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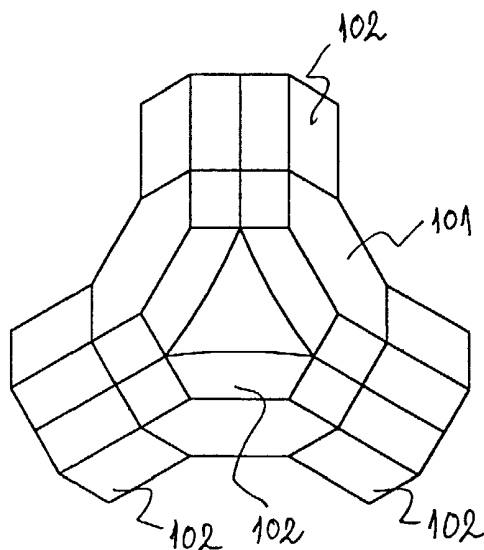
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(54) Title: THREE-DIMENSIONAL PUZZLE DEVICE COMPRISING A CENTRAL BODY, ROTATION-ELEMENTS AND PUZZLE-ELEMENTS



(57) Abstract: Puzzle device comprising a spatial central body with centre-symmetrical geometry, whereby the outer surface of said central body consists of eight equilateral hexagons and six squares, whereby the length of the sides of the squares equals the length of the sides of the equilateral hexagons, characterised by the fact that to some of said planes, puzzle-elements are attached in such a manner that a puzzle-element can be rotated round an imaginary axis which is perpendicular to the symmetry-centre of the central body to which the concerning puzzle-element is attached. The invention is further characterized by the fact that parts of said central body constitute rotation-elements, and that, through rotation of these rotation-elements, parts, can be exchanged between two or more puzzle-elements. The puzzle can be solved by combining rotations of the puzzle-elements and the rotation-elements in such a manner that, through mutual exchange of parts between puzzle-elements, a pre-defined initial situation can be restored. Said puzzle-elements can have such a shape and/or such appearance, that the puzzle device can serve as, for example, promotional item, advertising item, business gift, means of education etc.



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THREE-DIMENSIONAL PUZZLE DEVICE COMPRISING A CENTRAL BODY,
ROTATION-ELEMENTS AND PUZZLE-ELEMENTS

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The invention generally relates to a puzzle device having a spatial central body with centre-symmetrical geometry, whereby said central body may comprise various removable or movable parts and whereby the outer surface of said central body consists of multiple planes with centre-symmetrical geometry, characterised
10 by the fact that puzzle-elements are attached to several of said planes in such a manner that a puzzle-element can be rotated round an imaginary axis perpendicular to the symmetry-centre of the plane of the central body to which the particular puzzle-element is attached, and in such a manner that the plane of rotation is parallel to the plane of the central body to which the particular puzzle-element is
15 attached. The invention is further characterised by the fact that parts of said central body constitute rotation-elements, and that, through rotation of these rotation-elements, parts of the elements can be exchanged between two or more puzzle-elements. The puzzle can be solved by combining said rotations of the puzzle-elements and the rotation-elements in such a manner that, through mutual exchange of parts between puzzle-elements, a predefined initial situation can be
20 restored.

Three-dimensional puzzle structures are well-known in literature. One could think of the famous "Rubik's cube", where in the standard version each side
25 plane of the cube is divided into nine square parts, three of which can be simultaneously exchanged with other side planes of the cube by manual rotation of parts of the cube in planes parallel to the side planes.

In the course of time many variants of the concept appeared, with divers spatial shapes and operating principles. For example in US patent no. 4 865 323 a puzzle
30 device is described, consisting of a spherical body with an outer surface that is divided into surface-elements. Bands of surface-elements can be shifted horizontally around the spherical body, and two hemispheres of the spherical body can be rotated vertically with respect to each other along various vertical intersections.

The surface-elements of the outer surface of the spherical body can for example be numbered, coloured or printed with an illustration. The solution of the puzzle consists of restoring the initial configuration of the surface-elements of the spherical body through horizontal shifting of bands of surface-elements and through vertical rotation of hemispheres of the spherical body with respect to each other. A disadvantage of the described device is that the spherical body offers a bad grip for the hands of a user. In addition to this, the device only offers possibilities for promotion and advertising when the outer surface is, for instance, provided with an illustration and the difficulty level can not be modified by the user after purchase of the puzzle.

The patent document US 5 628 512 describes a puzzle-device consisting of two disc-shaped parts which are rotatable with respect to each other in the horizontal plane. At three locations in the outer periphery of the discs, smaller spherical parts are attached, that are rotatable round an axis in the plane of the outer periphery of said disc-shaped parts. The spherical parts are each subdivided into eight similar parts, four of which can be exchanged with other spherical parts through rotation of the disc-shaped parts. The two hemispheres of each spherical part can be rotated with respect to each other. Also in this case the puzzle is to be solved by restoring an initial situation through rotation of the disc-shaped parts with respect to each other, and through rotation of the hemispheres of the spherical parts with respect to each other. Also in this case a disadvantage of this device is the fact that the difficulty level can not be modified by the user after purchase of the puzzle, and the fact that one is restricted to the shape of the puzzle device for promotions and advertising.

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The principal aim of the present invention is to remedy said disadvantages of the prior art in this field by providing a puzzle device that is available in multiple variants and, additionally, offers a user the possibility to increase or decrease the difficulty-level of the puzzle device after purchase by simple replacement of certain parts. In addition to this, the shape of certain elements of the puzzle can be modified for promotional or advertising purposes and the construction of the device enables a good grip for experienced as well as for inexperienced users.

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To achieve this aim, the puzzle device can be advantageously constructed as a spatial central body with centre-symmetrical geometry, that can consist of several removable or movable parts. Geometrically such a central body can be envisaged as a combination of two pyramids with sides consisting of four equilateral triangles and with coinciding base-planes. Now when one tops off the six corners of this resulting body in the right manner, a geometrical body results, with an outer surface consisting of six squares and eight equilateral hexagons. The length of the sides of said squares are thereby equal to the length of the sides of said equilateral hexagons. Puzzle-elements are attached to some of the hexagonal planes in such a manner that a puzzle-element can be rotated round an imaginary axis that is perpendicular to the symmetry-centre of the plane of the central body to which the concerning puzzle-element is attached. A puzzle-element can be rotated in a plane that is parallel to the plane of the central body to which the concerning puzzle-element is attached. In the following description a rotation of a puzzle-element will be referred to as 'C_x-rotation'. The index x refers to the kind of C-rotation as will be explained in more detail later.

Furthermore, in the device according to the invention, each plane of the outer surface of the central body which has no puzzle-element attached to it, can form the central plane of a so-called rotation-element. A rotation-element consists of parts of the central body which can be rotated as a whole round an imaginary axis which goes through the symmetry-centre of said central plane of the rotation-element, and which is perpendicular to said central plane. A rotation element can be rotated in a plane parallel to said central plane of the rotation-element.

Said puzzle-elements of the device according to the invention preferably have such a construction and consist of such parts that, upon rotation of a rotation-element, one or more parts are detached from at least two puzzle-elements, are carried along by the rotation-element, and are added to another puzzle-element if the rotation-element is rotated over less than 360 degrees, thus enabling transportation of parts of a puzzle-element to other puzzle-elements. As will

be illustrated later in the description of preferred embodiments by means of the figures, the device according to the invention may comprise rotation-elements enabling exchange of parts between three puzzle-elements by means of rotation, and rotation-elements enabling exchange of parts between two puzzle-elements
5 by means of rotation. In a preferred embodiment of the device according to the invention, the rotation of the first rotation-element is at least 120 degrees and will be referred to as 'A-rotation' in the following. In a further preferred embodiment of the device according to the invention, the rotation of the latter rotation-element is at least 180 degrees and will be referred to as 'B-rotation' in the following.

10

In the device according to the invention a puzzle-element can be intersected one or several times in a plane that is parallel to the plane of the outer surface of the central body, to which the puzzle-element is attached, creating in every puzzle-element several parallel layers that can be rotated independently
15 from each other round a rotation centre that coincides with the symmetry-centre of the plane of the central body, to which the specific puzzle-element is attached, and where the rotation takes place in a plane that is parallel to the plane of the central body, to which the specific puzzle-element is attached. In the description of preferred embodiments of the device according to the invention by means of the
20 attached figures, the rotation of a puzzle-element that is not intersected parallel to the plane of the central body, to which it is attached, will be referred to as 'C₁-rotation', and the rotation of a puzzle-element that is intersected one or several times in the aforementioned way, will be referred to as 'C₂-rotation'.

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In the basic embodiment of the puzzle device according to the invention, puzzle-elements have to be rotated over at least 120 degrees in order to position parts of the puzzle-element in such a manner that these parts could be carried along by a next rotation-element, when this next rotation-element is rotated. Now when a puzzle-element is intersected in such a manner, along planes that are
30 perpendicular to the planes of the outer surface of the central body, to which the specific puzzle-element is attached, that the aforementioned minimal rotation is only 60 degrees, instead of 120 degrees, then such a rotation is referred to as 'C₃-

rotation'.

In a preferred embodiment of the device according to the invention, each puzzle-element has a colour or is provided with a graphical illustration that differs
5 from the colour/colours or the graphical illustration(s) of the visible parts of the outer surface of the central body. This offers a user the possibility to restore the initial situation by rotating rotation-elements and puzzle-elements and as such 'solve' the puzzle.

10 In a preferred embodiment of the puzzle device according to the invention, a user can easily replace puzzle-elements or parts of puzzle-elements with puzzle-elements or parts of puzzle-elements with other colours or graphical illustrations, or with a larger or smaller number of layers, thus increasing or decreasing
15 the difficulty level of the puzzle. Sets with parts enabling to change the difficulty level of the puzzle could for example be sold at the same points of sale where the basic-variants of the puzzle are also sold.

In a preferred embodiment of the puzzle device according to the invention, it comprises four rotation-elements and four puzzle-elements, where the rotation-
20 elements are rotatable round four imaginary axes that enclose angles of 120 degrees and coincide in the symmetry- centre of the central body. The puzzle-elements are rotated according to the earlier described C_x -rotations and the rotation-elements are rotated according to the earlier described A-rotations.

25 In a further preferred embodiment of the puzzle device according to the invention, it comprises six rotation-elements and four puzzle-elements, where the rotation-elements are rotatable round six imaginary axes that enclose angles of 90 degrees and coincide in the symmetry-centre of the central body. The puzzle-
30 elements are rotated according to the earlier described C_x -rotations and the rotation-elements are rotated according to the earlier described B-rotations.

In yet another preferred embodiment of the puzzle device according to the

invention, it comprises ten rotation-elements and four puzzle-elements, where four rotation-elements are rotatable round four imaginary axes (A-rotation) that enclose angles of 120 degrees, six rotation-elements are rotatable round six imaginary axes (B-rotation) that enclose angles of 90 degrees, and the ten imaginary axes
5 coincide in the symmetry-centre of the central body. The puzzle-elements are rotated according to the earlier described C_x -rotations.

Said puzzle-elements can have such a shape and/or have such an appearance, that the puzzle device can serve as, for example, a promotional item,
10 advertising item, business gift, means of education etc. One could envisage for example construction of the puzzle-elements as soft drink cans, chocolate bars, tulips etc. The puzzle device according to the invention provides many flexible options for this.

15 Figure 1A shows a top view of an $A-C_1$ embodiment of the device according to the invention.

Figure 1B shows a front view of $A-C_1$ embodiment of the device according to the invention.

20 Figure 2A shows a perspective view of an $A-C_1$ embodiment of the device according to the invention, in which the possible rotations of puzzle-elements and rotation-elements are illustrated by means of arrows.

Figure 2B shows a perspective view of an $A-C_1$ embodiment of the device according to the invention, where one of the four rotation-elements is illustrated after it has been rotated over 60 degrees.

25 Figure 2C shows a perspective view of the basic elements of the central body and the basic elements of the puzzle-elements in the case of an $A-C_x$ embodiment of the device according to the invention, where the internal system of axes has been illustrated in dotted lines.

30 Figure 2D illustrates how rotation-elements are added and attached to the basic elements of an $A-C_x$ embodiment of the device according to the invention.

Figure 2E illustrates how cover-elements are added and attached to the puzzle-elements for an $A-C_1$ or $A-C_2$ embodiment of the device according to the

invention.

Figure 2F illustrates how cover-elements are added and attached to the puzzle-elements for an A-C₃ or A-C_{2,3} embodiment of the device according to the invention.

5 Figure 3A shows a top view of a B-C₁ embodiment of the device according to the invention.

Figure 3B shows a front view of a B-C₁ embodiment of the device according to the invention.

10 Figure 4A shows a perspective view of a B-C₁ embodiment of the device according to the invention, in which the possible rotations of puzzle-elements and rotation-elements are illustrated by means of arrows.

Figure 4B shows a perspective view of a B-C₁ embodiment of the device according to the invention, where one of the six rotation-elements is illustrated after it has been rotated over 60 degrees.

15 Figure 4C shows a perspective view of the basic elements of the central body and the basic elements of the puzzle-elements in the case of a B-C_x embodiment of the device according to the invention, where the internal system of axes has been illustrated in dotted lines.

20 Figure 4D illustrates how the rotation-elements are added and attached to the basic elements of a B-C_x embodiment of the device according to the invention.

Figure 4E illustrates how cover-elements are added and attached to the puzzle-elements for a B-C₁ or B-C₂ embodiment of the device according to the invention.

25 Figure 4F illustrates how cover-elements are added and attached to the puzzle-elements for a B-C₃ or B-C_{2,3} embodiment of the device according to the invention.

Figure 5A shows a top view of an A-B-C₁ embodiment of the device according to the invention

30 Figure 5B shows a front view of an A-B-C₁ embodiment of the device according to the invention.

Figure 6A shows a perspective view of an A-B-C₁ embodiment of the device according to the invention, in which the possible A-rotations of the rotation-

elements and the possible C_1 -rotations of the puzzle-elements are illustrated by means of arrows.

Figure 6B shows a perspective view of an A-B- C_1 embodiment of the device according to the invention, in which the possible B-rotations of the rotation-
5 elements and the possible C_1 -rotations of the puzzle-elements are illustrated by means of arrows.

Figures 6C-6F schematically show the construction of an A-B- C_x embodiment of the device according to the invention.

Figure 7A shows a top view of a second variant of the A- C_1 embodiment
10 of the device according to the invention.

Figure 7B shows a front view of a second variant of the A- C_1 embodiment of the device according to the invention.

Figure 8A shows a perspective view of a second variant of the A- C_1 embodiment of the device according to the invention, in which the possible A-
15 rotations of the rotation-elements and the possible C_1 -rotations of the puzzle-elements are illustrated by means of arrows.

Figure 8B shows a perspective view of a second variant of the A- C_1 embodiment of the device according to the invention, where one of the four rotation-
elements is illustrated after having been rotated over 60 degrees.

Figures 8C-8E schematically show the construction of a second variant of
20 the A- C_x embodiment of the device according to the invention.

Figure 9A shows a top view of a second variant of the B- C_1 embodiment of the device according to the invention.

Figure 9B shows a front view of a second variant of the B- C_1 embodiment
25 of the device according to the invention.

Figure 10A shows a perspective view of a second variant of the B- C_1 embodiment of the device according to the invention, in which the possible B-
rotations of the rotation-elements and the possible C_1 -rotations of the puzzle-
elements are illustrated by means of arrows.

Figure 10B shows a perspective view of a B- C_1 embodiment of the device
30 according to the invention where one of the six rotation-elements is illustrated after having been rotated over 45 degrees.

Figures 10C-10E schematically show the construction of a second variant of the B-C₁ embodiment of the device according to the invention.

In the following several embodiments of the puzzle device according to the invention will be further explained by means of the attached figures. The description of the embodiments are merely meant to illustrate the invention and are by no means meant to limit the field of application of the invention.

In a first embodiment of the device according to the invention, the aforementioned A-rotation of four rotation-elements is combined with the aforementioned C₁-rotation of four puzzle-elements. As shown in the figures 1A, 1B, 2A, and 2B, four puzzle-elements (102) are present on four hexagonal planes of a central body (101). The remaining four hexagonal planes of the central body each form the central plane of one of four rotation-elements (201). In figure 2A the possible rotations of puzzle-elements and rotation-elements are shown by means of arrows. Furthermore, in this figure intersections that are required to enable rotation of the rotation-elements are shown by means of dotted lines. In figure 2A only the rotations and intersections of visible parts are shown. However, based on the symmetry of the device, rotations and intersections of non-visible parts are evident. To illustrate the A-rotation figure 2B shows one of the four rotation-elements that has been rotated over 60 degrees.

In figure 2C the basic elements of the central body (202) and the basic elements of the puzzle-elements (204) are shown for this embodiment of the puzzle device according to the invention. To enable rotation of the puzzle-elements and to hold the construction together, a system of axes (203) is present, consisting of eight axes extending radially from the symmetry-centre of the central body. Figure 2D shows how a rotation-element (201) is attached to the basic element (202) of the central body. The rotation-element (201) is rotatably attached to the end of one of the axes of the internal system of axes (203), through an opening (211), by means of a screw (205) and a coil-spring (206). When one desires to rotate a puzzle-element (102), it is necessary that the extending parts of the rotation-elements (201) are in line with the corresponding basic elements (204) of the puzzle-

elements. To facilitate this line-up of rotation-elements, each rotation-element is provided with three cylindrical cavities (207), each containing a metal pellet (208) and a coil-spring (209). The basic element (202) of the central body is provided with three semi-spherical recesses (210). When the extending parts of a rotation-

5 element are in line with the corresponding basic elements (204) of the puzzle-elements (102), the three pellets (208) are forced into the recesses (210) by coil-spring (209), which 'locks' the rotation-element in this position. A user can however easily rotate a 'locked' rotation-element by applying some force to the element. During the described rotation the pellets (208) function as ball-bearings. On

10 the outer surface of a rotation-element (201) a cover-element (212) is mounted, for example by glueing. This hides the screw (205) and the cavities (207) from view. The basic-elements (204) of the puzzle-elements are attached to the basic element (202) of the central body by mounting them on an axis of the internal system of axes (203) by means of a screw (213) and a coil-spring (214), through a

15 ring (215). In this process the head of screw (213) is countersunk into ring (215). The screw (213) is hidden from view by cover-element (216). Cover-element (216) has extending parts (217) which enable 'locking' it on the ring (215). The extending parts and the ring have a construction that is suited for this purpose. In addition to this, the cover-element (216) is attached to the basic-element (204) of the

20 puzzle-element by the extending widening parts (218) and the similar shaped grooves (219) in element (204). During assembly, the cover-element (216) is attached by first locking the extending parts (217) in the ring (215) and, subsequently, rotating the cover-element to slide the extending parts (218) into the grooves (219).

25 Figure 2E shows how the cover-elements (220) are attached to the extending parts of the rotation-elements. The appearance and shape of these cover-elements determine the appearance of the puzzle-elements. For attachment, each cover-element (220) is provided at the inner side with two ledges (221) which widen inwardly. The extending parts of the rotation-elements contain grooves

30 (222) in which the ledges (221) of the cover-elements (220) fit. To facilitate the sliding of ledges (221) into the grooves (222), metal pellets (223) are present in both grooves (222) of every extending part of a rotation-element, which are forced

outwardly by a coil-spring (not shown) and serve as ball-bearings. The cover-elements (220) may now be attached to the extending parts of the rotation-elements by rotating a rotation-element from the 'locked' position over about 60 degrees and subsequently sliding the ledges (221) of the cover-elements into the
5 grooves (222). When all cover-elements (220) are in place, the puzzle-elements can be rotated as a whole and a user can exchange cover-elements between different puzzle-elements by rotating a rotation-element.

When one would desire to increase the complexity of this embodiment of the puzzle device according to the invention, one could for instance replace every cover-
10 element (220) by a set of two cover-elements (224 and 225). This changes the C_1 -rotation of the puzzle-elements into the aforementioned C_2 -rotation. A user can easily perform this modification. A further possibility to increase the complexity of this embodiment of the puzzle device according to the invention is shown in figure 2F. Here each cover-element (220) is replaced with the set of two cover-elements
15 (226 and 227), or with the set of four cover-elements (228-231). In fact this causes cover elements (220), respectively cover-elements (224 and 225) to be vertically divided into two parts. This brings about the aforementioned C_3 -variant. Now a puzzle-element needs only to be rotated over 60 degrees instead of over 120 degrees to transport cover-elements to the adjacent extending part of a rotation-
20 element. To arrive at this configuration, the cover-elements (216) need to be replaced by the cover-element (232) and the three cover-elements (233). The attachment of these elements is achieved in a way similar to that of cover-elements (216). The use of the aforementioned cover-elements (228-231) combines the C_3 -variant of the puzzle-elements of this embodiment with a C_2 -rotation. In conclusion, one can now distinguish rotation variants C_1 , C_2 , C_3 or $C_{2,3}$ of the puzzle-
25 elements of this embodiment of the puzzle device according to the invention.

In a second embodiment of the puzzle device according to the invention, the aforementioned B-rotation of six rotation-elements is combined with the
30 aforementioned C_1 -rotation of four puzzle-elements. As shown in the figures 3A, 3B, 4A, and 4B, four puzzle-elements (302) are present on four hexagonal planes of a central body (301). The six square planes of the central body each form the

central plane of six rotation-elements (401). In figure 4A the possible rotations of puzzle-elements and rotation-elements are shown by means of arrows. Furthermore, in this figure intersections that are required to enable rotation of the rotation-elements are shown by means of dotted lines. In figure 4A only the rotations and intersections of visible parts are shown. However, based on the symmetry of the device, rotations and intersections of non-visible parts are evident. To illustrate the B-rotation figure 4B shows one of the four rotation-elements that has been rotated over 60 degrees.

In figure 4C the basic elements of the central body (402) and the basic elements of the puzzle-elements (404) are shown for this embodiment of the puzzle device according to the invention. To enable rotation of the puzzle-elements and to hold the construction together, a system of axes (403) is present, consisting of ten axes extending radially from the symmetry-centre of the central body. Figure 4D shows how a rotation-element (401) is attached to the basic element (402) of the central body. The rotation-element (401) is rotatably attached to the end of one of the axes of the internal system of axes (403), through an opening (411), by means of a screw (405) and a coil-spring (406). When one desires to rotate a puzzle-element (302), it is necessary that the extending parts of the rotation-elements (401) are in line with the corresponding basic elements (404) of the puzzle-elements. To facilitate this line-up of rotation-elements, each rotation-element is provided with two cylindrical cavities (407), each containing a metal pellet (408) and a coil-spring (409). The basic element (402) of the central body is provided with two semi-spherical recesses (410). When the extending parts of a rotation-element are in line with the corresponding basic elements (404) of the puzzle-elements (302), the two pellets (408) are forced into the recesses (410) by coil-spring (409), which 'locks' the rotation-element in this position. A user can however easily rotate a 'locked' rotation-element by applying some force to the element. During the described rotation the pellets (408) function as ball-bearings. On the outer surface of a rotation-element (401) a cover-element (412) is mounted, for example by glueing. This hides the screw (405) and the cavities (407) from view. The basic-elements (404) of the puzzle-elements are attached to the basic element (402) of the central body by mounting them on an axis of the internal

system of axes (403) by means of a screw (413) and a coil-spring (414), through a ring (415). In this process the head of screw (413) is countersunk into ring (415). The screw (413) is hidden from view by cover-element (416). Cover-element (416) has extending parts (417) which enable 'locking' it on the ring (415). The extending parts and the ring have a construction that is suited for this purpose. In addition to this, the cover-element (416) is attached to the basic-element (404) of the puzzle-element by the extending widening parts (418) and the similar shaped grooves (419) in element (404). During assembly, the cover-element (416) is attached by first locking the extending parts (417) in the ring (415) and, subsequently, rotating the cover-element to slide the extending parts (418) into the grooves (419).

Figure 4E shows how the cover-elements (420) are attached to the extending parts of the rotation-elements. The appearance and shape of these cover-elements determine the appearance of the puzzle-elements. For attachment, each cover-element (420) is provided at the inner side with two ledges (421) which widen inwardly. The extending parts of the rotation-elements contain grooves (422) in which the ledges (421) of the cover-elements (420) fit. To facilitate the sliding of ledges (421) into the grooves (422), two metal pellets (423) are present in both grooves (422) of every extending part of a rotation-element, which are forced outwardly by a coil-spring (not shown) and serve as ball-bearings. The cover-elements (420) may now be attached to the extending parts of the rotation-elements by rotating a rotation-element from the 'locked' position over about 90 degrees and subsequently sliding the ledges (421) of the cover-elements into the grooves (422). When all cover-elements (420) are in place, the puzzle-elements can be rotated as a whole and a user can exchange cover-elements between different puzzle-elements by rotating a rotation-element.

When one would desire to increase the complexity of this embodiment of the puzzle device according to the invention, one could for instance replace every cover-element (420) by a set of two cover-elements (424 and 425). This changes the C_1 -rotation of the puzzle-elements into the aforementioned C_2 -rotation. A user can easily perform this modification. A further possibility to increase the complexity of this embodiment of the puzzle device according to the invention is shown in figure

4F. Here each cover-element (420) is replaced with the set of two cover-elements (426 and 427), or with the set of four cover-elements (428-431). In fact this causes cover elements (420), respectively cover-elements (424 and 425) to be vertically divided into two parts. Now a puzzle-element needs only to be rotated over 60
5 degrees instead of over 120 degrees to transport cover-elements to the adjacent extending part of a rotation-element. To arrive at this configuration, the cover-elements (416) need to be replaced by the cover-element (432) and the six cover-elements (433). The attachment of these elements is achieved in a way similar to that of cover-elements (416). The use the aforementioned cover-elements (428-
10 431) combines the C_3 -variant of the puzzle-elements of this embodiment with a C_2 -rotation. In conclusion, one can now distinguish rotation variants C_1 , C_2 , C_3 or $C_{2,3}$ of the puzzle-elements of this embodiment of the puzzle device according to the invention.

15 In a third embodiment of the puzzle device according to the invention, the aforementioned A-rotation of four rotation-elements and the B-rotation of six rotation-elements are combined with the C_1 -rotation of four puzzle-elements. As shown in the figures 5A, 5B, 6A, and 6B, four puzzle-elements (502) are present on four hexagonal planes of a central body (501). Of the remaining planes of the
20 central body, four hexagonal planes and six square planes form the central planes of four type-A rotation-elements and six type-B rotation-elements respectively. In figure 6A the possible A-rotations of said four rotation-elements and the C_1 -rotations of the puzzle-elements are shown by means of arrows. In figure 6B the possible B-rotations of said six rotation-elements and again the C_1 -rotations of the
25 puzzle-elements are shown by means of arrows. Furthermore, in both figures 6A and 6B only the rotations and intersections of visible parts are shown. However, based on the symmetry of the device, rotations and intersections of non-visible parts are evident. As shown in figure 6C, contrary to the two previously described embodiments of the device according to the invention, this third embodiment con-
30 tains no basic element of the central body. The basic elements (603) of the puzzle-elements (502) and the basic elements of the ten rotation-elements are directly attached to the axes of a central system of axes (602).

When one desires to rotate a puzzle-element (502), it is necessary that the extending parts of the rotation-elements are in line with the corresponding basic elements (603) of the puzzle-elements. To facilitate this line-up of rotation-elements, the axes of the system of axes (602) to which the rotation-elements are to be attached, are provided with disc-shaped elements (604). Each of these disc-shaped elements (604) to which a rotation-element for A-rotations is to be attached, is provided with three semi-spherical recesses (605), and each of the disc-shaped elements to which a rotation-element for B-rotations is to be attached, is provided with two semi-spherical recesses (605). As will be clear later in the description of this embodiment of the device according to the invention, rotation-elements can be 'locked' in certain positions because ball-bearings of the rotation-element fall into said recesses (605). Each of the four basic elements (603) of the puzzle-elements is attached to an axis of the central system of axes (602) by means of a screw and a coil-spring (not shown in figure 6C).

Figure 6D shows how a basic element (606) of a rotation-element for the B-rotation is attached to one of said disc-shaped elements (604) by means of a screw (607) and a coil-spring (608). Each basic element (606) furthermore contains two cylindrical cavities (609) in which a pellet (610) and a coil-spring (611) are placed. When the extending parts of a basic element (606) of a rotation-element are in line with the corresponding basic elements (603) of the puzzle-elements, the pellets (610) will be forced into the two recesses (605) by coil-springs (611), and basic element (606) is 'locked' in this position. A user can however easily release basic element (606) from this position by applying some force to the element. During the described rotation the pellets (610) function as ball-bearings. The screw (607) and the cavities (609) with coil-springs (611) and pellets (610) are covered by cover-element (612), which can for instance be attached by glueing.

Figure 6E shows how a basic element (613) of a rotation-element for the A-rotation is attached to one of said disc-shaped elements (604) by means of a screw (614) and a coil-spring (615). Each basic-element (613) furthermore comprises three cylindrical cavities (616) in which a pellet (617) and a coil-spring (618) are placed. When the extending parts of a basic element (613) of a rotation-

element are in line with the corresponding basic elements (603) of the puzzle-elements, the pellets (617) will fall into the three recesses (605) and the basic element (613) will be 'locked' in this position. A user can however easily release basic element (613) from this position by exercising some force on the corresponding element. During such a rotation the pellets (617) function as ball-bearings. The screw (614), the cavities (616) with coil-springs (618) and pellets (617) are covered by cover-element (619) which can for instance be mounted by glueing.

Figure 6F shows, among other things, how the basic-elements (603) of the puzzle elements are attached on the corresponding axes of the central system of axes (602) by means of a screw (620) and a spiral spring (621), through a ring (622). In this process the head of the screw (620) is countersunk into ring (622). The screw (620) is hidden from view by cover-element(623). The cover-element can be 'locked' onto the ring (622) by means of the extending parts (624) on cover-element (623). The extending parts and the ring have a construction that is suited for this purpose. Furthermore, six triangular cover-elements (625) and (626) are placed in a star-shape around cover-element (623). The shape of the three cover-elements (625) differs from that of the three cover-elements (626) because of the different shapes of the intersections of a puzzle-element, caused by combining A-rotations and B-rotations in one and the same embodiment of the device according to the invention. The cover-elements (625) and (626) are attached to the puzzle-element by means of the widening extending parts (627) and the similar grooves (628) in the puzzle-element. Subsequently, the elements (629) are placed between the basic-elements of the rotation-elements for the A-rotations and the basic-elements of the rotation-elements for the B-rotations. These elements play a part in both the A-rotations and the B-rotations and are held in the construction by a curved ledge (630) which takes hold under the edge (631) of the internal cavity of the construction.

Figure 6F furthermore shows how the cover-elements (632) are attached to the extending parts of the basic elements of the rotation-elements. The appearance and shape of these cover-elements determine the appearance of the puzzle-elements. For attachment, each cover-element (632) is provided at the inner side

with two ledges (633) which widen inwardly. The extending parts of the rotation-elements contain grooves (634) in which the ledges (633) of the cover-elements (632) fit. To facilitate the sliding of ledges (632) into the grooves (633), metal pellets (635) are present in both grooves (633) of every extending part of a rotation-
5 element, which are forced outwardly by a coil-spring (not shown) and serve as ball-bearings. The cover-elements (632) may now be attached to the extending parts of the rotation-elements by slightly rotating a rotation-element from the 'locked' position and subsequently sliding the ledges (633) of the cover-elements into the grooves (634). When all cover-elements (632) are in place, the puzzle-
10 elements can be rotated as a whole and a user can exchange cover-elements between different puzzle-elements by rotating a rotation-element.

When one would desire to increase the complexity of this embodiment of the puzzle device according to the invention, one could for instance replace every cover-element (632) by a set of two cover-elements (635 and 636). This changes the C_1 -
15 rotation of the puzzle-elements into the aforementioned C_2 -rotation. A user can easily perform this modification. In conclusion, one can now distinguish rotation variants C_1 and C_2 of the puzzle-elements of this embodiment of the puzzle device according to the invention. The aforementioned C_3 -rotation is not possible in this case because of the differences in intersection of the puzzle-elements caused by
20 the combination of A- and B-rotations in this embodiment of the device according to the invention. For a correct functioning, puzzle-elements are in this case to be rotated over multiples of 120 degrees.

As fourth embodiment of the puzzle-device according to the invention a
25 variant of the earlier described A- C_x embodiment is described. The earlier described A- C_x embodiment had such a construction that intersections of the puzzle-elements did not cross each other and, therefore, the rotation-elements had no common parts. In the presently described variant of the A- C_x embodiment, intersections of the puzzle-elements do cross each other, and there are, besides the
30 cover-elements of the puzzle-elements, common parts present which can be taken along with the rotation of various rotation-elements. Furthermore, this variant is characterised by the fact that there are no basic-elements for puzzle-

elements present. These consist completely of the extending parts of the rotation-elements and said common parts.

As shown in the figures 7A, 7B, 8A, and 8B, four puzzle-elements (702) are present on four hexagonal planes of a central body (701). The four hexagonal planes
5 of the central body each form the central plane of four rotation-elements (801). In figure 8A only the rotations and intersections of visible parts are shown. However, based on the symmetry of the device, rotations and intersections of non-visible parts are evident. To illustrate this variant of the A-rotation, figure 8B shows one of the four rotation-elements that has been rotated over 60 degrees.

10 In figure 8C the basic-elements (802) of the rotation-elements (801) of this embodiment of the puzzle device according to the invention are shown. To enable rotation of the puzzle-elements and to hold the construction together a system of axes (803) is present, consisting of four axes that extend radially from the symmetry-centre of the central body. Each basic element (802) of a rotation-element
15 (801) is rotatably attached to the end of one of the axes of the internal system of axes (803) by means of a screw (804) and a coil-spring (805). In each basic-element (802) of a rotation-element, three cylindrical cavities (806) are present in a plane parallel to the central hexagonal plane of the element, each containing a pellet (807) and a coil-spring (808). The cavities extend radially from the centre of
20 said hexagonal plane, towards the respective middles of the sides between the extending parts of the basic-elements (802) of the rotation-elements. Under the influence of the spring pressure of the coil-springs (808) the pellets (807) are forced in outward direction and function as ball-bearings during the rotation of rotation-elements. The screw (804) and the cavities (806) in a basic element (802)
25 of a rotation-element are covered by a cover-element (809) which, for example, can be mounted by glueing.

Figure 8D shows that after attachment of the basic elements (802) to the axes of the system of axes (803), openings remain between said basic-elements. In these six openings the six common parts (809) are placed. These parts (809) are held
30 by the construction because they have a curved ledge (810), which takes hold under the edge of the spherical internal cavity of the construction.

Figure 8D furthermore shows how the cover-elements (811) are attached to the

extending parts of the basic elements (802) of the rotation-elements, and how the cover-elements (812) are attached to the extending parts of the common elements (809). The shape of cover-elements (811) differs from that of cover-elements (812). The appearance and shape of these cover-elements determine the appearance of the puzzle-elements. For attachment, each cover-element (811) and (812) is provided at the inner side with two ledges (813) which widen inwardly. The extending parts of the basic elements (802) of the rotation-elements, as well as the extending parts of the common elements (809) contain grooves (814) in which the ledges (813) of the cover-elements (811) and (812) fit. To facilitate the sliding of ledges (813) into the grooves (814), two metal pellets (815) are present in both grooves (814) of an extending part of a basic element, as well as in both grooves of an extending part of a common element (809), which are forced outwardly by a coil-spring (not shown) and serve as ball-bearings. When all cover-elements (811) and (812) are in place, the puzzle-elements can be rotated as a whole and a user can exchange cover-elements between different puzzle-elements by rotating a rotation-element (combination of basic elements of rotation-elements and two common parts).

Figure 8E clearly shows the opening between two basic elements (802) of the rotation-elements, in which a common element (809) is to be placed.

When one would desire to increase the complexity of this embodiment of the puzzle device according to the invention, one could for instance replace every cover-element (811) and (812) by a set of two cover-elements (not shown in the figures). This changes the C_1 -rotation of the puzzle-elements into the aforementioned C_2 -rotation. A user can easily perform this modification.

The aforementioned C_3 -rotation is not possible in this case, because of the crossing intersection of puzzle-elements. For a correct functioning puzzle-elements are to be rotated over multiples of 120 degrees in this case.

In conclusion, one can now distinguish rotation variants C_1 and C_2 of the puzzle-elements of this embodiment of the puzzle device according to the invention.

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As fifth embodiment of the puzzle-device according to the invention a second variant of the earlier described B- C_x embodiment is described. The earlier de-

- scribed B-C_x embodiment had such a construction that intersections of the puzzle-elements did not cross each other and, therefore, the rotation-elements had no common parts. In the presently described variant of the B-C_x embodiment, intersections of the puzzle-elements do cross each other, and there are, besides the cover-elements of the puzzle-elements, common parts present which can be taken along with the rotation of various rotation-elements. Furthermore, this variant is characterised by the fact that there are no basic-elements for puzzle-elements present. These consist completely of the extending parts of the rotation-elements and said common parts.
- 5
- 10 As shown in the figures 9A, 9B, 10A, and 10B, six puzzle-elements (902) are present on six hexagonal planes of a central body (901). The six square planes of the central body each form the central plane of six rotation-elements (1001). In figure 10A the possible rotations of puzzle-elements and rotation-elements are shown by arrows. Furthermore, intersections that are required to enable rotation of the rotation-elements are shown by dotted lines in this figure. In figure 10A only the rotations and intersections of visible parts are shown. However, based on the symmetry of the device, rotations and intersections of non-visible parts are evident. To illustrate this variant of the B-rotation, figure 10B shows one of the six rotation-elements that has been rotated over 45 degrees.
- 15
- 20 In figure 10C the basic-elements (1002) of the rotation-elements (1001) of this embodiment of the puzzle device according to the invention are shown. To enable rotation of the rotation-elements and to hold the construction together, a system of axes (1003) is present, consisting of six axes that extend radially from the symmetry-centre of the central body. Figure 10E shows that each basic element (1002) of a rotation-element (1001) is rotatably attached to the end of one of the axes of the internal system of axes (1003) by means of a screw (1004) and a coil-spring (1005). In each basic-element (1002) of the rotation-element four cylindrical cavities (1006) are present in a plane parallel to the central square plane of the element, each containing a pellet (1007) and a coil-spring (1008). The cavities extend radially from the centre of said square plane, towards the respective corners of the square plane. Under the influence of the spring pressure of the coil-springs (1008) the pellets (1007) are forced in outward direction and function as
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ball-bearings during the rotation of the rotation-elements. The screw (1004) and the cavities (1006) in a basic element (1002) of a rotation-element are covered by a cover-element (1009) which, for example, can be mounted by glueing.

Figure 10D shows that after attachment of the basic elements (1002) to the axes of the system of axes (1003), openings remain between said basic-elements. In these twelve openings the twelve common parts (1009) are placed. These parts (1009) are held by the construction because they have a curved ledge (1010), which takes hold under the edge of the spherical internal cavity of the construction.

Figure 10D furthermore shows how the cover-elements (1011) are attached to the extending parts of the basic elements (1002) of the rotation-elements, and how the cover-elements (1012) are attached to the extending parts of the common elements (1009). The shape of cover-elements (1011) differs from that of cover-elements (1012). The appearance and shape of these cover-elements determine the appearance of the puzzle-elements. For attachment, each cover-element (1011) and (1012) is provided at the inner side with two ledges (1013) which widen inwardly. The extending parts of the basic elements (1002) of the rotation-elements, as well as the extending parts of the common elements (1009) contain grooves (1014) in which the ledges (1013) of the cover-elements (1011) and (1012) fit. To facilitate the sliding of ledges (1013) into the grooves (1014), two metal pellets (1015) are present in both grooves (1014) of every extending part of a basic-element (1002), as well as in both grooves of every extending part of a common element (1009), which are forced outwardly by a coil-spring (not shown) and serve as ball-bearings. When all cover-elements (1011) and (1012) are in place, the puzzle-elements can be rotated as a whole and a user can exchange cover-elements between different puzzle-elements by rotating a rotation-element (combination of basic elements of rotation-elements and two common parts).

When one would desire to increase the complexity of this embodiment of the puzzle device according to the invention, one could for instance replace every cover-element (1011) and (1012) by a set of two cover-elements (not shown in the figures). This changes the C_1 -rotation of the puzzle-elements into the aforementioned C_2 -rotation. A user can easily perform this modification.

The aforementioned C_3 -rotation is not possible in this case, because of the crossing intersection of puzzle-elements. For a correct functioning puzzle-elements are to be rotated over multiples of 120 degrees in this case.

In conclusion, one can now distinguish rotation variants C_1 and C_2 of the puzzle-
5 elements of this embodiment of the puzzle device according to the invention.

By replacing the described standard cover-elements of the different embodiments, with cover-elements with other colours, graphical illustrations, or even other shapes, the puzzle device according to the invention can also be used as
10 promotional item, advertising item, business gift, means of education etc.

All parts of the described embodiments of the puzzle device according to the invention can be manufactured with the use of standard materials and common production techniques and methods.

CLAIMS

1. Puzzle device comprising a spatial central body with centre-symmetrical geometry, which can consist of various removable or movable parts,
5 whereby the outer surface of said central body consists of eight equilateral hexagons and six squares, whereby the length of the sides of the squares equals the length of the sides of the equilateral hexagons, characterised by the fact that to some of said planes puzzle-elements are attached in such a manner that a puzzle-element can be rotated round an imaginary axis which is perpendicular to the
10 symmetry-centre of the plane of the central body to which the concerning puzzle-element is attached, and whereby the rotation takes place in a plane parallel to the plane of the central body to which the concerning puzzle-element is attached.

2. Puzzle device according to claim 1, characterised by the fact that each
15 plane of the outer surface of the central body, to which no puzzle-element is attached, can form the central plane of a rotation-element, whereby a rotation-element consists of parts of the central body which can be rotated as a whole round an imaginary axis which is perpendicular to the symmetry-centre of said central plane of the rotation-element, and whereby the rotation takes place in a
20 plane parallel to said central plane of the rotation-element.

3. Puzzle device according to claim 2, characterised by the fact that said puzzle-elements have such a construction, and consist of such parts that, during rotation of a rotation-element, one or more parts are detached from at least two
25 puzzle-elements, which are carried along by the rotation-element and are added to another puzzle-element if the rotation-element is rotated over less than 360 degrees, thus enabling transportation of parts of a puzzle-element to other puzzle-elements.

30 4. Puzzle-device according to one of the previous claims, characterised by the fact that each puzzle-element is intersected one or more times, in a plane parallel to the plane of the outer surface of the central body to which the puzzle-

element is attached, thus creating multiple parallel layers in each puzzle-element, which can be rotated independently of each other round a rotation centre that coincides with the symmetry-centre of the plane of the central body to which the concerning puzzle-element is attached, whereby the rotation takes place in a plane parallel to the plane of the central body to which the concerning puzzle-element is attached.

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5. Puzzle-device according to one of the claims 2 to 4, characterised by the fact that each puzzle-element is intersected along planes perpendicular to the plane of the outer surface of the central body to which the concerning puzzle-element is attached, in such a manner that a puzzle-element only needs to be rotated over 60 degrees to transport parts of the puzzle-element to a next rotation-element.

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6. Puzzle device according to one of the previous claims, characterised by the fact that each puzzle-element has a color or is provided with a graphical illustration, that differs from the color/colors or graphical illustration(s) of the visible parts of the outer surface of the central body.

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7. Puzzle device according to claim 5, characterised by the fact that a user can easily replace puzzle-elements or parts of puzzle-elements, with puzzle-elements with other colors or with a larger or smaller number of layers, through which the difficulty level of the puzzle is increased or decreased.

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8. Puzzle device according to one of the claims 2 to 7, characterised by the fact that the device comprises four rotation-elements and four puzzle-elements, whereby the rotation-elements are rotatable round four imaginary axes that enclose angles of 120 degrees and coincide in the symmetry-centre of the central body.

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9. Puzzle device according to one of the claims 2 to 7, characterised by the fact that the device comprises six rotation-elements and four puzzle-elements,

whereby the rotation-elements are rotatable round six imaginary axes that enclose angles of 90 degrees and coincide in the symmetry-centre of the central body.

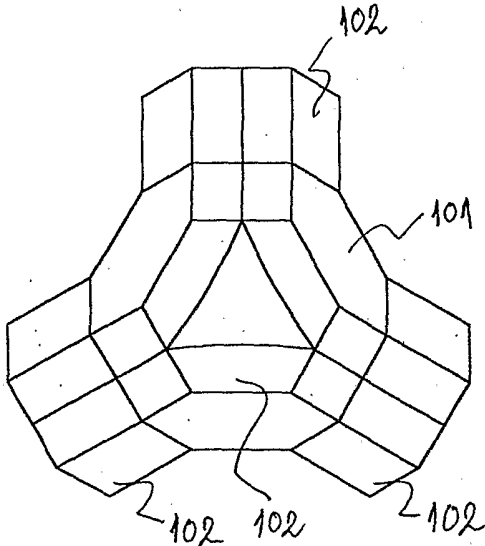
10. Puzzle-device according to one of the claims 2 to 7, characterised by
5 the fact that the device comprises ten rotation-elements and four puzzle-elements, whereby four rotation-elements are rotatable round four imaginary axes that enclose angles of 120 degrees, and six rotation-elements are rotatable round six imaginary axes that enclose angles of 90 degrees, and whereby the ten imaginary axes coincide in the symmetry-centre of the central body.

10

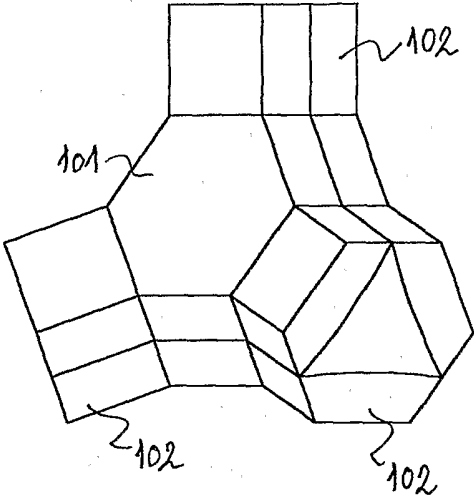
11. Puzzle-structure according to one of the previous claims, characterised by the fact that said puzzle-elements have such a shape and/or have such appearance, that the puzzle device can serve as, for example, promotional item, advertising item, business gift, means of education etc.

15

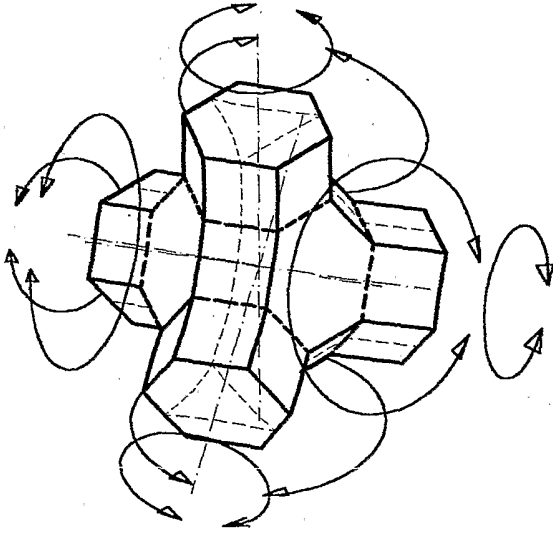
FIGUUR 1 A



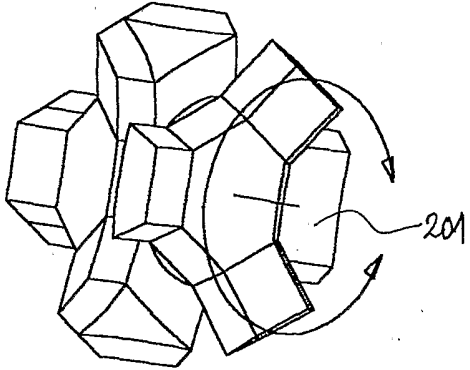
FIGUUR 1 B



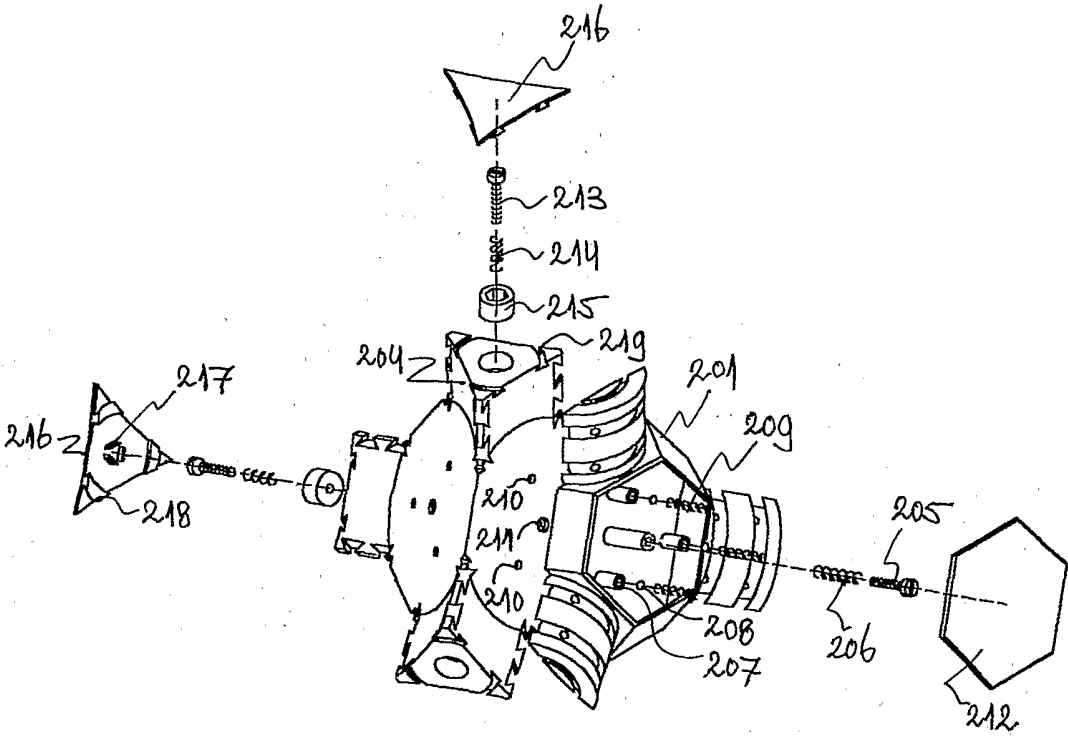
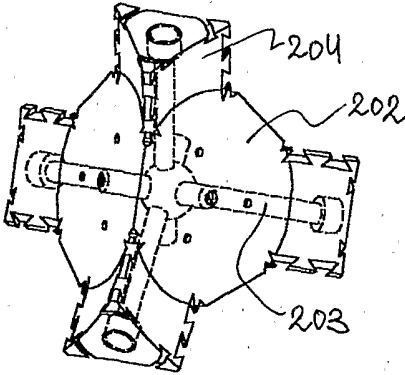
FIGUUR 2 A



FIGUUR 2 B

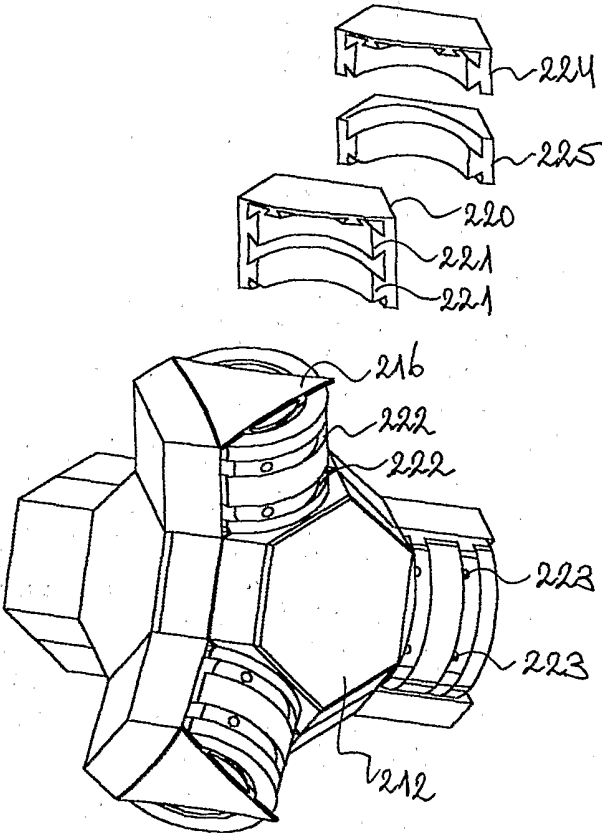


FIGUUR 2C

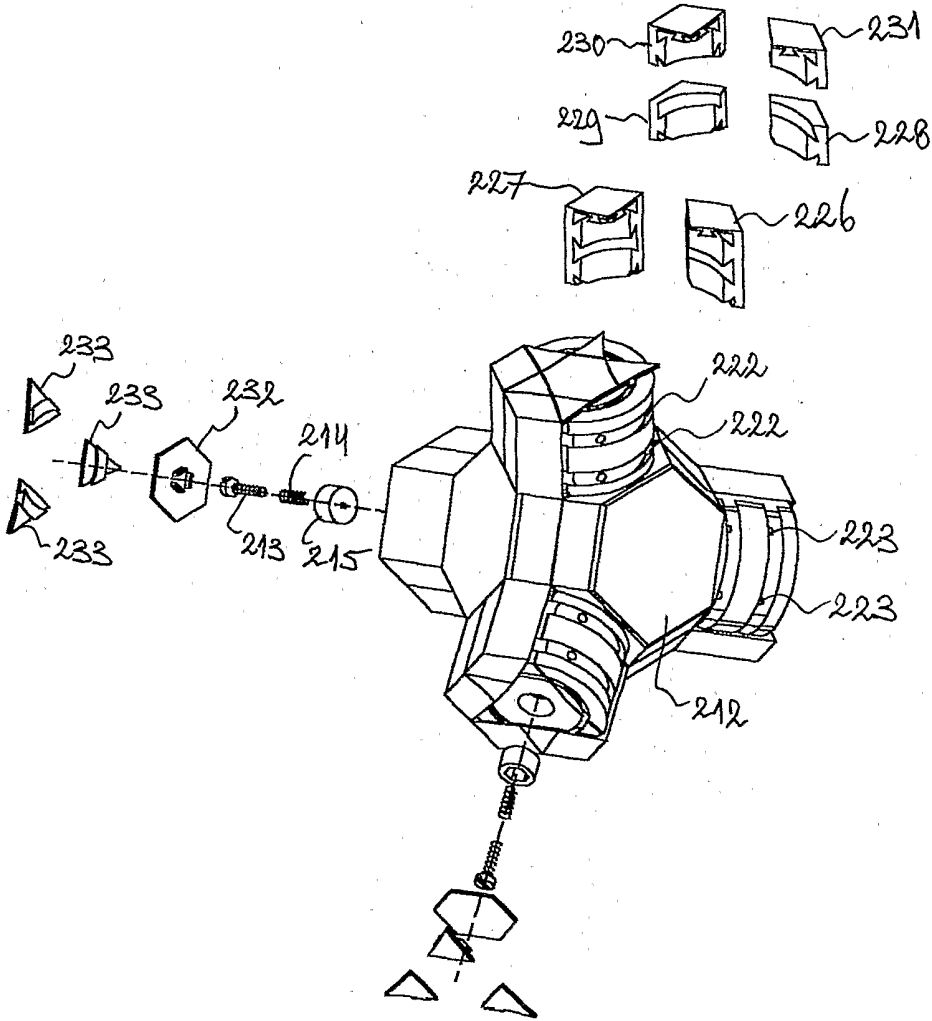


FIGUUR 2D

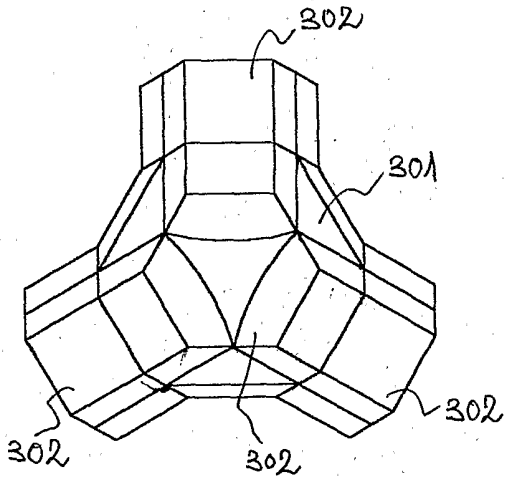
FIGUUR 2E



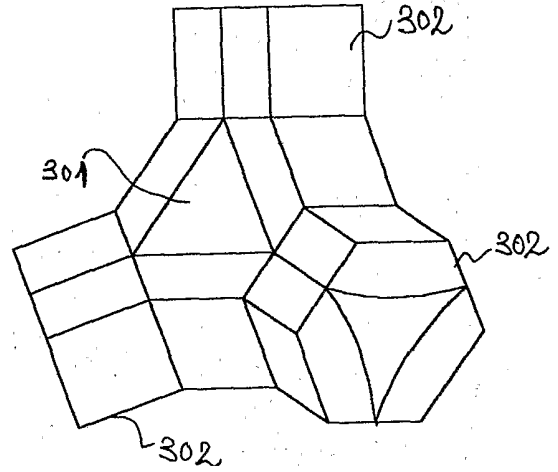
FIGUUR 2F



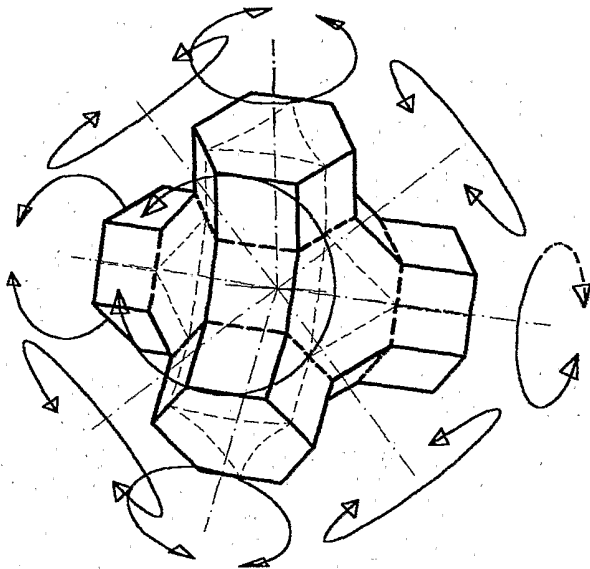
FIGUUR 3A



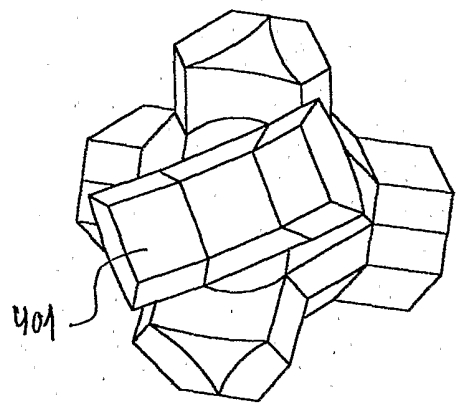
FIGUUR 3B



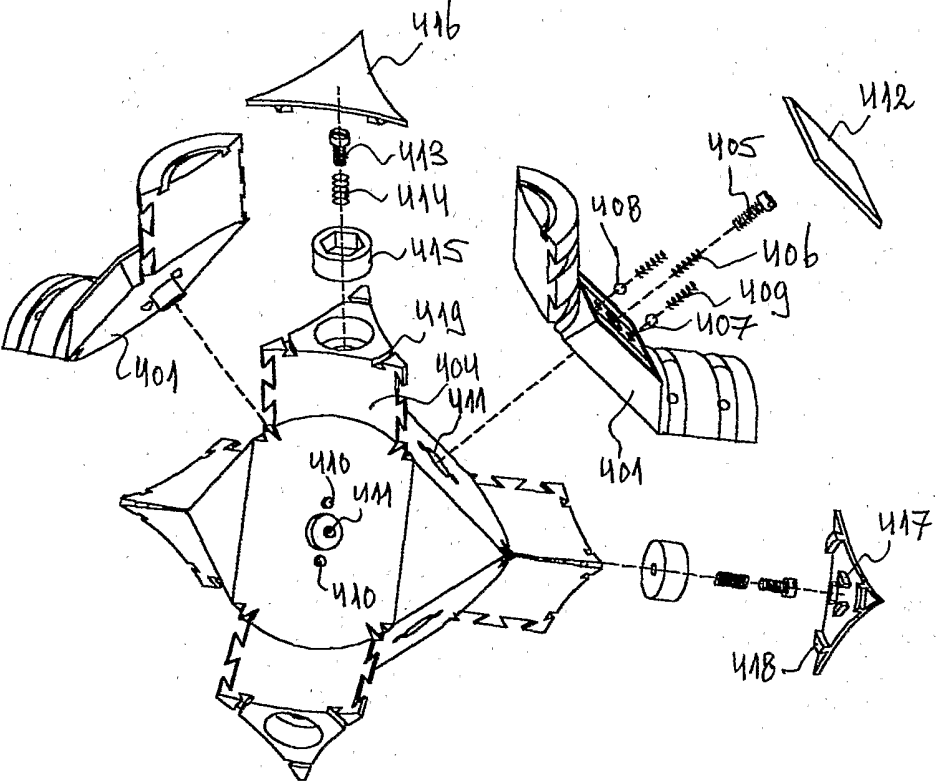
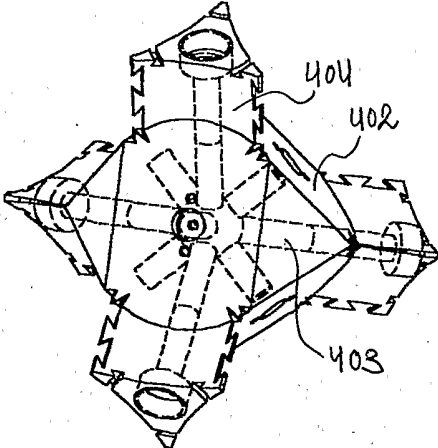
FIGUUR 4A



FIGUUR 4B

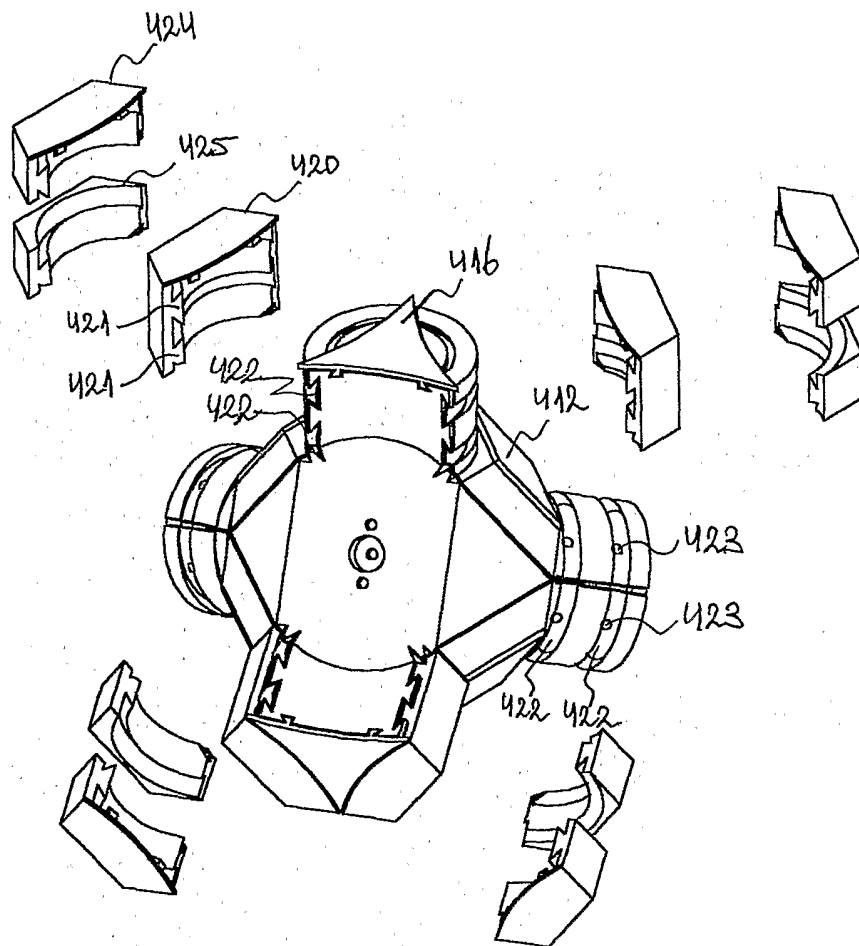


FIGUUR 4C

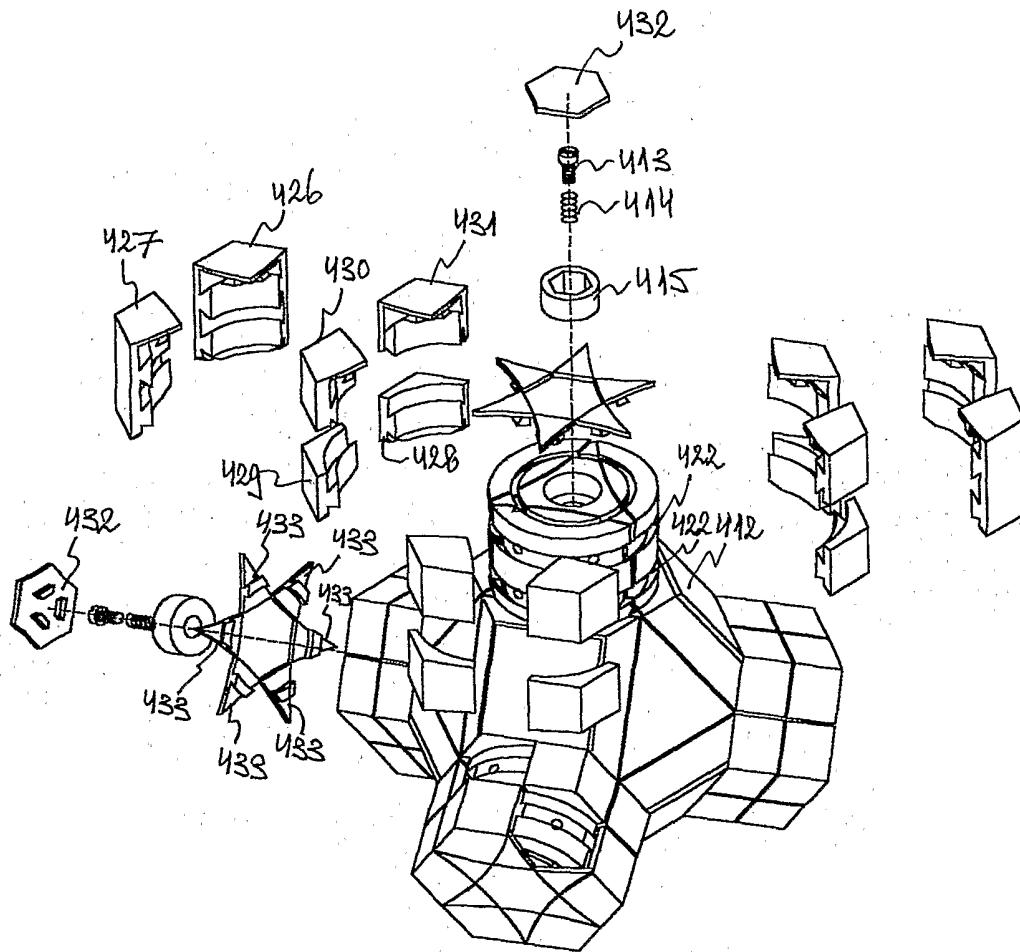


FIGUUR 4D

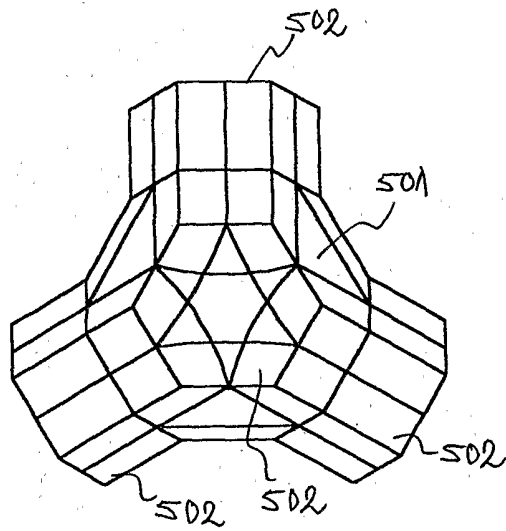
FIGUUR 4E



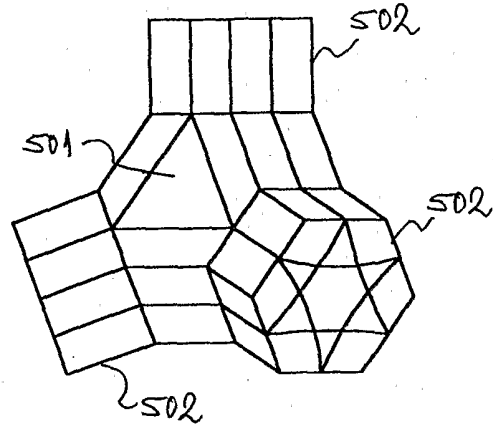
FIGUUR 4F



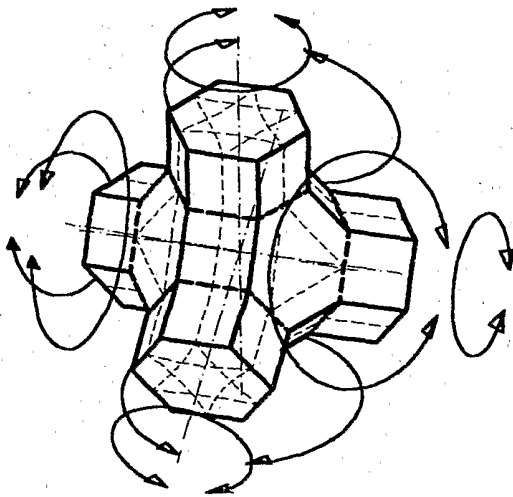
FIGUUR 5A



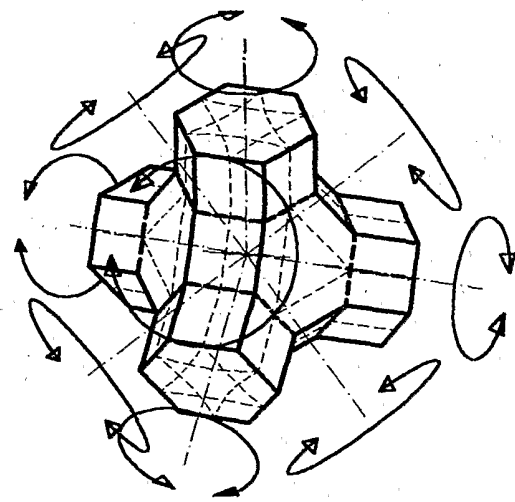
FIGUUR 5B



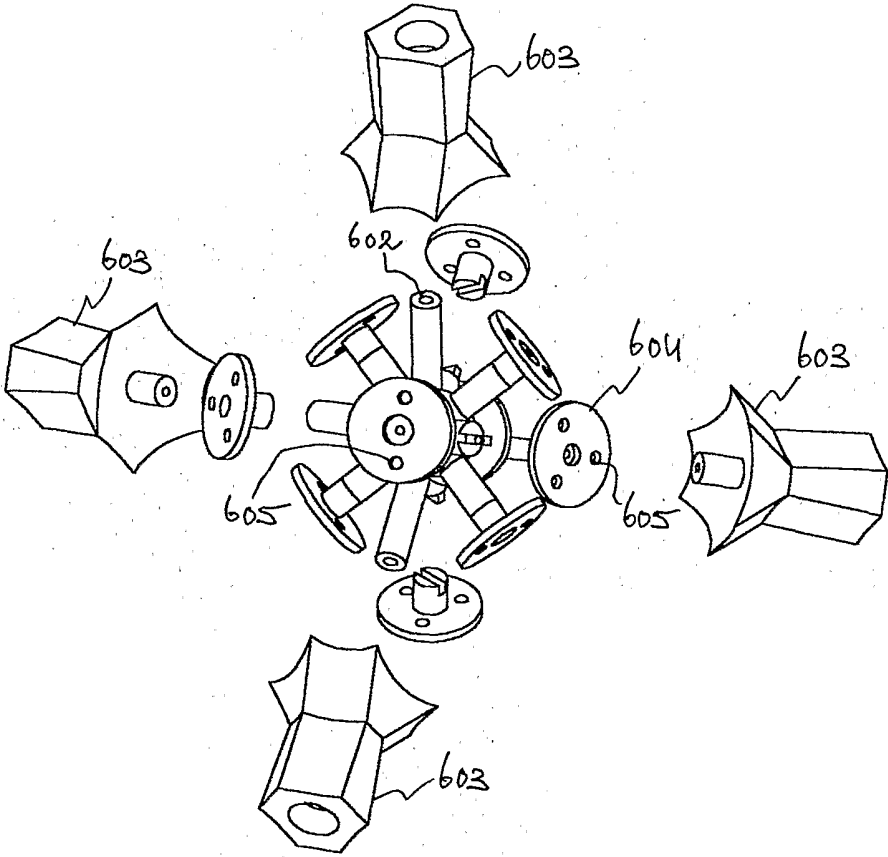
FIGUUR 6A



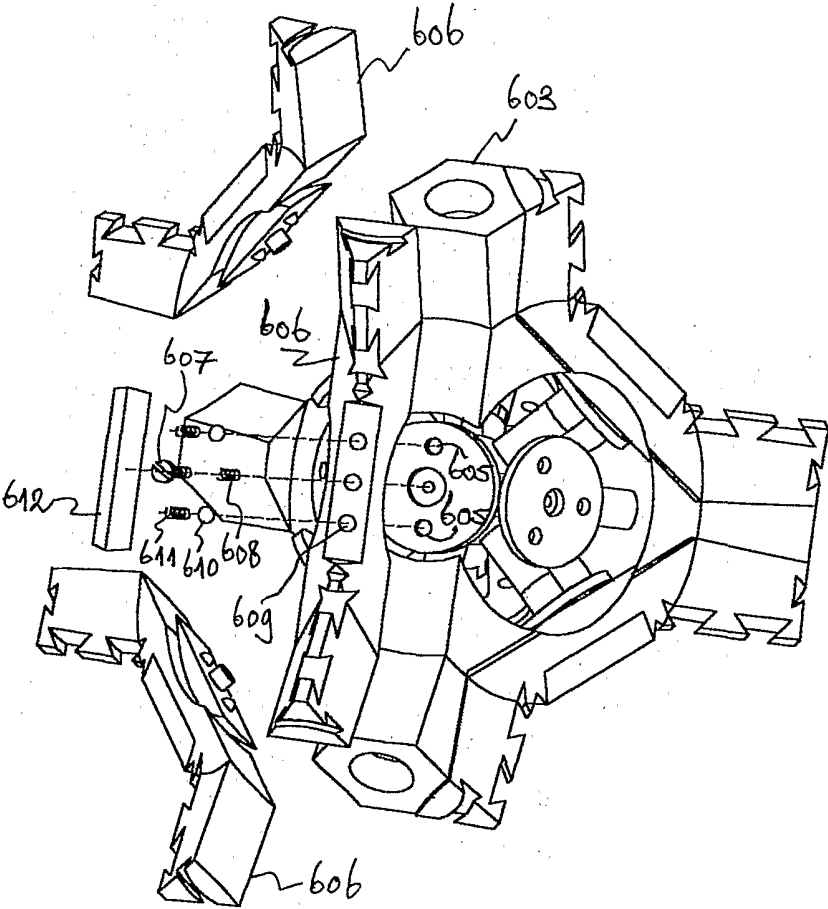
FIGUUR 6B



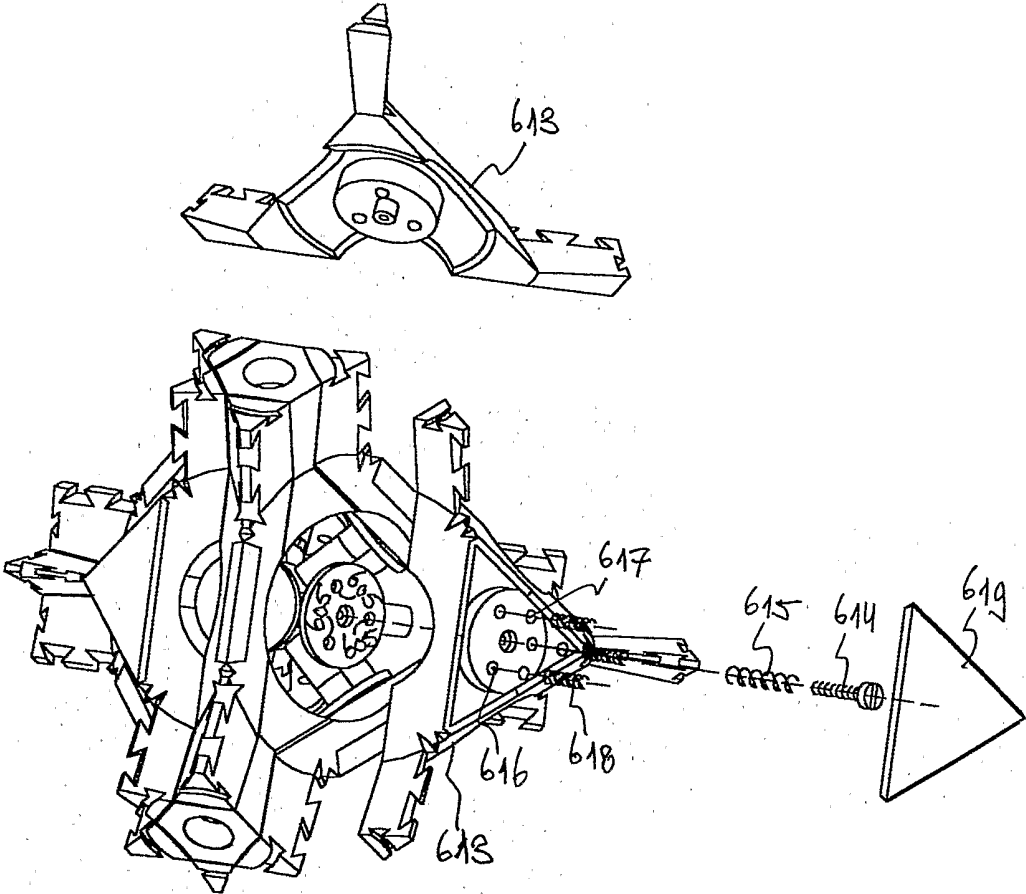
FIGUUR 6C



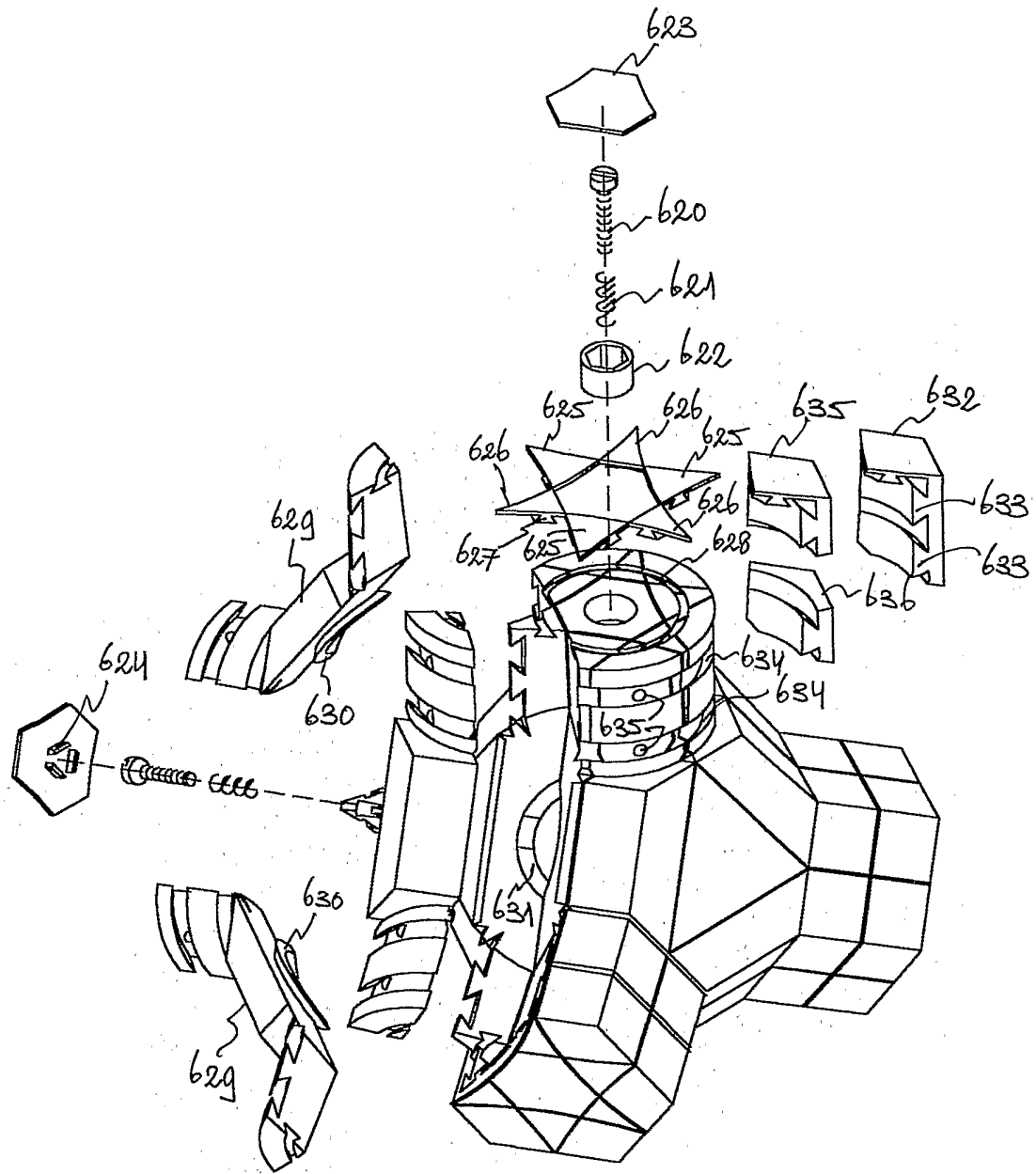
FIGUUR 6D



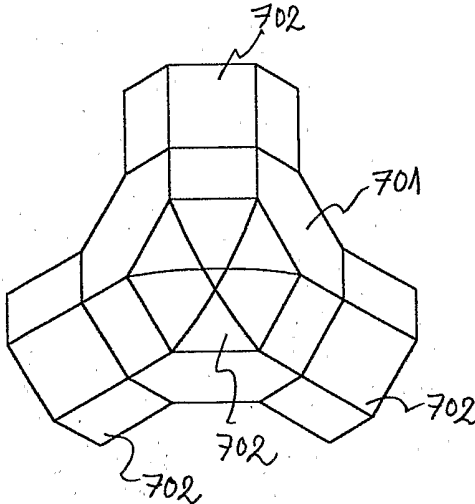
FIGUUR 6E



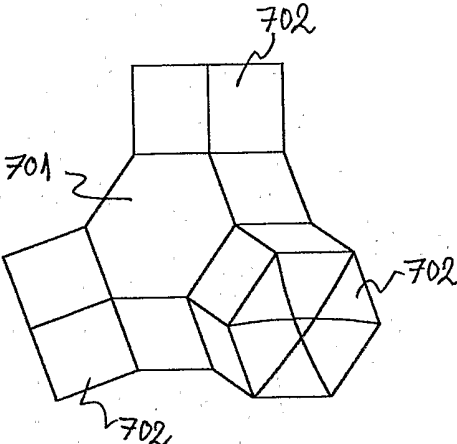
FIGUUR 6F



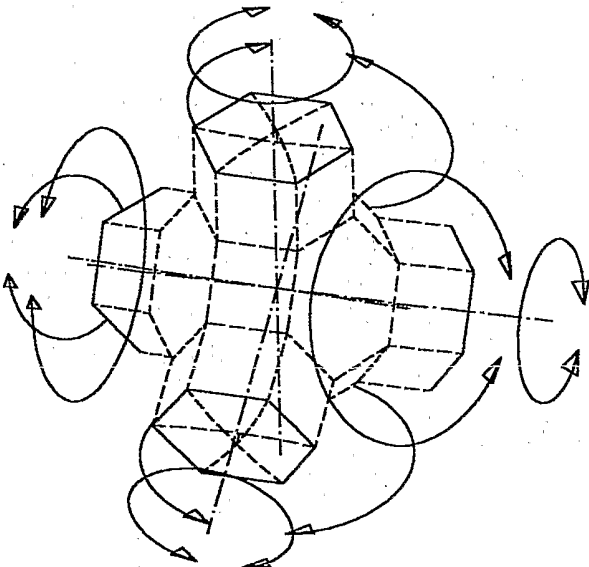
FIGUUR 7A



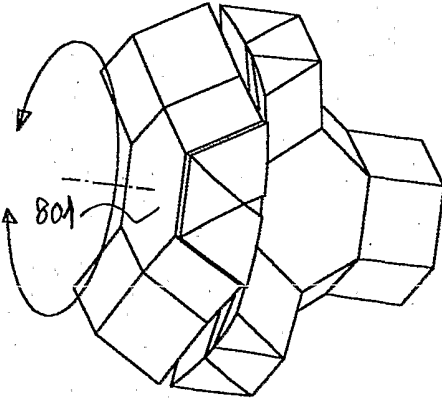
FIGUUR 7B



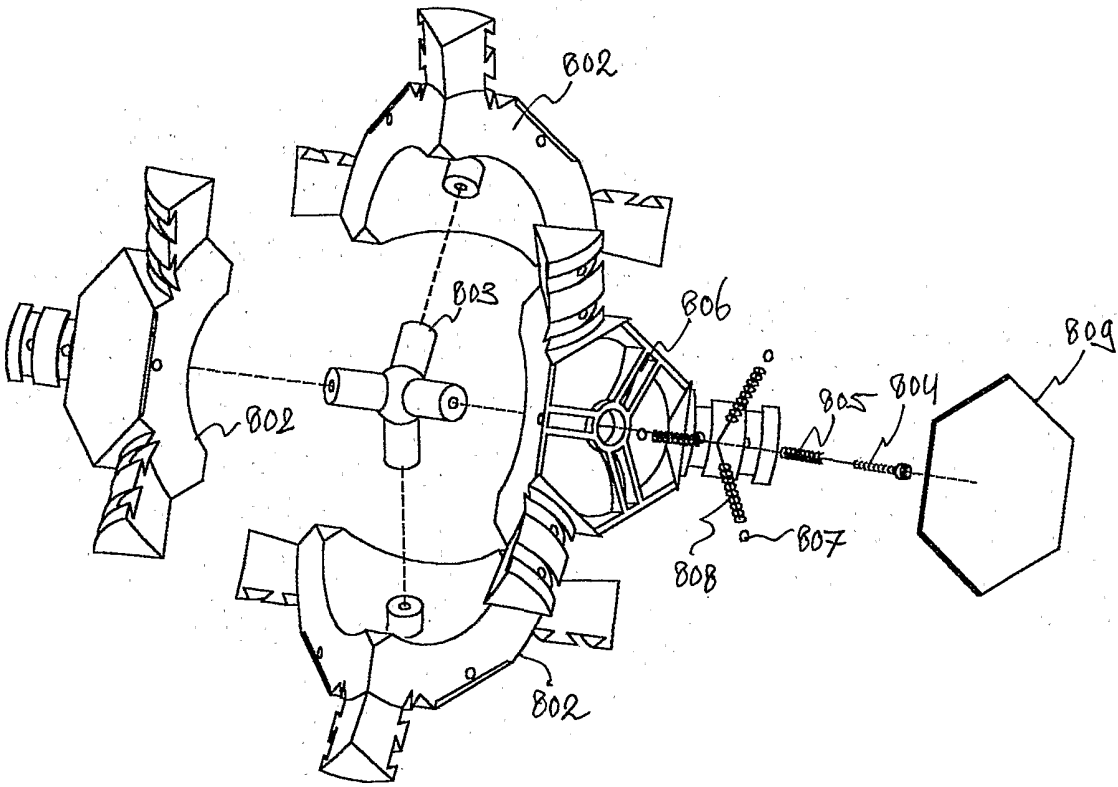
FIGUUR 8A



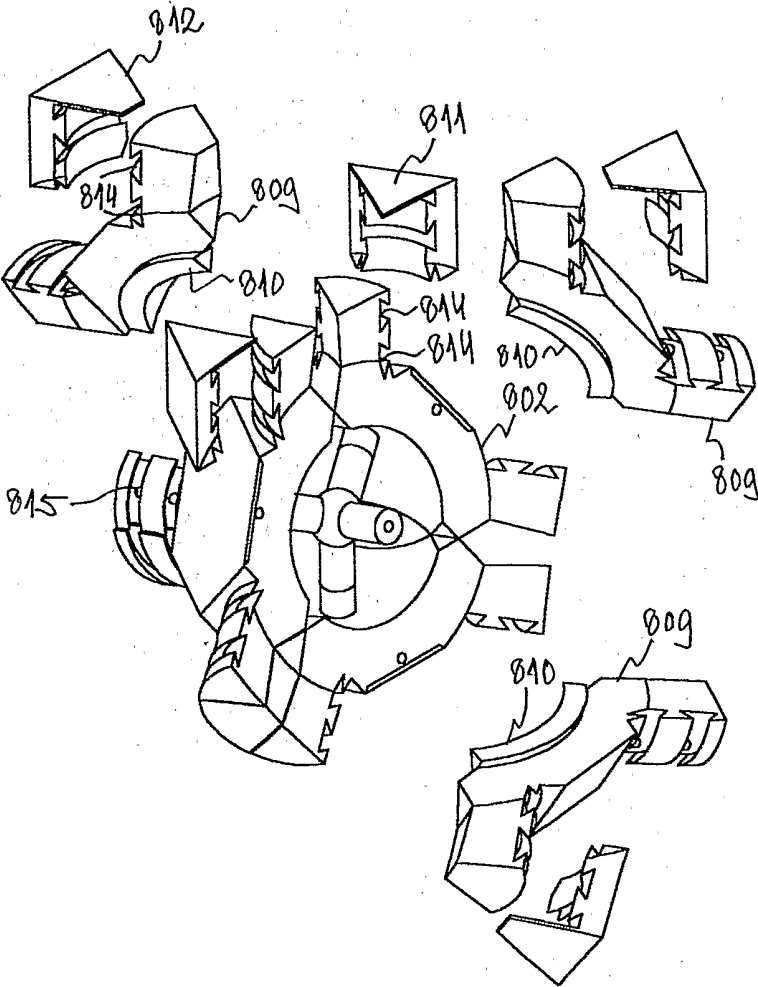
FIGUUR 8B



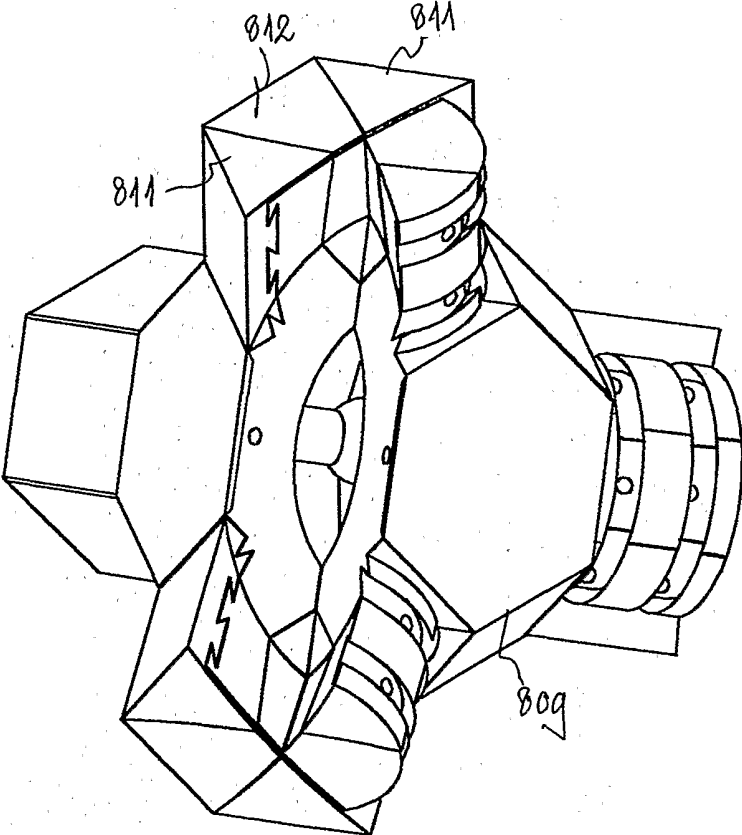
FIGUUR 8C



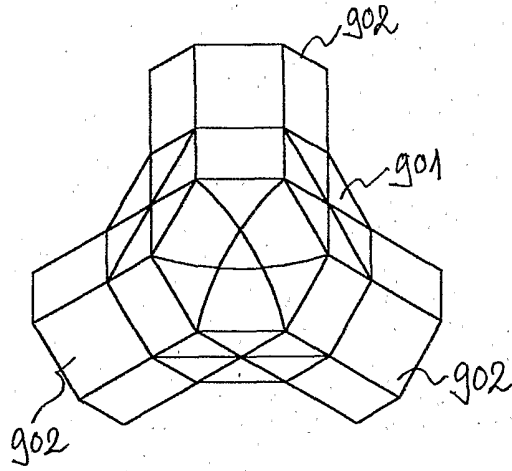
FIGUUR 8D



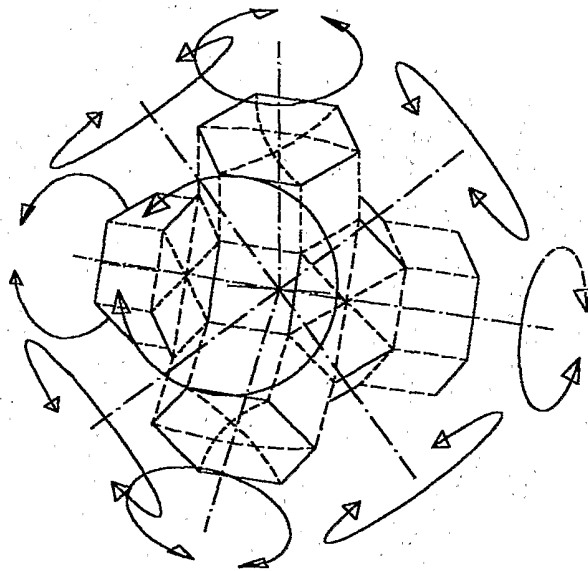
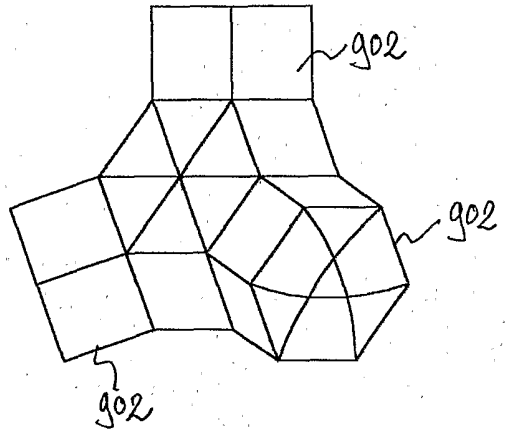
FIGUUR 8E



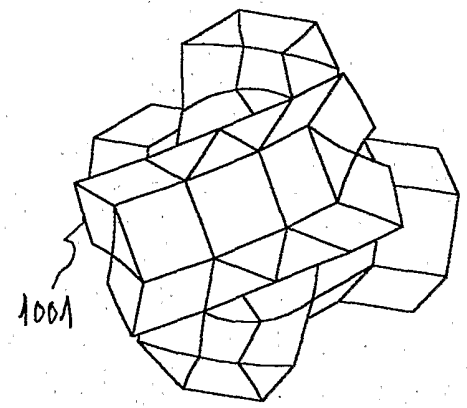
FIGUUR 9A



FIGUUR 9B

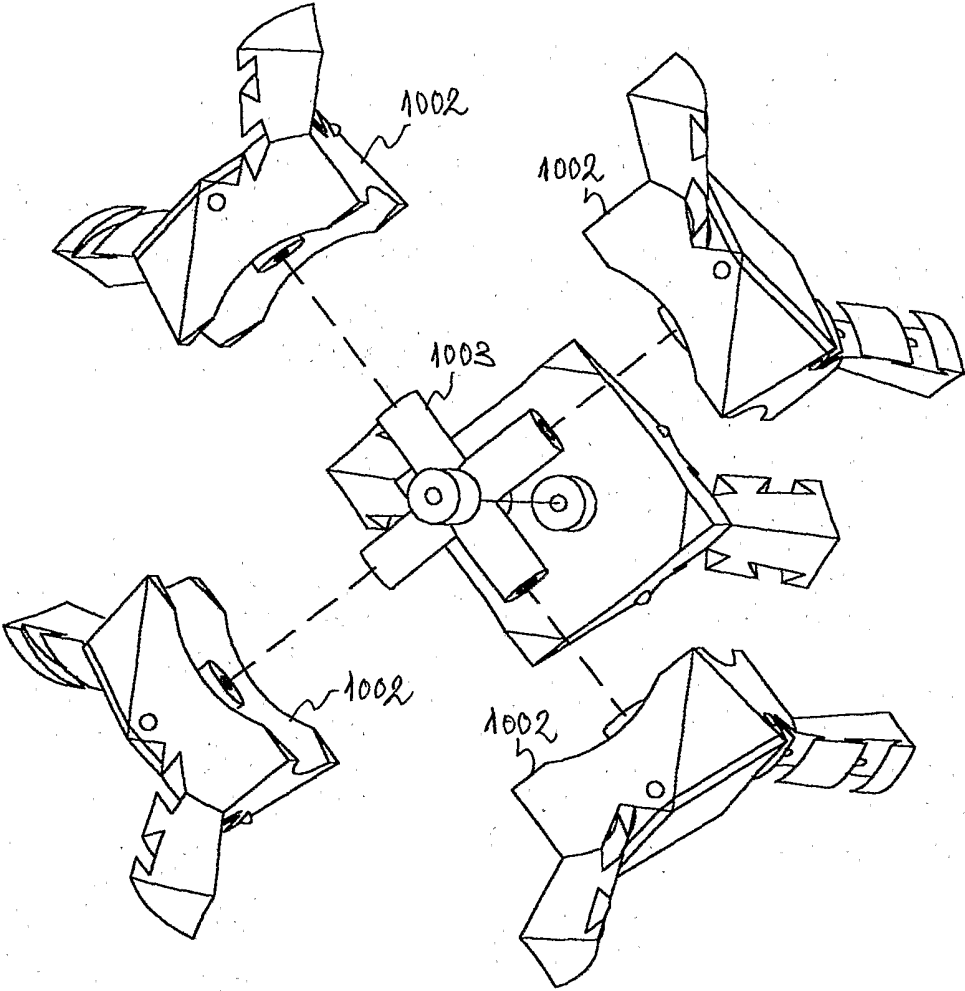


FIGUUR 10A

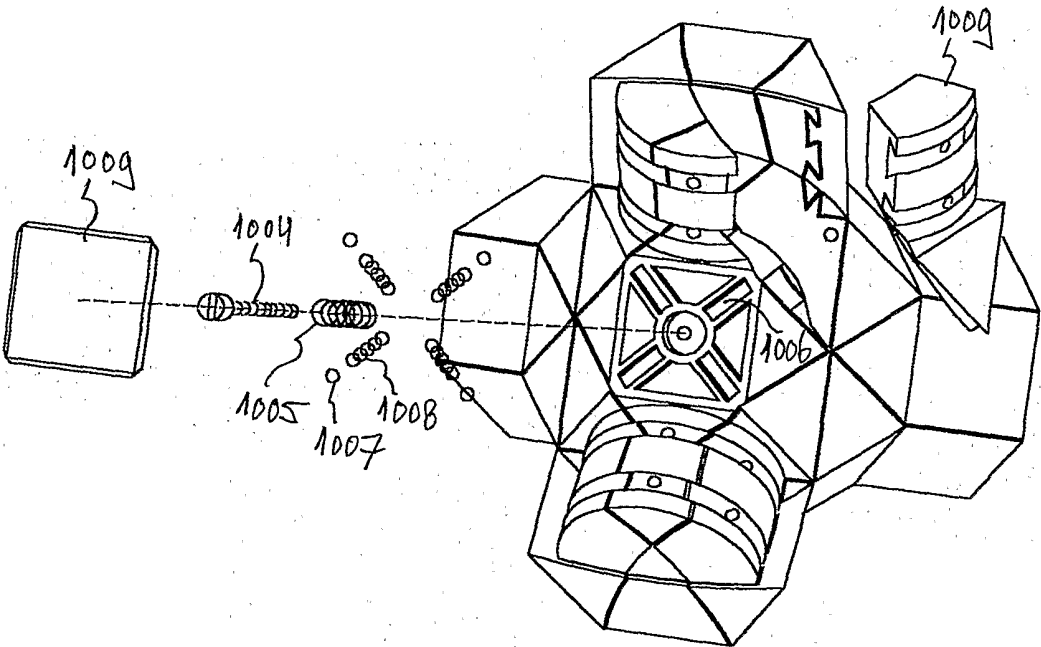


FIGUUR 10B

FIGUUR 1 OC



FIGUUR 1 OE



INTERNATIONAL SEARCH REPORT

PCT/NL 02/00431

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 A63F9/08

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)

IPC 7 A63F

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, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 116 052 A (POP) 26 May 1992 (1992-05-26) the whole document ---	1-11
A	US 5 722 657 A (CABRERA) 3 March 1998 (1998-03-03) the whole document ---	1
A	US 5 823 530 A (YANG) 20 October 1998 (1998-10-20) the whole document ---	1
A	US 4 836 549 A (FLAKE) 6 June 1989 (1989-06-06) the whole document ---	1
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Date of the actual completion of the international search

9 October 2002

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PCT/NL 02/00431

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	CH 683 397 A (CREPEZ) 15 March 1994 (1994-03-15) figures -----	1
A	DE 81 11 356 U (DECKER) figures 2,7 -----	1

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