

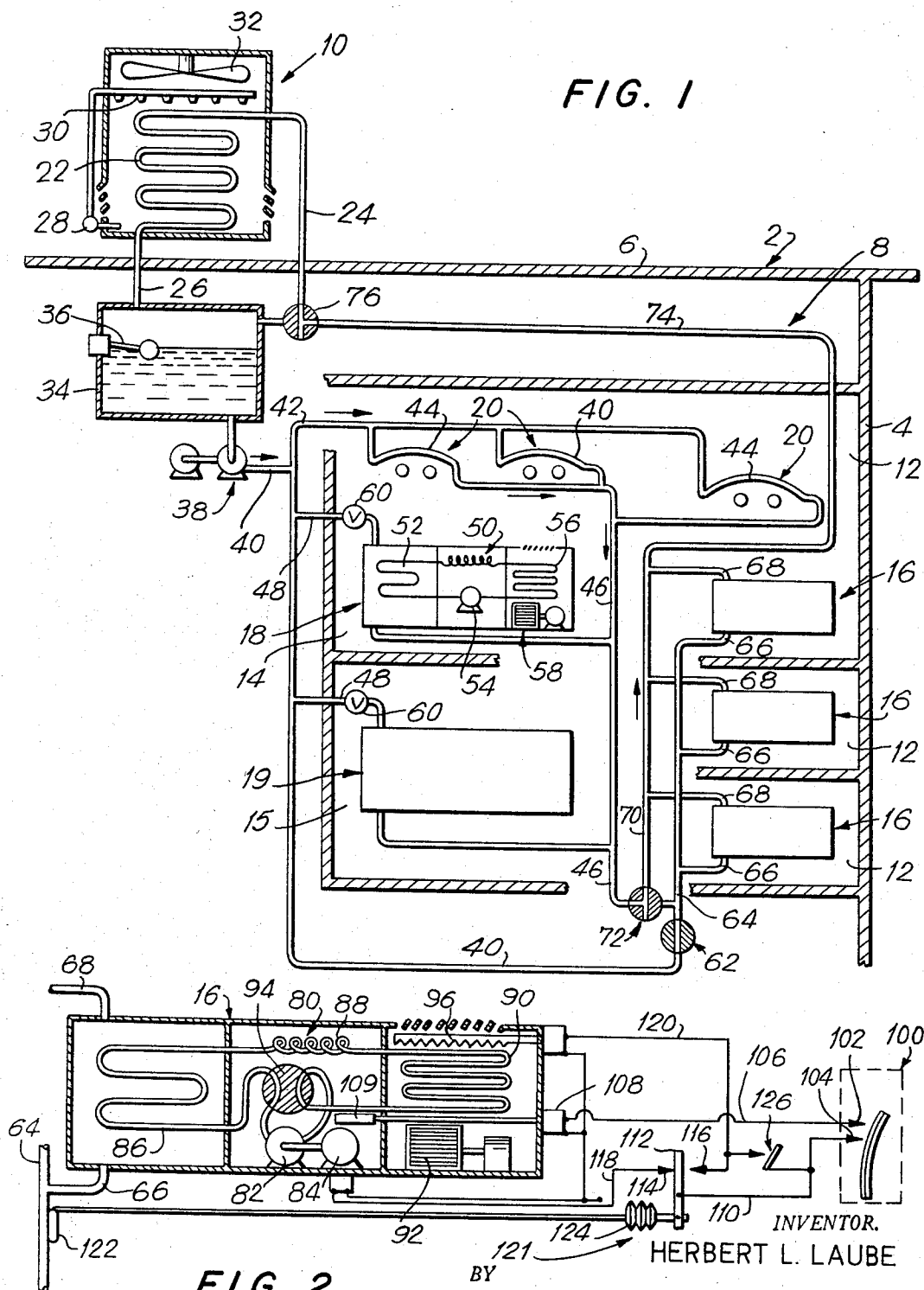
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AIR CONDITIONING SYSTEM

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1

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AIR CONDITIONING SYSTEM

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ABSTRACT OF THE DISCLOSURE

An air conditioning system for a building having several zones at least one of which requires only cooling and several of which require either heating or cooling. A self-contained refrigeration system is provided in each of the zones and a heat exchange fluid such as water is circulated to carry heat from the condensers of the units in the zone or zones requiring only cooling and to deliver heat to or carry heat away from the units in the other zones. A tank is provided to which the circulated water is returned through either the cooling tower or directly from the return line. Hence, the steam or water which passes through the units in the zone or zones requiring only cooling may be passed directly to the water tank without passing through the cooling tower and the heat picked up by it is then delivered to the other units.

This invention relates to air conditioning, and more particularly to heating and cooling systems for buildings of the type which have separate rooms or spaces, some of which require heating and cooling, and others of which may require only cooling during the normal period of occupancy.

It is an object of the present invention to provide an efficient and dependable air conditioning system for a building having exterior rooms which may require either heating or cooling and interior rooms which normally require only cooling. It is a further object to provide an improved air conditioning system of the type which utilizes a circulating liquid to transfer heat from one space or a plurality of spaces to other spaces where the heat is utilized or required by operating individual refrigeration systems which act as heat pumps, but which may also be operated to cool their respective spaces. It is a further object to provide air conditioning systems of the above types which are simple in construction and operation and efficient and dependable in use, and which are free of difficulties which have been encountered with prior similar systems. These and other objects will be in part obvious and in part pointed out below.

In the drawing:

FIGURE 1 is a somewhat schematic representation of an air conditioning system constituting one embodiment of the invention; and,

FIGURE 2 is an enlarged sectional view of a unit in an exterior space of the embodiment of FIGURE 1, with the electrical controls represented.

Referring to FIGURE 1 of the drawings, a building 2 is represented by one outside wall 4 and a roof 6. Installed within the building is an air conditioning system 8 which has upon the building roof a cooling tower 10. Within the building there is a circulating liquid system by means of which streams of circulating liquid flow through the building to transfer heat from one space to another or to the cooling tower, as the case may be. In this embodiment, the circulating liquid is water, although it may be a glycol solution or another heat transfer liquid. Building 2 has exterior spaces, represented by rooms 12 along wall 4, and interior spaces 14 and 15 at the center of the figure. Each of rooms 12 has a self-contained air conditioning unit 16 which provides it with the desired

2

heating and cooling. During normal periods of occupancy spaces 14 and 15 require only cooling, and they are provided with self-contained air conditioning units 18 and 19, respectively. Units 16 are of the heat pump type, that is, they may be operated as conventional air cooling units or they may be operated on reverse cycle to heat the air in their respective rooms or spaces. Each of the rooms and spaces has one or more light fixtures 20, some of which are not shown.

Cooling tower 10 is of the evaporative cooler type, which has a cooling coil 22 through which the circulating water flows from an inlet pipe 24 to an outlet pipe 26. A water pump 28 circulates tower water from a sump in the bottom of the tower to a spray header 30 from which the water flows downwardly over coil 22. A fan 32 in the top of the tower draws air into the tower at the bottom and exhausts it upwardly at the top, thus to cause rapid evaporation of the water and cooling of the circulating water in coil 22.

Pipe 26 leads to a supply tank 34 to which fresh water is supplied under the control of a float valve 36, and from which water is withdrawn by a pump 38 driven by an electric motor. Pump 38 discharges a stream of primary circulating water through a distribution line or pipe 40 which has a branch 42 through which water flows to a heat transfer unit 44 in each of the various light fixtures 20. When passing through units 44, the circulating water absorbs and carries away the excess heat produced by the light fixtures. The circulating water from units 44 flows to a heated water line 46. Primary circulating water also flows from line 40 through lines 48 to each of units 18 and 19.

Each of units 18 and 19 includes a refrigeration system 50 which has a water-cooled condenser 52, a compressor 54, an evaporator 56, a capillary tube expansion device, and the other standard components. There is also a blower 58 which is driven by an electric motor and is operative to circulate air through evaporator 56 and to provide for the distribution of the cooled air in the spaces 14 and 15. Each of the lines 48 has a normally-closed valve 60 which is open whenever its refrigeration system 50 is operated, so as to cause the circulating water to flow through the water-cooled condenser where it is heated. The water is discharged into the heated circulating water line or pipe 46.

Line 40 also supplies primary circulating water to each of the units 16 through a plurality of supply risers 64 each of which extends from a valve 62 upwardly past several units 16. A discharge riser 70 also extends upwardly parallel to riser 64, and it is connected at the bottom through a valve 72 to the end of the heated circulating water line 46. Each valve 62 may be turned so as to restrict or stop water flow to its riser 64 from line 40, and valve 72 may be turned one-quarter turn counter-clockwise so that line 46 is disconnected from riser 70 and is connected to the riser 64. Valves 62 and 67 are positioned as shown whenever it is desirable for any unit on the particular riser 64 to either heat or cool air. When all of the units on that riser are operating as heat pumps, valve 72 may be turned to connect line 46 to riser 64, and then valve 62 is positioned either completely or partially closed to insure that the heated water from line 46 flows to the riser, but that additional water is supplied through valve 62 to insure the proper supply to the riser.

Each of units 16 has a water inlet line 66 connected to riser 64 and a water outlet line 68 connected to deliver water to riser 70. The top of riser 70 is connected through a line 74 and a valve 76 to pipe or line 24 which extends to the cooling tower. Hence, the circulating water passes upwardly from riser 70 to the tower where it is cooled, and it is then discharged into

3

tank 34. However, as will be explained more fully below, the cooling tower is not operated to cool the circulating water when all of the units 16 of the system are operating as heat pumps. Valve 76 may be turned manually or automatically to deliver all or part of the circulating water directly from line 74 into tank 34.

Referring now to FIGURE 2, one of the units 16 is shown schematically along with certain of its controls. The unit has a refrigeration system 80 formed by a compressor 82 driven by an electric motor 84, a water-cooled condenser-evaporator coil 86 which is in heat exchange relationship with the circulating water which flows through the unit from line 66 to line 68, a capillary tube expansion device 88, and an evaporator-condenser coil 90 through which air is directed by a blower 92 driven by an electric motor. A four-way valve 94 is connected between compressor 82 and coils 86 and 90 so as to operate the system to either cool or heat the air from blower 92. When valve 94 is positioned as shown, compressor 82 discharges the compressed refrigerant into coil 86 so that that coil acts as a water-cooled condenser, and refrigerant is withdrawn from coil 90 so that that coil acts as an evaporator. When valve 94 is turned one-quarter turn clockwise from the position shown, the refrigerant is withdrawn from coil 86 so that it acts as an evaporator, and the compressed refrigerant is delivered to coil 90 so that it acts as a condenser to heat the air from blower 92. An electric heater unit 96, comprising strip heaters, is also positioned in the path of the air from the blower. Hence, when desirable, the air may be heated simultaneously by the electric heater unit and by heat-pump operation of the refrigeration system. However, as will be explained more fully below, the more usual operation in this embodiment is to provide heating by the heat-pump operation, and to use the electric heater unit only when the heat-pump operation is not feasible.

The control for unit 16 includes manual and thermostatic controls which are not shown, but which provide the standard controls for unit 16 when it is operating to cool the air in the space or room. However, a wall thermostat 100 with contacts 102 and 104 is also provided which controls the operation of unit 16 when it is operating as a heat pump. Contact 102 is connected through a line 106 to a relay 108 which is energized to operate a unit 109 which turns valve 109 one-quarter turn from the full line position, so that the refrigeration system operates as a heat pump. Contact 104 is connected through a line 110 to the armature 112 of a switch having a pair of contacts 114 and 116. Contact 114 is connected through a line 118 to the relay for motor 84, and contact 116 is connected through a line 120 to a relay for heater unit 96. Armature 112 is adapted to be moved between contacts 114 and 116 in accordance with the temperature of the circulating water in riser 64. For that purpose, a thermostatic control unit 121 is provided which has a bulb 122 positioned to be responsive to the temperature of the circulating water in riser 64. Bulb 122 is connected through a tube to a bellows 124 which is mechanically connected to an extension of the pivoted armature 112. The arrangement is such that when the temperature of the circulating water in riser 64 is high enough to make the heat pump operation feasible, armature 112 is positioned as shown in the drawing. However, when the circulating water temperature drops below that critical value, the thermostatic control unit 121 swings armature 112 away from contact 114 and against contact 116. Hence, when heating is called for, the refrigeration system operates as a heat pump, provided the circulating water temperature is above the critical temperature which makes heat pump operation feasible; otherwise, a call for heat energizes the electric heater unit 96. A manual switch 126 is connected in parallel with the switch formed by contact 116, so that the electric heater unit may be energized manually, even though the refrigeration system is operating as a heat pump, or when it has been turned off.

4

The provision of both the electric heating units and the heat pump systems permits efficient and versatile operation. Any of the units 16 may be operated individually, or there may be a master control system which starts them or renders them inoperative and permits individual control in accordance with the demands of the various rooms. The electric heater units provide for quick "warm-up," for example, in the morning when the internal load is small or negligible. Also, during daytime operation when the system is operating to cool the air in rooms or spaces 12, the temperature in one room or space 12 may be sufficiently low to require heating. In that event, that unit 16 may be operated as a heat pump, or its refrigeration system may be turned off and its electric heater unit used to provide the desired heat.

While units 18 and 19 generally are identical, in this embodiment unit 19 is identical with units 16, because while space 15 normally requires only cooling, it may be heated when desired. For example, if the building has been unoccupied for an extended period of time, the temperature on the inside of the building may be lower than desired. In such event, heat may be provided by the electric heater unit, and circumstances may make heat pump operation feasible.

It has been indicated above that the cooling tower is used to dissipate the heat which is picked up by the circulating liquid and is not utilized by the heat pump operation. In cold weather, the cooling tower is normally out of service, so that valve 76 is turned to short circuit the cooling tower and deliver the circulating water from pipe 74 to tank 34. The invention contemplates that there may be circumstances when the circulating liquid will be passed through coil 22 in the cooling tower without there being evaporative cooling of water supplied from spray header 30. With that mode of operation, coil 22 is a "dry" heat transfer coil which passes the circulating liquid into heat transfer relationship with the air, and the circulating liquid may be a glycol solution or another liquid which does not tend to freeze. Such operation permits the dissipation of a substantial amount of heat at relatively low ambient temperatures. Also, it provides a source of heat under some conditions of operation.

This invention is limited to the above-identified illustrative embodiment only to the extent that the claims are so limited.

What is claimed is:

1. In an air conditioning system for separate spaces a plurality of which require either heating or cooling and at least one other of which requires only cooling during normal operation, the combination of, a plurality of individual air conditioning units each of which is operative to either heat or cool one of said plurality of spaces and which is operative to extract heat from or to deliver heat to a circulating liquid, a refrigeration system which is operative to cool said one other space and to deliver heat to said circulating liquid, means constituting a supply of primary circulating liquid, liquid circulating means including pump means to circulate the circulating liquid to absorb heat from said refrigeration system to provide a stream of heated circulating liquid, said liquid circulating system also including means to alternatively supply to any of said plurality of air conditioning units either said primary circulating liquid or said heated circulating liquid, electric heater means comprising a plurality of electric heater units positioned respectively in heat exchange relationship with the air for said plurality of spaces, and control means for the system including individual thermostat means for each of said plurality of air conditioning units adapted to control the heating and cooling of the air for its space, said control means including means responsive to the drop to a predetermined value of the temperature of said stream of heated circulating liquid to disconnect any of said plurality of air conditioning units for operating to heat the air in its respective space and to energize

5

said electric heater units to supply heat to that space as required.

2. The combination as described in claim 1 wherein there are heat producing components in the spaces and which includes, heat transfer means through which the circulating liquid passes to absorb heat from said components and the liquid so passed is added to said stream of heated circulating liquid.

3. The combination as described in claim 2 wherein said components are lighting fixtures.

4. A combination as described in claim 1 wherein said means constituting a supply of primary circulating liquid comprises a storage tank and means to supply water thereto, and a cooling tower through which the stream of heated circulating liquid passes so as to be cooled, and means to deliver the cooled circulating liquid to said tank.

5. The combination as described in claim 1 wherein said control means includes pipes carrying said heated circulating liquid and a stream of said primary circulating liquid to a riser, valve means at said riser to control the flow of circulating liquid thereto, means providing liquid connections from said riser to and from each of said air conditioning units, and means to return the liquid to said supply.

6. The combination as described in claim 5 wherein each of said air conditioning units has a heat transfer coil which acts as either an evaporator or a condenser and which either delivers heat to or receives heat from the circulating liquid supply to that air conditioning unit.

7. In an air conditioning system for separate spaces a plurality of which require either heating or cooling and at least one other of which requires only cooling during normal operation, the combination of, a plurality of individual air conditioning units each of which has air heat exchange means past which air flows to one of said

6

plurality of spaces to thereby either heat or cool the air, each of said air conditioning units also having liquid heat exchange means past which a primary circulating liquid flows to either extract heat from or to deliver heat to said primary circulating liquid, a refrigeration system which is operative to cool said one other space and to deliver heat to said primary circulating liquid, liquid storage means constituting a supply of said primary circulating liquid, liquid circulating means including pump means to circulate a stream of said primary circulating liquid from and to said liquid storage means along a heat absorbing path along which said refrigeration system delivers heat to said stream of said primary circulating liquid, said circulating means also circulating a stream of said primary circulating liquid simultaneously along a path in heat exchange relationship with said liquid heat exchange means of each of said air conditioning units, cooling means for said primary circulating liquid, and valve means through which all of said primary circulating liquid flows to said liquid storage means and which is operative to divert all or part of the circulating liquid through said cooling means and thence to said storage means with the remainder flowing directly to said storage means.

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