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(54) **HEATED SOLAR PANEL SYSTEM AND METHOD**

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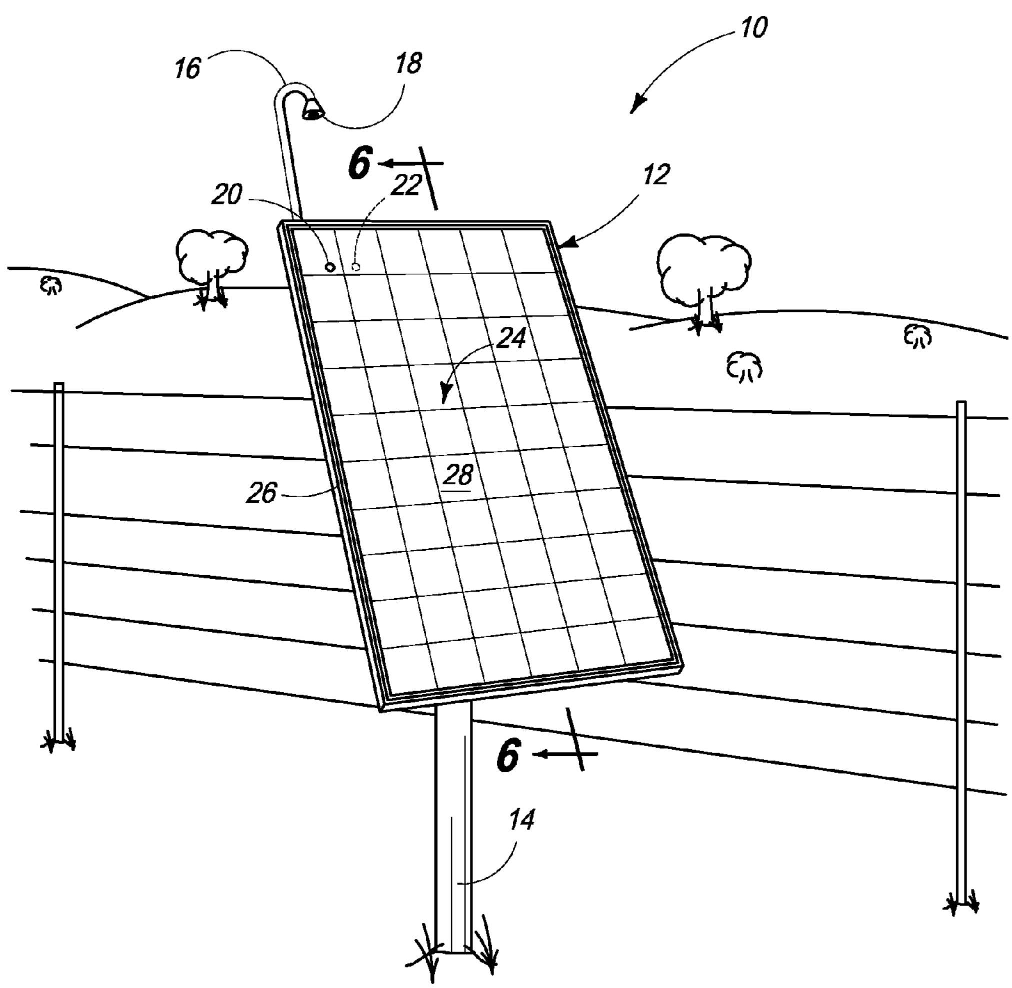
USPC **219/213**

(57) **ABSTRACT**

A solar collection device is provided having a solar panel, a frame, a back panel, and a heat source. The frame is affixed to a rear surface of the solar panel. The back panel is affixed to a rear surface of the frame providing at least one air chamber between the solar panel, the frame, and the back panel. The heat source communicates with the chamber operative to heat the solar panel to melt ice from the solar panel. A method for heating a solar panel is also provided.



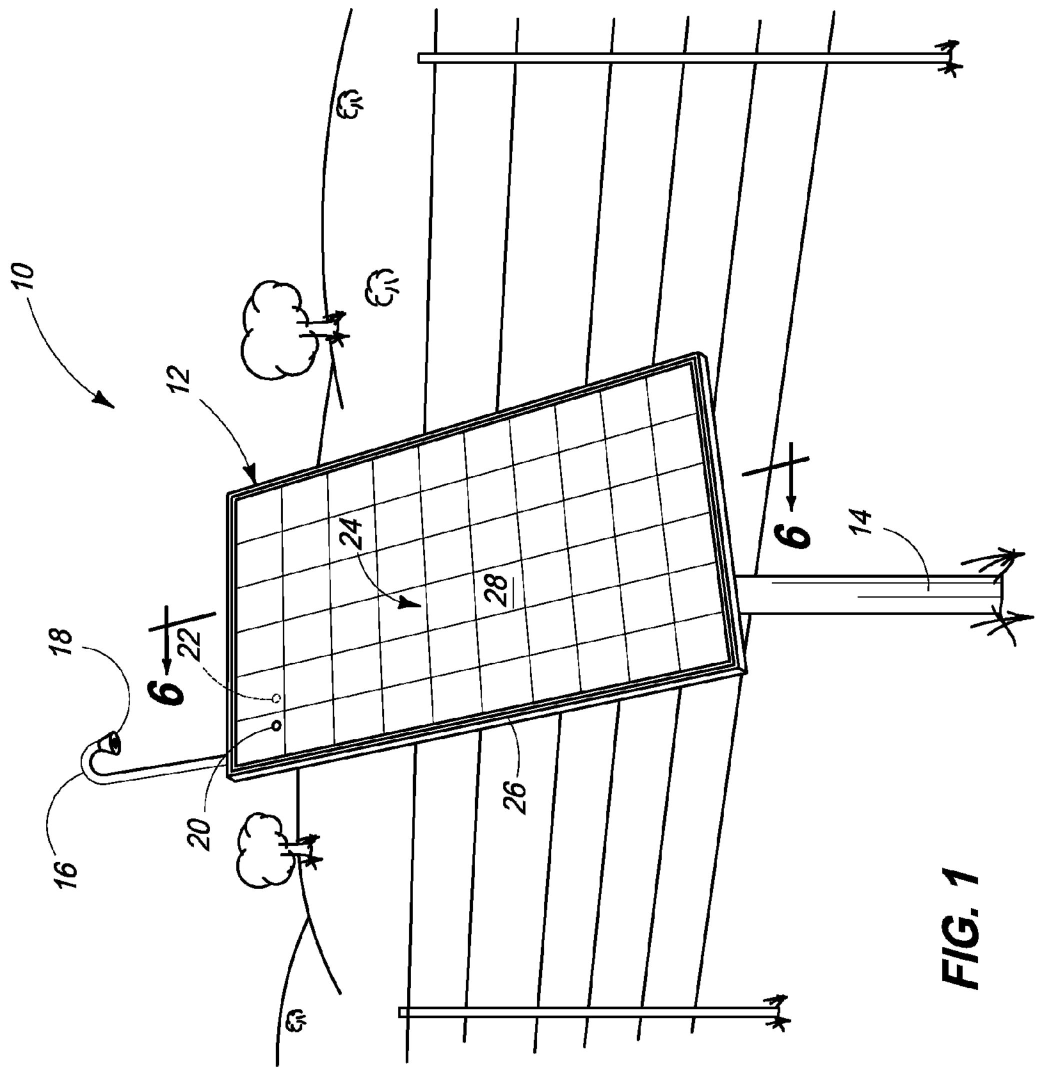


FIG. 1

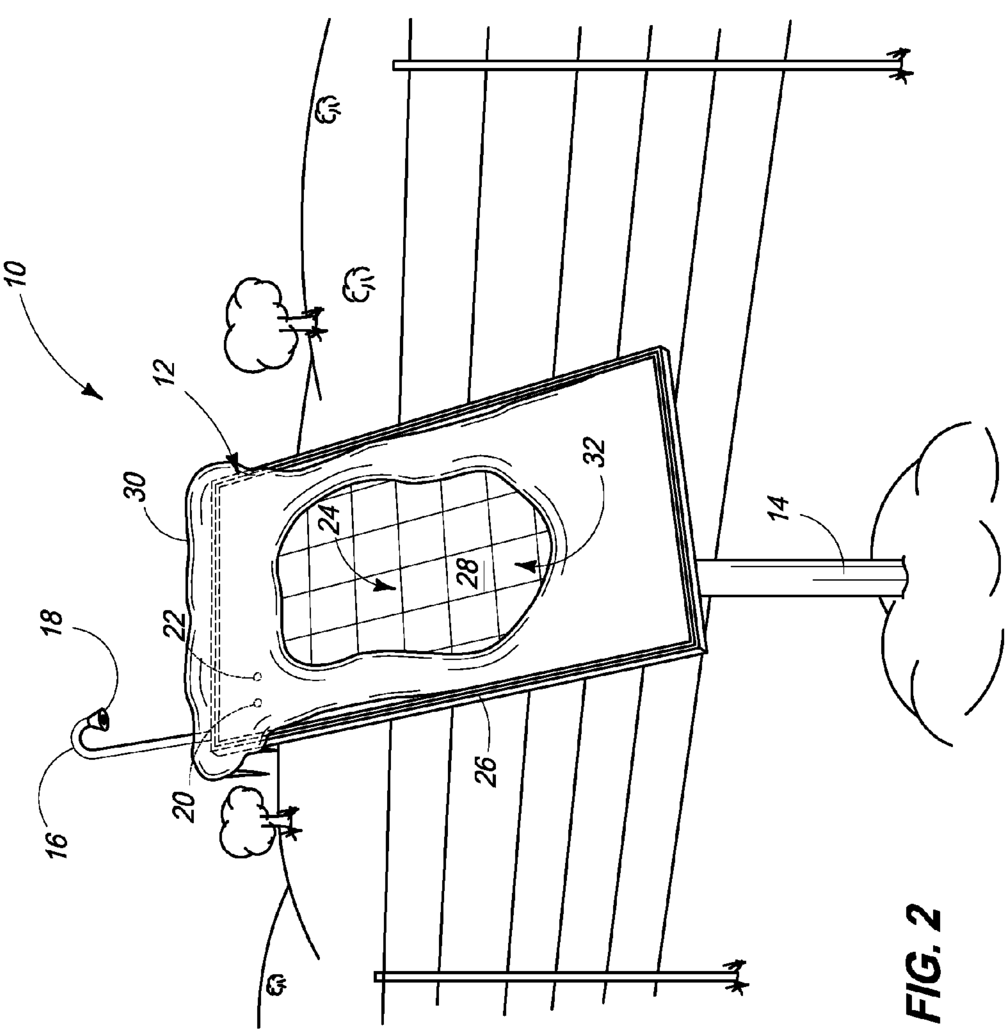


FIG. 2

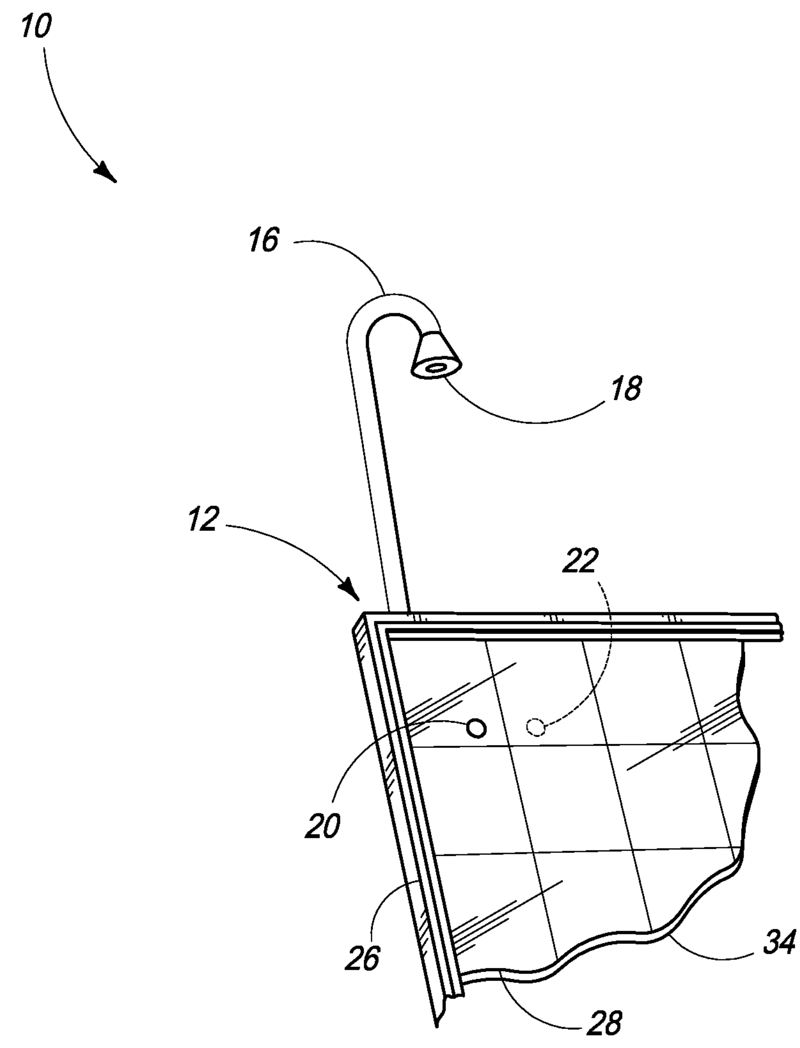
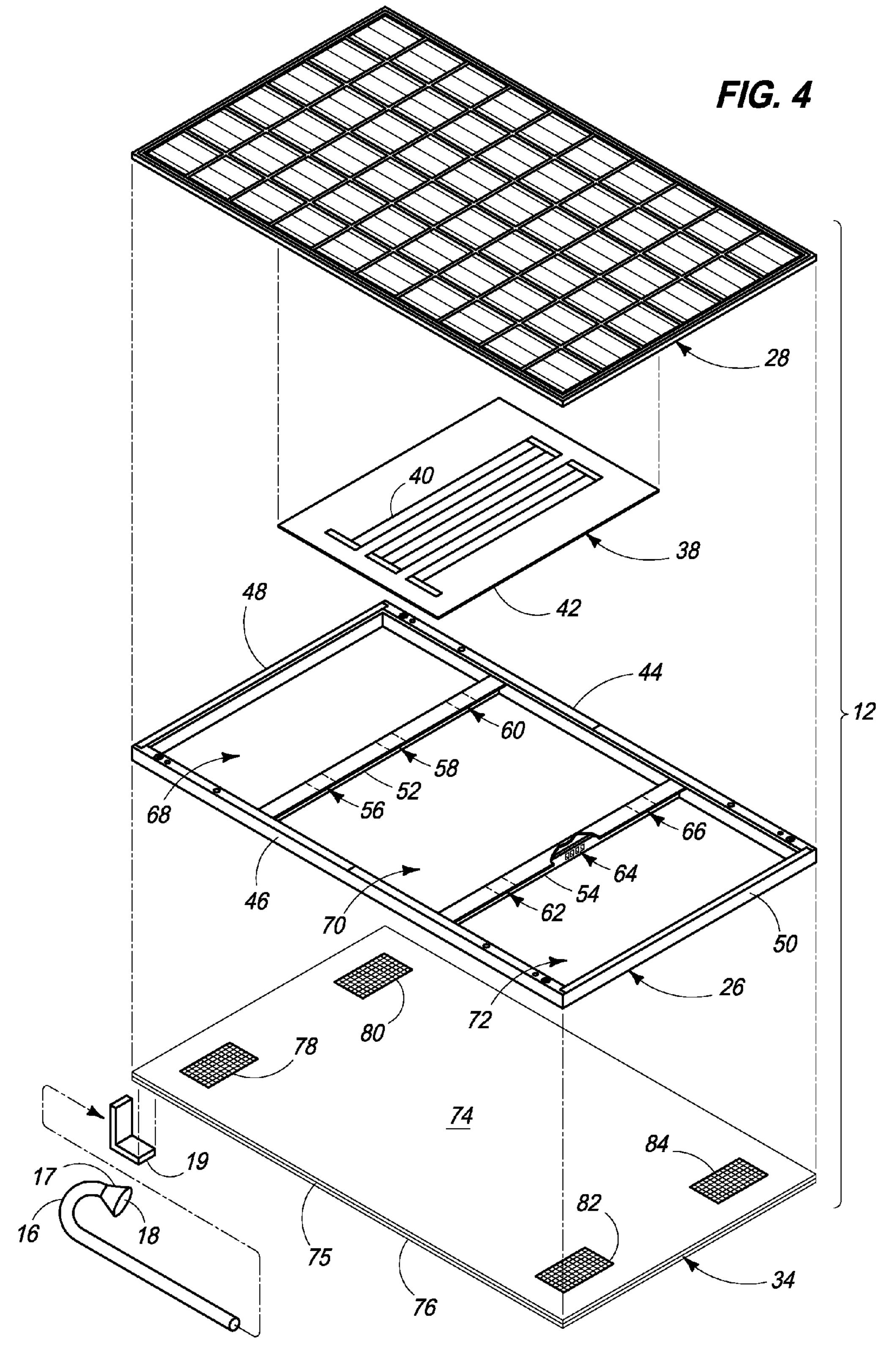


FIG. 3

FIG. 4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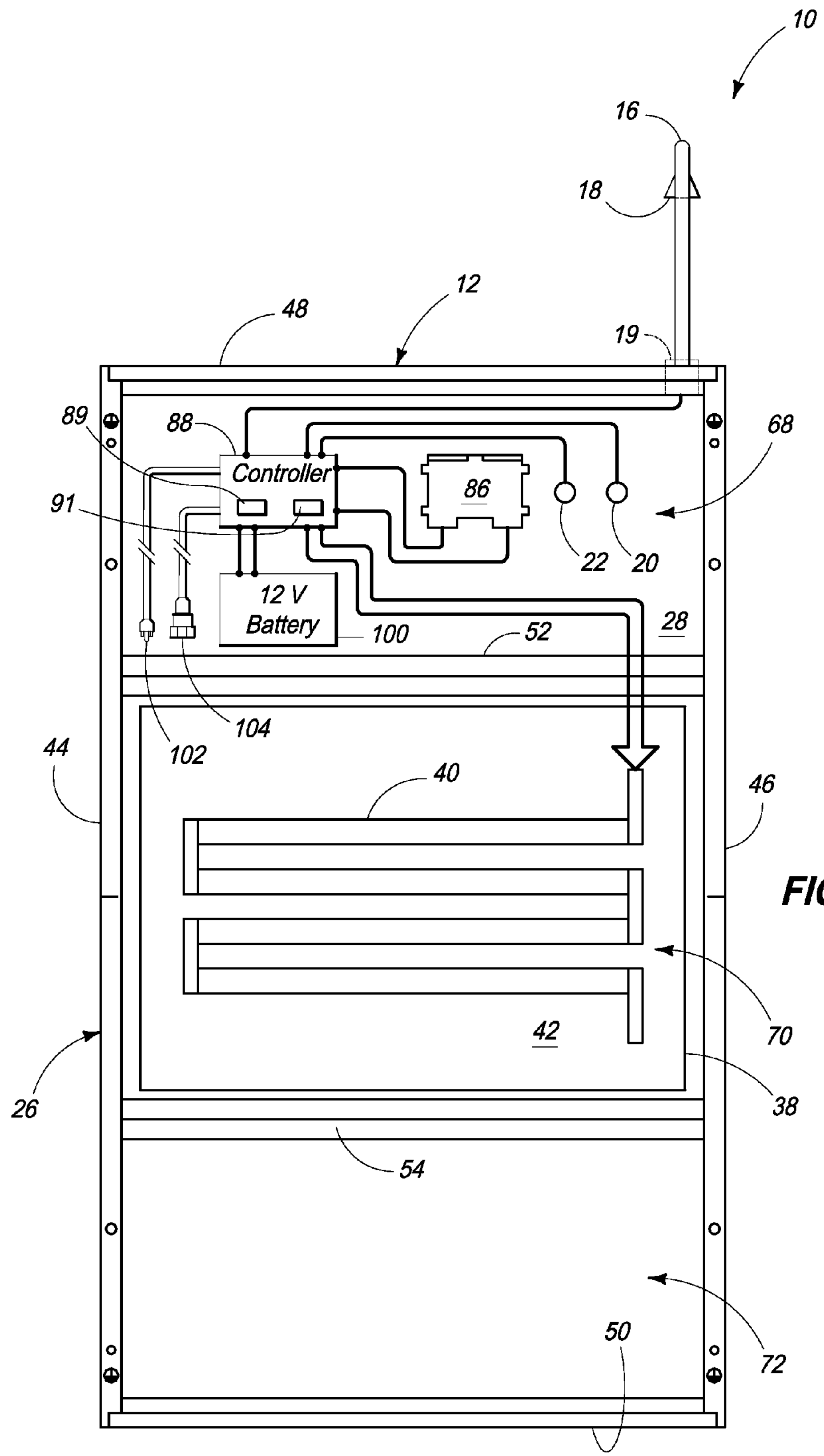
76
12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18
12
48
19
89
88
Controller
86
68
91
22
20
12 V
Battery
100
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42
26
38
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50
72

FIG. 5

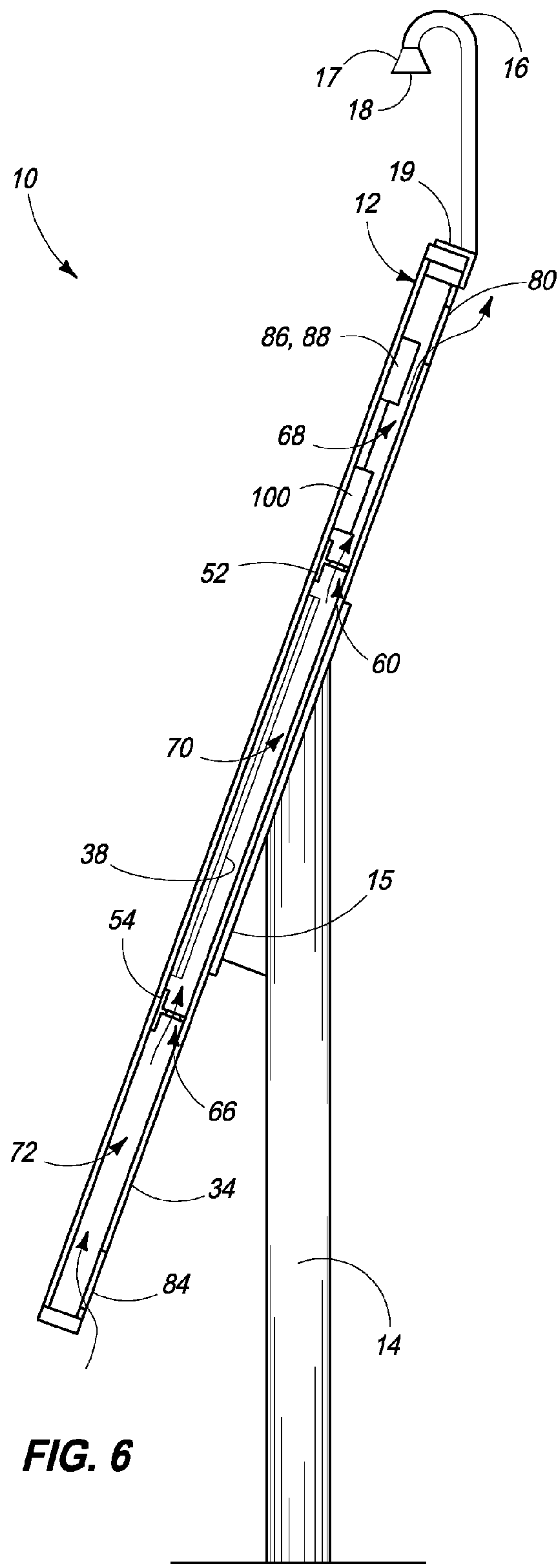


FIG. 6

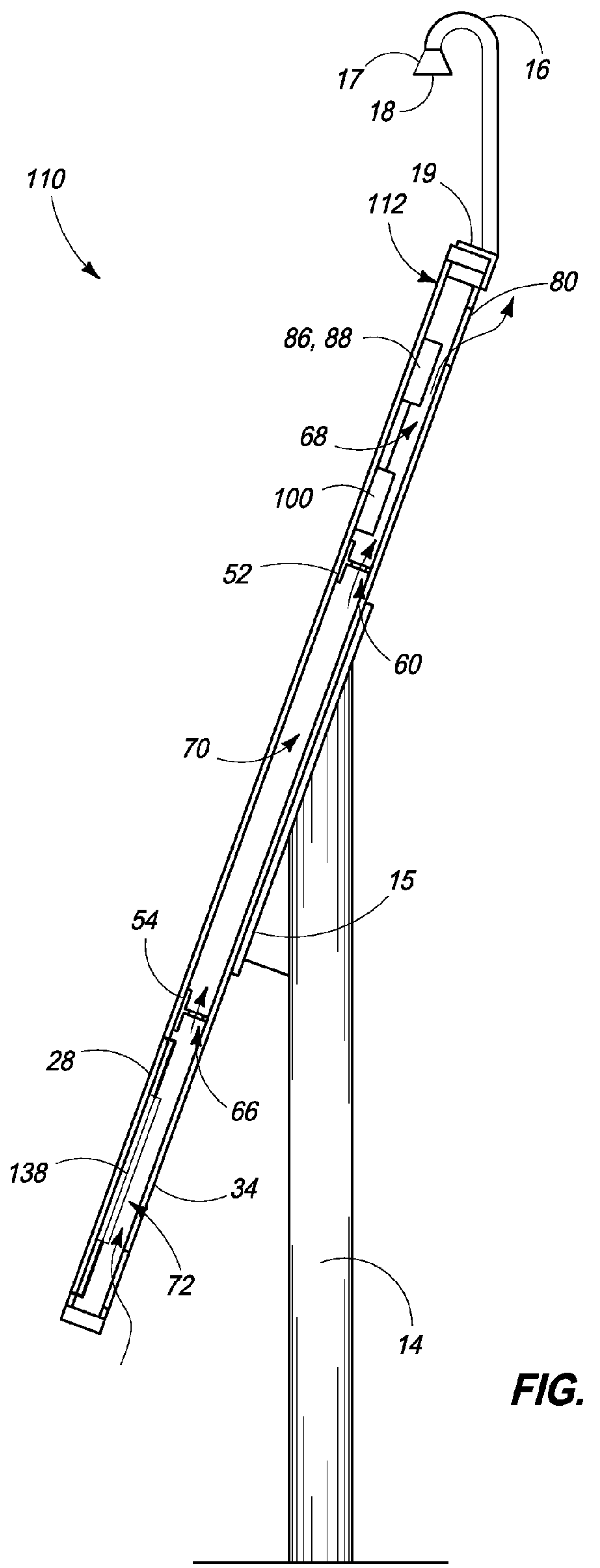


FIG. 7

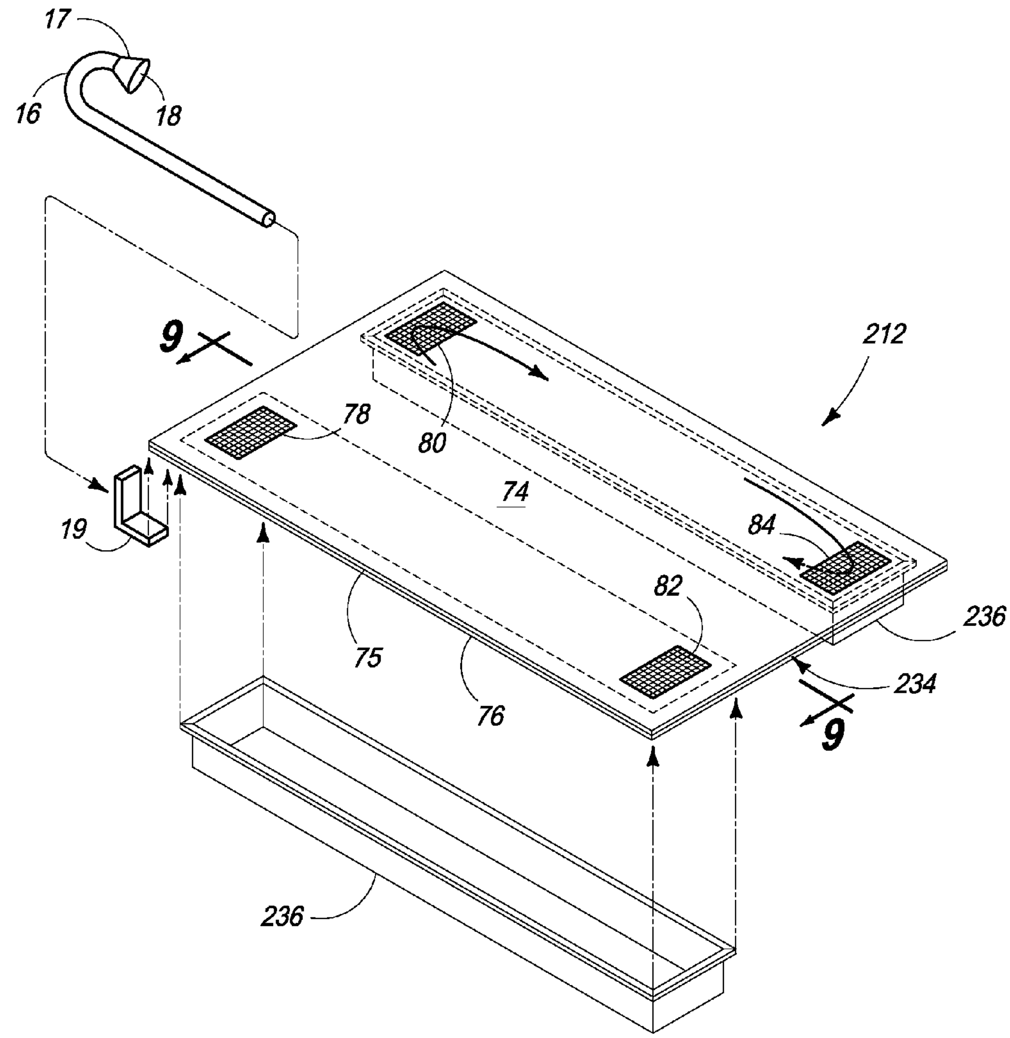
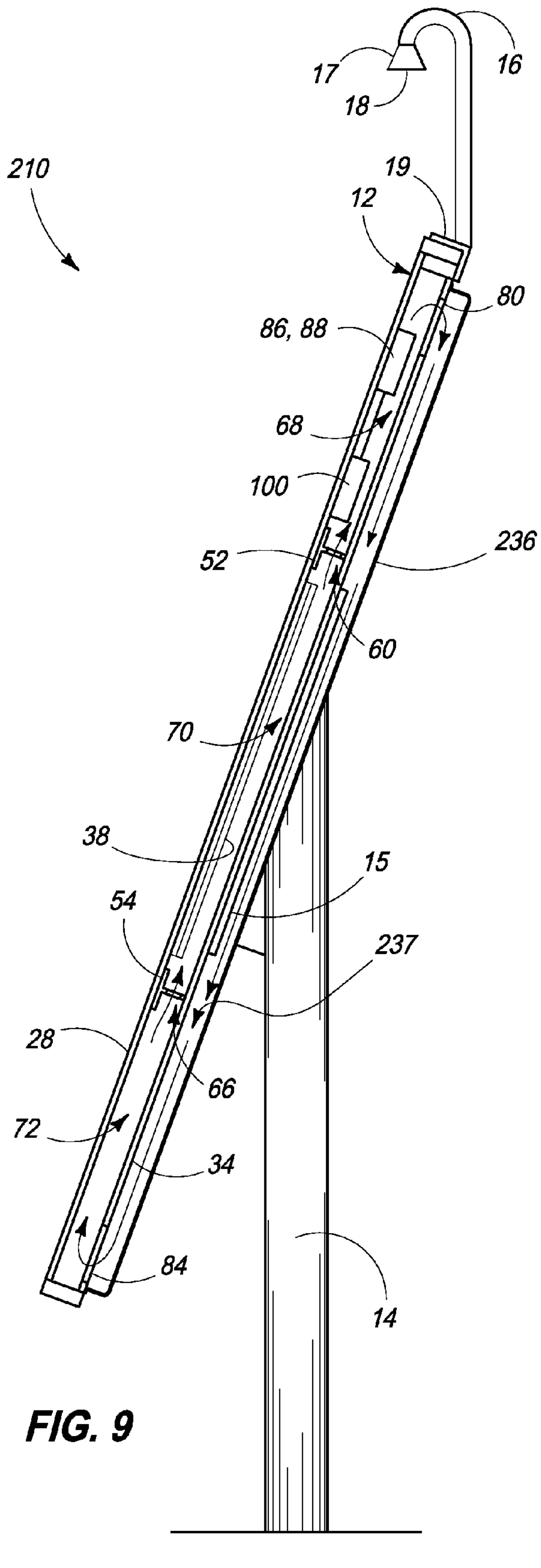


FIG. 8



16
17
18
210
19
12
80
86, 88
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100
236
52
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70
38
15
54
237
28
66
72
34
84
14

FIG. 9

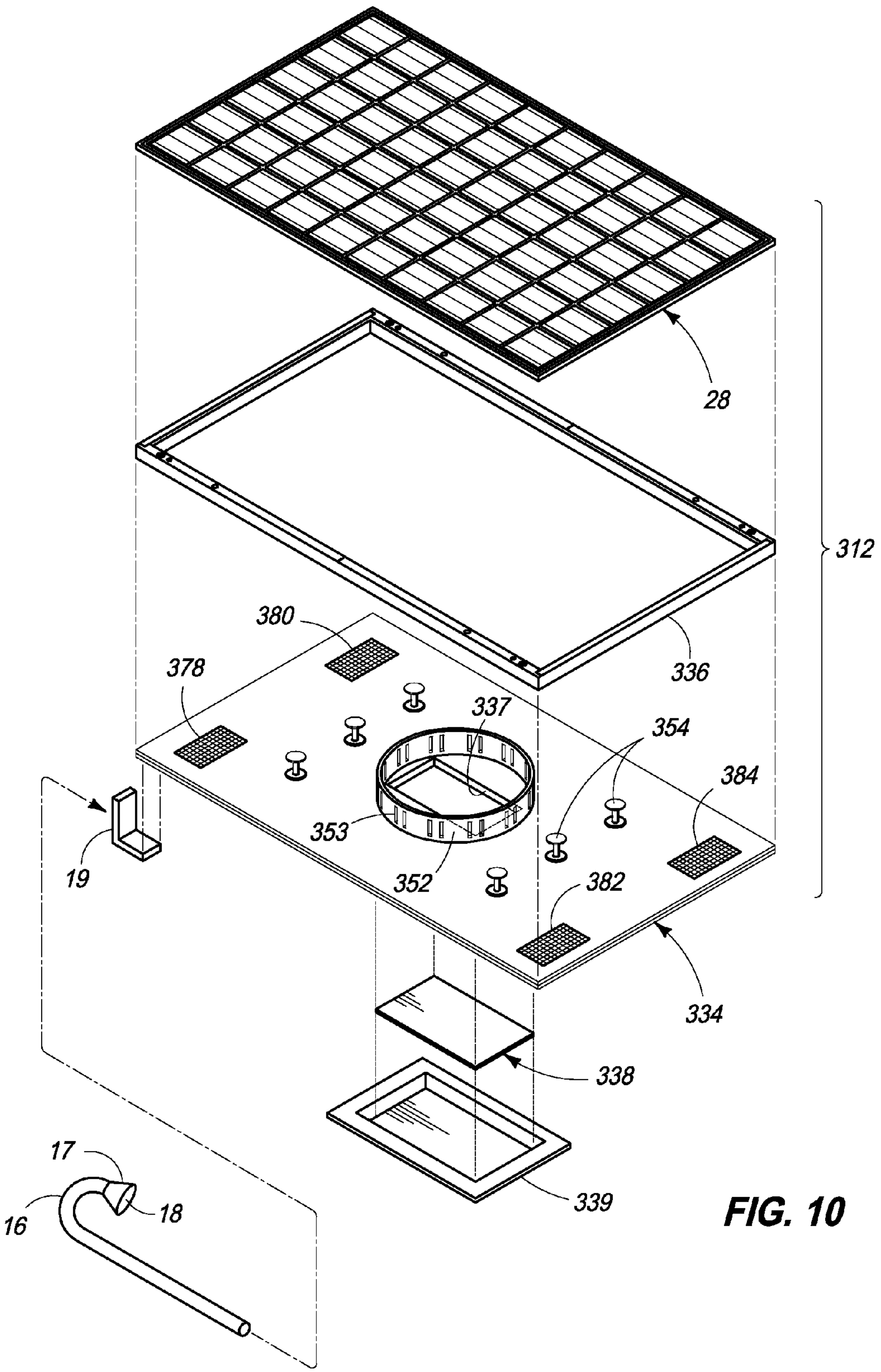

FIG. 10

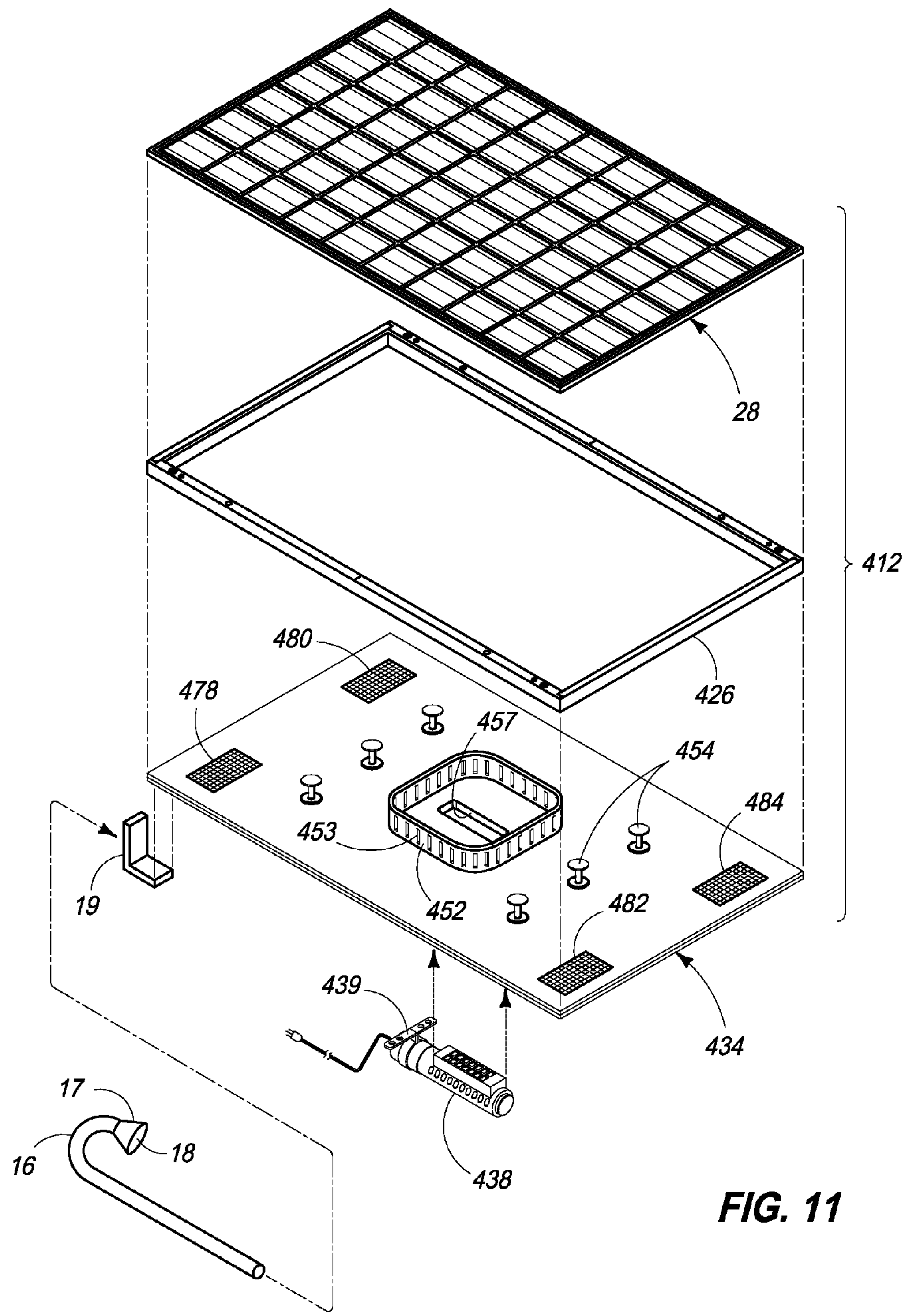

FIG. 11

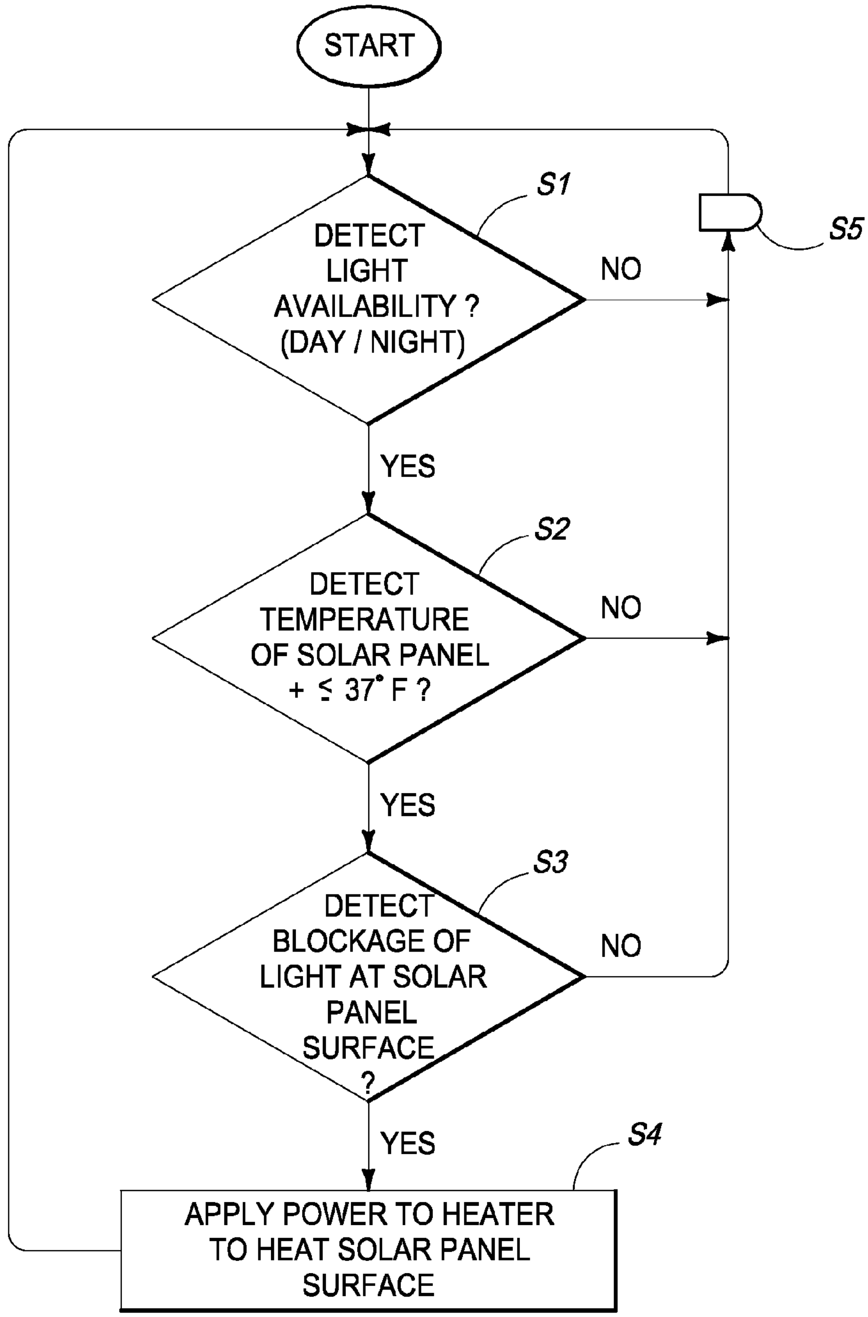
START
S1
DETECT
LIGHT
AVAILABILITY ?
(DAY / NIGHT)
NO
S5
YES
S2
DETECT
TEMPERATURE
OF SOLAR PANEL
+ ≤ 37° F ?
NO
YES
S3
DETECT
BLOCKAGE OF
LIGHT AT SOLAR
PANEL
SURFACE
?
NO
YES
S4
APPLY POWER TO HEATER
TO HEAT SOLAR PANEL
SURFACE

FIG. 12

HEATED SOLAR PANEL SYSTEM AND METHOD

TECHNICAL FIELD

[0001] This disclosure pertains to energy conversions devices. More particularly, this disclosure relates to apparatus and methods for melting snow and ice from photovoltaic and solar collection systems.

BACKGROUND OF THE INVENTION

[0002] Techniques are known for operating solar and photovoltaic systems to mitigate formation of ice in or on select system components. One technique involves using reflected solar rays that are passively collected in a solar thermal collector. However, passive solar ray collection is not fully effective for applications in cold environments where large accumulations of snow, ice or frost form on solar panels. Another technique uses resistive electric wires in heat-flow communication with supply and return pipes located outside of a building that has a hot water solar heating system. However, such a system does not remove ice from the solar collection surface(s). Accordingly, improvements are needed to better enable removal of ice from solar collection surfaces in cold environments, and while remaining relatively energy efficient so they do not drain an undue amount of collected energy from the solar collection system.

SUMMARY OF THE INVENTION

[0003] A solar panel is provided with a heater operative to remove presence of ice in the form of snow, graupel, hail or frost from a solar collection surface on the solar panel to facilitate collection of solar energy by the solar panel.

[0004] According to one aspect, a solar collection device is provided having a solar panel, a frame, a back panel, and a heat source. The frame is affixed to a rear surface of the solar panel. The back panel is affixed to a rear surface of the frame providing at least one air chamber between the solar panel, the frame, and the back panel. The heat source communicates with the chamber operative to heat the solar panel to melt ice from the solar panel.

[0005] According to another aspect, a heated solar panel system is provided having a solar panel and a heater. The heater is provided in thermally conductive relation with the solar panel operative to heat the solar panel to melt ice from the solar panel.

[0006] According to yet another aspect, a method is provided for removing snow from a solar panel. The method includes: providing a solar panel with a heat source in thermally conductive relation with the solar panel, and an ice detector; detecting presence of ice in the form of one or more of snow, frost, hail, ice and graupel on a solar collection surface of the solar panel; and heating the solar panel with the heat source responsive to detecting presence of the ice.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Preferred embodiments of the disclosure are described below with reference to the following accompanying drawings.

[0008] FIG. **1** is a perspective view of a heated solar panel assembly mounted for in-field use during temperate weather according to one aspect.

[0009] FIG. **2** is a perspective view of the heated solar panel assembly of FIG. **1** during inclement weather with snow accumulation present on the solar panel.

[0010] FIG. **3** is an enlarged breakaway corner portion of the heated solar panel assembly of FIGS. **1** and **2** showing a day/night sensor, light obstruction sensor, and temperature sensor array.

[0011] FIG. **4** is an exploded perspective view from above of the solar panel assembly of FIGS. **1-3**.

[0012] FIG. **5** is a rear plan view with an insulated back panel removed showing internal controller, sensor and electrical components for the heated solar panel assembly of FIGS. **1-4**.

[0013] FIG. **6** is a vertical sectional view taken along line **6-6** of FIG. **1** illustrating a convective flow path for the heating system for the assembly of FIGS. **1-5**.

[0014] FIG. **7** is a vertical sectional view corresponding with the view of FIG. **6** but for an alternative construction heated solar panel assembly having a heater within a lowermost heated chamber providing an enhanced convective flow path.

[0015] FIG. **8** is an exploded perspective view from above of selected components of an alternative solar panel assembly similar to that depicted in FIGS. **1-7** forming a closed-loop convection current heating system.

[0016] FIG. **9** is a vertical sectional view taken along line **9-9** of FIG. **8** illustrating a closed-loop convective flow path for the heating system of the solar panel.

[0017] FIG. **10** is an exploded perspective view of another alternative construction heated solar panel assembly with a centrally located cylindrical heated chamber, a resistive heating pad element, and pillar supports used in place of frame cross members.

[0018] FIG. **11** is an exploded perspective view of another alternative construction heated solar panel assembly with a centrally located square heated chamber, a positive temperature coefficient (PTC) heater, and pillar supports used in place of frame cross members.

[0019] FIG. **12** is a flowchart illustrating one control scheme for implementing operation of the heated solar panel assemblies of FIGS. **1-9** based at least in part on detected ambient light, temperature, and obstruction of solar panel elements from a light source.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] This disclosure is submitted in furtherance of the constitutional purposes of the U.S. Patent Laws "to promote the progress of science and useful arts" (Article 1, Section 8).

[0021] In FIG. **1**, a representation of an illustrative heated solar panel system is shown and identified by reference numeral **10**. More particularly, heated solar panel system **10** in one implementation is realized by a solar panel assembly **12** affixed atop a stationary pole mount **14** that is ground supported in a yard adjacent a building or residence (not shown). Electrical wiring (not shown) from the solar panel **12** is typically routed through pole mount **14** into the ground where it is run underground to the building where further controller and battery storage components (not shown) are housed. A mast **16** is provided atop solar panel **12** for supporting a day/night sensor **18** elevated relative to a top surface of a solar panel array **24** so as to avoid obstruction from ice in the form of snow, graupel, hail, ice, or frost that has accumulated atop array **24**. A light obstruction sensor **20** is provided atop solar panel array **24** of solar panel **12** operative to detect presence of any light-obstructing material, such as snow, graupel, hail, ice, or frost, atop array **24**. Optionally, sensor **20** can be provided on a bottom surface of glass panel **28** between individual cells of array **24**. Solar panel array **24** is laminated to a back surface of a glass panel **28**. A temperature sensor **22** is provided on a bottom surface of glass panel **28**, which forms a substrate for supporting individual solar collectors in array **24**. Glass panel **28** of solar panel **12** is affixed to a support frame **26** that is rigidly affixed atop pole mount **14**. Optionally, pole mount **26** can include an articulating linkage (not shown) that pivots solar panel **12** to align and track solar panel **12** with movement of the sun overhead. Further optionally, pole mount **14** can include a frame that carries an array, or grid of solar panels **12**.

[0022] Although solar panel array **24** is shown in FIGS. **1-3** laminated to a back surface of a glass panel **28**, other constructions for photovoltaic (solar) panels can be accommodated. Optionally, array **24** can be laminated between a pair of glass panels. Further optionally, array **24** can be laminated to a top surface of a glass panel. Even further optionally, array **24** can be deposited onto a top or bottom surface of a glass panel, or any other suitable structural substrate.

[0023] As shown in FIG. **2**, heated solar panel system **10** is depicted in the wintertime where heat has been actively applied to a central region of panel **12** so as to melt and remove accumulated snow and/or ice **30** from a cleared region **32** atop solar panel array **24** on glass substrate **28**. In contrast, passive systems do not incorporate any source of electromotive force or energy storage. Accordingly, solar panel system **10** uses an active source of heat, or heat generator, in order to melt snow or frost from a top surface of panel **12**, thereby clearing any solar-blocking obstruction from atop glass **28** and array **24**. Heat will be applied to panel **12** until region **32** grows in size sufficiently to clear snow accumulation from atop light obstruction sensor **20**, at which point a control system (see FIGS. **5** and **10**) will terminate heat delivery to the panel **12**. Mast **16** is mounted to frame **26** and supports day/night sensor **18** beneath a conical, or flared end-fitting **17** (see FIG. **4**) and elevated above panel **12** to prevent any snow accumulation from obstructing sensor **18**. In such configuration, sensor **18** is presented to detect ambient light sufficient to determine whether a source of solar light is available to system **10**.

[0024] As shown in FIGS. **1-3**, one suitable day/night sensor is a Cadmium Sulfide sensor (CdS), a form of light dependent resistor that forms a photocell, such as provided by Adafruit Industries, 150 Varick Street, New York, N.Y. 10013 and distributed by SpikenzieLabs, 6135 de Maisonneuve West, Suite 12, Montreal, QC H4A 2A3 and sold as Model No. SEN-09088, herein incorporated by reference. According to one implementation, one side of the photocell (either one, as the photocell is symmetric) is connected to power (for example 12V) and the other side is connected to a microcontroller's analog input pin. A 10K pull-down resistor is then connected from that analog pin to ground. The voltage on the pin will be 2.5V or higher when its light out and near ground when its dark. Such photocell can also be used for light obstruction sensor **20**. Pole mount **14** elevates panel **24** sufficiently high (relative to ground level) to prevent snow accumulation from obstructing array **24**. Optionally, any other form of light sensor, whether digital or analog can be used.

[0025] Temperature sensor **22**, according to one implementation, is an analog temperature sensor. One suitable sensor is manufactured by Analog Device, One Technology Way, P.O. Box 9106, Norwood, Mass. 02062-9106 and is sold as a low voltage temperature sensor under Model No. TMP36 by Adafruit Industries, 150 Varick Street, New York, N.Y. 10013, herein incorporated by reference. Optionally, any other form of temperature sensor, whether digital or analog can be used.

[0026] As shown in FIGS. **1-3**, day/night sensor **18** atop mast **16** detects whether or not sunlight (solar energy) is available for collection at solar panel **12**, and whether or not light obstruction sensor **20** is obstructed by ice in one or more of the forms of snow, graupel, hail, ice, or frost. Furthermore, temperature sensor **22** detects whether temperature conditions are sufficient to create/sustain snow or frost conditions. In this manner, power is not consumed to heat solar panel system **12** in the middle of the night, where stored battery capacity would be used to needlessly melt snow, or when temperature conditions are too warm to generate snow or frost. Instead, the detection of daylight via day/night sensor **18** in combination with detection of limited available light atop solar panel **12** via obstruction sensor **20** will signal a control system (see FIG. **5**) to apply heat (via a battery source) to solar panel **12**, heating the back of glass panel **28** and solar panel array **24** sufficient to melt snow, graupel, hail, ice, or frost therefrom.

[0027] FIG. **4** illustrates one exemplary construction for solar panel **12** of heated solar panel system **10** (of FIGS. **1-3**). More particularly, panel **12** is formed from solar (photovoltaic) panel **28**, frame **26**, and insulated back panel **34**. Together, panel **28**, frame **26**, and insulated panel **34** provide an upper chamber **68**, a middle chamber **70**, and a lower chamber **72** where an active source of heat is both contained and transported so as to heat a back surface of solar panel **28**. A heater **38** is affixed, or laminated, to a back surface of solar panel **28**, behind array **24** (see FIG. **1**) of solar cells. Energy output from heater **38** directly heats solar panel **28**, as well as heats air within chamber **70**. Optionally, insulated panel **34** can be eliminated in order to provide a more cost-efficient panel assembly **10**, with heater **38** directly heating a back surface of panel **28** (sufficient to melt snow or ice).

[0028] As shown in FIG. **4**, chamber **70** has a contained volume that is less than the entire volume provided between panel **28**, frame **26**, and insulated panel **34** which causes heat to build up within chamber **70** from heater **38**, further elevating temperatures within chamber **70** in such local region, causing further heating of panel **28** atop chamber **70**. In addition, a series of air vents **56**, **58**, **60** and **62**, **64**, **66** are provided in stabilizer bars, or members **52** and **54** of frame **26**. According to one construction, each air vent **56**, **58**, **60** and **62**, **64**, **66** comprise an array of adjacent parallel slots cut in each stabilizer bar **52** and **54** sized to provide for heat build up in chamber **70** relative to chambers **68** and **72**, yet still enable heat transfer (and natural convection currents) into and between chambers **68** and **72**, as well as chamber **70**. Stabilizer bars **52** and **54** are affixed with fasteners between longitudinal frame members **44** and **46** and parallel to lateral frame members **48** and **50** of frame **26**.

[0029] According to one construction, frame members **44**, **46**, **48** and **50**, and stabilizer bars **52** and **54** are formed from aluminum sheet that is folded in a bend/brake to form structural sheet metal members. Other suitable materials, such as steel, plastic, or composite can optionally be used to form frame **26**.

[0030] According to one construction, heater **38** comprises a circuitous conductive trace, or wire **40** provided on a selfadhesive backing **42** that is adhered to a back surface of panel **28**. One suitable heater **38** is a Clear View II electric defroster sold under the Frost Fighter brand by Planned Products LLC, 4699 Nautilus Court S., Suite 201, Boulder, Colo. 80301 USA, herein incorporated by reference. Optionally, the conductive traces can be made from Indium Tin Oxide (ITO) that is deposited as a thin film directly onto a glass component of the solar panel, or is deposited onto a layer that is subsequently adhesively affixed onto the solar panel.

[0031] Also according to one construction, insulated back panel **34** is formed from an adhesively laminated sandwich of a plastic sheet **74**, an insulated sheet **75**, and a plastic sheet **76**. Plastic sheets **74** and **76** can be formed from sheets of polyethylene, whereas insulating sheet **75** can be formed from a sheet of foamed polyethylene. Optionally, insulating sheet **75** can include a layer of Mylar®, or can be formed from any suitable foam or insulating material, including glass insulating sheet material. In assembly, pairs of screen-covered vents **78**, **80** and **82**, **84** are provided at opposite ends of insulated back panel **34** operative to provide in-flow and out-flow of air to/from chambers **68** and **72**, respectively, resulting from convection currents generated by operation of heater **38**, while preventing bug and rodent ingress. In one case, panel **34** comprises a pair of thin plastic sheets adhesively laminated to opposed sides of an insulating sheet or board, and vents **78**, **80**, **82**, and **84** are cut out and their screens are adhesively laminated between the inner plastic sheet and the central insulating sheet or board.

[0032] FIG. **5** depicts heated panel system **10** from behind with insulated back panel **34** (see FIG. **4**) and a base portion of mast **16** removed in order to facilitate viewing of associated sensor, energy source and control components. More particularly, upper chamber **68** of solar panel **12** houses a potted junction box **86** that is adhesively affixed to a back surface of solar panel **28**. Junction box **86** provides a single electrical output for the array **24** of solar cells on a front face of panel **28**. Likewise, a controller **88** and a battery **100** are also affixed to a back surface of panel **28**. Optionally, controller **88**, battery **100**, and junction box **88** can be mounted with threaded fasteners to components of frame **26**, including stabilizer members **52** and **54**. Light obstruction sensor **20** is mounted through an aperture, or bore that passes through panel **28** to detect light on a front surface of panel **28**. Optionally, sensor **20** can be mounted to a front surface of panel **28** with adhesive or a mounting bracket assembly. Temperature sensor **22** is adhesively affixed to a rear surface of panel **24** in thermally conductive relation so as to measure temperature of panel **24**.

[0033] Controller **88** of FIG. **5** includes a central processing unit (CPU) having processing circuitry **89**, and further includes memory **91** signal coupled with processing circuitry **88**. A control algorithm is implemented on controller **88** pursuant to the control scheme depicted in FIG. **10** to determine when to apply heat via heater **38** to panel **28** from battery **100** using input signals generated from sensors **18**, **20** and **22**. A pair of electrical connectors **102** and **104** is coupled in switched relation through controller **88** from junction box **86**. On a normal solar panel that does not have a heater, electrical connectors analogous to connectors **102** and **104** exit junction box **86** for coupling with an inverter and battery storage array (not shown) configured to store collected solar energy from an array of panels **28**. Junction box **86**, controller **88**, battery **100**, sensors **18**, **20** and **22**, and heater **38** are electrically coupled together via insulated wires (or optionally conductive traces). Such insulated wires can be physically adhered with adhesive tape to a backside of panel **28**, similar to adhesive backing **42** of heater **40**. Small ports or passages (not shown) provided in a flange of stabilizer bar **52** enable passage of such wires between conductive traces **40** of heater **38** and controller **38** as they extend from chamber **70** to chamber **68**.

[0034] FIG. **5** illustrates the circuitous conductive traces **40** of heater **38** adhered with a sheet of adhesive-backed plastic backing **42** to a back surface of panel **28** within chamber **38**. Chamber **38** is bounded by frame members **44** and **46**, stabilizer members **52** and **54**, panel **28**, and insulated back panel **34** (see FIG. **6**). Likewise, upper chamber **68** is bounded by frame members **44**, **44**, and **48**, stabilizer member **52**, panel **28**, and insulated back panel **34** (see FIG. **6**). Lower chamber **72** is bounded by frame members **44**, **46**, and **50**, stabilizer member **54**, panel **28**, and insulated back panel **34** (see FIG. **6**). Optionally, each vent can be formed by a rectangular (or other suitable geometric configuration) of screen mesh that is mechanically affixed to panel **34** via one or more fasteners, or screws over a respective aperture formed through panel **34**.

[0035] FIG. **6** illustrates heated solar panel system **10** of FIGS. **1-5** mounted in-use atop a pole mount in a yard. More particularly, panel **28** is mounted at an upright angle that optimizes solar energy collection using an angled mounting bracket **15**. Optionally, bracket **15** can be affixed to pole mount **14** via a kinematic or gear linkage that enables reorientation of solar panel **28** to track (and maintain general perpendicularity with) the sun. As shown in FIGS. **1-6**, a heated solar panel system **10** uses a single solar panel with heater **38** mounted within middle chamber **70** and junction box **86**, controller **88** and battery **100** mounted within upper chamber **68**. However, optional configurations with multiple solar panels configured in an array provide controller **88** and battery **100** (as well as mast **16** and sensors **18**, **20** and **22** of FIG. **5**) in just a single one of the array of solar panels, namely panel **28**. By providing heater **38** in middle chamber **70**, assembly of the array is simplified for the remaining solar panels in the array, as the remaining panels can be mounted with either end elevated, and it is not necessary to identify "which end is up" during assembly in the array.

[0036] In operation, heater **38** of FIG. **6** is turned on in response to a control signal that is generated by controller **88** responsive to sensor **18** (and sensors **20** and **22** of FIG. **5**) when a presence of ice in the form of one or more of snow, graupel, hail, ice, or frost is detected on a front surface of panel **28** (and there is a detected presence of light and sufficiently cool temperatures to form such ice). Heat generated by heater **38** and battery **100** rises within middle chamber **70** where a localized hot spot is generated behind panel **28**. A portion of the heated air in chamber **70** rises through air vents in stabilizer member **52** (such as vent **60**) and passes into upper chamber **68**, and eventually out through vents in the top of panel **36** (such as vent **80**). Convection currents cause fresh air to be drawn in through vents in the bottom of panel **36** (such as vent **84**) and into lower chamber **72**, and through air vents in stabilizer member **54** (such as vent **66**) where such air is heated by heater **38**.

[0037] FIG. **7** depicts an optional construction heated solar panel system **110** with a heated solar panel assembly **112**. Assembly **112** is essentially the same as assembly **12** (of FIGS. **1-6**) except a smaller heater **138** is mounted within lower chamber **72** to a back surface of panel **28**, enabling heated to rise via convection from chamber **72**, through chamber **70**, and into chamber **68**. Such construction requires proper orientation of panel **28** in a specific upright configuration, but directly heats lower chamber **72** in contrast with the version depicted in FIG. **6**. Heater **138** is constructed in essentially the same manner as heater **38**, except the layout size of the conductive traces is more compact in order to fit in the smaller surface area provided within lower chamber **72**.

[0038] FIG. **8** illustrates one optional construction for a solar panel assembly **212** similar to assembly **12** (of FIGS. **1-6**) but with portions removed to illustrate the differences between the two constructions. More particularly, solar panel assembly **212** is a closed-loop heating system that adds a pair of recirculating ducts **236**, one between each set of top and bottom vents **78**, **82** and **80**, **84**. Each duct **236** is formed by an elongated box that is affixed to a back side of insulated back panel **234** in sealed relation using either adhesive or fasteners (not shown). In one case, duct **236** is formed from a lamination of plastic outer layers adhered on either side of a central insulating layer, similar to the construction for insulating back panel **234** with plastic skins **74** and **76** affixed to opposed sides of middle insulating panel **75**. Optionally, duct **236** can be formed from a sheet of plastic, such as a vacuum molded plastic tray. Mast **16** is secured to a top edge of a respective solar panel **212** with metal bracket **19** using fasteners (not shown), positioning day/night sensor **18** beneath flared end portion **17** of mast **16** which inhibits any accumulation of snow atop sensor **18** and end portion **17**.

[0039] As shown in FIG. **9**, heat is generated by heater **38** in chamber **70** (and optionally, in chamber **72**) from a control scheme implemented via controller **88** with power stored in battery **100**, and convection causes heated air in chamber **70** to rise into chamber **68** (optionally, chambers **70** and **72**). Battery **100** is charged using controller **88** and solar panel **28** during daylight hours. As heat is transferred to solar panel **28** of assembly **12**, the risen air starts to cool. Such air then exits to the top vents (for example, vent **80**) and returns in duct **236** down to bottom vent **84**. Accordingly, convection currents generated by heater **38** causes a closed-loop recirculation of rising air from chamber **72**, to chamber **70**, into chamber **68**, and back down through chamber **237** provided by each of ducts **236**.

[0040] FIG. **10** depicts another optional construction for a solar panel assembly **312** similar to assembly **12** (of FIGS. **1-6**) and assembly **112** (of FIG. **7**). More particularly, solar panel assembly **312** has a centrally located heater, or heat mat **338** mounted through a complementary rectangular aperture **337** in an insulated back panel **334**. An insulating cover **339** further encases heater **338** to an outer surface of back panel **334**. A cylindrical dam wall, or divider **352** having a circumferential array of spaced-apart vents **353** encircles a portion of heater **338** exposed through aperture **337**. One suitable heater **338** is a 4 Watt terrarium heater that uses a wire heating element, such as a Zilla 09936 Terrarium Heater Heat Mat, sold by Zilla Products, Central Aquatics, 5401 West Oakwood Park Drive, Franklin, Wis. 53132, herein incorporated by reference.

[0041] As shown in FIG. **10**, a rectangular frame **326** joins together solar panel **28** and insulated back panel **334**. In addition to frame **326** and dam wall **352** providing structural support between panel **28** and panel **334**, a plurality of spaced apart support posts **354** are provided in two rows, extending between panel **28** and panel **334**. Posts **354** are constructed from metal or plastic, and are adhesively affixed to a top surface of panel **354**, in assembly. A pair of vents **378**, **380** and **382**, **384** are provided at respective top and bottom edges of insulated back panel **334**, in a manner similar to the construction of back panel **34** (in FIG. **4**).

[0042] FIG. **11** depicts yet another optional construction for a solar panel assembly **412** similar to assembly **212** of FIG. **8**. More particularly, solar panel assembly **412** has a centrally located heater **438** exposed through a complementary rectangular aperture **437** in an insulated back panel **434**. One suitable heater **438** is a Fairview Defogger Model 9303 sold by Caframo Limited, 501273 Grey Road 1, Wiarton, Ontario NOH 2T0 Canada that uses a Positive Temperature Coefficient (PTC) heating element, herein incorporated by reference. A modified strap bracket **439** is used to mount heater **438** with threaded fasteners (not shown) to panel **434** such that the respective heating element passes through a rectangular aperture **457** in panel **434**. A rectangular dam wall, or divider **452** having a circumferential array of spaced-apart vents **453** surrounds a portion of heater **438** exposed through aperture **437**.

[0043] As shown in FIG. **11**, an array of posts **454** are provided in two rows, in combination with dam **452** and frame **426** when securing together panel **28**, frame **426**, and panel **434** with fasteners and/or edge brackets. Additionally, screen vents **478**, **480** and **483**, **484** are provided at respective ends of panel **434**.

[0044] FIG. **12** illustrates one exemplary process flow control implemented using controller **88**, heater **38** and sensors **18**, **20** and **22**. Such control scheme can be implemented on any of the embodiments depicted in FIGS. **1-11**. More particularly, the process initiates at "START" and proceeds to Step "S1".

[0045] In Step "S1", the process detects light availability using sensor **18** (of FIG. **5**). Sensor **18** is elevated above a top surface of the solar panel, preventing obstruction of light from any snow that has accumulated atop the solar panel. If light is detected, the process proceeds to Step "S2". If light is detected, then the process proceeds to Step "S6" where a delay is implemented.

[0046] In Step "S2", the process detects whether a back surface temperature of the solar panel is less than or equal to a preset target temperature (37 degrees Fahrenheit, in one case) using temperature sensor **22** (see FIG. **5**). If the detected temperature is less than or equal to the target temperature, the process proceeds to Step "S3". If the temperature is greater than the target temperature, then the process proceeds to Step "S5".

[0047] In Step "S3", the process detects whether light is detected at the top surface of the solar panel indicating presence of accumulated ice in the form of one or more of snow, graupel, hail, ice, or frost. If blockage of light is detected, then the process proceeds to Step "S4". If no blockage is detected (light is present), then the process proceeds to Step "S5".

[0048] In Step "S4", the process via the controller directs the battery **100** (see FIG. **5**) to apply power to the heater in order to heat the back surface of the solar panel which imparts heat to the top surface of the solar panel to melt accumulated snow, ice, or frost from the top surface of the solar panel. The process then proceeds back to Step "S1".

[0049] In Step "S5", a delay routine is implemented with a counter and clock for a preselected time interval, such as every minute, or every 15 minutes in order to reduce power consumption from the battery.

[0050] In compliance with the statute, embodiments of the invention have been described in language more or less specific as to structural and methodical features. It is to be understood, however, that the entire invention is not limited to the specific features and/or embodiments shown and/or described, since the disclosed embodiments comprise forms of putting the invention into effect. The invention is, therefore, claimed in any of its forms or modifications within the proper scope of the appended claims appropriately interpreted in accordance with the doctrine of equivalents.

The invention claimed is:

1. A solar collection device, comprising:

a solar panel;

a frame affixed to a rear surface of the solar panel;

a back panel affixed to a rear surface of the frame providing at least one air chamber between the solar panel, the frame, and the back panel; and

a heat source communicating with the chamber operative to heat the solar panel to melt ice from the solar panel.

2. The solar panel system of claim **1**, further comprising a snow detector carried by the frame and configured to detect presence of ice obstructing a top solar collecting surface of the solar panel.

3. The solar panel system of claim **2**, wherein the snow detector comprises a first optical sensor configured to detect presence of a source of solar energy, a second optical sensor configured to detect obstruction of a solar collecting surface of the solar panel from the source of solar energy, and a temperature sensor configure to detect a thermal condition suitable for accumulating one of: snow, ice and frost on the solar collecting surface of the solar panel.

4. The solar panel system of claim **1**, wherein the frame comprises one of a frame member, a stabilizer member, and a wall configured to bound a volume of air between the solar panel and the back panel to which heat is applied from the heat source.

5. The solar panel system of claim **4**, wherein the frame comprises a cylindrical wall including an array of vents.

6. The solar panel system of claim **4**, wherein the frame comprises a rectangular wall including an array of vents.

7. The solar panel system of claim **1**, wherein at least two frame members and at least one stabilizer member encompass a volume of air between the solar panel and the back panel, and the stabilizer member includes an array of vents.

8. The solar panel system of claim **1**, wherein the heater comprises a circuitous conductive trace provide on a back surface of the solar panel.

9. The solar panel system of claim **1**, further comprising a battery electrically coupled with the conductive trace to heat the trace via electrical resistance.

10. The solar panel system of claim **1**, where the heater comprises an electrically resistive heating mat.

11. The solar panel system of claim **1**, wherein the heater comprises a Positive Temperature Coefficient (OTC) heating element.

12. The solar panel system of claim **1**, wherein the back panel comprises thermal insulation.

13. The solar panel system of claim **1**, further comprising at least one vent provided in the back panel adjacent a top edge of the back panel and at least another vent provided in the back panel adjacent a bottom edge of the back panel cooperating to provide convection of heated air in the at least one chamber provided between the solar panel, the frame, and the back panel.

14. The solar panel system of claim **1**, further comprising a duct fluid coupling together the at least one vent and the at least another vent to provide a closed-loop fluid convection system for circulating heated air between the solar panel, the frame, the back panel and the duct.

15. A heated solar panel system, comprising:

a solar panel; and

a heater provided in thermally conductive relation with the solar panel operative to heat the solar panel to melt ice from the solar panel.

16. The heated solar panel system of claim **15**, further comprising an air chamber provided behind the panel communicating with the heater.

17. The heated solar panel system of claim **15**, further comprising a frame affixed to a rear surface of the solar panel and a back panel affixed to a rear surface of the frame providing at least one air chamber between the solar panel, the frame, and the back panel.

18. The heated solar panel system of claim **15**, further comprising an ice detector provided proximate the panel and a controller signal coupled with the ice detector and operatively coupled with the heater to operate the heater when ice is detected on the panel.

19. The heated solar panel system of claim **18**, further comprising a battery electrically coupled with the heater and operative to power the heater.

20. The heated photovoltaic panel system of claim **19**, wherein the ice detector comprises a first optical sensor configured to detect presence of a source of solar energy, a second optical sensor configured to detect obstruction of a solar collecting surface of the solar panel from the source of solar energy, and a temperature sensor configure to detect a thermal condition suitable for accumulating one of: snow, ice and frost on the solar collecting surface of the solar panel.

21. The heated solar panel system of claim **15**, wherein the controller comprises processing circuitry and memory communicating with the first optical sensor, the second optical sensor, and the temperature sensor.

22. A method for removing snow from a solar panel, comprising:

providing a solar panel with a heat source in thermally conductive relation with the solar panel, and an ice detector;

detecting presence of ice in the form of one or more of snow, frost, hail, ice, and graupel on a solar collection surface of the solar panel; and

heating the solar panel with the heat source responsive to detecting presence of the ice.

23. The method of claim **22**, further comprising providing a controller coupled with the heat source and the ice detector and a power supply coupled between the heat source and the controller, wherein heating comprises switching power from the battery to the heat source via the controller responsive to detecting presence of ice.

24. The method of claim **22**, wherein detecting presence of ice comprises detecting available light.

25. The method of claim **22**, wherein detecting presence of ice comprises detecting temperature proximate the solar panel.

26. The method of claim **22**, wherein detecting presence of ice comprises detecting blockage of light at the solar collection surface of the solar panel.

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