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(54) **SYSTEM AND METHOD FOR PASSIVELY SECURING SOLAR PANELS TO A FLAT SURFACE**

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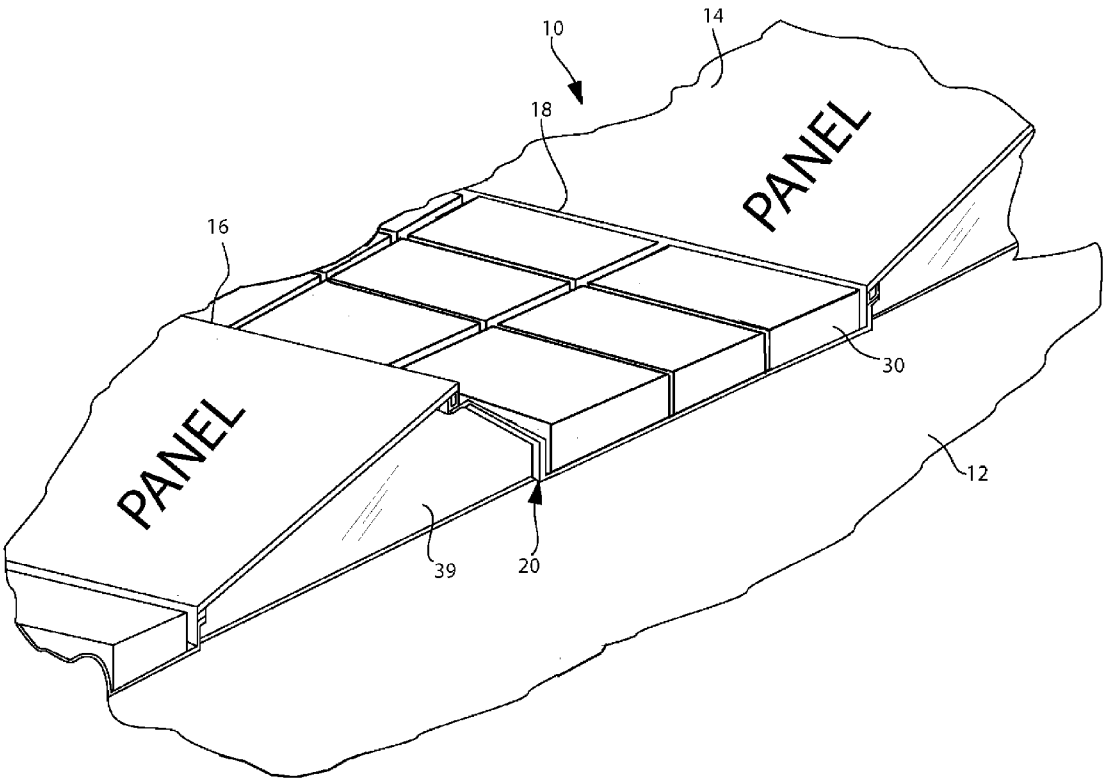
(57) **ABSTRACT**

A method of passively securing a solar panel array to a flat roof. The system utilizes mounting supports that hold solar panels at an inclined angle. Each mounting support includes a first mounting ledge, a second mounting ledge, a flat base section and an inclined section that is disposed between the flat base section and the first mounting ledge. A solar panel is attached between two of the mounting supports. Once mounted, the solar panel extends from the first mounting ledge of a first mounting support to a second mounting ledge of a second mounting support. Weights are then placed on the flat base section of the mounting supports to passively anchor the assembly to the roof.



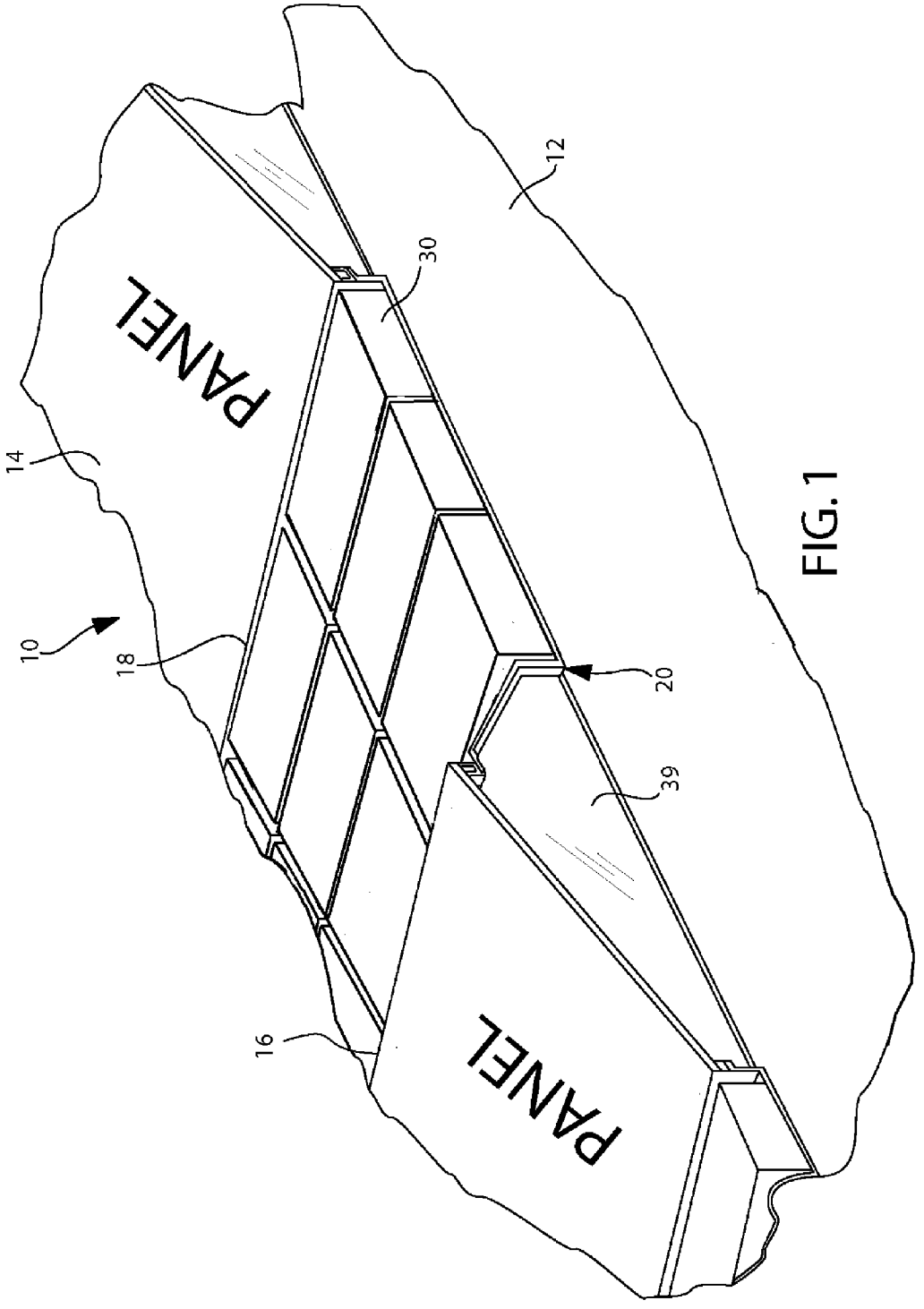


FIG. 1

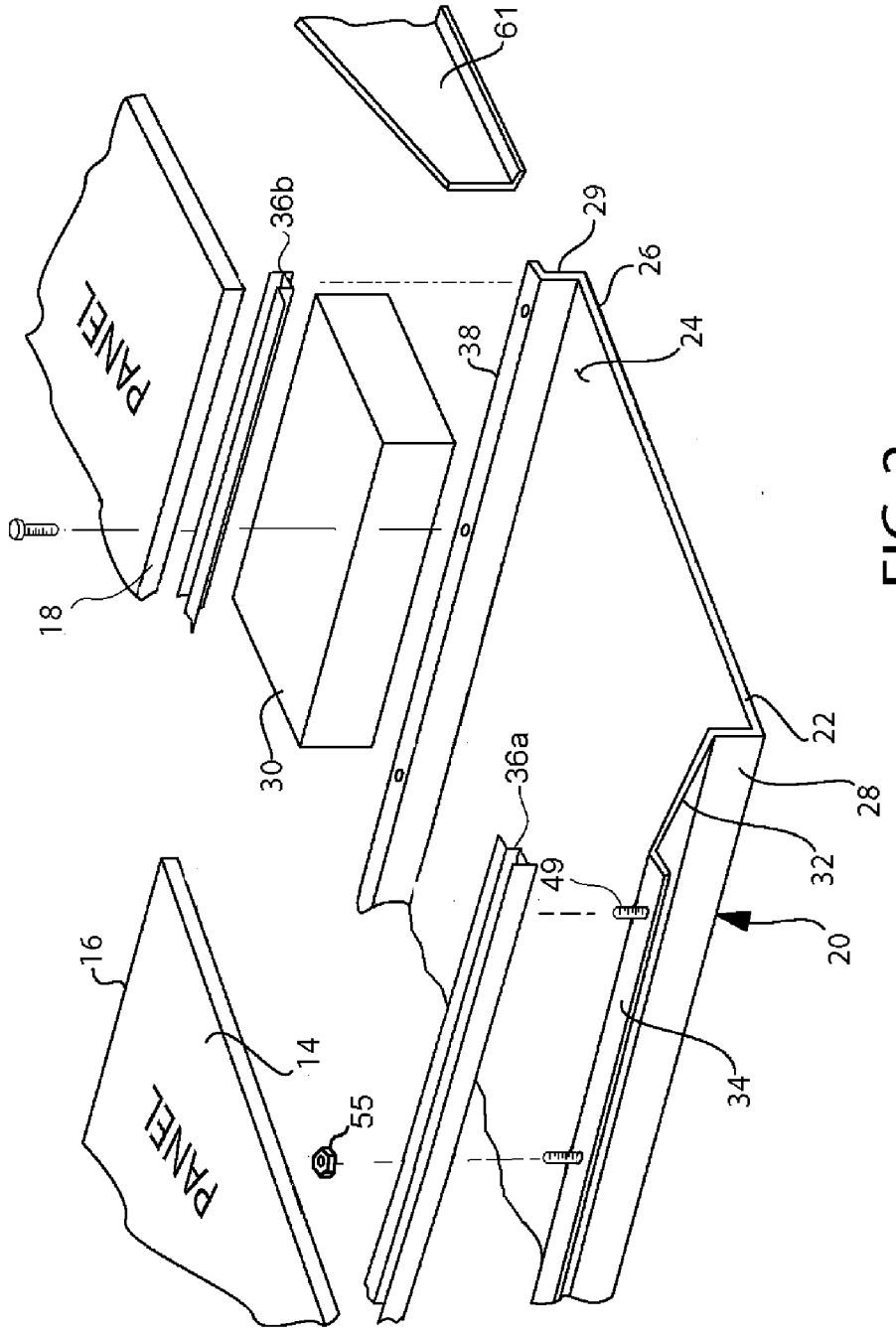


FIG. 2

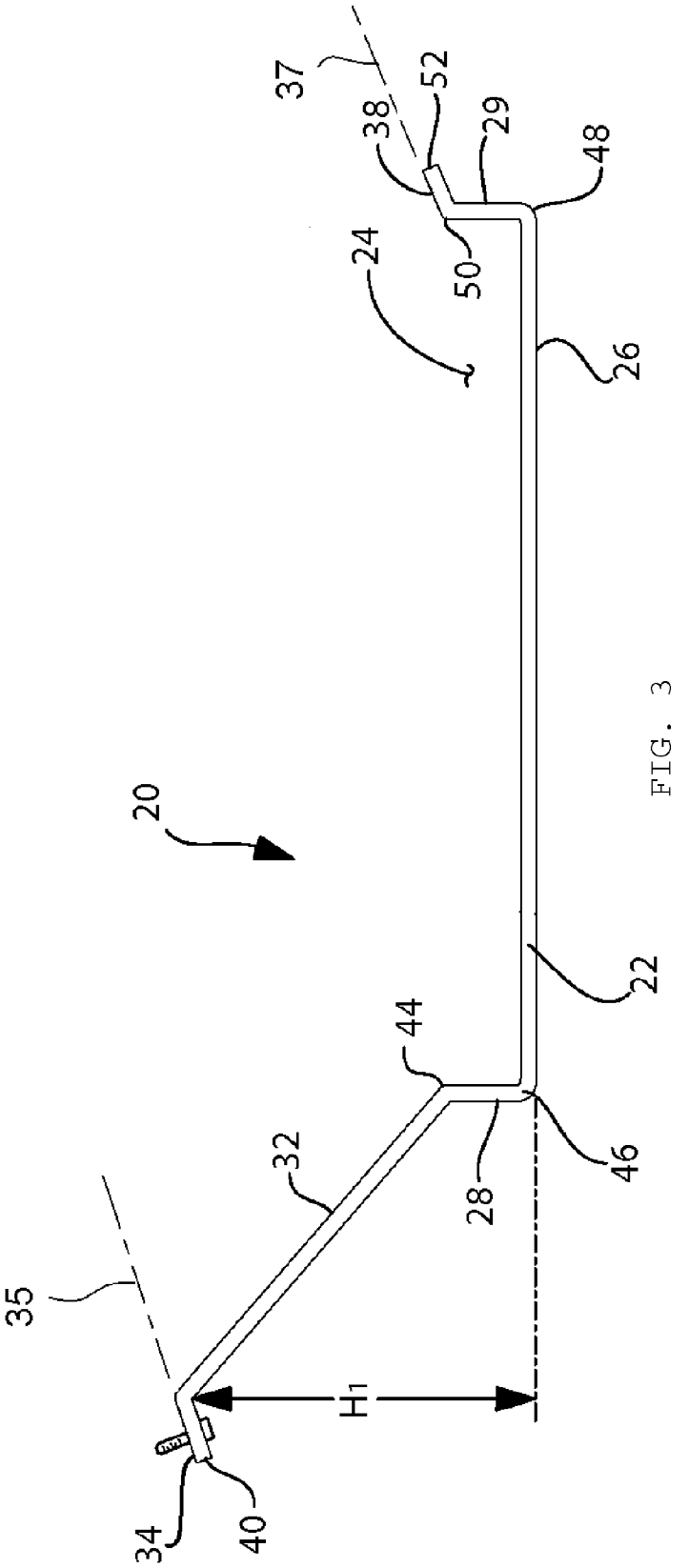


FIG. 3

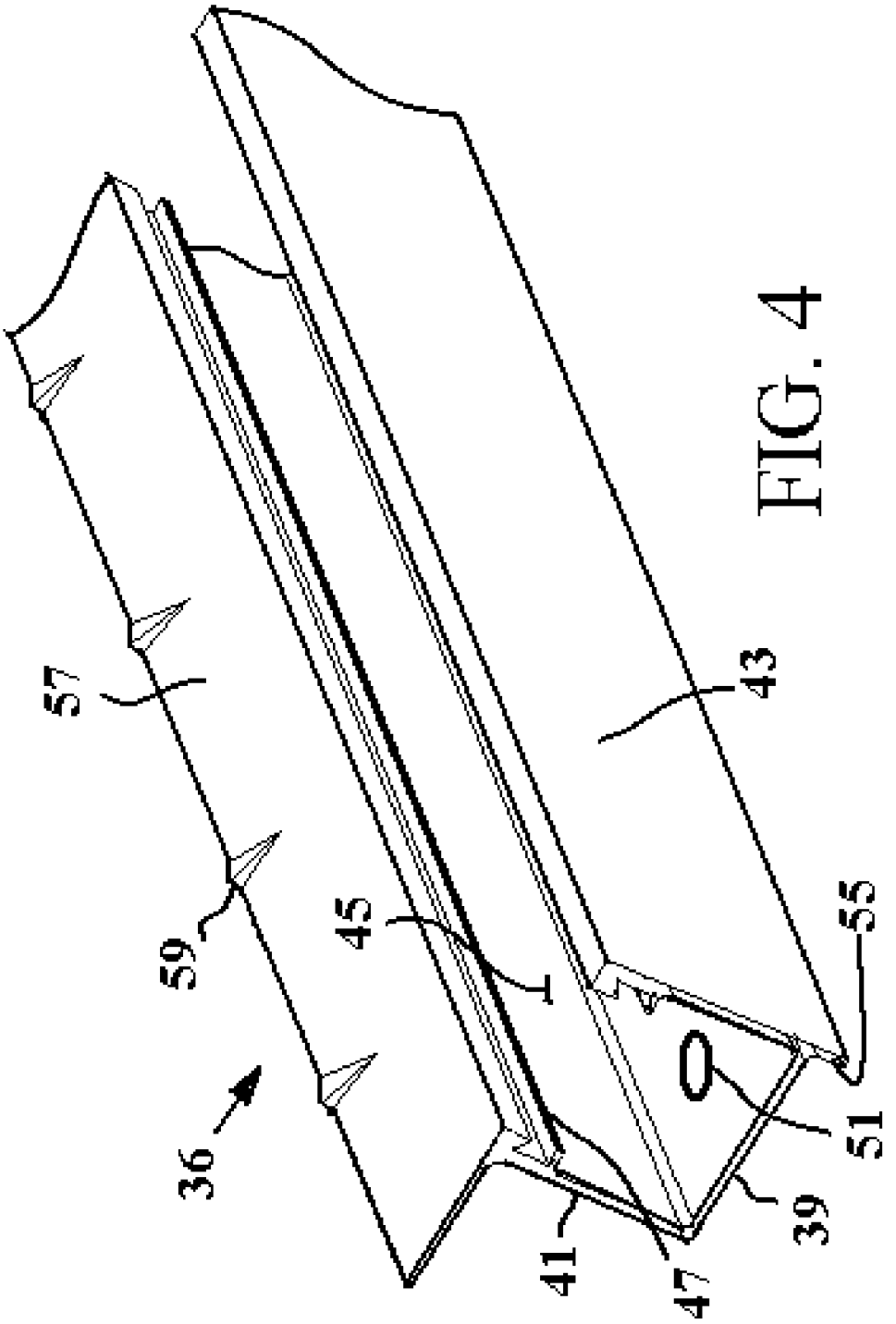


FIG. 4

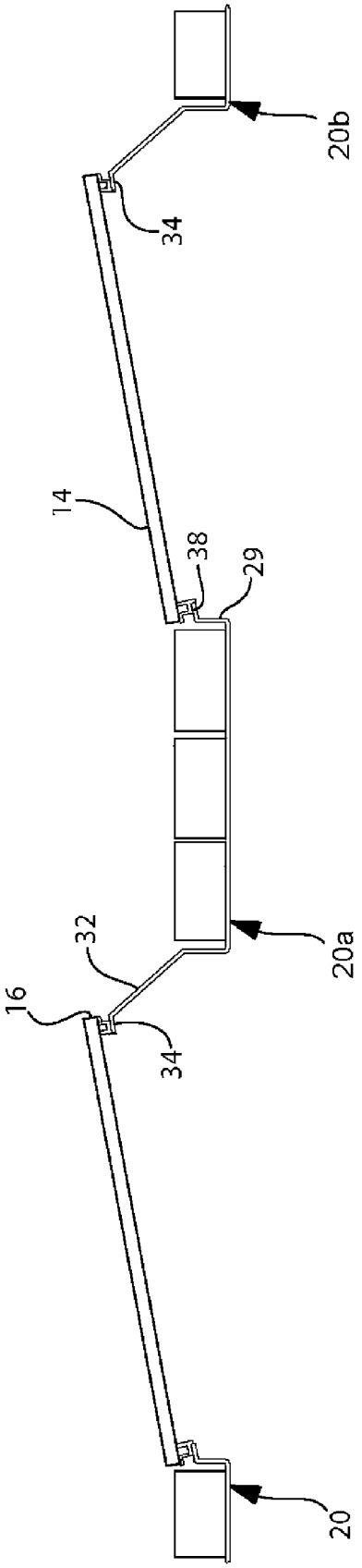


FIG. 5

SYSTEM AND METHOD FOR PASSIVELY SECURING SOLAR PANELS TO A FLAT SURFACE

RELATED APPLICATIONS

[0001] This application is a continuation-in-part of U.S. patent application Ser. No. 12/026,994, filed Feb. 6, 2008 that claims priority of Provisional Patent Application No. 60/899,702, filed Feb. 6, 2007.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] In general, the present invention relates to the support framework that is used to interconnect a solar panel to a flat or nearly flat surface, such as a flat roof. More particularly, the present invention relates to support frameworks that hold solar panels at an inclined angle.

[0004] 2. Prior Art Description

[0005] Given concerns about pollution, global warming and rising energy costs, many companies are trying to become more energy efficient and environmentally friendly. One way to achieve these goals is to use solar energy to produce electricity and/or heat water. Many commercial buildings have flat roofs. These large open roofs are ideal for placing an array of solar panels. However, many problems are encountered when solar panels are placed on a flat roof.

[0006] The flat roofs of commercial buildings comprise a large proportion of the solar panel arrays built in the U.S. and elsewhere. If the arrays should require many penetrations in order to fasten the panel mounting structures to the roofs, such penetrations carry a risk of producing roof leaks. It is for this reason that building owners often require that solar panel arrays and other such auxiliary objects be free standing on the roof and not be physically attached to the roof.

[0007] In the prior art there are many mounting brackets that are designed to hold solar panel arrays. However, most of these brackets must be physically mounted to the rooftop and therefore cannot be used in many commercial applications. Such prior art bracket systems are exemplified by U.S. Patent Application No. 2008/0087275 to Sade.

[0008] If solar panel arrays cannot be secured in place on a roof using fasteners, they must still be designed to be wind resistant. Solar panels are large flat structures. Gusts of wind acting under a solar panel can create lifting forces large enough to displace the solar panel.

[0009] Solar panels can be weighted to increase wind resistance. However, roofs have weight load limitations. Solar panel arrays must be made light so that they do not indent the roof or combine with a large snowfall to surpass the weight capacity of the roof.

[0010] To further complicate matters, solar panels are rarely installed flush against a roof. In most latitudes, solar panels are most efficient when mounted at an inclined angle. Accordingly, solar panels are traditionally placed upon some type of support framework that holds the solar panels at an incline. Mounting solar panels at inclined angles, however, exposes the underside of the panel to the wind and greatly reduces the wind resistance of the array.

[0011] In the prior art, the above-mentioned problems are addressed by using complex mounting frames that hold solar panels upon a flat roof. The mounting frames are comprised of a network of interconnected brackets that hold the solar panels at inclined angles. Weights are attached to the mounting frame to increase wind resistance. Lastly, windshields are connected to the mounting frame to prevent winds from reaching the undersides of the solar panels. Such a prior art solar panel mounting system is exemplified by the Rapid Rac® system currently being marketed by Unirac of Albuquerque, N. Mex.

[0012] The obvious problem with such prior art systems is their complexity. In order to place even a small solar panel array on a roof requires the assembly of hundreds of different brackets, weights, and air deflection panels. The complexity of such mounting systems adds significantly to both the cost and the labor of installing a solar panel array. Another problem with such prior art mounting frames is that they contact the roof only in the location of the support brackets. This concentrates the weight of the solar panel array to specific lines along the roof.

[0013] A need therefore exists for a mounting system for solar panels that can be installed using very little time and labor, and with relatively few parts. A need also exists for a mounting system that widely distributes the weight of a solar panel array on a roof, thereby enabling larger arrays to be used. A need also exists for a mounting system that can be manufactured easily and inexpensively. These needs are met by the present invention as described and claimed below.

SUMMARY OF THE INVENTION

[0014] The present invention is a system and method that is used to secure a solar panel array to a flat roof without fasteners. The system utilizes mounting supports that hold solar panels at an inclined angle. Each mounting support includes a weight trough, an upper mounting ledge, a lower mounting ledge, an inclined surface, and fasteners all in a single unit. The upper mounting ledge extends in a first plane, wherein the upper mounting ledge is at a first elevation above the weight trough. The lower mounting ledge extends in a second plane that is parallel to the first plane. The lower mounting ledge is at a second elevation above the weight trough that is lower than the first elevation of the upper mounting ledge. Furthermore, the weight trough is disposed between the upper mounting ledge and the lower mounting ledge. The inclined section is disposed between the weight trough and the upper mounting ledge.

[0015] The first mounting support and the second mounting support are arranged in a line on a roof. This causes the lower mounting ledge from the first mounting support to be parallel to, and a predetermined distance from, the upper mounting ledge of the second mounting support. The solar panel is attached to the lower mounting ledge of the first mounting support and to the upper mounting ledge of the second mounting support. Accordingly, the solar panel spans the predetermined distance at an inclined angle.

[0016] Lastly, weights are placed in the weight trough of both the first mounting support and the second mounting support to passively anchor the assembly to the roof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] For a better understanding of the present invention, reference is made to the following description of an exemplary embodiment thereof, considered in conjunction with the accompanying drawings, in which:

[0018] FIG. **1** is a perspective view of an exemplary embodiment of a segment of a solar panel roof array;

[0019] FIG. **2** is an exploded view of the exemplary embodiment of FIG. **1**;

[0020] FIG. **3** is a cross-sectional view of a mounting support;

[0021] FIG. **4** is a perspective view of a segment of a mounting rail; and

[0022] FIG. **5** is a cross-sectional view of a segment of an assembled array.

DETAILED DESCRIPTION OF THE DRAWINGS

[0023] Although the present invention mounting system can be used to hold solar panels on roofs with a slight pitch, the exemplary embodiment shows the mounting system used to join solar panels to a flat roof. The exemplary embodiment was selected for purposes of its ease of illustration and should not be considered a limitation upon the claims.

[0024] Referring to FIG. **1** in conjunction with FIG. **2**, a segment of a solar panel array **10** is shown. The solar panel array **10** rests upon the flat roof **12** of a commercial building. The array **10** contains numerous solar panels **14**. The solar panels **14** are made in different sizes by different manufacturers. There are also different types of solar panels that are used for different purposes, such as generating electricity or heating water. In the shown embodiment, a rectangular photovoltaic panel is illustrated. Rectangular photovoltaic panels are widely commercially available. Being rectangular in shape, such solar panels **14** have two long edges and two short edges. The solar panels **14** can be mounted in two orientations. In the first portrait orientation, the long side edges of each solar panel slope upwardly. In the second landscape orientation, the solar panel **14** is turned ninety degrees and the short side edges slope upwardly. The mounting supports **20** of the present invention are capable of holding solar panels in both the portrait and landscape orientations without any need of adjustment.

[0025] The solar panels **14** are joined to two separate mounting supports **20**. Likewise, at least two solar panels **14** are joined to most all the mounting supports **20** in the solar panel array **10**. When the solar panels **14** are mounted in the portrait configuration, two solar panels **14** can be mounted between two mounting supports **20**. However, if the solar panels **14** are turned into a landscape orientation, only one solar panel **14** can be mounted between the two mounting supports **20**. The distance between the mounting supports **20** is adjusted merely by moving the mounting supports **20** either closer together or farther apart.

[0026] Each solar panel **14** is inclined at an angle. Depending upon the location of the array **10**, most solar panels **14** face due south and are inclined between ten degrees and thirty-five degrees. It will therefore be understood that each mounted solar panel **14** has an upper edge **16** and a lower edge **18**, wherein the upper edge **16** is elevated above the lower edge **18** to produce the desired angle of inclination. The upper edge **16** and the lower edge **18** of the solar panel **14** can be either the long or short edges of the solar panel **14** depending upon the mounting orientation of the solar panel **14**.

[0027] The mounting supports **20** are arranged in parallel rows upon the roof **12**. As will later be explained in more detail, each mounting support **20** is made from metal. The metal is preferably a weather resistant metal such as aluminum, stainless steel, galvanized sheet metal or the like.

[0028] Each mounting support **20** is fabricated from a sheet metal **22** that is selectively bent into the form of the mounting support **20**. The bends in the sheet of metal **22** can be accomplished by a stamping die or an extrusion die. However, it is preferred that the various bends simply be created by subjecting the sheet of metal **22** to a bending brake. In that manner, the mounting supports **20** can be created with little or no tooling costs. Furthermore, the various bends can be selectively altered to meet the needs of a specific installation location or a specific solar panel.

[0029] It is preferred that the single piece of sheet metal **22** be used to form the mounting support **20**. However, it should be understood that the mounting support **20** can be fabricated by welding, riveting, bolting or otherwise connecting together separate sections of sheet metal.

[0030] Referring to FIG. **3** in conjunction with FIG. **2**, it can be seen that the mounting support **20** includes a weight trough structure **24**. The weight trough structure **24** has a flat bottom section **26** that extends between two side walls **28**, **29**. The sidewalls **28**, **29** can be vertical, but are preferably slightly angled so that multiple mounting supports **20** can readily nest together when stacked for storage. The weight trough structure **24** extends along the entire length of the mounting support **20**. The width of the weight trough structure **24** is sized to receive the ballast weights **30**. It is preferred that the width of the weight trough structure be between sixteen inches and thirty-two inches. The ballast weights **30** can be sand bags, water bladders, metal weights or the like. In the shown embodiment, the ballast weights **30** are commercially available concrete blocks. This type of ballast weight is preferred. Such ballast weights are weather resistant, heavy, and very low cost. The ballast weights **30** are added in the amount required to meet wind resistance requirements. Heavy arrays require less ballast weights than light arrays. Ballast weights in the form of bricks or blocks typically either four or eight inched wide. It is preferred that the width of the weight trough structure **24** is sized so that bricks and/or blocks can be neatly placed three or four abreast in the weight trough structure **24** with little unused space remaining.

[0031] It is preferred that the ballast weights **30** have a combined width that is just slightly smaller than the width of the weight trough structure **24**. In this manner, the ballast weights **30** are confined between the sidewalls **28**, **29** of the weight trough structure **24** and cannot be shifted out of position by the elements.

[0032] An inclined section **32** extends upwardly from the first sidewall **28** of the weight trough structure **24**. The inclined section **32** and the first side wall **28** are continuously formed and meet at a bend joint **44**. The angle between the inclined section **32** and the first side wall **28** is preferably between 100 degrees and 160 degrees. The inclined section **32** reaches a predetermined height H**1** above the plane shared by the flat bottom section **26** of the weight trough structure **24**. The height H**1** is typically between one and two feet high. As will later be explained, the height H**1** reached by the inclined section **32** can be selectively adjusted by increasing or decreasing the length of the angled section **32**, or by increasing or decreasing the angle at the bend joint **44**.

[0033] An upper mounting ledge **34** is formed at the top of the inclined section **32**. The upper mounting ledge **34** is preferably between one and three inches wide and extends in a first angled plane **35**. A mounting rail **36**A is attached to the upper mounting ledge **34** with mechanical fasteners. The mounting rail **36**A receives and retains the upper edge **16** of a solar panel **14**.

[0034] A lower mounting ledge **38** extends from the top of the second sidewall **29** of the weight trough structure **24**. The

lower mounting ledge **38** is also preferably between one and three inches wide and extends in a second angled plane **37** that is parallel to the first angled plane **35**. A mounting rail **36**B is also attached to the lower mounting ledge **38** with mechanical fasteners. The mounting rail **36**B receives and retains the lower edge **18** of the solar panel **14**.

[0035] Referring to FIG. **4**, a segment of a mounting rail **36** is shown. The mounting rail **36** is an extruded form that creates a generally U-shaped channel having a flat bottom wall **39**, two flat sidewalls **41**, **43** and an open top **45**. Reinforcement ribs **47** may be extruded onto the sidewalls **41**, **43** to increase the overall rigidity of the mounting rail **36**.

[0036] Referring to FIG. **4** in conjunction with FIG. **2**, it can be seen that the mounting rail **36** is either attached to the lower mounting ledge **38** or the upper mounting ledge **34**. The mounting rail **36** is affixed to the either the lower mounting ledge **38** or the upper mounting ledge **34** with bolts **49**. The bolts **49** can be separately provided. However, in the preferred embodiment, the bolts **49** are weld or otherwise affixed to the upper mounting ledge **34**. Holes **51** are formed through the bottom wall **39** of the mounting rail **36** to accommodate the bolts **49**. Clinching nuts **55** are used to engage the bolts and create a rapid connection between the mounting supports **20** and the mounting rails **36**. In the shown illustration, the bolts **49** are anchored in place and the nuts **55** are free to turn. It will be understood that the nuts **55** and bolts **49** can be reversed in position to the same effect.

[0037] To help rapidly align the mounting rail **36** in a proper orientation, a guide lip **55** is formed on the mounting rail **36**. The guide lip **55** extends down below the bottom wall **39** of the mounting rail **36** below the forward sidewall **43**. When the mounting rail **36** is placed against either the lower mounting edge **38** or the upper mounting edge **34**, the guide lip **55** abuts against that ledge and properly orients the mounting rail **36** so that the various holes **51**, **53** for the bolts **49** align.

[0038] An auxiliary support flange **57** is also formed as part of the mounting rail **36**. The auxiliary support flange **57** extends outwardly from the top of the inside sidewall **41** and in a plane parallel to the bottom wall **39**. In this manner, the auxiliary support flange **57** and the top the sidewalls **41**, **43** all extend in a common plane. The auxiliary support flange **57** provides a relatively large surface for use in contacting and supporting the solar panels **14**.

[0039] A plurality of upwardly projecting teeth **59** can be formed into the auxiliary support flange **57** and/or the tops of the sidewalls **41**, **43**. The projecting teeth **59** bite into the frame of the solar panel **14**. This creates a strong electrical interconnection between the mounting rail **36** and the solar panel **14** for grounding purposes. The projecting teeth **59** also help prevent any solar panel **14** from shifting in its mounts during high winds or other severe weather conditions.

[0040] As has been previously stated, the mounting support **20** is preferably formed from a single sheet of metal **22** that is selectively bent to form the features of the mounting support **20**. Referring back to FIG. **3**, it can be seen that the sheet of metal **22** initially has a first edge **40** and an opposite second edge **52**. The upper mounting ledge **34** extends from the first edge **40** to a first bend **42**. The inclined section **32** extends from the first bend **42** to a second bend **44**. The first side wall **28** of the weight trough structure **24** extends from the second bend **44** to a third bend **46**. The flat bottom section **26** of the weight trough structure **24** extends from the third bend **46** to a fourth bend **48**. The second side wall **29** of the weight trough structure **24** extends from the fourth bend **48** to a fifth bend **50**. Lastly, the lower mounting ledge **38** extends from the fifth bend **50** to the second edge **52**.

[0041] The upper mounting ledge **34** is higher than the lower mounting ledge **38**. However, both the upper mounting ledge **34** and the lower mounting ledge **38** exist in parallel planes. Accordingly, when a solar panel **14** is placed between the upper mounting ledge **34** and the lower mounting ledge **38** of adjacent mounting supports **20**, the solar panel **14** lay flush upon both surfaces.

[0042] Referring now to FIG. **5** in conjunction with FIG. **2**, it can be seen that the mounting supports **20** are placed in parallel rows, wherein all the mounting supports **20** face in the same direction. Accordingly, the upper mounting ledge **34** from one mounting support **20** always faces the lower mounting ledge **38** of an adjacent mounting support **20**. A solar panel **14** is placed between adjacent rows of mounting supports **20**. The lower edge **18** of a solar panel **14** connects to the lower mounting ledge **38** of a first mounting support **20***a*. The upper edge **16** of the same solar panel **14** connects to the upper mounting ledge **34** of an adjacent mounting support **20***b*. The solar panel **14** is, therefore, held at an inclined angle with respect to the horizontal. It will be understood that by adjusting the angle of the inclined section **32** and adjusting the distance between adjacent mounting supports **20***a*, **20***b*, the angle of the solar panel **14** can be selectively adjusted.

[0043] Once a solar panel **14** is mounted between mounting supports **20***a*, **20***b*, it will be understood that the inclined section **32** of one mounting support **20** extends to the upper edge **16** of that solar panel **14**. None of the solar panel **14** extends as a cantilever beyond the mounting support **20**. The inclined section **32**, therefore, serves as a full wind shield and prevents wind from acting upon any part of the underside of the solar panel **14** from behind. It therefore serves to decrease lift and improve the wind resistance of the array. Likewise the second side wall **29** of a weight trough structure **24** extends below the lower edge **18** of the solar panel **14**. This prevents wind from getting under the solar panel **14** from in front.

[0044] The inclined section **32** of the mounting support is preferably stainless steel or an aluminum alloy with a smooth or otherwise polished surface. In this manner, the inclined section **32** is highly reflective to sunlight. Accordingly, if the angle of the inclined section **32** is properly adjusted, during certain times of day and during certain times of the year, the inclined surface **32** can reflect additional sunlight onto the solar panels **14**. The solar energy received by the solar panels **14** is therefore increased, which increases the power output of the solar panels **14**.

[0045] Referring back to FIG. **1** and FIG. **2**, it can be seen that side panels **61** are provided. The side panels **61** attach to the sides of the mounting supports **20** under the solar panel **14** and prevent wind from getting under the solar panels **14** from the sides.

[0046] From the above, it will now be understood that to install a solar panel array **10**, solar panels **14** and mounting supports **20** are brought to the roof **12**. The mounting supports **20** require no preassembly. Rather, solar panels **14** can be attached to the mounting supports **20** with no preassembly preparation. The mounting supports **20** can be custom bent to achieve any desired angle of inclination for the solar panels **14**. In this manner, the mounting supports **20** can be made to compensate for rooftops that are slightly pitched for water drainage purposes. The solar panels **14** and mounting supports **20** are then arranged into an array **10** on the roof **12**.

Once properly oriented, the ballast weights **30** are placed in the weight trough structure **24** and side panels **61** are attached to any open side.

[0047] The mounting supports **20** require no preassembly. Furthermore, the weighing of the mounting supports **20** requires only the placement of ballast weights **30** into the weight trough structure **24**. It will therefore be understood that a solar array **10** can be assembled on a roof **12** in a highly time and labor efficient manner.

[0048] It will be further understood that a person skilled in the art can alter the illustrated embodiment of the present invention using functionally equivalent components. For instance, the sides of the weight trough structure, the angle of the inclined section, the length of the inclined section and the mounting ledges can all be altered. Furthermore, the weight trough structure can be eliminated by merely using a flat surface upon which weights can be placed. All such variations, modifications, and alternate embodiments are intended to be included within the scope of the present invention as defined by the claims.

What is claimed is:

1. A method of passively securing a solar panel to a roof, comprising the steps of:

providing a solar panel;

providing a first mounting support and a second mounting support, wherein both said first mounting support and said second mounting support include,

i. a weight trough;

ii. an upper mounting ledge that extends in a first plane, wherein said upper mounting ledge is at a first elevation above said weight trough;

iii. a lower mounting ledge that extends in a second plane that is parallel to said first plane, wherein said lower mounting ledge is at a second elevation above said weight trough that is lower than said first elevation; wherein said weight trough is disposed between said upper mounting ledge and said lower mounting ledge; and

iv. an inclined section disposed between said weight trough and said upper mounting ledge;

arranging said first mounting support and said second mounting support in a line on said roof so that said lower mounting ledge from said first mounting support is parallel to, and a predetermined distance from, said upper mounting ledge of said second mounting support;

attaching said solar panel to said lower mounting ledge of said first mounting support and to said upper mounting ledge of said second mounting support, wherein said solar panel spans said predetermined distance at an inclined angle;

placing weights in said weight trough of both said first mounting support and said second mounting support.

2. The method according to claim **1**, further including the steps of providing an upper mounting rail and a lower mounting rail.

3. The method according to claim **2**, further including the step of attaching said lower mounting rail to said lower mounting ledge of said first mounting support.

4. The method according to claim **3**, further including the step of attaching said upper mounting rail to said upper mounting ledge of said second mounting support.

5. The method according to claim **4**, wherein said step of attaching said solar panel to said lower mounting ledge of said first mounting support and said upper mounting ledge of said second mounting support includes attaching said solar panel to both said lower mounting rail and said upper mounting rail.

6. The method according to claim **1**, wherein said weight through has a flat bottom surface that lays between two parallel sidewalls.

7. The method according to claim **6**, wherein said flat base of said weight trough has a width between said parallel sidewalls that is between sixteen inches and thirty six inches wide.

8. The method according to claim **6**, wherein said inclined section extends from one of said parallel sidewalls to said upper mounting ledge.

9. The method according to claim **6**, further including the step of providing a plurality of ballast weights in the form of concrete blocks, wherein said step placing weights in said weight trough of both said first mounting support and said second mounting support included placing said concrete blocks side by side in said weight trough to fill said weight trough between said parallel sidewalls.

10. A method of passively securing a solar panel to a roof, comprising the steps of:

providing a plurality of mounting supports, wherein each of said mounting supports includes,

i. a weight trough having a flat base surface that extends between a first sidewall and a parallel second sidewall, wherein said second sidewall supports a lower mounting ledge that extends at an angle from said second sidewall in a first plane;

ii. an inclined surface that extends upwardly from said first side wall, wherein said inclined surface supports an upper mounting ledge that extends from said inclined surface in a second plane that is parallel to said first plane;

arranging said mounting supports in parallel rows that include a first row and a second row, so that said upper mounting ledge of some of said mounting supports in said first row lay parallel a predetermined distance apart from said lower mounting ledge from other of said plurality of mounting supports in said second row;

providing solar panels;

attaching said solar panels to said upper mounting ledge of said mounting supports in said first row and to said lower mounting ledge of said mounting supports in said second row, wherein said solar panels span said predetermined distance at an inclined angle;

placing weights in said weight trough of all of said mounting supports.

11. The method according to claim **10**, further including the steps of providing upper mounting rails and lower mounting rails.

12. The method according to claim **11**, further including the step of attaching said lower mounting rails to each said lower mounting ledge of said mounting supports.

13. The method according to claim **12**, further including the step of attaching said upper mounting rails to each said upper mounting ledge of said mounting supports.

14. The method according to claim **13**, attaching said solar panels to said upper mounting ledge of said mounting supports in said first row and to said lower mounting ledge of said mounting supports in said second row includes attaching said solar panels between each said lower mounting rail and each said upper mounting rail.

15. The method according to claim **10**, wherein said flat base of said weight trough has a width between said parallel sidewalls that is between sixteen inches and thirty six inches wide.

16. The method according to claim **15**, further including the step of providing a plurality of ballast weights in the form of concrete blocks, wherein said step placing weights in said weight trough of both said first mounting support and said second mounting support included placing said concrete blocks side by side in said weight trough to fill said weight trough between said parallel sidewalls.

17. A method of passively securing solar panels to a roof, comprising the steps of:

providing a plurality of mounting supports, wherein said mounting supports have upper mounting ledges, lower mounting ledges and weight troughs;

providing a plurality of upper mounting rails;

attaching said upper mounting rails to said upper mounting ledges;

providing a plurality of lower mounting rails;

attaching said lower mounting rails to said lower mounting ledges;

positioning said mounting supports in a first row and a parallel second row that are separated by a predetermined distance;

providing solar panels;

attaching said solar panels to said upper mounting rails in said first row and to said lower mounting rails in said second row, wherein said solar panels span said predetermined distance at an inclined angle;

placing weights in said weight troughs of said mounting supports.

18. The method according to claim **17**, wherein said weight through has a flat bottom surface that lays between two parallel sidewalls.

19. The method according to claim **18**, wherein said flat base of said weight trough has a width between said parallel sidewalls that is between sixteen inches and thirty six inches wide.

* * * * *