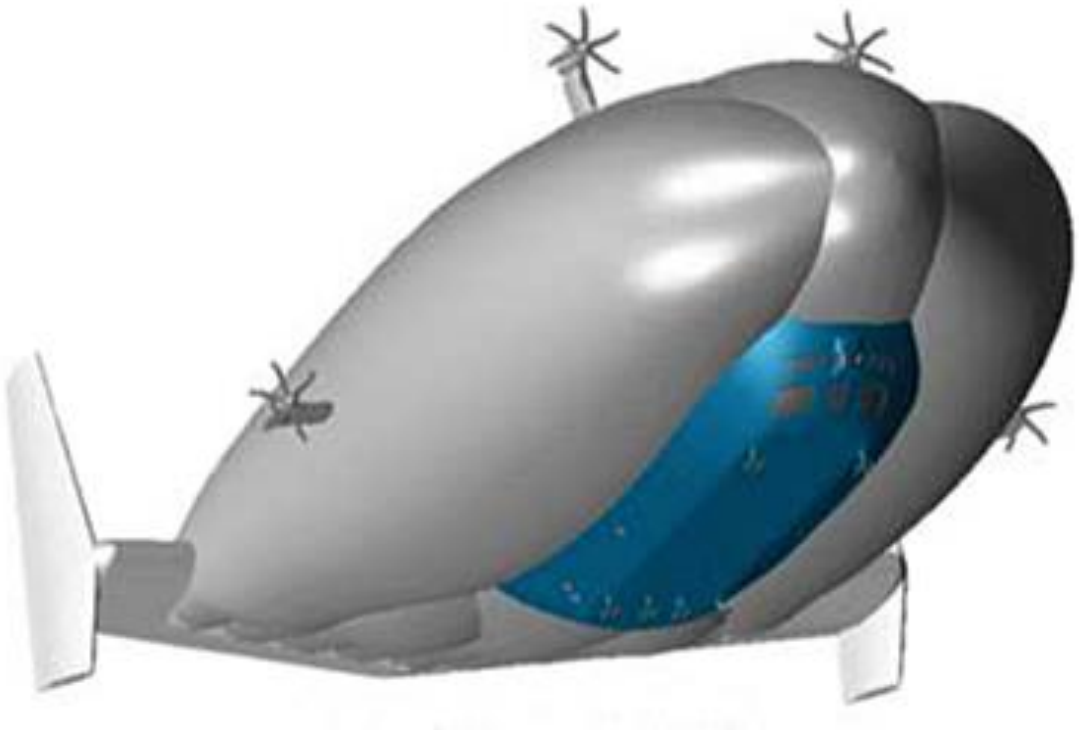
Lockheed Martin - Aerocraft semi-rigid hybrid airship

Peter Lobner, updated 16 June 2023

1. Introduction

Building on Lockheed's hybrid airship design work since the early 1980s, Lockheed Martin continued developing design concepts for semi-buoyant, hybrid airships with lifting body hulls after the two firms merged in 1995. One design concept was the semi-rigid, semi-buoyant, hybrid airship with lifting body hull, which is the subject of this article. This concept was trademarked in 1998 as the Aerocraft (not to be confused with the Aeroscraft trademark held by Worldwide Aeros Corp.).



Source: Lockheed Martin

This semi-rigid hybrid airship design, with an internal structural framework to support the engines, propulsion loads and cargo, predates the non-rigid Lockheed Martin P-791 and Sky Tug / LMH-1 hybrid airship designs, which are described in separate articles. Lockheed Martin did not build an Aerocraft hybrid airship.

2. Lockheed Martin's patents for hybrid airship technology

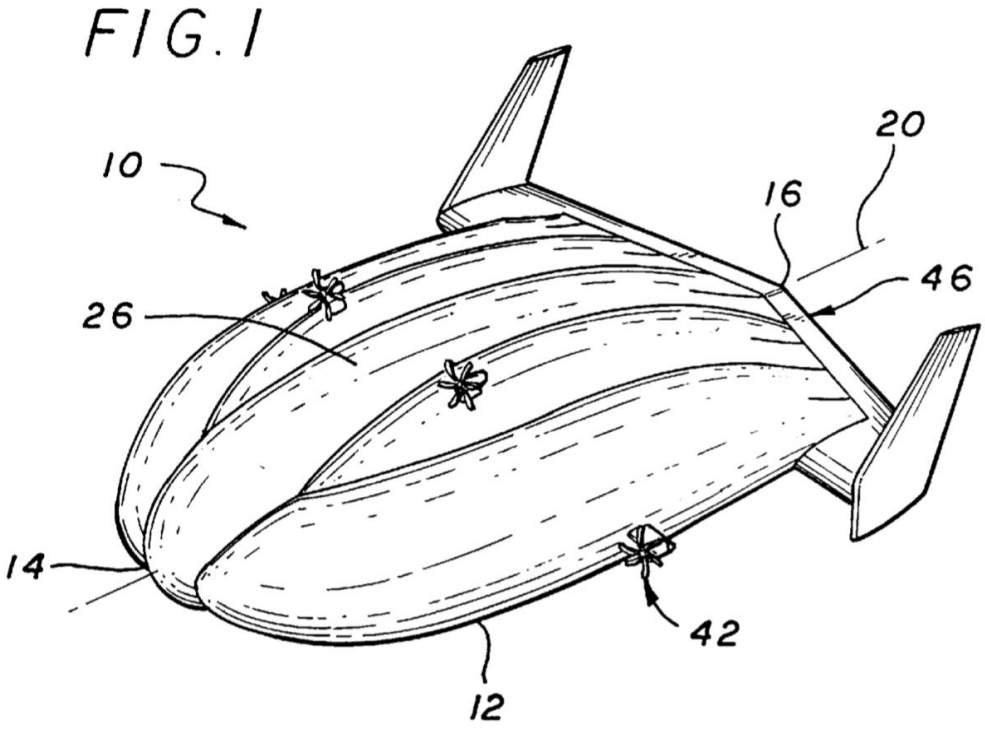
The following Lockheed-Martin airship technology patents granted in the early 2000s describe features of the Aerocraft hybrid airship:

- US6196498B1 - Semi-buoyant vehicle with aerodynamic lift capability
- US6293493B1 - Pressure stabilized gasbag for a partially buoyant vehicle
- US6302357B1 – Pressure stabilized inflated air transport vehicle
- US6315242B1 - Propulsion system for a semi-buoyant vehicle with an aerodynamic (hull)
- US5449129A - Propulsion system for a lighter-than-air vehicle

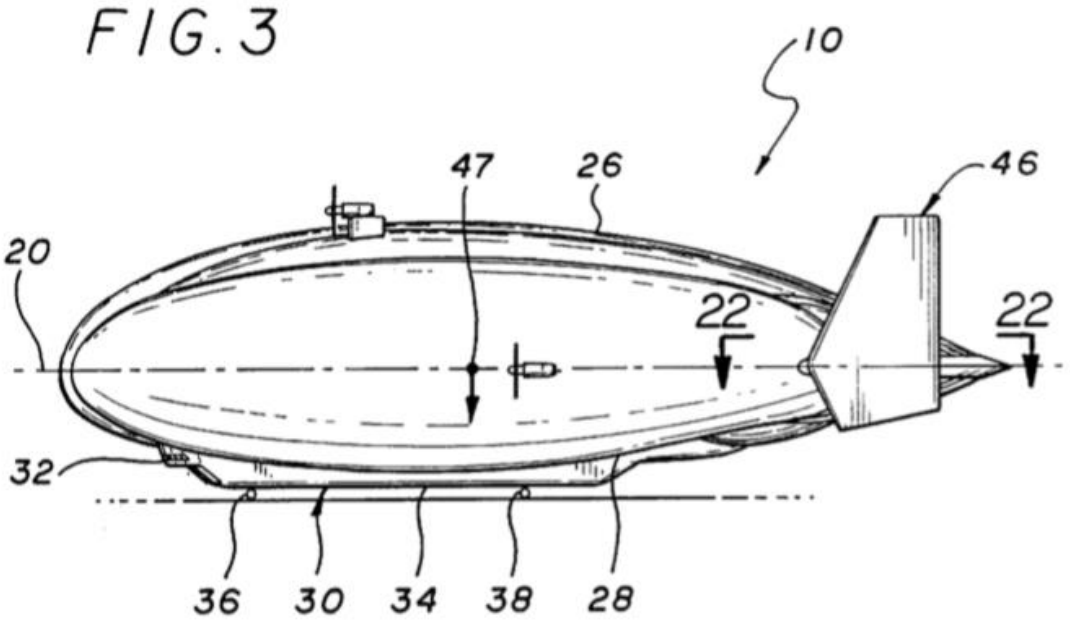
Patent US6196498B1 - Semi-buoyant vehicle with aerodynamic lift capability

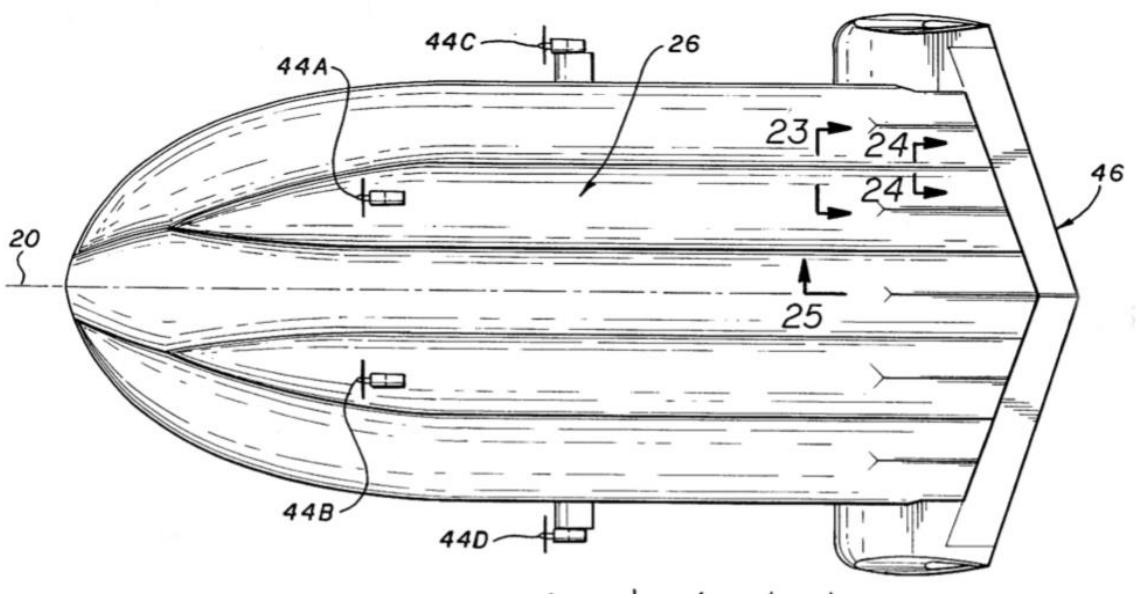
- Application filed: 21 December 1999
- Patent granted: 6 March 2001
- Available here: https://patents.google.com/patent/US6196498B1/en

This patent describes a semi-rigid, semi-buoyant, aerodynamic lift-producing hybrid airship with improved lifting gas distribution such that the center of buoyancy can be closely aligned with the center of gravity of the vehicle. This hybrid airship takes off and lands like an aircraft, but at very low speed. This patent was the first to describe the general arrangement of the Aerocraft hybrid airship, its propulsion system and flight controls.



Hybrid airship (10) has a very similar overall layout to the Aerocraft, with a pressure stabilized envelope (gasbag, 12), propulsion system (42) and tail assembly (46). The long gondola (30) under the envelope includes the flight deck (32), the cargo compartment (34), and the landing gear (36, 38). The center of gravity is at (47).





The propulsion system consists of four rotatable (vectoring) propulsion units arranged in two pairs. Propulsion units 44A and 44B extend out of the top surface of the vehicle and are capable of left-right thrust vectoring for yaw control. Propulsion units 44C and 44D extend out of the sides of the vehicle near the center of gravity and are capable of up-down thrust vectoring for direct lift or differential roll control. Due to the proximity of the center of gravity, the impact of vectoring 44C and 44D on pitch should be minor. The set of four vectoring propulsion units are intended to provide excellent directional control, particularly during takeoff and landing.

Patent US6293493B1 - Pressure stabilized gasbag for a partially buoyant vehicle

- Application filed: 21 December 1999
- Date of Patent: 25 September 2001
- Available here: https://patents.google.com/patent/US6293493B1/en

This patent applies to the design of a pressure stabilized gasbag having an aerodynamic shape for a semi-buoyant airship. The pressure stabilized gasbag is designed to provide close alignment of the center of buoyancy and the center of gravity of the airship, thereby minimizing bending of the non-rigid gasbag. The design also

provides for the efficient distribution of tail assembly loads into the non-rigid gasbag structure.

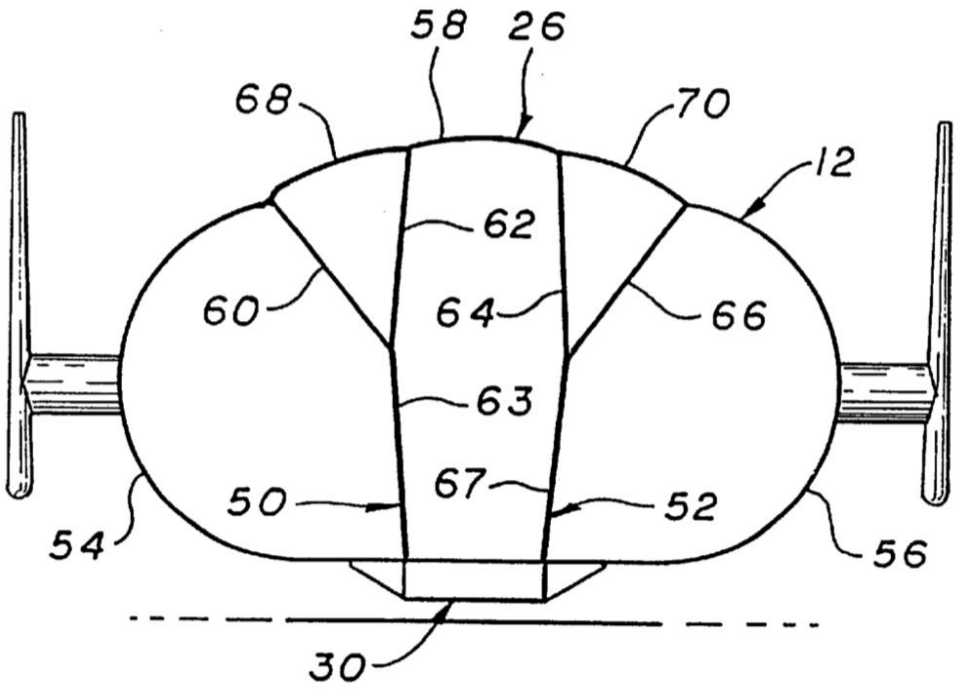


FIG. 17

Transverse cross-section of the envelope showing side lobes (54, 56), the center lobe (58), additional V-shaped lobes (68, 70), the Y-shaped catenary curtains (50, 52, also called "septums") comprised of Y-arms (60, 62, 64, 66) and legs (63, 67) that support the gondola (30) and distribute the loads into the top surface (26) of the gas envelope.

Patent US6302357B1 – Pressure stabilized inflated air transport vehicle

- Application filed: 28 August 2000
- Patent granted: 16 October 2001
- Available here: https://patents.google.com/patent/US6302357B1/en

This patent describes a design for the fabric hull of a pressure stabilized, inflated air transport vehicles, which will limit hull crack propagation so that the rate of escaping lift gas will not exceed the

capabilities airship systems used for maintaining gas pressure (i.e., a pump or the controlled release of lifting gas from a pressured gas storage cylinder).

Patent Figures 1 and 2 show the basic design of a non-rigid pressure stabilized fabric hull segment (8). The fabric skin (13) is a stiff and creep resistant material that carries the primary hull loads. A typical material would be VECTRAN®. A Mylar® film (32) covers the fabric skin (13) of the entire hull envelop (12) to serve as a helium leak barrier and protect the VECTRAN layer from damage by ultraviolet light.

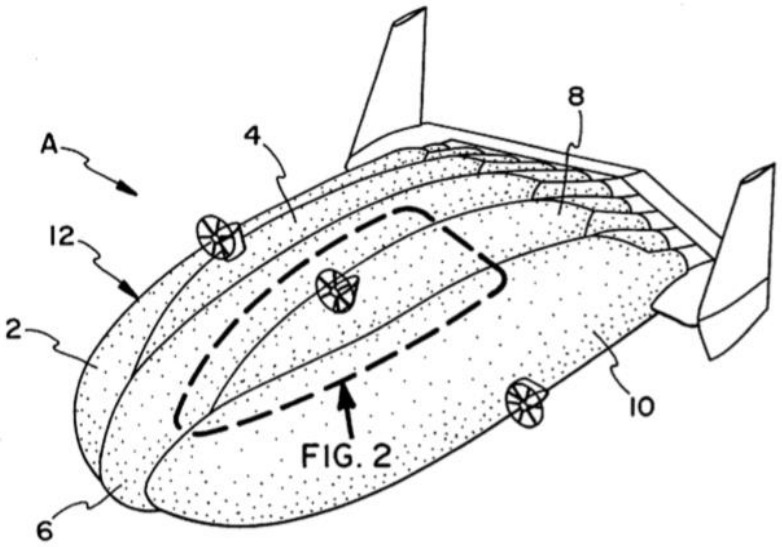


FIG. 1

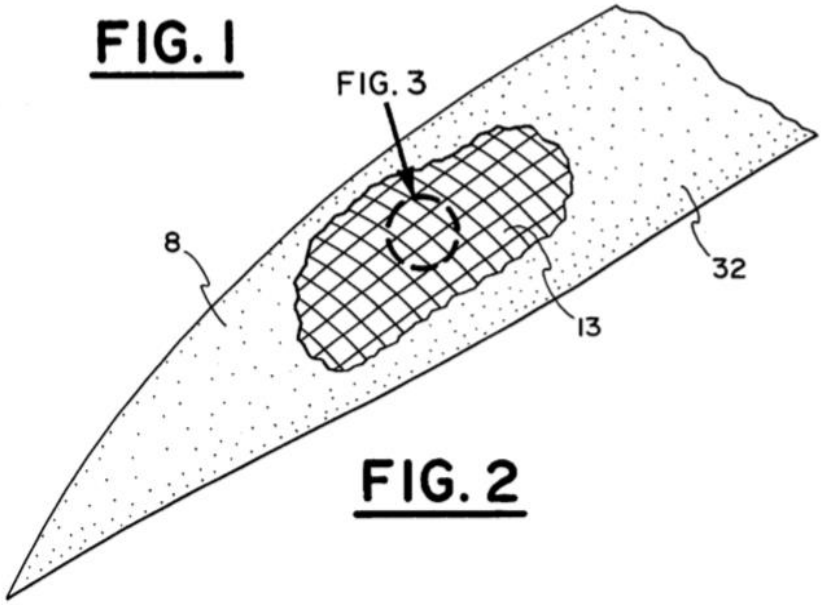


FIG. 2

As shown in patent Figure 3, bands (16, 18, 20, 23, 23) are bonded by thermos-sealing or adhesive to the hull skin material (13) to form an array of interconnected polygons. Transverse bands (20, 22, 23) encircle the hull, while the longitudinal bands (16, 18) wrap the hull lengthwise. If a crack (26) occurs in the fabric hull material, the bands minimize crack propagation by absorbing the load that would tend to widen the crack and reducing the stresses at the tips of the crack. The bands are designed with finite life under full load, but this life is long enough to enable the airship to safely complete a mission with a crack in the fabric hull material.

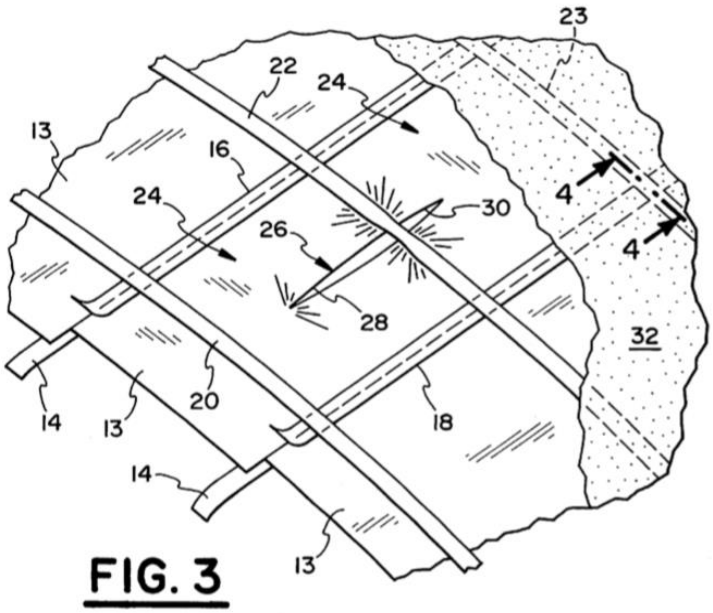


FIG. 3

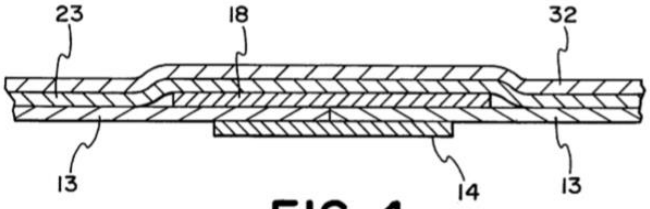


FIG. 4

Patent Figure 4 shows a cross section of the airship's fabric hull at the 4-4 section shown in Figure 3. Two pieces of VECTRAN® fabric skin (13) are joined on the inside by gore tape (14). A longitudinal strap (18) is bonded on the outside of this seam. A transverse strap (23) crosses this longitudinal seam. The entire hull has an external layer of Mylar® film (32).

Patent US6315242B1 - Propulsion system for a semi-buoyant vehicle with an aerodynamic (hull)

- Application filed: 21 December 1999
- Patent granted: 13 November 2001
- Available here: https://patents.google.com/patent/US6315242

For an airship similar in overall layout to the Aerocraft, this patent describes a means to install propulsion engines on a rigid internal structure that transfers propulsion system loads to a rigid gondola or keel structure and into the non-rigid envelope of a buoyant or semi-buoyant airship.

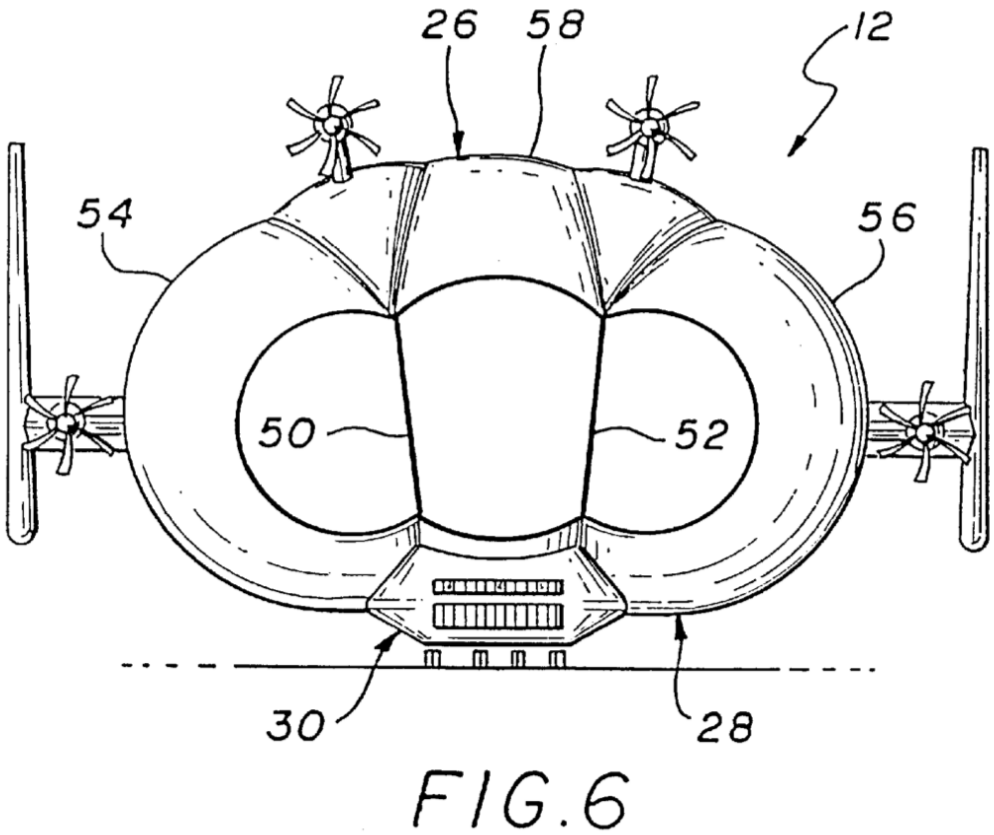
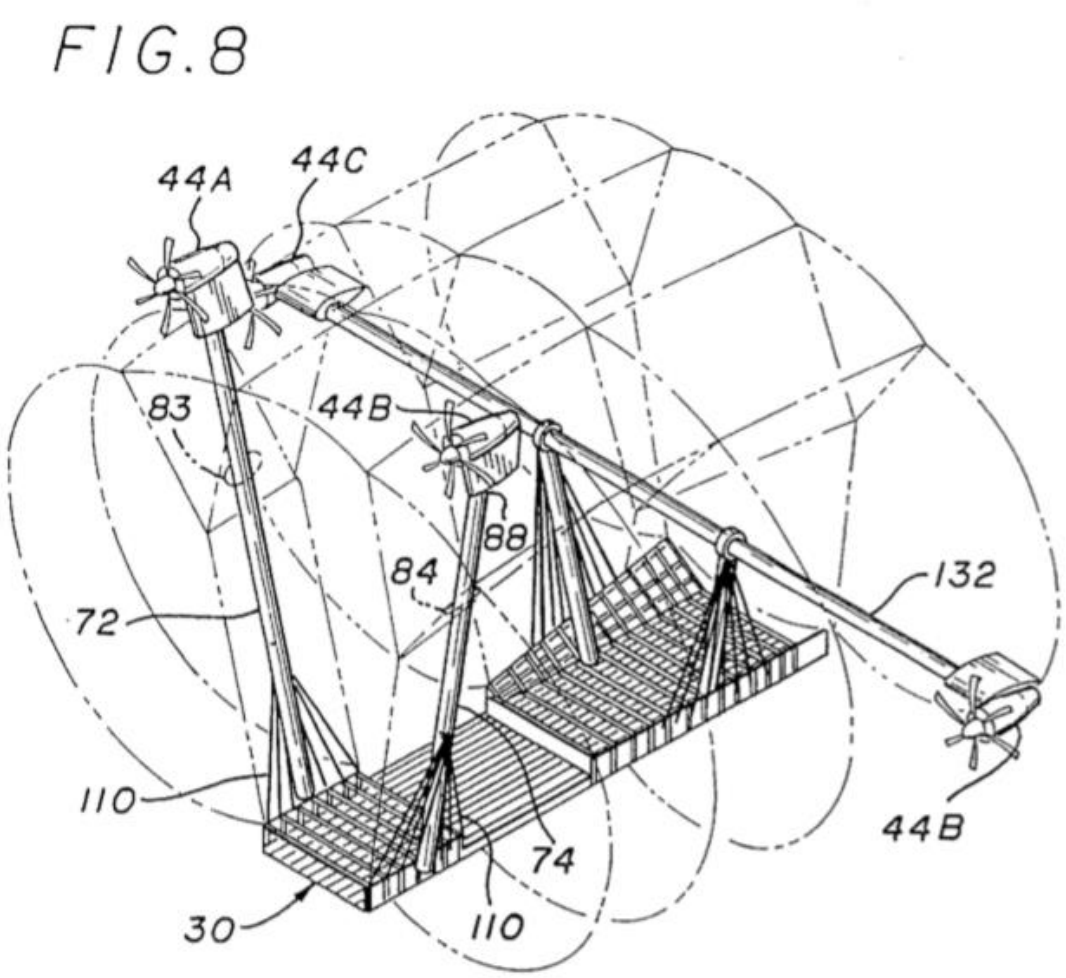


FIG.6

Bow view of a hybrid airship with four propulsors on rigid pylons that extend through the pressure stabilized non-rigid hull.



Cut-away view showing the rigid, load-bearing internal structures supporting the four propulsors.

In patent Figure 8, four propulsors (44) are supported by rigid frameworks (72, 74, 83, 84, 132) within the pressure stabilized hull. These frameworks transfer propulsion loads to a rigid keel (30) and thence into the envelope.

Patent US5449129A - Propulsion system for a lighter-than-air vehicle

- Application filed: 18 February 1994
- Patent granted: 12 September 1995
- Available here: https://patents.google.com/patent/US5449129A/en

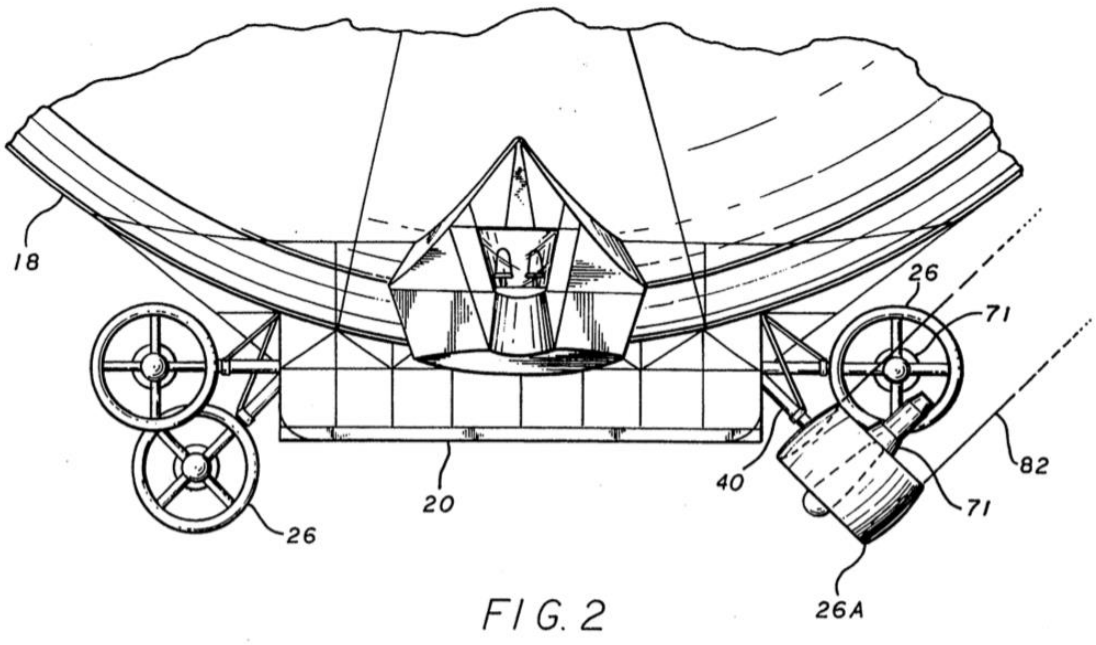


FIG. 2

Note propulsor 26A is rotated 90° relative to the orientation of the other three propulsors.

This patent describes a propulsion system that provides maneuvering and thrust vectoring control. This general concept of thrust vector control also has been applied by Lockheed Martin in their designs of the semi-rigid Aerocraft and non-rigid P-791 hybrid airships.

3. For more information

- "AEROCRAFT European Union Trademark Information," filed 28 July 1998, registration expired 31 May 2009: https://www.trademarkelite.com/europe/trademark/trademark-detail/000889972/AEROCRAFT

Other *Modern Airships* articles

- *Modern Airships - Part 1*: https://lynceans.org/all-posts/modern-airships-part-1/
    - Aereon Corporation – Dynairships & Aereon 26
    - Ohio Airships – Dynalifter semi-rigid hybrid airship
    - Lockheed Martin - Rigid hybrid airships
    - Lockheed Martin – P-791 non-rigid hybrid airship
    - Lockheed Martin - SkyTug & LMH-1 non-rigid hybrid airships
    - AT^2 Aerospace - non-rigid hybrid airship
- *Modern Airships - Part 2*: https://lynceans.org/all-posts/modern-airships-part-2/
- *Modern Airships - Part 3*: https://lynceans.org/all-posts/modern-airships-part-3/