

Oct. 23, 1962

W. W. BIRD

3,059,655

AIR INFLATED FABRIC STRUCTURES

Filed Dec. 23, 1957

2 Sheets-Sheet 1

FIG. 1

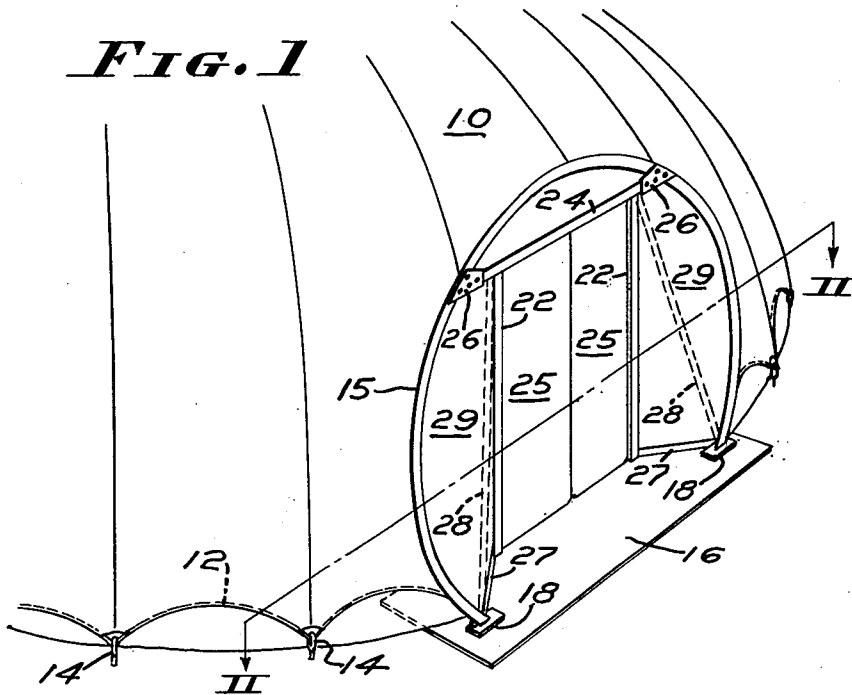


FIG. 2

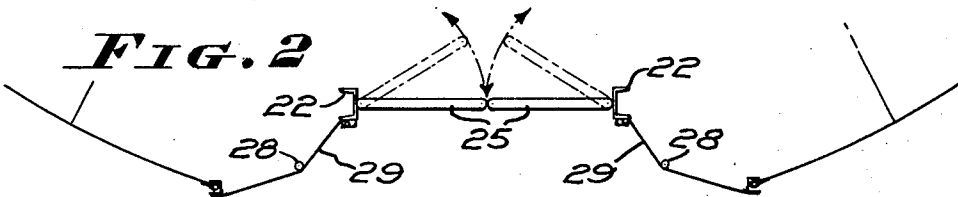


FIG. 3A

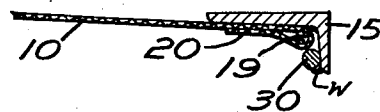


FIG. 3B

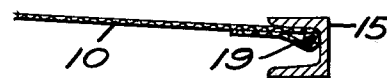
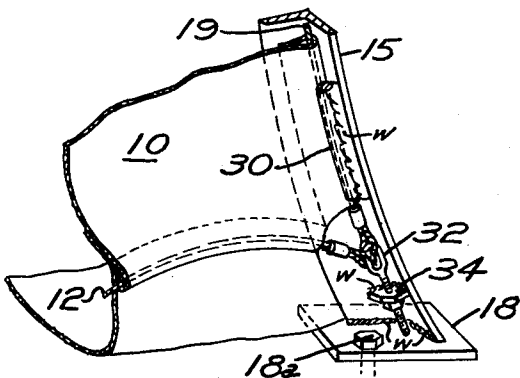


FIG. 4



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FIG. 5

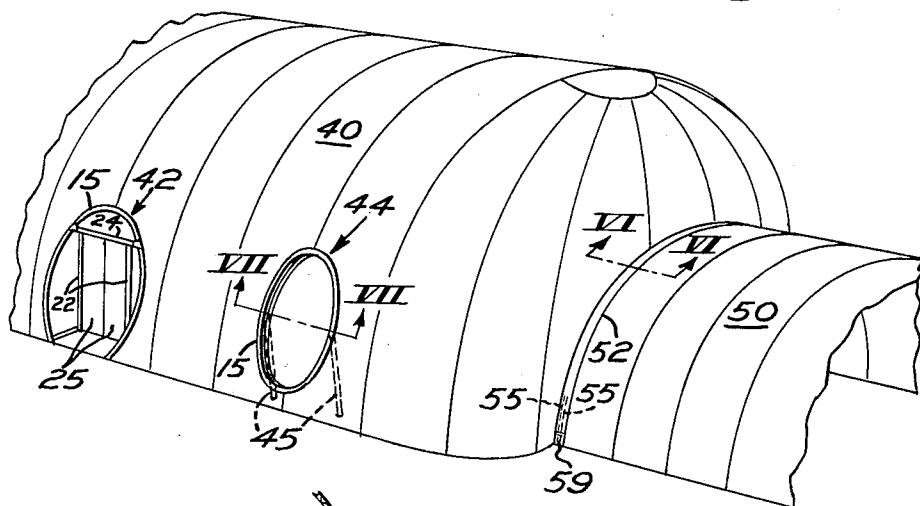


FIG. 6

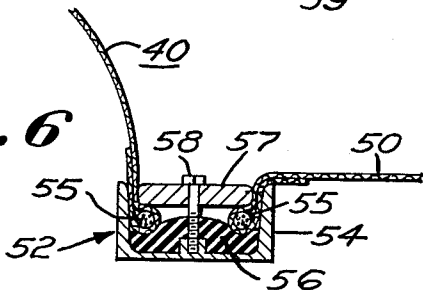


FIG. 7

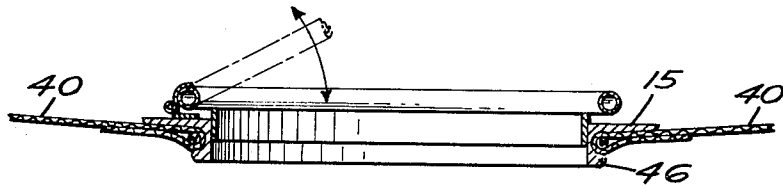


FIG. 8A

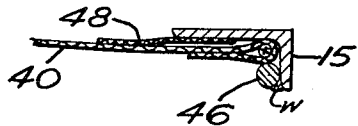
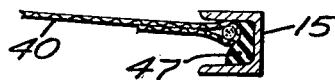


FIG. 8B



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AIR INFLATED FABRIC STRUCTURES
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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

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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,

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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. 3b illustrates one form of opening ring 15 as being fabricated of standard channel sectioned stock metal, FIG. 3a 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. 3a 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

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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, 8a, 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. 8a 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. 8b, 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. 8a illustrates preferred provision of a joint sealing flap 48 which is alternative to the arrangement of FIG. 8b. In the case of FIG. 8a, 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-

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imum facility and minimum expense. Furthermore, it will be appreciated that all of the structural parts required in connection with the practice of the invention as explained hereinabove may be fabricated with utmost facility and at minimum cost and are adapted to be easily transported and erected in the field, and that thus a wide variety of structural arrangements are readily available.

I claim:

1. A structural connection device for interconnecting an air-inflated structure and another structure, said air-inflated structure having a curving flexible fabric wall portion thereof apertured to provide an opening bounded by a marginal edge portion of said fabric, said connection device including a flexible substantially non-elastic tension member fixed to said marginal edge portion of said fabric, said opening being shaped so that the varying fabric load increments around said opening are directly supported by the corresponding load-receiving elements of said tension member without substantial redistribution of load in the fabric or distortion of the opening shape, said connection device also including a relatively inflexible channel-sectioned member bent generally to conform to the shape of said marginal edge portion and externally grooved to receive in the grooved portion thereof said marginal edge portion of said fabric, means mounting said channel-sectioned member upon another structure, said flexible tension member being trained within the grooved portion of said channel-sectioned member to hold said marginal edge portion of the fabric to said channel-sectioned member, and tension adjustment means positionally fixed relative to said channel-sectioned member and operatively connected to said tension member whereby the tensioning thereof may be adjusted.

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2. A structural connection device for interconnecting an air-inflated structure and another structure, said air-inflated structure having a curving flexible fabric wall portion thereof apertured to provide an opening bounded by a marginal edge portion of said fabric, said connection device including a flexible substantially non-elastic tension member fixed to said marginal edge portion of said fabric, said opening being shaped so that the varying fabric load increments around said opening are directly supported by the corresponding load-receiving elements of said tension member without substantial redistribution of load in the fabric or distortion of the opening shape, said connection device also including a relatively inflexible channel-sectioned member bent generally to conform to the shape of said marginal edge portion and externally grooved to receive in the grooved portion thereof said marginal edge portion of said fabric, means mounting said channel-sectioned member upon another structure, said flexible tension member being trained within the grooved portion of said channel-sectioned member to hold said marginal edge portion of the fabric to said channel-sectioned member.

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