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Montgomery

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[54] **FOLDING STRUCTURE**

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[21] Appl. No.: **329,077**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 73,756, Sept. 21, 1970, abandoned.

[52] **U.S. Cl.** **161/17,** 35/69, 46/26

[51] **Int. Cl.** **A63q 31/00**

[58] **Field of Search** ..... 161/17; 46/1 R, 26; 35/69, 35/70; 16/180

[56] **References Cited**

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2,228,110	7/1964	Grumbacher	16/180
3,222,072	12/1965	Dreyer	46/26
3,550,310	12/1970	Bock-Gressau	46/26
3,596,396	8/1971	Thomson	46/1 R
3,628,261	12/1971	Thompson	35/70

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Attorney, Agent, or Firm—Graybeal, Barnard, Uhlir & Hughes

[57] **ABSTRACT**

A plurality of rectangular members interconnected by hinges such that the members in one unfolded configuration form a square having a side length to height ratio of 8:1 and in a second configuration form a cube having an edge length of four units. A flexible cord is provided interconnecting some of the rectangular members such that pulling the central portion of the cord causes the square to fold to the cube form while pulling the opposed ends of the cord causes the cube to unfold to the square form.

6 Claims, 7 Drawing Figures

Fig. 1.

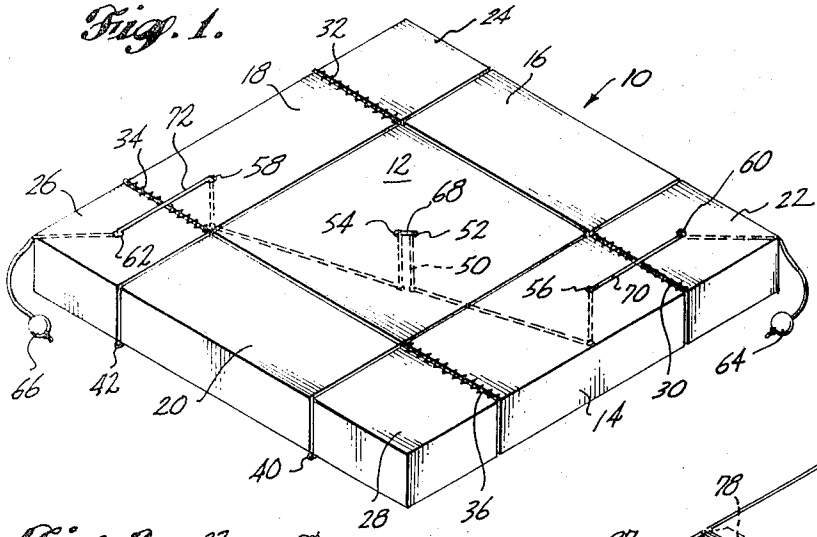
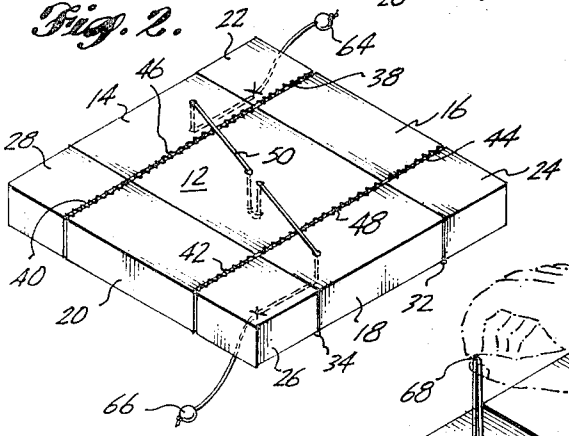


Fig. 2.



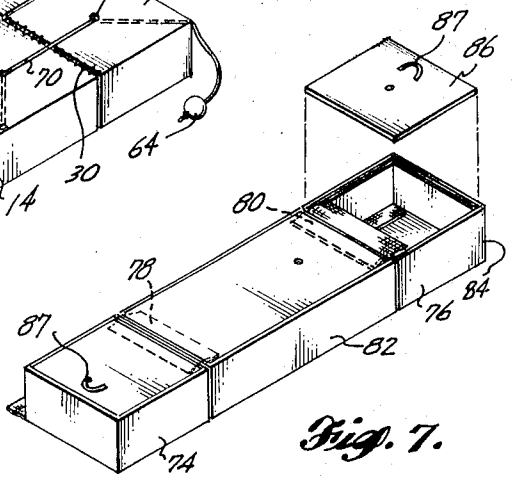


Fig. 7.

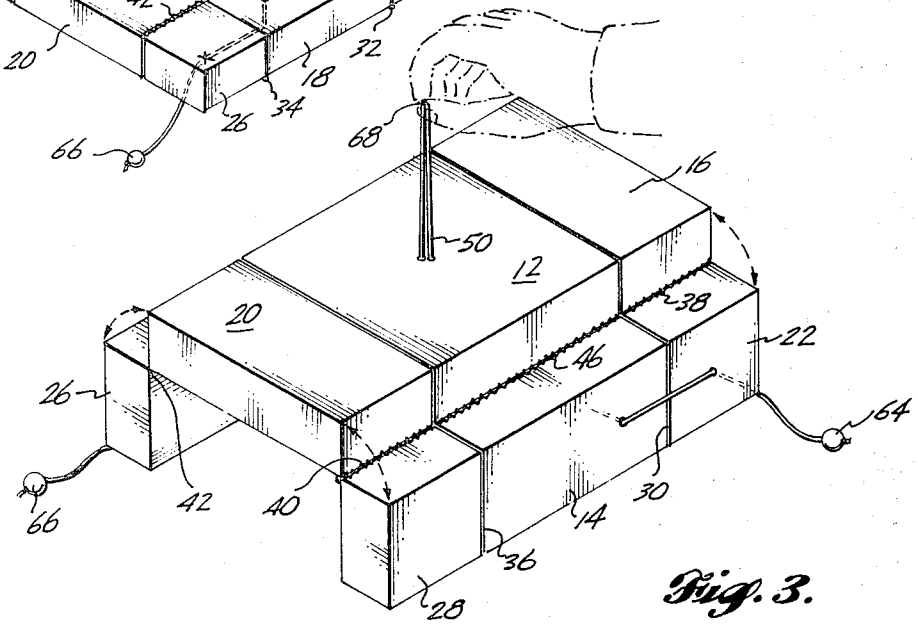


Fig. 3.

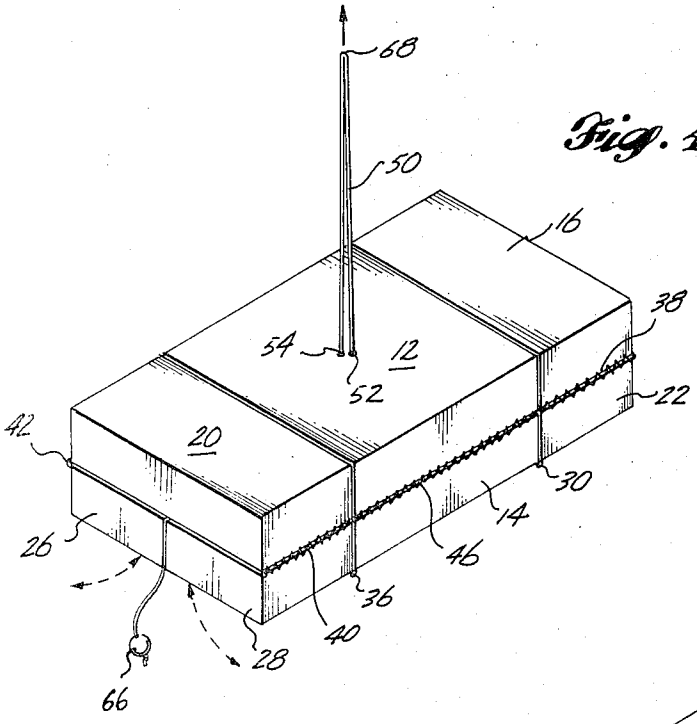


Fig. 4.

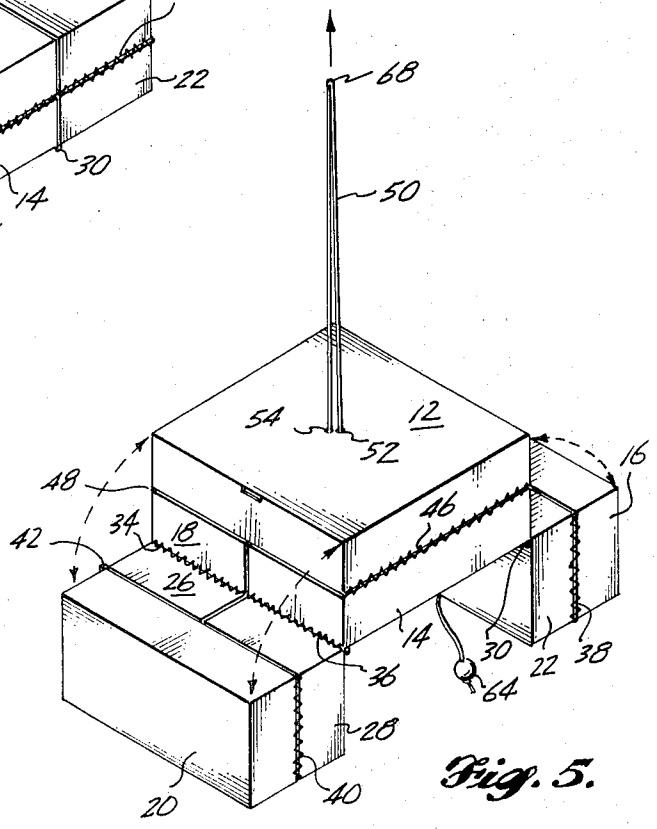


Fig. 5.

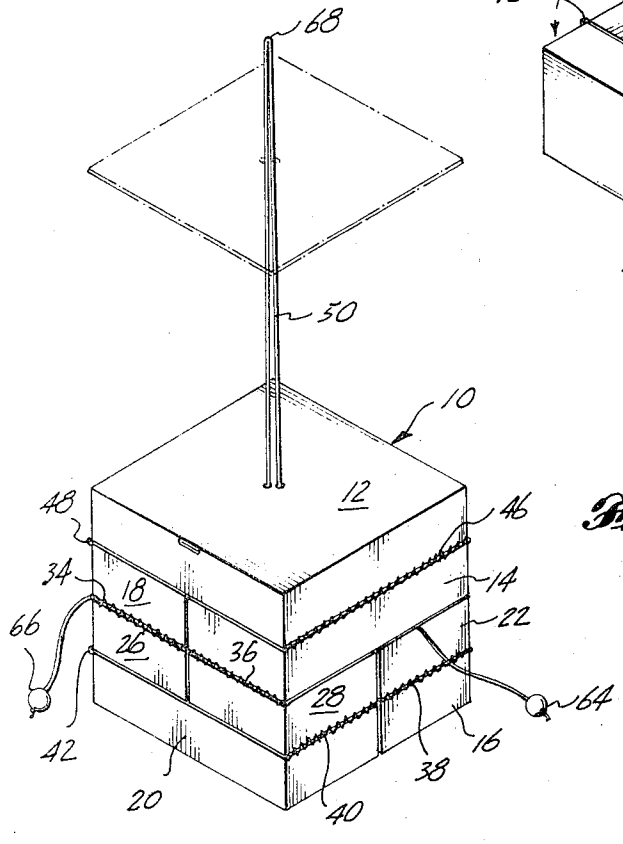


Fig. 6.

FOLDING STRUCTURE

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of my now pending application Ser. No. 73,756, entitled Multi-Fold Structure, filed Sept. 21, 1970 and now abandoned, and the drawings and specification of said application Ser. No. 73,756 are hereby incorporated by reference in this application.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates, in general, to a uniquely folding structure, and in particular, to a structure comprising a plurality of rectangular members hingedly interconnected to semi-automatically fold from a square to a cube or from a cube to a square in response to manipulation of a single cord running through or connected to selected rectangular members.

2. Description of the Prior Art

The interconnection of cube shaped units by means of cords to form a puzzle or amusement device is known per se. For example, U.S. Pat. Nos. 3,487,578 and 3,222,072 disclose puzzles of this type. Neither of these patents disclose the use of a flexible cord to manipulate the folding of the cubes with respect to each other, but rather the cord merely acts to interconnect the cubes. U.S. Pat. Nos. 3,550,310, 3,596,396 and 3,628,261 disclose other forms of cube puzzles all of which differ substantially from the instant invention with respect to both the shape of the interconnected members, the position of the hinges interconnecting the members, the location and function of the cord running through the members and the novel and intriguing operation thereof whereby the structure may be semi-automatically folded and unfolded between planar square and cube configurations.

Other patents illustrating the scope of the prior art but deemed to be substantially less relevant to the instant invention include U.S. Pat. Nos. 3,201,894; 3,577,673; 2,228,110; 926,365; 2,064,826; 2,334,486; 3,360,806; 3,462,150 and 2,880,001.

BRIEF SUMMARY OF THE INVENTION

This invention relates to a folding structure comprising a plurality of three dimensional rectangular members hingedly interconnected to fold between a square having a thickness of one unit and a side length of eight units and a cube having a side length of four units in response to pulling force applied to either the center or ends of a string interconnecting some of the rectangular members. The invention thus provides unique means for rapidly stacking a plurality of rectangular members in a stable, compact shape for storage.

In one embodiment, the surface decoration of the rectangular members may include alternating light and dark squares such that when the structure is in the planar square form it forms a chess or checker board. Alternately, the rectangular members may be hollow and each include a closable opening whereby they may be used to store a plurality of like items of varying size such as nuts, bolts, washers or the like.

It is an object of the present invention, therefore, to provide a folding structure adapted to be semi-automatically folded between a first planar square form and a second cube form.

Another object of the instant invention is to provide a folding structure having a single flexible cord extending through or interconnected with some of the hingedly interconnected rectangular members whereby a pulling force exerted on the ends of the cord causes the block to unfold from a cube to a square while a pulling force exerted on the center portion of the cord causes the structure to fold from a square to a cube.

Still another object is to provide a game board which may be quickly and easily unfolded for use or folded for storage.

An additional object of the present invention is to provide a folding structure of the disclosed type which may be used as an article of furniture.

One more object of the present invention is to provide a folding structure of the disclosed type which may be used as a storage unit.

One more object is to provide a folding structure formed from a plurality of varying sized rectangular members some of which are interconnected with adjacent members by means of a first set of hinges positioned along parallel lines on a first surface of the planar square form of the structure and a second set of hinges positioned along parallel lines transverse said first parallel lines on the surface of said planar square opposite said first surface.

Other and additional objects and advantages will be apparent from the following description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a typical folding structure made according to the instant invention unfolded to form a planar square. FIG. **2** is a perspective view of the bottom portion of the folding structure of FIG. **1**.

FIG. **3** is a perspective view of the folding structure of FIG. **1** wherein some of the members are being partially folded in response to an upward pulling force exerted on the center portion of the flexible cord.

FIG. **4** is a perspective view of the folding structure of FIG. **3** showing the structure after the folding action of FIG. **3** is completed.

FIG. **5** is a perspective view of the foldable structure of FIG. **4** wherein some of the rectangular members are being additionally folded in response to additional upward force on the center portion of the flexible cord.

FIG. **6** is a perspective view of the folding structure of FIG. **5** showing the folding structure completely folded to its cube form.

FIG. **7** is a perspective view showing a portion of one form of the folding structure of the instant invention including one manner of forming a hinge between hollow rectangular members.

DETAILED DESCRIPTION OF THE INVENTION

Referring initially to FIG. **1**, a folding structure **10** is disclosed formed in the shape of a substantially planar square having a side length eight times greater than its thickness or height. It will be understood that these dimensions have been found suitable for constructing one preferred embodiment of the present invention, but that these dimensions are not intended to be limitive and other dimensions may be substituted therefor to produce structures of differing shape but which fold

in substantially the same manner as disclosed herein. For example, use of structural members of lesser thickness to produce a planar square having a greater than 8:1 side length to height ratio will, when folded form a rectangular structure having a height of lesser dimension than its side length rather than a cube as shown in the preferred embodiment. Other obvious variations in the size of the rectangular members employed in the instant invention are considered to be within the scope of the instant invention.

As illustrated, folding structure **10** includes a central square member **12** having a side length of four units, four rectangular side members **14, 16, 18** and **20** positioned adjacent each of the sides of square member **12** and having a length of four units and a width of two units, and four corner members **22, 24, 26** and **28** having side lengths of two units.

While the surface configuration of the folding structure **10** is shown for clarity on the drawings to be unlined, as stated heretofore, a checked pattern may be imposed thereon by means of decoration or by constructing each of the members **12–28** from a plurality of individual cubes of light and dark shades having a side length of one unit, the light and dark cubes being interconnected alternately with respect to each other. It will further be understood that the size of the folding structure **10** may vary widely depending, for example, upon whether the folding structure is to be employed as a relatively small chessboard, a relatively large piece of furniture, or for any other purpose. Variation in size may be easily accomplished by changing the size of the "units" in terms of which the side length to height ratios have been previously discussed.

As seen in FIG. **1**, hinges **30, 32, 34** and **36** are provided to interconnect the corner members **22–28** with the end portions of the side members **14** and **18.** Hinges **30** and **32** and hinges **34** and **36** define a pair of parallel lines spaced on lateral sides of central square member **12.** Referring now to FIG. **2,** wherein the bottom portion of folding structure **10** is illustrated, it will be seen that hinges **38, 40, 42** and **44** are provided interconnecting the corner units **22–28** to the opposed ends of side members **16** and **20,** while hinges **46** and **48** interconnect the side members **14** and **18** with center square member **12.** Thus the hinges **38, 40** and **46** and the hinges **42, 44** and **48** also define a pair of parallel lines spaced on the lateral sides of central square member **12** and transverse the parallel lines defined by hinges **30, 32** and **34, 36.** Referring to FIG. **1,** it will be understood that the hinges **30–36** are mounted at the adjacent top corners of the members which they interconnect, while the hinges **38–48** are positioned on the bottom corners of the structural members which they interconnect. This top or bottom corner positioning of the hinges allows the structural members to fold one on top of the other in the manner to be described hereafter with reference to FIGS. **3–6.**

Flexible cord **50** is shown in FIG. **1** to extend through laterally spaced drilled holes **52** and **54** in square block **12,** outwardly to side members **14** and **18,** through drilled holes **56** in side member **14** and **58** in side member **18,** and thence toward attachment points **60** and **62** on corner blocks **22** and **26** respectively. Finger gripping beads or knobs **64** and **66** are fastened to the ends of cord **50** to allow the cord to be easily gripped in order to unfold the folding structure from the cube to the planar square form as will be discussed hereafter. Flexible cord **50** forms a loop portion **68** in FIG. **1** between holes **52** and **54** which loop may be gripped and pulled upwardly to cause the structure **10** to fold to the cube form.

As seen in FIG. **1,** the top openings of holes **52** and **54** in central block member **12** are spaced with respect to each other, and with respect to the block itself, such that the loop **68** formed by cord **50** extends essentially over the central portion of the block. The central positioning of the loop allows block **12** to be substantially balanced horizontally beneath the loop as the upward pulling force is exerted thereon during folding of the block to cube form. While holes **52** and **54** are shown to extend substantially vertically through block **12,** it will be understood that these holes may also be drilled at an angle to the vertical.

Holes **56** and **58** in side members **14** and **18** are shown positioned near the ends of the members adjacent corner blocks **22** and **26** respectively. It has been found that this end positioning of the holes improves the folding characteristics of the structure and reduces the tendency of the cord to become entangled with the blocks during folding. Attaching points **60** and **62** are shown centered respectively on corner blocks **22** and **26** and it will be understood that the attachment of the cord thereto can be made in a variety of ways such as through the use of a staple or by cementing the cord thereto such that the end portions of the cord extending from the attaching points **60** and **62** outwardly to the gripping members **64** and **66** are of a fixed length while at the same time the remaining central portion of the cord extending from the connecting points **60** and **62** inwardly to loop **68** is freely slidable through the holes in structural members **12, 14** and **18.** The holes in the structural members are sized to be only slightly greater in diameter than the cord **50** such that the cord is freely movable therethrough. Aligned grooves **70** and **72** may be formed on the top surfaces of side members **14** and **18** and corner blocks **22** and **26,** as well as between the top openings of holes **52** and **54** in block **12** if desired, sized to receive the cord **50** and retain it below the top surface level of the foldable structure **10** to provide a more pleasing appearance and additionally to prevent the cord from becoming entangled with playing pieces should the folding structure be used as a chess or checker board or the like. Additionally, a clasp, button or similar device may be affixed to the cord at its central loop portion **68** for ease and convenience in pulling the cord at that point, and a corresponding by sized recess may be provided centrally on the top surface of block **12** to hold the clasp below the playing surface in the manner of grooves **70** and **72.**

Referring now to FIGS. **3–6,** the semi-automatic folding of the structure **10** in response to the upward pulling of loop **68** will be described. FIG. **3** discloses that the upward pulling of loop **68** initially raises center block **12** and side members **16** and **20** and causes side members **14** and **18** and their adjacent interconnected corner members to fold downwardly with respect to block **12** and the side members **16** and **20.** On one lateral side of the structure **10,** corner squares **22** and **28** pivot respectively about hinges **38** and **40,** while side member **14** pivots about hinge **46.** On the opposite side of the structure corner blocks **24** and **26** pivot respectively about hinges **44** and **42** while side block **18** pivots about hinge **48.**

Referring additionally to FIG. **4**, it will be seen that additional upward pulling on loop **68** causes the members **22, 14, 28** and **24, 18, 26** to continue their pivoting movement until they are folded adjacent each other beneath center block **12** and side members **16** and **20.** At this point it will be understood that the effective size of the top surface area of the folding structure has been halved.

Referring additionally to FIG. **5**, it will be seen that additional upward pulling force applied to loop **68** causes the end units formed by side member **20** and corner members **26** and **28** and side member **16** and corner members **22** and **24** to begin folding downwardly beneath the central structural composite formed by square member **12** and side members **14** and **18.** The actual pivoting of the end units is carried out respectively about hinges **34** and **36** and hinges **30** and **32.** Referring additionally to FIG. **6**, the cubic form of the structural unit **10** attained upon completion of the folding action of FIG. **5** is illustrated.

It will be understood that the mechanism whereby the structural members are folded from the planar square form illustrated in FIG. **1** to the cube form shown in FIG. **6**, in response to upward pulling on loop **68**, involves the shortening of the portions of the cord **50** extending between drilled hole **52** and attachment point **60** and between drilled hole **54** and attachment point **62** and the corresponding increasing of the portion of the cord extending out of the top openings of holes **52** and **54** to form a loop **68.** Although not illustrated in the drawings, it will be understood that when the cube form of the structure shown in FIG. **6** has been reached, the portion of cord **50** extending between attaching points **60** and **62** and the top openings of holes **52** and **54** is drawn tightly therebetween and cannot be additionally shortened because of the surface contact of the folded members forming the cube. Upward pulling force on loop **68** prevents the cube from unfolding although setting the folded cube on its bottom surface as shown in FIG. **6** also prevents the cube from unfolding by itself.

As seen in FIG. **6**, after the cube form of the folding structure has been reached, the ends of cord **50** extend outwardly from the cube such that hand grips **64** and **66** may be pulled to cause the structure to semi-automatically unfold to the planar square form of FIG. **1.** The movement of the component members of the folding structure from the cube form to the planar square form is the opposite of the movement from the planar square to the cube form discussed heretofore i.e., the unfolding movement is illustrated serially in FIGS. **6, 5, 4, 3,** and **1** taken in that order. Again, the unfolding of the folding structure from the cube to the planar square form is accomplished by exerting opposing forces on the ends of cord **50** thereby decreasing the portion of the cord used to form loop **68** and increasing the portions of the cord extending between the bottoms of holes **52** and **54** and attaching points **60** and **62.**

Referring to FIG. **7**, one mode of constructing and hingedly interconnecting the structural members of the instant invention is disclosed. Corner members **74** and **76** are shown pivotally interconnected by means of fabric hinges **78** and **80** to a side member **82.** As mentioned heretofore, side member **82** is equal to the combined size of the corner members **74** and **76.** Hinges **78** and **80** may comprise pieces of fabric or tape fastened by glue or the like to the inner surfaces of the interconnected structural members. Alternatively, other known forms of hinges such as piano hinges may be substituted therefor. The choice of hinge is related to the material used to fabricate the structural members themselves. As shown in FIG. **7**, the structural members are hollow and are formed of plastic or wood side sections **84** and top and bottom sections **86.** In other embodiments the structural members may be formed from solid pieces of wood, metal, plastic or polyurethane foam or the like as desired. Further as mentioned heretofore, hollow structural members may also be provided with opening means **87** allowing the folding structure to be used for storage.

As illustrated, the hinges extend substantially completely along the corner edges of the joined adjacent structural members, but it will be understood that smaller individual laterally spaced hinges may also be satisfactorily substituted therefor. In selecting suitable hinges, it is important that they not be of excessive size so as to interfere with the complete folding of the structural members.

Referring again to FIGS. **1** and **2**, it will be seen that the instant invention comprises a structure formed from a plurality of structural members including corner members **22, 24, 26** and **28,** a first opposite pair of side members **14** and **18** and a second opposite pair of side members **16** and **20** and a square center member **12.** The corner members, side members and center member are related to each other in size as 1:2:4. The corner members and side members form a rectangular border around the central square member **12.** The rectangular border being comprised of alternating corner members and side members interconnected by a single hinge between each adjacent member, pairs of hinges about the border being alternately positioned on the top surface and bottom surface of the structural members. A single pair of bottom surface hinges extending between side members **14** and **18** and the center member **12** are the only connections between the rectangular border and the central square member. Thus the corner members as well as side members **16** and **20** are not directly hinged to the center member **12.**

A folding rectangular chess board 14 inches on a side and foldable to form a cube having a 7 inch side length has been formed in accordance with the teaching of this invention by the interconnection of 64 solid wood cubes having a side length of 1¾inches. In this embodiment, the corner members were formed by the rigid interconnection by means of glue or the like of four of the solid wood cubes, the side members formed by the rigid interconnection of eight of the solid wood cubes and the center section formed by the rigid interconnection of 16 of the solid wood cubes. The 64 cubes themselves were comprised of 32 cubes of a light colored wood and 32 cubes of a dark colored wood and in forming the chessboard the cubes of light and dark wood were alternated in the standard chessboard or checkerboard fashion. It will of course be understood that the folding structure of the instant invention may be formed to be of any desired size by the fabrication of larger or smaller corner, side and center structural members proportioned in accordance with the above disclosure.

The invention may be embodied in other specific forms without departing from the spirit or central characteristics thereof. The present embodiments are there-

fore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore to be embraced therein.

What is claimed is:

1. A folding structure in the form of a square board one unit thick and eight units long on each side foldable into a cube four units long on each edge, comprising:

a. a square center member measuring four units long on each side;

b. four side members, each four units long and two units wide comprising a first opposite pair of side members and a second opposite pair of side members flanking the four sides of the square center member;

c. four square corner members, each measuring two units long on each side;

d. hinge means connecting together on one side of the board the contiguous edges of the square center member with the first opposite pair of side members, and the contiguous edges of the four corner members with the second opposite pair of side members, so that the first opposite pair of side members can be folded inwardly onto the square center member and the four corner members inwardly onto the second opposite pair of side members; and

e. hinge means connecting together on the opposite side of the board the contiguous edges of the corner members and the first opposite pair of side members, so that when the first opposite pair of side members are folded onto the square center member and the square corner members are folded onto the second opposite pair of side members, the square corner members together with the second opposite pair of side members can be folded inwardly onto the first opposite pair of side members, to complete the cube.

2. The folding structure of claim **1** including a pair of holes in said center member and a single hole in each of said first opposite pair of side members; a single cord means extending through said holes and slidably movable therein such that the center portion of said cord forms a loop between said pair of holes in said center member; cord attaching points on a pair of diagonally opposed corner members; the opposed end portions of said cord means extending from said holes in said first opposite pair of side members to said cord attaching points and then outwardly therefrom; and whereby pulling said loop portion of said cord causes said structure to fold to a cube and pulling said opposed ends of said cord causes said cube to unfold to a square.

3. The folding structure of claim **2** wherein said opposed ends of said cord means include hand grip portions.

4. The folding structure of claim **1** wherein said square center member, said side member and said corner members are hollow and include opening means communicating with said hollow interiors.

5. The folding structure of claim **1** wherein said corner members, said side members and said center member are related to each other in size as one is to two is to four.

6. A folding structure comprising a square center member and a surrounding rectangular chain of four alternating side members and four corner members; hinge means interconnecting said alternating side members and corner members such that adjacent members are pivotal with respect to each other, consecutive pairs of hinges being alternately mounted on vertically opposed sides of said adjacent side members and corner members; and, a pair of hinge means extending between said center member and an opposed pair of side members to pivotally interconnect said center member with said surrounding rectangular chain.

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