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(54) A ROOFTOP AIR CONDITIONING UNIT

(57) A rooftop air conditioning unit, RTU, (100) is disclosed. The RTU (100) comprises an absorber (102) configured in a supply airstream (SA), a desorber (104) configured in a regeneration airstream (RA), wherein the desorber (104) is fluidically connected to the absorber (102) via a liquid desiccant system (106) and an interchange heat exchanger (108). The RTU (100) further comprises a first heat exchanger (110-1) configured upstream of the absorber (102) in the supply air stream (SA), a second heat exchanger (110-2) configured upstream of the desorber (104) in the regeneration airstream (RA), wherein the first heat exchanger (110-1) is fluidically connected to the second heat exchanger (110-2) via a vapor compression system (112), and one or more secondary heat exchangers (114-1, 114-2) configured between the vapor compression system (112) and the liquid desiccant system (106), wherein the one or more secondary heat exchangers (114-1, 114-2) are operable to control temperature of a desiccant associated with the liquid desiccant system (106) into the absorber (102) and/or into the desorber (104).

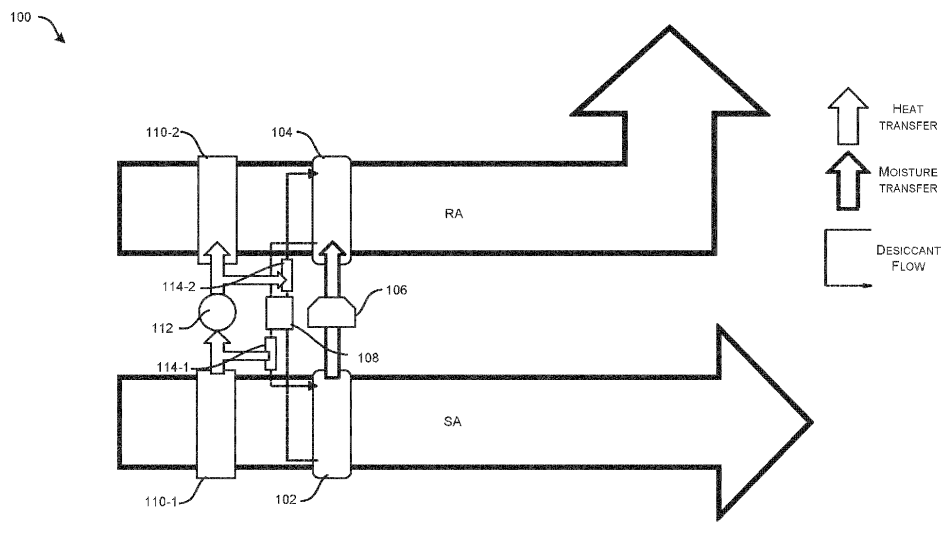

FIG. 1

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Description

BACKGROUND

[0001] This invention relates to the field of rooftop air conditioning units, and more particularly, a simple, improved, and efficient liquid desiccant-based rooftop air conditioning units.

[0002] Existing rooftop air conditioning units (RTUs) may involve a liquid desiccant system to provide dehumidification capabilities with a liquid desiccant contact media device installed downstream of an evaporator in the supply airstream. The non-isothermic process of the media device may condition the supply airstream. However, additional cooling or heating of the airstream prior to being supplied to space may be needed due to the state of the air coming out of the liquid desiccant device.

SUMMARY

[0003] Described herein is a rooftop air conditioning unit (RTU). The RTU comprises an absorber configured in a supply airstream, and a desorber configured in a regeneration airstream, wherein the desorber is fluidically connected to the absorber via a liquid desiccant system and an interchange heat exchanger. The RTU comprises a first heat exchanger configured upstream of the absorber in the supply air stream, a second heat exchanger configured upstream of the desorber in the regeneration airstream, wherein the first heat exchanger is fluidically connected to the second heat exchanger via a vapor compression system, and one or more secondary heat exchangers configured between the vapor compression system and the liquid desiccant system, wherein the one or more secondary heat exchangers are operable to control the temperature of a desiccant associated with the liquid desiccant system into the absorber and/or into the desorber.

[0004] In one or more embodiments the one or more secondary heat exchangers comprise a third heat exchanger configured in a desiccant upstream of the absorber.

[0005] In one or more embodiments, the one or more secondary heat exchangers comprise a fourth heat exchanger configured in a desiccant upstream of the desorber.

[0006] In one or more embodiments, the first heat exchanger, and a refrigerant side of the third heat exchanger are fluidically coupled to the second heat exchanger, and a refrigerant side of the fourth heat exchanger via the vapor compression system.

[0007] In one or more embodiments, a desiccant side of the third heat exchanger is fluidically coupled to a desiccant side of the fourth heat exchanger via the interchange heat exchanger and the liquid desiccant system.

[0008] In one or more embodiments, the one or more secondary heat exchangers are operable to control temperature of the desiccant supplied to the absorber to adjust the temperature and humidity of the supply airstream downstream of the absorber to predefined values.

[0009] In one or more embodiments, the predefined value of the temperature of the airstream downstream of the absorber is in a range of 70°F to 75°F.

[0010] In one or more embodiments, the third heat exchanger is operated as an evaporator when the desiccant supplied to the absorber is to be cooled for adjusting the temperature and the humidity of the supply airstream downstream of the absorber to the predefined values.

[0011] In one or more embodiments, the third heat exchanger is operated as a condenser when the desiccant supplied to the absorber is to be heated for adjusting the temperature and the humidity of the supply airstream downstream of the absorber to the predefined values.

[0012] In one or more embodiments, the one or more secondary heat exchangers are operable to control the temperature of the desiccant flowing into the absorber to a first predefined desiccant temperature to control mass transfer potential from the desiccant to the regeneration airstream at the absorber.

[0013] In one or more embodiments, the one or more secondary heat exchangers are operable to increase the temperature of the desiccant flowing into the desorber to a second predefined desiccant temperature to control mass transfer potential from the desiccant to the regeneration airstream at the desorber..

[0014] In one or more embodiments, the one or more secondary heat exchangers is a brazed-plate heat exchanger.

[0015] In one or more embodiments, the one or more secondary heat exchangers further comprise an upstream metering device or an expansion device for a refrigerant when the corresponding secondary heat exchanger is operated as an evaporator.

[0016] In one or more embodiments, the RTU is adapted to be configured at an area of interest (AOI) to supply the airstream having the predefined values of the temperature and humidity at the AOI, and further receive the return airstream from the AOI.

[0017] In one or more embodiments, the RTU comprises a controller that is configured to receive a set of instructions pertaining to the predefined values of the airstream to be supplied at the AOI, and control operation of one or more of the heat exchangers associated with the system to supply the airstream having the predefined values of the temperature and humidity to the AOI.

[0018] Also described herein is a liquid desiccant-based outdoor air system. The system comprises an absorber configured in a supply airstream, and a desorber configured in a regeneration airstream, wherein the desorber is fluidically connected to the absorber via a liquid desiccant system and an interchange heat exchanger. The system comprises a first heat exchanger configured upstream of the absorber in the supply air stream, a second heat exchanger configured upstream of the desorber in the regeneration airstream, wherein the first heat exchanger is fluidically connected to the second heat exchanger via a vapor compression system, and one or more secondary heat exchangers configured between the vapor compression system and the liquid desiccant system, wherein the one or more secondary heat exchangers are operable to control the temperature of a desiccant associated with the liquid desiccant system into the absorber and/or into the desorber.

[0019] The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, features, and techniques of the invention will become more apparent from the following description taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The accompanying drawings are included to provide a further understanding of the invention. The drawings illustrate exemplary embodiments of the invention and, together with the description, serve to explain the principles of the invention. However, the scope of the invention is defined only by the claims.

[0021] In the drawings, similar components and/or features may have the same reference label. Further, various components of the same type may be distinguished by following the reference label with a second label that distinguishes among the similar components. If only the first reference label is used in the specification, the description is applicable to any one of the similar components having the same first reference label irrespective of the second reference label.

FIG. 1 illustrates an exemplary representation of a liquid desiccant-based rooftop air conditioning unit (RTU) that is also capable of handling outside air (ventilation).

FIG. 2A illustrates an exemplary representation of the RTU when the supply airstream is to be cooled to provide a neutral or user-defined supply airstream downstream of the absorber.

FIG. 2B illustrates an exemplary psychrometric chart depicting the temperature and humidity of air in the supply airstream and regeneration airstream in the RTU of FIG. 2A.

FIG. 3 illustrates an exemplary block diagram of the RTU of FIG. 1.

DETAILED DESCRIPTION

[0022] The following is a detailed description of embodiments depicted in the accompanying drawings. The embodiments are in such detail as to clearly communicate the invention. However, the amount of detail offered is not intended to limit the scope of the invention; on the contrary, the intention is to cover all modifications, equivalents, and alternatives of these embodiments falling within the scope of the subject invention as defined by the appended claims.

[0023] Various terms are used herein. To the extent a term used in a claim is not defined below, it should be given the broadest definition persons in the pertinent art have given that term as reflected in printed publications and issued patents at the time of filing.

[0024] In the specification, reference may be made to the spatial relationships between various components and to the spatial orientation of various aspects of components as the devices are depicted in the attached drawings. However, as will be recognized by those skilled in the art after a complete reading of the subject disclosure, the components of this invention. described herein may be positioned in any desired orientation. Thus, the use of terms such as "above," "below," "upper," "lower," "first", "second" or other like terms to describe a spatial relationship between various components or to describe the spatial orientation of aspects of such components should be understood to describe a relative relationship between the components or a spatial orientation of aspects of such components, respectively, as the outdoor air system, liquid desiccant system, absorber, desorber, heat exchangers, vapor compression system, and corresponding components, described herein may be oriented in any desired direction.

[0025] Existing rooftop air conditioning units (RTUs) typically include a supply airstream, a regeneration airstream, and a return airstream. RTUs may also involve a liquid-desiccant system to condition the supply air stream. When humidification and cooling are required to condition the outdoor air to neutral conditions before supplying to a space where the RTU is installed, ambient or outside air is allowed to enter into the system from outdoors and is cooled down to a lower temperature and saturated state at an evaporator part of a vapor compression system installed in the supply airstream. The cooled supply airstream is then supplied through and dehumidified at a contact media device (absorber or dehumidifier) associated with a liquid desiccant system where a concentrated solution of liquid desiccant is sprayed or blown across the supply airstream. The absorber or media device is installed downstream of the evaporator part in the supply airstream, in a process that decreases the air dew point and increases its dry bulb temperature. However, at this point of the process, the air downstream of the absorber or media device may either be warmer or colder than a user-defined range making it inconvenient for the users in the space. The cooling or heating of the air downstream of the absorber or media device in the existing system is typically done by integrating additional heat exchangers and passive thermal devices such as enthalpy wheels and recirculated fluid loops in the supply airstream, regeneration airstream, and/or the return airstream. This makes the overall RTU bulky and expensive. There is therefore a need to overcome the dependence on additional heat exchangers and passive thermal devices in the airstreams of the RTU to adjust the temperature and humidity of the supply airstream to a user-defined range or a neutral range of 70°F to 75°F (21 °C to 24°C)..

[0026] This invention provides a simple, improved, efficient, and cost-effective liquid desiccant-based rooftop air conditioning unit. The RTU may be capable of handling outdoor air (ventilation). The RTU conditions the supply airstream downstream of the absorber in a comfortable or neutral range by controlling the temperature of the desiccant liquid itself such that heat exchange, as well as water mass transfer capability at the absorber and/or the desorber, may be improved without the use of additional heat exchangers and passive thermal devices in the airstreams, thereby efficiently and cost-effectively controlling the temperature and humidity of the supply airstream to a user-defined range or neutral range.

[0027] Referring to FIGs. 1 and 3, the rooftop air conditioning unit "RTU" 100 capable of handling outdoor air (ventilation) at an area of interest or space is disclosed. The RTU 100 may include an absorber 102 (also referred to as dehumidifier 102, herein) configured in a supply airstream (SA), and a desorber 104 (also referred to as regenerator 104, herein) configured in a regeneration airstream (RA). The desorber 104 may be fluidically connected to the absorber 102 via a liquid desiccant system 106 and an interchange heat exchanger 108. The RTU 100 may further include a first heat exchanger 110-1 configured upstream of the absorber 102 in the supply airstream SA, and a second heat exchanger 110-2 configured upstream of the desorber 104 in the regeneration airstream RA. The first heat exchanger 110-1 may be fluidically connected to the second heat exchanger 110-2 via a vapor compression system 112. In addition, the RTU 100 may include one or more secondary heat exchangers 114-1, 114-2 configured between the vapor compression system 112 and the liquid desiccant system 106. The secondary heat exchangers 114-1, 114-2 are operable to control the temperature of a liquid desiccant (also referred to as desiccant, herein) associated with the liquid desiccant system 106 into the absorber 102 and/or into the desorber 104 to adjust the temperature and humidity of the supply airstream downstream of the absorber 102 to predefined or user-defined values. In one or more embodiments, the predefined value of the temperature of the airstream downstream of the absorber 102 is in a neutral or comfort range of 70°F to 75°F but is not limited to the like. The supply airstream (SA) may be the conditioned outside air, however, the supply air stream may also be a conditioned return airstream, or a mixture of the outside air and return airstream.

[0028] In one or more embodiments, the secondary heat exchangers 114-1, 114-2 may be a brazed-plate heat exchanger, but is not limited to the like. The secondary heat exchangers may include a third heat exchanger 114-1 configured in a desiccant upstream of the absorber 102 and a fourth heat exchanger 114-2 configured in a desiccant upstream of the desorber 104. Further, the first heat exchanger 110-1 and the refrigerant side of the third heat exchanger 114-1 may be fluidically coupled to the second heat exchanger 110-2, and the refrigerant side of the fourth heat exchanger 114-2 via the vapor compression system 112. Furthermore, a desiccant side of the third heat exchanger 114-1 may be fluidically coupled to a desiccant side of the fourth heat exchanger 114-2 via the interchange heat exchanger 108 and the liquid desiccant system 106. In one or more embodiments, the secondary heat exchangers 114-1, 114-2 may further comprise an upstream metering device or an expansion device for a refrigerant when the corresponding secondary heat exchanger 114-1, 114-2 is operated as an evaporator.

[0029] The heat exchangers 110-1, 110-2, 114-1, 114-2 of the RTU 100 may be operated as an evaporator and/or a condenser to control the temperature of the desiccant supplied to the absorber 102 and/or the desorber 104, thereby adjusting the temperature and humidity of the supply airstream downstream of the absorber 102 and also facilitating controlling the mass transfer potential between the desiccant and the airstream at the absorber 102 and the desorber 104.

[0030] In one or more embodiments, the third heat exchanger 114-1 may be operated as an evaporator when the desiccant supplied to the absorber 102 is to be cooled for lowering the temperature and the humidity of the supply airstream downstream of the absorber 102, compared to the existing solutions where the supply airstream downstream of the absorber 102 is much warmer if there is no third heat exchanger 114-1. At the absorber 102, the heat released due to the conversion of water vapor to liquid diluted into the desiccant solution, goes mostly to the supply airstream to increase the temperature of the supply airstream, but at the same time, the supply airstream rejects heat to the cool desiccant. As a result, the increase in temperature of the supply airstream is not as high as it would be if there is no active cooling of the desiccant in the third heat exchanger 114-1. Further, the third heat exchanger 114-1 may be operated as a condenser when the desiccant supplied to the absorber 102 is to be heated for adjusting the temperature and the humidity of the supply airstream downstream of the absorber 102 to the predefined values.

[0031] In one or more embodiments, the secondary heat exchanger 114-1, 114-2 may be operated as an evaporator and/or condenser to adjust the temperature of the desiccant flowing into the absorber 102 to a first predefined desiccant temperature to control mass transfer potential from the desiccant to the regeneration airstream at the absorber 102. Further, the secondary heat exchanger 114-1, 114-2 may be operated as an evaporator and/or condenser to control the temperature of the desiccant flowing into the desorber 104 to a second predefined desiccant temperature to control mass transfer potential from the desiccant to the regeneration airstream at the desorber 104.

[0032] In the liquid desiccant system 106, the desiccant circulates between the absorber 102 and the desorber 104. In the absorber 102 (humidifier), a concentrated solution of the desiccant is distributed over a contact media device while ambient air or outdoor air is blown across the desiccant stream. The desiccant stream absorbs moisture from the air and is simultaneously cooled down. The results of this process are the cool dry air downstream of the absorber 102 and the diluted desiccant solution. In the desorber 104 (regenerator), the diluted desiccant solution from the absorber 102 is distributed over a contact media device, and the ambient air is blown across the desiccant solution stream. Accordingly, some moisture/water is taken away from the diluted desiccant solution by the ambient air while the desiccant is heated. The resulting concentrated desiccant solution is then collected, and hot humid air is rejected to the ambient. Further, the collected concentrated desiccant solution is circulated back to the absorber 102. The RTU 100 conditions the desiccant with the interchange heat exchanger (IHX) 108 by allowing hot desiccant downstream of the desorber 104 to cool down before entering the absorber 102, thereby improving water mass transfer from the air to the desiccant. Further, the IHX 108 allows cold desiccant downstream of the absorber 102 to heat up before it enters the desorber 104, thereby improving water mass transfer from the desiccant to air.

[0033] In one or more embodiments, the RTU 100 may be adapted to be configured or installed at an area of interest (AOI) to supply the air having the predefined values of the temperature and humidity at the AOI, and further, receive the return airstream from the AOI. Referring to FIG. 3, the RTU 100 may further comprise a controller 302 that may be configured to receive a set of instructions pertaining to the predefined values of the airstream to be supplied at the AOI. Users at the AOI or remote location may select the predefined values of the temperature and humidity of the air to be supplied at the AOI. Accordingly, the controller 302 can operate the heat exchangers associated with the RTU 100 as an evaporator and/or condenser to supply the airstream having the predefined values, which may also facilitate in conditioning the outside air to provide ventilation at the AOI. In one or more embodiments, when the heat exchangers 114-1, 114-2 are operated as an evaporator, the upstream metering device or expansion device may meter and control the flow of fluid into the heat exchangers 114-1, 114-2 to control heat transfer. Further, when the exchangers 114-1, 114-2 are operated as a condenser, a three-way valve may be employed to meter and control the amount of flow into the condenser coil and the heat exchangers 114-1, 114-2.

[0034] The RTU 100 generally has two separate functions. The conditioning side or supply airstream side of the RTU 100 provides conditioning of air to the user-defined conditions or ventilation at the AOI or space where the RTU 100 is installed, which may be set using thermostats or humidistats. The regeneration side of the RTU 100 provides a reconditioning function of the liquid desiccant so that the desiccant can be reused on the conditioning side. The controller 302 is used to properly balance the liquid desiccant between the two sides as conditions necessitate and that excess heat and moisture are properly dealt with without leading to over-concentrating or under-concentrating the desiccant.

[0035] The RTU 100 may include one or more humidity sensors 304 and one or more temperature sensors 306 installed in the supply airstream, regeneration airstream, and return airstream to monitor the temperature and humidity of air throughout the RTU 100. Further, temperature sensors 306 and flow sensors 308 may also be installed in the liquid desiccant system 106 to monitor temperature and pressure or flow rate circulated between the absorber 102 and desorber 104. The controller 302 may include a processor coupled to a memory storing instructions executable by the processor, which enables the controller 302 to receive the temperature, pressure, and humidity data from the corresponding sensors installed in the RTU 100. The controller 302 also receives user-defined conditions of air to be supplied at the AOI, which may be set using thermostats or humidistats 310. Accordingly, the controller 302 may actuate the one or more components associated with the RTU 100 to adjust the temperature of the desiccant, thereby adjusting the temperature and humidity of the supply airstream to user-defined values or a neutral range of 70°F to 75°F (21 °C to 24 °C)..

[0036] Referring to FIG. 2A and 2B, a psychrometric chart of the processes involved in the RTU 100 when the supply airstream is to be cooled to provide the user-defined or neutral supply airstream downstream of the absorber is disclosed. The RTU 100 takes in ambient/outside air OA1 or SA1 in the supply airstream, whose temperature may be lowered by additional energy recovery devices such as enthalpy wheel and the like (not shown) that may be installed upstream of the first heat exchanger 110-1 to provide SA2, however, the humidity of the SA1 and SA2 remains the same. The first heat exchanger 110-1 acting as an evaporator subsequently cools the SA2 upstream and provides cool SA3 to the absorber 102 where the air can lose moisture from SA2 to SA3e. The cool SA3 is then passed through the absorber 102 where the SA3 is dehumidified in a process where the third heat exchanger 114-1 is operated as an evaporator to cool the desiccant supplied to the absorber 102 and a concentrated solution of the cool desiccant is distributed over while SA3 is blown across the desiccant stream. The desiccant stream absorbs moisture from the SA3 that is simultaneously cooled down to keep the SA4 downstream of the absorber 102 cool and dehumidified in the neutral range or user-defined range. Finally, the cool and dehumidified SA4 is supplied to the AOI or space where the RTU 100 is employed.

[0037] The RTU 100 also takes in ambient/outside air OA1 in the regeneration airstream. The second heat exchanger 110-2 acting as a condenser subsequently heats the OA1 upstream of the second heat exchanger

110-2 and provides heated OA2 to the desorber 104, however, the humidity of the OA1 and OA2 remains the same. Further, the OA2 is then passed through the desorber 104 where the fourth heat exchanger 114-2 is operated as a condenser to further heat the desiccant supplied to the desorber 104. The diluted desiccant solution from the absorber 102 is heated by the fourth heat exchanger 114-2 before reaching the desorber 104 and the OA2 is blown across the desiccant solution stream. Accordingly, at the desorber 104, some moisture/water is taken away from the diluted desiccant solution by the OA2 while the desiccant is heated. The resulting concentrated desiccant solution is then collected, and hot humid air OA3 downstream of the desorber 104 is rejected to the ambient.

[0038] Further, the concentrated desiccant solution collected from the desorber 104 is further circulated back to the absorber 102. The RTU 100 conditions the desiccant with the interchange heat exchanger 108 (IHX) by allowing hot desiccant downstream of the desorber 104 to cool down before entering the absorber 102 and/or the third heat exchanger 114-1, thereby improving water mass transfer from the air to the desiccant. Further, the IHX 108 and fourth heat exchanger 114-2 allow cold desiccant downstream of the absorber 102 to heat up before it enters the desorber 104, thereby improving water mass transfer from the desiccant to the air.

[0039] Thus, the use of secondary heat exchangers 114-1, 114-2 in the liquid desiccant system of the RTU, eliminates the dependence on additional devices having bulky, space consuming coils, downstream of the absorber 102 and the desorber 104 in the supply airstream as generally employed in existing technologies, by controlling the temperature of the desiccant liquid itself to adjust the temperature and humidity of the supply airstream. Thus, the RTU offers a space-saving and cost-saving alternative. Moreover, conditioning the desiccant with the vapor compression system 112 also enhances the mass transfer potential at the absorber 102 and the desorber 104.

[0040] Also described herein is a liquid desiccant-based outdoor air system (LDOAS). The LDOAS may include an absorber configured in a supply airstream, and a desorber configured in a regeneration airstream. The desorber may be fluidically connected to the absorber via a liquid desiccant system and an interchange heat exchanger. The LDOAS may further include a first heat exchanger configured upstream of the absorber in the supply air stream, and a second heat exchanger configured upstream of the desorber in the regeneration airstream. The first heat exchanger may be fluidically connected to the second heat exchanger via a vapor compression system. Further, the LDOAS may include one or more secondary heat exchangers configured between the vapor compression system and the liquid desiccant system, where the one or more secondary heat exchangers are operable to control the temperature of a desiccant associated with the liquid desiccant system into the absorber and/or into the desorber.

[0041] In one or more embodiments, the first heat exchanger, and a refrigerant side of the third heat exchanger may be fluidically coupled to the second heat exchanger, and a refrigerant side of the fourth heat exchanger via the vapor compression system. Further, a desiccant side of the third heat exchanger may be fluidically coupled to a desiccant side of the fourth heat exchanger via the interchange heat exchanger and the liquid desiccant system the one or more secondary heat exchangers may be operable as a condenser and/or an evaporator to control the temperature of the desiccant supplied to the absorber to adjust the temperature and humidity of the supply airstream downstream of the absorber to predefined values. The overall working and functional elements of the LDOAS may remain same as the RTU 100 as explained in the above paragraphs.

[0042] While the invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements of the exemplary embodiments without departing from the scope of the invention as defined by the appended claims. Modifications may be made to adopt a particular situation or material to the teachings of the invention without departing from the scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed, but that the invention includes all embodiments falling within the scope of the invention as defined by the appended claims.

[0043] In interpreting the specification, all terms should be interpreted in the broadest possible manner consistent with the context. In particular, the terms "comprises" and "comprising" should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced elements, components, or steps may be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced. Where the specification claims refer to at least one of something selected from the group consisting of A, B, C ....and N, the text should be interpreted as requiring only one element from the group, not A plus N, or B plus N, etc.

Claims

1. A rooftop air conditioning unit, RTU, (100) comprising:

    an absorber (102) configured in a supply airstream (SA);
    a desorber (104) configured in a regeneration airstream (RA), wherein the desorber is fluidically connected to the absorber via a liquid desiccant system (106) and an interchange heat exchanger (108);
    a first heat exchanger (110-1) configured up-

stream of the absorber in the supply air stream;
a second heat exchanger (111-2) configured upstream of the desorber in the regeneration airstream, wherein the first heat exchanger is fluidically connected to the second heat exchanger via a vapor compression system (112); and
one or more secondary heat exchangers (114-1, 114-2) configured between the vapor compression system and the liquid desiccant system, wherein the one or more secondary heat exchangers are operable to control temperature of a desiccant associated with the liquid desiccant system into the absorber and/or into the desorber.

2. The RTU of claim 1, wherein the one or more secondary heat exchanger comprise a third heat exchanger (114-1) configured in a desiccant upstream of the absorber, and/or a fourth heat exchanger (114-2) configured in a desiccant upstream of the desorber.

3. The RTU of claim 2, wherein the first heat exchanger, and a refrigerant side of the third heat exchanger are fluidically coupled to the second heat exchanger, and a refrigerant side of the fourth heat exchanger via the vapor compression system.

4. The RTU of any one of claims 2 to 3, wherein a desiccant side of the third heat exchanger is fluidically coupled to a desiccant side of the fourth heat exchanger via the interchange heat exchanger and the liquid desiccant system.

5. The RTU of any one of claims 1 to 4, wherein the one or more secondary heat exchangers are operable to control the temperature of the desiccant supplied to the absorber to adjust the temperature and humidity of the supply airstream downstream of the absorber to predefined values, optionally wherein the predefined value of the temperature of the airstream downstream of the absorber is in a range of 70°F to 75°F (21 °C to 24 °C).

6. The RTU of any one of claims 1 to 5, wherein the third heat exchanger is operated as an evaporator when the desiccant supplied to the absorber is to be cooled for adjusting the temperature and the humidity of the supply airstream downstream of the absorber to predefined values; and/or
wherein the third heat exchanger is operated as a condenser when the desiccant supplied to the absorber is to be heated for adjusting the temperature and the humidity of the supply airstream downstream of the absorber to predefined values.

7. The RTU of any one of claims 1 to 6, wherein the one or more secondary heat exchangers are operable to control the temperature of the desiccant flowing into the absorber to a first predefined desiccant temperature to control mass transfer potential from the desiccant to the regeneration airstream at the absorber; and/or
wherein the one or more secondary heat exchangers are operable to increase the temperature of the desiccant flowing into the desorber to a second predefined desiccant temperature to control mass transfer potential from the desiccant to the regeneration airstream at the desorber.

8. The RTU of any one of claims 1 to 7, wherein the one or more secondary heat exchanger is a brazed-plate heat exchanger.

9. The RTU of any one of claims 1 to 8, wherein the one or more secondary heat exchangers further comprise an upstream metering device or an expansion device for a refrigerant when the corresponding secondary heat exchanger is operated as an evaporator.

10. The RTU of any one of claims 1 to 9, wherein the RTU is adapted to be configured at an area of interest (AOI) to supply an airstream having predefined values of the temperature and humidity at the AOI, and further receive the return airstream from the AOI, and optionally wherein the RTU comprises a controller that is configured to:

receive a set of instructions pertaining to the predefined values of the airstream to be supplied at the AOI; and
control operation of one or more of the heat exchangers associated with the system to supply the airstream having the predefined values of the temperature and humidity to the AOI.

11. A liquid desiccant based outdoor air system comprising:

an absorber configured in a supply airstream;
a desorber configured in a regeneration airstream, wherein the desorber is fluidically connected to the absorber via a liquid desiccant system and an interchange heat exchanger;
a first heat exchanger configured upstream of the absorber in the supply air stream;
a second heat exchanger configured upstream of the desorber in the regeneration airstream, wherein the first heat exchanger is fluidically connected to the second heat exchanger via a vapor compression system; and
one or more secondary heat exchangers configured between the vapor compression system and the liquid desiccant system, wherein the one or more secondary heat exchangers are oper-

able to control temperature of a desiccant associated with the liquid desiccant system into the absorber and/or into the desorber.

12. The system of claim 11, wherein the one or more secondary heat exchanger comprise:
a third heat exchanger configured in a desiccant upstream of the absorber; and a fourth heat exchanger configured in a desiccant upstream of the desorber.

13. The system of claim 12, wherein the first heat exchanger, and a refrigerant side of the third heat exchanger are fluidically coupled to the second heat exchanger, and a refrigerant side of the fourth heat exchanger via the vapor compression system.

14. The system of any one of claims12 and 13, wherein a desiccant side of the third heat exchanger is fluidically coupled to a desiccant side of the fourth heat exchanger via the interchange heat exchanger and the liquid desiccant system.

15. The system of any one of claims 11 to 14, wherein the one or more secondary heat exchangers are operable as a condenser and/or an evaporator to control the temperature of the desiccant supplied to the absorber to adjust the temperature and humidity of the supply airstream downstream of the absorber to predefined values.

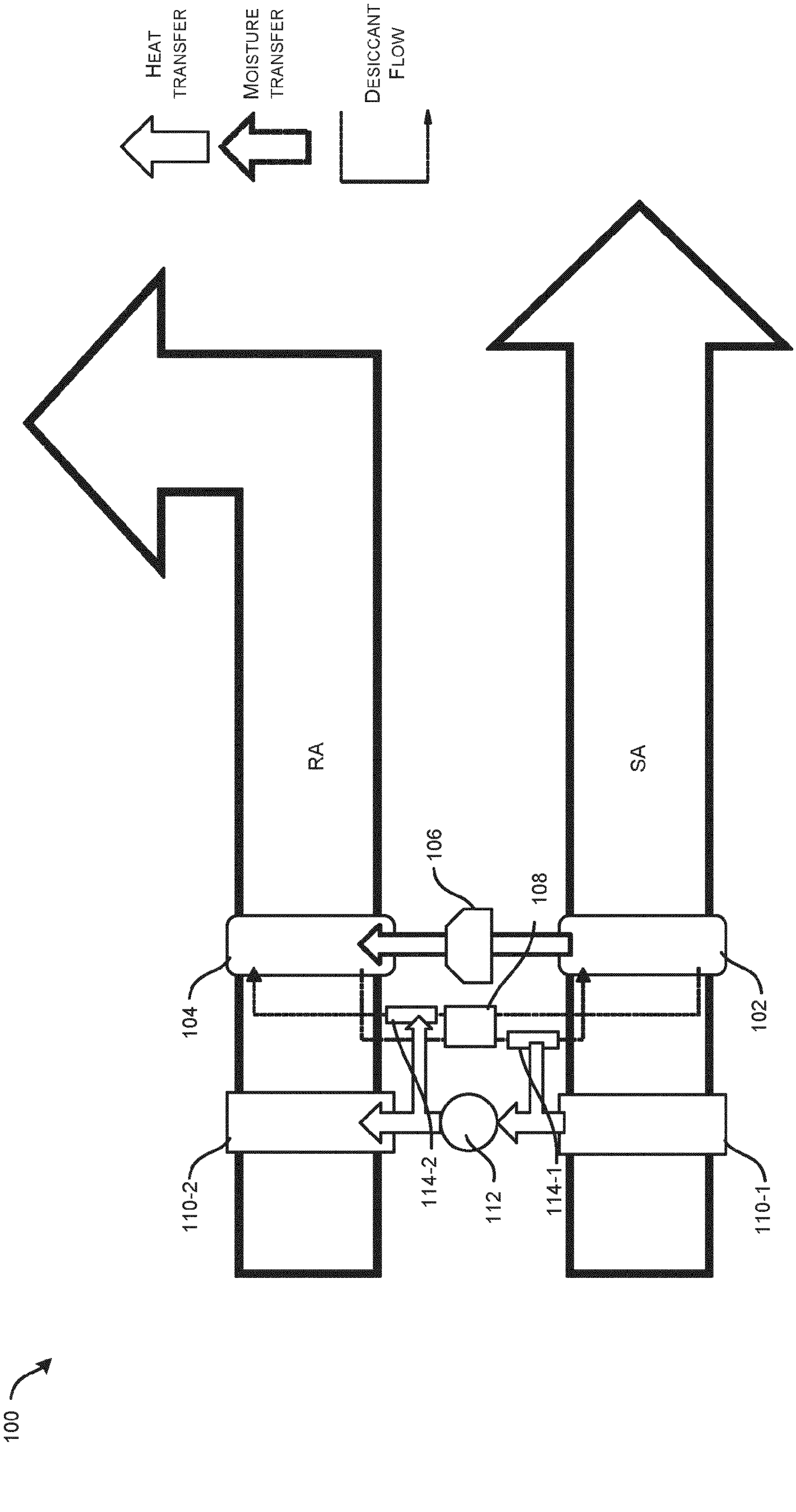
HEAT TRANSFER
MOISTURE TRANSFER
DESICCANT FLOW
RA
SA
106
108
104
102
110-2
114-2
112
114-1
110-1
100

FIG. 1

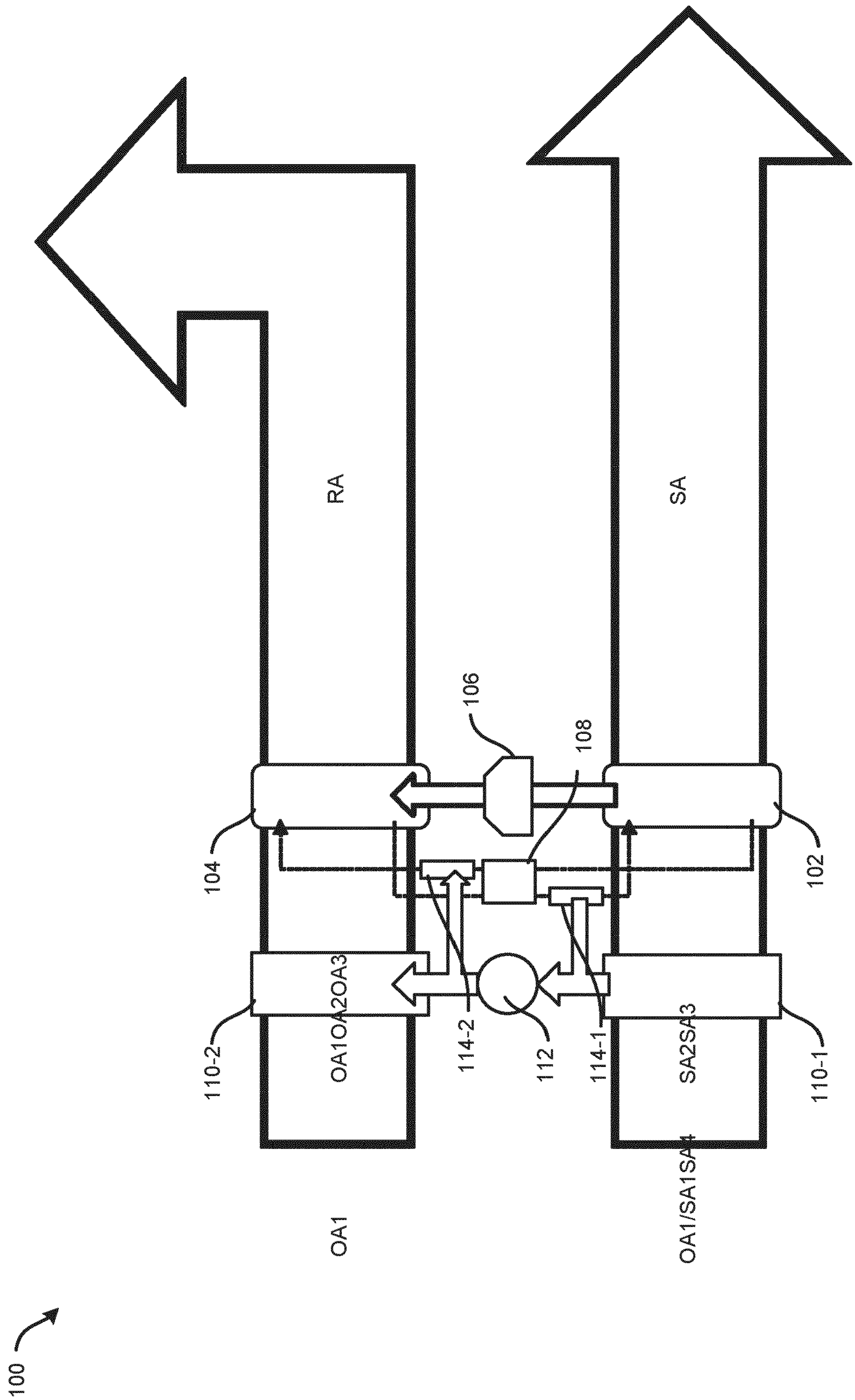
RA
SA
106
108
104
102
OA1OA2OA3
110-2
114-2
112
114-1
SA2SA3
110-1
OA1
OA1/SA1SA4
100

FIG. 2A

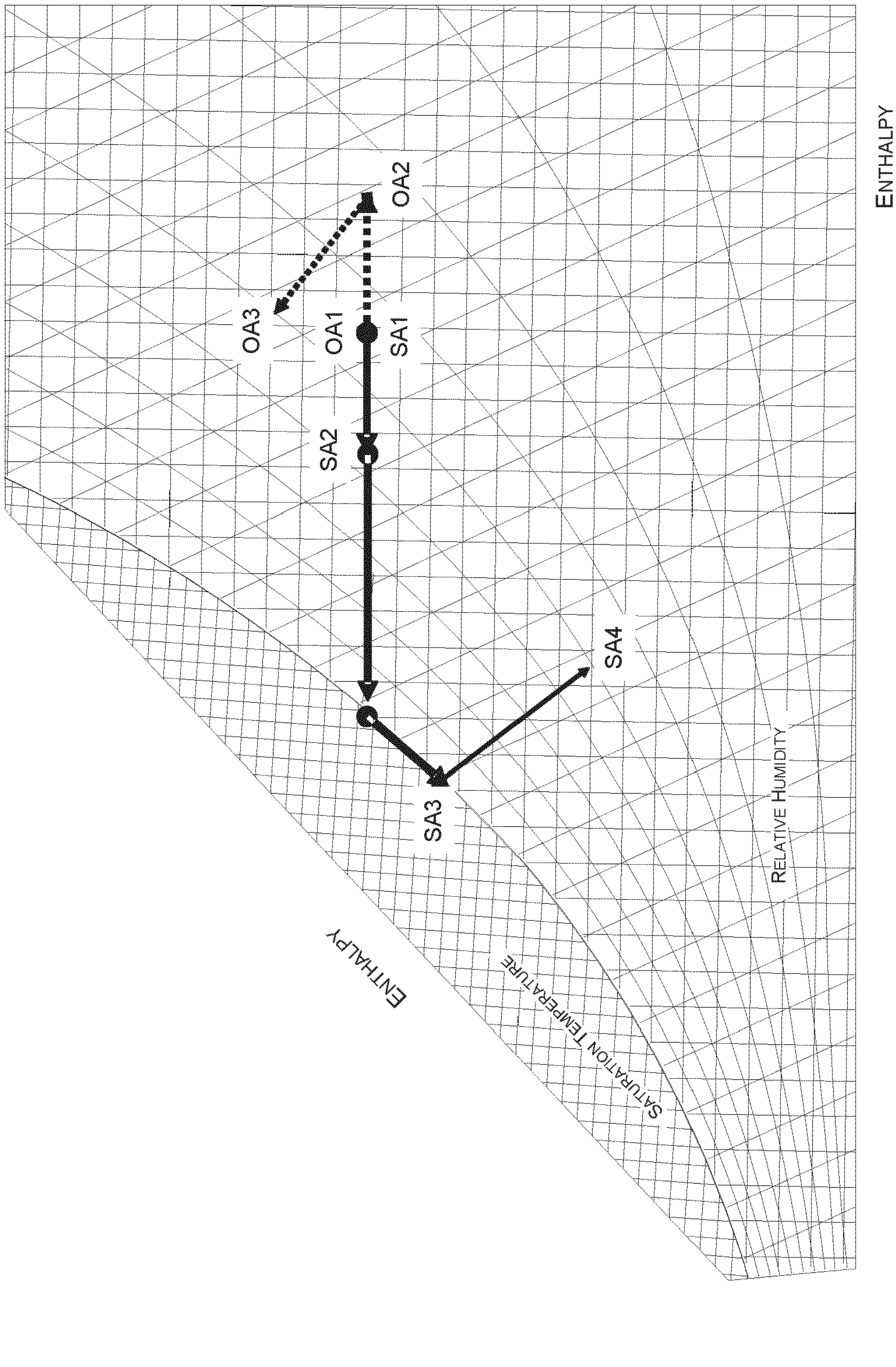
ENTHALPY
OA2
OA3
OA1
SA1
SA2
SA4
SA3
RELATIVE HUMIDITY
ENTHALPY
SATURATION TEMPERATURE

FIG. 2B

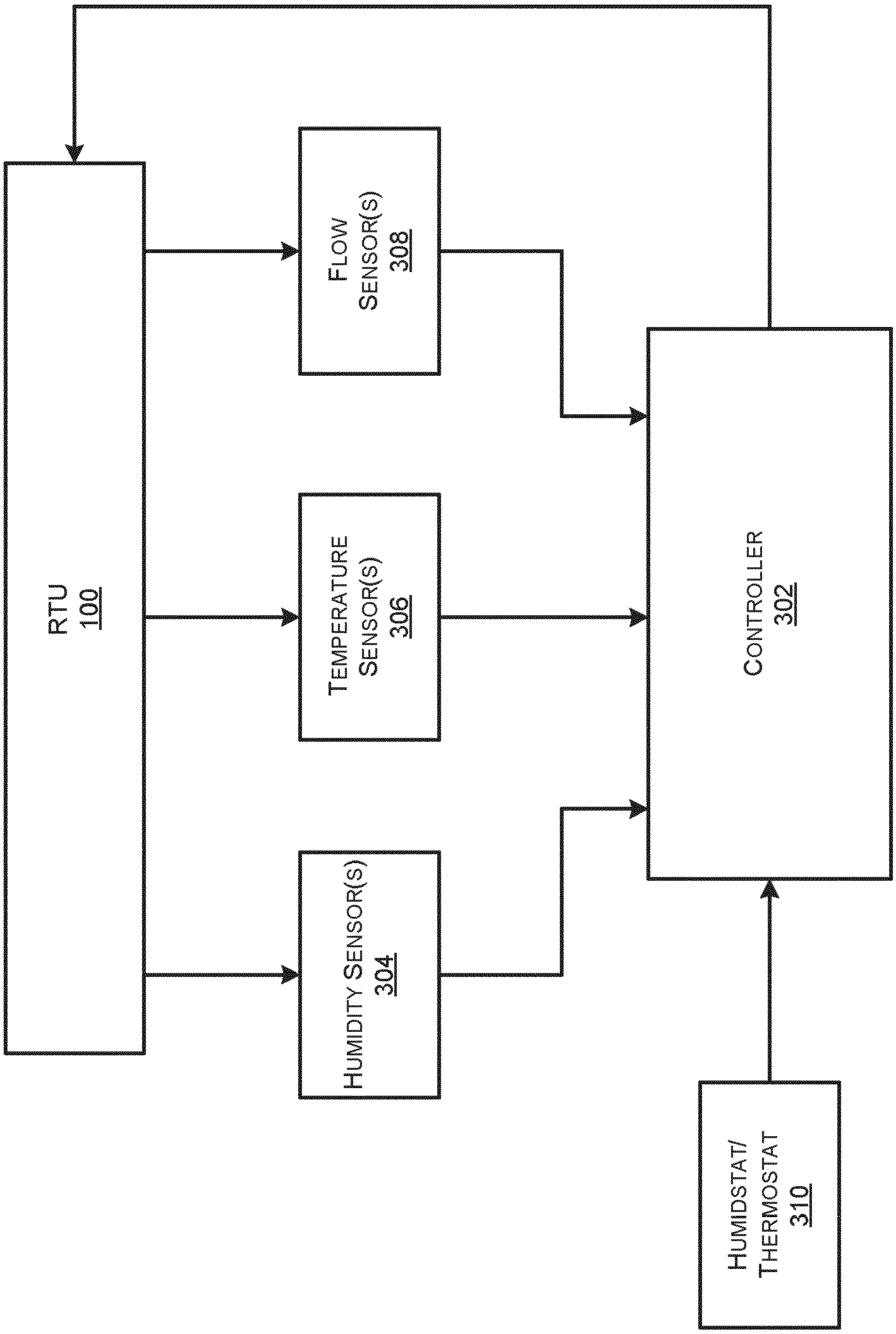
RTU
100
Flow
Sensor(s)
308
Temperature
Sensor(s)
306
Humidity Sensor(s)
304
Controller
302
Humidstat/
Thermostat
310

FIG. 3

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PARTIAL EUROPEAN SEARCH REPORT

under Rule 62a and/or 63 of the European Patent Convention. This report shall be considered, for the purposes of subsequent proceedings, as the European search report

Application Number
EP 24 18 0251

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 2017/292722 A1 (VANDERMEULEN PETER F [US]) 12 October 2017 (2017-10-12) * figure 1 * -----	1-10	INV. F24F3/14 F24F5/00
Y	EP 1 367 333 A1 (EBARA CORP [JP]) 3 December 2003 (2003-12-03) * figures 1-15 * -----	1-10	
A	CN 106 164 594 A (7AC TECH INC) 23 November 2016 (2016-11-23) * figures 1-16 * -----	1-10	
A	US 2022/003435 A1 (GE GAOMING [CA] ET AL) 6 January 2022 (2022-01-06) * figures 1-8 * -----	1-10	

TECHNICAL FIELDS SEARCHED (IPC)

F24F

INCOMPLETE SEARCH

The Search Division considers that the present application, or one or more of its claims, does/do not comply with the EPC so that only a partial search (R.62a, 63) has been carried out.

Claims searched completely :

Claims searched incompletely :

Claims not searched :

Reason for the limitation of the search:

see sheet C

3

Place of search	Date of completion of the search	Examiner
Munich	8 November 2024	Ismail, Youssef

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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INCOMPLETE SEARCH SHEET C

Application Number
EP 24 18 0251

Claim(s) completely searchable:
1-10

Claim(s) not searched:
11-15

Reason for the limitation of the search:

The search has been restricted to the subject-matter indicated by the applicant in his letter of 30 October 2024 filed in reply to the invitation pursuant to Rule 62a(1) EPC. Claims 1-10 are searched.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 24 18 0251

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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08-11-2024

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82