

Feb. 10, 1970

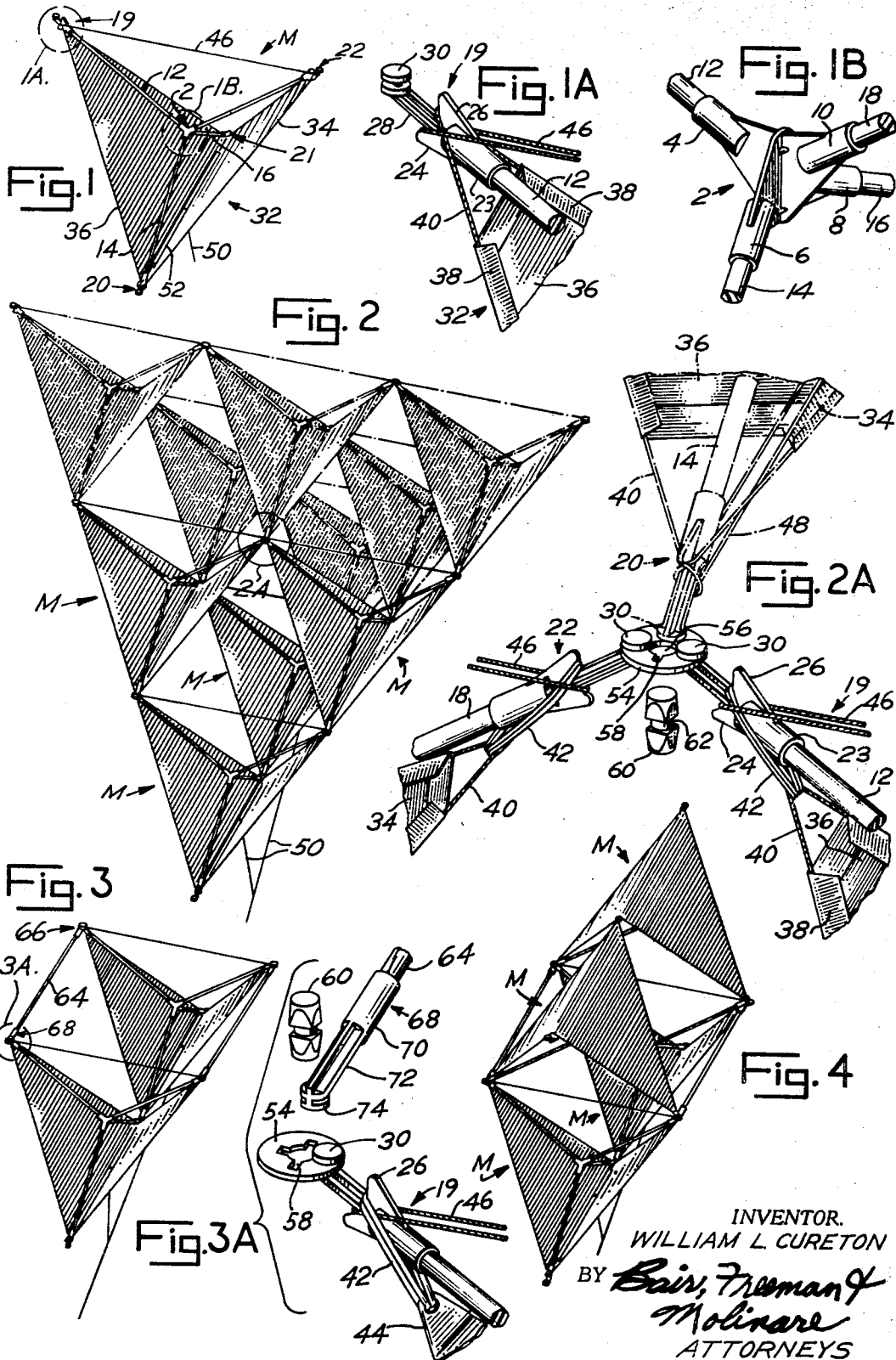
W. L. CURETON

3,494,578

CENTROIDALLY SUPPORTED MODULAR TETRAHEDRON STRUCTURE

Filed Jan. 24, 1968

2 Sheets-Sheet 1



INVENTOR.
WILLIAM L. CURETON

BY *Bair, Freeman & Molinare*
ATTORNEYS

Feb. 10, 1970

W. L. CURETON

3,494,578

CENTROIDALLY SUPPORTED MODULAR TETRAHEDRON STRUCTURE

Filed Jan. 24, 1968

2 Sheets-Sheet 2

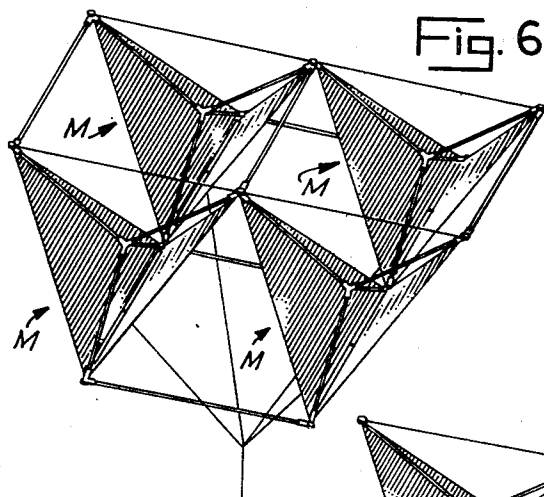


Fig. 6

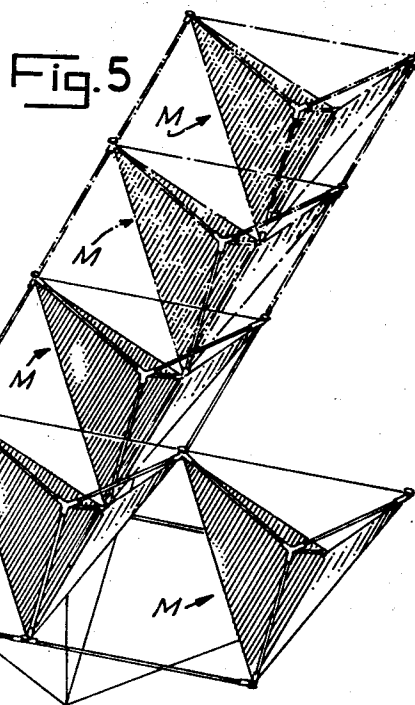


Fig. 5

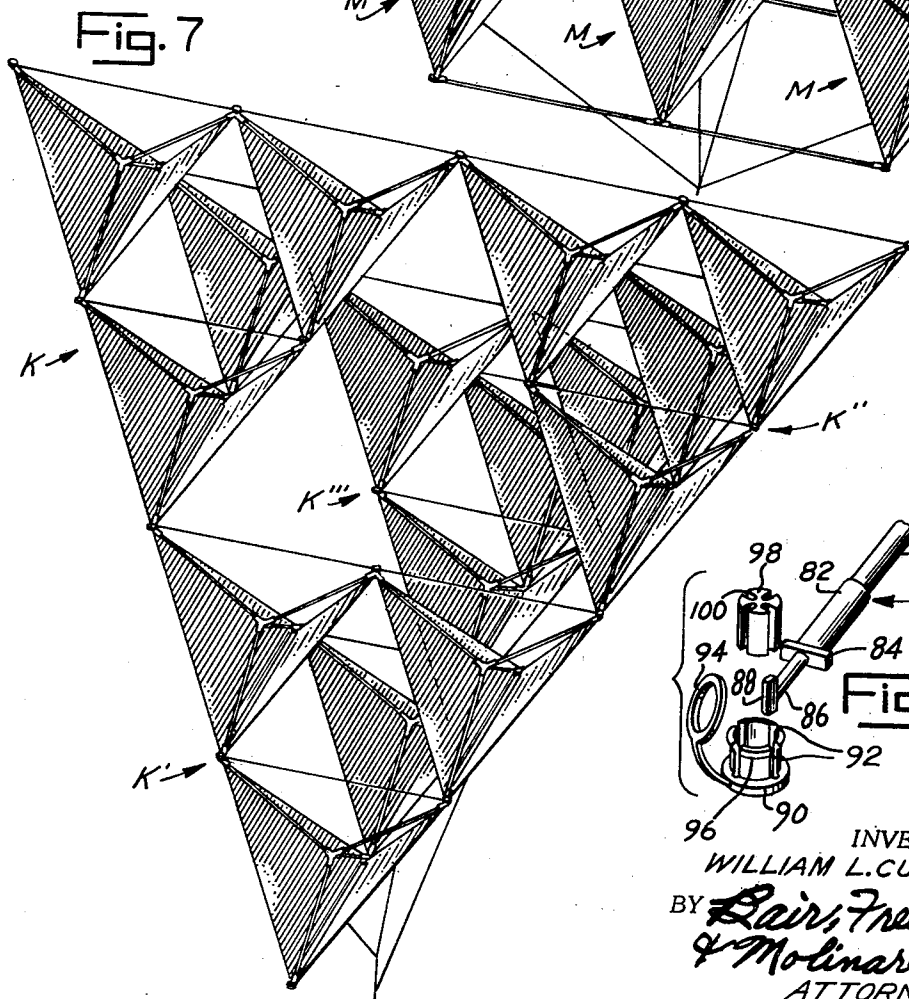


Fig. 7

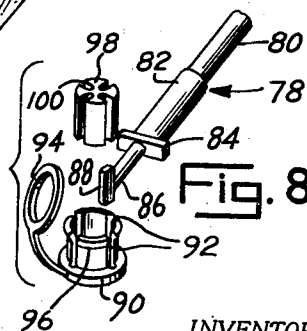


Fig. 8

INVENTOR.
WILLIAM L. CURETON
BY *Lair, Freeman
& Molinare*
ATTORNEYS

1

3,494,578

CENTROIDALLY SUPPORTED MODULAR TETRAHEDRON STRUCTURE

William L. Cureton, 21 W. Elm St., Chicago, Ill. 60610

Filed Jan. 24, 1968, Ser. No. 700,100

Int. Cl. B64c 31/06

U.S. Cl. 244-153

14 Claims

ABSTRACT OF THE DISCLOSURE

A centroidally supported modular tetrahedron structure, particularly adapted for use in a kite including a plurality of tetrahedron shaped units. Each unit has four supporting struts which are attached at their one end at the centroid of the unit and extend to the apices of the tetrahedron. A sheet member or sail is disposed on two of the faces of the tetrahedron and is attached at the ends of the struts. Tension strings and/or sail tension edges connect the ends of the struts together and tend to force the struts toward the centroid. Some of the sail ends may be attached to their strut ends by elastic bands to provide for a variable effective sail area. The strut ends have connectors whereby a plurality of units may be joined together as desired to form a variety of overall kite shapes.

BACKGROUND OF THE INVENTION

This invention relates to a modular tetrahedron structure and, more particularly, to a new and improved structure, particularly adapted for use as a kite, and formed of centroidally supported modular tetrahedron shaped units.

In the past, tetrahedron kits required a substantial number of relatively long support struts to prevent collapse and destruction of the kite structure during flight. The use of these support struts in the previous kits added weight to the kite, thus reducing the ability of the kite to become airborne. Moreover, due to the great number of strut members, more parts were necessary for the construction of the kite, which added to the complexity of joining the struts together. Also, because the support struts were relatively long, they were subjected to a higher probability of failure and breakage.

Moreover, previous tetrahedron kites were generally unable to adjust their effective sail surface area with respect to variations in wind velocity and therefore, during flight in high wind velocities, were likely to spin and/or become damaged or destroyed.

Further, the previous structures or kites were constructed in a more or less permanent manner and thus were not readily adapted to be easily assembled or disassembled either for storage or reassembly into other varied overall shapes.

It is accordingly a principal object of the present invention to provide a new and improved modular tetrahedron structure, particularly adapted for use as a kite, which is centroidally supported, having relatively few short supporting struts which firmly support the structure during flight and provide a relatively lightweight kite which is less the subject of damage or destruction.

It is also a principal object of the invention to provide a new and improved centroidally supported modular tetrahedron kite having sail surface areas which are variable during flight with respect to the wind velocity and thereby reduce the probability of damage or destruction during flight.

Moreover, it is a further object of the invention to provide a new and improved centroidally supported structure or kite which may be easily assembled in a variety of overall shapes and may be easily and readily disassembled for either storage or reassembly into other overall shapes.

2

These and other objects, features and advantages of the present invention will be more clearly understood through a consideration of the following detailed description.

BRIEF DESCRIPTION OF THE DRAWING

In the course of this description, reference will frequently be made to the attached drawings in which:

FIG. 1 is a view of one of the centroidally supported modular tetrahedron units of the structure or kite;

FIG. 1A is an enlarged view of one of the preferred embodiments of the apex connector of the present invention taken within circle 1A of FIG. 1;

FIG. 1B is an enlarged view of a centroid connector of the present invention taken within circle 1B of FIG. 1;

FIG. 2 is a four unit tetrahedron shaped structure or kite embodiment of the present invention and shows how the overall structure may be supplemented with additional units;

FIG. 2A is an enlarged partially exploded view of a unit-to-unit connector assembly of one of the preferred embodiments of the present invention taken within circle 2A of FIG. 2;

FIG. 3 is a two unit embodiment of the structure or kite of the present invention;

FIG. 3A is an enlarged, partially exploded view of a unit-to-unit connector assembly having a unit replacement strut taken within circle 3A of FIG. 3;

FIG. 4 is a box type embodiment of the structure or kite of the present invention;

FIG. 5 is a T-shaped embodiment of the structure or kite of the present invention;

FIG. 6 is a flat four unit embodiment of the structure or kite of the present invention;

FIG. 7 is a sixteen unit tetrahedron shaped embodiment of the structure or kite of the present invention; and

FIG. 8 is a view of another preferred embodiment of apex connector of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, the component parts of a preferred tetrahedron shaped modular structure or kite unit are shown. The modular unit M includes centroid connector 2 located at substantially the centroid of the tetrahedron. The unit M further includes four support struts 12, 14, 16 and 18 extending from the centroid of the tetrahedron to its apices. As more fully shown in the enlarged FIG. 1B, the centroid connector includes four sockets 4, 6, 8 and 10 which are integral therewith. The openings of the sockets point in a direction generally toward the four apices of the tetrahedron. Inserted into each of the aforementioned sockets are the support struts 12, 14, 16 and 18, respectively.

At the ends of the support struts 12, 14, 16 and 18, apex connectors 19, 20, 21 and 22 are respectively disposed. Because each apex connector is substantially identical, only apex connector 19 will be further described. As shown in FIG. 1A, apex connector 19 includes a socket 23 for receiving the outward apex end of support strut 12. The apex connector also includes a pair of fins 24 and 26, the purpose of which will be later described. Extending past the fins is an extended portion 28 terminating in a male connector head 30. Although the support struts are disclosed as being press fitted into their respective centroid and apex connectors' sockets, the struts may be affixed to their connectors in any other suitable manner as by gluing, integrally molding, etc.

As shown in FIG. 1, a sail 32 is disposed about the exterior of the modular tetrahedron unit M. Sheet or sail surfaces 34 and 36 cover two of the four faces of the tetrahedron. The sail may be constructed of paper, plastic or other suitable material as desired and may be brightly

colored or include artistic designs thereon to give the overall kite an aesthetic appearance. As shown in FIG. 1A, the sail 32 is folded and secured about its perimeter and a perimeter edge tension string 40 is held within the fold 38. The sail 32 is attached to apex connector 19 by placing the sail perimeter edge tension string 40 over the extended portion 28 and male connector head 30 and is retained by one of the fins 26. In the alternative, the perimeter edge tension string 40 may be attached to an elastic band 42 and the elastic band in turn placed over the extended portion 28 and male connector head 30 to be retained by the fin 26, as shown in FIG. 2A. Also, where the sail is constructed of a plastic or other similar material, the tips of the sail may be perforated or may be reinforced with a tab 44 and perforated and the elastic band 42 may be connected directly to the sail. In the latter instance, the other end of the elastic band 42 is placed over the apex connector 19 and retained by fin 26 as shown in FIG. 3A. The use of the elastic band 42 is preferred, since it allows flexing of the sail surface by varying wind velocities during flight, and thereby provides for a variation of the effective surface area of the sail presented to the wind. Thus, the elastic band connections act to allow reduction of the effective sail surface area in a high velocity wind to diminish the possibility of spinning and/or damage of the kite by such winds. Conversely, when the wind velocity is low, the elastic band connections allow a presentation of maximum effective sail surface area to the wind.

The tension edge of the sail itself or its associated perimeter string 40, when used, draws tension between apex connectors 19, 20 and 21, and apex connector 22, 20 and 21. A tension string 46 is also provided to draw a tension between apex connectors 19 and 22, respectively. When assembled, all tension forces along the edges of the tetrahedron modular unit M are essentially equal and balanced. Any force applied to any tension edge or group of edges will be transmitted to and shared by the remaining edges. Tension string 46 is looped under the connectors' extended portion 28 and male connector head 30 and is retained by the associated fin, for example 24 shown in FIG. 1A. A valley tension string 48, as shown in FIG. 2A, which may be an extension of the perimeter edge tension string 40, is also preferably provided in the valley formed by the intersecting planes of the sail surfaces 34 and 36. In some cases, such as with a plastic sail which need not have a perimeter string, a separate valley tension string 48 may be connected between apex connectors 20 and 21 and in a manner similar to that described for tension string 46. Since the tension strings, sails and/or sail perimeter string normally draw a tensile force between the apex connectors, a resultant of that force acts toward the centroid of the tetrahedron shaped unit along the longitudinal axes of the support struts. This resultant normally acts to keep the support struts under compression along their longitudinal axes and thereby tends to further seat the struts in their respective centroid and apex connector sockets. In fact, as the unit tends to be deformed by wind forces during flight, the tension between the apex connectors increases, thereby increasing the resultant axial compression forces on the struts thus tending to seat the struts even more firmly in their associated sockets.

A restraining or towing line 50 is connected in the valley. Restraining line 50 may be connected either to the valley tension string 48, or a valley strut 52 may be provided as shown in FIG. 1. The valley strut merely rests in the valley and acts as a force distributing anchor for the restraining line.

The use of centroidal support struts 12, 14, 16 and 18 meeting at substantially the centroid and extending to the apices of the tetrahedron shaped modular unit M, provides numerous advantages. Among other advantages, the number of support struts required to adequately support the unit is minimized and each of the struts is

substantially shorter than if the struts were located along the tetrahedron's edges. Thus, each of the struts is able to withstand greater forces which would tend to break them and the overall weight of the assembly is reduced. Moreover, the forces exerted upon the struts during flight which are primarily compressional in nature, are equally distributed through a central point at the centroid connector and along the struts' relatively strong longitudinal axes, thus substantially reducing the possibility of damage or destruction of the kite. If the support struts were located along the edges of modular unit M, they would be subjected to bending forces rather than essentially pure compression forces and would be more likely to break. Also the distance from the centroid to each of the apices of the tetrahedron may be equal, thus allowing uniformity of each of the support struts needed to assemble the modular unit. Although it is preferred that the inner ends of the struts be attached together at the centroid of the tetrahedron, the kite would, in all probability, still be operative if the ends were attached together at a point other than the centroid.

A plurality of the previously described tetrahedron shaped modular units M may be connected to each other to form various overall structure or kit shapes. For example, as shown in FIG. 2, four of the modular units M are joined together at their apices to form a four unit tetrahedron shaped kite. The dotted units, as shown in that figure, merely illustrate how additional units may be added, in an apex-to-apex fashion, to increase the size of the kite indefinitely. To connect the apices of the modular units M together, a unit-to-unit connector ring 54 is provided, as shown in FIG. 2A. The male connector heads 30 of each of the apex connectors are inserted, one at a time, in an aperture 56 of the connector ring 54, and each of the heads 30 is then pulled in a direction parallel to the surface of the connector ring and toward its outer periphery until each of the male connector heads 30 is disposed in one of the slots 58 of the connector ring. When each of the apex connectors of the units M which are desired to be connected together have been so inserted in the connector ring 54, locking pin or plug 60 is press fitted into the aperture 56 until its necked portion 62 is locked in the aperture 56. Either the connector ring 54, the locking pin 60 or both may be resilient such that they frictionally engage each other in their final locked position. Thus, a plurality of modular units M may be quickly and easily assembled and joined together to form a multi-unit kite. To remove any one of the units, the locking pin 60 is merely pressed out of aperture 56 and the various units' male connector heads are removed from the connector ring 54.

A two unit structure or kite is shown in FIG. 3. It will be noted that in the two unit construction, only one of the apex connectors of each individual modular unit M is connected to the other modular unit's apex connector. Thus, to form a structurally sound overall kite, unit replacement struts 64 are provided to connect two additional apex connectors of each of the units together. The unit replacement struts 64 are of such a length as to span the length between the two adjacent units' apex connectors which would normally be spanned by another unit M in other kite constructions. Each unit replacement strut 64 includes a unit replacement strut connector 66 and 68 at each of its ends. Each replacement strut connector comprises a socket 70 and an extended portion 72 which, at its end, terminates in a male connector head 74 similar in construction to the previously described male connector heads 30. As shown in FIG. 3A, the unit replacement strut 64 and its associated strut connector 68 are fixed to a unit-to-unit connector ring 54 in the same manner as previously described for apex connectors 19, 20, 21 and 22.

Utilizing the various structural elements previously described, a large number of structures or kites of various sizes and shapes may be constructed. For ex-

5

ample, in FIG. 4 a box type structure or kite employing the tetrahedron shaped modular units M of the present invention is shown. It will be noted that in the box type kite construction, the surfaces of the sails oppose each other.

As shown in FIG. 5, a T-shaped structure or kite is shown employing the tetrahedron shaped modular units M of the present invention. The dotted units, as shown in that figure, merely illustrate how additional modular units may be added, is desired.

In FIG. 6, a flat four unit structure or kite is shown employing the tetrahedron shaped modular units M of the present invention.

In FIG. 7 a sixteen unit tetrahedron shaped structure or kite employing the tetrahedron shaped modular units M of the present invention is shown. The sixteen unit kite may be assembled by joining together, in an adjacent manner four of the four unit tetrahedron shaped structures or kites shown in FIG. 2. The connection of each of the four unit kites K, K', K'' and K''' together is merely effected by joining the free apex connectors of three of the units of one of the four unit kites to the free apex connectors of three of the units of the other four unit kites by the use of the unit-to-unit connector ring and locking pin as previously described and shown in FIG. 2A.

An alternative embodiment of apex connector assembly is shown in FIG. 8. An apex connector 78 includes a socket 82 having a support strut 80 inserted therein. The apex connector 78 also includes ears 84 for holding the tension strings, sail perimeter strings and/or elastic bands as previously described with respect to fins 24 and 26. An extended portion 86 extends from ears 84 and terminates in a blade shaped connector head 88. The connector head 88 is inserted through the hollow opening of cylindrical ring 90 such that it is disposed in slots 92 and extends toward the inside of the cylindrical ring 90. Ring 94, which is attached to cylindrical ring 90, is then pressed down about the outside perimeter of ring 90 after all the desired connector heads have been so inserted. Ring 94 is retained in its downward position by shoulder 96 on cylindrical ring 90. Locking pin or plug 98 is then press fitted into the cylindrical ring 90 with the slots 100 aligning with the various connector heads 88 extending into ring 90. Thus, the various supporting struts and their associated apex connectors and, if desired, unit replacement struts and their connectors are locked into ring 90. Either ring 90, locking pin 98 or both may be resilient such that they fractionally engage each other and lock together.

The various connectors, rings and locking pins are preferably each of one piece molded design and are also preferably constructed of a synthetic polymer or other suitable material. The struts are preferably wooden dowels or other suitable relatively lightweight material.

It should be understood that, although the preferred embodiments have been described primarily as being adapted for use in a kite, it is not intended that the invention be limited only to such use. It is contemplated that the invention may be readily adapted to other uses, for example, artistic three-dimensional objects and load bearing building units. The invention is particularly suitable for the latter use due to the nature of the distribution of forces within its structure.

It should further be understood that the embodiments of the invention which have been described are merely illustrative of a few applications of the principles of the invention. Numerous modifications may be made by those skilled in the art without departing from the true spirit and scope of the invention.

What is claimed is:

1. A kite having at least one modular tetrahedron shaped unit, said modular unit comprising:
 - four relatively rigid elongated support struts forming the frame of the kite and each having inward and outward ends,

connector means disposed at a point within said unit

6

and at said inward ends of each of said struts and connecting each of said inward ends substantially adjacent each other,

said outward ends of said struts being disposed at the apices of said tetrahedron shaped unit,

flexible means normally under tension extending between each of said outward ends of said struts and the outward end of another of said struts,

attaching means adjacent the apices of said tetrahedron shaped unit at the outward ends of each of said struts for attaching said flexible means at said outward ends of said struts, and

sheet means disposed substantially in at least one of the planes defined by a face of said tetrahedron shaped unit and attached to at least some of said struts.

2. The kite of claim 1 wherein said point is disposed at substantially the centroid of said tetrahedron shaped unit.

3. The kite of claim 1 wherein said flexible means include said sheet means.

4. The kite of claim 1 wherein said sheet means is flexible and forms a sail surface located substantially in at least two intersecting planes defined by said unit and one of said attaching means includes elastic means attached to said sheet means to provide for variation of the effective area of the flexible sheet means during flight.

5. The kite of claim 1 wherein said struts are press fitted into at least one of said central connector means and said attaching means.

6. The kite of claim 1 including:

a plurality of tetrahedron shaped modular units, second connector means connecting at least one of said attaching means of one tetrahedron shaped unit directly to an attaching means of an adjacent unit, whereby a multiple unit structure may be assembled.

7. The kite of claim 6 wherein said second connector means includes:

an apertured member, said attaching means of said one unit and said adjacent unit, respectively, being inserted in the aperture of said apertured member, and

a locking pin frictionally fitted in said aperture to retain said attaching means inserted therein.

8. The kite of claim 6, including:

sheet means disposed substantially in the intersecting planes defined by at least two faces of said tetrahedron shaped units, and

a restraining line attached in a valley of at least one of said units, said valley being formed by the intersection of the planes of said sheet means.

9. The kite of claim 8 including a valley strut disposed in said valley, said restraining line being attached to said valley strut.

10. The kite of claim 8 including a tension string disposed in said valley, said restraining line being attached to said tension string.

11. The kite of claim 6 including:

at least one elongated unit replacement strut extending between at least one of said attaching means of said one unit and an attaching means of an adjacent unit, and

connector means connecting an end of said replacement strut to the last mentioned one of said attaching means.

12. The kite of claim 11 wherein both the last mentioned and the second connector means is the same means and thereby connects both said one unit, the first mentioned adjacent unit and the elongated unit replacement strut together.

13. The kite of claim 6 including sheet means disposed substantially in the intersecting planes defined by at least two faces of said tetrahedron shaped units, and all of the faces of the units having said sheet means disposed therein are arranged to face in one direction.

14. The kite of claim 6 including sheet means dis-

posed substantially in the intersecting planes defined by at least two faces of said tetrahedron shaped units, and the faces of some of the units having said sheet means disposed therein face in a direction opposite to the faces of the other units having said sheet means disposed therein.

References Cited

UNITED STATES PATENTS

770,626	9/1904	Bell	244—153
856,838	10/1906	Bell et al.	244—153 XR
2,744,701	5/1956	Robey	244—153
3,220,152	11/1965	Sturm	52—81 XR

3,296,617	1/1967	Rogallo	244—153 XR
3,354,591	11/1967	Fuller	52—81

OTHER REFERENCES

Architectural Design, July 1961, pp. 302 to 316.
Space Grid Structures by John Borrego, MIT Press, Report No. 11, 1968, pp. 101—103, 105.

MILTON BUCHLER, Primary Examiner

P. E. SAUBERER, Assistant Examiner

U.S. Cl. X.R.

52—81