

[54] **HEAT PUMP TYPE AIR CONDITIONING SYSTEMS**

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[22] Filed: **Sept. 6, 1972**

[21] Appl. No.: **286,545**

[30] **Foreign Application Priority Data**

Sept. 6, 1971 Japan 46/69105 (utility model)
Sept. 20, 1971 Japan 46/73684 (utility model)
Sept. 8, 1971 Japan 46/82036 (utility model)

[52] U.S. Cl. **62/324, 62/151, 62/160, 62/275, 62/276, 165/29**

[51] Int. Cl. **F25b 13/00**

[58] Field of Search. **62/160, 324, 151, 62/275, 276; 165/29**

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[57] **ABSTRACT**

A heat pump has a compressor, a discharge gas tube, a condenser, a receiver, an expansion valve, an evaporator, and a suction gas tube connected in series in the order named. The receiver is also connected to the discharge gas tube by a by-pass line including a liquid pump, a heat exchanger having an electric heater, and a control valve. At times, such as at low outdoor temperatures or at starting-up, with the control valve opened and simultaneously with the liquid pump actuated, a portion of the refrigerant liquid stored in the receiver is supplied into the heat exchanger where it is evaporated by heat from the electric heater. Hot evaporated refrigerant flows from the heat exchanger through the control valve into the discharge gas tube, and through the latter into the condenser. When condensed, the refrigerant gas releases the heat received from the heat exchanger, greatly increasing the heating effect.

16 Claims, 5 Drawing Figures

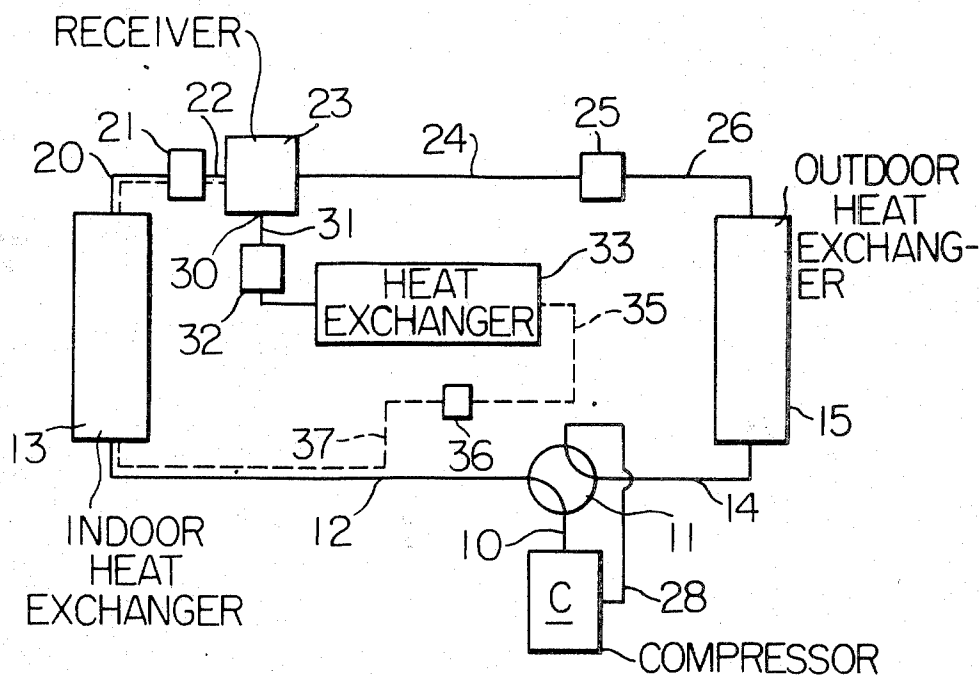


Fig. 1

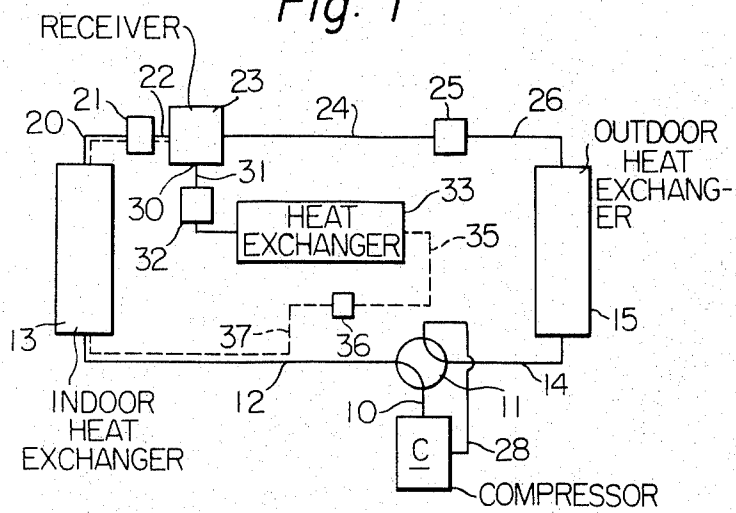


Fig. 2

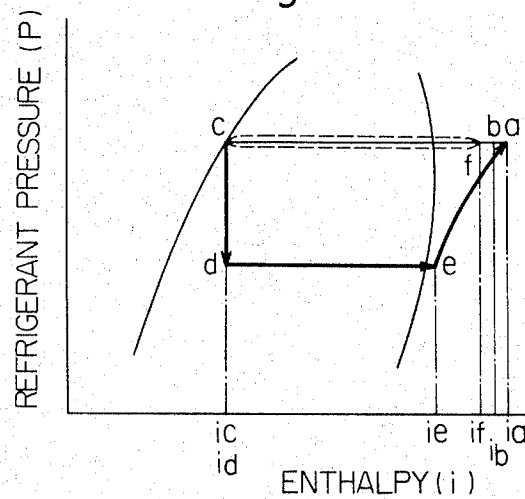


Fig. 3

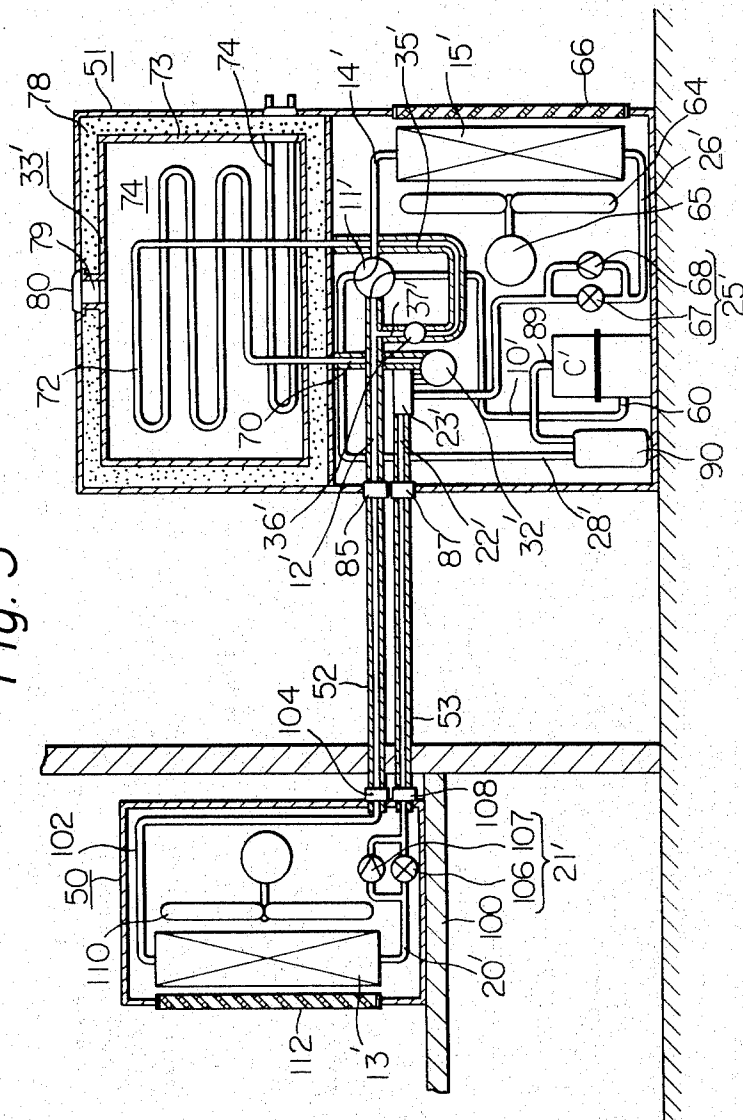


Fig. 4

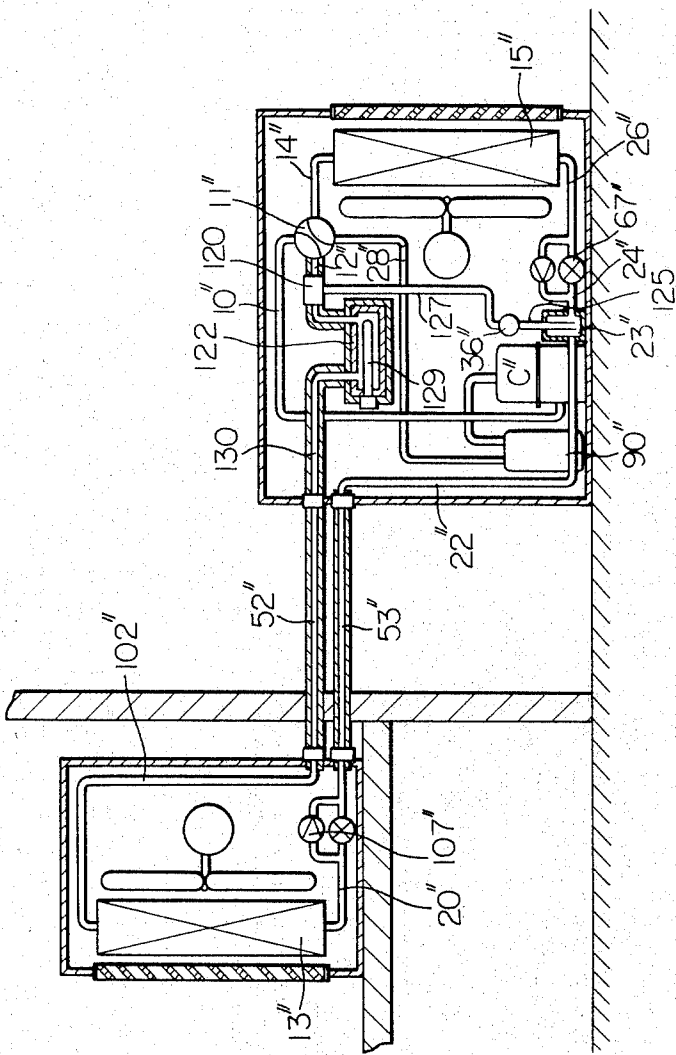
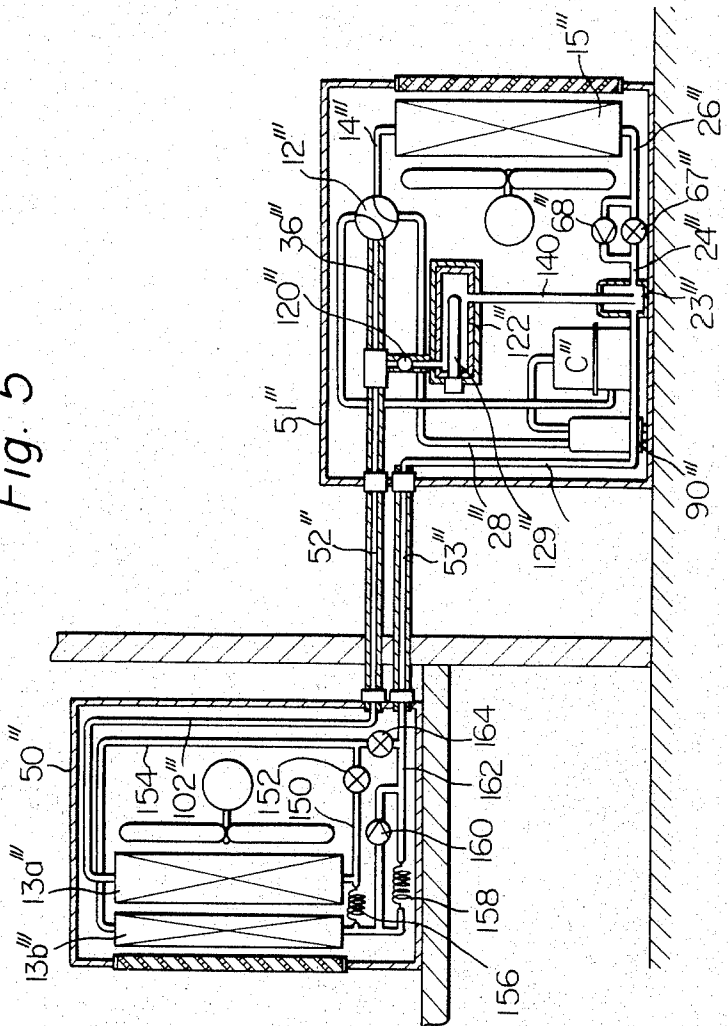


Fig. 5



HEAT PUMP TYPE AIR CONDITIONING SYSTEMS

FIELD OF THE INVENTION

The field of the invention is air conditioning systems of the heat pump type in which atmospheric air is utilized as a heat source. It is well known in the art that air conditioning systems of the heat pump type operate to transfer heat from outdoor air to an indoor heat exchanger operating as a condenser. In the systems of this type, however, at low outdoor temperatures the heating capacity becomes poor so that they cannot cope with the increased heating load. Another disadvantage of a heat pump type air conditioner is that the desired level of heating cannot be achieved quickly on start-up of the system.

Various well-known arrangements are available for obviating the above-mentioned disadvantages of the heat pump type air conditioning equipment. For example, one arrangement includes an electric heating device provided within the indoor heat exchanger unit to heat the air circulating therethrough. In another arrangement, the indoor heat exchanger comprises two separate coils between which is located an electric heater for heating the refrigerant flowing from the first coil to the second. A third arrangement also includes an electric heater located in the suction gas tube of a compressor so that the heat absorbed by the refrigerant gas is transferred to the indoor heat exchanger. A fourth arrangement includes a combined indoor unit of a heat pump type air conditioner and of the one in which hot water is circulated in the heat exchanger. However, these arrangements of the existing type raise many problems in the design and engineering thereof, especially in the location of electric heating, or have other deficiencies which exclude their adaptation from use in an air conditioning equipment of the present type.

SUMMARY OF THE INVENTION

The invention is embodied in an air conditioning system of the heat pump type having means for feeding a portion of the high pressure refrigerant liquid leaving an indoor heat exchanger back to the inlet thereof, and having means for heating the high pressure refrigerant liquid before entering the indoor heat exchanger.

An object of the present invention is to provide a by-pass line for feeding refrigerant liquid from a receiver to the line connecting the compressor discharge and the inlet of an indoor heat exchanger.

Another object of the present invention is to provide an electric heating means for heating the refrigerant liquid by-passed from a receiver before or after being mixed into the discharge gas flowing from the compressor.

A further object of the present invention is to provide an ejector means for introducing the refrigerant liquid by-passed from a receiver into the line connecting the compressor discharge and the inlet of an indoor heat exchanger.

A further object of the present invention is to provide an air conditioning system of the heat pump type that can perform a heating operation in a satisfactory manner regardless of ambient or load conditions.

A still further object of the present invention is to provide an air conditioning system of the heat pump type in which the desired level of heating can be achieved quickly on start-up of the system.

Still another object of the present invention is to provide an air conditioning system of the heat pump type in which "hot gas" defrosting is accomplished with increased efficiency through utilization of the heat of refrigerant liquid received from an electric heating means.

A still further object of the present invention is to provide an air conditioning system of the heat pump type characterized by its ability to operate as a dehumidifier as well.

These and still other objects and advantages of the present invention will become more apparent hereinafter.

FIG. 1 is a diagrammatic view of an air conditioning system according to the present invention;

FIG. 2 is a Mollier diagram for use in explaining the heating operation of the system shown in FIG. 1;

FIG. 3 is an illustration of a typical air conditioning system of the invention;

FIG. 4 is an illustration of another form of the invention; and

FIG. 5 is an illustration of still another form of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

Referring now to FIG. 1, a refrigerant compressor C is connected by a discharge gas tube 10 to a reversal valve 11 which is connected by a tube 12 to an indoor coil 13, and by a tube 14 to an outdoor coil 15. The reversal valve 11 is a four-way valve that is capable of selectively directing the flow of refrigerant to the outdoor coil 15 and the indoor coil 13 so as to set the system for cooling and heating operations, respectively. The indoor coil 13 is connected by a tube 20 to a parallel combination of an expansion valve and a check valve, generally designated at 21, which is connected by a tube 22 to a receiver 23 forming a liquid refrigerant source for operating the system. The check valve of the valve arrangement 21 is so arranged as to permit the flow of refrigerant in one direction, i.e., from the indoor coil flow to the receiver 23. The outlet of the receiver 23 is connected by a tube 24 to another parallel combination of an expansion valve and a check valve, generally designated at 25, which in turn is connected by a tube 26 to the outdoor coil 15. The check valve of the valve arrangement 25 is arranged so that it permits the flow of refrigerant in one direction, i.e., from the outdoor coil 15 to the receiver 23. The suction side of the compressor C is connected by a suction gas tube 28 to the four-way valve 11 by which the tube 28 is kept in communication with the tube 12 leading to the indoor coil 13 during cooling operation, and with the tube 14 leading to the outdoor coil 15 during heating operation.

The receiver 23 has an outlet 30 connected by a by-pass tube 31 to the inlet of a liquid pump 32 which is adapted to supply a portion of the refrigerant liquid stored in the receiver 23, to a heat exchanger 33 connected to the outlet of the pump 32. The heat exchanger 33 includes a heat exchange coil (not shown) which is surrounded by a heat accumulating medium to provide heat transfer from the medium to the refrigerant flowing through the heat exchange coil. The outlet of the heat exchanger 33 is connected by a by-pass tube 35 to a valve 36, the outlet of which is connected by a by-pass tube 37 to the tube 12 connecting the reversal valve 11 and the indoor coil 13.

The system is so designed that when, at low outdoor temperatures or at starting-up, the pump 32 is actuated, and the valve 36 is opened, the pump 32 supplies a portion of the refrigerant liquid stored in the receiver 23 into the heat exchanger 33 where it is evaporated by heat from the heat accumulating medium provided therein. The refrigerant gas thus generated flows from the heat exchanger 33 through the tube 35, the valve 36, and the tube 37 into the tube 12, and from the latter, together with the high pressure discharge gas flowing from the compressor C, to the indoor coil 13 operating as a condenser coil. During condensation, the heat of the refrigerant gas received from the heat accumulating medium is transferred to the indoor coil 13, thus greatly increasing the heating effect.

The heating cycle of the system according to the invention will be described in greater detail by reference to the Mollier diagram of FIG. 2 in which the axis of abscissa indicates enthalpy (i) of the refrigerant and the axis of ordinate indicates pressure thereof. The refrigerant gas flowing from the outdoor coil 15, after being adiabatically compressed by the compressor C, is in the state indicated at (a) in the diagram. When the refrigerant flows from the compressor C through the tube 12 into the indoor coil 13, the state of the refrigerant will reach the point indicated at (b). Within the indoor coil 13 the refrigerant is condensed while releasing the heat stored, so that the state of the refrigerant is changed from (b) to (c). Then, the refrigerant liquid flows through the check valve of the valve arrangement 21 into the receiver 23. Since, during normal heating operation, the valve 36 is in the closed position, the refrigerant flows from the receiver 23 into the expansion valve of the valve arrangement 25 where the expansion of the refrigerant takes place. The expanded refrigerant, which is in the state indicated at (d), flows from the expansion valve into the outdoor coil 15 operating as an evaporator coil. The evaporation of the refrigerant liquid within the outdoor coil 15 is accomplished with heat from the outdoor air so that the state of the refrigerant will change to the point indicated at (e). As previously explained, the evaporated refrigerant is sucked into the compressor C and then compressed thereby, returning to the state (a), whereby one heating cycle is completed.

At times, such as at low outdoor temperatures or at starting-up, the valve 36 is opened and simultaneously the liquid pump 32 is actuated. Under this condition, a portion of the refrigerant liquid in the receiver 23 is diverted to the heat exchanger 33 where it is evaporated by heat from the heat accumulating medium. Absorbing the heat from the medium, the refrigerant is changed from the state (c) to (f). The refrigerant with increased enthalpy i_f is then mixed with the discharge gas flowing from the compressor C, and the resulting flow of refrigerant gas is supplied to the indoor coil 13 operating as an evaporator coil. When evaporated, the refrigerant gas releases the heat received from the heat accumulating medium, returning to the point (c), whereby one heating subcycle is completed.

Now, if it is assumed that the amount of refrigerant circulating in the system during the normal heating operation is represented by G_1 kg/Hr, then the heating capacity of the system operating as a heat pump is expressed by the following:

$(i_b - i_c)G_1$ Kcal/Hr. Further, if it is assumed that, during the operation of the subcycle, the amount of refrig-

erant supplied from the compressor C and that of the refrigerant circulating in the subcycle are represented by G'_1 and G'_2 , respectively, then the total of the amount of the refrigerant flowing through the indoor coil 13 will be $(G'_1 + G'_2)$ Kg/Hr. Under this condition, the heating capacity of the entire system will be approximately equal to $(i_b - i_c)(G'_1 + G'_2)$ K Kcal/Hr, if i_f is approximately equal to i_b . Since G'_1 is approximately equal to G_1 , it will be appreciated that there is a marked increase of $(i_b - i_c)G'_2$ in the heating capacity of the entire system. If the heat accumulating medium is maintained at such high temperatures that $i_f > i_b$, the heating effect becomes still stronger, and the desired level of heating can be achieved more quickly on start-up of the system.

Thus, it will be appreciated that the operation of the subcycle may be initiated by opening the valve 36 and simultaneously actuating the liquid pump 32, when there is greater heating load being imposed on the system, such as at low outdoor temperatures or at starting-up.

The air conditioning system operates as a heat pump in the above-mentioned manner, resulting in the formation of frost or ice on the outdoor coil operating as an evaporator coil. In the present system, hot gas defrosting is employed by reversing the flow of refrigerant as in the case of cooling operation. In so doing, the reversal valve 11 is first switched to provide communication between the gas discharge tube 10 and the tube 14. As a result, the compressed discharge gas flows from the compressor C through the discharge tube 10, the reversal valve 11, and the tube 14 into the outdoor coil 15 operating as a condenser coil. Since the gaseous refrigerant flowing into the outdoor coil 15 is at high temperatures, it heats the coil 15, removing the frost or ice accumulation. The condensed refrigerant gas flows from the outdoor coil 15 through the check valve of the valve arrangement 25 into the receiver 23, and from the latter through the liquid pump 32 into the heat exchanger 33 where it is evaporated by heat from the heat accumulating medium. Hot evaporated refrigerant flows from the heat exchanger 33 through the tube 35, the valve 36, the tube 37, the tube 12, the reversal valve 11, an accumulator (not shown), and the suction gas tube 28 into the compressor C. This hot gas defrosting method is highly effective in removing the frost or ice accumulation, due to the utilization of the heat stored in the heat accumulating medium. Further, since the indoor coil 13 is not included in the hot gas defrost arrangement, the indoor coil does not operate as an evaporator coil during defrosting operation. This means that the air circulating through the indoor coil 13 is not cooled.

During cooling operation, the valve 36 is held in the closed position and the liquid pump 32 is kept deactuated. The compressor C supplies discharge gas through the tube 10, the reversal valve 11, and the tube 14 into the outdoor coil 15 operating as a condenser coil. Refrigerant liquid flows from the outdoor coil 15 through the tube 26, the check valve of the valve arrangement 25, and the tube 24 into the receiver 23, and from the latter through the tube 22 into the expansion valve of the valve arrangement 21. Expanded refrigerant flows from the expansion valve through the tube 20 into the indoor coil 13 operating as an evaporator coil. Gas and unevaporated refrigerant liquid flow from the indoor coil 13 through the tube 12, the reversal valve 11 into

an accumulator (not shown). The refrigerant gas flows from the accumulator through the suction gas tube 28 into the compressor C.

Referring to FIG. 3, there is illustrated a typical air conditioning system constructed in accordance with the teachings of FIG. 1. The system comprises an indoor unit 50, an outdoor unit 51 and two conduits or tubes 52 and 53 connecting both units. The conduits 52 and 53 each have a covering of thermally insulating material attached therearound which provides thermal insulation of the refrigerant flowing therethrough from outdoor air.

As shown, the outdoor unit 51 is divided into two compartments, the lower of which forms a machinery space and the upper of which is used for mounting the heat exchanger 33. Situated on the bottom of the machinery space is a refrigerant compressor C' having a discharge or high pressure side 60 with a discharge tube 10' through which hot compressed gaseous refrigerant is discharged to a reversal valve 11'. The reversal valve 11' is a four-way valve adapted to direct the flow of refrigerant selectively to an indoor coil 13' and an outdoor coil 15'. During heating operation, the reversal valve 11' provides communication between the tubes 10' and 12' so as to permit the flow of refrigerant from the compressor C' to the indoor coil 13', while, during the operations of both cooling and defrosting, the tube 10' is kept in communication with a tube 14' by the reversal valve 11' so that the refrigerant gas flows through the tube 10', the reversal valve 11', and the tube 14' into the outdoor coil 15'. The outdoor coil 15' operates as a condenser coil during both the cooling and defrosting operations, and as an evaporator coil during the heating operation. An electric fan 64 is provided adjacent the outdoor coil 15' to cool the coil and is electrically driven by a motor 65. The wall of the outdoor unit 51 is provided with a louver 66 adjacent the outdoor coil 15'. The lower end of the outdoor coil 15' is connected by a tube 26' to a valve arrangement 25' comprising an expansion valve 67 and a unidirectional or check valve 68 connected in parallel with each other. As previously explained in connection with the diagram of FIG. 1, the check valve 68 is so arranged as to permit refrigerant flow from the outdoor coil 15' to a receiver 23'. The receiver 23' is connected to a liquid pump 32' which in turn is connected by a tube 70 to one end of a coil 72 forming a part of the heat exchanger 33'. The other end of the heat exchange coil 72 is connected by a tube 35' to a valve 36'. In the illustrated embodiment, the heat exchanger 33' comprises a reservoir 73 for storing a heat accumulating medium 74, such as water, which is kept at high temperatures to heat the refrigerant flowing through the heat exchange coil 72. Extending generally horizontally within the reservoir 73 is an electric heater 76 for heating the heat accumulating medium 74. It would be advantageous to energize the electric heater 76 to store heat in the medium in the nighttime, such as at off-peak time of power demand, since an economical surplus power is available. The reservoir 73 is surrounded or covered by a thermally insulating material 78 and has an inlet 79 on its top for use in introducing the heat accumulating medium thereinto, the inlet 79 being closed by a closure member 80.

The valve 36' is connected by a tube 37' to a tube 12' which in turn is connected by a joint 85 to the tube 52. A tube 22' leading from the receiver 23' is connected

by a joint 87 to the tube 53. The reversal valve 11' is connected by a tube 28' to the suction side 89 of the compressor C'. An accumulator 90 is provided intermediate the suction gas tube 28'.

The indoor unit 50 is, as shown, situated on a shelf 100 and includes an indoor coil 13' which operates as an evaporator coil during the cooling operation, and as a condenser coil during the heating operation. The indoor coil 13' has its top end connected to a tube 102 which in turn is connected by a joint 104 to the tube 52. The bottom end of the indoor coil 13' is connected by a tube 20' to a valve arrangement 21' comprising an expansion valve 106 and a check valve 107, which arrangement is connected by a joint 108 to the tube 53. The check valve 107 is arranged to permit refrigerant flow from the indoor coil 13' toward the outdoor unit 51. An electric fan 110 is provided within the indoor unit 50 also, which serves to circulate through a grill 112 the air cooled or heated by the indoor coil 13'. A description of the operation of the system shown in FIG. 3 is herein omitted, since the system as shown is identical in structure to that of FIG. 1.

Referring to FIG. 4, there is illustrated another form of the air conditioning system of the present invention which differs from that of FIG. 3 in the provision of an ejector means 120 for introducing the high pressure refrigerant liquid into the discharge gas flowing from the compressor C''. Another difference of the present system lies in the fact that an electric heating means 122 is provided to heat the high pressure refrigerant liquid after having been mixed with the discharge gas.

In this embodiment, a receiver 23'' is connected by a tube 125 to a valve 36'', with the end of the tube 125 in the bottom of the receiver 23''. The valve 36'' is connected by a tube 127 to the ejector 120 which operates to suck the refrigerant liquid stored in the receiver 23'' and to supply it in a sprayed form into the discharge gas flowing from the compressor C''. The ejector 120 is connected to the electric heating means 122 including a U-shaped heating element 129. The electric heating means 122 in turn is connected by a tube 130 to the tube 52'' leading to an indoor coil 13''.

Where it is desired to operate the system as a heat pump, the reversal valve 11'' is arranged to provide communication between a discharge gas tube 10'' and the tube 12'' and between a tube 14'' and a tube 28''. With the reversal valve 11'' in this position, the compressor C'' supplies discharge gas through the tube 10'', the reversal valve 11'', the tube 12'', the ejector 120, the electric heating means 122, the tube 130, the tube 52'', and a tube 102'' into the indoor coil 13'' operating as a condenser coil. Condensed refrigerant flows from the coil 13'' through a tube 20'', a check valve 107'', a tube 53'', a tube 22'' into the receiver 23'', and from the latter through the tube 24'' into an expansion valve 67''. Expanded refrigerant flows from the valve 67'' through a tube 26'' into the outdoor coil 15'' operating as an evaporator coil. Gas and unevaporated refrigerant liquid flow from the coil 15'' through a tube 14'', the reversal valve 11'', the tube 28'', and an accumulator 90'' into the suction side of the compressor C''.

When, at low outdoor temperatures or at starting-up, the valve 36'' is opened and the electric heating means 122 is energized, the refrigerant liquid by-passed from the receiver 23'' is mixed in a sprayed form with the discharge gas by the ejector 120, the resulting refriger-

ant being supplied to the electric heating means 122 where the evaporation of the refrigerant liquid takes place. The refrigerant gas, when condensed within the indoor coil 13'', releases the heat received from the electric heating means 122, thus greatly increasing the heating effect. On the other hand, during both the cooling and defrosting operations, the system operates in a manner identical to that already explained in connection with the embodiment of FIG. 3.

Referring to FIG. 5, there is illustrated a further modification of the air conditioning system according to the present invention. One feature of this embodiment lies in the ability to operate as a dehumidifier as well for removing atmospheric moisture present in the room.

In this embodiment, a receiver 23''' is connected by a tube 140 to the inlet of an electric heating means 122''' for heating the refrigerant liquid flowing from the receiver 23'''. The electric heating means 122''' includes a U-shaped heating element 129''' and has its outlet connected to a valve 36'''. The valve 36''' is connected to one inlet of an ejector means 120''' of the type similar to that shown in FIG. 4. The ejector means 120''' is provided intermediate a tube 12''' connecting a reversal valve 11''' to a tube 52''' which in turn is connected by a tube 102''' to a first indoor coil 13a'''. As will be readily apparent, the outdoor unit 51''' of this embodiment is different from that shown in FIG. 4 in that the location of the electric heating means 122''' is modified so that the refrigerant liquid is heated before being mixed with the discharge gas flowing from the compressor C'''.

The first indoor coil 13a''' has its bottom end connected by a tube 150 to a valve 152 which in turn is connected by a tube 154 to the top end of a second indoor coil 13b'''. The bottom ends of the first and second indoor coils 13a''' and 13b''' are connected to each other by a capillary tube 156. The bottom end of the second indoor coil 13b''' is also connected to a parallel combination of a capillary tube 158 and a check valve 160, which combination is connected by a tube 162 to a tube 53''' leading to the receiver 23''' located in the outdoor unit 51''. A valve 164 is provided between the tube 154 and the tube 162.

In order to operate the system as a heat pump, the valve 152 should be kept in the open position with the valve 164 closed. The compressor C''' supplies discharge gas through the tube 10'', the reversal valve 11'', the tube 12'', the ejector means 120'', the tube 52'', the tube 102''' into the first indoor coil 13a''' operating as a condenser coil. Liquid and uncondensed refrigerant gas flow from the first indoor coil 13a''' through the tube 150, the valve 152, and the tube 154 into the second indoor coil 13b''' also operating as a condenser coil. Condensed refrigerant flows from the second indoor coil 13b''' through the check valve 160, the tube 162, the tube 53''', a tube 22'', and the receiver 23'', and from the latter through a tube 24''' into an expansion valve 67'''. Expanded refrigerant flows from the valve 67''' through a tube 26''' into an outdoor coil 15''' operating as an evaporator coil. Gas and unevaporated refrigerant liquid flow from the outdoor coil 15''' through a tube 14'', the reversal valve 11'', a tube 28'', and an accumulator 90''' into the suction side of the compressor C'''.

At times, such as at low outdoor temperatures or at starting-up, the valve 36''' is opened and the electric heating means 122''' is energized. Under this condi-

tion, portion of the refrigerant liquid stored in the receiver 23''' is sucked into the electric heating means 122''' where it is evaporated by heat therefrom. The hot refrigerant gas thus produced is sucked within the ejector means 120''' into the flow of compressed discharge gas from the compressor C''' and then is supplied to the first and second indoor coils 13a''' and 13b''', thereby greatly increasing the heating effect.

During the cooling operation, the valves 152 and 164 remain opened and closed, respectively. The compressor C''' supplies discharge gas through the tube 10'', the reversal valve 11'', and the tube 14''' into the outdoor coil 15''' operating as a condenser coil. Liquid and condensed refrigerant gas flow from the outdoor coil 15''' through the tube 26'', and a check valve 68''' into the receiver 23'', and from the latter through the tube 22'', the tube 53'', the tube 162, and the capillary tube 158 into the second indoor coil 15b''' operating as an evaporator coil. Gas and unevaporated refrigerant liquid flow from the second indoor coil 15b''' through the tube 154, the valve 152, and the tube 150 into the first indoor coil 13a''' also operating as an evaporator coil. Evaporated refrigerant flows from the first indoor coil 13a''' through the tube 102'', the tube 52'', the tube 12'', the ejector means 120'', the reversal valve 11'', the tube 28'', and the accumulator 90''' into the compressor C'''.

For the system to operate as a dehumidifier, the valves 152 and 164 are closed and opened, respectively, with the reversal valve 11''' in the same position as during the cooling operation. The compressor C''' supplies discharge gas through the tube 10'', the reversal valve 11'', the tube 14''' into the outdoor coil 15''' operating as a condenser coil. Refrigerant liquid flows from the outdoor coil 15''' through the tube 26'' and the check valve 68''' into the receiver 23'', and from the latter through the tube 22'', the tube 53'', the tube 162, the valve 164, and the tube 102''' into the second indoor coil 13b''' operating as a condenser coil. Condensed refrigerant flows from the second indoor coil 13b''' through the capillary tube 156 into the first indoor coil 13a''' operating as an evaporator coil. Evaporated refrigerant flows from the first indoor coil 13a''' through the tube 102'', the tube 52'', the tube 12'', the ejector means 120'', the reversal valve 11'', the tube 28'', and the accumulator 90''' into the compressor C'''. As described above, during the dehumidifying operation, the first and second indoor coils 13a''' and 13b''' operate as an evaporator coil and a condenser coil, respectively. Thus, the air in the room is first cooled and dehumidified by the first indoor coil 13a''' and then is heated by the second indoor coil 13b''' up to approximately the room temperature. Accordingly, it should be understood that the system is capable of dehumidifying the air in the room without causing any reduction in room temperature.

What is claimed is:

1. A heat pump comprising a refrigerant compressor, reversal means, a gas tube, indoor heat exchange means, means providing resistance to the flow of refrigerant, outdoor heat exchange means, and a suction gas tube connected in series in the order named, means for feeding a portion of the refrigerant liquid leaving said indoor heat exchanger back to the inlet thereof, and means for heating the refrigerant liquid before entering said indoor heat exchanger.

2. A heat pump according to claim 1, in which receiver means is provided for storing the refrigerant liquid flowing from said indoor heat exchanger, and in which by-pass means is provided for feeding refrigerant liquid from said receiver into said gas tube.

3. A heat pump according to claim 1, in which said heating means is provided in said by-pass means for heating the refrigerant liquid before entering said gas tube.

4. A heat pump according to claim 1, in which said heating means is provided in said gas tube for heating the refrigerant liquid after being mixed with discharge gas flowing from said compressor.

5. A heat pump according to claim 1, in which a liquid pump is provided in said by-pass means for supplying refrigerant liquid from said receiver to said gas tube.

6. A heat pump according to claim 1, in which control valve means is provided in said by-pass means for shutting off the flow of refrigerant therethrough except during increased heating load.

7. A heat pump according to claim 1, in which ejector means is provided in said gas tube for ejecting the refrigerant liquid flowing from said receiver means into the refrigerant gas flowing from said compressor.

8. A heat pump according to claim 3, in which said heating means comprises:

- a reservoir;
- a heat accumulating medium stored in said reservoir;
- a heat exchanger coil extending within said reservoir in heat exchange contact with said heat accumulating medium; and
- an electric heater provided in said reservoir to heat said heat accumulating medium.

9. A heat pump according to claim 3, in which said heating means comprises:

- an electric heater provided in said by-pass means.

10. A heat pump according to claim 3, in which said heating means comprises:

- burner means provided in said by-pass means.

11. A heat pump according to claim 4, in which said heating means comprises:

- an electric heater provided in said gas tube.

12. A heat pump comprising a refrigerant compressor, reversal means, a discharge gas tube connecting said means to the discharge side of said compressor, an indoor coil, a second tube connecting said means to said indoor coil, receiver means, a third tube connecting said indoor coil to said receiver means, an expansion valve, an outdoor coil, a fifth tube connecting said expansion valve to said outdoor coil, a sixth tube connecting said outdoor coil to said reversal means, accumulator means, a seventh tube connecting said reversal means to said accumulator means, a suction gas tube connecting said accumulator means to the suction side of said compressor, by-pass means for feeding refrigerant from said receiver means into said second tube, a second valve for controlling the flow of refrigerant through said by-pass means and means for heating the refrigerant flowing from said receiver means, said reversal means in heating position routing discharge gas through said second tube into said indoor coil operating as a condenser coil, and routing refrigerant from said outdoor coil operating as an evaporator coil through said sixth and seventh tubes into said accumulator means, said reversal means in cooling position routing discharge gas through said sixth tube into said

outdoor coil operating as a condenser coil, and routing refrigerant from said indoor coil operating as an evaporator coil through said second and seventh tubes into said accumulator means, said second valve being closed during cooling operation, said reversal means in defrosting position routing discharge gas through said sixth tube into said outdoor coil operating as a condenser coil, and routing refrigerant from said heating means through said second and seventh tubes into said accumulator means, said second valve being opened during defrosting operation.

13. A heat pump according to claim 12, in which ejector means is provided in said second tube for ejecting the refrigerant flowing through said by-pass means into the refrigerant gas flowing from said reversal means.

14. A heat pump according to claim 12, in which said heating means is provided in said second tube downstream of said ejector means.

15. A heat pump according to claim 12, in which said heating means is provided in said by-pass means upstream of said ejector means.

16. A heat pump comprising a refrigerant compressor, reversal means, a discharge gas tube connecting said means to the discharge side of said compressor, a first indoor coil, a second tube connecting said means to said first indoor coil, a first valve, a third tube connecting said first indoor coil to said first valve, a second indoor coil, a fourth tube connecting said first valve to said second indoor coil, a second valve, a fifth tube connecting said second indoor coil to said second valve, receiver means, a seventh tube connecting said second valve to said receiver means, an expansion valve, a eighth tube connecting said receiver means to said expansion valve, an outdoor coil, a ninth tube connecting said expansion valve to said outdoor coil, a tenth tube connecting said outdoor coil to said reversal means, accumulator means, an eleventh tube connecting said reversal means to said accumulator means, a suction gas tube connecting said accumulator means to the suction side of said compressor, by-pass means for feeding refrigerant from said receiver means into said second tube, a third valve for controlling the flow of refrigerant through said by-pass means, means for heating the refrigerant flowing from said receiver means, a fourth valve for controlling communication between said fourth and seventh tubes, a first capillary tube connecting said third and fifth tubes, and a second capillary tube connecting said fifth and seventh tubes, and fifth valve interconnecting said eighth and ninth tubes, said reversal means in heating position routing discharge gas through said second tube into said first indoor coil operating as a condenser coil and from said first indoor coil through said first valve and said third and fourth tubes into said second indoor coil operating as a condenser coil, and routing refrigerant from said outdoor coil operating as an evaporator coil through said tenth and eleventh tubes into said accumulator means, said fourth and fifth valves being closed during heating operation, said reversal means in cooling position routing discharge gas through said 10th tube into said outdoor coil operating as a condenser coil, and routing refrigerant from said second indoor coil operating as an evaporator coil through said first and fifth valves into said first indoor coil operating as an evaporator coil and from said first indoor coil through said second and 11th tubes into said accumulator means,

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said second, third and fourth valves being closed during cooling operation, said reversal means in defrosting position routing discharge gas through said tenth tube into said outdoor coil operating as a condenser coil, and routing refrigerant from said heating means through said second and 11th tubes into said accumulator means, said third valve being opened during defrosting operation, said reversal means in dehumidifying position routing discharge gas through said tenth tube into

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said outdoor coil operating as a condenser coil, and routing refrigerant from said second indoor coil operating as a condenser coil through said first capillary tube into said first indoor coil operating as an evaporator coil and from said first indoor coil through said second and 11th tubes into said accumulator means, said first, second and third valves being closed during dehumidifying operation.

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