

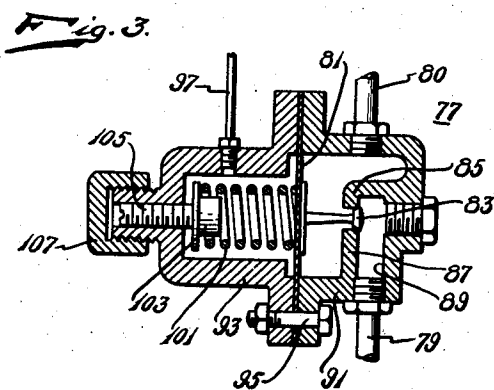
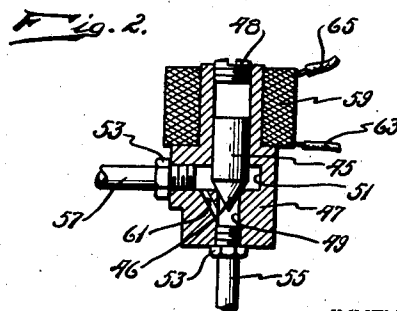
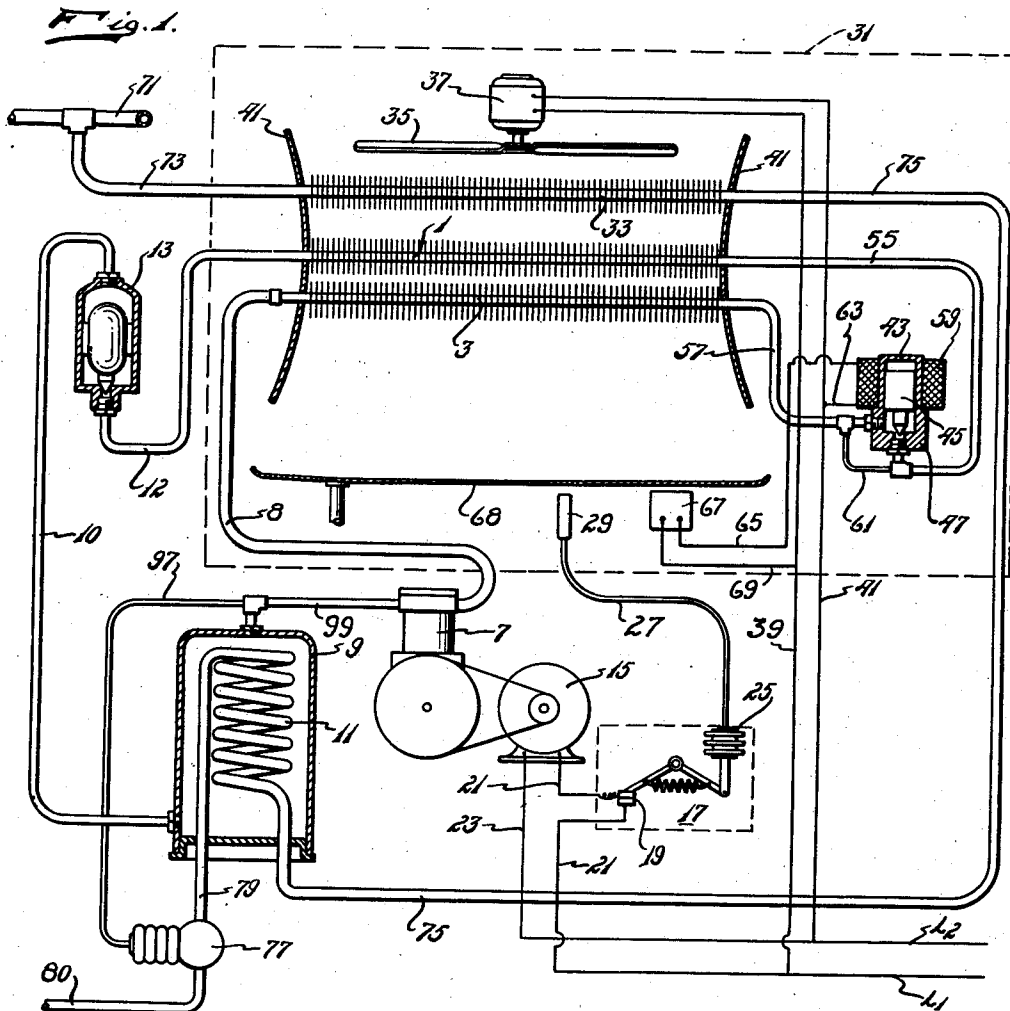
Feb. 7, 1939.

L. A. PHILIPP

2,146,483

AIR CONDITIONING SYSTEM

Filed Feb. 1, 1935



INVENTOR.
LAWRENCE A. PHILIPP

BY Warren H. F. Schmieding

ATTORNEY.

UNITED STATES PATENT OFFICE

2,146,483

AIR CONDITIONING SYSTEM

Lawrence A. Philipp, Detroit, Mich., assignor, by
mesne assignments, to Nash-Kelvinator Corpo-
ration, Detroit, Mich., a corporation of Mary-
land

Application February 1, 1935, Serial No. 4,429

10 Claims. (Cl. 62—6)

My invention pertains to air conditioning systems and more particularly to a water cooling system for use therewith.

It is an object of my invention to provide an air conditioning system comprising air circulating means for circulating the air over a plurality of evaporators which are supplied with refrigerant from a compressor condenser unit in conjunction with regulator means for regulating the operating temperatures of the evaporators to properly dehumidify the air while maintaining a predetermined temperature range, and associated with cooperative means for admitting a quantity of cooling medium in accordance with an operating condition of the refrigerating system to successively cool the air and the refrigerant.

It is also an object of my invention to provide an air conditioning system comprising heat absorbing means arranged to apply a cooling medium for successively absorbing heat from the air and from the vaporized refrigerant for condensing the same in conjunction with means for automatically regulating the flow of the cooling medium in accordance with the demand on the system.

Another object of my invention is to provide a water cooling system for air conditioning apparatus of the expansion type comprising a water cooled heat absorber for precooling the air and arranged in series connected relation with water cooling coils in the refrigerant condenser and automatic regulating means for regulating the flow of cooling water through the heat absorber and the condenser cooling coils in accordance with the pressure of the refrigerant in the high side of the system.

The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiment, when read in conjunction with the accompanying drawing, in which:

Fig. 1 is a diagrammatic view representing an air conditioning system arranged in accordance with my invention;

Fig. 2 is a sectional view illustrating the construction of an electromagnetic valve used in the system; and

Fig. 3 is a sectional view illustrating the construction of a pressure responsive valve used in the system.

Referring more particularly to Fig. 1 of the drawing, the apparatus comprises a pair of refrigerant evaporators 1 and 3 which are disposed

to receive refrigerant in series circuit relation from a compressor-condenser-unit 5 comprising a refrigerant compressor 7 for drawing vaporized refrigerant through a conduit 8 from the second evaporator 3 compressing and condensing it through a suitable condenser 9 which is provided with water cooling means 11 for dissipating the latent heat of vaporization. The liquid refrigerant passes from the condenser 9 under high pressure through a conduit 10 to a high-side float-type reducing valve 13 from which the liquid refrigerant is discharged through a conduit 12 into the first evaporator 1.

In order to control the compressor for supplying the required amount of refrigerant to the evaporator coils, it is driven by an electric motor 15 and a thermostatically controlled switch 17 is provided having its contacts 19 connected in the motor energizing circuit, which extends through conductors 21 and 23 from the service line conductors L1 and L2. The motor controlling switch 17 is actuated by a flexible metal bellows 25 connected thereto which receives actuating pressures through a conduit 27 which extends from a thermobulb 29 mounted within the compartment 31 which is to be conditioned. The temperature responsive characteristics of the thermostatic switch 17 may be readily predetermined by selecting a suitable biasing spring for the switch lever or a volatile liquid having suitable characteristics for the thermobulb 29, and the switch may be connected either for speed control or intermittent control as shown.

A water cooled heat absorber 33 is provided adjacent the evaporators for initially precooling the air before it is driven over the evaporators from a fan or blower 35 actuated by a suitable electric motor 37 which may be energized continuously from the service lines through conductors 39 and 41, as shown, or intermittently in parallel relation with the compressor motor 15. Suitable baffle vanes 41 are provided for guiding the circulated air to flow successively over the water cooled heat absorber 33 and the first and second evaporators 1 and 3 respectively. The respective water cooled heat absorbing conduit 33 and the refrigerant evaporators 1 and 2 may be provided with suitable fins and coiled in any suitable conformation for increasing their heat absorbing capacity in a manner that will be readily understood by those skilled in the art.

In addition to controlling the temperature of the air within predetermined limits it is also desirable to control the humidity thereof which is accomplished by the electromagnetic valve 43 in-

interconnected between the two evaporators. As shown in Fig. 2, this refrigerant pressure and temperature regulating device comprises a valve 45 which is slidably disposed in a cylindrical orifice provided in a suitable valve casing 47. The orifice is closed by a threaded cap 48. The valve casing 47 provides an inlet port 49 having an associated valve seat for receiving the low end of the valve member 46 which is tapered to seat therein for obstructing the flow of fluid. A suitable outlet port 51 passes through the side of the valve casing 47 and pipe fittings 53 are provided in the inlet and outlet ports to facilitate connection of the valve into the system. A conduit 55 extends from the outlet of the first evaporator 1 to the inlet port 49 of the valve and, from its outlet port 51, refrigerant is conducted through a suitable connection 57 to the end of the second evaporator 3.

A solenoid winding 59 is provided surrounding the upper portion of the valve casing which is of non-magnetic material such as brass for example. When the solenoid winding 59 is de-energized, the slidable valve 45 falls by gravity to its seated, fluid flow obstructing, position. In this position the flow of refrigerant fluid is not entirely shut-off but continues at a predetermined restricted rate through a by-pass aperture 61 which is provided directly between the inlet port and the outlet port for this purpose. The by-pass aperture 61 is selected of suitable cross section to pass sufficient refrigerant for cooling both of the evaporators 1 and 3 while maintaining a predetermined temperature differential therebetween such that the second evaporator 3 is operated at a temperature below the dew point temperatures of air of excessive humidity.

When the solenoid winding 59 is energized by connection with a suitable source of electric energy the valve 45 which is of magnetic material for operating as an armature in the winding, is lifted away from its seat and permits the free flow of refrigerant fluid through the valve casing. With the valve in its unobstructing position, the refrigerant vaporizes at substantially equal pressures in both of the evaporators 1 and 3 which then operate to absorb heat from the surrounding air at substantially equal temperatures above the dew point temperature of the air.

For automatically controlling the energization of the valve electromagnet, one terminal of the winding is connected through a conductor 63 to the conductor 41 which is connected directly to one of the main line conductors L2. The other terminal of the valve winding is connected by means of a conductor 65 to a humidostat 67, mounted in the compartment to be conditioned, thence by conductors 69 and 39 to the other line conductor L1. The humidostat 67 is thus connected in series relation in the valve energizing circuit which extends from the service line conductors L1 and L2 to the valve actuating solenoid winding.

When the relative humidity of the air is higher than a predetermined desirable value, the humidostat 67 opens the energizing circuit of the valve actuating solenoid. By this operation the valve 45 is lowered to its closed position and operates the evaporators 1 and 3 at different pressures and temperatures, and the refrigerant passing through the restricted by-pass aperture 61 in the valve sets up a back pressure in the first evaporator 1 and increases the vaporizing pressure in the second evaporator 3. This operates the first evaporator at a high temperature and

the second evaporator is again operated at a lower temperature than the dew point of the circulating air. The excessive moisture is thus condensed on the surface of the second evaporator and it drips down to a suitable drip pan which carries it into a drain.

Cooling water is supplied from a suitable source 71 through a conduit 73 to the water cooled heat absorbing coils 33 adjacent the first evaporator. In passing through the air heat absorber 33 the cooling water is initially utilized for precooling the circulating air before it impinges upon the evaporators 1 and 3. From the heat absorber 33 the water flows through a conduit 75 which is connected to one end of the cooling coil 11 within the refrigerant condenser where it absorbs the latent heat of vaporization from the high pressure refrigerant vapor thereby condensing the same. The water then passes from the condenser cooling coil 11 through a flow regulating valve 77 which is controlled by pressure responsive actuating means in accordance with the pressure of the refrigerant entering the condenser.

As shown in Fig. 3, a pressure responsive water regulating valve suitable for use in my system comprises a flexible metal diaphragm 81 which supports a valve 83 in cooperative adjacent relation to a seat 85 provided in a partition 87 which encloses an inlet port 89 in a valve casing 91. The cooling water enters the valve casing 91 through the inlet port 89 connected through the valve seat and passes from an outlet port provided on the other side of the valve seat whereby the position of the valve 83 adjacent the seat regulates the rate of flow of the cooling water therethrough. The valve is provided with a cover 93 which is clamped onto the valve casing by suitable bolts 95, and the peripheral edges of the diaphragm 81 are firmly clamped thereby. In order to automatically control the position of the valve 83, a conduit 97 is connected from the valve cover 93 to the high pressure refrigerant connection 99 between the compressor 7 and the condenser 9, and the refrigerant line pressure is thus applied to the opposite side of the diaphragm 81 which is thereby flexed to move the valve toward or away from its seat regulating the flow of cooling water accordingly.

For adjusting the pressure response characteristics of the valve a biasing spring 101 is provided which tends to move the valve 83 away from its seat in opposition to the water supply pressure. The end of the spring 101 is received by an adjustable stop member 103 mounted on a threaded shaft 105 which passes through the casing. By turning the shaft 105 the tension of the biasing spring 101 may be adjusted and the characteristics of the valve thereby modified. A cap 107 is preferably provided in screw threaded relation over the end of the cover member 93.

In operation the temperature within the compartment 31 is automatically maintained within predetermined limits by the thermostatic switch 17 which intermittently operates the compressor to provide the required refrigeration. The desired degree of humidification is automatically maintained by the humidity responsive valve 45 which either operates one of the evaporators 3 below the dew point temperature for removing excessive moisture or operates both evaporators above the dew point temperature.

When the demand for refrigeration is great, a larger quantity of water is required for initially precooling the air and for condensing the refrigerant in order that such a system may operate

with a desirable degree of efficiency. In accordance with my invention, this is provided by the pressure responsive valve 77 which is opened in accordance with the higher pressures which prevail in the high pressure side of the system under these conditions whereby a larger quantity of refrigerant may be condensed and greater pre-cooling of the air is provided in accordance with the demand.

While it is necessary for the purpose of illustration to describe the several disclosed forms of my invention in detail, it will be apparent that my invention is not so limited, and that other forms and applications thereof are embraced within the scope of the appended claims.

I claim as my invention:

1. In combination in an air conditioning system a compartment to be cooled, a pair of refrigerant evaporators therein, means connecting said evaporators in series relation comprising humidity responsive refrigerant flow controlling means interconnected therebetween, a refrigerant condensing heat exchanger, a refrigerant compressor for withdrawing refrigerant vapor from the second one of said evaporators, compressing the same and forcing it through said heat exchanger, and returning liquefied refrigerant to the first evaporator, control means for operating said compressor in accordance with the temperature in said compartment, a water cooled heat absorber adjacent said second evaporator, means for circulating air successively over said heat absorber and said first and second evaporators respectively, means for circulating cooling water successively through said heat absorber and said heat exchanger in series relation, and means for controlling the circulation of cooling water in accordance with a condition of the refrigerating system.

2. In combination in an air conditioning system, a water cooled heat absorber, a first refrigerant evaporator, a second refrigerant evaporator, a compartment enclosing said absorber and evaporators, means interconnecting said evaporators comprising a refrigerant control valve, a refrigerant condenser, means for receiving water to dissipate heat therefrom, a refrigerant compressor for drawing refrigerant vapor from said second evaporator, compressing the same and forcing it through said condenser, and supplying liquefied refrigerant to said first evaporator, means for operating said compressor in accordance with the temperature in said compartment, humidity responsive control means in said compartment for actuating said valve, means for circulating cooling water through said heat absorber and said condenser in accordance with a condition of said system, and means for circulating air over said heat absorber and said first and second evaporators in sequence.

3. The method of conditioning air which comprises circulating air in heat exchange relation with water and in heat exchange relation with a refrigerant evaporator, utilizing the cooling water to condense the vaporized refrigerant after it cools the air, and increasing and decreasing the flow of water in accordance with increase and decrease respectively of the heat load imposed by the air.

4. The method of conditioning air which comprises circulating air in heat exchange relation with water and in heat exchange relation with an evaporator, withdrawing vaporized refrigerant from the evaporator and utilizing the cool-

ing water to condense the vaporized refrigerant after the water cools the air, returning the condensed refrigerant to the evaporator, and controlling the flow of water and refrigerant in accordance with a demand for refrigeration.

5. The method of conditioning air which comprises circulating air in heat exchange relation with water and in heat exchange relation with an evaporator, withdrawing vaporized refrigerant from the evaporator and utilizing the cooling water to condense the vaporized refrigerant after the water cools the air, returning the condensed refrigerant to the evaporator, and controlling the flow of water in accordance with the pressure of the condensed refrigerant.

6. The method of conditioning air which comprises circulating air in heat exchange relation with water and in heat exchange relation with an evaporator, withdrawing vaporized refrigerant from the evaporator and utilizing the cooling water to condense the vaporized refrigerant after the water cools the air, returning the condensed refrigerant to the evaporator, varying the amount of moisture removed by the evaporator in accordance with certain humidity conditions of the air, and controlling the flow of water in accordance with the demands for refrigeration.

7. The method of conditioning air which comprises circulating air in heat exchange relation with water and in heat exchange relation with an evaporator, withdrawing vaporized refrigerant from the evaporator and utilizing the cooling water to condense the vaporized refrigerant after the water cools the air, returning the condensed refrigerant to the evaporator, varying the amount of moisture removed by the evaporator in accordance with humidity conditions of the air, and controlling the flow of water in accordance with the demands for refrigeration.

8. A refrigerating system for refrigerating a confined space to be cooled comprising means for conducting cooling water in heat exchange relation with the air in said space, a heat absorber within the space, a water cooled heat dissipator associated with the heat absorber for cooling the refrigerant circulating through the heat absorber, said heat dissipator being connected for receiving the water from said means, and pressure responsive means for controlling the flow of water through said first means.

9. In combination with a confined space to be cooled, means for conducting cooling water in heat exchange relation with the air in said space; a refrigerating system including an evaporator within the space, a water cooled refrigerant condenser operatively connected with the evaporator and connected for receiving the water from said means; and means responsive to increasing and decreasing pressures in the system for increasing and decreasing respectively the flow of water.

10. In combination with a confined space to be cooled, means within the space for conducting water for cooling purpose; a refrigerating system including an evaporator within the space, a water cooled refrigerant condenser operatively connected with the evaporator and connected for receiving the water from said means; means responsive to a humidity condition of the air for varying the amount of moisture removed from the air by the evaporator; and means responsive to a temperature condition of the air for controlling the flow of water.

LAWRENCE A. PHILIPP.