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(54) SOLAR WINDOW AND SOLAR WALL FOR COOLING AN ENVIRONMENT

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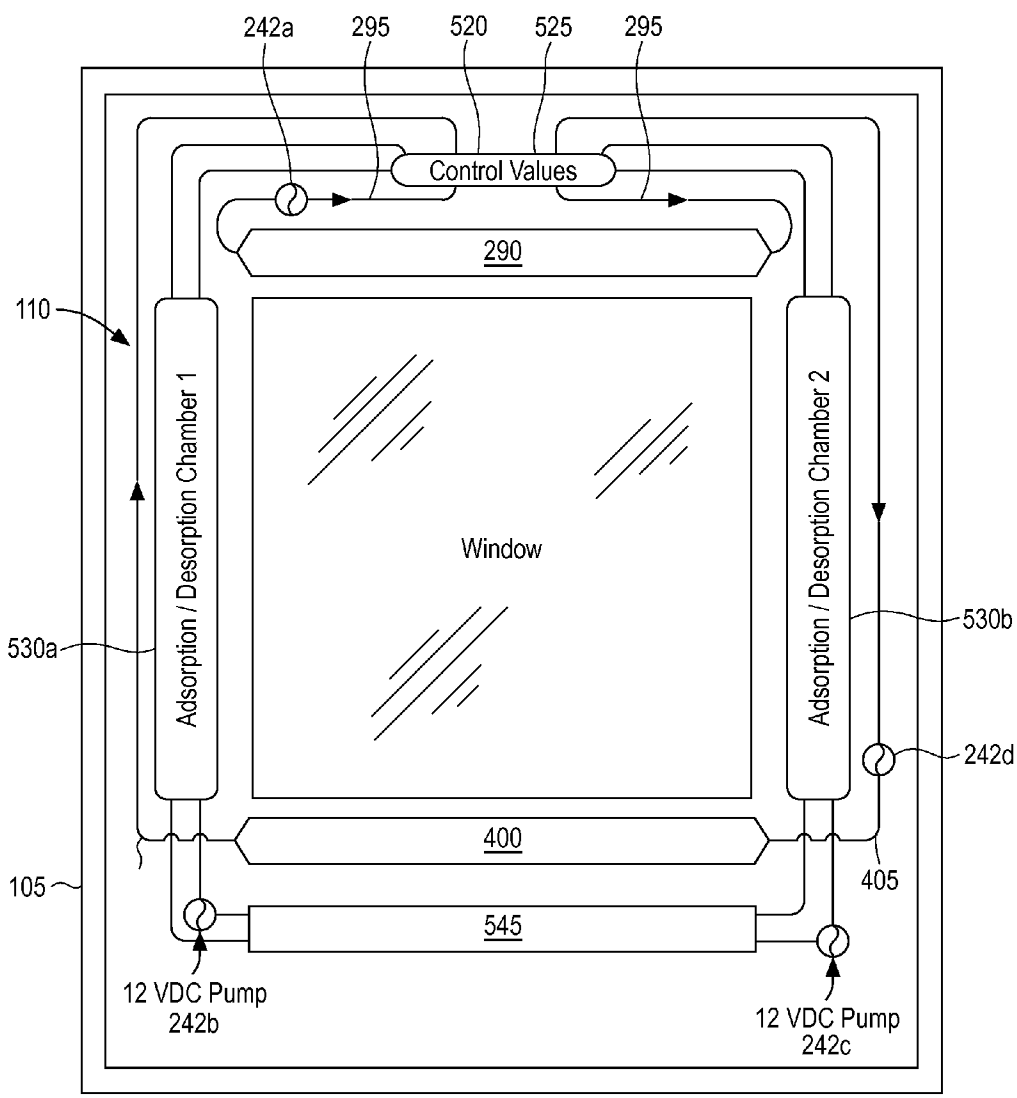
(57) **ABSTRACT**

A window for cooling an environment including first and second panes disposed opposite from one another; a frame coupled to the first and second panes forms an air gap between the first pane, the second pane, and the frame; and first and second reflective coatings disposed on first surfaces of the first and second panes. The first surfaces face the air gap, and the reflective coatings are configured to reflect infrared radiation into the air gap to generate heat. The window further includes first and second antireflective coatings respectively disposed on second surfaces of the first and second panes. The second surfaces face away from the air gap, and the antireflective coatings are configured to transmit radiation into the air gap. The window further includes an adsorption-cooling systems configured to collect heat from the air gap to cool air in an environment adjacent to the second pane.



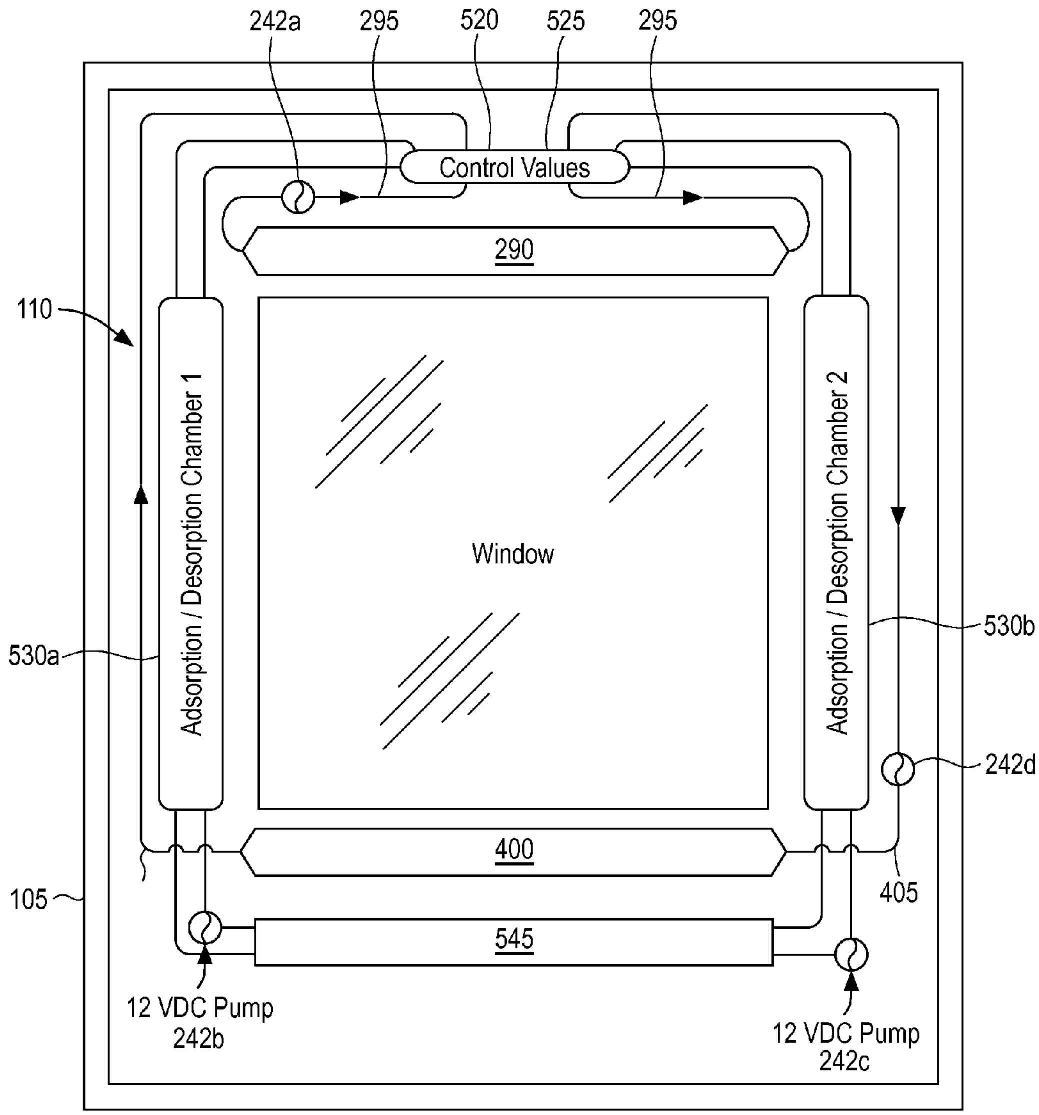

242a
295
520
525
295
Control Values
290
110
Adsorption / Desorption Chamber 1
Window
Adsorption / Desorption Chamber 2
530a
530b
242d
400
405
105
545
12 VDC Pump
242b
12 VDC Pump
242c

FIG. 1

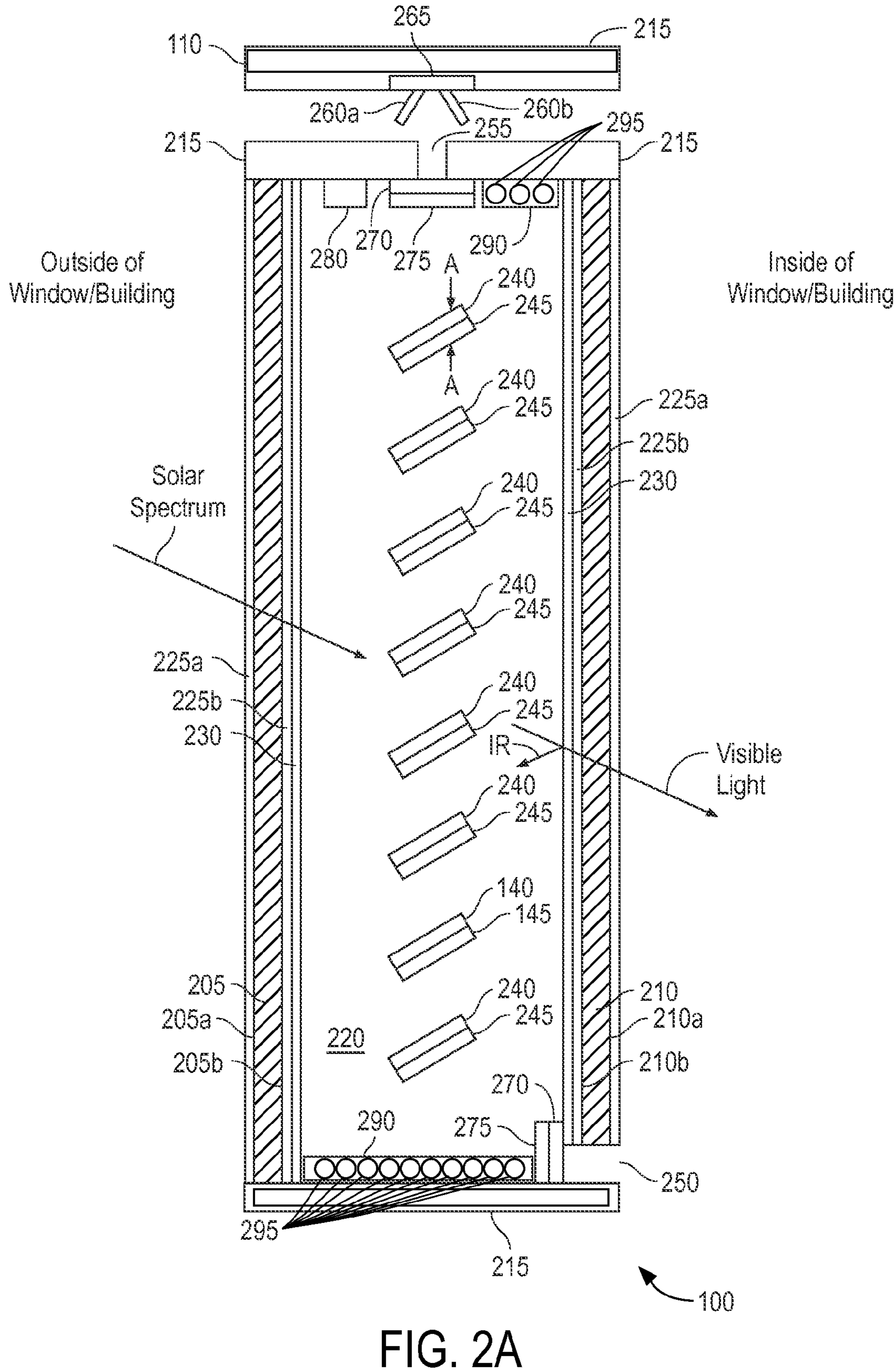

265
110
215
260a
260b
295
215
255
215
280
270
275
290
Outside of Window/Building
Inside of Window/Building
A
240
245
A
225a
225b
230
Solar Spectrum
225a
225b
230
IR
Visible Light
140
145
205
205a
205b
220
210
210a
210b
270
290
275
250
295
215
100

FIG. 2A

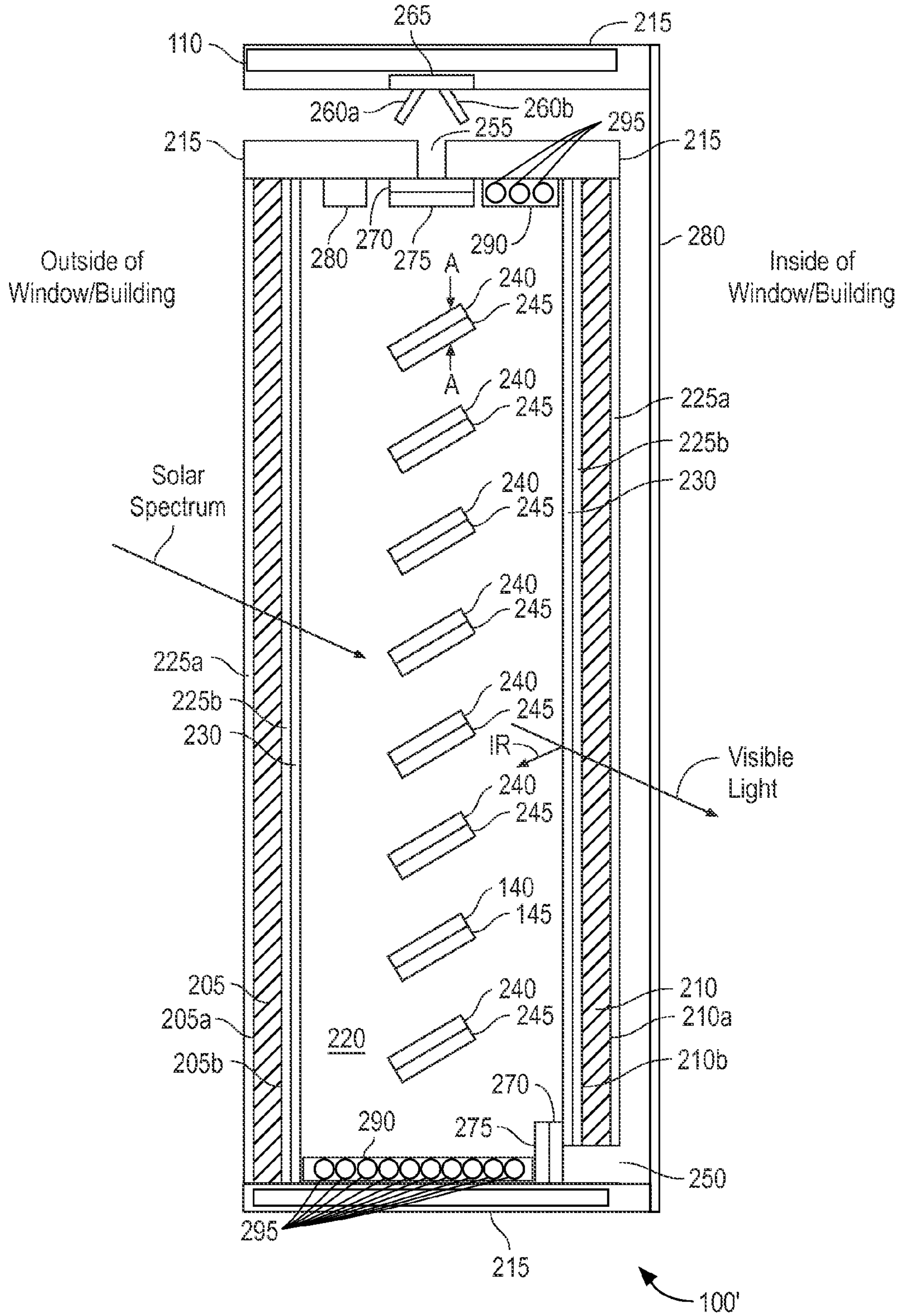

265
215
110
260a
260b
295
255
215
215
280
270
275
290
280
Outside of
Window/Building
Inside of
Window/Building
A
240
245
A
240
245
225a
225b
230
240
245
Solar
Spectrum
240
245
225a
225b
230
240
245
IR
Visible
Light
240
245
140
145
205
205a
205b
220
240
245
210
210a
210b
270
290
275
250
295
215
100'

FIG. 2B

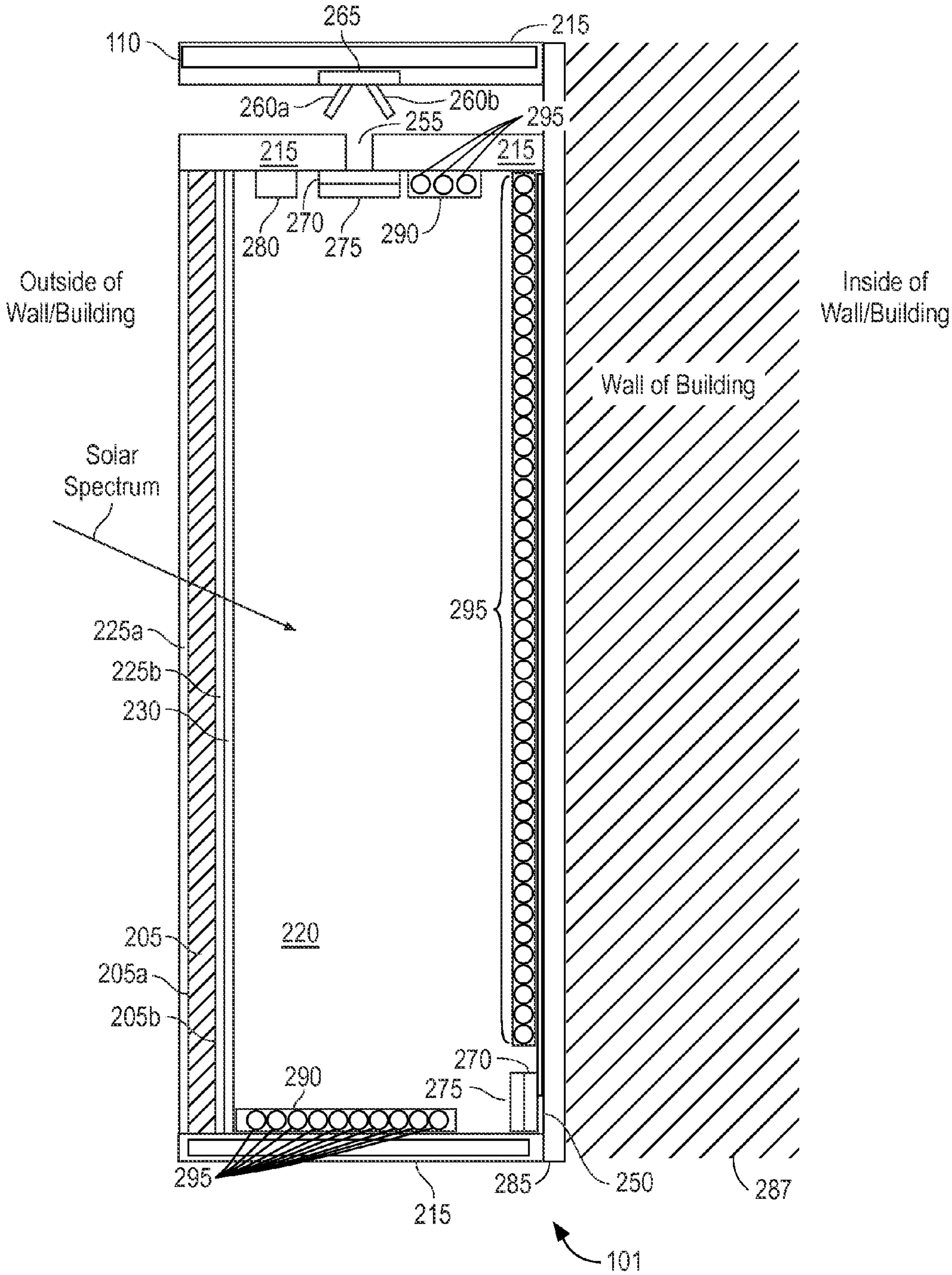

265
215
110
260a
260b
255
295
215
215
280
270
275
290
Outside of Wall/Building
Inside of Wall/Building
Wall of Building
Solar Spectrum
295
225a
225b
230
220
205
205a
205b
270
290
275
295
215
285
250
287
101

FIG. 2C

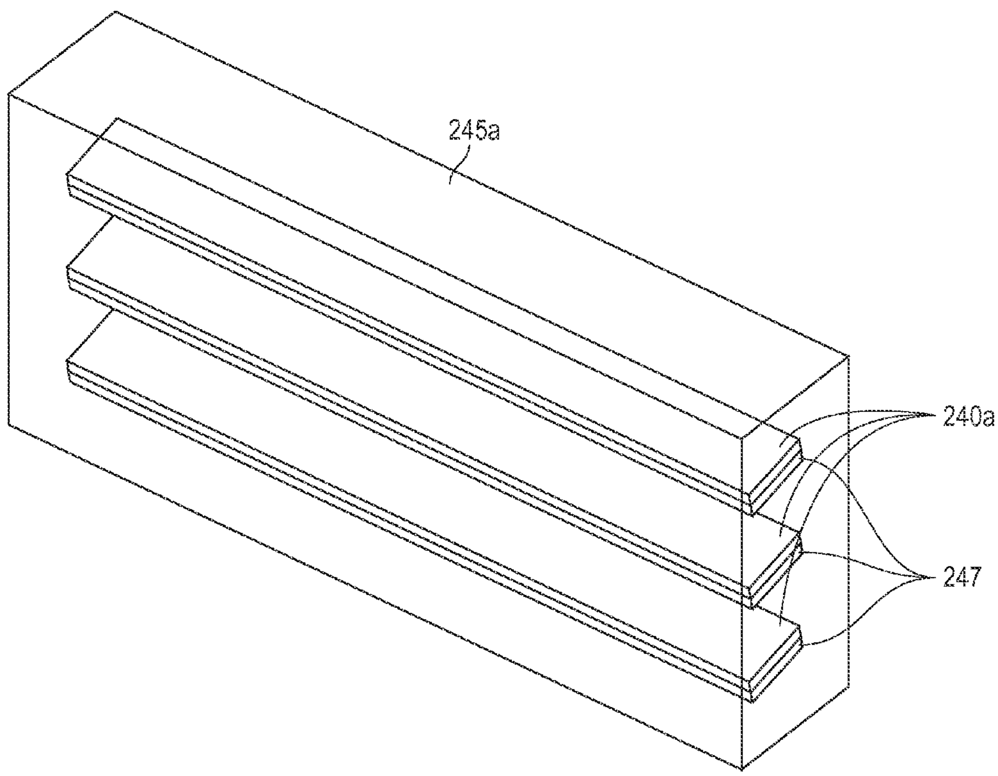
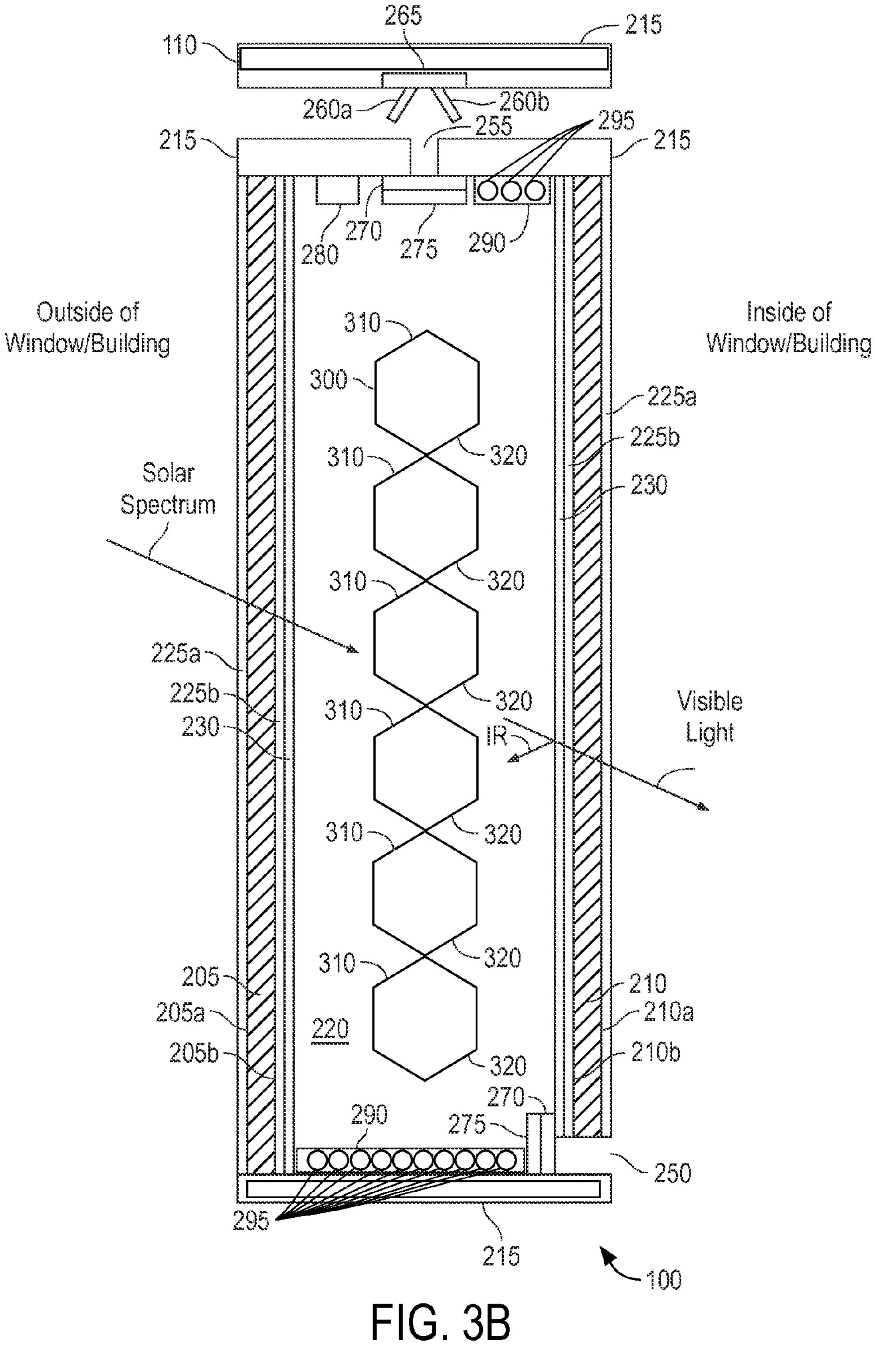


FIG. 3A



265
110
215
260a
260b
255
295
215
215
280
270
275
290
Outside of Window/Building
Inside of Window/Building
310
300
225a
225b
310
320
Solar Spectrum
230
310
320
225a
225b
230
310
320
Visible Light
IR
310
320
310
320
205
205a
205b
220
210
210a
210b
320
270
290
275
250
295
215
100

FIG. 3B

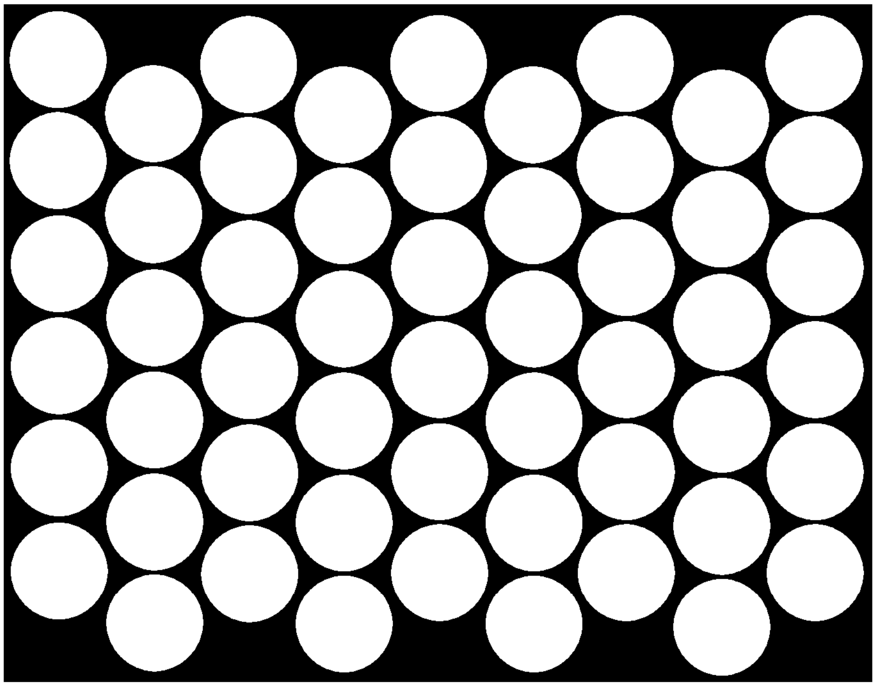


FIG. 3C

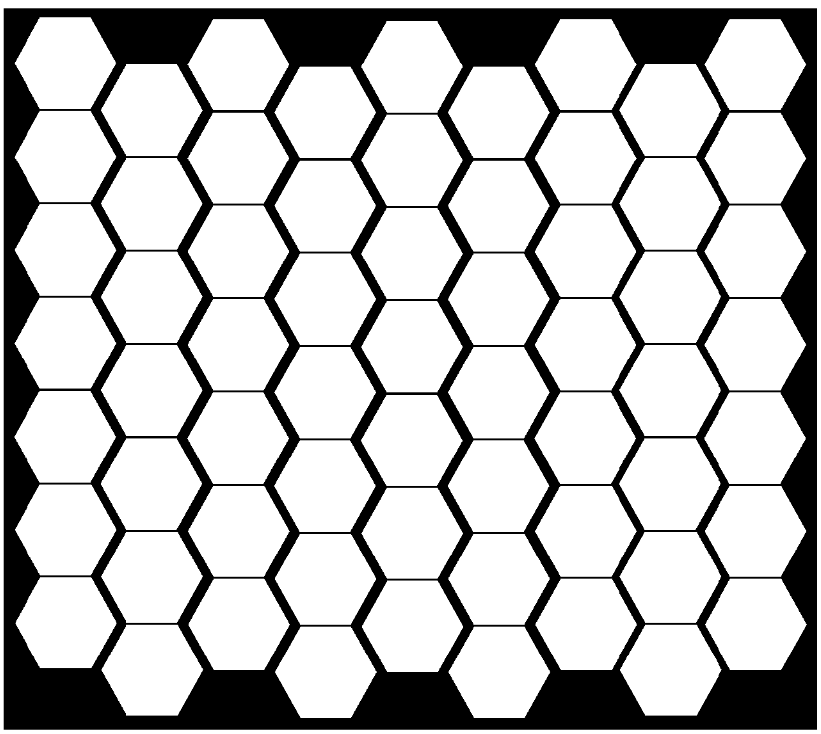


FIG. 3D

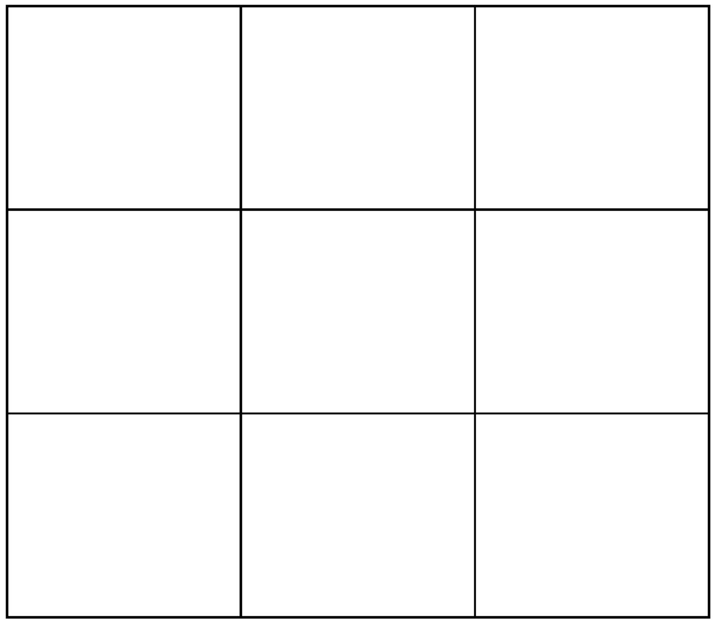


FIG. 3E

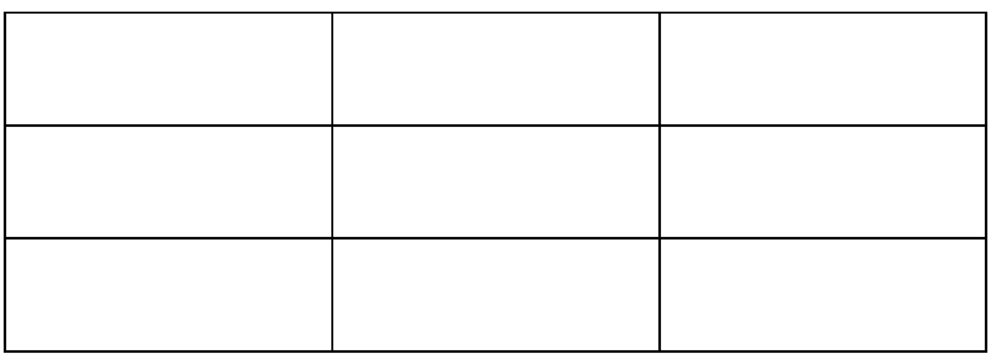


FIG. 3F

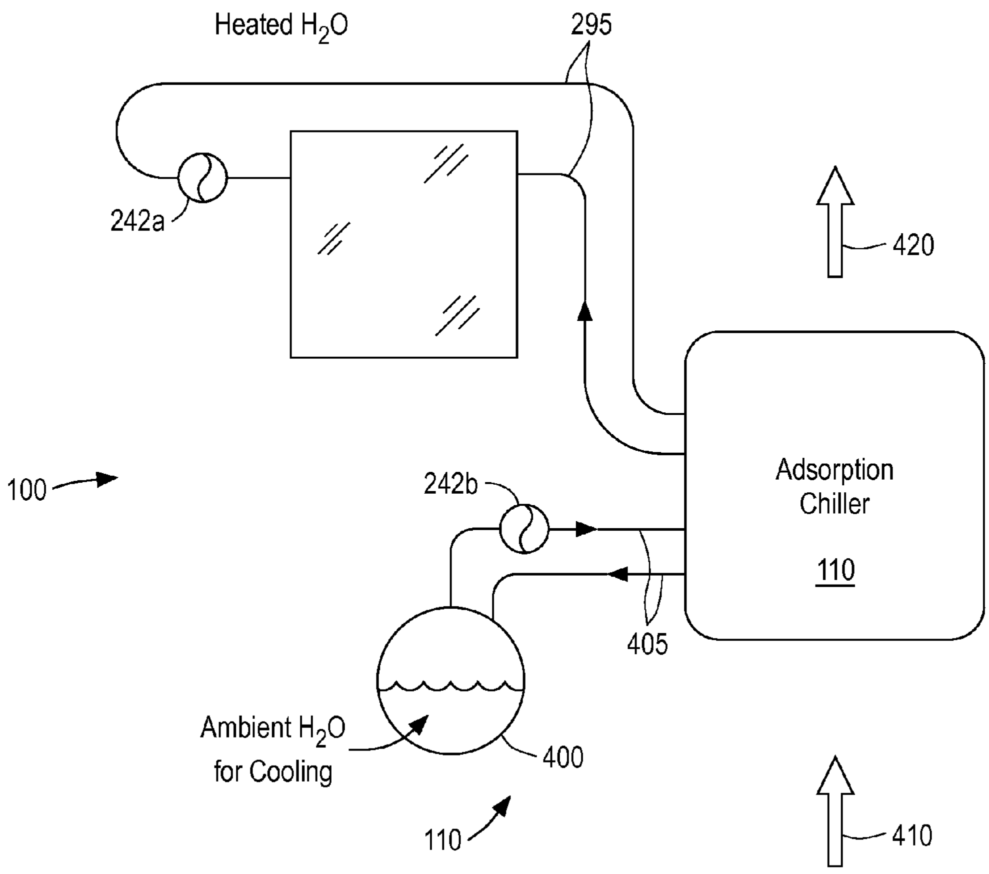

Heated H_2O
295
242a
420
Adsorption
Chiller
110
100
242b
405
Ambient H_2O
for Cooling
400
110
410

FIG. 4

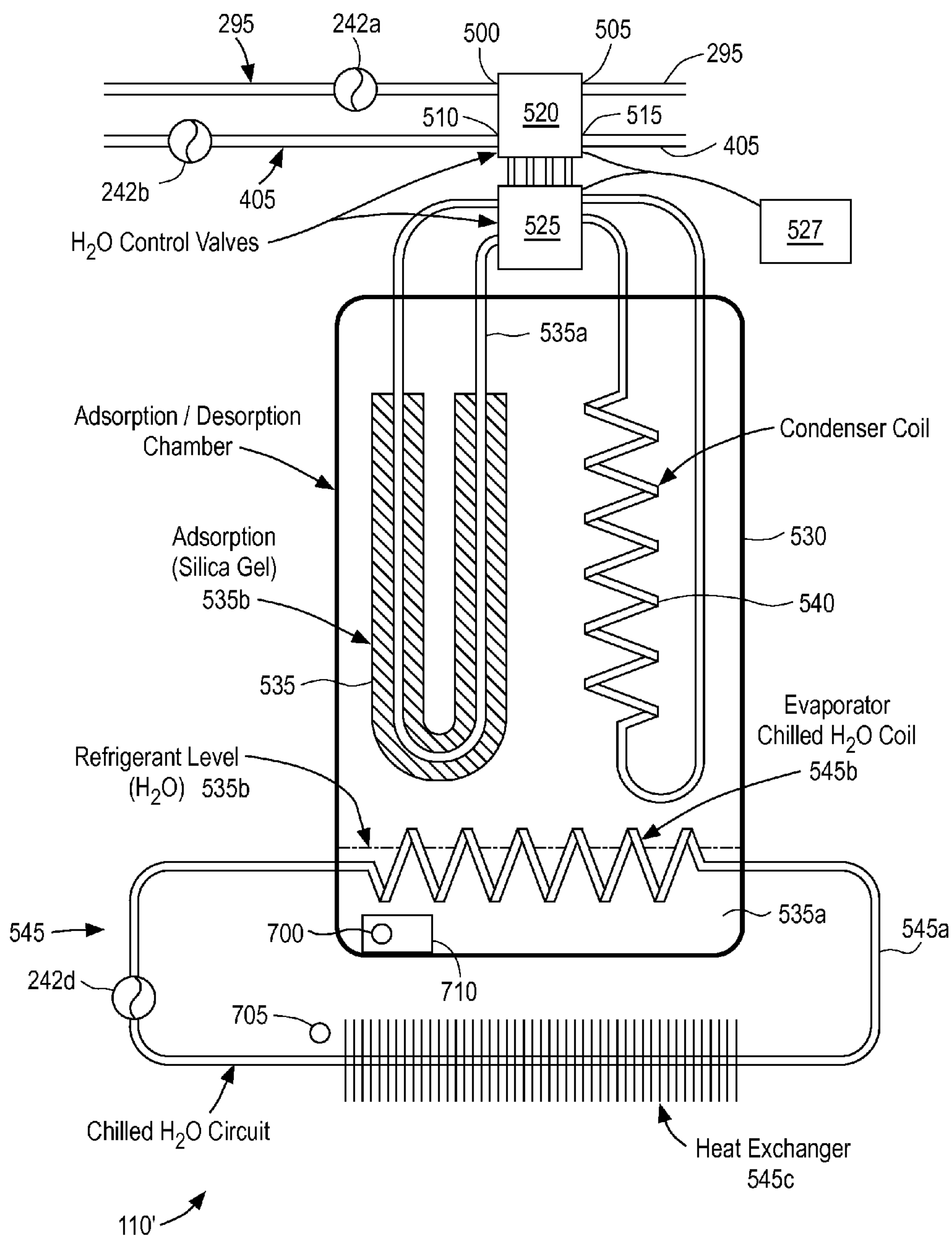
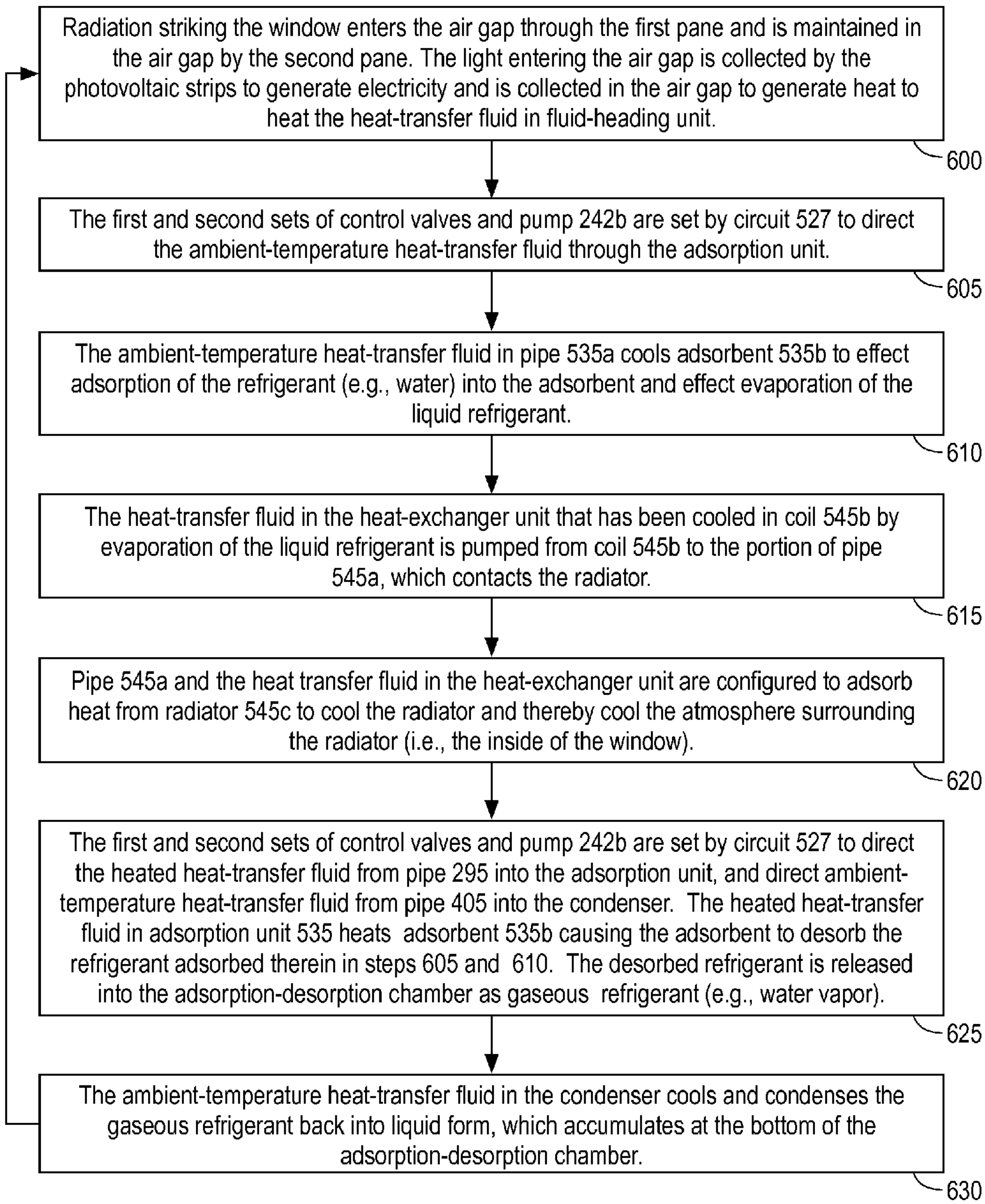

295
242a
500
505
295
510
520
515
405
242b
405
527
525
H2O Control Valves
535a
Adsorption / Desorption Chamber
Condenser Coil
Adsorption (Silica Gel) 535b
530
540
535
Evaporator Chilled H2O Coil 545b
Refrigerant Level (H2O) 535b
535a
545
545a
700
710
242d
705
Chilled H2O Circuit
Heat Exchanger 545c
110'

FIG. 5



Radiation striking the window enters the air gap through the first pane and is maintained in the air gap by the second pane. The light entering the air gap is collected by the photovoltaic strips to generate electricity and is collected in the air gap to generate heat to heat the heat-transfer fluid in fluid-heading unit.
600
The first and second sets of control valves and pump 242b are set by circuit 527 to direct the ambient-temperature heat-transfer fluid through the adsorption unit.
605
The ambient-temperature heat-transfer fluid in pipe 535a cools adsorbent 535b to effect adsorption of the refrigerant (e.g., water) into the adsorbent and effect evaporation of the liquid refrigerant.
610
The heat-transfer fluid in the heat-exchanger unit that has been cooled in coil 545b by evaporation of the liquid refrigerant is pumped from coil 545b to the portion of pipe 545a, which contacts the radiator.
615
Pipe 545a and the heat transfer fluid in the heat-exchanger unit are configured to adsorb heat from radiator 545c to cool the radiator and thereby cool the atmosphere surrounding the radiator (i.e., the inside of the window).
620
The first and second sets of control valves and pump 242b are set by circuit 527 to direct the heated heat-transfer fluid from pipe 295 into the adsorption unit, and direct ambient-temperature heat-transfer fluid from pipe 405 into the condenser. The heated heat-transfer fluid in adsorption unit 535 heats adsorbent 535b causing the adsorbent to desorb the refrigerant adsorbed therein in steps 605 and 610. The desorbed refrigerant is released into the adsorption-desorption chamber as gaseous refrigerant (e.g., water vapor).
625
The ambient-temperature heat-transfer fluid in the condenser cools and condenses the gaseous refrigerant back into liquid form, which accumulates at the bottom of the adsorption-desorption chamber.
630

FIG. 6

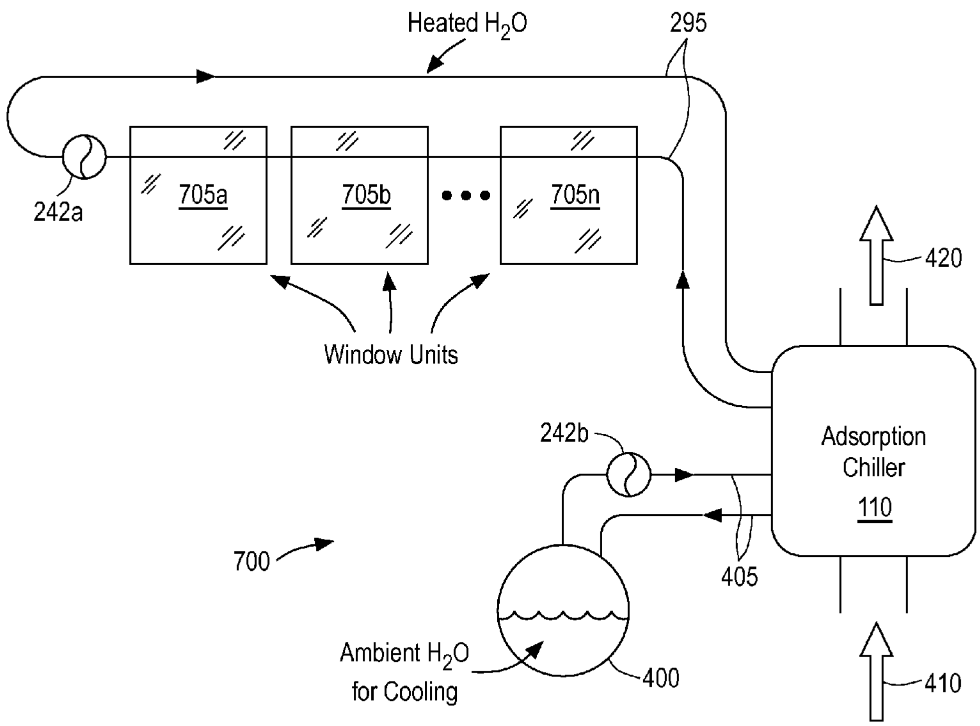

Heated H_2O
295
242a
705a
705b
705n
420
Window Units
Adsorption
Chiller
110
242b
700
405
Ambient H_2O
for Cooling
400
410

FIG. 7

SOLAR WINDOW AND SOLAR WALL FOR COOLING AN ENVIRONMENT

BACKGROUND OF THE INVENTION

[0001] The present invention generally relates to windows and walls for buildings. More particularly the present invention relates to windows and walls configured to cool an environment adjacent to the window or the wall from heat collected by the window or by the wall.

[0002] Traditional windows for buildings have typically been single paned. These single paned windows provide a relatively low level of heat insulation between the inside of the window and the outside the window. Due to the relatively low level of heat insulation of single pane windows, double pane and triple pane windows have been developed, which provide relatively higher levels of heat insulation compared to single pane windows. U.S. Pat. No. 3,793,961 of Wild, U.S. Pat. No. 3,936,157, of Kapany, and U.S. Pat. No. 4,078,548 each describe windows having two panes of glass.

[0003] Subsequent to the development of double pane windows, various double pane windows were developed that included photovoltaic cells formed between the panes. The photovoltaic cells in these windows are configured to generate electricity for use away from the windows (e.g., to light a lamp) without obstructing the view through the windows and the photovoltaic cells. U.S. Pat. No. 4,137,098, of Field, and U.S. Pat. No. 4,265,222, of Kapany, each discuss double pane windows that have photovoltaic cells disposed therein for electricity generation.

[0004] As is well known, double pane windows have an air gap between the individual panes in which heated air tends to be trapped. Various double pane windows have been developed to vent the heated air in the air gap to the "inside" of a window (e.g., into a room in a building), for example, if the inside of the window is colder than desired. These double pane windows are also often configured to vent the heated air from inside a window (e.g., from a room in a building) to the "outside" of the window (e.g., to the space outside of a building). For example, heat may be vented from inside the window to outside of the window, if the inside of the window is warmer than desired. U.S. Pat. No. 4,577,619, of Howe, and international patent publication no. WO 2008/095502, of Arndt, each describes a double pane window configured to transfer heated air into a building, or out from a building.

[0005] While a number of double pane windows have been developed to use light for electricity generation, and for moving heated air, window designers and manufacturers continue to strive to develop new windows configured for electricity generation, heat transfer, and the like where a relatively higher percentage of received electromagnetic radiation is for usable energy generation compared to known windows.

BRIEF SUMMARY OF THE INVENTION

[0006] The present invention generally relates to windows and walls for buildings. More particularly the present invention relates to window and walls configured to cool an environment adjacent to the window or the wall from heat collected by the window or the wall via an adsorption-cooling system integrally formed with the window or the wall.

[0007] According to one embodiment of the present invention, a window configured to cool an environment includes first and second panes disposed opposite from one another, and a frame coupled to the first and the second panes to form an air gap between the first pane, the second pane, and the frame. The window further includes first and second reflective coatings respectively disposed on first surfaces of the first and the second panes. The first surfaces face the air gap, and the reflective coatings are configured to reflect infrared radiation into the air gap to generate heated air in the air gap. The window further includes first and second antireflective coatings respectively disposed on second surfaces of the first and the second panes. The second surfaces face away from the air gap, and the antireflective coatings are configured to transmit visible light and infrared radiation into the air gap. The window further includes an adsorption-cooling systems configured to collect heat from the air gap to cool air in an environment adjacent to the second pane.

[0008] According to one specific embodiment of the window, the adsorption-cooling system includes an adsorption-desorption chamber configured to house an adsorption unit, a condenser, and a heat-exchanger unit. The adsorption unit is configured to adsorb a refrigerant in gas form in the adsorption-desorption chamber to cool the heat-exchanger unit, which is configured to be at least partially submerged in the refrigerant in liquid form, to cool the environment. The adsorption unit includes a pipe and an adsorbent coupled to the pipe, an ambient-temperature heat-transfer fluid is configured to flow in the pipe to cool the adsorbent to effect adsorption of the refrigerant in gas form and enhance evaporation of the refrigerant into gas to cool the heat exchanger unit, and the cooled heat exchanger unit is configured to cool the environment. If the ambient-temperature heat-transfer fluid is configured not to flow in the pipe, then a heated heat-transfer fluid heated in the air gap is configured to flow in the pipe to heat the adsorbent to effect desorption of the refrigerant into gas form. If the heated heat-transfer fluid is configured to flow in the pipe, then the ambient-temperature heat-transfer fluid is configured to flow in the condenser to condensate the refrigerant from gas from into liquid form.

[0009] According to another specific embodiment of the window, the window further includes an electrical generator disposed in the air gap to convert electromagnetic radiation to electricity. The adsorption-cooling system further includes a set of pumps configured to pump the ambient-temperature heat-transfer fluid, the heated heat-transfer fluid, and a heat-transfer fluid in the heat-exchanger unit. The electrical generator is coupled to the set of pumps to provide power to the set of pumps to drive the set of pumps.

[0010] According to another specific embodiment of the window, the heat exchanger unit includes a radiator configured to adsorb heat from the environment to cool the environment. The window may further include a circuit configured to control the operation of the set of pumps.

[0011] According to another specific embodiment of the window, the electrical generator includes a set of photovoltaic panels. The window may include a set of louvers in the air gap, wherein the set of photovoltaic panels is coupled to the set of louvers. The louvers in the set of louvers may be octagonal.

[0012] According to another embodiment of the present invention, a window configured to cool an environment includes first and second panes disposed opposite from one another, and a frame coupled to the first and the second panes to form an air gap between the first pane, the second pane, and the frame. The window includes first and second reflective coatings respectively disposed on first surfaces of the first and second panes. The first surfaces face the air gap, and the reflective coatings are configured to reflect infrared radiation into the air gap to generate heated air in the air gap. The window further includes first and second antireflective coatings respectively disposed on second surfaces of the first and the second panes. The second surfaces face away from the air gap, and the antireflective coatings are configured to transmit visible light and infrared radiation into the air gap. The window further includes an adsorption-cooling systems configured to collect heat from the air gap to cool air in an environment adjacent to the second pane, wherein the adsorption-cooling system includes a first adsorption-desorption chamber and a second adsorption-desorption chamber, and the first and the second adsorption-desorption chambers are configured to operate a cooling cycle temporally out of phase with each another.

[0013] According to a specific embodiment, the window further includes a heat-collection unit configured to collect heat from the air gap and transfer the heat to a heat-transfer fluid in the heat collection unit for use by the first and the second adsorption-desorption chambers to cool the environment. The first adsorption-desorption chamber includes a first adsorption unit, a first condenser, and a first heat-exchanger unit, and the second adsorption-desorption chamber includes a second adsorption unit, a second condenser, and a second heat-exchanger unit. The adsorption-cooling systems include a radiator coupled to the first and the second heat-exchanger units. The first adsorption unit is configured to adsorb a refrigerant in gas form in the first adsorption-desorption chamber to cool the first heat-exchanger unit to cool the environment, and wherein the second adsorption unit is configured to adsorb a refrigerant in gas form in the second adsorption-desorption chamber to cool the second heat-exchanger unit to cool the environment.

[0014] According to a specific embodiment, the first-adsorption unit includes a first pipe and a first adsorbent coupled to the first pipe. An ambient-temperature heat-transfer fluid is configured to flow in the first pipe to cool the first adsorbent to effect adsorption of the refrigerant in gas form and enhance evaporation of the refrigerant into gas to cool the first heat-exchanger unit. The first cooled heat-exchanger unit is configured to cool the environment. The second-adsorption unit includes a second pipe and a second adsorbent coupled to the second pipe. The ambient-temperature heat-transfer fluid is configured to flow in the second pipe to cool the second adsorbent to effect adsorption of the refrigerant in gas form and enhance evaporation of the refrigerant into gas to cool the second heat exchanger unit. The second cooled heat exchanger unit is configured to cool the environment.

[0015] If the ambient-temperature heat-transfer fluid is configured not to flow in the first pipe, then a heated heat-transfer fluid heated in the air gap is configured to flow in the first pipe to heat the first adsorbent to effect desorption of the refrigerant into gas form. If the heated heat-transfer fluid is configured to flow in the first pipe, then the ambient-temperature heat-transfer fluid is configured to flow in the first condenser to condensate the refrigerant from gas from into liquid form. If the ambient-temperature heat-transfer fluid is configured not to flow in the second pipe, then a heated heat-transfer fluid heated in the air gap is configured to flow in the second pipe to heat the second adsorbent to effect desorption of the refrigerant into gas form. If the heated heat-transfer fluid is configured to flow in the second pipe, then the ambient-temperature heat-transfer fluid is configured to flow in the second condenser to condensate the refrigerant from gas from into liquid form.

[0016] According to a specific embodiment, the window further includes an electrical generator disposed in the air gap configured to convert electromagnetic radiation to electricity;

[0017] wherein the adsorption-cooling system further includes a set of pumps configured to pump the ambient-temperature heat-transfer fluid, the heated heat-transfer fluid, and a heat-transfer fluid in the first and the second heat-exchanger units, and wherein the electrical generator is coupled to the set of pumps to provide power to the set of pumps to drive the set of pumps. The window may further include a circuit configured to control the operation of the set of pumps. The electrical generator includes a set of photovoltaic panels, which may be mounted on a set of louvers in the air gap. The louvers may be octagonal.

[0018] According to one embodiment of the present invention, a wall is configured to cool an environment adjacent to the wall and includes a pane configured to receive radiation, and a wall disposed adjacent to the pane. The wall further includes a frame coupled to the pane and the wall to form an air gap between the pane, the wall, and the frame. The wall further includes a reflective coating disposed on a first surface of the pane, wherein the first surface faces the air gap, and the reflective coating is configured to reflect infrared radiation into the air gap to generate heated air in the air gap. The wall further includes an antireflective coating disposed on second surfaces of the pane, wherein the second surface faces away from the air gap, and the antireflective coating is configured to transmit visible light and infrared radiation into the air gap. The wall further includes an adsorption-cooling system configured to collect heat from the air gap to cool air in an environment adjacent to the wall.

[0019] According to a specific embodiment of the wall, the adsorption-cooling system includes an adsorption-desorption chamber configured to house an adsorption unit, a condenser, and a heat-exchanger unit. The adsorption unit is configured to adsorb a refrigerant in gas form in the adsorption-desorption chamber to cool the heat-exchanger unit, which is configured to be at least partially submerged in the refrigerant in liquid form, to cool the environment. The adsorption unit includes a pipe and an adsorbent coupled to the pipe, an ambient-temperature heat-transfer fluid is configured to flow in the pipe to cool the adsorbent to effect adsorption of the refrigerant in gas form and enhance evaporation of the refrigerant into gas to cool the heat exchanger unit, and the cooled heat exchanger unit is configured to cool the environment. If the ambient-temperature heat-transfer fluid is configured not to flow in the pipe, then a heated heat-transfer fluid heated in the air gap is configured to flow in the pipe to heat the adsorbent to effect desorption of the refrigerant into gas form, and if the heated heat-transfer fluid is configured to flow in the pipe, then the ambient-temperature heat-transfer fluid is configured to flow in the condenser to condensate the refrigerant from gas from into liquid form.

[0020] According to another specific embodiment of the wall, the wall further includes an electrical generator disposed in the air gap configured to convert electromagnetic radiation to electricity; wherein the adsorption-cooling system further includes a set of pumps configured to pump the ambient-temperature heat-transfer fluid, the heated heat-transfer fluid, and a heat-transfer fluid in the heat-exchanger unit, and wherein the electrical generator is coupled to the set of pumps to provide power to the set of pumps to drive the set of pumps. The heat exchanger unit includes a radiator configured to adsorb heat from the environment to cool the environment. The wall may further include a circuit configured to control the operation of the set of pumps. According to one embodiment, the wall includes a window.

[0021] These and other benefits of the embodiments of the present invention will be more fully understood and appreciated from further review of the following specification and attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] FIG. **1** is a simplified plan view of a window according to an embodiment of the present invention where the window is configured to cool an environment adjacent to the window;

[0023] FIG. **2**A is a cross-sectional view of a window according to one embodiment of the present invention;

[0024] FIG. **2**B is a cross-sectional view of a window according to one embodiment of the present invention;

[0025] FIG. **2**C is a cross-sectional view of a wall according to one embodiment of the present invention;

[0026] FIG. **3**A is a simplified perspective view of a louver having a plurality of photovoltaic panels formed therein according to an alternative embodiment of the present invention;

[0027] FIG. **3**B is a simplified side view of a set of louvers according to another embodiment of the present invention;

[0028] FIGS. **3**C-**3**F are simplified schematics of various shaped inserts that may be inserted in the air gap onto which photovoltaic panels may be attached;

[0029] FIG. **4** is a simplified schematic of the window and shows an overview of the cooling operation of the window to cool an environment adjacent to the window;

[0030] FIG. **5** is a simplified schematic of an adsorption-cooling system according to one embodiment of the present invention;

[0031] FIG. **6** is a high-level flow diagram of a cooling method of the adsorption-cooling system of the window; and

[0032] FIG. **7** is a simplified schematic of a cooling system that includes set of windows configured to cool an environment adjacent to the window.

DETAILED DESCRIPTION OF THE INVENTION

[0033] The present invention generally provides a window. More particularly embodiments of the present invention provide a window configured to cool an environment adjacent to the window from heat collected by the window.

[0034] FIG. **1** is a simplified plan view of a window **100** according to an embodiment of the present invention. Window **100** may be a multiple-pane window according to one embodiment of the present invention. A multiple-pane window as referred to herein includes two or more panes. According to one embodiment of the present invention, window **100** is configured to cool a space on the "inside" of the window, for example, if the inside of the window is warmer than desired. The "inside" of the window, as referred to herein, includes a room or the like in a building in which the window is installed. The term "interior" of the window, as referred to herein, includes portions of the window itself, such as the interior space between the panes of the window, or an interior space in the window's frame **105**.

[0035] According to one embodiment of the present invention, window **100** includes an adsorption-cooling system **110** that is configured to perform the cooling function of window **100**. Adsorption-cooling system **110** is configured to use "heated" water generated by window **100** to drive the adsorption-cooling system to cool the inside of a window (i.e., a room on the inside of a building or the like). The generation of heated water by window **100** is described below in detail. While window **100** is described herein as being configured to generate heated water for use in the adsorption-cooling system, window **100** may be configured to heat other substances for use in the adsorption-cooling system that have relatively high thermal capacity and relatively high thermal conductivity, such as alcohol or the like.

[0036] FIG. **2**A is a cross-sectional view of window **100** according to one embodiment of the present invention. Window **100** may include a first pane **205** and a second pane **210**. The panes may be glass, plastic, or the like. The first pane and the second pane may be coupled by a frame **215**. Frame **215** may be composed of various materials, such as wood, plastic, vinyl, glass, composite material, or other materials and may contain the adsorption-cooling system **110**. The first pane, the second pane, and the frame may be arranged to form an air gap **220**, which is between the panes and the frame.

[0037] According to a specific embodiment of the present invention, an outside surface **205***a* of first pane **205** and an outside surface **210***a* of second pane **210** are coated with an antireflection coating **225***a*. Antireflection coating **225***a* may be configured to provide transmission of a relatively broad spectrum of electromagnetic radiation, such as infrared (IR) radiation, visible light, ultraviolet (UV) light, and the like.

[0038] According to a further embodiment, an inside surface **205***b* of first pane **205** and an inside surface **210***b* of second pane **210** are coated with an antireflection coating **225***b*. Antireflection coating **225***b*, similar to antireflection coating **225***a*, may be configured to provide transmission of a relatively broad spectrum of electromagnetic radiation, such as infrared (IR) radiation, visible light, ultraviolet (UV) light, and the like.

[0039] According to another specific embodiment of the present invention, a reflective coating **230** is disposed on antireflection coatings **225***b* on both panes **205** and **210**. Alternatively, reflective coatings **230** may be disposed on the surfaces **205***b* and **210***b*, and antireflection coatings **225***b* may be disposed on the reflective coatings. Reflective coatings **230** may be configured to reflect one or more select bandwidths of electromagnetic radiation. For example, reflective coatings **230** may be configured to reflect IR radiation. Providing for the transmission (i.e., antireflection) of electromagnetic radiation at surfaces **205***a*, **205***b*, **210***a*, and **210***b*, and for the reflection of IR radiation at surfaces **205***b* and **210***b* into air gap **220** provides for the collection of energy in the air gap. Thereby, the first and the second panes provide for the accumulation of heat relatively efficiently within air gap **220**. Antireflection coatings **225***a* and **225***b*, and reflective coating **230** may include traditional dielectric layers, or may include other materials, such as relatively thin polymer (e.g., silicone) rubber strips or sheets, which provide transparency and the desired antireflective and reflective properties, where the polymer rubber strips may also be photovoltaic. For convenience, antireflection coatings **225***a* and **225***b*, and reflective coatings **230**, and other elements of window **100** are not drawn to scale.

[0040] Window **100** may include a set of photovoltaic panels **240** where the photovoltaic panels are disposed in air gap **220**. According to one embodiment, the photovoltaic panels may be relatively thin panels. For example, the photovoltaic panels may be about 200 micrometers or less thick from front to back (e.g., from A-A). The photovoltaic panels may be configured to convert electromagnetic radiation striking the photovoltaic panels into electricity. The electricity may be configured to be directed to various electrical components inside the window (e.g., a room in a building directly adjacent to the second pane), outside the window for external use, or in the interior of the window. For example, the electricity generated by the set of photovoltaic panels **240** may be directed to a set of pumps **242** (see FIG. **1**, where each pump in the set of pumps **242** is labeled with the base reference numeral **242** and an alphabetic suffix) configured to pump heated and cooled water through the set of adsorption-cooling systems.

[0041] The set of photovoltaic panels may be coupled to a set of louvers **245**. The coupling may be one-to-one or one-to-many. That is, one photovoltaic panel may be coupled to one louver, or a plurality of photovoltaic panels may be coupled to one louver. The louvers may be formed of a variety of materials, such as plastic, wood, glass, composite material, or the like. The set of photovoltaic panels may be mechanically coupled to the louvers, chemically coupled to the louvers (e.g., glued, epoxied, etc.), or the like. The photovoltaic panels may be coupled to the louvers at a fixed position or may be configured to be rotatable with respect to the louvers. Those of skill in the art will know how to couple the photovoltaic panels to the louvers so that the photovoltaic panels may be rotatable with respect to the louvers. Antireflection coatings **225***a* and **225***b* provide that a relatively high percentage of received electromagnetic radiation (as compared to known windows) is transmitted through the panes to the photovoltaic panels for relatively high electricity generation rates. Window **100** may include any of the window features of the windows described in U.S. patent application Ser. No. 12/563,052, filed Sep. 18, 2009, titled "Solar Window Apparatus and Method," of Narinder Singh Kapany and U.S. patent application Ser. No. 12/720,982, filed Mar. 10, 2010, of titled "Solar Window Component," of Narinder Singh Kapany, both of which is incorporated by reference herein in their entireties for all purposes.

[0042] FIG. **2**B is a cross-sectional view of a window **100'** according to one embodiments of the present invention. Window **100'** is substantially similar to window **100** and is configured to perform the same cooling operation as window **100** described herein. Window **100'** differs from window **100** described above in that window **100'** includes a third pane **280** disposed adjacent to second pane and may cover the frame. Third pane **212** may be configured to inhibit heat from the entering inside the window and may inhibit burns to a person touching the window or frame from heat build up therein. The third pane may be shaped (e.g., to include apertures formed therein) to allow air to pass through various openings and air vents described above with respect to the description of window **100**.

[0043] FIG. **2**C is a cross-sectional view of a wall **101** according to some embodiments of the present invention. Wall **101** is configured to cool the inside of the wall (i.e., a room in a building on which wall **101** is mounted) similarly to windows **100** and **100'** described above. Wall **101** differs from windows **100** and **100'** described above in that wall **101** includes a back wall **285** configured to be coupled to a wall of a building **287**. Wall **101** may include a number of sets of pipes **295** for collecting heat in air gap **220**. The sets of pipes may be disposed in various places in air gap **220**, such as on back wall **285**, suspended in the air gap, disposed on first pane **205**, etc. According to some embodiment, wall **101** includes a window formed therein, such as window **100** or window **100'** described above. An aperture may be formed in wall **101** for receiving a window.

[0044] FIG. **3**A is a simplified perspective view of a louver **245***a* having a plurality of photovoltaic panels **240***a* formed therein according to an alternative embodiment of the present invention. While louver **245***a* is shown as including a plurality of photovoltaic panels therein, the louver may alternatively include a single photovoltaic panel. According to one embodiment, each photovoltaic panel is backed with an absorption coating **247**. The absorption coatings are configured to absorb electromagnetic radiation passing through the photovoltaic panel and convert the absorbed electromagnetic radiation to heat in the air gap.

[0045] According to one embodiment, the louvers may be configured to be rotated to provide optimal expose of the photovoltaic panels to electromagnetic radiation striking these photovoltaic panels. Optimal exposure includes a position at which the photovoltaic panels generate a substantial maximum power output for electromagnetic radiation received by the photovoltaic panels. For example, a position at which the louvers are oriented for optical expose to electromagnetic radiation is often ninety degrees. That is, the incoming electromagnetic radiation strikes the photovoltaic panel at ninety degrees. The louvers may be configured to be manually rotated by a user, or rotated automatically by one or more motor or the like (not shown). The window may include a detector circuit configured to determine if the photovoltaic panels are optimally positioned with respect to the electromagnetic radiation, and to control the one or motor to adjust the angle of the louvers until the photovoltaic panels are optimally oriented.

[0046] FIG. **3**B is a simplified side view of a set of louvers **300** according to another embodiment of the present invention. Each louver has an octagonal shape where photovoltaic panels **305** are disposed on a first angled surface **310** and a second angled surface **320**. The octagonal louvers may be vertically oriented in window **100** or horizontally oriented in the window. According to a set of alternative embodiments, various shaped inserts may be in air gap **220** in window **100** onto which photovoltaic panels may be attached. FIGS. **3**C-**3**F are simplified schematics of various shaped inserts that may be inserted in air gap **220** onto which the photovoltaic panels may be attached. The various insert shape may include octagonal shaped grids, hexagonal shaped grids, square grids, rectangular grinds, etc.

[0047] According to one embodiment, window **100** has a first opening **250** formed therein at a bottom portion, and has a second opening **255** formed therein at a top portion. First opening **250** may be between air gap **220** and the inside of the window. That is, the first opening may be toward a room in a building. Second opening **255** may be between air gap **220** and the inside of the window and/or the outside of the window. That is, the second opening may be toward a room in a building and/or to the outside of a building.

[0048] According to one embodiment, window **100** may include a first shutter **260***a* and/or a second shutter **260***b* that may be position at opening **255**. First shutter **260***a* may be positioned toward the outside of the window to regulate the flow of air through opening **255** to the outside of a building. Second shutter **260***b* may be positioned toward the inside of the window to regulate the flow of air through opening **255** to the inside of a building. The shutters may be configured to be manually opened and closed by a human user, and/or may be configured to be opened and closed by a thermostat **265**. The thermostat may be a mechanical device (such as a bimetal spring), an electronic device, an electro-mechanical device, or the like. The thermostat may be configured to be set at a given temperature at which one or both of the first and the second shutters may be opened or closed. For example, the thermostat may be configured to open a first shutter **260***a* and close a second shutter **260***b* if the temperature inside a room is say 75 degrees or greater. With the first shutter open, and the second shutter closed warm air is allowed to flow upward from first opening **250** from the room, and outward from second opening **255** out of the room. Thereby, heat collected in the air gap is limited from flowing into the room. This example operation of the thermostat and shutters provides that if the room becomes warmer than desired (e.g., say 75 degrees or greater), the window may vent heat from inside a room in a building to outside of the building. Alternatively, if a room is colder than desired, then first shutter **260***a* may be closed by the thermostat, and second shutter **260***b* may be opened by the thermostat thereby allowing warm air, which has accumulated inside the air gap, to enter the room. That is, cool air from inside a room may flow through first opening **250**, warm in the air gap, and exit into the room through second opening **255**.

[0049] According to another embodiment, a set of fans **270** is disposed in the air gap and/or adjacent to one or both of the openings to push air inside the air gap out through second opening **355** into the room or out from the room. The set of fans may be configured to operate in conjunction with the first and the second shutters to move air into the room or move air out from the room. The set of fans **270** may be electrically coupled to the set of photovoltaic panels to draw electricity there from for operation. The fan might alternatively be coupled to an external power source. The set of fans may be configured to power on and off under control of the thermostat. The window may include one or more filters **275** disposed in the air gap and/or in one or both of the first and the second openings to filter the air that passes into the air gap and/or out from the air gap. The filters may be configured to keep the inner surfaces of the panes clean by removing particulate matter in the air that moves through air gap **220**.

[0050] According to another embodiment, window **100** includes a fluid-heating unit **290**, such as a water-heating unit. While FIG. **2** shows a portion of fluid-heating unit **290** at the top of the window and the bottom of the window, other embodiments of window **100** may include only the top portion of the fluid-heating unit or may include the bottom portion of the fluid-heating unit. Fluid-heating unit **290** may be disposed in the air gap, adjacent to the air gap in frame **105** of the window, or in the air gap and adjacent to the air gap to collect the heat therein to heat a heat-transfer fluid in the fluid-heating unit **290**. More specifically, heat in the air gap may heat a set of pipes **295** included in the fluid-heating unit **290** to thereby heat the heat-transfer fluid in the set of pipes. According to one embodiment of the present invention, the heat-transfer fluid is water. The set of pipes **295** may provide a substantially optimal surface area for absorbing heat into the heat-transfer fluid. The set of pipes may be colored (e.g., colored black) to absorb light for conversion to heat. The set of pipes might additionally be coated with an antireflection coating, such as antireflection coating **125***a* described above, to substantially optimize the absorption of light and/or infrared radiation. The set of pipes may also be composed of a material, such as copper, having a relatively large thermal conductivity so that heat collected by the set of pipes is relatively efficiently transferred to the heat-transfer fluid.

[0051] According to one embodiment, the set of pipes **295** generate heated heat-transfer fluid for the adsorption-cooling system. According to one embodiment, pump **242***a* in the set of pumps **242** is configured to pump the heat-transfer fluid through the set of pipes **295**. Each pump may be a 12V DC pump. According to one alternative embodiment, water may be fed into fluid-heating unit **290** from outside the window and dispensed from window for external use.

[0052] FIG. **4** is a simplified schematic of window **100** and provides an overview of the cooling operation of window **100**. FIG. **4** shows the adsorption-cooling system **110** coupled to the set of pipes **295** where the pipes carry the heat-transfer fluid from the air gap to the adsorption-cooling system and carry the heat-transfer back from the adsorption-cooling system to the air gap. The heat-transfer fluid may be pumped from the set of pipes **295** to the adsorption-cooling system via pump **242***a*. According to one embodiment of the present invention, window **100** also includes an ambient-temperature fluid-storage container **400**, which is configured to provide an ambient-temperature heat-transfer fluid (e.g., water) to the adsorption-cooling system via a set of pipes **405** (also see FIG. **1**). The pipes in the set of pipes **405** may be copper or other material having a relatively high thermal conductivity. The ambient-temperature heat-transfer fluid from the ambient-temperature fluid-storage container may be pumped to the adsorption-cooling system via pump **242***b*. For simplification of the current description of the overview of the cooling operation of window **100**, pump **242***c* is not shown in FIG. **4**. Based on the alternating and repeating cycling of pumping heated heat-transfer fluid and thereafter pumping ambient-temperature heat-transfer fluid in the adsorption-cooling system, the adsorption-cooling system cools the ambient-temperature air **410** in the room to provide relatively cooled air **420**.

[0053] FIG. **5** is a simplified schematic of an adsorption-cooling system **110'** according to one embodiment of the present invention. The differences between adsorption-cooling system **110'** and adsorption-cooling system **110** are described below. While window **100** is described as including adsorption-cooling system **110**, window **100** may alternatively include adsorption-cooling system **110'**. The adsorption-cooling system is coupled to the set of pipes **295**, which provides a heat-transfer fluid inlet **500** and a heat-transfer fluid outlet **505** to the adsorption-cooling system. The adsorption-cooling system is also coupled to the set of pipes **405**, which provides an ambient-temperature heat-transfer-fluid inlet **510** and an ambient-temperature heat-transfer-fluid outlet **515** to the adsorption-cooling system. The adsorption-cooling system may include a first set of control valves **520** and a second set of control valves **525** configured to control the flow of heated water and ambient-temperature water through the heated water inlet, the heated water outlet, the ambient-temperature water inlet, and the ambient-temperature water outlet. The first and the second sets of control valves may be controlled by a circuit **527** to control the flow of the heated water or the ambient-temperature water through the adsorption-cooling system. Circuit **527** may include an integrated circuit configured to control the timed operation of the first and the second sets of control valves. Circuit **527** may include a programmable-integrated circuit (such as a field programmable gate array (FPGA), a programmable logic device (PLD), a microcontroller, etc), an application specific integrated circuit (ASIC), etc. Circuit **527** may also be configured to control the timed operations of the set of pumps **242**.

[0054] Adsorption-cooling system **110'** may also include adsorption-desorption chamber **530**, an adsorption unit **535**, a condenser **540**, and a heat-exchanger unit **545**. Adsorption-cooling system **110'** differs from adsorption-cooling system **110**, in that adsorption-cooling system **110** includes two adsorption-desorption chambers **530***a* and **530***b*, whereas adsorption-cooling system **110'** includes one adsorption-desorption chamber. The routing of the set of pipes in adsorption-cooling systems **110** and **110'** also differ. The purpose for the difference in the routing of the set of pipes will be readily apparent to those of skill in the art and is not described in detail herein. Adsorption-desorption chamber **530** is a substantially sealed chamber and forms essentially the main body of adsorption-cooling system **110'**. The adsorption-desorption chamber includes at least a portion of each of the adsorption unit, the condenser, and the heat-exchanger unit. The adsorption-desorption chamber is also configured to house the refrigerant **550** for the adsorption-cooling system. The refrigerant is described herein as being water, but may be another substance or may include a mix of substances. A variety of gases (e.g., air, helium, etc.) may be housed in the adsorption-desorption chamber to regulate the vapor pressure of the refrigerant and regulate the partial pressure of the refrigerant in gaseous form to optimize the cooling, optimize efficiency, etc.

[0055] According to one embodiment, the adsorption unit **535** includes at least one pipe **535***a* (e.g., a copper pipe), which is coupled to the first and the second sets of control valves for directing heated heat transfer fluid or ambient-temperature heat-transfer fluid through the adsorption-desorption chamber. The adsorption unit also includes an adsorbent **535***b*, which is coupled to a portion of pipe **535***a* inside the adsorption-desorption chamber. Adsorbent **535***b* is configured to adsorb the refrigerant and desorb the refrigerant from the atmosphere surrounding the adsorbent. The adsorbent may be any material that is configured to adsorb and desorb the refrigerant. According to one particular embodiment, adsorbent **535***b* is silica gel. Silica gel, as is well known in the art, is configured to adsorb water (an example refrigerant) from a surrounding atmosphere at temperatures up to 200° F. at one atmosphere of pressure and is configured to desorb water at a higher temperature at one atmosphere of pressure. The temperature range for water adsorption and desorption of silica gel may be varied by varying the local atmospheric pressure in the adsorption-desorption chamber. Heated heat-transfer fluid passing through pipe **535***a* is configured to transfer heat to adsorbent **535***b* to effect desorption of the refrigerant by the adsorbent. Ambient-temperature heat-transfer fluid passing through pipe **535***a* is configured to absorb heat from adsorbent **535***b* to effect adsorption of the refrigerant by the adsorbent. Condenser **540** may be a coil or other useful shape.

[0056] According to one embodiment, heat-exchanger unit **545** includes a pipe **545***a* (e.g., a copper pipe), which includes a coil portion **545***b* ("coil") that is disposed inside the adsorption-desorption chamber. Heat-exchanger unit **545** also includes a radiator **545***c* (sometimes referred to as a heat exchanger), which is disposed outside of the adsorption-desorption chamber. The heat exchange unit is disposed inside the window (e.g., in a room of a building) to cool the inside of the window. Radiator **545***c* may be disposed on a surface of frame **105** of window **100** where the surface of the frame and the radiator face the inside of the window. Coil **545***b* is configured to be partially disposed in refrigerant **535***b* with a top portion **545***d* of the coil above the refrigerant level **535***c*.

[0057] FIG. **6** is a high-level flow diagram of a cooling method of the adsorption-cooling system according to one embodiment of the present invention. The high-level flow diagram is exemplary and is not limiting on the claims. Those of skill in the art will understand that steps in the high-level flow diagram may be combined and/or added without deviating from the purview and the scope of the cooling method. Moreover, the ordering of the steps shown in the high-level flow diagram may also be reordered without deviating from the purview and the scope of the cooling method. The reordering of steps will be very well understood by those of skill in the art as cooling methods generally may be described in a variety of orders. At a step **600**, radiation (e.g., light, infrared radiation, etc.) striking the window is substantially optimally transmitted into air gap **220** through first pane **205** and maintained in the air gap by second pane **210** as described above. The light entering the air gap is collected by the photovoltaic panels to generate electricity and is collected in air gap to generate heat to the heat transfer fluid in fluid-heading unit **290** and more specifically in the set of pipes **295**. At a step **605**, the first and the second sets of control valves and pump **242***b* are set by circuit **527** to direct the ambient-temperature heat-transfer fluid through the adsorption unit, and more specifically through pipe **535***a*. At a step **610**, the ambient-temperature heat-transfer fluid in pipe **535***a* cools adsorbent **535***b* to effect adsorption of the refrigerant (e.g., water) into the adsorbent. That is, the adsorbent adsorbs the refrigerant from the air, which is inside adsorption-desorption chamber **530**, if the adsorbent is cooled by the ambient-temperature heat-transfer fluid. Adsorption of the refrigerant (e.g., water) by the adsorbent dries the air in the adsorption-desorption chamber and thereby causes refrigerant in liquid form (e.g., liquid water) in the bottom of the adsorption-desorption chamber to evaporate. Evaporation of the refrigerant from liquid form cools the heat-transfer fluid in the heat-exchanger unit. At a step **615**, the heat-transfer fluid in the heat-exchanger unit that has been cooled in coil **545***b* is pumped from coil **545***b* to the portion of pipe **545***a* that contacts the radiator. At a step **620**, pipe **545***a* and the heat transfer fluid in the heat-exchanger unit are configured to adsorb heat from radiator **545***c* to cool the radiator and thereby cool the atmosphere surrounding the radiator (i.e., the inside of the window). Steps **650**-**620** are generally referred to as the cooling cycle.

[0058] At a step **625**, the first and the second sets of control valves and pump **242***b* (and pump **242***c* according to some embodiments) are set by circuit **527** to direct the heated heat-transfer fluid from pipe **295** into the adsorption unit, and direct ambient-temperature heat-transfer fluid from pipe **405** into the condenser. The heated heat-transfer fluid in adsorption unit **535** heats adsorbent **535***b* causing the adsorbent to desorb the refrigerant adsorbed therein in steps **605** and **610**. The desorbed refrigerant is released into the adsorption-desorption chamber as gaseous refrigerant (e.g., water vapor). At a step **630**, the ambient-temperature heat-transfer fluid in the condenser cools and condenses the gaseous refrigerant back into liquid form, which accumulates at the bottom of the adsorption-desorption chamber. Steps **625-630** are generally referred to as the condensation cycle.

[0059] According to one embodiment, during the condensation cycle pump **242***d* is configured to stop pumping heat-transfer fluid through heat-exchanger unit **545**. According to an alternative embodiment, a first temperature gauge **700** may be disposed in the refrigerant to measure the temperature of the refrigerant, and a second temperature gauge **705** may be disposed inside the window to measure the temperature inside the window (e.g., a room in a building). Circuit **527** may be configured to monitor the output from the first and the second temperature gauges and compare the temperatures. If the temperature inside the window remains higher than the refrigerant during the condensation cycle, circuit **527** may be configured to continue to pump heat-transfer through the heat exchanger. Alternatively, if the temperature inside the window is same as, or lower than, the temperature of the refrigerant during the condensation cycle, circuit **527** may be configured to stop pump **242***d* from pumping heat-transfer fluid through the heat exchanger. According to a further embodiment, temperature gauge **705** may be included in a thermostat **710**, which may be set by a user for turning on and off the adsorption-cooling system at specified temperatures. Circuit **527** may operate in conjunction with the thermostat to control the adsorption-cooling system as will be well understood by those of skill in the art. Steps **600-630** are typically repeated a number of times to cool the inside of a window.

[0060] According to one embodiment of the present invention, if a window **100** includes two or more adsorption-desorption chambers **530***a* and **530***b*, the adsorption-desorption chambers may be configured to operate "out" of synchronization to provide a substantially continuous cooling inside the window. That is, the cooling cycle of the first adsorption-desorption chamber **530***a* may take place while the condensing cycle is taking place in the second adsorption-desorption chamber **530***b*. Further, the condensation cycle in the first adsorption-desorption chamber may take place while cooling cycling is taking place in the second adsorption-desorption chamber.

[0061] FIG. **7** is a simplified schematic of a cooling system **700** according to one embodiment of the present invention. Cooling system **700** includes a set of windows **705**. Each window in the set of windows is labeled with the base reference numeral **705** and an alphabetic suffix. According to one embodiment, the fluid-heating units **290** of the set of windows are coupled together to generate heated water that is fed to a set of adsorption-cooling systems **110** that might be in one of the windows (e.g., window **705***n*), might be external to the set of windows, or might be distributed in the set of windows.

[0062] The foregoing description is not limiting on the claims and variations, which are included in the instant application, will be apparent to those of skill in the art. For example, each of the methods described above for window **100** and **100'** may apply to wall **101**. Therefore, it will be evident that various modifications and changes may be made without departing from the broader spirit and scope of the invention as set forth in the claims and that the invention is intended to cover all modifications and equivalents within the scope of the following claims.

What is claimed is:

1. A window configured to cool an environment adjacent to the window comprising:

first and second panes disposed opposite from one another;

a frame coupled to the first and the second panes to form an air gap between the first pane, the second pane, and the frame;

first and second reflective coatings respectively disposed on first surfaces of the first and the second panes, wherein the first surfaces face the air gap, and the reflective coatings are configured to reflect infrared radiation into the air gap to generate heated air in the air gap;

first and second antireflective coatings respectively disposed on second surfaces of the first and the second panes, wherein the second surfaces face away from the air gap, and the antireflective coatings are configured to transmit visible light and infrared radiation into the air gap; and

an adsorption-cooling system configured to collect heat from the air gap to cool air in an environment adjacent to the second pane.

2. The window of claim **1**, wherein the adsorption-cooling system includes an adsorption-desorption chamber configured to house an adsorption unit, a condenser, and a heat-exchanger unit.

3. The window of claim **2**, wherein the adsorption unit is configured to adsorb a refrigerant in gas form in the adsorption-desorption chamber to cool the heat-exchanger unit, which is configured to be at least partially submerged in the refrigerant in liquid form, to cool the environment.

4. The window of claim **3**, wherein:

the adsorption unit includes a pipe and an adsorbent coupled to the pipe,

an ambient-temperature heat-transfer fluid is configured to flow in the pipe to cool the adsorbent to effect adsorption of the refrigerant in gas form and enhance evaporation of the refrigerant into gas to cool the heat exchanger unit, and

the cooled heat exchanger unit is configured to cool the environment.

5. The window of claim **4**, wherein:

if the ambient-temperature heat-transfer fluid is configured not to flow in the pipe, then a heated heat-transfer fluid heated in the air gap is configured to flow in the pipe to heat the adsorbent to effect desorption of the refrigerant into gas form, and

if the heated heat-transfer fluid is configured to flow in the pipe, then the ambient-temperature heat-transfer fluid is configured to flow in the condenser to condensate the refrigerant from gas from into liquid form.

6. The window of claim **5**, further comprising: an electrical generator disposed in the air gap configured to convert electromagnetic radiation to electricity; wherein the adsorption-cooling system further includes a set of pumps configured to pump the ambient-temperature heat-transfer fluid, the heated heat-transfer fluid, and a heat-transfer fluid in the heat-exchanger unit, and wherein the electrical generator is coupled to the set of pumps to provide power to the set of pumps to drive the set of pumps.

7. The window of claim **6**, wherein the heat exchanger unit includes a radiator configured to adsorb heat from the environment to cool the environment.

8. The window of claim **6**, further comprising a circuit configured to control the operation of the set of pumps.

9. The window of claim **6**, wherein the electrical generator includes a set of photovoltaic panels

10. The window of claim 9, further comprising a set of louvers in the air gap, wherein the set of photovoltaic panels is coupled to the set of louvers.

11. The window of claim 10, wherein the louvers in the set of louvers are octagonal.

12. A window configured to cool an environment adjacent to the window comprising:

first and second panes disposed opposite from one another;

a frame coupled to the first and the second panes to form an air gap between the first pane, the second pane, and the frame;

first and second reflective coatings respectively disposed on first surfaces of the first and the second panes, wherein the first surfaces face the air gap, and the reflective coatings are configured to reflect infrared radiation into the air gap to generate heated air in the air gap;

first and second antireflective coatings respectively disposed on second surfaces of the first and the second panes, wherein the second surfaces face away from the air gap, and the antireflective coatings are configured to transmit visible light and infrared radiation into the air gap; and

an adsorption-cooling system configured to collect heat from the air gap to cool air in an environment adjacent to the second pane, wherein the adsorption-cooling system includes a first adsorption-desorption chamber and a second adsorption-desorption chamber, and the first and the second adsorption-desorption chambers are configured to operate a cooling cycle temporally out of phase with each another.

13. The window of claim 12, further comprising a heat-collection unit configured to collect heat from the air gap and transfer the heat to a heat-transfer fluid in the heat collection unit for use by the first and the second adsorption-desorption chambers to cool the environment.

14. The window of claim 12, wherein the first adsorption-desorption chamber includes a first adsorption unit, a first condenser, and a first heat-exchanger unit, and the second adsorption-desorption chamber includes a second adsorption unit, a second condenser, and a second heat-exchanger unit.

15. The window of claim 14, wherein the adsorption-cooling systems include a radiator coupled to the first and the second heat-exchanger units.

16. The window of claim 14, wherein the first adsorption unit is configured to adsorb a refrigerant in gas form in the first adsorption-desorption chamber to cool the first heat-exchanger unit to cool the environment, and wherein the second adsorption unit is configured to adsorb a refrigerant in gas form in the second adsorption-desorption chamber to cool the second heat-exchanger unit to cool the environment.

17. The window of claim 16, wherein:

the first-adsorption unit includes a first pipe and a first adsorbent coupled to the first pipe,

an ambient-temperature heat-transfer fluid is configured to flow in the first pipe to cool the first adsorbent to effect adsorption of the refrigerant in gas form and enhance evaporation of the refrigerant into gas to cool the first heat-exchanger unit,

the first cooled heat-exchanger unit is configured to cool the environment, and wherein:

the second-adsorption unit includes a second pipe and a second adsorbent coupled to the second pipe,

the ambient-temperature heat-transfer fluid is configured to flow in the second pipe to cool the second adsorbent to effect adsorption of the refrigerant in gas form and enhance evaporation of the refrigerant into gas to cool the second heat exchanger unit,

the second cooled heat-exchanger unit is configured to cool the environment.

18. The window of claim 17, wherein:

if the ambient-temperature heat-transfer fluid is configured not to flow in the first pipe, then a heated heat-transfer fluid heated in the air gap is configured to flow in the first pipe to heat the first adsorbent to effect desorption of the refrigerant into gas form,

if the heated heat-transfer fluid is configured to flow in the first pipe, then the ambient-temperature heat-transfer fluid is configured to flow in the first condenser to condensate the refrigerant from gas from into liquid form, and wherein:

if the ambient-temperature heat-transfer fluid is configured not to flow in the second pipe, then a heated heat-transfer fluid heated in the air gap is configured to flow in the second pipe to heat the second adsorbent to effect desorption of the refrigerant into gas form, and

if the heated heat-transfer fluid is configured to flow in the second pipe, then the ambient-temperature heat-transfer fluid is configured to flow in the second condenser to condensate the refrigerant from gas from into liquid form.

19. The window of claim 14, further comprising: an electrical generator disposed in the air gap configured to convert electromagnetic radiation to electricity; wherein the adsorption-cooling system further includes a set of pumps configured to pump the ambient-temperature heat-transfer fluid, the heated heat-transfer fluid, and a heat-transfer fluid in the first and the second heat-exchanger units, and wherein the electrical generator is coupled to the set of pumps to provide power to the set of pumps to drive the set of pumps.

20. The window of claim 19, further comprising a circuit configured to control the operation of the set of pumps.

21. The window of claim 19, wherein the electrical generator includes a set of photovoltaic panels

22. The window of claim 19, further comprising a set of louvers in the air gap, wherein the set of photovoltaic panels is coupled to the set of louvers.

23. The window of claim 22, wherein the louvers in the set of louvers are octagonal.

24. A wall configured to cool an environment adjacent to the wall comprising:

a pane configured to receive radiation;

a wall disposed adjacent to the pane;

a frame coupled to the pane and the wall to form an air gap between the pane, the wall, and the frame;

a reflective coating disposed on a first surface of the pane, wherein the first surface faces the air gap, and the reflective coating is configured to reflect infrared radiation into the air gap to generate heated air in the air gap;

an antireflective coating disposed on second surfaces of the pane, wherein the second surface faces away from the air gap, and the antireflective coating is configured to transmit visible light and infrared radiation into the air gap; and

an adsorption-cooling system configured to collect heat from the air gap to cool air in an environment adjacent to the wall.

25. The wall of claim **24**, wherein the adsorption-cooling system includes an adsorption-desorption chamber configured to house an adsorption unit, a condenser, and a heat-exchanger unit.

26. The wall of claim **25**, wherein the adsorption unit is configured to adsorb a refrigerant in gas form in the adsorption-desorption chamber to cool the heat-exchanger unit, which is configured to be at least partially submerged in the refrigerant in liquid form, to cool the environment.

27. The wall of claim **26**, wherein:

the adsorption unit includes a pipe and an adsorbent coupled to the pipe,

an ambient-temperature heat-transfer fluid is configured to flow in the pipe to cool the adsorbent to effect adsorption of the refrigerant in gas form and enhance evaporation of the refrigerant into gas to cool the heat exchanger unit, and

the cooled heat exchanger unit is configured to cool the environment.

28. The wall of claim **27**, wherein:

if the ambient-temperature heat-transfer fluid is configured not to flow in the pipe, then a heated heat-transfer fluid heated in the air gap is configured to flow in the pipe to heat the adsorbent to effect desorption of the refrigerant into gas form, and

if the heated heat-transfer fluid is configured to flow in the pipe, then the ambient-temperature heat-transfer fluid is configured to flow in the condenser to condensate the refrigerant from gas from into liquid form.

29. The wall of claim **28**, further comprising: an electrical generator disposed in the air gap configured to convert electromagnetic radiation to electricity; wherein the adsorption-cooling system further includes a set of pumps configured to pump the ambient-temperature heat-transfer fluid, the heated heat-transfer fluid, and a heat-transfer fluid in the heat-exchanger unit, and wherein the electrical generator is coupled to the set of pumps to provide power to the set of pumps to drive the set of pumps.

30. The wall of claim **29**, wherein the heat exchanger unit includes a radiator configured to adsorb heat from the environment to cool the environment.

31. The wall of claim **29**, further comprising a circuit configured to control the operation of the set of pumps.

32. The wall of claim **24**, further comprising a window.

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