Sept. 27, 1966 J. E. FOREHAND 3,275,271

FLEXIBLE WING AIRCRAFT

Filed Nov. 27, 1964 3 Sheets-Sheet 1

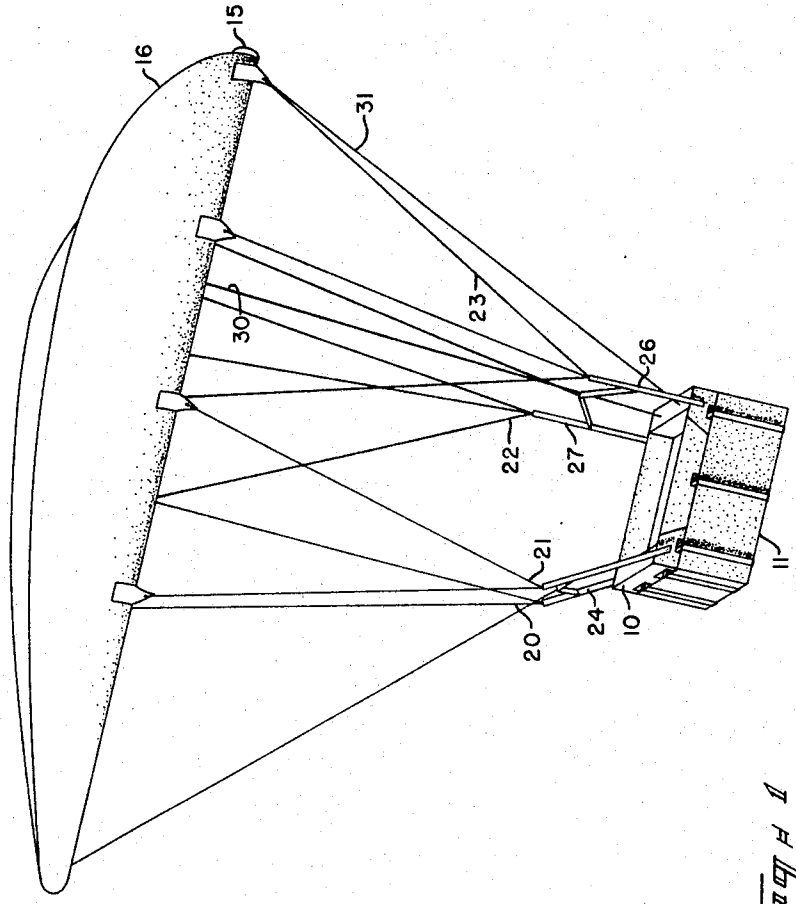

Fig. 1

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Filed Nov. 27, 1964 3 Sheets-Sheet 2

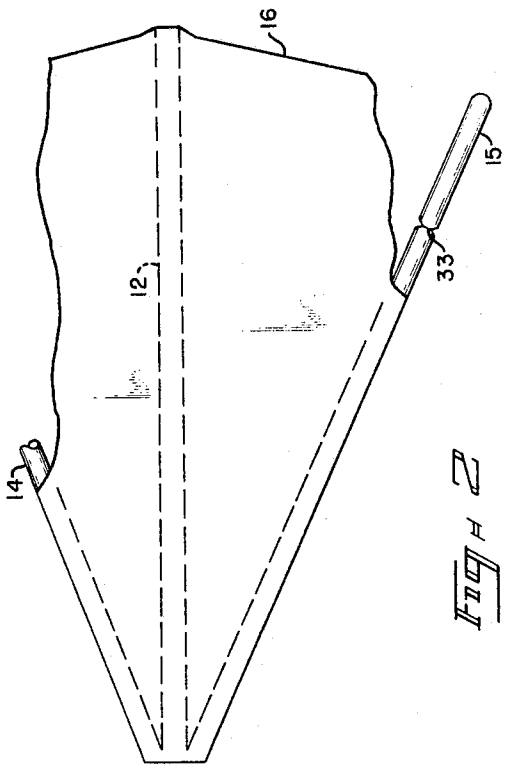

FIG 2

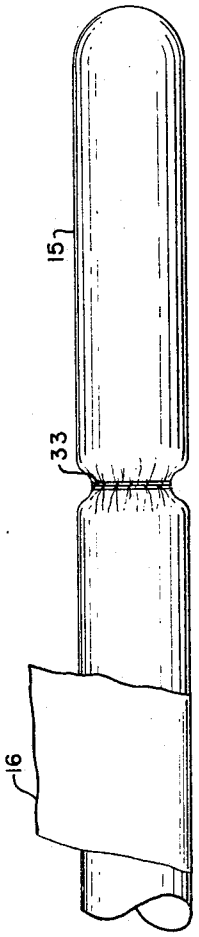

FIG 3

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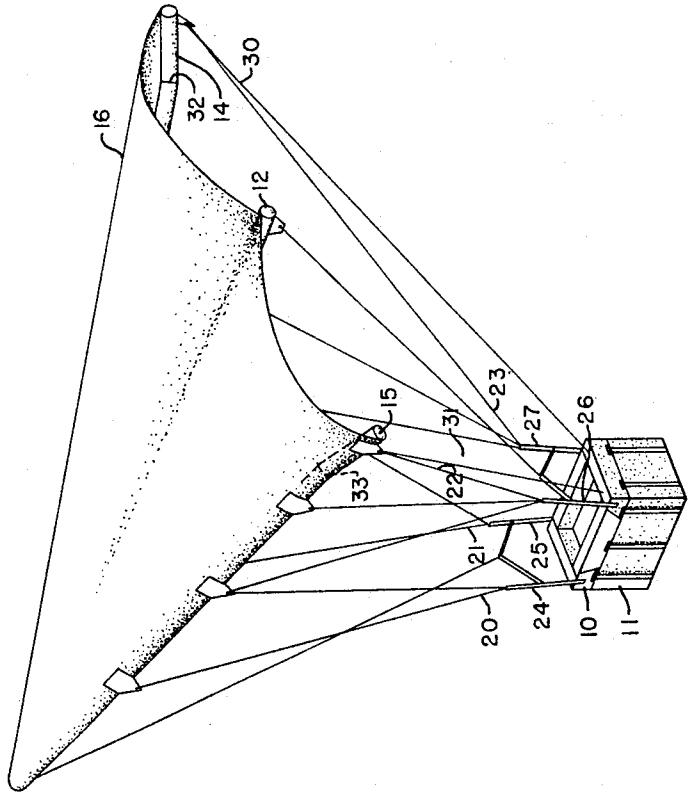

Fig 4

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FLEXIBLE WING AIRCRAFT

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Filed Nov. 27, 1964, Ser. No. 414,484
1 Claim. (Cl. 244—138)

The invention disclosed herein may be manufactured and used by or for the Government for governmental purposes without payment to me of any royalty thereon.

This invention relates to flexible wing aircraft such as flexible wing gliders of the type having a central keel, spars diverging from one end of the keel one at each side thereof and a flexible membrane of triangular shape secured to the keel and the spars, and more particularly to a foldable glider of the character indicated having inflatable keel and spars held in shape by internal air or gas pressure when the glider is unfolded.

Gliders of the character indicated carry a load or ballast suspended below the keel and directional control of the glider is provided by control lines extending from the load or ballast to the rear ends of the spars. By operating the control lines differentially, that is, by pulling in on one and letting out on the other, one rear corner of the wing is pulled down, increasing the lift at that side of the keel, while the other rear corner is permitted to move upwardly, decreasing the lift at the corresponding side of the keel. This causes the glider to bank and turn toward the side at which the lift has been decreased. The lift lines may be merely attached to the suspended load when it is desired to maintain a generally straight or unidirectional flight. However, when it is desired to vary the flight direction by remote control the control lines may be connected to a small power winch or similar servo device.

It has been found that when it is attempted to warp the inflated spars by use of the control lines, the bending or warping of such spars cannot be predicted as a spar may bend anywhere along its length where a buckling or wrinkling of the spar may occur. This makes it practically impossible to control or steer the glider in a desired path. In order to provide sensitive control of the glider it is necessary that the shape of the glider spars be accurately predictable as the spars are warped or bent to different degrees by the action of the control lines.

It is therefore among the objects of the invention to provide a glider of the character indicated having lateral spars that can be warped or bent by control lines connected thereto and which will uniformly bend or warp in a predetermined manner in response to control line operation.

A further object resides in the provision of a glider of the character indicated having its lateral spars modified at selected locations along the length of such spars so that the spars will bend at the locations of modification only.

A still further object resides in the provision in an elongated, inflated tube of flexible material of a portion of reduced diameter effective to determine the location of bending of the tube when the tube is subjected to bending forces.

Other objects and advantages will become apparent from a consideration of the following description and the appended claim in conjunction with the accompanying drawings wherein:

FIG. 1 is a diagrammatic perspective view of a flexible wing glider to which the improvement of the invention is applied;

FIG. 2 is a fragmentary top plan view of the glider shown in FIG. 1;

FIG. 3 is a fragmentary elevational view of a tubular inflated spar having a circumference reducing formation spaced from one end thereof; and

FIG. 4 is a perspective view of the glider similar to FIG. 1 showing the manner in which the lateral spars bend to control the direction of flight of the glider.

With continued reference to the drawings, the glider is foldable, when deflated, into a pan or tray **10** mounted on top of the cargo box **11**. The tray **10** may also contain the flight controlling servo mechanism, not illustrated, a radio receiver, controlled from a ground located transmitter, and necessary power supplies. The tray may also include a pressure gas bottle connection to the frame components of the glider to inflate these components to a condition of substantial rigidity when the glider is deployed from an aircraft in which it is carried. When the glider is deployed and inflated it assumes the shape shown in FIGS. 1, 2, and 4 wherein the keel **12** is straight and the lateral spars **14** and **15** are also straight. The spars are secured at their front ends to the keel near the front end of the latter and diverge symmetrically from the front end of the keel one at each of two opposite sides thereof. While the angle between each of the spars and the keel is not critical, an angle of approximately 35 degrees has been found to provide a satisfactory configuration for the flexible wing. A membrane **16** of a suitable fabric or other flexible sheet material and of triangular shape, is secured along mutually diverging side edges to the spars **14** and **15** and along its center line to the keel **12**. The base edge is not attached to the spars or keel but may be reinforced by a suitable hem or binding. With this arrangement the parts of the membrane at the opposite sides of the keel are bowed upwardly by air pressure when the wing is in flight, as shown in FIGS. 1 and 4.

The wing is secured to the cargo box **11**, or other load carrying structure by shroud lines as shown in FIG. 1. These shroud lines are arranged in four groups, as indicated at **20**, **21**, **22** and **23** with the several groups secured one to each of the four corners of the cargo box by suitable straps or hangers as indicated at **24**, **25**, **26** and **27**. Some of the shroud lines of groups **20** and **22** are secured at their ends remote from the hangers **24** and **26** to the spar **14** at locations spaced apart along the spar and other shroud lines of these two groups are secured to the keel **12**. Correspondingly, some of the shroud lines of groups **21** and **23** are secured to spar **15** and other shroud lines of these two groups are secured to the keel. These shroud lines support the load from the wing without imposing substantial bending loads on the keel and the spars.

Directional control of the wing in flight is obtained by the control lines **30** and **31** connected between the rear ends of the spars **14** and **15** respectively and the servo device mounted in the tray **10**. In order to obtain predetermined bending of the spars when the control lines are tightened or loosened each of the spars is provided at a predetermined distance from its rear end with a diameter reducing formation as indicated at **32** and **33** for the spars **14** and **15** respectively. Such a diameter reducing formation may be provided by wrapping the tubular spar at the desired location with a length of twine or tape and cementing the twine or tape in place on the spar. As shown in FIG. 4, when the diameter reducing windings are applied the spars bend rather sharply at the locations of the windings with no appreciable bending over the other portions of the spars. Thus, an increment of take in or let out of the control lines always produces the same bending of the spars and the banking of the wing can be accurately controlled to obtain a desired flight pattern of the glider.

While a particular physical embodiment has been hereinabove described and illustrated in the accompanying

drawings for the purpose of disclosing the invention, it is to be understood that the scope of the invention is in no way limited to the embodiment so illustrated and described but is commensurate with the scope of the appended claim.

I claim:

In an inflatable flexible wing glider a wing comprising a central keel and a pair of lateral spars all of inflatable tubular construction, and a flexible membrane secured to said keel and said spars, a load carrier, shroud lines suspending said load carrier from said keel and said spars, and control lines extending from said load carrier to corresponding ends of said spars for controlling the flight path of the glider by bending said spars, a diameter reducing

wrapping around each of said spars to localize deformation of the spars when subjected to bending forces by said control lines and thereby provide uniform bending of the spars for each increment of length said control lines are taken in or let out.

References Cited by the Examiner

UNITED STATES PATENTS

2,722,774	11/1955	Andreadis	46—88
3,093,354	6/1963	Pohl	244—154
3,141,640	7/1964	Sutliff et al.	244—138

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