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HEATING OR COOLING CONTROL SYSTEM FOR HEAT EXCHANGERS

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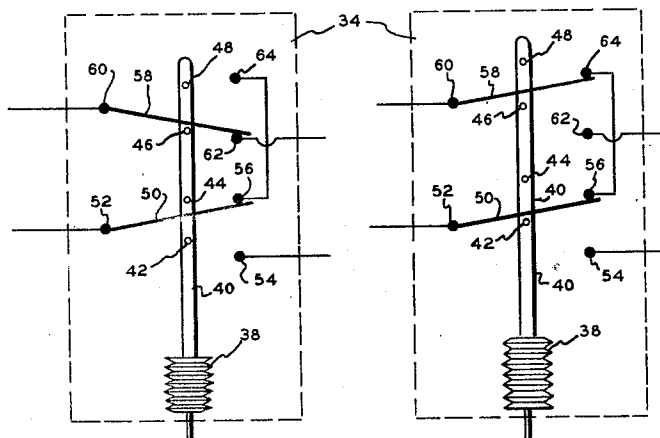
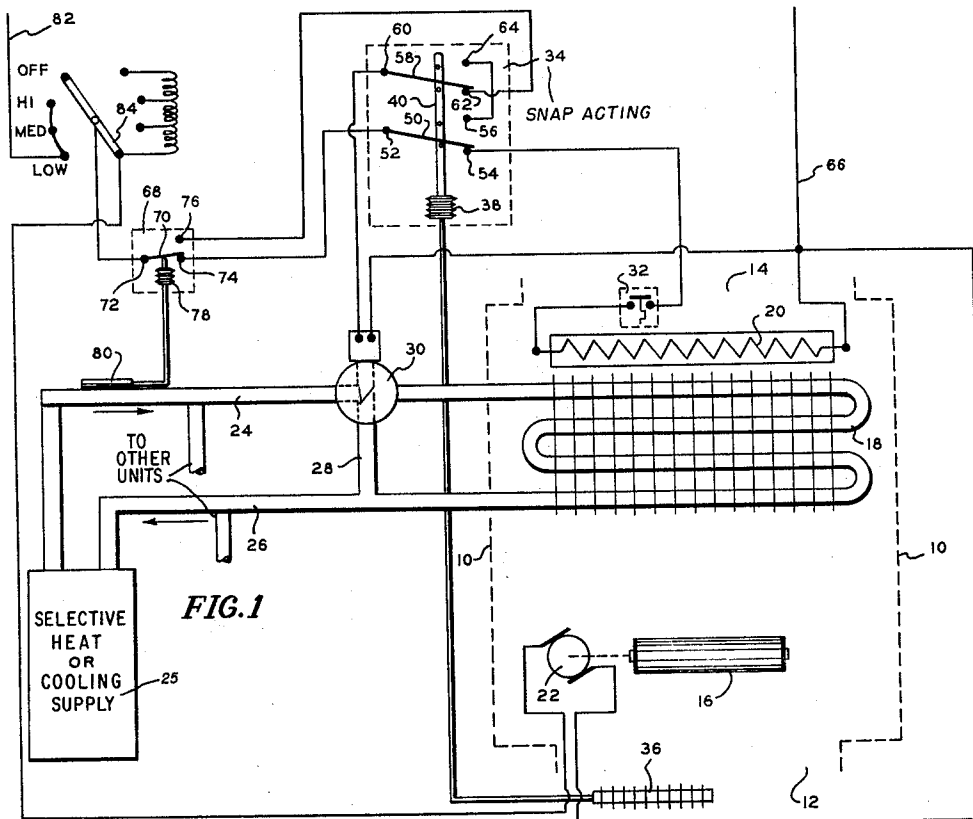


FIG. 2

FIG. 3

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3,166,120 HEATING OR COOLING CONTROL SYSTEM FOR HEAT EXCHANGERS

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The invention pertains to a control system for heat exchangers, and particularly relates to a control system for use in conjunction with air conditioning apparatus wherein the air is being heated or alternately heated and cooled.

The invention is particularly concerned with air conditioning devices wherein a central heating or cooling unit is employed to heat or cool a heat-transfer medium, such as water or brine. The heat-transfer medium is piped to the space to be conditioned and air circulating means within the space forces air over a heat exchanger to cause a transfer of heat from the exchanger to the air or vice versa. It is a basic object of the invention to provide apparatus of this type and a control circuit therefor, wherein two types of heating of the conditioned air may be selectively employed or, upon the circulation of a cooling-transfer medium, heating may occur without removing the cooling-transfer medium from the piping circuit.

The air conditioning requirements of structures, especially large commercial establishments, vary considerably at any given time within different spaces of the structure, particularly during the spring and fall months. Thus, it is not at all unusual to desire heating in a sparsely occupied room having a northern exposure, while at the same time a heavily populated area having a southern exposure may require cooling to produce the desired room air temperatures. When employing a central air conditioning unit, the above circumstances can only be met if the installation is of the dual-type permitting simultaneous circulation of heating and cooling transfer mediums. Such installations are very expensive. Also, in fall and summer months heating may be desired in the morning and cooling in the afternoon and it is practical to only circulate a cooling transfer medium, under these circumstances, with most single medium systems.

The invention permits simultaneous cooling and heating in different areas of a structure, having only a single heat-transfer medium piping circuit, and permits both heating and cooling temperature control to be obtained from an economically installed system.

A further object of the invention is to provide a control system for air conditioning apparatus wherein during the circulating of a cooling heat-transfer medium through the piping circuit, auxiliary means may be employed for heating while the cooling heat exchanger is rendered inoperative, and the auxiliary heating means is rendered inoperative while the cooling heat exchanger is in operation.

Another object of the invention is to provide air conditioning apparatus employing a fluid-transfer medium heat exchanger and an electric heater element wherein interlocking means are employed for automatically preventing simultaneous operation of the heat exchanger and heater element.

A further object of the invention is to provide air conditioning apparatus and controls therefor employing a fluid-transfer medium heat exchanger whereby the heat exchanger may be by-passed by the medium and is rendered operative only upon the need for heated or cooled air.

Yet another object of the invention is to provide an

air conditioning apparatus and control means therefor employing a single heat-transfer medium heat exchanger and circulating circuit whereby the presence of either a heating or cooling-transfer medium within the exchanger circuit is sensed and the control means is modified in accordance with the purpose of the heat-transfer medium.

These and other objects arising from the details and relationships of the components of an embodiment of the invention will be apparent from the following description and accompanying drawings wherein:

FIG. 1 is a schematic view of the apparatus and control circuit employed with the invention showing the heater element circuit closed,

FIG. 2 is a detail view of the primary control switches at a temperature wherein the lower switch is closing a maximum temperature terminal and the upper switch is at its minimum temperature terminal,

FIG. 3 is a detail view of the primary control switches wherein both of the switches are connected to their maximum temperature terminals.

The relationships of a typical embodiment of the invention will be apparent from FIG. 1 wherein an air conditioning housing unit is generally indicated by the dotted lines 10 defining the air-flow path thereof. The unit usually takes the form of a housing resting upon the floor and is provided with suitable vent structures whereby an air-flow path is defined within the housing. In FIG. 1 numeral 12 designates the inlet of the air-flow path and 14 designates the outlet thereof.

Within the air-flow path a fan or blower 16 is located for forcing air past a fluid heat-transfer medium heat exchanger coil 18 and an auxiliary electric strip heater element 20. Fan 16 is driven by electric motor 22. It is to be understood that it is not necessary that the fan, heat exchanger and electric heater be arranged in the sequence illustrated. Also, if a central air-circulation system is employed, the fan or blower 16 would not be employed in the air path, rather the inlet 12 would communicate with an outlet of the air-circulating system. For the purposes of the invention it is desired that air-flow means be employed for blowing or drawing air over the heat exchanger and heater element, although convection air-flow is conceivable it would not produce the desired efficiency and flow rate.

The heat exchanger 18 is provided with inlet and outlet passages 24 and 26, respectively, which communicate with the central heating or cooling unit 25. The central unit 25 may be of any conventional type capable of selectively circulating a heating-transfer medium through the passages 24 and 26 or a cooling medium such as water or brine, as desired. Whether the heat-transfer medium is for heating or cooling, will be primarily determined by the seasonal requirements. Where both cooling and heating will be desired simultaneously, a cooling-transfer medium will be circulated through the passages 24 and 26. A by-pass passage 28 interconnects the inlet and outlet passages prior to the medium reaching the heat exchanger coil 18, and a two-way electric actuated and operated valve 30 is located in the inlet passage 24 at the junction with the by-pass passage 28. The valve 30 selectively controls the flow of medium through the heat exchanger coil 18 or by the by-pass passage 28. The valve 30 may be of any conventional two-way motorized valve structure. The electric heater element 20 is of the type commonly termed a "strip heater" and may be of approximately 1,000 watts. It is desirable that a safety heat-actuated switch 32 be incorporated in the circuit of the electric heater adjacent the heater to prevent overheating in the event of a fan or blower failure or other reason causing inadequate air flow over the electric heater.

The primary space temperature control consists of a

room thermostat 34 having temperature sensing means such as a bulb 36 associated therewith for sensing the temperature within the room. The bulb 36 may be located within the inlet 12 or any other location within the space being conditioned. The thermostat 34 includes any conventional actuating member such as a bellows 38 for axially translating a switch actuating rod 40 having a plurality of switch-operating abutments 42, 44, 46 and 48 mounted thereon. Abutments 42 and 44 operate switch 50 and abutments 46 and 48 operate switch 58. The thermostat includes a first snap-acting switch 50 consisting of a terminal 52 which may be alternately connected to a minimum temperature signal 54 and a maximum temperature terminal 56. The second snap-acting switch 58 includes a common terminal 60 which may be alternately connected to a minimum temperature terminal 62 and a maximum temperature terminal 64. The terminal 54 is connected to the heater element 20 through the heater safety switch 32. The terminals 56 and 64 are commonly connected and the terminal 60 connects to the valve 30. The valve 30 is also connected to one of the primary power lines 66, as is the other end of the heater element 20 and the fan or blower motor 22.

The thermostat 34 is only illustrated schematically and is not to be construed as the actual thermostat construction. Any conventional two-switch thermostat capable of the described operation may be employed with the control system of the invention, and usually adjustment means will be provided for positioning the means operating the switches 50 and 58 whereby the operating temperatures of these switches may be easily regulated.

A second thermostat 68 includes a switch 70 having a common terminal 72 alternately connectable with terminals 74 and 76. The switch 70 is actuated by a thermostatic actuator, such as a bellows 78, associated with a bulb 80 which is maintained in intimate engagement with the heat-transfer medium inlet passage 24 and, thus, senses whether a heating or cooling-transfer medium is being circulated. If a heating medium is being circulated, the switch 70 will be shifted to its upper position wherein terminals 72 and 76 are interconnected. If a cooling medium is being circulated, the terminals 72 and 74 will be connected, as illustrated in FIG. 1.

The heat-transfer sensing switch terminal 74 is connected to the room thermostat terminal 52, and the other transfer medium sensing switch terminal 76 is connected to the room thermostat terminal 62.

It is to be understood that the room thermostat is of the adjustable type, and it is intended that the switches 50 and 58 be of the snap-acting type and, as mentioned above, be independently adjustable between the desired operating limits. The temperature operating limits of the switches 50 and 58 may overlap. However, a temperature rise from a temperature wherein terminals 52 and 56 will be connected to a temperature wherein terminals 60 and 64 will be connected, usually sequentially actuates first switch 50 and then switch 58. Switches 50 and 58 could simultaneously operate. However, such operation would not be desirable under most conditions. Normally, during a temperature rise, terminal 56 will be closed at a lower temperature than the terminal 64, and during a temperature decrease the terminal 62 will be closed at a higher temperature than the terminal 54. For instance, terminal 54 may be adjusted to close at 65° F., terminal 56 may close at 68° F., terminal 62 may close at 67° F., and terminal 64 may close at 70° F.

The other primary power line 82 preferably is connected to a three-speed fan or blower switch 84, and the switch also energizes the transfer medium thermostat common terminal 72.

Operation of the air conditioning apparatus and control is as follows:

Assuming a heating-transfer medium is being circulated and supplied to the valve 30, the switch 70 will be in its upper position connecting terminals 72 and 76. This

switch position connects room thermostat terminal 62 to the terminal 72. Upon the fan switch being turned to an "on" position, terminal 72 will be energized, and if the room air temperature is such as to call for heat, the switch 58 will be interconnecting terminals 60 and 62 and, thus, energize valve 30 to direct the flow of heated-transfer medium through the heat exchange coil 18, closing the by-pass passage 28. The air flow over the heat exchanger coil 18 will heat the air passing through the flow path 10 and, thus, heat the room. Upon the room air reaching the temperature causing switch 58 to actuate, terminals 60 and 64 will be connected which will de-energize the valve 30 causing valve 30 to direct the heating-transfer medium flow through the by-pass 28 and prevent further medium flow through the heat exchanger coil. Air will continue to circulate through the air-flow path, but will not be heated. Upon the room temperature reaching the minimum desired temperature, the switch 58 will shift back to the terminal 62, again energizing valve 30 and supplying the heater exchanger coil with a heat medium to again heat the air flowing through the air-flow path 10. This cycle continues to produce the desired room air temperature.

Upon circulating a cooling-transfer medium through the central air conditioning system, a cooling medium will be supplied to the passage 24 and valve 30. In this instance the switch 70 will be in the position shown in FIG. 1, interconnecting the terminals 72 and 74, thus connecting room thermostat terminal 52 to the fan circuit. Upon closing of the fan switch 84, terminal 52 will be energized, and if the room air temperature is lower than that desired, the switches 50 and 58 will be in the position shown in FIG. 1. At this time the interconnection of terminals 52 and 54 will energize the electric strip heater element 20 and heat the air flowing through the air conditioner flow path 10. As the switch 58 will be in engagement with the "dead" terminal 62, the valve 30 will be de-energized and the cooling medium circulation will be through the by-pass passage 28, rather than through heat exchanger coil 18.

Upon the room air temperature rising to the desired degree, the rod 40 will be sufficiently raised to cause switch 50 to interconnect terminals 52 and 56, whereupon the electric heater element 20 will be de-energized, and the switch circuitry will be as shown in FIG. 2. Under these conditions both the electric heater element and the valve 30 will be de-energized. Should the room temperature fall below the predetermined minimum temperature requirements, the terminals 52 and 54 will again be connected and the electric heater will again heat the room air.

Should the room temperature take on heat from external sources whereby the maximum operating temperature of switch 58 is achieved, the switch 58 will shift to connect terminals 60 and 64, and the switch positions will be as shown in FIG. 3. In this condition terminal 60 will be energized due to the interconnection of terminals 56 and 64, and the valve 30 will be energized closing the transfer medium flow through the by-pass 28 and permitting the cooling heat-transfer medium flow through the heat exchanger coil 18 to produce cooling of the air flowing through the air-flow path 10. Upon the desired cooling being achieved, the switch 58 will drop to the terminal 62, as shown in FIG. 2, de-energizing the valve 30 and again causing the transfer medium to flow through the by-pass passage 28, rather than the heat exchanger coil 18. If the room air temperature again rises above the desired value, terminals 60 and 64 will be connected to again energize the valve 30 and produce cooling of the flow path air. It will be appreciated that the switch actuation is such that the electric heater element and cooling coil will not be operative at the same time. By employing overlapping, but not identical, operating ranges for switches 50 and 58, effective temperature control may be maintained without instantaneous or "hunting" heating and cooling effects.

The thermostat 68 could, within the scope of the inven-

tion, be replaced by a relay actuated by control means at the boiler selectively supplying conduit 24 with a hot transfer medium for heating purposes. Thus, upon the boiler being operated, the relay would be actuated to connect terminal 62 with terminal 72. Upon a cooling medium being circulated, the boiler would be inactive, and the relay circuit would maintain the terminal connections shown in FIG. 1. Also, it will be understood that by-pass 28 is not critical to the practice of the invention. The by-pass provides means for maintaining a flowing heat-transfer medium circuit. However, the basic purpose of valve 30 is to selectively render the heat exchanger 18 operative and inoperative, and with other types of transfer medium circuits, an on-off valve may be substituted for valve 30.

It will be appreciated that various modifications to the invention, other than those discussed above, may be apparent to those skilled in the art without departing from the spirit and scope thereof, and it is intended that the invention be defined only by the following claims.

We claim:

1. An air temperature control system comprising, in combination, means defining an air flow path, a fluid-transfer medium heat exchanger and an electric heater within said flow path, means selectively supplying said heat exchanger with a heating or a cooling medium, means forcing air through said flow path, an inlet and an outlet passage associated with said heat exchanger, a by-pass conduit establishing communication between said inlet and outlet passages by-passing said heat exchanger, an electrically operated valve located within one of said passages and communicating with said by-pass conduit selectively closing said conduit and permitting flow through said heat exchanger, and opening said conduit establishing communication between said passages and preventing flow through said heat exchanger, an electric heater circuit including a first switch movable between first and second positions, an electric valve circuit including a second switch movable between first and second positions, a fluid-transfer medium temperature-sensing circuit including a third switch movable between first and second positions, fluid medium temperature-sensing means operatively associated with said third switch positioning said third switch to said first position upon a cooling medium being supplied to said valve and positioning said third switch to said second position upon a heating medium being supplied to said valve, air temperature-sensing means operatively associated with said first and second switches, said first switch in said first position being in series with said third switch in said first position energizing said electric heater, said second switch in said first position being in series with said third switch in said second position energizing said valve closing said conduit to fluid flow and directing fluid through said heat exchanger, said first switch in said second position being in series with said second switch when in said second position, thereby energizing said valve and directing a cooling medium through said heat exchanger when said third switch is in said first position.

2. An air temperature control system comprising, in combination, means defining an air flow path, a fluid-transfer medium heat exchanger and an electric heater within said flow path, means selectively supplying a heating or cooling medium to a fluid-transfer medium circuit supplying said heat exchanger, air circulating means flowing air through said path, electrically actuated valve means controlling the transfer medium flow through said heat exchanger, a heater circuit including first switch means controlling energization of said heater, a valve means circuit including second switch means controlling said valve means, air temperature-sensing switch actuating means operatively associated with said first and second switch means, third switching means adapted to be actuated to a first position upon a cooling medium being supplied to said heat exchanger fluid-transfer medium circuit and

adapted to be actuated to a second position upon a heating medium being supplied to said heat exchanger fluid-transfer medium circuit, said first position establishing a circuit to said first switch means and said second position establishing a circuit to said second switch means and opening the circuit to said first switch means, operation of said first and second switch means being such that upon a cooling medium being supplied to said heat exchanger fluid-transfer medium circuit when said first switch means is closed to energize said heater, said second switch means positions said valve means to prevent fluid-transfer medium flow through said heat exchanger while said heater is energized.

3. An air temperature control system comprising, in combination, means defining an air flow path, a fluid-transfer medium heat exchanger and an electric heater within said flow path, means selectively supplying a heating or cooling medium to a fluid-transfer medium circuit supplying said heat exchanger, air circulating means flowing air through said path, electrically actuated valve means controlling the transfer medium flow through said heat exchanger, a heater circuit including a first switch controlling energization of said heater, a valve means circuit including a second switch controlling said valve means, air temperature-sensing switch actuating means operatively associated with said switches, a fluid-transfer medium temperature-sensing circuit including a third switch having a first position establishing a circuit to said first switch and a second position establishing a circuit to said second switch and opening the circuit to said first switch, a fluid-transfer medium temperature-sensing switch actuator operatively associated with said third switch placing said third switch in said first position upon a cooling medium being supplied to said heat exchanger fluid-transfer medium circuit and placing said third switch in said second position upon a heating medium being supplied to said heat exchanger fluid-transfer medium circuit whereby said second switch provides the direct and sole control of said valve means upon a heating medium being supplied to said heat exchanger fluid-transfer medium circuit, interlock means interposed between said first and second switches rendering said second switch open to position said valve means so that when said first switch is closed to energize said heater, and a cooling medium is being supplied to said heat exchanger fluid-transfer medium circuit, fluid-transfer medium will not flow through said heat exchanger while said heater is energized.

4. In an air temperature control system as in claim 3, wherein said heat exchanger includes inlet and outlet passages, said valve means being interposed in one of said passages, a by-pass passage interconnecting said inlet and outlet passages by-passing said heat exchanger, said by-pass passage communicating with said valve means whereby said valve means selectively directs said fluid heat-transfer medium through said by-pass passage and said heat exchanger.

5. In an air temperature control system as in claim 3, wherein each of said first and second switches is provided with maximum and minimum temperature terminals, the minimum terminals being closed at predetermined minimum air temperatures below a predetermined temperature by associated switch actuating means and the maximum terminals being closed at predetermined air temperatures above a predetermined temperature by associated switch actuating means, the temperature required to close said maximum temperature terminal of said first switch being less than the temperature required to close said maximum temperature terminal of said second switch.

6. In an air temperature control system as in claim 5, wherein said interlock means comprises interconnecting the maximum terminal of said first switch to the maximum temperature terminal of said second switch whereby closing said maximum temperature terminal of said first switch de-energizes said heater, and closing of said maximum temperature terminal of said second switch opens

said valve means permitting fluid-transfer medium flow through said heat exchanger.

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