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(54) **PHOTOVOLTAIC MODULE MOUNTING SYSTEM**

(71) Applicants: **Scott Franklin**, Nederland, CO (US); **Christopher Stephen Klinga**, Boulder, CO (US)

(72) Inventors: **Scott Franklin**, Nederland, CO (US); **Christopher Stephen Klinga**, Boulder, CO (US)

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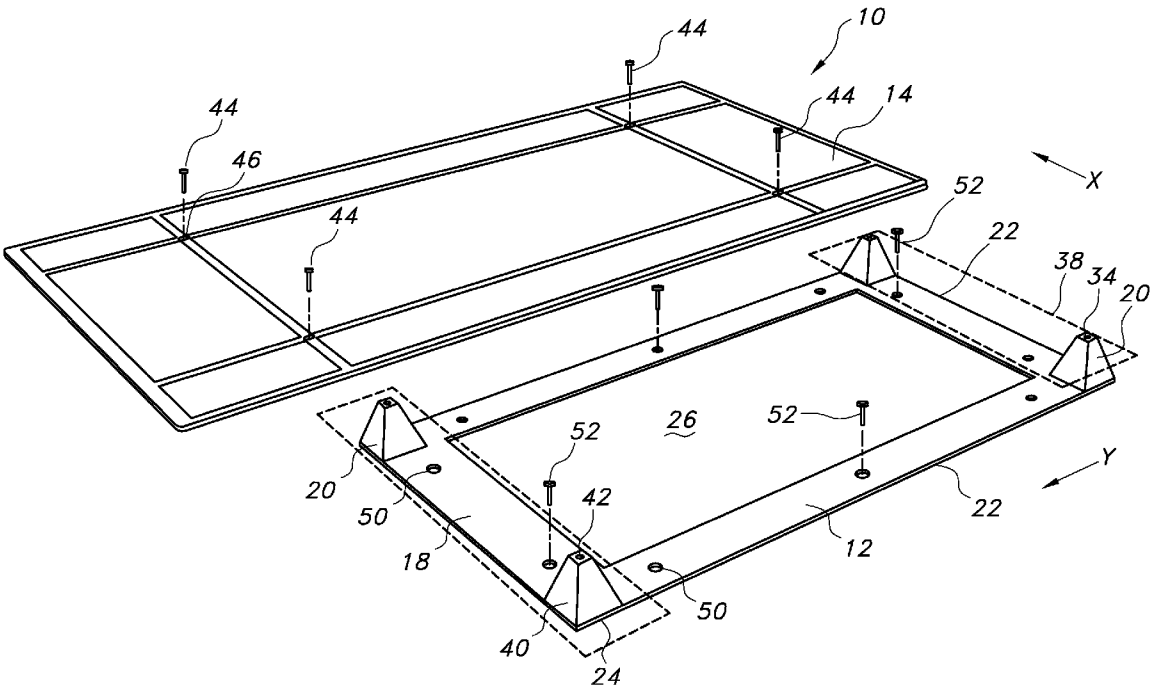
(57) **ABSTRACT**

A photovoltaic ("PV") module mounting system that includes a base having a platform with a plurality of supports extending upwardly therefrom. The PV module mounting system is secured to a support structure, such as a roof, and a mounting apparatus is adapted to fixedly secure a PV module to the base. A plurality of PV module mounting systems can be configured for the installation of an array of PV modules.



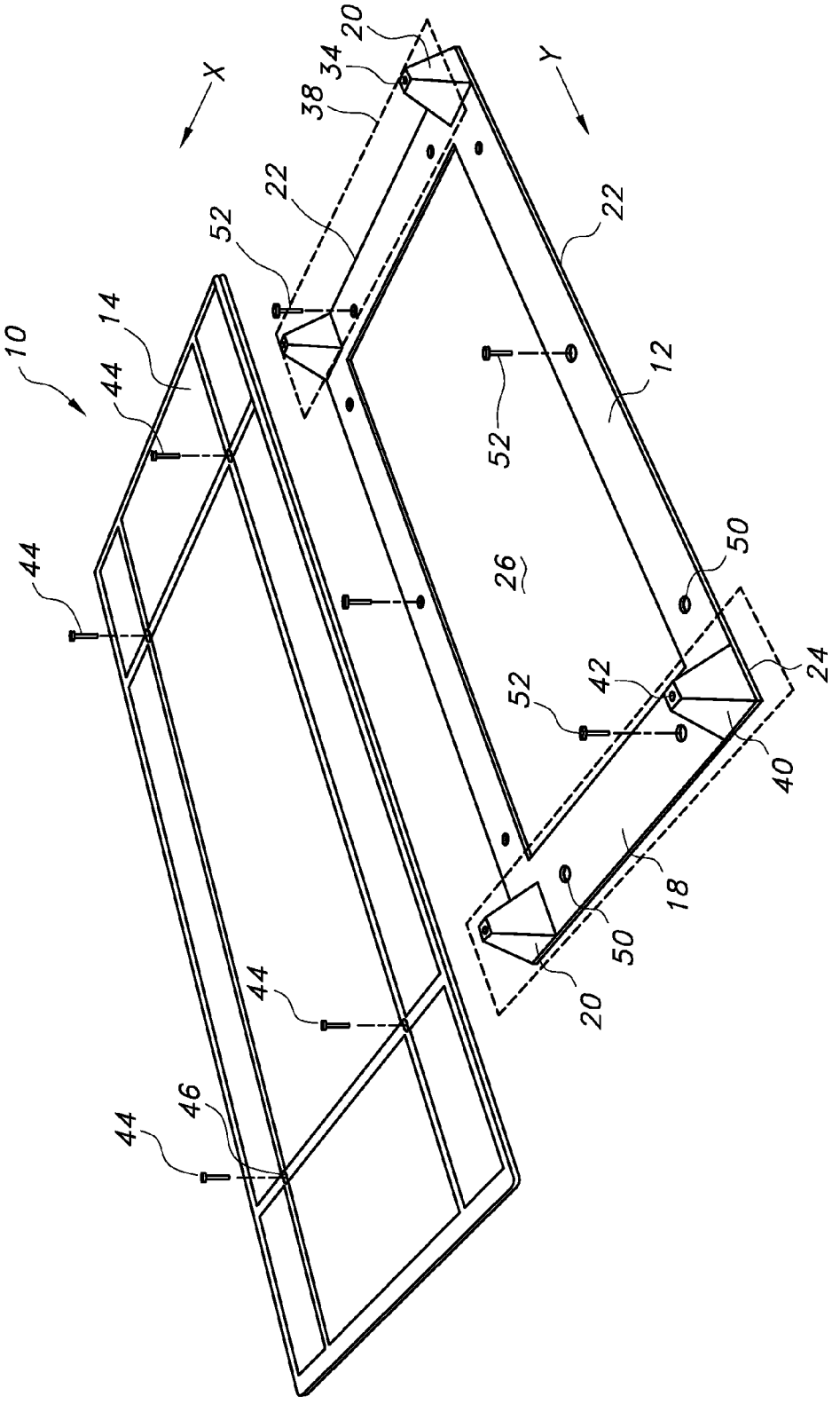


FIG. 1

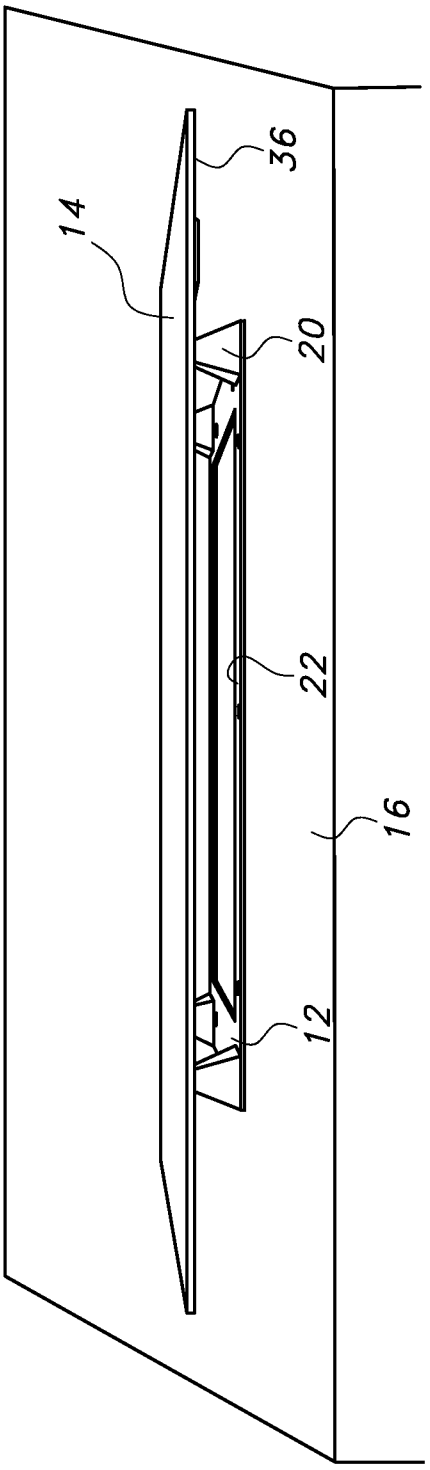


FIG. 2

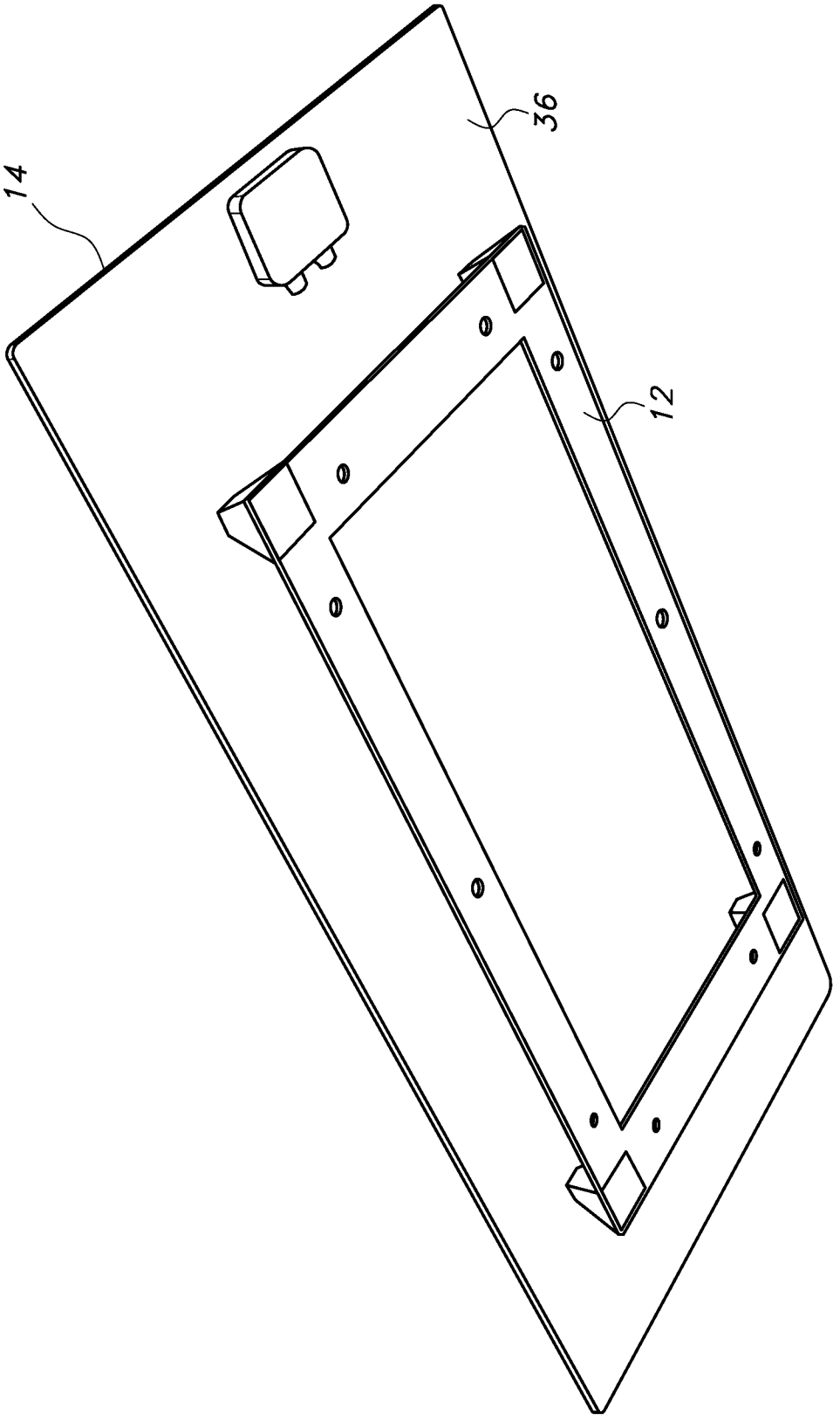


FIG. 3

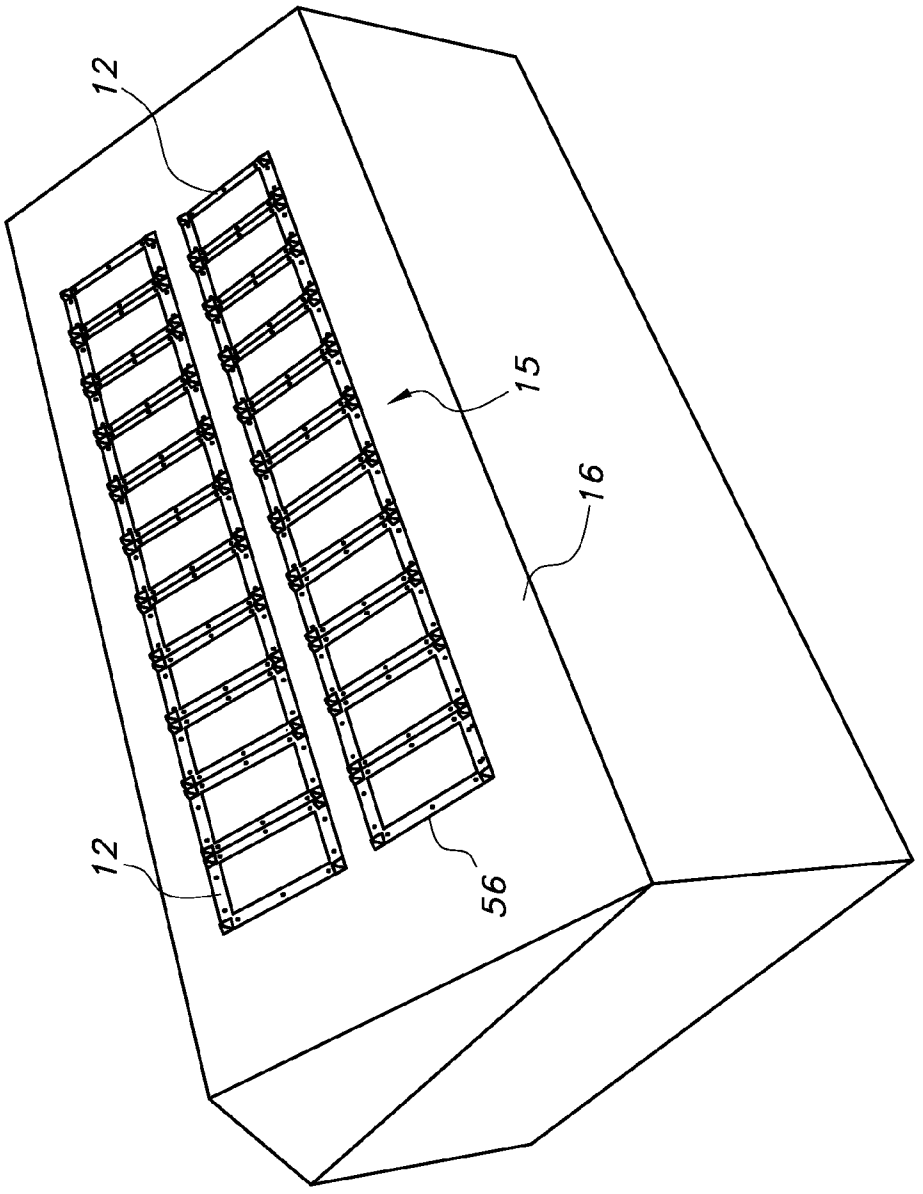


FIG. 4

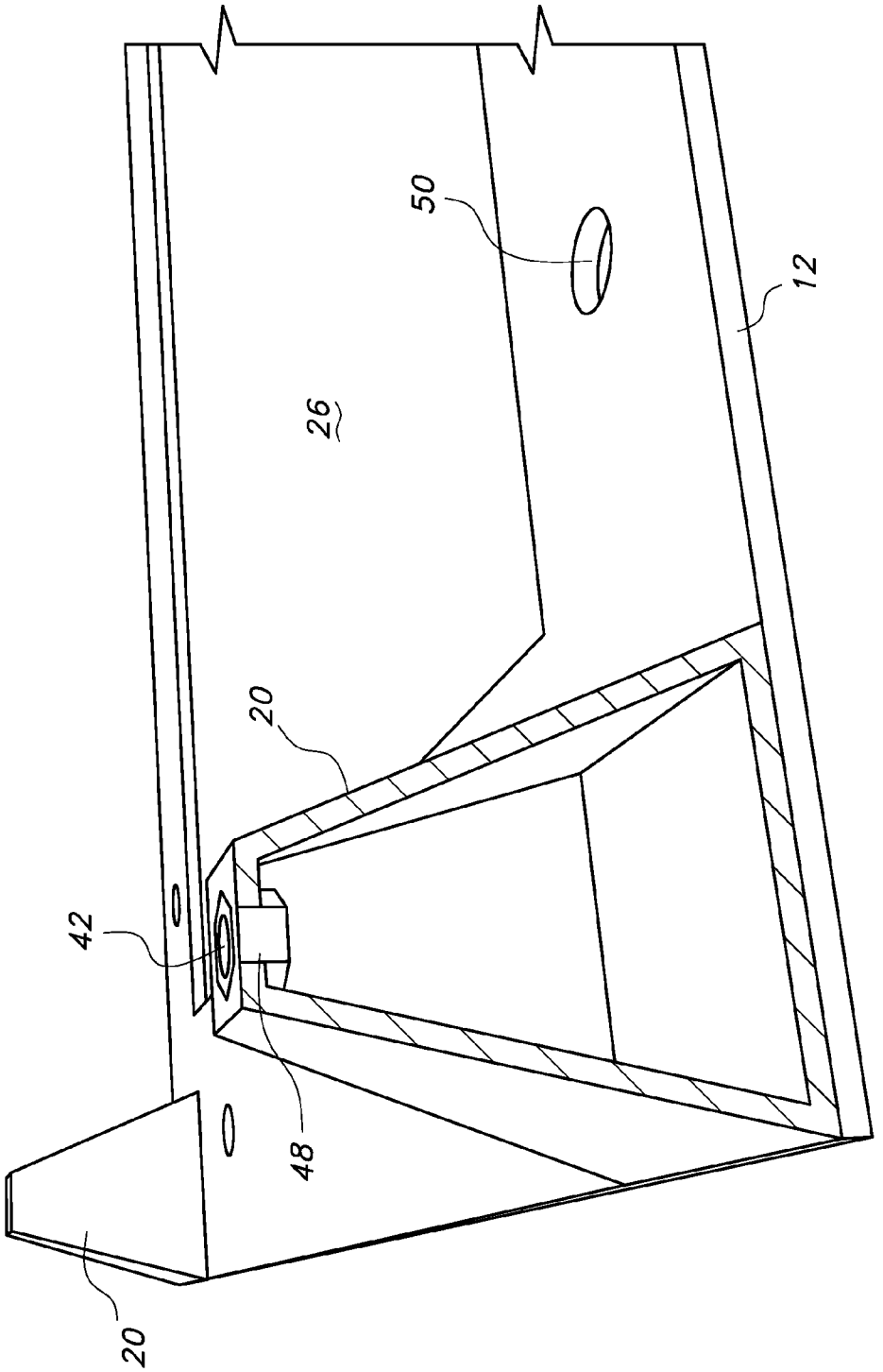


FIG. 5

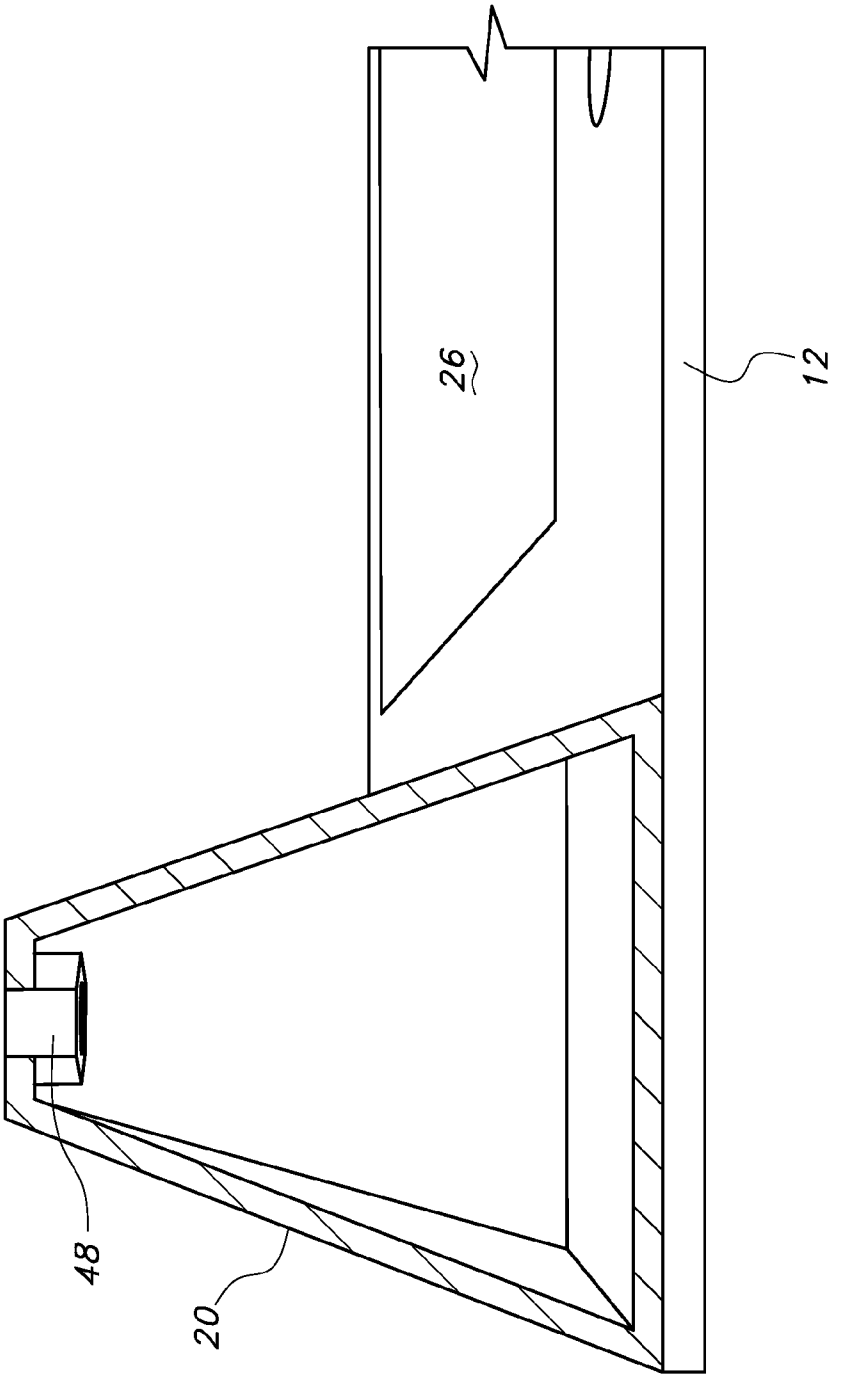


FIG. 5A

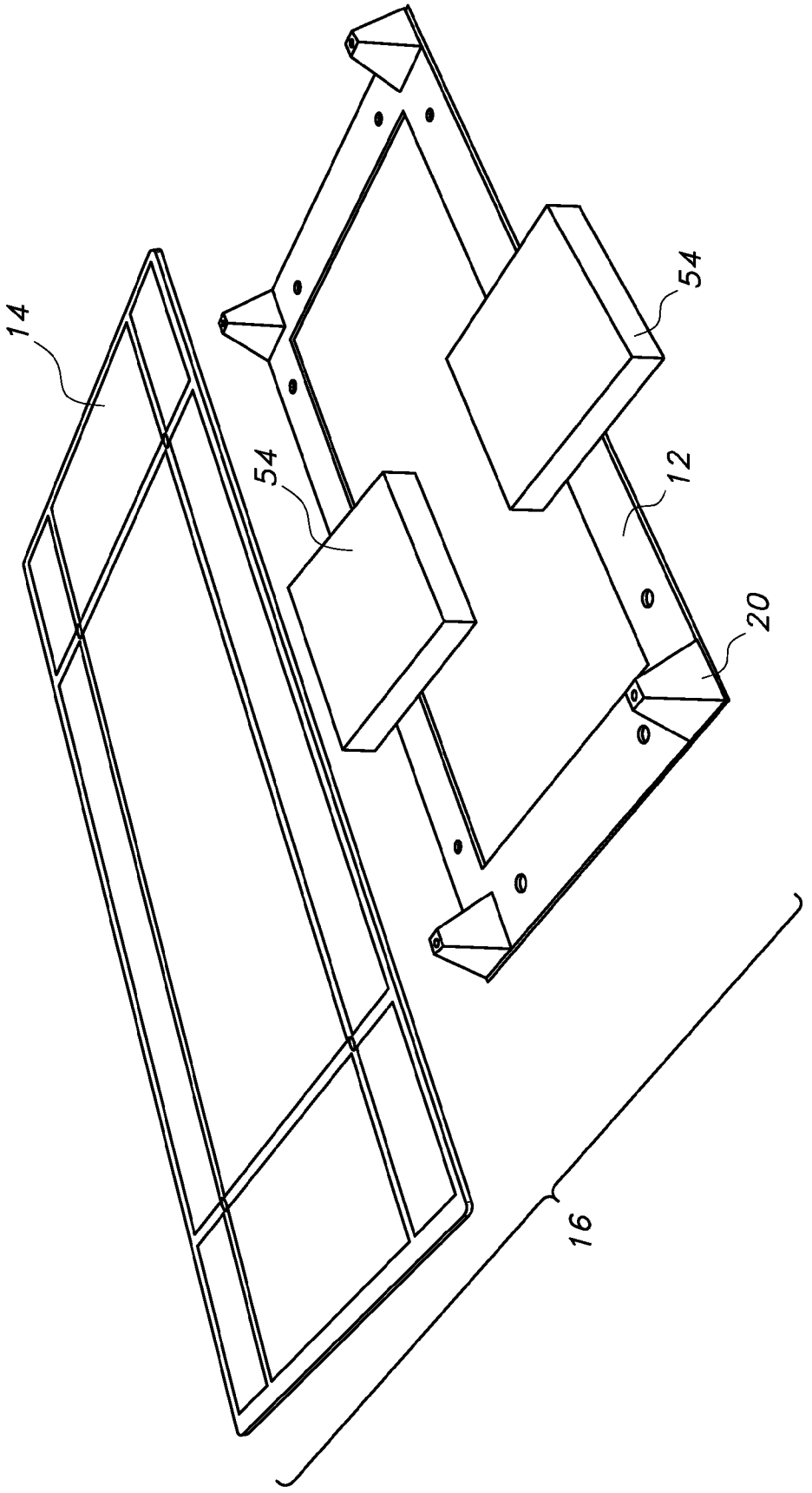


FIG. 6

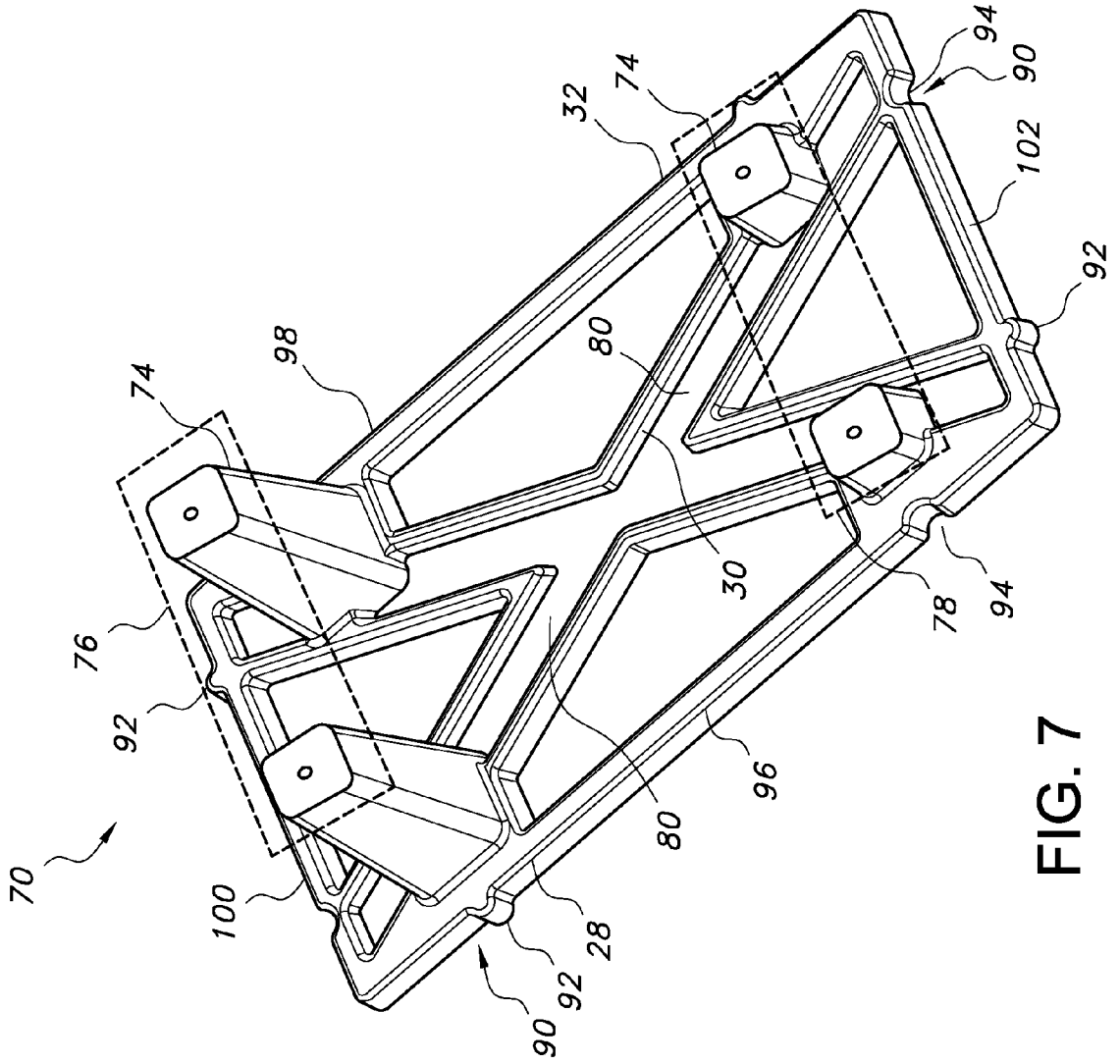


FIG. 7

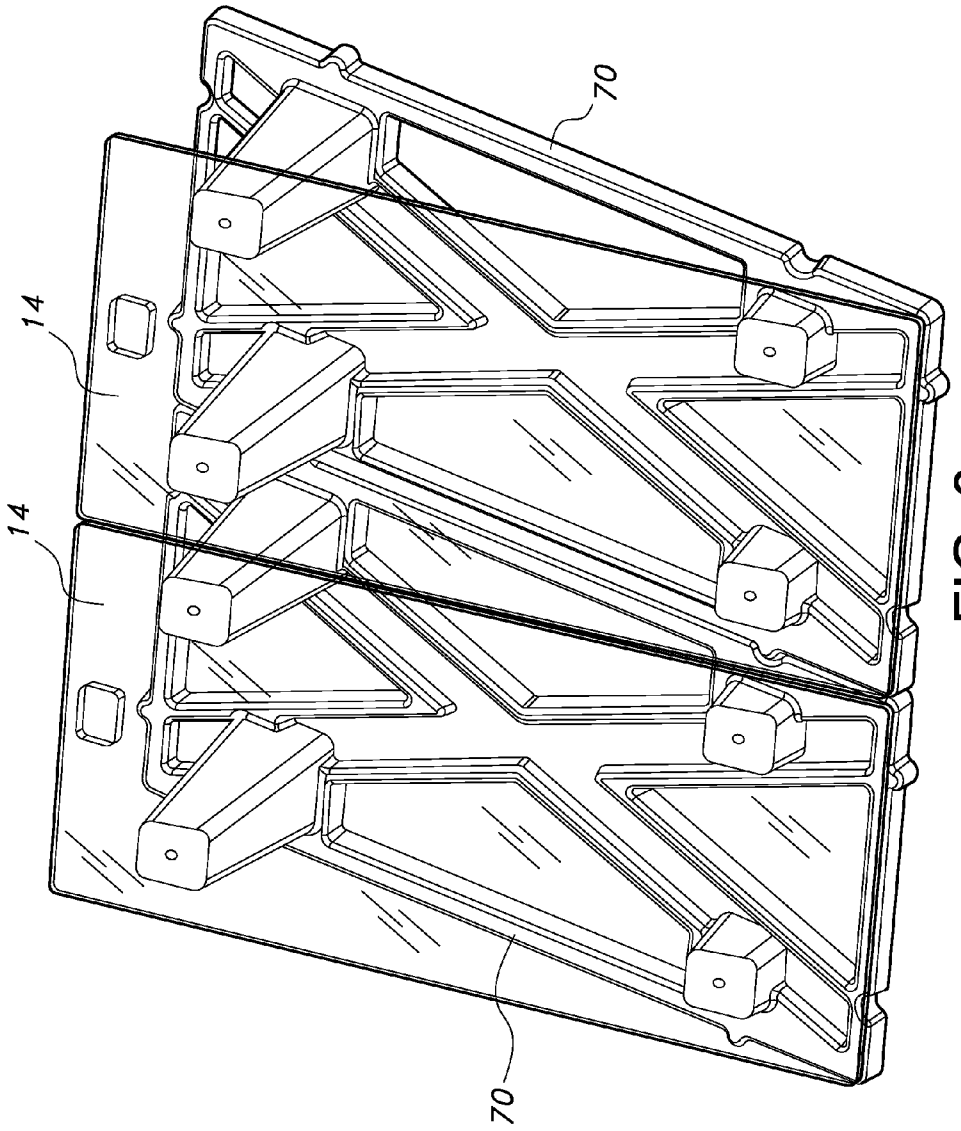


FIG. 8

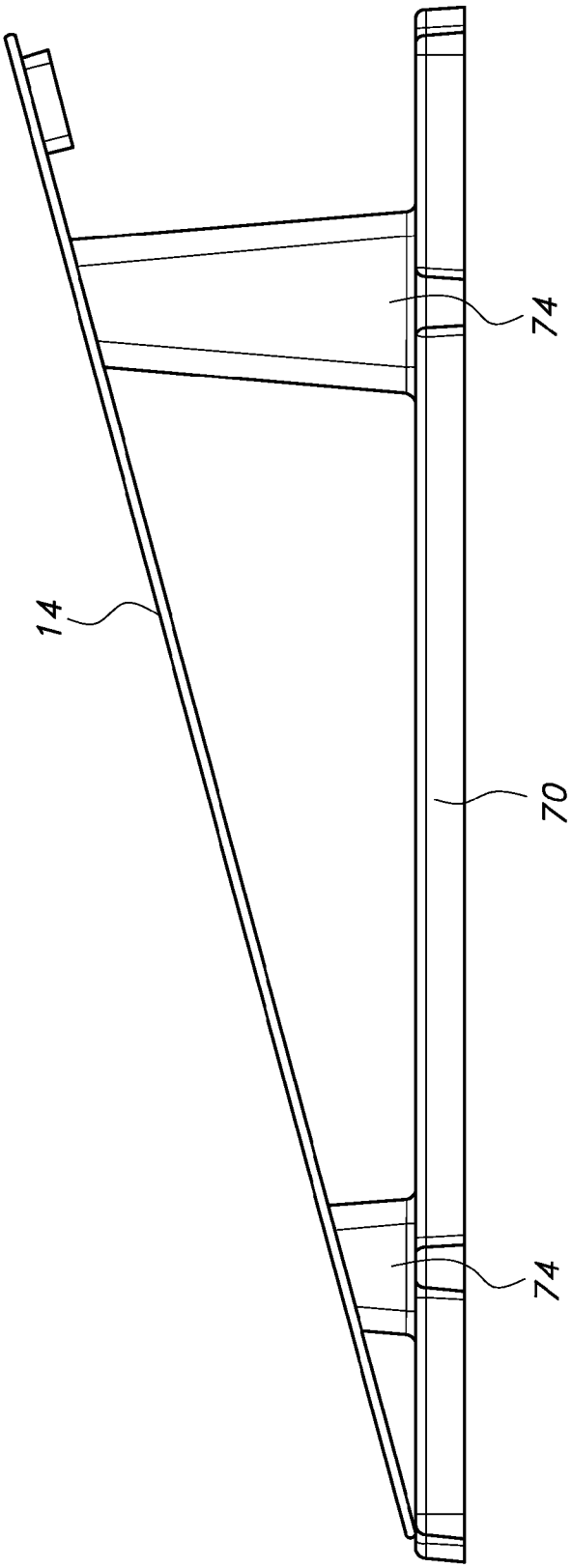


FIG. 9

PHOTOVOLTAIC MODULE MOUNTING SYSTEM

[0001] This application claims priority from provisional application Ser. No. 61/544,933, filed on Oct. 7, 2011, which is incorporated herein in its entirety.

FIELD OF INVENTION

[0002] The present invention relates to a mounting system having a base for supporting and securing a photovoltaic module on a support structure.

BACKGROUND OF THE INVENTION

[0003] Photovoltaic ("PV") modules, also known as solar panel modules, typically include a photovoltaic panel and the associated electrical wiring for connecting the module to a desired circuit. PV modules are typically mounted to the roofs of buildings or homes in order to place them in the best position for receiving the necessary sunlight to generate electricity. However, mounting the modules on such structures can be difficult since they need to be properly aligned in order to work most efficiently and also to be more aesthetically pleasing.

[0004] Working on the roofs of structures can be difficult in that equipment must be safely hauled up to the roof. When working on pitched roofs, it is especially difficult since the materials must be properly secured, even prior to installation, in order to prevent them from falling off. Photovoltaic modules are relatively heavy devices and are also fragile. Therefore, they are subject to breakage if not handled properly.

[0005] PV modules are typically mounted on a base which may consist of a plurality of spaced elongate rails. The rails are designed to accommodate a plurality of PV panels along their length. Such rails must be properly aligned and spaced from each other in order to provide a mounting surface which will engage the PV module. If one rail is not parallel to the other and spaced appropriately from the other to provide the correct amount of support for the module installation, problems will occur. Also, rails may have to be adjusted in length to accommodate a particular installation. Therefore, a significant amount of time and effort must be expended on top of a roof to install and align the rails.

[0006] Accordingly, it is desirable to provide a mounting base for a PV module which can be easily installed and aligned on a roof and allows for the PV module to be easily and quickly installed thereon.

SUMMARY

[0007] The present invention is a photovoltaic ("PV") module mounting system that includes a base and a plurality of mounting apparatus. The base includes a platform having a plurality of supports, wherein each support extends upwardly from the platform to a distal end. The plurality of mounting apparatus is adapted to fixedly secure a photovoltaic module to the plurality of supports. The PV module mounting system can also include a second base formed similarly to the first base. The first and second bases include complementary interlocking structures for aligning the first base with respect to the second base.

[0008] The platform can include a rectangular frame having first and second ends and first and second sides. The complementary interlocking structures are preferably located on the first and second sides and the first and second ends of the rectangular frame. The rectangular frame can also have two pairs of diagonally opposed corners and first and second diagonal members extending therebetween. The rectangular frame can also include four elongate members connected at four corners. The four elongate members can have a plurality of openings therethrough, which are adapted to receive fastening devices to secure the base to a support structure.

[0009] The platform can have first and second pairs of supports located at the first and second ends of the frame, respectively. The first and second pairs of supports can have first and second heights, respectively. The heights are equal to the distance from the platform to the distal end of the support. Preferably, the height of the first pair of supports is greater than the height of the second pair of supports so that the PV module supported by the supports is installed on the base at an angle and has a slope or a pitch downwardly between the first and second pairs of supports. This is especially desirable when the PV mounting base is installed on a substantially flat support structure.

[0010] Each of the supports has an aperture in the distal end for attaching a PV module. The locations of the apertures correspond to the locations of mounting apertures in the PV module. This allows fastening hardware, such as a bolt, to pass through the mounting aperture in the PV module and into the aperture in the support. In a preferred embodiment, the aperture is tapped (i.e., threaded) or includes a captured nut so that the bolt can be threaded into the distal end of the support. The plurality of supports can be adjustably positioned at a plurality of locations on the platform. This allows the supports to be repositioned so that the apertures in the supports align with the mounting apertures in PV modules with different mounting aperture configurations.

[0011] The present invention is also a PV module mounting system that includes a plurality of PV modules and a plurality of mounting bases. Each mounting base supports one PV module and is constructed as described above. The interlocking structures on the sides and ends of the base cooperate to align adjacent bases with each other. The mounting bases can be joined to form an array that can be configured to conform with the dimensions of the support structure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. **1** is an exploded perspective view of a preferred embodiment of the PV module mounting base showing a PV module prior to installation thereon;

[0013] FIG. **2** is a side perspective view showing the PV module mounted on the base shown in FIG. **1**;

[0014] FIG. **3** is a bottom perspective view showing the PV module mounted on the base shown in FIG. **2**;

[0015] FIG. **4** is a perspective view of an array of mounting bases secured to the roof of a building.

[0016] FIG. **5** is a detail perspective view of the mounting base with a sectional view of a preferred embodiment of the support structure;

[0017] FIG. **5**A is a detail side view of the mounting base shown in in FIG. **5**;

[0018] FIG. **6** is a perspective view showing a PV module and a mounting base secured to a support structure using ballast;

[0019] FIG. **7** is a top perspective view showing an alternative embodiment of the present invention for securing a PV module in a pitched orientation;

[0020] FIG. **8** is a perspective view of a pair of mounting bases with the PV modules in shown in phantom; and

[0021] FIG. **9** is a side elevational view of the base shown in FIG. **8** with a PV module installed on the base.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022] The present invention is a photovoltaic ("PV") module mounting system having a base with a plurality of upwardly extending supports for supporting a PV module. The PV module mounting system provides an individual base for each PV module. The base includes a platform having a plurality of supports, which can be adjustably positioned on the base and which can have different heights. As used herein, the height of the supports is the distance from the top surface of the base, on which the support is secured, to the distal end of the support. The distal end of each support can have an aperture (preferably threaded) for receiving a mounting apparatus, such as a bolt, which is adapted to fixedly secure a PV module to the base.

[0023] The PV module mounting system can be formed into an array that includes a plurality of PV modules and a plurality of individual mounting bases. Each mounting base supports one of the PV modules and includes a plurality of supports extending upwardly therefrom. The supports extend from the base to a distal end and are adapted to support the PV module at a plurality of locations. The bases are secured to a support structure and the supports offset the PV module a predetermined distance from the support structure. Typically, four supports are used to install a PV module on a base. The supports can have different heights depending on the pitch of the support structure (e.g., a roof) so that the PV modules can be oriented at different angles to maximize the exposure to sunlight.

[0024] With reference to FIGS. **1-3**, a photovoltaic module mounting system **10** is shown. The mounting system **10** includes a base **12**, which secures a PV module **14** to a support structure **16**, such as the roof of a building or house. The mounting base **10** includes a platform **18** having a plurality of upwardly extending module supports **20**. The supports **20** are spaced apart to support the PV module **14** at various locations. The platform **18** may be formed in a number of configurations. For example, as shown in FIG. **1**, the platform **18** is formed by four elongate members **22** that are joined together at four corners **24**. The elongate members **22** form a frame-like structure having an open center **26**. The elongate members **22** are generally flat members having a height less than their width or length. In an alterative embodiment shown in FIG. **7**, the platform **28** includes a number of elongate inner **30** and outer **32** members. In a further alternative embodiment (not shown), the platform can be a planar generally continuous member having a substantially closed central region.

[0025] In the PV module mounting system **10**, each PV module **14** is individually supported by a designated base **12**. In a preferred embodiment, the base **12** has a configuration generally similar to the PV module **14**. For example, if the PV module **14** is rectangular, the base **12** is generally rectangular.

[0026] The base **12** may be formed of a molded plastic material with the module supports **20** integrally formed with the elongate members **22**. Alternatively, the elongate members **22** of the platform **18** can be formed as one piece and each of the module supports **20** may be fixedly secured to the platform **18** using screws, bolts, clips or other fastening devices in a manner well known in the art. It is within the contemplation of the present invention that the base **12** may be formed of other materials including wood, composites, or metal.

[0027] In the embodiment show in FIGS. **1-6**, the module supports **20** are located at the four corners **24** of the platform **18**. The supports **20** are secured in place and extend upwardly from the elongate members **22** to a substantially flat mounting surface **34**. In one embodiment, the module supports **20** have generally the same height. The supports **20** can be formed in a variety of shapes such as a frusto-pyramidal shape, as shown in FIG. **1**, wherein they taper inwardly as they extend towards the distal end. The mounting surface **34** of the plurality of supports **20** contacts the underside **36** of the PV module **14**. Alternatively, the module supports **20** may be tubular shaped or a rectangular block, or any other of a number of configurations having a generally flat mounting surface on the distal end for supporting the PV module **14** thereon.

[0028] With specific reference to FIG. **1**, the module supports **20** are arranged on the base **12** such that a first set of two supports **38** are aligned with each other in the X direction at one end. A second set of two supports **40** are also aligned with each other in the X direction on the opposite end. The first set of supports **38** and the second set of supports **40** are offset from each other in the Y direction. This spacing allows the base **12** to support the PV module **14** at four locations so that the weight of the PV model **14** is evenly distributed.

[0029] With reference to FIGS. **1**, **5** and **5**A, the module supports **20** may include an opening **42** at the distal end for receiving module mounting apparatus such as fasteners **44**, which may be used to secure the PV module **14** to the base **12**. In one embodiment, the PV module **14** includes apertures **46** through which the mounting fasteners **44** may extend. The mounting fasteners **44** can be bolts and the supports **20** may include captured nuts **48** secured therein. As used herein, the term "captured nut" refers to a nut that is permanently attached to the support. For example, when a support is made from plastic, the nut is installed in the support during the extruding or molding process. Securing the PV module **14** to the base **12** is accomplished by placing the PV module **14** on top of the base **12** with the apertures **46** in the PV module **14** aligned with the apertures **42** in the supports. Fasteners **44** are then inserted through the apertures **46** in the PV module **14** into the supports **20**. FIG. **1** shows a frameless-type PV module **14**. For PV modules **14** having frames (not shown), the frame may have openings **50** therein that accept fastening hardware to secure the PV module **14**.

[0030] In order to secure the base **12** to the support surface **16**, the elongate members **22** of the platform **18** may include a plurality of openings **50** extending therethrough, which accept fastening hardware **52**. The fastening hardware **52** is used to fixedly secure the base **12** to the support structure **16**, such as the roof of a building or house. The fastening hardware **52** may include threaded bolts of a type know in the art, which preferably form a waterproof seal between the bolt and the support structure in order to prevent water from leaking in through fastening hardware attachment points. Alternatively, a suitable sealant material can be placed about the fastener **44** and base **12** to affect a watertight seal with the support structure.

[0031] With reference to FIG. **6**, in addition to, or instead of, using fastening hardware, the base **12** may be secured to the support structure **16** using mounting ballast **54**. Such ballast can be cement blocks, sandbags or other relatively heavy items. This installation may be most beneficial in a flat

roof installation where there is less likelihood of the base **12** sliding with respect to the support surface. By not using fasteners extending into the flat roof, the water-resistant integrity of the flat roof is not compromised.

[0032] A plurality of PV module bases **12** can be secured to a support structure in an array **56** as shown in FIG. **4**. An installer arranges the bases **12** in a desired configuration. Since the bases are lightweight and compact, it is easy for the installer to place the bases in any desired configuration. Once the bases are firmly secured to the support structure, the PV modules **14** may be brought to the roof and secured to the bases **12**. Once the bases **12** are secured to the support structure, all the installer needs to do is place the PV module **14** over the base **12** and align the apertures **46** in the PV module **14** with the support apertures **42**. The PV module **14** may then be secured to the base **12** using the mounting fasteners **44**. There is no need for any further alignment of the PV modules **14**. Accordingly, once the bases **12** are installed, each of the PV modules **14** secured to the bases **12** will be properly aligned.

[0033] An alternative embodiment of the mounting base **70** is shown in FIGS. **7** to **9**. The base **70** includes a platform **28** supporting a plurality of spaced module supports **74**. The dimensions of the perimeter of the base **70** are preferably the same as or slightly larger than the dimensions for the perimeter of the PV module **14**. This permits the side edges of adjacent mounting bases **70** to be butted together when mounted to a structure.

[0034] When mounting PV modules **14** to structures, especially on flat roofs, it may be desirable to pitch the PV modules **14** with respect to the roof. Accordingly, the height of the module supports **74** may be varied in order to provide the desired pitch of the PV module **14**. To achieve this, a first set of supports **76** may be greater in height than a second set of supports **78**. Pitching the PV modules **14** at an angle to the roof allows the PV modules **14** to be advantageously oriented to receive sunlight. In addition, rain and snow will tend to run off the top surface of the PV module **14**. Pitched PV modules **14** also tend to stay cleaner as water draining from the top surface carries away dust and dirt that may settle on the PV module **14**.

[0035] The base **70** may be formed as a one piece unit with the supports **74** formed at different heights. Alternatively, the supports **74** may be removably securable to the base **70** such that an installer may select supports **74** of different heights and secure them to the base **70** in order to customize the pitch of the PV modules **14** for a particular installation. The base **70** can also have a plurality of mounting locations for the supports **74** so that they can be positioned to accommodate PV modules **74** with different mounting aperture configurations.

[0036] In the embodiment shown in FIGS. **7** to **9**, the base **70** has crossing members **80** extending diagonally from one corner to the other and crossing at the middle. An installer may place fastening hardware through these members **80** to attach the base **70** to a roof. If the base is formed of a plastic material, the fasting hardware such as lag bolts may be driven right through the material in the roof. Alternatively, an installer could drill a pilot hole, or the holes could be preformed in the base.

[0037] The mounting bases **70** may further include interlocking structures **90** which align one or more bases **70** with respect to each other. In one embodiment, the interlocking structures **90** are alternating protrusions **92** and depressions **94** formed in the edges on the sides and ends of the bases **70**. The left and right side edges **96** and **98** of the base, as well as the opposing ends **100**, **102**, may have the location of the protrusion and depression inverted. Thus, the right side edge of one base can be interlocked with the left side edge of the other base. Similarly, the edges on the ends **100** and **102** may have the location of the protrusion and depression inverted. In this way, the bottom side edge of one base may be interlocked with the top edge of another adjacent base. This interlocking features aids in installation by aligning the adjacent bases with each other. Therefore, once an installer fixes the position of one base **70** on the roof, the position of the remainder of the bases **70** in the array is easily determined.

[0038] In addition, by inverting the arrangement of depressions and protrusions in the opposing sides and ends, all of the interlocking bases are the same. Therefore, only one type of mounting base needs to be used by an installer. For example, if an installer wants to install 10 PV modules, then 10 of the same type of bases can be used. This greatly simplifies installation and part management logistics.

[0039] Thus, while there has been disclosed what is presently believed to be preferred embodiments of the invention, those skilled in the art will appreciate that other and further changes and modifications can be made without departing from the scope or sprit of the invention, and it is intended that all such other changes and modifications are included in and are within the scope of the invention as described in the appended claims.

What is claimed is:

1. A photovoltaic ("PV") module mounting system comprising:

a first base including a platform having a plurality of supports, each support extending upwardly from the platform to a distal end; and

a plurality of mounting apparatus adapted to fixedly secure a PV module to the plurality of supports.

2. The PV module mounting system as defined in claim **1**, further comprising a second base formed similarly to the first base, the first and second bases including complementary interlocking structures for aligning the first base with respect to the second base.

3. The PV module mounting system as defined in claim **1**, wherein the platform comprises a rectangular frame having first and second ends and first and second sides.

4. The PV module mounting system as defined in claim **3**, wherein the rectangular frame has two pairs of diagonally opposed corners and first and second diagonal members extending therebetween.

5. The PV module mounting system as defined in claim **3**, wherein the rectangular frame comprises four elongate members connected at four corners.

6. The PV module mounting system as defined in claim **5**, wherein the four elongate members have a plurality of openings therethrough, which are adapted to receive fastening devices to secure the base to a support structure.

7. The PV module mounting system as defined in claim **3**, wherein the platform has first and second pairs of supports located at the first and second ends of the frame, respectively.

8. The PV module mounting system as defined in claim **7**, wherein the first and second pairs of supports have first and second heights, respectively, wherein each height is equal to the distance from the platform to the distal end of the support, and wherein the height of the first pair of supports is greater than the height of the second pair of supports.

9. The PV module mounting system as defined in claim **3**, wherein the complementary interlocking structures are located on the first and second sides and the first and second ends of the rectangular frame.

10. The PV module mounting system as defined in claim **1**, wherein each of the supports has an aperture in the distal end, and wherein the locations of the apertures corresponds to the locations of mounting apertures in the PV module.

11. The PV module mounting system as defined in claim **1**, wherein the plurality of supports can be adjustably positioned at a plurality of locations on the platform.

12. A PV module mounting system comprising:

a plurality of PV modules; and

a plurality of mounting bases, each mounting base supporting one of the plurality of PV modules, each of the mounting bases comprising a plurality of supports extending upwardly from the base to a distal end and adapted to support the PV module, each of the bases being adapted to be secured to a support structure, and the plurality of supports spacing the PV module from the support structure.

13. The PV module mounting system as defined in claim **12**, wherein each of the plurality of bases includes complementary interlocking structures that cooperate to align adjacent bases with each other.

14. The PV module mounting system as defined in claim **13**, wherein each of the mounting bases is similarly formed.

15. The PV module mounting system as defined in claim **13**, wherein each mounting base further comprises a rectangular frame having first and second ends and first and second sides, and wherein the complementary interlocking structures are located on the first and second ends and the first and second sides of the rectangular frame.

16. The PV module mounting system as defined in claim **15**, wherein the rectangular frame has two pairs of diagonally opposed corners and first and second diagonal members extending therebetween.

17. The PV module mounting system as defined in claim **15**, wherein the rectangular frame comprises four elongate members connected at four corners.

18. The PV module mounting system as defined in claim **17**, wherein the four elongate members have a plurality of openings, which are adapted to receive fastening devices to secure the base to the support structure.

19. The PV module mounting system as defined in claim **15**, wherein each base has first and second pairs of supports located at the first and second ends of the frame, respectively.

20. The PV module mounting system as defined in claim **19**, wherein the first and second pairs of supports have first and second heights, respectively, wherein each height is equal to the distance from the base to the distal end, and wherein the height of the first pair of supports is greater than the height of the second pair of supports.

21. The PV module mounting system as defined in claim **12**, wherein each of the supports has an aperture in the distal end, and wherein the locations of the apertures corresponds to the locations of mounting apertures in the PV module.

22. The PV module mounting system as defined in claim **12**, wherein the plurality of supports can be adjustably positioned at a plurality of locations on each of the mounting bases.

* * * * *