May 23, 1939. A. J. LAWLESS 2,159,276

AIR CONDITIONING SYSTEM

Filed June 16, 1937 2 Sheets-Sheet 1

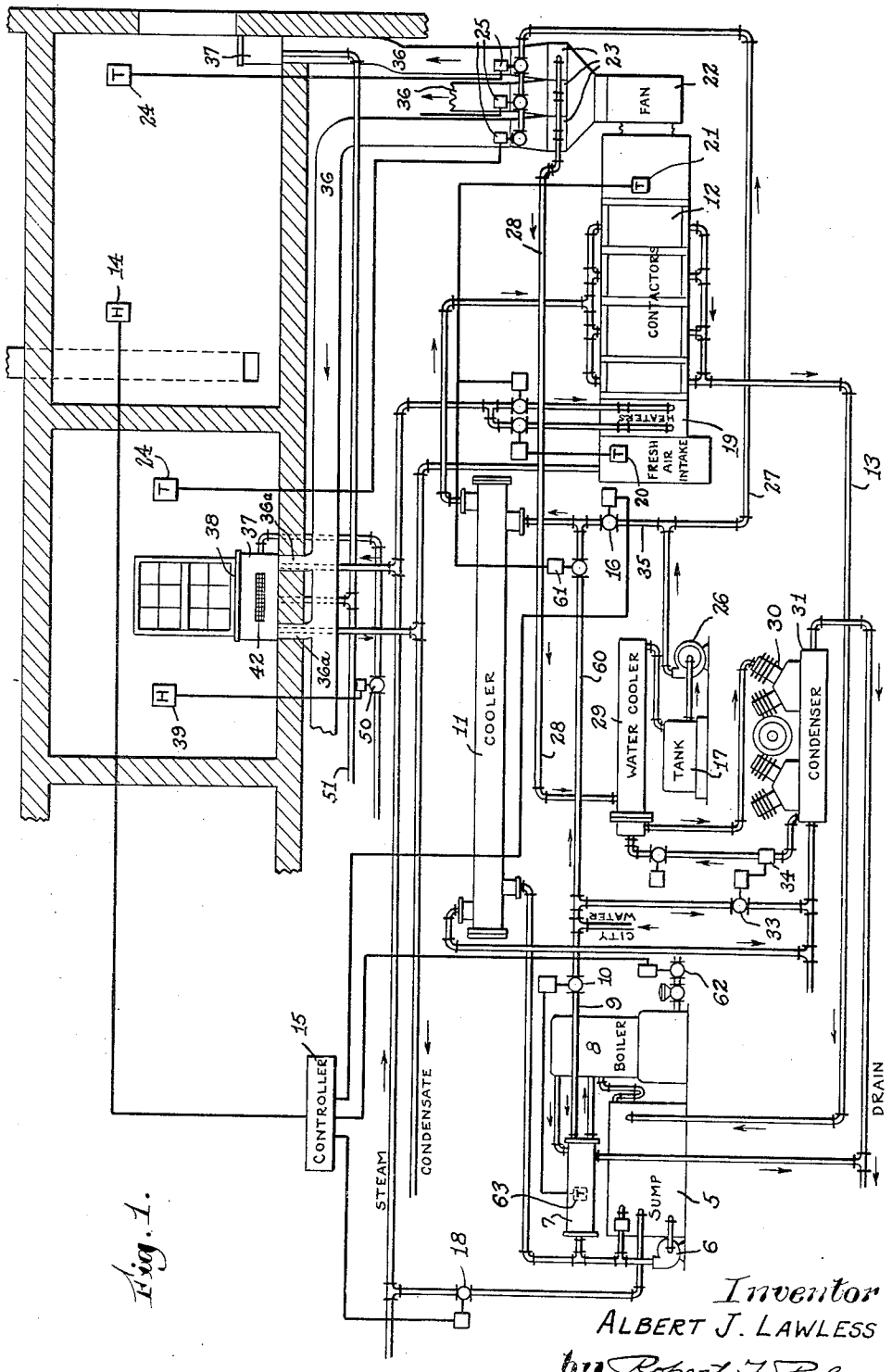

Fig. 1.

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Fig. 2.

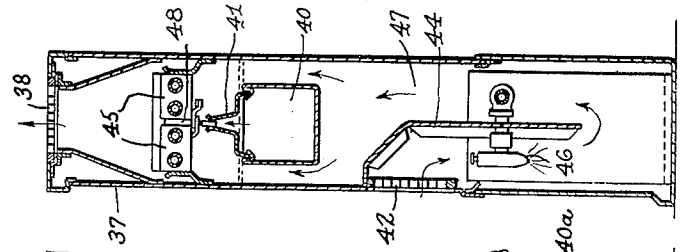
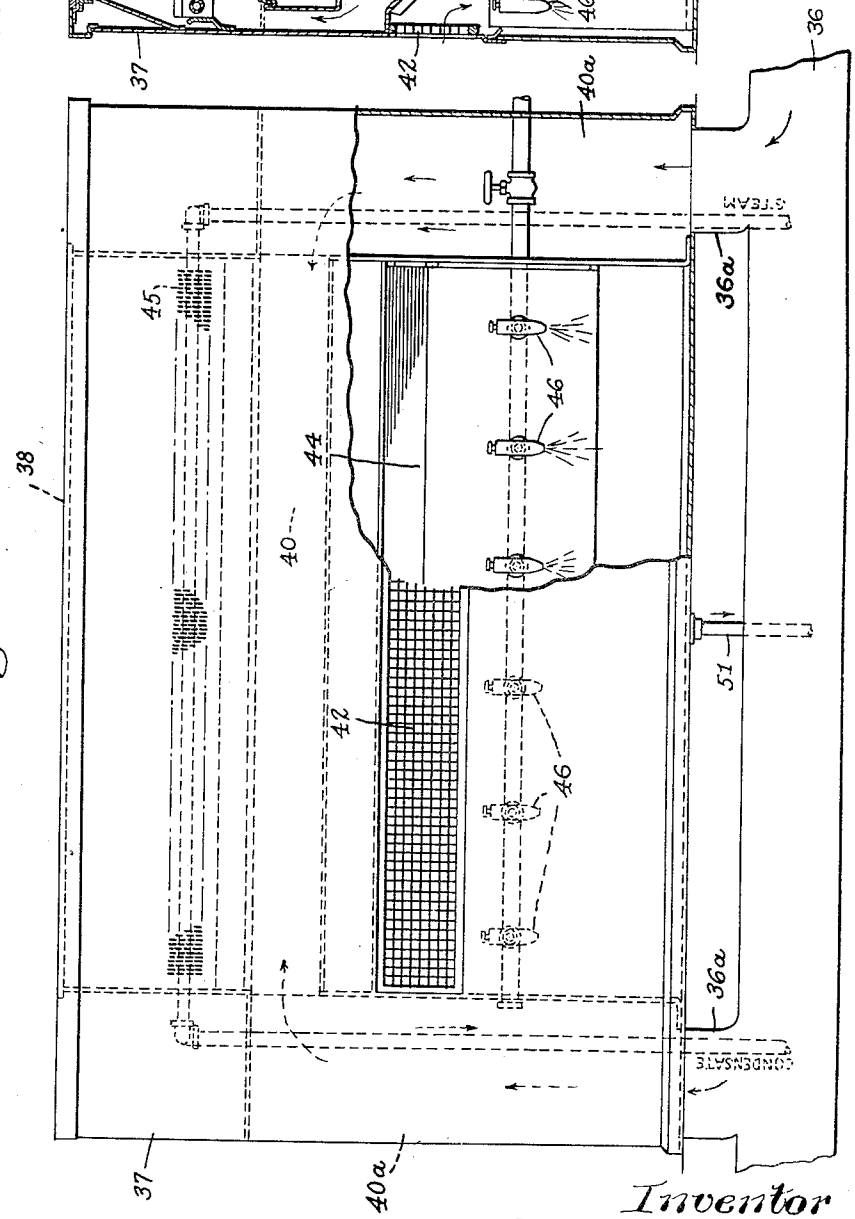


Fig. 3.



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AIR CONDITIONING SYSTEM

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Application June 16, 1937, Serial No. 148,536

7 Claims. (Cl. 98—39)

This invention relates to air conditioning systems and relates more particularly to air conditioning systems in which outdoor air is conditioned in a central plant and then distributed through local recirculation units.

The present invention was designed for a hospital in which more exact control of temperatures and humidities than usual, was required. It was not permitted to recirculate air through the conditioning system. Such low relative humidities in summer were required that the usual air distributing methods could not be used and the cost of dehumidification by refrigeration would have been excessive.

Accordingly a hygroscopic dehumidifier is used and city water cooled additionally by mechanical refrigeration is used for sensible cooling. The air is supplied by ducts to local recirculation units in the rooms where it is mixed with recirculated air prior to discharge into the rooms.

A feature of the invention resides in the most economical tie-up of an absorption dehumidification plant with regenerating and cooling equipment.

Another feature of the invention resides in the provision of automatic controls for providing desired conditions with maximum efficiency.

Another feature of the invention resides in the adjustment of the relative humidity of conditioned air at a central point, the supply of the conditioned air under pressure to local room units where it induces the flow of recirculated air through the local units, and the adjustment of the relative humidity of the air in the local units prior to discharge into the rooms.

Another feature of the invention resides in the provision of humidifiers in local recirculation units.

An object of the invention is to provide an efficient air conditioning system utilizing hygroscopic dehumidification.

Another object of the invention is to control the moisture content of conditioned air at a central source, to supply the conditioned air under pressure to local recirculation units where it induces the flow of recirculated air, and to again control the moisture content of the conditioned air in one or more local units prior to discharge into the rooms.

Another object of the invention is to pass recirculated air through a humidifier in a local recirculation unit supplied with primary air from a central source.

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 schematic lay-out of a complete air conditioning system according to this invention;

Fig. 2 is an end view in section of one of the local recirculation units employed, and

Fig. 3 is a profile veiw with a portion in dotted outline, of the unit of Fig. 2.

Because it was believed that low relative humidities of the order of 30 to 35 percent would be helpful in the treatment of arthritis and other rheumatic ailments, it was required that these unusually low relative humidities be provided. It was decided that a lithium chloride absorber would produce the desired effect at the lowest cost considering both full load and partial load operation.

In lithium chloride solutions, the vapor pressure is a function of both concentration and temperature; an increased concentration at constant temperature or a decreased temperature at constant concentration effects a decreased vapor pressure. When air flows in contact with such a fluid having a lower vapor pressure, there will be a flow from the air to the fluid. According to this invention, the vapor pressure is controlled by adjustment of both concentration and temperature of the solution.

The sump 5 contains the lithium chloride solution. The pump 6 recirculates the solution through the sump 5, the economizer and condenser 7 and the boiler concentrator 8 whereby a small portion of the total solution is highly concentrated and returned to the sump 5 while the vapor from the boiler 8 passes through the economizer and condenser 7 where partial condensation is obtained from the cool solution to the boiler and further condensation is obtained from the city water supplied through the pipe 9 to the condenser 7, the volume of this water being controlled by adjustment of the solenoid valve 10 under control of a thermostat 63 exposed to the condensate temperature.

The concentrated solution is forced by the pump 6 through the shell and tube type cooler 11, and then through the contactors 12 where it passes in intimate contact with the air to be dehumidified. The diluted solution is returned from the contactors 12 to the sump 5 through the pipe 13.

City water to the cooler 11 is supplied through the pipe 60 past the solenoid valve 61. The valve 61 is controlled by a thermostat 21 in the air

leaving the contactors 12. The thermostat for controlling the valve 61 may also be placed in the solution supply line from the cooler 11 to the contactors 12.

The concentration of the solution is controlled by a general humidostat 14. This humidostat 14 monitors a standard Minneapolis Honeywell three step, motor driven controller 15.

The second and third steps of the controller 15 control the concentration of the solution in summer as follows: As the relative humidity increases, the second step of controller 15 causes the gas valve 62 to open to supply increased heat to the boiler 8, thus increasing the concentration of the solution. If this is not sufficient, the third step of the controller 15 operates to adjust the valve 16 to vary the temperature of the water to the cooler 11 by varying the proportion of city water, to refrigerated water from the tank 17. The additional cooling of the solution by this water further reduces its vapor pressure and increases the absorption capacity.

During the humidifying season, the first step of the controller controls the concentration of the solution by adjusting through the valve 18, the volume of steam supplied to the sump 5 to deconcentrate the solution when higher relative humidities are desired. At this time, the local recirculation of the solution through the concentration apparatus is discontinued. Additional heat for the air is added as required, by two sections 19 of air heaters on the entering side of the contactors 12. The first section 19 is under control of the outdoor thermostat 20 and the second section is under control of a supply air thermostat 21 maintaining a delivered air temperature of 72° F. This same thermostat 21 is illustrated as also controlling the valve 61. In practice separate thermostats would be used.

Going back again to summer operation, at which time the heating sections 19 are inactive and no steam is supplied to the sump 5 for deconcentration purposes, the dehumidified air leaving the contactors 12 is moved by the fan 22 over the three sections of fin type coolers 23 to which refrigerated water is supplied through the valves 25 under control of three zone thermostats 24, one of which is not illustrated. The refrigerated water is drawn by the pump 26 from the tank 17 and forced through the pipe 27, through the coolers 23 and then through the pipe 28 to the shell and tube water cooler 29. Cooling is accomplished in the cooler 29 by the direct expansion of a volatile refrigerant supplied by the compressor 30 under the usual control of a thermostat which shuts off the supply of refrigerant and shuts down the compressor 30 when the temperature in the cooler 29 reaches a predetermined minimum.

The condenser 31 of the compressor 30 is in series with as regards water flow, and after the cooler 29. Under normal conditions of operation, the condenser 31 will receive sufficient water for condensing purposes but since this supply is controlled from the absorption system, an auxiliary water supply is provided to the condenser 31, from the city water supply through the solenoid valve 33 controlled by the compressor high pressure valve 34.

The refrigeration system is designed for a maximum outside temperature of 92° and with 75° wet bulb as a datum point, an increased load upon the absorption system because of a higher dew point in the outside air decreases the load in the refrigeration system. In order to take advantage of this excess capacity in refrigeration, the pipe 35 connects the refrigerated water with the city water supply to the solution cooler 11. As previously described, the valve 16 under the control of the third step of the controller 15 controls the volume of refrigerated water to the cooler 11.

The conditioned air passes from the conditioner through the ducts 36 to the individual rooms. In each room is mounted a local recirculation unit 37. The conditioned air passes from the ducts 36 through the branch ducts 36a into the passages 40a which lead into the compartments 40. The compressed air passes from the compartments 40 between the injector lips 41 to discharge through the slot 48 between the heater sections 45. Recirculated air is drawn from the room through the grille 42 by the injector action of the primary air and this recirculated air is deflected downwardly by the wall 44 to pass the spray nozzles 46 and then passes upwardly through the channel 47 to pass through the heaters 45 to be discharged with the primary air through the discharge grille 38.

It may be desired to maintain a relative humidity in any one room higher than that maintained as previously described by the general humidostat 14. Accordingly, an adjustable humidostat 39 adjusts the solenoid valve 50 to control the supply of water to the humidifier nozzles 46 in the units 37. The recirculated air is seen to be exposed throughout the width of the unit to the washing and humidifying action of the sprays. Waste water from the units 37 is carried away by the pipes 51 to the drain. It is seen that the air may be heated and humidified in the central conditioner and also heated and humidified in one or more of the local recirculation units. The present system was designed for a hospital where it was required that low relative humidities be maintained in certain rooms where patients were treated as for arthritis, while high relative humidities were required in operating rooms to discourage static electricity.

Under extreme conditions of operation, 60% of the total work is accomplished by the absorption system with approximately a 20% saving over mechanical refrigeration. A larger saving is accomplished through the thermodynamic efficiency of the absorption system in that under less than full load conditions, reheating is not required as it would be in the usual mechanical refrigeration system.

While 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 apparatus and arrangement described, as many departures may suggest themselves to those skilled in the art, without departing from the spirit of the invention.

What is claimed is:

1. An air conditioning unit comprising a relatively tall and relatively narrow upright casing, a recirculated air grille in the lower portion of one side of said casing, an air discharge grille in the upper portion of said casing, a partition in said casing extending from said one side above said recirculated air grille to a point below said grille for causing the recirculated air to flow in said casing, first in a downward and then in an upward path, and means for spraying water in the space between said partition and said one side for humidifying the recirculated air during its downward movement.

2. An air conditioning unit comprising a rela-

tively tall and relatively narrow upright casing, a recirculated air grille in the lower portion of one side of said casing, an air discharge grille in the upper portion of said casing, a partition in said casing extending from said one side above said recirculated air grille to a point below said grille for causing the recirculated air to flow in said casing, first in a downward and then in an upward path, and a plurality of spray nozzles in the space between said one side and said partition arranged to spray water downwardly into the recirculated air during its downward movement.

3. An air conditioning unit comprising a relatively tall and relatively narrow upright casing, a recirculated air grille in the lower portion of one side of said casing, an air discharge grille in the upper portion of said casing, a partition in said casing extending from said one side above said recirculated air grille to a point below said grille for causing the recirculated air to flow in said casing, first in a downward and then in an upward path, means for spraying water in the space between said partition and said one side for humidifying the recirculated air during its downward movement, a heater adjacent said outlet for heating the humidified recirculated air, and means between said heater and said partition for inducing the flow of recirculated air through said casing.

4. An air conditioning unit comprising a relatively tall and relatively narrow upright casing, a recirculated air grille in the lower portion of one side of said casing, an air discharge grille in the upper portion of said casing, a partition in said casing extending from said one side above said recirculated air grille to a point below said grille for causing the recirculated air to flow in said casing, first in a downward and then in an upward path, a plurality of spray nozzles in the space between said one side and said partition arranged to spray water downwardly into the recirculated air during its downward movement, a heater adjacent said outlet for heating the humidified recirculated air, and means between said heater and said partition for inducing the flow of recirculated air through said casing.

5. An air conditioning unit comprising a relatively tall and relatively narrow upright casing, a recirculated air grille in the lower portion of one side of said casing, an air discharge grille in the upper portion of said casing, a partition in said casing extending from said one side above said recirculated air grille to a point below said grille for causing the recirculated air to flow in said casing, first in a downward and then in an upward path, and a plurality of downwardly projecting spray nozzles spaced longitudinally of said casing in the space between said one side and said partition and arranged below said recirculated air grille for spraying water into the recirculated air during its downward movement.

6. An air conditioning unit comprising a relatively tall and relatively narrow upright casing, a recirculated air grille in the lower portion of one side of said casing, an air discharge grille in the upper portion of said casing, a partition in said casing extending from said one side above said recirculated air grille to a point below said grille for causing the recirculated air to flow in said casing, first in a downward and then in an upward path, and a plurality of downwardly projecting spray nozzles spaced longitudinally of said casing in the space between said one side and said partition and supported by said partition below said recirculated air grille for spraying water into the recirculated air during its downward movement.

7. An air conditioning unit comprising a relatively tall and relatively narrow upright casing, a recirculated air grille in the lower portion of one side of said casing, an air discharge grille in the upper portion of said casing, a partition in said casing extending from said one side above said recirculated air grille to a point below said grille for causing the recirculated air to flow in said casing, first in a downward and then in an upward path, a plurality of downwardly projecting spray nozzles spaced longitudinally of said casing in the space between said one side and said partition and supported by said partition below said recirculated air grille for spraying water into the recirculated air during its downward movement, a heater adjacent said outlet for heating the humidified recirculated air, and means between said heater and said partition for inducing the flow of recirculated air through said casing.

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