DIRIGIBLES

that made history

DAVID C. COOKE

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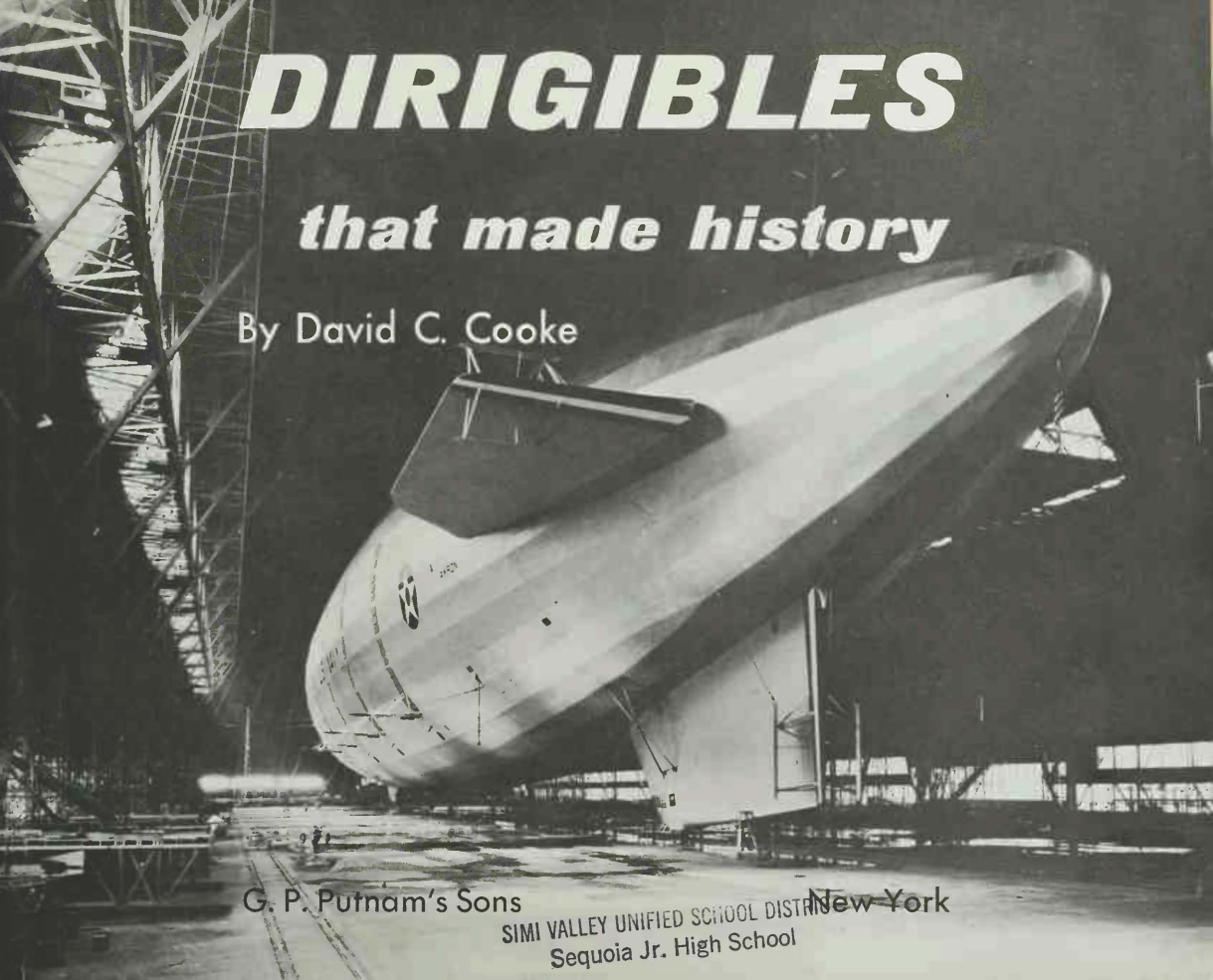
By David C. Cooke



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FOREWORD

The day of the big dirigible now seems to be gone, probably never to return. But this was truly one of the most fascinating chapters in the entire history of aviation, an era during which the pioneers struggled to provide a safe, fast method by which mankind could travel through the air.

The story of the dirigible is filled with disappointment and frustration and disaster. Many of the airships had their careers cut short by fire or by storm. Most of the explosions and crashes were caused by flammable hydrogen, which was used as lifting gas; by faulty weather forecasting; or by inexperienced ship commanders. Despite these proved facts, airship construction was discontinued — even though less money was spent on the entire development program in a hundred years and in many countries than is spent in perfecting some of the high-speed airplanes of today.

This book traces the entire span of dirigible development, starting with the first successful airship which flew more than fifty years before the Wright brothers took to the air at Kitty Hawk, North Carolina. It also tells a small part of the stories of the pioneers — of Henri Giffard, Alberto Santos-Dumont, Henri Julliot, Count von Zeppelin, Thomas Baldwin, Dr. Hugo Eckener, Ralph Upson, and others.

I have attempted to present every one of the most famous dirigibles. Some of these contributed much to aeronautical knowledge, while others, failures in themselves, paved the way to future advances in airship science. Each is described and illustrated in its approximate order of development.

The chore of locating accurate information and photographs led me to many people and many sources. Foremost among these were Major James Sunderman of the U. S. Air Force; Lieutenants J. W. Stierman and D. O. Small of the U. S. Navy; Philip Hopkins and Louis Casey of the Smithsonian Institution; A. J. Charge of the Imperial War Museum; A. D. Topping of the Wingfoot Lighter-Than-Air Society; Elizabeth Brown of the Institute of the Aeronautical Sciences; and Luftschiffbau-Zeppelin, G.m.b.H. I would also like to extend my thanks to Jesse and Milton Davidson, Martin Caidin, J. Gordon Vaeth, and Denny McMains, who helped in many ways.

— David C. Cooke

To Ernest Jones and E. C. Overton –
with fond memories of years gone by

CONTENTS

GIFFARD AIRSHIP

France

A Frenchman named Jean François Pilâtre de Rozier became the first man in the world to fly when, on October 15, 1783, he ascended from Paris in a balloon built by Joseph and Jacques Montgolfier. A month later Rozier and the Marquis d'Arlandes made the first free balloon flight, remaining aloft about twenty minutes and covering five and a half miles. But within a few years the pioneers realized that it was not enough to travel with the wind, and that some method would have to be found to control the direction of flight.

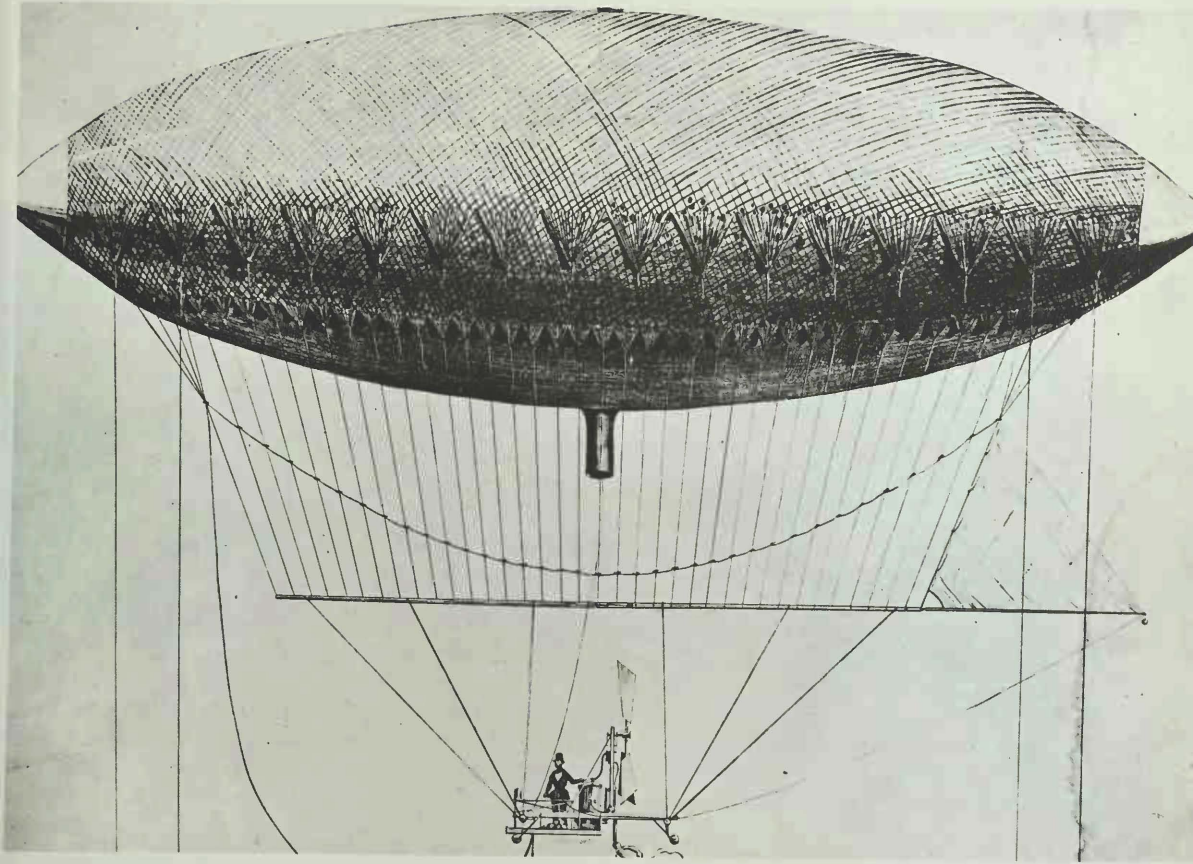
A number of interesting experiments were made, but none of these proved successful. Then, in 1850, a Frenchman named Henri Giffard started studying the problem. He reasoned that a model dirigible called *Le Précurseur* designed by another Frenchman, Pierre Jullien, had been sound, but that it needed a number of refinements as well as an engine powerful enough to drive it through the air by means of a propeller.

Giffard set about designing a lightweight steam engine, finally coming up with one which weighed about 350 pounds and delivered three horsepower. He also built an elongated balloon 144 feet long and with a capacity of 88,300 cubic feet of hydrogen. He suspended his engine and firebox under the balloon, fitting it with a propeller eleven feet long which turned at the rate of 110 revolutions per minute. The inventor calculated that this would provide enough thrust to give his airship a speed of about six miles per hour in still air.

Giffard had his dirigible ready for testing by September, 1852. The 24th of the month was clear and calm, and he announced that he was ready to go. His dirigible rose gently, its steam engine hissing and spluttering. After ascending to a safe altitude, he moved the rudder controls and was elated to discover that his craft responded to some extent. He succeeded in landing near Trappes at the precise location he had planned. This was a feat which no aeronaut had ever before accomplished!

Henri Giffard's airship was unstable and completely helpless in any slight wind, but he had pointed the way by making the first controlled flight in history.

Henri Giffard's primitive airship proved that controlled flight was possible.
(Institute of the Aeronautical Sciences)



The French brothers Gaston and Albert Tissandier built a dirigible model in 1881 which used a new form of power to turn its propellers — electricity. The model performed so well that they next made a full-size ship 92 feet long and containing 37,500 cubic feet of hydrogen. A trial flight was attempted on October 8, 1883, but their electric motor did not deliver enough power to move the ship even in a mild breeze.

Two French army captains named Charles Renard and Arthur Krebs next took up the idea of electric propulsion. Their theories appeared so promising that the French government agreed to advance them 200,000 francs (about $40,000) to conduct their experiments and build a working airship.

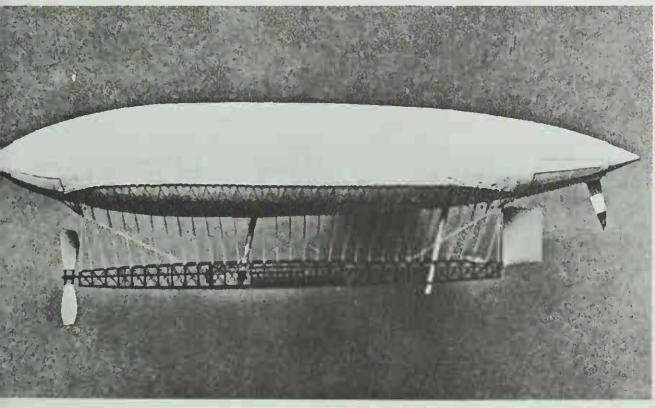
Krebs designed the engine, which was even lighter and more remarkable for the time than the one built by Tissandiers. It had an output of nine horsepower and weighed 211 pounds, with the batteries adding another 880 pounds. Meanwhile, Renard was working on the gasbag and control system.

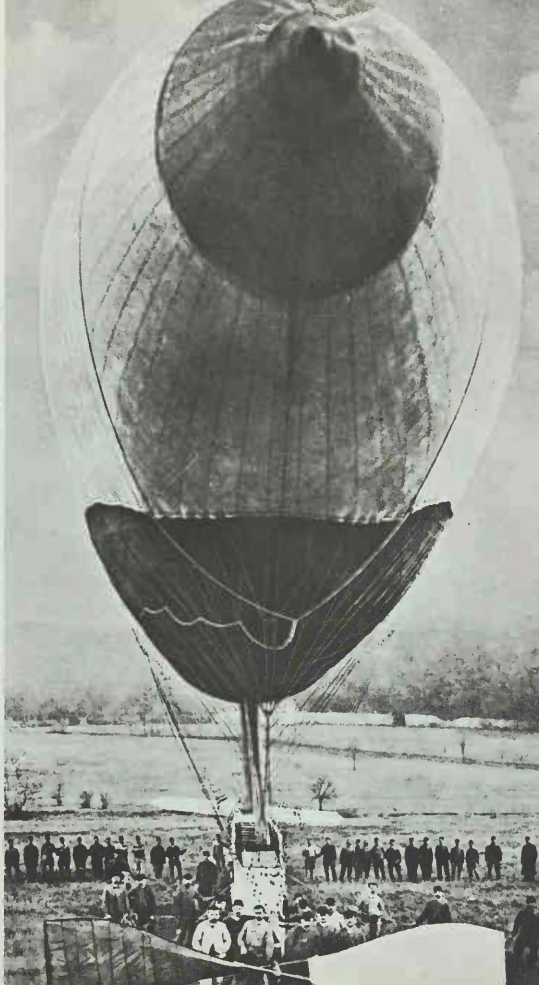
The nonrigid ship, which they named *La France*, incorporated a number of amazing advances. It was 165 feet long and had a capacity of 65,836 cubic feet of hydrogen. It had a much better streamlined shape than any other previous dirigible. Inside the balloon was a smaller balloon containing air. If the gas in the main bag expanded, the air would be driven from the smaller bag; or if the gas contracted, more air could be pumped into the inner bag. Through this pressure system, Renard and Krebs felt that there was little danger that the main bag would collapse.

The ship was a success from its first flight on August 9, 1884, covering a circular course of more than five miles in twenty-three minutes. This was the first time in history that an airship had made a round-trip flight under its own power.

This first successful flight was no accident. Renard and Krebs made several other ascents during the next few months, all of them without trouble. They found that the ship was even able to make headway against moderate winds. This was the greatest forward step that had been made in the quest for controlled flight.

The Renard and Krebs *La France* made the first round-trip flight in history. (Musée de l'Air, Paris)





SCHWARZ ALL-METAL AIRSHIP

Germany

An American named Edmund Stedman proposed in 1879 that aluminum would be the best substance for dirigible construction, and he designed several machines which displayed unusual advances. But aluminum was still a rare and expensive metal costing about $140 per pound, and Stedman was unable to build flying versions of his airship designs.

It remained for David Schwarz, an Austrian, to use aluminum to produce the world's first rigid dirigible in 1893, after the metal had become plentiful and considerably cheaper. The ship never flew, due to structural failures during inflation.

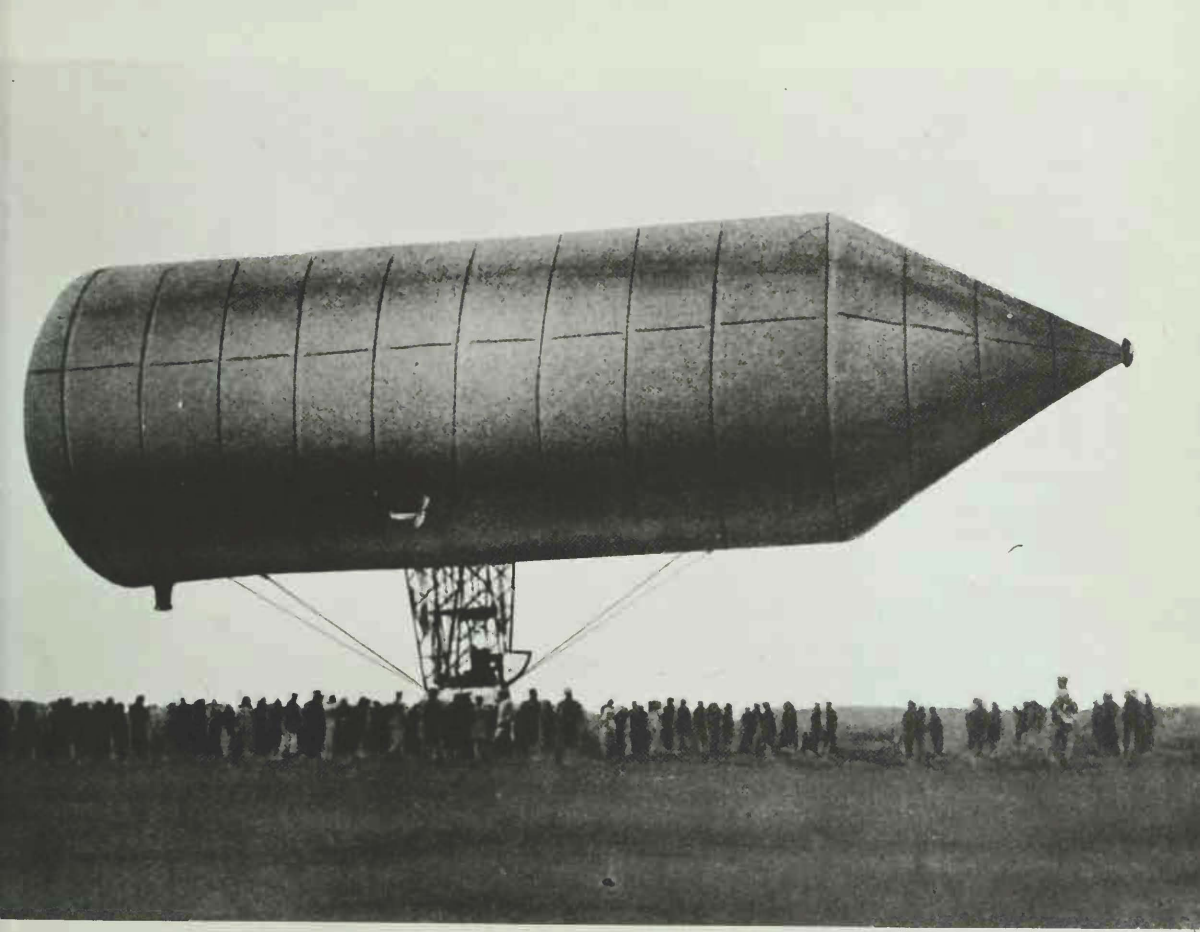
Schwarz continued his experiments, realizing that he would have to make the internal framework stronger. In 1895, with cooperation of the German government, he started work on an improved design.

The new Schwarz dirigible was 175 feet long and had a capacity of 130,500 cubic feet of hydrogen. Shaped like a bullet, it was pointed at the nose and only slightly rounded at the stern. The general design of the ship, as well as the suspension arrangement for the car, were not nearly as advanced as the earlier Stedman proposals had been. Power was supplied by a 16-horsepower Daimler engine which drove three propellers. The only previous dirigible to mount a gasoline engine had been Hans Wölfert's *Deutschland*, which burned and crashed on June 14, 1896.

Inflation of the airship was a problem, since there was no way to expel air from the metal cylinder. This difficulty was solved by Captain Hans Bartsch von Sigsfeld. He suggested that inflation could be accomplished by filling the metal cylinder with bags of gas, thus driving out the air, and then ripping and removing the bags.

David Schwarz died before his second ship could be tested but his wife, Melanie, continued his work. A German soldier named Platz volunteered to fly the airship, and an ascent was attempted on November 3, 1897. Trouble was encountered from the start, when the belts driving the propellers came off their pulleys. The metal hull also developed a serious leak, causing the ship to come down rapidly only four miles from the starting point. Platz escaped by jumping clear before the crash.

10 David Schwarz's airship displayed advanced thinking but was poorly engineered. (Press- und Informationsamt der Bundesregierung)



SANTOS-DUMONT NO. 1 *France*

Alberto Santos-Dumont was a Brazilian by birth, but he accomplished more than any other man to make flying a reality in France, his adopted country. He made the first successful powered airplane flight in Europe on September 13, 1906, but he had been active in airship experiments for a number of years before this date.

Santos-Dumont became interested in aeronautics early in 1897, while he was a student at the University of Paris. After making several ascents in free balloons, he began to think about methods by which the art of aerial navigation could be improved. Despite the limited gains of Renard and Krebs, no one had ever flown into the wind with real success. Santos-Dumont reasoned that this could be accomplished with a dirigible mounting a light gasoline engine which delivered sufficient power.

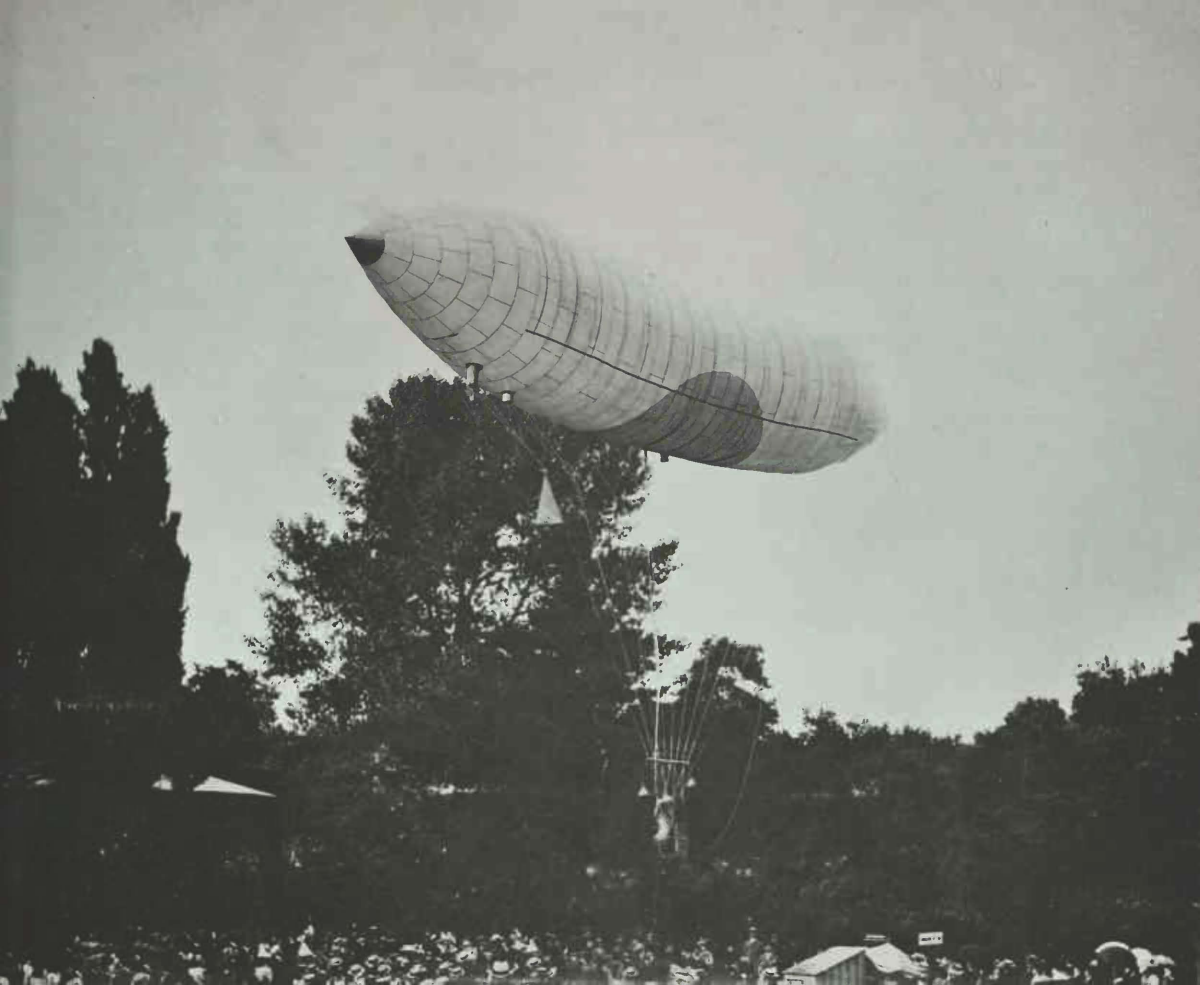
The young Brazilian designed a sausage-shaped envelope 82 feet 6 inches long and containing a mere 6,300 cubic feet of hydrogen. To give his gasbag strength at minimum weight, he made it of varnished Japanese silk. He suspended a wicker car under the bag and fitted it with a three-and-one-half-horsepower motorcycle engine. He called his small craft the No. 1, because he planned to build improved versions.

After one unsuccessful attempt to fly his airship, during which it was damaged by trees, Santos-Dumont was ready to try again on September 20, 1898. This time the No. 1 rose swiftly from the ground and passed safely over the trees, its two-cylinder engine chugging at top speed.

The airship continued to rise and make headway straight into the wind. Santos-Dumont then attempted a turn, and he was surprised that his ship obeyed every slight movement of the rudder.

There is no record of the length of time the No. 1 was airborne, but after a while Santos-Dumont noticed that his gasbag was collapsing — probably because of leaks from the earlier tree damage. He managed to land safely through the help of some boys on the ground. His airship was severely damaged, but it had flown well, proving that controlled flight in lighter-than-air craft was indeed possible.

Santos-Dumont's No. 1 before its ascent from the Zoological Gardens in Paris. (National Archives)



ZEPPELIN LZ-1

Germany

Count Ferdinand von Zeppelin was the most tireless experimenter in the history of airships. His name became so firmly linked with the form that even today many people continue to call all dirigibles "zeppelins," and the U. S. Navy still uses the letter *Z* to designate lighter-than-air craft.

Zeppelin had thought about the possibility of airships for many years, but his theories were entirely different from those of the other pioneers. He felt that a dirigible should be more than a flimsy balloon filled with gas, and that the best method of construction would be a rigid metal framework covered with fabric and containing a series of individual gas cells. However, he was unable to obtain financial backing to test his theories in practice until 1898, when he was sixty years old.

Zeppelin's first airship was designated the LZ-1 (*Luftschiff* Zeppelin-Number 1). It was by far the largest dirigible built up to that time, with a length of 419 feet and a gas capacity of 399,048 cubic feet of hydrogen. For all this size, it mounted only two 16-horsepower Daimler engines.

The LZ-1 was test-flown for the first time on July 2, 1900, at Lake Constance, near Friedrichshafen, Germany. The ship rose successfully, its small engines turning at top speed in an effort to provide sufficient power. Leveling off at an altitude of 1,312 feet, it moved slowly across the lake.

After a flight of seventeen minutes, trouble developed and the LZ-1's structure began to collapse. Count Zeppelin ordered an emergency landing, and the ship was brought down on the lake.

The next flight with the repaired airship was on October 17. It flew for an hour and twenty minutes without difficulty and attained a speed of 17 miles per hour — the fastest yet reached by a dirigible. The third flight was less successful. After being airborne for twenty-four minutes, the LZ-1's aluminum framework again buckled, forcing a speedy descent.

While the LZ-1 was not the complete success that Count von Zeppelin had expected, he was satisfied that his theories had been correct. He immediately started a campaign to raise funds to build an improved model.

Count von Zeppelin ushered in a new airship era with his huge rigid LZ-1. (Luftschiffbau-Zeppelin)

Alberto Santos-Dumont continued to build other airships after the successful flight of his No. 1 in 1898. The following year he completed the No. 2 and attempted to fly it during a rainstorm. The rain contracted the gas and the ship came down into trees, which ripped open the bag. Despite this ill fortune, he built No. 3 and No. 4, both of which were superior to his previous models.

Then, in 1900, a wealthy member of the Aero Club of France named Henri Deutsch offered a prize of 100,000 francs (about $20,000) to the first person to take off from the club's field at Saint-Cloud, circle the Eiffel Tower seven miles away, and return to the field within thirty minutes. Santos-Dumont decided to enter the contest and immediately started work on No. 5.

The Brazilian attempted his first Eiffel Tower flight on July 12, 1901. All went well on the trip to the Tower, but on the return route his craft developed engine trouble and was forced to come down. He tried again on August 4, and was forced down once more. Four days later he made his third attempt. This time the ship exploded, but Santos-Dumont escaped with only a few scratches. That same day he started work on No. 6.

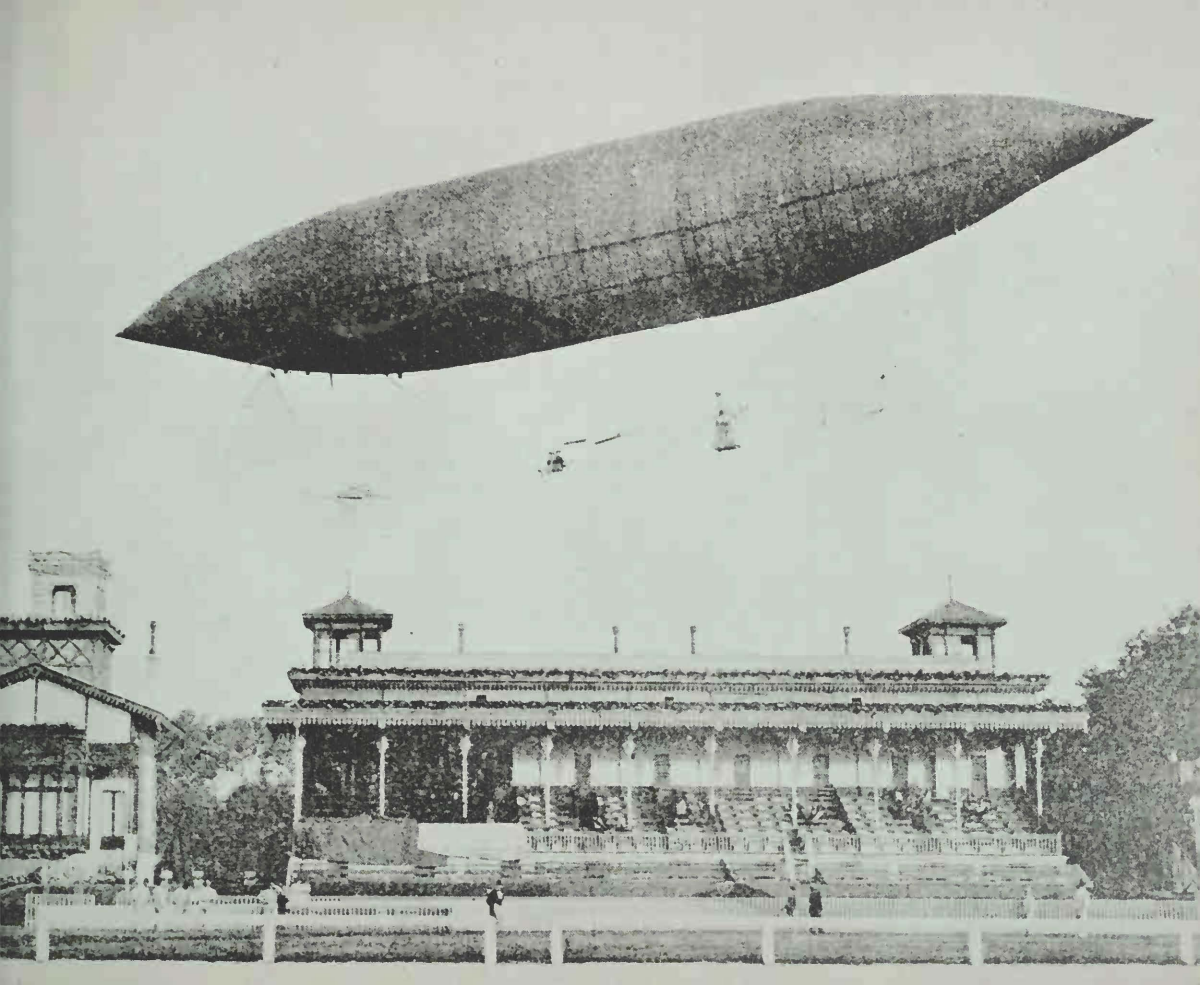
Deutsch offered Santos-Dumont the prize money as a gift if he would *not* attempt the flight again, but the aeronaut refused. Two months later the No. 6 was ready, and after tests the Brazilian announced that he was ready to go for the fourth time.

The dirigible rose from the Saint-Cloud field at 2:42 P.M. on October 19, 1901. Less than nine minutes later it was circling the Eiffel Tower at a height of 800 feet. Then, suddenly, the engine spluttered.

Santos-Dumont walked to the rear of his ship and adjusted the engine, and it started running properly. But many valuable minutes had been lost.

The No. 6 and its pilot crossed the finish line twenty-nine and a half minutes after starting. Upon landing, however, the president of the Aero Club announced that the flight had taken forty seconds too long. Two weeks later this decision was reversed and Santos-Dumont was awarded the prize, which he promptly donated to his mechanics and the poor people of Paris.

Santos-Dumont won world fame when he flew his No. 6 around the Eiffel Tower. (U. S. Air Force)



Paul and Pierre Lébaudy owned a sugar refinery in France and had no particular interest in aeronautics until 1896, when one of their employees, a man named Henri Julliot, asked them to finance a new type of dirigible he had designed. Julliot's theory was that the gasbags of previous airships had been too flexible, and that they would be more dependable with some sort of support. His idea was to hold the shape of the bag constant by attaching a heavy beam along the bottom surface.

The Lébaudys instructed Julliot to go ahead with his design, which was to become the world's first semirigid airship. It was 183 feet long and had a capacity of 80,000 cubic feet of hydrogen. Power was supplied by a 40-horsepower Daimler engine which turned two propellers about 900 revolutions per minute. The bag was made of yellow material, from which the ship derived its name, the *Jaune* (Yellow).

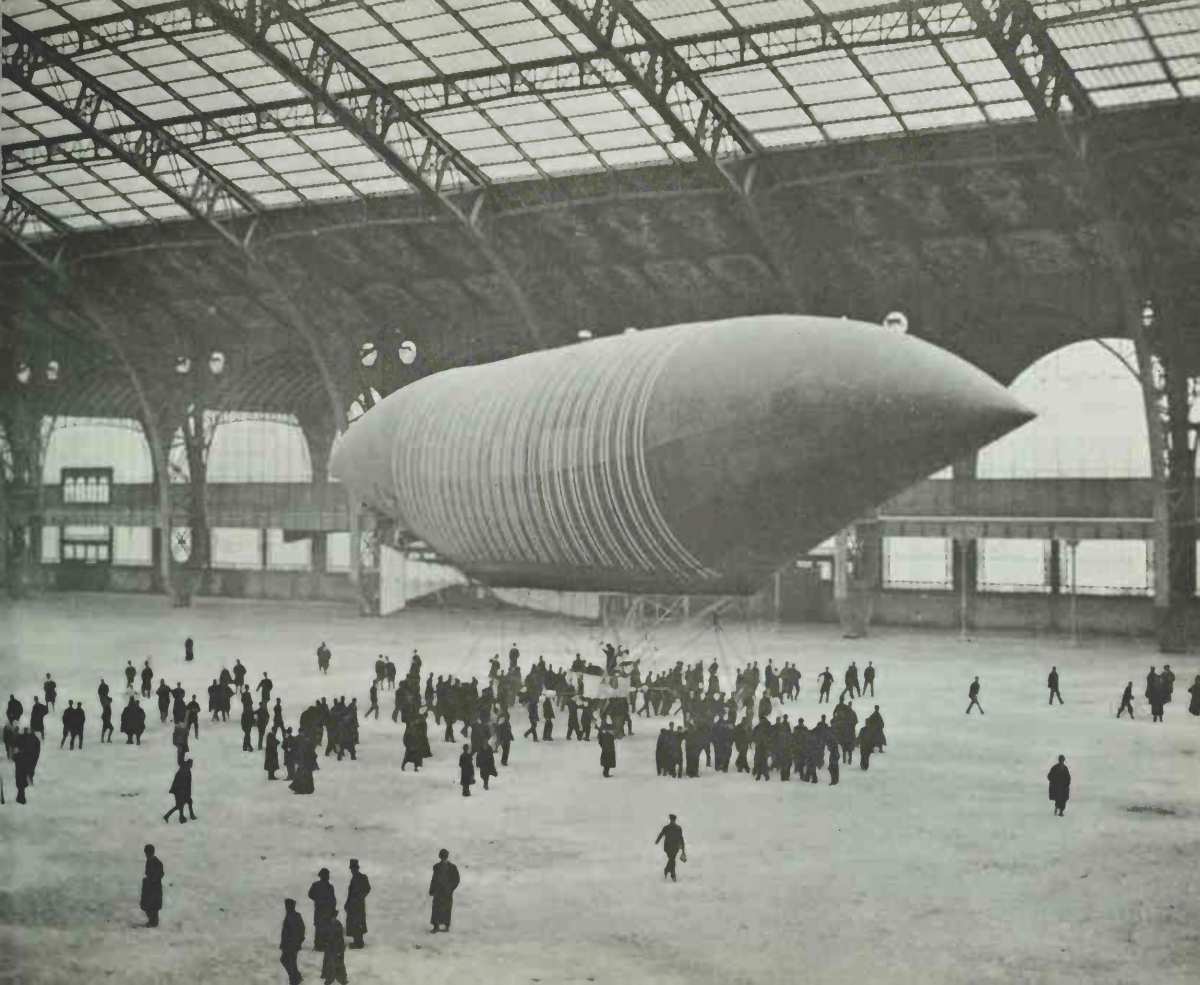
The machine was taken up for its first flight on November 13, 1902, and it proved entirely successful. During the next eight months it was flown twenty-nine times and was able to return to its starting place in all but one of these. It was then grounded for repairs, since the envelope had begun to show signs of wear.

The *Jaune's* longest flight was made on June 24, 1903, when it covered a sixty-mile course in two hours and forty-three minutes. Then, in the middle of November, the crew misunderstood signals from the ground upon landing after a routine flight, and the gasbag was ripped open by a tree.

The ship was rebuilt and improved during 1904. Among other changes, its gas capacity was increased to 116,545 cubic feet and its engine boosted to a 70-horsepower Panhard. In this new form, the craft was renamed the *Lébaudy*.

The French government soon became interested in the *Lébaudy* and ordered it tested for military purposes. Among other tests, it was used for bomb-dropping experiments from an altitude of 3,300 feet. After this evaluation program, the Ministry of War decided to buy the airship, thus making it the first flying machine in the service of any government.

The *Jaune*, renamed the *Lébaudy*, was the world's first military dirigible. (Institute of the Aeronautical Sciences)



Following the outstanding service record of the *Lébaudy*, the French government commissioned the Lébaudy brothers on February 27, 1906, to build a new ship, which was named the *Patrie*. This was to be the first machine in a fleet of dirigibles for the nation, and it was the first powered aircraft to be built to the special order of any government for military purposes.

The *Patrie* was generally similar to the *Lébaudy*, though slightly larger and with better performance. The gasbag was 200 feet long and had a capacity of 126,000 cubic feet of hydrogen, and power was supplied by a 70-horsepower Panhard engine.

Ministry of War specifications required that the airship remain in active operation for three months, during which time it was to be moored in the open, and also that it be capable of performing certain voyages and maneuvers. The *Patrie* passed all these tests in the summer and fall of 1906, after which it was officially approved for military service.

The semirigid dirigible made a number of successful flights. The longest of these was on November 23, 1907, when it flew the 130 miles from Chalais-Meudon to Verdun in six hours and fifty minutes. After landing, the crew discovered that the ship's tanks still contained enough fuel to travel another 200 miles or more.

On the morning of November 29, the *Patrie* left Verdun for a short routine flight. Within minutes, however, a mechanic somehow got his trousers caught in the magneto, thus stopping the engine. This mishap left the ship out of control, and it was carried away by the wind. Captain Bois, the commanding officer, finally managed to regain control and brought the crippled dirigible in for a landing at a small village about eight miles from Verdun, where it was grounded for engine repairs.

The following morning a storm blew up, and despite the fact that some 200 men tried to hold it down, the *Patrie* was ripped away from its makeshift mooring and soared into the air. When it was last sighted by people in Ireland, the runaway ship was traveling north-northwest toward the Atlantic Ocean. It was never seen again.

The *Patrie* was the first dirigible built specifically for military service. (Musée de l'Air, Paris)

In 1906 an American named Walter Wellman conceived the idea of flying across the North Pole in an airship. No civilized man had ever been to the Pole, and Wellman's proposed adventure was considered to be one of the most daring exploits ever planned.

Wellman designed his dirigible as the semirigid type. It was 228 feet long and had a capacity of 258,000 cubic feet of hydrogen. A car 156 feet long was slung beneath the balloon, with accommodations for a crew of six as well as two engines. As a safety measure, he also carried a 30-foot lifeboat below the car.

A unique feature of the airship, which was christened the *America*, was a guide rope called an "equilibrator." According to theory, the equilibrator would trail on ground, ice, or water and keep the ship at the same altitude without the need for venting gas or discharging ballast.

The dirigible was ready by the summer of 1907, and on September 2 Wellman and his five companions rose from the ground at Smeerenberg, Spitsbergen, and headed north toward the Pole. After only thirty-five miles, however, the ship encountered a violent storm and was forced down. Two years later Wellman tried a second time, only to be forced down after forty miles when the equilibrator broke.

Following these failures, Wellman decided to use the *America* for an attempted nonstop flight across the Atlantic Ocean. The big dirigible lifted from the water off Atlantic City, New Jersey, on the morning of October 15, 1910. Twenty-four hours later, after considerable engine trouble as well as difficulty with the equilibrator, the *America* was over Nantucket, Massachusetts. A strong wind then blew up, and by three o'clock that afternoon the situation began to look serious.

The *America* drifted helplessly for two days, after which the crew was rescued by a steamer 375 miles east of Norfolk, Virginia. The lightened airship then rose from the waves and drifted out of sight.

The *America's* career had been full of disappointments. But it had broken all airship records by flying 1,008 miles, only 250 miles of which had been on course.

Wellman's *America* in Spitsbergen before its first attempted Polar flight. (Underwood & Underwood)

With financial aid from the King of Württemberg as well as the people of Germany, Count von Zeppelin started work on his LZ-2, which was completed in November, 1905. But again the old count was beset by bad luck, and the ship was damaged before it was taken up for its first flight. After repairs had been made, it was flown for the first time on January 17, 1906. Everything went well for a time, and then the rudder controls jammed. The huge ship landed safely, but that night it was destroyed by a violent windstorm.

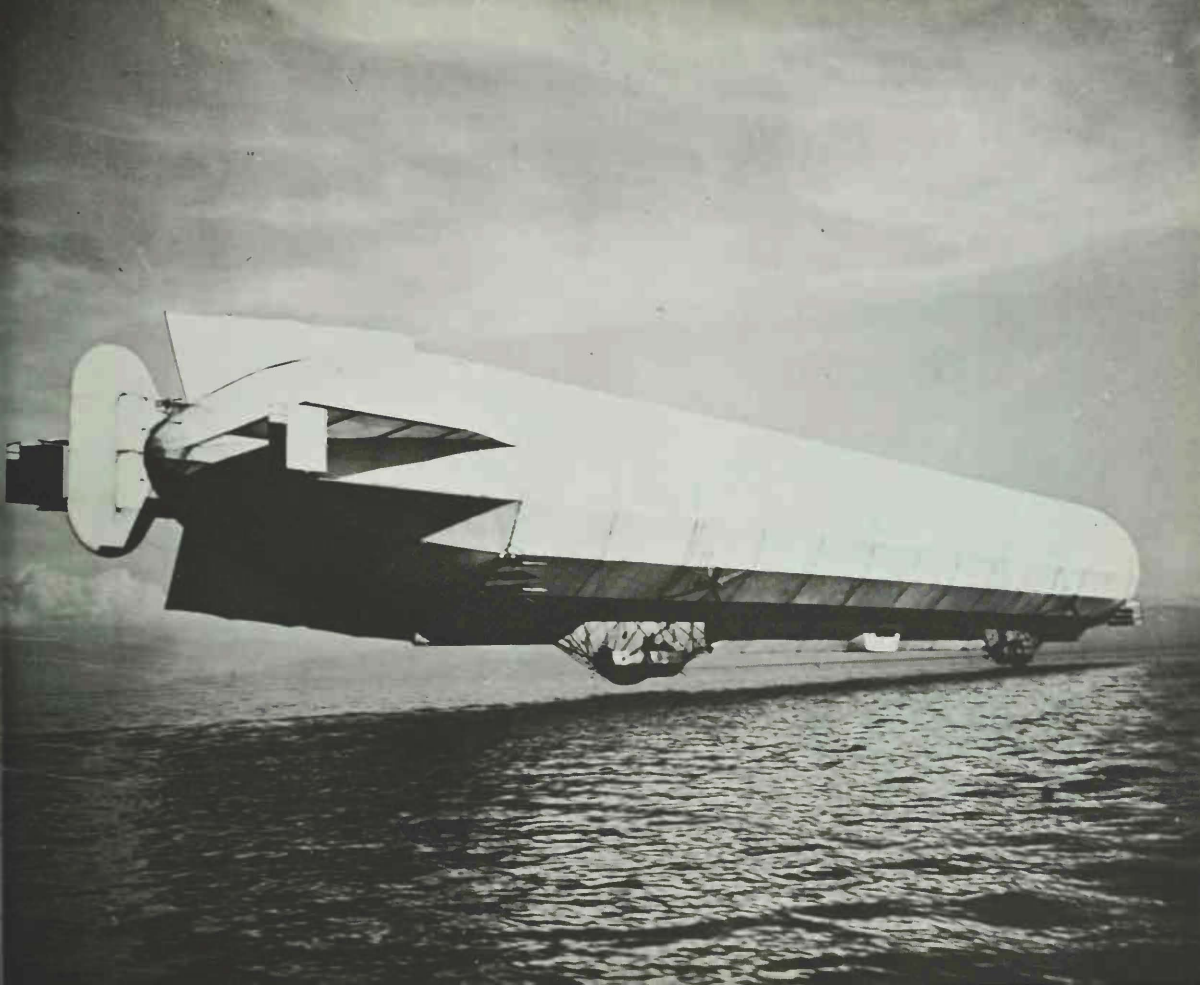
Next came the LZ-3 in 1906. This ship was a great success, and on one occasion it was flown 218 miles in less than eight hours. The German government was impressed, but it announced that future airships, in order to receive financial backing, would have to fly nonstop for at least twenty-four hours, cover a distance of 435 miles, and achieve an altitude of 5,000 feet. With these specifications in mind, Zeppelin started work on his LZ-4.

The airship was of monstrous proportions, 446 feet long and with a capacity of 519,000 cubic feet of hydrogen. It was completed in June, 1908, and on July 1, after several test flights, it made a nonstop twelve-hour run from Friedrichshafen to Switzerland and return, achieving speeds of up to 40 miles per hour. Elated by this success, Zeppelin next planned to undertake a twenty-four-hour nonstop voyage.

The LZ-4 rose from the ground at 7 A.M. on August 4 for its great journey. All went well for eleven hours, after which one of its two 104-horsepower Daimler engines developed trouble. Zeppelin ordered a landing at Nierstein, where the trouble was corrected. Engine trouble forced the ship down once again near Stuttgart on the return trip. While the ship was on the ground, a severe storm blew up unexpectedly, and the LZ-4 tore away from its moorings and burned.

Count von Zeppelin had lost three of his first four ships, but he was more than ever convinced that dirigibles were practical. Except for the delay at Nierstein, the LZ-4 had flown the required twenty-four hours. No other flying machine had ever achieved such a record.

The Zeppelin LZ-4 was the first dirigible to remain airborne for 24 hours. (Luftschiffbau-Zeppelin)



A number of pioneers in the United States experimented with airships in the early nineteen hundreds, the most successful of whom was Captain Thomas S. Baldwin. He built his first dirigible in 1904, calling it the *California Arrow*. The most important feature of the ship was its lightweight gasoline engine, which had been designed by a young motorcycle builder in Hammondsport, New York, named Glenn Curtiss.

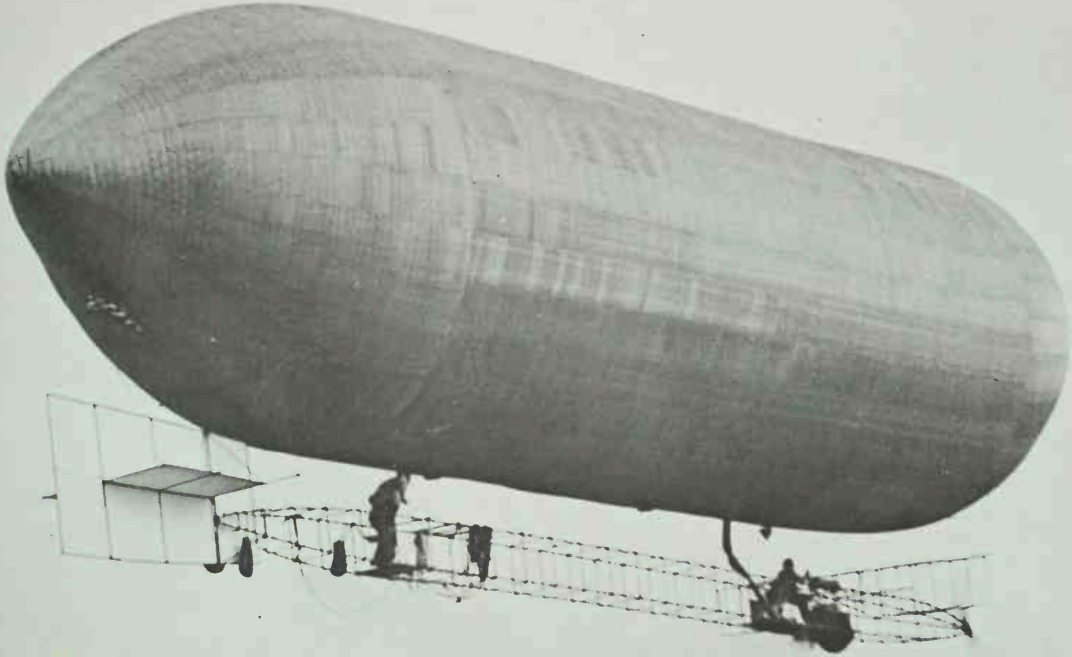
A nonrigid design, the *California Arrow* was similar in general layout to the Santos-Dumont types. The airship was a success from the beginning. On August 3, 1904, it became the first flying machine in the United States to cover a circular course and land at the point of departure. Later that same year it also proved itself superior to all domestic and European dirigibles exhibited at the World's Fair in St. Louis. Then, on February 3, 1905, the ship made headlines once again when it raced a Pope-Toledo automobile over a ten-mile course in California and won by three minutes.

As a result of the fine performance of the *California Arrow*, the U. S. Army decided to investigate the value of airships and contracted Baldwin to build one for the Signal Corps. It was designated SC-1 (Signal Corps-Number 1) and was the first powered aircraft ever ordered for military service in the United States.

Baldwin and Glenn Curtiss worked together on the design and construction of the SC-1. Its gasbag was made of rubberized silk and was 96 feet long, with a capacity of 19,500 cubic feet of hydrogen. The ship had a double rudder at the rear of its car and elevators in the front. Power was supplied by a 20-horsepower air-cooled engine developed by Curtiss.

According to military requirements, the SC-1 was to be capable of a speed of at least 20 miles per hour and an endurance of two hours. During tests on August 18, 1908, in which Baldwin was the pilot and Curtiss the engineer, the ship remained aloft the required two hours but averaged a speed of only 19.61 miles per hour. Since it had failed to meet the requirements by 39/100ths of a mile per hour, Baldwin was penalized 15 per cent of the contract price!

Captain Baldwin and Glenn Curtiss flying above Ft. Myer, Virginia, in the SC-1. (U. S. Air Force)



Germany was virtually "Zeppelin mad" in the early nineteen hundreds, but important work was also being accomplished by other designers in the country. Foremost among these was Major August von Parseval.

Parseval's interest in airships dated back to 1892, when he and Major Hans Bartsch von Sigsfeld designed a kite balloon, or *drachen*. These first appeared in maneuvers with the German army in 1897. Unlike other captive balloons, which twisted with the wind, the Parsevals were more stable because of their shape and method of inflation.

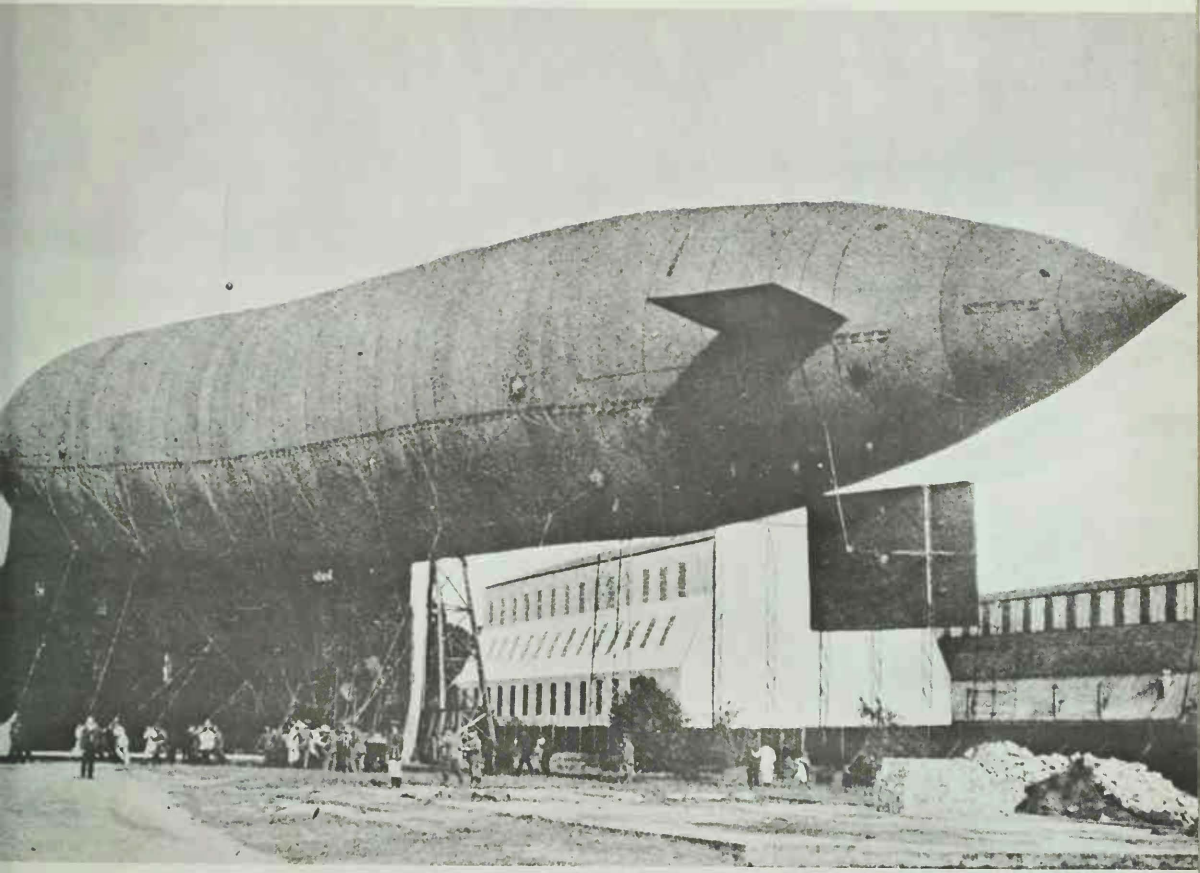
But while the *drachens* were extremely successful, they were not powered and had to be attached by cable to a winch on the ground. Parseval reasoned that his airship would have more military value if it could maneuver under its own power.

The first Parseval dirigible, the PL-1, was ready for tests in 1906. It was 170 feet 6 inches long and had a capacity of 113,000 cubic feet of hydrogen. Power was supplied by a 50-horsepower Daimler gasoline engine which turned a collapsible, canvas-covered propeller. The engine also operated a blower which forced air into two ballonets within the gasbag, thus keeping the bag fully inflated regardless of whether the gas expanded or contracted. Another advantage was that the ship could be deflated and packed on two horse-drawn wagons. This gave it excellent mobility for military purposes.

The PL-1 performed so well that the War Ministry contracted Parseval to build a larger model. This ship, which was designated PL-2 by Parseval and P-1 by the military, was 197 feet long, had a gas capacity of 141,270 cubic feet, and mounted an 85-horsepower Daimler engine.

Despite the fact that the Parsevals were the best nonrigids in existence, the German government was more interested in the rigid Zeppelins, and Parseval was given permission to sell his ships to other countries. Austria, Russia, Italy, France, Japan, and England soon placed orders. The British also arranged to build Parseval-type dirigibles under license, and several of these saw action against Germany in World War I.

The nonrigid Parseval P-1 had more mobility than cumbersome kite balloons. (National Archives)



Concerned by the fact that they had no dirigibles for possible military service while the French and Germans had several, the British attempted in 1906 to set up a building program of their own. Their first effort was built the following year by Major J. E. Capper of the Royal Engineers and Samuel Cody, an American. The machine was of the semirigid type, and it bore the imposing name of *Nulli Secundus*, which was Latin for "Second to None." This was an unfortunate selection of a name, for shortly after the ship was completed it was wrecked in a slight rainstorm.

Following another failure with the *Nulli Secundus II*, the British sought help from the French, and a ship was ordered from the Clément-Bayard firm. Gustave Clément had previously designed a dirigible for the Russian government, and it had proved quite successful before it was wrecked as the result of engine failure. Among other tests, it had flown continuously for two hours at an average speed of 30 miles per hour and had ascended to a height of 5,085 feet.

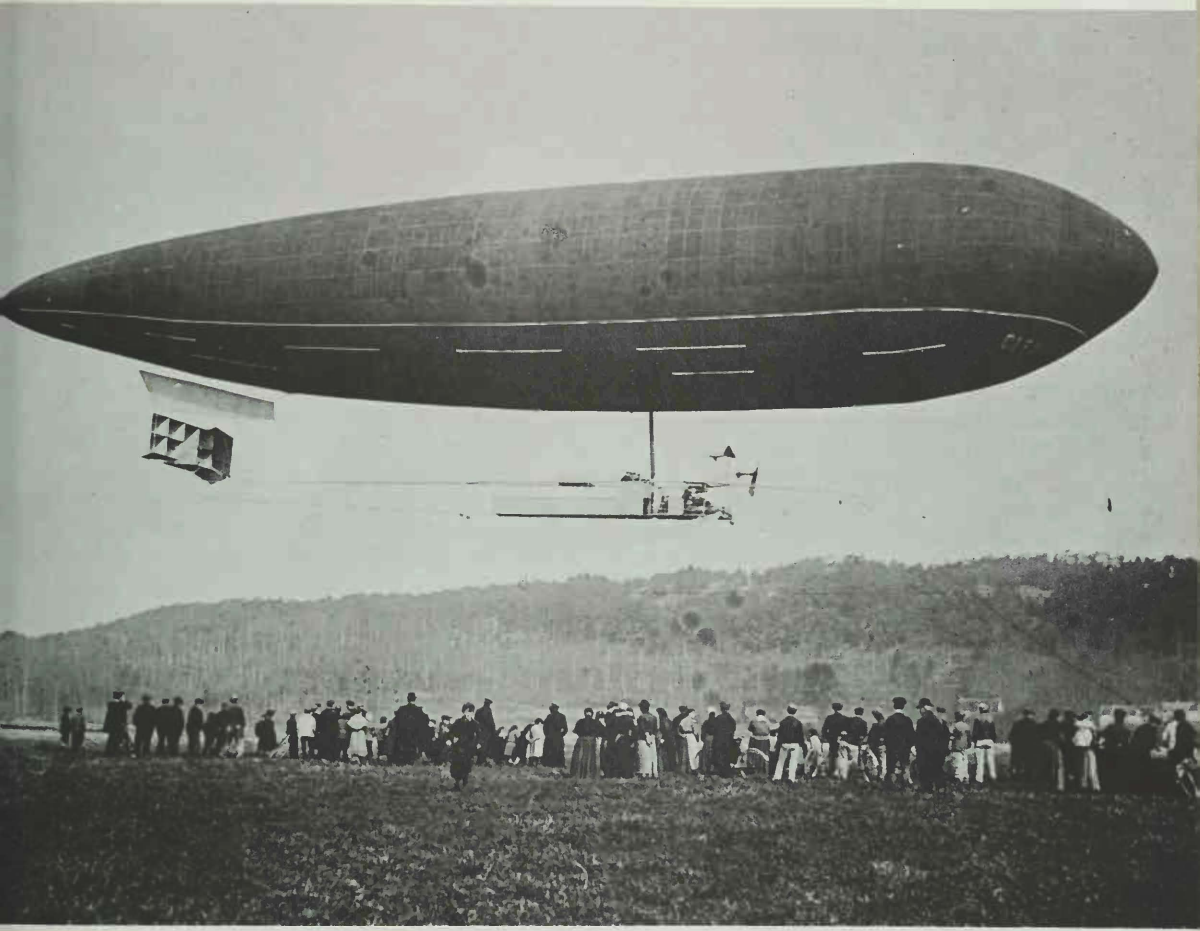
The Clément-Bayard II was completed in April, 1910, after eighteen months of work. The ship was large for a nonrigid, with a length of 251 feet and a capacity of 247,000 cubic feet of hydrogen. It was powered by two 130-horsepower Clément engines. As in the Parsevals, the shape of the gasbag was kept constant by two ballonets which were pumped full of air by the engines.

The airship made thirty-two shakedown flights in France and proved itself capable of operating in varying types of weather. The best cruising speed attained during these trials was 41 miles per hour.

On October 16, 1910, the Clément-Bayard II took off from the firm's field at Lamotte-Breuil and turned north toward London. This was the first time that any powered airship had attempted to cross the English Channel. The Channel crossing required only forty-five minutes, whereas the entire voyage of 242 miles was made nonstop in six hours at an average speed of slightly better than 40 miles per hour.

After the British examined the ship they found that the gasbag was defective, and it was never flown again.

The Clément-Bayard II was the first airship to fly across the English Channel. (Musée de l'Air, Paris)



While Count von Zeppelin was enjoying his early triumphs and also suffering his bitter defeats, an engineer named Johann Schütte was teaching ship construction in Danzig, Germany. After the LZ-4 was destroyed, Schütte turned his attention to the problem of the dirigible, with the hope that he might be able to improve upon the Zeppelin construction methods.

Schütte believed that Zeppelins continued to suffer troubles because their aluminum-alloy frames were too rigid. He planned, instead, to use aspen wood, laminated and then fashioned into girders. He reasoned that this would make for a more flexible structure which would bend but not collapse under the force of heavy storms. However, he did not have enough money to test his theories in actual practice.

An industrialist named Heinrich Lanz was attracted by Schütte's ideas, and he agreed to contribute money to build a full-size airship. Further financial assistance was given by a man named August Rochling.

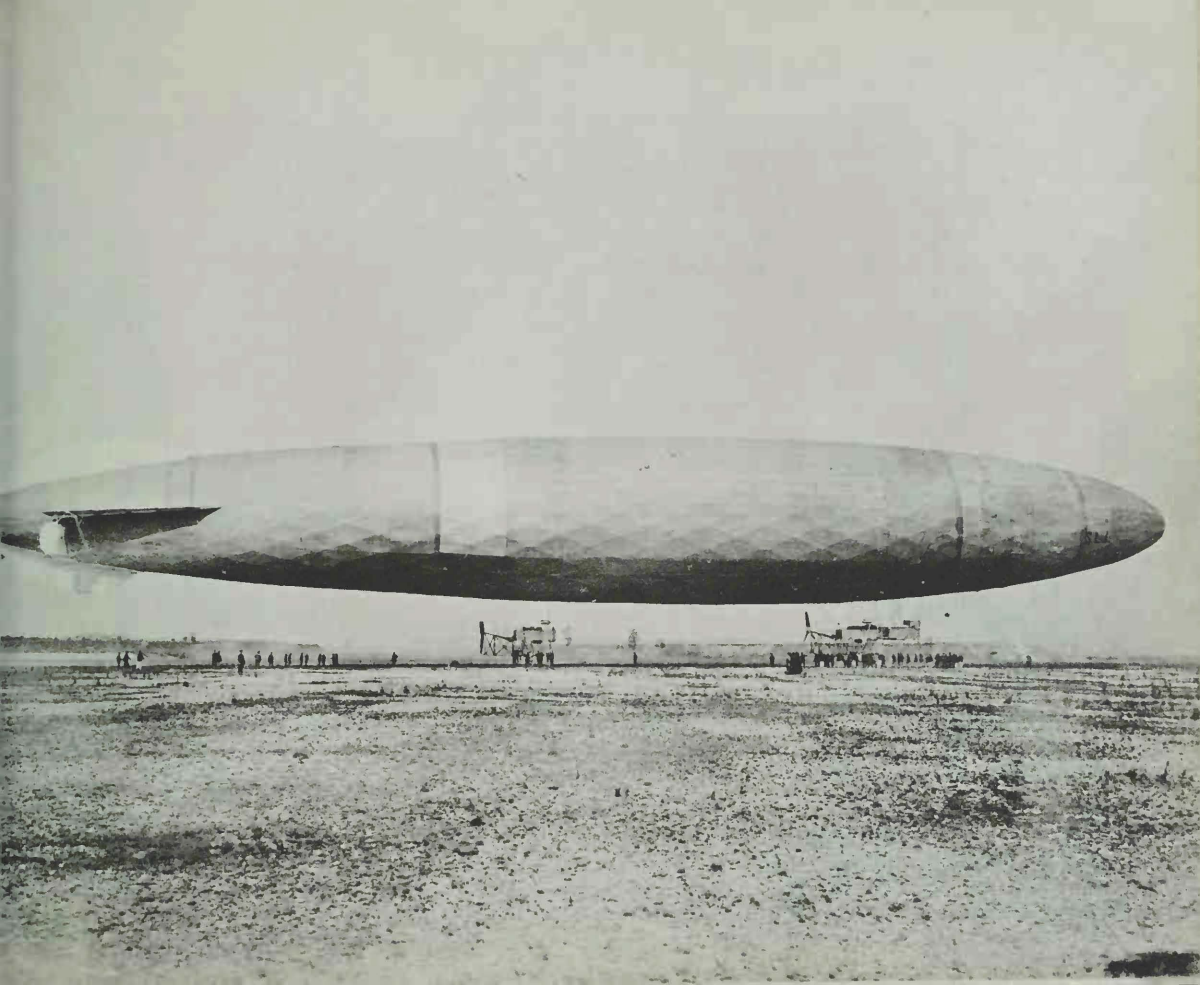
Schütte started work in the winter of 1908 to complete his plans for the Schütte-Lanz SL-1. The ship was ready for its first tests on October 11, 1911.

Whereas all Zeppelins before this time had been of cylindrical shape with pointed ends, the SL-1 was smoothly streamlined. Its steering system was also so much better than those on other airships that it was copied by future builders. The ship was 430 feet long and had a capacity of 723,650 cubic feet of hydrogen. Powered by two 250-horsepower Daimler engines, its cruising speed was 33 miles per hour.

The German Army was so impressed by the SL-1 that it not only bought the ship but contracted Schütte-Lanz to proceed with a larger and improved design.

The SL-2 made its first flight on February 28, 1914. It was 473 feet long and had a capacity of 882,800 cubic feet of hydrogen. With four 180-horsepower Maybach engines, it had a speed of 54 miles per hour. This was the first truly modern dirigible. Its streamlined shape, stabilizers, rudders, enclosed gondolas, and other features were later adopted by airship designers throughout the world.

Smoothly streamlined, the Schütte-Lanz SL-1 was a new concept in airship design. (U. S. Air Force)



Count von Zeppelin from the very beginning had visualized his rigid dirigible as a military weapon and had even said that he would "tolerate no commercialization of it." However, Dr. Hugo Eckener managed to convince the old count that his ships should not be strictly weapons of war. In November, 1909, following this new trend of thought, Zeppelin established the world's first true airline company, the Deutsche Luftschiffharts Aktien Gesellschaft (German Air Navigation Company), which was more commonly referred to as the Delag.

Before commercial service could be started, it was necessary to build docking facilities at major cities. Work on the first route was completed in the spring of 1910, and the introductory passenger flight was made on June 22 with the LZ-7 *Deutschland* over the 300-mile run between Friedrichshafen and Düsseldorf.

Disaster struck the *Deutschland* on the third flight, when its hydrogen cells sprung leaks during a storm. The ship was destroyed, but its thirty-three passengers escaped. Despite this setback, the older LZ-6 was placed in service over the route. It made fifty-nine flights and carried 1,679 passengers in complete safety.

In 1911 the LZ-10 *Schwaben* was added to the route, and in a period of a year it carried 2,380 passengers in 218 trips.

Inspired by this record, Zeppelin built three other ships for the Delag — the LZ-11 *Viktoria Luise*, the LZ-13 *Hansa*, and the LZ-17 *Sachsen*.

While all these new ships were successful, the *Viktoria Luise* compiled the most impressive record. In 489 flights it carried 9,738 passengers without serious trouble. It was also the smallest of the three, measuring 459 feet and with a capacity of 659,700 cubic feet of hydrogen. Powered by three 170-horsepower Maybach engines, it had a speed of 47 miles per hour.

With the outbreak of World War I in July, 1914, the Delag fleet was taken over by the German government. The company had been in operation four years, during which its airships had made 1,587 flights totaling 107,207 miles without injury to a single one of its 34,228 passengers.

The *Viktoria Luise* helped pave the way for passenger transportation by airship. (Institute of the Aeronautical Sciences)


VIKTORIA LUISE

During World War I, German airships made fifty-one bombing raids against England, during which 5,806 bombs weighing 196 tons were dropped. In these attacks 557 people were killed and 1,358 injured, while total property damage caused by the raiders amounted to $7,322,400. To combat the dirigible menace, the British were forced to keep twelve fighter plane squadrons and 17,341 officers and men away from the fighting fronts for home defense.

Despite this record, the greatest airship achievement during the war was not in bombing but in an attempt to relieve the German garrison at Mahenge in German East Africa (now Tanganyika). The garrison was more than 3,600 miles from the closest airship base in Europe, and all surface lines of communication were blocked by the Allies. The War Ministry decided that the only way to carry in needed medical supplies and ammunition would be by air.

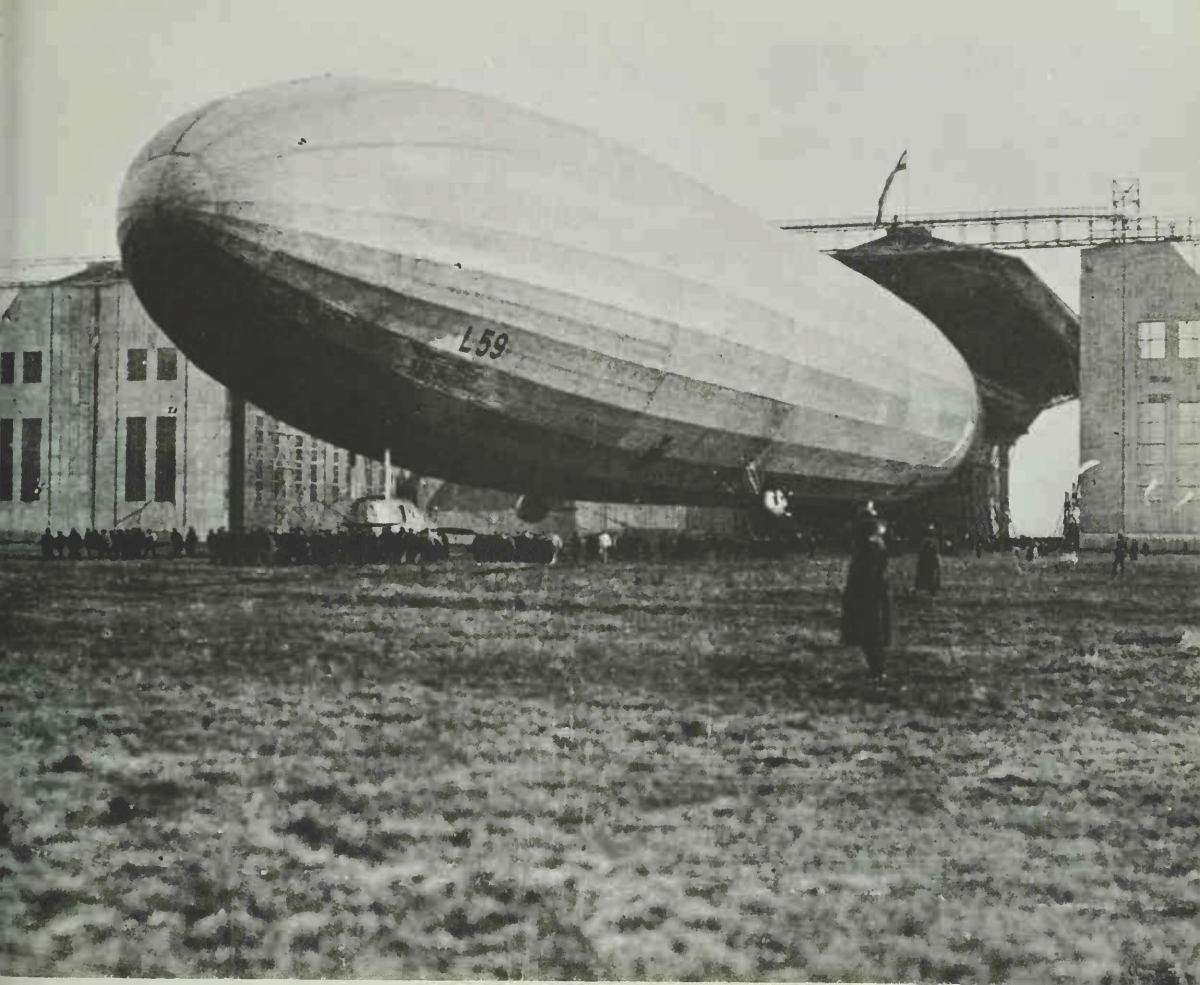
The ship selected for the long flight was the Zeppelin LZ-104, which had been redesignated L-59 by the military. It was 745 feet long and had a capacity of 2,381,000 cubic feet of hydrogen. Power was supplied by five 240-horsepower Maybach engines.

The L-59 was taken up for the first time on October 25, 1917. Eight days later, loaded with 30,332 pounds of supplies, including 382,000 rounds of ammunition, it took off from Staaken, Germany, and flew to Yambol, Bulgaria, in twenty-eight hours. On the morning of November 21, the airship left Yambol on its historic voyage.

The L-59 flew southeast to European Turkey, and then across the Aegean and Mediterranean seas toward Africa. Two days later, after it had traveled some 2,100 miles, the ship received an order by radio to return, since the East African garrison had been virtually surrounded.

No one in Germany actually thought that the Zeppelin would be able to make the return flight, but on November 24 it landed safely at Yambol, after ninety-five hours in the air and covering 4,225 miles. This was a nonstop flight record which was to stand unsurpassed for many years. It also proved that intercontinental airship transportation was entirely feasible.

The long flight of the L-59 in 1917 was an aerial record without comparison. (Imperial War Museum)


L59

The first dirigible in the U. S. Navy was the nonrigid DN-1, which was delivered for service in April, 1917, the month the United States entered World War I against Germany. However, the ship was poorly designed and was practically worthless for sustained flight operations.

The Navy next ordered the Type B ships into production. These were more successful and were able to remain aloft for twelve hours, but they were small and slow and had many shortcomings.

In the spring of 1918 the improved Navy-designed nonrigid Type C ships appeared. An order for twenty of these was shared by the Goodyear Tire & Rubber Company and the Goodrich Rubber Company. They had a length of 192 feet and a capacity of 180,000 cubic feet of hydrogen. Maximum speed with two 125-horsepower French Hispano-Suiza engines was 60 miles per hour. At a cruising speed of 45 miles per hour they could fly for approximately forty-seven hours and cover some 2,100 miles.

The Navy was so excited about the performance of the C-ships that after the war one of them, the Goodyear-built C-5, was groomed for an attempted crossing of the Atlantic Ocean — a feat that had never been accomplished by any type of aircraft.

The C-5 took off from Montauk, Long Island, New York, on May 15, 1919, and headed toward St. John's, Newfoundland. The trip of 1,400 miles was made in a little more than twenty-four hours.

An unexpected storm suddenly blew up the following morning and winds of up to 70 miles per hour battered the ship. The ground crew held on relentlessly, fighting against the elements. Then a tremendous gust abruptly tore the airship from their hands. Crewless, it soared into the air and was never seen again.

With just a bit of luck, the C-5 would undoubtedly have been the first aircraft to cross the Atlantic Ocean.

This was not the end of the history-making career of the C-ships. In 1921 the C-7 became the world's first airship to be inflated with helium. After this, no lighter-than-air craft in the U. S. Navy was allowed to fly with explosive hydrogen.

With a little luck, the C-5 would have crossed the Atlantic Ocean in 1919. (National Archives)


C-5

Aside from the purchase of the Baldwin SC-1 in 1908 (see page 26), neither the U. S. Army nor the Navy displayed any interest in powered lighter-than-air craft prior to World War I. With the doubtful success of the Navy's building program during the war, three nonrigid airships were ordered from the Société des Ballons Dirigeable Zodiac, a French firm that had been building airships for a number of years. The contract for these was signed on June 5, 1918.

With the advent of the Armistice in November, 1918, the order was reduced to two ships. The first of these was completed in the spring of 1919, and it made several shakedown flights in France, including one of six hours, before being shipped to the United States.

The Zodiac had been planned originally for service with the Navy, but the ship was turned over to the Army Air Service and designated ZD-US-1. It was the largest nonrigid dirigible built to that time, with a length of 262 feet and a capacity of 340,000 cubic feet of hydrogen. Powered by two 290-horsepower Renault engines, it had a speed of 49 miles per hour. Designed strictly as a fighting machine, it carried the most powerful weapon ever mounted on a dirigible — a 75-millimeter cannon which fired a projectile weighing thirteen pounds. It also had a fully enclosed cabin for the crew of eight officers and men.

The Air Service put the Zodiac through a strenuous test program to evaluate its military worth. It was used for bombing, for observation duties with radio equipment, and for aerial reconnaissance. During this period it was redesignated the DZ-1.

After three years of active service the ship was rebuilt by Airships Incorporated at Hammondsport, New York, and the designation changed once again — this time to RN-1. Among other changes, 400-horsepower Liberty engines were substituted for the Renaults, and a platform accommodating a machine gunner and two observers was added to the top of the envelope. Access from the car to the gun platform was by a tunnel shaft up through the gasbag.

In 1924, after four years of service, the RN-1 was dismantled.

The Zodiac RN-1 was the first dirigible built to mount a 75-millimeter cannon. (U. S. Air Force)


U.S.ARMY

German dirigibles caused so much bomb damage to England during World War I that the British designed two large rigid airships for reprisal raids, both of them based on the Zeppelin L-33, which had been shot down virtually intact in September, 1916. These were the Armstrong-Whitworth R-33 and the Beardmore R-34. However, neither machine was ready for active combat duty before the Armistice.

The R-34 was the first to be completed, and it made a number of shakedown flights over Europe and the North Sea, the longest of which covered 2,400 miles. The Air Ministry then proposed that the airship be used to fly nonstop from England to the United States. It was sufficiently large to make the crossing, measuring 643 feet from stem to stern and with a gas capacity of 1,980,000 cubic feet of hydrogen. Powered by five 270-horsepower Sunbeam Maori engines, it had a design range of some 5,000 miles.

The R-34 rose from the ground at East Fortune, near Edinburgh, Scotland, on July 2, 1919, to attempt its epic flight. Held to an altitude of 1,500 feet by its load of more than 46,000 pounds, including 4,900 gallons of gasoline, the airship pointed out into the fog-shrouded Atlantic Ocean.

The dirigible flew either in fog or between layers of clouds for hundreds of miles. Then, as it approached Newfoundland, heavy storms were encountered. At this point a startling discovery was made: due to strong headwinds, more fuel had been used than anticipated. In order to conserve gasoline, the ship's commander, Major G. H. Scott, ordered two of the engines stopped.

The R-34 ran into another storm as it approached Maine, reducing the fuel supply still more. When it landed at Roosevelt Field, New York, on July 6, its tanks contained enough fuel for only another forty minutes' flying. But the first dirigible crossing of the Atlantic had been made — 3,130 miles in 108 hours and twelve minutes.

On July 10 the ship started back to England. This time, due to favorable winds, the crossing was made in only seventy-five hours and three minutes. For the first time in history, the Atlantic had been spanned in both directions by air.

The R-34 at Roosevelt Field before its return flight across the Atlantic. (Smithsonian Institution)


R 34

Count von Zeppelin was seventy-nine years old when he died of pneumonia on March 8, 1917. The following year World War I came to an end.

During hostilities German airships had established excellent safety records and had made well over a thousand flights. With the coming of peace, Dr. Hugo Eckener, who was now in charge of the Zeppelin Company, turned his attention once again to peaceful application of the dirigible.

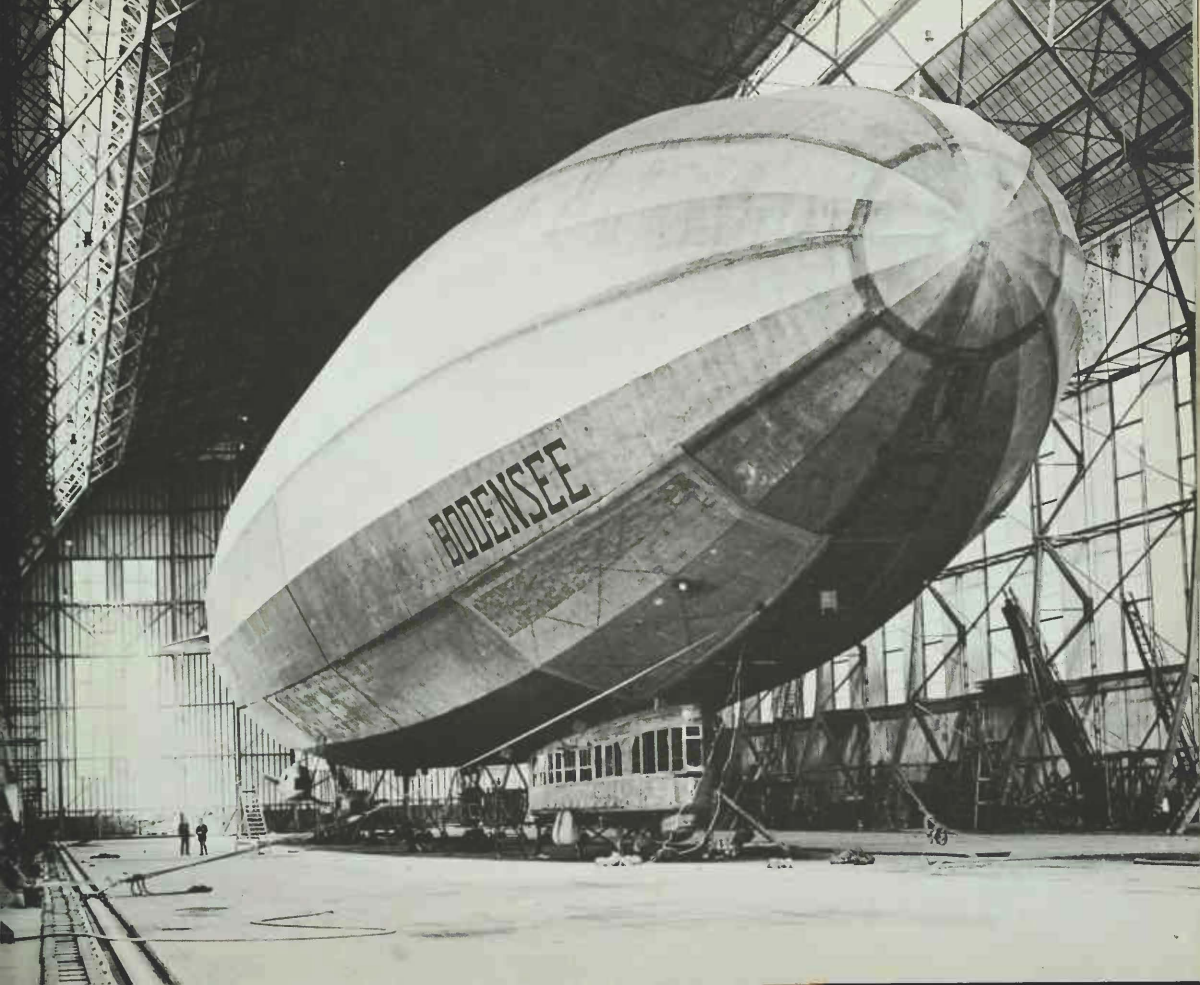
The Armistice Commission had restricted the size of the airships Germany could build, but Dr. Eckener proceeded with his plans to revive the Delag (see page 34). His first postwar ship was the LZ-120 *Bodensee*, which was completed in July, 1919. The machine was only about the size of the prewar *Sachsen*, but its lifting capacity and speed were once again as great. During test flights it attained a speed of 83 miles per hour, which was the fastest ever recorded to that time for a lighter-than-air craft. It had a capacity of 706,320 cubic feet of hydrogen, and power was supplied by four 260-horsepower Maybach engines.

The *Bodensee* went into service on the Friedrichshafen-to-Berlin route in the fall of 1919. In a period of only ninety-four days it made 103 successful trips between the two cities, logging 532 hours in the air and carrying 2,252 passengers. It was also flown to Sweden, and plans were made to open a run to Stockholm.

Experience with the *Bodensee* was so good that the Zeppelin Company built the LZ-121 *Nordstern*, which was also planned for Delag service. However, the Inter-Allied Air Control Commission ordered a halt to German air transport operations just as the *Nordstern* was to go into operation.

Then, in 1920, the Allies confiscated the remaining German wartime airships, the *Bodensee* and *Nordstern* among them, claiming that these had been constructed of war materials. The *Bodensee* was turned over to Italy and renamed the *Esperia*; it was used to a limited extent for several years. France took the *Nordstern*, renaming it the *Méditerranée*, and used it for experimental purposes until 1927. Loss of these ships put an end to further Delag operations.

Following World War I, the Germans built the *Bodensee* for passenger service. (Institute of the Aeronautical Sciences)


BODENSEE

NAVAL AIRCRAFT FACTORY ZR-1 *SHENANDOAH*

United States

On October 19, 1917, the Germans launched one of their greatest World War I air raids against England. Eleven Zeppelins took part in the attack, five of which were forced down by a severe storm during the return flight. One of these, the L-49, was captured intact. After the war this ship was to serve as the model for the United States' first rigid dirigible, the ZR-1 (Zeppelin Rigid-Number 1) *Shenandoah*. Shenandoah was an Indian name meaning "Daughter of the Stars."

The airship was built by the Naval Aircraft Factory in Philadelphia, Pennsylvania, and assembled at Lakehurst, New Jersey. It was 680 feet long and had a capacity of 2,115,000 cubic feet of helium — a gas which would neither burn nor explode. This was the first time that helium had ever been used in a rigid airship, and experts confidently insisted that it made the *Shenandoah* the safest aerial machine ever built.

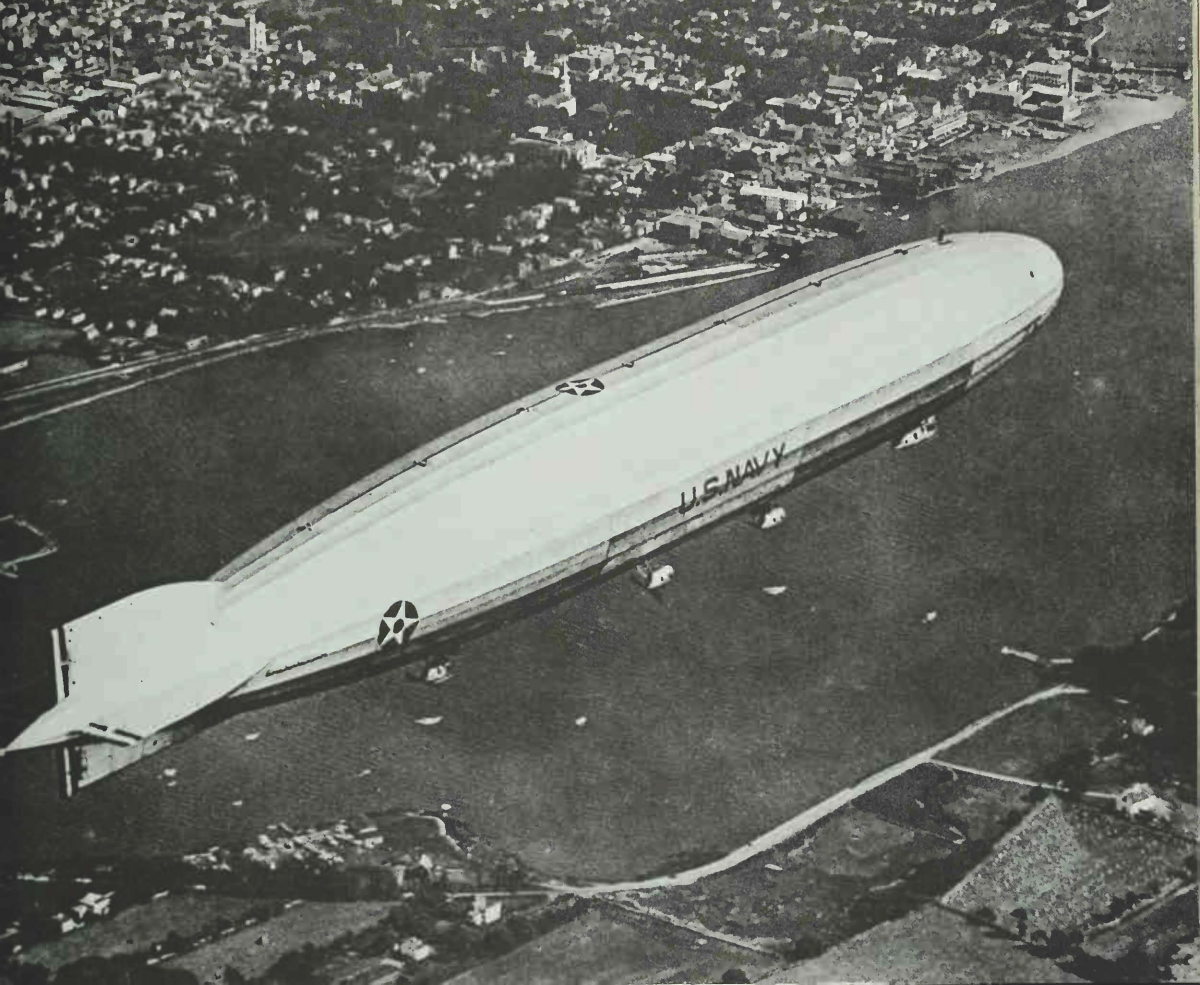
The dirigible was taken up for the first time on September 4, 1923. After a flight of fifty-nine minutes, it was brought down and proclaimed acceptable for service.

The *Shenandoah* experienced a number of thrilling incidents. In one of these, it was ripped from its mooring mast by a 70-mile-per-hour gale and blown almost 100 miles away. After fighting the storm for several hours, the damaged ship was finally brought back to Lakehurst.

The airship made fifty-seven flights covering about 25,000 miles, including a transcontinental demonstration tour of 9,317 miles. It performed so successfully that plans were even made to use it for an aerial assault against the North Pole. Then, at 2:52 P.M. on September 2, 1925, the *Shenandoah* left its dock at Lakehurst for what was to be its last flight.

All went well until 5:22 the following morning, when a violent line squall was unexpectedly encountered near Marietta, Ohio. Winds of up to 72 miles per hour tossed the huge dirigible around like a toy balloon, then snapped it into three separate sections. Fourteen members of the gallant crew of forty-one were killed in the crash, including the ship's captain, Commander Zachary Lansdowne.

The ZR-1 *Shenandoah* was the first rigid dirigible built in the United States. (U. S. Navy)


U.S.NAVY

On October 12, 1924, a Zeppelin designated LZ-126 rose from the ground at Friedrichshafen, Germany, and pointed toward the Atlantic Ocean. Eighty-one hours and seventeen minutes later, after a flight of 5,060 miles, Dr. Hugo Eckener brought the ship in for a landing at Lakehurst, New Jersey. The LZ-126 was then turned over to the U. S. Navy and named the ZR-3 *Los Angeles*. It had been built by the Germans as part of their World War I reparations, at no expense to the United States. However, the Zeppelin Company had been offered $100,000 if Dr. Eckener would deliver the ship personally.

The *Los Angeles* was by no means the largest airship ever built. Its length of 658 feet was 22 feet shorter than the ZR-1 *Shenandoah*, but its gas capacity of 2,472,000 cubic feet was 357,000 cubic feet greater. Powered by five 500-horsepower Maybach engines, it had a design maximum speed of 76 miles per hour and a cruising range of approximately 6,000 miles.

The craft had been inflated with hydrogen for its transatlantic voyage. However, military regulations in the United States forbade the operation of airships with any gas other than helium. The hydrogen was valved from the *Los Angeles*' cells and the ship sat in the dock at Lakehurst for ten days waiting for the *Shenandoah* to return from a trip, so that the latter's helium could be transferred over.

The *Los Angeles* was called the "Pride of the Navy," and it was to become the most successful rigid dirigible ever to serve in the United States. Its longest flight with the U. S. Navy was from Lakehurst to the Panama Canal and return.

The ship was operated in all kinds of weather and on many different missions for a period of eight years without a single serious accident or loss of life. Then, on June 30, 1932, after logging a total of 5,368 hours in 331 flights, the *Los Angeles* was decommissioned for economy. But it was kept in condition and used for test purposes during the next seven years. Finally, in 1939, the Navy decided that the usefulness of the old dirigible was at an end, and it was broken up for scrap.

The ZR-3 *Los Angeles* was one of the most famous rigid dirigibles of all time. (U. S. Air Force)


U.S.NAVY

The splendid performance of the *Los Angeles* attracted the attention of Roald Amundsen, the Norwegian explorer who discovered the South Pole in 1911. He and Lincoln Ellsworth, an American, had attempted to reach the North Pole by airplane in 1925, only to be forced down by engine trouble. A short time later they decided to buy the semirigid N-1 airship which had been built in Italy by Colonel Umberto Nobile. Colonel Nobile also agreed to pilot the ship on its voyage to the Arctic.

The N-1 was named *Norge* in honor of Amundsen's native country. While it was a sturdy, well-engineered ship, it was small by comparison with rigid dirigibles of the time. It was 348 feet long and had a capacity of 672,000 cubic feet of hydrogen. Powered by three 250-horsepower engines, it had a cruising speed of 50 miles per hour and a range of some 5,000 miles.

Colonel Nobile and a crew of nineteen left Rome, Italy, in the *Norge* on April 10, 1926. After making stops in France, England, and Norway, they flew to Gatschina, near Leningrad, Russia, where they were delayed while preparations were being made to receive the *Norge* at Kings Bay, Spitsbergen, starting point of the Polar flight.

The airship arrived in Spitsbergen on May 7. Two days later Lieutenant Commander Richard E. Byrd and Floyd Bennett took off from Kings Bay for the world's first airplane flight across the North Pole. Amundsen and his companions were disappointed, but they continued with their plans, at last taking off in the *Norge* for their great adventure at 9:50 on the morning of May 11.

The flight was entirely successful, and the airship reached the North Pole without incident at 2:30 A.M. the following day. After circling the Pole, the *Norge's* engines were speeded up for the long voyage to Alaska. Two days later, while fighting fog and strong winds, Amundsen decided to come down at Teller, Alaska, seventy-five miles northwest of Nome. In seventy hours and forty minutes' flying time, the airship had traversed 3,180 miles of one of the most forbidding regions of the earth. This was truly an historic flight without parallel in the annals of aviation.

The *Norge's* flight across the North Pole to Alaska was a great feat of daring. (Underwood & Underwood)


NORGE

A dirigible was launched on September 18, 1928, in Friedrichshafen, Germany, that was to become the most famous flying machine of all time. This was the LZ-127 *Graf Zeppelin*, the first ship produced by the Zeppelin Company since it had delivered the *Los Angeles* to the United States almost four years previously.

The *Graf Zeppelin* was the largest dirigible built to that date, 776 feet long and with a capacity of 3,708,600 cubic feet of hydrogen. Powered by five 530-horsepower Maybach engines, it had a cruising speed of 70 miles per hour and a range of 7,030 miles. It was the finest Zeppelin ever made, and with it Dr. Hugo Eckener hoped to reverse the distrust which many people had in airships and inaugurate the first transatlantic passenger service between Europe and the United States.

The ship's first trial run was for three hours and thirteen minutes, and it was pronounced airworthy in every respect. Less than a month later — October 11 — the *Graf* undertook its first flight across the Atlantic Ocean to Lakehurst, New Jersey, carrying a crew of forty and twenty passengers — the first transatlantic passengers in the history of aviation. The route covered 6,168 miles, and it was traversed in 111 hours. The return flight with a full load of passengers was made in seventy-one hours and twelve minutes.

The *Graf* was now tried and proved. After a number of flights over Europe, it crossed to the United States again in August, 1929. On the seventh of the month it left Lakehurst on the greatest airship voyage ever attempted — a cruise around the world. Fourteen paying passengers were carried, each of whom paid $9,000. Official time for the 19,500-mile flight was twenty-one days, seven hours, and twenty-six minutes, only 263 hours and forty-three minutes of which were spent in actual flying.

The *Graf Zeppelin* was then put on a regular transatlantic run for six years. However, when the *Hindenburg* burned in 1937, the *Graf* was withdrawn from service. It had made 590 flights, spent 17,000 hours in the air, cruised 1,053,000 miles, carried 40,000 persons, and crossed oceans 144 times.

The *Graf Zeppelin* has been called the most famous flying machine ever built. (U. S. Air Force)


GRAF ZEPPELIN

AIRCRAFT DEVELOPMENT ZMC-2

United States

A new aircraft company was organized in Detroit, Michigan, in 1922 for the express purpose of building an airship unlike anything that had been seen since 1896. Their plan was to pick up the old all-metal idea first attempted by David Schwarz (see page 10) and turn it into a practical flying machine. Ralph Upson, chief engineer of the new company, the Aircraft Development Corporation, was convinced that such a design would result in the safest and most dependable dirigible of all time.

Upson and his staff of engineers proceeded cautiously. They tested various bag shapes and experimented with different methods of construction until they were positive that they were on the right track.

The U. S. Navy became interested in the project in 1926. With a special Congressional appropriation of $300,000, the company was contracted to build one ship, which was designated ZMC-2 (Zeppelin Metal Clad-Number 2). Actual construction work was started two years later, and the ship was finally completed and filled with helium on August 10, 1929.

The ZMC-2 was 150 feet long and had a diameter of 53 feet. Its capacity of 200,000 cubic feet of helium gave it the ability to lift a useful load of 3,127 pounds. Powered by two 300-horsepower air-cooled radial Wright Whirlwind engines, it had a maximum speed of approximately 70 miles per hour and a cruising speed of 52 miles per hour. The ship was designated as a rigid, but the Navy classed it as a nonrigid since it depended upon internal gas pressure to maintain the shape of its metal bag.

The ZMC-2 was taken up for its first test flight on August 20, 1929. It remained aloft for almost fifty minutes and was completely successful. The following month it was flown 600 miles nonstop from Detroit to Lakehurst, New Jersey, where it was turned over to the Navy.

The ZMC-2 was the most successful nonrigid airship ever built, and it had a longer useful life than any other dirigible in history, including the *Los Angeles* and *Graf Zeppelin*. The Navy maintained it in constant use for a period of twelve years, without major trouble of any kind.

The U. S. Navy's all-metal ZMC-2 was flown 12 years without major trouble. (Underwood & Underwood)


U.S.NAVY
ZMC-2

AIRSHIP GUARANTEE R-100

Great Britain

Following the success of the Beardmore R-34 (see page 42), the British Air Ministry decided in 1924 to build two large rigid dirigibles which could be used to link by air the farthest reaches of their empire. One of these, the R-100, was ordered from the Airship Guarantee Company (a subsidiary of Vickers Limited), while the government-owned Royal Airship Works was instructed to design and build the R-101.

The R-101 was completed first and was taken up for its maiden flight on October 12, 1929. The R-100 was finished the next month. Both had a capacity of 5,000,000 cubic feet of hydrogen, but the R-101 was longer, measuring 732 feet as against 709 feet for the R-100. However, the R-100's six Rolls-Royce Condor gasoline engines produced a total of 3,600 horsepower whereas the R-101's five Beardmore Tornado diesels delivered only 2,350 horsepower instead of the design output of 3,250 horsepower.

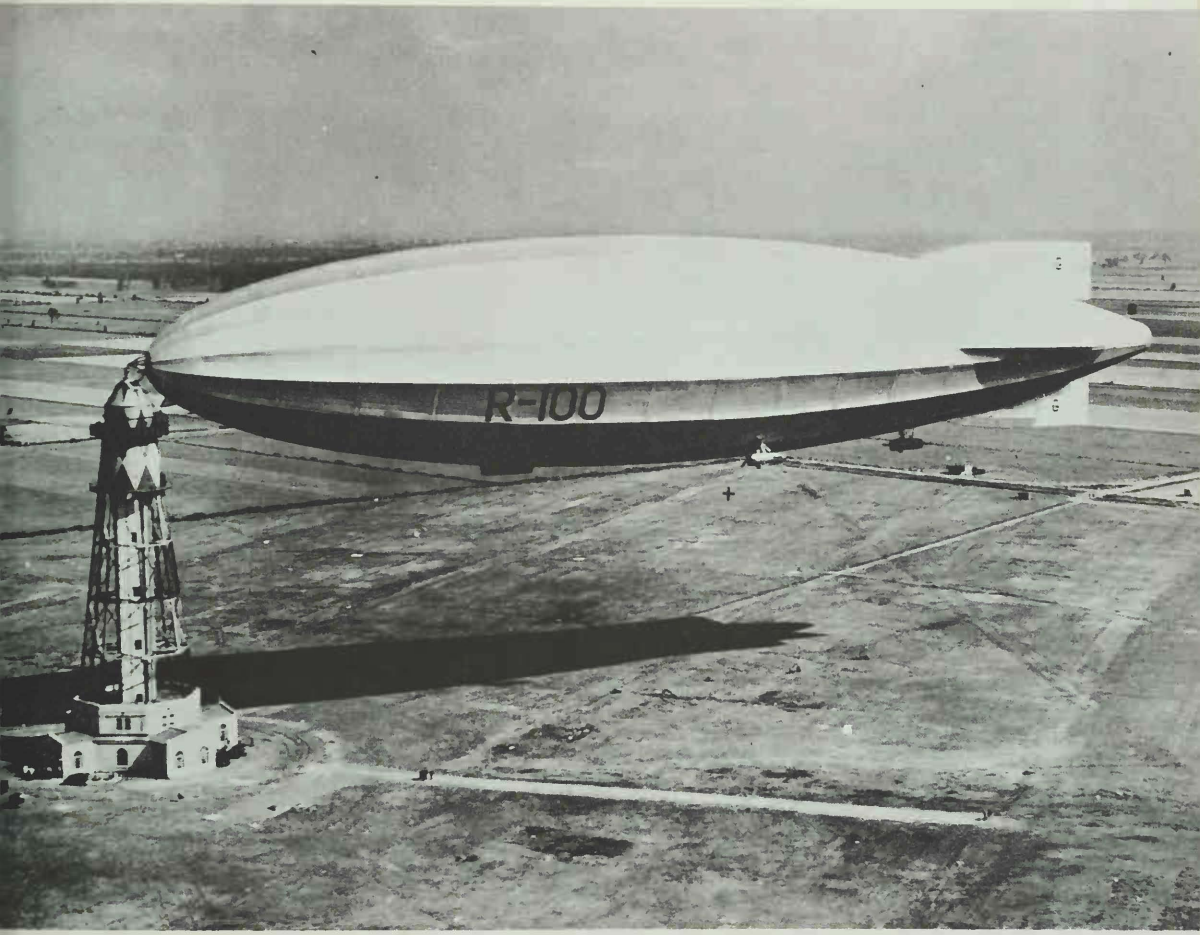
The R-101 had major troubles from the beginning. Both ships had been designed to carry 100 passengers, but the R-101's total weight was so much more than expected that the passenger list had to be reduced to fifty-two. In an effort to improve performance characteristics, the ship was sent back to the factory and lengthened 45 feet. But the engines were not changed and it remained difficult to fly.

After several shakedown flights, the R-100 took off from England on July 29, 1930, for a nonstop crossing of the Atlantic Ocean to Montreal, Canada. The trip required seventy-eight hours and fifty-one minutes. The return flight, which began on August 13, was made in fifty-seven hours and five minutes. With this voyage, the R-100 proved itself to be a safe and capable ship.

Then, on October 4, 1931, the R-101 left England for a flight to India. A few hours later, while flying in a heavy rainstorm, it crashed and burned near Beauvais, France, killing all but six of its fifty-four passengers and crew members.

As a result of this disaster, the successful R-100 was never flown again. The following year the ship, which had cost approximately $2,225,000 to build, was dismantled and sold for scrap.

The R-100 was successful, but it was scrapped after its sister ship burned. (Smithsonian Institution)


R-100

In June, 1926, while the ZR-3 *Los Angeles* was blazing new aviation trails for the United States, the U. S. Navy received authorization to purchase two new rigid dirigibles. The design competition was won by the Goodyear-Zeppelin Corporation (a new subsidiary of the Goodyear Tire & Rubber Company), and construction of the first of these, the ZR-4 *Akron*, was begun on November 7, 1928.

The *Akron's* length of 785 feet was only nine feet longer than the *Graf Zeppelin*, but its capacity of 6,500,000 cubic feet of helium was almost twice that of the famous German airship. Powered by eight 560-horsepower Maybach engines, it had a maximum speed of 83 miles per hour.

The *Akron* was commissioned on October 27, 1931, and the Navy proudly called it the "Queen of the Skies." The following month it made a ten-hour flight with 207 passengers and crew members. This was the largest number of people that had ever been carried into the air by a single craft.

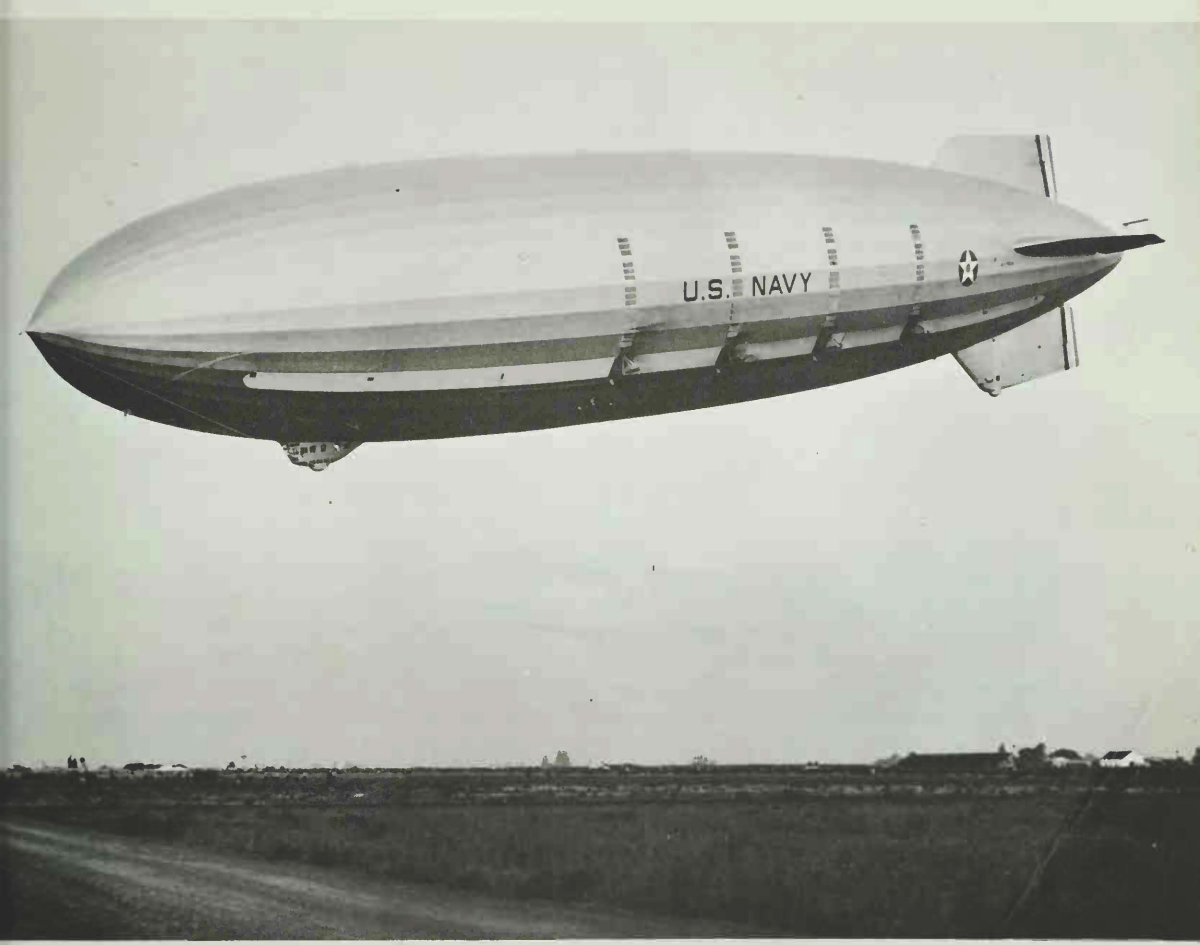
The airship was operated successfully for seventeen months and fifty-seven flights. Then, at 7:28 P.M. on April 3, 1933, it took off from Lakehurst, New Jersey, on what was to be its last flight.

The sky was thick with fog when the ship left the ground, and there were indications that a storm was moving in. Within an hour and a half the first strong winds whipped at the *Akron*, and the commander ordered the ship turned out to sea. This was a mistake, for it headed straight into the heart of a violent thunderstorm with winds of up to 100 miles per hour.

Despite the fury of the winds, the dirigible seemed to be riding out the storm. But unknown to the crew, the weather had caused their altimeter to give inaccurate readings. They were lower than anyone realized, in zero-zero visibility conditions, when the ship was maneuvered upward to offset a downdraft. One of the big fins snubbed the water, and the *Akron* immediately heeled around, slamming into the Atlantic Ocean.

Only three members of the crew of seventy-six survived the crash, which was the most disastrous in the history of dirigibles.

On one flight, the *Akron* carried a record 207 passengers into the air. (U. S. Navy)


U.S. NAVY

The *Akron's* sister ship, the ZR-5 *Macon*, was commissioned at Lakehurst, New Jersey, on June 23, 1933. The giant dirigibles were identical, except for certain details. Like the *Akron*, the *Macon* also had stowage space for five Curtiss F9C Sparrowhawk fighter planes, which hooked on or were launched by means of a trapeze arrangement.

Following its shakedown trials, the *Macon* was assigned to the Naval Air Station at Sunnyvale, California. The cross-country trip was made without incident.

The ship left California on April 20, 1934, and headed east to participate in naval maneuvers in the Caribbean. At about noon the following day, while fighting updrafts from the hot sands of the Rio Grande Valley, the *Macon's* tail-section girders were severely damaged. Temporary repairs were made in flight.

Lieutenant Commander Herbert Wiley — the only officer to survive the *Akron* crash — took over command of the *Macon* upon its return to California. He insisted that permanent repairs be made to the tail, but this would have grounded the ship for about two months, and Wiley's superior officers wanted it to remain in service. Three of the four tail surfaces were strengthened during the next several months, without removing the craft from duty, with the top fin to be worked on next.

The *Macon* took part in war games near San Francisco in November, 1934. Then, on February 11, 1935, with the top fin still not repaired, it took off to participate in fleet exercises off Los Angeles. The following evening, while returning to its base, the ship ran into turbulent weather. The damaged top fin tore off, puncturing three of the stern gas cells. So much helium was lost that the *Macon* became unmanageable, and it came down on the water off Point Sur, California. Of the eighty-one men in the crew, only two were lost.

Despite the fact that an investigating committee came to the conclusion that dirigibles should be as safe as any other means of transportation, and recommended continued construction, no further rigid airships were ever made in the United States.

The graceful Macon was the last rigid airship built in the United States. (U. S. Navy)


U.S. NAVY

Although the *Graf Zeppelin* had proved itself in many flights, it did not carry enough passengers to be operated economically as a commercial carrier. With the lessons learned from the *Graf*, the Zeppelin Company started work in 1933 on the much larger LZ-129 *Hindenburg*.

The new "wonder ship" had nearly twice the gas capacity of the *Graf* — 7,062,150 cubic feet — while its length of 804 feet was only 28 feet longer. It was designed to carry fifty passengers, but this was later increased to seventy-two. Powered by four 1,200-horsepower Daimler-Benz engines, it had a cruising speed of 78 miles per hour and a range of 8,000 miles.

The giant was walked from its building shed at Friedrichshafen, Germany, for the first time on March 4, 1936. It had been designed to operate on helium, but the United States refused to release the gas. Because of this embargo, the *Hindenburg* had been inflated with hydrogen.

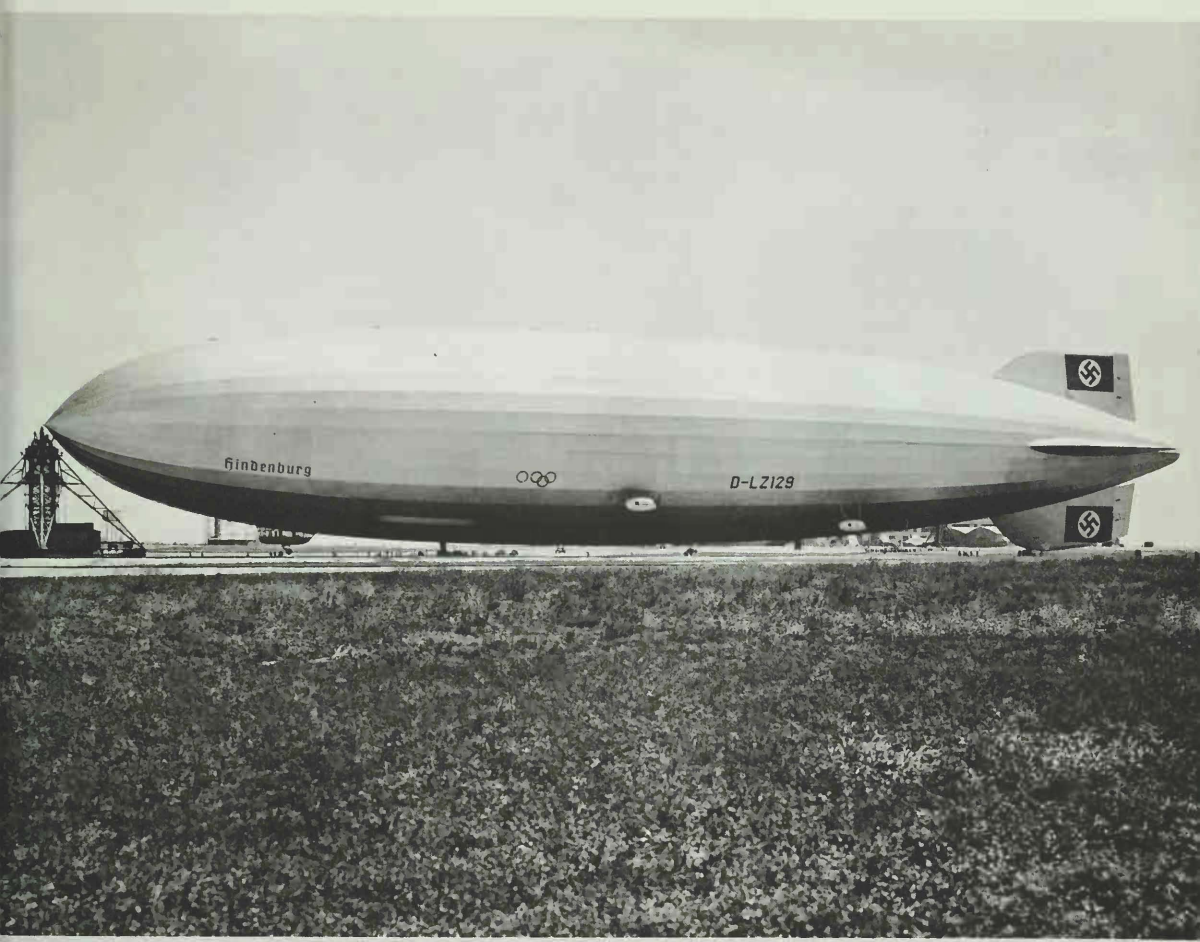
The dirigible's first long flight was to Rio de Janiero, Brazil. Then, on May 6, it took off for Lakehurst, New Jersey. The westward journey required sixty-one hours and fifty minutes, but the return trip was made in forty-nine hours and three minutes.

The *Hindenburg* made seventeen additional crossings of the North and South Atlantic during the remainder of the year. Passenger fare for the Frankfurt-to-Lakehurst run was only $450 during the peak summer months.

The dirigible started the 1937 season on March 16 with a flight to Brazil. Then, on May 3, it took off for the first of eighteen scheduled round-trip flights to the United States. The crossing was completely routine. But as the *Hindenburg* came in for a landing at Lakehurst at 7:25 P.M. on May 6, one of its hydrogen cells suddenly caught fire. Within seconds the huge ship was reduced to ashes, and thirty-five passengers and crew members were killed.

Zeppelins had made 23,000 commercial flights and carried more than 50,000 passengers since 1910, all with a perfect safety record. But with the tragic loss of the *Hindenburg*, the era of the large rigid airship in commerce was abruptly ended.

The giant *Hindenburg* made 18 passenger flights across the Atlantic in 1936. (U. S. Navy)


Hindenburg
D-LZ129

With both the *Graf Zeppelin* and *Hindenburg* in regular transatlantic service in 1936 and setting records for reliability and safety, the Zeppelin Company proceeded with plans to build still another commercial ship, the LZ-130.

The new machine was planned to be 800 feet long and have a capacity of 7,087,720 cubic feet of helium. After much urging from Dr. Hugo Eckener, it appeared that the United States was finally ready to release the precious gas to Germany. Plans called for the LZ-130 to make its first transatlantic flight to Brazil on October 27, 1937, and for the keel of the LZ-131 to be laid immediately thereafter.

Then the *Hindenburg* was destroyed, and work on the LZ-130 came to a virtual halt while the United States debated the helium question. The Congress was willing, the Army and the Navy were willing — but Secretary of the Interior Harold Ickes refused to sign the release forms, apparently with the fear that Germany would use the gas for military dirigibles.

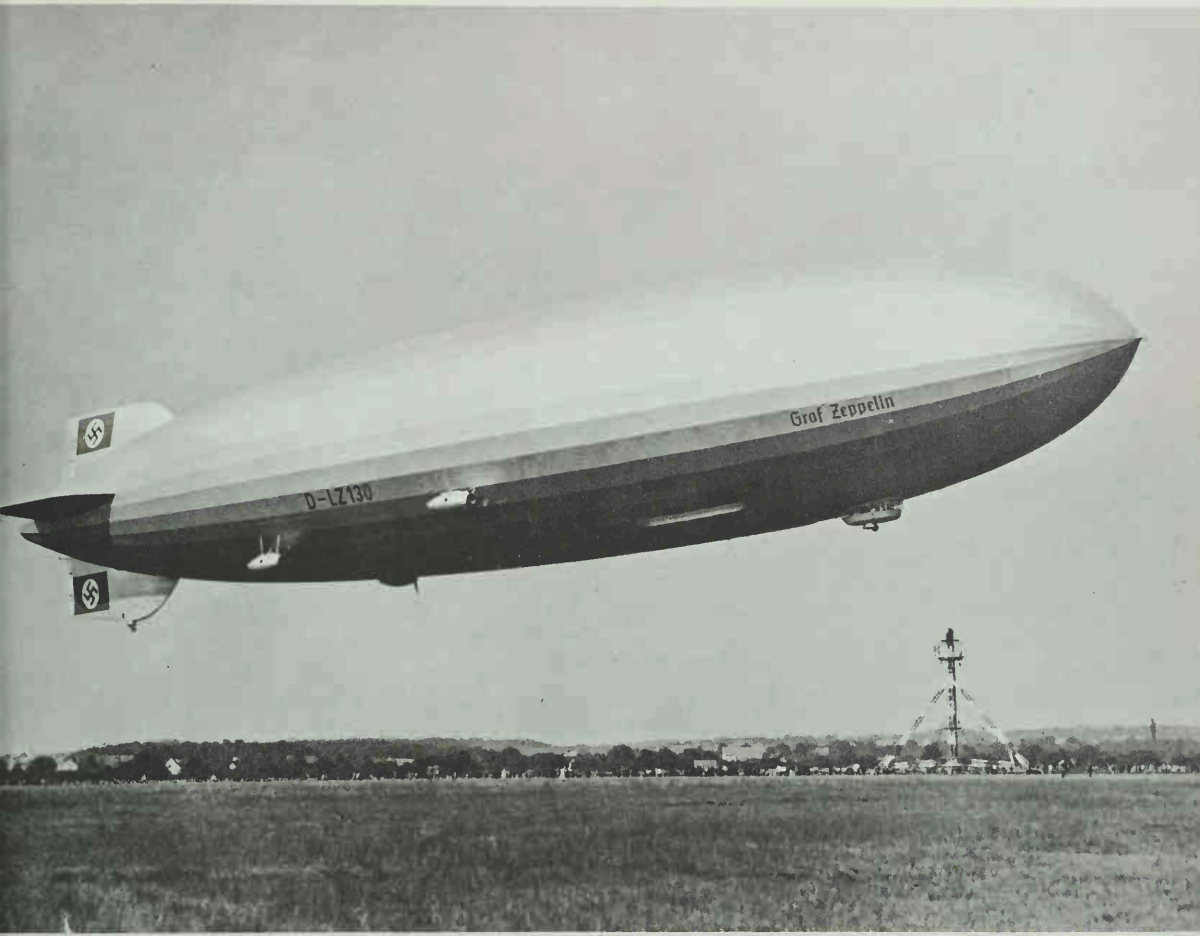
The LZ-130 was launched at last on September 14, 1938. It was christened the *Graf Zeppelin* in honor of the old *Graf*, which had been decommissioned. The cells were filled with hydrogen for the trial flights, but Dr. Eckener insisted that the ship would never carry passengers without helium.

The new *Graf's* first flight was for eight hours. Three days later it went on a twenty-six-hour trip. After this flight, Dr. Eckener announced that it was the safest, most advanced dirigible ever built, that now all it needed was helium.

The United States would not release the precious gas, and true to Dr. Eckener's word, the LZ-130 never carried passengers for hire. It made a number of short flights until World War II started, when it was deflated and hangared "for the duration."

Then, in 1940, Hermann Goering, Chief of the German Air Force, ordered both the *Graf Zeppelins* dismantled and their metal used to produce airplanes. The day of the great rigid airships had finally come to an end, and the greatest of them all, the LZ-130, was never given the opportunity to prove its value as a passenger transport.

Dr. Eckener called the LZ-130 the safest, most advanced dirigible ever built. (Institute of the Aeronautical Sciences)


Graf Zeppelin
D-LZ130

When the United States was plunged into World War II on December 7, 1941, there were ten airships in the U. S. Navy, only six of which were large enough for sea patrol duty. By the time the war ended in 1945, this nucleus had grown to a fleet of 168 ships, 142 of which were patrol types.

During the war, Navy airships logged 550,000 hours in the air in 55,900 operational flights and escorted 89,000 surface ships — not one of which was sunk by submarines. This was a record beyond comparison. In the same period only one Navy blimp was lost to enemy action. On the night of July 18, 1943, the K-74 was shot down by a German submarine, after the airship's bombs had failed to release in a point-blank attack.

In 1943 the Type M airship built by the Goodyear Aircraft Corporation (an outgrowth of the Goodyear-Zeppelin Corporation) made its appearance. It was 287 feet long and had a capacity of 625,000 cubic feet of helium. Powered by two 550-horsepower air-cooled radial Pratt & Whitney Wasp engines, it had a cruising speed of about 60 miles per hour and could lift a useful load of 10,000 pounds. The ship's bag contained four ballonets plus two air chambers to maintain a constant internal gas pressure.

The first of the M-ships, the experimental XM-1, made a series of extended flights in an effort to develop and improve the range and endurance features of airships. The longest of these flights was started from the Naval Air Station at Lakehurst, New Jersey, on October 27, 1946, with Lieutenant Howard Walton in command. After flying for 170 hours and eighteen minutes — or more than seven days — the ship was landed at Glynco, Georgia. This nonstop, nonrefueling feat was a new world's record for any type of aircraft.

Although the XM-1 had left Lakehurst with 630 gallons less than its installed fuel tank capacity, when it landed at Glynco the tanks still contained enough gasoline for another thirty hours' flying.

Due to the cutback in U. S. Navy airship operations following World War II, only four ZPM ships were built.

A Type M airship set a nonstop, nonrefueling record of 170 hours and 18 minutes. (Goodyear Tire & Rubber Co.)


U.S.NAVY

Despite the unfortunate histories of so many lighter-than-air craft, the U. S. Navy continued to believe in the safety and reliability of the airship. In 1948, following its convictions, the Navy contracted the Goodyear Aircraft Corporation to design the largest nonrigid dirigible ever built. The first of these, designated ZPN-1, was delivered to the Navy at Lakehurst, New Jersey, on June 17, 1952. The ship's designation was later changed to ZPG-2.

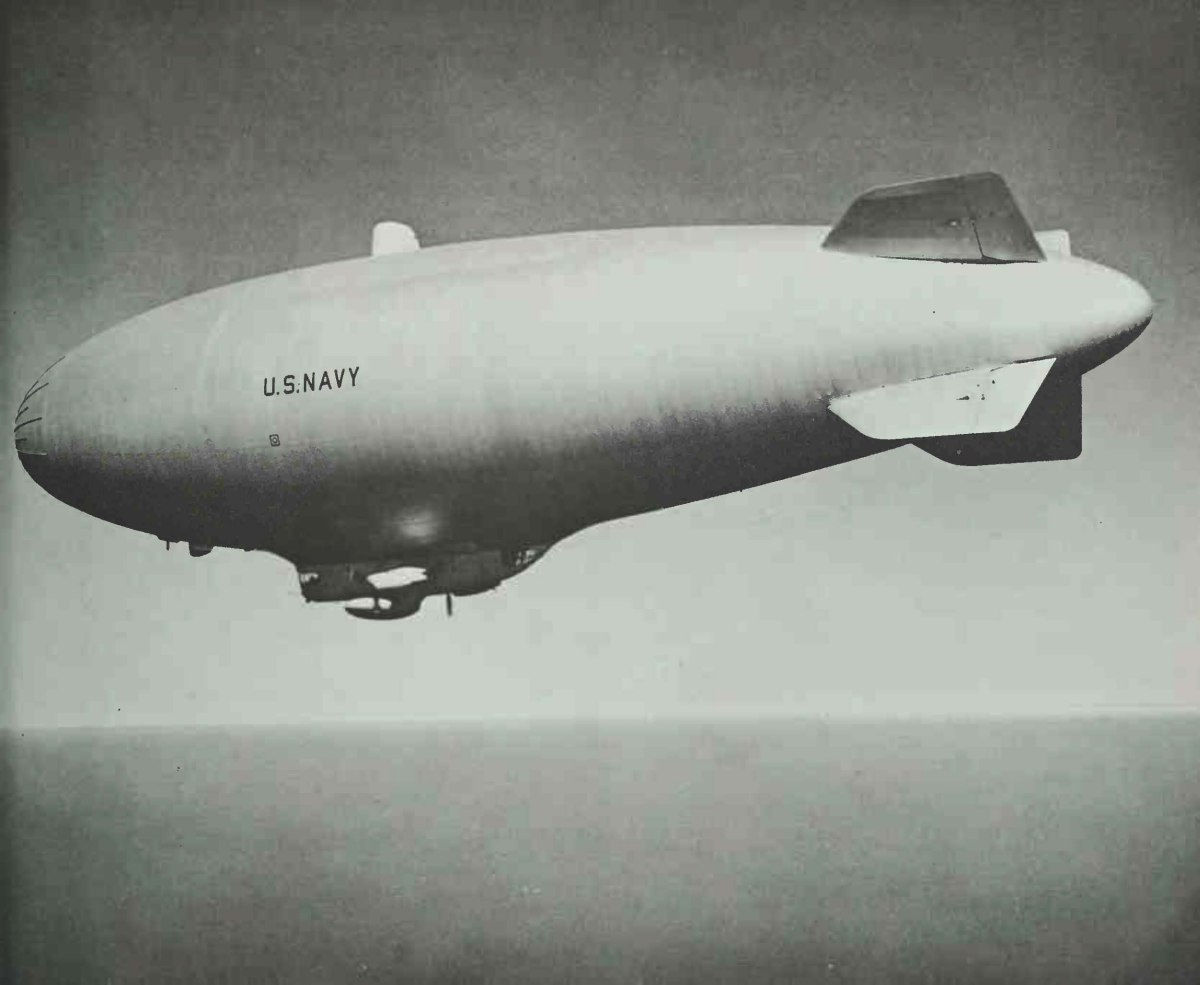
The new nonrigid was the first airship ever built for transoceanic convoy duty. It had a length of 343 feet and a capacity of 1,011,000 cubic feet of helium. Its all-aluminum car had accommodations for a normal crew of fourteen. Powered by two 700-horsepower air-cooled radial Wright Cyclone engines turning eighteen-foot propellers, it had a cruising speed of 57 miles per hour and a top speed of 80 miles per hour.

In May, 1954, after an exhaustive test program, a ZPG-2 broke all existing nonstop airship records by remaining aloft for 200 hours and twelve minutes, or more than eight days. Commander Marion Eppes, the ship's commanding officer, was awarded the Harmon International Trophy for 1955 as a result of this historic flight.

In March, 1957, another ZPG-2 smashed this record by sixty-four hours. The new flight started from Lakehurst and extended across the Atlantic Ocean, down the west coast of Africa, then back across the Atlantic to Key West, Florida, covering 8,216 miles. Total air time was 264 hours and fourteen minutes, or more than eleven days. This was the first time that any airship had spanned the Atlantic in both directions without stopping. The flight also broke by 1,236 miles the previous record set by the *Graf Zeppelin* in 1929, when it flew 6,980 miles nonstop from Germany to Japan.

Adding still further honors to its record, a modified ZPG-2 designated ZPG-2W was flown 6,200 miles in sixteen days during August, 1958, on an Arctic exploration tour. The ZPG-2W was basically similar to the ZPG-2, but it was designed to carry radar for airborne early-warning operations, searching out possible enemy aircraft approaching the United States.

The ZPG-2W was the first airship designed to carry radar search equipment. (Goodyear Tire & Rubber Co.)


U.S.NAVY

With the outstanding service records of the ZPG-2 and ZPG-2W, the U. S. Navy contracted the Goodyear Aircraft Corporation to proceed with the design and construction of the much larger ZPG-3W.

The ship was planned as the first of a new class of blimps for Airborne Early Warning radar picket patrol as part of the North American Air Defense Command operation. Since airships could remain in flight without refueling for longer periods of time than airplanes, and with more comfort for the crews, it was assumed that they would be better to locate unidentified airplanes approaching the United States.

The first ZPG-3W was taken into the air for its maiden flight on July 21, 1958. Sixty feet longer than the ZPG-2, the new ship measured 403 feet from stem to stern. Its envelope was the largest ever built in any country for a nonrigid airship, and it contained 1,516,300 cubic feet of helium. This gas displacement enabled the ZPG-3W to lift a useful load of 22,907 pounds. Powered by two 1,275-horsepower air-cooled radial Wright Cyclone engines, it had a maximum cruising speed of 69 miles per hour and a top speed in excess of 80 miles per hour.

Four radar scanners were mounted on the ship, three of them inside the gasbag and the fourth in a radome on top of the bag. Access to the radome was through a tunnel extending up from the control car. Accommodations were provided for a normal crew of twenty-one men.

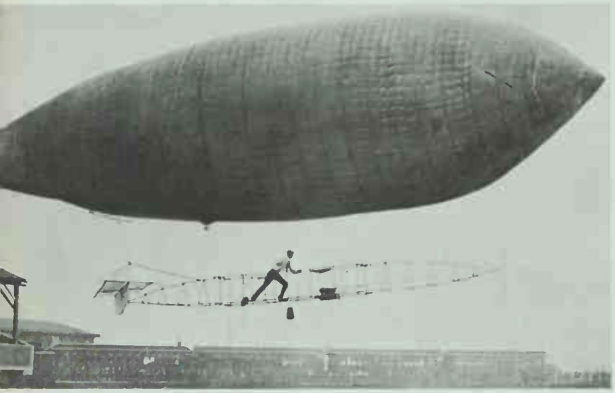
Four ZPG-3W's were built, and the first of these was delivered to the Navy on June 19, 1959. One of the four was lost when it crashed in the Atlantic Ocean off Barnegat Light, New Jersey, in July, 1960. (This was the same location where the *Akron* went down in 1933.) The three remaining ships joined the earlier ZPG-2W's on picket patrol.

The ZPG-3W's logged thousands of hours in radar operations. Then, on July 11, 1961, the Navy Bureau of Aeronautics announced that its entire lighter-than-air program would be terminated by November 30, 1961, and that the ships would be deflated and placed in storage. This decision seemed to signal the death blow to further military airship development in the United States.

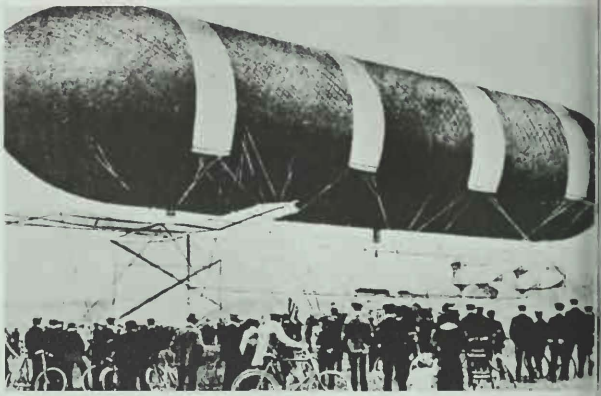
The ZPG-3W carried three huge radar scanners within its 403-foot gasbag. (Goodyear Tire & Rubber Co.)


U.S.NAVY

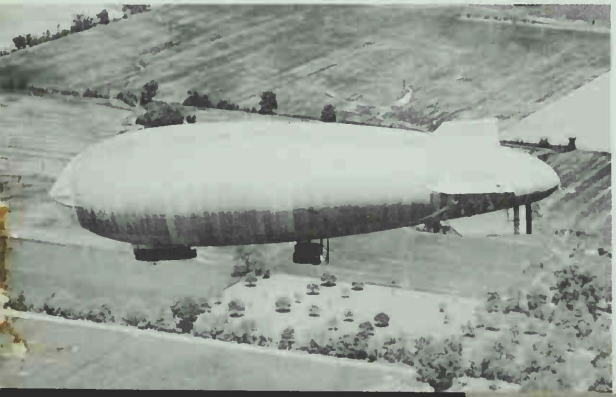
OTHER HISTORIC DIRIGIBLES



Above: Roy Knabenshue made many successful airship flights in 1905. *Below:* The Goodyear-Zeppelin RS-1 was the largest semirigid ship in the U. S. in 1926.



Above: England's first military airship, the *Nulli Secundus,* was a failure. *Below:* First transcontinental airship flight was made in 1922 by the C-2.



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