Hov-Air-Ship, Inc.

Peter Lobner, 12 February 2022

1. Introduction

Saul Slater founded the company Hov-Air-Ship, Inc. in Miami Beach, FL, in the mid-1970s “for the purpose of furthering the technology and manufacture of a feasible modern day airship,” and, in particular, to manufacture and fly the unmanned “Hov-Air-Ship Experimental 1” (HX-1) sub-scale technology demonstrator airship model.

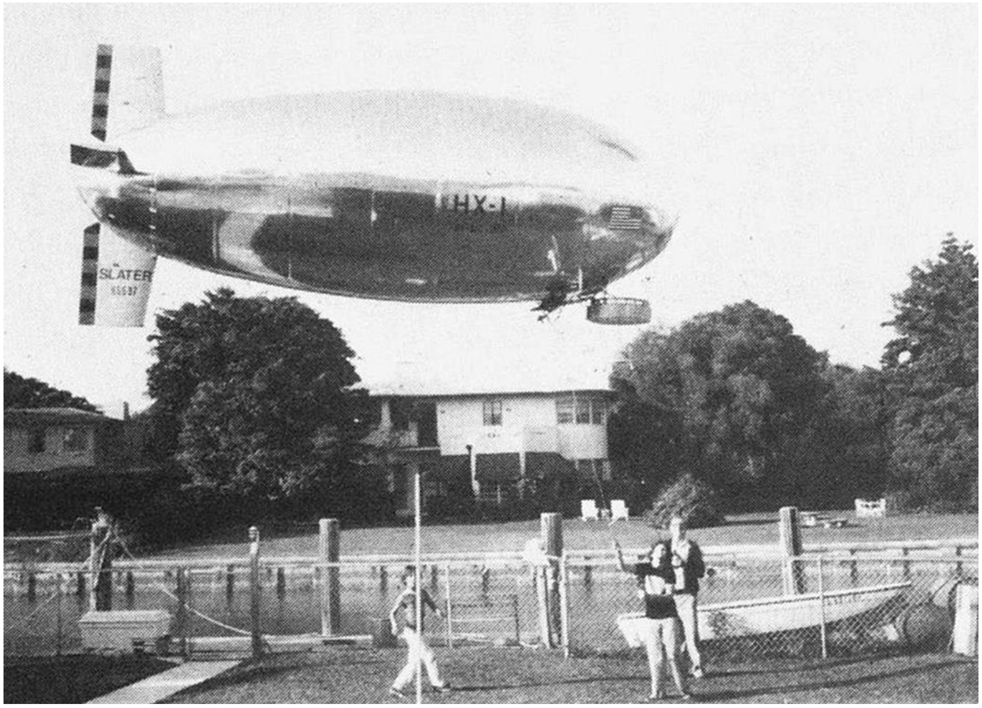
Their initial business goal was to interest potential US government customers, particularly the US Navy, US Coast Guard (USCG) and the National Aeronautics and Space Administration (NASA), based on the unique operational capabilities that could be demonstrated by the HX-1. Hov-Air-Ship, Inc. claimed that a full-size manned airship of similar design could provide a lower-cost alternative to helicopters for many military patrol and cargo lift tasks and for various civil and commercial applications.

The company developed designs for a larger, manned HX-2 experimental airship that was intended as the next step in the development path to a full-scale operational airship. However, at the time, the Navy, USCG and NASA had no operational requirements for such a vehicle.

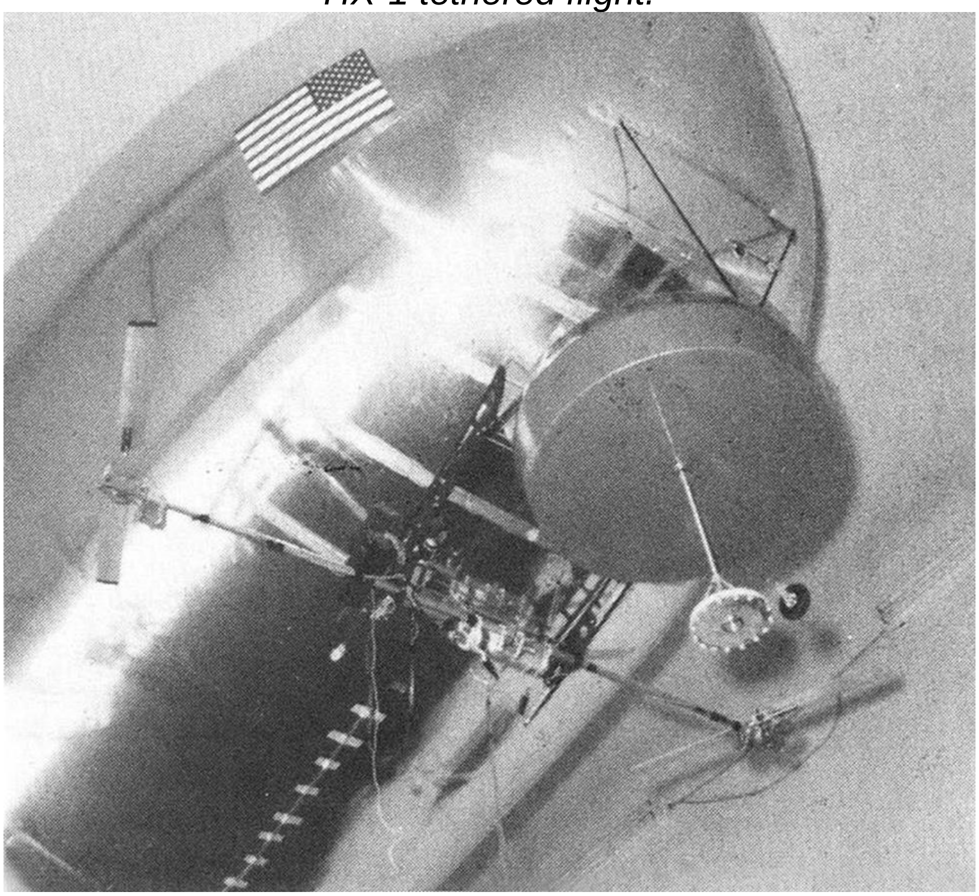
This article provides an overview of the HX-1 and HX-2 as well as the novel “convertible airship” and mooring techniques that are the subjects of patents granted to Saul Slater.

2. HX-1

The HX-1 was developed by Hov-Air-Ship, Inc. with internal funding as a low-cost, sub-scale, technology demonstrator that flew on a tether that provided electric power, flight control and lifting gas pressure control for the small airship. In early 1978, Slater was conducting tethered flight tests and demonstrations for the Navy, USCG and NASA in Miami Beach.



HX-1 tethered flight.



The magnetic mooring device being lowered from a drum.
Source, both photos: AW&ST magazine (10 April 1978)

The HX-1 had a magnetic mooring system, which was patented by Slater. A electromagnetic plate was lowered from a drum under the nose of the airship and engaged a pad anchored to the ground. The airship then could be winched down to the mooring.

The HX-1 was delivered to the Naval Air Development Center at Warminster, PA on 16 October 1978 for test and evaluation.

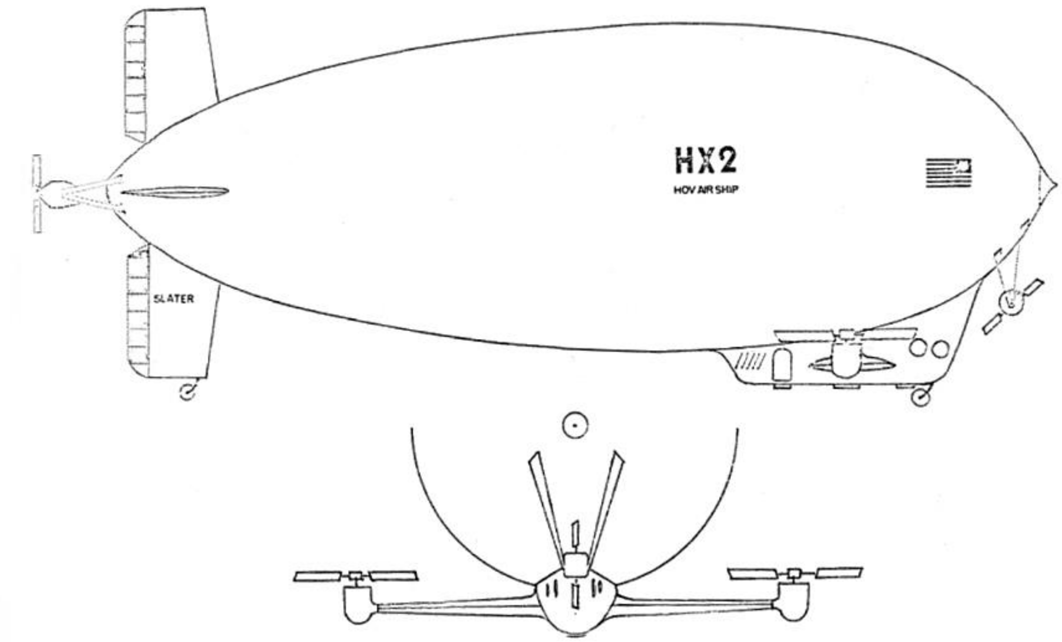
In February 1979, Slater explained to the Congressional Subcommittee on Science, Technology and Space that the HX-1 demonstrated that it could accomplish “what no other airships to date have ever accomplished, namely, to take off vertically by power, hover, fly in a figure eight pattern, stop while airborne and land vertically, all by remote control.”……“Its usefulness is apparent in the experimentations and alterations in control made by (LTA Program Director) Mr. John Eney, such as ‘single-stick’ operation, much like a helicopter, elimination of rudders and elevators by using the vectoring tail propulsion, and learning precision hovering and ‘no hands’ landing. Further experiments are planned for some inertial guidance control. Such ‘in-hand-hardware’ experimentation can save a lot of money when done on a small scale, such as the HX-1.”

3. HX-2

The HX-2 was a design for a larger, free-flying, manned experimental airship that Slater proposed as a platform for validating design features and equipment and demonstrating the ability to operate without a ground crew before committing to a larger airship.

In 1978, Slater offered to build the first HX-2 for $500,000, including the cost of a hangar. He is reported to have said that payment from the government would have been required “only if the HX-2 does everything I say it can do.” In spite of this enticing offer, a contract for the HX-2 was not placed.

Slater expected a production HX-2 to have a unit price of about $300,000.



HX-2 two-view drawing.
Source: Congressional Subcommittee Hearings, Feb-Mar 1979

General characteristics of the HX-1 and HX-2

Parameter	**HX-1**	**HX-2**
Length	19 ft (5.8 m)	135 ft (41.1 m)
Diameter	7 ft (2.1 m)	35 ft (11.0 m)
Volume	487 ft^3 (13.9 m^3)	70,000 ft^3 (1,982 m^3)
Ballonet	None, automatic lifting gas pressure control via tether	Yes
Power source	110 VAC electric power via tether	5-cylinder, supercharged Mercedes Benz engine
Propulsion	• 2 x collective pitch propellers on transverse beam, vectoring 90º up / 90º down • 1 x thrust vectoring propeller at the tail	• 2 x thrust vectoring, wing-mounted propellers • 1 x thrust vectoring propeller at the tail • 1 x lateral control propeller under the nose
Speed, cruise	Slow, limited by tether	50 knots (92.6 kph)
Endurance	Unlimited (power source is on the ground)	• 4 hrs @ 50 knots (92.6 kph) • 10 hrs @ 20 knots (37.0 kph)
Crew	None	2 to 3 crew + 400 lbs (181 kg) of gear
Control	Remotely piloted via tether	Manual, autopilot, or a remotely piloted unmanned version

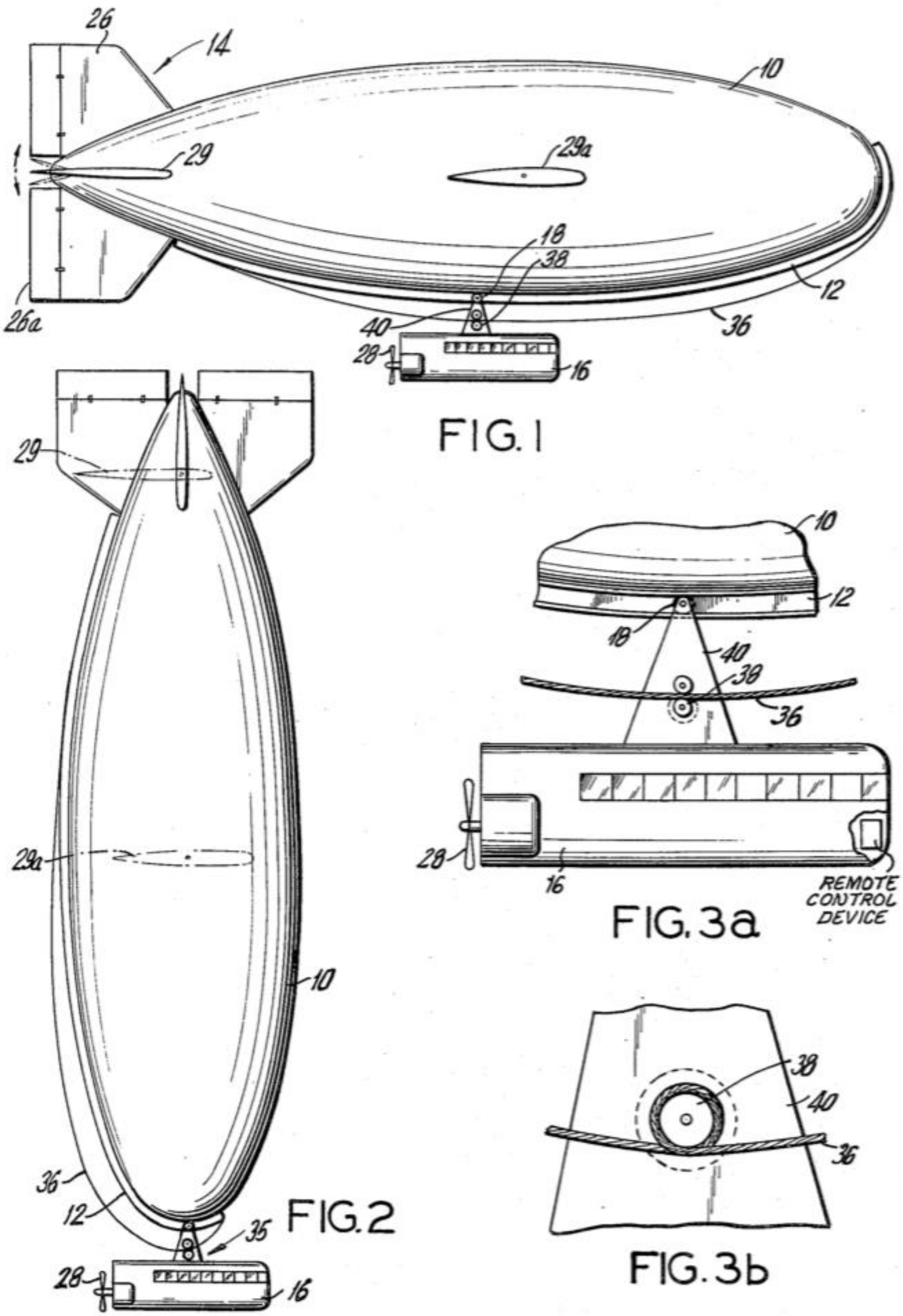
4. Convertible airship

Saul Slater's "convertible airship" is described in two patents, US3971533A and US4085912A, both of which present a unique design feature that enables an airship's suspended gondola to remain horizontal while the airship's gas envelope is pivoted 90º from its normal horizontal alignment in cruise flight to a vertical alignment for landing, with the nose abutting the top of the gondola and the tail in the air. The goal is to moor the horizontal gondola with the gas envelope floating vertically above, thereby greatly reducing the amount of outdoor ground space required by a moored airship that needs to move freely to align with changing wind directions.

The simplest implementation is shown in patent US3971533A, Figures 1, 2, 3a and 3b. The gondola (16), containing the propulsion system (28), is suspended from a track (12) that is part of a rigid keel that runs along the underside of the gas envelope (10) all the way to the nose. The gondola can be secured in place or pulled along the track by cable (36), which is operated by a winch (38).

The conversion from a conventional cruise configuration, with a horizontal gondola and gas envelope (patent Fig. 1), to a landing configuration, with a horizontal gondola and a vertical gas envelope (patent Fig 2), takes place while the airship is airborne, hovering above the landing site. The gondola is winched toward the nose, moving the center-of-gravity forward under the center-of-buoyancy, and causing the tail of the gas envelope to pivot upward. When this conversion is complete, descent is initiated with fans that expand the air ballonets within the gas envelope to a slight positive pressure, increasing overall weight and decreasing the buoyancy of the airship. At low altitude, the gondola engages a mooring and the airship is securely anchored.

Ascent from the mooring is accomplished by using fans to evacuate air from the ballonets, decreasing overall weight and increasing buoyancy as the lifting gas cells expand within the outer envelope. At an appropriate altitude, the conversion process is initiated by winching the gondola back to its cruise position, causing the tail of the gas envelope to pivot downward until the conventional cruise configuration has been reestablished and the gondola is secured.



Convertible airship. Source: Patent US3971533A

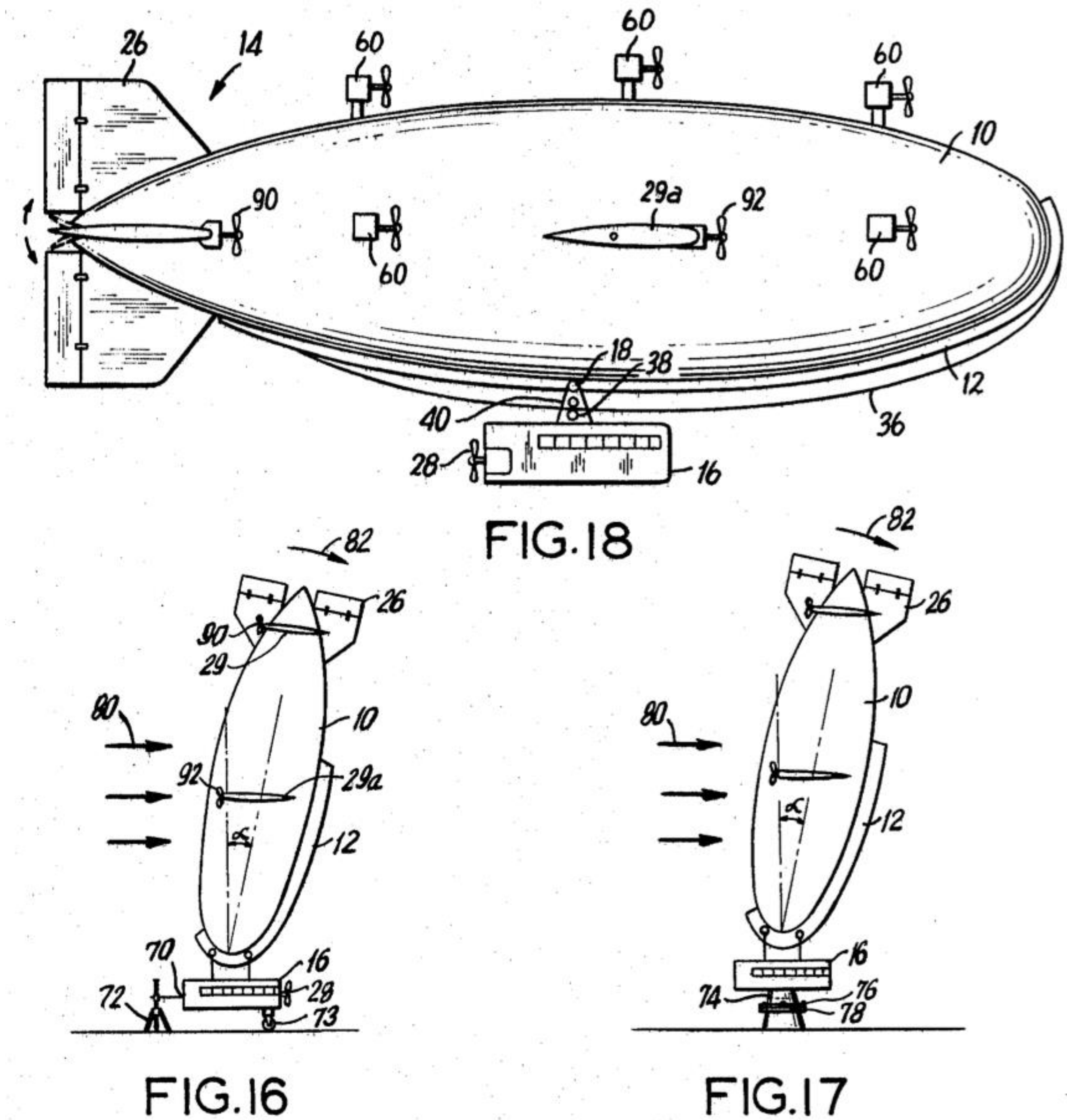
A more complex implementation in patent US4085912, Figures 16, 17 and 18 shows a convertible airship with a distributed propulsion system that is used for horizontal cruise propulsion and for vertical propulsion when descending to, and ascending from, a mooring on the ground.

As described in the patent:

> "…the airship includes propulsion means mounted to said gas-containing structure adapted to provide thrust generally parallel to said longitudinal axis, such that said propulsion means can provide forward thrust when the longitudinal axis is horizontal to propel the airship in flight, and such that said propulsion means can provide downward thrust when the longitudinal axis is vertical to cause the airship to descend. Also advantageously, the propulsion means is also provided with reversible thrust capability such that it can provide upward thrust when the axis is vertical to cause the airship to ascend."

> "…the method for landing a convertible airship includes the steps of substantially stopping all forward propulsion, rotating the longitudinal axis to a generally vertical orientation and propelling the airship downwardly toward earth. Likewise, the method for lifting a convertible airship includes the steps of reversing the downward thrust of the propulsion means to an upward thrust and rotating the longitudinal axis to a generally horizontal orientation when a predetermined altitude is reached for initiating forward propulsion. Thus, the airship according to the invention includes a method, and means therefor, for controlled descent and ascent, such that apparatus for changing the effective density of the lighter-than-air gas may not be necessary or need not be completely relied upon."

The airship is shown moored at two different typed of moorings: a conventional mooring tower (Fig. 16) and an rotating anchor plate (Fig. 17). Both moorings allow the airship to weathercock in response to changing wind directions. The rotating anchor plate (Fig. 17) requires less ground space.



Convertible airship and mooring concepts.
Source: Patent US4085912

5. Additional mooring systems

Slater presented designs for several airship mooring systems in his patents US4238095A and US4272042A. One notable example is the following magnetic mooring system, which is comprised of an electromagnet (100) on the bottom of the gondola that can be activated for magnetic attraction to an anchoring member (102). Preferably, the magnet on the gondola is designed to allow the airship to rotate freely in response to changing wind directions.

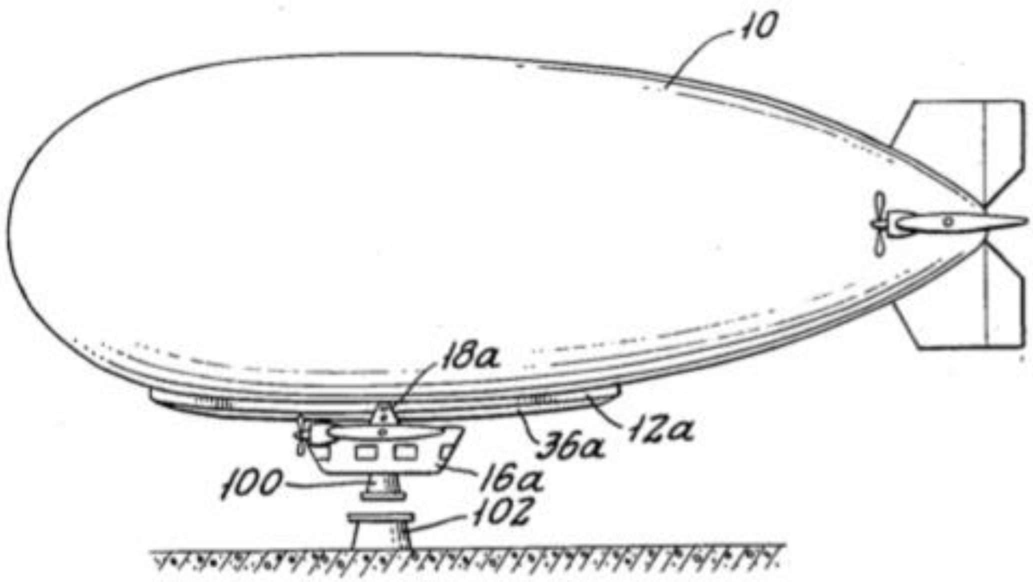


FIG. 19

Magnetic mooring concept. Source: US4272042A

6. For more information

- "Hov-Air-Ship Proposed for Patrol, Cargo Lift Tasks," Aviation Week & Space Technology, p. 45, 10 April 1978: https://archive.aviationweek.com/issue/19780410
- "Propelled Lighter Than Air Vehicles: Hearings Before the Subcommittee on Science, Technology and Space", pp. 152-153, 27 Feb – 1 March 1979: https://books.google.com/books?id=g87UAAAAMAAJ&pg=PA118&lpg=PA118&dq=goodyear+ZPG-X&source=bl&ots=qkvUZJCZHG&sig=ACfU3U1NUh6GpgTbxpJygmsp1qZATTlERg&hl=en&sa=X&ved=2ahUKEwicr6PJ5oT0AhVpqVsKHVOUBUI4MhDoAXoECBcQAw#v=onepage&q=goodyear%20ZPG-X&f=false

Patents

- US3971533A, “Convertible airship,” Inventor Saul Slater, Filed 25 February 1975, Granted 27 July 1976: https://patents.google.com/patent/US3971533A/en?oq=•US3971533
- US4085912A, “Convertible airship,” Inventor Saul Slater, Filed 14 April 1976, Granted 25 April 1978: https://patents.google.com/patent/US4085912A/en?oq=US4085912
- US4238095A, “Method of and apparatus for anchoring airships and propulsion means for airships," Inventor Saul Slater, Filed 14 February 1978, Granted 9 December 1980, Assigned to Hov-Air-Ship, Inc.: https://patents.google.com/patent/US4238095A/en?oq=•US4238095
- US4272042A, “Airship and associated apparatus and method for anchoring same,” Inventor Saul Slater, Filed 22 June 1977, Granted 9 June 1981, Assigned to Hov-Air-Ship, Inc.: https://patents.google.com/patent/US4272042A/en?oq=•US4272042
- US4228416, “Composite magnet and magnetic anchoring,” Inventor Saul Slater, Filed 15 September 1978, Granted 14 October 1980, Assigned to Hov-Air-Ship, Inc.: https://patents.google.com/patent/US4228416A/en?oq=4228416

Other *Modern Airships* articles

- *Modern Airships - Part 1:* https://lynceans.org/all-posts/modern-airships-part-1/
- *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/