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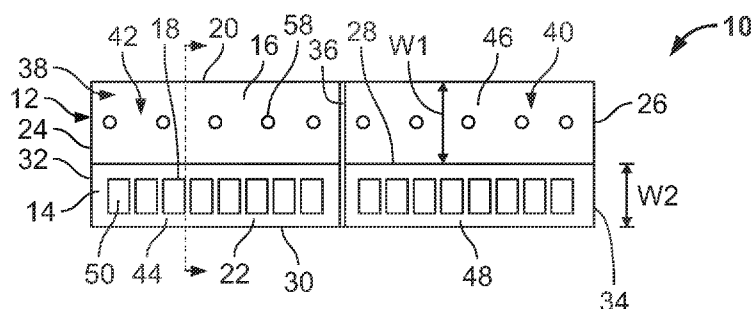


FIG. 1A

(57) Abstract: A building integrated photovoltaic system includes a plurality of photovoltaic modules installed in an array on a roof deck. Each of the photovoltaic modules at least one solar cell, a first encapsulant encapsulating the at least one solar cell, a frontsheet juxtaposed with a first surface of the first encapsulant, and a backsheet juxtaposed with a second surface of the first encapsulant. The frontsheet includes a glass layer, a second encapsulant, and a first polymer layer. The backsheet includes a first layer and a second polymer layer attached to the first layer. Each of the photovoltaic modules includes a wire cover bracket, which is configured to overlap the wire cover bracket of an adjacent one of the photovoltaic modules.



BUILDING INTEGRATED PHOTOVOLTAIC SYSTEM

Cross-Reference to Related Application

This application relates to and claims the benefit of commonly-owned, co-pending U.S.
5 Provisional Patent Application Serial No. 63/074,268, filed September 3, 2020, entitled
“PHOTOVOLTAIC SHINGLES AND METHODS OF INSTALLING SAME,” the contents of
which is incorporated herein by reference in its entirety.

Field of the Invention

10 The present invention relates to a building integrated photovoltaic system.

Background of the Invention

Photovoltaic systems having solar panels are commonly installed on roofing of structures.
What is needed is a building integrated photovoltaic system configured to be efficiently installed
15 on a roof structure.

Summary of the Invention

In some embodiments, a system, includes a plurality of photovoltaic modules installed on
a roof deck, wherein the photovoltaic modules are arranged in an array on the roof deck, wherein
20 each of the photovoltaic modules includes a first end and a second end opposite the first end, at
least one solar cell, a first encapsulant encapsulating the at least one solar cell, wherein the first
encapsulant includes a first surface and a second surface opposite the first surface, a frontsheet
juxtaposed with the first surface of the first encapsulant, wherein the frontsheet includes a glass

layer, a second encapsulant, and a first polymer layer, a backsheet juxtaposed with the second surface of the encapsulant, wherein the backsheet includes a first layer, and a second polymer layer attached to the first layer, wherein the first layer forms a lower surface of the photovoltaic module, and a wire cover bracket located at the first end, wherein the wire cover bracket of one of the
5 photovoltaic modules is configured to overlap the wire cover bracket of an adjacent another one of the photovoltaic modules, and wherein the wire cover bracket is configured to receive at least one electrical component.

In some embodiments, the first encapsulant is selected from the group consisting of thermosetting polyolefin, thermosetting polyolefin encapsulant material, thermosetting ethylene-
10 vinyl acetate (EVA), EVA encapsulants, thermoplastic olefin, thermoplastic polyolefin (TPO) and hybrids and combinations thereof. In some embodiments, the first encapsulant includes a thermosetting polyolefin encapsulant material. In some embodiments, the first encapsulant has a thickness of 1 μm to 900 μm .

In some embodiments, the first polymer layer includes a fluoropolymer. In some
15 embodiments, the fluoropolymer is selected from the group consisting of ethylene tetrafluoroethylene (ETFE), polyvinylidene fluoride (PVDF), tetrafluoroethylene-hexafluoropropylene copolymers (FEP), tetrafluoroethylene-hexafluoropropylene-vinylidene fluoride copolymers (THV), polyvinyl fluoride (PVF), and blends thereof. In some embodiments, the first polymer layer includes a material selected from the group consisting of acrylics,
20 polyesters, silicones, and polycarbonates. In some embodiments, the first polymer layer has a thickness of 0.01 mm to 0.5 mm. In some embodiments, the first layer includes a polymer. In some embodiments, the first layer includes thermoplastic polyolefin (TPO). In some

embodiments, the first layer includes polyvinyl chloride (PVC). In some embodiments, the first layer includes ethylene propylene diene monomer (EPDM) rubber.

In some embodiments, the system further includes at least one jumper module electrically connecting a first subarray of the array and a second subarray of the array, wherein the at least one
5 jumper module includes, at least one electrical bussing, an encapsulant encapsulating the at least one electrical bussing, wherein the encapsulant of the at least one jumper module includes a first surface and a second surface opposite the first surface of the encapsulant of the at least one jumper module, wherein the at least one electrical bussing electrically connects the first subarray to the second subarray, a frontsheet juxtaposed with the first surface of the encapsulant of the at least one
10 jumper module, wherein the frontsheet of the at least one jumper module includes a first layer, and a first polymer layer attached to the first layer of the frontsheet of the at least one jumper module, and wherein the first layer of the frontsheet of the jumper module forms an upper surface of the jumper module.

In some embodiments, the at least one jumper module includes a first side lap located at a
15 first end thereof and a second side lap located at a second end thereof opposite the first end of the at least one jumper module. In some embodiments, the at least one electrical bussing extends from a location proximate to the first end of the at least one jumper module to a location proximate to the second end of the at least one jumper module. In some embodiments, the at least one jumper module includes a first junction box located on the first side lap, and wherein the first junction box
20 is electrically connected to the at least one electrical bussing. In some embodiments, the at least one jumper module includes a second junction box located on the second side lap, and wherein the second junction box is electrically connected to the at least one electrical bussing. In some embodiments, the at least one electrical component includes a third junction box. In some

embodiments, the third junction box of each of the photovoltaic modules of the first subarray is electrically connected to the first junction box, and wherein the third junction box of each of the photovoltaic modules of the second subarray is electrically connected to the second junction box.

In some embodiments, at least one of the plurality of photovoltaic modules of the first
5 subarray includes a head lap portion, and wherein one of the at least one jumper module overlays the head lap portion. In some embodiments, the at least one of the plurality of photovoltaic modules of the first subarray includes a first side lap, and wherein the first side lap of the one of the at least one jumper module is proximate to the first side lap of the at least one of the plurality of photovoltaic modules of the first subarray. In some embodiments, the at least one of the
10 plurality of photovoltaic modules of the first subarray includes a second side lap, and wherein the second side lap of the one of the at least one jumper module is proximate to the second side lap of the at least one of the plurality of photovoltaic modules of the first subarray. In some embodiments, the at least one jumper module includes a plurality of jumper modules, and wherein the first side lap of another one of the plurality of jumper modules overlaps the second side lap of
15 one of the plurality of jumper modules. In some embodiments, the first junction box of the another one of the plurality of jumper modules is proximate to and electrically connected to the second junction box of the one of the plurality of jumper modules. In some embodiments, at least one of the plurality of photovoltaic modules of the second subarray includes a head lap portion, and wherein the another one of the plurality of jumper modules overlaps the head lap portion of the at
20 least one of the plurality of photovoltaic modules of the second subarray. In some embodiments, each of the plurality of photovoltaic modules of includes the first side lap, and wherein the wire cover bracket is attached to the first side lap.

In some embodiments, the wire cover brackets of the plurality of photovoltaic modules of the first subarray are configured to form a first wire channel, and wherein the wire cover brackets of the plurality of photovoltaic modules of the second subarray are configured to form a second wire channel. In some embodiments, the system further includes at least one cover removably attached to at least one of the wire cover brackets. In some embodiments, the at least one cover is removably attached to a plurality of the wire cover brackets.

In some embodiments, the system further comprises a transition box located proximate to the first wire channel, wherein the transition box is electrically connected to the first junction box. In some embodiments, each of the photovoltaic modules includes at least one bussing wire electrically connected to the at least one solar cell. In some embodiments, the at least one bussing wire is covered with a polymer layer. In some embodiments, the a polymer layer is expanded polyethylene ("EPE"). In some embodiments, the at least one bussing wire is coated with a colorant. In some embodiments, the glass layer has a thickness of 1 mm to 4 mm. In some embodiments, the second encapsulant includes a thickness of 1 μ m to 900 μ m. In some embodiments, the first polymer layer includes a thickness of 0.01 mm to 0.5 mm. In some embodiments, the glass layer includes a first edge, and wherein the first layer includes a second edge offset from the first edge.

In some embodiments, the first layer of the backsheet includes a composite material. In some embodiments, the composite material includes a substrate having a first surface and a second surface opposite the first surface of the substrate, a cap juxtaposed with the first surface of the substrate, and a core juxtaposed with the second surface of the substrate. In some embodiments, the cap includes at least one of one or more polymers, at least one infrared-reflective pigment, a stabilizer package, one or more fillers, or combinations thereof. In some embodiments, the cap

includes at least one of one or more thermoplastic polyolefins, at least one infrared-reflective black pigment, a stabilizer package, one or more fillers, or combinations thereof. In some embodiments, the stabilizer package includes at least one ultraviolet (UV) absorber. In some embodiments, the cap does not include a white colorant. In some embodiments, the cap includes one or more
5 thermoplastic polyolefins, an ultraviolet absorber, an infrared-reflective black pigment, and optionally one or more fillers, and wherein the cap does not comprise at least one of a white colorant, a white pigment, or any combination thereof. In some embodiments, the infrared-reflective pigment is 0.01% by weight to 15% by weight of a total weight of the cap. In some embodiments, the core includes one or more polymers, a stabilizer package, one or more fillers, or
10 combinations thereof.

In some embodiments, the wire cover bracket includes a first end, a second end opposite the first end of the wire cover bracket, and at least one tab extending from the first end, wherein the at least one tab of the wire cover bracket of the one of the photovoltaic modules is configured to overlap the wire cover bracket of the adjacent another one of the photovoltaic modules. In some
15 embodiments, the wire cover bracket includes at least one clip configured to receive an electrical wire. In some embodiments, the wire cover bracket is attached to the first side lap by an adhesive. In some embodiments, the at least one cover is textured.

In some embodiments, the system further includes a plurality of step flaps, wherein each of the step flaps is installed adjacent to a corresponding one of the photovoltaic modules. In some
20 embodiments, the second side lap of each of the photovoltaic modules overlaps a corresponding at least one roofing shingle. In some embodiments, the roofing shingle is an asphalt shingle.

In some embodiments, the second side lap of the photovoltaic module is attached to the at least one roofing shingle by an adhesive, a fleece layer and an adhesive, plasma treatment, or combinations thereof. In some embodiments, the system further includes a first flashing base installed on the roof deck proximate to and aligned with the first wire channel, wherein the transition box is installed on the first flashing base. In some embodiments, the first flashing base includes an aperture, wherein the transition box includes a sidewall and a cover portion extending from the sidewall, and wherein the cover portion of the transition box covers at least a portion of the aperture of the first flashing base, and wherein the first junction box is located within the aperture. In some embodiments, the system further includes a second flashing base installed on the roof deck proximate to and aligned with the second wire channel, wherein the second flashing base includes an aperture, and wherein the second junction box is located within the aperture of the second flashing base. In some embodiments, the system further includes an electrical cable passthrough, wherein the electrical cable passthrough is located within the aperture of the second flashing base. In some embodiments, the system further includes a plurality of roofing shingles, wherein the roofing shingles overlay the first flashing base, the second flashing base, and a headlap of each of the jumper modules. In some embodiments, each of the photovoltaic shingles includes an adhesive located on a rear surface of the first layer. In some embodiments, the adhesive is at least one peel and stick film sheet.

Brief Description of the Drawings

FIGS. 1A through 1D are top plan and cross-sectional views of some embodiments of a photovoltaic shingle and some embodiments of a system of photovoltaic shingles;

FIGS. 2A through **2E** are top plan views, cross-sectional views and a bottom plan view of some embodiments of a photovoltaic shingle and some embodiments of a system of photovoltaic shingles;

FIGS. 3A through **3E** are embodiments of photovoltaic shingles and associated wireways
5 employed by the photovoltaic shingles;

FIGS. 4 and **5** are embodiments of roofing systems including photovoltaic shingles and associated wireways;

FIGS. 6 through **7B** are embodiments of wireways having flashing and covers;

FIGS. 8 and **9** are embodiments of photovoltaic shingles having wireways and associated
10 covers;

FIGS. 10 through **11** are embodiments of a wireway cover;

FIGS. 12A through **12D** are top perspective views of embodiments of a wireway cover;

FIGS. 13A and **13B** are top perspective views of embodiments of covers for wireways;

FIGS. 14A through **14E** illustrate embodiments of photovoltaic shingles and associated
15 wireways and covers;

FIGS. 15A through **15C** are top perspective views of embodiments of wireway covers including markings;

FIG. 16 is a top perspective view of some embodiments of a roofing system with photovoltaic shingles and the wireway covers of **FIGS. 15A** through **15C**;

FIGS. 17A and **17B** are a top plan view and side cross-sectional view, respectively, of
20 some embodiments of a system of photovoltaic shingles with electrical connectors;

FIGS. 18A and **18B** are a top plan view and side cross-sectional view, respectively, of some embodiments of a system of photovoltaic shingles with USB connectors;

FIG. 19 is a system of photovoltaic shingles having step flashing;

FIGS. 20, 21A and **21B** are embodiments of systems of photovoltaic shingles having integrated step flaps;

FIGS. 22A through **22D** are schematic views of some embodiments of a method of
5 installing a photovoltaic system;

FIGS. 23A through **23D** are schematic views of some embodiments of a method of installing a photovoltaic system;

FIG. 24 is a perspective view of a roofing system including some embodiments of a plurality of wireways;

10 **FIGS. 25** through **28** illustrate embodiments of a wireway;

FIGS. 29 through **32** illustrate embodiments of a wireway and an endcap employed thereby;

FIGS. 33 and **34** are top perspective and side elevational views, respectively, of some embodiments of a wireway;

15 **FIGS. 35A** and **35B** illustrate some embodiments of a lid for a wireway;

FIGS. 36A and **36B** illustrate some embodiments of a lid for a wireway;

FIGS. 37A and **37B** illustrate some embodiments of a lid for a wireway;

FIGS. 38A and **38B** illustrate some embodiments of a lid for a wireway;

FIGS. 39A and **39B** are top plan views of some embodiments of a photovoltaic module;

20 **FIGS. 40** and **41** are schematic view of some embodiments of a photovoltaic module;

FIG. 42 is a top plan view of some embodiments of a photovoltaic module;

FIG. 43 is a schematic view of some embodiments of a backsheet employed by a photovoltaic module;

FIG. 44 is a top perspective view of some embodiments of a jumper module for a photovoltaic system;

FIG. 45 is a top plan view of the jumper module shown in **FIG. 44**;

FIG. 46 is a side elevational view of the jumper module shown in **FIG. 44**;

5 **FIG. 47** is a bottom plan view of the jumper module shown in **FIG. 44**;

FIG. 48 is an exploded, top perspective view of an active portion of the jumper module shown in **FIG. 44**;

FIG. 49 is schematic view of the active portion of the jumper module shown in **FIG. 44**;

10 **FIG. 50** is a top plan view of a jumper module shown in **FIG. 44** overlaying another one of the jumper module;

FIGS. 51 through 57 are views of embodiments of a wire cover bracket;

FIG. 58 is an exploded, top perspective view of a photovoltaic system;

FIGS. 59A and 59B are views of embodiments of photovoltaic modules and associated wire cover brackets;

15 **FIG. 60** is a top perspective view of embodiments of overlapping wire cover brackets;

FIG. 61 is a top perspective view of embodiments of a cover and a cap installed on the wire cover brackets shown in **FIG. 60**;

FIG. 62 is a top perspective view of embodiments of a first flashing base employed by the photovoltaic system shown in **FIG. 58**;

20 **FIG. 63** is a top perspective view of embodiments of flashing bases installed on a roof deck;

FIGS. 64A through 65 are top perspective views of a transition box employed by the photovoltaic system shown in **FIG. 58**;

FIG. 66 is a top perspective view of embodiments of the transition box shown in **FIGS. 64A** through **65** installed on a roof deck;

FIG. 67B is a top perspective view of embodiments of a second flashing base employed by the photovoltaic system shown in **FIG. 58**; and

5 **FIG. 68** is a top perspective view of embodiments of a building integrated photovoltaic system installed on a roof deck.

Detailed Description

Referring to **FIGS. 1A** through **2D**, in some embodiments, a roofing system **5** includes a
10 plurality of photovoltaic shingles **10**, each of which includes a first layer **12** and a second layer **14** overlaying the first layer **12**. In some embodiments, the first layer **12** includes a head lap **16**. In some embodiments, the second layer **14** includes at least one solar cell **18**. In some embodiments, the at least one solar cell **18** includes a plurality of the solar cells **18**. In some embodiments, at least one of the plurality of photovoltaic shingles **10** overlays at least the head lap **16** of another of
15 the plurality of photovoltaic shingles **10**.

Still referring to **FIGS. 1A** through **2D**, in some embodiments, the first layer **12** includes a first end **20**, a second end **22** opposite the first end **20**, a third end **24** extending from the first end **20** of to the second end **22**, and a fourth end **26** opposite the third end **24** and extending from the first end **20** to the second end **22**. In some embodiments, the head lap **16** extends from the third
20 end **24** to the fourth end **26**. In some embodiments, the second layer **14** extends from the third end **24** of the first layer **12** to the fourth end **26** of the first layer **12**. In some embodiments, the second layer **14** extends intermediate the third and fourth ends **24, 26** of the first layer **12**. In some embodiments, the second layer **14** is located proximate to the second end **22** of the first layer **12**.

In an embodiment, the second layer **14** includes a first end **28**, a second end **30** opposite the first end **28**, a third end **32** extending from the first end **28** to the second end **30**, and a fourth end **34** opposite the third end **32** and extending from the first end **28** to the second end **30**. In some embodiments, the second end **30** of the second layer **14** is substantially aligned with the second end **22** of the first layer **12**.

In some embodiments, the head lap **16** includes a first width **W1** and the second layer **14** includes a second width **W2**. In some embodiments, the first width **W1** extends from the first end **20** of the first layer **12** to the first end **28** of the second layer **14**. In some embodiments, the second width **W2** extends from the first end **28** of the second layer **14** to the second end **30** of the second layer **14**. In some embodiments, the first width **W1** is greater than the second width **W2**. In some embodiments, the second width **W2** is greater than the first width **W1**. In some embodiments, the first width **W1** and the second width **W2** are equal to one another.

In some embodiments, the first width **W1** is in a range of 1 inch to 10 inches. In some embodiments, the first width **W1** is in a range of 2 inches to 10 inches. In some embodiments, the first width **W1** is in a range of 3 inches to 10 inches. In some embodiments, the first width **W1** is in a range of 4 inches to 10 inches. In some embodiments, the first width **W1** is in a range of 5 inches to 10 inches. In some embodiments, the first width **W1** is in a range of 6 inches to 10 inches. In some embodiments, the first width **W1** is in a range of 7 inches to 10 inches. In some embodiments, the first width **W1** is in a range of 8 inches to 10 inches. In some embodiments, the first width **W1** is in a range of 9 inches to 10 inches.

In some embodiments, the first width **W1** is in a range of 1 inch to 9 inches. In some embodiments, the first width **W1** is in a range of 2 inches to 9 inches. In some embodiments, the first width **W1** is in a range of 3 inches to 9 inches. In some embodiments, the first width **W1** is

in a range of 4 inches to 9 inches. In some embodiments, the first width **W1** is in a range of 5 inches to 9 inches. In some embodiments, the first width **W1** is in a range of 6 inches to 9 inches. In some embodiments, the first width **W1** is in a range of 7 inches to 9 inches. In some embodiments, the first width **W1** is in a range of 8 inches to 9 inches.

5 In some embodiments, the first width **W1** is in a range of 1 inch to 8 inches. In some embodiments, the first width **W1** is in a range of 2 inches to 8 inches. In some embodiments, the first width **W1** is in a range of 3 inches to 8 inches. In some embodiments, the first width **W1** is in a range of 4 inches to 8 inches. In some embodiments, the first width **W1** is in a range of 5 inches to 8 inches. In some embodiments, the first width **W1** is in a range of 6 inches to 8 inches.

10 In some embodiments, the first width **W1** is in a range of 7 inches to 8 inches.

 In some embodiments, the first width **W1** is in a range of 1 inch to 7 inches. In some embodiments, the first width **W1** is in a range of 2 inches to 7 inches. In some embodiments, the first width **W1** is in a range of 3 inches to 7 inches. In some embodiments, the first width **W1** is in a range of 4 inches to 7 inches. In some embodiments, the first width **W1** is in a range of 5

15 inches to 7 inches. In some embodiments, the first width **W1** is in a range of 6 inches to 7 inches.

 In some embodiments, the first width **W1** is in a range of 1 inch to 6 inches. In some embodiments, the first width **W1** is in a range of 2 inches to 6 inches. In some embodiments, the first width **W1** is in a range of 3 inches to 6 inches. In some embodiments, the first width **W1** is in a range of 4 inches to 6 inches. In some embodiments, the first width **W1** is in a range of 5

20 inches to 6 inches.

 In some embodiments, the first width **W1** is in a range of 1 inch to 5 inches. In some embodiments, the first width **W1** is in a range of 2 inches to 5 inches. In some embodiments, the

first width **W1** is in a range of 3 inches to 5 inches. In some embodiments, the first width **W1** is in a range of 4 inches to 5 inches.

In some embodiments, the first width **W1** is in a range of 1 inch to 4 inches. In some embodiments, the first width **W1** is in a range of 2 inches to 4 inches. In some embodiments, the first width **W1** is in a range of 3 inches to 4 inches. In some embodiments, the first width **W1** is in a range of 1 inch to 3 inches. In some embodiments, the first width **W1** is in a range of 2 inches to 3 inches. In some embodiments, the first width **W1** is in a range of 1 inch to 2 inches.

In some embodiments, the first width **W1** is 1 inch. In some embodiments, the first width **W1** is 2 inches. In some embodiments, the first width **W1** is 3 inches. In some embodiments, the first width **W1** is 4 inches. In some embodiments, the first width **W1** is 5 inches. In some embodiments, the first width **W1** is 6 inches. In some embodiments, the first width **W1** is 7 inches. In some embodiments, the first width **W1** is 8 inches. In some embodiments, the first width **W1** is 9 inches. In some embodiments, the first width **W1** is 10 inches.

In some embodiments, the second width **W2** is in a range of 1 inch to 10 inches. In some embodiments, the second width **W2** is in a range of 2 inches to 10 inches. In some embodiments, the second width **W2** is in a range of 3 inches to 10 inches. In some embodiments, the second width **W2** is in a range of 4 inches to 10 inches. In some embodiments, the second width **W2** is in a range of 5 inches to 10 inches. In some embodiments, the second width **W2** is in a range of 6 inches to 10 inches. In some embodiments, the second width **W2** is in a range of 7 inches to 10 inches. In some embodiments, the second width **W2** is in a range of 8 inches to 10 inches. In some embodiments, the second width **W2** is in a range of 9 inches to 10 inches.

In some embodiments, the second width **W2** is in a range of 1 inch to 9 inches. In some embodiments, the second width **W2** is in a range of 2 inches to 9 inches. In some embodiments,

the second width **W2** is in a range of 3 inches to 9 inches. In some embodiments, the second width **W2** is in a range of 4 inches to 9 inches. In some embodiments, the second width **W2** is in a range of 5 inches to 9 inches. In some embodiments, the second width **W2** is in a range of 6 inches to 9 inches. In some embodiments, the second width **W2** is in a range of 7 inches to 9 inches. In some
5 embodiments, the second width **W2** is in a range of 8 inches to 9 inches.

In some embodiments, the second width **W2** is in a range of 1 inch to 8 inches. In some embodiments, the second width **W2** is in a range of 2 inches to 8 inches. In some embodiments, the second width **W2** is in a range of 3 inches to 8 inches. In some embodiments, the second width **W2** is in a range of 4 inches to 8 inches. In some embodiments, the second width **W2** is in a range
10 of 5 inches to 8 inches. In some embodiments, the second width **W2** is in a range of 6 inches to 8 inches. In some embodiments, the second width **W2** is in a range of 7 inches to 8 inches.

In some embodiments, the second width **W2** is in a range of 1 inch to 7 inches. In some embodiments, the second width **W2** is in a range of 2 inches to 7 inches. In some embodiments, the second width **W2** is in a range of 3 inches to 7 inches. In some embodiments, the second width
15 **W2** is in a range of 4 inches to 7 inches. In some embodiments, the second width **W2** is in a range of 5 inches to 7 inches. In some embodiments, the second width **W2** is in a range of 6 inches to 7 inches.

In some embodiments, the second width **W2** is in a range of 1 inch to 6 inches. In some embodiments, the second width **W2** is in a range of 2 inches to 6 inches. In some embodiments, the second width **W2** is in a range of 3 inches to 6 inches. In some embodiments, the second width
20 **W2** is in a range of 4 inches to 6 inches. In some embodiments, the second width **W2** is in a range of 5 inches to 6 inches.

In some embodiments, the second width **W2** is in a range of 1 inch to 5 inches. In some embodiments, the second width **W2** is in a range of 2 inches to 5 inches. In some embodiments, the second width **W2** is in a range of 3 inches to 5 inches. In some embodiments, the second width **W2** is in a range of 4 inches to 5 inches.

5 In some embodiments, the second width **W2** is in a range of 1 inch to 4 inches. In some embodiments, the second width **W2** is in a range of 2 inches to 4 inches. In some embodiments, the second width **W2** is in a range of 3 inches to 4 inches. In some embodiments, the second width **W2** is in a range of 1 inch to 3 inches. In some embodiments, the second width **W2** is in a range of 2 inches to 3 inches. In some embodiments, the second width **W2** is in a range of 1 inch to 2
10 inches.

In some embodiments, the second width **W2** is 1 inch. In some embodiments, the second width **W2** is 2 inches. In some embodiments, the second width **W2** is 3 inches. In some embodiments, the second width **W2** is 4 inches. In some embodiments, the second width **W2** is 5 inches. In some embodiments, the second width **W2** is 6 inches. In some embodiments, the second
15 width **W2** is 7 inches. In some embodiments, the second width **W2** is 8 inches. In some embodiments, the second width **W2** is 9 inches. In some embodiments, the second width **W2** is 10 inches.

Still referring to **FIGS. 1A** through **2D**, in some embodiments, each of the plurality of photovoltaic shingles **10** includes a fold line **36** extending from the first end **20** of the first layer
20 **12** to the second end **22** of the first layer **12** and intermediate the third and fourth ends **24**, **26** of the first layer **12**. In some embodiments, the fold line **36** extends from and through the first end **28** of the second layer **14** to the second end **30** of the second layer **14**. In some embodiments, the fold line **36** enables the photovoltaic shingle **10** to be folded in half for reduction of space in

connection with the storage or transport of the photovoltaic shingle **10**. In some embodiments, each of the plurality of photovoltaic shingles **10** includes a first section **38** extending from the third end **24** of the first layer **12** to the fold line **36**, and a second section **40** extending from the fourth end **26** of the first layer **12** to the fold line **36**. In some embodiments, the first section **38** includes
5 a first portion **42** of the head lap **16** and a first portion **44** of the second layer **14**, and the second section **40** includes a second portion **46** of the head lap **16** and a second portion **48** of the second layer **14**. In some embodiments, the at least one solar cell **18** includes a first one **50** of the at least one solar cell **18** located in the first portion **44** of the second layer **14** and a second one **52** of the at least one solar cell **18** located in the second portion **48** of the second layer **14**. In some
10 embodiments, the first one **50** of the at least one solar cell **18** includes a first plurality of the solar cells **18**, and the second one **52** of the at least one solar cell **18** includes a second plurality of the solar cells **18**.

Referring to **FIGS. 2A** and **2C**, in some embodiments, the second layer **14** extends intermediate the third and fourth ends **24**, **26** of the first layer **12**. In some embodiments, the first
15 layer includes a first step flap **54** adjacent the third end **32** of the second layer **14** and a second step flap **56** adjacent the fourth end **34** of the second layer **14**. In some embodiments, the first step flap **54** includes a length **L1** extending from the third end **32** of the second layer **14** to the third end **24** of the first layer **12**. In some embodiments, the first step flap **54** includes a width **W3** extending from the first end **20** of the first layer **12** to the second end **22** of the first layer **12**. In some
20 embodiments, the second step flap **56** includes a length **L2** extending from the fourth end **34** of the second layer **14** to the fourth end **26** of the first layer **12**. In some embodiments, the second step flap **56** includes a width **W4** extending from the first end **20** of the first layer **12** to the second end **22** of the first layer **12**. In some embodiments, the width **W3** is equal to the width **W4**. In

some embodiments, the length **L1** and is equal to the length **L2**. In some embodiments, the head lap **16**, the first step flap **54**, and the second step flap **56** are contiguous.

In some embodiments, the second layer **14** extends from the third end **24** of the first layer **12** to a location intermediate the third and fourth ends **24**, **26** of the first layer **12**. In some
5 embodiments, the first layer **12** includes the second step flap **56** adjacent the fourth end **34** of the second layer **14**. In some embodiments, the head lap **16** and the second step flap **56** are contiguous. In some embodiments, the second layer **14** extends from the fourth end **26** of the first layer **12** to a location intermediate the third and fourth ends **24**, **26** of the first layer **12**. In some embodiments, the first layer **12** includes the first step flap **54** adjacent the third end **32** of the second layer **14**. In
10 some embodiments, the head lap **16** and the first step flap **54** are contiguous.

In some embodiments, each of the first layer **12** and the second layer **14** is composed of a polymer. In some embodiments, each of the first layer **12** and the second layer **14** is composed of thermoplastic polyolefin (TPO). In some embodiments, each of the first layer **12** and the second layer **14** is composed of polyethylene terephthalate (PET), polyethylene naphthalate (PEN),
15 polyetheretherketone (PEEK), polyaryletherketone (PAEK), polyarylate (PAR), polyetherimide (PEI), polyarylsulfone (PAS), polyethersulfone (PES), polyamideimide (PAI), or polyimide; polyvinyl chloride (PVC); ethylene propylene diene monomer (EPDM) rubber; silicone rubber; fluoropolymers - ethylene tetrafluoroethylene (ETFE), polyvinylidene fluoride (PVDF), tetrafluoroethylene-hexafluoropropylene copolymers (FEP), and tetrafluoroethylene-
20 hexafluoropropylene-vinylidene fluoride copolymers (THV), or blends thereof.

In some embodiments, the first layer **12** and the second layer **14** are laminated. In some embodiments, the second layer **14** is ultrasonically welded to the first layer **12**. In some

embodiments, the second layer **14** is heat welded to the first layer **12**. In some embodiments, the second layer **14** is thermally bonded to the first layer **12**.

In some embodiments, an impact resistance of the photovoltaic shingle **10** is characterized by a Class 4 rating in accordance with the standards of ANSI FM 4473 test standards.

5 In some embodiments, the plurality of photovoltaic shingles **10** is installed on a roof deck **200**. In some embodiments, the plurality of photovoltaic shingles **10** is installed directly to the roof deck **200**. In some embodiments, each of the plurality of photovoltaic shingles **10** is installed on the roof deck **200** by a plurality of fasteners **58**. In some embodiments, the plurality of fasteners **58** are installed through the head lap **16**. In some embodiments, the plurality of fasteners **58**
10 includes a plurality of nails.

Referring to **FIG. 2E**, in some embodiments, each of the plurality of photovoltaic shingles **10** is installed on the roof deck **200** by an adhesive **60**. In some embodiments, the adhesive **60** is adhered directly to the roof deck **200**. In some embodiments, the adhesive **60** is adhered to an underlayment. In some embodiments, the underlayment is adhered directly to the roof deck **200**.
15 In some embodiments, the adhesive **60** is located on a rear surface **62** of the photovoltaic shingle **10**. In some embodiments, the adhesive **60** includes at least one adhesive strip. In some embodiments, the adhesive **60** includes a plurality of adhesive strips. In some embodiments, the plurality of adhesive strips is arranged intermittently. In some embodiments, the adhesive **60** is located proximate to one edge of the photovoltaic shingle **10**. In some embodiments, the adhesive
20 **60** is a peel and stick film sheet. In some embodiments, the peel and stick film sheet includes at least one sheet of film removably attached to the rear surface **62**. In some embodiments, the peel and stick film sheet is composed of EverGuard Freedom HW peel and stick membrane manufactured by GAF. In some embodiments, the adhesive **60** includes polyvinyl butyrate,

acrylic, silicone, or polycarbonate. In some embodiments, the adhesive **60** includes pressure sensitive adhesives.

In some embodiments, the system **5** includes an underlayment layer **202** installed on the roof deck **200** (see **FIG. 6**). In some embodiments, the plurality of photovoltaic shingles **10** overlay the underlayment layer **202**.

Referring to **FIGS. 1A** through **1D**, in some embodiments, one of the plurality of photovoltaic shingles **10** overlays the head lap **16** of another of the plurality of photovoltaic shingles **10**. In some embodiments, one of the plurality of photovoltaic shingles **10** overlays the first section **38** and the second section **40** of the another of the of the plurality of photovoltaic shingles **10** for a staggered installation of the photovoltaic shingles **10**. In some embodiments, the first section **38** of the one of the plurality of photovoltaic shingles **10** overlays the first section **38** and the second section **40** of the another of the of the plurality of photovoltaic shingles **10**. In some embodiments, the second section **40** of the one of the plurality of photovoltaic shingles **10** overlays the first section **38** and the second section **40** of the another of the of the plurality of photovoltaic shingles **10**.

Referring to **FIGS. 2A** through **2D**, in some embodiments, the first step flap **54** of one of the plurality of photovoltaic shingles **10** overlays the first step flap **54** of another of the plurality of photovoltaic shingles **10**, and the second step flap **56** of the one of the plurality of photovoltaic shingles **10** overlays the second step flap **56** of the another of the plurality of photovoltaic shingles **10** for a non-staggered installation of the photovoltaic shingles **10**. In some embodiments, the first step flap **54** of the one of the plurality of photovoltaic shingles **10** substantially aligns with the first step flap **54** of the another of the plurality of photovoltaic shingles **10**, and the second step flap **56** of the one of the plurality of photovoltaic shingles **10** substantially aligns with the second step flap

56 of the another of the plurality of photovoltaic shingles **10**. In some embodiments, the third end **32** of the second layer **14** of the one of the plurality of photovoltaic shingles **10** substantially aligns with the third end **32** of the second layer **14** of the another of the plurality of photovoltaic shingles **10**, and the fourth end **34** of the second layer **14** of the one of the plurality of photovoltaic shingles **10** substantially aligns with the fourth end **34** of the second layer **14** of the another of the plurality of photovoltaic shingles **10**. In some embodiments, the second step flap **56** of one of the plurality of photovoltaic shingles **10** overlays the first step flap **54** of another of the plurality of photovoltaic shingles **10**.

In some embodiments, each of the plurality of photovoltaic shingles **10** meets the standards of Florida Testing Application Standard (TAS) 100-95 when tested in accordance therewith.

In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 5 mm to 20 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 6 mm to 20 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 7 mm to 20 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 8 mm to 20 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 9 mm to 20 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 10 mm to 20 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 11 mm to 20 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 12 mm to 20 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 13 mm to 20 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 14 mm to 20 mm. In some embodiments,

each of the plurality of photovoltaic shingles includes a height **H1** in a range of 15 mm to 20 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 16 mm to 20 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height in a range of 17 mm to 20 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 18 mm to 20 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 19 mm to 20 mm.

In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 5 mm to 19 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 6 mm to 19 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 7 mm to 19 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 8 mm to 19 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 9 mm to 19 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 10 mm to 19 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 11 mm to 19 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 12 mm to 19 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 13 mm to 19 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 14 mm to 19 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 15 mm to 19 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 16 mm to 19 mm. In some embodiments, each of the plurality of photovoltaic shingles

includes a height **H1** in a range of 17 mm to 19 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 18 mm to 19 mm.

In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 5 mm to 18 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 6 mm to 18 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 7 mm to 18 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 8 mm to 18 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 9 mm to 18 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 10 mm to 18 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 11 mm to 18 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 12 mm to 18 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 13 mm to 18 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 14 mm to 18 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 15 mm to 18 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 16 mm to 18 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 17 mm to 18 mm.

In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 5 mm to 17 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 6 mm to 17 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 7 mm to 17 mm. In some embodiments,

each of the plurality of photovoltaic shingles includes a height **H1** in a range of 8 mm to 17 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 9 mm to 17 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 10 mm to 17 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 11 mm to 17 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 12 mm to 17 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 13 mm to 17 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 14 mm to 17 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 15 mm to 17 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 16 mm to 17 mm.

In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 5 mm to 16 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 6 mm to 16 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 7 mm to 16 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 8 mm to 16 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 9 mm to 16 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 10 mm to 16 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 11 mm to 16 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 12 mm to 16 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a

height **H1** in a range of 13 mm to 16 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 14 mm to 16 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 15 mm to 16 mm.

In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1**
5 in a range of 5 mm to 15 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 6 mm to 15 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 7 mm to 15 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 8 mm to 15 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a
10 range of 9 mm to 15 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 10 mm to 15 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 11 mm to 15 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 12 mm to 15 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a
15 height **H1** in a range of 13 mm to 15 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 14 mm to 15 mm.

In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 5 mm to 14 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 6 mm to 14 mm. In some embodiments, each of the plurality
20 of photovoltaic shingles includes a height **H1** in a range of 7 mm to 14 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 8 mm to 14 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 9 mm to 14 mm. In some embodiments, each of the plurality of photovoltaic shingles

includes a height **H1** in a range of 10 mm to 14 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 11 mm to 14 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 12 mm to 14 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 13 mm to 14 mm.

In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 5 mm to 13 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 6 mm to 13 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 7 mm to 13 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 8 mm to 13 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 9 mm to 13 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 10 mm to 13 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 11 mm to 13 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 12 mm to 13 mm.

In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 5 mm to 12 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 6 mm to 12 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 7 mm to 12 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 8 mm to 12 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 9 mm to 12 mm. In some embodiments, each of the plurality of photovoltaic shingles

includes a height **H1** in a range of 10 mm to 12 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 11 mm to 12 mm.

In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 5 mm to 11 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 6 mm to 11 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 7 mm to 11 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 8 mm to 11 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 9 mm to 11 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 10 mm to 11 mm.

In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 5 mm to 10 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 6 mm to 10 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 7 mm to 10 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 8 mm to 10 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 9 mm to 10 mm.

In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 5 mm to 9 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 6 mm to 9 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 7 mm to 9 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 8 mm to 9 mm.

In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 5 mm to 8 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 6 mm to 8 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 7 mm to 8 mm.

5 In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 5 mm to 7 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 6 mm to 7 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** in a range of 5 mm to 6 mm.

10 In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** of 5 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** of 6 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** of 7 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** of 8 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** of 9 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** of 10 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** of 11 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** of 12 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** of 13 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** of 14 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** of 15 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** of 16 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** of 17 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** of 18 mm. In some embodiments, each

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of the plurality of photovoltaic shingles includes a height **H1** of 19 mm. In some embodiments, each of the plurality of photovoltaic shingles includes a height **H1** of 20 mm.

Referring to **FIGS. 3A** through **5**, in some embodiments, the system **5** includes at least one wireway **100** installed proximate to the plurality of photovoltaic shingles **10** on the roof deck **200**.

5 In some embodiments, the at least one wireway **100** is installed intermediate the plurality of photovoltaic shingles **10**. In some embodiments, the at least one wireway **100** is installed proximate to each of the third ends **32** of the second layers **14**. In some embodiments, the at least one wireway **100** overlays each of the first step flaps **54**. In some embodiments, the at least one wireway **100** is installed proximate to each of the fourth ends **34** of the second layers **14**. In some
10 embodiments, the at least one wireway **100** overlays each of the second step flaps **56**. In some embodiments, the at least one wireway **100** is installed intermediate each of the third ends **32** of a first plurality of the photovoltaic shingles **10** and the fourth ends **34** of a second plurality of the photovoltaic shingles **10**. In some embodiments, the at least one wireway **100** overlays each of the first step flaps **54**. In some embodiments, the at least one wireway **100** overlays each of the
15 second step flaps **56**. In some embodiments, the step flaps **54**, **56** form the wireway **100**.

Referring to **FIGS. 6** through **11**, in some embodiments, the at least one wireway **100** includes a pair of rails **102** spaced apart from one another. In some embodiments, the rails **102** extend outwardly from the roof deck **200**. In some embodiments, the rails **102** are substantially parallel to another. In some embodiments, each of the rails **102** includes side flashing **104**. In
20 some embodiments, each of the side flashing **104** includes a first portion **106** positioned on the roof deck **200** and second portion **108** extending obliquely and inwardly in a first direction relative to the first portion **106**. In some embodiments, slots **109** are formed between the first portions **106** and the second portions **108**. In some embodiments, the at least one wireway **100** is rectangular

in shape. In some embodiments, the photovoltaic shingles **10** overlay the second portion **108** of the side flashing **104**. In some embodiments, the at least one wireway **100** is sized and shaped to receive electrical components of a photovoltaic system, such as an electrical junction box, electrical wire, and electrical connectors.

5 Still referring to **FIGS. 6** through **11**, in some embodiments, the at least one wireway **100** includes a lid **110**. In some embodiments, the lid **110** is removably attached to the at least one wireway **100**. In some embodiments, the lid **110** includes a cover portion **112** and a pair of rails **114** spaced apart from one another and extending obliquely and inwardly in a second direction opposite the first direction of the second portion **108** of the rails **102**. In some embodiments, the
10 lid **110** is removably engaged with the side flashing **104** of the wireway **100** such that the rails **114** of the lid **110** engage (e.g., snap-in) the second portions **108** of the side flashing **104**. In some embodiments, the lid **110** is substantially rectangular in shape. In some embodiments, the rails **114** extend outwardly and obliquely in the first direction. In some embodiments, the lid **110** is removably attached to the at least one wireway **100** by screws, nails, rivets, adhesives or other
15 fasteners.

In some embodiments, the at least one wireway **100** includes a plurality of wireways **100**. In some embodiments, one of the lids **110** of one of the plurality of wireways **100** overlaps another of the lids **110** of another of the plurality of wireways **100** (see **FIGS. 9** through **11**). In some embodiments, the overlapping lids **110** promote water shedding. In some embodiments, the at
20 least one wireway **100** is moisture resistant. As used herein, the term “moisture resistant” means having a water transmission rate of less than or equal to 0.05 U.S. perms, as measured by ASTM E 96, Procedure B – Standard Test Methods for Water Vapor Transmission of Materials. In some embodiments, the wireway **100** withstands walking loads/step resistance that conforms to

standards under UL 3741 test standards (UL Standard for Safety Photovoltaic Hazard Control). In some embodiments, the wireway **100** includes an axe impact resistance that conforms to standards under UL 3741 test standards. In some embodiments, the wireway **100** includes a body fall resistance that conforms to standards under UL 3741 test standards.

5 In certain embodiments, the lid **110** includes a plurality of louvers **116**. See **FIGS. 12C** and **12D**. In some embodiments, the louvers **116** are formed within the rails **114** of the lid **110**. In some embodiments, the louvers **116** are formed within the cover portion **112**. In some embodiments, the louvers **116** are elongated. In some embodiments, the louvers **116** are rectangular in shape. In some embodiments, the louvers **116** are semi-circular in shape.

10 In some embodiments, the lid **110** includes at least one support member **118** extending from an interior surface **120** of the cover portion **112**. In some embodiments, the at least one support member **118** includes a plurality of support members. In some embodiments, each of the plurality of support members **118** is spaced apart from one another. In some embodiments, each of the plurality of support members **118** is oriented in at least two opposing rows (see **FIGS. 10**
15 and **11**). In some embodiments, the at least one support member **118** is integral with the cover portion **112**. In some embodiments, the at least one support member **118** is formed by crimping a section of the cover portion **112** (see **FIGS. 12A** and **13A**). In some embodiments, the at least one support member **118** is attached to the interior surface **120** of the cover portion **112** (see **FIGS. 12B** and **13B**). In some embodiments, the at least one support member **118** is attached to the
20 interior surface **120** of the cover portion **112** by welding. In some embodiments, the at least one support member **118** is attached to the interior surface **120** of the cover portion **112** by an adhesive. In some embodiments, the at least one support member **118** includes a T-rail shape.

Referring to **FIGS. 14A** through **14C**, In some embodiments, the lid **110** is attached to the first layer **12** of one the photovoltaic shingles **10** by an adhesive **121**. In some embodiments, the lid **110** includes a hook member **122**. In some embodiments, the hook member **122** includes an upper rail **124** and a lower rail **126** spaced apart from and substantially parallel to the upper rail **124**. In some embodiments, the hook member **122** is removably positioned intermediate the first layer **12** of one of the plurality of photovoltaic shingles **10** and the second layer **14** of the one of the plurality of photovoltaic shingles **10** such that the second layer **14** is positioned between the upper and lower rails **124, 126**.

Referring to **FIGS. 14D** and **14E**, in some embodiments, the wireway **100** includes a length **L1** of 100 mm to 450 mm. In some embodiments, the wireway **100** includes a length **L1** of 100 mm to 400 mm. In some embodiments, the wireway **100** includes a length **L1** of 100 mm to 350 mm. In some embodiments, the wireway **100** includes a length **L1** of 100 mm to 300 mm. In some embodiments, the wireway **100** includes a length **L1** of 100 mm to 250 mm. In some embodiments, the wireway **100** includes a length **L1** of 100 mm to 200 mm. In some embodiments, the wireway **100** includes a length **L1** of 100 mm to 150 mm.

In some embodiments, the wireway **100** includes a length **L1** of 150 mm to 450 mm. In some embodiments, the wireway **100** includes a length **L1** of 150 mm to 400 mm. In some embodiments, the wireway **100** includes a length **L1** of 150 mm to 350 mm. In some embodiments, the wireway **100** includes a length **L1** of 150 mm to 300 mm. In some embodiments, the wireway **100** includes a length **L1** of 150 mm to 250 mm. In some embodiments, the wireway **100** includes a length **L1** of 150 mm to 200 mm.

In some embodiments, the wireway **100** includes a length **L1** of 200 mm to 450 mm. In some embodiments, the wireway **100** includes a length **L1** of 200 mm to 400 mm. In some

embodiments, the wireway **100** includes a length **L1** of 200 mm to 350 mm. In some embodiments, the wireway **100** includes a length **L1** of 200 mm to 300 mm. In some embodiments, the wireway **100** includes a length **L1** of 200 mm to 250 mm.

In some embodiments, the wireway **100** includes a length **L1** of 250 mm to 450 mm. In
5 some embodiments, the wireway **100** includes a length **L1** of 250 mm to 400 mm. In some
embodiments, the wireway **100** includes a length **L1** of 250 mm to 350 mm. In some embodiments,
the wireway **100** includes a length **L1** of 250 mm to 300 mm.

In some embodiments, the wireway **100** includes a length **L1** of 300 mm to 450 mm. In
some embodiments, the wireway **100** includes a length **L1** of 300 mm to 400 mm. In some
10 embodiments, the wireway **100** includes a length **L1** of 300 mm to 350 mm. In some
embodiments, the wireway **100** includes a length **L1** of 350 mm to 450 mm. In some embodiments,
the wireway **100** includes a length **L1** of 350 mm to 400 mm. In some embodiments, the wireway
100 includes a length **L1** of 400 mm to 450 mm.

In some embodiments, the wireway **100** includes a width **W1** of 100 mm to 200 mm. In
15 some embodiments, the wireway **100** includes a width **W1** of 100 mm to 175 mm. In some
embodiments, the wireway **100** includes a width **W1** of 100 mm to 150 mm. In some
embodiments, the wireway **100** includes a width **W1** of 100 mm to 125 mm.

In some embodiments, the wireway **100** includes a width **W1** of 125 mm to 200 mm. In
some embodiments, the wireway **100** includes a width **W1** of 125 mm to 175 mm. In some
20 embodiments, the wireway **100** includes a width **W1** of 125 mm to 150 mm. In some
embodiments, the wireway **100** includes a width **W1** of 150 mm to 200 mm. In some
embodiments, the wireway **100** includes a width **W1** of 150 mm to 175 mm. In some
embodiments, the wireway **100** includes a width **W1** of 175 mm to 200 mm.

In some embodiments, the wireway **100** includes a height **H1** of 5 mm to 25 mm. In some embodiments, the wireway **100** includes a height **H1** of 5 mm to 20 mm. In some embodiments, the wireway **100** includes a height **H1** of 5 mm to 15 mm. In some embodiments, the wireway **100** includes a height **H1** of 5 mm to 10 mm.

5 In some embodiments, the wireway **100** includes a height **H1** of 10 mm to 25 mm. In some embodiments, the wireway **100** includes a height **H1** of 10 mm to 20 mm. In some embodiments, the wireway **100** includes a height **H1** of 10 mm to 15 mm. In some embodiments, the wireway **100** includes a height **H1** of 15 mm to 25 mm. In some embodiments, the wireway **100** includes a height **H1** of 15 mm to 20 mm. In some embodiments, the wireway **100** includes a height **H1** of
10 20 mm to 25 mm.

In some embodiments, the wireway **100** is composed of a polymeric material. In some embodiments, the wireway **100** is composed of polypropylene. In some embodiments, the wireway **100** is composed of polyethylene. In some embodiments, the wireway **100** is composed of polyethylene. In some embodiments, the wireway **100** is composed of metal. In some
15 embodiments, the wireway **100** is composed of aluminum.

In some embodiments, the wireway **100** includes a fire resistance that conforms to standards under UL 94 test standards. In some embodiments, the wireway **100** includes a fire-resistance having a V-0 rating in accordance with the standards of UL 94 test standards. In some
20 embodiments, the wireway **100** includes a fire-resistance having a V-1 rating in accordance with the standards of UL 94 test standards. In some embodiments, the wireway **100** includes a fire-resistance having a V-2 rating in accordance with the standards of UL 94 test standards. In some embodiments, the photovoltaic shingle **10** is a component of a roofing/photovoltaic system that conforms to standards under UL 790/ASTM E 108 test standards. In some embodiments, the

roofing/photovoltaic system includes a fire-resistance having a Class A rating in accordance with the standards of UL 790/ASTM E 108 test standards.

Referring to **FIGS. 15A** through **16**, in some embodiments, the outer surface **119** of the cover portion **112** of the lid **110** includes at least one band **128**. In some embodiments, the at least one band **128** includes a first color. In some embodiments, the first color is different from a color of a remainder of the outer surface **119**. In some embodiments, the lid **110** includes a first end **130**, a second end **132** opposite the first end **130**, a third end **134** extending from the first end **130** to the second end **132**, and a fourth end **136** extending from the first end **130** to the second end **132**.

In some embodiments, one of the at least one band **128** extends from the first end **130** to the second end **132**. In some embodiments, the one of the at least one band **128** is proximate to the third end **134**. See **FIG. 15A**. In some embodiments, the one of the at least one band **128** is proximate to the fourth end **136**. See **FIG. 15B**. In some embodiments, the one of the at least one band **128** is intermediate the third end **134** and the fourth end **136**. See **FIG. 15C**. In some embodiments, one of the at least one band **128** extends from the third end **134** to the fourth end **136**. In some embodiments, the one of the at least one band **128** is proximate to the first end **130**. In some embodiments, the one of the at least one band **128** is proximate to the second end **132**. In some embodiments, the at least one band **128** includes a second band **128**, wherein the second band **128** extends from the first end **130** to the second end **132**. In some embodiments, the second band **128** is proximate to the third end **134**. In some embodiments, the second band **128** is proximate to the fourth end **136**. In some embodiments, the second band **128** is intermediate the third end **134** and the fourth end **136**. In some embodiments, the bands **128** mimic the appearance of the photovoltaic shingles **10** to provide a blended aesthetic look between the lids **110**, the

photovoltaic shingles **10**, and a plurality of roofing shingles **204** of the roofing system **5** (see **FIG. 16**).

Referring to **FIGS. 17A** through **18B**, in some embodiments, the at least one solar cell **18** includes an electrical bussing **140** and at least one electrical connector **142** electrically connected to the electrical bussing **140**. In some embodiments, the at least one electrical connector **142** is positioned on the head lap **16**. In some embodiments, the at least one electrical connector **142** includes a first electrical connector **142a** and a second electrical connector **142b**. In some embodiments, the first electrical connector **142a** is positioned proximate to the third end **24** and the second electrical connector **142b** is positioned proximate to the fourth end **26**. In some embodiments, the first electrical connector **142a** of one of the plurality of photovoltaic shingles **10** is connected to the second electrical connector **142b** of another of the plurality of photovoltaic shingles **10**. In some embodiments, the first electrical connector **142a** is a male connector and the second electrical connector **142b** is a female connector. In some embodiments, the first and second electrical connectors **142a**, **142b** are connected to one another by an electrical wire **144** (see **FIGS. 17A** and **17B**). In some embodiments, the first and second electrical connectors **142a**, **142b** are removably connected to one another. In some embodiments, the first and second electrical connectors **142a**, **142b** are USB connectors (see **FIGS. 18A** and **18B**). In some embodiments, when the photovoltaic shingles **10** are installed to the roof deck **200**, each of the electrical connectors **142** are positioned within a corresponding space **206** formed between one of the photovoltaic shingles **10** and another overlapping one of the photovoltaic shingles **10**.

Referring to **FIG. 19**, in some embodiments, the system **5** includes step flashing **208** installed on the roof deck **200**. In some embodiments, the step flashing **208** includes a first portion **210** and a second portion **212**. In some embodiments, the photovoltaic shingle **10** overlays the

first portion **210**, while one of the roofing shingles **204** overlays the second portion **212**. In some embodiments, the roofing shingles **204** include asphalt shingles. Referring to **FIGS. 20, 21A** and **21B**, in some embodiments, the one of the roofing shingles **204** overlays one of the step flaps **54, 56** of a corresponding one of the photovoltaic shingles **10**. In some embodiments, the plurality of
5 photovoltaic shingles **10** is coplanar with the plurality of roofing shingles **204**. As used herein, the term “coplanar” means the plurality of photovoltaic shingles **10** and the plurality of roofing shingles **204** are positioned and extend within the same plane, or the plurality of photovoltaic shingles **10** is positioned and extends in a first plane, and the plurality of roofing shingles **204** is positioned and extends within a second plane that is offset from the first plane of a relatively of no
10 more than ten percent of a height measured from the roof deck to an upper surface of the plurality of photovoltaic shingles.

In some embodiments, a method of installing a photovoltaic system includes the following steps:

- obtaining a first photovoltaic shingle and a second photovoltaic shingle, each of
15 which includes a first layer, and a second layer overlaying the first layer, wherein the first layer includes a head lap, wherein the second layer includes at least one solar cell;
- installing the first photovoltaic shingle on a roof deck; and
- overlaying the second photovoltaic shingle on at least the head lap of the first photovoltaic shingle.

20 In some embodiments, the method of installing the photovoltaic system may include the step of installing a wireway proximate to the plurality of photovoltaic shingles. In some embodiments, the method of installing the photovoltaic system may include the step of installing at least one electrical junction box installed within the at least one wireway. In some embodiments,

the method of installing the photovoltaic system may include the step of installing at least one lid on the at least one wireway.

Referring to **FIGS. 22A** through **22D**, in some embodiments, a method of installing a photovoltaic system includes the following steps:

- 5 • obtaining a first photovoltaic shingle, a second photovoltaic shingle, a third photovoltaic shingle, and fourth photovoltaic shingle, each of which includes a first layer, and a second layer overlaying the first layer, wherein the first layer includes a head lap and a step flap, wherein the second layer includes at least one solar cell;
- installing a junction box on the step flap of the first photovoltaic shingle;
- 10 • installing the second photovoltaic shingle on a roof deck;
- installing the first photovoltaic shingle on the roof deck by overlaying the step flap of the second photovoltaic shingle with the step flap of the first photovoltaic shingle;
- installing a junction box on the step flap of the third photovoltaic shingle;
- installing the fourth photovoltaic shingle on the roof deck by overlaying the fourth
- 15 photovoltaic shingle on at least the head lap of the second photovoltaic shingle;
- installing the third photovoltaic shingle on the roof deck by overlaying the step flap of the third photovoltaic shingle with the step flap of the fourth photovoltaic shingle and overlaying the third photovoltaic shingle on at least the head lap of the first photovoltaic shingle.

In some embodiments, the method of installing the photovoltaic system may include the step of covering each of the step flaps and junction boxes with a corresponding lid.

Referring to **FIGS. 23A** through **23D**, in some embodiments, a method of installing a photovoltaic system includes the following steps:

- obtaining a first photovoltaic shingle, a second photovoltaic shingle, a third photovoltaic shingle, and a fourth photovoltaic shingle, each of which includes a first layer, and a second layer overlaying the first layer, wherein the first layer includes a head lap, wherein the second layer includes at least one solar cell, and wherein each of the first photovoltaic shingle and the third photovoltaic shingle includes a wireway located at a first end thereof;
5
- installing a junction box on each of the corresponding wireways of the first and third photovoltaic shingles;
- installing the first photovoltaic shingle on a roof deck;
- installing the second photovoltaic shingle on the roof deck such that a first end of
10 the second photovoltaic shingle abuts the wireway of the first photovoltaic shingle;
- installing the third photovoltaic shingle on the roof deck by overlaying the third photovoltaic shingle on at least the head lap of the first photovoltaic shingle; and
- installing the fourth photovoltaic shingle on the roof deck such that a first end of the fourth photovoltaic shingle abuts the wireway of the third photovoltaic shingle and overlays at
15 least the head lap of the second photovoltaic shingle.

In some embodiments, the method of installing the photovoltaic system may include the step of covering each of the wireways and junction boxes with a corresponding lid.

In some embodiments, a method of installing a photovoltaic system includes the following steps:

- Obtaining a plurality of photovoltaic shingles, with each photovoltaic shingle of the plurality of the photovoltaic shingles including a first end, a first layer including a head lap portion, a second layer overlaying the first layer, the second layer including at least one solar cell,
20

- Laying a first photovoltaic shingle of the plurality of photovoltaic shingles directly on a deck surface of a steep slope roof.

- Attaching the first photovoltaic shingle of the plurality of photovoltaic shingles to the deck surface of the steep slope roof.

5 • Laying a second photovoltaic shingle of the plurality of photovoltaic shingles over at least a part of the head lap portion of the first photovoltaic shingle of the plurality of photovoltaic shingles.

- Attaching the second photovoltaic shingle to the deck surface of the steep slope roof to form a roof integrated photovoltaic system.

10 As defined herein, a “steep slope roof” is any roof substrate that is disposed on a roof having a pitch of Y/X , where Y and X are in a ratio of 4:12 to 12:12, where Y corresponds to the “rise” of the roof, and where X corresponds to the “run” of the roof.

In some embodiments, Y and X are in a ratio of 5:12 to 12:12. In some embodiments, Y and X are in a ratio of 6:12 to 12:12. In some embodiments, Y and X are in a ratio of 7:12 to 12:12. In some embodiments, Y and X are in a ratio of 6:12 to 12:12. In some embodiments, Y and X are in a ratio of 8:12 to 12:12. In some embodiments, Y and X are in a ratio of 6:12 to 12:12. In some embodiments, Y and X are in a ratio of 9:12 to 12:12. In some embodiments, Y and X are in a ratio of 10:12 to 12:12. In some embodiments, Y and X are in a ratio of 11:12 to 12:12.

20 In some embodiments, Y and X are in a ratio of 4:12 to 11:12. In some embodiments, Y and X are in a ratio of 4:12 to 10:12. In some embodiments, Y and X are in a ratio of 4:12 to 9:12. In some embodiments, Y and X are in a ratio of 4:12 to 8:12. In some embodiments, Y and X are in a ratio of 4:12 to 7:12. In some embodiments, Y and X are in a ratio of 4:12 to 6:12. In some embodiments, Y and X are in a ratio of 4:12 to 5:12.

[1] In some embodiments, Y and X are in a ratio of 5:12 to 11:12. In some embodiments, Y and X are in a ratio of 6:12 to 10:12. In some embodiments, Y and X are in a ratio of 7:12 to 9:12.

In some embodiments, Y and X are in a ratio of 2:12. In some embodiments, Y and X are in a ratio of 3:12.

5 Referring to **FIG. 24**, in some embodiments, a roofing system **310** includes a plurality of solar shingles **312** arranged in a plurality of rows, a plurality of roofing shingles **314**, and a plurality of wireways **300**. In some embodiments, the plurality of rows of the solar shingles **312** includes an upper row **R1** and a lower row **R2**. In some embodiments, each of the wireways **300** includes a length **L1**. In some embodiments, the length **L1** extends from the lower row **R2** to the upper
10 row **R1**. In some embodiments, the length **L1** extends from the lower row **R2** to at least to the upper row **R1**. In some embodiments, the length **L1** extends from the lower row **R2** to a location past the upper row **R1**. In some embodiments, the wireways **300** includes a lid **316**. In some embodiments, the lid **316** is a single lid that extends the length **L1**.

Referring to **FIGS. 25** through **27**, in some embodiments, a wireway **400** includes a bracket
15 **402** and a lid **404** attached removably to the bracket **402**. In some embodiments, the bracket **402** includes a body **406** having a first end **408**, a second end **410** opposite the first end **408**, and a pair of side edges **412**, **414** extending from the first end **408** to the second end **410**. In some embodiments, the body **406** is rectangular in shape. In some embodiments, the body **406** includes a first alignment portion **416** located proximate to the first end **408** and a second alignment portion
20 **418** located proximate to the second end **410**. In some embodiments, the first alignment portion **416** includes a base **419** and a tab **420** connected to the base **419** and extending outwardly and spaced from a surface **421** of the body **406**. In some embodiments, the tab **420** includes an L-

shape. In some embodiments, the second alignment portion **418** includes a slot **422**. In some embodiments, the slot **422** is rectangular in shape.

In some embodiments, the bracket **402** includes a plurality of clips **424**. In some embodiments, the plurality of clips **424** extends outwardly from the surface **421**. In some
5 embodiments, each of the plurality of clips **424** is curvilinear in shape and includes a slot **426**. In some embodiments, the slot **426** is sized and shaped to receive and hold an electrical wire or cable therein. In some embodiments, one of the plurality of clips **424** is located proximate to the first end **408** and another of the plurality of clips **424** is located proximate to the second end **410**. In some embodiments, the bracket **402** includes a plurality of stops **428** located proximate to the
10 second end **410**. In some embodiments, one of the plurality of stops **428** is located proximate to the first end **408** and another of the plurality of stops **428** is located proximate to the second end **410**. In some embodiments, the bracket **402** includes a plurality of hold down portions **430**. In some embodiments, one of the plurality of hold down portions **430** is located proximate to the first end **408** and another of the plurality of hold down portions **430** is located proximate to the second
15 end **410**. In some embodiments, each of the hold down portions **430** extends from a first end **432**, located proximate to the second end **410**, and to a second end **434**, located intermediate the first end **408** and the second end **410**. In some embodiments, each of the hold down portions **430** includes a stepped surface **431**. In some embodiments, each of the stepped surfaces **431** provides clearance for an adjacent photovoltaic shingle.

20 Referring to **FIG. 27**, in some embodiments, the lid **404** includes a first portion **436** and side portions **438** extending from the first portion **436**. In some embodiments, the side portions **438** are angled (i.e., oblique) relative to the first portion **436**. In some embodiments, the side portions **438** are angled to prevent shading over adjacent photovoltaic cells. In some embodiments,

each of the side portions **438** includes a tab portion **440** that is sized and shaped to removably engage a corresponding one of the hold down portions **430** of the bracket **402**. In some embodiments, the lid **404** includes a plurality of support members **442** extending from an interior surface **444** of the lid **404**. In some embodiments, each of the plurality of support members **442**
5 engages a corresponding one of the plurality of stops **428** of the bracket **402**. In some embodiments, air is permitted to enter the wireway **400** through the side edges **412**, **414** for ventilation, since the hold down portions **430** do not extend the entire length of the wireway **400**.

Referring to **FIG. 28**, in some embodiments, a plurality of the wireways **400** are connected to one another. In some embodiments, the slot **422** of one of the plurality of wireways **400** is sized
10 and shaped to receive the tab **420** of an adjacent one of another of the plurality of wireways **400** to maintain alignment of the plurality of wireways **400** with one another.

Referring to **FIGS. 29** through **31**, in some embodiments, a lid **510** for a wireway includes a first end **512** and a second end **514** opposite the first end **512**, and an extended portion **516** extending from the first end **512**. In some embodiments, the extended portion **516** includes a cross-
15 section similar to the remaining portion **518** of the lid **510**, except that ends of side portions **520** of the extended portion **516** are offset from ends of the side portions **522** of the lid **510**. In some embodiments, the second end **514** of one of the lids **510** is sized and shaped to overlay the extended portion **516** of another of the lids **510** such that the second end **514** of the one of the lids **510** is aligned with the first end **512** of the other of the lids **510**. In some embodiments, the lid **510**
20 includes a first stop **511** extending from an interior surface of the lid **510** and located proximate to the first end **512** for alignment with the second end **514** of an adjacent one of the lids **510**. In some embodiments, the lid **510** includes a pair of second stops **513** extending from the interior surface of the lid **510** and located proximate to the second end **514**. Referring to **FIG. 32**, in some

embodiments, an end cap **526** includes a body **528** having a first end **530** and a second end **532** opposite the first end **530**, and a plurality of vents **534** extending from the first end **530** to the second end **532**. In some embodiments, the second end **514** of the lid **510** is sized and shaped to receive the end cap **526**. In some embodiments, the second stops **513** prevent the end cap **526**
5 from being pushed too far within the lid **510** and fully past the second end **514**. In some embodiments, the plurality of vents **534** permit air flow within the wireway. In some embodiments, the lid **510** includes a centrally located third stop **515** for support and stability of the lid **510** on the wireway.

Referring to **FIGS. 33** and **34**, in some embodiments, a lid **600** for a wireway includes a
10 base **602** having a first surface **604** and a second surface **606** opposite the first surface **604**. In some embodiments, the base **602** is square in shape. In some embodiments, the base **602** is rectangular in shape. In some embodiments, the lid **600** includes a cover portion **608** extending outwardly from the first surface **604**. In some embodiments, the cover portion **608** is integral with the base **602**. In some embodiments, the cover portion **608** is sized and shaped to cover an end of
15 a wireway. In some embodiments, the cover portion **608** is sized and shaped to cover a wireway located at an end of a column of a plurality of wireways. In some embodiments, the lid **600** includes a pair of side flaps **610**. In some embodiments, one or more roofing shingles are configured to overlay each of the side flaps **610**. In some embodiments, an electrical component is configured to overlay either of the side flaps **610**. In some embodiments, the electrical
20 component is a junction box. In some embodiments, the electrical component is at least one electrical connector. In some embodiments, the lid **600** includes a head lap **612**. In some embodiments, one or more roofing shingles are configured to overlay the head lap **612**. In some embodiments, an electrical component is configured to overlay the head lap **612**. In some

embodiments, an electrical component is configured to overlay the head lap **612**. In some embodiments, the electrical component is an electrical termination box.

Referring to **FIGS. 35A** and **35B**, in some embodiments, a lid **700** for a wireway includes a first portion **702** and a second portion **704** overlaying the first portion **702**. In some
5 embodiments, the lid **700** includes opposed sidewalls **706**. In some embodiments, the sidewalls **706** include a curvilinear profile. In some embodiments, the sidewalls **706** include a linear profile. In some embodiments, the first portion **702** is composed of an opaque material. In some embodiments, the second portion **704** is composed of a transparent material. In some
10 embodiments, the second portion **704** is composed of a translucent material. In some embodiments, the second portion **704** includes a coating. In some embodiments, the second portion **704** is composed of a polymer gel. In some embodiments, the first portion **702** and the second portion **704** are laminated with one another. In some embodiments, the lid **700** is configured to mimic the appearance of a photovoltaic module having a glass layer.

Referring to **FIGS. 36A** and **36B**, in some embodiments, a lid **800** for a wireway includes
15 opposed sidewalls **806**. In some embodiments, the each of the sidewalls **806** includes a plurality of surfaces **808**. In some embodiments, the plurality of surfaces **808** includes linear surfaces **810**. In some embodiments, the linear surfaces **810** form an angled pattern. In some embodiments, the plurality of surfaces **808** includes curvilinear surfaces **812**. In some embodiments, the plurality of surfaces **808** form a sinusoidal pattern. In some embodiments, each of the plurality of surfaces
20 **808** is configured to create shadows on the sidewalls **806** to provide a consistent tone of the lid **800** and enable the lid **800** to blend in with other components of a roofing system, such as roofing shingles and photovoltaic shingles.

Referring to **FIGS. 37A** and **37B**, in some embodiments, a lid **900** for a wireway includes opposed sidewalls **906**. In some embodiments, each of the sidewalls **906** includes a plurality of fins **908**. In some embodiments, the plurality of fins **908** is configured to dissipate heat from and within the wireway. In some embodiments, the plurality of fins **908** includes an angular profile **910**. In some embodiments, the plurality of fins **908** includes a curvilinear profile **912**. In some
5 embodiments, the plurality of fins **908** includes a rectangular profile **914** (e.g., similar to a heat sink).

Referring to **FIGS. 38A** and **38B**, in some embodiments, a lid **1000** for a wireway includes an upper portion **1002** and pair of sidewalls **1004** extending from the upper portion **1002**. In some
10 embodiments, each of the sidewalls **1004** includes a rail **1006** that extends the length of the lid **1000** and forms a slot **1008** between the rail **1006** and the upper portion **1002**. In some embodiments, an insert **1010** is sized and shaped to be slidably received within the slots **1008** and over the upper portion **1002**. In some embodiments, the insert **1010** is rectangular in shape. In some embodiments, the insert **1010** is flat. In some embodiments, the insert **1010** is U-shaped. In
15 some embodiments, the insert **1010** includes asphalt material. In some embodiments, the insert **1010** includes an appearance that mimics the appearance of an asphalt roofing shingle. In some embodiments, the insert **1010** includes a photovoltaic cell. In some embodiments, the insert **1010** includes an appearance that mimics the appearance of a photovoltaic cell. In some embodiments, the insert **1010** includes a printed graphic.

20 Referring to **FIGS. 39A** and **39B**, in some embodiments, a photovoltaic module **1110** includes an active area **1109** having a plurality of solar cells **1112**. In some embodiments, the photovoltaic module **1110** includes an inactive area comprising a headlap portion **1113**, a first side lap **1115** located at one end of the photovoltaic module **1110**, and a second side lap **1117** located

at an opposite end of the photovoltaic module **1110**. In some embodiments, the headlap portion **1113** is textured. In some embodiments, the texture of the headlap portion **1113** is different from a texture of the solar cells **1112**. In some embodiments, a wire cover bracket **1300** is attached to the first side lap **1115**. In some embodiments, the wire cover bracket **1300** includes a junction box **1423**. Details of the wire cover bracket **1300** shall be provided hereinbelow.

In some embodiments, the plurality of solar cells **1112** includes a first set of solar cells **1112a** and a second set of solar cells **1112b**. In some embodiments, the first set of solar cells **1112a** includes eight of the solar cells **1112**. In some embodiments, the second set of solar cells **1112b** includes eight of the solar cells **1112**. In some embodiments, each of the first set of solar cells **1112a** and the second set of solar cells **1112b** includes more or less than eight of the solar cells **1112**. In some embodiments, a last one of the solar cells **1112** of the first set of solar cells **1112a** is separated by a first one of the solar cells **1112** of the second set of solar cells **1112b** by a space **S**. In some embodiments, the space **S** is located approximately half the length of the photovoltaic module **1110**. In some embodiments, the solar cells **1112** of each of the first and second sets of solar cells **1112a**, **1112b** are strung together with bussing **1101**. In some embodiments, the bussing **1101** includes nine bussing wires. In some embodiments, the bussing **1101** may include more or less than the nine bussing wires.

In some embodiments, a first bussing wire **1103a** extends from the first side lap **1115** to the space **S**. In some embodiments, the first bussing wire **1103a** extends to approximately half the length of the photovoltaic module **1110**. In some embodiments, one end of the first bussing wire **1103a** is electrically connected to the junction box **1423** and the other end of the first bussing wire **1103a** is electrically connected to the first set of solar cells **1112a**. In some embodiments, a second bussing wire **1103b** extends from the first side lap **1115** to a location proximate to the second side

lap **1117**. In some embodiments, the second bussing wire **1103b** extends substantially the entire length of the photovoltaic module **1110**. In some embodiments, one end of the second bussing wire **1103b** is electrically connected to the junction box **1423** and the other end of the second bussing wire **1103b** is electrically connected to the second set of solar cells **1112b**. In some
5 embodiments, each of the first bussing wire **1103a** and the second bussing wire **1103b** is covered with a polymer layer. In some embodiments, each of the first bussing wire **1103a** and the second bussing wire **1103b** is covered with expanded polyethylene (“EPE”). In some embodiments, the EPE is comprised of a black strip. In some embodiments, each of the first bussing wire **1103a** and the second bussing wire **1103b** is coated with a colorant or dye to reduce reflectivity.

10 In some embodiments, the plurality of solar cells **1112** includes a plurality of the solar cells **1112**. In some embodiments, the plurality of solar cells **1112** is arranged in one row (i.e., one reveal). In some embodiments, the plurality of solar cells **1112** is arranged in two rows (i.e., two reveals). In some embodiments, the plurality of solar cells **1112** is arranged in three rows (i.e., three reveals). In some embodiments, the plurality of solar cells **1112** is arranged in four rows
15 (i.e., four reveals). In some embodiments, the plurality of solar cells **1112** is arranged in five rows (i.e., five reveals). In some embodiments, the plurality of solar cells **1112** is arranged in six rows (i.e., six reveals). In some embodiments, the plurality of solar cells **1112** is arranged in more than six rows.

Referring to **FIG. 40**, in some embodiments, the active area **1109** of the photovoltaic
20 module **1110** includes the plurality of solar cells **1112**, an encapsulant **1114** encapsulating the plurality of solar cells **1112**, and a frontsheet **1116** juxtaposed with the encapsulant **1114**. In some embodiments, the frontsheet **1116** is juxtaposed with a first surface of the encapsulant **1114**. As used herein, the terms “encapsulating” and “encapsulates” mean to partially or fully envelope or

enclose, and with respect to certain embodiments of the photovoltaic module **1110**, the plurality of solar cells **1112** is fully enveloped by or enclosed within the encapsulant **1114**, or partially enveloped by or enclosed within the encapsulant **1114**. In some embodiments, the plurality of solar cells **1112** includes a plurality of the solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 50% to 99.9% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 55% to 99.9% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 60% to 99.9% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 65% to 99.9% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 70% to 99.9% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 75% to 99.9% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 80% to 99.9% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 85% to 99.9% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 90% to 99.9% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 95% to 99.9% of an exterior surface area of the plurality of solar cells **1112**.

In some embodiments, the encapsulant **1114** encapsulates 50% to 95% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 55% to 95% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 60% to 95% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 65% to

95% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 70% to 95% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 75% to 95% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 80% to 95% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 85% to 95% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 90% to 95% of an exterior surface area of the plurality of solar cells **1112**.

In some embodiments, the encapsulant **1114** encapsulates 50% to 90% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 55% to 90% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 60% to 90% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 65% to 90% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 70% to 90% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 75% to 90% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 80% to 90% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 85% to 90% of an exterior surface area of the plurality of solar cells **1112**.

In some embodiments, the encapsulant **1114** encapsulates 50% to 85% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 55% to 85% of an exterior surface area of the plurality of solar cells **1112**. In some

embodiments, the encapsulant **1114** encapsulates 60% to 85% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 65% to 85% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 70% to 85% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 75% to 85% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 80% to 85% of an exterior surface area of the plurality of solar cells **1112**.

In some embodiments, the encapsulant **1114** encapsulates 50% to 80% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 55% to 80% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 60% to 80% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 65% to 80% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 70% to 80% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 75% to 80% of an exterior surface area of the plurality of solar cells **1112**.

In some embodiments, the encapsulant **1114** encapsulates 50% to 75% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 55% to 75% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 60% to 75% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 65% to 75% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the

encapsulant **1114** encapsulates 70% to 75% of an exterior surface area of the plurality of solar cells **1112**.

In some embodiments, the encapsulant **1114** encapsulates 50% to 70% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114**
5 encapsulates 55% to 70% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 60% to 70% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 65% to 70% of an exterior surface area of the plurality of solar cells **1112**.

In some embodiments, the encapsulant **1114** encapsulates 50% to 65% of an exterior
10 surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 55% to 65% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 60% to 65% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 50% to 60% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the
15 encapsulant **1114** encapsulates 55% to 60% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 55% to 60% of an exterior surface area of the plurality of solar cells **1112**.

In some embodiments, the encapsulant **1114** encapsulates 50% of an exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 55%
20 of the exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 60% of the exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 65% of the exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 70% of the

exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 75% of the exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 80% of the exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 85% of the exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 90% of the exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 95% of the exterior surface area of the plurality of solar cells **1112**. In some embodiments, the encapsulant **1114** encapsulates 100% of the exterior surface area of the plurality of solar cells **1112**.

In some embodiments, the encapsulant **1114** has a thickness of 0.5 mm to 4 mm. In some embodiments, the encapsulant **1114** has a thickness of 0.5 mm to 3.5 mm. In some embodiments, the encapsulant **1114** has a thickness of 0.5 mm to 3 mm. In some embodiments, the encapsulant **1114** has a thickness of 0.5 mm to 2.5 mm. In some embodiments, the encapsulant **1114** has a thickness of 0.5 mm to 2 mm. In some embodiments, the encapsulant **1114** has a thickness of 0.5 mm to 1.5 mm. In some embodiments, the encapsulant **1114** has a thickness of 0.5 mm to 1 mm.

In some embodiments, the encapsulant **1114** has a thickness of 1 mm to 4 mm. In some embodiments, the encapsulant **1114** has a thickness of 1 mm to 3.5 mm. In some embodiments, the encapsulant **1114** has a thickness of 1 mm to 3 mm. In some embodiments, the encapsulant **1114** has a thickness of 1 mm to 2.5 mm. In some embodiments, the encapsulant **1114** has a thickness of 1 mm to 2 mm. In some embodiments, the encapsulant **1114** has a thickness of 1 mm to 1.5 mm. In some embodiments, the encapsulant **1114** has a thickness of 1.5 mm to 4 mm. In some embodiments, the encapsulant **1114** has a thickness of 1.5 mm to 3.5 mm. In some embodiments, the encapsulant **1114** has a thickness of 1.5 mm to 3 mm. In some embodiments,

the encapsulant **1114** has a thickness of 1.5 mm to 2.5 mm. In some embodiments, the encapsulant **1114** has a thickness of 1.5 mm to 2 mm.

In some embodiments, the encapsulant **1114** has a thickness of 2 mm to 4 mm. In some embodiments, the encapsulant **1114** has a thickness of 2 mm to 3.5 mm. In some embodiments, the encapsulant **1114** has a thickness of 2 mm to 3 mm. In some embodiments, the encapsulant **1114** has a thickness of 2 mm to 2.5 mm. In some embodiments, the encapsulant **1114** has a thickness of 2.5 mm to 4 mm. In some embodiments, the encapsulant **1114** has a thickness of 2.5 mm to 3.5 mm. In some embodiments, the encapsulant **1114** has a thickness of 2.5 mm to 3 mm. In some embodiments, the encapsulant **1114** has a thickness of 3 mm to 4 mm. In some embodiments, the encapsulant **1114** has a thickness of 3 mm to 3.5 mm. In some embodiments, the encapsulant **1114** has a thickness of 3.5 mm to 4 mm.

In some embodiments, the encapsulant **1114** has a thickness of 0.5 mm. In some embodiments, the encapsulant **1114** has a thickness of 0.6 mm. In some embodiments, the encapsulant **1114** has a thickness of 0.7 mm. In some embodiments, the encapsulant **1114** has a thickness of 0.8 mm. In some embodiments, the encapsulant **1114** has a thickness of 0.9 mm. In some embodiments, the encapsulant **1114** has a thickness of 1 mm. In some embodiments, the encapsulant **1114** has a thickness of 1.5 mm. In some embodiments, the encapsulant **1114** has a thickness of 2 mm. In some embodiments, the encapsulant **1114** has a thickness of 2.5 mm. In some embodiments, the encapsulant **1114** has a thickness of 3 mm. In some embodiments, the encapsulant **1114** has a thickness of 3.5 mm. In some embodiments, the encapsulant **1114** has a thickness of 4 mm.

In some embodiments, the encapsulant **1114** includes a first layer **1114a** and a second layer **1114b**. In some embodiments, the first layer **1114a** of the encapsulant **1114** initially comprises two layers prior to lamination thereof.

In some embodiments, a first layer **1114a** of the encapsulant **1114** has a thickness of 0.2 mm to 2 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.2 mm to 1.5 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.2 mm to 1 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.2 mm to 0.9 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.2 mm to 0.8 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.2 mm to 0.7 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.2 mm to 0.6 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.2 mm to 0.5 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.2 mm to 0.45 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.2 mm to 0.4 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.2 mm to 0.3 mm.

In some embodiments, a first layer **1114a** of the encapsulant **1114** has a thickness of 0.3 mm to 2 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.3 mm to 1.5 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.3 mm to 1 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.3 mm to 0.9 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.3 mm to 0.8 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.3 mm to 0.7 mm. In some embodiments, the

first layer **1114a** of the encapsulant **1114** has a thickness of 0.3 mm to 0.6 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.3 mm to 0.5 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.3 mm to 0.45 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of
5 0.3 mm to 0.4 mm.

In some embodiments, a first layer **1114a** of the encapsulant **1114** has a thickness of 0.4 mm to 2 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.4 mm to 1.5 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.4 mm to 1 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114**
10 has a thickness of 0.4 mm to 0.9 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.4 mm to 0.8 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.4 mm to 0.7 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.4 mm to 0.6 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.4 mm to 0.5 mm.
15 In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.4 mm to 0.45 mm.

In some embodiments, a first layer **1114a** of the encapsulant **1114** has a thickness of 0.45 mm to 2 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.45 mm to 1.5 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.45 mm to 1 mm. In some embodiments, the first layer **1114a** of the encapsulant
20 **1114** has a thickness of 0.45 mm to 0.9 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.45 mm to 0.8 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.45 mm to 0.7 mm. In some embodiments, the

first layer **1114a** of the encapsulant **1114** has a thickness of 0.45 mm to 0.6 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.45 mm to 0.5 mm.

In some embodiments, a first layer **1114a** of the encapsulant **1114** has a thickness of 0.5 mm to 2 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness
5 of 0.5 mm to 1.5 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.5 mm to 1 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.5 mm to 0.9 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.5 mm to 0.8 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.5 mm to 0.7 mm. In some embodiments, the
10 first layer **1114a** of the encapsulant **1114** has a thickness of 0.5 mm to 0.6 mm.

In some embodiments, a first layer **1114a** of the encapsulant **1114** has a thickness of 0.6 mm to 2 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness
of 0.6 mm to 1.5 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.6 mm to 1 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114**
15 has a thickness of 0.6 mm to 0.9 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.6 mm to 0.8 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.6 mm to 0.7 mm.

In some embodiments, a first layer **1114a** of the encapsulant **1114** has a thickness of 0.7 mm to 2 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness
20 of 0.7 mm to 1.5 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.7 mm to 1 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.7 mm to 0.9 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.7 mm to 0.8 mm.

In some embodiments, a first layer **1114a** of the encapsulant **1114** has a thickness of 0.8 mm to 2 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.8 mm to 1.5 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.8 mm to 1 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.8 mm to 0.9 mm. In some embodiments, a first layer **1114a** of the encapsulant **1114** has a thickness of 0.9 mm to 2 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.9 mm to 1.5 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.9 mm to 1 mm. In some embodiments, a first layer **1114a** of the encapsulant **1114** has a thickness of 1 mm to 2 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 1 mm to 1.5 mm. In some embodiments, a first layer **1114a** of the encapsulant **1114** has a thickness of 1.5 mm to 2 mm.

In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.2 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.3 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.4 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.45 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.5 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.6 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.7 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.8 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 0.9 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 1 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 1.5 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 2 mm. In

some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 2.5 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 3 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 3.5 mm. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness of 4 mm.

5 In some embodiments, a second layer **1114b** of the encapsulant **1114** has a thickness of 0.2 mm to 2 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.2 mm to 1.5 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.2 mm to 1 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.2 mm to 0.9 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.2 mm to 0.8 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.2 mm to 0.7 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.2 mm to 0.6 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.2 mm to 0.5 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.2 mm to 0.45 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.2 mm to 0.4 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.2 mm to 0.3 mm.

 In some embodiments, a second layer **1114b** of the encapsulant **1114** has a thickness of 0.3 mm to 2 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.3 mm to 1.5 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.3 mm to 1 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.3 mm to 0.9 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.3 mm to 0.8 mm. In some embodiments, the

second layer **1114b** of the encapsulant **1114** has a thickness of 0.3 mm to 0.7 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.3 mm to 0.6 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.3 mm to 0.5 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.3 mm to 0.45 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.3 mm to 0.4 mm.

In some embodiments, a second layer **1114b** of the encapsulant **1114** has a thickness of 0.4 mm to 2 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.4 mm to 1.5 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.4 mm to 1 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.4 mm to 0.9 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.4 mm to 0.8 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.4 mm to 0.7 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.4 mm to 0.6 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.4 mm to 0.5 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.4 mm to 0.45 mm.

In some embodiments, a second layer **1114b** of the encapsulant **1114** has a thickness of 0.45 mm to 2 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.45 mm to 1.5 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.45 mm to 1 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.45 mm to 0.9 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.45 mm to 0.8 mm. In some embodiments, the

second layer **1114b** of the encapsulant **1114** has a thickness of 0.45 mm to 0.7 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.45 mm to 0.6 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.45 mm to 0.5 mm.

5 In some embodiments, a second layer **1114b** of the encapsulant **1114** has a thickness of 0.5 mm to 2 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.5 mm to 1.5 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.5 mm to 1 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.5 mm to 0.9 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.5 mm to 0.8 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.5 mm to 0.7 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.5 mm to 0.6 mm.

In some embodiments, a second layer **1114b** of the encapsulant **1114** has a thickness of 0.6 mm to 2 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.6 mm to 1.5 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.6 mm to 1 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.6 mm to 0.9 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.6 mm to 0.8 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.6 mm to 0.7 mm.

In some embodiments, a second layer **1114b** of the encapsulant **1114** has a thickness of 0.7 mm to 2 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.7 mm to 1.5 mm. In some embodiments, the second layer **1114b** of the encapsulant

1114 has a thickness of 0.7 mm to 1 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.7 mm to 0.9 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.7 mm to 0.8 mm.

In some embodiments, a second layer **1114b** of the encapsulant **1114** has a thickness of 0.8 mm to 2 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.8 mm to 1.5 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.8 mm to 1 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.8 mm to 0.9 mm. In some embodiments, a second layer **1114b** of the encapsulant **1114** has a thickness of 0.9 mm to 2 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.9 mm to 1.5 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.9 mm to 1 mm. In some embodiments, a second layer **1114b** of the encapsulant **1114** has a thickness of 1 mm to 2 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 1 mm to 1.5 mm. In some embodiments, a second layer **1114b** of the encapsulant **1114** has a thickness of 1.5 mm to 2 mm.

In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.2 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.3 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.4 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.45 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.5 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.6 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.7 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness

of 0.8 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 0.9 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 1 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 1.5 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 2 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 2.5 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 3 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 3.5 mm. In some embodiments, the second layer **1114b** of the encapsulant **1114** has a thickness of 4 mm.

In some embodiments, the thickness of the first layer **1114a** is equal to the thickness of the second layer **1114b**. In some embodiments, the thickness of the first layer **1114a** is different from the thickness of the second layer **1114b**. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness that is sufficient to prevent or reduce leakage current to an amount that will not provide a risk of electrocution to a user by touch in the event the glass layer **1122** breaks or shatters. In some embodiments, such thickness of the first layer **1114a** of the encapsulant **1114** is described above. In some embodiments, the first layer **1114a** of the encapsulant **1114** has a thickness that is sufficient to prevent or reduce leakage current to an amount that will not provide a risk of electrocution to a user by touch when the photovoltaic module **1110** is wet, in the event the glass layer **1122** breaks or shatters. In some embodiments, such thickness of the first layer **1114a** of the encapsulant **1114** is described above.

In some embodiments, the photovoltaic module **1110** withstands walking loads/step resistance that conforms to standards under UL 3741 test standards (UL Standard for Safety Photovoltaic Hazard Control). In some embodiments, the photovoltaic module **1110** includes an

axe impact resistance that conforms to standards under UL 3741 test standards. In some embodiments, the photovoltaic module **1110** includes a body fall resistance that conforms to standards under UL 3741 test standards. In some embodiments, a wet leakage current test performed in accordance with UL 3741 results in a leakage current of less than 130 nA.

5 In some embodiments, the photovoltaic module **1110** includes an impact resistance that conforms to standards under UL 1703 test standards. The UL 1703 test involves attaching the photovoltaic module **1110** to a representative model of a roof and dropping a 2-inch diameter steel ball onto the photovoltaic module **1110** from 1.3 meters. A photovoltaic module is deemed to pass the UL 1703 standard if there are no exposed electrical components and no large pieces of glass
10 are ejected.

In some embodiments, the encapsulant **1114** may be composed of polyolefins, ethyl vinyl acetates, ionomers, silicones, poly vinyl butyral, epoxies, polyurethanes, or combinations/hybrids thereof. In some embodiments, the encapsulant **1114** is composed of thermosetting polyolefin.

In some embodiments, the photovoltaic module **1110** includes a first surface **1119** and a
15 second surface **1121** opposite the first surface **1119**. In some embodiments, the first surface **1119** is an upper, sun facing-side surface of the photovoltaic module **1110**, and the second surface **1121** is a lower surface configured to face a roof deck on which the photovoltaic module **1110** is installed.

In some embodiments, the frontsheet **1116** includes a glass layer **1122** and a polymer layer
20 **1124** attached to a first surface of the glass layer **1122**. In some embodiments, the frontsheet **1116** is juxtaposed with the first layer **1114a** of the encapsulant **1114**. In some embodiments, each of the encapsulant **1114**, the glass layer **1122**, and the polymer layer **1124** is transparent. In some embodiments, the polymer layer **1124** is attached to the glass layer **1122** by a first adhesive layer

1126. In some embodiments, the first adhesive layer **1126** may include polyvinyl butyrate, acrylic, silicone, or polycarbonate. In some embodiments, the first adhesive layer **1126** may include pressure sensitive adhesives. In some embodiments, the polymer layer **1124** is attached to the glass layer **1122** by thermal bonding. In some embodiments, the frontsheet **1116** includes at least one of the glass layer **1122** or the polymer layer **1124**. In some embodiments, the first adhesive layer **1126** is transparent. As used herein, the term “transparent” means having a solar weighted transmittance of 80% or greater, and with respect to certain embodiments of the photovoltaic module **1110**, a transparent layer of the photovoltaic module has a solar weighted transmittance of 80% or greater. In some embodiments, the frontsheet **1116** does not include the glass layer **1122**. In some embodiments, the polymer layer **1124** is textured.

In some embodiments, the glass layer **1122** has a thickness of 1 mm to 4 mm. In some embodiments, the glass layer **1122** has a thickness of 1 mm to 3.5 mm. In some embodiments, the glass layer **1122** has a thickness of 1 mm to 3 mm. In some embodiments, the glass layer **1122** has a thickness of 1 mm to 2.5 mm. In some embodiments, the glass layer **1122** has a thickness of 1 mm to 2 mm. In some embodiments, the glass layer **1122** has a thickness of 1 mm to 1.5 mm. In some embodiments, the glass layer **1122** has a thickness of 1.5 mm to 4 mm. In some embodiments, the glass layer **1122** has a thickness of 1.5 mm to 3.5 mm. In some embodiments, the glass layer **1122** has a thickness of 1.5 mm to 3 mm. In some embodiments, the glass layer **1122** has a thickness of 1 mm to 2.5 mm. In some embodiments, the glass layer **1122** has a thickness of 1.5 mm to 2 mm.

In some embodiments, the glass layer **1122** has a thickness of 2 mm to 4 mm. In some embodiments, the glass layer **1122** has a thickness of 2 mm to 3.5 mm. In some embodiments, the glass layer **1122** has a thickness of 2 mm to 3 mm. In some embodiments, the glass layer **1122**

has a thickness of 2 mm to 2.5 mm. In some embodiments, the glass layer **1122** has a thickness of 2.5 mm to 4 mm. In some embodiments, the glass layer **1122** has a thickness of 2.5 mm to 3.5 mm. In some embodiments, the glass layer **1122** has a thickness of 2.5 mm to 3 mm. In some embodiments, the glass layer **1122** has a thickness of 3 mm to 4 mm. In some embodiments, the glass layer **1122** has a thickness of 3 mm to 3.5 mm. In some embodiments, the glass layer **1122** has a thickness of 3.5 mm to 4 mm.

In some embodiments, the glass layer **1122** has a thickness of 1 mm. In some embodiments, the glass layer **1122** has a thickness of 1.5 mm. In some embodiments, the glass layer **1122** has a thickness of 2 mm. In some embodiments, the glass layer **1122** has a thickness of 2.5 mm. In some embodiments, the glass layer **1122** has a thickness of 3 mm. In some embodiments, the glass layer **1122** has a thickness of 3.2 mm. In some embodiments, the glass layer **1122** has a thickness of 3.5 mm. In some embodiments, the glass layer **1122** has a thickness of 4 mm.

In some embodiments, the first adhesive layer **1126** is composed of thermosetting polyolefin, thermosetting polyolefin encapsulant material, thermosetting ethylene-vinyl acetate (EVA), EVA encapsulants, thermoplastic olefin, thermoplastic polyolefin (TPO) or hybrids/combinations thereof.

In some embodiments, the first adhesive layer **1126** has a thickness of 0.2 mm to 2 mm. In some embodiments, the first adhesive layer **1126** has a thickness of 0.2 mm to 1.5 mm. In some embodiments, the first adhesive layer **1126** has a thickness of 0.2 mm to 1 mm. In some embodiments, the first adhesive layer **1126** has a thickness of 0.2 mm to 0.5 mm. In some embodiments, the first adhesive layer **1126** has a thickness of 0.5 mm to 2 mm. In some embodiments, the first adhesive layer **1126** has a thickness of 0.5 mm to 1.5 mm. In some

embodiments, the first adhesive layer **1126** has a thickness of 0.5 mm to 1 mm. In some embodiments, the first adhesive layer **1126** has a thickness of 1 mm to 2 mm. In some embodiments, the first adhesive layer **1126** has a thickness of 1 mm to 1.5 mm. In some embodiments, the first adhesive layer **1126** has a thickness of 1.5 mm to 2 mm.

5 In some embodiments, the first adhesive layer **1126** has a thickness of 0.2 mm. In some embodiments, the first adhesive layer **1126** has a thickness of 0.3 mm. In some embodiments, the first adhesive layer **1126** has a thickness of 0.4 mm. In some embodiments, the first adhesive layer **1126** has a thickness of 0.45 mm. In some embodiments, the first adhesive layer **1126** has a thickness of 0.5 mm. In some embodiments, the first adhesive layer **1126** has a thickness of 1 mm.

10 In some embodiments, the first adhesive layer **1126** has a thickness of 1.5 mm. In some embodiments, the first adhesive layer **1126** has a thickness of 2 mm. In some embodiments, the first adhesive layer **1126** has a thickness of 2.5 mm. In some embodiments, the first adhesive layer **1126** has a thickness of 3 mm. In some embodiments, the first adhesive layer **1126** has a thickness of 3.5 mm. In some embodiments, the first adhesive layer **1126** has a thickness of 4 mm.

15 In some embodiments, the first adhesive layer **1126** has a thickness of 1 μm to 900 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 1 μm to 850 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 1 μm to 800 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 1 μm to 750 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 1 μm to 700 μm . In some

20 embodiments, the first adhesive layer **1126** has a thickness of 1 μm to 650 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 1 μm to 600 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 1 μm to 550 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 1 μm to 500 μm . In some

embodiments, the first adhesive layer **1126** has a thickness of 1 μm to 450 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 1 μm to 400 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 1 μm to 350 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 1 μm to 300 μm . In some
5 embodiments, the first adhesive layer **1126** has a thickness of 1 μm to 250 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 1 μm to 200 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 1 μm to 150 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 1 μm to 100 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 1 μm to 50 μm .

10 In some embodiments, the first adhesive layer **1126** has a thickness of 50 μm to 900 μm .
In some embodiments, the first adhesive layer **1126** has a thickness of 50 μm to 850 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 50 μm to 800 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 50 μm to 750 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 50 μm to 700 μm . In some
15 embodiments, the first adhesive layer **1126** has a thickness of 50 μm to 650 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 50 μm to 600 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 50 μm to 550 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 50 μm to 500 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 50 μm to 450 μm . In some
20 embodiments, the first adhesive layer **1126** has a thickness of 50 μm to 400 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 50 μm to 350 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 50 μm to 300 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 50 μm to 250 μm . In some

embodiments, the first adhesive layer **1126** has a thickness of 50 μm to 200 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 50 μm to 150 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 50 μm to 100 μm .

In some embodiments, the first adhesive layer **1126** has a thickness of 100 μm to 900 μm .

5 In some embodiments, the first adhesive layer **1126** has a thickness of 100 μm to 850 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 100 μm to 800 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 100 μm to 750 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 100 μm to 700 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 100 μm to 650 μm . In some
10 embodiments, the first adhesive layer **1126** has a thickness of 100 μm to 600 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 100 μm to 550 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 100 μm to 500 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 100 μm to 450 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 100 μm to 400 μm . In some
15 embodiments, the first adhesive layer **1126** has a thickness of 100 μm to 350 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 100 μm to 300 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 100 μm to 250 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 100 μm to 200 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 100 μm to 150 μm .

20 In some embodiments, the first adhesive layer **1126** has a thickness of 150 μm to 900 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 150 μm to 850 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 150 μm to 800 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 150 μm to 750 μm . In some

embodiments, the first adhesive layer **1126** has a thickness of 150 μm to 700 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 150 μm to 650 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 150 μm to 600 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 150 μm to 550 μm . In some
5 embodiments, the first adhesive layer **1126** has a thickness of 150 μm to 500 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 150 μm to 450 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 150 μm to 400 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 150 μm to 350 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 150 μm to 300 μm . In some
10 embodiments, the first adhesive layer **1126** has a thickness of 150 μm to 250 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 150 μm to 200 μm .

In some embodiments, the first adhesive layer **1126** has a thickness of 200 μm to 900 μm .
In some embodiments, the first adhesive layer **1126** has a thickness of 200 μm to 850 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 200 μm to 800 μm . In some
15 embodiments, the first adhesive layer **1126** has a thickness of 200 μm to 750 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 200 μm to 700 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 200 μm to 650 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 200 μm to 600 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 200 μm to 550 μm . In some
20 embodiments, the first adhesive layer **1126** has a thickness of 200 μm to 500 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 200 μm to 450 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 200 μm to 400 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 200 μm to 350 μm . In some

embodiments, the first adhesive layer **1126** has a thickness of 200 μm to 300 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 200 μm to 250 μm .

In some embodiments, the first adhesive layer **1126** has a thickness of 250 μm to 900 μm .

In some embodiments, the first adhesive layer **1126** has a thickness of 250 μm to 850 μm . In some

5 embodiments, the first adhesive layer **1126** has a thickness of 250 μm to 800 μm . In some

embodiments, the first adhesive layer **1126** has a thickness of 250 μm to 750 μm . In some

embodiments, the first adhesive layer **1126** has a thickness of 250 μm to 700 μm . In some

embodiments, the first adhesive layer **1126** has a thickness of 250 μm to 650 μm . In some

embodiments, the first adhesive layer **1126** has a thickness of 250 μm to 600 μm . In some

10 embodiments, the first adhesive layer **1126** has a thickness of 250 μm to 550 μm . In some

embodiments, the first adhesive layer **1126** has a thickness of 250 μm to 500 μm . In some

embodiments, the first adhesive layer **1126** has a thickness of 250 μm to 450 μm . In some

embodiments, the first adhesive layer **1126** has a thickness of 250 μm to 400 μm . In some

embodiments, the first adhesive layer **1126** has a thickness of 250 μm to 350 μm . In some

15 embodiments, the first adhesive layer **1126** has a thickness of 250 μm to 300 μm .

In some embodiments, the first adhesive layer **1126** has a thickness of 300 μm to 900 μm .

In some embodiments, the first adhesive layer **1126** has a thickness of 300 μm to 850 μm . In some

embodiments, the first adhesive layer **1126** has a thickness of 300 μm to 800 μm . In some

embodiments, the first adhesive layer **1126** has a thickness of 300 μm to 750 μm . In some

20 embodiments, the first adhesive layer **1126** has a thickness of 300 μm to 700 μm . In some

embodiments, the first adhesive layer **1126** has a thickness of 300 μm to 650 μm . In some

embodiments, the first adhesive layer **1126** has a thickness of 300 μm to 600 μm . In some

embodiments, the first adhesive layer **1126** has a thickness of 300 μm to 550 μm . In some

embodiments, the first adhesive layer **1126** has a thickness of 300 μm to 500 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 300 μm to 450 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 300 μm to 400 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 300 μm to 350 μm .

5 In some embodiments, the first adhesive layer **1126** has a thickness of 350 μm to 900 μm .
In some embodiments, the first adhesive layer **1126** has a thickness of 350 μm to 850 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 350 μm to 800 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 350 μm to 750 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 350 μm to 700 μm . In some
10 embodiments, the first adhesive layer **1126** has a thickness of 350 μm to 650 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 350 μm to 600 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 350 μm to 550 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 350 μm to 500 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 350 μm to 450 μm . In some
15 embodiments, the first adhesive layer **1126** has a thickness of 350 μm to 400 μm .

 In some embodiments, the first adhesive layer **1126** has a thickness of 400 μm to 900 μm .
In some embodiments, the first adhesive layer **1126** has a thickness of 400 μm to 850 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 400 μm to 800 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 400 μm to 750 μm . In some
20 embodiments, the first adhesive layer **1126** has a thickness of 400 μm to 700 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 400 μm to 650 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 400 μm to 600 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 400 μm to 550 μm . In some

embodiments, the first adhesive layer **1126** has a thickness of 400 μm to 500 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 400 μm to 450 μm .

In some embodiments, the first adhesive layer **1126** has a thickness of 450 μm to 900 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 450 μm to 850 μm . In some
5 embodiments, the first adhesive layer **1126** has a thickness of 450 μm to 800 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 450 μm to 750 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 450 μm to 700 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 450 μm to 650 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 450 μm to 600 μm . In some
10 embodiments, the first adhesive layer **1126** has a thickness of 450 μm to 550 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 450 μm to 500 μm .

In some embodiments, the first adhesive layer **1126** has a thickness of 500 μm to 900 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 500 μm to 850 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 500 μm to 800 μm . In some
15 embodiments, the first adhesive layer **1126** has a thickness of 500 μm to 750 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 500 μm to 700 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 500 μm to 650 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 500 μm to 600 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 500 μm to 550 μm .

20 In some embodiments, the first adhesive layer **1126** has a thickness of 550 μm to 900 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 550 μm to 850 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 550 μm to 800 μm . In some
embodiments, the first adhesive layer **1126** has a thickness of 550 μm to 750 μm . In some

embodiments, the first adhesive layer **1126** has a thickness of 550 μm to 700 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 550 μm to 650 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 550 μm to 600 μm .

In some embodiments, the first adhesive layer **1126** has a thickness of 600 μm to 900 μm .

5 In some embodiments, the first adhesive layer **1126** has a thickness of 600 μm to 850 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 600 μm to 800 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 600 μm to 750 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 600 μm to 700 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 600 μm to 650 μm .

10 In some embodiments, the first adhesive layer **1126** has a thickness of 650 μm to 900 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 650 μm to 850 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 650 μm to 800 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 650 μm to 750 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 650 μm to 700 μm . In some
15 embodiments, the first adhesive layer **1126** has a thickness of 700 μm to 900 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 700 μm to 850 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 700 μm to 800 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 700 μm to 750 μm . In some
20 embodiments, the first adhesive layer **1126** has a thickness of 750 μm to 900 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 750 μm to 850 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 750 μm to 800 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 800 μm to 900 μm . In some

embodiments, the first adhesive layer **1126** has a thickness of 800 μm to 850 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 850 μm to 900 μm .

In some embodiments, the first adhesive layer **1126** has a thickness of 1 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 50 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 100 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 150 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 200 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 250 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 300 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 350 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 400 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 450 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 500 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 550 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 600 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 650 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 700 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 750 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 800 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 850 μm . In some embodiments, the first adhesive layer **1126** has a thickness of 900 μm .

In some embodiments, the polymer layer **1124** is composed of a fluoropolymer. In certain embodiments, the fluoropolymer may be ethylene tetrafluoroethylene (ETFE), fluoropolymer is polyvinylidene fluoride (PVDF), tetrafluoroethylene-hexafluoropropylene copolymers (FEP), and tetrafluoroethylene-hexafluoropropylene-vinylidene fluoride copolymers (THV), polyvinyl fluoride (PVF), or blends thereof. In some embodiments, the frontsheet is composed of

fluoropolymers, acrylics, polyesters, silicones, polycarbonates, or combinations thereof. In some
embodiments, the polymer layer **1124** is composed of polyethylene terephthalate (PET),
polyethylene naphthalate (PEN), polyetheretherketone (PEEK), polyaryletherketone (PAEK),
polyarylate (PAR), polyetherimide (PEI), polyarylsulfone (PAS), polyethersulfone (PES),
5 polyamideimide (PAI), polyphenylsulfone (PPSU), polyolefin, cyclic olefin copolymers (CPCs),
or polyimide. In some embodiments, the polymer layer **1124** is composed of a crosslinked
polymeric material. In some embodiments, 50% to 99% of the polymer chains of the polymeric
material are crosslinked.

In some embodiments, the polymer layer **1124** has a thickness of 0.01 mm to 0.5 mm. In
10 some embodiments, the polymer layer **1124** has a thickness of 0.01 mm to 0.45 mm. In some
embodiments, the polymer layer **1124** has a thickness of 0.01 mm to 0.4 mm. In some
embodiments, the polymer layer **1124** has a thickness of 0.01 mm to 0.35 mm. In some
embodiments, the polymer layer **1124** has a thickness of 0.01 mm to 0.3 mm. In some
embodiments, the polymer layer **1124** has a thickness of 0.01 mm to 0.25 mm. In some
15 embodiments, the polymer layer **1124** has a thickness of 0.01 mm to 0.2 mm. In some
embodiments, the polymer layer **1124** has a thickness of 0.01 mm to 0.15 mm. In some
embodiments, the polymer layer **1124** has a thickness of 0.01 mm to 0.1 mm. In some
embodiments, the polymer layer **1124** has a thickness of 0.01 mm to 0.05 mm.

In some embodiments, the polymer layer **1124** has a thickness of 0.05 mm to 0.5 mm. In
20 some embodiments, the polymer layer **1124** has a thickness of 0.05 mm to 0.45 mm. In some
embodiments, the polymer layer **1124** has a thickness of 0.05 mm to 0.4 mm. In some
embodiments, the polymer layer **1124** has a thickness of 0.05 mm to 0.35 mm. In some
embodiments, the polymer layer **1124** has a thickness of 0.05 mm to 0.3 mm. In some

embodiments, the polymer layer **1124** has a thickness of 0.05 mm to 0.25 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.05 mm to 0.2 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.05 mm to 0.15 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.05 mm to 0.1 mm.

5 In some embodiments, the polymer layer **1124** has a thickness of 0.1 mm to 0.5 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.1 mm to 0.45 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.1 mm to 0.4 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.1 mm to 0.35 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.1 mm to 0.3 mm. In some embodiments, the polymer layer **1124**
10 has a thickness of 0.1 mm to 0.25 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.1 mm to 0.2 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.1 mm to 0.15 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.15 mm to 0.5 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.15 mm to 0.45 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.15 mm to 0.4 mm. In some
15 embodiments, the polymer layer **1124** has a thickness of 0.15 mm to 0.35 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.15 mm to 0.3 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.15 mm to 0.25 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.15 mm to 0.2 mm.

In some embodiments, the polymer layer **1124** has a thickness of 0.2 mm to 0.5 mm. In
20 some embodiments, the polymer layer **1124** has a thickness of 0.2 mm to 0.45 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.2 mm to 0.4 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.2 mm to 0.35 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.2 mm to 0.3 mm. In some embodiments, the polymer layer **1124**

has a thickness of 0.2 mm to 0.25 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.25 mm to 0.5 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.25 mm to 0.45 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.25 mm to 0.4 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.25 mm to 0.35 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.25 mm to 0.3 mm.

In some embodiments, the polymer layer **1124** has a thickness of 0.3 mm to 0.5 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.3 mm to 0.45 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.3 mm to 0.4 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.3 mm to 0.35 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.35 mm to 0.5 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.35 mm to 0.45 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.35 mm to 0.4 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.4 mm to 0.5 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.4 mm to 0.45 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.45 mm to 0.5 mm.

In some embodiments, the polymer layer **1124** has a thickness of 0.01 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.05 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.1 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.15 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.2 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.25 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.3 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.35 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.4 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.45 mm. In some embodiments, the polymer layer **1124** has a thickness of 0.5 mm.

In some embodiments, a backsheet **1128** is juxtaposed with a second layer **1114b** of the encapsulant **1114**. In some embodiments, the backsheet **1128** includes a first layer **1130** and a second layer **1132**. In some embodiments, the first layer **1130** is juxtaposed with the second layer **1114b** of the encapsulant **1114**. In some embodiments, the second layer **1132** is juxtaposed with the first layer **1130**.

In some embodiments, the first layer **1130** of the backsheet **1128** is composed of a polymeric material. In some embodiments, the first layer **1130** of the backsheet **1128** is composed of polyethylene terephthalate (“PET”). In some embodiments, the first layer **1130** of the backsheet **1128** is composed of ethylene tetrafluoroethylene (“ETFE”). In some embodiments, the first layer **1130** of the backsheet **1128** is composed of an acrylic such as polymethyl methacrylate (“PMMA”). In some embodiments, the first layer **1130** of the backsheet **1128** is composed of thermoplastic polyolefin (TPO). In some embodiments, the first layer **1130** of the backsheet **1128** includes of a single ply TPO roofing membrane. In some embodiments, non-limiting examples of TPO membranes are disclosed in U.S. Patent No. 9,359,014 to Yang et al., which is incorporated by reference herein in its entirety. In some embodiments, the first layer **1130** of the backsheet **1128** is composed of polyvinyl chloride. In some embodiments, the first layer **1130** of the backsheet **1128** is composed of ethylene propylene diene monomer (EPDM) rubber. In some embodiments, the first layer **1130** of the backsheet **1128** includes a flame retardant additive. In some embodiments, the flame retardant additive may be clays, nanoclays, silicas, carbon black, metal hydroxides such as aluminum hydroxide, metal foils, graphite, and combinations thereof.

In some embodiments, the first layer **1130** has a thickness of 0.2 mm to 0.5 mm. In some embodiments, the first layer **1130** has a thickness of 0.2 mm to 0.4 mm. In some embodiments, the first layer **1130** has a thickness of 0.2 mm to 0.3 mm. In some embodiments, the first layer

1130 has a thickness of 0.3 mm to 0.5 mm. In some embodiments, the first layer **1130** has a thickness of 0.3 mm to 0.4 mm. In some embodiments, the first layer **1130** has a thickness of 0.4 mm to 0.5 mm. In some embodiments, the first layer **1130** has a thickness of 0.2 mm. In some embodiments, the first layer **1130** has a thickness of 0.3 mm. In some embodiments, the first layer **1130** has a thickness of 0.4 mm. In some embodiments, the first layer **1130** has a thickness of 0.5 mm.

In some embodiments, the second layer **1132** of the backsheet **1128** is composed of a polymeric material. In some embodiments, the second layer **1132** of the backsheet **1128** is composed of thermoplastic polyolefin (TPO). In some embodiments, the second layer **1132** of the backsheet **1128** includes a single ply TPO roofing membrane. In some embodiments, non-limiting examples of TPO membranes are disclosed in U.S. Patent No. 9,359,014 to Yang et al., which is incorporated by reference herein in its entirety. In some embodiments, the second layer **1132** of the backsheet **1128** is composed of polyethylene terephthalate ("PET"). In some embodiments, the second layer **1132** is composed of styrene acrylic copolymer. In some embodiments, the second layer **1132** of the backsheet **1128** is composed of ethylene tetrafluoroethylene ("ETFE"). In some embodiments, the second layer **1132** of the backsheet **1128** is composed of an acrylic such as polymethyl methacrylate ("PMMA"). In some embodiments, the second layer **1132** of the backsheet **1128** is composed of polyvinyl chloride. In some embodiments, the second layer **1132** of the backsheet **1128** is composed of ethylene propylene diene monomer (EPDM) rubber. In some embodiments, the second layer **1132** of the backsheet **1128** includes a flame retardant additive. In some embodiments, the flame retardant additive may be clays, nanoclays, silicas, carbon black, metal hydroxides such as aluminum hydroxide, metal foils, graphite, and combinations thereof.

FIG. 41 shows a schematic view of the first side lap **1115**. In some embodiments, the first side lap **1115** includes a structure and materials similar to those of the active area **1109**, with certain differences. In some embodiments, the first side lap **1115** includes ends of the bussing wires **1103a**, **1103b** encapsulated by the encapsulant **1114**. In some embodiments, the first side lap **1115** includes the polymer layer **1124**. In some embodiments, the polymer layer **1124** is an upper, sun facing-side surface of the first side lap **1115**. In some embodiments, the second side lap **1117** includes a structure and materials similar to those as the first side lap **1115**. In some embodiments, the headlap portion **1113** includes a structure and materials similar to those as the first side lap **1115**.

In some embodiments, the wire cover bracket **1300** is located on a surface **1105** of the polymer layer **1124**. In some embodiments, the wire cover bracket **1300** is composed of a polymer. In some embodiments, the wire cover bracket **1300** is composed of a composite material. In some embodiments, the wire cover bracket **1300** is composed of a reinforced plastic. In some embodiments, the wire cover bracket **1300** is composed of a fiber-reinforced polymer. In some embodiments, the wire cover bracket **1300** is composed of fiberglass. In some embodiments, the wire cover bracket **1300** is injection molded. In some embodiments, the wire cover bracket **1300** is configured to receive a cover **1304**, which shall be described in detail hereinafter. In some embodiments, the wire cover bracket **1300** is attached to the surface **1105** of the polymer layer **1124** by an adhesive. In some embodiments, the wire cover bracket **1300** is attached to the surface **1105** of the polymer layer **1124** by thermal bonding. In some embodiments, the wire cover bracket **1300** is attached to the surface **1105** of the polymer layer **1124** by ultrasonic welding.

In some embodiments, the wire cover bracket **1300** has a height of 1 mm to 10 mm. In some embodiments, the wire cover bracket **1300** has a height of 1 mm to 9 mm. In some

embodiments, the wire cover bracket **1300** has a height of 1 mm to 8 mm. In some embodiments, the wire cover bracket **1300** has a height of 1 mm to 7 mm. In some embodiments, the wire cover bracket **1300** has a height of 1 mm to 6 mm. In some embodiments, the wire cover bracket **1300** has a height of 1 mm to 5 mm. In some embodiments, the wire cover bracket **1300** has a height of 1 mm to 4 mm. In some embodiments, the wire cover bracket **1300** has a height of 1 mm to 3 mm. In some embodiments, the wire cover bracket **1300** has a height of 1 mm to 2 mm.

In some embodiments, the wire cover bracket **1300** has a height of 2 mm to 10 mm. In some embodiments, the wire cover bracket **1300** has a height of 2 mm to 9 mm. In some embodiments, the wire cover bracket **1300** has a height of 2 mm to 8 mm. In some embodiments, the wire cover bracket **1300** has a height of 2 mm to 7 mm. In some embodiments, the wire cover bracket **1300** has a height of 2 mm to 6 mm. In some embodiments, the wire cover bracket **1300** has a height of 2 mm to 5 mm. In some embodiments, the wire cover bracket **1300** has a height of 2 mm to 4 mm. In some embodiments, the wire cover bracket **1300** has a height of 2 mm to 3 mm. In some embodiments, the wire cover bracket **1300** has a height of 3 mm to 10 mm. In some embodiments, the wire cover bracket **1300** has a height of 3 mm to 9 mm. In some embodiments, the wire cover bracket **1300** has a height of 3 mm to 8 mm. In some embodiments, the wire cover bracket **1300** has a height of 3 mm to 7 mm. In some embodiments, the wire cover bracket **1300** has a height of 3 mm to 6 mm. In some embodiments, the wire cover bracket **1300** has a height of 3 mm to 5 mm. In some embodiments, the wire cover bracket **1300** has a height of 3 mm to 4 mm.

In some embodiments, the wire cover bracket **1300** has a height of 4 mm to 10 mm. In some embodiments, the wire cover bracket **1300** has a height of 4 mm to 9 mm. In some embodiments, the wire cover bracket **1300** has a height of 4 mm to 8 mm. In some embodiments, the wire cover bracket **1300** has a height of 4 mm to 7 mm. In some embodiments, the wire cover

bracket **1300** has a height of 4 mm to 6 mm. In some embodiments, the wire cover bracket **1300** has a height of 4 mm to 5 mm. In some embodiments, the wire cover bracket **1300** has a height of 5 mm to 10 mm. In some embodiments, the wire cover bracket **1300** has a height of 5 mm to 8 mm. In some
5 embodiments, the wire cover bracket **1300** has a height of 5 mm to 7 mm. In some embodiments, the wire cover bracket **1300** has a height of 5 mm to 6 mm.

In some embodiments, the wire cover bracket **1300** has a height of 6 mm to 10 mm. In some embodiments, the wire cover bracket **1300** has a height of 6 mm to 9 mm. In some
10 embodiments, the wire cover bracket **1300** has a height of 6 mm to 8 mm. In some embodiments, the wire cover bracket **1300** has a height of 6 mm to 7 mm. In some embodiments, the wire cover bracket **1300** has a height of 7 mm to 10 mm. In some embodiments, the wire cover bracket **1300** has a height of 7 mm to 9 mm. In some embodiments, the wire cover bracket **1300** has a height of 7 mm to 8 mm. In some embodiments, the wire cover bracket **1300** has a height of 8 mm to 10 mm. In some
15 embodiments, the wire cover bracket **1300** has a height of 8 mm to 9 mm. In some embodiments, the wire cover bracket **1300** has a height of 9 mm to 10 mm.

In some embodiments, the wire cover bracket **1300** has a height of 1 mm. In some
embodiments, the wire cover bracket **1300** has a height of 2 mm. In some embodiments, the wire
cover bracket **1300** has a height of 3 mm. In some embodiments, the wire cover bracket **1300** has
a height of 4 mm. In some embodiments, the wire cover bracket **1300** has a height of 5 mm. In
20 some embodiments, the wire cover bracket **1300** has a height of 6 mm. In some embodiments, the
wire cover bracket **1300** has a height of 7 mm. In some embodiments, the wire cover bracket **1300**
has a height of 8 mm. In some embodiments, the wire cover bracket **1300** has a height of 9 mm.
In some embodiments, the wire cover bracket **1300** has a height of 10 mm.

Referring to **FIG. 42**, in some embodiments, an edge **1133** of the second layer **1132** is offset from an edge **1123** of the glass layer **1122** by a distance **D**. In some embodiments, the distance **D** is of a sufficient amount so as to enable the edge **1133** to be cut or trimmed when the photovoltaic module **1110** is installed on the roof deck for aesthetically matching the photovoltaic modules **1110** with other ones of the photovoltaic modules **1110**. In some embodiments, the distance **D** is 1 mm to 10 mm. In some embodiments, the distance **D** is 1 mm to 9 mm. In some embodiments, the distance **D** is 1 mm to 8 mm. In some embodiments, the distance **D** is 1 mm to 7 mm. In some embodiments, the distance **D** is 1 mm to 6 mm. In some embodiments, the distance **D** is 1 mm to 5 mm. In some embodiments, the distance **D** is 1 mm to 4 mm. In some embodiments, the distance **D** is 1 mm to 3 mm. In some embodiments, the distance **D** is 1 mm to 2 mm.

In some embodiments, the distance **D** is 2 mm to 10 mm. In some embodiments, the distance **D** is 2 mm to 9 mm. In some embodiments, the distance **D** is 2 mm to 8 mm. In some embodiments, the distance **D** is 2 mm to 7 mm. In some embodiments, the distance **D** is 2 mm to 6 mm. In some embodiments, the distance **D** is 2 mm to 5 mm. In some embodiments, the distance **D** is 2 mm to 4 mm. In some embodiments, the distance **D** is 2 mm to 3 mm. In some embodiments, the distance **D** is 3 mm to 10 mm. In some embodiments, the distance **D** is 3 mm to 9 mm. In some embodiments, the distance **D** is 3 mm to 8 mm. In some embodiments, the distance **D** is 3 mm to 7 mm. In some embodiments, the distance **D** is 3 mm to 6 mm. In some embodiments, the distance **D** is 3 mm to 5 mm. In some embodiments, the distance **D** is 3 mm to 4 mm. In some embodiments, the distance **D** is 4 mm to 10 mm. In some embodiments, the distance **D** is 4 mm to 9 mm. In some embodiments, the distance **D** is 4 mm to 8 mm. In some

embodiments, the distance **D** is 4 mm to 7 mm. In some embodiments, the distance **D** is 4 mm to 6 mm. In some embodiments, the distance **D** is 4 mm to 5 mm.

In some embodiments, the distance **D** is 5 mm to 10 mm. In some embodiments, the distance **D** is 5 mm to 9 mm. In some embodiments, the distance **D** is 5 mm to 8 mm. In some
5 embodiments, the distance **D** is 5 mm to 7 mm. In some embodiments, the distance **D** is 5 mm to 6 mm. In some embodiments, the distance **D** is 6 mm to 10 mm. In some embodiments, the distance **D** is 6 mm to 9 mm. In some embodiments, the distance **D** is 6 mm to 8 mm. In some
10 embodiments, the distance **D** is 6 mm to 7 mm. In some embodiments, the distance **D** is 7 mm to 10 mm. In some embodiments, the distance **D** is 7 mm to 9 mm. In some embodiments, the distance **D** is 7 mm to 8 mm. In some embodiments, the distance **D** is 8 mm to 10 mm. In some
embodiments, the distance **D** is 8 mm to 9 mm. In some embodiments, the distance **D** is 9 mm to 10 mm.

In some embodiments, the distance **D** is 1 mm. In some embodiments, the distance **D** is 2 mm. In some embodiments, the distance **D** is 3 mm. In some embodiments, the distance **D** is 4
15 mm. In some embodiments, the distance **D** is 5 mm. In some embodiments, the distance **D** is 6 mm. In some embodiments, the distance **D** is 7 mm. In some embodiments, the distance **D** is 8 mm. In some embodiments, the distance **D** is 9 mm. In some embodiments, the distance **D** is 10 mm.

In some embodiments, the first layer **1130** of the backsheet **1128** includes a composite
20 material. In some embodiments, the second layer **1132** of the backsheet **1128** includes a composite material. In some embodiments, the composite materials may absorb less solar radiation than conventional composite materials (e.g., conventional black building materials, conventional black roofing materials, etc.). In some embodiments, the composite materials may have a solar

reflectance that is at least 20% greater than conventional composite materials. In some embodiments, the composite materials may be used as a roof attachment and a water shedding layer. In some embodiments, the composite materials, when used as roofing materials for photovoltaic modules, may increase power for such photovoltaic modules by 1% to 2%. In some
5 embodiments, the composite materials may have a relative temperature index (RTI) of greater than 90 °C. In some embodiments, the composite material may be a black thermoplastic polyolefin membrane.

As used herein, the term “building material” may include, without limitation, at least one of a roofing material, a siding, a flooring, or any combination thereof. As used herein, the term
10 “roofing material” may include any material of a roof and may include, for example and without limitation, at least one of shingles (e.g., such as photovoltaic modules), roofing membranes (e.g., such as waterproofing membranes), underlayments, tiles, any component thereof, or any combination thereof. In some embodiments, the roofing material may comprise, consist of, or consist essentially of a photovoltaic module. In some embodiments, the roofing material may
15 comprise, consist of, or consist essentially of a component of a photovoltaic module. For example, in some embodiments, the roofing material may comprise, consist of, or consist essentially of a backsheet or a portion of a backsheet (e.g., a bottom flap, a head flap, etc.). Further examples of roofing materials include, without limitation, at least one of rolled roofing, flexible rolled roofing, or any combination thereof.

20 In some embodiments, the composite material is a roofing composite material. In some embodiments, the roofing composite material may comprise, consist of, or consist essentially of one or more layers. For example, in some embodiments, the roofing composite material may comprise, consist of, or consist essentially of at least one of a substrate, a cap, a core, or any

combination thereof. In some embodiments, the substrate may have a first surface and a second surface opposite the first surface. In some embodiments, the cap may be on the first surface of the substrate. In some embodiments, the cap may be in contact with the first surface of the substrate. In some embodiments, the core may be on the second surface of the substrate. In some
5 embodiments, the core may be in contact with the second surface of the substrate. In some
embodiments, one or more layers may be located between the cap and the substrate. In some
embodiments, one or more layers may be located between the core and the substrate.

In some embodiments, the roofing composite material is the backsheet **1128** of the photovoltaic module **1110**. In some embodiments, the first layer **1130** of the backsheet **1128** is
10 composed of the roofing composite material. In some embodiments, the second layer **1132** of the
backsheet **1128** is composed of the roofing composite material.

In some embodiments, the substrate may comprise, consist of, or consist essentially of a scrim (e.g., a polymeric scrim, such as a polyester scrim), a plywood substrate, a glass substrate, a cellulosic substrate, a roof shingle, a mat, a fabric, a glass mat, a fiberglass mat, an underlayment,
15 a roofing membrane, a roof deck, a photovoltaic (PV) panel, a modified bitumen (MODBIT)
substrate, a roll good, a board (such as but not limited to at least one of a foam board (e.g., a polyisocyanurate (ISO) foam board), a cover board, or any combination thereof), a pipe, a base
sheet, a chimney, a wax paper, or any combination thereof.

In some embodiments, the cap may comprise, consist of, or consist essentially of at least
20 one of the following: one or more polymers, at least one infrared-reflective pigment, a stabilizer
package, one or more fillers, or any combination thereof. In some embodiments, the cap may
comprise, consist of, or consist essentially of at least one of the following: one or more
thermoplastic polyolefins, at least one infrared-reflective black pigment, a stabilizer package, one

or more fillers, or any combination thereof. In some embodiments, the stabilizer package may comprise at least one ultraviolet (UV) absorber. In some embodiments, the cap may not comprise a white colorant. In some embodiments, the term white colorant includes white pigments. In some embodiments, the term infrared-reflective black pigment includes infrared-reflective black colorants. In some embodiments, the cap may comprise, consist of, or consist essentially of one or more thermoplastic polyolefins, an ultraviolet absorber, an infrared-reflective black pigment, and optionally one or more fillers, wherein the cap does not comprise at least one of a white colorant, a white pigment, or any combination thereof.

In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 200 nm or greater. For example, in some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 200 nm to 500 nm. In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 200 nm to 475 nm. In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 200 nm to 450 nm. In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 200 nm to 425 nm. In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 200 nm to 400 nm. In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 200 nm to 375 nm. In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 200 nm to 350 nm. In some embodiments, the white colorant may

comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 200 nm to 325 nm. In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 200 nm to 300 nm. In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 200 nm to 275 nm. In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 200 nm to 250 nm. In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 200 nm to 225 nm.

In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 225 nm to 500 nm. In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 250 nm to 500 nm. In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 275 nm to 500 nm. In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 300 nm to 500 nm. In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 325 nm to 500 nm. In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 350 nm to 500 nm. In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 375 nm to 500 nm. In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles

having a particle size of 400 nm to 500 nm. In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 425 nm to 500 nm. In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 450 nm to 500 nm.

5 In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 475 nm to 500 nm. In some embodiments, the white colorant may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 250 nm to 450 nm.

In some embodiments, the cap does not comprise at least one of a white colorant, a white
10 pigment, or any combination thereof. In some embodiments, the cap may comprise an amount of a white colorant, provided that the overall color appearance of the composite material remains black. For example, in some embodiments, the cap may comprise less than 10% by weight of the white colorant based on the total weight of the cap. In some embodiments, the cap may comprise less than 9% by weight of the white colorant based on the total weight of the cap. In some
15 embodiments, the cap may comprise less than 8% by weight of the white colorant based on the total weight of the cap. In some embodiments, the cap may comprise less than 7% by weight of the white colorant based on the total weight of the cap. In some embodiments, the cap may comprise less than 6% by weight of the white colorant based on the total weight of the cap. In some embodiments, the cap may comprise less than 5% by weight of the white colorant based on
20 the total weight of the cap. In some embodiments, the cap may comprise less than 4% by weight of the white colorant based on the total weight of the cap. In some embodiments, the cap may comprise less than 3% by weight of the white colorant based on the total weight of the cap. In some embodiments, the cap may comprise less than 2% by weight of the white colorant based on

the total weight of the cap. In some embodiments, the cap may comprise less than 1% by weight of the white colorant based on the total weight of the cap. In some embodiments, the cap may comprise from 0.1% to 1% by weight of the white colorant based on the total weight of the cap.

In some embodiments, the ultraviolet absorber may comprise, consist of, or consist
5 essentially of titanium dioxide (TiO₂) particles having a particle size of less than 200 nm. In some
embodiments, the ultraviolet absorber may comprise, consist of, or consist essentially of titanium
dioxide (TiO₂) particles having a particle size of less than 190 nm. In some embodiments, the
ultraviolet absorber may comprise, consist of, or consist essentially of titanium dioxide (TiO₂)
particles having a particle size of less than 180 nm. In some embodiments, the ultraviolet absorber
10 may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a
particle size of less than 170 nm. In some embodiments, the ultraviolet absorber may comprise,
consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of less
than 165 nm. In some embodiments, the ultraviolet absorber may comprise, consist of, or consist
essentially of titanium dioxide (TiO₂) particles having a particle size of less than 150 nm. In some
15 embodiments, the ultraviolet absorber may comprise, consist of, or consist essentially of titanium
dioxide (TiO₂) particles having a particle size of less than 140 nm. In some embodiments, the
ultraviolet absorber may comprise, consist of, or consist essentially of titanium dioxide (TiO₂)
particles having a particle size of less than 130 nm. In some embodiments, the ultraviolet absorber
may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a
20 particle size of less than 120 nm. In some embodiments, the ultraviolet absorber may comprise,
consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of less
than 110 nm. In some embodiments, the ultraviolet absorber may comprise, consist of, or consist
essentially of titanium dioxide (TiO₂) particles having a particle size of less than 100 nm.

In some embodiments, the ultraviolet absorber may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 1 nm to less than 200 nm. In some embodiments, the ultraviolet absorber may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 50 nm to 165 nm. In some embodiments, the ultraviolet absorber may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 50 nm to 150 nm. In some embodiments, the ultraviolet absorber may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 50 nm to 135 nm. In some embodiments, the ultraviolet absorber may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 50 nm to 120 nm. In some embodiments, the ultraviolet absorber may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 50 nm to 105 nm. In some embodiments, the ultraviolet absorber may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 65 nm to 165 nm. In some embodiments, the ultraviolet absorber may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 80 nm to 165 nm. In some embodiments, the ultraviolet absorber may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 95 nm to 165 nm. In some embodiments, the ultraviolet absorber may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 110 nm to 165 nm. In some embodiments, the ultraviolet absorber may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 70 nm to 135 nm. In some embodiments, the ultraviolet absorber may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 125 nm to 150 nm. In some embodiments, the ultraviolet absorber may comprise, consist of, or consist essentially of titanium dioxide (TiO₂)

particles having a particle size of 110 nm to 165 nm. In some embodiments, the ultraviolet absorber may comprise, consist of, or consist essentially of titanium dioxide (TiO₂) particles having a particle size of 1 nm to 50 nm.

In some embodiments, the ultraviolet absorber is present in the cap in an amount of 0.1% by weight to 10% by weight based on the total weight of the cap. In some embodiments, the ultraviolet absorber is present in the cap in an amount of 1% by weight to 10% by weight based on the total weight of the cap. In some embodiments, the ultraviolet absorber is present in the cap in an amount of 2% by weight to 9% by weight based on the total weight of the cap. In some embodiments, the ultraviolet absorber is present in the cap in an amount of 2% by weight to 8% by weight based on the total weight of the cap. In some embodiments, the ultraviolet absorber is present in the cap in an amount of 2% by weight to 7% by weight based on the total weight of the cap. In some embodiments, the ultraviolet absorber is present in the cap in an amount of 3% by weight to 9% by weight based on the total weight of the cap. In some embodiments, the ultraviolet absorber is present in the cap in an amount of 3% by weight to 8% by weight based on the total weight of the cap. In some embodiments, the ultraviolet absorber is present in the cap in an amount of 4% by weight to 8% by weight based on the total weight of the cap. In some embodiments, the ultraviolet absorber is present in the cap in an amount of 1% by weight to 5% by weight based on the total weight of the cap. In some embodiments, the ultraviolet absorber is present in the cap in an amount of 1% by weight to 4% by weight based on the total weight of the cap. In some embodiments, the ultraviolet absorber is present in the cap in an amount of 1% by weight to 3% by weight based on the total weight of the cap. In some embodiments, the ultraviolet absorber is present in the cap in an amount of 1% by weight to 2% by weight based on the total weight of the cap. In some embodiments, the ultraviolet absorber is present in the cap in an amount of 1% by

weight to 2% by weight based on the total weight of the cap. In some embodiments, the ultraviolet absorber is present in the cap in an amount of 1% by weight to 10% by weight based on the total weight of the cap.

In some embodiments, the infrared-reflective pigment may comprise, consist of, or consist essentially of an infrared-reflective black pigment. Examples of infrared-reflective black pigments include, without limitation, one or more of the following commercially available products: “new black” (Ferro product no. V-799) and “old black” (Ferro product no. V-7970), which are available from Ferro Corporation (Cleveland, Ohio) and sold as Cool Colors™ and Eclipse™ pigments. Other infrared-reflective pigments include, for example and without limitation, one or more of the following: “turquoise” (Ferro product no. PC-5686), “blue” (Ferro product no. PC-9250), “camouflage green” (Ferro product no. V-12600), “IR green” (Ferro product no. V-12650), “autumn gold” (Ferro product no. PC9158), “yellow” (Ferro product no. PC-9416), and “red” (Ferro product nos. V-13810 and V-13815).

In some embodiments, the infrared reflective pigment is present in the cap in an amount of 0.01% by weight to 15% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 1% by weight to 15% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 1% by weight to 14% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 1% by weight to 13% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 1% by weight to 12% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 1% by weight to 11% by weight based on the total weight of

the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 1% by weight to 10% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 1% by weight to 9% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 1% by weight to 8% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 1% by weight to 7% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 1% by weight to 6% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 1% by weight to 5% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 1% by weight to 4% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 1% by weight to 3% by weight based on the total weight of the cap.

In some embodiments, the infrared reflective pigment is present in the cap in an amount of 2% by weight to 15% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 3% by weight to 15% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 4% by weight to 15% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 5% by weight to 15% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 6% by weight to 15% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is

present in the cap in an amount of 7% by weight to 15% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 8% by weight to 15% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 9% by weight to 15% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 10% by weight to 15% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 11% by weight to 15% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 12% by weight to 15% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 13% by weight to 15% by weight based on the total weight of the cap.

In some embodiments, the infrared reflective pigment is present in the cap in an amount of 0.01% by weight to 10% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 2% by weight to 9% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 2% by weight to 8% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 2% by weight to 7% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 2% by weight to 6% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 3% by weight to 9% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of

3% by weight to 8% by weight based on the total weight of the cap. In some embodiments, the infrared reflective pigment is present in the cap in an amount of 4% by weight to 6% by weight based on the total weight of the cap.

In some embodiments, the cap has a CIELAB color value comprises an L value range of 0
5 $\leq L^* < 40$. In some embodiments, the cap has a CIELAB color value comprises an L value range of $0 \leq L^* < 35$. In some embodiments, the cap has a CIELAB color value comprises an L value range of $0 \leq L^* < 30$. In some embodiments, the cap has a CIELAB color value comprises an L value range of $0 \leq L^* < 25$. In some embodiments, the cap has a CIELAB color value comprises an L value range of $0 \leq L^* < 20$. In some embodiments, the cap has a CIELAB color value
10 comprises an L value range of $0 \leq L^* < 15$. In some embodiments, the cap has a CIELAB color value comprises an L value range of $0 \leq L^* < 10$. In some embodiments, the cap has a CIELAB color value comprises an L value range of $0 \leq L^* < 5$. In some embodiments, the cap has a CIELAB color value comprises an L value range of $0 \leq L^* < 4$. In some embodiments, the cap has a CIELAB color value comprises an L value range of $0 \leq L^* < 3$. In some embodiments, the cap has a CIELAB
15 color value comprises an L value range of $0 \leq L^* < 2$. In some embodiments, the cap has a CIELAB color value comprises an L value range of $0 \leq L^* < 1$.

In some embodiments, the core may comprise, consist of, or consist essentially of at least one of the following: one or more polymers (e.g., thermoplastic polyolefins), a stabilizer package, one or more fillers, or any combination thereof.

20 A non-limiting example of a cross-section of at least a portion of a composite material is shown in **FIG. 43**, according to some embodiments of the present disclosure. As shown in **FIG. 43**, in some embodiments, the composite material **1100** may comprise, consist of, or consist essentially of a substrate **1170**, a cap **1172**, and a core **1174**. In some embodiments, the substrate

1170 has a first surface and a second surface. In some embodiments, the cap **1172** may be on the first surface of the substrate **1170**. In some embodiments, the core **1174** may be on the second surface of the substrate **1170**.

In some embodiments, the second layer **1132** has a thickness of 1 mm to 5 mm. In some
5 embodiments, the second layer **1132** has a thickness of 1 mm to 4 mm. In some embodiments, the
second layer **1132** has a thickness of 1 mm to 3 mm. In some embodiments, the second layer **1132**
has a thickness of 1 mm to 2 mm. In some embodiments, the second layer **1132** has a thickness
of 2 mm to 5 mm. In some embodiments, the second layer **1132** has a thickness of 2 mm to 4 mm.
In some embodiments, the second layer **1132** has a thickness of 2 mm to 3 mm. In some
10 embodiments, the second layer **1132** has a thickness of 3 mm to 5 mm. In some embodiments, the
second layer **1132** has a thickness of 3 mm to 4 mm. In some embodiments, the second layer **1132**
has a thickness of 4 mm to 5 mm. In some embodiments, the second layer **1132** has a thickness
of 1 mm. In some embodiments, the second layer **1132** has a thickness of 2 mm. In some
embodiments, the second layer **1132** has a thickness of 3 mm. In some embodiments, the second
15 layer **1132** has a thickness of 4 mm. In some embodiments, the second layer **1132** has a thickness
of 5 mm.

In some embodiments, the first layer **1130** is attached to the second layer **1132** by a second
adhesive layer **1134**. In some embodiments, the second adhesive layer **1134** may include polyvinyl
butyrate, acrylic, silicone, or polycarbonate. In some embodiments, the second adhesive layer
20 **1134** may include pressure sensitive adhesives. In some embodiments, the second adhesive layer
1134 is composed of thermosetting polyolefin, thermosetting polyolefin encapsulant material,
thermosetting ethylene-vinyl acetate (EVA), EVA encapsulants, thermoplastic olefin,
thermoplastic polyolefin (TPO) or hybrids/combinations thereof.

In some embodiments, the second adhesive layer **1134** has a thickness of 0.2 mm to 2 mm. In some embodiments, the second adhesive layer **1134** has a thickness of 0.2 mm to 1.5 mm. In some embodiments, the second adhesive layer **1134** has a thickness of 0.2 mm to 1 mm. In some embodiments, the second adhesive layer **1134** has a thickness of 0.2 mm to 0.5 mm. In some
5 embodiments, the second adhesive layer **1134** has a thickness of 0.5 mm to 2 mm. In some embodiments, the second adhesive layer **1134** has a thickness of 0.5 mm to 1.5 mm. In some embodiments, the second adhesive layer **1134** has a thickness of 0.5 mm to 1 mm. In some embodiments, the second adhesive layer **1134** has a thickness of 1 mm to 2 mm. In some
10 embodiments, the second adhesive layer **1134** has a thickness of 1 mm to 1.5 mm. In some embodiments, the second adhesive layer **1134** has a thickness of 1.5 mm to 2 mm.

In some embodiments, the second adhesive layer **1134** has a thickness of 0.2 mm. In some embodiments, the second adhesive layer **1134** has a thickness of 0.3 mm. In some embodiments, the second adhesive layer **1134** has a thickness of 0.4 mm. In some embodiments, the second adhesive layer **1134** has a thickness of 0.45 mm. In some embodiments, the second adhesive layer
15 **1134** has a thickness of 0.5 mm. In some embodiments, the second adhesive layer **1134** has a thickness of 1 mm. In some embodiments, the second adhesive layer **1134** has a thickness of 1.5 mm. In some embodiments, the second adhesive layer **1134** has a thickness of 2 mm. In some embodiments, the second adhesive layer **1134** has a thickness of 2.5 mm. In some embodiments, the second adhesive layer **1134** has a thickness of 3 mm. In some embodiments, the second
20 adhesive layer **1134** has a thickness of 3.5 mm. In some embodiments, the second adhesive layer **1134** has a thickness of 4 mm.

In some embodiments, the second adhesive layer **1134** has a thickness of 1 μm to 900 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 1 μm to 850 μm . In

some embodiments, the second adhesive layer **1134** has a thickness of 1 μm to 800 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 1 μm to 750 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 1 μm to 700 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 1 μm to 650 μm . In some
5 embodiments, the second adhesive layer **1134** has a thickness of 1 μm to 600 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 1 μm to 550 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 1 μm to 500 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 1 μm to 450 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 1 μm to 400 μm . In some
10 embodiments, the second adhesive layer **1134** has a thickness of 1 μm to 350 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 1 μm to 300 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 1 μm to 250 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 1 μm to 200 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 1 μm to 150 μm . In some
15 embodiments, the second adhesive layer **1134** has a thickness of 1 μm to 100 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 1 μm to 50 μm .

In some embodiments, the second adhesive layer **1134** has a thickness of 50 μm to 900
 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 50 μm to 850 μm .
In some embodiments, the second adhesive layer **1134** has a thickness of 50 μm to 800 μm . In
20 some embodiments, the second adhesive layer **1134** has a thickness of 50 μm to 750 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 50 μm to 700 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 50 μm to 650 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 50 μm to 600 μm . In some

embodiments, the second adhesive layer **1134** has a thickness of 50 μm to 550 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 50 μm to 500 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 50 μm to 450 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 50 μm to 400 μm . In some
5 embodiments, the second adhesive layer **1134** has a thickness of 50 μm to 350 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 50 μm to 300 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 50 μm to 250 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 50 μm to 200 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 50 μm to 150 μm . In some
10 embodiments, the second adhesive layer **1134** has a thickness of 50 μm to 100 μm .

In some embodiments, the second adhesive layer **1134** has a thickness of 100 μm to 900
 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 100 μm to 850 μm .
In some embodiments, the second adhesive layer **1134** has a thickness of 100 μm to 800 μm . In
some embodiments, the second adhesive layer **1134** has a thickness of 100 μm to 750 μm . In some
15 embodiments, the second adhesive layer **1134** has a thickness of 100 μm to 700 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 100 μm to 650 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 100 μm to 600 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 100 μm to 550 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 100 μm to 500 μm . In some
20 embodiments, the second adhesive layer **1134** has a thickness of 100 μm to 450 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 100 μm to 400 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 100 μm to 350 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 100 μm to 300 μm . In some

embodiments, the second adhesive layer **1134** has a thickness of 100 μm to 250 μm. In some embodiments, the second adhesive layer **1134** has a thickness of 100 μm to 200 μm. In some embodiments, the second adhesive layer **1134** has a thickness of 100 μm to 150 μm.

In some embodiments, the second adhesive layer **1134** has a thickness of 150 μm to 900 μm. In some embodiments, the second adhesive layer **1134** has a thickness of 150 μm to 850 μm. In some embodiments, the second adhesive layer **1134** has a thickness of 150 μm to 800 μm. In some embodiments, the second adhesive layer **1134** has a thickness of 150 μm to 750 μm. In some embodiments, the second adhesive layer **1134** has a thickness of 150 μm to 700 μm. In some embodiments, the second adhesive layer **1134** has a thickness of 150 μm to 650 μm. In some embodiments, the second adhesive layer **1134** has a thickness of 150 μm to 600 μm. In some embodiments, the second adhesive layer **1134** has a thickness of 150 μm to 550 μm. In some embodiments, the second adhesive layer **1134** has a thickness of 150 μm to 500 μm. In some embodiments, the second adhesive layer **1134** has a thickness of 150 μm to 450 μm. In some embodiments, the second adhesive layer **1134** has a thickness of 150 μm to 400 μm. In some embodiments, the second adhesive layer **1134** has a thickness of 150 μm to 350 μm. In some embodiments, the second adhesive layer **1134** has a thickness of 150 μm to 300 μm. In some embodiments, the second adhesive layer **1134** has a thickness of 150 μm to 250 μm. In some embodiments, the second adhesive layer **1134** has a thickness of 150 μm to 200 μm.

In some embodiments, the second adhesive layer **1134** has a thickness of 200 μm to 900 μm. In some embodiments, the second adhesive layer **1134** has a thickness of 200 μm to 850 μm. In some embodiments, the second adhesive layer **1134** has a thickness of 200 μm to 800 μm. In some embodiments, the second adhesive layer **1134** has a thickness of 200 μm to 750 μm. In some embodiments, the second adhesive layer **1134** has a thickness of 200 μm to 700 μm. In some

embodiments, the second adhesive layer **1134** has a thickness of 200 μm to 650 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 200 μm to 600 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 200 μm to 550 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 200 μm to 500 μm . In some
5 embodiments, the second adhesive layer **1134** has a thickness of 200 μm to 450 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 200 μm to 400 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 200 μm to 350 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 200 μm to 300 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 200 μm to 250 μm .

10 In some embodiments, the second adhesive layer **1134** has a thickness of 250 μm to 900 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 250 μm to 850 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 250 μm to 800 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 250 μm to 750 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 250 μm to 700 μm . In some
15 embodiments, the second adhesive layer **1134** has a thickness of 250 μm to 650 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 250 μm to 600 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 250 μm to 550 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 250 μm to 500 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 250 μm to 450 μm . In some
20 embodiments, the second adhesive layer **1134** has a thickness of 250 μm to 400 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 250 μm to 350 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 250 μm to 300 μm .

In some embodiments, the second adhesive layer **1134** has a thickness of 300 μm to 900 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 300 μm to 850 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 300 μm to 800 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 300 μm to 750 μm . In some
5 embodiments, the second adhesive layer **1134** has a thickness of 300 μm to 700 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 300 μm to 650 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 300 μm to 600 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 300 μm to 550 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 300 μm to 500 μm . In some
10 embodiments, the second adhesive layer **1134** has a thickness of 300 μm to 450 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 300 μm to 400 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 300 μm to 350 μm .

In some embodiments, the second adhesive layer **1134** has a thickness of 350 μm to 900 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 350 μm to 850 μm .
15 In some embodiments, the second adhesive layer **1134** has a thickness of 350 μm to 800 μm . In
some embodiments, the second adhesive layer **1134** has a thickness of 350 μm to 750 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 350 μm to 700 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 350 μm to 650 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 350 μm to 600 μm . In some
20 embodiments, the second adhesive layer **1134** has a thickness of 350 μm to 550 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 350 μm to 500 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 350 μm to 450 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 350 μm to 400 μm .

In some embodiments, the second adhesive layer **1134** has a thickness of 400 μm to 900 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 400 μm to 850 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 400 μm to 800 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 400 μm to 750 μm . In some
5 embodiments, the second adhesive layer **1134** has a thickness of 400 μm to 700 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 400 μm to 650 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 400 μm to 600 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 400 μm to 550 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 400 μm to 500 μm . In some
10 embodiments, the second adhesive layer **1134** has a thickness of 400 μm to 450 μm .

In some embodiments, the second adhesive layer **1134** has a thickness of 450 μm to 900 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 450 μm to 850 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 450 μm to 800 μm . In some
15 embodiments, the second adhesive layer **1134** has a thickness of 450 μm to 700 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 450 μm to 650 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 450 μm to 600 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 450 μm to 550 μm . In some
embodiments, the second adhesive layer **1134** has a thickness of 450 μm to 500 μm .

20 In some embodiments, the second adhesive layer **1134** has a thickness of 500 μm to 900 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 500 μm to 850 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 500 μm to 800 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 500 μm to 750 μm . In some

embodiments, the second adhesive layer **1134** has a thickness of 500 μm to 700 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 500 μm to 650 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 500 μm to 600 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 500 μm to 550 μm .

5 In some embodiments, the second adhesive layer **1134** has a thickness of 550 μm to 900 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 550 μm to 850 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 550 μm to 800 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 550 μm to 750 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 550 μm to 700 μm . In some
10 embodiments, the second adhesive layer **1134** has a thickness of 550 μm to 650 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 550 μm to 600 μm .

 In some embodiments, the second adhesive layer **1134** has a thickness of 600 μm to 900 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 600 μm to 850 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 600 μm to 800 μm . In
15 some embodiments, the second adhesive layer **1134** has a thickness of 600 μm to 750 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 600 μm to 700 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 600 μm to 650 μm .

 In some embodiments, the second adhesive layer **1134** has a thickness of 650 μm to 900 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 650 μm to 850 μm .
20 In some embodiments, the second adhesive layer **1134** has a thickness of 650 μm to 800 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 650 μm to 750 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 650 μm to 700 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 700 μm to 900 μm . In some

embodiments, the second adhesive layer **1134** has a thickness of 700 μm to 850 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 700 μm to 800 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 700 μm to 750 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 750 μm to 900 μm . In some
5 embodiments, the second adhesive layer **1134** has a thickness of 750 μm to 850 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 750 μm to 800 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 800 μm to 900 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 800 μm to 850 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 850 μm to 900 μm .

10 In some embodiments, the second adhesive layer **1134** has a thickness of 1 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 50 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 100 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 150 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 200 μm . In some embodiments, the second adhesive layer **1134** has a
15 thickness of 250 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 300 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 350 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 400 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 450 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 500 μm . In some embodiments, the second
20 adhesive layer **1134** has a thickness of 550 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 600 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 650 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 700 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 750 μm . In

some embodiments, the second adhesive layer **1134** has a thickness of 800 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 850 μm . In some embodiments, the second adhesive layer **1134** has a thickness of 900 μm .

In some embodiments, the first layer **1130** is attached to the second layer **1132** by thermal bonding. In some embodiments, each of the plurality of photovoltaic modules **1110** is installed on the roof deck by an adhesive. In some embodiments, the adhesive is adhered directly to the roof deck. In some embodiments, the adhesive is adhered to an underlayment. In some embodiments, the underlayment is adhered directly to the roof deck. In some embodiments, the adhesive is located on a rear surface of the photovoltaic module **1110**. In some embodiments, the adhesive is located on the second layer **1132** of the backsheet **1128**. In some embodiments, the adhesive includes at least one adhesive strip. In some embodiments, the adhesive includes a plurality of adhesive strips. In some embodiments, the plurality of adhesive strips is arranged intermittently. In some embodiments, the adhesive is located proximate to one edge of the photovoltaic module **1110**. In some embodiments, the adhesive is a peel and stick film sheet. In some embodiments, the peel and stick film sheet includes at least one sheet of film removably attached to the rear surface. In some embodiments, the peel and stick film sheet is composed of EverGuard Freedom HW peel and stick membrane manufactured by GAF. In some embodiments, the adhesive includes polyvinyl butyrate, acrylic, silicone, or polycarbonate. In some embodiments, the adhesive includes pressure sensitive adhesives. In some embodiments, the adhesive has a similar structure and location as the adhesive **60** shown in **FIG. 2E**.

Referring to **FIGS. 44** through **49**, in some embodiments, a jumper module **1210** includes an active portion **1212** having a first end **1214**, a second end **1216** opposite the first end **1214**, a first edge **1218** extending from the first end **1214** to the second end **1216**, and a second edge **1220**

opposite the first edge **1218** and extending from the first end **1214** to the second end **1216**. In some embodiments, the active portion **1212** includes a first surface **1222** and a second surface **1224** opposite the first surface **1222**. In some embodiments, the jumper module **1210** is configured to be installed on a roof deck. In some embodiments, the jumper module **1210** is installed on the
5 roof deck by a plurality of fasteners. In some embodiments, the active portion **1212** includes a first zone **1226** (nail zone) that extends from the first end **1214** to the second end **1216** and from the first edge **1218** to a location intermediate the first edge **1218** and the second edge **1220**. In some embodiments, the first zone **1226** is configured to receive the plurality of fasteners. In some embodiments, the plurality of fasteners is installed through the first zone **1226**. In some
10 embodiments, the plurality of fasteners includes a plurality of nails. In some embodiments, the plurality of fasteners includes a plurality of rivets. In some embodiments, the plurality of fasteners includes a plurality of staples. In some embodiments, the plurality of fasteners includes a plurality of screws.

In some embodiments, the jumper module **1210** is installed on the roof deck by an adhesive
15 **1228**. In some embodiments, the adhesive **1228** is adhered directly to the roof deck. In some embodiments, the adhesive **1228** is adhered to an underlayment. In some embodiments, the underlayment is adhered directly to the roof deck. In some embodiments, the adhesive **1228** includes at least one adhesive strip. In some embodiments, the adhesive **1228** includes a plurality of adhesive strips. In some embodiments, the adhesive **1228** is located on the second surface **1224**.
20 In some embodiments, the adhesive **1228** is located proximate to the first edge **1218**. In some embodiments, the adhesive **1228** is located intermediate the first edge **1218** and the second edge **1220**. In some embodiments, the adhesive **1228** is located proximate to the second edge **1220**. In some embodiments, the adhesive **1228** is a peel and stick film sheet. In some embodiments, the

peel and stick film sheet includes at least one sheet of film removably attached to the second surface **1224**. In some embodiments, the peel and stick film sheet is composed of EverGuard Freedom HW peel and stick membrane manufactured by GAF. In some embodiments, the adhesive **1228** is covered by a release liner. In some embodiments, the release liner includes paper with a silicone coating. In some embodiments, the adhesive **1228** includes polyvinyl butyrate, butyl, acrylic, silicone, or polycarbonate. In some embodiments, the adhesive **1228** includes pressure sensitive adhesives. In some embodiments, the adhesive **1228** has a similar structure and location as the adhesive **60** shown in **FIG. 2E**.

Still referring to **FIGS. 44** through **49**, in some embodiments, the jumper module **1210** includes a first side lap **1230** located the first end **1214**. In some embodiments, the jumper module **1210** includes a second side lap **1232** located at the second end **1216**. In some embodiments, the first side lap **1230** includes a surface **1234**. In some embodiments, the second side lap **1232** includes a surface **1236**. In some embodiments, the first side lap **1230** is square in shape. In some embodiments, the first side lap **1230** is rectangular in shape. In some embodiments, the first side lap **1230** includes other suitable shapes and sizes. In some embodiments, the second side lap **1232** is square in shape. In some embodiments, the second side lap **1232** is rectangular in shape. In some embodiments, the second side lap **1232** includes other suitable shapes and sizes. In some embodiments, the first side lap **1230** is integral with the active portion **1212**. In some embodiments, the first side lap **1230** is a separate component from the active portion **1212**. In some embodiments, the first side lap **1230** is attached to the active portion **1212**. In some embodiments, the second side lap **1232** is integral with the active portion **1212**. In some embodiments, the second side lap **1232** is a separate component from the active portion **1212**. In some embodiments, the second side lap **1232** is attached to the active portion **1212**.

In some embodiments, the first side lap **1230** includes a first width **W1**. In some embodiments, the first width **W1** extends from the second edge **1220** to a location intermediate the first edge **1218** and the second edge **1220**. In some embodiments, the second side lap **1232** includes a second width **W2**. In some embodiments, the second width **W2** extends from the first edge **1218** to the second edge **1220**. In some embodiments, the width **W1** of the first side lap **1230** is approximately half the width **W2** of the second side lap **1232**.

In some embodiments, the width **W1** of the first side lap **1230** is 70 mm to 120 mm. In some embodiments, the width **W1** of the first side lap **1230** is 70 mm to 110 mm. In some embodiments, the width **W1** of the first side lap **1230** is 70 mm to 100 mm. In some embodiments, the width **W1** of the first side lap **1230** is 70 mm to 90 mm. In some embodiments, the width **W1** of the first side lap **1230** is 70 mm to 80 mm. In some embodiments, the width **W1** of the first side lap **1230** is 80 mm to 120 mm. In some embodiments, the width **W1** of the first side lap **1230** is 80 mm to 110 mm. In some embodiments, the width **W1** of the first side lap **1230** is 80 mm to 100 mm. In some embodiments, the width **W1** of the first side lap **1230** is 80 mm to 90 mm. In some embodiments, the width **W1** of the first side lap **1230** is 90 mm to 120 mm. In some embodiments, the width **W1** of the first side lap **1230** is 90 mm to 110 mm. In some embodiments, the width **W1** of the first side lap **1230** is 90 mm to 100 mm. In some embodiments, the width **W1** of the first side lap **1230** is 100 mm to 120 mm. In some embodiments, the width **W1** of the first side lap **1230** is 100 mm to 110 mm. In some embodiments, the width **W1** of the first side lap **1230** is 110 mm to 120 mm.

In some embodiments, the width **W2** of the second side lap **1232** is 70 mm to 200 mm. In some embodiments, the width **W2** of the second side lap **1232** is 70 mm to 190 mm. In some embodiments, the width **W2** of the second side lap **1232** is 70 mm to 180 mm. In some

embodiments, the width **W2** of the second side lap **1232** is 70 mm to 170 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 70 mm to 160 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 70 mm to 150 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 70 mm to 140 mm. In some
5 embodiments, the width **W2** of the second side lap **1232** is 70 mm to 130 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 70 mm to 120 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 70 mm to 110 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 70 mm to 100 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 70 mm to 90 mm. In some
10 embodiments, the width **W2** of the second side lap **1232** is 70 mm to 80 mm.

In some embodiments, the width **W2** of the second side lap **1232** is 80 mm to 200 mm. In
some embodiments, the width **W2** of the second side lap **1232** is 80 mm to 190 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 80 mm to 180 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 80 mm to 170 mm. In some
15 embodiments, the width **W2** of the second side lap **1232** is 80 mm to 160 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 80 mm to 150 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 80 mm to 140 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 80 mm to 130 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 80 mm to 120 mm. In some
20 embodiments, the width **W2** of the second side lap **1232** is 80 mm to 110 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 80 mm to 100 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 80 mm to 90 mm.

In some embodiments, the width **W2** of the second side lap **1232** is 90 mm to 200 mm. In some embodiments, the width **W2** of the second side lap **1232** is 90 mm to 190 mm. In some embodiments, the width **W2** of the second side lap **1232** is 90 mm to 180 mm. In some embodiments, the width **W2** of the second side lap **1232** is 90 mm to 170 mm. In some
5 embodiments, the width **W2** of the second side lap **1232** is 90 mm to 160 mm. In some embodiments, the width **W2** of the second side lap **1232** is 90 mm to 150 mm. In some embodiments, the width **W2** of the second side lap **1232** is 90 mm to 140 mm. In some embodiments, the width **W2** of the second side lap **1232** is 90 mm to 130 mm. In some
10 embodiments, the width **W2** of the second side lap **1232** is 90 mm to 120 mm. In some embodiments, the width **W2** of the second side lap **1232** is 90 mm to 110 mm. In some embodiments, the width **W2** of the second side lap **1232** is 90 mm to 100 mm.

In some embodiments, the width **W2** of the second side lap **1232** is 100 mm to 200 mm. In some embodiments, the width **W2** of the second side lap **1232** is 100 mm to 190 mm. In some
15 embodiments, the width **W2** of the second side lap **1232** is 100 mm to 180 mm. In some embodiments, the width **W2** of the second side lap **1232** is 100 mm to 170 mm. In some embodiments, the width **W2** of the second side lap **1232** is 100 mm to 160 mm. In some
20 embodiments, the width **W2** of the second side lap **1232** is 100 mm to 150 mm. In some embodiments, the width **W2** of the second side lap **1232** is 100 mm to 140 mm. In some embodiments, the width **W2** of the second side lap **1232** is 100 mm to 130 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 100 mm to 120 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 100 mm to 110 mm.

In some embodiments, the width **W2** of the second side lap **1232** is 110 mm to 200 mm. In some
In some embodiments, the width **W2** of the second side lap **1232** is 110 mm to 190 mm. In some

embodiments, the width **W2** of the second side lap **1232** is 110 mm to 180 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 110 mm to 170 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 110 mm to 160 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 110 mm to 150 mm. In some
5 embodiments, the width **W2** of the second side lap **1232** is 110 mm to 140 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 110 mm to 130 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 110 mm to 120 mm.

In some embodiments, the width **W2** of the second side lap **1232** is 120 mm to 200 mm.
In some embodiments, the width **W2** of the second side lap **1232** is 120 mm to 190 mm. In some
10 embodiments, the width **W2** of the second side lap **1232** is 120 mm to 180 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 120 mm to 170 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 120 mm to 160 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 120 mm to 150 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 120 mm to 140 mm. In some
15 embodiments, the width **W2** of the second side lap **1232** is 120 mm to 130 mm.

In some embodiments, the width **W2** of the second side lap **1232** is 130 mm to 200 mm.
In some embodiments, the width **W2** of the second side lap **1232** is 130 mm to 190 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 130 mm to 180 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 130 mm to 170 mm. In some
20 embodiments, the width **W2** of the second side lap **1232** is 130 mm to 160 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 130 mm to 150 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 130 mm to 140 mm.

In some embodiments, the width **W2** of the second side lap **1232** is 140 mm to 200 mm.

In some embodiments, the width **W2** of the second side lap **1232** is 140 mm to 190 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 140 mm to 180 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 140 mm to 170 mm. In some
5 embodiments, the width **W2** of the second side lap **1232** is 140 mm to 160 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 140 mm to 150 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 150 mm to 200 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 150 mm to 190 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 150 mm to 180 mm. In some
10 embodiments, the width **W2** of the second side lap **1232** is 150 mm to 170 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 150 mm to 160 mm.

In some embodiments, the width **W2** of the second side lap **1232** is 160 mm to 200 mm.

In some embodiments, the width **W2** of the second side lap **1232** is 160 mm to 190 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 160 mm to 180 mm. In some
15 embodiments, the width **W2** of the second side lap **1232** is 160 mm to 170 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 170 mm to 200 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 170 mm to 190 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 170 mm to 180 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 180 mm to 200 mm. In some
20 embodiments, the width **W2** of the second side lap **1232** is 180 mm to 190 mm. In some
embodiments, the width **W2** of the second side lap **1232** is 190 mm to 200 mm.

In some embodiments, the jumper module **1210** includes a first junction box **1238**. In some
embodiments, the first junction box **1238** is located on the surface **1234** of the first side lap **1230**.

In some embodiments, the first junction box **1238** is attached to the surface **1234** by an adhesive. In some embodiments, the first junction box **1238** is encapsulated by the first side lap **1230**. In some embodiments, the jumper module **1210** includes a second junction box **1240**. In some embodiments, the second junction box **1240** is located on the surface **1236** of the second side lap **1232**. In some embodiments, the second junction box **1240** is attached to the surface **1236** by an adhesive. In some embodiments, the second junction box **1240** is encapsulated by the second side lap **1232**. In certain embodiments, other electronic and electrical components may be attached to the first side lap **1230** and/or the second side lap **1232**. In some embodiments, non-limiting examples of such electronic and electrical components include an electrical connector, a rapid shutdown device, an optimizer, and an inverter. In some embodiments, the electrical connector includes a flat wire connector.

Referring to **FIGS. 48** and **49**, in some embodiments, the active portion **1212** is a laminated structure. In some embodiments, the active portion **1212** includes electrical bussing **1242**, an encapsulant **1244** encapsulating the electrical bussing **1242**, a frontsheet **1246** juxtaposed with the encapsulant **1244**, and a backsheet **1248** juxtaposed with the encapsulant **1244**. As used herein, the terms “encapsulating” and “encapsulates” mean to partially or fully envelope or enclose, and with respect to certain embodiments of the jumper module **1210**, the electrical bussing **1242** is fully enveloped by or enclosed within the encapsulant **1244**, or partially enveloped by or enclosed within the encapsulant **1244**. In some embodiments, the encapsulant **1244** includes a first layer **1244a** and a second layer **1244b**. In some embodiments, the encapsulant **1244** includes a structure and/or materials that is similar to the encapsulant **1114**.

In some embodiments, the electrical bussing **1242** includes a first bus ribbon **1250** extending from a first end **1252** proximate to the first end **1214** and a second end **1254** proximate

to the second end **1216**. In some embodiments, the first bus ribbon **1250** includes a first terminal **1256** located at the first end **1252** and a second terminal **1258** located at the second end **1254**. In some embodiments, the first terminal **1256** is a positive terminal, while the second terminal **1258** is a negative terminal. In some embodiments, the first terminal **1256** is a negative terminal, while
5 the second terminal **1258** is a positive terminal.

In some embodiments, the electrical bussing **1242** includes a second bus ribbon **1260** extending from a first end **1262** proximate to the first end **1214** and a second end **1264** proximate to the second end **1216**. In some embodiments, the second bus ribbon **1260** includes a first terminal **1266** located at the first end **1262** and a second terminal **1268** located at the second end **1264**. In
10 some embodiments, the first terminal **1266** is a negative terminal, while the second terminal **1268** is a positive terminal. In some embodiments, the first terminal **1266** is a positive terminal, while the second terminal **1268** is a negative terminal.

In some embodiments, the encapsulant **1244** may be composed of polyolefins, ethyl vinyl acetates, ionomers, silicones, poly vinyl butyral, epoxies, polyurethanes, or combinations/hybrids thereof. In some embodiments, the encapsulant **1244** is composed of thermosetting polyolefin.
15

In some embodiments, the encapsulant **1244** has a thickness of 0.4 mm to 1.8 mm. In some embodiments, the encapsulant **1244** has a thickness similar to those of the encapsulant **1114** of the photovoltaic module **1110** described above. In some embodiments, the first layer **1244a** of the encapsulant **1244** has a thickness of 0.2 mm to 0.9 mm. In some embodiments, the first layer
20 **1244a** of the encapsulant **1244** has a thickness similar to those of the first layer **1114a** of the encapsulant **1114** described above. In some embodiments, the second layer **1244b** of the encapsulant **1244** has a thickness of 0.2 mm to 0.9 mm. In some embodiments, the second layer **1244b** of the encapsulant **1244** has a thickness similar to those of the second layer **1114b** of the

encapsulant **1114** described above. In some embodiments, the thickness of the first layer **1244a** is equal to the thickness of the second layer **1244b**. In some embodiments, the thickness of the first layer **1244a** is different from the thickness of the second layer **1244b**.

In some embodiments, the first layer **1244a** is white in color. In some embodiments, the
5 second layer **1244b** is white in color.

In some embodiments, the frontsheet **1246** includes an upper layer **1270** and a polymer layer **1272** attached to the upper layer **1270**. In some embodiments, the frontsheet **1246** is juxtaposed with the first layer **1244a** of the encapsulant **1244**. In some embodiments, the polymer layer **1272** is attached to the upper layer **1270** by an adhesive layer **1274**. In some embodiments,
10 the adhesive layer **1274** may include polyvinyl butyrate, acrylic, silicone, or polycarbonate. In some embodiments, the adhesive layer **1274** may include pressure sensitive adhesives. In some embodiments, the polymer layer **1272** is attached to the upper layer **1270** by thermal bonding. In some embodiments, the frontsheet **1246** includes at least one of the upper layer **1270** or the polymer layer **1272**. In some embodiments, the upper layer **1270** is an upper, sun facing-side
15 surface of the jumper module **1210**.

In some embodiments, the upper layer **1270** is composed of thermoplastic polyolefin (TPO). In some embodiments, the upper layer **1270** includes a single ply TPO roofing membrane. In some embodiments, the upper layer **1270** is colored black. In some embodiments, non-limiting examples of TPO membranes are disclosed in U.S. Patent No. 9,359,014 to Yang et al., which is
20 incorporated by reference herein in its entirety.

In some embodiments, the upper layer **1270** is composed of polyvinyl chloride (PVC). In some embodiments, the upper layer **1270** is composed of ethylene propylene diene monomer (EPDM) rubber. In some embodiments, the upper layer **1270** includes a flame retardant additive.

In some embodiments, the flame retardant additive may be clays, nanoclays, silicas, carbon black, metal hydroxides such as aluminum hydroxide, metal foils, graphite, and combinations thereof. In some embodiments, the upper layer **1270** is white in color.

In some embodiments, the upper layer **1270** has a thickness of 2.5 mm to 4 mm. In some
5 embodiments, the upper layer **1270** has a thickness of 2.5 mm to 3.5 mm. In some embodiments,
the upper layer **1270** has a thickness of 2.5 mm to 3 mm. In some embodiments, the upper layer
1270 has a thickness of 3 mm to 4 mm. In some embodiments, the upper layer **1270** has a thickness
of 3 mm to 3.5 mm. In some embodiments, the upper layer **1270** has a thickness of 3.5 mm to 4
mm. In some embodiments, the upper layer **1270** has a thickness of 2.5 mm. In some
10 embodiments, the upper layer **1270** has a thickness of 2.6 mm. In some embodiments, the upper
layer **1270** has a thickness of 2.7 mm. In some embodiments, the upper layer **1270** has a thickness
of 2.8 mm. In some embodiments, the upper layer **1270** has a thickness of 2.9 mm. In some
embodiments, the upper layer **1270** has a thickness of 3 mm. In some embodiments, the upper
layer **1270** has a thickness of 3.1 mm. In some embodiments, the upper layer **1270** has a thickness
15 of 3.2 mm. In some embodiments, the upper layer **1270** has a thickness of 3.3 mm. In some
embodiments, the upper layer **1270** has a thickness of 3.4 mm. In some embodiments, the upper
layer **1270** has a thickness of 3.5 mm. In some embodiments, the upper layer **1270** has a thickness
of 3.6 mm. In some embodiments, the upper layer **1270** has a thickness of 3.7 mm. In some
embodiments, the upper layer **1270** has a thickness of 3.8 mm. In some embodiments, the upper
20 layer **1270** has a thickness of 3.9 mm. In some embodiments, the upper layer **1270** has a thickness
of 4 mm.

In some embodiments, the adhesive layer **1274** is composed of thermosetting polyolefin,
thermosetting polyolefin encapsulant material, thermosetting ethylene-vinyl acetate (EVA), EVA

encapsulants, thermoplastic olefin, thermoplastic polyolefin (TPO) or hybrids/combinations thereof. In some embodiments, the adhesive layer **1274** is white in color.

In some embodiments, the adhesive layer **1274** has a thickness of 1 μm to 900 μm . In some embodiments, the adhesive layer **1274** has a thickness similar to those of the first adhesive layer **1126** of the photovoltaic module **1110** described above. In some embodiments, the adhesive layer **1274** has a structure and/or is composed of materials similar to the first adhesive layer **1126**.

In some embodiments, the polymer layer **1272** is composed of a fluoropolymer. In certain embodiments, the fluoropolymer may be ethylene tetrafluoroethylene (ETFE), fluoropolymer is polyvinylidene fluoride (PVDF), tetrafluoroethylene-hexafluoropropylene copolymers (FEP), and tetrafluoroethylene-hexafluoropropylene-vinylidene fluoride copolymers (THV), polyvinyl fluoride (PVF), or blends thereof. In some embodiments, the frontsheet is composed of fluoropolymers, acrylics, polyesters, silicones, polycarbonates, or combinations thereof. In some embodiments, the polymer layer **1272** is composed of polyethylene terephthalate (PET), polyethylene naphthalate (PEN), polyetheretherketone (PEEK), polyaryletherketone (PAEK), polyarylate (PAR), polyetherimide (PEI), polyarylsulfone (PAS), polyethersulfone (PES), polyamideimide (PAI), polyphenylsulfone (PPSU), polyolefin, cyclic olefin copolymers (CPCs), or polyimide. In some embodiments, the polymer layer **1272** is composed of a crosslinked polymeric material. In some embodiments, 50% to 99% of the polymer chains of the polymeric material are crosslinked. In some embodiments, the polymer layer **1272** is white in color.

In some embodiments, the polymer layer **1272** has a thickness of 0.01 mm to 0.5 mm. In some embodiments, the polymer layer **1272** has a thickness of 0.01 mm to 0.4 mm. In some embodiments, the polymer layer **1272** has a thickness of 0.01 mm to 0.3 mm. In some embodiments, the polymer layer **1272** has a thickness of 0.01 mm to 0.2 mm. In some

embodiments, the polymer layer **1272** has a thickness of 0.01 mm to 0.1 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.01 mm to 0.09 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.01 mm to 0.08 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.01 mm to 0.07 mm. In some
5 embodiments, the polymer layer **1272** has a thickness of 0.01 mm to 0.06 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.01 mm to 0.05 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.01 mm to 0.04 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.01 mm to 0.03 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.01 mm to 0.02 mm.

10 In some embodiments, the polymer layer **1272** has a thickness of 0.01 mm to 0.4 mm. In
some embodiments, the polymer layer **1272** has a thickness of 0.02 mm to 0.4 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.03 mm to 0.4 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.04 mm to 0.4 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.05 mm to 0.4 mm. In some
15 embodiments, the polymer layer **1272** has a thickness of 0.06 mm to 0.4 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.07 mm to 0.4 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.08 mm to 0.4 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.09 mm to 0.4 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.1 mm to 0.4 mm. In some embodiments,
20 the polymer layer **1272** has a thickness of 0.15 mm to 0.4 mm. In some embodiments, the polymer
layer **1272** has a thickness of 0.2 mm to 0.4 mm. In some embodiments, the polymer layer **1272**
has a thickness of 0.25 mm to 0.4 mm. In some embodiments, the polymer layer **1272** has a

thickness of 0.3 mm to 0.4 mm. In some embodiments, the polymer layer **1272** has a thickness of 0.35 mm to 0.4 mm.

In some embodiments, the polymer layer **1272** has a thickness of 0.025 mm to 0.1 mm. In some embodiments, the polymer layer **1272** has a thickness of 0.03 mm to 0.1 mm. In some
5 embodiments, the polymer layer **1272** has a thickness of 0.035 mm to 0.1 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.04 mm to 0.1 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.045 mm to 0.1 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.05 mm to 0.1 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.06 mm to 0.1 mm. In some
10 embodiments, the polymer layer **1272** has a thickness of 0.065 mm to 0.1 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.07 mm to 0.1 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.075 mm to 0.1 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.08 mm to 0.1 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.085 mm to 0.1 mm. In some
15 embodiments, the polymer layer **1272** has a thickness of 0.09 mm to 0.1 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.095 mm to 0.1 mm.

In some embodiments, the polymer layer **1272** has a thickness of 0.01 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.02 mm. In some embodiments, the
polymer layer **1272** has a thickness of 0.03 mm. In some embodiments, the polymer layer **1272**
20 has a thickness of 0.04 mm. In some embodiments, the polymer layer **1272** has a thickness of 0.05
mm. In some embodiments, the polymer layer **1272** has a thickness of 0.06 mm. In some
embodiments, the polymer layer **1272** has a thickness of 0.07 mm. In some embodiments, the
polymer layer **1272** has a thickness of 0.08 mm. In some embodiments, the polymer layer **1272**

has a thickness of 0.09 mm. In some embodiments, the polymer layer **1272** has a thickness of 0.1 mm. In some embodiments, the polymer layer **1272** has a thickness of 0.2 mm. In some embodiments, the polymer layer **1272** has a thickness of 0.3 mm. In some embodiments, the polymer layer **1272** has a thickness of 0.4 mm. In some embodiments, the polymer layer **1272** has a thickness of 0.5 mm.

In some embodiments, the backsheet **1248** includes a lower layer **1276**. In some embodiments, the backsheet **1248** includes a polymer layer **1278**. In some embodiments, the lower layer **1276** and the polymer layer **1278** are attached to one another by an adhesive layer **1280**. In some embodiments, the adhesive layer **1280** may include polyvinyl butyrate, acrylic, silicone, or polycarbonate. In some embodiments, the adhesive layer **1280** may include pressure sensitive adhesives. In some embodiments, the adhesive layer **1280** is composed of thermosetting polyolefin, thermosetting polyolefin encapsulant material, thermosetting ethylene-vinyl acetate (EVA), EVA encapsulants, thermoplastic olefin, thermoplastic polyolefin (TPO) or hybrids/combinations thereof. In some embodiments, the adhesive layer **1280** is white in color. In some embodiments, the lower layer **1276** is attached to the polymer layer **1278** by thermal bonding. In some embodiments, the backsheet **1248** includes at least one of the lower layer **1276** or the polymer layer **1278**. In some embodiments, the lower layer **1276** is a lower surface of the jumper module **1210** configured to face a roof deck on which the jumper module **1210** is installed.

In some embodiments, the lower layer **1276** is composed of thermoplastic polyolefin (TPO). In some embodiments, the lower layer **1276** includes a single ply TPO roofing membrane. In some embodiments, the lower layer **1276** is colored black. In some embodiments, non-limiting examples of TPO membranes are disclosed in U.S. Patent No. 9,359,014 to Yang et al., which is incorporated by reference herein in its entirety.

In some embodiments, the lower layer **1276** is composed of polyvinyl chloride. In some
embodiments, the lower layer **1276** is composed of ethylene propylene diene monomer (EPDM)
rubber. In some embodiments, the lower layer **1276** includes a flame retardant additive. In some
embodiments, the flame retardant additive may be clays, nanoclays, silicas, carbon black, metal
5 hydroxides such as aluminum hydroxide, metal foils, graphite, and combinations thereof. In some
embodiments, the lower layer **1276** is white in color.

In some embodiments, the lower layer **1276** has a thickness of 2.5 mm to 4 mm. In some
embodiments, the lower layer **1276** has a thickness of 2.5 mm to 3.5 mm. In some embodiments,
the lower layer **1276** has a thickness of 2.5 mm to 3 mm. In some embodiments, the lower layer
10 **1276** has a thickness of 3 mm to 4 mm. In some embodiments, the lower layer **1276** has a thickness
of 3 mm to 3.5 mm. In some embodiments, the lower layer **1276** has a thickness of 3.5 mm to 4
mm.

In some embodiments, the lower layer **1276** has a thickness of 2.5 mm. In some
embodiments, the lower layer **1276** has a thickness of 2.6 mm. In some embodiments, the lower
15 layer **1276** has a thickness of 2.7 mm. In some embodiments, the lower layer **1276** has a thickness
of 2.8 mm. In some embodiments, the lower layer **1276** has a thickness of 2.9 mm. In some
embodiments, the lower layer **1276** has a thickness of 3 mm. In some embodiments, the lower
layer **1276** has a thickness of 3.1 mm. In some embodiments, the lower layer **1276** has a thickness
of 3.2 mm. In some embodiments, the lower layer **1276** has a thickness of 3.3 mm. In some
20 embodiments, the lower layer **1276** has a thickness of 3.4 mm. In some embodiments, the lower
layer **1276** has a thickness of 3.5 mm. In some embodiments, the lower layer **1276** has a thickness
of 3.6 mm. In some embodiments, the lower layer **1276** has a thickness of 3.7 mm. In some
embodiments, the lower layer **1276** has a thickness of 3.8 mm. In some embodiments, the lower

layer **1276** has a thickness of 3.9 mm. In some embodiments, the lower layer **1276** has a thickness of 4 mm.

In some embodiments, the polymer layer **1278** is composed of a fluoropolymer. In certain embodiments, the fluoropolymer may be ethylene tetrafluoroethylene (ETFE), fluoropolymer is
5 polyvinylidene fluoride (PVDF), tetrafluoroethylene-hexafluoropropylene copolymers (FEP), and tetrafluoroethylene-hexafluoropropylene-vinylidene fluoride copolymers (THV), polyvinyl fluoride (PVF), or blends thereof. In some embodiments, the frontsheet is composed of fluoropolymers, acrylics, polyesters, silicones, polycarbonates, or combinations thereof. In some
10 embodiments, the polymer layer **1278** is composed of polyethylene terephthalate (PET), polyethylene naphthalate (PEN), polyetheretherketone (PEEK), polyaryletherketone (PAEK), polyarylate (PAR), polyetherimide (PEI), polyarylsulfone (PAS), polyethersulfone (PES), polyamideimide (PAI), polyphenylsulfone (PPSU), polyolefin, cyclic olefin copolymers (CPCs), or polyimide. In some embodiments, the polymer layer **1278** is composed of a crosslinked
15 polymeric material. In some embodiments, 50% to 99% of the polymer chains of the polymeric material are crosslinked. In some embodiments, the polymer layer **1278** is white in color.

In some embodiments, the polymer layer **1278** has a thickness of 0.01 mm to 0.5 mm. In some embodiments, the polymer layer **1278** has a thickness of 0.01 mm to 0.4 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.01 mm to 0.3 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.01 mm to 0.2 mm. In some
20 embodiments, the polymer layer **1278** has a thickness of 0.01 mm to 0.1 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.01 mm to 0.09 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.01 mm to 0.08 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.01 mm to 0.07 mm. In some

embodiments, the polymer layer **1278** has a thickness of 0.01 mm to 0.06 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.01 mm to 0.05 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.01 mm to 0.04 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.01 mm to 0.03 mm. In some
5 embodiments, the polymer layer **1278** has a thickness of 0.01 mm to 0.02 mm.

In some embodiments, the polymer layer **1278** has a thickness of 0.01 mm to 0.4 mm. In
some embodiments, the polymer layer **1278** has a thickness of 0.02 mm to 0.4 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.03 mm to 0.4 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.04 mm to 0.4 mm. In some
10 embodiments, the polymer layer **1278** has a thickness of 0.05 mm to 0.4 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.06 mm to 0.4 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.07 mm to 0.4 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.08 mm to 0.4 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.09 mm to 0.4 mm. In some
15 embodiments, the polymer layer **1278** has a thickness of 0.1 mm to 0.4 mm. In some embodiments,
the polymer layer **1278** has a thickness of 0.15 mm to 0.4 mm. In some embodiments, the polymer
layer **1278** has a thickness of 0.2 mm to 0.4 mm. In some embodiments, the polymer layer **1278**
has a thickness of 0.25 mm to 0.4 mm. In some embodiments, the polymer layer **1278** has a
thickness of 0.3 mm to 0.4 mm. In some embodiments, the polymer layer **1278** has a thickness of
20 0.35 mm to 0.4 mm.

In some embodiments, the polymer layer **1278** has a thickness of 0.025 mm to 0.1 mm. In
some embodiments, the polymer layer **1278** has a thickness of 0.03 mm to 0.1 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.035 mm to 0.1 mm. In some

embodiments, the polymer layer **1278** has a thickness of 0.04 mm to 0.1 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.045 mm to 0.1 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.05 mm to 0.1 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.06 mm to 0.1 mm. In some
5 embodiments, the polymer layer **1278** has a thickness of 0.065 mm to 0.1 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.07 mm to 0.1 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.075 mm to 0.1 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.08 mm to 0.1 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.085 mm to 0.1 mm. In some
10 embodiments, the polymer layer **1278** has a thickness of 0.09 mm to 0.1 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.095 mm to 0.1 mm.

In some embodiments, the polymer layer **1278** has a thickness of 0.01 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.02 mm. In some embodiments, the
polymer layer **1278** has a thickness of 0.03 mm. In some embodiments, the polymer layer **1278**
15 has a thickness of 0.04 mm. In some embodiments, the polymer layer **1278** has a thickness of 0.05
mm. In some embodiments, the polymer layer **1278** has a thickness of 0.06 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.07 mm. In some embodiments, the
polymer layer **1278** has a thickness of 0.08 mm. In some embodiments, the polymer layer **1278**
has a thickness of 0.09 mm. In some embodiments, the polymer layer **1278** has a thickness of 0.1
20 mm. In some embodiments, the polymer layer **1278** has a thickness of 0.2 mm. In some
embodiments, the polymer layer **1278** has a thickness of 0.3 mm. In some embodiments, the
polymer layer **1278** has a thickness of 0.4 mm. In some embodiments, the polymer layer **1278** has
a thickness of 0.5 mm.

In some embodiments, the adhesive layer **1280** has a thickness of 1 μm to 900 μm . In some embodiments, the adhesive layer **1280** has a thickness similar to those of the second adhesive layer **1134** described above.

In some embodiments, the jumper module **1210** has a thickness of 1 mm to 10 mm. In
5 some embodiments, the jumper module **1210** has a thickness of 1 mm to 9 mm. In some
embodiments, the jumper module **1210** has a thickness of 1 mm to 8 mm. In some embodiments,
the jumper module **1210** has a thickness of 1 mm to 7 mm. In some embodiments, the jumper
module **1210** has a thickness of 1 mm to 6 mm. In some embodiments, the jumper module **1210**
has a thickness of 1 mm to 5 mm. In some embodiments, the jumper module **1210** has a thickness
10 of 1 mm to 4 mm. In some embodiments, the jumper module **1210** has a thickness of 1 mm to 3
mm. In some embodiments, the jumper module **1210** has a thickness of 1 mm to 2 mm.

In some embodiments, the jumper module **1210** has a thickness of 2 mm to 10 mm. In
some embodiments, the jumper module **1210** has a thickness of 2 mm to 9 mm. In some
embodiments, the jumper module **1210** has a thickness of 2 mm to 8 mm. In some embodiments,
15 the jumper module **1210** has a thickness of 2 mm to 7 mm. In some embodiments, the jumper
module **1210** has a thickness of 2 mm to 6 mm. In some embodiments, the jumper module **1210**
has a thickness of 2 mm to 5 mm. In some embodiments, the jumper module **1210** has a thickness
of 2 mm to 4 mm. In some embodiments, the jumper module **1210** has a thickness of 2 mm to 3
mm.

20 In some embodiments, the jumper module **1210** has a thickness of 3 mm to 10 mm. In
some embodiments, the jumper module **1210** has a thickness of 3 mm to 9 mm. In some
embodiments, the jumper module **1210** has a thickness of 3 mm to 8 mm. In some embodiments,
the jumper module **1210** has a thickness of 3 mm to 7 mm. In some embodiments, the jumper

module **1210** has a thickness of 3 mm to 6 mm. In some embodiments, the jumper module **1210** has a thickness of 3 mm to 5 mm. In some embodiments, the jumper module **1210** has a thickness of 3 mm to 4 mm.

In some embodiments, the jumper module **1210** has a thickness of 4 mm to 10 mm. In
5 some embodiments, the jumper module **1210** has a thickness of 4 mm to 9 mm. In some
embodiments, the jumper module **1210** has a thickness of 4 mm to 8 mm. In some embodiments,
the jumper module **1210** has a thickness of 4 mm to 7 mm. In some embodiments, the jumper
module **1210** has a thickness of 4 mm to 6 mm. In some embodiments, the jumper module **1210**
has a thickness of 4 mm to 5 mm. In some embodiments, the jumper module **1210** has a thickness
10 of 5 mm to 10 mm. In some embodiments, the jumper module **1210** has a thickness of 5 mm to 9
mm. In some embodiments, the jumper module **1210** has a thickness of 5 mm to 8 mm. In some
embodiments, the jumper module **1210** has a thickness of 5 mm to 7 mm. In some embodiments,
the jumper module **1210** has a thickness of 5 mm to 6 mm.

In some embodiments, the jumper module **1210** has a thickness of 6 mm to 10 mm. In
15 some embodiments, the jumper module **1210** has a thickness of 6 mm to 9 mm. In some
embodiments, the jumper module **1210** has a thickness of 6 mm to 8 mm. In some embodiments,
the jumper module **1210** has a thickness of 6 mm to 7 mm. In some embodiments, the jumper
module **1210** has a thickness of 7 mm to 10 mm. In some embodiments, the jumper module **1210**
has a thickness of 7 mm to 9 mm. In some embodiments, the jumper module **1210** has a thickness
20 of 7 mm to 8 mm. In some embodiments, the jumper module **1210** has a thickness of 8 mm to 10
mm. In some embodiments, the jumper module **1210** has a thickness of 8 mm to 9 mm. In some
embodiments, the jumper module **1210** has a thickness of 9 mm to 10 mm.

In some embodiments, the jumper module **1210** has a thickness of 1 mm. In some embodiments, the jumper module **1210** has a thickness of 2 mm. In some embodiments, the jumper module **1210** has a thickness of 3 mm. In some embodiments, the jumper module **1210** has a thickness of 4 mm. In some embodiments, the jumper module **1210** has a thickness of 5 mm. In some embodiments, the jumper module **1210** has a thickness of 6 mm. In some embodiments, the jumper module **1210** has a thickness of 7 mm. In some embodiments, the jumper module **1210** has a thickness of 8 mm. In some embodiments, the jumper module **1210** has a thickness of 9 mm. In some embodiments, the jumper module **1210** has a thickness of 10 mm.

In some embodiments, the jumper module **1210** is moisture resistant. As used herein, the term “moisture resistant” means having a water transmission rate of less than or equal to 0.05 U.S. perms, as measured by ASTM E 96, Procedure B – Standard Test Methods for Water Vapor Transmission of Materials. In some embodiments, the jumper module **1210** withstands walking loads/step resistance that conforms to standards under UL 3741 test standards (UL Standard for Safety Photovoltaic Hazard Control). In some embodiments, the jumper module **1210** includes an axe impact resistance that conforms to standards under UL 3741 test standards. In some embodiments, the jumper module **1210** includes a body fall resistance that conforms to standards under UL 3741 test standards.

Referring to **FIG. 50**, in some embodiments, one of the jumper module **1210a** is configured to overlay another one of the jumper module **1210b**. In some embodiments, the first side lap **1230** of the jumper module **1210a** overlays the second side lap **1232** of the jumper module **1210b**. In some embodiments, the first side lap **1230** of the jumper module **1210a** is attached to the second side lap **1232** of the jumper module **1210b**. In some embodiments, the first side lap **1230** of the jumper module **1210a** is attached to the second side lap **1232** of the jumper module **1210b** by an

adhesive. In some embodiments, the first side lap **1230** of the jumper module **1210a** is attached to the second side lap **1232** of the jumper module **1210b** by thermal bonding. In some embodiments, the first side lap **1230** of the jumper module **1210a** is attached to the second side lap **1232** of the jumper module **1210b** by ultrasonic welding. In some embodiments, the first side lap **1230** of the jumper module **1210a** is attached to the second side lap **1232** of the jumper module **1210b** by at least one fastener. In some embodiments, the first junction box **1238** of the jumper module **1210a** is positioned proximate to the second junction box **1240** of the jumper module **1210b**. In some embodiments, the first junction box **1238** and the second junction box **1240** are arranged in a linear array.

FIGS. 51 through **55** show embodiments of the wire cover bracket **1300**. In some embodiments, the wire cover bracket **1300** includes a body **1306** having a first end **1308**, a second end **1310** opposite the first end **1308**, and a pair of sidewalls **1312**, **1314** extending from the first end **1308** to the second end **1310**. In some embodiments, the body **1306** is rectangular in shape. In some embodiments, a corresponding side flange **1313** extends from each of the sidewalls **1312**, **1314**. In some embodiments, the side flange **1313** includes a first portion **1315** and a second portion **1317** connected to and elevated from the first portion **1315** in a step-like or shelf-like manner. In some embodiments, the body **1306** includes a pair of alignment tabs **1316** located proximate to the first end **1308** and an alignment portion **1318** located proximate to the second end **1310**. In some embodiments, each of the alignment tabs **1316** includes a substantially rounded rectangular-shaped end. In some embodiments, each of the alignment tabs **1316** includes a rectangular-shaped end. In some embodiments, each of the alignment tabs **1316** includes a rounded end. In some embodiments, the wire cover bracket **1300** includes only one of the alignment tabs **1316**. In some embodiments, the wire cover bracket **1300** includes a plurality of

the alignment tabs **1316**. In some embodiments, the alignment tabs **1316** are configured to overlap the second end **1310** of another adjacent one of the wire cover brackets **1300**. In some embodiments, the alignment portion **1318** includes an elevated portion **1319** extending from the body **1306**. In some embodiments, the alignment portion **1318** includes a slot **1322**. In some
5 embodiments, the slot **1322** is rectangular in shape.

In some embodiments, the wire cover bracket **1300** includes at least one clip **1324**. In some embodiments, the at least one clip **1324** extends outwardly from a first surface **1321** of the body **1306**. In some embodiments, the at least one clip **1324** is curvilinear in shape and includes a slot **1326**. In some embodiments, the at least one clip **1324** includes a plurality of the clips **1324**. In
10 some embodiments, the slot **1326** is sized and shaped to receive and hold an electrical wire or cable therein. In some embodiments, one of the plurality of clips **1324** is located proximate to the sidewall **1312** and proximate to the first end **1308**. In some embodiments, another of the plurality of clips **1324** is located proximate to the sidewall **1314** and intermediate the first end **1308** and the second end **1310**. In some embodiments, the bracket **1300** includes a plurality of hold down
15 portions **1330**. In some embodiments, one of the plurality of hold down portions **1330** extends from the sidewall **1312** and another of the plurality of hold down portions **1330** extends from the sidewall **1314**.

In some embodiments, the wire cover bracket **1300** includes a table **1332** extending from the first surface **1321**. In some embodiments, the table **1332** includes a flat portion **1334** elevated
20 by a pair of supports **1336**. In some embodiments, each of the supports **1336** is curvilinear in shape and includes a slot **1338**. In some embodiments, the slot **1338** is sized and shaped to receive and/or hold an electrical wire or cable therein. In some embodiments, the flat portion **1334** is configured to receive a printed label. In some embodiments, the printed label includes information

concerning components and characteristics of the photovoltaic system. In some embodiments, the wire cover bracket **1300** includes a guiderail **1340** extending from the first surface **1321**. In some embodiments, the guiderail **1340** is configured to guide an electrical cable or wire extending within the wire cover bracket **1300**. In some embodiments, the guiderail **1340** maintains the cable or wire
5 away a distance away from the sidewall **1312** so that the cable/wire does not impede the attachment of an associated wire cover to the wire cover bracket **1300**. In some embodiments, the wire cover bracket **1300** includes a plurality of the guiderails **1340**.

In some embodiments, the wire cover bracket **1300** includes a first cutout **1342** extending from the first surface **1321** to the second surface **1325**. In some embodiments, the first cutout **1342**
10 is sized and shaped to receive an electrical component. In some embodiments, the electrical component is a junction box **1423**. In some embodiments, the wire cover bracket **1300** includes a second cutout **1343**. In some embodiments, the second cutout **1343** is for weight and material savings of the wire cover bracket **1300**.

In some embodiments, a corresponding one of the wire cover bracket **1300** is located on
15 the first side lap **1115** of each of the plurality of photovoltaic modules **1110**. In some embodiments, the wire cover bracket **1300** is attached to the first side lap **1115**. In some embodiments, the wire cover bracket **1300** is attached to the first side lap **1115** by an adhesive. In some embodiments, the wire cover bracket **1300** includes a sealant **1323** located on a second surface **1325**. In some embodiments, the sealant **1323** is composed of a room temperature
20 vulcanizing material. In some embodiments, the sealant **1323** is composed of silicone. In some embodiments, the sealant **1323** is located around a perimeter of the second surface **1325**. In some embodiments, the wire cover bracket **1300** is attached to the first side lap **1115** by thermal bonding. In some embodiments, the wire cover bracket **1300** is attached to the first side lap **1115** by

ultrasonic welding. In some embodiments, the wire cover bracket **1300** is laminated with the first side lap **1115**. In some embodiments, the wire cover bracket **1300** is attached to the second side lap **1117** of the photovoltaic module **1110**.

In some embodiments, a corresponding one of the wire cover bracket **1300** is located on
5 the first side lap **1230** of the jumper module **1210**. In some embodiments, the wire cover bracket **1300** is attached to the first side lap **1230** by an adhesive. In some embodiments, the wire cover bracket **1300** is attached to the first side lap **1230** by thermal bonding. In some embodiments, the wire cover bracket **1300** is attached to the first side lap **1230** by ultrasonic welding. In some
10 embodiments, the wire cover bracket **1300** is laminated with the first side lap **1230**. In some
embodiments, the wire cover bracket **1300** is attached to the second side lap **1232** of the jumper
module **1210**.

Referring to **FIGS. 56A** through **56C**, in some embodiments, a cover **1304** is removably
attached to the wire cover bracket **1300**. In some embodiments, the cover **1304** includes a first
portion **1337** and side portions **1339** extending from the first portion **1337**. In some embodiments,
15 the side portions **1339** are angled (i.e., oblique) relative to the first portion **1337**. In some
embodiments, the side portions **1339** are angled to prevent shading over adjacent photovoltaic
cells. In some embodiments, each of the side portions **1339** includes a tab portion **1341** that is
sized and shaped to removably engage a corresponding one of the hold down portions **1330** of the
bracket **1300**. In some embodiments, the side portions **1339** are positioned on the first portion
20 **1315** of the bracket **1300**. In some embodiments, the first portion **1337** is textured. In some
embodiments, the side portions **1339** are textured.

In some embodiments, the plurality of the wire cover brackets **1300** engage one another
such that the alignment tabs **1316** of one of the wire cover brackets **1300** overlaps an adjacent one

of another adjacent one of the wire cover brackets **1300**. In some embodiments, the alignment portion **1318** supports the cover **1304**. Referring to **FIG. 57**, in some embodiments, an end cap **1344** includes a first end **1346** and a second end **1348** opposite the first end **1346**, and a plurality of louvers **1350** extending from the first end **1346** to the second end **1348**. In some embodiments, a plurality of vents **1352** are formed between the louvers **1350**. In some embodiments, one end of the cover **1304** is sized and shaped to receive the end cap **1344**.

Referring to **FIG. 58**, in some embodiments, a photovoltaic system **1400** includes an underlayment layer **1404** installed on a roof deck **1402**. In some embodiments, the photovoltaic system **1400** includes a plurality of the photovoltaic modules **1110**. In some embodiments, the plurality of photovoltaic modules **1110** overlay the underlayment layer **1404**. In some embodiments, the photovoltaic modules **1110** are arranged in an array on the roof deck **1402**. In some embodiments, the array of the photovoltaic modules **1110** includes subarrays **S1**, **S2**. In certain embodiments, the array includes more than the two subarrays **S1**, **S2**. In some embodiments, the array includes a single array **S1**. In some embodiments, each of the subarrays **S1**, **S2** include a plurality of rows **R** of the photovoltaic modules **1110**.

Referring to **FIGS. 59A** and **59B**, in some embodiments, the reveal portion **1111** of one **1110a** of the photovoltaic modules **1110** in the subarray **S1** overlays the head lap portion **1113** of an adjacent another one of the photovoltaic modules **1110b** of the subarray **S1**. In some embodiments, at least a portion of the first side lap **1115** of the one of the photovoltaic modules **1110a** overlays at least a portion of the first side lap **1115** of the another one of the photovoltaic modules **1110b**. In some embodiments, at least a portion of the second side lap **1117** of the one of the photovoltaic modules **1110a** overlays at least a portion of the second side lap **1117** of the another one of the photovoltaic modules **1110b**. Referring to **FIGS. 60** and **61**, in some

embodiments, the wire cover bracket **1300** of the photovoltaic module **1110a** overlaps the wire cover bracket **1300** of the photovoltaic module **1110b**. In some embodiments, the alignment tabs **1316** of the wire cover bracket **1300** of the photovoltaic module **1110a** overlaps the second end **1310** of the wire cover bracket **1300** of the photovoltaic module **1110b**. In some embodiments, the end cap **1344** is installed on the wire cover bracket **1300** of the photovoltaic module **1110** in the lowest row **R** of the subarray **S1**.

In some embodiments, the reveal portion **1111** has a width of 5 inches to 10 inches. In some embodiments, the reveal portion **1111** has a width of 5 inches to 9 inches. In some embodiments, the reveal portion **1111** has a width of 5 inches to 8 inches. In some embodiments, the reveal portion **1111** has a width of 5 inches to 7 inches. In some embodiments, the reveal portion **1111** has a width of 5 inches to 6 inches. In some embodiments, the reveal portion **1111** has a width of 6 inches to 10 inches. In some embodiments, the reveal portion **1111** has a width of 6 inches to 9 inches. In some embodiments, the reveal portion **1111** has a width of 6 inches to 8 inches. In some embodiments, the reveal portion **1111** has a width of 6 inches to 7 inches. In some embodiments, the reveal portion **1111** has a width of 7 inches to 10 inches. In some embodiments, the reveal portion **1111** has a width of 7 inches to 9 inches. In some embodiments, the reveal portion **1111** has a width of 7 inches to 8 inches. In some embodiments, the reveal portion **1111** has a width of 8 inches to 10 inches. In some embodiments, the reveal portion **1111** has a width of 8 inches to 9 inches. In some embodiments, the reveal portion **1111** has a width of 9 inches to 10 inches.

In some embodiments, the reveal portion **1111** has a width of 5 inches. In some embodiments, the reveal portion **1111** has a width of 6 inches. In some embodiments, the reveal portion **1111** has a width of 7 inches. In some embodiments, the reveal portion **1111** has a width

of 8 inches. In some embodiments, the reveal portion **1111** has a width of 9 inches. In some embodiments, the reveal portion **1111** has a width of 10 inches.

In some embodiments, the overlay of the first side laps **1115** form at least one wireway **1422**. In some embodiments, the at least one wireway **1422** includes a plurality of wireways. In
5 some embodiments, the at least one wireway **1422** includes a plurality of the wire cover brackets **1300**. In some embodiments, the wire cover brackets **1300** are aligned in a column.

Referring to **FIGS. 58** and **61**, in some embodiments, at least one of the cover **1304** is attached to at least a corresponding one of the wire cover brackets **1300**. In some embodiments, the at least one cover **1304** is removably attached to at least a corresponding one of the wire cover
10 brackets **1300**. In some embodiments, one of the covers **1304** is attached to a plurality of the wire cover brackets **1300**. In some embodiments, the at least one cover **1304** includes a plurality of covers **1304**. In some embodiments, each of the plurality of covers **1304** is configured to removably interlock with one another.

With reference to **FIG. 58**, in some embodiments, the first side lap **1115** of one of the
15 photovoltaic modules **1110** in the subarray **S2** overlays the second side lap **1117** of an adjacent another one of the photovoltaic modules **1110** in the subarray **S1** in the same one of the rows **R**. In some embodiments, one of the jumper modules **1210** overlays an uppermost one of the photovoltaic modules **1110a** in a column of the subarray **S1**. In some embodiments, the active portion **1212** of the jumper module **1210** overlays the head lap portion **1113** of the photovoltaic
20 module **1110a**. In some embodiments, the active portion **1212** of the jumper module **1210** overlays a portion of the head lap portion **1113** of the photovoltaic module **1110a**. In some embodiments, the active portion **1212** of the jumper module **1210** overlays the entirety of the head lap portion

1113 of the photovoltaic module **1110a**. In some embodiments, the first side lap **1230** of the jumper module **1210** aligns with the first side lap **1115** of the photovoltaic module **1110a**.

In some embodiments, the jumper module **1210** has a length **L1**. In some embodiments, each of the photovoltaic modules **1110** has a length **L2**. In some embodiments, the length **L1** is
5 equal to **L2**. In some embodiments, the length **L1** is approximately equal to **L2**.

In some embodiments, the length **L1** is 30 inches to 80 inches. In some embodiments, the length **L1** is 30 inches to 75 inches. In some embodiments, the length **L1** is 30 inches to 70 inches. In some embodiments, the length **L1** is 30 inches to 65 inches. In some embodiments, the length **L1** is 30 inches to 60 inches. In some embodiments, the length **L1** is 30 inches to 55 inches. In
10 some embodiments, the length **L1** is 30 inches to 50 inches. In some embodiments, the length **L1** is 30 inches to 45 inches. In some embodiments, the length **L1** is 30 inches to 40 inches. In some embodiments, the length **L1** is 30 inches to 35 inches.

In some embodiments, the length **L1** is 35 inches to 80 inches. In some embodiments, the length **L1** is 35 inches to 75 inches. In some embodiments, the length **L1** is 35 inches to 70 inches.
15 In some embodiments, the length **L1** is 35 inches to 65 inches. In some embodiments, the length **L1** is 35 inches to 60 inches. In some embodiments, the length **L1** is 35 inches to 55 inches. In some embodiments, the length **L1** is 35 inches to 50 inches. In some embodiments, the length **L1** is 35 inches to 45 inches. In some embodiments, the length **L1** is 35 inches to 40 inches. In some embodiments, the length **L1** is 40 inches to 80 inches. In some embodiments, the length **L1** is 40
20 inches to 75 inches. In some embodiments, the length **L1** is 40 inches to 70 inches. In some embodiments, the length **L1** is 40 inches to 65 inches. In some embodiments, the length **L1** is 40 inches to 60 inches. In some embodiments, the length **L1** is 40 inches to 55 inches. In some

embodiments, the length **L1** is 40 inches to 50 inches. In some embodiments, the length **L1** is 40 inches to 45 inches.

In some embodiments, the length **L1** is 45 inches to 80 inches. In some embodiments, the length **L1** is 45 inches to 75 inches. In some embodiments, the length **L1** is 45 inches to 70 inches.

5 In some embodiments, the length **L1** is 45 inches to 65 inches. In some embodiments, the length **L1** is 45 inches to 60 inches. In some embodiments, the length **L1** is 45 inches to 55 inches. In some embodiments, the length **L1** is 45 inches to 50 inches. In some embodiments, the length **L1** is 50 inches to 80 inches. In some embodiments, the length **L1** is 50 inches to 75 inches. In some
10 embodiments, the length **L1** is 50 inches to 70 inches. In some embodiments, the length **L1** is 50 inches to 65 inches. In some embodiments, the length **L1** is 50 inches to 60 inches. In some embodiments, the length **L1** is 50 inches to 55 inches.

In some embodiments, the length **L1** is 55 inches to 80 inches. In some embodiments, the length **L1** is 55 inches to 75 inches. In some embodiments, the length **L1** is 55 inches to 70 inches. In some embodiments, the length **L1** is 55 inches to 65 inches. In some embodiments, the length
15 **L1** is 55 inches to 60 inches. In some embodiments, the length **L1** is 60 inches to 80 inches. In some embodiments, the length **L1** is 60 inches to 75 inches. In some embodiments, the length **L1** is 60 inches to 70 inches. In some embodiments, the length **L1** is 60 inches to 65 inches. In some embodiments, the length **L1** is 65 inches to 80 inches. In some embodiments, the length **L1** is 65 inches to 75 inches. In some embodiments, the length **L1** is 65 inches to 70 inches. In some
20 embodiments, the length **L1** is 70 inches to 80 inches. In some embodiments, the length **L1** is 70 inches to 75 inches. In some embodiments, the length **L1** is 75 inches to 80 inches.

In some embodiments, the length **L1** is 30 inches. In some embodiments, the length **L1** is 35 inches. In some embodiments, the length **L1** is 40 inches. In some embodiments, the length

L1 is 45 inches. In some embodiments, the length **L1** is 50 inches. In some embodiments, the length **L1** is 55 inches. In some embodiments, the length **L1** is 60 inches. In some embodiments, the length **L1** is 65 inches. In some embodiments, the length **L1** is 70 inches. In some embodiments, the length **L1** is 75 inches. In some embodiments, the length **L1** is 80 inches.

5 In some embodiments, the length **L2** is 30 inches to 80 inches. In some embodiments, the length **L2** is 30 inches to 75 inches. In some embodiments, the length **L2** is 30 inches to 70 inches. In some embodiments, the length **L2** is 30 inches to 65 inches. In some embodiments, the length **L2** is 30 inches to 60 inches. In some embodiments, the length **L2** is 30 inches to 55 inches. In some embodiments, the length **L2** is 30 inches to 50 inches. In some embodiments, the length **L2** is 30 inches to 45 inches. In some embodiments, the length **L2** is 30 inches to 40 inches. In some
10 embodiments, the length **L2** is 30 inches to 35 inches.

 In some embodiments, the length **L2** is 35 inches to 80 inches. In some embodiments, the length **L2** is 35 inches to 75 inches. In some embodiments, the length **L2** is 35 inches to 70 inches. In some embodiments, the length **L2** is 35 inches to 65 inches. In some embodiments, the length
15 **L2** is 35 inches to 60 inches. In some embodiments, the length **L2** is 35 inches to 55 inches. In some embodiments, the length **L2** is 35 inches to 50 inches. In some embodiments, the length **L2** is 35 inches to 45 inches. In some embodiments, the length **L2** is 35 inches to 40 inches. In some embodiments, the length **L2** is 40 inches to 80 inches. In some embodiments, the length **L2** is 40 inches to 75 inches. In some embodiments, the length **L2** is 40 inches to 70 inches. In some
20 embodiments, the length **L2** is 40 inches to 65 inches. In some embodiments, the length **L2** is 40 inches to 60 inches. In some embodiments, the length **L2** is 40 inches to 55 inches. In some embodiments, the length **L2** is 40 inches to 50 inches. In some embodiments, the length **L2** is 40 inches to 45 inches.

In some embodiments, the length **L2** is 45 inches to 80 inches. In some embodiments, the length **L2** is 45 inches to 75 inches. In some embodiments, the length **L2** is 45 inches to 70 inches. In some embodiments, the length **L2** is 45 inches to 65 inches. In some embodiments, the length **L2** is 45 inches to 60 inches. In some embodiments, the length **L2** is 45 inches to 55 inches. In some embodiments, the length **L2** is 45 inches to 50 inches. In some embodiments, the length **L2** is 50 inches to 80 inches. In some embodiments, the length **L2** is 50 inches to 75 inches. In some embodiments, the length **L2** is 50 inches to 70 inches. In some embodiments, the length **L2** is 50 inches to 65 inches. In some embodiments, the length **L2** is 50 inches to 60 inches. In some embodiments, the length **L2** is 50 inches to 55 inches.

In some embodiments, the length **L2** is 55 inches to 80 inches. In some embodiments, the length **L2** is 55 inches to 75 inches. In some embodiments, the length **L2** is 55 inches to 70 inches. In some embodiments, the length **L2** is 55 inches to 65 inches. In some embodiments, the length **L2** is 55 inches to 60 inches. In some embodiments, the length **L2** is 60 inches to 80 inches. In some embodiments, the length **L2** is 60 inches to 75 inches. In some embodiments, the length **L2** is 60 inches to 70 inches. In some embodiments, the length **L2** is 60 inches to 65 inches. In some embodiments, the length **L2** is 65 inches to 80 inches. In some embodiments, the length **L2** is 65 inches to 75 inches. In some embodiments, the length **L2** is 65 inches to 70 inches. In some embodiments, the length **L2** is 70 inches to 80 inches. In some embodiments, the length **L2** is 70 inches to 75 inches. In some embodiments, the length **L2** is 75 inches to 80 inches.

In some embodiments, the length **L2** is 30 inches. In some embodiments, the length **L2** is 35 inches. In some embodiments, the length **L2** is 40 inches. In some embodiments, the length **L2** is 45 inches. In some embodiments, the length **L2** is 50 inches. In some embodiments, the length **L2** is 55 inches. In some embodiments, the length **L2** is 60 inches. In some embodiments,

the length **L2** is 65 inches. In some embodiments, the length **L2** is 70 inches. In some embodiments, the length **L2** is 75 inches. In some embodiments, the length **L2** is 80 inches.

In some embodiments, the reveal portion **1111** has a length of 35 inches to 75 inches. In some embodiments, the reveal portion **1111** has a length of 35 inches to 70 inches. In some
5 embodiments, the reveal portion **1111** has a length of 35 inches to 65 inches. In some embodiments, the reveal portion **1111** has a length of 35 inches to 60 inches. In some embodiments, the reveal portion **1111** has a length of 35 inches to 55 inches. In some embodiments, the reveal portion **1111** has a length of 35 inches to 50 inches. In some
10 embodiments, the reveal portion **1111** has a length of 35 inches to 45 inches. In some embodiments, the reveal portion **1111** has a length of 35 inches to 40 inches.

In some embodiments, the reveal portion **1111** has a length of 40 inches to 75 inches. In some embodiments, the reveal portion **1111** has a length of 40 inches to 70 inches. In some embodiments, the reveal portion **1111** has a length of 40 inches to 65 inches. In some
15 embodiments, the reveal portion **1111** has a length of 40 inches to 60 inches. In some embodiments, the reveal portion **1111** has a length of 40 inches to 55 inches. In some embodiments, the reveal portion **1111** has a length of 40 inches to 50 inches. In some embodiments, the reveal portion **1111** has a length of 40 inches to 45 inches. In some
20 embodiments, the reveal portion **1111** has a length of 45 inches to 75 inches. In some embodiments, the reveal portion **1111** has a length of 45 inches to 70 inches. In some embodiments, the reveal portion **1111** has a length of 45 inches to 65 inches. In some
embodiments, the reveal portion **1111** has a length of 45 inches to 60 inches. In some
embodiments, the reveal portion **1111** has a length of 45 inches to 55 inches. In some
embodiments, the reveal portion **1111** has a length of 45 inches to 50 inches.

In some embodiments, the reveal portion **1111** has a length of 50 inches to 75 inches. In some embodiments, the reveal portion **1111** has a length of 50 inches to 70 inches. In some embodiments, the reveal portion **1111** has a length of 50 inches to 65 inches. In some embodiments, the reveal portion **1111** has a length of 50 inches to 60 inches. In some
5 embodiments, the reveal portion **1111** has a length of 50 inches to 55 inches. In some embodiments, the reveal portion **1111** has a length of 55 inches to 75 inches. In some embodiments, the reveal portion **1111** has a length of 55 inches to 70 inches. In some embodiments, the reveal portion **1111** has a length of 55 inches to 65 inches. In some embodiments, the reveal portion **1111** has a length of 55 inches to 60 inches. In some
10 embodiments, the reveal portion **1111** has a length of 60 inches to 75 inches. In some embodiments, the reveal portion **1111** has a length of 60 inches to 70 inches. In some embodiments, the reveal portion **1111** has a length of 60 inches to 65 inches. In some embodiments, the reveal portion **1111** has a length of 65 inches to 75 inches. In some embodiments, the reveal portion **1111** has a length of 65 inches to 70 inches. In some
15 embodiments, the reveal portion **1111** has a length of 70 inches to 75 inches.

In some embodiments, the reveal portion **1111** has a length of 35 inches. In some embodiments, the reveal portion **1111** has a length of 40 inches. In some embodiments, the reveal portion **1111** has a length of 45 inches. In some embodiments, the reveal portion **1111** has a length of 50 inches. In some embodiments, the reveal portion **1111** has a length of 55 inches. In some
20 embodiments, the reveal portion **1111** has a length of 60 inches. In some embodiments, the reveal portion **1111** has a length of 65 inches. In some embodiments, the reveal portion **1111** has a length of 70 inches. In some embodiments, the reveal portion **1111** has a length of 75 inches.

In some embodiments, the first side lap **1115** has a length of 1 inch to 5 inches. In some embodiments, the first side lap **1115** has a length of 1 inch to 4 inches. In some embodiments, the first side lap **1115** has a length of 1 inch to 3 inches. In some embodiments, the first side lap **1115** has a length of 1 inch to 2 inches. In some embodiments, the first side lap **1115** has a length of 2 inches to 5 inches. In some embodiments, the first side lap **1115** has a length of 2 inches to 4 inches. In some embodiments, the first side lap **1115** has a length of 2 inches to 3 inches. In some embodiments, the first side lap **1115** has a length of 3 inches to 5 inches. In some embodiments, the first side lap **1115** has a length of 3 inches to 4 inches. In some embodiments, the first side lap **1115** has a length of 4 inches to 5 inches.

In some embodiments, the first side lap **1115** has a length of 1 inch. In some embodiments, the first side lap **1115** has a length of 2 inches. In some embodiments, the first side lap **1115** has a length of 3 inches. In some embodiments, the first side lap **1115** has a length of 4 inches. In some embodiments, the first side lap **1115** has a length of 5 inches.

In some embodiments, the second side lap **1117** has a length of 1 inch to 5 inches. In some embodiments, the second side lap **1117** has a length of 1 inch to 4 inches. In some embodiments, the second side lap **1117** has a length of 1 inch to 3 inches. In some embodiments, the second side lap **1117** has a length of 1 inch to 2 inches. In some embodiments, the second side lap **1117** has a length of 2 inches to 5 inches. In some embodiments, the second side lap **1117** has a length of 2 inches to 4 inches. In some embodiments, the second side lap **1117** has a length of 2 inches to 3 inches. In some embodiments, the second side lap **1117** has a length of 3 inches to 5 inches. In some embodiments, the second side lap **1117** has a length of 3 inches to 4 inches. In some embodiments, the second side lap **1117** has a length of 4 inches to 5 inches.

In some embodiments, the second side lap **1117** has a length of 1 inch. In some embodiments, the second side lap **1117** has a length of 2 inches. In some embodiments, the second side lap **1117** has a length of 3 inches. In some embodiments, the second side lap **1117** has a length of 4 inches. In some embodiments, the second side lap **1117** has a length of 5 inches.

5 In some embodiments, the second side lap **1232** of the jumper module **1210** aligns with the second side lap **1117** of the photovoltaic module **1110a**. In some embodiments, the first junction box **1238** of the jumper module **1210** is electrically connected to a junction box **1423** of the photovoltaic module **1110a**. In some embodiments, the second junction box **1240** of the jumper module **1210** is electrically connected to the junction box **1423** of another of the photovoltaic
10 modules **1110b**. In some embodiments, the jumper module **1210** electrically connects the subarrays **S1**, **S2** of the photovoltaic modules **1110** within the array of the photovoltaic system **1400**. In some embodiments, the first bus ribbon **1250** and the second bus ribbon **1260** electrically connect the subarrays of the photovoltaic modules **1110** with one another. In some embodiments, the first bus ribbon **1250** and the second bus ribbon **1260** electrically connect the junction boxes
15 **1423** of the first subarray **S1** of the photovoltaic modules **1110** with the junction boxes **1423** of the second subarray **S2** of the photovoltaic modules **1110**.

In some embodiments, the jumper module **1210** is coplanar with the plurality of photovoltaic modules **1110**. As used herein, the term “coplanar” means the jumper module **1210** and the plurality of photovoltaic modules **1110** are positioned and extend within the same plane,
20 or the jumper module **1210** is positioned and extends in a first plane, and the plurality of photovoltaic modules **1110** is positioned and extends within a second plane that is offset from the first plane of no more than ten percent of a height measured from the roof deck **1402** to an upper surface of the jumper module **1210**.

In some embodiments, a plurality of step flaps **1426** is installed adjacent to one of the subarrays **S1** of the photovoltaic modules **1110**. In some embodiments, roofing shingles are configured to overlay the step flaps **1426**. In some embodiments, the roofing shingles are asphalt shingles. In some embodiments, the roofing shingles are electrically inactive solar shingles. In some embodiments, a composition shingle **1427** overlays the active portion **1212** of the jumper module **1210**. In some embodiments, another one of the jumper module **1210** overlays the jumper module **1210** of the first subarray, as shown in **FIG. 58**. In some embodiments, the composition shingle **1427** conceals the jumper modules **1210**. In some embodiments, the composition shingle **1427** is a watershedding layer. In some embodiments, the composition shingle **1427** is an asphalt shingle. In some embodiments, the composition shingle **1427** is located at least 36 inches away from the roof ridge.

In some embodiments, the second side lap **1117** of at least one of the photovoltaic modules **1110** of the subarray **S2** overlaps a roofing shingle. In some embodiments, the roofing shingle is an asphalt shingle. In some embodiments, the second layer **1132** of the backsheet **1128** is attached to the roofing shingle by an adhesive. In some embodiments, the adhesive is a butyl adhesive. In some embodiments, a fleece layer and an adhesive are utilized between the second layer **1132** of the backsheet **1128** and the roofing shingle to secure the bonding thereof. In some embodiments, the second layer **1132** of the backsheet **1128** is attached to the roofing shingle by plasma treatment. In some embodiments, the second layer **1132** of the backsheet **1128** is attached to the roofing shingle by a combination of any of the adhesive, the fleece layer and/or plasma treatment. In some embodiments, one or more roofing shingle overlays the second side laps **1117** of the photovoltaic modules **1110** of the subarray **S2**. In some embodiments, the roofing shingle is an asphalt shingle.

Referring to **FIGS. 58, 62 and 63**, in some embodiments, the photovoltaic system **1400** includes a first flashing base **1428**. In some embodiments, the first flashing base **1428** includes a flat base portion **1431** having a first surface and a second surface opposite the first surface, an aperture **1433** extending from the first surface to the second surface, and a sidewall **1435** extending
5 from the first surface to the second surface and surrounding the aperture **1433**. In some embodiments, the base portion **1431** is rectangular in shape. In some embodiments, the base portion **1431** is square in shape. In some embodiments, the base portion **1431** is trapezoidal in shape. In some embodiments, the base portion **1431** is circular in shape. In some embodiments, the sidewall **1435** includes flanged portions **1437** extending obliquely and inwardly. In some
10 embodiments, an opening **1439** is located proximate to a lower end **1441** of the first flashing base **1428**. In some embodiments, the aperture **1433** is substantially rectangular in shape. In some embodiments, the aperture **1433** extends from a first end **1443** located proximate to the lower end **1441** of the first flashing base **1428** and a second end **1445** located intermediate the lower end **1441** and an upper end **1447** of the first flashing base **1428**. In some embodiments, the aperture
15 **1433** is sized and shaped to receive at least one electrical component therein. In some embodiments, the second end **1445** includes a width that is wider than a width of the first end **1443**. In some embodiments, the wider width of the second end **1445** is sized and shaped to receive relatively larger sized electrical components. In some embodiments, the at least one electrical component is the junction box **1238** of the jumper module **1210**. In some embodiments, the lower
20 end **1441** of the first flashing base **1428** includes a tab **1449**. In some embodiments, screw tabs **1451** are located on the flanged portions **1437** and/or an upper end of the sidewall **1435**.

In some embodiments, the first flashing base **1428** is configured to be installed on the roof deck **1402**. In some embodiments, the first flashing base **1428** is installed at the top of the wireway

1422 of the subarray **S1**. In some embodiments, the sidewall **1435**, the aperture **1433** and the flanged portions **1437** of the first flashing base **1428** are aligned with the wire cover bracket **1300** of the photovoltaic module **1110** in the uppermost row **R** of the subarray **S1**. In some embodiments, the tab **1449** is sized and shaped to contact an end of the wire cover bracket **1300**.

- 5 In some embodiments, a first flashing base **1428** overlays the first side lap **1230** of the jumper module **1210**. In some embodiments, the first flashing base **1428** is configured to be installed to the roof deck **1402** by at least one fastener. In some embodiments, the base portion **1431** is configured to receive the at least one fastener. In some embodiments, the at least one fastener includes a plurality of fasteners. In some embodiments, the plurality of fasteners is roofing nails.
- 10 In some embodiments, the first flashing base **1428** is configured to be installed to the roof deck by an adhesive. In some embodiments, the first flashing base **1428** overlays at least one of the step flaps **1426**.

In some embodiments, the photovoltaic system **1400** includes a second flashing base **1430**. In some embodiments, the second flashing base **1430** has a structure and function similar to those of the first flashing base **1428**, with certain differences. In some embodiments, the second flashing base **1430** overlays the second side lap **1232** of the jumper module **1210**. In some embodiments, the second flashing base **1430** is installed on the roof deck and is aligned with the wireway **1422** of the second subarray **S2** in a manner similar to that of the first flashing base **1428**.

15

In some embodiments, one of the composition shingles **1427** overlays the base portion **1431** of the first flashing base **1428** on at least one side of the sidewall **1435** thereof. In some embodiments, each of a plurality of the composition shingles **1427** overlays the base portion **1431** of the first flashing base **1428** on opposite sides of the sidewall **1435**. In some embodiments, one of the composition shingles **1427** overlays the base portion **1431** of the second flashing base **1430**

20

on at least one side of the sidewall **1435** thereof. In some embodiments, each of a plurality of the composition shingles **1427** overlays the base portion **1431** of the second flashing base **1430** on opposite sides of the sidewall **1435**. In some embodiments, asphalt roofing shingles are utilized instead of the composition shingles **1427**.

5 Referring to **FIGS. 58** and **64A** and **64B**, in some embodiments, a transition box **1432** is installed on the first flashing base **1428**. In some embodiments, the transition box **1432** includes a housing **1453** having an interior portion **1455**. In some embodiments, the interior portion includes at least one base **1457**. In some embodiments, the at least one base **1457** is configured to receive an electrical component mounted thereto. In some embodiments, the at least one base
10 **1457** includes a plurality of the bases **1457**. In some embodiments, the interior portion **1455** includes an aperture **1459** that extends through a bottom portion of the housing **1453**. In some embodiments, a cover portion **1461** extends outwardly from a lower wall **1463** of the housing **1453**. In some embodiments, the cover portion **1461** includes flanged walls **1465**. In some embodiments, the flanged walls **1465** are angled. In some embodiments, the cover portion includes
15 tabs **1467** extending outwardly from the free end thereof.

In some embodiments, the transition box **1432** is installed on the first flashing base **1428** by fasteners. In some embodiments, the fasteners are screws that engage corresponding ones of the screw tabs **1451** of the first flashing base **1428**. In some embodiments, the transition box **1432** is installed on the first flashing base **1428** by an adhesive. In some embodiments, the cover portion
20 **1461** is sized and shaped to cover at least a portion of the sidewall **1435** and at least a portion of the aperture **1433** of the first flashing base **1428**. In some embodiments, the flanged walls **1465** of the cover portion **1461** are juxtaposed with the flanged portions **1437** of the first flashing base **1428**. In some embodiments, the tabs **1467** of the cover portion **1461** engage the cover **1304** of

the wire cover bracket **1300**. In some embodiments, the cover portion **1461** slidably engages the cover **1304** of the wire cover bracket **1300**, such that a lower end of the cover portion **1461** is juxtaposed with an upper end of the cover **1304**. In some embodiments, the cover portion **1461** of the transition box **1432** covers the first junction box **1238** of the jumper module **1210**.

5 In some embodiments, the housing **1453** of the transition box **1432** is sized and shaped to cover at least another portion of the sidewall **1435** and at least a portion of the aperture **1433** of the first flashing base **1428**. In some embodiments, at least a portion of the aperture **1459** of the transition box **1432** is substantially aligned with the aperture **1433** of the first flashing base **1428**. In some embodiments, the aperture **1459** and the aperture **1433** substantially align with an aperture
10 or penetration within the roof deck **1402**. In some embodiments, the transition box **1432** covers the aperture or penetration in the roof deck **1402** and is used as part of a pathway to run electrical wiring therethrough. In some embodiments, a passthrough **1460** is located within the aperture **1459** and the aperture **1433**. In some embodiments, the passthrough **1460** is inserted within the aperture or penetration of the roof deck **1402**. In some embodiments, the passthrough **1460** is
15 configured to receive an electrical wire or cable to facilitate its insertion through the roof deck aperture an into the associated structure.

Referring to **FIG. 65**, in some embodiments, the transition box **1432** includes a rapid shutdown device. In some embodiments, the transition box **1432** includes a middle circuit interrupter (MCI) **1469**. In some embodiments, the transition box includes a junction box **1471**.
20 In some embodiments, the transition box **1432** houses electrical wiring for the photovoltaic system **1400**. In some embodiments, the electrical wiring includes THHN electrical wiring. In some embodiments, the THHN electrical wire is electrically connected to an inverter.

Referring to **FIG. 66**, in some embodiments, the transition box **1432** includes a cover **1434**. In some embodiments, the cover **1434** is removably attached to the housing **1453**. In some embodiments, the cover **1434** includes an interior surface. In some embodiments, the interior surface includes an interior wall structure that is configured to provide structural integrity and strength to the cover **1434**. In some embodiments, the interior wall structure is configured to maintain its structural integrity due to hail impacts. In some embodiments, the interior wall structure is a honeycomb structure. In some embodiments, a sidewall **1470** of the transition box **1432** is configured to have an aperture formed therein, either by drilling or cutting. In some embodiments, the aperture is sized and shaped to receive a conduit connected to the junction box **1471**. In some embodiments, the conduit is configured to house and run electrical wiring across the roof.

Referring to **FIG. 67**, in some embodiments, the second flashing base **1430** includes a cover **1473**. In some embodiments, the cover **1473** is sized and shaped to cover the aperture **1433** of the second flashing base **1430**. In some embodiments, flanged walls **1475** of the cover **1473** are juxtaposed with the flanged portions **1437** of the second flashing base **1430**. In some embodiments, the cover portion **1461** slidably engages the cover **1304** of the wire cover bracket **1300**, such that a lower end of the cover **1473** is juxtaposed with an upper end of the cover **1304**. In some embodiments, the cover **1473** covers the second junction box **1240** of the jumper module **1210**.

Referring to **FIG. 68**, in some embodiments, the photovoltaic system **1400** is installed on the roof deck **1402**. In some embodiments, an additional, non-active (i.e., “dummy”) wireway **1480** and associated cover **1304**, similar to the at least one wireway **1422** and the associated covers **1304**, may be installed on the end of the second subarray **S2** for symmetry and aesthetics. In some

embodiments, the non-active wireway **1480** is installed over the second side laps **1117** of the photovoltaic modules **1110b**. In some embodiments, the non-active wireway **1480** does not include any electrical components or electrical wiring. In some embodiments, the non-active wireway **1480** is optional and need not be included. In some embodiments, roofing shingles
5 overlay the second side laps **1117** of the photovoltaic modules **1110b** of the second subarray **S2**. In some embodiments, it should be understood that the non-active wireway **1480** or roofing shingles may overlay the second side laps **1117** of the photovoltaic modules **1110a** of the first subarray **S1** in the absence of the second subarray **S2**.

It should be understood that the embodiments described herein are merely exemplary and
10 that a person skilled in the art may make many variations and modifications without departing from the spirit and scope of the invention. All such variations and modifications are intended to be included within the scope of the invention.

CLAIMS

What is claimed is:

1. A system, comprising:

- 5 a plurality of photovoltaic modules installed on a roof deck,
wherein the photovoltaic modules are arranged in an array on the roof deck,
wherein each of the photovoltaic modules includes
a first end and a second end opposite the first end,
at least one solar cell,
10 a first encapsulant encapsulating the at least one solar cell,
wherein the first encapsulant includes a first surface and a
second surface opposite the first surface,
a frontsheet juxtaposed with the first surface of the first encapsulant,
wherein the frontsheet includes
15 a glass layer,
a second encapsulant, and
a first polymer layer,
a backsheet juxtaposed with the second surface of the encapsulant,
wherein the backsheet includes
20 a first layer, and
a second polymer layer attached to the first layer,
wherein the first layer forms a lower surface of the
photovoltaic module, and

a wire cover bracket located at the first end,

wherein the wire cover bracket of one of the photovoltaic modules is configured to overlap the wire cover bracket of an adjacent another one of the photovoltaic modules, and

wherein the wire cover bracket is configured to receive at least one electrical component.

2. The system of Claim 1, wherein the first encapsulant is selected from the group consisting of thermosetting polyolefin, thermosetting polyolefin encapsulant material, thermosetting ethylene-vinyl acetate (EVA), EVA encapsulants, thermoplastic olefin, thermoplastic polyolefin (TPO) and hybrids and combinations thereof.

3. The system of Claim 2, wherein the first encapsulant includes a thermosetting polyolefin encapsulant material.

4. The system of Claim 2, wherein the first encapsulant has a thickness of 1 μm to 900 μm .

5. The system of Claim 1, wherein the first polymer layer includes a fluoropolymer.

6. The system of Claim 5, wherein the fluoropolymer is selected from the group consisting of ethylene tetrafluoroethylene (ETFE), polyvinylidene fluoride (PVDF), tetrafluoroethylene-hexafluoropropylene copolymers (FEP), tetrafluoroethylene-

hexafluoropropylene-vinylidene fluoride copolymers (THV), polyvinyl fluoride (PVF), and blends thereof.

7. The system of Claim 1, wherein the first polymer layer includes a material selected
5 from the group consisting of acrylics, polyesters, silicones, and polycarbonates.

8. The system of Claim 1, wherein the first polymer layer has a thickness of 0.01 mm
to 0.5 mm.

10 9. The system of Claim 1, wherein the first layer includes a polymer.

10. The system of Claim 9, wherein the first layer includes thermoplastic polyolefin
(TPO).

15 11. The system of Claim 9, wherein the first layer includes polyvinyl chloride (PVC).

12. The system of Claim 9, wherein the first layer includes ethylene propylene diene
monomer (EPDM) rubber.

20 13. The system of Claim 1, further comprising:
at least one jumper module electrically connecting a first subarray of the array and
a second subarray of the array,
wherein the at least one jumper module includes,
at least one electrical bussing,
25 an encapsulant encapsulating the at least one electrical
bussing,

wherein the encapsulant of the at least one jumper module includes a first surface and a second surface opposite the first surface of the encapsulant of the at least one jumper module, wherein the at least one electrical bussing electrically connects the first subarray to the second subarray, a frontsheet juxtaposed with the first surface of the encapsulant of the at least one jumper module, wherein the frontsheet of the at least one jumper module includes a first layer, and a first polymer layer attached to the first layer of the frontsheet of the at least one jumper module, and wherein the first layer of the frontsheet of the jumper module forms an upper surface of the jumper module.

14. The system of Claim 13, wherein the at least one jumper module includes a first side lap located at a first end thereof and a second side lap located at a second end thereof opposite the first end of the at least one jumper module.

15. The system of Claim 14, wherein the at least one electrical bussing extends from a location proximate to the first end of the at least one jumper module to a location proximate to the second end of the at least one jumper module.

16. The system of Claim 15, wherein the at least one jumper module includes a first junction box located on the first side lap, and wherein the first junction box is electrically connected to the at least one electrical bussing.

5 17. The system of Claim 16, wherein the at least one jumper module includes a second junction box located on the second side lap, and wherein the second junction box is electrically connected to the at least one electrical bussing.

18. The system of Claim 17, wherein the at least one electrical component includes a
10 third junction box.

19. The system of Claim 18, wherein the third junction box of each of the photovoltaic modules of the first subarray is electrically connected to the first junction box, and wherein the third junction box of each of the photovoltaic modules of the second subarray is electrically
15 connected to the second junction box.

20. The system of Claim 19, wherein at least one of the plurality of photovoltaic modules of the first subarray includes a head lap portion, and wherein one of the at least one jumper module overlays the head lap portion.

20 21. The system of Claim 20, wherein the at least one of the plurality of photovoltaic modules of the first subarray includes a first side lap, and wherein the first side lap of the one of the at least one jumper module is proximate to the first side lap of the at least one of the plurality of photovoltaic modules of the first subarray.

25

22. The system of Claim 21, wherein the at least one of the plurality of photovoltaic modules of the first subarray includes a second side lap, and wherein the second side lap of the one of the at least one jumper module is proximate to the second side lap of the at least one of the plurality of photovoltaic modules of the first subarray.

5

23. The system of Claim 22, wherein the at least one jumper module includes a plurality of jumper modules, and wherein the first side lap of another one of the plurality of jumper modules overlaps the second side lap of one of the plurality of jumper modules.

10

24. The system of Claim 23, wherein the first junction box of the another one of the plurality of jumper modules is proximate to and electrically connected to the second junction box of the one of the plurality of jumper modules.

15

25. The system of Claim 24, wherein at least one of the plurality of photovoltaic modules of the second subarray includes a head lap portion, and wherein the another one of the plurality of jumper modules overlaps the head lap portion of the at least one of the plurality of photovoltaic modules of the second subarray.

20

26. The system of Claim 25, wherein each of the plurality of photovoltaic modules of includes the first side lap, and wherein the wire cover bracket is attached to the first side lap.

25

27. The system of Claim 26, wherein the wire cover brackets of the plurality of photovoltaic modules of the first subarray are configured to form a first wire channel, and wherein the wire cover brackets of the plurality of photovoltaic modules of the second subarray are configured to form a second wire channel.

28. The system of Claim 27, further comprising at least one cover removably attached to at least one of the wire cover brackets.

5 29. The system of Claim 28, wherein the at least one cover is removably attached to a plurality of the wire cover brackets.

30. The system of Claim 27, further comprising a transition box located proximate to the first wire channel, wherein the transition box is electrically connected to the first junction box.

10 31. The system of Claim 1, wherein each of the photovoltaic modules includes at least one bussing wire electrically connected to the at least one solar cell.

15 32. The system of Claim 31, wherein the at least one bussing wire is covered with a polymer layer.

33. The system of Claim 32, wherein the a polymer layer is expanded polyethylene (“EPE”).

20 34. The system of Claim 31, wherein the at least one bussing wire is coated with a colorant.

35. The system of Claim 1, wherein the glass layer has a thickness of 1 mm to 4 mm.

25 36. The system of Claim 1, wherein the second encapsulant includes a thickness of 1 μm to 900 μm .

37. The system of Claim 1, wherein the first polymer layer includes a thickness of 0.01 mm to 0.5 mm.

38. The system of Claim 1, wherein the glass layer includes a first edge, and wherein
5 the first layer includes a second edge offset from the first edge.

39. The system of Claim 1, wherein the first layer of the backsheet includes a composite material.

10 40. The system of Claim 39, wherein the composite material includes a substrate having a first surface and a second surface opposite the first surface of the substrate, a cap juxtaposed with the first surface of the substrate, and a core juxtaposed with the second surface of the substrate.

41. The system of Claim 40, wherein the cap includes at least one of one or more
15 polymers, at least one infrared-reflective pigment, a stabilizer package, one or more fillers, or combinations thereof.

42. The system of Claim 40, wherein the cap includes at least one of one or more
thermoplastic polyolefins, at least one infrared-reflective black pigment, a stabilizer package, one
20 or more fillers, or combinations thereof.

43. The system of Claim 41, wherein the stabilizer package includes at least one ultraviolet (UV) absorber.

25 44. The system of Claim 40, wherein the cap does not include a white colorant.

45. The system of Claim 40, wherein the cap includes one or more thermoplastic polyolefins, an ultraviolet absorber, an infrared-reflective black pigment, and optionally one or more fillers, and wherein the cap does not comprise at least one of a white colorant, a white pigment, or any combination thereof.

5

46. The system of Claim 41, wherein the infrared-reflective pigment is 0.01% by weight to 15% by weight of a total weight of the cap.

10

47. The system of Claim 40, wherein the core includes one or more polymers, a stabilizer package, one or more fillers, or combinations thereof.

15

48. The system of Claim 1, wherein the wire cover bracket includes a first end, a second end opposite the first end of the wire cover bracket, and at least one tab extending from the first end, wherein the at least one tab of the wire cover bracket of the one of the photovoltaic modules is configured to overlap the wire cover bracket of the adjacent another one of the photovoltaic modules.

20

49. The system of Claim 1, wherein the wire cover bracket includes at least one clip configured to receive an electrical wire.

50. The system of Claim 26, wherein the wire cover bracket is attached to the first side lap by an adhesive.

25

51. The system of Claim 28, wherein the at least one cover is textured.

52. The system of Claim 1, further comprising a plurality of step flaps, wherein each of the step flaps is installed adjacent to a corresponding one of the photovoltaic modules.

53. The system of Claim 22, wherein the second side lap of each of the photovoltaic modules overlaps a corresponding at least one roofing shingle.

5 54. The system of Claim 53, wherein the roofing shingle is an asphalt shingle.

55. The system of Claim 53, wherein the second side lap is of the photovoltaic module is attached to the at least one roofing shingle by an adhesive, a fleece layer and an adhesive, plasma treatment, or combinations thereof.

10 56. The system of Claim 30, further comprising a first flashing base installed on the roof deck proximate to and aligned with the first wire channel, wherein the transition box is installed on the first flashing base.

15 57. The system of Claim 56, wherein the first flashing base includes an aperture, wherein the transition box includes a sidewall and a cover portion extending from the sidewall, and wherein the cover portion of the transition box covers at least a portion of the aperture of the first flashing base, and wherein the first junction box is located within the aperture.

20 58. The system of Claim 56, further comprising a second flashing base installed on the roof deck proximate to and aligned with the second wire channel, wherein the second flashing base includes an aperture, and wherein the second junction box is located within the aperture of the second flashing base.

25 59. The system of Claim 58, further comprising an electrical cable passthrough, wherein the electrical cable passthrough is located within the aperture of the second flashing base.

60. The system of Claim 58, further comprising a plurality of roofing shingles, wherein the roofing shingles overlay the first flashing base, the second flashing base, and a headlap of each of the jumper modules.

5 61. The system of Claim 1, wherein each of the photovoltaic shingles includes an adhesive located on a rear surface of the first layer.

62. The system of Claim 61, wherein the adhesive is at least one peel and stick film sheet.

10

15

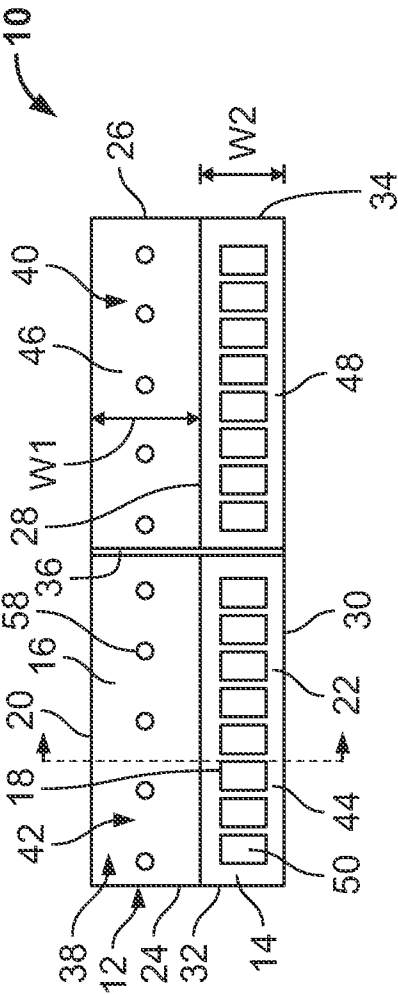


FIG. 1A

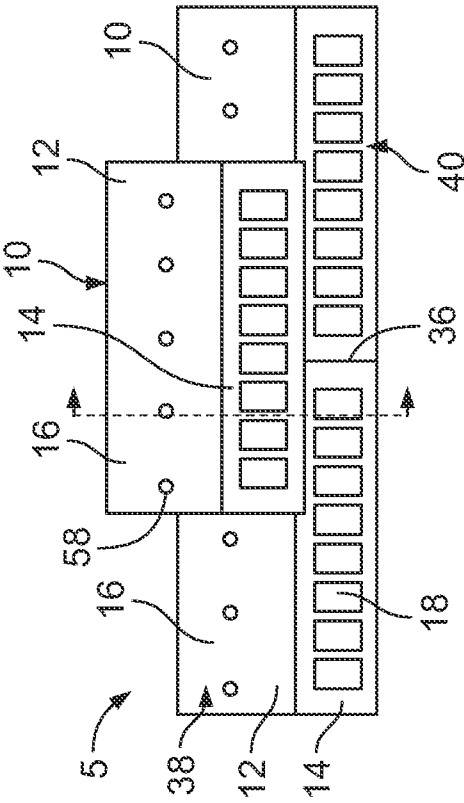


FIG. 1C

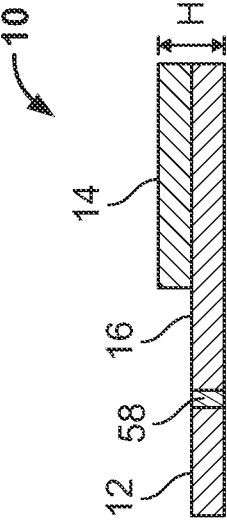


FIG. 1B

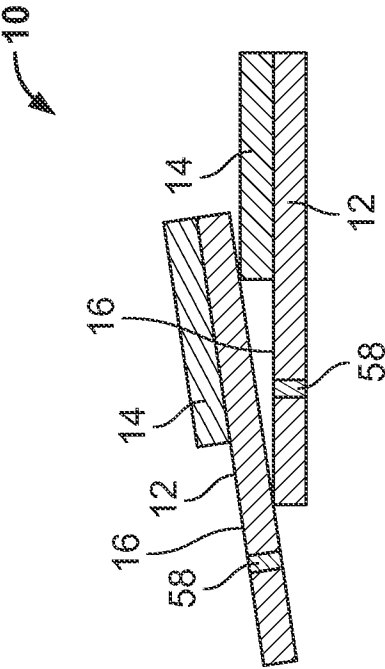


FIG. 1D

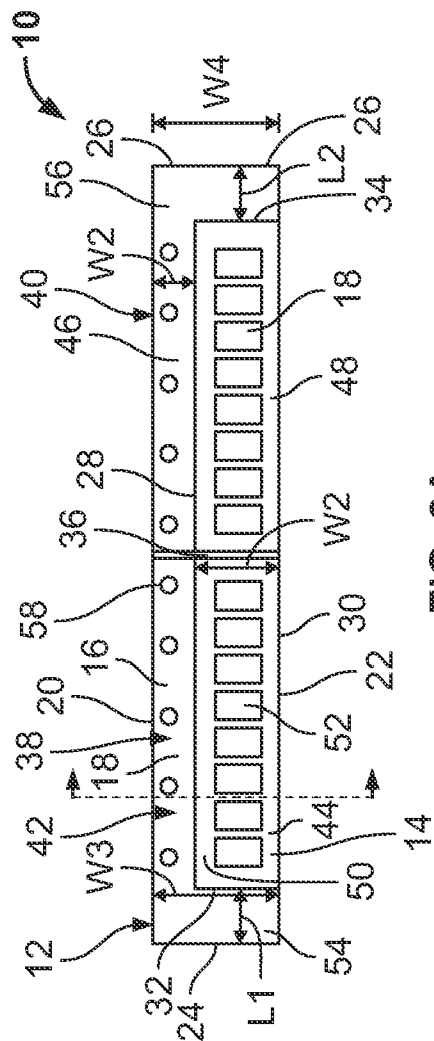


FIG. 2A

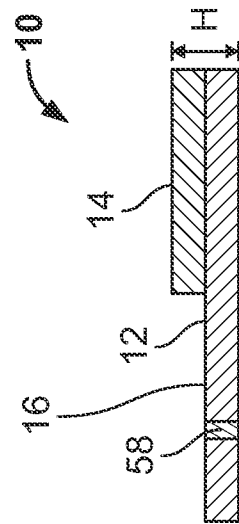
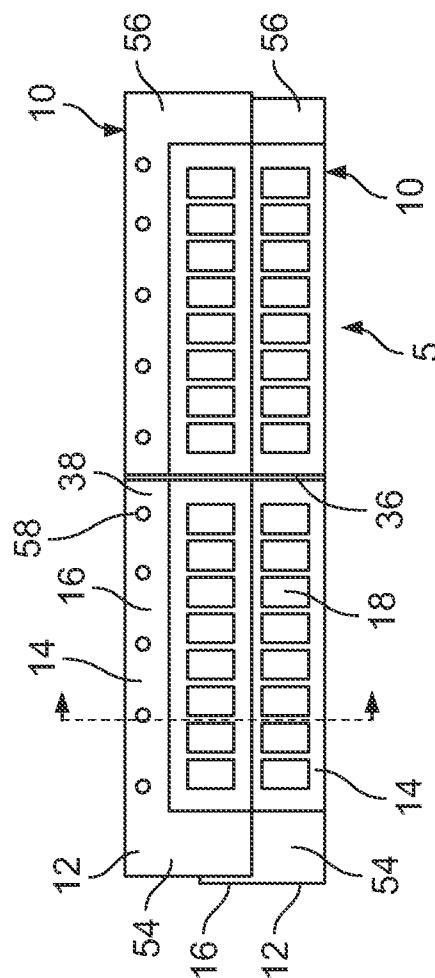
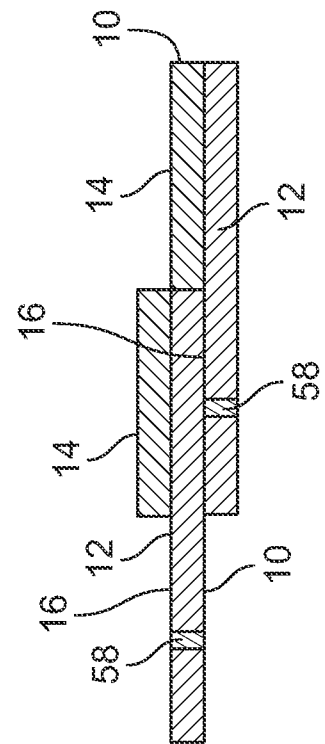


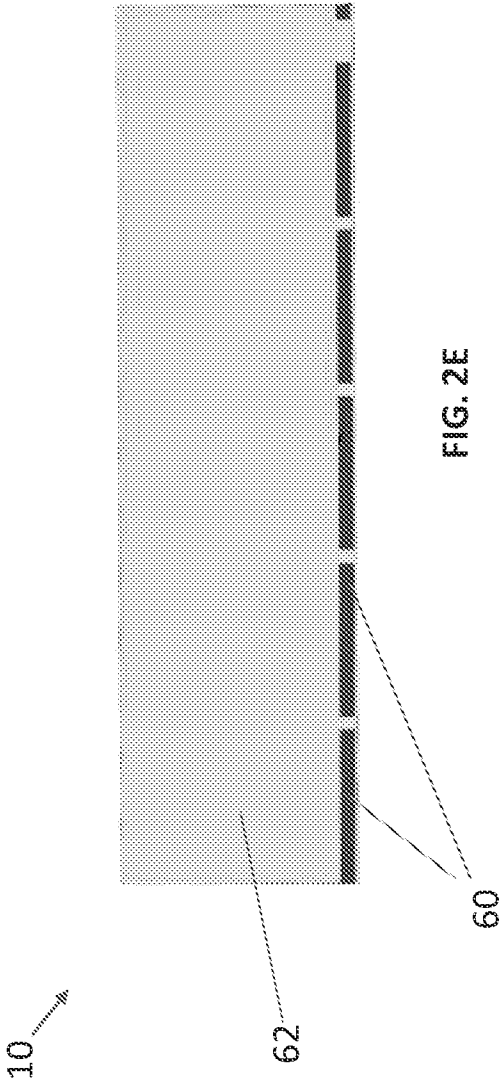
Fig. 2B



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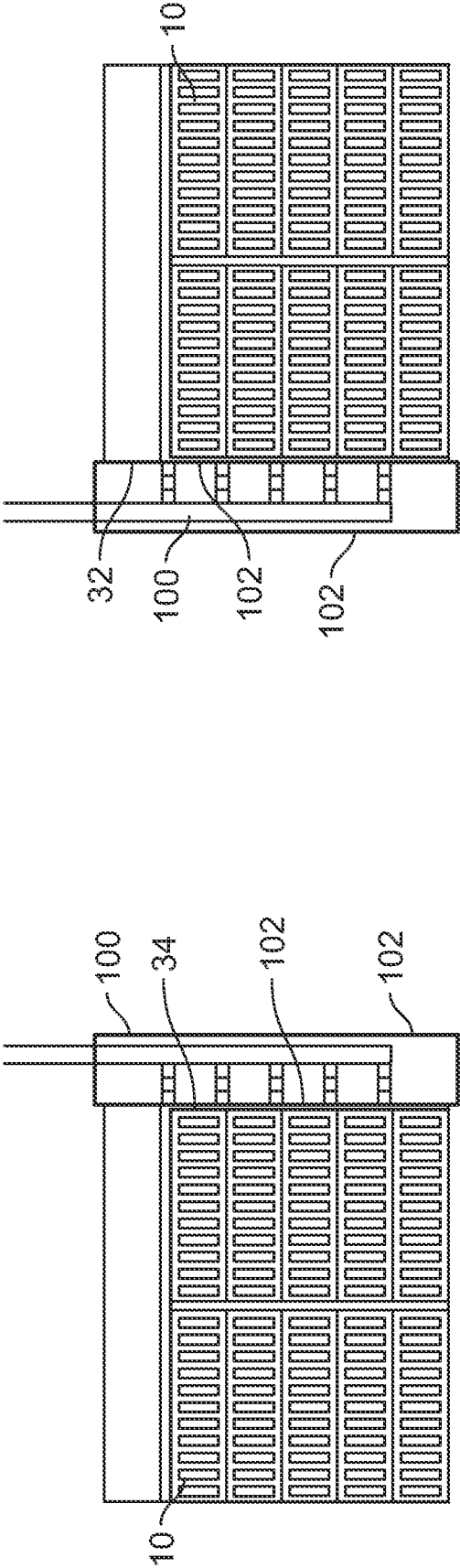


FIG. 3A

FIG. 3B

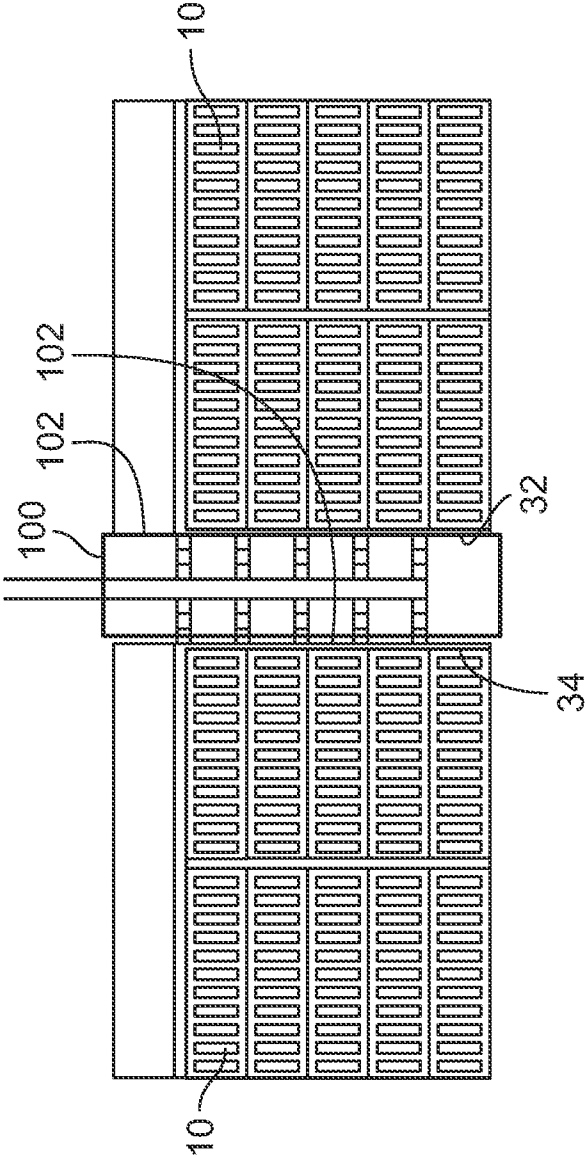


FIG. 3C

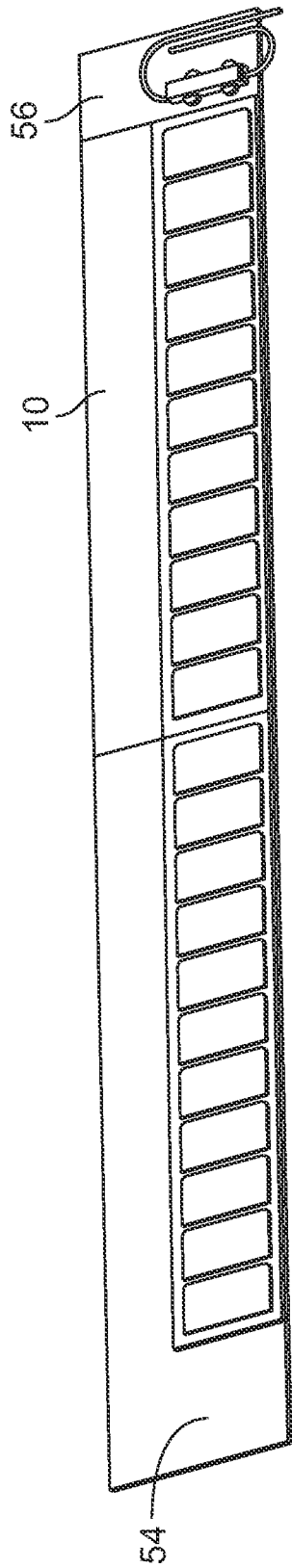


FIG. 3D

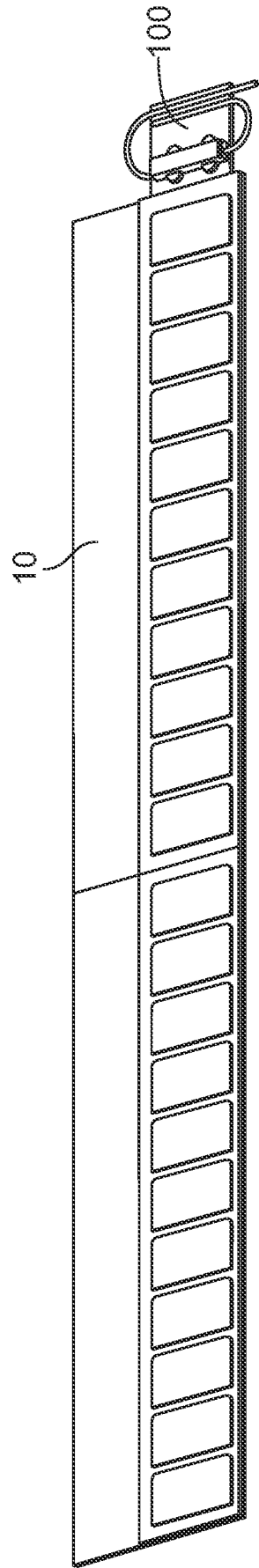


FIG. 3E

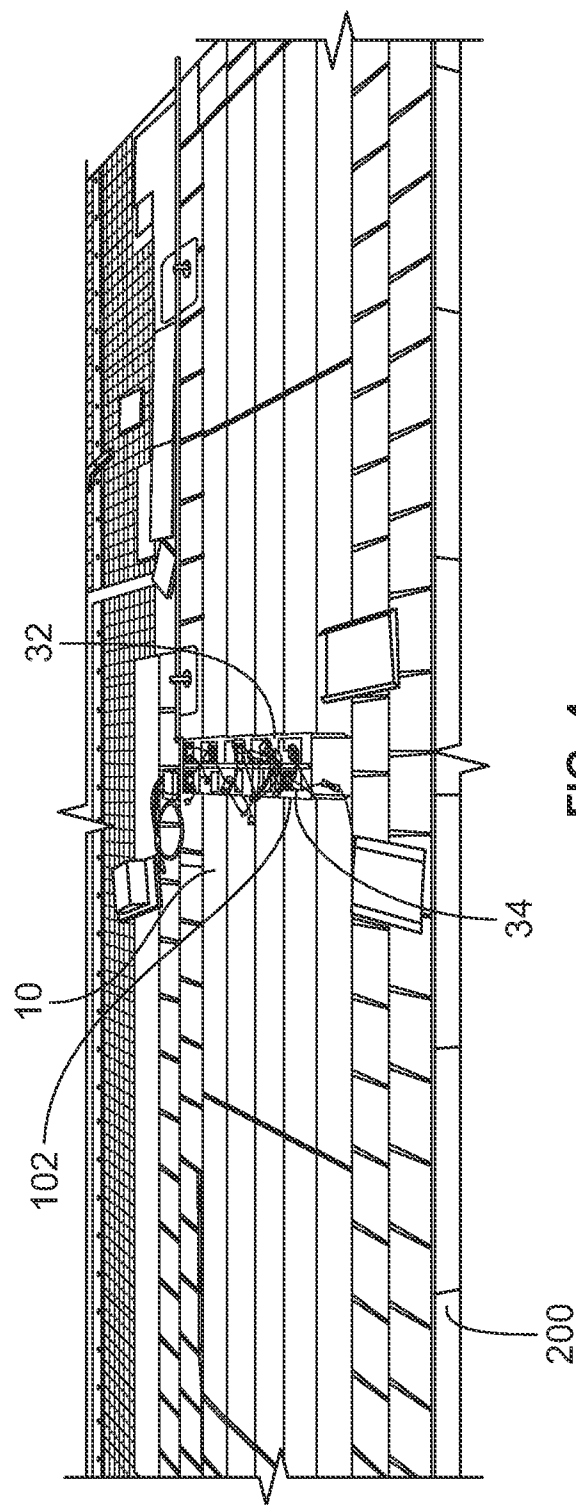


FIG. 4

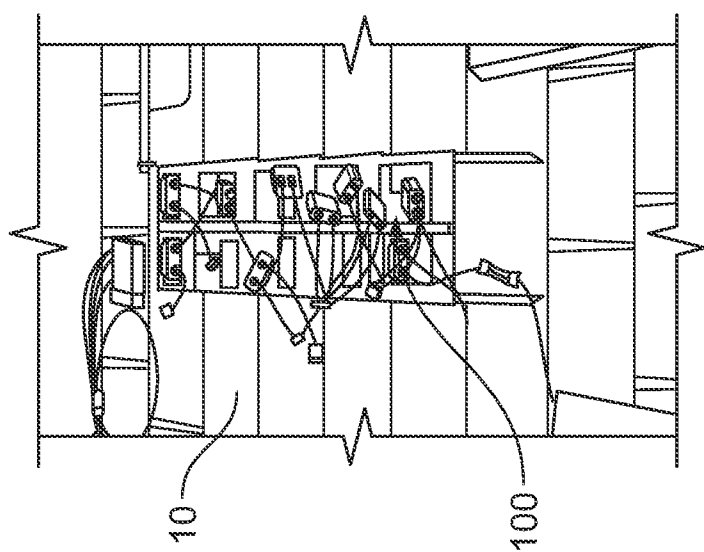


FIG. 5

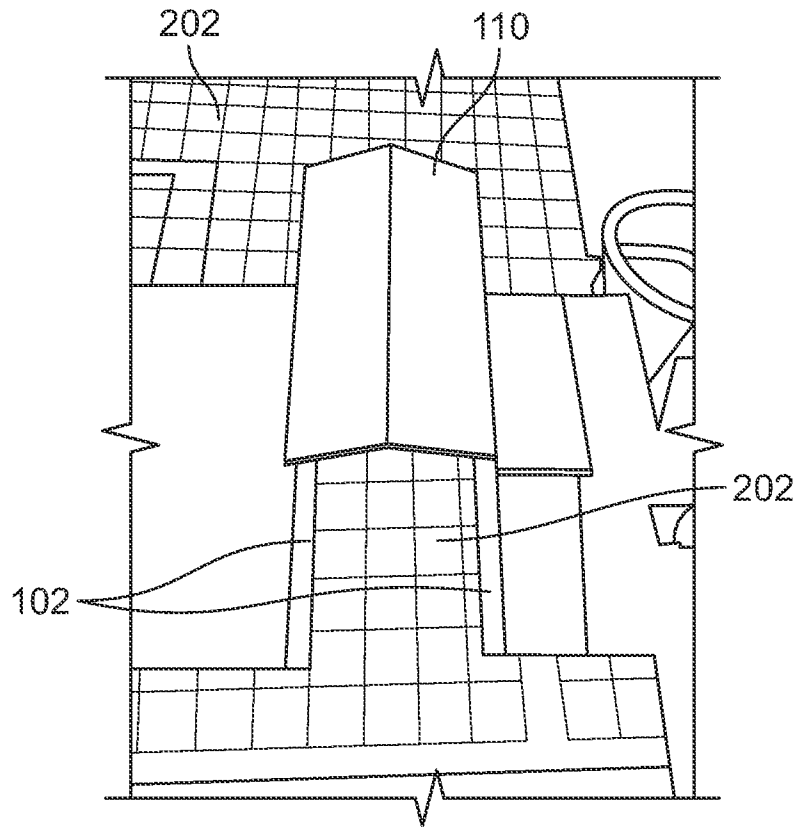


FIG. 6

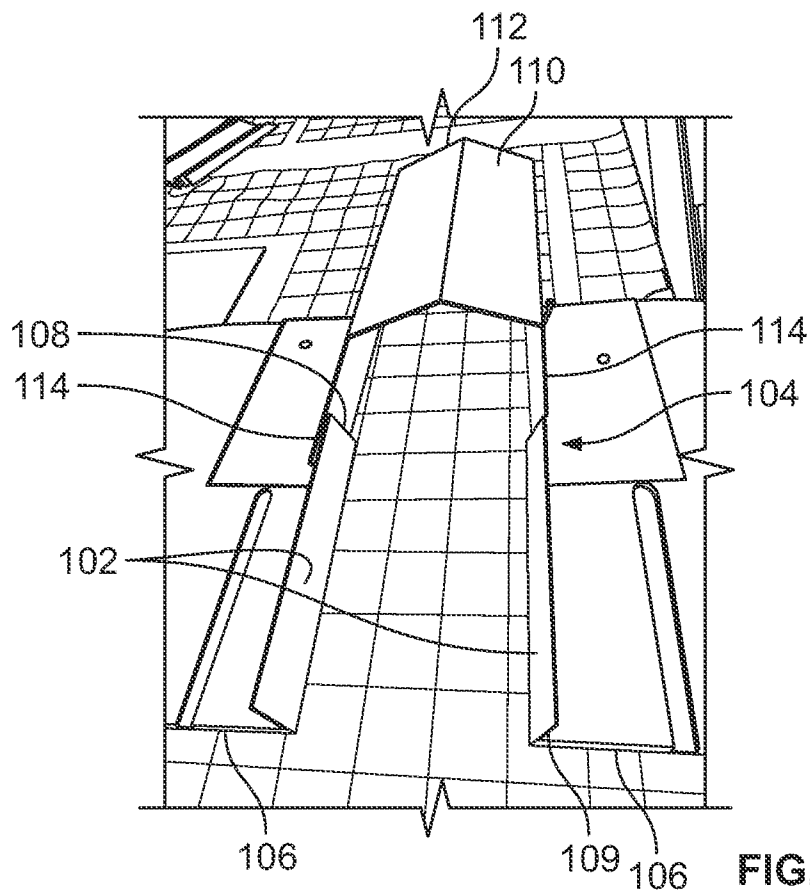


FIG. 7A

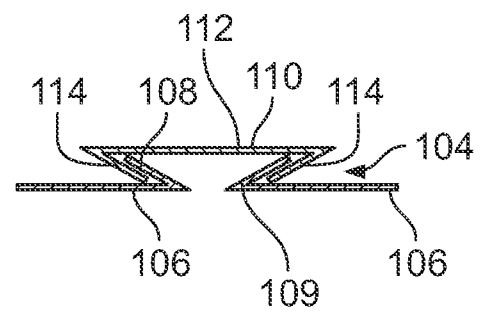


FIG. 7B

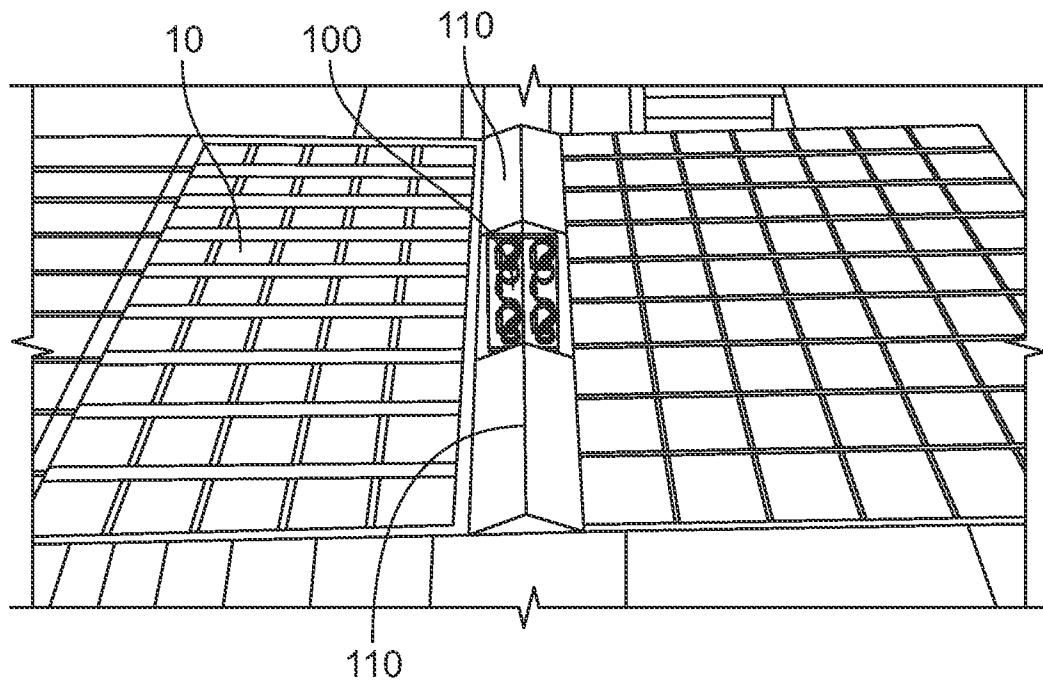


FIG. 8

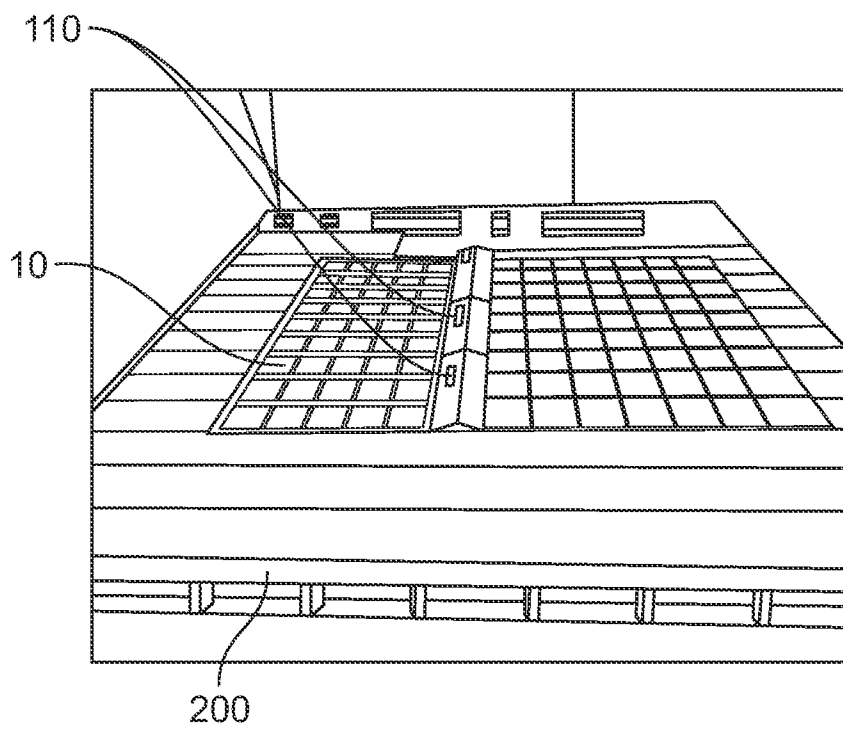


FIG. 9

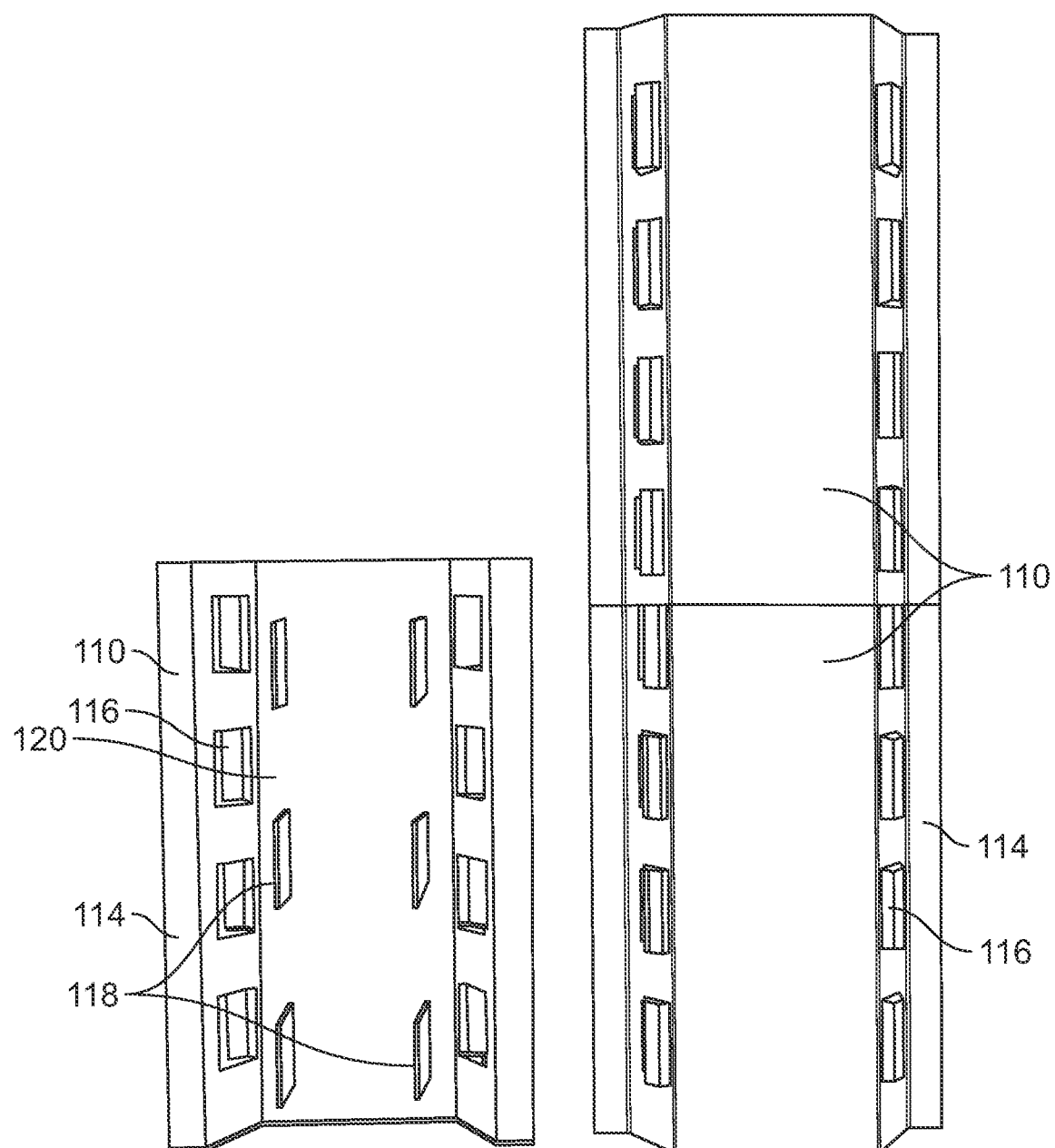


FIG. 10

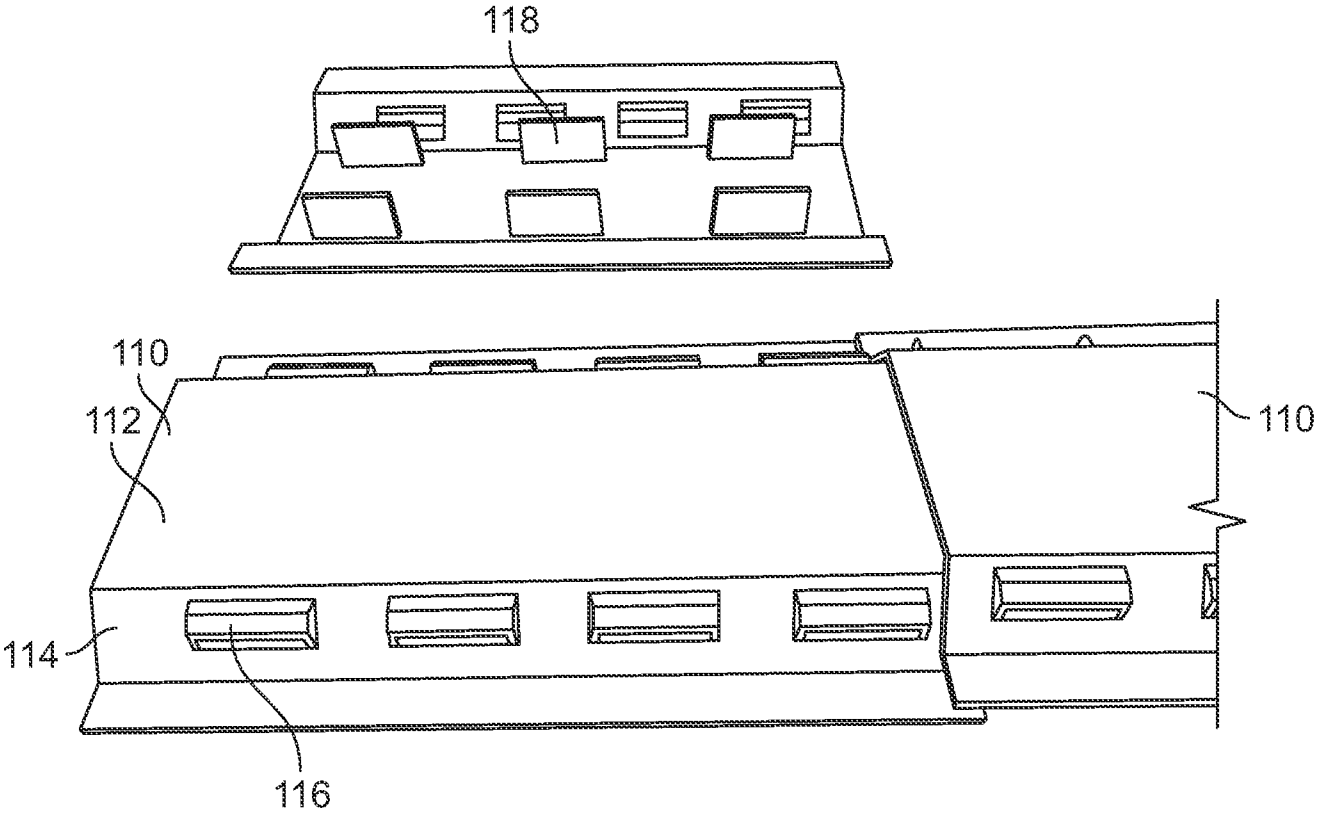


FIG. 11

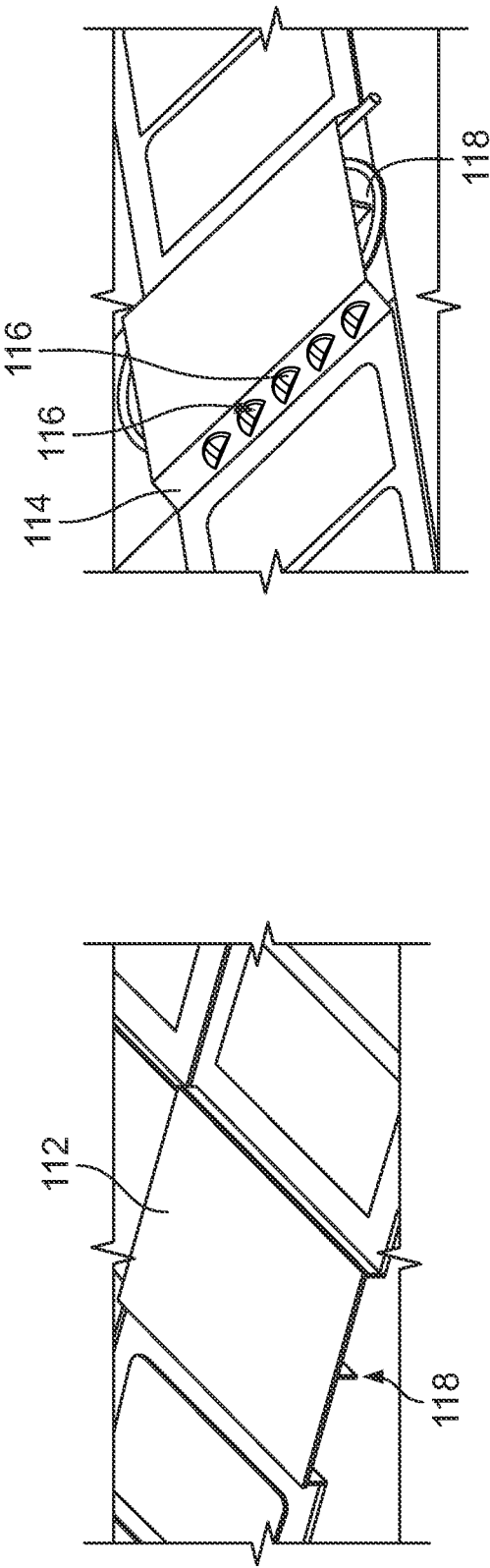


FIG. 12A

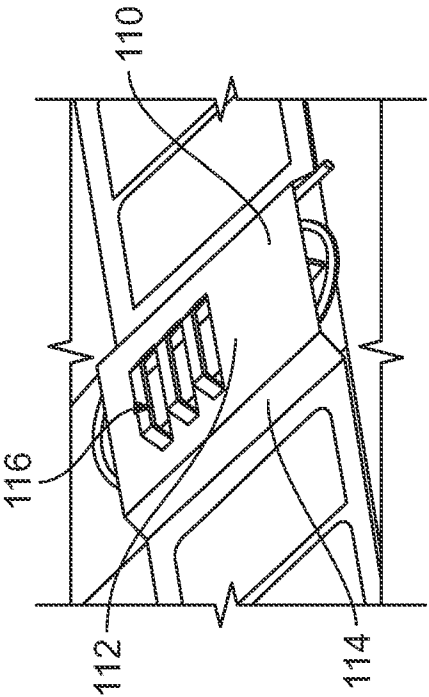


FIG. 12B

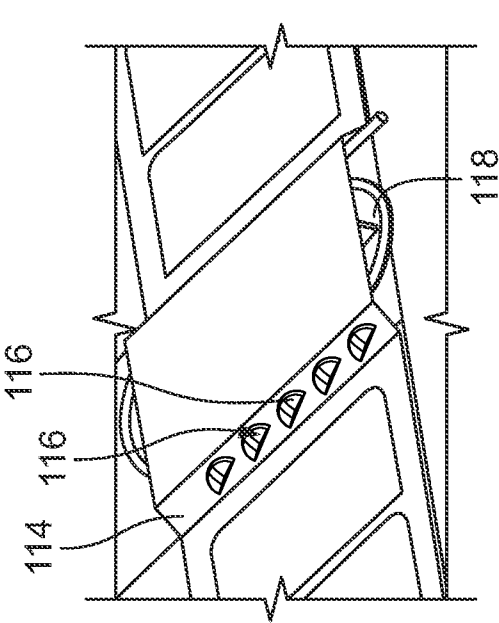


FIG. 12C

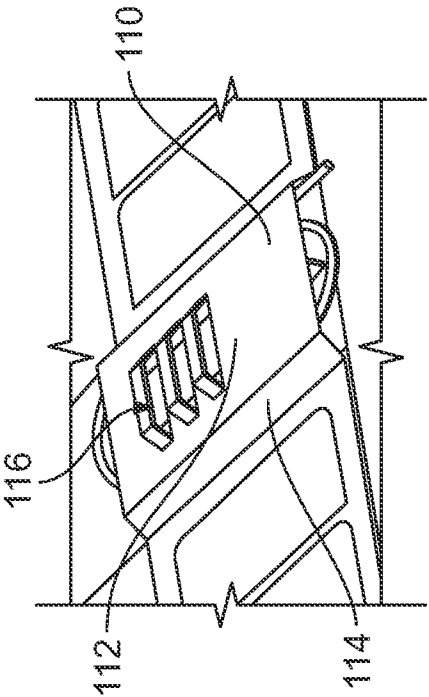


FIG. 12D

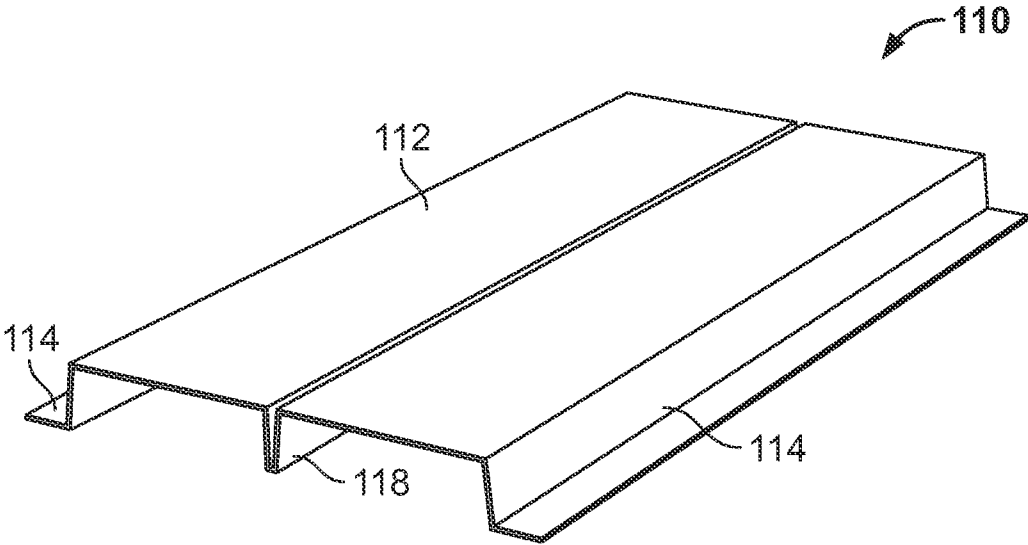


FIG. 13A

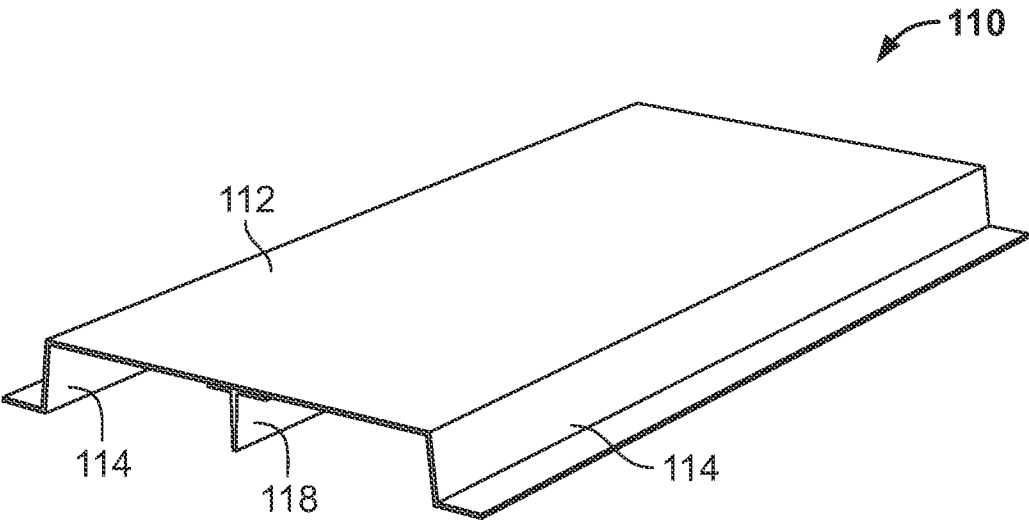


FIG. 13B

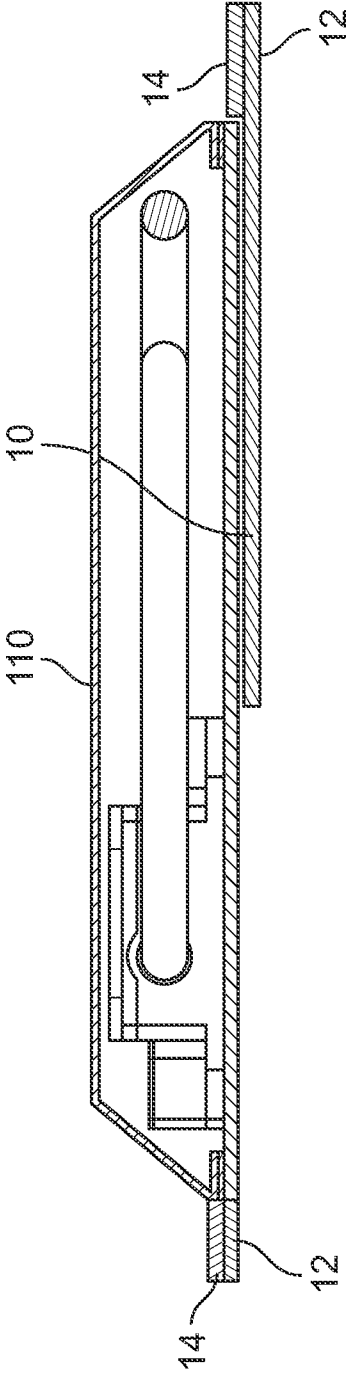


FIG. 14A

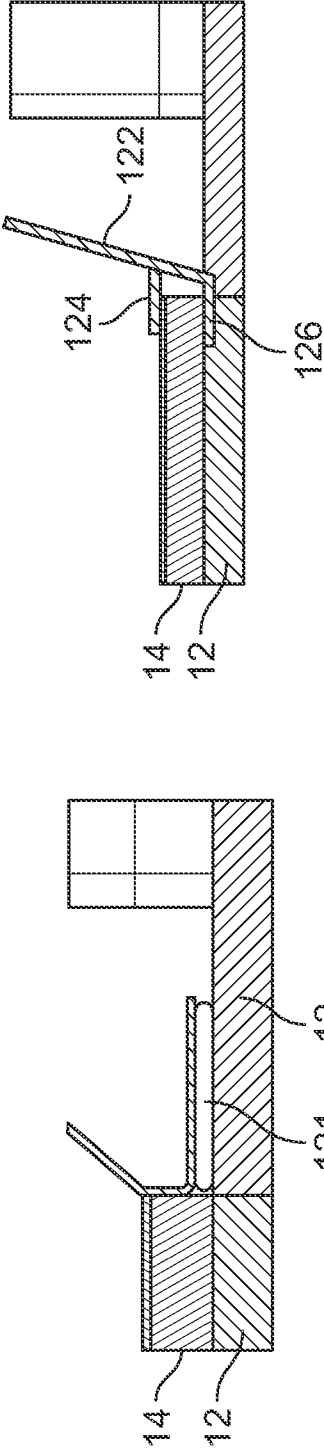


FIG. 14B

FIG. 14C

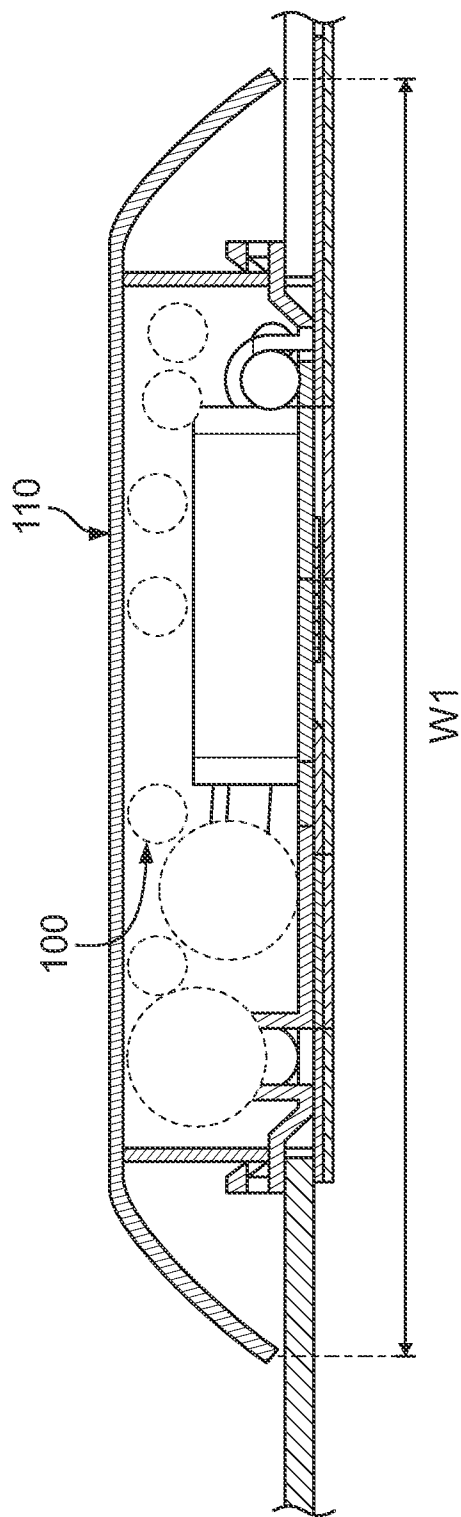
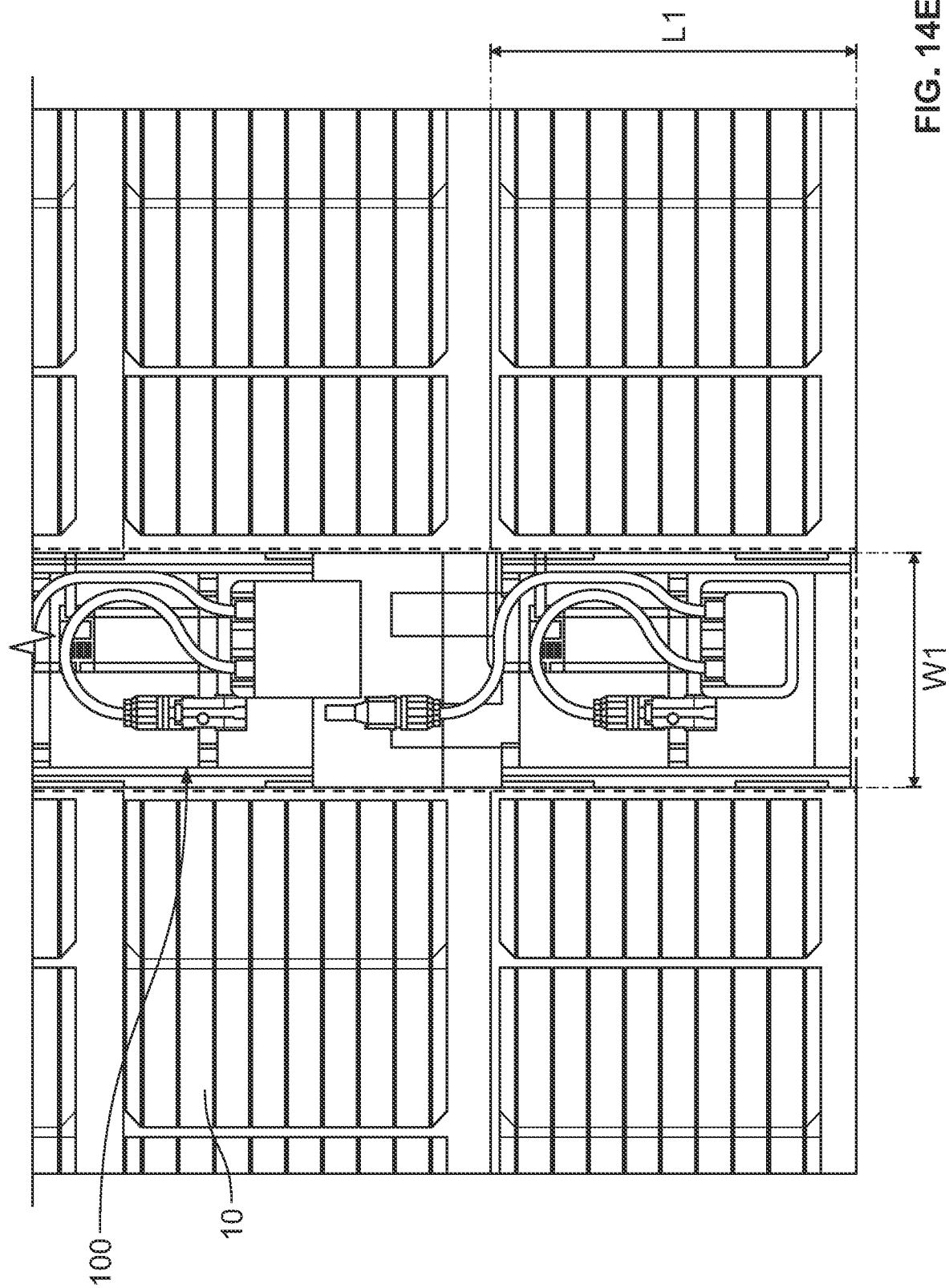


FIG. 14D



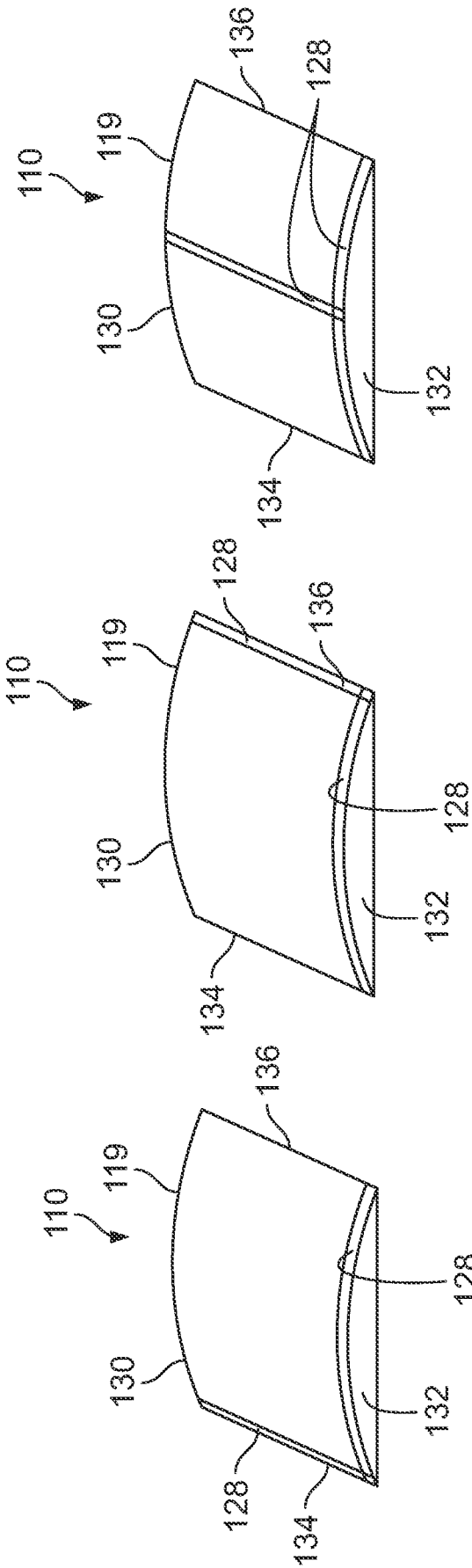
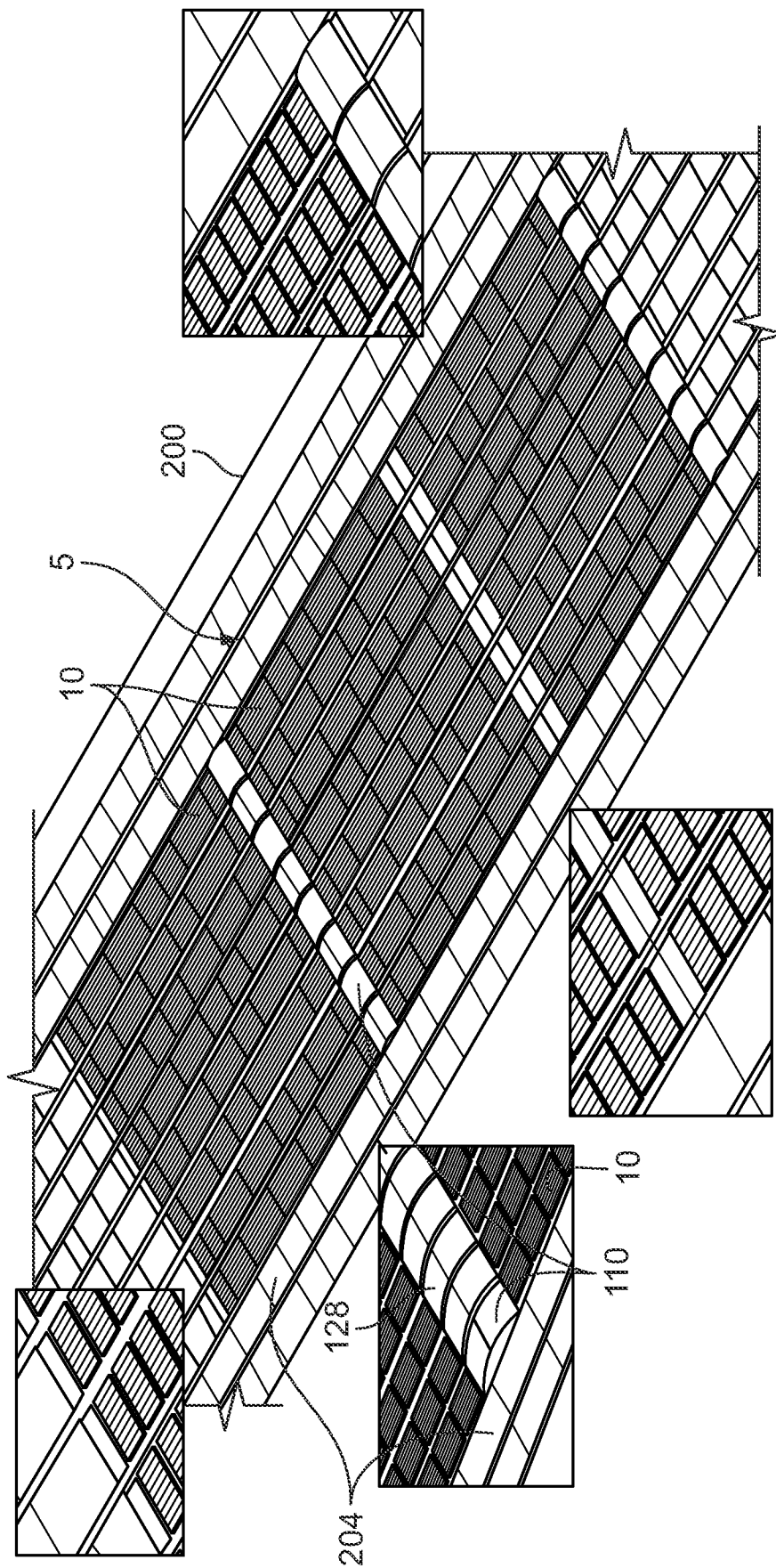


FIG. 15C

FIG. 15B

FIG. 15A



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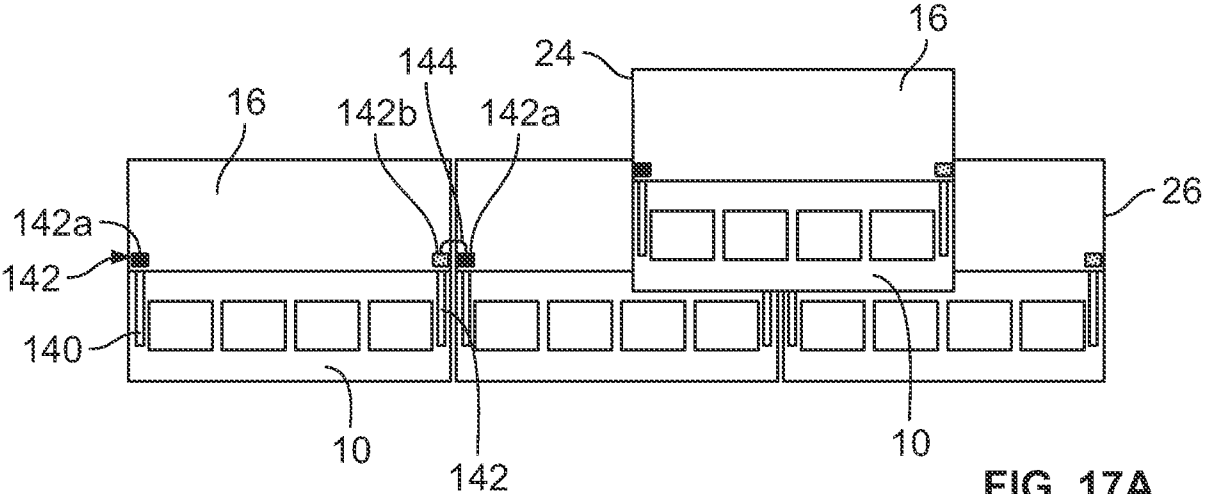


FIG. 17A

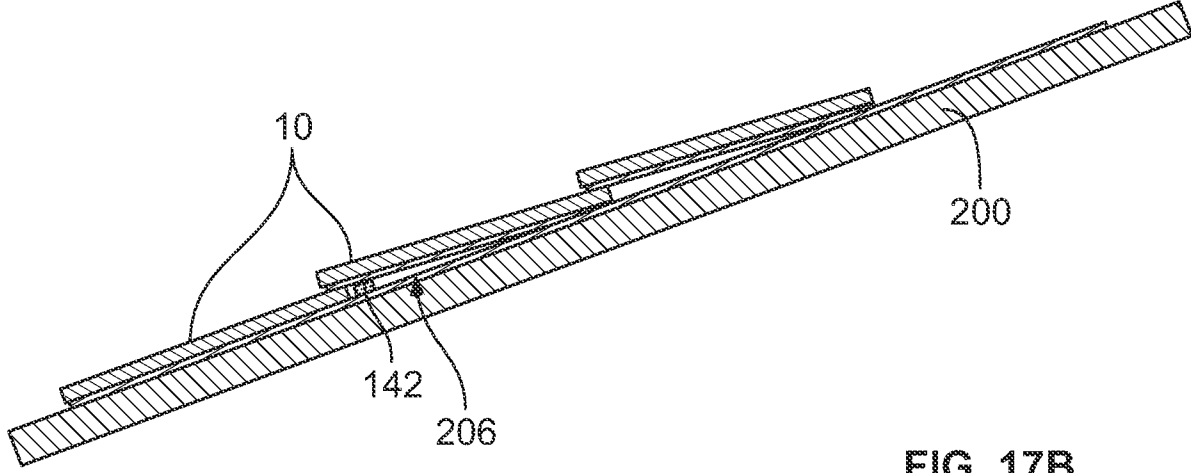
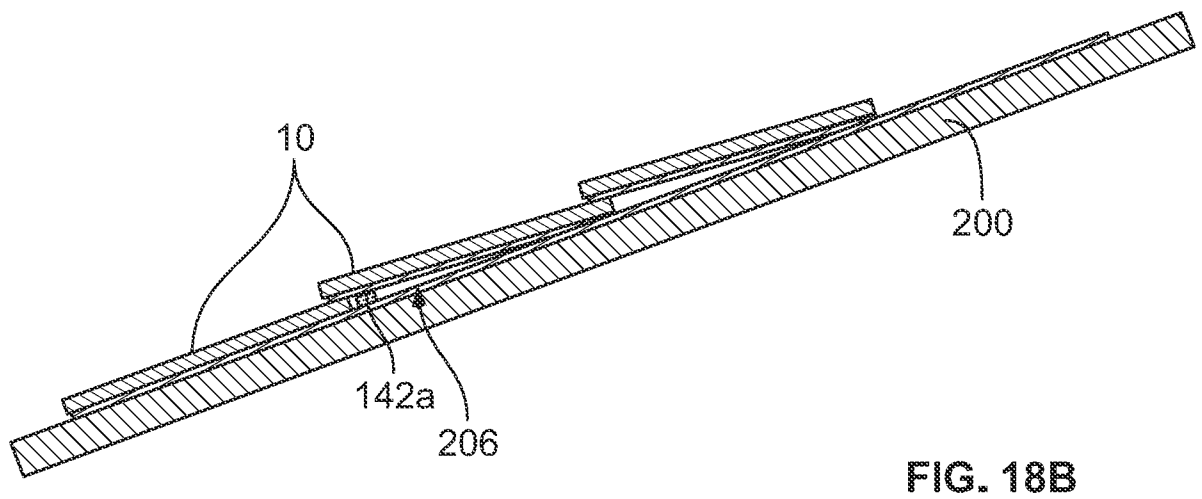
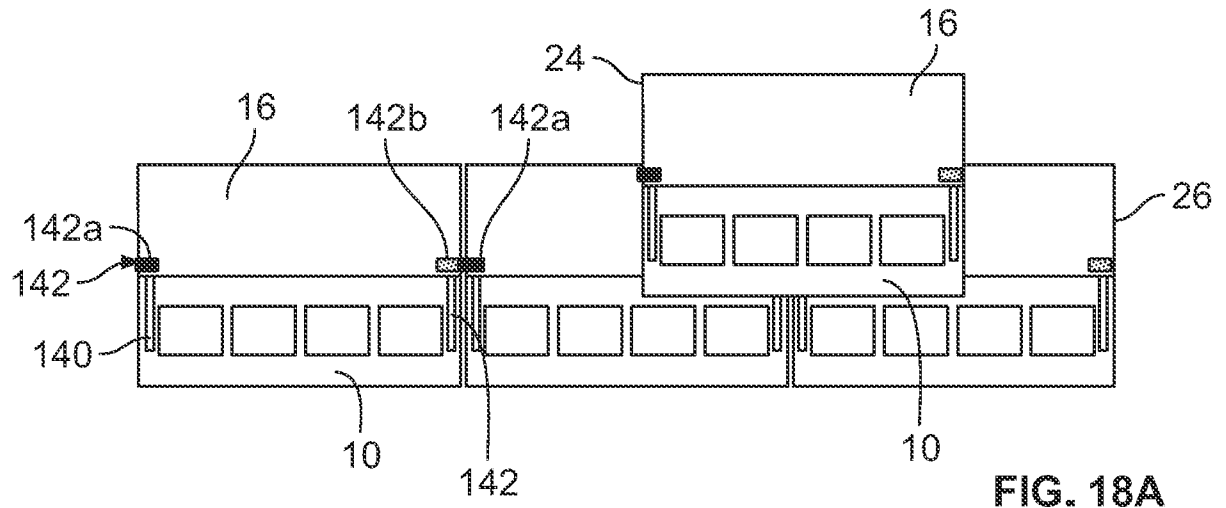


FIG. 17B



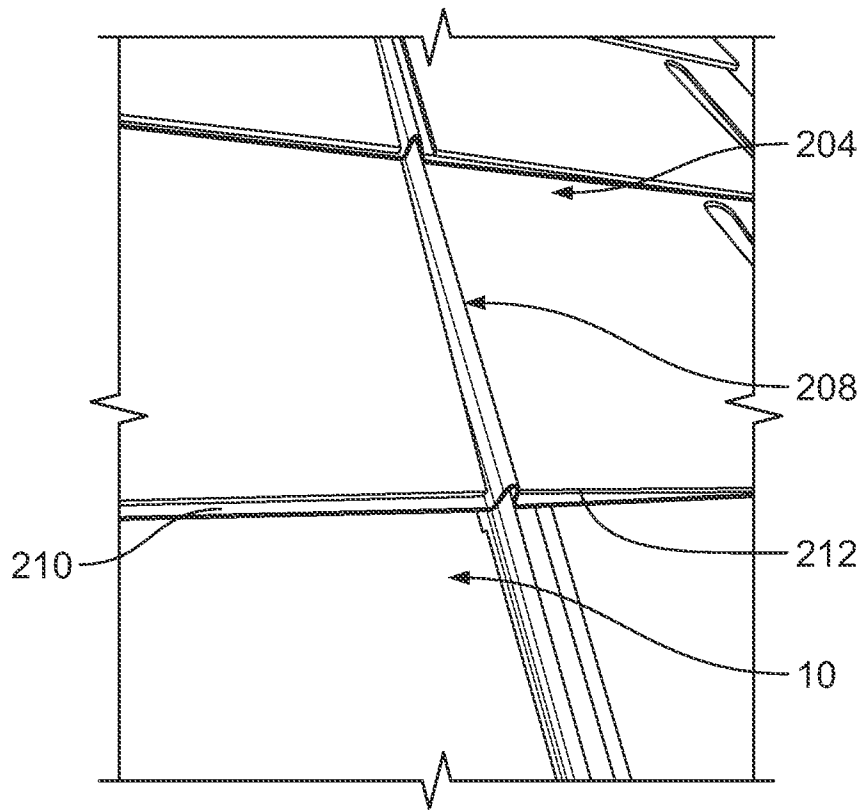


FIG. 19

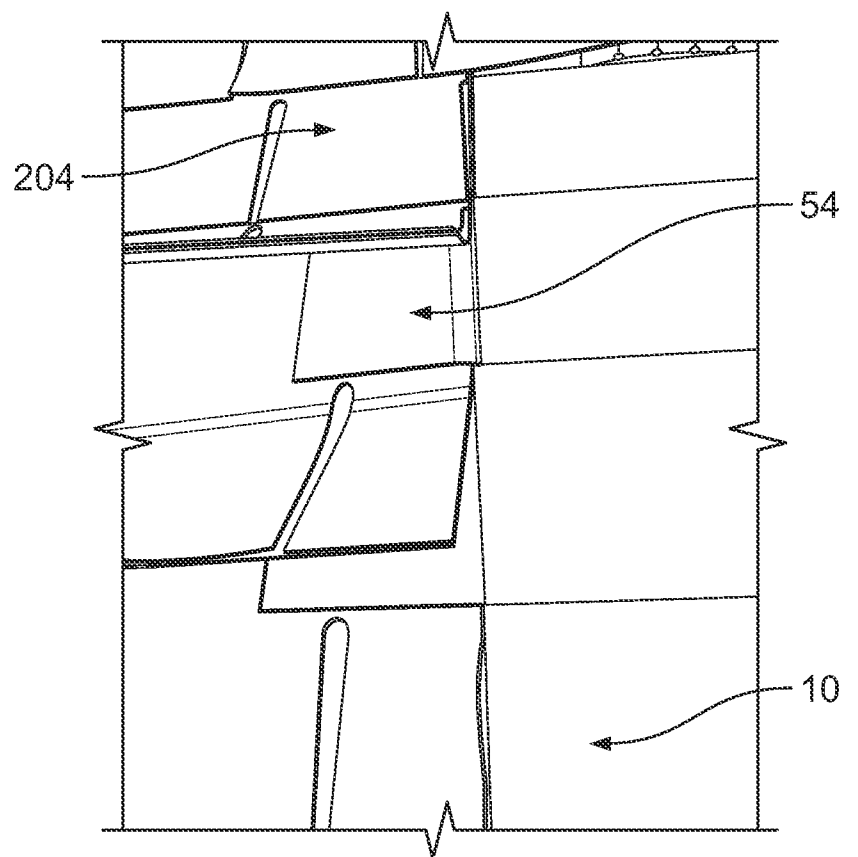


FIG. 20

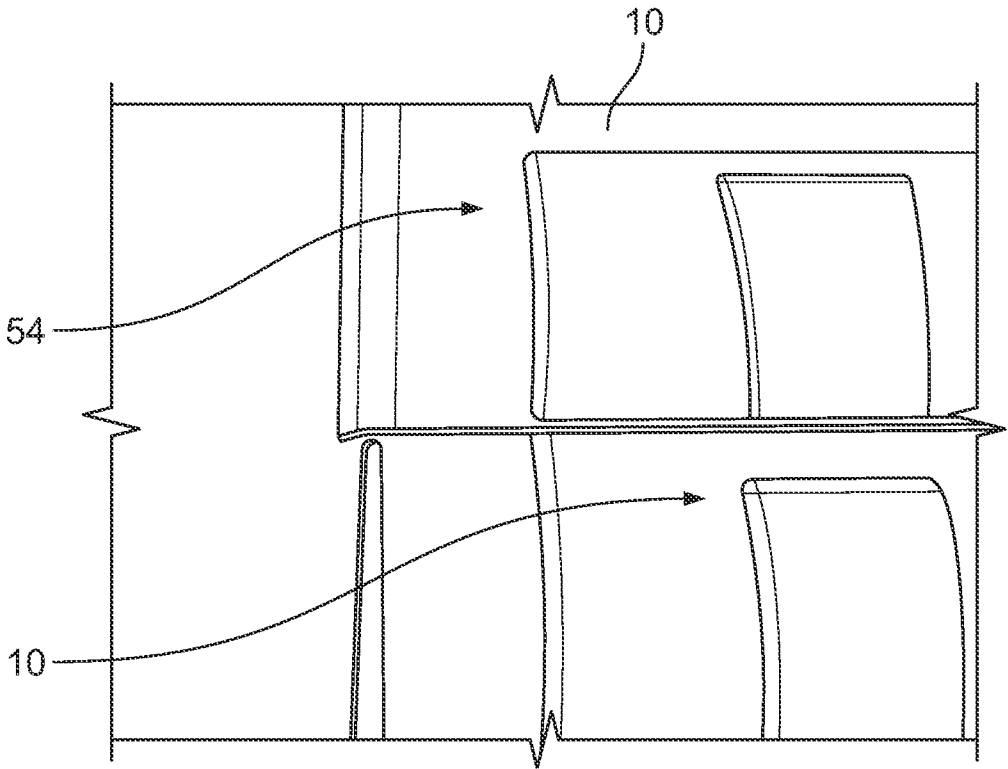


FIG. 21A

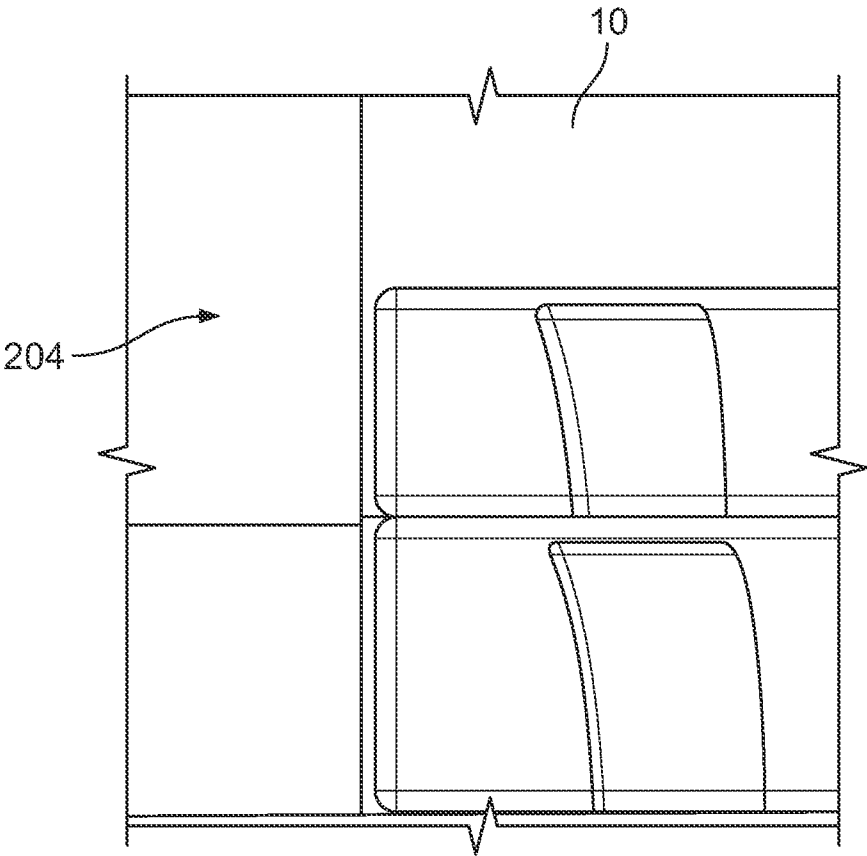


FIG. 21B

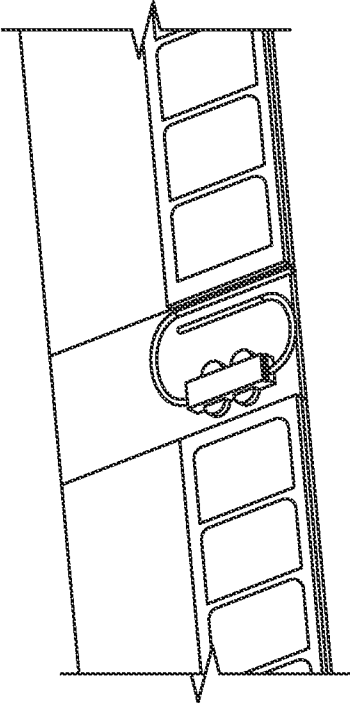


FIG. 22B

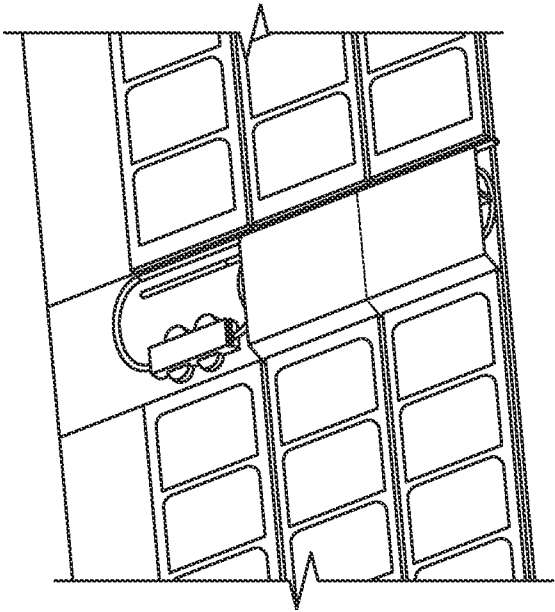


FIG. 22D

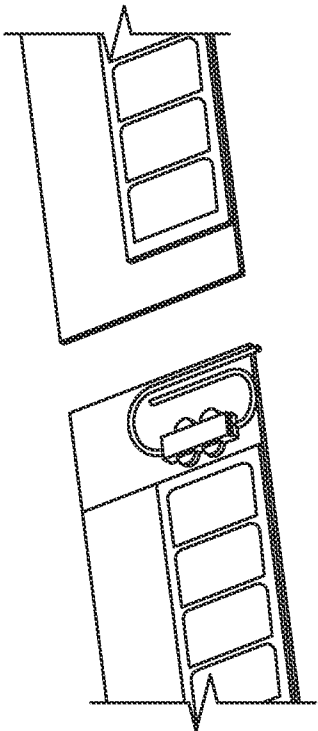


FIG. 22A

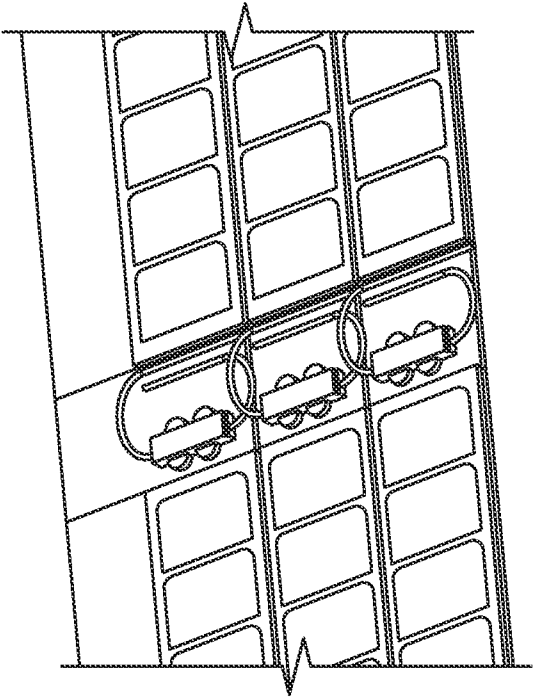


FIG. 22C

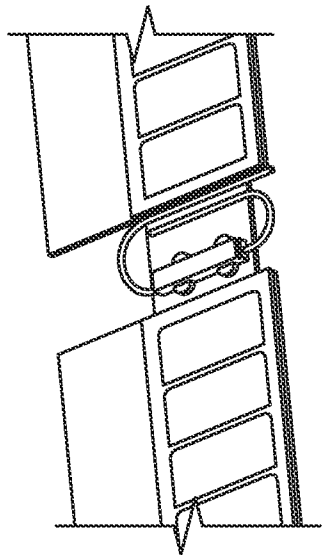


FIG. 23B

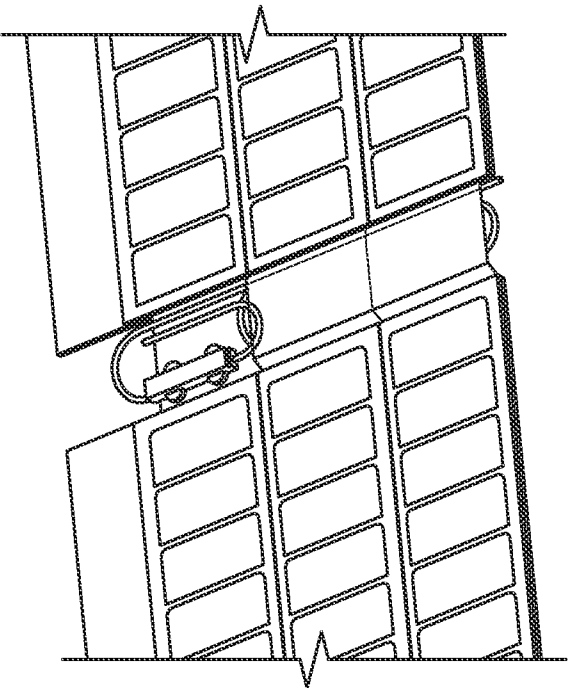


FIG. 23D

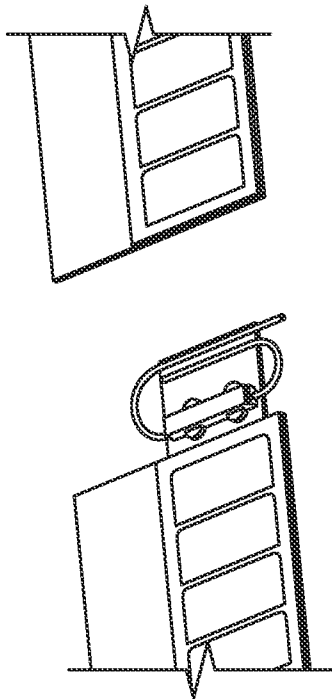


FIG. 23A

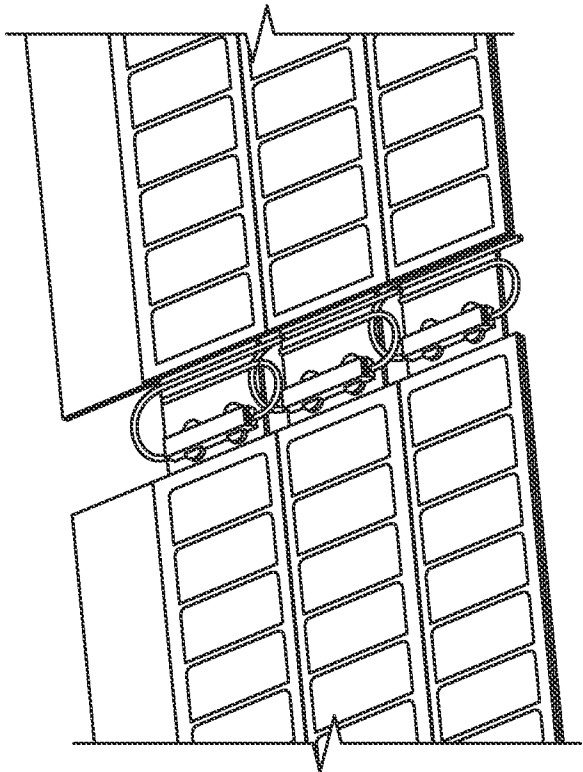


FIG. 23C

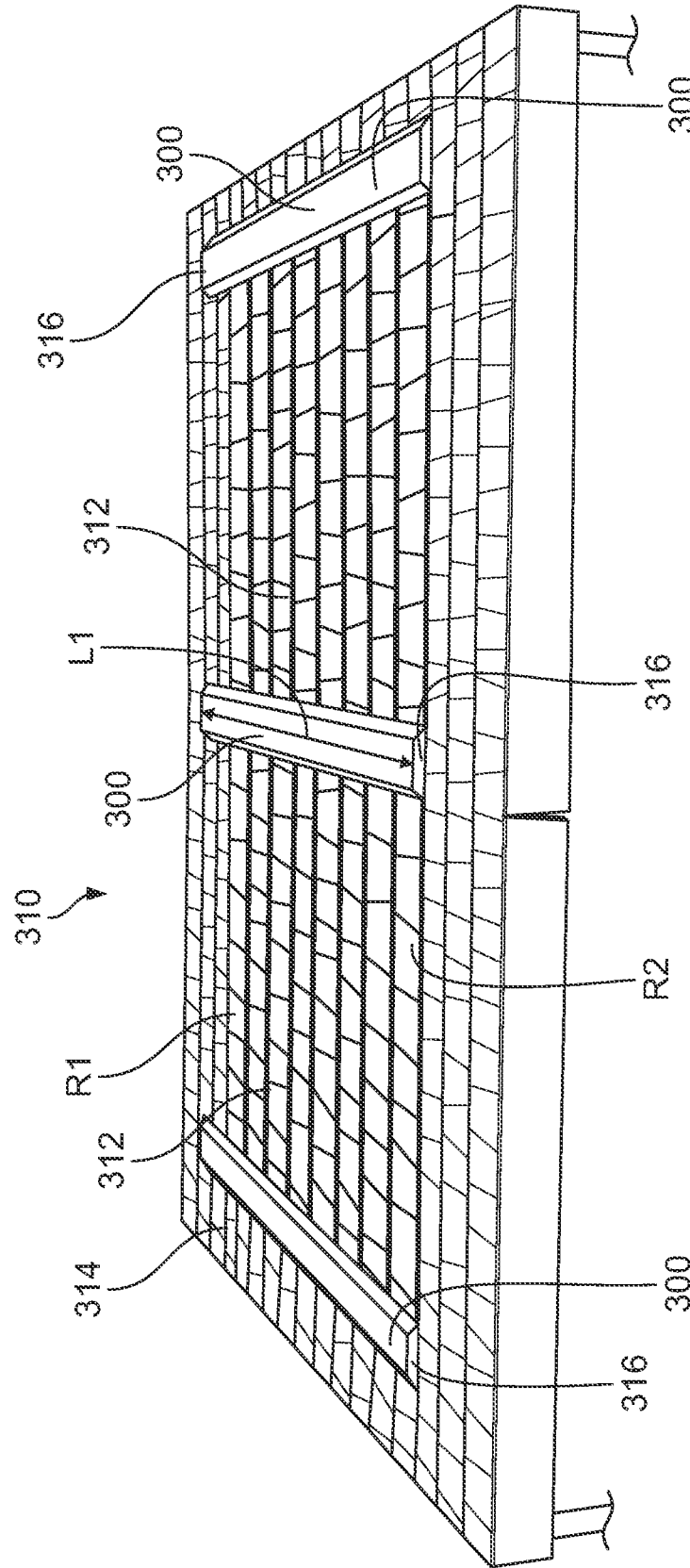


FIG. 24

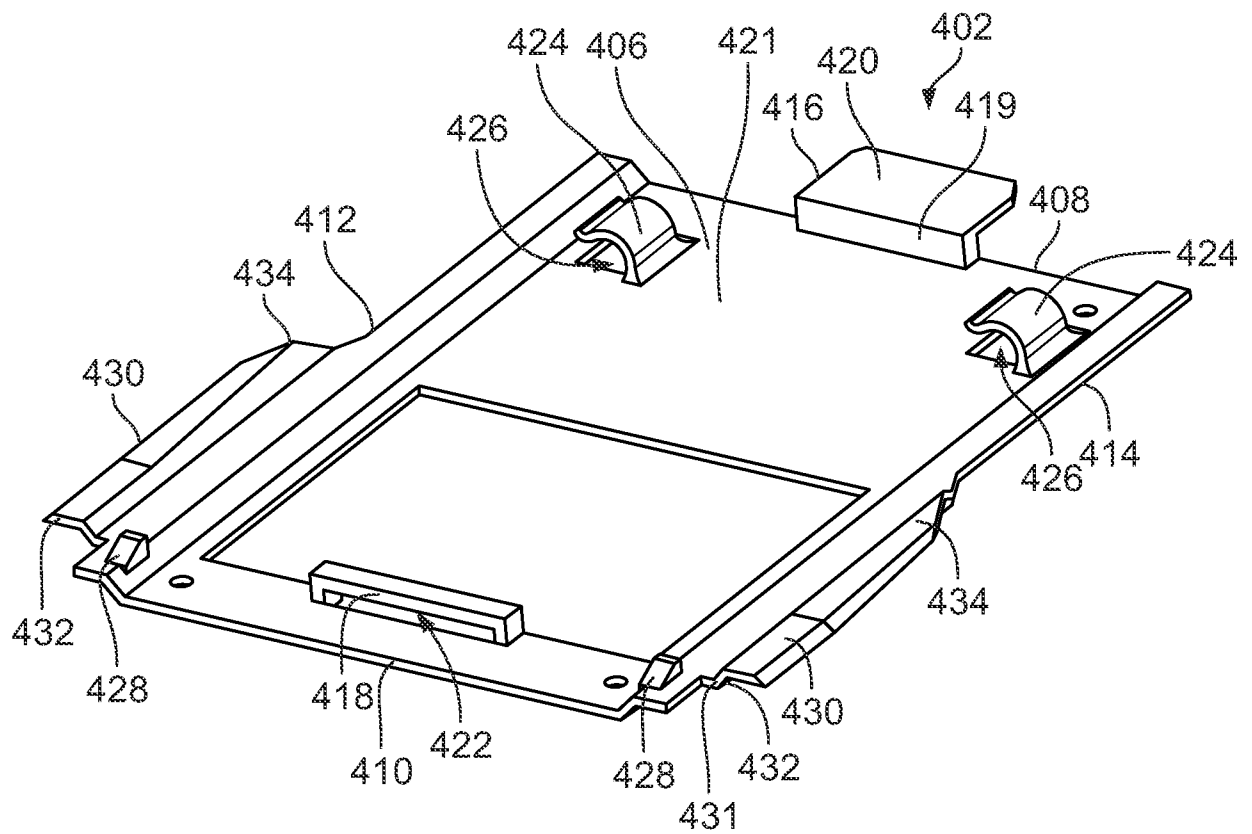


FIG. 25

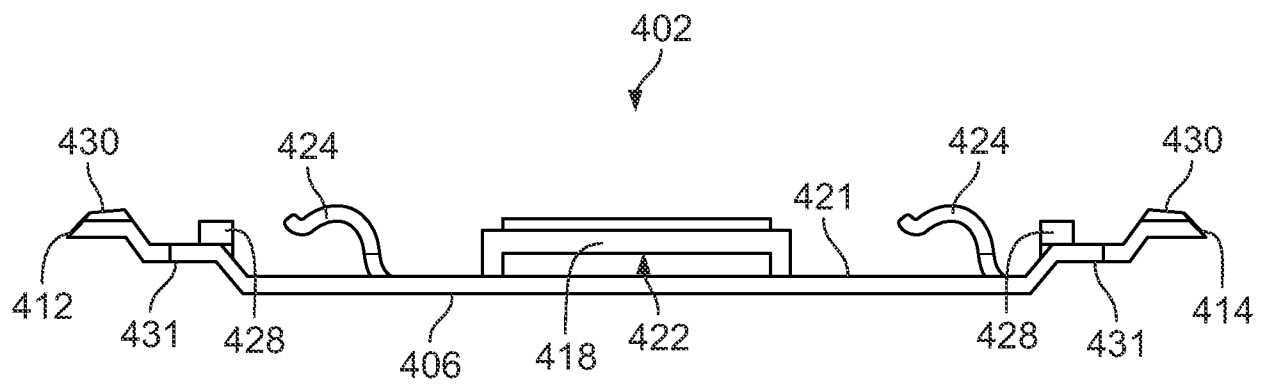


FIG. 26

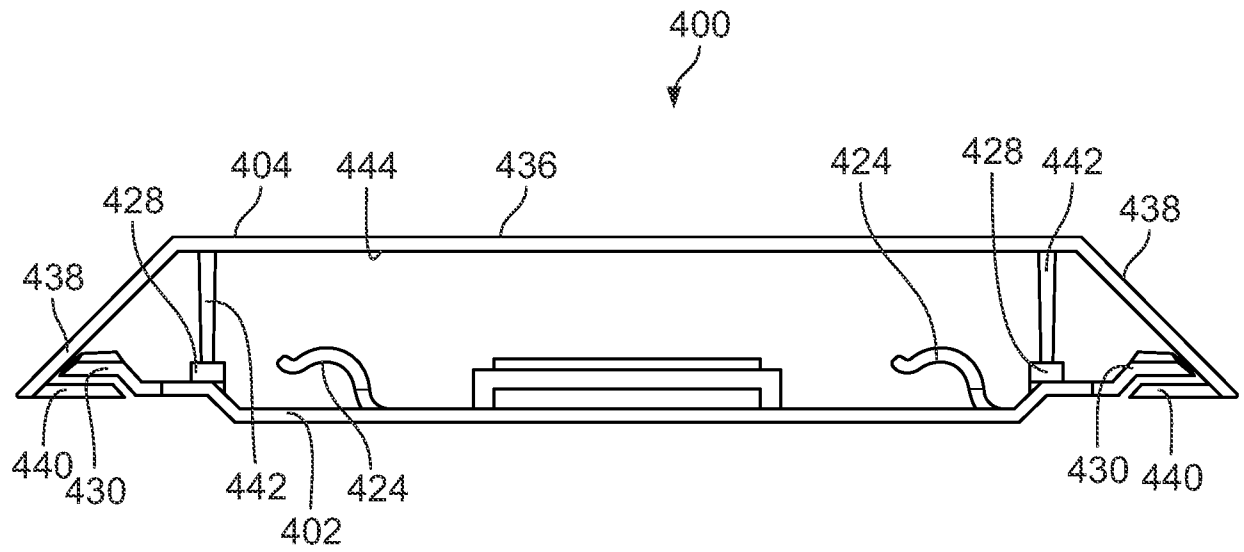


FIG. 27

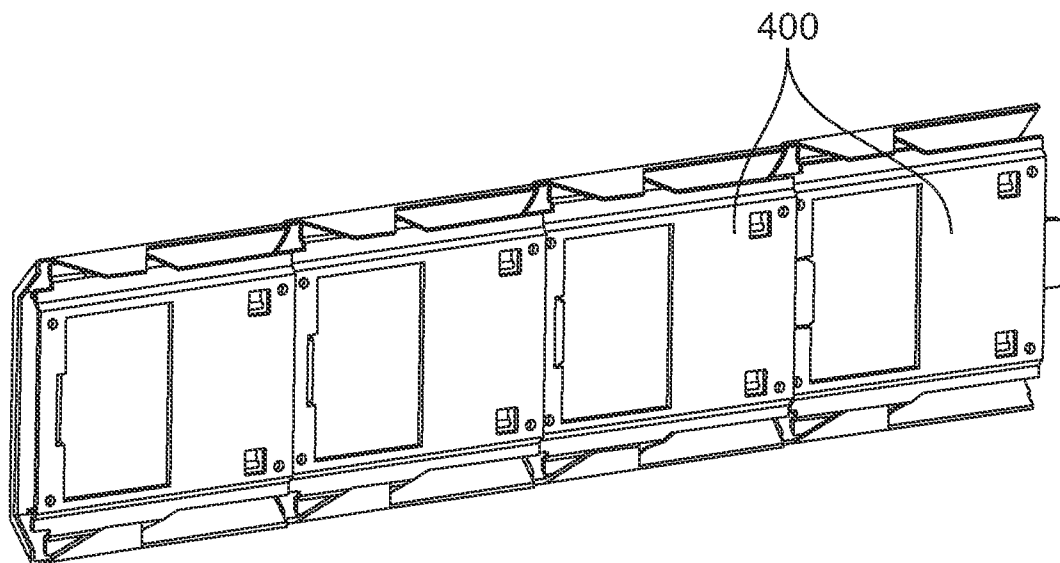


FIG. 28

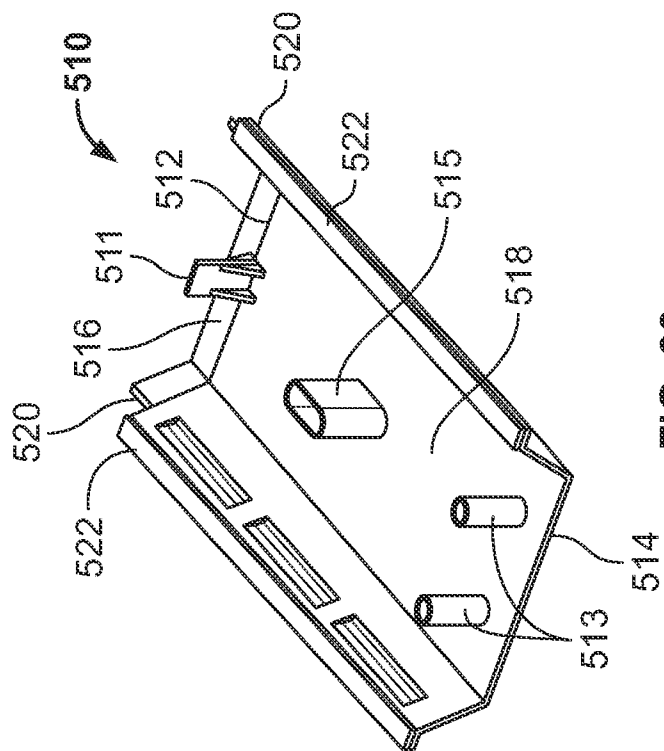


FIG. 29

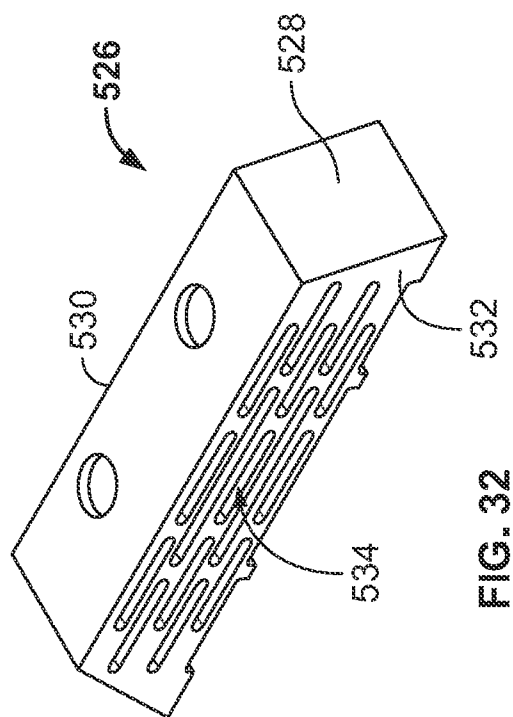


FIG. 30

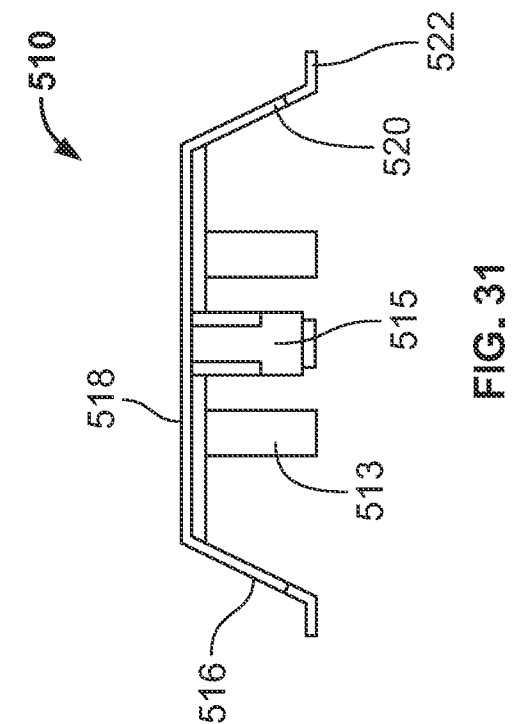


FIG. 31

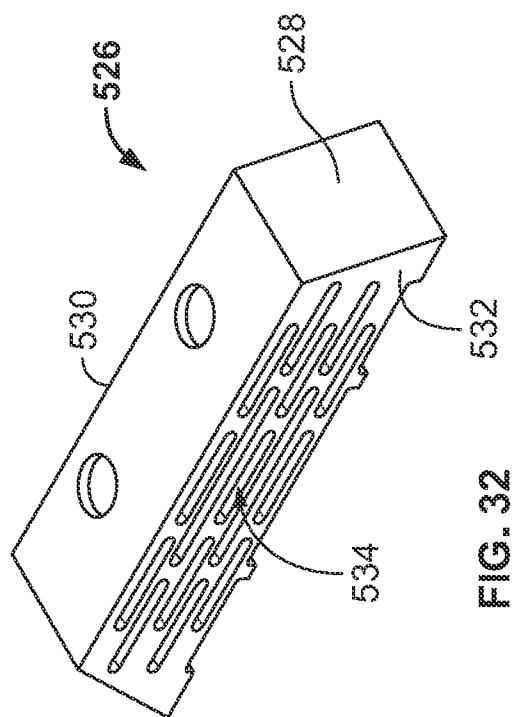


FIG. 32

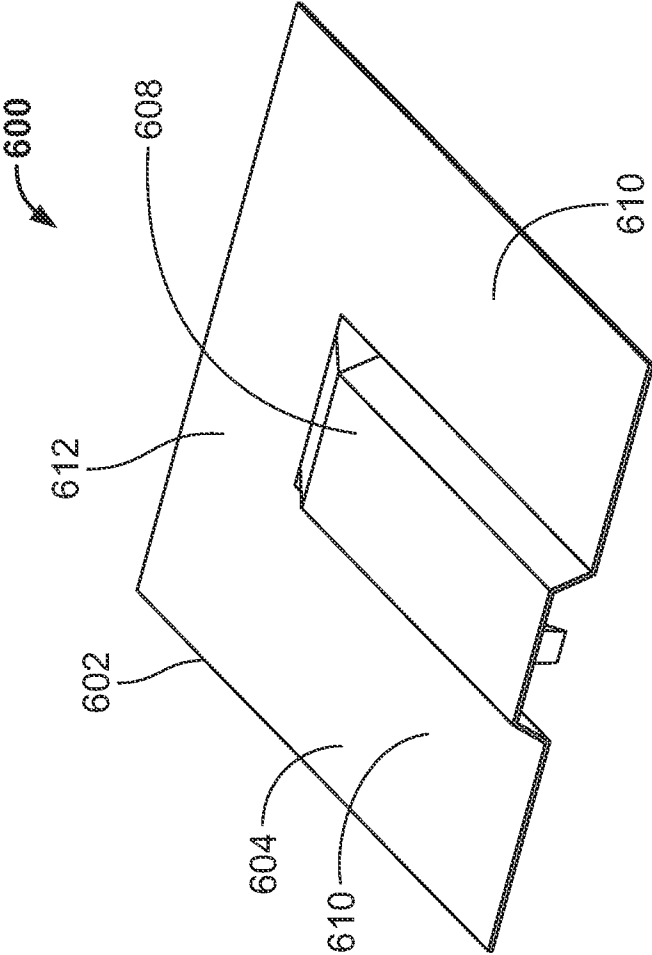


FIG. 33

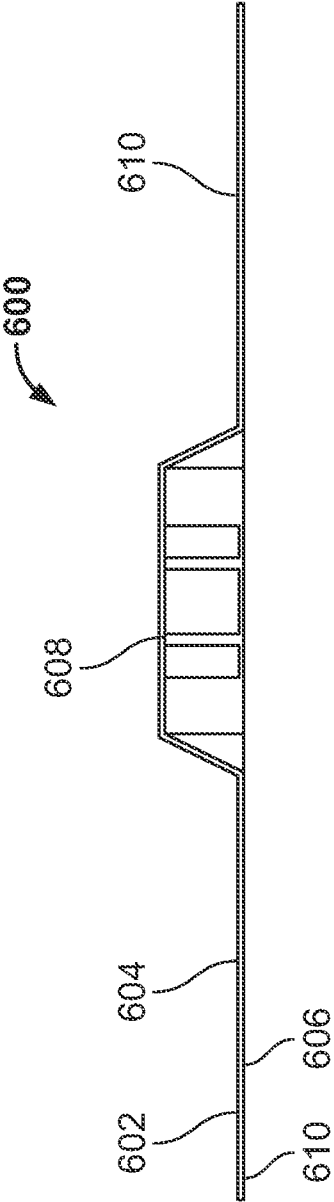


FIG. 34

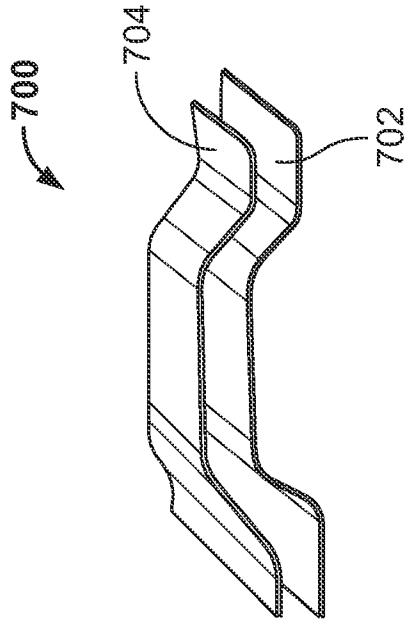


FIG. 35B

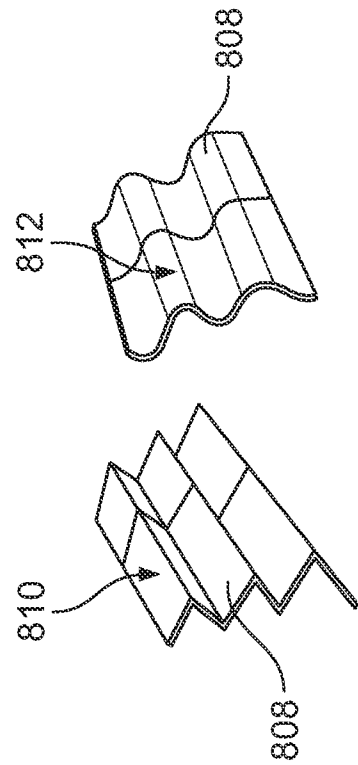


FIG. 36B

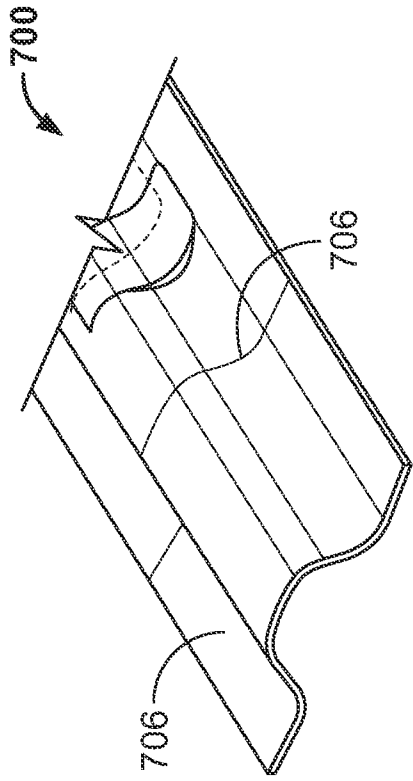


FIG. 35A

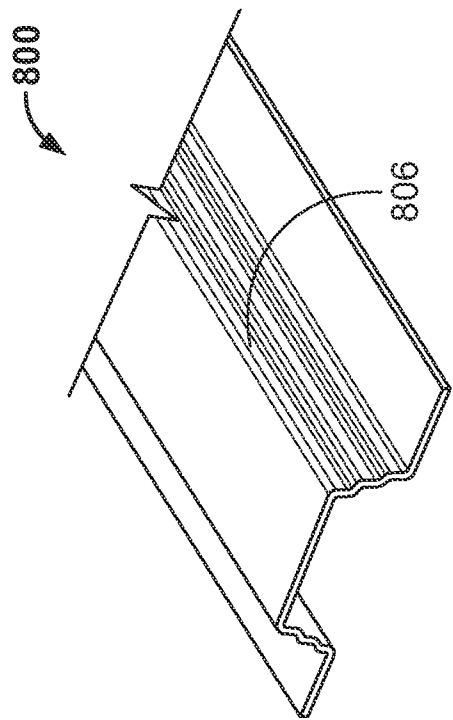
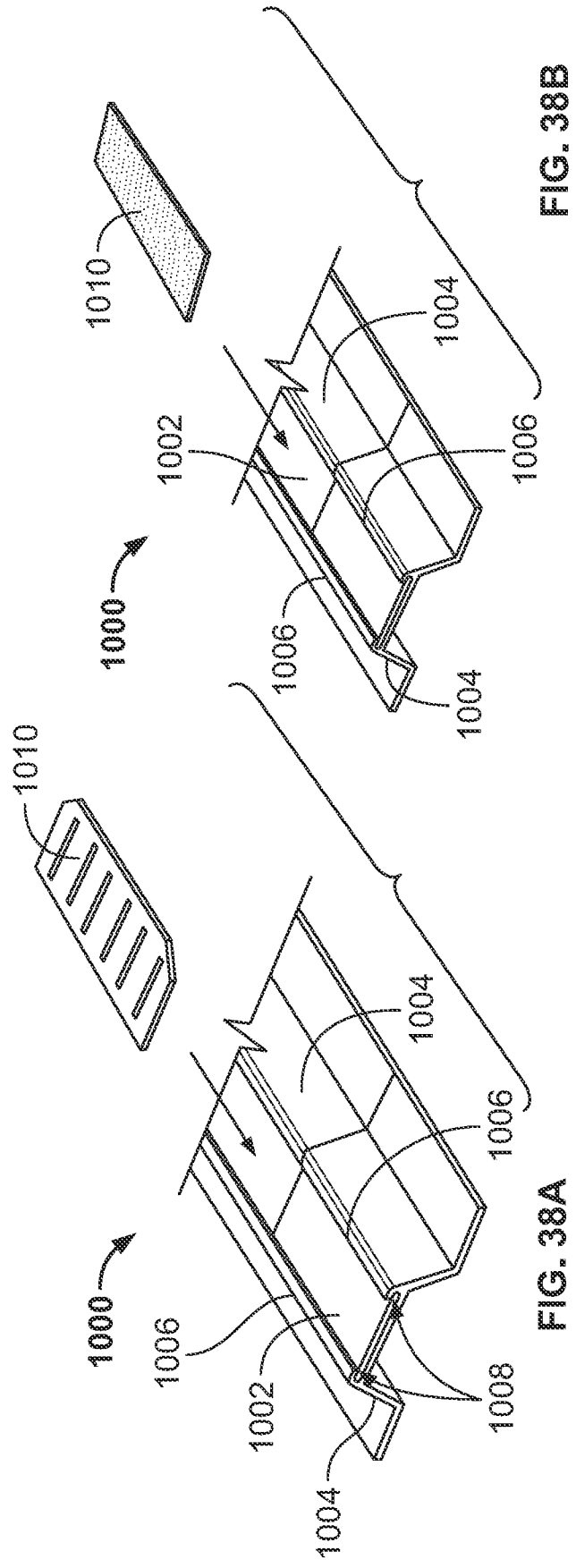
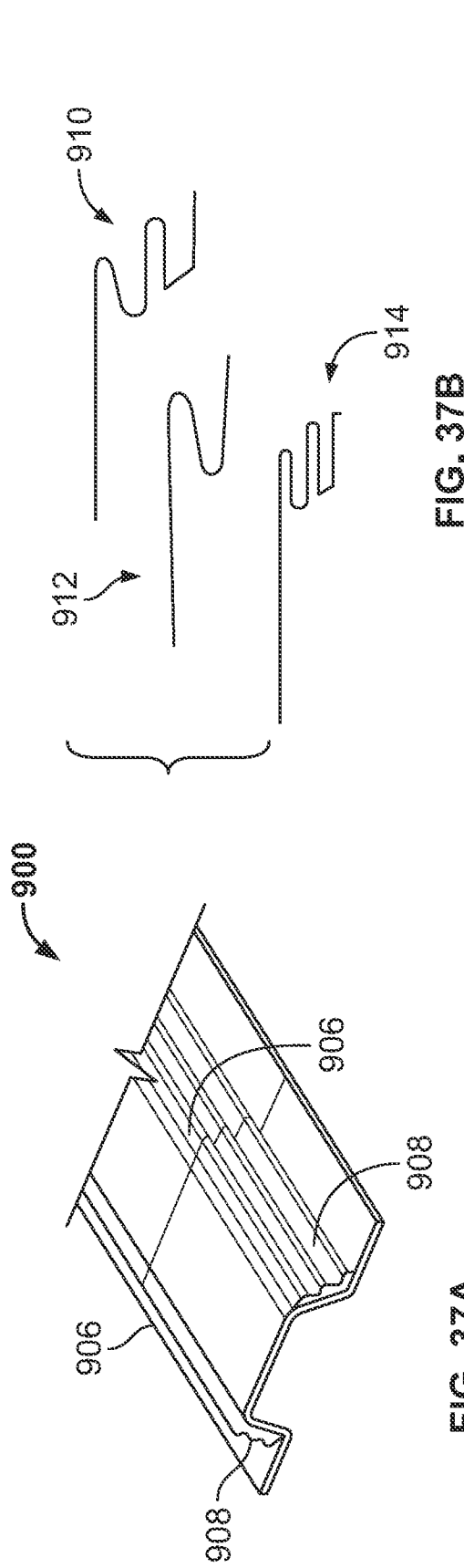


FIG. 36A



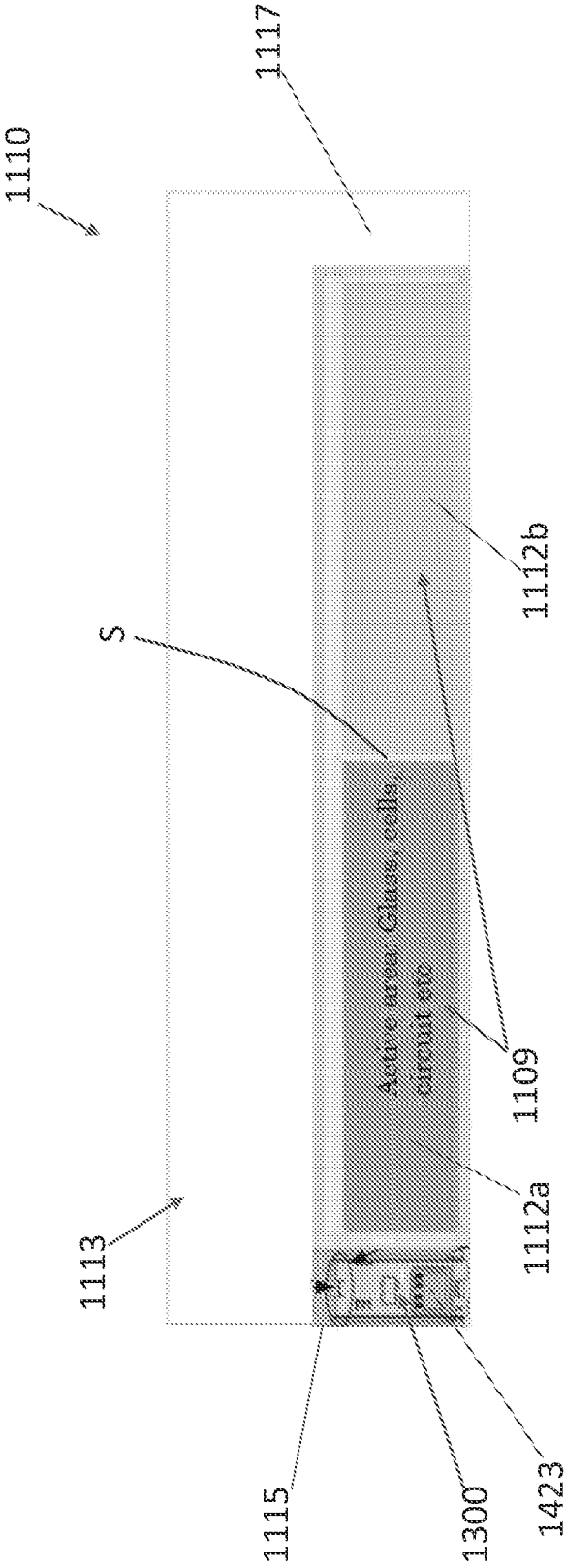


FIG. 39A

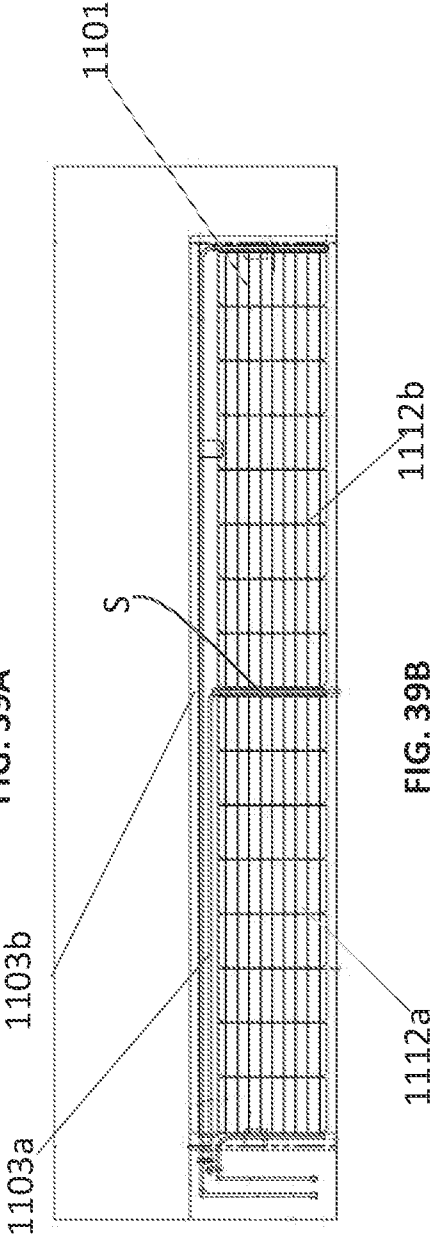


FIG. 39B

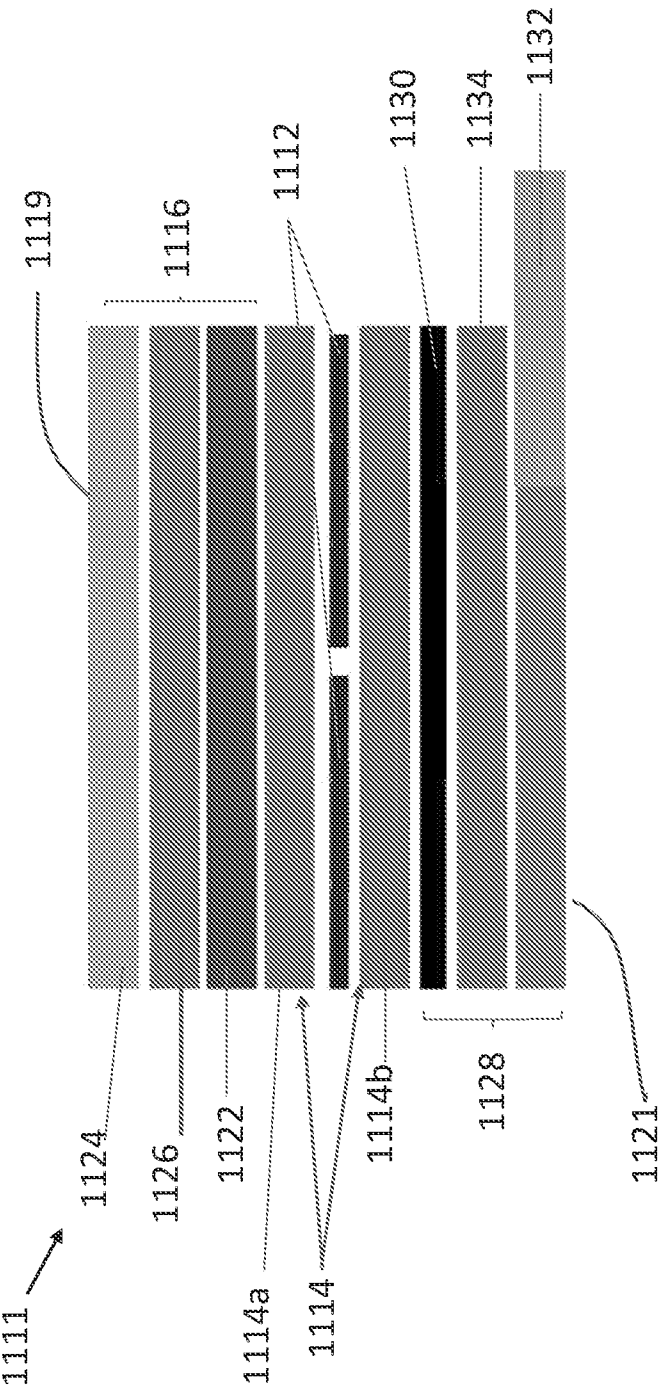


FIG. 40

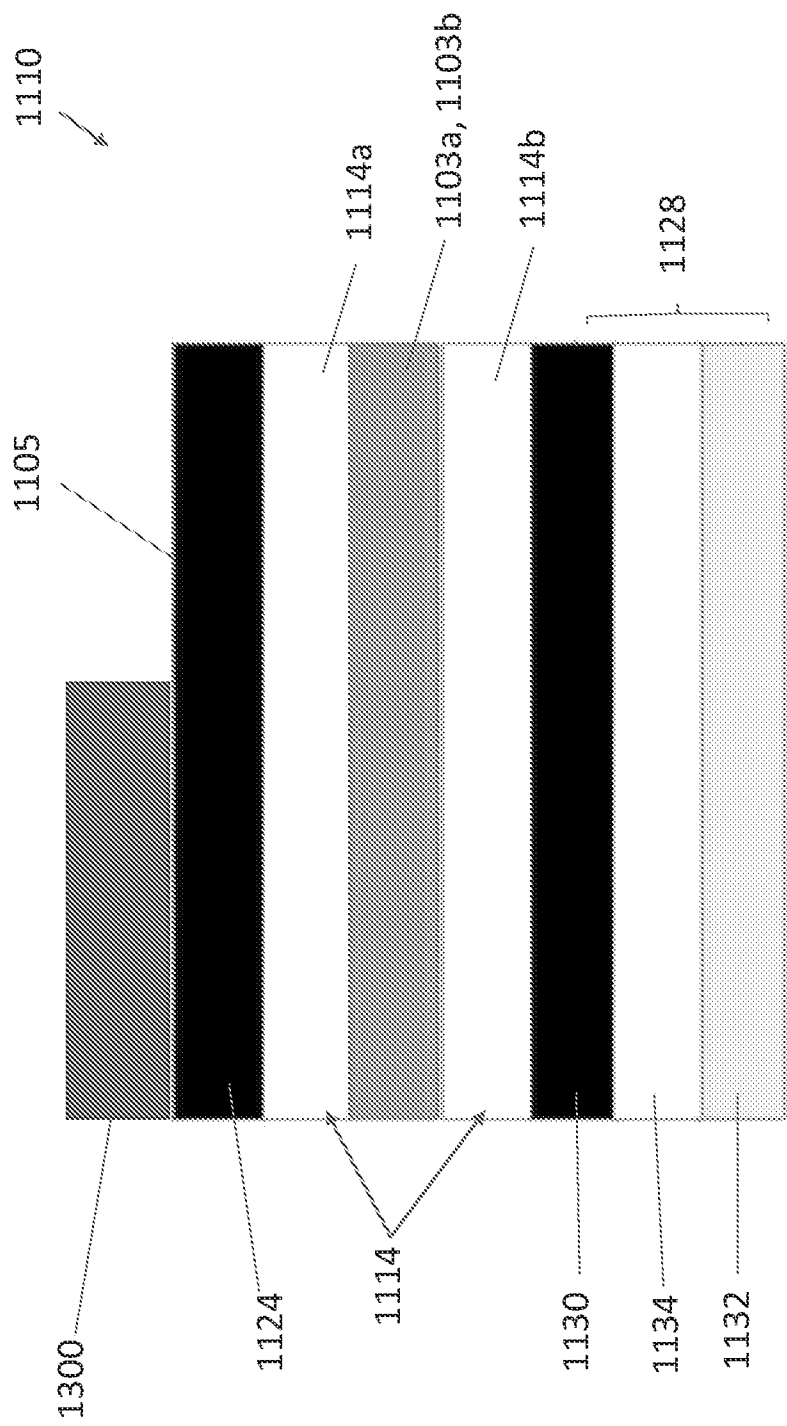


FIG. 41

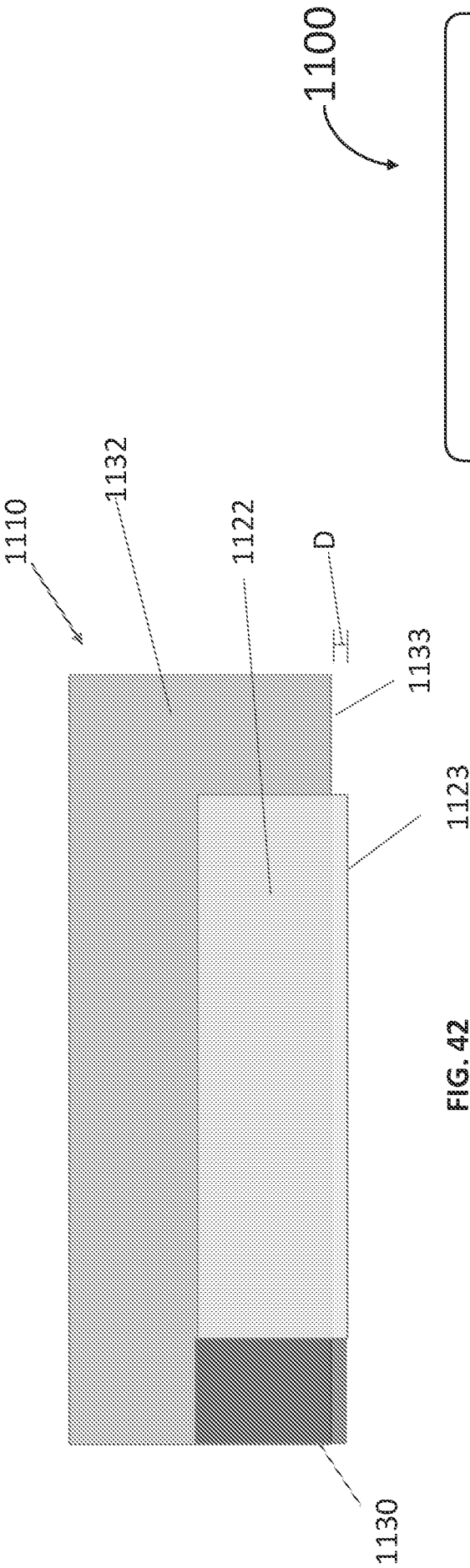


FIG. 42

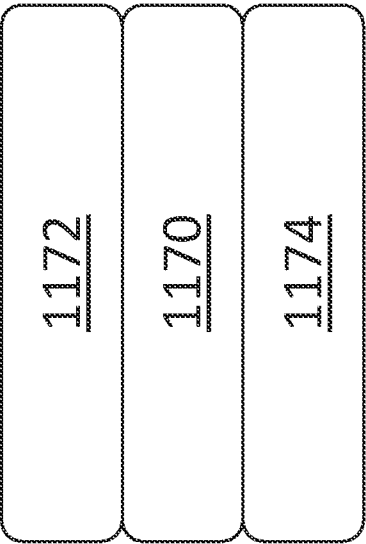
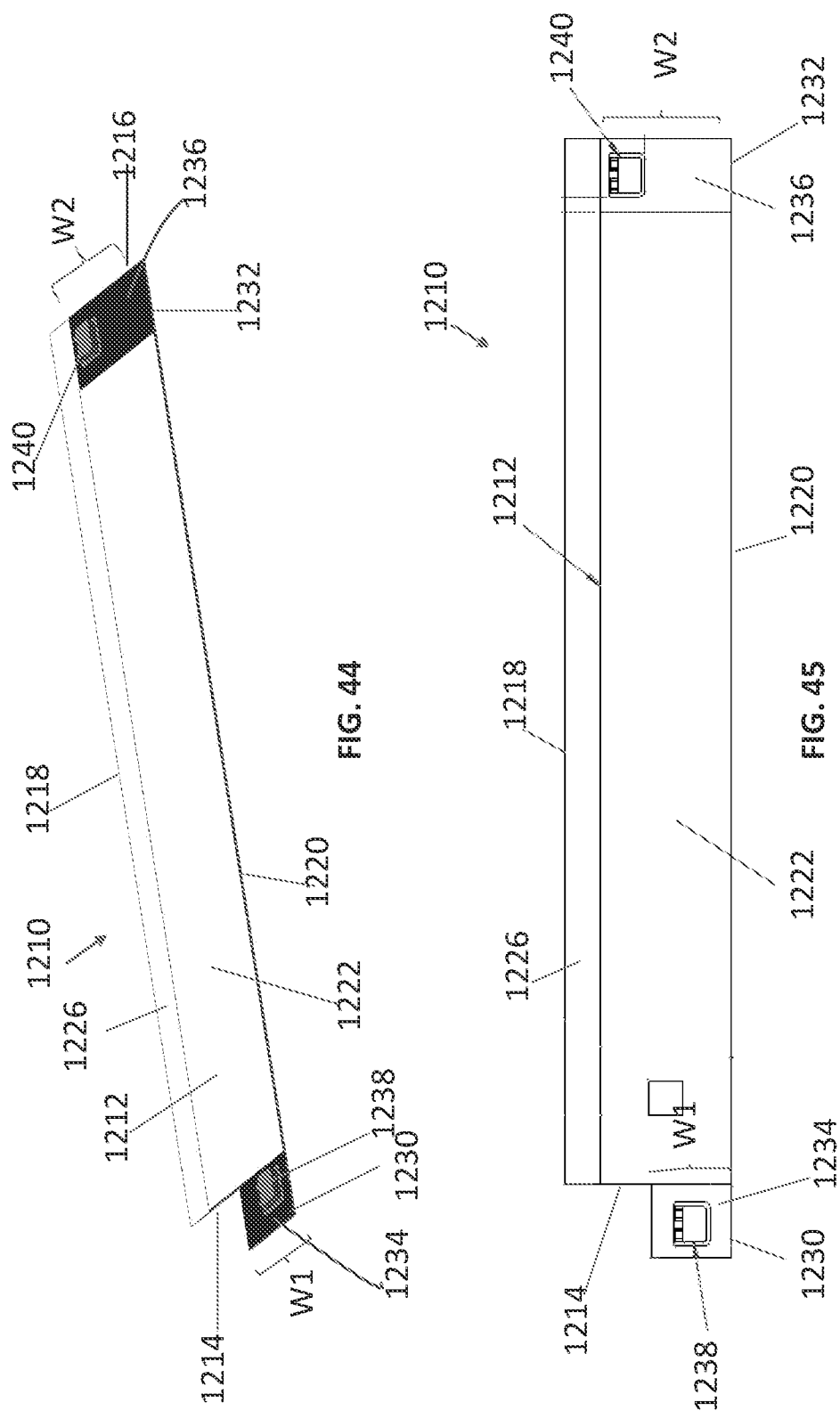
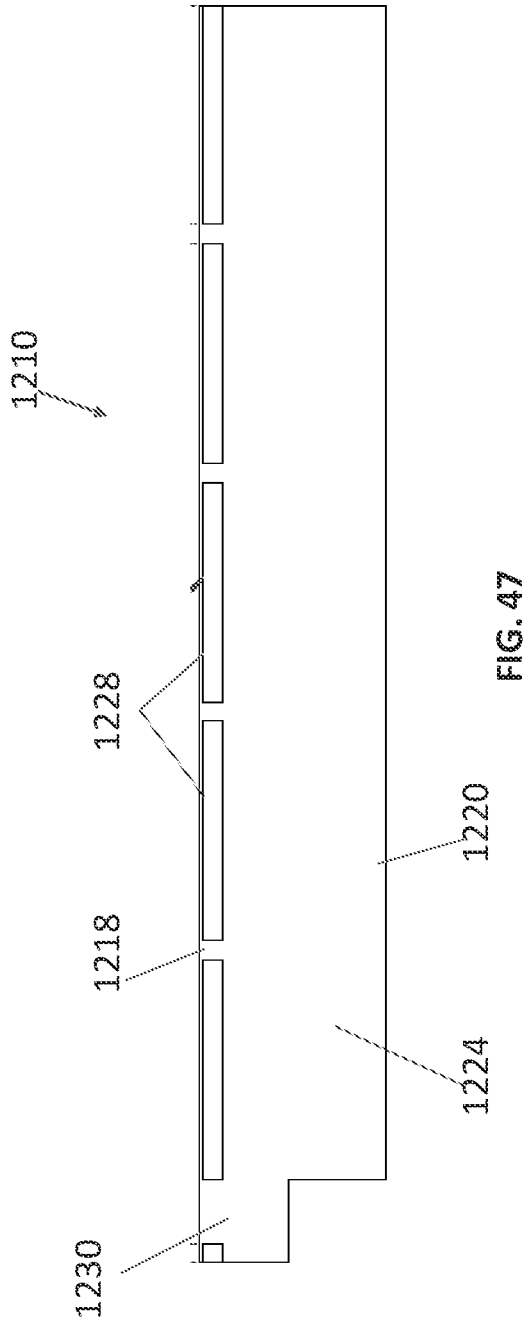
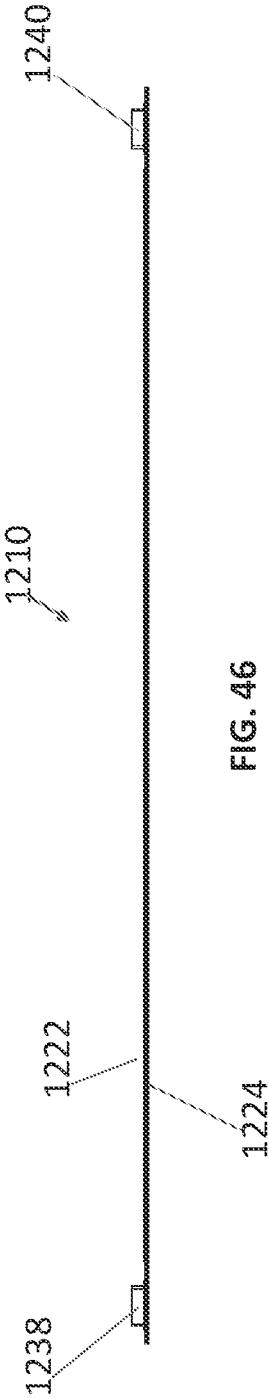
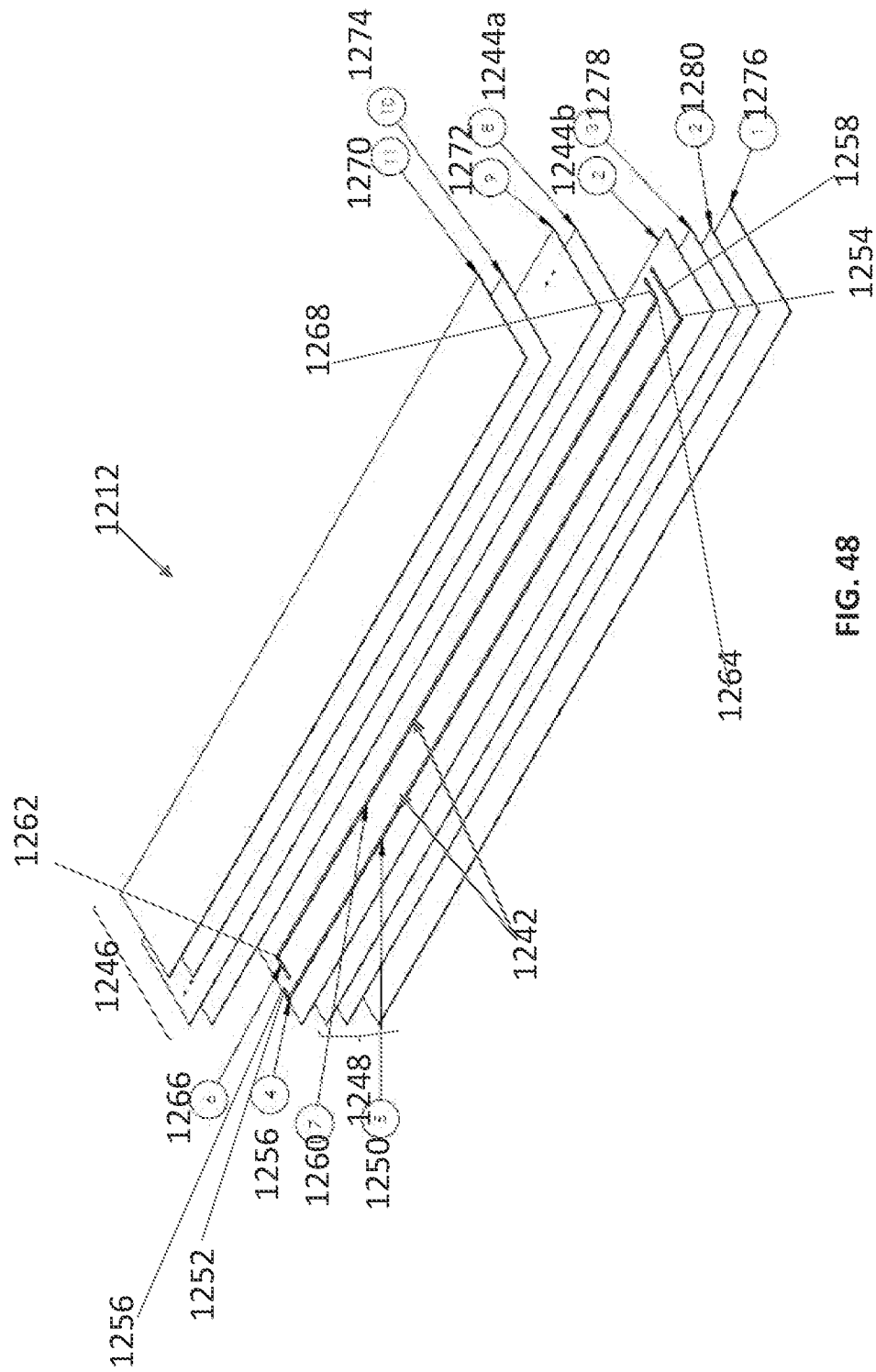


FIG. 43







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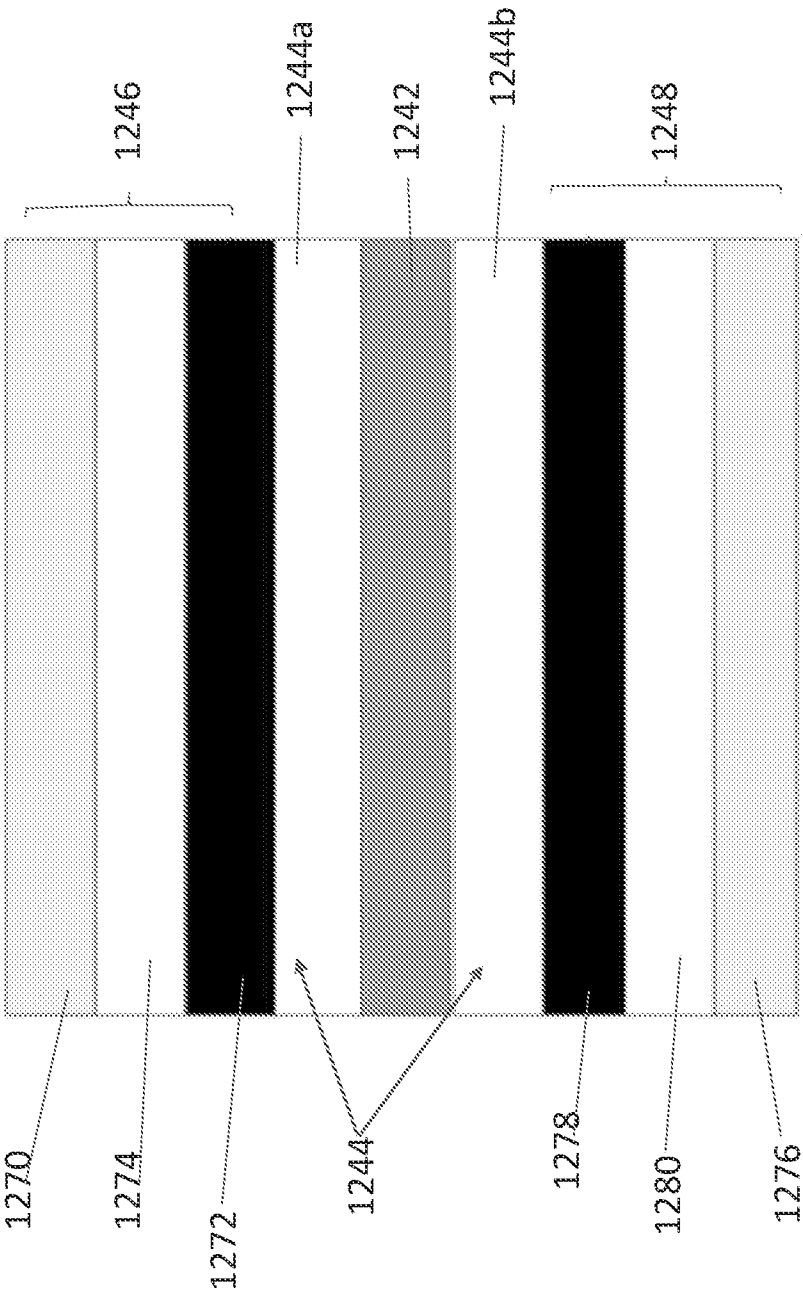


FIG. 49

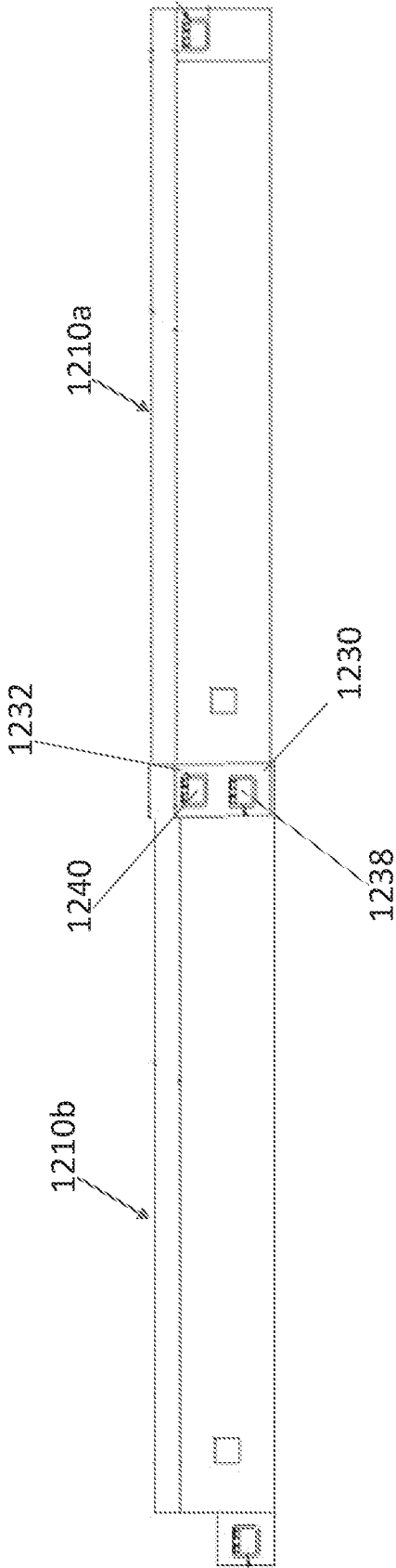
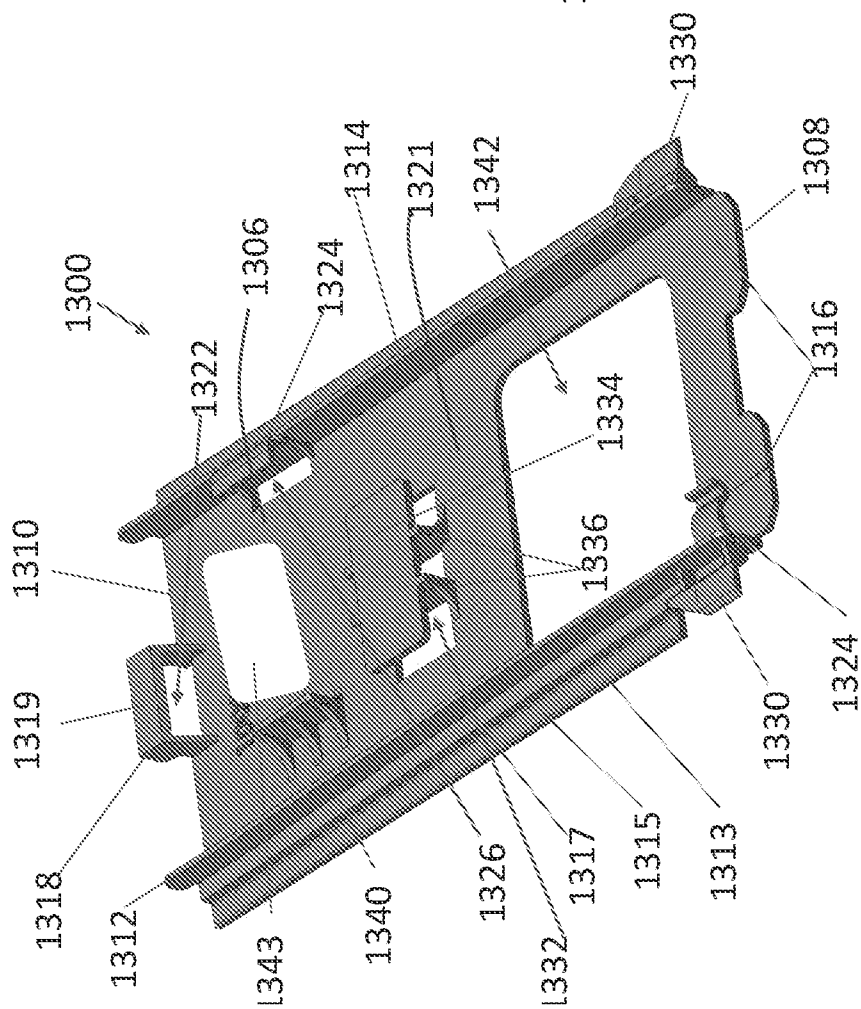
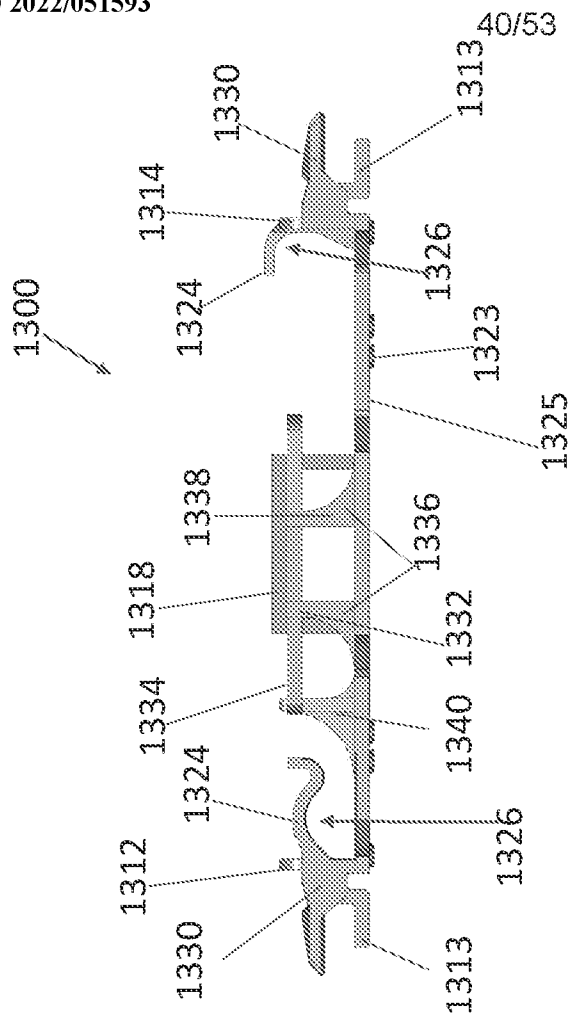


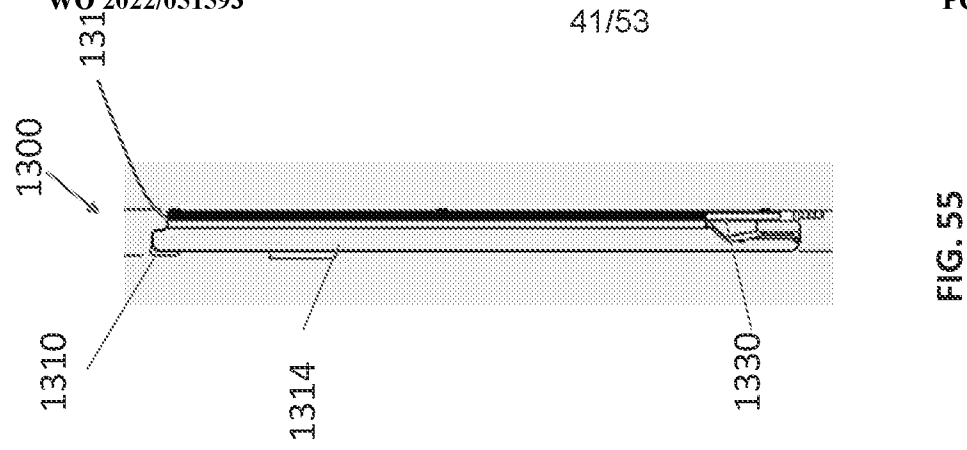
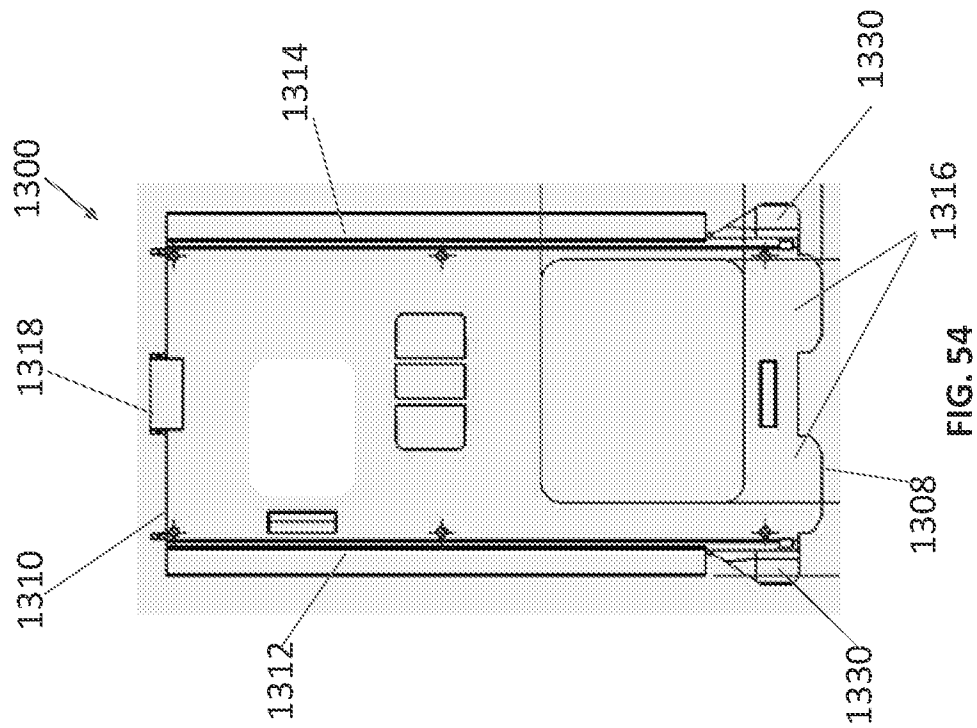
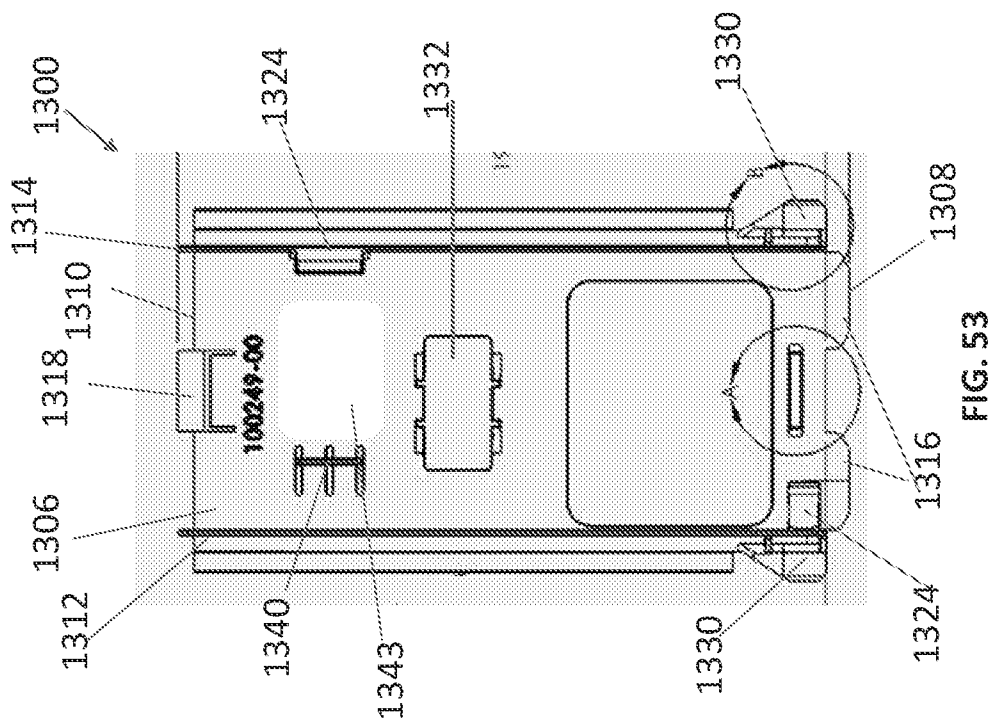
FIG. 50

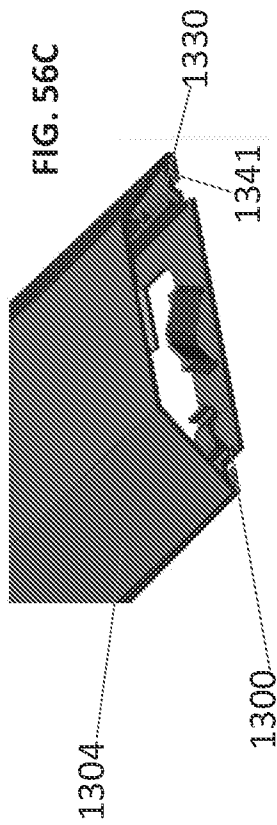
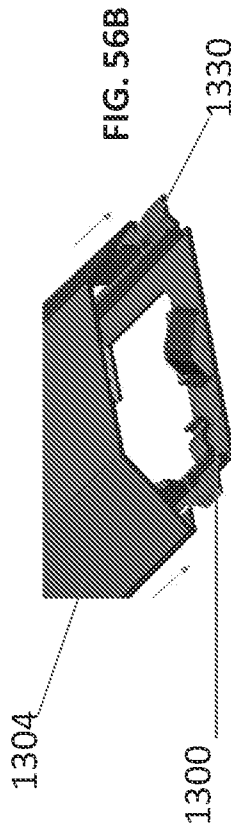
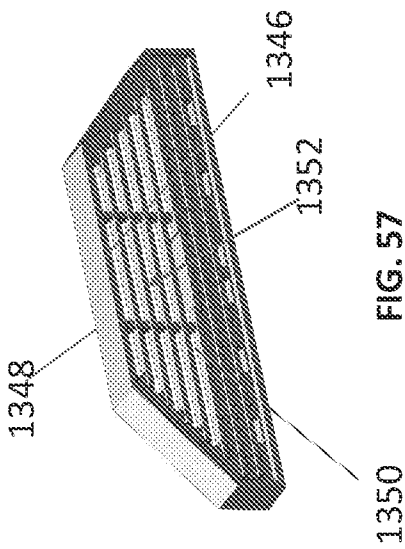
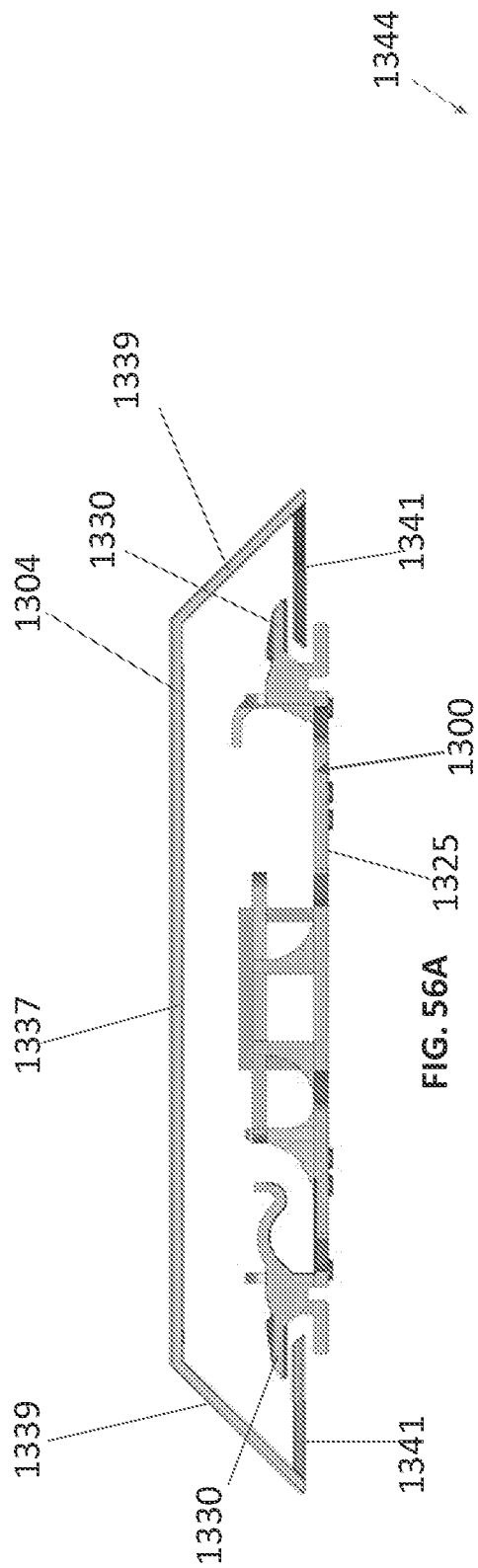


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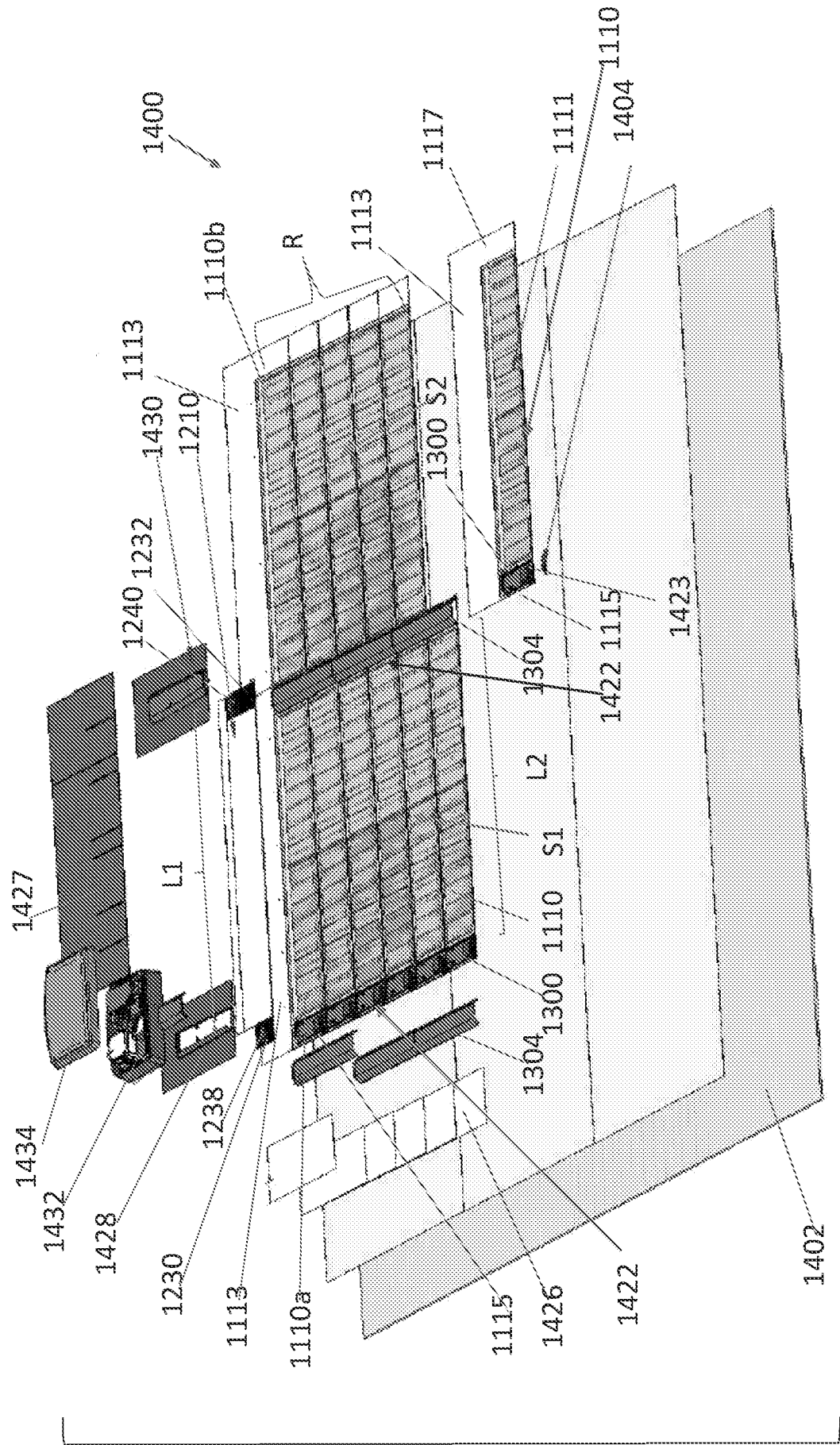


FIG. 58

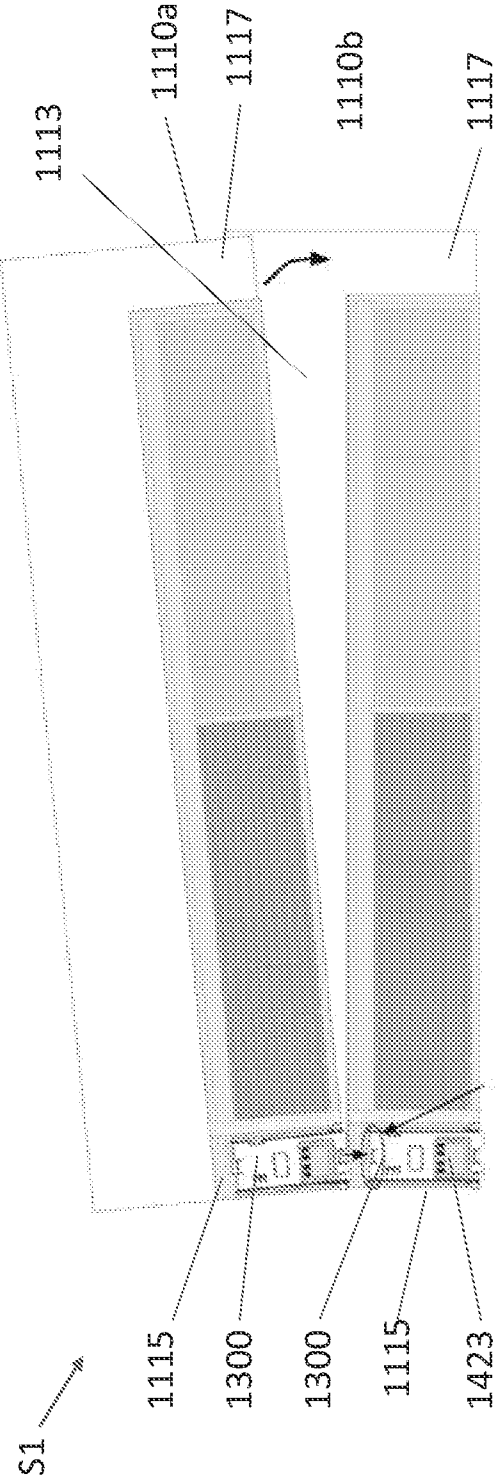


FIG. 59A

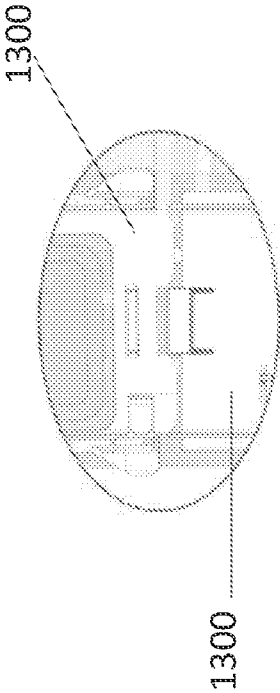


FIG. 59B

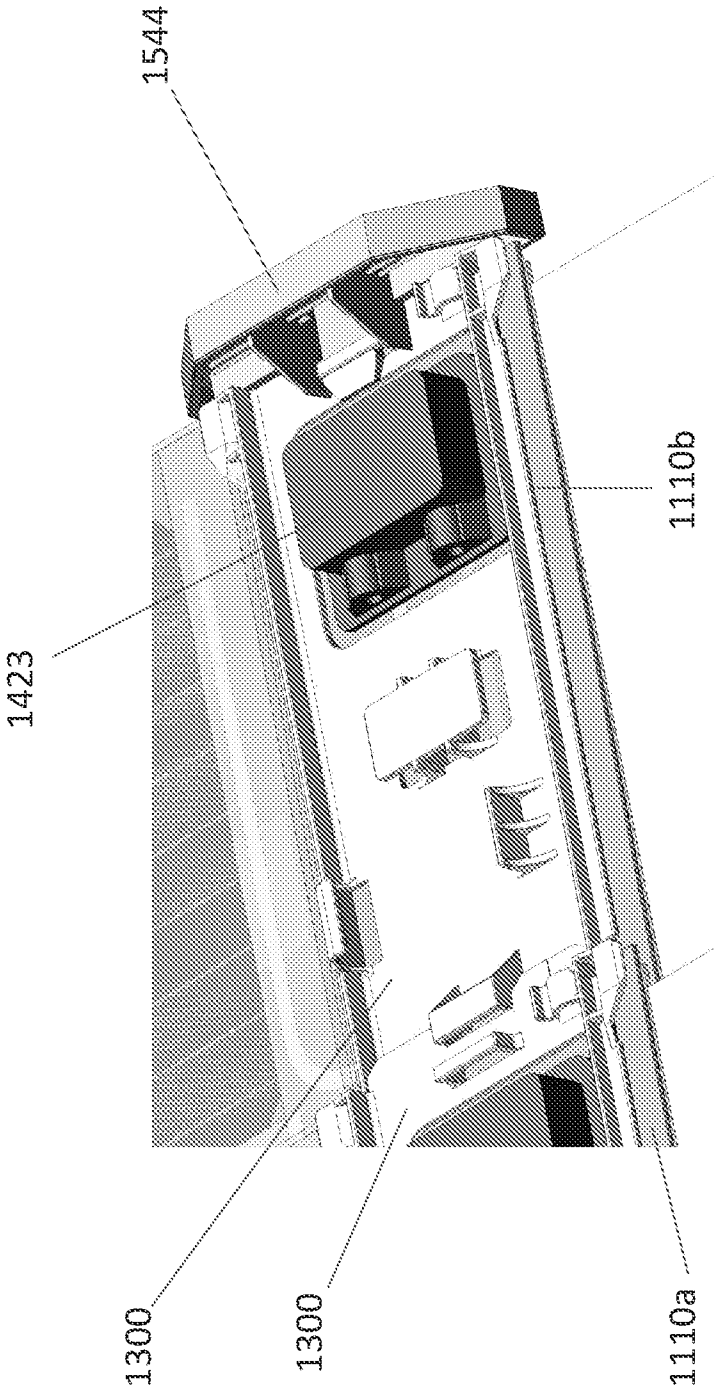
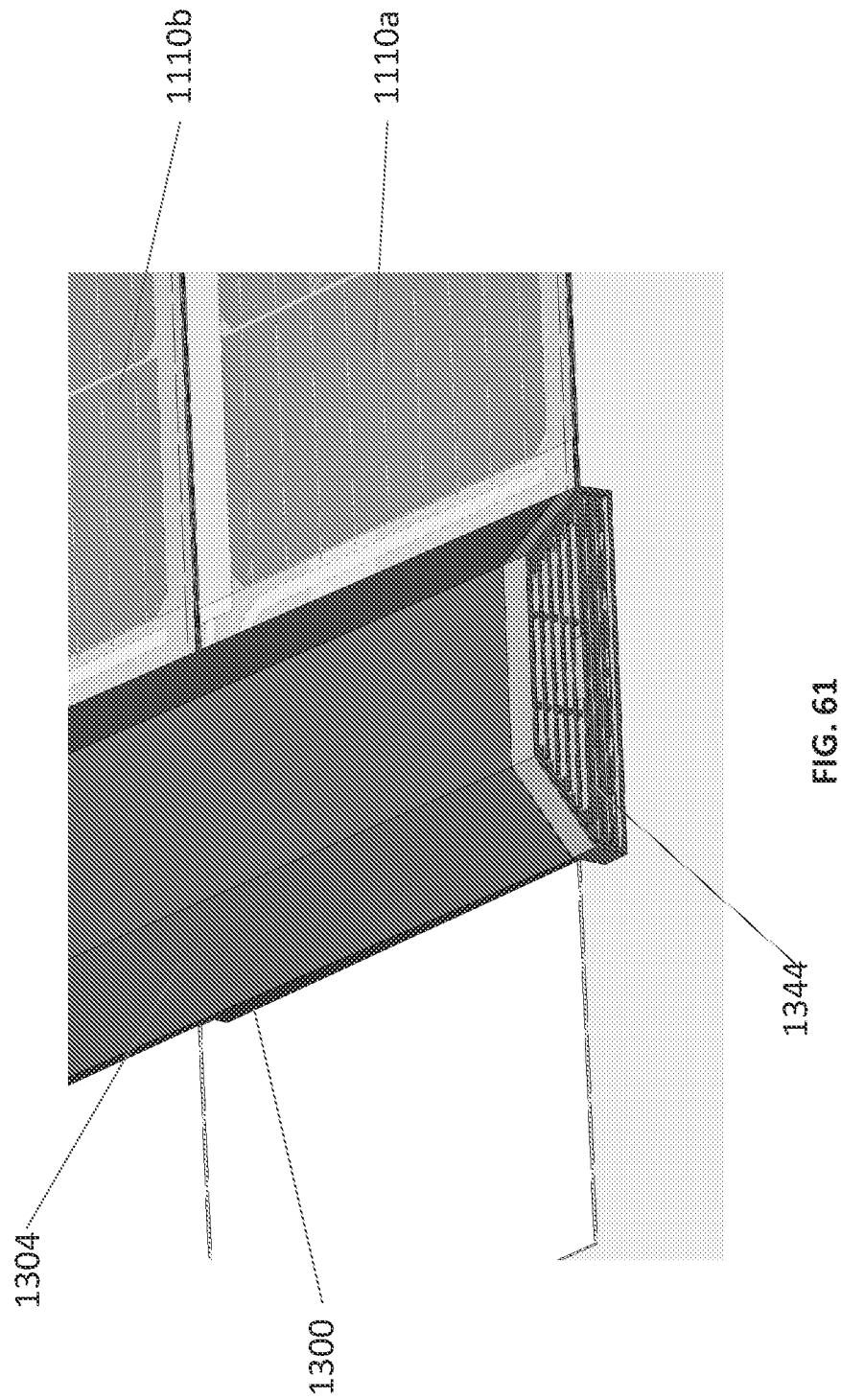


FIG. 60



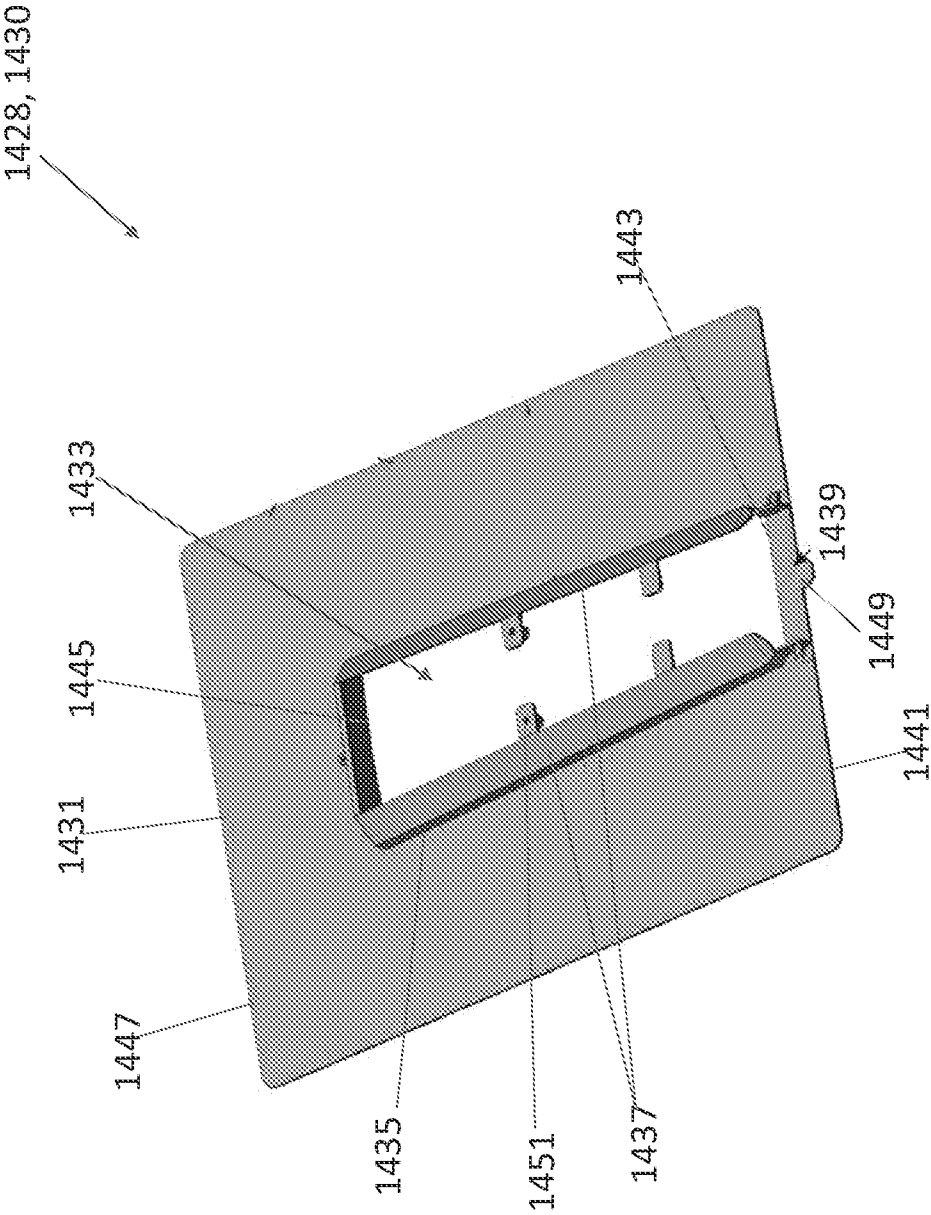
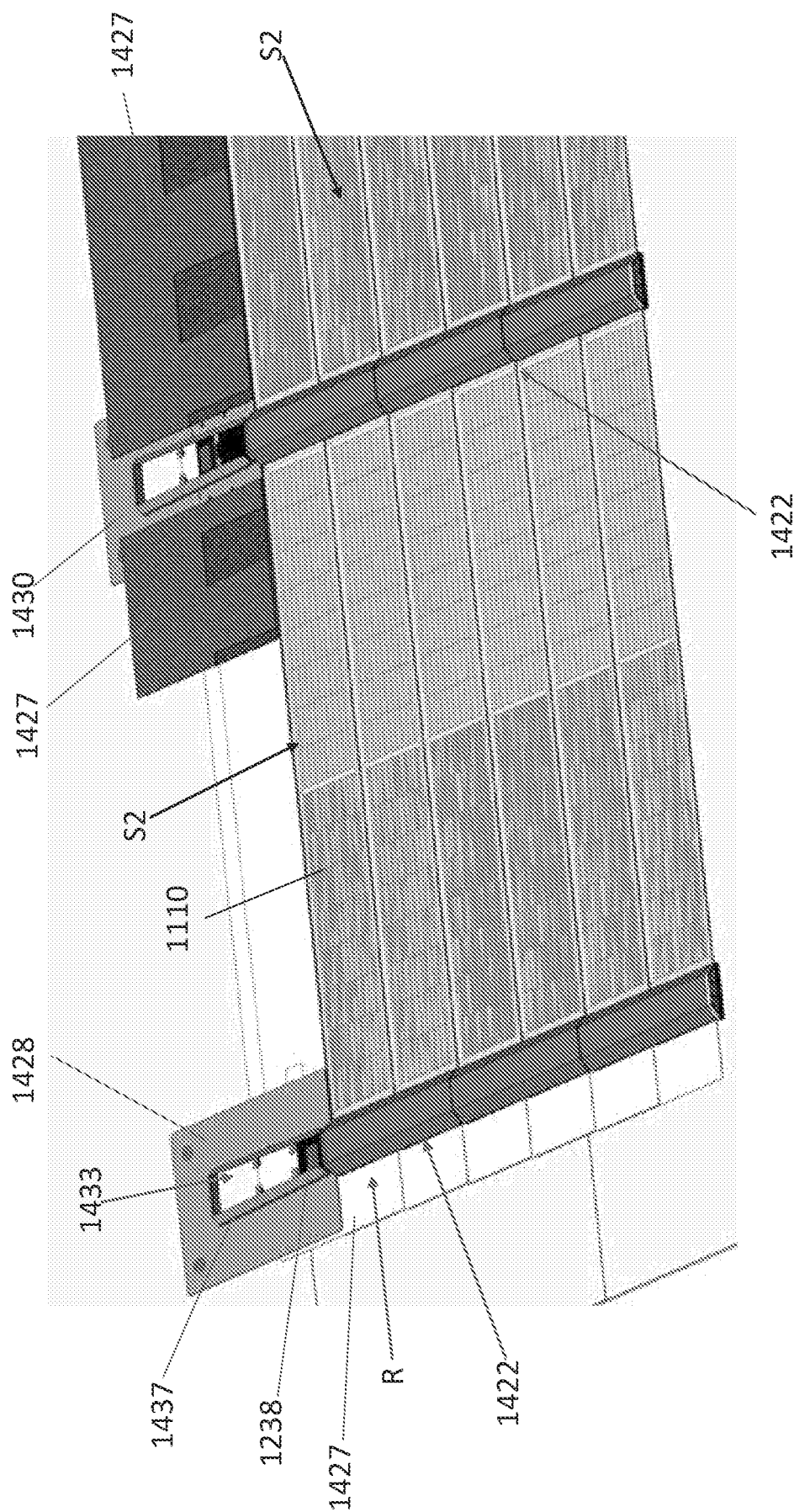


FIG. 62



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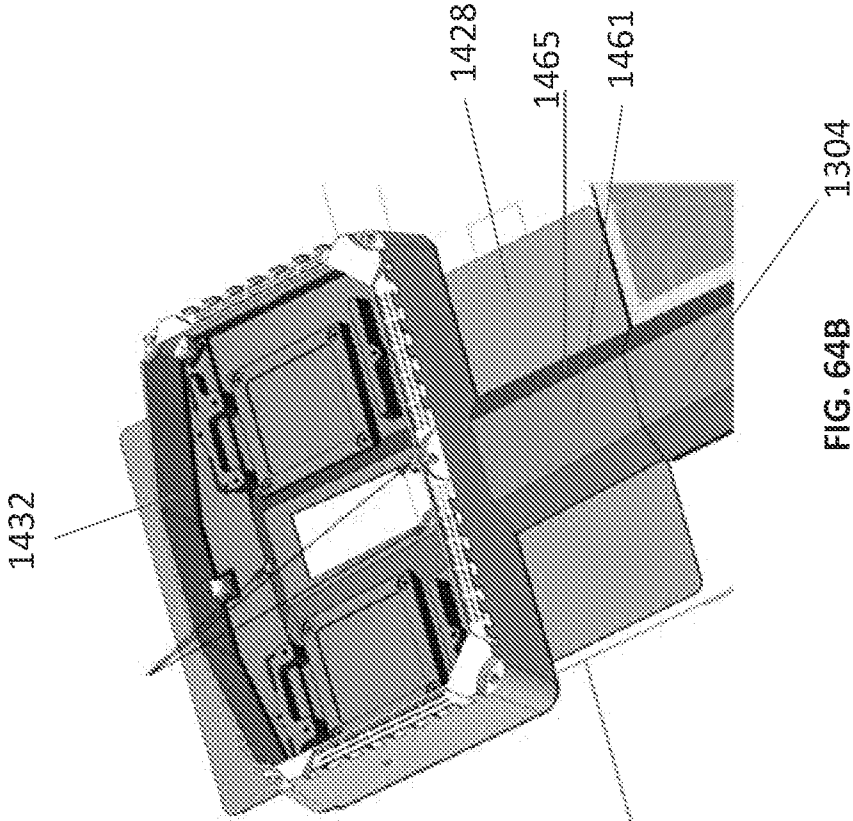


FIG. 64B

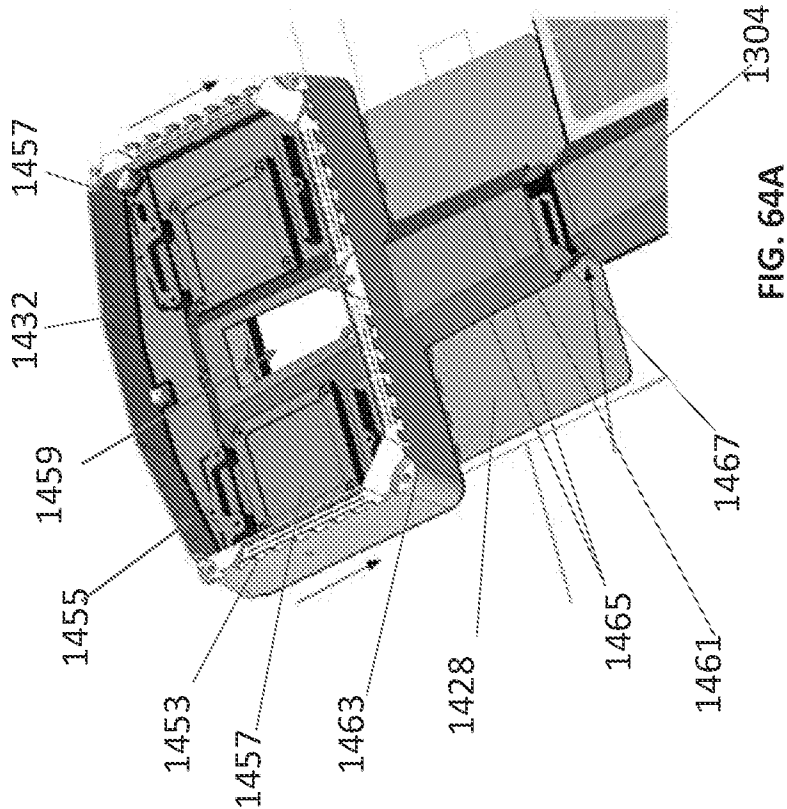
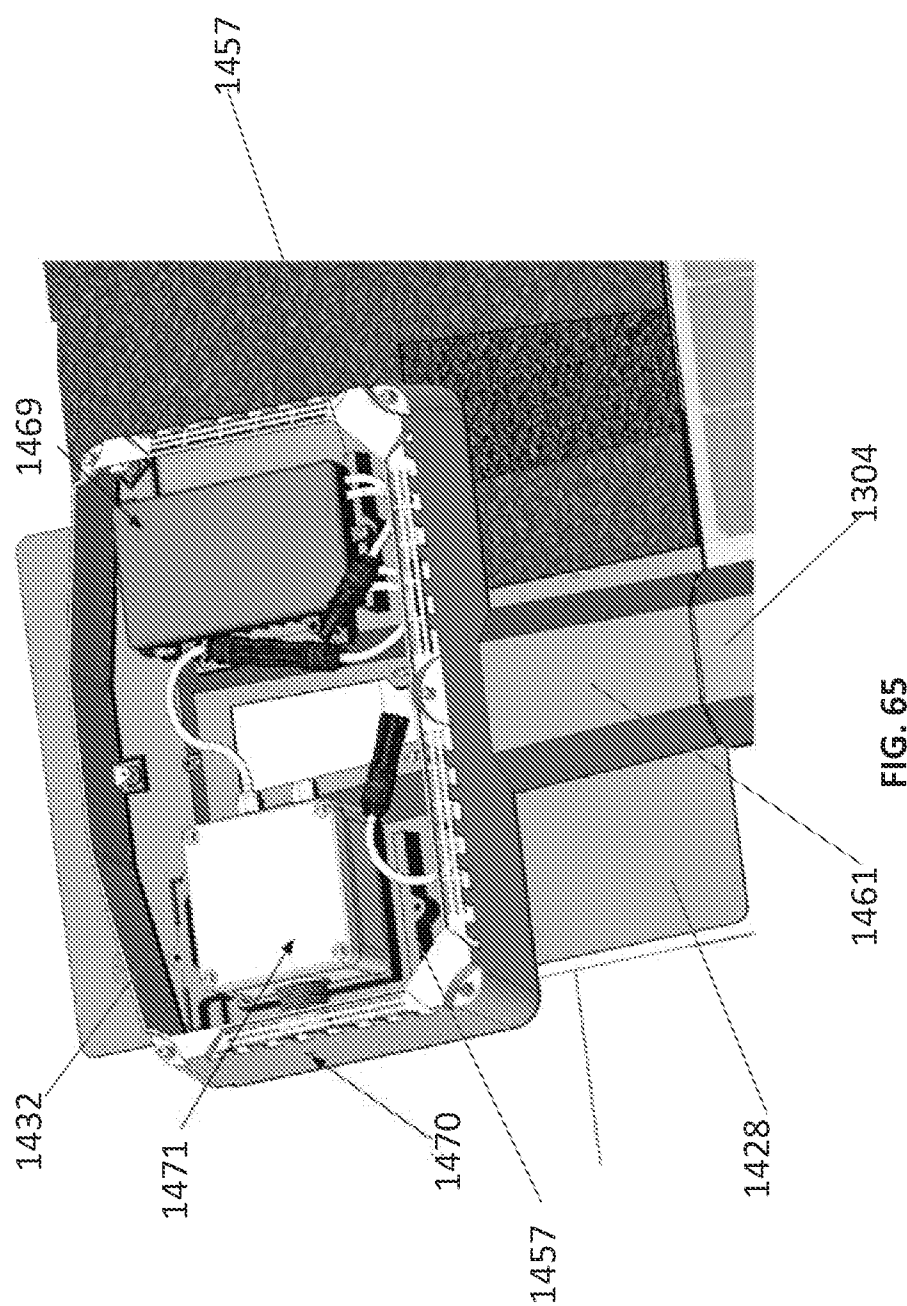
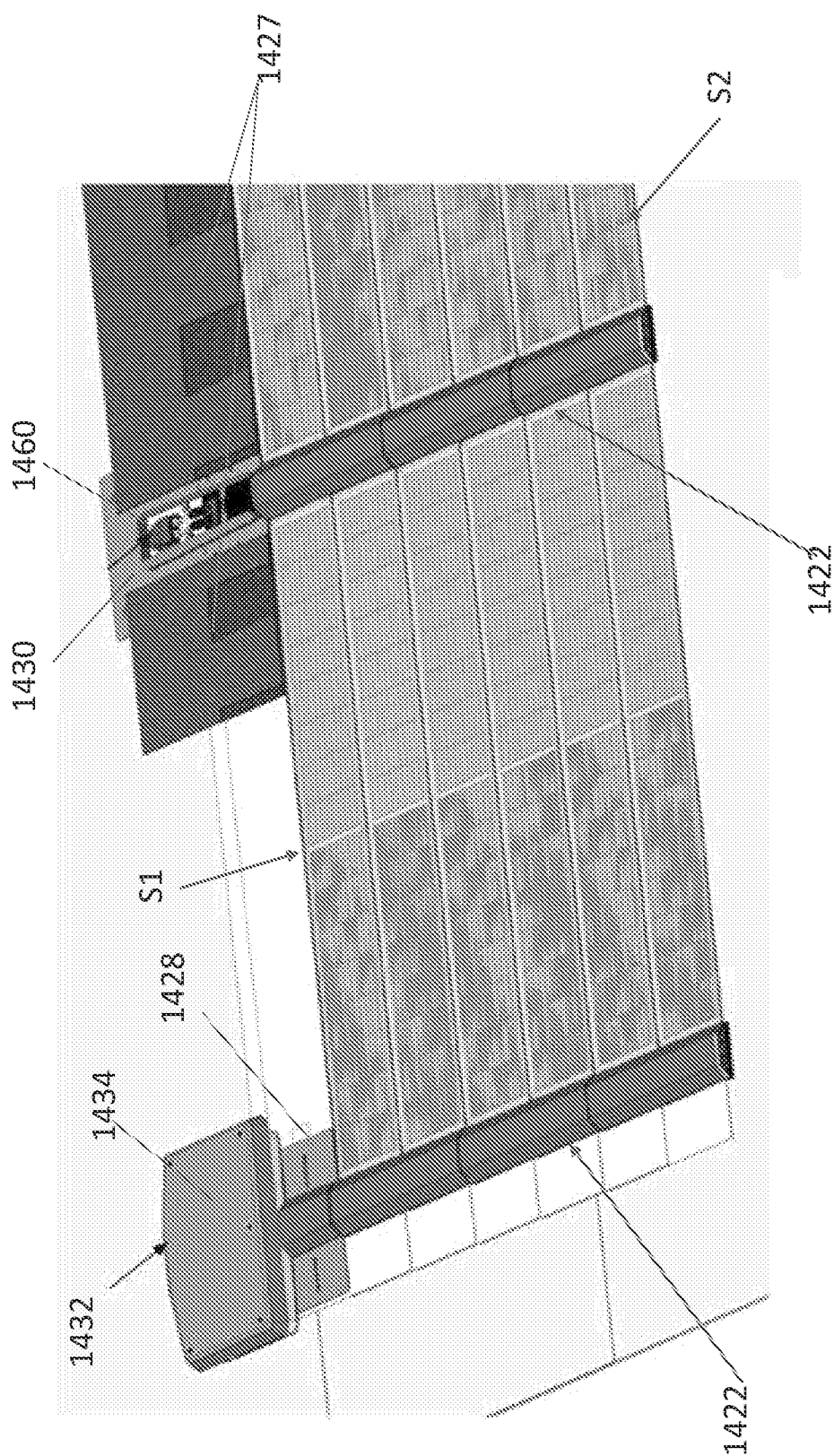


FIG. 64A



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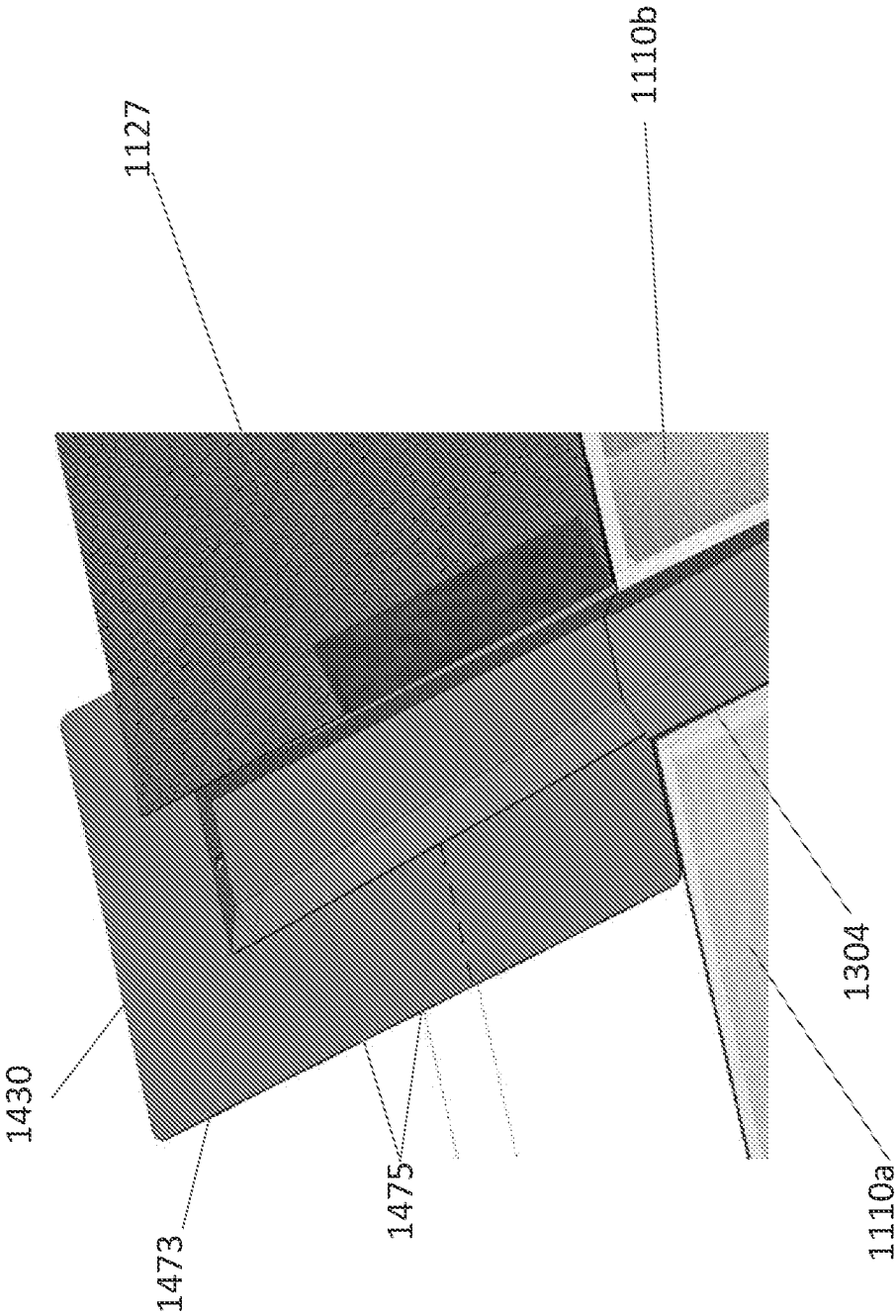


FIG. 67

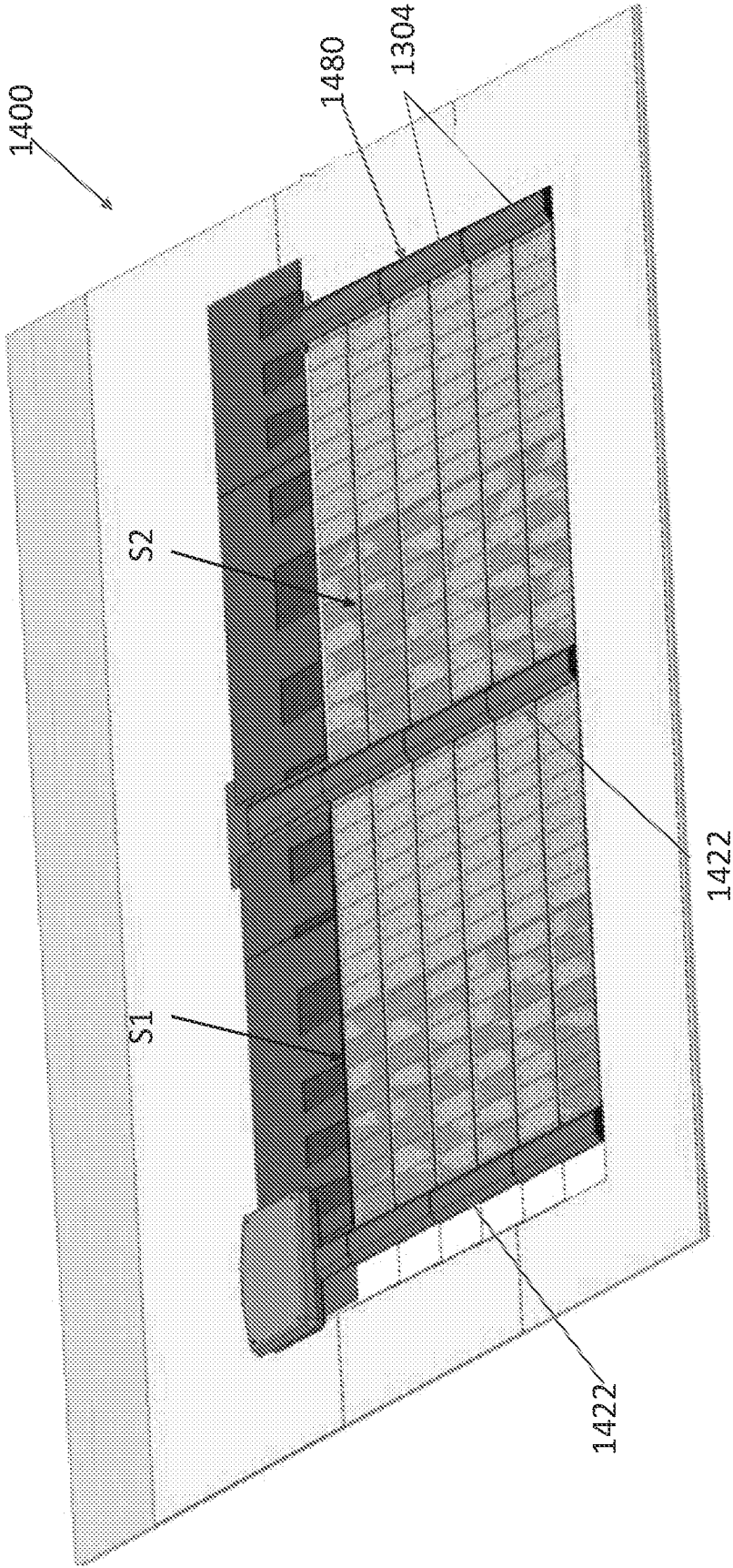


FIG. 68

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2021/049017

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - H01L 31/048; H01L 31/02; H01L 31/042; H01L 31/049; H02S 20/23; H02S 20/25 (2021.01)

CPC - H01L 31/048; H01L 31/049; H02S 20/23; H02S 20/25 (2021.08)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

see Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

see Search History document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

see Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2014/0060609 A1 (KUMAR et al) 06 March 2014 (06.03.2014) entire document	1-62
A	US 2018/0331652 A1 (SUNPOWER CORPORATION) 15 November 2018 (15.11.2018) entire document	1-62
A	US 2012/0080078 A1 (FARRELLY et al) 05 April 2012 (05.04.2012) entire document	1-62
A	US 2008/0289682 A1 (ADRIANI et al) 27 November 2008 (27.11.2008) entire document	1-62
A	SCHINAGL. Flexible encapsulation with backsheets and frontsheets for PV applications. 26.09.2012 (26.09.2012). [retrieved on 04.11.2021]. Retrieved from the Internet: <URL: https://pdfs.semanticscholar.org/945b/0b4b5b122c81dc2d65a289cdce448a901669.pdf > entire document	1-62
A	US 2015/0207458 A1 (MONARCH POWER CORP) 23 July 2015 (23.07.2015) entire document	1-62
A	US 2017/0237390 A1 (SOLARCITY CORPORATION) 17 August 2017 (17.08.2017) entire document	1-62

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

04 November 2021

Date of mailing of the international search report

NOV 30 2021

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