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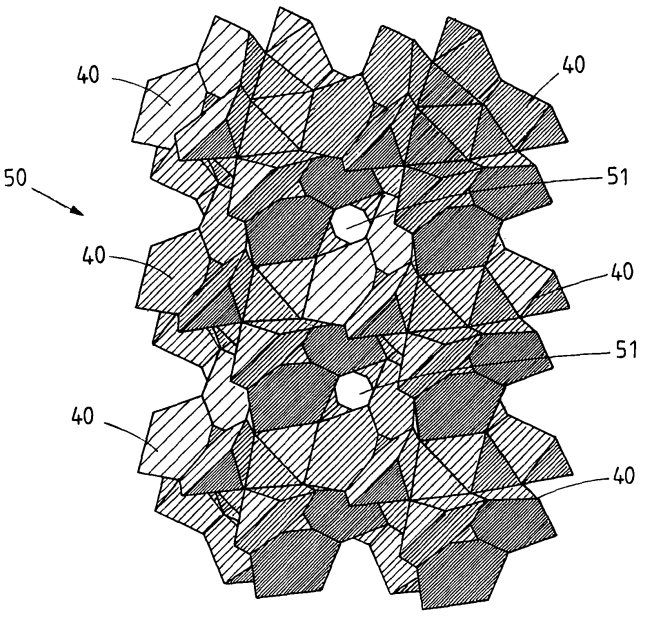
(54) Building block and structures using such a block

(57) Building blocks (40) are described comprising at least one set of three pyramid elements (1, 2, 3) each of the three pyramid elements (1, 2, 3) generatable from a regular dissection of a cube, the pyramid elements (1, 2, 3) each having four sides and each having one base plane, the first pyramid element (1) and the second pyramid element (2) being positioned on opposite sides of the third pyramid element (3), the square base plane of the third pyramid element (3) being positioned on one of the non-triangular sides of a cuboctahedron (4). Furthermore, structures using those building blocks (40) are described.

Fig. 9



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Description

[0001] For many applications in e.g. furniture design, lighting design, lamp design or architecture building blocks like cubes, spheres or other simple forms are used to generate complex designs. These simple building blocks have the advantage that they can be manufactured easily.

[0002] On the other hand the creativity of a designer is limited by the choice of simple forms. Furthermore, structures built from simple building blocks with simple surfaces are prone to structural problems since the surfaces do not interlock. Therefore, it is in many cases beneficial to have building blocks with more complex shapes which can be used to build more complex structures and structurally sound structures.

[0003] In the following different embodiments of building blocks are shown in an exemplary way.

Fig. 1 shows a perspective partial view of a first embodiment of the building block;

Fig. 2 shows a perspective partial view of a second embodiment of the building block;

Fig. 3 shows a perspective view of a cuboctahedron;

Fig. 4 shows a perspective view of an extended cuboctahedron;

Fig. 5 shows an axonometric view of an embodiment of a building block;

Fig. 6 shows a frontal view of the embodiment of Fig. 5;

Fig. 7 shows a top view of the embodiment of Fig. 5;

Fig. 8 shows a view from the right hand side of the embodiment of Fig. 5;

Fig. 9 shows an axonometric view of an embodiment of a structure comprising six building blocks according to Fig. 5;

Fig. 10 shows a frontal view of the structure shown in Fig. 9;

Fig. 11 shows a top view of the structure shown in Fig. 9;

Fig. 12 shows a view from the left hand side of the structure shown in Fig. 9;

Fig. 13 shows a further structure comprising building blocks according to Fig. 9;

Fig. 14 shows a further embodiment of a building block;

Fig. 15 shows the building block of Fig. 14 with two sets of pyramid elements removed;

Fig. 16 shows the building block of Fig. 15 with visible sides of an extended cuboctahedron;

Fig. 17 shows the building block of Fig. 14 with three sets of pyramid elements removed;

Fig. 18 shows the building block of Fig. 17 with visible sides of an extended cuboctahedron.

[0004] Before applications of building blocks 40 are shown, some design alternatives for constructing the building blocks 40 (see e.g. Fig. 5) are described.

[0005] In Fig. 1 to 4 parts of the building blocks 40 are described, before different design alternatives are given.

[0006] A first embodiment of a building block 40 comprises at least three pyramid elements 1, 2, 3 as shown in Fig. 1.

[0007] Those pyramid elements 1, 2, 3 are the result of a regular dissection of a cube. A cube can be regularly dissected into six pyramids, each having square base planes of equal size (i.e. the six sides of the cube) and each pyramid element 1, 2, 3 having four triangular sides of equal size and shape. In Fig. 1 three of such pyramid elements 1, 2, 3 are shown. A side of the first pyramid element 1 and a side of the second pyramid element 2 are positioned on opposite sides of a third pyramid element 3. The three apexes of the pyramid elements 1, 2, 3 meet at one contact point 10. This contact point 10 would be at the center of the cube from which the three pyramid elements 1, 2, 3 are formed. In this first embodiment the base planes of the first and second pyramid 1, 2 are parallel to each other and perpendicular to the base plane of the third pyramid element 3.

[0008] It will be understood by the person skilled in the art that the three dimensional shape shown in Fig. 1 has not be manufactured by assembling three distinct pyramid elements 1, 2, 3, e.g. by gluing, welding or bolting those pyramid elements 1, 2, 3 together. Neither are those connection methods excluded from the scope. Neither it is necessary to manufacture the pyramid elements 1, 2, 3 from a single cube. The above description is meant as an explanation how the construction can be defined, i.e. how the structure can be generated. In other embodiments the three pyramid elements 1, 2, 3 can e.g. be manufactured from one piece of material or molded in one piece. In this case there would be no real contacting plane between e.g. the first and the third pyramid element 1, 3 and no real physical dissection of a cube.

[0009] It also should be noted that e.g. due to manufacturing constraints the edges of the geometrical shapes (pyramids etc.) used in the description above and in the following might deviate from the ideal shape. Edges can e.g. be rounded or the connection point 10 might not be

a mathematically exact point. The person skilled in the art will understand that the geometry of the building block and its parts can best be described by ideal geometric shapes and bodies but the building block in reality might deviate somewhat from this mathematical ideal shape.

[0010] As will be demonstrated below, the three dimensional shape formed by the three pyramid elements 1, 2, 3 can be used as a part in a building block 40 to form very complex structures.

[0011] In Fig. 2 a variation of the three-dimensional shape shown in Fig. 1 is shown. As in the first embodiment, the three pyramid elements 1, 2, 3 can be generated in the same way as described in connection with Fig. 1. But in the second embodiment the base plane of the first and second pyramid element 1, 2 are not parallel to each other.

[0012] This is achieved by providing triangular extensions 5A, 5B to opposing sides of the first and the second pyramid elements 1, 2. In Fig. 2 one triangular extension 5A is shown on the right (cross-hatched in Fig. 2). The triangular extension 5A is coplanar with the side of the first pyramid element 1. The angle measured around a baseline 6 of the first pyramid element 1 is 0°. In other embodiments this angle can differ by -5° to +5°.

[0013] On the opposite side of the first pyramid element 1 a similar triangular extension 5 is present but is not visible in the perspective drawing in Fig. 2.

[0014] In principle the angles in the triangular extension 5 can vary. In the present case the angle opposite the baseline 6 is 112°. The smaller remaining angle is 23°. Consequently, the remaining third angle is 45°, the three angles in the triangular extension 5 adding up to 180°.

[0015] The two triangular extensions 5 to the first pyramid element 1 (and the two triangular extensions 5B to the second pyramid element 2) add an essentially wedge-shaped connection means 7 (shown with a cross-hatched pattern in Fig. 2) to the pyramid elements 1, 2. The function of the connection means 7 will become clearer in the further description.

[0016] As mentioned in connection with Fig. 1 it is clear that the above description of the adding of a wedge shaped connection means 7 is meant to describe the construction of a part of the building block. In real applications the pyramid elements 1, 2, 3 and the connection means 7 can also be manufactured in one piece.

[0017] In Fig. 2 the triangular extensions 5B of the second pyramid element are almost not visible. But in the depicted embodiment the triangular extensions 5B have the same shape as on the left hand side of Fig. 2, only they are oriented differently. The extension means 7 for the first and the second pyramid elements 1, 2 are in this case symmetrically positioned, the symmetry plane being a plane perpendicular to the base plane of the third pyramid element 3, the plane going through the connection point 10.

[0018] The base plane of the connection means 7 (i.e. the plane facing away from the apex of the pyramid elements 1, 2) can have different polygonal shapes. The embodiment shown in Fig. 2 uses a symmetric but non-regular hexagon. The symmetry axis 8 of the hexagon shown as dotted line. In principle, other polygons, especially polygons with symmetry properties, are possible.

[0019] The sum of the six internal angles of the hexagon is 720°. Four angles (i.e. the one closest to the corner points of the base plane of the pyramid element 1, 2) are 106°. The remaining two angles are 148°. In other embodiments other combinations of angles and sizes of angles can be chosen.

[0020] Due to the triangular extensions 5A, 5B, the base plane of the connection means 7 is tilted at an angle to the base plane (not shown in Fig. 2) of the first and second pyramid element 1, 2. In this case the tilting angle is 16°.

[0021] Looking at Fig. 2 the shape of the connection means 7 can be described as essentially a polyhedral wedge.

[0022] The pyramid elements 1, 2, 3 with (Fig. 2) or without (Fig. 1) connection means 7 form a part of a building block 40 which can be used to construct devices, like e.g. lamps or furniture.

[0023] To construct a building block 40 the square base plane of the third pyramid element 3, with two pyramid elements 1, 2 attached as e.g. shown in Fig. 2, are positioned on the quadratic sides of a virtual cuboctahedron 4.

[0024] A cuboctahedron 4 (also called cuboctaeder) is a cube from which the eight corners have been removed symmetrically. One embodiment of such a cuboctahedron 4 is shown in Fig. 3. The cuboctahedron 4 consequently has six quadratic sides 21, 22, 23 (three of them visible in Fig. 3) all having the same size and eight triangular sides 24, 25, 26 (three of them visible in Fig. 3) at the corner of the former cube, all having the same size. The six quadratic sides 21, 22, 23 are the non-triangular sides of the cuboctahedron 4.

[0025] For constructing a building block 40, at least three pyramid elements 1, 2, 3 (in Fig. 3 without the extension means 7) are positioned relative to each other as if the square base plane of the third pyramid element 3 is positioned at least on one of the quadratic (i.e. the non-triangular) sides 21, 22, 23 of a cuboctahedron 4.

[0026] It is not necessary to build a physical cuboctahedron 4 to physically attach the pyramid elements 1, 2, 3 on the cuboctahedron 4, but the spatial arrangement of the pyramid elements 1, 2, 3 relative to each other can be described relative to the shape of this virtual cuboctahedron 4.

[0027] The term virtual cuboctahedron 4 in this context does not exclude that some construction exists which has the shape of a cuboctahedron 4 (or parts thereof) and to which the pyramid elements 1, 2, 3 are fixed. In this case the term real cuboctahedron 4 could be used.

[0028] If e.g. six sets of the three pyramid elements 1, 2, 3 as shown in Fig. 2 are positioned on the quadratic sides of a virtual cuboctahedron 4, the hollow space sur-

rounded by the pyramid elements 1, 2, 3 would have the shape of a cuboctahedron 4.

[0029] In Fig. 4 a cuboctahedron 4 for an alternative embodiment is shown. The depicted embodiment is an extended cuboctahedron 4 which is intended to form the basis of three pyramid elements 1, 2, 3 with connections means 7. Since the connection means 7 extend the surface and size of the pyramid elements 1, 2, 3, the space enclosed by the pyramid elements 1, 2, 3 is different from the one shown e.g. in Fig. 3. At three corners of the cuboctahedron 4, extensions 30 are shown. If the quadratic base plane 21 has a side length of 100%, the extension 30 extends the base plane 21 on each side by 29,3%.

[0030] Therefore, the cuboctahedron 4 comprises eight triangular sides and six non-triangular sides. The latter being formed by the quadratic planes 21, 22, 23 and the extensions 30.

[0031] Otherwise, the extended cuboctahedron 4 according to Fig. 4 can comprise either a real structural base or can be a virtual shape formed by pyramid elements 1, 2, 3 as described in connection with Fig. 3.

[0032] In Fig. 5 one embodiment of a building block 40 is shown in an axonometric view. The shading shown in the view of Fig. 5 by different hatching of the surfaces is caused by light falling onto the building block 40 from the general direction of the arrow B.

[0033] Such a building block is also called a "Star-Brick". This building block 40 comprises six identical sets of pyramid elements 1, 2, 3 with extension elements 5 (like shown in Fig. 2) resulting in connection means 7. For reasons of clarity the connection means 7 are not indicated in Fig. 5.

[0034] The pyramid elements 1, 2, 3 are built around an extended cuboctahedron 4, like the one shown in Fig. 4. The cuboctahedron 4 is not shown in Fig. 5, it is the hidden space surrounded by the pyramid elements 1, 2, 3. The six base planes of the third pyramids 3 are positioned on the six extended square base planes (i.e. the non-triangular sides) of the cuboctahedron 4. Each of the three pyramid elements 1, 2, 3 form together a saddle like (or grip like) surface generally indicated by an arrow A in Fig. 5.

[0035] The inherent symmetry of the building block 40 allows the construction of larger structures, while maintaining a high internal stability between the building blocks 40 of the structure. The complex shape of the building blocks 40 allows an interlocking of several building blocks 40 leading to stable structures. The shape of the building blocks 40 provides line or planar contacts between the building blocks 40 enhancing the stability of a structure built by those building blocks.

[0036] Furthermore, the building block 40 comprises a hollow space in the middle which can be used e.g. for a lighting element. The lighting element can be included alternatively or additionally in at least one of the the pyramid elements 1, 2, 3. The material of the pyramid elements 1, 2, 3 would then e.g. determine how the light will be perceived by somebody looking at a lamp built from building blocks 40.

[0037] In Fig. 6 the same building block 40 as in Fig. 5 is shown in a frontal view, in Fig. 7 in a view from the top and in Fig. 8 in a view from the right hand side. Again, the lighting is indicated by the arrow B.

[0038] In Fig. 9 a structure 50 comprising 6 building blocks 40 is shown. This structure is part of a lighting structure, e.g. a floor or table lamp. The lighting elements can be positioned in the hollow parts of the structure, i.e. the parts which are surrounded by the pyramid elements 1, 2, 3. As mentioned above, the lighting elements 1, 2, 3 can be alterantively or additionally be positioned in at least one of the pyramid elements 1, 2, 3.

[0039] The identical building blocks 40 are arranged in two columns. Two building blocks 40 contact each other in the saddle like (or grip like) surface A formed by the first, second and third pyramids 1, 2, 3. In the structure 50 shown, each building block 40 contacts two or three other building blocks 40 of the same kind. Here, the building blocks 40 have the same shape and size. The building blocks 40 are oriented all in the same direction.

[0040] As will be seen in the other Figures, the symmetry of the structure 50 provides some regular geometric features, like the two holes 51 in the middle of the structure 50. From the angle of the chosen perspective in Fig. 9 those holes 51 have a regular octagonal shape.

[0041] But this regular octagonal shape of the holes 51 is also maintained if the structure 50 is viewed from a different angle. In Fig. 10 a frontal view of the structure 50 shown in Fig. 9 is given, indicating the same regular octagonal shapes. Furthermore, in this view multiple triangular shaped holes 52 are visible. As explained above, the building blocks 40 comprise hollow shapes (e.g. cuboctahedrons or extended cuboctahedrons). By stacking up building blocks 40 as shown in Fig. 9, more hollow shapes are created by the building blocks. In those hollow shapes, lighting elements can be positioned to provide light for a room. Due to the many surfaces in the structure 50 the designer has the possibility to create a very complex arrangement of light effects e.g. by specifying the texture, the color and / or the transparencies of the pyramid elements 1, 2, 3 and / or the walls of the pyramid elements 1, 2, 3. The holes 51, 52 could be covered by light transparent material to generate additional light effects, especially if the structure 50 is used as a lamp.

[0042] In Fig. 11 a top view of the two parallel columns comprising the building blocks 40 of the structure 50 is given. The building blocks 40 form an essentially planar structure. From this viewing angle, only triangular holes are visible.

[0043] In Fig. 12 a view from the left hand side of the structure 50 shown in Fig. 9 is depicted. Again, only triangular holes are visible from this angle.

[0044] In Fig. 13 an alternative structure comprising the building blocks 40 as shown in Fig. 5 is depicted. Unlike in Fig. 9 to 12, this structure 50 is not planar if seen from the top. The structure 50 in Fig. 13 comprises columns of three building blocks 40 which are arranged

in a zigzag-like structure, providing extra stability if this structure is positioned on a floor.

[0045] The structure 50 in Fig. 13 can also be a lighting element or a part of lighting element.

[0046] The person skilled in the art will recognize that structures 50 like the one in Fig. 13 or Fig. 9 can be used in other contexts as well. Structures 50 can e.g. be used as part of furniture, like racks, cupboards or chairs. Structures 50 can also be used as part of buildings, e.g. as decorative elements on the outsides of houses.

[0047] The building blocks 30 can be manufactured from a wide range of materials such as plastic, especially polycarbonate, metal, especially aluminium and /or magnesium, paper, cardboard, moulded materials and / or wood. The person skilled in the art will recognize that the the building block 30 does not have to be manufactured by one material alone, but can comprise more than one material. Furthermore, structures build from building blocks 30 do not necessarily have to be built from identical building blocks 30, i.e. especially building blocks made from the same material.

[0048] In Fig. 14 an embodiment of a building block 40 like in Fig. 5 is shown. Again this building block comprises six sets of pyramid elements 1, 2, 3. The sets of pyramid elements are grouped around a space with the shape of an extended cuboctahedron 4. The latter is better visible in Fig. 15 to 16. The contact planes of the sets of pyramid elements 1, 2, 3 are indicated by bold lines 60.

[0049] Fig. 15 shows the view of Fig. 14 but with two of the pyramid elements 1, 2, 3 in the front removed. The contact planes 60 have become visible. In Fig. 15 a cuboctahedron 4 itself is not visible, just the extended planes (i.e. the non-triangular planes) at the inside of the building block 40. In Fig. 16 the same situation as in Fig. 15 is shown, but this time with the extended cuboctahedral surface visible also in the front, i.e. a closed extended cuboctahedron 4 is shown inside.

[0050] In Fig. 17 the building block 40 is even more reduced, i.e. only three sets of pyramid elements 1, 2, 3 are visible. Like in Fig. 15, the internal cuboctahedron 4 is not visible, only the extended surfaces on the base planes of the set of the pyramid elements 1, 2, 3. Like in Fig. 16 in Fig. 18 the cuboctahedron 4 is shown with all sides visible from the front.

[0051] As mentioned perviously, the extended cuboctahedron 4 as in Fig. 15 to 18 is not necessarily a bodily internal structure. It is used here to describe the internal shape of an embodiment of a building block 40. In other embodiments the cuboctehedron or the extended cuboctahedron can be structural element within the building block 40.

Reference numbers

[0052]

1 First pyramid element
2 Second pyramid element
3 Third pyramid element
4 cuboctahedron
5 Triangular extension
6 Baseline
7 Connection means
8 Symmetry axis

10 Contact point

21, 22, 23 quadratic sides of a cuboctahedron
24, 25, 26 triangular sides of a cuboctahedron

30 Extension of cuboctahedron

40 Building block

50 Structure of building blocks

60 Contact plane between sets of pyramid elements

A Saddle structure
B Direction of light in perspective views

Claims

1. Building block (40) comprising at least one set of three pyramid elements (1, 2, 3) each of the three pyramid elements (1, 2, 3) generatable from a regular dissection of a cube, the pyramid elements (1, 2, 3) each having four sides and each having one base plane, the first pyramid element (1) and the second pyramid element (2) being positioned on opposite sides of the third pyramid element (3), the square base plane of the third pyramid element (3) being positioned on one of the non-triangular sides of a cuboctahedron (4).

2. Building block (40) according to claim 1, wherein the cuboctahedron (4) comprises at least one extension (30) extending at least one of the quadratic base planes (21, 22, 23) of the cuboctahedron (4) into a non-triangular side.

3. Building block (40) according to claim 1 or 2, wherein the cuboctahedron (4) is a virtual space formed by the positioning of pyramid elements (1, 2, 3) or the cuboctahedron (4) being at least in part a physical structure comprising pyramid elements (1, 2, 3).

4. Building block (40) according to at least one of the preceding claims, wherein the apexes of the three pyramid elements (1, 2, 3) meet in one contact point (10).

5. Building block (40) according to at least one of the preceding claims, wherein at least a first set of pyramid elements (1, 2, 3) and at least a second set of

pyramid elements (1', 2', 3') are positioned at an angle of 90° on opposite sides of the cuboctahedron (4).

6. Building block (40) according to at least one of the preceding claims, wherein on two opposite sides of the first pyramid element (1) and two opposite sides of the second pyramid element (2) triangular extensions (5) are formed at the baseline (6) of the pyramid elements (1, 2), thereby forming a connection means (7) at the base plane of the first pyramid element (1) and the second pyramid element (2).

7. Building block (40) according to claim 6, wherein in the triangular extension (5) the angle opposite the baseline (6) of the first or second pyramid element (1, 2) is 112°.

8. Building block (40) according to claim 6 or 7, wherein the triangular extension (5) lies in the same plane as the side of the first pyramid element (1) or the second pyramid element (2) or the triangular extension (5) is positioned at an angle between -60° and 60° around the baseline (6) relative to the side of the first pyramid element (1) or the side of the second pyramid element (2).

9. Building block (40) according to at least one of the claims 6 to 8, wherein the connection means (7) comprises a base plane with a polygonal shape, specially a regular polygonal shape, especially a hexagonal shape.

10. Building block (40) according to at least one of the preceding claims, wherein the at least one set of pyramid elements (1, 2, 3) forms a saddle-like surface (A) for contacting another building block (40), especially another building block (40) of the same shape and / or size.

11. Building block (40) according to at least one of the preceding claims, wherein at least one pyramid element (1, 2, 3), at least one of the sides of the at least one pyramid element (1, 2, 3) and / or one side of the cuboctahedron (4) and / or an extended cuboctahedron (4) is colored and / or transparent to light.

12. Building block (40) according to at least one of the preceding claims, wherein at least in one space within one of the pyramid elements (1, 2, 3) and / or the cuboctahedron (4) a light source is positioned.

13. Structure comprising at least one of the building blocks of claims 1 to 12.

14. Lamp comprising a structure according to claim 13.

FIG 1

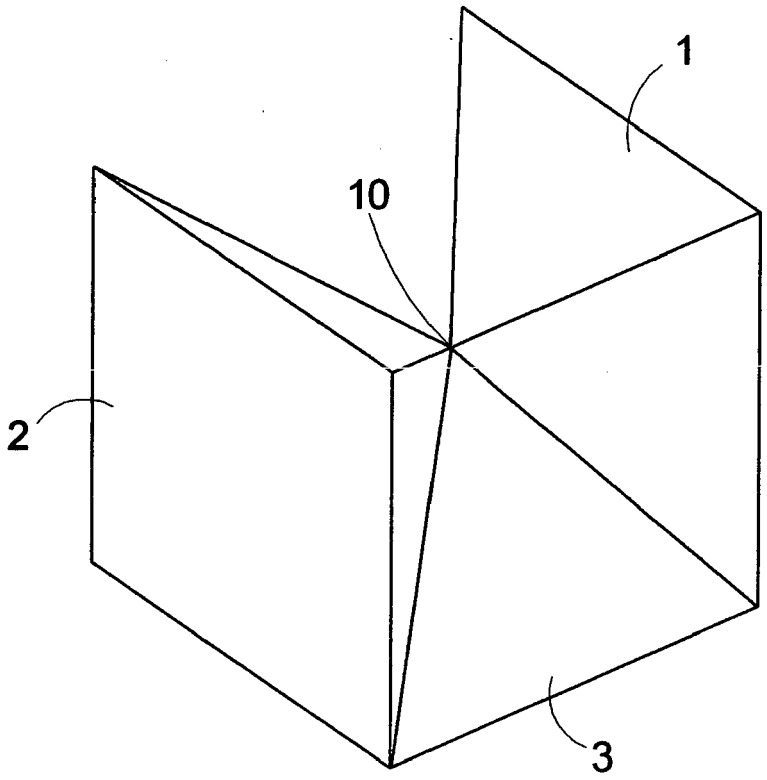


FIG 2

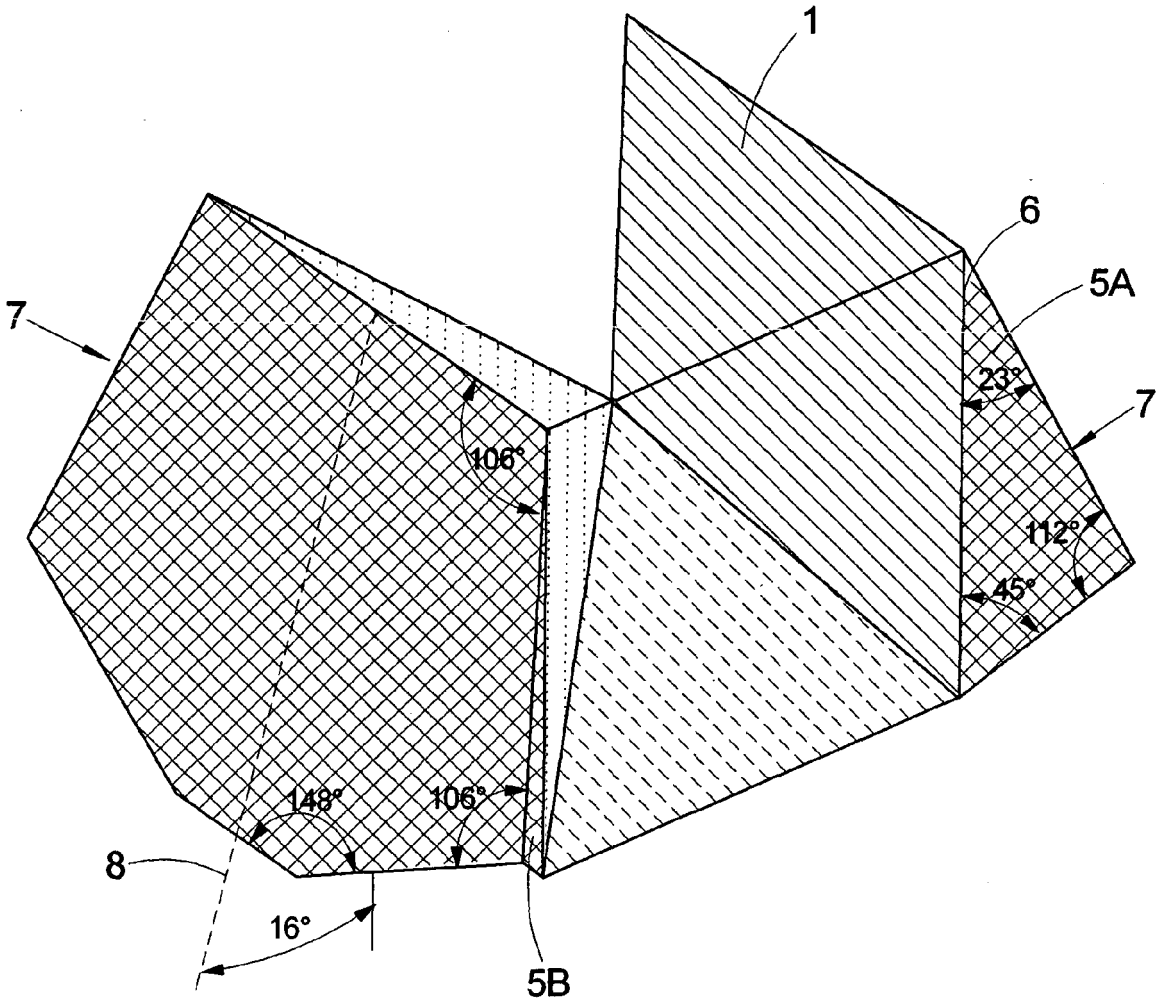


FIG 3

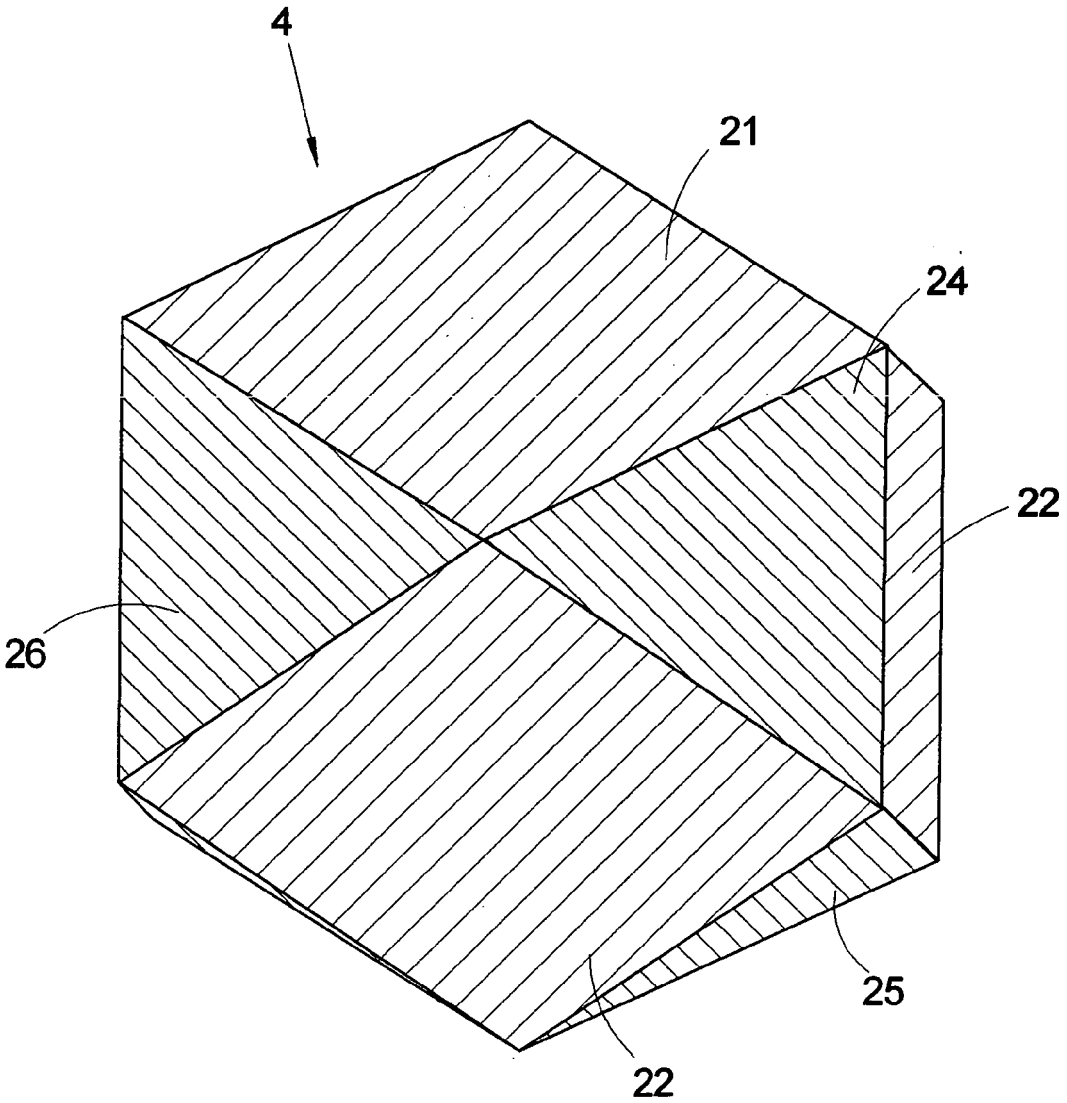


FIG 4

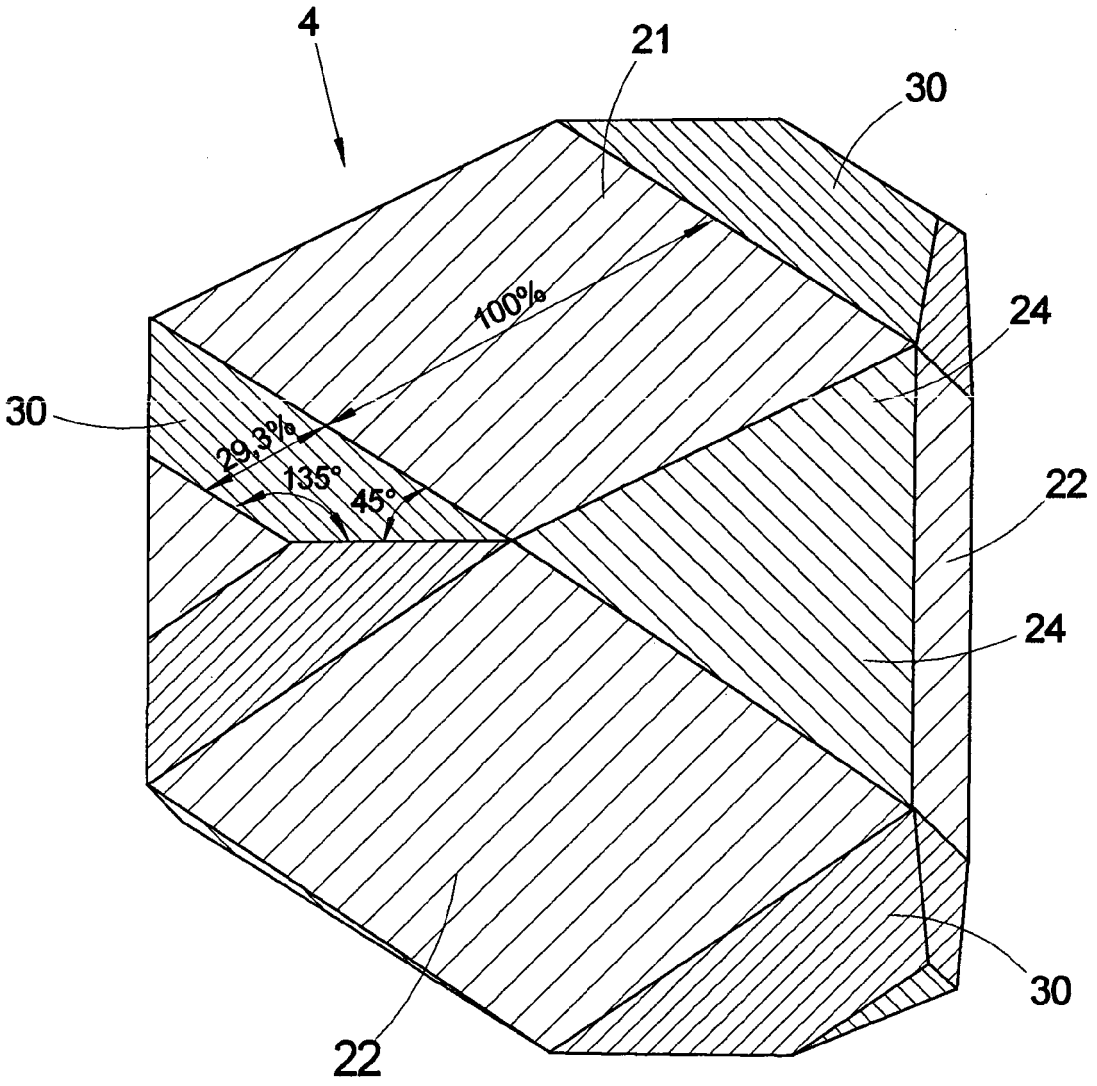


FIG 5

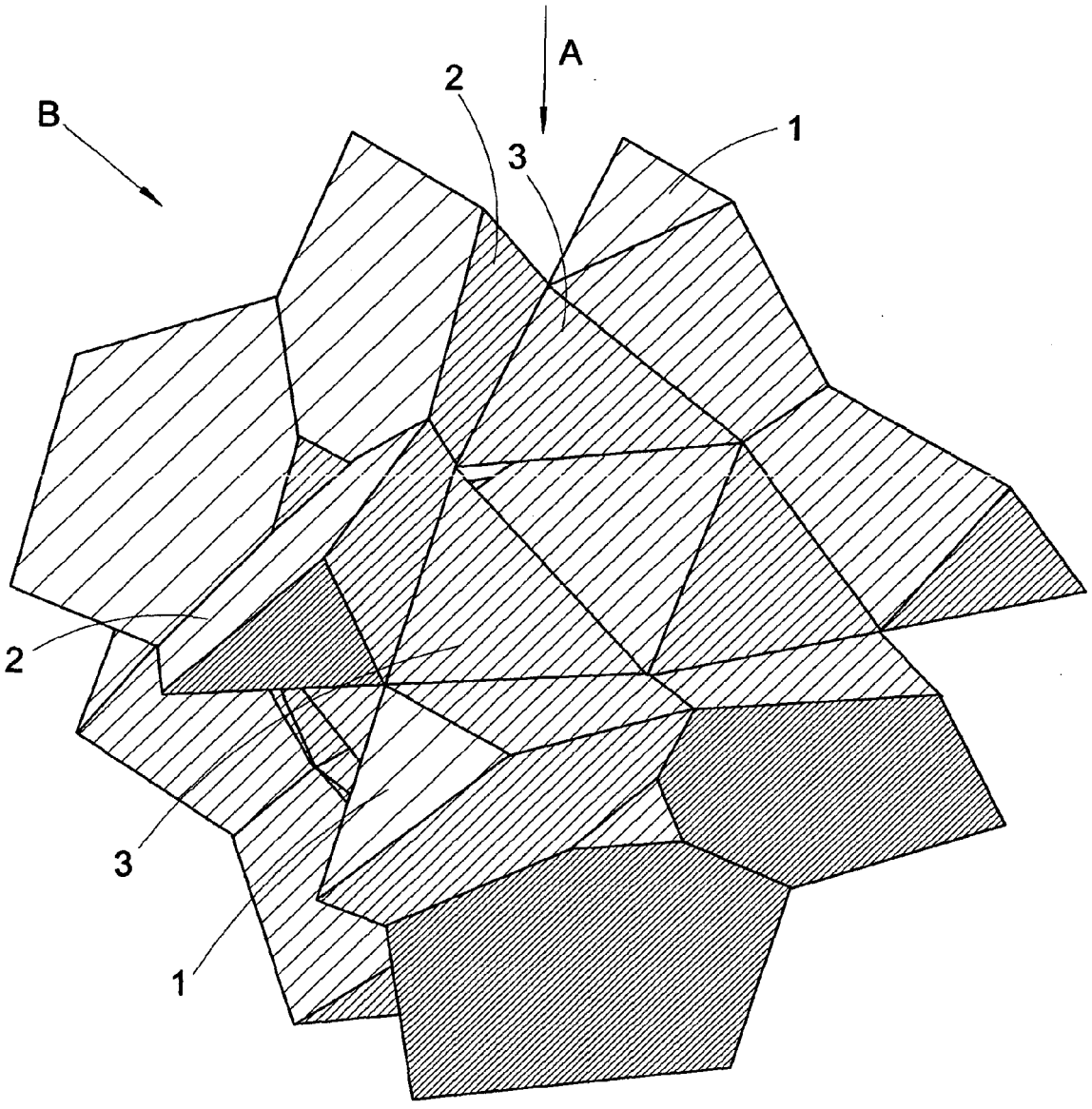


FIG 6

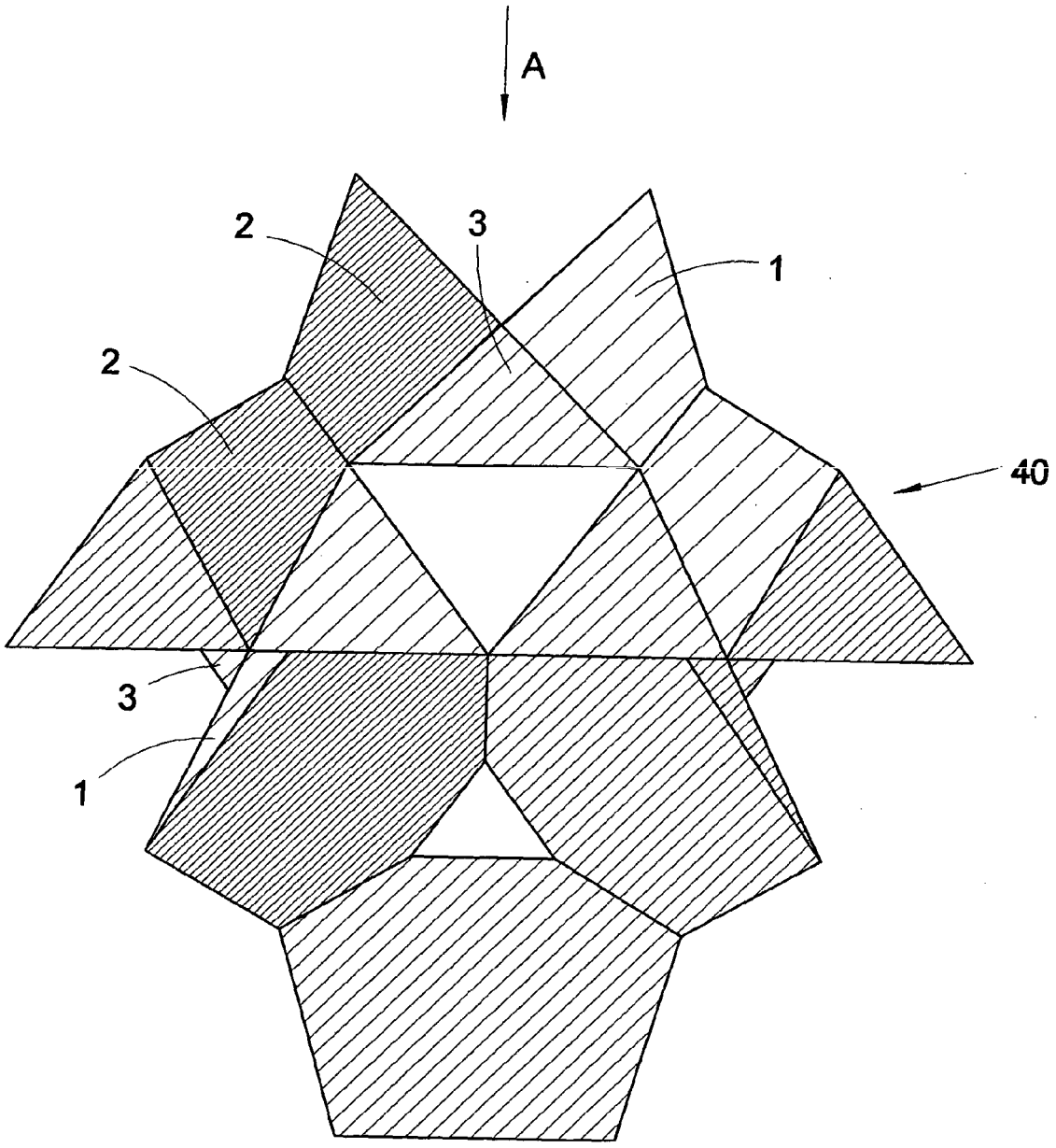


FIG 7

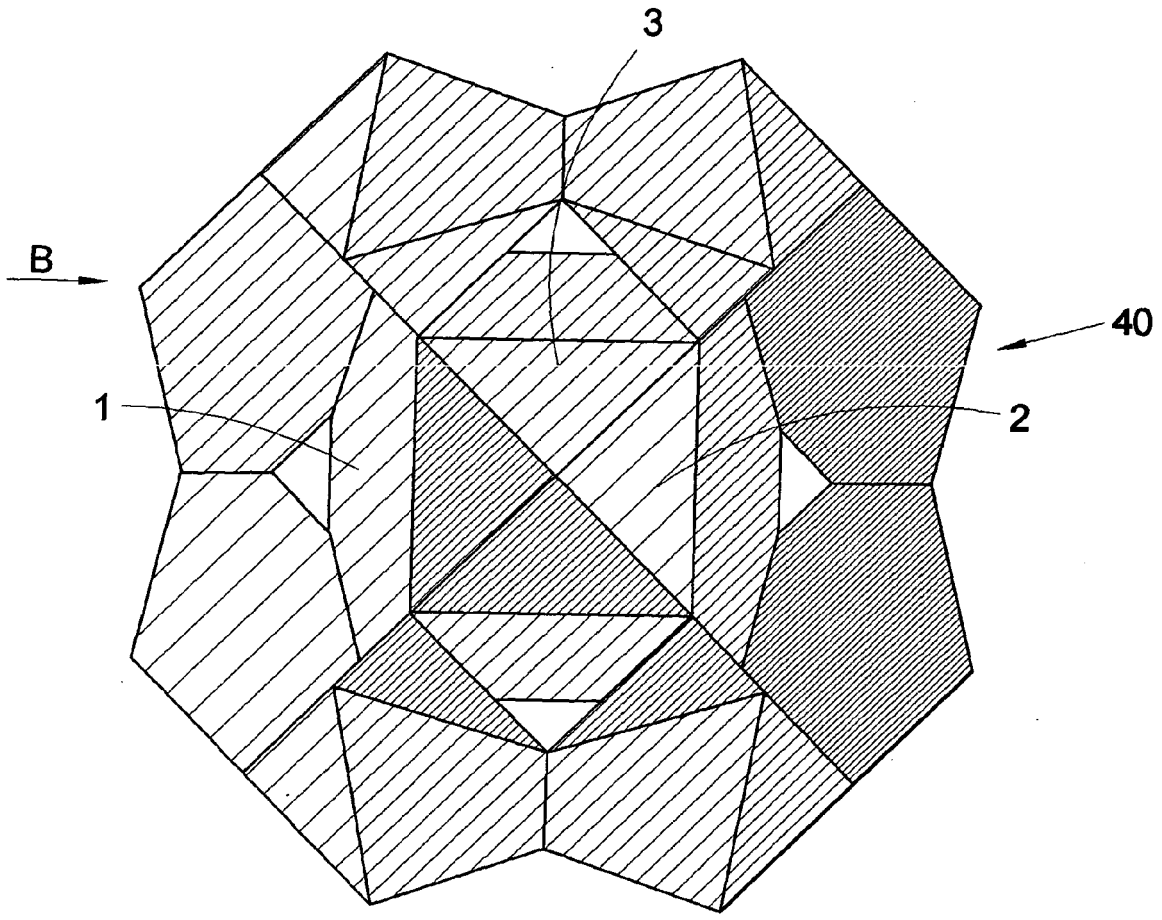


FIG 8

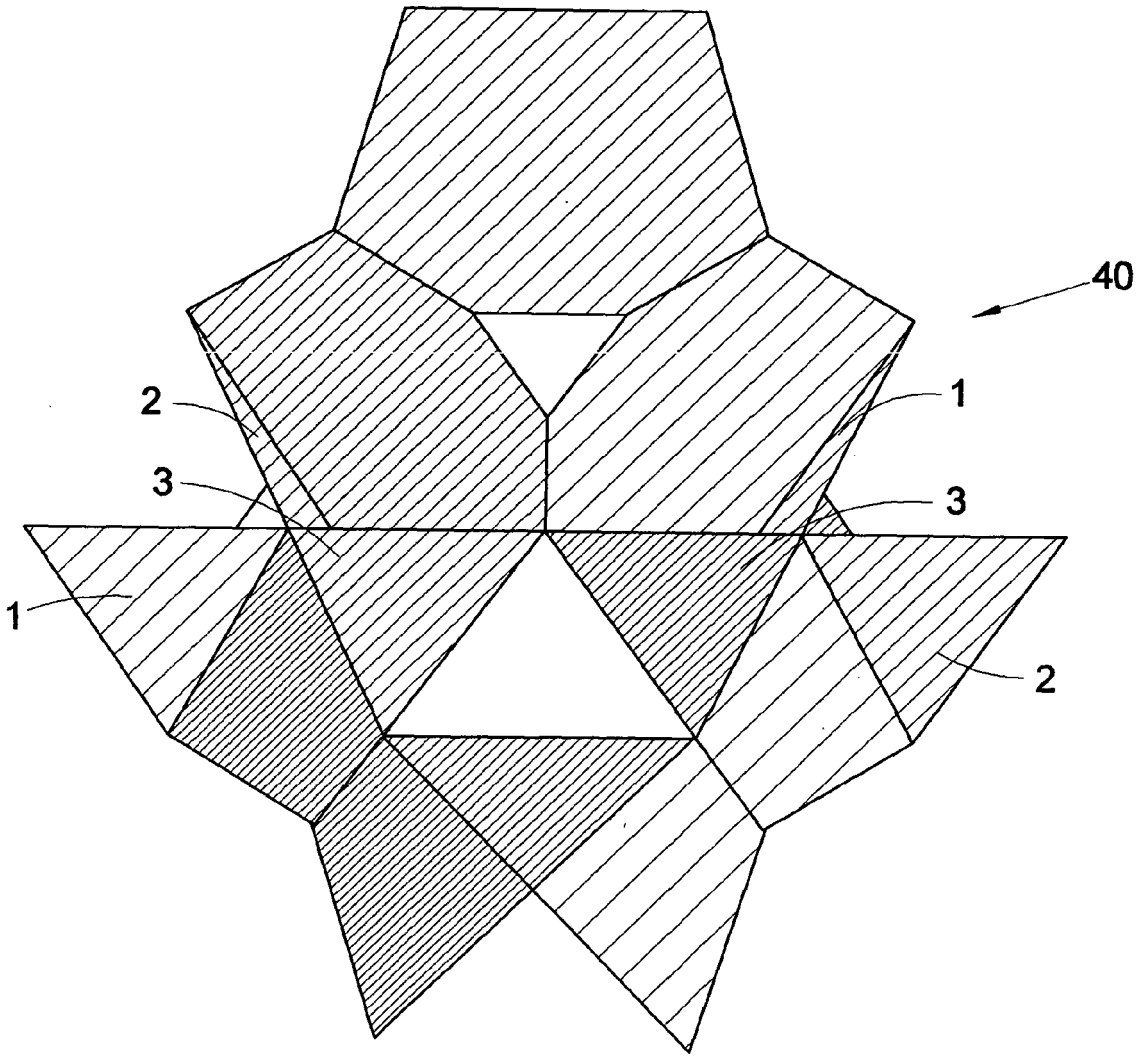


Fig. 9

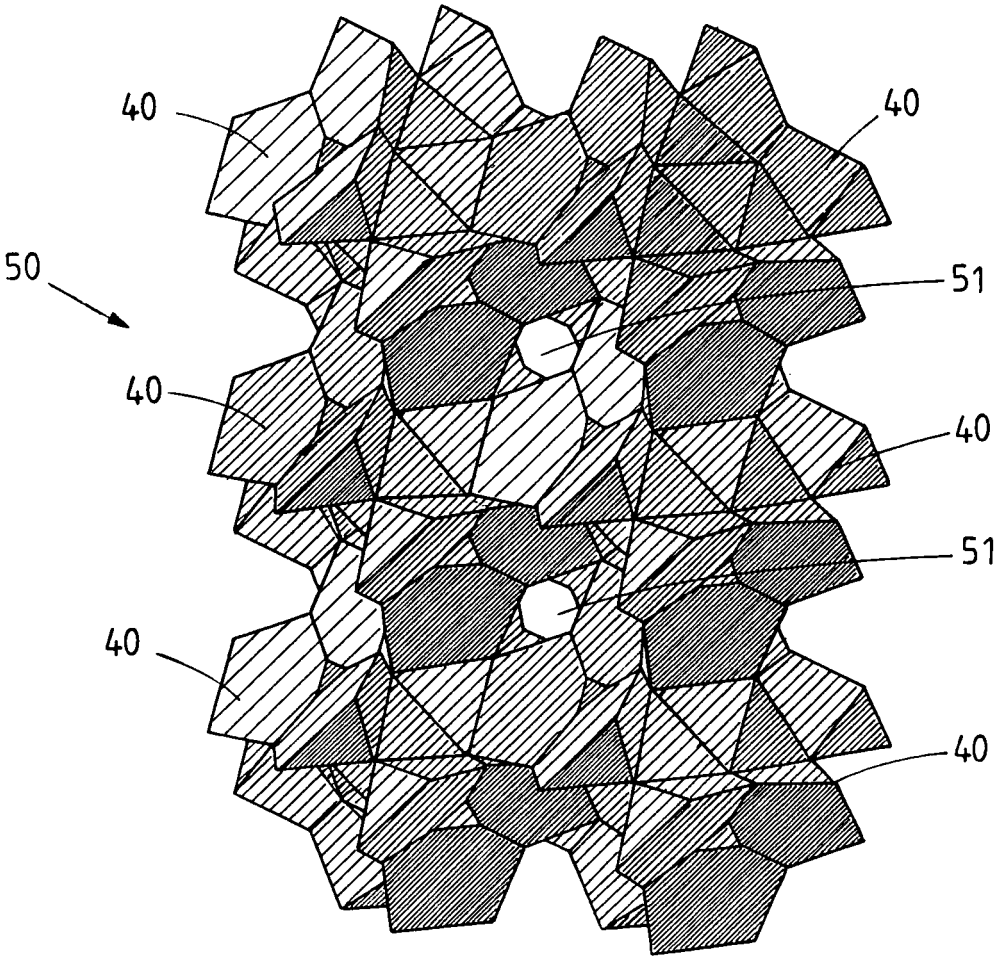
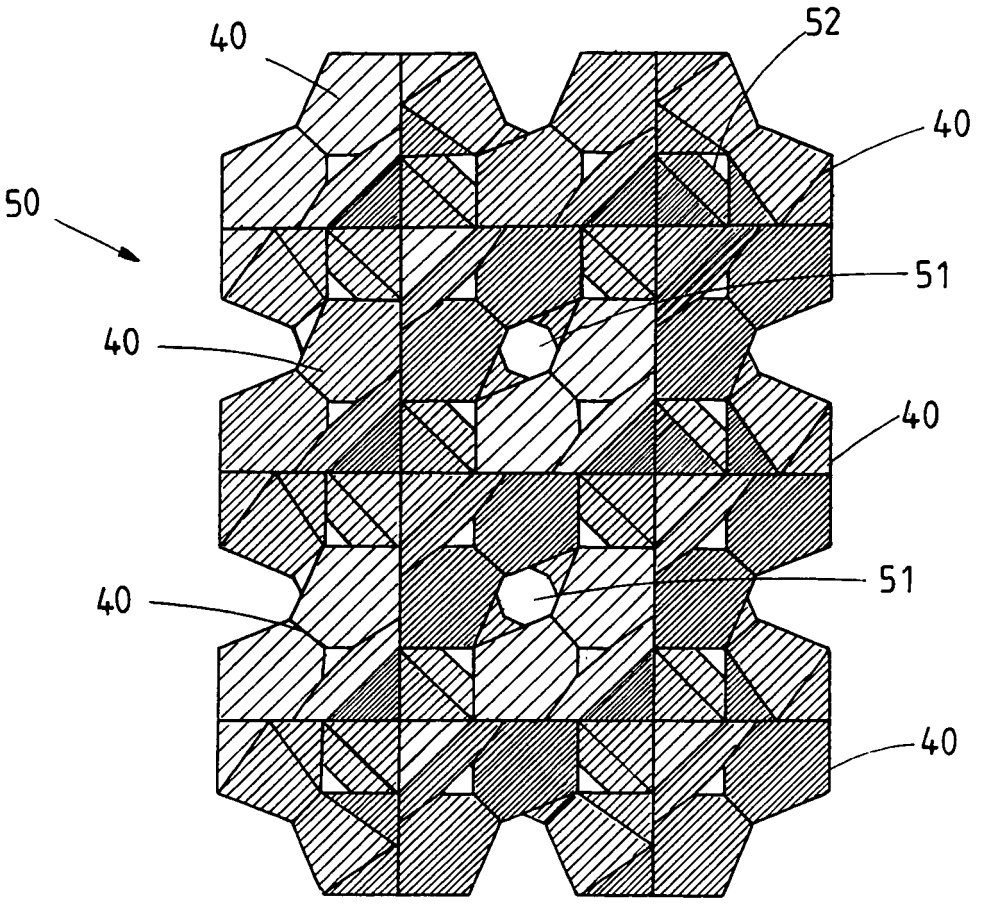


Fig. 10



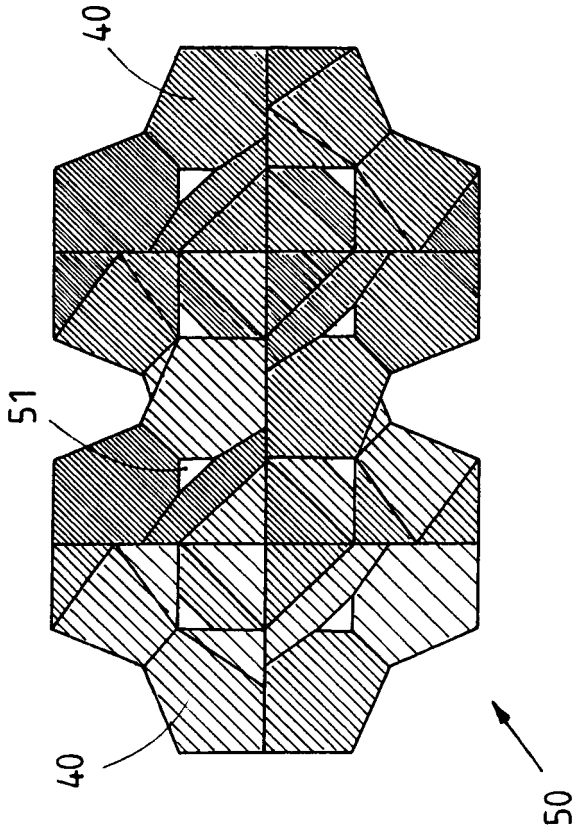
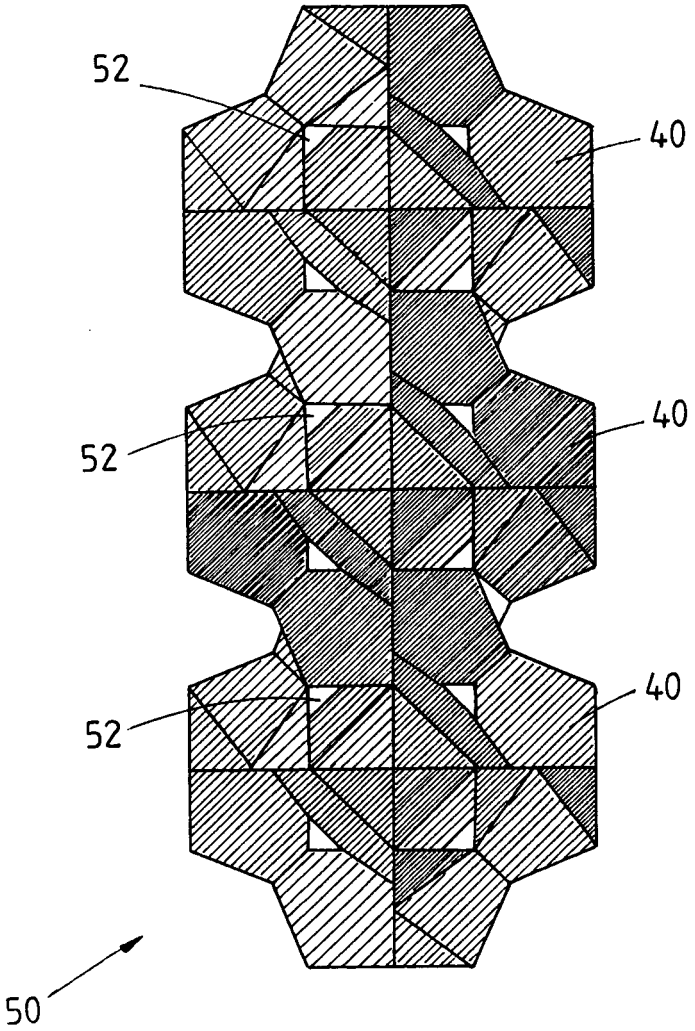


Fig. 11

Fig. 12



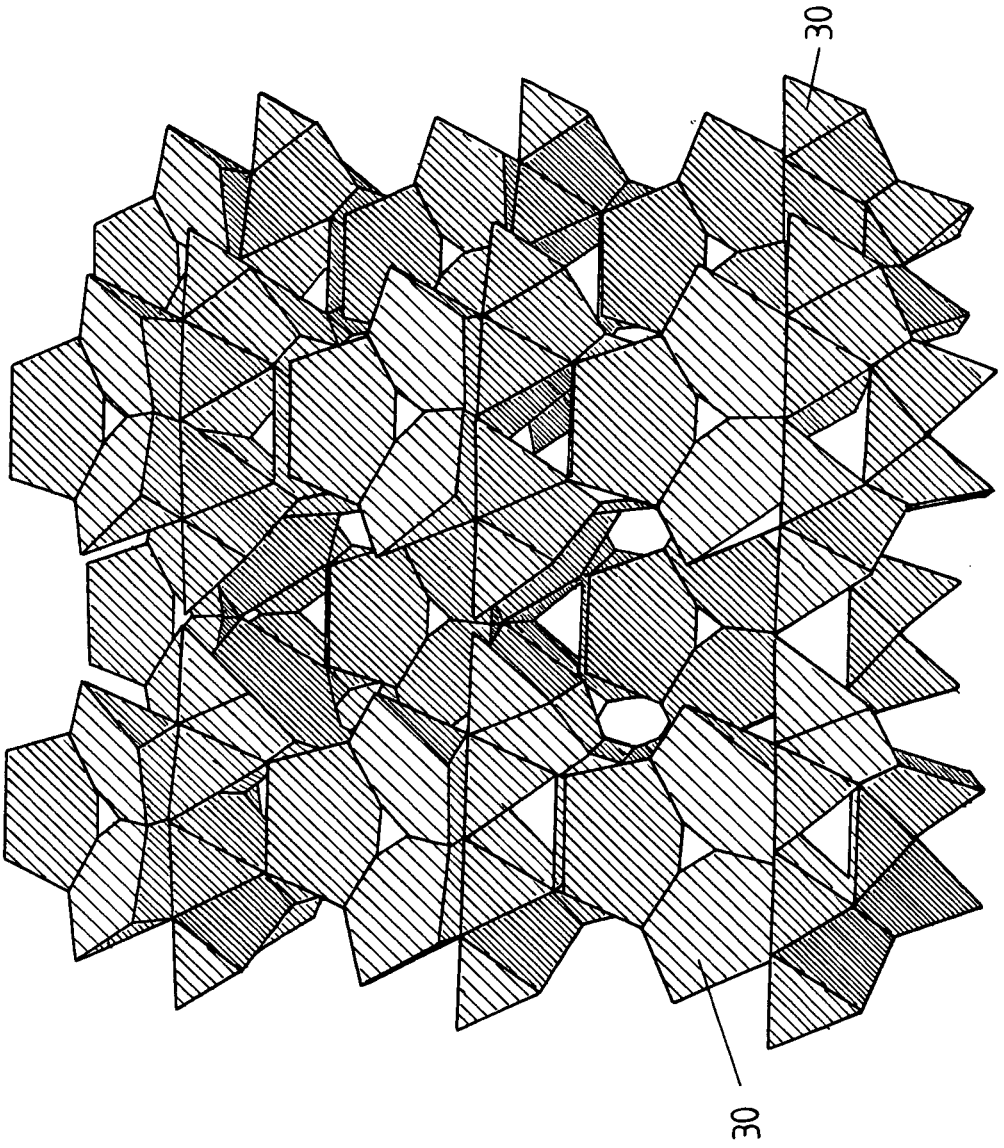


Fig. 13

Fig. 14

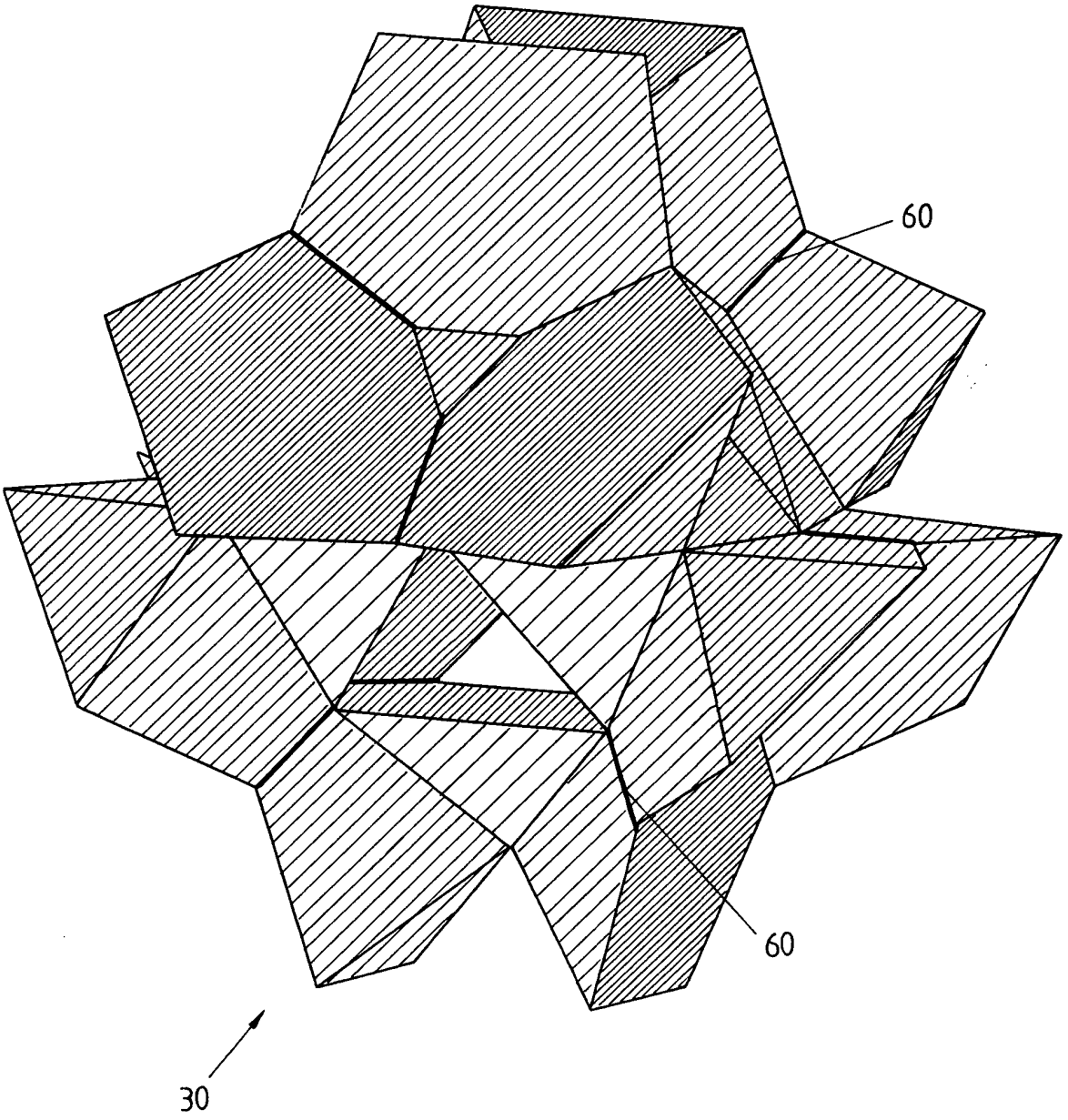


Fig. 15

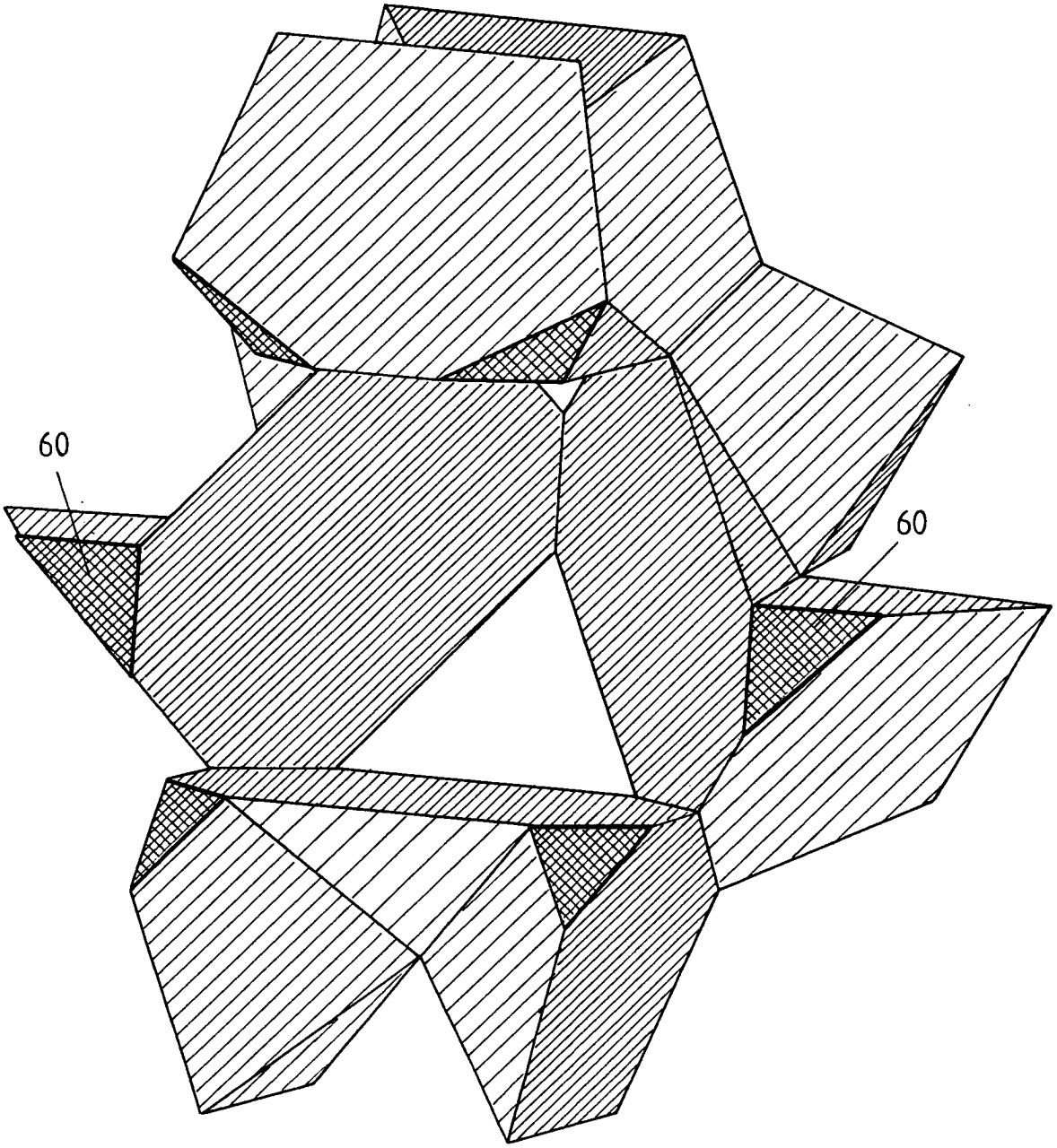


Fig. 16

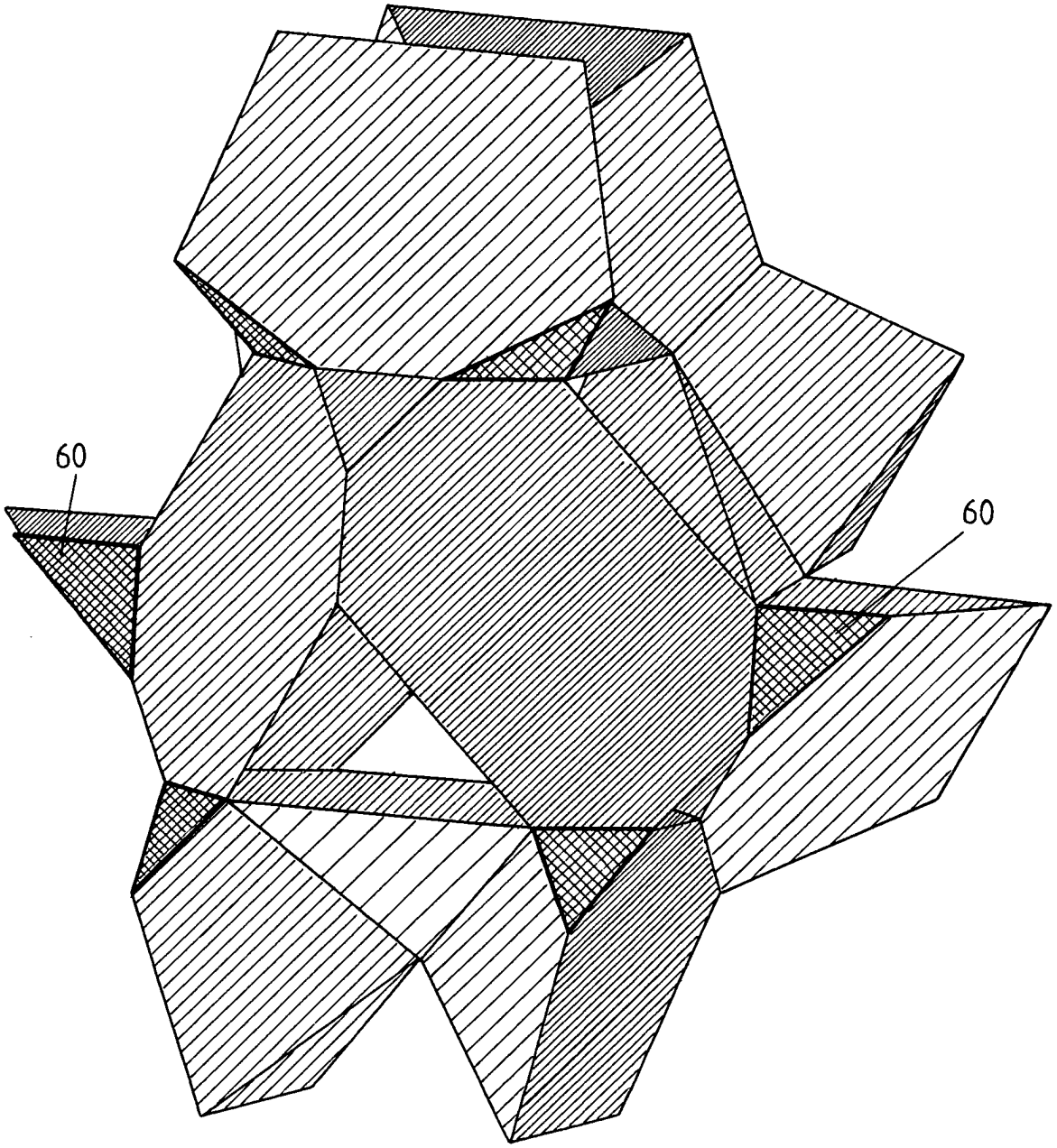


Fig. 17

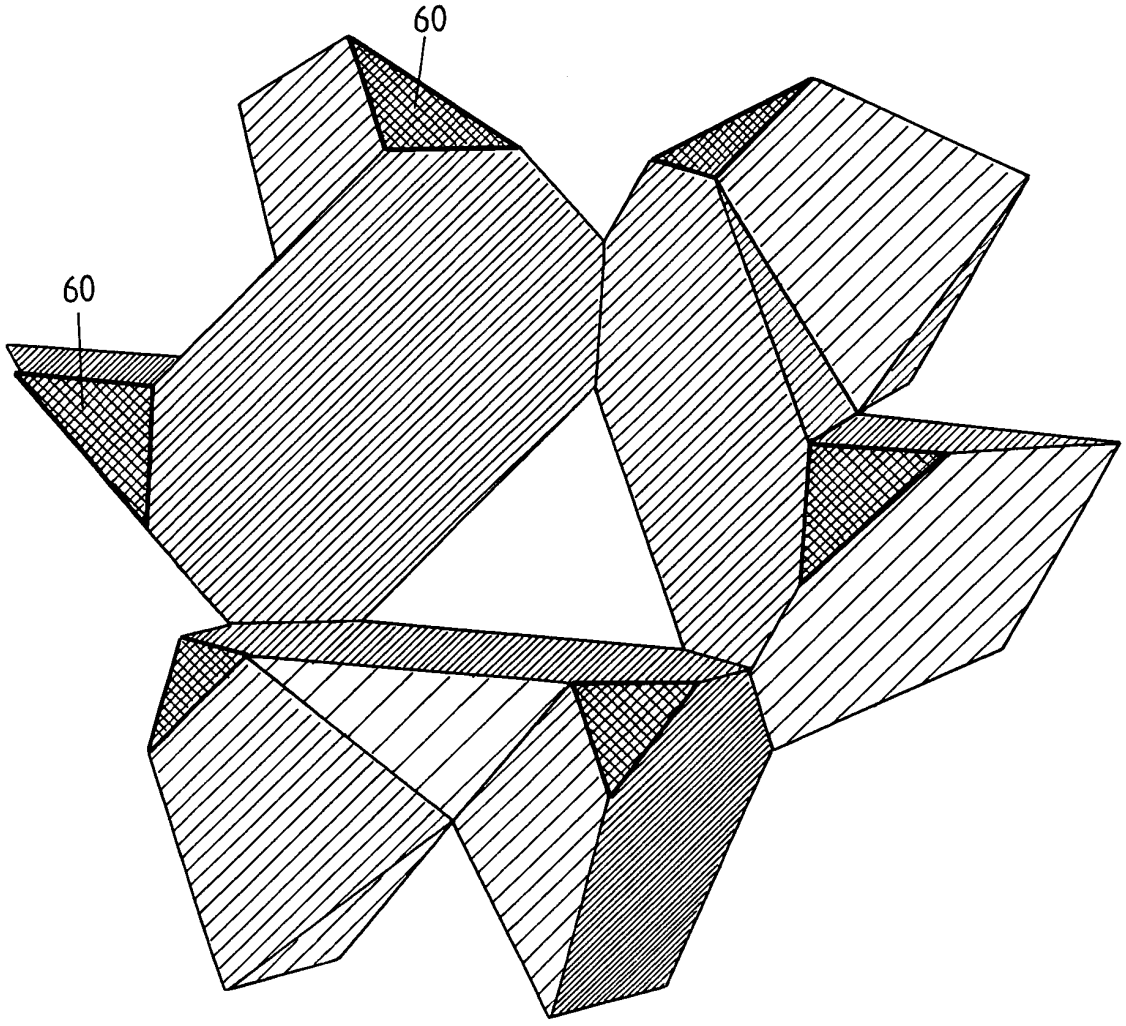
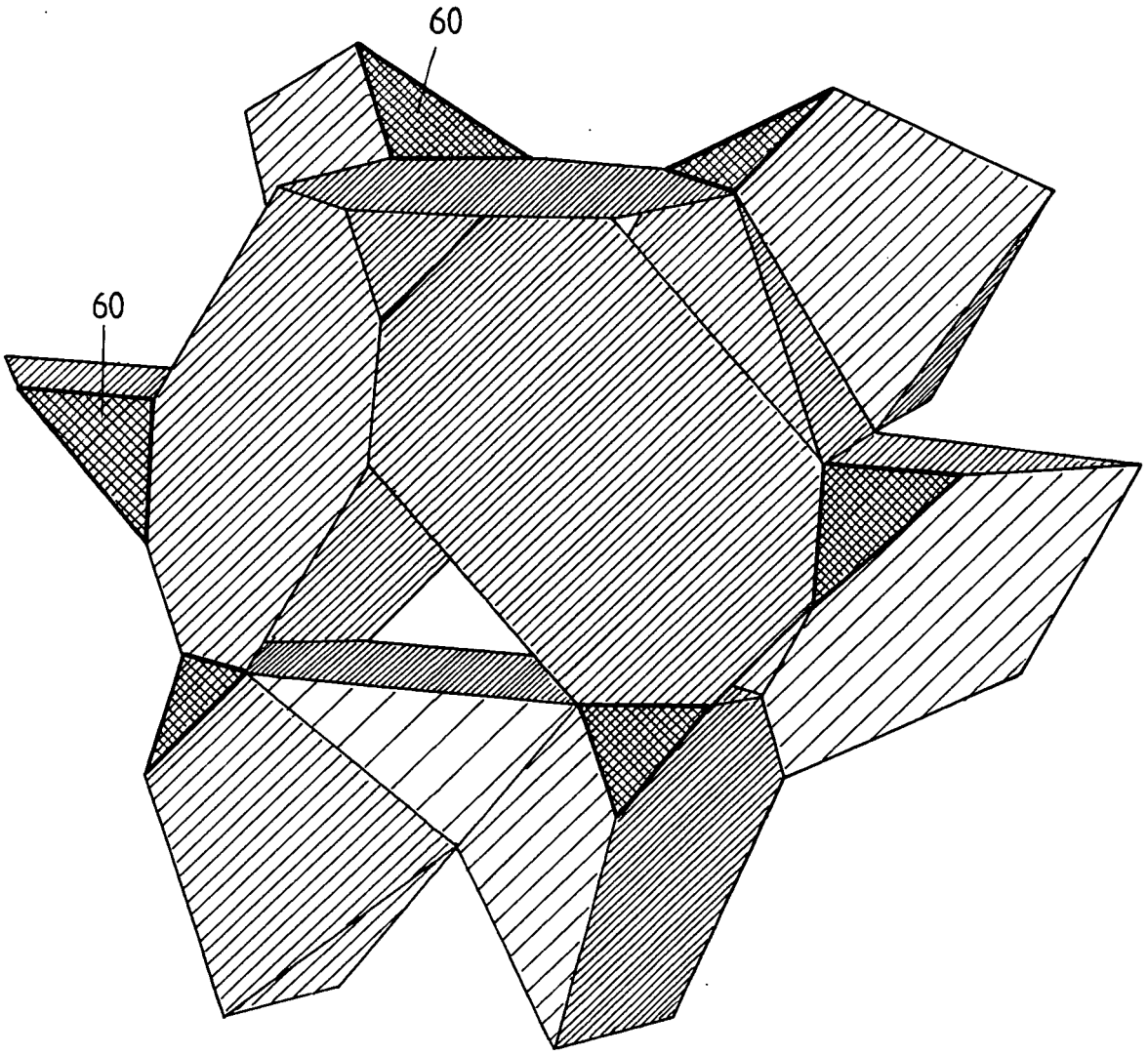


Fig. 18



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EUROPEAN SEARCH REPORT

Application Number
EP 09 07 5150

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	DE 16 09 752 A1 (NEUMANN HERWIG) 22 January 1970 (1970-01-22) * figures *		INV. E04B2/12
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			E04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	31 August 2009	Vratsanou, Violandi

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