Walden Aerospace / LTAS - Variable Buoyancy Propelled Airships / Aircraft

Peter Lobner, updated 12 August 2023

1. Introduction

In 1976, Michael K. Walden founded Lighter Than Air Solar (LTAS) Corp. in Nevada, where he served as Chief Technology Officer (CTO). In 1997, the firm was rebranded as LTAS / CAMBOT LLC, and in 2003, to LTAS Holdings LLC and LTAS International LLC. Michael Walden and the LTAS firms developed and demonstrated an impressive range of technologies and design concepts for lighter-than-air (LTA) craft, including design concepts developed in the 1990s for variable buoyancy propelled hybrid airships / aircraft.

These unique hybrid vehicles implemented a version of Walden's active density controlled buoyancy (DCB) system to vary their buoyancy between positive and negative and alternately fly like a winged buoyant airship and then as a semi-buoyant glider.

After leaving LTAS in 2005, Michael Walden founded Walden Aerospace where he is the President and CTO, building on the creative legacy of his work with the former LTAS firms.

The Walden Aerospace website moved to the Internet Archive's WayBack Machine in May 2023, at the following link:
https://web.archive.org/web/20180809061812/http://www.walden-aerospace.com/HOME.html

In this article, we'll take a look at two of Michael Walden's unique design concepts for variable buoyancy propelled hybrid airships / aircraft: the Hybrid Soaring Buoyancy Activated Transport (HY-SOAR B.A.T.) and the Variable Buoyancy, Multi-Person International Research and Expedition (VAMPIRE).

Special thanks to Michael Walden for his thoughtful input for this article.

2. The Hybrid Soaring Buoyancy Activated Transport (HY-SOAR B.A.T.)

Walden describes the B.A.T as follows: “The B.A.T. is an ultra-light class aircraft with a height of 16 feet (4.9 m), (including the 4 foot / 1.2 m diameter pilot's pod). The wing has a center chord of 40 feet (12.2 m) and a span of 80 feet (24.4 m). Landing gear are mounted under the pilot’s pod and in each of the wing tip rudders.”

The HY-SOAR B.A.T. concept shown on the ground.
Source: Walden Aerospace

Helium lifting gas is carried in cells within the high aspect ratio wing. For this size aircraft, the maximum altitude of the B.A.T. is about 20,000 feet (6,096 m). The pilot and gear allowance is 300 pounds (136 kg). A higher maximum altitude would require a lighter payload or a larger airship.

Walden’s density controlled buoyancy (DCB) system is at the heart of the HY-SOAR B.A.T. and other Walden airship designs developed since the early 1970s. However, the US patent process for this invention was not completed until 2 January 2007, when a patent was granted as US2006/0065777A1, "Systems for actively controlling the aerostatic lift of an airship." You can read this patent here:

https://patents.google.com/patent/US20060065777A1/en

Operation of the HY-SOAR B.A.T. DCB system is quite simple, as shown in the following patent Figures 4A and 4B.

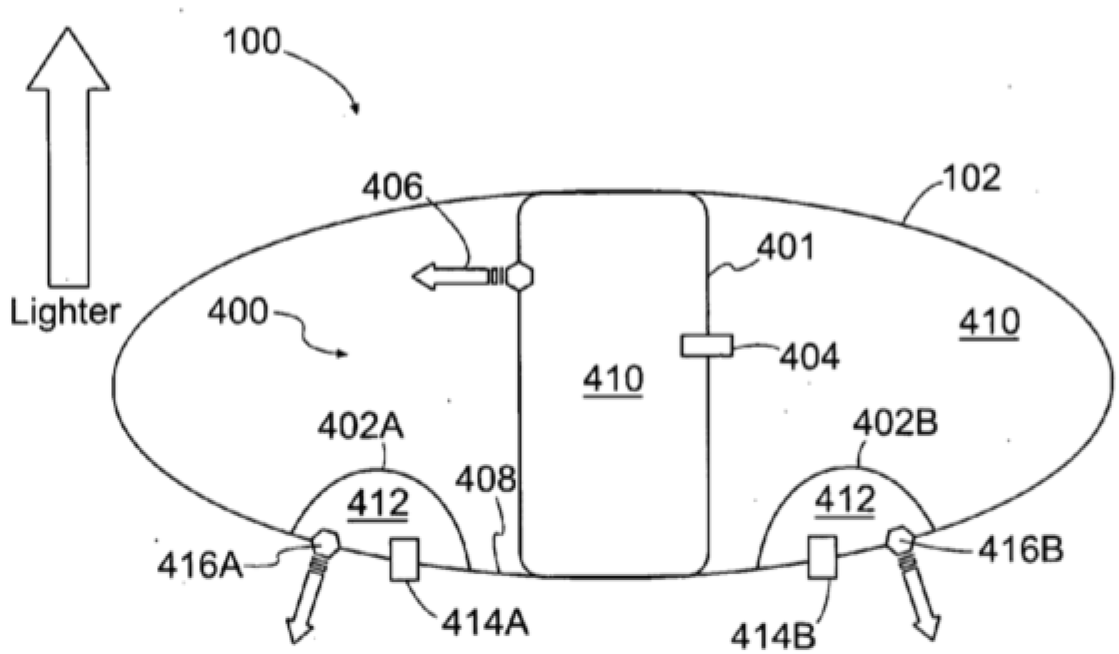


Fig. 4A

In Figure 4A, the aerostatic lift of a fixed-volume airship (102) is increased by releasing helium (410) from a fixed-volume pressure tank (401) via a helium control valve (406) into an atmospheric pressure helium cell (400). As more helium gas enters the helium cell, heavier air (412) is forced out of the ballonets (402, also known as "displacement change bags") and is discharged to the atmosphere via vent valves (416). The total mass of the HY-SOAR B.A.T. decreases as the heavier air is displaced and there is a corresponding increase in buoyancy. Very little power is needed for operating the helium control valve (406), which also can be operated with a manual actuator.

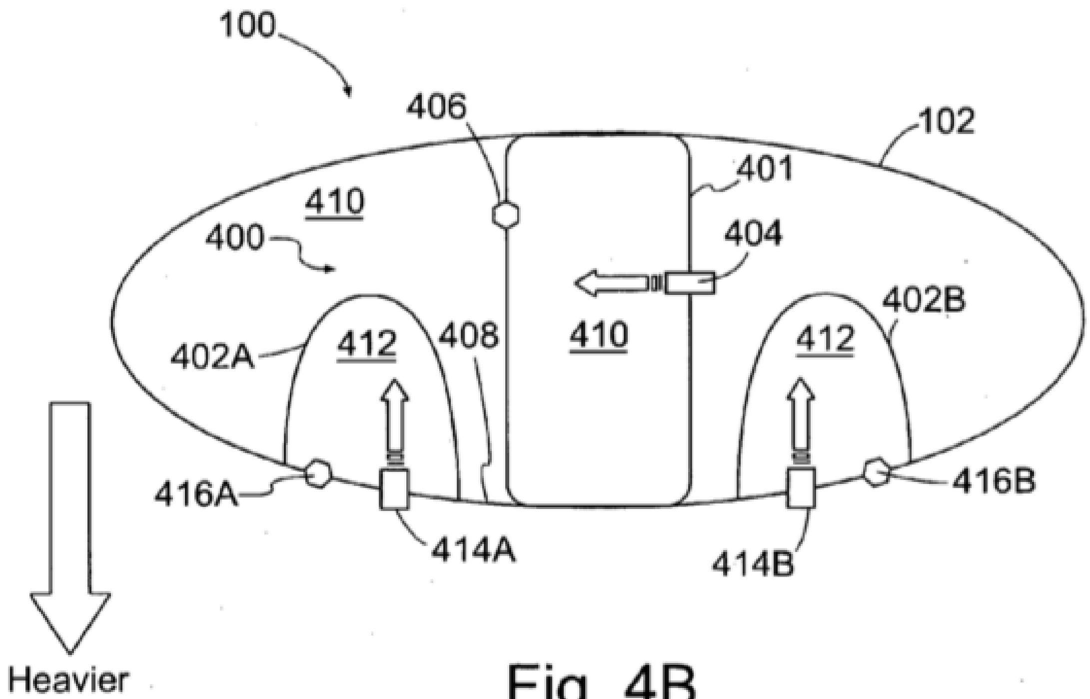
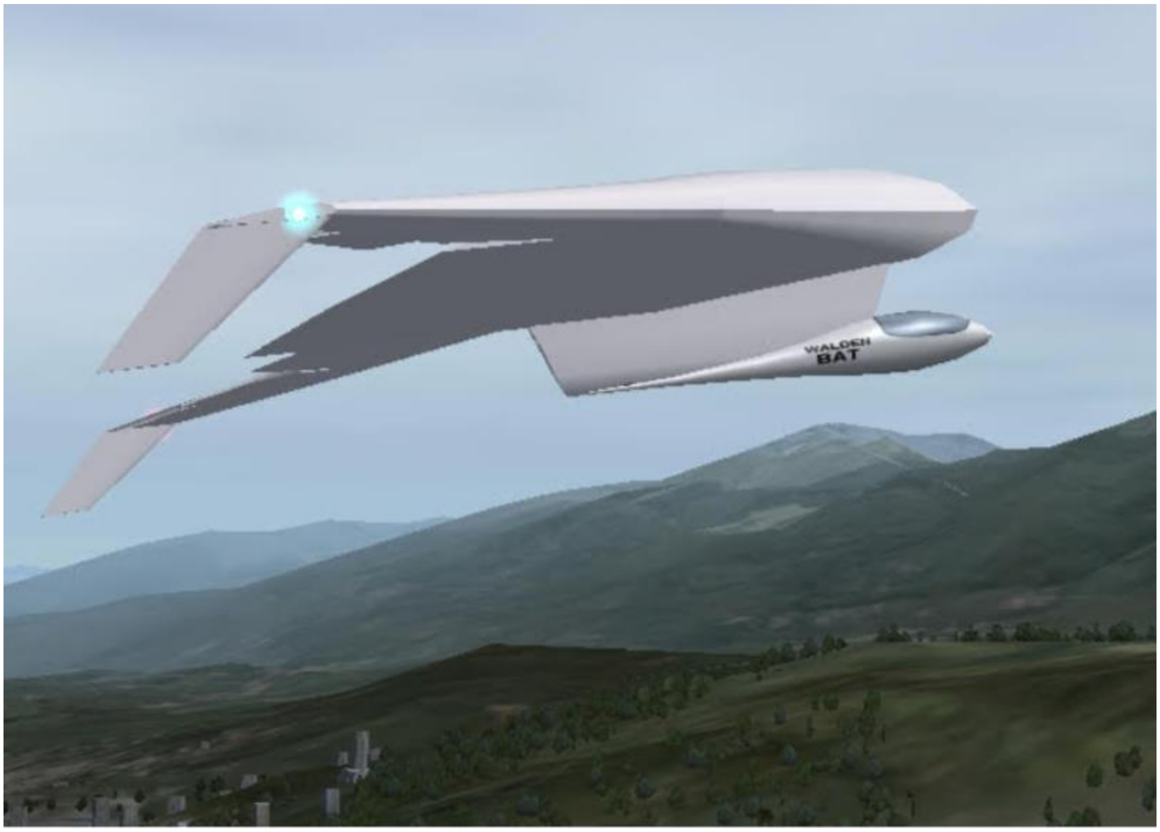


Fig. 4B

In Figure 4B, the aerostatic lift of a fixed-volume airship (102) is decreased when helium from the atmospheric pressure helium cell (400) is compressed by a pump (404) and discharged into the fixed-volume pressure tank (401). As the helium is transferred, the ballonet volumes (402) expand as fans (414) add heavier atmospheric air (412). The total mass of the HY-SOAR B.A.T. increases as the heavier air is added to the ballonets and there is a corresponding decrease in buoyancy. Power is needed for compressing some helium from the atmospheric pressure helium cells in the wings and returning it the fixed-volume pressure tank (401).

No helium is lost during this venting and compressing cycle.



The HY-SOAR B.A.T. concept shown in flight.
Source: Walden Aerospace

The HY-SOAR B.A.T. has the following operational characteristics:

- **For stability on the ground:** The buoyancy control system maintains maximum negative buoyancy. B.A.T is heavier than air.
- **For takeoff and ascent:** The buoyancy control system establishes positive buoyancy by releasing some helium from the pressure tank into the atmospheric pressure lift gas chambers in the wings, making the B.A.T a lighter-than-air airship. The craft is trimmed for an “up” angle-of-attack for aerodynamic lift and forward thrust as the B.A.T. makes its aerostatic ascent. Control surfaces on the wing enable the direction on flight to be controlled. Speed, both forward and ascending, is controlled by how much lift gas is released into the gas chambers in the wings and the angle-of-attack of the craft. Buoyancy control also establishes the maximum flight altitude (pressure altitude).

- **For gravity-powered descent:** The buoyancy control system establishes negative buoyancy, making the B.A.T. heavier than air. The B.A.T becomes a semi-buoyant aircraft that can be trimmed like a glider for the desired flight condition (i.e., maximum or best speed, maximum lift/drag ratio).
- **For a porpoising flight profile:** A descent can be terminated by using the buoyancy control system to re-establish positive buoyancy, enabling the B.A.T. to continue flying in a desired direction as it ascends to a new, higher altitude. The repetitive cycling between a higher altitude and a lower altitude enables the B.A.T. to exploit the forces of aerostatic lift and gravity for propulsion. Energy is required to recompress some of the lift gas at the start of each descent cycle. Venting helium back into the helium cells at the end of a descent requires little energy for operating a control valve.
- **For high-altitude station keeping and transits**: The B.A.T. will level off upon reaching its "pressure altitude," which is the maximum possible altitude that can be reached when the lift gas takes up the entire gas volume of the wing and there is no more air in the ballonets. However, the B.A.T lacks a conventional propulsion system, so the prevailing wind will blow the craft downwind of its prescribed target. The gravity-driven porpoising flight profile enables B.A.T. to fly back to the designated station keeping point. The B.A.T. also can fly between distant station keeping points or conduct a long-distance transit using the porpoising flight profile.
- **For landing:** At the end of a gravity-powered, gliding descent on approach to an airport, the buoyancy control system trims the B.A.T. to its maximum weight. The B.A.T. is flying like an unpowered, semi-buoyant aircraft and is able to make a controlled approach and landing at an airfield. Unlike a glider, the buoyancy control system allows the B.A.T. to abort a landing approach by reestablishing positive buoyancy and then flying a porpoising go-around for another landing attempt.

Thin film photovoltaic arrays on the wing upper surface and a battery for energy storage can support the operation of the buoyancy control system and other airship systems. A small pedal-powered generator operated by the pilot may be able to supplement the power needed to operate airship systems and compress some lift gas during a descent cycle or landing.

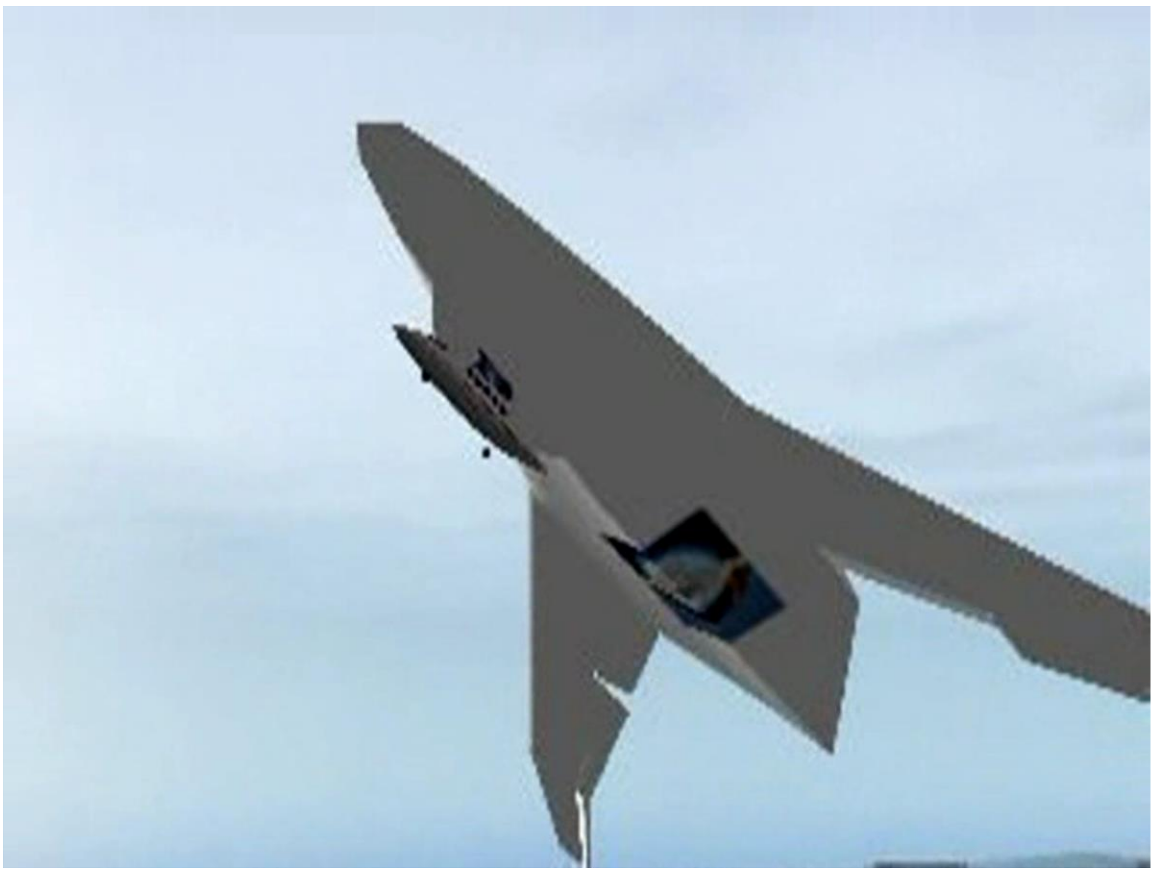
HY-SOAR B.A.T. concept control panel. Note the simple "Up/Down" control for managing buoyancy. Source: Walden Aerospace

The B.A.T. can be configured for operation as a remotely piloted vehicle. It also can be scaled as needed to meet mission payload requirements.

The HY-SOAR B.A.T. was not built.

3. Variable Buoyancy, Multi-Person International Research and Expedition (VAMPIRE)

Walden Aerospace developed a concept for a larger variable buoyancy propelled hybrid airship / aircraft named the Variable Buoyancy, Multi-Person International Research and Expedition (VAMPIRE). This craft was intended for an around-the-world flight with a crew of three or four.



VAMPIRE concept airship designed for an around-the-world mission using variable buoyancy propulsion. Source: Walden Aerospace

The VAMPIRE design concept had a wingspan of about 200 feet (61 m), a wing chord of 40 feet (12.2 m) and maximum wing thickness of 25 feet (7.6 m). With the thick wing "center body," its overall lift gas volume was 250,000 to 300,000 cubic feet (7,079 to 8,495 cubic meters). A payload (crew + supplies) of about 2,000 pounds (907 kg) was carried in a crew pod mounted under the nose of the craft.

The VAMPIRE was not built.

VAMPIRE. Source: Walden Aerospace

4. For more information

- Michael Walden, "The HY-SOAR B.A.T. - Walden Aerospace Corporation's Hybrid Soaring Buoyancy Activated Transport," 2019: https://lynceans.org/wp-content/uploads/2020/12/Walden_HY-SOAR-BAT-paper.pdf

Other *Modern Airships* articles

- *Modern Airships - Part 1*: https://lynceans.org/all-posts/modern-airships-part-1/
  - Walden LTAS Part 1 - Lenticular toroidal DCB airships
- *Modern Airships - Part 2*: https://lynceans.org/all-posts/modern-airships-part-2/
  - Hunt Aviation – Gravity plane
  - New Mexico State University – AHAB
  - Phoenix – gravity-propelled drone airship
  - Solomon Andrews - Aereon I and Aereon II

    - Utah Aereon Corp. – Aereon SA-1
    - Walden LTAS - Electro-kinetic (EK) propulsion airships
- *Modern Airships - Part 3*: https://lynceans.org/all-posts/modern-airships-part-3/
    - Walden LTAS - Exotic hybrid airships