May 19, 1936. S. M. ANDERSON 2,041,039

COMBINED HEATING AND COOLING SYSTEM

Filed Jan. 31, 1934 2 Sheets-Sheet 1

Fig. 1.

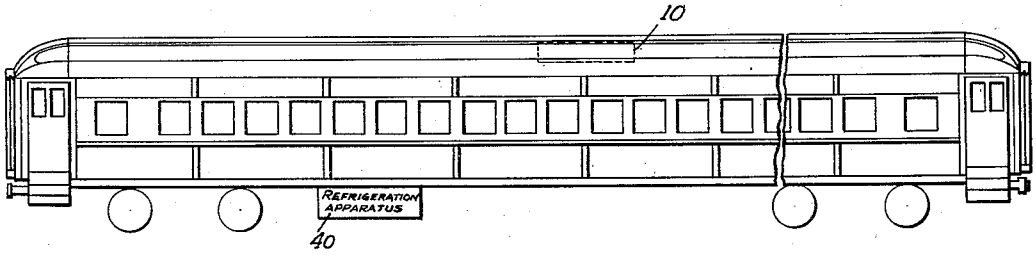

Fig. 2.

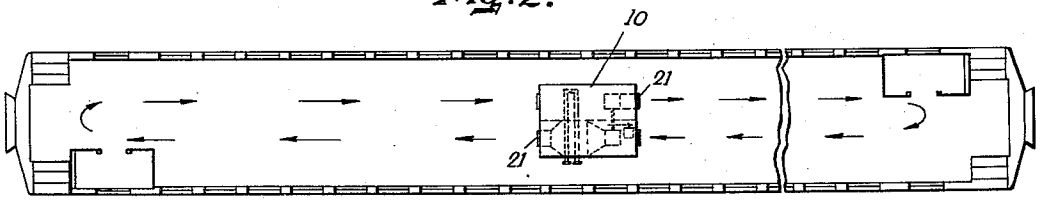

Fig. 3.

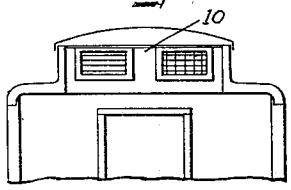

Fig. 4.

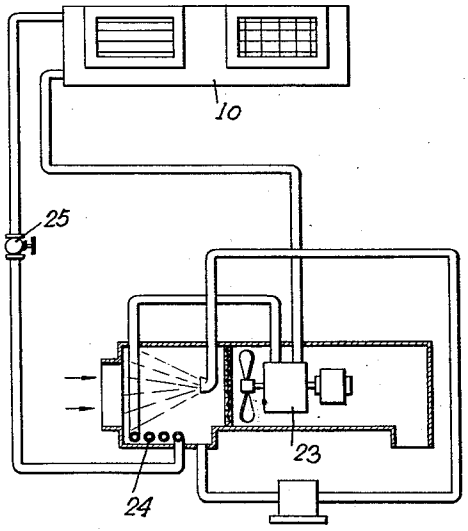

Fig. 5.

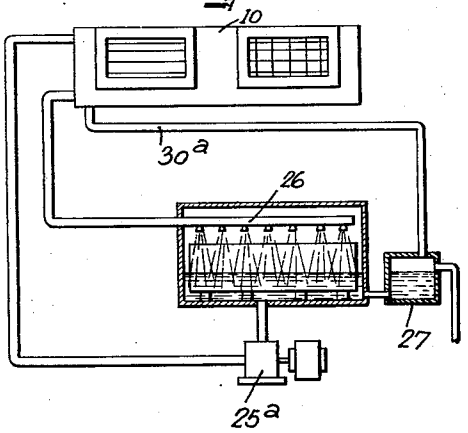

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Fig. 6.

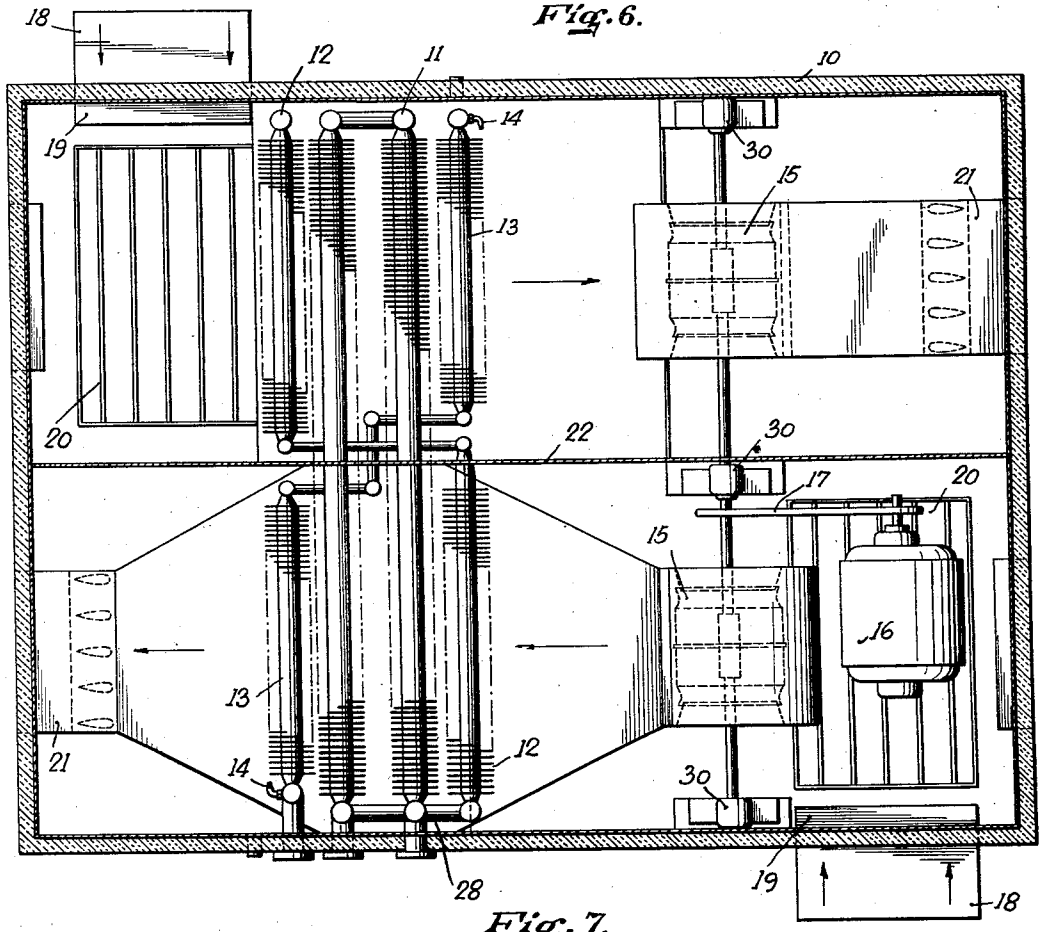
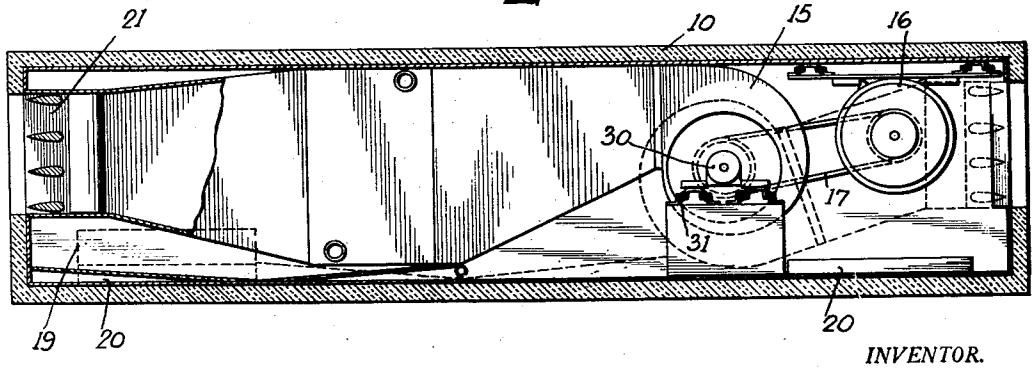


Fig. 7.



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COMBINED HEATING AND COOLING SYSTEM

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10 Claims. (Cl. 257—7)

This invention relates to the conditioning of air for passenger vehicles and relates more particularly to the conditioning of air circulated through railway cars.

It is now becoming well known that human comfort requires that the air within an enclosure should be not only circulated to provide sufficient ventilation, but should in winter be warmed, with moisture added to maintain the proper relative humidity and in summer should be cooled, and moisture extracted from it to overcome the excessive humidity which is usually present.

While the conditioning of air for motion picture theaters, hotel, office and industrial buildings has been developed to a high degree in recent years, the air conditioning of vehicles, and particularly railway cars, has been more or less neglected, due, perhaps, to the peculiar problems involved and the many difficulties present. Among the difficulties which present themselves are the lack of space in a railway car which already of necessity has had to accommodate the maximum of equipment in the minimum of space, the excessive refrigeration equipment which would have to be carried if the ordinary method of conditioning buildings were followed, the changing temperature conditions through which a railway car must pass, the cost of the equipment, and other difficulties.

According to a feature of this invention, an air conditioning system in which the conditioned air is distributed without ducts, is provided. The air conditioning chamber is mounted in the center of the car, or other space being served, and the conditioned air is discharged towards each end of the car from the center. The air is discharged from the chamber in two loop circuits, overhead the passenger space. The air passes down along one side of the car and overhead the passenger space and is returned to the chamber down along the other side of the car and overhead the passenger space from each of the two sides of the chamber, the chamber thus serving to supply air without ducts from a central location to the two halves of the car. Outside and recirculated air is drawn into the chamber, filtered, temperature conditioned, and discharged. In summer, the air is cooled and dehumidified, and, in winter, the air is heated and humidified.

According to another feature of the invention, the air conditioning chamber has all the necessary apparatus assembled within it as an insulated unit which may be easily bolted to the car roof without any material or substantial change of the car structure.

According to another feature of the invention, the air conditioning chamber is provided with filters which may be easily inserted and removed from the under side of the chamber.

According to another feature of the invention, the compartment is supplied with cold water from the ice cooling system and pre-cooling coils are provided in the path of mixed outside and recirculated air, the warmest ice water being fed through the pre-cooling coils which extract all of the heat possible from the air being conditioned.

According to another feature of the invention, both heating and cooling coils are provided in a single air conditioning compartment and the heating coils are provided on the discharge side of the cooling coils.

According to another feature of the invention, the fan passing the air through the air conditioning chamber is provided with ball bearings which are mounted on rubber so that the noise originating in the bearings is completely absorbed at the point of origin.

An object of this invention is to supply conditioned air from a centrally located air conditioning unit without air distribution ducts.

Another object of the invention is to provide air conditioning apparatus in a compact insulated compartment which can be easily mounted in the space to be served.

Another object of the invention is to provide pre-cooling coils in an ice cooling system in the path of the mixed recirculated and outside air to be conditioned.

Other objects of the invention will be apparent from the following description taken with the drawings.

The invention will now be described with reference to the drawings, of which:

Fig. 1 is a side view of a railway car equipped according to the present invention;

Fig. 2 is a plan view, with top removed, of the car and apparatus of Fig. 1;

Fig. 3 is a view looking into the car of Figs. 1 and 2 from one end, with end removed;

Fig. 4 is a diagrammatic view showing a mechanical refrigeration system for cooling the air;

Fig. 5 is a diagrammatic view showing an ice cooling system for cooling the air;

Fig. 6 is a sectional plan view showing the apparatus in an air conditioning chamber of this invention, and

Fig. 7 is a side sectional view of the compartment shown by Fig. 6.

The air conditioning compartment shown by Fig. 6 comprises an insulating casing 10 which ex-

tends completely around the sides of the compartment. The compartment contains the extended surface main cooling coils 11, the pre-cooling coils 12, the steam heating coils 13, the steam humidifiers 14, the fans 15, which are driven by motor 16 through the intermediary of the belt 17, the outside air inlets 18, the filters 19 mounted within the inlets 18 on the inside of the compartment, the recirculated air inlets 20, and the discharge outlets 21.

The cooling compartment is thus seen to have two recirculated air inlets and two discharge outlets. The compartment is divided into two units by the partition 22 so that the air drawn in by one of the fans 15 enters through one of the outside air inlets 18, one of the recirculated air inlets 20, passes first over one of the precooling coils 12, then over half of the cooling coils 11, then over the steam coil 13, and out one of the discharge outlets 21. It is seen that two complete units, each serving half of the car with conditioned air, are provided in a single compact and efficient compartment requiring a minimum of apparatus due to the fact that much of the apparatus is common to the two units.

The air is discharged, as shown by Figs. 1 and 2, overhead the passenger space and down along one side of the car and is returned overhead the passenger space and down along the other side of the car. It has been found that this arrangement is particularly suitable for the supply of cold and dehumidified air in hot weather. In order to dehumidify the air sufficiently, it is usually necessary to cool it to a very low dew point, at which the temperature of the cold air is too low for comfort. But, with the present arrangement, this highly cooled air does not enter directly the area occupied by passengers. Air is circulated completely above the passenger space and, by the action of gravity, the cold air gradually diffuses down from the level at which it is discharged from the cooling compartment, and, before entering the area occupied by passengers, contacts, intimately with the warm air above the passenger space and so has sufficient superheat added to it that by the time the conditioned air reaches the passengers it has a temperature which is not too cold for comfort.

The necessary cooling effect may be supplied by a mechanical refrigeration system, such as shown by Fig. 4, as where a compressor 23 compresses any suitable refrigerant, such, for example, as freon, which then passes through the condenser coils 24, which may be cooled in the cooling tower arrangement illustrated, the refrigerant then passing through the expansion valve 25 to expand in the cooling coils 11.

Alternatively, an ice cooling system may be used such as that illustrated by Fig. 5. In this case, ice water is circulated through the cooling coils 11 by the pump 25a, the returned water being sprayed through the spray nozzles 26 on the ice surface so as to remove, by the melting of the ice, the heat units in the water. In order to prevent the excess water caused by the melting of the ice from being discharged to the tracks at too low a temperature, a portion of the relatively warm water leaving the cooling coils 11 is passed at the junction point 28 (Fig. 6) through the two pre-cooling coils 12, one of which is mounted in each of the two air conditioning units included within the cooling compartment 10. The amount of water passing through the pre-cooling coils 12 is preferably equal to that which would ordinarily be excess water, caused by the melting of the ice, and ordinarily drained to the tracks. This water serves to additionally cool the air and then is discharged from the cooling coils 12, through the pipe 30a, to the compartment 27, from which it is drained to the tracks.

It has been the practice in the past to mount pre-cooling coils, such as coils 12, in the outside air inlets. The advantages of mounting coils in the path of the mixed outside and recirculated air are that less power is required to move the air over the coils to obtain the same heat transfer. Usually the larger part of the conditioned air is recirculated air, while a minor portion is outside air. To obtain sufficient heat transfer from a pre-cooler used to cool the small volume of outside air requires more surface in a smaller area with higher resistance than where the pre-cooler is mounted in the path of the mixed air, where, due to the larger volume, less surface is required. Also from the design engineering standpoint, it is preferable that all of the heat exchange surfaces be arranged within the main cooling compartment where more space is available.

In winter operation, steam from the ordinary steam source is passed through the steam coils 13 and the humidifiers 14. In the past, it has been the practice, where separate heat exchange surfaces were provided for heating and for cooling, to place the heating coils between the air intake and the cooling coils. It has been found, however that when the heated air is passed over coils formerly used for cooling, unpleasant odors where introduced into the passenger space, this believed to be due to the presence of vegetable organisms deposited on the surfaces of the cooling coils by the precipitation of moisture during dehumidification, the heating of these organisms causing unpleasant odors. By placing the heating coils after the cooling coils, any organisms or coatings on the surfaces of the cooling coils are not heated and the unpleasant odors are avoided.

The filters 19, which are mounted in the fresh air inlets 18, just within the compartment 10, may be easily removed or inserted into place from the under side of the compartment.

The bearings 30, which support the rotors of the fans 15, are roller bearings and are mounted, as shown by Fig. 7, on the rubber mountings 31. It has been found that these mountings absorb the noise and any other vibration resulting from the roller bearings.

As shown by Fig. 1, the refrigeration apparatus, whether it be of mechanical type, as shown by Fig. 4, or of the ice type, as shown by Fig. 5, may be mounted in a compact unit 40, bolted on the under side of the car, and the air conditioning compartment 10 is a compact unit which may be mounted without any substantial alteration of the car roof. With the refrigeration unit and air conditioning compartment in place, only a slight amount of installation work is required to provide the necessary electric wiring for energizing the fan, pump and compressor motors from the car storage battery and/or from an axle driven generator, and to provide the necessary piping between the refrigeration unit and the air conditioning unit.

Whereas the invention has been described in connection with the conditioning of air supplied to passengers within a railway car, it should be understood that the invention is also applicable to any other enclosure to which it is desired to supply conditioned air.

Whereas one embodiment of the invention has been described for the purpose of illustration, it

should be understood that the invention is not limited to the details described, since many modifications may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. Air conditioning apparatus for a passenger vehicle, comprising a conditioning compartment located substantially in the center of the vehicle and in the roof zone thereof, completely above the useful passenger space, means in said compartment for cooling the air passing therethrough, and means for passing air through one side of said compartment where it is cooled and down along one side of the vehicle above the passenger space, and for returning the air through the other side of said compartment where it is again cooled and then down along the other side of the vehicle and above the passenger space.

2. Air conditioning apparatus for a passenger vehicle, comprising a conditioning compartment located substantially in the center of the vehicle and in the roof zone thereof, completely above the useful passenger space, means in said compartment for alternatively heating or cooling the air as desired, and means for passing air through one side of said compartment where it is cooled and down along one side of the vehicle above the passenger space, and for returning the air through the other side of said compartment where it is again cooled and then down along the other side of the vehicle and above the passenger space.

3. The method of conditioning air, which comprises locating a conditioning unit substantially in the center of and overhead the space to be served, conditioning air in said unit, discharging conditioned air from one side of said unit down along one side of and overhead the space to be served, returning recirculated air to said one side of said unit down along the other side and overhead the space to be served, discharging conditioned air from the opposite side of said unit down along one side of and overhead the space to be served, and returning recirculated air to said opposite side of said unit down along the other side of and above the space to be served.

4. Air conditioning apparatus for a passenger vehicle, comprising a conditioning compartment located substantially in the center of the vehicle and in the roof zone thereof, completely above the useful passenger space, means in said compartment for conditioning the air passing therethrough, a recirculated air inlet in said compartment and located adjacent one longitudinal side of said vehicle, a discharge outlet in said compartment and located adjacent the other longitudinal side of said vehicle, a second recirculated air inlet in said compartment and located adjacent said other longitudinal side of said vehicle, a discharge outlet in said compartment and located to the other side of the center of the vehicle from that occupied by said second recirculated air inlet, and means for drawing air in through said inlets, passing it in through said compartment, and passing it out through said outlets.

5. Heat exchange apparatus for a railway passenger car comprising an air conditioning unit mounted in the roof zone of and substantially midway between the two ends of said car, a plurality of heat exchange coils extending crosswise said unit and in contact with the air passing therethrough, a longitudinal partition dividing said unit into two compartments and said coils into two sections, a discharge outlet in one of said compartments at one end of said unit, a discharge outlet in the other of said compartments at the other end of said unit, a recirculated air inlet in each of said compartments arranged at the other end of said unit from the outlet thereof and communicating with the passenger space of said car, a blower in each of said compartments, and a motor in one of said compartments for rotating said blowers, said blowers indrawing recirculated air from the passenger space in opposite directions through said inlets and discharging conditioned air into the passenger space in opposite directions from said outlets.

6. Heat exchange apparatus for a railway passenger car comprising an air conditioning unit mounted in the roof zone of and substantially midway between the two ends of said car, a plurality of heat exchange coils extending crosswise said unit and in contact with the air passing therethrough, a longitudinal partition dividing said unit into two compartments and said coils into two sections, a discharge outlet in one of said compartments at one end of said unit, a discharge outlet in the other of said compartments at the other end of said unit, a recirculated air inlet in each of said compartments arranged at the other end of said unit from the outlet thereof and communicating with the passenger space of said car, and means for indrawing air into said compartments, through said inlets, and discharging it from said outlets, said unit indrawing recirculated air from the passenger space in opposite directions through said inlets and discharging conditioned air into the passenger space in opposite directions through said outlets.

7. Heat exchange apparatus for a railway passenger car comprising an air conditioning unit mounted in the roof zone of and substantially midway between the two ends of said car, a partition dividing said unit into two compartments, means in each of said compartments for alternatively heating or cooling the air passing therethrough, a discharge outlet in one of said compartments at one end of said unit, a discharge outlet in the other of said compartments at the other end of said unit, a recirculated air inlet in each of said compartments arranged at the other end of said unit from the outlet thereof and communicating with the passenger space of said car, and means for indrawing air into said compartments, through said inlets, and discharging it from said outlets, said unit indrawing decirculated air from the passenger space in opposite directions through said inlets and discharging conditioned air into the passenger space in opposite directions through said outlets.

8. Heat exchange apparatus for a railway passenger car, comprising an air conditioning unit located substantially in the center and in the roof zone of said car, a partition dividing said unit into two compartments, means in each of said compartments for alternatively heating or cooling the air passing therethrough, a discharge outlet in one of said compartments, at one end of said unit and adjacent one longitudinal side of said car, a discharge outlet in the other of said compartments, at the other end of said unit and adjacent the other longitudinal side of said car, a recirculated air inlet in each of said compartments arranged at the other end of said unit from the outlet thereof, and means for indrawing air into said compartments, through said inlets, and discharging it from said outlets, said unit indrawing recirculated air in opposte direc-

tions through said inlets and discharging conditioned air in opposite directions through said outlets.

9. Heat exchange apparatus for a railway passenger car, comprising an air conditioning unit mounted in the roof zone of said car, extended surface heating coils in said compartment adapted to receive a heating medium, a humidifier in said compartment for moistening the heated air, extended surface cooling coils in said compartment adapted to receive a refrigerant, a discharge outlet at one end of said unit and adjacent one of the longitudinal sides of said car, a recirculated air inlet at said end of said unit and adjacent the other longitudinal side of said car, and means for discharging conditioned air from said unit through said outlet in an unconfined stream down along one side of said car and overhead the space being served, and for indrawing said conditioned air as recirculated air in an unconfined stream down along the other side of the car and overhead the space being served, and into said inlet.

10. Heat exchange apparatus for a railway passenger car, comprising an air conditioning unit located substantially halfway between the two ends and in the roof zone of said car, heat exchange means in said unit, means for indrawing recirculated air into said unit from both ends of said car and for passing it in contact with said heat exchange means for conditioning, means for discharging a portion of the conditioned air from one end of said compartment down along one longitudinal side of said car and overhead the passenger space thereof to serve the passenger space of one half of the car, and means for discharging the remainder of the conditioned air from the other end of said unit down along the other longitudinal side of said car and overhead the passenger space thereof to serve the passenger space in the other half of said car.

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