

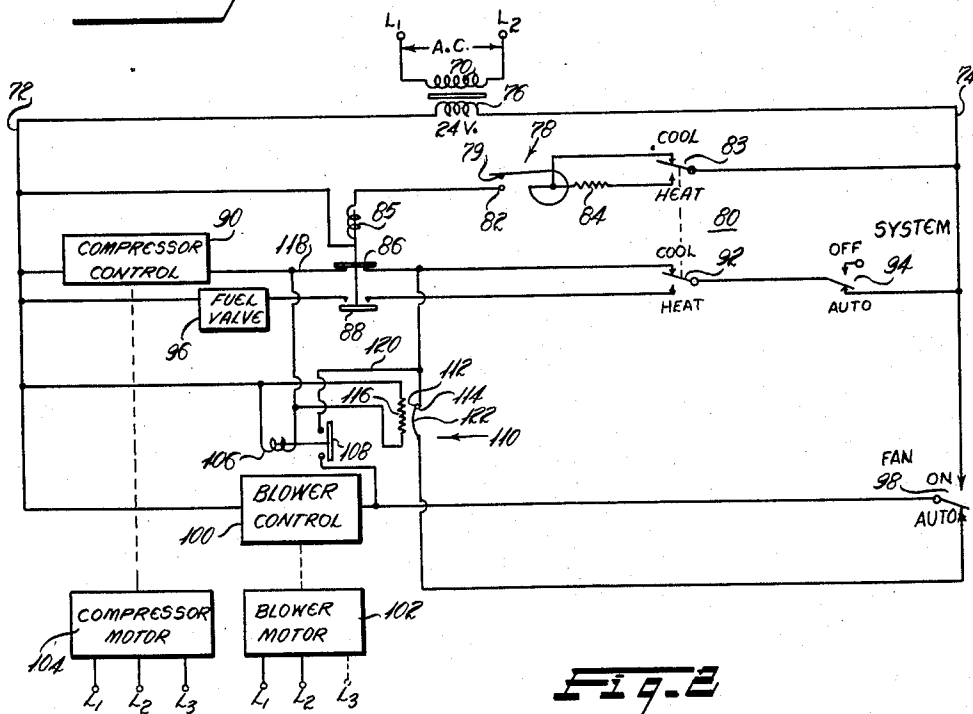
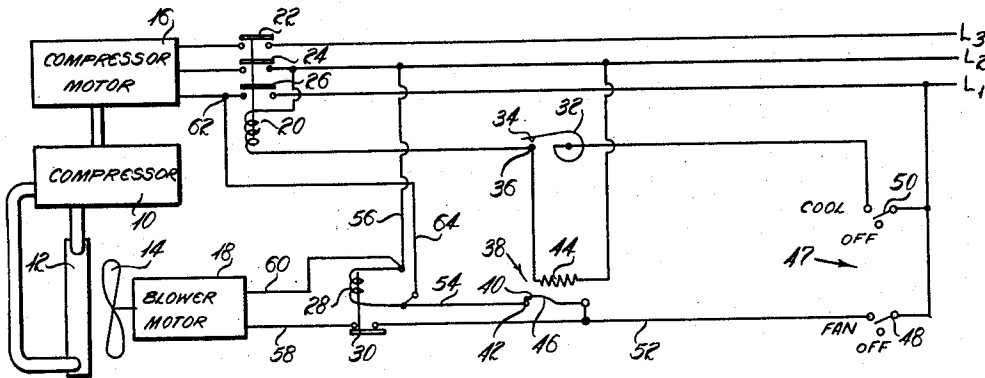
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AIR COOLING SYSTEM

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AIR COOLING SYSTEM

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This invention relates to systems for operating air cooling apparatus having a refrigeration type cooling unit and blower providing forced air flow, and more particularly to a cycle of operation which provides reduced humidity due to improved regulation and control of the forced air flow.

Air conditioning systems which cool confined regions adapted for habitation conventionally include refrigeration type cooling units and blowers for providing forced air circulation through the cooling unit. The comfort of a cooled region in the summertime depends in a large part on the relative humidity in the region as well as the temperature and the rate of air circulation. Thus the temperature of the cooled region is conventionally controlled by a temperature sensitive element such as a thermostat connected to start and shut down or otherwise control operation of the cooling unit and the amount of air circulation generally remains substantially constant regardless of the operation of the cooling unit.

Because of the reduced temperature of the cooling unit relative to the ambient outdoor temperature, considerable condensation of moisture accumulates on the cooling coils. In residence cooling systems, the temperature of the cooling coils generally does not drop below the freezing temperature of water and hence the accumulated moisture which condenses on the coils drips or otherwise runs off the coils and is removed from the system.

During operation of the blower a considerable amount of condensed moisture in the form of water remains suspended on the coils due to the air motion across the coils. Only the excess water condensing on the cooling coils during continuous operation of the cooling unit runs off. When the cooling unit is shut down, the temperature of the cooling coil increases and in prior systems the suspended water on the coils gradually evaporates due to forced air flow across the coils and thus enters the confined region to be cooled to undesirably increase the humidity and produce the foul odor mentioned above. In thermostat controlled systems where the cooling unit may shut down several times a day in ordinary operation, the total quantity of moisture introduced into the circulating air of the system is appreciable and reduces both the comfort of the cooled region and the efficiency of the cooling equipment since this moisture must again be evaporated from the air by the cooling unit.

It is accordingly a major object of the present invention to provide in an air conditioning system means permitting moisture on the cooling coil to drain away when the cooling unit is shut down rather than to be supplied into the cooled region and thereby avoid undesirably increasing the relative humidity.

Another object of this invention is to provide an air conditioning system wherein a compressor is operated intermittently and air is forced across the cooling coils substantially continuously with means for interrupting

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forced air flow across the cooling coils when the compressor is shut down to permit moisture drainage from the cooling unit rather than re-evaporation of the moisture into the air of the system.

Still another object of the invention is to provide in an air conditioning system switch means effective to de-energize both the compressor and blower motors in response to the temperature of cooled region and a time delay means effective to re-energize the blower motor only after a period sufficient to permit moisture drainage from the cooling unit.

A further and more detailed object of this invention is to provide a thermally actuated time delay switch having normally closed contacts for energizing the blower when the compressor is shut down, and effective to provide interruption of the blower operation for a period sufficient to permit moisture drainage from the cooling unit upon de-energization of the compressor.

These and other objects of the invention will become more fully apparent from the claims, and as the description proceeds in connection with the appended drawings wherein:

Figure 1 is a circuit diagram of an air conditioning system having a control circuit in accordance with the present invention; and

Figure 2 is a circuit diagram of a combination heating and cooling system having a control circuit for providing the interrupted blower operation in accordance with the present invention.

A room refrigeration cooling system of the type used in residences or commercial establishments as illustrated in Figure 1 conventionally includes a compressor 10, a heat exchanger or cooling coils 12 across which air is forced by blower or fan 14 as well as other components which are not pertinent to the present invention and accordingly not illustrated. The compressor 10 is driven by motor 16 and blower 14 is driven by motor 18 both of which are energized from commercial power mains such for example as are designated L₁, L₂ and L₃ in the drawing and supply three phase alternating current power. Three phase alternating current power is commonly used in larger cooling units while single phase power is used in smaller units. The control circuit according to the present invention is identical regardless of whether used with three phase equipment as illustrated or used with single phase cooling equipment as the only change required in the control system for single phase equipment is the omission of line L₃.

Compressor motor 16 may be started in any conventional manner as through the energization of compressor relay coil 20 which closes the associated switch contacts 22, 24 and 26. Blower motor 18 is similarly rendered operative by energization of blower relay coil 28 which closes switch contacts 30.

Thermostat 32 is conventionally used as part of room air conditioning systems for controlling the operation of compressor motor 16 in accordance with the temperature in the air conditioned region, and in the embodiment illustrated in Figure 1 contacts 34 and 36 close with a rising temperature, open with a falling temperature and have an appreciable operating differential.

In accordance with one embodiment of the present invention there is provided a time delay switch 38 having normally closed contacts 40 and 42. While there are several different types of switches which operate after a predetermined time delay and are suitable for use in accordance with the present invention, switch 38 illustrated in the described embodiment is a thermal type having resistor 44 which when energized heats element 46. Element 46 may for example be a bi-metal strip and arranged to open contacts 40 and 42 when heated.

Heating resistor 44 is connected to contact 36 of thermostat 32 and to return line L_2 to be energized only when thermostat contacts 34 and 36 are closed and when power is supplied to the thermostat.

A conventional on-off switch 47 includes the positions corresponding to "off," "fan" where the blower only is energized, and "cool" where both the blower and compressor motors may be energized. In the illustrated arrangement, movable blades 48 and 50 comprise a conventional three position sequence switch which in one operating position energizes only the blower and in the other operating position energizes both the blower and the compressor circuits from power line L_1 .

When switch 47 is in the "off" position, neither blower motor 18 nor compressor motor 16 is energized. When switch 47 is moved to the "fan" position, blower relay coil 28 is energized through switch blade 48, conductor 52, normally closed contacts 40 and 42, lead 54 and from coil 28 through lead 56 to line L_2 . Switch contacts 30 are closed when coil 28 is energized thereby applying power through lead 58 to blower motor 18 which is connected through conductors 60 and 56 to return line L_2 . The circuit through thermostat 32 is not energized and thus neither compressor motor 16 nor heater resistance 44 of time delay switch 38 is energized and the blower thus operates continuously.

When switch 47 is moved to the "cool" position switch blade 48 closes and blade 50 remains closed, and blower motor 18 remains initially energized through the circuit described in the preceding paragraph. If thermostat 32 is set so that contacts 34 and 36 are open as illustrated, there is no change in operation and just blower motor 18 is energized.

When contacts 34 and 36 of thermostat 32 close, compressor relay coil 20 is energized thus closing the contacts associated with switches 22, 24 and 26 thereby energizing compressor motor 16. At this time conductor 62 adjacent switch contact 26 is connected to power line L_1 and there is thus established a parallel circuit through conductor 64 for keeping blower relay coil 28 energized with voltage between power lines L_1 and L_2 so long as compressor motor 16 is energized through the switch contacts associated with coil 20. When contacts 34 and 36 of thermostat 32 close, resistor 44 of time delay switch 38 is energized thereby supplying heat to element 46 and eventually opening contacts 40 and 42. The time of opening of contacts 40 and 42 is not critical because there is no change in the operation of the system by the opening of the contacts since blower relay coil 28 is now held energized through conductor 64 and contacts 26 of the energized compressor relay.

When the temperature in the room lowers by an amount sufficient to cause contacts 34 and 36 of thermostat 32 to open, compressor relay coil 20 is de-energized thus opening switches 22, 24 and 26 and turning off compressor 16. Since power is then no longer available on conductor 64, blower relay coil 28 is de-energized and blower 18 shut-down. Resistor 44 is also simultaneously de-energized with the de-energization of compressor relay coil 20, but contacts 40 and 42 remain open for a short period of time due to the latent heat stored in resistor 44 and element 46.

After a predetermined time interval, element 46 cools and contacts 40 and 42 close thus re-establishing the circuit through blower relay coil 28 and starting up operation of blower motor 18. The blower operates continuously after the delay provided when the compressor first shuts down and compressor motor 16 does not start again until contacts 34 and 36 of thermostat 32 close.

During the operation of compressor 10, coils 12 provide a region in the ducts of the air conditioning system in which the temperature of the forced air reduces appreciably. The moisture in the air forced across coils 12 condenses and accumulates on the coils as droplets of

water. While the amount of condensation from the warm air forced by fan 14 across coils 12 depends upon the relative humidity of the incoming air, there is nearly always some moisture present which accumulates on coils 12 and a considerable quantity of the condensed moisture remains suspended on coils 12 as water due solely to air motion across the coils which rapidly drains away when there is no forced air circulation. Thus the interruption of the operation of blower 14, provided when compressor motor 16 shuts down and continuing during the time interval required for element 46 and resistor 44 to cool to thereby close contacts 40 and 42 and re-establish the circuit for energizing blower motor 16, provides a condition where there is no air motion across cooling coils 12 thereby permitting immediate drainage of the moisture held suspended solely due to the motion of the air across cooling coils 12.

The time period of interruption of blower operation necessary to permit the portion of the previously accumulated moisture on coils 12 held suspended by the forced air flow to drain away is relatively short, as for example in the range for approximately thirty seconds. Thus a time delay element 38 of a thermal type as described is an inexpensive but effective means for providing the desired results without requiring additional mechanical modifications of the air conditioning system such as a parallel air conduit by-passing coil 12 (not shown) but which can also be used in accordance with the broad concept of the present invention.

Referring now to Figure 2 there is illustrated another system incorporating the present invention which may be used for controlling the heating system in the winter as well as a cooling system in summer. In this system, power is supplied to conductors $L-1$ and $L-2$ to transformer primary 70 and a control circuit voltage of approximately 24 volts as conventionally used in furnace control systems is provided between conductors 72 and 74 from transformer secondary winding 76. This system conventionally may have a thermostat 78 having contacts 79 and 82 which close with a decrease in temperature, open with an increase in temperature and have an appreciable temperature differential.

Switch 80 is provided with one set of "cool" and "heat" contact switch positions indicated at 83 to provide a circuit by-passing heat anticipating resistor 84 conventionally used in heating systems to reduce temperature variation in the heated room by compensating for the latent heat stored in the system. Connected in series between thermostat 78 and line 72 is a relay coil 85 controlling the position of normally closed contacts 86 and normally open contacts 88. A compressor control relay 90 is connected between lead 72 and contacts 86 to be in series with a second set of "cool" and "heat" contact switch positions indicated at 92 as part of switch 80 and master system switch 94. A fuel valve 96 is connected between lead 72 and contacts 88 to be in series with the "heat" position contacts at 92 of switch 80 and master system switch 94. When switch 94 is in its "off" position, neither the compressor for the cooling system nor the fuel valve for the heating system can be energized.

There is also provided a separate blower switch 98 which when in the "on" position energizes blower control relay 100 to provide continuous forced air circulation and when in the automatic system runs only when the fan control switch in the furnace bonnet (not shown) is heated or when the cooling system is in use through circuits to be discussed below in accordance with the present invention. Blower motor 102 and compressor motor 104 are preferably energized by power directly from power main L_1 , L_2 and L_3 as controlled by the energization of the respective control relays 100 and 90.

The circuit which provides the delayed interruption of the operation of blower motor 102 may include a relay coil 106 connected on one side to line 72 and on the other side to line 74 through contacts 86 and switches

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80 and 94. Contacts 108 associated with coil 106 may be connected between blower control relay 100 and line 74 through switches 80 and 94. Other equivalent circuit arrangements may be devised which are effective to energize blower control relay 100 concurrently with energization of the compressor.

In this embodiment with fan switch 98 set at the illustrated "auto" position, system switch 94 at "auto" and switch 80 at "cool," when thermostat contacts 79 and 82 are closed indicating the temperature is low, relay coil 85 is energized thereby causing contacts 86 to be open to the compressor starter relay 90 is accordingly de-energized. Blower control relay 100 is energized through switches 94 and 92, normally closed contacts 112 and 114 and fan switch 98 to run continuously. Relay coil 106 and heating resistance 116 connected to conductor 118 at contacts 86 are both de-energized.

When thermostat contacts 79 and 82 open, relay coil 85 de-energizes thus closing contacts 86 and energizing compressor control relay 90, relay coil 106 and heating resistance 116. Blower control relay 100 is now energized also through switch contacts 108 and lead 120 to switches 80 and 94 thus by-passing contacts 112 and 114 of the delay device 110. As resistor 116 heats, heat sensitive element 112 causes contacts 112 and 114 to open thereby opening one of two parallel circuits to blower control relay 100.

When the room temperature drops, thermostat contacts 79 and 82 close thereby energizing relay coil 85 thus opening contacts 86 to de-energize compressor control relay 90 and shut down the compressor. Relay coil 106 is also de-energized and contacts 108 open to de-energize blower control relay 100 and shut down operation of the blower. Heating resistor 116 is de-energized and after a suitable time delay of, for example a half minute or so, element 122 cools and contacts 112 and 114 close to reestablish the circuit to blower control relay 100 through fan switch 98.

When thermostat control switch 80 is in "heat" position, the circuit of the present invention is ineffective and does not interfere with normal operation of the heating system.

There is thus provided by the present invention an interruption of the forced air flow across the cooling coils for a brief period each time the compressor is shut down thereby giving the previously accumulated moisture suspended on the cooling coils by the air forced across the coils an opportunity to drain off and thus be removed from the air conditioning system. In the present embodiment, time delay means is provided for interrupting the operation of the blower for a period sufficient to permit the desired moisture drainage from the cooling coils each time the compressor is shut down. A thermally actuated time delay switch for controlling operation of the blower is particularly well adapted for use in systems where a thermostat controls the operation of the compressor motor and provides an inexpensive and reliable system having the desired short interruption of blower operation each time the compressor is shut down.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. In an air conditioning system including a refrigerant type cooling unit, a blower for providing forced circulation of air over a large surface area of said cooling unit, said surface area being operated at a temperature whereby condensation from said forced air accumulates on said surface and is suspended on said surface by said forced

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circulation of air, a first circuit including a switching means effective to de-energize both said blower and said cooling unit when energized, a second circuit for energizing said blower when said cooling unit is de-energized and time delay means in said second circuit effective after said cooling unit is de-energized to permit moisture drainage from said surface area before said second circuit is rendered operative to energize said blower.

2. In an air conditioning system including a refrigerant type cooling unit having a large surface area internally cooled, a blower for providing forced circulation of air over said surface area, said surface area being maintained at a temperature whereby moisture in said forced air condenses thereon, said area being so formed that a substantial quantity of condensed moisture remains suspended thereon due to forced air flow across said surface during normal operation, switching means for controlling "on" and "off" periods of operation of said cooling unit, temperature responsive means adapted to be positioned in the region to be air conditioned for controlling the operation of said switching means, a relay coil for controlling operation of said blower, means for energizing said relay coil through said switching means when said cooling unit is energized, a time delay switch having normally closed contacts connected in a circuit independent of said switching means to energize said relay coil, a heating element effective when energized for opening said normally closed contacts, and circuit means effective to energize said heating element during "on" periods of operation of said cooling unit, the delay in closing of the normally closed contacts in said time delay switch providing an interruption of the operation of said blower for a time period sufficient to permit drainage of said suspended moisture from said surface area before re-energizing said relay after an initiation of an "off" period by said temperature responsive means.

3. In an air conditioning system of the type wherein a fan moves air past refrigerating apparatus in heat conducting relationship therewith and into a space to be cooled, said apparatus condensing some of the water vapor content of such air, and wherein an automatic control system including a thermostat located in the space to be cooled causes the operation and nonoperation of the fan and the refrigerating apparatus while the space temperature is respectively above and below the temperature setting of the thermostat, the combination with said automatic control system of a control circuit including a time delay device for causing the reoperation of the fan a short time interval after the fan is stopped by the thermostat to permit removal of the condensate from the apparatus while maintaining substantially continuous fan operation.

4. In an air conditioning apparatus having refrigerating means including a heat exchanger having air cooling surfaces, a motor driven fan for circulating air from the room to be air conditioned past the cooling surfaces for cooling such air and condensing therefrom some of the water vapor content thereof; and a room thermostat located in the space to be air conditioned for controlling the operation of the refrigerating means including the heat exchanger and for controlling the operation of the fan; a manually operable switch normally positioned to cause substantially continuous operation of the fan irrespective of whether the refrigerating means is in operation; and means including a time delay relay means rendered effective in the normal position of the switch to cause stopping of the operation of the fan only for a short interval following stopping the operation of the refrigerating means thereby to allow time for water condensed on the cooling surface of the heat exchanger to drain therefrom.

5. In a control means for an air conditioning system having refrigerating means; a fan for circulating air from the space to be cooled past the refrigerating means; a thermostat switch in the space to be cooled to control the

operation of the refrigerating means; the combination of a circuit completed upon closure of the room thermostat switch to cause starting of the refrigerating means; a control relay energized upon closure of the room thermostat switch; a fan operation means; said control relay including contacts connected to complete a circuit to the fan operating means, and a time delay means including normally open contacts closed in response to the deenergization of the control relay to complete a circuit to energize the fan operating means whereby upon opening of the room thermostat switch the operation of the refrigerating means and fan motor will be stopped and at a predetermined time delay thereafter by operation of the time delay switch will cause regeneration of the fan motor.

6. In a room air cooling system having a cooling unit and fan, the method of cooling air which includes intermittently operating the cooling unit responsive to the temperature of the air in the room while causing substantially continuous circulation of air to be cooled across said cooling unit with a velocity such that condensation forming on said cooling unit is retained during operation, the improvement which consists of stopping the fan each time the cooling unit is stopped during said intermittent operation for a short time interval to permit drainage of

the retained condensation out and away from the cooling unit while otherwise maintaining substantially continuous fan operation.

7. In an air conditioning system, a heat exchanging cooling means, a fan for causing the air to be cooled to flow past the heat exchanging means, thermostatic means responsive to the temperature of the air of the space to be cooled for controlling the operation of the fan and the cooling means, and circuits including a time delay means under the control of the thermostatic means for simultaneously stopping operation of both said cooling means and said fan for a time interval to permit drainage of condensation from the heat exchanging cooling means before completing the circuit to resume operation of the fan while the cooling means is stopped, said condensation draining away from the cooling means and out of the system.

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