Nov. 9, 1965 D. D. MULLIN 3,217,325

INFLATABLE SUPPORT STRUCTURE

Filed Oct. 18, 1961

FIG. 4

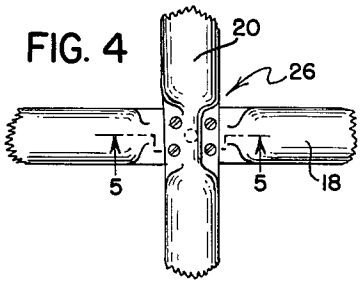


FIG. 2

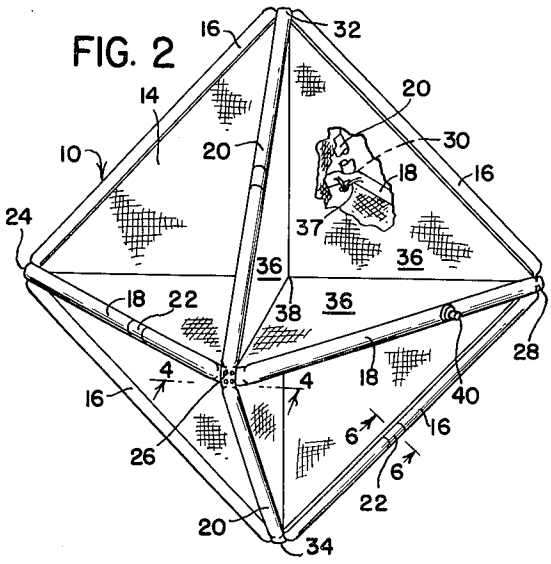


FIG. 5

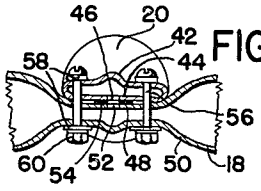


FIG. 10

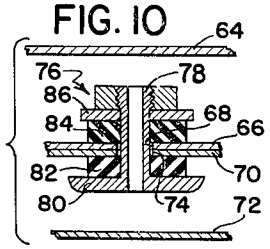


FIG. 6

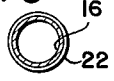


FIG. 7

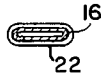


FIG. 8

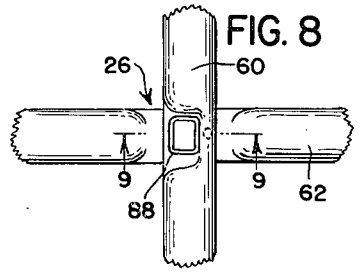


FIG. 3

FIG. 9

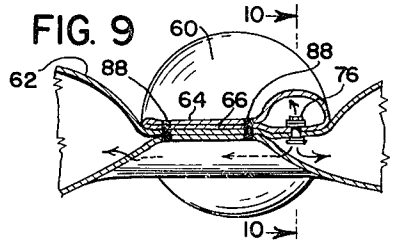
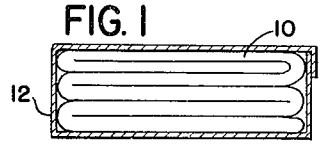


FIG. 1



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INFLATABLE SUPPORT STRUCTURE

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The present invention relates to a support structure and more particularly to an inflatable structure for supporting a radar corner reflector.

Corner reflectors comprised of a plurality of radar reflecting surfaces are used for identifying the position of a person or an object which is in distress or lost on land or at sea. These types of reflectors are used so that the lost person or object can be located by means of a search party in an airplane, ship, or from the ground. In addition, by floating a plurality of such reflectors in a body of water or in the atmosphere, or by orbiting them in space, by suitable means, they might be effectively used as a decoy system. As used herein, the term space excludes the atmosphere surrounding the earth.

Corner reflectors of this nature have been constructed by connecting together a plurality of plane surfaces made of rigid material such as sheet metal; by connecting together a number of panels made of a flexible, collapsible light-weight material having a reflecting material adhered thereto; or by connecting together a number of panels made of a flexible, collapsible metallic fabric. The latter two types of reflectors require the use of a rigid framework or other support structure for maintaining the reflector in a proper reflecting condition. In addition, if the reflector is used on water, some means must be provided for maintaining the reflector above the surface of the water.

Various types of structures are used to effectively support a corner reflector and maintain it in a proper reflecting condition. According to the known state of the art, collapsible support structures constructed of metallic or other rigid components, and inflatable support structures, such as spherical balloons constructed of a light-weight, gas-impervious material, are most commonly used to support a corner reflector. Neither of these support structures are entirely satisfactory. For example, a metallic support structure because of its weight is limited regarding the environment of its proposed use, and unless a light-weight material is used, the structure may become unduly heavy. On the other hand, a spherical balloon is difficult to make, especially if the balloon is formed by securing together a plurality of gores having curved edges; in addition, such a balloon requires a relatively large volume of gas to inflate it, therefore, its use is best suited to small sizes.

Accordingly, one object of the present invention is to provide an improved support structure.

Another object is to provide an inflatable structure for supporting a radar corner reflector.

Still another object is to provide an inflatable support structure for a corner reflector which is easy and inexpensive to make, and which is simple in construction.

A further object is to provide an inflatable support structure for a pliable, collapsible radar corner reflector which may be initially stored in a collapsed condition and thereafter inflated to an erected and rigid condition.

A still further object is to provide an inflatable support structure for a radar corner reflector which may be

used in any environment, which is light in weight and which requires a minimum amount of inflation medium to inflate it and maintain it in an erected condition.

In general, the support structure of this invention is comprised of three square-shaped inflatable tubes having a desired cross-sectional area, which are connected together to form a structure for supporting a radar corner reflector. The inflatable tubes are connected to each other by securing their respective corners together in such a manner that a support structure having six corners results. A flexible corner reflector, having six outer apices and a plurality of reflecting surfaces, is positioned within the structure and connected to the six corners of the structure so that when the structure is filled with an inflation medium, the reflecting surfaces become taut and form a plurality of trihedrons. The surfaces of each trihedron being mutually perpendicular to each other.

Other objects and advantages of the invention will become apparent from a consideration of the following specification and drawings, wherein:

FIGURE 1 is a partial sectional elevational view of a deflated support structure folded and stored in a suitable container.

FIG. 2 is a partial schematic perspective view of the support structure fully inflated with an inflation medium, and having a corner reflector attached.

FIG. 3 is a perspective view of the invention illustrated in FIG. 2 but viewed from a different position.

FIG. 4 is a partial schematic view taken along line 4—4 of FIG. 2, illustrating one way of connecting two corners of the support structure together.

FIG. 5 is an enlarged partial sectional view taken along line 5—5 of FIGURE 4.

FIG. 6 is a cross-sectional view of a pressure beam taken along line 6—6 of FIG. 2.

FIG. 7 is a cross-sectional view similar to FIG. 6 but showing the pressure beam in a deflated condition.

FIG. 8 is a partial schematic view illustrating another embodiment of connecting two corners of the inflatable structure together.

FIG. 9 is a partial sectional view taken along line 9—9 of FIG. 8.

FIG. 10 is an enlarged partial sectional view taken along line 10—10 of FIG. 9.

FIGURE 1 illustrates a support structure 10 in a deflated and collapsed condition, and folded into a container 12, for storage prior to use.

FIGURE 2 shows the support structure 10 in an inflated and rigid condition, after it has been filled with an inflation medium. In this connection, the particular type of inflation medium and inflation device used might vary. For example, a pressurized container (not shown) containing a gaseous medium might be used, or the structure might be inflated by using a sublimating substance. On the other hand, it may be preferred to inflate the structure with a hardenable foam substance so that a rigid support structure is formed after the foam hardens. Foam substances of this nature are well known in the art and will not be described in detail.

The support structure 10 is shown supporting a flexible, collapsible corner reflector 14. As stated hereinbefore, such units might be used for decoy purposes, by floating a number of them on a body of water. It is also envisioned that the invention might be used in the atmosphere as well. For example, a plurality of the reflecting units might be dropped from a space vehicle,

and as it floats toward the earth, it would serve as an effective decoy system. In addition, it is conceivable that a plurality of such units might be orbited in space. Furthermore, while the inflatable structure **10** is shown in combination with a radar corner reflector **14**, it is not intended that the use of the invention should be limited to only supporting corner reflectors, as it is envisioned that the inflatable structure might be effectively used for supporting other objects as well. For purposes of illustration, however, the invention will be described in combination with a corner reflector.

The support structure **10** is comprised of three separate tubular members or pressure beams **16**, **18**, and **20**, preferably having a deflated cross-sectional area as shown in FIG. 7, and a circular cross-sectional area when inflated, as shown in FIG. 6. The two ends of each pressure beam are connected together to form a continuous tube. This connection is made by butting the two ends of the tube together and thereafter sealing or bonding a strip of material **22** over the two ends. The three pressure beams are connected together at their respective corners as shown in FIG. 2 to form a support structure having six corners **24**, **26**, **28**, **30**, **32**, and **34**. Each pressure beam when connected to the other two pressure beams is formed into the shape of a square, note particularly pressure beam **16** in FIG. 2. The three pressure beams when connected together form eight equilateral-shaped triangles, note FIG. 3, and the structure when inflated with a gaseous medium may be positioned on any one of the eight triangles and still provide a suitable base for the support structure. An alternative method of forming the structure **10** would be to connect the pressure beams **16**, **18**, and **20** together at their respective corners before each pressure beam is formed into a continous tube as shown at **22**.

The inflatable structure **10** is shown supporting a corner reflector **14**, comprised of a plurality of reflecting surfaces, designated generally by reference numeral **36**. The reflector is attached to the support structure by suitable means such as tie-strings **37**. The reflector is preferably comprised of a flexible, collapsible, reflecting mesh-type material or the like, which may be conveniently folded along with the support structure for storage during non-use. It is however, also envisioned that the reflector might be constructed of a rigid material, such as sheet metal, as well. The corner reflector **14** is comprised of eight trihedrons in which each is provided with three mutually perpendicular reflecting surfaces **36** which meet at an inner apex **38**. The inner apices of each trihedron are symmetrically positioned with respect to a common center. The reflector **14** includes six outer corners or apices which are adapted to be attached to the corners of the support structure **10**.

The pressure beams are constructed of any suitable, non-extensible, light-weight, gas impervious material, such as a nylon fabric coated with polyurethane, vinyl or the like; or a thermoplastic, such a polyethylene. The pressure beams are inflatably connected together at their corners so that the entire structure is inflatable through a single valve **40**. The specific connection between the two corners depends upon the type of material used, the amount of internal pressure, and the like. As stated above, inflation of the structure **10** might be accomplished by any commercially available means, such as a pressurized container provided with valve means for inflating the structure at a desired time, and will not be described in detail.

FIGURES 4 and 5 illustrate one method of inflatably connecting two corners of two pressure beams together. In this embodiment, the support structure is constructed of a fabric type material. The pressure beams are connected together by superimposing a first pressure beam **20** over a second pressure beam **18**, and at right angles to it. As noted in FIG. 5, the pressure beam **20** has a top surface **42**, and a bottom surface **44** which is provided with an opening **46**. The pressure beam **18** on the other hand, has a top surface **48** which is provided with an opening **52**, and a bottom surface **50**. In this connection, note that while the pressure beams illustrated in FIGURES 4 and 5 are shown in an inflated condition, they are connected together while they are in a deflated condition as shown in FIG. 7. The pressure beam **20** is superimposed over the pressure beam **18** so that the openings **46** and **52** are in alignment. The two surfaces **44** and **48** are adhered together by means of a suitable adhesive **54** which is placed around the openings **46** and **52**. The adhesive **54** not only secures the pressure beams together, but also provides a gas tight connection between the two surfaces. Four bolts **56**, provided with gaskets **58**, and a nut and washer assembly **60** are provided to more securely connect the two pressure beams together. As the gaseous medium is forced into the support structure through the valve **40**, the gaseous medium flows from one pressure beam to the other until a uniform pressure is attained throughout the entire support structure. It may be preferred to provide inflatable connections as described above at each corner of the structure. On the other hand, if desired, only two such connections need be used; that is one inflatable connection at corner **26** which connects pressure beams **18** and **20** together, and a similar connection at corner **28** which connects pressure beams **16** and **18** together (note FIGURE 2). Note that the valve **40** is positioned between corners **26** and **28**.

As illustrated in FIG. 3, two corners of each pressure beam are connected to two corners of a second and third pressure beam, so that as the support structure becomes fully inflated, the three pressure beams **16**, **18** and **20** each form a square-shaped member, and a six cornered support structure results.

The embodiment depicted in FIGURES 8 and 9 illustrates a support structure constructed of a heat sealable thermoplastic, and more specifically, the manner of inflatably connecting the corners of such a structure together. A first heat-sealable pressure beam **60** is superimposed over a second heat-sealable pressure beam **62**, and at right angles to it. The pressure beam **60** has a top surfaces **64** and a bottom surface **66** which is provided with an opening **68** (note FIG. 10). The pressure beam **62** has a top surface **70** which is provided with an opening **74**, and a bottom surface **72**. In this connection, note that while the pressure beams are again shown in an inflated condition in FIGURES 8 and 9, they are connected together while they are in a deflated condition and preferably before each pressure beam is formed into a continuous tube. The pressure beam **60** is superimposed over the pressure beam **62** so that the two openings are in alignment. A component, designated generally by reference numeral **76** is provided in at least two corners of the support structure **10** for permitting the passage of a gaseous medium from one pressure beam to the other.

The component **76** includes a tubular stem **78** having an integral flange portion **80**, two rubber washers **82** and **84**, and a nut and washer assembly **86**. The rubber washer **82** is placed on top of the flange **80** and they are inserted into the interior of one pressure beam through the open end of the beam before it is formed into a continuous tube; and the stem **78** is inserted through the openings **68** and **74** of the pressure beams **60** and **62**, respectively. The second rubber washer **84**, and the nut and washer assembly **86** are similarly inserted in the second pressure beam and attached to the stem. The two rubber washers are clamped against the two surfaces **66** and **70** of the pressure beams by tightening the nut assembly. Care should be taken that the stem **78** is only of sufficient length that it does not extend past the nut in such a manner that it could rub against the surface **64** and cause an abrasion in that surface.

The two pressure beams are sealed together as shown

at 88 to provide a durable connection between the two pressure beams. As the gaseous medium is forced into one of the pressure beams, it will flow from one pressure beam to the other until a uniform pressure is attained throughout the enitre support structure. Two corners of each pressure beam are connected to two corners of a second and third pressure beam, in a manner similar to that described above, so that a six cornered support structure results.

In the above description and the attached drawings, a disclosure of the principles of this invention is presented, together with some of the embodiments in which the invention may be carried out.

I claim:

1. A support structure for a corner reflector comprising a first four cornered inflatable tube, a second four cornered inflatable tube, a third four cornered inflatable tube, means for connecting said tubes together so that when they are inflated they form a six cornered support structure, means for introducing an inflation medium into said support structure, and means for connecting a corner reflector having six outer apices to the six corners of the support structure.

2. An inflatable support structure comprising a first four cornered inflatable tube, a second four cornered inflatable tube, a third four cornered inflatable tube, means for connecting said tubes together when inflated thereby forming a six cornered support structure, and inlet means for permitting said support structure to be filled with an inflation medium.

3. A support structure for a corner reflector comprising a first square-shaped inflatable tube, a second square-shaped inflatable tube, a third square-shaped inflatable tube, means for connecting said tubes together in such a manner that when they are inflated they form a six cornered support structure, said means including means for connecting a first two corners of the first tube to a first two corners of the second tube, means for connecting a first two corners of the third tube to a second two corners of the first tube, means for connecting a second two corners of the third tube to a second two corners of the second tube, inlet means for permitting said support structure to be inflated with a gaseous medium, and means for connecting a corner reflector having six outer apices to the six corners of the support structure.

4. A six cornered support structure comprising a first inflatable tube forming a first four cornered member when inflated lying in a first plane, a second inflatable tube forming a second four cornered member when inflated lying in a second plane, means for connecting the second member to the first member so that the second plane is perpendicular to the first plane, a third inflatable tube forming a third four cornered member when inflated lying in a third plane, means for connecting the third member to the first and second members so that the third plane is perpendicular to the first and second planes, and valve means operatively associated with the support structure for admitting a gaseous medium into said support structure.

5. The combination of claim 4 wherein each plane described by the tubular members is square-shaped and of equal dimensions, and means are provided for connecting each corner of each tube to a corner of another tube, at least two of said means having an opening forming a passage between the two tubes.

6. A six cornered support structure for a corner reflector comprising a first inflatable tube forming a first four cornered member when inflated lying in a first plane, a second inflatable tube forming a second four cornered member when inflated lying in a second plane, means for connecting the second member to the first member so that the second plane is perpendicular to the first plane, a third inflatable tube forming a third four cornered member when inflated lying in a third plane, means for connecting the third member to the first and second members so that the third plane is perpendicular to the first and second planes, valve means for permitting the support structure to be inflated with a gaseous medium, means for connecting each corner of each tube to a corner of another tube, at least two of said means having an opening forming a passage between the two tubes, and means for attaching a corner reflector having six outer apices to the six corners of said structure.

7. A collapsible six cornered support structure for a flexible corner reflector comprising a first inflatable tube forming a first square-shaped member when inflated lying in a first plane, a second inflatable tube forming a second square-shaped member when inflated lying in a second plane, means for connecting a first two corners of the first tube to a first two corners of the second tube so that the second plane is perpendicular to the first plane, a third inflatable tube forming a third square-shaped member when inflated lying in a third plane, means for connecting a first two corners of the third tube to a second two corners of the first tube and means for connecting a second two corners of the third tube to a second two corners of the second tube so that the third plane is perpendicular to the first and the second planes, valve means operatively associated with the support structure for admitting a gaseous medium into said support structure, at least two of the means for connecting the corners of the tubes together having an opening forming a passage between the two tubes forming the corner, said openings permitting all the tubes to be inflated with the gaseous medium, and means for attaching a flexible corner reflector having six outer apices to the six corners of the support structure.

8. The combination of claim 7 wherein the support structure is comprised of a non-extensible, gas-impervious, light-weight fabric material.

9. The combination of claim 8 wherein an adhesive is provided for connecting the corners of the tubes together, said adhesive disposed between the surfaces of the tubes in such a manner that it surrounds the opening forming the passage, and a plurality of bolts connecting the tubes together are provided for reinforcing the connection.

10. The combination of claim 7 wherein the support structure is comprised of a non-extensible, gas-impervious, light-weight plastic material.

11. The combination of claim 10 wherein the means for connecting at least two of the tubes together includes a tubular component inserted within the opening forming the passage between said tubes thereby connecting the interior of one tube to the interior of a second tube, and a sealed portion connecting the tubes together is provided for reinforcing the connection.

12. A collapsible support structure for a pliable corner reflector comprising a first inflatable square-shaped pressure beam having a circular cross-sectional area when inflated, a second inflatable square-shaped pressure beam having a circular cross-sectional area when inflated, a third inflatable square-shaped pressure beam having a circular cross-sectional area when inflated, means for connecting said pressure beams together to form a six cornered support structure, inlet means for permitting said support structure to be inflated with a gaseous medium, and means for connecting a pliable corner reflector having six outer apices, and a plurality of reflecting surfaces to the six corners of the support structure, so that as the structure is inflated with the gaseous medium the reflecting surfaces become taut and at least some of said surfaces mutually perpendicular to each other.

13. A flexible support structure comprising a first four-cornered inflated continuous tube lying in a first plane, a second four-cornered inflated continuous tube lying in a second plane, a third four-cornered inflated continuous tube lying in a third plane, means for connecting the corners of said inflated tubes to each other thereby forming an inflated six-cornered support structure, said three planes being perpendicular to each other when the corners

of the tubes are connected together, and valve means for introducing an inflation medium into said support structure.

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CHESTER L. JUSTUS, *Primary Examiner.*