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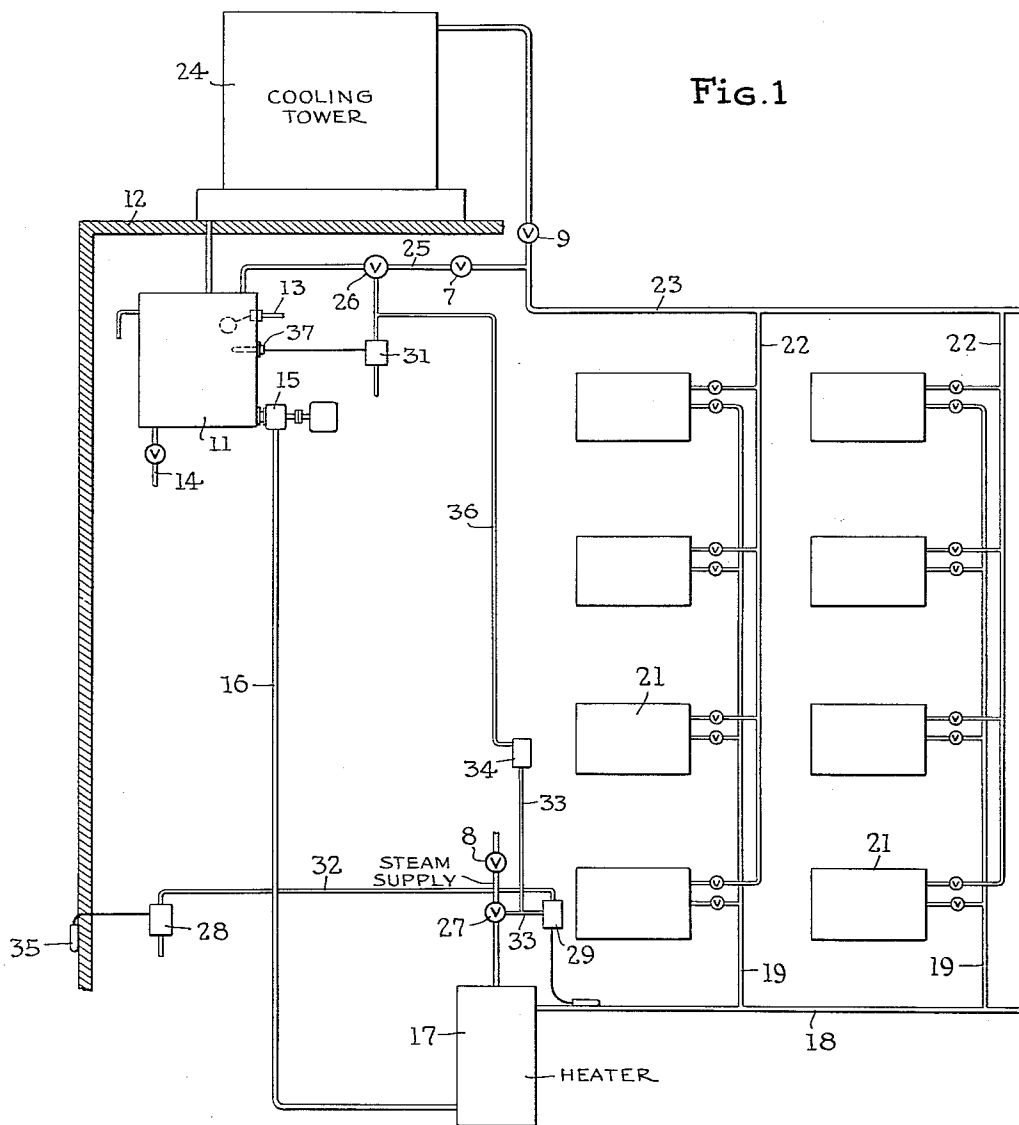
W. S. STAIR

2,715,514

AIR CONDITIONING SYSTEM

Filed Sept. 10, 1951

2 Sheets-Sheet 1



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FIG. 2

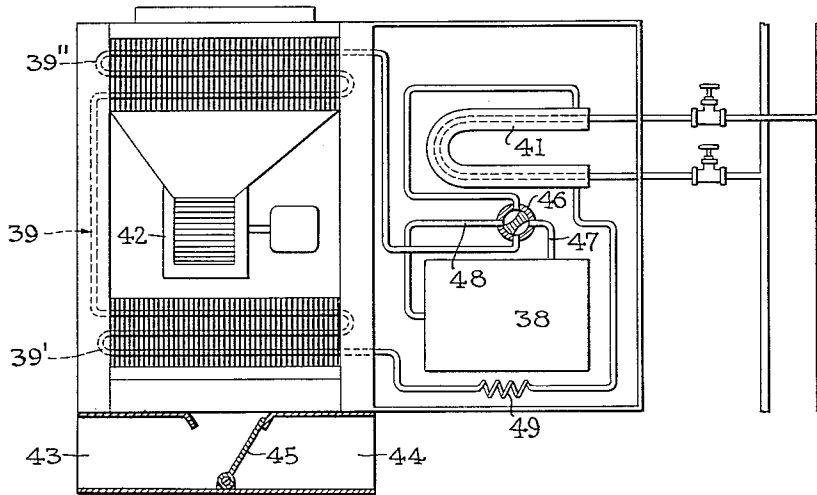
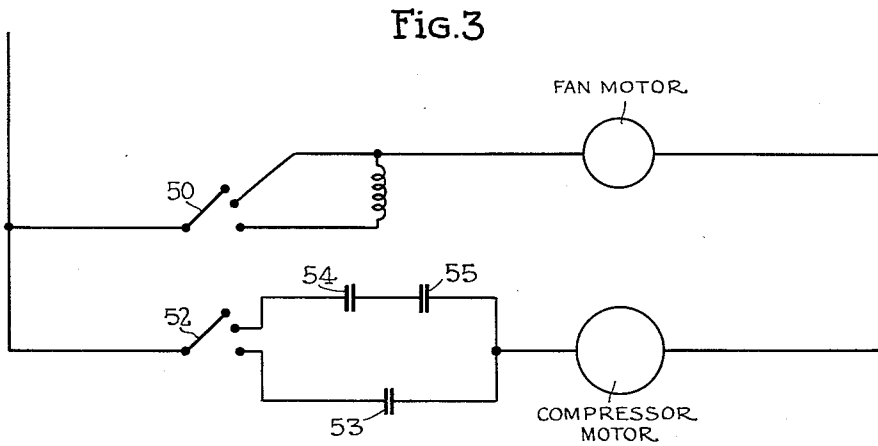


FIG. 3



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AIR CONDITIONING SYSTEM

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3 Claims. (Cl. 257—3)

This invention relates to a heating and cooling installation for office buildings, hotels, apartment houses and the like.

Specifically, it concerns an installation which comprises a central circulating system for a liquid heat exchange medium. A central heater and a central cooler are provided whereby said medium may be selectively heated or cooled. The liquid passes through the liquid paths of a plurality of heat exchangers. One of these heat exchangers is included in each of a plurality of individual room units. These room units include reversible refrigerating apparatus.

This refrigerating apparatus includes a motor driven compressor, the above heat exchanger and a second heat exchanger, the first and second heat exchangers being connected to function interchangeably as a condenser and as an evaporator. Each of the room units also includes a fan whereby room air or a mixture of room air and fresh air is circulated in heat exchange relation with the second heat exchanger. Depending upon the manner in which the compressor and the two heat exchangers are connected, the units may operate to absorb heat from the circulated air and reject it to the circulated medium or they may absorb heat from the circulated medium and supply it to the circulated air.

During the summer the room units will be operating to absorb heat from the air. Under this condition, the central cooler is operated so that the medium is at a reduced temperature when it reaches the room units.

In the winter the room units are reversely conditioned so that heat is delivered to the circulated air. Under these conditions the heater is operated so that the circulated medium is supplied to the units at an elevated temperature.

Between seasons the load on the system may be unbalanced. Under these conditions the individual room units may act either to heat or to cool the circulated air, and the operation of each unit is independent of the operation of the other units throughout the building. During this time of the year, the circulated medium is supplied to room units at the same temperature as during the heating season.

The elevated temperature to which the medium is raised during the heating season and between seasons is not so high as would preclude operation of the room units as coolers. The safe operation of the units as coolers depends upon the condensers being adequately cooled by the circulated medium. The units are so designed as to capacity that they may be operated as coolers when the temperature of the circulated medium is equal to or less than the elevated temperature. This feature insures safe operation during the between seasons period of the year. A safety switch is provided to prevent operation of the compressor should the temperature of the circulated medium become excessive. Because the elevated temperature to which the circulated medium is raised during the heating season and between seasons is not high, appreciable quantities of low-level waste heat

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from laundries, kitchens and similar sources in hotels, and apartment houses can be applied to the circulated medium to maximum advantage.

A system built according to this invention provides a single installation which is operable either to heat or to cool the building. It is also operable to heat or cool any particular room or rooms in the building independently of its operation in other rooms.

It will be seen that the system combines a heating system and individual room air conditioning units in a manner which affords an installation which is very flexible in its operation. It is not necessary that the pipes in the circulating system be insulated. The refrigerating apparatus, when acting to heat the room, operates as a heat pump. This heat pump absorbs heat from the circulated medium which may be relatively cool and supplies heat to the room air at an elevated temperature. The heat absorbed from the circulated medium must be supplied from other sources such as gas, oil or coal. Hence, the system is particularly adapted to localities where costs of these fuels are relatively high and costs of electric power relatively low. Further reduction in normal electric power rates may be anticipated by virtue of the high annual load factor resulting from operation of the motor driven compressors during the heating season and between seasons, as well as during the summer for cooling only.

Figure 1 is a diagrammatic showing of a preferred embodiment of the invention;

Figure 2 is a diagrammatic showing of one of the room units;

Figure 3 is a diagram of a typical control circuit for one of the room units.

The closed circulating system comprises an expansion tank 11 located near the roof 12 of the building. The tank 11 is provided with a float controlled make-up connection 13 and a drain 14. Liquid passes from the tank 11 through the motor driven circulatory pump 15 through the connection 16 to the heater 17. After passing through the heater 17, the liquid flows through a manifold 18 to risers 19 and to the room units generally indicated at 21. The room units are connected in parallel between the risers 19 and return lines 22 through which the heat exchange liquid flows to the collector 23 and the cooling tower 24 located on the roof of the building. From the tower 24 the fluid returns to the expansion tank 11. A by-pass 25 extends between the collector 23 and the expansion tank 11. A manual valve 7 is interposed in the by-pass 25; another, 8, in the steam supply line; and a third, 9, in the line from the collector 23 to the cooling tower.

Flow through the by-pass 25 is controlled by a pneumatically operated valve 26, as will be more fully described. The supply of steam to the heater 17 is controlled by a pneumatically operated valve 27 which is thermostatically controlled. Direct fired heating means, using any type of fuel, and a thermostatically actuated switch for its control may be substituted for heater 17 and steam valve 27. Because the temperature of the circulated medium during the heating season is far below that required in conventional hot water heating systems, maximum fuel economy is possible.

The thermostatic control system for the valves 26 and 27 includes three pneumatic thermostats 28, 29, and 31. The thermostat 28 has a branch line 32 connected to the thermostat 29. The branch line 33 of the thermostat 29 is connected to the pneumatic valve 27 and to the relay valve 34. The thermostat 28 is responsive to outdoor temperature sensed by the bulb 35. Thermostat 29 is operated in response to the temperature of the circulated medium leaving the heater 17. Thermostat 28 is a reverse-acting instrument and serves to readjust the control point of the thermostat 29 so that

the temperature of the circulating medium is varied inversely relatively to outdoor temperature, up to the predetermined maximum temperature of the circulated medium.

The relay 34 is piloted by the pressure in the branch line 33. When this pressure reaches a predetermined value the relay valve is opened and vents the branch line 36 of the thermostat 31. The valve 26 is open when the line 36 is vented. When the pressure in the branch line 33 reaches this predetermined value the valve 27 is opened. As long as the relay valve 34 is closed, the thermostat 31 controls the opening and closing of the valve 26. The thermostat 31 is responsive to the temperature of the circulated medium in the tank 11 which is sensed by the bulb 37.

The thermostat 31 is active during the between seasons period of the year to maintain a constant temperature in the tank 11. During the cooling season the valve 26 will normally remain closed. Manual valve 7 can be closed at this time.

As shown in Figure 2, the room units 21 include a motor driven compressor 38, a first heat exchanger 39, and a second heat exchanger 41. A fan 42 draws air from the room air inlet 43 and the fresh air inlet 44 and circulates it in heat exchange relation with the first heat exchanger 39. The proportion of fresh air and room air circulated by the fan 42 is determined by the damper 45. This damper is manually operated in the illustrated embodiment, but could be operated by a thermostatically controlled motor. Such motors and their controls are well known in the art.

The heat exchanger 39 is made in two sections, 39' and 39''. When the heat exchanger 39 is serving as a condenser, as will be more fully described, both sections 39' and 39'' are effectively used as heat exchange surfaces. During operation of this exchanger as an evaporator the lower section 39' carries the heat exchange load while upper section 39'' serves only as a part of the suction line through which vaporized refrigerant is returned to the compressor. This arrangement provides the added heat exchange surface which is required when the coil 39 is operated as an air cooled condenser.

The second heat exchanger 41 may be of the double pipe type. The liquid heat exchange medium from the closed circulatory system flows through the inner pipe indicated in dotted lines, and refrigerant passes through the annular space.

A valve 46 controls the direction of flow of refrigerant through the heat exchangers 39 and 41. In the position illustrated, compressed refrigerant vapors flow from the compressor discharge 47 to the heat exchanger 39 which is operating as a condenser. Heat exchanger 41 is operating as an evaporator. Valve 46 may be shifted so as to discharge compressed refrigerant vapor to the heat exchanger 41 while drawing gas from the exchanger 39 through the suction line 48. The function of the two heat exchangers may thus be interchanged. Expansion of the liquid refrigerant is controlled by a restrictor tube 49, although other expansion controlling means can be used.

A typical control circuit for each of the room units is shown in Figure 3. Operation of the fan is controlled by manually operated switch 50.

A switch 52 can be positioned to complete a circuit through either the cooling control switch 53 or the heating control switches 54 and 55. The switch 53 is thermostatically operated in response to room temperature and is effective to open the circuit when the room temperature falls below a predetermined minimum. The switch 54 is a thermostatically controlled switch and is effective to open the circuit when the room temperature exceeds a predetermined maximum. Switch 55 responds to temperature of the circulated liquid leaving the heater 17 and shuts off the compressor when it exceeds a predetermined maximum. It is a safety control.

Operation

During the heating season valve 7 is opened and valve 9 may be closed so that the by-pass 25 between the collector 23 and the tank 11 is open and the cooling tower 24 is idle. Valve 8 is opened and steam is supplied to the heater 17 so that the temperature of liquid supplied to the system is elevated to the desired value. When the room units 21 are arranged as shown in Figure 2, the heat exchanger 39 acts as a condenser and heat exchanger 41 acts as an evaporator. Thus it will be seen that the unit acts as a heat pump to absorb heat from the circulated medium and deliver it to the room air.

During the summer, when cooling is desired, the valve 46 is moved to the position in which the heat exchanger 41 functions as a condenser and exchanger 39 functions as an evaporator. The switch 52 is positioned so that the summer controls are operating. Valve 8 is closed and the heater 17 is shut down. The by-pass 25 may be closed by closing valve 7. Valve 9 is opened so as to cause the circulated medium to pass through the cooling tower 24.

The room units under summer conditions operate as a conventional unit cooler. The use of a water cooled condenser is desirable because an increased efficiency may be realized.

Between the summer and winter seasons the load on the installation may be unbalanced because, for example, the rooms on the north side will be cool while those on the south are warm. The room units can be independently set to cool or heat the room, as the occupant thereof may desire. This setting is controlled by the setting of the valve 46 and switch 52.

During the heating season the refrigerating apparatus acts as a heat pump. The heat is absorbed at a relatively low temperature and delivered at a much higher temperature. Therefore, the circulated medium need not be supplied at as high a temperature as is characteristic of a conventional hot water heating system. This fact permits the use of uninsulated piping, because the heat loss will be slight. The use of uninsulated pipes results in a considerable saving in installation costs.

What is claimed is:

1. A heating and cooling installation for buildings comprising in combination, a circulating system through which a heat exchange medium is circulated, the system including means to circulate the medium, a cooler operable to cool said medium, a heater operable to heat said medium, said heater and cooler being selectively operable, and a supply riser and a return riser; a plurality of independently operable room units, each unit including reversible refrigerating apparatus, said apparatus including a first and second heat exchanger operatively interconnected and interchangeably effective respectively as a refrigerant evaporator and as a refrigerant condenser or respectively as a refrigerant condenser and refrigerant evaporator, one of said heat exchangers in each unit having a path for circulated heat exchange medium, said path having its ends directly connected to said supply riser and to said return riser, means to circulate air to be supplied to the room in heat exchange relation with the other heat exchanger in each unit; and means controlling the temperature of the circulated medium supplied to the heat exchangers through which it flows, said temperature being such that the liquid will serve as a source of heat in those exchangers operating as a refrigerant evaporator but less than the maximum permissible for it to act as a cooling medium in those heat exchangers which are operating as refrigerant condensers.

2. The method of conditioning air in a building which consists in circulating a liquid heat exchange medium to a plurality of heat exchangers, connected in parallel flow relation, and selectively and individually operating said heat exchangers as the heat absorbing or heat dissipating surface of a reversible refrigerating unit; controlling the temperature at which said liquid is supplied thereto so that

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the maximum is less than the maximum permissible for cooling any of the heat dissipating surfaces which it contacts and circulating air in heat exchange relation with the other heat exchange surfaces of said units.

3. A heating and cooling installation for buildings comprising in combination, a circulating system through which a heat exchange medium is circulated, the system including means to circulate the medium, a cooler operable to cool said medium, a heater operable to heat said medium, said heater and cooler being selectively operable, and a supply header and a plurality of supply risers connected in parallel flow relation therewith and a return header and a plurality of return risers connected in parallel flow relation therewith; a plurality of independently operable room units, each unit including reversible refrigerating apparatus, said apparatus including a first and second heat exchanger operatively interconnected and interchangeably effective respectively as a refrigerant evaporator and as a refrigerant condenser or respectively as a refrigerant condenser and refrigerant evaporator, one of said heat exchangers in each unit having a path for circulated heat exchange medium, said path having its

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ends directly connected to one of the aforesaid supply risers and to one of the aforesaid return risers, means to circulate air to be supplied to the room in heat exchange relation with the other heat exchanger in each unit; and means controlling the temperature of the circulated medium supplied to the heat exchangers through which it flows, said temperature being such that the liquid will serve as a source of heat in those exchangers operating as a refrigerant evaporator but less than the maximum permissible for it to act as a cooling medium in those heat exchangers which are operating as refrigerant condensers.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 22,100	Brace et al.	May 26, 1942
2,260,887	Dasher	Oct. 28, 1941
2,401,890	Smith et al.	June 11, 1946
2,441,885	Kemler et al.	May 18, 1948
2,513,373	Sporn et al.	July 4, 1950