

## Anexos



**Anexo 1:** Primeras patentes de construcciones  
neumáticas.



## Índice Anexo 1: Primeras patentes de construcciones neumáticas.

1. <b>GIESSMANN</b> , Max Carl Johann Gottlieb. 1891	541
2. <b>SUMOVSKI</b> , Joachim Adolfovich. 1892.	549
3. <b>SUMOVSKI</b> , Joachim Adolfovich. 1893.	557
4. <b>LANCHESTER</b> , Frederick William. 1919.	563
5. <b>HOOD</b> , Robert A. 1933.	571
6. <b>CAPITA</b> , E. R. 1944.	581



**1. GIESSMANN, Max Carl Johann Gottlieb, nº EN 468,455.  
1891-1892**

**Tienda de campaña de muro hinchable**

Nota\* Aplicado para aire y/u otros gases

**Solicitud** 8 abril 1891

**Fecha** 9 febrero 1892

**Lugar** Londres, Inglaterra

**Inventor** M.C.J.G. Giessmann

**Patente nº** EN 468,455

**Título** *Inflatable wall-tent*



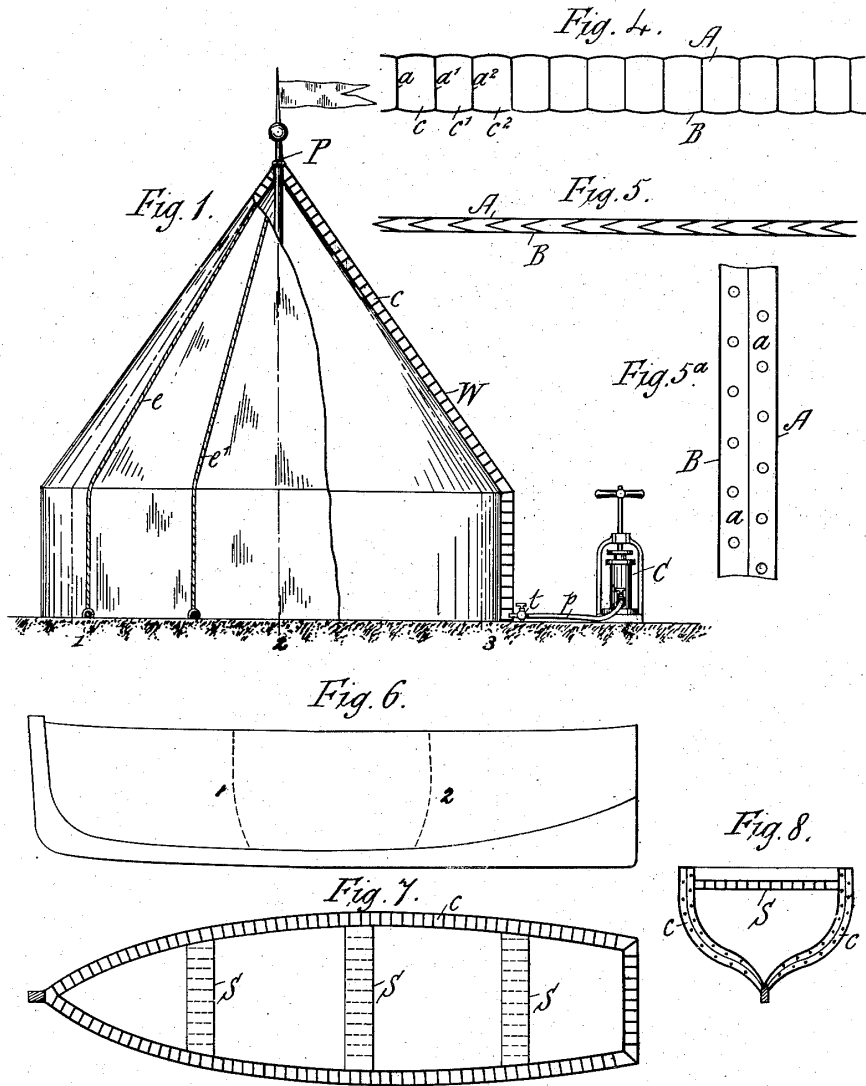
(No Model.)

3 Sheets—Sheet 1.

M. C. J. G. GIESSMANN.  
INFLATABLE WALL TENT.

No. 468,455.

Patented Feb. 9, 1892.



Witnesses :-  
E. H. Sturtevant.  
L. M. Low.

Inventor:  
M. C. J. G. Giessmann  
by Richards & Co.  
attorneys

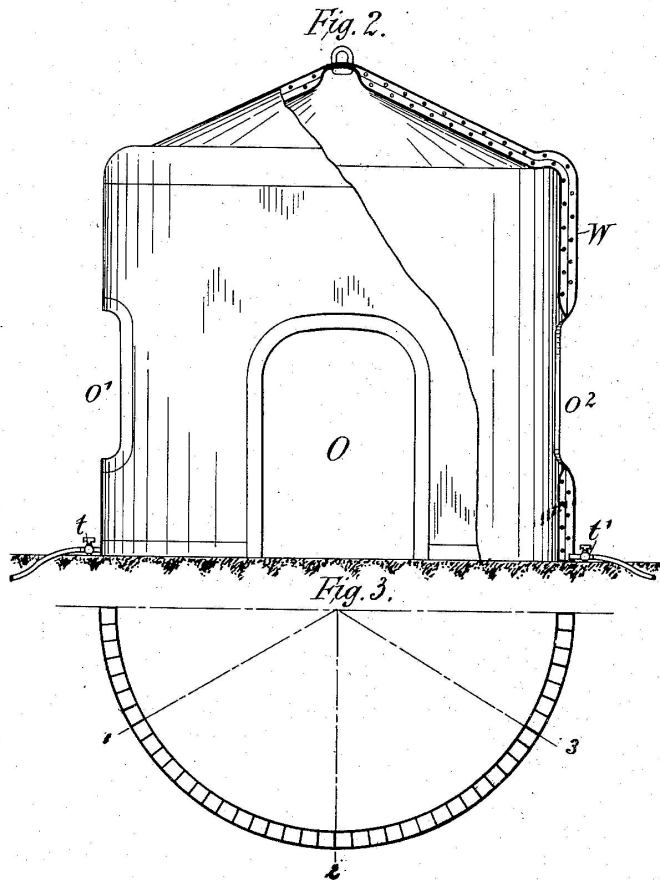
(No Model.)

3 Sheets—Sheet 2.

M. C. J. G. GIESSMANN.  
INFLATABLE WALL TENT.

No. 468,455.

Patented Feb. 9, 1892.



Witnesses:  
E. K. Stewart  
L. M. Low

Inventor :-  
M. C. J. G. Giessmann,  
by Richards & Co.,  
attorneys

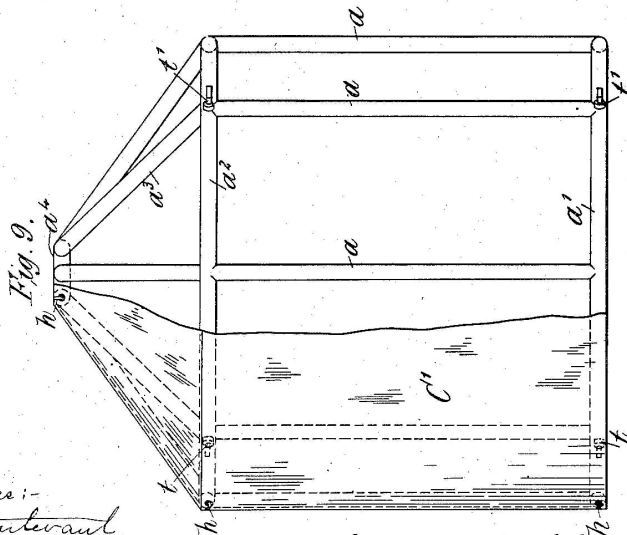
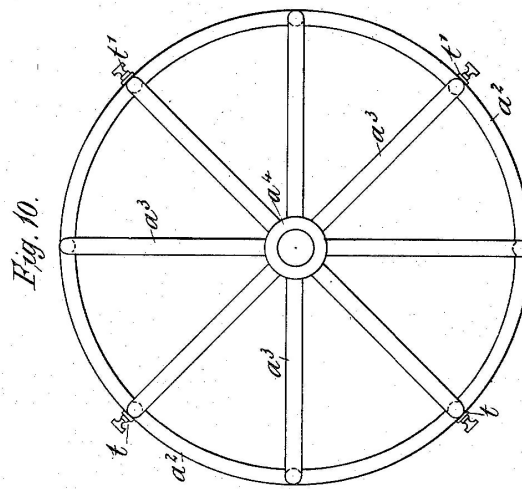
(No Model.)

3 Sheets—Sheet 3.

M. C. J. G. GIESSMANN.  
INFLATABLE WALL TENT.

No. 468,455.

Patented Feb. 9, 1892.



Witnesses:-  
E. K. Sturtevant.  
L. M. Low

Inventor, M. C. J. G. Giessmann,  
by Richards & Co.,  
attys.

# UNITED STATES PATENT OFFICE.

MAX CARL JOHANN GOTTLIEB GIESSMANN, OF LONDON, ENGLAND.

## INFLATABLE WALL-TENT.

SPECIFICATION forming part of Letters Patent No. 468,455, dated February 9, 1892.

Application filed April 8, 1891. Serial No. 388,175. (No model.)

To all whom it may concern:

Be it known that I, MAX CARL JOHANN GOTTLIEB GIESSMANN, engineer, a subject of the Queen of Great Britain, residing at London, in the county of London, England, have invented a certain new or improved inflatable and collapsible cellular wall, shell, or covering applicable to the construction of portable tents, huts, marquees, boats, and other hollow objects, of which the following is a full, clear, and exact description.

My invention relates to a new or improved wall, shell, or covering composed of inflatable and collapsible cells or chambers applicable to the construction of portable tents, huts, marquees, boats, and other hollow objects.

The chief object of my invention is to so construct tents, boats, trunks, and other similar objects which are formed of textile fabrics that they can be readily folded, rolled, or packed for transport, so as to occupy a very small space, while on arriving at their destination they can be unpacked, unrolled, or unfolded and then rapidly inflated with air entirely or in sections, whereby these objects can be used in their different capacity in the same manner as if they were built up—*i. e.*, made of solid material, such as wood, iron, or the like—such inflation being effected by means of an air-pump of small dimensions.

My invention is particularly applicable and especially valuable for explorers and their escort traveling in the unknown and dusky regions of Africa or in other parts, who will now be able to carry in a small bulk all the appliances or implements required to protect them from climatic *intemperies*, and in the case of trunks and the like to carry their food and provisions, which as they are being consumed will unburden some of the trunks, which can be immediately rolled and packed away, so as to occupy a considerably reduced volume. A similar advantage is obtained in the case of boats, which can be inflated and used to cross a river, then collapsed, folded, and placed in wagons or on camels' backs, so that a small fleet can be at any time improvised, and yet be carried wholly in a small wagon or on a single camel's, mule's, or horse's back.

In carrying my invention into practice I

form within two outer sheets of moderately-thick canvas, india-rubber cloth, or other suitable material a series of vertical or horizontal rectangular cells or chambers by means of collapsible perforated partitions of similar but thinner material, which partitions can be folded centrally in one sense or the other until the two outer sheets come in contact. A suitable number of cells or chambers form a section, the different sections in which the object is divided being inflated separately to prevent, in the event of one of the sections being torn open, hence collapsed, the other sections from being affected thereby. The partition forming the boundary of two sections is made solid instead of being perforated like the other.

According to a modification of my invention I provide collapsible tubes or pipes arranged in such a manner that when inflated they form vertical supports connected by an upper and a lower tubular ring surmounted by a tubular frame for the roof, the whole constituting the frame-work of the object required, such frame-work being covered inwardly or outwardly, or both, by sheets of canvas, india-rubber cloth, or other suitable material suspended from the upper tubular ring or fixed to the said tubes or pipes, the latter being provided with taps which, when closed and after the frame-work has been inflated, divide the latter into sections, so that if one of the pipes were torn open the remainder of the frame-work would not collapse; and in order that my invention may be more fully understood I have shown the same in the accompanying two sheets of illustrative drawings.

Referring to Sheet 1, Figure 1 illustrates in elevation, partly in section, the application of my invention to one form of tent or hut. Figs. 2 and 3 are respectively an elevation partly in section and a horizontal half-section illustrating the application to another form of tent or hut. Figs. 4 and 5 show my arrangement of cells or chambers in an inflated and collapsed state, respectively. Fig. 5<sup>a</sup> shows one of the perforated partitions. Figs. 6, 7, and 8 show, respectively, a side view, a sectional plan, and a cross-section of a boat constructed according to my invention. Re-

ferring to Sheet 2, Fig. 9 is an elevation, and Fig. 10 a plan, of a modification of my invention likewise applied to a tent.

The above drawings show the various objects inflated. When collapsed, they may be made to assume any desired shape.

The arrangement of cells or chambers herebefore mentioned is fully illustrated in Figs. 4, 5, and 5<sup>a</sup>, A and B being the two outer sheets of canvas, india-rubber cloth, or other material divided by the partitions  $a^1 a^2$  into cells or chambers  $c^1 c^2$ , &c., which are perforated, as shown in Fig. 5<sup>a</sup>, the whole forming a cellular wall. These partitions may be also formed with gauze. This cellular wall is used to form tents such as shown in Figs. 1 and 2.

In Fig. 1 the cellular wall is fixed at the top to a pole P and also the shape shown. Suitable ropes or cords  $e e'$ , &c., are fixed at one end to the said pole and at the other to staples, hooks, or pegs forced in the ground. The cellular wall W, the series of cells of which are arranged horizontally, is divided in sections at 1 2 3, &c., each section being provided with a tap  $t$ , which is connected to the india-rubber pipe  $p$  of the air-pump C, the boundary partition of each section being solid.

Figs. 2 and 3 show the application of my invention to another tent provided with openings  $O o'$ , the former forming a doorway and the other two windows,  $t t'$  being, as above, taps which are connected in turn to the india-rubber tube  $p$  of the air-pump C in order to successively inflate the various sections. In this application the cells of the wall W are arranged in a vertical direction. 1 2 3, &c., indicate the different sections or impermeable joints formed of solid partitions.

Figs. 6, 7, and 8 show the application of the invention to a boat, the sides of which are formed of a cellular wall W, formed of a single row of cells or chambers. The seats S are formed in the same manner. 1 2 3 are

the sectional joints.  $h$  is a keel made of a solid or hollow piece of india-rubber or other substance.

Figs. 9 and 10, Sheet 2, show a modification of my invention, according to which I use a number of collapsible pipes or tubes  $a a$ , &c.,  $a^1 a^2 a^3 a^4$ , &c.,  $a^4$ , arranged and connected together so as to form the frame-work of the tent, which is covered subsequently by canvas or other material.  $a a$  &c., are vertical tubes connected at the bottom with another tube  $a^1$ , curved in the form of a ring and at the top with a ring  $a^2$  similarly formed. The tubes  $a^3 a^4$  &c., represent the rafters and are connected to the ring  $a^2$  and the small ring  $a^4$  at the top. C' is the covering material torn off, as shown, to illustrate the tubular frame-work and fixed by hooks  $h h h$ , &c., to the rings  $a^1 a^2$ , and  $a^4$ . The tubes are welded or cemented together wherever they meet.  $t t'$ , &c., are taps fixed at the junction of the vertical and inclined tubes at the upper and lower rings  $a^1 a^2$ .

Instead of forming in the applications above described a number of cells into sections, I may allow all the cells to communicate, so that the object formed therewith may be inflated at once. I may connect the taps of several sections to a common feeding-pipe.

Having thus particularly described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. A cellular tent the cellular wall of which has a tap for each section, substantially as described.
2. A cellular tent the cellular wall of which has a tap for each section and a flexible pipe connected to each tap, substantially as described.

MAX CARL JOHANN GOTTLIEB GIESSMANN.

Witnesses:

A. J. ELL,

FRANK HUGHES,

76 Chancery Lane, London, W. C.



**2. SUMOVSKI, Joachim Adolfovicz, n° RUS 511,472.  
1892-1893**

**Estructura tubular rellena con fluido gaseoso**

Nota\* Aplicado para aire y/u otros gases

<b>Solicitud</b>	17 octubre 1892
<b>Fecha</b>	26 diciembre 1893
<b>Lugar</b>	San Petersburgo, Rusia
<b>Inventor</b>	J. A. Sumovski
<b>Patente n°</b>	RUS 511,472
<b>Título</b>	<i>Tubular structure filled with gaseous fluid</i>



(No Model.)

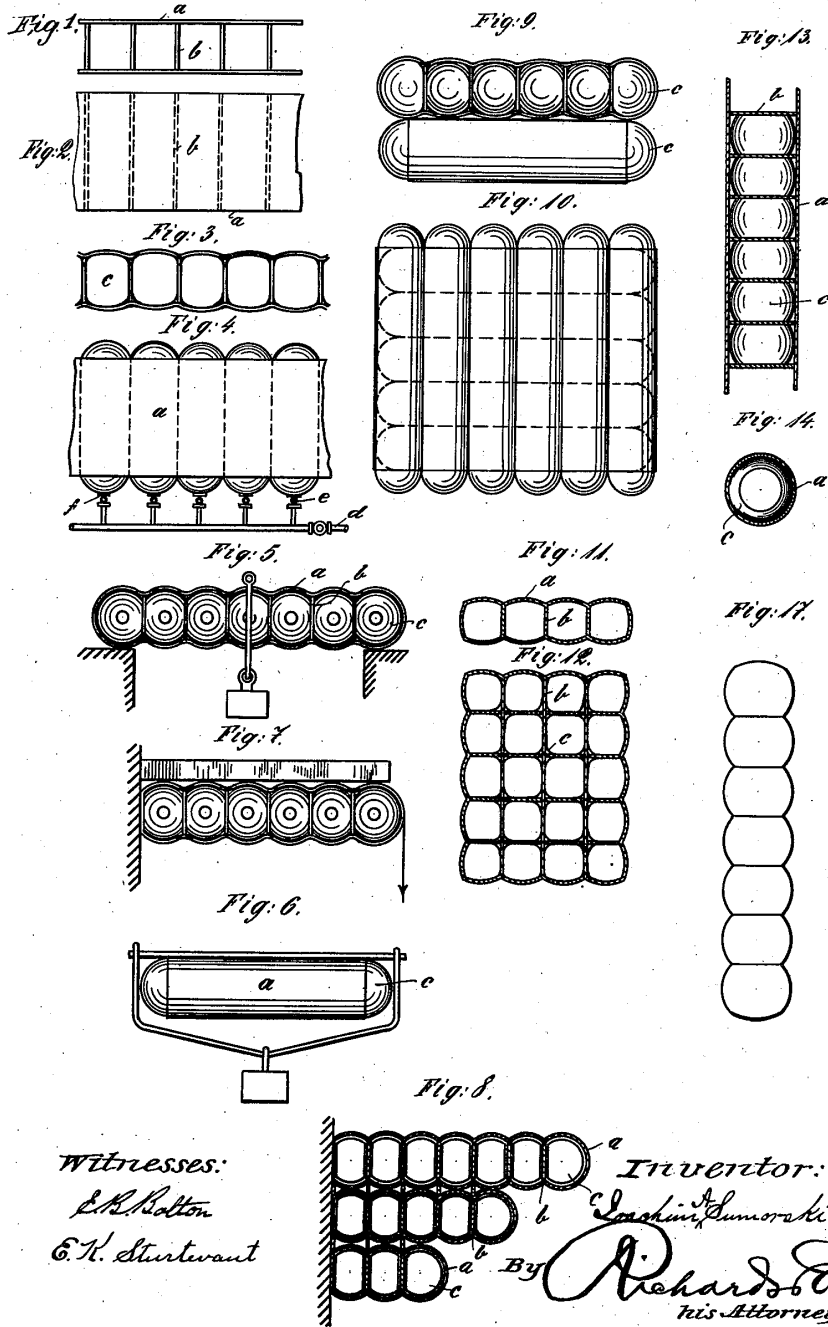
3 Sheets—Sheet 1.

J. A. SUMOVSKI.

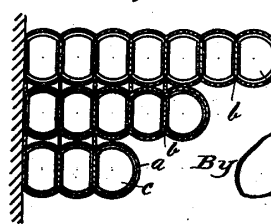
TUBULAR STRUCTURE FILLED WITH GASEOUS FLUID.

No. 511,472.

Patented Dec. 26, 1893.



Witnesses:  
 E. H. Bolton  
 C. H. Sturtevant



Inventor:  
 J. A. Sumovski  
 By *Richardson*  
 His Attorneys

(No Model.)

3 Sheets—Sheet 2.

J. A. SUMOVSKI.

TUBULAR STRUCTURE FILLED WITH GASEOUS FLUID.

No. 511,472.

Patented Dec. 26, 1893.

Fig. 15.

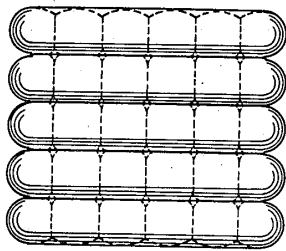


Fig. 16.

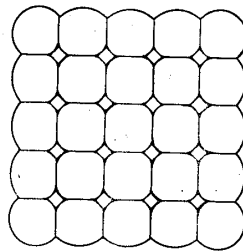


Fig. 22.

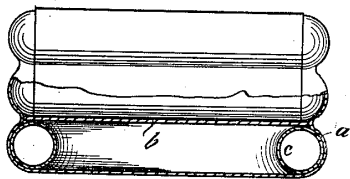


Fig. 23.

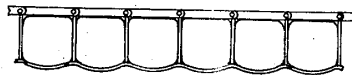


Fig. 18.

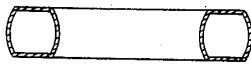


Fig. 20.

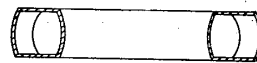


Fig. 19.

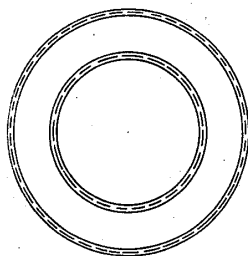


Fig. 21.

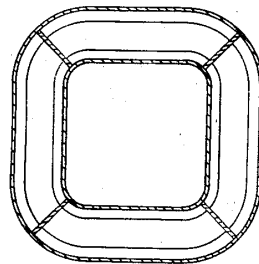
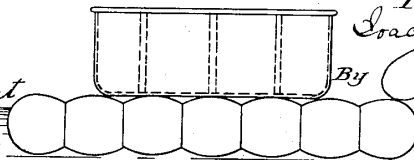


Fig. 24.



Witnesses:

L. H. Bolton

E. H. Sturtevant

Inventor:

Joaquin Sumovski

By

Richardson

his Attorneys.

(No Model.)

3 Sheets—Sheet 3.

J. A. SUMOVSKI.

TUBULAR STRUCTURE FILLED WITH GASEOUS FLUID.

No. 511,472.

Patented Dec. 26, 1893.

Fig. 25.

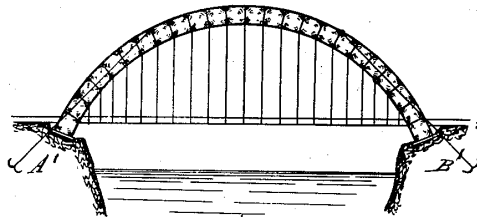


Fig. 26.

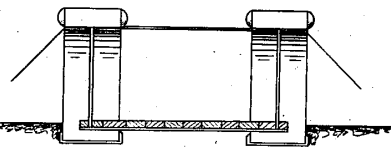


Fig. 27.

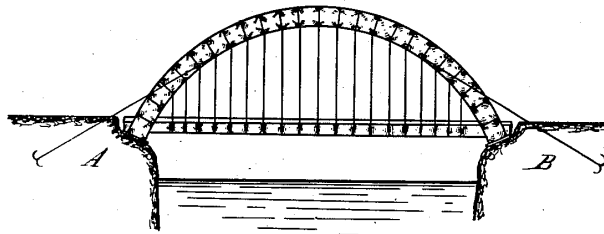


Fig. 28.

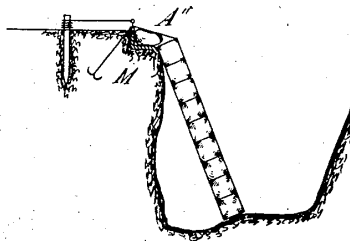
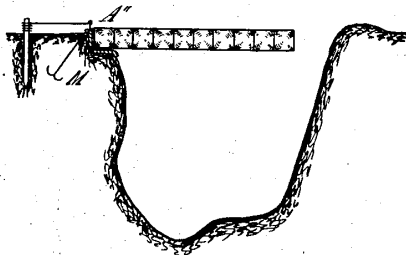


Fig. 29.



Witnesses

*E. H. Bolton*

*E. H. Sturtevant*

Inventor:

*J. A. Sumovski*

By

*Richardson*  
his Attorneys

# UNITED STATES PATENT OFFICE.

JOACHIM ADOLFOVICZ SUMOVSKI, OF ST. PETERSBURG, RUSSIA.

TUBULAR STRUCTURE FILLED WITH GASEOUS FLUID.

SPECIFICATION forming part of Letters Patent No. 511,472, dated December 26, 1893.

Application filed October 17, 1892. Serial No. 449,179. (No model.)

*To all whom it may concern:*

Be it known that I, JOACHIM ADOLFOVICZ SUMOVSKI, a subject of the Emperor of Russia, residing at St. Petersburg, Russia, have invented certain new and useful Improvements in Tubular Structures Filled with Gaseous Fluid, of which the following is a specification.

The subject matter of the present invention is a bearer, which consists of flexible hollow bodies of whatsoever shape, but of same shape relatively to each other, and located next to each other and filled with air or gas. The hollow bodies are surrounded by a common casing and are separated the one from the other by partition walls connecting with said casing; the separation being made in such a way that each of the hollow bodies for itself is located in a chamber of the casing. A bearer constructed in such a way out of hollow bodies connected with each other offers sufficient resistance to bending and pressure so that it can be used with success for diminishing the draft of ships, for constructing bridges over precipices and rivers and for building purposes.

In annexed drawings I have shown several constructions and applications of the invention.

In the drawings:—Figures 1, 2 and 3 are views of the casing for containing the inflated bags. Fig. 4, is a plan view showing the manner of inflating the bags. Figs. 5, 6, 7 and 8, show different arrangements of the bearers to sustain different weights. Figs. 9 and 10, show two series of bags placed at right angles to each other. Figs. 11, 12, 13 and 14 are sectional views of modifications. Figs. 15, 16 and 17 show further modifications. Figs. 18, 19, 20 and 21 show bags in the form of rings. Fig. 22, shows the rings arranged together. Fig. 23, is a modified form of casing. Fig. 24, shows how the structure can be used for floating a vessel. Figs. 25, 26 and 27 show the structure embodied in a bridge. Figs. 28 and 29 show how it may be used for crossing a ravine or the like.

Figs. 1 and 2 show a casing divided into chambers formed by two longitudinal bands *a*, and several cross bands *b*, connecting those two bands the one to the other. These bands are made of an ordinary tissue sufficiently re-

sistant, for instance linen, or of tissues with a wire netting or of flexible metallic tissue. A bag *c* of flexible and impermeable tissue is drawn through each of the chambers formed by the bands in such a manner that an equal part of said bag projects outside from each side of the casing or chamber. These bags are filled with air and assume the form shown in Figs. 3 and 4. The filling is done by means of a tube *d*, Fig. 4, which is provided with cocks and carries small branch tubes, the extremity of each of which is connected with one of the bags *c*. After the filling is completed, each of the bag extremities through which the filling took place is shut tight in any convenient way and they are removed from the tubes. The bags are preferably made of rubber, gummed linen or of a tissue covered with linseed oil, varnish and gum lac. In order to make the bags very strong and impermeable it is advisable that each bag consists of two or more bags put the one into the other and connected by gum lac, so that the wall of each bag consists of two or more layers of tissue. A bearer thus constructed of inflated bags and bands can when resting with both ends on supports, carry a large weight without sagging and without any bursting of the bags. If said bearer is fixed to a wall by one extremity, Fig. 7, it can carry a weight evenly divided upon its upper part and moreover another weight hanging down at its free extremity. Such free bearing bearers, as Fig. 7, can be elevated the one above the other in the way as shown in Fig. 8, in order to make the same more resisting against sagging.

If it is desired to construct a bearer which offers still greater resistance against sagging, it is possible to obtain it in the following manner: Two bearers of the kind as shown in Figs. 3 and 4 are put together in such a manner that the bags of one of them cross those of the other at a right angle, Figs. 9 and 10; or, instead of cylindrical bags I may use spherical bags and I locate the same in a flat casing divided into chambers by longitudinal and cross partition walls, Figs. 11 and 12, or in a tubular casing divided into chambers by cross walls, Figs. 13 and 14. Bearers of the latter kind can be put together as shown in Figs. 15 and 16.

Instead of the cylindrical bags, Fig. 3, or of the bearer in the shape of a column, Fig. 13, it is possible to use tubes, Fig. 17, which are divided in separate chambers by cross partition walls and of which each chamber is filled with air separately, for the construction of a bearer the form of which corresponds to what is shown in Figs. 4, 10, 12, and 16. It is also possible to dispose hollow rings of the shape as shown in Figs. 18 to 21, or constructed from the tube shown in Fig. 17, the one above the other or the one next to the other, combining the same by longitudinal and cross bands, Fig. 22.

In certain cases, when the bearer must be used as a floating bridge said bearers as shown in Figs. 3 and 4 instead of being connected by one longitudinal flexible band only, are connected by a longitudinal band consisting of stiff pieces connected to each other in an articulated way, the articulations or hinges of which are located between the two bags being next to each other.

Fig. 24 represents a ship lifted out of the water by a raft like bearer of the kind shown in Figs. 3 and 4. The raft like bearer is fixed to the keel of the ship when not inflated and is then inflated with air. Vessels can be lifted very high by so doing, and so high that they can easily pass through shallow places, &c., without it being necessary to unload previously part of the cargo.

Figs. 25 to 27 show a bridge constructed of the described bearers. In this case the bearers are of an arched shape. The ends of the same rest at A' and B' on the banks of the stream

and are fixed by the means of anchors. The platform instead of being constructed of boards can also be made of a bearer of the described kind, covered with a flooring, as shown in Fig. 26.

Figs. 28 and 29 show how the bearer can be used for constructing a bridge over a precipice. The first bag A'' or the part of the casing surrounding the same is connected with an end abutment M, which is fixed in the ground by an anchor. First all the bags are filled except the bag A'' and the bearer is put in the position as shown by Fig. 28. The bag A'' is then filled and the bearer is brought in the position shown in Fig. 29.

The described bearer can be used further for the construction of tents, barracks, wind motors, &c.

I claim—

A bearer comprising the casing divided into a series of compartments by flexible partition walls connected with and extending between the opposing sides of the casing and the inflated bags in the compartments filling the same and bearing against the partitions to form a continuous bearer, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOACHIM ADOLFOVICZ SJMOWSKI.

Witnesses:

KOTALEL MIECZYSTAEOEVIEL  
MOVZYELZ,  
STANISLAW KONSTANDINOWITSEL  
SWIZTUK.



### 3. SUMOVSKI, Joachim adolfovicz, n° RUS 510,492. 1893

#### Globo

Nota\* Aplicado para aire y/u otros gases

<b>Solicitud</b>	23 enero 1893
<b>Fecha</b>	12 diciembre 1893
<b>Lugar</b>	Kursk, Rusia
<b>Inventor</b>	J. A. Sumovski
<b>Patente n°</b>	RUS 510,492
<b>Título</b>	<i>Balloon</i>

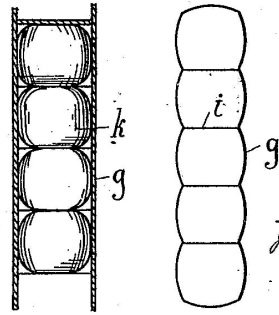
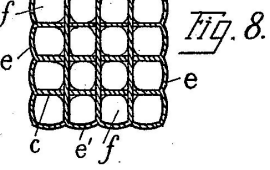
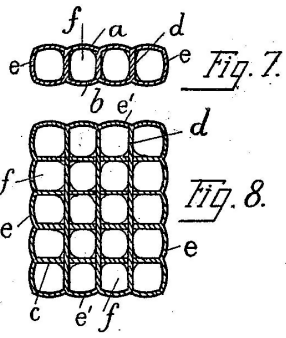
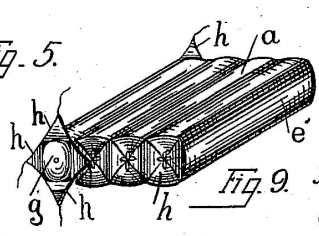
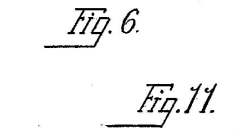
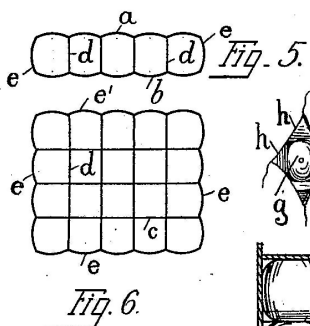
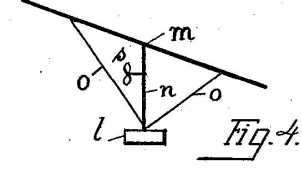
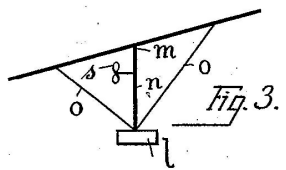
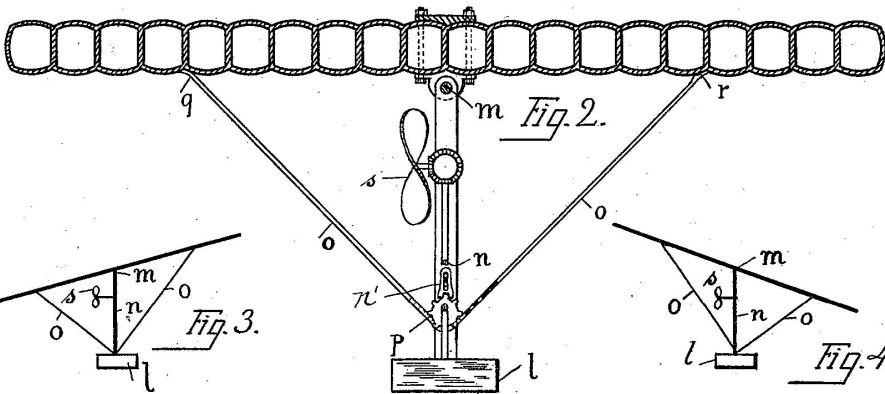
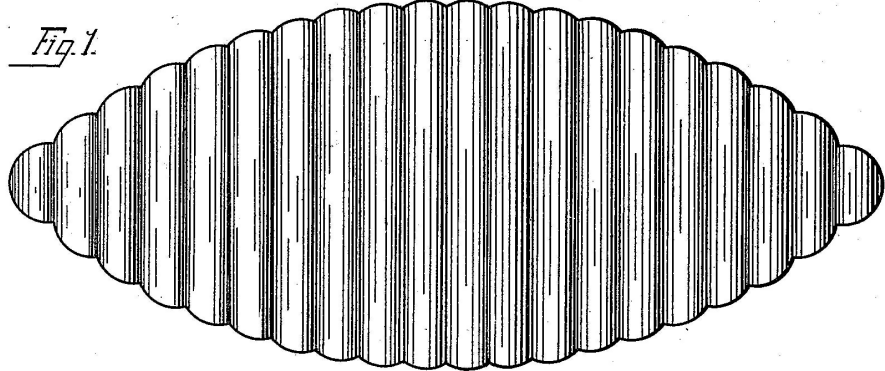


(No Model.)

J. A. SUMOVSKI.  
BALLOON.

No. 510,492.

Patented Dec. 12, 1893.



Witnesses:  
E. H. Stewart  
E. W. Amos

Fig. 10. Inventor:  
Joachim Adolpawicz Sumowski,  
by *Richardson*  
attorneys.

THE NATIONAL LITHOGRAPHING COMPANY,  
WASHINGTON, D. C.

# UNITED STATES PATENT OFFICE.

JOACHIM ADOLFOWICZ SUMOVSKI, OF KURSK, RUSSIA.

## BALLOON.

SPECIFICATION forming part of Letters Patent No. 510,492, dated December 12, 1893.

Application filed January 23, 1893. Serial No. 459,344. (No model.)

*To all whom it may concern:*

Be it known that I, JOACHIM ADOLFOWICZ SUMOVSKI, a subject of the Emperor of Russia, residing at Kursk, a city of the Russian Empire, have invented certain new and useful Improvements in Balloons, of which the following is a specification.

The object of this invention is certain improvements in balloons and consists of a flat shape envelope provided with partitions forming compartments or chambers, each of which may be separately filled with gas or receive a bag or casing charged with gas.

In the accompanying drawings, Figures 1 and 2 are a plan and a vertical longitudinal section respectively of this improved balloon. Figs. 3 and 4 are diagrams showing how the balloon should be set or arranged when it is required to ascend or descend obliquely. Fig. 5, is a diagrammatic view of the cell structure of the balloon case. Fig. 6, is a plan view of the same. Figs. 7 and 8, are sectional views of the cell case adapted to receive air pockets or bags. Fig. 9, is a perspective view showing the manner of inclosing the independent air bags in the case. Fig. 10, is a plan view of a compartment air bag, and Fig. 11, is a sectional view of a modification.

The simplest mode of forming the balloon is as follows: Two pieces of material of equal size *a* and *b*, Figs. 5 and 6, are connected together by longitudinal or transverse partitions *c* or *d*, and are joined at their edges by strips of material *e*, *e'*, in such a manner as to form a flat cushion like casing closed on all sides and subsequently divided by the partitions *c* and *d* into gas tight chambers separately filled with gas. Instead of filling the said chambers with gas, each chamber may be provided in the course of the manufacture of the envelope with a hollow bulb *f* filled with gas, Figs. 7 and 8, the sides which are formed of flexible material. The hollow bulbs may also be inserted in a collapsed condition in the chambers and subsequently inflated with gas when the envelope is completed through openings which can be readily closed.

By dispensing in the envelope shown in Figs. 5 and 6, with the longitudinal partitions *e* and the edge strips marked *e'*, an envelope

is produced, the two end chambers of which are left open. In each of these open chambers is inserted a bolster like bag *g* close at its two circular or spherical ends (Fig. 9) and made of flexible material which is inflated with gas after it has been placed in position. Each bag is somewhat longer than the corresponding chamber or compartment, so that the spherical ends project slightly beyond the envelope. To prevent this tubes or bags slipping out of the envelope, flaps or bands *h* fixed to the envelope and to its partition walls or forming extensions of the envelope and of its partitions, are attached crosswise over these tubes or bags.

In Fig. 9, the three bags on the right hand side are shown fully closed, while the end of the fourth bag on the left hand side is shown uncovered, the flaps *h* being thrown back. The tubes *g* may be likewise divided into compartments by transverse partitions *i*, Fig. 10; and moreover, instead of filling each one of these compartments with gas, they may be supplied with a hollow case or bulb *k*, Fig. 11, filled with gas in the course of the manufacture of this tube or bag.

The balloon manufactured according to one of the methods above described is preferably made to assume the shape shown in Figs. 1 and 2, and is attached by a frame *n* to the car *l* in such a manner as to be capable of turning, relatively to the car, upon its transverse axis *m*, or upon an axis parallel to the former but placed somewhat lower as shown in the drawings and firmly connected to the balloon, the car being suspended to the same.

The adjustment of the balloon in an oblique position (see Figs. 3 and 4) is effected by means of a chain *o* passing in the middle over a chain wheel *p* Fig. 2, arranged on or in the car, while its ends are connected to the balloon at *q* and *r*. The chain wheel may be fixed in any suitable position by any suitable form of gravity pawl *n'* engaging the chain wheel. The fixing of the chain wheel makes the balloon rigid.

s, Figs. 2, 3 and 4 shows a screw of the form ordinarily used for balloons propelled by screws, and which is driven by a motor placed in the car.

When the balloon is constructed of bags in

the manner shown in Fig. 9, two, three, or more tubes or bags can be inserted telescopically one within the other for the purpose of making them resistant and thoroughly impermeable, these tubes or bags being connected together by their coverings, or in any other suitable manner, so that the wall of each bag may consist of two or more layers of material connected together.

10 Having now particularly described and ascertained the nature of this invention and in what manner the same is to be performed, I declare that what I claim is—

1. In combination, the casing having elongated bags inserted therein having cells, sub-

stantially as described. 15

2. In combination, the casing divided into compartments, elongated bags adapted to said compartments, each of said bags being provided with cells and inflated bags in said 20 cells, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOACHIM ADOLFWICZ SUMOVSKI.

Witnesses:

W. HAUPT,  
C. G. VOGT.



#### 4. LANCHESTER, Frederick William, nº EN 1,302,182.1919

**Construcción para tiendas de campaña para hospitales en el campo, depósitos y propósitos similares**

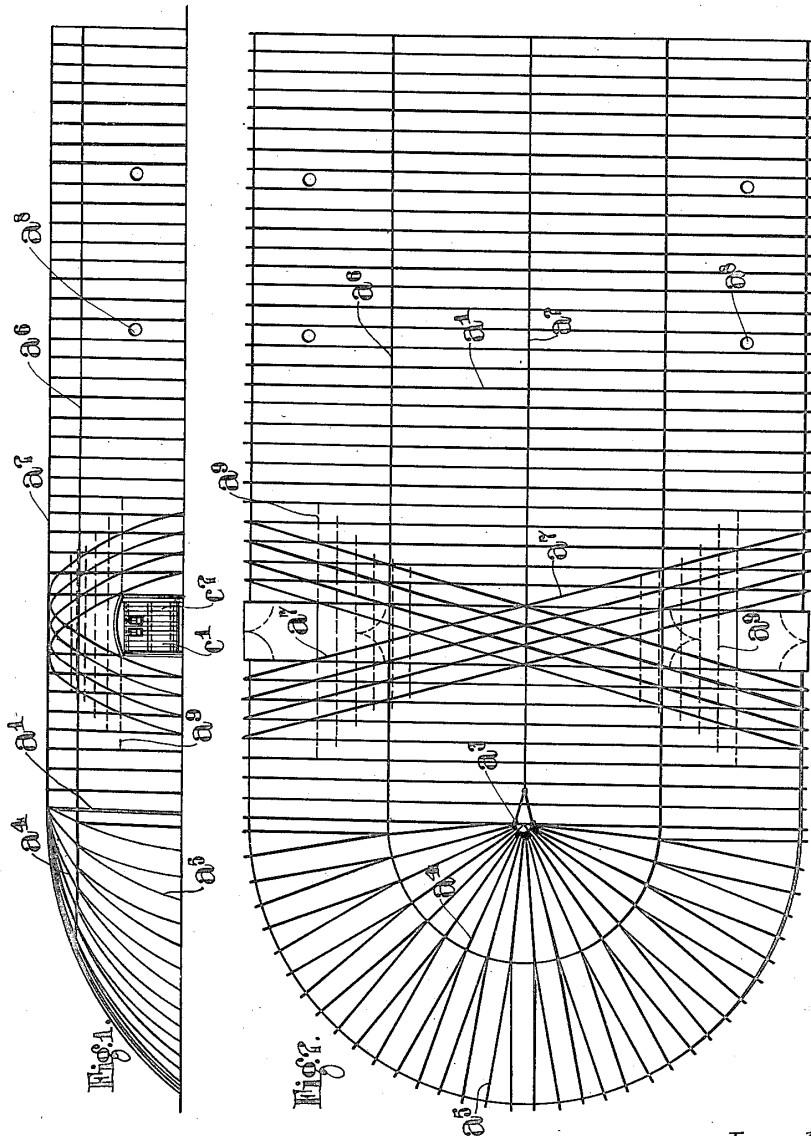
Nota\* Aplicado para aire y/u otros gases

<b>Solicitud</b>	11 febrero 1919
<b>Fecha</b>	29 abril 1919
<b>Lugar</b>	Londres, Inglaterra
<b>Inventor</b>	F. W. Lanchester
<b>Patente nº</b>	EN 1,302,182
<b>Título</b>	<i>Construction of tents for field-hospitals, depots, and like purposes</i>

F. W. LANCHESTER.  
 CONSTRUCTION OF TENTS FOR FIELD HOSPITALS, DEPOTS, AND LIKE PURPOSES.  
 APPLICATION FILED FEB. 11, 1919.

1,302,182.

Patented Apr. 29, 1919.  
 3 SHEETS—SHEET 1.



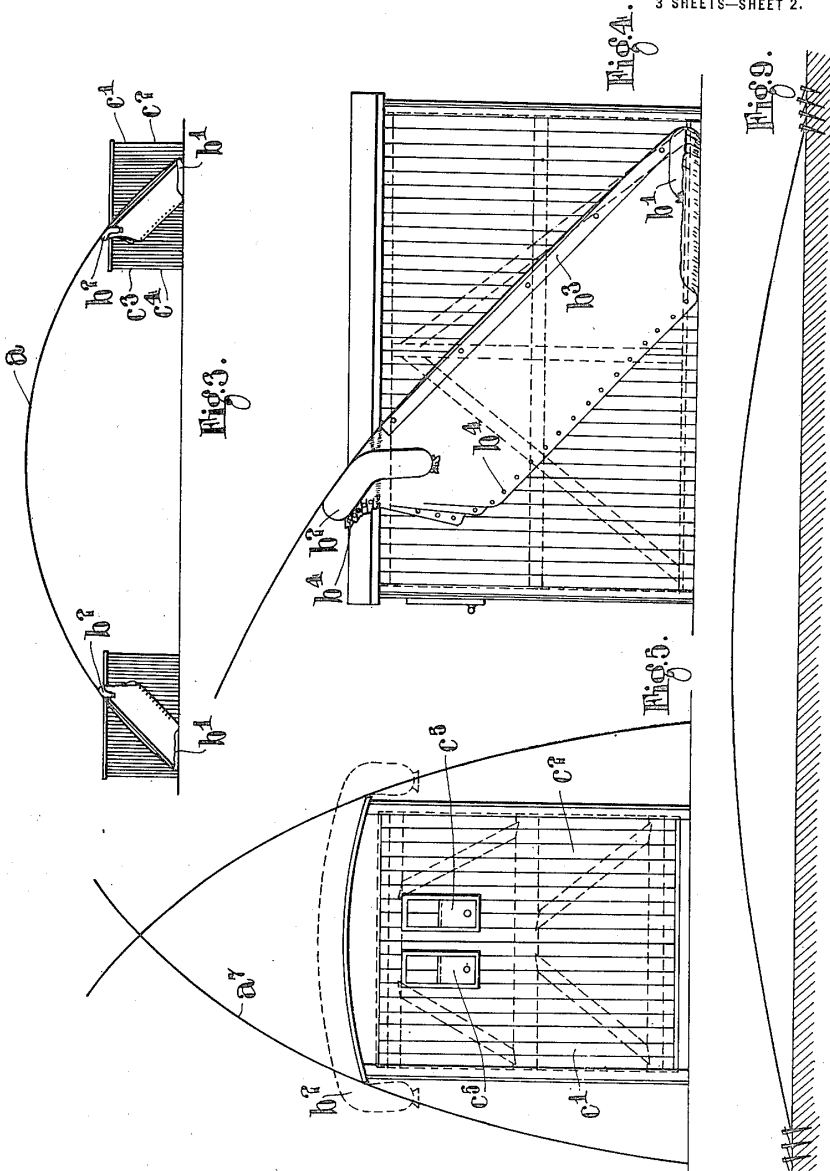
*Inventor.*  
 F. W. Lancheester.  
 By H. R. Kerslake  
 Atty.

F. W. LANCHESTER.  
 CONSTRUCTION OF TENTS FOR FIELD HOSPITALS, DEPOTS, AND LIKE PURPOSES.  
 APPLICATION FILED FEB. 11, 1919.

1,302,182.

Patented Apr. 29, 1919.

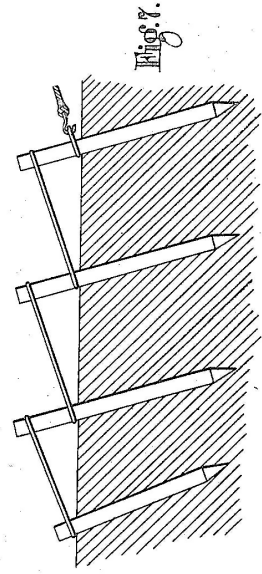
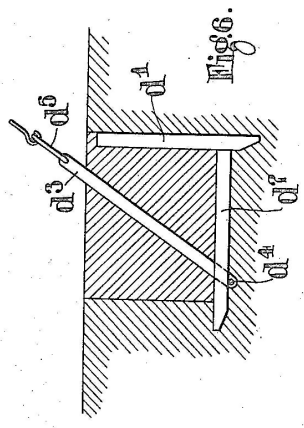
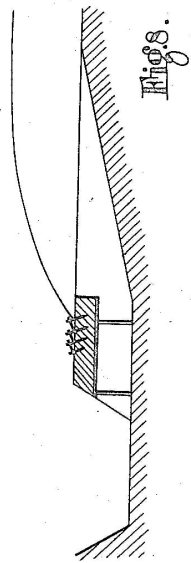
3 SHEETS—SHEET 2.



INVENTOR  
 F. W. Lancaster.  
 BY *H. R. Kerlake*  
 ATTORNEY

F. W. LANCHESTER.  
 CONSTRUCTION OF TENTS FOR FIELD HOSPITALS, DEPOTS, AND LIKE PURPOSES.  
 APPLICATION FILED FEB. 11, 1919.

1,302,182. Patented Apr. 29, 1919.  
3 SHEETS—SHEET 3.



INVENTOR  
*F. W. Lancaster*  
 13Y *H. R. Kerlake*  
 ATTORNEY

# UNITED STATES PATENT OFFICE.

FREDERICK WILLIAM LANCHESTER, OF LONDON, ENGLAND.

CONSTRUCTION OF TENTS FOR FIELD-HOSPITALS, DEPOTS, AND LIKE PURPOSES.

1,302,182.

Specification of Letters Patent. Patented Apr. 29, 1919.

Application filed February 11, 1919. Serial No. 276,379.

*To all whom it may concern:*

Be it known that I, FREDERICK WILLIAM LANCHESTER, a subject of the King of Great Britain and Ireland, and residing at 41 Bedford Square, London, W. C. 1., England, have invented a certain new and useful Improved Construction of Tents for Field-Hospitals, Depots, and like Purposes, of which the following is a specification.

10 The present invention relates to an improved construction of tent for field hospitals, depots, and like purposes.

The present invention has for its object to provide a means of constructing and erecting a tent of large size without the use of poles or supports of any kind. The present invention consists in brief in a construction of tent in which balloon fabric or other material of low air permeability is employed and maintained in the erected state by air pressure and in which ingress and egress is provided for by one or more air locks.

The present invention further consists in a tent maintained in the erected state by air pressure, in the provisions for ingress and egress, for rendering pressure tight, and for lighting hereinafter described.

A tent constructed according to the present invention may be conveniently designed either as a segment of a sphere or as a segment of a cylinder.

In one mode of carrying the present invention into effect, a rectangular sheet of balloon fabric suitably reinforced by bands, ropes or nets, is pegged to the ground along two of its parallel edges, a flap being left beyond the point of attachment which is turned under. The ends of the said rectangular sheet have stitched or laced to them extensions cut after the manner of a spherical balloon to form quadrant segments of spherical or approximately spherical form. These extensions likewise have a marginal flap which is turned under.

The whole of the above having been securely staked and if necessary loaded by ballast the interior is inflated by moderate air pressure by a centrifugal fan, and the whole so inflated forms a tent of segmental form terminated by dome-like ends. The

marginal flap initially turned under in laying out the envelop now forms an air seal in contact with the ground, and where necessary is loaded by sandbags in order to maintain it in close contact and minimize air leakage. One or more doors in the form of an air lock, constructed as hereinafter described, are arranged at suitable points according to the use to which the tent is required to be put. For the purposes of lighting either the fabric employed for the envelop may be made of some transparent or translucent material or panels or portions of it may be of transparent or translucent material, oiled silk may be used for this purpose. Alternatively artificial lighting may be relied upon.

Assuming balloon fabric of fair quality to be employed and the sealing in contact with the earth to be good the supply of air required to maintain inflation against leakage is small in comparison with that required to inflate initially and a comparatively small power installation is required for permanent running. It is desirable to have a certain moderate amount of leakage in order to provide for adequate ventilation. Disused balloon fabric may therefore be used for constructing tents in accordance with this invention.

The pressure required is of the same order of magnitude as that needed in ballons of the non-rigid type and is less than  $\frac{1}{4}$  lb. per square inch. The pressure necessary is related to the velocity of wind and may be increased in bad weather or in order to maintain the envelop against a weight of snow the anchorage requires to be calculated and provision made according to the maximum pressure which it is contemplated will be employed. Where the soil provides an insufficient anchorage the latter may require to be assisted by ballast.

The present invention is more particularly applicable to tents of large size, and permits of a very great span being employed. There is no engineering difficulty in constructing a tent for example of 100 feet span and any length required. The technique of construction in such matters as roping, netting, reinforcing, etc., may

closely follow similar well known methods at present practised in connection with dirigible balloons.

Referring to the accompanying sheets of diagrammatic drawings:—

Figure 1 is an elevation, and

Fig. 2 is a plan, of part of a tent constructed in accordance with the present invention.

Fig. 3 is a transverse section showing two air locks in elevation.

Fig. 4 is a side elevation of an air lock in greater detail.

Fig. 5 is an end elevation of same.

Fig. 6 represents an appropriate anchorage.

Fig. 7 is a section showing an alternative anchorage where the maximum angle of slope is small, as for example where it is important that the tent shall cast no shadow.

Fig. 8 illustrates a method of air lock construction giving access to the structure where the general ground level is above the level of the service road.

Fig. 9 is an example of the employment of anchorage given in Fig. 7.

With reference to Figs. 1, 2 and 3 a number of ropes  $a'$  are secured to appropriate means of anchorage at their extremities; a central ridge rope is provided  $a^2$  terminating in a "banjo" member  $a^3$  from which radial ropes  $a^4$  and  $a^5$  are arranged, similarly connected to a land anchorage, to form the retaining members for the end of the tent or structure. One or more longitudinal rope members  $n^6$  are provided and, at the points where provision is made for an air lock or entrance, diagonal ropes  $a^7$  are provided to reinforce the structure locally and take the place of the transverse ropes that are omitted; as shown more particularly in Figs. 1 and 2, and in Fig. 5.

The air lock Figs. 3, 4 and 5 conveniently takes the form of a van body in which two sets of doors are provided opening inward, as indicated in the plan view Fig. 2.

The van body is adapted to be utilized as a means of packing the whole outfit when transporting the tent from place to place. The diagonal rope members  $a^7$  adjacent to the air lock or entrance, Fig. 5, form, together with the roof of the air lock aforesaid, the figure of the capital letter A and where it is not desired to make the outfit portable the air lock may comprise structural panels filling in the triangular spaces included between the sides and roof of the air lock Fig. 5 and the adjacent rope members aforesaid.

Beneath the rope network constructed and arranged as hereinbefore described a canvas or fabric envelop is provided of low air permeability, the said envelop being cut and sewn or jointed to fit the rope network just as in the case of a balloon of the non-rigid

type. The edges of the envelop do not terminate on the ground line, but allow of a flap extending inward, as shown more particularly in Figs. 3 and 4, the said flap either being pressed to the ground by internal air pressure or, where necessary, being loaded by sand bags as shown at  $b'$ , Figs. 3 and 4. Where the envelop is cut to permit of the insertion of the air locks or entrances a flap is likewise provided and this may be sealed by a sandbag, as shown at  $b^2$  or by strips and bolts as shown at  $b^3$ , or both methods may be utilized and the flap may be additionally nailed, as indicated at  $b^4$ . Reinforcement ropes or bands may be provided as at  $a^8$ ,  $a^9$ . The van bodies serving as air locks are arranged with doors, one pair at each end,  $c'$ ,  $c^2$ , and  $c^3$ ,  $c^4$ , opening in like direction, and apertures may be provided  $c^5$ ,  $c^6$  fitted with sliding doors, both to equalize the pressure when it is desired to open the doors, acting thus in the manner of the sluice gates of a lock, and to allow of observation if required to ascertain that the lock is not otherwise engaged.

For the purpose of lighting the fabric or canvas employed may be translucent or other means may be provided. For example port holes may be fitted in the canvas in the interspace between the adjacent transverse ropes, at a suitable level for lighting purposes and to allow of observation from the interior of the tent, as shown by way of example at  $a^8$ ; for this latter purpose the height of the port holes from the ground level requires to be regulated at about five feet. Alternatively, and as is frequently desirable from a military stand point, the material of the envelop should be opaque and artificial means of lighting exclusively relied upon.

The means of anchorage for the transverse ropes depicted in Fig. 6 comprises wooden planks or balks  $d'$ ,  $d^2$  with an iron tension bar  $d^3$  cottered at  $d^4$  and with a coupling at link  $d^5$ , the said link being connected to its corresponding transverse rope member by a rigging screw or lanyard. The method of constructing the anchorage is to dig a trench of the necessary width and depth, drive the timber in place, and, with the tension bar  $d^3$  in position, fill in and tamp. The vertical component of the load on the tension bar is taken mainly by the filled in and tamped earth, but in part by the driving of the horizontal timber member  $d^2$  under the virgin soil as indicated, the timber member  $d^2$  inserted in an inclined position, being driven down by its butt end while the chamfered end forces its way into the undisturbed soil.

In cases where camouflage is important, as in a military zone, where liable to aerial observation, the tent or structure is made of considerable span and minimum altitude, so

that the maximum roof angle is insufficient to cast a shadow. In such cases the transverse tension members or ropes  $a'$ ,  $a'$ ,  $a'$  may be held by double, triple or multiple picketing, as indicated in Fig. 7.

In erecting a tent or structure in accordance with the present invention it is desirable to employ a centrifugal fan of considerable delivery capacity, the outlet of the fan being coupled up by a flexible conduit to any convenient point in the envelop and the inflation volume being sufficient to take charge of considerable leakage. While inflated by this means the tent may be entered by passing beneath the sealing flap, and sand bags, etc., may be loaded on to the sealing flap at points of leakage in order to make good; also the air locks may be inserted and the sealing around them be made secure. When this is done the permanent air pressure plant, consisting of a comparatively small motor and fan, may be set to work and will be sufficient to maintain the inflation pressure. An appropriate inflation pressure under ordinary weather conditions is about one inch water gage, but in stormy weather as much as two or three inches water gage may become necessary.

In place of the definite distribution of transverse and longitudinal ropes hereinbefore described the ropework may take the form of a net in which the whole of the members are diagonally knotted or cross fastened in any well known manner.

In the case of a tent of circular form the method hereinbefore described as concerns the ends of the structure may be adhered to, the tent taking the form of two ends with no cylindrical portion as figured on the left of Figs. 1 and 2.

If air locks in the form described are insufficient in size, as in the case of stowage for aeroplanes, special locks may be employed of larger dimensions or the whole end of a building may be occupied by an air lock. In such structures it is necessary, however, that the air lock should be of semi-permanent character and either steel or ferro concrete may be conveniently employed to form end buildings containing the lock adapted to be connected by a cylindrical inflated roof constructed as hereinbefore described.

In other cases and on sites where the conditions indicate the method as suitable, access to the structure may be obtained by a tunnel or "cut and cover" with a ramp leading upward to the floor level and such construction is indicated where the site chosen

is adjacent to a sunken road; a diagrammatic example of this is given in Fig. 8.

In order to provide for the excess inflation pressure required when there is a high wind a cowl raised on a stand pipe, or suitably mounted on the top of the tent structure, may be employed, the cowl consisting of a wind catcher pivotally mounted and directed by a weather vane. The wind catcher may consist merely of a right angle bend or hood with the vane so attached that the aperture of the bend is always facing the wind and the said aperture may be flared or made funnel shaped in order to obtain the maximum effect. This device is similar to the ordinary chimney cowl except that the vane is arranged to act in the diametrically opposite sense.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. The combination with a tent supported by air pressure in the interior of the same, of means provided at the lower edge of the tent and rendering the lower edge substantially air tight, and a substantially air tight body arranged in the wall of said tent and having doors provided at each end of the same.

2. The combination with a flexible tent supported by air pressure in the interior of the same and having its edges secured by substantially air tight means, of a hollow body passing through the wall of said tent, and doors provided at each end of said body.

3. The combination with a tent supported by air pressure in the interior of the same, of a flap provided at the lower edge of said tent and rendering the lower edge substantially air tight.

4. In a combination as defined in claim 1, a series of transverse ropes extending across the tent, and a plurality of longitudinal ropes extending lengthwise of said tent.

5. A tent comprising a body portion having its lower edge secured by means of a substantially air tight joint, a series of ropes extending across said body portion and reinforcing the same, a passageway extending through the wall of said body portion and having one of its ends located in the interior of the body portion and its other end located outside of the body portion, and doors provided at the ends of said passage-way and operative independent of each other.

In testimony whereof I have signed my name to this specification.

FREDERICK WILLIAM LANCHESTER.



**HOOD, Robert A, n°US 1,964,818**

**1933-1934**

**Estructura plegable hinchable**

Nota\* Aplicado para aire y/u otros gases

<b>Solicitud</b>	25 marzo 1933
<b>Fecha</b>	3 julio 1934
<b>Lugar</b>	Búfalo, Nueva York
<b>Inventor</b>	R. A. Hood
<b>Patente n°</b>	US 1,964,818
<b>Título</b>	<i>Air-inflated collapsible structure</i>

July 3, 1934.

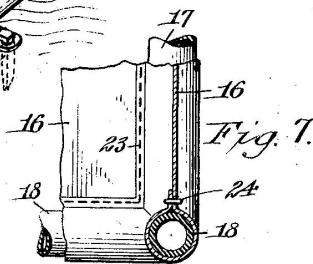
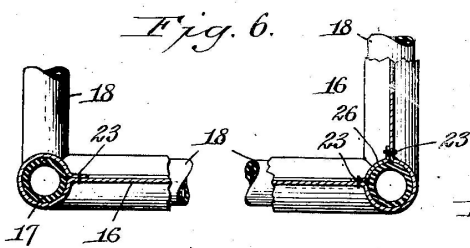
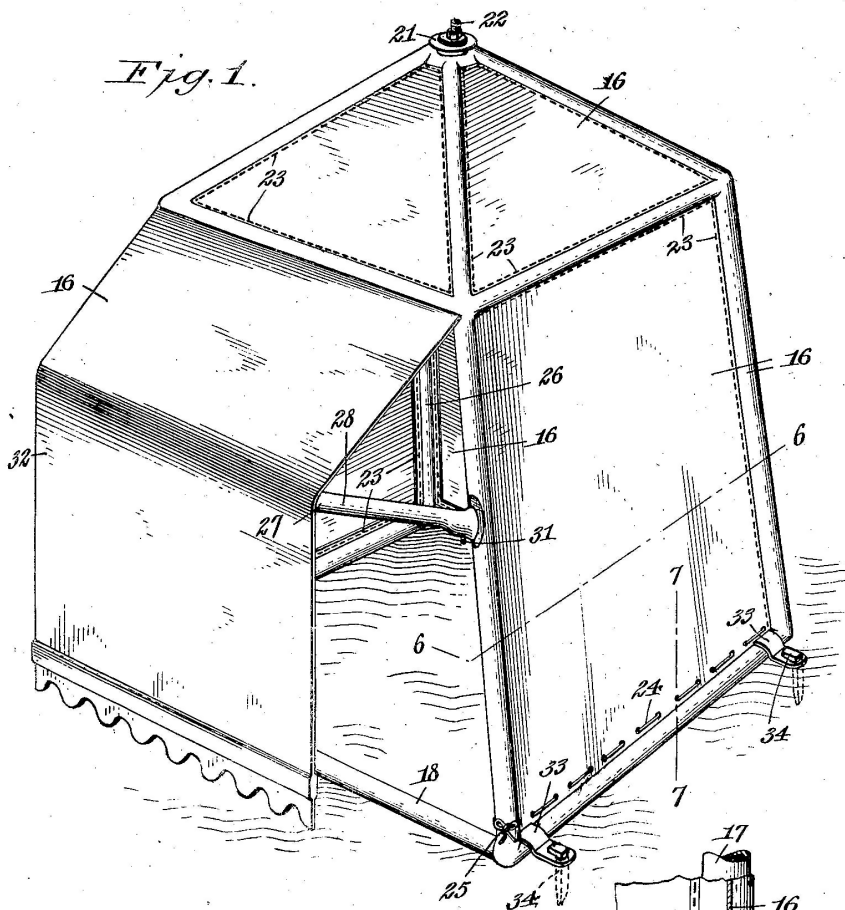
R. A. HOOD

1,964,318

AIR INFLATED COLLAPSIBLE STRUCTURE

Filed March 25, 1933

4 Sheets-Sheet 1



Robert A. Hood,  
Inventor.  
By *Emil Kumberg*  
Attorney.

July 3, 1934.

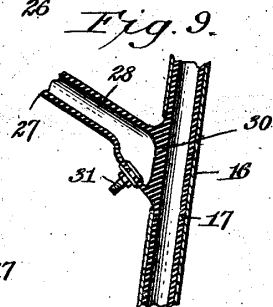
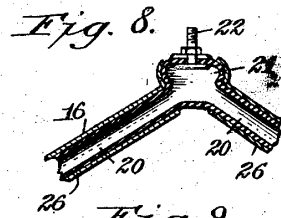
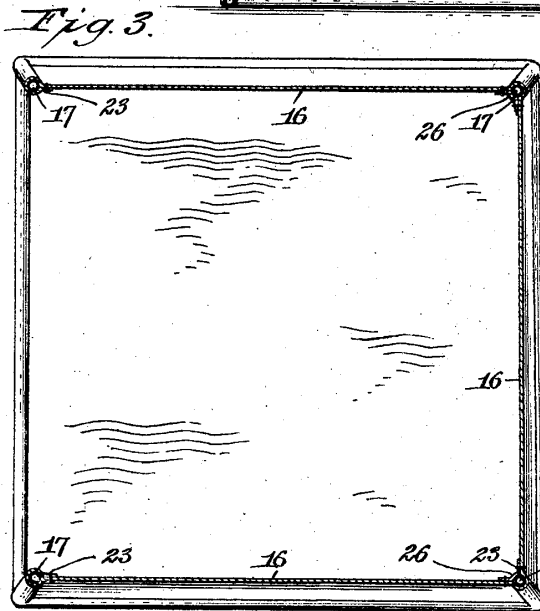
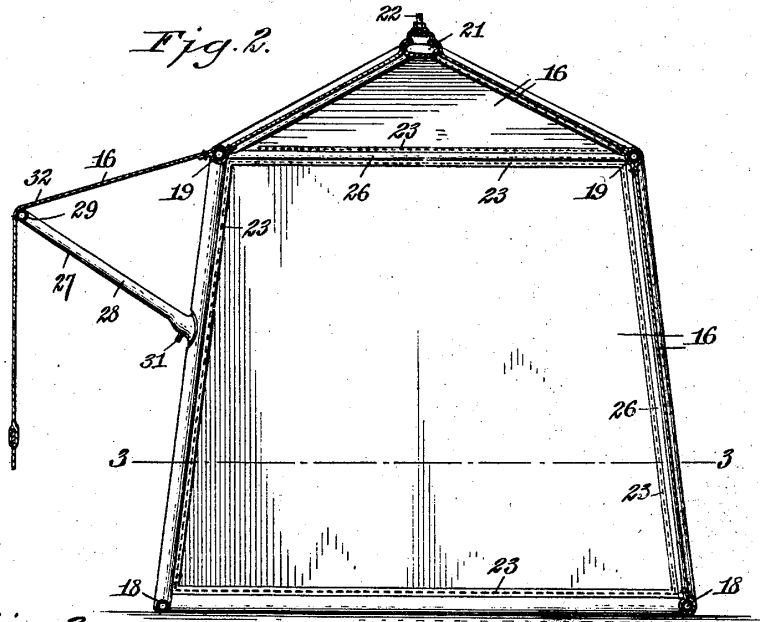
R. A. HOOD

1,964,818

AIR INFLATED COLLAPSIBLE STRUCTURE

Filed March 25, 1933

4 Sheets-Sheet 2



Robert A. Hood,  
Inventor.  
By Emil Neubach,  
Attorney.

July 3, 1934.

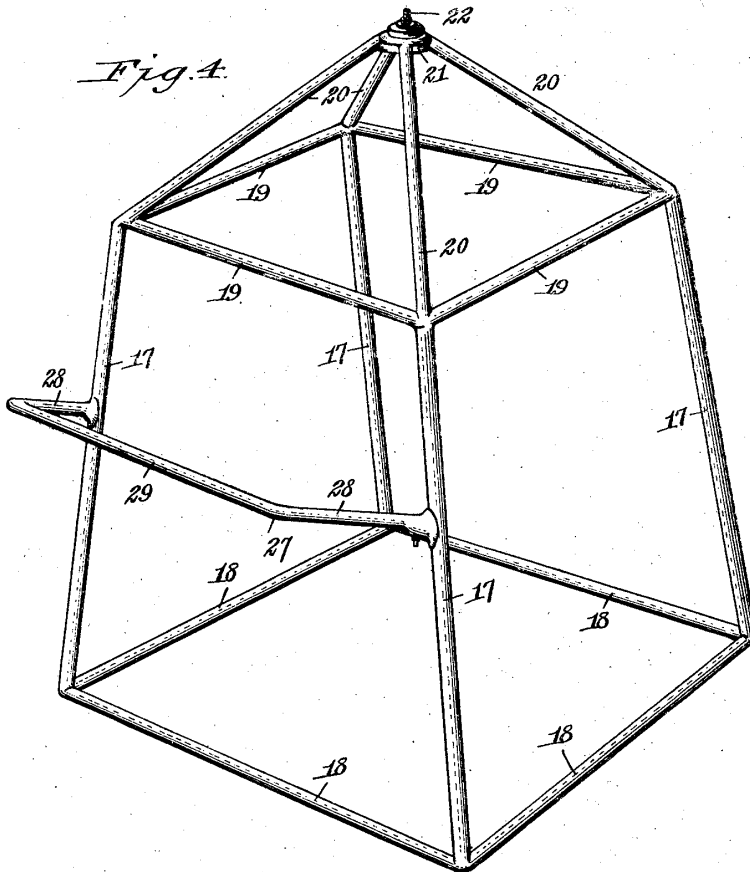
R. A. HOOD

1,964,818

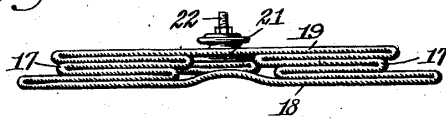
AIR INFLATED COLLAPSIBLE STRUCTURE

Filed March 25, 1933

4 Sheets-Sheet 3



*Fig. 5.*



Robert A. Hood, Inventor.  
By Emil Neubach,  
Attorney.

July 3, 1934.

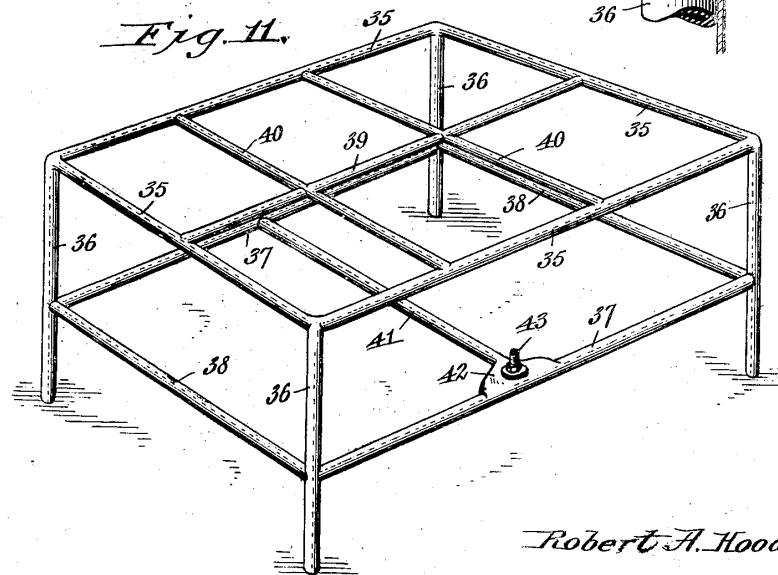
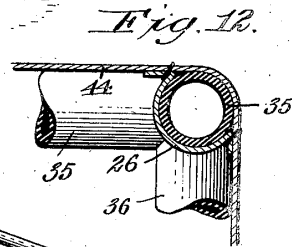
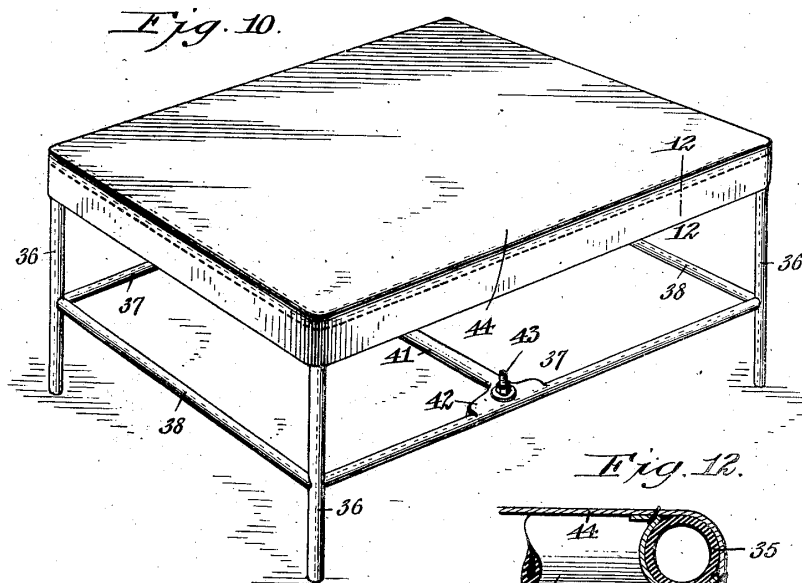
R. A. HOOD

1,964,818

AIR INFLATED COLLAPSIBLE STRUCTURE

Filed March 25, 1933

4 Sheets-Sheet 4



Robert A. Hood,  
Inventor.  
By Emil Kunkel,  
Attorney.

# UNITED STATES PATENT OFFICE

1,964,818

## AIR-INFLATED COLLAPSIBLE STRUCTURE

Robert A. Hood, Buffalo, N. Y.

Application March 25, 1933, Serial No. 662,742

9 Claims. (Cl. 135-1)

My invention relates to air-inflated collapsible structures.

While this invention is capable of being embodied in various structures, it is particularly applicable to a collapsible tent constructed so that the usual rigid frame members and poles are entirely dispensed with, and when so used can be conveniently transported from points distant to camping grounds or bathing beaches where it may be set up for sleeping or for dressing purposes.

One of the objects of my invention is the provision of an inflatable frame comprising hollow distensible elements capable of supporting or having applied thereto, adjustably or permanently, canvas or other covering material in a manner to prevent undue distention of said hollow distensible elements.

Another object of my invention is the provision of an inflatable frame which, when collapsed, can be folded in any desired manner, or rolled up into compact form, and by application of air thereto may be expanded into a frame structure having distensible supporting legs, studs or posts, and spreading members, all filled with air under pressure so as to provide the desired design or outline for the frame, and the necessary stability due to the employment of restraining means whereby undue distention of the various frame members is prevented.

A further object of my invention is the provision of a tent in which the various sills, posts, headers and rafters are air-inflated and distensible to render them capable of supporting weight, and when air-inflated will stretch canvas or other covering or enclosing material taut from post to post, from sills to headers, and from headers to peak; also from rafters to rafters, and which may also embody an air-inflated support capable of supporting a wall of the tent in canopy fashion, said support being separately collapsible or separately inflatable, and when collapsed or deflated will permit the canopy to serve as a closure for the entrance to the tent.

A still further object of my invention is the provision of a collapsible structure in which the frame members are air-inflated and distensible, and to which canvas or other material may be applied to serve as supporting or enclosing or restraining means, such material being either sewed to or laced onto the frame members; or such material may be fastened to the frame members by means of grommets and turnbuckles or any other means may be employed for detachably fastening the canvas or other material to the

frame members; it being understood that lacing the material to the frame members also serves as a detachable means for fastening the material to the frame members.

In some instances it may be found of advantage to fold or roll the canvas or other supporting or covering material separately from the deflated frame structure, while in other instances, especially where the canvas or other supporting or covering material is sewed to the frame structure, both will be folded together.

The invention consists in a structure having an inflatable frame which, when inflated, will provide the required distensible legs or support, the necessary distensible tie members, and in some instances distensible supporting members, and brace members, all of which are surrounded with distention-restraining members all depending on the particular structure into which the invention is to be embodied.

The invention further consists in a frame having hollow elastic rubber or other inflatable members connected together in desired form and capable of being inflated so as to provide a frame for any desired article, similar to the common wood or iron frames commonly employed for such articles, or at least serving the purpose of such common frame; and wherein a covering or enclosure is provided which is attached to the frame to restrain the distention of the elastic members and which, when attached to the frame when deflated, will be drawn taut by the air under pressure within the frame, serving to render the members of the frame comparatively rigid.

The invention further consists in providing a frame for a tent in which the supporting uprights are connected together by horizontal members, and the roof framing formed by rafters or hip members connected to the uprights; said uprights, horizontal members and rafters or hip members being hollow, collapsible and inflatable, and having connection one with the other so that upon introducing air at any point thereof, all of said elements will be stiffened under air pressure and properly inflated; canvas being applied to said elements, either permanently or detachably, as may be desired, and being stretched upon inflation of said frame elements; the canvas preferably encircling or enclosing said elements so as to prevent undue inflation and to render the structure more rigid.

The invention further consists in the novel features of construction and in the arrangement and combination of parts to be hereinafter de-

scribed and more particularly pointed out in the subjoined claims.

In the drawings:

Fig. 1 is a perspective view of a tent of a particular type constructed in accordance with this invention.

Fig. 2 is a central vertical section through the tent.

Fig. 3 is a horizontal section taken on line 3—3, Fig. 2.

Fig. 4 is a perspective view of an air-inflated frame for a tent and the canopy support projecting forwardly therefrom, the enclosing material of the tent being removed from the frame.

Fig. 5 is a view of the frame collapsed and folded, showing approximately the manner in which the frame can be transported due to its occupying comparatively little space.

Fig. 6 is an enlarged broken horizontal section taken on line 6—6, Fig. 1.

Fig. 7 is an enlarged vertical section taken on line 7—7, Fig. 1.

Fig. 8 is a vertical section through the peak of the air-inflated frame and through upper portions of opposite rafters or hip members.

Fig. 9 is a vertical section through a portion of one of the corner uprights of the tent and the adjacent connected portion of one of the brace members of the canopy support.

Fig. 10 is a perspective view of a table constructed in accordance with this invention.

Fig. 11 is a perspective view of the air-inflated frame of the table shown in Fig. 10, with the canvas cover removed therefrom.

Fig. 12 is an enlarged section taken on line 12—12, Fig. 10.

The reference numeral 15 designates the frame of a tent, and 16 the canvas enclosure.

Although I have shown in the drawings an upwardly-tapering rectangular tent with a hip roof, it is to be understood that this invention can be as easily embodied in a round tent, or any other form of tent.

The frame of the tent comprises tubular members similar to inner casings of automobiles, but preferably having their walls of heavier material so that when inflated to a certain degree they retain the desired form without resorting to tube enclosing means. However, I so attach the canvas 16, or other enclosing material employed, to said tubular members, that portions of such material serve as casings for the tubular members and, being relatively non-stretchable, limit the degree of inflation or distention of the tubular members but do not restrict the pressure of the air under which said members are inflated; it being understood that the greater the air pressure the more rigid the frame portion of the structure.

The tent shown comprises tubular uprights or corner members 17 connected at their lower ends by tubular horizontal or sill members 18, which when inflated or distended become straight-lined and serve as connectors for the uprights, which also assume straight-line form when inflated or distended. The upper ends of the uprights 17 are connected by tubular horizontal or header members 19, and converging upwardly toward the vertical axis of the frame are hollow rafter or hip members 20, an enlargement or air chamber 21 serving as a means of convergence or common connection for said rafters or hip members, all being inflatable or distensible.

A valve-controlled air-inlet tube 22 similar to

the air-inlet tube of an automobile tire casing is applied to the enlargement or air chamber 21. All of these tubular or hollow elements are in communication with each other, and when they are deflated may be folded in approximately the form shown in Fig. 5, or otherwise. Any means for supplying air to these inflatable or distensible tubular members may be connected to the air inlet tube 22, and as the air enters these tubes they are gradually air filled and distended and separated one from another to assume angular relations, while each retains conduit connection with all of the others. When well inflated they assume the positions shown in Fig. 4.

In Fig. 1 I have shown the canvas or other material serving as the enclosure, sewed to these tubular members, as at 23, except at the bottom at one side, where I have illustrated a means of lacing the canvas onto a tubular member; the lacing being indicated by the numeral 24 and being fastened by tying the same around one of the front uprights 17, as indicated at 25, or in any other approved manner.

As clearly shown in Fig. 6, the enclosing or covering material 16 serves to form the walls of the tent, and when the frame is properly inflated these walls are drawn taut, both horizontally and vertically. Said walls extend from tubular member to tubular member substantially in line with the axes thereof, so that the material forming these walls may be curved around such tubular members and be retained thereon by tie or retainer strips 26 which, in connection with the curved portions of the canvas walls form relatively non-stretchable tubular portions wholly confining the inflatable or distensible tubular members of the frame. In said figure, opposite marginal portions of the tie or retainer strips 26 are sewed to the canvas walls, and when so applied the tent is folded as an entirety upon deflating the tubular members of the frame. This method of forming the tubular canvas retainer members is employed at all angles of the tent where the canvas is continued in two different directions from such angle. The lower marginal portion of the canvas is, however, curved around the lower horizontal or sill members 18, as shown in Fig. 7, and sewed as described. This is also true at the front uprights 17, as the front wall of the tent is used as a closure, and when desired, as a canopy. The canvas may, however, be retained in tubular form by lacing a cord back and forth through the canvas, as previously described, so as to enable the canvas to be removed from the inflatable frame. While in Figs. 1 and 7 this lacing is shown at only one of the sill members, it is understood that this arrangement of securing the canvas to the frame can be substituted at all places where sewing of the canvas is shown or, if desired, grommets and turnbuckles may be employed, or any other means for fastening the canvas around the tubular members of the frame so as to enable the canvas to be applied to the frame when inflated or removed from the frame before deflating the same. Under such conditions, both the canvas or members of the frame may be folded separately in any desired compact form.

In connection with the tent frame I have employed a canopy support 27 which is formed of hollow elastic rubber tubing or the like connected to the two front uprights or corner members 17. This support, when inflated, comprises two outstanding upwardly directed arms 28 and a transverse connector member 29 in connection with

each other. This support has the inner ends of its arms 28, or brace members as they may be termed, vulcanized or otherwise connected to the front uprights or corner members 17, and it is preferably sans communication with the inflatable frame proper; the interior of said brace members 28 and the interior of the said uprights or corner members being separated by a wall 30 so that the canopy support can be separately inflated or deflated. To admit of this it is also provided with a valve-controlled air inlet tube 31 which may have any suitable source of compressed air connected thereto.

It may here be stated that an ordinary hand operated pump, such as employed in introducing air into automobile tires, may be employed for the purpose of inflating the tent frame and the canopy support, and under the arrangement described, the front wall 32, serving as an entrance closure when lowered, is connected to the front header member 19, but is otherwise loose so that it may be draped over the canopy support and hang from the transverse connector member 29 thereof, said front wall under such conditions serving as the canopy for the tent and providing side entrances to the tent. I have shown this front wall with parallel edges, but this wall may be flared downwardly from the top if desired, to conform to the entrance opening, and in most instances would be so arranged.

The tent may be closed by deflating the canopy support 27, whereupon such support will hang downwardly from the side of the front uprights or corner members 17 of the tent. This would be found undesirable, and consequently I prefer to draw the same upwardly by means of a cord and tie the same in an elevated position. The canopy support, when deflated, will not interfere with admission to the tent. At such times the front wall or canopy of the tent will hang loosely from the header to which it is attached, and when flared to conform to the downwardly-flaring remaining walls, would completely enclose the tent so that security from the elements of the weather would be assured.

To guard against windstorms striking the tank and lifting or upsetting the same or moving the same from the position selected for it, I sew or otherwise apply canvas or other tabs 33 to the lower horizontal member or sill enclosures of the tent, these tabs having openings therein through which suitable spikes 34, or other fastening means, are passed and driven into the ground. The use of these tabs will not be required in temporary positions, nor in fair weather, although they are preferably used when overnight camping is planned, or may be quickly placed into use when a breeze arises.

If desired, the canopy support may be dispensed with and the front wall made in two sections to be folded back laterally, as is common in tents of the type shown.

While I have illustrated a rectangular tent in which a square formation is given the four sill members employed and the four headers, these could be of circular formation, or given any other formation desired. It is apparent also that the headers could be dispensed with where a hip roof for a tent is not desirable, and in such cases the uprights could be extended in an upwardly-converging manner to meet at the top of the tent.

While I have particularly designed this invention for use in connection with tents or the like, it may be employed in various other structures.

For instance, when a picnic is planned and a table desired, not otherwise available, the frame of the table, shown in Fig. 11, could be formed in accordance with this invention. In this figure the frame comprises hollow upper horizontal distensible members 35 shown connected in rectangular formation, but which may be otherwise constructed if desired. At the angles of these upper members, hollow distensible legs 36 are connected thereto, and these legs are connected together between their ends by hollow longitudinal distensible connector members 37 and hollow distensible transverse or end connector members 38. The upper horizontal members may also be connected together by a hollow distensible longitudinal connector member 39 and hollow distensible transverse connector members 40 which are also connected to the longitudinal connector member 39. The horizontal connector members 37 connecting the legs together between their ends are connected together by a hollow distensible transverse connector member 41 enlarged at one end to form an air chamber 42 in which a valve-controlled inlet tube 43 is secured. Like the members of the tent frame, all of these members are tubular members formed of rubber or rubber composition, and are therefore inflatable or distensible, and when filled with air, under the proper pressure, they assume the positions shown in Fig. 11 and form a substantial frame-work onto which a canvas or other covering 44 may be placed, which is sewed thereto, as indicated in Figs. 10 and 12, or otherwise fastened so that the cover has portions enclosing the hollow inflatable or distensible members to which it is fastened. The various hollow inflatable or distensible members of the frame not having the cover fastened thereto may be enclosed within relatively non-stretchable canvas or other distention-restraining tubes, which will enable the air to be forced into said members under considerable pressure to assure a very rigid structure.

Upon inflation of the table frame, the canvas covering 42 will be stretched taut over the top thereof, and supported by the longitudinal and transverse connector members 37 and 38. A table of this kind will therefore support considerable weight. Chairs may be similarly constructed, and many other articles of furniture, or other commodities.

In the figures of the drawings showing my invention embodied in a tent, the relatively non-stretchable enclosing tubes forming part of the canvas or other enclosure or covering material are distinctly outlined exteriorly, but this is solely due to the fact that the tie members or retainer strips 26 employed at these regions are comparatively narrow so as to draw the canvas portions stretched between the members inwardly in line with the longitudinal axes of said members. In Fig. 12 I have shown the tie member or retainer strip 26 comparatively wide so that the canvas forming the covering material is curved around approximately only a quarter of the inflated tubular members of the frame, thus only rounded exterior surfaces are provided for the canvas.

It is apparent that such quarter-rounded arrangement of the canvas can be as readily applied to the tent structure, and may be found of advantage, due to the fact that less strain will be applied to the stitching, lacing, or other fastening employed for securing the canvas to the frame. In either case relatively non-stretchable enclosure tubes are provided for the rubber

or other inflatable or distensible members of the frame, and these may enclose certain or all of said members, as may be desired, or as the nature of the structure may disclose advisable. In any event, when such enclosure tubes, or restraining enclosures as they may be termed, are employed, a limit of expansion of the inflatable or distensible tubes is assured, without in any manner restricting the pressure of the air forced into said tubes. Since the enclosure tubes or distention restraining enclosures formed as part of the canvas or other enclosing or covering material serve as a convenient means of attaching such material to the inflatable or inflated frame of the structure, I consider them as offering decided advantages in use; particularly for the reason that the inflatable or distensible tubes can be made comparatively thin; resulting in diminishing cost of production and less weight to be carried when transporting the parts from place to place.

Although I have referred to air-inflated tubular elements, it is to be understood that any gas or other substance serving the purpose of air may be employed.

The uprights of the tent structure and the legs of the table structure may be broadly termed "inflatable supporting elements", while the sill members, header members, and hip or rafter members of the tent, and the various horizontally-disposed connector members of the table structure, may be broadly termed "inflatable stay elements", these terms being employed in certain of the appended claims.

It may also be stated that all of the inflatable members or elements, by reason of their tubular formation and physical connection one to another, are in conduit connection, forming a continuous air passage or chamber within the structure; but where the structure comprises numerous members or elements it may be of advantage to provide means for introducing air under pressure at more than a single point of the structure.

Having thus described my invention, what I claim is:

1. A collapsible frame for structures, comprising air-inflated tubular extensible elements disposed at an angle, one to another, and capable of being collapsed under escape of air therefrom, and flexible sheet material extending over at least the area between certain of said tubular elements and having portions thereof surrounding said elements to form retainer sleeves for said tubular elements to limit the expansive action of said elements.

2. A collapsible structure, comprising a frame formed of connected distensible tubes, and flexible sheet material spanning spaces between said tubes and being sewed to said tubes, to surround the same and prevent undue distention of the tubes.

3. A collapsible structure, comprising a frame formed of connected distensible tubes, and relatively non-stretchable flexible sheet material spanning spaces between said tubes and having tubular portions surrounding said tubes to prevent undue distention of the latter and detachably secured thereto.

4. A collapsible structure, comprising a frame formed of connected tubes distensible under air

pressure and spaced apart, said tube trending in a plurality of different directions to form the desired outline, and relatively non-stretchable flexible sheet material applied to said frame serving as enclosure walls and having marginal portions of the same enclosing certain of said distensible tubes, the edges of said marginal portions being secured to said sheet material to form retainer tubes confining said distensible tubes and restricting the distensive qualities thereof under air pressure.

5. A tent formed of a collapsible air-inflated frame, comprising tubular distensible sill members and tubular distensible uprights in conduit connection with said sill members, and sheet material secured to said tubular members and uprights so as to completely enclose the same and serve as the covering for said tent and as a means to prevent undue distention of said tubular members and uprights.

6. A tent formed of a collapsible air-inflated frame, comprising a distensible tubular sill structure and distensible tubular uprights in conduit connection with said sill structure, and flexible sheet material having enclosing tubes applied to and surrounding said uprights and serving as an enclosure for the tent and as distention-restrainers for said uprights.

7. A tent formed of a collapsible air-inflated frame, comprising a rectangular sill structure formed of tubular members, tubular uprights at the corners of said sill structure in conduit connection therewith, a super-structure formed of tubular members and carried by said tubular uprights, the tubular members of said super-structure being in conduit connection with said tubular uprights, means for introducing air to said tubular members and uprights, flexible sheet material secured to said sill members, uprights, and the tubular members of said super-structure to enclose said frame at three sides and the top, a canopy support at the open side comprising tubular members extending outwardly from the adjacent tubular uprights and a tubular connector member connecting said last-mentioned tubular members and in conduit connection therewith, means for separately introducing air into said canopy support, and flexible sheet material suspended from said superstructure and extending outwardly and downwardly and receiving support from said canopy support, said suspended flexible sheet material being adapted to close the open side of said tent upon collapsing of said canopy support.

8. A collapsible frame for structures, comprising hollow supporting elements, distensible under air pressure, stay elements distensible under air pressure in conduit connection with said supporting elements, and a flexible medium having portions thereof formed into retainer tubes encircling said distensible elements to prevent undue distention of the latter.

9. A collapsible frame for structures, comprising tubular elements, distensible under air pressure and relatively non-stretchable flexible sheet material extending from element to element to cover the areas between the same and having tubular portions encasing said elements to prevent undue distention of said elements.

ROBERT A. HOOD. 145



**CAPITA, E. R, n° US 2,411,316**

**1944-1946**

**Hangar para aviones**

Nota\* Aplicado para aire y/u otros gases

**Solicitud** 17 agosto 1944  
**Fecha** 19 noviembre 1946  
**Lugar** North Bergen,  
Nueva Jersey  
**Inventor** E.R. Capita  
**Patente n°** US 2,411,316  
**Título** *Airplane Hangar*

Nov. 19, 1946.

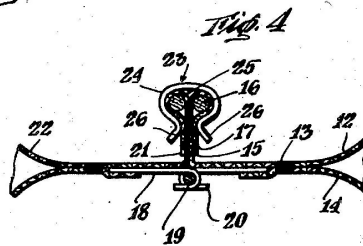
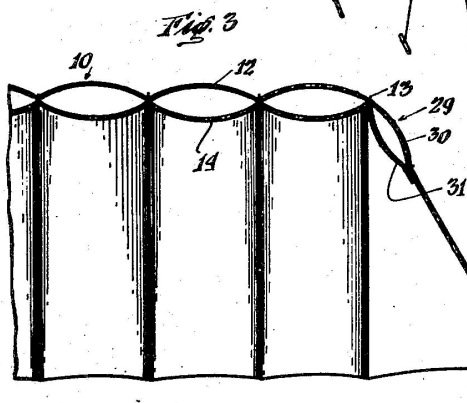
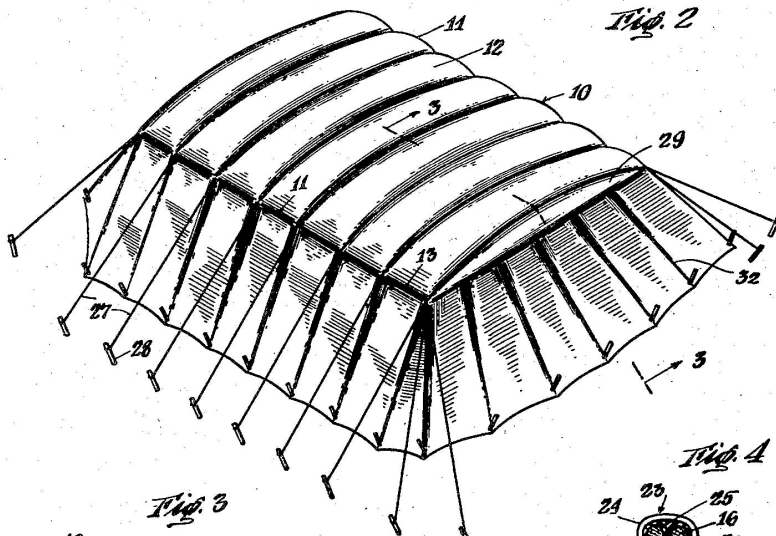
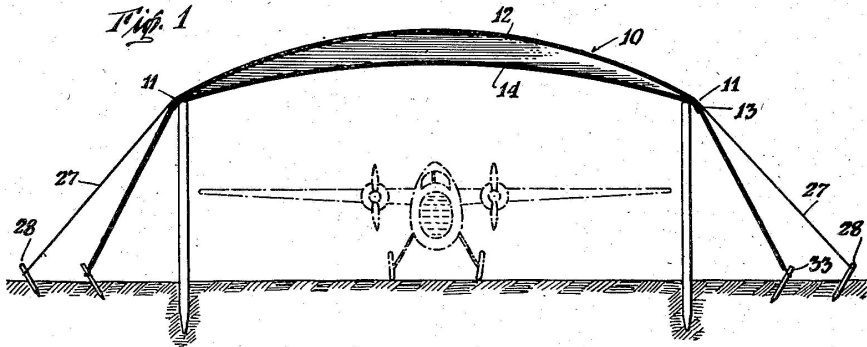
E. R. CAPITA

2,411,316

AIRPLANE HANGAR

Filed Aug. 17, 1944

2 Sheets-Sheet 1



INVENTOR.

Emil R. Capita

BY

Norman Heland

ATTORNEY

Nov. 19, 1946.

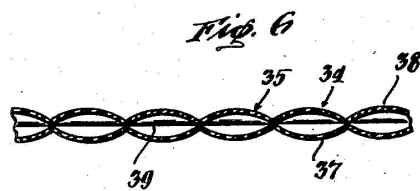
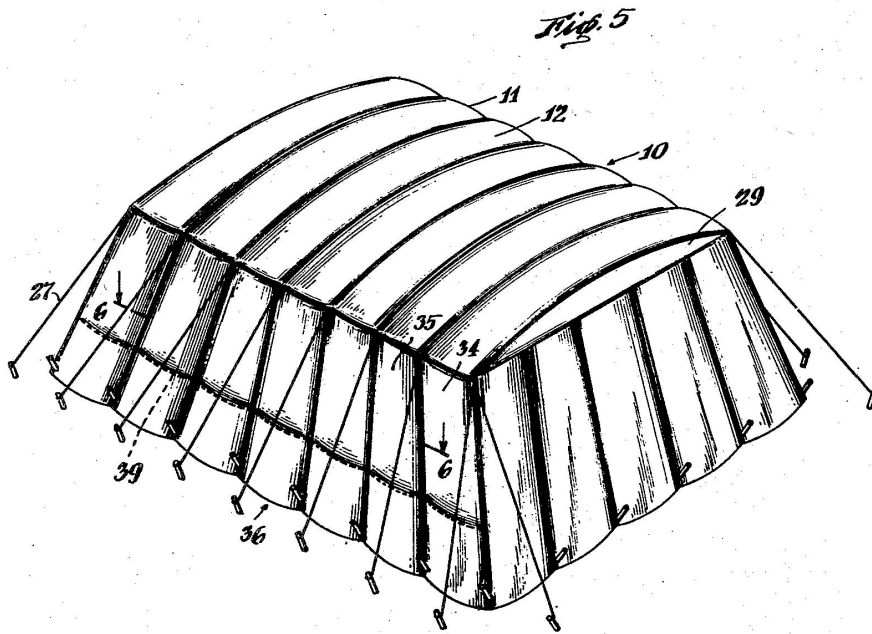
E. R. CAPITA

2,411,316

AIRPLANE HANGAR

Filed Aug. 17, 1944

2 Sheets-Sheet 2



INVENTOR

*Emil R. Capita*

BY

*Norman D. Collaugh*

ATTORNEY

# UNITED STATES PATENT OFFICE

2,411,316

## AIRPLANE HANGAR

Emil R. Capita, North Bergen, N. J.

Application August 17, 1944, Serial No. 549,917

16 Claims. (Cl. 135—1)

1

This invention relates to airplane hangars and is herein illustrated in some detail as embodied in a hangar suitable for providing the wide span of opening necessary to accommodate large planes.

Such hangars usually require roofs giving upwards of one hundred feet clear opening in front, but the opening, and, in fact, the whole roof is ordinarily needed to give a height of only a fraction as much. For this reason a high arch provides much unnecessary space, while a low horizontal girder of 100 feet span exceeds the limit usually accepted for girders, and is necessarily heavy and expensive.

A low arch involves strong end thrust members, and therefore raises structural problems equal to the problems presented by a girder design, although the problems are different.

According to the present invention the foregoing and other difficulties and objections are overcome, and a roof is provided which works on a different principle, and involves none of the structural problems inherent in girders and arches, and which exerts no side thrust requiring expensive foundations.

On the contrary the roof is well adapted to be packed in a small space and to be set up rapidly without the need of skilled metal workers or structural engineers.

In the form shown a fabric surface provides the top of the roof, and the roof is shown as consisting of hollow cells made of suitable fabric and inflated with a suitable gas, such as helium, so that the gas supports the fabric surface. The side-edges of the roof are shown as made of fabric, which may be utilized as the walls of gas-inflated cells to carry the load of the walls, or help to carry that load.

The side edges and back of the roof may be held down by cords stretched outwardly and secured to tent pegs of an ordinary type.

Such a fabric roof may be set up hastily, is well adapted to be so designed that it serves other uses, such as a cover for fabric gasoline tanks, movable repair shops, and many other purposes.

The fabric units may be rolled up for shipment and rapidly unrolled, filled with gas from portable cylinders of compressed gas, and assembled, together with accessories such as tents or hangars, and equally rapidly demounted and shipped away by plane or otherwise.

The roofs are lighter and less bulky than hangar girder roofs and require no special vehicles for transporting them. In addition, minor repairs are easily made by unskilled workmen, and

2

they are less expensive than the metal roofs with girders generally used.

Other features and advantages will herein-after appear.

5 In the accompanying drawings:

Fig. 1 is a front view of a hangar embodying the present invention;

Fig. 2 shows the hangar in perspective from near a back corner;

10 Fig. 3 is a diagrammatic section on the line 3—3 of Fig. 2;

Fig. 4 is a sectional view diagrammatically showing how units may be joined;

15 Fig. 5 is a perspective view of a modification; and

Fig. 6 is a sectional view along the line 6—6 of Fig. 5.

In the form shown, the hangar includes roof units 10 made of a suitable fabric, such, for example, as is used in balloons or dirigible units. Each roof unit is shown as extending from one edge or eave 11 of the roof to the opposite eave 11, being preferably several times as long as it is wide, and containing sufficient helium or other gas to give it considerable net buoyancy.

25 In the form shown, the top fabric 12 of each unit 10 extends beyond its seam 13, by which it is stitched to the bottom fabric 14, so that the free end 15 may be carried around a rope or steel cable 16 and stitched down over the cable 16 by a seam 17.

30 When the hangar roof is assembled the units are brought together, edge to edge, and hooks 18 lying against the insides of the ends 15 and fastened to the fabric are hooked over a free steel cable 19. The hooks 18 are shown as alternating with similar hooks 20 on an adjacent free end 21 (like the end 15) of the adjacent unit 22, so that the cable 19 holds two units together.

40 When the adjacent units are thus firmly united the joint may be made tight against rain by slipping a resilient clamp-like molding member 23 over the now loose and projecting end fabrics 15 of the units and hold them together. The molding member 23 thus presents its convex outer surface 24 to the weather and rain and its U-shape enables its outwardly bent edges 26 to be sprung or slipped over the bulges 25 produced by the cable 16, 16 with the fabric over them.

50 The free cables 19 may include long free ends 27 which extend well beyond the eaves 11 and are shown as carried down to earth to be fastened to tent pegs 28.

In order that the whole weight of the walls and cables of the hangar may not fall upon the

3

net buoyancy of the roof units 10, the end wall 29 is shown as made of two layers of fabric 30, 31, spaced apart and forming a cell inflated by buoyant gas like the cells 10, and as held down by cables 32, pulling from its lower end and drawn down by tent pegs 33 forming an inner row so that the end walls may be nearly vertical although the pegs 28 are shown as pulling their cables at a far flatter angle.

The side walls may be fabric or may be inflated cells 34, 35, held down by pegs 33 in an inner row.

Fig. 5 shows the modified form in which the side walls 36 include the additional buoyant cells 34, 35 along an edge of the roof 10 having outer fabric faces 37 and inner fabric faces 38, and closed at their bottoms by seams 39. Thus the side cells carry at least part of the weight of the cables.

As appears in Fig. 1, the buoyancy of the gas raises the center of the roof formed by the cells 10 well above the height of the eaves so that the roof sheds rain. The molding members are accordingly curved lengthwise and of suitable shorter length to assemble readily. It will be noted they supply a certain stiffness to give the roof an arched shape.

The seams, including the seam 13, are shown only diagrammatically, as also the edges from which spring the free ends 27 of the draw ropes, and these are made gas tight and strengthened in any ordinary or suitable manner, as is well known to those skilled in the art of balloons.

Having thus described in some detail one form of the invention, what is claimed is:

1. A roof including cells inflatable with buoyant gas, and releasable means for uniting said cells along their edges to form a continuous roof.

2. A roof including cells inflatable with buoyant gas and extending from eave to eave at their end edges, and releasable means for uniting said cells along their longitudinal edges to form a continuous roof.

3. A roof including cells inflatable with buoyant gas and extending from eave to eave at their end edges, means uniting said cells along their longitudinal edges to form a continuous roof, cables stretched outwardly and at intervals, holding the roof at its edges, and additional buoyant cells along an edge carrying at least part of the weight of the cables.

4. A roof including cells inflatable with buoyant gas and extending from eave to eave at their end edges, means uniting said cells along their longitudinal edges to form a continuous roof, cables stretched outwardly and at intervals, holding the roof at its edges, and additional buoyant cells along an edge forming a wall and carrying at least part of the weight of the cables.

5. A roof including cells inflatable with buoyant gas and extending from eave to eave at their end edges, means uniting said cells along their longitudinal edges to form a continuous roof, cables stretched outwardly at a low angle and holding the roof at intervals at its edges, additional buoyant cells along an edge forming a wall and carrying at least part of the weight of the cables, and devices holding said wall more nearly vertical.

6. A roof including two buoyant cells, fabric walls for said cells, extensions of said fabrics be-

4

yond the cell edge, and releasable means for uniting two cells by said extensions.

7. A roof including two buoyant cells, fabric walls for said cells, extensions of said fabrics beyond the cell edge, a cable in each extension producing a bulge and means for uniting said cells by said cable bulges.

8. A roof including two buoyant cells, fabric walls for said cells, extensions of said fabrics beyond the cell edge, a cable in each extension producing a bulge and means embracing said bulges for uniting said cells by said cable bulges.

9. A roof including two buoyant cells, fabric walls for said cells, hooks along an edge of each of said cells adapted to grasp a cable to hold the cells together, and an extension of said cable adapted to hold the cells to the ground.

10. A roof including two buoyant cells, fabric walls for said cells, hooks along an edge of each of said cells adapted to grasp a cable to hold the cells together, buoyant side cells nearly vertical, and an extension of said cable adapted to be stretched at a low angle to hold the roof cells to the ground.

11. A roof including two buoyant cells, fabric walls for said cells, extensions of the fabric enclosing cables to hold the cells together, hooks along an edge of each of said cells adapted to grasp a cable to additionally hold the cells together, and an extension of said cable adapted to hold the cells to the ground.

12. A roof including two buoyant cells, fabric walls for said cells, extensions of the fabric enclosing cables to hold the cells together, hooks along an edge of each of said cells adapted to grasp a cable to additionally hold the cells together, an extension of said cable adapted to hold the cells to the ground, and a member embracing the fabric extensions to hold the cells.

13. A roof including buoyant fabric cells extending from eave to eave, extensions of the cell fabric enclosing cables to hold the cells together, hooks along the cell edges to additionally hold them together, and a cover member adapted to embrace the cables to hold the cells.

14. A roof including buoyant fabric cells extending from eave to eave, extensions of the cell fabric enclosing cables to hold the cells together, hooks along the cell edges to additionally hold them together, a cover member adapted to embrace the cables to hold the cells, and an additional cable through the hooks having an extension to hold the roof.

15. A roof including buoyant fabric cells extending from eave to eave, extensions of the cell fabric enclosing cables to hold the cells together, hooks along the cell edges to additionally hold them together, a cover member adapted to embrace the cables to hold the cells, and side wall buoyant cells nearly vertical.

16. A roof including buoyant fabric cells extending from eave to eave, extensions of the cell fabric enclosing cables to hold the cells together, hooks along the cell edges to additionally hold them together, a cover member adapted to embrace the cables to hold the cells, an additional cable through the hooks having extension to hold the roof, and side wall buoyant cells nearly vertical.

EMIL R. CAPITA.



**Anexo 2:** Patentes realizadas por Walter  
Bird y/o Birdair. (\*S. Solicitud; C. Concesión).



## Índice Anexo 2: Patentes realizadas por Walter Bird y/o Birdair. (\*S. Solicitud; C. Concesión).

### Patentes realizadas por Walter Bird previas a 1960: 591

1. Air inflatable tower or the Like, n° US2849011, (S.1957- C.1958). 593
2. Air inflated fabric structures, n° US3059655, (S. 1957-C.1962.). 599
3. Air supported structures, n° US3024796, (S. 1958-C.1962.). 605
4. Sectionalized air supported structures, n° US3116746, (S. 1958-C.1964.). 611

### Patentes realizadas por Walter Bird entre 1960-1970: 617

5. Quikly strikable air supported building, n° US3150670, (S. 1960-C.1964.). 619
6. Building construction, n° US3139464, (S. 1960-C.1964.). 629
7. Support with adjusting means, n° US3325887, (S. 1961-C.1967.). 639
8. Dual Wall air inflated structure, n° US3247627, (S. 1962-C.1966). 645
9. Structural Assembly, n° US3240217, (S. 1963-C.1966). 651
10. Air inflated Structures, n° US3346441, (S. 1963-C.1967). 657
11. Pressure balanced door, n° US3407534, (S. 1967-C.1968). 663
12. Wheather-tight enclosure system, n° US3496686, (S. 1967-C.1970). 671
13. Taped tension web-skin joint for air inflatable s., n° US3490184, (S. 1968-C.1970). 677

### Patentes realizadas por Walter Bird posteriores a 1970: 681

14. Air Inflatable Structure, n° US3651609, (S. 1970-C.1972). 681
15. Large air supported structures, n°US3744191, (S. 1971-C.1973). 691
16. Squared end section for air supported structure, n°US3893268, (S. 1973-C.1975). 703



## Patentes realizadas por Walter Bird previas a 1960



**BIRD, Walter, n° US 2,849,011**

**1957-1958**

**Torre hinchada con aire o similar**

Nota\* Aplicado para aire y/u otros gases

**Solicitud** 26 septiembre 1957  
**Fecha** 26 agosto 1958  
**Lugar** Williamsville, Nueva York  
**Inventor** W. W. Bird  
**Patente n°** US 2,849,011  
**Título** *Air inflated tower or the like*

Aug. 26, 1958

W. W. BIRD

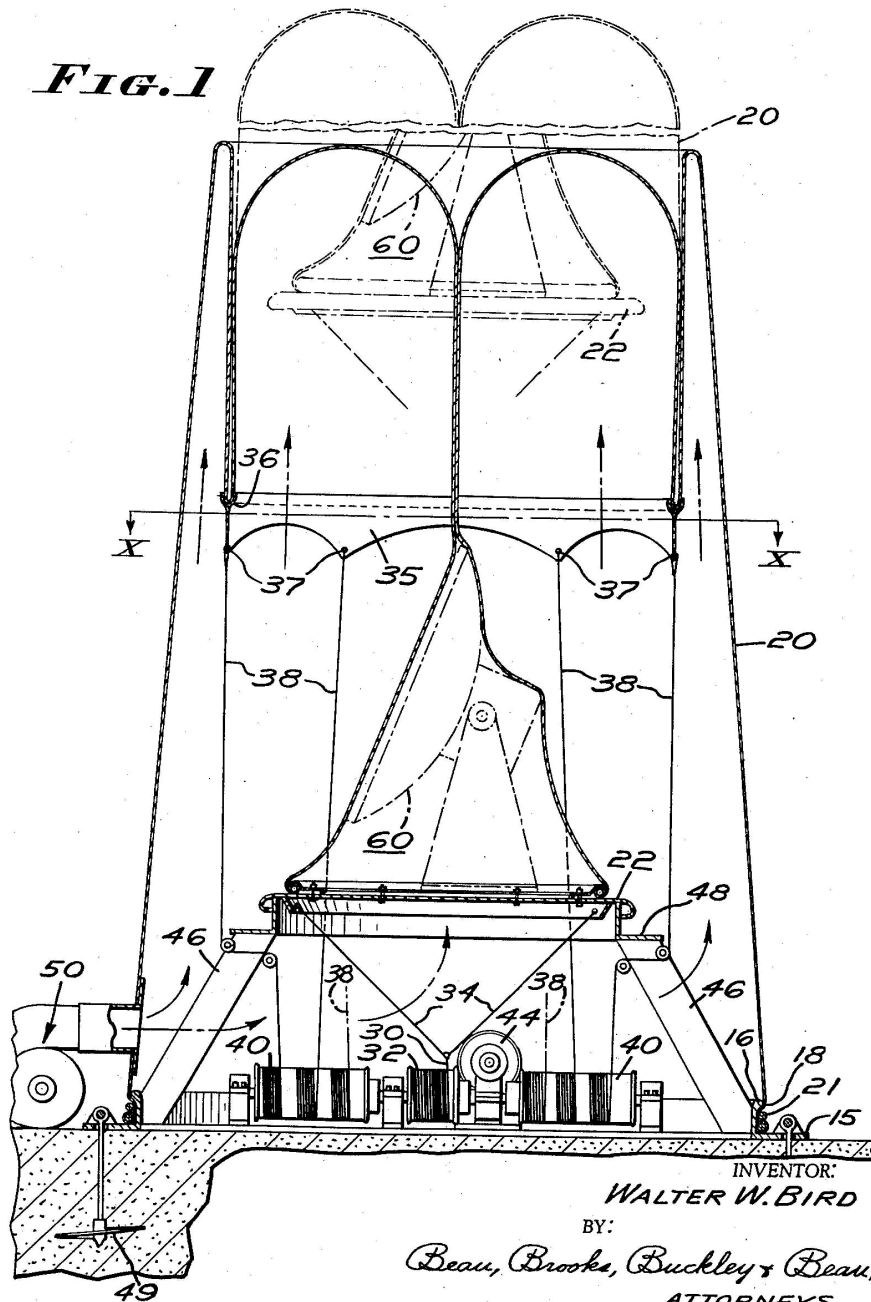
2,849,011

AIR INFLATED TOWER OR THE LIKE

Filed Sept. 26, 1957

3 Sheets-Sheet 1

**FIG. 1**



INVENTOR:

WALTER W. BIRD

BY:

Beau, Brooks, Buckley & Beau,  
ATTORNEYS.

Aug. 26, 1958

W. W. BIRD

2,849,011

AIR INFLATED TOWER OR THE LIKE

Filed Sept. 26, 1957

3 Sheets-Sheet 2

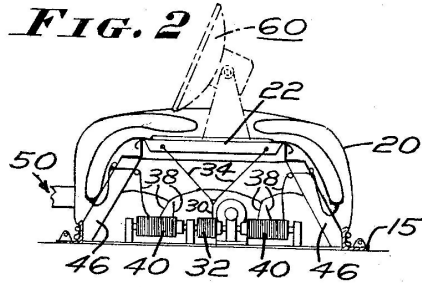


FIG. 3

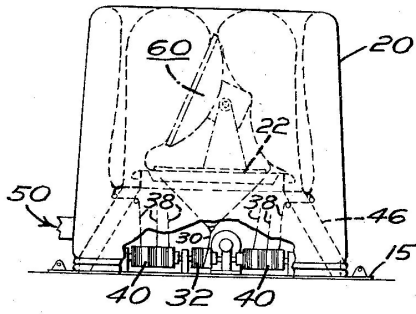
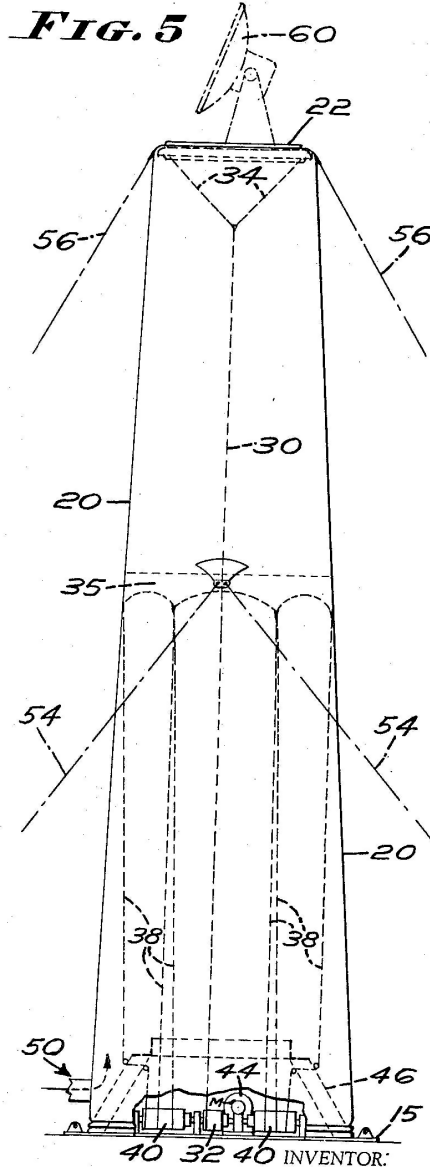
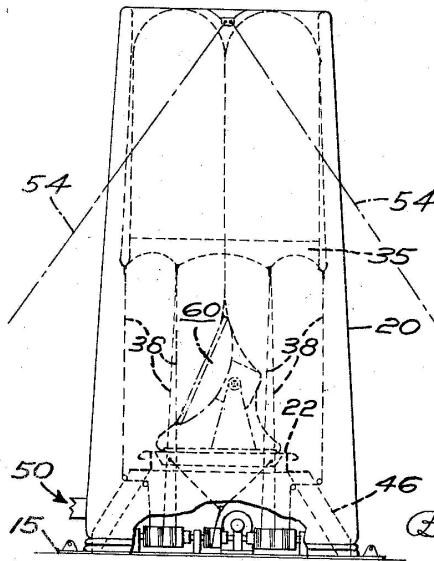


FIG. 4



40 32 46 INVENTOR:  
WALTER W. BIRD  
BY:  
Beau, Brooks, Buckley & Beau,  
ATTORNEYS.

Aug. 26, 1958

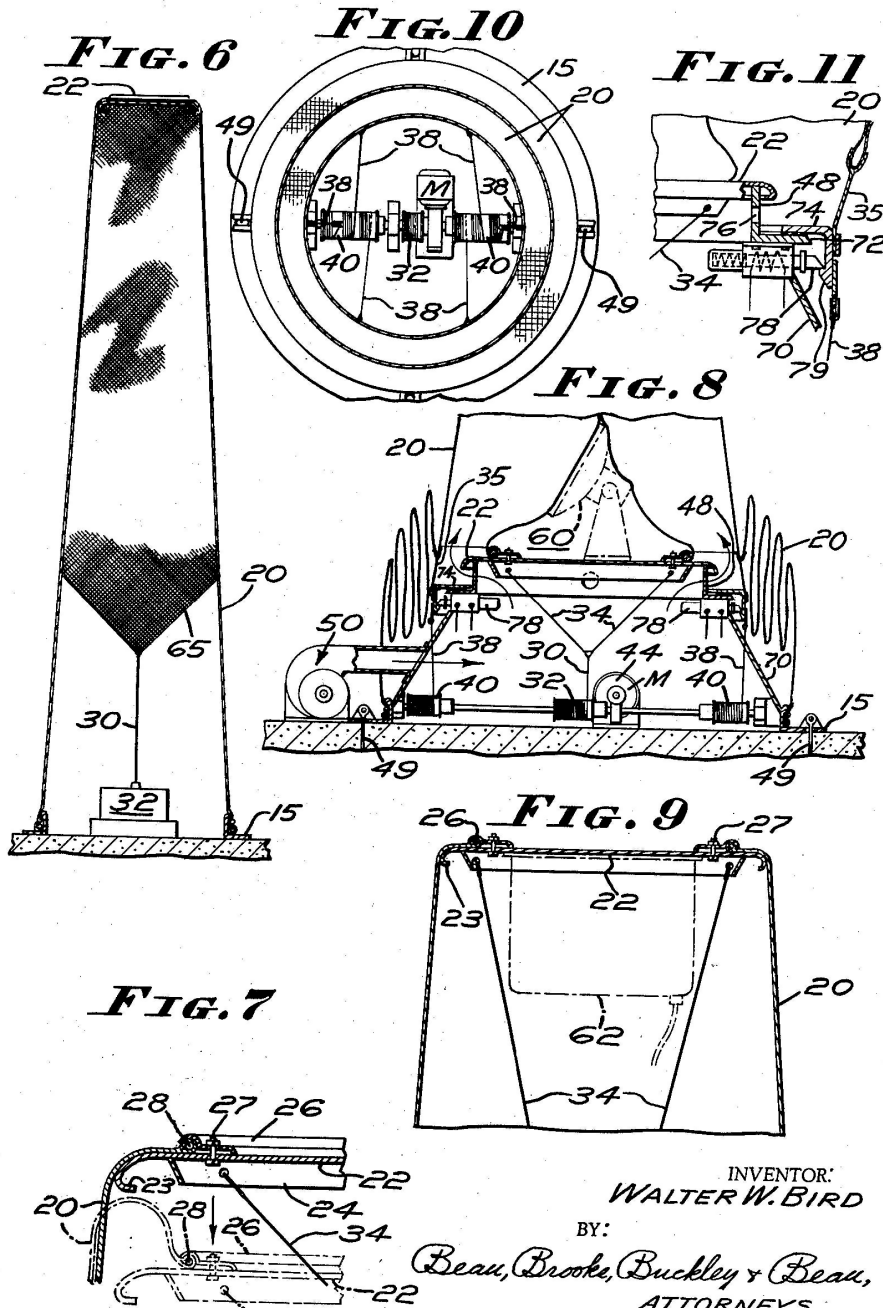
W. W. BIRD

2,849,011

AIR INFLATED TOWER OR THE LIKE

Filed Sept. 26, 1957

3 Sheets-Sheet 3



INVENTOR:  
WALTER W. BIRD

BY:

Beau, Brooks, Buckley & Beau,  
ATTORNEYS.

1

2,849,011

**AIR-INFLATED TOWER OR THE LIKE**

Walter W. Bird, Williamsville, N. Y., assignor to  
Birdair Structures, Inc., Buffalo, N. Y.

Application September 26, 1957, Serial No. 686,462

5 Claims. (Cl. 135-1)

This invention relates to air supported structures and more particularly to self-erecting air-inflated towers or the like.

A primary object of the invention is to provide an improved self-erecting air-supported tower construction which is adapted to fold into minimum space when deflated and to be so tensioned throughout the erection process as to be self-stabilizing during the erection process and subsequent thereto, even under windy conditions. Other objects and advantages of the invention will appear from the specification hereinafter.

In the drawing:

Fig. 1 is a vertical sectional view through an apparatus of the invention, illustrating the device at an initial stage of erection thereof;

Fig. 2 is a vertical sectional view through a device of the invention showing it in fully retracted or "stow-away" condition;

Fig. 3 is an elevational view showing a first stage of inflation and erection of the apparatus of Fig. 2;

Fig. 4 is a view corresponding to Fig. 3 but showing the apparatus at an intermediate stage of erection;

Fig. 5 is a view corresponding to Fig. 4 but showing the apparatus in fully erect condition;

Fig. 6 is a vertical sectional view through an erect tower of the invention embodying a novel antenna device;

Fig. 7 is a fragmentary sectional view showing details and construction of the tower top plate and side wall fabric components, and showing schematically the device at different initial stages of a retraction operation;

Fig. 8 is a fragmentary sectional view corresponding to portions of Figs. 1 and 2 but showing a modified form of tower height control mechanism;

Fig. 9 is a fragmentary sectional view through the upper end of the tower when inflated, and illustrating a modified form of support for accessories;

Fig. 10 is a horizontal section, on reduced scale, taken along line X-X of Fig. 1; and

Fig. 11 is an enlarged scale fragmentary sectional view of a detail of the mechanism of Fig. 8.

Generally stated, the invention contemplates an improved tower of the type adapted to be erected simply by inflation by means of moderate air or gas pressure, such as by a centrifugal blower.

As shown in Figs. 1-5, 7, 10 the tower of the invention is constructed to comprise generally a base plate or ring 15 having a vertical flange 16 about which is secured the lower end portion of a cone or cylindrical shaped sleeve of fabric 20 comprising the wall structure of the tower when inflated. The bottom end of the wall structure 20 is conveniently fixed to the base flange 16 by means of an encircling cable as indicated at 21 (Fig. 1) or by any other suitable means. The sleeve 20 is closed at its top end either by fabric or by a cap or platform member as illustrated for example at 22. As shown in better detail in Fig. 7, the platform 22 may comprise a shaped metal plate to include a downwardly curled edge flange 23 and a stiffening flange 24. The sleeve material is conveniently

2

affixed to the plate 22 by means of a ring clamp 26 held in place by bolts 27 and embracing the edge of the sleeve which is rolled over a cable 28. The outside diameter of the plate 22 is kept less than the diameter of the adjacent portion of the sleeve 20, for reasons to be explained hereinafter.

A tensioning device is attached to the top plate 22 and as shown herein may conveniently comprise a cable 30 fixed at its lower end to a winch or the like as indicated at 32 and is preferably connected at its upper end to the three or more divergent strands 34 which tie at their outer ends to the top plate 22 so that tension forces through the cable 30 will not tend to tilt the top plate 22. As shown in the drawing, intermediately of its vertical extent the sleeve 20 may be provided with a girdle 35 comprising a reinforcing girth panel sewn or otherwise permanently fixed to the sleeve 20 as indicated at 36 (Fig. 1) and provided with grommets 37 at intervals therearound to which are attached tension cables 38 which wrap upon and are fixedly connected at their lower ends to winches 40-40. Whereas, the drawing herewith illustrates the device of the invention to include a single intermediate girth panel as indicated at 35 and corresponding tension cables 38, it is to be understood that any preferred number girth panel and tension control devices may be employed, if any, according to the height of the tower and the indicated need.

As illustrated in better detail in Fig. 1, the winches 30, 40, 40 are arranged to be selectively operated, as by means of any suitable clutch devices and a driving mechanism and motor, as indicated at 44. The motor and winch unit is conveniently carried upon the base plate device 15, and upwardly inclined legs 46 are conveniently arranged to provide vertical support for a support ring 48 arranged to receive the top cover plate 22 when the latter is pulled down by winch 32 as to the full line position thereof shown in Fig. 1. The base plate 15 is conveniently anchored to the erection site, as by means of screws 49 or the like as illustrated in Fig. 1; and a low pressure air blower as indicated at 50 or other air supply device such as a pump, gas cylinder or generator is arranged to deliver air or gas under pressure to the interior of the sleeve 20 for purposes to be explained hereinafter.

Thus, it will be appreciated that the tower fabrication as hereinabove described is adapted for storage and transport purposes to be collapsed and/or folded in its fully deflated form upon the supporting frame comprising the legs 46 and the support ring 48; as in the manner illustrated in Fig. 2 of the drawing herewith. The device of the invention is designed for many purposes under a large variety of installation conditions, and may for example be carried on a transport vehicle with the base ring 15 permanently mounted thereon. Or, the unit may be designed for field erection purposes, and thus upon unloading of the unit at the erection site, the base ring 15 is first anchored to the ground and the air supply device 50 is then activated to commence inflation of the structure. As air moves into the structure the winches 40 controlling the cables 38 are initially braked to permit the air to first inflate the sleeve only into the condition shown in Fig. 3. Then, the winches 40 are permitted to unwind in response to further tower inflating tensions transmitted to the cables 38, as by selective slipping of the clutches controlling the winches 40-40. At the same time the winch 32 controlling the tension cable 30 is held braked, whereby the structure next assumes the condition shown in its solid line positions of Figs. 1 and 4. Thus, the inflating air initially causes the lower portion of the tower structure to rise as to the positions shown in Figs. 1, 4, while being constantly under restraint of the tension cables 38.



**BIRD, Walter, n°US 3,059,655**

**1957-1962**

**Estructuras textiles hinchadas con aire**

Nota\* Aplicado para aire y/u otros gases

**Solicitud** 23 diciembre 1957  
**Fecha** 23 octubre 1962  
**Lugar** Williamsville, Nueva York  
**Inventor** W. W. Bird  
**Patente n°** US 3,059,655  
**Título** *Air inflated fabric structures*

Oct. 23, 1962

W. W. BIRD

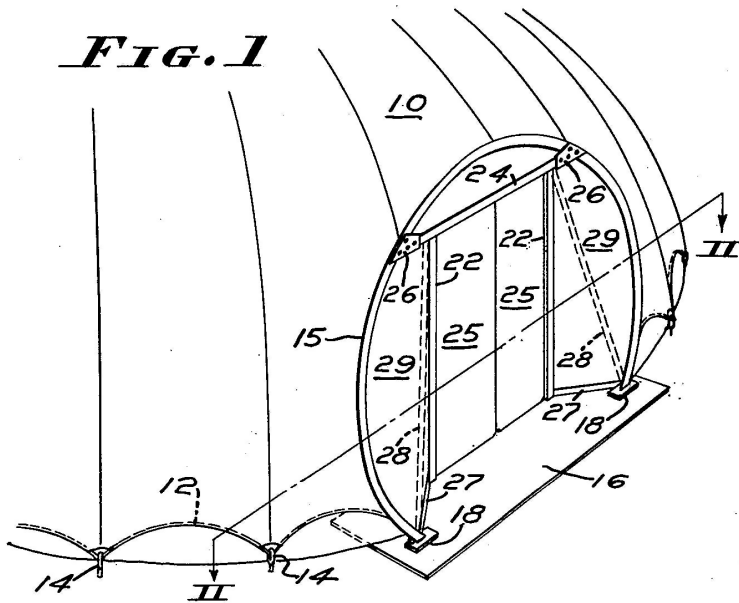
3,059,655

AIR INFLATED FABRIC STRUCTURES

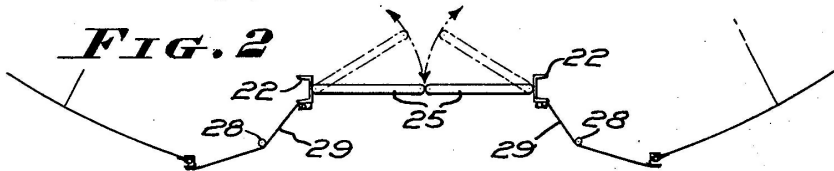
Filed Dec. 23, 1957

2 Sheets-Sheet 1

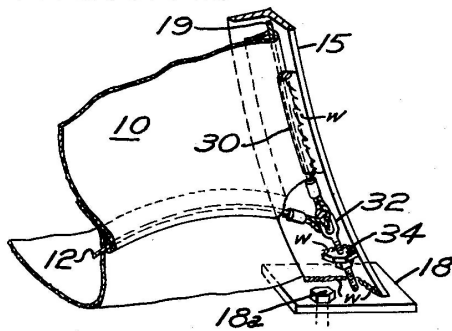
**FIG. 1**



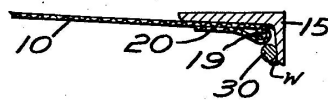
**FIG. 2**



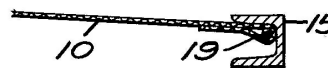
**FIG. 4**



**FIG. 3A**



**FIG. 3B**



INVENTOR:  
WALTER W. BIRD

BY:

*Beau, Brooks, Buckley & Beau,*  
ATTORNEYS.

Oct. 23, 1962

W. W. BIRD

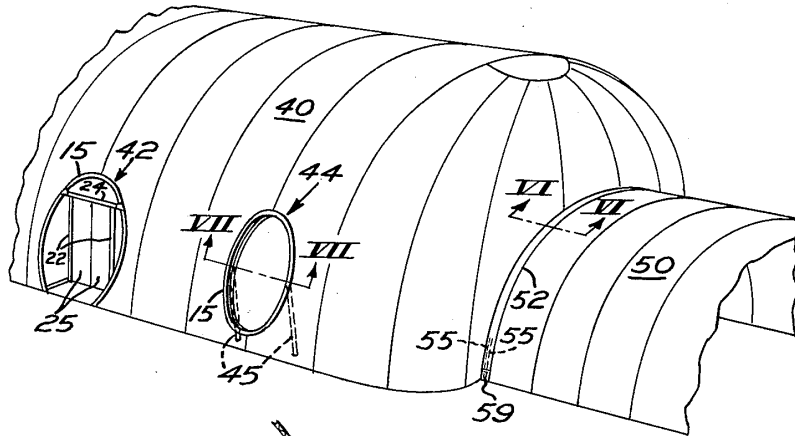
3,059,655

AIR INFLATED FABRIC STRUCTURES

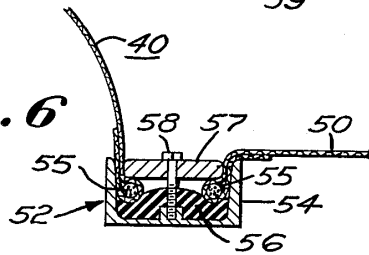
Filed Dec. 23, 1957

2 Sheets-Sheet 2

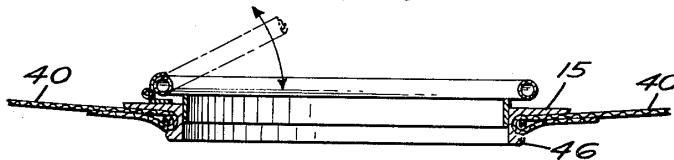
**FIG. 5**



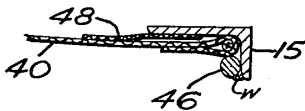
**FIG. 6**



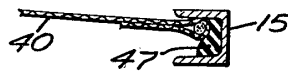
**FIG. 7**



**FIG. 8A**



**FIG. 8B**



INVENTOR:

WALTER W. BIRD

BY:

Beau, Brooks, Buckley & Beau,  
ATTORNEYS.

1

3,059,655  
**AIR INFLATED FABRIC STRUCTURES**  
Walter W. Bird, Williamsville, N.Y., assignor to  
Birdair Structures, Inc., Buffalo, N.Y.  
Filed Dec. 23, 1957, Ser. No. 704,613  
2 Claims. (Cl. 135-1)

This invention relates to air or frame supported structures constructed largely of flexible fabric or similar material, and more particularly to improved arrangements in such structures for installing access openings such as doors, etc.

A primary objective is to provide improved arrangements in such structures for installing doors or the like, and for providing attachments thereof to the other structures (either rigid or flexible) which will minimize stress concentrations in the envelope fabric, such as would be likely to cause rupture of the material and failure of the structure. Another object is to provide attachment means as aforesaid which are easy and inexpensive to construct, yet can be assembled and disassembled quickly and easily. A further object is to provide attachment means as aforesaid having no rigid elements integral with the envelope fabric such as would interfere with folding or packing the envelope for storage or transport. Other objects and advantages of this invention will appear in the specification hereinafter wherein the accompanying drawings are identified as follows:

FIG. 1 is a fragmentary perspective view showing a door installation incorporating subject invention installed in the spherical end portion of one typical form of air supported building;

FIG. 2 is a section taken along line II—II of FIG. 1, on enlarged scale;

FIGS. 3a and 3b are fragmentary sections showing details of alternate arrangements for attachments between the fabric envelope and the outer door frame;

FIG. 4 is a fragmentary perspective showing a cut-away view of a portion of the structure of FIG. 1;

FIG. 5 is a fragmentary perspective view of an air inflated structure showing other installations employing subject invention.

FIG. 6 is a section taken along line VI—VI of FIG. 5; FIG. 7 is a section taken along line VII—VII of FIG. 5; and

FIGS. 8a and 8b are sections showing details of construction alternate to those shown in FIG. 7.

Because air inflated structures tend to distort under wind loads, installations of access doors, etc., and attachment devices for connecting air inflated structures to such and other buildings, must be made in such manner as to avoid load concentrations which would damage the fabric of the structure possibly resulting in ultimate destruction of the building. It is therefore desirable to avoid sharp corners or perimetral discontinuities at the areas of fabric-structural attachments, whereby to maintain a uniform distribution of loading into the fabric envelope. The present invention provides a means of joining the fabric envelope for example to a door frame or like structure, in a simple but effective manner through use of a generally circular frame member and by reinforcing the edge of the opening in the envelope fabric with tape, rope, cable, or the like, so that the cable or the like will take the fabric loads in the manner of hoop tension. A uniform load transfer is thus accomplished without load concentrations on the fabric such as would be likely to cause rupture.

If the access opening of the structure is in a spherically shaped section thereof, normal loads in the fabric due to inflation pressures are uniform in all directions in the plane of the fabric; and an equilibrium condition will

2

exist when the opening is circular. In a cylindrically shaped structure the inflation pressure loading on the envelope fabric in the circumferential or arch direction is twice that of the loading in the longitudinal direction. Therefore the optimum opening shape in a cylindrical fabric wall portion as shown in FIG. 5 would be of generally elliptical configuration with the long axis of the opening twice the length of the transverse axis and directed circumferentially of the cylindrical section.

Variable loads in the fabric due to high winds or the like are transmitted by the cable to the opening framing member; and hence are resisted by the stiffness to bending of the ring-shaped framing member. Thus, for example, as shown in FIGS. 3a, 3b, 7, 8a, 8b, the opening framing member may be readily fabricated by suitably bending a grooved metal angle or channel; the fabric attachment cable being made of such length as to be adapted to snap over the bead or flange at one side of the framing member into the groove therebehind, thereby holding it securely when the building is deflated and all fabric tensions are relaxed.

When the building is pressurized, slight stretching of the cable may be tolerated because the inflation pressure holds the wide flange portion of the frame piece tightly against the marginal edge portion of the envelope; thus providing an ample air-seal and preventing dislodgement of the frame from the opening. Although an adequate seal may be provided by the pressure of the frame against the envelope, the invention also contemplates further improved seal arrangements as will now be explained in detail.

Thus for example as shown in FIG. 1, the invention is embodied in an air inflated structure comprising generally a fabric envelope section 10 such as may comprise a spherically shaped end portion of a cylindrically shaped air inflated building. An anchor cable as indicated at 12 is enclosed within a bottom edge seam portion on the lower skirt of the envelope 10, and at intervals therearound is anchored to the ground as indicated at 14, by any suitable tie-down devices. The envelope 10 is provided with an access door arrangement comprising an opening framing element 15 which may be readily provided in the form of a circularly bent angle or channel sectioned, metal stock piece as shown in better detail for example in FIGS. 3a, 3b, and 4. The framing element 15 is preshaped to conform to a generally circular shaped opening cut in the envelope fabric 10; and as shown in FIG. 1 the opening and the framing members are interrupted at the position of ground contact to provide a suitable threshold opening as indicated at 16. At the bottom ends of the framing member 15, it carries integrally mounted anchor plates 18 which are adapted to be fixed to the building supporting surface by any suitable means such as indicated at 18a (FIG. 4). Thus, the ring 15 is stabilized in erect position, but slightly inclining away from the vertical to conform approximately to the slope of the spherical envelope surface.

The envelope fabric 10 may be easily detachably connected to the ring 15 at its edge portion marginal to the door forming opening in the fabric, for example by simply laying the marginal edge of the fabric in the groove of the channel section ring member 15, and then locking it in position by suitable means such as a flexible cable, cord, or the like as indicated at 19, training around on top of the fabric nested in the groove and fastened at its ends as by eye bolts indicated at 32 (FIG. 4). Preferably, however, provision will be incorporated to more positively insure against accidental release of the fabric piece 10, such as by reversely folding around the cable 19 the extreme marginal edge portion of the fabric to provide a flap 20 (FIGS. 3a and 3b) enclosing the cable,

3

which is then cemented or sewed or otherwise attached to the body of the fabric piece 10. In any case, it will be appreciated by virtue of this arrangement a construction is provided whereby uniform distribution of loads in the envelope fabric relative to the framing ring 15.

The door device per se is preferably disposed in vertically upright position, and therefore may be conveniently arranged to comprise a rigid metal casement consisting of uprights 22—22 and a header 24. A floor sill may or may not be employed, as preferred. One or more door panels as indicated at 25 may be hingedly carried by the casement frame. At its upper end the casement framing members may be conveniently attached to the framing ring 15, as by means of brackets as indicated at 26. At their lower ends the uprights 22—22 may be fixed to the supporting surface at points 27—27; and to further stabilize the door structure diagonal braces 28—28 are furnished at opposite sides of the doorway and rigidly connect at their top ends to the header 24 and conveniently connect at their bottom ends to the anchor plates 18—18. To complete the normally air-tight closure of the access opening in the envelope fabric 10, fabric panels 29—29 are provided to interconnect the uprights 22—22 with adjacent side portions of the ring member 15. Thus, it will be appreciated that a self-sustaining swing door arrangement is provided whereby ready access may be obtained to the interior of the structure and that the fabric loading in the area of the doorway arrangement is uniformly distributed throughout the fabric as explained hereinabove.

Whereas, FIG. 3*b* illustrates one form of opening ring 15 as being fabricated of standard channel sectioned stock metal, FIG. 3*a* illustrates that a standard angle-sectioned stock piece may be employed for the same purpose; a relatively small shoulder 30 being welded or otherwise fixed to the web portion of the member to cooperate with the main flange portion of the member to lock the fabric mounting cable therebetween. The shoulder portion 30 may be conveniently provided by bending a metal rod into the angle conforming position shown in FIG. 3*a* and then welding it to the angle, in lieu of using a standard channel sectioned stock piece. In the event that the frame is continuous as in FIGS. 5 and 7 the fabric holding cable may be endless and applied to the frame by manually slip-fitting it over the extending ridge 30 whereupon it snap-fits into the groove therebehind. An alternative arrangement is illustrated by FIG. 4, wherein the eye bolt 32 is adjustably connected to the ring frame 15 as by means of a screwthreaded bracket device 34, whereby it will be understood that the cable may be first trained over the arch and into the grooved portion of the member 15 and then connected at its lower ends by means of eye bolts 32, whereupon the latter are adjusted so as to suitably tension the cable to insure locking of the fabric 10 to the ring member 15.

FIG. 5 illustrates application of the principles of the present invention to a cylindrically shaped inflated structure wherein the envelope fabric is indicated generally at 40. As indicated at 42, a doorway construction may be provided in the cylindrically curved side wall portion of the structure generally in the manner illustrated and described in detail hereinabove in connection with FIG. 1. Thus, the doorway 42 comprises an opening forming ring member 15; door casement elements 22—24; and the hinged door panels 25, as in the manner of the construction of FIG. 1. However, in the case of 42, because of the cylindrical surface formation of the envelope in the region of the doorway installation, the ring member 15 is of generally elliptical form so as to uniformly distribute the unequal circumferential and longitudinal loadings in the fabric as explained hereinabove; the ring member 15 being also truncated at its bottom end to provide a more convenient threshold arrangement for the doorway as explained in connection with FIG. 1. Thus, details of the construction of the doorway 42 may be similar to those

4

illustrated and described hereinabove in connection with FIGS. 1—4.

In FIG. 5 at 44 another form of access doorway construction is illustrated wherein the fabric connecting ring member 15 is supported entirely by the envelope fabric 40 except that its weight and the weight of the door hingedly mounted therein are taken by struts 45—45 extending from ring 15 to the building supporting surface. The struts 45 are hingedly connected to the ring 15 for convenience in folding the structure and adjusting it to different installations of the building. In the case of the doorway 44, the ring is of continuous circular or elliptical form, and as explained hereinabove comprises essentially a grooved angle member into which the marginal edge portion of the envelope fabric is laid. In this case the fabric locking cable is preferably formed of endless strand form dimensioned to snugly fit the inner groove of the ring member 15. Thus, due to the slight elasticity of the cable it may be manually slip-fitted over the outer shoulder portion 46 of the ring member 15 whereupon it then slip-fits downwardly into the groove of the ring 15 elastically locking the fabric to the ring. FIGS. 7, 8*a*, show alternative details of construction in connection with the ring device 15; it being noted that in FIG. 7 the locking shoulder 46 is formed integral with the member 15, while in FIG. 8*a* the locking shoulder 46 is provided by welding a rod of metal to the web portion of a standard angle-sectioned stock piece. In FIG. 8*b*, the provision of a soft rubber cushion 47 is illustrated, to provide an improved air-sealed connection between the fabric and the member 15. FIG. 8*a* illustrates preferred provision of a joint sealing flap 48 which is alternative to the arrangement of FIG. 8*b*. In the case of FIG. 8*a*, the sealing flap 48 is initially set in place on the grooved member 15 and bonded thereto, and is dimensioned so as to extend therebeyond so that the air pressure interiorly of the structure presses the flap 48 against the envelope fabric 40, thereby further sealing the joint.

FIGS. 5, 6 also illustrate application of the invention to the problem of innerconnecting an air-inflated structure as hereinabove described with a like or other structure. Thus, for example, as shown in FIG. 5 the generally cylindrical structure 40 may be connected to an otherwise separate structure designated 50 which may be either another air-inflated structure or a rigid building or the like to which it is desired to connect structure 40 in open communication relation. Thus, the structure 50 may for example comprise an entrance vestibule or pressure lock accessory component to the main building 40. In any case the inner connection between the two structures as indicated generally at 52 is provided by means of a generally circularly bent channel sectioned connection element 54 which may be formed of any suitable metal material or the like to provide a grooved element into which contiguous edge portions of the structures 40—50 are engaged. Thus, as shown in detail in FIG. 6, a locking cable designated 55 is bonded into the marginal edge portion of the envelope fabric members 40—50 to draw them into the grooved portion of the member 54 circumferentially of the latter. Preferably an air-sealing gasket, or the like, as indicated at 56 is provided in the bottom of the grooved portion of the ring member to compensate for any elasticity in the cables 55. A locking strip of metal or the like as indicated at 57 (FIG. 6) may be employed if desired to further secure the cabled edges of the fabric pieces 40—50 in the grooved member 54; the strip 57 being fastened down by means of bolts 58 or the like. As shown in FIG. 5, the cables 55 terminate in take-up anchor devices 59 which are fixedly carried by the bottom ends of the grooved member 54. Thus, the tensions of the cables 55 may be readily adjusted so as to always maintain a proper fit relative to the grooved member 54.

Thus, it will be appreciated that by virtue of the construction shown in FIG. 6 modular or other type multiple structural unit assemblies may be effected with maxi-



**BIRD, Walter, n°US 3,024,796**

**1958-1962**

**Estructuras sustentadas por aire**

Nota\* Aplicado para aire y/u otros gases

**Solicitud** 18 abril 1958  
**Fecha** 13 marzo 1962  
**Lugar** Williamsville, Nueva York  
**Inventor** W. W. Bird  
**Patente n°** US 3,024,796  
**Título** *Air supported structures*

March 13, 1962

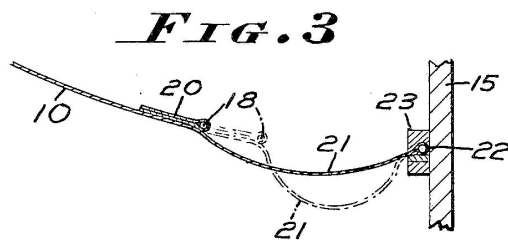
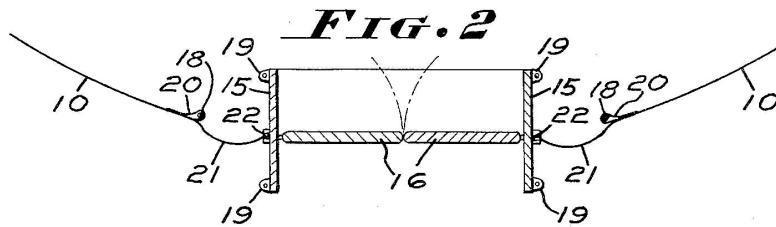
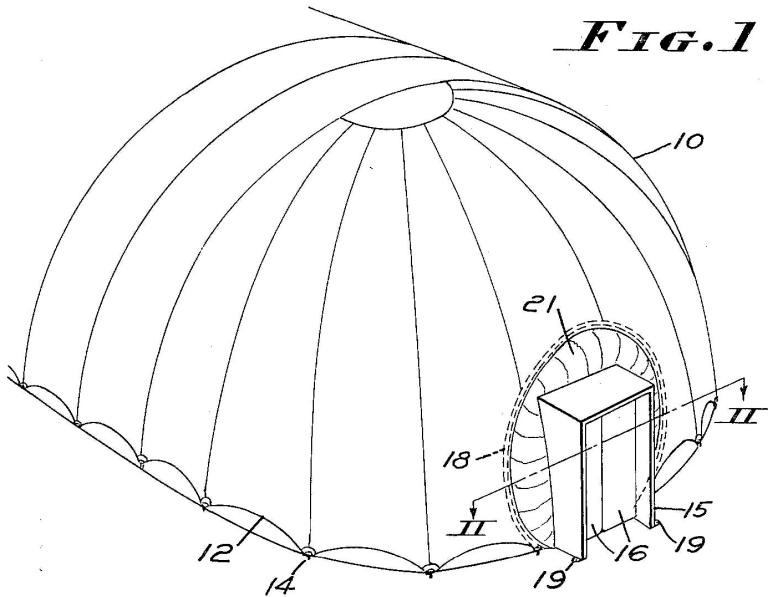
W. W. BIRD

3,024,796

AIR SUPPORTED STRUCTURES

Filed April 18, 1958

2 Sheets-Sheet 1



INVENTOR:  
WALTER W. BIRD

BY:

Beau, Brooks, Buckley & Beau,  
ATTORNEYS.

March 13, 1962

W. W. BIRD

3,024,796

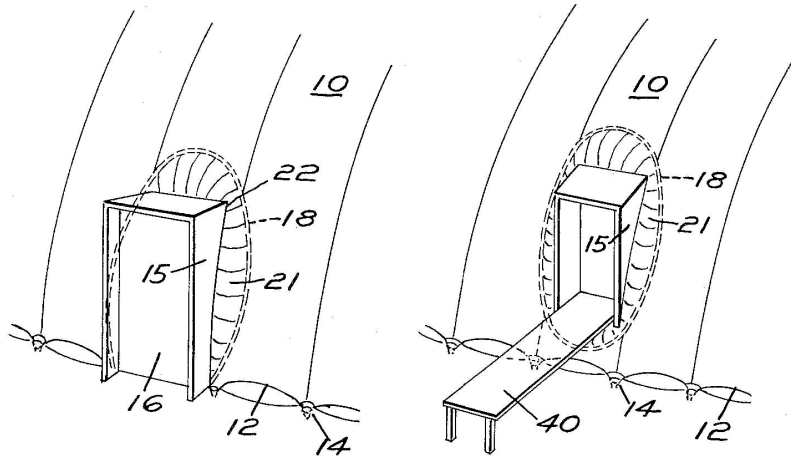
AIR SUPPORTED STRUCTURES

Filed April 18, 1958

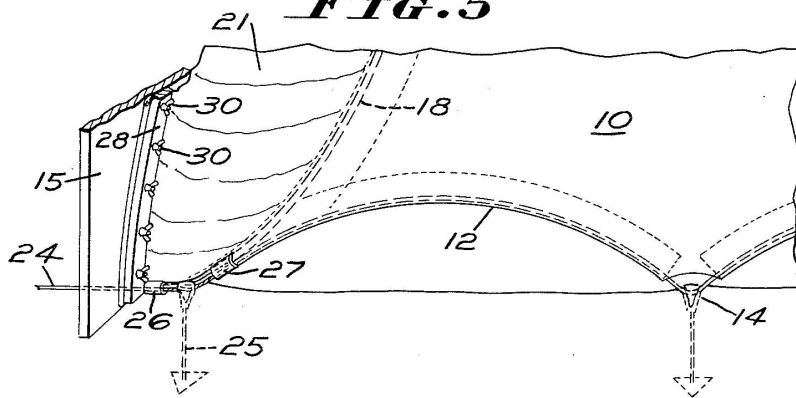
2 Sheets-Sheet 2

**FIG. 4**

**FIG. 6**



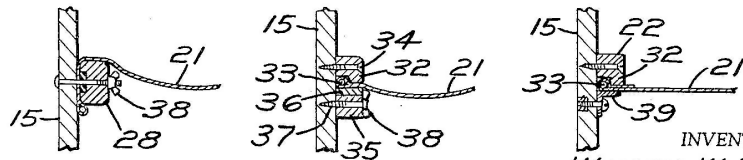
**FIG. 5**



**FIG. 7**

**FIG. 8**

**FIG. 9**



INVENTOR:  
WALTER W. BIRD  
BY:

*Beau, Brooks, Buckley & Beau,*  
ATTORNEYS.

1

3,024,796

**AIR SUPPORTED STRUCTURES**

Walter W. Bird, Williamsville, N.Y., assignor to Birdair Structures, Inc., Buffalo, N.Y.

Filed Apr. 18, 1958, Ser. No. 729,367

4 Claims. (Cl. 135—1)

This invention relates to air supported and other types of portable structures constructed of flexible fabric or similar material, and more particularly to an improved doorway or other opening arrangement.

A primary object, for example, is to provide improved means for reinforcing a flexible envelope adjacent to an opening, such as around a doorway or other cutouts, in such manner as to prevent stress concentrations in the envelope material due to distortion of the envelope form. A further object is to provide improved means for relieving loads transferred to a rigid door frame or the like as a result of movements of the flexible envelope, for example, under windy conditions. A further objective is to provide an extremely simple, portable, air and water tight installation unit which is applicable as a standard item to an inflated structure, and which is adapted to accommodate a wide variety of door sizes and configurations; and which will permit installation and disassembly and transport of the structure in minimum time. Other objects and advantages of this invention will appear in the specifications hereinafter wherein the accompanying drawings are identified as follows:

FIG. 1 is a perspective view showing a typical installation of a door in accord with subject invention, in a spherical wall portion of an air supported building;

FIG. 2 is a fragmentary section on enlarged scale as along line II—II of FIG. 1;

FIG. 3 is an enlarged detail of FIG. 2 diagrammatically illustrating how the envelope structure can distort without applying appreciable load to the door frame;

FIG. 4 illustrates a similar installation of a door in a cylindrical sidewall section of an air supported building;

FIG. 5 is a fragmentary perspective view showing door arrangement details;

FIG. 6 is a view similar to FIG. 4, but of a modified arrangement;

FIGS. 7, 8, 9, illustrate several possible methods of attaching the closing skirt to the door frame in order to provide an air and weather tight connection.

Because air inflated structures distort under wind loads, it is desirable that attachments of such structures to stationary or rigid objects, such as at entrance ways or interconnecting structures, be made in such manner as to avoid concentrations of load which would damage the fabric or the connecting structures and possibly result in destruction of the building. It is particularly important that such distortion of the structure be allowed for in making such attachments. Because such distortions are minimum in any spherical wall portion of a building, this is the preferred location for doors and other cutouts. However, even in this section, the structure may distort appreciably in high winds and such distortions have previously resulted in excessive concentrations of load both on the envelope and on the rigid structure to which it is attached. The cylindrical side sections of an air supported structure will tend to distort a great deal more than do the spherical ends and therefore it is of even greater importance to provide redistribution of load, to avoid stress concentrations in this area.

The present invention provides a means of collecting and redistributing the loads in the envelope of an air supported structure in a simple but effective manner by employing a cable or other relatively strong, flexible, load carrying member to reinforce the opening in the

2

envelope in a manner such that the normal fabric loads can be picked up by the cable and carried around the opening. Because of variations in the loads developed in different areas of the structure, the load transfer cable must be differently shaped to perform effectively in accord with the present invention. The present invention contemplates provision of a cable shaped to complement the normal load distribution in the envelope fabric in the area of the cable installation. For example, in spherically shaped wall portions, the normal inflation pressure results in a uniform load, and an approximately circular cable shape is required to provide equilibrium conditions. For similar reasons, for surfaces with compound curvatures the cable shape must be varied in accordance with the normal fabric loading in the principal planes of stress. In cylindrically shaped portions, the load in the vertical direction is twice that in the horizontal direction and hence the reinforcing cable must have a shape approximately that of a 2:1 ellipse in order to maintain equilibrium conditions. Furthermore, it is also necessary to inter-connect the cabled section and rigid structure with a flexible diaphragm which will allow the envelope to move relative to rigid structure without substantial transfer of load.

In accord with this invention, therefore, by way of one example a cable or the like may be encased in a fabric sleeve which is bonded directly to the envelope in a manner such that the cable picks up full envelope loads; the cable being thereby fixed to the envelope in a shape that most closely corresponds to the local equilibrium condition of envelope stress under its normal loading. In order to accommodate the distortion due to the aerodynamic loads superimposed on top of the normal loading, the closing diaphragm between the cable section and the rigid door structure is cut at the corners and shaped to provide an oversized skirt which flexibly encloses the area between the cabled opening and the door frame, without transfer of any appreciable load to the rigid door frame. The smooth curvature of the cabled section permits the redistribution of load in the envelope to take place without any appreciable concentration of stress, thus minimizing any problem of load concentration which would be likely to cause local failure of the envelope.

If the stationary structure connected to the envelope does not extend to the ground in the plane of the envelope, an endless cable can be used as shown in FIG. 5 which illustrates an opening of the type such as may be used to accommodate an elevated track or conveyor or similar type of device. Where the door or opening is required to be flush with the ground and the cable terminates at ground level, it is necessary that a ground attachment be provided which is able to carry the cable loads and transfer them across the opening into the ground. One method of attaching the cable is illustrated in FIG. 6. Several methods of making attachments of the skirt to the stationary structure are illustrated in FIGS. 7, 8 and 9.

As stated hereinabove, a primary objective of this invention is to permit the installation of doors and like equipment of a variety of shapes within a given opening, thus permitting standardization of the structure and allowing a considerable degree of versatility.

Thus, for example, as shown in FIG. 1, the invention may be embodied in an air inflated structure comprising generally a fabric envelope 10, such as includes a spherically shaped end portion of a generally cylindrically shaped air inflated building. An anchor cable, as indicated at 12, is enclosed within a bottom edge seam portion of the lower margin of the envelope 10, and at intervals therearound is anchored to the ground as indicated at 14 by any suitable tie-down devices. The en-

3

velope 10 is provided with an access door arrangement comprising a framed enclosure 15, into which are mounted the access doors 16. The entire door framing assembly is enclosed by a cable 18, which is encased in a fabric sleeve 20 and is bonded to the envelope 10 in a manner such that it can pick up and redistribute the loads imposed thereon as shown in FIG. 2. The flexible skirt 21 between the reinforcing cable 18, and the door framing members 15, is cut and patterned so as to billow out from the normal envelope contour and is shaped so as to permit relative movement between the envelope and door framing as shown in FIG. 3. The inner edge of the skirt 21 is attached to the door enclosure 15 by providing a roped edge 22 (FIG. 3) which can be clamped to the door framing member by means of grip blocks 23 or by any other suitable means of attachment.

Where an access door is located in the cylindrical side section of the building, the reinforcing cable is installed in an elliptical shape having a height to width ratio of approximately 2:1 as illustrated in FIG. 4. In this case, as in the case where the entrance door is located in a spherical section, the skirt 21 between the reinforcing cable 18 and door framing 15, is shaped and patterned so as to allow relative movement between the envelope and door framing without resulting in substantial transfer of load to the door framing members. In order to pick up and transfer the loads in the door reinforcing cable 18 and lower skirt catenary cable 12 at the door opening, continuity must be provided by carrying a cable portion 24 across under the door as illustrated in FIG. 5 and by providing an anchor 25 connected to the intersection of the cables 18, 12 and 24 to carry the vertical component of load necessary to provide stability. Collars 26 and 27 are used to join the cables to provide necessary transfer of load. An alternate method of attaching the skirt 21 to the door framing member 15 is illustrated in FIG. 5 and comprises a clamping strip 28 which is clamped down on the marginal edge of the skirt and is secured by bolts and wing nuts 30 to clamp the skirt tightly against the door enclosure 15. A section of this attachment is shown in FIG. 7.

Alternate methods of making an attachment between the envelope and door framing members are shown in FIGS. 8 and 9. For example, in FIG. 8, a strip 32 made of wood or metal and internally grooved as shown to accommodate the roped edge 33 of the skirt 21 is shaped to correspond to the envelope intersection on the door framing member and is securely attached to the door enclosure by screws 34. A second strip 35 is shaped to correspond to that of 32 and spaced out away from 32 sufficient to allow insertion of strip 36, the strip 35 being permanently joined to the door enclosure member by means of screws 37 or other suitable attachment devices. The skirt member 21 is secured to the door enclosure simply by inserting strip 36 into place. As tension on the skirt, tending to pull the rope edge out of place is exerted against the grooved edge of members 32, there is no load delivered to strip 36 such as to cause it to come out of place, and the attachment device is capable of carrying relatively high loads. Thumb nut 38 is used to prevent strip 36 from being accidentally dislodged.

The method of attachment shown in FIG. 9 employs a strip 32 having a groove section similar to that shown in FIG. 8. In this case, a small angle 39 is pressed back against the rope edge of the skirt 21 to secure it in place. The angle is secured in position by dowels, top and bottom, which position it and by screws or bolts as illustrated.

The framed enclosure 15 is preferably anchored to the ground or base mounting platform in any suitable manner as indicated at 19 (FIG. 2) so as to hold it securely in position. A floor sill may or may not be employed as preferred and one or more door panels, as indicated at 16 hingedly carried by the framed enclosure 15, may

4

be used. In order to transfer the load carried in the reinforcement cable 18, and in the anchor cables 12 where they join and terminate adjacent to the door frame, provision must be made to transfer this load into the base structure, either by attaching the cables to a suitable connection on the framed enclosure 15, which is in turn attached to the ground, or by carrying the cable across under the door enclosure as illustrated in FIG. 5 and by employing a ground anchor identical to that used for securing the envelope 10, to the ground to resist the vertical component of load. The door arrangement as described thus provides a convenient, relatively air tight door and framing enclosure, secured to the ground but joined to the envelope in such a manner as to permit movement of the envelope relative to the framing as required to avoid transfer of any substantial load from the envelope to the door enclosure, thus assuring a uniform distribution of load into the envelope and the avoidance of stress concentrations which would be likely to lead to failure of the fabric and possibly ultimate destruction of the building. Thus, in addition to allowing the desired relative movement of the envelope to the framed enclosure, the basic stress in this element is kept small so that the attachment to the enclosure is not structurally critical.

FIG. 6 illustrates the application of the principles of the present invention to a cylindrically shaped side wall section of the structure where the framed enclosure is not mounted flush with the ground so as to accommodate a raised walkway or conveyor, the reinforcing cable 18 may be endless. As illustrated in FIG. 6, the reinforcing cable 18 is again bonded to the envelope with an elliptical shape having a height to width ratio of approximately 2:1. The framed enclosure 15 is supported from the ground or base of structure inside of the envelope and has one edge of the enclosure projecting out through the envelope to provide an entrance through which packages or other materials may be passed by means of a ramp 40 or other type of conveyor.

I claim:

1. In combination, an air inflated flexible wall structure including a curving wall portion subjected to flexing movement responsive to loadings applied to the structure, a rigid structural component disposed in positionally anchored relation adjacent said wall portion, and means providing connection between said rigid component and said structure comprising a flexible skirt device substantially surrounding said rigid component and fixed thereto in substantially air tight relation and extending therefrom into connection with said air inflated structure, the connection between said skirt member and said air inflated structure being provided at a wall portion of said air inflated structure and including a flexible cable fixed to the wall portion and adapted to flex therewith and shaped to complement the load distribution pattern in said inflated structure at that area, said skirt element being flexible to permit said air inflated structure and said flexible cable to move relative to said rigid component without transfer of substantial loads thereto, the fixed connection between said skirt and said rigid component being provided by an undercut grooved molding fixed to said rigid component, said skirt having a bead integral therewith at its edge and adapted to lie in the undercut portion of said groove, and a locking strip slip-fitting into said groove thereby preventing withdrawal of said bead portion from the groove.

2. In combination, an air inflated flexible wall structure including a curving wall portion subjected to flexing movement responsive to loadings applied to the structure, a positionally stationary structural component disposed in positionally anchored relation adjacent said wall portion, and means providing open communication between said stationary component and the interior of said structure comprising a flexible skirt device substantially surrounding said stationary component and fixed thereto in substantial-



**BIRD, Walter, n° US 3,116,746**

**1958-1964**

**Estructuras seccionadas soportadas por aire**

Nota\* Aplicado para aire y/u otros gases

**Solicitud** 2 junio 1958  
**Fecha** 7 enero 1964  
**Lugar** Williamsville, Nueva York  
**Inventor** W. W. Bird  
**Patente n°** US 3,116,746  
**Título** *Sectionalized air supported structures*

Jan. 7, 1964

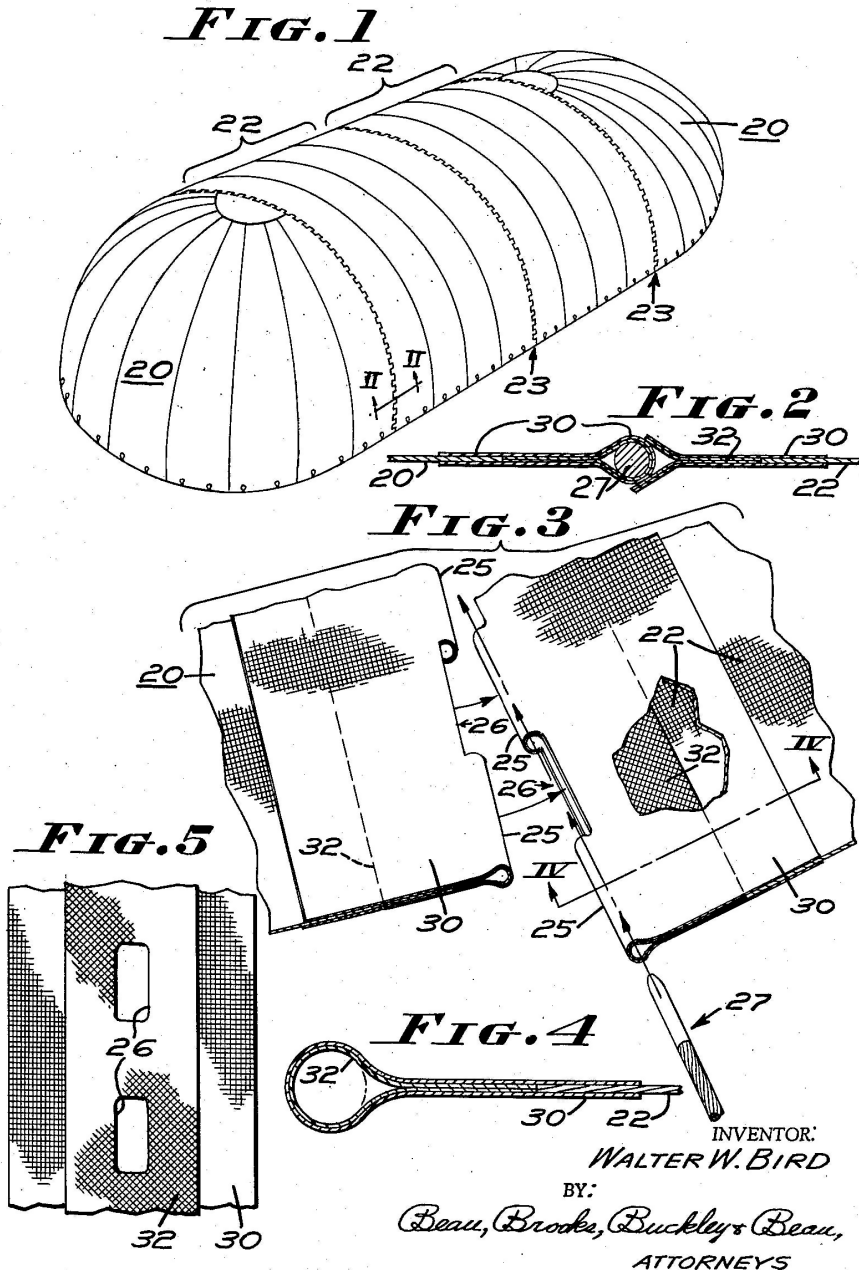
W. W. BIRD

3,116,746

SECTIONALIZED AIR SUPPORTED STRUCTURES

Filed June 2, 1958

3 Sheets-Sheet 1



INVENTOR:  
WALTER W. BIRD

BY:  
*Beau, Brooks, Buckley & Beau,*  
ATTORNEYS

Jan. 7, 1964

W. W. BIRD

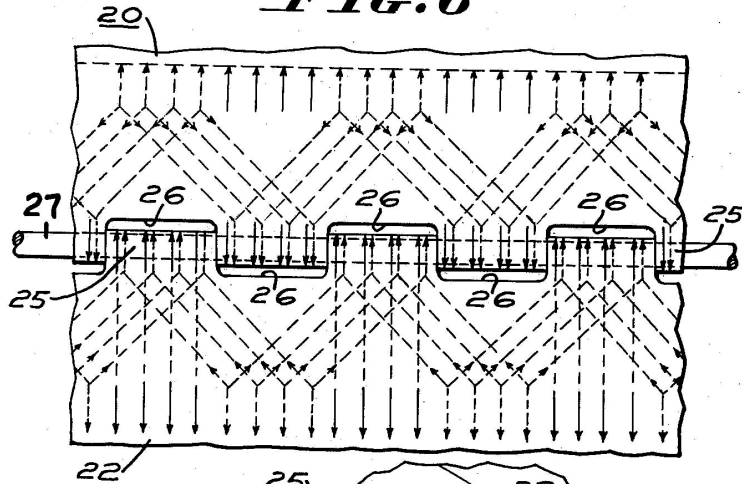
3,116,746

SECTIONALIZED AIR SUPPORTED STRUCTURES

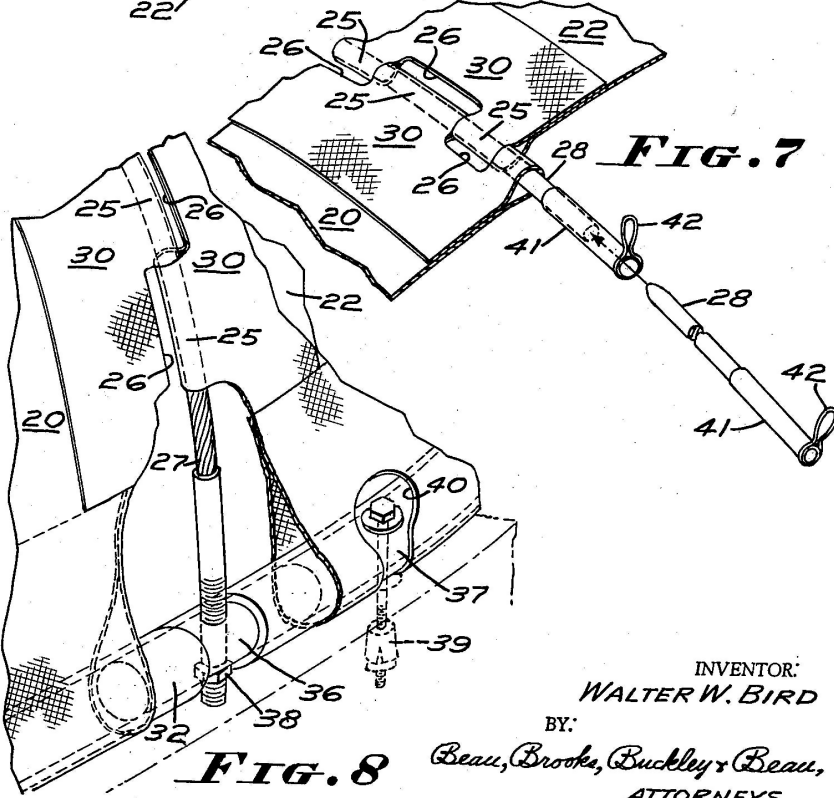
Filed June 2, 1958

3 Sheets-Sheet 2

**FIG. 6**



**FIG. 7**



**FIG. 8**

INVENTOR:  
WALTER W. BIRD  
BY:  
Beau, Brooks, Buckley & Beau,  
ATTORNEYS.

Jan. 7, 1964

W. W. BIRD

3,116,746

SECTIONALIZED AIR SUPPORTED STRUCTURES

Filed June 2, 1958

3 Sheets-Sheet 3

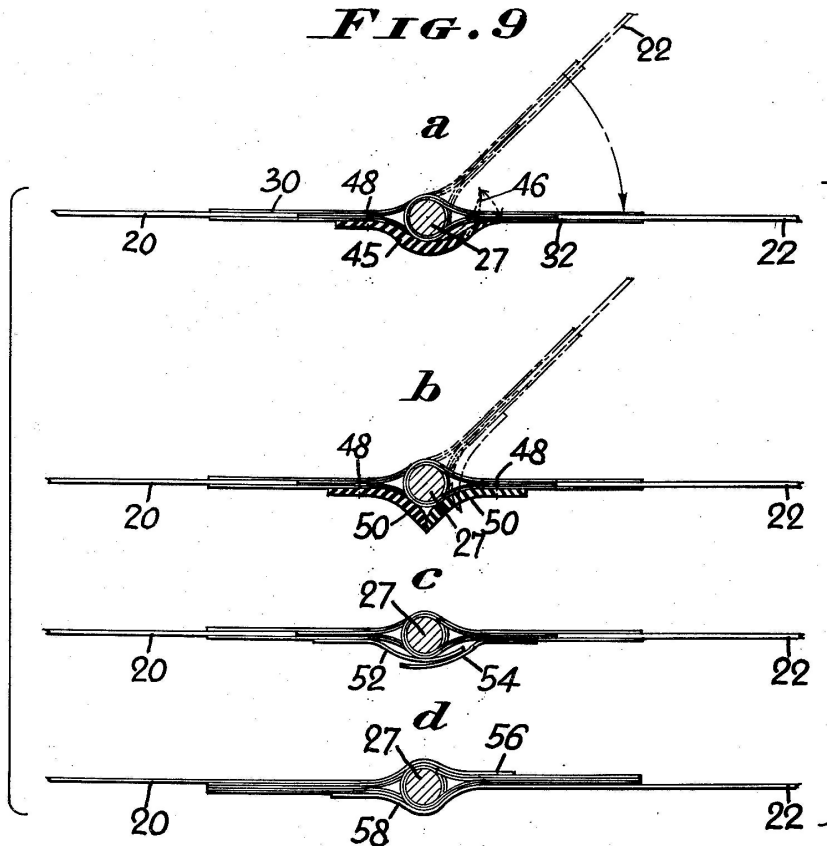
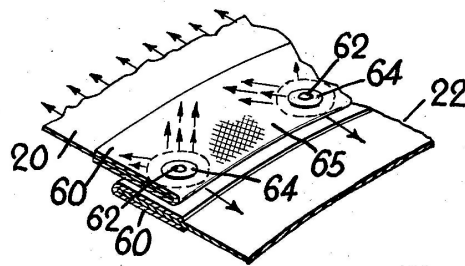


FIG. 10



INVENTOR:

WALTER W. BIRD

BY:

Beau, Brooks, Buckley & Beau,  
ATTORNEYS.

1

3,116,746

**SECTIONALIZED AIR SUPPORTED STRUCTURES**  
 Walter W. Bird, Williamsville, N.Y., assignor to Birdair  
 Structures, Inc., Buffalo, N.Y.  
 Filed June 2, 1958, Ser. No. 739,022  
 8 Claims. (Cl. 135—1)

This invention relates to modular-type, air supported structures built of flexible fabric or similar material, and, more particularly, to provision in such structures for improved means of affecting the detachable connections between the structural components.

The primary object of this invention is to provide improved, structurally simple means for detachably joining flexible sheet elements in such a manner as to transfer loads across the joints in a highly efficient manner. Another object is to provide a joint as aforesaid of substantially air tight and water tight construction which will facilitate sectionalized construction and modularized assembly, disassembly, and rearrangement operations. Another object is to provide a joint as aforesaid which will withstand rigorous use, but which, if damaged, will continue to function efficiently. Another object is to provide a joint as aforesaid which is so constructed that in event of abuse any rupture of the joint elements will not tend to propagate and may be easily repaired in the field. Other objects and advantages of this invention will appear in the specification hereinafter wherein the accompanying drawings are identified as follows:

FIG. 1 is a perspective view showing an air supported, shelter-type structure embodying modular section joining means of the present invention;

FIG. 2 is a fragmentary section, on enlarged scale, taken along line II—II of FIG. 1;

FIG. 3 is a fragmentary perspective of a detail of the fabric joining means of the invention, illustrating the mode of interconnection;

FIG. 4 is a section taken along line IV—IV of FIG. 3;

FIG. 5 is a fragmentary plan of a component of the joiner device of FIGS. 2, 3, illustrating elements of the latter in their initial flat pattern form;

FIG. 6 is a schematic view illustrating the pattern of load transfer across a joint of the invention;

FIG. 7 is a view corresponding to FIG. 3 of a modified form of interconnecting arrangement;

FIG. 8 is a fragmentary perspective of a terminal end portion of a joiner device of the invention, with portions of the fabric broken away showing the end of the attaching cable of the joiner device and its securement to a ground anchor device;

FIGS. 9a, b, c, and d are sections through alternative forms of the joiner device illustrating means of providing essentially air and water tight connections;

FIG. 10 is a fragmentary perspective view of a flexible sheet edge portion mounting a load distributing device in accord with the invention.

As shown in FIG. 1, the invention is embodied in an air supported structure built of a flexible, relatively air tight, material having two spherical end sections, 20, 20, joined to two center sections 22, 22, by means of joiners of subject invention designated generally at 23. Each joiner is constructed by arranging two flat strips 30, 32 of strong flexible fabric as shown in FIG. 5 with the outer strip 30 arranged with its yarns running substantially perpendicular and parallel to the length of the strip. The strip 32 is of a narrower width, may be a fabric having its weave running on a 45 degree bias or may be a substantially isotropic strong flexible film material such as a synthetic plastic, is bonded to the first strip by means of cement, heat sealing, sewing, or other suitable means which will assure a good

2

transfer of load between the two strips of material. This assembly is then punched to provide openings 26 approximately as illustrated in FIG. 5, along the approximate center line of the strips. The assembly is then folded over on itself as shown in FIG. 4, and is bonded to itself and to the marginal edges of its connected structure 20, 22 as the case may be. Thus the holes 26 form alternate loop and slot portions designated 25 and 26 (FIG. 3). The joiners are positioned on adjacent sections of the structure so that the loops and slots mesh together; and cable 27 as illustrated in FIGS. 2, 3; or a rod 28 as shown in FIG. 7 is then passed through the alternate loops, thus joining the adjacent sections together to provide a strong, structural attachment. When joined in this manner, a snug-fitting assembly is provided. The inner edges of the slots 26 are cut to fit snugly around the corresponding loops 25 on the joining section, to initially provide a substantially air and water tight connection as shown in FIG. 2. That is to say, the width or depths of the cut-outs or slots 26 are less than the circumference of the cable or rod so that the inner edges of the slots partially embrace the cable or rod as is shown in FIG. 2. Here it can be seen how the loop sections wedge in between the leafs of the slot sections, and thus the internal air pressure helps to seal the joint.

When a cable 27 is used in connection with this joiner, the free ends of the cable are preferably fixed in position and are thereby prevented from being pulled out of position by means of a take-up device as illustrated in FIG. 8. As shown herein, a swaged threaded end terminal on the cable is passed through a hole in a rod, 36, which in turn is inserted into the ends of hold-down pipes 37. The cable length is adjusted by means of a nut 38. Thus, anchorage of the cable to the ground or base structure is accomplished by means of anchor bolts 39. Access to the anchor bolt heads is obtained through slots 40 provided in the skirts of the structure 20—22. When a flexible rod is used to join the sections, as illustrated in FIG. 7, the rods are cut in lengths which are convenient to handle and are each equipped with a ferrule section 41, on one end, into which the tip of the adjacent rod is slip-fitted to assure a strong, continuous attachment. In addition, the ferrule 41 is equipped with a small, looped handle 42 to facilitate handling of the rod. When assembled, these handles project out from between the adjacent loop sections, and serve to lock the rods in place when the rods are slipped into their assembled positions.

The efficiency of this joint is greatly increased, and an improved distribution of load is achieved by the bias construction and distribution of load across the joint as diagrammatically shown in FIG. 6. In order to provide the slots 26, one-half of the looped portion 25 along the length of the joint is cut away to provide room for the corresponding loops of the mating parts. The load on the loop is therefore twice that of the average load on the material adjacent to the joint. In order to prevent undue concentrations of loads on these loop elements, and to provide redistribution of these loads into the basic structure with minimum distortion thereof, the members 32 are arranged on a bias, or a strong, substantially isotropic film capable of transferring this load, may be used. With this construction, as shown in FIG. 6, the load acting on the panels 20—22 opposite the cut-outs 26 therein for the loops 25 are redistributed longitudinally through cords of bias ply 32 into the loop portions 25, as shown by the dotted lines and arrows indicating the components of load. The slotted portions of the device do not carry any loads, but lay over the corresponding loop 25 (FIG. 2), thereby forming a relatively air and water tight seal. Thus, the bias construction reinforces the loops 25,



## Patentes realizadas por Walter Bird entre 1960 - 1970



**BIRD, Walter; REITMEIER, George; BASCHMANN Anson,  
n° US 3,150,670** **1960-1964**

**Estructuras de edificio sustentadas por aire plegada rápidamente**

Nota\* Aplicado para aire y/u otros gases

**Solicitud** 2 mayo 1960  
**Fecha** 29 septiembre 1964  
**Lugar** Williamsville, Nueva York  
**Inventor** W. W. Bird  
**Patente n°** US 3,150,670  
**Título** *Quickly strikable air  
supported building  
structure*

Sept. 29, 1964

W. W. BIRD ET AL.

3,150,670

QUICKLY STRIKABLE AIR SUPPORTED BUILDING STRUCTURE

Filed May 2, 1960

6 Sheets-Sheet 1

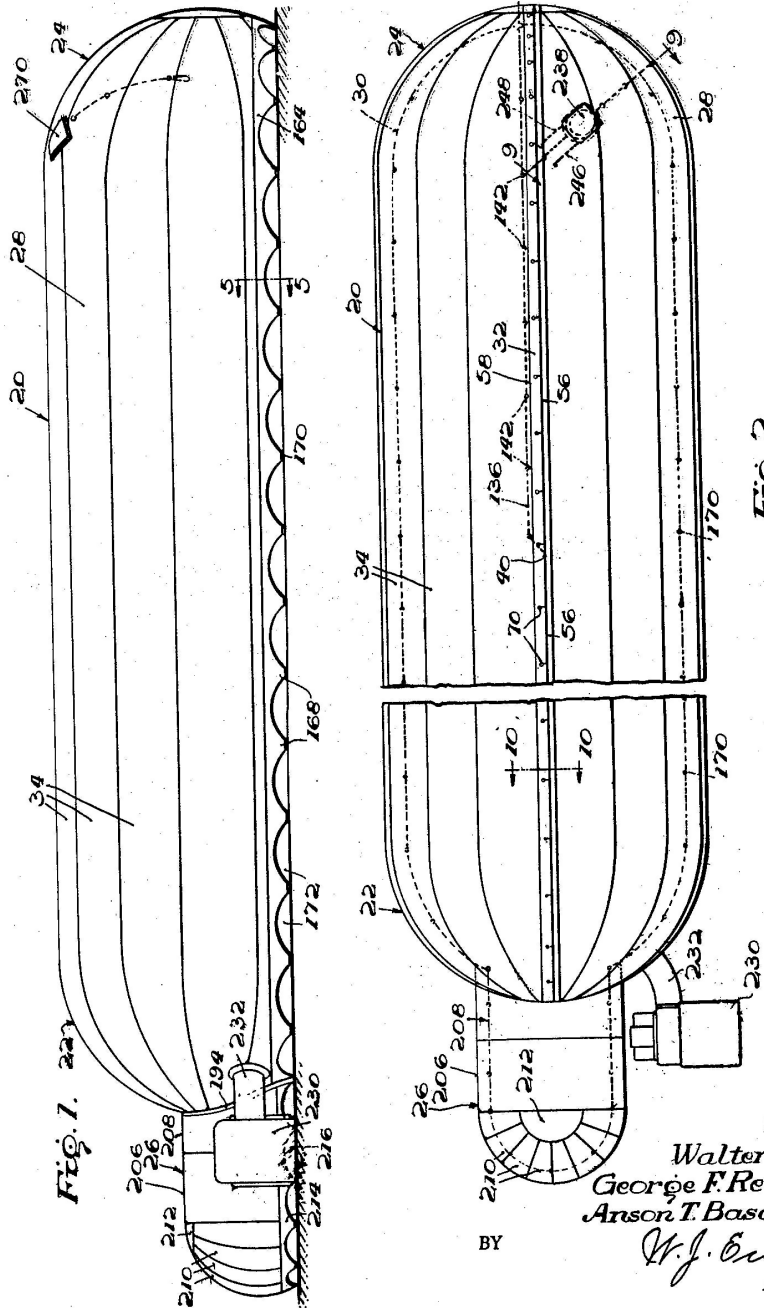


FIG. 1.

FIG. 2.

INVENTORS  
 Walter W. Bird  
 George F. Reitmeier  
 Anson T. Baschmann

BY  
*W. J. Eckert*  
 ATTORNEY

Sept. 29, 1964

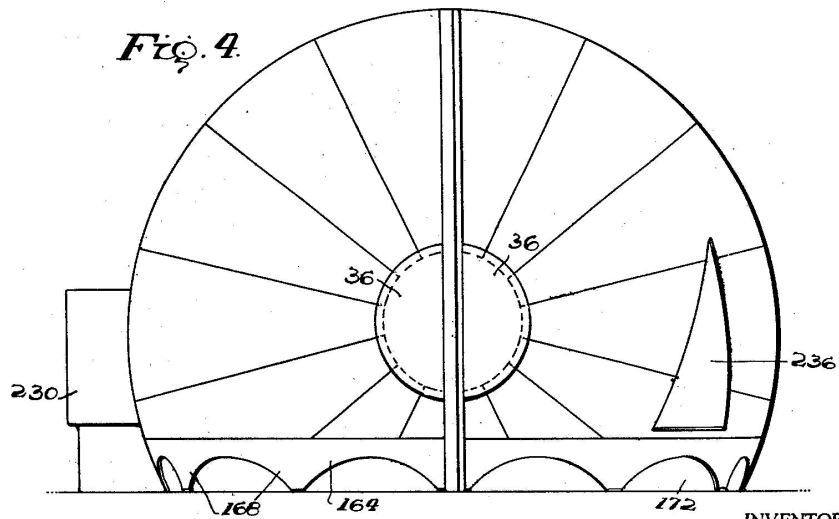
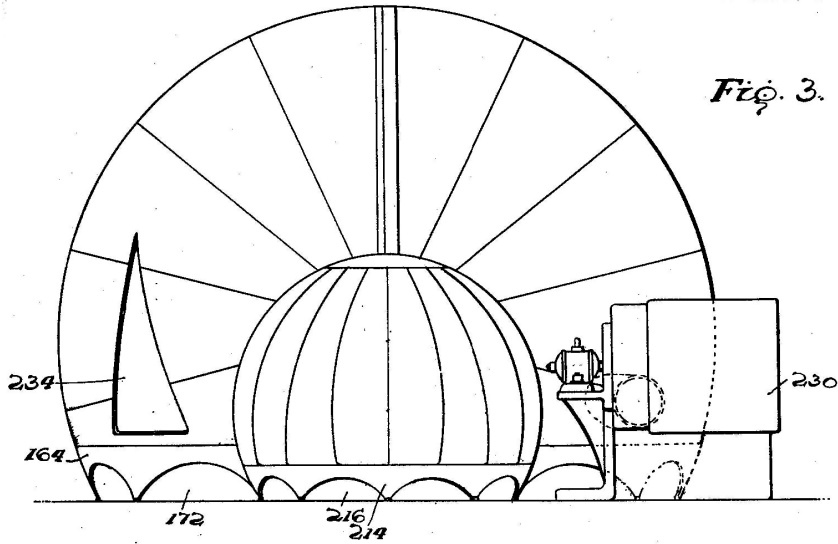
W. W. BIRD ET AL

3,150,670

QUICKLY STRIKABLE AIR SUPPORTED BUILDING STRUCTURE

Filed May 2, 1960

6 Sheets-Sheet 2



INVENTORS  
*Walter W. Bird*  
*George F. Reitmeier*  
*Anson T. Baschmann*

BY

*W. J. Eccleston*  
ATTORNEY

Sept. 29, 1964

W. W. BIRD ET AL

3,150,670

QUICKLY STRIKABLE AIR SUPPORTED BUILDING STRUCTURE

Filed May 2, 1960

6 Sheets-Sheet 3

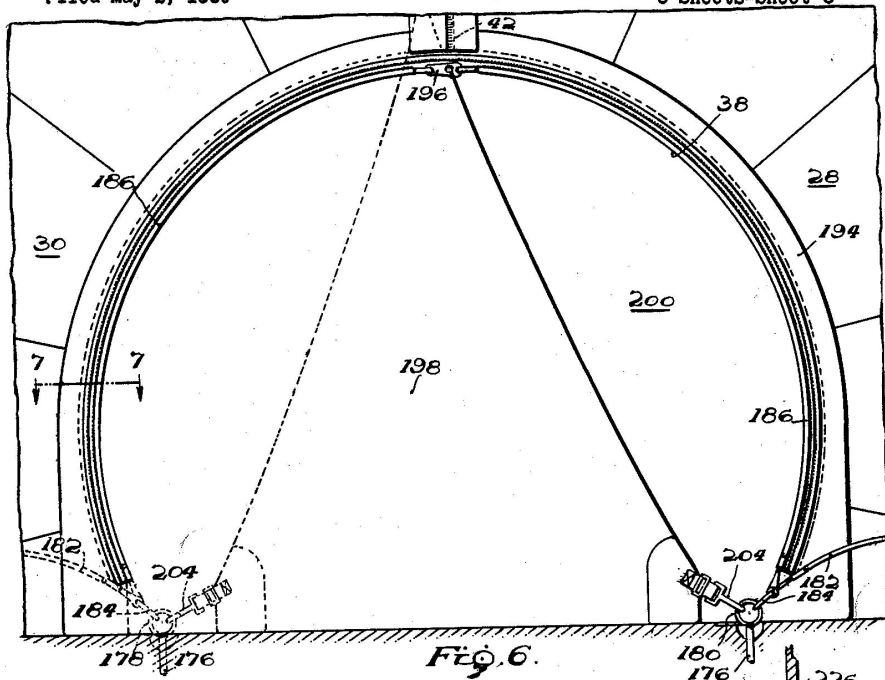


Fig. 6.

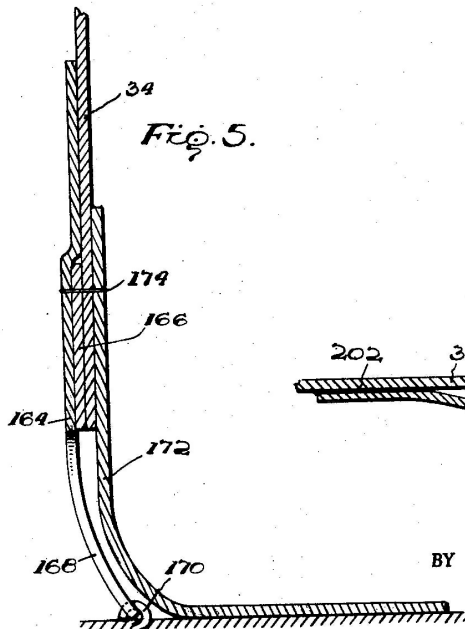


Fig. 5.

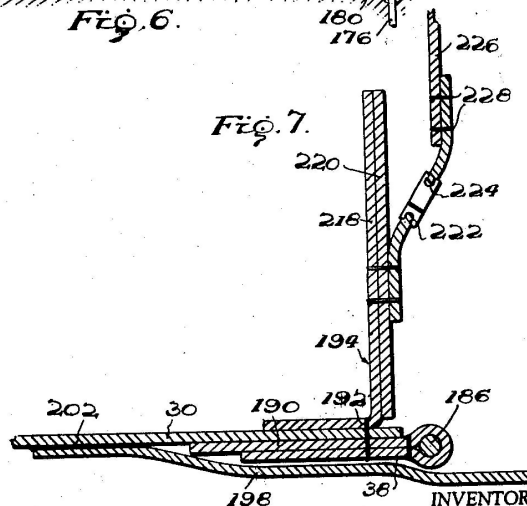


Fig. 7.

INVENTORS  
Walter W. Bird  
George F. Reitmeier  
Anson T. Baschmann  
BY *W. J. Eckert*  
ATTORNEY

Sept. 29, 1964

W. W. BIRD ET AL

3,150,670

QUICKLY STRIKABLE AIR SUPPORTED BUILDING STRUCTURE

Filed May 2, 1960

6 Sheets-Sheet 4

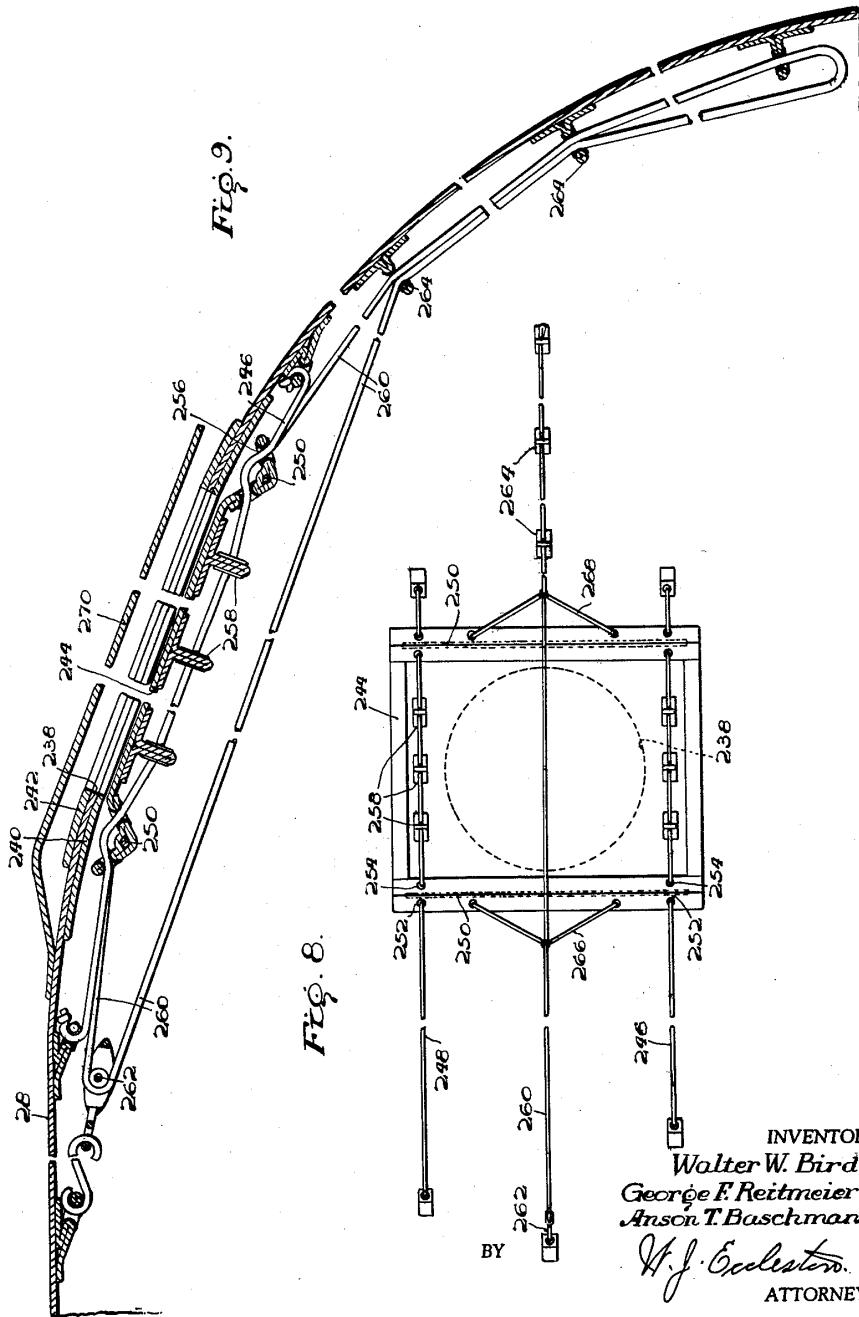


Fig. 9.

Fig. 8.

INVENTORS  
Walter W. Bird  
George F. Reitmeier  
Anson T. Buschmann  
BY *H. J. Eccleston*  
ATTORNEY

Sept. 29, 1964

W. W. BIRD ET AL

3,150,670

QUICKLY STRIKABLE AIR SUPPORTED BUILDING STRUCTURE

Filed May 2, 1960

6 Sheets-Sheet 5

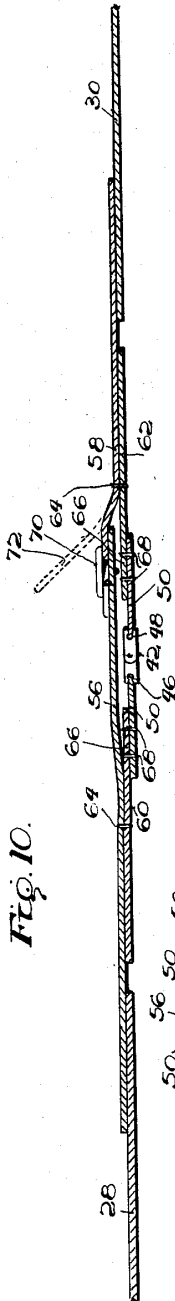


Fig. 10.

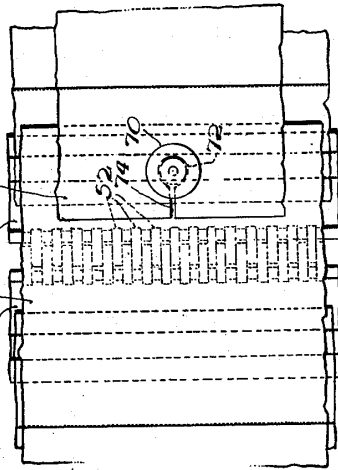
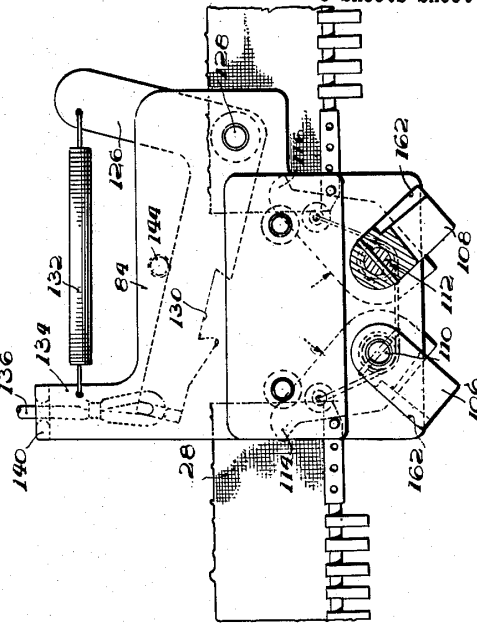


Fig. 11.

Fig. 15.



BY

INVENTORS  
Walter W. Bird  
George F. Reitmeier  
Anson T. Baschmann

W. J. Eckert  
ATTORNEY



1

2

3,150,670  
**QUICKLY STRIKABLE AIR SUPPORTED  
 BUILDING STRUCTURE**

Walter W. Bird, Williamsville, George F. Reitmeier, East  
 Aurora, and Anson T. Baschmann, Elma, N.Y.,  
 assignors to the United States of America as represented by the Secretary of the Army  
 Filed May 2, 1960, Ser. No. 26,382  
 16 Claims. (Cl. 135-1)

The present invention relates to inflatable building structures, and more particularly to an air-erected and supported building structure which is strikable substantially instantaneously and in a manner to fall clear of the ground area normally covered by the structure.

Inflatable building structures comprising a substantially airtight envelope erected and supported by maintaining the air in the envelope under a pressure somewhat greater than atmospheric have been increasingly utilized because of their many advantages, such as ease of erection and striking, the freedom of the interior thereof from obstructions to that a large storage space is provided, and the ready adaptability of these structures to manufacture in the various sizes and shapes required for various housing or storage needs. This has led to the use of these structures by the armed forces for various purposes, including recent use to house various kinds of missiles. When used for this purpose, it is desirable that the housing structure be quickly strikable so that the housed missile may be made operational in minimum time. Use for this purpose also requires the provision of means for gaining access to the interior of the erected structure at intervals by relatively large so-called checkout equipment. This was found to be best accomplished by the provision of an auxiliary compartment detachably connected to the main compartment and an airtight closure means to open the two compartments to each other when they were connected together, or to airtightly close off the opening in the main compartment through which the two compartments were opened to each other when the presence of the auxiliary compartment was no longer needed.

Accordingly, an object of the invention is to provide a new and improved air-erected and supported flexible building structure which is substantially instantaneously strikable and falls clear of the ground area normally covered thereby in automatic response to the instantaneous striking of the structure.

Another object of the invention is to provide a new and improved air-erected and supported flexible building structure comprising a plurality of sections connected together by separable fasteners of the quick release type to permit substantially instantaneous separation of the sections from each other.

A further object of the invention is to provide a new and improved air-erected and supported building structure of sectionalized construction, the sections of which are separable at will substantially instantaneously to strike the structure.

A still further object of the invention is to provide a new and improved air-erected and supported building structure which is formed of a pair of duplicate flexible sections joined by separable fasteners along a line coinciding with the ridge line of the structure so that the structure may be struck by separating the sections along the ridge line.

Another object of the invention is to provide a new and improved building structure of separable sections erected and supported by maintaining the air therein under a pressure slightly in excess of atmospheric which is designed to utilize the force exerted along the line of separation between adjacent sections by the escape of

pressurized air from the structure, once separation commences, to produce a quick separation of the sections.

Yet another object of the invention is to provide a new and improved air-erected and supported building structure including interconnectable and disconnectable main and auxiliary compartments, communication between which may be opened and closed by substantially airtight closure means on the main compartment so that the latter may be used either alone or in conjunction with the auxiliary compartment.

A further object of the invention is to provide a new and improved mechanism for effecting the quick release and complete separation of the adjacent sections in an air-erected and supported building structure of sectionalized construction.

A more specific object of the invention is to provide a new and improved mechanism for releasably holding the starting ends of complementary quick release type slide fastener stringers in operative relationship which is releasable at will to start a quick release of the coupled fasteners.

Another specific object of the invention is to provide a new and improved means for mounting slide fasteners used to connect together adjacent sections in a flexible building structure of sectionalized construction so as to facilitate replacement thereof and protect the same from the weather.

Another specific object of the invention is to provide a new and improved mechanism to control the coupling and uncoupling of the closing ends of a pair of complementary quick release type completely separable slide fasteners.

Another object of the invention is to provide a new and improved baffle to control the venting of air from an air-erected and supported flexible building structure.

A more general object of the invention is to provide a new and improved air-erected and supported flexible building structure which is relatively simple and inexpensive in construction, easily and quickly erectable and strikable which provides a maximum of covered storage space, and which is relatively light in weight and easily foldable into a compact package when dismantled so as to facilitate handling, storage, or transportation thereof in that condition.

These and other objects, advantages and capabilities of the invention will become apparent from the following description wherein reference is had to the accompanying drawings in which,

FIGURE 1 is a side elevational view of the improved building structure of the present invention;

FIGURE 2 is a top plan view thereof;

FIGURE 3 is a front elevational view thereof;

FIGURE 4 is a rear elevational view thereof;

FIGURE 5 is a fragmentary transverse vertical sectional view on the line 5-5 of FIGURE 1;

FIGURE 6 is a fragmentary front elevational view of the building structure of the present invention with the auxiliary compartment removed therefrom;

FIGURE 7 is a fragmentary transverse horizontal sectional view taken on the line 7-7 of FIGURE 6;

FIGURE 8 is a diagrammatic layout or plan view of an improved baffle for controlling the venting of air from an air erected and supported building structure;

FIGURE 9 is a fragmentary vertical transverse sectional view taken on the line 9-9 of FIGURE 2;

FIGURE 10 is a transverse vertical sectional view taken on the line 10-10 of FIGURE 2;

FIGURE 11 is a fragmentary top plan view of a portion of the improved building structure of the present invention along the ridge line thereof;

FIGURE 12 is a fragmentary plan view of the inwardly or downwardly facing side of the improved build-

3

ing structure of the present invention along the ridge line or the line of separation between the two sections thereof showing a mechanism for quickly releasing the starting ends of the separable fasteners used to connect together the separable sections of the structure and the closing end stop and separating means for these separable fasteners;

FIGURE 13 is a top plan view of the top or outwardly facing side of an improved mechanism for quickly releasing the starting ends of the separable fasteners which are used in the improved building structure of the present invention;

FIGURE 14 is a sectional view on an enlarged scale on the line 14—14 of FIGURE 13; and

FIGURE 15 is a view similar to FIGURE 13 on a somewhat enlarged scale showing the movable parts of the quick release mechanism at an intermediate position in the release of the starting ends of the separable fasteners connecting together the separate sections of the improved building structure of the present invention, one part of the movable release mechanism being shown in action.

As best seen in FIGS. 1 and 2, the building structure of the present invention comprises an elongated main compartment 20 of substantially semicylindrical transverse section and having spherically rounded ends 22 and 24, and a much smaller second or auxiliary compartment 26 of the same general shape centered upon the longitudinal center line of the main compartment and projecting from one end thereof. This latter end will hereinafter be referred to as the front end of the structure. The main compartment 20 comprises a pair of duplicate complementary sections 28 and 30, the line of division or separation between the sections coinciding substantially with the longitudinal center line of the main compartment and thus with the ridge line of this compartment as indicated at 32 in FIG. 2.

Each of the two half sections 28 and 30 is formed from a plurality of panels 34 which, contrary to the usual practice, extend longitudinally of the structure. These panels may be made from any suitable tough and flexible substantially airtight material as described hereinafter. The panels have generally parallel edges throughout the major portion of their length but these edges taper to a declining width adjacent both ends thereof as seen in FIGS. 1 to 4. The adjacent panels are secured together by lapping the contiguous edges thereof and cementing these lapped edges with any suitable adhesive, sealing or bonding the same in any suitable manner as by conventional electronic means or by a combination of cementing and bonding so that a strong and airtight seam is formed between the adjacent panels 34. At their rear ends, the panels 34 in each of the sections 28 and 30 are joined in semi-circular crowns 36 (FIG. 4), while the forward ends thereof define portions of the periphery of an opening 38 in the front end of the structure which will be described in greater detail hereinafter.

The two adjacently positionable half sections 28 and 30 are releasably secured together to form the main compartment 20 by any suitable separable fasteners. Since the capability of obtaining quick separation of the two sections 28 and 30 is one of the objectives of the structure of the present invention, several features have been embodied therein to attain that objective among which is the provision of two pairs of separable fasteners for connecting together the half sections 28 and 30 instead of a single pair of separable fasteners. The two pairs of separable fasteners extend in opposite directions, i.e., in a forward and rearward direction, from a common region or starting point located between the ends of the line of separation between the two sections. This starting point is indicated at 40 in FIG. 2, and in the present structure it is located somewhat to the left of the center of the ridge line 32 of the erected main compartment for a purpose that will be described.

This common starting point 40 is shown in detail in

4

FIGS. 12 and 13 where the forwardly and rearwardly running separable fasteners are indicated at 42 and 44, respectively. These separable fasteners may be of conventional zipper type and, to promote the desired quick separation of the two half sections 28 and 30, they should be of the quick release completely separable type which is readily available on the market. Since the forwardly and rearwardly extending separable fasteners 42 and 44, respectively, are of duplicate construction, only the forward separable fastener 42 will be considered in detail. This separable fastener comprises complementary left and right-hand stringers 46 and 48, each including a fabric tape 50, the tapes of these complementary stringers being connected along one edge thereof to the two opposed or complementary edges of the two half sections 28 and 30 by a means to be described, which forms one of the features of the present invention. Metallic jaws or scoops 52 are secured along the free edges of these stringer tapes 50, the scoops on the complementary left and right-hand stringers 46 and 48 normally being interlockingly coupled by the slider 54 when the latter is moved away from the strating ends of these stringers and uncoupled when the slider is moved in an opposite direction.

Referring to FIG. 10 wherein the complementary stringers 46 and 48 of the forward separable fasteners 42 and the opposed edge portions of the two half sections 28 and 30 to which these stringers are connected are shown laid out flat, the improved separable fastener connecting means of the present invention comprises opposed or left and right-hand flaps 56 and 58 cemented or electronically bonded, respectively, to the outer sides of the opposed edges of the adjacent half sections 28 and 30. These flaps extend continuously from end to end of these sections, and they are made of the same material as the panels 34, but they preferably are of at least double ply. The union between these flaps and the sections 28 and 30 should be weatherproof for a reason to be described. Relatively narrow elongated separable fastener bonding tapes 60 and 62 are connected along one edge thereof to the underside of the external or weather flaps 56 and 58, respectively, spaced inwardly slightly from the opposed edges of the half-sections 28 and 30 by cementing or electronically bonding the tapes to the flaps and by a single row of stitching 64 so as to leave the opposed edges 66 of the bonding tapes free of attachment. These bonding tapes extend in each direction from adjacent the starting point 40 to the outer ends of the weather flaps 56 and 58, and the complementary left and right-hand stringers of the forwardly and rearwardly running slide fasteners 42 and 44, such as the complementary stringers 46 and 48 of the forward separable fasteners 42, are connected to the free edges of the tapes by a double row of stitching 68.

It will be noted that the left-hand weather flap 56, as seen in FIGS. 2 and 10, is wide enough to extend completely over the closed separable fasteners 42, while the right-hand weather flap 58 is of less width but overlaps the left flap over a portion of its width. Since these flaps are secured to the outer side of the two half sections 28 and 30 and extend from end to end of the line of separation between the two sections, they serve to protect the forwardly and rearwardly extending separable fasteners 42 and 44, respectively, throughout their length, from the weather. To prevent the outer or right-hand flap 58 from being raised by the wind, cooperating buttons 70 and buttonholes 72 are provided on the weather flaps. The buttons 70, which may be of the overall type, are arranged in regularly spaced relation longitudinally of the left weather flap 56, while the buttonholes 72 in the right weather flap 58 are spaced to cooperate with the buttons 70.

In order to permit the connection thus made to be quickly released so that there can be a quick separation of the two half sections 28 and 30, right weather flap



**BIRD, Walter; STROBEL, Peter; RONGVED, Paul;  
ZAMORE, David, n° US 3,139,464 1960-1964**

### **Construcción del edificio**

Nota\* Aplicado para aire y/u otros gases

**Solicitud** 22 julio 1960  
**Fecha** 30 junio 1964  
**Lugar** Williamsville, Nueva York  
**Inventor** W. W. Bird  
**Patente n°** US 3,139,464  
**Título** *Building construction*

June 30, 1964

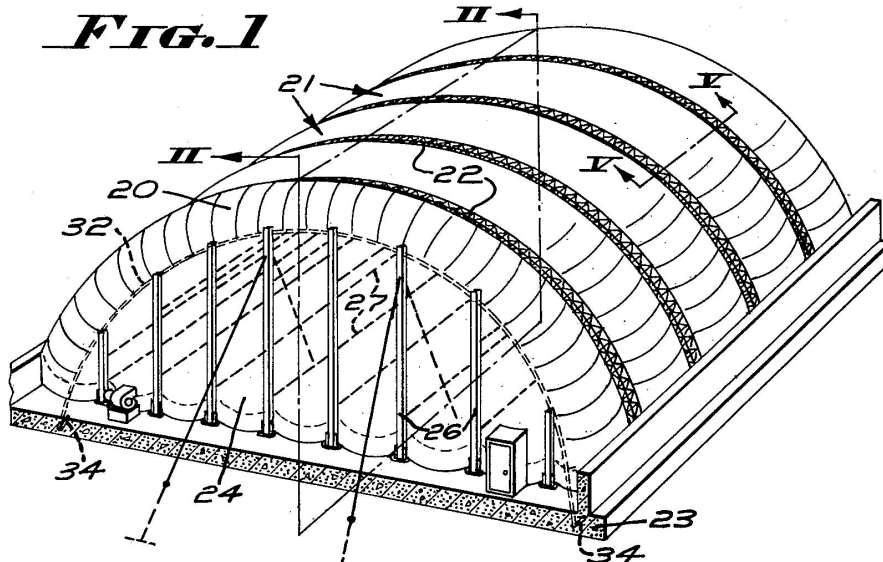
W. W. BIRD ETAL  
BUILDING CONSTRUCTION

3,139,464

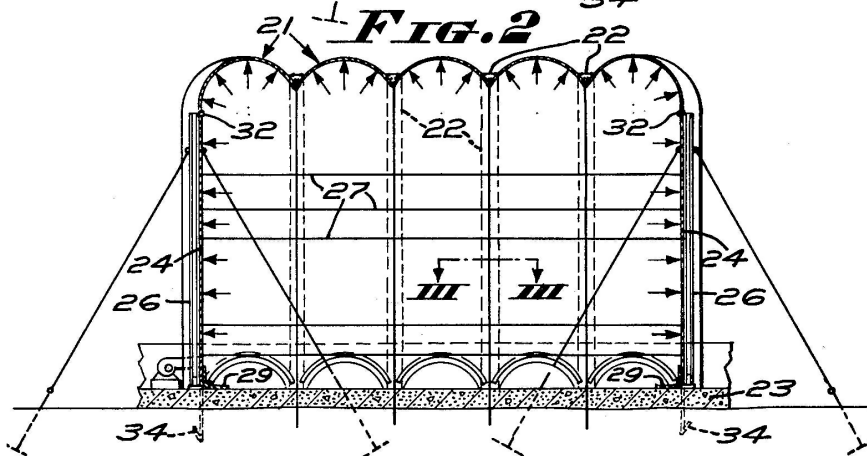
Filed July 22, 1960

7 Sheets-Sheet 1

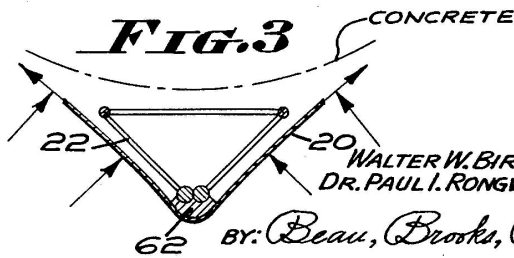
**FIG. 1**



**FIG. 2**



**FIG. 3**



INVENTORS:

WALTER W. BIRD, PETER A. STROBEL,  
DR. PAUL I. RONGVED and DAVID P. ZAMORE

BY: Beau, Brooks, Buckley & Beau,  
ATTORNEYS.

June 30, 1964

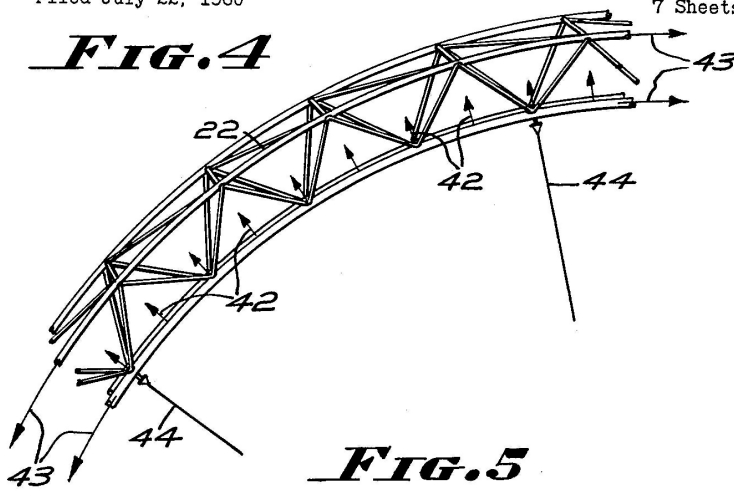
W. W. BIRD ETAL  
BUILDING CONSTRUCTION

3,139,464

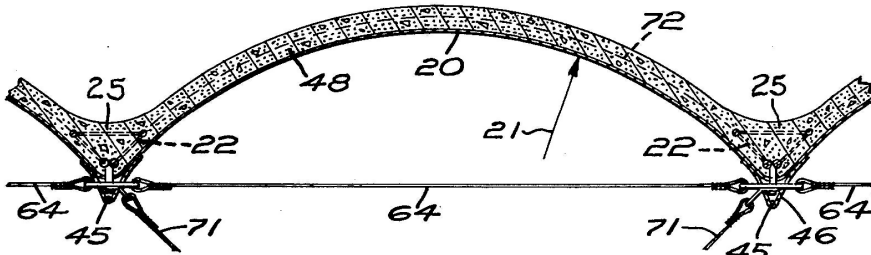
Filed July 22, 1960

7 Sheets-Sheet 2

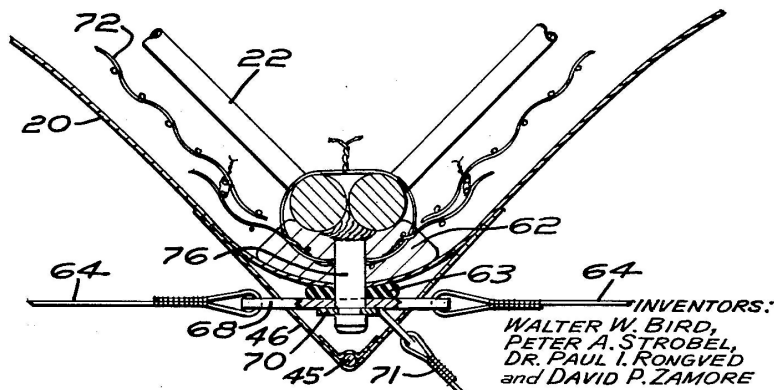
**FIG. 4**



**FIG. 5**



**FIG. 6**



INVENTORS:  
WALTER W. BIRD,  
PETER A. STROBEL,  
DR. PAUL I. RONGVED  
and DAVID P. ZAMORE

BY: *Beau, Brooks, Buckley & Beau,*  
ATTORNEYS.

June 30, 1964

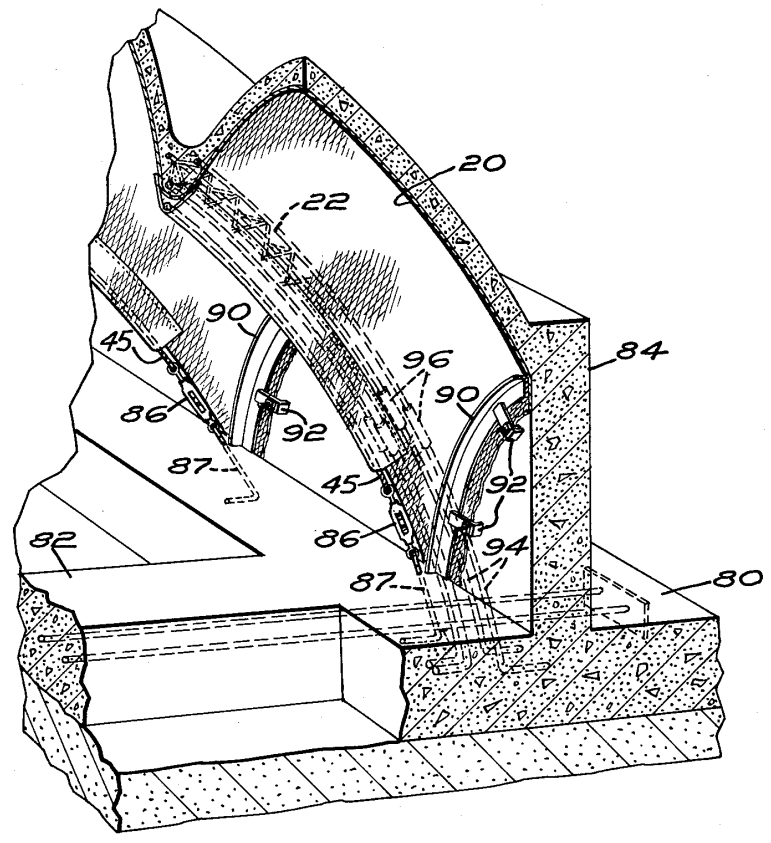
W. W. BIRD ETAL  
BUILDING CONSTRUCTION

3,139,464

Filed July 22, 1960

7 Sheets-Sheet 3

**FIG. 7**



INVENTORS:  
WALTER W. BIRD, PETER A. STROBEL,  
DR. PAUL I. RONGVED and DAVID P. ZAMORE  
BY: Beau, Brooks, Buckley & Beau,  
ATTORNEYS.

June 30, 1964

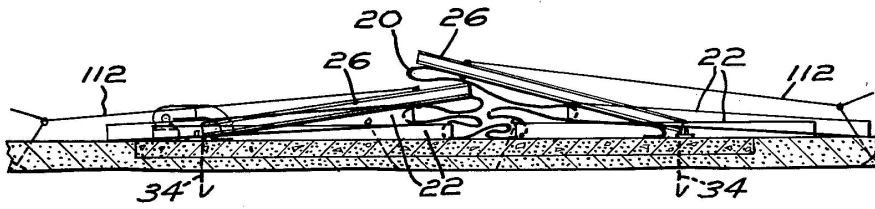
W. W. BIRD ET AL  
BUILDING CONSTRUCTION

3,139,464

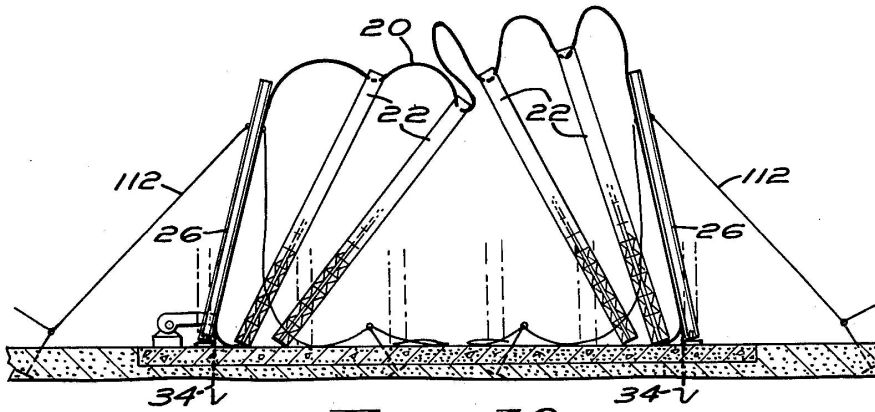
Filed July 22, 1960

7 Sheets-Sheet 4

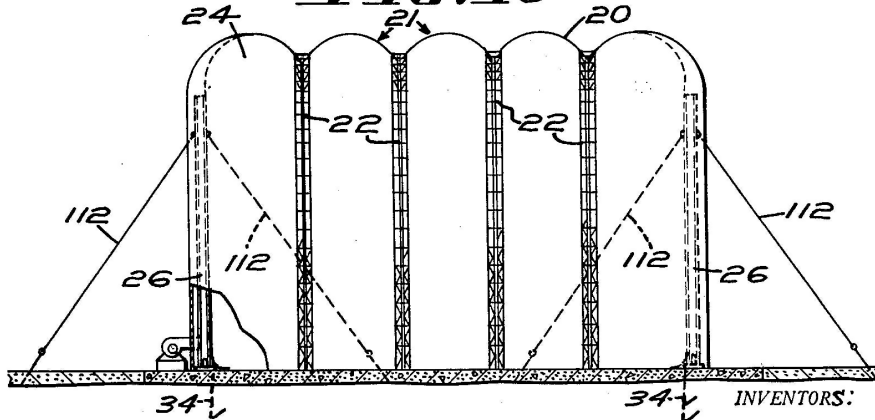
**FIG. 8**



**FIG. 9**



**FIG. 10**



INVENTORS:  
WALTER W. BIRD, PETER A. STROBEL,  
DR. PAUL I. RONGVED and DAVID P. ZAMORE  
BY: *Beau, Brooks, Buckley & Beau,*  
ATTORNEYS.

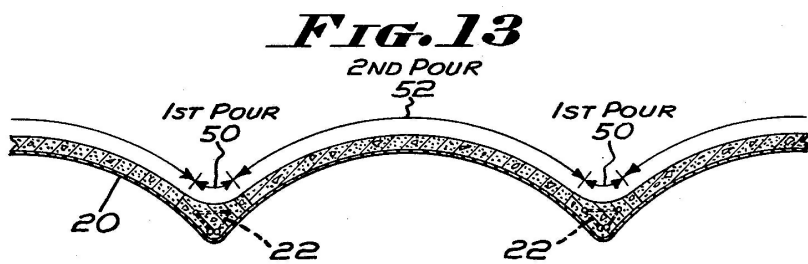
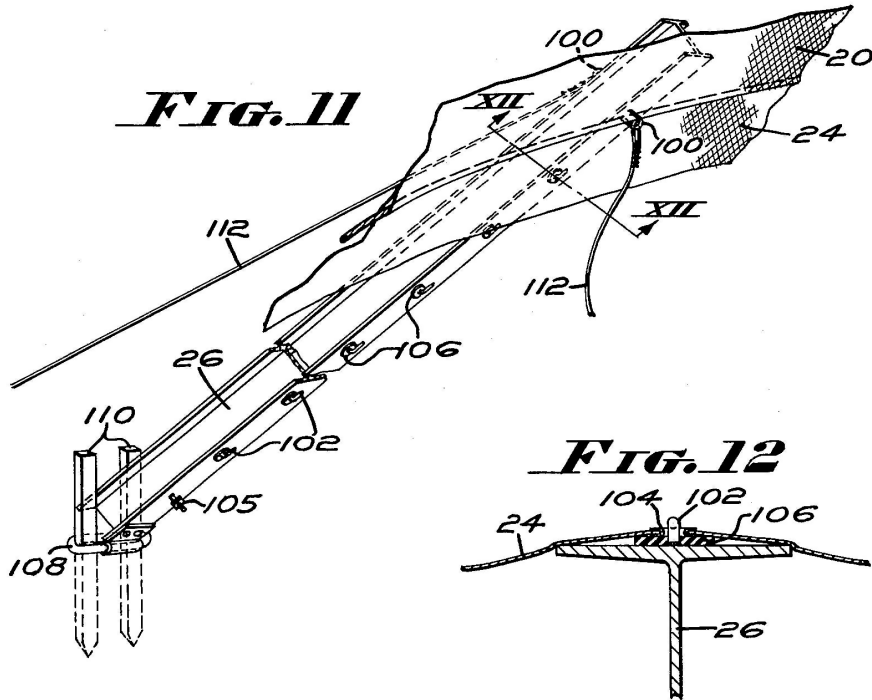
June 30, 1964

W. W. BIRD ET AL  
BUILDING CONSTRUCTION

3,139,464

Filed July 22, 1960

7 Sheets-Sheet 5



INVENTORS:  
WALTER W. BIRD, PETER A. STROBEL,  
DR. PAUL I. RONGVED and DAVID P. ZAMORE  
BY: *Beau, Brooks, Buckley & Beau,*  
ATTORNEYS.

June 30, 1964

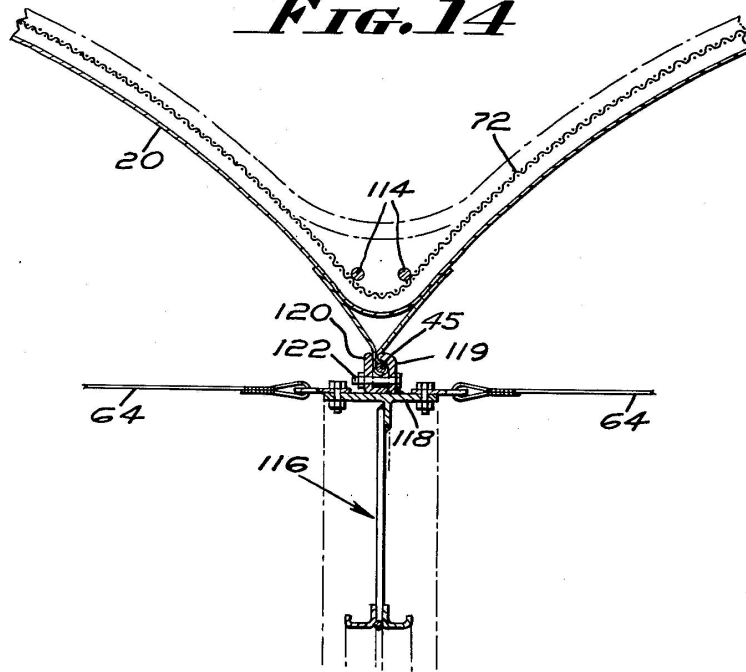
W. W. BIRD ETAL  
BUILDING CONSTRUCTION

3,139,464

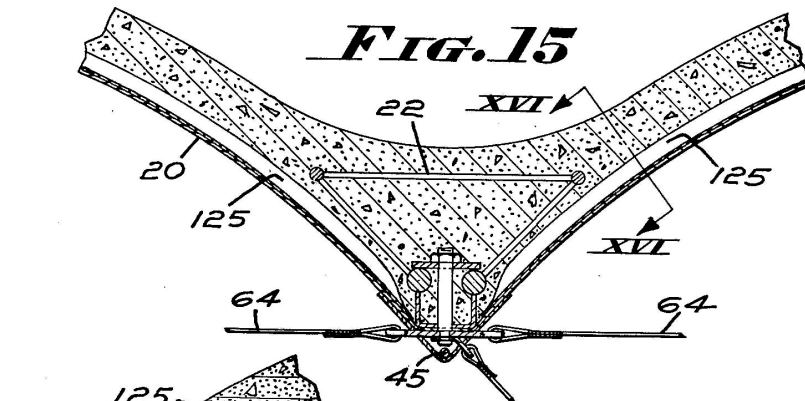
Filed July 22, 1960

7 Sheets-Sheet 6

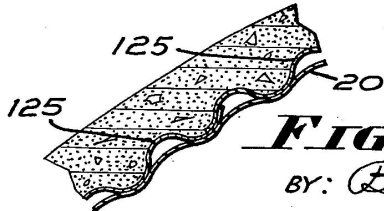
**FIG. 14**



**FIG. 15**



**FIG. 16**



INVENTORS:  
WALTER W. BIRD, PETER A. STROBEL,  
DR. PAUL I. RONGVED  
and DAVID P. ZAMORE

BY: *Beau, Brooks, Buckley & Beau,*  
ATTORNEYS.

June 30, 1964

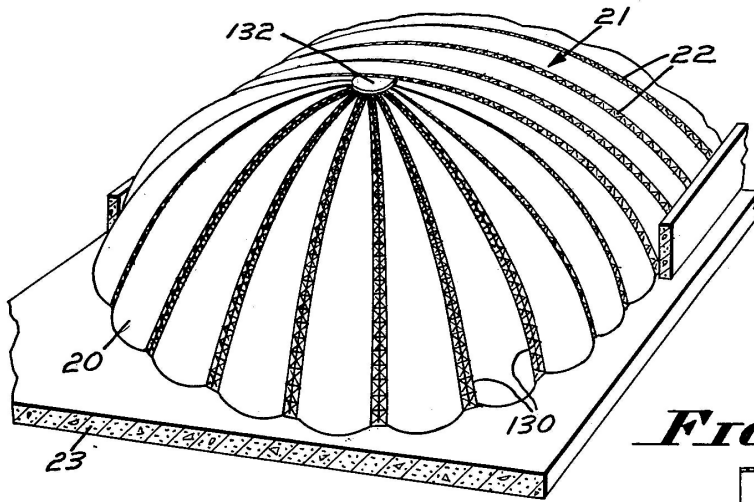
W. W. BIRD ETAL  
BUILDING CONSTRUCTION

3,139,464

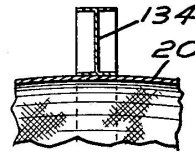
Filed July 22, 1960

7 Sheets-Sheet 7

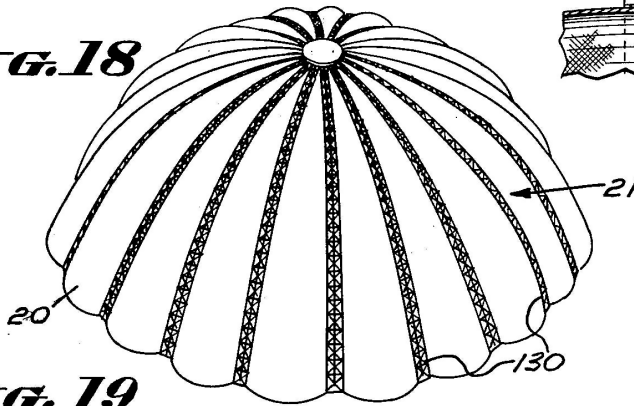
**FIG. 17**



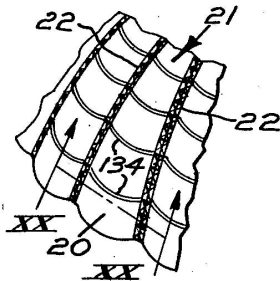
**FIG. 21**



**FIG. 18**



**FIG. 19**



**FIG. 20**

INVENTORS:

WALTER W. BIRD, PETER A. STROBEL,  
DR. PAUL I. RONGVED and DAVID P. ZAMORE

BY: *Beau, Brooks, Buckley & Beau,*  
ATTORNEYS.

1

3,139,464

## BUILDING CONSTRUCTION

Walter W. Bird, 355 N. Forest Road, Williamsville, N.Y.;  
Peter A. Strobel, 735 The Parkway, Mamaroneck, N.Y.;  
Paul I. Rongved, 250 E. 39th St., New York, N.Y.; and  
David P. Zamore, 181 Union St., Montclair, N.J.  
Filed July 22, 1960, Ser. No. 44,645  
7 Claims. (Cl. 264-32)

This invention relates to improvements in building construction and more specifically to methods and means for utilizing inflatable envelopes in the fabrication of buildings of concrete or other building materials. In one of its principal aspects, the invention relates to the use of a removable, flexible, inflatable form in combination with a unique stabilizing system comprising a structural member or members arranged in such manner that the resulting structure is of improved stability for the support of the poured or laid concrete.

A primary object of the present invention is, accordingly, to improve the stability of inflated envelopes used in building construction.

Other objects of the present invention are to provide an improved form system for building concrete shell structures in order to greatly reduce the cost of the form work, and economical methods for producing such concrete shell structures.

Another object is to provide an improved form system, the components of which are readily portable and reusable.

Another object of the invention is to provide an improved air-supported form for concrete work which will be of improved versatility and dependability.

Other objects and advantages of the invention will appear from the detailed description hereinbelow and the accompanying drawings.

The use of inflatable forms has heretofore been largely limited to essentially spherically-shaped structures, as only such shapes provide sufficient stability to acceptably support the weight of concrete during forming. Also, the inflation pressure required to support the weight of wet concrete results in much higher fabric loads with prior art arrangements, and has therefore heretofore necessitated use of heavy and relatively costly fabric materials; thus making the form costs prohibitive, especially for larger size structures.

Air inflated members inherently tend to assume generally circular cross-sectional shapes, as this form represents an equilibrium condition. In a spherical structure all elements are circular and the pressure is therefore resisted by equal tension in all circular elements. Distortion of a spherical shape under non-uniform loading is relatively small as the load is at least partially redistributed between different circular elements to achieve an equilibrium condition without excessive distortion. With a cylindrical shape the inflation pressure is resisted by hoop tension in the circular elements, while the pressure against the ends of the cylinder is resisted by tension in the longitudinal direction. Under a uniform loading this shape is relatively stable, but under a non-uniform loading, such as would be encountered in supporting wet concrete, or under wind loads, the shape immediately distorts because on a cylindrical section non-uniform loads can be supported only by distortion, as this is the only way in which equilibrium conditions can be established at every point on the surface. Thus, if such distortion is not limited, the shape of the form will change upon placement of the concrete, and also it may shift under wind loads before the concrete is set. Obviously, a distortable form is not suitable for use with concrete because such forms cannot maintain the required shape and the supported concrete will be subject to cracking during

2

setting. It is because of such factors that use of the inflatable forms for supporting wet concrete has heretofore been practical only with essentially spherically shaped structures.

The present invention in its principal embodiments contemplates use of air-supported forms of flexible sheet materials, in combination with prefabricated structural members formed from lightweight structural elements in a manner such that the inflation pressure stabilizes and pre-stresses the trusses which in turn serve to shape the inflatable form. The form is patterned so as to provide a shell form surface having a general curvature and comprising a plurality of subsidiary arch shaped portions, thereby limiting the fabric loads to relatively small values; thus permitting use of higher inflation pressures such as are required to properly support the weight for example of wet concrete. The structural trusses may become integral parts of the resulting reinforced concrete beams formed after placement of the concrete.

Exemplary forms of the invention are illustrated in the drawing furnished herewithin wherein:

FIG. 1 is a perspective view of a frame-stabilized air-supported form constructed in accordance with the present invention;

FIG. 2 is a section through the inflated form along lines II—II of FIG. 1, illustrating the distribution of inflation pressure loads;

FIG. 3 is a section through one of the trusses taken on line III—III of FIG. 2, showing the loading thereon;

FIG. 4 is a fragmentary side elevational view of one of the structural truss members illustrating the loading of the arch by inflation pressure;

FIG. 5 is a section through the form taken along line V—V in FIG. 1, illustrating in more detail the shape and arrangement of the components, and showing concrete in place;

FIG. 6 is an enlarged detailed view of a portion of FIG. 5;

FIG. 7 is a fragmentary perspective view on enlarged scale showing the form and concrete structure at the base of the arch;

FIGS. 8, 9 and 10 illustrate sequential steps of one method of erecting the form;

FIG. 11 is a fragmentary section through an end supporting beam illustrating a method of joining the beam to the form and anchoring it to ground;

FIG. 12 is a section on line XII—XII of FIG. 11 illustrating details of the attachment of the form to a supporting beam;

FIG. 13 is a section through a typical finished concrete arch constructed in accordance with the invention;

FIG. 14 is a fragmentary section corresponding to FIG. 6 but of a modified form of the construction;

FIG. 15 is a view also corresponding to FIGS. 6 and 14 but showing a supplementary device of the invention;

FIG. 16 is a section taken on line XVI—XVI of FIG. 15;

FIG. 17 is a perspective view of a frame-stabilized air-supported form similar to that shown in FIG. 1, but having a spherically shaped end section;

FIG. 18 is a perspective view illustrating the frame and form for a hemispherically-shaped building;

FIG. 19 is a fragmentary perspective view illustrating the use of transverse stiffeners;

FIG. 20 is a section on enlarged scale thru the form taken along line XX—XX of FIG. 19, illustrating the position of the transverse stiffener and showing the concrete in place; and

FIG. 21 is a section thru the transverse stiffener taken along line XXI—XXI in FIG. 20.

As shown herein by way of example, one form of the present invention as illustrated in FIG. 1 may be con-

