May 28, 1968 K. E. MARSTELLER 3,385,077

AIR CONDITIONER

Filed Feb. 23, 1967

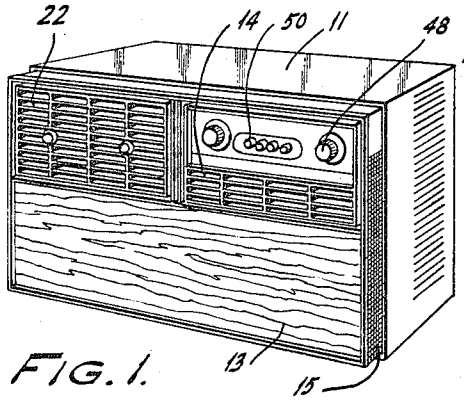


FIG. 1.

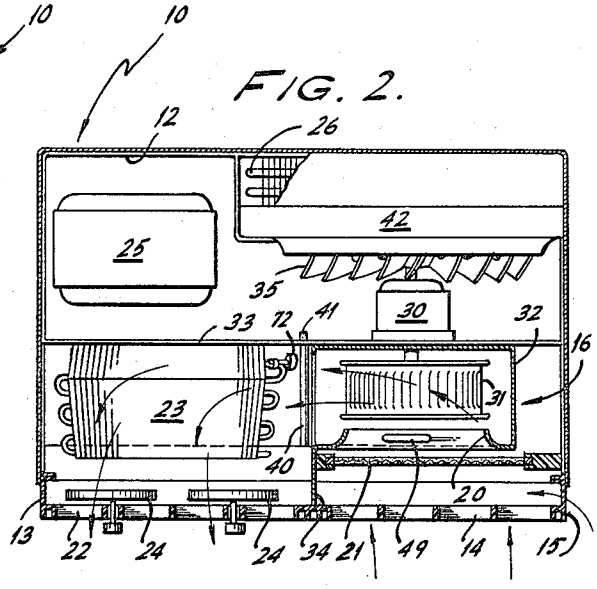


FIG. 2.

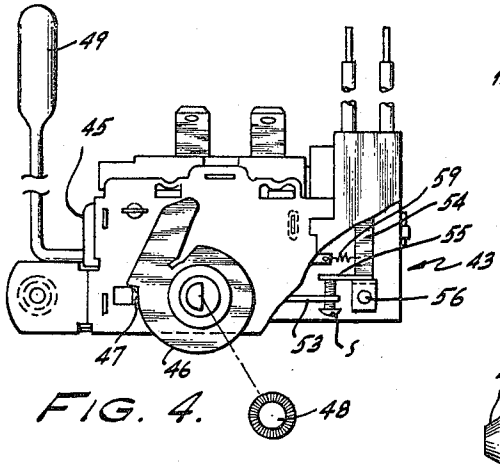


FIG. 4.

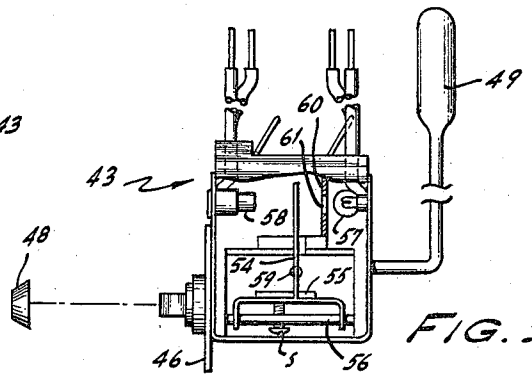
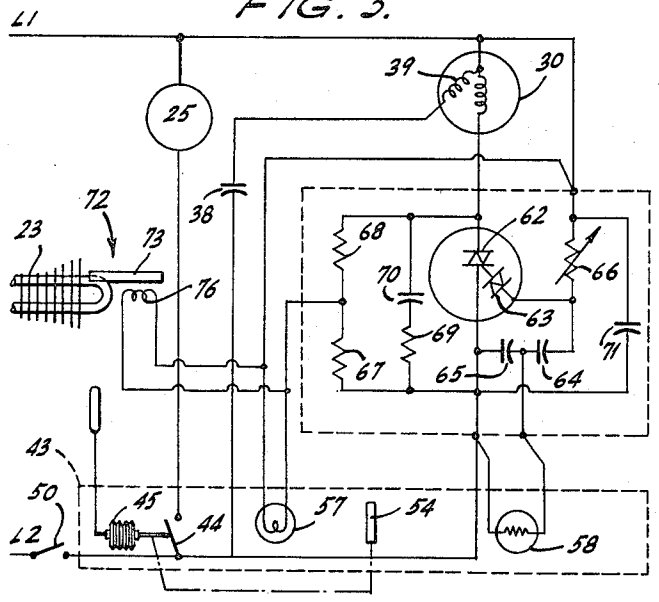


FIG. 5.

FIG. 3.



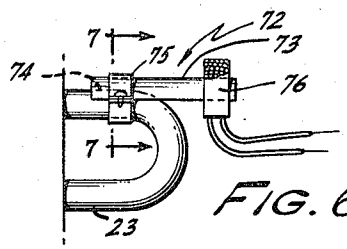


FIG. 6.

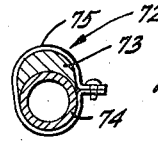


FIG. 7.

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AIR CONDITIONER

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11 Claims. (Cl. 62—180)

ABSTRACT OF THE DISCLOSURE

An air conditioner having a temperature control system, which, in addition to cycling the compressor between predetermined temperature limits, modulates air flow passing over the evaporator and into the room in accordance with room temperatures in excess of such limits. Modulation of air flow is accomplished by varying the speed of the fan inducing such flow, through a solid state electrical circuit controlled by an optical system comprising a lamp, a photocell, and an interposed shutter arrangement actuated by a thermostat. An evaporator icing sensor is arranged to vary the intensity of the lamp to insure continued operation of the fan at higher speeds as icing temperatures are approached, thereby to prevent evaporator icing.

Background of the invention

This invention relates to air conditioners, and more particularly to improvements in temperature control systems for room air conditioners. In its primary aspect the present invention is directed to improvements in control systems of the type described and claimed in my copending disclosure bearing Ser. No. 616,310, filed Feb. 15, 1967, and assigned to the assignee of the present invention.

As disclosed in the above-identified copending patent application, temperature control can be achieved by varying the flow rate of room air over an air conditioner evaporator. If the air flow rates are maintained according to room temperatures falling within a very small temperature range, the room temperature can be maintained within such range as long as the cooling load requirements are within the range of cooling capaicty defined by the highest and lowest air flow rates. However, practical considerations, such, for example, as the tendency for ice to form on the cooling coil at reduced loading conditions limit the minimum air flow rate to about half of the maximum flow rate.

It is a general objective of this invention to provide improved control apparatus which is readily adaptable for use in a room air conditioner of conventional design and insures against ice formation on the evaporator coil of the air conditioner under reduced loading conditions.

Summary of the invention

The present invention resides in the combination, in an air conditioner, of cooling means, apparatus operable to energize the cooling means, apparatus operable to direct air over the cooling means, and control means for varying the cooling effect on the cooling means, which control means comprises a manually adjustable control for regulating energization of the cooling means in response to temperatures of air moving over the latter. The control means further is operable continuously to modulate the air directing apparatus to effect a change in air flow as the conditioned air temperature is changed. Broadly, the invention is particularly characterized by provision of means operable to increase the conditioned air flow at reduced temperatures in response to temperatures of said cooling means conducive to formation of ice thereon.

A preferred embodiment of the invention achieves such control through a unique and simple modification of a conventional thermostat mechanism in which temperature variations are accompanied by motion of a linkage which, toward the end of its travel, actuates the energizing switch for the motor-compressor of a room air conditioner. It is proposed, in accordance with the invention, to drive a shutter or other suitable vane means by this linkage, which shutter is interposed between a light source and a photocell. Movement of the shutter is such that the linkage motion prior to the switch actuation is translated into changes in photocell illumination. The resultant variable signal from the photocell is used to operate apparatus for changing evaporator-coil air flow from maximum to minimum. As outlined just above, the apparatus disclosed herein is claimed in my other disclosure identified also above.

Preferably, the mechanism is so constructed and arranged that the signal for minimum flow may occur prior to actuation of the motor-compressor switch to deenergize the motor-compressor. In further, and special accordance with this invention, means is provided for overriding the apparatus for changing air flow by regulating the intensity of light impinging on the photocell in response to evaporator coil temperature. The last mentioned means preferably comprises a shunt in the lamp energizing circuit, and means inductively coupling the shunt to a member capable of having its permeability changed in response to temperature changes of the evaporator coil. By this novel construction, changes in the inductance of the auxiliary circuit effect changes in intensity of the light, whereby to change the air flow rate in the temperature range at which there is a tendency for ice to form on the evaporator coil.

Brief description of the drawing

The manner in which the foregoing general objectives and advantages of the invention may best be achieved will be understood from a consideration of the following description, taken in light of the accompanying drawing in which:

FIGURE 1 is a perspective view of a room air conditioner embodying the invention;

FIGURE 2 is a generally horizontal sectional view of apparatus in FIGURE 1, with parts broken away;

FIGURE 3 is a diagrammatic showing of control apparatus embodying the invention, and associated with the air conditioner illustrated in the preceding figures;

FIGURES 4 and 5 are somewhat more detailed showings, with parts broken away, of a portion of the control apparatus illustrated in FIGURE 3;

FIGURE 6 is a detailed showing of another portion of the control apparatus illustrated in FIGURE 3; and

FIGURE 7 is a sectional view of apparatus seen in FIG. 6, looking in the direction of arrows 7—7 applied thereto.

Description of the preferred embodiment

With more detailed reference to the drawing, there is seen in FIGURES 1 and 2 a window mounted room air conditioner **10** including a cabinet **11** of generally rectangular configuration and having a base portion **12** and a conventional decorative panel **13**. The decorative panel comprises inlet and outlet room air passages for the air moving means to be more fully described. The inlet air passage includes grilles **14** and **15** disposed in the right hand region of panel **13** and in air flow communication with the inlet opening **20** of the indoor blower **16** of the air moving means. A filter **21** is positioned as shown, and is traversed by air flowing through grilles **14** and **15**. The outlet air passage includes a grille **22** disposed in air flow communication with an evaporator coil **23**. A plurality of independently rotatable louvers **24** are disposed between evaporator coil **23** and outlet grille **22** and are operable to provide selectivity of the direction of outlet air flow.

Evaporator coil 23, preferably of the finned type, is part of the usual refrigerating system including a motor compressor 25, a condenser 26, and associated conduits (not shown) through which the motor compressor, the condenser coil, and the evaporator coil are coupled in series refrigerant flow circuit. These conduits include a discharge line through which refrigerant normally is delivered from the compressor to the outdoor coil as the condenser, and a feed line comprising a continuously open restrictive connection through which liquified refrigerant is normally fed to the indoor coil for expansion therein. Refrigerant is withdrawn by the compressor from the evaporator through a suction line to complete the refrigerant flow circuit. Compressor 25 is selectively energized by electrical circuit means hereinafter to be more fully described.

Referring again to the air moving means, a variable speed motor 30 rotatably supports the blower wheel 31 adapted to circulate air in heat exchange relation with evaporator coil 23. It is the speed control of motor 30 to which the invention is particularly directed. Means for implementing such control will be described later, with especial reference to FIGURES 3 to 7. Blower wheel 31 is housed within a scroll structure 32 disposed adjacent a partition 33 which divides the cabinet into an evaporator coil chamber and a condenser coil chamber.

The portion of cabinet 11 comprising one chamber is adapted to extend into a room or space to be air conditioned while the other chamber lying to the other side of partition 33 extends outwardly of the room, preferably through a window opening thereof. The evaporator coil chamber is subdivided by means of another partition 34 into a section having disposed therein blower wheel 31 and scroll 32, and a section in which is disposed the evaporator coil 23. The mouth portion of scroll 32 extends through partition 34 and into position to direct air against one face of the inclined evaporator coil.

The condensing coil chamber also has disposed therein motor compressor 25 and fan motor 30. A propeller-type fan 35 is rotatably supported within the chamber by motor 30 to provide for drawing outside air into the chamber over coil 26, and for discharging the spent air outwardly from the chamber over motor compressor 25.

Disposal means for condensate dripping from evaporator coil 23 includes sloping baffle 36 disposed below the evaporator coil and a trough 40 extending across the baffle and feeding into a conduit 41 extending through partition 33 and below a lower sump portion of base 12. This construction is best seen in FIGURE 2, in which figure is also seen the anti-icing control element 72 which ensures sufficient air flow over the evaporator coil to prevent the condensate from feezing. Control element 72 will be hereinafter more fully described in especial connection with FIGURES 3, 6, and 7. A conventional slinger ring (not shown) is carried by fan 35 and is adapted to dip into condensate collected in the sump portion of base 12. As the fan rotates, condensate entrained by the ring is centrifuged onto a baffle plate 42 arranged to direct such condensate for flow over condenser coil 26 for evaporation therefrom.

With reference to FIGURES 3, 4, and 5, substantial portions of which are concerned with apparatus which, per se, is claimed in my mentioned copending disclosure, the preferred embodiment includes a circuit for energizing motor compressor 25, including line switch 50 and bellows-actuated thermostatic switch 43 disposed in series electrical circuit with a source of A.C. energy L_1, L_2 and with motor compressor 25. A sensing bulb for switch 43 is positioned in the path of air caused to flow into inlet 20 of blower scroll 32. Thermostatic switch 43 is of the adjustable type, and may be set to achieve cyclic operation of the motor compressor. Also in parallel electrical circuit with the compressor, and in series with

L_1, L_2, is fan motor 30 and its associated control circuit for modulating its speed, whereby to vary the cooling capacity of the air conditioner.

Thermostatic switch 43 includes elements of the aforementioned associated control circuit. Considered in its entirety, switch 43 includes a single-pole single-throw switch element 44 that is actuated through a lever type linkage (not shown) by a vapor-pressure type bellows 45. Selectivity of temperature operating range is provided through a rotatable cam 46 coupled with a cam arm or follower 47 arranged to vary the force on a spring (not shown) that is operable, in turn, to vary the load on bellows 45. Cam 46 is rotatable by a manual knob 48 to the desired temperature setting. Thermostatic switch 43 further includes a lever 53 actuable by the switch linkage when the temperature sensed by control bulb 49 coupled to bellows 45 exceeds the compressor cut-out temperature setting. Lever 53 includes a set-screw S that abuts arm 54 of a vane 54 pivotally mounted at 56 and interposed between a lamp 57 and a photocell 58, such as, for example, a photoelectric device known as a photoresistor. A tension spring 59 extends between the body of control 43 and the vane 54 and maintains engagement of lever 53 against set screw S that provides for presetting of the vane's position. A shield 60 overlies the lamp 57 and is provided with a slotted aperture 61 that predetermines the maximum intensity of light impinging on photocell 58.

Lamp 57 and photocell 58 are wired into the circuit illustrated in FIGURE 3, and including the variable speed fan motor 30. The circuit is so arranged thart when vane 54 completely blocks off the light impinging upon photocell 58, fan motor 30 runs at high speed, and when vane 54 permits full passage of light to the photocell, fan motor 30 runs at low speed. Fan motor 30 is of the permanent capacitor, split-phase type, and is capable of having its speed infinitely varied between about 1100 and 550 r.p.m. Fan motor speed is varied between these limits in correspondence to the quantity of light permitted by vane 54 to impinge on photocell 58.

As disclosed herein, speed control of fan motor 30 is achieved by means of a semiconductive device 62 known in the trade as a TRIAC and disposed in series circuit with L_1, L_2, and the main winding 37 of motor 30. A capacitor 38 is connected in series circuit with motor start winding 39, which two elements are connected in parallel electrical circuit with the main winding 37 of the motor and its control circuit. Firing of TRIAC 62 is achieved by another semiconductive device 63 known in the trade as a DIAC and connected as shown in a circuit including the TRIAC 62, a pair of capacitors 64 and 65, and a resistor 66, each in series with one another while forming a circuit in parallel with motor 30 and TRIAC 62. Photocell 58 is connected in parallel with capacitor 65, and functions to control the rate of attainment of firing voltage applied by DIAC 63 to TRIAC 62, and consequently the effective operating current applied to the motor winding 37.

The photoresistor or photocell 58 is connected in series electric circuit with L_1, L_2, capacitor 64, and resistor 66. The firing voltage for achieving low fan speed is preset by adjusting variable resistor 66. Fan speeds between low and high are controlled by variations in resistance of the photoresistor, as provided by variations in the position of vane 54. To ensure uniform intensity of light emitted by lamp 57, it is connected directly to L_1, on the one hand, and to L_2, on the other hand, through resistors 67 and 68 as shown.

In especial accordance with the present invention and with reference to FIGURES 3, 6 and 7, an anti-icing control 72 is provided for evaporator coil 23. More specifically, it is the function of this control to increase the fan speed under reduced evaporator loading conditions when the fan normally is caused to run at low speed. This in effect increase the thermal load on the evaporator,

thereby ensuring against ice formation thereon. Control 72 includes a core 73 of a material capable of having its magnetic permeability controlled in response to temperature changes. A material found to exhibit such characteristics for the purposes of this invention comprises a compound of chromium maganese antimonide. As appears in FIGURES 6 and 7 core 73 is of elongate, generally rod-like configuration having one end formed as seen at 74 and closely engaging a return bend of evaporator coil 23. Core 73 is held in such position by a screw-clamp arrangement as seen at 75. A free end portion of core 73 is closely encircled by an electrical coil 76 connected in parallel electrical circuit with lamp 57, as is shown in FIGURE 3. The material of core 73 is so compounded as to exhibit a sharp change in permeability slightly above the freezing point of water. By such characteristic, the impedence of coil 76 inductively coupled to core 73 is caused to drop as the freezing temperature is sensed. As shown, this change in impedance increases shunting of current from lamp 57, decreasing its brightness, with a resultant increase in speed of fan motor due to the reduction in the intensity of light impinging on the photocell. If desired, the resultant impedance change could be used to control the fan motor directly.

A series circuit comprised of a resistor 69 and capacitor 70 is connected in parallel with TRIAC 62 to provide for voltage surge suppression, which surge is characteristic in the controlling of an inductive load such as motor 30. Finally, a capacitor 71 is connected in parallel circuit with capacitors 64 and 48, 65 and resistor 66 to provide radio frequency suppression.

While a preferred electrical circuit has been shown for deriving a fan motor speed change signal from photoresistor 58, it will, of course, be understood that other known circuit arrangements may be resorted to in achieving the inventive combination set forth in the appended claims, and as also briefly described in the earlier-presented summary of the invention.

I claim:

1. In air conditioning apparatus, cooling means, means operable to energize said cooling means, a fan for moving air over said cooling means, a variable speed motor for operating said fan, manually adjustable control means for regulating energization of said cooling means in response to temperatures of air being caused to move over said cooling means, said control means further being operable to decrease the speed of said fan motor in correspondence to the reduction of air temperature sensed by said control means, and means operable in response to said cooling means approaching a temperature sufficiently low to be conductive to formation of ice thereon to prevent further decrease of the speed of said fan motor.

2. Apparatus according to claim 1, and further characterized in that said adjustable control means comprises: a temperature sensing element and linkage means driven thereby movable between predetermined limits in correspondence to sensed temperatures; switch means operable by said linkage means to energize said cooling means at a higher air temperature value and to deenergize said coil means at a lower air temperature value; and means operable by said linkage means continuously to vary the speed of said fan motor in a range comprising higher speeds upon energization of said cooling means and minimum speed upon deenergization thereof.

3. Apparatus according to claim 2 and further characterized in that said means operable continuously to vary said motor speed comprises a photoresistor and circuit means associated therewith operable to modulate the fan motor speed, a lamp for directing light onto said photoresistor, a movable vane interposed between said lamp and said photoresistor, and means operably coupling said vane to said movable linkage means to vary the quantity of light impinging on said photoresistor, and consequently to vary the speed of the fan motor.

4. Apparatus according to claim 1 and characterized in that said means operable continuously to vary the motor speed comprises a photoresistor and circuit means associated therewith operable to modulate the fan motor speed, a lamp for directing light onto said photoresistor, a movable vane interposed between said lamp and said photoresistor, and means operably coupling said vane to said movable linkage means to vary the quantity of light impinging on said photoresistor, and consequently to vary the speed of the fan motor, said apparatus further being characterized in that said means operable to increase the fan motor speed includes temperature responsive means for modifying the intensity of light emitted by said lamp.

5. For use in an air conditioner having a refrigeration system comprising a motor-compressor, a condenser, an evaporator, fan means for directing individual air streams over said condenser and evaporator, and a variable speed motor for said fan means, control means comprising: a temperature sensing element movable between predetermined limits in correspondence to temperatures of the evaporator air stream sensed thereby; switch means operable in correspondence with temperatures detected by said sensing element to energize said motor-compressor at a higher evaporator air stream temperature and to deenergize said motor-compressor at a lower air stream temperature; fan speed modulating means operable in correspondence with temperatures detected by said sensing element continuously to vary the speed of said fan motor in a range comprising higher speed at higher temperatures and lower speed at lower temperatures; and means operable in response to temperatures of said evaporator conducive to formation of ice thereon to increase the speed of said fan motor.

6. In air conditioning apparatus, cooling means, means operable to energize said cooling means, means operable to direct air over said cooling means, and means for varying the cooling effect of said cooling means comprising; manually adjustable control means for regulating energization of said cooling means in response to temperatures of air directed over the latter, said control means further being operable continuously to modulate the air directing means to effect a decrease in air flow as the air temperature is decreased; and means operable in response to temperatures of said cooling means conducive to formation of ice thereon to condition said control means to effect an increase in the quantity of air directed over said cooling means at reduced temperatures.

7. Air conditioning apparatus according to claim 6, and further characterized in that said control means includes a photocell and circuit means associated therewith operable to modulate the air directing means, a lamp for directing light onto the photocell, a movable vane operable in response to temperature changes in air directed over said coil means, to vary the quantity of light impinging on said photocell, and consequently to vary the quantity of directed air, and in that the last recited means includes temperature responsive means for varying the intensity of light emitted by said lamp.

8. Air conditioning apparatus according to claim 7, and further characterized in that said temperature responsive means for varying the intensity of light emitted by said lamp comprises a body of material capable of having its magnetic permeability modified in response to temperature changes, and an electrical coil in shunt circuit with said lamp while disposed in inductively coupled relationship to said body of magnetic material, whereby changes in permeability modify the flow of current through said coil and vary the energizing current flow to said lamp.

9. Control means according to claim 5, and characterized in that said last recited means is operable to increase the speed of said fan motor while said motor-compressor is energized.

10. Control means according to claim 5 and characterized in that the temperature responsive means of

said last recited means comprises a body of magnetic material which exhibits an abrupt change in permeability near the freezing temperature of water, and means inductively coupled with said body of material and operable to modify the operating characteristics of said fan speed modulating means in achievement of the recited fan speed control, under conditions of ice formation of said coil means.

11. In air conditioning apparatus, cooling means, means operable to direct air over said cooling means, and air flow control means operable to modulate the air directing means to effect changes in air flow rates over the cooling means to vary its cooling effect, said air flow control means comprising: a body of material disposed in heat exchange relation with said cooling means and capable of having its magnetic permeability modified in response to temperature changes; an electrical current carrying coil inductively coupled to said body of magnetic material, whereby changes in permeability of the magnetic material modify the flow of current through said coil; and means for deriving a signal from such change in current flow to control the rate of air flow induced by said air directing means.

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