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## (54) Method for forming a three-dimensional object and a corresponding object

(57) The invention relates to a method for forming a three-dimensional object and a three-dimensional object that includes a first part (1), which includes at least two halves (14, 15), which are joined by a neck and separated by at least one slot (11) extending inwards from the outer surface of the part (1), and a second slot (12) running in the same direction as the first slot, which is on the same side of the neck (10) as the first slot (11), a second part (2), which includes at least two halves (14, 15), which are joined by a neck and separated by at least one slot (11) extending inwards from the outer surface of the part (1), and a second slot (12) running in the same direction as the first slot, which is on the same side of the neck (10) as the first slot (11), and at least one following (third) part (3), in which there is at least one slot (11, 12). The second slots of the first (1) and the second (2) parts are dimensioned in such a way that they can be fitted into each other crosswise, so that the necks (10) of the parts are at least partly next to each other, and the first slots (11) of the first (1) and second (2) parts are dimensioned to be wider than the second slots. At least one slot of the following (third) part (3) is dimensioned to be sufficiently wide for the edges of the slot (11, 12) to be fitted to the counter-angles of the crosswise structure formed by the first and second parts, in such a way that at least part of the part opposite the necks of the first and second parts (1, 2) is in the slot (11, 12) of the following (third) part.

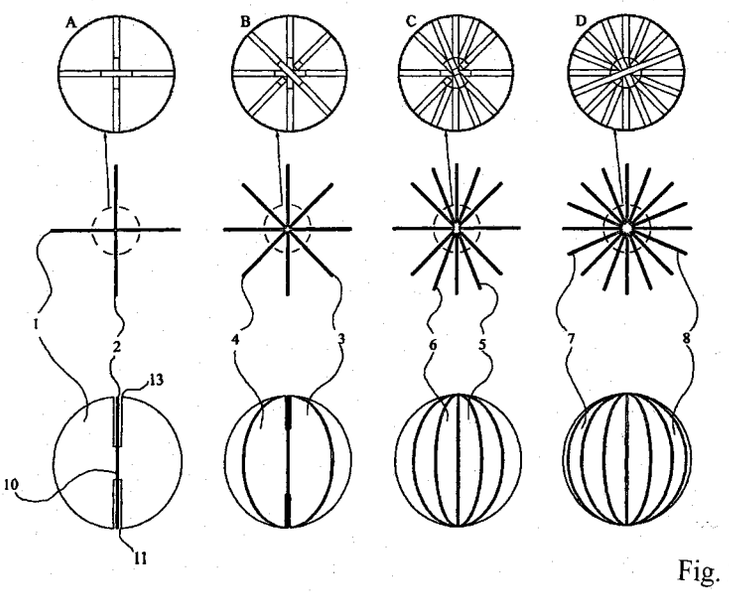


Fig. 3

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## Description

**[0001]** The present invention relates to a method, according to the preamble of Claim 1, for forming a three-dimensional object. The object can be, for example, a decoration, carrier beam, or some other three-dimensional object.

**[0002]** The invention also relates to an object formed with the aid of the method.

**[0003]** Various kinds of jointing methods are required in the most diverse tasks. Examples include, for instance, log structures, decorations in kit form, grid structures, and toys. Two parts are most easily joined to each other by forming notches in them that fit into each other, so that the parts can be joined at the desired angle. By increasing the number of notches and making more complicated shapes, even several parts can be joined together. Naturally, the more parts that are required, the more complicated the joint becomes. This becomes apparent, for example, from the interlocking puzzles known as brain teasers, the construction of which becomes extremely complicated as the number of parts increases. Examples of the jointing methods appear in the following publications: FI 20000674, US 4715503, US 2977701, US 4999383, and US 5908342.

**[0004]** A weakness in the known jointing methods is that they are poorly adaptable to different kinds of structures. Usually the different types of joint have been developed for only a single specific application, so that, if the number of parts to be joined changes, or if it is wished to vary the shape or mutual angle of the parts, different jointing methods must be used.

**[0005]** The invention is intended to create a jointing method, which is more adaptable than known jointing methods, and which can be implemented simply.

**[0006]** In particular, the invention is intended to create a jointing method for joining parts that have principally a planar shape, in order to form three-dimensional structures.

**[0007]** The invention is based on at least three parts being joined to each other and on at least two of the parts having two halves divided by a neck, and at least two slots centred on the same line. These parts are fitted crosswise at the location of the first slots, in such a way that their necks lie against each other. The third part has a slot, which can be fitted into the corresponding angle of the grid structure, in such a way that the necks of the first and second parts lie inside the slot.

**[0008]** The number of parts being joined can be easily increased by increasing the number of slots.

**[0009]** More specifically, the jointing method according to the invention is characterized by what is stated in the characterizing portion of Claim 1.

**[0010]** The object according to the invention is, in turn, characterized by what is stated in the characterizing portion of Claim 6.

**[0011]** Considerable advantages are gained with the aid of the invention.

**[0012]** With the aid of the invention, it is possible to manufacture the most diverse shapes, ranging from load-bearing structures to decorative objects. One example of such a load-bearing structure is, for instance, a carrier column manufactured from parts that are joined together. The column can be easily transported in a flat form dismantled into parts while, with its aid, a durable structure that will easily withstand a lateral load in obtained. Structures of different shapes are created by altering the shape and volume of the parts to be joined together. The mutual angles of the parts being joined can be easily altered by only changing their dimensions, while the basic idea of the structure itself remains unaltered. If the structure is dimensioned precisely, so that the parts fit tightly to each other, no attachment elements or joining agents will be required. The structure can be easily dismantled, allowing the parts to be easily transported and stored. The invention has various embodiments, by means of which parts of different shapes or different or varying thicknesses, or bent parts can be used. With the aid of the invention, it is possible to implement support structures, or even furniture, while the structures can be easily dismantled and the structures that have been dismantled into parts can be transported in stacks, so that they take up only a little space. The structures according to the invention are simple and rapid to erect, so that they can be used to implement various structures intended for short-term use, for example, for large public events. Because the parts can be similar to each other in terms of their joints, a broken part can be easily replaced and there is no need for a large number of spare parts.

In the following, the invention is examined with the aid of examples and with reference to the accompanying drawings.

Figure 1 shows one object according to the invention in its assembled state.

Figure 2 shows the parts of the object of Figure 1.

Figures 3A - 3D show the stages of the assembly of the object of Figure 1.

Figures 4 - 6 show shapes implemented with the aid of the invention.

Figure 7 shows yet another embodiment of the invention.

Figure 8 shows one object according to the invention in its assembled state.

Figure 9 shows the parts of the object of Figure 10.

Figures 10a - 10d show the stage of the assembly of the object of Figure 8.

**[0013]** Figure 1 show a spherical decorative object, which is assembled in the manner according to the invention. The object consists of planar parts joined to each other and it has a string for hanging it. The object of Figure 1 includes eight planar parts 1 - 8. In these parts, there are slots for joining the parts together. In the middle of parts 1 and 2, there is a neck 10, which divides the part into two halves 14, 15. On one side of the neck 10 there is one slot 13 while on the opposite side there are two consecutive slots 11 and 12. All of these slots lie in the same direction and on the same centre line. The width of the inner, second slot 12, which is a continuation of the first slot 11 starting from the outer surface of the object, corresponds to the thickness of the individual parts 1 - 8. This first and the third slots 13 are wider than it. Part 2 is a mirror image of part 1 and the second slot is at the end of the third slot 13.

**[0014]** In part 3, the second slot 12 starting from the first slot 11 is wider that the second slot 12 of parts 1 and 2, whereas the first and third slots are the same width as the corresponding slots of parts 1 and 2. In parts 5 and 6, there is no second slot at all. The third slot 11 starts from the outer surface of the part and is, once again, the same width as the thickness of the parts being joined. In parts 7 and 8, there is no third slot while the neck 10 extends to the outer surface of the part. Once again, the width of the second slot 12 is the same as the thickness of the parts.

**[0015]** Figures 3A - 3D show the assembly of the object according to Figure 1. First of all, parts 1 and 2 are pushed over each other, so that the second slots 12 are next to each other. The slots 12 then go on top of the neck 10 of the opposite part and, when viewed from the top, form a right-angled cross. Free space, which is bounded by the slots, remains at the first 11 and third 13 slots. Next, parts 3 and 4 can be pushed into place. The second slot 12 now comes on top of the cross formed by the necks 10 of parts 1 and 2, so that the width of the slot must be so dimensioned that it fits over this cross at an angle. The fit is preferably tight, in order to improve the object's ability to hold together. Next, parts 5 and 6 are set in place. The first slots 11 now come on top of the cross formed by the first and second parts and the double neck section, so that the width of the slot should be greater. In parts 7 and 8, the second slots are at the bottom of the first slots 11 and come against the third slots 13 extending to the outer circumference of parts 5 and 6. The width of the first slots 11 in parts 7 and 8 corresponds to that of parts 5 and 6 and they too come on top of the double neck cross. If further parts are added to the object, the structure will become stronger, because the edges of the greater number of slots press the structure and the previous parts together.

**[0016]** Alternatively, assembly can take place by first of all joining parts 6 and 8, then parts 4 and 2 in that order to the cross that has been formed and after that attaching the odd-numbered parts in their numerical order.

**[0017]** In this example, the number of parts follows the mathematical series 2, 4, 8, 16, 32..., so that, when forming a structure from planes of equal thickness, in which the angle between the adjacent parts is the same, a cross joint of two parts can be used as the base of the structure. The width of the narrower slots 12 is equal to the thickness of the parts, so that the parts lie at an angle of 90° to each other, while the wider slots 11, 13 ensure that the desired number of parts can be attached to the structure. The next stage of the series, when the number of parts is four, is achieved when the slots of the next parts are set to support the middle of the joint between two parts. The next number in the series is eight, i.e. it too is achieved by adding the same number of parts as is already in the structure, i.e. four, to support the middle of the joint between the previous parts. By following the series, the width of the slots can be determined according to the thickness and number of the parts, as long as the material thicknesses and the thickness at the joint of each part currently being added are known. The angles between the parts are always half of the previously formed angle, starting from 90°. Of course, if the dimensioning of the slots is altered and their edges are bevelled, angles differing from this can be achieved. In such a structure, each stage according to the mathematical series will be stable. In the example of Figure 1, the parts form pairs with an identical intersection point, which lie at opposite sides of the centre point of the structure while their necks will be equally distant from the centre point.

**[0018]** The material of the decoration according to Figure 1 can be aircraft plywood, with a thickness of, for instance, 1 mm. In this case, the width of the neck is always 1/8 of the diameter of the circular part, so that the necks will form a unified support over the entire diameter of the object.

**[0019]** It is thus preferable to start the assembly of the object of Figure 1 from the most central parts 1 and 2, which are slotted over each other in such a way that their 1 x 10-mm slots, which are closest to the centre, will fit over each other, so that the angle between the parts will be 90°. Parts 3 and 4 are attached above and below the cross formed by parts 1 and 2, in such a way that they lie at an angle of 90° to each other and that the 2.5 x 20-mm slots form a support for the intersection between parts 1 and 2 from four directions. Part 5 is set between parts 2 and 3 and part 6 correspondingly between parts 2 and 4 from the opposite side, so that the slots of parts 5 and 6 support the structure at the intersection of the previously attached parts. The final parts 7 and 8 form a cross and are set at an angle of 90° to parts 5 and 6, in such a way that the 1 x 10-mm slots overlap each other. Before this, the hanging string 9 can be placed between parts 7 and 8. With the aid of precise dimensioning and friction, the structure holds together without glue or other attachment means and, if necessary, can be easily dismantled without damaging the structure. It should be noted that the stability of such a structure in-

creases as the number of parts increases, because the pressure in the central joint grows as parts are added at ever-decreasing angles.

**[0020]** The decorative object need not necessarily look like a rotational object, instead, in the manner according to the invention, it is possible to make, for example, a bird with spread wings, as in Figure 4. The bird consists of two body parts 17, to which the wing parts 16 are attached. The slots of the parts can be formed in the manner described above. Figure 5 shows a spherical object with individual parts. When forming such an object, the broadening of the parts can be exploited and the slot arrangement according to the invention will not be required, instead all the slots can have the same width. The object will then remain intact thanks to the mutual compressive forces between the halves of the parts. However, a better ability to remain intact will be achieved by forming the joint in the manner according to the invention. Figure 6 shows, for example, a structure suitable for use as the blades of a fan or as a paddle wheel. To facilitate assembly, the parts can widen at some distance from the joint location, so that the walls will initially support each other, but nearer to the edges the contact ceases. Further, the parts can widen from the joint point to one edge, but can be thinner on the other side.

**[0021]** Figure 7 shows an example of a grid structure implemented with the aid of the invention. In order to form the grid, parts must be made, in which there are joint points 18, 19 for at least two joints. In this way, the joint points can be linked to each other to form even extensive structures. The structure formed from four joint points shown in Figure 7 would be suitable, either in this size, or including even more joints, for example, as an infill between composite structures. Because the jointing method according to the invention creates an extremely good object for carrying a load acting parallel to the joint, and because the structure will be light when using thin part sheets, the structure has obvious advantages in composite construction.

**[0022]** Figures 8 - 10 show set another embodiment of the invention, which is stronger and has a greater ability to remain intact. In this solution, three slots are formed in each part 1 - 8 and in each part the slots are of different widths. This creates a continuous joint over the entire diameter or length of the object, depending on the shape of the object. Mirror images of the parts are obtained by simply turning a part around. Further, the assembly of the object can be started by joining together any parallel pair of parts whatever, for example, 1 and 2, 2 and 3, 5 and 6, and so on. After this, it is possible to continue adding a part in either descending or ascending numerical order, until the object is complete. In each part, there is first of all the widest slot 20, on the opposite side to which relative to the edge of the part, there are two other slots 21, 22, and a neck 10. The neck moves from the edge of the part to the centre, in such a way that in the first part 1 the neck is at the edge of the part and the widths of the slots 20 - 22 run from widest to narrowest. In the next part, the neck moves towards the centre, by a distance equal to the length of the narrowest slot 22, which itself moves to the edge of the part. In the following part, the neck 10 has moved towards the centre, by a distance equal to the length of the medium slot 21, while the narrowest slot 22 is a continuation of the widest slot. In the final part 4, and in its mirror image 5, the narrowest and medium slots are next to each other and the neck is at the end of the widest slot. The essential feature in this arrangement is that the neck 10 moves towards the centre point of the object first of all by the length of the narrowest slot 22, then by the length of the medium slot, and then by their combined length. The slots must always remain on the same line. The lengths of the slots are selected in such a way that the length of the narrowest slot is 1/8 of the diameter of the part, the next is 1/4, and the widest is one-half. If a different number of parts is used, the dimensioning must, of course, be changed. The width of the slots is defined as described above. On the other hand, the length of the slots may vary, but in that case the ease of assembly and strength will be diminished. If the number of parts follows the mathematical series 2, 4, 8, 16, ..., then the rule used to govern the number of slots can be that the number of slots is the same as the sequence number of the number of parts in the series, i.e. the number 8 corresponds to 3 slots, the number 16 to 4 slots, and so on.

**[0023]** Embodiments of the invention, differing from those disclosed above, can also be envisaged. In all of the parts of the structure, the width of the neck can be the same, or it can vary.

## Claims

1. A method for forming a three-dimensional object, **characterized in that**

   - a first part (1) is created, which includes at least two halves (14, 15), which are joined by a neck and separated by at least one slot (11) extending inwards from the outer edge surface of the part (1), and a second slot (12) running in the same direction as the first slot, which is on the same side of the neck (10) as the first slot (11),

   - a second part (2) is created, which includes at least two halves (14, 15), which are joined by a neck and separated by at least one slot (11) extending inwards from the outer edge surface of the part (1), and a second slot (12) running in the same direction as the first slot, which is on the same side of the neck (10) as the first slot (11),

   - at least one following (third) part (3) is created,

in which there is at least one slot (11, 12),

- the second slots of the first (1) and the second (2) parts are dimensioned in such a way that they can be fitted into each other crosswise, so that the necks (10) of the parts are at least partly next to each other,

- the first slots (11) of the first (1) and second (2) parts are dimensioned to be wider than the second slots,

- at least one slot of the following (third) part (3) is dimensioned to be sufficiently wide for the edges of the slot (11, 12) to be fitted to the counter-angles of the crosswise structure formed by the first and second parts, in such a way that at least part of the part opposite the necks of the first and second parts (1, 2) is in the slot (11, 12) of the following (third) part, and

- the first and second parts are fitted crosswise and at least one following (third) part is fitted into the angles of the cross.

**2.** A method according to Claim 1, **characterized in that** at least one following part is created and is fitted together with the third part into the corresponding angle of the cross formed by the first and seconds parts.

**3.** A method according to any of the above Claims, **characterized in that**

- four different parts are created, as well as their identically shaped pairs (1 - 8), in such a way that in part there is first of all a wide slot (20), at the edge on the side of the part opposite to which there are two other slots (21, 22) and a neck (10),

- the neck is arranged in the part in such a way that it moves from the edge of the part towards the centre, so that, in the first part (1) the neck is at the edge of the part and the widths of the slots (20 - 22) run from widest to narrowest, in the next part (2), the neck moves towards the centre, by a distance equal to the length of the narrowest slot (22) while the narrowest slot (22) moves to the edge of the part (2), in the following part (3), the neck (10) has moved towards the centre, by a distance equal to the length of the medium slot (21), while the narrowest slot (22) is a continuation of the widest slot (20), and in part (4), and in its mirror image (5), the narrowest (22) and medium (21) slots are next to each other and the neck (10) is at the end of the widest slot (20).

**4.** A method according to any of the above Claims, **characterized in that** the parts of the structure are, at least at the joint point, of the same thickness and the number of the parts is chosen from the integers of the mathematical series 2, 4, 8, 16, ..., in which the following number is always double the preceding number.

**5.** A method according to Claim 4, **characterized in that** the number of slots is chosen in such a way that the value of the sequence number of the integer in the series determines the number of slots, i.e. the number 8 corresponds to 3 slots, the number 16 to four, and so on.

**6.** A three-dimensional object, **characterized in that** it includes

- a first part (1), which includes at least two halves (14, 15), which are joined by a neck and separated by at least one slot (11) extending inwards from the outer edge surface of the part (1), and a second slot (12) running in the same direction as the first slot, which is on the same side of the neck (10) as the first slot (11),

- a second part (2), which includes at least two halves (14, 15), which are joined by a neck and separated by at least one slot (11) extending inwards from the outer edge surface of the part (1), and a second slot (12) running in the same direction as the first slot, which is on the same side of the neck (10) as the first slot (11),

- at least one following (third) part (3), in which there is at least one slot (11, 12), and in which

- the second slots of the first (1) and the second (2) parts are dimensioned in such a way that they can be fitted into each other crosswise, so that the necks (10) of the parts are at least partly next to each other,

- the first slots (11) of the first (1) and second (2) parts are dimensioned to be wider than the second slots,

- at least one slot of the following (third) part (3) is dimensioned to be sufficiently wide for the edges of the slot (11, 12) to be fitted to the counter-angles of the crosswise structure formed by the first and second parts, in such a way that at least part of the part opposite the necks of the first and second parts (1, 2) is in the slot (11, 12) of the following (third) part.

**7.** An object according to Claim 6, **characterized in that** it includes at least one further following part,

which is fitted in the opposing crosswise angle formed by the first and second parts.

**8.** An object according to any of the above Claims, **characterized in that** it includes

- four different parts, as well as their identically shaped pairs (1 - 8), in such a way that in part there is first of all a wide slot (20), at the edge on the side of the part opposite to which there are two other slots (21, 22) and a neck (10), and
- the neck is formed in the part in such a way that it moves from the edge of the part towards the centre, so that, in the first part (1) the neck is at the edge of the part and the widths of the slots (20 - 22) run from widest to narrowest, in the next part (2), the neck moves towards the centre, by a distance equal to the length of the narrowest slot (22) while the narrowest slot (22) moves to the edge of the part (2), in the following part (3), the neck (10) has moved towards the centre, by a distance equal to the length of the medium slot (21), while the narrowest slot (22) is a continuation of the widest slot (20), and in part (4), and in its mirror image (5), the narrowest (22) and medium (21) slots are next to each other and the neck (10) is at the end of the widest slot (20).

**9.** An object according to any of the above Claims, **characterized in that** the parts of the structure are, at least at the joint point, of the same thickness and the number of the parts is chosen from the integers of the mathematical series 2, 4, 8, 16, ..., in which the following number is always double the preceding number.

**10.** An object according to Claim 4, **characterized in that** the number of slots is chosen in such a way that the value of the sequence number of the integer in the series determines the number of slots, i.e. the number 8 corresponds to 3 slots, the number 16 to four, and so on.

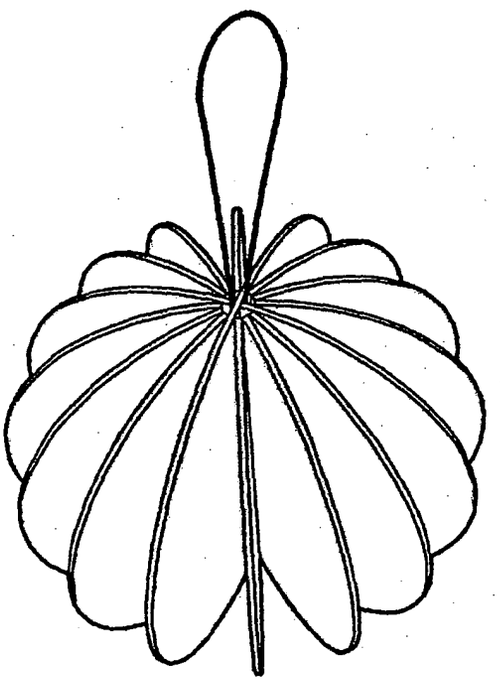

Fig. 1

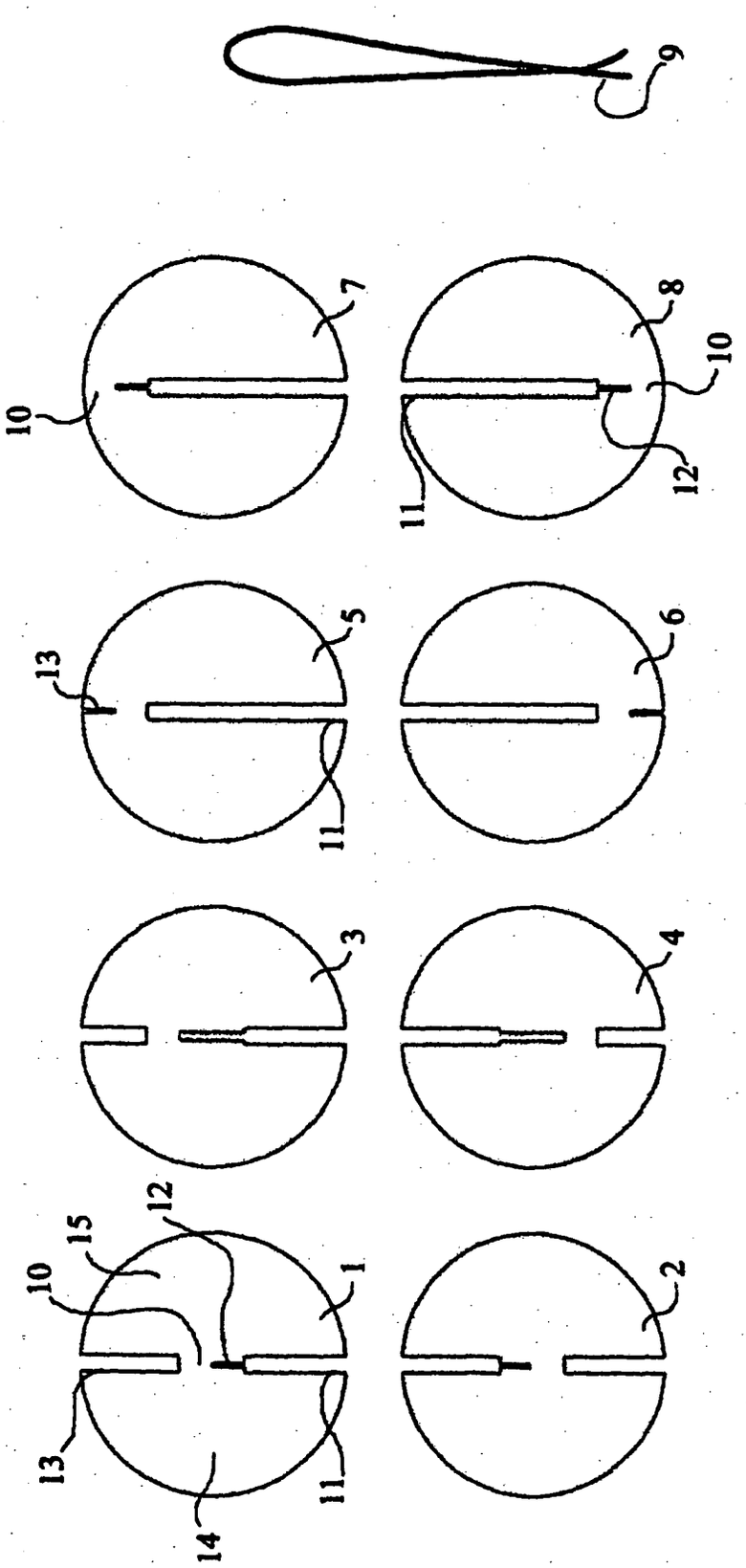


Fig. 2

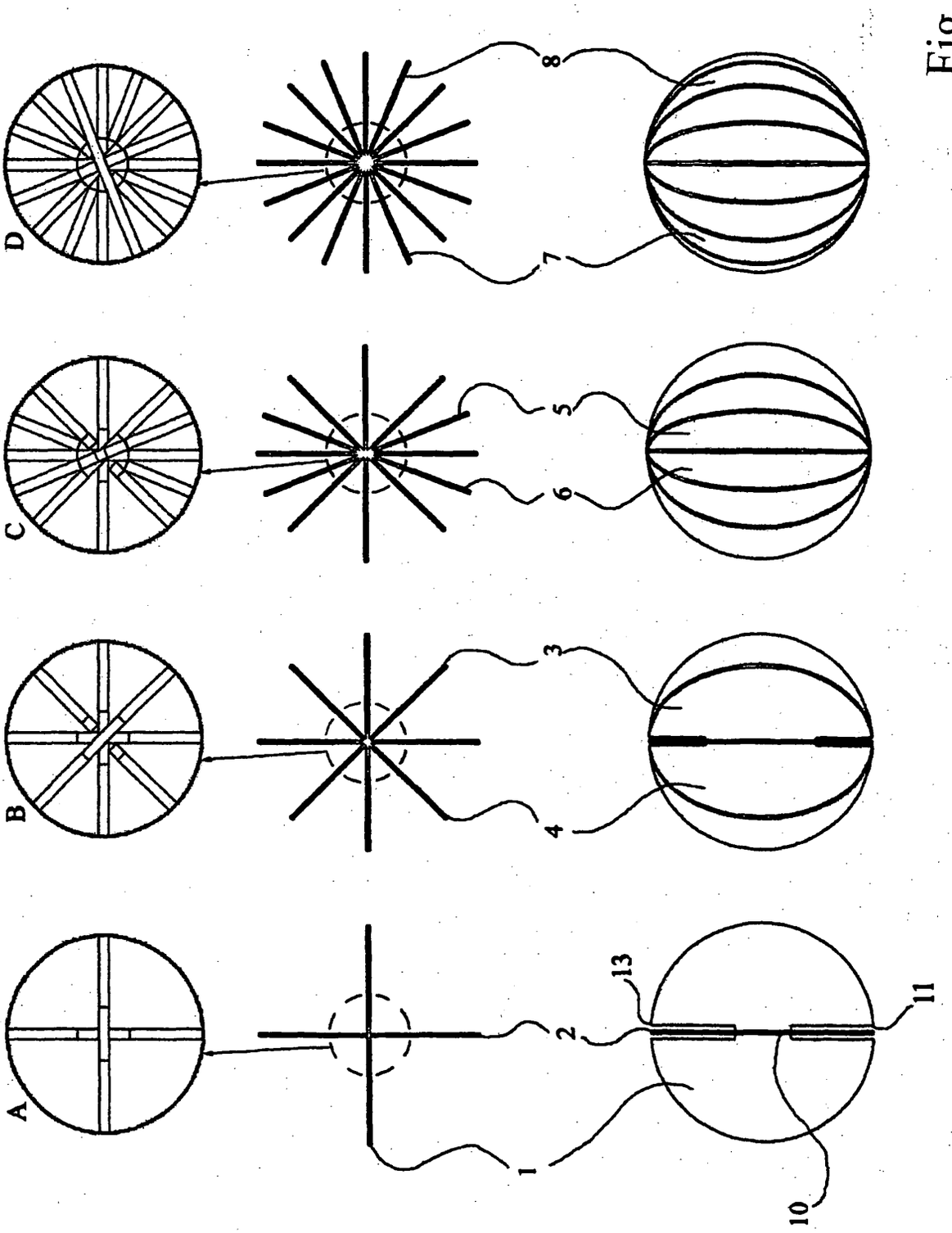


Fig. 3

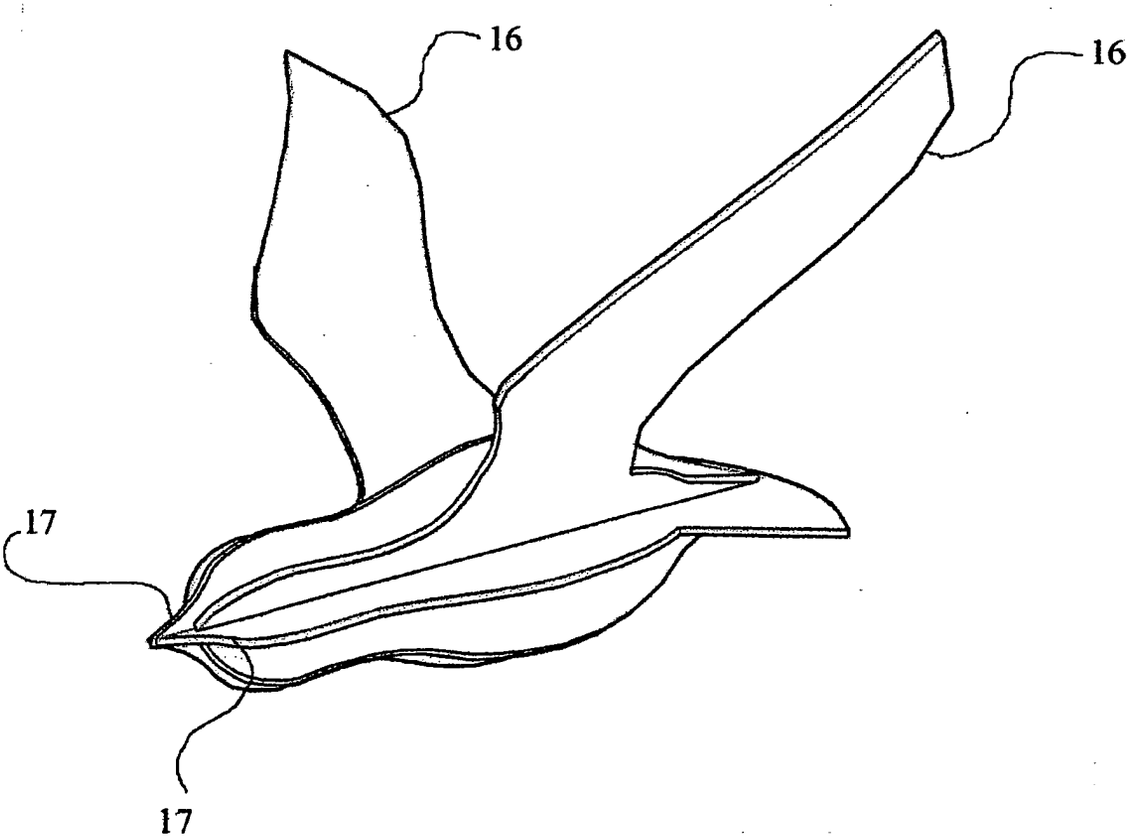


Fig. 4

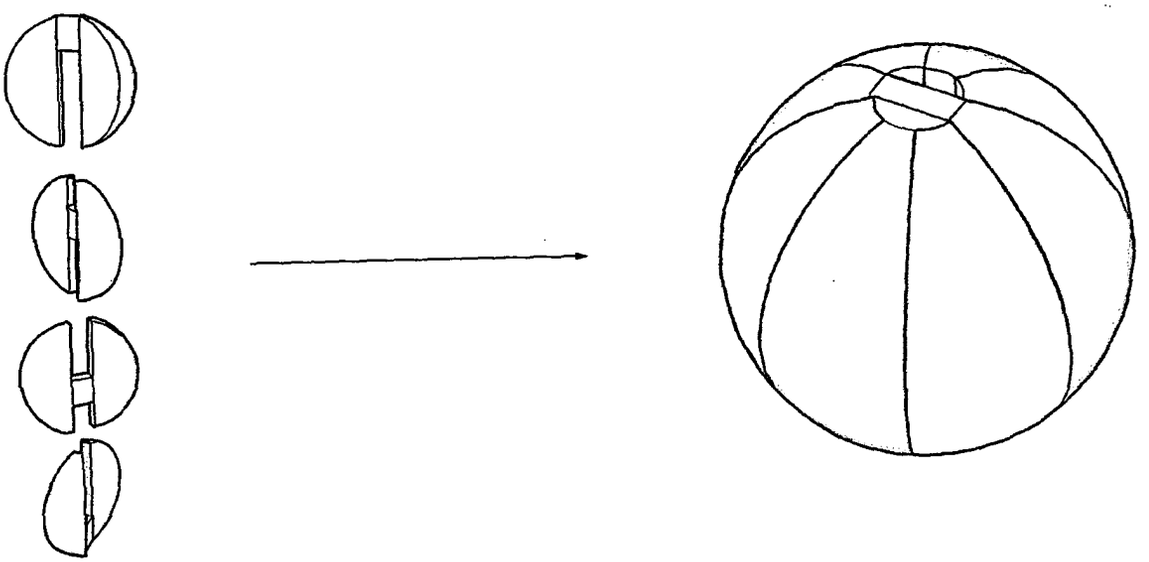

Fig. 5

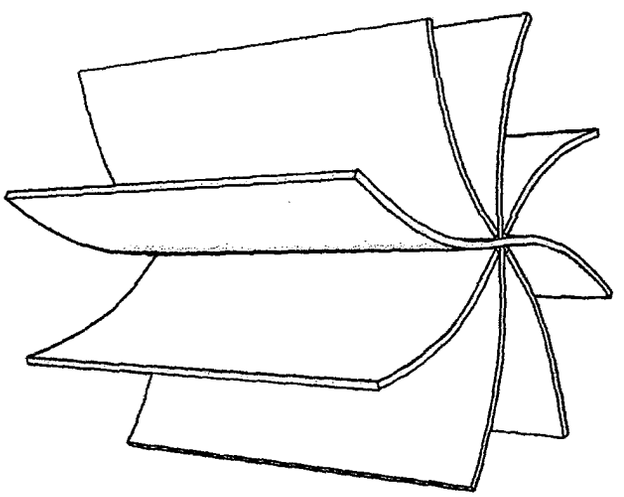

Fig. 6

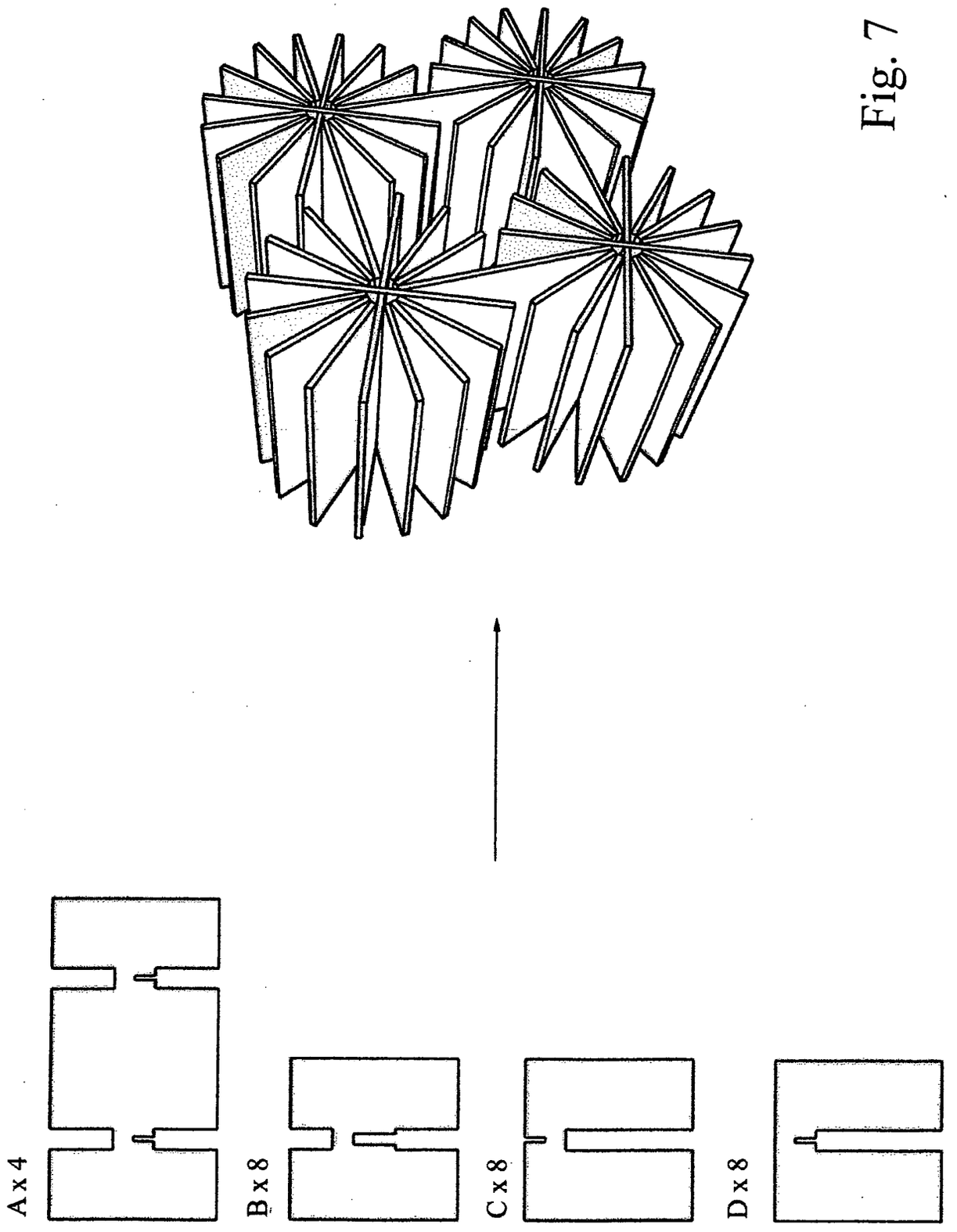


Fig. 7

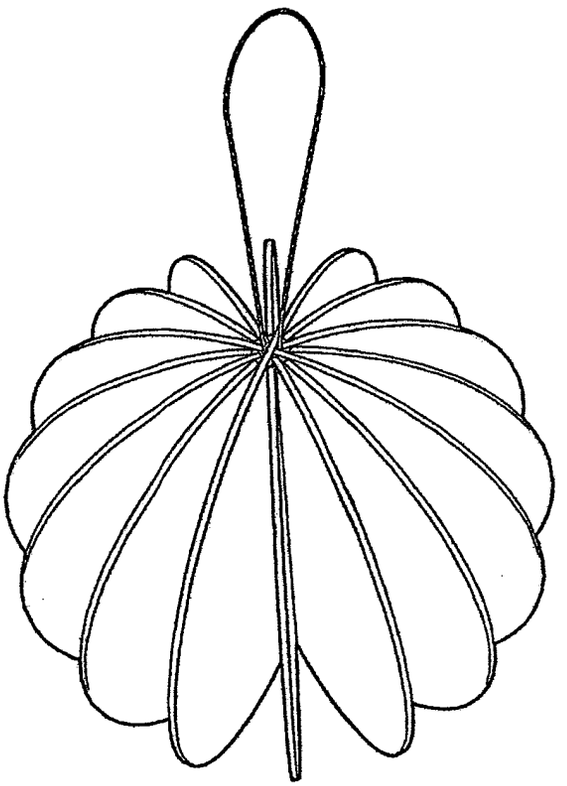

Fig. 8

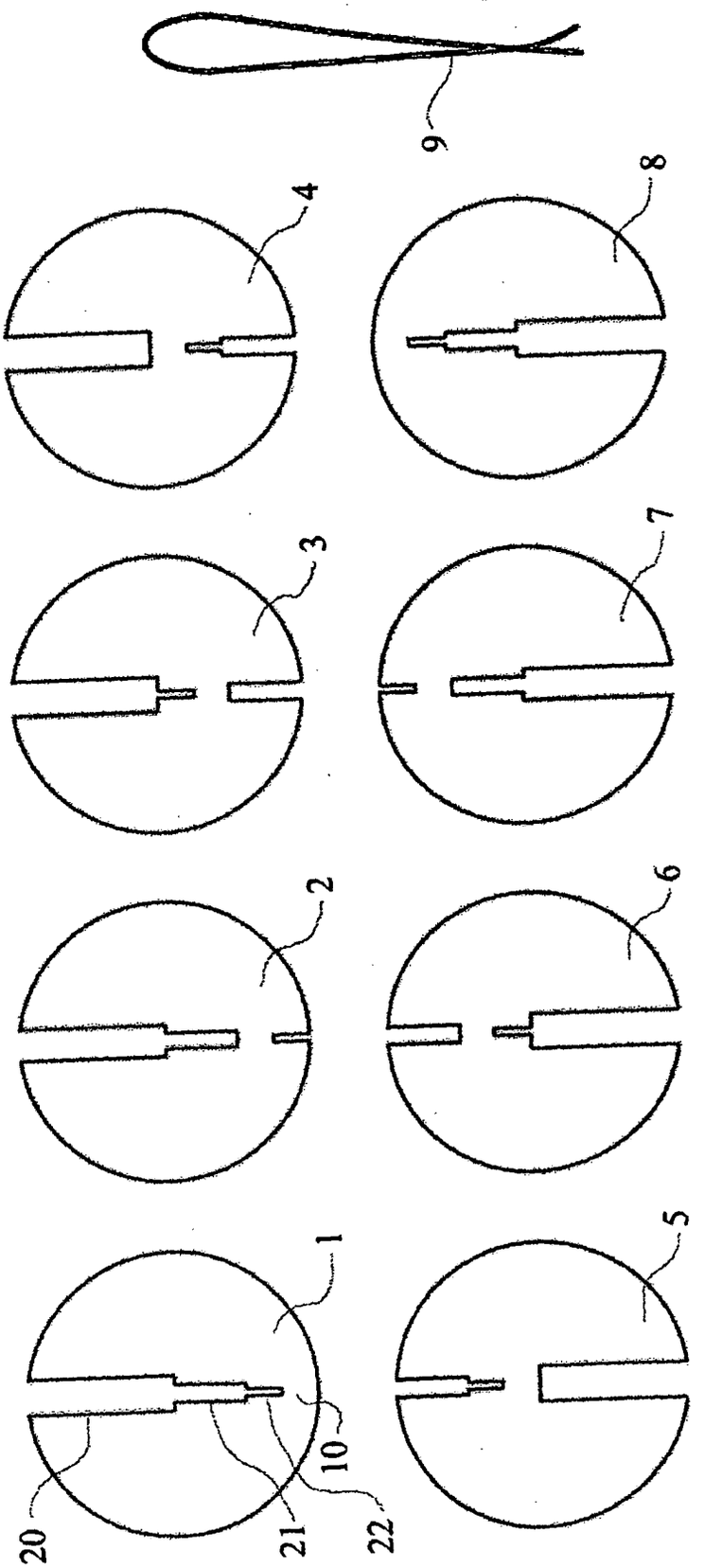


Fig. 9

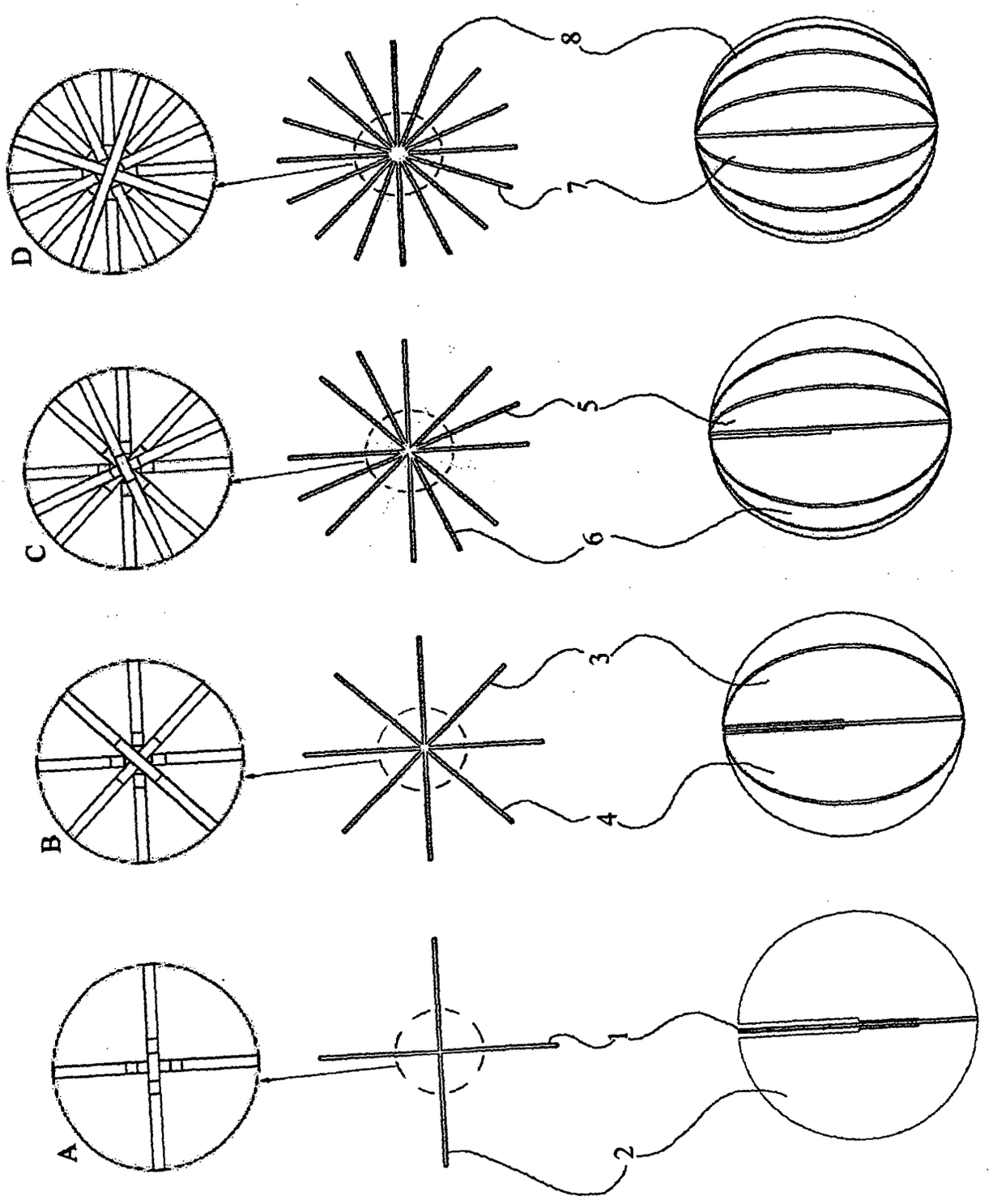


Fig. 10

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 04 39 6077

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.7) |
|---|---|---|---|
| A | US 5 465 961 A (BURTCH RONALD P)<br>14 November 1995 (1995-11-14)<br>* figure 3 *<br>----- | 1,6 | A63H33/08 |
| A | US 2 067 527 A (GREENE GEORGE A)<br>12 January 1937 (1937-01-12)<br>* figures 7-11 *<br>----- | 1,6 | |
| A | US 5 593 337 A (LAPOINTE BRIAN)<br>14 January 1997 (1997-01-14)<br>* the whole document *<br>----- | 1,6 | |
| A | DE 201 14 589 U (GLORY INNOVATIONS INC)<br>14 February 2002 (2002-02-14)<br>* the whole document *<br>----- | 1,6 | |
| | | | TECHNICAL FIELDS SEARCHED (Int.Cl.7)<br>A63H |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 18 January 2005 | Turmo Peruga, R |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 04 39 6077

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18-01-2005

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US 5465961 A | 14-11-1995 | NONE | |
| US 2067527 A | 12-01-1937 | NONE | |
| US 5593337 A | 14-01-1997 | NONE | |
| DE 20114589 U | 14-02-2002 | DE 20114589 U1 | 14-02-2002 |



For more details about this annex : see Official Journal of the European Patent Office, No. 12/82