21st Century Airships & Techsphere spherical airships

Peter Lobner, updated 10 March 2022

1. Introduction

Hot air balloon and airship entrepreneur Hokan Colting founded 21st Century Airships, Inc. in 1988 in Newmarket, Ontario, Canada, with an original goal of developing a non-rigid airship that was simpler to operate with a smaller ground crew than contemporary blimps.

His early efforts focused on a spherical airship design concept, which he patented in Canada and the US, and with which he set several airship altitude records, some of which still stand in 2021. 21st Century Airships licensed Techsphere Systems International LLC (TSI) in 2002 to manufacture spherical airships. TSI built several large prototypes under their trademarked name AeroSphere™ and conducted flight tests for potential commercial (Sanswire), government (Department of Homeland Security) and military (Navy and Army) customers. No version of the spherical airship entered production. TSI was acquired by Cyber Defense Systems, Inc. on 20 September 2005. TSI and their parent company, Cyber Defense Systems, Inc., are no longer in business.

In 2004, Colting and 21st Century Airships started development of a more conventional-looking, non-rigid airship design they had patented in 1994. For more information on this airship, see my separate article on 21st Century's Voyager airship.

In this article, we'll take a look at Colting's spherical airships.

2. 21st Century Airships spherical airships

21st Century Airships identified the following advantages of spherical airships:

- A sphere has the minimum surface area for a given volume. Since surface area is proportional to envelope weight, a spherical shape can generate maximum static lift with minimum weight.

- A spherical airship uses fast-acting active propulsors for precise, nimble airship control and propulsion. Slow-acting, conventional aerodynamic control surfaces (elevator / rudder) are not used.
- A spherical airship is more stable in changing wind conditions than conventional cylindrical airships (i.e., presents the same cross-sectional area regardless of wind direction).
- A spherical airship can be moored by tying it to the ground without using a mooring mast to point the airship into the wind.
- A spherical high-altitude airship is more stable during ascent than conventional cylindrical airships (i.e., lift gas stays at the top of the sphere and has less mobility within the envelope).
- Without a gondola, a spherical airship can land in water.

SPAS-4 in 1996 painted as a baseball for the Atlanta Braves baseball team and the Atlanta Olympics. Note the interior cockpit at the bottom of the sphere. The port engine and slipstream deflector vanes are a prominent feature at the "equator" of the spherical envelope. Source: Pinterest

Spherical airship patents

Hokan Colting's key patents for spherical airships are:

- **CA2391252C**, "Airship and method of operation," which was filed in Canada on 25 June 2002 and granted on 10 August 2010. You can read this patent here: https://patents.google.com/patent/CA2391252C/en?oq=%2320050173591
- **US2005/0173591A1**, "Airship and method of operation," which was filed in the US on 24 November 2003 and granted on 22 November 2005. You can read this patent here: https://patents.google.com/patent/US20050173591A1/en?oq=%2320050173591

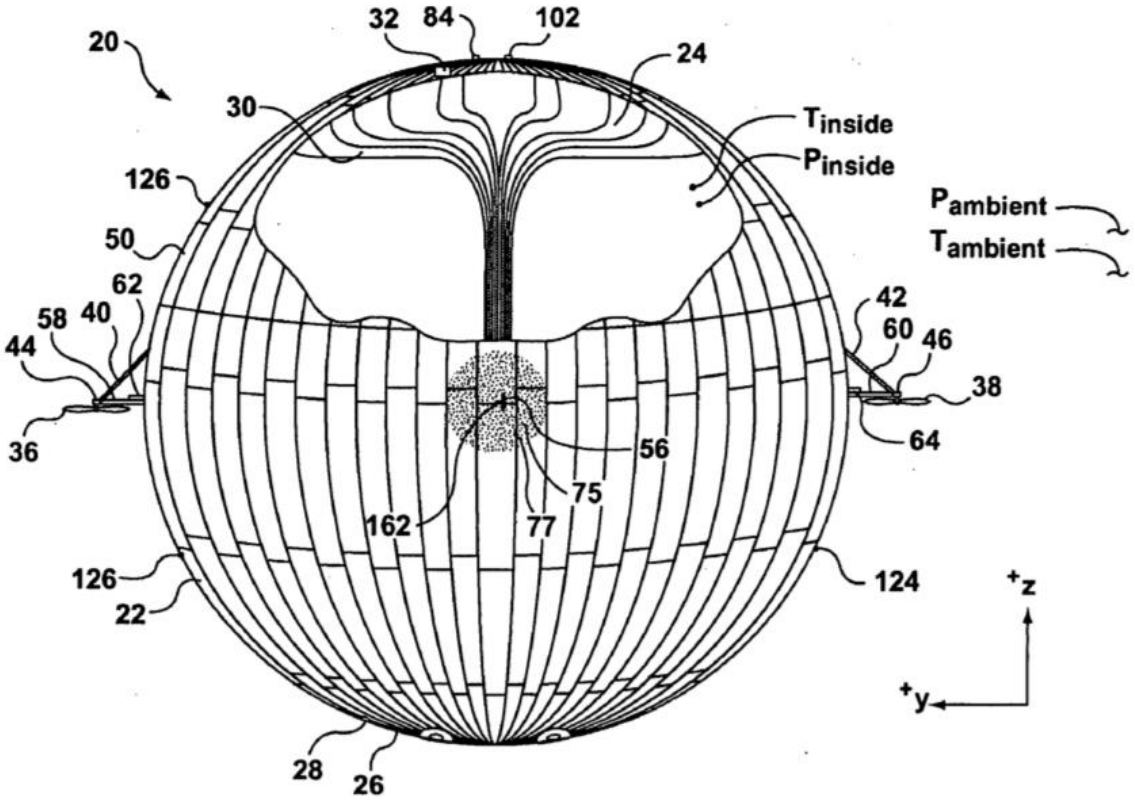


FIG. 1a

With reference to US patent Figure 1a, the spherical airship (20) consists of a load bearing outer envelope (22) made of high-strength

fabric, which is inflated by electric blower (26) that establishes the positive pressure (P_{inside}) needed to maintain the airship's spherical shape. This pressurized volume functions as a ballonet. The pilot, passengers and equipment are carried inside this ballonet volume, at the bottom of the sphere. This results in the center of gravity being well below the center of buoyancy, thereby improving airship stability. The pilot and passengers enter this volume through a simple airlock. The mechanical integrity of the outer envelope is protected from overpressurization by a relief valve (28).

US patent Figure 1a shows a partially inflated lifting gas envelope (24, 30) at the top of the sphere, as it would be at sea level with the airship trimmed for neutral buoyancy. The initial charge of lifting gas establishes the service ceiling (the pressure altitude) that the airship can reach before the inner gas envelope is fully expanded within the outer envelope. Details are in the following table.

Initial % of maximum inflation	Inflation factor to reach max. inflation	Service ceiling (pressure altitude)
70	1.4	10,000 ft / 3,038 m
50	2	18,000 ft / 5,486 m
25	4	35,000 ft / 10,668 m
20	5	40,000 ft / 12,192 m
10	10	50,000 ft / 15,240 m
7.5	13.3	60,000 ft / 18,288 m
5	20	70,000 ft / 21,336 m

Of course, a much heavier payload can be carried to a lower service ceiling than to a higher service ceiling.

Propulsion is provided by cantilevered, electric motor-driven, variable speed / reversible propellers (36, 38). These may be fixed or equipped with thrust deflectors. An additional pusher propeller may be installed on the trailing hemisphere to help suppress boundary layer separation in that region and improve airship stability.

Power is provided by a hybrid electrical system supplied by a solar array (50) on the hull of the airship and/or an auxiliary power unit (i.e., a turbo-diesel generator) in the ballonet volume.

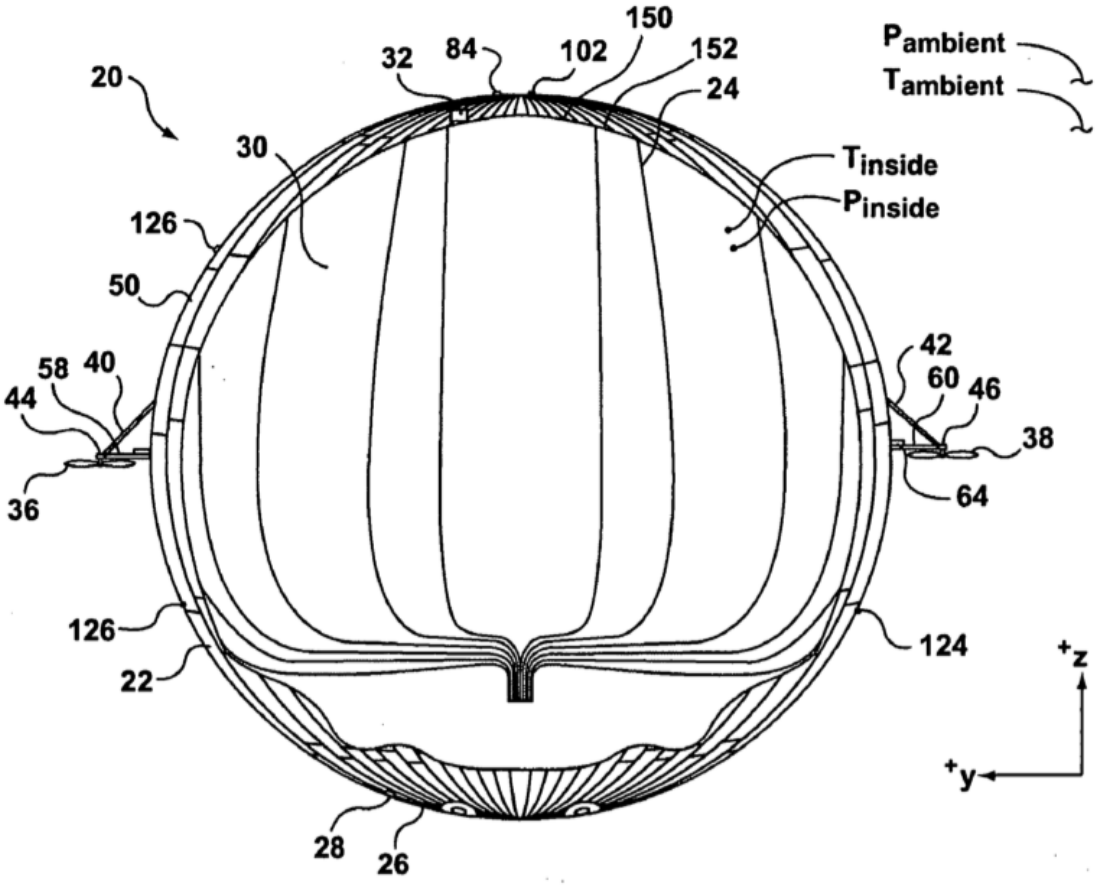


FIG. 1b

US patent Figure 1b shows the inner lifting gas envelope (24, 30) expanded to its maximum extent, filling the inner volume except for the lower portion (the ballonet) containing equipment, the pilot and passengers. The airship may carry an optional pressurized lift gas reservoir to replenish leakage, thereby enabling long-duration flights. If needed, maximum altitude can be controlled with a lift gas dump valve (32) or an optional lift gas compression system that, together with the lift gas reservoir, establishes a limited capacity variable buoyancy control system.

For low altitude manned operation, helium is the preferred lift gas. For high-altitude operation as an unmanned drone, hydrogen is the preferred lift gas.

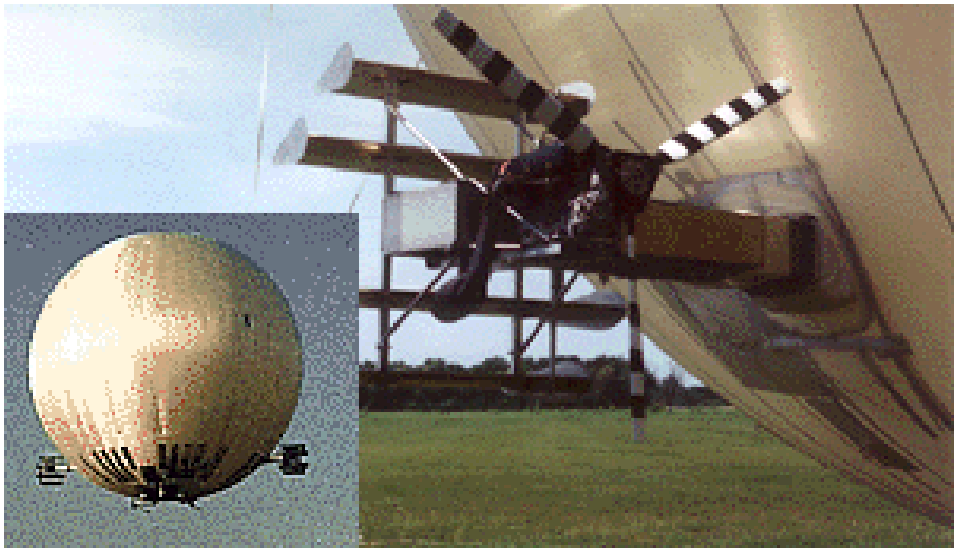
Airship altitude records

Between 1992 and 2003, Colting established a series of world altitude records for airships, culminating on 12 June 2003 with a flight in a spherical airship (designated SPS 62.5) with crew member Tim Buss to the current FAI-ratified world record altitude for airship subclass BA (non-rigid, gas airship, blimps) of 20,435 feet (6,234 meters). This record also stood as the Class B (airships) absolute altitude record until 2006 when a subclass BX (hot air airship) set a new absolute record. You'll find a complete listing of Hokan Colting's FAI airship altitude records at the following link: https://www.fai.org/records?record=hokan+colting

In the video, "Hokan Colting - Taking To The Sky With An Updated Version Of The Blimp," (26:15 minutes), Colting recounts his record-setting flight in the SPS 62.5. You can watch this video here: https://www.youtube.com/watch?v=zy6X-JI1pJA

SPAS-4

The 21st Century Airships SPAS-4 prototype (registration C-FRLM) had a diameter 43 ft (13.1 m) and a volume of 41,500 cubic feet (1,180 cubic meters). The airship could accommodate a pilot and one passenger. The SPAS-4 airship was powered by two 50 hp engines with thrust deflectors in the propeller slipstream.



SPAS-4. Source: http://www.myairship.com/database/21century.html

SPAS-4 in 1996 painted as a baseball for the Atlanta braves baseball team and the Atlanta Olympics.
Source: Screenshot, Hokan Colting video.

SPAS-70

The SPAS-70 (registration C-FYOK) was a prototype intended for type certification. As in Colting's earlier spherical airships, the pilot sits in a cabin at the bottom of the sphere, inside the ballonet. The airship was powered by turbo diesel engines supplying a hybrid electrical system. Propulsion and control were provided by two large, electric motor-driven propellers mounted on the equator of the sphere. Differential thrust from the propellers provided yaw control. "Venetian blind" deflectors mounted in the propeller slipstream served to vector propeller thrust up or down.

The airship's outer skin is made from Spectra fiber, which is a component in some modern body armor. The inner lift gas cell envelope is made of Mylar polyester film.

Basic characteristics of this airship were:

- Diameter: 56 ft (17.05 m)
- Volume: 91,000 cubic feet (2,595 cubic meters)
- Accommodations: Pilot + 3 passengers in an internal gondola.
- Propulsion: 2 x 100 hp engines mounted on opposites sides on the equator of the sphere.
- Directional control: "Venetian blind" deflectors in the propeller slipstream

SPAS-70 on the ground. Source: Bill Blanchard via Airliners.net

3. Techsphere Systems International LLC (TSI) spherical airships

With encouragement from Hokan Colting, Mike Lawson and a group of investors formed TSI in 2002 in Columbus, GA and acquired the exclusive rights to manufacture and sell manned and unmanned versions of the spherical airship developed and patented by 21st Century Airships. These airships would be marketed under the TSI trademarked name "Aerosphere." TSI's primary market involved high altitude, loitering missions for commercial communication, border patrol and other surveillance applications. In May 2005, TSI became a wholly owned subsidiary of Cyber Defense Systems, Inc.

Sanswire "Stratellite"

The US firm Sanswire trademarked the term "Stratellite," which they defined as a future emissions-free, high-altitude stratospheric airship that serves as a stationary communications platform for various types of wireless signals traditionally carried by communications towers or satellites. In 2002, Sanswire engaged TSI and 21st Century Airships to develop a spherical stratospheric airship that could operate at

altitudes of 60,000 to 70,000 ft (18,300 to 21,336 m) to deliver a variety of telecommunications, environmental monitoring and surveillance services over a wide service area. It appears that preliminary tests were conducted with the SPAS-70 spherical airship and a concept was developed for a much larger spherical Stratellite. However, by 2004, Sanswire redirected their Stratellite developments efforts to their own design for the large Sanswire One prototype.

Sanswire test vehicle, circa 2004.
Source: Achmed Khammas, Buch der Synergie, Tiel C (4)

Artist's rendition of a spherical, solar-powered Stratellite operating in the stratosphere. Source: ZDNet, 19 July 2006

AS-62 (modified SPAS-70)

In 2004, this spherical airship (registration N8041X), configured with three propulsors (two flank + one pusher) conducted flight demonstrations for the US Department of Homeland Security and other government agencies. The airship originally was the SPAS-70 prototype and subsequently was reregistered in the US and renamed the Techsphere Spherical Airship-62, or AS-62. Mission equipment was integrated by Sierra Nevada Corporation. Basic capabilities of the AS-62 included:

- Mission duration: 48 hours
- Maximum airspeed: 40 mph (64 kph)
- Can be unloaded from a truck and readied for liftoff in about 24 hours

You can watch a short (3:34 minute) AP Archives video of an AS-62 flight demonstration here:
https://www.youtube.com/watch?v=kidM3QxefEs

AS-62 in flight in 2004. Source: AP Archives

No order was placed for an AS-62 Aerosphere.

Above: View of the AS-62 as it flies overhead, showing the two flank propulsors and the pusher propulsor on the rear hemisphere.

Left: Close-up view of one vectorable electric motor-driven flank propulsor installation attached to a reinforced section of the non-rigid, fabric hull. Source, both photos: screenshots from AP Archives video


Left: *This appears to be a four-engine adaptation of the AS-62 Aerosphere configured as a soccer ball and being prepared for launch. Source: Jeremy Gutsche via TrendHunter, 27 March 2006;* ***Right:*** *Soccer ball in flight. Source: Screenshot from video.*

The cockpit area of the soccer ball Aerosphere. Source: Pinterest

You can watch a short video of the soccer ball Aerosphere taking off here: https://www.youtube.com/watch?v=pvjowsheOfs

SA-60

In January 2005, UAV News reported that Naval Air Systems Command (NAVAIR) had been flight testing the TSI SA-60 spherical airship to evaluate its potential to satisfy future military and defense requirements. In addition, NAVAIR had awarded TSI a Sierra Nevada a contract for the initial development of an unmanned high altitude airship able to reach and maintain an altitude of 20,000 feet (6,096 m) and fly for up to two days.

In December 2005, TSI signed an agreement with RTI International (RTI) giving TSI a worldwide exclusive to test and utilize lightweight "paint-on antenna" technology on Techsphere airships for communication, radar, remote sensing and other applications. Under a NASA's Innovative Partnership Program (IPP), the team of RTI, TSI and Sierra Nevada successfully tested the "paint-on antenna" technology on board a TSI spherical airship designated SA-60, flying above the Nevada desert in July 2007. The two primary tests were:

- Iridium Global satellite communications: Paint on antennas transmitted and received voice and data with good overall radio frequency performance and low bit error rate.
- NASA's GPS Reflectance Experiment: Paint on antennas measured GPS signals reflected from water, wet ground, or artificial conducting (metal) bodies on the Earth's surface to help develop this remote sensing application.

SA-60 appears indistinguishable from the AS-62.
Source: TSI via Popular Mechanics

SA-90

In September 2007, Ben Iannotta reported for Air & Space magazine:

> "The Navy tested the spheres, and now the Army has awarded a contract to spy equipment manufacturer Sierra Nevada Corporation of Sparks, Nevada, to test a 94-foot-diameter Techsphere prototype, the SA-90. The first flight is scheduled for August (2008).
>
> The Army contract specifies that the SA-90 must demonstrate its usefulness by flying at 18,000 to 20,000 feet (5,486 to 6,096 m) for up to 24 hours. Aluminum propellers, 18 feet in diameter, will provide maneuvering. Hovering is easy, but engineers want to see if the sphere can fly at 55 mph (88.5 kph) to keep up with special operations units on the ground."

No order was placed for an SA-90 Aerosphere.

4. For more information

- "Sierra And Techsphere Receive Order For High Altitude Airship," UAV News, 14 January 2005: https://www.spacewar.com/news/uav-05e.html
- "'Paint-On' Antenna Test Flight Paves Way for Next-Generation High-Altitude Airships," Phys.Org, 17 July 2008: https://phys.org/news/2006-07-paint-on-antenna-flight-paves-next-generation.html
- Roland Escher, "21st Century Airships," Airship and Blimp Resources, 1995 - 2003: http://www.myairship.com/database/21century.html
- Greg Allen, "The SA-60 Spherical Airship," 26 August 2009: https://greg.org/archive/2009/08/26/the-sa-60-spherical-airship.html

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/