May 23, 1939. H. R. SEWELL ET AL 2,159,570

AIR CONDITIONING SYSTEM UTILIZING REFRIGERATION

Filed Dec. 4, 1936 3 Sheets-Sheet 1

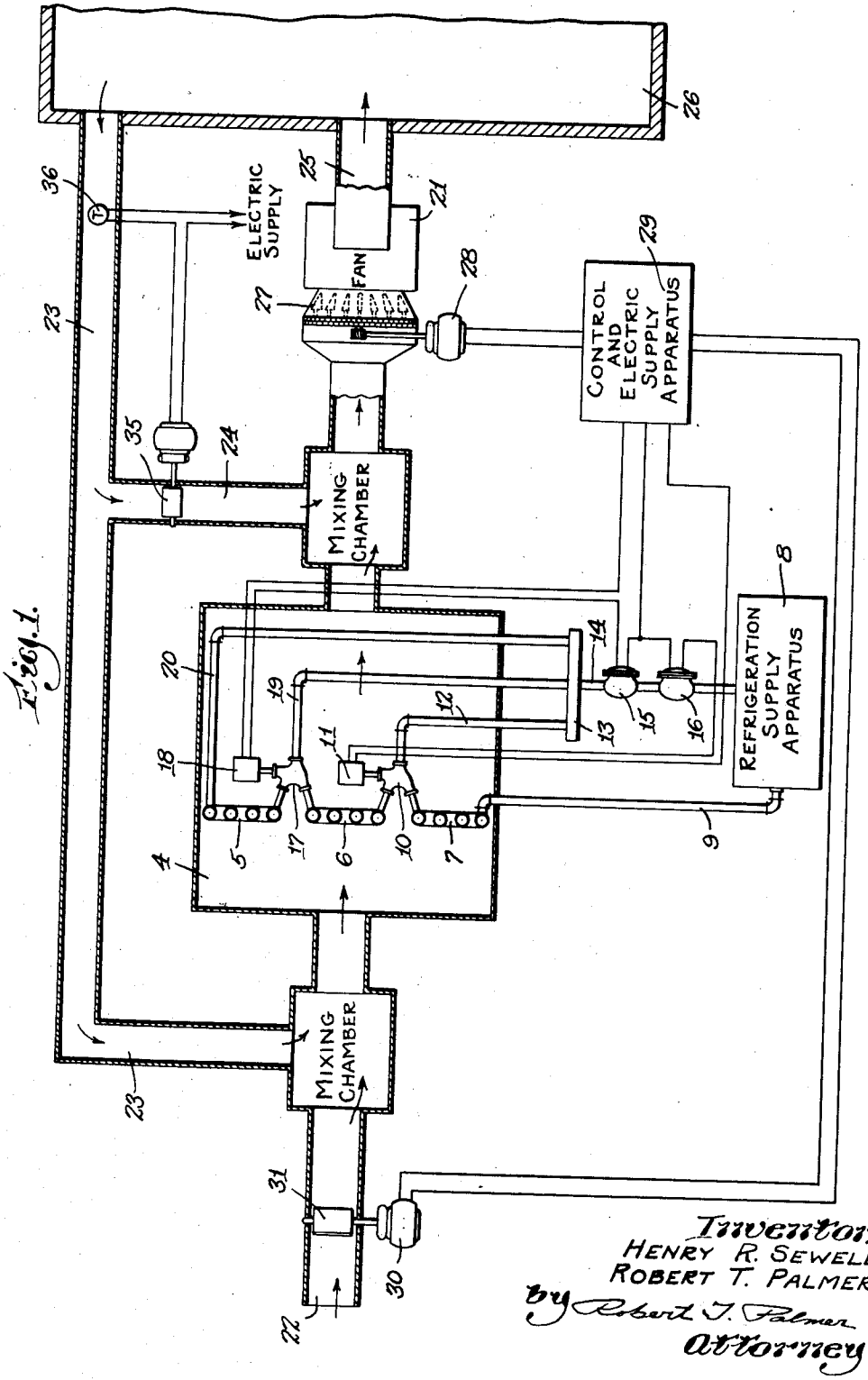


Fig. 1.

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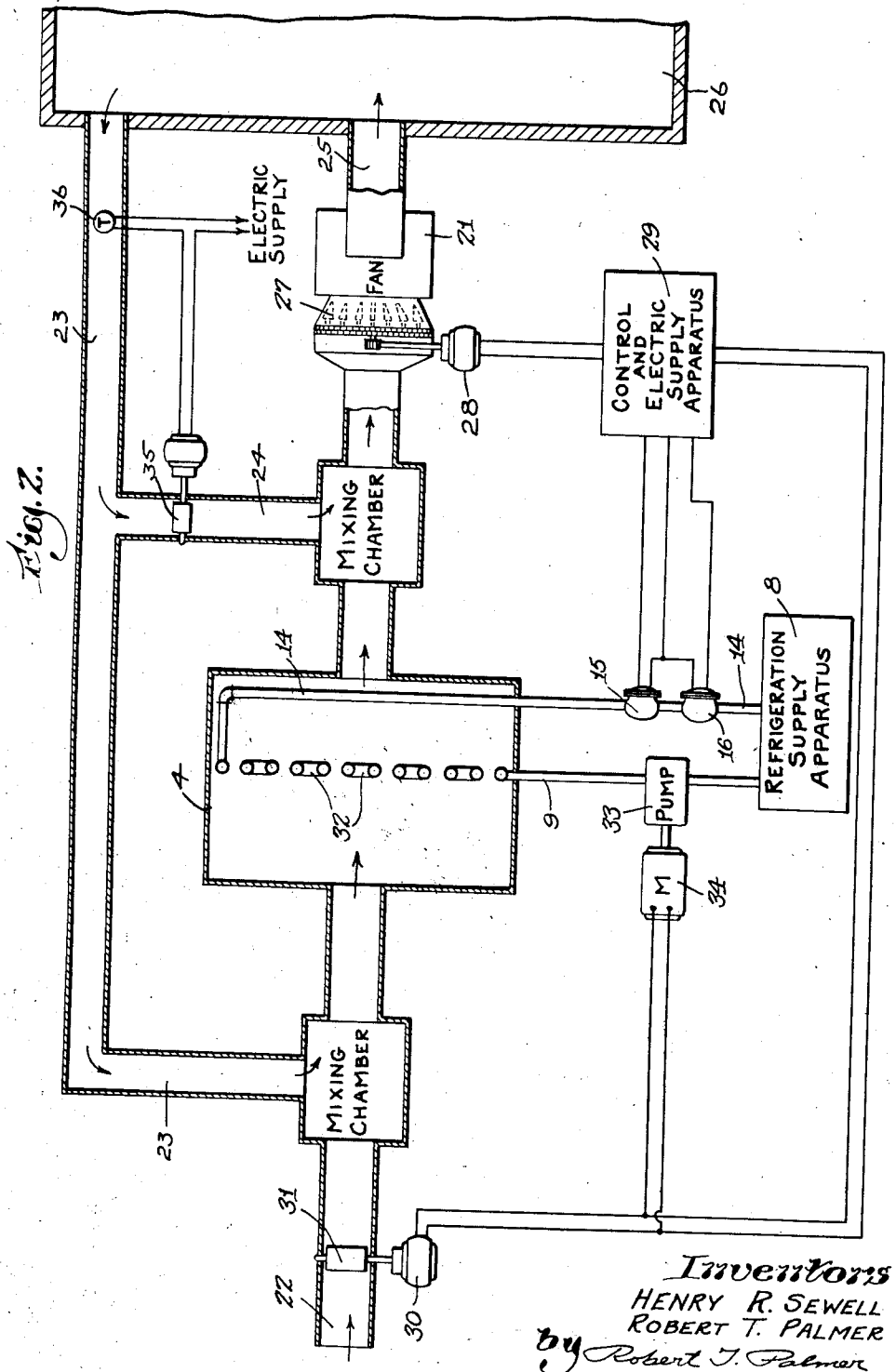


Fig. 2.

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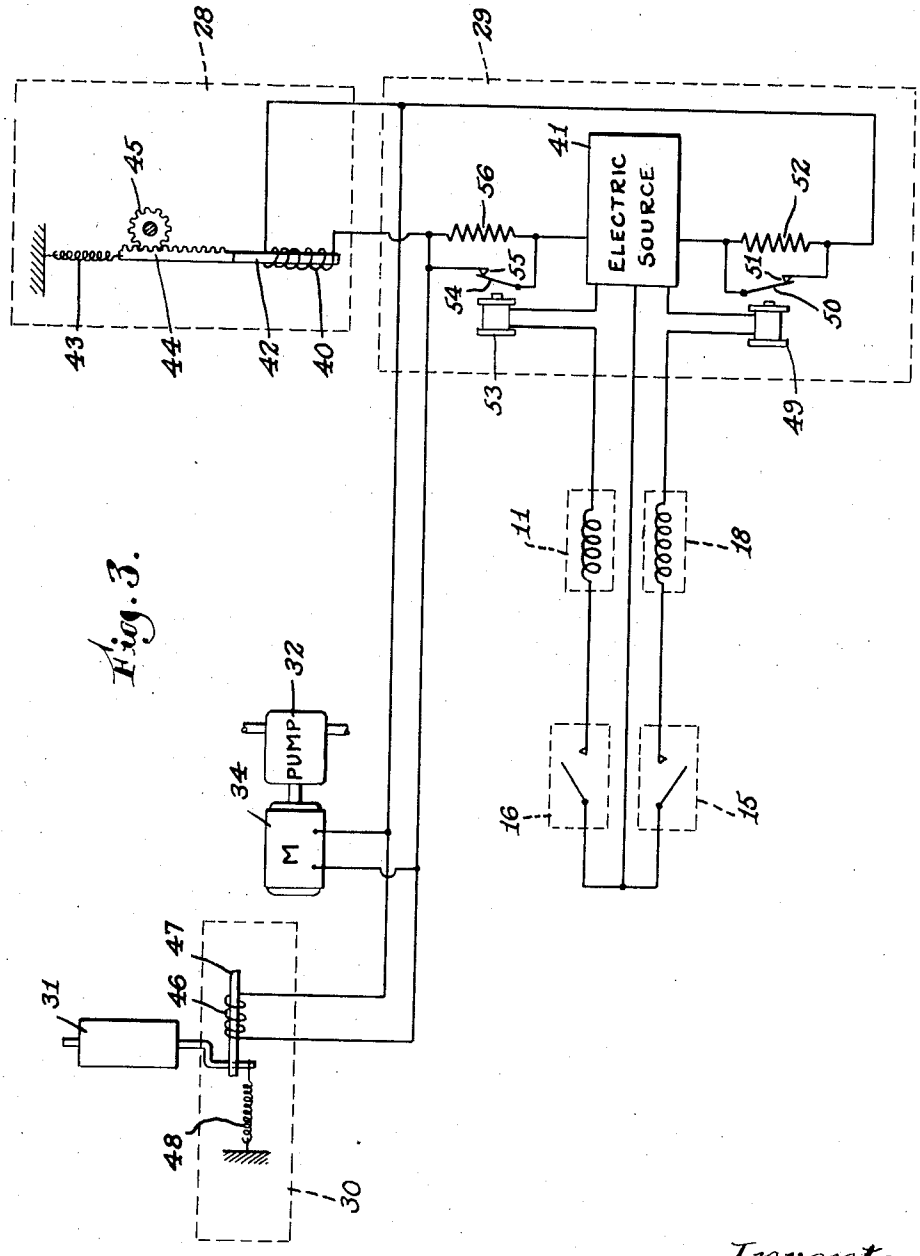


Fig. 3.

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AIR CONDITIONING SYSTEM UTILIZING REFRIGERATION

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Application December 4, 1936, Serial No. 114,216

8 Claims. (Cl. 62—6)

This invention relates to air conditioning systems utilizing refrigeration and relates more particularly to a system in which the air volume and refrigerating effect is varied in accordance with temperature changes.

According to a feature of the invention, a vane control fan is used to supply variable volumes of conditioned air into an enclosure, and the vanes are adjusted in accordance with changes in the refrigerating effect required, to maintain a desired air condition.

According to another feature of the invention, the total volume of conditioned air supplied to an enclosure is decreased when a reduced refrigerating effect is required while the volume of fresh air is increased.

An object of the invention is to vary in an air conditioning system, both the air volume and the refrigerating effect as temperature conditions change.

Another object of the invention is to decrease the total volume of air delivered to an enclosure as less cooling is required and to simultaneously increase the volume of fresh air.

Another object of the invention is to adjust the supply of refrigeration and the vanes in a vane control fan moving the refrigerated air, as temperature conditions change.

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

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

Fig. 1 is a diagrammatic view of one embodiment of the invention in which the refrigerating effect is varied by varying the cooling surface;

Fig. 2 is a diagrammatic view of another embodiment of the invention in which the refrigerating effect is varied by varying the rate of flow of the refrigerant, and

Fig. 3 is a diagrammatic view of one embodiment of control apparatus which may be used with the systems of Figs. 1 and 2.

Referring now to Fig. 1 of the drawings, the conditioner indicated generally by 4, contains the three groups of air cooling coils, 5, 6 and 7. These are shown as placed across the air stream in series relationship to each other, but they may be placed in multiple. The refrigeration supply apparatus 8 which may be of any well known type utilizing direct or indirect expansion, or ice, for example, supplies a cooling fluid through the pipe 9, to the lower group of coils 7. The refrigerant leaving the coils 7 passes through the three way valve 10, if its actuating solenoid 11 is deenergized, through the coils 6, and if the solenoid 11 is energized, through the return pipe 12, header 13 and pipe 14 past the thermostats 15 and 16, to the refrigeration supply 8.

The refrigerant leaving the coils 6 passes through the three way valve 17, if its actuating solenoid 18 is deenergized through the coils 5, and if the solenoid 18 is energized, through the return pipe 19, header 13 and pipe 14 to the refrigeration supply 8.

The refrigerant leaving the coils 5 passes through the pipe 20, header 13 and pipe 14 to the refrigeration supply 8.

The fan 21 draws outside air through the duct 22 and recirculated air through the duct 23, through the conditioner 4, and draws by-pass air through the duct 24, and discharges the mixed air through the duct 25 into the enclosure 26.

The fan 21 is of the constant speed variable volume type utilizing what are known as vane controls for varying the volume of air acted upon by the fan. Such fans are disclosed by the H. F. Hagen Patent Nos. 1,846,863 and 1,989,413. In brief, the air volume is varied by adjusting spin inducing vanes in the fan inlet from open towards closed position. In wide open position, the vanes have no effect upon the air and as they are adjusted towards closed position they impart more and more spin to the air entering the fan with the result that the air is acted upon to a less extent by the fan wheel. In the present embodiment, the vanes 27 are adjusted by the motor 28 under control of the control apparatus 29 to vary the volume of air moved by the fan 21.

The control apparatus 29 is controlled by the thermostats 15 and 16 in the refrigerant return line 14. These thermostats control directly the solenoids 11 and 18 and control through the control apparatus 29, the volume of air moved by the fan 21, and the operation of the damper control motor to adjust the position of the damper 31 in the fresh air duct 32.

Air conditioning installations have been installed and are now being operated, which utilize vane control fans for varying the volume of conditioned air discharged into the space served. In such installations, the vanes have been adjusted by thermostats exposed to air in the rooms served and such thermostats functioned when additional cooling was required, by increasing the air volume and functioned when less cooling was required by decreasing the air volume. An increased heat load was taken care of solely by supplying a greater volume of conditioned air, which moved

through a conditioner in which the refrigerating effect was maintained constant.

According to this invention, as less cooling is required, both the volume of air and the refrigerating effect are reduced and as more cooling is required, more air and a greater refrigerating effect is supplied.

According to a feature of this invention, the temperature of the return refrigerant determines when more or less cooling is required. This is accomplished by the thermostats 15 and 16 as will now be explained. When the temperature of the refrigerant passing the thermostat 15 reaches a predetermined low point, this shows that the condition of the air passing through the coolers is such that less refrigeration is required. The thermostat 15 therefore acts to energize the solenoid 18 to return the refrigerant from the coils 6 back through the pipe 19 to the refrigerating supply 8, thus rendering the coils 5 ineffective. At the same time, the control apparatus 29 adjusts the vanes 27 in the inlet of the fan 21 to cause the movement of a smaller volume of air.

If the temperature of the return refrigerant continues to fall, the thermostat 16 functions to energize the solenoid 11 which acts to shunt the coils 6 out of service, and the control apparatus 29 functions to reduce further the air volume.

Of course, instead of discontinuing the supply of refrigerant to first one and then a second group of coils, the volume of refrigerant supplied to the coils may be throttled by the apparatus of Fig. 2.

In many buildings occupied by humans, a considerable portion of the load imposed upon an air conditioning system, is due to sun and wind effect, lights, motors, and other load factors other than those resulting from the heat and moisture given off by the occupants. Changes in load are not always due therefore to changes in the number of occupants and often when the air volume is decreased upon a decrease in load, insufficient fresh air is provided for it has been the practice in the past to vary the volume of fresh air proportional to the volume of total air.

According to another feature of this invention, as the total air supplied to an enclosure is decreased, the proportion of fresh air is increased. This is accomplished in the embodiment illustrated by Fig. 1 by the control apparatus 29 functioning when it adjusts the vanes 27 towards closed position, to adjust the damper control motor 30 to move the fresh air damper towards open position.

In the embodiment of the invention illustrated by Fig. 2, the greater part of the apparatus is identical with that of Fig. 1 and hence has been identified by the same reference characters. In this embodiment, the coils 32 are placed across the air stream in the conditioner 4 and the refrigerant from all coils is returned to the refrigeration supply apparatus 8 through the single return pipe 14. Refrigerant is supplied to the coil by the pump 33 driven by the motor 34. As the control apparatus 29 is actuated by the thermostats 15 and 16 to lower the air volume by adjustment of the vanes 27, and to increase the proportion of fresh air by adjusting the damper control motor 30, it also acts to adjust the speed of the pump motor 34 to cause the pump 33 to be operated more slowly so as to supply refrigerant at a lower rate to the coils 32.

The refrigeration supply apparatus 8 is preferably adjusted to supply refrigerant at a constant low temperature. Then as less refrigerating effect is required, less refrigerant is circulated and less air is conditioned. The controls of the system may therefore be so adjusted that air having a constant dew point temperature will be delivered by the conditioner.

In both embodiments, the by-pass air damper 35 under control of the thermostat 36 in the recirculated air duct 23 may be provided for varying the proportions of by-pass air to conditioned air if the system is for any reason out of balance.

While coil coolers have been illustrated, it is obvious that a plurality of spray coolers could be used and in fact are preferred in many types of installations.

One embodiment of the control apparatus indicated generally by 29 in Figs. 1 and 2 is shown in more detail by Fig. 3. For purposes of illustration, the control motors 28 and 30 are shown as of the solenoid type while the pump motor 34 is of the rotary type. Fig. 3 as is applies to Fig. 2. In Fig. 1 there is of course no pump motor 34 but otherwise Fig. 3 applies to Fig. 1.

Normally the motors 28, 30 and 34 are connected to the electric source without being influenced by the thermostats 15 and 16. The solenoid 40 under full voltage from the electric source 41 maintains its plunger 42 at lower-most position against the opposition of the spring 43. The plunger 42 carries the rack 44 which then holds the pinion 45 of the fan adjusting mechanism in a position corresponding to open position of the vanes of the fan. Likewise the solenoid 46 of the motor 30, against the opposition of the spring 48 holds the damper 31 towards closed position. The pump motor 34 under full voltage from the source 41 rotates at maximum speed.

When the temperature of the refrigerant falls to a predetermined point, the thermostat 15 first closes its contacts to energize the circuit including the valve solenoid 18, the relay 49 and the electric source 41. The relay 49 pulls over its armature 50 causing it to leave the contact 51 and open the shunt around the resistance 52 causing this resistance to be placed in series with the motors 28, 30 and 34. These are thus supplied with reduced voltage from the source 41. The pull of the solenoids 40 and 46 on the plungers 42 and 47 respectively is less and the springs 43 and 48 move the plungers 44 and 47 respectively, outwardly. This causes the rack 44 to rotate the pinion 45 to move the vanes towards closed position and causes the plunger 47 to rotate the damper 31 towards open position. The motor 34 rotates at reduced speed.

Upon a further drop in the temperature of the refrigerant, the thermostat 16 closes its contacts and closes a circuit including the electric source 41 and the relay 53. The relay 53 pulls over its armature 54 causing it to leave the contact 55. This opens the shunt circuit around the resistance 56 causing it to be included in the circuit from the electric source 41 to the motors 28, 30 and 34. This causes a reduced voltage to these motors which results again in the vanes of the fan being adjusted further towards closed position, the damper 31 to be adjusted further towards open position, and the motor 34 to rotate at a still slower speed.

While two embodiments of the invention have been disclosed for the purpose of illustration, it should be understood that the invention is not limited to the arrangements described, as many departures therefrom may be made by those skilled in the art, without departing from the spirit of the invention.

What is claimed is:

1. Air conditioning apparatus comprising an air cooler, a fan for moving air through said cooler and for supplying air from said cooler into a room, spin inducing vanes in the inlet to said fan for varying the volume of the air moved thereby, means for adjusting said vanes, means for circulating a refrigerant through said cooler, and means in heat exchange contact with the refrigerant returned from said cooler for actuating said first mentioned means.

2. Air conditioning apparatus comprising an air cooler, a fan for moving air through said cooler and for supplying air from said cooler into a room, spin inducing vanes in the inlet to said fan for varying the volume of the air moved thereby, means for adjusting said vanes, means for circulating a refrigerant through said cooler, and means in heat exchange contact with the refrigerant returned from said cooler for actuating said first mentioned means and for varying the effectiveness of said second mentioned means.

3. Air conditioning apparatus comprising an air cooler, a fan for moving air through said cooler and for supplying air from said cooler into a room, means for adjusting the volume of air moved by said fan, means for admitting outside air into said cooler, means for circulating a refrigerant through said cooler, and means in heat exchange contact with the refrigerant returned from said cooler for adjusting said first mentioned means for varying the volume of air moved by said fan and for varying the effectiveness of said second mentioned means.

4. Air conditioning apparatus comprising an air cooler, a fan for moving air through said cooler and for supplying air from said cooler into a room, means for varying the volume of air moved by said fan, means for admitting outside air into said cooler, means for circulating a refrigerant through said cooler, and means responsive to the temperature of the refrigerant returned from said cooler for adjusting said first mentioned means for varying the volume of air moved by said fan and for varying the effectiveness of said second and third mentioned means.

5. Air conditioning apparatus comprising an air cooler, a fan for moving air through said cooler and for supplying air from said cooler into a room, volume control means for said fan, means for supplying a refrigerant to said cooler, and means for adjusting said volume control means for varying the volume of air moved by said fan in accordance with changes in the temperature of said refrigerant caused by absorption of heat by said cooler from the air moved therethrough.

6. Air conditioning apparatus comprising an air cooler, a fan for moving air through said cooler and for supplying air from said cooler into a room, volume control means for said fan, means for supplying a refrigerant to said cooler, and means for varying the effectiveness of said last mentioned means for varying the volume of refrigerant supplied to said cooler and for adjusting said volume control means for varying the volume of air moved by said fan in accordance with changes in the temperature of said refrigerant caused by absorption of heat by said cooler from the air moved therethrough.

7. Air conditioning apparatus comprising an air cooler, a fan for moving air through said cooler and for supplying the air into a room, means for varying the volume of air moved by said fan, means for supplying fresh air into said cooler, means for supplying a refrigerant to said cooler, and means for adjusting said volume control means for varying the volume of air moved by said fan and for adjusting said second mentioned means for inversely varying the volume of fresh air supplied to said cooler in response to changes in the temperature of said refrigerant caused by absorption of heat from the air moved through said cooler.

8. Air conditioning apparatus comprising an air cooler, a fan for moving air through said cooler and for supplying air from said cooler into a room, volume control means for said fan, means for supplying fresh air into said cooler, means for supplying a refrigerant to said cooler, and means for varying the effectiveness of said last mentioned means for varying the volume of refrigerant supplied to said cooler, and for adjusting said volume control means for varying the volume of air moved by said fan, and for adjusting said second mentioned means for inversely varying the volume of fresh air supplied to said cooler in response to changes in the temperature of said refrigerant caused by absorption of heat from the air moved through said cooler.

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