United States Patent [19]

Kuwagaki et al.

[11] 3,837,652

[45] Sept. 24, 1974

[54] SOLID PUZZLE

[75] Inventors: Akira Kuwagaki; Sadao Takenaka, both of Kyoto, Japan

[73] Assignee: Nippon Cloth Industry Co. Ltd., Kyoto, Japan

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[30] Foreign Application Priority Data

May 13, 1972 Japan 47-46886

[52] U.S. Cl. ..... 273/157 R

[51] Int. Cl. A63f 9/12

[58] Field of Search ..... 273/157, 146; 35/18 A, 35/34, 72

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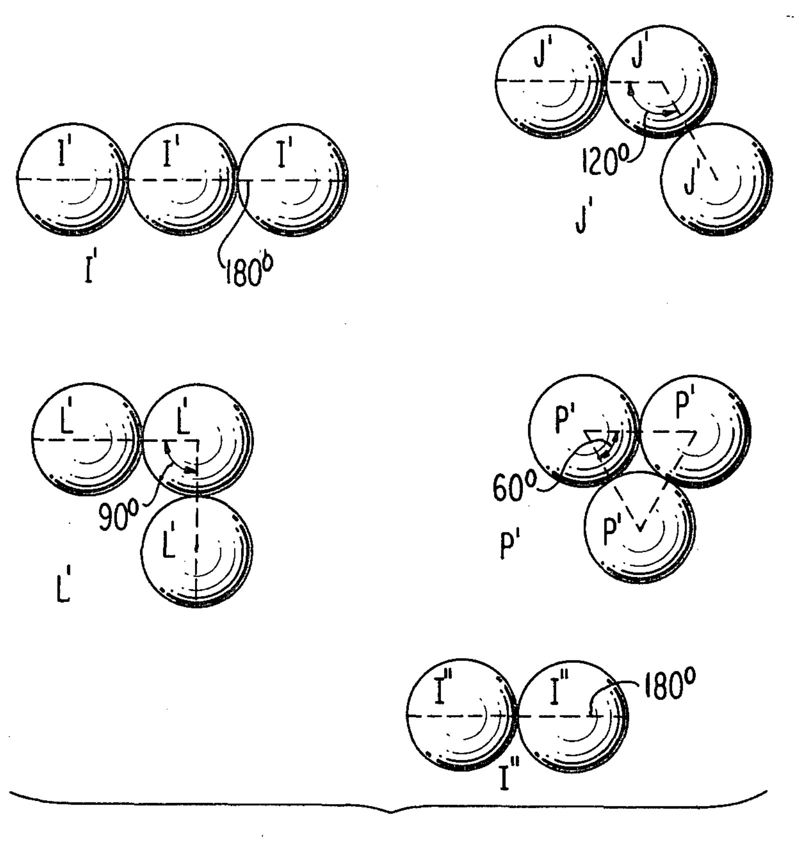
Primary Examiner—Anton O. Oechsle

Attorney, Agent, or Firm—Sughrue, Rothwell, Mion, Zinn & Macpeak

[57] ABSTRACT

A solid puzzle of regular geometrical configuration consists of a number of layers of identical spheres, each of said layers including several kinds of connected units of spheres having connecting axes extending through the centers of the individual spheres, all of the connecting axes being on the same plane and any of two adjoining axes forming an included angle of 60°, 90°, 120° or 180°.

2 Claims, 18 Drawing Figures



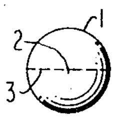
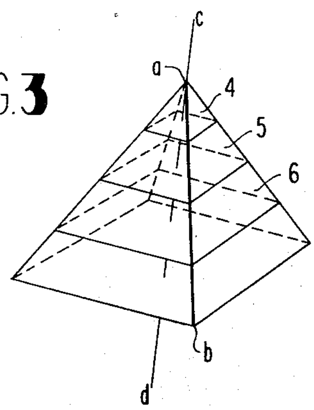


FIG.1

FIG.3



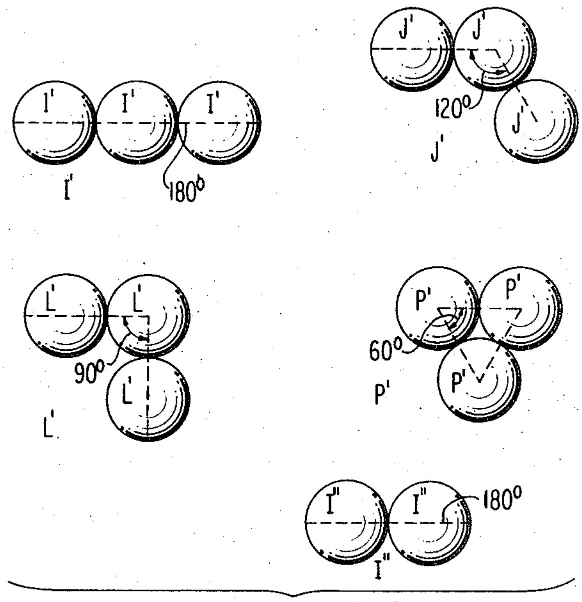


FIG.2

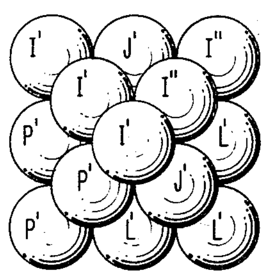


FIG.4

FIG.5a

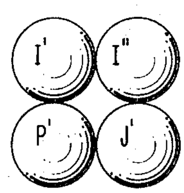


FIG.5b

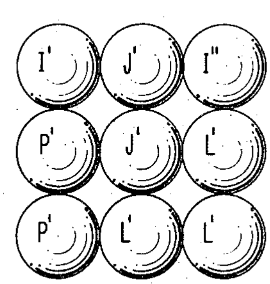


FIG.5c

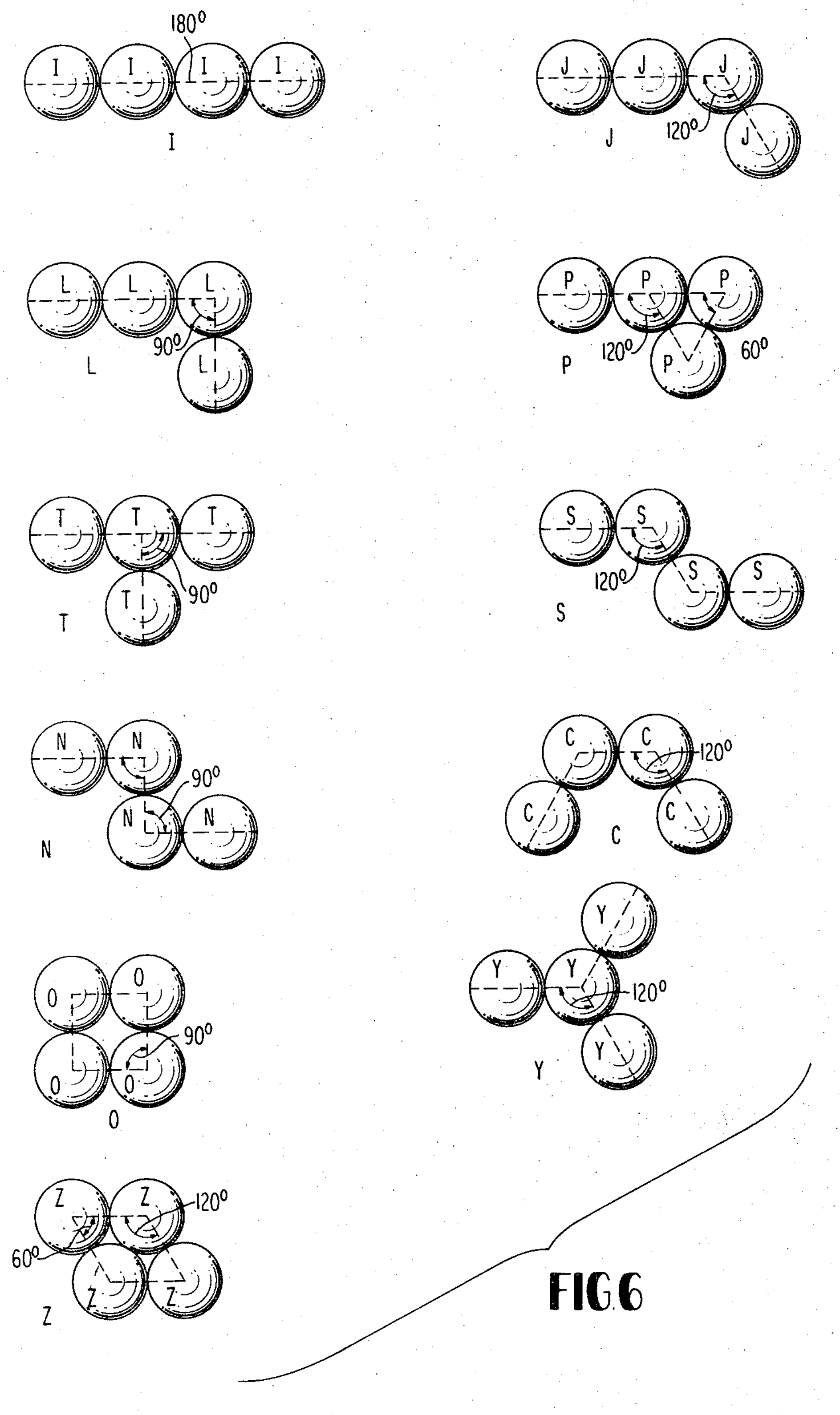


FIG. 6

FIG. 7

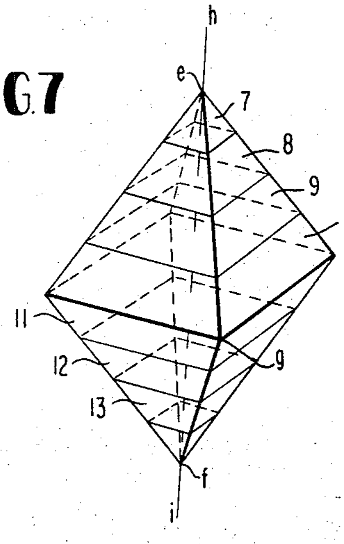
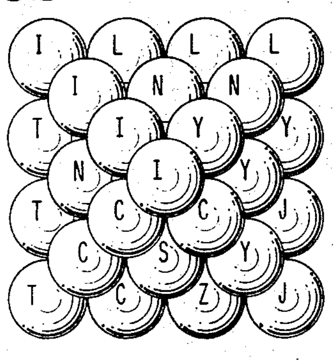


FIG. 8



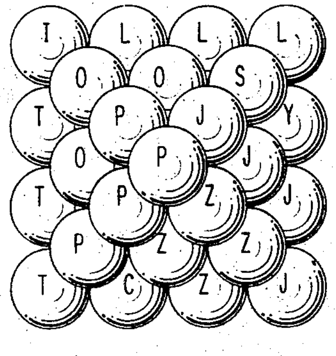


FIG. 9

FIG. 10a

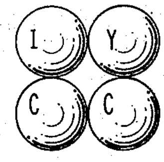


FIG. 10b

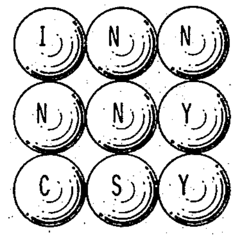


FIG. 10c

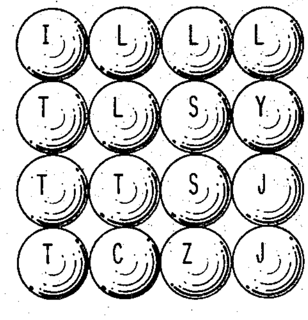


FIG. 10d

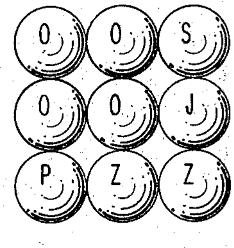


FIG. 10e

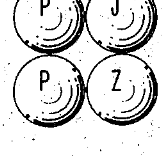


FIG. 10f

FIG. 10g

SOLID PUZZLE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a solid puzzle consisting of spheres of the same diameter. More specifically, it relates to a solid puzzle consisting of two or more spheres of the same diameter connected to each other by axes extending through the centers of the individual spheres (to be referred to as the connecting axes), all of said axes being on the same plane and the connecting axes of any two adjoining spheres forming an angle of either 60°, 90°, 120° or 180° and those connecting axes can be defined as either an n X 60° group or an n X 90° group or both, in which *n* is an integer.

SUMMARY OF THE INVENTION

One of the characteristics of the puzzle of this invention is that by assembling some of the connected units of spheres (to be referred to as the connected unit) in a three-dimensional space, a regular tetrahedron, regular quadrangular pyramid, equilateral triangular hexahedron or regular octahedron can be built. The player thus can take advantage of a very unique aspect not experienced with conventional puzzle games. If a cube is used as a constituent element of a connected unit instead of spheres, the arrangement of the connected units used to build up a solid (polyhedron) by filling a three-dimensional space is limited. However, by using the connected unit of spheres as in the solid puzzle of this invention, there are many different arrangements possible, and the game becomes extremely complicated as compared with the case of using other constituent elements which are not spheres. Therefore, the value of the puzzle is very greatly increased. Thus, the puzzle of this invention has an advantageous feature in that in building any of a regular tetrahedron, regular quadrangular pyramid, equilateral triangular hexahedron or regular octahedron, there is a wide variety of combinations of assembled positions of the individual connected units of spheres.

This solid puzzle possesses much of the character of an intellectual game because a high level of thinking is required of the player in order to find a solution to the largest possible number of the combinations of the assembled positions of the connected units of spheres in the course of building a regular quadrangular pyramid, equilateral triangular hexahedron or regular octahedron.

The assembled positions of the connected units of the spheres can be easily ascertained by the player if the spheres of the same diameter which constitute one connected unit are colored in a color different from those of another unit or a suitable sign is attached according to each unit. This makes the game more interesting.

If the number of spheres of the same diameter in one connected unit is increased, a higher level of thinking is required of the player, and therefore, it will be tremedously effective for training the player's ability to think and create.

The specific embodiments of the solid puzzle of this invention will be described in detail with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a plan view of a single sphere employed in the present invention.

FIG. **2** is a plan view illustrating a number of different units of connected spheres in accordance with the invention.

FIG. **3** is a schematic view of a solid figure of a regular quadrangular pyramid formed by the units of FIG. **2**, consisting of four layers of spheres defined by horizontal severance planes.

FIG. **4** is a plan view of the pyramid of FIG. **3** as seen from the apex.

FIG. **5***a* is a plan view of the single sphere appearing at the apex of the pyramid of FIG. **3.**

FIG. **5***b* is a plan view of the spheres forming the layer just beneath the apex as designated by plane **5** of FIG. **3.**

FIG. **5***c* is a plan view of the layer of spheres designated by plane **6** in the pyramid of FIG. **3.**

FIG. **6** is a plan view in similar fashion to that of FIG. **2** of a plurality of connected units of spheres of the same diameter.

FIG. **7** is a schematic perspective view of a solid figure as an alternate embodiment of the present invention.

FIG. **8** is a top plan view of the solid figure of FIG. **7** in regular octahedron form as comprised of a number of units of connected spheres in an arranged order.

FIG. **9** is a bottom plan view of the solid figure of FIG. **8** as seen from the opposite apex.

FIG. **10***a* is a plan view of the single sphere defining the apex of the regular octahedron of FIG. **7.**

FIG. **10***b* is a plan view of the layer of spheres designated by plane **8** in the regular octahedron of FIG. **7.**

FIG. **10***c* is a plan view of the layer of spheres designated by plane **9** of the regular octahedron of FIG. **7.**

FIG. **10***d* is a plan view of the spheres making up the layer designated by plane **10** of the regular octahedron of FIG. **7.**

FIG. **10***e* is a plan view of the layer of spheres making up a portion of the regular octahedron seen in FIG. **7** as designated by plane **11.**

FIG. **10***f* is a plan view of the spheres making up a layer of the regular octahedron of FIG. **7** as designated by plane **12.**

FIG. **10***g* is a plan view of the single sphere defining the lower apex of the regular octahedron of FIG. **7.**

DESCRIPTION OF PREFERRED EMBODIMENTS

These embodiments show the building of a regular quadrangular pyramid in which three single spheres of the same diameter are arranged in a row on an edge line, and a regular octahedron in which four single spheres of the same diameter are arranged in a row on an edge line, using various kinds of connected units each composed of two or three single spheres of the same diameters (FIG. 2) or four single spheres of the same diameter (FIG. 6). Other solid bodies than the regular quadrangular pyramid and regular octahedron as illustrated can be built up by using the above kinds of the connected units. By devising various modes of assembling, a regular tetrahedron and an equilateral triangular hexahedron can also be built up, and a wide variety of the prescribed positions of the connected units are conceivable for each solid body.

The following description will be directed to the building of a regular quadrangular pyramid and a regular octahedron.

If a regular quadrangular pyramid in which three single spheres of the same diameters are arranged in a row on an edge line is to be built up by using single spheres of the same diameter, a total of 14 spheres arranged like $1^2 + 2^2 + 3^2$ are required. These 14 single spheres can be divided into one connected unit composed of two single spheres connected to each other by a connecting axis and four kinds of connected units each composed of three single spheres connected to each other by connecting axes with any of the two adjoining connecting axes forming an angle of either 60°, 90°, 120° or 180°.

FIG. **2** is a plan view of five kinds of connected units composed of two or three single spheres **1** shown in FIG. **1** connected to each other by connecting axes extending through the center **2** of the sphere **1,** the connecting axes **3** being on the same plane and any of the two adjoining connecting axes forming an angle of either 60°, 90°, 120° or 180°. These connected units are designated I′, J′, L′, P′, and I″ respectively. In this case, L′ is a member of n X 90° group and J′, P′ are members of n X60° group. Particularly, I′ is a member of the n X 90° group and a member of the n X 60° group also. Using these five kinds of the connected units as one set, the regular quadrangular pyramid shown in FIG. **3** is built up. There can be a very large number of combinations of the positions of setting the five kinds of the connected units, and it is the purpose of this embodiment to demand as many solutions as possible to the player. In the present specification, the arrangement of single spheres as shown by FIGS. **4** and **5** (that is, I′ is set at the apex a of the regular quadrangular pyramid — FIG. 3) is shown as one solution. FIGS. **5***a*, **5***b* and **5***c* respectively show the arrangement of single spheres which appear corresponding to planes **4, 5** and **6** that are perpendicular to the center line cd of the regular quadrangular pyramid (FIG. **3**) and are same in number as the number of the spheres **1** disposed on the edge line *ab*.

Now, if a regular octahedron in which four single spheres of the same diameter are arranged in a row in one edge line is to be built by using spheres of the same diameter, a total of 44 single spheres arranged like $1^2 + 2^2 + 3^2 + 4^2 + 3^2 + 2^2 + 1^2$ are required. These 44 spheres can be divided into **11** kinds of connected units of different forms each composed of four single spheres connected to each other by connecting axes, all of the connecting axes being on the same plane and any of the two adjoining axes forming an angle of either 60°, 90°, 120° or 180°.

FIG. **6** is a plan view of **11** connected units each composed of four single spheres **1** of the same diameter connected to each other by connecting axes **3** extending through the centers **2** of the spheres **1** with all of the connecting axes being on the same plane and any of the two adjoining axes forming an angle of either 60°, 90°, 120° or 180° and those connecting axes can be defined as either an n X 60° group or an n X 90° group or both, in which *n* is an integer. These units are designated I, L, T, N, O, J, P, S, C, Y and Z respectively. In this case, L, T, N and O are members of n X 90° group and J, P, S, C, Y and Z are members of n X 60° group. Particularly, I is a member of the n X 90° group and a member of the n X 60° group also. Using these eleven units as one assembly, the regular octahedron shown in FIG. **7** is built up. There can be a very large number of combinations of set positions of the eleven connected units, and it is the purpose of this embodiment to demand as many solutions as possible of the player. In the present specification, the arrangement of single spheres is shown by FIGS. **8** and **9,** that is, I and P are set respectively on the apexes *e* and *f* of the regular octahedron wherein FIG. **7** shows one solution. In FIG. **8,** the regular octahedron is seen from the apex e, and in FIG. **9,** it is seen from the apex *f*. FIGS. **10***a*, **10***b*, **10***c*, **10***d*, **10***e*, **10***f*, and **10***g* respectively show the arrangement of single spheres appearing corresponding to planes **7, 8, 9, 10, 11, 12** and **13** which are perpendicular to the center line hi of the regular octahedron (FIG. **7**) and are same in number as the number of the spheres **1** disposed on the edge line *egf*.

There is shown one example of a solution in the case of building both a regular quadrangular pyramid and a regular octahedron using **5** kinds and **11** kinds of connected units as one assembly, each unit consisting of three or less spheres of the same diameter or four single spheres of the same diameter, respectively. The player, however, can find the pleasure of an intellectual game of the solid puzzle of this invention and at the same time train his thinking and creative ability by attempting to find out as many arrangements as possible of the various connected units of single spheres to produce the solid desired.

The single spheres in the solid puzzle of this invention may be fixedly connected to each other, or removably connected.

Although the single spheres used in this invention must be of the same diameter, the size and weight of each sphere are not restricted. The spheres may be made of any material, such as metal, plastics, rubber, wood or stone, which can retain the spherical form. They may either be colored or not colored, and the surface of the spheres may either be roughened or smooth. In other respects, too, the surface condition of the spheres are not limited.

What is claimed is:

1. A solid puzzle consisting of the five connected units of spheres as illustrated in FIG. **2,** assemblable into the structure illustrated in FIG. **4.**

2. A solid puzzle consisting of the eleven connected units of spheres as illustrated in FIG. **6,** assemblable into the structure illustrated in FIGS. **8** and **9.**

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