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(54) **SOLAR PANEL ROOF KIT**

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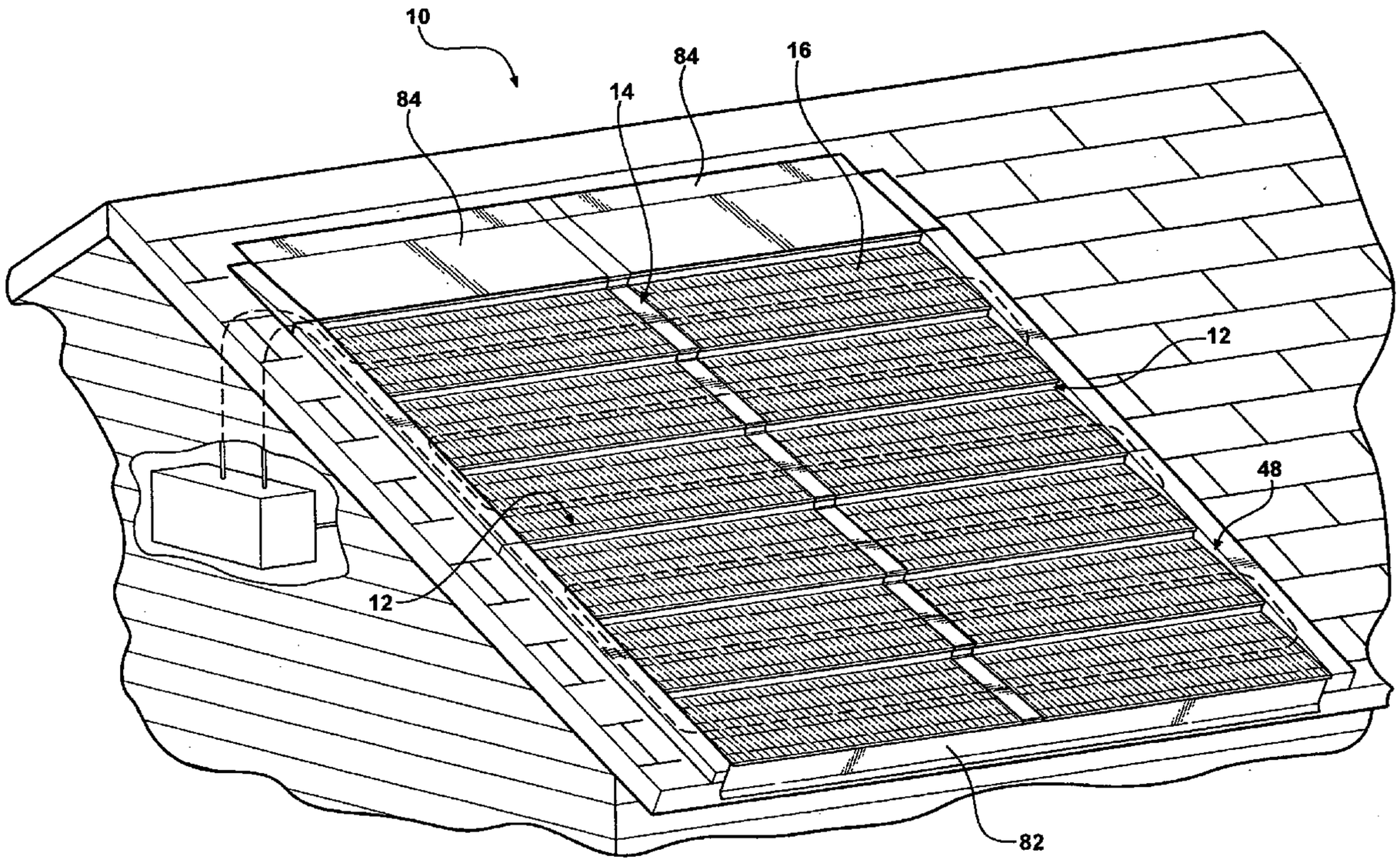
(57) **ABSTRACT**

A solar roofing kit for placing over a section of roof deck to generate electricity. The kit comprises at least one elongated strip of flexible photovoltaic material having a predetermined length and at least one panel supporting the strip. The panels have a riser or rib that extends generally perpendicularly away from the edge to engage and elevate a part of an adjacent panel. The kit also includes at least one side flashing for extending along and sealing at least one of the left and right edges of a panel; at least one splice plate for interconnecting adjacent left and right edges of two panels; at least one top flashing for extending along and sealing the top edge of a panel; and at least one bottom flashing for extending along and sealing the bottom edge of a panel.



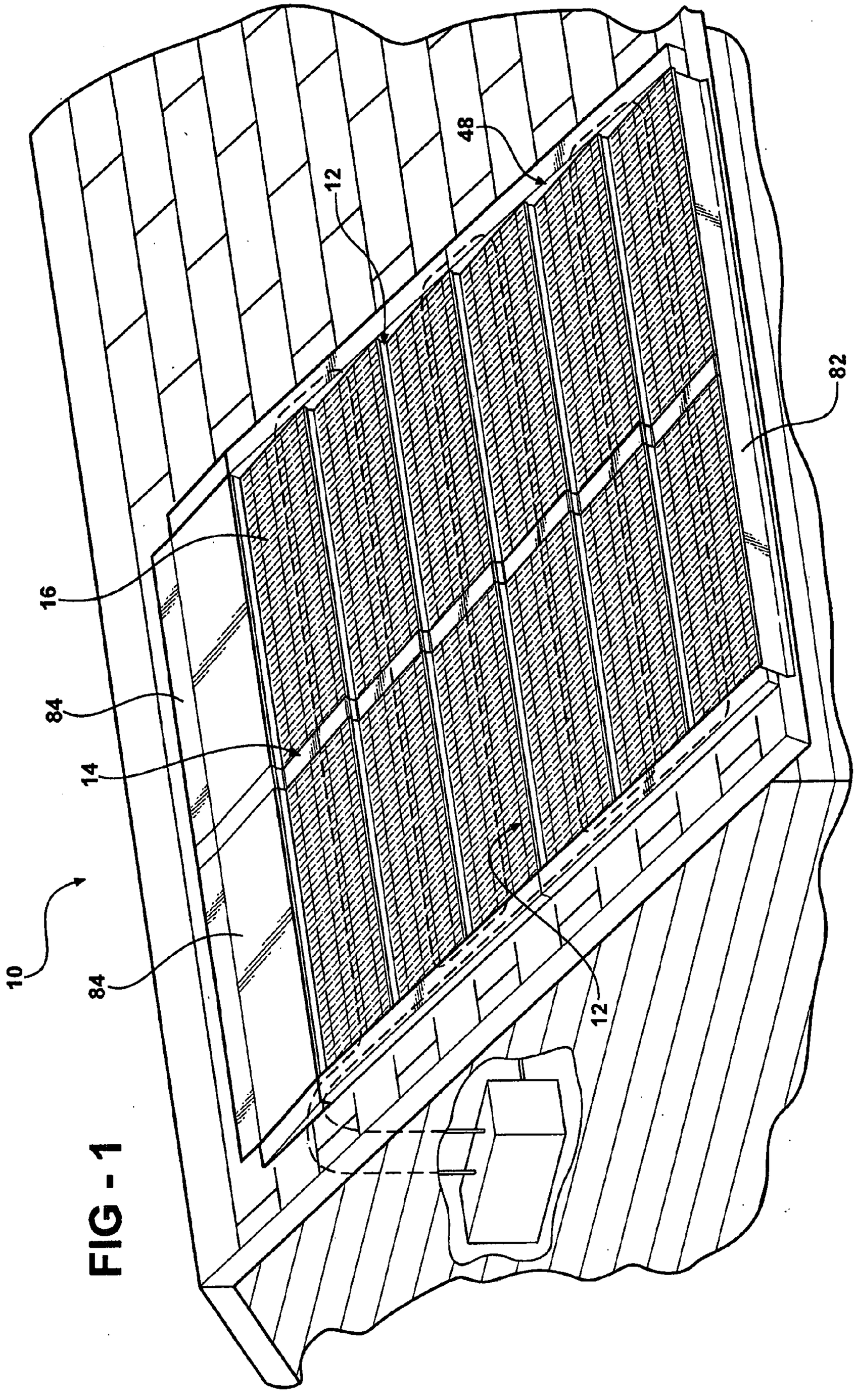


FIG - 1

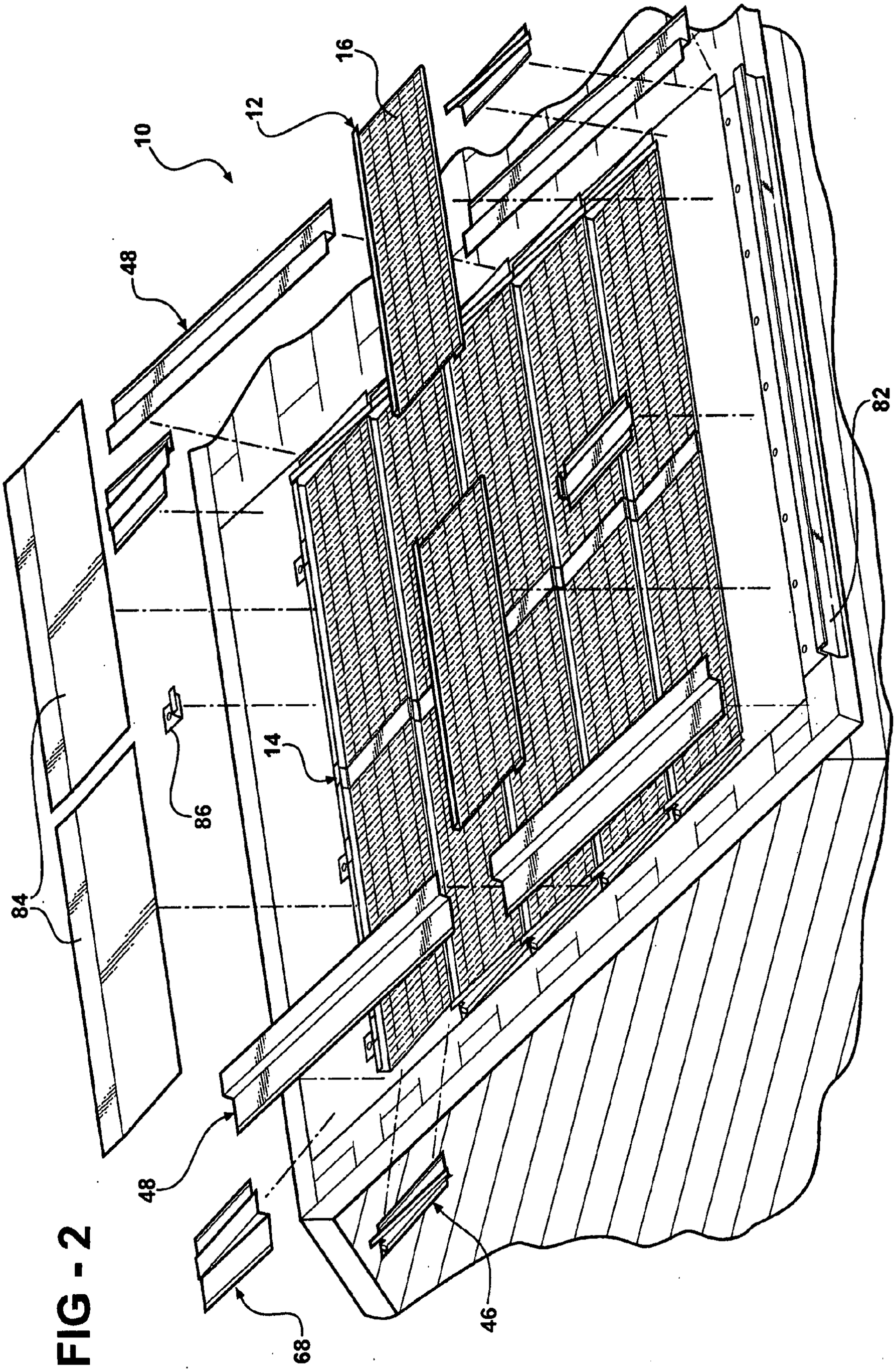


FIG - 2

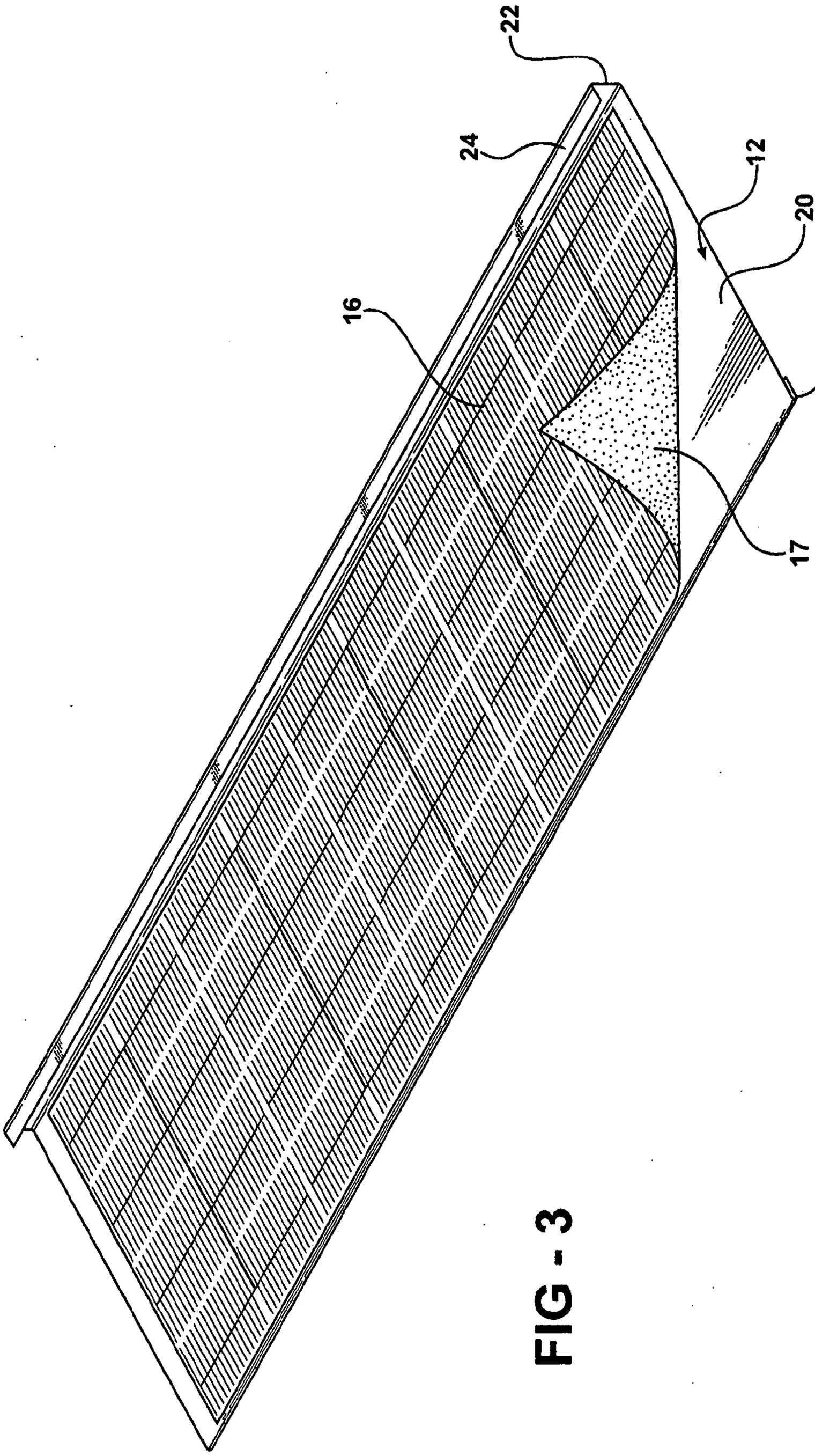


FIG - 3

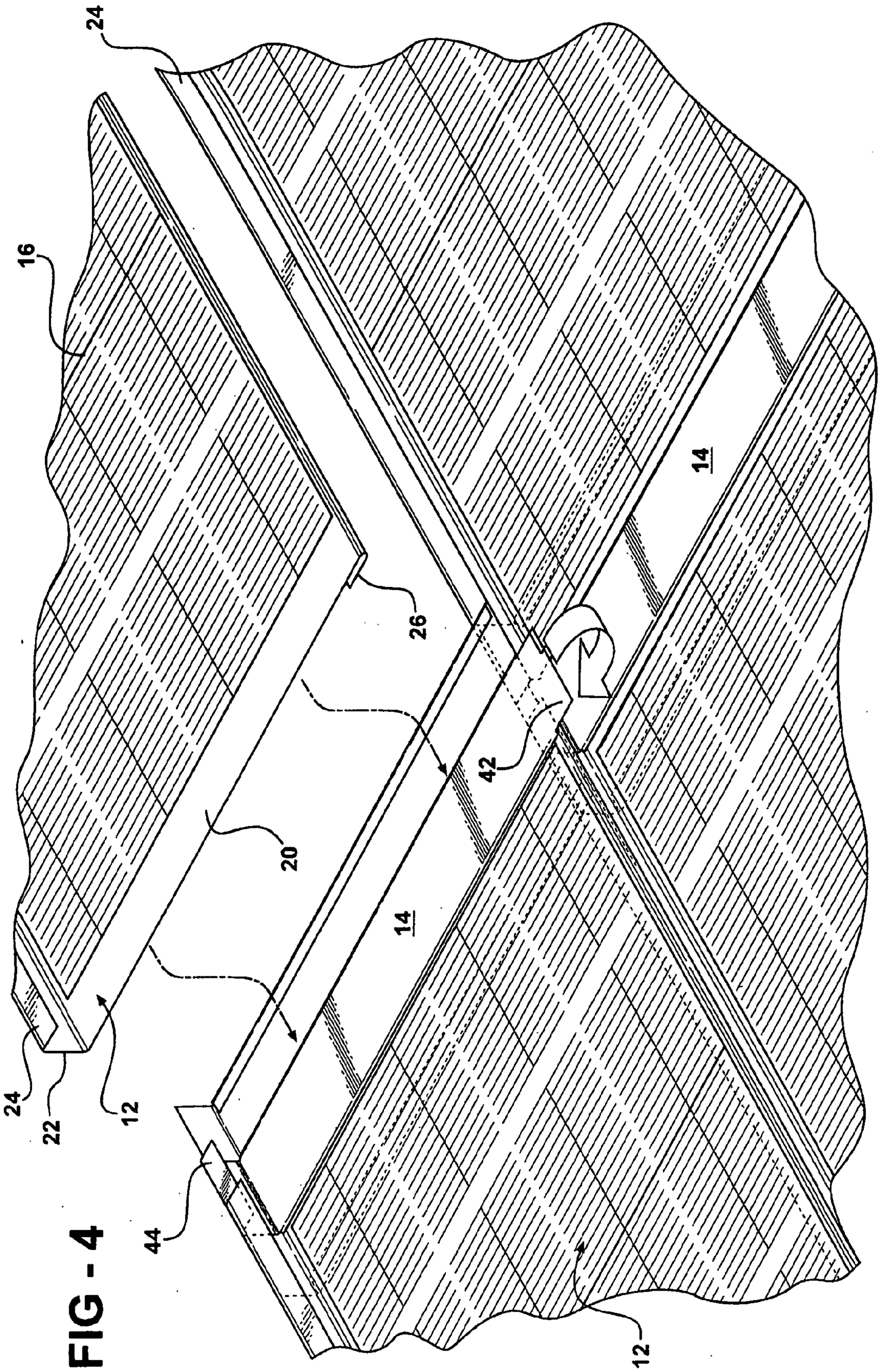


FIG - 4

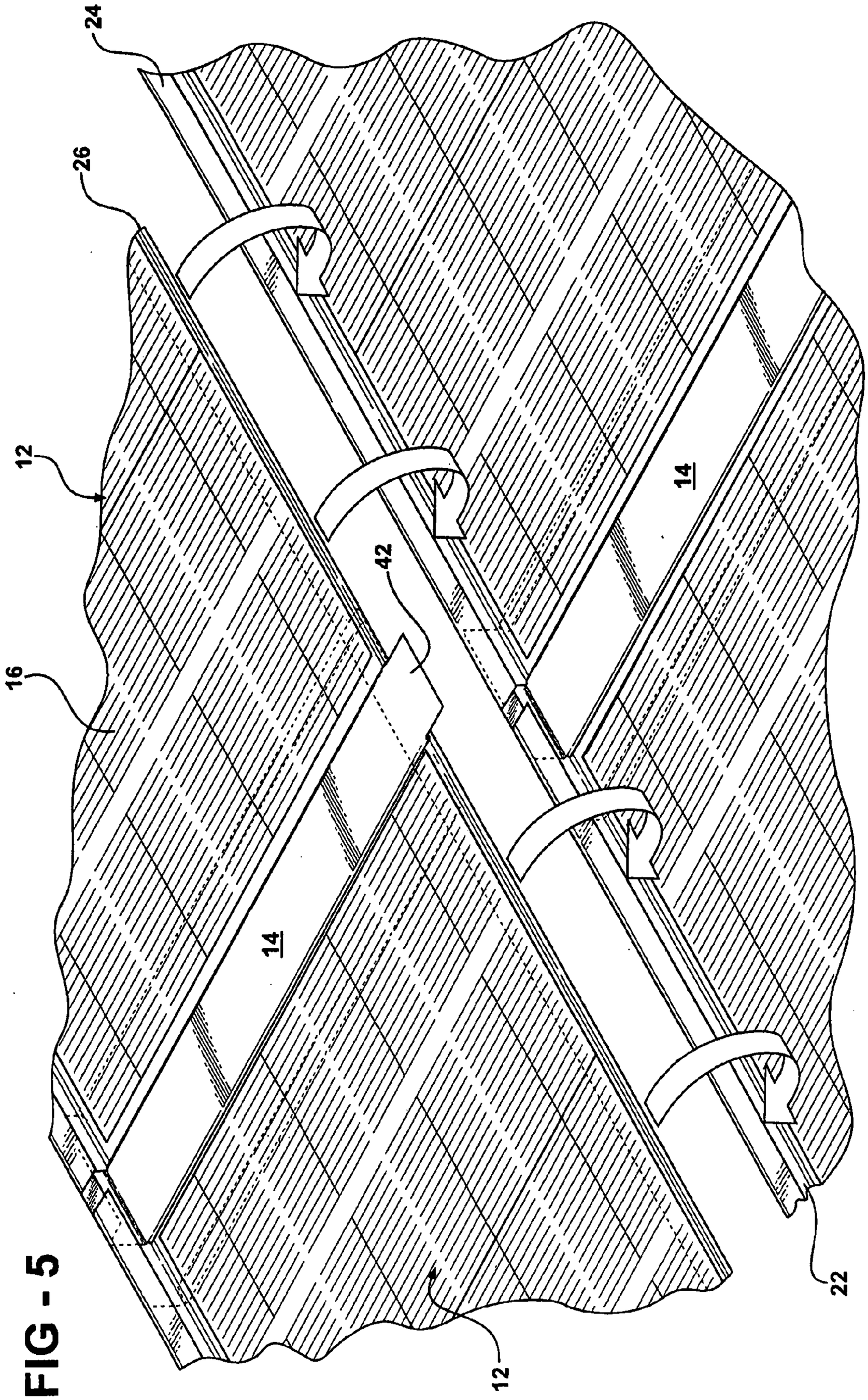


FIG - 5

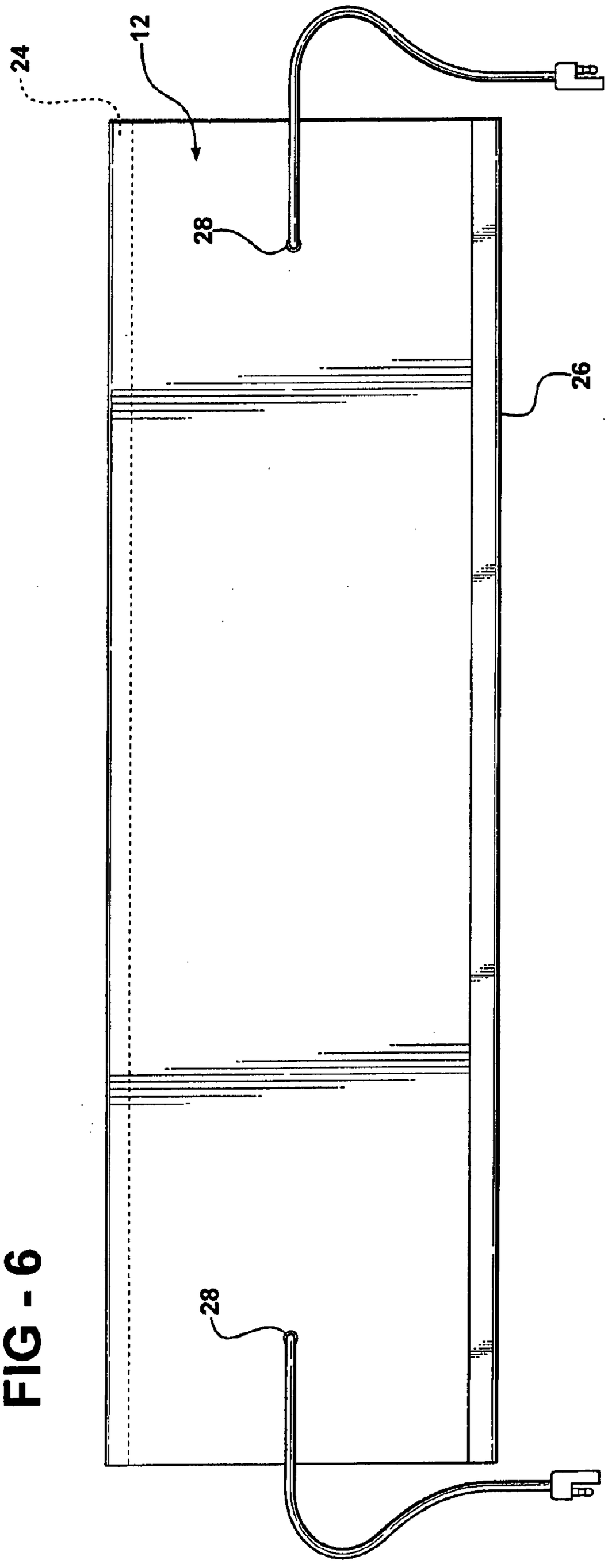
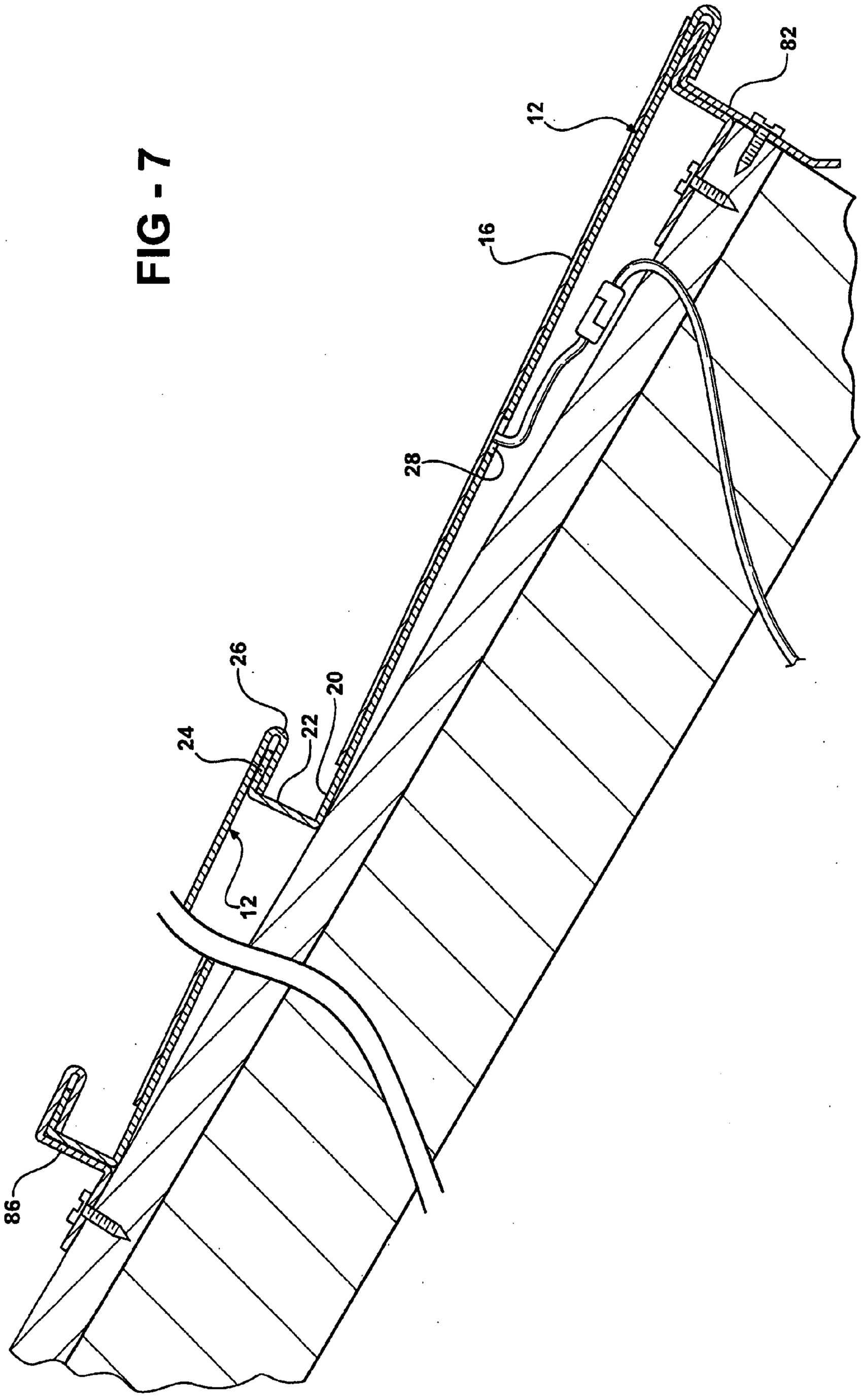


FIG - 6

FIG - 7



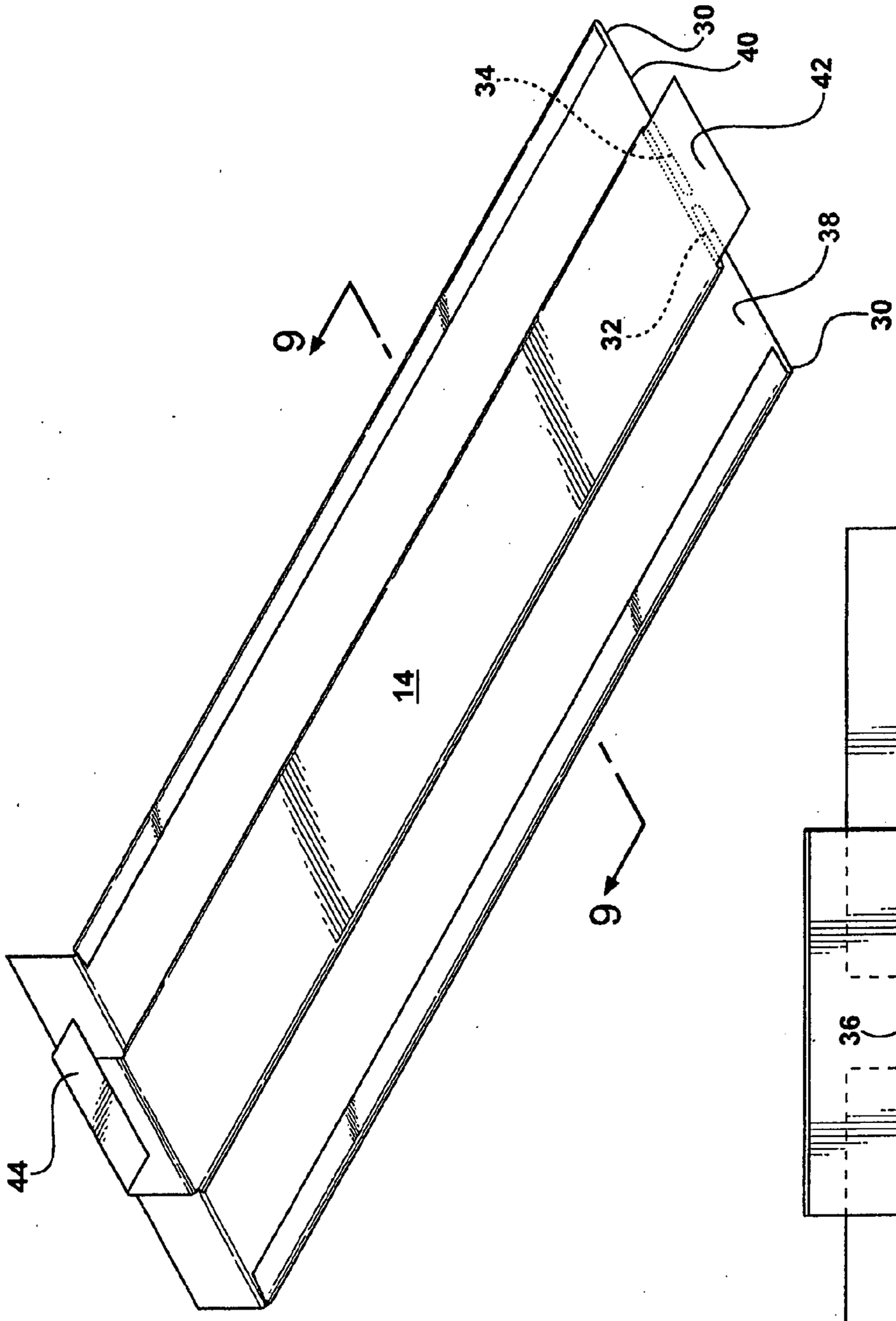


FIG - 8

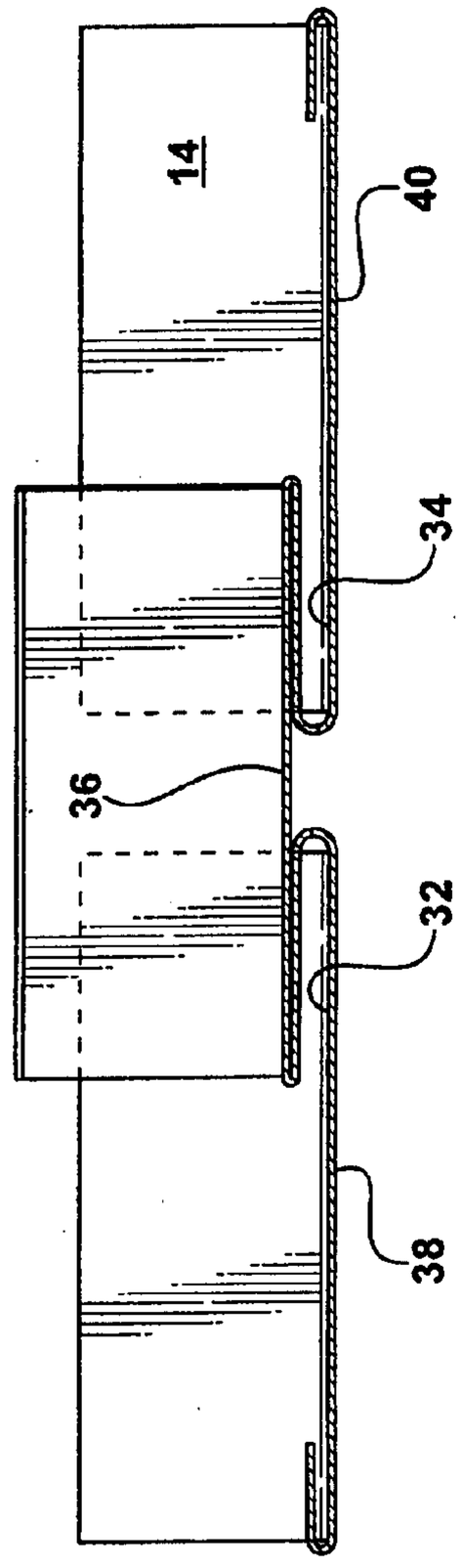


FIG - 9

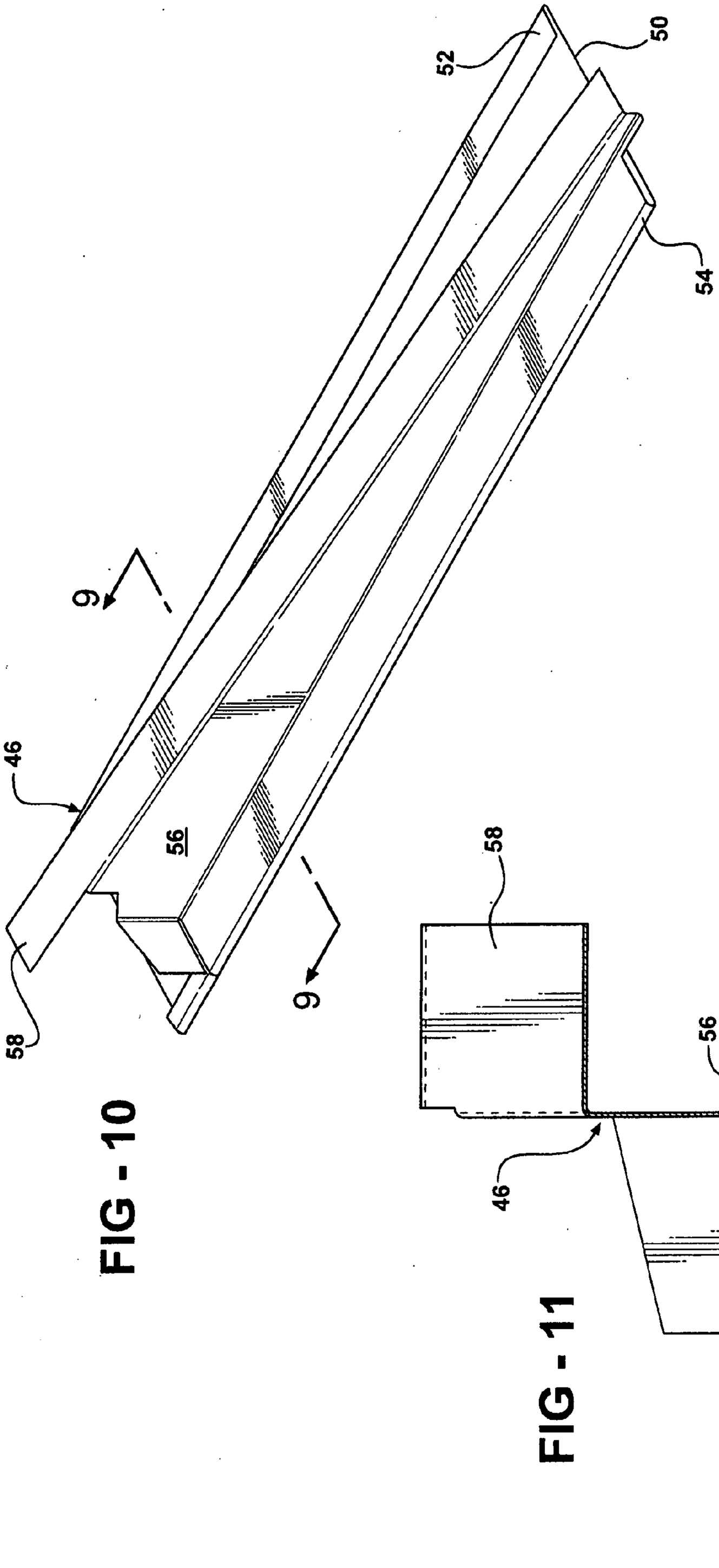


FIG - 10

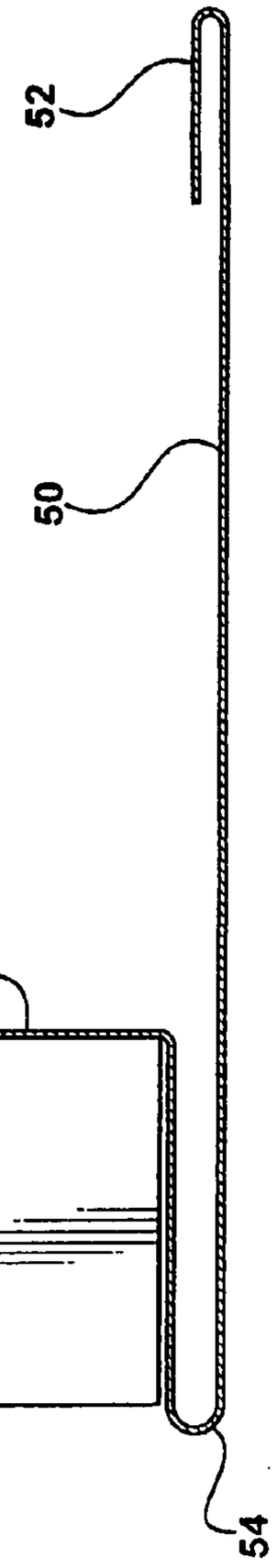


FIG - 11

FIG - 12

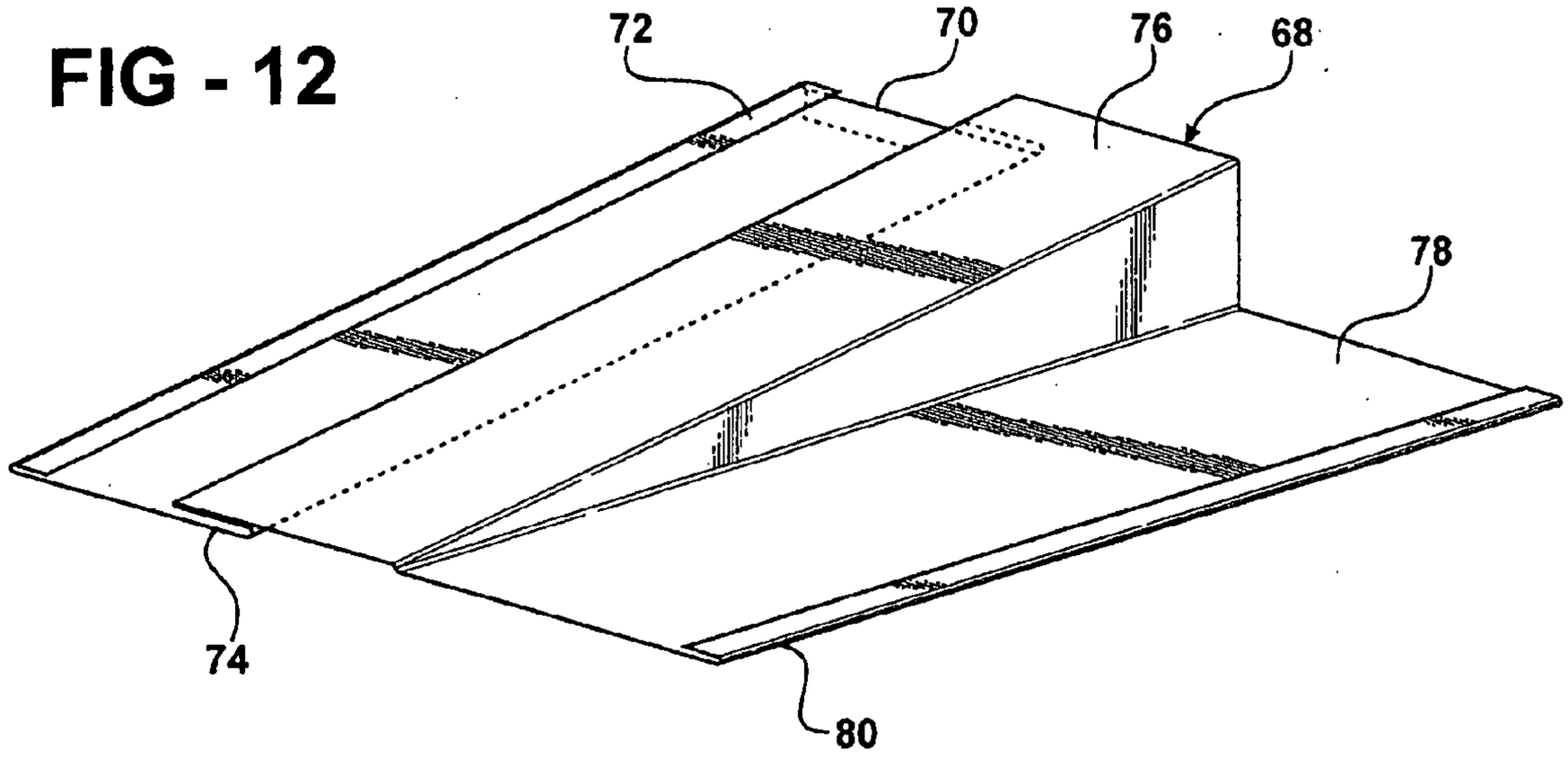
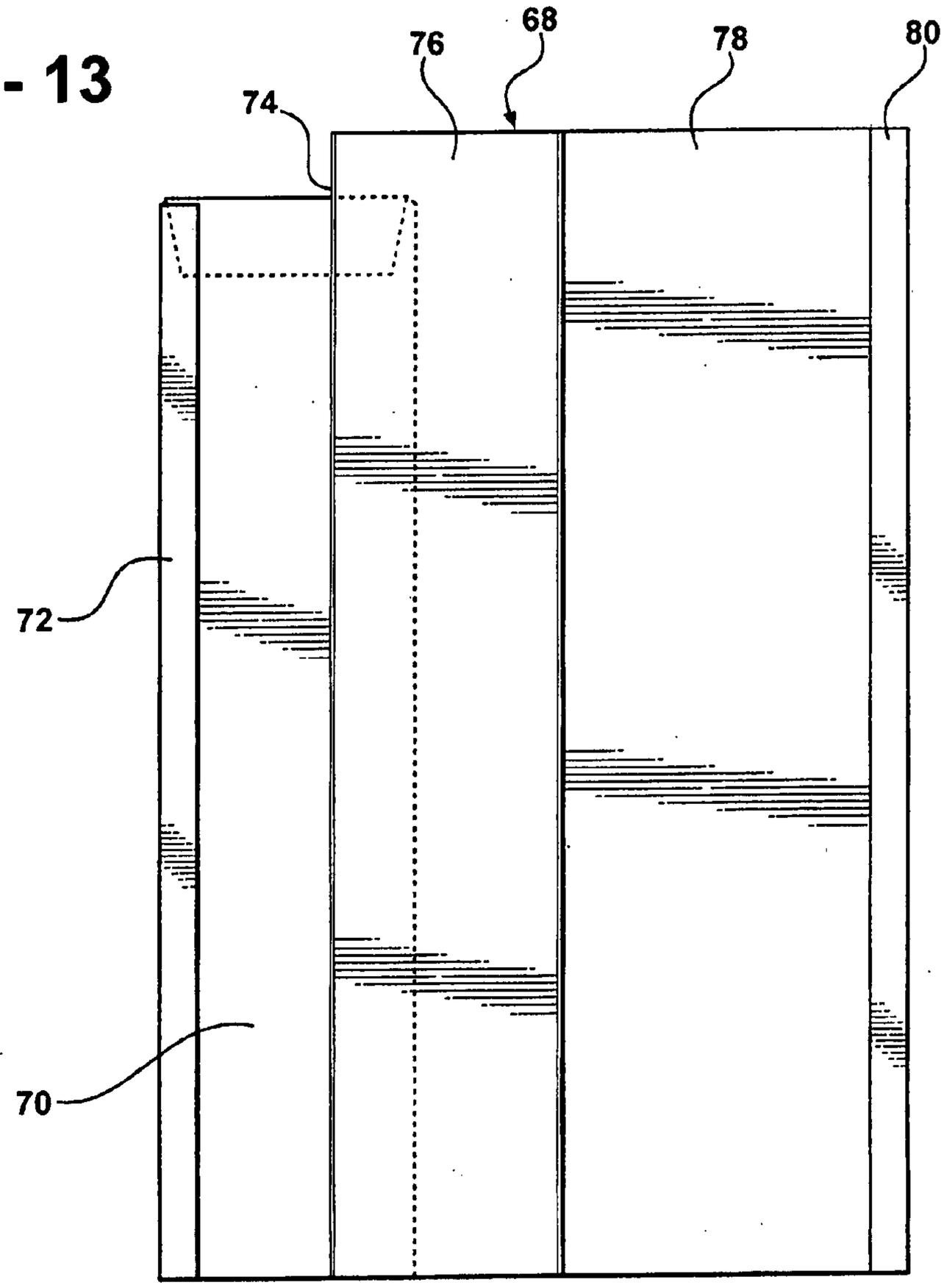


FIG - 13



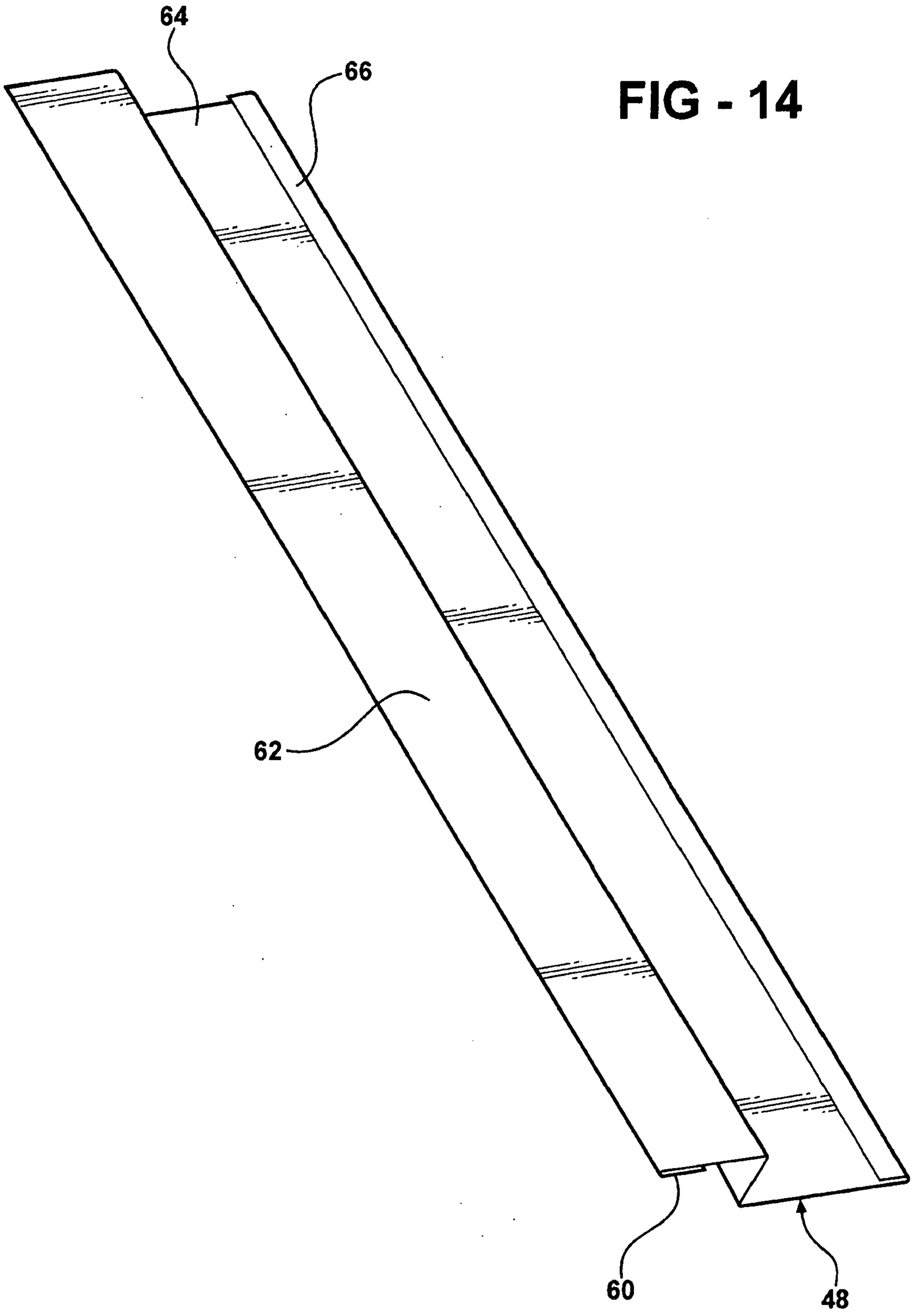


FIG - 14

SOLAR PANEL ROOF KIT

RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application 60/888,875, filed Feb. 8, 2007, the teachings of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present invention relates to the use of solar panels on roofs, and more particularly to the roofing components for supporting pre-manufactured sheets or strips of photovoltaic material.

BACKGROUND

[0003] Photovoltaic material is well-known by now and readily commercially available in a variety of forms. For example, United Solar Ovonics advertises products under the name Uni-Solar® on its web site, www.uni-solar.com. These photovoltaic products come in shingle form and in sheet form. BP Solar and other companies like Guangdong Fivestar Solar Energy Company Ltd. also supply photovoltaic material.

[0004] As to the material sold in sheet form, the sheets are often sold in rolls of sheet that can be rolled out on a roof and installed fairly conveniently by means of adhesive backing material. The sheet material is relatively inexpensive and light weight; and it generates electricity from solar energy in many weather conditions. The photovoltaic material may also be made in strips or in rigid panel form. In any case, on any given roof, the installer may need to apply several sheets or panels to cover the desired portion. The inventor here recognized that this poses several challenges—especially on roofs having any significant slope or pitch.

[0005] First, the sheets will present multiple edges that will buck water flowing down off the roof. Over time, the water can cause the edges to lift, which creates the possibility that the water can flow under the sheets, which can damage the sheets and the roofing underneath the sheets. This is not as much of a problem when the photovoltaic material is sold in shingle form; but when it is sold in sheet form for application on metal roofs and the like, there could be more of a problem over time.

[0006] Also, while the sheets have a favorable fire safety rating on low-pitched roofs, they have a lower rating on higher pitched roofs. It is commercially significant to have a favorable fire safety rating on a variety of roof pitches, so something needed to be done to address this.

[0007] Still further, if the photovoltaic sheets lie flat on the roofing substrate, there is an issue about where to put the electrical wiring. Ideally, the wiring should stow neatly underneath the sheeting where it is protected and out of sight.

[0008] Finally, there are a number of technical problems—including those just discussed—that need to be solved in order to install a typical system on a roof in a way that meets common roofing standards. The system should be durable and robust, and it should of course prevent leaking for many years. Because these problems will arise every time someone installs the typical system, the inventor appreciated that there is a need for a kit of common components that can be used to solve these problems efficiently and correctly every time the typical system, or one like it, is installed.

SUMMARY OF THE INVENTION

[0009] The inventor has an improved roofing system for supporting sheets of photovoltaic material on a roof. According to one aspect of the invention, the roofing system includes: at least one panel having a support plate adapted to support the photovoltaic sheet; a rib extending from one edge of the support plate to a distal end; a receiver flange extending generally perpendicularly from the distal end of the rib over the support plate; and a hem extending from an opposite edge of the support plate, where the hem is adapted to engage a receiver flange on another panel when the panel is mounted on the roof adjacent other panels. The rib extends a predetermined distance greater than the thickness of the photovoltaic material so that the receiver flange can extend over the photovoltaic material when it is installed on the support plate.

[0010] According to another aspect of the invention there is a roofing kit for placing over a section of roof deck to generate electricity, the kit comprising: at least one elongated strip of flexible photovoltaic material having a predetermined length; at least one panel supporting the strip where the panels each have edges on the top, bottom, left and right; the panels having a riser on one of the top and bottom edge, where the riser extends generally perpendicularly away from the edge; at least one side flashing for extending along and sealing at least one of the left and right edges of a panel; at least one splice plate for interconnecting adjacent left and right edges of two panels; at least one top flashing for extending along and sealing the top edge of a panel; and at least one bottom flashing for extending along and sealing the bottom edge of a panel.

[0011] Another aspect of the invention focuses on the roofing panel, which includes: a substantially flat portion that extends between top and bottom edges as well as left and right edges; a riser extending away from one of the top and bottom edges in a direction generally perpendicularly from the flat portion toward a remote end; an overhang extending away from the remote end of the riser; and a sheet having photovoltaic material and an adhesive on a back surface of the sheet, with the sheet being applied to the flat portion of the panel with the adhesive bonding to the flat portion.

[0012] Another aspect of the invention focuses on the splice plate that interconnects laterally disposed left and right solar roofing panels on a roof. The splice plate includes: a slot housing defining left and right slots for receiving edges from the left and right panels, respectively, a left apron connected to the slot housing adjacent the left slot for extending under the left panel, the left apron terminating in a distal check; a right apron connected to the slot housing adjacent the right slot for extending under the right panel, the right apron terminating in a distal check; wherein the splice plate interconnects the panels and prevents water from leaking between the two panels.

[0013] Another aspect of the invention focuses on the closure assembly for the side of a panel in a solar roofing system, the assembly comprising: a cover support including an apron for extending under the panel, the apron including a check along one edge of the apron; a slot housing connected to the apron at its opposite edge and forming a slot for receiving an edge of a panel; a side wall extending up from the slot housing; and a mounting flange supported on the side wall.

[0014] A final aspect of the invention focuses on the top closure for the side of a top panel in a solar roofing system, the top closure comprising: an inside apron for extending under the top panel, the inside apron including a check; a slot housing connected to the inside apron defining a slot for receiving an edge of the top panel; an inclined surface assembly connected to the slot housing; and an outside apron connected to the inclined surface assembly and extending away from it to a check.

[0015] By applying the invention in its various aspects, one can install a robust solar roofing system efficiently and inexpensively. The materials, especially when provided as a kit, can provide an inexpensive, yet well-engineered and easily manufactured and installable solar roofing system. Roofer contractors and even do-it-yourself homeowners can buy the system as a kit and install it, with simple electrical connections that can be completed by an electrician.

FIGURES IN THE DRAWINGS

[0016] FIG. **1** is a perspective view of a roof with a complete kit of solar panels assembled on it;

[0017] FIG. **2** is a similar view with components of the kit exploded away;

[0018] FIG. **3** is a perspective view of a panel from the kit with a corner of the photovoltaic material peeled back;

[0019] FIG. **4** is a perspective view showing how panels are joined at their sides with splice plates;

[0020] FIG. **5** is a perspective view showing how panels are joined top to bottom;

[0021] FIG. **6** is a bottom view of the panel;

[0022] FIG. **7** is a side sectional view showing the panels of the kit installed on a roof;

[0023] FIG. **8** is a perspective view of an embodiment of a splice plate;

[0024] FIG. **9** is a front view of an embodiment of a splice plate;

[0025] FIG. **10** is a perspective view of a closure support;

[0026] FIG. **11** is a section view of the closure support taken along lines **9-9**;

[0027] FIG. **12** is a perspective view of a top closure:

[0028] FIG. **13** is a top view of a top closure; and

[0029] FIG. **14** is a perspective view of a cover.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0030] The system or kit is generally shown at **10** in the Figures and includes a variety of components—chiefly: a series of panels generally indicated at **12**, splice plates generally indicated at **14** for interconnecting the panels in a waterproof manner; various closures; various top, bottom and side flashings; and miscellaneous other pieces and trim. These components can be supplied as a kit and assembled in place on a roof for providing a robust system, where the system supports the flexible photovoltaic sheets **16** and their respective wiring and electronics to generate electricity. A typical kit is shown in FIGS. **1** and **2**. The figures show a kit that has two columns of panels with six panels in a column. But the size can and will vary depending on the desired electrical output.

[0031] The Uni-Solar.com web site includes specification materials for various types of the photovoltaic material commercially available from Uni-Solar®. The typical sheet **16** has photovoltaic material and an adhesive **18** on a back surface of the sheet so that the sheet can be applied to the flat portion of a panel **12** with the adhesive bonding to the flat portion. The adhesive can be an ethylene propylene copolymer adhesive sealant, and it can include a microbial inhibitor. The sheet **16** has amorphous solar cells encapsulated in a high light transmissive polymer, where the high light transmissive polymer can be ETFE. Other types of photovoltaic sheet other than Uni-Solar® can be used with the kit **10**, and some of these other types are referenced above. Still others are referenced on the internet.

[0032] Of course, the components are also selected to provide a roofing system **10** that functions to provide dry, leak-free shelter under the roof. The inventive system **10** is intended to involve metal roofing components together with the photovoltaic sheeting **16**, but it is likely that the system has applicability and benefit for other types of roofing that are not necessarily metal.

[0033] The system **10** includes at least one panel **12** having a support plate **20** adapted to support the photovoltaic sheet **16**. This is shown most clearly in FIGS. **3** and **4**. The support plate **20** is simply the elongated flat part of the panel **12** that is sized to receive the sheet **16** of the photovoltaic material having a known dimension. As mentioned above, the sheet material **16** may come with a pre-applied adhesive **18** for attaching the sheet to the support plate **20**.

[0034] A rib or riser **22** extends generally perpendicularly (i.e. up) from one edge of the support plate **20** to a distal end. As shown in the figures, the edge for the rib **22** is usually the upslope edge (i.e. the higher edge when the plate is installed on a sloped roof), although rib **22** could also extend from the downslope edge. The rib **22** extends a predetermined distance above the level of the support plate **12** that is greater than the thickness of the photovoltaic sheet material **16** so that the receiver flange **24** can extend over the photovoltaic material when it is installed on the support plate. The height of the rib **22** will be selected to optimize fire retardation, water flow off the panels, manufacturing and material cost considerations, clearance for electrical wiring, and other considerations. The point of the rib or riser **22** is to elevate the edge of the next panel so that the terrace effect is created. The adjacent panel **12** can engage the rib **22** in a variety of ways. According to one possible embodiment, a receiver flange or overhang **24** extends generally perpendicularly from the distal end of the rib **22** back over the support plate. A hem **26** extends from an opposite edge of the support plate, where the hem is adapted to engage a receiver flange **24** on another panel when the panel is mounted on the roof adjacent other panels. The hem **26** is typically formed by bending the edge of the support plate **12** back under itself. The term, "hem" is intended to broadly describe hooks, clips, and similar structures that allow the one panel to hook onto the other. Other ways of engaging the rib **22** and an adjacent panel are possible. For example, the edge of an adjacent panel **12** could simply rest on top of the rib **22**.

[0035] The typical panel **12** can be formed from a single piece of sheet metal using conventional metal-bending techniques. Clearance holes **28** may be formed in the panel **12** to provide clearance for electrical connectors and wiring. While metal bending is one possibility, other techniques like extrusion can be used for at least some of the parts like the panel. Moreover, materials other than metal can be used, including composites and plastics.

[0036] The system also includes at least one splice plate generally indicated at **14** for interconnecting laterally dis-

posed left and right panels **12**. The splice plate **14** is shown in connection with the kit **10** in FIGS. **1**, **2**, **4**, and **5**; and it is featured alone in FIG. **8**. The splice plate **14** includes checks **30** formed on either side for catching and channeling water down and off the roof. The splice plate **14** also has two central slots **32**, **34** that are formed to receive lateral edges of the panels **12**, as best shown in FIG. **4**. The central slots **32**, **34** are formed by the central cover **36** and the base **38**, **40**. The central slots **32**, **34** so formed also act as checks to direct any water down and off the roof. The splice plate **14** may also include securing tabs **42**, **44**. These are shown in FIGS. **4**, **5**, and **8**. The tabs **42** can be bent and secured with a roofer's hand brake in the direction shown in FIG. **4**. The tabs **44** can receive the hem **26** from another plate. The typical splice plate **14** can be formed from a single piece of sheet metal using known techniques.

[0037] The splice plate **14** may also be described in another way. For example, it can be said to include a slot housing defining left and right slots **32**, **34** for receiving edges from the left and right panels **12**, respectively. A left apron **38** connected to the slot housing adjacent the left slot **32** can extend under the left panel. The left apron **38** terminates in a distal check **30**. A right apron **40** connected to the slot housing adjacent the right slot **34** can extend under the right panel. The right apron terminates in a distal check **30**. As a result, the splice plate **14** can interconnect the panels and prevent water from leaking between the two panels.

[0038] The system **10** may also include closure assemblies as shown in FIGS. **1**, **2**, and **10-14**. As best shown in FIG. **2**, the closure assemblies are disposed along or near the edges of the panels to close off the open side gap. As shown best in FIG. **7**, the side gap is formed under the lower or downslope portion of each panel as that portion engages the receiver or rib on the panel beneath it. The closure assemblies are sized to cover the gap; and they can be formed from bending sheet metal. The closure assemblies each typically include a panel cover portion for extending over the flat edge of the panel, a generally vertical side cover for covering the gap, and a base for mounting on the underlying roof deck.

[0039] One such closure assembly comprises a cover support generally indicated at **46** and a cover generally indicated at **48**. The cover support **46** includes an apron **50** for extending under the panel, the apron **50** including a check **52** along one edge of the apron. The cover support **46** also includes a slot housing **54** connected to the apron **50** at its opposite edge and forming a slot for receiving an edge of a panel **12**. A side wall **56** extends up from the slot housing **54**; and a mounting flange **58** is supported on the side wall.

[0040] A right side cover is shown in FIG. **14**. The cover **48** includes a hem **60** for engaging the mounting flange **58** on the cover support, a cover box **62** extending away from the hem **60**, and an apron **64** extending from the cover box to a distal edge having a check **66**. One or more covers **48**—left and right—can be used in a given kit. The illustrated kit **10** shown in FIGS. **1** and **2** show two left covers **48** and two right covers. Covers **48** such as these close off the sides of the system and also provide a conduit for any wiring that must run up or down the roof. Such wiring is shown in phantom in FIG. **1** and elsewhere in the other figures.

[0041] A related closure is a top closure generally indicated at **68** for the side of a top panel **12** in a solar roofing system or kit **10**. As shown in FIGS. **12** and **13**, the top closure **68** comprises an inside apron **70** for extending under the top panel **12**, where the inside apron includes a check **72**. The top closure **68** also includes a slot housing **74** connected to the inside apron **70** defining a slot for receiving an edge of the top panel **12**. An inclined surface assembly **76** is connected to the slot housing **74**. And an outside apron **78** is connected to the inclined surface assembly **76** and extends away from it to a check **80**. The inclined surface assembly provides a transition down from the top of cover **48** to the normal pitch of the roof. A typical kit **10** will include two top closures **68**—one for the top left side and one for the top right side, as illustrated in FIG. **2**.

[0042] The system **10** may also include at least one flashing. Flashings come in a variety of shapes and sizes to deal with a variety of applications. FIGS. **1**, **2** and **7** show some possible flashings, primarily a drip or eave edge **82** and top flashings **84**. The drip edge **82** includes a standard front drip edge, an apron for extending up the roof edge, and a mounting flange for receiving the hem of the first (lowest) panel **12**.

[0043] Top flashings **84** are shown in FIGS. **1** and **2**. These are sheets that include a hem on one edge for hooking onto the top-most panels **12**, and a crease or bend located toward the other edge for transitioning back to the roof slope. Splice plates can be used to connect the side edges of adjacent flashings **84**.

[0044] Other flashing possibilities (not shown) include a rake edge and a starter strip. The rake edge is used when the edge of the solar panel system is at the side edge of the roof itself. The kit **10** that is shown in FIGS. **1** and **2** is installed in a location spaced away from the side edge of the roof, and so rake edges are not needed in that instance. The rake edge, when used, includes a top cover having a clip or hem that attaches to the closure such as cover support **46**; a side cover that protects the side edge of the closure and the roof edge; and a drip edge extending down and away from the side cover.

[0045] For flashing the bottom or front edge of a roof, the system could provide a starter strip that includes typical starter strip features—an eave edge, and front cover, and a top cover. The panels can then be mounted on the roof above this and overlapping the top cover.

[0046] Various other flashings (e.g. stack flashings) can and should be used to flash around vents, walls, HVAC units, etc. These can include material that is shaped and colored to resemble the panels.

[0047] Finally, the system may include anchoring clips **86** of the general type shown in FIGS. **2** and **7**. Clips such as these can be provided to attach at one end to the receiver flange **24** of the panel **12** with a hem or other means; and at another end to the roof. Roofers can use several such clips to clip the panels to the roof to prevent undesired movement relative to the roof. Typically, the system **10** will use several clips for each panel.

[0048] As the reader can appreciate, the various kit elements, including the panels **12**, the splice plates **14**, the closures and the flashings, fit together in a terraced fashion to create a type of Bermuda-style roof. This is shown best in FIGS. **1**, **2**, and **7**. The figures depict the steps created by the ribs **22**, and they show the overall terracing effect of the construction. This permits water to flow down and off the roof, and the edges of the photovoltaic sheet material **16** will not buck the water as it does. This is because the water flowing off the preceding or upslope panel **12** will flow over the edge of the sheet material **16** on the lower panel. Moreover, the height of the terracing impairs the possible movement of flame up the roof, and so the photovoltaic sheet material **16** will benefit from a higher fire safety rating even on higher

pitched roofs. Finally, the steps created by the ribs **22** create a clearance underneath the panels to provide for the running of the electric wires from the photovoltaic sheet material **16**. This shelters and covers the wires under the panels, and it allows the roofer to select where to feed the wires through the roofing. Accordingly, the wires need not run above the photovoltaic sheets **16**.

[0049] Obviously, many modifications and variations of the present invention are possible in light of the above teachings. As just one example, the roofing components are typically made from sheet metal, but they could be made from a variety of other materials including wood, plastics, composites, etc. Also, while the components are typically formed with sheet metal bending and forming equipment, they can typically also be formed using known extrusion or molding techniques. Therefore, it is to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described. Moreover, the reference numerals and labels are merely for convenience and are not intended to be in any way limiting.

We claim:

1. A roofing system for supporting a sheet of photovoltaic material, the system comprising:

at least one panel having a support plate adapted to support the photovoltaic sheet;

a rib extending generally perpendicularly from one edge of the support plate to a distal end;

a receiver flange extending from the distal end of the rib over the support plate;

a hem extending from an opposite edge of the support plate, where the hem is adapted to engage a receiver flange on another panel when the panel is mounted on the roof adjacent other panels;

wherein the rib extends a predetermined distance greater than the thickness of the photovoltaic material so that the receiver flange can extend over the photovoltaic material when it is installed on the support plate.

2. The roofing system of claim **1** further including at least one splice plate for interconnecting the panels, the splice plate including a central cover and a base extending laterally from either side of the central cover.

3. The splice plate of claim **2** wherein the base includes a lateral check along a lateral edge.

4. The splice plate of claim **2** wherein the base and the central cover form a central check.

5. The roofing system of claim **1** further including at least one closure adapted to be disposed on an edge of the panel to cover and close the edge.

6. The roofing system of claim **1** further including at least one flashing, where the flashing is one of a starter strip, a rake edge, and a transition flashing.

7. A roofing panel including:

a substantially flat portion that extends between top and bottom edges as well as left and right edges;

a riser extending away from one of the top and bottom edges in a direction generally perpendicularly from the flat portion toward a remote end;

an overhang extending away from the remote end of the riser; and

a sheet having photovoltaic material and an adhesive on a back surface of the sheet, the sheet being applied to the flat portion of the panel with the adhesive bonding to the flat portion.

8. The sheet of claim **7** further having amorphous solar cells encapsulated in a high light transmissive polymer.

9. The sheet of claim **8** wherein the high light transmissive polymer is ETFE.

10. The panel of claim **7** wherein the adhesive includes an ethylene propylene copolymer adhesive sealant.

11. The panel of claim **10** wherein the adhesive includes a microbial inhibitor.

12. A roofing kit for placing over a section of roof deck to generate electricity, the kit comprising:

at least one elongated strip of flexible photovoltaic material having a predetermined length;

at least one panel supporting the strip where the panels each have edges on the top, bottom, left and right; the panels having a riser on one of the top and bottom edge, where the riser extends generally perpendicularly away from the edge;

at least one side flashing for extending along and sealing at least one of the left and right edges of a panel;

at least one splice plate for interconnecting adjacent left and right edges of two panels;

at least one top flashing for extending along and sealing the top edge of a panel; and

at least one bottom flashing for extending along and sealing the bottom edge of a panel.

13. The kit of claim **12** further including dummy panels decorated to match the appearance of the panels having strips of photovoltaic material.

14. The kit of claim **12** further including at least one stack flashing for flashing around a vent stack.

15. The kit of claim **12** further including at least one anchoring clip.

16. The kit of claim **12** wherein the splice plate includes a slot housing defining left and right slots for receiving the edges from the left and right panels, respectively, a left apron connected to the slot housing adjacent the left slot for extending under the left panel, the left apron terminating in a distal check;

a right apron connected to the slot housing adjacent the right slot for extending under the right panel, the right apron terminating in a distal check

17. The kit of claim **12** wherein the side flashing includes an apron for extending under the panel, the apron including a check along one edge of the apron;

a slot housing connected to the apron at its opposite edge and forming a slot for receiving an edge of a panel;

a side wall extending up from the slot housing; and

a mounting flange supported on the side wall.

18. A splice plate for interconnecting laterally disposed left and right solar roofing panels on a roof including:

a slot housing defining left and right slots for receiving edges from the left and right panels, respectively,

a left apron connected to the slot housing adjacent the left slot for extending under the left panel, the left apron terminating in a distal check;

a right apron connected to the slot housing adjacent the right slot for extending under the right panel, the right apron terminating in a distal check;

wherein the splice plate interconnects the panels and prevents water from leaking between the two panels.

19. A closure assembly for the side of a panel in a solar roofing system, the assembly comprising:

a cover support including an apron for extending under the panel, the apron including a check along one edge of the apron;

a slot housing connected to the apron at its opposite edge and forming a slot for receiving an edge of a panel;

a side wall extending up from the slot housing; and

a mounting flange supported on the side wall.

20. The closure assembly of claim **19** further including a cover for mounting on the cover support, the cover including:

a hem for engaging the mounting flange;

a cover box extending away from the hem; and

an apron extending from the cover box to a distal edge having a check.

21. A top closure for the side of a top panel in a solar roofing system, the top closure comprising:

an inside apron for extending under the top panel, the inside apron including a check;

a slot housing connected to the inside apron defining a slot for receiving an edge of the top panel;

an inclined surface assembly connected to the slot housing; and

an outside apron connected to the inclined surface assembly and extending away from it to a check.

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