



(43) International Publication Date
20 December 2012 (20.12.2012)

- (51) International Patent Classification:
F24J 2/04 (2006.01) *H01L 31/042* (2006.01)
F24J 2/52 (2006.01)
- (21) International Application Number:
PCT/GB2012/000526
- (22) International Filing Date:
15 June 2012 (15.06.2012)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
1110100.3 15 June 2011 (15.06.2011) GB
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(GB).
- (81) Designated States (*unless otherwise indicated, for every
kind of national protection available*): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO,
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,

HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR,
KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD,
SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR,
TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

- (84) Designated States (*unless otherwise indicated, for every
kind of regional protection available*): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the
claims and to be republished in the event of receipt of
amendments (Rule 48.2(h))

(54) Title: IMPROVEMENT IN OR RELATING TO THREE DIMENSIONAL SOLAR PANEL APPARATUS

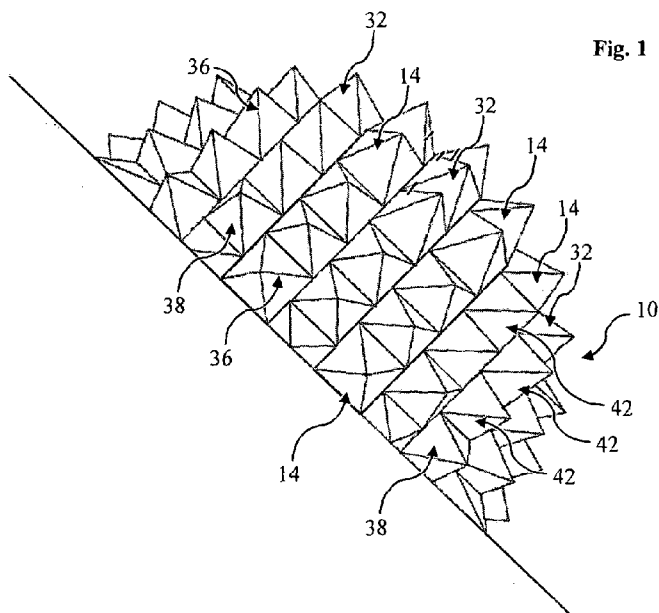


Fig. 1

(57) Abstract: Three-dimensional solar panel apparatus (10) comprises a rigid base element (12) having an upper convex surface (16), and a plurality of multi-faceted solar collector elements (14) on the upper convex surface (16) of the base element (12). Each said solar collector element (14) includes at least one solar collector device (32) on each facet (34) spaced from the base element (12). A three-dimensional solar panel array (44) utilising the three-dimensional solar panel apparatuses (10), a building (48) having the three-dimensional solar panel apparatus (10), and a method of improving solar energy conversion are also provided.

Improvements In Or Relating To Three Dimensional Solar Panel Apparatus

The present invention relates to three-dimensional solar panel apparatus, to a three-dimensional solar panel array having such three-dimensional solar panel apparatus, to a building including such three-dimensional solar panel apparatus, and to a method of
5 improving solar energy conversion.

Two-dimensional flat solar panels are now relatively common, being found installed on the roofs of both domestic and commercial properties. Such flat solar panels are intended to at least in part offset the standard energy requirements from fossil fuel and more traditional utility suppliers. However, even with Government rebates to
10 incentivize uptake and installation, it is still estimated that in the UK it will take around twenty five years to break even.

Part of the reason for the extended period for repayment is due, especially in regions of higher latitude, to the relative lack of direct incident light. Light at non-normal angles of incidence impacts the efficiency of the flat solar panel, and this is especially apparent
15 not only when considering the sun's movement during its daily cycle, but also its movement during its yearly cycle.

The present invention therefore seeks to provide a solution to these problems.

According to a first aspect of the invention, there is provided three-dimensional solar panel apparatus comprising a rigid base element having an upper convex surface, and a
20 plurality of multi-faceted solar collector elements on the upper convex surface of the base element, each said solar collector element including at least one solar collector device on each facet spaced from the base element.

Preferable and/or optional features of the first aspect of the invention are set forth in claims 2 to 15, inclusive.

25 According to a second aspect of the invention, there is provided a three-dimensional solar panel array comprising a support and a plurality of three-dimensional solar panel apparatuses in accordance with the first aspect of the invention.

Advantageously, the support may be rigid and planar or substantially planar.

According to a third aspect of the invention, there is provided a building comprising walls and a roof supported by the walls, at least one three-dimensional solar panel apparatus in accordance with the first aspect of the invention being provided on the said
5 roof.

According to a fourth aspect of the invention, there is provided a method of improving solar energy conversion, the method comprising the steps of arranging clusters of solar collector devices in a non-planar configuration relative to each other, and orientating each solar collector device of each cluster in a different direction relative to each other,
10 so that each cluster defines at least substantially a polyhedral form, whereby a fixed energy collection surface area is optimised to receive incident and reflected sunlight.

Preferable and/or optional features of the fourth aspect of the invention are set forth in claims 23 to 26, inclusive.

The invention will now be more particularly described, by way of examples only, with
15 reference to the accompanying drawings, in which:

Figure 1 shows a side elevational view of one embodiment of three-dimensional solar panel apparatus, in accordance with the first aspect of the present invention;

Figure 2 shows a vertical cross-sectional view through the three-dimensional solar panel apparatus of Figure 1;

20 Figure 3 is a top plan view of the three-dimensional solar panel apparatus of Figure 1;

Figure 4 shows a side elevational view of one embodiment of a three-dimensional solar panel array, in accordance with the second aspect of the present invention and utilising a plurality of three-dimensional solar panel apparatuses as shown
25 in Figure 1;

Figure 5 is a top plan view of the three-dimensional solar panel array, shown in Figure 4.

Referring firstly to Figures 1 to 3 of the drawings, there is shown one embodiment of three-dimensional solar panel apparatus 10 which comprises a rigid base element 12 and a plurality of multi-faceted solar collector elements 14 on an upper surface 16 of the base element 12. The base element 12 is advantageously at least in part curved, whereby the upper outer surface 16 presents a concave mounting surface 18 for the solar collector elements 14.

To reduce weight, along with manufacturing costs and to beneficially provide a cavity 20 which, for example, can house electrical equipment associated with the solar collector elements 14, the base element 12 may be hollow.

In this embodiment, the base element 12 is domed or inverted dished, and may include a flat or substantially flat base 22 from which a part-spherical mounting wall 24 extends. The mounting wall 24 may be continuously uniform, or may be apertured to reduce weight as well as to provide gaps for wiring to extend between the solar collector elements 14 and the hollow interior.

Although part-spherical and preferably hemispherical in this embodiment, the mounting wall 24 may be other arcuate shapes, such as ovoidal or elliptical in order to accommodate a variety of different installation sites.

Preferably, the base element 12 is formed of rigid and weather-resistant moulded plastics or metal, but any other suitable material may be considered.

Each multi-faceted solar collector element 14 typically includes a rigid framework 26 defining a base 28 and sides 30 of the solar collector element 14. A plurality of solar collector devices 32 is provided on the framework 26, whereby there is at least one solar collector device 32 on each face or facet 34 of the solar collector element 14.

Due to the multi-faceting of the solar collector element 14, the faces 34 and therefore the solar collector devices 32 are all oriented in different directions.

In this embodiment, at least a majority of the solar collector elements 14 define a square pyramid having a square base 28 and four triangular sides 30. The sides 30 may define equilateral or isosceles triangles, and preferably the sides 30 are planar or substantially planar. However, in contrast, the base 28 of each solar collector device 32 is typically
5 arcuate to conform to the curvature of the upper convex surface 16 of the base element 12.

Although a square pyramid form is utilised, other forms can be considered, such as a tetrahedron, pentagonal pyramid, hexagonal pyramid and star pyramid. Furthermore, although it is advantageous to have a large base area whereby the solar collector
10 element 14 can be stably and securely located on the arcuate base element 12, other non-pyramidal polyhedral shapes can be considered.

In the current embodiment, each solar collector device 32 tapers with the triangular side 30 to or proximate to an apex of the solar collector element 14, and preferably also extends to or adjacent to the edges 36 of each side 30.

15 Each solar collector element 14 can therefore be considered as a discrete, separate or independent cluster 38 of solar collector devices 32. Wiring for each solar collector device 32 of each cluster 38 can conveniently extend from the back of the solar collector devices 32 and through the framework 26 before passing, preferably, through the upper convex surface 16 of the base element 12, and into the cavity 20 thereby
20 defined. Further associated equipment may be conveniently located within the domed or inverted dish hollow base element 12, thereby dispensing with the need to find space on or within the structure to which the apparatus 10 is mounted.

Rows 40 of the solar collector elements 14 are provided on the upper convex surface 16 of the base element 12. However, to maximise incident sunlight during the sun's daily
25 and annual path of travel, adjacent solar collector elements 14 of neighbouring rows 40 are preferably offset relative to each other. Due to the curvature of the base element 12, this staggering of the rows 40 results in each solar collector device 32 presenting a solar collector surface 42 which is uniquely orientated relative to the other solar collector surfaces 42 projecting from the said base element 12.

Additionally, at least one solar collector device 32 of one solar collector element 14 is preferably oriented to be able to receive reflected light from at least one other solar collector device 32 of a neighbouring solar collector element 14. This again improves efficiency and makes use of at least a portion of incident but reflected photons.

- 5 The rows 40 of solar collector elements 14 are preferably contiguous or substantially contiguous with each other.

Referring now to Figures 4 and 5, a three-dimensional solar panel array 44 can be formed which comprises a base support 46 and a plurality of the three-dimensional solar panel apparatuses 10. Preferably, the base support 46 is a rigid, planar or substantially
10 planar sheet or frame on which the solar panel apparatuses 10 can be attached and supported. However, the base support 46 may be a roof of a building on which the array 44 is arranged.

As can be understood from Figure 5 in particular, a six by five array 44 of the three-dimensional solar panel apparatuses 10 is formed in regular rows and columns.
15 Although regularly formed, the rows and/or columns may be staggered or offset relative to each other, so that the substantially circular base elements 12 of the solar panel apparatuses 10 can fitted closer together.

Such an array 44 provides a significantly larger overall energy collection surface area than a standard two-dimensional flat solar panel. By providing a plurality of the
20 apparatuses 10, groups of solar collector devices 32 having like or very closely similar fixed orientations can be provided, thereby maximising a particular solar collection area having a given angle which receives direct incident sunlight during the sun's travel.

In use, a building structure 48, such as a domestic dwelling or commercial premises, typically has a roof 50 supported by a number of walls. The roof 50, preferably having a
25 pitch in a range of 35 degrees to 55 degrees, and more preferably approximately 45 degrees, rather than being flat. The roof 50 provides a convenient mounting location for a single said three-dimensional solar panel apparatus 10 if the installation site is small, or a said three-dimensional solar panel array 44 if the installation site is larger and able to accept multiple apparatuses 10.

In the above embodiments, the solar collector devices 32 are preferably photovoltaic or PV devices. However, any suitable solar collector can be utilised.

Even though the above described array 44 utilises six by five apparatuses 10, two or more apparatuses 10 can be mounted together to form a suitable said array 44.

- 5 It is thus possible to provide a three-dimensional solar panel apparatus having fixed solar collector devices which are oriented to maximise direct incident sunlight during the sun's travel and thus changing angle throughout the day and year. The fixed-surface orientation polyhedral multi-faceted solar collector elements placed on top of the domed or inverted dished base, by being arranged in staggered rows, maximise the photon
- 10 passage from substantially any direction and also minimise shadowing. By virtue of this arrangement, the flat sides of the solar collector elements that are facing the sun capture a maximum or optimum amount of light that typically strikes their surfaces at any given angle without any or substantially any obstruction from the adjacent solar collector elements. The staggering of the neighbouring rows of solar collector elements allows
- 15 the solar collection surfaces of the solar collector devices that are not facing the sunlight to absorb a certain amount of reflected sunlight from the solar collector elements that are positioned opposite and which are directly exposed to the sunlight. This does aid in eliminating or reducing photon reflection issues identified in current flat panel system, whilst also increasing collected solar energy. It is also possible to provide three-
- 20 dimensional solar panel apparatus which optimises a flat solar collection area and which has improved efficiency during diffuse light when overcast.

The embodiments described above are provided by way of examples only, and various modifications will be apparent to persons skilled in the field without departing from the scope of the invention as defined by the appended claims.

Claims

1. Three-dimensional solar panel apparatus (10) comprising a rigid base element (12) having an upper convex surface (16), and a plurality of multi-faceted solar collector elements (14) on the upper convex surface (16) of the base element (12), each said solar collector element (14) including at least one solar collector device (32) on each facet (34) spaced from the base element (12).
5
2. Three-dimensional solar panel apparatus (10) as claimed in claim 1, wherein the multi-faceted solar collector elements (14) are arranged in rows (40) on the base element (12).
- 10 3. Three-dimensional solar panel apparatus (10) as claimed in claim 2, wherein adjacent solar collector elements (14) in neighbouring rows (40) are staggered.
4. Three-dimensional solar panel apparatus (10) as claimed in any one of claims 1 to 3, wherein the plurality of solar collector elements (14) extend across at least substantially an entirety of the upper convex surface (16) of the base element
15 (12).
5. Three-dimensional solar panel apparatus (10) as claimed in any one of claims 1 to 4, wherein the said facets (34) orientate respective solar collector surfaces (42) of the solar collector devices (32) in at least three different directions.
6. Three-dimensional solar panel apparatus (10) as claimed in any one of claims 1
20 to 5, wherein each solar collector device (32) tapers towards an apex of the respective solar collector element (14).
7. Three-dimensional solar panel apparatus (10) as claimed in any one of claims 1 to 6, wherein each solar collector device (32) extends to or substantially to an edge of the respective solar collector element (14).
- 25 8. Three-dimensional solar panel apparatus (10) as claimed in any one of claims 1 to 7, wherein each multi-faceted solar collector element (14) is a polyhedron.

9. Three-dimensional solar panel apparatus (10) as claimed in claim 8, wherein each multi-faceted solar collector is of pyramidical form.
10. Three-dimensional solar panel apparatus (10) as claimed in claim 8 or claim 9, wherein a base of the multi-faceted solar collector element (14) is a quadrilateral.
- 5 11. Three-dimensional solar panel apparatus (10) as claimed in any one of the preceding claims, wherein each solar collector device (32) of the solar collector element (14) is planar or substantially planar.
12. Three-dimensional solar panel apparatus (10) as claimed in any one of the preceding claims, wherein a base (28) of each solar collector device (32) is
10 arcuate.
13. Three-dimensional solar panel apparatus (10) as claimed in any one of the preceding claims, wherein the base element (12) is hollow.
14. Three-dimensional solar panel apparatus (10) as claimed in any one of the preceding claims, wherein the base element (12) is domed.
- 15 15. Three-dimensional solar panel apparatus (10) as claimed in any one of the preceding claims, wherein the base element (12) is at least one of part-spherical and elliptical.
16. Three-dimensional solar panel apparatus (10) substantially as hereinbefore described with reference to the accompanying drawings.
- 20 17. A three-dimensional solar panel array (44) comprising a support (46) and a plurality of three-dimensional solar panel apparatuses (10) as claimed in any one of the preceding claims.
18. A three-dimensional solar panel array (44) as claimed in claim 17, wherein the support (46) is rigid and planar or substantially planar.
- 25 19. A three-dimensional solar panel array (44) substantially as hereinbefore described with reference to the accompanying drawings.

20. A building (48) comprising walls and a roof (50) supported by the walls, at least one three-dimensional solar panel apparatus (10) as claimed in any one of claims 1 to 16 being provided on the said roof (50).
21. A building (48) as claimed in claim 20, wherein the roof (50) has a pitch in the
5 range of 35 degrees to 55 degrees.
22. A method of improving solar energy conversion, the method comprising the steps of arranging clusters (38) of solar collector devices (32) in a non-planar configuration relative to each other, and orientating each solar collector device (32) of each cluster (38) in a different direction relative to each other, so that
10 each cluster (38) defines at least substantially a polyhedral form, whereby a fixed energy collection surface area is optimised to receive incident and reflected sunlight.
23. A method as claimed in claim 22, wherein the non-planar configuration is arcuate.
- 15 24. A method as claimed in claim 22 or claim 23, wherein adjacent clusters (38) are arranged to minimise shading of neighbouring solar collector devices (32).
25. A method as claimed in claim 24, wherein the clusters (38) of solar collector devices (32) are arranged in a plurality of staggered rows (40).
- 20 26. A method as claimed in any one of claims 22 to 25, wherein at least one solar collector device (32) of one cluster (38) is oriented to receive reflected light from at least one solar collector device (32) of a neighbouring cluster (38).

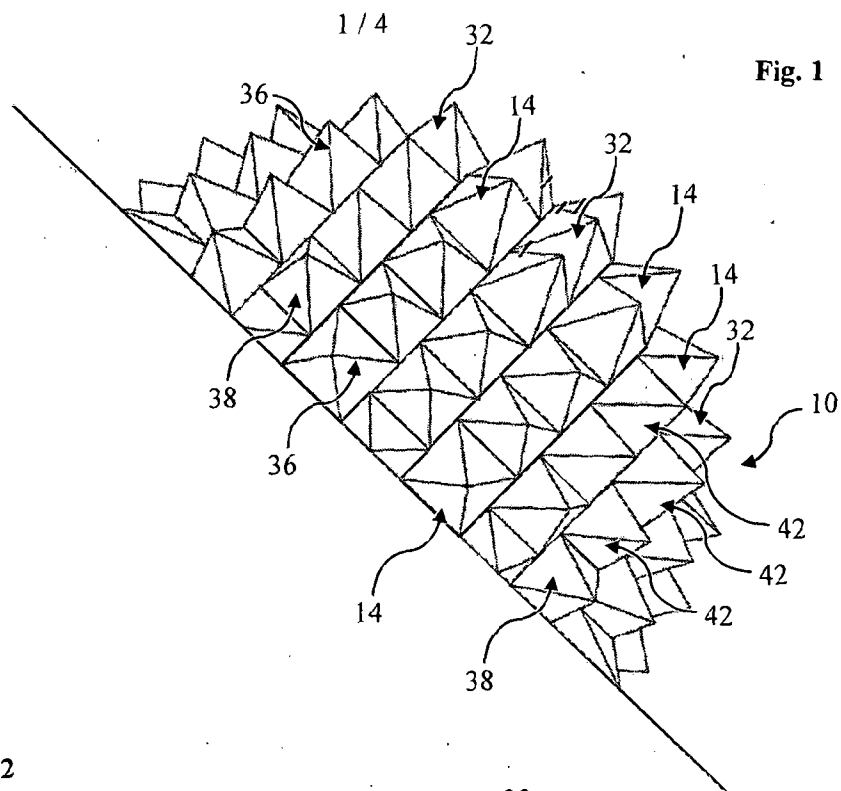


Fig. 2

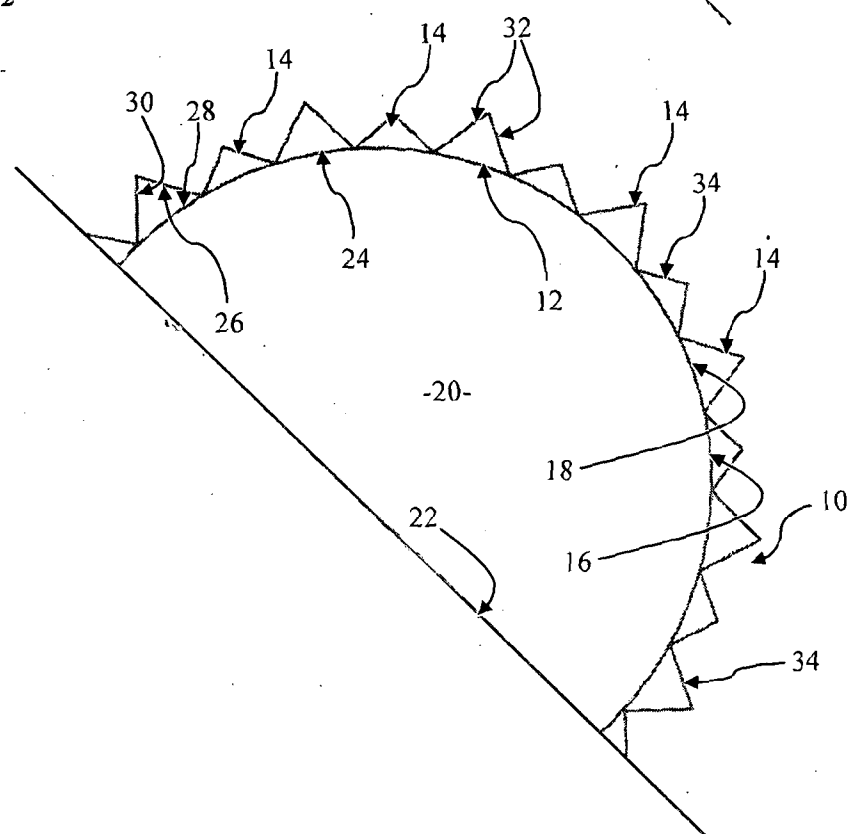
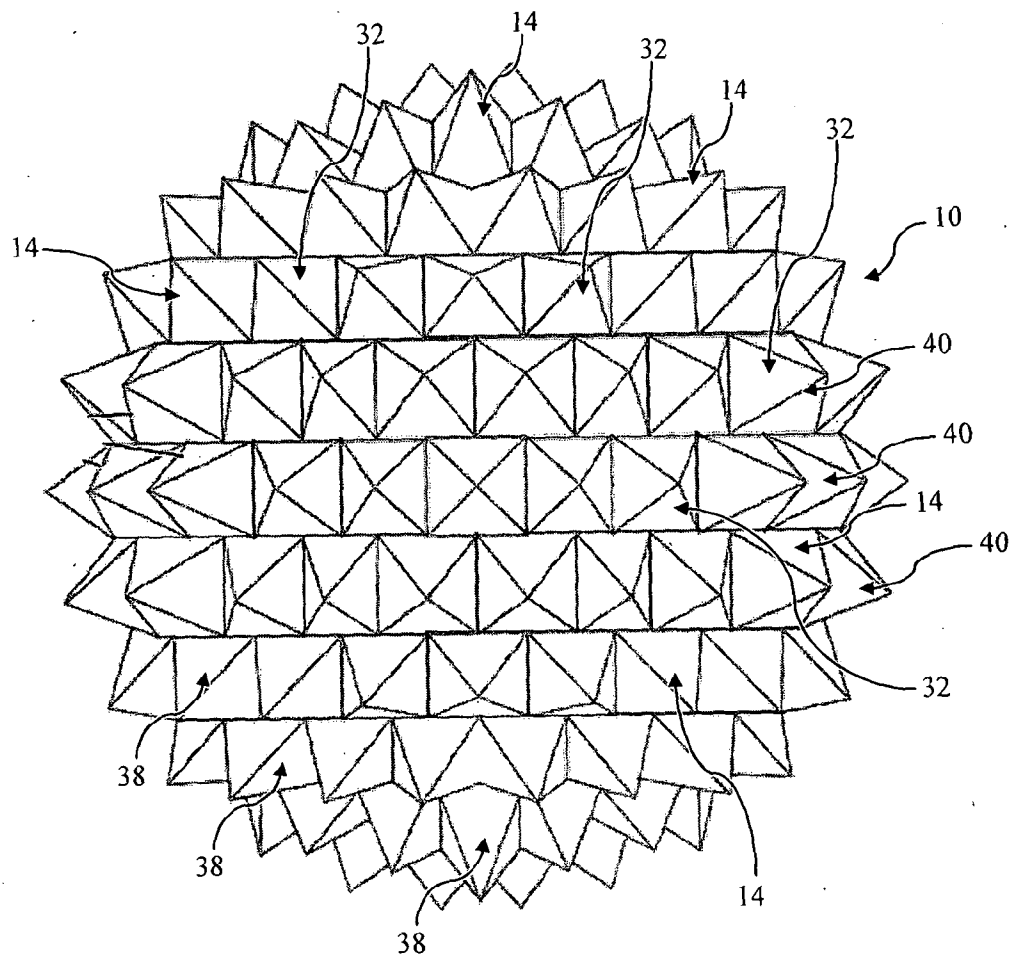


Fig. 3



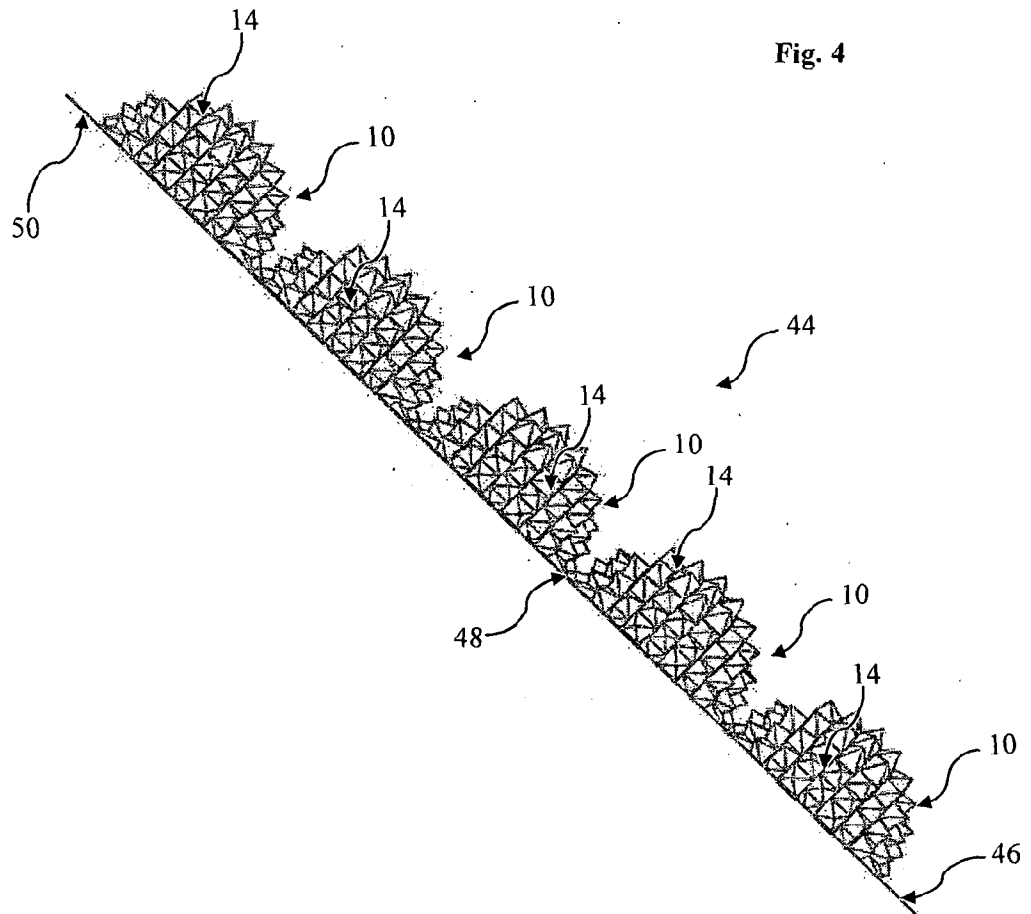
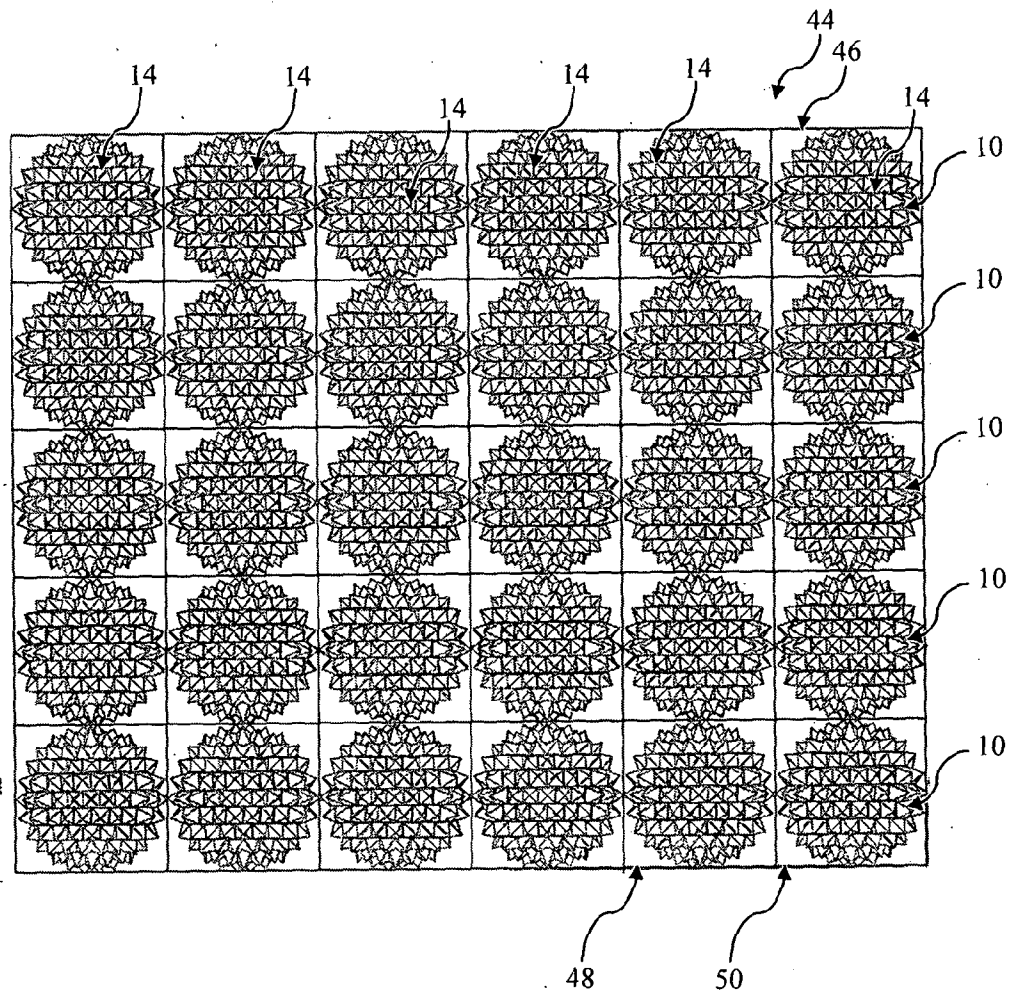


Fig. 5



INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2012/000526

A. CLASSIFICATION OF SUBJECT MATTER
INV. F24J2/04 F24J2/52 H01L31/042
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)
F24J 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 practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	DE 20 2010 012272 U1 (SCHUECO INT KG [DE]) 25 November 2010 (2010-11-25) the whole document -----	1-15,17, 18,20-26
A	DE 100 47 400 A1 (HNE ELEKTRONIK GMBH & CO SATEL [DE]) 18 April 2002 (2002-04-18) the whole document -----	1-15,17, 18,20-26
A	JP 2003 298093 A (TAKIRON CO) 17 October 2003 (2003-10-17) the whole document -----	1-15,17, 18,20-26



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

25 October 2012

Date of mailing of the international search report

06/11/2012

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/GB2012/000526

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