

Bothe - Helitruck & semi-buoyant hybrid aircraft

Peter Lobner, 24 August 2021

1. Introduction

The Helitruck was conceived in 1980 – 1981 by Hans-Jürgen Bothe, a former vice president of the German Zeppelin Co., as a family of quad-rotor helistats for transporting passengers and cargo in developing nations at speeds significantly faster than traditional airships.

In the mid-1990s, Bothe filed a European patent application for two semi-buoyant hybrid aircraft concepts. One design had a broad fuselage shape approximating that of the Helitruck, and four thrust vectoring propellers resembling the arrangement on a semi-buoyant Goodyear Dynastat. A second design used an array of lift fans in place of the thrust vectoring propellers.

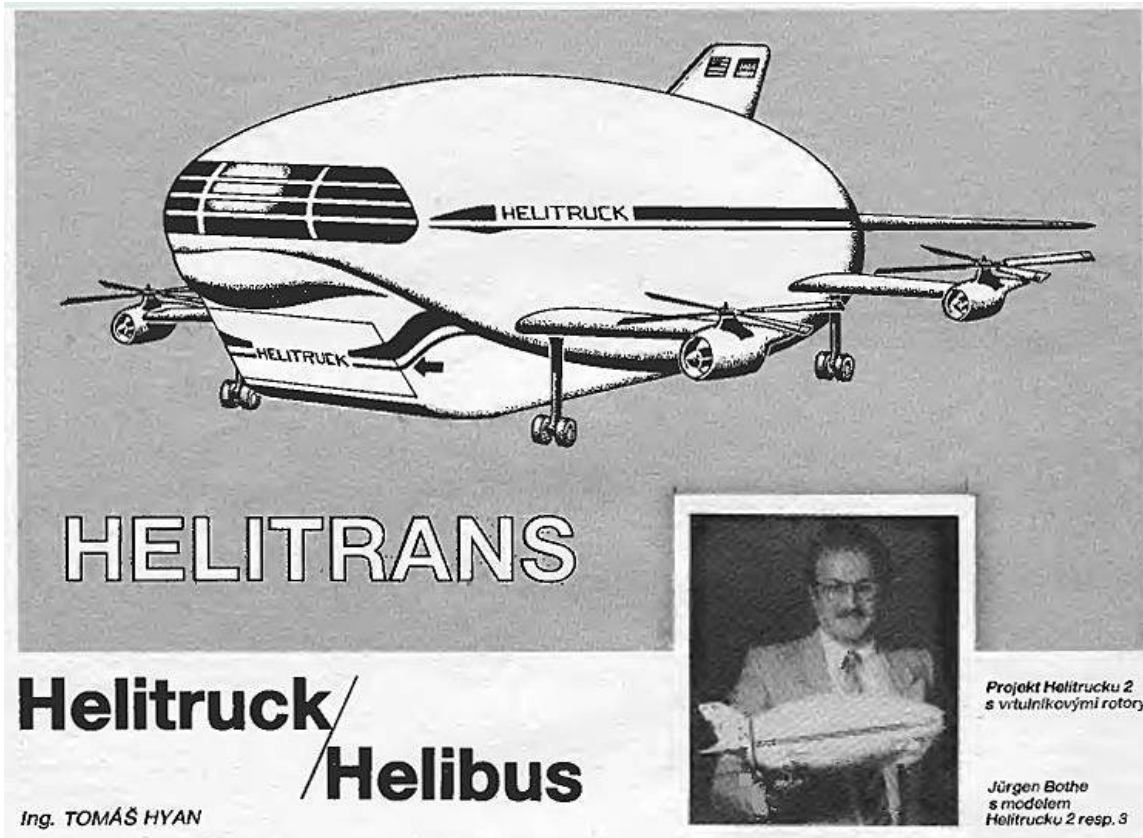
This article will address these three design concepts by Hans-Jürgen Bothe.

2. Bothe Helitruck (circa early 1980s)

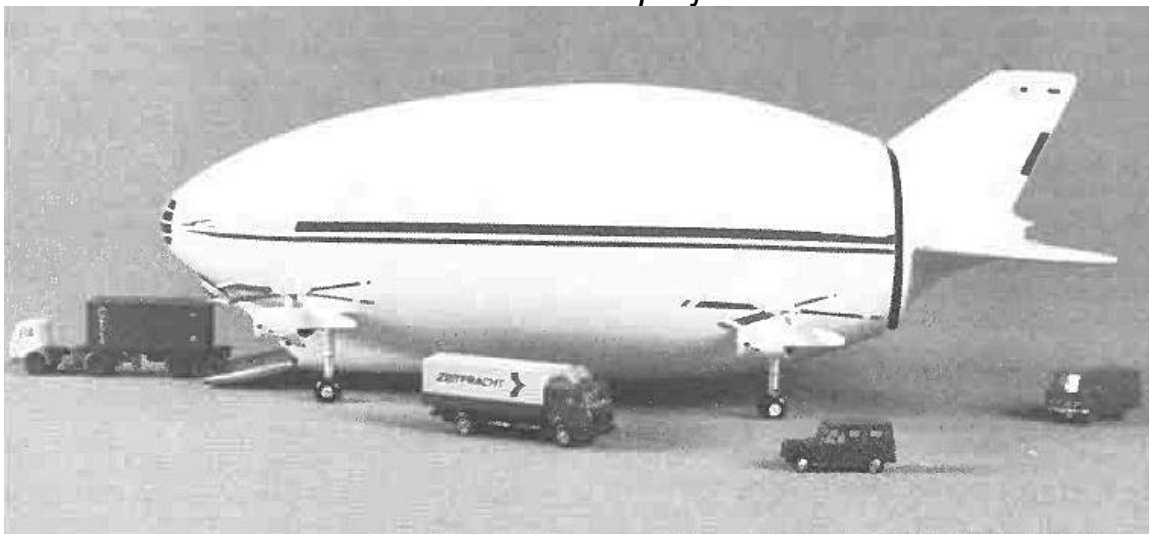
The Helitruck was a wide-body, streamlined, four-rotor helistat. This multi-purpose, vertical takeoff and landing (VTOL) / short takeoff and landing (STOL) transport was designed to support a wide range of applications, such as:

- Providing short-haul passenger transportation
- Providing short-haul heavy-lift transportation
- Hauling large volumes of low density cargo
- Laying pipelines
- Erecting power lines
- Transferring cargo between ships and shore
- Supplying oil platforms & transporting crews
- Serving as a search & rescue craft
- Supporting disaster recovery and related humanitarian efforts
- Harvesting timber

A Helitruck was expected to use one-half to one-third the fuel of a helicopter for similar tasks and be competitive with fixed-wing aircraft on routes of up to 400 km (about 250 miles).

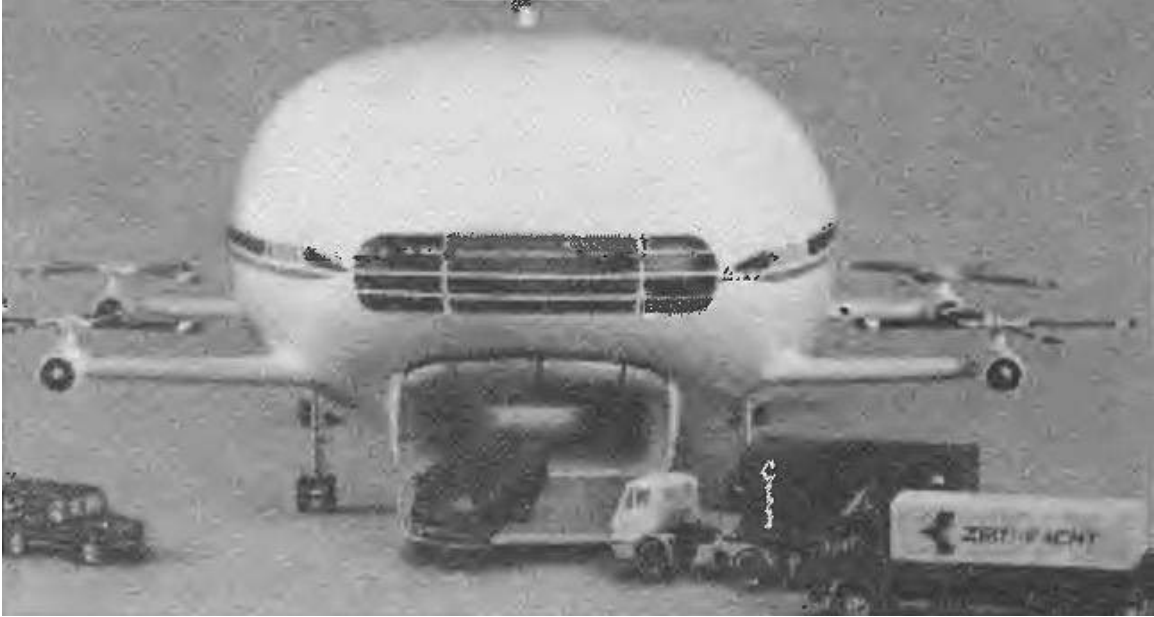


Source: Secretprojects



Side view of a Helitruck model highlighting the elliptical profile of the lifting body hull and the placement of the tandem rotors.

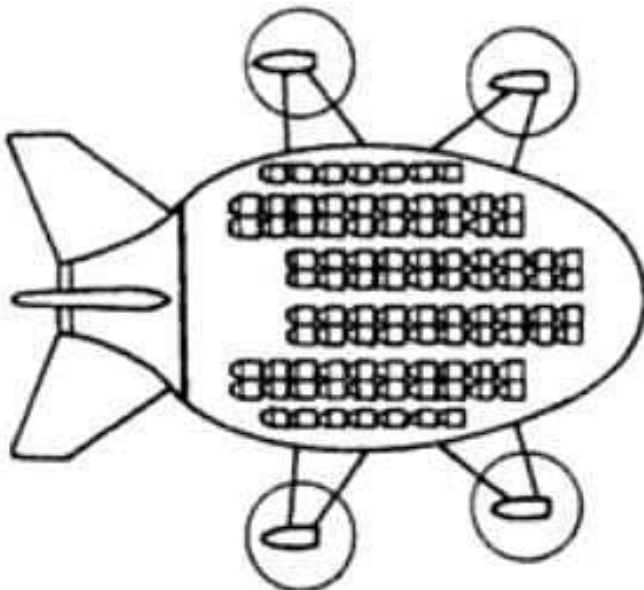
Source: Secretprojects



Bow view of a Helitruck model showing the wide-body hull and large front cargo door. Source: Secretprojects



Side view of the Helitruck payload bay open at both ends. Source: UNIDO, Section 7.5 (1983)



Example of the Helitruck's wide-body fuselage configured for high-density passenger transport. Source: Secretprojects

Development of the Helitruck

The Helistat was being developed by the German firm Helitrans Hybrid-Flugzeugbau GmbH and its US counterpart Helitrans Inc. Initial funding was provided by the West German government, through the Gesellschaft für Technische Zusammenarbeit (GTZ) in Frankfurt, and GeoVenture of Moerfelden/Walldorf. Jürgen Bothe was the president of Helitrans Inc., which was a subsidiary of Unsworth Transport International, Inc. (UTI) of New York.

Initial tests of a one-sixth scale, remote controlled model in Frankfurt yielded favorable results. The model has a length of 6 meters (19.7 ft) and a weight of 75 kg (165 lb).

The next stage was to be a 35 m (114.8 ft) long prototype capable of lifting a 5,000 kg (11,023 lb) payload in VTOL mode and 7,000 kg (15,432 lb) in STOL mode. In October 1982, the UPI reported that a “A half-scale model of one version of the airship, called the Helitruck, will be built by a subsidiary of Westinghouse Electric Corp. at Elizabeth City, NC, in the coming year.” The subsidiary would have been Westinghouse Aircraft, Inc., which had facilities at the Weeksville Naval Air Station near Elizabeth City, NC.

A model of the Helitruck was displayed at the 1984 Hanover Air Show in Germany.

Basic design features of the Helitruck

The Helitruck had a rigid structural frame with semi-rigid shell and skin made of Dupont's Kevlar, Tedlar and Dacron fabrics.

- Aerostatic lift from a lift gas volume in the top of the large volume hull carried 95% of the helistat's empty weight.
- Dynamic lift from the four turbo-shaft engine powered helicopter-style rotors carried the full weight of the payload plus 5% of the empty weight plus the weight of the crew and fuel. Dynamic lift enabled VTOL and STOL operations and hovering in wind speeds up to 50 kph (31 mph).
- Aerodynamic lift in forward flight was generated by the wide, lifting body hull, which had a lift-over-drag ratio of $L/D = 6$.

Aerodynamic lift unloads the rotors during forward flight. A gas turbine powered ducted fan in the tail provided propulsion.

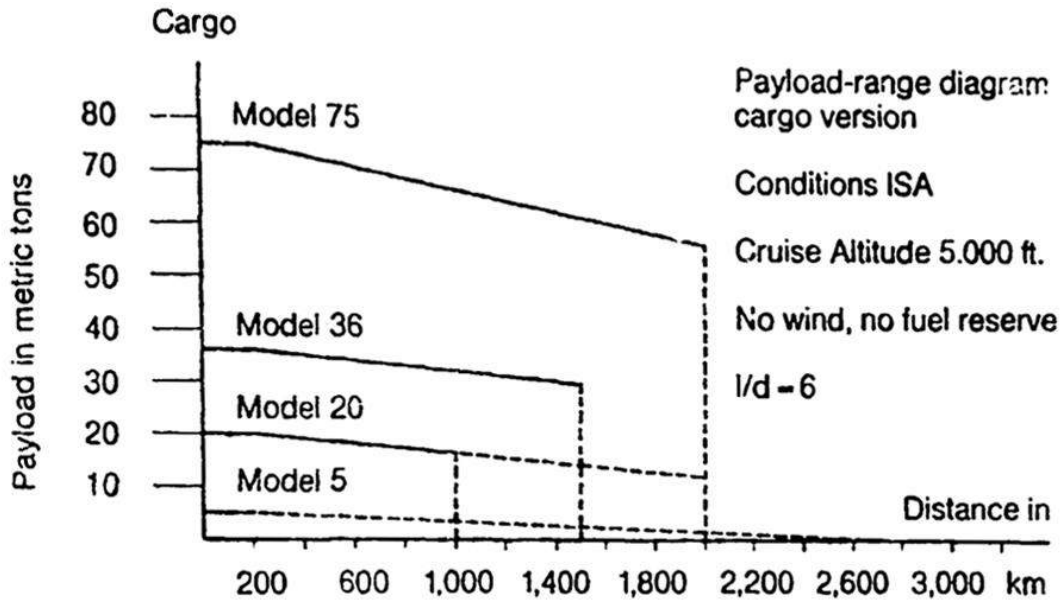
The Helitruck was designed to operate from unprepared sites with no ground support infrastructure. The four-wheel retractable landing gear was supplemented with a central anchor. When the anchor was deployed, an unloaded Helitruck was designed to swivel on its anchor in winds stronger than 20 kph (12 mph) and point into the wind.

Helitruck models

There were four basic models of the Helitruck with useful loads ranging from 5 to 75 metric tons: Helitruck 5, 21, 36 and 75.

Parameter	Helitruck 5	Helitruck 21	Helitruck 36	Helitruck 75
Gross weight, kg / lb	12,000 / 26,455	42,000 / 92,594	72,000 / 158,733	150,000 / 330,693
Empty weight, kg / lb	7,000 / 15,432	21,000 / 46,297	36,000 / 79,366	75,000 / 165,347
Helium volume, m ³ / ft ³	6,300 / 222,482	18,900 / 667,447	32,400 / 1,144,195	67,500 / 2,387,740
Helium lift at STP, kg / lb	6,678 / 14,722	20,034 / 44,167	34,344 / 75,716	71,550 / 157,741
Useful load, kg / lb	5,000 / 11,023	21,000 / 46,297	36,000 / 79,366	75,000 / 165,346
At range, km / mile	2,500 / 1,553	1,000 / 621	1,000 / 621	2,000 / 1,242
Payload, Kg / lb	1,604 / 3,536	18,765 / 41,370	31,367 / 69,373	56,711 / 125,026
At cruising speed, kph / mph	200 / 124	200 / 124	200 / 124	220 / 136
<ul style="list-style-type: none"> • Useful load is the difference between the gross weight and the basic empty weight. It includes the flight crew, usable fuel, drainable oil, if applicable, and payload. • Payload is the weight of the passengers, cargo, and baggage 				

Source: Adapted from Helitrans Consulting, "The Helitruck VTOL Cargo Mover," via UNIDO (1983)



Helitruck "payload / range" (actually useful load / range) diagram. Source: Helitrans Consulting, "The Helitruck VTOL Cargo Mover," via UNIDO (1983)

The Helitruck 5 would be well suited for commuter service with about 50 passengers. It also would be useful in light industrial roles such as resource exploration and prospecting, border patrol, and pipeline / electric power line inspections.

The Helitruck 36 had a large cargo bay measuring 36 m (118 ft) length x 5.4 m (17.7 ft) width x 3 m (10 ft) height. It was well suited for low density cargos such as fruit and cotton. Front and rear cargo doors enabled quick and easy "roll-on/ roll-off" (Ro-Ro) loading and unloading.

The Helitruck 75 was the largest model, with a length of 85.3 m (280 ft.) It could carry 700 passengers or a maximum payload of almost 57 metric tons (62.7 tons). It would be a useful heavy-lifter on large construction projects.

No Helitruck was ever built.

3. Bothe semi-buoyant hybrid aircraft (circa mid-1990s)

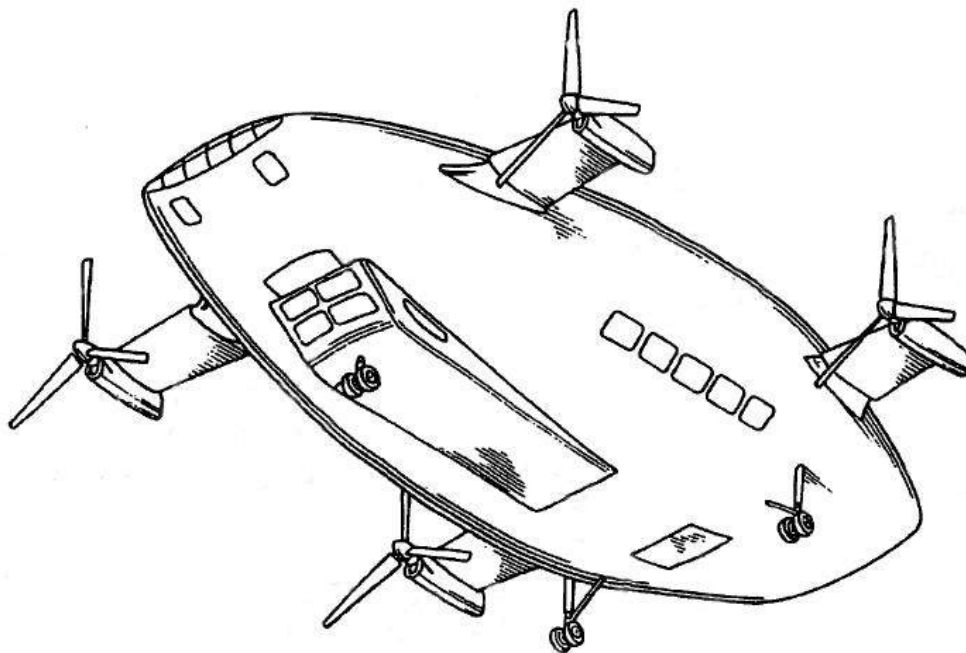
In the mid-1990s, Hans-Jürgen Bothe developed design concepts for semi-buoyant hybrid aircraft that are described in European Patent Application EP1209076A2; “Hybrid Aircraft,” which was filed on 26 October 1996 and published on 24 October 2002. You can read this document here:

<https://patents.google.com/patent/EP1209076A2>

This patent cites Bothe’s earlier German patent application DE3508101A1, “Hybrid Aircraft,” filed on 7 March 1985, for a semi-buoyant hybrid quad-rotor aircraft with a similar structural design.

Semi-buoyant, four-rotor, vectored thrust hybrid airship

One of Bothe’s hybrid airship concepts described in EP1209076A2 resembles his Helitruck design, with a broad, elliptical lifting body fuselage and short tandem wings. It also resembles a Goodyear Aerospace Dynastat, in that both are semi-buoyant airships with flank-mounted, large diameter, vectored propellers / rotors that pivot vertically for lift and return to the horizontal for cruise propulsion.



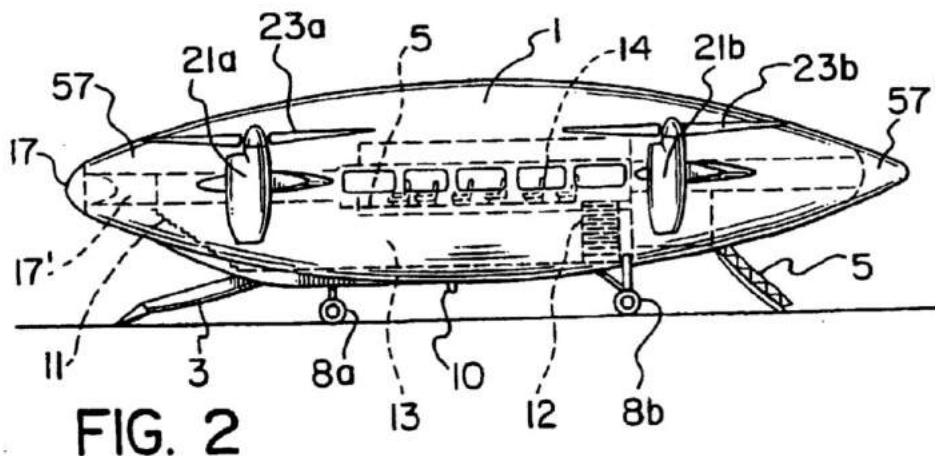
General arrangement of Bothe’s semi-buoyant hybrid aircraft with engines vectored for cruise flight.

Source: adapted from EP1209076A2

This semi-buoyant hybrid aircraft is a multi-purpose transport capable of carrying medium-payloads (5 – 50 metric tons / 5.5 - 55 tons) on short-to-medium range routes at a relatively high cruise speed (280 – 370 kph / 174 – 230 mph). The aircraft is capable of vertical and short takeoff and landing (VTOL / STOL) operations. In STOL mode, the aircraft can carry 100% to 120% more payload than in VTOL mode. In addition to serving as a cargo transport, this wide-body (hull width of 6 - 7 m / 19.6 – 23 ft) aircraft also would be useful in short haul (150 – 300 km / 93 – 186 mi), multiple stop passenger shuttle service. Other applications include slow or low flying missions, such as aerial surveying, patrolling, and search and rescue.

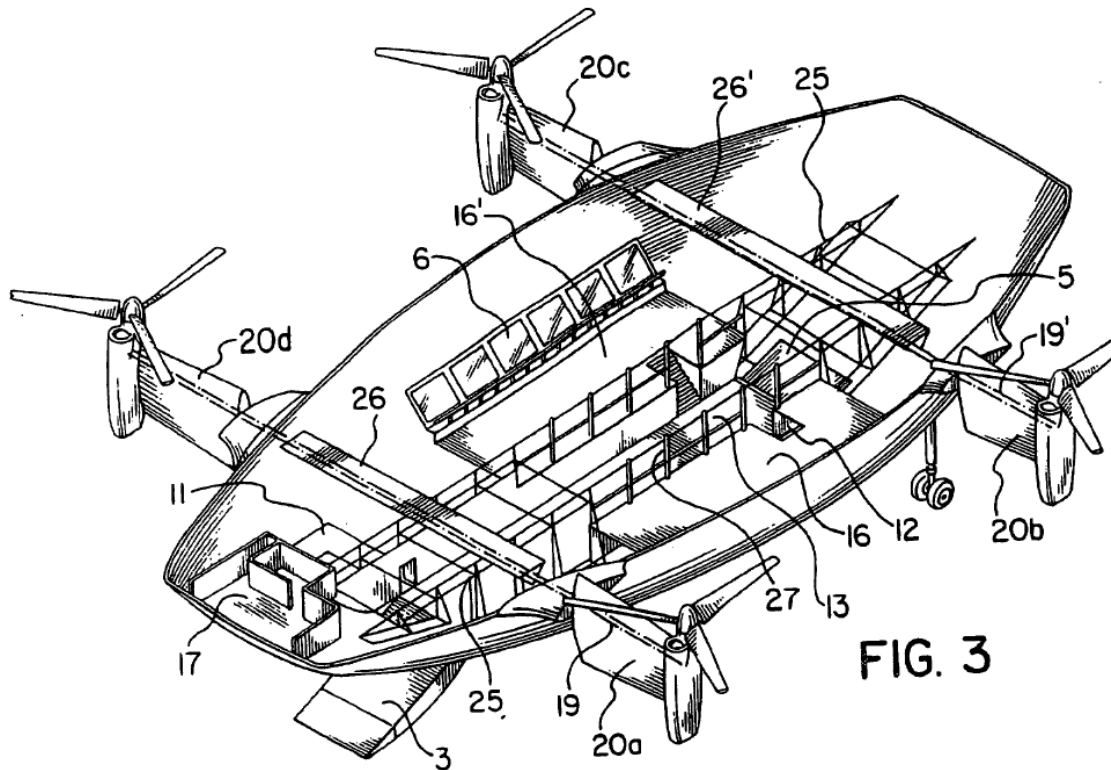
The broad lifting body hull (1) is shaped to provide aerodynamic lift in an airstream. The fuselage forms a lift gas container. In the relative voluminous upper interior portion of the hull, significant space is available for a lifting gas (helium or hot air) volume, with provisions for lifting gas heating from engine heat exchangers. The inclusion of a lifting gas would be particularly useful for VTOL operations.

The aircraft has four flank-mounted, short, pivoting wing sections (20) with engine / motor units (21) that drive large diameter propellers / rotors (23). The pivoting wing sections can be rotated and controlled collectively or individually from -10° to 90° . The engine / motor unit type is not specified, but may be a turboprop engine or an electric motor. The patent provides details for a turbo-electric power system, with the turbine engines mounted in the stern of the hybrid aircraft.



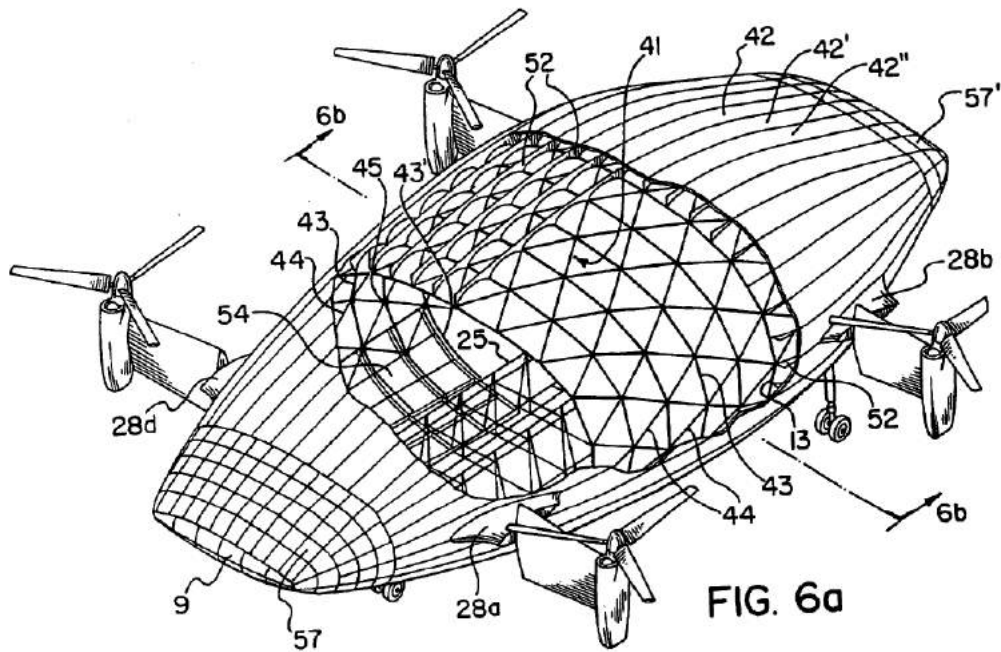
Side view highlights elliptical cross-section. Engines vectored up for lift during VTOL operations. Source: EP1209076A2

As shown in patent Figure 2, access to the internal payload area is through a bow ramp (3) and rear stairs (5). External cargo can be carried as a sling load by connecting to a cargo hook (10) that distributes external cargo loads directly to the keel.



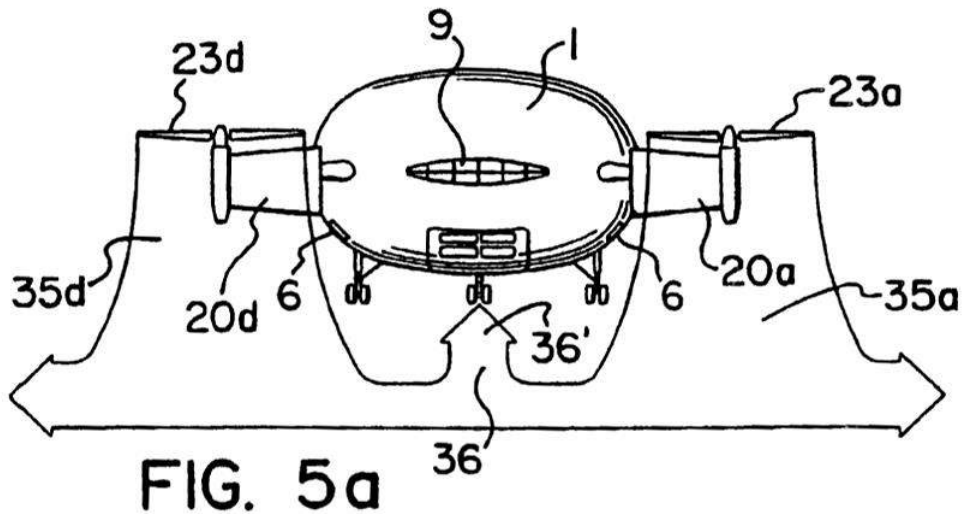
Cut-away diagram showing interior arrangement and major structural elements. Source: EP1209076A2

Patent Figure 2 shows the rigid hull structure, which consists of a longitudinal keel (25) connected to two transverse carry through beams (26, 26'), which carry the aerodynamic and propulsive loads from the pivoting wings and propellers. Engine cross-shafts (19) running through the carry through beams enable a single engine / motor to drive both propellers / rotors. The exterior shell shown in Figure 6a is formed by a pressure-tensioned space frame (41) covered with semi-rigid panels, a lower cladding frame and bow and stern cladding nose cones.



Exterior shell space frame. Source: EP1209076A2

The patent claims that, in close proximity to the ground, the aircraft benefits from a substantial ground effect derived from propulsive lift airflow, as shown in Figure 5a. The slipstream air masses (35) from each of the propellers (23) impinge on the ground and are forced outwardly and upwardly (36), the latter forming a cushion of air beneath the hull, acting upwardly to create a ground lift effect that enhances VTOL performance.

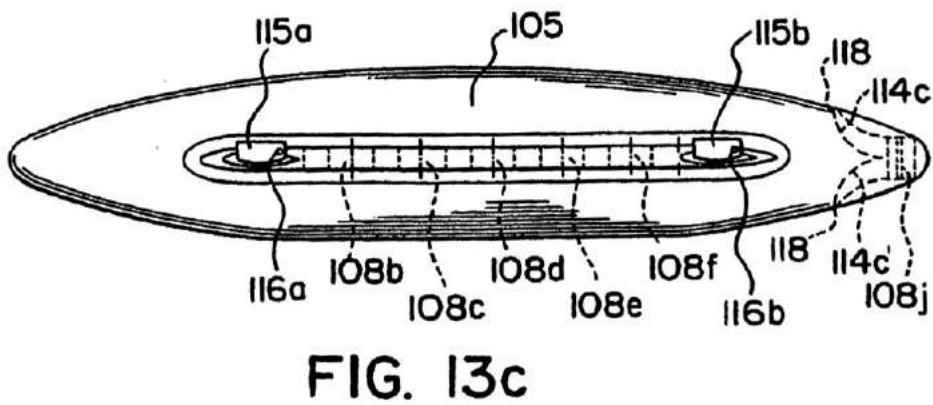
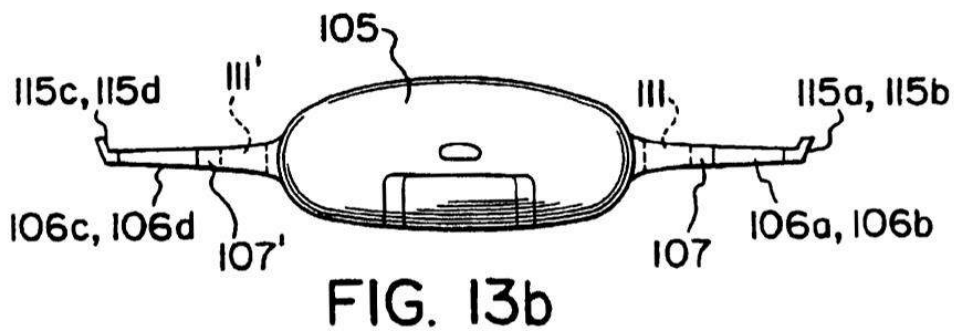
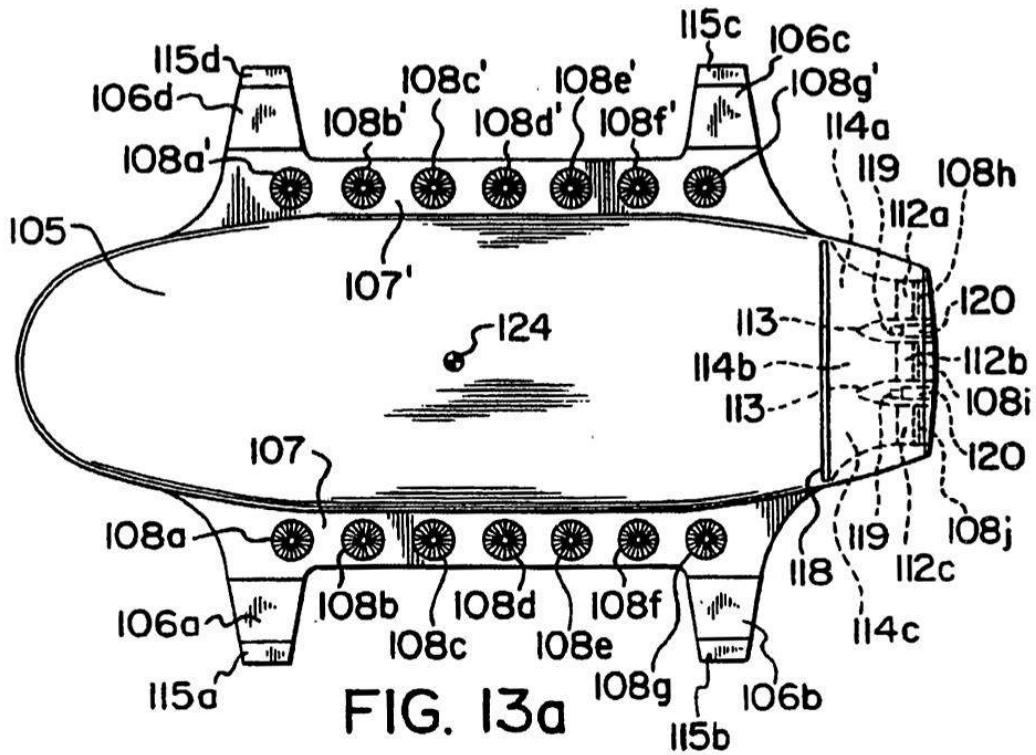


Slipstream flow in VTOL. Source: EP1209076A2

Semi-buoyant, advanced hybrid aircraft with lift fans

The advanced semi-buoyant hybrid aircraft is a more complex vehicle that splits the functions of lift and cruise propulsion. The following table provides a brief comparison to the

Hybrid Aircraft (HA)	Advanced Hybrid Aircraft (AHA)
Wide, elliptical cross section lifting body fuselage provides aerodynamic lift in forward flight	Same (105)
Tandem wings with pivoting outer sections	Tandem wings with pivoting outer sections (106, 115) for aerodynamic control
Individually controllable thrust vectoring quad propellers / rotors enable integrated control of lift and propulsion.	Arrays of 8 – 14 fixed electric motor-driven lift fans (108) in chines (107) along the sides of the hull provide 15 – 30 metric tons (16.5 – 33 tons) of dynamic lift for VTOL & STOL operations. Individually controlled thrust deflectors are mounted below the fans. Lift fans are shut down during cruise flight. Fixed engines in the stern for turbo-electric power system (113, 119) for lift fans. Fixed engines in the stern for cruise propulsion.
Cruise speed: 280 – 370 kph (174 – 230 mph)	Cruise speed: 400 kph (249 mph)
Significant space is available to accommodate static lifting gas in the upper hull volume.	The hull can accommodate a lifting gas to provide aerostatic lift up to 15% of the aircraft's maximum takeoff weight.



Three views of a semi-buoyant, advanced hybrid aircraft with lift fans.
 Source: EP1209076A2

4. For more information

Helitruck

- Anthony J. Dolman, “Current and Possible Future Developments in Lighter-Than-Air (LTA) System Technology,” Section 7.5, The Helitruck, pp. 198 - 204, United Nations Industrial Development Organization (UNIDO), 1983:
<https://open.unido.org/api/documents/4793600/download/CURRENT%20AND%20POSSIBLE%20FUTURE%20DEVELOPMENTS%20IN%20LIGHTER-THAN-AIR%20>
- “HTH Helitruck,” 13 August 2017:
<https://www.secretprojects.co.uk/threads/hth-helitruck.29319/>
- LeRoy Pope, “New Helitruck a hybrid cross of dirigible and helicopter,” UPI, 15 October 1982:
<https://www.upi.com/Archives/1982/10/15/New-Helitruck-a-hybrid-cross-of-dirigible-and-helicopter/5725403502400/>

Bothe semi-buoyant hybrid aircraft

- German patent application DE3508101A1, “Hybrid Aircraft,” filed 7 March 1985, published 11 September 1986, abstract available here:
<https://patents.google.com/patent/DE3508101A1/en?q=DE3508101A1>
- International Application WO1997015492A2 (aka WO97/15492), “Hybrid Aircraft,” filed 24 October 1996, published 1 May 1997:
<https://patents.google.com/patent/WO1997015492A2/en?q=W097%2f15492+>
- Australian patent application AU7272696A, “Hybrid aircraft,” Inventor: Hans Jürgen Bothe, filed 24 October 1996, published 15 May 1997:
<https://patents.google.com/patent/AU7272696A/zh>

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