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(54) **MOUNTING APPARATUS FOR PHOTOVOLTAIC MODULES**

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Related U.S. Application Data

(63) Continuation of application No. 18/315,975, filed on May 11, 2023, now Pat. No. 12,255,575, which is a continuation of application No. 17/941,934, filed on Sep. 9, 2022, now Pat. No. 11,689,149, which is a continuation of application No. 17/501,606, filed on Oct. 14, 2021, now Pat. No. 11,444,569.

(60) Provisional application No. 63/091,428, filed on Oct. 14, 2020.

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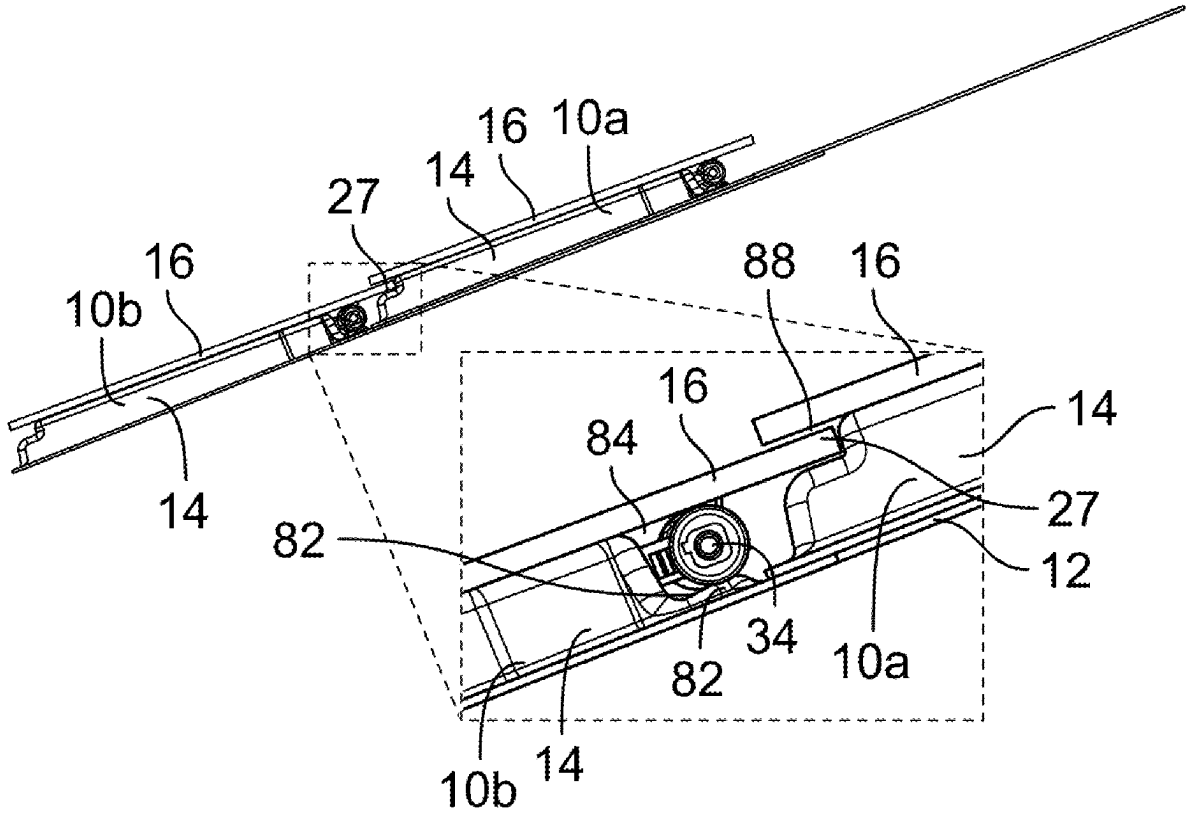
E04D 1/30	(2006.01)
E04D 1/34	(2006.01)
H02S 30/10	(2014.01)

(52) **U.S. Cl.**

CPC ***H02S 20/25*** (2014.12); ***E04D 1/12*** (2013.01); ***E04D 1/265*** (2013.01); ***E04D 1/2918*** (2019.08); ***E04D 1/2956*** (2019.08); ***E04D 1/30*** (2013.01); ***E04D 1/34*** (2013.01); ***H02S 30/10*** (2014.12); *E04D 2001/308* (2013.01); *E04D 2001/3408* (2013.01); *E04D 2001/345* (2013.01); *E04D 2001/3458* (2013.01); *E04D 2001/3494* (2013.01)

(57) **ABSTRACT**

A system includes a plurality of photovoltaic modules, each having a mat with an edge and a spacer with an edge, the edge of the mat being attached to the edge of the spacer. The spacer includes a plurality of support members and a solar module mounted to the support members. Each of the support members includes a ledge. The solar module and the ledge form a space therebetween. The space is sized and shaped to receive an edge of a solar module of another of the photovoltaic modules. The spacer of one of the photovoltaic modules overlays the mat of another of the photovoltaic modules.



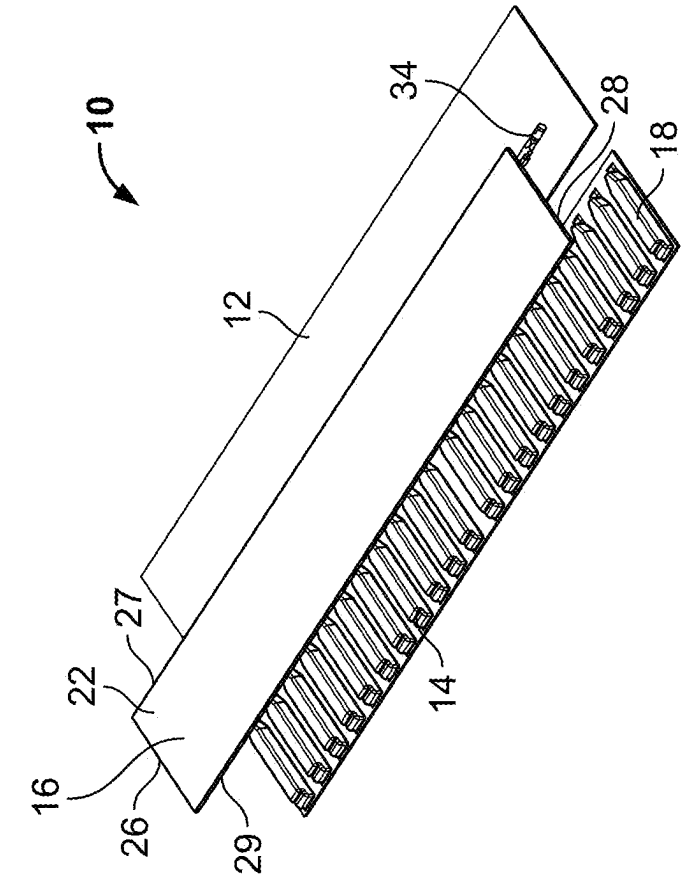


FIG. 2

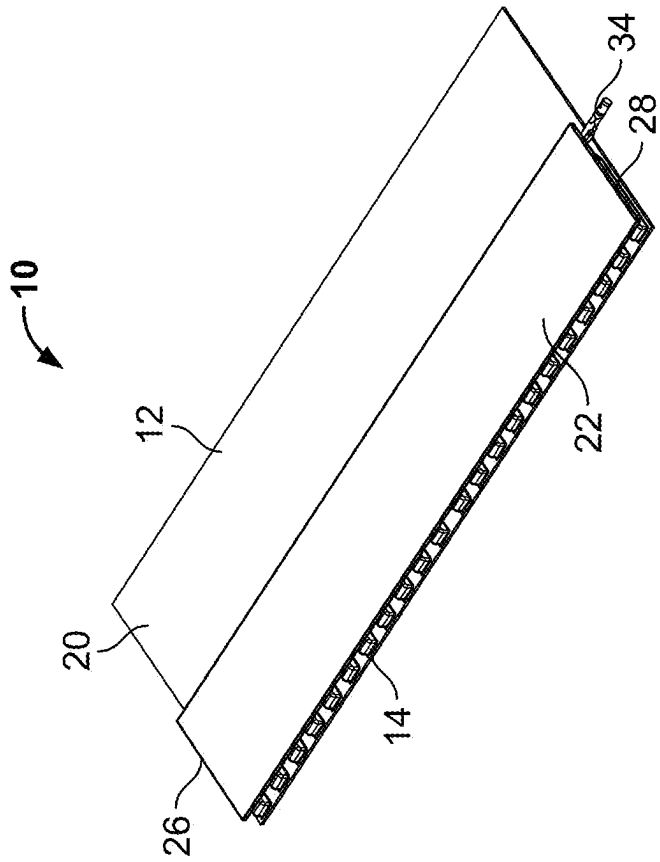


FIG. 1

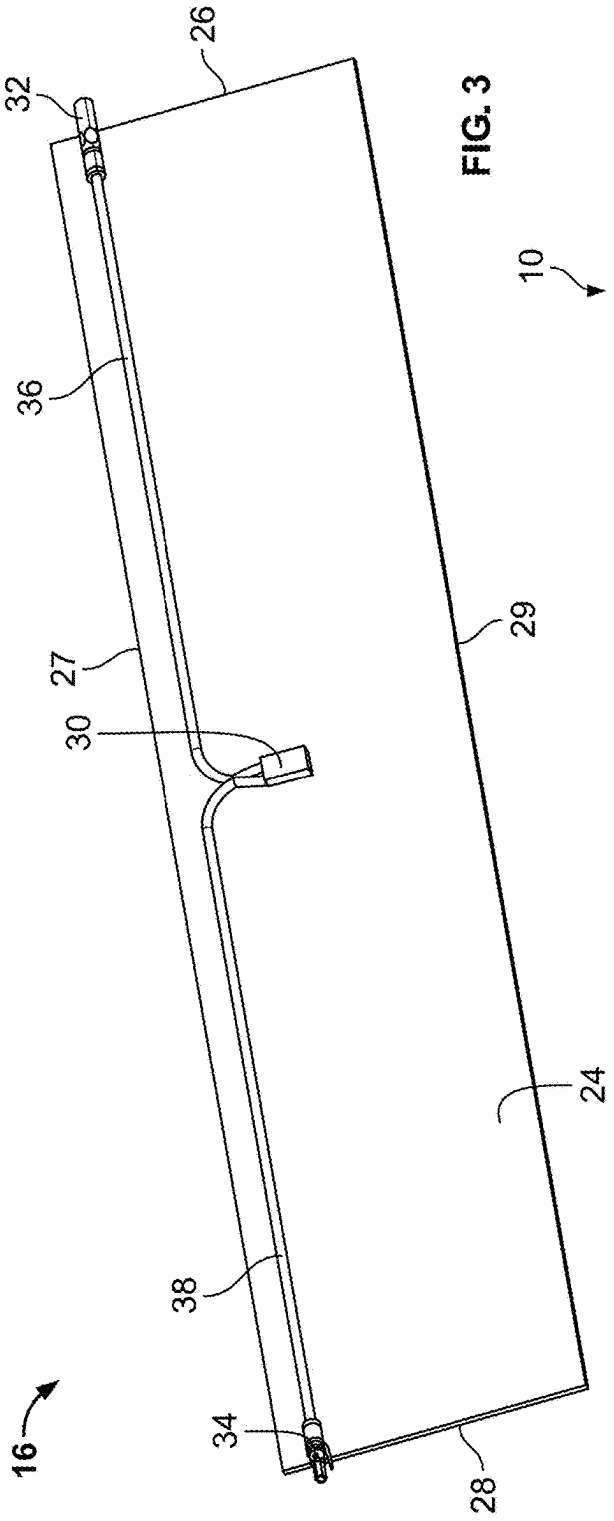


FIG. 3

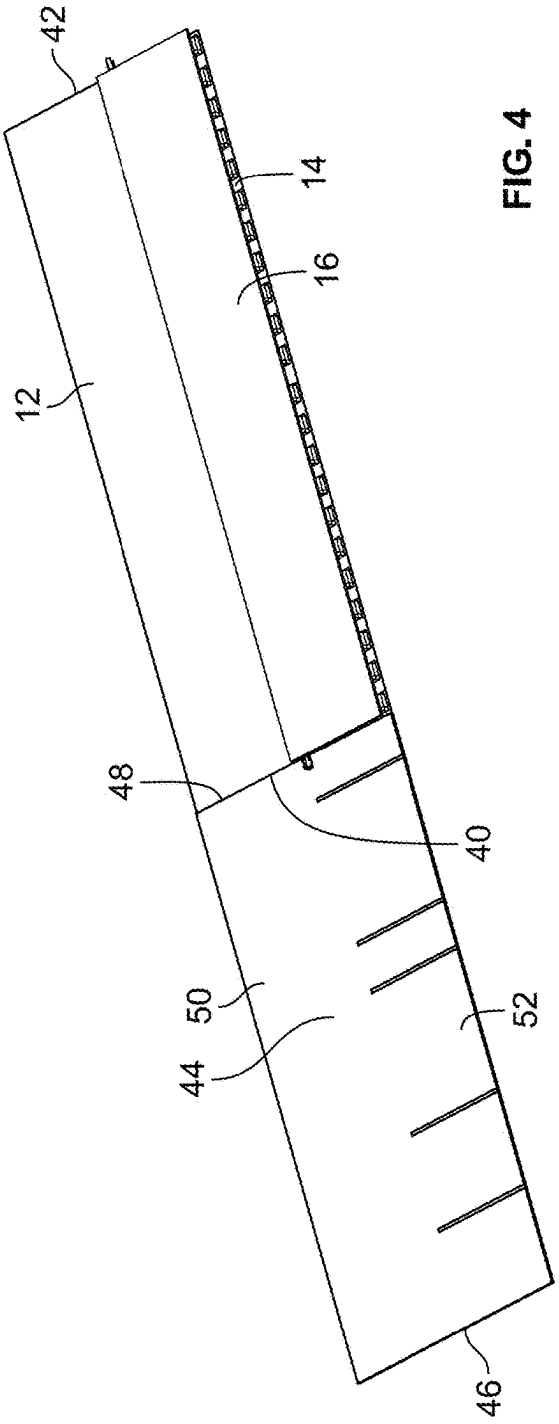


FIG. 4

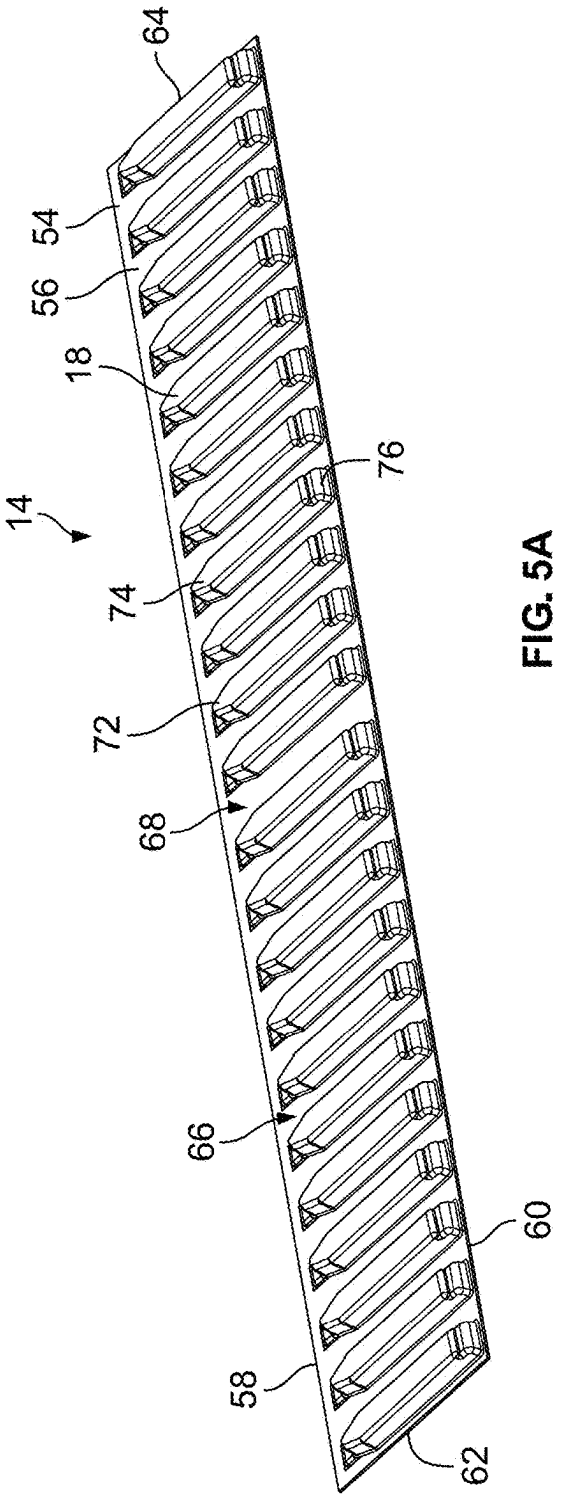


FIG. 5A

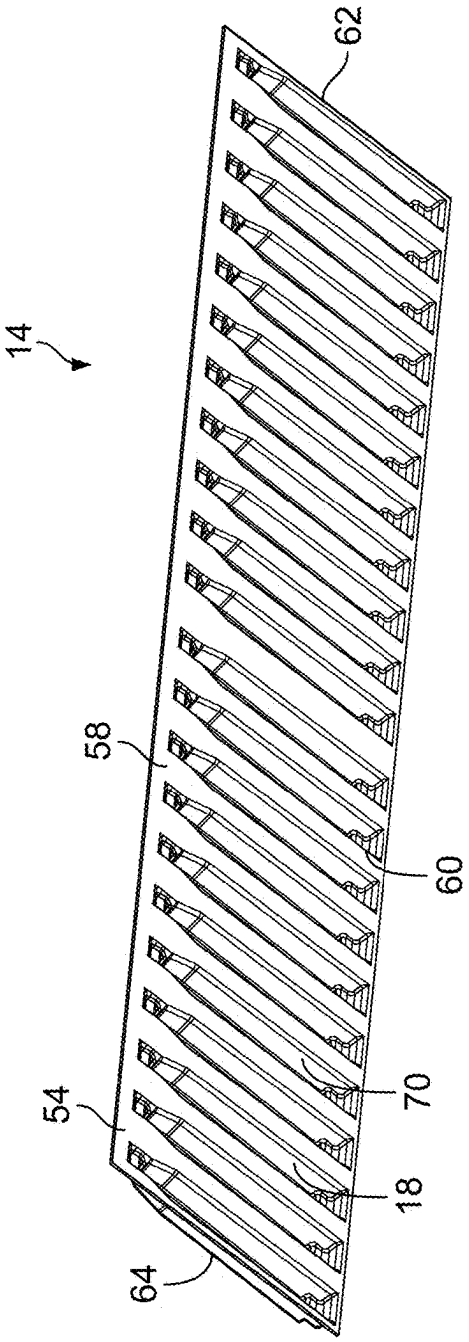


FIG. 5B

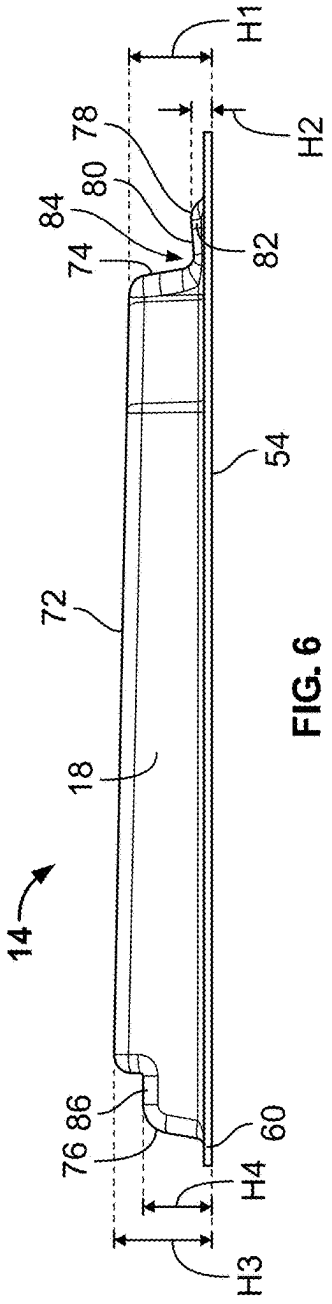


FIG. 6

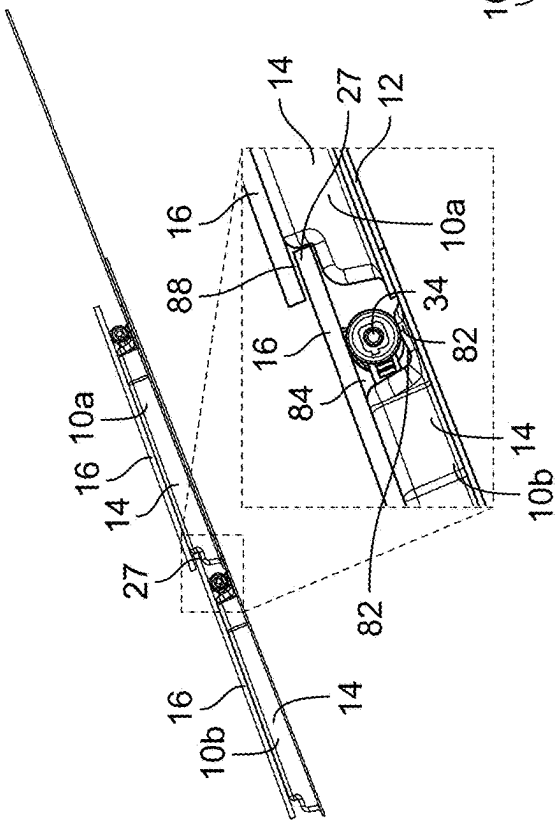


FIG. 7

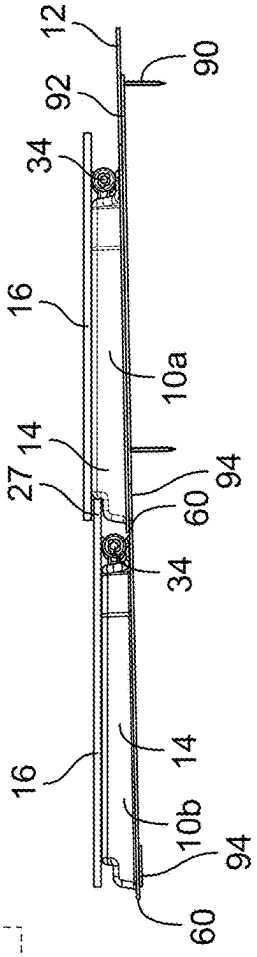


FIG. 8

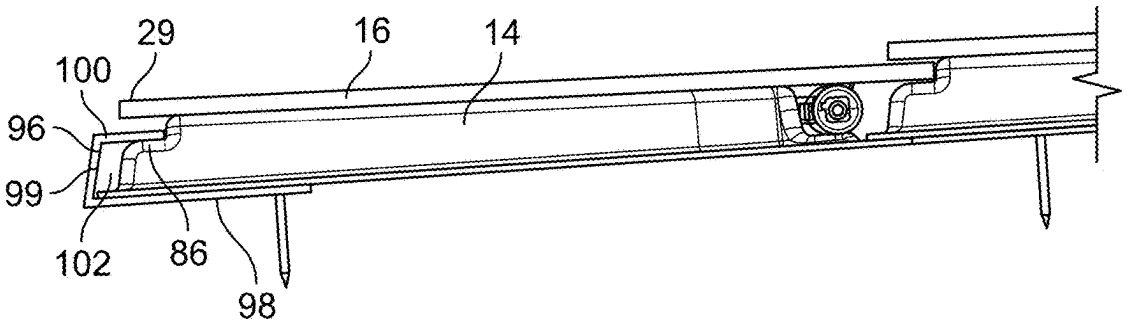


FIG. 9

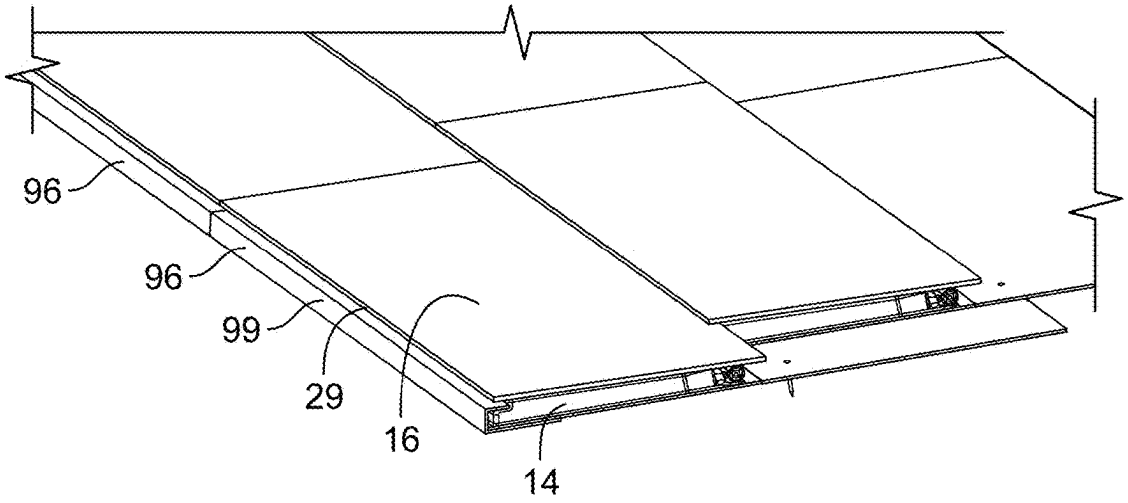


FIG. 10

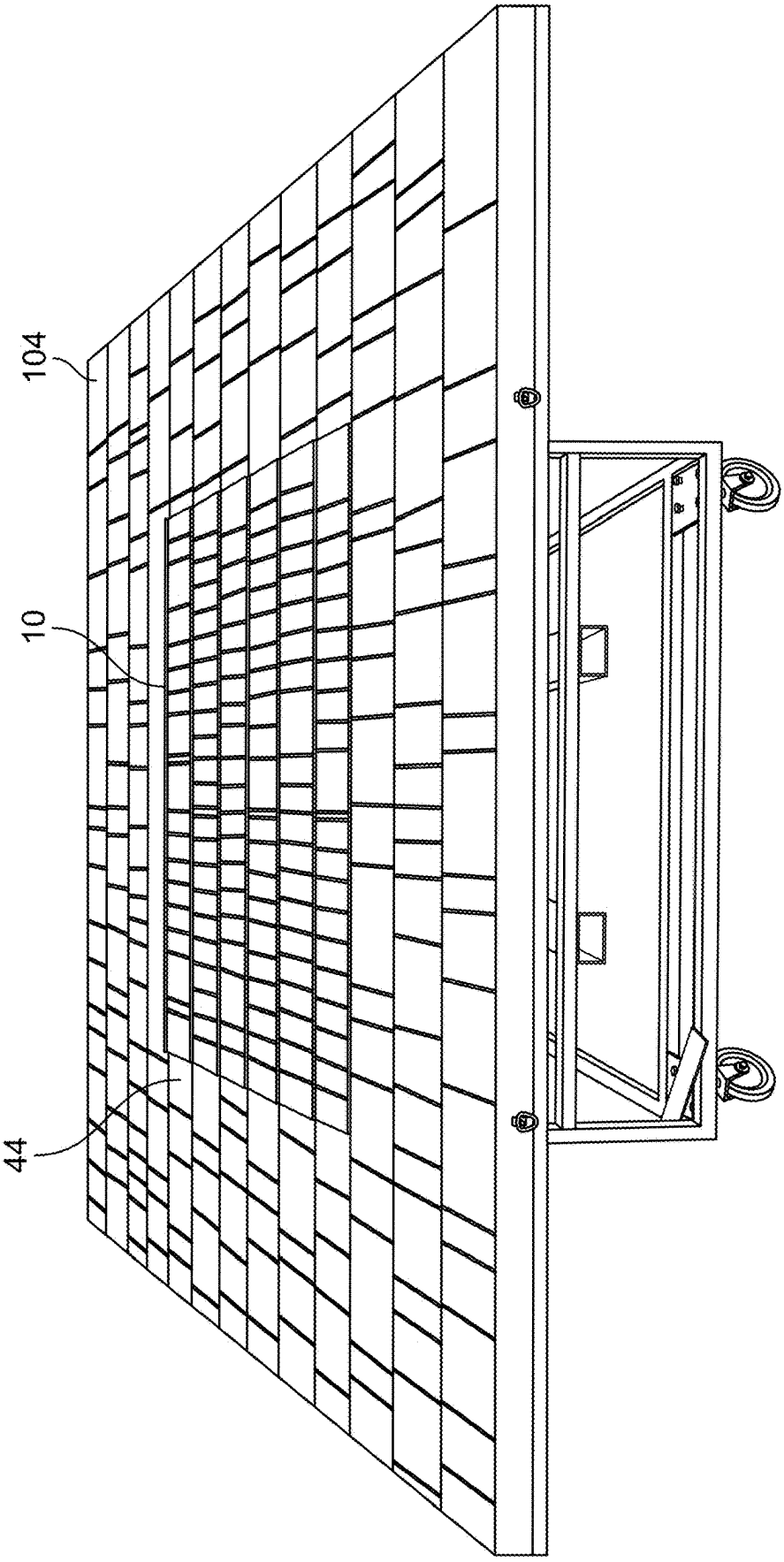


FIG. 11

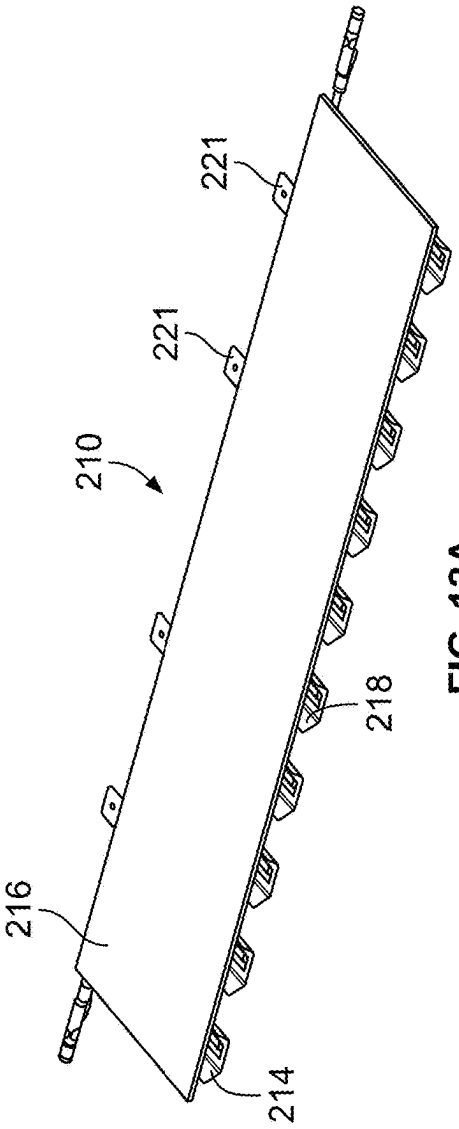


FIG. 12A

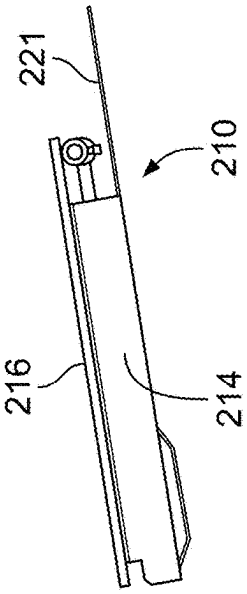


FIG. 12C

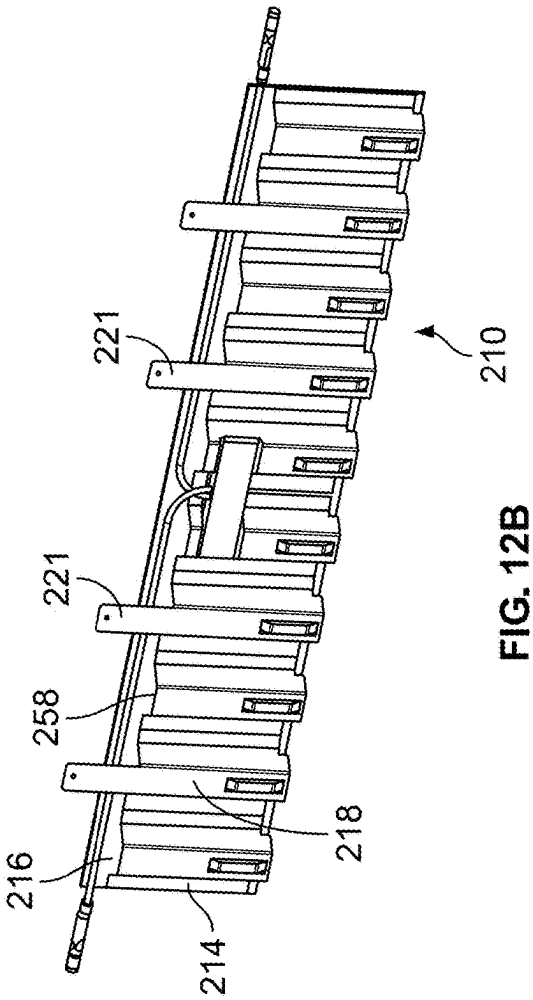


FIG. 12B

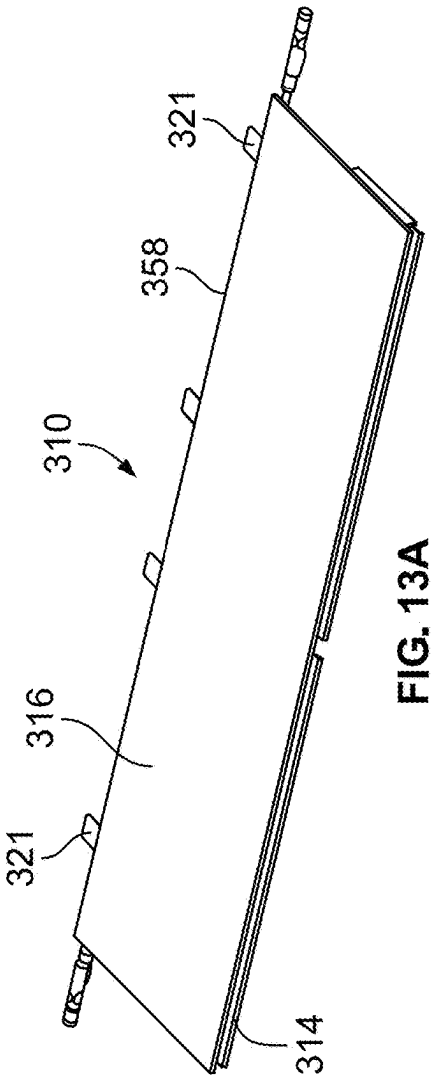


FIG. 13A

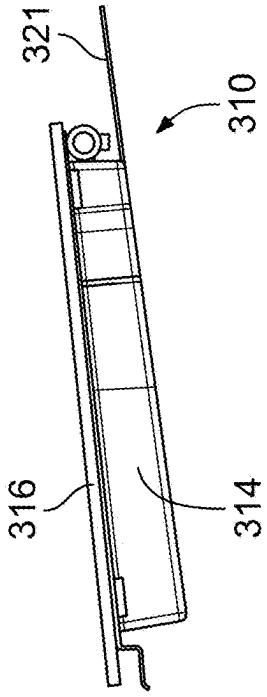


FIG. 13C

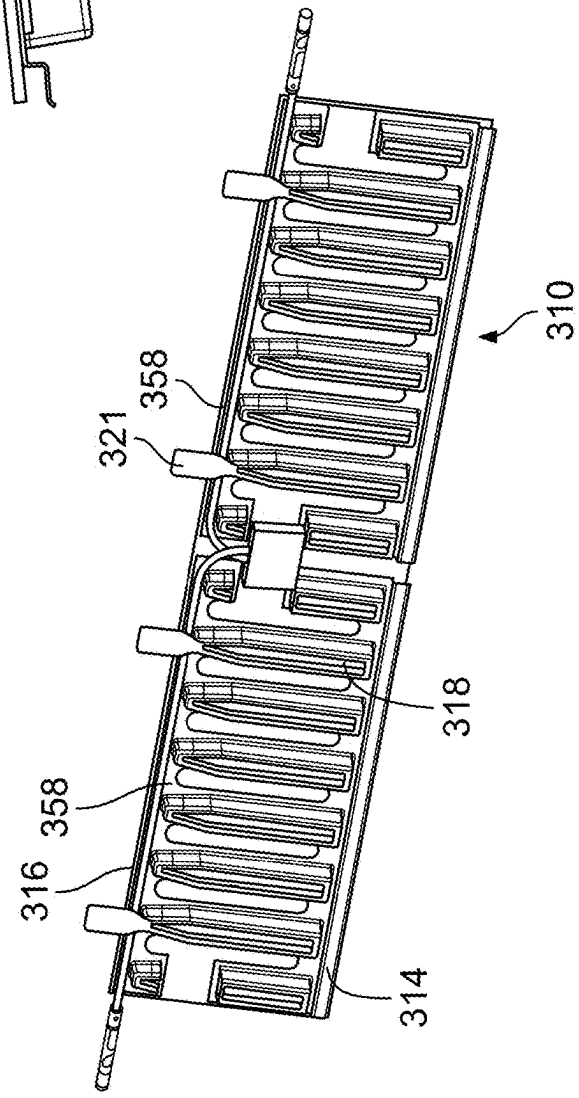


FIG. 13B

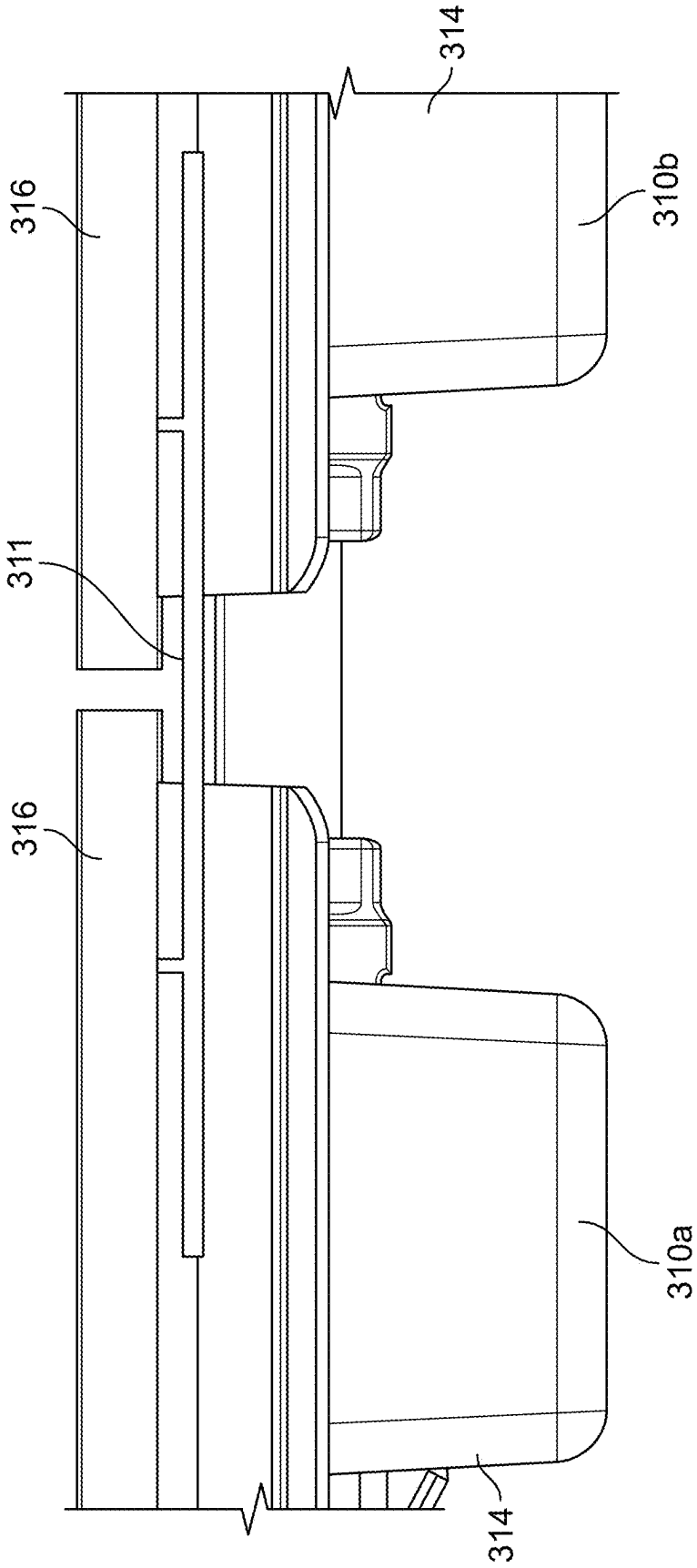


FIG. 14

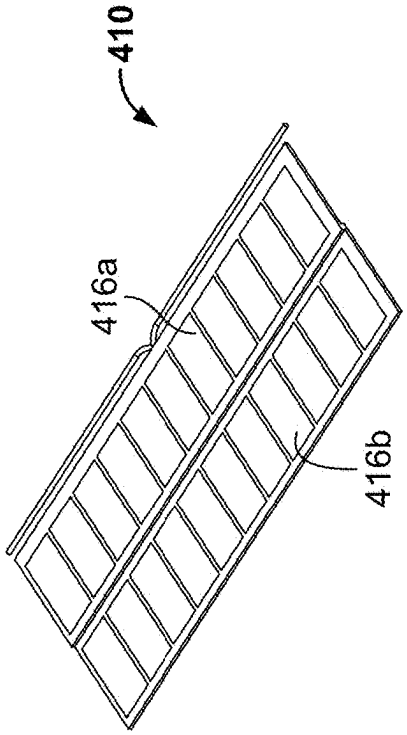


FIG. 15A

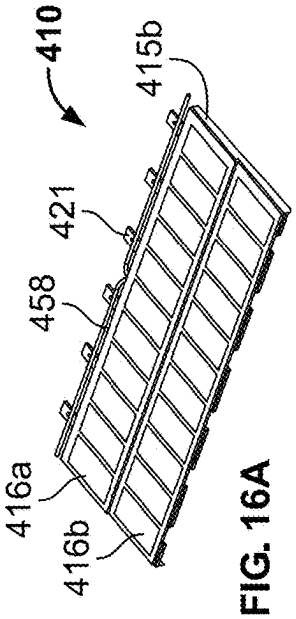


FIG. 16A

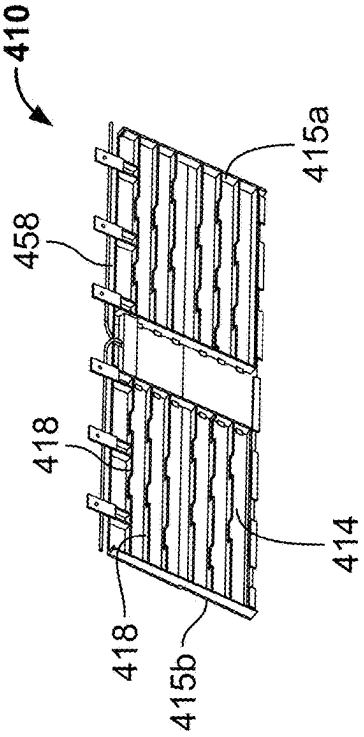


FIG. 16B

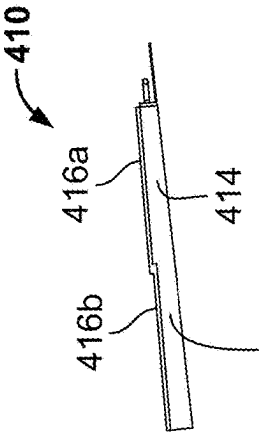


FIG. 16C

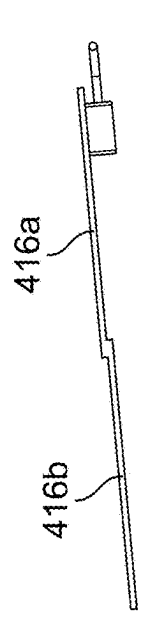


FIG. 15B

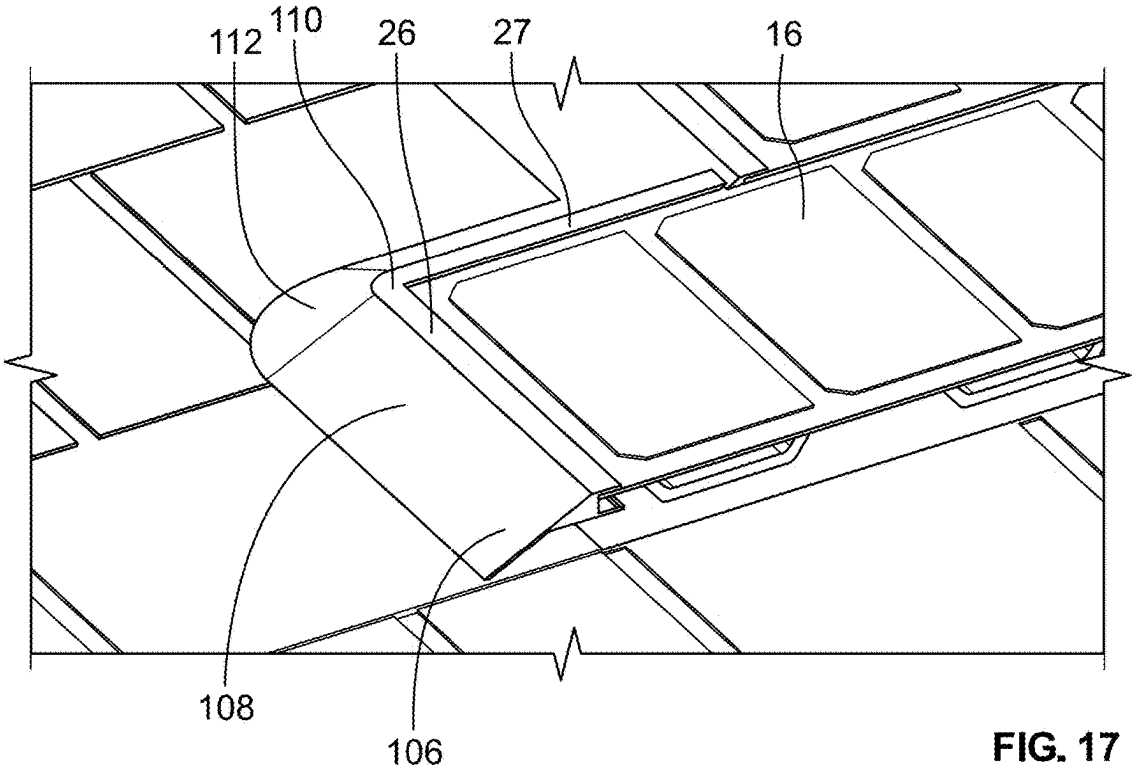


FIG. 17

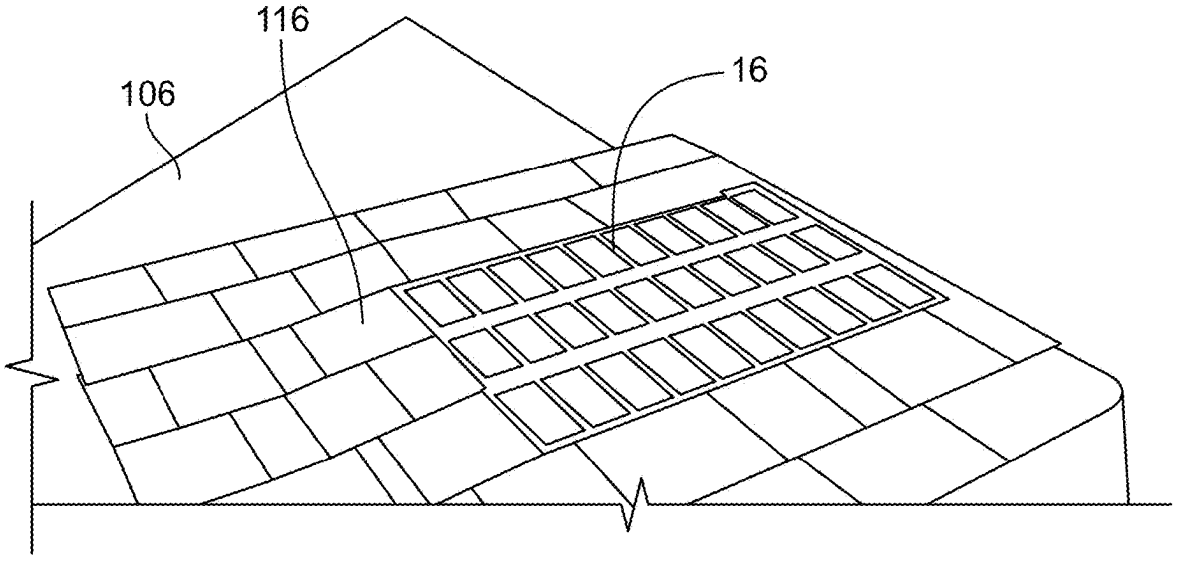


FIG. 18

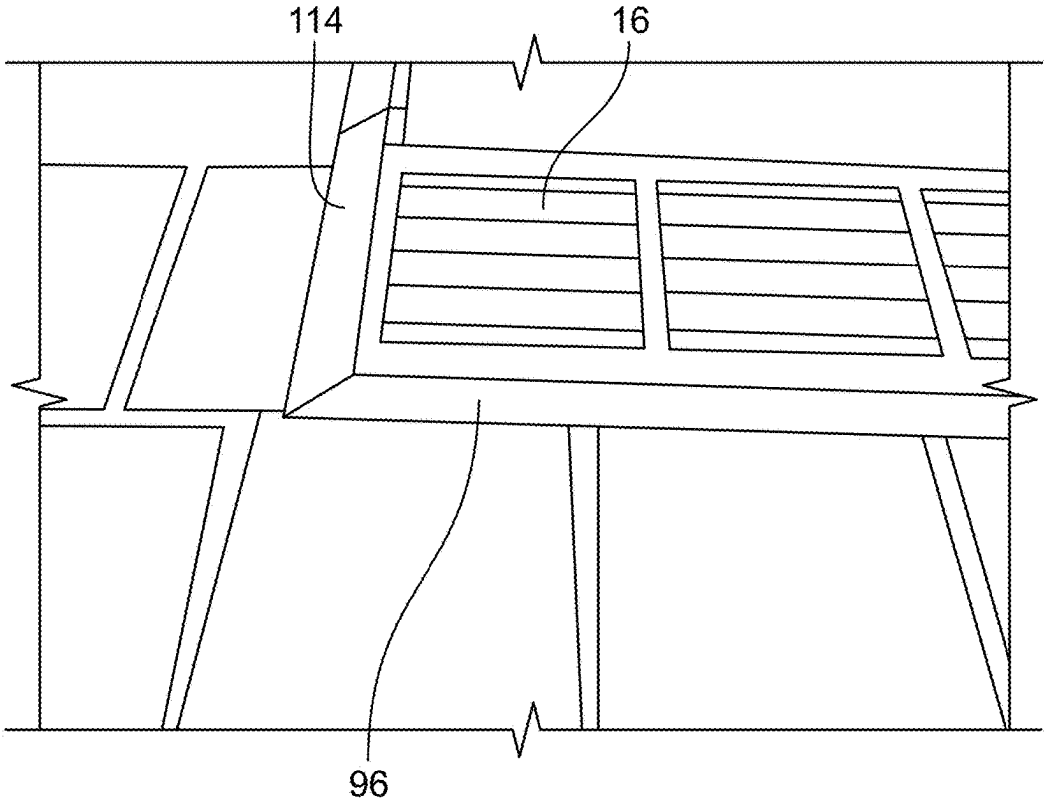


FIG. 19A

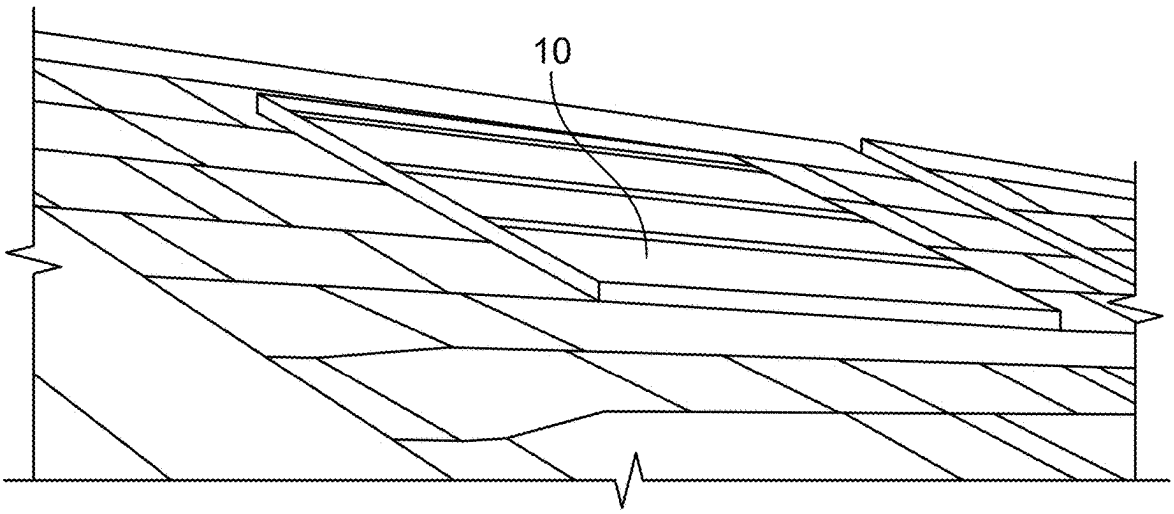


FIG. 19B

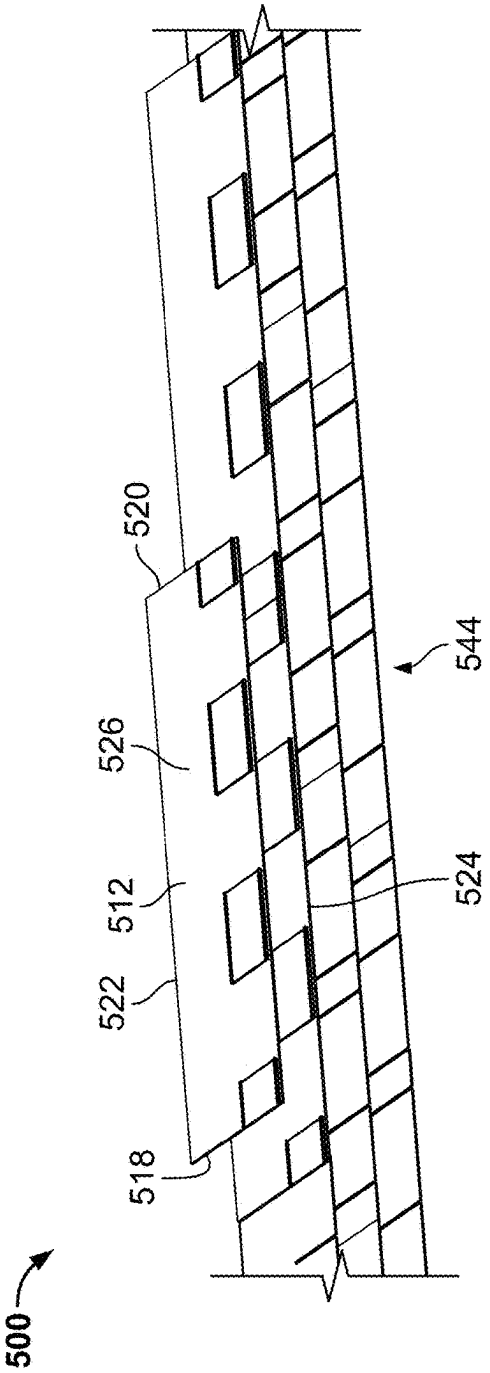

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FIG. 20

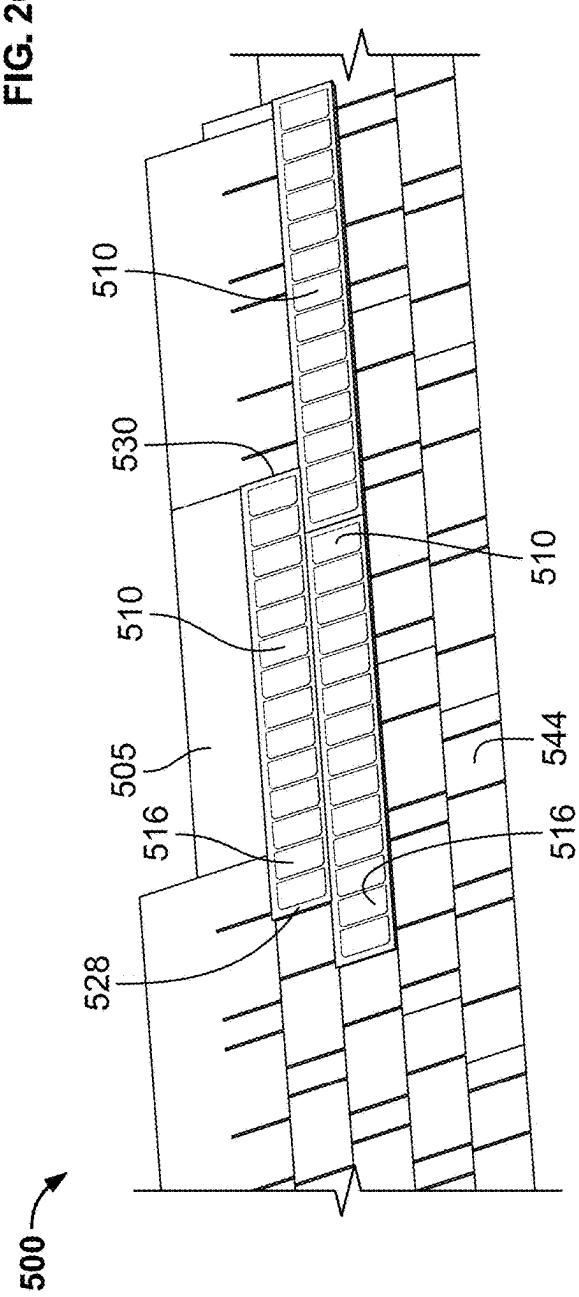
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FIG. 21

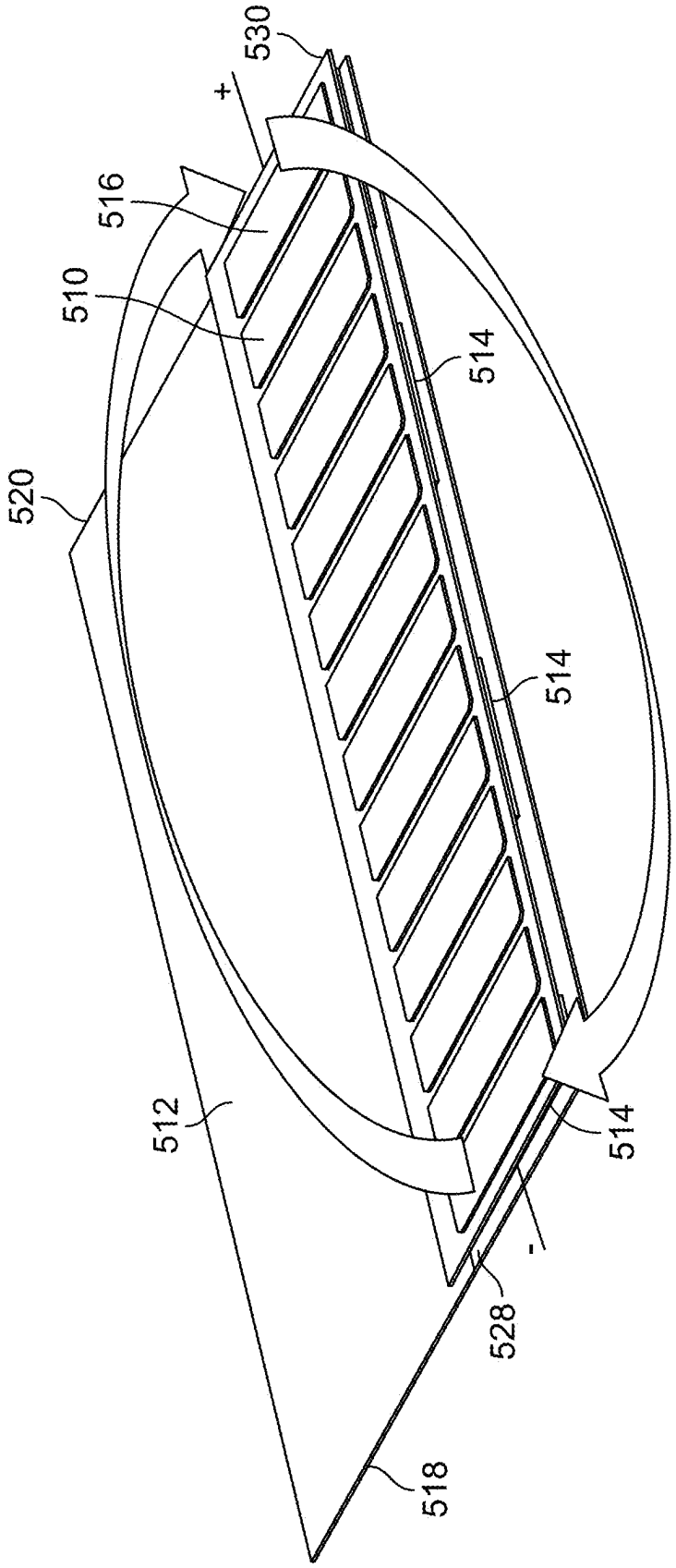

FIG. 22

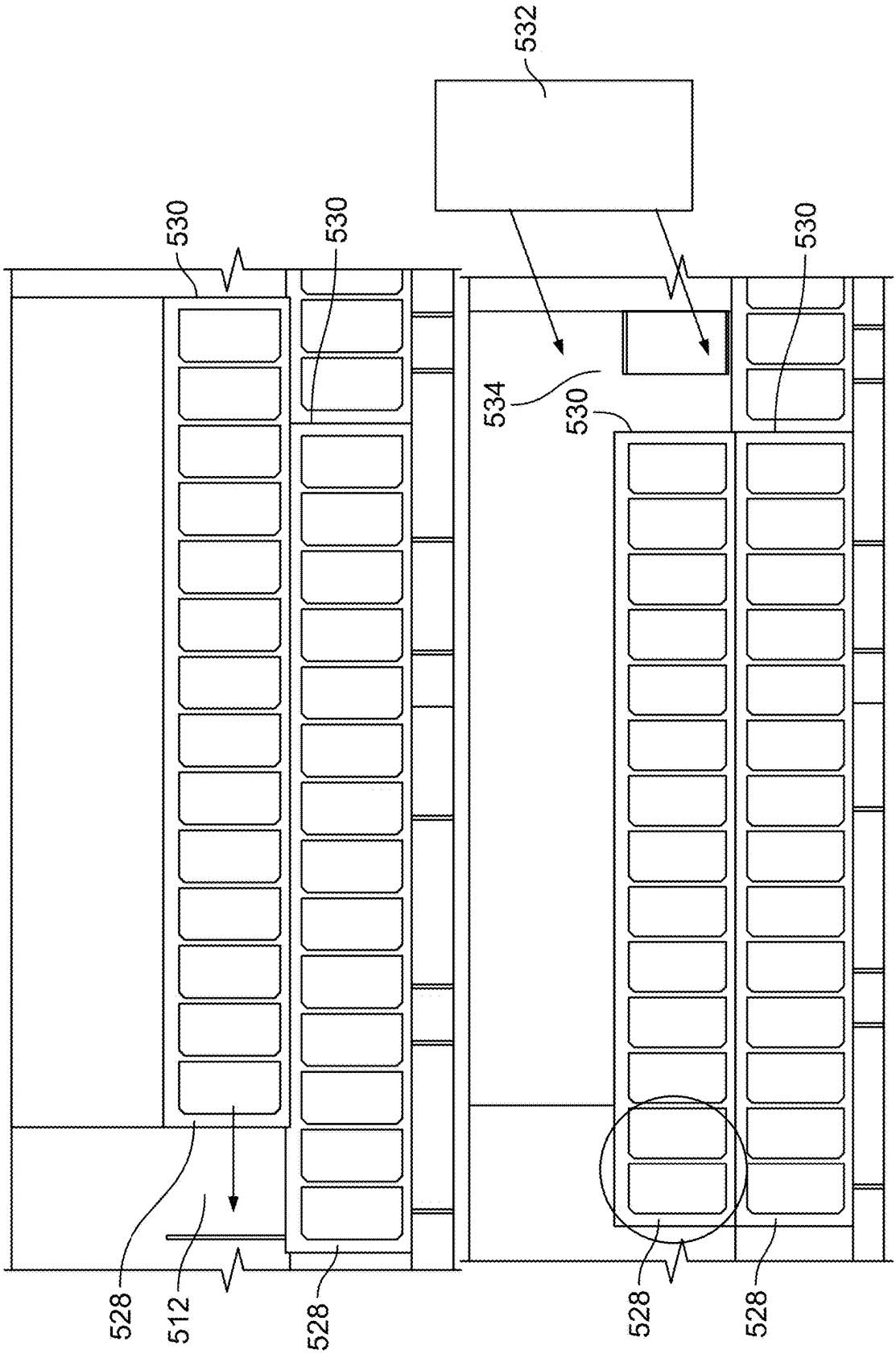

FIG. 23

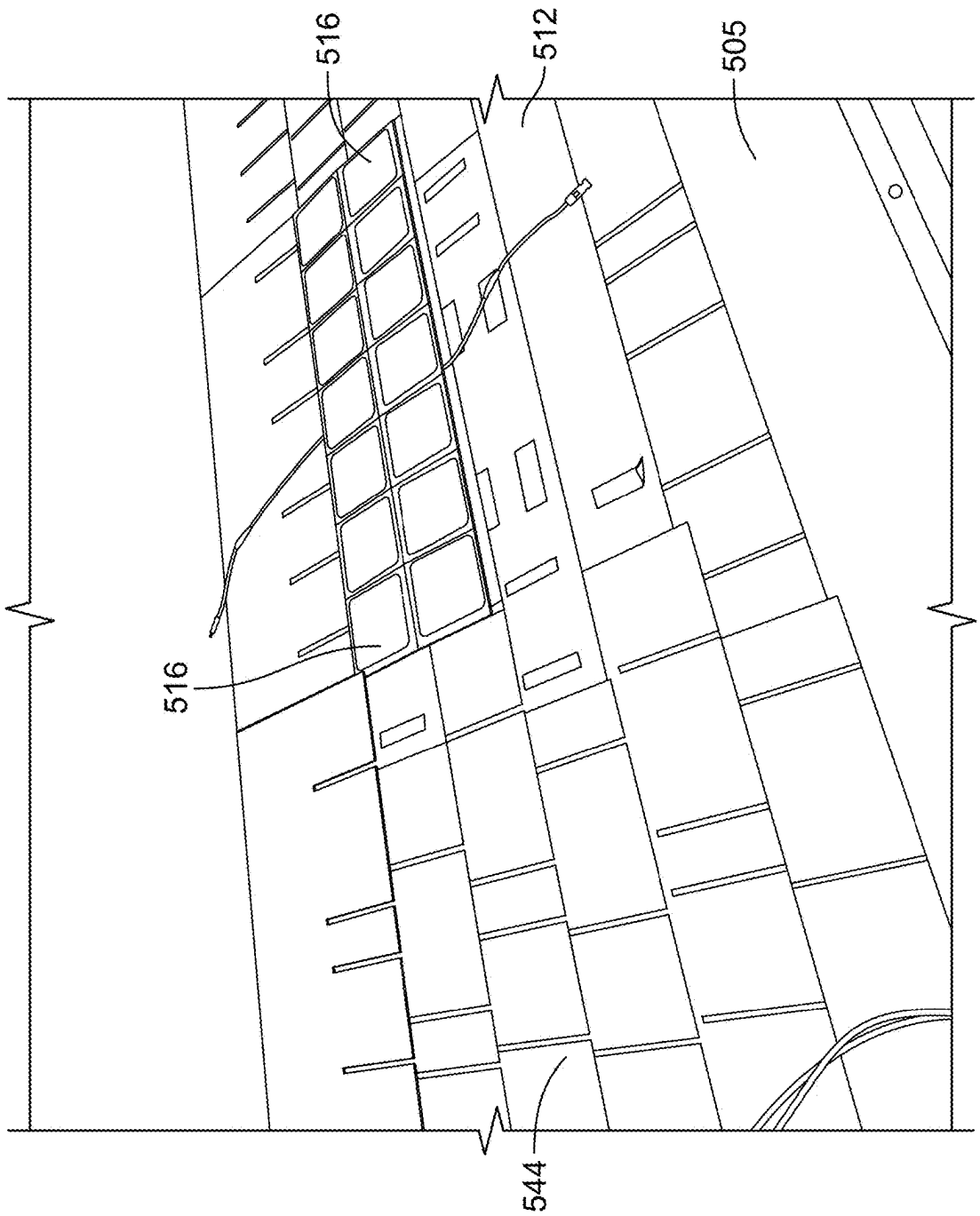

FIG. 24

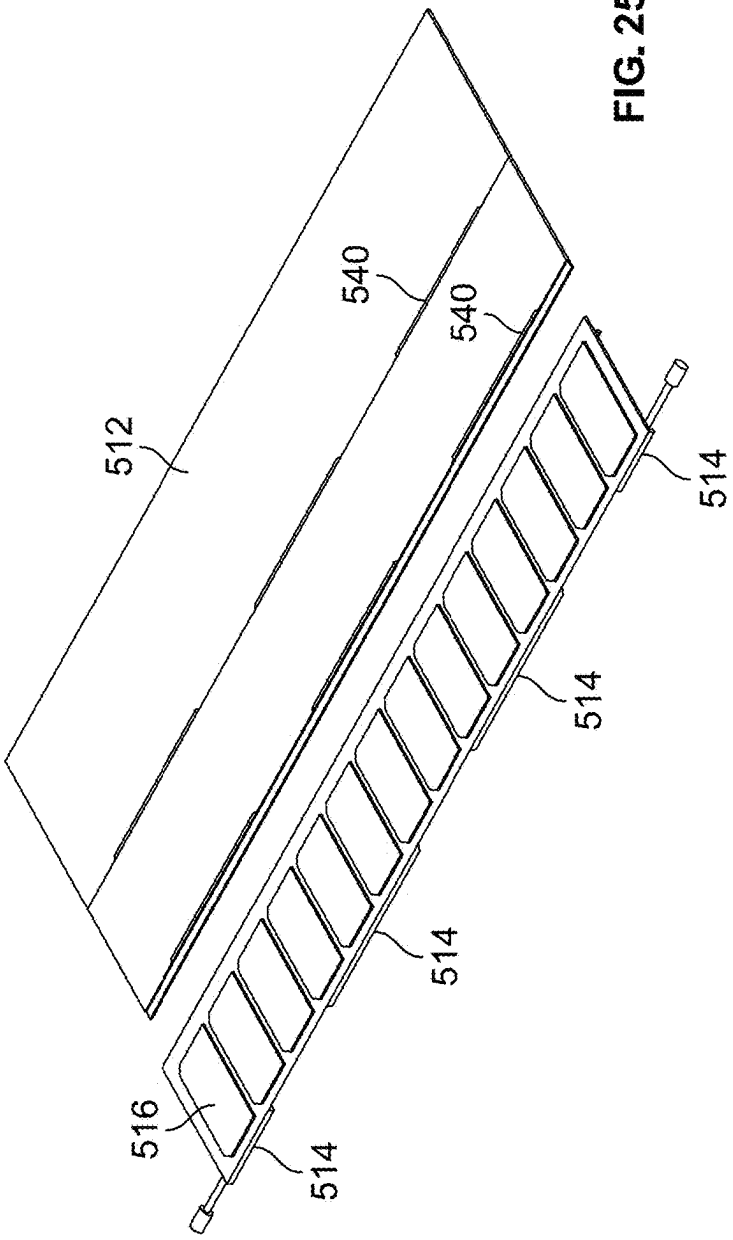

FIG. 25A

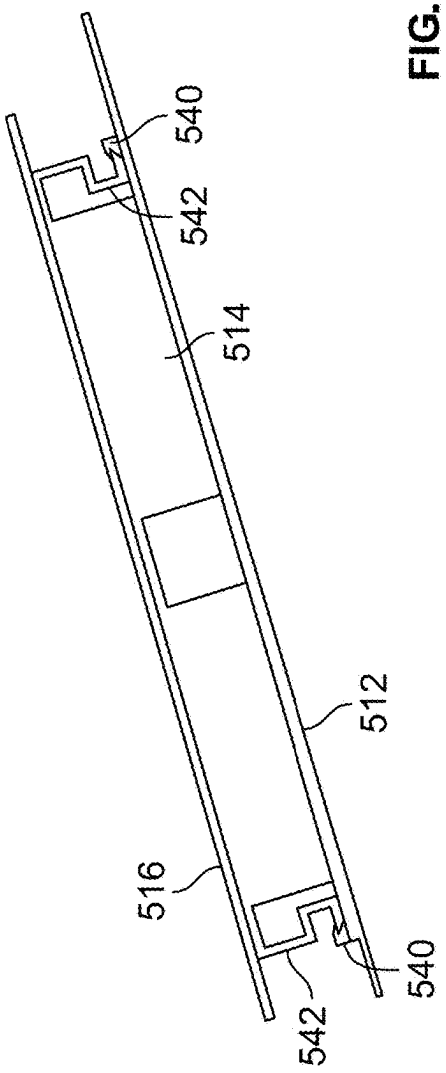

FIG. 25B

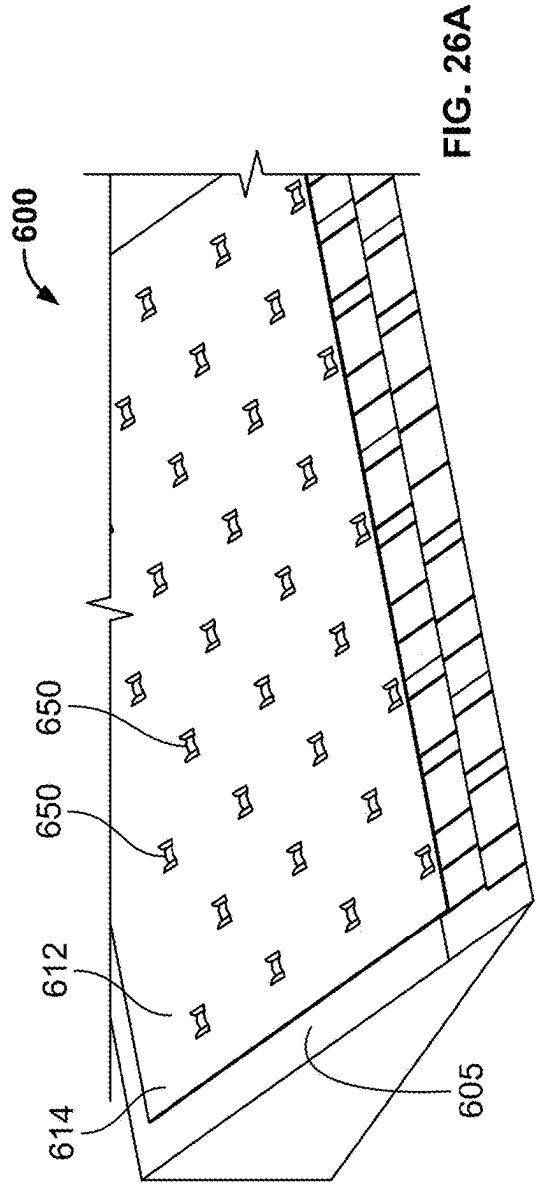

FIG. 26A

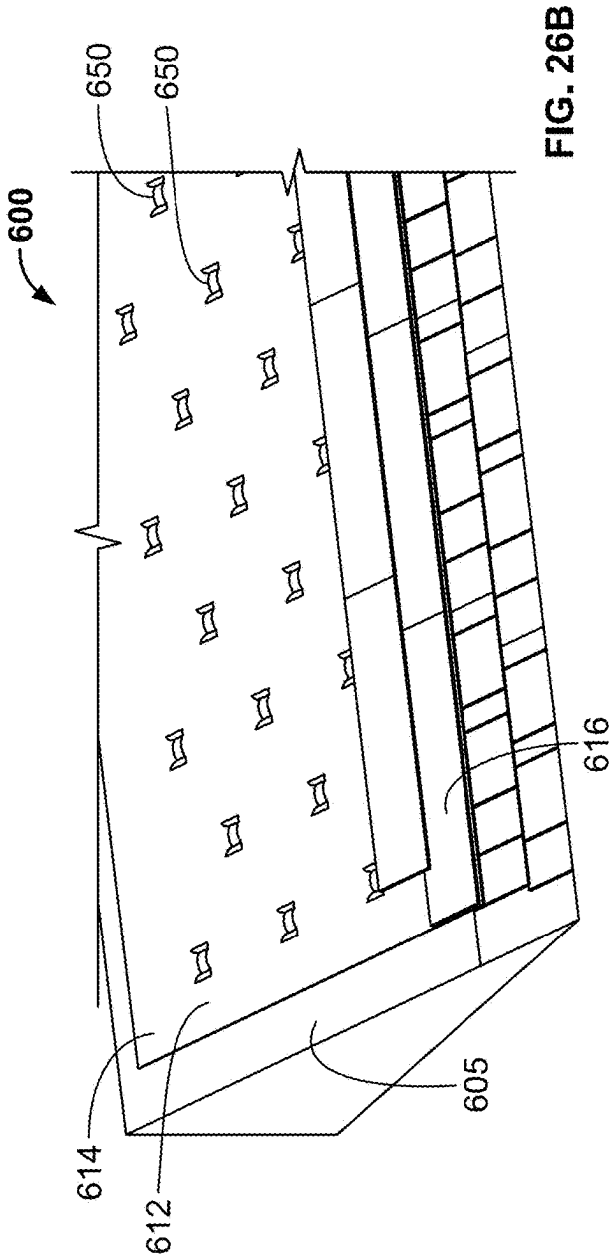

FIG. 26B

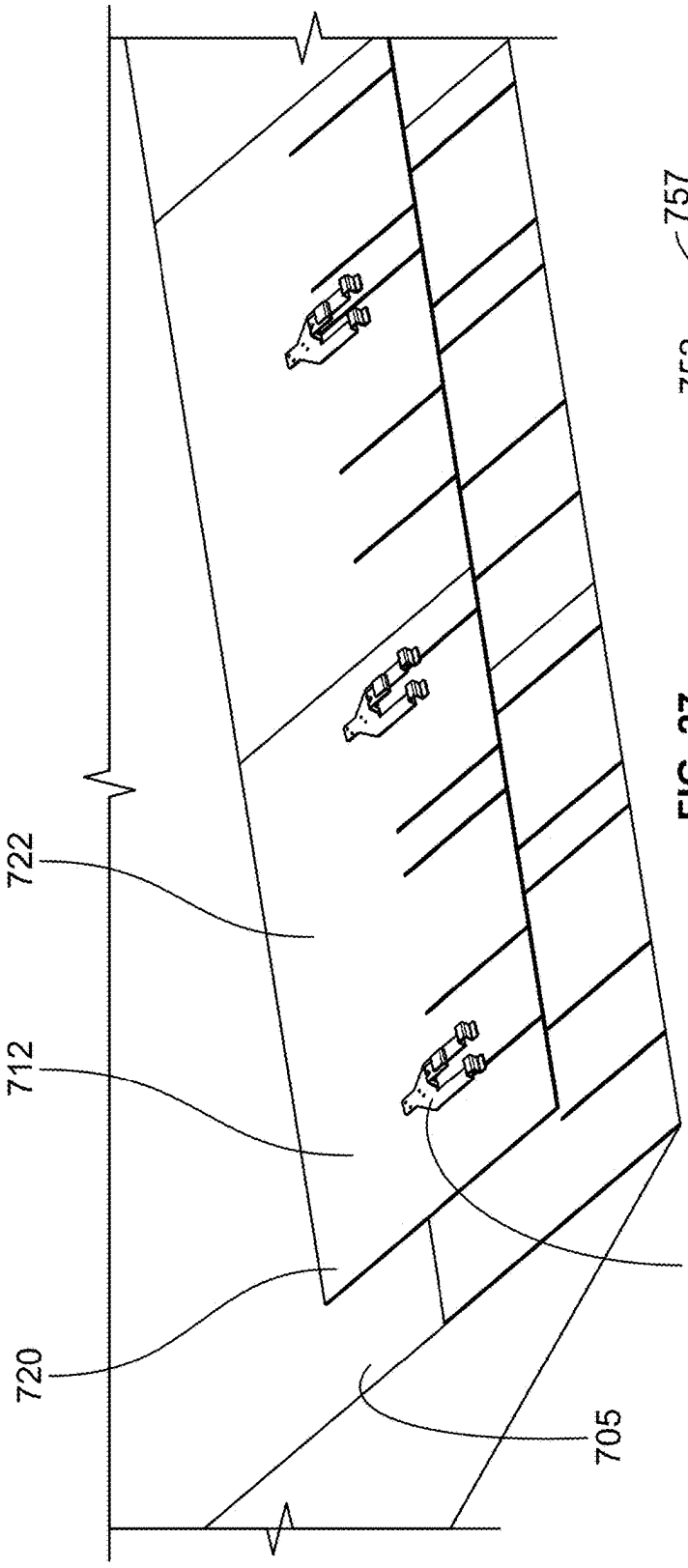
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FIG. 27

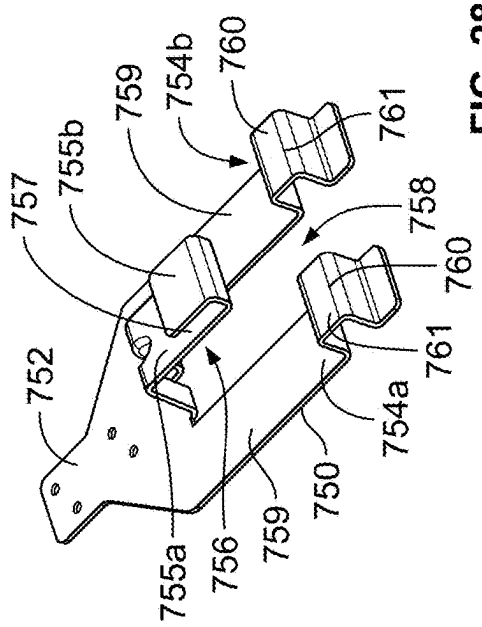
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FIG. 28

FIG. 29

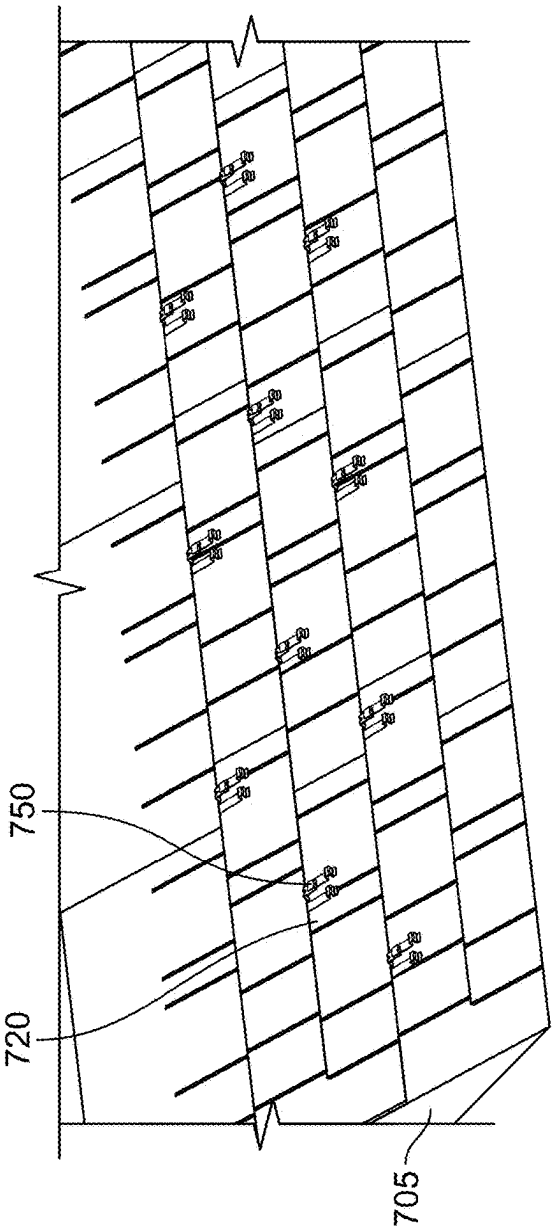
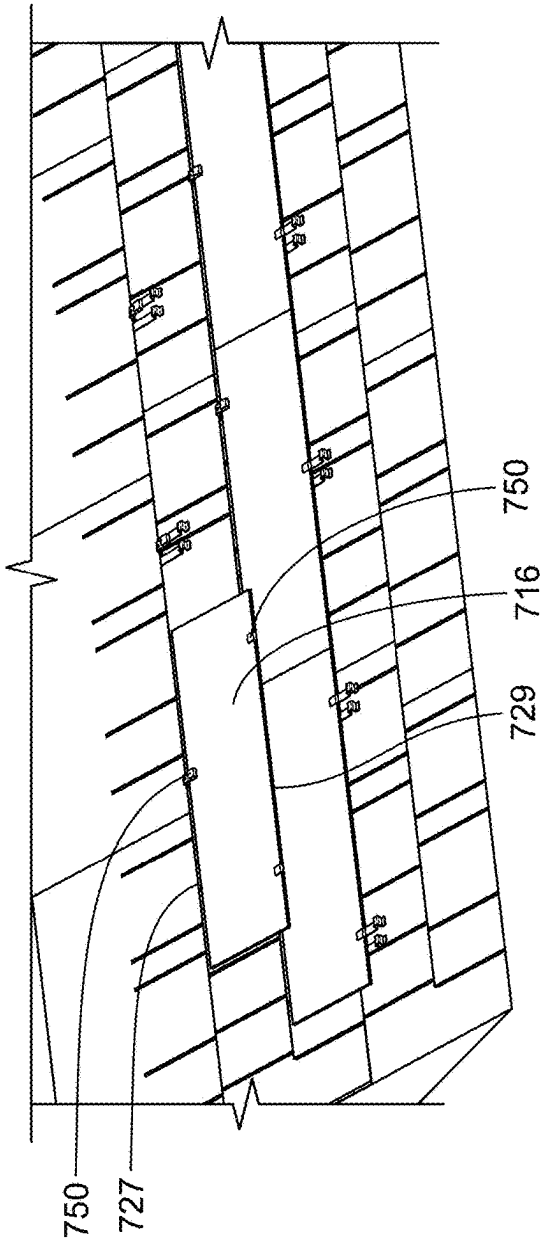


FIG. 30



MOUNTING APPARATUS FOR PHOTOVOLTAIC MODULES

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation of U.S. patent application Ser. No. 18/315,975, filed May 11, 2023, entitled "MOUNTING APPARATUS FOR PHOTOVOLTAIC MODULES," continuation of U.S. patent application Ser. No. 17/941,934, filed Sep. 9, 2022, now U.S. Pat. No. 11,689,149, entitled "MOUNTING APPARATUS FOR PHOTOVOLTAIC MODULES," which is a continuation of U.S. patent application Ser. No. 17/501,606, filed Oct. 14, 2021, now U.S. Pat. No. 11,444,569, entitled "MOUNTING APPARATUS FOR PHOTOVOLTAIC MODULES," which claims the benefit of U.S. Provisional Patent Application Ser. No. 63/091,428, filed Oct. 14, 2020, entitled "MOUNTING APPARATUS FOR PHOTOVOLTAIC MODULES," the contents of which are incorporated herein by reference in their entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to photovoltaic modules and, more particularly, mounting apparatus for photovoltaic modules for roofing systems and methods for installing same.

BACKGROUND OF THE INVENTION

[0003] Photovoltaic systems having solar panels are commonly installed on roofing of structures. What is needed is mounting apparatus for photovoltaic modules having features for efficient installation thereof.

SUMMARY OF THE INVENTION

[0004] In some embodiments, a system includes a plurality of photovoltaic modules configured to be installed on a roof deck, each of the photovoltaic modules includes a mat having a first edge, a spacer having a first edge, wherein the first edge of the mat is attached to the first edge of the spacer wherein the spacer includes a plurality of support members, wherein each of the support members includes a first end, a second end opposite the first end, and a first ledge located at the first end, and at least one solar module mounted to the plurality of support members, wherein the at least one solar module of one of the plurality of photovoltaic modules and the first ledge of the one of the plurality of photovoltaic modules form a first space therebetween, wherein the first space is sized and shaped to receive an edge of a solar module of another of the plurality of photovoltaic modules, and wherein the spacer of one of the plurality of photovoltaic modules overlays the mat of another of the plurality of photovoltaic modules.

[0005] In some embodiments, the mat includes a first surface, and wherein the spacer overlays the first surface of the mat. In some embodiments, the spacer includes a base, and wherein the plurality of support members extends from the base. In some embodiments, the base of the spacer includes a first surface and the plurality of support members extends outwardly from the first surface of the base. In some embodiments, the spacer includes a first end and a second end opposite the first end, and wherein the plurality of support members extends from the first end to the second end. In some embodiments, each of the plurality of support members is spaced apart from at least an adjacent one other of the plurality of support members. In some embodiments, the spacer includes a plurality of gaps, each of which is formed between a corresponding pair of the plurality of support members, and wherein each of the plurality of gaps is sized and shaped to receive electrical wiring. In some embodiments, at least one of the plurality of gaps is sized and shaped to receive an electrical component. In some embodiments, the spacer includes a third end extending from the first end to the second end, and a fourth end opposite the third end and extending from the first end to the second end, and wherein each of the plurality of support members extends from the third end to the fourth end.

[0006] In some embodiments, each of the plurality of support members includes an upper surface, and wherein the at least one solar module is mounted on the upper surface of each of the plurality of support members. In some embodiments, each of the plurality of support members includes a first height measured from the first surface of the base of the spacer to the upper surface of the support member, and the first ledge includes a second height measured from the first surface of the base of the spacer to an upper surface of the first ledge, and wherein the second height is less than the first height. In some embodiments, the at least one solar module and the first ledge form a first space therebetween, and wherein the first space is sized and shaped to receive at least one electrical component. In some embodiments, each of the plurality of support members includes a second ledge located at the second end thereof. In some embodiments, the second ledge includes a third height measured from the first surface of the base of the spacer to an upper surface of the second ledge, and wherein the third height is less than the first height, and wherein the third height is greater than the second height.

[0007] In some embodiments, a system includes a roofing layer configured to be installed directly on a roof deck, the roofing layer including a first surface, and a plurality of hooks installed on the first surface wherein the plurality of hooks is arranged in a pattern, wherein the pattern includes a plurality of rows and a plurality of columns; and a plurality of solar modules configured to be attached to the plurality of hooks. In some embodiments, the roofing layer includes a roofing membrane. In some embodiments, each of the plurality of hooks includes a double wing hook. In some embodiments, each of the plurality of hooks includes a mounting portion, a pair of feet extending from the mounting portion, and a hook portion extending from the mounting portion and offset from the pair of feet to form a slot therebetween, wherein a first edge of one of the plurality of solar modules engages the slot of one of the plurality of hooks, and a second edge of the one of the plurality of solar modules engages the hook portion of at least another one of the plurality of hooks. In some embodiments, the roofing layer includes at least one roofing shingle, wherein the roofing shingle includes a head lap, and wherein the mounting portion of at least one of the plurality of hooks is attached to the head lap of a corresponding one of the at least one roofing shingle. In some embodiments, the pattern is a long-staggered pattern.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** is a top perspective view of an embodiment of a photovoltaic module;

[0009] FIG. **2** is an exploded, top perspective view of the photovoltaic module of FIG. **1**;

[0010] FIG. **3** is a bottom perspective view of a solar module employed by the photovoltaic module of FIG. **1**;

[0011] FIG. **4** is a top perspective view of the photovoltaic module of FIG. **1** juxtaposed with a shingle;

[0012] FIGS. **5**A and **5**B are top and bottom perspective views of a spacer employed by the photovoltaic module of FIG. **1**;

[0013] FIG. **6** is a side elevational view of the spacer shown in FIGS. **5**A and **5**B;

[0014] FIGS. **7** through **9** are side elevational views of a plurality of photovoltaic modules shown in FIG. **1**, the modules installed on a roof deck and interlocked with one another;

[0015] FIG. **10** is a top perspective view of a plurality of photovoltaic modules shown in FIG. **9**;

[0016] FIG. **11** is a photo of a plurality of photovoltaic modules installed on a roof deck;

[0017] FIGS. **12**A through **12**C are top perspective, bottom perspective and side elevational views of an embodiment of a photovoltaic module;

[0018] FIGS. **13**A through **13**C are top perspective, bottom perspective and side elevational views of an embodiment of a photovoltaic module;

[0019] FIG. **14** is a side view of an embodiment of a plurality of photovoltaic modules;

[0020] FIGS. **15**A and **15**B are top perspective and side elevational views of an embodiment of a solar module;

[0021] FIGS. **16**A through **16**C are top perspective, bottom perspective and side elevational views of an embodiment of a photovoltaic module;

[0022] FIGS. **17** and **18** are photos of embodiments of photovoltaic modules with aesthetic trim installed on a roof deck;

[0023] FIGS. **19**A and **19**B are photos of embodiments of photovoltaic modules with side flashing installed on a roof deck;

[0024] FIGS. **20** through **22** are top perspective views of an embodiment of a system of mounting mats, roofing shingles and solar modules installed on a roof deck;

[0025] FIGS. **23** and **24** are a top plan view and a photo of an embodiment of the system shown in FIGS. **20** through **22**;

[0026] FIGS. **25**A and **25**B are top perspective and side elevational views of an embodiment of a photovoltaic module;

[0027] FIGS. **26**A and **26**B are top perspective views of an embodiment of a system of solar modules installed on a roof deck; and

[0028] FIGS. **27** through **30** are top perspective views of an embodiment of a system of hook members for installing solar modules on a roof deck.

DETAILED DESCRIPTION

[0029] Referring to FIGS. **1** and **2**, in some embodiments, a photovoltaic module **10** includes a mat **12**, a spacer **14** juxtaposed with the mat **12**, and a solar module **16** mounted to the spacer **14**. In some embodiments, the solar module **16** is elevated relative to the mat **12**. In some embodiments, the spacer **14** includes a plurality of support members **18**. In some embodiments, the solar module **16** is mounted to the plurality of support members **18**. In some embodiments, the mat **12** includes a first surface **20** and the spacer **14** overlays the first surface **20** of the mat **12**. In some embodiments, the photovoltaic module **10** is configured to be installed on a roof deck. In some embodiments, the roof deck is a component of a roofing system. In some embodiments, the roofing system includes a plurality of roofing shingles installed on the roof deck. In some embodiments, the roofing shingles include asphalt shingles. In some embodiments, the roofing system includes roof tiles. In some embodiments, the roofing system includes terracotta roof tiles.

[0030] Referring to FIGS. **1** through **3**, in some embodiments, at least one solar module **16** includes a first surface **22**, a second surface **24** opposite the first surface **22**, a first end **26**, a second end **28** opposite the first end **26**, a first edge **27** extending from the first end **26** to the second end **28**, and a second edge **29** opposite the first edge **27** and extending from the first end **26** to the second end **28**. In some embodiments, a junction box **30** is mounted to the second surface **24**. In some embodiments, the junction box **30** is mounted on the second surface **24** proximate to the first edge **27**. In some embodiments, a first electrical connector **32** is mounted to the second surface **24**. In some embodiments, a second electrical connector **34** is mounted to the second surface **24**. In some embodiments, the first and second electrical connectors **32**, **34** are mounted to the second surface **24** proximate to the first edge **27**. In some embodiments, the first electrical connector **32** is a female connector. In some embodiments, the second electrical connector **34** is a male connector. In some embodiments, the first electrical connector **32** extends outwardly from the first end **26**. In some embodiments, the second electrical connector **34** extends outwardly from the second end **28**. In some embodiments, the first and second electrical connectors **32**, **34** are electrically connected to the junction box **30** by electrical wires **36**, **38**, respectively.

[0031] Referring to FIG. **4**, in some embodiments, the photovoltaic module **10** includes a first edge **40** and a second edge **42** opposite the first edge **40**. In some embodiments, a roofing shingle **44** includes a first edge **46** and a second edge **48** opposite the first edge **46**. In some embodiments, the second edge **48** of the roofing shingle **44** is juxtaposed with the first edge **40** of the photovoltaic module **10**. In some embodiments, the first edge **46** of the roofing shingle **44** is juxtaposed with the second edge **42** of the photovoltaic module **10**. In some embodiments, the roofing shingle **44** includes a head lap **50** and a reveal portion **52**. In some embodiments, the head lap **50** is aligned with the mat **12** of the photovoltaic module **10**, while the reveal portion **52** is aligned with the solar module **16**.

[0032] Referring to FIGS. **5**A and **5**B, the spacer **14** includes a base **54** having a first surface **56**. In some embodiments, the plurality of support members **18** extends outwardly from the first surface **56** of the base **54**. In some embodiments, the spacer **14** includes a first edge **58** and a second edge **60** opposite the first edge **58**. In some embodiments, the mat **12** is adjacent to the first edge **58** of the base **54** of the spacer **14**. In some embodiments, the mat **12** is attached to the first edge **58** of the base **54** of the spacer **14**.

[0033] In some embodiments, the mat **12** is composed of a polymer. In some embodiments, the mat **12** includes thermoplastic polyolefin (TPO). In other embodiments, the mat **12** is composed of polyethylene terephthalate (PET), polyethylene naphthalate (PEN), polyetheretherketone (PEEK), polyaryletherketone (PAEK), polyarylate (PAR), polyetherimide (PEI), polyarylsulfone (PAS), polyethersulfone (PES), polyamideimide (PAI), or polyimide; poly-

vinyl chloride (PVC); ethylene propylene diene monomer (EPDM) rubber; silicone rubber; fluoropolymers-ethylene tetrafluoroethylene (ETFE), polyvinylidene fluoride (PVDF), tetrafluoroethylene-hexafluoropropylene copolymers (FEP), and tetrafluoroethylene-hexafluoropropylene-vinylidene fluoride copolymers (THV), or blends thereof.

[0034] Still referring to FIGS. **5**A and **5**B, in an embodiment, the spacer **14** includes a first end **62** and a second end **64** opposite the first end **62**. In some embodiments, the plurality of support members **18** extends from the first end **62** to the second end **64**. In some embodiments, each of the plurality of support members **18** is spaced apart from at least an adjacent one other of the plurality of support members **18**. In some embodiments, the spacer **14** includes a plurality of gaps **66**, each of which is formed between a corresponding pair of the plurality of support members **18**. In some embodiments, each of the plurality of gaps **66** is sized and shaped to receive electrical wiring. In some embodiments, electrical wiring may be routed through at least one of the plurality of gaps **66**. In some embodiments, each of the plurality of gaps **66** is configured to permit a flow water to travel and drain therethrough. In some embodiments, at least one gap **68** of the plurality of gaps **66** is sized and shaped to receive an electrical component. In some embodiments, the electrical component is the junction box **30**. In some embodiments, the at least one gap **68** of the plurality of gaps **66** receives the junction box **30** when the solar module **16** is positioned on the spacer **14**. In some embodiments, each of the plurality of support members **18** extends intermediate the first edge **58** and the second edge **60**. In some embodiments, each of the plurality of support members **18** is substantially parallel to one another. In some embodiments, each of the plurality of support members **18** is hollow and includes an interior portion **70**. In some embodiments, the interior portions **70** result in a weight reduction of the spacer **14**.

[0035] Referring to FIGS. **6** through **8**, each of the plurality of support members **18** includes an upper surface **72**. In some embodiments, the solar module **16** is mounted on the upper surface **72** of each of the plurality of support members **18**. In some embodiments, the solar module **16** is mounted on the upper surface **72** of at least one of the plurality of support members **18**. In some embodiments, the upper surface **72** extends obliquely relative to the mat **12**.

[0036] In some embodiments, the upper surface **72** extends obliquely in a range of 0.1 degree to 5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 0.1 degree to 4.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 0.1 degree to 4 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 0.1 degree to 3.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 0.1 degree to 3 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 0.1 degree to 2.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 0.1 degree to 2 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 0.1 degree to 1.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 0.1 degree to 1 degree relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 0.1 degree to 0.5 degree relative to the base **54**.

[0037] In some embodiments, the upper surface **72** extends obliquely in a range of 0.5 degree to 5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 0.5 degree to 4.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 0.5 degree to 4 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 0.5 degree to 3.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 0.5 degree to 3 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 0.5 degree to 2.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 0.5 degree to 2 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 0.5 degree to 1.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 0.5 degree to 1 degree relative to the base **54**.

[0038] In some embodiments, the upper surface **72** extends obliquely in a range of 1 degree to 5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 1 degree to 4.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 1 degree to 4 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 1 degree to 3.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 1 degree to 3 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 1 degree to 2.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 1 degree to 2 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 1 degree to 1.5 degrees relative to the base **54**.

[0039] In some embodiments, the upper surface **72** extends obliquely in a range of 1.5 degrees to 5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 1.5 degrees to 4.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 1.5 degrees to 4 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 1.5 degrees to 3.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 1.5 degrees to 3 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 1.5 degrees to 2.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 1.5 degrees to 2 degrees relative to the base **54**.

[0040] In some embodiments, the upper surface **72** extends obliquely in a range of 2 degrees to 5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 2 degrees to 4.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 2 degrees to 4 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 2 degrees to 3.5 degrees relative to the base **54**. In some

embodiments, the upper surface **72** extends obliquely in a range of 2 degrees to 3 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 2 degrees to 2.5 degrees relative to the base **54**.

[0041] In some embodiments, the upper surface **72** extends obliquely in a range of 2.5 degrees to 5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 2.5 degrees to 4.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 2.5 degrees to 4 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 2.5 degrees to 3.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 2.5 degrees to 3 degrees relative to the base **54**.

[0042] In some embodiments, the upper surface **72** extends obliquely in a range of 3 degrees to 5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 3 degrees to 4.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 3 degrees to 4 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 3 degrees to 3.5 degrees relative to the base **54**.

[0043] In some embodiments, the upper surface **72** extends obliquely in a range of 3.5 degrees to 5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 3.5 degrees to 4.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 3.5 degrees to 4 degrees relative to the base **54**.

[0044] In some embodiments, the upper surface **72** extends obliquely in a range of 4 degrees to 5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 4 degrees to 4.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely in a range of 4.5 degrees to 5 degrees relative to the base **54**.

[0045] In some embodiments, the upper surface **72** extends obliquely 0.1 degree relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely 0.5 degree relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely 1 degree relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely 1.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely 2 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely 2.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely 3 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely 3.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely 4 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely 4.5 degrees relative to the base **54**. In some embodiments, the upper surface **72** extends obliquely 5 degrees relative to the base **54**.

[0046] Still referring to FIGS. **6** through **8**, In some embodiments, each of the plurality of support members **18** includes a first end **74**, a second end **76** opposite the first end **74**, and a ledge **78** located at the first end **74** of the support member **18**. In some embodiments, each of the plurality of support members **18** includes a first height H1 measured from the base **54** of the spacer **14** to the upper surface **72** of the support member **18** proximate to the first end **74**, and the ledge **78** includes a second height H2 measured from the base **54** of the spacer **14** to an upper surface **80** of the ledge **78**. In some embodiments, the second height H2 is less than the first height H1. In some embodiments, the ledge **78** includes a raised bump **82**. In some embodiments, the solar module **16** and the ledge **78** form a first space **84** therebetween. In some embodiments, the first space **84** is sized and shaped to receive at least one electrical component. In some embodiments, the at least one electrical component includes at least the junction box **30**. In some embodiments, the at least one electrical component includes at least one of the first and second electrical connectors **32**, **34**. In some embodiments, the at least one electrical component includes at least one of the first and second electrical wiring **36**, **38**. In some embodiments, the raised bump **82** is configured to elevate the first and second electrical connectors **32**, **34** relative to the roof deck to prevent water from reaching the connectors **32**, **34**.

[0047] Still referring to FIGS. **6** through **8**, in an embodiment, each of the plurality of support members **18** includes a ledge **86** located at the second end **76** thereof. In some embodiments, each of the plurality of support members **18** includes a third height H3 measured from the base **54** of the spacer **14** to the upper surface **72** of the support member **18** proximate to the second end **76**, and the ledge **86** includes a fourth height H4 measured from the base **54** of the spacer **14** to an upper surface **72** of the ledge **86**. In some embodiments, the third height H3 is greater than the first height H1. In some embodiments, the third height H3 is greater than the second height H2. In some embodiments, the third height H3 is greater than the fourth height H4. In some embodiments, the fourth height H4 is less than the first height H1. In some embodiments, the fourth height H4 is greater than the second height H2.

[0048] In some embodiments, the first height H1 is in a range of 10 mm to 20 mm. In some embodiments, the first height H1 is in a range of 10 mm to 19 mm. In some embodiments, the first height H1 is in a range of 10 mm to 18 mm. In some embodiments, the first height H1 is in a range of 10 mm to 17 mm. In some embodiments, the first height H1 is in a range of 10 mm to 16 mm. In some embodiments, the first height H1 is in a range of 10 mm to 15 mm. In some embodiments, the first height H1 is in a range of 10 mm to 14 mm. In some embodiments, the first height H1 is in a range of 10 mm to 13 mm. In some embodiments, the first height H1 is in a range of 10 mm to 12 mm. In some embodiments, the first height H1 is in a range of 10 mm to 11 mm.

[0049] In some embodiments, the first height H1 is in a range of 11 mm to 20 mm. In some embodiments, the first height H1 is in a range of 11 mm to 19 mm. In some embodiments, the first height H1 is in a range of 11 mm to 18 mm. In some embodiments, the first height H1 is in a range of 11 mm to 17 mm. In some embodiments, the first height H1 is in a range of 11 mm to 16 mm. In some embodiments, the first height H1 is in a range of 11 mm to 15 mm. In some embodiments, the first height H1 is in a range of 11 mm to 14 mm. In some embodiments, the first height H1 is in a range of 11 mm to 13 mm. In some embodiments, the first height H1 is in a range of 11 mm to 12 mm.

[0050] In some embodiments, the first height H1 is in a range of 12 mm to 20 mm. In some embodiments, the first

height H1 is in a range of 12 mm to 19 mm. In some embodiments, the first height H1 is in a range of 12 mm to 18 mm. In some embodiments, the first height H1 is in a range of 12 mm to 17 mm. In some embodiments, the first height H1 is in a range of 12 mm to 16 mm. In some embodiments, the first height H1 is in a range of 12 mm to 15 mm. In some embodiments, the first height H1 is in a range of 12 mm to 14 mm. In some embodiments, the first height H1 is in a range of 12 mm to 13 mm.

[0051] In some embodiments, the first height H1 is in a range of 13 mm to 20 mm. In some embodiments, the first height H1 is in a range of 13 mm to 19 mm. In some embodiments, the first height H1 is in a range of 13 mm to 18 mm. In some embodiments, the first height H1 is in a range of 13 mm to 17 mm. In some embodiments, the first height H1 is in a range of 13 mm to 16 mm. In some embodiments, the first height H1 is in a range of 13 mm to 15 mm. In some embodiments, the first height H1 is in a range of 13 mm to 14 mm.

[0052] In some embodiments, the first height H1 is in a range of 14 mm to 20 mm. In some embodiments, the first height H1 is in a range of 14 mm to 19 mm. In some embodiments, the first height H1 is in a range of 14 mm to 18 mm. In some embodiments, the first height H1 is in a range of 14 mm to 17 mm. In some embodiments, the first height H1 is in a range of 14 mm to 16 mm. In some embodiments, the first height H1 is in a range of 14 mm to 15 mm.

[0053] In some embodiments, the first height H1 is in a range of 15 mm to 20 mm. In some embodiments, the first height H1 is in a range of 15 mm to 19 mm. In some embodiments, the first height H1 is in a range of 15 mm to 18 mm. In some embodiments, the first height H1 is in a range of 15 mm to 17 mm. In some embodiments, the first height H1 is in a range of 15 mm to 16 mm.

[0054] In some embodiments, the first height H1 is in a range of 16 mm to 20 mm. In some embodiments, the first height H1 is in a range of 16 mm to 19 mm. In some embodiments, the first height H1 is in a range of 16 mm to 18 mm. In some embodiments, the first height H1 is in a range of 16 mm to 17 mm.

[0055] In some embodiments, the first height H1 is in a range of 17 mm to 20 mm. In some embodiments, the first height H1 is in a range of 17 mm to 19 mm. In some embodiments, the first height H1 is in a range of 17 mm to 18 mm. In some embodiments, the first height H1 is in a range of 18 mm to 20 mm. In some embodiments, the first height H1 is in a range of 18 mm to 19 mm. In some embodiments, the first height H1 is in a range of 19 mm to 20 mm.

[0056] In some embodiments, the first height H1 is 10 mm. In some embodiments, the first height H1 is 11 mm. In some embodiments, the first height H1 is 12 mm. In some embodiments, the first height H1 is 13 mm. In some embodiments, the first height H1 is 14 mm. In some embodiments, the first height H1 is 15 mm. In some embodiments, the first height H1 is 16 mm. In some embodiments, the first height H1 is 17 mm. In some embodiments, the first height H1 is 18 mm. In some embodiments, the first height H1 is 19 mm. In some embodiments, the first height H1 is 20 mm.

[0057] In some embodiments, the second height H2 is in a range of 1 mm to 5 mm. In some embodiments, the second height H2 is in a range of 1 mm to 4 mm. In some embodiments, the second height H2 is in a range of 1 mm to 3 mm. In some embodiments, the second height H2 is in a range of 1 mm to 2 mm.

[0058] In some embodiments, the second height H2 is in a range of 2 mm to 5 mm. In some embodiments, the second height H2 is in a range of 2 mm to 4 mm. In some embodiments, the second height H2 is in a range of 2 mm to 3 mm. In some embodiments, the second height H2 is in a range of 3 mm to 5 mm. In some embodiments, the second height H2 is in a range of 3 mm to 4 mm. In some embodiments, the second height H2 is in a range of 4 mm to 5 mm.

[0059] In some embodiments, the second height H2 is 1 mm. In some embodiments, the second height H2 is 2 mm. In some embodiments, the second height H2 is 3 mm. In some embodiments, the second height H2 is 4 mm. In some embodiments, the second height H2 is 5 mm.

[0060] In some embodiments, the third height H3 is in a range of 15 mm to 25 mm. In some embodiments, the third height H3 is in a range of 15 mm to 24 mm. In some embodiments, the third height H3 is in a range of 15 mm to 23 mm. In some embodiments, the third height H3 is in a range of 15 mm to 22 mm. In some embodiments, the third height H3 is in a range of 15 mm to 21 mm. In some embodiments, the third height H3 is in a range of 15 mm to 20 mm. In some embodiments, the third height H3 is in a range of 15 mm to 19 mm. In some embodiments, the third height H3 is in a range of 15 mm to 18 mm. In some embodiments, the third height H3 is in a range of 15 mm to 17 mm. In some embodiments, the third height H3 is in a range of 15 mm to 16 mm.

[0061] In some embodiments, the third height H3 is in a range of 16 mm to 25 mm. In some embodiments, the third height H3 is in a range of 16 mm to 24 mm. In some embodiments, the third height H3 is in a range of 16 mm to 23 mm. In some embodiments, the third height H3 is in a range of 16 mm to 22 mm. In some embodiments, the third height H3 is in a range of 16 mm to 21 mm. In some embodiments, the third height H3 is in a range of 16 mm to 20 mm. In some embodiments, the third height H3 is in a range of 16 mm to 19 mm. In some embodiments, the third height H3 is in a range of 16 mm to 18 mm. In some embodiments, the third height H3 is in a range of 16 mm to 17 mm.

[0062] In some embodiments, the third height H3 is in a range of 17 mm to 25 mm. In some embodiments, the third height H3 is in a range of 17 mm to 24 mm. In some embodiments, the third height H3 is in a range of 17 mm to 23 mm. In some embodiments, the third height H3 is in a range of 17 mm to 22 mm. In some embodiments, the third height H3 is in a range of 17 mm to 21 mm. In some embodiments, the third height H3 is in a range of 17 mm to 20 mm. In some embodiments, the third height H3 is in a range of 17 mm to 19 mm. In some embodiments, the third height H3 is in a range of 17 mm to 18 mm.

[0063] In some embodiments, the third height H3 is in a range of 18 mm to 25 mm. In some embodiments, the third height H3 is in a range of 18 mm to 24 mm. In some embodiments, the third height H3 is in a range of 18 mm to 23 mm. In some embodiments, the third height H3 is in a range of 18 mm to 22 mm. In some embodiments, the third height H3 is in a range of 18 mm to 21 mm. In some

embodiments, the third height H3 is in a range of 18 mm to 20 mm. In some embodiments, the third height H3 is in a range of 18 mm to 19 mm.

[0064] In some embodiments, the third height H3 is in a range of 19 mm to 25 mm. In some embodiments, the third height H3 is in a range of 19 mm to 24 mm. In some embodiments, the third height H3 is in a range of 19 mm to 23 mm. In some embodiments, the third height H3 is in a range of 19 mm to 22 mm. In some embodiments, the third height H3 is in a range of 19 mm to 21 mm. In some embodiments, the third height H3 is in a range of 19 mm to 20 mm.

[0065] In some embodiments, the third height H3 is in a range of 20 mm to 25 mm. In some embodiments, the third height H3 is in a range of 20 mm to 24 mm. In some embodiments, the third height H3 is in a range of 20 mm to 23 mm. In some embodiments, the third height H3 is in a range of 20 mm to 22 mm. In some embodiments, the third height H3 is in a range of 20 mm to 21 mm.

[0066] In some embodiments, the third height H3 is in a range of 21 mm to 25 mm. In some embodiments, the third height H3 is in a range of 21 mm to 24 mm. In some embodiments, the third height H3 is in a range of 21 mm to 23 mm. In some embodiments, the third height H3 is in a range of 21 mm to 22 mm.

[0067] In some embodiments, the third height H3 is in a range of 22 mm to 25 mm. In some embodiments, the third height H3 is in a range of 22 mm to 24 mm. In some embodiments, the third height H3 is in a range of 22 mm to 23 mm. In some embodiments, the third height H3 is in a range of 23 mm to 25 mm. In some embodiments, the third height H3 is in a range of 23 mm to 24 mm. In some embodiments, the third height H3 is in a range of 24 mm to 25 mm.

[0068] In some embodiments, the third height H3 is 15 mm. In some embodiments, the third height H3 is 16 mm. In some embodiments, the third height H3 is 17 mm. In some embodiments, the third height H3 is 18 mm. In some embodiments, the third height H3 is 19 mm. In some embodiments, the third height H3 is 20 mm. In some embodiments, the third height H3 is 21 mm. In some embodiments, the third height H3 is 22 mm. In some embodiments, the third height H3 is 23 mm. In some embodiments, the third height H3 is 24 mm. In some embodiments, the third height H3 is 25 mm.

[0069] In some embodiments, the fourth height H4 is in a range of 5 mm to 15 mm. In some embodiments, the fourth height H4 is in a range of 5 mm to 14 mm. In some embodiments, the fourth height H4 is in a range of 5 mm to 13 mm. In some embodiments, the fourth height H4 is in a range of 5 mm to 12 mm. In some embodiments, the fourth height H4 is in a range of 5 mm to 11 mm. In some embodiments, the fourth height H4 is in a range of 5 mm to 10 mm. In some embodiments, the fourth height H4 is in a range of 5 mm to 9 mm. In some embodiments, the fourth height H4 is in a range of 5 mm to 8 mm. In some embodiments, the fourth height H4 is in a range of 5 mm to 7 mm. In some embodiments, the fourth height H4 is in a range of 5 mm to 6 mm.

[0070] In some embodiments, the fourth height H4 is in a range of 6 mm to 15 mm. In some embodiments, the fourth height H4 is in a range of 6 mm to 14 mm. In some embodiments, the fourth height H4 is in a range of 6 mm to 13 mm. In some embodiments, the fourth height H4 is in a range of 6 mm to 12 mm. In some embodiments, the fourth height H4 is in a range of 6 mm to 11 mm. In some embodiments, the fourth height H4 is in a range of 6 mm to 10 mm. In some embodiments, the fourth height H4 is in a range of 6 mm to 9 mm. In some embodiments, the fourth height H4 is in a range of 6 mm to 8 mm. In some embodiments, the fourth height H4 is in a range of 6 mm to 7 mm.

[0071] In some embodiments, the fourth height H4 is in a range of 7 mm to 15 mm. In some embodiments, the fourth height H4 is in a range of 7 mm to 14 mm. In some embodiments, the fourth height H4 is in a range of 7 mm to 13 mm. In some embodiments, the fourth height H4 is in a range of 7 mm to 12 mm. In some embodiments, the fourth height H4 is in a range of 7 mm to 11 mm. In some embodiments, the fourth height H4 is in a range of 7 mm to 10 mm. In some embodiments, the fourth height H4 is in a range of 7 mm to 9 mm. In some embodiments, the fourth height H4 is in a range of 7 mm to 8 mm.

[0072] In some embodiments, the fourth height H4 is in a range of 8 mm to 15 mm. In some embodiments, the fourth height H4 is in a range of 8 mm to 14 mm. In some embodiments, the fourth height H4 is in a range of 8 mm to 13 mm. In some embodiments, the fourth height H4 is in a range of 8 mm to 12 mm. In some embodiments, the fourth height H4 is in a range of 8 mm to 11 mm. In some embodiments, the fourth height H4 is in a range of 8 mm to 10 mm. In some embodiments, the fourth height H4 is in a range of 8 mm to 9 mm.

[0073] In some embodiments, the fourth height H4 is in a range of 9 mm to 15 mm. In some embodiments, the fourth height H4 is in a range of 9 mm to 14 mm. In some embodiments, the fourth height H4 is in a range of 9 mm to 13 mm. In some embodiments, the fourth height H4 is in a range of 9 mm to 12 mm. In some embodiments, the fourth height H4 is in a range of 9 mm to 11 mm. In some embodiments, the fourth height H4 is in a range of 9 mm to 10 mm.

[0074] In some embodiments, the fourth height H4 is in a range of 10 mm to 15 mm. In some embodiments, the fourth height H4 is in a range of 10 mm to 14 mm. In some embodiments, the fourth height H4 is in a range of 10 mm to 13 mm. In some embodiments, the fourth height H4 is in a range of 10 mm to 12 mm. In some embodiments, the fourth height H4 is in a range of 10 mm to 11 mm.

[0075] In some embodiments, the fourth height H4 is in a range of 11 mm to 15 mm. In some embodiments, the fourth height H4 is in a range of 11 mm to 14 mm. In some embodiments, the fourth height H4 is in a range of 11 mm to 13 mm. In some embodiments, the fourth height H4 is in a range of 11 mm to 12 mm.

[0076] In some embodiments, the fourth height H4 is in a range of 12 mm to 15 mm. In some embodiments, the fourth height H4 is in a range of 12 mm to 14 mm. In some embodiments, the fourth height H4 is in a range of 12 mm to 13 mm. In some embodiments, the fourth height H4 is in a range of 13 mm to 15 mm. In some embodiments, the fourth height H4 is in a range of 13 mm to 14 mm. In some embodiments, the fourth height H4 is in a range of 14 mm to 15 mm.

[0077] In some embodiments, the fourth height H4 is 5 mm. In some embodiments, the fourth height H4 is 6 mm. In some embodiments, the fourth height H4 is 7 mm. In some embodiments, the fourth height H4 is 8 mm. In some

embodiments, the fourth height H4 is 9 mm. In some embodiments, the fourth height H4 is 10 mm. In some embodiments, the fourth height H4 is 11 mm. In some embodiments, the fourth height H4 is 12 mm. In some embodiments, the fourth height H4 is 13 mm. In some embodiments, the fourth height H4 is 14 mm. In some embodiments, the fourth height H4 is 15 mm.

[0078] In some embodiments, the solar module **16** and the ledge **86** form a second space **88** therebetween. In some embodiments, the second space **88** of one **10***a* of the photovoltaic modules **10** is sized and shaped to receive the first edge **27** of the solar module **16** of another **10***b* photovoltaic module **10** and interlock the photovoltaic modules **10***a*, **10***b*. In some embodiments, the solar module **16** of the photovoltaic module **10***a* overlays and holds-down the first edge **27** of the solar module **16** of the photovoltaic module **10***b*. In some embodiments, the interlocked photovoltaic modules **10***a*, **10***b* promote watershedding.

[0079] In some embodiments, the photovoltaic modules **10***a*, **10***b* are installed on a roof deck by a plurality of fasteners **90**. In some embodiments, the mat **12** is configured to receive the plurality of fasteners **90**. In some embodiments, the plurality of fasteners **90** includes a plurality of nails. In some embodiments, the mat **12** includes a head lap **92**. In some embodiments, the head lap **92** is configured to receive the plurality of nails. In some embodiments, the second edge **60** of the spacer **14** is attached to the roof deck by an adhesive **94**. In certain embodiments, the adhesive **94** includes polyvinyl butyrate, acrylic, silicone, polycarbonate, or pressure sensitive adhesives.

[0080] In some embodiments, the spacer **14** of one of the photovoltaic modules **10** overlays the mat **12** of another of the photovoltaic modules **10**. In some embodiments, the spacer **14** of one of the photovoltaic modules **10** overlays the head lap **92** of the mat **12** of another of the photovoltaic modules **10**.

[0081] Referring to FIGS. **9** and **10**, in an embodiment, a starter bar **96** is engaged with the ledge **86** of the spacer **14** of one of the photovoltaic modules **10**. In some embodiments, the starter bar **96** includes a base **98**, a front wall **99** extending from the base **98**, an upper rail **100** extending from the front wall, and a channel **102** formed by the base **98**, the front wall **99** and the upper rail **100**. In some embodiments, the front wall **99** extends substantially perpendicular to the base **98**. In some embodiments, the upper rail **100** extends substantially parallel to the base **98**. In some embodiments, the starter bar **96** includes a C-shaped cross-section. In some embodiments, the channel **102** is sized and shaped to receive the second edge **60** of the spacer **14**, such that the second edge **60** is positioned therein intermediate the base **98** and the upper rail **100**. In some embodiments, the upper rail **100** is configured to be positioned intermediate the ledge **86** of the spacer **14** and the second edge **29** of the solar module **16**. In some embodiments, the starter bar **96** is installed on the roof deck. In some embodiments, the base **98** of the starter bar **96** is attached to the roof deck. In some embodiments, the base **98** is attached to the roof deck by a plurality of the nails **90**. In some embodiments, FIG. **11** shows a system of a plurality of photovoltaic modules **10** and a plurality of the roofing shingles **44** installed on a roof deck **104**.

[0082] In some embodiments, the spacer **14** is composed of plastic. In some embodiments, the spacer **14** is composed of a polymer. In some embodiments, the polymer is a thermoformed polymer. In some embodiments, the polymer is an injection molded polymer. In some embodiments, the spacer **14** is ultrasonically welded to the mat **12**. In some embodiments, the spacer **14** is heat welded to the mat **12**. In some embodiments, the spacer **14** is thermally bonded to the mat **12**. In some embodiments, the spacer **14** is attached to the mat **12** by an adhesive. In some embodiments, the spacer **14** and the mat **12** are integral with one another. In some embodiments, the solar module **16** is ultrasonically welded to the spacer **14**. In some embodiments, the solar module **16** is removably attached to the spacer **14**. In some embodiments, the solar module **16** is heat welded to the spacer **14**. In some embodiments, the solar module **16** is thermally bonded to the spacer **14**. In some embodiments, the solar module **16** is attached to the spacer **14** by an adhesive. In some embodiments, the spacer **14** is composed of metal. In some embodiments, the spacer **14** is composed of aluminum.

[0083] Referring to FIGS. **12**A through **12**C, in another embodiment, a photovoltaic module **210** includes a spacer **214** and a solar module **216** attached to the spacer **214**. In some embodiments, the spacer **214** includes a plurality of support members **218**. In some embodiments, the spacer **114** includes at least one tab **221** extending outwardly from a first edge **258** thereof. In some embodiments, the at least one tab **221** extends from a corresponding one of the plurality of support members **218**. In some embodiments, the at least one tab **221** includes a plurality of the tabs **221**. In some embodiments, the at least one tab **221** is configured to receive a fastener. In some embodiments, the fastener includes a nail. In some embodiments, the spacer **214** is composed of metal. In some embodiments, the spacer **214** is composed of sheet metal.

[0084] Referring to FIGS. **13**A through **13**C, in another embodiment, a photovoltaic module **310** includes a spacer **314** and a solar module **316** attached to the spacer **314**. In some embodiments, the spacer **314** includes a plurality of support members **318**. In some embodiments, the spacer **314** includes at least one tab **321** extending outwardly from a first edge **358** thereof. In some embodiments, the at least one tab **321** extends from a corresponding one of the plurality of support members **318**. In some embodiments, the at least one tab **321** includes a plurality of the tabs **321**. In some embodiments, the at least one tab **321** is configured to receive a fastener. In some embodiments, the fastener includes a nail. In some embodiments, the spacer **314** is composed of plastic. In some embodiments, the spacer **314** is injection molded. Referring to FIG. **14**, a side lap **311** extends between two of adjacent photovoltaic modules **310***a*, **310***b*. In some embodiments, the side lap **311** is located intermediate the spacer **314** and the solar module **316** of each of the photovoltaic modules **310***a*, **310***b*.

[0085] Referring to FIGS. **15**A through **16**C, in another embodiment, a photovoltaic module **410** includes a spacer **414** and at least two solar modules **416***a*, **416***b* attached to the spacer **414**. In some embodiments, the solar modules **416***a*, **416***b* are aligned in rows. In some embodiments, the spacer **414** includes a plurality of support members **418**. In some embodiments, the spacer **414** includes at least one tab **421** extending outwardly from a first edge **458** thereof. In some embodiments, the at least one tab **421** includes a plurality of the tabs **421**. In some embodiments, the at least one tab **421** is configured to receive a fastener. In some embodiments, the fastener includes a nail. In some embodi-

ments, the spacer **414** includes sidewalls **415***a*, **415***b* that enclose the photovoltaic module **410** when it is installed on roof deck.

[0086] Referring to FIGS. **17** through **19**B, in an embodiment, at least one trim element **106** is attached to at least one of the first and second ends **26**, **28** of the solar module **16**. In some embodiments, the trim element **106** is clipped to the at least one of the first and second ends **26**, **28**. In some embodiments, the trim element **106** includes an upper surface **108**. In some embodiments, the upper surface **108** is oblique relative to the first surface **22** of the solar module **16**. In some embodiments, the solar module **16** includes a corner **110** formed by the first end **26** and the first edge **27** and the trim element **106** is attached to the corner **110**. In other embodiments, the corner **110** may be formed by the first edge **27** and the second edge **29**, the second end **28** and the first edge **27**, or the second end **28** and the second edge **29**, one or more of which is configured to receive a corresponding trim element **106**. In some embodiments, the trim element **106** includes a curvilinear side surface **112**. In some embodiments, the trim element **106** includes flashing **114**. In some embodiments, at least one roofing shingle **116** overlays the upper surface **108** of the trim element **106**.

[0087] Referring to FIGS. **20** through **22**, in an embodiment, a roofing system **500** includes a photovoltaic module **510** configured to be installed on a roof deck **505**. In some embodiments, the photovoltaic module **510** includes at least one mat **512** configured to be installed to the roof deck **505**, at least one spacer **514** installed on the mat **512**, and at least one solar module **516** mounted to a corresponding one of the at least one spacer **514**. In some embodiments, the at least one spacer **514** includes a plurality of spacers **514**. In some embodiments, the at least one solar module **516** includes a plurality of solar modules **516** mounted to a corresponding one of the plurality of spacers **514**.

[0088] In some embodiments, the at least one mat **512** includes a first end **518** and a second end **520** opposite the first end **518**, a first edge **522** extending from the first end **518** to the second end **520**, and a second edge **524** opposite the first edge **522** and extending from the first end **518** to the second end **520**. In some embodiments, the at least one mat **512** includes a head lap **526**. In some embodiments, the at least one solar module **516** includes a first end **528** and a second end **530** opposite the first end **528**. In some embodiments, the first end **528** of the at least one solar module **516** is substantially aligned with the first end **518** of the at least one mat **512**, and the second end **530** of the at least one solar module **516** is substantially aligned with the at least one second end **520** of the mat **512**. In some embodiments, the second end **530** of the at least one solar module **516** is substantially aligned with the first end **518** of the at least one mat **512**, and the first end **528** of the at least one solar module **516** is substantially aligned with the at least one second end **520** of the mat **512** (see FIG. **22**). Referring to FIGS. **23** and **24**, in an embodiment, the first end **528** of the at least one solar module **516** is offset from the first end **518** of the at least one mat **512**, and the second end **530** of the at least one solar module **516** is offset from the second end **520** of the least one mat **512**. In some embodiments, at least one shingle section **532** overlays an exposed area **534** of the mat **512**.

[0089] In some embodiments, the at least one mat **512** includes a plurality of mats **512**. In some embodiments, the roofing system **500** includes a plurality of roofing shingles **544** installed adjacent to the at least one mat **512**.

[0090] Referring to FIGS. **25**A and **25**B, in an embodiment, the at least one mat **512** includes at least one first hook member **540**. In some embodiments, the photovoltaic module **510** includes at least one second hook member **542** engaged with a corresponding one of the at least one first hook member **540**. In some embodiments, the at least one first hook member **540** includes at least one pair of first hook members **540** and the at least one second hook member **542** includes at least one pair of second hook members **542**. In some embodiments, each of the at least one pair of first hook members **540** engages a corresponding one of the at least one pair of second hook members **542**. In some embodiments, each of the at least one pair of first hook members **540** is spaced apart from one another. In some embodiments, the at least one pair of second hook members **542** is spaced apart from one another. In some embodiments, the at least one pair of first hook members **540** includes a plurality of pairs of first hook members **540**. In some embodiments, each of the plurality of pairs of first hook members **540** is spaced apart from one another. In some embodiments, the plurality of pairs of first hook members **540** are aligned in rows.

[0091] Referring to FIGS. **26**A and **26**B, in an embodiment, a roofing system **600** includes a roofing layer **612** configured to be installed directly on a roof deck **605**. In some embodiments, the roofing layer **612** includes a roofing membrane. In some embodiments, the roofing membrane is configured to be rolled. In some embodiments, the roofing membrane is composed of a polymer. In some embodiments, the roofing membrane includes thermoplastic polyolefin (TPO). In other embodiments, the roofing membrane is composed of polyethylene terephthalate (PET), polyethylene naphthalate (PEN), polyetheretherketone (PEEK), polyaryletherketone (PAEK), polyarylate (PAR), polyetherimide (PEI), polyarylsulfone (PAS), polyethersulfone (PES), polyamideimide (PAI), or polyimide; polyvinyl chloride (PVC); ethylene propylene dicnc monomer (EPDM) rubber; silicone rubber; fluoropolymers-ethylene tetrafluoroethylene (ETFE), polyvinylidene fluoride (PVDF), tetrafluoroethylene-hexafluoropropylene copolymers (FEP), and tetrafluoroethylene-hexafluoropropylene-vinylidene fluoride copolymers (THV), or blends thereof. In some embodiments, the roofing layer **612** includes a first surface **614**.

[0092] In some embodiments, a plurality of hooks **650** is installed on the first surface **614** of the roofing layer **612**. In some embodiments, the system **600** includes a plurality of solar modules **616** configured to be attached to the plurality of hooks **650**. In some embodiments, each of the plurality of hooks **650** includes a double wing hook. In some embodiments, the plurality of hooks **650** is arranged in a defined pattern. In some embodiments, the pattern includes a plurality of rows and a plurality of columns. In some embodiments, the plurality of hooks **650** is arranged in a long-staggered pattern, as shown in FIGS. **26**A and **26**B. In some embodiments, the plurality of hooks **650** in each row of the long-staggered pattern are arranged and located in alternate columns. In some embodiments, the plurality of hooks **650** is arranged in a short-staggered pattern. In some embodiments, the plurality of hooks **650** in each column of the short-staggered pattern are arranged and located in alternate rows. In some embodiments, the plurality of hooks **650** is arranged in a square or rectangular pattern. In some embodiments, the plurality of hooks **650** in each row of the

long-staggered pattern are arranged and located in each column, and vice-versa. In some embodiments, the plurality of hooks **650** is arranged in a random pattern.

[0093] Referring to FIGS. **27** through **30**, in an embodiment, a roofing layer **712** includes at least one roofing shingle **720**. In some embodiments, the at least one roofing shingle **720** is installed on the roof deck **705** by a plurality of fasteners. In some embodiments, the at least one roofing shingle **720** includes a plurality of roofing shingles **720**. In some embodiments, the at least one shingle **720** includes a head lap **722**. In some embodiments, the head lap **722** is configured to receive the plurality of fasteners. In some embodiments, the plurality of fasteners includes a plurality of nails. In some embodiments, the at least one roofing shingle **720** is installed on the roof deck **705** by an adhesive. In some embodiments, one of the plurality of roofing shingles **720** overlays the head lap **722** of another of the plurality of roofing shingles **720**.

[0094] In some embodiments, a plurality of hooks **750** includes a mounting portion **752**, a pair of legs **754***a*, **754***b* extending from the mounting portion **752**, and a hook portion **756** extending from the mounting portion **752** and offset from the pair of legs **754***a*, **754***b* to form a slot **758** therebetween.

[0095] In some embodiments, the pair of legs **754***a*, **754***b* are spaced apart and substantially parallel to one another. In some embodiments, the hook portion **756** includes a first portion **755***a* extending in a first direction and second portion **755***b* extending in a second direction opposite the first direction. In some embodiments, a slot **757** is formed between the first and second portions **755***a*, **755***b*. In some embodiments, each of the legs **754***a*, **754***b* includes an extended portion **759** and a foot **760** having a raised portion **761** offset from the extended portion **759**. In some embodiments, a first edge **727** of one of the plurality of solar modules **716** engages the slot **758** of one of the plurality of hooks **750**, and a second edge **729** of the one of the plurality of solar modules **716** engages the hook portion **756** of at least another one of the plurality of hooks **750**. In some embodiments, the hook portion **756** is resiliently biased. In some embodiments, the mounting portion **752** is attached to the head lap **722** of the corresponding one of the plurality of roofing shingles **720**. In some embodiments, the mounting portion **752** is configured to receive at least one fastener. In some embodiments, the at least one fastener includes at least one nail.

[0096] It should be understood that the embodiments described herein are merely exemplary and 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.

What is claimed is:

1. A system, comprising:
- a roof deck;
- a plurality of photovoltaic modules installed on the roof deck,
  - wherein the plurality of photovoltaic modules is arranged in an array,
  - wherein the array includes
    - an upper side extending along the roof deck,
    - a lower side extending along the roof deck,
    - at least a first side extending between the upper side and the lower side, and
    - an upper surface,
    - wherein the upper surface extends in a first plane;
- at least one trim element installed on the roof deck,
  - wherein the at least one trim element includes a first trim element,
  - wherein the first trim element is proximate to the first side of the array; and
- a plurality of roofing shingles installed on the roof deck,
  - wherein each of the plurality of roofing shingles includes an upper surface,
  - wherein the plurality of roofing shingles includes a first roofing shingle,
  - wherein the first roofing shingle includes a first end,
  - wherein the first roofing shingle overlays the first trim element,
  - wherein at least a portion of the first roofing shingle extends in a second plane,
  - wherein the second plane is different from the first plane, and
  - wherein the upper surface of the array is above the upper surface of the first roofing shingle, and
  - wherein the first end of the first roofing shingle is adjacent to the upper surface of the array at the first plane.

2. The system of claim **1**, wherein the first trim element includes an upper surface, and wherein the at least a portion of the first roofing shingle overlays the upper surface of the first trim element.

3. The system of claim **1**, wherein each of the plurality of photovoltaic modules extends substantially in the first plane.

4. The system of claim **1**, wherein the second plane is oblique to the first plane.

5. The system of claim **1**, wherein the first roofing shingle is an asphalt shingle.

6. The system of claim **1**, wherein the plurality of photovoltaic modules includes a first photovoltaic module, and wherein the first trim element is clipped to the first photovoltaic module.

7. The system of claim **1**, wherein the array includes a second side extending between the upper side and the lower side, wherein the at least one trim element includes a second trim element, and wherein the second trim element is located proximate to the second side of the array.

8. The system of claim **7**, wherein the plurality of roofing shingles includes a second roofing shingle, and wherein at least a portion of the second roofing shingle overlays the second trim element.

9. The system of claim **8**, wherein the second trim element includes an upper surface, and wherein the at least a portion of the second roofing shingle overlays the upper surface of the second trim element.

10. The system of claim **8**, wherein the second roofing shingle is an asphalt shingle.

11. The system of claim **7**, wherein the plurality of photovoltaic modules includes a second photovoltaic module, wherein the second trim element is clipped to the second photovoltaic module.

12. A system, comprising:
- a roof deck;
- a plurality of photovoltaic modules installed on the roof deck,
  - wherein the plurality of photovoltaic modules is arranged in an array,
  - wherein the array includes

an upper side extending along the roof deck,
a lower side extending along the roof deck,
a first side extending between the upper side and the lower side,
a second side extending between the upper side and the lower side, and
an upper surface,
wherein the upper surface extends in a first plane;
a plurality of trim elements installed on the roof deck,
wherein the plurality of trim elements includes a first trim element and a second trim element,
wherein the first trim element is proximate to the first side of the array,
wherein the second trim element is proximate to the second side of the array; and
a plurality of roofing shingles installed on the roof deck,
wherein each of the plurality of roofing shingles includes an upper surface and a first end,
wherein the plurality of roofing shingles includes a first roofing shingle and a second roofing shingle,
wherein the first roofing shingle overlays the first trim element,
wherein at least a portion of the first roofing shingle extends in a second plane, and
wherein the second plane is different from the first plane,
wherein the second roofing shingle overlays the second trim element,
wherein at least a portion of the second roofing shingle extends in a third plane,
and wherein the third plane is different from the first plane,
wherein the upper surface of the array is above the upper surface of the first roofing shingle and the upper surface of the second roofing shingle,
wherein the first end of the first roofing shingle is adjacent to the upper surface of the array at the first plane, and
wherein the first end of the second roofing shingle is adjacent to the upper surface of the array at the first plane.

13. The system of claim **12**, wherein each of the first trim element and the second trim element includes an upper surface, wherein the at least a portion of the first roofing shingle overlays the upper surface of the first trim element, and wherein the at least a portion of the second roofing shingle overlays the upper surface of the second trim element.

14. The system of claim **12**, wherein each of the plurality of photovoltaic modules extends substantially in the first plane.

15. The system of claim **12**, wherein the second plane is oblique to the first plane.

16. The system of claim **12**, wherein the third plane is oblique to the first plane.

17. The system of claim **12**, wherein each of the first roofing shingle and the second roofing shingle is an asphalt shingle.

18. The system of claim **12**, wherein the plurality of photovoltaic modules includes a first photovoltaic module and a second photovoltaic module, wherein the first trim element is clipped to the first photovoltaic module, and wherein the second trim element is clipped to the second photovoltaic module.

19. A system, comprising:
a roof deck;
a plurality of photovoltaic modules installed on the roof deck,
wherein the plurality of photovoltaic modules is arranged in an array,
wherein the array includes
an upper side extending along the roof deck,
a lower side extending along the roof deck,
at least a first side extending between the upper side and the lower side, and
an upper surface,
wherein the upper surface extends in a first plane;
at least one trim element installed on the roof deck,
wherein the at least one trim element includes a first trim element,
wherein the first trim element is proximate to the first side of the array; and
a plurality of roofing shingles installed on the roof deck,
wherein each of the plurality of roofing shingles includes an upper surface,
wherein the plurality of roofing shingles includes a first roofing shingle,
wherein the first roofing shingle includes a first end,
wherein the first roofing shingle overlays the first trim element,
wherein at least a portion of the first roofing shingle extends in a second plane,
wherein the second plane is different from the first plane, and
wherein the upper surface of the array is above the upper surface of the first roofing shingle, and
wherein the first end of the first roofing shingle intersects the upper surface of the array at the first plane.

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