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(54) **CLOTHES DRYING SYSTEMS HAVING CONTROL BASED ON SURROUNDING TEMPERATURE DETECTION**

(57) A clothes drying system (100) includes an apparatus (10) that comprises a drying air circuit. A temperature sensor (90) provides a signal indicative of a temperature of an environment outside the apparatus. A memory and processing circuitry is coupled to the memory. The memory includes logic that, when executed by the processing circuitry, directs at least one of: (i) a vent air control valve (28) to change an amount of heated air flowing from the drum (16) through the vent air control valve and into the environment based on the signal from the temperature sensor, (ii) a fan (27) to change a flow rate of air flowing through the drying air circuit based on the signal from the temperature sensor, and (iii) a heater (24) to change an amount of heat provided to the air flowing through the drying air circuit based on the signal from the temperature sensor.

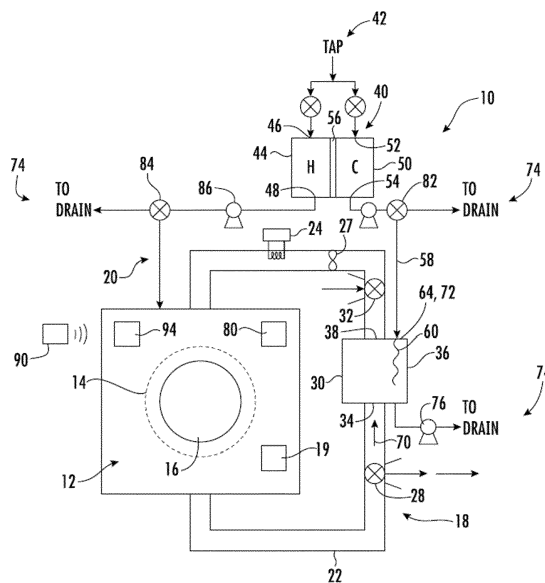


FIG. 1

Description

FIELD

[0001] The present application relates to clothes drying systems and, in particular, clothes drying systems that control operations based on surrounding temperatures.

BACKGROUND

[0002] Combination washing and drying apparatuses include both a washing cycle for washing clothes and a drying cycle for drying clothes. For the drying cycle, the washing and drying apparatuses may be either open-loop (vented) or closed-loop (condensing). In the case of an open-loop washing and drying apparatus, the wet air from a drum where the clothes are dried is directed to the environment. In the case of a closed-loop washing and drying apparatus, the wet air from the drum is directed to a condenser where moisture is removed from the wet air. The drier air is then directed from the condenser back to the drum for the drying operation.

[0003] Both open and closed-loop drying systems have advantages. For example, open-loop drying systems vent the wet air to the environment and replace the vented air with drier intake air. This venting of the relatively wet air can reduce drying time compared to a closed-loop drying system. Closed-loop drying systems may be used in locations where a vent is not present or would require major infrastructure changes to allow access to an outside space, such as in some apartment buildings. These closed-loop drying systems can have longer drying times than open-loop drying systems. It would be desirable to allow some controlled venting into a room to relatively quickly remove moist air from the system, which can reduce drying time compared to a closed-loop drying system.

SUMMARY

[0004] In an embodiment, a clothes drying system includes an apparatus that comprises a drying air circuit. The system includes a drum in communication with the drying air circuit. A condenser is in communication with the drying air circuit and is located downstream of the drum. The condenser includes a cooled water inlet that directs cooled water into the heated air to remove moisture from the heated air. The condenser includes a condenser water outlet for egress of water from the condenser. The cooled water inlet of the condenser is configured to receive water from a tap water source. A temperature sensor provides a signal indicative of a temperature of an environment outside the apparatus. The temperature sensor may be part of the apparatus or may be removed from the apparatus and communicate wirelessly with the apparatus. A memory and processing circuitry is coupled to the memory. The memory includes logic that, when executed by the processing circuitry, directs at least one

of: (i) a vent air control valve to change an amount of heated air flowing from the drum through the vent air control valve and into the environment based on the signal from the temperature sensor, (ii) a fan to change a flow rate of air flowing through the drying air circuit based on the signal from the temperature sensor, and (iii) a heater to change an amount of heat provided to the air flowing through the drying air circuit based on the signal from the temperature sensor.

[0005] In another embodiment, a method of controlling a clothes drying system comprising an apparatus that comprises a drying air circuit is provided. The method includes directing air through the drying air circuit to a drum. Heated air is directed from the drum to a condenser in communication with the drying air circuit and located downstream of the drum. The condenser includes a cooled water inlet directing cooled water into the heated air thereby removing moisture from the heated air, the cooled water inlet of the condenser configured to receive water from a tap water source. A signal is provided using a temperature sensor indicative of a temperature of an environment outside the apparatus. Based on the signal from the temperature sensor, a controller directs at least one of: (i) a vent air control valve to change an amount of heated air flowing from the drum through the vent air control valve and into the environment based on the signal from the temperature sensor, (ii) a fan to change a flow rate of air flowing through the drying air circuit based on the signal from the temperature sensor, and (iii) a heater to change an amount of heat provided to the air flowing through the drying air circuit based on the signal from the temperature sensor.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] While the specification concludes with claims particularly pointing out and distinctly claiming the present invention, it is believed the same will be better understood from the following description taken in conjunction with the accompanying drawing in which:

FIG. 1 is a schematic view of a washing and drying apparatus including temperature sensor, according to one or more embodiments shown and described herein;

FIG. 2 is a schematic view of a washing and drying system including the washing and drying apparatus of FIG. 1, according to one or more embodiments shown and described herein; and

FIG. 3 is a method of controlling the washing and drying apparatus of FIG. 1, according to one or more embodiments shown and described herein.

DETAILED DESCRIPTION

[0007] Embodiments described herein may be under-

stood more readily by reference to the following detailed description. It is to be understood that the scope of the claims is not limited to the specific compositions, methods, conditions, devices, or parameters described herein, and that the terminology used herein is not intended to be limiting. Also, as used in the specification, including the appended claims, the singular forms "a," "an," and "the" include the plural, and reference to a particular numerical value includes at least that particular value, unless the context clearly dictates otherwise. When a range of values is expressed, another embodiment includes from the one particular value and/or to the other particular value. Similarly, when values are expressed as approximations, by use of the antecedent basis "about," it will be understood that the particular values form another embodiment. All ranges are inclusive and combinable.

[0008] Embodiments described herein are generally directed to a drying apparatuses that include a drying air circuit for use during a drying cycle. The drying apparatuses may also include a wash water circuit for use in a washing cycle. The drying apparatuses include a drum that is in communication with both the drying air circuit and the wash water circuit. A condenser is in communication with the closed drying air circuit and is located downstream of the drum for receiving heated wet air (i.e., high humidity) from the drum during the drying cycle. The condenser has a water inlet that directs water into the heated air for removing moisture from the heated wet air through the process of condensation.

[0009] The drying apparatuses further include a temperature sensor that provides a signal that is indicative of a temperature of an environment outside the drying apparatuses. The temperature sensor may be part of the apparatus or may be removed from the apparatus and communicate wirelessly with the apparatus. The drying apparatuses include a memory and processing circuitry coupled to the memory. The memory includes logic that, when executed by the processing circuitry, directs at least one of (i) an air control valve (i.e., a vent valve) to change an amount of heated, wet air that exits the drum to travel through the air control valve and into the environment based on the signal from the temperature sensor, (ii) a fan to change a flow rate of air flowing through the drying air circuit based on the signal from the temperature sensor, and (iii) a heater to change an amount of heat provided to the air flowing through the drying air circuit based on the signal from the temperature sensor.

[0010] Referring to FIG. 1, a washing and drying apparatus 10 is illustrated diagrammatically and includes a housing 12, a tub 14 located in the housing and a drum 16 that is located inside the tub 14. A motor 19 is located inside the housing 12 and is used to rotate the drum 16. The washing and drying apparatus 10 includes a closed drying air circuit, generally referenced as element 18, and a wash water circuit, generally referenced as element 20. While components of the closed drying air circuit 18 and the wash water circuit 20 are illustrated outside the housing 12, this is merely for illustration as the closed

drying air circuit 18 and wash water circuit 20 are located inside the housing 12.

[0011] The closed drying air circuit 18 includes an air circulation duct 22 that is fluidly connected to the drum 16. The air circulation duct 22 is fluidly connected to the drum 16 for delivering air that is heated by heater 24 to a heated temperature to the drum 16 during a drying cycle. A fan 27 may be provided to encourage air circulation through the air circulation duct 22 to and from the drum 16. The closed drying air circuit 18 further includes a vent air control valve 28 that is located upstream from a condenser 30 and between the condenser 30 and the drum 16 and an intake air control valve 32 that is located downstream of the condenser 30 and between the condenser 30 and the fan 27.

[0012] Once the heated air is cycled through the drum 16, the heated wet air may be delivered through the circulation duct 22 to an air inlet 34 of the condenser 30. The condenser 30 includes a condensing apparatus 36 (e.g., a tube, etc.) that is fluidly connected to the circulation duct 22 at both the air inlet 34 and an air outlet 38. The condenser 30 is configured to remove moisture from the heated wet air and through the process of condensation before the air is reheated by heater 24 and delivered back to the drum 16 with reduced relative humidity after heating back to about the same (e.g., $\pm 5^\circ\text{C}$) heated temperature.

[0013] The vent air control valve 28 allows the heated air to be vented from the circulation duct 22 to the surrounding environment. In some embodiments, a filter 33 may be provided for filtering the air as it is being vented. The vent air control valve 28 may be controllable to allow venting of between zero percent and 100 percent. The percentage or fraction of total air flow being vented at the vent air control valve 28 may be referred to as the "vented fraction." The vent air control valve 28 is used to change the vented fraction, as will be described in greater detail below. The intake air control valve 32 allows drier outside air to enter the circulation duct 22. The amount of air entering the circulation duct 22 through the intake air control valve 32 may be controlled to be substantially the same amount of air exiting the circulation duct 22 through the vent air control valve 28 in order to maintain a desired pressure within the circulation duct 22.

[0014] A thermoelectric apparatus 40 includes a thermoelectric device 56 that may be provided between the condenser 30 and a tap water source 42. A "thermoelectric device" refers to a device that uses the Peltier effect to create a heat flux at the junction of two different types of materials. The thermoelectric device is a solid-state active heat pump that transfers heat from one side of the device to the other using electrical energy. The thermoelectric apparatus 40 includes a hot side flow device 44 that includes a hot side water input 46 and a hot side water output 48. The thermoelectric apparatus 40 further includes a cold side flow device 50 that includes a cold side water input 52 and a cold side water output 54. The hot side flow device 44 and the cold side flow device 50

each contain a duct that extends between the inputs 46, 52 and outputs 48, 54 that can be any suitable shape, such as curved, undulating, straight, etc. that allows for heating and cooling of the tap water therethrough. Located between the hot side flow device 44 and the cold side flow device 50 is the thermoelectric device 56. The thermoelectric device 56 may be connected to the hot side flow device 44 and the cold side flow device 50 using any suitable process, such as a thermal adhesive. The thermoelectric device 56 transfers heat from tap water flow through the cold side flow device 50 to tap water flowing through the hot side flow device 44 thereby cooling the tap water from an initial tap outlet temperature to a cooled water temperature. While a thermoelectric device is described, any other suitable device (e.g., refrigerant-based, water-based, etc.) may be used to cool the incoming tap water or, in some embodiments, a device to cool the incoming tap water may not be used.

[0015] The cooled water is delivered along line 58 to the condenser 30. At the condenser, the cooled water 60 is released into the condenser 30 at a rate of between about 1 g/s and about 16 g/s. In one embodiment, the cooled water 60 is released from a cooled water inlet 64 along an inner surface of a wall of the condenser 30, which cools the wall to a temperature below that of the heated wet air 70 entering the condenser.

[0016] In some embodiments, the cooled water inlet 64 may include a nozzle 72 having a reduced inner diameter compared to the line 58 to generate a spray of small cooled water droplets. The droplet size may be large enough that the water droplets do not become entrained in the heated wet air 70 and to increase the heat transfer coefficient and/or the heat transfer area of the cooled water droplets. As one example, for an air flow of greater than about 4 m/s through the condensing tube 36, a droplet size of greater than about 1076 μm from the nozzle 72 may be used. A pump upstream of the nozzle may be used to generate adequate hydraulic pressure necessary for atomization of the water. Water that is removed from the air and also provided to the condenser 30 through the line 58 is directed to a drain, represented by element 74. A pump 76 may be provided at a condenser water outlet 78 to pump the water from the condenser 30.

[0017] The washing and drying apparatus 10 may include a controller 80. The controller 80 may include processing circuitry and a memory that includes logic in the form of machine-readable instructions that is used to control operation of the one or more valves and pumps during the washing and drying cycles. For example, during a washing cycle, the logic may cause the processing circuitry to direct cooled water from the cold side flow device 50 to the drain 74 using valve 82 (e.g., a 3-way valve) that is communicatively coupled to the controller 80. The heated water from the hot side flow device 44 may be directed to the tub 14 using valve 84 and pump 86 that are communicatively coupled to the controller 80. During a drying cycle, the logic may cause the processing

circuitry to direct heated water from the hot side flow device 44 to the drain 74 using valve 84. The cooled water from the cold side flow device 50 may be directed to the condenser 30 using the valve 82. In some embodiments, the controller 80 may control the fan 27, the vent air control valve 28 and/or the intake air control valve 32 to maintain a preselected air flow rate through the condenser 30.

[0018] A temperature sensor 90 may provide a signal that is indicative of a temperature of an environment outside the washing and drying apparatus 10. The controller 80 may include the memory that may include logic that, when executed by the processing circuitry, directs at least one of the (i) vent air control valve 28 to change an amount of heated, wet air that exits the drum 16 to travel through the vent air control valve 28 and into the environment based on the signal from the temperature sensor 90, (ii) fan 27 to change a flow rate of air flowing through the circulation duct 22 based on the signal from the temperature sensor, and (iii) heater 24 to change an amount of heat provided to the air flowing through the circulation duct 22 based on the signal from the temperature sensor. Other sensor types may also be used in conjunction with the temperature sensor 90, such as a humidity sensor that provides a signal indicative of a humidity level of the environment outside the washing and drying apparatus 10 and/or a proximity sensor that can provide spatial information, such as dimensions of a room in which the washing and drying apparatus 10 is located.

[0019] The memory may include a default temperature (e.g., between about 20 °C and 25 °C) that is used by the controller 80 to control operation of the washing and drying apparatus 10 based on a difference between the default temperature and a surrounding temperature determined based on the signal from the temperature sensor 90. Details of the control based on temperature difference will be described in greater detail below. In some embodiments, a user input 94 may be provided that allows a user to input a user selected temperature that is different from (i.e., higher or lower) the default temperature. In this case, the controller 80 may control operation of the washing and drying apparatus 10 based on a difference between the user selected temperature and the surrounding temperature determined based on the signal from the temperature sensor 90.

[0020] Referring to FIG. 2, an exemplary washing and drying system 100 utilizing the washing and drying apparatus 10 is illustrated schematically. It should be noted that only selected components of the washing and drying system 100 will be described below for clarity and other components, such as various pumps and control valves, may also be utilized. The washing and drying system 100 includes a communication path 102, the controller 80 including a processor 104, a memory module 106, the fan 27, the heater 24, the vent air control valve 28, the intake air control valve 32, the sensor 90 (temperature, proximity and humidity) and the user input 94.

[0021] The processor 104 may include any device capable of executing machine-readable instructions stored

on a non-transitory computer-readable medium. The processor 104 may include one or more processors. Accordingly, each processor 104 may include a controller, an integrated circuit, a microchip, a computer, and/or any other computing device. The washing and drying system 100 may further include network interface hardware 108. The communication path 102 can provide data interconnectivity between the various modules that may send and receive data. The communication path 102 may be wired and/or wireless.

[0022] The washing and drying system 100 may further include the network interface hardware 108 for communicatively coupling the washing and drying system 100 with a network 110. The network interface hardware 108 can be communicatively coupled to the communication path 102 and can be any device capable of transmitting and receiving data via the network 113. The network interface hardware 108 may include antenna, modem, LAN port, Wi-Fi, mobile communications hardware, etc. The network interface hardware 108 may include a Bluetooth® module for sending and receiving Bluetooth communications to and from a mobile device 114. The network interface hardware 108 can allow to control operation of the washing and drying system 100 and to input the user selected temperature remotely, for example, using a handheld computing device 113.

[0023] Referring to FIG. 3, a method 120 of controlling the washing and drying system 100 is illustrated. The method includes the temperature sensor 90 sending a signal to the controller 80 that is indicative of temperature of the environment around the washing and drying apparatus 10 at step 122. At step 124, the controller 80 checks for a user selected temperature. If a user selected temperature is present, the controller 80 determines if the surrounding temperature is greater than the user selected temperature at step 126. If the surrounding temperature is greater than the user selected temperature, the controller 80 may reduce one or more of (i) the vented fraction using the vent air control valve 28, which reduces the amount of wet, heated air vented into the surroundings as step 128, (ii) the heat from the heater 24, which reduces the air temperature in the circulation duct 22 at step 130, and (iii) the air flow rate using the fan 27, which also reduces the amount of wet, heated air vented at step 132. Conversely, if the surrounding temperature is less than the user selected temperature, the controller 80 may increase one or more of (i) the vented fraction using the vent air control valve 28, which increases the amount of wet, heated air vented into the surroundings as step 134, (ii) the heat from the heater 24, which increases the air temperature in the circulation duct 22 at step 136, and (iii) the air flow rate using the fan 27, which also increases the amount of wet, heated air vented at step 138. Increasing one or more of the vented fraction, air temperature and air flow rate can reduce drying time of clothes in the drum, taking advantage of the reduced temperature of the surroundings. The amount of change of the vented fraction, air temperature and air flow rate can be deter-

mined by an algorithm to reduce the absolute value of the difference between the user selected temperature and the surrounding temperature.

[0024] Similarly, if a user selected temperature is not present and the default is used, the controller determines if the surrounding temperature is greater than the default temperature at step 140. If the surrounding temperature is greater than the default temperature, the controller 80 may reduce one or more of (i) the vented fraction using the vent air control valve 28, which reduces the amount of wet, heated air vented into the surroundings at step 142, (ii) the heat from the heater 24, which reduces the air temperature in the circulation duct 22 at step 144, and (iii) the air flow rate using the fan 27, which also reduces the amount of wet, heated air vented at step 146. Conversely, if the surrounding temperature is less than the default temperature, the controller 80 may increase one or more of (i) the vented fraction using the vent air control valve 28, which increases the amount of wet, heated air vented into the surroundings as step 148, (ii) the heat from the heater 24, which increases the air temperature in the circulation duct 22 at step 150, and (iii) the air flow rate using the fan 27, which also increases the amount of wet, heated air vented at step 152.

[0025] The above-described washing and drying systems and apparatuses provide drying systems that react based on a surrounding temperature outside the apparatuses. If the surrounding temperature is above a set temperature (either default or user selected), the washing and drying apparatuses can reduce the amount of heated, wet air vented into the surrounding environment, reduce the heat provided to the air and/or reduce an air flow rate through the drying circuit. If the surrounding temperature is below the set temperature, the washing and drying apparatuses can increase the amount of heated, wet air vented into the surrounding environment, increase the heat provided to the air and/or increase an air flow rate through the drying circuit, taking advantage of the reduced environmental temperature to decrease drying time. While a temperature sensor is described above, referring again to FIG. 2, other inputs may be used to control the vent air control valve, the fan and the heater. For example, another temperature sensor 160 may be located at an air vent of a heating, ventilation and air conditioning (HVAC) system to provide a signal indicative of temperature at the air conditioning vent. Such an arrangement of a temperature sensor 160 at the air conditioning vent can allow the washing and drying system to predict a temperature change in the surroundings and adjust accordingly. As another example, the heating and drying system may receive remotely provided weather information from a server of a weather information source, e.g., through the network interface hardware 108. This weather information can also be used by the washing and drying system to predict a temperature change in the surroundings and adjust accordingly. As yet another example, a proximity sensor 162 may be used to provide size information (e.g., distance to walls, floors

and ceilings of a room in which the washing and drying apparatus is located.

[0026] An example is below:

Clause 1: A clothes drying system comprising an apparatus that comprises a drying air circuit, the system comprising: a drum in communication with the drying air circuit; a condenser in communication with the drying air circuit and located downstream of the drum, the condenser comprising a cooled water inlet that directs cooled water into the heated air to remove moisture from the heated air, the condenser comprising a condenser water outlet for egress of water from the condenser, the cooled water inlet of the condenser configured to receive water from a tap water source; a temperature sensor that provides a signal indicative of a temperature of an environment outside the apparatus; and a memory and processing circuitry coupled to the memory, the memory including logic that, when executed by the processing circuitry, directs at least one of (i) a vent air control valve to change an amount of heated air flowing from the drum through the vent air control valve and into the environment based on the signal from the temperature sensor; (ii) a fan to change a flow rate of air flowing through the drying air circuit based on the signal from the temperature sensor; and (iii) a heater to change an amount of heat provided to the air flowing through the drying air circuit based on the signal from the temperature sensor.

Clause 2: The system of clause 1, wherein the memory includes logic that, when executed by the processing circuitry, directs the vent air control valve to increase or decrease an amount of heated air flowing from the drum into the environment based on the signal from the temperature sensor.

Clause 3: The system of clause 2, wherein the memory includes logic that, when executed by the processing circuitry, directs the vent air control valve to reduce an amount of heated air flowing from the drum into the environment based on the signal when a detected temperature is above a default temperature and to increase an amount of heated air flowing from the drum into the environment when a detected temperature is below the default temperature.

Clause 4: The system of any one of clauses 1-3, wherein the memory includes logic that, when executed by the processing circuitry, directs an intake air control valve to control an amount of air flowing into the drying air circuit from the environment at a location downstream of the condenser to a flow rate that is about equal to a flow rate that the vent control valve vents into the environment.

Clause 5: The system of any one of clauses 1-4 fur-

ther comprising a user input that allows a user to provide a user selected temperature.

Clause 6: The system of any one of clauses 1-5, wherein the temperature sensor is located outside of the apparatus.

Clause 7: The system of any one of clauses 1-6 further comprising a sensor that provides a signal indicative of a distance of the proximity sensor to one or more walls that at least partially define a boundary of the environment.

Clause 8: The system of any one of clauses 1-7, wherein the memory includes logic that, when executed by the processing circuitry, controls a flow rate of air through the condenser using the vent air control valve, an intake air control valve and/or the fan.

Clause 9: The system of any one of clauses 1-8 further comprising another temperature sensor at an air vent of an HVAC system that provides a signal indicative of a temperature at the air vent, the memory includes logic that, when executed by the processing circuitry, directs the vent air control valve to control an amount of heated air flowing from the drum into the environment based on the signal from the another temperature sensor.

Clause 10: The system of any one of clauses 1-9, the memory includes logic that, when executed by the processing circuitry, directs the vent air control valve to control an amount of heated air flowing from the drum into the environment based on weather information received over a wireless network.

Clause 11: A method of controlling a clothes drying system comprising an apparatus that comprises a drying air circuit, the method comprising: directing air through the drying air circuit to a drum; directing heated air from the drum to a condenser in communication with the drying air circuit and located downstream of the drum, the condenser comprising a cooled water inlet directing cooled water into the heated air thereby removing moisture from the heated air, the cooled water inlet of the condenser configured to receive water from a tap water source; providing a signal using a temperature sensor indicative of a temperature of an environment outside the apparatus; and based on the signal from the temperature sensor, a controller directing at least one of: (i) a vent air control valve to change an amount of heated air flowing from the drum through the vent air control valve and into the environment based on the signal from the temperature sensor; (ii) a fan to change a flow rate of air flowing through the drying air circuit based on the signal from the temperature sensor; and (iii) a heater to change an amount of

heat provided to the air flowing through the drying air circuit based on the signal from the temperature sensor.

Clause 12: The method of clause 11 comprising directing the air control valve using the controller to increase or decrease an amount of heated air flowing from the drum into the environment based on the signal from the temperature sensor.

Clause 13: The method of clause 12 comprising directing the vent air control valve using the controller to reduce an amount of heated air flowing from the drum into the environment based on the signal when a detected temperature is above a default temperature and to increase an amount of heated air flowing from the drum into the environment when a detected temperature is below the default temperature.

Clause 14: The method of any one of clauses 11-13 further comprising changing the default temperature to a user selected temperature that is different from the default temperature.

Clause 15: The method of any one of clauses 11-14, wherein the method further comprises directing an intake air control valve to control an amount of air flowing into the drying air circuit from the environment at a location downstream of the condenser to a flow rate that is about equal to a flow rate that the vent air control valve vents air into the environment.

Clause 16: The method of any one of clauses 11-15, wherein the temperature sensor is located outside of the apparatus.

Clause 17: The method of any one of clauses 11-16 further comprising providing a signal indicative of a distance of a proximity sensor to a wall that at least partially defines a boundary of the environment using a sensor.

Clause 18: The method of any one of clauses 11-17 further comprising heating air in the drying circuit using the heater downstream of the condenser.

Clause 19: The method of any one of clauses 11-18 further comprising providing a signal indicative of a temperature at an air vent of a HVAC system using another temperature sensor at the air vent, and the controller directing the vent air control valve to control an amount of heated air flowing from the drum into the environment using the processing circuitry based on the signal from the another temperature sensor.

Clause 20: The method of any one of clauses 11-19 further comprising directing the vent air control valve

to control an amount of heated air flowing from the drum into the environment using the processing circuitry based on weather information.

[0027] The dimensions and values disclosed herein are not to be understood as being strictly limited to the exact numerical values recited. Instead, unless otherwise specified, each such dimension is intended to mean both the recited value and a functionally equivalent range surrounding that value. For example, a dimension disclosed as "40 mm" is intended to mean "about 40 mm."

Claims

1. A clothes drying system (100) comprising an apparatus (10) that comprises a drying air circuit, the system (18) comprising:

a drum (16) in communication with the drying air circuit;

a condenser (30) in communication with the drying air circuit and located downstream of the drum, the condenser comprising a cooled water inlet (64) that directs cooled water into the heated air to remove moisture from the heated air, the condenser comprising a condenser water outlet (78) for egress of water from the condenser, the cooled water inlet of the condenser configured to receive water from a tap water source (42);

a temperature sensor (90) that provides a signal indicative of a temperature of an environment outside the apparatus; and

a memory and processing circuitry coupled to the memory, the memory including logic that, when executed by the processing circuitry, directs at least one of

(i) a vent air control valve (28) to change an amount of heated air flowing from the drum through the vent air control valve and into the environment based on the signal from the temperature sensor;

(ii) a fan (27) to change a flow rate of air flowing through the drying air circuit based on the signal from the temperature sensor; and

(iii) a heater (24) to change an amount of heat provided to the air flowing through the drying air circuit based on the signal from the temperature sensor.

2. The system of claim 1, wherein the memory includes logic that, when executed by the processing circuitry, directs the vent air control valve to increase or decrease an amount of heated air flowing from the drum into the environment based on the signal from the

temperature sensor.

3. The system of Claim 1 or 2, wherein the memory includes logic that, when executed by the processing circuitry, directs the vent air control valve to reduce an amount of heated air flowing from the drum into the environment based on the signal when a detected temperature is above a default temperature and to increase an amount of heated air flowing from the drum into the environment when a detected temperature is below the default temperature. 5
4. The system of any of the preceding claims, wherein the memory includes logic that, when executed by the processing circuitry, directs an intake air control valve (32) to control an amount of air flowing into the drying air circuit from the environment at a location downstream of the condenser to an intake flow rate that is about equal to an outtake flow rate that the vent control valve vents into the environment. 10
5. The system of any of the preceding claims further comprising a user input (94) that allows a user to provide a user selected temperature, wherein the memory includes logic that, when executed by the processing circuitry, directs the vent air control valve to reduce an amount of heated air flowing from the drum into the environment based on the signal when a detected temperature is above the user selected temperature and to increase an amount of heated air flowing from the drum into the environment when a detected temperature is below the user selected temperature. 15
6. The system of any of the preceding claims, wherein the temperature sensor is located outside of the apparatus. 20
7. The system of any of the preceding claims further comprising a proximity sensor (162) that provides a signal indicative of a distance of the proximity sensor to one or more walls that at least partially define a boundary of the environment. 25
8. The system of any of the preceding claims, wherein the memory includes logic that, when executed by the processing circuitry, controls a flow rate of air through the condenser using the vent air control valve, an intake air control valve (32) and/or the fan. 30
9. The system of any of the preceding claims further comprising another temperature sensor (90) at an air vent of an HVAC system that provides a signal indicative of a temperature at the air vent, the memory includes logic that, when executed by the processing circuitry, directs the vent air control valve to control an amount of heated air flowing from the drum into the environment based on the signal from 35

the another temperature sensor.

10. The system of any of the preceding claims, the memory includes logic that, when executed by the processing circuitry, directs the air control valve to control an amount of heated air flowing from the drum into the environment based on weather information received over a wireless network for a geographic area where the apparatus is located. 40
11. A method of controlling the clothes drying system comprising the system of any of Claims 1 to 10, the method comprising:
 - directing air through the drying air circuit to the drum;
 - directing heated air from the drum to the condenser;
 - providing a signal using the temperature sensor indicative of a temperature of an environment outside the apparatus; and
 - based on the signal from the temperature sensor, a controller (80) directing at least one of:
 - (i) the vent air control valve to change an amount of heated air flowing from the drum through the vent air control valve and into the environment based on the signal from the temperature sensor;
 - (ii) the fan to change a flow rate of air flowing through the drying air circuit based on the signal from the temperature sensor; and
 - (iii) the heater to change an amount of heat provided to the air flowing through the drying air circuit based on the signal from the temperature sensor. 45
12. The method of claim 11 comprising directing the air control valve using the controller to increase or decrease an amount of heated air flowing from the drum into the environment based on the signal from the temperature sensor. 50
13. The method of Claim 11 or 12 comprising directing the vent air control valve using the controller to reduce an amount of heated air flowing from the drum into the environment based on the signal when a detected temperature is above a default temperature and to increase an amount of heated air flowing from the drum into the environment when a detected temperature is below the default temperature. 55
14. The method of any of Claims 11 to 13, wherein the method further comprises directing an intake air control valve to control an amount of air flowing into the drying air circuit from the environment at a location downstream of the condenser to an intake flow rate that is about equal to an outtake flow rate that the

vent air control valve vents air into the environment.

15. The method of claim 13 further comprising changing the default temperature to a user selected temperature that is different from the default temperature. 5

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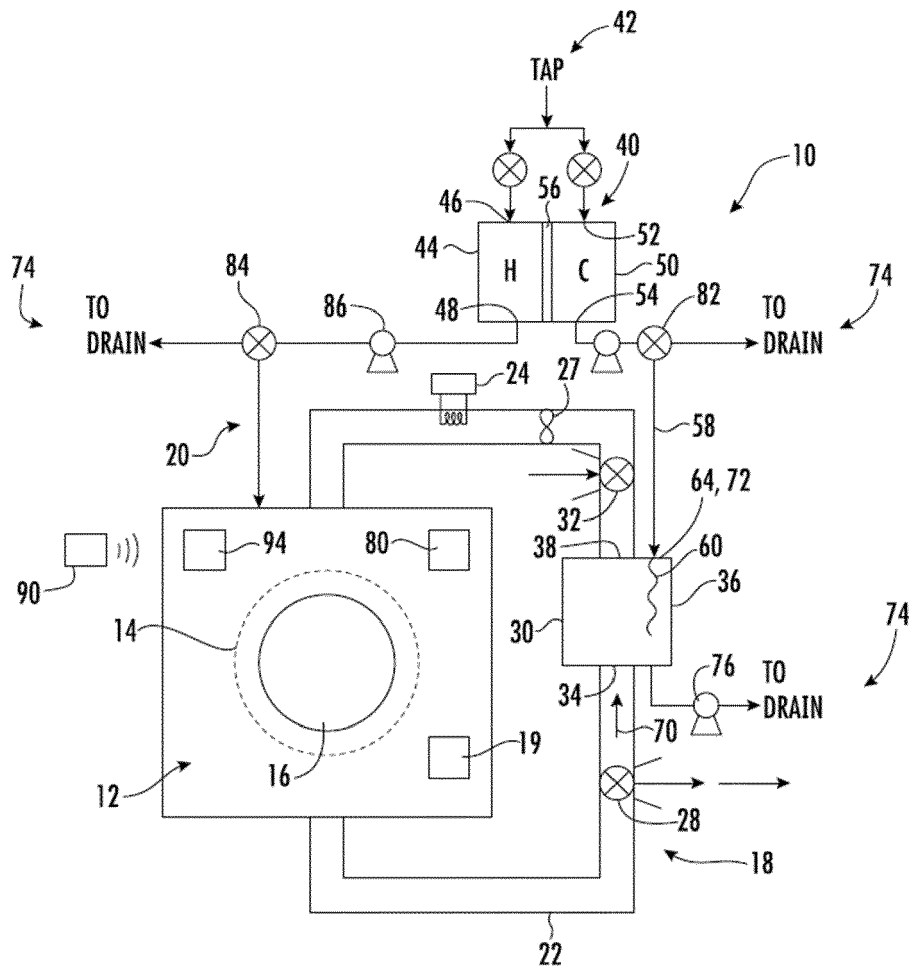


FIG. 1

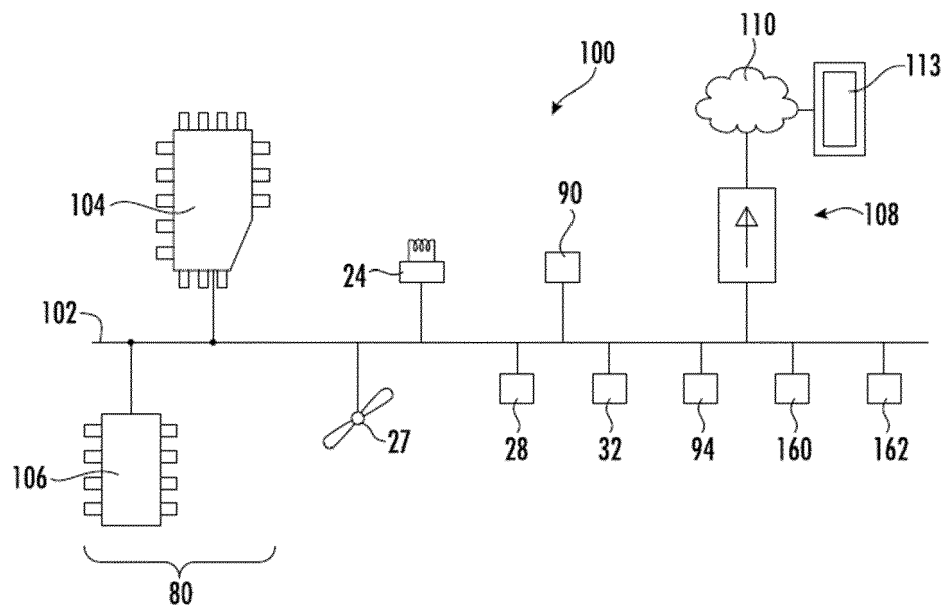


FIG. 2

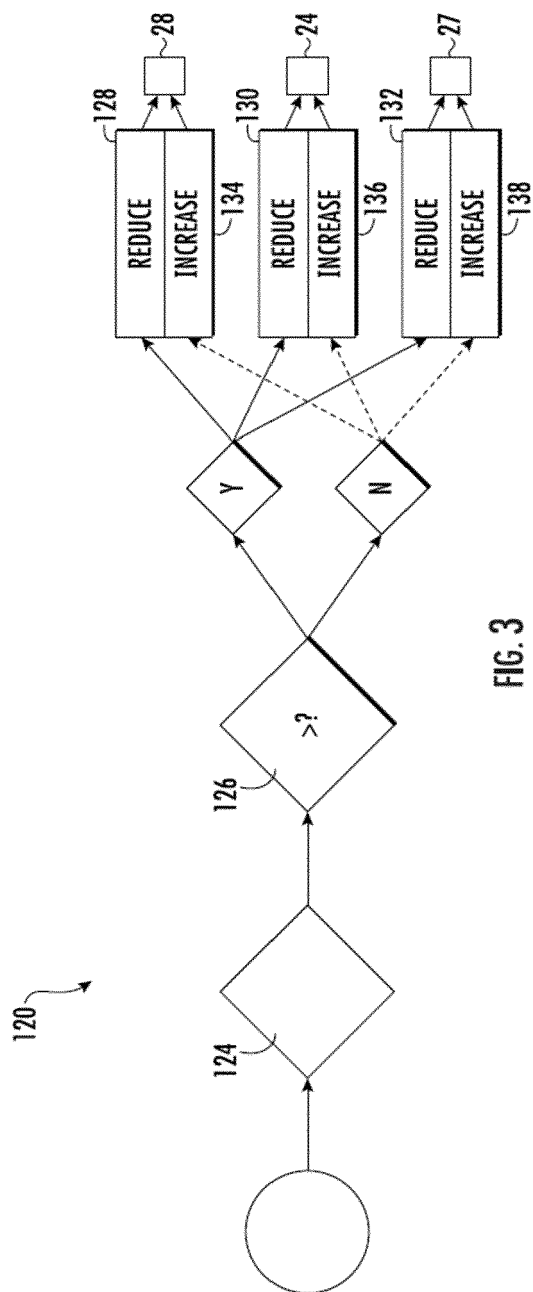


FIG. 3



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			D06F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 9 April 2020	Examiner Diaz y Diaz-Caneja
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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