

Jan. 25, 1938.

E. WANAMAKER

2,106,515

AIR CONDITIONING SYSTEM

Filed July 21, 1936

3 Sheets-Sheet 1

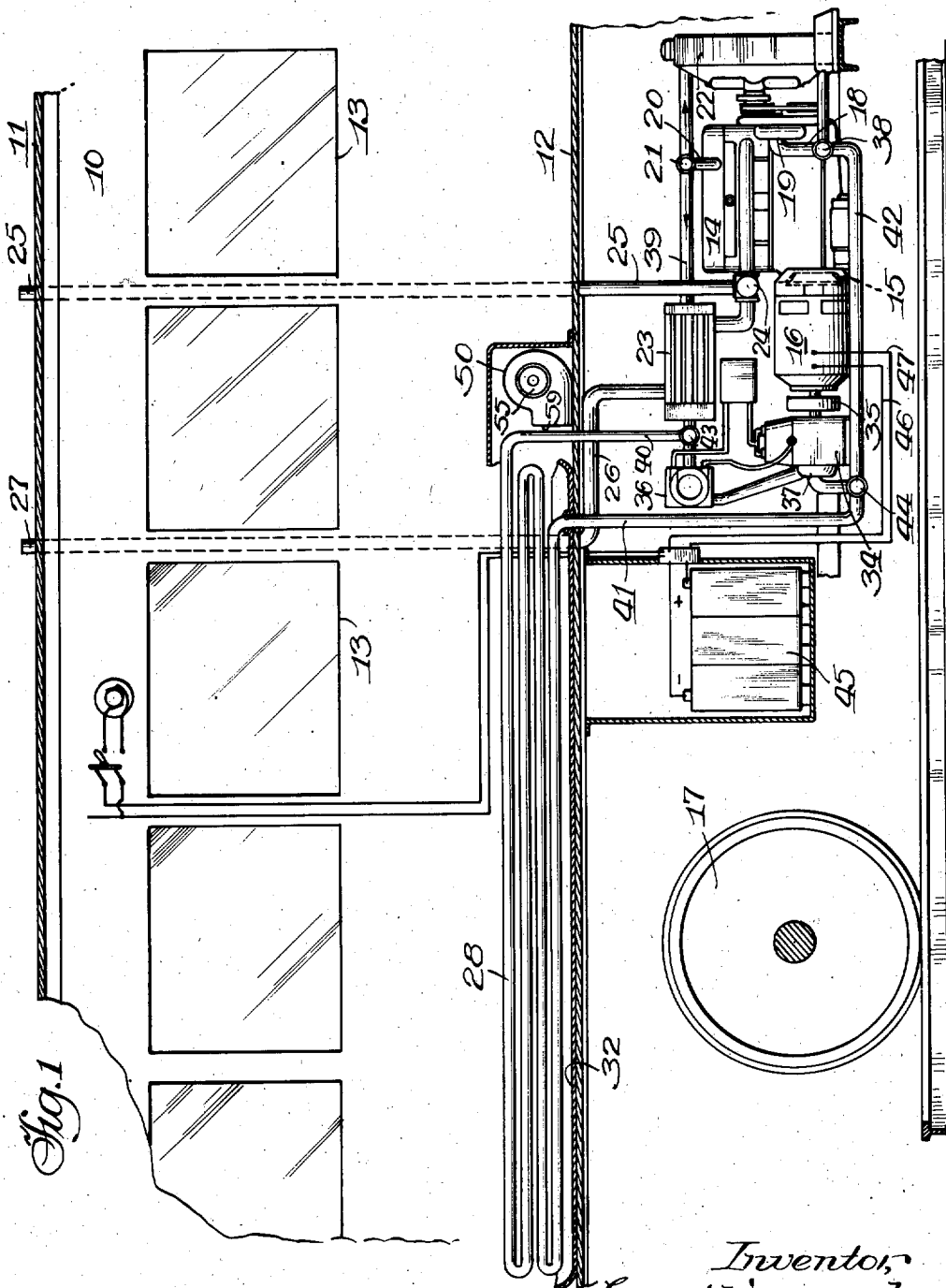


Fig. 1

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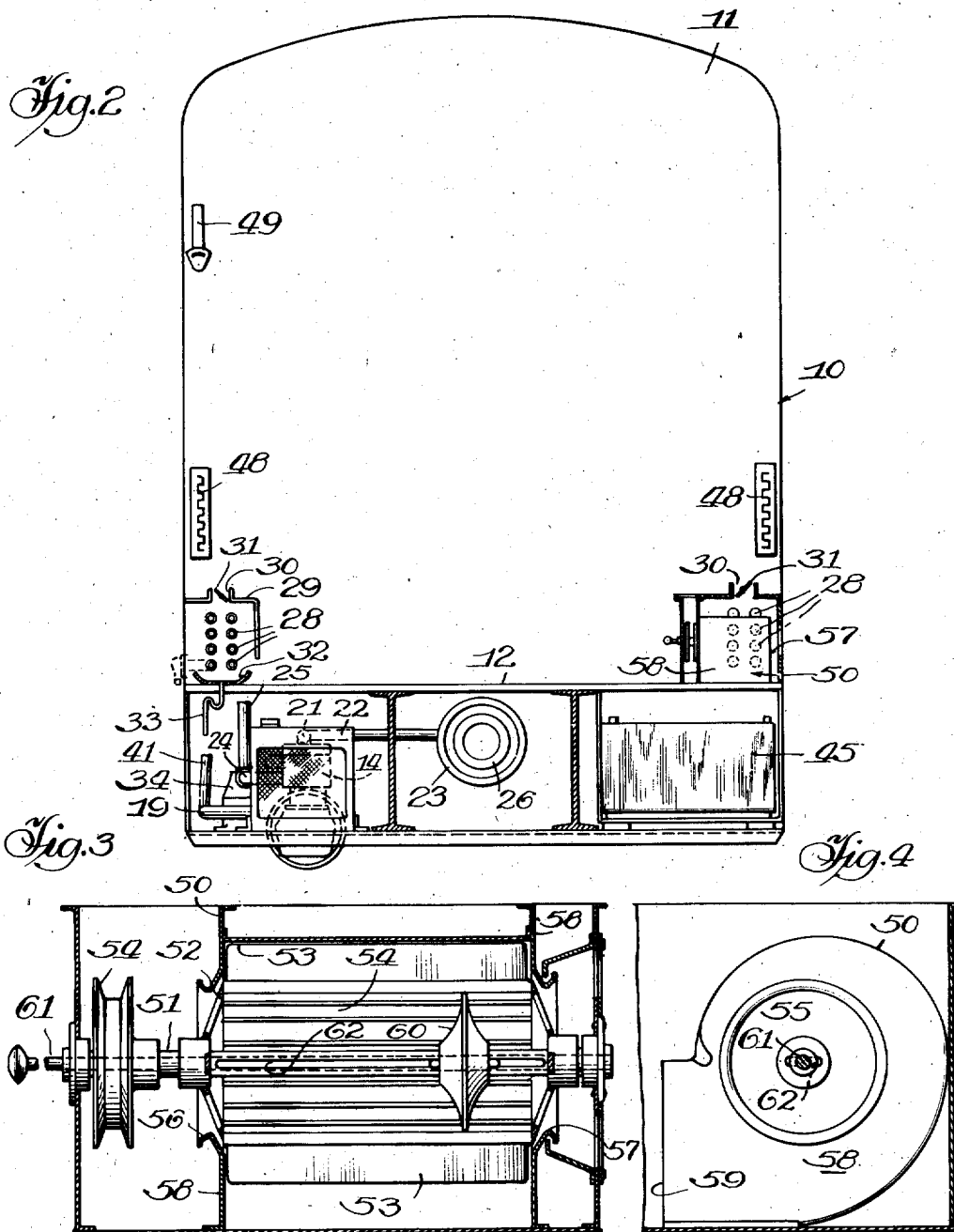
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3 Sheets-Sheet 2



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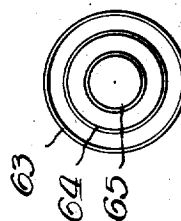
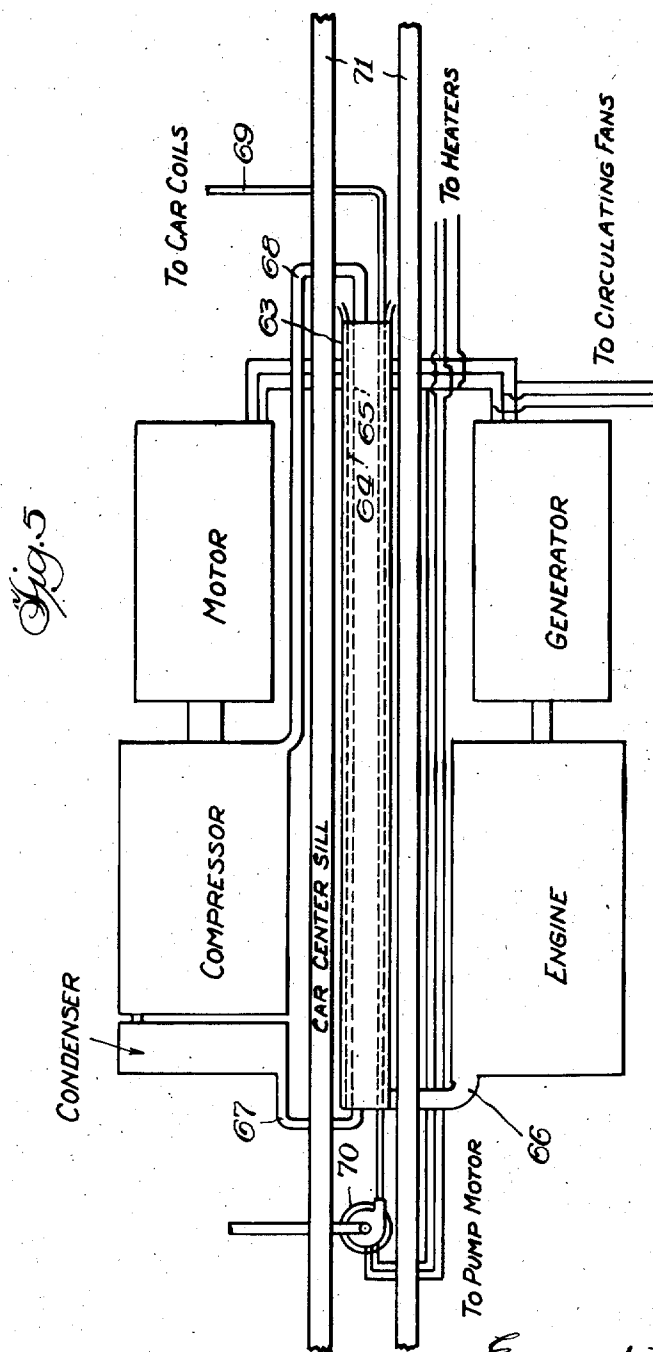
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,106,515

AIR CONDITIONING SYSTEM

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Application July 21, 1936, Serial No. 91,733

10 Claims. (Cl. 257-7)

This invention relates to an air conditioning system, and more particularly to a system in which the power is supplied by an internal combustion engine. An important commercial embodiment of the invention is an automatic Diesel-electric air conditioning unit for heating, cooling and regulating humidity, and otherwise controlling the air in railway cars, homes, offices, stores, shops, laboratories, ships, etc., and at the same time furnishing electric current for light and power.

One feature of this invention is that it affords simple and economical means either for heating or cooling a room, vehicle, or other enclosure; another feature is the utilization of the heat of combustion developed in the engine; a further feature is the method of control of the humidity of the air; yet another feature is that it provides additional cooling means for the internal combustion driving engine; an additional feature is that it permits fresh air and recirculated air to be mixed in the desired proportions. Further features and advantages of the invention will be apparent from the following specification and drawings in which:

Figure 1 is a side elevation, partly in section and somewhat diagrammatic, of a portion of railway car having one form of the novel air conditioning system installed therein; Fig. 2 is a vertical transverse sectional view of the car; Fig. 3 is a vertical sectional view of the blower; Fig. 4 is a side elevation of the same blower; Fig. 5 is a diagram of a modified arrangement of the mechanical parts on a railway car; and Fig. 6 is a section on a larger scale, of a heat exchanger.

The wide spread public demand for air conditioning has made it desirable to install air conditioning systems in the railway cars now being developed or in those already in service. The method disclosed herein uses the heat of combustion of a Diesel engine, either the driving motor of the car or an independent unit, to heat the car, transferring the heat from the engine and exhaust to the heating coils in the car by a liquid heat transfer medium. The engine is used to drive a generator and a refrigerating or cooling apparatus, and when desired the liquid heat transfer medium is circulated through the cooling apparatus rather than through the engine. In this latter case a radiator provides an auxiliary flow circuit for dispersing the heat of the Diesel engine in the usual manner. Also, the heat transfer medium furnishes a means for the storage of heat.

In the particular embodiment of the invention disclosed herein a railway car 10 is shown having a roof 11, floor 12, and windows 13. Immediately beneath the floor of the car a Diesel engine 14 is mounted, which engine is directly connected through a clutch 15 to a generator 16 adapted to furnish current to the motors driving the wheels of the car, as 17.

The Diesel engine is provided with the usual water jacket having an inlet pipe 18 thereto, with a circulating pump 19 and an outlet pipe 20 communicating with a two way valve 21 adapted to direct the water either through a radiator 22 or the heat exchanger 23, hereinafter explained. The exhaust from the engine passes through one of two paths in accordance with the setting of the valve 24. One path is directly up the exhaust pipe 25 extending through the roof 11 of the car; the other path is through the outer ring of the heat exchanger 23, then through the pipe 26 and up the exhaust pipe 27 to exhaust above the roof of the car.

In order to heat the car in cold weather and to cool it in warm weather, said car has mounted therein heat transfer means here shown as water pipes 28. These pipes are mounted adjacent the outer walls of the car on each side thereof, and are adapted to pass under the seats. They are surrounded by a housing or enclosure 29 having openings 30 therethrough at intervals, controlled by the manually operable valves 31. Beneath the pipes or heat transfer means 28 is a humidity controlling means here shown as a shallow pan 32 adapted to contain water. When the car is being cooled, moisture condensing on the pipes 28 drops into the pan 32 from which it may be drawn, as by the pipe 33; when the car is being heated, water may be supplied to the pan 32 by any convenient means, so that evaporation will maintain the moisture content of the air at the desired humidity.

In order to cool the medium circulated through the heat transfer means 28, a compressor 34 is provided, which may be directly connected to the generator 16 by the clutch 35. This compressor unit is operatively connected to a cooling means or expansion coil 36, in which the refrigerant is allowed to expand and absorb heat from the liquid heat transfer medium. A pump 37 connected to the compressor 34 is used to circulate the liquid medium through the cooling means 36.

When it is desired to heat the car, the valve 24 is set so that the exhaust passes through the heat exchanger 23; and valves 21 and 38 are set

to block communication with the radiator 22 and permit the liquid circulating through the engine 14 to pass along the pipe 39, through the heat exchanger 23, up the pipe 40, through the heat transfer means 28 in the car, and back through the pipes 41 and 42 to the circulating pump 19 and the cooling jacket of the engine. When this flow circuit is in use the valves 43 and 44 are set to prevent the flow of the liquid through the cooling means 36 and the compressor 34 is disconnected from its driving means by the clutch 35. When it is desired to cool the car, the valve 24 is adjusted to permit the exhaust gases from the engine to pass directly up the exhaust pipe 25; valves 44 and 43 are changed so that circulation from the heat transfer means 28 is through the pump 37 and cooling means 36 and the pipe 40; and valves 21 and 38 are adjusted so that the heat of the engine is dissipated by the radiator 22 in the usual manner. Thus when the cooling operation takes place there are two distinct flow circuits operative, the first through the cooling means to cool the car and the other through the radiator to cool the engine.

25 The car is shown as provided with one or more batteries 45 connected by the wires 46 and 47 to the generator 16. These batteries may be used to start the Diesel engine, or for auxiliary lighting, ventilating and heating or other purposes when the engine is not running. The car is provided with electrical heating units 48 mounted on the walls thereof, which may be supplied with current when desired, as when the main heat transfer means is not being used. The car is also equipped with one or more thermostats 49 which may be used to control the operation of the various valves automatically, if desired.

In order to keep the air within the car in circulation and to dissipate the heat from the heat transfer means 28, a centrifugal blower 50 is here shown as mounted near one end of the housing 29 and adapted to blow air around the pipes 28. This blower has two inlets, one being within the car and the other opening to the outside of the car. In this way air from within the car may be drawn into the blower and recirculated; and fresh air from the outside of the car may be brought in and circulated over the heat transfer means. Referring more particularly to Figs. 3 and 4 it will be seen that the centrifugal blower 50 has mounted therein on a tubular shaft 51, an impeller 52 having vanes 53. The shaft 51 is provided with means for rotating the impeller, here shown as a pulley 54 adapted to be belt driven from any desired motor means. The impeller has extending completely therethrough axially thereof an opening 55 connecting at each end with inlet openings 56 and 57 in the housing 58. The inlet opening 57 draws fresh air from without the car; and the inlet opening 56 recirculates air drawn from within the car; the delivery of the blower is through the peripheral outlet opening 59. Within the axial opening in the impeller and extending substantially completely thereacross is a disk 60 mounted on a rod 61 within the tubular shaft 51. Connection between the rod 61 and the disk 60 is through a longitudinal slot 62 in the shaft 51. Through movement of the rod 61 the disk 60 may be positioned at any desired point within the axial opening in the impeller. When this disk is substantially centrally located practically equal amounts of air will be drawn from within and without the car; when the disk is close to the inlet opening 57 the major portion of the air will be recirculated

from within the car and only a small amount of fresh air will be drawn in through the inlet opening 57; and when the disk 60 is close to the inlet 56 the major portion of the air drawn in will be fresh air from without the car. It is thus seen that the position of the disk 60, whether manually or automatically set, controls the proportion of recirculated air to fresh air. This enables very good control of both temperature and humidity conditions, since if the heating capacity of the system, for example, cannot raise cold outer air to the desired temperature, only a small amount of fresh air would be drawn in and a large portion of air from within recirculated. Control of the portion of fresh air admitted thus enables an air conditioning system of small capacity to maintain a desired temperature within the car regardless of outdoor conditions. Suitable means may also be provided for washing the air to remove dust, odors, etc.

Where it is desired to substantially balance the weight on opposite sides of the car, the Diesel engine and direct connected generator are mounted on one side of the car, preferably beneath the floor, and the compressor and direct connected motor therefor are mounted on the opposite side beneath said car, with the heat exchanger centrally located between the two groups. In other words, a motor drive is provided for the compressor instead of the direct mechanical drive illustrated in Fig. 1. This arrangement is illustrated somewhat diagrammatically in Fig. 5. Fig. 6 is a section of the heat exchanger used in the embodiment shown in Fig. 5. It consists essentially of three concentric shells 63, 64 and 65. The space between the two outer shells constitutes a conduit for the exhaust gases from the engine. The middle annular space contains the water which flows through the heating and cooling coils in the car and the inner space constitutes the expansion chamber for the refrigerant. Thus the water jacket has heating means on one side of it and cooling means on the other side of it, the drawings showing the exhaust gases as surrounding the container for the water, and the refrigerating medium in the inner of the three concentric passages.

The exhaust gases are conducted from the engine to the heat exchanger through a conduit 66. The refrigerant is led from the condenser through a conduit 67 to the inner chamber in which it expands and is drawn off through the conduit 68 and returned to the compressor. The water jacket has a pipe 69 leading to the heating and cooling coils and is also connected to a suitable pump 70 to aid in circulating the water, said pump being driven by a suitable motor, preferably electric. The heat exchanger is mounted between the girders 71.

The flexibility and usefulness of a system of this type will be readily apparent. For example, in a railway passenger car frequently hauled in freight trains or left on sidings for temporary office facilities, the usual heating has been by means of an ordinary coal fired hot water system, arranged with a steam heat exchanger coil so that the water in the heating system can also be heated with steam from a locomotive or from a plant in the yards or terminals. Such a system can be readily supplanted by one of the type illustrated and described herein, using a 30 horse power Diesel engine and an electric generator of about that capacity. In very cold weather not only will the heat from the engine exhaust be used to heat the car, but about 25 horse power of

electric energy from the generator can be dispersed from the electric heating units as 48, in the car. The remainder of the power will be absorbed in circulating water, driving the blower, and the like. As the outside temperature moderates, of course, less electric energy would have to be used for heat. As the temperature outside rises above the desired point the system would be switched, either manually or automatically, so that the heat transfer means would be cooled to cool the interior of the car. Normally this heat transfer medium circulating in the pipes 28 is water, with some common commercial anti-freeze substance therein. A unit of this type is sufficiently small so that it can be installed in the usual ice box space of an ice activated air conditioned car.

This system is particularly adapted for ready connection to station or terminal outlets, in that the heat exchanger can be used with steam to heat the water, and commercial electrical current can be used either to heat the car through the electrical heating units or, where the compressor is driven by a separate electric motor, to operate the cooling system. Water or other heat transfer means has sufficient specific heat to provide considerable heat storage, so that where less than the maximum heating is needed, the engine can be run to operate both the heat exchanger and the electrical heating units and then shut down, or where the water has been heated from some other source, the circulation of the heated water may continue in either case, and supply sufficient heat to maintain the desired temperature for a considerable time.

Control of the various valves and other operating mechanisms described may be either manual or by means of thermostats and automatic devices controlled thereby. Thus, if desired, automatic regulation may be had of the rate of circulation of the cooling medium, the rate of air circulation over the coils 28, the proportion of fresh air to recirculated air, the amount of air passed through the openings 30, the heat taken by the exhaust, and other factors. In fact, the system may be made automatic in its selection and use of heat (or so-called cold) from whatever source is most available and economical.

The foregoing detailed description has been given to illustrate certain uses of the invention, and no unnecessary limitations should be understood therefrom. Certain features may be used without others, and various other combinations of the apparatus and parts thereof may be employed within the scope of said invention.

I claim:

1. Air conditioning apparatus of the character described for a vehicle having an internal combustion engine, including: heat transfer means in said car, said means being adapted to have a heat transfer medium flow therethrough; a heat exchanger adapted to have the exhaust gases of said engine pass therethrough; a flow circuit for said medium including said engine, said heat exchanger, and said heat transfer means, whereby said car is heated and said engine cooled; cooling means; a second flow circuit for said medium including said heat transfer means and said cooling means whereby said car is cooled; selective means for rendering either of said flow circuits operative; a radiator for cooling said engine, and means for establishing communication between said engine and said radiator when said second circuit is operative, and for cutting off such com-

munication when said first flow circuit is operative.

2. Air conditioning apparatus of the character described for a railway car driven by an internal combustion engine, including: heat transfer means in said car, said means being adapted to have a heat transfer medium flow therethrough; a heat exchanger adapted to have the exhaust gases of said engine pass therethrough; a flow circuit for said medium including said engine, said heat exchanger, and said heat transfer means, whereby said car is heated and said engine cooled; cooling means; a second flow circuit for said medium including said heat transfer means and said cooling means whereby said car is cooled; selective means for rendering either of said flow circuits operative; a radiator for cooling said engine, a third flow circuit including said engine and said radiator, selective means for rendering said third flow circuit operative only when said second circuit is operative; and a blower for circulating air around said heat transfer means in said car.

3. Apparatus of the character claimed in claim 2 wherein said blower has two inlets, one opening within said car and the other without said car.

4. Apparatus of the character claimed in claim 2, including means for regulating the humidity in said car.

5. Air conditioning apparatus of the character described for a railway car driven by a liquid cooled internal combustion engine, including: heat transfer means in said car, said means being adapted to have said liquid flow therethrough as a heat transfer medium; a heat exchanger adapted to have the exhaust gases of said engine pass therethrough to heat said liquid; a pump; pipes connecting said engine, pump, heat exchanger, and heat transfer means, whereby said liquid is circulated therethrough to heat said car from the exhaust gases and the engine cooling liquid as joint sources of heat; cooling means; valve means connecting said cooling means to said heat transfer means, whereby said liquid is circulated through said cooling means to cool said car; and radiator means for cooling said engine only when said car is being cooled.

6. Air conditioning apparatus of the character described for a railway car driven by an internal combustion engine, including: heat transfer means in said car, said means being adapted to have a liquid heat transfer medium flow therethrough; a heat exchanger adapted to have the exhaust gases of said engine pass therethrough; a radiator for the engine; cooling means; a pipe having a valve therein for selectively connecting said engine to said heat exchanger or to said radiator; pipes connecting said engine, heat exchanger, and heat transfer means in a flow circuit for said liquid, whereby said car may be heated; pipes connecting said heat transfer means and said cooling means in a second flow circuit, whereby said car may be cooled; selective valve means for rendering either of said flow circuits operative; and a third flow circuit including said radiator and said engine, whereby said engine may be cooled when said second flow cooling circuit is operative and said heating circuit is inoperative, and may furnish heat to said heating circuit when the latter is operative.

7. Apparatus of the character claimed in claim 6 including a blower adapted to circulate air around said heat transfer means, said blower having an inlet within said car and a second inlet without said car; and means for regulating the

proportion of air admitted to said blower through each inlet thereof.

8. Air conditioning apparatus of the character described for a railway car comprising an internal combustion engine and a direct connected generator beneath said car on one side of the center thereof, a compressor direct connected to a motor, both located on the other side of said car beneath the same, said motor being connected to and driven from said generator, a condenser for a refrigerant adjacent said compressor, a heat exchanger located beneath said car and connections therefrom to said engine, compressor and condenser near the center thereof, pipes for liquid heat transfer medium leading from said heat exchanger to the interior of said car to heat and cool the same.

9. Air conditioning apparatus comprising an internal combustion engine having a radiator, a heat exchanger through which the exhaust gases from said engine may pass, pipes connected to said engine and radiator and to said heat exchanger, containing a liquid heat transfer medium for warming the air adjacent said pipes, refrigerating apparatus operated by said engine

and to which said pipes are connected also, a container for water below said pipes to supply moisture for regulating the humidity of the air adjacent said pipes and to collect the condensate formed when said pipes are used for cooling the said adjacent air and said engine, and valves for rendering said refrigerating apparatus or said radiator effective at will, whereby the engine dissipates heat from said radiator only when said pipes are used for cooling.

10. Air conditioning apparatus of the character described, for a system having an internal combustion engine, including: heat transfer means for the space to be conditioned, said means being adapted to have a heat transfer medium flow therethrough; a heat exchanger comprising three concentric conduits, the middle one being connected to permit said heat transfer medium to flow therethrough, one of the other two conduits being connected to the exhaust of said engine and a refrigerating unit connected to the other of said conduits to permit a refrigerant to expand therein and cool said medium.

ERNEST WANAMAKER.

CERTIFICATE OF CORRECTION.

Patent No. 2,106,515.

January 25, 1938.

ERNEST WANAMAKER.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, first column, line 12, claim 8, strike out "and" and insert instead the words and comma near the center thereof;; line 14, same claim, strike out "near the center thereof" and after the comma and before "pipes" insert and; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 8th day of March, A. D. 1938.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.

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