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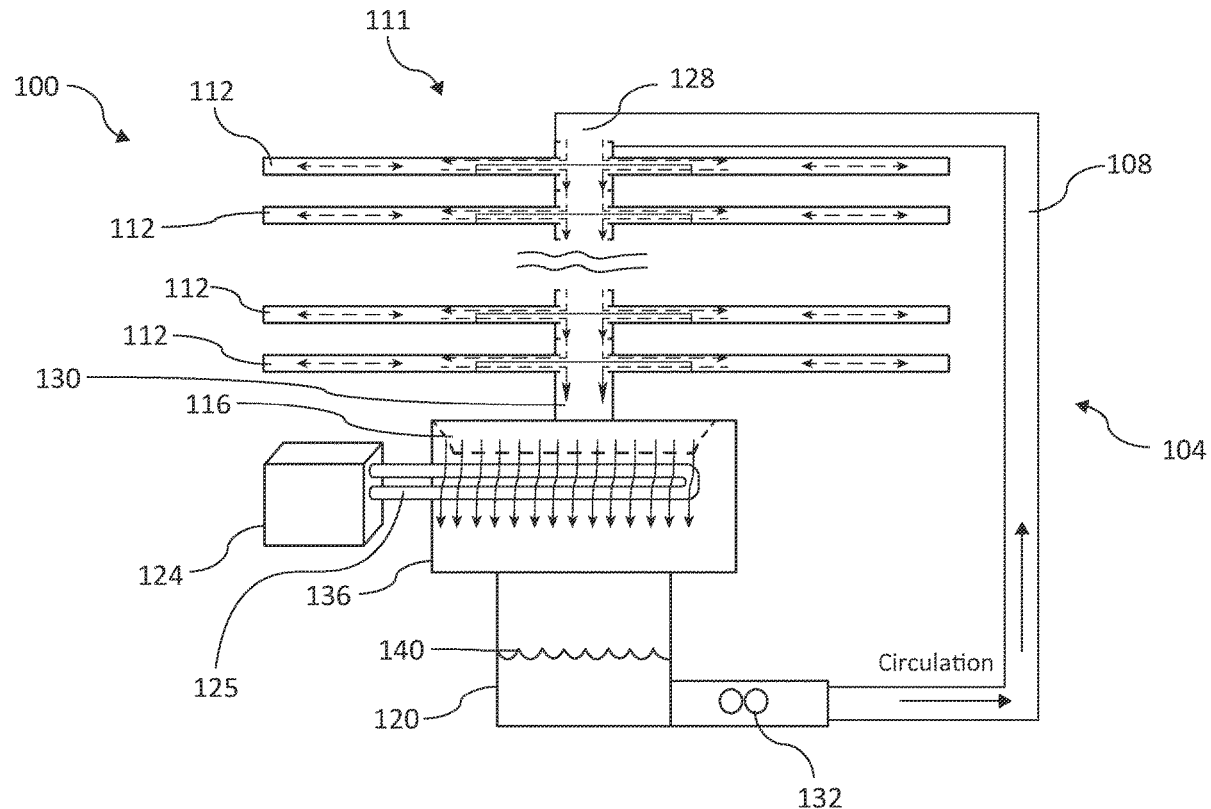
(19) **United States**(12) **Patent Application Publication**
Song(10) **Pub. No.: US 2023/0097411 A1**(43) **Pub. Date: Mar. 30, 2023**(54) **WATER-MEDIATED THERMAL
CONDITIONING SYSTEM**(52) **U.S. Cl.**CPC **F28D 7/0083** (2013.01)(71) Applicant: **Saeheum Song**, Skillman, NJ (US)

(57)

ABSTRACT(72) Inventor: **Saeheum Song**, Skillman, NJ (US)(21) Appl. No.: **17/488,144**(22) Filed: **Sep. 28, 2021****Publication Classification**(51) **Int. Cl.****F28D 7/00**

(2006.01)

A water-mediated thermal conditioning system. The thermal conditioning system includes a first thermal fluid circulation system and a heat exchanger. The circulation system includes a dispersed fluid region through which the heat exchanger conduits with second thermal fluid extend, for heat exchange with the dispersed first thermal fluid. The first thermal fluid circulation system may include a plurality of panels for exchange of thermal energy between the first thermal fluid and ambient air.



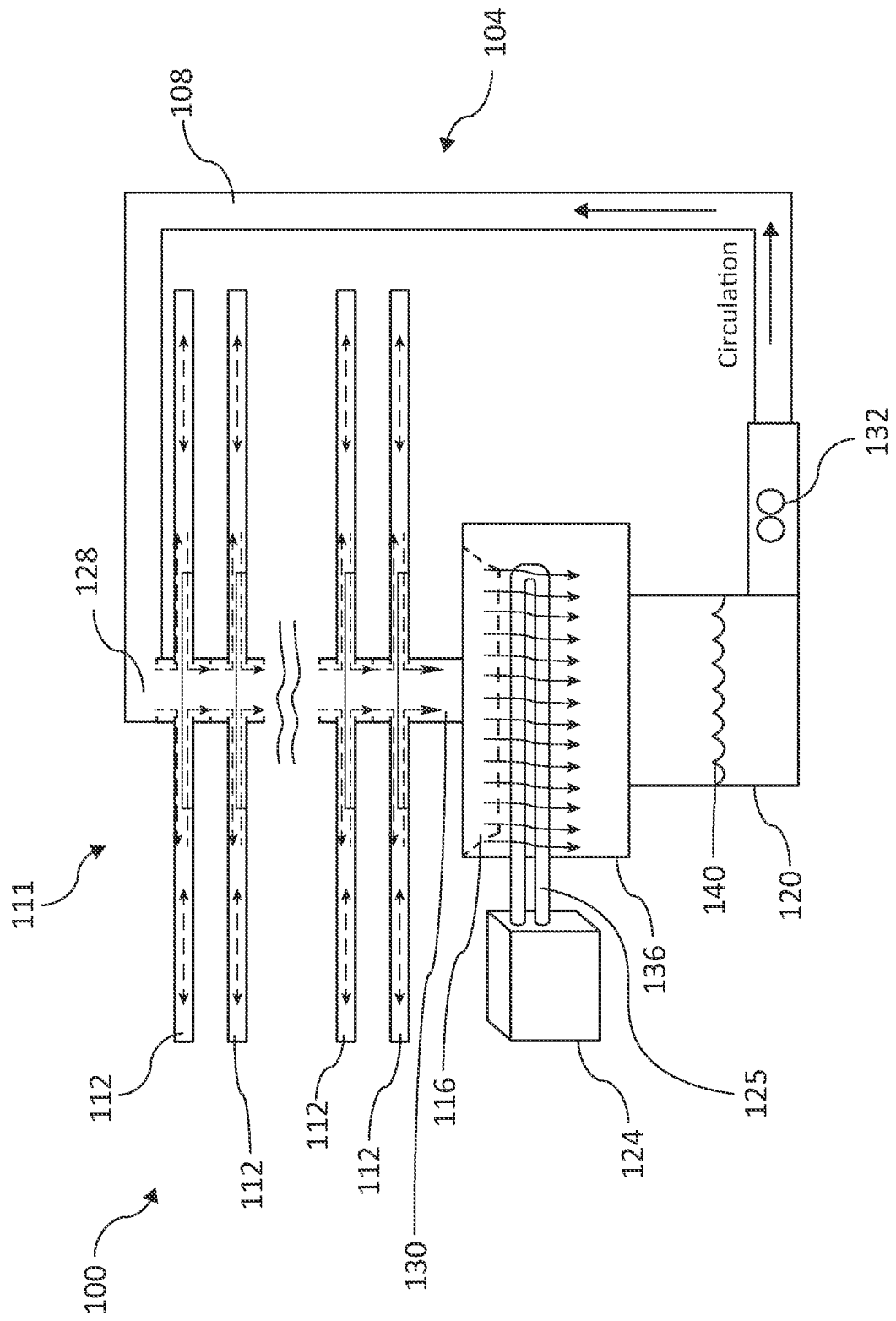


FIG. 1

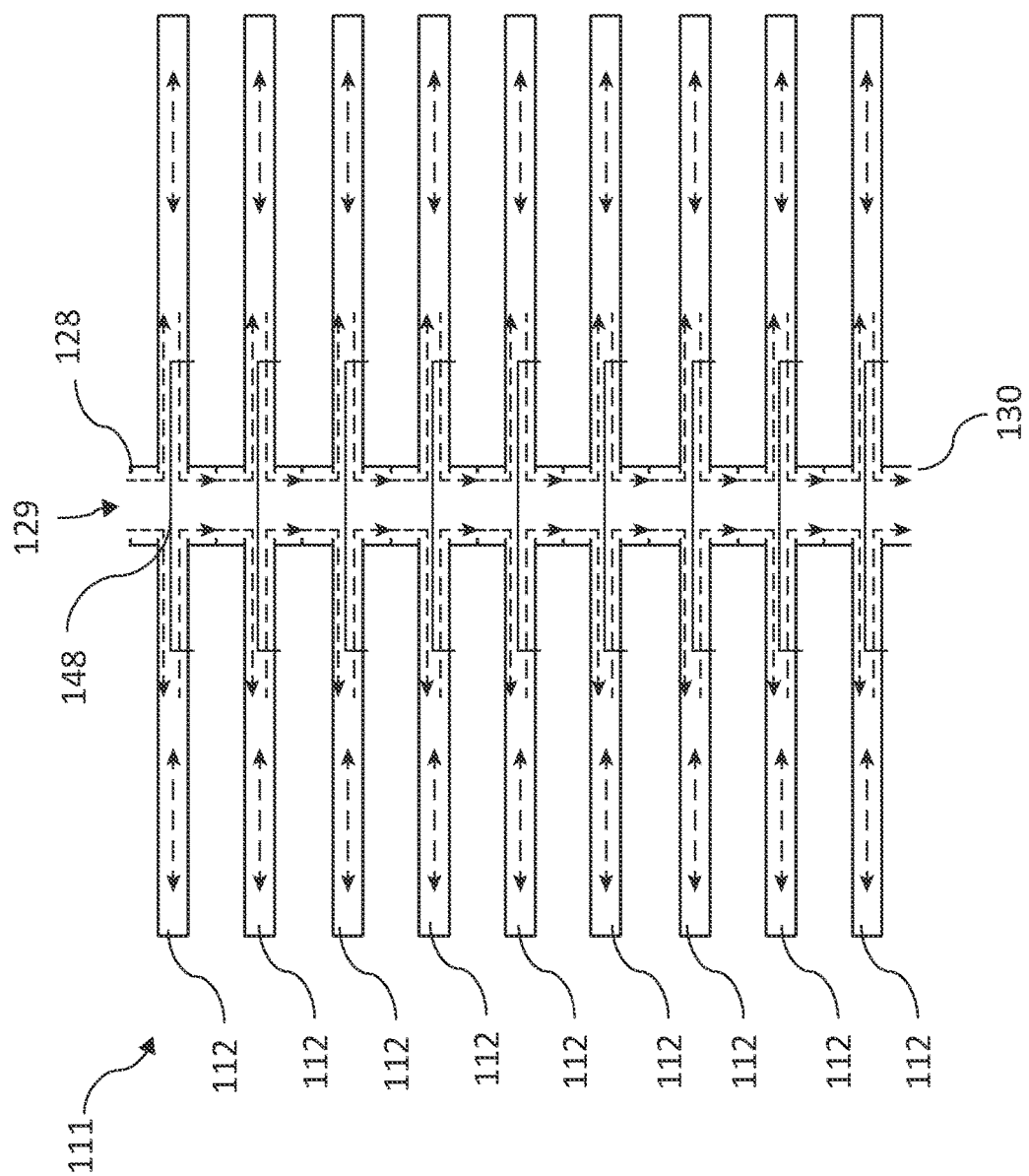


FIG. 2

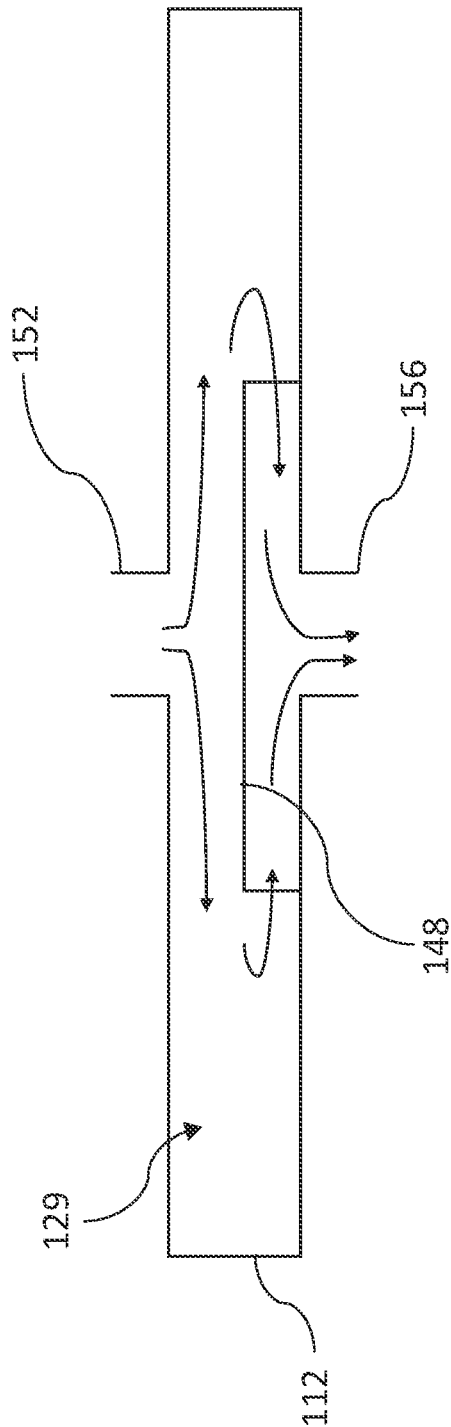


FIG. 3

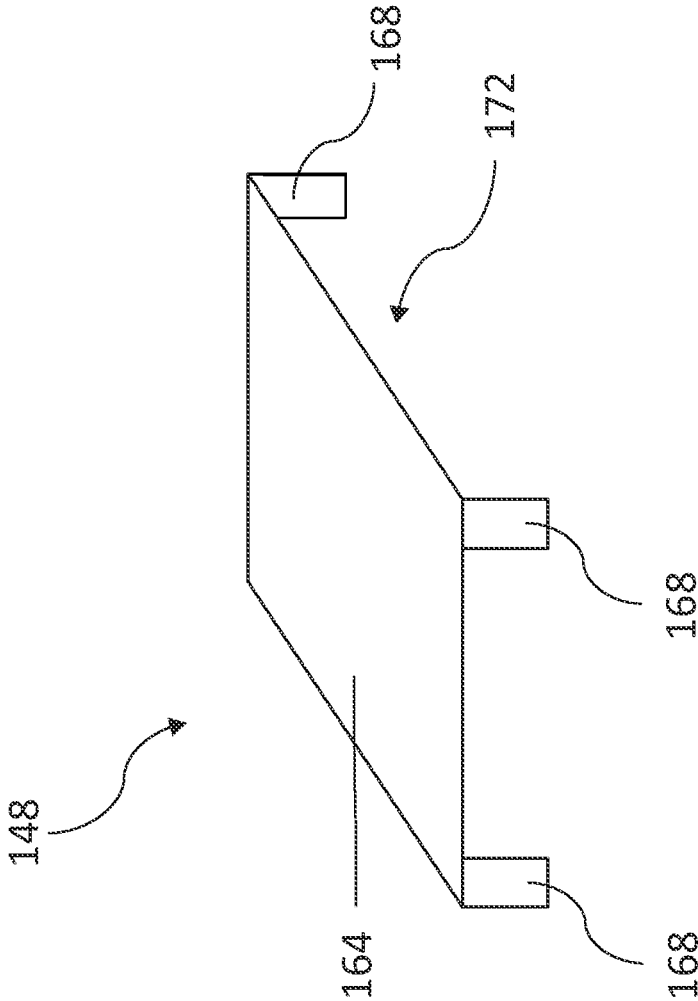


FIG. 4

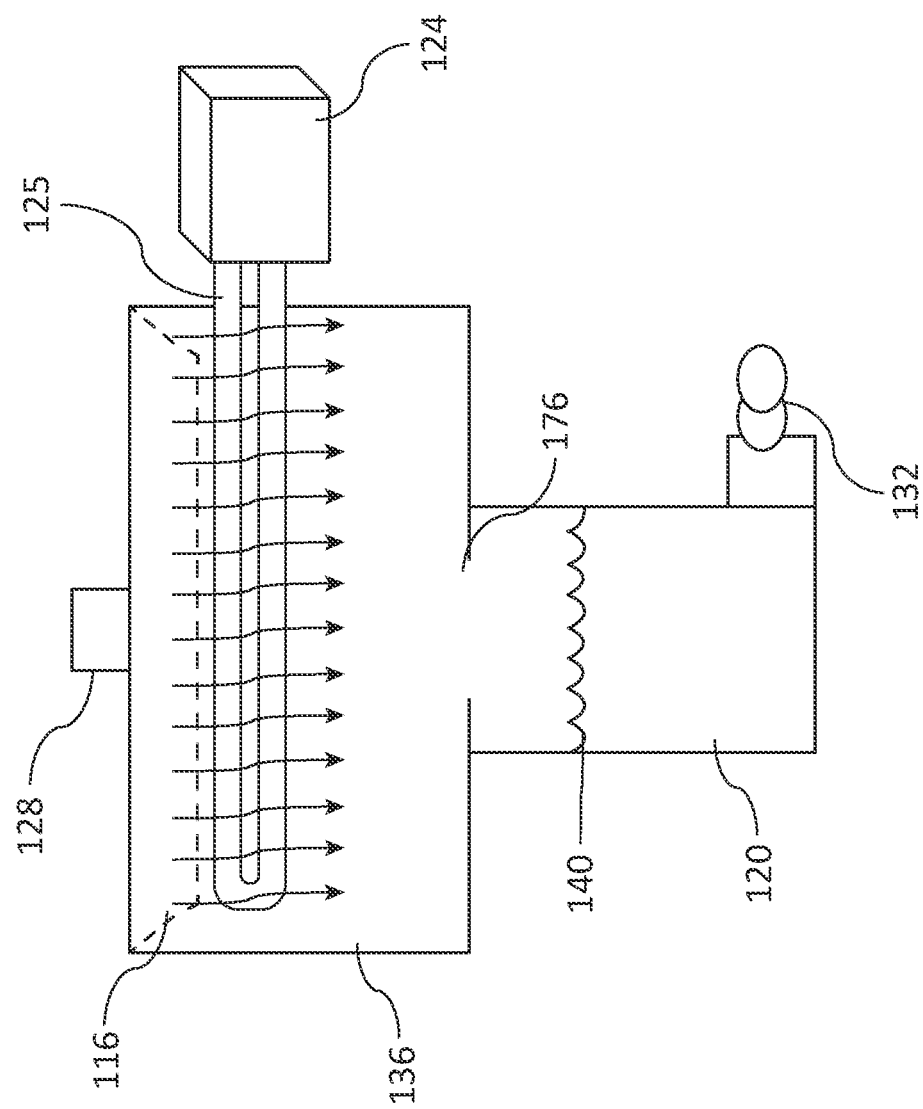


FIG. 5

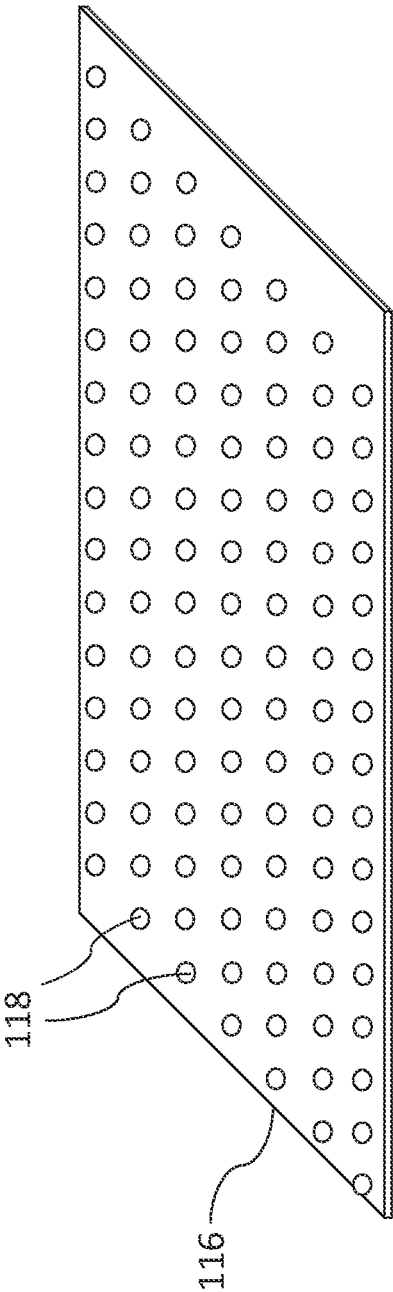


FIG. 5A

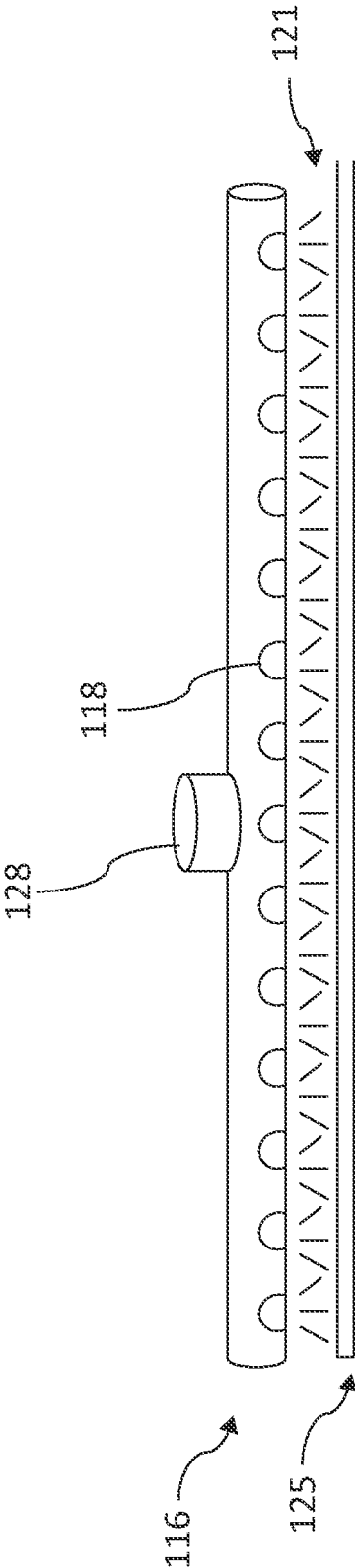


FIG. 5B

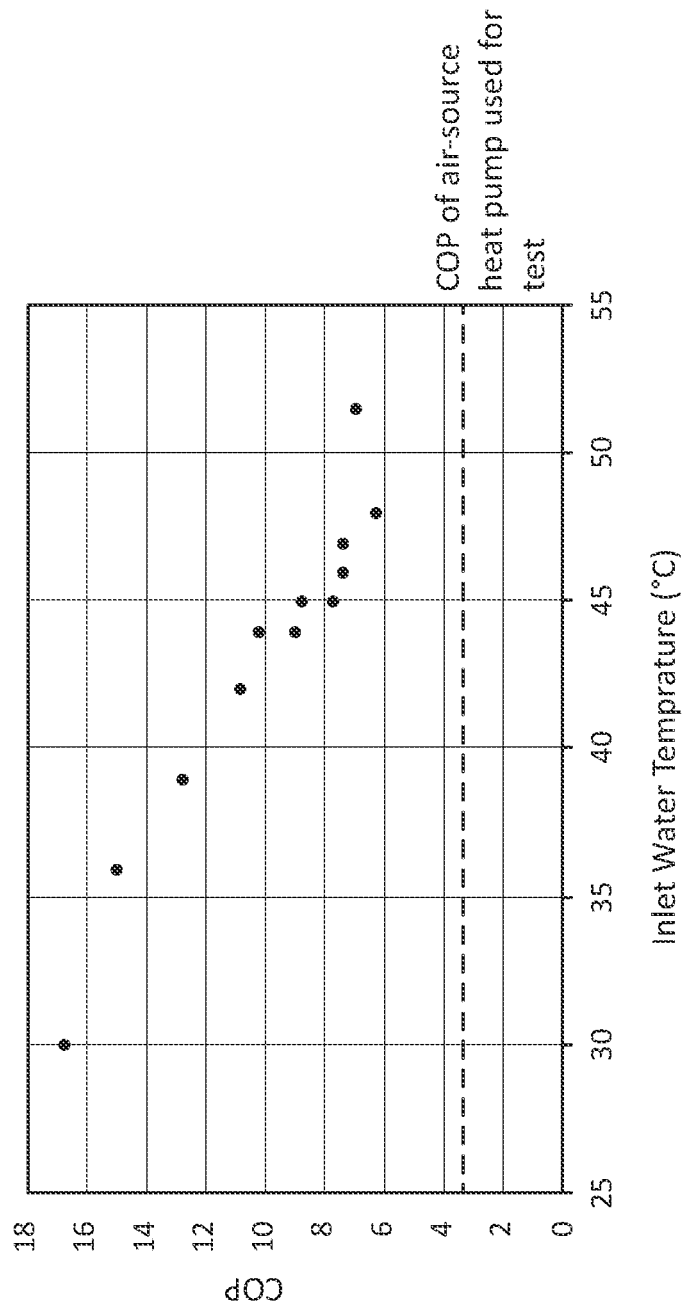


FIG. 6

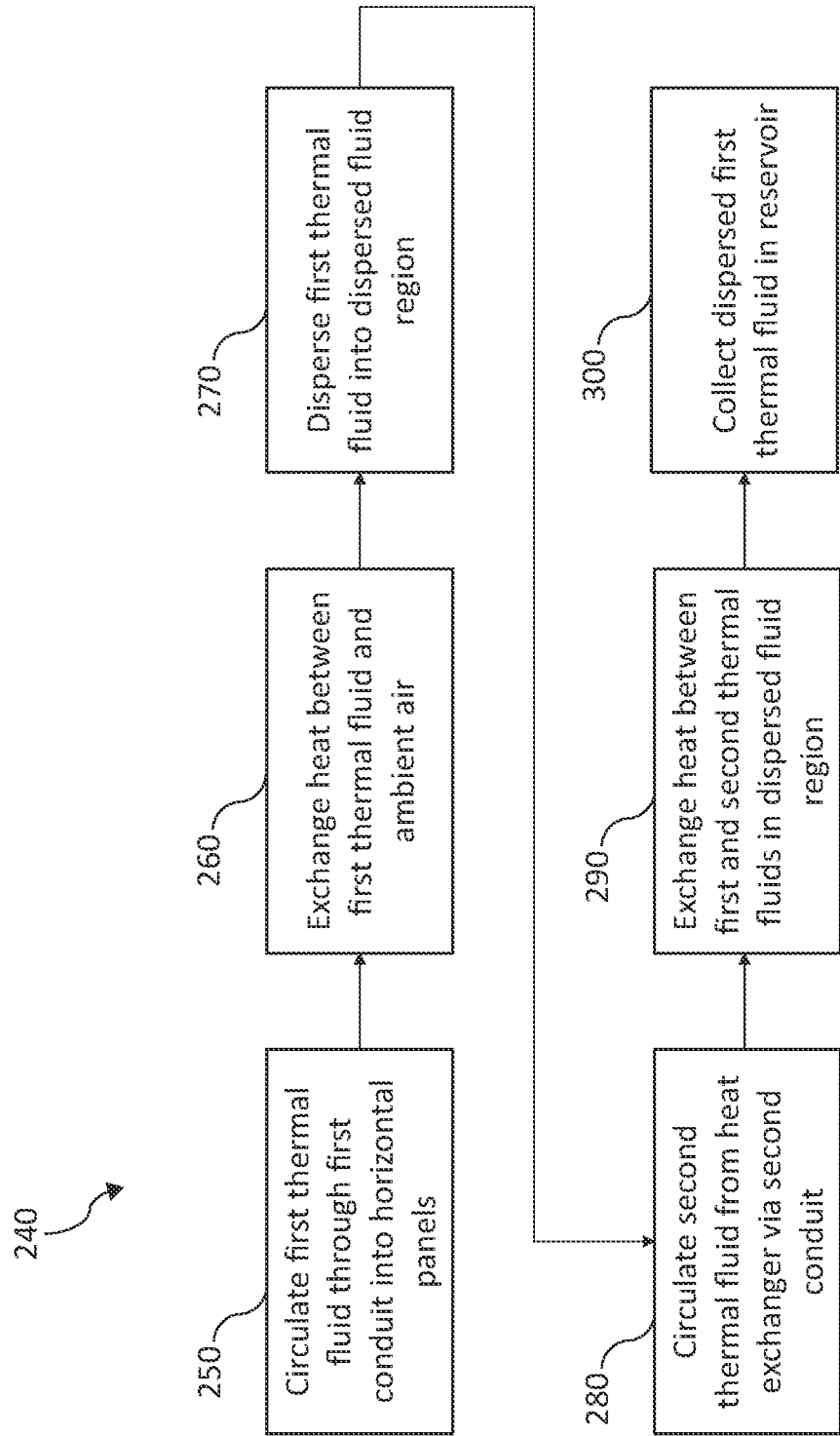


FIG. 7

WATER-MEDIATED THERMAL CONDITIONING SYSTEM

BACKGROUND

Field

[0001] The development relates generally to thermal conditioning systems, in particular to thermal conditioning systems with water mediation.

Description of the Related Art

[0002] Thermal conditioning systems are used for providing heating or cooling. Heat exchange with the thermal working fluid adds or removes heat to provide the thermal conditioning. Existing systems such as heat pumps with air-source heat exchange have lower heat exchange efficiency compared to water-source heat exchange. However, the cost of water source heat exchange systems are high and their system requirements are difficult to fulfill. Therefore, there is a need to enhance air-source thermal conditioning systems equivalent or superior to water source thermal conditioning systems without much increase in system costs and requirements.

SUMMARY

[0003] The embodiments disclosed herein each have several aspects no single one of which is solely responsible for the disclosure's desirable attributes. Without limiting the scope of this disclosure, its more prominent features will now be briefly discussed. After considering this discussion, and particularly after reading the section entitled "Detailed Description," one will understand how the features of the embodiments described herein provide advantages over existing systems, devices and methods for thermal conditioning.

[0004] The following disclosure describes non-limiting examples of some embodiments. For instance, other embodiments of the disclosed systems and methods may or may not include the features described herein. Moreover, disclosed advantages and benefits may apply only to certain embodiments of the invention and should not be used to limit the disclosure.

[0005] Systems, devices and methods are described for a water-mediated thermal conditioning system. The thermal conditioning system includes a first thermal fluid circulation system and a heat exchanger. The circulation system includes a dispersed fluid region through which the heat exchanger conduits with second thermal fluid extend, for heat exchange with the dispersed first thermal fluid. The first thermal fluid circulation system may include a plurality of panels for exchange of thermal energy between the first thermal fluid and ambient air. A reservoir may collect the dispersed first thermal fluid, such that the heat exchanger conduits are not submersed within the first thermal fluid.

[0006] In one aspect, a thermal conditioning system includes a circulation system and a heat exchanger. The circulation system is configured to circulate a first thermal fluid through a first conduit. The circulation system has a plurality of panels, a dispersal device, and a reservoir. The plurality of panels are configured to be oriented horizontally. Each panel is configured to receive the first thermal fluid and to exchange thermal energy between the first thermal fluid and ambient air. The dispersal device is in fluid communi-

cation with the plurality of panels and is configured to disperse the first thermal fluid into a dispersed fluid region. The reservoir is in fluid communication with the dispersed fluid region and configured to collect the dispersed fluid from the dispersed fluid region. The heat exchanger is configured to circulate a second thermal fluid through a second conduit. The second conduit is in thermal communication with the dispersed fluid region of the circulation system.

[0007] Various embodiments of the various aspects may be implemented. In some embodiments, each panel of the plurality of panels defines a flow path therethrough that is configured to not be fully filled with the first thermal fluid.

[0008] In some embodiments, each panel of the plurality of panels defines a flow path therethrough that is configured to allow un-pressurized flow of the first thermal fluid at a pre-determined flow rate.

[0009] In some embodiments, the second conduit circulating the second thermal fluid is not submersed in the first thermal fluid. Thermal heat exchange may occur between the first thermal fluid and the second thermal fluid via a surface area of the second conduit.

[0010] In some embodiments, each panel of the plurality of panels has a thickness and defines a flow path having a height that is less than the thickness.

[0011] In some embodiments, each panel of the plurality of panels comprises an inner wall separating an interior of the panel into at least two flow paths. In some embodiments, the at least two flow paths comprise an outward flow path, configured to flow the first thermal fluid away from a center of the panel, and an inward flow path, configured to flow the first thermal fluid toward the center of the panel.

[0012] In some embodiments, the dispersal device is a screen.

[0013] In some embodiments, the first thermal fluid in the dispersed fluid region comprises a series of drops.

[0014] In some embodiments, a surface of the first thermal fluid collected in the reservoir is below the dispersed fluid region such that the second conduit is not submersed in the first thermal fluid.

[0015] In some embodiments, the system further comprises a pump configured to re-circulate the first thermal fluid from the reservoir to the plurality of panels via the first conduit.

[0016] In some embodiments, the heat exchanger is a heat pump.

[0017] In some embodiments, the first thermal fluid comprises water.

[0018] In another aspect, a thermal conditioning system includes a circulation system and a heat exchanger. The circulation system is configured to circulate a first thermal fluid through a first conduit. The circulation system includes a first region, a dispersal device, and a reservoir. The first region is configured to exchange thermal energy between the first thermal fluid and ambient air. The dispersal device is configured to receive the first thermal fluid from the first region and disperse the first thermal fluid into a dispersed fluid region. The reservoir is in fluid communication with the dispersed fluid region and configured to collect the dispersed fluid from the dispersed fluid region. The heat exchanger is configured to circulate a second thermal fluid through a second conduit. The second conduit is in thermal communication with the dispersed fluid region of the circulation system.

[0019] Various embodiments of the various aspects may be implemented. In some embodiments, the dispersal device comprises a screen.

[0020] In some embodiments, the first thermal fluid in the dispersed region comprises a series of drops.

[0021] In some embodiments, the first region comprises a plurality of panels configured to be oriented horizontally and each panel is configured to receive the first thermal fluid.

[0022] In another aspect, a thermal conditioning system includes a circulation system and a heat exchanger. The circulation system is configured to circulate a first thermal fluid through a first conduit. The circulation system includes a plurality of panels and a heat exchange region. The plurality of panels are configured to be oriented horizontally, and each panel is configured to receive the first thermal fluid to exchange thermal energy between the first thermal fluid and ambient air. The heat exchange region is configured to receive the first thermal fluid from the plurality of panels. The heat exchanger is configured to circulate a second thermal fluid through a second conduit. The second conduit is in thermal communication with the heat exchange region of the circulation system.

[0023] Various embodiments of the various aspects may be implemented. In some embodiments, the system has a dispersal device in fluid communication with the plurality of panels. The dispersal device is configured to disperse the first thermal fluid into the heat exchange region. In some embodiments, the system has a reservoir in fluid communication with the heat exchange region and configured to collect the dispersed fluid from the dispersed fluid region such that the second conduit is not submersed in the first thermal fluid.

[0024] In some embodiments, each panel of the plurality of panels defines a flow path therethrough that is configured to not be fully filled with the first thermal fluid to allow un-pressurized flow of the first thermal fluid at a pre-determined flow rate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] The foregoing and other features of the present disclosure will become more fully apparent from the following description and appended claims, taken in conjunction with the accompanying drawings. Understanding that these drawings depict only several embodiments in accordance with the disclosure and are not to be considered limiting of its scope, the disclosure will be described with additional specificity and detail through use of the accompanying drawings. In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols typically identify similar components, unless context dictates otherwise. The illustrative embodiments described in the detailed description, drawings, and claims are not meant to be limiting. Other embodiments may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented here. It will be readily understood that the aspects of the present disclosure, as generally described herein, and illustrated in the drawing, may be arranged, substituted, combined, and designed in a wide variety of different configurations, all of which are explicitly contemplated and make part of this disclosure.

[0026] FIG. 1 is a schematic of an embodiment of a water-mediated air source thermal conditioning system having a circulation system and a heat exchanger.

[0027] FIG. 2 is a cross-sectional view of a schematic of an embodiment of panels that may be used to exchange thermal energy between fluid and ambient air and that may be used with the system of FIG. 1.

[0028] FIG. 3 is a close up cross-sectional view of one of the plurality of panels of FIG. 2 including an embodiment of an inner wall forming flow channels.

[0029] FIG. 4 is a perspective view of the inner wall of FIG. 3.

[0030] FIG. 5 is a schematic of an embodiment of a water-mediated thermal conditioning system having a dispersal device and a dispersed fluid heat exchange region.

[0031] FIGS. 5A and 5B are perspective and side views respectively of embodiments of dispersal devices that may be used with the various thermal conditioning systems described herein.

[0032] FIG. 6 is a data plot showing an embodiment of improved coefficient of performance (COP) for various inlet water temperatures that may be achieved with the various thermal conditioning systems described herein.

[0033] FIG. 7 is a flow chart showing an embodiment of a method of thermal conditioning using water mediation.

DETAILED DESCRIPTION

[0034] The following detailed description is directed to certain specific embodiments of the thermal conditioning systems, devices, and methods. In this description, reference is made to the drawings wherein like parts or steps may be designated with like numerals throughout for clarity. Reference in this specification to “one embodiment,” “an embodiment,” or “in some embodiments” means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearances of the phrases “one embodiment,” “an embodiment,” or “in some embodiments” in various places in the specification are not necessarily all referring to the same embodiment, nor are separate or alternative embodiments necessarily mutually exclusive of other embodiments. Moreover, various features are described which may be exhibited by some embodiments and not by others. Similarly, various requirements are described which may be requirements for some embodiments but may not be requirements for other embodiments. Reference will now be made in detail to embodiments of the invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0035] FIG. 1 is a schematic of an embodiment of a water-mediated air source thermal conditioning system 100. The system 100 may be used as a heat pump to provide heating. In some embodiments, the system 100 may be used to provide cooling.

[0036] Air source heat pumps provide a convenient and low cost installation in systems that utilize a heat pump. However, use of an air source heat pump is limited due to critical balancing points and the need for frequent defrosting. On the other hand, water source heat pumps provide high efficiency at a wide range of entering water temperature, typically about 20° F. to 100° F. However, use of a water source heat pump is limited to the availability of a convenient water source, such as ground water, lakes, and rivers.

[0037] Thermal conditioning system efficiency may be characterized by the coefficient of performance (COP). The COP is generally a measure of the amount of thermal conditioning available for a given input of work or electrical energy. A higher ratio indicates a higher efficiency. For example, for heat pumps, the COP is a measure of the amount of heat added to a system being heated. Conventional air source heat pumps exhibit a COP of about 3 at 47° F., with the typical average COP over seasonal variations being in the range of 2.5 to 2.8. Water source heat pumps, on the other hand, typically exhibit a COP of 4 to 5, at an entering water temperature of about 40° F. to 50° F. Some embodiments of the present development use ambient air in combination with a circulated thermal working fluid, such as water. For instance, in an area of mild to moderate climate, ambient temperature hardly ever falls below the freezing point. Therefore, the use of ambient air to regulate the temperature of water circulated in the thermal conditioning system 100 employing a water source heat pump will enable the use of a high efficiency water source heat pump in connection with an ambient air installation, without the need for a traditional water source. In a cold climate, for example if the ambient air temperature falls below the freezing point, then antifreeze solution may substitute for water.

[0038] As shown in FIG. 1, the thermal conditioning system 100 may have a circulation system 104 and a heat exchanger 124. In some embodiments, the circulation system 104 may have a first region 111 for exchanging heat with air, a dispersal device 116, and/or a reservoir 120. In some embodiments, the heat exchanger 124 may be a heat pump.

[0039] The first region 111 (e.g., as shown in FIG. 2) may comprise any number of panels 112. For example, there may be one, two, three, four, five, six, seven, eight, nine, ten, or more individual panels 112. The panels 112 may be part of the first region 111 for thermal heat exchange with ambient air. The air may flow between the adjacent panels 112 and add heat to the fluid flowing through the panels 112. The panels 112 may be oriented horizontally, as shown. The panels 112 may be in fluid communication with, and receive via an inlet 128, first thermal fluid from a first conduit 108. The panels 112 may be in fluid communication via an outlet 130 with a heat exchange region that includes a second heat exchange region, for heat exchange between the thermal fluids, comprising a dispersed fluid region 136. The first thermal fluid (e.g., water) may flow through the inlet 128, through each panel 112, and through the outlet 130. After flowing through the outlet 130, the fluid may flow through the dispersal device 116 and into the dispersed fluid region 136. One or more second conduits 125 of the heat exchanger 124 may extend into the dispersed fluid region 136. In the dispersed fluid region 136, heat is exchanged between the dispersed first thermal fluid and a second thermal fluid flowing through the second conduit 125.

[0040] The dispersed first thermal fluid may then fall into and collect within the reservoir 120. The conduit 125 of the heat exchanger 124 is thus not submersed in the first thermal fluid. By “submersed” it is meant that an object is located within a three-dimensional collection of a fluid, for example within a tank filled with the fluid. The reservoir 120 may not be fully filled, in order to minimize thermal contact between the fluid in the reservoir 120 and the incoming dispersed first thermal fluid and to allow un-pressurized first thermal fluid flow in the system 100. The water level 140 of the collected first thermal fluid in the reservoir 120 may remain below a

pre-determined height. By not submersing the second conduit 125 within the first thermal fluid, the system 100 may allow for more efficient heat exchange. For example, if the second conduit 125 was submersed in the first thermal fluid, the incoming first thermal fluid from the panels 112 would be immediately mixed with the fluid in which the second conduit 125 is already submersed, which could lower the heat exchange efficiency. By separating the dispersed fluid where heat exchange occurs from the collected fluid in the reservoir 120, the heat exchange is vastly improved. Due to these and other features, the system 100 can provide improved COP, as further discussed herein, for example with respect to FIG. 6.

[0041] As further shown in FIG. 1, the collected first thermal fluid may be removed from the reservoir 120 via a circulating pump 132. The first thermal fluid may then flow through one or more conduits 108 of the circulation system 104 and back to the panels 112 in the first region 111 to repeat the process described above.

[0042] FIG. 2 is a cross-sectional view of an embodiment of the panels 112 of the system 100. The panels 112 may be used to exchange thermal energy between the first thermal fluid and ambient air. As shown, there are nine panels 112 in this example. As described above, each panel 112 may be positioned horizontally. “Horizontal” as used herein includes its usual and ordinary meaning and includes, without limitation, orthogonal to the direction of gravity. In some embodiments, the panels 112 may be substantially horizontal. In some embodiments, the panels 112 may be angled relative to the horizontal, for example where fluid enters each panel 112 at one end and exits at an opposite end.

[0043] As shown, the panels 112 may be configured to receive the first thermal fluid at or near a central region of the planar panel 112 and may be used to exchange thermal energy between the thermal fluid and ambient air. A first, upper panel 112 may be connected to the conduit 108 via the inlet 128. A final, lower panel 112 may be fluidly connected to the dispersed fluid region 136 via the outlet 130. A flow path 129 may extend from the inlet 128, through the first upper panel 112, through all intermediate panels 112, out the final lower panel 112, and to the outlet 130, as shown via the arrows in FIG. 2. Within each panel 112, the flow path 129 may extend around an inner wall 148. The flow path 129 may extend over the inner wall, along the top of the inner wall between an upper surface of the inner wall 148 and an upper wall of the panel 112, around the sides of the inner wall 148, and along the lower wall of the panel 112 between the panel 112 and a lower surface of the inner wall 148.

[0044] In some embodiments, the panels 112 are not fully filled with the first thermal fluid. This may allow for un-pressurized fluid, such as water, to flow at a pre-determined flow rate through the panels 112. The un-pressurized fluid flow may reduce the risk of the panel bursting. The un-pressurized fluid flow may allow sufficient flow rate to allow for sufficient heat exchange with the ambient air. A sufficient flow rate may include the volume of water flow exceeding a conventional water flow rate in the water source heat exchange system, e.g. the flow may be ten gallons/min from conventional two gallons/min restraint, which allows five times more heat exchange, as the amount of heat exchanged is proportional to the product of inlet 129 and outlet 130 temperature differences and the sum of fluid volume passed through the panels 112. The panels 112 may have a thickness defined between the upper wall and lower

wall of the panel 112. The portion of the flow channel 129 between the inner wall 148 and the panel 112 may be less than the thickness of the panel 112. Each panel 112 may be planar and have a planar length and width that are each greater than a transverse thickness of the panel 112. A smaller thickness may reduce overall system weight to retain heat, which may enhance overall system efficiency. In some embodiments, the panels 112 may be made of aluminum or a similar material to help maintain a lower overall system weight and higher heat conduction between first heat exchange fluid and panel 112 and between panel 112 and ambient air. A lower overall system weight may reduce overall system latent heat which may enhance heat exchange efficiencies.

[0045] The temperature of the first thermal fluid will change as it flows through and from panel 112 to panel 112 due to continuous heat exchange with ambient air surrounding each panel 112. The first thermal fluid may be closest to ambient air temperature when the fluid exits the final lower panel 112. The first thermal fluid may decrease in temperature as it flows through the panels 112, for example in cooling applications close to ambient air temperature. In some embodiments, the first thermal fluid may increase in temperature as it flows through the panels 112 in heating applications close to ambient air temperature.

[0046] FIG. 3 is a close up, side cross-sectional view of one of the panels 112. The panel 112 includes an embodiment of the inner wall 148. The flow path 129 through the panel 112 is defined in part by the inner wall 148. The inner wall 148 is described in further detail herein, for example with respect to FIG. 4.

[0047] As shown in FIG. 3, the panel 112 may have an elongate shape. For example, the length of the panel 112 (in the horizontal direction as oriented) may be greater than the thickness (in the vertical direction as oriented). The width (into the plane of the figure as oriented) may also be greater than the thickness. The panel 112 may be planar.

[0048] The inner wall 148 may extend across 50% or more of the length and/or width of the panel 112. In some embodiments, the inner wall 148 may extend across 25% or more, 30% or more, 35% or more, 40% or more, 45% or more, 55% or more, 60% or more, 65% or more, 70% or more, or 75% or more of the length and/or width of the panel 112. The dimensions of the panel 148 may be wide enough to allow full contact of the first thermal fluid to the interior of the panel 112, to accommodate efficient heat exchange area between the first thermal fluid and ambient air while passing through the panel 112.

[0049] The inner wall 148 may divide the interior of the panel 112 into upper and lower portions of a flow channel 129. The upper and lower portions may be of equal thickness or height. For example, the upper portion of the flow channel 129 above the inner wall 148 may have the same or similar height as the lower portion of the flow channel below the inner wall 148. In some embodiments, the two portions may have different heights. The height of these portions may be constant, as shown, or it may vary along the flow channel 129. The flow channel 129 may have a greater height beyond the edges of the inner wall 148, where the upper and lower portions of the flow channel meet. The flow channel 129 may therefore have a first height above the inner wall 148, a second height beyond the edges of the inner wall 148, and a third height below the inner wall 148. The second height may be greater than each of the first and third heights. In

some embodiments, the second height may be the same or similar as the first and/or third heights. For example, the portion of the panel 112 beyond the inner wall 148 may have a smaller thickness than the portion of the panel 112 above/below the inner wall 148.

[0050] In some embodiments, the panel 112 may include a first opening 152 on an upper side of the panel 112 and a second opening 156. The panel 112 may extend horizontally, with portions of the panel 112 located on either side of the first opening 152. The second opening 156 may be positioned opposite the first opening 152 on a lower side of the panel 112. The first opening 152 and/or second opening 156 may be positioned generally in the center of the panel 112. In some embodiments, the openings 152, 156 may be off-center, closer to or near the outer edges of the panel 112, positioned offset from each other, or combinations thereof.

[0051] The flow path 129 may extend from the first opening 152, into the panel 112, over and around the inner wall 148, under the inner wall 148, and into the second opening 156. The first opening 152 may receive the first thermal fluid from the conduit 108 or from an adjacent upper panel 112. The first thermal fluid may flow through the second opening 156 and into an adjacent lower panel 112 or into the dispersal device 116.

[0052] The fluid may enter through the first opening 152 and disperse or spread out over the inner wall 148 and follow the path shown by the arrows. The inner wall 148 may create two or more flow paths. For example, an outward flow path allows the thermal fluid to flow away from the center of the panel 112 toward the edges, and an inward flow path allows the thermal fluid to flow from the edges toward the center of the panel 112. The fluid may flow throughout the flow path 129 which may extend in all directions radially outward from the first opening 152.

[0053] As described above, in some embodiments, the flow path 129 within the panel 112 may not be fully filled with the first thermal fluid. The flow path 129 within the panel 112 may be configured to allow un-pressurized flow of the first thermal fluid at a pre-determined flow rate. The flow rate may be determined based on a desired amount of heat exchange, ambient temperature, thermal load on the system, geometry of the flow path 129, and/or the composition of the first thermal fluid.

[0054] The panel 112 may have a length and/or width from about 18 inches to about 30 inches, including any value in between. The panel 112 may have a thickness from about 0.03 inches to about 1 inch, including any value in between. The openings 152 and/or 156 may have a diameter from about 0.5 inches to about 1.5 inches, including any value in between. In some embodiments the diameter of the openings 152, 156 are the same. In some embodiments, the diameters of the openings 152, 156 are different. The openings 152, 156 may be large enough to allow for un-restricted water flow through the plurality of panels 112. The dimensions of the panel 112 and/or the openings of 152, 156 may be adjusted, e.g. further enlarged, to the extent of heat exchange requirements, i.e., capacity of the heat pump and pre-determined flow rate of the first thermal fluid.

[0055] FIG. 4 is a perspective view of the inner wall 148 shown in isolation. The inner wall 148 may have a flat surface 164 supported by one or more legs 168. The inner wall 148 may define an open space 172 under the surface 164 and between the legs 168. The surface 164 may be supported by two, three, four or more legs 168. In some

embodiments, the surface 164 may have a rectangular or square shape, as shown. The surface 168 may be sized to act as a barrier between the first opening 152 and second opening 156 of the panel 112 (e.g., as shown in FIG. 3). The legs 168 may be positioned in each corner of the surface 168. The inner wall 148 may be sized to fit within the panels 112. The surface 164 may be planar. In some embodiments, the surface 164 may be angled, for example to bias the fluid to flow off the outer edges of the surface 164. The surface 164 may be angled downward from the center of the surface 164.

[0056] The first thermal fluid may flow into the panel 112 and be spread out by the inner wall 148 when the fluid comes in contact with the surface 164. The fluid may undergo heat exchange with ambient air surrounding the panel 112 via the walls of the panel 112 prior to exiting the panel 112 through the second opening 156. An unrestricted fluid flow may allow for an increase of fluid flow rate, which may lead to enhanced efficiency. The change in the amount of heat contained by the first thermal fluid as it flows through the series of panels 112 may be estimated based on the change in flow rate of the fluid, the amount of time the fluid flows through the panels 112, and the difference in temperature of the fluid at the inlet 128 and the outlet 130. This may be expressed mathematically as follows:

$$\Delta(\text{Heat}) = \Delta(\text{Flow Rate}) \times \text{Time} \times (\text{Temp. outlet} - \text{Temp. inlet})$$

[0057] FIG. 5 is a schematic showing a portion of the water-mediated thermal conditioning system 100. The dispersal device 116 is located above the dispersed fluid heat exchange region 136. The dispersed fluid region 136 is in fluid communication with the water reservoir 120. The first thermal fluid may flow through the inlet 128, pass through the dispersal device 116 and be dispersed in the dispersed fluid region 136 for heat exchange with the second thermal fluid in the second conduit 125. The dispersed first thermal fluid may fall into the reservoir 120. The fluid in the reservoir 120 may include a valve to control flow to the circulating pump 132, which may re-circulate the first thermal fluid, as described.

[0058] FIGS. 5A and 5B are perspective and side views respectively of embodiments of dispersal devices that may be used with the various thermal conditioning systems 100 described herein. FIG. 5A shows an example embodiment of the dispersal device 116 shaped as a plate. The dispersal device 116 may include multiple openings 118 (for clarity, only some of the openings 118 are labelled in FIG. 5A). The dispersal device 116 may have any number of openings 118, for example, twenty, fifty, one hundred, or more openings 118. The openings 118 may have the same or different sizes, areas, shapes, widths, etc. The openings 118 may be positioned in rows across the dispersal device 116. In some embodiments, the openings 118 in a first row may be offset from the openings 118 in an adjacent second row. In some embodiments, the dispersal device 116 may be a screen. The openings 118 may therefore be very small, such that the water breaks up as it passes through the screen.

[0059] The dispersal device 116 may disperse the thermal fluid into a series of drops or droplets. The dispersed fluid may be a mist. The dispersed fluid may be a combination of drops, droplets, mist, larger masses of water, etc. For example, the openings 118 may have different sizes.

[0060] The second conduit 125 may be positioned below the dispersal device 116. The second conduit 125 may be connected to the heat exchanger 124, which may be a heat

pump. The heat exchanger 124 may circulate a second thermal fluid through the second conduit 125. Heat exchange may occur between the dispersed first thermal fluid within the dispersed fluid region 136 and the second thermal fluid inside the second conduit 125 via the surface area of the second conduit 125, for example the outer pipe surface(s) of the second conduit 125. The second conduit 125 may be a series of conduits or pipes extending through the dispersed fluid region 136.

[0061] FIG. 5B is a side view of another example embodiment of the dispersal device 116. The dispersal device 116 may have a tubular or pipe-like structure. The dispersal device 116 may have the openings 118 positioned at the bottom of the tube structure. The fluid may enter the dispersal device 116 through the outlet 128 of the panels 112. The fluid may then be dispersed through the openings 118, which may have any of the features described above. The fluid may be dispersed between the dispersal device 116 and the second conduit 125, as shown schematically for illustration by the arrow 121. The dispersal device 116 may disperse the thermal fluid into a series of drops, droplets, etc. of fluid, as described above. In some embodiments, the dispersal device 116 may be or include a sprinkler, a mister, other suitable devices to disperse the water, or combinations thereof.

[0062] FIG. 6 is a data plot showing an embodiment of improved coefficient of performance (COP) for various inlet water temperatures at COP exemplary evaluation test set with 5000 BTU/h capacity at a flow rate of about 10 gallons/hr/ton. The various inlet water temperatures may vary in relation to the ambient air temperature, and the data may be produced using the various thermal conditioning systems 100 described herein. The first thermal fluid is water or antifreeze in this example. The plot shows the model system efficiency of the thermal conditioning system 100, for example of FIG. 1. The x-axis represents the inlet water temperature in Celsius (° C.) and the y-axis represents the COP. The inlet water temperature may correspond to the inlet 128. A baseline COP of about 3.2 is shown for a conventional air-source air-conditioner that does not include the panels 112 or the dispersed fluid heat exchange features described herein. As shown, for the system 100 that includes the panels 112 and the dispersed fluid heat exchange features, the COP is well above 6 for a range of inlet water temperatures from about 30° C. to about 52° C. Further, when the inlet water temperature is lower, the COP is higher as used for a cooling system. Alternatively, when the inlet water temperature is high, the COP is higher as used for a heating system. The system thus provides a higher COP in both cooling and heating applications.

[0063] FIG. 7 is a flow chart showing an embodiment of a method of thermal conditioning using water mediation. The method 240 may use the various thermal conditioning systems 100 described herein.

[0064] The method 240 may begin at block 250, where the thermal conditioning system may circulate a first thermal fluid through a first conduit and into horizontal panels, as described above. The method 240 then moves to block 260, where heat may be exchanged between the first thermal fluid within the panels and the ambient air. The first thermal fluid may thermally communicate with the ambient via the external walls of the panels. Heat may be added or removed from the first thermal fluid.

[0065] The method 240 then moves to block 270, where the thermal fluid may then be dispersed, for example by the dispersal device 116, and enter a dispersed fluid region. The method 240 then moves to block 280, where the thermal conditioning system may circulate a second thermal fluid from a heat exchanger via a second conduit located within the dispersed fluid region.

[0066] The method 240 then moves to block 290, where heat may be exchanged between the first and second thermal fluids in the dispersed fluid region. The dispersed first thermal fluid may thermally communicate with the second thermal fluid via the walls of the second conduit. Heat may be added or removed from the second thermal fluid. The method 240 then moves to block 300, where the dispersed first thermal fluid exits the dispersed fluid region and may be collected in a fluid reservoir for re-circulation through the panels. The method 240 may then return to block 250 and repeat. In some embodiments, the block 290 may be located between blocks 250 and 260. For example, heat exchange between the thermal fluids in block 290 may be occurring during or between the circulation and heat exchange of the first thermal fluid with ambient air as in blocks 250 and 260. Thus the method 240 may be performing more than one of the blocks simultaneously or in various orders.

[0067] Various modifications to the implementations described in this disclosure will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other implementations without departing from the spirit or scope of this disclosure. Thus, the disclosure is not intended to be limited to the implementations shown herein, but is to be accorded the widest scope consistent with the claims, the principles and the novel features disclosed herein. The word “example” is used exclusively herein to mean “serving as an example, instance, or illustration.” Any implementation described herein as “example” is not necessarily to be construed as preferred or advantageous over other implementations, unless otherwise stated.

[0068] Certain features that are described in this specification in the context of separate implementations also may be implemented in combination in a single implementation. Conversely, various features that are described in the context of a single implementation also may be implemented in multiple implementations separately or in any suitable sub-combination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination may in some cases be excised from the combination, and the claimed combination may be directed to a sub-combination or variation of a sub-combination.

[0069] Similarly, while operations are depicted in the drawings in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. Additionally, other implementations are within the scope of the following claims. In some cases, the actions recited in the claims may be performed in a different order and still achieve desirable results.

[0070] It will be understood by those within the art that, in general, terms used herein are generally intended as “open” terms (e.g., the term “including” should be interpreted as “including but not limited to,” the term “having” should be interpreted as “having at least,” the term “includes” should

be interpreted as “includes but is not limited to,” etc.). It will be further understood by those within the art that if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such recitation no such intent is present. For example, as an aid to understanding, the following appended claims may contain usage of the introductory phrases “at least one” and “one or more” to introduce claim recitations. However, the use of such phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles “a” or “an” limits any particular claim containing such introduced claim recitation to embodiments containing only one such recitation, even when the same claim includes the introductory phrases “one or more” or “at least one” and indefinite articles such as “a” or “an” (e.g., “a” and/or “an” should typically be interpreted to mean “at least one” or “one or more”); the same holds true for the use of definite articles used to introduce claim recitations. In addition, even if a specific number of an introduced claim recitation is explicitly recited, those skilled in the art will recognize that such recitation should typically be interpreted to mean at least the recited number (e.g., the bare recitation of “two recitations,” without other modifiers, typically means at least two recitations, or two or more recitations). Furthermore, in those instances where a convention analogous to “at least one of A, B, and C, etc.” is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., “a system having at least one of A, B, and C” would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). In those instances where a convention analogous to “at least one of A, B, or C, etc.” is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., “a system having at least one of A, B, or C” would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). It will be further understood by those within the art that virtually any disjunctive word and/or phrase presenting two or more alternative terms, whether in the description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms. For example, the phrase “A or B” will be understood to include the possibilities of “A” or “B” or “A and B.”

1. A thermal conditioning system comprising:
 - a closed loop circulation system configured to circulate a first thermal fluid through a circulating path closed off from ambient air and configured to transport the first thermal fluid through the circulation system, the circulating path comprising:
 - a plurality of panels configured to be oriented horizontally, wherein each panel is configured to receive the first thermal fluid to exchange thermal energy between the first thermal fluid and ambient air through surfaces of the panel, wherein the first thermal fluid is separate from the ambient air;
 - wherein each panel of the plurality of panels comprises an inner wall separating an interior of the panel into at least two flow paths to allow the first thermal fluid to contact the inner wall of each panel, the inner wall having a planar surface extending generally parallel to a length of each panel, and wherein the first

- thermal fluid in the two flow paths is un-pressurized such that the panel is not fully filled with the first thermal fluid;
- a dispersal device in fluid communication with the plurality of panels and configured to allow the first thermal fluid to fall down into a dispersed fluid region,
 - a reservoir in fluid communication with the dispersed fluid region and configured to collect the dispersed fluid from the dispersed fluid region; and
 - a first conduit configured to continuously transport the first thermal fluid from the reservoir to the plurality of panels, wherein all of the first thermal fluid remains within the circulating path; and
- a heat exchanger configured to circulate a second thermal fluid through a second conduit, the second conduit positioned between the dispersal device and the reservoir, wherein a sidewall of the second conduit is in thermal communication with the dispersed fluid region of the circulation system to exchange heat through the sidewall of the second conduit such that the second thermal fluid is separate from the first thermal fluid.
2. (canceled)
 3. The thermal conditioning system of claim 1, wherein each panel of the plurality of panels is configured to allow the un-pressurized flow of the first thermal fluid at a pre-determined flow rate.
 4. The thermal conditioning system of claim 1, wherein the second conduit circulating second thermal fluid is not submersed in the first thermal fluid.
 5. (canceled)
 6. The thermal conditioning system of claim 1, wherein the at least two flow paths comprise an outward flow path, configured to flow the first thermal fluid away from a center of the panel, and an inward flow path, configured to flow the first thermal fluid toward the center of the panel.
 7. The thermal conditioning system of claim 1, wherein the dispersal device comprises a screen.
 8. The thermal conditioning system of claim 1, wherein the first thermal fluid in the dispersed fluid region comprises a series of drops.
 9. The thermal conditioning system of claim 1, wherein a surface of the first thermal fluid collected in the reservoir is below the dispersed fluid region such that the second conduit is not submersed in the first thermal fluid.
 10. The thermal conditioning system of claim 1, further comprising a pump configured to re-circulate the first thermal fluid from the reservoir to the plurality of panels via the first conduit.
 11. The thermal conditioning system of claim 1, wherein the heat exchanger is a heat pump.
 12. The thermal conditioning system of claim 1, wherein the first thermal fluid comprises water.
 13. A thermal conditioning system comprising:
 - a closed loop circulation system configured to circulate a first thermal fluid through a circulating path to transport the first thermal fluid through the circulation system, the circulating path comprising:
 - a first region configured to exchange thermal energy between the first thermal fluid and ambient air, wherein the first thermal fluid is separate from the ambient air by walls of the first region, and the first region comprises a plurality of thermal exchange regions, each thermal exchange region comprising
 - an inner wall separating an interior of each thermal exchange region into at least two flow paths to allow the first thermal fluid to contact inner walls of the thermal exchange regions, the inner wall having a planar surface extending horizontally, wherein the first thermal fluid is separate from the ambient air by walls of the first region;
 - a circulating pump configured to continuously assist the flow of the first thermal fluid through the circulation system, wherein the first thermal fluid in the thermal exchange regions is un-pressurized such that the thermal exchange regions are not fully filled with the first thermal fluid;
 - a dispersal device configured to receive the first thermal fluid from the first region and to allow the first thermal fluid to fall down into a dispersed fluid region,
 - a reservoir in fluid communication with the dispersed fluid region and configured to collect the dispersed fluid from the dispersed fluid region; and
 - a first conduit configured to transport the first thermal fluid from the reservoir to the first region, wherein all of the first thermal fluid remains within the circulating path; and
 14. The thermal conditioning system of claim 13, wherein the dispersal device comprises a screen.
 15. The thermal conditioning system of claim 13, wherein the first thermal fluid in the dispersed fluid region comprises a series of drops.
 16. The thermal conditioning system of claim 13, wherein the first region comprises a plurality of panels configured to be oriented horizontally, wherein each panel is configured to receive the first thermal fluid.
 17. A thermal conditioning system comprising:
 - a closed loop circulation system configured to circulate a first thermal fluid through a circulating path configured to transport the first thermal fluid through the circulation system, the circulating path comprising:
 - a plurality of panels configured to be oriented horizontally, wherein each panel is configured to receive the first thermal fluid to exchange thermal energy between the first thermal fluid and ambient air through surfaces of the panel, wherein the first thermal fluid is separate from the ambient air;
 - wherein each panel of the plurality of panels comprises an inner wall separating an interior of the panel into at least two flow paths to allow the first thermal fluid to contact the inner wall of each panel, the inner wall having a planar surface extending generally parallel to a length of each panel, and wherein the first thermal fluid in the panel is un-pressurized such that the panel is not fully filled with the first thermal fluid,
 - a heat exchange region configured to receive the first thermal fluid from the plurality of panels; and
 - a first conduit configured to continuously transport the first thermal fluid from the reservoir to the plurality of panels, wherein all of the first thermal fluid remains within the circulating path; and
 - a heat exchanger configured to circulate a second thermal fluid through a second conduit, wherein the second

conduit is in thermal communication with the heat exchange region of the circulation system to exchange heat through a sidewall of the second conduit.

18. The thermal conditioning system of claim **17**, further comprising a dispersal device in fluid communication with the plurality of panels and configured to disperse the first thermal fluid into the heat exchange region.

19. The thermal conditioning system of claim **18**, further comprising a reservoir in fluid communication with the heat exchange region and configured to collect the dispersed fluid from the dispersed fluid region such that the second conduit is not submersed in the first thermal fluid.

20. The thermal conditioning system of claim **17**, wherein each panel of the plurality of panels is configured to not be fully filled with the first thermal fluid to allow the unpressurized flow of the first thermal fluid at a pre-determined flow rate.

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