Air conditioner units and methods for operating air conditioner units are provided. A method includes determining an operational mode for the air conditioner unit, the air conditioner unit comprising a plurality of heater banks, and determining a speed of a blower fan of the air conditioner unit when the operational mode is a heating mode. The method further includes comparing an input current level to a current threshold value when the speed is a low speed, and disabling one of the plurality of heater banks when the input current level is greater than or equal to the current threshold value.
FIG. -4-
AIR CONDITIONER UNIT AND METHOD FOR OPERATING SAME

FIELD OF THE INVENTION

[0001] The present disclosure relates generally to air conditioner units, and more particularly to methods and apparatus for reducing or eliminating overheating of air conditioner units during heating operations.

BACKGROUND OF THE INVENTION

[0002] Air conditioner units are conventionally utilized to adjust the temperature within structures such as dwellings and office buildings. In particular, one-unit type room air conditioner units may be utilized to adjust the temperature in, for example, a single room or group of rooms of a structure. A typical such air conditioner unit includes an indoor portion and an outdoor portion. The indoor portion is generally located indoors, and the outdoor portion is generally located outdoors. Accordingly, the air conditioner unit generally extends through a wall, window, etc. of the structure.

[0003] In the outdoor portion of a conventional air conditioner unit, a compressor that operates a refrigerating cycle is provided. At the back of the outdoor portion, an outdoor heat exchanger connected to the compressor is disposed, and facing the outdoor heat exchanger, an outdoor fan for cooling the outdoor heat exchanger is provided. At the front of the indoor portion of a conventional air conditioner unit, an air inlet is provided, and above the air inlet, an air outlet is provided. A blower fan and a heating unit are additionally provided in the indoor portion. Between the blower fan and heating unit and the air inlet, an indoor heat exchanger connected to the compressor is provided.

[0004] When cooling operation starts, the compressor is driven to operate the refrigerating cycle, with the indoor heat exchanger serving as a cold-side evaporator of the refrigerating cycle, and the outdoor heat exchanger as a hot-side condenser. The outdoor heat exchanger is cooled by the outdoor fan to dissipate heat. As the blower fan is driven, the air inside the room flows through the air inlet into the air passage, and the air has its temperature lowered by heat exchange with the indoor heat exchanger, and is then blown into the room through the air outlet. In this way, the room is cooled.

[0005] When heating operation starts, the heating unit is operated to raise the temperature of air in the air passage. The air, having had its temperature raised, is blown out through the air outlet into the room to heat the room.

[0006] In many currently known air conditioner units, the heating unit is formed from a plurality of heater banks. Each bank may have a different rated power output. The highest output for the unit generally occurs when all heater banks are operating at the same time. Additionally, many currently known air conditioner units have multiple blower fan speed settings. For example, a blower fan may in some cases be operated at a low setting or a high setting, or in some cases at various other intermediate settings.

[0007] One concern during operation of air conditioner units is overheating of the unit, particularly if a blockage occurs. For example, a blockage to the air inlet path and/or air outlet path prevents proper airflow from occurring within the unit. Particularly when all heater banks are on and the fan speed is low, temperatures within the unit can rise significantly, leading to deformation and/or other damage to components of the unit. Particularly vulnerable components include, for example, plastic components of the heater housing.

[0008] Accordingly, improved methods and apparatus for operating air conditioner units are desired. In particular, methods and apparatus that reduce or prevent overheating of the air conditioner unit would be advantageous.

BRIEF DESCRIPTION OF THE INVENTION

[0009] Aspects and advantages of the invention will be set forth in part in the following description, or may be obvious from the description, or may be learned through practice of the invention.

[0010] In accordance with one embodiment, a method for operating an air conditioner unit is provided. The method includes determining an operational mode for the air conditioner unit, the air conditioner unit comprising a plurality of heater banks, and determining a speed of a blower fan of the air conditioner unit when the operational mode is a heating mode. The method further includes comparing an input current level to a current threshold value when the speed is a low speed, and disabling one of the plurality of heater banks when the input current level is greater than or equal to the current threshold value.

[0011] In accordance with another embodiment, an air conditioner unit is provided. The air conditioner unit includes a blower fan, the blower fan comprising a blade assembly and a motor connected to the blade assembly. The air conditioner unit further includes a heating unit, the heating unit comprising a plurality of heater banks. The air conditioner unit further includes a power source in electrical communication with the blower fan motor and the plurality of heater banks, and a controller in operable communication with the motor and the plurality of heater banks. The controller is operable for determining an operational mode for the air conditioner unit, the air conditioner unit comprising a plurality of heater banks, determining a speed of a blower fan of the air conditioner unit when the operational mode is a heating mode, comparing an input current level to a current threshold value when the speed is a low speed, and disabling one of the plurality of heater banks when the input current level is greater than or equal to the current threshold value.

[0012] These and other features, aspects and advantages of the present invention will become better understood with reference to the following description and appended claims. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] A full and enabling disclosure of the present invention, including the best mode thereof, directed to one of ordinary skill in the art, is set forth in the specification, which makes reference to the appended figures, in which:

[0014] FIG. 1 provides a perspective view of an air conditioner unit, with a room front exploded from a remainder of the air conditioner unit for illustrative purposes, in accordance with one embodiment of the present disclosure;

[0015] FIG. 2 is a perspective view of components of an indoor portion of an air conditioner unit in accordance with one embodiment of the present disclosure;

[0016] FIG. 3 is a schematic diagram of components of an air conditioner unit in accordance with one embodiment of the present disclosure; and
FIG. 4 is a flow chart illustrating steps of a method in accordance with one embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE INVENTION

Reference now will be made in detail to embodiments of the invention, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation of the invention, not limitation of the invention. In fact, it will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope or spirit of the invention. For instance, features illustrated or described as part of one embodiment can be used with another embodiment to yield a still further embodiment. Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents.

Referring now to FIG. 1, an air conditioner unit 10 is provided. The air conditioner unit 10 is a one-unit type air conditioner, also conventionally referred to as a room air conditioner. The unit 10 includes an indoor portion 12 and an outdoor portion 14, and generally defines a vertical direction V, a lateral direction L, and a transverse direction T. Each direction V, L, T is perpendicular to each other, such that an orthogonal coordinate system is generally defined.

A housing 20 of the unit 10 may contain various other components of the unit 10. Housing 10 may include, for example, a rear grill 22 and a front room 24 which may be spaced apart along the transverse direction by a wall sleeve 26. The rear grill 22 may be part of the outdoor portion 14, which the room front 24 is part of the indoor portion 12. Components of the outdoor portion 14, such as an outdoor heat exchanger 30, outdoor fan (not shown), and compressor (not shown) may be housed within the wall sleeve 26. A casing 34 may additionally enclose the outdoor fan, as shown.

Referring now also to FIGS. 2 and 3, indoor portion 12 may include, for example, an indoor heat exchanger 40, a blow fan 42, and a heating unit 44. These components may, for example, be housed behind the room front 24. Additionally, a heater housing 46 may generally support and/or house various other components or portions thereof of the indoor portion 12, such as the blow fan 42 and the heating unit 44.

Heater housing 46 may have peripheral surfaces 50 that define a housing interior 51. For example, the peripheral surfaces 50 may include a first sidewalk 52 and a second sidewalk 54 which are spaced apart along the lateral direction L. Peripheral surfaces 50 may additionally include a base pan 56 and an outlet air diverter 58, each of which may extend between the sidewalks 52, 54 along the lateral direction L.

The housing 46 may be formed from one or more components. For example, in exemplary embodiments, the housing 46 may be formed from a bulkhead 60 and a shroud 62. The bulkhead 60 may in some embodiments be formed from a suitable plastic, or alternatively may be formed from any suitable material. The shroud 62 may in some embodiments be formed from a suitable metal, or alternatively may be formed from any suitable material. The shroud 62 may be connected to the bulkhead 60, and the bulkhead 60 and shroud 62 may together include the peripheral surfaces 50. For example, base pan 56 and outlet air diverter 58 may be components of the bulkhead 60, and portions of or entire sidewalks 52, 54 may be components of the shroud 62. Shroud 62 may additionally include an interior shroud base 64, which may for example be disposed within interior 51 adjacent base pan 56.

In exemplary embodiments, blow fan 42 may be a tangential fan. Alternatively, however, any suitable fan type may be utilized. Blow fan 42 may include a blade assembly 70 and a motor 72. The blade assembly 70, which may include one or more blades disposed within a fan housing 74, may be disposed within the interior 51 of the heater housing 46. As shown, blade assembly 70 may for example extend along the lateral direction L between the first sidewalk 52 and the second sidewalk 54. The motor 72 may be connected to the blade assembly 70, such as through the housing 74 to the blades via a shaft. Operation of the motor 72 may rotate the blades, thus generally operating the blow fan 42. Further, in exemplary embodiments, motor 72 may be disposed exterior to the heater housing 46. Accordingly, the shaft may for example extend through one of the sidewalls 52, 54 to connect the motor 72 and blade assembly 70.

Heating unit 44 in exemplary embodiments includes one or more heater banks 80. Each heater bank 80 may be individually powered, separately from other heater banks 80, to provide heat. In exemplary embodiments, three heater banks 80 may be utilized. Further, each heater bank 80 may in some embodiments have a different rated power level. For example in some embodiments, a heating unit 44 may include a low power heater bank, a medium power heater bank, and a high power heater bank. In some specific embodiments, a heating unit 44 may include a 1000 Watt bank 80, a 1400 Watt bank 80, and a 2400 Watt bank 80. Each heater bank 80 may further include at least one heater coil or coil pass 82, such as in exemplary embodiments two heater coils or coil passes 82. As shown, in exemplary embodiments multiple heater banks 80 may be stacked vertically, and the coils 82 of a heater bank 80 may be arranged side-by-side. Accordingly, in exemplary embodiments wherein each heater bank 80 has two heater coils 82 the coils 82 may be arranged in two columns and three rows as shown.

The operation of air conditioner unit 10 including blow fan 42, heater banks 80, heating coils 82 thereof, and other suitable components may be controlled by a processing device such as a controller 85. Controller 85 may be in communication (via for example a suitable wired or wireless connection) to such components of the air conditioner unit 10. By way of example, the controller 85 may include a memory and one or more processing devices such as microprocessors, CPUs or the like, such as general or special purpose microprocessors operable to execute programming instructions or micro-control code associated with operation of unit 10. The memory may represent random access memory such as DRAM, or read only memory such as ROM or FLASH. In one embodiment, the processor executes programming instructions stored in memory. The memory may be a separate component from the processor or may be included onboard within the processor.

Unit 10 may additionally include a control panel 87 and one or more user inputs 89, which may be included in control panel 87. The user inputs 89 may be in communication with the controller 85. A user of the unit 10 may interact with the user inputs 89 to operate the unit 10, and user commands may be transmitted between the user inputs 89 and controller 85 to facilitate operation of the unit 10 based on such user commands. A display 88 may additionally be provided in the control panel 87, and may be in communication
with the controller 85. Display 88 may, for example be a touchscreen or other text-readable display screen, or alternatively may simply be a light that can be activated and deactivated as required to provide an indication of, for example, an event or setting for the unit.

[0029] A power source 90 may supply power to the unit 10 generally, and specifically to the controller 85, fan 42 (and motor 72 thereof) and heater banks 80. Power source 90 may generally be any suitable electrical power source, such as a power cable that is connected to the various components of the unit 10. Power source 90 may interact with a power supply 92, such as the electrical grid, via for example a power outlet and suitable wiring as is generally understood. The power sources 90 may thus generally provide the electrical communication between the power supply 92 and the unit 10 generally and components thereof.

[0030] Unit 10 may additionally include a temperature sensor 95, which may be disposed within the interior 51 of housing 46 to measure, for example, temperatures during a heating mode when the heating unit 44 generally is active and/or temperature during a cooling mode. Sensor 95 may be in communication with the controller 85, and may provide such temperature readings to the controller 85.

[0031] As discussed, improved methods and apparatus for reducing or preventing overheating of an air conditioner units 10 during operation thereof would be advantageous. Accordingly, the present disclosure is further directed to methods for operating air conditioner units 10. It should further be understood that, in exemplary embodiments, a controller 85 in accordance with the present disclosure may be operable to perform the various methods steps as disclosed herein. Controller 85 may advantageously be in communication with, for example, the motor 72 and the heater banks 80 to facilitate such operation.

[0032] A method 200 may thus include, for example, the step 210 of determining an operational mode 212 for the air conditioner unit 10. The unit 10 may, for example, be operated in a cooling mode or a heating mode, as is generally understood. If it is determined that the air conditioner unit 10 is operating in a cooling mode, present operation of the unit 10 may simply be continued, with no further action taken with respect to presently disclosed methods. The continuation of present operation in accordance with the present disclosure is generally continuance of operation of the unit 10 in accordance with the present settings, with no adjustments in accordance with the present method. If it is determined that the air conditioner unit 10 is operating in a heating mode, further steps may be taken in accordance with the present disclosure.

[0033] Method 200 may thus further include, for example, the step 230 of determining a speed 232 of the blower fan 42. In some embodiments, such as when step 210 is performed, the step 230 may only occur when the operational mode 212 is a heating mode, as discussed above. Blower fan 42 may be operable at a variety of speeds 232, such as a low speed, one or more optional intermediate speeds, and a high speed.

[0034] In some embodiments, suitable components such as speed sensors, rotational frequency sensors, etc. may be utilized to determine the speed 232 of the blower fan 42. In other embodiments, step 230 may include the step 235 of determining a speed setting 237. As discussed above, the speed setting 237 for the fan 42 may, for example, be a low speed setting or a high speed setting or, optionally, one or more intermediate speed settings. The speed setting 237 may be selected by a user, and associated signals may be transmitted to the fan 42 (and specifically the motor 72 thereof) to operate the fan 42 at a speed 232 associated with that setting 237. Accordingly, when the speed setting 237 is a low speed setting, the speed 232 is a low speed. When the speed setting 237 is a high speed setting, the speed 232 is a high speed. When the speed setting 237 is an intermediate speed setting, the speed 232 is an intermediate speed. As such, by determining the speed setting 237, the speed 232 may additionally be determined.

[0035] In further embodiments, the speed setting 237 may be an automatic setting. The automatic setting is generally a setting that allows the speed 232 to be determined and adjusted based on other variables during operation, such as temperature differentials. Accordingly, in some embodiments, the step 230 of determining the speed 232 of the blower fan 42 may include the step 240 of comparing an actual temperature differential 242 to a differential threshold 244. In some embodiments, step 240 may occur only when the speed setting 237 is the automatic setting. The actual temperature differential 242 may be a difference in an actual temperature as measured by, for example, temperature sensor 95, and a desired temperature that is for example set by a user and saved in the controller 85. The differential threshold 244 is a predetermined temperature difference that is programmed into the controller 85. For example, if the actual temperature is less than or equal to the differential threshold, the fan 42 may be operated at one speed, and if the actual temperature is greater than the differential threshold 244, the fan 42 may be operated at a different speed. In some embodiments, for example, the speed 232 is a low speed when the actual temperature differential 242 is less than or equal to the differential threshold 244 and the speed 232 is a high speed when the actual temperature differential 242 is greater than the differential threshold 244.

[0036] Accordingly, the speed 232 of the fan 42 may be determined in accordance with the present disclosure. In some cases, the speed 232 may be a high speed or an intermediate speed. In some embodiments, method 200 may thus further include, for example, the step 245 of continuing present operation of the unit 10 when the speed 232 is a high speed or intermediate speed.

[0037] In other cases, the speed 232 may be a low speed. Method 200 may thus further include, for example, the step 250 of comparing an input current level 252 to a current threshold value 254. In some embodiments, such step 250 may only occur when the speed 232 is a low speed. The input current level 252 is the amount of current through the power source 90 during operation of the unit 10. A suitable current sensor 100 may be connected to the power source 90 to measure the input current level 252. The current sensor 100 may further, for example, be in communication with the controller 85, and may transmit such input current level 252 data to the controller 85. The current threshold value 254 is a predetermined current value that is programmed into the controller 85.

[0038] The input current level 252 in many cases may be based on the type of power source 90 utilized to supply power to the unit 10. For example, a conventionally-named 15 ampere power cord (which may for example supply power at approximately 13 amperes), 20 ampere power cord (which may for example supply power at approximately 16 amperes), or 30 ampere power cord (which may for example supply power at approximately 22 amperes) may be utilized to supply power to the unit 10. The 30 ampere power cord (or
another suitable high current level power source) may accordingly supply the greatest amount of power to the unit 80, and specifically to the heating unit 44. Further, in many cases, the only instances in which each and every heater bank 80 is active are when the 30 ampere power cord (or another suitable high current level power source) is utilized.

[0039] As discussed, overheating of the unit 10 can occur when the blower fan 42 is operating at a low speed and all of the heater banks 80 are active. Accordingly, to prevent overheating, the input current level 252 is utilized to ensure that such scenario does not occur during operation of the unit 10. The current threshold value 254 may thus be set at a level at or below the current level of a high current level power source and/or any power source that operates at a sufficient current level to activate all heater banks 80. The current threshold value 254 may further be set at a level above the current level of other power sources that do not operate at sufficient current levels to activate all heater banks 80.

[0040] As such, in some cases, the input current level 252 may be less than the current threshold value 254. In these embodiments, method 200 may thus further include, for example, the step 255 of continuing present operation of the unit 10 when the input current level 252 is less than the current threshold value 254. In other cases, the input current level 252 may be greater than or equal to the current threshold value 254. Method 200 may thus further include, for example, the step 260 of disabling one of the plurality of heater banks 80. In some embodiments, such step 260 may only occur when the input current level 252 is greater than or equal to the current threshold value 254. Advantageously, the risk of overheating of the unit 10 is thus reduced or eliminated by disabling one of the plurality of heater banks 80 when it is detected that the fan speed 232 is low, and the input current level 252 is greater than or equal to the current threshold value 254, thus preventing the possibility of all heater banks 80 being active when the fan speed 232 is low and as a result reducing or preventing the possibility of overheating.

[0041] In exemplary embodiments, the low power heater bank 80 is disabled when the input current level 252 is greater than or equal to the current threshold value 254. Alternatively, however, the medium power heater bank 80, high power heater bank 80, or any other suitable heater bank(s) 80 may be disabled when the input current level 252 is greater than or equal to the current threshold value 254.

[0042] In some embodiments, method 200 may additionally provide an indication that a heater bank 80 has been disabled. For example, method 200 may further include the step 270 of transmitting a heater bank inactive signal 272 when the input current level 252 is greater than or equal to the current threshold value 254. Such signal 272 may, for example, be transmitted by the controller 85 to, for example, the display 88. Such transmission, and resulting output provided by the display 88, may advantageously provide an indication to a user that a heater bank 80 has been disabled to reduce or prevent overheating.

[0043] It should be noted that, in exemplary embodiments, the deactivated heater bank 80 may be re-activated when, for example, the speed 232 is changed from a low speed to another speed, such as a high speed.

[0044] This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they include structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

What is claimed is:

1. A method for operating an air conditioner unit, the method comprising:
   determining an operational mode for the air conditioner unit, the air conditioner unit comprising a plurality of heater banks;
   determining a speed of a blower fan of the air conditioner unit when the operational mode is a heating mode;
   comparing an input current level to a current threshold value when the speed is a low speed; and
   disabling one of the plurality of heater banks when the input current level is greater than or equal to the current threshold value.

2. The method of claim 1, further comprising continuing a present operation when the operational mode is a cooling mode.

3. The method of claim 1, further comprising continuing a present operation when the speed is a high speed.

4. The method of claim 1, wherein the step of determining the speed of the blower fan comprises determining a speed setting.

5. The method of claim 4, wherein the speed is a low speed when the speed setting is a low speed setting and the speed is a high speed when the speed setting is a high speed setting.

6. The method of claim 4, wherein the step of determining the speed of the blower fan comprises comparing an actual temperature differential to a differential threshold when the speed setting is an automatic setting, and wherein the speed is a low speed when the actual temperature differential is less than or equal to the differential threshold and the speed is a high speed when the actual temperature differential is greater than the differential threshold.

7. The method of claim 1, further comprising transmitting a heater bank inactive signal when the input current level is greater than or equal to the current threshold value.

8. The method of claim 1, wherein the plurality of heater banks comprises a low power heater bank, a medium power heater bank and a high power heater bank.

9. The method of claim 8, wherein the low power heater bank is disabled when the input current level is greater than or equal to the current threshold value.

10. An air conditioner unit comprising:
    a blower fan, the blower fan comprising a blade assembly and a motor connected to the blade assembly;
    a heating unit, the heating unit comprising a plurality of heater banks;
    a power source in electrical communication with the blower fan and the plurality of heater banks; and
    a controller in operable communication with the motor and the plurality of heater banks, the controller operable for: determining an operational mode for the air conditioner unit, the air conditioner unit comprising a plurality of heater banks;
    determining a speed of a blower fan of the air conditioner unit when the operational mode is a heating mode;
comparing an input current level to a current threshold value when the speed is a low speed; and

disabling one of the plurality of heater banks when the input current level is greater than or equal to the current threshold value.

11. The air conditioner unit of claim 10, wherein the controller is further operable for continuing a present operation when the operational mode is a cooling mode.

12. The air conditioner unit of claim 10, wherein the controller is further operable for continuing a present operation when the speed is a high speed.

13. The air conditioner unit of claim 10, wherein the step of determining the speed of the blower fan comprises determining a speed setting.

14. The air conditioner unit of claim 13, wherein the speed is a low speed when the speed setting is a low speed setting and the speed is a high speed when the speed setting is a high speed setting.

15. The air conditioner unit of claim 13, wherein the step of determining the speed of the blower fan comprises comparing an actual temperature differential to a differential threshold when the speed setting is an automatic setting, and wherein the speed is a low speed when the actual temperature differential is less than or equal to the differential threshold and the speed is a high speed when the actual temperature differential is greater than the differential threshold.

16. The air conditioner unit of claim 10, wherein the controller is further operable for transmitting a heater bank inactive signal when the input current level is greater than or equal to the current threshold value.

17. The air conditioner unit of claim 10, wherein the plurality of heater banks comprises a low power heater bank, a medium power heater bank and a high power heater bank.

18. The air conditioner unit of claim 17, wherein the low power heater bank is disabled when the input current level is greater than or equal to the current threshold value.

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