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(54) **INFLATABLE SHELTER**

(57) An inflatable structure that can be easily transported, inflated, assembled, disassembled and stored with minimal if any tools and in a fraction of the time associated with prior art structures. The inflatable structure is comprised of a plurality of interchangeable structural members removably attached to one another, and that

afford the user virtually endless design options and superior weatherproofing and insulating qualities. The structural member further comprises a plurality of filaments positioned in an airtight void, wherein said plurality of filaments are in tension when the structural member is inflated.

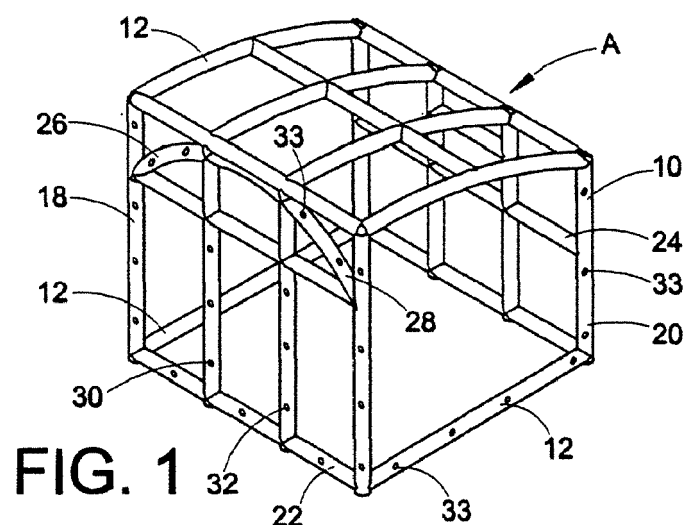


FIG. 1

EP 3 715 559 A1

Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present application claims priority to, and the benefit of, U.S. Provisional Application No. 62/823,063, which was filed on March 25th, 2019 and is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] The disclosure relates to building structures. More particularly, it relates to the method and apparatus for building temporary or permanent structures for use as shelters.

BACKGROUND OF THE DISCLOSURE

[0003] There are many instances where a temporary structure is needed to provide shelter. For example, natural disasters such as hurricanes, tornadoes, tsunamis, earthquakes and floods often render thousands of people homeless, either temporarily or permanently. Often-times, victims of such disasters need shelter, at least on a temporary basis. Tents are often used for shelters, but are not very stable or durable and typically can only be used for a short duration of time. Additionally, tents do not always provide adequate shelter from the elements, such as rain, snow or excessive heat or cold, and are not particularly effective at providing insulation.

[0004] Therefore, there is a long felt need in the art for a structure which is relatively easy to assemble and disassemble, and which can provide an insulated shelter that is both sturdy and durable and that can be used for either a short-term or long-term basis. There is also a long felt need in the art for a structure that can be constructed from interchangeable and inflatable panels that may be removably attached to one another or to similarly constructed inflatable columns or other structural members, such as trusses, beams and the like, to form the structure's roof, walls, floor, doors, etc.

[0005] Additionally, there is a long felt need in the art for a structure whose walls, floor and/or roof are generally planar and have superior insulating, waterproofing and strength characteristics. Finally, there is a long felt need in the art for temporary or permanent structures which overcome the above-mentioned deficiencies and others, while providing improved overall results. The structures disclosed herein, in their various embodiments, can be used for other applications as well, such as during military operations or as homes for individuals in third world countries or to shelter homeless people.

SUMMARY OF THE DISCLOSURE

[0006] The disclosure relates to building structures. More particularly, it relates to a method and apparatus for building temporary or permanent structures for use

as shelters, command centers, offices, or the like. Accordingly, the present specification makes specific reference thereto. However, it is to be appreciated that aspects of the present invention are also equally amenable to other like applications, devices and methods of manufacture.

[0007] In accordance with one aspect of the disclosure, a shelter assembly has a frame having a plurality of fillable support members, each having a hollow portion for receiving a filling material. The support members are configured to form a structure, wherein the support members form walls of the structure.

[0008] In accordance with another aspect of the disclosure, the shelter assembly has a plurality of columns which form corner posts of a structure; and a plurality of walls which are removably attached to a pair of adjacent columns. The walls include support members to which at least one panel is attached, wherein the support members are secured to a pair of adjacent columns via fasteners. An upper portion forms a roof of the structure, wherein the columns are attached to the corner members of the upper portion.

[0009] In accordance with another aspect of the disclosure, a method of assembling a shelter assembly is comprised of the following steps: (a) providing a roof assembly which has a plurality of fillable support members; (b) injecting filling material into the roof support members by inserting a nozzle of a filling gun into a fill valve located on each of the support members; (c) installing the roof assembly onto columns at opposite corners of the roof assembly by inserting the columns into coupling members at corners of the roof assembly; (d) providing wall assemblies formed by flexible support members and at least one panel; (e) filling the support members of the wall assemblies by injecting filling material into the wall support members; and (f) securing the wall assemblies to the columns via fasteners.

[0010] One aspect of the disclosure is to provide a structure which is durable, rigidly supported and that can be relatively easily assembled and disassembled. Another aspect of the disclosure relates to support members that are chambers which may be filled with foam, concrete, or any other suitable fill material which can be held together by binders or by being packed, to provide rigidity and/or insulating value to the structure. Yet another aspect of the disclosure relates to chambers which may be filled by air, gas, water, or any other fluid which has a high or low viscosity to provide insulation and/or support to the structure.

[0011] Further aspects of the disclosure relate to filled containment structures (e.g., tubes or pipes), which form troughs or channels for housing electrical wiring, and various center wall sections which have chambers formed in a ribbed or quilted arrangement to form a combination of foam filled or storage chambers. such as for water or other liquids.

[0012] Additional aspects of the disclosure relate to the inclusion of a plurality of fill valves that are placed inter-

mittently along the lengths of the foam chambers for completely filling the chambers with foam, and to a slit valve having a lip seal for forming a seal around a foam filling gun. Still another aspect of the disclosure relates to a two-part polyurethane foam mixture which includes a catalyst for fast curing of the foam and that allows for fast filling of the foam chambers while minimizing or eliminating air or gas voids and avoiding compression damage of the foam which is being layered. Other aspects of the disclosure relate to a valve that can be used for injecting foam or any other fill material uniformly into the fill chambers which may have a plurality of shapes, such as "t-shape", "v-shape", etc. Still another aspect of the disclosure relates to a modular arrangement of frame structures which are connected by a flap or tarp, and removable and interchangeable walls having support members and panels which are removably secured to columns of the structure.

[0013] In accordance with an alternative embodiment of the present invention, a shelter assembly may be comprised of a plurality of interchangeable and inflatable panels that may be removably attached to one another via a flange, or to similarly constructed inflatable columns or other support members, such as beams, trusses and the like, to form the structure's roof, walls, floor, etc. As explained more fully below, the interchangeable and inflatable panels of this alternative embodiment of the present invention have exterior and interior surfaces that are relatively flat and rigid, and have superior insulating, waterproofing and strength characteristics. More specifically, the panels and other structural members are comprised of an interior surface, an exterior surface, opposing top and bottom surfaces, and opposing side surfaces that form a void or opening therebetween for receipt of air or other gas to inflate said panel or structural member. In accordance with an important aspect of the present invention, the interior and exterior surfaces are further connected to one another by a plurality of filaments or fibers that span the void and that are placed in tension when the panel or support is inflated, thereby providing added strength and support to the inflated panel. It is also contemplated that the plurality of filament or fibers could also be used to connect opposing top and bottom surfaces and/or opposing side surfaces.

[0014] In accordance with another aspect of the invention there is provided an inflatable structural member comprising: an exterior; an interior; and a plurality of filaments extending between said exterior and interior.

[0015] The inflatable structural member may further comprise a port and a flange attached to at least one of said exterior or interior.

[0016] The inflatable structural member may further comprise a length of hook and loop fasteners.

[0017] The inflatable structural member may further comprise an airtight void, wherein said plurality of filaments are positioned within said airtight void and are in tension when the inflatable structural member is inflated.

[0018] In accordance with another aspect of the inven-

tion there is provided an inflatable shelter comprising: at least one inflatable panel having a port; at least one flange; and at least one column, wherein said at least one inflatable panel further comprises an airtight void with a plurality of filaments positioned in said airtight void.

[0019] The inflatable structural member may further comprise a roof.

[0020] The inflatable structural member may further comprise at least one ingress point.

[0021] The inflatable structural member may further comprise at least one cross member.

[0022] The inflatable shelter may be free-standing.

[0023] The at least one inflatable panel is connected to at least one of the following: (a) the at least one flange; (b) a roof; and (c) a cross member.

[0024] The said plurality of filaments may be in tension when the at least one inflatable panel is inflated.

[0025] The inflatable structural member may further comprise a floor.

[0026] The inflatable structural member may further comprise a vestibule.

[0027] In accordance with another aspect of the invention there is provided a complex comprising: a first inflatable shelter having at least one inflatable panel, and at least one flange; and a second inflatable shelter.

[0028] The complex may further comprise at least one column that is one of an inflatable column, a non-inflatable column and an expandable column.

[0029] The said at least one inflatable panel further comprises an airtight void with a plurality of filaments positioned in said airtight void.

[0030] The said plurality of filaments may be in tension when the at least one inflatable panel is inflated.

[0031] The first inflatable shelter may further comprise at least one ingress point.

[0032] The first inflatable shelter may further comprise at least one of a conduit, a roof and a floor.

[0033] The at least one inflatable may be connected to at least one of the following: (a) the at least one flange; (b) a roof; and (c) a cross member.

[0034] Other aspects of the disclosure will become apparent upon a reading and understanding of the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] The disclosure may take form in various components and arrangements of components, and in various steps and arrangements of steps. The drawings are for purposes of illustrating the preferred embodiments and are not construed as limiting the disclosure.

FIG. 1 is a perspective view of one embodiment of a shelter frame with an arched roof in accordance with one aspect of the disclosure; FIG. 2 is a top plan view of the shelter frame of FIG. 1; FIG. 3 is a front elevational view of the shelter frame of FIG. 1;

FIG. 4 is a side elevational view of the shelter frame of FIG. 1;

FIG. 5 is a perspective view of a shelter frame having a flat roof in accordance with another aspect of the disclosure;

FIG. 6 is a perspective view of a center wall section with ribbed supports for the shelter frame;

FIG. 7 is a front elevational view of the center wall section of FIG. 6;

FIG. 8 is a side elevational view of the center wall section of FIG. 6;

FIG. 9 is a perspective view of a center wall section with pivot joints;

FIG. 10 is a front elevational view of the center wall section of FIG. 9;

FIG. 11 is a side elevational view of the center wall section of FIG. 9;

FIG. 12 is a perspective view of a center wall section with center air chambers in accordance with another aspect of the disclosure;

FIG. 13 is a front elevational view of the center wall section of FIG. 12;

FIG. 14 is a side elevational view of the center wall section of FIG. 12;

FIG. 15 is a perspective view of a center wall section with quilted supports in accordance with another aspect of the disclosure;

FIG. 16 is a front elevational view of the center wall section of FIG. 15;

FIG. 17 is a side elevational view of the center wall section of FIG. 15;

FIG. 18 is a perspective view of a center wall section with panel supports in accordance with another aspect of the disclosure;

FIG. 19 is a front elevational view of the center wall section of FIG. 18;

FIG. 20 is a side elevational view of the center wall section of FIG. 18;

FIG. 21 is a perspective view of a flexible fill valve for a fill chamber in accordance with another aspect of the disclosure;

FIG. 22 is a front elevational view of the fill valve of FIG. 21;

FIG. 23 is a side elevational view of the fill valve of FIG. 21;

FIG. 24 is a side elevational view of a foam filling gun in accordance with another aspect of the disclosure;

FIG. 25 is a side elevational view of a foam filling gun filling a foam tube of the disclosure;

FIG. 26 illustrates a foam having a non-uniform density;

FIG. 27 illustrates a foam having a uniform density in accordance with the disclosure;

FIG. 28 is a perspective view of a flexible fill valve with t-shaped extension tubes and a mixing auger disposed within the valve and a foam filling gun extending therefrom in accordance with another aspect

of the disclosure;

FIG. 29 is a side elevational view of a flexible fill valve with t-shaped extension tubes in accordance with another aspect of the disclosure;

FIG. 30 is a front elevational view of the valve of FIG. 29;

FIG. 31 is a side elevational view of the valve of FIG. 29;

FIG. 32 is a perspective view of foam chamber support frame sections with a sealing joint in accordance with another aspect of the disclosure;

FIG. 33 is a front elevational view of the support frame with sealing joint of FIG. 32;

FIG. 34 is a side elevational view of the support frame with sealing joint of FIG. 32;

FIG. 35 is a perspective view of two support frame assemblies connected together via sealing joints with a panel from FIG. 18 forming a portion of the roof;

FIG. 36 is a perspective view of two support frame assemblies held together by elongated flaps and illustrating panels shown in FIGS. 6 and 9 forming wall portions;

FIG. 37 is a perspective view of a cover secured to a support frame structure by fastening members and illustrating solar panels on a roof and a wall formed by a panel shown in FIG. 12;

FIG. 38 is a perspective view of a cover held onto a support frame structure by cables and stakes;

FIG. 39 is a perspective view of a partially assembled support frame assembly with cloth walls in accordance with another aspect of the disclosure;

FIG. 40 is a perspective view of an assembled structure of FIG. 39;

FIG. 41 is a perspective view of a column and straps with flaps removed to expose the column and straps;

FIG. 42 is an enlarged perspective view of a bottom portion of a column secured to a bottom or floor material;

FIG. 43 is a perspective view of inner walls and a column of the structure of FIG. 40;

FIG. 44 is a perspective view of a foldable support frame assembly in accordance with another aspect of the disclosure;

FIGS. 45 and 45A are a perspective and cross sectional view of a support frame and baffle member; and

FIG. 46 is a perspective view of a roof support frame in partial cross section having straps thereon.

FIG. 47 is a perspective view of an alternative embodiment of an interchangeable and inflated panel.

FIG. 48 is a perspective cross-sectional view of the alternative panel of FIG. 47 at cut line A-A.

FIG. 49 is a side perspective view of an alternative embodiment of interchangeable and inflated support.

FIG. 50 is a top perspective view of the alternative interchangeable and inflated support.

FIG. 51 is a perspective view of one embodiment of

a structure comprised of the alternative panels and alternative supports.

FIG. 52 is a bottom perspective view of the structure of FIG. 51 without a floor portion.

FIG. 53 is a perspective exploded view of the structure of FIGS. 51 and 52.

FIG. 54 is a perspective view of an alternative embodiment of a structure comprised of alternative panels and alternative supports.

FIG. 55 is a bottom perspective view of the structure of FIG. 54 without a floor portion.

FIG. 56 is a perspective view of an alternative embodiment of a complex comprised of multiple interconnected structures comprised of alternative panels and alternative supports.

FIG. 57 is a bottom perspective view of the complex of FIG. 56 comprised of multiple interconnected structures comprised of alternative panels and alternative supports without a floor portion.

FIG. 58 is a bottom perspective view of an alternative embodiment of a structure comprised of alternative panels and alternative supports and having a floor and flaps.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0036] The disclosure relates to temporary or permanent structures for providing shelter. In particular, it relates to a shelter frame which utilizes foam, air, gas, water or any other appropriate filling media for providing insulation and rigidity and is durable and easily assembled or disassembled.

[0037] If the structure is deemed for use as a short-term, disposable shelter, the frame may be fabricated from many different materials including, without limitation, a high density polyethylene, polyvinyl chloride (PVC), plastic or any other suitable material types. The material can be the form of relatively thin sheets such as 2 mil thickness to 6 mil thickness (i.e. 0.002 to 0.006 inches thick), or any other suitable thickness or shape.

[0038] By comparison, if the structure is intended to be used for a long-term application, such as about two years or more, then a longer lasting material such as vinyl-coated polyester or nylon cloth or any other suitable material such as that which is used in children's bouncing jumpers can be used.

[0039] Referring now to FIGS. 1-4, shelter A may include a frame assembly 10 formed by a plurality of fill containment structures 12 (such as bars or tubes) which are formed of plastic such as thermoplastic, polyethylene, PVC, or any plastic similar to that used for inflatable rafts or thicker plastic such as that used for tarps. The plastic can be of various thicknesses and can be either flexible or rigid. The tubes or pipes themselves are preferably hollow and form a trough or channel which may be filled with water, concrete, air, gas, or fill material such as polyurethane (PU) expandable foam, but is not limited

to same. Alternatively, the tubes can be of a rigid, sufficient thickness of plastic, and do not need to be filled with foam or water or any other filling material.

[0040] Water within the tubes or pipes may be used for insulation purposes or as a water supply for supplying water to inhabitants of the structure such as for cooking, cleaning or bathing purposes. The water may also be carbon filtered in the tubes. Alternatively, the troughs or channels of the tubes 12 may be used for housing electrical wires for providing electricity to the shelter for lighting, heating, cooling, etc. The chambers may be baffled or isolated from each other, or any combination where fill material (such as foam or liquid) can pass between chambers or not. Foam may be used in a cold environment to provide insulation, and water may be used in hot environments for insulation, for example. Foam may be used to fill seam joints to provide a seal or bond between adjacent fill containment structures. Adhesives, glue or other sealants or bonding agents may also be used. Alternatively, straps, flaps or Velcro® or any other suitable fastening means may be used to join or secure adjacent fill containment structures.

[0041] The shelter may be easily disassembled or re-assembled by releasing the seam joint (e.g., Velcro®) seal or bonding material, and reapplying the seam joint or bonding material when reassembling the shelter. When no longer of use, the shelter may also be shredded for easy disposal, or for use as blown insulation which may be reusable and thus is an environmentally "green" product.

[0042] Referring still to FIGS. 1-4, the frame bars 12 are preferably assembled in a rectangular- or square-shaped structure, though other shapes and configurations are also contemplated, with multiple fill containment structures such as tubes or pipes, forming a roof or a top wall 16, a pair of side walls 18, 20, a front wall 22 and a back wall 24. The structure in FIGS. 1-4 is shown to have an arched roof. The front wall has several curved tubes 26, 28 which serve to provide additional rigidity to the structure. Additionally, a door may be formed in front wall 22 between tubes 30, 32, and windows may also be formed between adjacent bars 12. Further, side walls 18 and/or 20 may be removable or cut, or otherwise configured to receive an attachable structure similar to structure 10, such as shown in FIG. 35 to form a modular arrangement. Fill valves 33 may be formed in each of the tubes for adding foam, gas, or any other fill material to the chambers formed within the tubes.

[0043] The tubes in the roof may also be used to accommodate electrical raceways, and stand-alone solar cells may be placed over the tubes or as cells 206 printed on the surface of the shelter (see e.g., FIG. 37) for providing heat or energy for the structure. A roof, wall or formed material, such as a sheet of plastic, or a tarp may be secured to the top wall by Velcro® or any other suitable fastening means such as glue, stitching, or welding or a combination thereof, such as best shown in FIG. 37. Other fastening means include fusing plastic to the tubes,

welding, gluing, taping, stitching or bonding to the fill containment structures (see e.g., FIGS. 5-20), or any combination or variation thereof. The arch support tubes provide rigidity which, in turn, translates to the outer support tubes.

[0044] Nonetheless, as an alternative to the arched roof shelter, a flat roof shelter frame B may also be used and is shown in FIG. 5. The flat roof shelter frame 40 includes a flat roof wall 42, a pair of side walls 44, 46, a front wall 48 and a back wall 50 formed by a plurality of tubes or bars 51. Additionally, a door opening 52 can be formed between tubes 54, 56 in front wall 48, and window openings 58 may be formed on any of the side walls 44, 46. Further, fill valves 59 can be formed in each of the tubes for adding support fill (such as gas, water, foam) to the chambers formed within the tubes.

[0045] A side wall of the frame is shown in cross section to illustrate a ribbed center panel 60, which is described in more detail in FIGS. 6-8. Various types of center wall sections can be used with the frame, which will be discussed below. The center wall sections can be secured to the frame by any suitable fastening means such as Velcro® or by fusing, stitching, strapping or bonding at contact points along the length of the wall sections as discussed below.

[0046] Referring now to FIGS. 6-8, a first embodiment of a ribbed center panel 60 is shown. The panel 60 is secured to one of the walls of the frame structures. The panel has a plurality of ribbed stiffeners or louvers 62 which are preferably parallel and equally spaced apart along the length and height of the panel. However, the panels 60 do not have to be equally spaced apart. Foam or support fill or water or gas or air chambers 64 are formed between adjacent stiffeners or louvers. The chambers 64 can be separated from each other by the stiffeners or louvers, or they can be perforated or have openings in the stiffeners or louvers so that adjacent chambers can be interconnected. The stiffeners and louvers can be unequally spaced apart as well.

[0047] Fill valves 66 are positioned along the length of each chamber 64 to fill the chamber completely with foam, or water. By filling the chamber 64 with foam or water, the panel becomes insulated and forms a thermal barrier. Furthermore, the panel has additional rigidity and stiffness and additional structural strengths as a result of adding the support fill media (such as foam or water or liquid) and maintains its shape. Alternatively, the chambers 64 can alternate between air or gas chambers and foam chambers, or between water or liquid chambers and air or gas chambers, or between foam chambers and water chambers, or any other combination of chambers as needed. A faucet or spigot 67 can be added to any of the chambers 64 to allow for draining of water from the chamber for use in cooking, cleaning, bathing, etc.

[0048] Referring now to FIGS. 9-11, a center wall section 70 with pivot joints is shown. Foam or fill media filled chambers 72 are connected by pivot joints 74. Each foam chamber can be substantially or completely filled with

foam to increase its rigidity and stiffness. Fill valves 75 may be used in each of the tubes for adding foam, air, gas or water to each of the tube's chambers.

[0049] Referring now to FIGS. 12-14, another alternate of a center wall section 80 is shown. This wall section has a plurality of tubular foam filled chambers 82 which surround tubular central air or gas filled chambers 84 which are inflated with gas, such as air, and then the foam chambers are filled with foam using one of the methods described in this disclosure. Fill valves 85 can be used in each of the fill containment structures for adding fill media to each of the tube's chambers.

[0050] Referring now to FIGS. 15-17, another central wall section 90 is shown. Wall section 90 has quilted supports or stiffeners 92 which are staggered along a length of the wall section and also can extend the length of the wall sections. The supports or stiffeners can be parallel and equally spaced apart but are not limited to the configuration. Foam chambers 94 are formed between the stiffeners 92. Support columns 96 are positioned on opposite ends of the wall section and also have foam chambers 98 formed therein. A plurality of fill valves 99 are positioned along a length of each foam chamber for injecting foam or Kaocrete® or any other suitable castable or expandable material into the chambers. A single center wall section can be used to form a wall of the shelter, or multiple center wall sections can be used.

[0051] Referring now to FIGS. 18-20, another alternative center wall section 100 is shown. The center wall section 100 has a single layer panel or stiffener 102 formed between two tubular foam (or other material) chambers 104 at opposite ends of the panel. A plurality of fill valves 106 are provided along the lengths of the chambers 104 to fill the chambers 104 completely with foam.

[0052] Referring now to FIGS. 21-23, a flexible seal sealing valve 110 has a fill valve slot or slit 112 made of rigid or flexible plastic, or elastomer, or any suitable material, a flexible lip seal 114 and a bonding flange lip 116. The fill valve slot 112 is shown on a vertical slit in the flange. Other slits (horizontal, angled, tapered, etc.) may also be used, or a flapper or other valving means. The flange lip 116 has a bonding surface for bonding the valve to a center wall section and/or frame, bar, or any chamber that needs filled.

[0053] Referring now to FIGS. 24 and 25, a foam filling gun 122 has a nozzle, a handle 124, a squeeze trigger 126 and two flow tubes 128, 130 for receiving the two-part foam chemicals (commonly called "A-B foam" or "2K foam"). The nozzle of foam filling gun 122 is inserted into and past the fill valve slot or slit 12, and the flexible lip seal 114 surrounds and seals the valve and gun nozzle. Additionally, the nozzle of foam filling gun 122 has a corkscrew style auger 132 formed within the nozzle which is used to mix the two parts of the foam mixture together, and then the foam is injected through valve 110 into the center wall sections. The gun 122 may be attached to a timer to control the amount of foam injected into one of

the fill valves. The proper amount of foam is injected to avoid air or gas voids from forming or being trapped in the foam chambers. For cold environments, a heating element may be attached to the gun 122 to heat the foam material before it is injected into the foam chamber. Accordingly, fill valves are preferably placed about every two or three feet or any suitable spacing to ensure the proper amount of foam is injected in each section of the foam chambers to avoid overfilling or over pressurizing. The foam cures fairly quickly, to allow the user to erect the structure quickly, but the nozzle can only be used once if the foam cures in the nozzle and then is discarded.

[0054] The foam to be injected is preferably a fast curing or acting foam which assumes the shape of the chamber within about 30 seconds. Nonetheless, the chemistry can be changed or modified to speed up or slow down the curing time. The foam, which can preferably be a closed cell, two-part polyurethane foam which is fast-curing, is fire-resistant, and has a high expansion rate. However, the foam is not limited to these properties.

[0055] The two-part polyurethane foam (PU) mixture (called an A-B or 2K foam mixture) has a first part and a second part which when mixed together react and produce CO₂ which in turn produces foam bubbles. The goal is to mix the foam and inject it completely into the foam chamber to fill every corner and void. An example of foam 130 which is not uniform and has gas voids or "bubbles" 132 is shown in FIG. 26. An object of the disclosure is to avoid producing foam with such air or gas voids. A propellant is used to quickly mix and move the PU foam from compressed storage canisters but not limited to same. The restriction of foam expanding due to space constraints helps limit the forming of air or gas voids. The chambers help control expansion of the foam. The foam contacts a baffle and expands in a certain direction.

[0056] An example of uniform foam 134 provided by the disclosure under compression which has very little or minimal air voids as shown in FIG. 27. The foam is very dense (such as 25 to 1 density), uniform, and can withhold high compression loads. The foam is used to "inflate" the structure and can also help provide a structure for use in construction applications where concrete is poured in, around or over the structure or in any combination. The foam can also be used to form features of the structure, such as a toilets, sinks, beds, tables, or other desired features.

[0057] The foam does not have to be limited to PU foam. Semi-soft foam, such as a sponge foam can be used. Other types of foam (such as used with Kaocrete®, which is a refractory concrete mix) can also be used. For example, the foam can be environmentally safe, or "green," and can even have soybean as part of its chemical composition. The foam can also be polyurethane foam, which is fire resistant and expands under pressure and produces carbon dioxide which makes the foam self-inflating. Nonetheless, other mixes, such as regular concrete or other materials can also be used.

[0058] Referring now to FIGS. 28-31, a flexible fill valve

140 with extension foam tubes 142, 144, 145 or a substantially "t-shaped" valve is shown. This valve allows a nozzle to spray in different directions such as along a longitudinal or transverse axis when it is inserted into the valve to uniformly fill the chambers with foam. The valve has a fill valve slot 146, a flexible lip seal 148 and a bonding flange lip 150. The extension foam tubes 142, 144 extend away from each other in opposite directions but not limited to same. Extension tube 145 extends perpendicular to tubes 142, 144 but not limited to same.

[0059] The foam filling gun's nozzle will be inserted into and past the fill valve slot 146 in FIG. 28. The diameter, length or shape of foam extension tubes can vary to change the amount or direction of flow of foam from the foam gun. As the foam is injected, each corner of the foam chamber is filled to avoid or minimize air or gas gaps or voids. The gun is inserted into the fill valve, and the PU tank pressure propels the foam to fill up the chamber's space through each of the extension tubes 142, 144, 145. The foam expands quickly within about 30 seconds. The valve lip seals ensure the foam does not leak out when foam is being dispensed into the chambers. The valves also provide relief for overpressure of gas or foam from the bottom of the structure upwardly.

[0060] Referring to FIG. 28, a static mixer or auger 160 can be placed within the valve assembly so that the foam mixture can be mixed within the valve immediately after leaving the gun nozzle. A similar auger assembly can be placed within valve 110 of FIG. 21. The auger mixes the two foam chemical components, A and B, where B acts as a catalyst, which cures or hardens in about 30 seconds. The auger has a corkscrew configuration and can mix the chemicals in opposite directions.

[0061] The one-part PU foam is sprayed into a gap in the foam chamber and reacts to moisture of the air slowly and expands and hardens. Two-part PU foam uses a catalyst to speed up the expanding and hardening process to about 30 seconds. The auger mixes the two parts using a corkscrew configuration and spins in opposite directions. By placing the auger in the valve assembly, the gun nozzle does not have to be replaced, since the mixing does not occur in the nozzle. In a dry environment, such as a desert, water can be mixed with the PU to control the curing process. In a cold environment, heat and/or water can be added to the PU to cause different reaction speeds.

[0062] If a fill material needs to be de-gassed, such as PU foam for example, additional micro-sized holes can be added on the inside or inboard side of the fill containment structures (that is in the interior of the frame assembly) wherein the holes are small enough to let gas escape but not the actual foam or fill material itself.

[0063] Another option is to form fill containment structures from fine woven cloth or non-porous plastic which is perforated to allow gas to exit or escape while the fill material such as PU foam does not escape. A central tube in the fill containment structure such as central tube 84 in FIGS. 12-14 can have small pinholes added or the

tube can be made semi-porous or porous enough to allow the gas to escape through the holes, but not the PU foam or fill media. Yet another option is to add twine or cloth woven into the PU foam or fill media whereby the gas escapes along the strands of fiber in the foam or fill media, such as in a wicking fashion.

[0064] Referring now to FIGS. 32-34, several structure frame assemblies can be attached or connected together in a modular fashion. A fabric such as plastic or a tarp can be used to span the distance between adjacent frames and is secured by the flexible sealing joint. FIG. 32 shows a first support frame member 160 from a first shelter and a second support frame member 170 from a second shelter.

[0065] A flexible sealing and joining flashing or flap 180 with a sealing lip 181 is connected to the first support member 160 and extends across both support frame members 160, 170 and is secured in place on the second support frame member 170 using mating Velcro® pads or strips 182, 184 formed on the flap and the second support member, respectively, as shown in FIGS. 33 and 34. The joining flaps can cover the complete wall to keep unwanted water out, etc.

[0066] Referring now to FIG. 35, the flaps 180 are shown as being used in several locations on adjacent support frame members 186, 188 of two adjacent frame assemblies 190, 200 which are connected in a modular fashion. However, any number of flaps and flap lengths may be used to secure the frames together. The flaps can also be used for attaching center wall sections to the frame structure. Referring to FIG. 36, the flaps 180 may extend across a substantial portion of each tube 186, 188 to provide additional rigidity as well as provide a seal between adjacent tubes of adjacent structures.

[0067] FIG. 37 shows a tarp or cover 202 which is secured to the top tubes of the frame via Velcro® strips 204 or any other suitable fastening means. The cover provides a shield for the interior of the structure and also seals the structure from water entering the structure from above. Referring to FIG. 38, a tarp or cover 210 can be secured to the roof of the structure via cables 212 and stakes 214 which are secured to the ground. Also, stakes 214 and cables 212 can be used to secure the structure frame itself to the ground.

[0068] Referring to FIGS. 35-37, various panels illustrated in FIGS. 6-20 are shown as forming portions of the roof section or side wall or end wall sections. For example, in FIG. 35 the roof panel is shown to be formed by panel 100 of FIG. 18. The entire roof as well as the side and end walls can also be formed by panels 100, or any combination or orientation of panels from FIGS. 6-20 can be used depending on the desired purpose.

[0069] Referring to FIG. 36, a side wall is shown to contain panel 60 from FIG. 6, and an end wall is formed by panel 70 of FIG. 9. Again, any combination of these panels, or any panels from FIGS. 6-20 can be used on any frame assembly in any orientation. Referring to FIG. 37, a panel 80 from FIG. 12 is shown forming part of a

side wall. Panels 80 can be used on the entire frame. As mentioned earlier, any combination of panels from FIGS. 6-20 can be used on any frame assembly and in any orientation.

[0070] Typically, the structure tubes or center wall sections are filled from the bottom up. Air or gas, is filled into the structure's tubes 12 to form the shape of the structures. Then foam or other material is added from the bottom up. If there is too much pressure, the valve slit opens and pressure is relieved through the valve. The valves and/or internal baffling help ensure the right amount of PU foam is held in the structure.

[0071] The structure itself when deflated can be rolled up and stored in a packing container similar to the way a tent is stored. If for whatever reason, additional PU or other foam cannot be added to the structure, such as for cost savings, etc., cable straps or other forms of reinforcement can be used to increase the structural strength and minimize the fill media needed. Straps can be placed in place of horizontal or the arched tubes or any other location. Other materials such as steel, cloth or twine, can be integrated with the walls at various orientations. Fiber can be added to the PU foam for greater rigidity and strength. Other materials can be used to increase the rigidity and strength as well.

[0072] A strapping means can be used in conjunction with the structure to secure the structure to the ground or to secure a covering over the structure. For example, eyelets can be added at the bottom of the walls to allow a rope or cable to secure the structure against high winds, gusts, rain, etc. Eyelets can also be placed flush to the ground so stakes can be used adjacent the tubes or walls. Tubes also can have holes for staking directly into the ground.

[0073] Referring to FIGS. 39-43, an alternate preferred embodiment of the disclosure is shown. A shelter frame assembly 300 is formed by a roof assembly 302, columns 306 and a plurality of walls 308 removably connected to the roof and columns.

[0074] The roof assembly includes fillable support members 304 which can be filled with foam, water or any suitable material as previously discussed herein. The roof is installed onto four columns or corner posts 306 by inserting the posts 306 into coupling or connecting members 324 as shown in FIG. 41. Connecting members 324 can be formed of cloth or other material and extend over an upper portion of a column in a covering or sock-like fashion.

[0075] Once the roof is installed on the columns, walls 308 are installed between adjacent columns as seen in FIGS. 39-43. Walls 308 are formed by a plurality of fillable support members 310 which are filled with foam or water or any suitable material as discussed above. Panels 312 such as made of cloth or any other suitable material are installed between support members 310. Windows 314 and doors 316 can be formed between support members 310 as seen in FIG. 39. The walls can be interchangeable and are replaceable as needed.

[0076] Referring now to FIG. 40, flaps 320 made of cloth or other suitable material are folded over the corners of the structure and over the columns 306. The flaps can be covered with Velcro® or hook and loop straps or any other suitable fastening means which securely fasten to corresponding strip 321 on the columns. Further, a coupling member 326 can be formed on a floor panel 328 made of cloth or other suitable material as seen in FIG. 42 which matingly receives a lower portion of the columns.

[0077] Straps 330 such as Velcro® straps or any other suitable fastening means such as clips, hooks, buttons, etc. can be attached to support members 310 and/or columns 306 to removably secure the support members 310 and columns 306 together. Flaps 322 are also secured to the roof structure and overlap the support members 304, 310 and columns 306. Straps 340 such as Velcro® straps or any other suitable fastening means can be attached to support members 310 to removably secure the plurality of walls 308 to the roof assembly.

[0078] Referring now to FIG. 44, a frame support assembly 400 is shown in accordance with another aspect of the disclosure. Support assembly 400 is formed by support members 402 which are hollow and are integrally formed, along with roof support members 404. The assembly can be folded up into a compact shape or configuration where each side wall 406 is collapsed or folded on each other. The folded up configuration can be square shaped, or the support members can be rolled on top of each other. To use the assembly, the assembly is either unfolded or unrolled into the configuration shown in FIG. 44. Then, either air, water or foam is pumped into the structure to inflate each support member. The structure is then positioned into the configuration shown such as in FIG. 35 or 39. Thus, the structure is a one-piece assembly in which the foam is injected to inflate the structure into the use or final configuration such as shown in FIGS. 35 and 39.

[0079] Referring now to FIGS. 45 and 45A, baffles in support members 500 can be in the form of a fine mesh material 502. The mesh is made of a fine weave such that it allows the foam to push against it while retaining the foam in place and allowing gas to escape. For example, the fine mesh can be made of nylon such as used in fabricating tents. Only two fill ports 504 are needed, one on each side of the baffle which is preferably centrally positioned can control movement and injection of the foam on either side of the baffle but not limited to same.

[0080] The support member can preferably be made from a long tube which is sealed at each end and has a baffle formed in the middle for controlling filling of each side. The filling can occur in two opposite directions simultaneously but not limited to same.

[0081] FIG. 46 illustrates a roof support member 600 which has support members 602 filled with foam 604. Instead of foam in the bottom support members, a strap 606 can be used instead.

[0082] FIG. 47 is a perspective view of an alternative

embodiment of an interchangeable and inflated panel 700 with a flange 720 extending outwardly therefrom. Panel 700 is preferably comprised of an interior surface 702, an exterior surface 704, opposing top and bottom surfaces 706, 708, and opposing side surfaces 710 that form a void or opening 712 therebetween for receipt of air or other gas (not shown) to inflate said panel 700, as explained more fully below.

[0083] In accordance with an important aspect of the present invention, the interior and exterior surfaces 702, 704 are further connected to one another by a plurality of filaments or fibers 714 that span the void 712 and that are placed in tension when panel 700 is inflated, thereby providing added strength and support to the inflated panel 700. More specifically, increased working gas pressures will keep panel 700 substantially flat or planar, which also increases the stiffness of panel 700 and avoids the generally bulbous nature of prior art inflated panels or structures. It is also contemplated that the plurality of filament or fibers 714 could also be used to connect opposing top and bottom surfaces 706, 708 and/or opposing side surfaces 710. FIG. 48 is a perspective cross-sectional view of panel 700 of FIG. 47 at cut line A-A, and illustrates the plurality of fibers 714 that span the void 712 and connect the interior and exterior surfaces 702, 704 of panel 700.

[0084] Each panel 700 may further comprise a Velcro® strip 730, or any other suitable fastening means such as glue, stitching, or welding or a combination thereof positioned on the exterior and/or interior surfaces 704, 702 for removably fastening panel 700 to flange 720, another panel 700, a column or other structural members, as described more fully below. More specifically, FIG. 47 illustrates elongated Velcro® strips 730 positioned along the edges of exterior surfaces 704 and internal surfaces 702 of panel 700.

[0085] Each panel 700 may further comprise at least one port 716 positioned, for example, on the exterior or interior surfaces 704, 702, to permit panel 700 to be inflated, deflated and/or to act as a pressure relief valve. Panels 700 are preferably inflated with compressed air, but it is contemplated that other materials, liquids or gases could also be used without affecting the overall concept of the present invention. It is further contemplated that port 716 can be positioned virtually anywhere along panel 700.

[0086] Further, when panel 700 is inflated, the presence of the plurality of fibers 714 in tension between interior and exterior surfaces 702, 704 of panel 700 cause panel 700 to remain generally flat or planar, thereby eliminating the disadvantages typically associated with curved inflated walls, such as wasted interior floor space, the inability to use interior walls as hanging surfaces, etc. Inflated panel 700, and the similarly constructed structural members described more fully below, all have superior waterproofing and insulating properties.

[0087] Panel 700 may be constructed of many different types of materials such as fabric reinforced high density

polyethylene, polyvinyl chloride (PVC), plastic or any other suitable material types such as those used in children's bouncing jumpers. The material can be thin sheets such as 30 oz./yd² to 80 oz./yd² fabric weight, or any suitable thickness or shape. It is also contemplated that if the resulting structure is intended to be used for a long-term application (e.g., longer than 1 year) and/or in harsher environments, such as in hot desert or cold winter conditions, then a longer lasting material such as vinyl-coated polyester or nylon cloth (such as complex drop stitch base fabric) or any other suitable material can be used.

[0088] As best shown in FIGS. 47 and 48, flange 720 is a generally planar elongated member further comprised of an inboard surface 722 and an outboard surface 724. Flange 720 may be permanently attached to panel 700, but is preferably removably attached to panel 700 via Velcro® strips 730, or any other suitable fastening means such as glue, stitching, etc., to provide more flexibility to the user in shipping, assembling and/or storing the temporary structure of the present invention. More specifically, and as shown in FIG. 47, Velcro® strips 730 may be positioned along the inboard surface 722 of flange 720 for mating engagement with the Velcro® strips 730 positioned along the edges of panel 700 or other structural members such as columns, trusses, beams, cross members and the like, as described more fully below. In this manner, panels 700 may be connected to flanges 720 which, in turn, may be connected to other panels or other structural components or members, as explained more fully below.

[0089] As best shown in FIGS. 49 and 50, supports or columns 740 may also be constructed in a similar fashion to panels 700, and used to construct an overall temporary structure. More specifically, columns 740 may be comprised of an interior surface 742, an exterior surface 744, opposing top and bottom surfaces 746, 748, and opposing side surfaces 749 that form a void or opening 750 therebetween for receipt of air or other gas (not shown) to inflate said column 740, as explained more fully below. Nonetheless, it is also contemplated that columns 740 could be non-inflatable and/or a telescoping or otherwise expandable column.

[0090] In accordance with an important aspect of the present invention, the interior and exterior surfaces 742, 744 are further connected to one another by a plurality of filaments or fibers 714 that span the void 750 and that are placed in tension when column 740 is inflated, thereby providing added strength and support to the inflated column. It is also contemplated that the plurality of filament or fibers 714 could also be used to connect opposing top and bottom surfaces 746, 748 and/or opposing side surfaces 749.

[0091] Similar to panels 700, each column 740 may further comprise a Velcro® strip 730, or any other suitable fastening means such as glue, stitching, or welding or a combination thereof positioned on the exterior and/or interior surfaces 744, 742 for removably fastening column 740 to flange 720, a panel 700, or other structural mem-

bers, as described more fully below. More specifically, FIG. 49 illustrates elongated Velcro® strips 730 positioned along column 740.

[0092] Each column 740 may further comprise a port 716 positioned, for example, on the exterior or interior surfaces 742, 744 or opposing side surfaces 749, to permit column 740 to be inflated, deflated, and/or to serve as a pressure relief valve. Columns 740 are preferably inflated with compressed air, but it is contemplated that other materials, liquids or gasses could also be used without affecting the overall concept of the present invention. It is further contemplated that port 716 can be positioned virtually anywhere along column 740.

[0093] Further, when column 740 is inflated, the presence of the plurality of fibers 714 in tension between interior and exterior surfaces 742, 744 of column 740 cause column 740 to remain generally flat or planar, thereby eliminating the disadvantages typically associated with curved inflated support members and walls, such as wasted interior floor space, less uniform contact and mounting surfaces and the inability to use interior walls as hanging surfaces, etc.

[0094] Similar to panel 700, column 740 may be constructed of many different types of materials such as fabric reinforced high density polyethylene, polyvinyl chloride (PVC), plastic or any other suitable material types such as those used in children's bouncing jumpers. The material can be thin sheets such as 30 oz./yd² to 80 oz./yd² fabric weight, or any suitable thickness or shape. It is also contemplated that if the resulting structure is intended to be used for a long-term application (e.g., longer than 1 year) and/or in harsher environments, such as in hot desert or cold winter conditions, then a longer lasting material such as vinyl-coated polyester or nylon cloth (such as complex drop stitch base fabric) or any other suitable material can be used.

[0095] As with inflated panels 700 and columns 740, other structural members, such as trusses 760, beams or cross members 770, etc., can be constructed in a similar fashion. For example, trusses 760 and beams 770 could also be comprised of an inflatable member having a port 716 in fluid communication with an interior void, similar to void 712 in panel 700 or opening 750 in column 740, wherein a plurality of fibers or filaments 714 are placed in tension and span from one side of the structural member to the opposing side when the member is inflated. Further, trusses 760 and beams 770 may further comprise a Velcro® strip 730, or any other suitable fastening means such as glue, stitching, or welding or a combination thereof positioned on their exterior and/or interior surfaces for removably fastening trusses 760 and/or beams 770 to other structural members such as panels 700, flanges 720, columns 740, etc. Examples of trusses 760 and beams 770 are illustrated in the FIGS referenced below.

[0096] As an important feature of the present invention, one or more interchangeable panels 700, flanges 720, columns 740, trusses 760 and/or beams 770 can be com-

bined to construct a temporary inflatable structure 800. FIG. 51 is a perspective view of one possible embodiment of structure 800, which is comprised of a plurality of interchangeable and inflated panels 700, flanges 720, columns 740, trusses 760, windows 780, a roof 802, flaps 803, a floor 804 and a vestibule 806. Each of roof 802, floor 804 and vestibule 806 may be comprised of one or more interconnected panels 700, flanges 720, columns 740, trusses 760 and/or beams 770.

[0097] For example, and while not specifically depicted in FIG. 51, structure 800 may further comprise a floor 804 constructed of interconnected panels 700, flanges 720 and columns 740, thereby encapsulating the interior of the structure from the cold and/or moisture typically associated with an earthen floor. Further, due to the general flat, hard exterior surfaces created by the tensioned fibers 714 within said panels 700, flanges 720 and columns 740, the floor is relatively sturdy and safe to traverse. FIG. 52 is a bottom perspective view of the structure 800 of FIG. 52, also without a floor portion. Alternatively, floor 804 can be a non-inflatable structure.

[0098] Similarly and as best shown in FIGS. 51 and 52, the roof 802 of structure 800 may be comprised of a single panel 700, or may be constructed of a plurality of panels 700 and/or columns 740 interconnected by one or more flanges 720 and supported by one or more trusses 760 and/or beams 770. Further, the edges of roof 802 may further comprise flaps or drip edges 803 to direct rain, snow and other elements away from the side panels 700 of structure 800, as best shown in FIG. 51, and to seal the gaps from the elements when outside structures 800 are combined at the peak or roof ridge and at the side pitched outer roof truss panel 760, as best shown in FIG. 56. As shown in FIG. 58, flaps 803 may be also useful in other locations along structure 800, for example on or over the exterior or interior corners to form a more weather resistant and secure barrier, and may be integrally formed with panel 700 or column 740, or may be removably attached to the same with Velcro® strip 730, or any other suitable fastening means such as glue, stitching, or welding or a combination thereof

[0099] As best shown in FIG. 51, vestibule 806 may also be comprised of a plurality of interchangeable panels 700, flanges 720 and/or columns 740 interconnected together by Velcro® strip 730, or any other suitable fastening means such as glue, stitching, or welding or a combination thereof. Vestibule 806 may further comprise a panel 700 with an opening 808 therein for easy ingress or egress. Opening 808 may be in the shape of a door, window 780, etc., and may be any shape, size and/or orientation necessary to suit user need or preference.

[0100] As best shown in FIG. 52, structure 800 may further comprise a panel 700 with an opening 808 therein for HVAC ductwork 810 and/or other utility conduit (not shown) in an effort to provide heat, air conditioning, electrical power, water, sewer and/or other utilities and amenities to the occupants of structure 800. FIG. 53 is a perspective exploded view of the structure of FIGS. 51 and

52. Alternatively, a removable flexible panel (not shown) can be used for the door, window, ductwork, etc.

[0101] FIG. 54 is a perspective view of structure 800, without vestibule 806, and FIG. 55 is a bottom perspective view of the structure 800 of FIG. 54 without a floor portion. FIG. 56 is a perspective view of an alternative embodiment of a complex 900 comprised of multiple interconnected structures 800. FIG. 57 is a bottom perspective view of yet another alternative embodiment of a complex 950 comprised of multiple interconnected structures 800. All structural components of structure 800 may be manufactured in any shape and/or size to suit user need and/or preference, and as illustrated in FIGS. 51-57, the possibilities are endless.

[0102] The inflatable structure of the present invention in its various embodiments is a secure, weather resistant and efficient structure that can be easily transported, inflated, assembled, disassembled and stored in a fraction of the time associated with the temporary structures of the prior art. The inflatable structure of the present invention in its various embodiments requires little if any tools to assembly and/or disassembly, is relatively lightweight and affords the user virtually endless design options as illustrated in the many FIGS. contained herein. The inflatable structure of the present invention in its various embodiments may also be used in conjunction with a strapping means to secure the structure to the ground or to secure a covering over the structure. For example, eyelets can be added at the bottom of the panels 700, flanges 720 and/or columns 740 to allow a rope or cable to secure the structure against high winds, gusts, rain, etc. Eyelets can also be placed flush to the ground so stakes can be used adjacent the panels 700, flanges 720 and/or columns 740. The panels 700, flanges 720 and/or columns 740 also can have holes for staking directly into the ground.

[0103] What has been described above includes examples of the claimed subject matter. It is, of course, not possible to describe every conceivable combination of components or methodologies for purposes of describing the claimed subject matter, but one of ordinary skill in the art may recognize that many further combinations and permutations of the claimed subject matter are possible. Accordingly, the claimed subject matter is intended to embrace all such alterations, modifications and variations that fall within the spirit and scope of the appended claims. Furthermore, to the extent that the term "includes" is used in either the detailed description or the claims, such term is intended to be inclusive in a manner similar to the term "comprising" as "comprising" is interpreted when employed as a transitional word in a claim.

Claims

1. An inflatable structural member comprising:
an exterior;

- an interior; and
a plurality of filaments extending between said exterior and interior.
2. The inflatable structural member of claim 1 further comprising a port and a flange attached to at least one of said exterior or interior. 5
 3. The inflatable structural member of claim 1 or 2 further comprising a length of hook and loop fasteners. 10
 4. The inflatable structural member of any preceding claim further comprising an airtight void, wherein said plurality of filaments are positioned within said airtight void and are in tension when the inflatable structural member is inflated. 15
 5. An inflatable shelter comprising:
 - at least one inflatable panel having a port; 20
 - at least one flange; and
 - at least one column, wherein said at least one inflatable panel further comprises an airtight void with a plurality of filaments positioned in said airtight void. 25
 6. The inflatable shelter of claim 5 further comprising at least one cross member.
 7. The inflatable shelter of claim 5 or 6, wherein the inflatable shelter is free-standing. 30
 8. The inflatable shelter of any of claims 5 to 7, wherein the at least one inflatable panel is connected to at least one of the following: (a) the at least one flange; (b) a roof; and (c) a cross member. 35
 9. The inflatable shelter of any of claims 5 to 8, wherein said plurality of filaments are in tension when the at least one inflatable panel is inflated. 40
 10. The inflatable shelter of any of claims 5 to 9 further comprising a vestibule.
 11. A complex comprising: 45
 - a first inflatable shelter having at least one inflatable panel, and at least one flange; and
 - a second inflatable shelter. 50
 12. The complex of claim 11 further comprising at least one column that is one of an inflatable column, a non-inflatable column and an expandable column.
 13. The complex of claim 11 or 12, wherein said at least one inflatable panel further comprises an airtight void with a plurality of filaments positioned in said airtight void. 55
 14. The complex of claim 13, wherein said plurality of filaments are in tension when the at least one inflatable panel is inflated.
 15. The complex of any of claims 11 to 14, wherein the at least one inflatable panel is connected to at least one of the following: (a) the at least one flange; (b) a roof; and (c) a cross member.

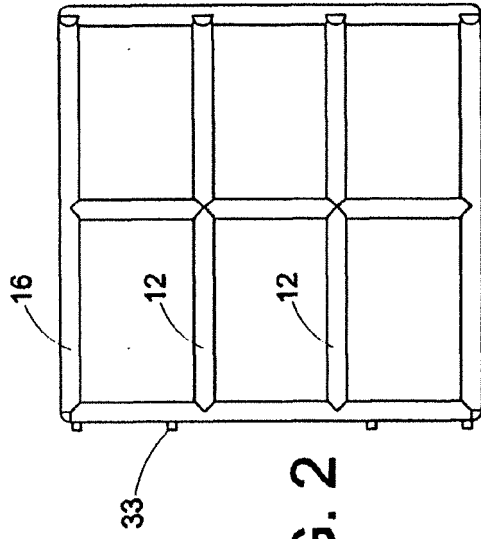


FIG. 2

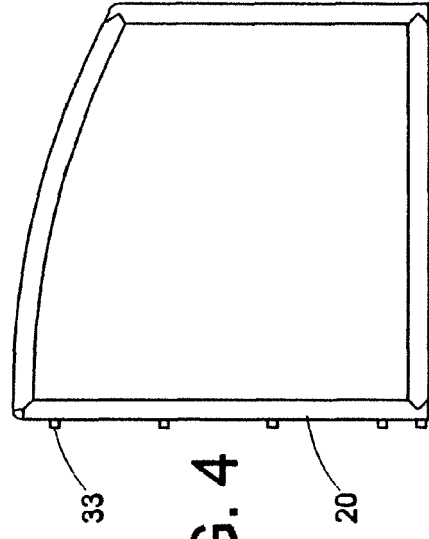


FIG. 4

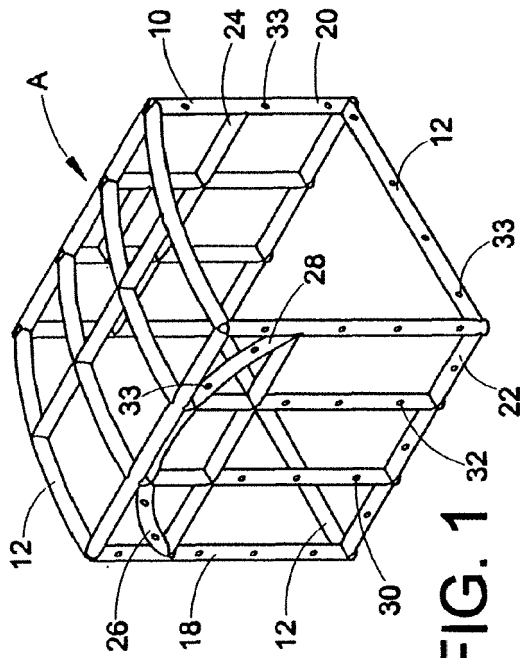


FIG. 1

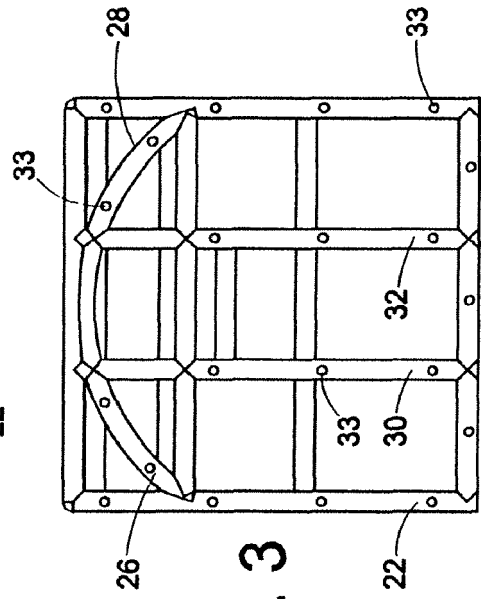
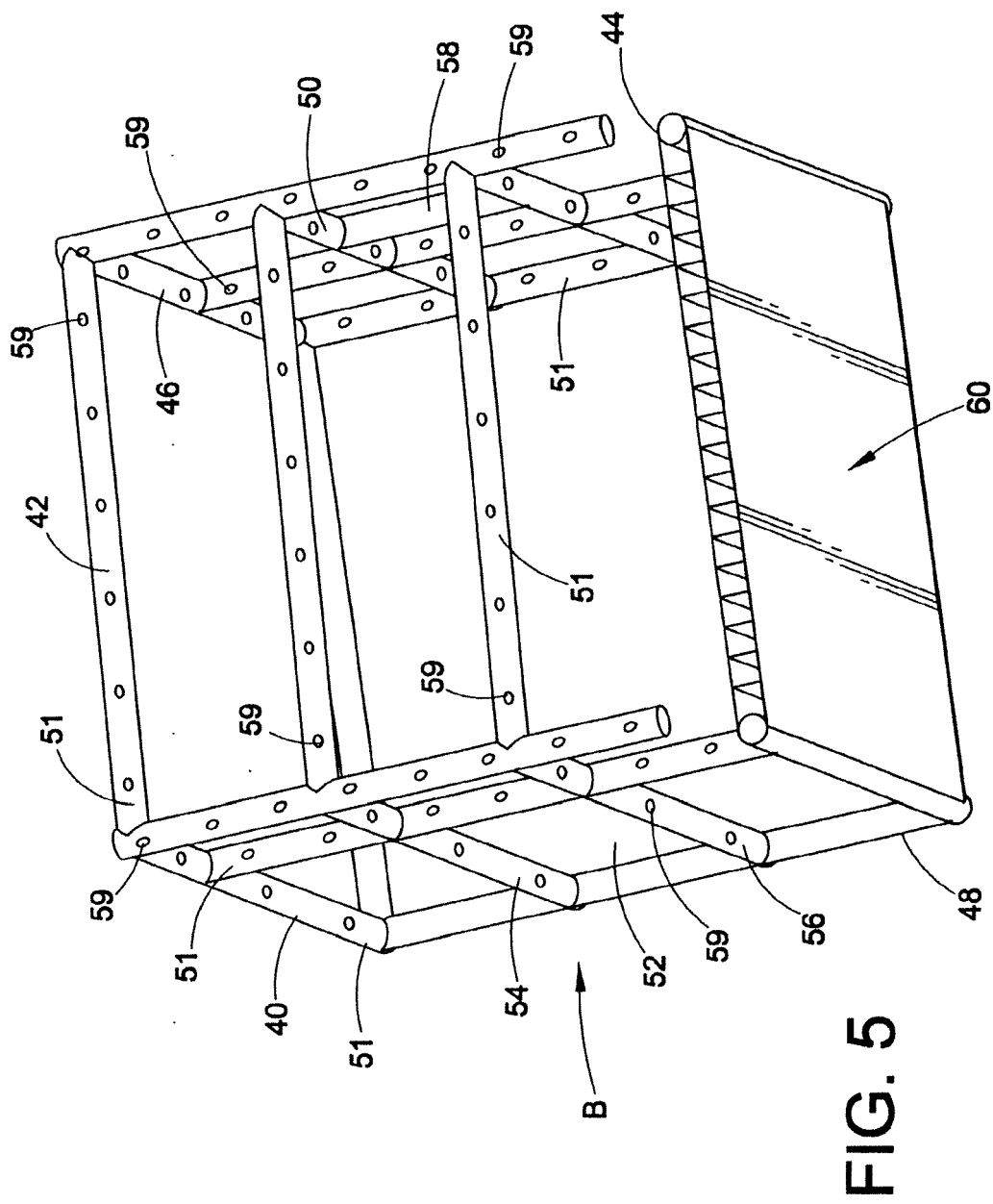


FIG. 3



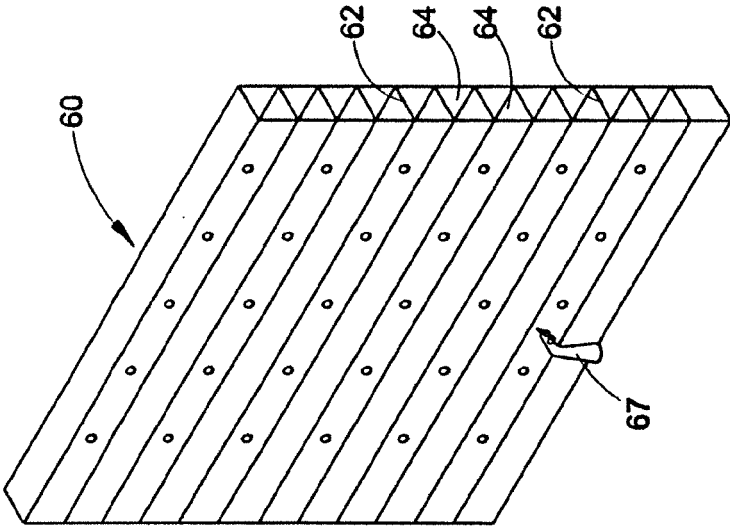


FIG. 6

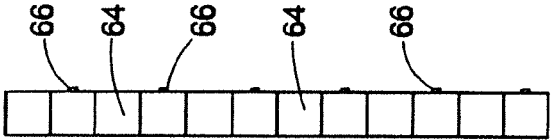


FIG. 8

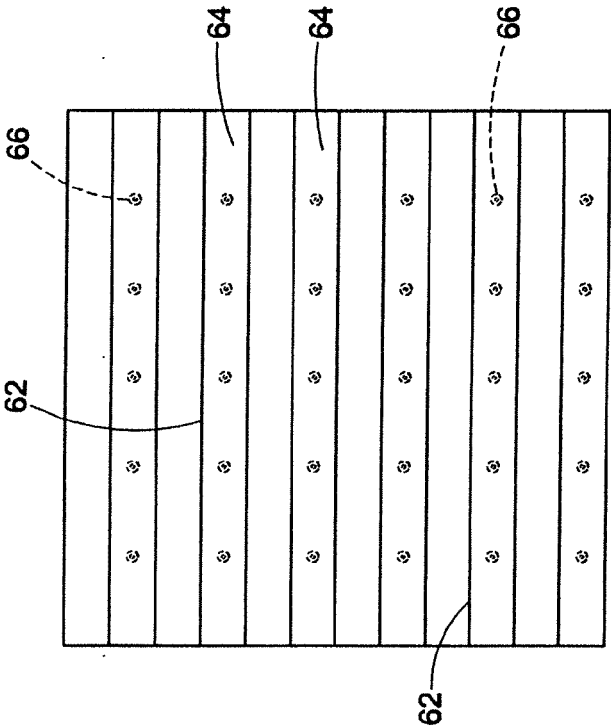
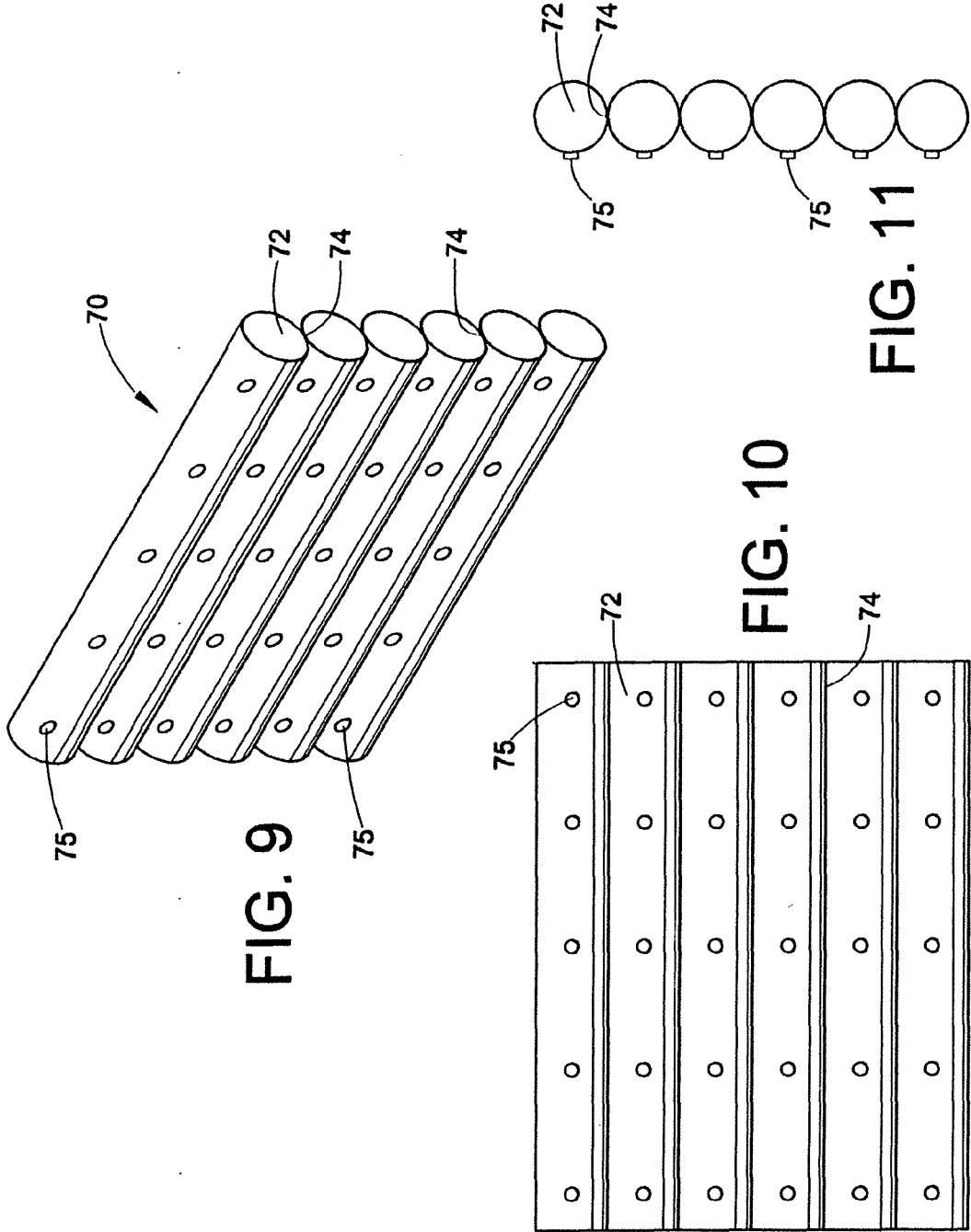
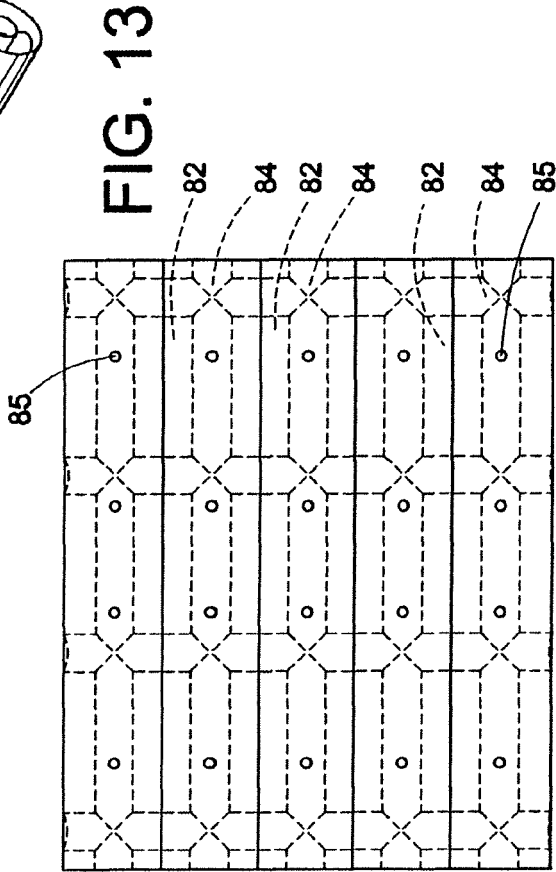
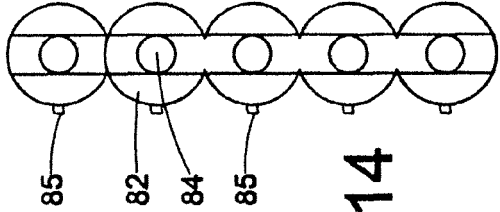
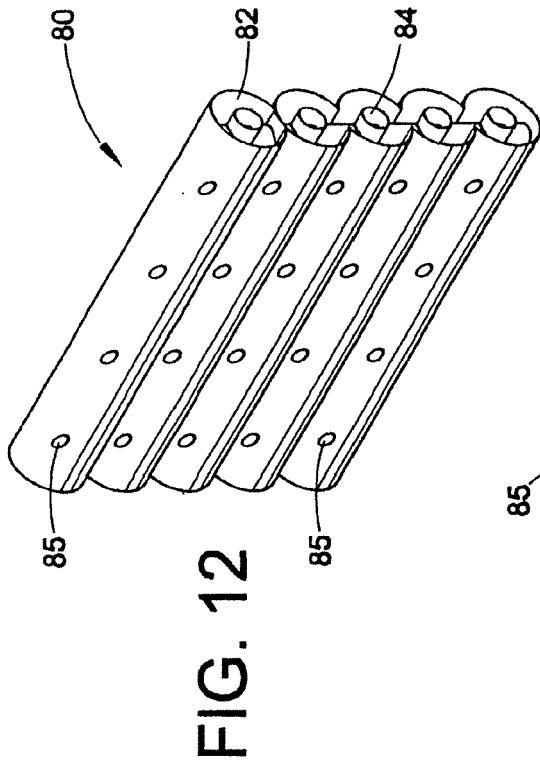
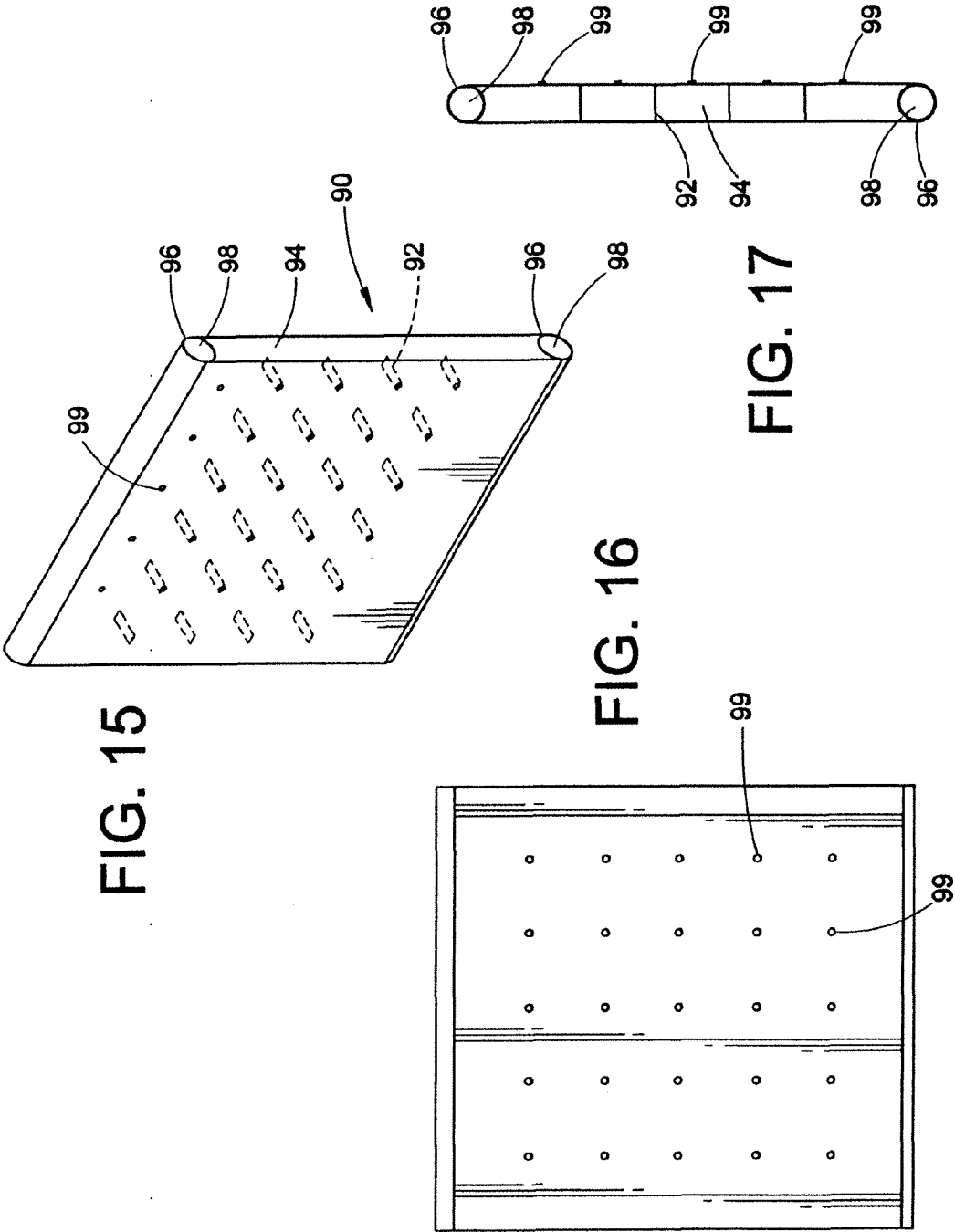


FIG. 7







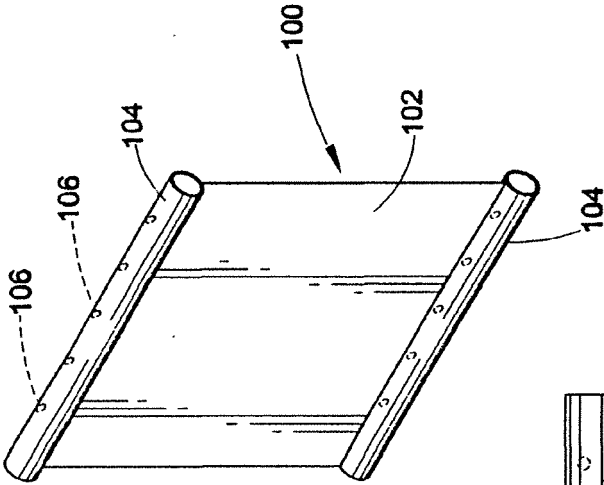


FIG. 18

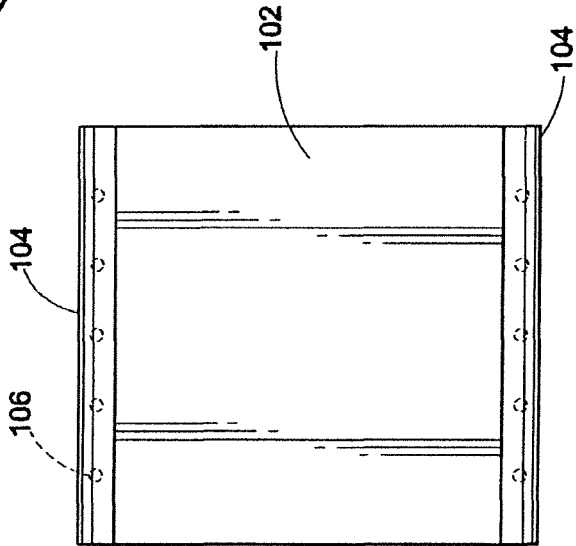


FIG. 19

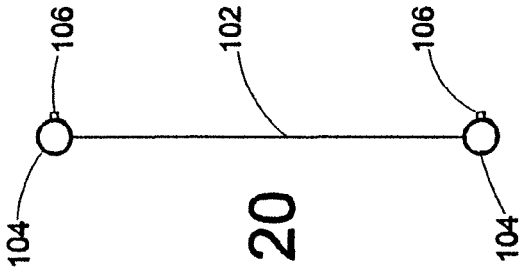


FIG. 20

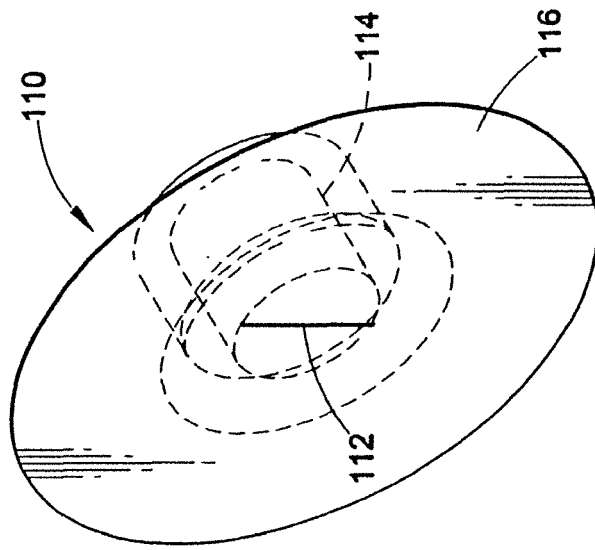


FIG. 21

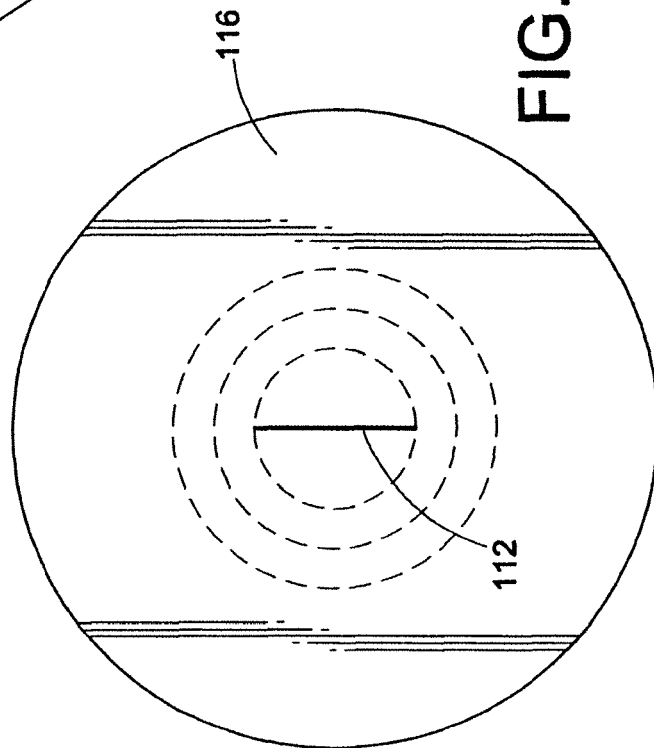


FIG. 22

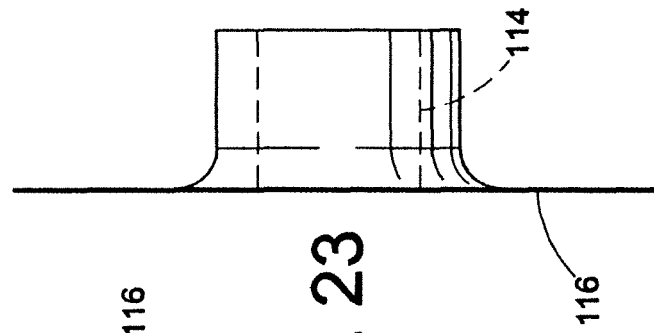


FIG. 23

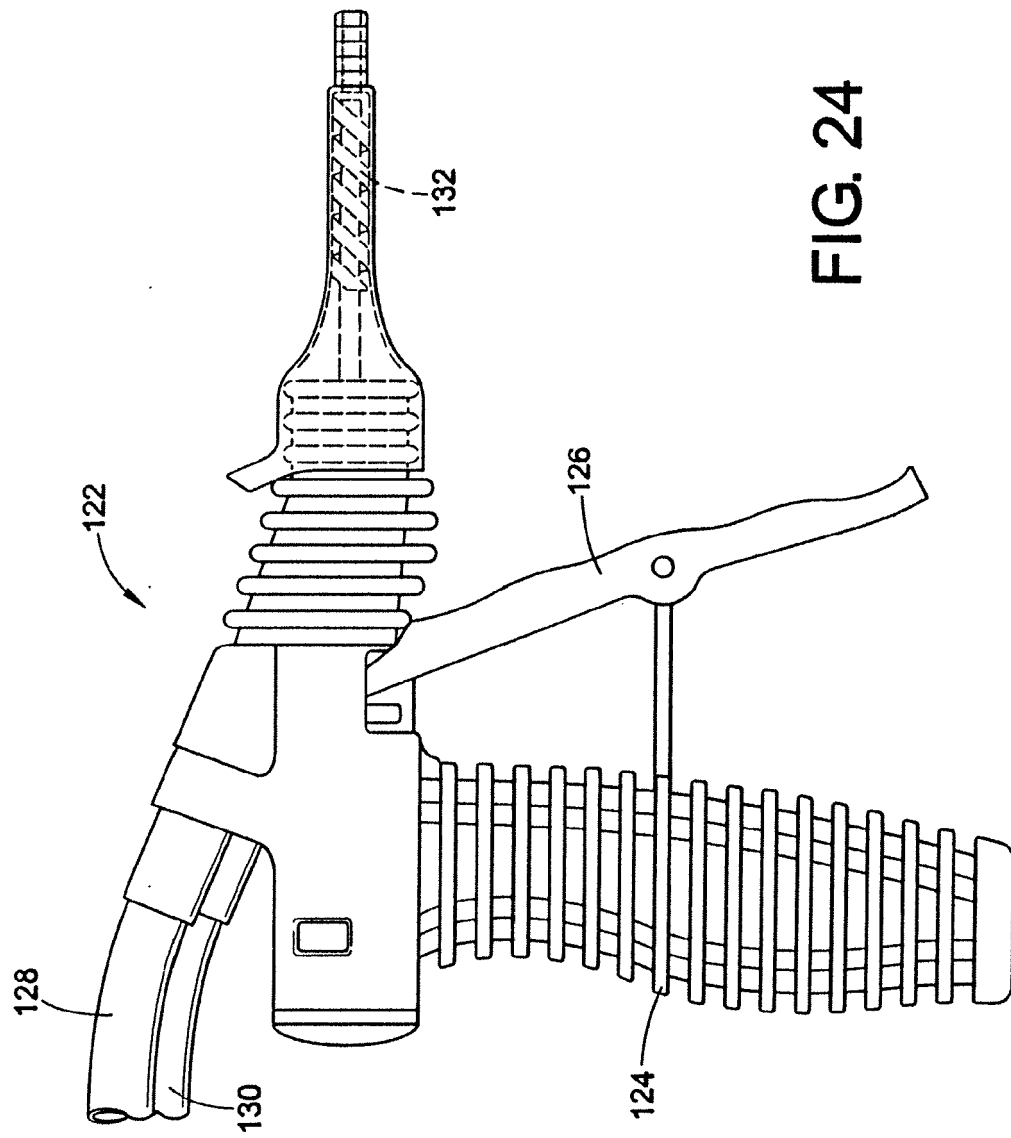


FIG. 24

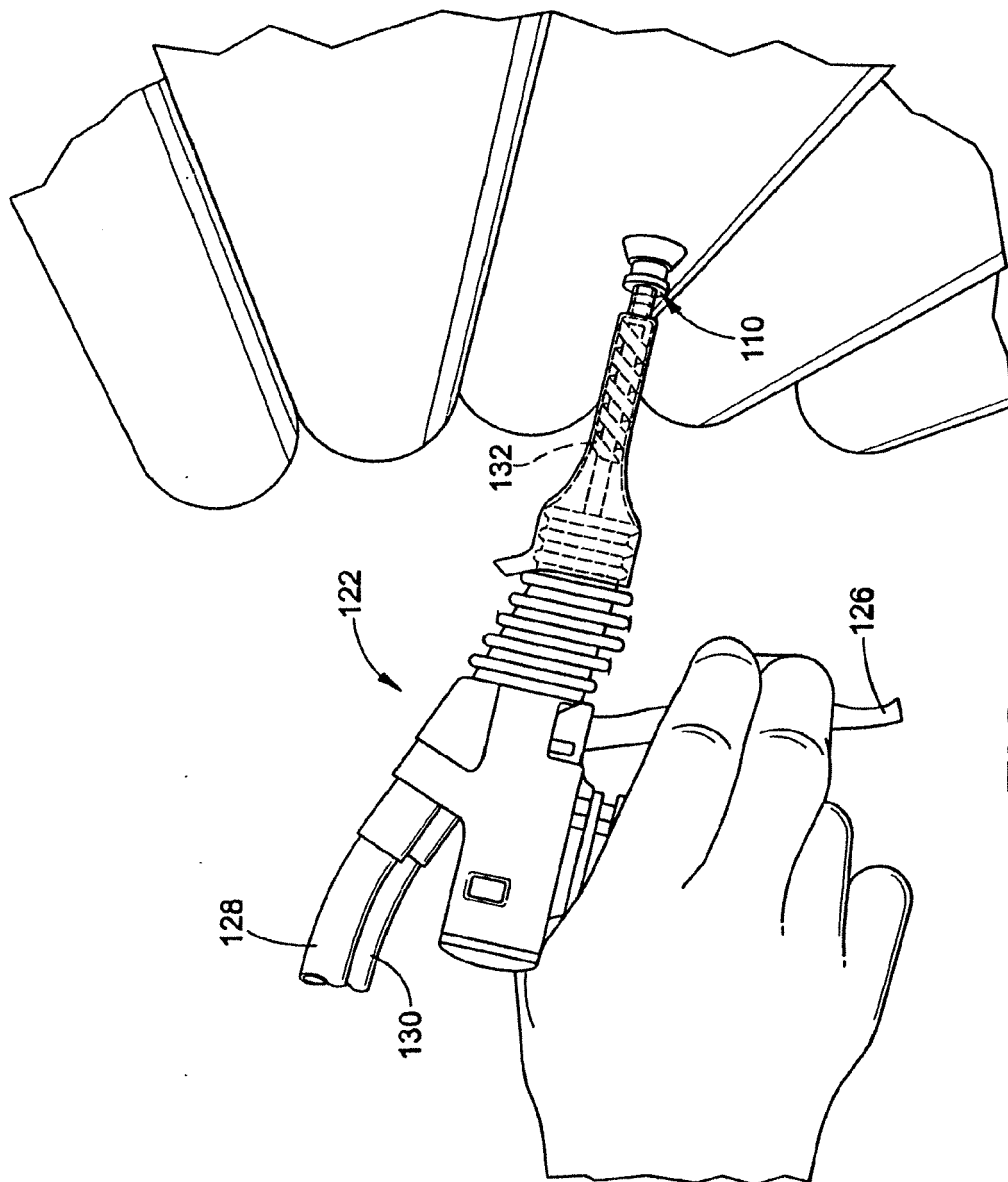


FIG. 25

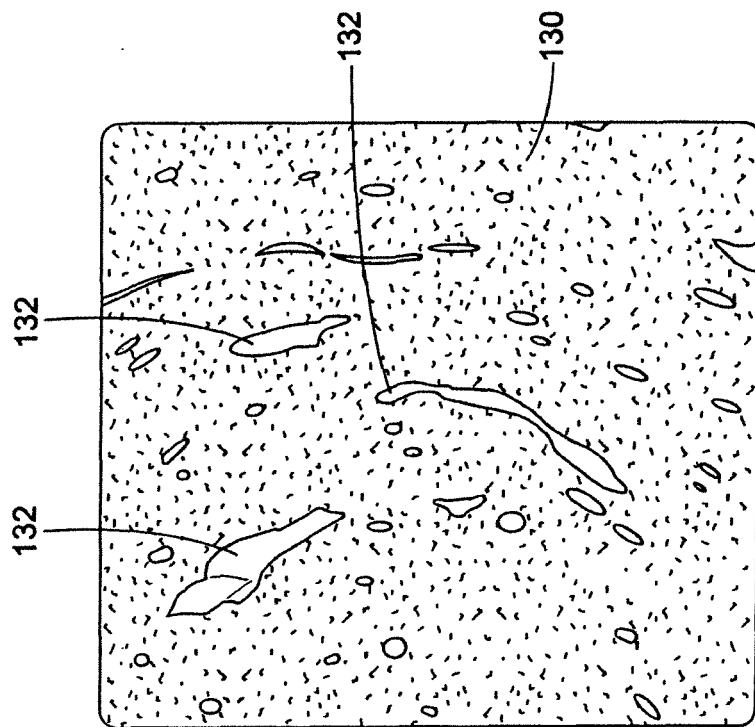


FIG. 26

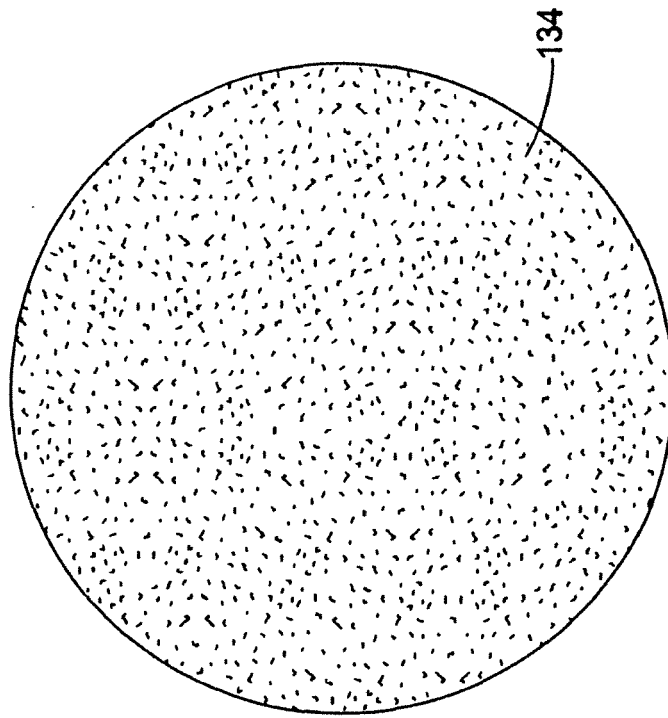


FIG. 27

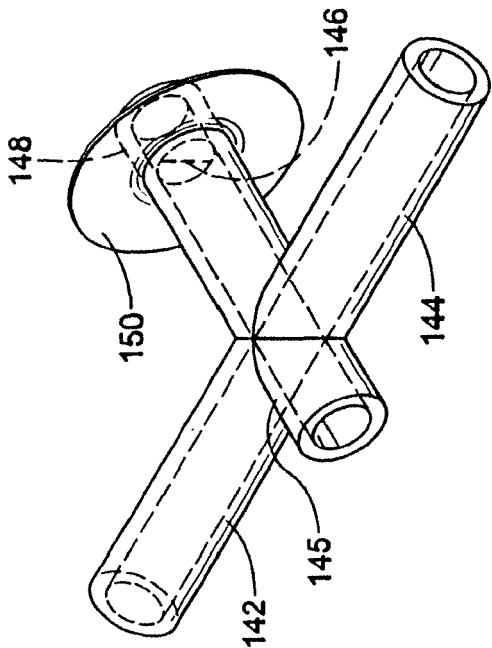


FIG. 29

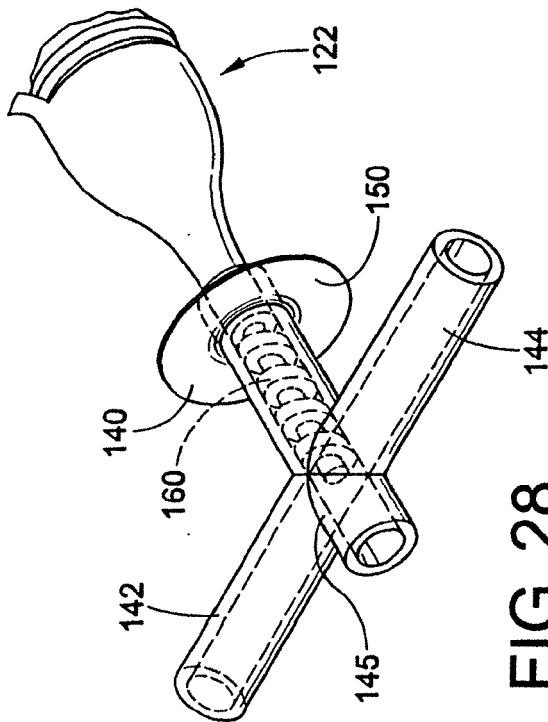


FIG. 28

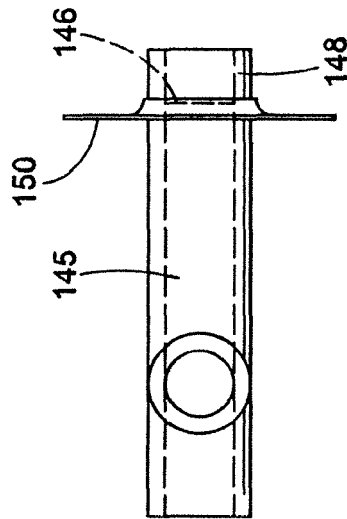


FIG. 31

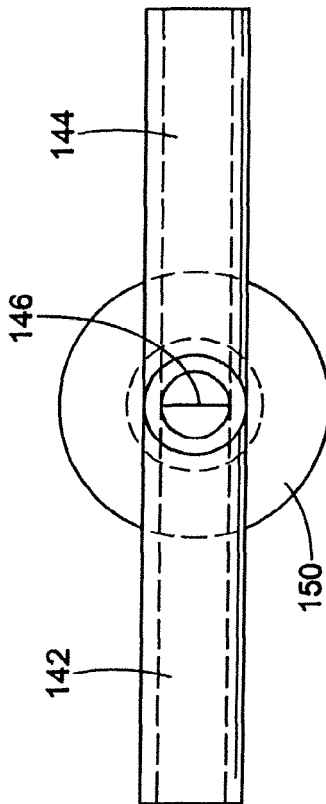


FIG. 30

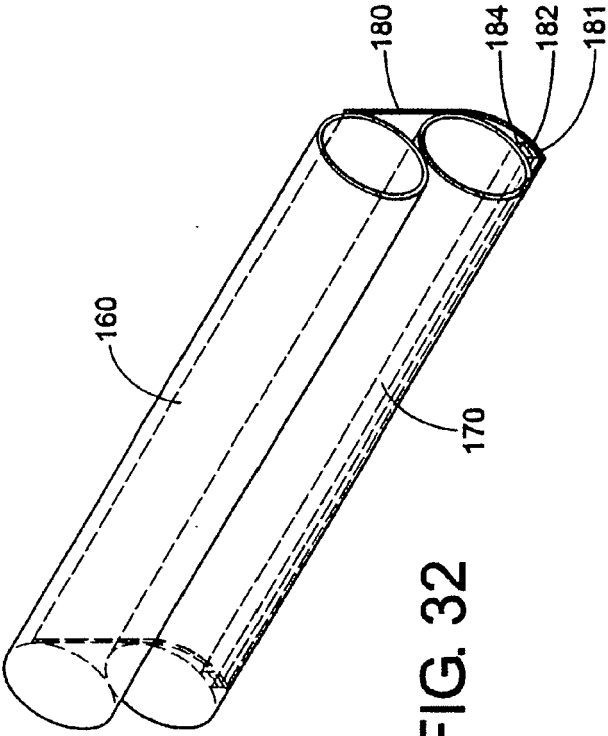


FIG. 32

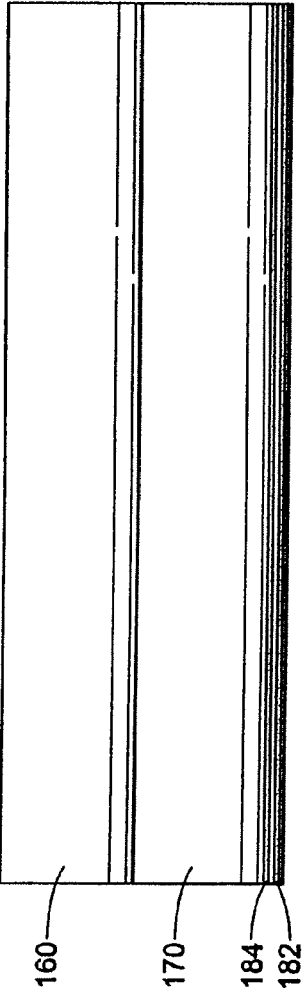


FIG. 33

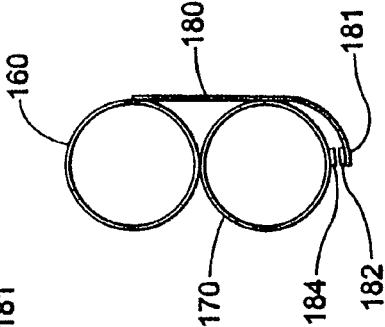


FIG. 34

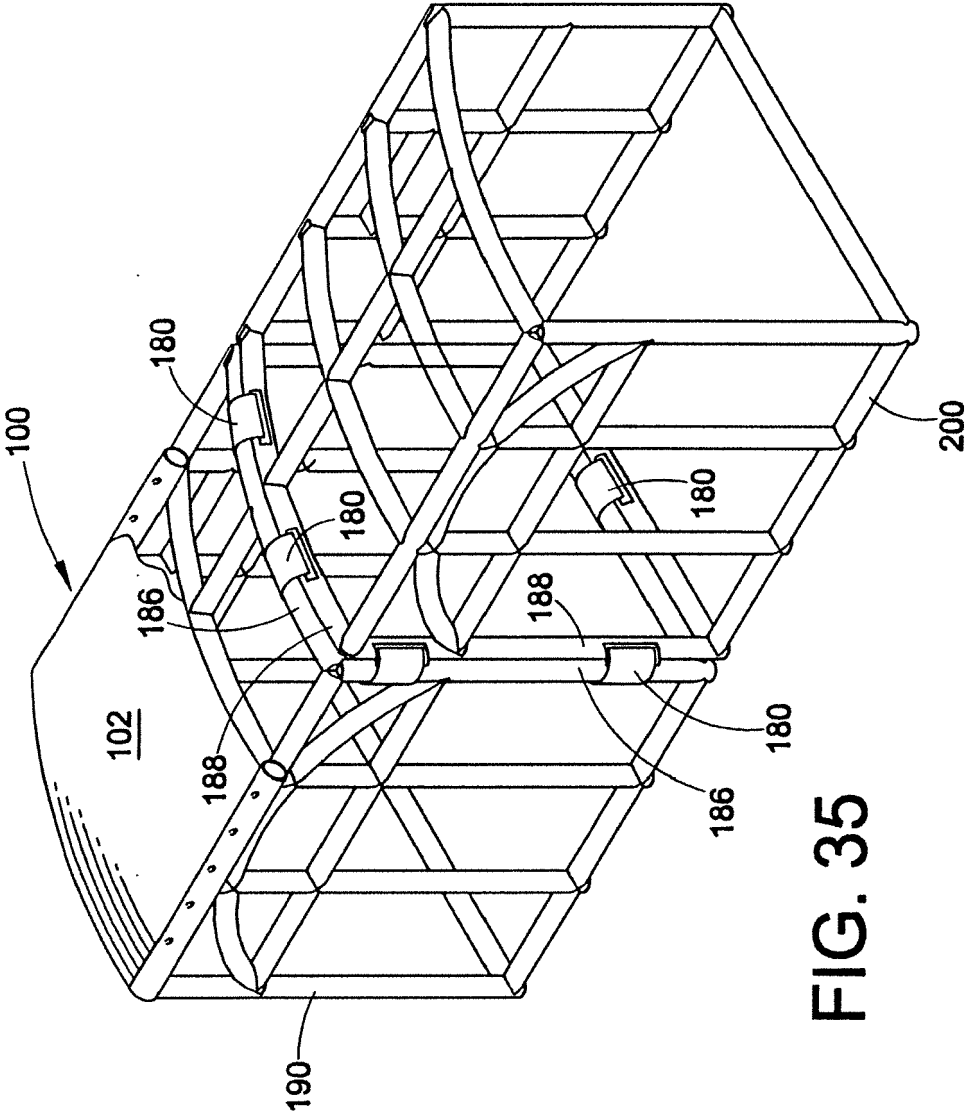


FIG. 35

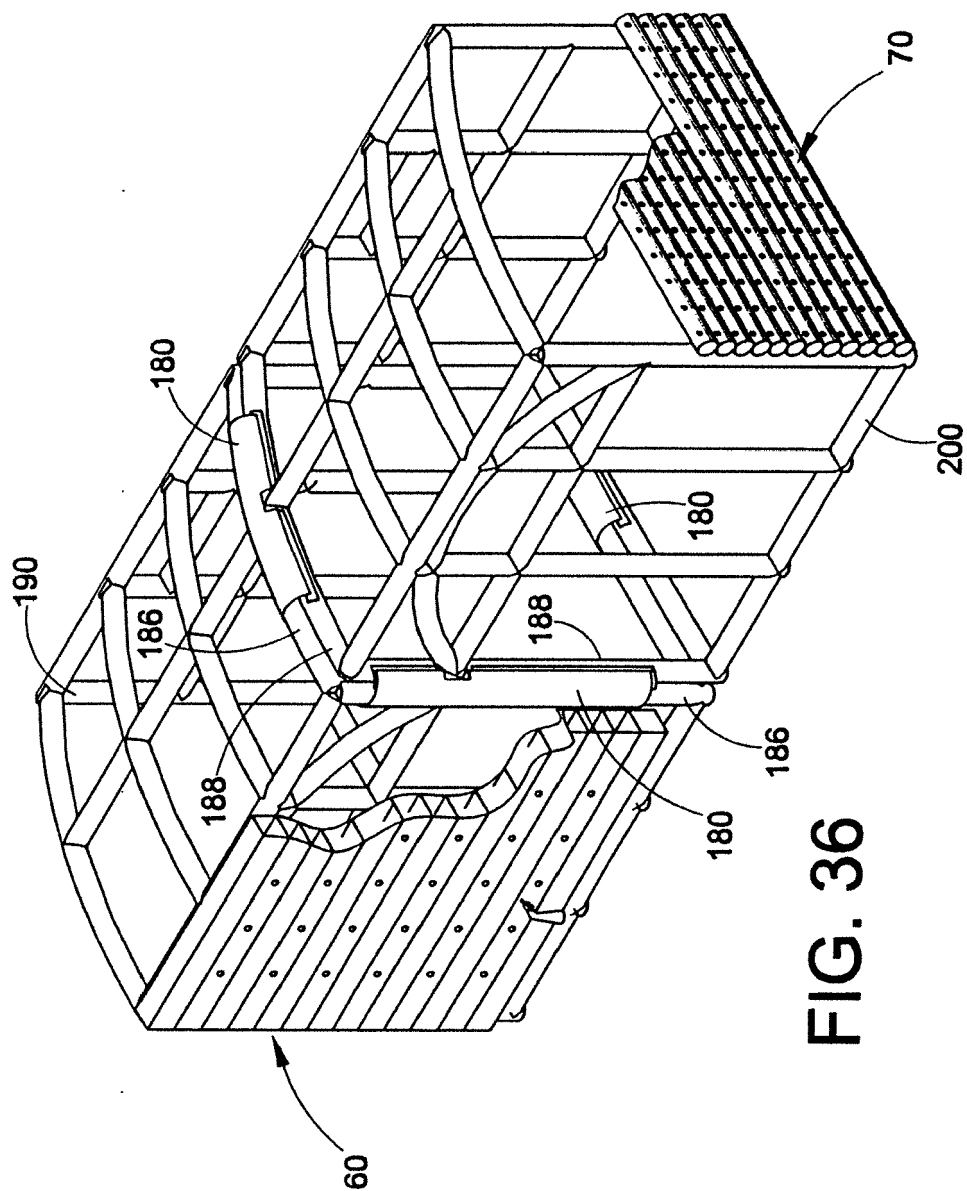


FIG. 36

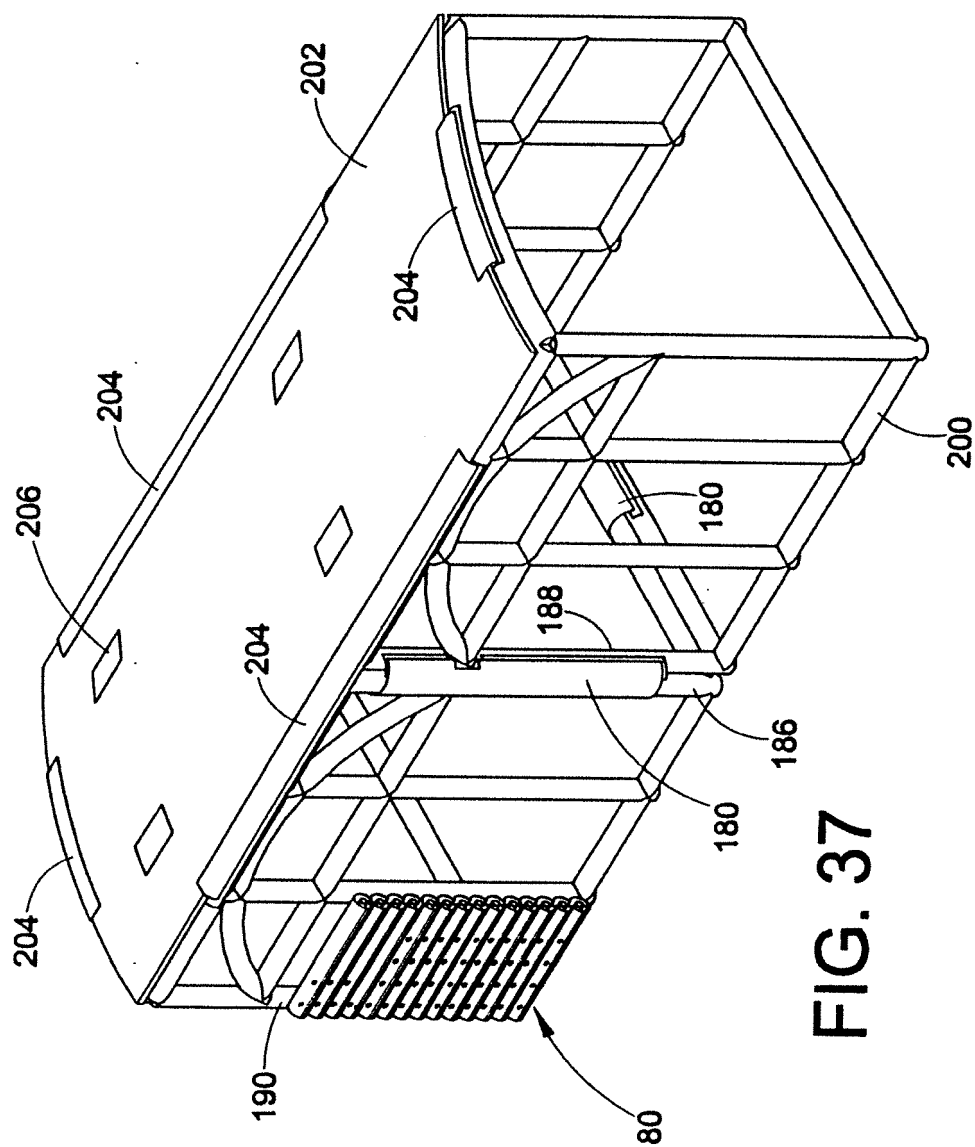


FIG. 37

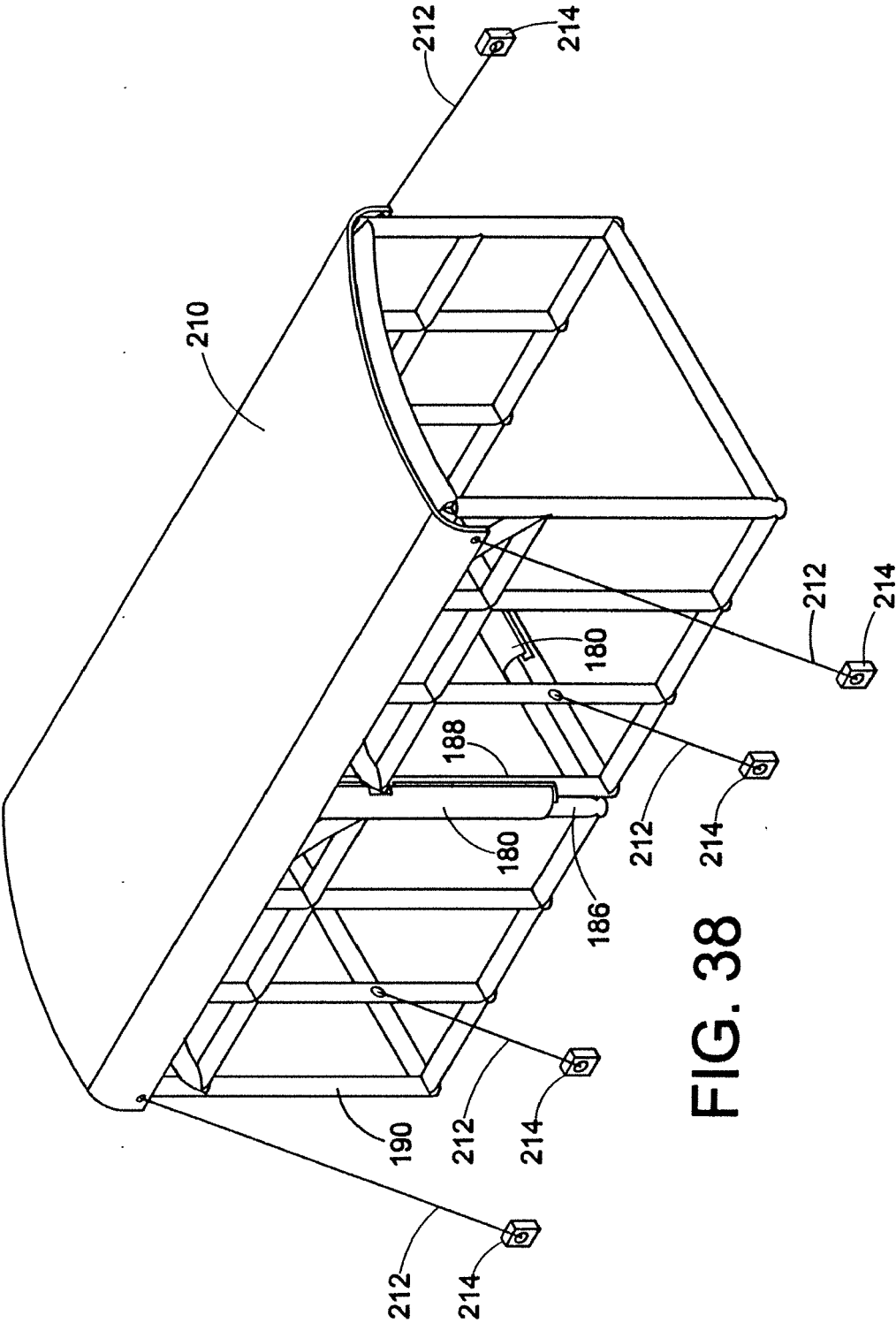


FIG. 38

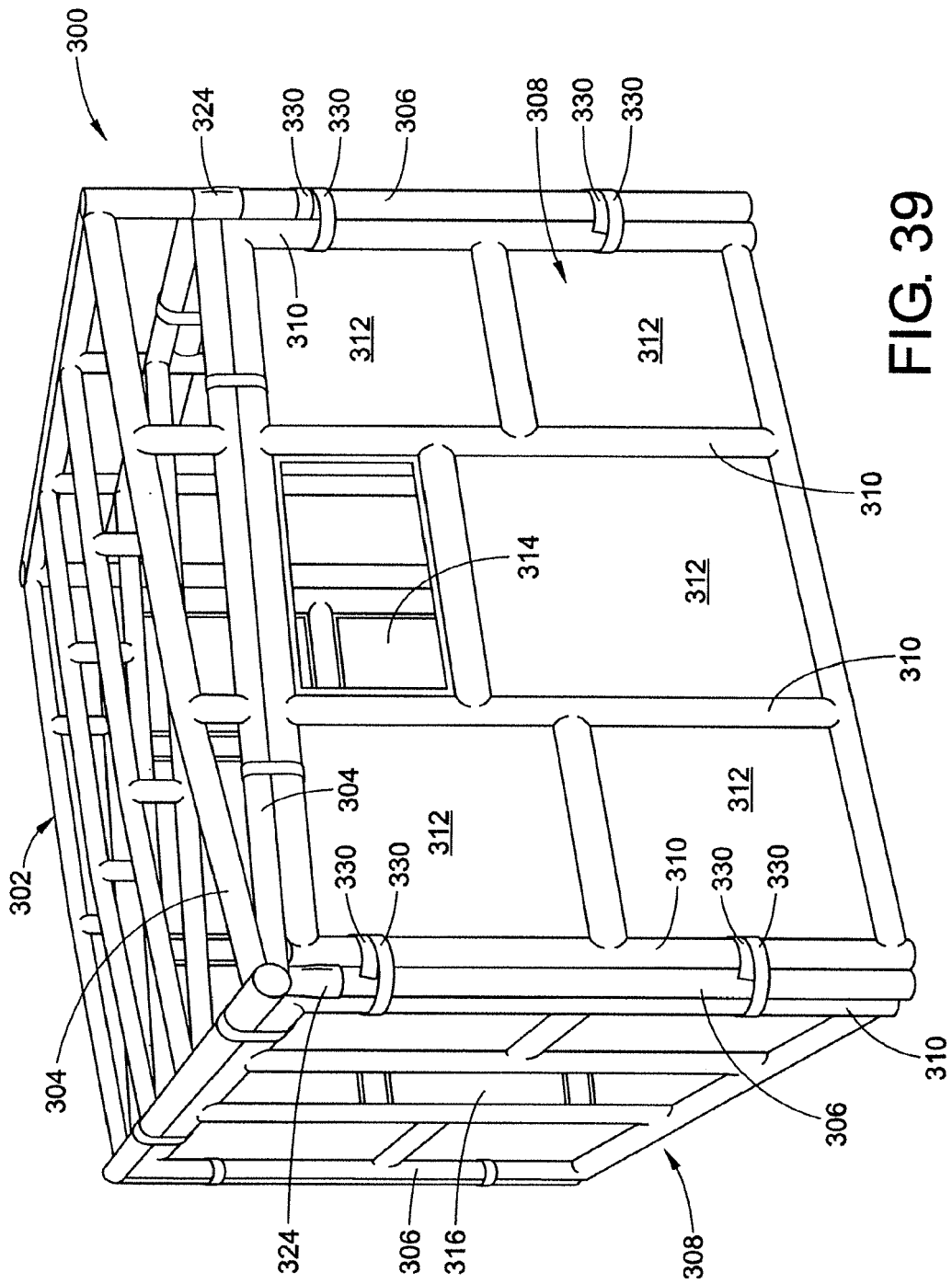


FIG. 39

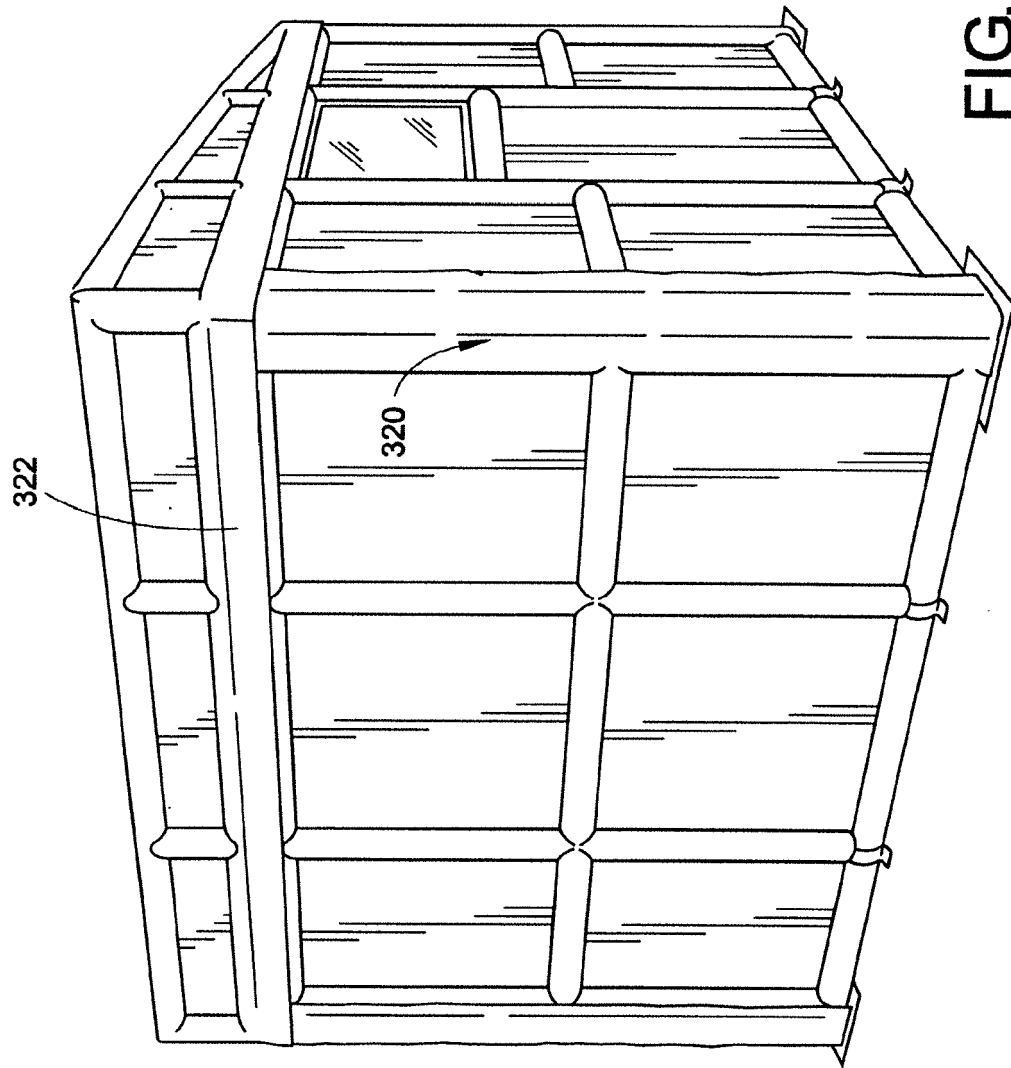


FIG. 40

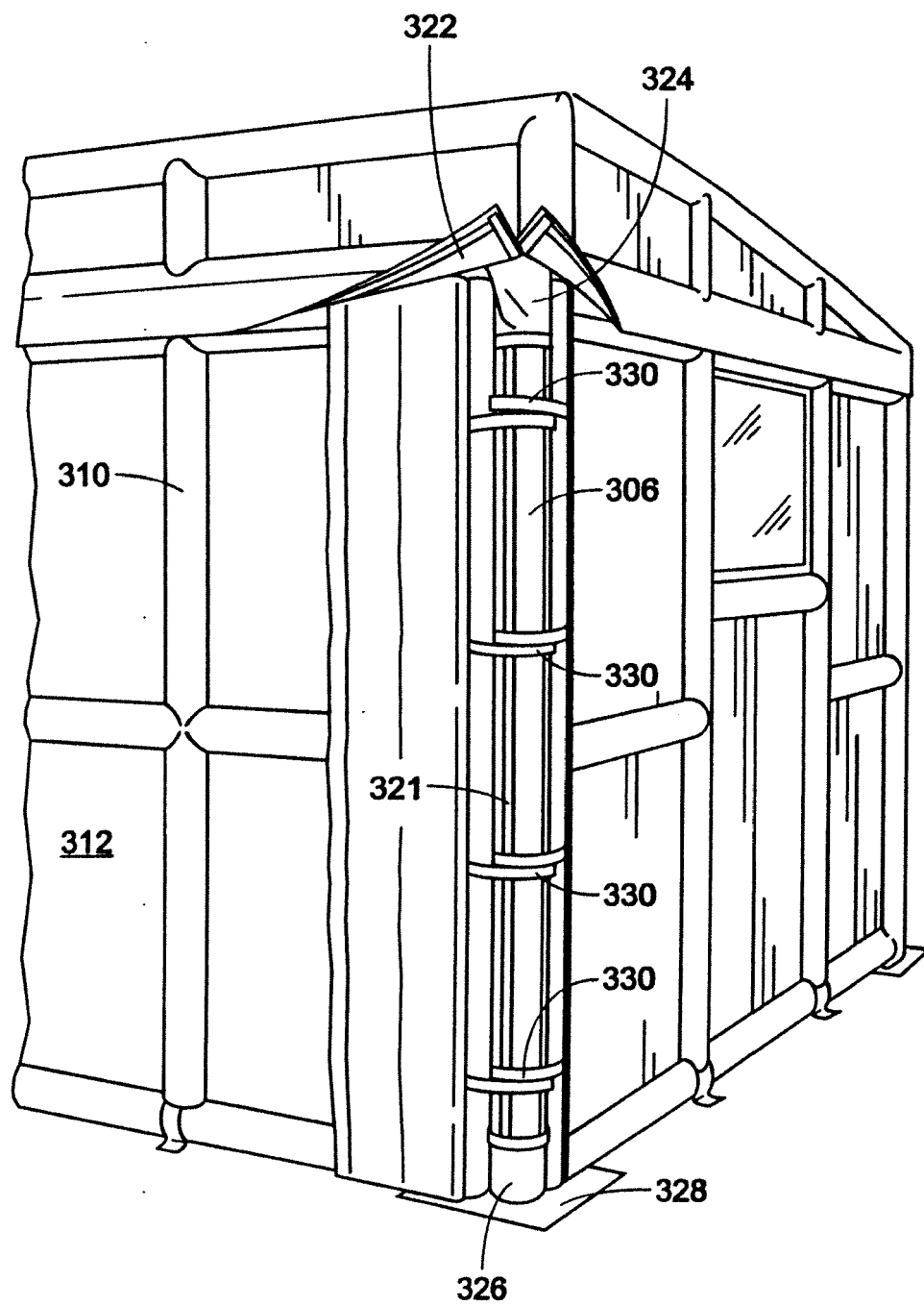


FIG. 41

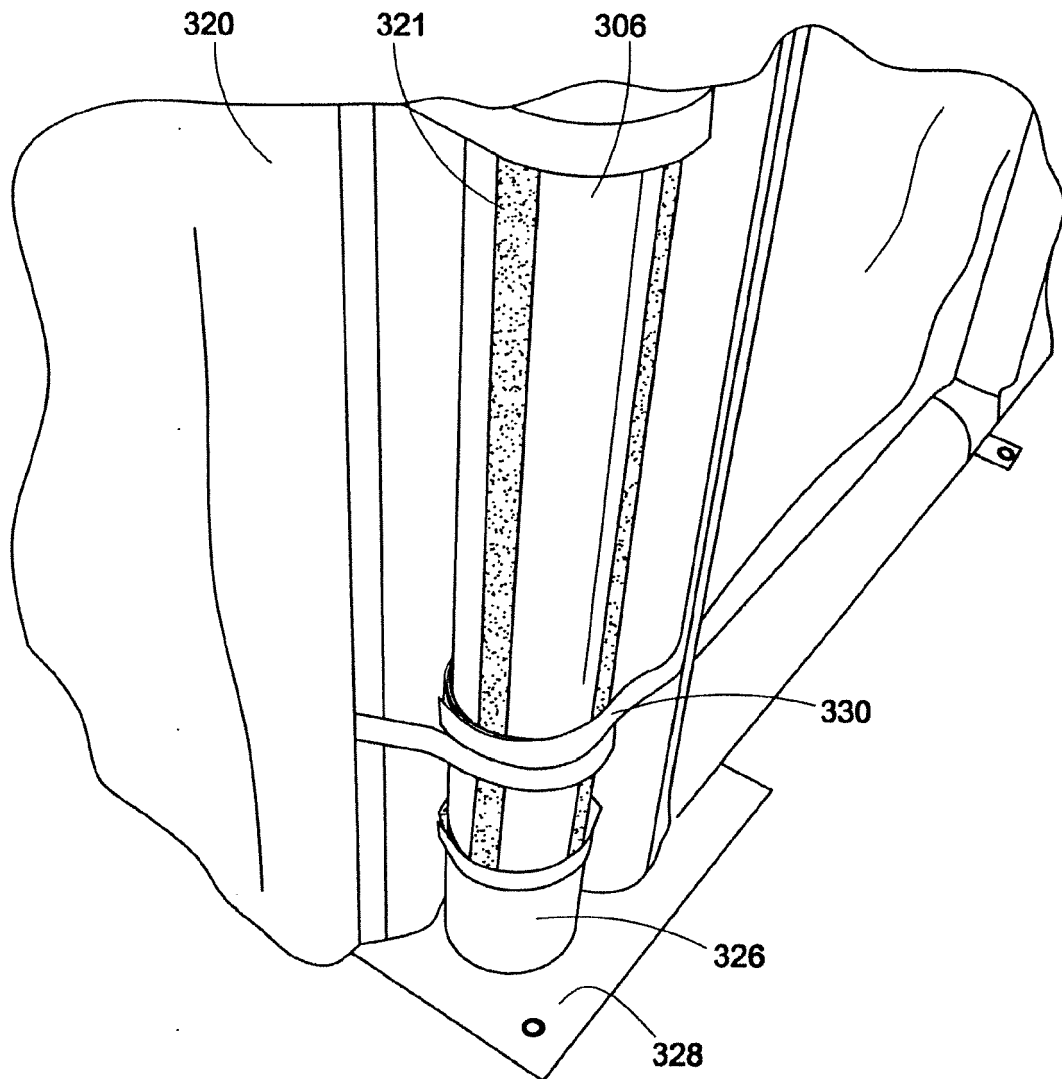


FIG. 42

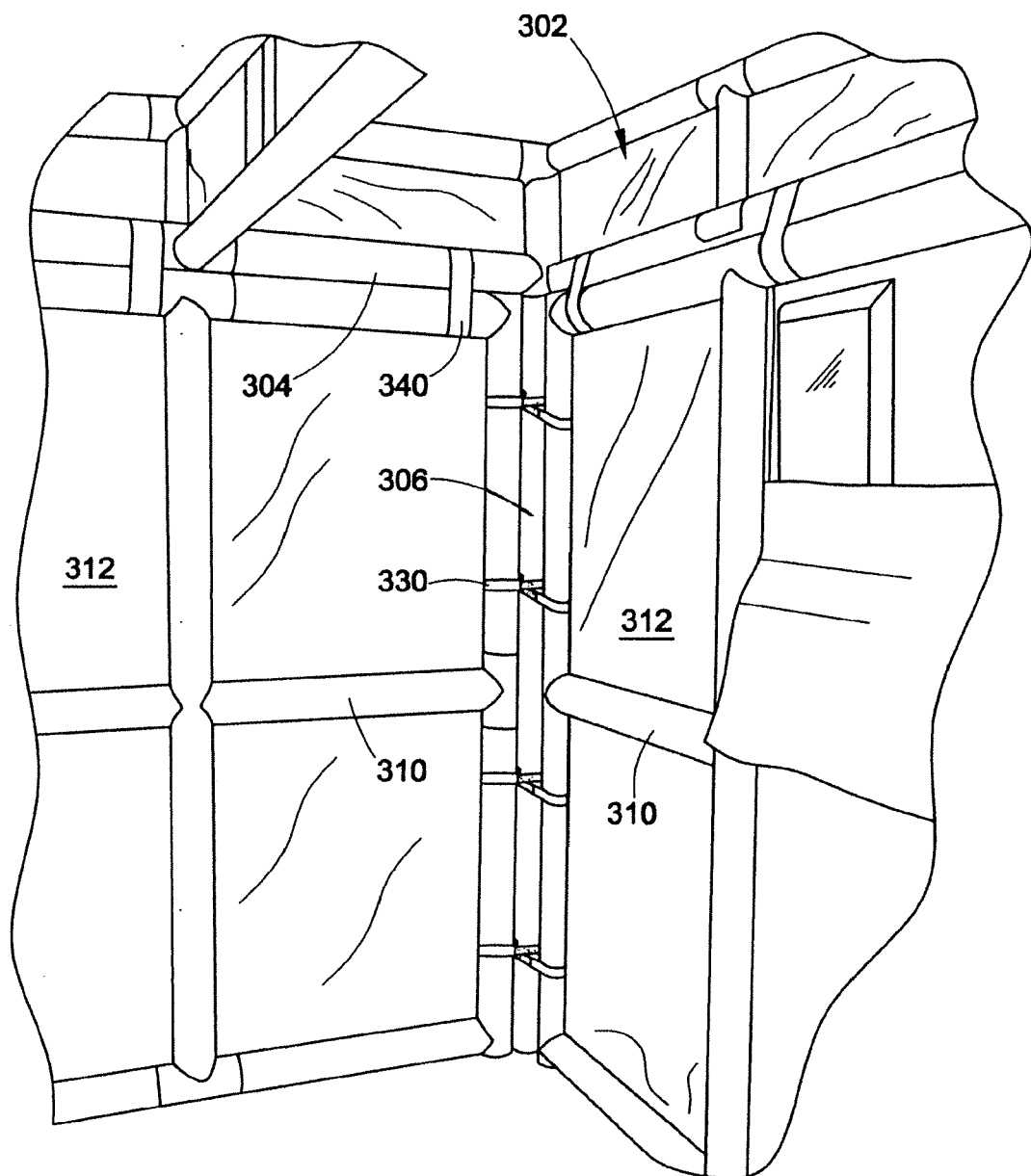


FIG. 43

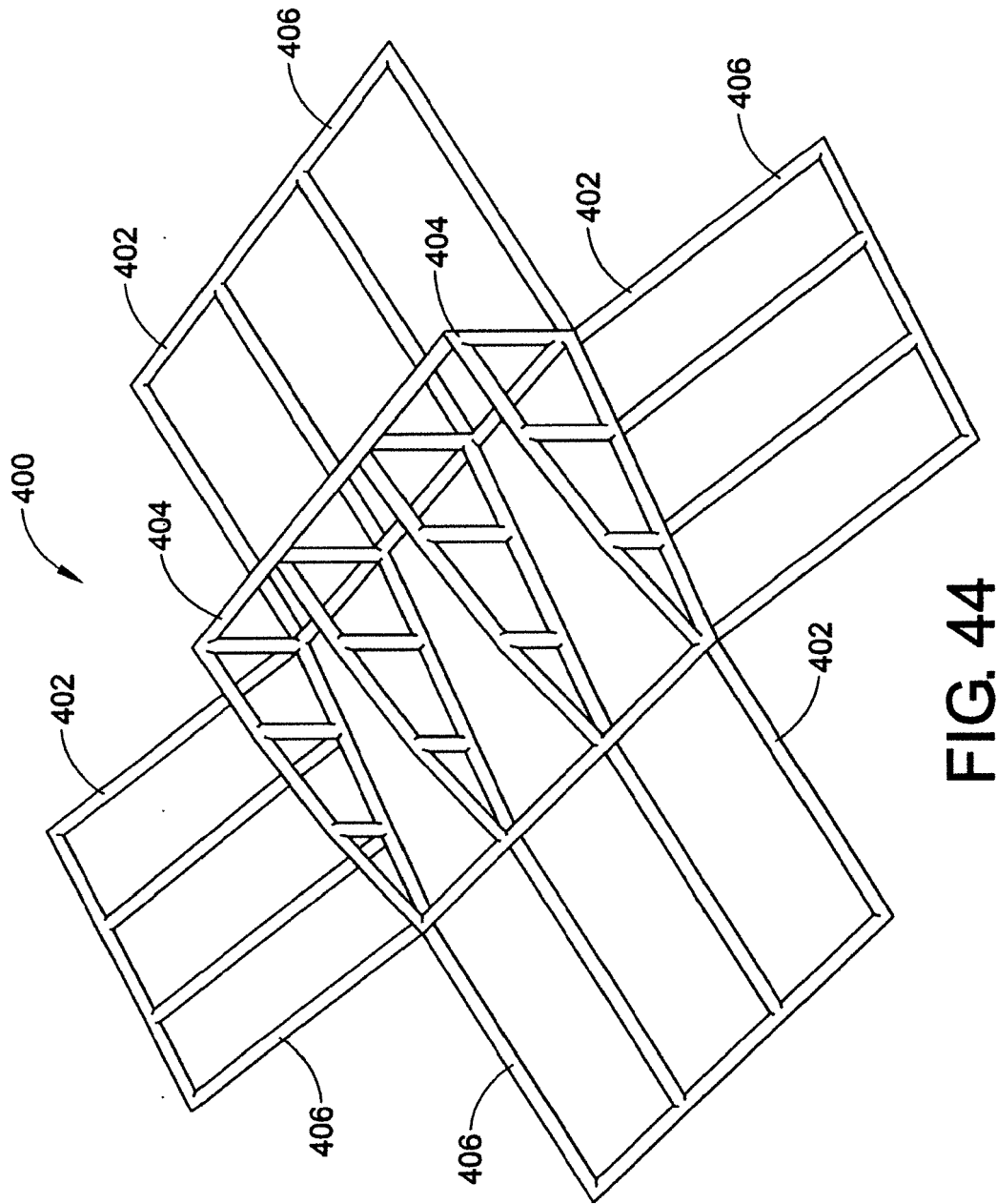


FIG. 44

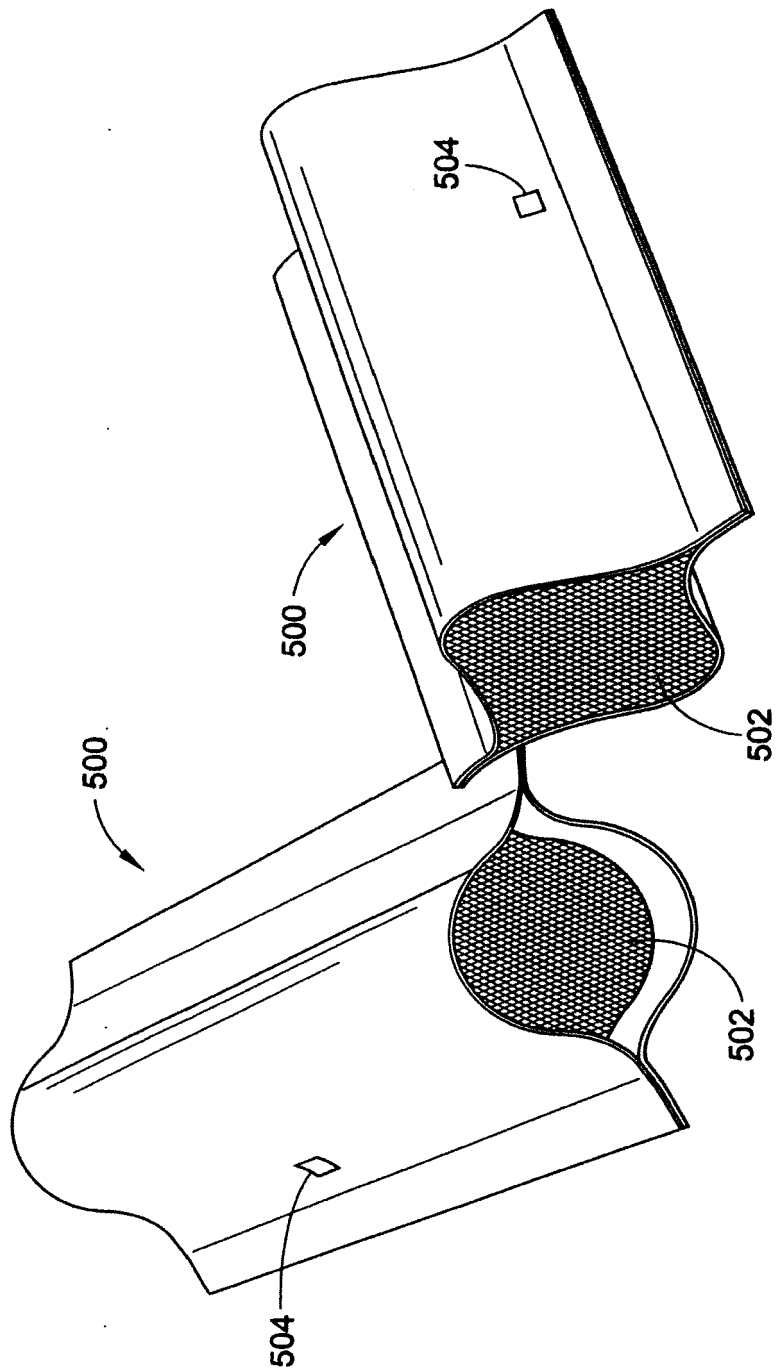


FIG. 45

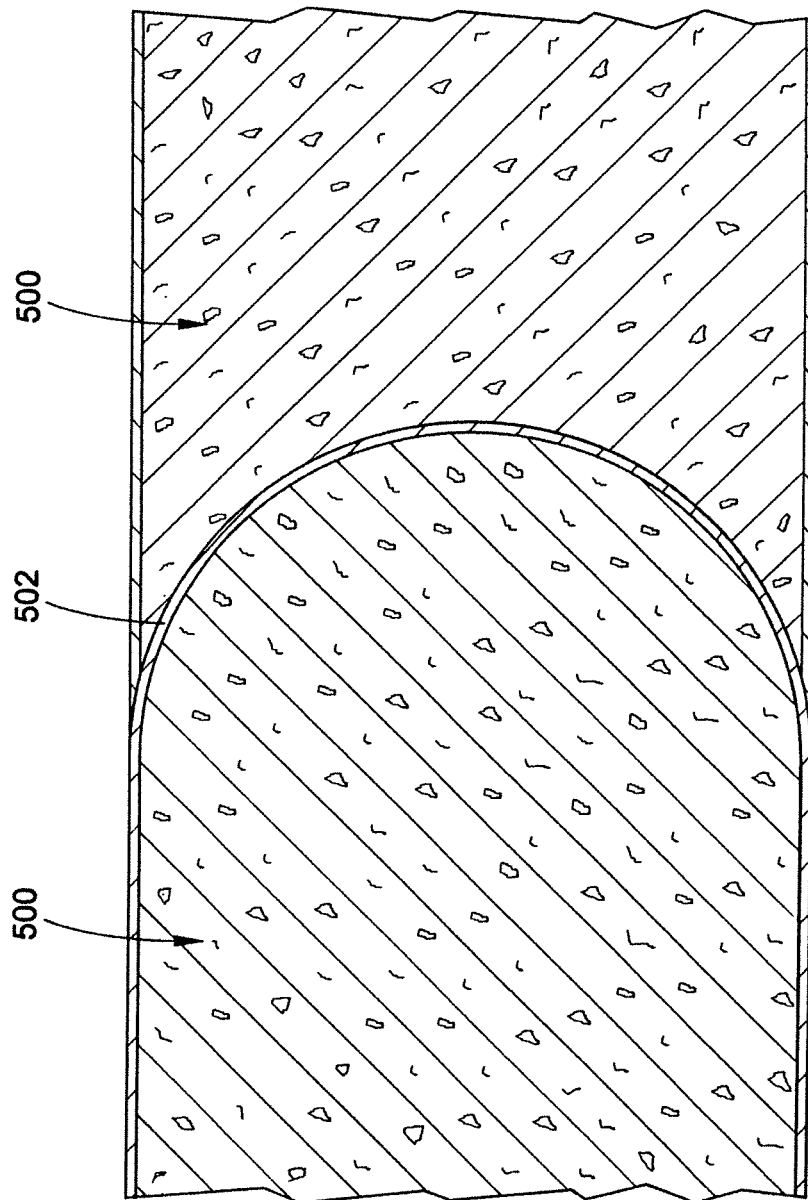


FIG. 45A

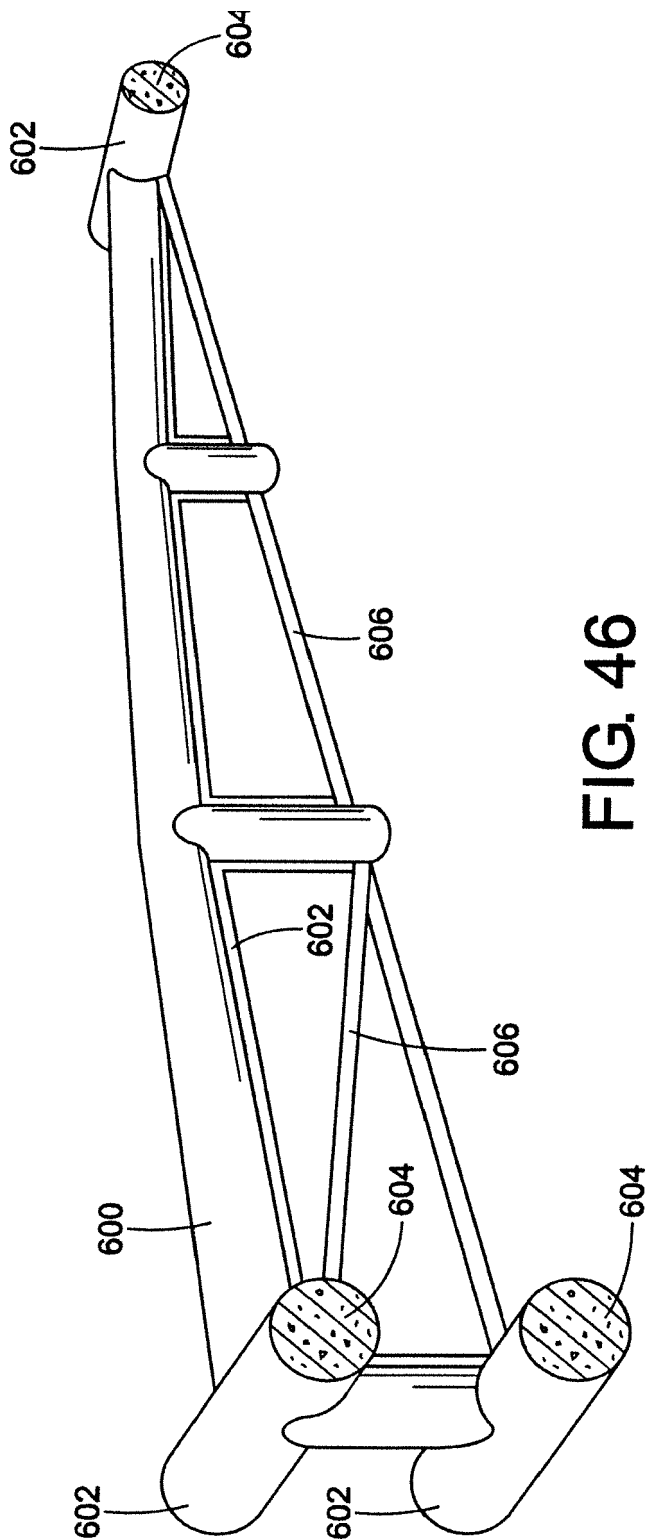


FIG. 46

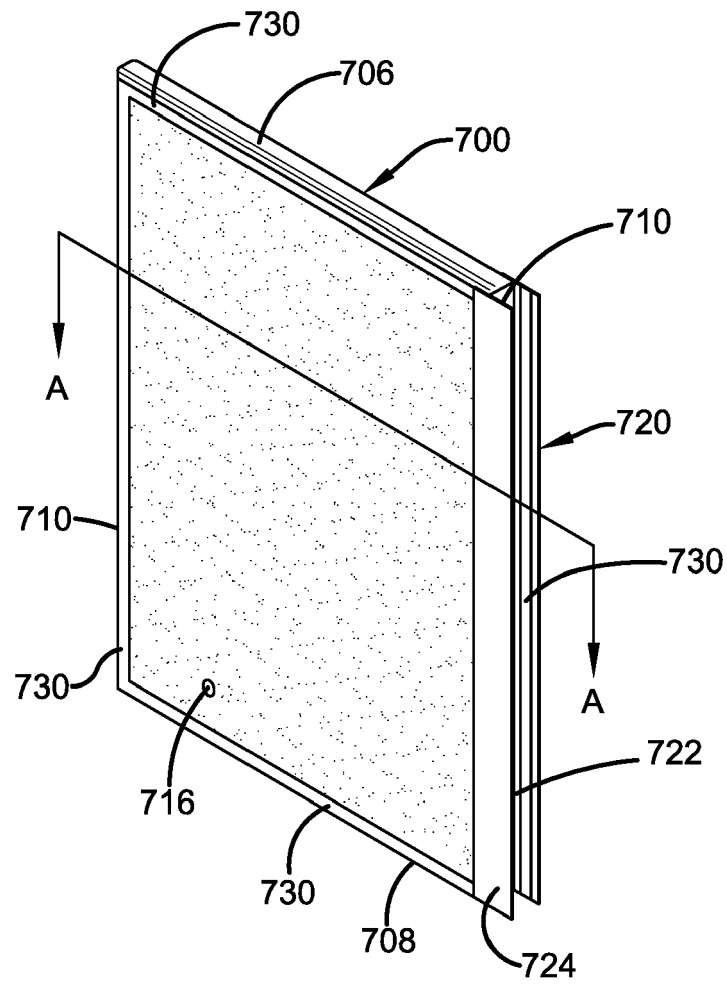


FIG. 47

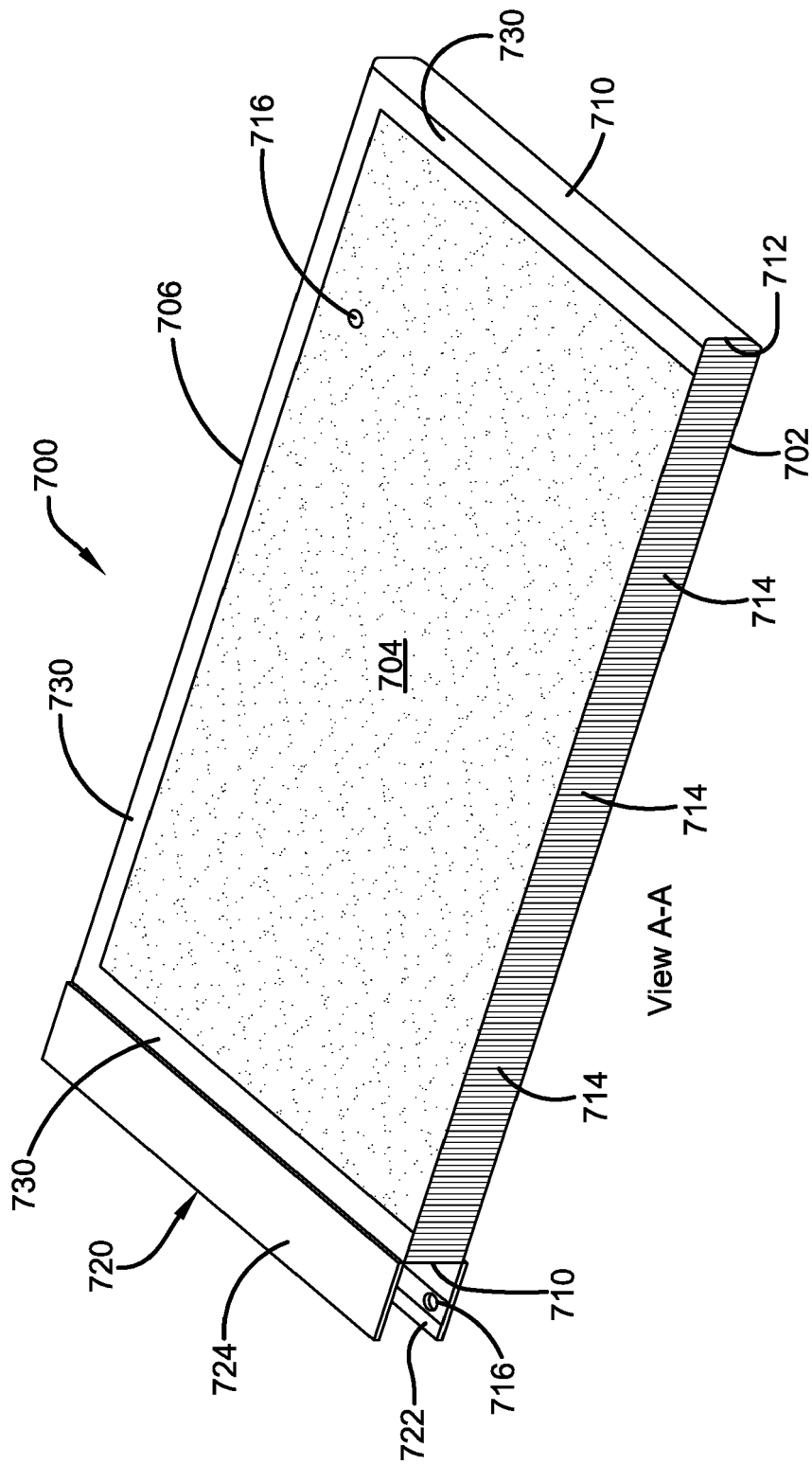


FIG. 48

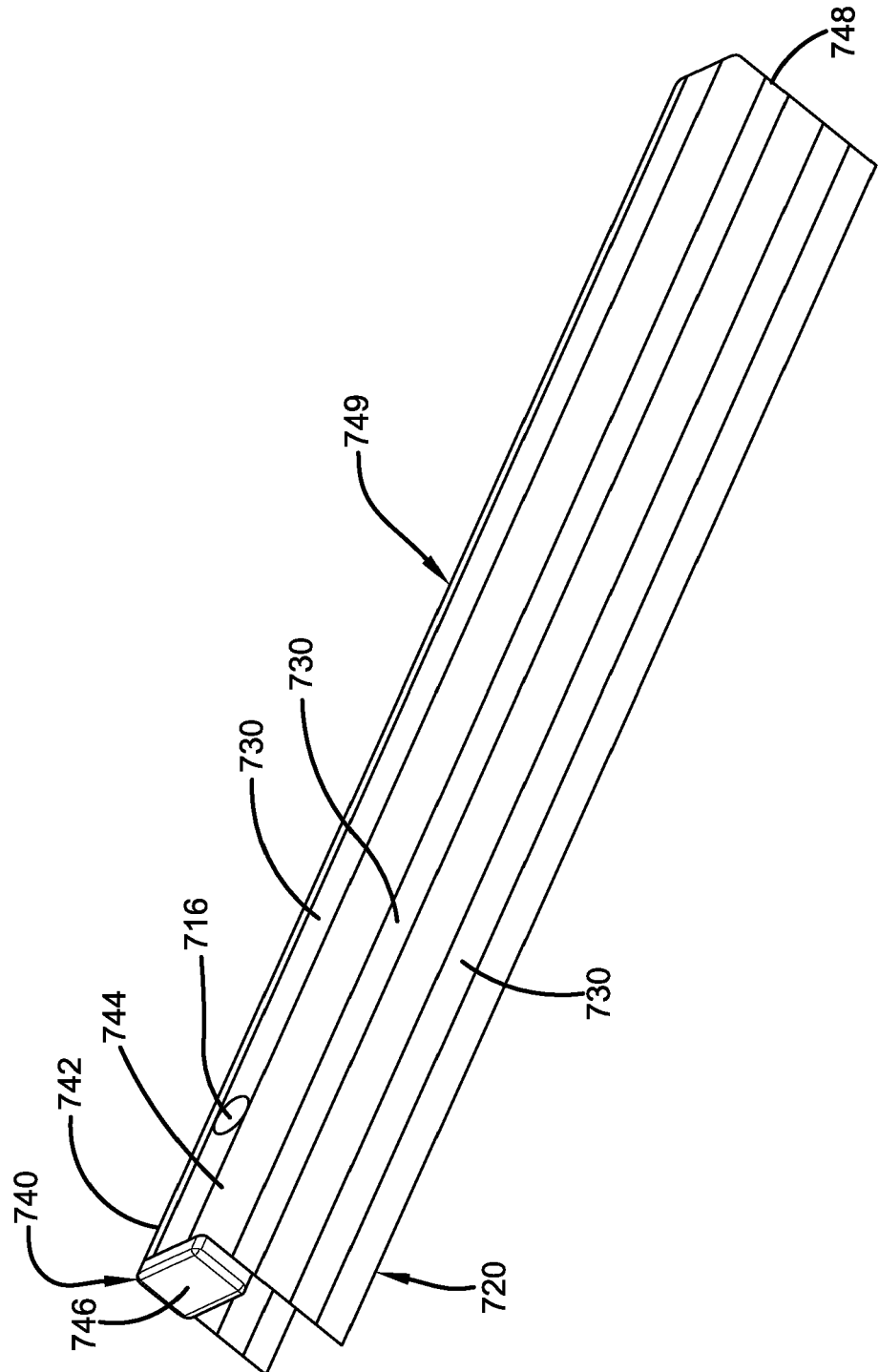
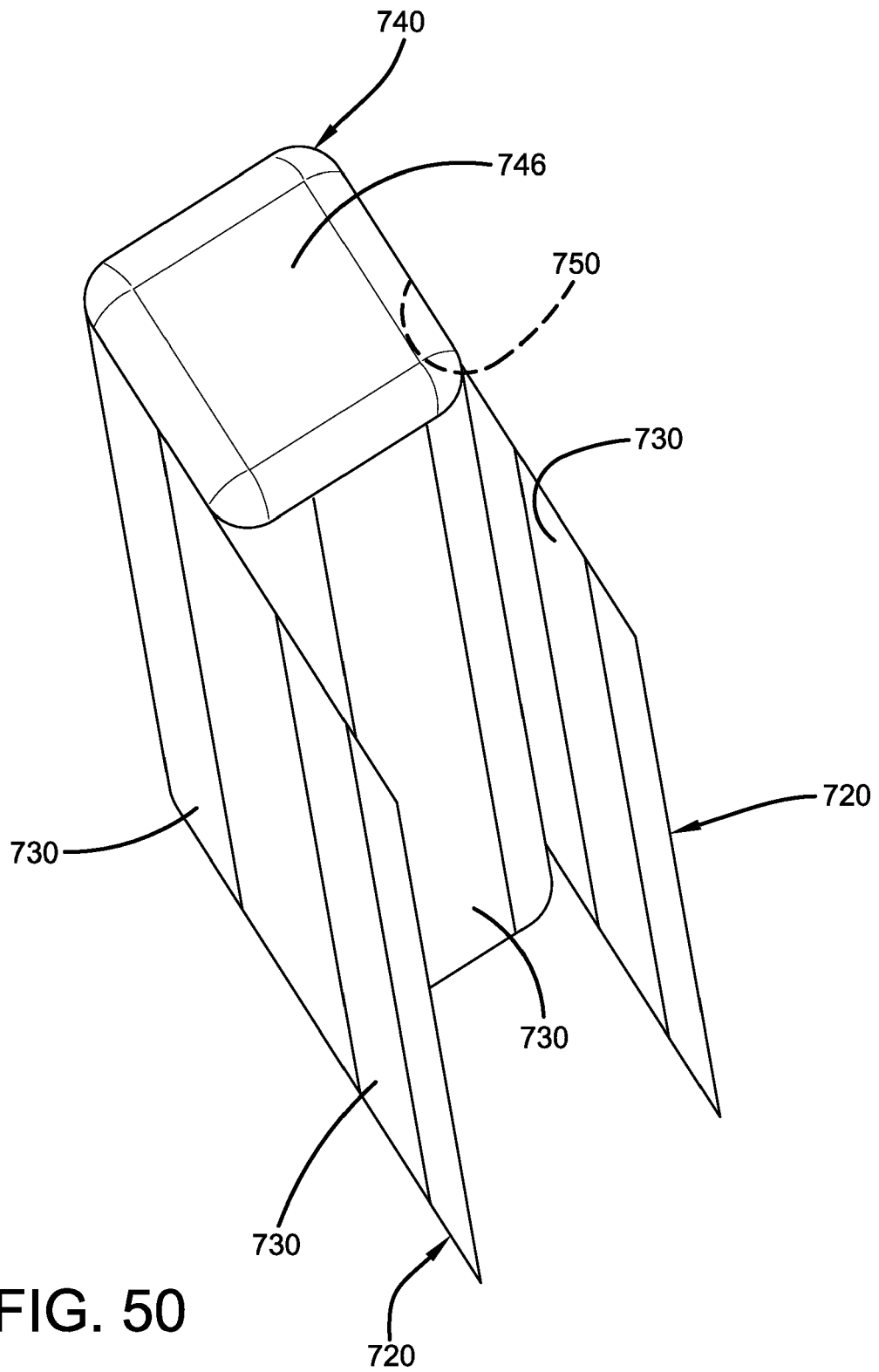
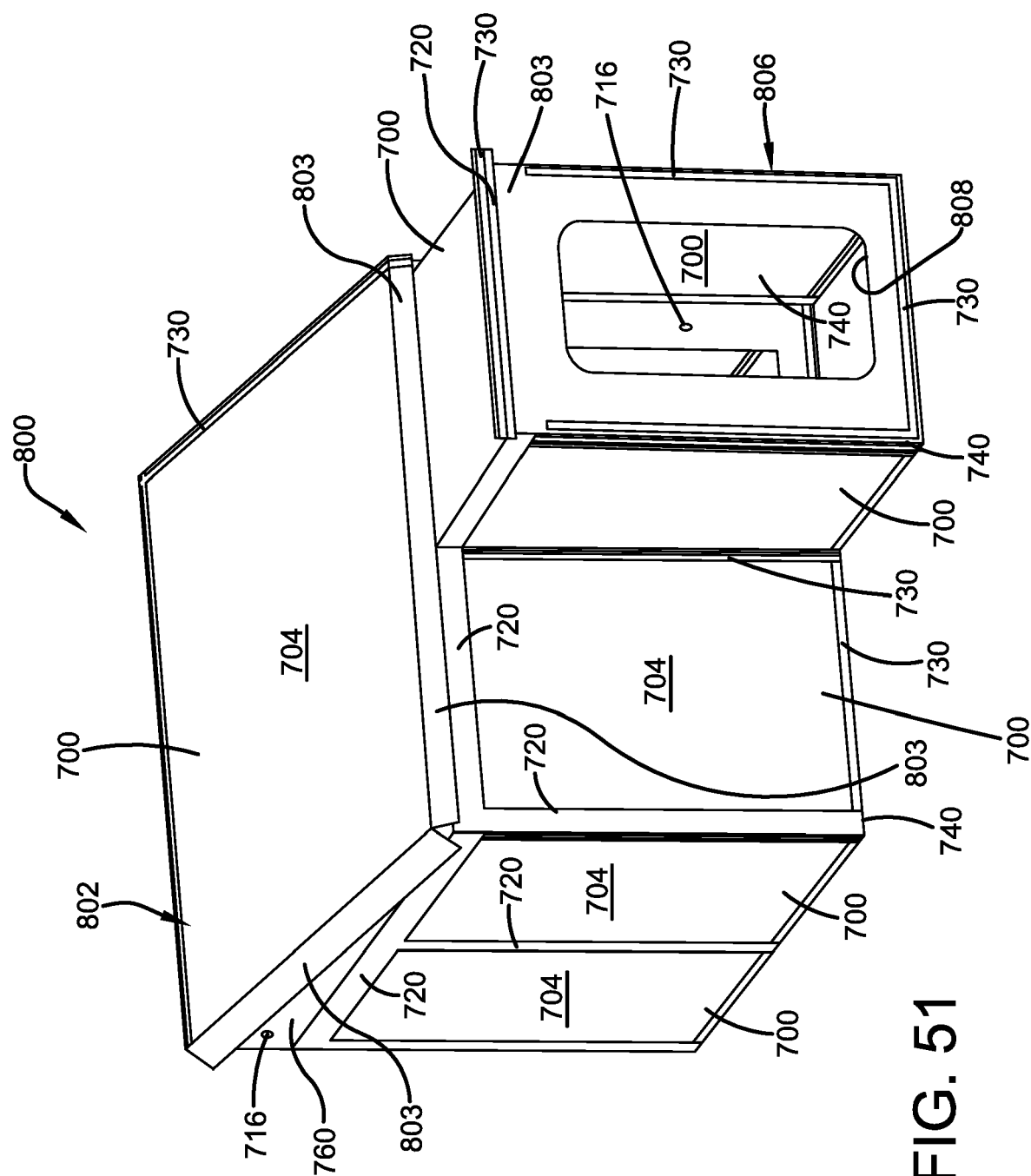


FIG. 49





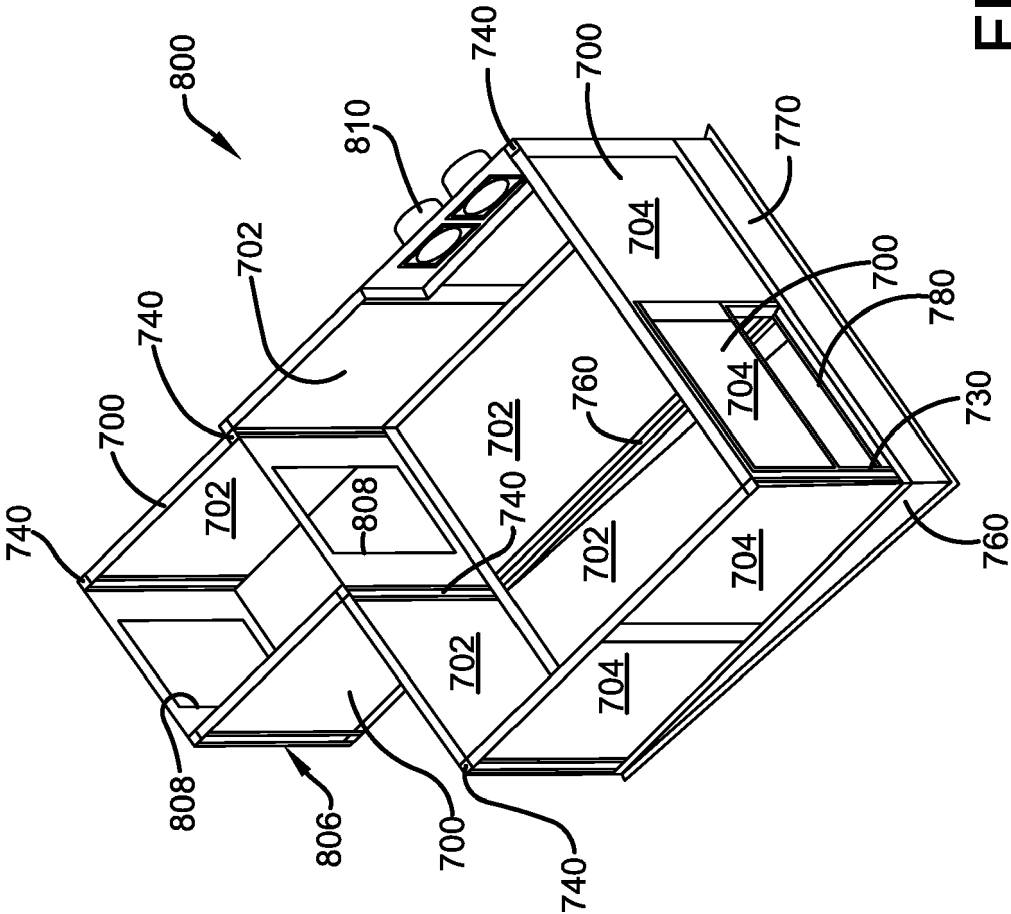


FIG. 52

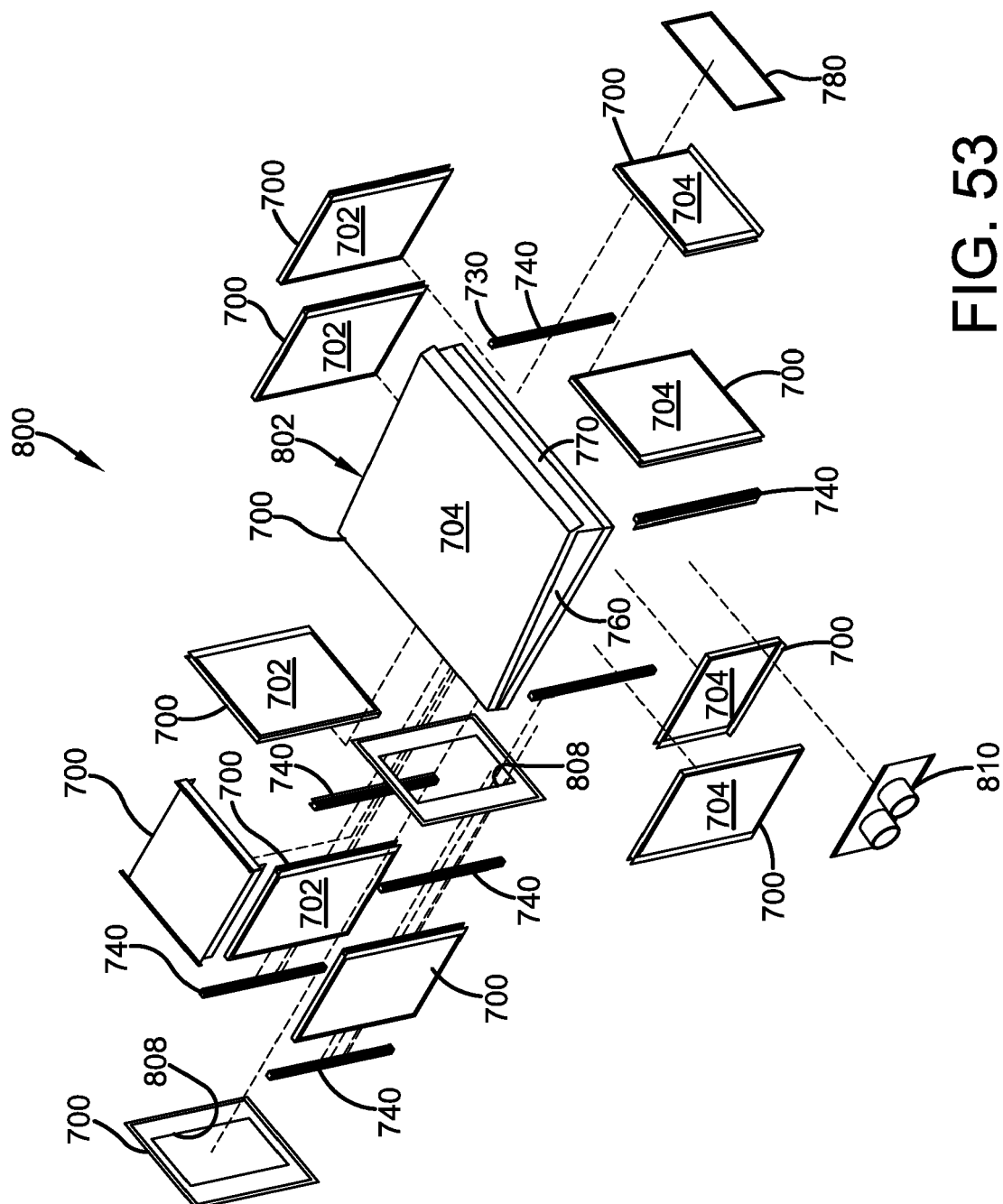


FIG. 53

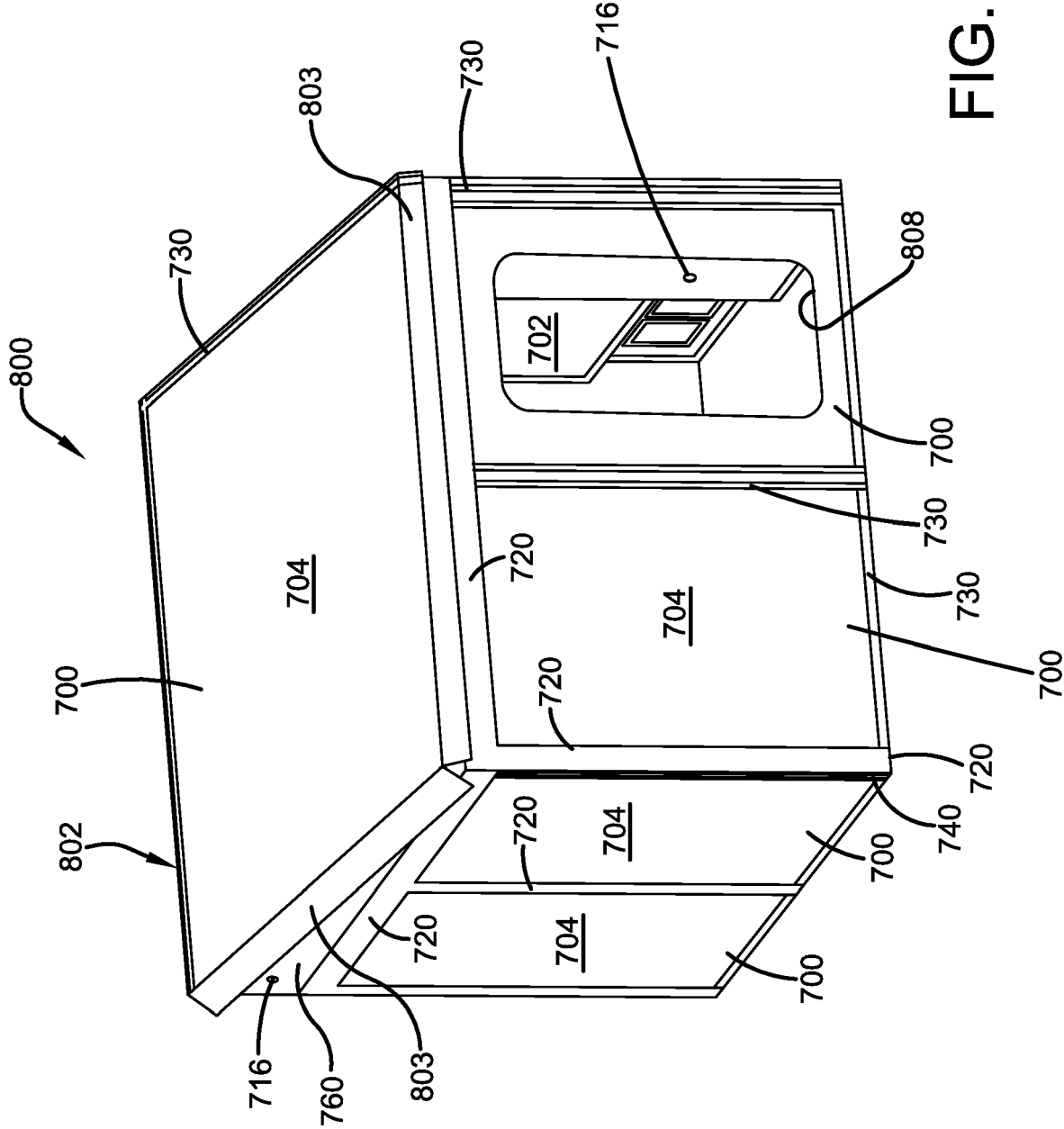


FIG. 54

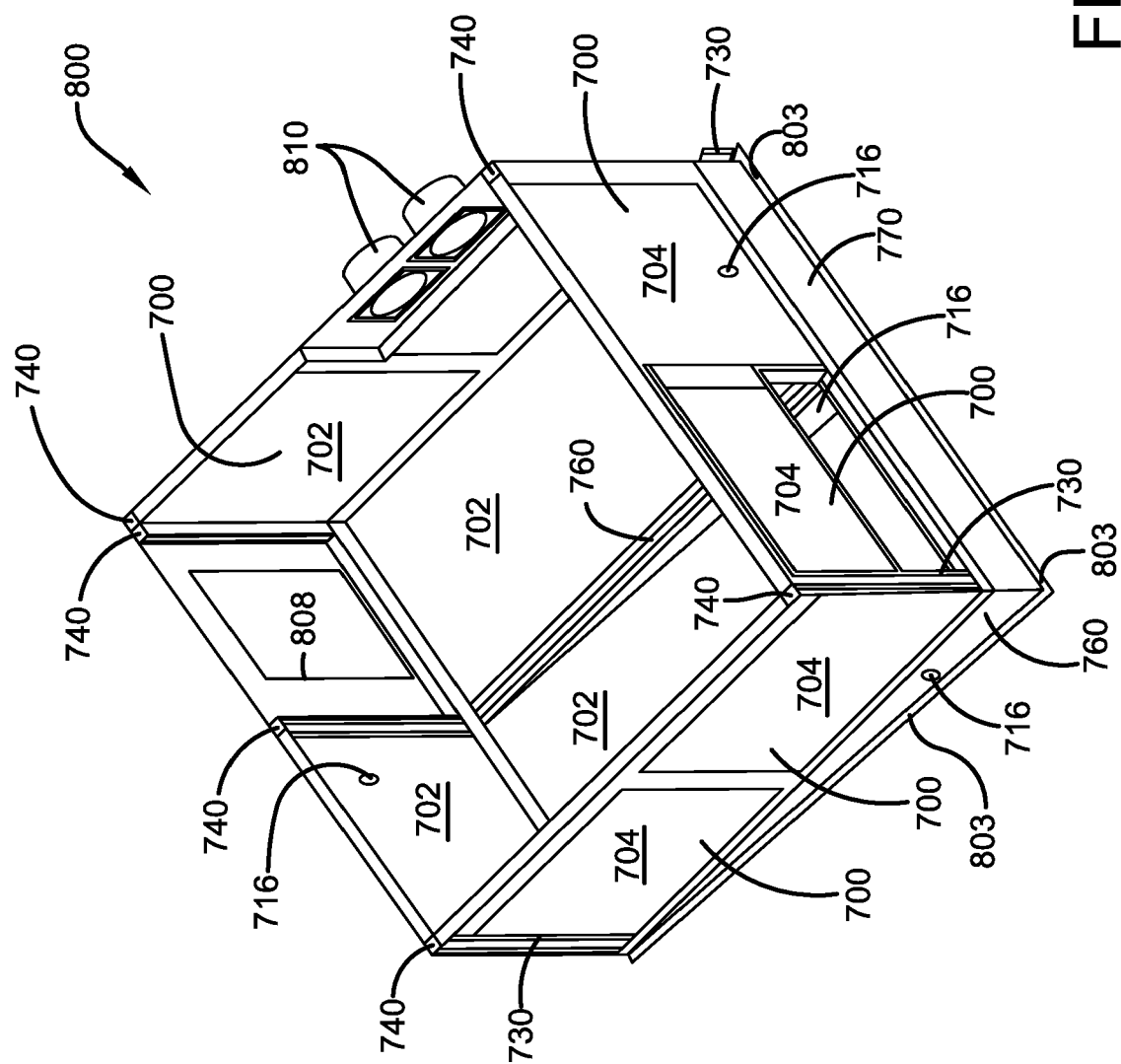


FIG. 55

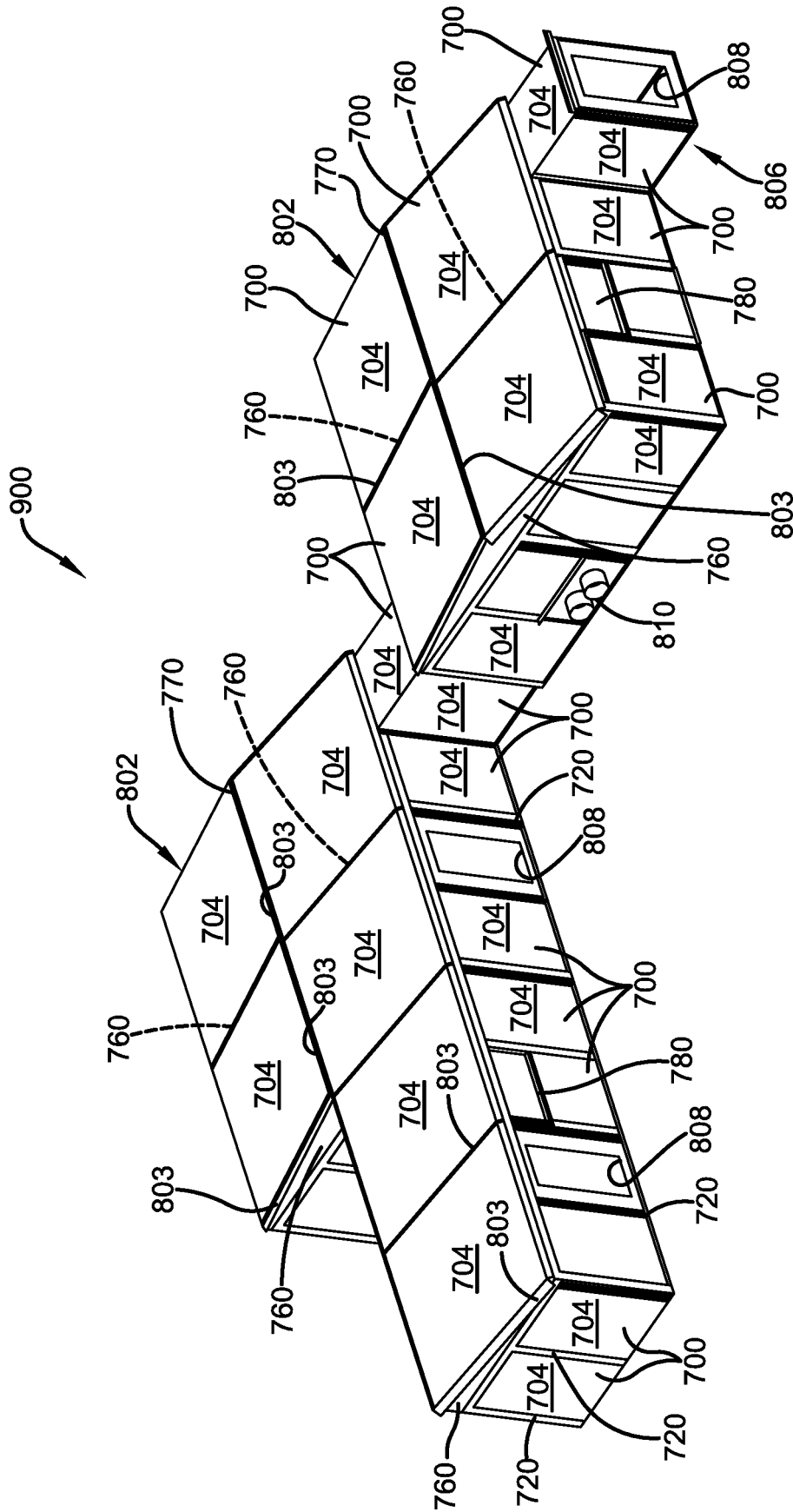


FIG. 56

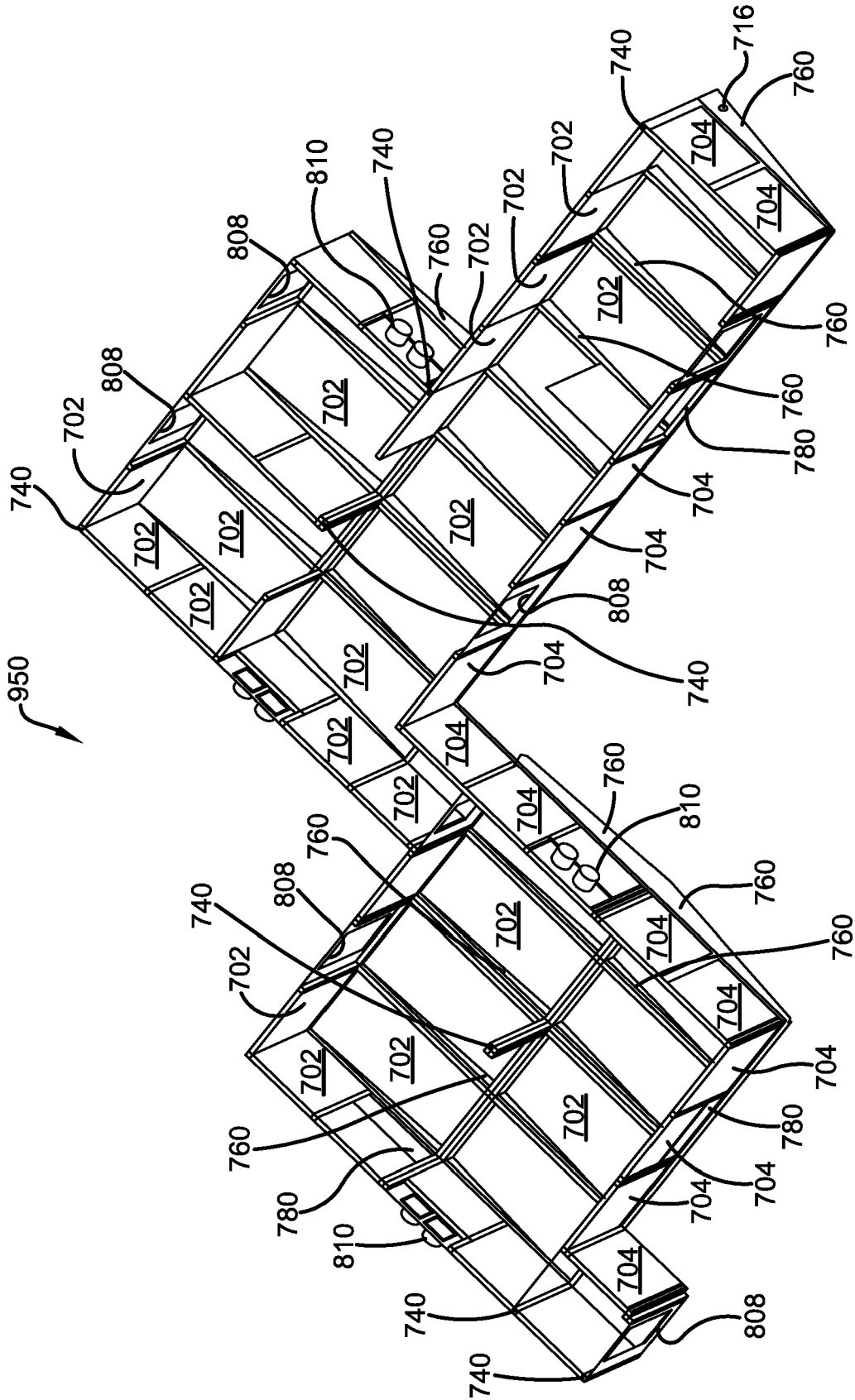


FIG. 57

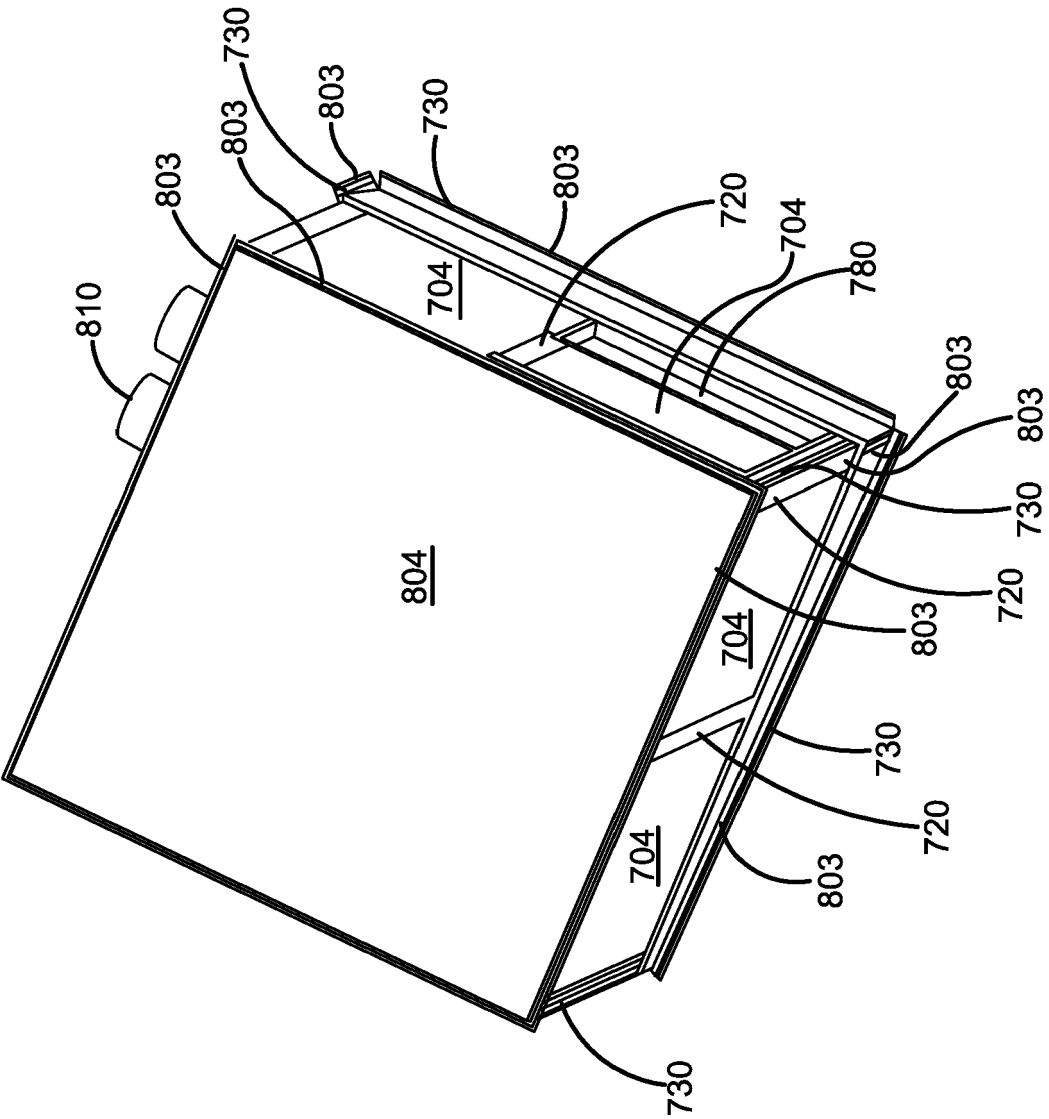


FIG. 58



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X	US 2 955 606 A (WALKER ALAN B) 11 October 1960 (1960-10-11) * figures 1-7 * * column 2, line 29 - column 3, line 61 * -----	1-15	INV. E04H1/00 E04H15/20
X	US 3 390 491 A (HAYDEN HOWARD L ET AL) 2 July 1968 (1968-07-02) * the whole document * -----	1-15	
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 17 July 2020	Examiner Schnedler, Marlon
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