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(54) **AIRFORM FOR FACILITATING CONSTRUCTION OF A STRUCTURE**

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Related U.S. Patent Documents

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(51) **Int. Cl.**
E04B 1/16 (2006.01)
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CPC .... ***E04B 1/166*** (2013.01); ***E04B 1/169*** (2013.01); ***E04H 15/20*** (2013.01); (Continued)

(58) **Field of Classification Search**
None
See application file for complete search history.

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Photo A: Image of a PVC fabric being hoisted into position for use as a temporary form, 2012.

(Continued)

Primary Examiner — Glenn K Dawson
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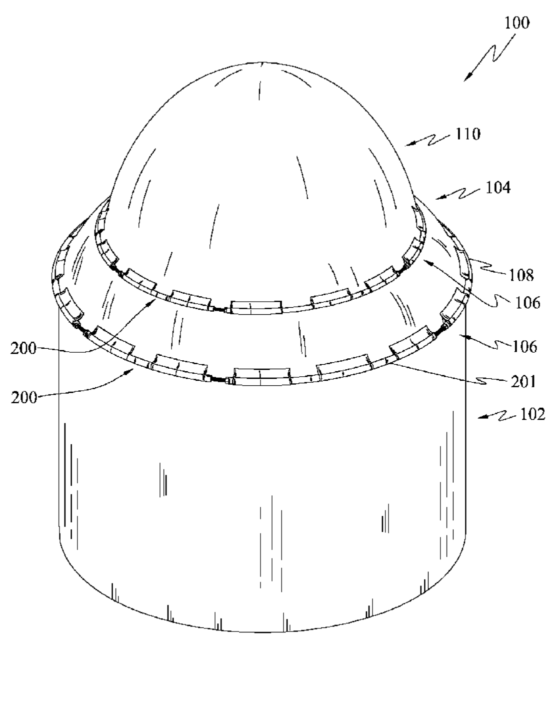
(57) **ABSTRACT**

An airform that can be inflated, for example, for facilitating construction of a structure is provided. The airform may include a first portion, a second portion, or multiple other portions, and reinforcement. The first portion may, for example, be configured to be disposed in a first orientation, such as vertically or in a radial profile, when the airform is inflated. The second portion transitioning from the first portion may be configured, for example, to assume an alternate shape and profile, such as a radial shape and profile, when the airform is inflated. The reinforcement may, for example, be provided at a portion of the airform that defines a transition from the first portion to the second portion.

24 Claims, 15 Drawing Sheets



(51) **Int. Cl.**
E04B 1/32 (2006.01)
E04H 15/20 (2006.01)

(52) **U.S. Cl.**
CPC *E04B 2001/0061* (2013.01); *E04B 2001/3264* (2013.01); *E04H 2015/201* (2013.01); *E04H 2015/202* (2013.01); *E04H 2015/203* (2013.01); *E04H 2015/204* (2013.01); *E04H 2015/205* (2013.01)

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Photo 1: Image of the hoisting connection apparatus of Photo A, 2012.
Photo 2: Image of the Photo A form partially hoisted and partially inflated, 2012.
Photo 3: Image of a temgorary wood blockout form, 2014.
Photo 4:Concrete dome sitting on concrete columns with a flexible “skirt” draped around the columns, 2010.
Photo 5: Renderings of a concrete dome roof, with traditional stud framed exterior walls. Dome roof resting on concrete columns, 2011.
Photo 6: Concrete dome being used age planetarium structure, within a structural steel building, 2013.
Photo 7: Artist’s rendering of a water tank concept, 2008.
Photo 8: Desktop conceptual model of a water tank concept, 2008.
Photo B: Concrete dome being used as a planetarium structure, 1999.
Photo A: Dome Technology Photo; https://www.facebook.com/DomeTechnology/photos/a.347594532724.148848.346577372724/443860707724/?type=3&theater; purportedly dated Oct. 26, 2010.
Photo B: Dome Technology Photo; https://www.facebook.com/DomeTechnology/photos/a.500766002724.271718334657737 2724/10150142176007725/?type=3&theater; purportedly dated Apr. 5, 2011.

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Photo C: Dome Technology Photo; https://www.facebook.com/DomeTechnology/photos/a.10152396201202725.1073741827.346577372724/10152396193397725/?type=3&theater; purportedly dated Aug. 26, 2014.
Photo D: Dome Technology Photo; https://www.facebook.com/DomeTechnology/photos/a.10152396201202725.1073741827.346577372724/10152396193312725?type=3&theater; purportedly dated Aug. 26, 2014.

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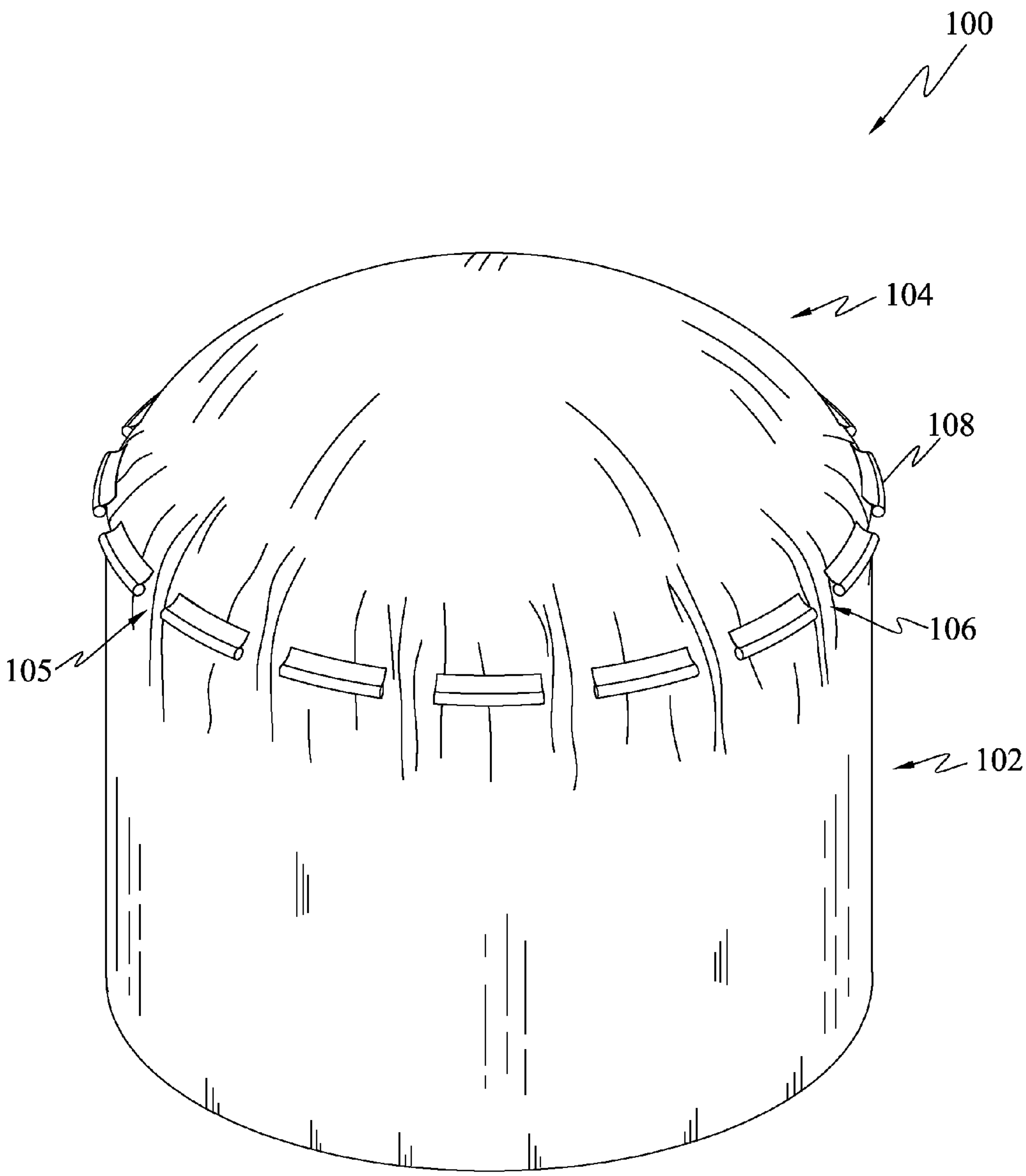

FIG. 1A

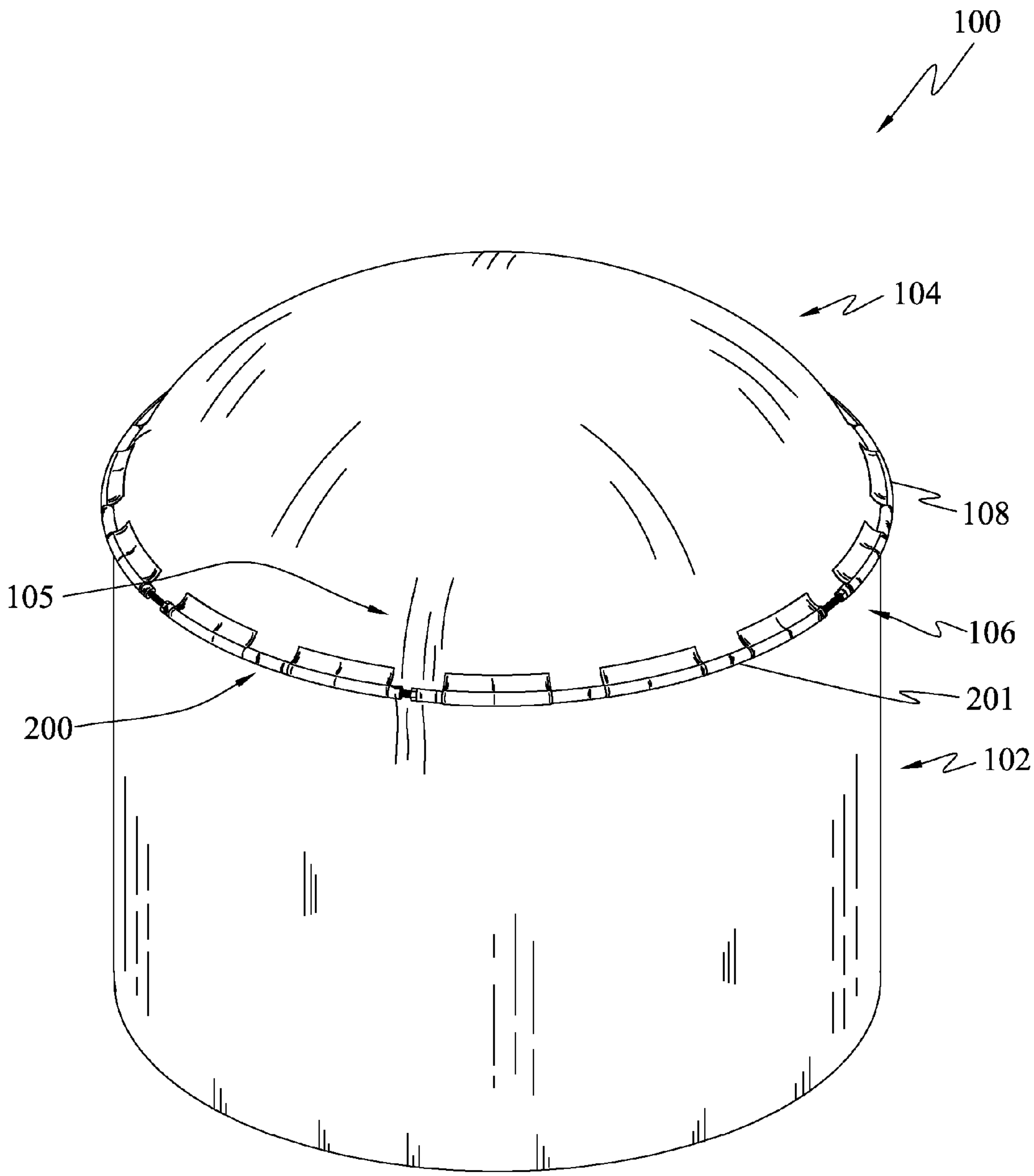

FIG. 1B

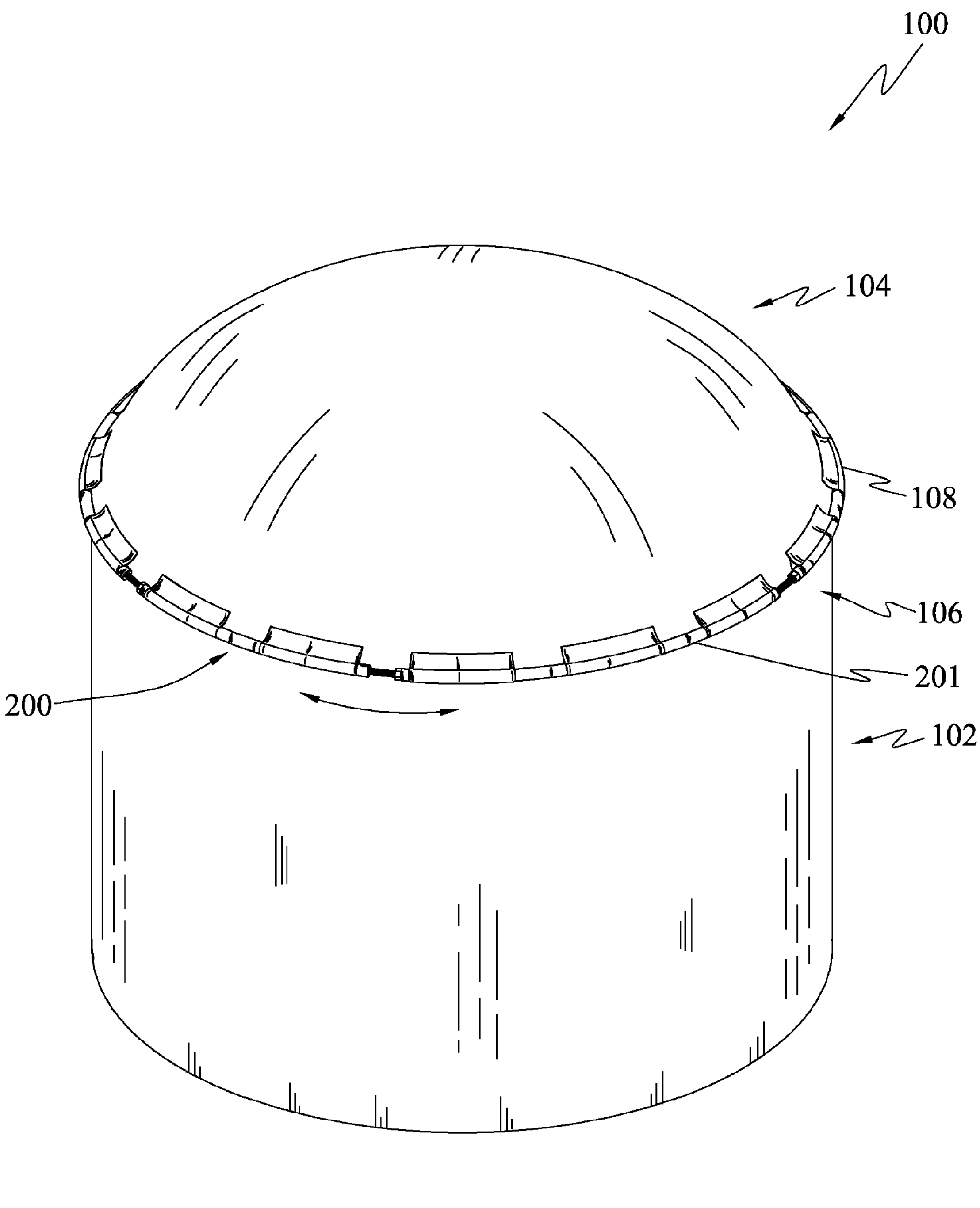

FIG. 1C

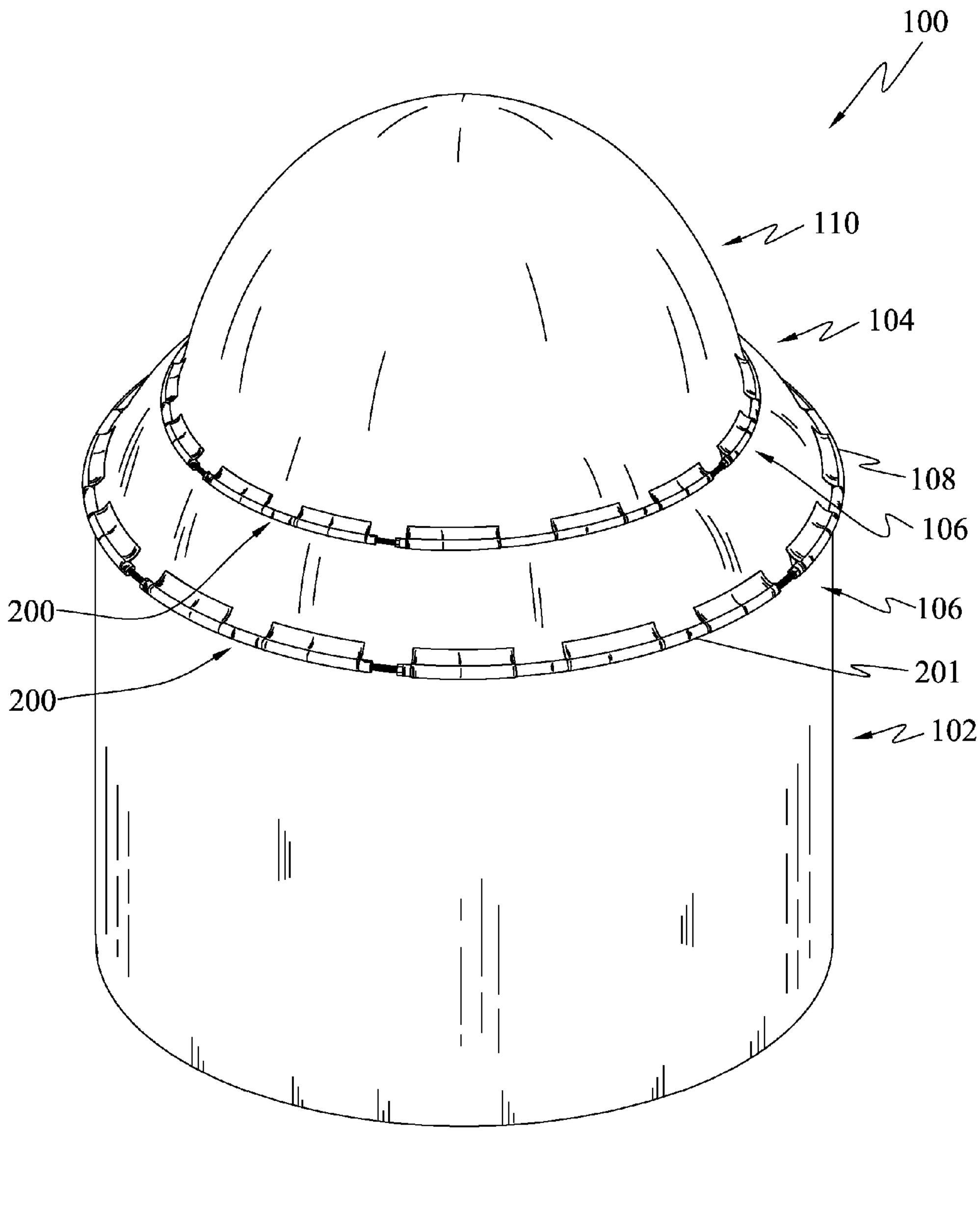

FIG. 1D

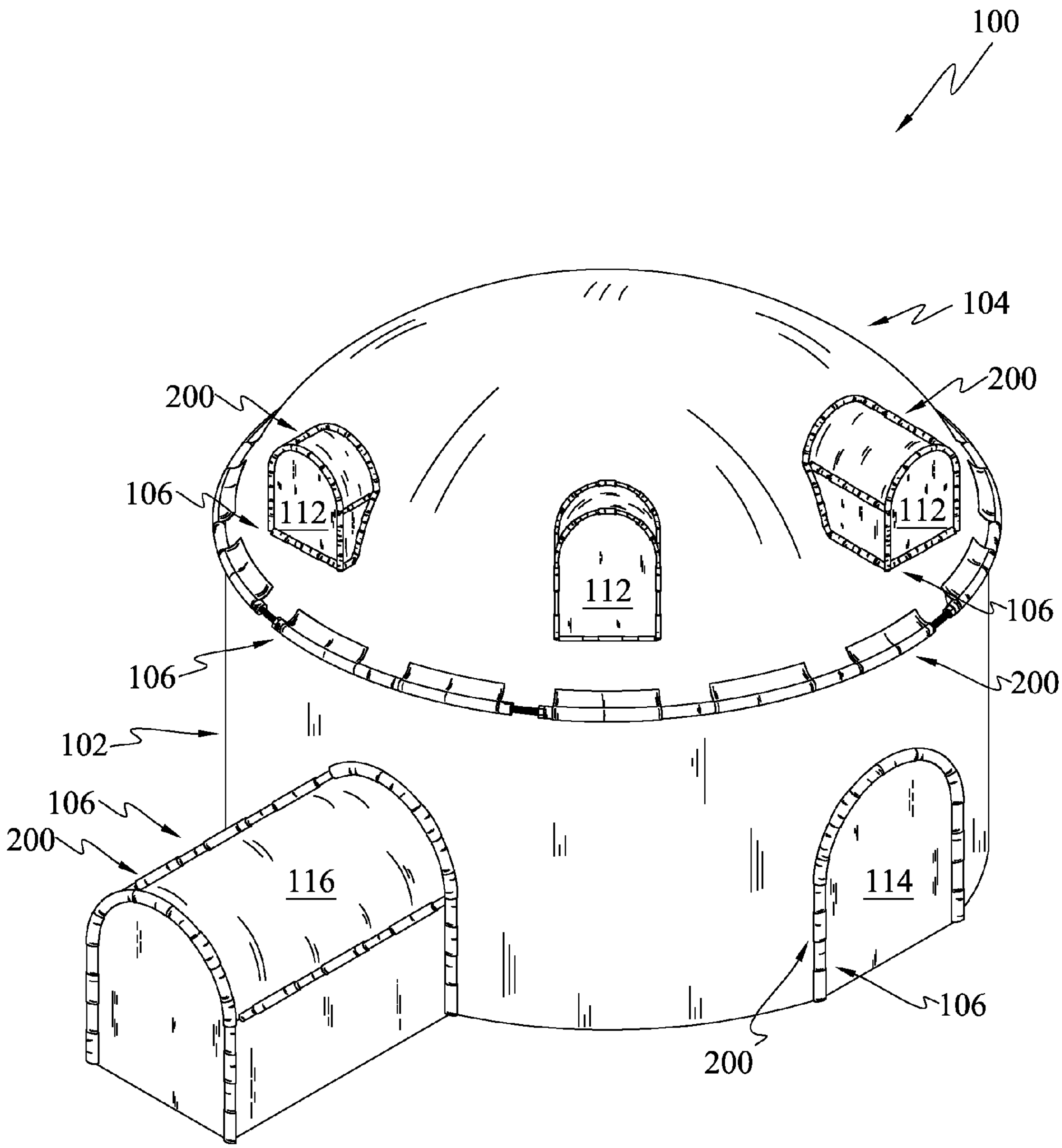
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FIG. 1E

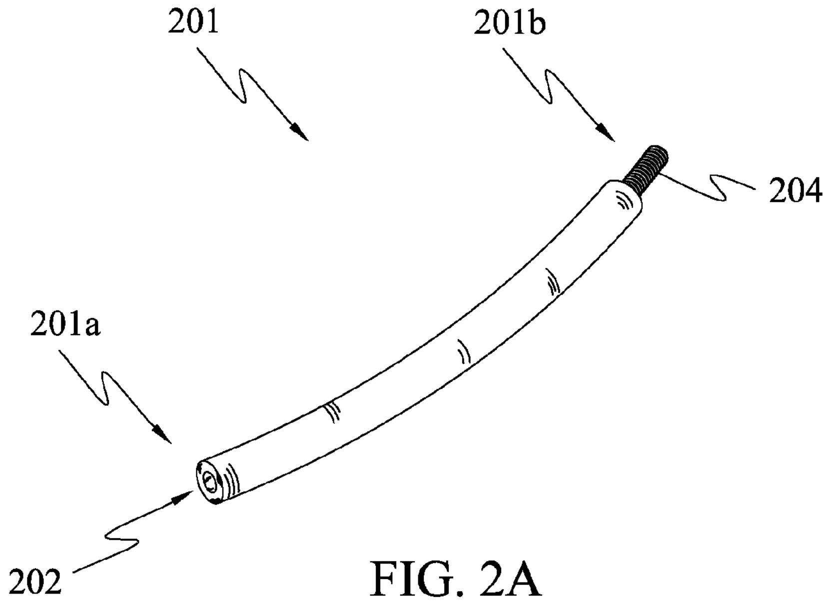


FIG. 2A

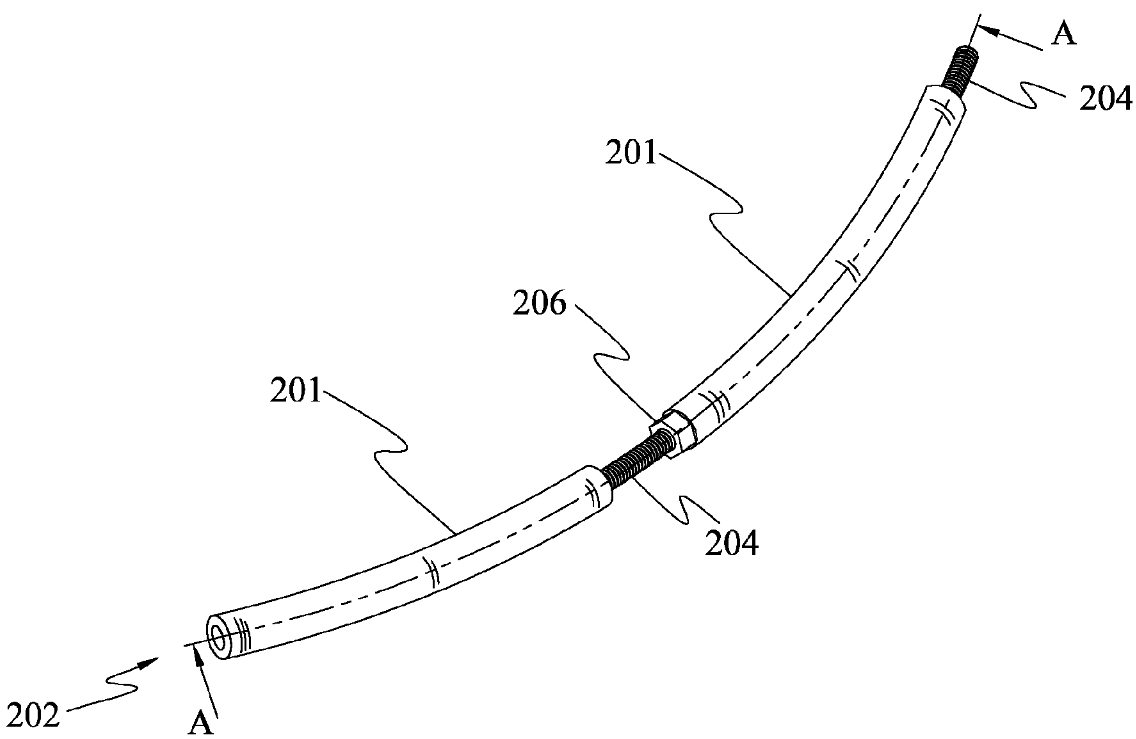


FIG. 2B

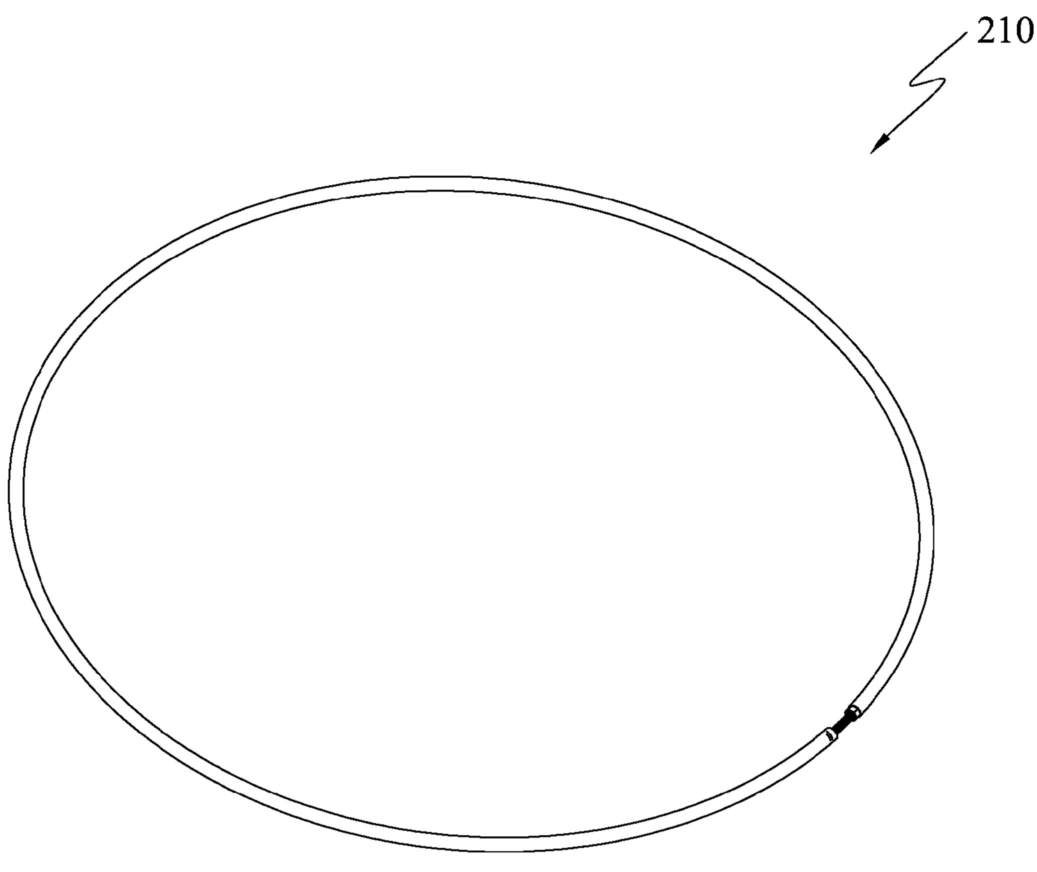
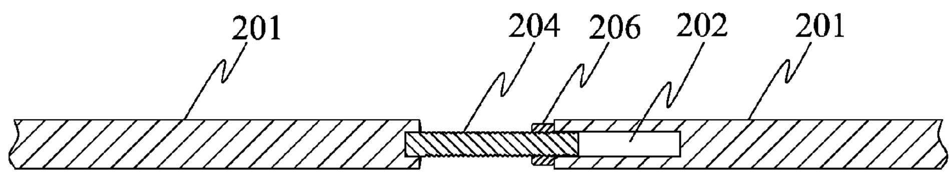


FIG. 2C



(A-A)
FIG. 2D

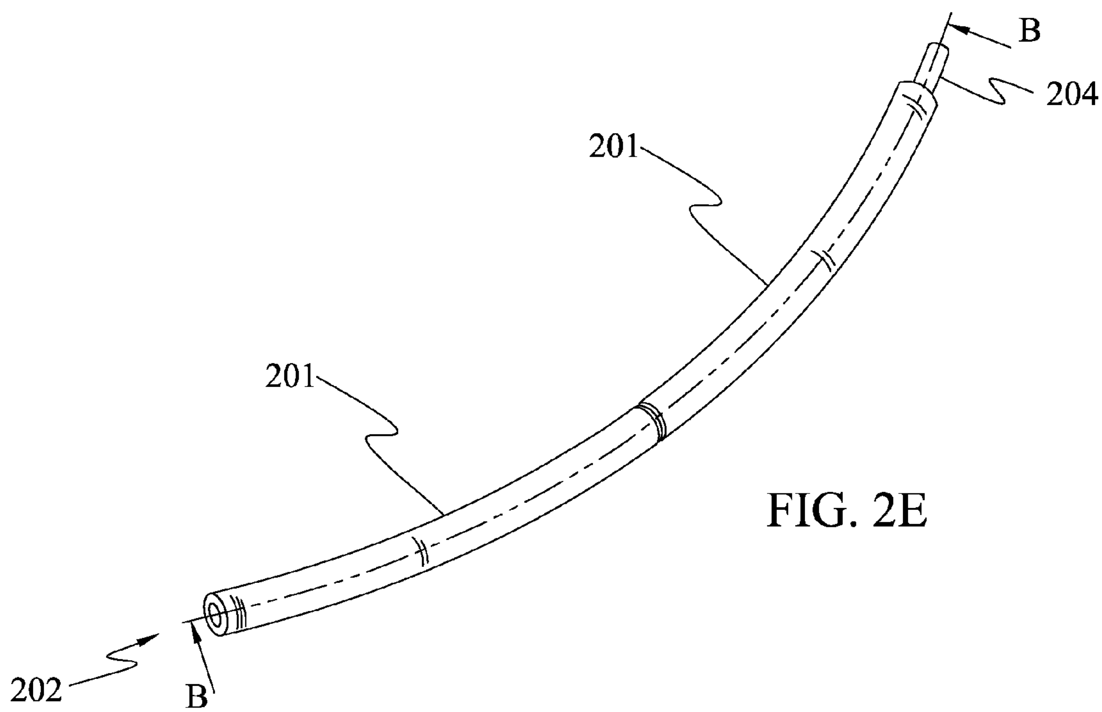
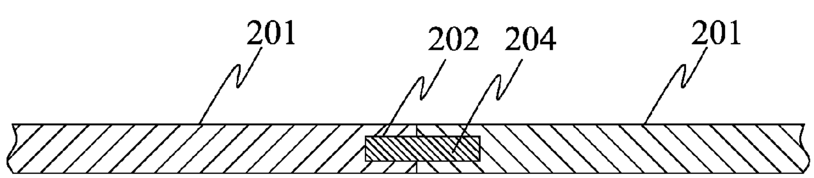


FIG. 2E



(B-B)
FIG. 2F

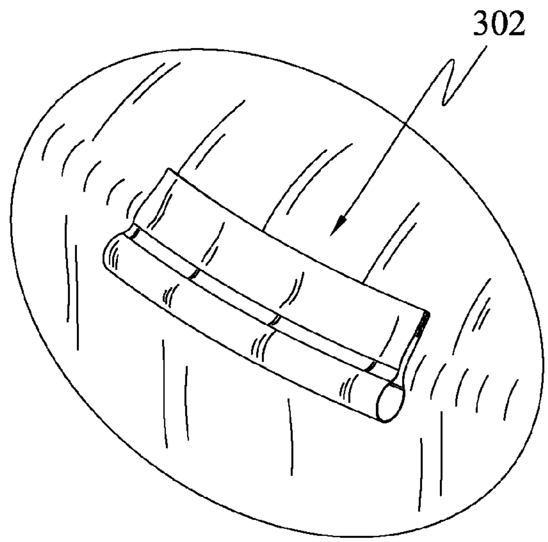


FIG. 3A

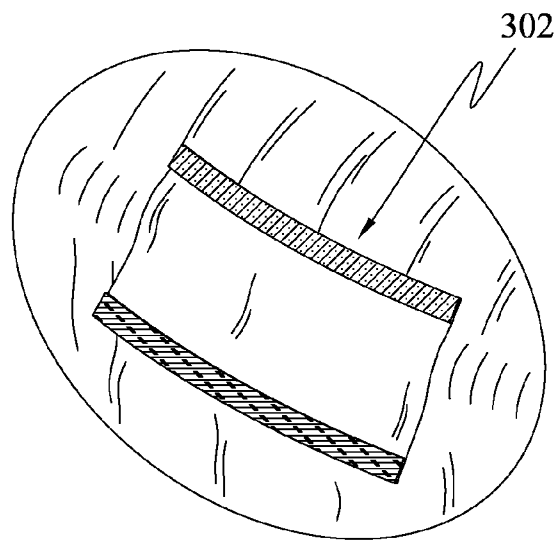


FIG. 3B

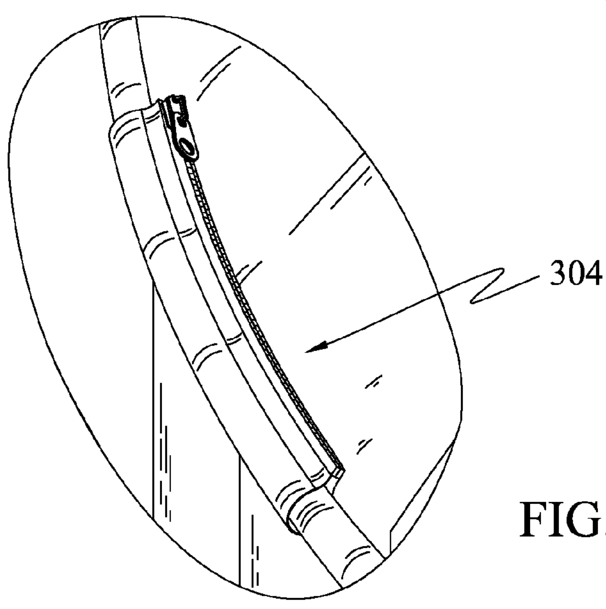


FIG. 3C

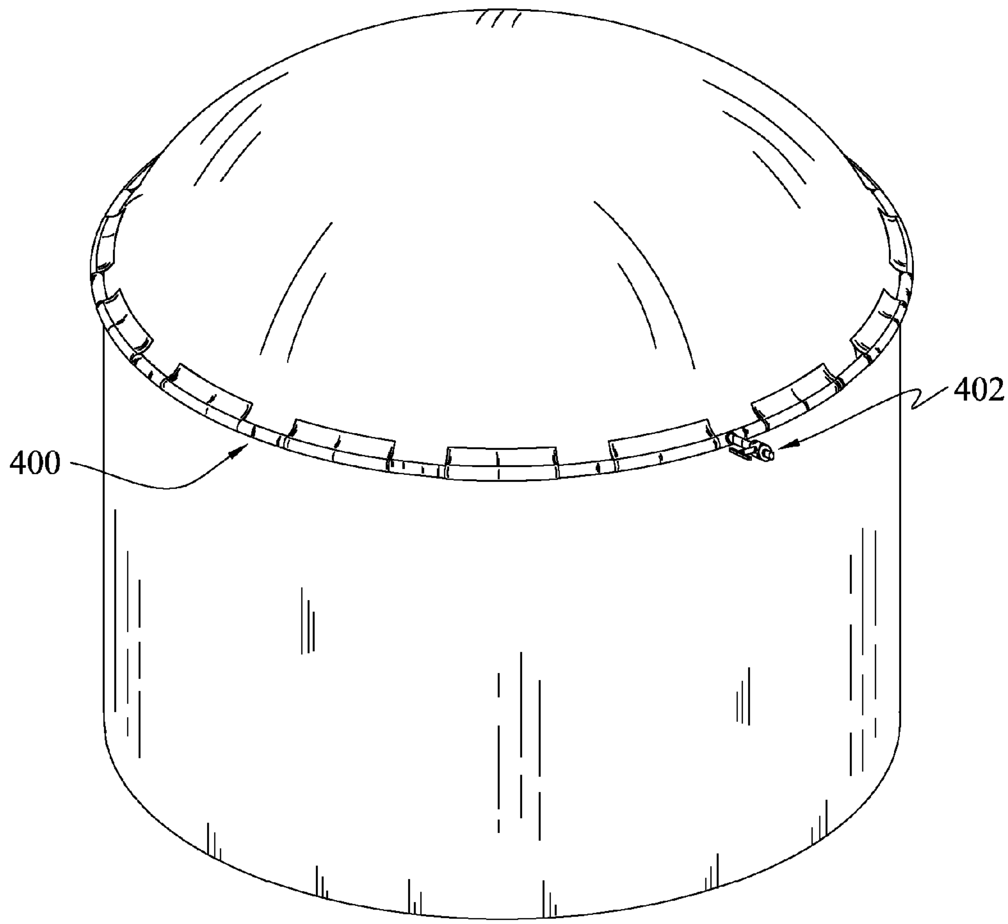


FIG. 4

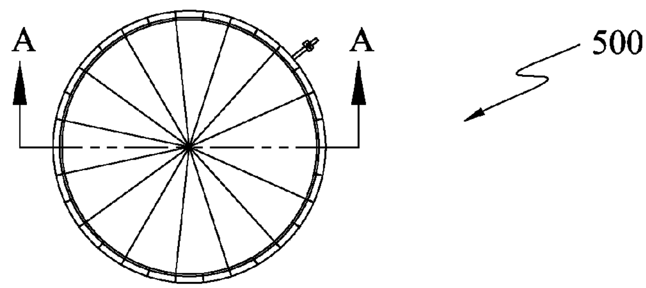
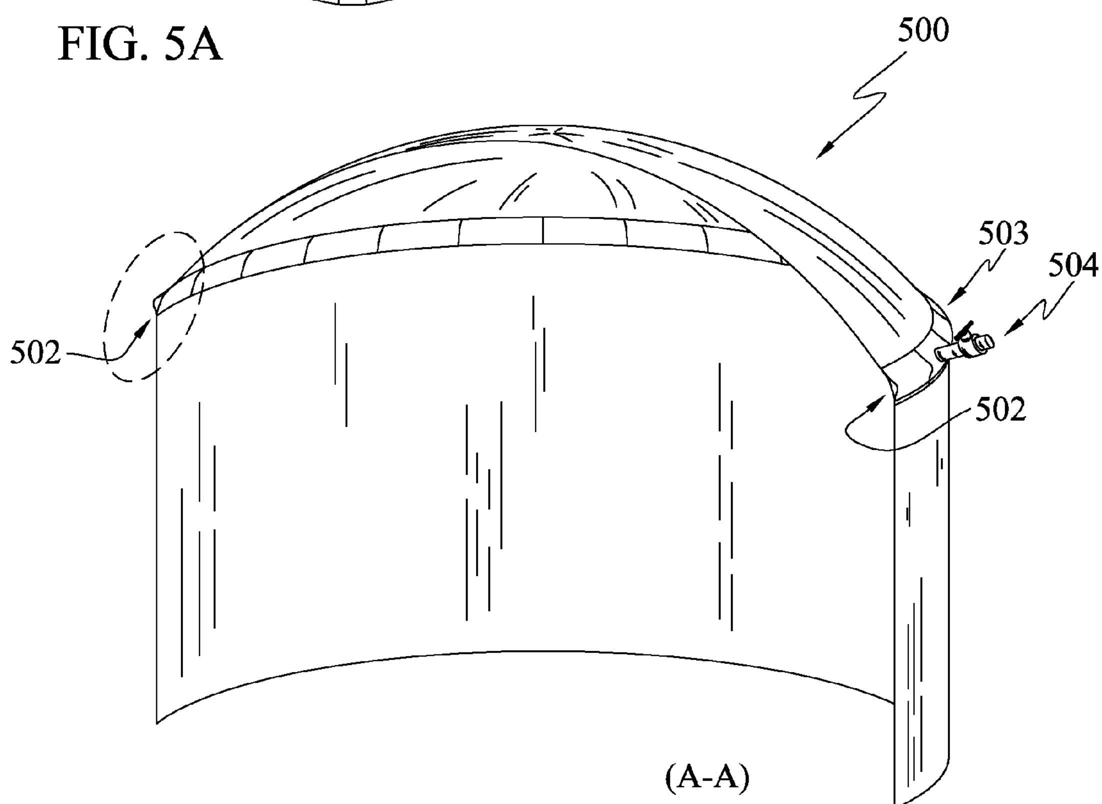


FIG. 5A



(A-A)
FIG. 5B

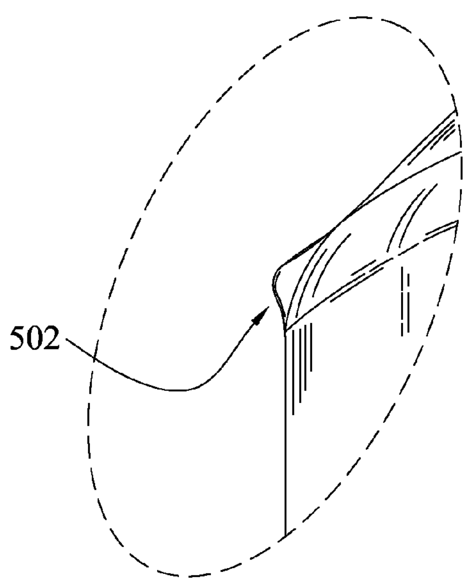


FIG. 5C

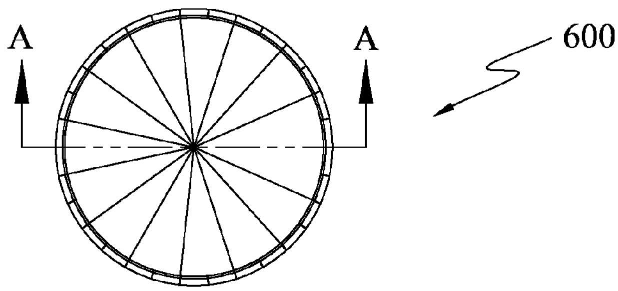
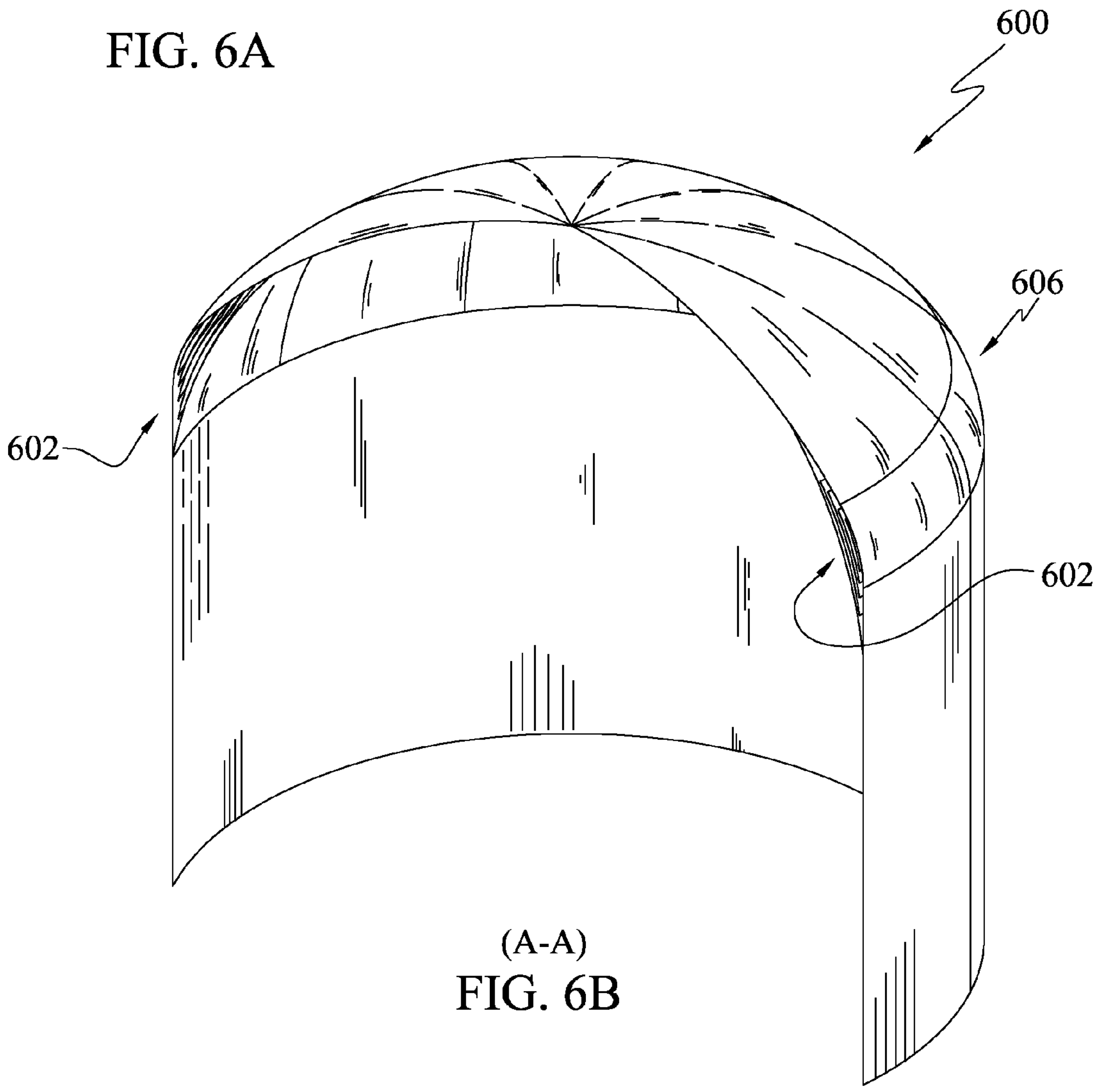


FIG. 6A



(A-A)
FIG. 6B

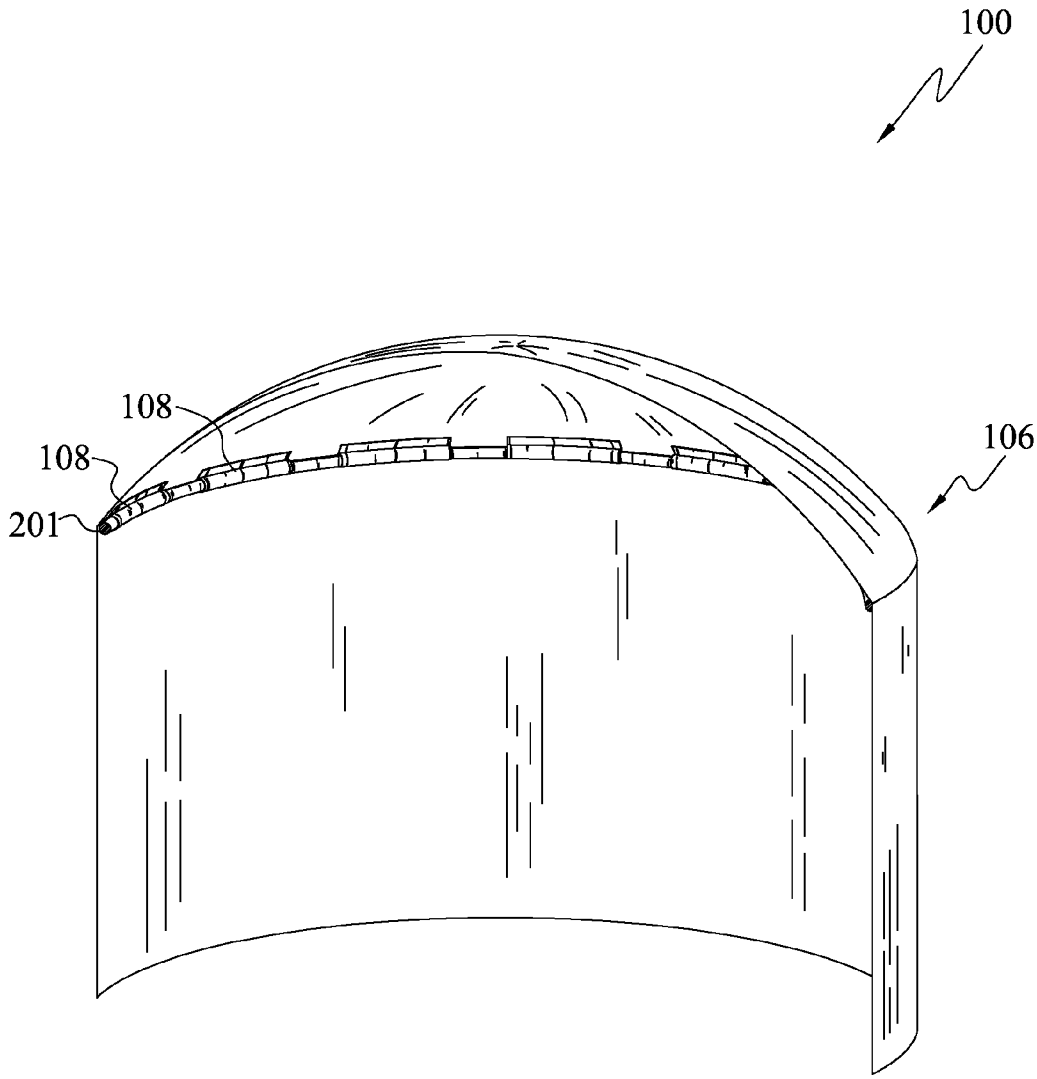


FIG. 7A

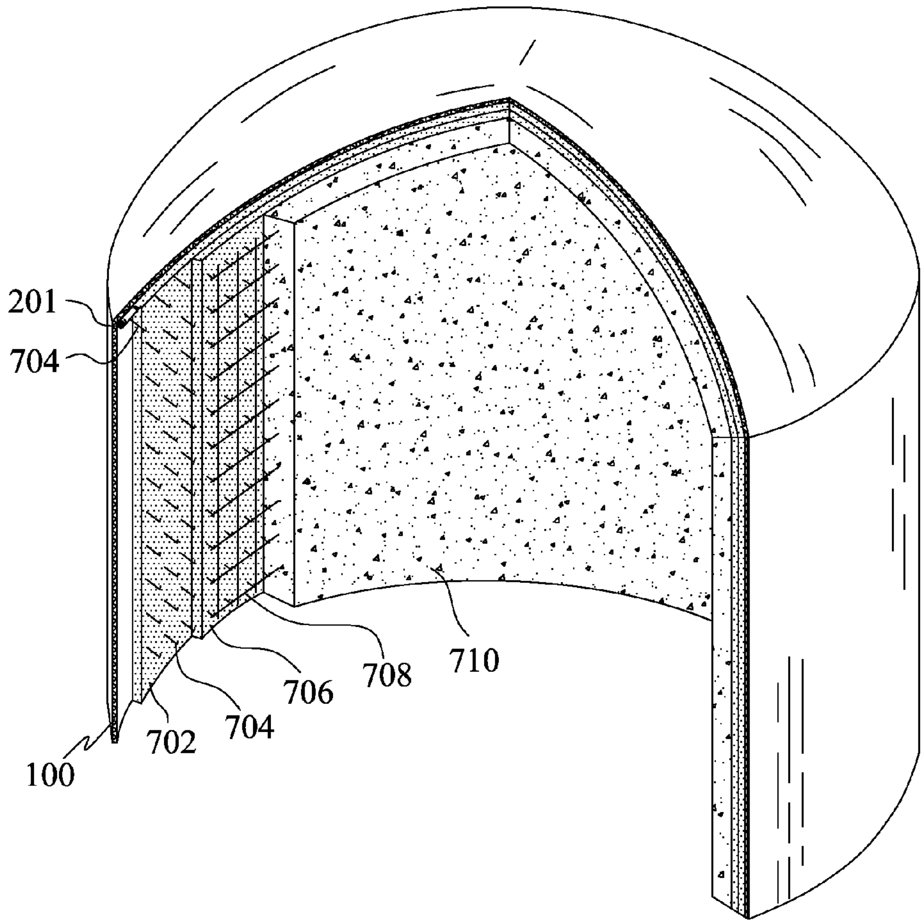

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FIG. 7B

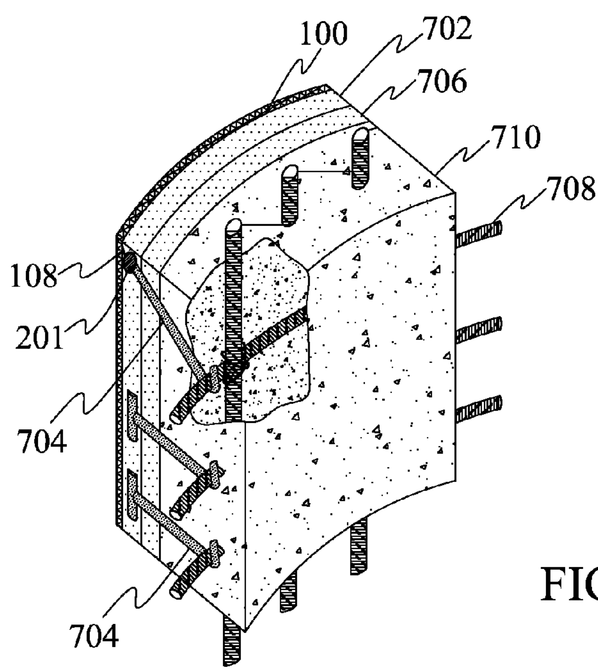
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FIG. 7C

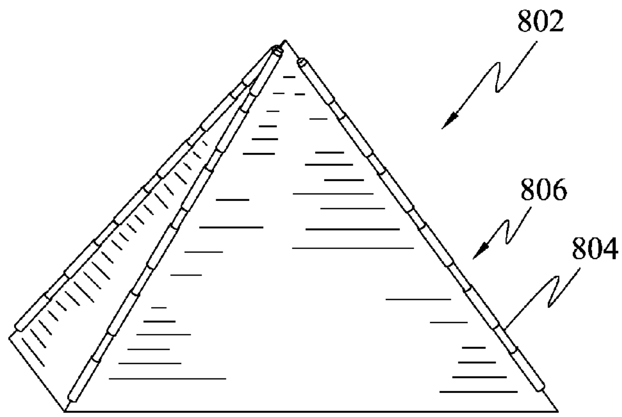

FIG. 8A

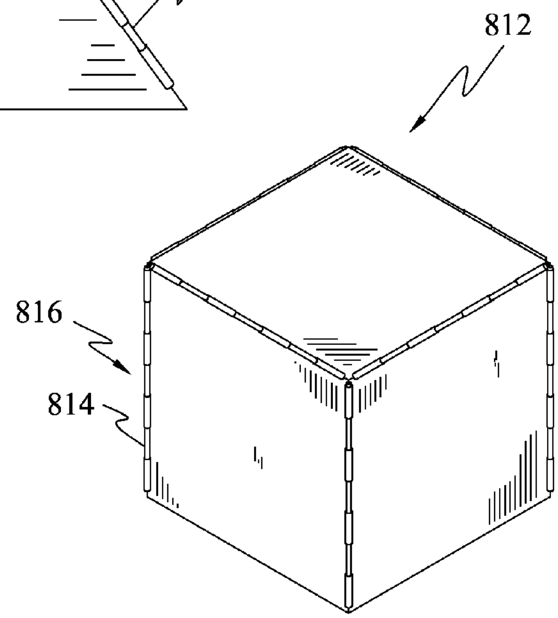

FIG. 8B

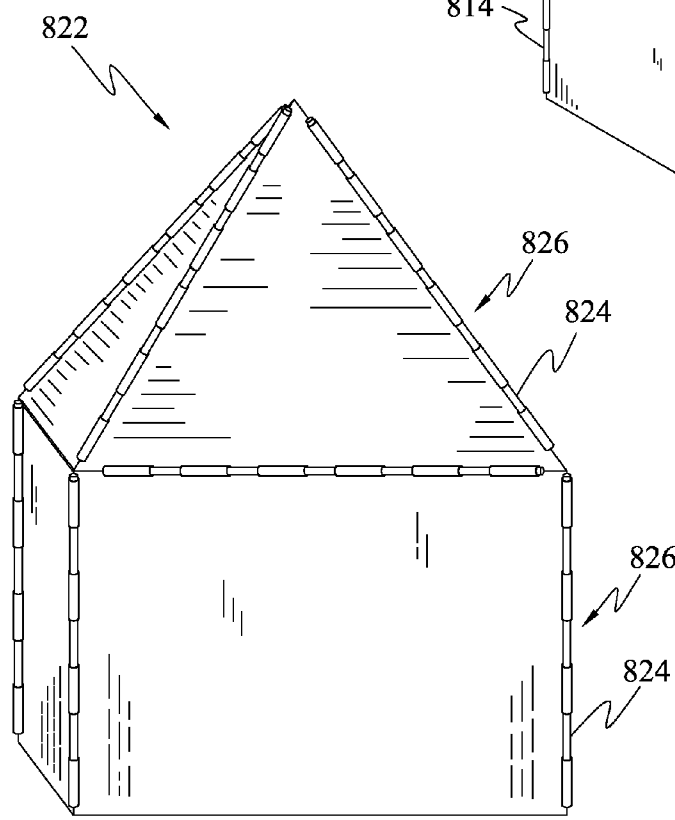

FIG. 8C

AIRFORM FOR FACILITATING CONSTRUCTION OF A STRUCTURE

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

BACKGROUND

1. Technical Field

In general, the subject matter contained herein relates to the field of monolithic dome structures or other permanent structures. More particularly, but not exclusively, the subject matter relates to air-inflated and air-supported forms ("airforms") used for enabling construction of permanent monolithic dome structures.

2. Discussion of Related Field

Monolithic dome structures may be constructed using airforms. One end of an airform may be attached to a foundation, and thereafter the airform may be inflated. Sustained pressure within the inflated airform is maintained until a polyurethane layer is applied to the wall of the airform, a metal lattice is erected adjacent the polyurethane layer, concrete is applied to the metal lattice and polyurethane, and the polyurethane and concrete layers are permitted to cure, thus forming a self-supported shell structure.

Conventional airforms may extend superiorly in an oblique configuration from the foundation to define a shape that resembles a portion of a sphere. Headroom and/or other conventionally accessible and usable space (for human interaction and storage) at the structure's perimeter along the inside circumference of the airform, and therefore the eventual dome structure, may be adversely affected due to the oblique configuration, thereby negatively affecting the vertically-usable area of the structure. Thus, there is a need to provide a monolithic dome structure with increased usable space.

Further, due to the oblique configuration of the dome structures, it is difficult to install doors, windows, multiply-stacked domes, and other architectural features that are planar or otherwise shaped differently than conventional domes. Certain of such architectural features may be more easily provided if the dome structure has vertical walls. However, conventional domes that have been placed atop vertical walls are often formed of a different material and process as the dome structures. Employing different materials and processes between the dome, vertical support wall, doors, windows, and other features can cause long-term maintenance, water-tightness, or structural problems that might otherwise be avoided with a monolithic single-shell construction. Thus, there is a need to provide a monolithic dome structure that accommodates integrated architectural features having shapes and surfaces that vary from the shape of the dome structure.

Yet, when conventional airforms with transitions that vary from one shape to another (such as from a cylindrical vertical wall to a spherically-domed top) are placed under pressure, wrinkles are formed in the material of the airform along the transition portion between the two shapes. These wrinkles are similar to those seen along the circumference of a mylar birthday balloon. However, such wrinkles, if formed during the process of constructing a habitable structure, can cause suboptimal structural and/or aesthetic defects along any transition portion between two different shapes or surfaces of the structure. Thus, there is a need for a monolithic dome structure having varied shapes and/or surfaces without wrinkles, distortions, or other aberrations formed along transitions portions between such shapes and/or surfaces.

In light of the foregoing discussion, an improved airform and associated processes for facilitating construction of a structure enabling improved space utilization, varied shapes and/or surfaces, and/or no wrinkles, distortions, or other aberrations may be desired.

BRIEF DESCRIPTION OF THE DRAWINGS

Various embodiments of the present invention will now be discussed with reference to the appended drawings. It is appreciated that these drawings depict only typical embodiments of the invention and are therefore not to be considered limiting of its scope.

FIG. **1**A is a perspective view of an airform in which wrinkles are formed, at the connection of a dome and a vertical wall, as a result of air pressure within the airform;

FIG. **1**B is a perspective view of the airform of FIG. **1**A to which reinforcement, such as a restrained compressive junction stiffener, is provided, and a wrinkle is still present in the airform;

FIG. **1**C is a perspective view of the airform of FIG. **1**B in which the wrinkle has been removed by adjusting the reinforcement, such as by expanding or otherwise lengthening the restrained compressive junction stiffener;

FIG. **1**D is a perspective view of an alternative embodiment of an airform in which multiple transition portions are provided and reinforced between a cylindrical shape and a dome shape and between two different dome shapes;

FIG. **1**E is a perspective view of an alternative embodiment of an airform in which multiple transition portions are provided and reinforced between windows frames, a door frame, a hallway or connection portion between one or more monolithic structures, a cylinder, and a dome;

FIG. **2**A is a perspective view of a reinforcement member;

FIG. **2**B is a perspective view illustrating engagement between two reinforcement members of the type illustrated in FIG. **2**A;

FIG. **2**C is a perspective view of an alternative embodiment of a reinforcement member;

FIG. **2**D is a partial cross sectional view (A-A) of the engagement illustrated in FIG. **2**B;

FIG. **2**E is a perspective view illustrating engagement between two reinforcement members, each having a non-threaded protrusion;

FIG. **2**F is a cross sectional view (B-B) of the engagement illustrated in FIG. **2**E;

FIG. **3**A is a perspective view of a loop, which has a hook and loop type mechanism, adaptable with an airform;

FIG. **3**B is the loop of FIG. **3**A in which loop of the mechanism is separated from the hook of the mechanism;

FIG. **3**C is a perspective view of a loop, which has a zip fastening mechanism, adaptable with an airform;

FIG. **4** is a perspective view of an airform adapted with a reinforcement member which is inflatable;

FIG. **5**A is a top view of an airform defining a continuous airtight loop or pocket which is inflatable;

FIG. **5**B is a perspective sectional view along line A-A of the airform of FIG. **5**A;

FIG. **5**C is a detailed perspective sectional view of the pocket provided in the airform of FIG. **5**B;

FIG. **6**A is a top view of an airform having multiple layers of flexible sheets provided along a perimeter of a transition portion;

FIG. **6**B is a perspective sectional view taken along line A-A of the airform of FIG. **6**A;

FIG. **7**A is a perspective sectional view illustrating an airform with one or more reinforcement members along an inner circumference of the airform;

FIG. **7**B is a perspective sectional view illustrating several layers of a monolithic structure formed within the airform of FIG. **7**A;

FIG. **7**C is an enlarged cutout view of the layers illustrated in FIG. **7**B;

FIG. **8**A is a perspective view of an airform resembling a pyramid;

FIG. **8**B is a perspective view of an airform resembling a cube; and

FIG. **8**C is a perspective view of an airform resembling a pyramid disposed over a cube.

DETAILED DESCRIPTION

The present disclosure relates to an airform that can be inflated for facilitating construction of a structure, such as a monolithic structure, including without limitation a monolithic dome structure, or any other shaped structure.

The following description illustrates principles, which may be applied in various ways to provide many different alternative embodiments. This description is not meant to limit the inventive concepts in the appended claims. The principles, structures, elements, techniques, and methods disclosed herein may be adapted for use in other situations where undesirable wrinkles occurring in inflatable structures, such as airforms, are desired to be removed.

While exemplary embodiments of the present technology have been shown and described in detail below, it will be clear to the person skilled in the art that changes and modifications may be made without departing from its scope. As such, that which is set forth in the following description and accompanying drawings is offered by way of illustration only and not as a limitation. In addition, one of ordinary skill in the art will appreciate upon reading and understanding this disclosure that other variations for the technology described herein can be included within the scope of the present technology.

Referring to FIG. **1**A, an airform **100** for enabling construction of one or multiple monolithic dome structures may be provided. The airform **100** may be inflatable and reinforced, and upon inflation and reinforcement, the airform **100** may resemble the size and shape of the monolithic dome structure that may be constructed as per a template defined by the airform **100**.

The airform **100** may have an open end towards its inferior side or inferior end. The open end of the airform **100** may be attached or otherwise engaged to a foundation. The open end may be engaged to the foundation such that a substantially airtight engagement may be formed along a perimeter or periphery of the open end. The airform **100** may be equipped with a mechanism to engage the airform **100** with an inflating device. The inflating device may pump air into the airform **100**, to inflate the airform **100** to achieve a desired shape. In addition to inflating the airform **100**, the inflating device may facilitate in retention of requisite pressure inside the airform **100** such that the airform retains the desired shape. The airform **100** may provide access to the inside or enclosed area of the inflated airform **100** to construction personnel such that, when personnel ingress or egress the airform **100**, the pressure inside the inflated airform **100** is not lost substantially. Such access may be enabled by providing dual doors in the airform **100**, in which there may a corridor in between the doors. The construction personnel may open and enter a first door, and thereupon close the first door, and subsequently open and enter a second door, and then close the second door. The corridor between the doors may also be inflated.

The airform **100** may include a first portion **102**, a second portion **104** and at least one reinforcement retainer, such as loops **108**. The first portion **102** of the inflated airform **100** may be of cylindrical shape, another dome shape, a singly- or multiply-curved surface around a principal axis, a window, a door, a hallway, an interconnecting structure, and/or any other varied shape or surface. The second portion **104** or a superior end of the inflated airform **100** may be a radial shape, such as a shape that resembles a portion of a sphere, oval, or quasi-sphere with an irregular, increasing, or decreasing radius of curvature, and may be disposed distally from the foundation when the airform **100** is inflated. The second portion **104** may alternatively or additionally be of cylindrical shape, another dome shape, a singly- or multiply-curved surface around a principal axis, a window, a door, a hallway, an interconnecting structure, and/or any other varied shape or surface. The first portion **102** may transition into the second portion **104** at a transition portion **106**, such that the cylindrical shape transits into the radially-shaped portion. The shape of the airform **100** may be based on the desired shape of the monolithic dome structure. The first portion **102** of the airform **100** may be predominantly vertical when inflated.

The transition portion **106** may define a curved or smooth transition, as opposed to a sharp transition, when the airform **100** is inflated but not reinforced. Further, striations, dimples or wrinkles **105** may be formed in the transition portion **106**, the first portion **102** and/or the second portion **104**. It may be desirable to have a sharp transition from the first portion **102** to the second portion **104**, or a transition that defines a sharp or hard angle. Such a transition may facilitate inclusion of doors and windows in the monolithic dome structures, and may also define ample headroom even at the perimeter of the airform **100**, and therefore the eventual structure. Further, removal of the wrinkles **105** may be desired since in certain construction processes the airform **100** is retained as an outer shell of the final structure, and wrinkles may be aesthetically unpleasant. Furthermore, even if the airform **100** were to be removed after construction, the wrinkles may appear on the outer surface of the structure. Additionally, adjustments may have to be made while spraying concrete if such wrinkles **105** are present in the airform **100**.

Reinforcement may be provided at the transition portion **106** or the portion of the airform **100** that may be desired to be the transition portion **106**. The reinforcement may segregate the airform **100** into the first portion **102** and the second portion **104**. The reinforcement may enable defining a transition portion that may have a sharp transition from the first portion **102** to the second portion **104**, or a transition that defines a sharp or hard angle. Further, the reinforcement may enable disposing the first portion **102** vertically or perpendicularly to the foundation, such that ample headroom may be defined even at the perimeter of the airform **100**. Furthermore, the reinforcement may enable elimination or removal of unwanted wrinkles **105** from the airform **100**.

Referring to FIGS. **1**A-**2**B, the loops **108** may be provided along the transition portion **106**. The loops **108** may be engaged to the transition portion **106** by techniques such as heat welding, sewing, adhesive, mechanical connection, or other means of attachment. The loops **108** may enable providing reinforcement **200** to the airform **100** at the transition portion **106**. The loops **108** may be provided at predetermined gaps or intervals along the perimeter of the transition portion **106**. The loops **108** may be configured such that reinforcement members **201** may be passed through the loops **108**. The loops **108** may be made of the same or a different material as the airform **100**.

The reinforcement **200** may be formed of a plurality of reinforcement members **201**. A plurality of reinforcement members **201** may be joined together to form the reinforcement **200**. Referring to FIGS. **2**A-**2**B, each reinforcement member **201** may have a curved longitudinal axis. The curvature of the axis may depend on the curvature and shape of the airform **100** or the transition portion **106**. Further, the number of reinforcement members **201** used to form the reinforcement **200** may depend on the length of the circumference or perimeter of the transition portion **106**.

The reinforcement member **201** may include one or more mating, locking, or engagement mechanisms at a first end **201**a and a second end **201**b that may enable engagement with another reinforcement member **201** at each of its ends **201**a, **201**b. The reinforcement members **201** may be engaged or arranged to form a closed loop. At the first end **201**a a slot or aperture or bore **202** may be provided. At the second end **201**b a protrusion **204** may be provided. The bore **202** of a first reinforcement member **201** may be configured to receive the protrusion **204** of a second reinforcement member **201**. The protrusion **204** may include threading defined on the external surface of the protrusion **204**. A nut **206** may be engaged to the protrusion **204**. Adjustment of the nut **206** may enable controlling the extent of insertion of the protrusion **204** into the bore **202**. Hence, adjustment of one or more such nuts **206** may enable alteration of the length of the perimeter of the reinforcement **200**. Increasing the perimeter may result in stretching or tensioning of the first portion **102** and the second portion **104**, which may in turn result in stretching the transition portion and thereby removal of wrinkles **105**. A wrinkle **105** may be removed by manipulating one or more reinforcement members **201** proximal to the wrinkle **105**. Referring to FIG. **2**D, a cross sectional view of the engagement of the threaded protrusion **204** with the nut **206** is illustrated.

Referring to, FIGS. **2**E and **2**F some of the reinforcement members **201** may not have threaded protrusions; rather the protrusion **204** may be non-threaded or may have a plain surface (alternatively and/or additionally, the protrusion **204** may include an irregular, geared, notched, keyed, starred, or other surface). The non-threaded protrusion **204** may be received by the bore **202** of an adjacent reinforcement member **201**. An interference fit or friction fit may be established between the bore **202** and the non-threaded protrusion **204**.

The protrusion **204** may define one or more diametrically extending bores. Alternatively or additionally, a diametrically extending bore may be formed in the protrusion **204**. Further, a stop may be inserted through the bore after the position of the nut **206** is finalized. Such an arrangement may prevent movement of the nut **206** away from the finalized position when the structure is placed under pressure.

Referring to FIGS. **1**D and **1**E, multiple transition portions **106** may be defined. Reinforcement **200** may be provided at each of the transition portions **106**. The transition portions **106** may be concentric (FIG. **1**D), irregular (FIG. **1**E), and/or intermittent (FIG. **1**E). Each of the transition portions **106** may define a same angle of transition. Alternatively, at least one of the transition portions **106** may define an angle of transition that may differ from angle(s) of transition defined at the remaining transition portion(s) **106**. FIG. **1**D shows two concentric transitions portions **106** forming a transition from a vertical cylindrical wall of a first portion **102** to a radial sphere or quasi-sphere of a first dome of a second portion **104**, and forming a transition from the second portion **104** to a smaller and taller radial or quasi-sphere of a second dome of a third portion **110**. FIG. **1**E shows an airform **100** in which multiple transition portions **106** are provided and reinforced between at least three windows frames **112**, a door frame **114**, a hallway or connection portion **116** between one or more monolithic structures, a cylinder or first portion **102**, and a dome or second portion **104**.

Referring to FIG. **2**C, a single reinforcement member **210** may form the requisite reinforcement. The reinforcement member **210** may be flexible in nature. The reinforcement member **210** may define a circular configuration. Ends of the reinforcement member **210** may be engaged with each other to define a closed loop. One or more mating, locking, or engagement mechanisms may be provided, such as those described previously, which can be manipulated to alter the length of the perimeter of the reinforcement member **210**.

FIGS. **3**A-**3**C illustrate multiple embodiments of loops capable of being opened for insertion of a reinforcement member into the loop, closed around a reinforcement member, and re-opened for removal and/or reclamation of the reinforcement member. Various loop, sleeve or other retention or retainer members may be used to connect transition portions of the airform with a variety of one or more reinforcement members. For example, U.S. Pat. Nos. 6,192,633, 5,893,238, 6,722,084, 4,901,481, 4,031,674, 4,665,935, 7,954,504, 5,628,336, 7,128,078, and 8,615,966 illustrate a variety of tent structures with inflatable or structural members interfacing with sleeves. The elements, principles, structures, techniques, and methods of the aforementioned patents may be combined in any manner with any of the elements, principles, structures, techniques, and methods of the present invention disclosed herein. All of the subject matter and disclosure of the aforementioned patents is incorporated herein by reference in its entirety.

Referring to FIGS. **3**A-**3**B, at least one reinforcement retainer, such as loops **302**, may be provided for receiving reinforcement. The loops **302** may hang from the transition portion **106**. One or more loops **302** may include a hook and loop type fastener such that loops can be selectively formed by operating the hook and loop type fastener. A hook mechanism may be provided on or towards a first edge of the loop **302** and a loop mechanism may be provided on or towards a second edge, opposite the first edge, of the loop **302**. Upon engaging the hook and loop mechanism, the loop **302** may be formed, which may be configured to receive the reinforcement. The formation of the loop **302** may facilitate selective usage of the loops **302** based on requirements of the user. The loops **302** may be formed based on user requirements to form the loops **302** to enable reception of the reinforcement. In an embodiment, some of the loops may be fastened to the airform **100** by adopting hook and loop mechanisms. The position of such loops relative to the airform may be altered based on user requirements.

Referring to FIG. **3**C, at least one reinforcement retainer, such as loops **304**, may be provided for receiving reinforcement. One or more loops **304** may include a zip fastening mechanism such that the loops can be selectively formed by operating the zip fastening mechanism. The loops **304** may be selectively formed by operating the zip fastening mechanism. The zip fastening mechanism may be configured such that one end of the loop **304** may include one row of the zip fastening mechanism and the other end of the loop **304** may include another row with protruding teeth. The ends may be brought together and a slider of the zip fastening mechanism may be slid over the two rows, thereby interlocking the rows and forming the loop **304**. In an embodiment, a zip fastening mechanism may be used to fasten the loops to the airform **100**. The zip fastening mechanism may be configured such that, one row of the zip fastening mechanism with protruding teeth may be provided on the airform **100** and the other row of the zip fastening mechanism with protruding teeth may be provided on the loops **304**. The slider of the zip fastening mechanism may be slid over the two rows, thereby interlocking the two rows and attaching the loop **304** to the airform **100**.

Referring to FIG. **4**, an inflatable reinforcement member **400** may be provided. The reinforcement member **400** may be a flexible pipe or tube whose ends may be engaged to define a closed loop. The reinforcement member **400** may include a valve **402** which may be adapted with an inflating device to inflate the reinforcement member **400**. The reinforcement member **400** may be inflated using fluid, which may include liquid and/or gas. Wrinkles may be removed by manipulating or altering the pressure created by the fluid. The pressure created by the fluid may vary from the pressure at which the airform is retained. The pressure created by the fluid may be higher compared to the pressure at which the airform is retained.

Referring to FIGS. **5**A-**5**C, a single continuous airtight reinforcement retainer, such as a loop **502**, tube, or pocket, may be provided along the perimeter of a transition portion **503** of an airform **500**. The loop **502** may include a mechanism **504**, such as a valve, for connecting the loop **502** to the inflating device. The loop **502** may be configured to be in inflated using fluid. The inflated loop **502** may function as the reinforcement to the airform **500**. Wrinkles may be removed by manipulating or altering the pressure created by the fluid. The pressure created by the fluid may vary from the pressure at which the airform is retained. In order to remove the wrinkles, the pressure created by the fluid may be higher compared to the pressure at which the airform is retained.

Referring to FIGS. **6**A-**6**B, a reinforcement **602** in the form of one or more (e.g., multiple) layers of flexible sheets may be provided in the airform **600**. The flexible sheets of material may be formed of any material compatible with the airform **600**, and such sheets may be heat welded, glued, sewn, hermetically sealed, or otherwise secured in an airtight and water-tight connection to each other. The reinforcement **602** may be provided along the perimeter of a transition portion **606** of the airform **600**. The multiple layers of flexible sheets provided along the perimeter of the transition portion **606** of the airform **600** may increase the thickness and stiffness of the area along the perimeter of the transition portion **606**. The flexible sheets may be made of the same or different material as the airform **600** or its various portions. Various portions of the airform **600** and transition portion **606** may have materials of different rigidity and strength in order to help provide structural stiffness to the airform and transition portion capable of minimizing or removing wrinkles or other surface aberrations. The multiple layers of flexible sheets reinforce the area around the transition portion **606**, which may be prone to wrinkles Upon inflating the airform **600**, the presence of reinforcement **602** along the perimeter of the transition portion **606** restricts or limits the formation of wrinkles in the airform **600**.

The first portion and the second portion and any other multiple portions of the airform may be configured to define a singular or monolithic airform. The reinforcement may be removed from the airform after a solid structure is built along the airform, and the structure is capable of retaining the desired shape absent air pressure within the air form.

Referring to FIGS. **7**A through **7**C, the airform **100** may include at least one reinforcement retainer, such as loops **108**, along the inner circumference of a transition portion **106** on the inside surface of the airform **100**. The loops **108** may retain one or more reinforcement members **201** or reinforcement hangers **201** on the inner surface of the airform **100**. Any portion of any inner surface of the airform **100** may include any number of reinforcement retainers and/or reinforcement members. The reinforcement **200** described on the exterior surface of the airform in any or all of the various figures of this disclosure may be inverted, that is, placed on the interior surface instead of the exterior surface, of the airform. For example, the reinforcement **200** shown and described on the exterior surface of the airform with reference to FIGS. **1**B, **1**D, **1**E, **3**A-**3**C, **4**, and **8**A-**8**C may be provided as reinforcement **200** on the inner surface or interior of the airform at any location of the airform.

The structure built as per the template of the airform **100** may include several layers formed of different materials. The airform **100** may be inflated and reinforced to remove wrinkles or striations, if any. Upon inflation of the airform **100**, the construction process may be begun either from the inside of the inflated airform or from the outside of the inflated airform **100**, based on a chosen method of construction. If construction is carried out from the inside of the inflated airform **100**, the airform **100** may form the outer layer of the structure. Alternatively, if construction is carried out from the outside of the inflated airform **100**, the airform **100** may form the inside layer of the structure. The structure may include the airform **100**, a first layer of sprayed polyurethane foam **702**, rebar hangers **704** embedded in the first layer of polyurethane foam, a second layer of polyurethane foam **706** as desired to embed and retain the rebar hangers **704** or otherwise provide additional insulation or structural support, steel, metal, or other rigid reinforcement **708** arranged as per design specification and concrete **710** of desired thickness sprayed over the steel reinforcement **708**.

The first layer of polyurethane foam **702** may be sprayed onto to the inflated airform **100**, permitting rebar hangers **704** to extend through the first layer of polyurethane foam **702** from the reinforcement hangers **201**. Additional or alternative rebar hangers **704** may be embedded in the first layer of sprayed polyurethane foam **702** at suitable positions. The rebar hangers **704** facilitate in attaching the steel reinforcement to the airform **100**. The second layer of polyurethane foam **704** may be sprayed onto the earlier layers, thereby embedding the rebar hangers **704**. Upon embedding the rebar hangers **704**, steel reinforcement **708** may be arranged as per design specification, considering the doors, windows, vents and/or chimney, among others, to be provided in the structure. Concrete **710** of desired thickness may be sprayed to complete the structure. Upon setting of the concrete **710**, the structure may be complete. The airform **100** may be retained under a suitable pressure until the concrete sets. The airform **100** may be separated from the structure and reused.

Other internal and/or external structures in addition to and/or instead of rebar hangers **704**, steel reinforcements

708, and/or concrete 710 may be used in conjunction with the structures, features, benefits, methods, steps, and processes of the present disclosure. For example, a furring strip or other internal and/or external structure may be placed along the internal and/or external vertical, horizontal, circumferential, spherical, quasi-spherical, irregular, and/or other surface(s) of the airform. The furring strip (of wood, PVC, or other penetrable and/or fixable material), or other structure, may then be used to anchor or otherwise affix auxiliary structures or materials (such as hangers 704, steel reinforcements 708, concrete 710, siding, flashing, rain gutter, and/or other structures).

Referring to FIG. 8A, an airform 802 may be provided to resemble a pyramid. Reinforcement 804 may be provided at one or more transition portion 806 so that the desired transition is achieved and/or wrinkles if any may be removed.

Similarly, referring to FIG. 8B, an airform 812 may be provided to resemble a cube. Reinforcement 814 may be provided at one or more transition portion 816 so that the desired transition is achieved and/or wrinkles if any may be removed.

Likewise, referring to FIG. 8C, an airform 822 may be provided to resemble a pyramid disposed over a cube. Reinforcement 824 may be provided at one or more transition portion 826 so that the desired transition is achieved and/or wrinkles if any may be removed. In light of this disclosure, other shapes may be contemplated, and FIGS. 8A to 8C are merely examples of a variety of curved or linear shapes, ellipses, etc. that may be employed.

FIGS. 8A to 8C include straight reinforcements 824 that may buckle at certain weak inflection points along the length of the reinforcement members and under the internal air pressure of a fully-inflated and pressurized airform. In other embodiments with straight sections, sigmoid sections, or other sections of reinforcement members that do not follow the natural profile and geometry of a fully-inflated and pressurized airform, such as the examples in FIGS. 8A through 8C, it may be preferable to further strengthen such reinforcement members. Reinforcement members may be strengthened by using stronger, more rigid materials (such as metal alloys or carbon fiber materials) to form the reinforcement members and/or by using additional structure on or surrounding each of the reinforcement members (such as increased diameter, straight or bent I-beam geometries, triangular or truss like geometries, supplemental sleeves, or other structures and geometries). By providing additional strength along at least a portion of each reinforcement member where such member is likely to bend, buckle, or otherwise deform when the airform changes shape under pressure, the airform is more likely to retain a desired shape influenced by the reinforcement members whenever such members are present and adequately strengthened.

In an embodiment, reinforcement may be provided for reinforcing the airform and thereby remove wrinkles that may be formed upon inflating the airform. The reinforcement provided may be such that shape of the reinforcement may facilitate collection of water which may drip down from the top of the structure. The reinforcement may function as a rain gutter around the structure and facilitate collection and disposal of rain water dripping from the roof of the structure.

The reinforcement members may be made of materials, such as steel, PVC pipes, wires, cables and rigid canvas, among other suitable materials. The airform may be made of material capable of withstanding inflation and/or providing protection against nature's elements.

In an embodiment, a design of a structure or a monolithic dome structure to be constructed may be finalized. An airform may be manufactured to complement the design of the structure. The airform may be manufactured by joining several sheets which may be joined using techniques such as heat welding. Foundation may be prepared for the structure. An inferior end of the airform may be engaged to the foundation. Subsequently, the airform may be inflated and a requisite pressure may be retained inside the airform. Reinforcement may be provided to the airform, and the reinforcement may be adjusted or manipulated such that wrinkles, striations, dimples or other surface aberrations, if any, formed on the airform are removed. The airform may be sprayed and other preparation steps may be carried out to ready the airform for rest of the construction steps. The construction steps may include spraying a polyurethane foam or other insulation against the inside surface of the airform and/or erection of steel or other reinforcement inside the airform or outside, depending on the chosen construction technique. Concrete of desired thickness may be sprayed over the steel reinforcement, insulation, and/or airform. Once the concrete structure is capable of retaining the desired shape, mechanisms that may be used to retain the airform at requisite pressure may be turned off. The airform may be left on the structure or may be reused.

What is claimed is:

1. An *inflatable* airform [that can be inflated for facilitating construction of a permanent structure, the airform] *for building construction,* comprising:

a first portion comprising a first *complete* surface of revolution when the airform is inflated, wherein the first portion is configured to be disposed in a first shape and to form a first profile when the airform is inflated;

a second portion comprising a second *complete* surface of revolution when the airform is inflated, wherein the second portion is configured to be disposed in a second shape and to form a second profile when the airform is inflated;

wherein at least one of the following *is present*: the first *complete* surface of revolution is configured to be different than the second *complete* surface of revolution, the first shape is configured to be different than the second shape, or the first profile is configured to be different *than* the second profile, when the airform is inflated;

at least one transition portion comprising at least one portion of the airform that defines a transition from the first portion to the second portion when the airform is inflated, wherein the first portion and the second portion share at least one common radius of revolution at the transition when the airform is inflated;

at least one reinforcement comprising at least one reinforcement member [provided] *located* at the at least one transition portion, wherein the at least one reinforcement [enables defining the] *defines a* transition *point* from the first portion to the second portion and [maintaining] *maintains* the first shape and the second shape when the airform is inflated; and

at least one reinforcement retainer configured to retain *the* at least one reinforcement member at the at least one transition portion;

wherein the at least one reinforcement comprises a plurality of reinforcement members; and

wherein the airform is configured to facilitate the construction of a permanent structure.

[2. The airform of claim 1, wherein the at least one reinforcement comprises a plurality of reinforcement members.]

3. The airform of claim [2] *1*, wherein the plurality of reinforcement members are configured to be engaged to each other to form a closed loop encircling the at least one transition portion, wherein the closed loop comprises a perimeter.

4. The airform of claim 3, wherein [said engagement is] *the plurality of reinforcement members are* configured to be manipulated to alter the length of the perimeter of the closed loop.

[5. The airform of claim 1,

wherein the first portion further comprising a first at least one radius of curvature when the airform is inflated;

wherein the second portion further comprising a second at least one radius of curvature when the airform is inflated; and

wherein at least one radius of curvature of the second at least one radius of curvature is different than at least one radius of curvature of the first at least one radius of curvature at the at least one transition portion when the airform is inflated.]

6. The airform of claim 1, further comprising at least one window and at least one door.

7. The airform of claim 1, further comprising a third portion configured to be disposed in a third shape when the airform is inflated, wherein the at least one transition portion further comprising at least one portion of the airform that defines a transition from the second portion to the third portion when the airform is inflated.

8. The airform of claim 1, wherein the at least one transition portion comprises a plurality of portions of the airform that define transition from the first portion to the second portion, wherein at least two of the plurality of portions of the airform are configured to be reinforced.

9. The airform of claim 1, wherein the first shape is cylindrical.

10. The airform of claim 1, wherein the second shape is doubly curved.

11. A method of preparing an airform that can be inflated for facilitating construction of a permanent structure, the method comprising:

inflating the airform of claim 1, such that the first portion of the airform is disposed in [said] *the* first profile, and the second portion of the airform assumes [said] *the* second profile, which *the second profile* is different [to] *than* the first profile[, then]*;*

manipulating the at least one reinforcement at the at least one transition portion to remove at least one surface aberration extending across the at least one transition portion.

12. The method of claim 11, wherein [providing] *manipulating the* at least one reinforcement comprises assembling [a] *the* plurality of reinforcement members along the at least one transition portion of the airform.

13. The method of claim 11, wherein manipulating the at least one reinforcement comprises altering a perimeter of the at least one reinforcement for removing the at least one surface aberration.

14. The method of claim 11, wherein manipulating the at least one reinforcement comprises altering a dimension of the at least one reinforcement at least proximal to the at least one surface aberration.

15. The method of claim 11, wherein the second shape is doubly curved.

16. An [monolithic] *architectural* structure, comprising:

a [cement] *concrete* layer;

a structural layer of metal adjoining the [cement] *concrete* layer;

insulation adjoining the structural layer of metal; and

the airform of claim 1 adjoining the insulation;

wherein the first portion of the airform is configured to be engaged to a foundation;

wherein the second portion of the airform is configured to be disposed distally from the foundation when the airform is inflated; and

wherein the at least one reinforcement is configured to be manipulated for removing one or more striations, if any, at the at least one transition portion, when the airform is inflated.

17. The [monolithic] *architectural* structure of claim 16, wherein,

the first portion extends perpendicularly from the foundation to the at least one reinforcement;

the second portion extends superiorly from the at least one reinforcement; and

the second shape is doubly curved.

18. The [monolithic] *architectural* structure of claim 17, wherein the at least one reinforcement *comprises a rigid material and* is configured to be operable for manipulating [a] *the* material under tension at the at least one transition [portion].

19. The [monolithic] *architectural* structure of claim 16, wherein the [at least one reinforcement comprises a] plurality of reinforcement members *are* configured with ends that engage to define a closed loop, wherein engagement of the ends is configured to be manipulated to alter a dimension of the closed loop.

20. The airform of claim 7, wherein the third shape is doubly curved.

21. An architectural structure, comprising:

a concrete layer;

a structural layer comprising metal adjoining the concrete layer;

an airform integrally connected to the structural layer, the airform comprising:

a first portion having a first complete surface of revolution when the airform is inflated to form a first profile;

a second portion having a second complete surface of revolution when the airform is inflated to form a second profile, wherein the first and second profiles are different;

a plurality of reinforcement members located at a transition between the first and second portions, wherein the first and second portions share a common radius of revolution at the transition between the first and second portions; and

one or more retainers configured to retain the plurality of reinforcement members;

wherein the airform is configured so as to be capable of facilitating construction of a permanent structure, and the plurality of reinforcement members define the transition from the first portion to the second portion and maintain the first profile and the second profile when the airform is inflated.

22. The architectural structure of claim 21, further comprising insulation adjoining the structural layer.

23. The architectural structure of claim 21, further comprising a foundation operably connected to the first portion.

24. A method of preparing an architectural structure, comprising:

providing an airform configured so as to be capable of facilitating construction of a permanent structure, the airform comprising:

a first portion having a first complete surface of revolution when the airform is inflated to form a first profile;

a second portion having a second complete surface of revolution when the airform is inflated to form a second profile, wherein the first and second profiles are different;

a reinforcement member located at a transition between the first and second portions, wherein the first and second portions share a common radius of revolution at the transition between the first and second portions; and

one or more retainers configured to retain the reinforcement member; and

inflating the airform;

wherein the reinforcement member defines the transition from the first portion to the second portion and maintains a first shape and a second shape when the airform is inflated; and

wherein the method further comprises assembling a plurality of reinforcement members along the transition of the airform.

25. The method of claim 24, further comprising removing at least one surface aberration extending across the transition.

26. The method of claim 24, further comprising altering a perimeter of the reinforcement member.

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