June 21, 1966 W. L. DUQUETTE 3,256,895

TENSION-RESTRAINED AIR SUPPORTED STRUCTURE

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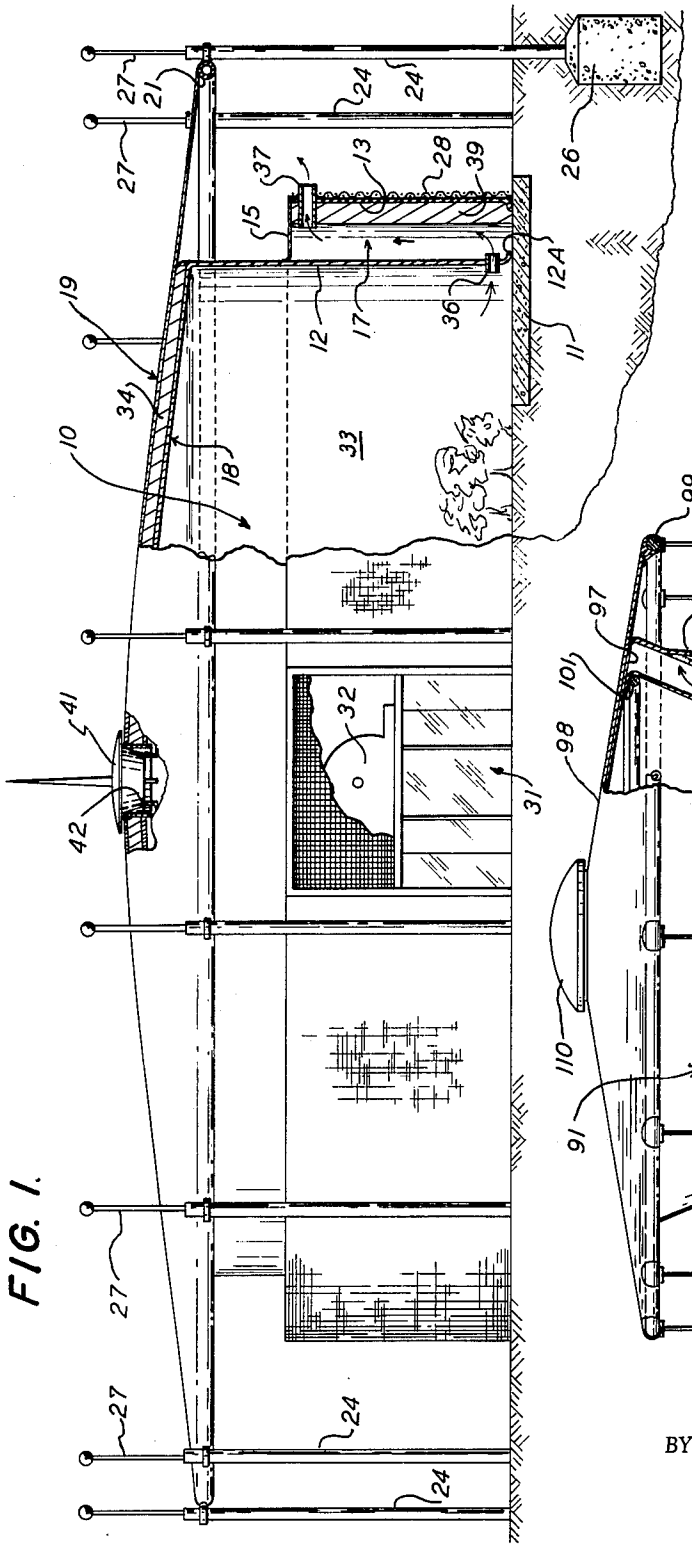


FIG. 1.

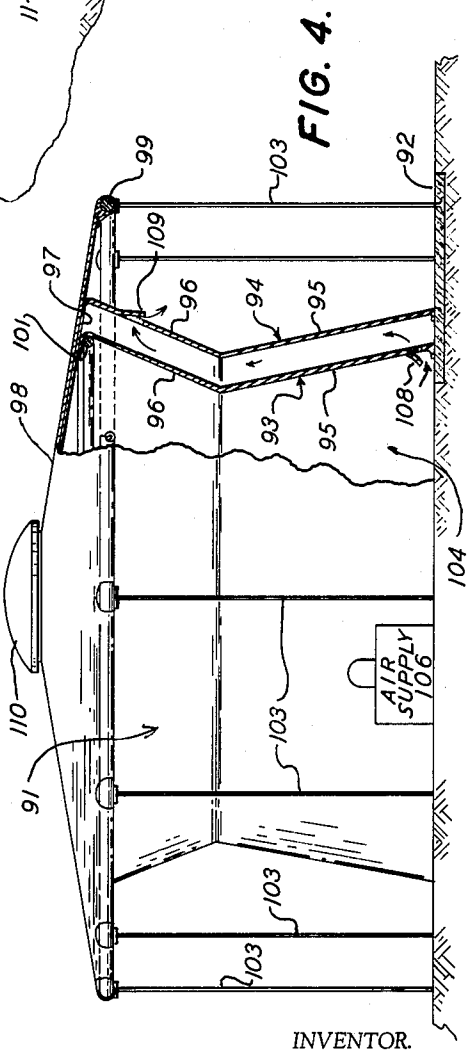


FIG. 4.

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FIG. 3.

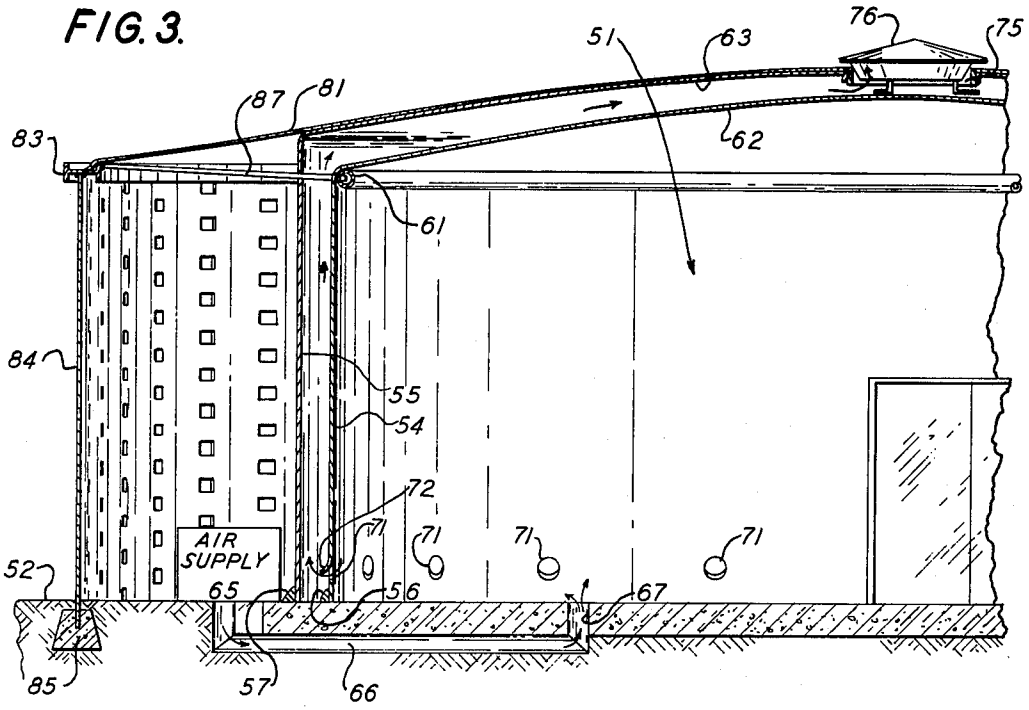
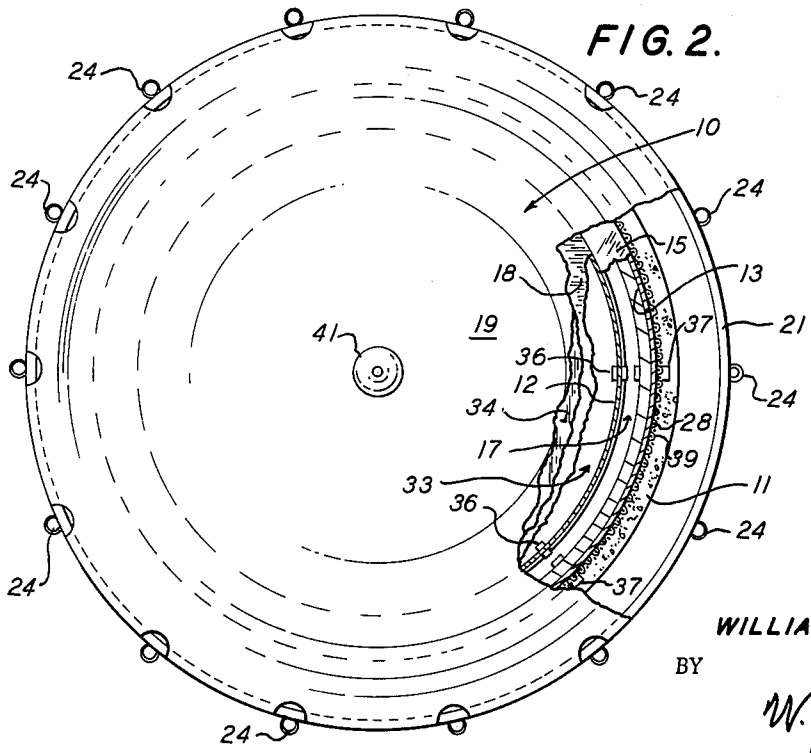


FIG. 2.



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TENSION-RESTRAINED AIR SUPPORTED STRUCTURE

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2 Claims. (Cl. 135—1)

The invention relates to air supported structures, and more particularly to such structures having external tension restraints imposed thereupon.

The economic advantages of air supported structures for covering and enclosing large volumes have engendered much activity in this field of art. Only a small air pressure differential between the enclosed volume and the outer atmosphere is needed to support the structure. Air supported structures, such as that shown in my co-pending U.S. patent application Serial No. 235,288, filed November 5, 1962, and entitled, "Air Supported Structure," are economical to fabricate and to erect. Speed of assembly and construction are also favorable factors in this type of structure. However, because of the newness of concept in these structures, conventional building rules and their interpretation have inhibited the construction of air supported structures in many localities. I have invented an air supported structure that not only has the advantages inherent in this type of structure but which in a large measure eliminates the objections to air supported structures put forth by older building codes and regulations.

The invention contemplates an air supported structure on a base area that comprises a plurality of concentric upstanding walls upon the base area with an air supported first top wall covering the volume defined by the upstanding walls and a second top wall extending outwardly horizontally beyond the upstanding walls. Means insulate the volume within the upstanding walls from the external environment. Additional means provide for discharge of supporting air to atmosphere. A structural ring at the periphery of the second top wall is fixed to the top of one or more tension members extending between the ring and the base area to impose a downward force upon the second top wall that impinges upon the first air supported top wall. It is thus unnecessary to use elaborate securing means to retain the walls to the base area.

The tension members may be cables or columnar uprights. The columnar uprights are not only vertical tension members but may be of sufficient compressive strength to support the structure should failure of the air supply remove the prime support for the structure. Alternatively, a single tension member may be used. A vertical tension band having compressive strength may surround the outer concentric upstanding wall. An additional similar band, in tension about the concentric walls, may serve to restrain the air supported structure horizontally and vertically.

The upstanding walls may have lesser diameters near their vertical midpoints such that the girth of the upstanding walls is restrictively restrained. This latter configuration may be combined with tension members exteriorly fastened to the structural ring as in the first described embodiment. This configuration has substantial artistic merit as well as architectural advantages.

Conventional air supply and temperature control apparatus may be used to supply air under pressure to the interior volume defined by the walls. Preferably, such air circulates between the concentric upstanding walls and exhausts to atmosphere through valving at the top walls and acts to inhibit heat transfer between interior and exterior volumes. If further insulation is desirable, the top walls may be compound and held spaced apart

by air under pressure or by insulating materials filling the volume between the spaced top walls.

These and other advantages of the invention are apparent in the following detailed description and drawing in which:

FIG. 1 is an elevational view, partly in section, of a preferred embodiment of the invention;

FIG. 2 is a plan view of the embodiment of FIG. 1, partly broken away;

FIG. 3 is a fragmentary sectional elevation of an alternate embodiment of the invention; and

FIG. 4 is an elevational view, partly in section, of a further alternate embodiment of the invention.

The embodiment of FIGS. 1 and 2 comprises a cylindrical structure **10** upon a base area which may include a cement slab **11**, from which spaced vertical side walls **12** and **13** rise. Both inner wall **12** and outer wall **13** preferably define cylindrical volumes concentric one with the other. A horizontal band **15** connects from the top of wall **13** to an intermediate point in the vertical extent of wall **12**, confining a volume **17** between the two walls.

A first top wall **18** extends from the upper end of vertical inner wall **12** across the volume defined by the inner wall. A second top wall **19** extends above the first top wall and outwardly beyond inner and outer walls to a circular structural or compression ring **21**. The second top wall is fastened to the compression ring around its entire periphery. While the ring is shown in FIG. 1 as a tube of cylindrical cross-section, the ring may take many configurations, such as an I-beam or a cast concrete ring.

The compression ring is secured at numerous points about its outward extent to a plurality of columnar uprights **24**. Each upright extends from the compression ring to the base area and may be fixed at its bottom by a concrete footing **26**. Optional decorative masts **27** extend from the top of each columnar upright.

An exterior screen **28**, to protect from vandalism, surrounds outer wall **13** of the structure and is co-extensive in height with the outer wall. The screen is pierced by a doorway **31** through which access is gained to the interior of the structure. The doorway may have revolving doors or outer and inner doors so that an air lock exists between interior and exterior atmospheres.

A source of air under pressure such as a blower **32** is supported above the doorway. The blower may be a conventional air-supplying apparatus with temperature and humidity controls. The blower draws exterior air through the screen and discharges it into the volume **33** defined by inner wall **12** and top wall **18**. The blower is capable of maintaining an interior pressure slightly above atmospheric. The air pressure supports top wall **18**, lifting it upwardly. The space between top wall **18** and second top wall **19** is filled with an insulating material **34**. The insulating material transmits the downward force imposed upon second top **19** by the columns **24** to the first top wall, inhibiting upward movement of the first top wall.

The walls of the structure are preferably of a lightweight plastic material. A plastic such as "Tedlar," by Du Pont, has been effective in this case. Vinyl coated cloths may also be used, provided their tensile strength is sufficient. Preferably the upper extent of inner wall **12** above horizontal band **15** is transparent to light effectively the interior of the structure. If lighting requirements dictate, the entire wall expanse may be of translucent plastic material.

An air circulation pattern within the structure aids in insulating the structure from the external environment. A plurality of air vents **36** penetrate inner wall **12** near the bottom of the wall. Since the wall terminates in a bottom portion **12A**, which is preferably sealed to the

base area, the vents are not at the extreme bottom edge of the wall. Ducts may be used extending below the ground or floor and connecting between volumes 33 and 17. An upper discharge vent 37 passes through outer wall 13 and screen 28 at a plurality of points about the structure. If added insulation from the outer environment is desired, an insulating annular band 39 may be placed in volume 17 between walls 12 and 13. In this instance vents 37 also pass through the insulating band.

Thus, because of the slightly pressurized interior of the structure, air flows through vents 36 and between walls 12 and 13 to discharge through vents 37. The air flow inhibits heat transfer between the exterior environment and interior volume of the structure supplementing or replacing insulating band 39.

A pressure relief valve 41 is situated centrally of the two top walls. The pressure relief valve may be a simple weighted check valve in a port 42 that extends through both top walls and the insulating layer 34. While a simple air responsive valve has been found sufficient, it may be desirable to use a more sophisticated device to keep the inner pressure at a constant figure rather than using the check valve to periodically relieve pressure.

FIG. 3 illustrates an alternate embodiment of the invention wherein a structure 51 resides upon a base area 52, from which concentric cylindrical vertical walls 54, 55 rise. Walls 54 and 55 are inner and outer walls, respectively. The bottoms 56 and 57 of walls 54, 55, respectively, are fixed to the base areas to preclude air passage under the walls. Inner wall 54 rises substantially vertically to an inner structural ring 61. The ring is a closed ring to which the inner wall is rigidly fixed. A first top wall 62 extends across the top of the volume enclosed by inner wall 54. The first top wall is held to a circular configuration by its attachment to the inner ring.

The outer vertical wall 55 extends upwardly and is secured to a second top wall 63. The second top wall is spaced from first top wall 62 and the spaced relationship is maintained by a flow of air under pressure from an air supply unit 65. An underground conduit 66 extends from the air supply unit to an air exit 67 within the structure enclosure. The air supply unit preferably has temperature and humidity controls and is such that pressure within the structure is maintained at slightly greater than atmospheric.

A plurality of ports 71 with check valves 72 conduct air from the inner volume of the enclosure. Air under pressure flows through the ports and upwardly between the inner and outer vertical walls and between the first and second top walls. The air exhausts through a port 75 in the second top wall. A check valve 76 or other air flow control mechanism determines the amount of the flowing through the port. The air supply 65 and the valving mechanism 76 combine to maintain a pressure within the volume and between the walls sufficient to maintain the building structure erect. The air flow between the walls also serves as an insulating barrier between the environment and the interior of the structure.

In order that the structure not be lifted from the base area, restraining means are provided, comprising an outer top cover or wall 81 that is circular in configuration and extends outwardly beyond outer wall 55. An outer structural or compression ring of circular cinfiguration 83 is fixed to the outer periphery of cover 81. A tension band 84 surrounds the entire structure and is secured at its top to the compression ring. The tension band is fixed in a circular concrete footing 85 in the base area.

Tension band 84 not only exerts a tension force upon the compression ring, imposing cover 81 upon second top wall 63, but also has columnar strength such that the failure of the air supply unit will not cause collapse of the structure. The band thus has the dual purposes of exerting a downward tension force on the ring and also

resisting the compressive loading of the ring and its outer cover.

The tension band may take many forms, such as a concrete wall of pierced blocks or a metallic screen material. The compression ring to which it is secured may have, among others, the cross-sectional configuration of a U or an I-beam. In either case the upper groove of the ring series as a gutter or water channel to take drainage from the cover 81.

It may be desirable to support inner structural ring 61 from the supported compression ring 83, particularly if the inner ring is relatively heavy. This can be done by a plurality of tension cables 87, each extending through outer wall 55 between the inner and outer rings. The tension cables preclude collapse of the inner envelope of the structure if the air supply should fail.

Such collapse is not contemplated except on rare occasions when the walls of the structure are breached. If the valving mechanism 76 is properly calibrated there is no loss of air once the pressure drop starts, because the valving mechanism then shuts off any outward flow of air.

Access to the inner volume of the structure may be similar to that shown for the embodiment of FIG. 1, although many other suitable access means are feasible.

The embodiment of FIG. 4, like the other embodiments, illustrates an air supported structure, such as the structure 91, in place upon a base area 92. A plurality of side walls, such as an inner wall 93 and an outer wall 94, rise from the base area. In the embodiment of FIG. 4, each side wall has an inwardly sloping lower portion 95 and an outwardly sloping upward portion 96. The vertical extent of the upper portion is less than the vertical extent of the lower portion. Each wall defines a circular volume over which a first top wall 97 extends. The first top wall closes the inner volume defined by wall 93 and also the space annulus between walls 93 and 94. A second top wall 98 that is circular in plan configuration extends over the structure heretofore defined and outwardly beyond wall 94 to a compression ring 99. The periphery of the second top wall is fixed to the compression ring. The ring is shown as circular in cross-section in FIG. 4, but may have one of many cross-sectional configurations, including those previously described. A small inner compression ring 101 is secured to the juncture of inner wall 93 and first top wall 97.

A plurality of tension cables 103 are fixed to outer structural or compression ring 99 and extend downwardly to the base area where they are firmly secured. The tension cables exert a downward force on ring 99 and second top wall 98 that impinges upon the wall 97. The downward force thus exerted is opposed by air pressure within interior 104 of the structure. The inner air pressure is slightly in excess of atmospheric. Air under pressure is supplied by an air pressure device 106, which discharges air into interior 104. A plurality of lower vents 108 in wall 93 and a plurality of upper vents 109 in outer wall 94 establish a flow of air between the concentric inner and outer walls 93, 94, respectively.

As in previous embodiments, a pressure relief valve or control valve 110 is centrally located, in a port (not shown) extending through both top walls.

The two portions 95, 96 of each of the upwardly extending walls establish a restricted diameter on each of the walls at a point above the vertical midpoint. This configuration has a pleasing design aspect and also tends to resist outward distortion of the vertical walls.

All of the illustrative embodiments described embody the concept of an air supported structure which does not need elaborate means to secure it to its base area. Only a simple air seal is needed at the bottom of each vertical wall. The concept of a tension force impinging upon the top wall of the structure permits simpler structural techniques to be used. The structures of the described in-

vention benefit from the air flow patterns which establish insulating balance between ambient atmosphere and the structural interior. A plurality of concentric volumes may be established by using more than two vertical walls. However, the air flow pattern does not interfere with the use of insulating materials that may be used where conditions require them.

While several embodiments have been shown, many other forms of the invention will occur to those skilled in the art. Therefore, the scope of the invention is defined by the appended claims rather than by the illustrative embodiments described herein.

I claim:

1. An air supported structure for use upon a base area comprising a plurality of concentric upstanding walls upon the base area, an air supported first top wall covering the volume defined by the inner of the upstanding walls, a second top wall extending over the first top wall and extending outwardly horizontally beyond the upstanding walls, means insulating the volume within the upstanding walls from the external environment, valving means for discharging supporting air to atmosphere, a structural ring fixed to the periphery of the second top wall, and tension means connected between the structural ring and the base area so as to impose upon the second top wall a downward force that impinges upon the air supported first top wall.

2. An air supported structure for use upon a base area comprising a plurality of substantially concentric upstanding walls upon the base area, a first top wall covering the volume defined by the upstanding walls, a second top wall extending outwardly horizontally beyond the upstanding walls, means for circulating air in the space between the upstanding walls, means for discharging the circulated air to atmosphere, a structural ring defining the periphery of the top wall, and a plurality of tension members extending between the structural ring and the base area, each of the plurality of tension members also being a vertical compression member.

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