United States Patent [19]

Fraioli

[11] **3,885,360**

[45] **May 27, 1975**

[54] **REINFORCES INFLATABLE**

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[73] Assignee: **Air-Tech Industries Inc.**, Clifton, N.J.

[22] Filed: **Oct. 2, 1974**

[21] Appl. No.: **511,281**

Related U.S. Application Data

[63] Continuation of Ser. No. 376,137, July 3, 1973, abandoned.

[52] **U.S. Cl.** **52/2**

[51] **Int. Cl.** **E04b 1/345; E04g 11/04**

[58] **Field of Search** 52/2, 3, 23, 80, 81

[56] **References Cited**

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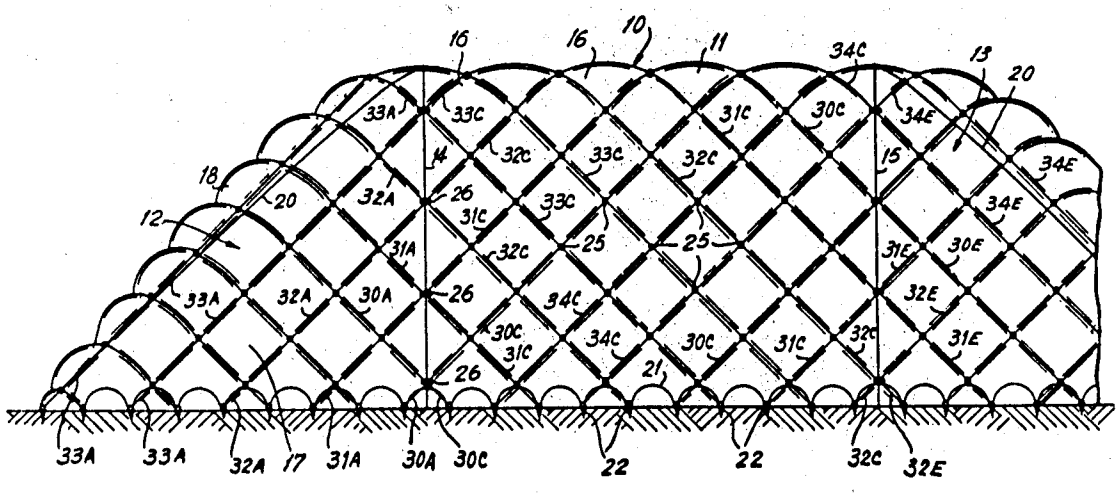
Primary Examiner—John E. Murtagh

Attorney, Agent, or Firm—Gerald Durstewitz

[57] **ABSTRACT**

A reinforced inflatable building in which an elongated fabric shell, anchored and sealed to the ground around its periphery, is supported by filling the enclosed volume with air at above atmospheric pressure. The entire outer surface of the building is overlayed with a cable network wherein the individual cables are arranged to form two intersecting sets of parallel cable lines. Each set of cable lines is oriented at an acute angle to the longitudinal axis of the building.

10 Claims, 6 Drawing Figures



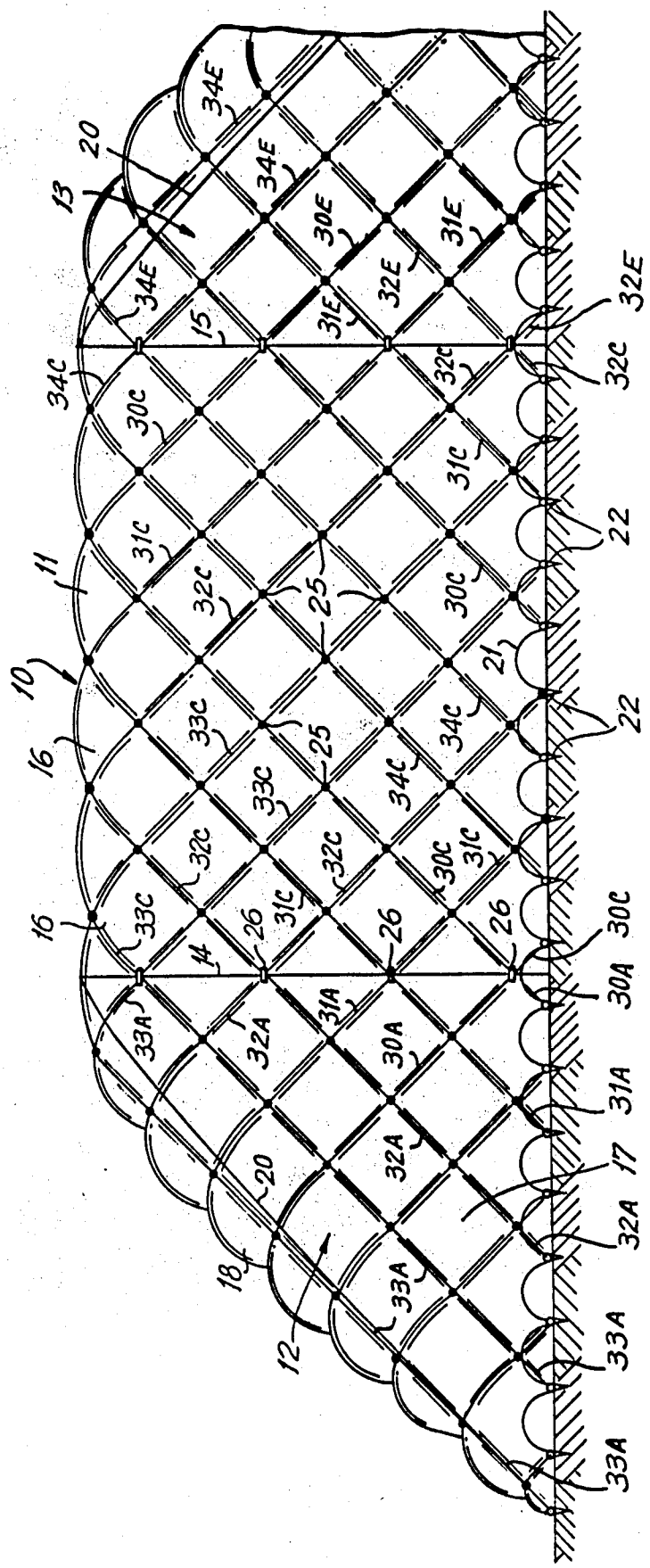

34E
20
13
34E
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30E
31E
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15
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34C
32C
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11
31C
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30C
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21
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33C
33C
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34C
34C
32C
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30C
31C
16
33C
26
26
26
30C
14
31C
30A
33A
32A
31A
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17
18
33A
32A
12
33A
33A

FIG. 1

FIG. 2

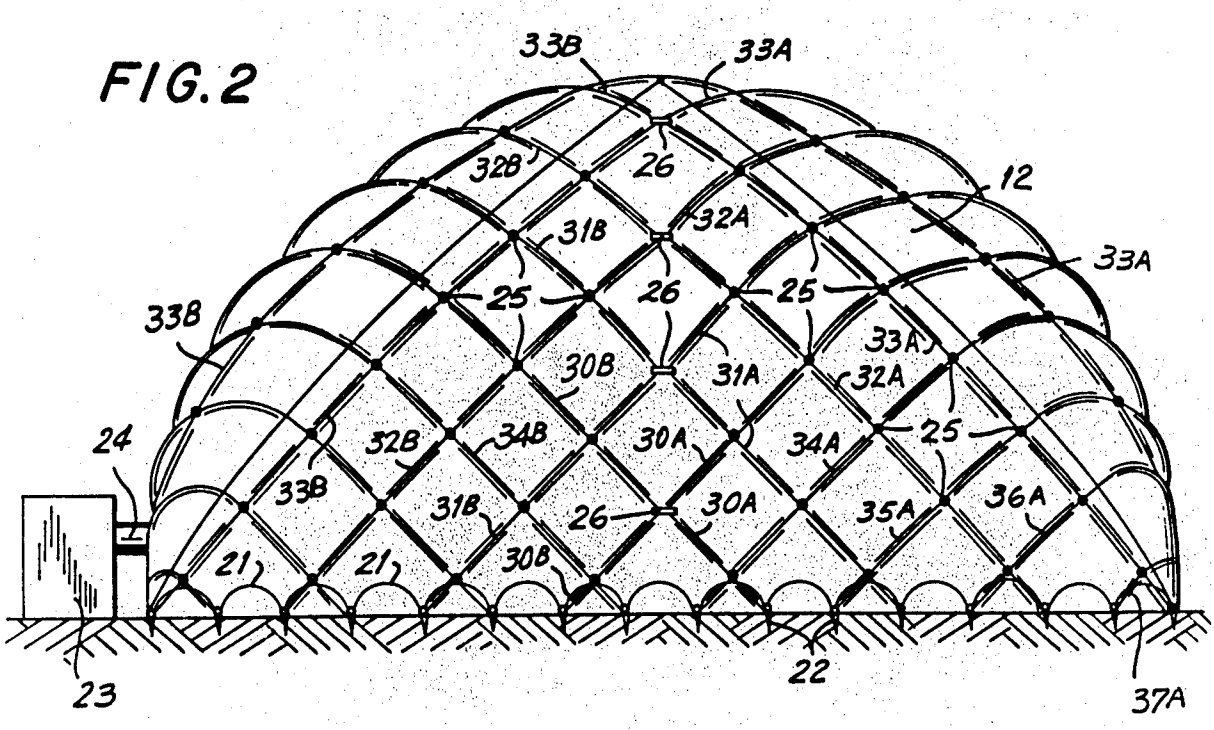
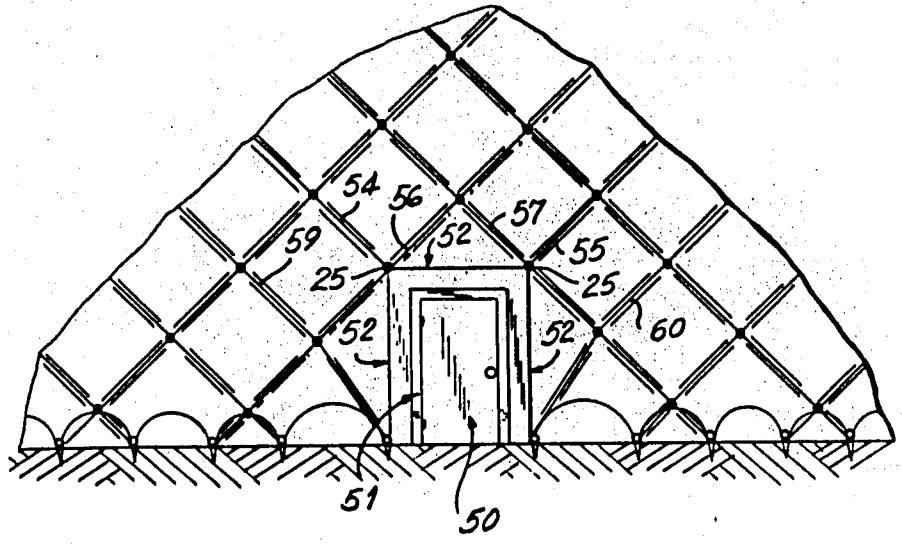

33B
33A
32B
26
12
31B
32A
33A
25
26
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33B
30B
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32B
34B
30A
34A
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33B
31B
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30A
35A
36A
21
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FIG. 7


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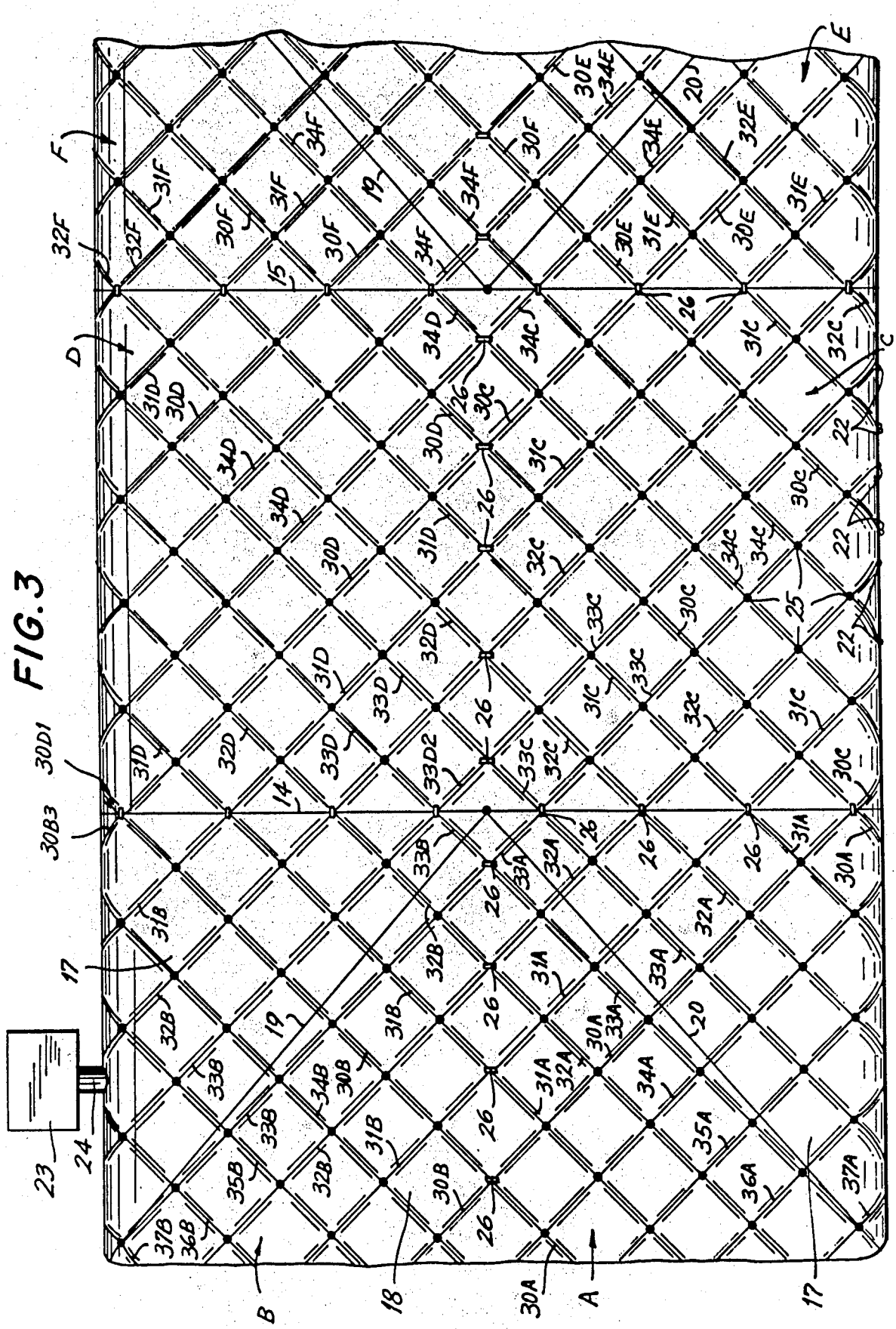


FIG. 3

FIG. 4

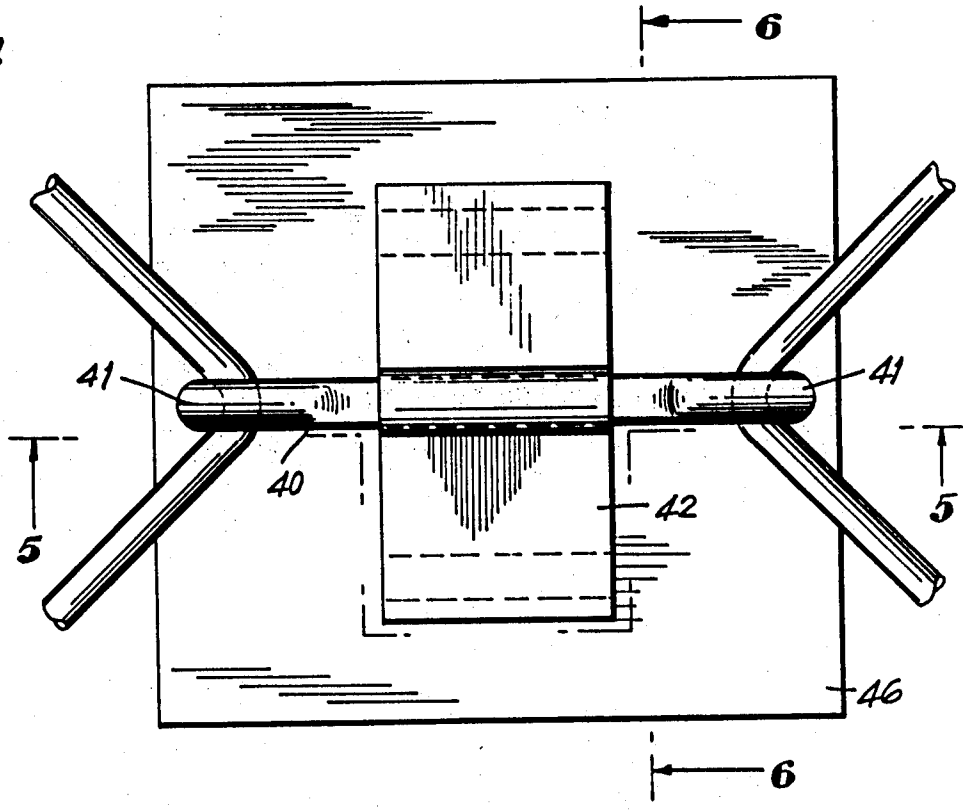


FIG. 5

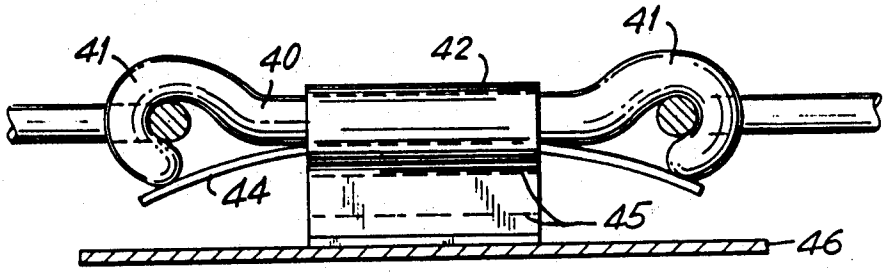
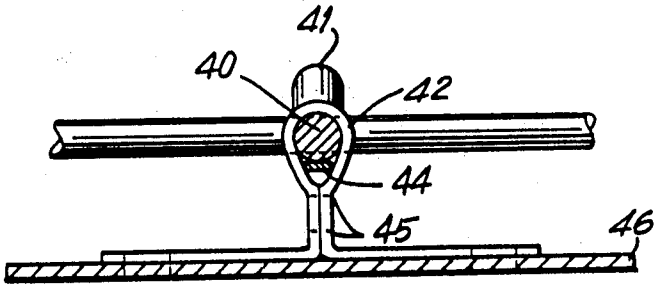


FIG. 6



REINFORCES INFLATABLE

This is continuation of application Ser. No. 376,137, filed July 3, 1973, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to inflatable buildings of the type wherein a fabric shell is anchored and sealed to the ground around its periphery and the enclosed volume is filled with air having a pressure greater than atmospheric pressure. The shell is lifted by the internal pressure and takes on a dome like configuration above the ground which forms the floor of the building.

One conventional form of inflated structure has a central section which is semi-cylindrical and has two end sections which are quarter spheres or truncated segments of quarter spheres. The action of the air pressure on the fabric skin produces a tensile stress in the fabric skin. Where the skin takes on a curved configuration, as for example between the two edges of the semi-cylindrical center section, the tensile force produced by the internal air pressure is directly proportional to the radius of the curve. The tensile stress in the fabric is also effected by the action of wind against the building. Wind loading adds to the overall stress of the fabric and also deforms the building and thereby redistributes the forces within various portions of skin reducing the stress in some areas and increasing it in other areas.

In small inflated buildings, the arched portions of the building have relatively small radii and a fabric of reasonable weight is capable of withstanding the pressures generated by the static internal pressure and by wind loading. However, when the size of the building is increased, the radii of the arched portions increase and a fabric of reasonable weight will no longer be able to carry the forces generated, particularly under heavy wind conditions.

It has been common practice in the past to releave the tension in the fabric by extending parallel cables over the outer surface of the skin and anchoring the ends of the cables to the ground at the edges of the building. One type of cable system previously used consists of a series of parallel cables extending perpendicular to the longitudinal axis of the structure such as shown in U.S. Pat. No. 3,651,609. These cables releave the hoop tension generated in fabric skin and enable the building to withstand a greater degree of wind loading, however, under high wind loads, the fabric will fail between the cables. When such a failure occurs, the fabric will rip along a line parallel to the cables and the structure will collapse.

In other cable systems, these transverse or hoop cables have been augmented by a series of parallel cables running longitudinally of the structure from end to end. Systems of this general type are shown in U.S. Pat. Nos. 1,302,182 and 1,402,077.

Such two directional cable systems give added strength to the buildings and under static conditions would help to prevent rips or cuts from propogating over distances sufficient to cause the collapse of the building. However, under severe wind loading, such structures experience twisting and deformation which cause high stresses in the fabric and redistribute the loads on the cables so that rips can propogate past the longitudinal cables causing collapse of the building.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide an improved reinforced inflatable building capable of withstanding greater static and dynamic loads.

Another object is to provide such a building including a cable system which uniformly releaves fabric tension in all directions under all conditions.

Another object is to provide such a building wherein the tension generated in the fabric skin in all directions by static pressure is greatly reduced.

Another object is to provide such a building highly resistant to deformation and twisting under wind loading.

The foregoing objects are accomplished by providing a reinforced inflatable building compressing an inflatable fabric skin adapted to be supported by air pressure within the enclosed volume and a plurality of cables arranged to form first and second intersecting sets of parallel equally spaced cable lines overlying the entire outer surface of the skin, each of the cable lines extending along the surface of the skin between peripheral ground anchors, each cable line extending from its ground anchors at an acute angle to a vertical plane taken through the building perpendicular to the surface of the skin.

DETAILED DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the invention has been chosen for purposes of illustration and description, and is shown in the accompanying drawings, forming a part of the specification, wherein:

FIG. 1 is a side elevational view of a reinforced inflatable building according to the present invention.

FIG. 2 is a elevational view of the left end of the building shown in FIG. 1.

FIG. 3 is a top view of the building shown in FIG. 1.

FIG. 4 shows a cable connector used in the cable network of the building shown in FIGS. 1-3.

FIG. 5 is a view taken along line 5—5 on FIG. 4.

FIG. 6 is a view taken along line 6—6 on FIG. 4.

FIG. 7 is an elevational view of door installation in a building according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings in detail, there is shown a reinforced inflatable building according to the present invention which includes a fabric skin 10 anchored around its periphery to ground anchor bolts and a system of intersecting plastic coated steel cables overlying the outer surface of the skin and also anchored to the ground anchor bolts.

The skin 10 has a cylindrical center section 11 and two end sections 12 and 13 which are in the form of truncated quarter spheres and are sewn to the section 11 along lines 14 and 15 respectively. The section 11 is fabricated from a number of fabric strips 16 which are sewn together at their edges and extend transversely or hoop wise to the longitudinal axis of the building. The end sections 12 and 13 each comprise a pair of generally triangular side panels 17 and a generally triangular end panel 18 which are sewn together along lines 19 and 20. Each of these panels are fabricated from a number of vertically oriented fabric strips

A catenary cable 21 is sewn to fabric pockets in the ground engaging edge of the skin, in accordance with standard practice, and is connected to ground anchor bolts 22 at regular intervals around the periphery of the base of the building.

The building is inflated by an air blower unit 23 through a fabric conduit 24 in accordance with standard practice. The cable system is divided into six interconnected sections A, B, C, D, E and F to facilitate the erection of the structure. In the drawings, each of the cables in each section is numbered and given a suffix letter corresponding to the cable section in which it is located. As will be seen from the drawings, the cables in different sections having the same number interact to form continuous cable lines between ground anchor bolts. The intersecting cables in each section are clamped rigidly together by cable clamps 25 of conventional design and the cables in adjoining sections are interconnected by connectors 26. Cable sections A and B each cover one half of the end section 12, cable sections C and D each cover one half of the center section 11, and the cable sections E and F each cover one half of the end section 13.

As shown in FIGS. 1–3, the cable section A includes cables 30A to 37A. The cables 30A to 33A extend from ground anchor bolts at the end of the building upwardly and toward the center line of the building at an acute angle. At the center of the building, these cable pass through connectors 26 and make a right angle turn and extend to the junction line 14 between the end building section 12 and the center building section 11. These cables pass through connectors 26 at the line 14 and make another right angle turn and extend downwardly toward the end of the building to ground anchor bolts. Cables 34A to 37A extend from ground anchor bolts upwardly at an acute angle toward the side of the building and over the corner of the building to anchor bolts at the side of the skin end section 12.

In cable section B, the cables 30B to 33B extend upwardly from anchor bolts toward the center of the building and pass through the same connectors which respectively hold the cables 30A to 33A. The cables 30B to 33B make right angle turns and extend upwardly to connectors 26 on the junction line 14 and then downwardly to anchor bolts. Cables 34B to 37B extend upwardly and away from the longitudinal center line of the building in the same manner as cables 34A to 37A.

In cable section C, cables 30C to 33C extend upwardly to the junction line 14 and pass through the same connectors 26 which respectively hold cables 30A to 33A. From the connectors, the cables extend upwardly at an angle to the top of the building where they pass through connectors 26 joining the sections C and D and thence downwardly toward the end 13 of the building. The cables 30C to 32C extend to the junction line 15 where they pass through another set of connectors spaced along the junction line and are redirected downwardly toward the end 12 of the building to ground anchor bolts. The cable 33C extends directly from the top of the building to a ground anchor bolt. The cable 34C extends upwardly from an anchor bolt toward the end 13 of the building and passes through a connector at the top of the building. It then extends downwardly to a connector on the junction line 17 and extends downwardly toward the building end 12 to an anchor bolt.

In cable section D, cables 30D to 34D are arranged in a similar manner to that employed in section C, while in cable sections E and F, the cables are arranged in a manner similar to that employed in sections A and B.

As will be seen most clearly in FIG. 3, the cables in each cable section are aligned with cable portions of like number in the other sections to form continuous cable lines extending at equal acute angles to the longitudinal axis of the building between ground anchor bolts.

As shown in FIGS. 4–6, the connectors 26 include a metal bar 40 provided with a hook 41 at each end and a piece of fabric tape 42 for attaching the bar 40 to the skin of the building. A spring metal strip 44 is attached to the bar 40 and extends over the openings in the hooks. The cable is inserted into the hook by bending the end of the spring strip 41 which then snaps back to prevent accidental disengagement during erection of the building.

The tape 42 is wrapped loosely around the bar 40 and stitched along lines 45 and the ends of the tape are stitched to a fabric skin of the building.

As shown in FIG. 7, one or more doors can be positioned on the side or end walls of the building without weakening the cable system.

By means of a slight local modification of the cable system, as shown in FIG. 7, one or more doorways can be positioned at any convenient position in the side or end walls of the building. The door structure, which may be of any design conventionally used in such buildings, includes a door 50 mounted within a door frame 51. The cable system is altered by removing the portions of the cables which would pass through the door location. These shortened cables are attached to a header cable 52 at the points where they are clamped to the cables which intersect with them just above the doorway. In FIG. 7, the cables which are shortened to accomodate the door are indicated by the reference numerals 54 and 55. The cables intersecting the shortened cables above the doorway are indicated by the reference numerals 56 and 57.

The header cable 52 extends upwardly from a ground anchor bolt to the junction of cables 54 and 56, then horizontally to the junction of cables 55 and 57, and then downwardly to a ground anchor bolt.

The cables parallel to and below the shortened cables 54 and 55 are indicated by reference numerals 59 and 60 respectively. The ends of the cables 59 and 60 are attached to the anchor bolts to which the ends of the header cable 52 are attached.

In constructing the building, the section 11 and the panels 17 and 18 of the fabric skin are fabricated from strips of fabric and the sections and panels are sewn together along the lines 14, 15, 19 and 20. The catenary cable is sewn into pockets around the base of the building and the connectors 26 are sewn to the fabric skin at the appropriate locations. Each of the cable sections A–F are laid out on a flat surface and the intersecting cables are locked together at right angles by the cable clamps 25.

The elements of the building can then be moved to the erection site. In erecting the building, the doorway is anchored in place, the skin is spread over the ground and the catenary cable is secured to ground anchor bolts at regular intervals. The edge of the skin is sealed to the ground by conventional methods and the skin is secured to the door frame. The cable sections are then

laid over the fabric skin on the ground and the free ends of the cables are secured to anchor bolts. The cables at the edges of each section are then placed in the hooks of the appropriate connectors 26. The blower unit 23 is then placed in operation and the skin inflates. During the inflation of the skin, the connectors 26 maintain the cable system in proper orientation with respect to the skin.

The forces generated by the pressure within the inflated building are largely carried by the cable system. The fabric skin spanning each diamond shaped area between the intersecting cables baloons outwardly to give the surface of the building a dimpled effect. Each of these balooned sections of fabric assumes a curvature having a very short radius in all directions. Therefore, the stress in the fabric is severely reduced in all directions.

Each of the cables in the cable system is equally tensioned by the internal pressure because of their orientation with respect to the longitudinal axis of the building. The tension in the cables in each section is transmitted to the cables in the adjoining sections through the connectors 26, which are part of the same cable lines.

In buildings employing cable systems using cables extending longitudinally and transversely (hoop wise) with respect to the longitudinal axis of the building, the transverse or hoop cables are subjected to about twice the tension as are the longitudinal cables. The fabric was therefore insufficiently reinforced in one direction and the entire structure would collapse if the stress on the fabric in that direction exceeded that which the fabric could withstand. Also, because of this uneven static loading, such a prior art building is highly subject to twisting under wind loading which could transfer the entire tension in one direction from the cables to the fabric.

It has been found that a building constructed according to the present invention is extremely stable under wind loading. It is believed that this extreme stability under wind loading is the result of a number of factors. Since the cables are equally tensioned under static loading conditions there are no inequalities to be magnified by wind loading. Wind loads perpendicular to the side or the end of the building are equally absorbed by the intersecting cable lines because the cable lines are at equal angles to the wind. Wind loads at an angle to the building have components perpendicular to the side of the building and the end of the building. The cable lines being at equal angles to each of these components are equally loaded.

The shape of the building in cross section cannot change appreciably since in order for the windward side of the building to be depressed, the lee side must raise and this is prevented by the cable system. Also, the dimpled surface of the building creates turbulent air flow over the entire surface and thereby reduces the relative effect of the lift forces on the lee side of the building.

It will be seen from the foregoing that the present invention provides an improved reinforced inflatable building capable of withstanding greater static and dynamic forces in which an improved cable system uniformly releaves fabric tension in all directions under all conditions and prevents the building from deforming and twisting under wind loading.

I claim:

1. A reinforced inflatable building comprising i combination an inflatable fabric skin anchored to th ground at its periphery and adapted to be sel supporting upon filling of the interior of the buildin with air under pressure, a cable network overlying th outer surface of said skin including a plurality of cable lying along first and second intersecting sets of paralle cable lines, each of said cable lines extending betwee peripheral ground anchors, means for rigidly clampin the intersecting cables together at the points of inte section, said cable network comprising a number c sections interconnected at connection points, and cor nectors provided at said connection points for inte connecting the cables in adjacent cable sections, sai sections comprising a number of cables which exten along a cable line in one of said sets through a connec tor at a connection point and turn to extend along cable line in the other of said sets, each end of the c bles in each of said sections terminating at ground a chors at the edge of the section positioned at the p riphery of the building.

2. A reinforced inflatable building according to clai 1, wherein said connectors are readily detachable fro at least one of the cables interconnected thereby.

3. A reinforced inflatable building according to clai 2, wherein said connectors include hook means f loosely engaging each of the cables interconnecte thereby.

4. A reinforced inflatable building according to clai 3, wherein said connectors include a pair of interco nected hook members and resilient means position to normally close the opening in each hook member allow insertion of a cable therein and to retain the cab therein.

5. A reinforced inflatable building according to clai 4, wherein said connectors include a bar member inte connecting said hook members and means for attac ing said bar member to said fabric skin.

6. A reinforced inflatable building, comprising combination an inflatable fabric skin having a recta gular floor plan including end sections each in the ge eral form of a truncated quarter sphere, said skin bei anchored to the ground at its periphery and adaptab to be self-supporting upon filling of the interior of t building with air under pressure, a plurality of cabl arranged to form a cable network overlying the enti outer surface of the skin, the cables in the netwo forming only first and second sets of parallel cable lin extending over the surface of the skin between perip eral ground anchors, said first and second sets of cat lines intersecting substantially at right angles and bei positioned at equal angles to the longitudinal axis said building, and means for interconnecting the cab at the points of intersection.

7. A reinforced inflatable building according to cla 6, wherein said cable network comprises a number sections interconnected at connection points a wherein connectors are provided at said connecti points for interconnecting the cables in adjacent n work sections, said sections comprising a number of bles which extend along a cable line in one of said s through a connector at a connection point and turn extend along a cable line in the other of said sets, e end of each of the cables in each of said sections ter nating at ground anchors at the edge of the section sitioned at the periphery of the building.

8. A reinforced inflatable building according to claim 6, wherein each of said end sections of said skin is formed from a triangular end panel and two right triangular side panels, said end panel having two equal sides and a base lying along the peripheral end edge of the building, each of said side panels having its hypotenuse connected to one of said equal sides of said end panel and having its base lying along the end portion of the side of the building.

9. A reinforced inflatable building according to claim 8, wherein said connectors are formed to be readily detachable from at least one of the cables interconnected thereby.

10. A reinforced inflatable building according to claim 9 wherein said connectors include hook means for loosely engaging each of the cables interconnected thereby.

* * * * *