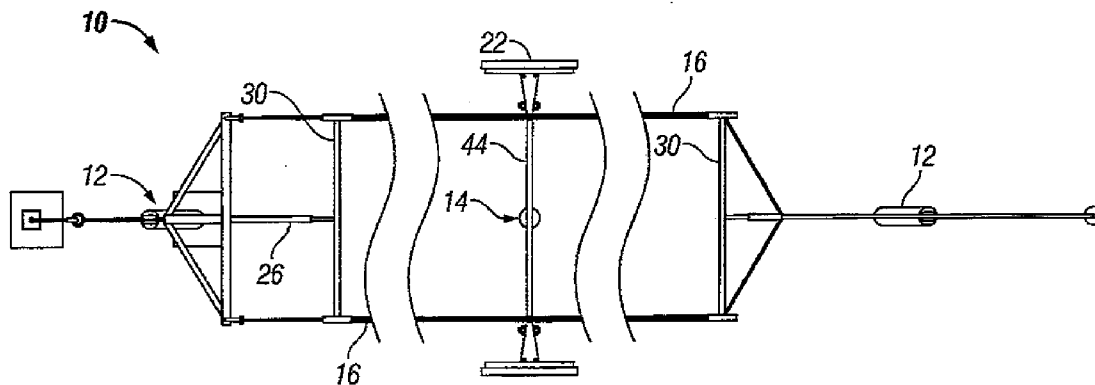




US 20100294265A1

(19) **United States**(12) **Patent Application Publication****Baer et al.**(10) **Pub. No.: US 2010/0294265 A1**(43) **Pub. Date: Nov. 25, 2010**(54) **DUAL AXIS SUPPORT FOR HIGH WIND
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(US)(21) Appl. No.: **12/779,639**(22) Filed: **May 13, 2010****Related U.S. Application Data**(63) Continuation-in-part of application No. 12/468,992,
filed on May 20, 2009, now abandoned.**Publication Classification**(51) **Int. Cl.**
F24J 2/52 (2006.01)
F24J 2/00 (2006.01)(52) **U.S. Cl.** **126/680; 126/714**(57) **ABSTRACT**

A solar panel mounting system and structure which provides dual axis tracking while only requiring a force to be applied about a single axis. The system can provide desirable results with both actively-powered and passively-powered drive mechanisms. Also provided is a solar panel mounting frame which permits a solar panel to be mounted without requiring additional frame components.



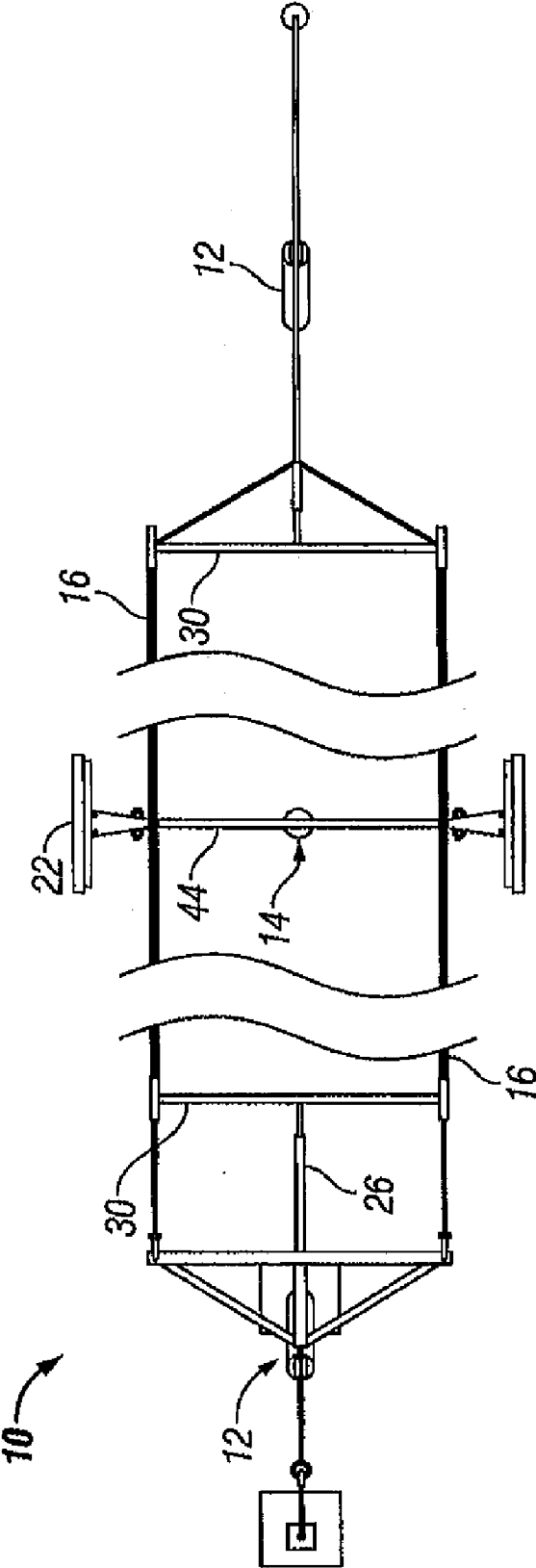


FIG. 1A

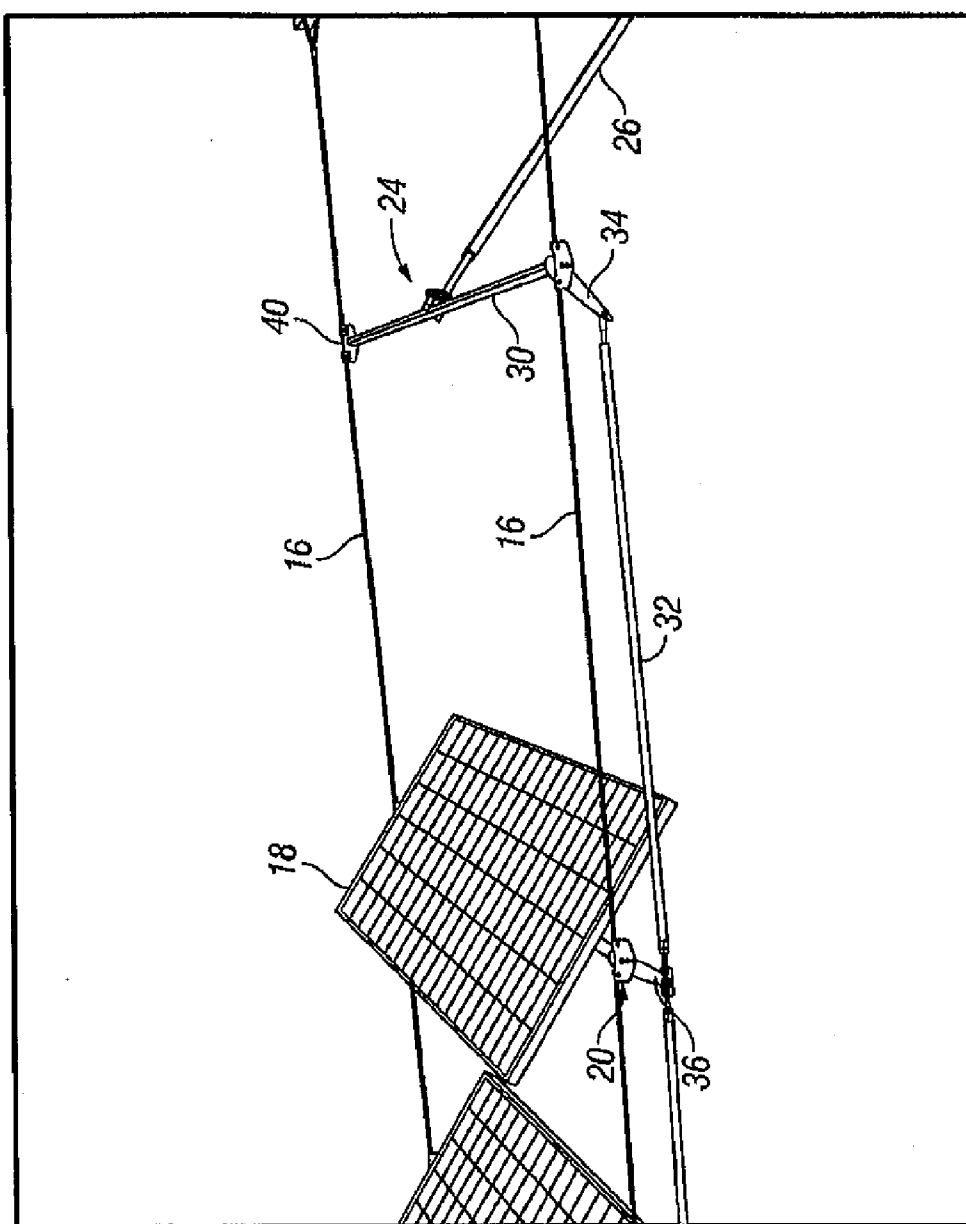


FIG. 1B

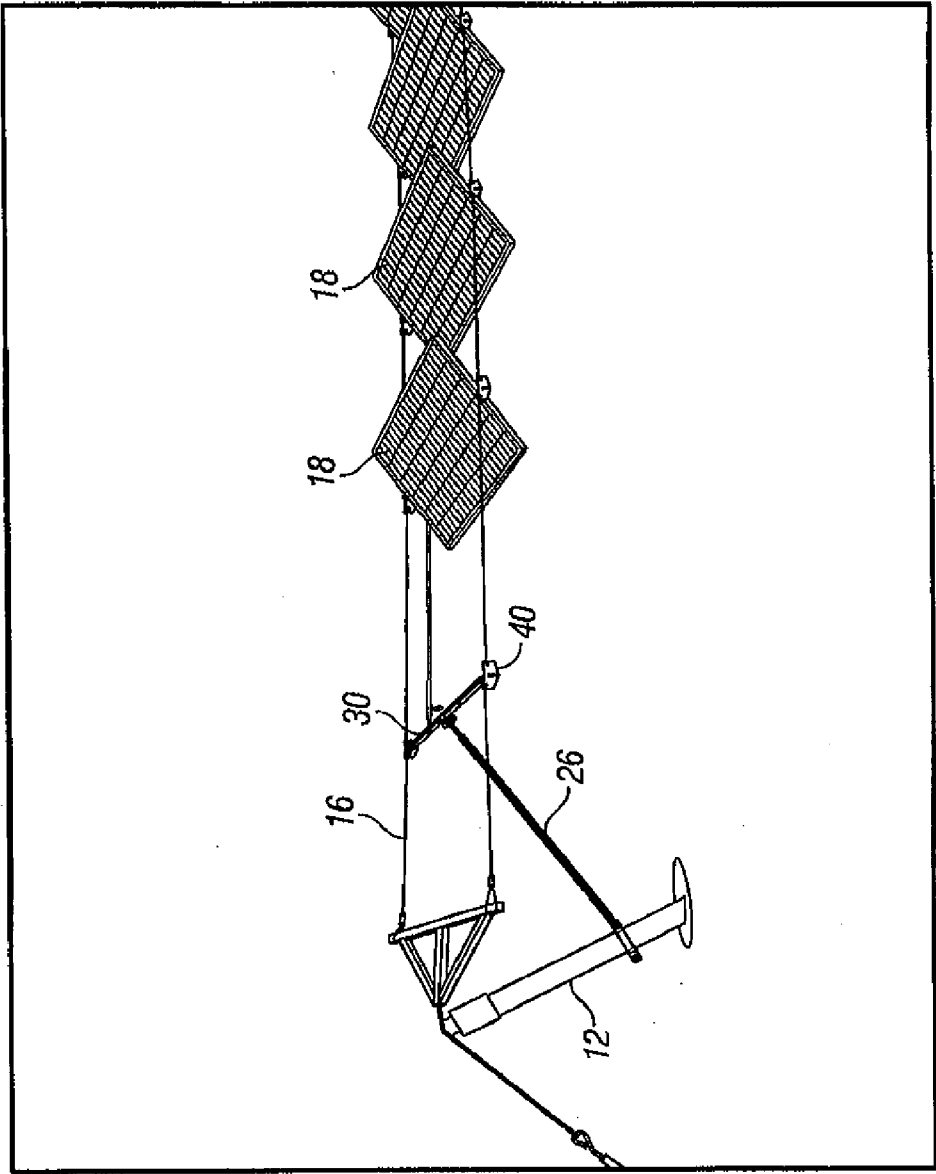


FIG. 2

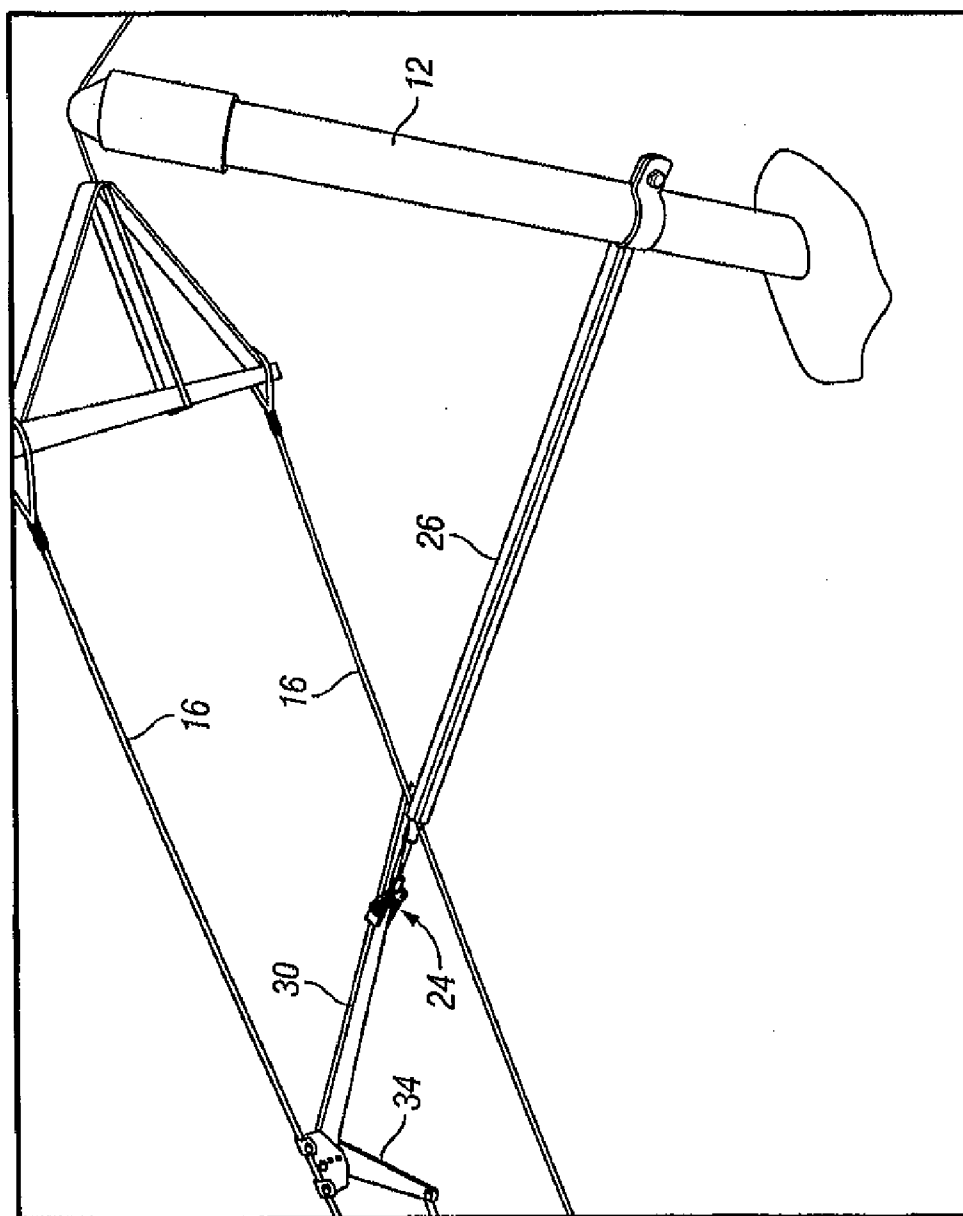


FIG. 3

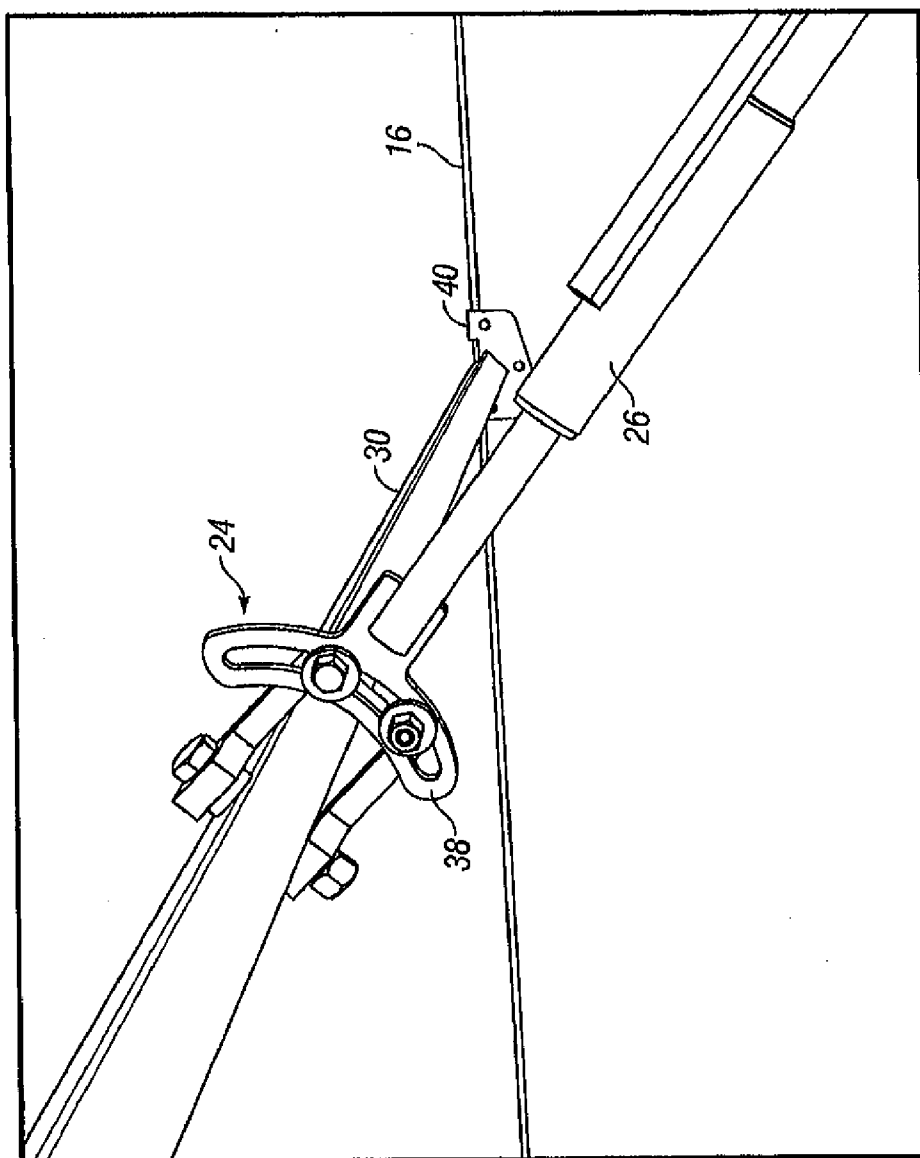


FIG. 4

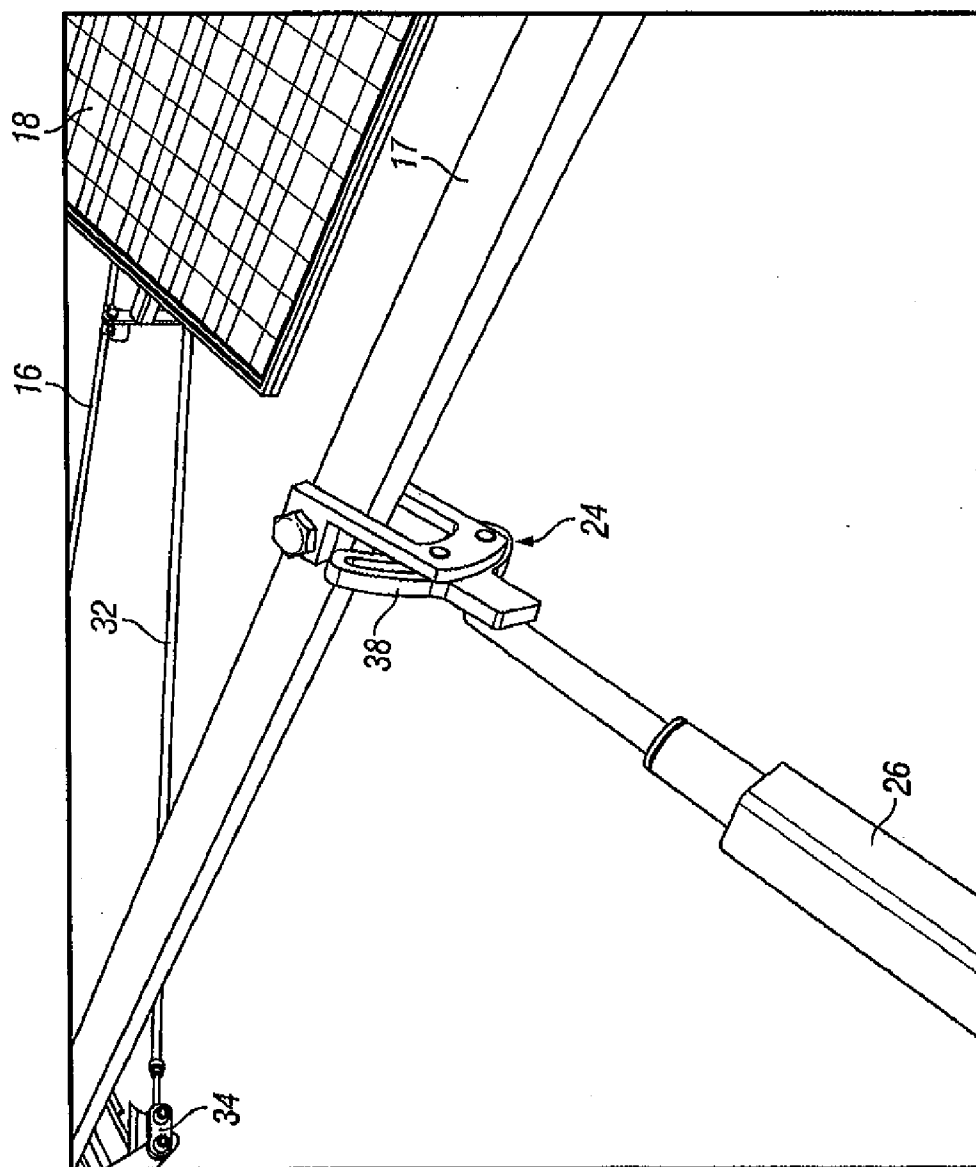


FIG. 5

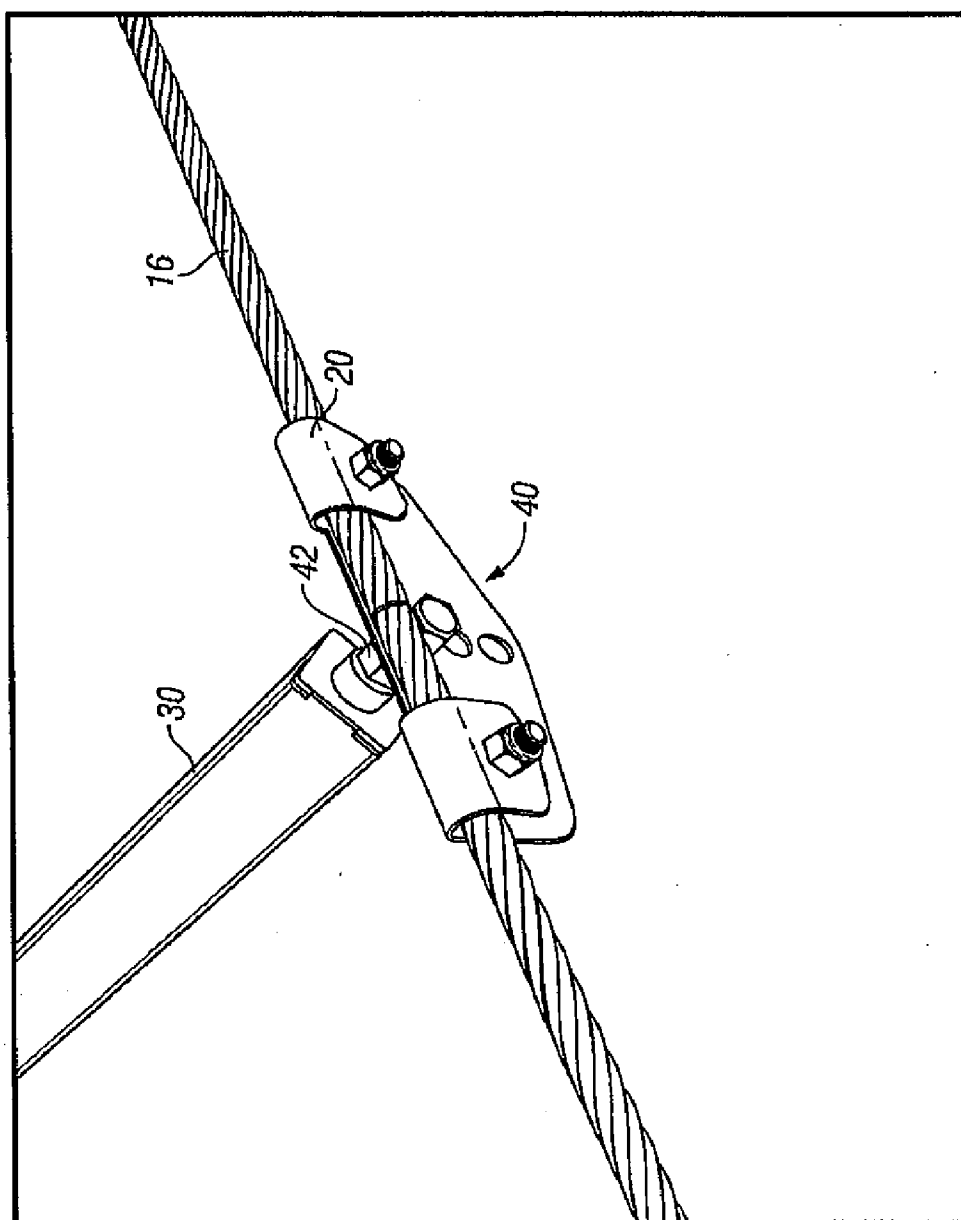


FIG. 6

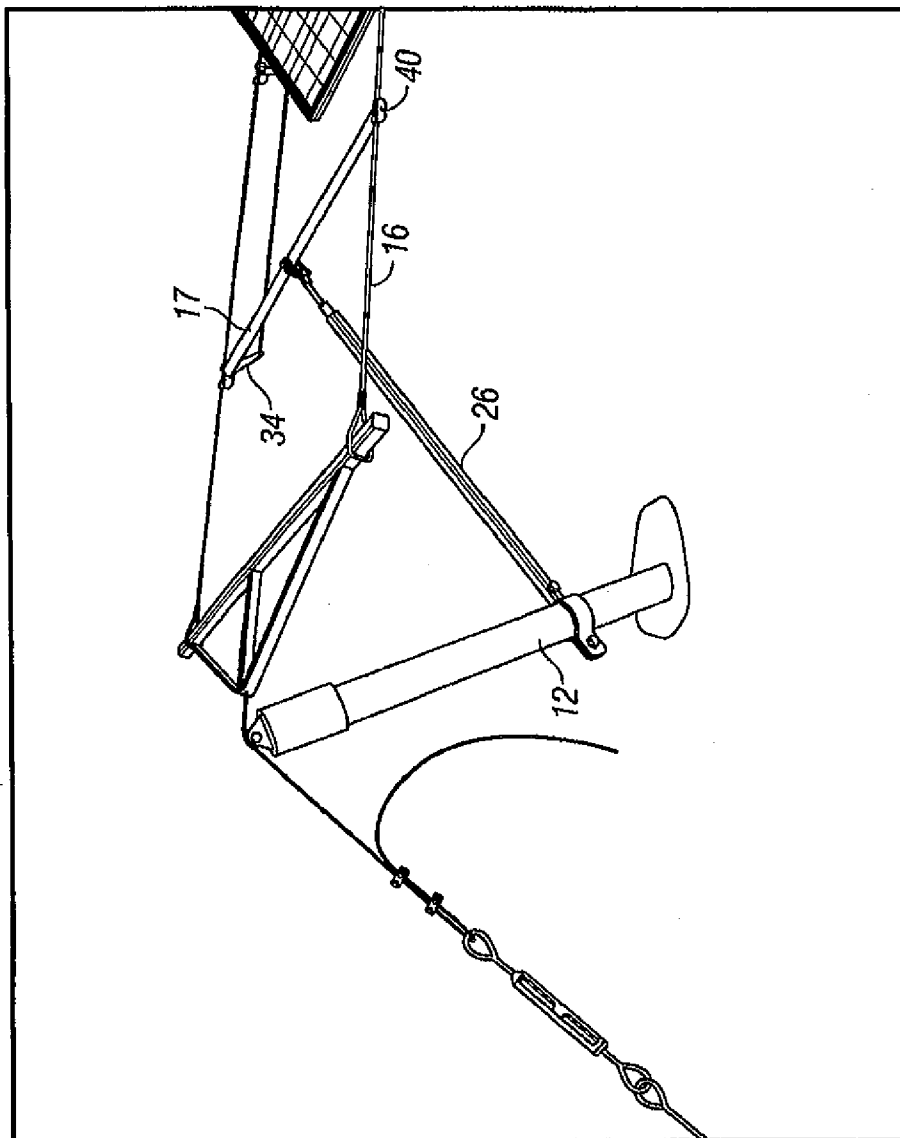


FIG. 7

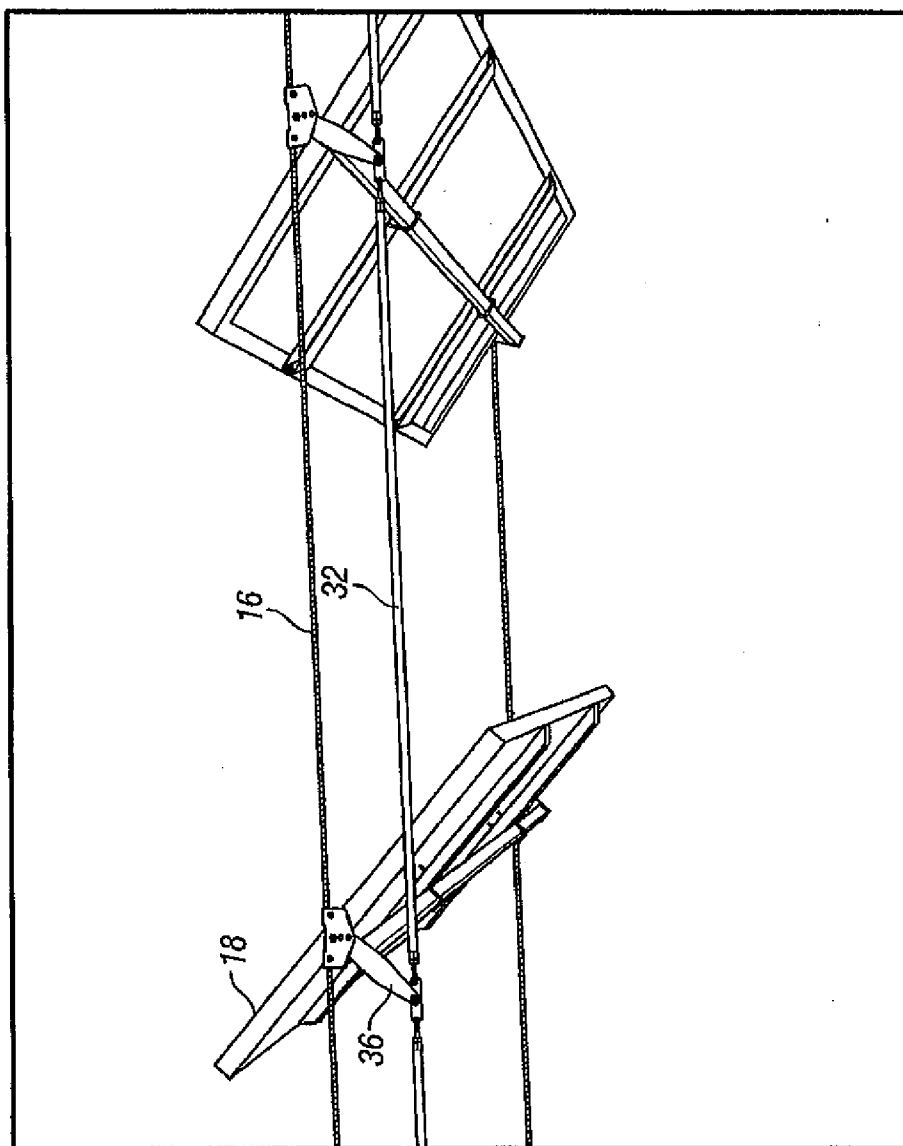


FIG. 8

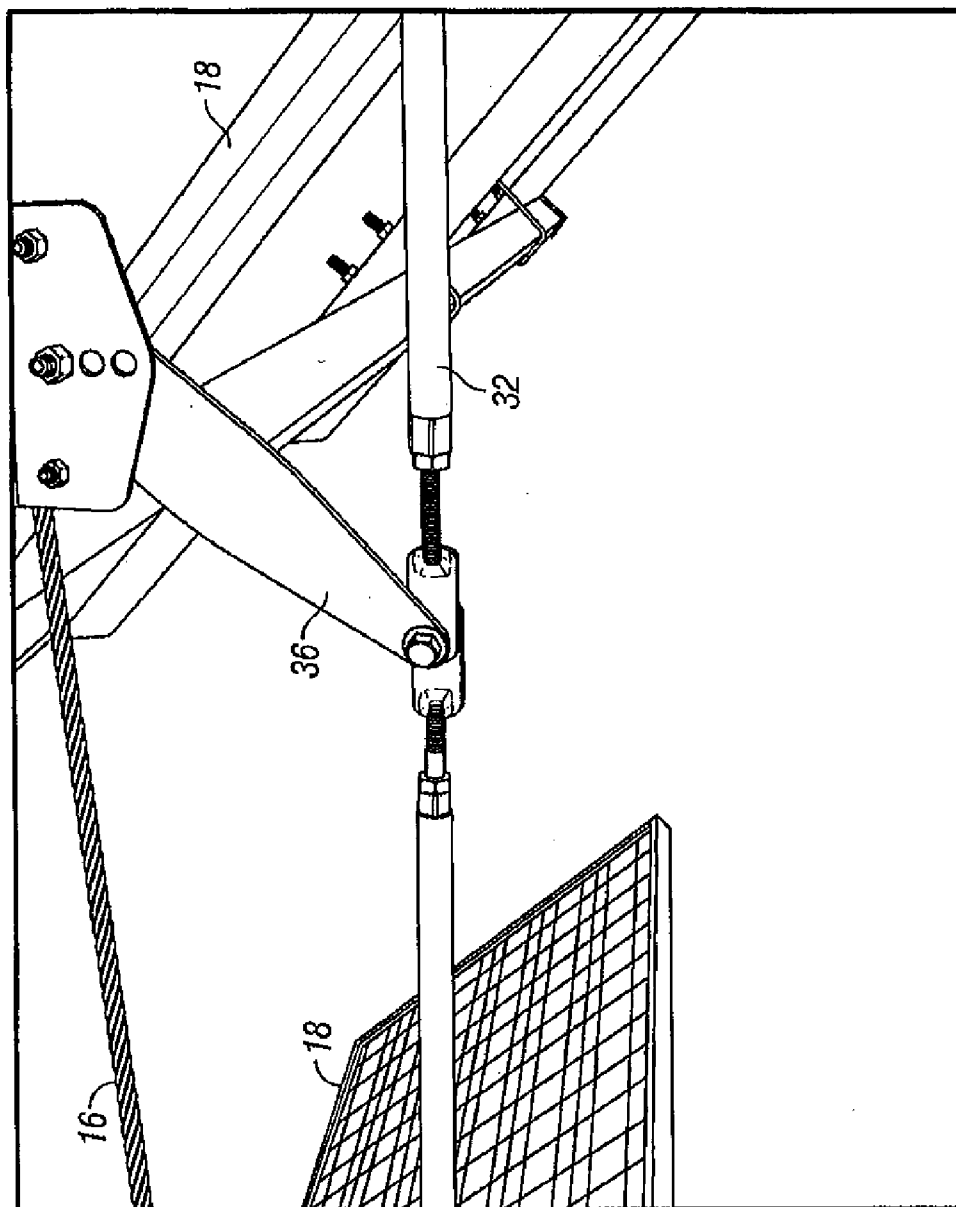


FIG. 9

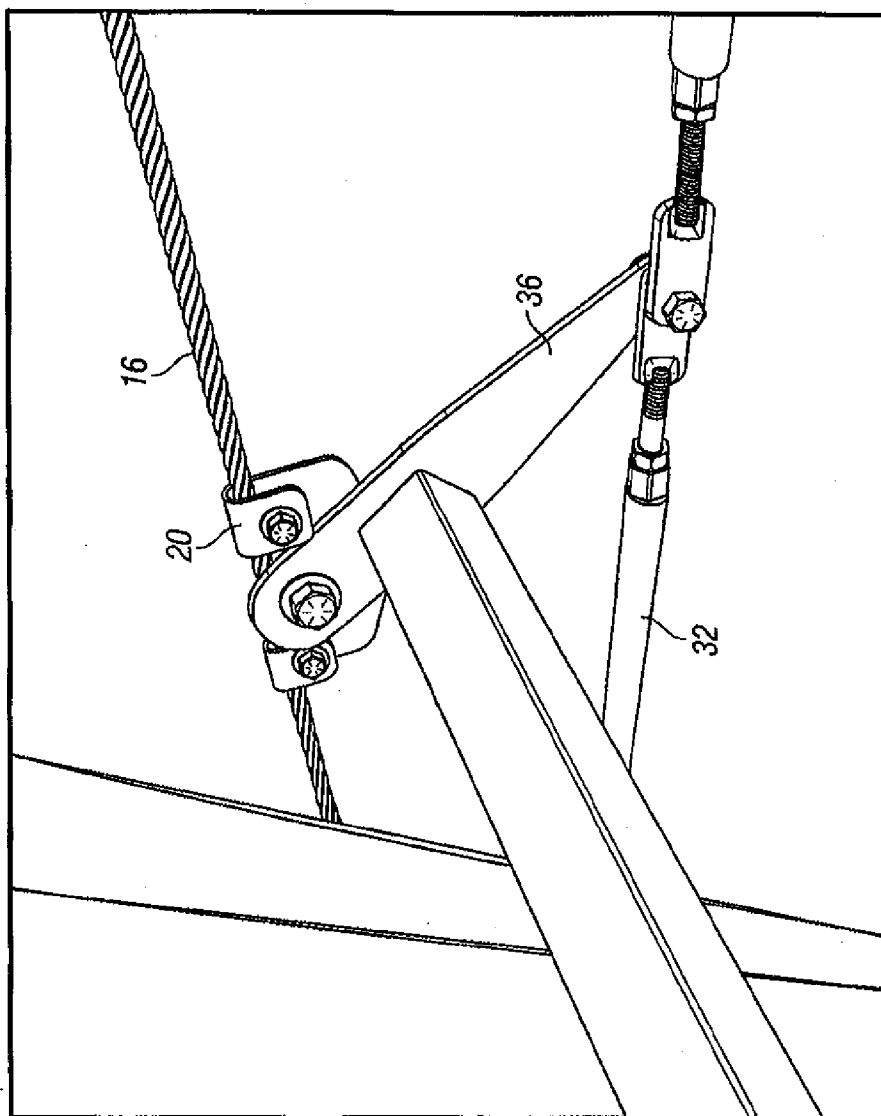


FIG. 10

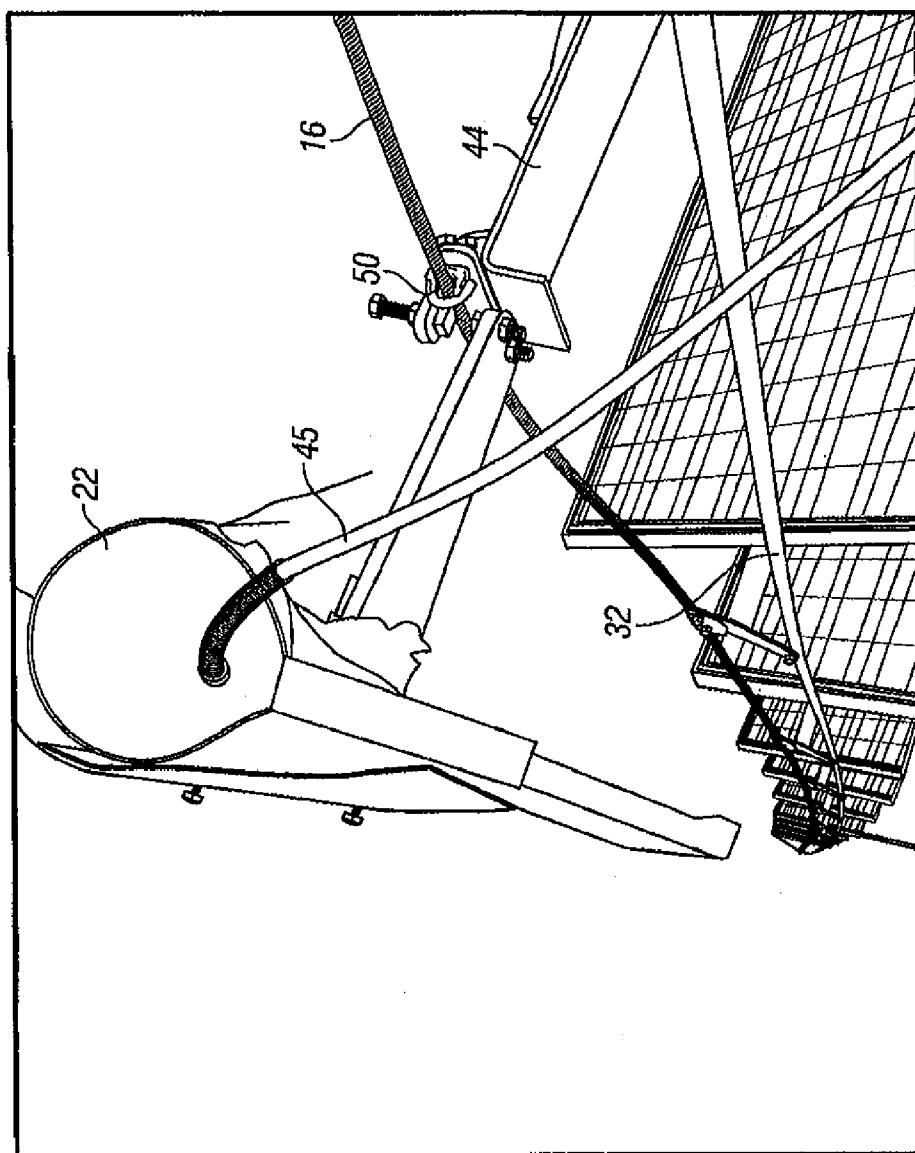


FIG. 11

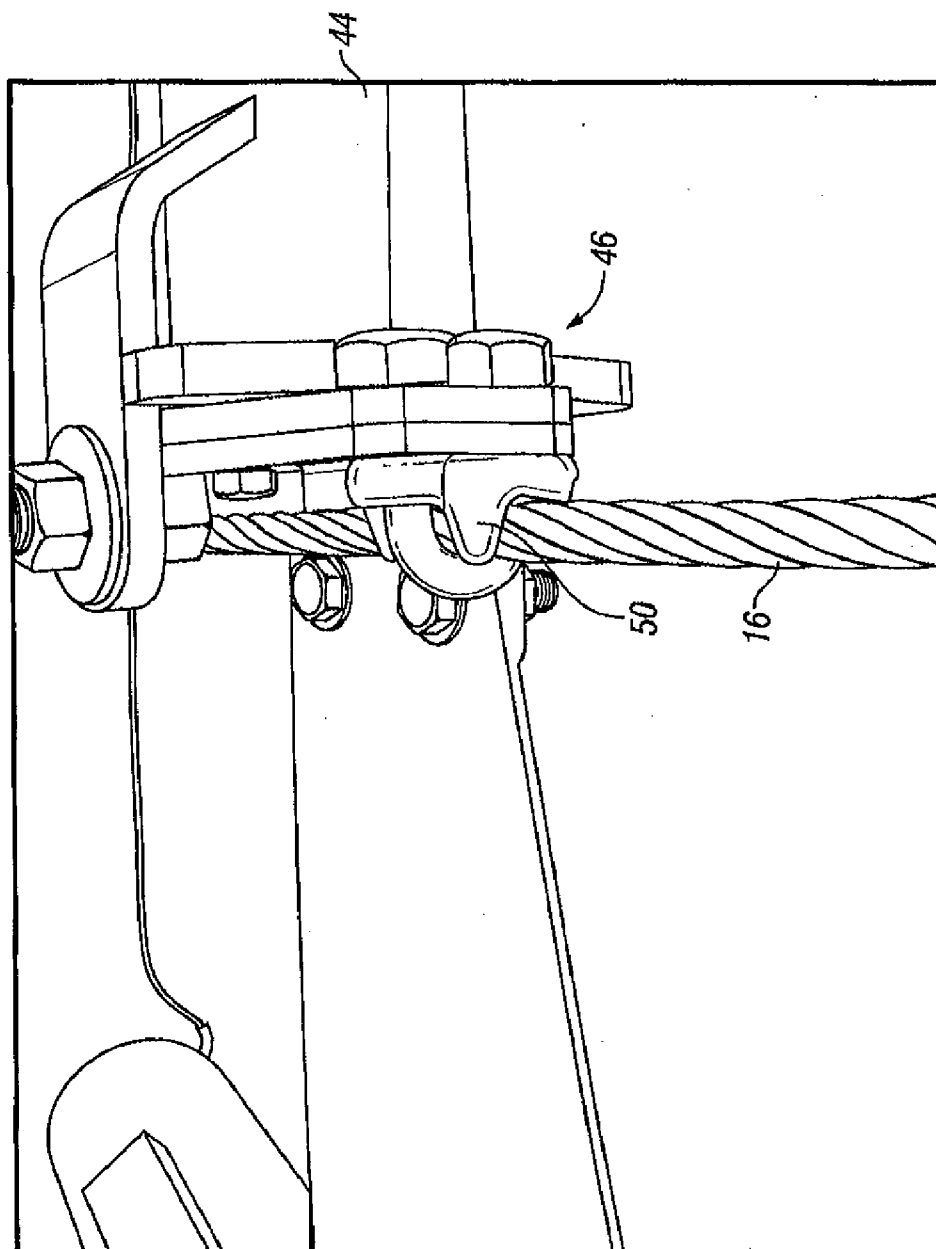


FIG. 12

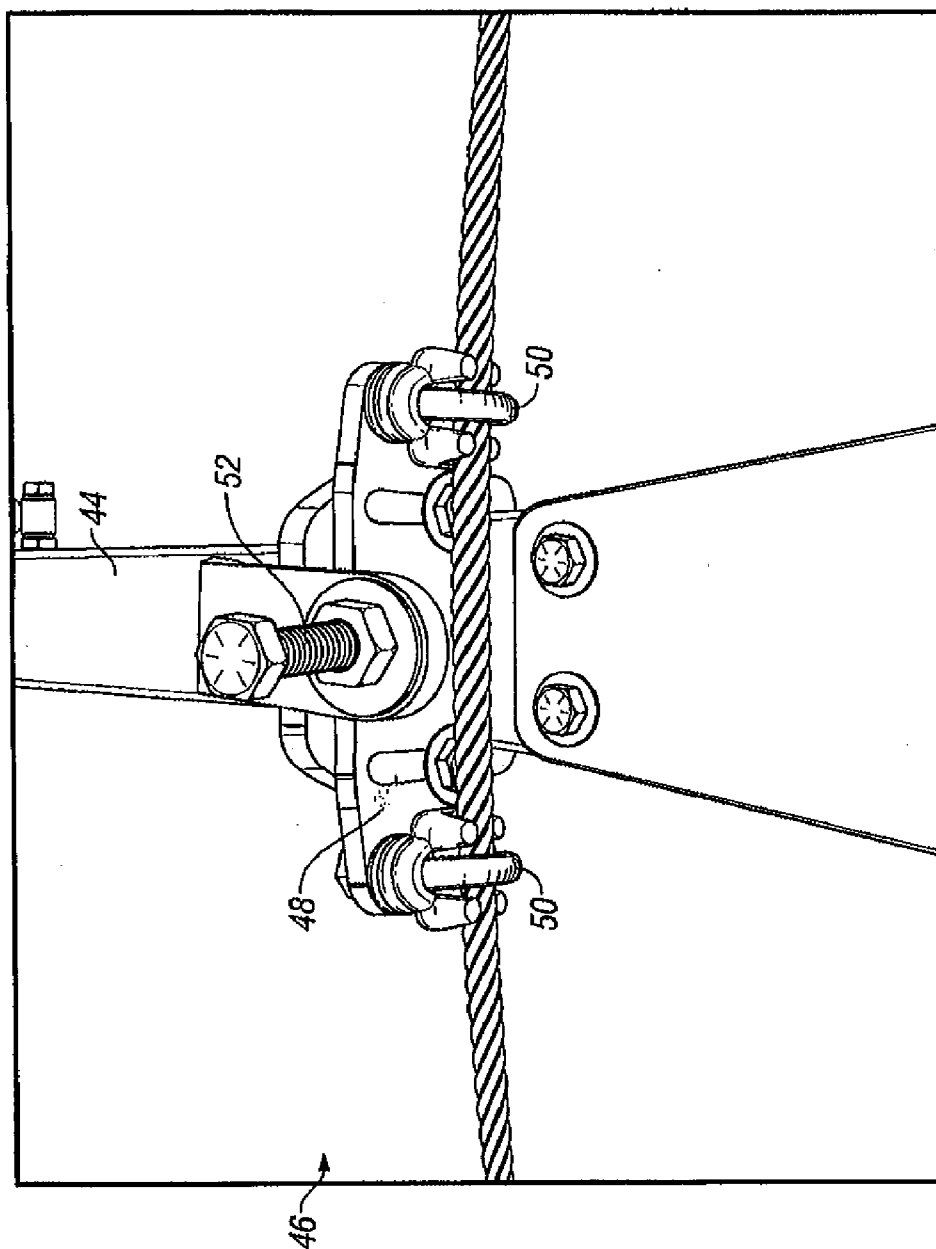


FIG. 13A

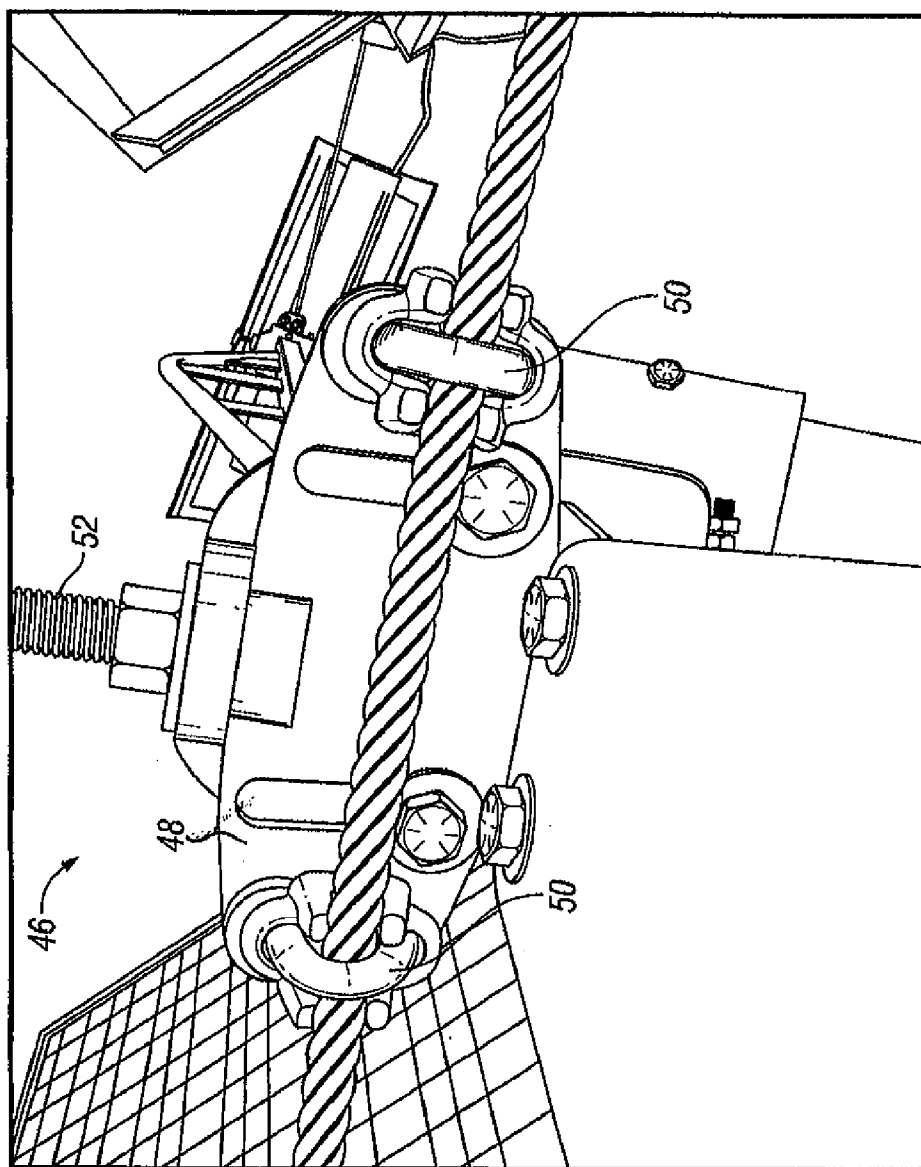


FIG. 13B

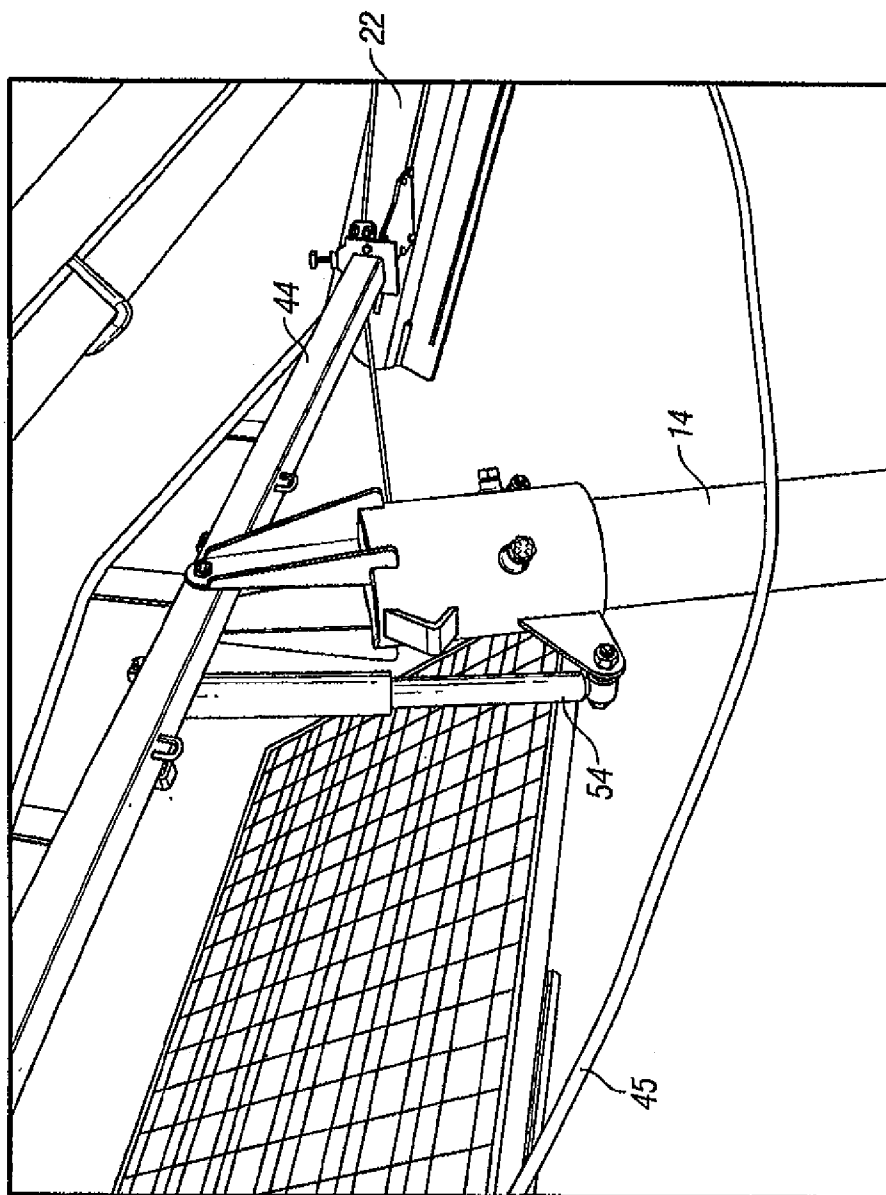


FIG. 14

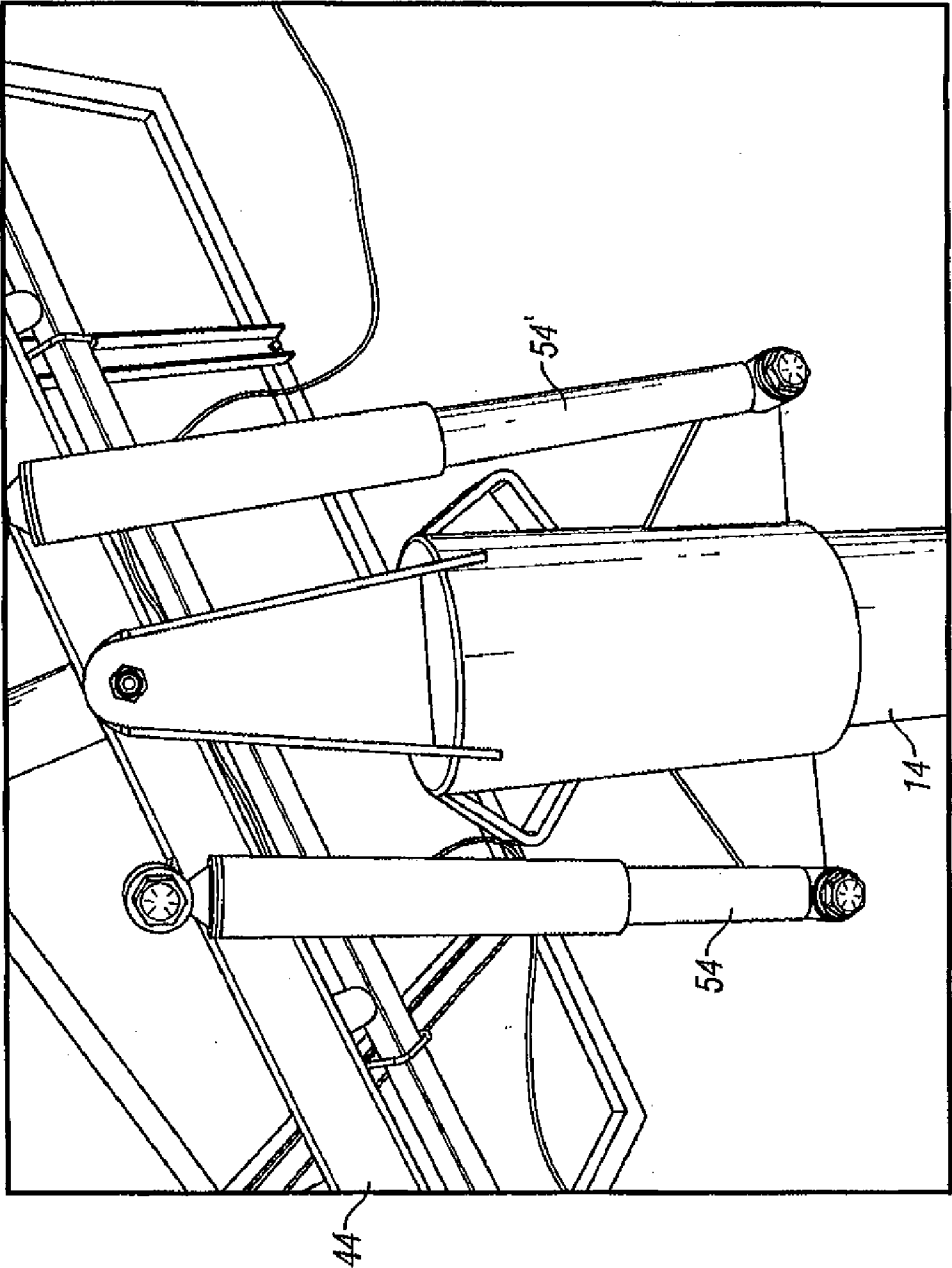


FIG. 15

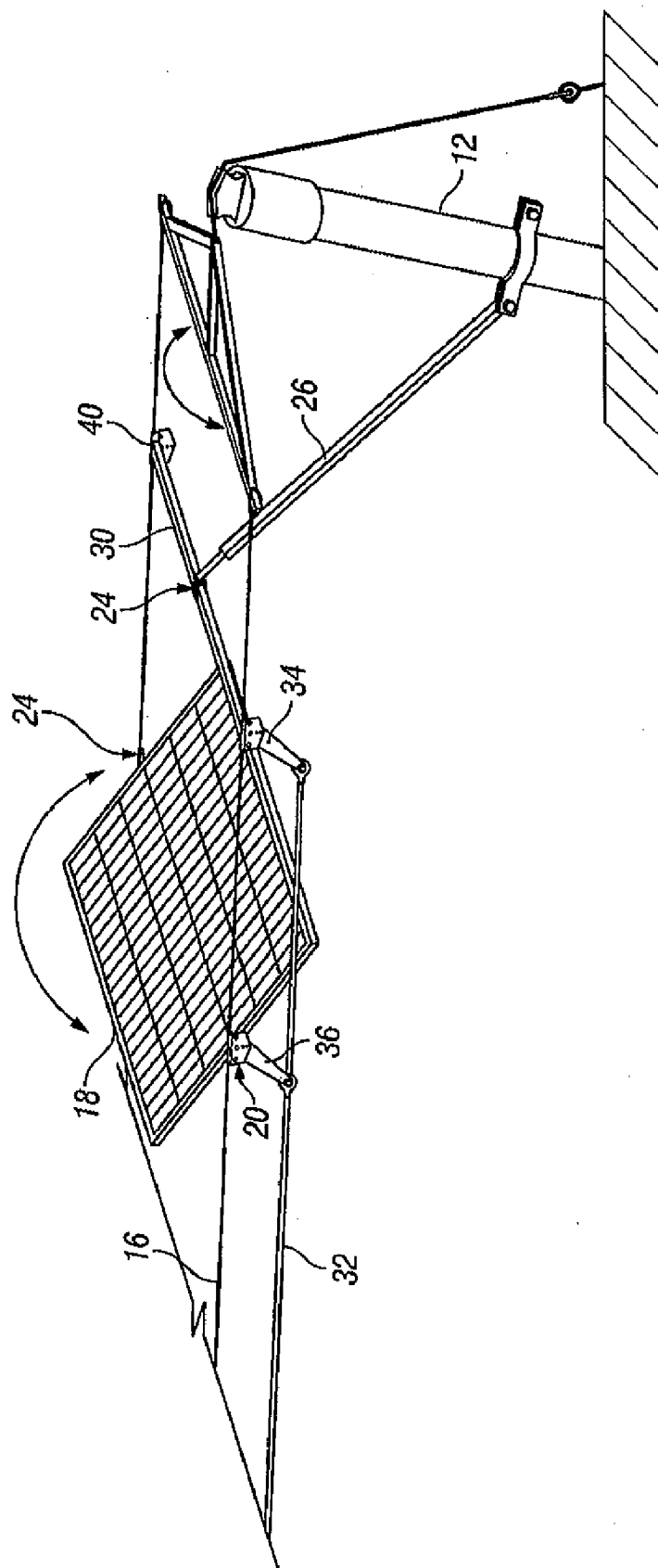


FIG. 16

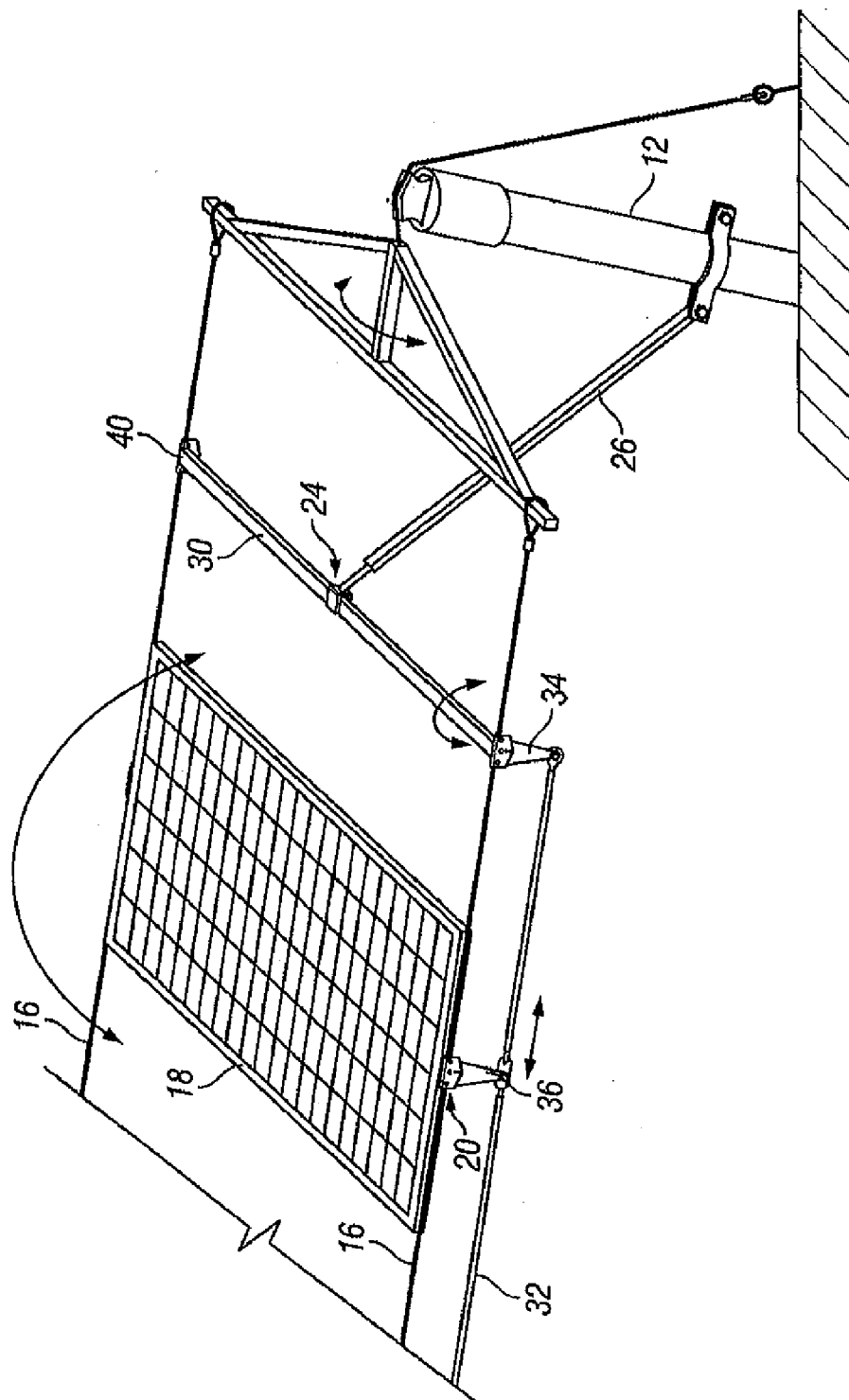


FIG. 17

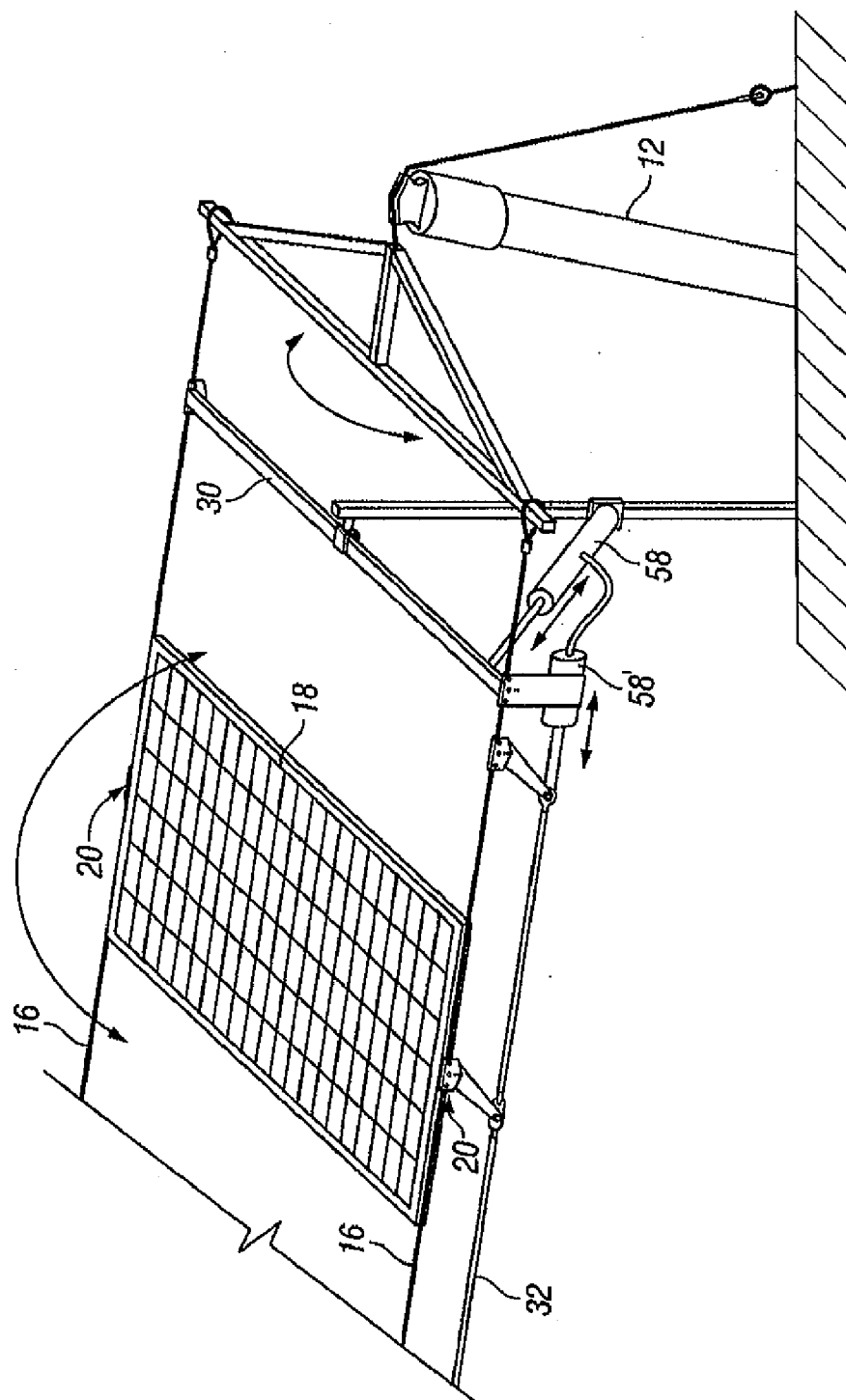


FIG. 18

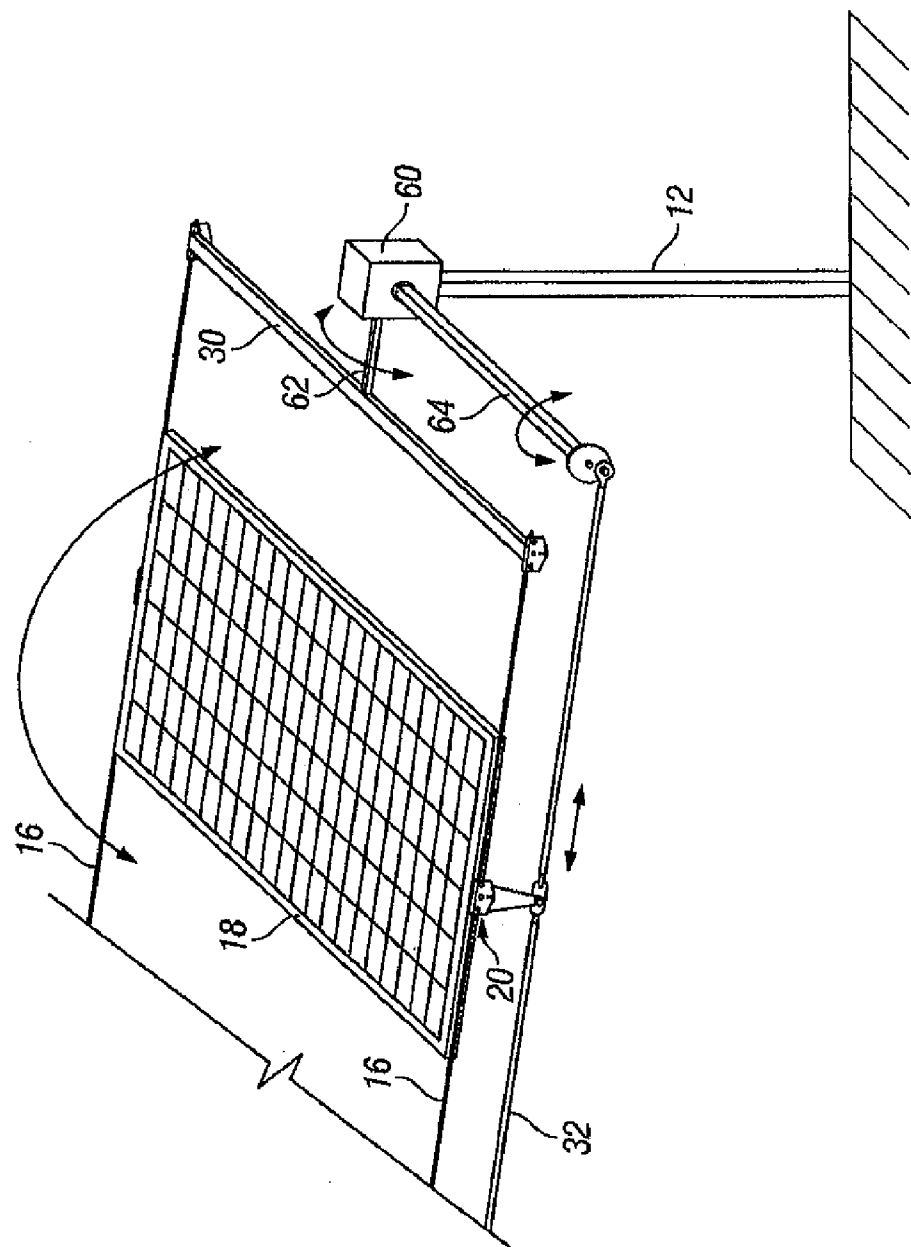


FIG. 19

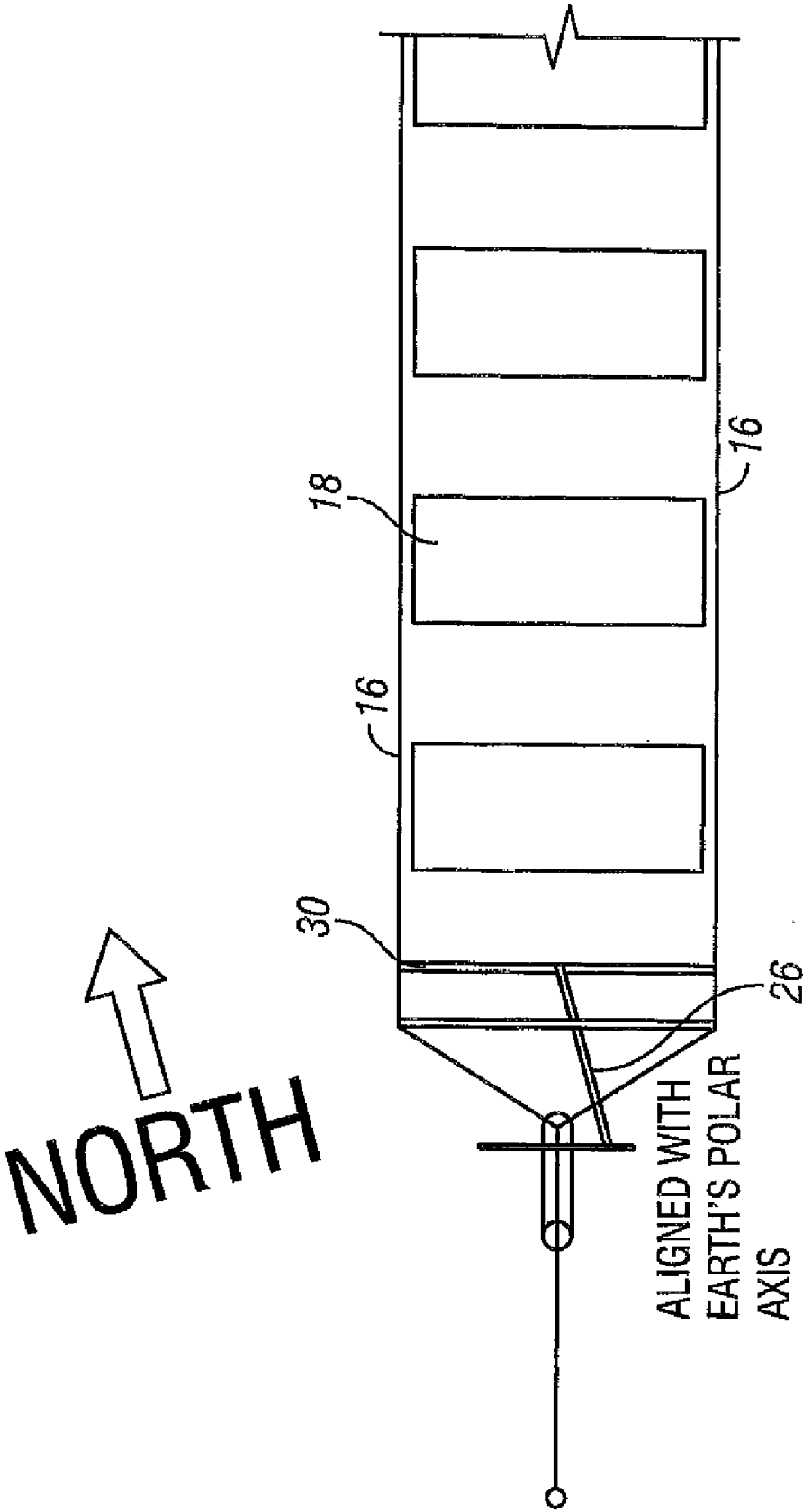


FIG. 20A

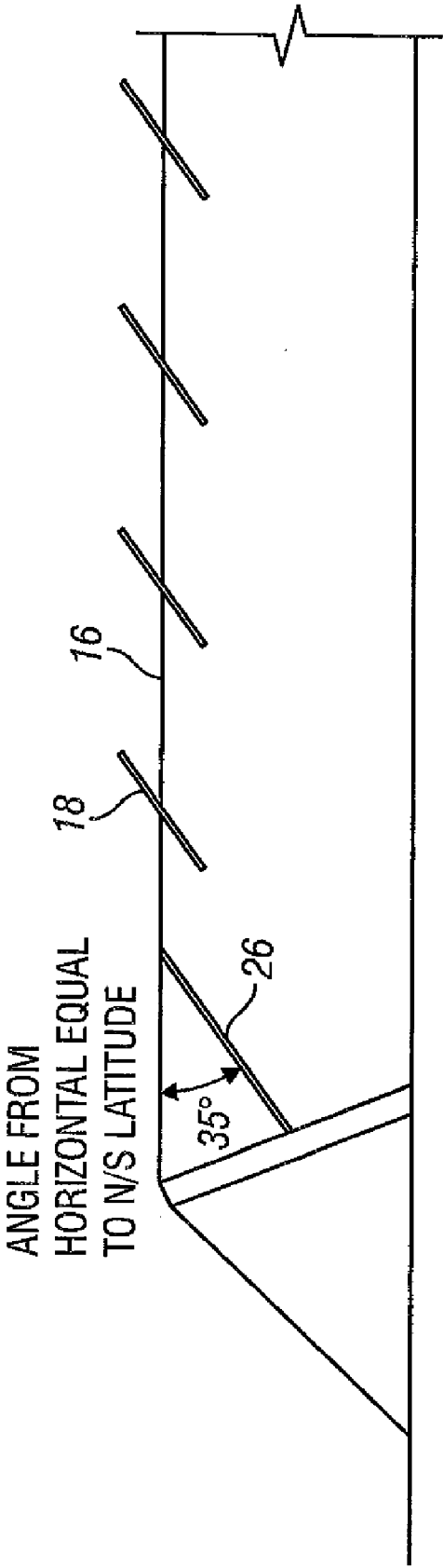


FIG. 20B

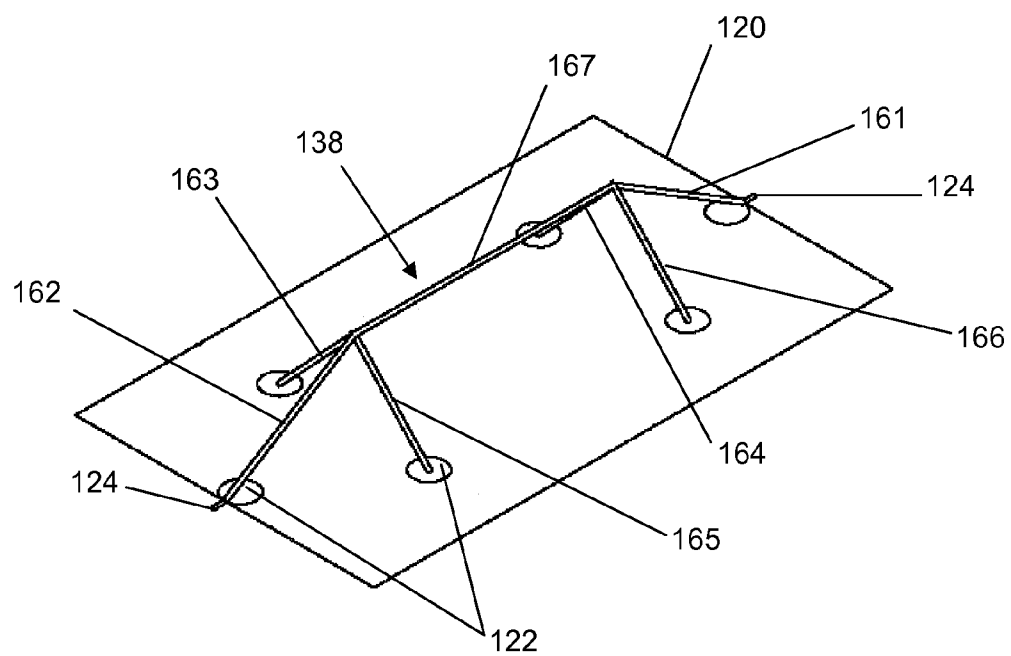


Fig. 21

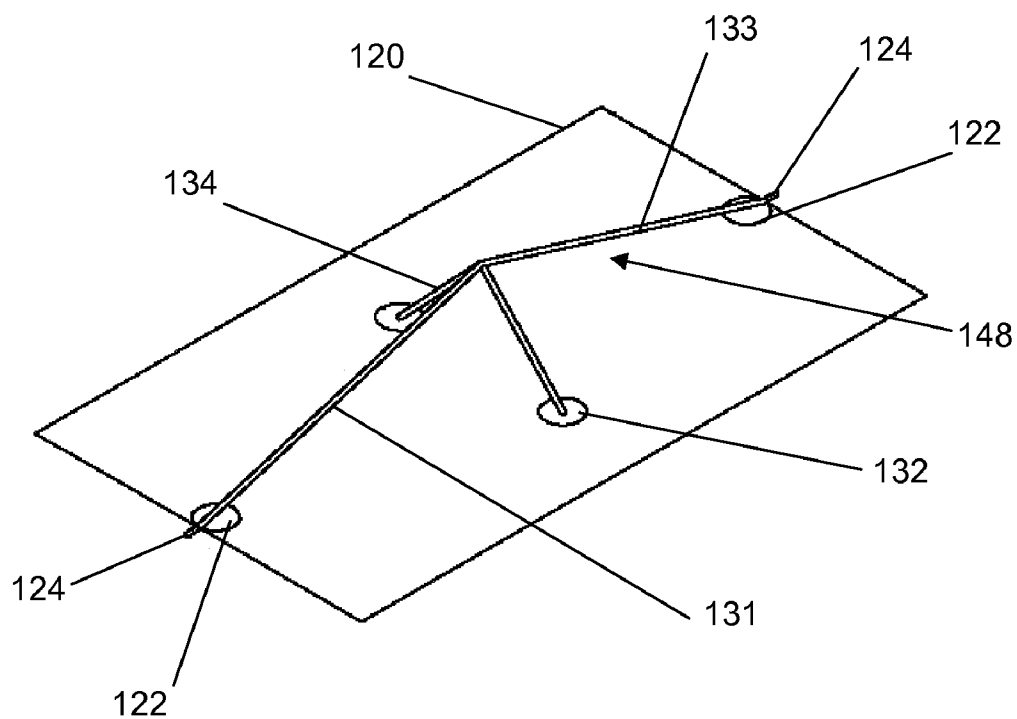


Fig. 22

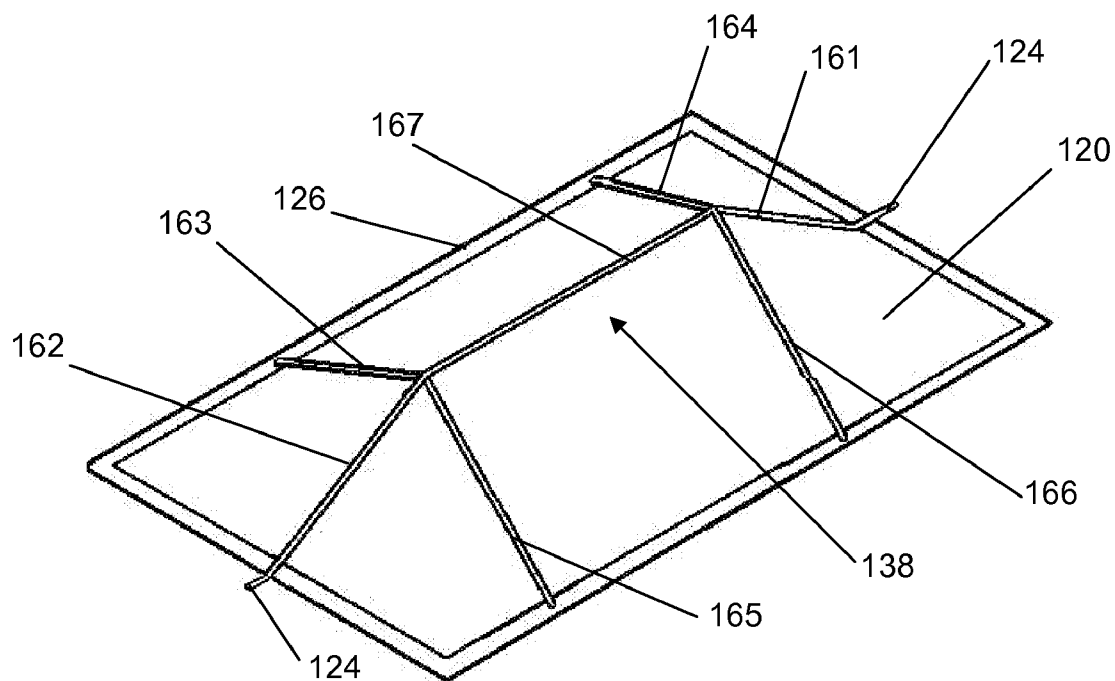


Fig. 23

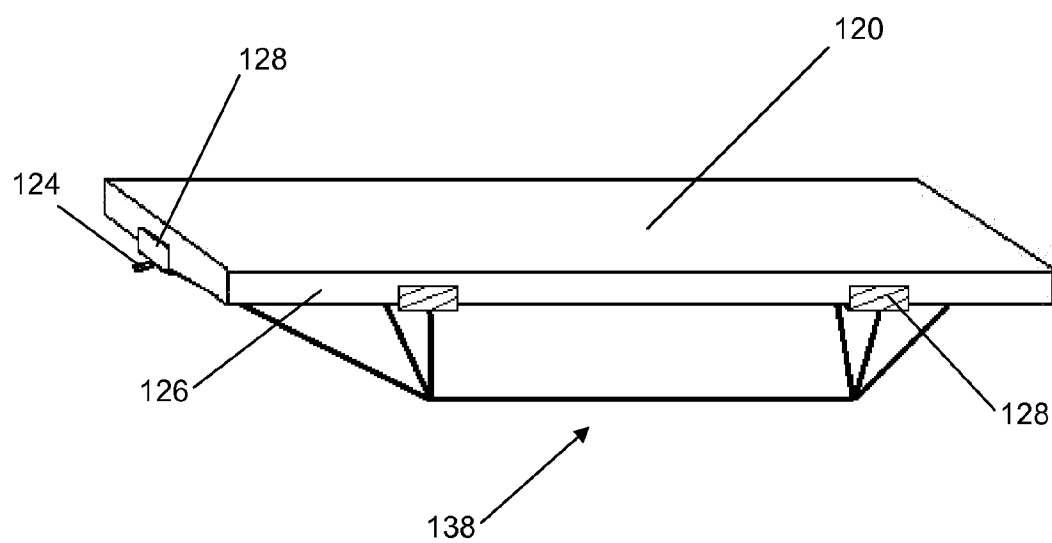


Fig. 24

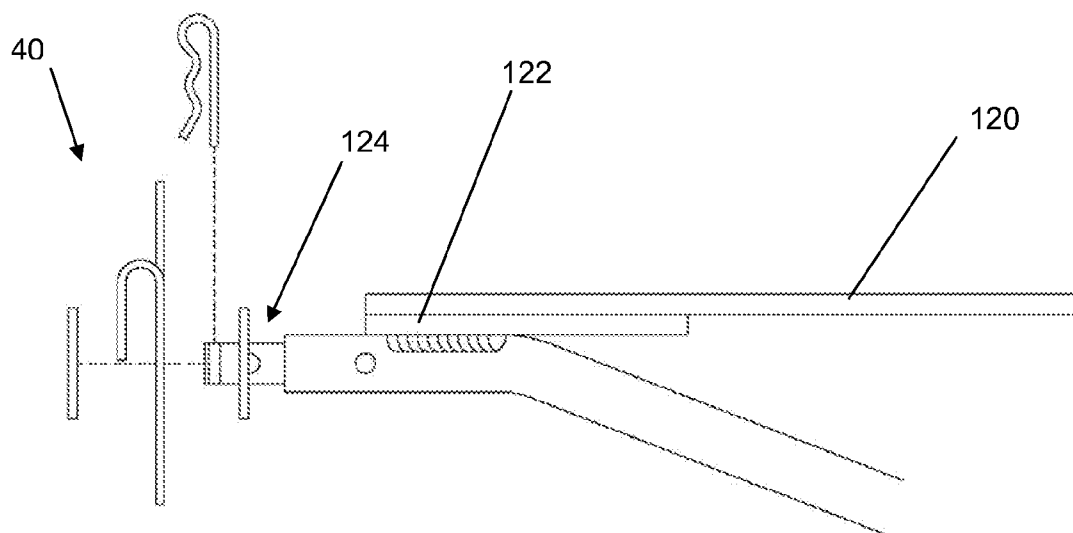


Fig. 25A

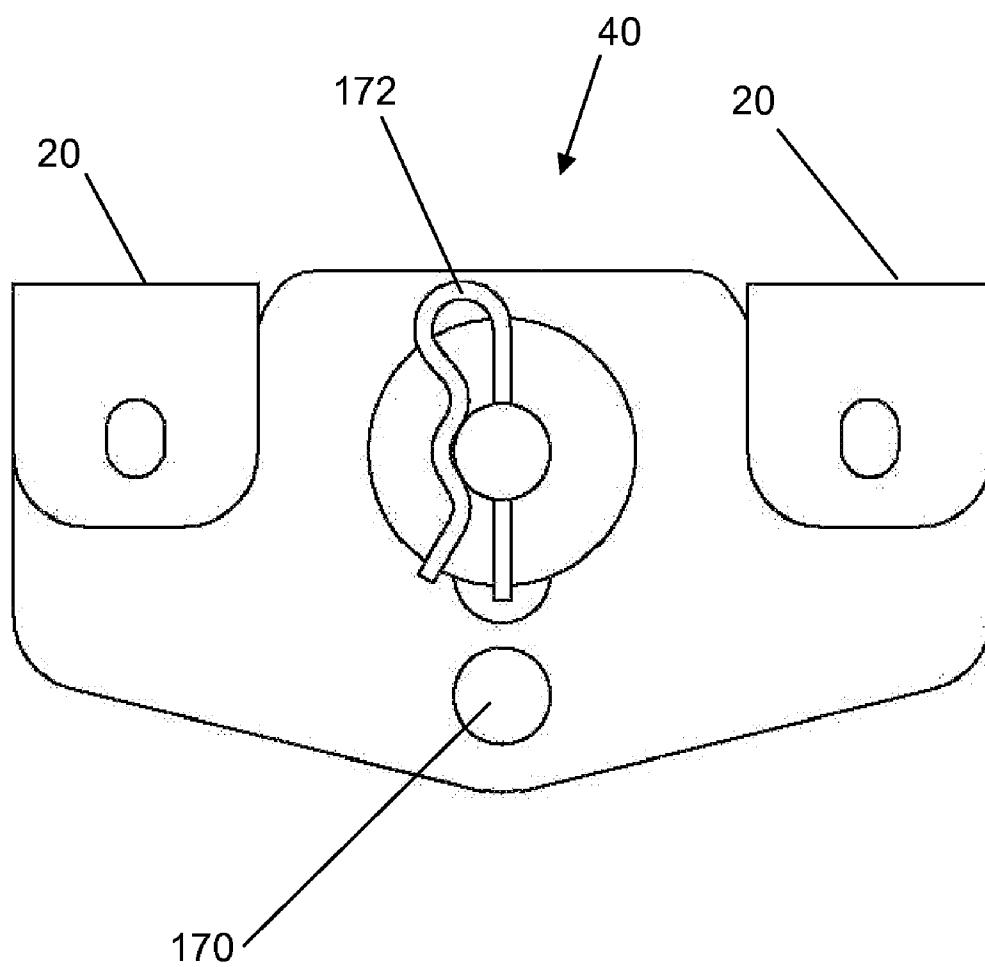


Fig. 25B

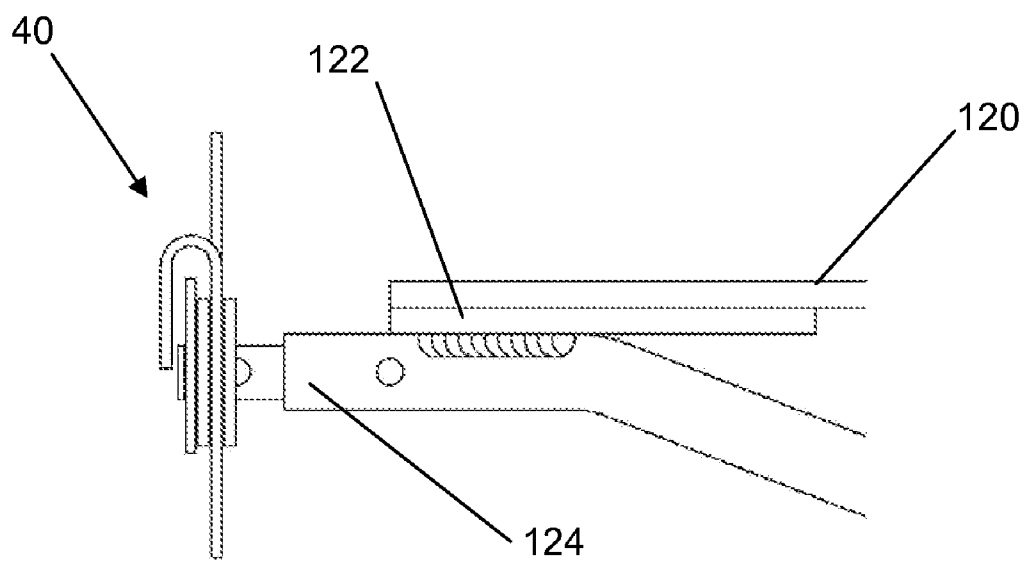


Fig. 25C

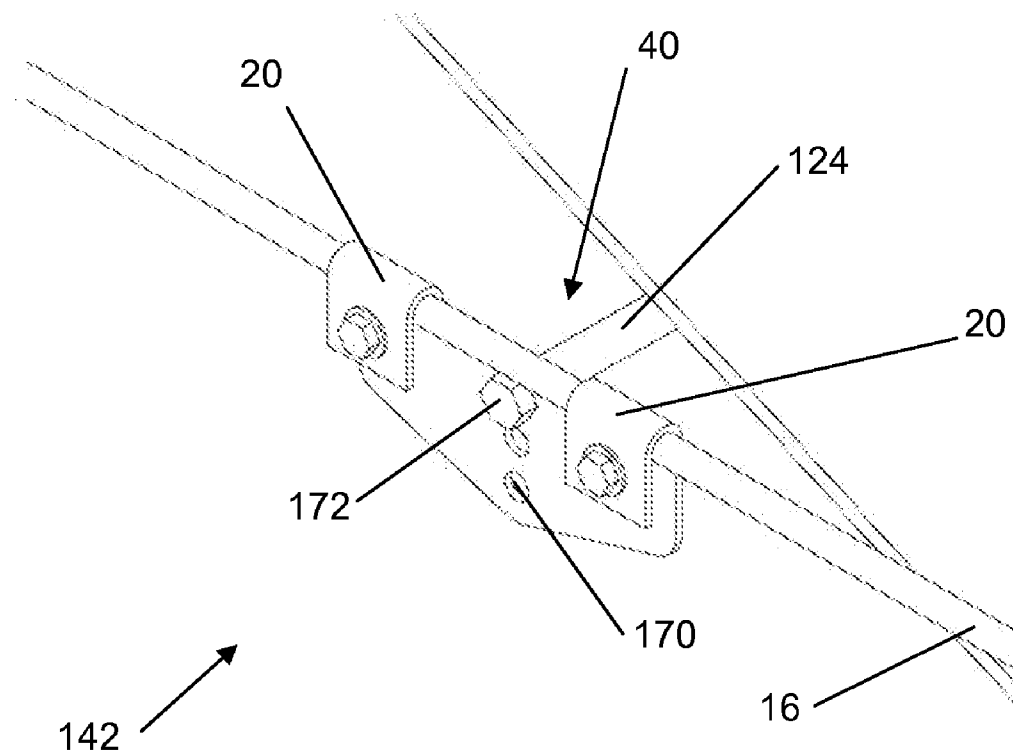


Fig. 25D

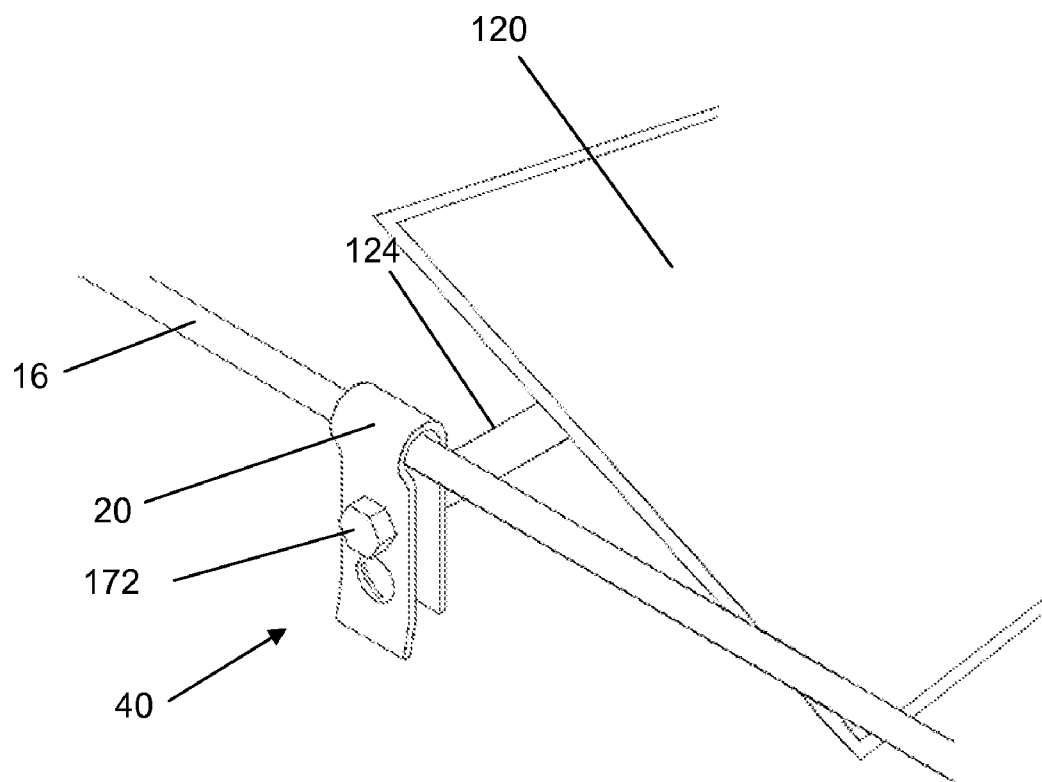


Fig. 26

DUAL AXIS SUPPORT FOR HIGH WIND SOLAR PANELS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part application of U.S. patent application Ser. No. 12/468,992, entitled "A Solar Panel Adapted to Suspend From a Longitudinally Extending Linkage Means", to Baer et al., filed on May 20, 2009, and the specification and claims thereof are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention (Technical Field)

[0003] An embodiment of the present invention relates to a solar panel support and track, particularly, one which provides the ability for a solar panel to automatically track in a second axis when moving about a first axis, and which is capable of supporting a high wind solar panel. The movement of the sun can be very closely approximated by revolving a pointer around an axis parallel to that of the Earth and adjusting its angle with respect to the polar axis to about 90 degrees $\pm$ about 23.5 degrees to account for seasonal declination. An embodiment of the present invention mechanically coordinates the motion of a single driven tracking axis (of any orientation) with an additional, perpendicular axis in order to emulate the action of two driven axes. The result is two-axis tracking that can be accomplished with only a single axis being driven. In one embodiment, the basis of this mechanism is the Cardan or universal joint.

[0004] 2. Description of Related Art

[0005] Numerous structural support systems for supporting a solar panel are known. Of these, the most economical is a single axis cable supported mounting system, such as that described in U.S. Pat. No. 4,832,001. While easy to install and low in cost, that system provides only a single axis of rotation for the supported panels. Further, that known system is often difficult to balance such that it functions properly. Modern photovoltaic solar installations are now almost on the cusp of being cost competitive with other electrical generation systems.

[0006] Known solar panel supports need large structural steel because the basic structural elements of the support, principally the pedestal and torque tubes, are subjected to large bending loads. The present invention provides a structure in which the support elements act either in compression or tension, and bending loads are minimized. Relatively inexpensive and lightweight pipes can be used as the compression members, with cables, rods or tubes (either round or square) used as the tension members. Rather than a large concrete base, only small concrete pads are needed to support the compression members, and the tension members can be secured to the ground using conventional helical anchors. The structural elements required for the support of the present invention are thus lightweight and easily transportable even to a remote location.

[0007] The total cost of a solar installation and the total output power are the primary factors which typically determine the feasibility of installing such systems. Accordingly, the ability of embodiments of the present invention to provide a low-cost mounting system while also providing a dual axis system, thereby improving the efficiency of the installation and increasing the total power output, address both of the

primary factors in determining the feasibility of solar installations. There is thus a present need for a solar panel mounting system which is low cost and provides increased efficiency via a two axis system. Embodiments of the present invention can render viable an economically non-viable solar installation.

[0008] Although others have attempted to suspend solar panels, U.S. Pat. No. 4,466,423 for example, such known techniques rely on conventional cross frames and do not disclose the ability to attach a space frame directly to the rear face of a solar panel. There is thus a present need for a solar panel supporting structure which permits a solar panel to be mounted directly thereto without enclosing the back of the solar panel and without requiring additional panel frame components.

BRIEF SUMMARY OF EMBODIMENTS OF THE PRESENT INVENTION

[0009] An embodiment of the present invention relates to a dual axis solar panel support structure which includes at least one cable arranged into at least two substantially parallel cable runs, at least two cable supports suspending the cable above a ground surface, and a mechanism which translates a force in a first direction into a force in a second direction. The force in a first direction can include a rotational force about an axis which is substantially parallel with the substantially parallel runs. The at least one cable can include two cables extended in an arrangement substantially parallel with one another. The mechanism can include a Cardan joint and/or an adjustment mechanism, which can be adjustable for seasonal changes in the Earth's orbit about the sun. Optionally, the Cardan joint can be attached at its first end to a cross member which extends between the parallel runs of cable and/or the Cardan joint can be attached at its second end to a downward-depending member. The downward-depending member can be arranged to form an angle with respect to a primary axis of the substantially parallel runs which is approximately equal to a north-south latitude at which the support structure is disposed.

[0010] In one embodiment, the mechanism can include a piston and/or a transfer box. Optionally, a linkage can also be provided which transfers the force in the second direction to a solar panel. A bracket can be attached to one of the cable runs. The structure can also include a balancing adjustment mechanism and/or a space frame disposed between the cable runs which supports a solar panel. The structure can also include a solar support space frame comprising a plurality of frame members, the space frame configured to receive a solar panel. The space frame can attach to a back of a solar panel and/or to a frame of a solar panel. Optionally the space frame can have a pyramidal shape or a hexamidal shape. The space frame can also include an attachment mechanism. A solar panel can be attached to the space frame at a plurality of points, which points can lie around a periphery of the panel. A solar panel can be disposed within a frame and the frame can be attached to the space panel at a plurality of points. An embodiment of the present invention also relates to a method of supporting a solar panel which includes arranging at least one cable into at least two substantially parallel cable runs, suspending the cable above a ground surface with at least two cable supports, and translating a force applied in a first direction into a force in a second direction with a translation mechanism.

[0011] Objects, advantages and novel features, and further scope of applicability of the present invention will be set forth in part in the detailed description to follow, taken in conjunction with the accompanying drawings, and in part will become apparent to those skilled in the art upon examination of the following, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and attained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0012] The accompanying drawings, which are incorporated into and form a part of the specification, illustrate one or more embodiments of the present invention and, together with the description, serve to explain the principles of the invention. The drawings are only for the purpose of illustrating one or more preferred embodiments of the invention and are not to be construed as limiting the invention. In the drawings:

[0013] FIGS. 1A and 1B are drawings of a solar panel support system according to an embodiment of the present invention, note that the panels are not illustrated in FIG. 1A;

[0014] FIGS. 2 and 3 are drawings illustrating a second axis drive mechanism according to an embodiment of the present invention;

[0015] FIGS. 4 and 5 are drawings illustrating an angle adjustment for the second axis drive mechanism according to an embodiment of the present invention;

[0016] FIG. 6 is a drawing illustrating a cable mount for a cross bar of the second axis drive mechanism;

[0017] FIG. 7 is a drawing illustrating an arm attached to a cross bar of the second axis drive mechanism which drives the linkage attached to the arm;

[0018] FIG. 8 is a drawing illustrating an embodiment of the present invention wherein a plurality of linkages are attached to panel mount arms, thereby movably connecting the panel mounts to the cross bar of the second axis drive mechanism;

[0019] FIGS. 9 and 10 are drawings which respectively illustrate outside and inside portions of panel mount arms and cable mounts;

[0020] FIG. 11 is a drawing illustrating a balance ballast and an adjustable, balancing, cable mount;

[0021] FIGS. 12, 13A and 13B are drawings illustrating perspective views of an adjustable, balancing, cable mount;

[0022] FIGS. 14 and 15 are drawings illustrating interior support posts with a support arm supporting balance ballasts;

[0023] FIGS. 16 and 17 are drawings which illustrate an embodiment of the present invention in different states of rotation about two axes;

[0024] FIG. 18 is a drawing which schematically illustrates an embodiment of the present invention wherein a plurality of pistons are configured such that rotation about a first axis causes a second piston to react to a force induced on a first piston;

[0025] FIG. 19 is a drawing which schematically illustrates an embodiment of the present invention wherein a transfer box cause a rotational force to be translated from a first axis to a second axis;

[0026] FIGS. 20A and 20B are drawings which schematically illustrates top and side views of an embodiment of the

present invention disposed in an orientation which is not aligned with the north-south polar axis of the Earth;

[0027] FIGS. 21 and 22 are drawings which illustrate embodiments of the present invention wherein a solar panel is attached to a space frame;

[0028] FIGS. 23 and 24 are drawings which illustrate embodiments of the present invention wherein a frame of a solar panel is attached to a space frame;

[0029] FIGS. 25A-D are drawings which illustrate an embodiment of a receiver which attaches a space frame to a solar panel support; and

[0030] FIG. 26 is a drawing which illustrates an alternative embodiment of a receiver which attaches a space frame to a solar panel support.

DETAILED DESCRIPTION OF THE INVENTION

[0031] An embodiment of the present invention is directed to a photovoltaic solar panel support system, particularly to a dual axis, suspended cable, support system.

[0032] The term “cable” as used throughout the specification and claims is intended to include any elongated member capable of supporting a solar panel, including but not limited to rods, belts, ropes, metal and synthetic braided and/or twisted cables, chains, wires, and the like.

[0033] The term “fastener” as used throughout the specification and claims is intended to include bolts, nails, screws, adhesive, welds, bonds, links, straps, snaps, buttons, tape, combinations thereof and the like.

[0034] An embodiment of the present invention is illustrated in FIGS. 1A and 1B. As illustrated therein, system 10 includes a pair of end supports 12 and optionally one or more center supports 14. End supports 12 are preferably connected via a plurality of support cables 16, which are attached to crossbars 30. Panels 18 are preferably attached to cables 16 via one or more cable clamps 20 or other mounting mechanisms. To effect rotation about a first axis, drive mechanism 22 is preferably attached thereto. Drive mechanism 22 can optionally be an active drive mechanism, passive drive mechanism, or a combination thereof. In a preferred embodiment, drive mechanism 22 comprises a passive drive mechanism affixed to center support 14. However, desirable results can also be obtained by affixing an active drive mechanism 22 to one of end supports 12 or to center supports 14. Of course desirable results can also be achieved by attaching a drive mechanism in another configuration which causes movement about an axis of the panels without being affixed to one of the end or center supports 12 or 14. For example, a pump can be used to pump fluid from a tank on one side of the system to a tank on the other side of the system. In yet another embodiment, a rotational drive mechanism can be coupled to shaft 26 such that rotation of shaft 26 induces rotational forces, via second axis drive mechanism 24, in both the long and short axes of cross support 17, thereby imparting movement about two axes of panels 18. In one embodiment, when the wind blows against system 10, cables 16 thus bow and thereby create a curved shape which is stronger than a straight member.

[0035] As illustrated in FIGS. 2-10, in a preferred embodiment, second axis drive mechanism 24 is preferably provided. In one embodiment, second axis drive mechanism 24 preferably includes shaft 26, which is preferably attached to end support 12 such that shaft 26 resides at an angle between 0 and 90 degrees with respect to the long axis of cable 16 (see FIG. 20B).

[0036] Adjustment mechanism 38 is preferably disposed on a terminal portion of shaft 26 and permits crossbar 30 to be rotationally adjustable with respect to shaft 26. Linkages 32 preferably translate rotational movement of crossbar 30 to each of panels 18 via crossbar arm 34 and panel mount arms 36. In this embodiment, when crossbar 30 rotates about a first axis (i.e. the long axis of system 10, as illustrated in FIG. 1), panels 18 also rotate. As best illustrated in FIGS. 4 and 5, because of the angular relationship between shaft 26 with respect to crossbar 30, when crossbar 30 attempts to rotate about the first axis, a rotational force is imparted to crossbar 30 by shaft 26. This rotational force is transferred to crossbar arm 34 (see FIGS. 7 and 8). Because linkages 32 are movably connected to crossbar arm 34 the rotational force of crossbar 30 is thus translated into a rotational force of panels 18 about a second axis.

[0037] In one embodiment of the present invention, second axis drive mechanism 24 optionally comprises an angular adjustment 38, such that an angle of interaction between shaft 26 and crossbar 30 is adjustable. Angular adjustment 38 can include a variety of known angular adjustment configurations, including but not limited to a curved slot plate and one or more locking mechanisms. Shaft 26 is preferably adjustable at a terminal portion of shaft 26 via adjustment mechanism 38. When in motion, second drive axis mechanism 24 functions in a manner similar to Cardan joint.

[0038] As best illustrated in FIG. 6, in a further embodiment of the present invention, crossbar 30 and panels 18 are mounted onto cables 16 via cable clamps 20 which are incorporated or otherwise attached to rotational bracket 40. Because crossbar 30 and panels 18 preferably rotate in a second axis with respect to cable 16, rotational bracket 40 permits such rotation with rotational shaft 42, thereby preventing cable 16 from binding and inhibiting such second axis rotation. Like rotational bracket 40, crossbar arm 34 and panel mount arms 36 (see also FIGS. 9 and 10) also preferably comprise one or more cable clamps 20 and a rotational shaft to prevent cable 16 from binding while panels 18 and crossbar 30 rotate about a second axis.

[0039] In another embodiment of the present invention, linkages 32 are preferably adjustable and can comprise a single cable that pulls against the force of the downward hanging panels. In this embodiment, the cable is connected to center crossbar 44 at the opposite end of the tracker with sufficient slack to prevent the panels from flipping backwards in high winds. In an alternative embodiment, linkages 32 can comprise a cable. In this embodiment, a second axis drive mechanism is positioned at each end of system 10 such that the drive mechanism at one end of system 10 removes slack from cable linkages 32 which is introduced by the drive mechanism at the other end of system 10. In an alternative embodiment, linkages 32 can comprise individual members, which can optionally have an adjustment mechanism disposed on one or both ends thereof, including but not limited to a male and female threaded member which adjusts the length of the linkage by rotating one with respect to the other in a manner similar to that encountered in a turnbuckle device.

[0040] FIG. 11 illustrates an embodiment of the present invention wherein a fluid-containing tank, such as a chlorofluorocarbon-containing tank, is attached to an end of center crossbar 44, and wherein line 45 preferably links the illustrated tank of drive mechanism 22 to a second tank disposed at the opposite end of center crossbar 44.

[0041] As illustrated in FIGS. 12-14, an embodiment of the present invention also relates to balancing adjustment mechanism 46. Adjustment mechanism 46 addresses the shortcomings of prior art systems which were plagued with difficulty in balancing a fully-constructed system. Because such balancing often took a considerable amount of time and some degree of sheer luck, adjustment mechanism 46 thus provides the ability for a user to quickly balance system 10. Balancing adjustment mechanism 46 provides a user with the ability to rapidly and easily balance the system. In a preferred embodiment, slot plate 48 or other adjustment mechanisms are preferably provided such that cable mount 50 is movably positionable with respect to center crossbar 44, thereby permitting the height of cable 16 with respect to center crossbar 44 to be adjusted. As illustrated in the figures, in one embodiment, slide grooves in slot plate 48 are preferably adjustable via rotation of threaded member 52 which urges slot plate 48 up and down while under the weight of the cables 16 and panels 18.

[0042] As illustrated in FIGS. 14 and 15, an embodiment of the present invention comprises first and/or second shock absorbers 54 and 54' and, which can be hydraulic or pneumatic. As illustrated therein, when center crossbar 44 attempts to rotate with respect to center support 14, first shock absorber 54 is compressed and second shock absorber 54' is extended, or vice-a-versa depending on the direction of rotation of crossbar 44 with respect to center support 14. Accordingly center crossbar 44 is permitted to rotate slowly with respect to center support 14, thereby preventing the system 10 from rapidly thrashing back and forth during windy conditions. In an alternative embodiment, system 10 can be actively-driven by replacing one or both of shock absorbers 54 and 54' with an active drive mechanism, such as a fluid-activated piston, or a linear actuator, including but not limited to a screw-drive mechanism. Of course if such an active drive mechanism is provided, drive mechanism 22 is thus no longer needed.

[0043] FIGS. 16 and 17 illustrate an embodiment of the present invention with second axis drive mechanism 24, wherein panels 18 are in exaggerated first and second positions to illustrate their motion about the second axis.

[0044] As illustrated in FIGS. 18 and 19, an embodiment of the present invention comprises first and second pistons 58 and 58', which can be hydraulic or pneumatic. As illustrated therein, when crossbar 30 rotates with respect to end support 12, first piston 58 is compressed, thereby forcing fluid into second piston 58', and thus extending or retracting (depending upon the particular configuration) second piston 58'. Extension and/or retraction of second piston 58' moves linkage 32 and thus causes panel 18 to rotate about a second axis. Transfer box 60 in FIG. 19 can be a geared configuration, a belt or chain-driven configuration, or a combination thereof. As illustrated therein, rotation of panel 18 about a first axis induces a rotational force on input shaft 62 which is translated into a rotational force about output shaft 64, thereby causing linear displacement of linkage 32, which thus causes panel 18 to rotate about a second axis.

[0045] In an embodiment of the present invention, a single drive mechanism induces rotation about a first and a second axis. In an embodiment of the present invention movement about a first axis induces movement about a second axis via a passive second axis drive mechanism. In an embodiment of the present invention, movement about a first axis induces

movement about a second axis based on a predetermined ratio of a passive second axis drive mechanism.

[0046] Although desirable results are achieved when system **10** is orientated such that its primary axis lies parallel with the Earth's polar axis, embodiments of the present invention easily accommodate orientations of system **10** wherein system **10** is not orientated such that its primary axis lies parallel with the Earth's polar axis (for example if a geographic feature prevents such orientation). As illustrated in FIG. 20A, in this embodiment, the lower end of shaft **26** is preferably positioned to one side or another of the center of the primary axis of system **10**, such that, when viewed from above, the primary axis of shaft **26** does not lie in a parallel orientation with the primary axis of system **10**, but rather most preferably lies at least substantially parallel with the Earth's polar axis.

[0047] In an embodiment of the present invention, shaft **26** is preferably positioned such that it forms an angle with respect to the primary axis of cable **16** which is substantially equal with the north-south latitude at which system **10** is disposed. For example, if system **10** is disposed somewhere near Albuquerque, N. Mex., which has a latitude of roughly 35 degrees North, then shaft **26** is preferably positioned such that it forms an angle of about 35 degrees with respect to the primary axis of cable **16** as is illustrated in FIG. 20B.

[0048] Some embodiments of the present invention relate to a support for solar panels, and in particular to a lightweight support which minimizes the use of heavy structural steel or otherwise costly materials while also providing a dual axis tracking mechanism.

[0049] The space frame embodiments of the present invention also reduce excess heat created by panels which would otherwise be trapped by a solid-backing applied to a panel.

[0050] Some of the embodiments of the present invention comprise a lightweight pyramidal or hexagonal (a six-sided structure having a hexagonal base) space frame. The space frame also optionally attaches at intermediate points (such as quarter points) which best support the rigid panel without interfering with air flow or radiations.

[0051] FIGS. 21 and 22 respectively illustrate embodiments of the present invention wherein solar panel **120** is attached to space frame **138** and **148**. Space frame **138** preferably comprises a plurality of frame members **161**, **162**, **163**, **164**, **165**, **166**, and **167**. Optionally, several of the frame members, including but not limited to **161**, **162** and **167**, can optionally be formed from one or more continuous pieces. Non-continuous frame members are preferably fastened to one another through a manner known in the art, including but not limited to welding, an adhesive, and/or one or more fasteners. Terminal ends of one or more of frame members of space frame **138** are preferably attached a back side of solar panel **120**. Although numerous manners of attachment of the members to the back of panel **120** are known and will provide desirable results, in one embodiment, an adhesive is optionally used.

[0052] In an alternative embodiment, pads **122** can be adhesively attached to panel **120** on a first side of pad **122** and mechanically attached to a frame member on another side of pad **122**.

[0053] As with space frame **138**, space frame **148**, which comprises a pyramidal shape, instead of the hexamidal shape of space frame **138**, can also comprise numerous frame members **131**, **132**, **133**, and **134**, two or more of which can optionally be formed from one or more continuous pieces.

And, as with space frame **138**, non-continuous frame members of frame **148** are also preferably fastened to one another through a manner known in the art, including but not limited to welding, an adhesive, and/or one or more fasteners. Terminal ends of one or more of members of space frame **148** are preferably attached a back side of photovoltaic panel **120** in a manner which is consistent with that taught for space frame **138**.

[0054] Referring now to FIGS. 23 and 24, space frame **138** is attached directly to frame **126** of panel **120** instead of to the back of panel **120** as was illustrated in FIG. 21. In this embodiment, space frame **138** is the same as previously illustrated, except that instead of connecting to a back of panel **120** via pads **122**, it instead connects to frame **126**, which surrounds panel **120**, via connection brackets **128**. While brackets **128** can include any device capable of attaching a frame member end to a panel frame, brackets **128** most preferably comprise a length of right angle beam, which is most preferably welded to a terminal end of a space frame member. Brackets **128** can optionally be fastened to frame **126** via one or more screws. While the particular shape of space frame **138** is illustrated as being attached to panel frame **126**, any space frame shape, including but not limited to pyramidal (such as that illustrated in FIG. 22) can be used as long as panel frame **126** is attached to the space frame at a plurality of points. While desirable results can be obtained from a space frame design which attaches to panel frame **126** at points along only two sides of panel **120**, more desirable results can be produced by attaching the space frame at points along all sides (i.e. 4 sides for a rectangular-shaped panel) of panel **120**.

[0055] The members of space frames **138** and **148** can optionally be constructed from any material capable of supporting the weight of a photovoltaic panel, including but not limited to, rods, pipes, tubes, beams, and the like. Although space frames **138** and **148** are illustrated as comprising pyramidal and hexamidal shapes, other space frame shapes can of course be used in accordance with the teachings illustrated above. This is particularly true for other shapes which stiffen and evenly distribute stress throughout the panel.

[0056] In one embodiment, space frame attachment mechanisms **124** can optionally be disposed at alternate ends of space frames **138** and/or **148**. While numerous methods, devices, apparatuses, and systems are known for mounting a structure, such as a space frame and will provide desirable results, in one embodiment, attachment mechanisms **124** can optionally comprise a pin which can be received by a pin-holding member, thereby providing the ability for space frames **138** and **148** to optionally be pivotally attached to a rotational bracket.

[0057] Referring to FIGS. 25A-D, in one embodiment of the present invention bracket **40** can be used to suspend space frame **138** and/or **148** from cable **16** of a solar panel support structure, similar to that previously discussed in reference to FIG. 6. In this embodiment, attachment mechanisms **124** are preferably received into opening **170** of bracket **40**. Optionally, bracket **40** can comprise a plurality of openings such that attachment mechanisms **124** can be selectively installed into one of the plurality of openings **170** of bracket **40**, which can assist a user in balancing panel **120**. Receiver preferably comprises one or more clamps **20** which secure bracket **40** to cable **16** of a solar panel support structure. Fastener **172** is preferably used to secure attachment mechanism **124** to bracket **40**. Fastener **172** can optionally comprise a pin, clip, clamp, bolt, or other known fastening device which is capable

of securing attachment mechanism 124 to bracket 40. Of course, upon studying this application, those skilled in the art will readily appreciate that other designs and configurations of bracket 40 can be constructed and will provide desirable results. The particular shape and configuration of receiver is not important, so long as receiver permits space frames 138 and/or 148 to be mounted to a support structure. For example, FIG. 26 illustrates an alternative configuration of bracket 40 wherein cable 16 is secured to bracket 40 via clamp 20 and wherein fastener 172 secures attachment mechanism 124 to receiver 40.

[0058] Variations and modifications of the present invention will be obvious to those skilled in the art and it is intended to cover all such modifications and equivalents. The entire disclosures of all references, applications, patents, and publications cited above and/or in the attachments, and of the corresponding application(s), are hereby incorporated by reference.

What is claimed is:

1. A dual axis solar panel support structure comprising: at least one cable arranged into at least two substantially parallel cable runs; at least two cable supports suspending said cable above a ground surface; and a translation mechanism translating a force in a first direction into a force in a second direction.
2. The structure of claim 1 wherein the force in a first direction comprises a rotational force about an axis which is substantially parallel with said substantially parallel runs.
3. The structure of claim 1 wherein said at least one cable comprises two cables extended in an arrangement substantially parallel with one another.
4. The structure of claim 1 wherein said mechanism comprises a Cardan joint.
5. The structure of claim 4 wherein said mechanism further comprises an adjustment mechanism.
6. The structure of claim 5 wherein said adjustment mechanism is adjustable for seasonal changes in the Earth's orbit about the sun.
7. The structure of claim 4 wherein said Cardan joint is attached at its first end to a cross member which extends between said parallel cable runs.
8. The structure of claim 4 wherein said Cardan joint is attached at its second end to a downward-depending member.
9. The structure of claim 8 wherein said downward-depending member is arranged to form an angle with respect to

a primary axis of said substantially parallel cable runs which is approximately equal to a north-south latitude at which said support structure is disposed.

10. The structure of claim 1 wherein said translation mechanism comprises a piston.

11. The structure of claim 1 wherein said translation mechanism comprises a transfer box.

12. The structure of claim 1 further comprising a linkage transferring the force in the second direction to a solar panel.

13. The structure of claim 1 further comprising a bracket attached to one of said substantially parallel cable runs.

14. The structure of claim 1 further comprising a balancing adjustment mechanism.

15. The structure of claim 1 further comprising a space frame supporting a solar panel, said space frame disposed between said substantially parallel cable runs.

16. A solar support space frame comprising a plurality of members, said space frame configured to receive a solar panel.

17. The space frame of claim 16 wherein said space frame attaches to a back of the solar panel.

18. The space frame of claim 16 wherein said space frame attaches to a frame of the solar panel.

19. The space frame of claim 16 wherein said space frame comprises a pyramidal shape.

20. The space frame of claim 16 wherein said space frame comprises a hexamidal shape.

21. The space frame of claim 16 wherein said space frame additionally comprises an attachment mechanism.

22. The space frame of claim 16 wherein the solar panel is attached to said space frame.

23. The space frame of claim 22 wherein the solar panel frame is attached to said space frame at a plurality of points.

24. The space frame of claim 23 wherein said space frame is attached to the solar panel frame at a plurality of points about a periphery thereof.

25. The space frame of claim 16 wherein the solar panel is disposed within the frame and wherein said space frame is attached to the frame.

26. A method of supporting a solar panel comprising: arranging at least one cable into at least two substantially parallel cable runs; suspending the cable above a ground surface with at least two cable supports; and translating a force applied in a first direction into a force in a second direction with a translation mechanism.

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