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(54) SOLAR ARRAY MOUNTING SYSTEM

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(57) **ABSTRACT**

A mounting stand for supporting a solar panel or other solar energy collection device on a mounting surface, includes a body including a stand-off element for supporting the body clear of the surface, and a tension device, adapted to be connected between the body and the mounting surface, so as to hold the stand-off element securely in contact with the surface. The body preferably includes a triangular space-frame made up of three parallel members one of which has legs forming a stand-off elements while the other two form a mounting for the solar energy collection device.

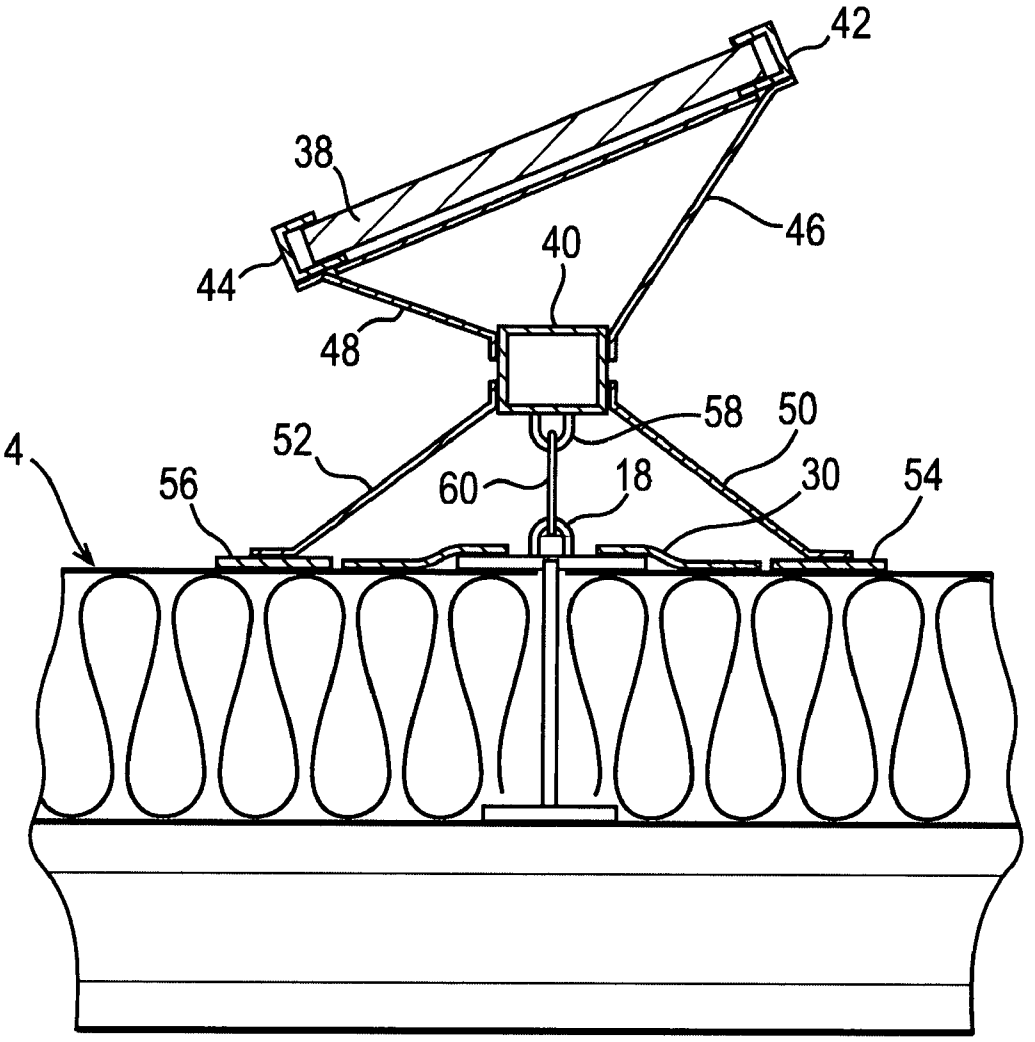
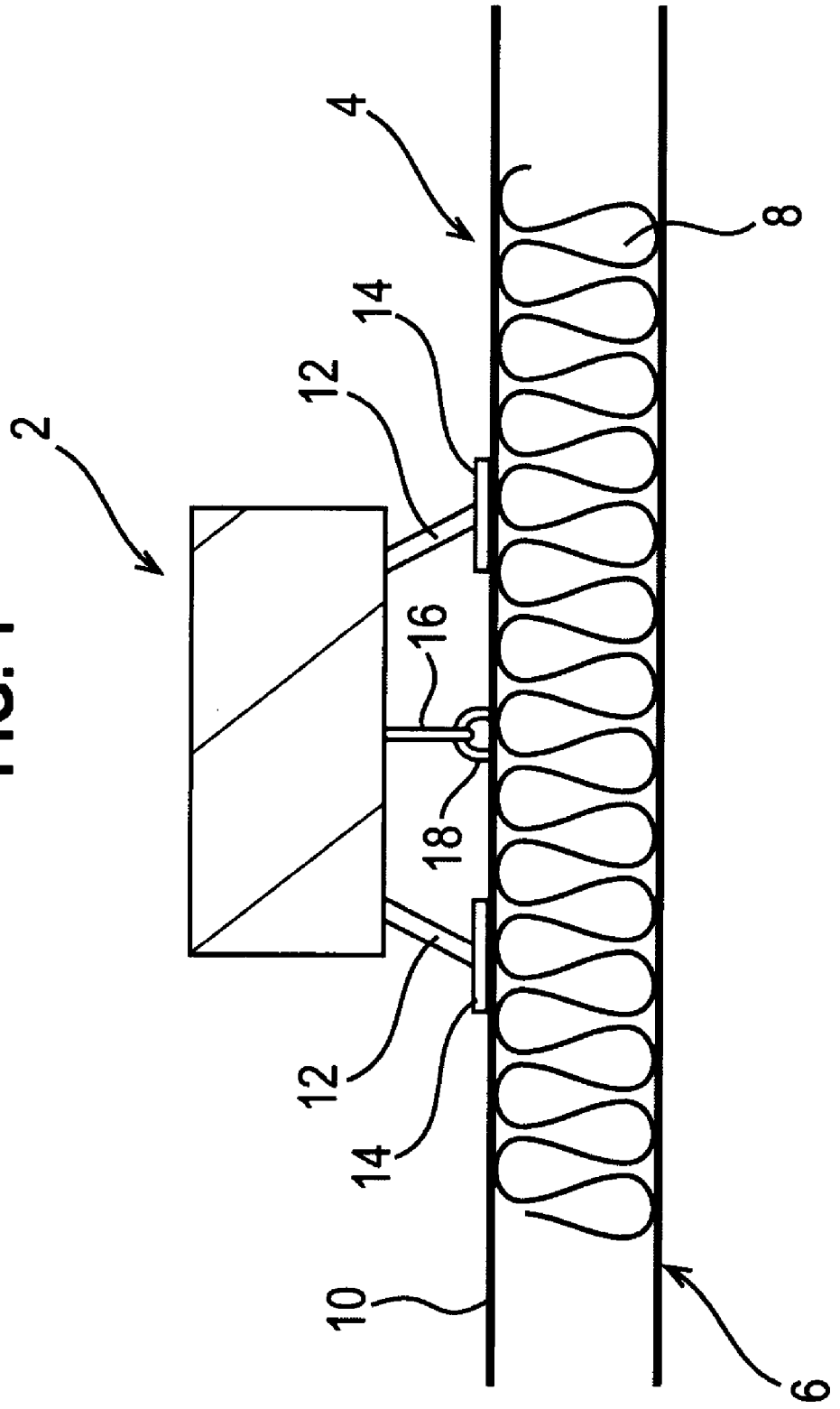


FIG. 1



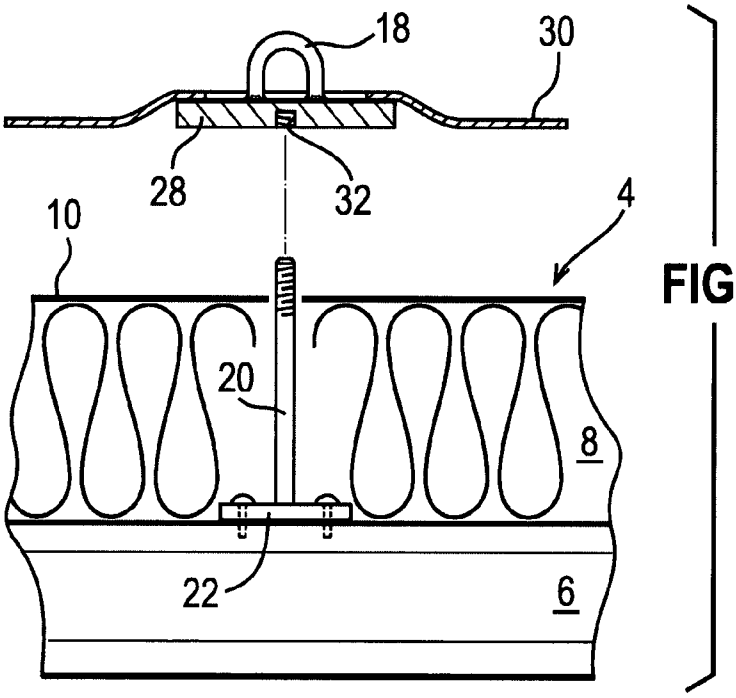


FIG. 2

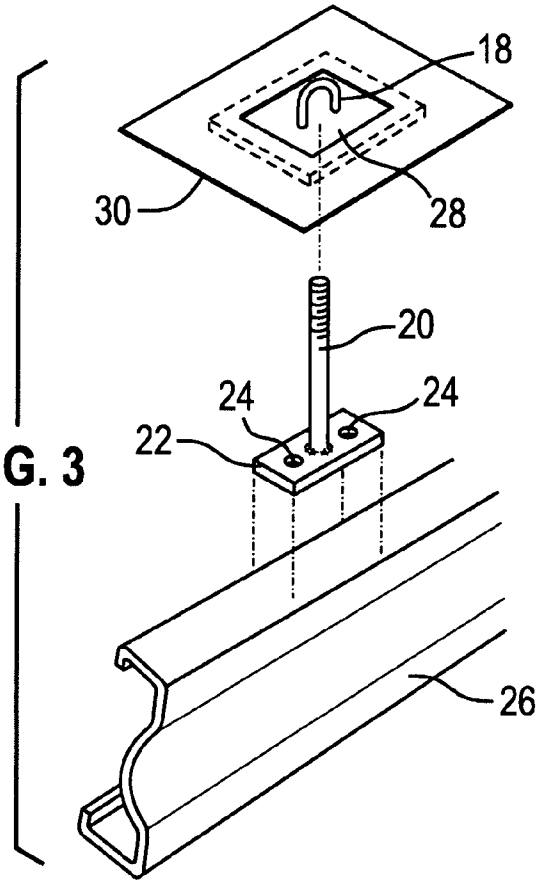


FIG. 3

FIG. 4

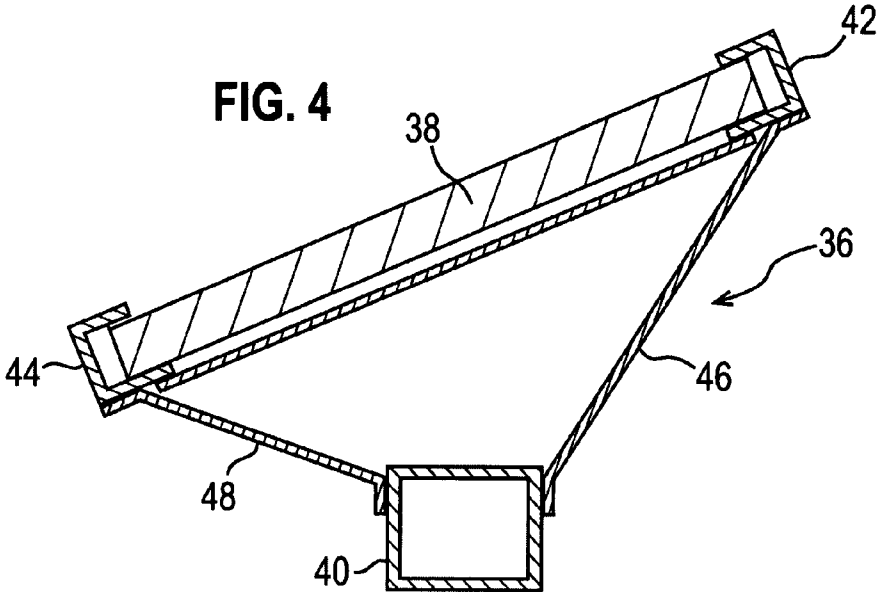
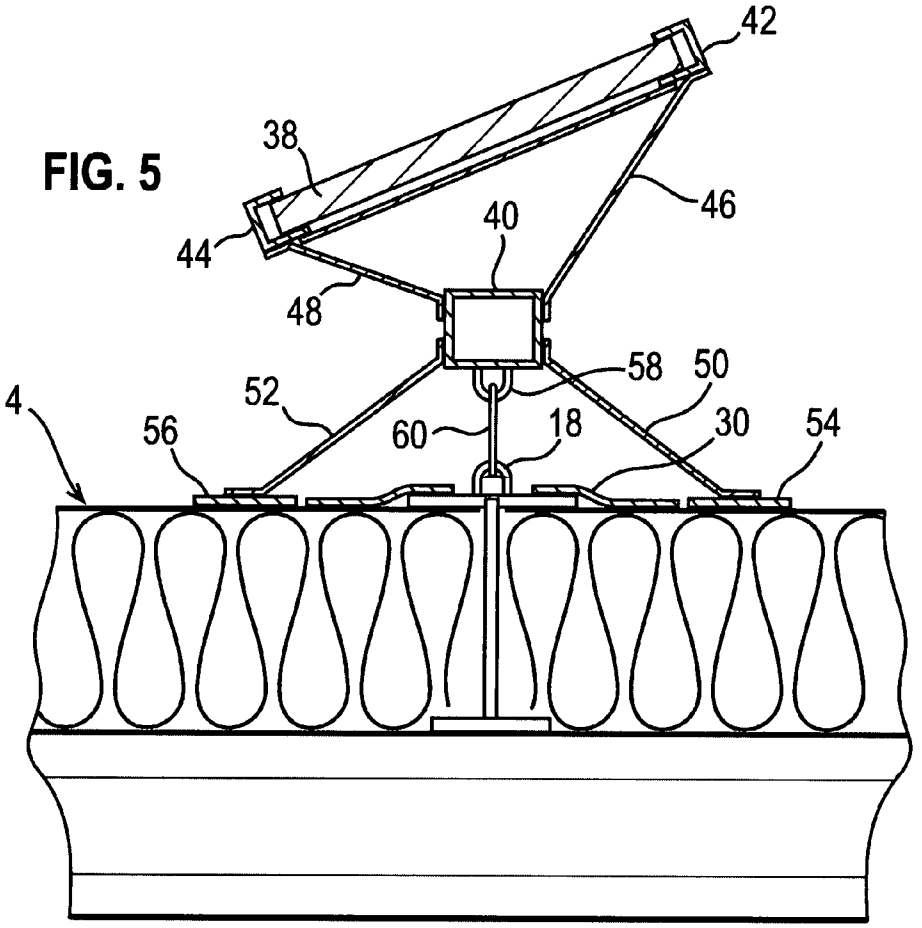


FIG. 5



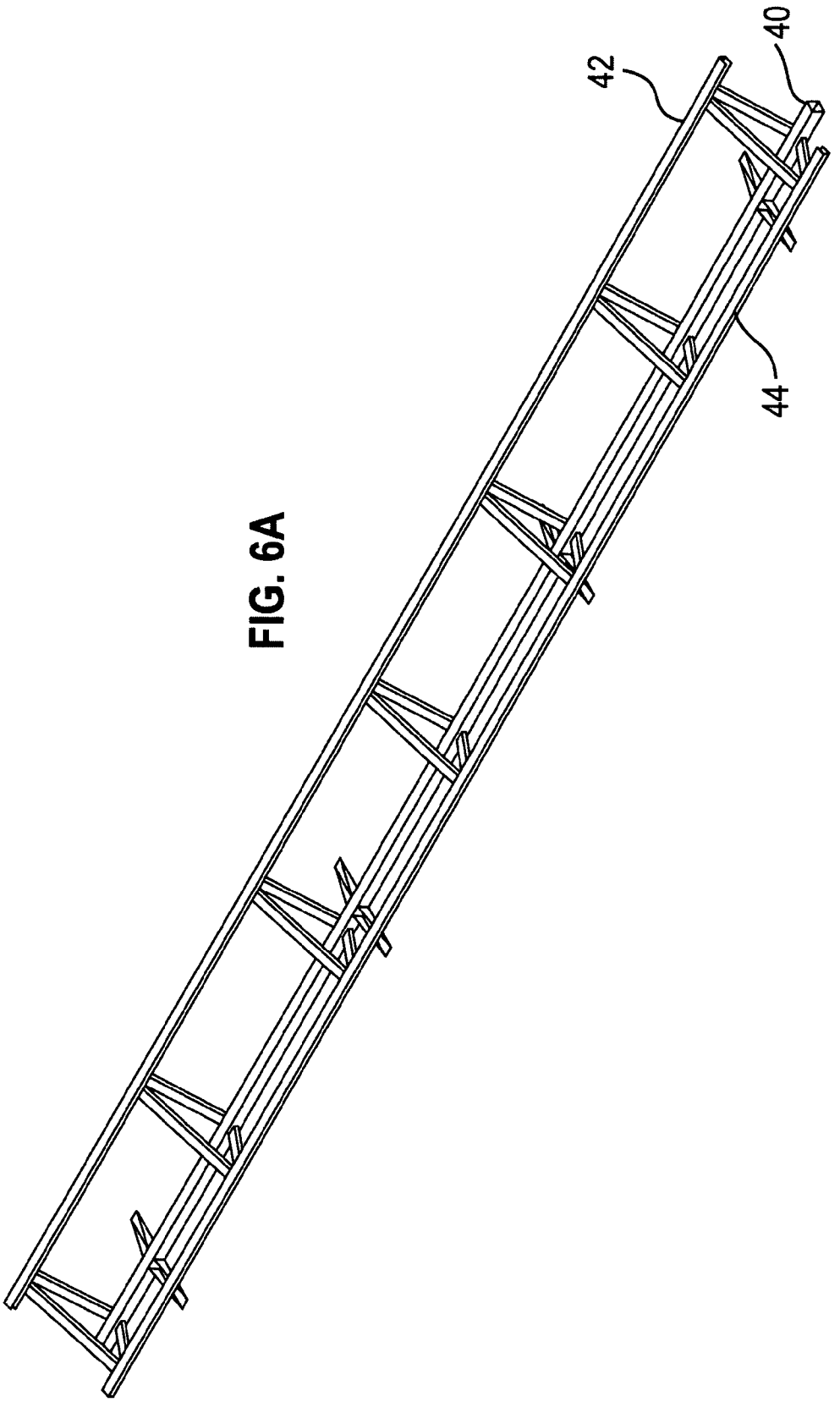


FIG. 6A

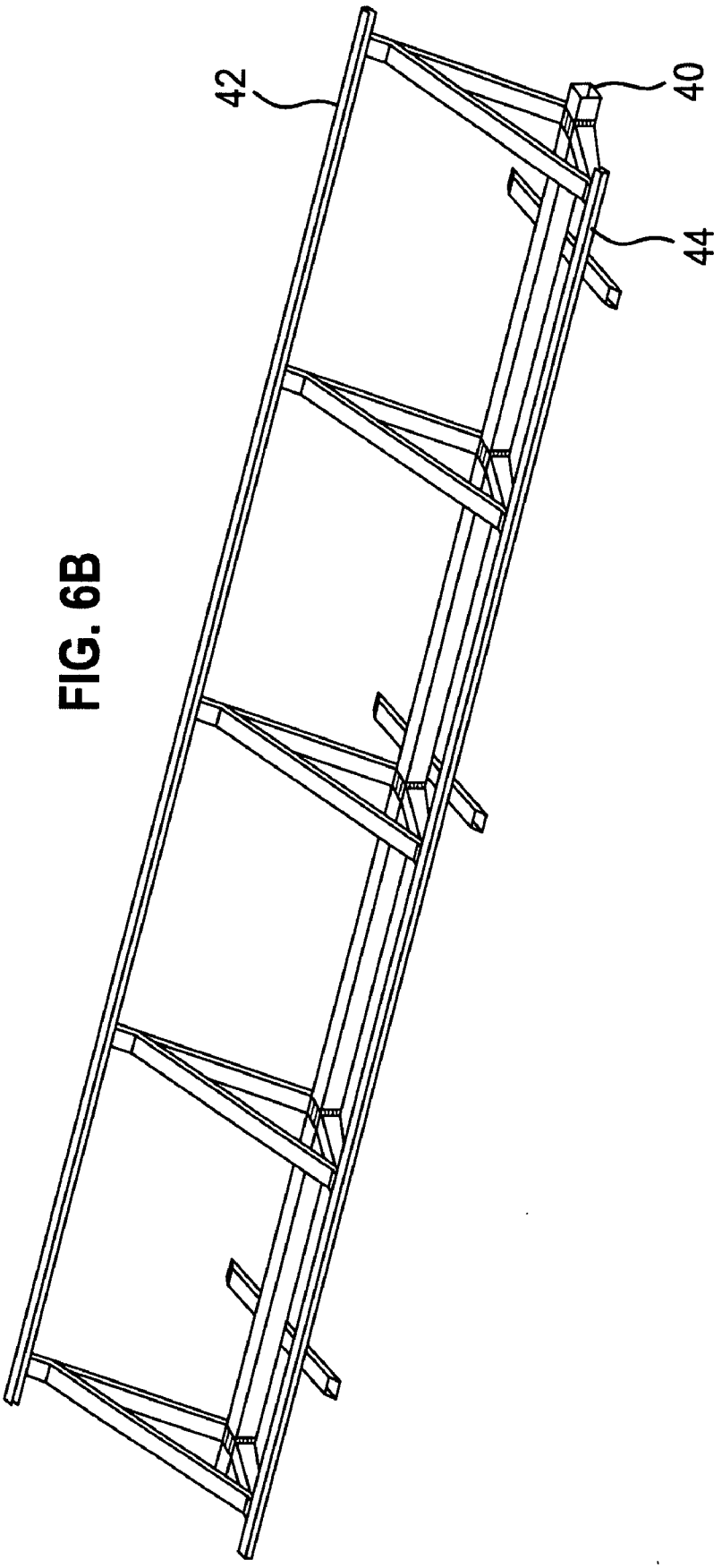


FIG. 6B

FIG. 7A

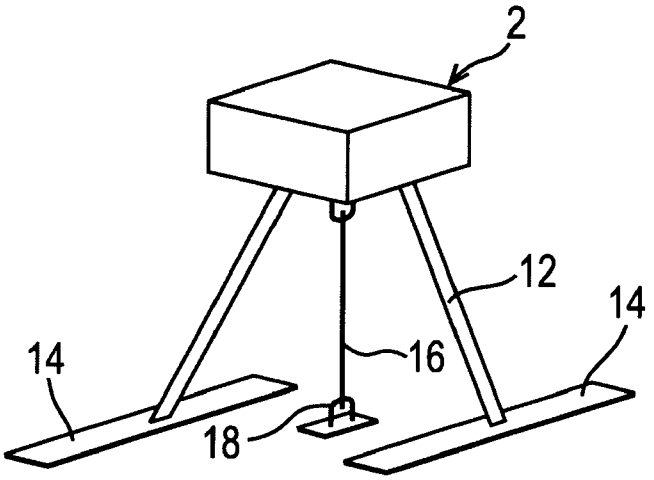


FIG. 7B

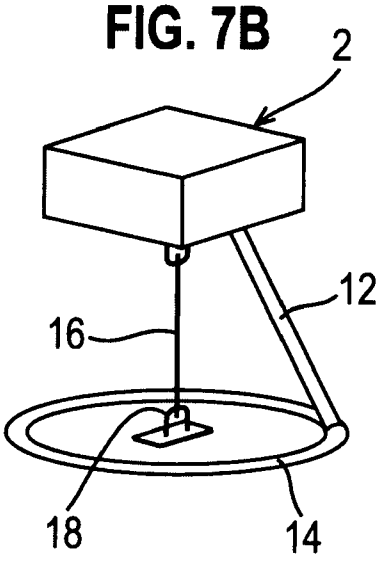


FIG. 7C

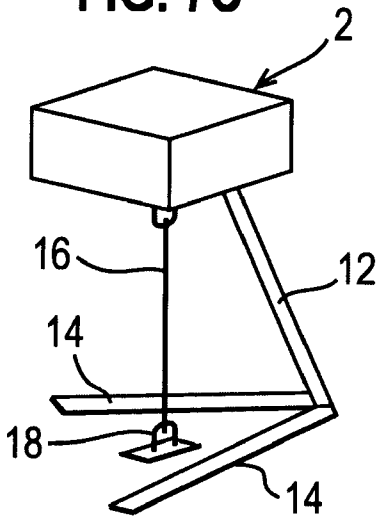


FIG. 8

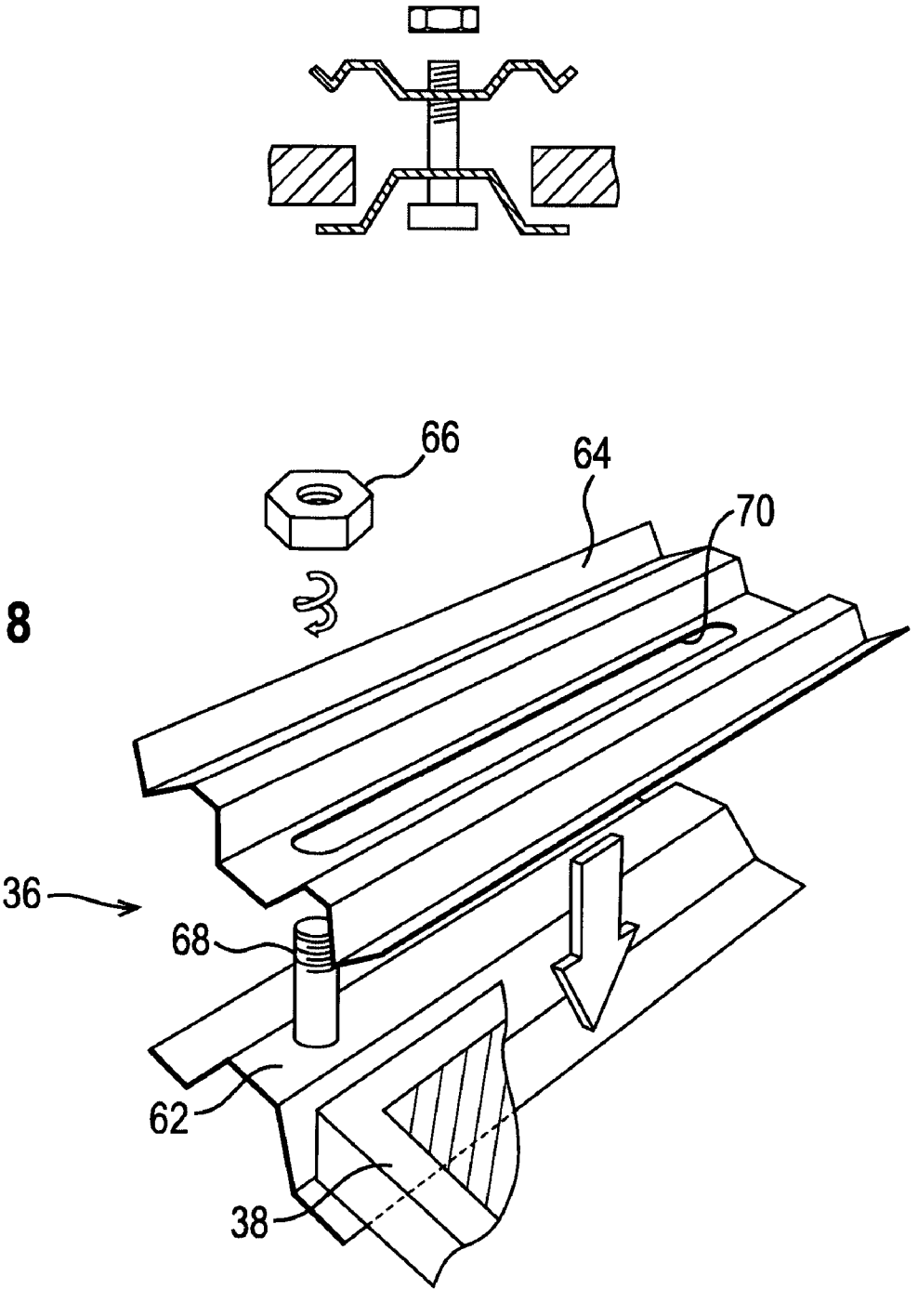


FIG. 9A

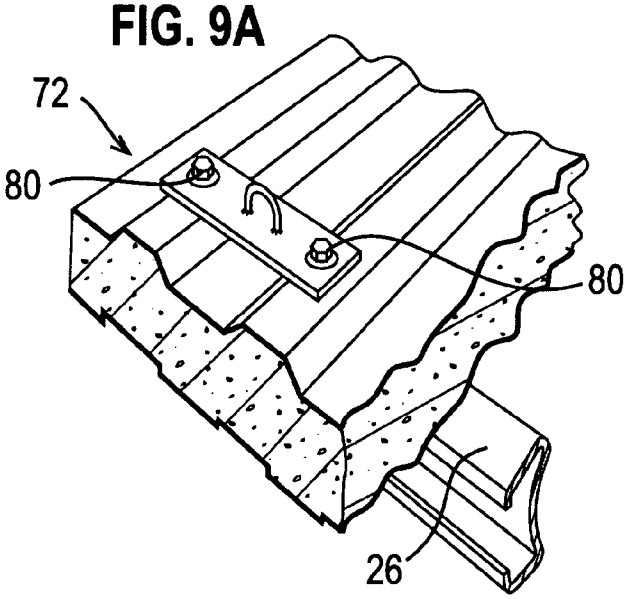
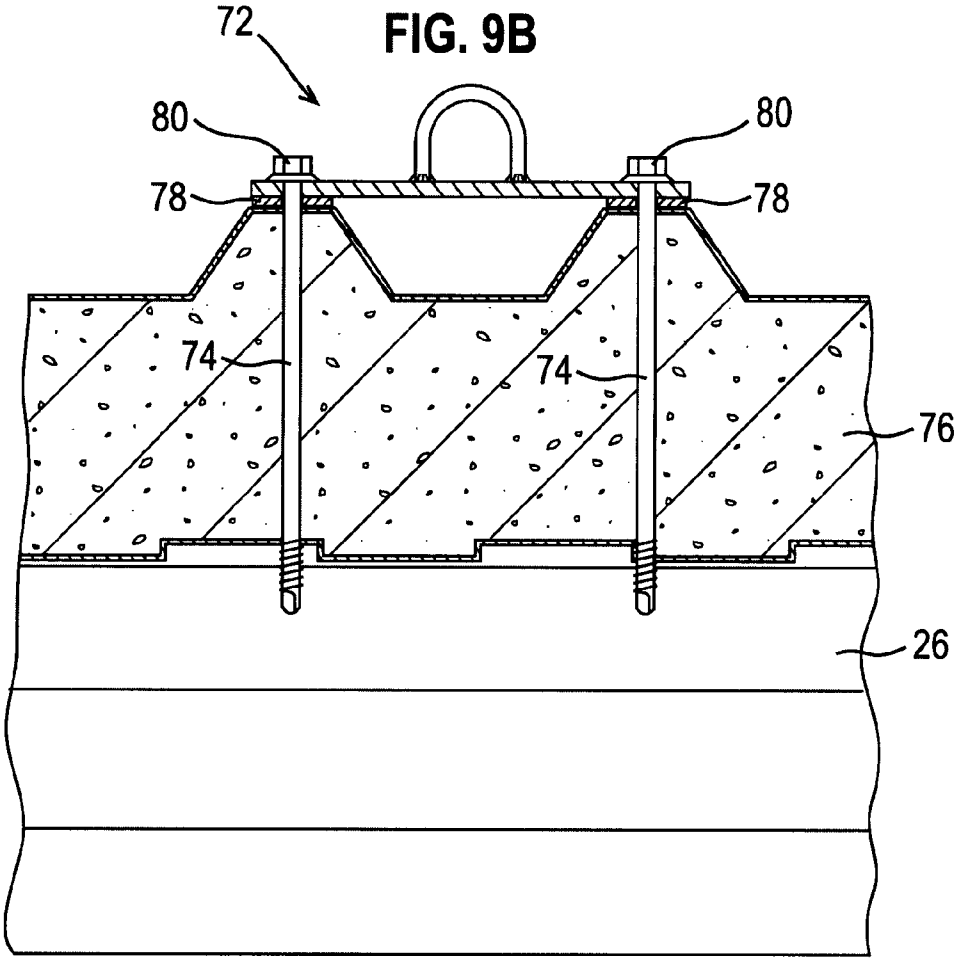


FIG. 9B



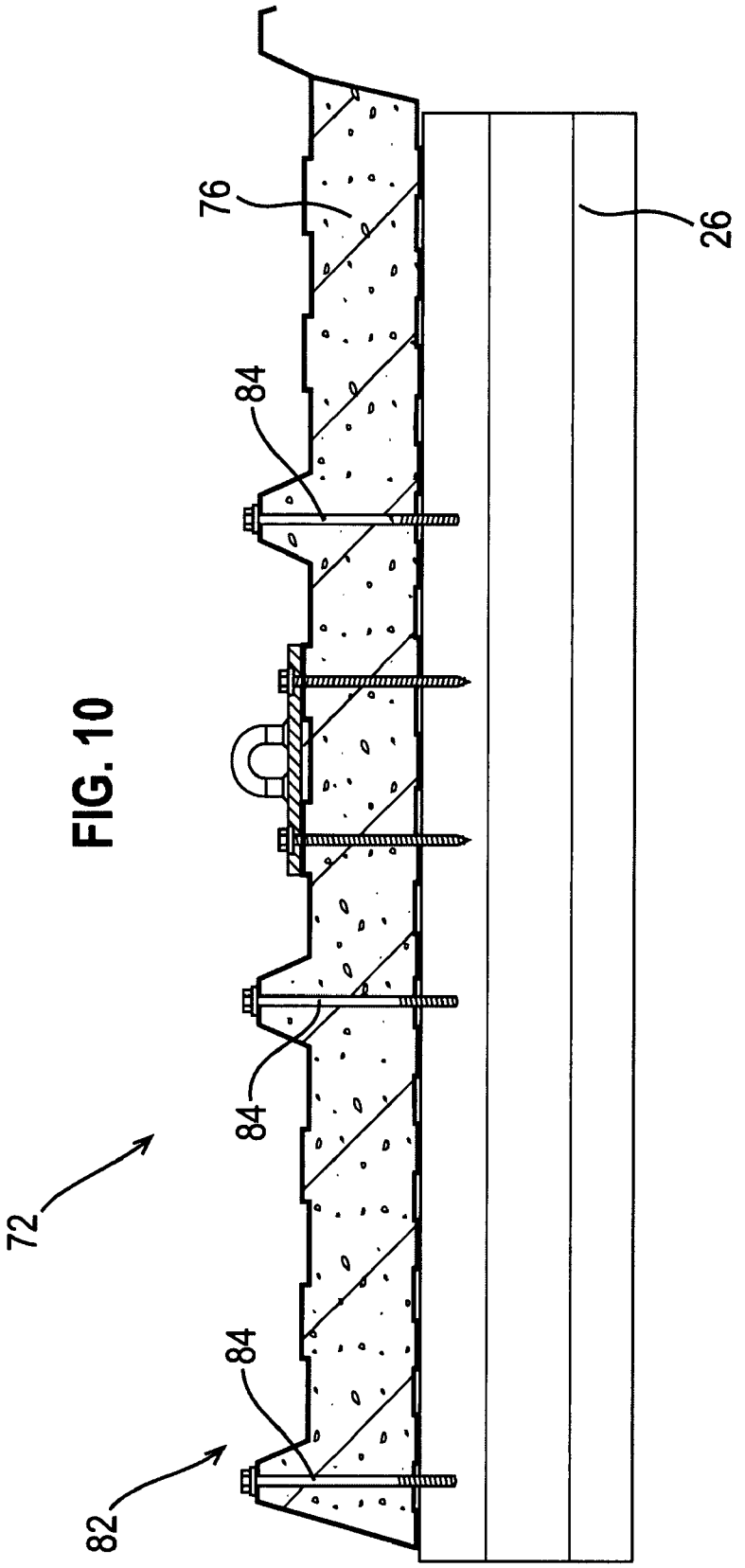


FIG. 10

SOLAR ARRAY MOUNTING SYSTEM

[0001] This invention relates to a method for mounting solar energy collectors, such as photovoltaic arrays and solar thermal collectors, onto building structures, and particularly, although not exclusively, onto flat roof or low-pitch roof systems.

[0002] When mounting a solar panel array onto a flat roof, it is desirable to provide a system which is quick to install, and avoids the necessity for strengthening the building structure to take additional loads. Preferably, it should be possible to install the system without needing specialist lifting or handling equipment, and without utilising special roofing methods, or compromising the weather tightness of the roof.

[0003] Accordingly, the present invention provides a method of mounting a solar energy collection system onto a surface, comprising the steps of

[0004] a) placing a support comprising a body including stand-off means for supporting it clear of the surface, in a desired position: and

[0005] b) connecting a tension member between the body, and a point on the surface so that the stand-off means is held securely in contact with the surface.

[0006] The invention also extends to a mounting stand for supporting a solar panel or other solar energy collection device on a mounting surface, comprising a body including stand-off means for supporting the body clear of the surface, and a tension device, adapted to be connected between the body and the mounting surface, so as to hold the stand-off means securely in contact with the surface.

[0007] Preferably, the stand-off means comprises at least two legs with enlarged pads or skid-shaped feet at their lower ends to spread the load on the surface. The angle at which the legs are attached to the body may be made adjustable, so that the inclination of the body may be varied to accommodate different latitudes and/or roof pitches.

[0008] Various other load-spreading geometries are also possible for the stand-off means such as a foot comprising a ring which has a relatively large diameter and a single leg extending upwardly at an angle from one side of the ring, with its upper end connected to the underside of the body. The tension device is then connected to the surface, inside the ring, so that the leg forms a braced cantilever. As a further alternative the ring can be replaced by a pair of elongated splayed-apart feet extending from the base of the leg.

[0009] Preferably, the tension device comprises a resilient rod or cable made from a polymer or similar material that will not transfer heat from a building exterior to the building interior.

[0010] Preferably, where the mounting surface is weatherproofed, for example on a flat roof, the tension device is arranged to penetrate the surface, with suitable weatherproofing arrangements, and is attached to a structural member or deck beneath the surface.

[0011] Preferably, the tension device comprises two parts, the first part comprising an anchoring means including a flange for connection to the structural member or deck beneath the roof surface, at its lower end, and an attachment means which extends through the weatherproof membrane, at its upper end, and the second part comprising a resilient rod or cable having connection means at its lower end for connection to the upper end of the first member, and a further connection means at its upper end, for connection to the body of the mounting stand. Alternatively blind or self tapping fixings can be used to pierce through the roof to the structural member or deck, securing a mounting means that sits on the roof which incorporates suitable waterproofing measures. A resilient rod or cable that is connected to the mounting means and the body of the mounting stand secures the frame to the mounting surface.

[0012] Preferably, the body of the stand comprises a light-weight "space frame" construction, which may for example be made of aluminium, and in a preferred embodiment the frame takes the form of a triangular beam, comprising three elongate members which are arranged parallel to one another and connected together by arrangements of struts, at a spaced-apart intervals along the length of the frame. Pairs of legs for contacting the support surface are also attached to one of the members which forms the main structural member, at suitable intervals, so as to provide adequate support for the entire structure, when mounted on a roof.

[0013] Preferably the beam comprises a main structural member, such as a box-section or a tube, and a further pair of members which form supports for the solar collection device. Thus the pair of support members may be L-section or channel section members.

[0014] It will be appreciated that at least one tensioning member is required, but when the stand is relatively long, there is preferably one tensioning member near each end.

[0015] In one embodiment of the invention, the second and third members are channel section members arranged with their open sides facing one another, and at a spacing which is adapted to allow a photovoltaic module or modules, or other solar energy collector, to be mounted between them.

[0016] Some embodiments of the invention will now be described, by way of example with reference to the accompanying drawings, in which;

[0017] FIG. **1** is a schematic diagram of the mounting method of the present invention;

[0018] FIG. **2** is a cross-section through a flat roof structure illustrates a practical form of anchorage for the mounting system of the present invention;

[0019] FIG. **3** is an exploded perspective view corresponding to FIG. **2**;

[0020] FIG. **4** is a transverse cross-section through a mounting device according to the invention;

[0021] FIG. **5** is an end elevation of a mounting system arranged "in-situ" on a flat roof;

[0022] FIGS. **6***a* and **6***b* are perspective views of mounting frames according to the invention;

[0023] FIGS. **7***a*-**7***c* illustrate alternative stand geometries;

[0024] FIG. **8** is a cross-sectional view of an alternative example of a mounting device according to the invention;

[0025] FIGS. **9***a* and **9***b* are cross-sectional views of an alternative example of an anchorage for the mounting system of the present invention; and

[0026] FIG. **10** is a cross-sectional view of a fixing arrangement for the alternative anchorage of FIG. **9**.

[0027] Referring firstly to FIG. **1**, this illustrates the general principle of the mounting method of the present invention in which a structure indicated generally at **2** is required to be mounted on a flat roof surface **4**. It will be understood that such roof typically comprises an underlying support structure **6**, a layer of insulation **8**, and a weatherproof covering **10**.

[0028] In order to secure the structure **2** in a desired position, it is preferable to avoid piercing the weatherproof covering **10**, as far as possible, or at least, reducing the number of such perforations to a minimum. Accordingly, as illustrated, the structure is supported clear of the surface by legs **12**, each of which terminates in a foot **14** comprising a compression pad. These pads are formed with a relatively large area, so as to spread the load on the roof.

[0029] In order to avoid multiple perforations in the roof, the structure is secured in position by a tensioning member **16** which is attached to an anchoring point **18** on the roof. In this way, the number of fixings to the roof can be substantially reduced, and a relatively large structure can be attached to a roof with just one or two fixings (for example). It will be appreciated that the use of such a small number of fixings with a conventional system could result in damaging turning moments being applied to the roof.

[0030] FIG. **2** illustrates a suitable anchoring structure, which comprises a tie rod **20** of suitable length to extend through the insulation layer **8**, mounted on a fixing plate **22** having fixing holes **24** which enable it to be screwed or bolted onto a roof member **26** of the support structure **6**, as illustrated more clearly in FIG. **3**. The upper end the tie rod **22** is threaded for attachment to a plate **28** carrying the anchorage **18**, and a sealing member **30**, which may for example comprise a suitably shaped piece of roofing felt, is attached to the top of the mounting plate **28**.

[0031] It will be understood that the construction of flat roofs of this kind is such that the insulation layer **8** is generally of a standard thickness, and consequently, the tie rod **20** only needs to made in a few different standard lengths, to enable the mounting plate **28** to be mounted at a suitable level, just above the waterproof membrane **10**. Accordingly, the upper end of the rod **20** may be threaded into a blind hole **32** in the base of the mounting plate **28**, or, of course, there may be a hole passing right through the plate **28**, and the tension rod **20** may be attached by means of a suitable nut, provided that any resultant joint can be suitably sealed.

[0032] Referring to FIGS. **4** and **5**, a practical example of a "space frame" PV mounting system **36** is illustrated, in cross-section in FIG. **4** which shows the frame alone i.e. the specific arrangement for mounting a PV module or other solar energy collector, **38**. As can be seen from the drawing, this comprises a primary structural member **40** which, in the example, is a fairly substantial box section, and two channel section members **42** and **44** which are arranged facing one another, and extending parallel to the primary box section **40**. All three members are interconnected by a triangulated space frame, an example of which is shown in the perspective view of FIGS. **6***a* and **6***b*, and it will be appreciated that this arrangement provides a very high strength-to-weight ratio. In addition, it enables the mounting angle of the solar energy collector **38** to be preset for its location, by suitably dimensioning the interconnecting struts **46** and **48** forming the sides of the triangle, so that when the primary box section structural member **40** is mounted horizontally, the orientation of the frame will automatically be suitable for the latitude of the installation.

[0033] It will be appreciated that the frame may also be made up of members of various different cross-sections, depending on the application. For example the main structural member may be a tube which is rotatably mounted in a collar on the support system so that the frame can be set at different angles. The secondary members, on which the actual solar collection device is mounted, may also be of other cross-sections such as L-shaped or simply flat strips so as to allow a variety of different fixing methods to be employed. The spacing between the members can also be varied to allow for different size panels or different fixing methods. The frame may also be made in various different widths and lengths. For example, the frame shown in FIG. **6***b* is approximately 6 metres in length.

[0034] As illustrated in FIG. **5**, outwardly extending legs **50**, **52** are attached to the primary structural member **40** at intervals along its length, and are terminated at their lower ends with pads **54**, **56**, which in turn rest on the upper surface of a flat roof **4**. A mounting eye **58** is fixed on the underneath surface of the member **40**, and is connected to an anchorage **18** on the roof, by means of a tension member **60** which can for example be a polymer cable. The interconnection between the anchorage point **18**, and the roof, corresponds to that described above with reference to FIGS. **2** and **3**, and accordingly, will not be described in detail here.

[0035] It will be appreciated that dependent upon the length of the solar array, the support frame may be relatively long, as shown in FIGS. **6***a* and **6***b*. If that is the case, it will be preferable to provide two anchorage points **18**, spaced-apart towards the end of the structure, in order to stabilise it properly against possible movement under the influence of weather, for example. Where a smaller frame design is used, a single fixing point can be situated in the centre of the frame, with multiple frames mechanically joined by, for example, a flange, to prevent rotation of the frames. It will be appreciated that this enables a relatively large structure to be fixed firmly into position, without the need for a large number of fixings, or the addition of unwieldy ballast to hold it in the desired position.

[0036] The mounting system of the invention also lends itself well to multiple modular PV installations or installations which can easily be upgraded by adding another similar module. For this purpose each module may be equipped with a built-in inverter, for example a "string inverter" set up for its respective solar array, so that additional arrays can simply be connected in parallel with one another.

[0037] Alternatively a number of frames may be connected to a central inverter. In this case each frame would be designed such that it matched the electrical requirements of the inverter. For example a 300 kW inverter might require 25 parallel strings of 24 PV modules attached in series. A frame

in this case could have 8, 12, or 24 modules, meaning that 3, 2 or just one frame would be required to create a string. This would simplify the design of the electrical connections.

[0038] FIGS. 7*a*-7*c* illustrate some diagrammatic examples of further possible stand-off mounting arrangements which are relatively self-explanatory, the main parts being referenced similarly to those in FIG. **1**. As will be clear from the drawings, although it is desirable to have at least two legs (FIG. 7*a*) with suitable skid-shaped feet **14** it is also feasible to utilise a "braced cantilever" geometry in which there is only one stiff leg (FIGS. 7*b* and 7*c*) and the spaced-apart foot portions extend away from it in the form of a single ring (7*b*) or two splayed apart feet (7*c*). Both of these arrangements provide suitable spaced-apart foot portions so that the anchorage (**18**) on the roof surface can be suitably arranged between them to tension the stand against the surface.

[0039] FIG. **8** shows another example of a PV mounting system **36** in which one of the channel section members **42**,**44** (FIG. **4**) is replaced by a clamping arrangement comprising first and second folded sheets **62**, **64**. The folded sheets **62**, **64** are arranged such that the PV module or other solar energy collector **38** can be securely clamped therebetween. The folded sheets **62**, **64** extend parallel to the primary box section **40** (FIG. **4**). The folded sheets are clamped together by way of a nut **66** and a corresponding bolt **68** which extends through a slot **70** in one of the folded sheets **62**, **64**. The sheets **62**, **64** may be made from aluminium. Although only one clamping arrangement **62**, **64** is shown in FIG. **8**, it will be appreciated that both of the channel section members **42**, **44** could be replaced therewith.

[0040] Referring to FIGS. 9*a* and 9*b*, an alternative example of an anchorage **72** for securing the structure (not shown) to the roof structure or member **26** is shown. The anchorage **72**, which includes a mount, is secured to the roof member **26** by means of screws **74** or roofers' fixings of a suitable length which pass through an intermediate, or sandwiched, panel **76**. The intermediate panel **76**, preferably comprises a composite panel roof deck. A suitable sealing method, for instance butyl tape, silicon, washers or gaskets, **78** may be provided between the head **80** of the screws **74** and an upper surface of the panel **76**. In this way, the anchorage **72** comprises a plate that sits on a roof **76** and is fixed to the structural member **26** below the roof without compromising the weather tightness of the roof. In the case of a membrane roof, the anchorage may be compressible so that, if stood upon, tearing of the membrane can be prevented.

[0041] Referring to FIG. **10**, a fixing arrangement **82** for securing the anchorage **72** to the roof member **26** is shown. In addition to the intermediate panel **76** being secured to the structural member **26** indirectly by way of the screws **74**, additional screws **84** may be provided so as to fix the panel **76** directly to the structural member **26**.

1. A method of mounting a solar energy collection system onto a surface, comprising

a) placing a support comprising a body including stand-off means for supporting it clear of the surface in a desired position; and

b) connecting a tension member between the body, and a point on the surface so that the stand-off means is held securely in contact with the surface.

2. A mounting stand for supporting a solar panel or other solar energy collection device on a mounting surface, comprising a body including stand-off means for supporting the body clear of the surface, and a tension device, adapted to be connected between the body and the mounting surface, so as to hold the stand-off means securely in contact with the surface.

3. A mounting stand according to claim 2 in which the tension member comprises a resilient rod or cable.

4. A mounting stand according to claim 3 the lower end of the rod or cable is connected to an anchorage point which is adapted to be fixed to an underlying structure beneath the surface of a roof.

5. A mounting stand according to claim 4 in which the anchorage comprises an upstanding portion which is adapted to extend through the roof surface, having a fixing flange at its lower end.

6. A mounting stand according to claim 4 in which the upper end of the anchorage comprises a mounting plate including a weatherproofing flange of material adapted to be sealed to the roof surface.

7. A mounting stand according to claim 2 in which the stand-off means includes at least one leg having a foot member or members extending away from the base of the leg or legs in different directions across the surface.

8. A mounting stand according to claim 7 including a plurality of plate-like or skid-shaped foot members.

9. A mounting stand according to claim 7 including a foot which comprises a single ring-shaped member, whereby the anchorage point can be arranged inside the ring.

10. A mounting stand according to claim 2 in which the body comprises a triangular section space-frame forming a beam.

11. A mounting stand according to claim 10 in which the space-frame comprises a primary elongate box-section or tube member and two secondary elongate members which are arranged facing one another and parallel to the primary member so as to form a triangular-section beam, whereby a solar energy collection device can be mounted between the secondary members, and the primary member can then be mounted on a support surface.

12. A mounting stand according to claim 10 in which the beam is provided with at least two pairs of legs spaced apart along its length.

13. A mounting stand according to claim 12 further comprising a tensioning member at or near each end.

14. A solar panel array mounted on a stand according to claim 2.

15. A solar panel array according to claim 14 further comprising an inverter mounted on the stand and including power output rails which are adapted to be connected in parallel with one or more similar arrays.

16. A space-frame mounting for solar energy collection systems comprising a primary elongate structural member and two secondary elongate members which are all arranged parallel to one another and connected together by arrangements of struts at suitable intervals, so as to form a triangular-section beam, whereby a solar energy collection

device can be mounted on the secondary members and the primary structural member can then be mounted on a support surface.

17. A space-frame according to claim 16 in which the primary member comprises a tube whereby the frame can be rotatably mounted on a support.

18. A space-frame according to claim 16 in which the secondary members are L-section or channel-section members.

19. A solar energy collection system mounted on a space-frame according to claim 16.

20. A solar panel array mounted on a space-frame according to claim 16 and further comprising an inverter having power output rails which are adapted to be connected in parallel with one or more similar arrays.

* * * * *