Av-Intel Inc. - articulated Cargo Airship System (CAS)

Peter Lobner, 1 November 2024

1. Introduction

Frederick D. Ferguson, with funding from U.S. investors, founded Av-Intel Inc. in the early 1990s as a small private company in Ottawa, Canada. The firm's goal was to develop a novel, semi-rigid, articulated Cargo Airship System (CAS) design concept that Ferguson had invented and patented. The airship is comprised of a nose section with the cockpit and propulsion system, one or more intermediate sections carrying the payload, and a tail section with aerodynamic control surfaces. Articulated joints between each section enable the airship to bend in response to varying gust loads and thereby reduce the overall structural loads on the airship.

Rendering of Av-Intel's Cargo Airship System (CAS) with six articulated sections for flexibility in flight. Note the propulsors along the lower portion of the nose section, flanking the cockpit under the nose. The intermediate sections sit on individual mooring pads. The tail section has three fins with control surfaces in an inverted-Y configuration. Source: Magenn Power

Ferguson previously had invented and patented another novel airship design, this one a rotating, spherical, hybrid airship known as the LTA 20-1, which was under development in the 1980s by the Canadian firm Magnus Aerospace Corporation. In about 2005, Ferguson launched another Canadian venture, Magenn Power, Inc., to develop his patented tethered airborne wind turbine, which was known as the Magenn Airborne Rotor System (MARS).

Jane's All The World's Aircraft reported that Pan Atlantic Aerospace Corporation (a subsidiary of Av-Intel) was involved in several lighter-than-air (LTA) projects, including the CAS project. Jane's further reported:

> "Patents for the CAS were purchased by an aerospace group in Texas in December 2002; an 80 ton payload airship development program has started, with completion of a first article scheduled for late 2004."

An articulated CAS was never completed. Nonetheless, it remains an intriguing LTA design concept.

2. Technical background

On the Magann Power archived website, the firm provided the follow technical description of Fred Ferguson's Av-Intel articulated airship design:

> "Av-Intel's research has shown that a modern long fineness ratio airship is substantially more load and cost efficient than equivalent payload shorter blimp-like airships. However, history has shown that all past long fineness ratio rigid airships had inherent structural inadequacies, many resulting in catastrophic failures. The Av-Intel series of airships has correctly analyzed and isolated the inadequacies of the past era. The Av-Intel airship design advances the current state-of-the-art for ultra-large pressure airships. The overall result is a fineness ratio in excess of 8:1, which provides a minimal cross-section and cost relative to load capability."

> "The new Av-Intel airships encompass an advanced new technology that divides the long cigar-shaped airship into sections or segments that act similar to a huge shock absorber. In simulation studies contracted to the Lockheed Advanced Development Corporation, Av-Intel's design proved to exceed the current requirements for safety and gust loading by a broad

positive margin. Other contractual analysis included extensive loads-versus-economic analysis utilizing the Texas A&M wind tunnel, structural envelope design evaluation at France's CNES, and Froude similarity scale model flying prototypes, the latest of which have been tested to 10,000-ft (3,048-m) altitude. Commercial market studies were conducted by Federal Express and American President Lines, which show the Av-Intel Cargo Airship efficiency is based upon projected technical and economic performance features."

"The Av-Intel airship patents also include the correct positioning of propulsion for controlled low speed flight, and precision low speed crosswind maneuvers. The propulsion design includes off-the-shelf technologies and does not require new rotational or gear box systems. The first commercial prototype planned is similar to the aerodynamic design of the historical US dirigible, '*The Shenandoah'* (which had a fineness ratio of 8.6) and will be built for a net payload of 40 tons. The larger airship sizes, as anticipated by the past FedEx-LADC assessment, include net payloads up to 500 tons."

Rendering of Av-Intel's Cargo Airship System (CAS) in FedEx livery. Source: Magenn Power

3. Patent

Fred Ferguson's patent, US5348251A, describes a self-powered, elongated, semi-rigid airship comprising three different types of sections: a nose (front) section with a propulsion system and controls, at least one intermediate section to carry a payload but without propulsion, and a rear section with aerodynamic control surfaces. Each section has a lifting gas cell and ballonets.

When this airship is subjected to substantial transient bending moments (i.e., because of external gust loads), it is designed to bend at the articulated joints located between each section. Accordingly, the individual sections of the airship are not subjected to very large bending moments or compressive forces under gust loading conditions.

The flexibility of the elongated hull is achieved by connecting all sections end-to-end with a rigid beam running along the central axis of the airship, with universal joints between each section. In addition, adjacent sections are joined around their outer peripheries by extensible cables that control the amount of hull flexing between sections and return the hull to an aligned state when the transient external load is gone.

In the nose section, engine loads (deadweight, thrust) are supported by internal rigid structures that are connected to the rigid beam running along the central axis, and are braced with lateral and longitudinal cable stays.

A flexible skin may be installed to provide a streamlined exterior shape for the airship. Alternatively, the sections may have rims that mate together when there is no articulation to provide an aerodynamically smooth exterior shape.

The patent describes thee different implementations of an articulated, high aspect ratio airship design. Two are described in the following text.

As shown in patent Figures 1 and 12, the first embodiment of the articulated airship comprises five sections, a nose section, three intermediate sections and a tail section, all circular in cross-section.

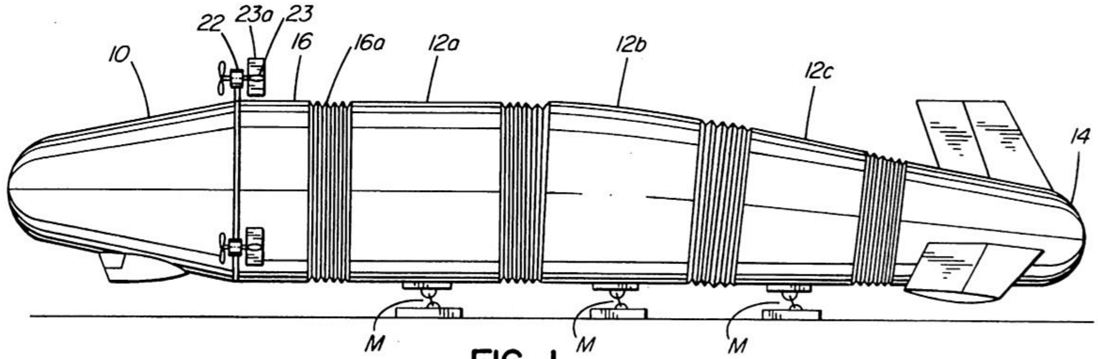


FIG. 1

Exterior side view of 5-section articulated airship

Legend
A 5-section airship comprised of a nose section (10), three intermediate sections, (12a, b, c) and a tail section (14). An outer cover installed between the sections may be smooth (16) or bellows-like (16a). Independently-controlled fixed engines (22) have thrust-deflecting rudder & aileron control surfaces (23, 23a) in the propeller slipstreams. Each of the intermediate sections has a mooring fitting (M).

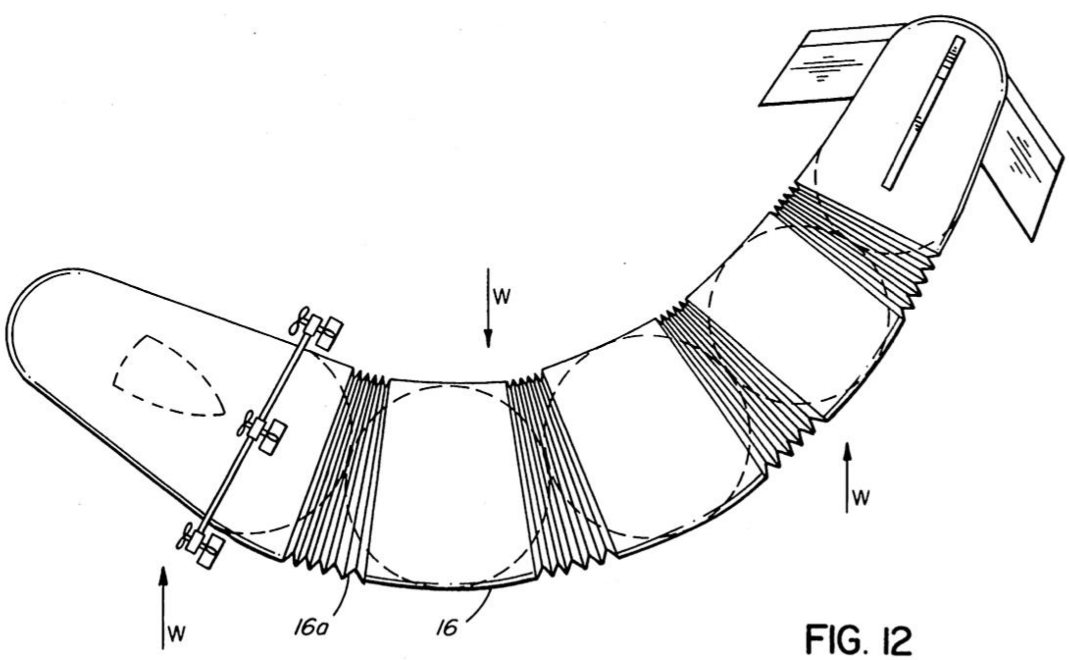


FIG. 12

Overhead view of articulated airship bending in response to a cross-wind.

The airship is held together end-to-end by a rigid, hollow, axially extending structural member (18a to 18e) along the axis of each section, with adjacent ends of the structural members being connected by universal joints. The degree of articulation between sections is controlled by extensible cables (70), which may be elastic or winch-operated.

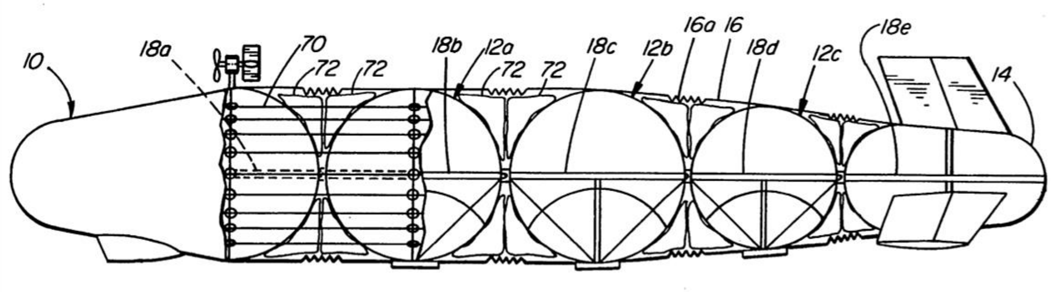
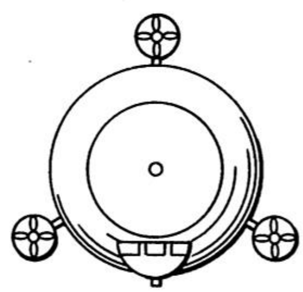


FIG. 3

Cutaway view showing the internal structure of the 5-section articulated airship.

Legend
Axial structural members (18a to 18e) with universal joints, extensible cables (70) connecting sections at their peripheries, several large spherical higher-pressure helium cells (50), each containing two ballonets (60), lower-pressure annular helium cells (72) accommodate helium movement during hull flexing. In the intermediate sections, the axial structural members are connected by vertical struts (52) to a load carrying bracket (54) suitable for attaching an external payload under the section. Support cables (59) connected to the axial structural member (18b to 18d) transmit these loads into the upper section of the spherical gas cells.

FIG. 2



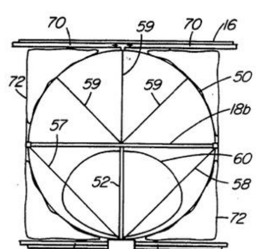


FIG. 7

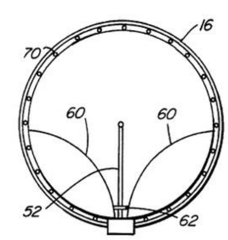
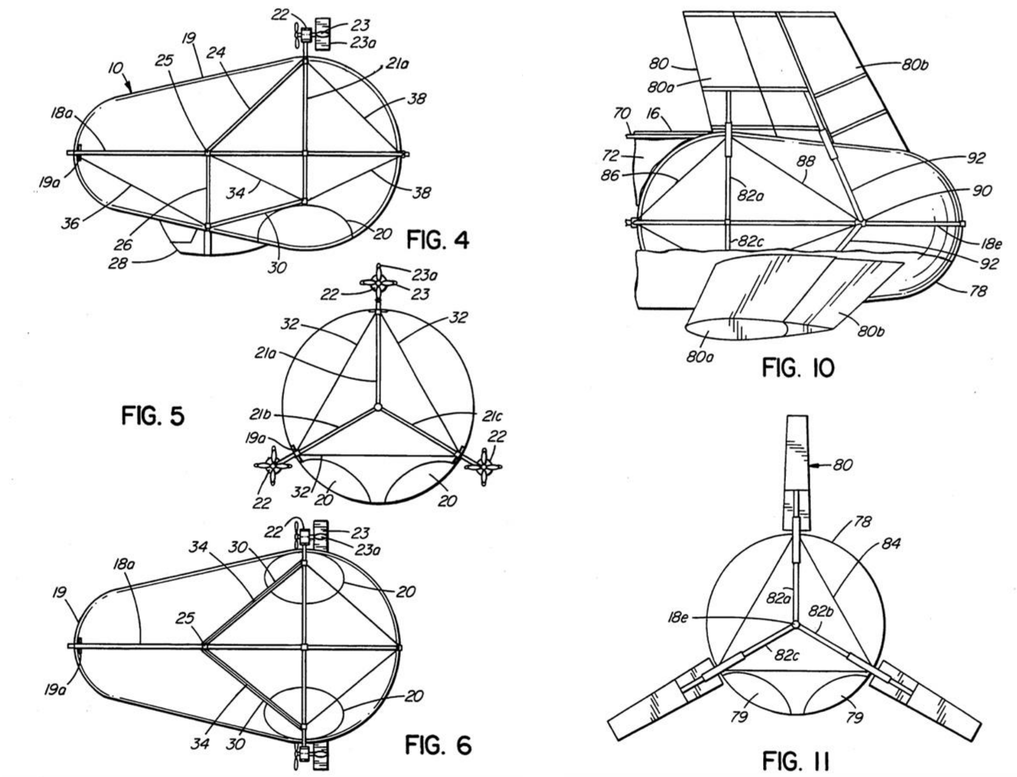


FIG. 8

(L) Exterior bow view, (Mid) longitudinal section showing a spherical gas cell and ballonet, (R) Transverse section of a spherical gas cell and ballonet.

The spherical helium cells (50) are designed to operate at a pressure of about 10 millibars or about 0.157 psi, with two internal air ballonets (60) to maintain helium pressure within desired limits with ambient air supplied by a compressor and vented with a control valve.

The nose and tail sections also include helium cells and ballonets. The small cockpit is tucked under the nose. The three tail planes in an inverted-Y configuration have movable control surfaces that function as “ruddervators,” combining the functions of elevators & rudder.



(L) Nose section: side view (Fig. 4), transverse section thru engines (Fig. 5), longitudinal section thru lower engines (Fig. 6).
(R) Tail section: side view (Fig. 10), transverse section thru tail planes (Fig. 11)

<u>Legend</u>

Nose section *(10) with a cockpit (28), independently-controlled fixed engines (22) with thrust-deflecting rudder & aileron control surfaces (23, 23a) in the propeller slipstreams, lifting gas cell (19) and two ballonets (20). The engines and cockpit are supported by braced structural frameworks (21a, b, c, 24, 26, 20, 3234, 36, 38).*

Tail section *(14) has three tail planes in an inverted-Y configuration, each with a fixed part (80a) and a movable control surface (80b), a lifting gas cell (78) and two ballonets (79). The tail planes are supported by a braced structural framework (82a, b, c, 84, 92)*

The larger second embodiment of the articulated airship shown in patent Figure 13 and 15 comprises six sections with aerodynamically refined junctions between sections enclosed by outer cover portions or skirts to maintain a streamlined shape. This is the design shown in the renderings of the AV-Intel Cargo Airship System in Section 1.

The cylindrical helium cells (115) have circumferential and longitudinal reinforcements to permit operating at a pressure of about 10 millibars or about 0.157 psi. There are two ballonets in each helium cell.

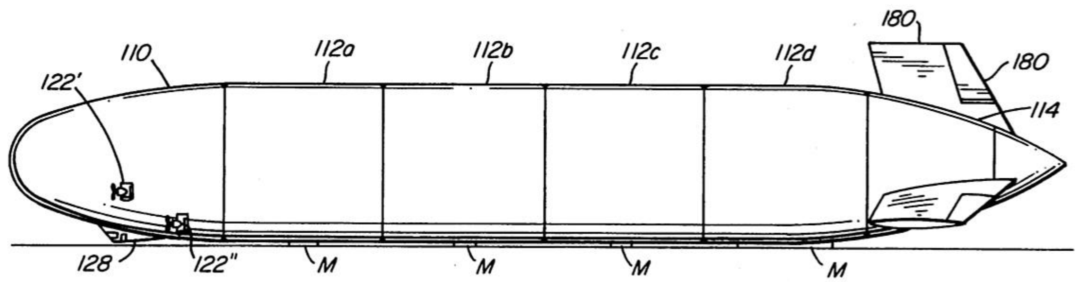


FIG. 13

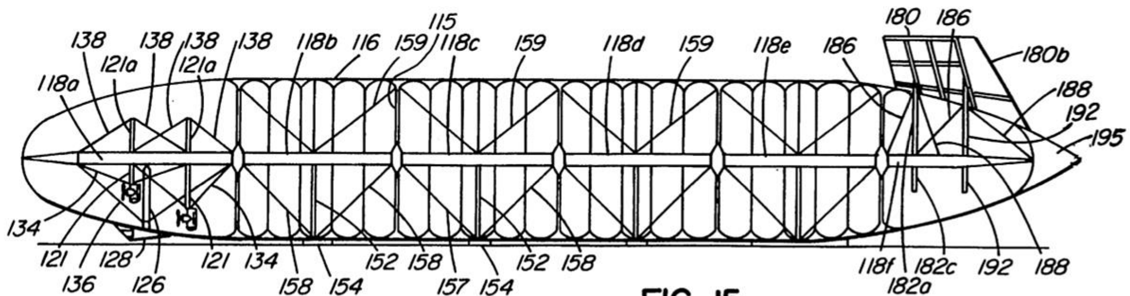
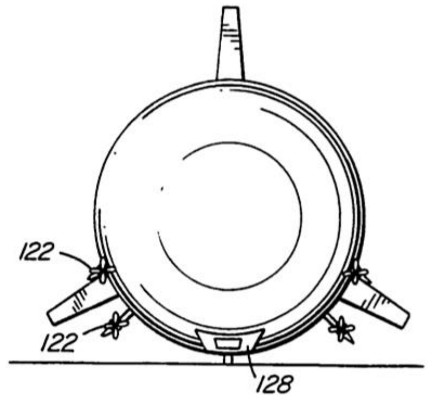


FIG. 15

Top: Exterior side view of 6-section articulated airship
Below: Cutaway view showing the internal structure

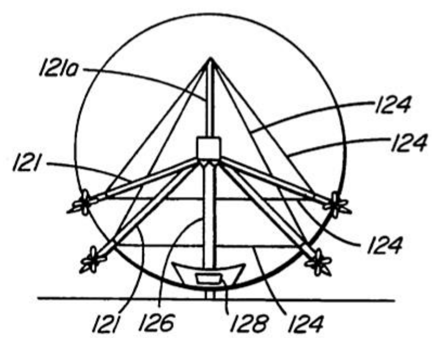
Legend
Exterior view *of airship with 6 sections (110, 112a – 112d, 114), engines (122), tail planes (180) and mooring fixtures (M).*
***Cut-away view**: axial structural members (118a to 18f), radial structural members supporting the engines (121) that are stayed by fore & aft cables (134,138) and lateral cables (not shown), cockpit support girder (126), cockpit (128). In the intermediate sections, the axial structural members are connected by vertical struts (152) to a load carrying bracket (154) suitable for attaching an external payload under the section. Support cables (159) connected to the axial structural member (118b to 118e) transmit these loads into the upper section of the cylindrical gas cells.*

FIG. 14



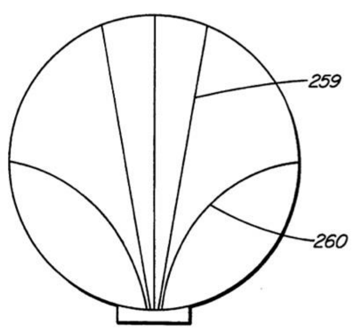
(Top) Exterior bow view showing four engines (122) and the gondola (128) in the nose section. The engines have movable flaps in their slipstreams for a thrust-vectoring capability.

FIG. 16



(Mid) Transverse section showing the support structure for four engines and the gondola. The engines are supported by radial members (121) that are stayed by lateral cables (124) from kingpost (121a) and fore and aft cables (not shown here). The gondola is supported by a girder (126) with cable stays.

FIG. 19

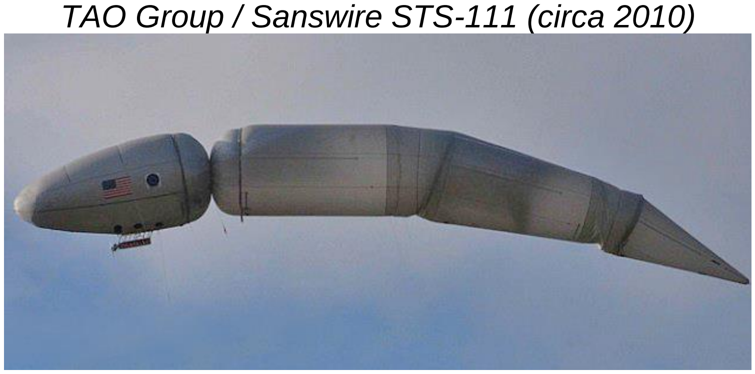


(Bottom) Transverse section thru a helium cell showing the ballonets (260) and some of the many cables (259)that maintain the external dimensions of the section.

4. Other flexible segmented airships

Three non-rigid segmented airships have been flown by two airship developers, Tao Group and Sanswire / WSGI. The Tao Group developed the STS-111 and later teamed with Sanswire. After the teaming agreement expired, Sanswire, and its successor WSGI developed the Argus One, based on the STS-111. Meanwhile, Tao Group developed its giant SkyDragon. These airships are described in more detail in separate articles in my *Modern Airships* series.

TAO Group / Sanswire STS-111 (circa 2010)



Sanswire / WSGI Argus One (circa 2011)

TAO Group SkyDragon (circa 2018)

5. For more information

- “About Magenn Power,” (Magenn Power website includes a history of founder Fred Ferguson, including Av-Intel Inc.), circa 2010: https://web.archive.org/web/20081216034041/http://www.magenn.com/about.php
- “Pan Atlantic Aerospace Corporation (Subsidiary of Av-Intel Corporation),” Jane’s All The World’s Aircraft, circa 2002: https://janes.migavia.com/ca/pan-atlantic.html

Patents

- US5203523A, “Dirigible airship,” Inventor: Frederick D. Ferguson, Filed 9 September 1991 as application US75705991A, Granted 20 April 1993, abandoned (no link)
- US5348251A, “Dirigible airship,” Inventor: Frederick D. Ferguson, Filed 5 April 1993 as application US08/043158 (as a continuation of application US75705991A), Granted 20 September 1994, Current assignee: Jacquelyn Baumberg: https://patents.google.com/patent/US5348251A/en
- RU2087378C1, “Airship,” Inventor: Frederick D. Ferguson, Filed 9 September 1992 as RU94022475A, Granted 20 August 1997: https://patents.google.com/patent/RU2087378C1/en

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/
    - Magenn Power Inc. – Fred Ferguson’s Magenn Air Rotor System (MARS)
    - Magnus Aerospace Corp. – Fred Ferguson’s LTA 20-1
    - Sanswire and World Surveillance Group Inc. (WSGI) - *Argus One* segmented airship
    - TAO Group - STS-111 and *SkyDragon* segmented airship
- *Modern Airships - Part 3*: https://lynceans.org/all-posts/modern-airships-part-3/