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(54) **SOLAR MODULE ARRANGEMENT AND ROOF ARRANGEMENT**

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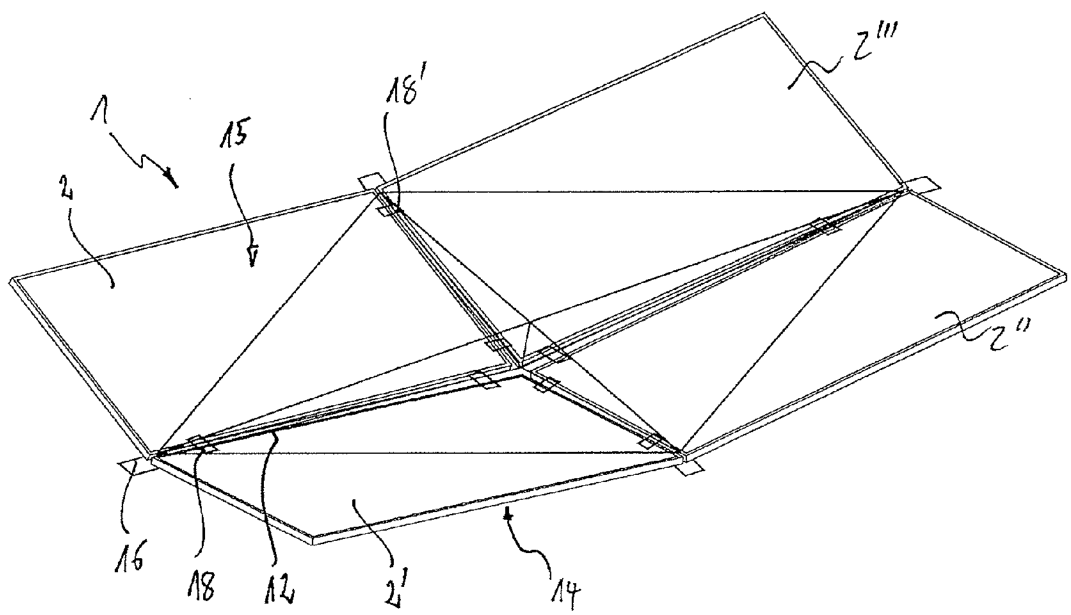
(57) **ABSTRACT**

A solar module arrangement for, in particular, solar-thermal and/or photovoltaic energy production, comprising at least three solar module elements (**2**) which are arranged in a substantially horizontal, flat composite and are each inclined relative to one another with respect to the horizontal plane (H) in such a way that side edges (**4**) which frame the solar module arrangement (**1**) are lower or higher than a substantially middle central region (**6**) relative to the horizontal plane (H). Furthermore, a roof arrangement with a plurality of solar module arrangements of the above-mentioned type, wherein the solar module arrangements (**1**) are arranged on subsections (**22**), which run substantially parallel to one another, of the side borders (**4**) of adjacent solar module arrangements (**1**) to form an, in particular, diamond-shaped, roof arrangement (**30**).



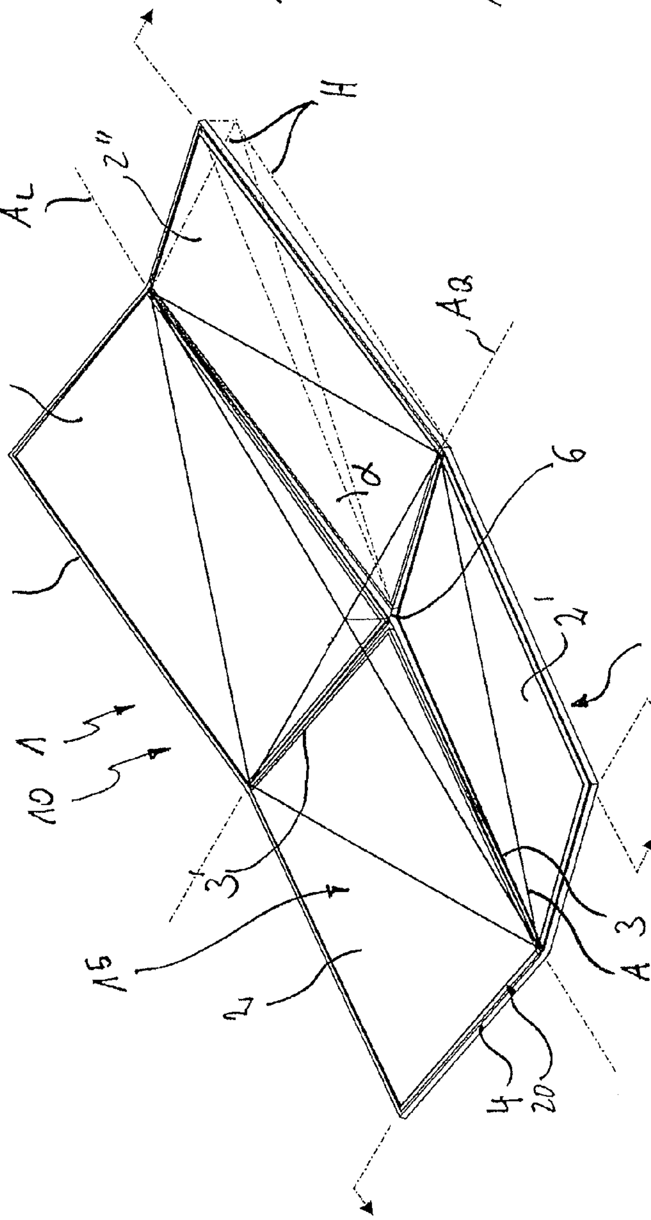


Fig. 1

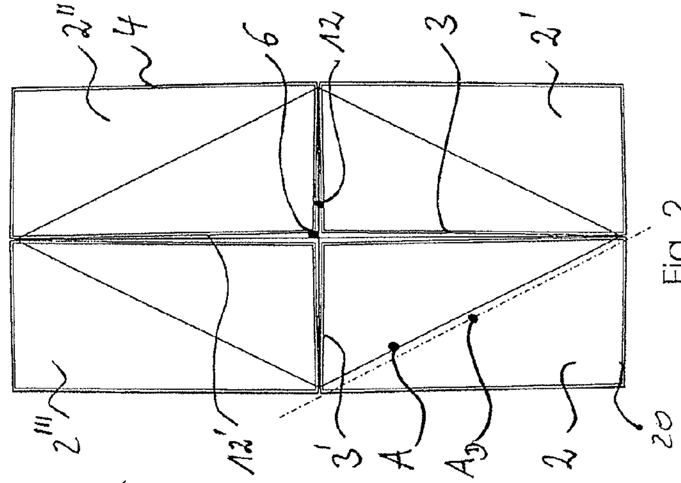


Fig. 2

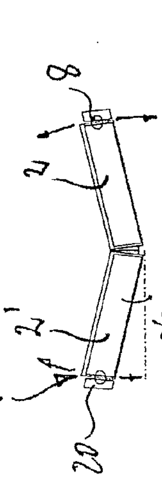


Fig. 3

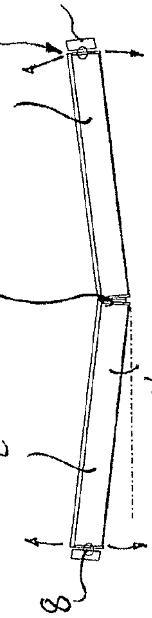


Fig. 4

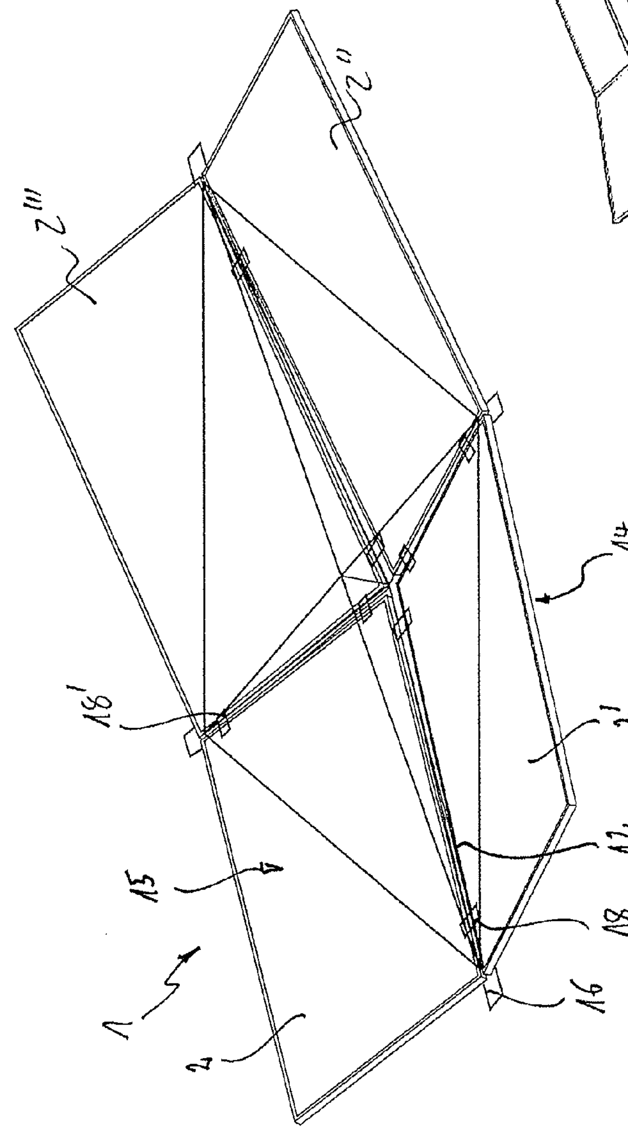


Fig. 5

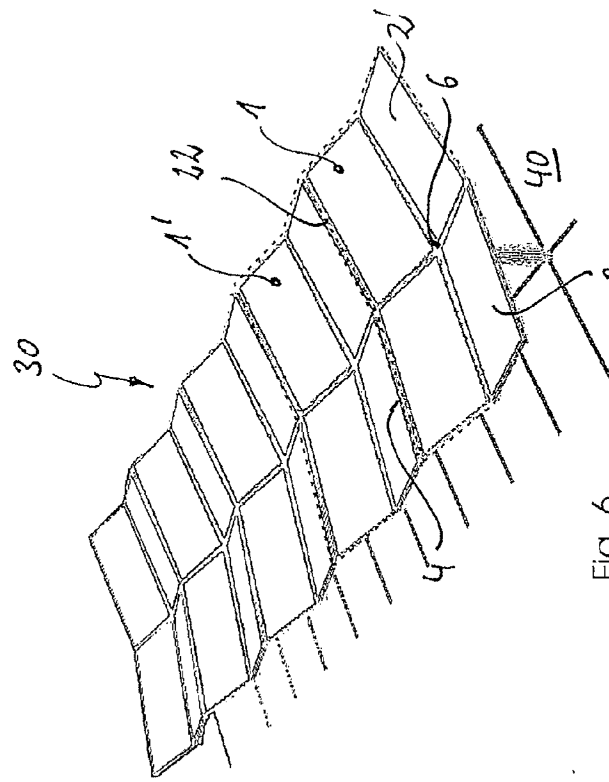


Fig. 6

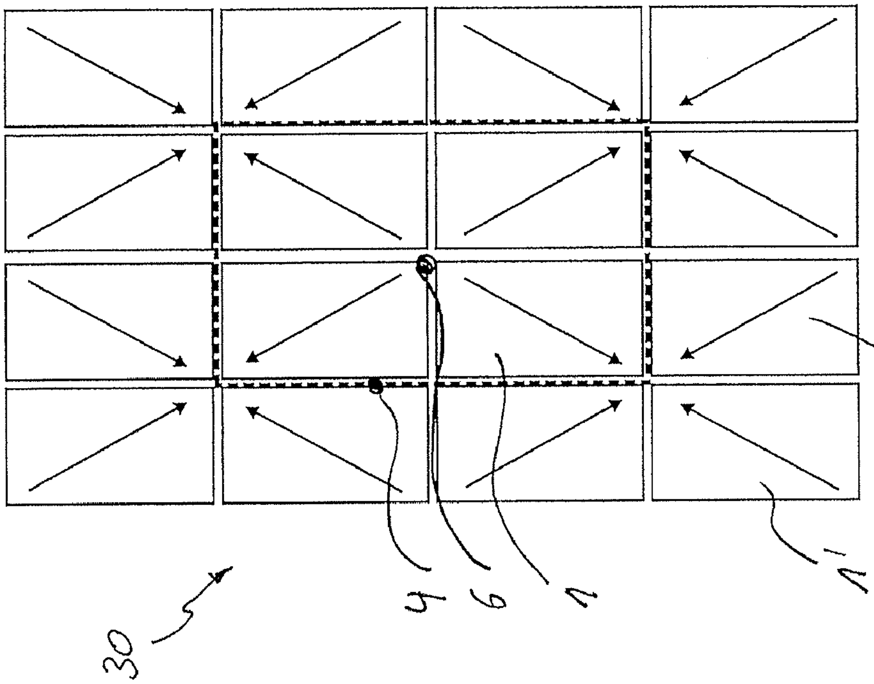


Fig. 8

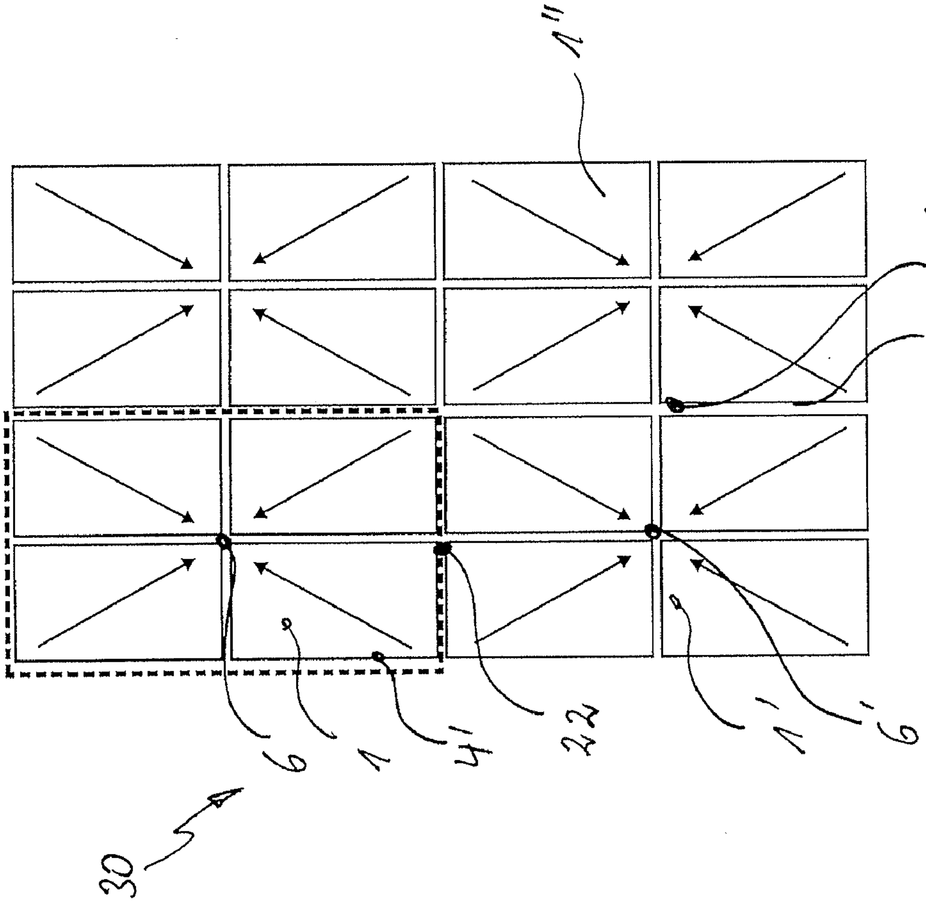


Fig. 7

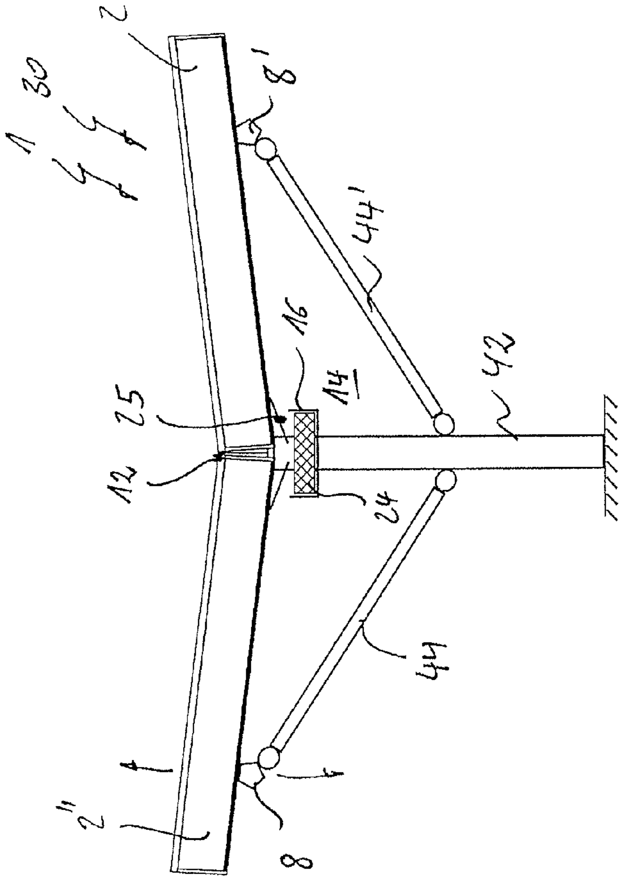


Fig. 10

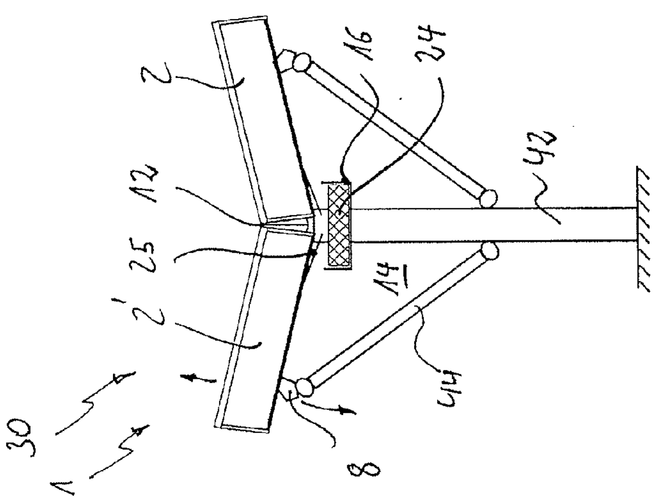


Fig. 9

SOLAR MODULE ARRANGEMENT AND ROOF ARRANGEMENT

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a solar module arrangement, in particular for solar-thermal and/or photovoltaic energy generation, and to a roof arrangement having a plurality of such solar module arrangements.

[0003] 2. Description of Related Art

[0004] Both photovoltaic and also solar-thermal energy generation plants are known from the prior art. Both use the incident solar radiation to generate either electrical or thermal energy and supply it to a further consumer. So-called combination modules also exist, which allow a combination of photovoltaic and solar-thermal energy generation. In all modules, an orientation toward the sun which is a function of the geographical usage region is absolutely necessary to optimize the efficiency.

[0005] Typically, such modules are mounted elevated on roofs, flat roofs, free surfaces, or also façades in such a way that they have this optimum orientation toward the sun. In order to further optimize the efficiency here, solar energy generation plants are also known, which are actively tracked to the course of the sun, in order to ensure an optimum orientation toward the sun at nearly every time of day.

[0006] However, it is problematic in the case of such solar energy generation modules which are mounted elevated, i.e., inclined to the horizontal on one side to the south or north depending on the use on the southern or northern hemisphere, that modules arranged in a composite lose efficiency due to mutual shadowing. Sufficient distances to keep this shadowing as slight as possible are absolutely necessary here.

[0007] In this regard, German Utility Model DE 90 10 696 U1 proposes, to achieve better utilization of the sunlight incident on the solar modules in the case of collector surfaces arranged adjacent to one another, using reflection surfaces which are capable of deflecting components of the incident light onto the solar modules. However, the component usable for solar energy generation per unit of area is also reduced here, so that the overall efficiency sinks.

[0008] German Utility Model DE 20 2006 020 180 U1 and corresponding U.S. Patent Application Publication No. 2010/0000165 A1 also propose such a solution, solar and reflection surfaces which are alternately inclined toward one another being used in the arrangement of solar modules as a solar roof. These reflection surfaces also reflect sunlight onto the solar modules here. The overall efficiency is correspondingly low, as above.

[0009] In addition, the attempt is made in all of the above-mentioned arrangements to optimize the output of the solar modules by optimum orientation toward the sun and an inclination by 25°. However, in addition to the shadowing problems, such a structure also has disadvantages with respect to its static resistance capability, in particular in the case of strong occurring wind loads, such structures requiring a very complex and costly static reinforcement.

SUMMARY OF THE INVENTION

[0010] The object of the present invention is therefore to offer a solar module arrangement or a roof arrangement making use of such solar module arrangements, which has an improved overall efficiency with respect to the self-cleaning, the efficiency, and in consideration of the installation costs in relation to the static resistance capability and in particular the static resistance capability against wind loads.

[0011] Overall efficiency is understood here, in particular, as the economic efficiency in consideration of all above-mentioned factors.

[0012] This object is achieved by a solar module arrangement as described herein.

[0013] In particular, this object is therefore achieved by a solar module arrangement for solar-thermal and/or photovoltaic energy generation, in particular, comprising a solar module arrangement for solar-thermal and/or photovoltaic energy generation, in particular, comprising at least three solar module elements, which are arranged in an essentially horizontal, planar composite and are each inclined relative to horizontal with respect to one another in such a manner that a peripheral lateral border of the solar module arrangement is lower or higher relative to horizontal than an essentially middle central area.

[0014] Furthermore, this object is achieved by a roof arrangement having a plurality of the above-mentioned solar module arrangements, the solar module arrangements being arranged to form a roof arrangement via parts of the lateral borders of adjacent solar module arrangements which run essentially parallel to one another.

[0015] The term solar module element is understood in the scope of this application as any element for solar-thermal and/or photovoltaic energy generation. Therefore, it also comprises the combination modules known from the prior art.

[0016] An essential point of the solar module arrangement according to the invention is that, through the arrangement of the individual solar module elements to form a composite having a peripheral lateral border area which is elevated or depressed in relation to the middle central area, arrangements result which have an optimum overall efficiency in consideration of all factors relevant for the implementation of the above solar module arrangements. In particular in tropical latitudes, this effect has proven to be particularly serious.

[0017] In the case of a solar module arrangement whose peripheral lateral border is higher than the essentially middle central area, a depression or shell essentially results geometrically, whose efficiency remains essentially constant with respect to its geographical orientation. Studies in this regard have shown that, in particular in tropical latitudes, essentially an efficiency deviation of 1% exists as a function of the orientation, i.e., for example, between a north-south and east-west orientation. This means that almost no restrictions are predefined with respect to the installation planning, so that even in the case of installation surfaces which offer bad conditions with respect to their location and local conditions upon the use of solar modules according to the prior art, the solar module arrangements or roof arrangement according to the invention are installable without problems. In comparison to solar modules oriented “optimally” to the north or south, the efficiency is only slightly reduced, these efficiency losses being well compensated for by the further accompanying advantages of the solar module arrangement or roof arrangement according to the invention.

[0018] The solar module arrangement or roof arrangement according to the invention thus allows nearly complete coverage of the space available for the installation. The ratio of energetically active surface to used installation surface of the solar module arrangement or roof arrangement according to the invention is practically one. While shadow-related minimum distances between the individual modules significantly reduce the degree of surface usage in the case of systems up to this point, the built-over surface is optimally utilized according to the invention here. The solar module arrangements according to the invention may thus be installed directly adjacent to one another arbitrarily, often, without shadowing the respective adjacent solar module arrangements, and therefore, impairing the energy generation thereof, reliable self-cleaning of the solar module elements nonetheless remaining ensured in particular. The energy generation, in contrast to typical systems having solar thermal or photovoltaic modules installed elevated on one side, is independent of the distance of the adjacent module, which also significantly increases the planning possibilities.

[0019] In addition, in the case of the roof arrangement mentioned at the beginning employing the solar module arrangements according to the invention, a very statically stable geometry results, whose production costs are significantly less than the production costs for the solar roofs known from the prior art. In particular in geographic areas in which high wind loads are to be expected, such an arrangement, which is characterized in particular by a reduced inclination of the solar module elements, represents an optimum structure, since the static reinforcing measures for dissipating the wind loads are significantly reduced and the costs may thus be decreased immensely. The tropics are also an optimum usage region here because of the cyclones, hurricanes, and typhoons which occur very frequently in these regions. However, this positive effect is also significant in other latitudes.

[0020] If multiple solar module arrangements according to the invention are connected to form a roof arrangement via connection of the parts of the lateral border areas of adjacent solar module arrangements, which run essentially parallel to one another, an economically optimized structure therefore also results for large surfaces, which offers decisive energetic and also static advantages in particular because of the discontinuous surface development.

[0021] Depending on whether the solar module arrangements have lower or higher lateral borders relative to the middle central area, a roof arrangement results in which the respective solar module arrangements, having their solar module elements arranged in a composite, form roof arrangement depressions or roof arrangement peaks. These differences will be discussed in greater detail hereafter.

[0022] The solar module elements are preferably implemented as essentially rectangular solar module elements and are also arranged in an essentially rectangular 2×2 matrix, and in particular, in the form of a helm roof or inverted roof.

[0023] A helm roof or helm roof arrangement is understood in the context of this application as the typical design from the prior art for a roof arrangement having a rectangular projection surface, having four gables, on which further essentially identical "four-gable roofs" adjoin in the case of a corresponding helm roof arrangement. The term rhomboid roof arrangement is also typical in the prior art for such a helm roof arrangement. Of course, such a helm roof arrangement only results when the solar module arrangements arranged according to the helm roof arrangement also have a rectangular projection surface. In the case of a projection surface differing therefrom, for example, a triangular projection surface, a sequence of pyramidal roof arrangements results, the definition roof arrangement also comprising all corresponding roof arrangements which are discontinuous with respect to their surface development here.

[0024] The term "rectangular 2×2 matrix" essentially relates here to the projection surface of the resulting solar module arrangement. Such a rectangular solar module arrangement allows the combination of multiple solar module arrangements to form a large-area roof arrangement or helm roof arrangement cost-effectively, a decisive cost factor here being the rectangular production of the individual solar module elements. Of course, it is instead also possible, as already noted at the beginning, to form solar module arrangements from solar module elements having different geometric shapes, for example, by a composite of three triangular solar module elements or by the combination of differently shaped solar module elements. Optimization can be performed as needed here as a function of the geographic usage region and the available installation surface. Of course, it is also possible, instead of implementing continuous solar module elements to form the solar module arrangements, to also implement the solar module elements from individual solar modules which are also arranged in a composite, and which are grouped as the solar module elements. This has advantages in particular with respect to the production, the transport, and the ventilation of the solar module arrangements.

[0025] In the case of rectangular solar module elements which are connected to form the solar module arrangement according to the invention, the rectangular solar module elements are inclined relative to one another around an axis which is nonparallel in each case to their lateral edge, and in particular, around a diagonal axis running essentially diagonally. Through this inclination, a solar module arrangement results in a very simple way having a peripheral lateral border area lying elevated or lowered in relation to the middle central area. The inclination of the rectangular solar module elements around an axis which does not run coaxially, but rather axially-parallel to the diagonal axis, i.e., is arranged somewhat offset thereto, allows the arrangement of the inclined solar module elements in the solar module arrangement, without the solar module elements touching at their lateral border, inter alia, an optimum surface utilization thus being achievable per unit of area.

[0026] The angle of inclination of each solar module element in the direction of the middle central area is preferably essentially between 5° and 25°, in particular 15°, or −5° and −25°, in particular −15°. Such an inclination of the individual solar module elements has an optimum overall efficiency in their composite as the solar module arrangement and in consideration of possible wind loads to be dissipated. In particular, such an inclination takes the self-cleaning of the solar module elements into consideration, which has a decisive influence on the efficiency of a corresponding energy generation plant, since the soiling of the solar module elements is known to cause significant efficiency losses over time. In geographic latitudes in which snow or ice covering is to be expected, a reduction of the efficiency can thus also be avoided. In general, it is possible in this context, of course, to assign a different inclination to each individual solar module element within the solar module arrangement and in particular as a function of the geographic location, and thus, to optimize the energy generation. In association with this varying inclination, it is possible to adapt the lengths or widths of each solar module element accordingly, in order to minimize shadowing in particular. The result would be a solar module arrangement whose middle central area is arranged "shifted", similarly to an "offset" focal point of a parabola section. Of course, the entire solar module arrangement can also be inclined, if the boundary conditions at the installation location allow it.

[0027] The solar module arrangement preferably has at least one inclination control element to adjust the inclination angle of at least one solar module element. Such an inclination control element can be both a passive and also an active inclination control element, i.e., adjustable using a positioning motor. The change of the inclination offers, on the one hand, the possibility of optimizing the energy introduction and, on the other hand, taking occurring soiling or occurring wind loads into consideration. The inclination can thus be increased in the case of strong soiling and a strengthened cleaning effect can thus be achieved. For example, if it is established over a specific period of time that the solar module arrangement is soiled, this soiling can be counteracted via a changed inclination of the individual solar module elements.

[0028] The inclination control element preferably has a communication connection to at least one sensor element, in particular a precipitation sensor, an energy output sensor, a time encoder, or a light sensor, so that the adjustment of the inclination angle can be regulated as a function of at least one item of detected sensor information. The inclination control element is preferably implemented in such a way that the inclination angle of at least one solar module element is adjustable between a production or day position, having an optimum inclination angle for energy generation in particular, and a night and/or precipitation position, having a greater inclination angle, which is optimal for self-cleaning in particular.

[0029] Since solar modules are well known to only be energetically active during the daytime, it is possible to adjust the solar module arrangement between a day position and a night position, the inclination being increased in the night position, in order to improve the cleaning of the modules in the case of precipitation. In the day position, the inclination can be reduced to an optimum minimal inclination (in tropical latitudes approximately 0°) in order to optimize their energy output. In this context, timers or also light or output sensors may initiate the required regulation. Such a regulation is also possible, of course, as a function of occurring precipitation phases, during which the solar module arrangement or the individual solar module elements may be adjusted into a precipitation position having increased inclination. The use of corresponding precipitation sensors is conceivable here, for example, which allow automatic regulation of the inclination. Such a principle is fundamentally applicable to nearly all other types of solar module arrangements.

[0030] A ventilation free space, and in particular, a ventilation gap is preferably arranged between the solar module elements arranged in the composite. This ventilation gap takes air circulation between the bottom side and the top side of the solar module arrangement into consideration, and thus, results in cooling of the individual solar module elements. This cooling of the solar module elements has a significant effect on the efficiency, solar module elements having a lower temperature typically having better efficiency than heated solar module elements. Efficiency differences of up to 5% have been observed here in the case of a temperature difference of 10 K.

[0031] The ventilation free spaces, and in particular, ventilation gaps, which are provided between the individual solar module elements and naturally also between the adjacent solar module arrangements of the roof are arrangement according to the invention, additionally ensure that if wind loads occur, the pressure differences on the top side and a bottom side of the respective modules and elements are reduced, which in turn relieves the structure and thus results in significant cost savings.

[0032] The ventilation free space or ventilation gap can additionally be used simultaneously as a drain for occurring precipitation water, and thus, also for removing contaminants.

[0033] The ventilation free space preferably has a water drain element for this purpose, in particular on the solar module bottom side, which collects or drains water which has penetrated via the top side of the solar module arrangement and via the ventilation free space. It is preferably to be ensured here that the air circulation between bottom side and top side of the solar module arrangement is impaired only slightly or not at all by the arrangement of the water drain element. Of course, these water drain elements may additionally also adopt the function of supply units, i.e., for example, for guiding the feed and drain lines of the individual solar module elements.

[0034] In this context, it is additionally possible to situate corresponding evaporation devices on the solar module bottom side, and in particular, in the area of the ventilation free space, which are fed in particular by the water supply unit or directly by the individual solar module elements, and which cool the solar module arrangement by the evaporation of the water, which is collected in particular during a precipitation phase. Water-storing tiles, mats, etc. may be used here, for example, which are arranged on the bottom side of the solar module arrangement, in particular spaced apart therefrom. Air which passes over these mats is preferably guided via flow-guiding units along the bottom side of the solar module elements, so that the modules are effectively cooled. Of course, the evaporation device can also be actively supplied in this context, for example, via a water feed line. Such a device is also fundamentally applicable in any type of solar module.

[0035] Preferably, at least one solar module element, and in particular, the solar module element which is irradiated least by the sun as a function of the geographical orientation of the solar module arrangement, at least partially has a reflector surface, a transparent surface, or a similar surface which differs from the surfaces of the other solar module elements. The use of a reflector surface can increase the energy output in the other adjacent solar module elements depending on the geographic latitude, so that the overall efficiency of the solar module arrangement rises. In contrast, the use of a transparent surface allows the illumination of the space lying underneath.

[0036] The solar module elements are preferably implemented as static self-supporting elements and are connected to one another so they are statically stable by connection units and in particular are linked to one another so they are pivotable. In the case of such an embodiment, the solar module arrangement formed from the statically stable solar module elements can therefore be installed nearly without a substructure, for example, as a roof surface, the connection units on the solar module elements preferably being implemented as complementary here in such a way that the solar module elements can be arranged to form the solar module arrangements similarly to a building block principle. All connection units known from the prior art are applicable here. Such a design also applies for the arrangement of the solar module arrangements to form the roof arrangement according to the invention.

[0037] The solar module arrangement and/or each solar module element preferably has a peripheral support frame in particular, into which the solar module elements are insertable or inserted or via which the solar module elements are connectable to one another. Such a support frame allows the arrangement of multiple solar module arrangements to form large roof arrangements or surfaces and, in addition, the simple replacement of defective solar module elements.

[0038] Fundamentally, both an embodiment having statically stable solar module elements, which are connected to one another in a statically stable way via connection elements, and also the embodiment of the solar module arrangement via a particularly peripheral support frame can be industrially prefinished, so that the individual components are connectable to one another cost-effectively and rapidly at the construction site.

[0039] Of course, the solar module arrangement according to the invention can also be arranged on typical roof substructures, which then preferably already predefine the geometry of the solar module arrangements or the roof arrangement.

[0040] If a support frame is used, the solar module elements are preferably mounted so they are pivotable in support frames, so that an inclination adaptation is easily possible.

[0041] Fundamentally, the roof arrangement according to the invention, comprises a plurality of solar module arrangements, has a three-dimensional structure, which stabilizes it very much better than large-area, flat systems. Simultaneously, it has a relatively small front face, which makes it easier to use the roof arrangement for roofing in windy regions, while typical elevated systems are extraordinarily problematic in the case of high wind loads.

[0042] Studies have shown that the roof arrangement according to the invention has an extraordinarily high-performance in comparison to elevated systems known from the prior art. In the case of a simulated installation in tropical latitudes, and in particular, at a geographic location of 60° east/15° south, the solar module arrangement or roof arrangement according to the invention only displays losses in the yearly output in the magnitude of approximately 10% in the case of an inclination of the individual solar elements by 15°. In the case of 10° inclination of the modules, the relative yearly losses are decreased to approximately 8%. Through the optimum adaptation to the self-cleaning conditions, the significantly reduced static requirements, and in particular, in the case of usage as roofing, due to the extraordinarily advantageous cost structuring, these losses are not reflected negatively in the pure energy generation so that, in comparison to typical systems, a positive benefit balance and improved overall efficiency nonetheless result.

[0043] The invention is described hereafter on the basis of exemplary embodiments, which are explained in greater detail with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0044] FIG. **1** is an isometric view of a first embodiment of a solar module arrangement;

[0045] FIG. **2** is a top view of the solar module arrangement shown in FIG. **1**;

[0046] FIG. **3** is a cross-sectional view through the solar module arrangement from FIG. **1**;

[0047] FIG. **4** shows a longitudinal section through the solar module arrangement from FIG. **1**;

[0048] FIG. **5** shows a second embodiment of the solar module arrangement;

[0049] FIG. **6** shows a first embodiment of a roof arrangement according to the invention;

[0050] FIG. **7** shows a second embodiment of the roof arrangement according to the invention;

[0051] FIG. **8** shows a third embodiment of the roof arrangement according to the invention;

[0052] FIG. **9** is a transverse cross-sectional view of a fourth embodiment of the roof arrangement according to the invention; and

[0053] FIG. **10** is a longitudinal sectional view of the roof arrangement from FIG. **9**.

DETAILED DESCRIPTION OF THE INVENTION

[0054] The same reference numerals are used hereafter for identical and identically acting components, apostrophes and quote marks sometimes being used.

[0055] FIG. **1** perspective view of a first embodiment of the solar module arrangement **1** according to the invention. It comprises four solar module elements **2**, **2'**, **2"**, **2'''** which are arranged in an essentially horizontal, flat composite and are each inclined relative to a horizontal plane H and relative to one another by an inclination angle α in such a way that a peripheral lateral border **4** of the solar module arrangement **1** is higher relative to the horizontal plane H than an essentially middle central area **6**.

[0056] In the following explanations, reference is made to FIGS. **1** to **4**. The solar module arrangement **1** comprises, as noted, four solar module elements **2** in this embodiment, which are all implemented as rectangular solar module elements **2**. To form the solar module arrangement **1**, these solar module elements **2** are arranged via their lateral borders **3** in a 2×2 matrix. The resulting solar module arrangement **1** is thus also rectangular at least in its projection relative to the plane H.

[0057] Each individual solar module element **2** is inclined around an axis A in the direction of the middle central area **6**, so that the form of an inverted helm roof **10** results for the solar module arrangement **1**.

[0058] The respective axis A around which the solar module elements **2** are inclined runs nonparallel to the lateral borders **4**, and in this embodiment, axially-parallel to the respective diagonal axis A_D and offset in the direction of the middle central area **6**.

[0059] The inclination angle α by which the respective solar module elements **2** are inclined in relation to the horizontal plane H in the direction of the middle central area **6** is essentially 15° in this embodiment. Such an inclination has had a very positive effect with respect to the overall efficiency, inter alia, because of the self-cleaning effect and the static resistance capability of the solar module arrangement **1**.

[0060] Because of the two-axis inclination, namely around an axis parallel to the transverse axis A_Q and around an axis parallel to the longitudinal axis A_L, the inclination angles α_Q and α_L shown in FIGS. **3** and **4** result for the total inclination angle α of each solar element **2**.

[0061] In order to achieve an optimization with respect to the efficiency, the self-cleaning, or also a reduction of the wind loads to be dissipated during operation of the solar module arrangement **1**, it is possible to adapt the individual solar module elements **2** in their inclinations α, α_Q, and α_L via the inclination control elements **8** shown in FIGS. **3** and **4**. For example, if it proves at a starting angle α of 10°, for example, that the solar module arrangement tends to be soiled quickly, the angle α can be increased by activation of the inclination control element **8** and the self-cleaning can thus be improved. The mentioned inclination control elements **8** may be both active inclination control elements, for example, activatable via a wired control unit, for example, or also elements which are manually lockable via screw connections.

[0062] Ventilation free spaces **12** are arranged between the individual solar module elements **2** arranged in the solar module arrangement **1**, as is clearly recognizable in FIG. **2** in particular, which are implemented as increasing from the lateral borders **4** toward the middle central area **6** because of geometric boundary conditions and resulting from the inclination of the respective solar module elements **2**. These ventilation free spaces **12** fulfill multiple functions. Thus, they allow air circulation between the bottom side **14** and the top side **15** of the solar module arrangement **1**, so that the individual solar module elements **2** are cooled. This contributes to improving the energetic efficiency.

[0063] In addition, of course, the free spaces or gaps **12** for ventilation reduce the wind pressure loads acting on the solar module arrangement **1**, so that smaller static demands may be placed on the design here.

[0064] Finally, the ventilation free spaces **12** also allow the drainage of precipitation water which hits the top side **15** of the solar module arrangement **1** or the solar module elements **2**. Because of the inclination of the solar module elements, this precipitation water runs into the ventilation free spaces or gap **12**, which advantageously increase in the direction of the central area **6** for this purpose, where it is then either drained via water guiding units **16** (see, FIG. **5**) or simply drips off of the solar module arrangement **1** onto the floor lying underneath. Of course, it is also possible in this context to seal the transition areas between the individual solar module elements **2** fluid-tight and only situate a corresponding water drain unit in the middle central area **6**.

[0065] For static stabilization of the solar module arrangement **1**, a support frame **20** runs completely around the solar module arrangement **1** following the geometry of the lateral borders **4**. The solar module elements **2** are fitted in this support frame **20** and are particularly linked thereto so they are pivotable, so that their inclination is changeable via the inclination control elements **8**. Of course, it is also possible in this context to use substructures known from the prior art instead of a support frame **20**, on which the solar module elements **2** are mounted.

[0066] FIG. **5** shows a second embodiment of the solar module arrangement **1**, which differs from the above-described embodiment according to FIGS. **1** to **4** essentially through the static implementation of the solar module elements **2**. They are implemented here as static self-supporting elements **2** and are connected to the solar module arrangement **1** via connection units **18**, which are also statically stable. Such a structure can therefore be mounted with very little material outlay for the substructure on corresponding mounting surfaces, the installation being significantly simplified in particular by the self-supporting capability of the individual solar module elements **2**.

[0067] In addition, the water drain element **16**, which extends on the solar module bottom side **14** along the ventilation free spaces **12** between the individual solar module elements **2**, is arranged on the bottom side **14** of the solar module arrangement **1** shown here. The water drain element **16** is used, as noted, for draining precipitation water which is supplied from the top side **15** of the solar module elements **2**. So as not to obstruct the above-described air circulation between the bottom side **14** and the top side **15**, the water drain element **16** is spaced apart from the bottom side **14** of the solar module arrangement **1**.

[0068] FIG. **6** shows an embodiment of the roof arrangement **30** according to the invention, in which a total of five solar module arrangements **1** according to FIG. **5** are installed to form a helm roof arrangement. The solar module arrangements **1** are arranged on parts **22** of the lateral borders **4** of the adjacent solar module arrangements **1** running essentially parallel to one another, so that a discontinuous helm roof arrangement essentially running in a "zigzag" results in their surface development. This has an efficiency which is essentially independent of the geographical orientation because of the respective solar module elements **2** inclined toward the middle central area **6**. In addition, the installation of the solar module arrangements **1** according to the invention to form a helm roof arrangement **30** allows an optimum surface exploitation of the surface **40** to be overbuilt, as is recognizable in FIG. **6**.

[0069] FIGS. **7** and **8** schematically show two further embodiments of the roof arrangement **30**, which essentially differ through the implementation of the solar module arrangements **1**.

[0070] The roof arrangement **30** from FIG. **7** is thus formed by four solar module arrangements **1**, which are arranged on adjacent parts **22** of the border areas **4**. The solar module arrangements **1** used here are implemented in such a way that the peripheral lateral border **4** of the solar module arrangement **1** is higher in relation to the horizontal plane H (see, FIG. **1**) than the essentially middle central area **6**. The respective inclination of the solar module elements **2** is shown in both FIGS. **7** and **8** by arrows, the arrow points each indicating the gradient direction.

[0071] In the embodiment shown in FIG. **8**, the roof arrangement **30** is formed by a solar module arrangement **1** whose lateral border **4** lies lower in relation to the horizontal plane H (see FIG. **1**) than the essentially middle central area **6**. Further correspondingly implemented solar module arrangements **1'**, **1"** (only partially shown here) each adjoin this solar module arrangement **1**, which is shown in the middle here. As a result, identity therefore results for the geometry of the helm roof arrangement in the embodiments from FIGS. **7** and **8**, the structure only making use in each case of differently implemented solar module arrangements **1**.

[0072] FIGS. **9** and **10** show a fourth embodiment of the roof arrangement **30** according to the invention in transverse and longitudinal cross-sectional views, respectively. A water drain element **16** is also arranged on the bottom side **14** of the solar module bottom **14**, here, into which precipitation water can run via the ventilation free space or gap **12**. An evaporation unit **24**, which is implemented here as a water-storing tile, is arranged inside the water drain element. The water stored in the tile evaporates successively after a precipitation phase, whereby energy is withdrawn from the air which flows from the bottom side **14** to the top side **15**, which results in cooling of the solar module arrangement **1**. In order to channel this cooled air stream, flow-guiding elements **25** are arranged above the evaporation unit **24**.

[0073] The inclination adjustment of the individual solar module elements **2** is also performed here via inclination control elements **8**, which are arranged in this embodiment on corresponding diagonal supports **44** attached to a middle support **42** in this embodiment, however. These supports **44** are simultaneously used as load-bearing supports for the protruding solar module elements **2**.

1-14. (canceled)

15. A solar module arrangement, comprising:

at least three solar module elements which are arranged into a unit in which each solar module element is inclined relative to a horizontal plane and relative to one another in such a manner that a peripheral lateral border of the solar module arrangement lies at a different height than said horizontal plane and than a middle central area of the unit constituted by the at least three solar module elements.

16. The solar module arrangement according to claim **15**, wherein said at least three essentially rectangular solar module elements comprise four essentially rectangular solar module elements and the unit formed thereof is an essentially rectangular 2×2 matrix.

17. The solar module arrangement according to claim **16**, wherein said unit is in the form of a helm roof or inverted helm roof.

18. The solar module arrangement according to claim **16**, wherein the rectangular solar module elements are inclined relative to one another around an axis nonparallel to each of their lateral edges around an essentially diagonally running diagonal axis or an axis offset axially-parallel thereto.

19. The solar module arrangement according to claim **15**, wherein the inclination angles of the solar module elements in the direction of the middle central area are essentially between 5° and 25°.

20. The solar module arrangement according to claim **15**, wherein the inclination angles of the solar module elements in the direction of the middle central area are 15°.

21. The solar module arrangement according to claim **18**, wherein at least one inclination control element for adjusting the inclination angle of at least one of solar module elements is provided.

22. The solar module arrangement according to claim **18**, wherein at least one inclination control element for adjusting the inclination angle of the solar module arrangement is provided.

23. The solar module arrangement according to claim **21**, wherein the inclination control element has a communication connection to at least one sensor element for adjustment of the inclination angle as a function of at least one item of detected sensor information.

24. The solar module arrangement according to claim **23**, wherein the at least one sensor element is one of a precipitation sensor, an energy output sensor, a time encoder, and a light sensor.

25. The solar module arrangement according to claim **21**, wherein the inclination control element is adapted to adjust the inclination angle of said at least one solar module element between a day position having an inclination angle for energy generation, and a night or precipitation position having a greater inclination angle for self-cleaning of said at least one solar module element.

26. The solar module arrangement according to claim **15**, wherein a ventilation free space or gap is arranged between the solar module elements.

27. The solar module arrangement according to claim **26**, wherein a water drain element is arranged in the area of the ventilation free space or gap on a bottom side the solar module arrangement.

28. The solar module arrangement according to claim **27**, wherein an evaporation device which is fed by the water drain element is provided on the bottom side of the solar module arrangement in the area of the ventilation free space or gap.

29. The solar module arrangement according to claim **15**, wherein a one of the solar module elements which is positioned so as to receive less solar radiation than the other solar module elements as a function of the geographical orientation of the solar module arrangement has at least one of an at least partially reflective surface, a transparent surface, or other surface differing from the surfaces of the other solar module elements.

30. The solar module arrangement according to claim **15**, wherein the solar module elements are statically self-supporting elements and are connected to one another in a statically stable manner by connection units.

31. The solar module arrangement according to claim **30**, wherein the connection units are pivotable links.

32. The solar module arrangement according to claim **15**, further comprising a peripheral support frame into which the solar module elements are inserted to form the solar module arrangement.

33. A roof arrangement having a plurality of solar module arrangements comprising at least one solar module arrangement having four essentially rectangular solar module elements which are arranged into a unit formed as an essentially rectangular 2×2 matrix in which each solar module element is inclined relative to a horizontal plane and relative to one another in such a manner that a peripheral lateral border of the solar module arrangement lies at a different height than said horizontal plane and than a middle central area of the unit constituted by the at least three solar module elements, and wherein one of additional solar module arrangements and additional essentially rectangular solar module elements are positioned adjacent to and parallel to at least plural sides of the solar module arrangement to form a roof arrangement.

34. A roof arrangement according to claim **33**, where the roof arrangement is a helm roof arrangement.

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