Boeing - hybrid thermal airship

Peter Lobner, updated 10 March 2022

1. Introduction

Starting in about 2008, Boeing's Phantom Works was developing the design and patents for a large, hybrid thermal airship with a bi-convex hull. This airship gets part of its aerostatic lift from a fixed amount of lift gas (helium) and a variable amount of lift from hot air. Airship controls match the amount of variable lift to the operational needs of the airship. This basic concept is similar to that used on two Russian hybrid thermal airships: the ALA-40 Thermoplane (circa 1992) and the Aerosmena (current design in 2020). See my separate articles for more information on these two Russian hybrid thermal airships.

Author Todd Bishop reported in 2011 that a YouTube video briefly on the Internet explained that this Boeing airship was designed to "deliver cargo anywhere in the world without the need for a runway or any other infrastructure……. As an added bonus, the airship also would have defended itself against incoming missiles with high-powered lasers, and taken out threats on the ground with destructive radio-frequency beams."

Source: Boeing via Todd Bishop/GeekWire (2011)

By August 2011, Boeing reported that the company's Phantom Works unit was no longer working on such a project.

2. Boeing hybrid thermal airship patents

Boeing filed at least three patents related to the hybrid thermal airships in June 2008.

- **Patent US8033497B2, "Hybrid thermal airship:"** This patent was filed on 2 June 2008 and was granted on 11 October 2011. The patent is active and remains in effect until 2030. You can read this patent here: https://patents.google.com/patent/US8033497
- **US2009/0314879, "Hybrid Thermal Airship:"** This patent was filed on 2 June 2008 and granted on 11 October 2011. The patent is active and remains in effect until 2032. You can read this patent here: https://patents.google.com/patent/US20090314879A1/en?oq=•US2009%2f0314879
- **US8905353B2, "Bi-convex airship:"** This patent was filed on 2 June 2008 and granted on 9 December 2014. The patent is active and remains in effect until 2032. You can read this patent here: https://patents.google.com/patent/US8905353B2/en

The abstract for patent US8033497B2 describes the component parts of a hybrid thermal airship in simple terms as follows:

> "An airship comprises a shell, a gas storage system, an air storage system, a cargo storage system, a heating system, and a propulsion system. The shell encompasses a volume. The gas storage system is located within the volume, wherein the gas storage system is capable of storing a lighter than air gas. The air storage system is located within the volume, wherein the air storage system is capable of storing heated air. The heating system is capable of heating air. The propulsion system is capable of propelling the shell during flight."

The general exterior layout of the bi-convex hybrid thermal airship (100) is shown in patent US8905353B2 Figure 1. Aerodynamic features include a strake (104) and tail (106).

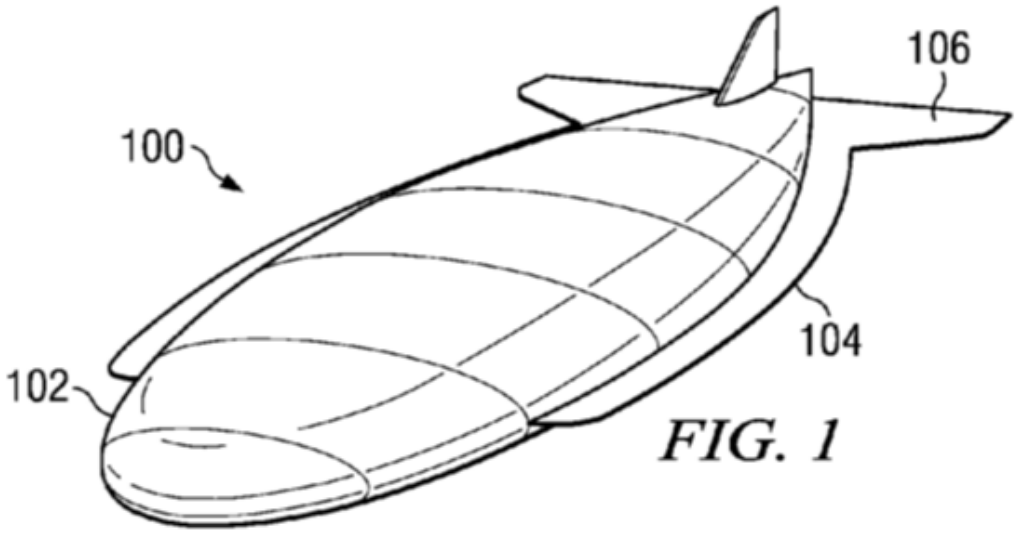


FIG. 1

The rigid frame structure is comprised of perimeter section 1902 and many cross-section ribs (1904, 1906, 1908, etc.).

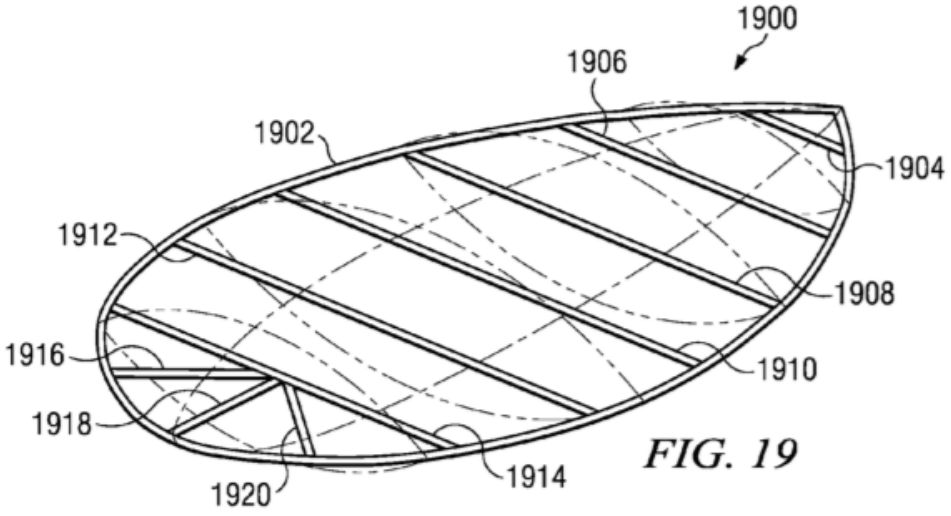


FIG. 19

Patent US8033497B2 Figure 3 is a plan view cross-section of the hull showing the egg crate arrangement of lift gas and hot air cells inside the hull. Figure 4 is a profile view of the same airship. The air storage system may store air at different temperatures in different cells.

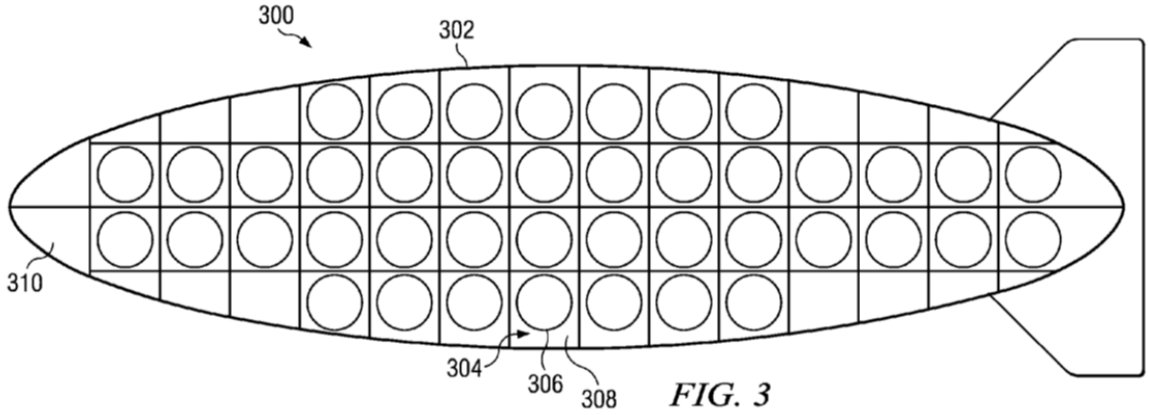


FIG. 3

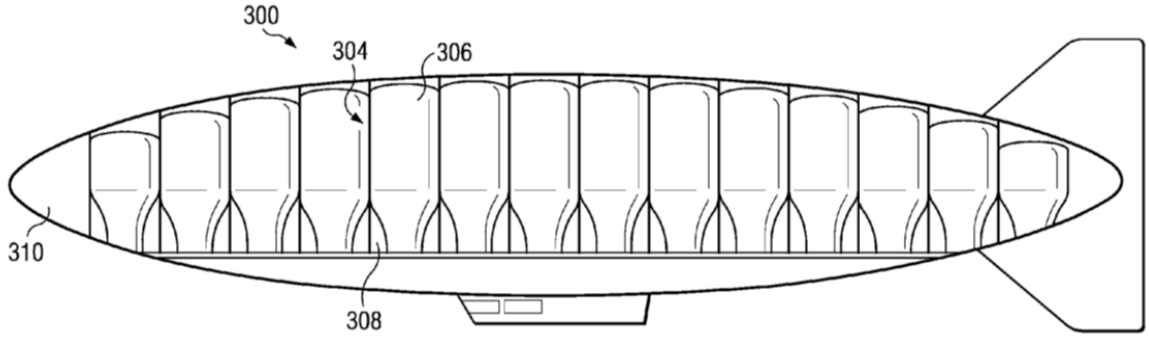


FIG. 4

A typical gas cell (700) is shown in Patent US8033497B2 Figures 7 and 8. The lift gas cells (702 & 704) are sealed. The heated air storage volumes (706) are not sealed. The air storage volumes are able to “breath” in and out as the airship’s altitude changes. The temperature of the air in the air volume (706) is managed through the introduction of heated air or cool ambient air coupled with the coordinated operation of controllable vents (708, 710, & 712), as explained below. The rate of heating or cooling of an air volume (706) can be increased through the use of inlet and exhaust fans. The air heating system can be implemented in various ways, such as heating air with the high temperature exhaust of the propulsion system engines.

Patent US8033497B2 describes how the air storage volumes are managed to control the overall buoyancy of the airship.

- **Increasing aerostatic lift:** Figure 7 shows aerostatic lift being increased by introducing heated air through inlet 718. Cooler air is displaced through vents 710 and 712. The average air temperature in air volume 706 increases, thereby increasing aerostatic lift.

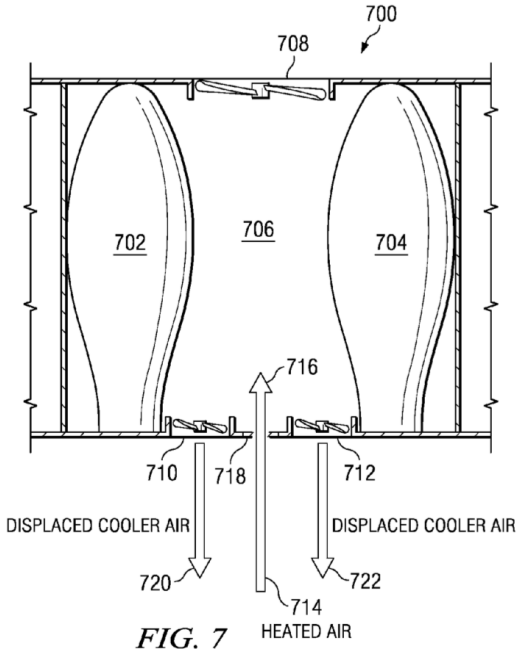


FIG. 7

- **Decreasing aerostatic lift:** Figure 8 shows aerostatic lift being decreased by introducing cool ambient air through vents 710 and 712 and discharging heated air through vent 708. The average air temperature in air volume 706 decreases, thereby decreasing aerostatic lift.

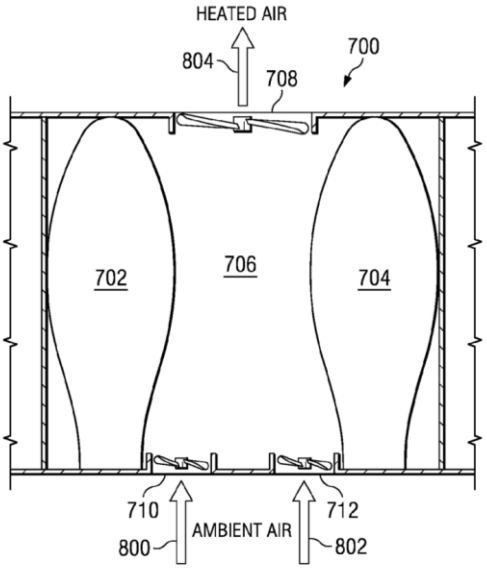


FIG. 8

3. Design of Boeing's hybrid thermal airship

This is a hybrid airship and total lift is the sum of the following components:

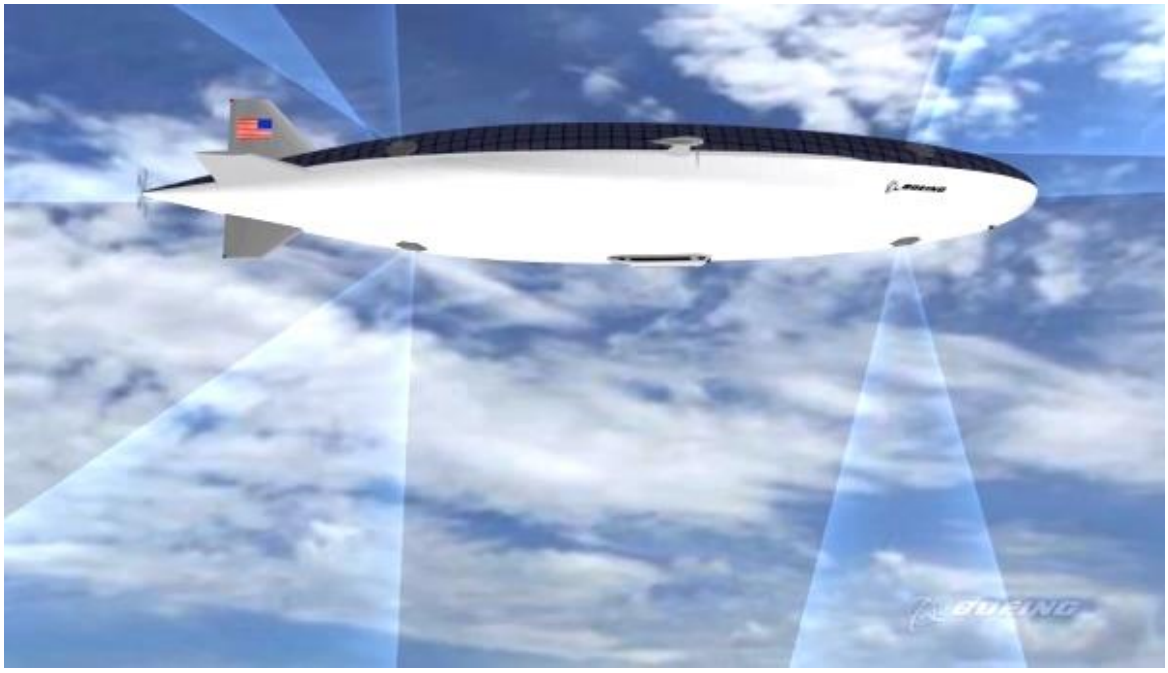
- The combined aerostatic lift from the lift gas and hot air
- The propulsive lift from vectoring propulsors
- The aerodynamic lift generated by the bi-convex hull in forward flight

At minimum weight (no payload present), it may be possible to trim the airship for neutral buoyancy and conduct a vertical takeoff and landing (VTOL) on aerostatic lift alone. At heavier gross weights, VTOL operations can be conducted up to the propulsive lift limits of the propulsion system. In flight, the aerodynamic lift of the hull becomes a significant contributor to total lift and propulsive lift is no longer needed. This allows the propulsors to be vectored into their horizontal cruise position. On the ground, the airship likely would be trimmed for slight negative buoyancy for added stability.

General characteristics of Boeing's hybrid thermal airship are summarized below:

- Type: semi-rigid
- Hybrid power system:
    - 8 MW solar array on the top of the hull
    - Fuel-powered generators
    - Batteries
- Propulsion: 3 x propulsors (2 x flank mounted and 1 x stern mounted)
- Operating altitude: up to 30,000 ft (9,144 m)
- Endurance: 60 days

Todd Bishop reported, "The video depicted the airship scanning its surroundings, blowing up an threatening vehicle on the ground with radio-frequency directed energy weapons 'operating at terrawatt energy levels,' and blasting an incoming missile with 'high-powered, solid state lasers.' It said those built-in defense systems allow the airship "to attain spherical dominance out to the radar horizon."



A depiction of Boeing's Hybrid Thermal Airship scanning for incoming threats. Source: Boeing via Todd Bishop/GeekWire (2011)

A depiction of Boeing's Hybrid Thermal Airship making an in-flight load exchange. Source: Boeing via Todd Bishop/GeekWire (2011)

4. For more information

- Todd Bishop, “Update: Boeing no longer working on hybrid airship, but damn it looked cool,” GeekWire, 29 August 2011: https://www.geekwire.com/2011/solarpowered-boeing-airship-traverse-globe-deliver-cargo-zap-missiles/

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- *Modern Airships - Part 2*: https://lynceans.org/all-posts/modern-airships-part-2/
    - Aerosmena - hybrid thermal airships
    - LokomoSky - hybrid thermal airships
    - Thermo Skyships - hybrid thermal airships
    - Thermoplan - hybrid thermal airships
- *Modern Airships - Part 3*: https://lynceans.org/all-posts/modern-airships-part-3/