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Babbidge

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[54] **CAPTIVE INFLATED LIGHTER-THAN-AIR STRUCTURES**

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[52] **U.S. Cl.** .... **244/153 R,** 244/33

[51] **Int. Cl.** **B64c 31/06**

[58] **Field of Search** ...... 244/30, 33, 153 R, 154, 24

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[57] **ABSTRACT**

Captive inflatable lighter-than-air structures comprised of heat-retaining metallized film envelopes for the inflating gas. Internal and/or external stays, suitably guyed if desired, may be used to maintain shape and configuration of envelopes against distortion by internal gas pressure. Structures may be used as kites, mobile sculptures, and/or displays. In kites the metallized film functions as a radar reflector.

9 Claims, 5 Drawing Figures

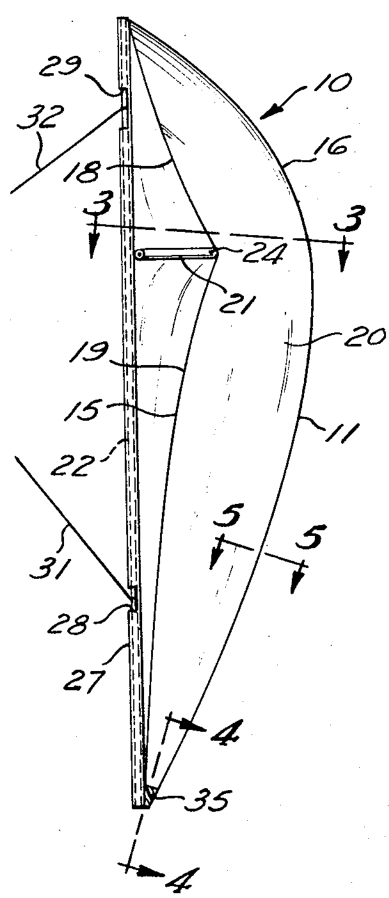


Fig. 2

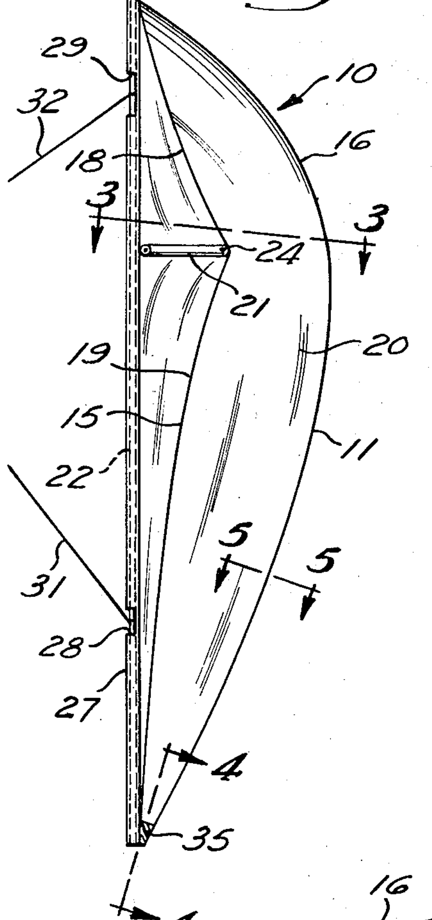
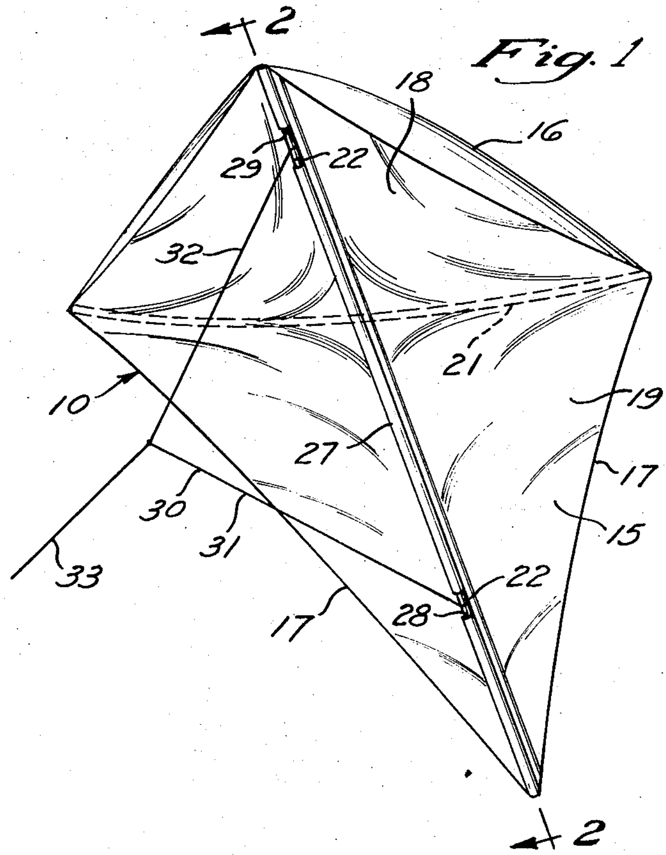


Fig. 1



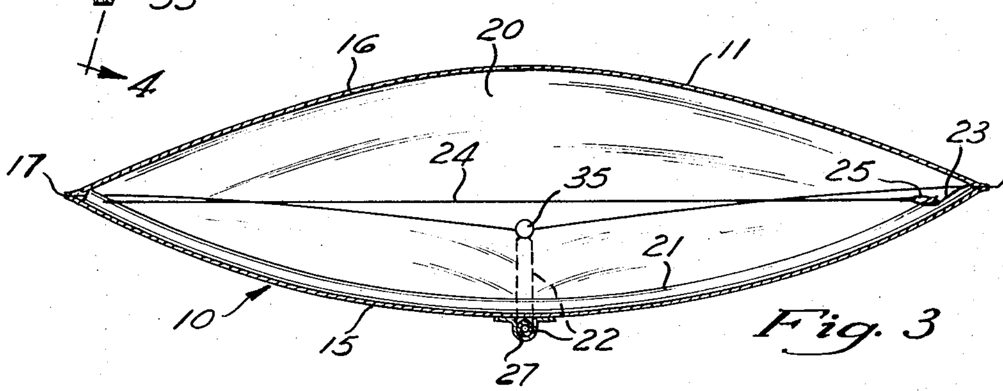


Fig. 3

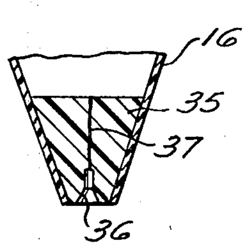


Fig. 4

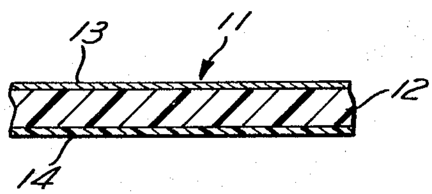


Fig. 5

CAPTIVE INFLATED LIGHTER-THAN-AIR STRUCTURES

This invention relates to improvements in lighter-than-air structures of pre-determined configuration and which are captive, i.e., held to a relatively fixed base by an anchoring line, string, or wire. More particularly this invention relates to improved inflated kites, mobile structures, and floating display devices which are lifted by an inflating gas and which resist loss of gas and gas pressure by means of a film envelope which has thermal-insulating properties as well as improved gas retention.

Inflatable lighter-than-air kites have long been proposed as amusement devices or for the more serious purpose of captive equipment for life rafts and life boats, whereby they will serve as attention-attracting devices for search planes or surface vessels. In either case, the purpose of providing an inflatable kite has been to overcome the inability to fly the kites initially in the absence of sufficient surface winds, but which, after they reach upper winds, will be lifted by the winds, rather than blown down by them (as in the case of simple captive balloons). Such proposals have heretofore turned out to be impractical or inoperative for several reasons. The pressurized inflating gas, such as hydrogen, helium, or the like, is often chilled by expansions from its pressurized source from which it is released for inflation and, picking up heat from the body of the kite and the ambient atmosphere, the kite can become over-inflated; such over-inflation can destroy the requisite configuration of the kite's surfaces required to lift the weight of the kite and the string or cord by which it must be held captive if it is to fly, rather than merely float as a balloon. At the same time the films heretofore proposed have notoriously poor gas retention and, as has been less apparent, when such residual inflating gas that is retained is chilled by the normally cooler upper atmosphere, it loses its pressure and fails as inflating medium. If the upper atmosphere should be still or have an insufficient wind velocity to lift the kite, it will fall and thereby, if it is intended as other than a temporary amusement device, fail its purpose as a life raft marker, for example.

It is an object and advantage of this invention that I have devised as a captive lighter-than-air structure which lessens the above problem of sea-rescue kites and which is capable of serving other functions, such as mobile sculptures, advertising and display devices and the like. A particular advantage of my invention is that, in combination with suitable internal and/or external stays or ribs, it may be made in a variety of configurations. When used as a sea-rescue kite, the thin metallized coating which provides the film envelope with thermal-and gas-retention properties will also function as a radar reflector; this permits its use at night, in fog, or in like conditions of poor visibility which heretofore rendered similar kites useless.

Other objects and advantages of this invention will be apparent from the following specification, claims, and drawings, in which:

FIG. **1** is a perspective of a kite made according to this invention.

FIG. **2** is a section taken along the line **2—2** of FIG. **1**, cross-sectioning of the film and small elements being omitted for clarity of illustration.

FIG. **3** is a fragmentary section taken along the line **3—3** of FIG. **2**, the proportional thickness of the film being exaggerated relative to the other elements shown.

FIG. **4** is a detailed section of a valve for inflation, taken along the lines **4—4** of FIG. **2.**

FIG. **5** is a vastly enlarged fragmentary section of the film taken at the line **5—5** of FIG. **2**, for example.

Referring to the drawings, the kite **10** shown therein, as one of the many embodiments and forms which structures made according to this invention may take, is specifically intended and designed for use as a kite. As shown, it may be packaged in a compact, disassembled kit form that can be readily assembled without tools, inflated, and flown; since this may have to be done under emergency conditions, the particular structure shown is adaptable for use as a flying, attention-attracting marker for life boats and life rafts, for example. The particular embodiment shown is in the conventional "Malay" type of kite which can be flown without requiring a tail to stabilize it. A tail (not shown) comprised of a fine thread connecting separately spaced pieces of very fine gauge aluminum foil may be attached, not because it would be required for stability but to increase the visibility of the kite to the naked eye and the size of the "blip" it will make on a radar screen used in search and rescue work at sea.

The rib or stay-supported "fabric" of the kite **10** is an envelope **11**, which, as shown in FIG. **5**, is comprised of a thin plastic film **12** preferably of polyester [e.g., "Mylar"] because of its dimensional stability, adaptability to metallizing, availability in thin gauges (as low as one-half mil or less), ageing-resistance, and, for its weight, its relatively high tensile strength, resistance to snagging and ripping, and low permeability to light-density gases. Other light-weight film of adequate dimensional stability may be employed such as, for example, high-density polyolefins such as polypropylene and polyethylene; also, particularly for larger structures, laminates or films cast on wide-mesh nettings of high tensile strength fabric filaments may be employed. Irrespective of the chemical composition of the core **12**, however, it is provided, on the surface which forms the interior of the envelope **11**, with a metallizing coating **13**, preferably (and now easily obtainable) a "thin film" of aluminum conventionally formed by depositing a vapor of aluminum upon the film core **12** in an ultra-high vacuum. This metallizing coating **13** may be only a few Angstroms in thickness (and thus its thickness with respect to the core **12** as shown in FIG. **5** is greatly exaggerated) but its presence vastly improves the performance of inflated structures made according to this invention, as set forth below. The opposite surface of the film core **12** optionally may or may not be metallized and is also optionally coated, directly on the film or over a metallized coating (not shown) with a suitably printed or otherwise applied coating of a pigmented and/or dyed ink or paint **14**. The coating **14** is indicated in FIG. **5** as a plastic, because of the organic nature of its vehicle. The coating **14**, if employed, can provide a decorative as well as subtractive-colored (and thus heat-absorptive) outer surface for all or selected areas of the envelope **11**.

The envelope **11** is formed of a front panel **15** and a back panel **16** joined by edge seams **17** formed by adhesive or heat sealing, the multiple thickness at such edge seams **17** providing boundary strength and stability to the panels. The front panel **15** is cut as a diamond elongated at its lower point so as to allow, when the kite framework is assembled, the formation of upper and lower pockets **18** and **19** which enable the kite to "fly." The back panel **16** is larger in area and shaped by stretching or constructed of gores so as to provide the lifting volume **20** for the kite when inflated and flown.

To provide structural stiffness for the kite, a cross stay or rib **21** and a vertical stay or "backbone" **22** are employed. To avoid puncture in the closed envelope **11**, the cross-rib **21** is secured to the inner surface of the front panel **15** before closing the envelope **11**. As shown, the cross-rib **21** is secured by adhesive to reduce weight; alternatively a tube of film, similar to the tube **27** for the backbone **22** may be employed. Because, for satisfactory flying characteristics in a "Malay" type of kite, the cross-rib **21** should be bowed, but the rib should be straight so that it can be rolled up with the envelope **11** before the kite is assembled and inflated, the cross-rib **21** is provided at one end with a deep notch **23** and a bow-string or wire **24** is pinched or otherwise secured to the opposite end. A small ring **25** on the other end of the string **24** allows the disconnected bow-string **24** to be connected and held by tension in the notch **23** by bowing the rib **21**; even though the entire rib **21**, string **24**, and ring **25** are enclosed within the sealed envelope **11**, the ring **25** can be readily manipulated into place in the notch **23** through the thin film of the envelope **11**.

To attach and secure the backbone **22** and complete the framework of the kite **10**, the front panel **15** is provided with a tube **27** formed by a layer of film adhered to the outer surface of the panel along its vertical center line. The tube **27**, preferably closed at the upper and lower ends, is interrupted at two points, at a lower opening **28** and at an enlarged upper opening **29**, which allow the backbone **22** to be inserted in the tube and also allow attachment of the bridle **30**, having lower and upper looped ends **31** and **32**. That is, the backbone is inserted at the opening **29** until it protrudes at the lower opening **28**, where the bridle loop **31** may be slipped over it as the backbone is slid into the lower end of the tube **27**. With the upper bridle loop **32** slipped over the upper end of the backbone **22**, it is bowed until its upper end can be slipped into the upper end or pocket of the tube **27**. The kite string or cord **33** is usually pre-attached to the bridle **34**, but its position on the bridle may be adjusted by knotting so as to give the kite its proper flying "balance."

The rib **21** and backbone **22** may be of light wood but are preferably, for stiffness for their weight, of stiff, thin-walled aluminum or magnesium tubing or, where expense is a minor factor, of thin-walled titanium tubing.

To inflate the kite, a suitable valve is incorporated. As shown in FIG. **4**, this may be simply a plug of soft resilient plastic, such as a highly plasticized vinyl **35**, provided with a molded needle recess **36** and adhesively secured in the seam **17** at the lower tip of the kite. A conventional inflating needle attached to a metal vial of pressurized inflating gas, preferably helium, is inserted in the socket and pushed through the balance of the plug. Upon withdrawal of the inflating needle, the torn line of puncture **37** collapses and seals the plug **35**.

The inflating gas may be coupled from a tank through a cut-off valve, but the vial or other container of the pressurized inflating gas supplied with a kit usually contains a charge just sufficient to inflate the volume **20** so that, when the kite, held captive by the cord **31**, rises and is struck by wind, the pockets **18** and **19** will be formed in the front panel **15** and the back panel will take the contour shown in FIG. **2** due to the lower wind pressure behind the front panel **15**. In kits for life rafts and boats, the inflating vial may also be supplied with an electric battery which heats the inflating needle so as, in turn, to supply sensible heat to the inflating gas released into the kite.

The function of the metallized coating **13** on the film core **12** is two-fold. First, it can greatly increase the impermeability of the envelope to the inflating gas and thereby prevent loss of the gas by diffusion through the walls of the envelope **11**. Secondly, it reflects heat back into the volume of gas contained in the envelope, lowering the loss of sensible heat of the gas by radiation into the usually cooler upper atmosphere.

The thermal- and gas-retention efficiency provided by the envelope **10** permits structures embodying the principles of this invention to provide a new type of mobile sculptures. Heretofore, such sculptures have been supported from above so that, by a system of wires and rods, gravity causes the elements to assume their balances while permitting air current to move the element with respect to each other. As indicated by the embodiment shown in FIGS. **1** to **4** as a kite, the contour of the envelope can be controlled by internal and/or external stays and guys, and its shape can then be selected within broad limits as the artist selects. By anchoring such inflated envelopes as elements of a mobile sculpture to a suitable base by a system of wires (or tubes through which additional gas may be supplied as required) unusual and ethereal mobile sculptures may be created. The unusual effect of such mobiles also makes them effective as advertising and display devices.

This invention, therefore, is not limited to the specific embodiment disclosed but may be varied by those skilled in the art without departing from the scope of the following claims.

What is claimed is:

1. A captive inflatable lighter-than-air structure comprising a closed contoured envelope of organic film having a metallized surface substantially throughout its interior, said envelope being formed of a plurality of panels joined at seams providing additional dimensional stability to said panels and one or more relatively rigid stays co-acting with said seams to restrain distortion of said envelope by the pressure of inflating gas held therein, valving means to permit said envelope to be inflated, and restraining means extending exteriorly of said envelope to anchor the same to a base, the volume of said envelope when filled with a gas which, at the same temperatures and pressures, is less dense than ambient air, being sufficient to offset the weight of the structure in ambient air.

2. A structure as defined in claim **1** in which at least one of said stays is attached to the exterior of said envelope.

3. A structure as defined in claim **1** in which at least one of said stays is attached to the interior of said envelope.

4. A structure as defined in claim **1** in which at least one of said stays is flexible and is bowed by a guy.

5. A structure as defined in claim **1** constituting a kite having a front panel and a back panel and crossed stays connected to said front panel, said external restraining means being connected to one of said crossed stays, the area of said back panel being greater than the area of said front panel, whereby, when said front panel is struck by wind, the back panel will provide a volume for inflating gas aiding the lifting effect of wind on said first panel.

6. A kite as claimed in claim **5** in which one of said stays includes a normally straight flexible horizontal cross-rib mounted internally of said envelope and connected thereto and a detachable guy extendable internally of said envelope between points of attachment on said cross-rib to bow the same.

7. A structure as defined in claim **1** in which the exterior of said envelope is provided at least in part with a coating colored other than the color of said metallized film.

8. A plurality of structures as defined in claim **7** differently contoured and colored and anchored to a common base, whereby the plurality of structures constitutes a mobile sculpture.

9. A structure as defined in claim **8** in which said externally extending anchoring means for at least one of said structures constitutes a tube connected to a source of inflating gas to maintain the pressure of inflating gas within said structure.

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