CHAPTER SIX: THE ADVENT OF THE AIRSHIP 6

While the development of heavier-than-air flight during the middle of the nineteenth century was the more interesting aspect of man's quest to fly, it wasn't the only research that was going on. Ballooning remained as popular in the mid-nineteenth century as it had in the eighteenth century. In terms of advancements in lighter-than-air technology, however, little had changed since the Montgolfier brothers had launched their first balloons in 1783. New and more resilient materials had been developed and other small innovations had been introduced since then, of course, but for the most part lighter-than-air development seemed to be stuck at an evolutionary dead end.

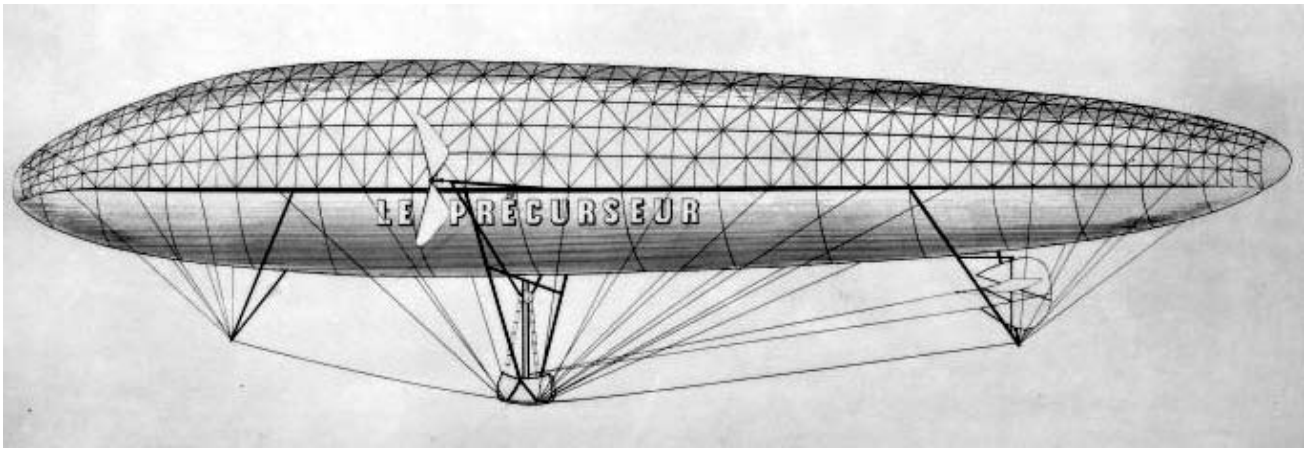
The problem remained, as it had from the beginning, the inability to make balloons go where their pilot wished them to go. While a good deal of vertical control was to be had, balloons continued to be subject to the vagaries of the wind, often with unfortunate consequences. In the middle of the nineteenth century, however, things promised to change when engines capable of providing the sort of power required to propel a balloon through the air started to become available. Unfortunately, they were still years away from fulfilling their complete potential, but they were a sign that things were beginning to change, This ignited a flurry of activity in regards to airship development, with a number of inventors working hard to produce the first steerable balloon—or airship, as such machines were known—but it would be a little known Parisian engineer by the name of Henri Giffard who would be the first to actually succeed, and in so doing kick-start an era of airship development that was to last well into the succeeding century.

The Little Big Airship of Henri Giffard

Baptiste Henri Jacques Giffard (1825-1882) was a French railway engineer known mainly for his expertise with steam generation and boiler technology. However, he also had an interest in aviation and to that end, in 1844 he acquired his ballooning license at the remarkably young age of nineteen. That might have remained the extent of his aeronautical interests, too, had he not been called upon to help a fellow Frenchman, Pierre Jullien of Villejuif, demonstrate a streamlined model for an airship he named *Le Précurseur*[19] at the 1850 Paris Hippodrome. Fascinated by the futuristic shape of Jullien's revolutionary airship, it wasn't long before Giffard decided to construct his own fully flyable airship, based in large part on Jullien's design.

Apparently a man of some means, Giffard spent the next two years of his life pursuing his dream, which he finally completed in 1852. Unlike most balloons of the era—and in keeping with the general shape of Jullien's model—his was not spherical like a standard balloon, but cigar-shaped, with conical ends and a sail-like triangular vertical rudder mounted aft. To power the machine, he constructed a small steam engine that weighed just 350 pounds (including the boiler and the coke to fire it), which

[19] Jullien's airship model, in mounting a rudder, elevator, and gondola, possessed all the elements of a modern airship, making it decades ahead of its time.



Jullien of Villejuif's highly streamlined airship Le Précurseur, a small model of which was displayed at the Paris Hippodrome in 1850, proved to be the source of inspiration for Giffard's airship, which would incorporate many of Jullien's ideas.

drove a large, ten-foot diameter, three-bladed propeller mounted at the aft end of the gondola. (The engine was also unique in that it was fitted with a downward pointing funnel and featured a new system designed to prevent sparks from rising upward and igniting the gas bag by mixing the combustion gases, thereby neutralizing any sparks.) Although it produced a mere three horsepower, he believed that would be sufficient to demonstrate that controlled flight was possible. At 144-feet in length, it was also the largest balloon ever built up to that time, and so, not surprisingly, it caused quite a sensation when it was unveiled to the public for the first time.

Anxious to test his new machine, on September 24, 1852, Giffard, flying from the Hippodrome in Paris, cast off the tethers that held the ship in place and the craft rose majestically into the calm autumn air. Stoking the machine's tiny boiler, soon its massive propeller was spinning at maximum velocity and the ship slowly made its way almost fourteen miles to the nearby town of Trappes where, despite the fact it could barely manage a tepid six miles per hour, it was observed to make a number of slow turns and circles. In doing so, Giffard demonstrated for the first time that a powered airship could be steered. Of course, he flew his craft under ideal conditions on a dead calm day; had there been even the slightest breeze, it's likely the underpowered craft would have proven unsteerable. Nonetheless, he did prove that the direction of flight of a lighter-than-air craft could be controlled, even if only for short distances under ideal circumstances, marking a milestone in the development of the airship.

Unfortunately, the enthusiastic Mr. Giffard got caught up in his own success and, instead of further refining his airship and perhaps learning as much as he could about controlling it in flight, he decided to dismantle it and start work on an even larger version, which he was to spend the next three years working on. This one, however, was to have a larger and more powerful engine capable of pushing the craft along at a more useful ten miles per hour, but to carry the additional weight, he needed to increase the length of the envelope by nearly one hundred feet, making the airship nearly as large as a modern day Goodyear blimp. However, while this provided enough lift to get the larger engine off the ground, Giffard had neglected to widen the diameter of the envelope, resulting in the ship being unable to maintain its cigar shape. This nearly proved to be a fatal mistake when during its first and only flight, the envelope sagged dramatically and began to pitch violently, resulting in the gas bag becoming detached from the netting and splitting. Releasing much of the 113,000 cubic

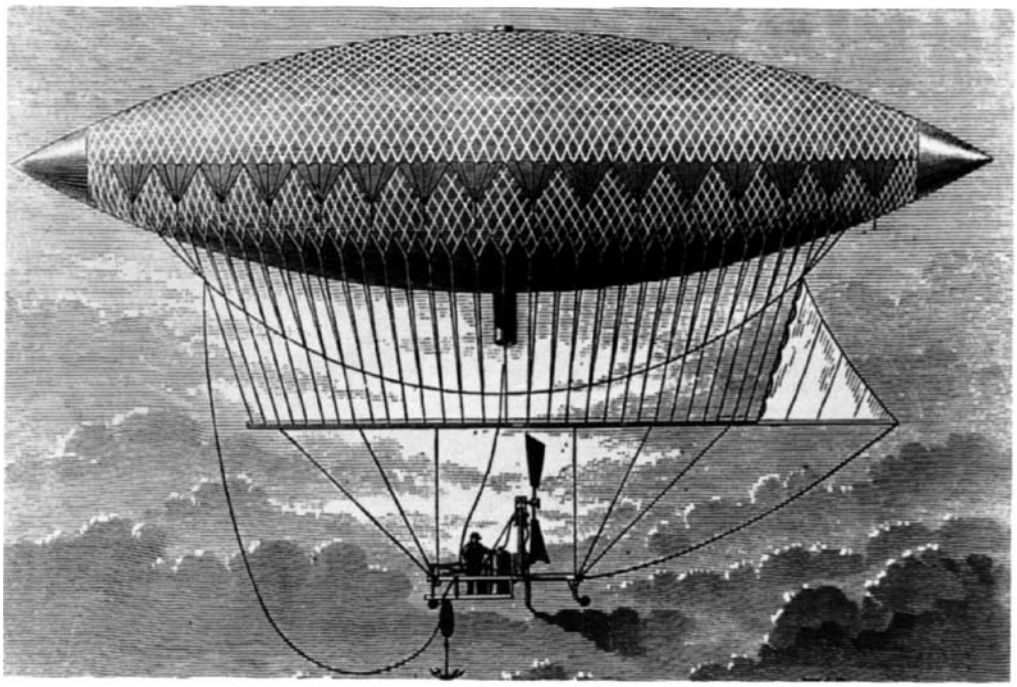
feet of hydrogen contained within it, the ship began descending rapidly and it looked as though Giffard was going to go down with the ship, but he was able to set it down successfully and escape before the limp gas bag fell onto the hot boiler and ignited, completely incinerating the ship.

Despite the disastrous flight, Giffard was undeterred in his efforts to make his dreams a reality and he soon set about planning an even larger airship. He turned out to be quite the dreamer, however, for his new airship was to be nearly two thousand feet in length and with a maximum diameter of just under one hundred feet (twice the size of the famous German dirigible *Hindenburg*). Of course, such a craft was far beyond the capacity of the nascent technology of the age to build and so it never got beyond the planning stage, but no one could ever accuse Henri of not thinking big.

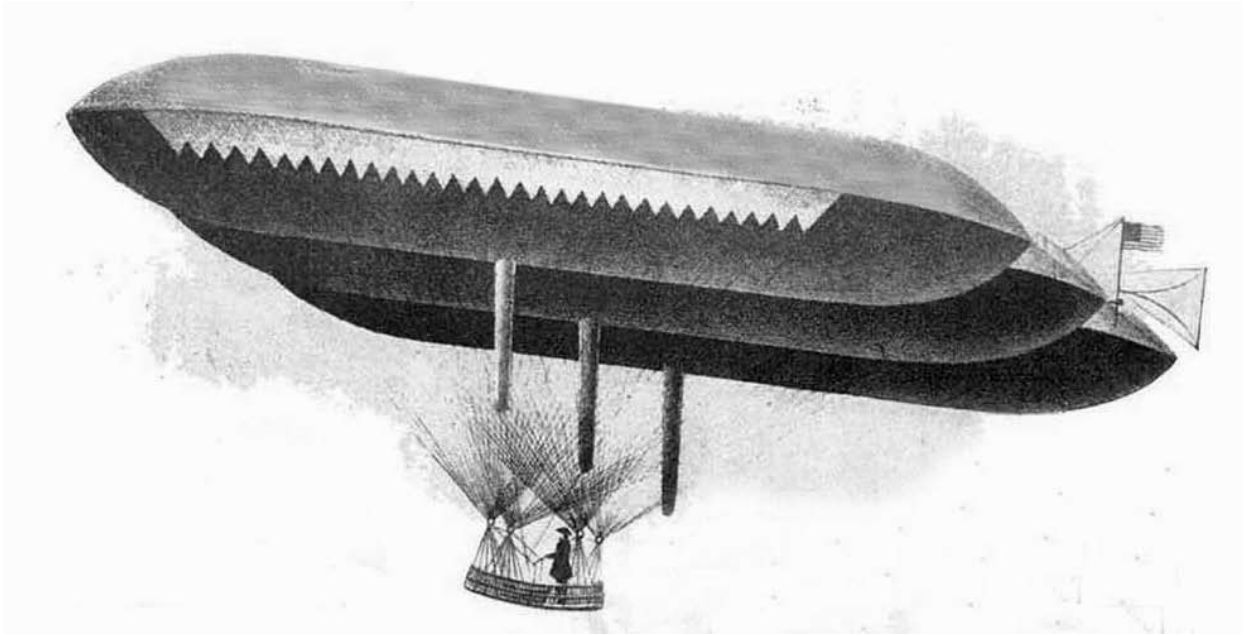
Solomon Andrews' Remarkable Airship

It's always interesting to see how some people easily find their way into the history books while others remain almost entirely forgotten even though their contributions may be, in many ways, every bit as significant as those who do make it. Such is the case, it would seem, with Doctor Solomon Andrews (1806-1872), a prolific inventor and medical doctor from Perth Amboy, New Jersey, who came as close to aviation immortality as any man ever has, and yet somehow managed to remain virtually unknown to this day.

Certainly Andrews seemed to be the sort of man capable of great things. A man of considerable talent and a seemingly inexhaustible passion for innovation, during the course of his lifetime Andrews accumulated a number of patents on everything from an improved sewing machine to the first practical kitchen range. (He even designed a padlock which has been used by the U.S. Post Office since 1842, demonstrating that he definitely knew how to make things that would last.) With such a far-ranging mind, then, it's not remarkable that at some point in his life he started playing around with airships. Unlike most airship inventors of the era, however, Andrews took a novel approach to the idea of airship propulsion. While others were looking at steam



Henri Giffard's 1852 airship, though tiny and slow, was the first steerable airship in history, which portended the future of airship development well into the twentieth-century..



Solomon Andrews' first airship in 1863. The craft was revolutionary in that it had no engine, directional control being accomplished by the movement of the pilot along the gondola and basic gravity. (Drawing courtesy Popular Science Magazine, January 1932 edition.)

as a propellant, he decided he could get his airship to fly simply through what he called "gravitation"; effectively, his craft would glide through the air by making use of the specific gravity between the balloon and the surrounding atmosphere through a system of inclined planes designed to steer the craft. With this technique, the airship would cycle between positive and negative buoyancy, resulting in an airflow across the body of the craft and attached airfoils. As such, to ascend, one would simply drop ballast from the bow (or have the pilot move aft) until the craft reached an angle of approximately 10 to 15 degrees, forcing it to rise. Then, by valving off some of the hydrogen and shifting weight forward, the craft would descend, again providing forward momentum. In this way the craft would effectively tack against the wind much like a sailing ship would when running against a headwind, providing an energy-free means of travel. It was a curious idea that, if successful, would eliminate the need for a power plant—with all the resultant weight and fuel such entailed—providing humanity with a cheap and simple means of conquering the skies.

How far Andrews got with this idea is unclear. It appears that as early as 1842 he built and tested a small scale model (though still of substantial size). It's not clear whether these tests went anywhere, however, but they must have been enough to convince Andrews that he was onto something, for he continued to work on his "gravitation-powered" airship right up to the start of the American Civil War.

Though the war forced him to curtail his motorless airship experiments for a time while he volunteered his services as a medical doctor for the Union army, he never gave up trying to find a way to bring his idea to life. After observing how inadequate the fixed balloons of the Union army were in terms of providing useful reconnaissance of enemy positions, he hit upon the idea of presenting his airship idea to the government as a legitimate military device.

While he waited for a response from the government—which seemed to be dragging its feet on his proposal—Andrews set about building a full size example of his airship—which he called the *Aereon*—in an effort to prove the practicality of his novel approach to manned flight. What resulted from his ambitious efforts was a most usual-looking craft made up of three 80-foot-long cigar-shaped

balloons attached to a rudder and gondola, which Andrews was ready to test for the first time in the summer of 1863.

One might imagine that an unpowered airship would not do well in terms of maneuverability or directional control, but in fact it seemed to have actually worked. Flying the *Aereon* over Perth Amboy, New Jersey in June of 1863, the craft seemed to perform as advertised, with Andrews making it turn and circle merely by moving ballast and himself forward and backwards along the length of the narrow gondola. After completing some modifications, he apparently flew it again in August of that year, during which time, at least according to an article that ran in the *New York Herald* on September 8, 1863, Dr. Andrews' craft was observed to climb in a tight upward spiral until it was almost lost in the clouds. If true, this made Andrews' unusual machine the first dirigible capable of being flown against the wind—and for considerable distances at that.

It's not clear, however, exactly how much actual directional control Andrews had over the craft or whether he was merely riding the prevailing currents much like a kite. It's also not certain how much control he might have maintained over the craft against a strong breeze, or how much straight-line control he would have been able to maintain over an extended period. It certainly appears unlikely that the craft could have been made to travel along a fixed course for any period of time, as it would have been forced to fly an exhausting zigzag path while it climbed and descended much like a roller coaster, making its practicality open to debate. It was still an interesting concept that showed promise, however, and perhaps that's all the intrepid Mr. Andrews wanted to demonstrate through his novel design.

Convinced he had largely perfected his craft, Andrews grew increasingly excited about using his unusual airship for the Union cause, even going so far as to write to Abraham Lincoln offering the *Aereon* for use in the war as an observational vehicle. It appears that his concept of "gravitational flight" was not taken seriously by the government or the military, however, despite the fact that he had repeatedly demonstrated that the concept worked. Through sheer persistence, however, he did finally manage to arrange a demonstration before the Smithsonian Institution early in 1864, only to have his demonstration repeatedly postponed. Unfortunately, by the time officials in Washington appeared to be finally ready to give his airship a look, the war ended and Andrews and his dirigible were quickly forgotten.

However, Andrews wasn't one to let a good idea go to waste. Deciding his *Aereon* had civilian applications as well, he organized the Aerial Navigation Company in the hopes of establishing a regular airline between New York and Philadelphia—a fantastic proposal at the time and one that predated the advent of the world's first airline, DELAG (see chapter twelve) by over fifty years.

Unfortunately, Andrews' second craft, the *Aereon #2*, which worked along the same principle as his earlier craft, proved far less successful. Considerably larger than his first craft and more lemon-shaped than cigar-shaped, he quickly discovered he had less control over its direction of movement than he had with his previous airship. In spite of that, Andrews still made two controlled flights in the thing, one over New York City on May 25, 1866 and a second just a few days later on June 5, both of which were enthusiastically covered by the local press and both of which carried passengers (the first airship passengers in history, it appears). It was even claimed by one paper, the *New York World*, that the ship obtained a height of some 2,000 feet and drifted lazily over the city for some time before landing safely on Long Island. Obviously enthused that it appeared the age of air transport was at hand, the paper wrote: "Navigation of the air is a fixed fact. The problem of the century has been solved."[20]

What should have been heralded as one of the great triumphs of the ages, however, ended abruptly—not by technical difficulties or unforeseen catastrophe, but by economic collapse. It seems that just

[20] New York World, May 28, 1866.

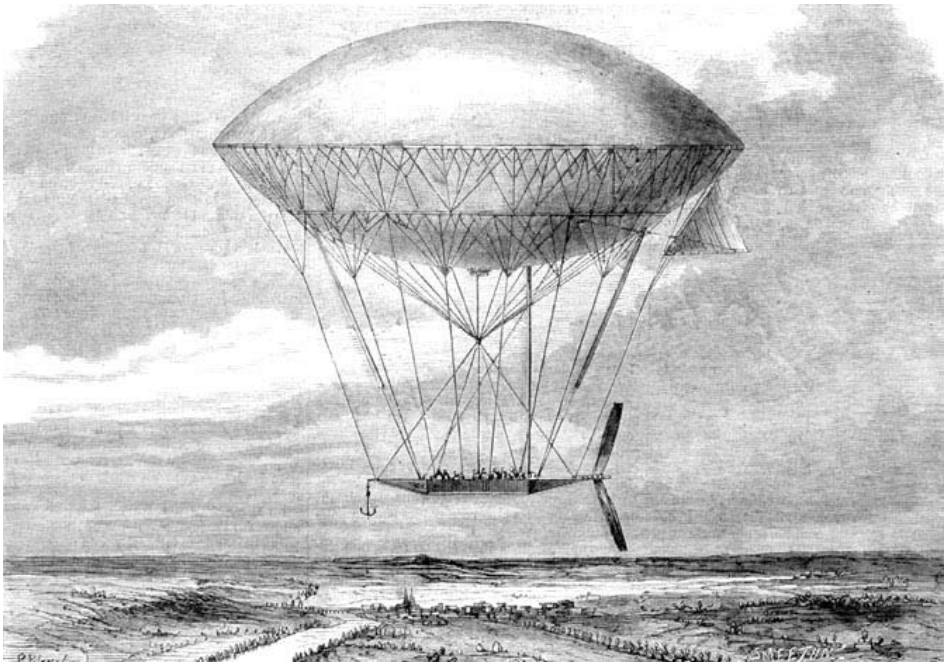
as Andrews was beginning to find the capital to fund his airship service, many banks collapsed, leaving his fledgling airship company/airline bankrupt and ending both his flights and his dreams for a New York to Philadelphia air service. It also leaves us to wonder what might have happened had Andrews found the capital to continue to refine his design; would the dirigible have become a common sight in the sky through the last decades of the nineteenth century and the history of aviation been dramatically rewritten, or would his airship have flown off the pages of history as the exhausting and impractical (imagine having to have scores of passengers continually move from one end of the airship to the other to keep it in motion) form of travel it really was? Of course, the world will never know.

The Human-Powered Airship of Dupuy de Lome

It's curious how much impact the brief Franco-Prussian War of 1870 had on aeronautics. When Paris was surrounded by Prussian forces in mid-September of 1870, the French came up with some innovative ideas to keep their forces inside the city in communication with the rest of the country. Perhaps the most unique strategy that came out of it was the idea of using hot-air balloons to fly over the Prussian lines to deliver letters and communiqués—and frequently people—outside the city. (It was an idea that seemed especially appropriate, considering the city's rich aeronautical history.) In any case, among those who participated in this scheme was a man named Henri Dupuy de Lôme who, while not personally piloting any balloons over Paris himself, did create and build one that, were it not for the end of the war, may have resulted in the first human-powered airship in history.

Stanislas Charles Henri Dupuy de Lôme (1816–1885) was considered by many to have been the greatest French naval architect of the nineteenth century and, arguably, the greatest in French history. Mostly known for his work on steam-driven ironclads, battleships, and submarines, what's less known about him is that he also put his engineering prowess to work trying to create a controllable balloon designed to circumvent the siege of his beloved Paris.

The problem de Lôme faced, as it was for all balloon enthusiasts of the era, was the balloon's dependence upon the whim of the weather and



Dupuy de Lôme's innovative hand-cranked airship might have become a reality had not the Franco-Prussian War ended before it was ready for its first flight. Note the large two-bladed propeller that was to propel the craft at a leisurely 8 knots, along with the quaint boat anchor hanging from its bow.

the direction of the prevailing winds. De Lôme, however, believed it might be possible to develop a practical, navigable balloon that could fly to specific destinations without having to depend upon favorable winds to do so. The airship he came up with was large for the time, with a length of one hundred twenty feet and a nearly fifty foot diameter at its maximum. It also had an elongated basket that could carry up to eight people, most of whom would be busy turning a hand-driven shaft that would drive the craft on a predetermined course at—in theory—a respectable 8 knots. Christened the *Dupuy de Lôme* after himself (the man obviously being no stranger to self promotion), France capitulated just a few days before it was ready for its maiden voyage, thereby depriving the world of seeing whether it would have flown or not. As it is, it was quickly dismantled a few weeks after the armistice was signed and forgotten (except, apparently, by Mr. de Lome and his biographers).

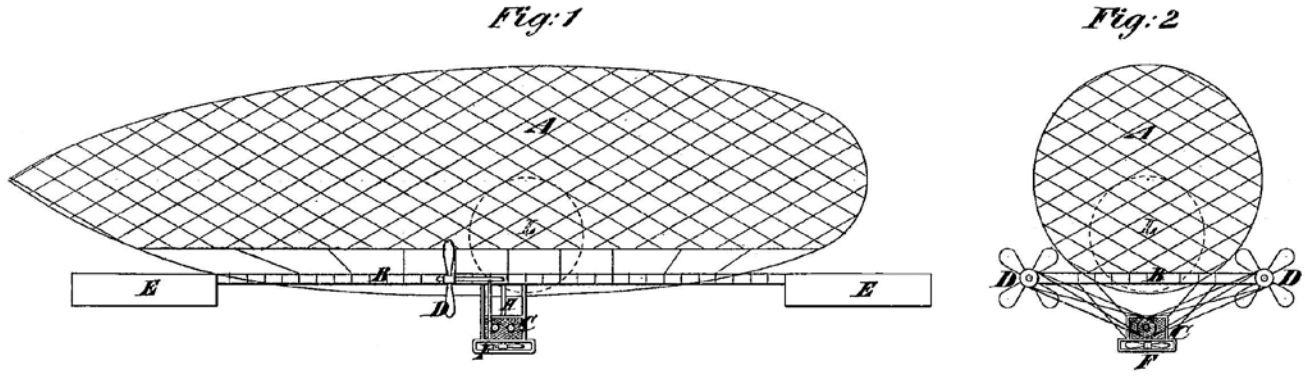
Whether it would have worked is anyone's guess, of course, but it demonstrated that even in 1870 man was already imaging ways lighter-than-air craft might be used in military operations—a prospect that was to become a reality less than a half century later when France and Prussia (later united into the country of Germany) would clash again in the skies of Europe—and this time airships would play a much larger role.

Paul Haenlein's Hydrogen-Powered Airship

Another man to have some success with a steerable airship was the German engineer Paul Haenlein (1835-1905), who was to build and fly one of the first successful semi-rigid dirigibles[21] in history.

A graduate of the prestigious Technische Hochschule in Karlsruhe, Haenlein was a pattern maker and civil engineer who had worked for several companies in Germany before turning his attention to airships. What he eventually came up with was revolutionary—not in its size or configuration—but in its propulsion system. What Haenlein proposed using to power his craft was not steam (Giffard) or gravity (Andrews) or even human power (de Lôme), but a small Lenoir-type internal combustion engine that actually ran off of the hydrogen contained in the airship itself!

With his system, the gas was actually pumped from the envelope of the balloon—which was kept fully inflated by pumping in compensating air to the bags inside the main envelope—directly into the engine itself to serve as the fuel for combustion. This would deliver about 6 horsepower to a 15-foot diameter propeller, causing it to spin at a respectable 40 revolutions per minute. The problem was that the revolutionary engine consumed about 250 cubic feet of gas per hour which, in continually consuming its own lifting agent, greatly reduced its range. The engine also had the disadvantage of requiring



Patent drawing from Paul Haenlein's 1870 hydrogen-powered airship design.

[21] A semi-rigid dirigible is differentiated by the fact that the nonrigid envelope is attached to a bow-to-stern keel that gives it some degree of rigidity, as opposed to a "blimp", which has no rigid structure to help maintain the envelope's shape, or a fully rigid airship, which has a complete internal skeleton within the body of the envelope.

a large storage capacity. It did, however, prove to be an elegant solution to the problem of fuel storage and was the first instance of the use of an internal combustion engine in connection with aeronautical experiments.

Interestingly, Haenlein actually went on to build and test his novel airship. On December 13, 1872, he flew his airship near Brunn, Germany, where he was able to get the 164 foot long, 30 foot diameter craft to reach a sustained speed of 15 knots, which was not only quite an accomplishment for the time but was nearly three times faster than what Giffard's earlier airship had been able to achieve. The trial was made with the dirigible tied down, however, and while Haenlein intended to perform an untethered flight next, he ran out of money at the worst possible moment and was forced to call the whole thing off.

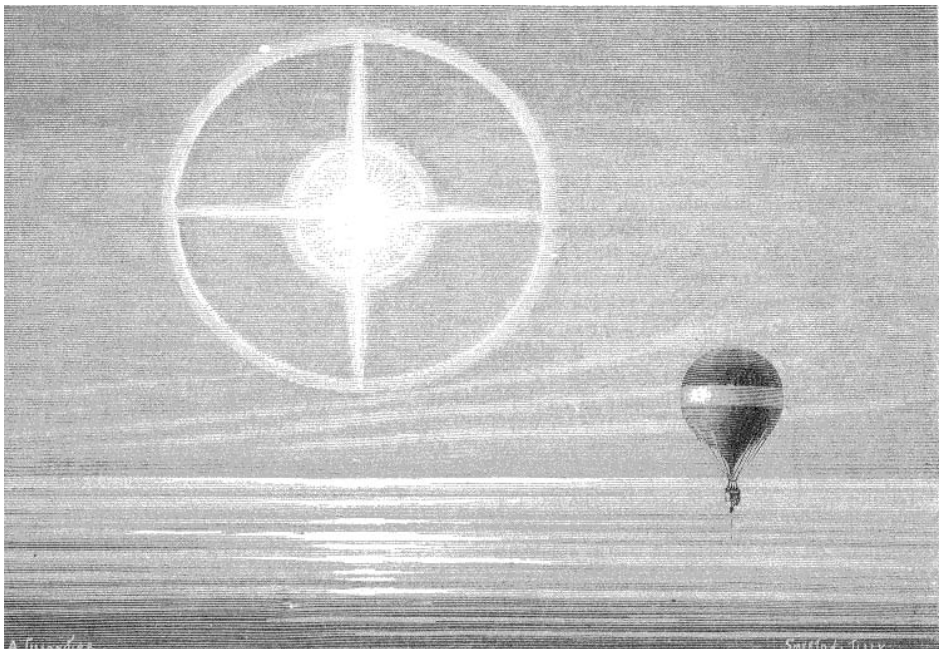
It's difficult to imagine that the funds couldn't have been found to see what the man's ship might have accomplished, but even what little was shown demonstrated the craft to have been a major advance over all previous designs. In using its own lifting agent as an energy source, however, it was doomed to be a short-range novelty at best, so perhaps it was better the idea died an early death.

The Airship of Albert and Gaston Tissandier

Other than the Montgolfier brothers, there are few siblings as famous in France for their work with lighter-than-air aviation than the famous Tissandier brothers, each of whom were to be credited with a number of firsts in a century known for many aeronautical firsts.

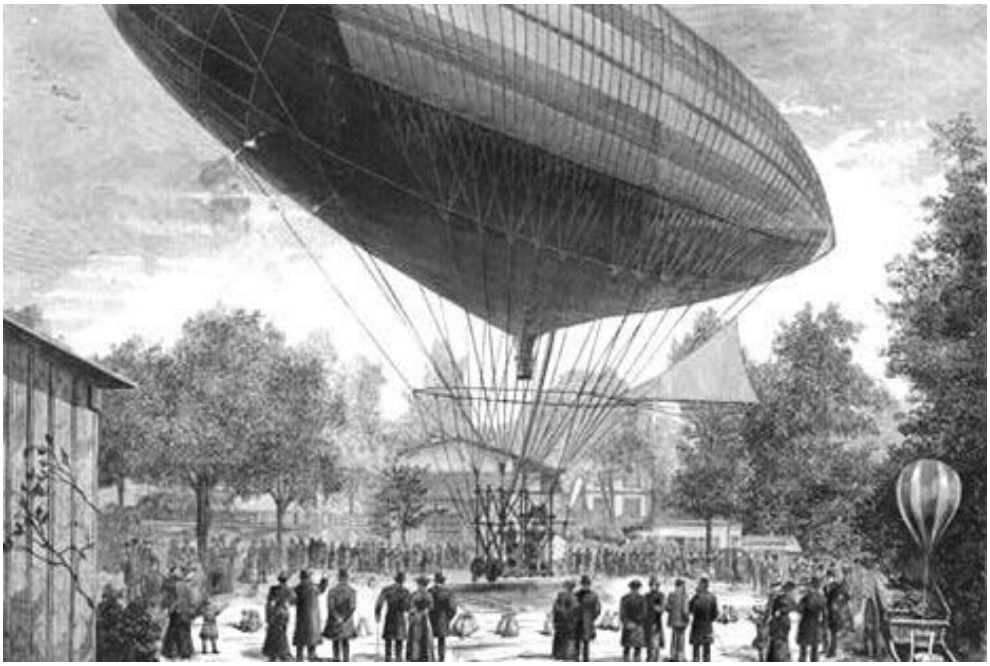
The Tissandiers were from a family of well-educated architects, artists, and scientists. Albert (1839-1906) was an architect of some renown as well as a proficient illustrator while his brother Gaston (1843-1899) was a well-known chemist and meteorologist with a fervent fascination for balloons and airships.[22] Together they founded and edited the scientific journal *La Nature*, a publication that continues to this day under the name *La Recherche*.

It was Gaston who first took up the cause of ballooning when he made an ascent in one at Calais in 1868. He even had the distinction of being spirited out of a besieged Paris during the Franco-Prussian War of 1870 by balloon, but his most adventurous flight aloft took place in April 1875 when, together with fellow aviation enthusiasts Joseph Croce-Spinelli and Theodore Sivel, he ascended in a hot air balloon to an unheard of altitude of nearly 28,000 feet,



Albert Tissandier's hauntingly beautiful pencil-sketch of the Zenith floating beneath a haloed moon at night, made from the gondola of the craft at 3,600 feet, March, 1875.

[22] He is also the father of Paul Tissandier (1881-1944) who became a well-known aviator in his own right.



The Tissandier's elegant 1883 airship proved to be as underpowered as Giffard's earlier machine had been. Without access to a more powerful engine, the brothers apparently gave up their lighter-than-air pursuits and moved on to more lucrative ventures.

setting a new world altitude record in the process. Tragically, the flight almost proved to be Gaston's last, for without portable oxygen, the men quickly succumbed to the lack of air and both Spinelli and Sivel died. Remarkably, Gaston survived, though he was rendered deaf by the experience—an affliction he would struggle with the rest of his life.

Albert was no less adventurous and every bit as committed to aviation as his brother, having first flown in a hot-air balloon between Melun and Paris in 1868—a flight which was made during a snowstorm. Later he served as a pilot on one of the first balloons to fly in and out of Paris during the Franco-Prussian War, carrying letters and dispatches—a feat for which he was awarded the Medaille Militaire for bravery. Like his brother, he also escaped from the city in the gondola of a balloon during the height of the siege.

It was their flights together, however, for which they are best remembered, the most famous being one they took in 1875 onboard a hydrogen-filled balloon called the *Zenith*[23]. Flying from Paris to Arcachon near Bordeaux—a record-setting distance of nearly four hundred miles—in two days, during the flight Albert drew pictures of the countryside below and even sketched a drawing of the balloon flying over a shimmering field of clouds at night, demonstrating his considerable talents as an illustrator.

Eventually the brothers became interested in the prospect of controlled flight and decided to experiment with the concept using small electric motors, which they demonstrated at an exposition by attaching one to a large model of a dirigible. After determining that it may be possible to control an airship in this manner, they set about building a full-sized ship that they named *Aerostat* to test out their ideas. Unfortunately, the electric motors of the era were not powerful enough to power a full-sized dirigible (the motor they used could only produce 1.5 horsepower). It appears that at this point, perhaps because of the failure of their *Aerostat* to perform satisfactorily, they gave up any further studies of airships and, like many pioneers who also walked away just at the point when success seemed inevitable, they moved on to other pursuits—much to the detriment of the aeronautical community.

[23] It was in this same balloon that Gaston took his nearly fatal flight a month later.

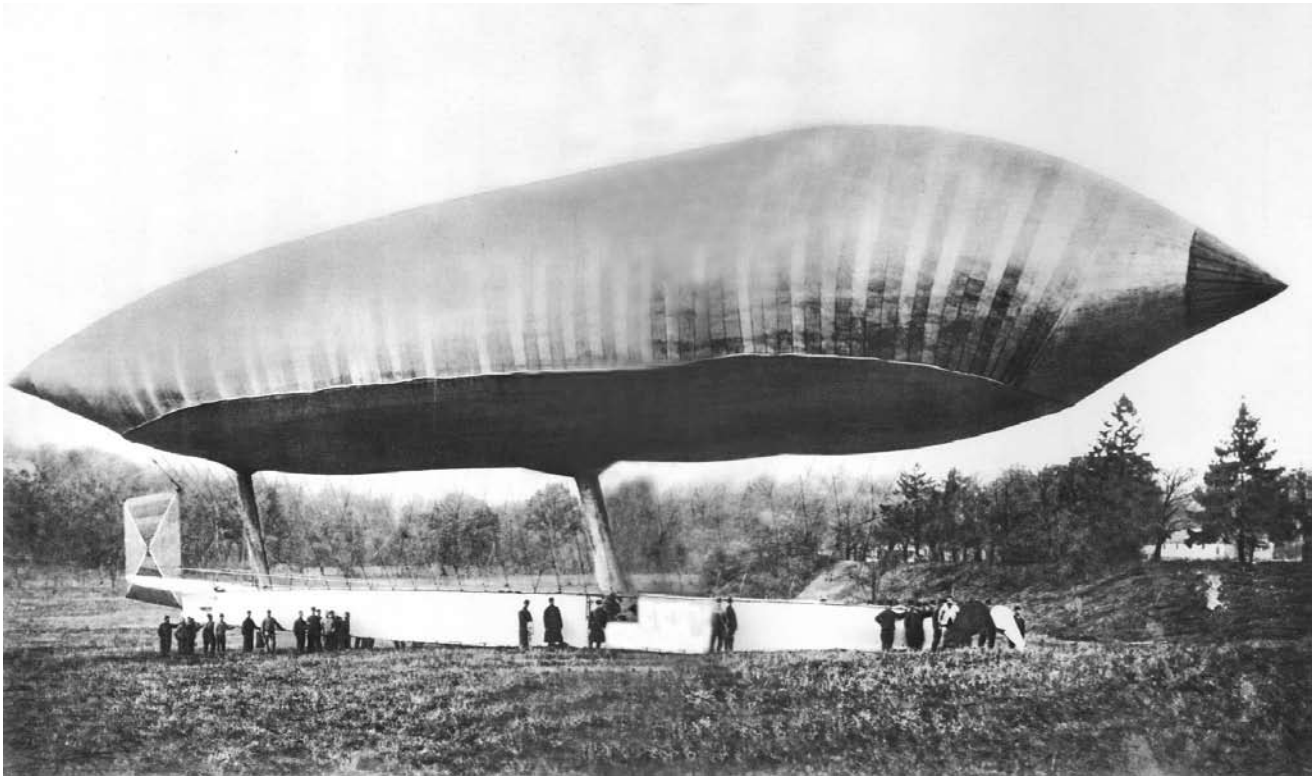
It's always difficult to determine what the history of aviation might have looked like had the brothers continued their experiments, but it is likely, had they pursued their experiments with more determination and made a concerted effort to obtain a more powerful engine, that they might well have become one of the premier names in lighter-than-air development. As it is, the world was left with only a tantalizing taste of what they might have accomplished—along with, of course, Albert Tissandier's wonderful illustrations.

Renard and Krebs's Successful *La France*

Up to this point, successfully controlling an airship had met with mostly disappointing results. Giffard, Haenlein, and the Tissandier brothers all had workable designs, but none of them had designed a consistently controllable airship, largely due to the lack of a light and powerful enough motor to move a craft against the wind. With each attempt and subsequent failure, however, the aviators of the day got ever closer to realizing their dream of a genuinely steerable airship. This trial-and-error approach finally paid off just a year after the Tissandiers' attempt when another pair of Frenchmen, Charles Renard (1847-1905) and Arthur C. Krebs (1850-1935), built and flew the first truly practical airship in 1884.

Officers in the French Army Corps of Engineers, Renard and Krebs were well suited for the task fate put before them. Renard had started to work on airship designs at the French armies' aeronautical department shortly after the Franco-Prussian War of 1870, while Krebs was an inventor of considerable engineering expertise. With the help of a grant from the French government, over the course of six years together they quietly constructed a 170-foot long airship that would finally demonstrate that airships could be controlled in powered flight.

Named *La France,* the craft proved to be a vast improvement over earlier attempts. Like the Tissandier brothers' airship, it also had an electric, battery-powered motor, but while the Tissandiers' mo-

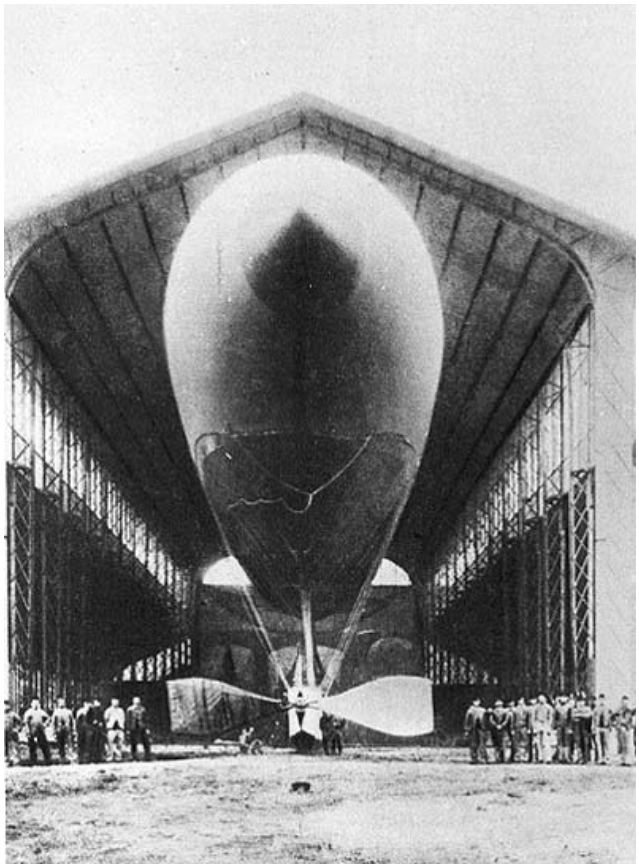


The hugely successful La France, which made no fewer than seven flights between 1884 and 1885.

tor could produce only an anemic 1.5 horsepower, theirs produced 8.5 horsepower, making it capable of pushing the ship through a calm sky at an impressive thirteen miles per hour—an extraordinary accomplishment at the time. The *La France* also had a number of other fairly sophisticated design features, including a 23-foot diameter, four-bladed wooden tractor propeller that could be inclined upwards when landing to avoid damaging the blades. It also had a futuristic rudder and elevator assembly, a sliding weight to compensate for any shift in the center of gravity, and even ballonettes—small air-filled bladders located inside the envelope of an airship that are deflated or inflated as necessary to maintain the envelope's external shape during ascent or descent (a feature still used on today's blimps to perform exactly the same purpose.)

The first flight of the *La France* took place on August 9, 1884 and, though the craft flew only five miles, Renard and Krebs managed to maintain complete control of the ship throughout the flight, even returning to their starting point and landing successfully, thereby demonstrating that controlled flight was possible if an airship had a sufficiently powerful motor. The *La France* proved to be more than a single-flight wonder as well, making no less than seven flights between 1884 and 1885, each of them under control and in five of which Renard and Krebs managed to return to their starting point, thereby establishing that the first flight had been no fluke. In many ways their achievement also signaled that the age of the controllable airship had at last arrived, though it would be a few decades before the fullest extent of that fact would be realized.

However, Renard and Krebs's airship, while impressive, was fragile and, like all electric-powered craft of the era, had too limited a range to be practical. It did, however, have one unanticipated side-benefit: It served as a source of inspiration to science fiction writer Jules Verne, who wrote of "the striking experiments of Captain Krebs and Captain Renard" in his 1886 novel *Robur the Conqueror*.



Reminiscent of photos of dirigibles taken in the 1930s, this photo of the La France in its hangar shortly after one of its successful flights looks remarkably modern from this perspective. Note the enormous size of the propeller blades.

Conclusions

Renard and Krebs' *La France* demonstrated that the world was on the brink of a new era in aviation and that truly practical, passenger-carrying craft were on the horizon. It would take another two decades for all the elements to come together, but the important foundation upon which lighter-than-air aviation in the twentieth century was to be built upon had been laid. However, as the century began drawing to a close and the advances in technology were becoming more marked, it was the aeroplane that was to rise to the forefront of aviation development, forcing the airship to take a back seat until the turn of the century, at which time it would come to dominate the skies once again.