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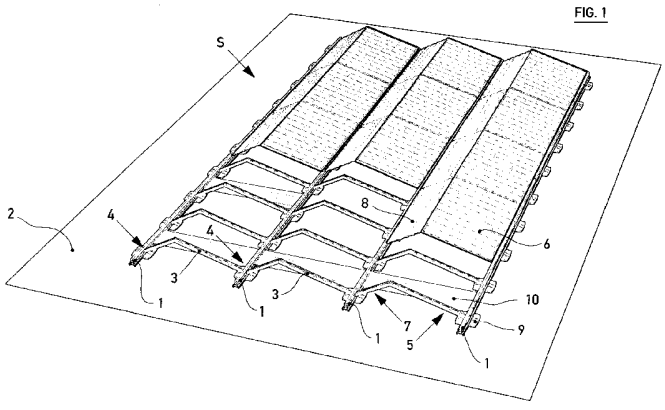
(54) **Title**: SOLAR PANEL SYSTEM, AND PROFILE MOUNTING ASSEMBLY AND METHOD OF MOUNTING FOR SUCH A SYSTEM

FIG. 1



(57) **Abstract**: Solar panel system for a flat roof, with three or more base profiles arranged on or near said flat roof parallel to each other, two or more carrier profiles, perpendicular to the base profiles and extending from a first to a second one of the base profiles and from a second to a third one of the base profiles, at least one photovoltaic solar panel, mounted on at least one carrier profile, with the solar panel inclined to the flat roof, at least two interconnections, one between said second base profile and an end of one of said two carrier profiles and another interconnection between said second base profile and an end of the other of said two carrier profiles, wherein each of said interconnections fastens the second base profile to an end of the respective carrier profile with means that are capable of preventing a) relative rotation between the second base profile and the respective carrier profile about an axis parallel to the longitudinal axis of the base profile and b) translation between the second base profile and the respective carrier profile.

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Solar panel system, and profile mounting assembly and method of mounting for such a system

The invention relates to a solar panel system for a flat roof and to a profile mounting assembly for use in such a solar panel system as well as to a method of mounting such a solar panel system.

Solar panel systems for a roof, such as a flat roof, are nowadays increasingly in demand, as a result of an increasing need for sustainable energy such as electrical energy generated by photovoltaic cells.

Such a photovoltaic solar panel system is often positioned on a flat, or nearly flat roof, with the solar panels at an inclination relative to the roof and at an orientation facing south when possible. In most cases, multiple parallel rows of solar panels are positioned behind each other, at equal distances chosen in such a way that the rows of solar panels do not cast too much shadow onto each other while still maintaining a relatively dense packing of solar panels on the roof.

One of the requirements for such systems is that they are wind-resistant; even in weather conditions of high wind velocities at the roof level, the solar panels need to remain in place on the roof without being lifted, tilted, shifted or even blown away. This requirement may be met by fixing the system to the roof, but this solution introduces potential damage to the roof, with the possibility of leakage, and is laborious. Another common solution lies in the creation of a construction too heavy to be blown away. However, many modern roofs using profiled steel sheets or light weight sandwich panels have a very limited load capacity. Therefore the challenge is to construct the system in such a way that it is wind-resistant at only a low total weight to be added onto the roof.

A known solution for lightweight flat roofs consists of a system that has a construction comprising a plurality of parallel beams or profiles and a second plurality of parallel beams or profiles fixed perpendicular to the first plurality; thus, a kind of matrix is constructed. Often in these solutions, the required inclination of the solar panels is realised by additional profiles or triangular shaped sub-constructions to support the solar panels. The beams in the matrix have a relatively high bending stiffness and stretch across several solar panels. As a result, the system is stable in comparison with systems in which the solar panels are connected in a looser manner or where the solar panels are not interconnected at all. A matrix construction helps to distribute wind loads over the construction and it prevents individual solar panels to be lifted or shifted and to tip over. This makes such a construction capable of withstanding higher wind velocities with a lower overall weight load onto the roof, thus reducing the need to add additional ballast.

One such a known relatively lightweight and freestanding system on the market is produced by Schueco in Germany under the name of ezFlatRoof 2.0 Mounting System. However, the described solution has the disadvantage that it consists of many different parts and connections to be made during installation, and is therefore costly. Additionally, in many matrix-based systems such as that of Schueco, the first plurality of parallel beams rests directly on top of the roof, therefore blocking the free flow of water over the roof. During heavy rainfall, large amounts of water may accumulate between the beams without the possibility to flow away to lower areas. The access weight of this water may form a serious threat to the weight-carrying capacity of the roof.

A second known relatively lightweight and freestanding system is produced by HB Solar in Germany under the name of Scirocco. In this system, wind diversion plates, are mounted at an elevated backside of the solar panels, to prevent that

wind reaches the bottom side of the solar panels and causes them to tip over. However, in this system the wind diversion plate at the back side of the solar panel has a much steeper inclination angle relative to the roof than the solar panel itself, with as a result that wind coming from the back side of the solar panel will still push the solar panel away relatively easy. It may be argued that when wind diversion plates are to be used in a system, their inclination angle should match the inclination angle of the solar panels as close as possible, in order to prevent the introduction of asymmetry in the wind-sensitivity of the system.

The present invention has as a goal to provide a solar panel system for a flat roof and with photovoltaic cells that has a low roof load, is at least as stable with respect to wind as the systems described above and additionally offers reduced costs and/or increased convenience of installation.

The invention realizes this goal by a solar panel system according to claim 1.

As a result of the matrix-like arrangement of the profiles and the presence of interconnections that provide stiffness to the arrangement, the stability (in terms of lifting, shifting and tipping over in strong winds) of known systems with a matrix structure is maintained.

The specific layout of the system according to the invention allows for a mounting method that requires only little effort. Such a mounting method may, for instance, be as follows.

As a first step, the base profiles, factory pre-fitted with at least two feet per profile, are put on the roof, parallel to each other at roughly the required distance. Multiple base profiles may be connected to each other to extend the length of one profile row to the required row length of the solar panel system.

Then, as a second step, the carrier profiles, factory-made to a length exactly right to span the required distance

between two rows of base profiles, can be easily positioned and then fixed to the base profiles present. The carrier profiles thereby serve to finalise, or fine-adjust, the required distance between the base profiles in a convenient manner. The carrier profiles are shaped in such a way that they can be positioned between the base profiles from above, meaning that if already two or more carrier profiles are connected to base profiles, the next carrier profiles can still be added easily.

A further advantage of the system according to the invention is that less material and less installation labour are required compared to traditional matrix-based systems. This results from the fact that no additional supports are needed for mounting the solar panels and wind diversion plates since these are mounted directly on the carrier profiles. The carrier profiles fulfil multiple functions at once: carrying the solar panels and wind diversion plates, being part of the stable construction (i.e., the matrix) and setting the right distance between the base profiles.

It will be clear to persons skilled in the art that 'means that prevent relative rotation between the base profile and the respective carrier profile' refers to constructive elements capable of transferring a bending force from the base profile to the carrier profile. For instance, two surfaces bearing against each other and pulled towards each other by means of a simple hook and lip or nuts and bolts are capable of fulfilling this function. It will also be clear that 'profile' refers to an elongated constructive element, possibly hollow, with a high bending stiffness in relation to its weight. Finally, it is noted that in the present application the term 'perpendicular' refers not only to an angle of exactly 90 degrees but also to slightly deviating angles, such as, for example, 87 or 92 degrees.

Beneficial embodiments of the invention are defined in the sub claims 2 through 10. These are directed at even more

convenient mounting or improved stability in strong wind conditions. Additionally, the feet will ensure the free flow of water over the roof under the entire system, with as a result reduced risk of a roof collapsing under the weight of rain water or melting water. The feet, especially when made of relatively soft material such as thermoplastic material, will also prevent damage of the roof as could occur when metal profiles would be placed directly on the roof. They may also be used as guides for the exact position where the carrier profiles are to be connected to the base profiles, thus preventing the need for measurements or calculations to be made on the roof and thus further increasing the ease of mounting. Finally, the feet, when made of material with a high friction coefficient, will provide added resistance against translational movement of the system over the roof under strong winds.

The invention also concerns a profile mounting assembly according to claim 11. This assembly provides a perpendicular connection between two profiles that is rigid, especially prevents relative rotation and translation between the two profiles. Additionally, this assembly can be supplied to the installation with all required parts for the connection, including bolts, already pre-fitted in the factory. In other words, it enables the realization of a system according to claims 1-10. It should be noted that one interpretation of the phrase ‘a hook slidably mounted to the second profile...’ is that said hook lies within the perimeter of a hollow second profile; other interpretations are possible, however.

Further beneficial embodiments of the profile mounting assembly are defined in claims 12 through 14. These offer increased comfort of mounting.

Finally, the invention relates to a method of mounting according to the claim 15. When a system according to the invention is mounted according to this method, the mounting required relatively little effort, thereby enabling increased

mounting time efficiency.

The invention will now be clarified on the basis of a preferred embodiment, referring to the accompanying drawings and solely as an illustration of the invention and not in limitation thereof. In the drawings:

- Figure 1 shows a perspective view of a solar panel system according to the invention, with the solar panels and wind diversion plates partly removed for the sake of clarity,
- Figure 2a shows a longitudinal section of a carrier profile in an unmounted position, with the hook retracted within the perimeter of the profile,
- Figure 2b shows a cross-section A-A of the carrier profile and hook in Figure 2a, and
- Figure 2c shows a cross-section of a base profile with two carrier profiles mounted on opposite sides of the base profile.

In Figure 1, a system S according to the invention has four base profiles 1 arranged parallel and at equal distances on a flat roof 2, a number of carrier profiles 3, arranged perpendicular to and between the base profiles 1. In Figure 1, for the sake of clarity only two of the carrier profiles are indicated by a reference number; this also holds for some other components of the system shown in the drawings. At their ends, the carrier profiles 3 are fastened to base profiles, near the roof, by means of interconnections 4.

Each of the carrier profiles 3 has a first inclined section 5, with respect to the horizontal, on which a photovoltaic solar panel 6 is mounted. The carrier profiles contain longitudinal grooves where known mounting clamps can slide in and be fixed onto in such a way that variations in the size of the solar modules (e.g. between various solar panel brands and makes) can be compensated for. The mounting clamps for the solar panels are not shown. Each solar panel 6 is carried by two adjacent carrier profiles 3 at a mutual distance of about half the width of the solar panel at

positions at about one-quarter from the edges of the solar panel. In an alternative embodiment of the invention (not shown), the solar panels are carried by carrier profiles positioned in the area between two solar panels, reducing the total number of required carrier profiles to an average of about one per solar panel.

The base profiles have a length that is at least the width of one solar panel, possibly longer, or may have a length that is independent of the solar panel dimensions. A small dilation spacing is left between each two subsequent base profiles (not shown).

Each interconnection 4 fastens a carrier profile 3 to a base profile 1, in such a manner that the carrier profile 3 cannot rotate or move relative to the base profile 1 about any axis parallel to the longitudinal axis of the base profile. This rotation- and movement-preventing function of the interconnections enables the creation of a highly stable solar panel system S, that will not be affected by wind forces, even in extreme wind conditions.

The carrier profiles 3 have a second inclined section 7 of which the inclination is opposite to that of the first inclined section 5 and serves to carry wind diversion plates 8. In the shown embodiment, the angle of inclination of the second inclined section (for the wind diversion plates) is as low as is possible given the row spacing of the solar panels, thus matching the solar shading angle between two rows of solar panels as close as possible, based on the assumption that the lower the wind diversion plate inclination angle is, the less force the wind will exert on the system.

In the system S, some spacing is left between the wind diversion plates and the solar panels, in order to allow for ventilation of the backside of the solar panels; this serves the electricity production efficiency of the photovoltaic cells in the solar panels.

Each carrier profile is made of at least two hollow

aluminium profiles, connected with an angle to each other by means of inserts (not shown). Alternatively, the carrier profiles may be bended out of one piece or may be welded together, etc. Additional provisions may be integrated in or attached to the carrier profiles, such as a cable clamp for the solar panel cables.

The base profiles are also hollow and made of aluminium, and they are factory pre-fitted with injection-moulded plastic feet 9 which may have a bottom of a thermoplastic elastomer (TPE), i.e., a thermoplastic rubber, with an increased friction between the system and the roofing material as result. This increases the stability of the system S on the roof with respect to wind forces.

In the embodiment shown, the solar panels are mounted in landscape orientation, but in a different embodiment they may also be mounted in portrait orientation.

Here, the wind diversion plates 8 span the whole area between two rows of solar panels 6, leaving no gangway. The diversion plates 8 can be made of white-painted sheet metal that reflects sunlight onto the solar panels, leading to an increase of the electricity yield of the solar panels. In an alternative embodiment, not shown, the carrier profiles may have a second bend, with a horizontal section near one of their ends. This allows for a gangway.

The wind diversion plates can be mounted by means of mounting elements (not shown) that can be released quickly and easily should they be removed in case of e.g. servicing or maintenance of the solar panels.

Figure 1 shows that ballast material may be added to the system S when the local wind conditions require so, by positioning sheet metal profiles 10 between (some of) the base profiles 1, and resting on these profiles 1. Ballast material e.g. in the shape of street tiles (not shown) is put on top of these sheet metal profiles 10. Said sheet metal profiles 10 may also serve as an aid in the positioning of

base profiles 1 before the carrier profiles 3 are added.

In Figure 2a and 2b, one end of the carrier profile 3a is shown with hook 11. Each end of the carrier profiles is pre-fitted with such a hook element, made of strong aluminium or stainless steel. This hook has a clearly indicated retracted and extended position: the retracted position (i.e. production-, transport- and pre-mounting position) is with the hook retracted into the carrier profile as shown in figure 2a; the extended position (i.e. the fixed position after mounting) is with the hook locked onto the base profile as shown in figure 2c. The hook is slidable within the perimeter of the carrier profiles from one position to the other and vice versa, resting on profile ribs 12 and 13.

Figure 2c shows two carrier profiles 3a and 3b, supporting a photovoltaic solar panel 6 on its first inclined section 5 and a wind diversion plate 8 on its second inclined section 7, and fastened to a base profile 1 resting on top of a foot 9. The base profile 1 is hollow and made of aluminium, and provided with two vertically downward extending profile lips 14 and 15, part of its two opposite side walls 16 and 17, and extending in their lateral directions along the entire base profile 3 length.

The carrier profiles 3a, 3b have slanted heads on both ends that each rest against a respective side wall 16, 17 of the base profile 1 over a large part of the head surface of the respective carrier profile.

A hook extending from one end of the carrier profile 3a or 3b, such as hook 11, can reach into a matching indentation 18 and 19 of the base profile 1 and engages a respective profile lip 14, 15 of the base profile 1, pulling the heads of the carrier profiles against the wall of the base profile.

The hook 11 is fixed with respect to the carrier profile 3 in either the retracted or the extended position by means of an Allen bolt 20 that is screwed into a threaded hole in the hook and that extends into one of two holes 21

and 22 corresponding with the retracted and extended positions at the bottom of the carrier profile, thus securing the hook into either position. By unscrewing the bolt in the retracted position of the hook, the tip of the bolt comes away from the hole 21, and the hook can then slide downwards over ribs 12 and 13, aided by gravity, with the bolt moving along a slotted hole 23 made in a top wall of the carrier profile.

At the end of this movement, the hook extends beyond the end of the carrier profile and is loosely positioned into indentation 18 or 19 of the base profile.

When the Allen bolt is then tightened again, the hook comes up until it is firmly pulled against the profile lips 14 or 15 of the base profile, which may be wedge-shaped matching the wedge-shaped tip of the hook, helping to pull the carrier profile head against the base profile side wall 16 or 17. Further tightening of the Allen bolt will now screw the tip of the bolt into the end position hole 22 in the bottom of the carrier profile, which will prevent any future sliding movement of the hook in the carrier profile. After final tightening of the Allen bolt, the whole construction is secured rigidly.

As a result of this construction, the carrier profiles cannot rotate or translate in any direction with respect to the base profile; this provides for a stable solar panel system. Moreover, the two clear retracted and extended positions ensure error-free mounting. The retracted position with the hook and bolt assembly completely stowed away in the carrier profiles secures safe transport and avoids the use of loose fixing materials (nuts and bolts) with all their disadvantages (missing items, pieces dropping onto the floor etc.). Finally, because the hooks do not protrude from the carrier profiles in the start position, carrier profiles can be mounted between the base profiles by lowering them from above. They may be mounted one after another even if other

carrier profiles are already into place. It also does not matter which of the two hooks at either end of the carrier profile is secured first.

The combination of a carrier profile 3 and a base profile 1 and a hook 11 fastening said carrier profile and said base profile constitutes a profile mounting assembly according to the invention. The hook 11 and its counterpart on the other end of the carrier profile and profile lips 14, 15 and the parts of the profiles bearing against each other constitute two interconnections 4.

It will be clear to persons skilled in the art that the embodiment of the solar panel system according to the invention as described above and illustrated in the drawings is suitable for repeated application of the method of mounting according to claim 17. This method will therefore not be clarified.

Variants can be made to the embodiments shown, without leaving the scope of the claims. For example, the carrier profiles may be provided with two or more bends instead of one. Moreover, the flat roof may be slightly inclined to the horizontal.

CLAIMS

1. Solar panel system for a flat roof, comprising
- three or more base profiles arranged on or near said flat roof at distances parallel to each other,
- two or more carrier profiles, arranged perpendicular to the base profiles and extending respectively from a first to a second one of the base profiles and from a second to a third one of the base profiles,
- at least one photovoltaic solar panel, mounted on at least one carrier profile, in such a manner that the solar module has an inclination to the flat roof,
- at least two interconnections, of which one lies between said second base profile and an end of one of said two carrier profiles and another interconnection lies between said second base profile and an end of the other of said two carrier profiles, each of which interconnections fastens the second base profile to an end of the respective carrier profile with means that are capable of preventing: a) relative rotation between the second base profile and the respective carrier profile about an axis parallel to the longitudinal axis of the base profile and b) translation between the second base profile and the respective carrier profile.

2. Solar panel system according to claim 1, wherein said profiles are hollow.

3. Solar panel system according to claim 1 or 2, wherein said means that prevent said rotation and translation are constituted by: a) the end of the carrier profile resting against a side wall of said base profile over part of the entire head cross-section surface of said carrier profile and b) connector means that are capable of pulling the end of said carrier profile against said side wall of said base profile.

4. Solar panel system according to claim 3, wherein said connector means comprise a hook that engages both said carrier profile and said base profile within the perimeter of the end of the carrier profile, or within the elongation of said perimeter.

5. Solar panel system according to one of the preceding claims, wherein one or more of the carrier profiles have a first section, that has an inclination to the flat roof and wherein the at least one solar panel is mounted on said first inclined section of said carrier profile.

6. Solar panel system according to claim 5, wherein one or more carrier profiles have a second section, which has an opposite inclination relative to the first section, on which second section one or more wind diversion plates are mounted.

7. Solar panel system according to one of preceding claims, wherein at least one of the base profiles has two or more feet that create a spacing between the base profile and the roof.

8. Solar panel system according to claim 7, wherein at least one of the feet is made of thermoplastic material.

9. Solar panel system according to claim 7 or claim 8, wherein the two or more feet are provided with reference points indicating where the carrier profiles should be positioned in the longitudinal direction of the base profile.

10. Solar panel system according to one of preceding claims, wherein at least two of said base profiles have a lip extending along one of their respective side walls, and wherein at least one carrier profile rests on said two lips.

11. Assembly for mounting profiles, in particular for a solar panel system according to one of the claims 1 through 10, comprising:
- a first profile,
- a second profile, positioned perpendicular to the first profile,
- a hook slidably mounted to the second profile between a retracted position wherein the hook does not extend beyond the end face of the second profile, and an extended position wherein the hook extends beyond the end face of the second profile,
in which assembly for mounting profiles, in the mounted state of the assembly, the hook lies in the extended position and the hook engages the profile in such a manner that the head of the first profile rests against the second profile.

12. Assembly for mounting profiles according to claim 11, wherein the hook is provided with thread in which a bolt extends through a slotted hole of the profile, wherein the bolt can be tightened and loosened from the outside of the second profile.

13. Assembly for mounting profiles according to claim 11 or 12, wherein the second profile contains a hole in which, in the extended position of the hook, the bolt, when inserted in the hole, secures the hook in its extended position.

14. Solar panel system according to one of the claims 1 through 10, wherein at least one of said interconnections is fastened by the assembly for mounting profiles according to one of the claims 11 through 13.

15. Solar panel system according to claim 14, wherein at least one of said carrier profiles is fastened between and to two base profiles positioned at or nearby the flat roof by two assemblies for mounting profiles according to one of the

claims 7 through 10, in each of which two assemblies the second profile is the at least one of the carrier profiles.

16. Method for mounting a solar panel system according to one of the claims 1 through 10 and 14 and 15, comprising the steps of:

- positioning two or more base profiles parallel at distances on a flat roof,
- lowering at least one carrier profile until it is between said base profiles without coarse adjusting base profile spacing, and
- fastening the carrier profile to the two or more base profiles.

FIG. 1

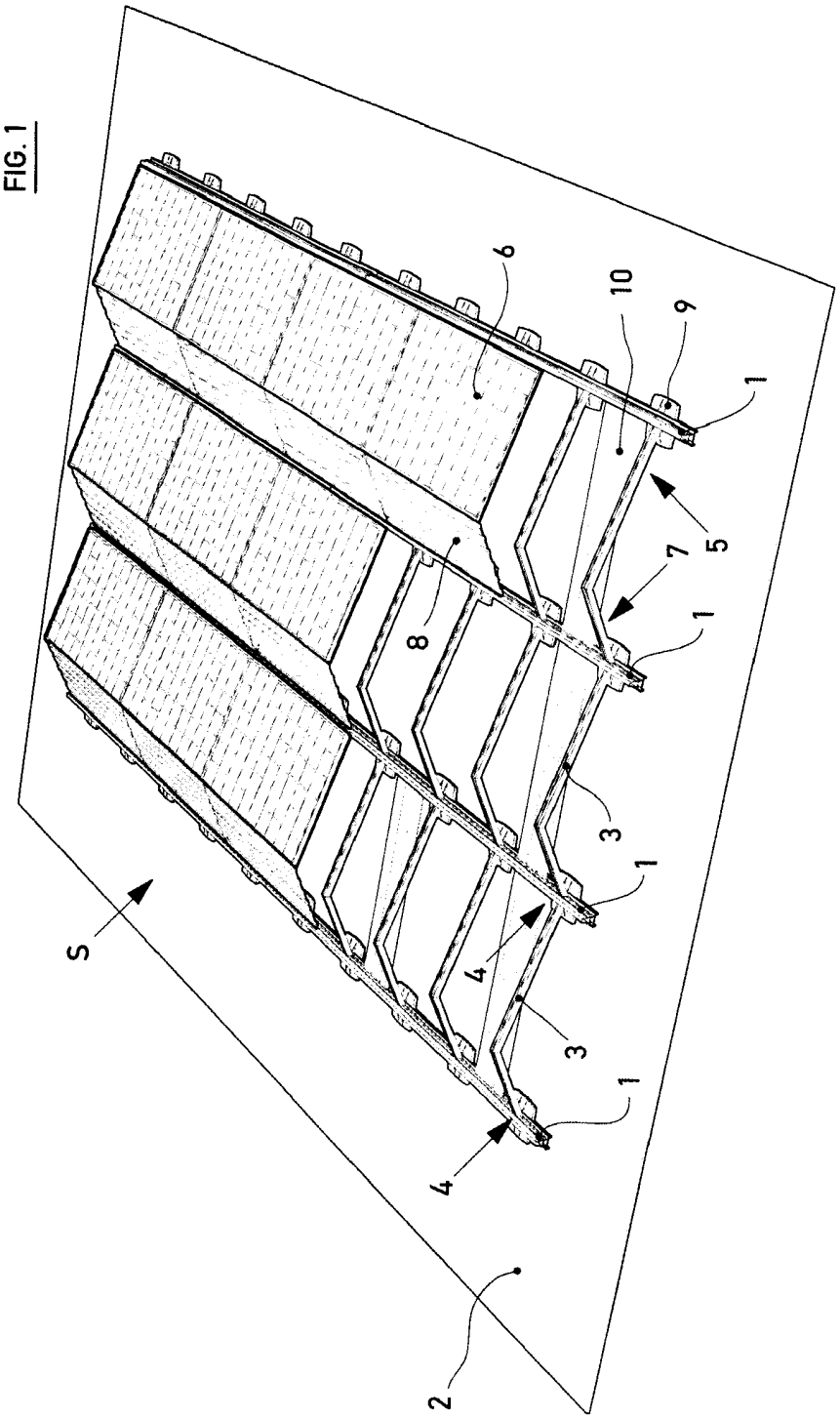


FIG. 2a

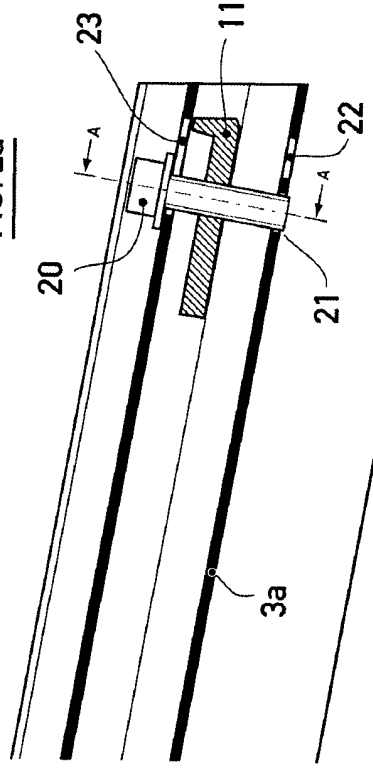


FIG. 2b

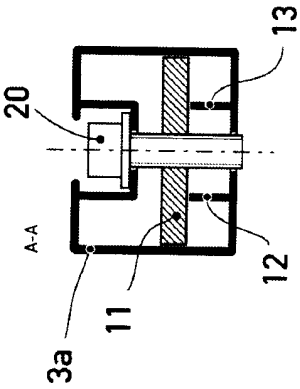
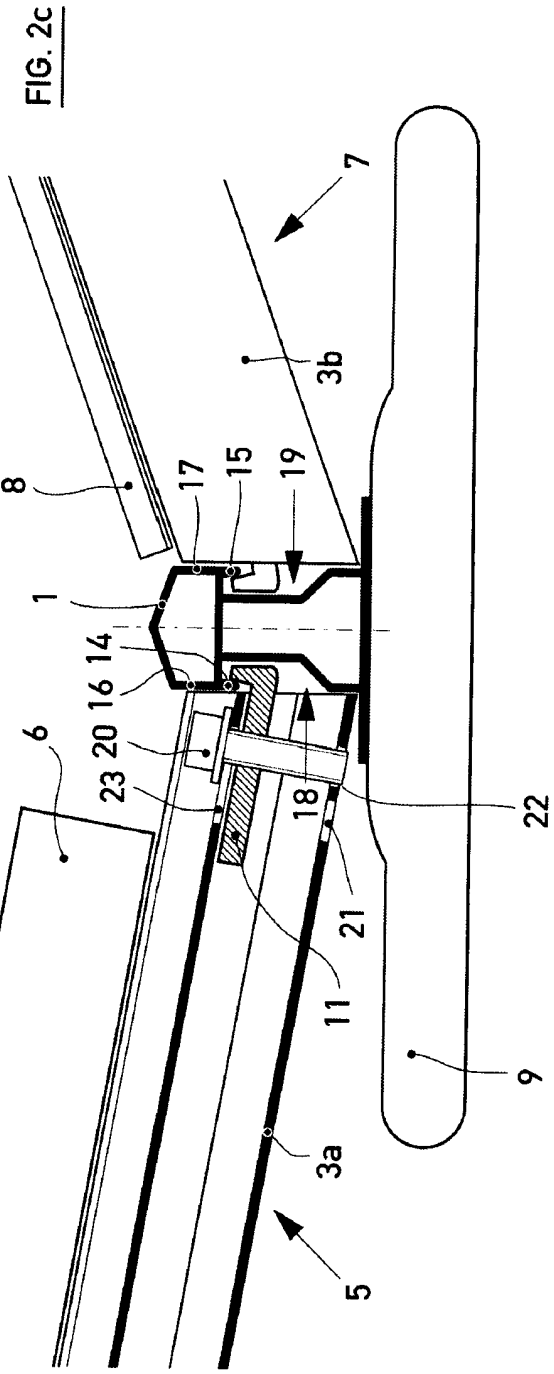


FIG. 2c



INTERNATIONAL SEARCH REPORT

International application No
PCT/NL2011/050224

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01L31/048 F24J2/52 E04D13/18
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2007 211399 A (ASAHI KASEI HOMES KK) 23 August 2007 (2007-08-23) Abstract; paragraphs [0051] - [0059]; figures 1,2,5,6,7	1,2,5,6, 10,16
A	DE 20 2008 013414 U1 (C & L GMBH [DE]) 20 May 2009 (2009-05-20) paragraphs [0030] - [0047]; claim 1; figures 1-3	1,2,5,7, 10,11,16
A	EP 1 783 440 A2 (FUTUREFASTENINGSYSTEMS SOLARTR [DE]) 9 May 2007 (2007-05-09) paragraphs [0032], [0044], [0048] - [0050], [0056], [0057]; claim 1; figures 7,9,11,14,15,18	1-3,5,6, 11,16

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
2 May 2011	11/05/2011

Name and mailing address of the ISA/	Authorized officer
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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

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PCT/NL2011/050224

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 20 2008 009134 U1 (SUNTIMES PV SYSTEMS GMBH [DE]) 6 November 2008 (2008-11-06) the whole document	1,3,5,16
A	DE 295 03 315 U1 (ENERGIEBISS GES FUER SONNENENE [DE]; IKU INGENIEURBUERO KUBE J KUBE [D) 27 April 1995 (1995-04-27) the whole document	1,5,7,16
A	US 2009/134291 A1 (MEIER CHRIS M [US] ET AL) 28 May 2009 (2009-05-28) paragraphs [0023] - [0037]; figures 1-15	1,2,5, 11,14-16
A	WO 2009/137809 A1 (SOLAR POWER INC [US]; PATTON JOHN C [US]; LI YANGLIN [CN]; ZHANG ZHENG) 12 November 2009 (2009-11-12) figures 1-22	1,3-7,9, 11,14,16
A	EP 1 947 402 A1 (APLISUN DEVELOP S L [ES]) 23 July 2008 (2008-07-23) the whole document	1,2,5, 11,14,16

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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