(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 348 473 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
17.01.2007 Bulletin 2007/03

(51) Int Cl.:
A63H 33/04 *(2006.01)*

(21) Application number: **03425308.8**

(22) Date of filing: **14.05.2003**

(54) **Set of elements for assembling structures**

Bausatz für zusammenbau von Strukturen

Ensemble d'éléments pour l'assemblage de structures

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PT RO SE SI SK TR
Designated Extension States:
AL LT LV MK

(30) Priority: **15.07.2002 IT RM20020133 U**

(43) Date of publication of application:
01.10.2003 Bulletin 2003/40

(73) Proprietor: **Plast Wood s.r.l.**
07023 Calangianus (SS) (IT)

(72) Inventor: **Tusacciu, Edoardo Pio,**
Plast Wood s.r.l.
07023 Calangianus (SS) (IT)

(74) Representative: **Iannone, Carlo Luigi et al**
Barzanò & Zanardo Roma S.p.A.
Via Piemonte 26
00187 Roma (IT)

(56) References cited:
WO-A-02/055168
DE-A- 3 910 304
FR-A- 2 153 792
US-A- 3 998 004

EP 1 348 473 B1

Description

[0001] The present invention relates to a set of elements for assembling structures.

[0002] More specifically, the invention concerns a set of the above kind employing magnetic elements having different and suitable dimensions and ferromagnetic elements, preferably ferromagnetic spheres.

[0003] Particularly, by the present set it is possible to assemble tridimensional structures of every kind, even of the crystallographic kind, both for playing and educational purposes, but also shapes for reproducing objects.

[0004] It is already known the existence of systems to be able to realise tridimensional complex shapes or structures by elements that can be coupled magnetically. Particularly, as described in the GB patent N° 726328, magnetic elements exist not only with the simple NS (North-South) polarity, but also with combined polarities NSN or SNS, having different shapes, or others that can be coupled in an original way to be able to create different structures.

[0005] Systems are known, comprised of ferromagnetic elements, or bars, and metallic spheres, providing inside, embedded, a magnet, thus allowing the realisation of tridimensional structures, being it possible to represent also some crystallographic shapes.

[0006] It is further known a system comprised of a set of means including bar like elements, all having the same length, said elements being each one comprised of two magnets, one on each of the two ends, separated by a ferromagnetic interspace, and of ferromagnetic spheres. Said system allows to realise complex tridimensional structures.

[0007] FR-A-2153792 and DE-A-3910304 describe sets of elements for realising complex structures.

[0008] The problem that the present invention aims to solve concerns the possibility of building a bigger variety of tridimensional and crystallographic structures employing the minimum number of elements.

[0009] Furthermore, having at disposal magnetic elements, such bar like elements, and ferromagnetic elements, such spheres, it is an object of the present invention that of allowing to realise assemblies more stable under the structural point of view, making it possible, in this way, to assemble bigger and more complex assemblies.

[0010] It is therefore object of the present invention a set of elements for assembling complex structures, comprising at least a plurality of first bar elements and a plurality of second bar elements and a plurality of ferromagnetic elements, said first and second bar elements having a different lengths, wherein said first and second bar elements are magnetic elements and in that said second length of the second bar elements corresponds to the length of the diagonal of the square comprised of four first bar elements as sides, coupled to each other in correspondence of the corners of the square by four ferromagnetic elements, and or said second length of the second bar elements corresponds to a integral fraction of the length of the diagonal of the square comprised of four first bar elements as sides, coupled to each other in correspondence of the corners of the square by four ferromagnetic elements, and or in that said second length of the second bar elements is the half of the diagonal of the square comprised of four first bar elements as sides, coupled to each other in correspondence of the corners of the square by four ferromagnetic elements, minus one of the main dimensions of said ferromagnetic element.

[0011] Particularly, said first and second lengths can be determined in such a way that, using only two bar elements, it is possible to realise many of the classic bi- and tri- dimensional structures.

[0012] Preferably, according to the invention, the ferromagnetic elements have symmetrical tridimensional shape.

[0013] Still more preferably, according to the invention, the ferromagnetic elements have a spherical shape.

[0014] Advantageously, according to the invention, said integral fraction can be half (1/2) of the diagonal.

[0015] Still according to the invention, said integral fraction can be one third (1/3) of the diagonal,

[0016] Furthermore, according to the invention, said integral fraction can be one fourth (1/4) of the diagonal.

[0017] The main dimension of a ferromagnetic element can be comprised, for example in a parallelepiped element, by one of the distances between opposite faces of the geometrical figure.

[0018] Advantageously, according to the invention, said main dimension is the diameter of the sphere.

[0019] Still according to the invention, said ferromagnetic elements can be used both as vertex of the complex figures and as coupling elements for said second bar elements provided along said diagonals.

[0020] Furthermore, according to the invention, said ferromagnetic elements can be used both as vertex of the complex figures and as coupling elements of at least two of said second bar elements, in such a way to couple with the same second bar elements at the centre of complex figures.

[0021] Preferably, according to the invention, main dimension of said ferromagnetic elements corresponds to about $(\sqrt{3} - \sqrt{2})$ times the length of the corner used to create a complex figure, said corner length being the distance between the centres of the two ferromagnetic elements used.

[0022] Furthermore, according to the invention, the above set of elements can provide second ferromagnetic elements having dimensions different with respect to those of the first ferromagnetic elements.

[0023] Still according to the invention, said second ferromagnetic elements are used as coupling elements for said second bar elements provided along the diagonals of the figures.

[0024] Furthermore, according to the invention, said second ferromagnetic elements can be used as coupling elements provided in such a way to couple at the centre

of complex figures.

[0025] According to the invention, said first bar elements can have an octagonal cross-section.

[0026] According to the invention, said second bar elements can have an octagonal cross-section.

[0027] Still according to the invention, said first bar elements and/or said second bar elements can have an outer cover, said cover does not cover the basis of the bar element.

[0028] Furthermore, according to the invention, said first bar elements and/or said second bar elements can have an outer cover that can partially or completely include the basis, said cover being preferably comprised of plastic material.

[0029] Preferably, according to the invention, the ferromagnetic elements are comprised of steel.

[0030] The present invention will be now described, for illustrative but not limitative purposes, according to its preferred embodiments, with particular reference to the figures of the enclosed drawings, wherein:

figure 1 shows a first magnetic bar of a set according to the invention;
figure 2 shows a second magnetic bar of a set according to the invention having a length minor than the first bar element;
figure 3 shows a spherical ferromagnetic material element of a set according to the invention;
figure 4 shows the realisation of a square having a diagonal realised by a single module;
figure 5 shows the realisation of a square having a diagonal realised by to modules;
figure 6 shows the realisation of a square having a diagonal realised by two modules and a coupling spherical block; and
figure 7 shows the realisation of a centred face cube.

[0031] Making reference to figure 1, it can be seen a magnetic bar 1 having a determined length. Said bar can be eventually coated by plastic material, such as polypropylene, to protect the metallic material. Further, in case under evaluation, the bar has an octagonal cross-section.

[0032] In figure 2 it can be observed a magnetic bar 2 equivalent to the magnetic bar 1, but characterised in that it has a different length, that can be suitably calculated in order to obtain determined geometric figures.

[0033] Figure 3 shows a ferromagnetic coupling element 3, in this case of spherical shape. Material to realise said element can be for example steel.

[0034] Making reference to figure 4 it can be observed the coupling of four magnetic modules 1 coupled in such a way to realise a square, putting four spherical coupling elements 3 into the corners. Two opposed vertexes are coupled by a further magnetic module 4, thus realising the diagonal of the same square. Assuming the dimension of the module 1 equal to *l*, ray of the coupling sphere 2 equal to *r* and the length of module 4 equal to a, the following relationship is obtained to realise the described figure:

$$a = \sqrt{2}(l + 2r) - 2r$$

[0035] Figure 5 shows the same square described in figure 1, comprised of four modules 1 and four spherical coupling elements 3, having the diagonal comprised of two elements 5 long the half of a single element 4, thus creating a diagonal with two modules.

[0036] Figure 6 shows the same square shown in figures 4 and 5, comprised of four modules 1 and of four spherical coupling elements 3, having a diagonal realised by two modules 6 coupled by a central spherical coupling element 3. In this way it is possible to realise more complex shapes. Relationship between the dimension of the module 6, indicated as *b,* and with respect to dimension of module 1 and to the coupling element 3 (using the same symbols indicated for figure 3):

$$b = \sqrt{2}/2 \times (l + 2r) - 2r$$

figure 7 shows a centred face cube, the twelve corners of which are realised by modules 1, coupled by eight spherical coupling elements 3. Each corner of the cube is coupled with a further coupling element 3 provided at the centre of the same cube by the same module 7. Relationship between length *l* of the corner created by modules 1, dimension *r* of the ray of the sphere of the coupling element 3 and the dimension, indicated by *c*, of the element 7 coupling the vertex at the centre of the cube, is:

$$c = (l + 2r)/2 \times (\sqrt{3}) - 2r$$

[0037] if we want to consider the absolute dimensions of an ideal cube, it is sufficient to subtract to the length *a* and *c* of the bars, the amount *2r,* taking into account the finished dimension of the coupling element. In this way, ratio between the distance of a corner and the centre of the cube, with respect to the same cube, is equal to $\sqrt{3}/2$. Instead, if we want to know the dimension of a single sphere to be used for all the vertexes, and to leave the dimensions consequently determined, then the latter will have a diameter equal to $\sqrt{3}$-$\sqrt{2}$ times the length of the absolute corner of the ideal cube corresponding to the evaluated structure.

[0038] It is possible to realise the centred face cube also using only modules 1, but using spherical coupling elements 3 with a different diameter.

[0039] By the present innovation, it is possible to realise assembly to play or to study, to represent crystallographic structures with a minimum number of elements, making the same structures more resistant and obtaining also economic advantages with respect to the number

of elements to be used to realise complex elements.

[0040] The present invention has been described for illustrative but not limitative purposes, according to its preferred embodiments, but it is to be understood that modifications and/or changes can be introduced by those skilled in the art without departing from the relevant scope as defined in the enclosed claims.

Claims

1. A set of elements for assembling complex structures, comprising at least a plurality of first bar elements (1) and a plurality of second bar elements and a plurality of ferromagnetic elements (3), said first and second bar elements having a different lengths, **characterised in that** said first and second bar elements are magnetic elements and **in that** said second length of the second bar elements (4) corresponds to the length of the diagonal of the square comprised of four first bar elements (1) as sides, coupled to each other in correspondence of the corners of the square by four ferromagnetic elements (3), and or said second length of the second bar (5) elements corresponds to a integral fraction of the length of the diagonal of the square comprised of four first bar elements as sides, coupled to each other in correspondence of the corners of the square by four ferromagnetic elements (3), and or **in that** said second length of the second bar (6) elements is the half (1/2) of the diagonal of the square comprised of four first bar elements (1) as sides, couple to each other in correspondence of the corners of the square by four ferromagnetic elements (3), minus one of the main dimensions of said ferromagnetic element (3).

2. Set of elements according to claim 1, **characterised in that** the ferromagnetic elements have a symmetric tridimensional shape.

3. Set of elements according to claim 1 or 2, **characterised in that** the ferromagnetic elements (3) have a spherical shape.

4. Set of elements according to claim 1, **characterised in that** said integral fraction is half (1/2) of the diagonal.

5. Set of elements according to claim 1, **characterised in that** said integral fraction is one third (1/3) of the diagonal.

6. Set of elements according to claim 1, **characterised in that** said integral fraction is one fourth (1/4) of the diagonal.

7. Set of elements according to claim 1, **characterised in that** said main dimension is the diameter of the sphere.

8. Set of elements according to claim 1, **characterised in that** said ferromagnetic elements (3) are used both as vertex of the complex figures and as coupling elements for said second bar elements (2,6) provided along said diagonals.

9. Set of elements according to one of the preceding claims 6 - 8, **characterised in that** said ferromagnetic elements (3) are used both as vertex of the complex figures and as coupling elements of at least two of said second bar elements (2,6), in such a way to couple with the same second bar elements (2,6) at the centre of complex figures.

10. Set of elements according to claim 9, **characterised in that** the main dimension of said ferromagnetic elements (3) corresponds to about ($\sqrt{3}$ - $\sqrt{2}$) times the length of the corner used to create a complex figure, said corner length being the distance between the centres of the two ferromagnetic elements used.

11. Set of elements according to one of the preceding claims, **characterised in that** it provides second ferromagnetic elements (3) having dimensions different with respect to those of the first ferromagnetic elements.

12. Set of elements according to claim 11, **characterised in that** said second ferromagnetic elements (3) are used as coupling elements for said second bar elements (2,4,6,7) provided along the diagonals of the figures.

13. Set of elements according to claim 11 or 12, **characterised in that** said second ferromagnetic elements (3) are used as coupling elements provided in such a way to couple at the centre of complex figures.

14. Set of elements according to one of the preceding claims, **characterised in that** said first bar elements (1) have an octagonal cross-section.

15. Set of elements according to one of the preceding claims, **characterised in that** said second bar elements (2,4,6,7) have an octagonal cross-section.

16. Set of elements according to one of the preceding claims, **characterised in that** said first bar elements (1) and/or said second bar elements (2,4,6,7) have an outer cover, said cover does not cover the basis of the bar element.

17. Set of elements according to one of the preceding claims 1 - 16, **characterised in that** said first bar elements (1) and/or said second bar elements

(2,4,6,7) can have an outer cover that can partially or completely include the basis, said cover being preferably comprised of plastic material.

18. Set of elements according to claim 17 or 18, **characterised in that**, the ferromagnetic elements (3) are comprised of steel.

Patentansprüche

1. Bausatz zum Zusammenbauen von komplexen Strukturen, umfassend mindestens eine Vielzahl von ersten Stabelementen (1) und eine Vielzahl von zweiten Stabelementen und eine Vielzahl von ferromagnetischen Elementen (3), wobei die ersten und zweiten Stabelemente unterschiedliche Längen haben, **dadurch gekennzeichnet, dass** die ersten und zweiten Stabelemente magnetische Elemente sind und dass die zweite Länge der zweiten Stabelemente (4) der Länge der Diagonalen des Quadrats entspricht, das aus vier ersten Stabelementen (1) als Seiten besteht, die in Bezug auf die Ecken des Quadrats durch vier ferromagnetische Elemente (3) aneinander gekoppelt sind, und/oder diese zweite Länge der zweiten Stabelemente (5) einem integralen Bruchteil der Länge der Diagonale des Quadrats entspricht, das aus vier ersten Stabelementen als Seiten besteht, die in Bezug auf die Ecken des Quadrats durch vier ferromagnetische Elemente (3) aneinander gekoppelt sind, und/oder dass diese zweite Länge der zweiten Stabelemente (6) die Hälfte (1/2) der Diagonalen des Quadrats beträgt, das aus vier ersten Stabelementen (1) als Seiten besteht, die in Bezug auf die Ecken des Quadrats durch vier ferromagnetische Elemente (3) aneinander gekoppelt sind, minus eine der Hauptabmessungen von diesem ferromagnetischen Element (3).

2. Bausatz nach Anspruch 1, **dadurch gekennzeichnet, dass** die ferromagnetischen Elemente eine symmetrische, dreidimensionale Form aufweisen.

3. Bausatz nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die ferromagnetischen Elemente (3) eine kugelförmige Form aufweisen.

4. Bausatz nach Anspruch 1, **dadurch gekennzeichnet, dass** dieser integrale Bruchteil die Hälfte (1/2) der Diagonalen ist.

5. Bausatz nach Anspruch 1, **dadurch gekennzeichnet, dass** dieser integrale Bruchteil ein Drittel (1/3) der Diagonalen ist.

6. Bausatz nach Anspruch 1, **dadurch gekennzeichnet, dass** dieser integrale Bruchteil ein Viertel (1/4) der Diagonalen ist.

7. Bausatz nach Anspruch 1, **dadurch gekennzeichnet, dass** diese Hauptabmessung der Durchmesser der Kugel ist.

8. Bausatz nach Anspruch 1, **dadurch gekennzeichnet, dass** diese ferromagnetischen Elemente (3) sowohl als Vertex der komplexen Figuren als auch als Kopplungselemente für diese zweiten Stabelemente (2,6) verwendet werden, die entlang dieser Diagonalen bereitgestellt werden.

9. Bausatz nach einem der vorhergehenden Ansprüche 6 - 8, **dadurch gekennzeichnet, dass** diese ferromagnetischen Elemente (3) sowohl als Vertex der komplexen Figuren als auch als Kopplungselemente von mindestens zwei dieser zweiten Stabelemente (2, 6) verwendet werden, auf eine solche Weise, dass sie mit den gleichen zweiten Stabelementen (2, 6) in der Mitte der komplexen Figuren koppeln.

10. Bausatz nach Anspruch 9, **dadurch gekennzeichnet, dass** die Hauptabmessung von diesen ferromagnetischen Elementen (3) etwa ($\sqrt{3}$ - $\sqrt{2}$) Mal der Länge der Ecke entspricht, die verwendet wird, um eine komplexe Figur zu erzeugen, wobei genannte Eckenlänge die Entfernung zwischen den Mittelpunkten der beiden verwendeten ferromagnetischen Elemente ist.

11. Bausatz nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** er zweite ferromagnetische Elemente (3) bereitstellt, deren Abmessungen bezogen auf die der ersten ferromagnetischen Elemente unterschiedlich sind.

12. Bausatz nach Anspruch 11, **dadurch gekennzeichnet, dass** diese zweiten ferromagnetischen Elemente (3) als Kopplungselemente für diese zweiten Stabelemente (2, 4, 6, 7) verwendet werden, die entlang der Diagonalen der Figuren bereitgestellt werden.

13. Bausatz nach Anspruch 11 oder 12, **dadurch gekennzeichnet, dass** diese zweiten ferromagnetischen Elemente (3) als Kopplungselemente verwendet werden, wobei sie auf eine solche Weise bereitgestellt werden, dass sie in der Mitte der komplexen Figuren koppeln.

14. Bausatz nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** diese ersten Stabelemente (1) einen achteckigen Querschnitt aufweisen.

15. Bausatz nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** diese zweiten Stabelemente (2, 4, 6, 7) einen achteckigen Querschnitt aufweisen.

16. Bausatz nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** diese ersten Stabelemente (1) und/oder diese zweiten Stabelemente (2, 4, 6, 7) eine äußere Bedeckung aufweisen, wobei diese Bedeckung nicht den Boden des Stabelements bedeckt.

17. Bausatz nach einem der vorhergehenden Ansprüche 1 - 16, **dadurch gekennzeichnet, dass** diese ersten Stabelemente (1) und/oder diese zweiten Stabelemente (2, 4, 6, 7) eine äußere Bedeckung aufweisen können, die teilweise oder vollständig den Boden einschließen können, wobei diese Bedekkung vorzugsweise aus einem Kunststoffmaterial besteht.

18. Bausatz nach Anspruch 17 oder 18, **dadurch gekennzeichnet, dass** die ferromagnetischen Elemente (3) aus Stahl bestehen.

Revendications

1. Ensemble d'éléments pour assembler des structures complexes comprenant au moins une pluralité de premiers éléments en barre (1) et une pluralité de deuxièmes éléments en barre et une pluralité d'éléments ferromagnétiques (3), lesdits premiers et deuxièmes éléments en barre ayant des longueurs différentes, **caractérisé en ce que** lesdits premiers et deuxièmes éléments en barre sont des éléments magnétiques et **en ce que** ladite deuxième longueur des deuxièmes éléments en barre (4) correspond à la longueur de la diagonale du carré composé de quatre premiers éléments en barre (1) comme côtés, raccordés les uns aux autres en correspondance des coins du carré par quatre éléments ferromagnétiques (3), et ou la dite deuxième longueur des deuxième éléments en barre (5) correspond à une fraction entière de la longueur de la diagonale du carré composé de quatre premiers éléments en barre comme côtés, raccordés les uns aux autres en correspondance des coins du carré par quatre éléments ferromagnétiques (3), et ou **en ce que** ladite deuxième longueur des deuxièmes éléments en barre (6) est la moitié (1/2) de la diagonale du carré composé de quatre premiers éléments en barre (1) comme côtés, raccordés les uns aux autres en correspondance des coins du carré par quatre éléments ferromagnétiques (3), moins une des dimensions principales dudit élément ferromagnétique (3).

2. Ensemble d'éléments selon la revendication 1, **caractérisé en ce que** les éléments ferromagnétiques ont une forme tridimensionnelle symétrique.

3. Ensemble d'éléments selon la revendication 1 ou 2, **caractérisé en ce que** les éléments ferromagnétiques (3) ont une forme sphérique.

4. Ensemble d'éléments selon la revendication 1, **caractérisé en ce que** ladite fraction entière est la moitié (1/2) de la diagonale.

5. Ensemble d'éléments selon la revendication 1, **caractérisé en ce que** ladite fraction entière est le tiers (1/3) de la diagonale.

6. Ensemble d'éléments selon la revendication 1, **caractérisé en ce que** ladite fraction entière est le quart (1/4) de la diagonale.

7. Ensemble d'éléments selon la revendication 1, **caractérisé en ce que** ladite dimension principale est le diamètre de la sphère.

8. Ensemble d'éléments selon la revendication 1, **caractérisé en ce que** lesdits éléments ferromagnétiques (3) sont utilisés à la fois comme sommet des figures du complexe et comme éléments de raccord pour lesdits deuxièmes éléments en barre (2, 6) prévus le long desdites diagonales.

9. Ensemble d'éléments selon l'une quelconque des revendications 6 à 8 précédentes, **caractérisé en ce que** lesdits éléments ferromagnétiques (3) sont utilisés à la fois comme sommet des figures du complexe et comme éléments de raccord d'au moins deux desdits deuxièmes éléments en barre (2, 6), afin de se raccorder avec les mêmes deuxièmes éléments en barre (2, 6) au centre des figures du complexe.

10. Ensemble d'éléments selon la revendication 9, **caractérisé en ce que** la dimension principale desdits éléments ferromagnétiques (3) correspond à environ ($\sqrt{3}$ à $\sqrt{2}$) fois la longueur du coin utilisé pour créer une figure de complexe, ladite longueur d'angle étant la distance entre les centres des deux éléments ferromagnétiques utilisés.

11. Ensemble d'éléments selon l'une quelconque des revendication précédentes, **caractérisé en ce qu'**il fournit des deuxièmes éléments ferromagnétiques (3) ayant des dimensions différentes par rapport à celles des premiers éléments ferromagnétiques.

12. Ensemble d'éléments selon la revendication 11, **caractérisé en ce que** lesdits deuxièmes éléments ferromagnétiques (3) sont utilisés comme éléments de raccord pour lesdits deuxièmes éléments ferromagnétiques (2, 4, 6, 7) fournis le long des diagonales des figures.

13. Ensemble d'éléments selon la revendication 11 ou 12, **caractérisé en ce que** lesdits deuxièmes élé-

ments ferromagnétiques (3) sont utilisés comme éléments de raccord prévus de façon à raccorder au centre des figures du complexe.

14. Ensemble d'éléments selon l'une quelconque des revendications précédentes, **caractérisé en ce que** lesdits premiers éléments (1) ont une section transversale octogonale.

15. Ensemble d'éléments selon l'une quelconque des revendications précédentes, **caractérisé en ce que** lesdits deuxièmes éléments en barre (2, 4, 6, 7) ont une section transversale octogonale.

16. Ensemble d'éléments selon l'une quelconque des revendications précédentes, **caractérisé en ce que** lesdits premiers éléments en barre (1) et/ou lesdits deuxièmes éléments en barre (2, 4, 6, 7) ont un revêtement extérieur, ledit revêtement ne recouvrant pas la base de l'élément en barre.

17. Ensemble d'éléments selon l'une quelconque des revendications 1 à 16 précédentes, **caractérisé en ce que** lesdits premiers éléments en barre (1) et/ou lesdits deuxièmes éléments en barre (2, 4, 6, 7) peuvent avoir un revêtement extérieur qui peut comprendre partiellement ou complètement la base, ledit revêtement étant de préférence composé d'une matière plastique.

18. Ensemble d'éléments selon la revendication 17 ou 18, **caractérisé en ce que**, les éléments ferromagnétiques (3) sont composés d'acier.

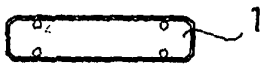

Fig. 1

Fig. 2

Fig. 3

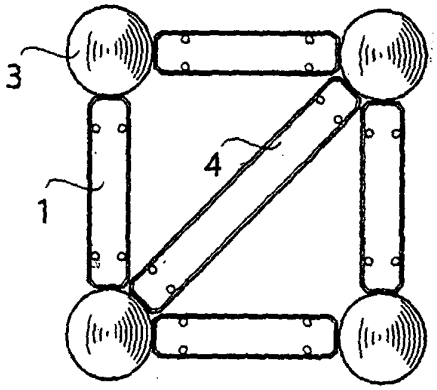

Fig. 4

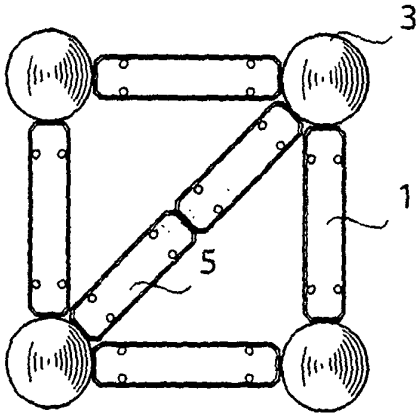

Fig. 5

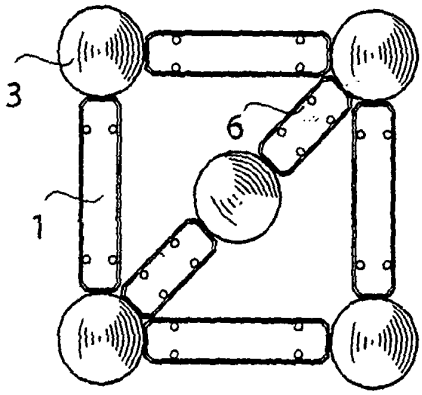

Fig. 6

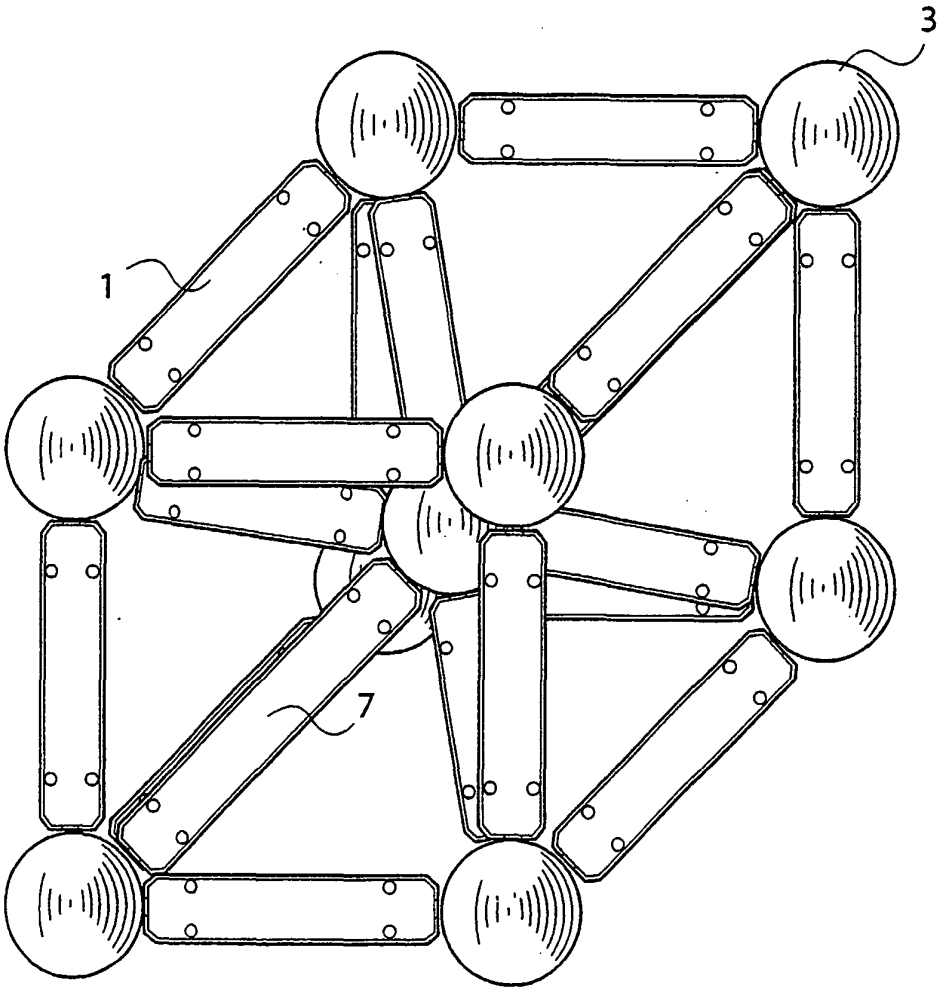

Fig. 7