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Hindenburg: Last of the Great Airships

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Hindenburg: Last of the Great Airships

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Part 1

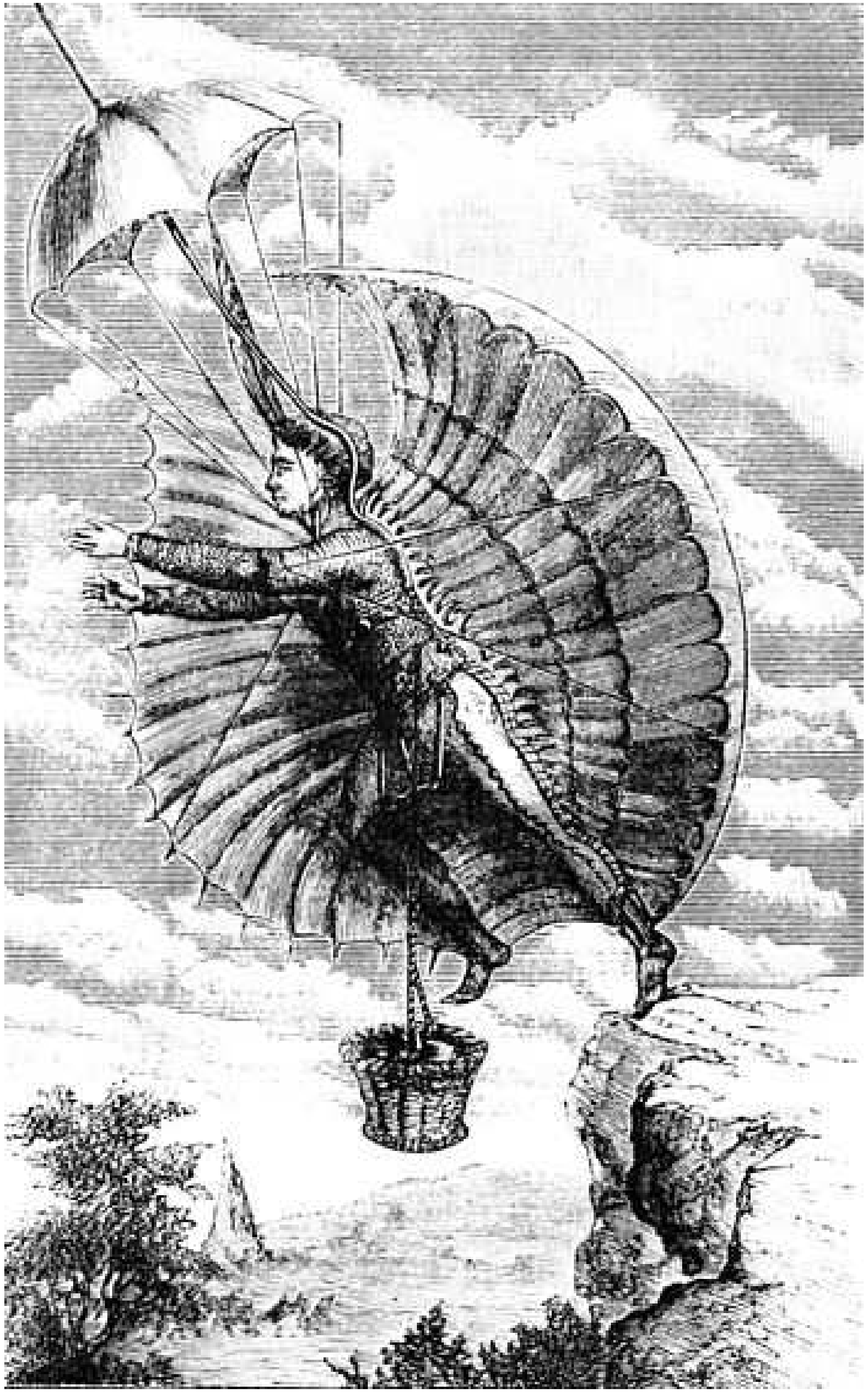
Exceeding the Grasp

"Ah, but a man's reach should exceed his grasp, or what's a heaven for?"
Robert Browning, **Poet**

The Dreams of Inventors

"...as by certain mechanical art and power to fly; so nicely was it balanced by weights and put in motion by hidden and enclosed air"

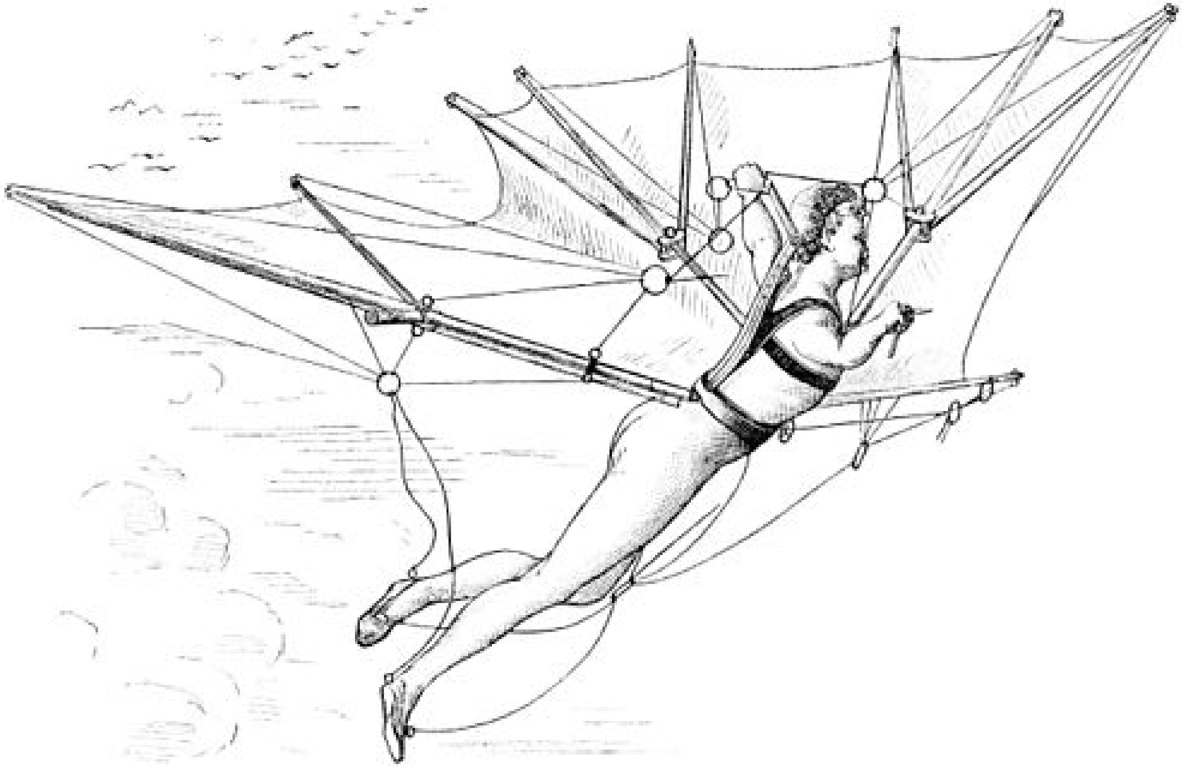
***Archytas of Tarentura,* 400 B.C.**



"…Then we are told of a monk who attempted a flight with wings from the top of a tower in Spain. He broke his legs, and was afterward burned as a sorcerer. Another similar trial was made from St. Mark's steeple in Venice; another in Nuremberg; and so on - legs or arms were usually broken, occasionally a neck. In the sixteenth century we read of a certain Italian who went to the court of James IV of Scotland, and attempted to fly from the walls of Sterling Castle to France. His thigh was broken; but, as a reason for the failure, he asserted that some of the feathers used in constructing his wings were from barn-yard fowls, with a natural affinity for the dung-hill; whereas, if composed solely of eagle-feathers, they would have been attracted to the air. However, he does not appear to have carried the experiment further…"

***Popular Science Monthly*, November 1885**

<u>Left</u>: caption: "The Flying Man (Retif de la Bretonne's idea)"



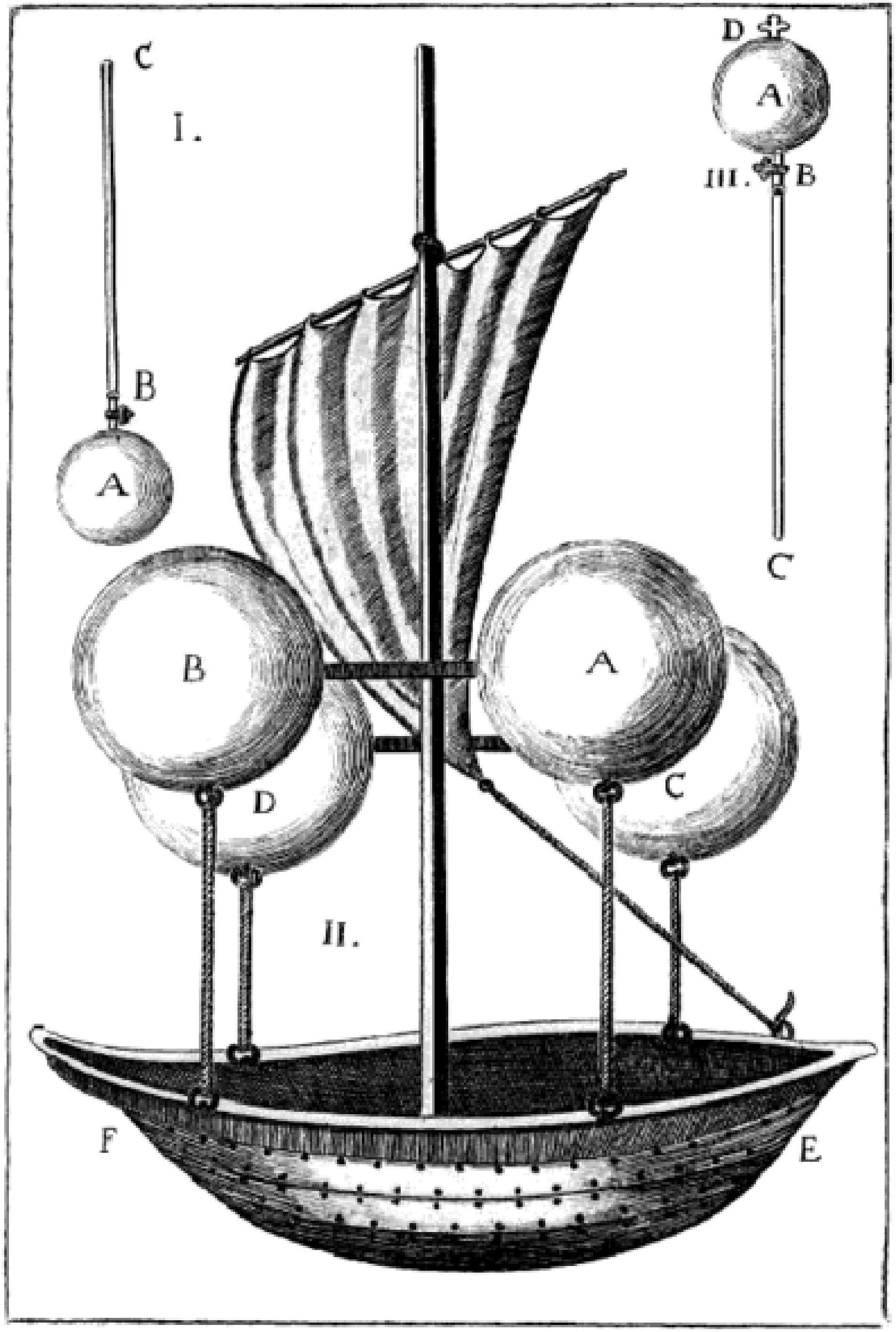
"…Many other trials have there been of the same character. The results were generally discouraging, but men can always be found ready to risk life and limb in striving to attain something much less important than the art of flying; without a knowledge of the principles involved, ignorant of the nature of the atmosphere, without machinery or power, fettered by a superstition that looked upon all learning outside of the Church as coming from the prince of darkness, it was a struggle in the dark - brave but hopeless…"

***Popular Science Monthly,* November 1885**

<u>Above</u>: caption: "The Modern Flying Man (Taken from U.S. Patent-Office Reports)"

"…to be filled with ethereal air or liquid fire and then launched forth from some elevated point into the atmosphere, where it will float like a vessel on water…there is certainly a flying instrument, not that I ever knew a man who had it, but I am particularly acquainted with the ingenious person who contrived it…"

***Roger Bacon,* Inventor (1214-1294)**



"…More than three centuries after the time of Bacon, Father Lana wrote out his idea of a vessel that might be made to rise in the air. Four hollow globes of copper, each having a diameter of about twenty-five feet, were to be carefully exhausted and then attached to a car. Torricelli and Pascal had already proved that the pressure of the atmosphere was nearly fifteen pounds per square inch at sea-level, and Lana's proposed method of exhausting his globes was to be an application of Torricelli's principles…Unlike the product of Bacon's imagination, his conception was a correct application of demon-strated physical laws; but, had it been tested by experiment, he would at once have found that there were other laws which he had not taken into account…"

***Popular Science Monthly,* July 1885**

Left: *Father Francesco Lana de Terzi's* flying boat concept (ca.1670)

A Child is Born

"…Soon after the discovery of hydrogen gas by Cavendish and Watt in 1766, experiments were made with a view to utilizing it for the purpose of lifting bodies into the air. But, until 1783, nothing more substantial than a soap-bubble could be made thus to ascend. Joseph Montgolfier, who was a successful manufacturer of paper, tried bags of this material; but hydrogen was found to diffuse so rapidly through it that the idea was abandoned by him. Observing that clouds of vapor and smoke remained floating at various heights, he though that, if they could be confined in bags of paper, these might be made to float in like manner. Since the experiments of Franklin in 1752 had proved the existence of atmospheric electricity, the idea gained currency that the lightness of clouds and of smoke was in some way due to electric charge. A paper bag was made, and, with its opening downward, a fire was kindled, 'as well as to increase the layer of electric fluid upon the vapor in the vessel as to divide the vapors into smaller molecules and dilate the gas in which they are suspended.' The bag was carried up to a considerable height. Montgolfier seems not to have attributed the ascension to the effect of heat diminishing the specific gravity of the contained air. The first successful experiment in ballooning was thus based on a misconception…"

***Popular Science Monthly*, July 1885**

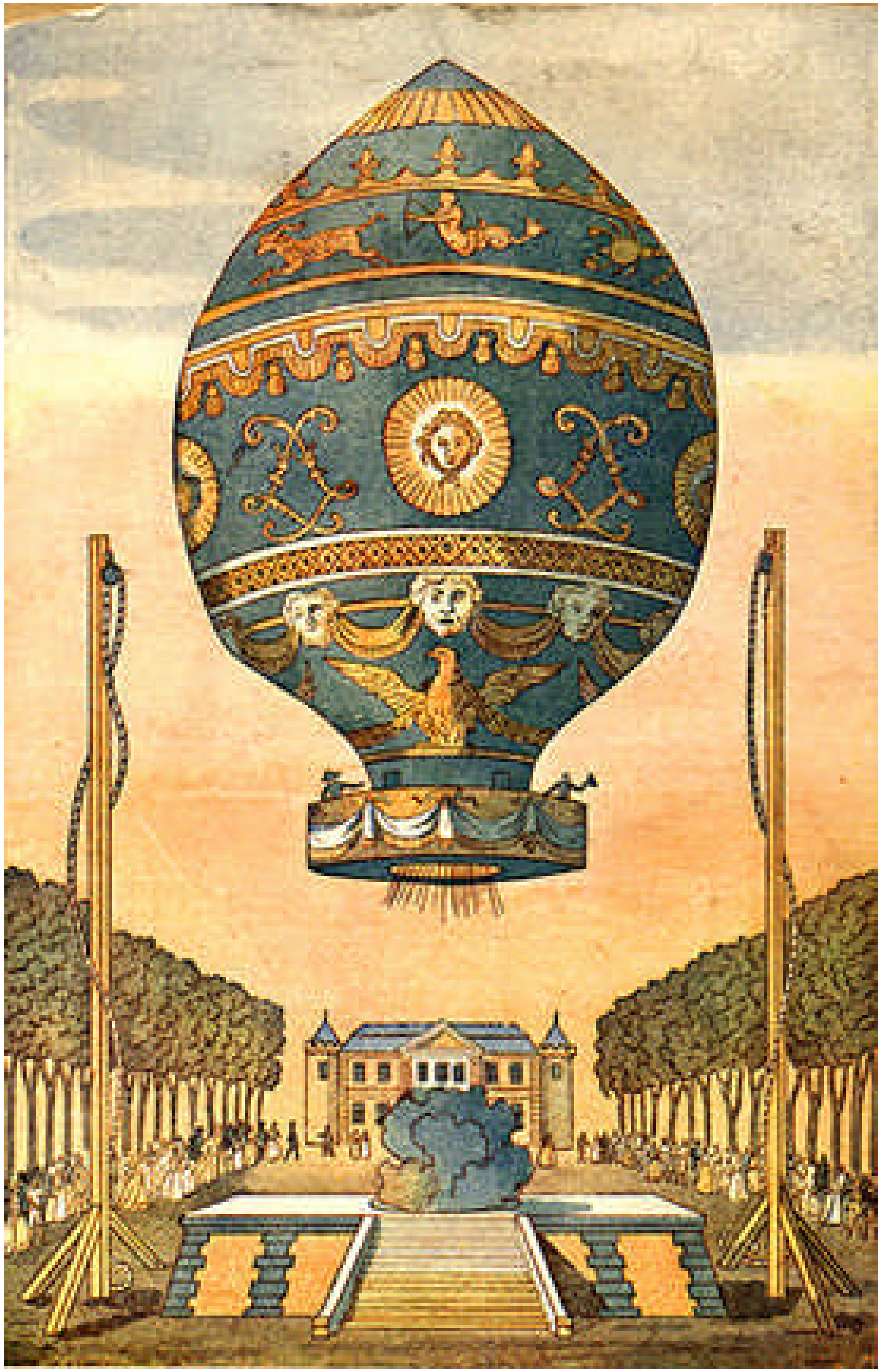
“…Montgolfier’s first public exhibition of his invention was made on June 4, 1783. The news of his success was rapidly spread; and at Paris a balloon was soon constructed under the superintendence of M. Charles, who substituted hydrogen for smoke, confining it in a bag of varnished silk instead of paper and linen. The ascension was successfully accomplished on the 27th of August…”

***Popular Science Monthly*, July 1885**

<u>Left</u>: first public demonstration, June 4th 1783

“…The whole art of piloting a free balloon consists of maneuvering it to the right level, where a favorable wind will take you the way you want to go. So the principal problem of ballooning is how to alter the craft’s buoyancy in order to ascend and descend at will. A gas balloon, the rival of the hot-air kind, has to make do with a comparatively crude solution. Inflated with lighter-than-air gas – originally hydrogen, but nowadays safer, fireproof helium – it starts its flight with its maximum buoyancy. Thereafter its lift can only diminish as its gas slowly leaks away. To check its settling and go up again, the pilot of a gas balloon must toss over sandbags or loose sand. To reduce his altitude, he must sacrifice irreplaceable buoyancy by releasing some of the lifting gas – and then, to end the descent, jettison more sand ballast. His supply of ballast sets the limit for the duration of his flight. With a hot-air balloon, there’s no dropping of ballast or valving-off of precious gas. In theory, it ability to manufacture its lift in flight should be a decisive advantage. But the early hot-air balloon, whose primitive burner was a brazier fed with bundles of chopped straw, was far from a practical embodiment of this alluring theory. Not surprisingly, the gas balloon outmoded it…”

Popular Science, **August 1961**



"…It is related by a writer in the London 'Quarterly Review' for July, that when Pilatre de Rozier had descended safely to the earth, after making the first aerial voyage ever undertaken by man, Benjamin Franklin, who at the time (November 21, 1783) was in Paris, on being asked his opinion of the brothers Montgolfier's invention, replied, 'A child has just been born.'…"

***Popular Science Monthly,* April 1876**

<u>Left</u>: the first free ascent of a hot-air balloon with human passengers

Servant of the Air

"…Charles at once proceeded to the construction of a new and much larger balloon, in which he ascended with his colleague, Robert, on the 1st of December, making a journey of more than twenty-five miles. This balloon was provided with a safety-valve of Charles' invention, a hoop, to which the car was attached, and netting intended to equalize the distribution of weight upon the balloon. It was in all important particulars the same as the balloon almost universally employed throughout a century afterward….to Charles is due the credit for making the balloon a moderately safe vehicle…"

***Popular Science Monthly*, July 1885**

"…It would be difficult to describe the excitement which followed this invention. The most extravagant hopes and anticipations were entertained. The problem had been solved. The birds and insects would no longer have a monopoly. Every gentleman would have a balloon hitched to his gate-post, or, wafted along by summer breezes, would look down in luxurious pity upon the poor plodders. Sails and rudders were to be used as on ships to direct the course. Regular lines of aerial passenger and mail coaches were to be established. There seemed no limit to the possible speed. Rome, or St. Petersburg, or even America, might be reached in a few hours, and for the comfort of travelers the arrangements proposed went far ahead of our palace-cars. Floating hospitals were to be built; methods of warfare would need to be entirely reorganized; and England's boasted supremacy on the sea would be of no avail, unless she also maintained supremacy in the air…"

***Popular Science Monthly,* November 1885**

"…Some of the early objections against ballooning were singular enough. Thus, it was urged that female honor and virtue would be in continual peril, if access could be had by balloons at all hours to the windows of houses! Politicians objected that, if the path of air were to be made free, all limits of property and frontiers of nations would be destroyed. As a matter of course, aerial navigation was denounced as 'impious.' And, when the brave Pilatre des Rozier's balloon took fire in the air over the city of Boulogne, and he lost his life, many a one recognized herein the 'hand of Providence.'…"

***Popular Science Monthly*, April 1876**

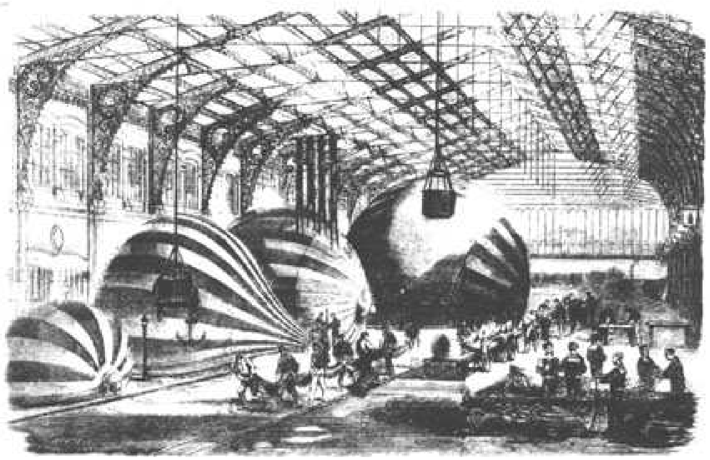
"…Well is it, then, for humanity that balloons have not proved a very great success. Many extensive voyages and many interesting observations have been made; but as a flying-machine the balloon has no place. It is the servant of the air, not the master. It must obey at will, pitiless, fickle, sometimes kind, but never trustworthy. The expectation that headway could be made against the wind by means of sails and rudders had no basis in sound theory or sense. A sailing-ship is immersed in two fluids of widely differing densities, and its sail is only effective because the water, while supporting, at the same time allows the vessel to move more readily in one direction than another. A balloon, on the other hand, is totally immersed in an ocean of air, and being of the same weight bulk for bulk, and subject to no external forces, must necessarily follow the slightest current. One might as well attempt to steer a boat, swept along by a great stream, without wind or oar. It forms an integral part of the current itself. It is a thistle-down blown by an autumn gale…It is strange that people have not realized that a thing necessarily so big and light as a balloon can not be made strong and durable enough to stand the pressure of the wind at comparatively low velocities. Floating with the current, the velocity would have no destructive effect; but brought into opposition to this current, or forced at any great speed through the air, the resistance would be much greater than a silk bag could safely stand…"

***Popular Science Monthly*, November 1885**

Le Siege de Paris

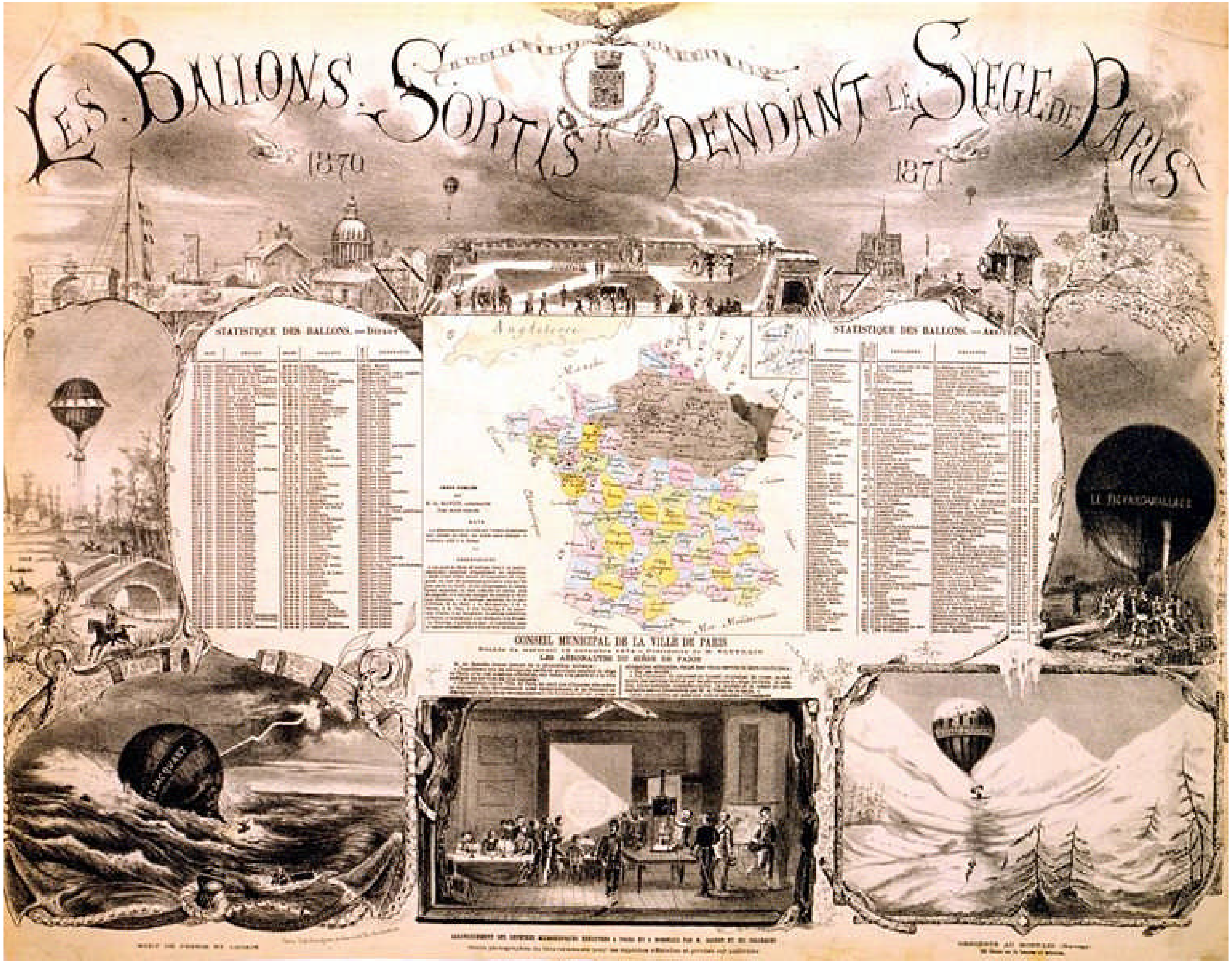
"…During the siege of Paris by the Germans, a balloon post was established in the city. At first there appeared to be innumerable obstacles in the way of this enterprise, the chief one being the difficulty of obtaining a sufficient number of aeronauts. In this strait, the aid of seafaring men resident in the city was invoked, as their training had made them familiar with operations and dangers akin to those of ballooning. From September to January, sixty-four balloons were sent off, and of these fifty-seven fulfilled their mission. The number of letters thus dispatched was 3,000,000…On one occasion, the crew of a balloon found themselves over the sea, out of sight of land. Seeing vessels they made signals for help, but were not answered, and one vessel fired on them. The men afterward descended to the earth in Norway…"

***Popular Science Monthly*, April 1876**



When the siege of *Paris* began during the *Franco-Prussian War* of 1870, there were only seven existing balloons in the city, most of them in disrepair. On September 23rd 1870, a successful solo flight was made to *Evreux* by free balloon and three days later, the Minister of Posts; *M. Rampont*, decreed the establishment of a "Balloon Post." Thereafter, balloons took off at a rate of about two or three a week. The balloons themselves were constructed simply of varnished cotton (silk was unobtainable) and filled with highly explosive coal-gas thus, they were exceptionally vulnerable to Prussian sharp-shooters. Capable of unpredictable motion in all three dimensions, none of which was controllable in inexperienced hands, they had an unpleasant habit of shooting suddenly up to six-thousand feet, then falling back again almost to ground-level. Often the aeronauts carried no compass and after a few minutes of twisting, giddy progress they had in any case lost all sense of direction. To every corner of *France* and beyond, the winds blew them and they seldom had the remotest idea where they were on landing. Added to this, since a frustrated Bismarck had proclaimed that he would submit any apprehended balloonists to the fate of common line-crossers (spies), there was always the prospect of a Prussian bullet at the end of each flight (although, on hearing of the Prussian threat, another 172 aeronauts had promptly volunteered).

<u>Above</u>: in the deserted halls of the *Gare d'Orleans*, *Eugene Godard*, veteran of some eight hundred free balloon flights, had set up an assembly line for fabricating balloons



Above: caption: "Broadside with map of where the balloons landed during the siege and a list of the pilots"

Birth of the Dirigible

"…balloons as hitherto constructed are at best but temporary affairs, quickly losing their gas and buoyancy, expensive and unwieldy, and, however valuable for certain kinds of work, must be considered as simply floating, not flying machines. If we expect to gain the respect of the birds or butterflies, we must go to work in a much less clumsy way…"

***Popular Science Monthly*, November 1885**

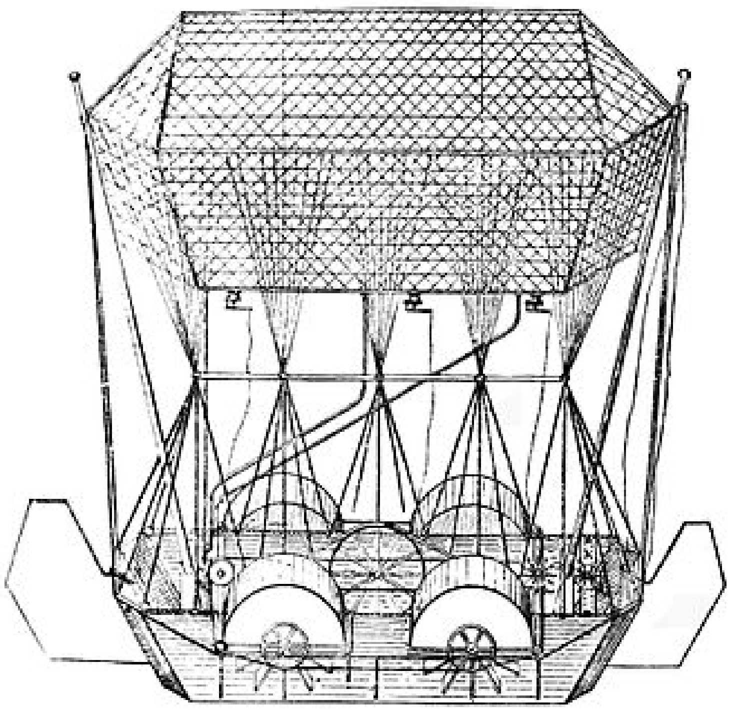
"…No sooner was the fact demonstrated that men could safely rise into the air at will, than inventors began to devise plans for directing aerial machines. So long as the balloon is completely at the mercy of the wind, it is practically useless as means of conveyance…more than one aeronaut has lost his life by being carried out to sea. In the early part of 1784 M. Robert, the colleague of Charles, attempted the propulsion of a balloon by means of oars, but in vain. He subsequently tried artificial wings, but with no better success. M. Blanchard, who crossed the English Channel in 1785 with Dr. Jeffries, tried a variety of similar devices without success. For the directing of balloons one of the first suggestions was offered by Francis Hopkinson…"

***Popular Science Monthly,* July 1885**

“…This wheel should consist of many vanes or fans of canvas, whose planes should be considerably inclined with respect to the plane of its motion, exactly like the wheel of a smoke-jack. If the navigator turns this wheel swiftly round by means of a winch, there is no doubt but it would (in a calm at least) give the machine a progressive motion, upon the same principle that a boat is ‘sculled’ through the water…”

Francis Hopkinson

RE: excerpt from a letter dated May 24th 1784 to *Benjamin Franklin* whereby he recommends that the balloon be made oblong instead of spherical and be provided with a large and light “wheel” (screw-propeller) at the stern



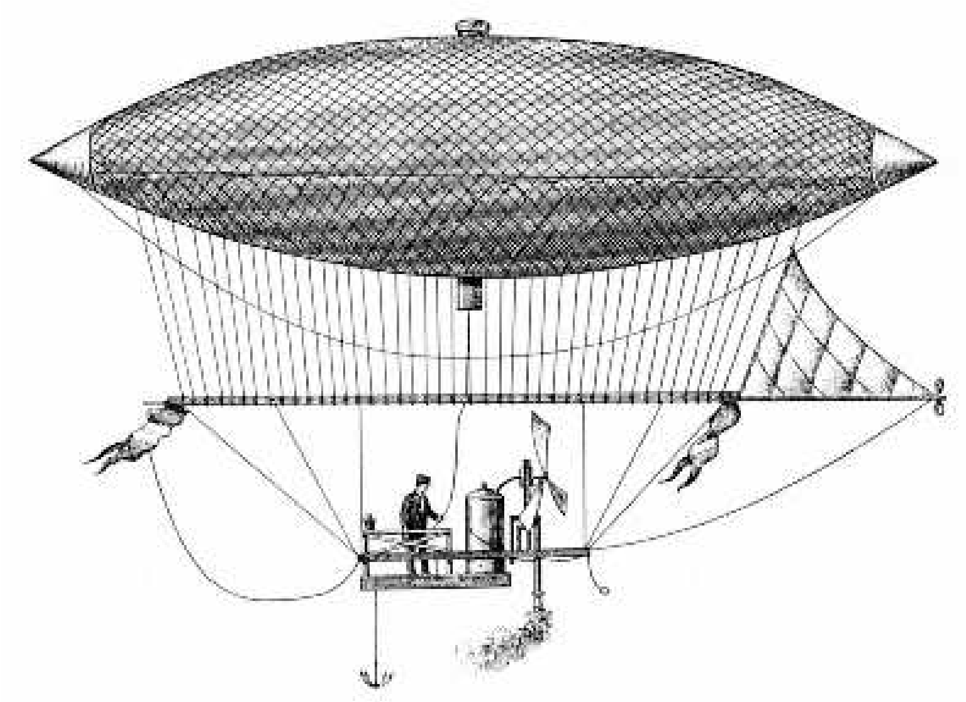
"…Of course we may provide our balloon with wings or propeller, and fly as the birds fly. This has been and continues to be a favorite combination with our inventors. One patented in this country in 1880 has been chosen as an illustration. The balloon, oblong in shape and divided for safety into compartments, supports a car containing the propelling machinery, and also a gas-generator to make up such loss of hydrogen as may occur. Two immense rudders steer the machine. It is propelled by four paddle-wheels, which would act, one would think, very much as the wheels of our river-steamers would act, if totally immersed in the water, and would be about as likely to drive the balloon backward as forward…"

***Popular Science Monthly,* November 1885**

<u>Above</u>: caption: "Sullivan's Flying-Machine (Taken from U.S. Patent-Office Reports)"

"…In 1852, a young French engineer, who subsequently won the highest distinction, M. Giffard, constructed an elongated balloon pointed at both ends and filled with illuminating gas. Suspended beneath it by cords was a longitudinal shaft, at the end of which was a triangular sail that could be turned about an almost vertical axis and be made to serve the purpose of a rudder. About twenty feet beneath the shaft was a long framework of wood, on which rested a small steam engine, whose piston gave motion to a screw-propeller. The weight of the machine, including furnace, boiler, coal, and water, was not quite fourteen hundred pounds. On the 24th of September Giffard ascended with it over Paris to a height of five thousand feet. The wind was quite strong; but he was able to make very perceptible headway against this, and by the aid of the rudder to turn the machine into any desired direction. He thus proved incontestably that the problem of directing an aerial steamer was by no means insoluble…"

***Popular Science Monthly*, July 1885**



"With his balloon, Giffard carried out some experiments of the greatest value. The low independent speed (three meters per second) which he obtained in conformity with his calculations did not permit him to describe a circle in the air, but he was able to make some very neat evolutions, deviating at his desire from the direction of the wind, thereby testifying to the efficiency of the rudder."

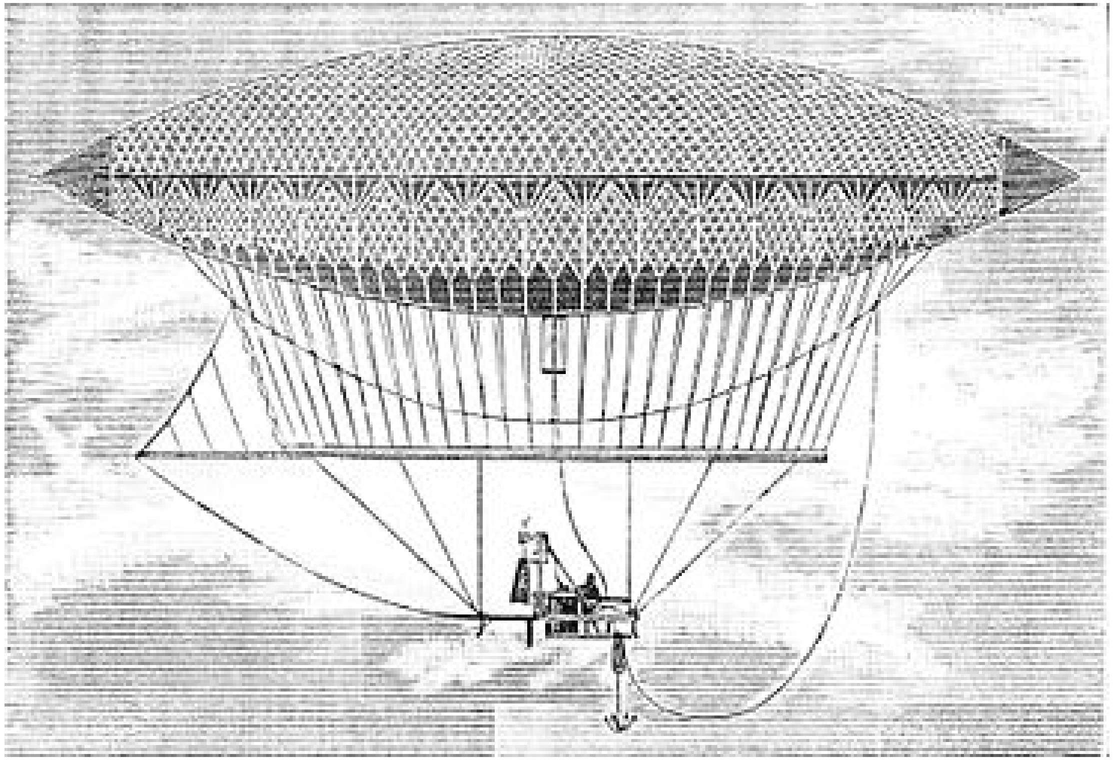
Alphonse Berget, **French Author**

RE: excerpt from his book: "The Conquest of the Air"

<u>Above</u>: Giffard's "Aerial Steamer" (1852)

“…A second ascent was accomplished by him in 1855, but under unfavorable conditions. He made no further attempts with this machine, the abandonment of these experiments being due chiefly to their danger. A steam-engine, sending forth sparks beneath a mass of thirty-thousand cubic feet of inflammable gas contained within an envelope of this cloth, is a source of peril to which few men would be willing to expose themselves. Trouble also resulted from the fact that the weight of the balloon could not be kept constant. The loss of the product of combustion and of spent steam made it difficult to preserve the proper relation between the ascensive power and the weight to be sustained…”

***Popular Science Monthly*, July 1885**



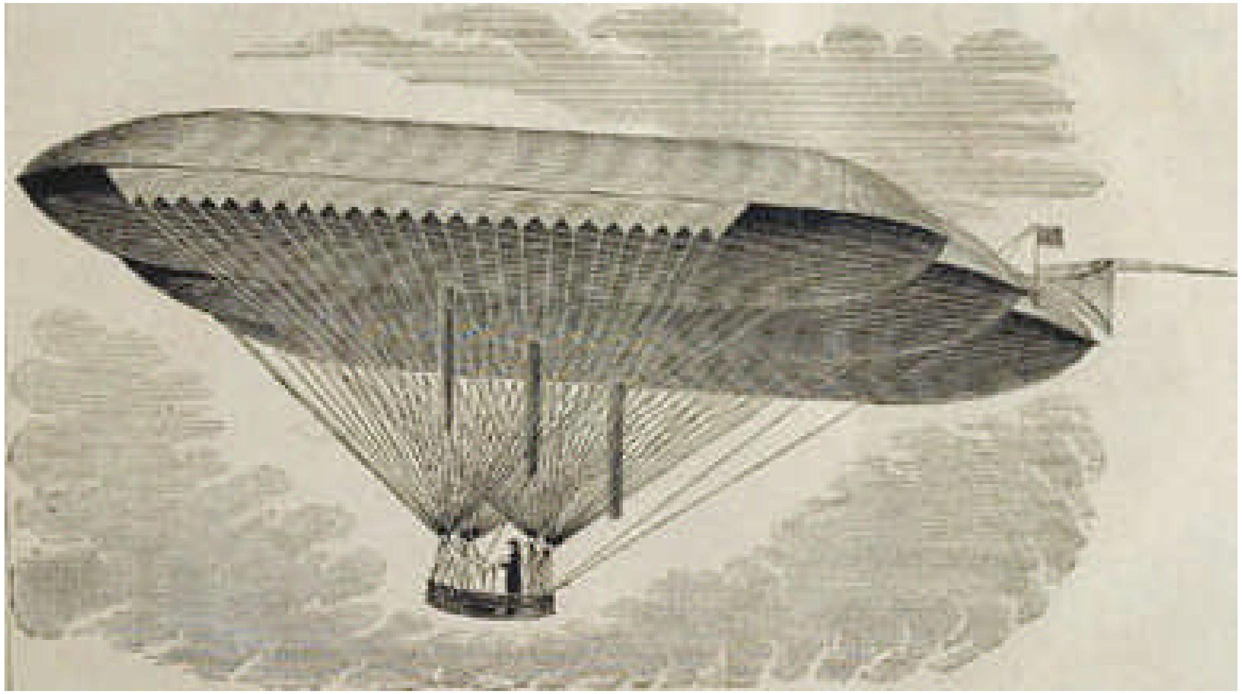
"Giffard devised a steam engine weighing, with fuel and water for one hour, 154 pounds per horsepower, and was bold enough to employ it in proximity to a balloon filled with coal gas. He was not able to stem a medium wind, but attained some deviation. He repeated the experiment in 1855 with a more elongated spindle, which proved unstable and dangerous."

Encyclopedia Britannica

<u>Above</u>: Giffard's "Aerial Steamer" (1855)

The Aerial Navigation Company

"…We have this week the pleasure to record the success of the most extraordinary invention of the age, if not most so of any the world ever saw – at least the greatest stride in invention ever made by a single individual…"
***New York Herald*, May 1865**



"…Andrews was the first man to steer a course through the air in the United States, and he was the first man anywhere to do so with any degree of success. At a time when the only accepted means of rising from the earth was the free balloon, a prey to every wind that blew, he controlled his airship, a motor-less gas bag propelled by an ingenious application of natural forces. He flew her independent of the wind, and steered her in any direction…He navigated directly against the wind. He took three passengers into the air and landed them safely. He flew cross-country. He swung around in circles a mile and a half in circumference. He zigzagged back and forth over wide-eyed, cheering crowds that jammed the streets in the heart of New York City. Taking off from a certain point, he cruised about in all directions and succeeded in returning to his starting place…"

***Popular Science Monthly*, January 1932**

Above: Dr. Solomon Andrews' first airship: "Aereon" (ca. 1863)

“…Andrews proposed to apply to a balloon the same principles that drive a sailboat. With a cross wind, the pressure on the sail is resisted by the pressure of water against the opposite side of the hull, and the boat moves ahead when the hull is held at an angle that will bring these forces together to give forward motion. Similarly, the downward pull of gravitation on a gliding airplane is resisted by the air pressure under the wings. These forces combine to give forward motion as the plane is set at the gliding angle; and descent, instead of being in a straight drop, is on a long slant. Until Dr. Andrews’ time, most balloons were spherical, and met equal air resistance when moving in any direction. His idea was to shape the balloon so that there would be less resistance to forward motion than to motion up or down. To do this he made a balloon in the form of a fat cigar or, as he called it, a ‘flattened oblate spheroid.’ From this bulging cylindrical envelope with pointed ends he suspended a basket containing a weight that could be moved from end to end. The shifting of this weight would tilt the entire machine and thus give the skipper control over the angle of flight. He calculated that an angle of from ten to fifteen degrees would result in satisfactory forward progress. To fly, the bow would be tilted upward and ballast discharged to make the craft lighter-than-air. She would then rise; but with the lift opposed by the air pressure against the broad upper surface, her movement would be forward, at the angle established by the lift. Once in motion, she could be steered with an ordinary rudder. Arrived at the desired height, the pilot would discharge gas to make the ship heavier than air, and with the angle reversed she would descend on a slant that would carry her farther ahead. In this manner, flight would continue until, through the discharge of gas and ballast, the ship would be brought to earth…”

Popular Science Monthly, **January 1932**

Dr. Solomon Andrews (1806-1872) was a man well ahead of his time, inventing the first self-propelled balloon that could be properly controlled. His flying machine named "Aereon" (a combination of "aero" and "eon" – _the age of air_) could master the stiffest wind using the same principle that a sailboat uses sailing into the wind. In actuality, Andrews discovered that the difference of specific gravity between the balloon and the atmosphere in which it floated could be applied as power to propel the airship in any direction. The Aereon made its maiden voyage over the city of _Perth Amboy_ on June 1st 1863. The dirigible made of three parallel cigar-shaped balloons, each 80-feet long and 13-feet wide, included twenty-one gas bag "cells" inside the balloon to prevent the movement of the hydrogen gas. It also included a rudder and a basket for the pilot and passenger/s. In the ensuing months, more trials were performed until Andrews wrote a letter to POTUS _Abraham Lincoln_ on August 26th 1863. After much delay, he met with Lincoln in January 1864 and shortly afterward gave a demonstration before a scientific committee in the _Smithsonian Institute_. Andrews wrote a letter to Secretary of War _Edward M. Stanton_ in which he detailed his thoughts of using the airship to the Union's advantage: "_sail the airship five to ten miles into Seccesia (enemy territory)…for observing the position, force and disposition of the enemy."_ Nearly a year later, after much red tape, the military committee informed Andrews of little interest in the airship even though balloons had been used with success for observing enemy movements. Undaunted, Andrews organized the _Aerial Navigation Company_ to build commercial airships and establish a regular line between _New York_ and _Philadelphia_. He built _Aereon No.2_ and on May 25th 1865, using only one cylinder shaped like a giant lemon, he sailed over _New York City_, stunning the populace. On June 5th 1865 with great fanfare, Andrews again sailed over NYC, brought the city to a standstill and landed at _Oyster Bay, Long Island_. Although more spectacular flights were predicted, he never flew again. In the post-war panic, hundreds of banks failed, the Aerial Navigation Company's funds were wiped out and the company dissolved. Having demonstrated his flight principles, Dr. Andrews left it to others to develop them. Sadly, when he died in 1872, his work was already forgotten.

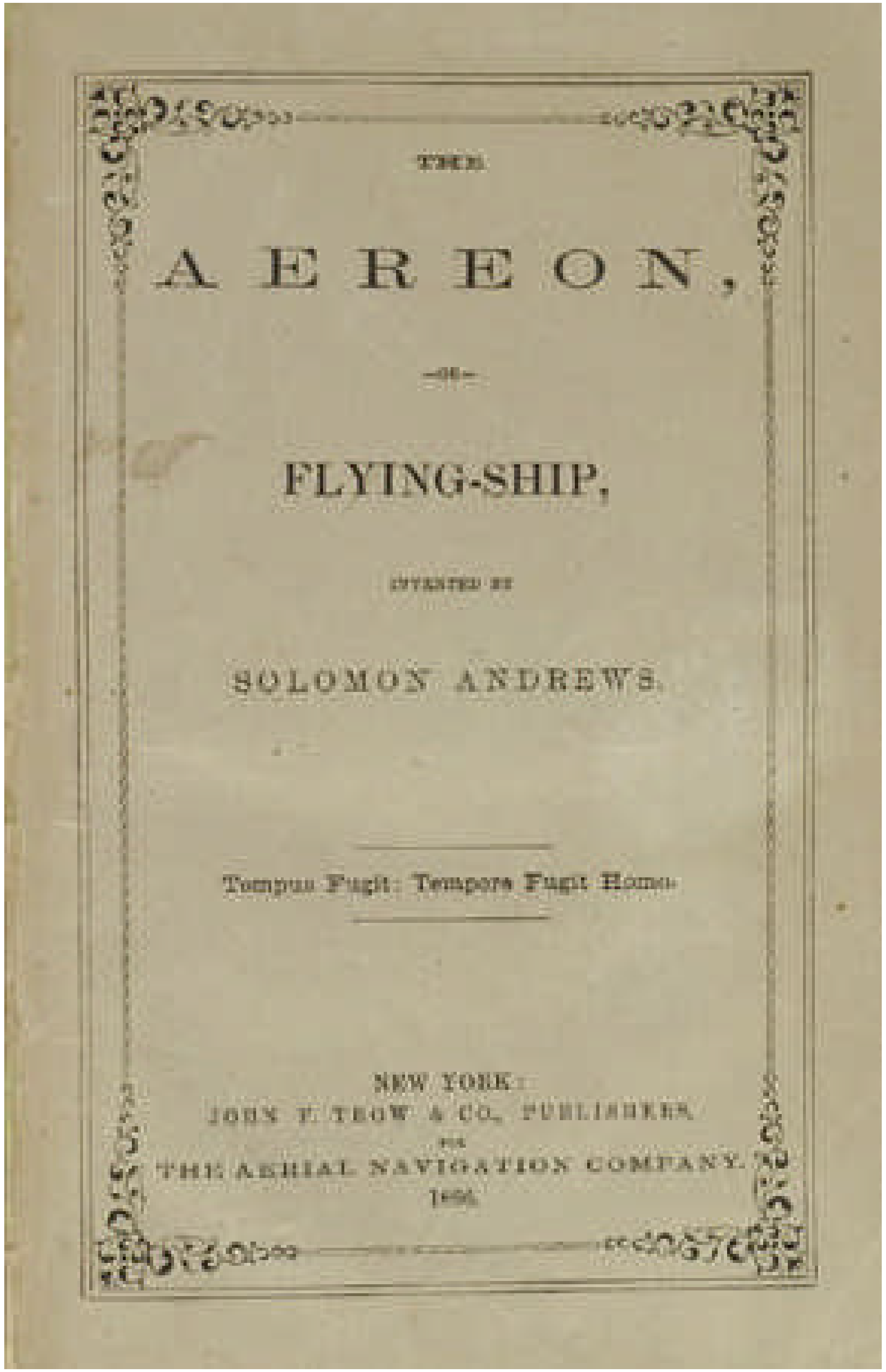
"…Andrews' last airship, built just after the close of the Civil War, was constructed not by an individual, but by a company incorporated for the purpose. The Aerial Navigation Company, unquestionably the first organization for the commercial exploitation of aircraft, was chartered in November, 1865…The company's charter authorized 'the transportation of passengers, merchandise, and other matter from place to place'…America's first air pilot was no crank or impractical dreamer. Living from 1806 to 1872, he was a prominent physician; a leading citizen of Perth Amboy, N.J., a much more important city than now; and an inventor with twenty-four patents…"

***Popular Science Monthly*, Jan. 1932**

<u>Left</u>: *Doctor Solomon Andrews*

"…Instantly the machine righted herself as ordered, and shot along at a rate that threw the astonished miles rapidly behind her. That course conclusively tested, the Aereon was headed due southeasterly, or directly against the wind. Changing he course, the gallant vessel, freighted with so many hopes, veered around as directed and, for five full minutes, whose luxurious duration seemed hours, she bore on her unswaying, undeviating way, with tremendous velocity, annihilating space, and spurning the wind across whose path she rode, and whose advancing hosts she met and conquered. Navigation of the air was a fixed fact. The problem of the centuries had been solved…"

***New York World,* May 1866**



"…Young Zeppelin, then a twenty-four-year-old Prussian lieutenant attached as an observer to the Northern Army, was in the country at the time. His first airship was not built until 1900. Did he witness the flights of the American pioneer? Did he have an opportunity to examine his mechanism? Did he notice the divided gas bag? In any case, the idea originated with Dr. Andrews, who patented it in July, 1864…"

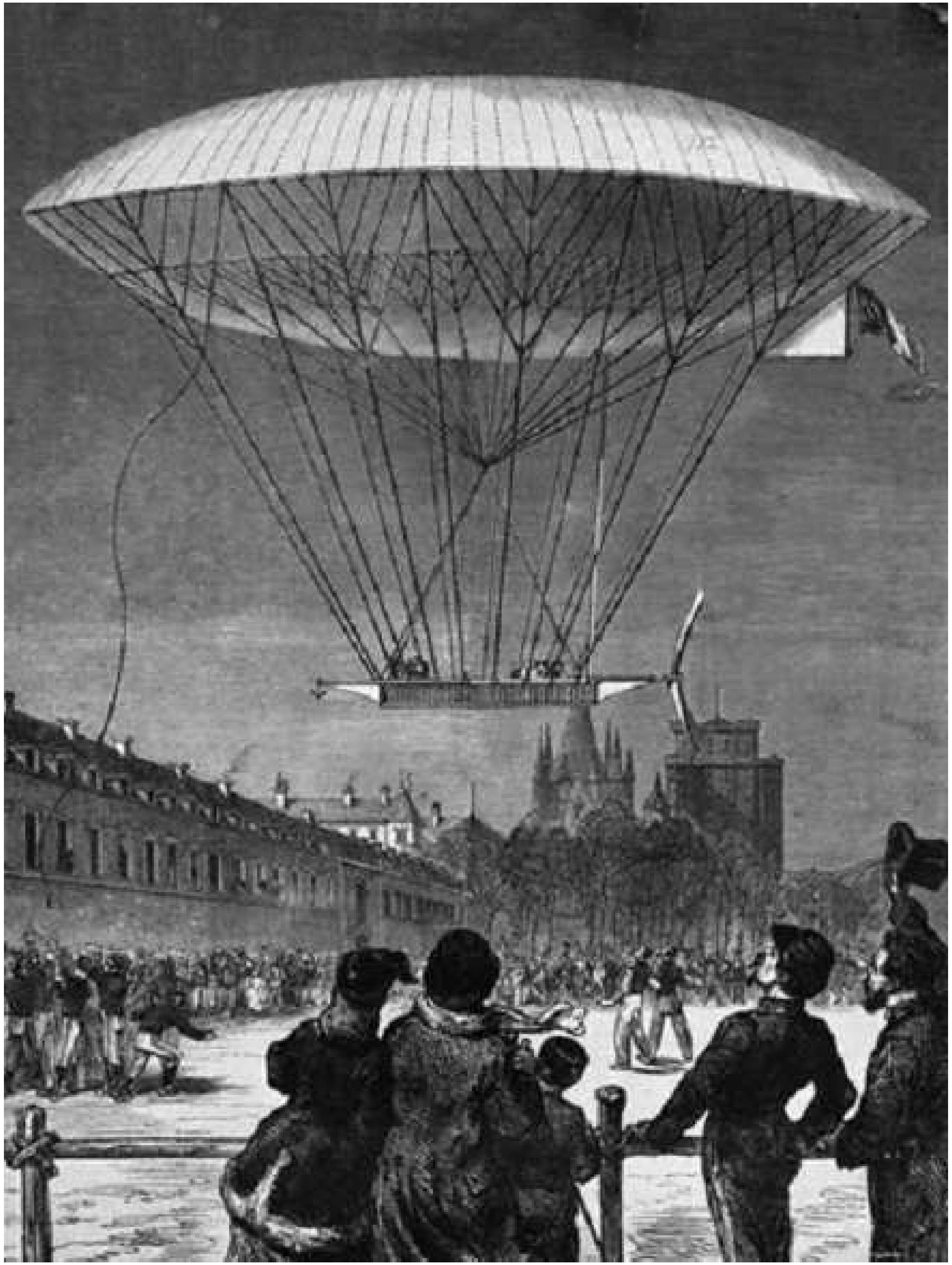
***Popular Science Monthly,* January 1932**

<u>Left</u>: cover of "The Aereon or Flying-Ship" by *Solomon Andrews*, 1866

Vive Le France

“…On the basis of the success already attained, calculations have been made which indicate that it may be quite possible in the near future to construct larger balloons that will travel in calm air at the rate of twenty-five or thirty miles an hour. Such air-ships, capable of ready direction at safe elevations, may serve important purposes in time of war. But for the public their use must long continue to be very limited…for the development of aeronautics as an art, we must continue to look to France, its earliest home…The day is perhaps not far distant when at least a favored few in our country may enjoy the luxury of summer afternoon excursions through the air, free from dust and cinders, and occasionally even vying with the birds in speed.”

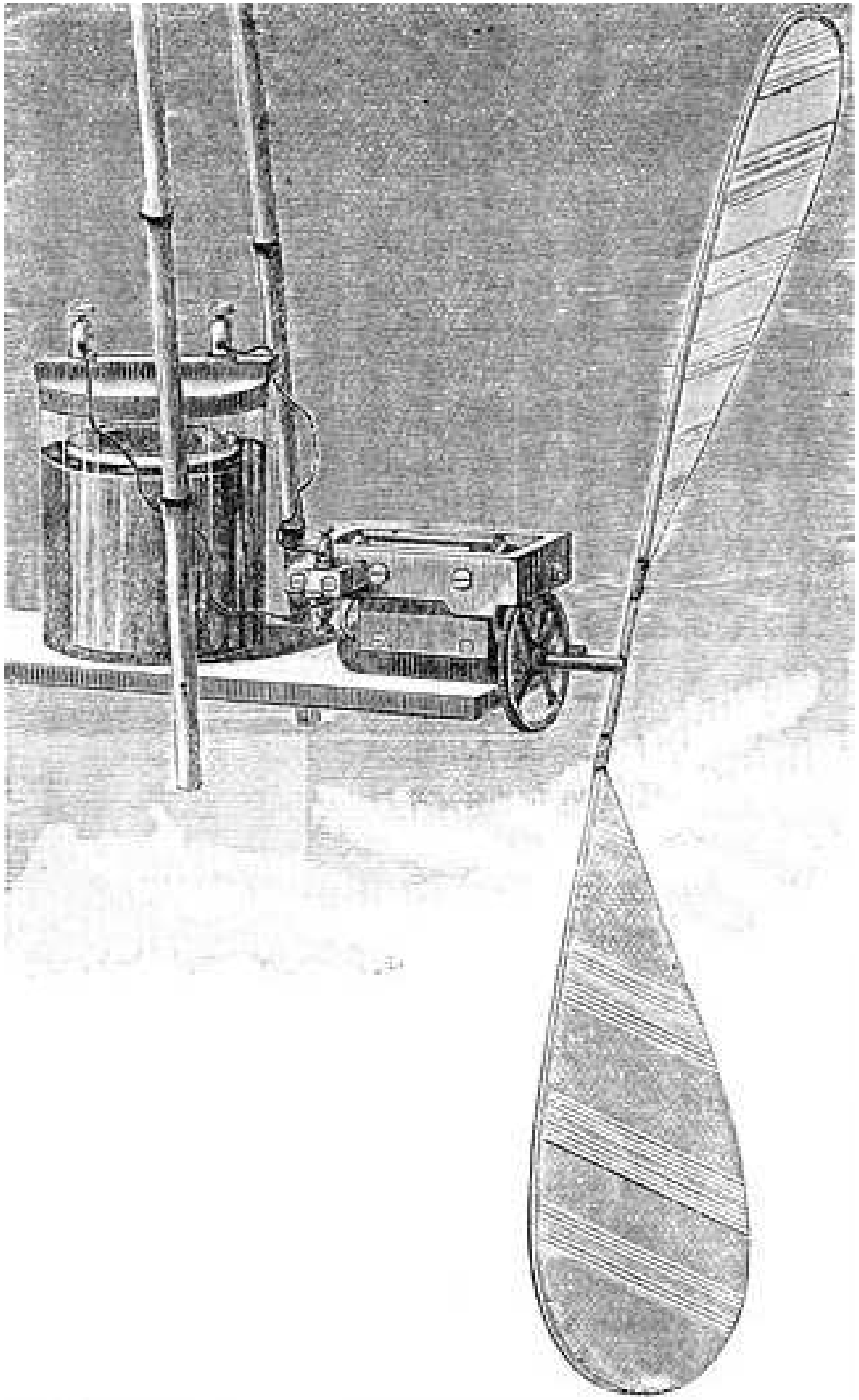
***Popular Science Monthly,* July 1885**



"…Not quite twenty years after Giffard's experiments the problem was again attacked by M. Dupuy de Lome. His immense balloon, containing one hundred and twenty thousand cubic feet of pure hydrogen, was nearly similar in shape to that of Giffard. The car beneath was capable of carrying easily fourteen men, seven of whom at a time were employed in working a capstan which controlled the shaft of the propeller, each of the two blades of this being about ten feet in length. On February 2, 1872, Dupuy de Lome ascended in this balloon, and attained a speed estimated at 2.8 metres per second, equivalent to about six miles per hour. By means of the rudder he changed the direction through an angle of twelve degrees. Giffard had attained an estimated speed of four metres per second, or nine miles per hour. Muscular power was thus shown to be far too uneconomical, while steam was too dangerous, to be employed in the direction of aerostats…"

***Popular Science Monthly,* July 1885**

Left: de Lome's "Navigational Balloon"



“…It was not until 1881, the year of Giffard’s death, that electricity was applied as a motive power in the attempt to solve the difficult problem with which he had grappled. His pupil, M. Gaston Tissandier. Had early imbibed a passion for aeronautics, and made many successful ascents with spherical ball-oons…Tissandier conceived the idea of employing storage-batteries instead of steam or hand power, as the immediate source of energy to actuate the propeller of an elongated balloon. He constructed a small experimental balloon, which was filled with hydrogen, the affective ascensional force being two kilograms. A motor of the Siemens type, weighing only two hundred and twenty grammes, was made to turn the propeller, which consisted of a pair of vanes, each ten centimetres long; storage cell, motor, and propeller being supported on a light platform suspended by netting. This ‘dirigeable’ aerostat was exhibited at the Electrical Exposition of 1881, and a bronze medal awarded to the inventor. It attained a speed of about three metres per second…”

***Popular Science Monthly,* July 1885**

<u>Left</u>: caption: “Tissandier’s Miniature Electric Motor and Propeller, 1881”

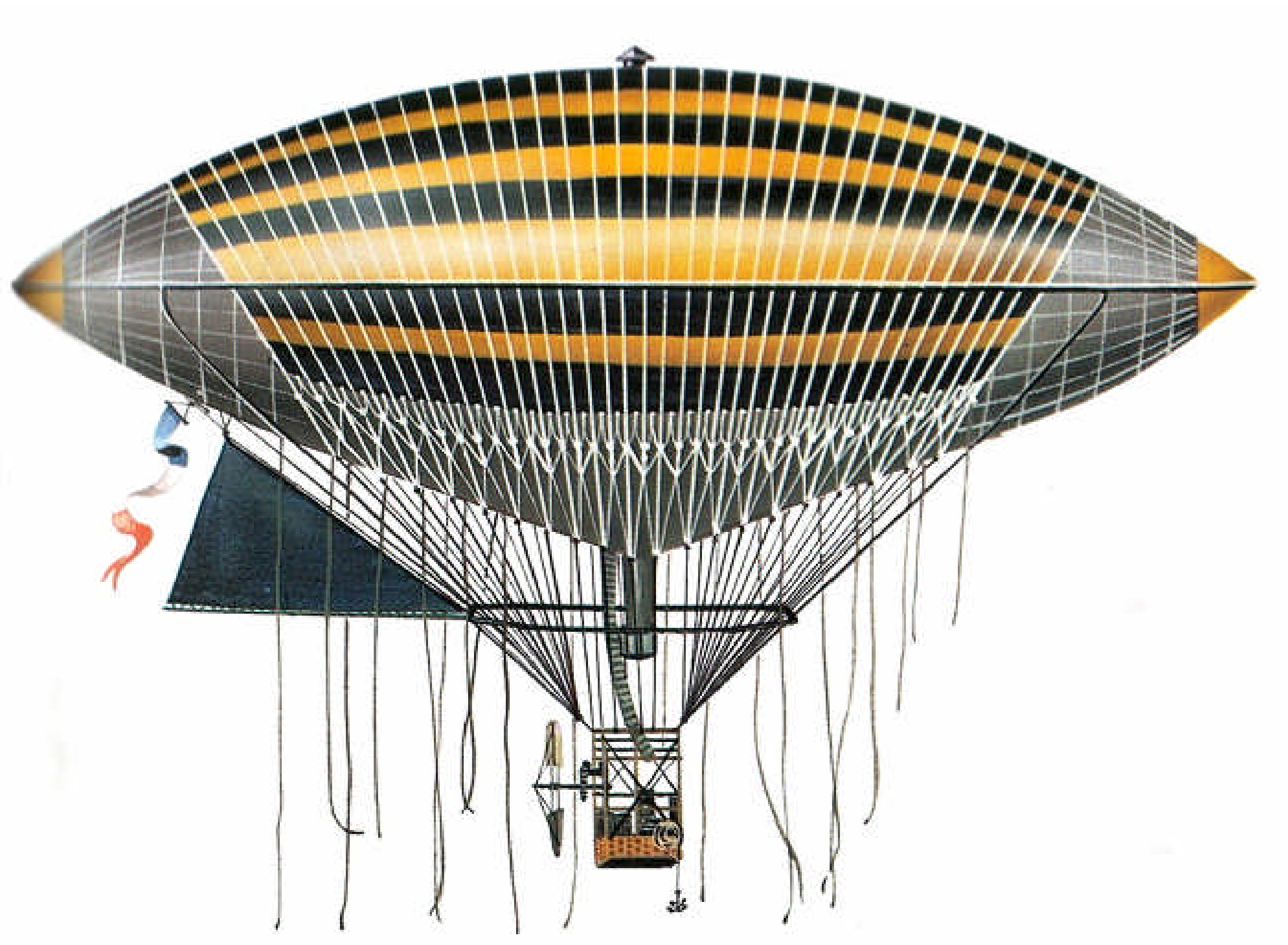
“…Encouraged by this success, Tissandier undertook the work of constructing an aerostat large enough to lift two or three persons in addition to the weight of the propelling apparatus and other accessories…The persevering aeronaut could not find no one but his brother to join him in laying out capital for the promotion of what was generally regarded as a visionary scheme…M. Gaston Tissandier had found by experiments with his small aerostat that better results were to be had by a battery of cells, arranged in series, where a strong acid solution of potassium bichromate was the exciting liquid, than from a storage-battery. He originated ingenious contrivances by which great lightness was secured, and the liquid could be conveniently brought into contact with the zinc and carbon plates, or removed at will without disturbing the plates. A Siemens electric motor was constructed, weighing but eighty-five kilogrammes. When excited by the current from a battery of twenty-four elements weighing one hundred and sixty-eight kilogrammes, this motor was found capable of doing work equivalent to that of fifteen men, that is, from seventy-five to one hundred kilogramme-metres per second, continued through three hours, the weight of battery and motor together being but little in excess of the weight of three men…”

***Popular Science Monthly*, July 1885**

“The two brothers henceforth worked together, Gaston continuing to devote himself to the perfection of the electrical appliances on which reliance was to be placed, while Albert, who is by profession an architect, gave his attention to the mechanical construction of the aerostat…Gaston Tissandier devised also important improvements in the method of generating pure hydrogen rapidly on a large scale. The ascensive force of this gas when pure is about seventy-five pounds per thousand cubic feet, or eleven hundred and eighty grammes per cubic metre; while that of coal-gas which has been most generally employed for ballooning purposes is not more than five-eighths as much. By the substitution of hydrogen, the size, and consequently the expense, of the balloon is correspondingly diminished…”

***Popular Science Monthly*, July 1885**

<u>Above</u>: the Tessandier brothers; *Albert* (1839-1906) at left and *Gaston* (1843-1899) at right



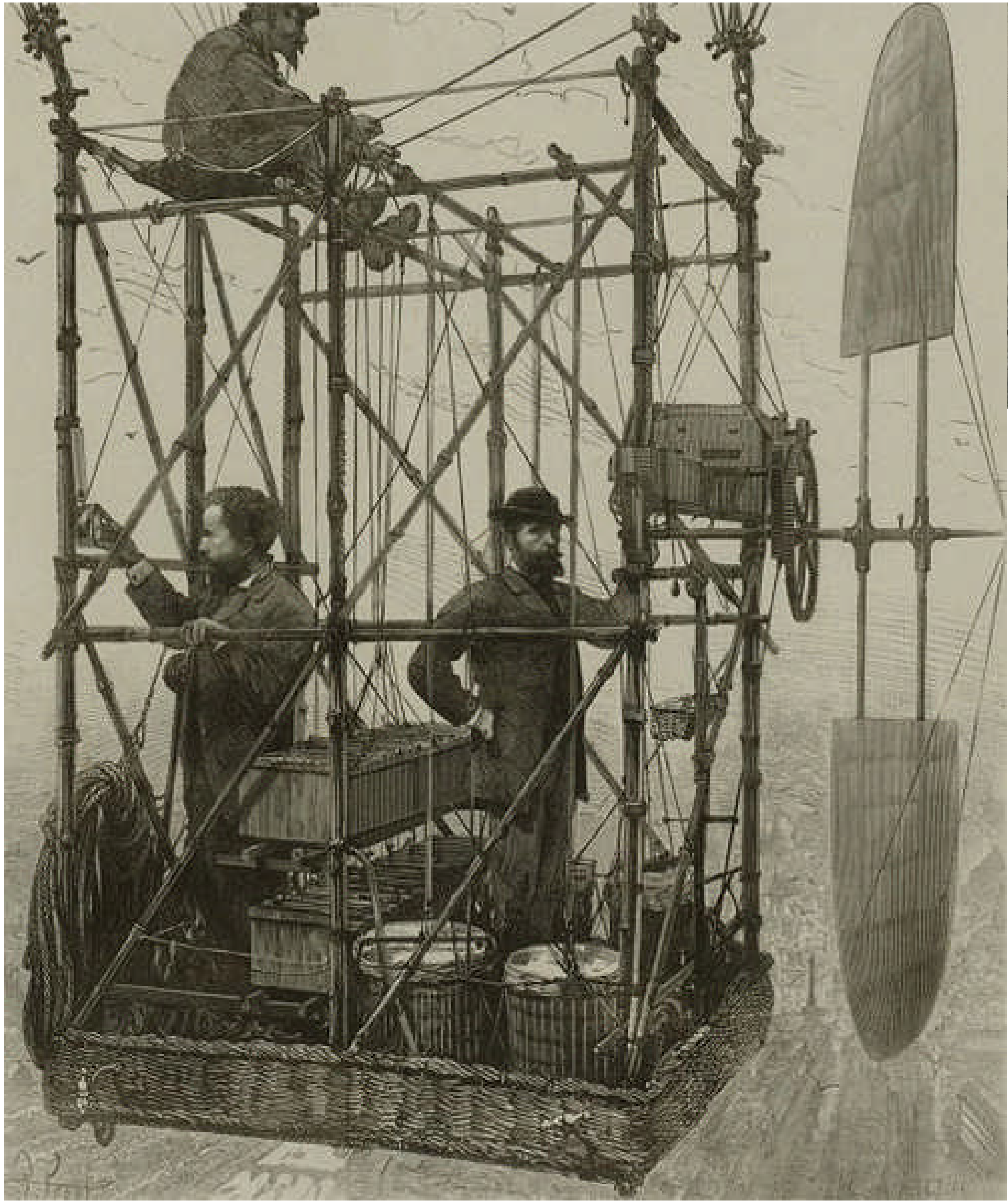
"…The aerostat by M. Albert Tissandier is ninety-two feet long, thirty-feet in its greatest diameter, with capacity of about thirty-eight thousand cubic feet, and ascensive power of about twenty-eight hundred pounds. The propeller, nine feet in diameter, is in the rear of the cage. Above it, and farther back, is a triangular sail, to be manipulated as a rudder…"

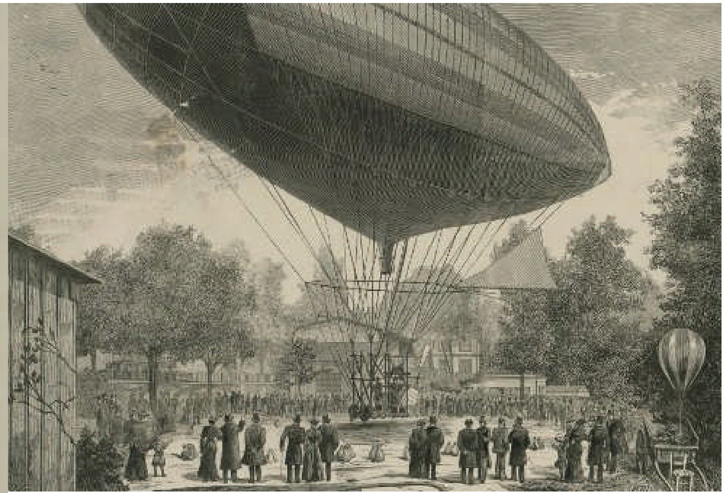
***Popular Science Monthly*, July 1885**

<u>Above</u>: the electrically powered dirigible by the Tissandier brothers

"…On October 8, 1883, the first ascent was made. The air at the ground was calm, but on reaching a height of sixteen hundred feet the wind was blowing at the rate of rather more than six miles an hour. On putting the propeller into action, with a velocity of three revolutions per second, and turning the head of the aerostat against the breeze, it was kept motionless for some minutes; but the rudder soon proved to be insufficient to keep the direction constant, flapping like a sail, and at times leaving the aeronauts at the mercy of the wind. After stopping the propeller and waiting until the direction of the aerostat coincided with that of the wind, the action was renewed. A marked acceleration in speed was the immediate result, and the deviations from the line of the wind were secured by very slight motion of the rudder, the aerostat keeping its stability perfectly. The descent was safely accomplished after remaining in the air a little more than an hour…"

***Popular Science Monthly*, July 1885**





<u>Above</u>: caption: "Airship powered by an electric motor developed by Albert and Gaston Tissandier departing from Auteuil, Paris, France, October 8, 1883"

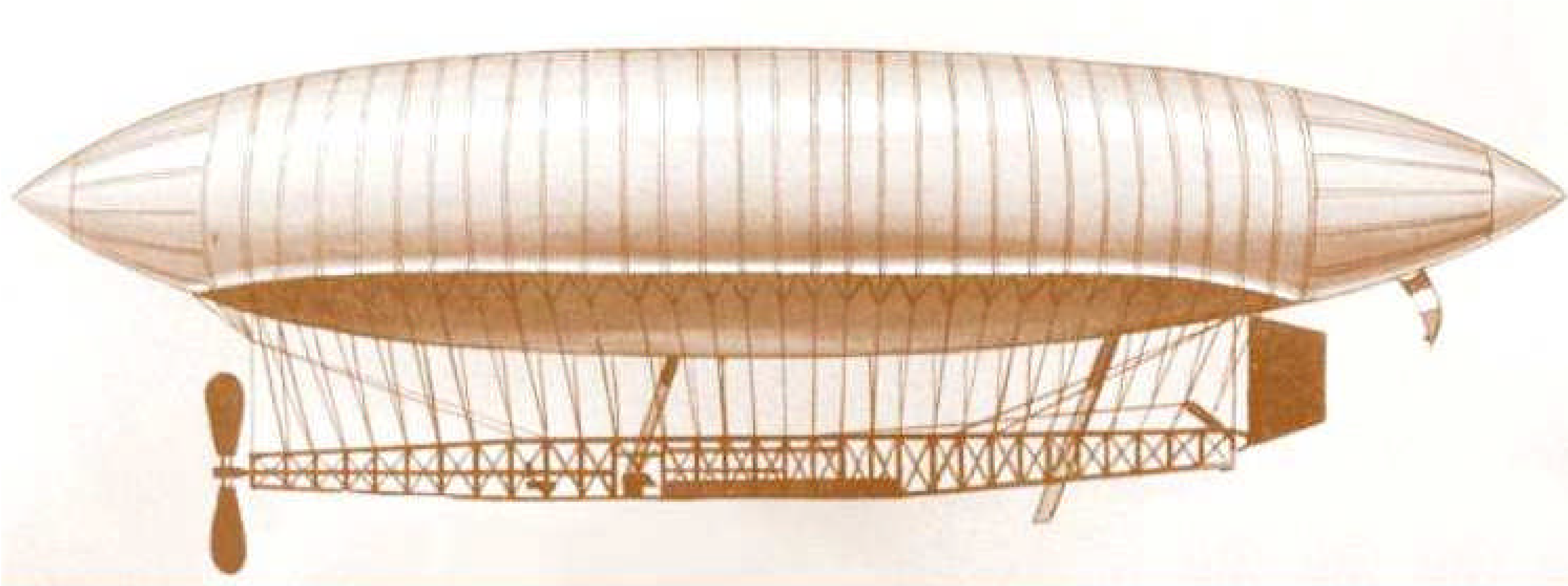
<u>Left</u>: caption: "Albert Tissandier (left), Gaston Tissandier (right), and an unidentified man in the basket of their airship demonstrating an electric navigational system featuring a propeller."

“…The first experiment in the use of electricity in practical aeronautics was about as successful as that of Giffard with steam in 1852, so far as relates to the attainment of speed; but it showed that such speed could now be secured without danger and without uncontrollable variation in the weight of the mass propelled. Tissandier did not expect the attainment of complete success in a single trial; such as he did attain was enough to convince not only him but others that he had opened out a pathway which could be followed with entire confidence. He had not the means at hand sufficient to enable him to keep his aerostat inflated, so as to repeat his experiment on the first favorable day after imposing such modifications as were suggested by the experience of the first ascent. It was not until September 26, 1884, that this opportunity was presented. The velocity of the wind was about the same as during the first ascent, but the aerostat was propelled at a rate about one-third greater, so as to make at times very perceptible headway against the wind…”

***Popular Science Monthly*, July 1885**

"…Meanwhile the success achieved by the Tissandier brothers in 1881 and 1883 had inspired MM. Renard and Krebs, officers of the French army, who were stationed at Chalais-Muedon, near Paris. They had for several years been conducting experiments on the conditions requisite for directing balloons, being guided in their studies by the previous work of Dupuy de Lome. An appropriation of one hundred thousand francs had been granted them, and their investigations were conducted with the utmost secrecy. The pecuniary resources at their command gave them a great advantage over Tessandier, in the ability to construct a balloon much larger than that with which Tissandier's success had been achieved; and this permitted the application of a motor nearly seven times as powerful as the one previously employed…"

***Popular Science Monthly*, July 1885**



"…Their balloon is one hundred and sixty-six feet long, twenty-eight feet in greatest diameter, its capacity sixty-seven thousand cubic feet, and ascensional power nearly five thousand pounds. The ratio of length to thickness is thus much greater than in Tissandier's balloon. The details of construction of the battery and motor have not been given to the public by Captain Renard. The rudder is also a parallelogram in form, and thickest in the middle, the cloth being tightly stretched over a light framework so as to present a rigid surface to the air. The propeller is fixed to the extremity of a long shaft, and placed at the front, instead of the rear of the balloon. The front end of the machine is thicker than the rear end. This feature seems rather unaccountable. The balloon is filled with hydrogen, but within it a subsidiary balloon, connected by a tube with the cage, where air can be pumped in or out at pleasure, thus varying slightly the specific gravity of the mass as a whole and enabling the aeronauts to vary their elevation at will…"

***Popular Science Monthly,* July 1885**

<u>Above</u>: Renard and Kreb's dirigible balloon (1884)

"…On August 9, 1884, an ascent was accomplished with this balloon, the atmosphere being almost perfectly calm. A journey of nearly two miles was made in a southerly direction, then over a mile westward, after which the balloon was turned northward and eastward. Very slight motion of the rudder was needed to execute these curves Twenty-three minutes after their flight was begun the aeronauts were immediately over their starting-point, having made a trip of not quite five miles. In descending it was necessary to move backward and forward several times in succession, alternately reversing the direction of rotation of the propeller. The return to the ground was at the very spot from which the departure had been made. This remarkable feat was thus accomplished almost exactly one hundred and one years after the ascent of the first hydrogen balloon, sent up by Charles but a few miles distant. A second ascent was made by Renard and Krebs on the 12th of September, but with only partial success, in consequence of an accident to the motor. On the 8th of November two successive journeys were taken, the balloon returning each time to its point of departure, and attaining a speed of nearly fifteen miles an hour, independently of the wind, which was blowing at the rate of five miles an hour…"

***Popular Science Monthly,* July 1885**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Charles Renard y
Arthur Krebs 1884
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"…In their communication to the French Academy of Sciences, on the 18th of August, Renard and Krebs accorded to Tissandier the credit of priority in successfully applying electricity to the propulsion of balloons. Tissandier, on the other hand, equally freely accords to them the credit of making a pronounced success of what has been developed to only a limited extent in his hands on account of the want of funds. To each of the group the world must now give praise for the solution of a problem which was theoretically solved long ago, but involved practical difficulties that seemed almost if not quite insurmountable…"

***Popular Science Monthly*, July 1885**

<u>Left</u>: period print featuring both the Tessandier Bros. (right) and Genard and Krubs' (left) electric aerostats

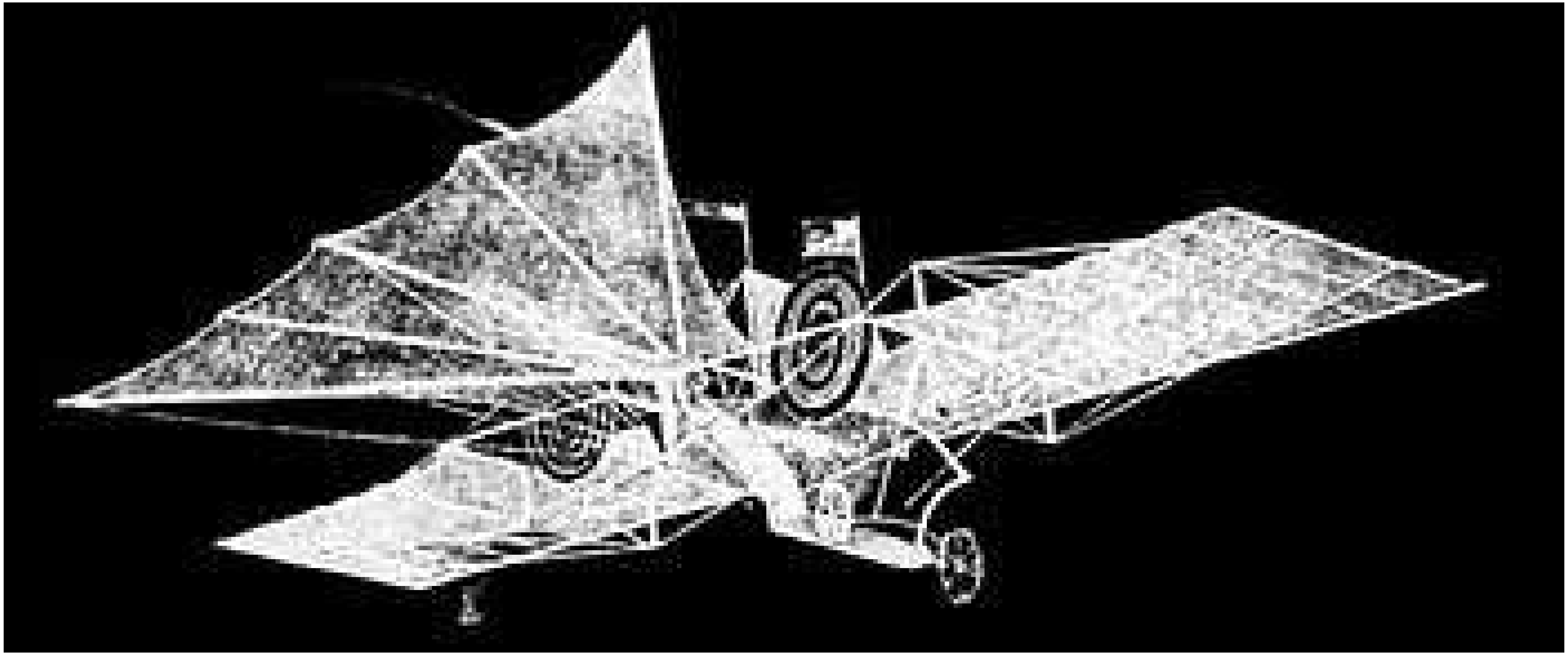
“…In 1893 the French War Department built the ‘General Meusnier,’ named after an aeronautical officer of extraordinary merit of the first French Republic. This war balloon is said to be 230 feet long, 30 feet in diameter, 120,000 cubic feet in capacity and to have been originally provided with a gasoline motor of 45 horse power. It is said by the writers on the subject that it was never taken out. Possibly the French were waiting for a war which fortunately never came; but, be this as it may, it is probable that with the reduction which has since taken place in gasoline motors this balloon could carry an engine of some 70 horse power, and attain a speed of about 30 miles an hour, which is greater than that of transatlantic steamers…”

***Popular Science Monthly*, March 1904**

The Edge of the Possible

"A succinct history was given by M.G. Dary, in a recent number of 'L'Electricien' of the vain efforts that have been made at different times to steer balloons in the atmosphere. Some of the experiments were, indeed, of real merit; but they did not succeed practically, because the problem they were intended to solve offers insurmountable obstacles. The steering of balloons and the realization of great speed with them are practically impossible, and the results of experiments directed to those objects have not been worth the immense outlays that have been made upon them. Yet balloons styled directable will probably render very appreciable services in military art and under a few other special circumstances. The experiments of M. Gaston Tissandier and Commandant Renard have not been useless, and it will be of some advantage to continue them. But balloonists are right in seeking to increase the dimensions of their globes in order to increase at once the ascensional power and of motor and propulsive energy to resistance, we, advocates of machines heavier-than-air, looking especially to great speed, would gradually diminish the function of the balloon as a sustainer, reduce it, and bring into greater predominance the propulsory organs, making them at once more powerful and lighter. These are those which, with the motor and the generator, represent the element heavier-than-air. When the balloon shall have been eliminated in this way, practical aerial navigation will have been accomplished."

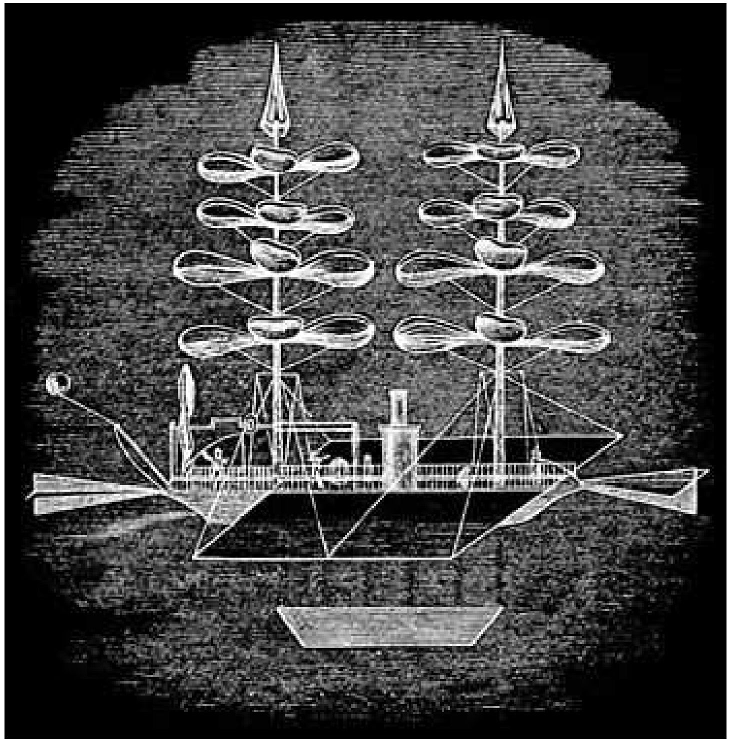
***M.G. Trouve,* January 1892**



"…One of our illustrations shows the flying-machine invented by Mr. Henson in England in 1842, and deserves mention as being the first of importance designed to fly without the aid of muscular power. The chief feature was the very great expanse of its sustaining planes, which were larger in proportion to the weight than in many birds. The machine advanced with its front edge a little raised, and the air acting upon the lower surface, when the proper speed had been attained, was expected to lift and sustain it. This speed at the start-off was to be got by running down an inclined plane or hill, and the object of the screw-propeller was simply to keep up the motion. It is unnecessary to say that this machine did not work, and yet Henson evidently had a glimmering of what is required. He introduces the inclined plane and propeller, but does not apply them in a practical way. Such a machine, of course, would be completely at the mercy of the winds; and while he might find a convenient hill to roll down in order to get the required velocity, in coming to earth again there might be trouble…"

***Popular Science Monthly*, November 1885**

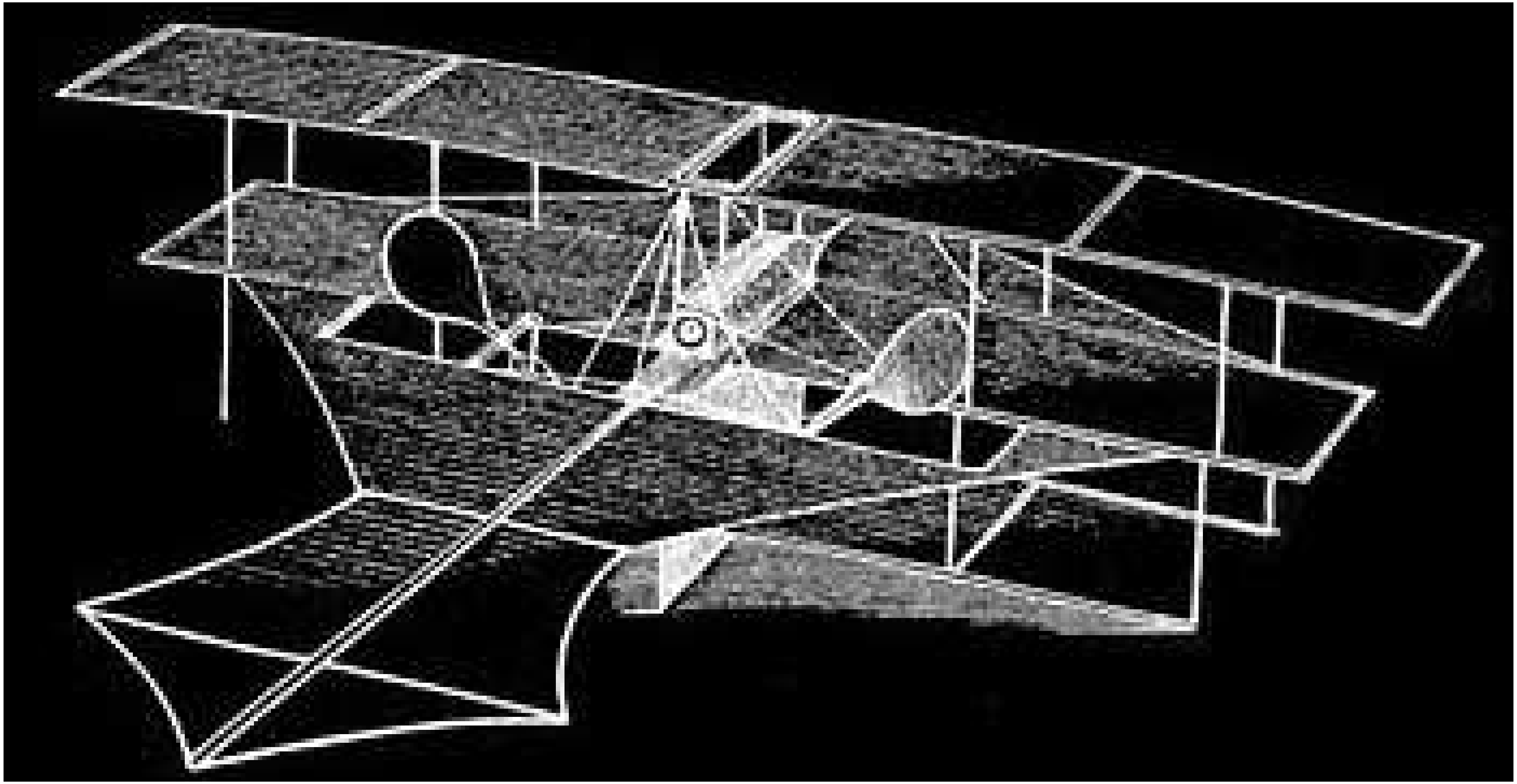
Above: caption: "Henson's Aerostat"



"…Landell's flying-machine, invented in 1863, was also provided with an extensive aero-plane, but differs in having screws acting vertically to sustain the machine in addition to those for driving it forward. Capping all are two parachutes, intended to open and prevent a sudden fall in case of accident. There are four sets of blades on each vertical screw-shaft, on the principle, one would think, that if one set would be a good thing, four sets would be four times as good. They would be likely to act somewhat like four screw-propellers, one behind the other, on an ocean-steamer. The mechanism was to be driven by a steam-engine. The dark object suspended below may be ballast to counteract any superfluous energy of the steam…"

***Popular Science Monthly*, November 1885**

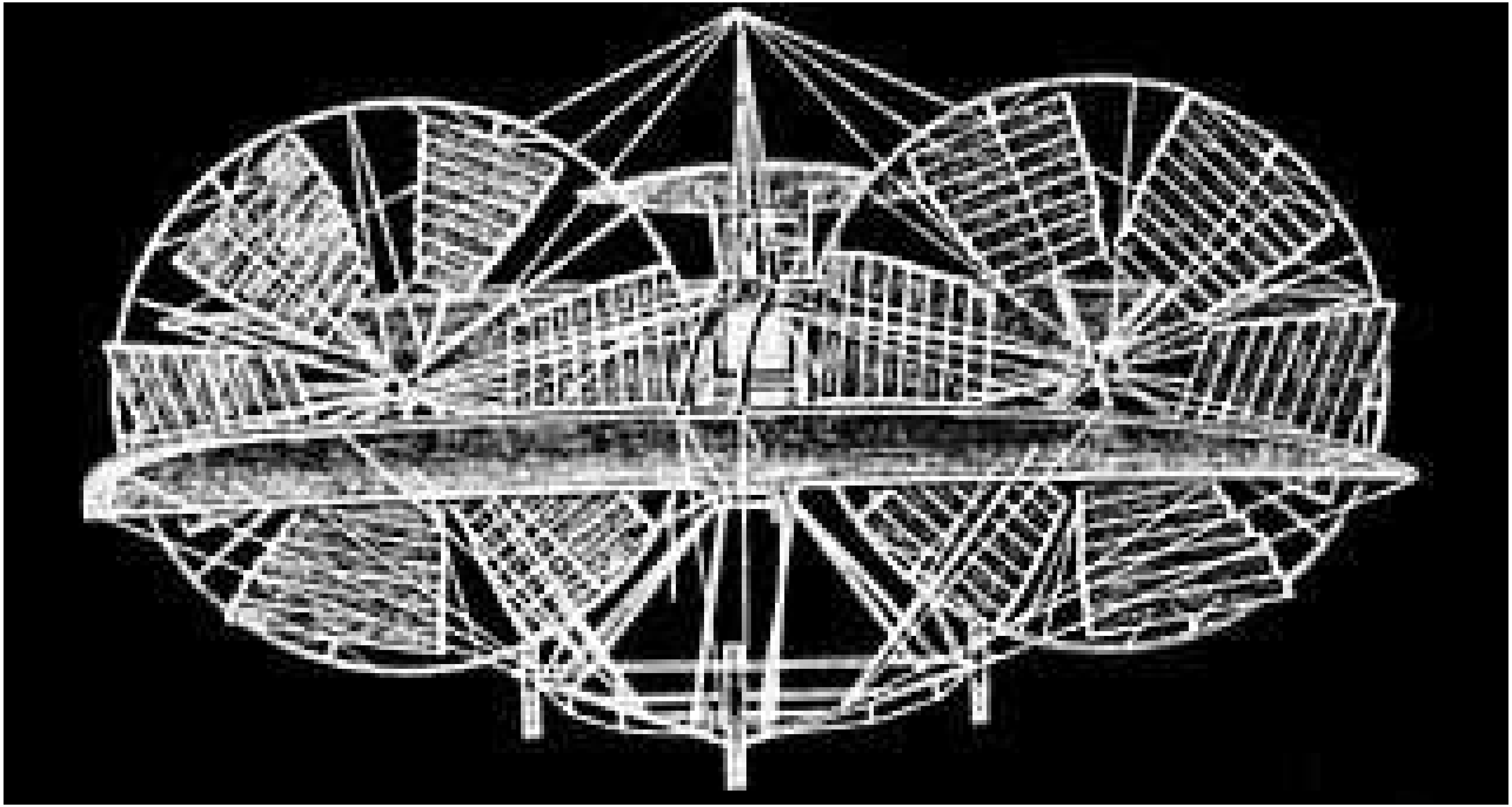
Above: caption: "Landell's Flying-Machine"



"…In 1868 Mr. Stringfellow built and exhibited a model of a flying-machine at the Crystal Palace, in London, where it took a prize. There are three aero-planes, one above the other, with a broad tail behind. As in Henson's machine, no provision was made for lifting it from the ground, the power being applied simply to produce or keep up horizontal velocity, the reaction of the air against the inclined planes serving to sustain the weight. At the exhibition the model ran down an inclined wire, but refused to rise into the air. It weighed only twelve pounds, including an engine exerting one third of a horse-power, boiler, water, and everything. Of course, even if the model had been a success, no large machine constructed in such a way could be of practical value…"

Popular Science Monthly, **November 1885**

Above: caption: "Stringfellow's Flying-Machine"



"…The machine designed by Mr. Moy in 1874 was somewhat similar to Henson's and Stringfellow's. There are two inclined planes, one behind the other, and two horizontal screws. The necessary speed to lift the machine was to be obtained by a preliminary run along the ground on the wheels underneath. In coming to earth again we should only need to look out for some favorable locality, strike tangentially, and the resistance of the wheels over stones, fences, and the like would speedily bring us to rest…"

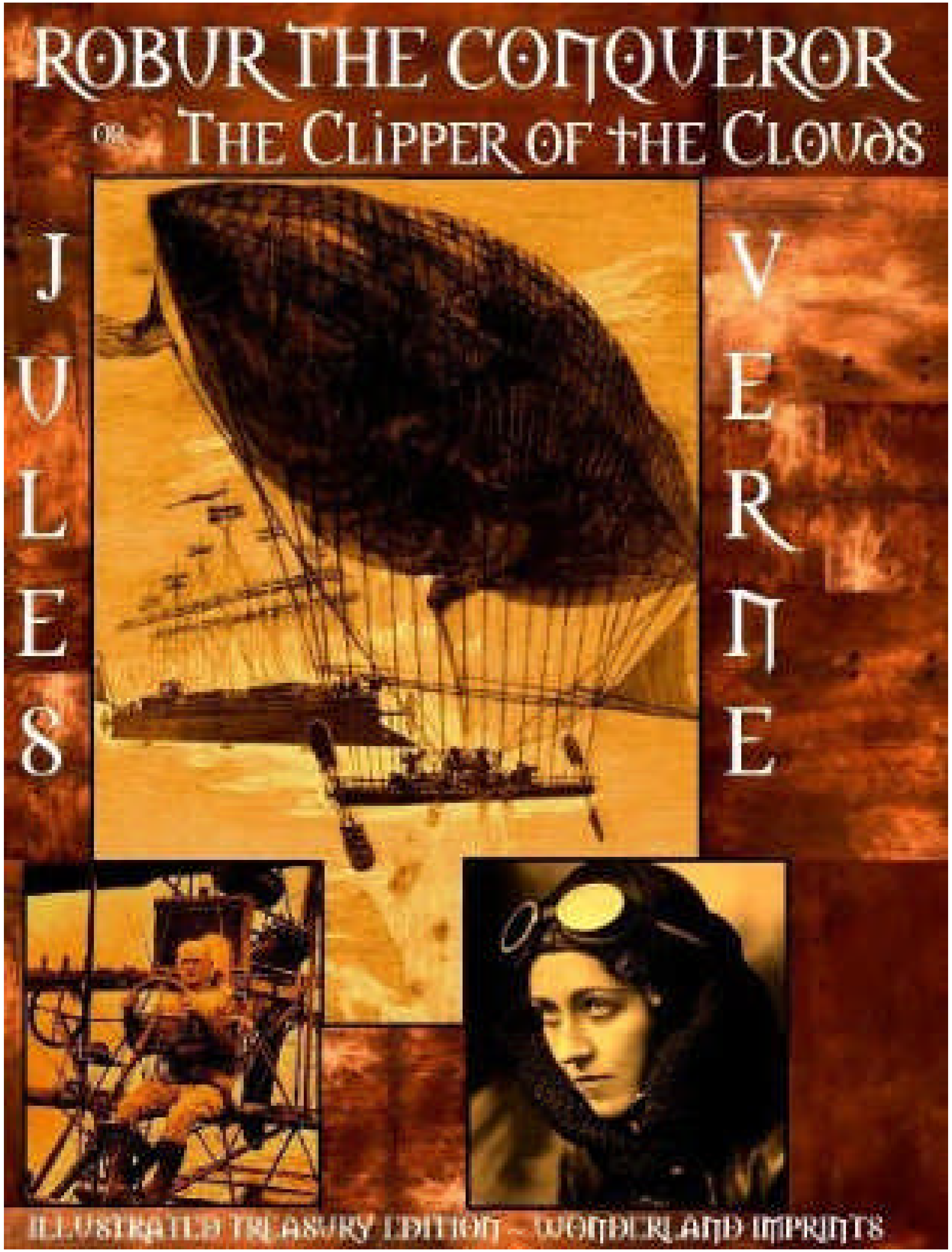
***Popular Science Monthly,* November 1885**

<u>Above</u>: caption: "Moy's Aerial Steamer"

"…These are the more important inventions of this class - that is, self-raising and self-propelling machines - and it must be confessed the results are far from encouraging. M. Penaud and others have constructed flying models, but on too small a scale to be of much practical importance. But still there are the birds; they completely refute the arguments of those who say, 'It is impossible to build a successful flying-machine.'"

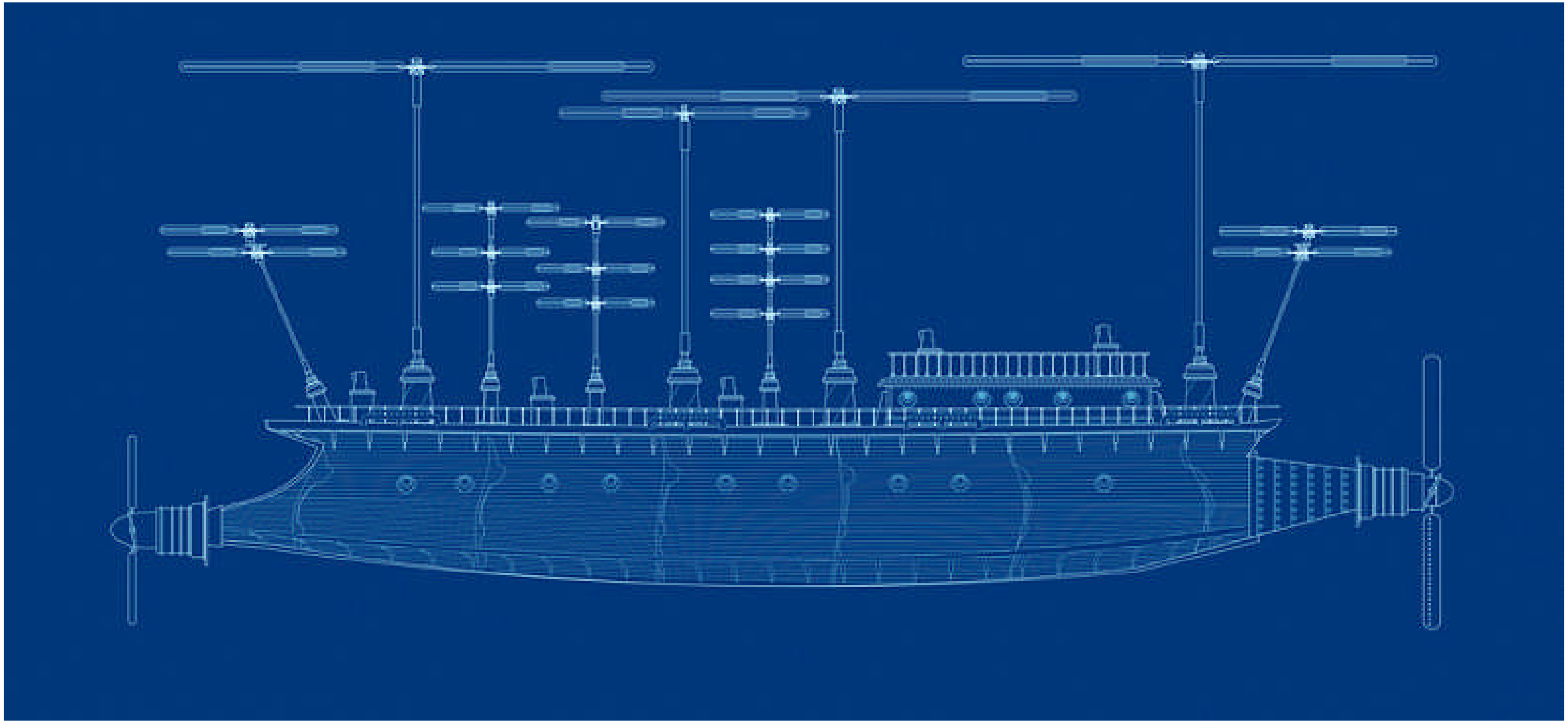
***Popular Science Monthly*, November 1885**

The Man Who Saw Tomorrow



"…The greatest of Verne's stories of the conquest of the air is 'Robur the Conqueror,' which appeared in 1886. Even at that time Verne anticipated the controversy between the proponents of lighter-than-air machines and advocates of the heavier-than-air type. In 'Robur the Conqueror,' Verne has the inventor of a heavier-than-air machine kidnap two champions of the lighter-than-air type, and take the amazed victims on a nonstop flight practically around the world. The two kidnapped men finally escape – still unconvinced – and build a lighter-than-air machine. Verne's climax is reached when this lighter-than-air dirigible, making its trial flight, is crashed into and brought to earth by the heavier than air 'Albatross.' The scientific prophecy which Verne made was the prediction that the heavier-than-air type would prove more practicable than the lighter-than-air type…

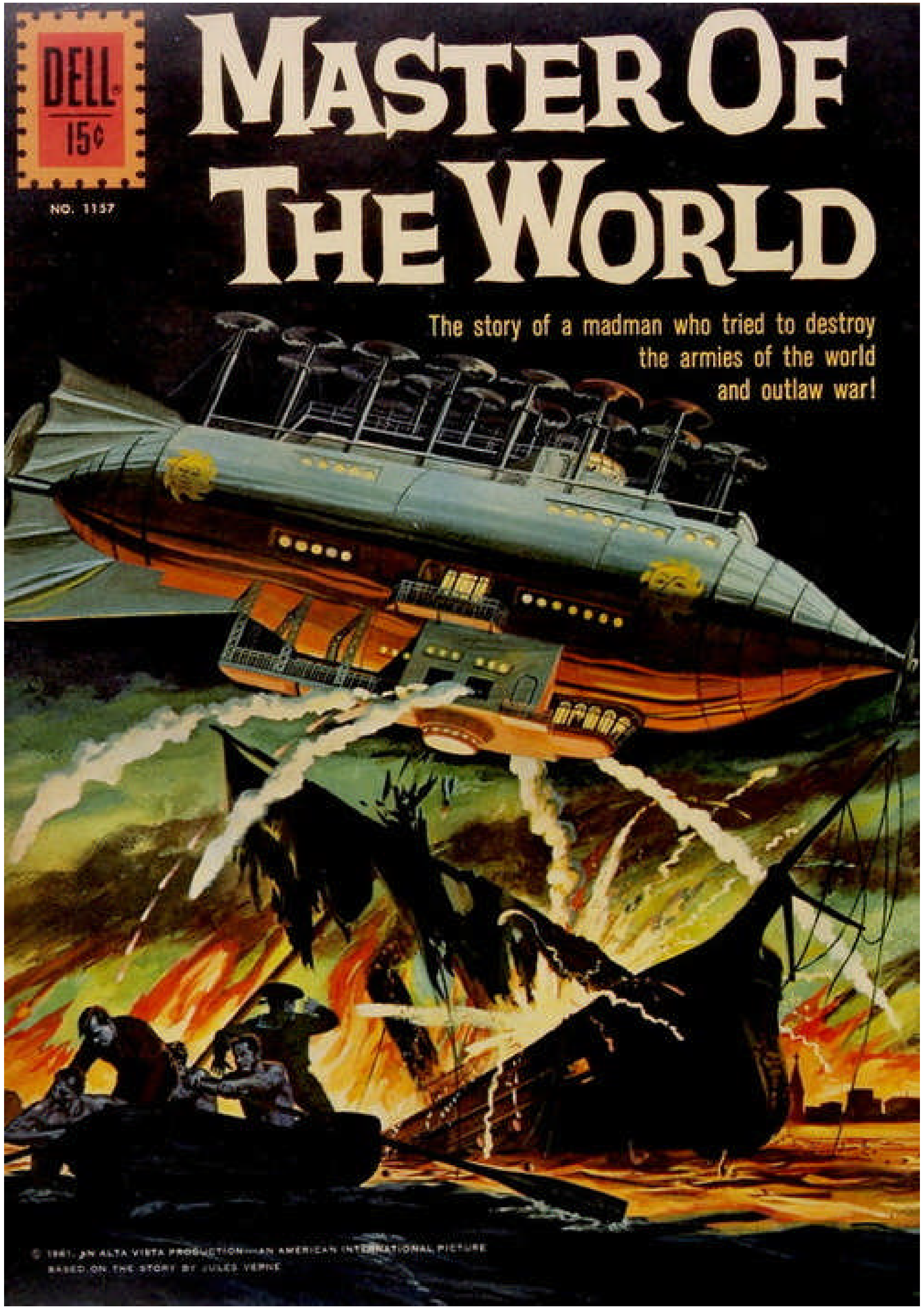
***Popular Science Monthly,* July 1927**



"…To date, Verne has been correct in this prediction – although the matter is not yet settled. Experiments are today being made with the rigid dirigible which may bring the lighter-than-air type into the lead. The fascinating thing about 'Robur the Conqueror' is Verne's description of his aircraft of the future, the Albatross – a flying machine with a body of compressed paper, lifted and held in the air by seventy-four horizontal screws and propelled by electric motors actuated by batteries of 'secret' composition…"

***Popular Science Monthly*, July 1927**

<u>Above</u>: blueprint of Jules Verne's fictional heavier-than-air flying machine "Albatross"



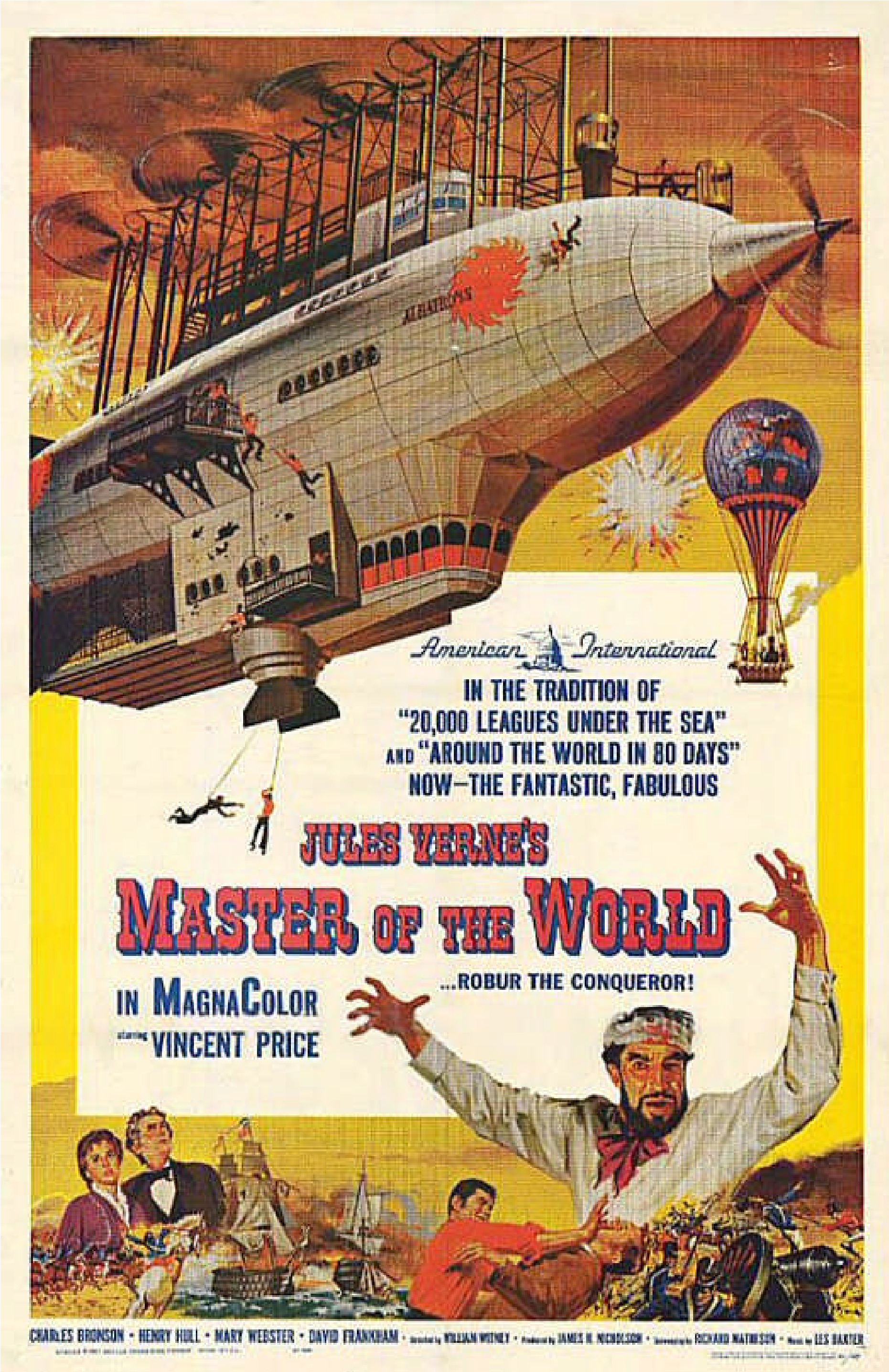
"…Even by 1905, Verne had not given up his idea that electricity would prove to be the master motive power. In the story, the 'head inspector in the federal police department' taken on board 'The Terror', says: 'The power by which the machine was driven was neither steam nor gasoline. No doubt it was electricity, generated on board, at some high power. Naturally, I asked myself whence comes this electricity, from piles or accumulators charged? Unless, indeed, the electricity was drawn directly from the surrounding air or from the water, by processes hitherto unknown…"

***Popular Science Monthly*, July 1927**

<u>Left</u>: cover of Verne's 1905 sequel novel: "Master of the World"

"…The screws mounted on perpendicular axes, which enabled Verne's machine to rise straight from the ground without any forward motion whatever, have not materialized. In this, did Verne make a mistake? – or was he even ahead of our own time? Inventors are still working on this idea today – the helicopter. Thus far, they have been only partly successful. But can we say that it cannot – will not – be done?..."

***Popular Science Monthly*, July 1927**

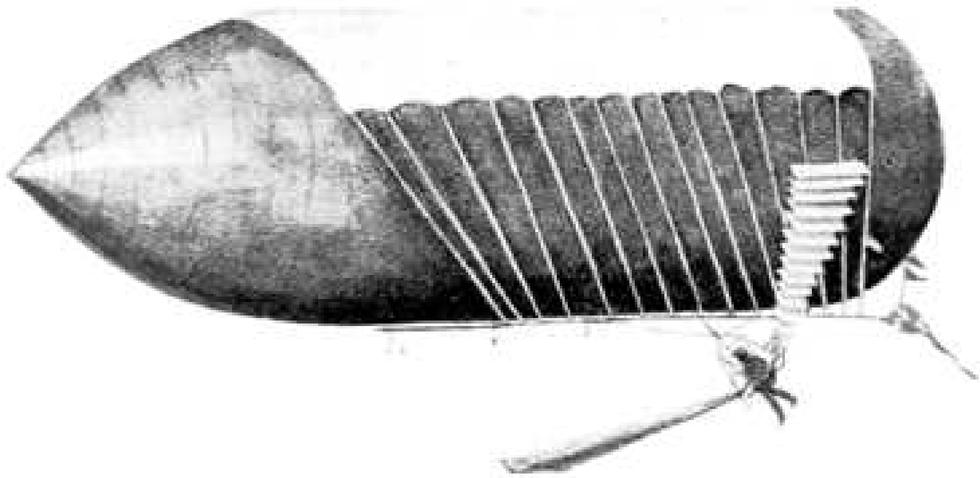


The 1961 film: "Master of the World," (poster at left) was based on two of Jules Verne's later works: *Master of the World* (1905) and *Robur the Conqueror* (1886). Improving on the source material in which "Robur" - a genius who invents both lighter and heavier-than-air airships and, with the help of his futuristic airships, idealist Robur determines to end warfare on planet earth. The film's plot borrowed loosely from the film version of Verne's *Mysterious Island*.

Trial and Error

"…Some unsuccessful experiments were carried on in Germany in 1897. First Dr. Wolfert, whose balloon was set on fire by his gasoline motor and exploded in the air, killing both himself and his engineer, and later by Schwarz, whose aluminum balloon proved unmanageable and was smashed in landing. The most ambitious attempt, however, was that of Count Zeppelin, who built in 1900 a monster airship 420 feet long and 39 feet in diameter…"

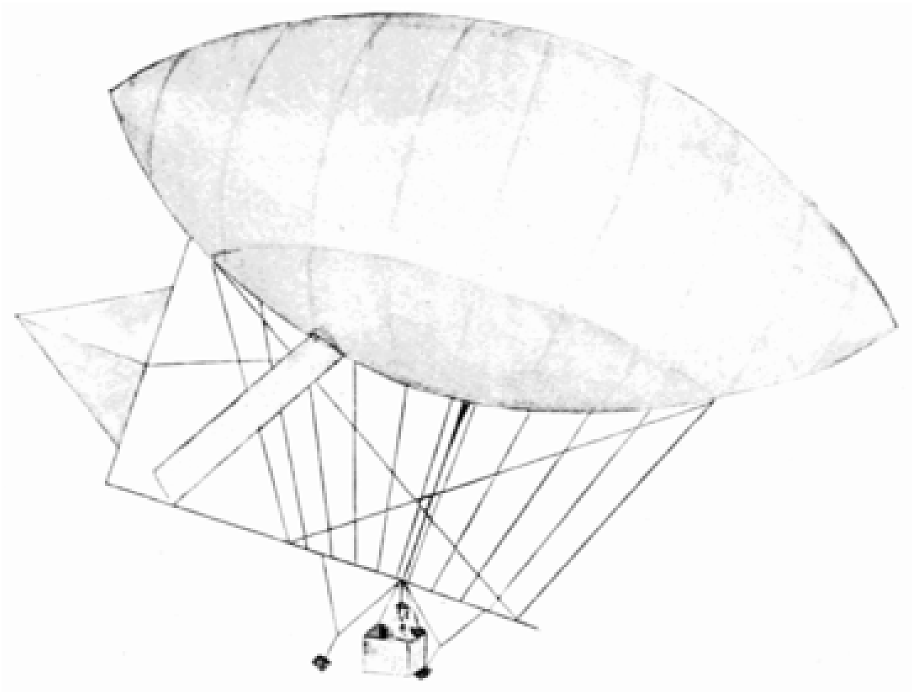
***Popular Science Monthly*, March 1904**



"The recent successful trips of the Zeppelin airship make it appropriate to review and illustrate some of the less known attempts at aerial navigation. Somewhat similar in plan to Count von Zeppelin's enormous airship is the dirigible flying-machine shown in Fig. 1, with which at various times during 1897 and 1898 Dr. K.I. Danilewsky, of Charkov, Russia, made excursions. The object of making the balloon sausage-shaped was, of course, that its forward end might be brought toward the wind, and then, with the nose pointed upwards, as in the illustration, its under surface served somewhat as that of a kite. The wings were made about twelve feet in length, and it was found possible to handle them so as to turn the balloon entirely around in the air, and also to keep it practically stationary in a moderate breeze…"

***Popular Science Monthly,* April 1901**

<u>**Above**</u>: **Figure 1; Danilewsky's dirigible balloon**

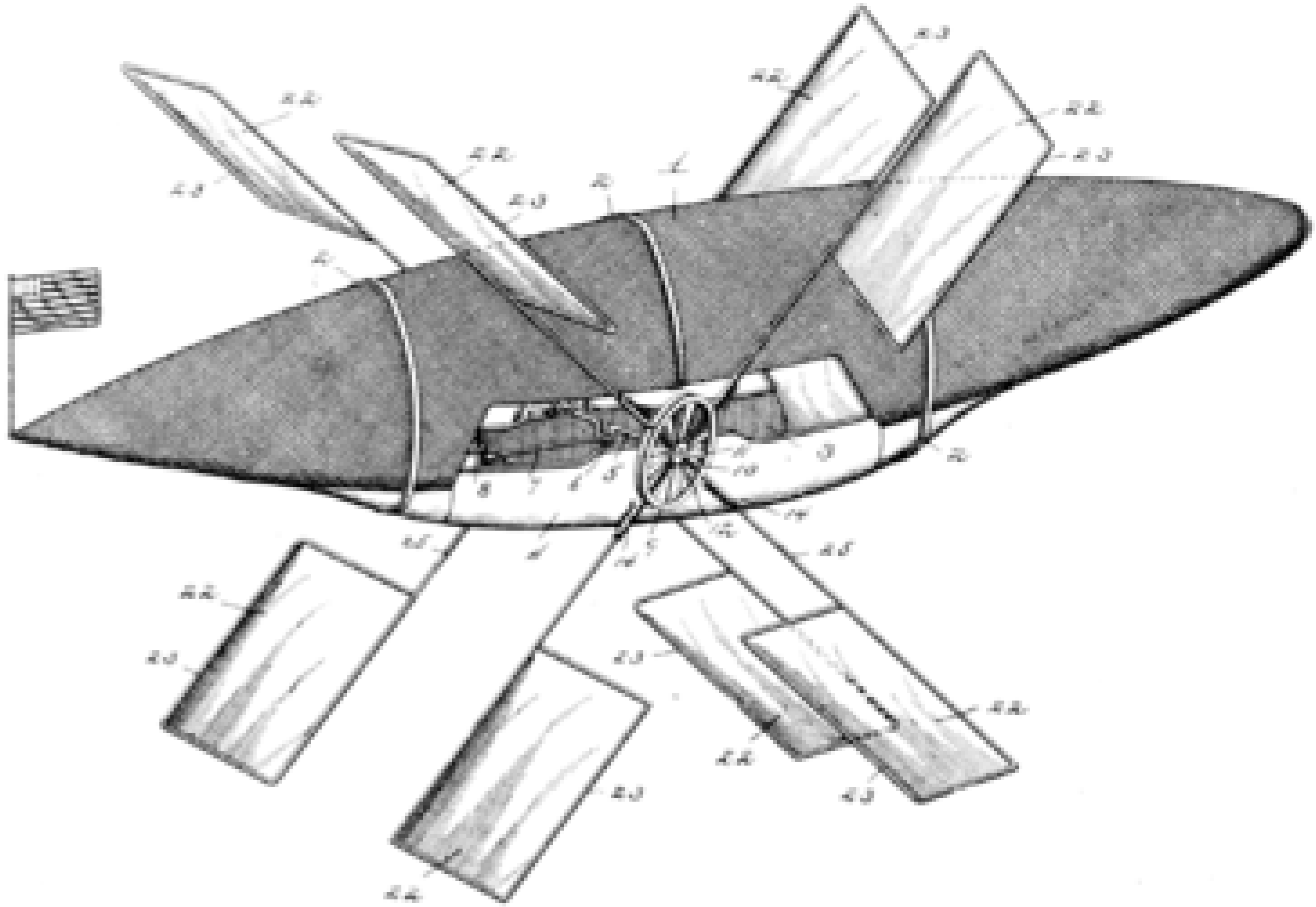


"…M. de Santos Dumont has sailed about the Eiffel Tower in Paris in the dirigible balloon shown in Fig. 2. It was 65 feet long, 25 in diameter and contained 17,658 cubic feet of gas. He used a small petroleum engine for controlling the rudder and aeroplane. The reports are that he was able to navigate very much at will. Fig. 3 is another form of dirigible balloon tried by M. Dumont. This was also reasonably successful…"

***Popular Science Monthly,* April 1901**

Left: Figure 2; Santos Dumont's dirigible balloon (I)

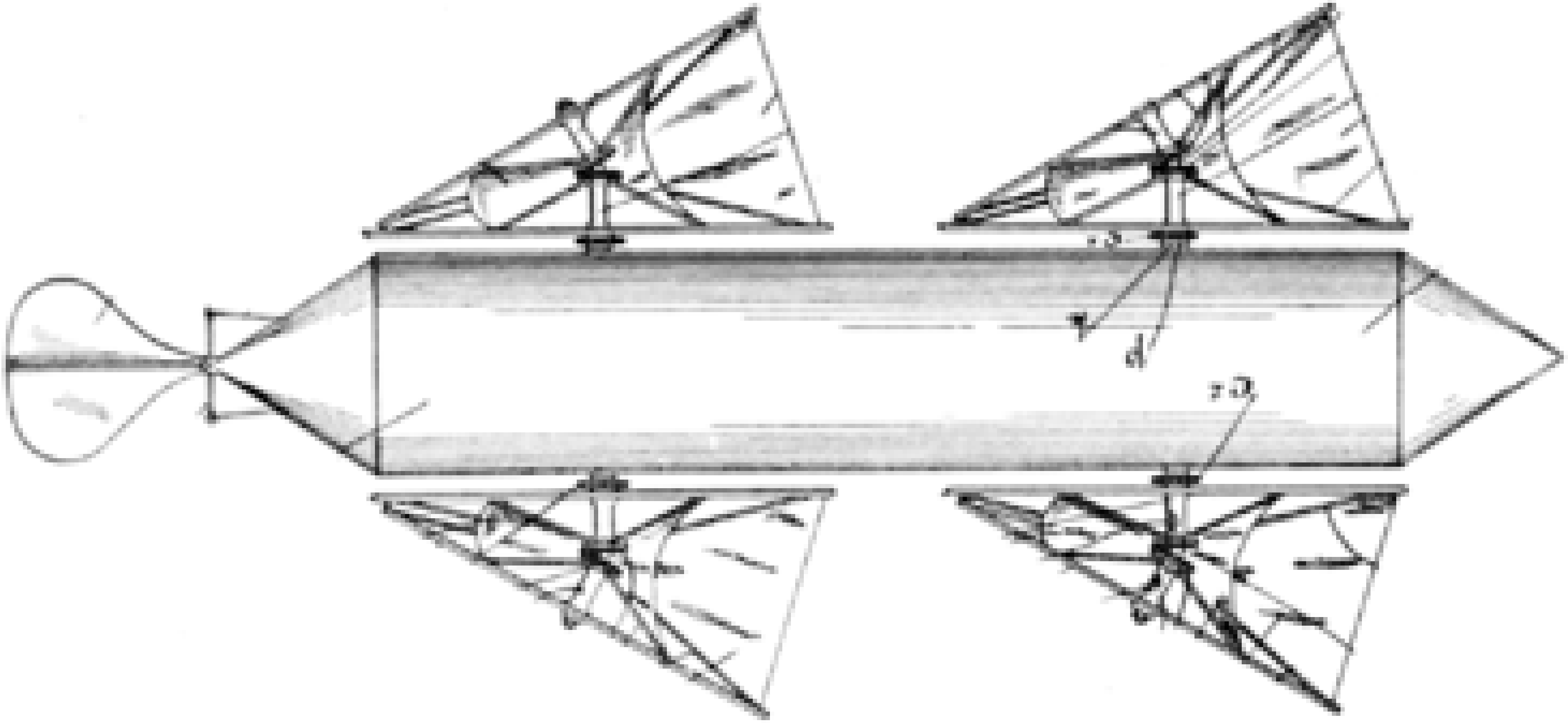
Right: Figure 3; Santos Dumont's dirigible balloon (II)



"…Fig. 4 represents a machine designed by Frederick P. Merritt, with windmill sails below and on both sides of his balloon, and a mechanism for feathering them in such a manner as to drive the craft either forwards or backwards…"

***Popular Science Monthly,* April 1901**

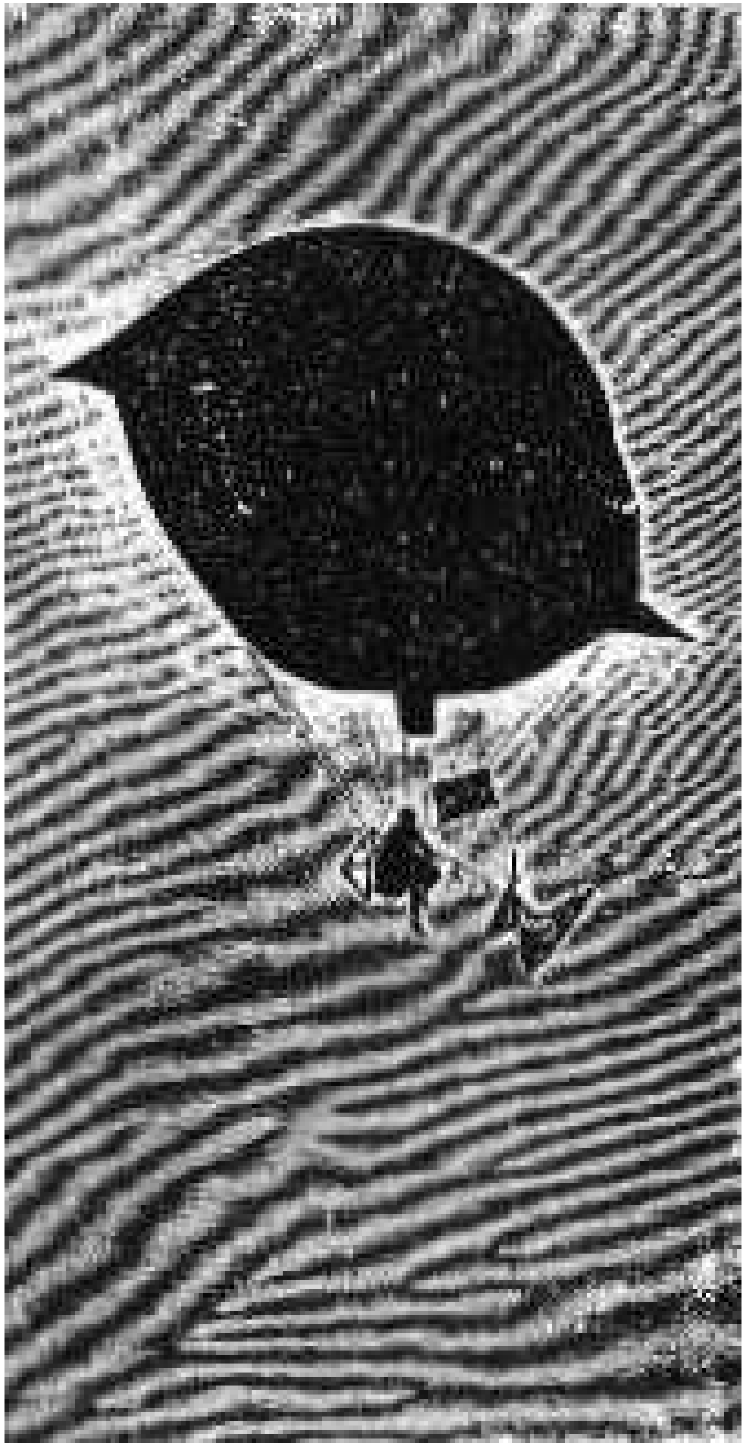
<u>Above</u>: Figure 4; Merritt's flying machine



“…Fig. 5 is a design of Theodore Liebrand. The cylinder is of aluminum, and the wings transform themselves into wheels when the machine rims along the ground. We have no record of the actual success of either Merritt’s or Liebrand’s inventions, or even of their trial…”.

***Popular Science Monthly*, April 1901**

<u>Above</u>: Figure 5; Liebrand’s flying machine



"…Returning to the realm of actual experiment, in Fig. 6 is shown a view of Carl F. Myers's 'sky-cycle.' Of this Mr. Myers writes, under date of February 5, 1900, with the enthusiasm of the inventor: 'The sky-cycle, or gas-kite, is a hand and foot propelled air-ship, provided with revolving screw-sails, vibrating wings, movable aeroplanes and universal rudder—the object of the entire equipage being to test the relative advantages of all known systems for propulsion and guidance, and to attain practical experience in manipulating air craft. The operator and machinery are suspended below a peculiarly shaped gas-spindle, whose fabric has been treated by a special process, original with me, which enables it to retain hydrogen permanently during use. It has within a limited period made upwards of one hundred flights, embracing New York State, Massachusetts, New Hampshire, Maine, Delaware, Connecticut, New Jersey, Pennsylvania, Maryland, Virginia, Tennessee, Ohio, Michigan and Illinois. Three machines only have been built, varying somewhat in form of spindle and extent of surface handled. As used at present, the screw, formerly fifteen feet diameter, has been reduced to eight feet, and the wings and rudder abandoned, the universal-jointed aeroplanes on each side having proved in every way superior for all evolutions. With practice acquired by use of the sky-cycle, and with some indicated variation in structure and equipment, including a light auto-motor engine of best type, there should be no great difficulty in accomplishing an overland transcontinental journey by two or three persons with this type of air craft in less time than the same trip could be made by the same party on the ground….'"

Popular Science Monthly, **April 1901**

<u>Left</u>: Figure 6; Myer's sky-cycle

The Rubber Cow

"…My most thrilling thirty seconds in the air was experienced at Tampa, Florida, in February, 1907. I was flying a 'rubber cow,' as we called the early dirigibles, at 200 feet when a gasoline connection broke, the fuel ignited, and flames shot toward the gas bag, filled with 10,000 cubic feet of hydrogen which when mixed with air is as dangerous as T.N.T. I was riding on a frail wood and wire framework slung beneath the balloon. Sliding toward the engine, I tried to smother the blaze. My gloves and cap caught fire, burning my hands. The gasoline pipe, swinging from side to side, spouted flame like a blowtorch. Overhead, blisters were puffing out in the brown silk of the gas bag. The explosion was a matter of seconds. While hydrogen must be mixed with air to burn, the envelope leaked sufficiently to be surrounded with a ring of igniting mixture. A circle of fire shot up the bag. In a flash, the envelope was a mass of roaring, shooting flames. I leaped out into space, 200 feet from the ground. As I jumped, the hooks on one of my high top shoes caught in the netting. For a split second I dangled head downward before I kicked myself free and somersaulted through the air. The dirigible was flying over a park when the connection broke. When I jumped, it was directly above a lagoon in which a score of big white swans floated. As I fell, I heard a terrific detonation and saw flames shooting in all directions above me. Then I struck. I landed in a sitting position directly on top of one of the swans, and an instant later struck the mud at the bottom of the pond. Just as I bobbed to the surface, the flaming motor and heavy center section of the framework crashed into the lagoon not twenty feet away. When I was pulled out I was black and blue from my ears to my heels but without a bone broken. I ate my meals standing up for months afterward, The miracle of being above that tiny pond saved my life. Carried by the wind, pieces of the flaming gas bag fell among the barns of a large race track near by, starting a fire in which twenty horses perished. When I finished paying the bills, I was cleaned out. I had come to Tampa in a private car, with $22,000 in the bank. I left with my wife, baby, and a gripsack, thankful to be alive…"

Horace B. Wild, **dirigible airship pioneer (1931)**

"…It used to break my heart to let out a bag of gas. From thirty-six to forty-eight hours were required to generate enough hydrogen for the dirigible and the cost was in the neighborhood of $600. Into great wooden tanks we would pour tons of iron filings, sulfuric acid and water. The acid eating away the filings produced the hydrogen which was carried by cloth pipes to the gas bag. Great care had to be taken to prevent air from being sucked in with the gas. A small percentage of air in a gas bag would kill the buoyancy. The big generating vats were carried from place to place on a special car that transported airship and crew…"

Horace B. Wild **(1931)**

The Year of the Airship

"…Nineteen hundred and seven was 'Airship Year' in America. Beachey, Baldwin, Knabenshue, Dixon, Goodale, Dallas, Mars, and I were racing our motored gas bags and giving immense exhibitions before immense crowds at the larger cities…In the fall of 1907, St. Louis held a 'Balloon Week.' the whole country went 'air-minded.'…The papers reported that President Roosevelt's first question on arriving at the White House from a hunting trip was: 'Who won the balloon race?'

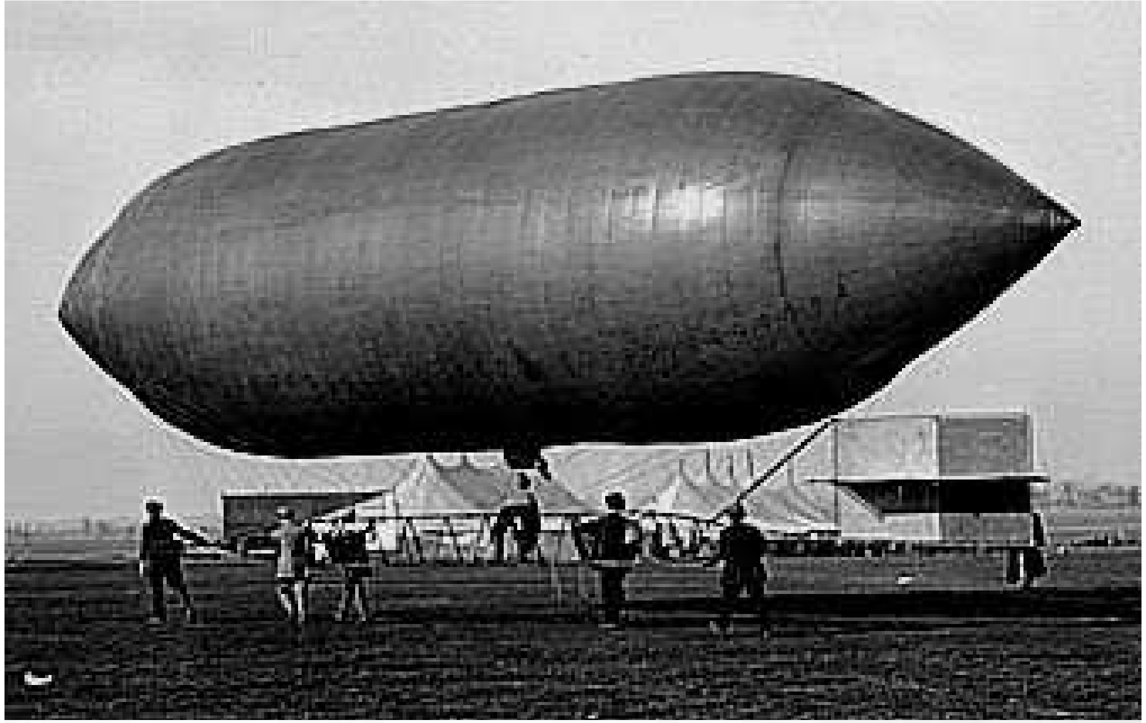
***Horace B. Wild* (1931)**

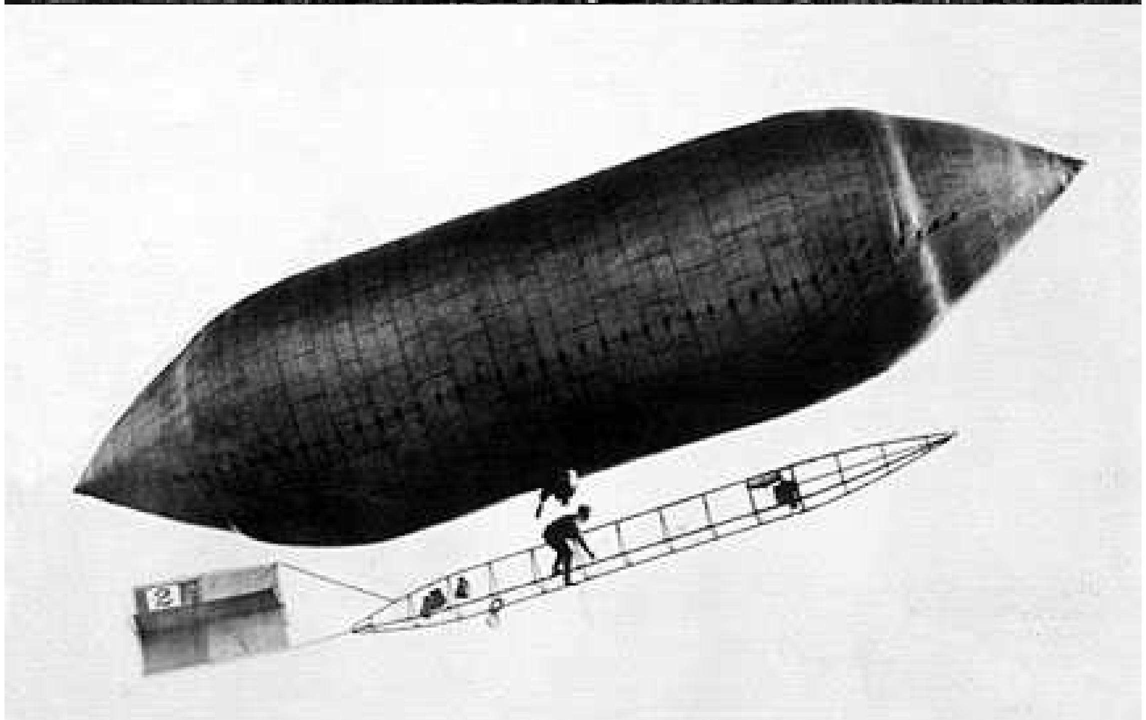
<u>Left</u>: poster with H.B. Wild at center


Knabenshue's Airship sailing over City Hall, Brockton, Mass. Oct. 5, 1907.

"…The first of the fleet of fourteen airships, which I built at various times, was finished in the fall of 1905. I called it 'The Eagle.' All of these early lumbering machines had high sounding names like 'The Arrow,' 'The Comet,' 'The Eagle.' And their top speeds were close to eighteen miles an hour! I remember that I used to advertise that I would 'fly in any wind – up to twelve miles an hour.' The gas bag of 'The Eagle' measured seventy feet in length and eighteen feet in diameter. The envelope was sewed together in squares, like a patchwork quilt, so a rip could not run farther than one square. I used the finest grade of Japanese silk, costing $1.25 a yard, and coated it with a varnish made by boiling down raw linseed oil and diluting it with high-grade naphtha. Afterwards the bag was talcumed to keep the silk from sticking. This first ship cost me about $7,000. Under the bag hung a thirty-six-foot framework. Three slender spars of spruce were braced with crosspieces and wire, and they held the operator and the motor, a six-horsepower engine weighing fifty-six pounds which I designed myself. The propeller had four-foot blades made by stretching canvas across spruce strips. At the rear, a fishtail rudder steered the machine. I pointed the nose up or down by walking back and forth on the three-inch 'planks' of the framework and I operated the rudder by means of two ropes which I held in my hands like reins…"

Horace B. Wild **(1930)**

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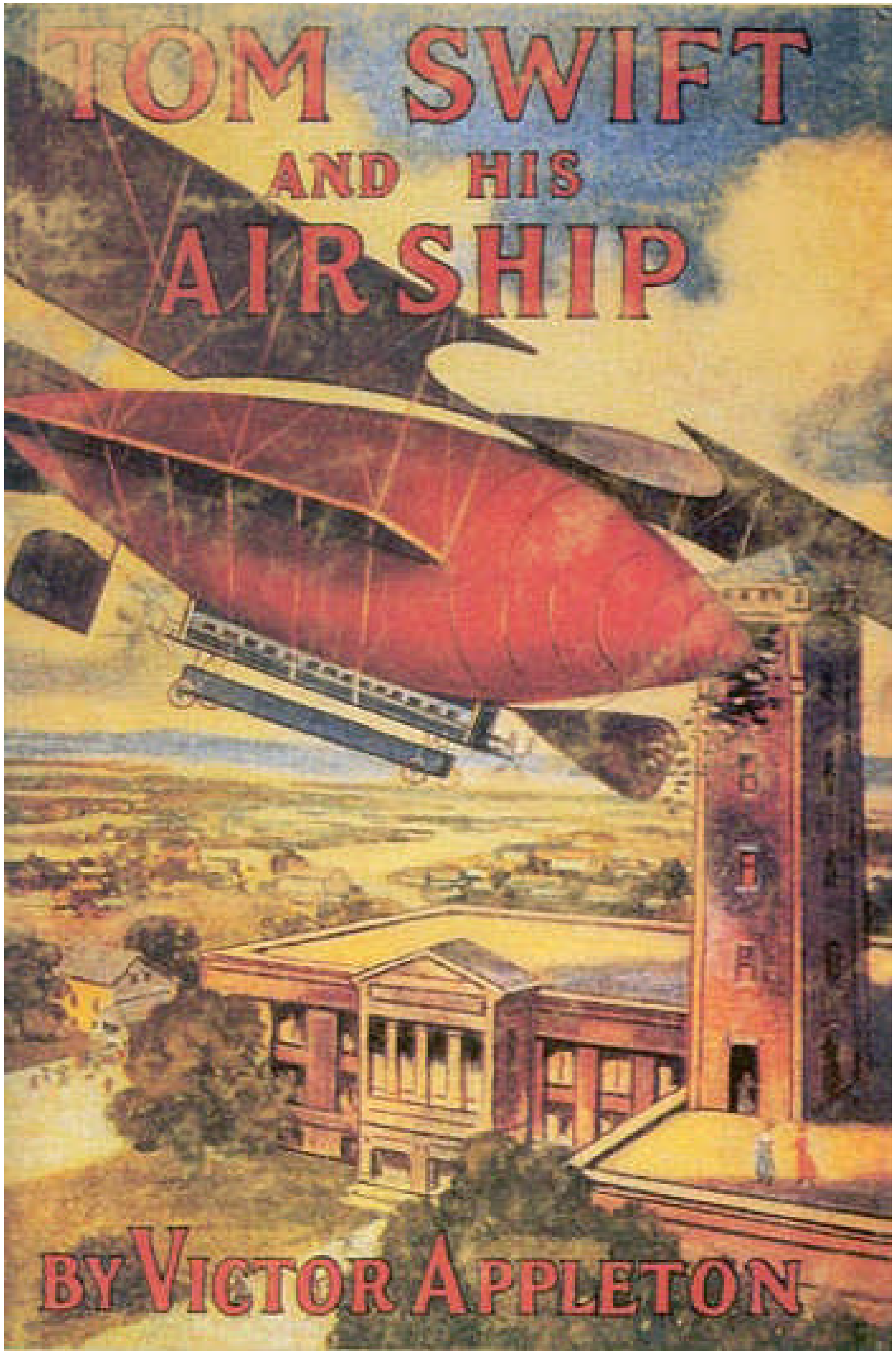
"…In 1904, Captain Baldwin finished his 'California Arrow,' the first successful dirigible built in America. I helped him construct it at Oakland, California. When it passed its tests, we loaded it on a train and started for the St. Louis Exposition to race the great Santos-Dumont, who had come from France to win the $10,000 Grand Prize offered by the Exposition Committee for an airship race. A millionaire bachelor who owned extensive coffee plantations in Brazil, Santos-Dumont had spent a fortune on his navigable balloons. His flights around the Eiffel Tower in France had stirred interest throughout the world. His airship was built like a watch. Ours looked as though it had been turned out with a butcher knife and a bucksaw…"

***Horace B. Wild* (1930)**



"…In racing 'rubber cows,' one of the chief dangers was the likelihood of blowing out the tail of the airship. When the cigar-shaped envelope was driven through the air it met great outside resistance at the nose, while at the tail the outside pressure was reduced. As a result, internal pressure concentrated at the rear. A second danger of pushing a gas bag rapidly through the air was that if the silk was not taught, the nose might belly in and be cut by the whirling propeller. To keep the envelope taut, I had a small air balloon inside the main envelope which could be filled by means of a pump attached to the motor. As gas leaked out of the envelope, or chill condensed the hydrogen, I blew up the air balloon to increase internal pressure and keep the envelope taut…"

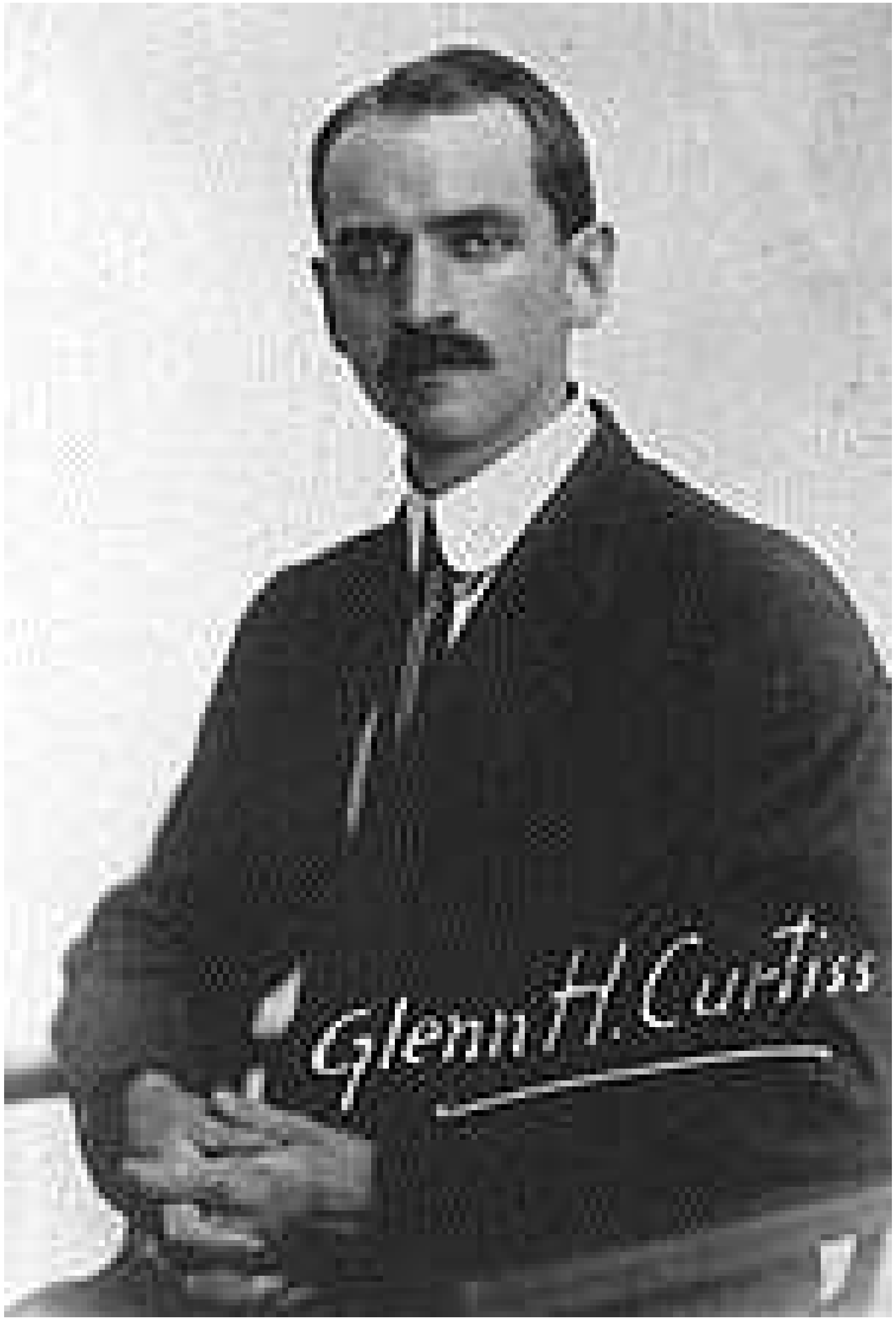
Horace B. Wild **(1931)**

<u>Left</u>: at the beginning of the *20th Century*, there was a series of children's books about a character named *Tom Swift*. The protagonist was a boy genius who invented incredible machines, including dirigible airships, and had all sorts of fantastic adventures.

The Fallacy of the Dirigible (?)

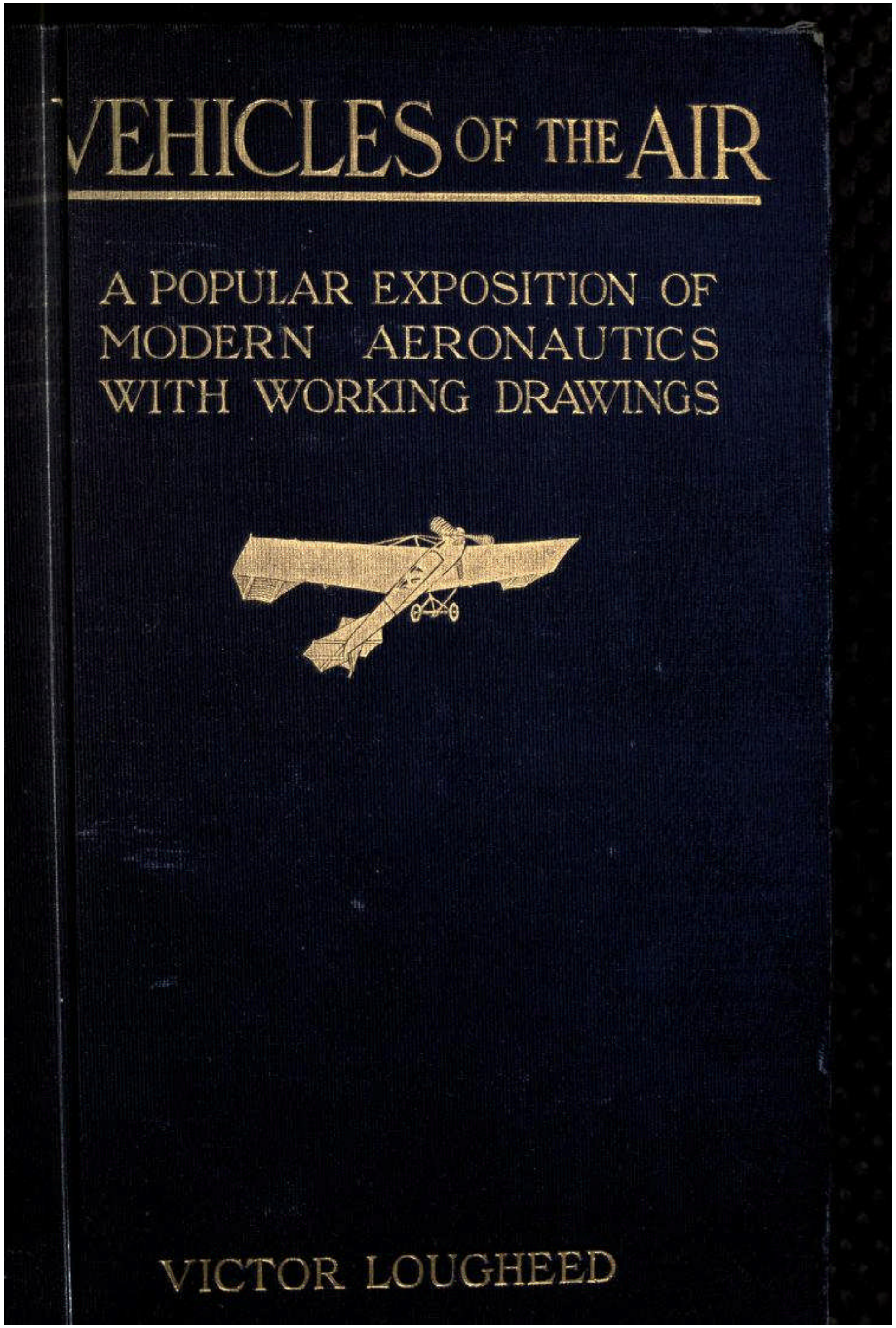
"…In forty years of flying, I have looked down upon the earth from every kind of craft that sails the air. I have seen it from the swaying trapeze of a hot-air balloon, from the wicker basket of a Gordon Bennett racing gas bag, and from the cabin of a modern airplane. In 1906, I flew the first dirigible across the Canadian border, and when I circled the Flatiron Building – I was the second man to perform that feat – it was the only skyscraper in midtown New York. Put end on end, my flying hours would total a year in the air. I have had the good fortune to live in the midst of that Arabian Night's tale which is the history of modern flying. I helped Chanute when he flew his pioneer gliders in the Indiana sand dunes, met the Wright Brothers before they went to Kitty Hawk, knew Glenn Curtiss when he was a maker of motorcycles in Hammondsport, N.Y. I flew in Europe with Bleriot, Framan, Latham, Esnault, Peltine, and Count Zeppelin, long before the war. I piloted half a dozen early types of early planes and I am still flying. Last year I flew a big cabin plane from coast-to-coast in twenty-nine hours…I made my first flight at Hinsdale, Illinois, on the fourth of July, 1882. I was eleven years old…On those early exhibitions my flat rate was $1,500 guarantee and $1,000 for every flight of ten minutes or over…When I had been up six minutes, I used to start holding my breath for fear the engine would give out. Dirigibles are a different proposition today from what they were then. A Zeppelin has circled the globe, and last year American blimps flew 132,000 miles and carried 6,000 passengers without an accident…"

Horace B. Wild **(1930)**



"I don't remember when or how I first heard that a couple of young men named Wright had actually flown a heavier-than-air machine. Perhaps Captain Baldwin and I discussed it after the news of their experimental flight at Kitty Hawk had appeared in the newspapers; but if we did, it didn't make a lasting impression on me. We weren't thinking heavier-than-air machines then; all of our interests were centered on the dirigible. It is quite likely that I was skeptical, like everybody else."

Glenn H. Curtiss, **Aviation Pioneer (1927)**



"…A few weeks ago, at the National Air races in Chicago, I met an old friend of the pioneer days, Victor Lougheed. Lougheed was the author of a famous early book on aviation called 'Vehicles of the Air.' We used to argue by the hour over the relative merits of dirigibles and airplanes. Once he wrote a long article for a magazine on 'The Fallacy of the Dirigible.' He must have bought a hundred copies of that issue for every time I had an accident he would send me a marked copy…"

***Horace B. Wild* (1930)**


THE WEATHER
Cloudy today; showers tomorrow; no change in temperature.
TWO CENTS In Greater New York | THREE CENTS Within 200 Miles | FOUR CENTS Elsewhere Except 7th and 8th Postal Zones
ZEPPELIN OFF AT 12:40 A. M. ON FLIGHT AROUND WORLD WITH FAIR WEATHER AHEAD
Larder on Graf Zeppelin Stocked With Delicacies
Special to The New York Times. LAKEHURST, N. J., Aug. 7.—The passengers of the Graf Zeppelin will have all the delicacies that could be supplied by the
22 PASSENGERS ABOARD
Dirigible Heads for New York for Gesture of

PRESS
The Weather:
CITY EDITION PRICE THREE CENTS
WORLD CRUISE OF ZEPPELIN OPENS NEW ERA, LINKS ENDS OF EARTH IN TWELVE DAYS
Graf Zeppelin at the End of Long, Long Trail
Argosy of German Air Liner, Over Frozen Siberia Into Sunny Climes, Grips All.
Great Lakehurst Crowds Praise It
Daring Feat Captures Imagination of U. S.; Eckener Acclaimed.
By WILLIAM LAURENCE.
NAVAL AIR STATION, LAKEHURST, N. J., Aug. 29.—A new page was added today to the story of man's achievement when the Graf Zeppelin, celestial knight errant, ended her

"…the ship came down in a back yard. A clothes pole poked a hole in the gas bag. I slapped my hat over the hole to keep in the gas and shouted for someone to run to the corner drugstore and get some adhesive tape. When this came, I pasted up the hole and got the machine up on the flat roof of a car barn nearby. Nearly 70,000 people gathered, crowding the streets…In the midst of all this excitement, a Western Union messenger boy climbed up where I was and handed me a marked copy of 'The Fallacy of the Dirigible.' Lougheed had been in the neighborhood and dashed home to get it. I found a nice red brick and looked over the edge of the car barn for Lougheed but I couldn't see him anywhere. I never did find out how he got that magazine there so quickly. But last year I had back at him. When the 'Graf Zeppelin' completed its round-the-world trip, I sent him the big black headlines in the New York papers and wrote above them: 'The Fallacy of the Dirigible' – Read 'Em and Weep'…"

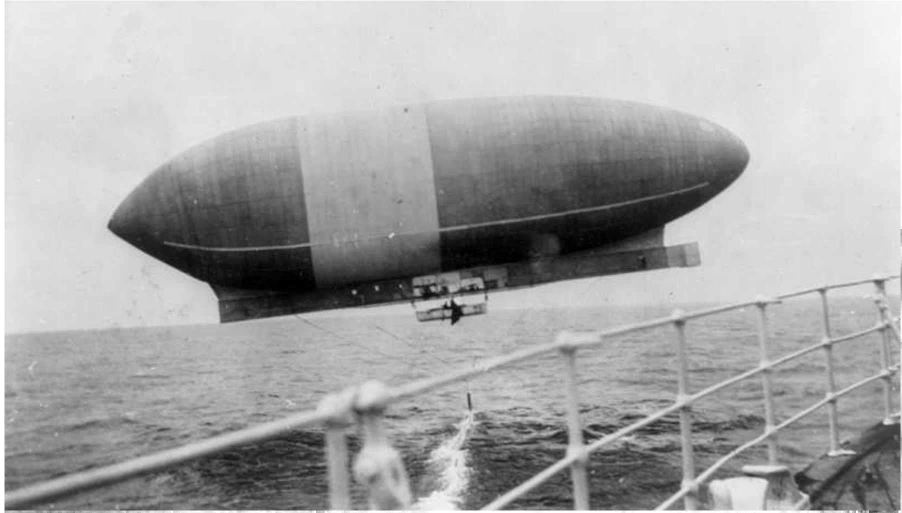
***Horace B. Wild* (1930)**

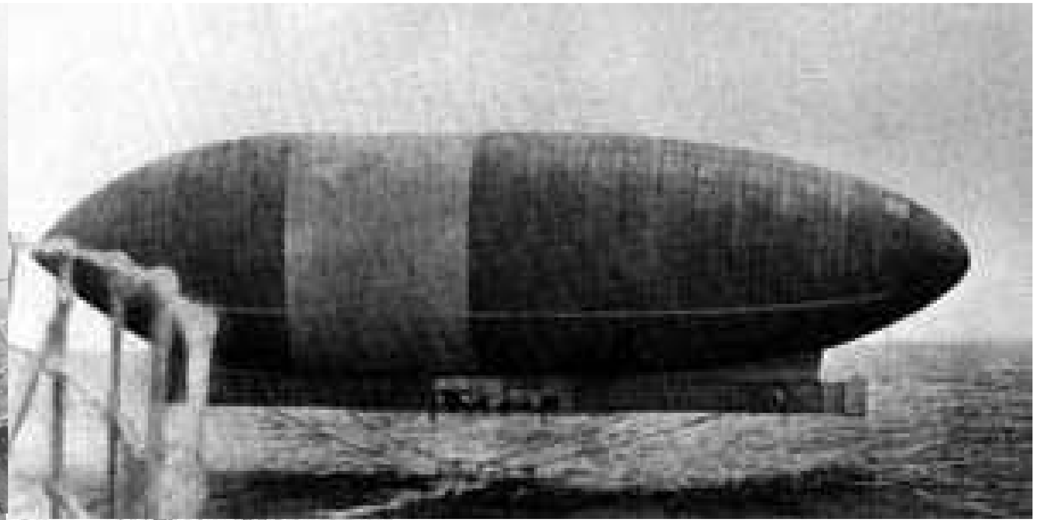
Air Minded

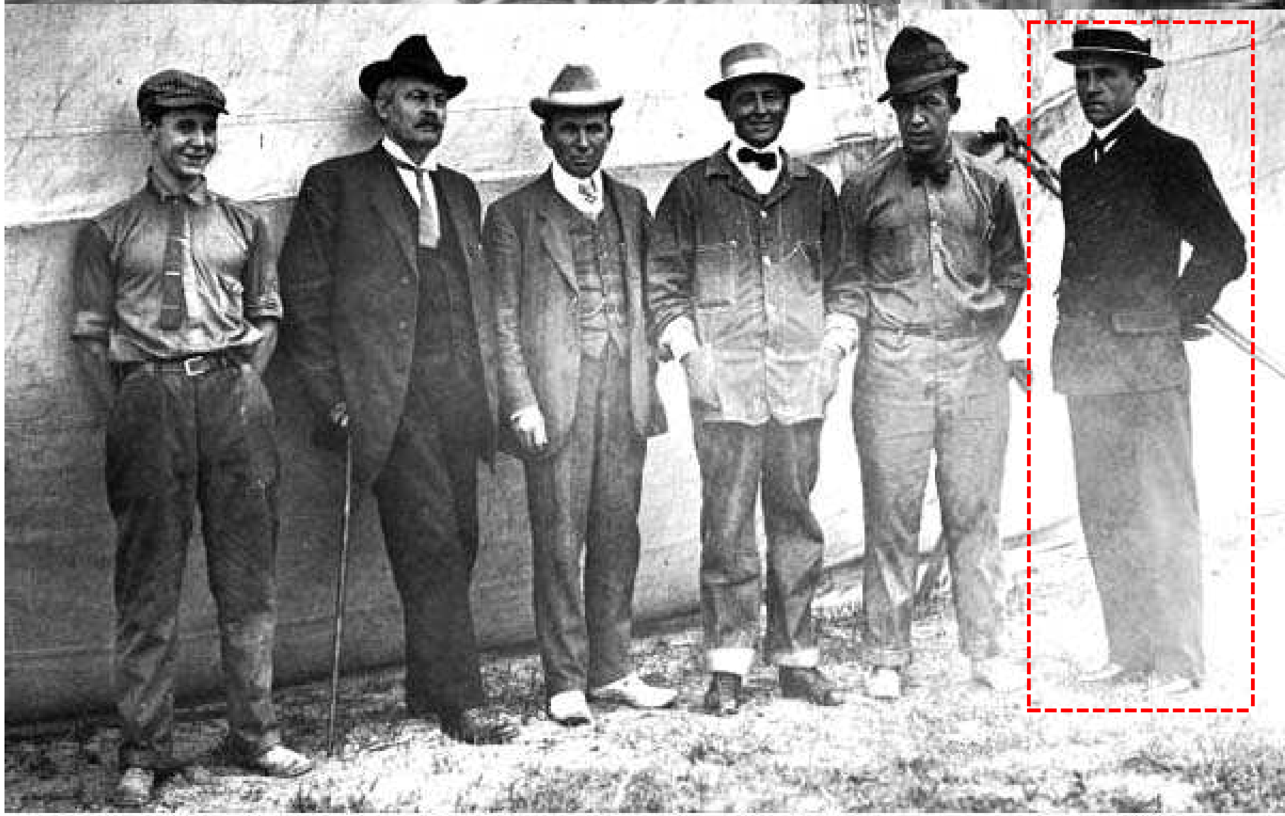
"…That was the way we flew twenty-three years ago. Haphazard hops in under-powered 'rubber cows' that were ready to explode like firecrackers or burst like paper bags – that was aeronautics in 1907. These lighter-than-air tumbleweeds of the sky, bowled along by the slightest wind, breaking down on every flight, probably had little practical value. But they helped make the world 'air-minded' and prepared the way for the everyday sky travel now a reality."

***Horace B. Wild* (1931)**

Left: H.B. Wild (ca. 1911)

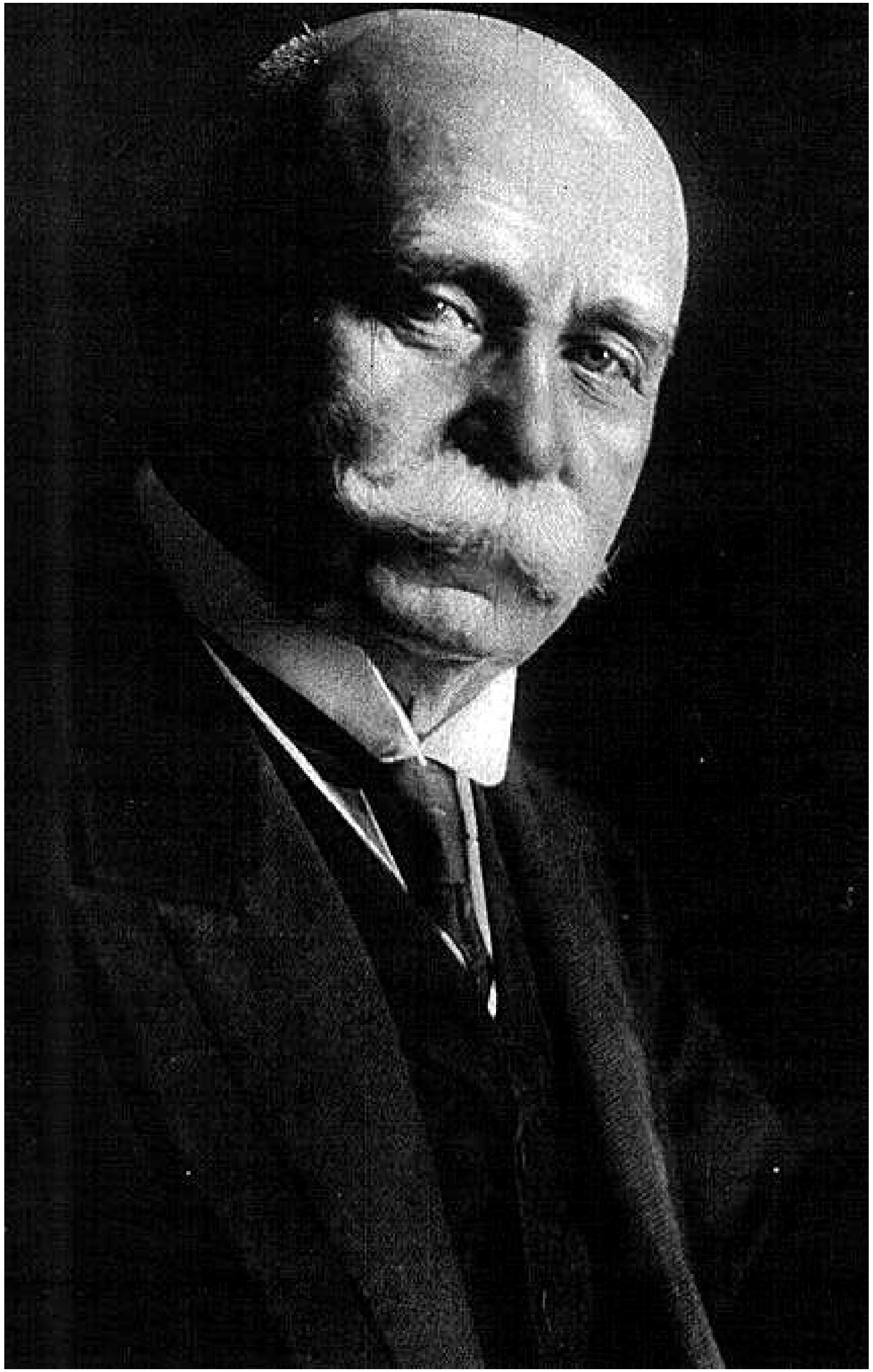






Crew of the airship America. From left to right: Fred Aubert, asst. engineer; Walter Wellman, commander; Melvin Vaniman, chief engineer; Jack Irwin, wireless; Louis Loud, asst. engineer; and Murray Simon, navigator. Photograph from Anthony Simon.

<u>Above L&R</u>: in October 1910, Walter Wellman's dirigible *America* attempted to cross the *Atlantic* ocean. America traveled for two days before being brought down by engine failure. The pioneering airship's crew was rescued by a passing steamer. *Murray Simon* (highlighted), who was the navigator on the failed flight, would be a passenger on the maiden flight of the *Hindenburg* in May 1936.



"The dream of inventors who pictured the day when huge air liners that would bring Podunk within a few hours of Paris, seems about to be realized. Count Ferdinand von Zeppelin flew his first successful rigid airship in July, 1900 over lake Constance on the German-Swiss border. Since then, there has been rapid development of this mode of travel…

Popular Mechanics, **February 1930**

Left: ***Count Ferdinand von Zeppelin*** **(1838-1917)**

Part 2

Biggest Birds That Ever Flew

“The sky has never seen anything to match the giant Zeppelins. Like luxurious airborne hotels – with promenades, staterooms, dining salons, showers – they swiftly flew passengers over oceans…They were unbelievably long – as much as a sixth of a mile. Their shadows darkened several city blocks. They held gas enough to heat a small town for several months. In the caverns of their compartments they carried, with space to spare, dozens of passengers and colorful loads of bulky cargo: circus animals, sports cars, even airplanes. Voyagers paced their promenade decks, stretched out in smoking lounges, even sang in shower baths. The Zeppelins looked like whales and handled like submarines. But the sky was home. They were the biggest birds that ever flew. There had been nothing remotely like them before they came. There has been nothing remotely like them since the last died in flaming public death…”

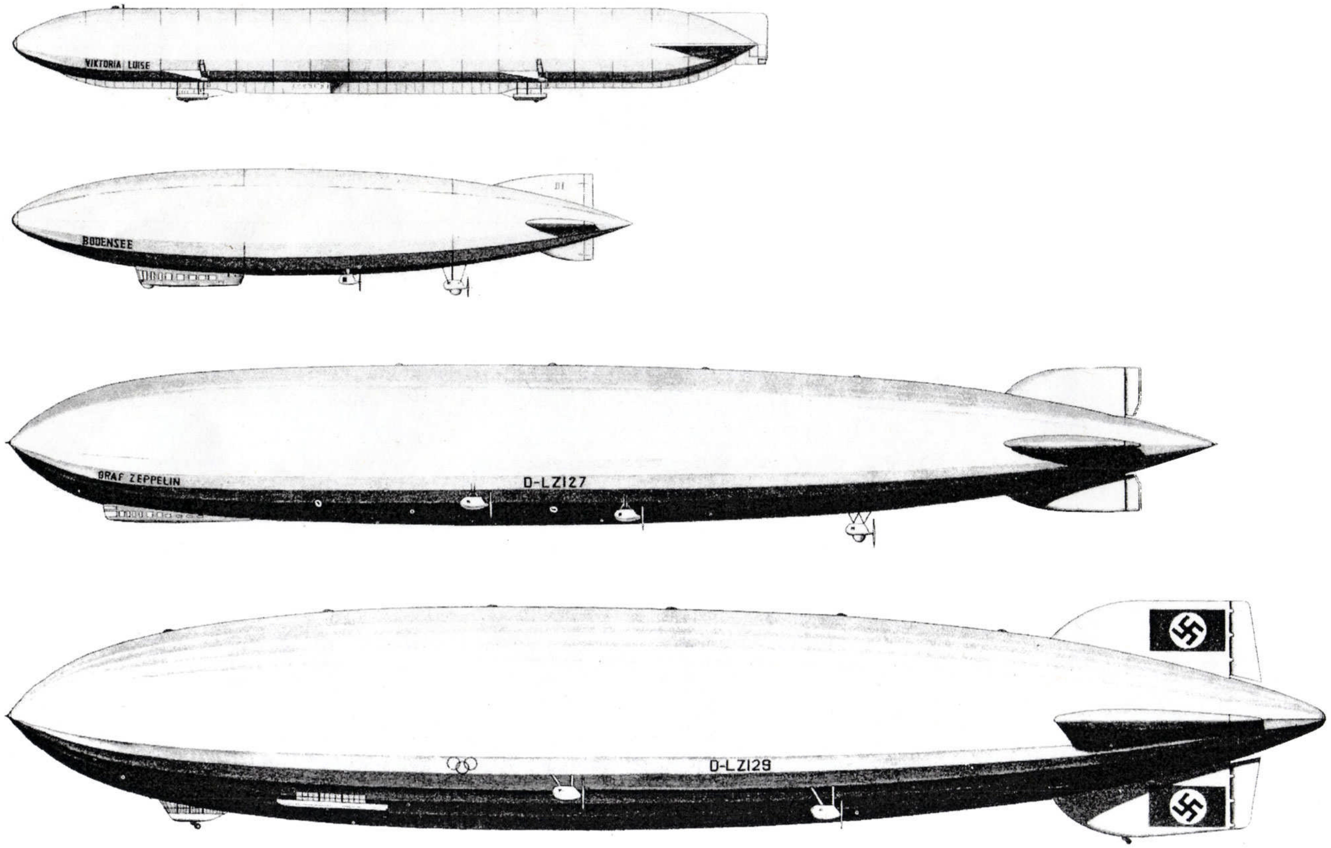
***Popular Science*, May 1962**

Luftschiff

<u>Above</u>: size comparison of a *Boeing 707* passenger jet and the LZ-129 (a.k.a. *Hindenburg*). When completed, LZ-129 (and her sister airship LZ-130) was 803.8-feet long with a diameter of 135.1-feet and a total gas capacity of 7,062,000 cubic-feet of hydrogen gas. They were the largest objects that ever flew. The airship (in German, “Luftshiff”) originally planned was designated LZ-128 and would have been 761-feet long lifted by 5,307,000 cubic-feet of hydrogen gas. In October 1930, the fiery crash of the British airship R-101 in which passengers and crew were killed by the hydrogen fire that followed the crash, not by the impact itself, convinced the *Zeppelin Company* to alter its plans and develop a ship capable of being lifted by helium gas. Helium is heavier than hydrogen thus it provides less lift. Therefore, as compared to a hydrogen airship, a helium airship must be larger to carry the same payload. The plans for the LZ-128 were, therefore, abandoned in favor of a design for a much larger ship; the plus seven million cubic-foot LZ-129, later named *Hindenburg*. Ominously, the Zeppelin Company purchased 5K kg of the metal *duralumin* from the wreckage of the R-101 and used it to fabricate components for the Hindenburg.

"…The sheer size made your jaw drop. This Zeppelin was enormous: 135 feet across the middle and 804 feet in length. From stern to bow she extended more than three city blocks. If stood on end, she would have reached the 67th floor of the Empire State Building, and towered over the Washington Monument…"

***Popular Science*, May 1962**



"…How swift may be the development of subsequent airliners, capable of transporting large numbers of passengers, with baggage, is indicated by the fact that every increase in size means a proportional greater increase in speed and lifting power. In fact, dirigible designers declare that doubling the length of an airship increases its lifting power more than eight times! This means that while the 680 foot 'ZR-1' as a liner could carry 50 passengers, a ship only twice as long could carry 400 passengers…"

Popular Science Monthly, **January 1923**

<u>Above</u>: relative sizes (top to bottom) of: LZ-11 (*Viktoria Luise,* 1912); LZ-120 (*Bodensee,* 1919); LZ-127 (*Graf Zeppelin,* 1928) and LZ-129 (*Hindenburg,* 1936)

von Zeppelin

"…After graduation from a military school at Ludwigsburg, he had become a lieutenant in the Wurttenberg army. But the quiet life of a peacetime garrison did not appeal to him. At that time the Civil War in America beckoned to adventurous spirits the world over, and Zeppelin found it an excuse to 'add to his military education.' He came to the United States and joined the Union Army as a volunteer officer. By chance he was assigned to a balloon corps. At St. Paul, Minn., he made his first balloon ascension, followed by many more in the weeks that ensued. Then the idea came to him that a power-driven balloon capable of being steered would be a valuable invention – an impression heightened by his hunting parties with other officers, in their free time, through sparsely inhabited regions of the Mississippi Valley. A dirigible – 'steerable' – balloon, he became convinced, would prove a boon for reaching inaccessible, unexplored places of the earth…"

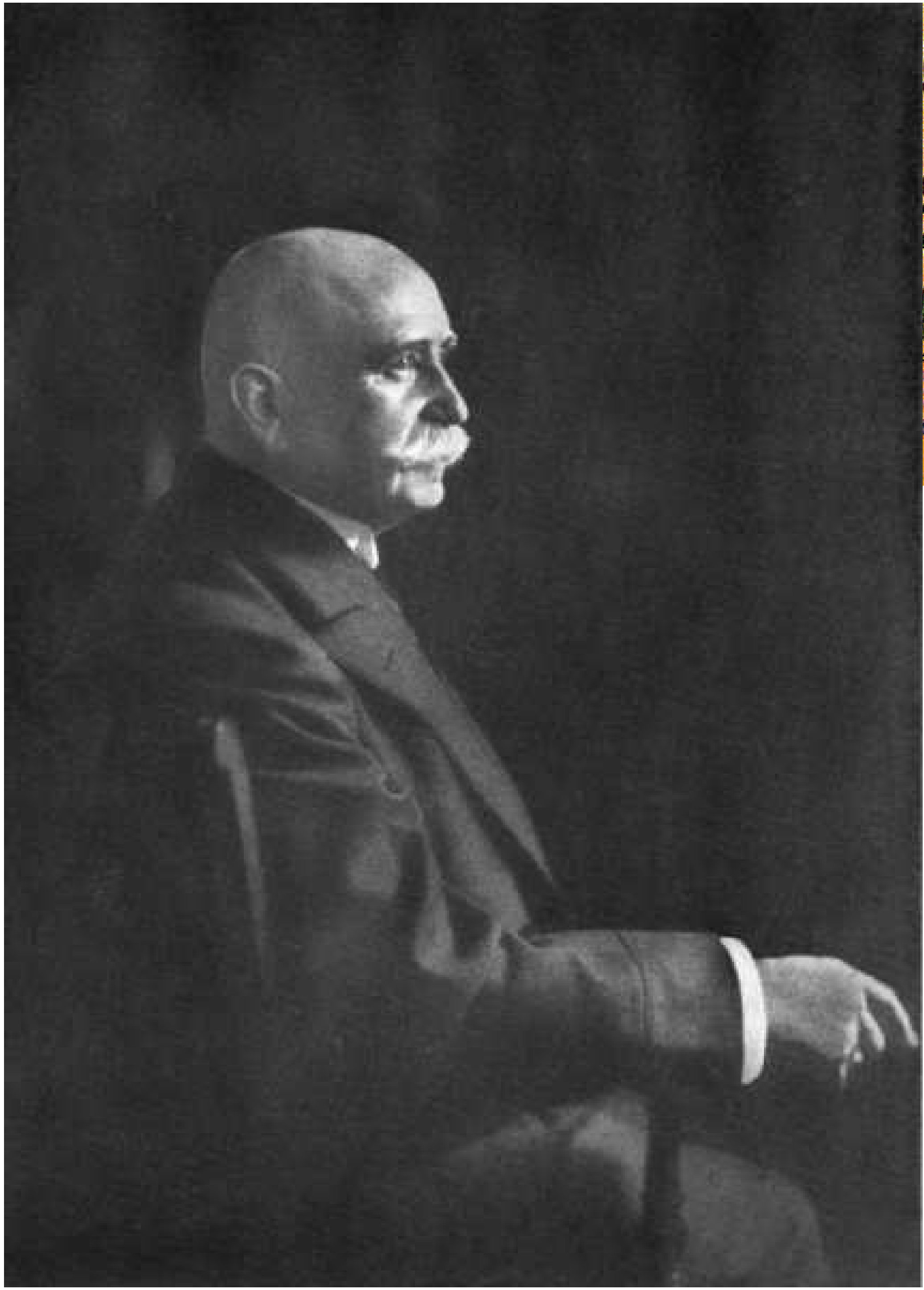
***Popular Science Monthly*, October 1929**

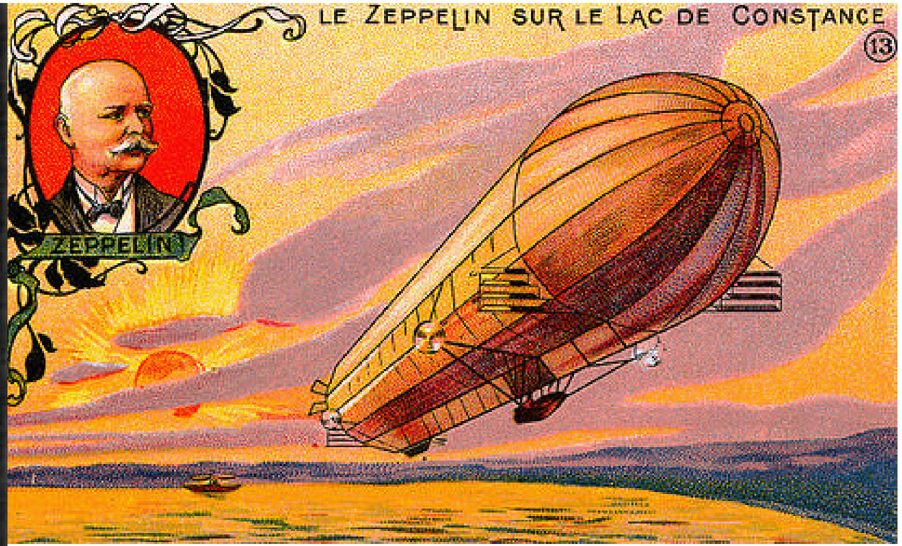
Ferdinand Adolf August Heinrich Graf von Zeppelin **was born on July 8th 1838 on an island in *Lake Constance*. In 1863, Zeppelin traveled to the *United States* as a military observer during the *American Civil War*. Zeppelin's first experience with lighter-than-air flight was an ascent in a 41K cubic-foot balloon, inflated with coal-gas, which had previously been used as an observation balloon by the *Union Army*. In 1874, Zeppelin made entries in his diary describing a rigid-framed airship constructed of rings and longitudinal girders and containing individual gas cells. In 1887, Zeppelin sent a memo to the king of *Wurttemberg* formally proposing the use of airships for military purposes. It was not until his forced retirement from the Army (at the age of fifty-two, in 1890) that Zeppelin was able to devote himself more fully to the problems of lighter-than-air flight. Within ten years, he would build his first airship.**

"…If anyone knew how to build and fly airships it was the Teutons from Friedrichshafen. Count Ferdinand von Zeppelin had built the first practical dirigible in 1900 (these things were giants from the start – old LZ-1 stretched 420 feet). Ten years later he was hauling passengers in the world's first commercial air transport…"

***Popular Science,* May 1962**

<u>Above</u>: German postal stamp honoring *Ferdinand von Zeppelin*





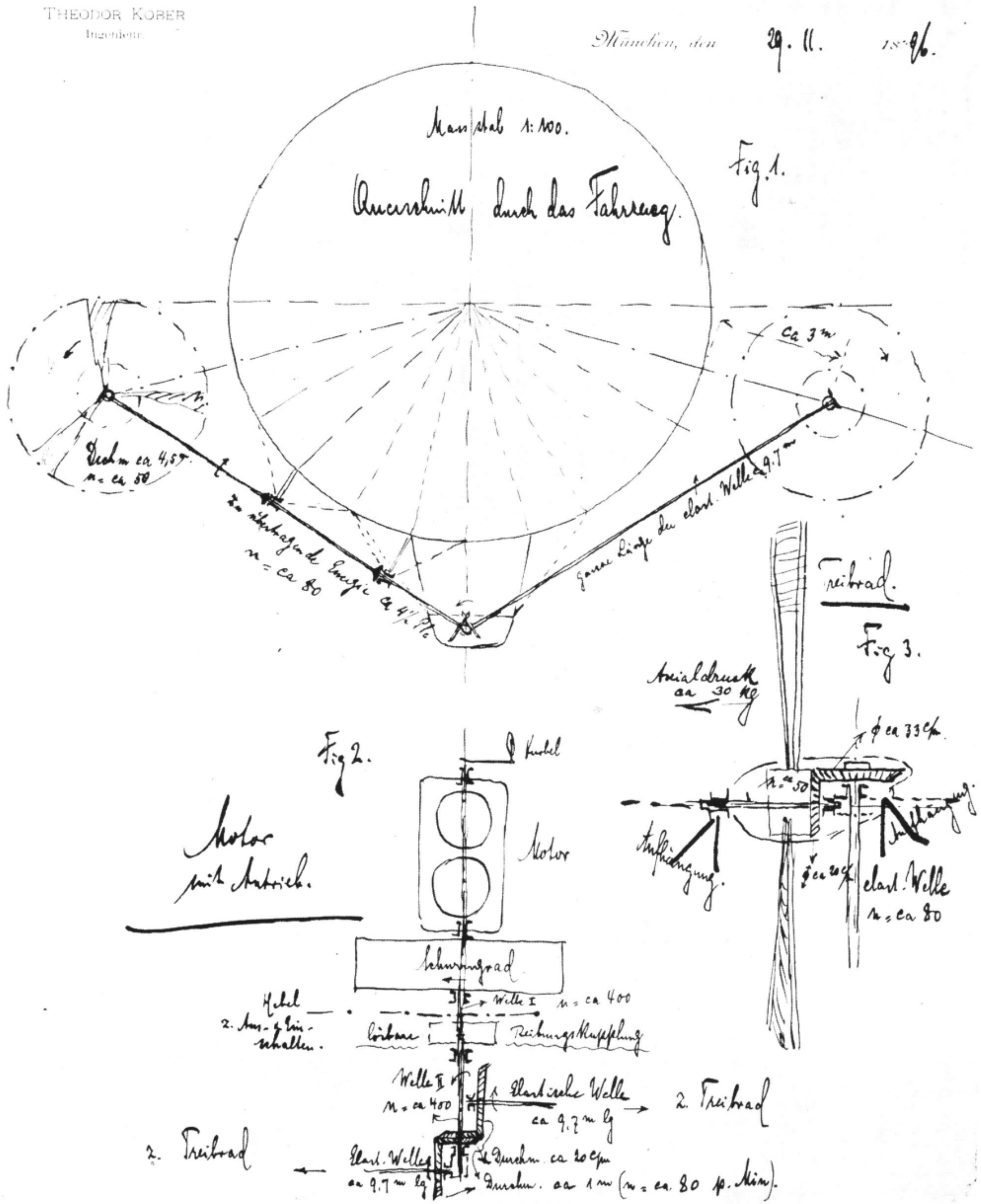
“***The forces of nature cannot be eliminated but they may be balanced one against the other***”

Count Ferdinand von Zeppelin, Friedrichshafen, **May 1914**

Above: postcard with Count von Zeppelin (inset) and his first dirigible: LZ-1

Left: Count Ferdinand von Zeppelin

LZ-1



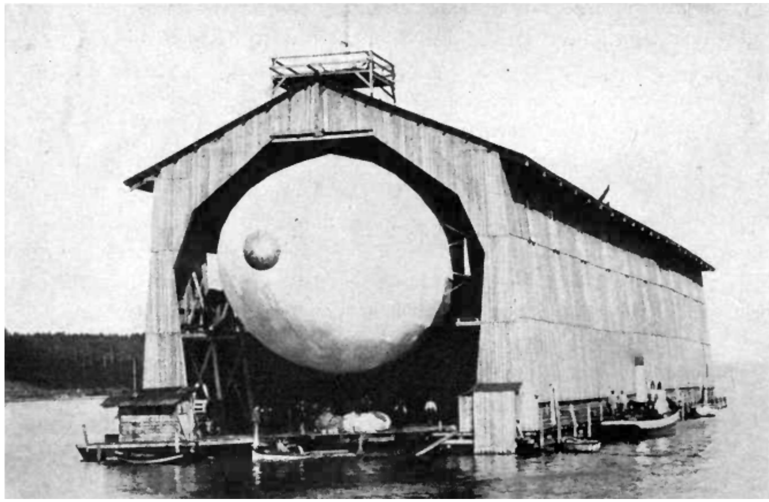
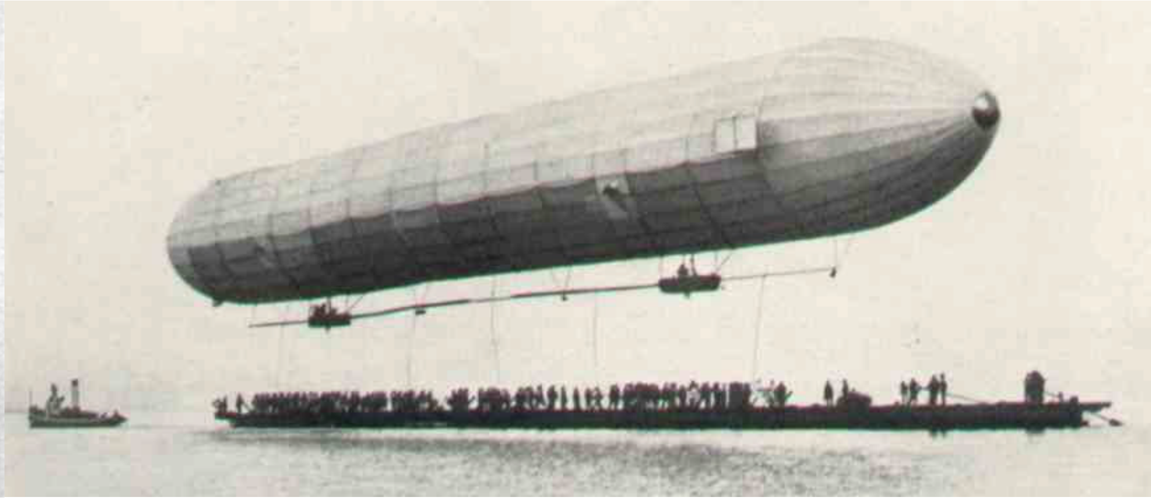
"…It was a long time, however, before his half-formed ideas took definite shape. Meanwhile, he served in the Franco-Prussian war, saw balloons carry messages from besieged Paris, and perfected his own plans for a self-propelled balloon. By 1873 he had completed a design, on paper, for a dirigible – a design that, with later improvements, was the basis of the 'LZ-1,' the world's first successful rigid airship…Count von Zeppelin had no precedent to go by. The wonder is that he produced a ship that would fly at all…"

Popular Science Monthly, **October 1929**

<u>Left</u>: one of these first sketches of the cross-section of the LZ-1 by Count Ferdinand von Zeppelin (engines with propellers and parts of the gondola can be seen)

"…In 1894 Zeppelin submitted the plans to a special committee of leading German scientists. The group failed to recommend the building of the airship – though it could find no flaw in the specifications. Now a man passing middle age, fighting to make his invention come true, Count Zeppelin at sixty succeeded in obtaining support to build his first ship. And then an unforeseen event almost ruined his plans. Another group of experimenters had built, near Berlin, a rigid airship about 150 feet long, of essentially different design, and covered with metal. Unlike all previous 'rigid' airships it succeeded in getting off the ground. But on its first trial flight it made a forced landing and was completely wrecked. The framework was too weak. Only after great difficulty did Zeppelin convince his supporters that this was not a fault inherent with all rigid airships…"

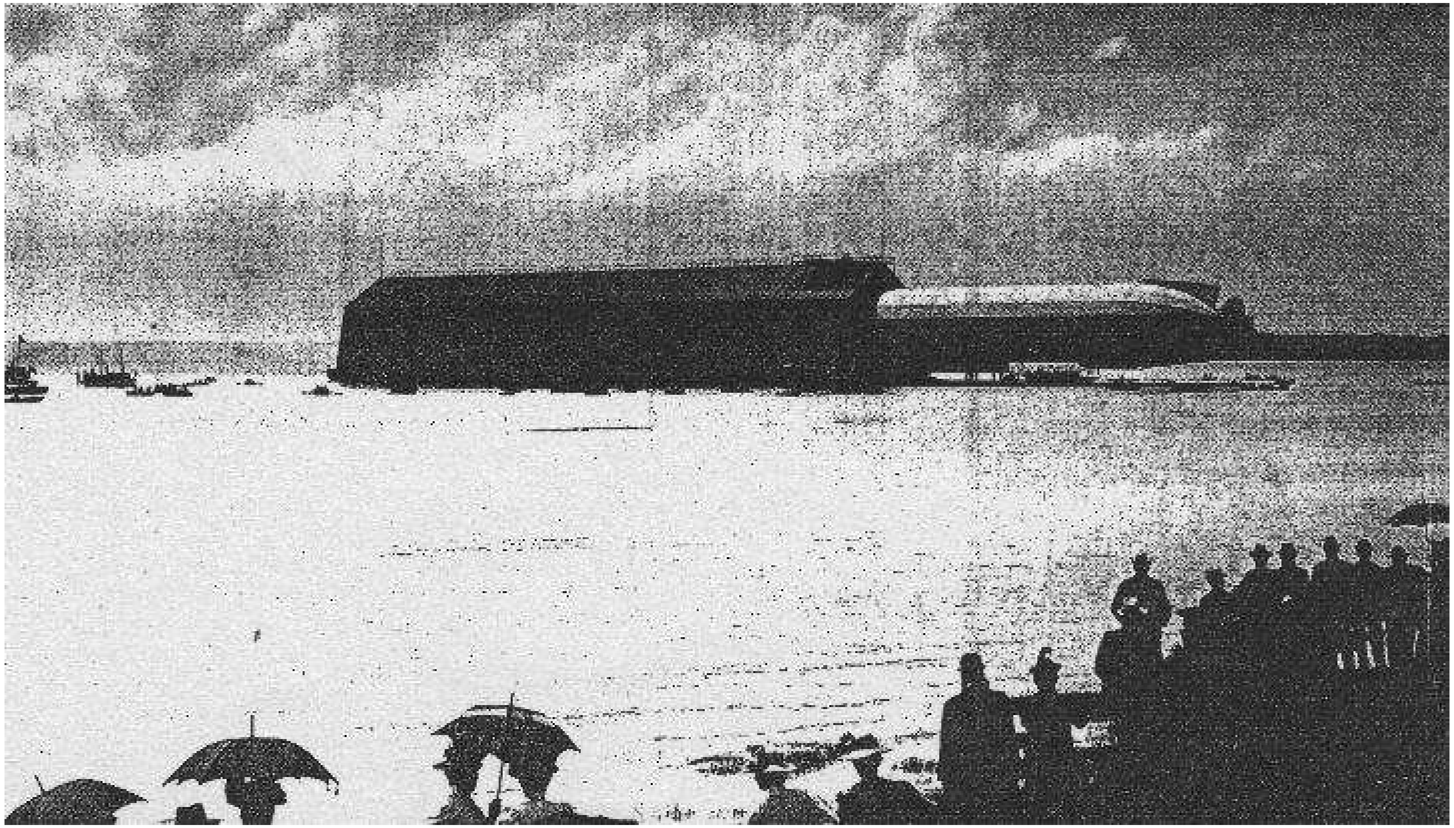
***Popular Science Monthly*, October 1929**

"…To house his first creation, Zeppelin built, on the shores of lake Constance, a structure unlike any other in the world – a shed that floated on the water. It was a huge building even by modern standards, 450 feet long, with eleven windows at each side to admit light to the great single room where the Zeppelin was to be built. It floated on ninety-five pontoons, some of which supported an ingenious detachable floor. This floor when unhitched from the rest of the hangar and floated out In the lake, was to serve as a launching platform for the dirigible. The shed was anchored at one end so it could swing in the wind, keeping the mouth always on the leeward side to facilitate handling the airship. After the structure was built, it narrowly missed disaster several times, when heavy winds tore it from its moorings and threatened to dash it on the shore. From naval dockyards at Kiel, Zeppelin obtained a number of huge ship's anchors, and at last he was ready to build his airship…"

***Popular Science Monthly*, October 1929**

Above: Zeppelin's floating hangar (left), detachable floor and LZ-1 (right)

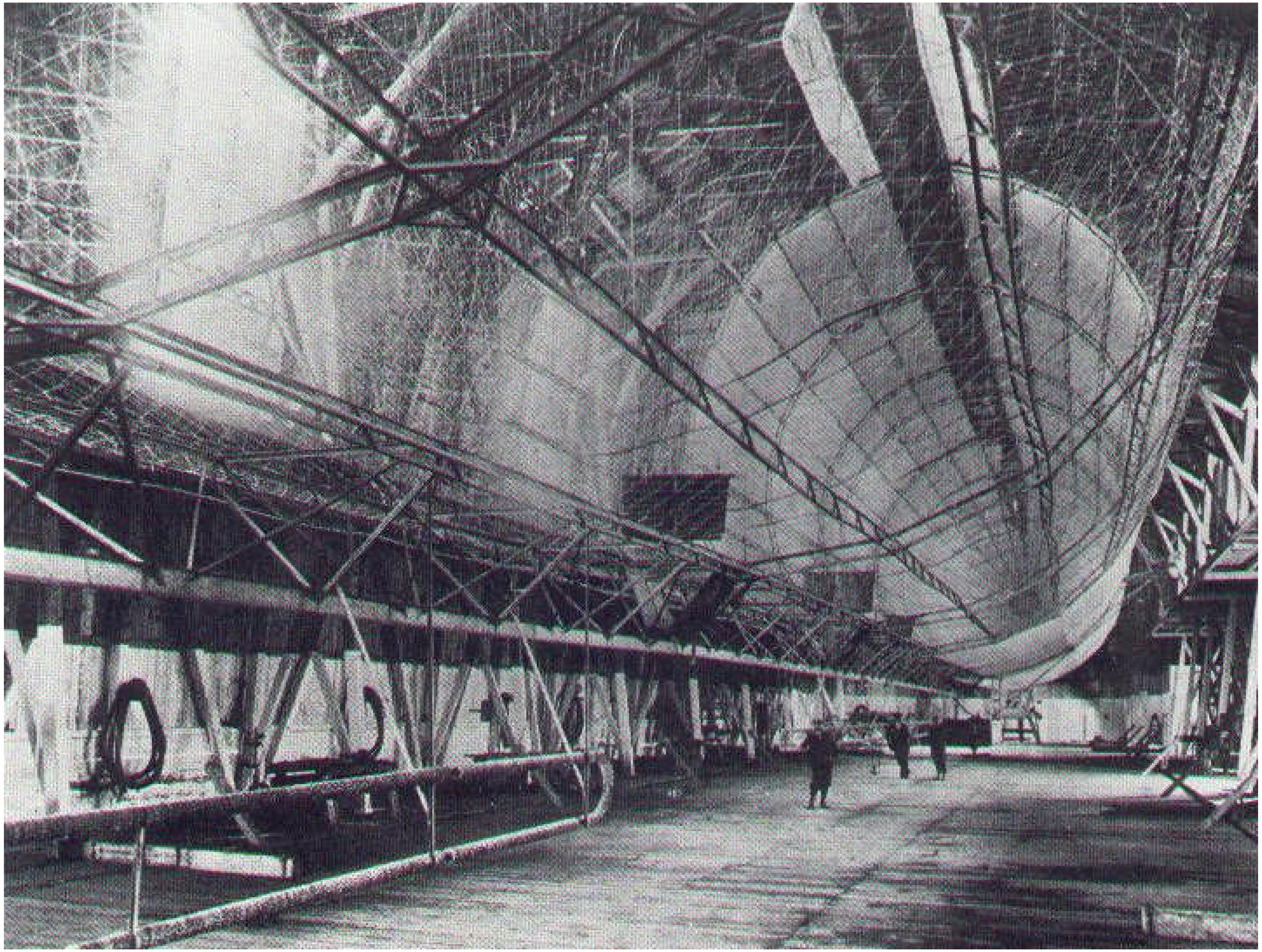


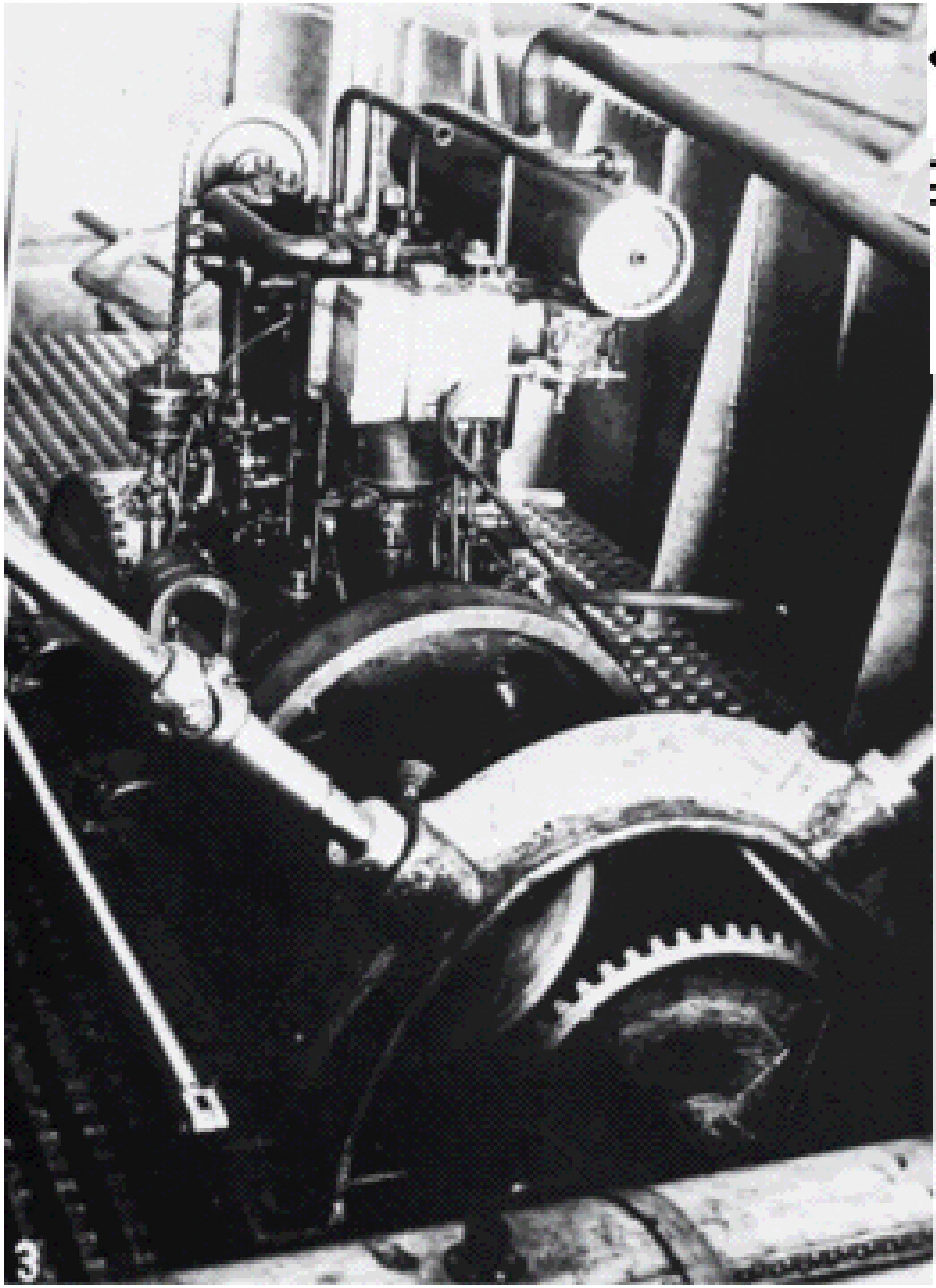
"…With no experimental data, nothing but his own imagination to draw upon, Zeppelin perfected his plans. He foresaw that an airship, to carry freight and passengers to distant ports, must be a huge craft. In such a ship it would be foolish to trust the valuable lifting gas to a single compartment. So Zeppelin worked out the multiple-cell principle. He put the gas in a number of separate compartments. One or more could be destroyed, and the gas lost, without causing the ship to fall. Moreover, cross-partitions that separated the gas chambers would keep gas from surging from one end of the ship to the other and would improve her stability. Another revolutionary idea was the introduction of a rigid framework of light metal girders, covered with cloth…"

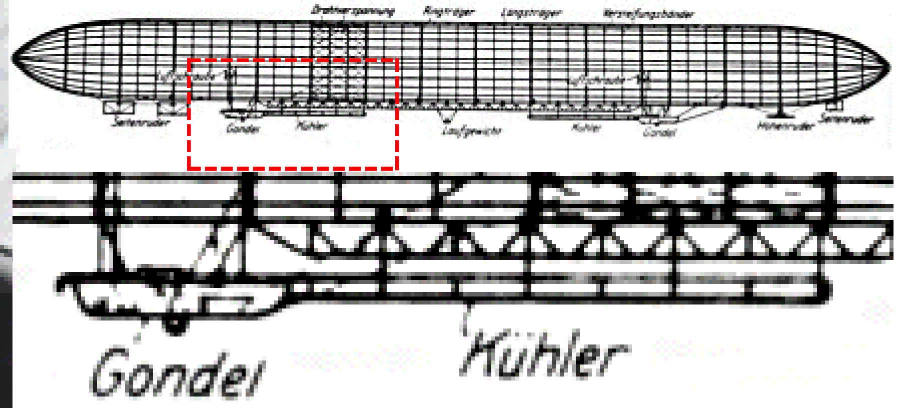
***Popular Science Monthly*, October 1929**

"…Under direction of Zeppelin's builder Herr Kaubler, seventy carpenters and thirty mechanics fitted seventeen individual gas cells, holding in all about 388,000 cubic feet of hydrogen gas, into the 420 foot framework, braced by many-sided 'rings' set eight yards apart. Held rigid by innumerable cross wires, they looked like a row of great bicycle wheels. A light network of ramie, a vegetable fiber, covered the frame members. Between each pair of rings was placed one of the hydrogen gas bags of rubberized silk cloth, each capable of holding a gas supply for two or three weeks. Outside the aluminum framework, a skin of cotton cloth protected the valuable gas in the cells from the sun and rain. Each filling of the ship cost about $2,500 and took fully five hours…"

***Popular Science Monthly*, October 1929**





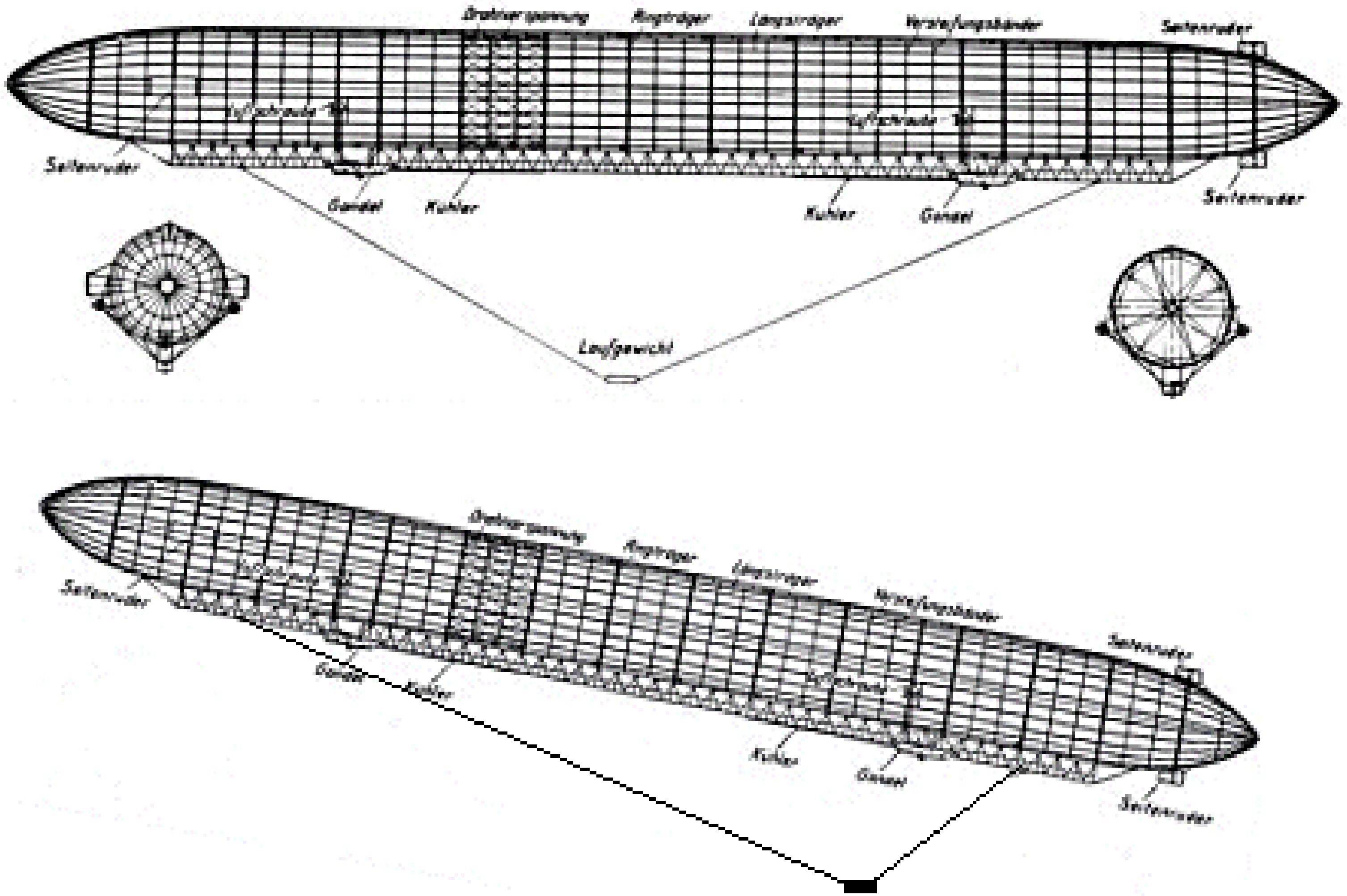


"…Two tiny sixteen-horsepower motors – each less powerful than those which run the smallest American automobile today – drove the aluminum propellers of the big ship. Their diminutive five-foot gondolas fore and aft, connected by a catwalk, were swung far enough below the hull to minimize fire danger. Sufficient fuel could be carried for ten hours of flight…."

***Popular Science Monthly*, October 1929**

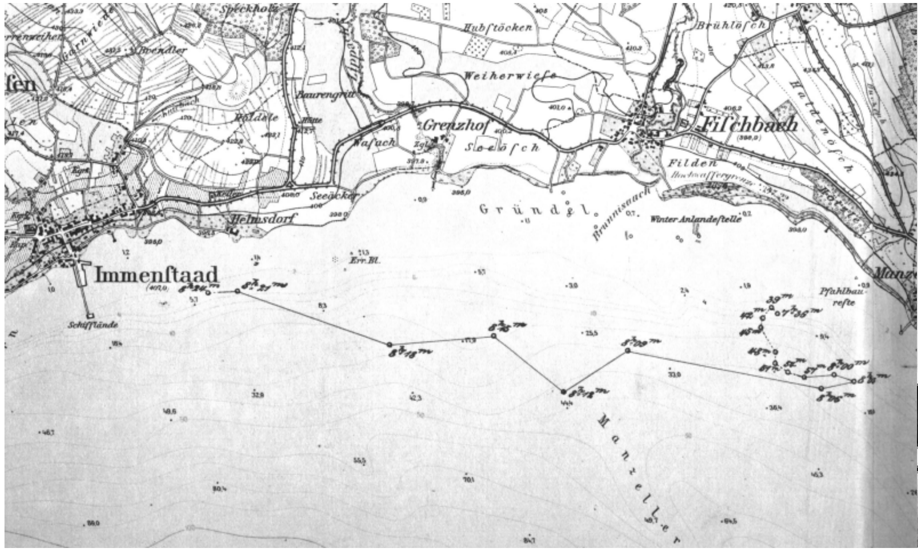
<u>Above</u>: full profile of LZ-1 (top) and detail (bottom) of gondola ("Gondel") and catwalk ("Kuhler")

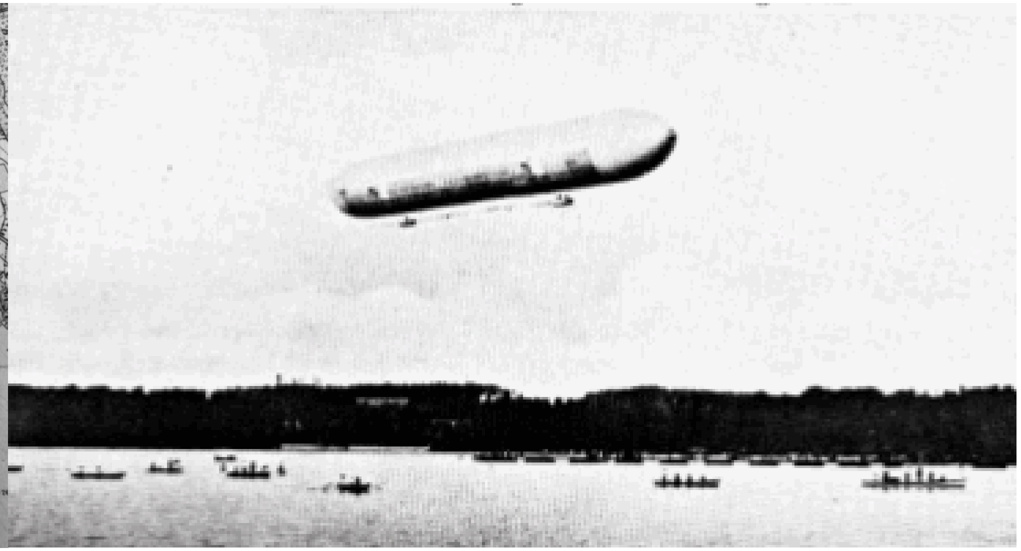
<u>Left</u>: one of LZ-1's engine and gearbox (in gondola)



"…A novel feature was the balancing apparatus – a 600-pound lead weight attached by a cable between the two cars and moved forward or backward by a windlass. Thus the ship's navigator could tilt the nose up or down…"

***Popular Science Monthly*, October 1929**



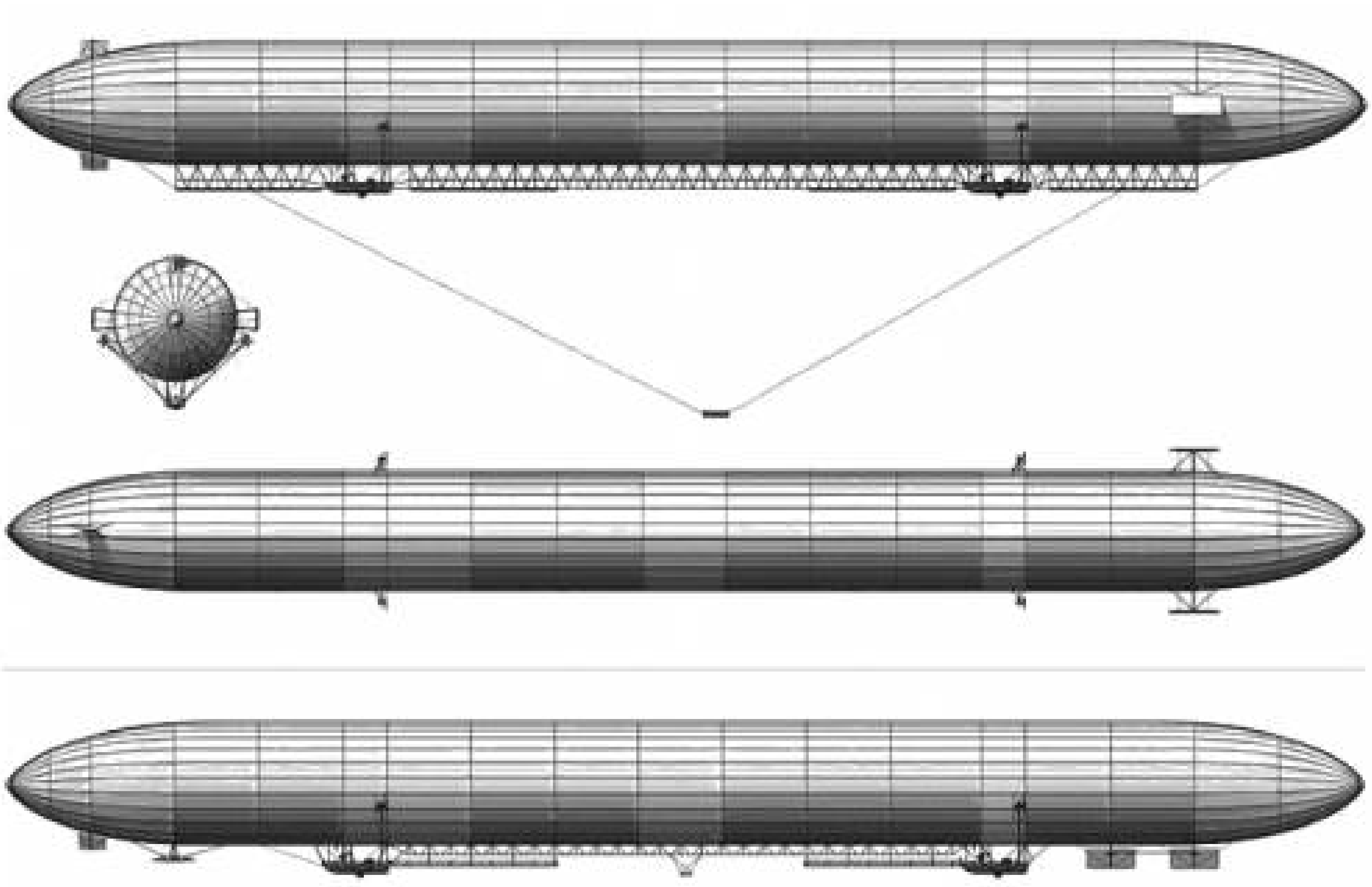


"…On a July evening in 1900 – three years before the airplane had been invented – a 420-foot airship shaped like a huge lead pencil was towed by a group of men out of its floating hangar on lake Constance, on the German-Swiss border. At the ends of the restraining ropes it ascended to a height of seventy-five feet. Then the ropes were cut and two sixteen-horsepower motors on the airship started. This ship, the 'LZ-1' (LZ is an abbreviation of Luftschiff Zeppelin – German for Zeppelin airship) was the first Zeppelin. First it nosed down a little. Then the propellers took hold and it sailed gracefully upward. A few moments later it began to behave strangely. First it would advance a few hundred feet. Then, for no apparent reason, it would reverse and back up an equal distance. Failure of a sliding weight that balanced the craft had put the steering apparatus out of commission. But those on the ground did not know it. Aboard the cranky craft its inventor, Count Zeppelin, managed to land it safely with its four other passengers…"

Popular Science Monthly, **October 1929**

<u>Above</u>: route of LZ-1 over *Lake Constance* (left) and LZ-1 in flight (right)

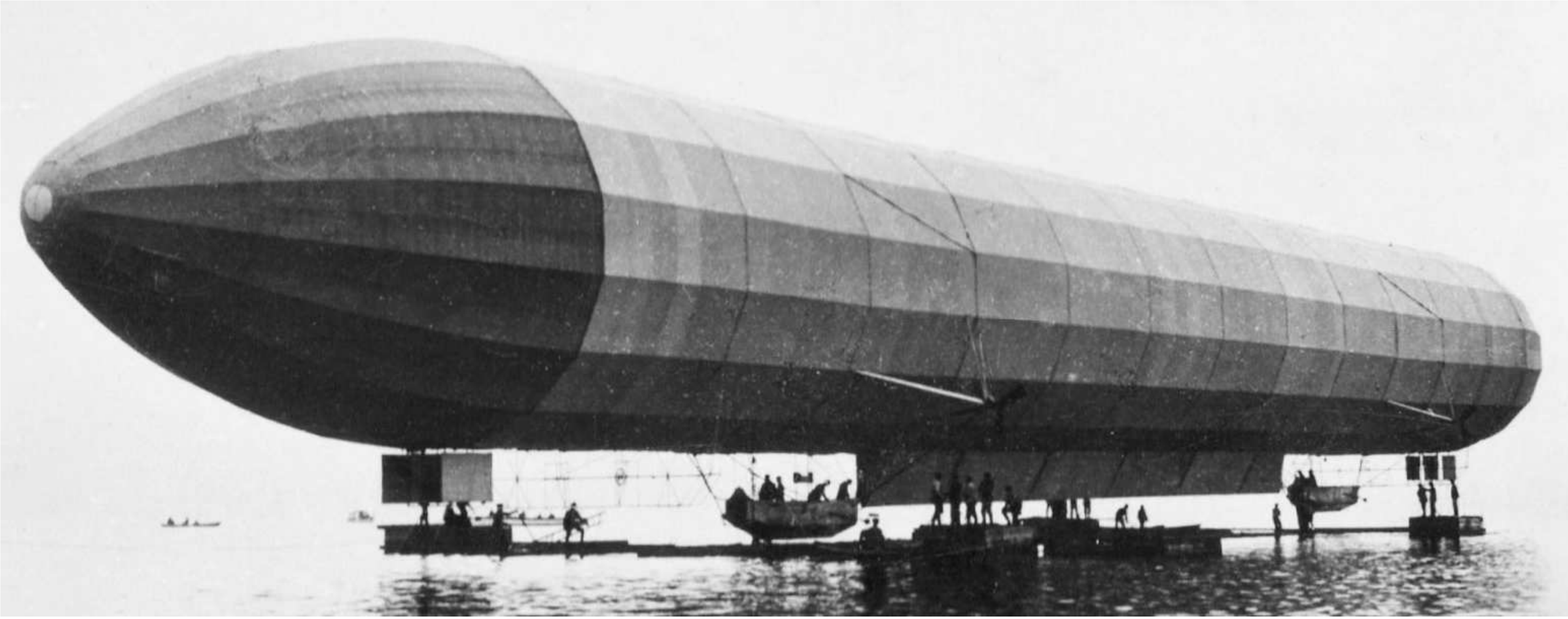
Luftschiff Zeppelin 1 (LZ-1) was 420-feet long, 38.5-feet in diameter and contained approximately 399K cubic feet of hydrogen in seventeen gas cells made of rubberized cotton fabric. Two metal gondolas were suspended below the ship - one forward and one aft - and each gondola housed a four-cylinder water-cooled _Daimler_ gasoline engine producing roughly fourteen horsepower. Each engine was connected by long shafts to two outrigger propellers mounted on either side of the hull. Pitch was controlled by a sliding weight suspended under the hull which could be shifted fore and/or aft. However, there were no elevators (for pitch control) or fins (for stability). LZ-1 was overweight and a severe lack of engine power and speed made it difficult to control in even light winds. The engines were unreliable (one failed during the short maiden flight). The airship suffered from poor controllability due to its lack of horizontal and/or vertical stabilizing fins and/or control surfaces. The sliding weight system jammed, eliminating any pitch control and most importantly, the structure itself lacked rigidity due to its weak tubular frame, which "hogged" during flight (its center portion rose high above its drooping bow and stern). Attempts were made to increase the rigidity of the frame and address the other problems. Two additional flights were made, but the flights did not impress representatives of the German military who were in attendance thus public funds were denied. Without adequate funds to continue, Count von Zeppelin was forced to dismantle LZ-1. Although LZ-1 itself was not a success, von Zeppelin's basic concept was sound and formed the basis for all future Zeppelin airships.



"…This was the ship that floated out on Lake Constance in 1900, before the eyes of aeronautical experts. Critics were outspoken in their doleful predictions of mishap. They declared the airship would bend with the weight of the gondolas under its ends. They feared the ship would keel over in mid-air, they said, its center of gravity was too high. Some said the motors were too close to the hull and would cause an explosion. But the first test flight, in which the ship flew at a speed of more than thirteen miles an hour, proved these fears groundless. Later, it made two short, successful flights, and then was dismantled because it cost too much to run. But it had proved that Zeppelin's dream was practical…"

***Popular Science Monthly*, October 1929**

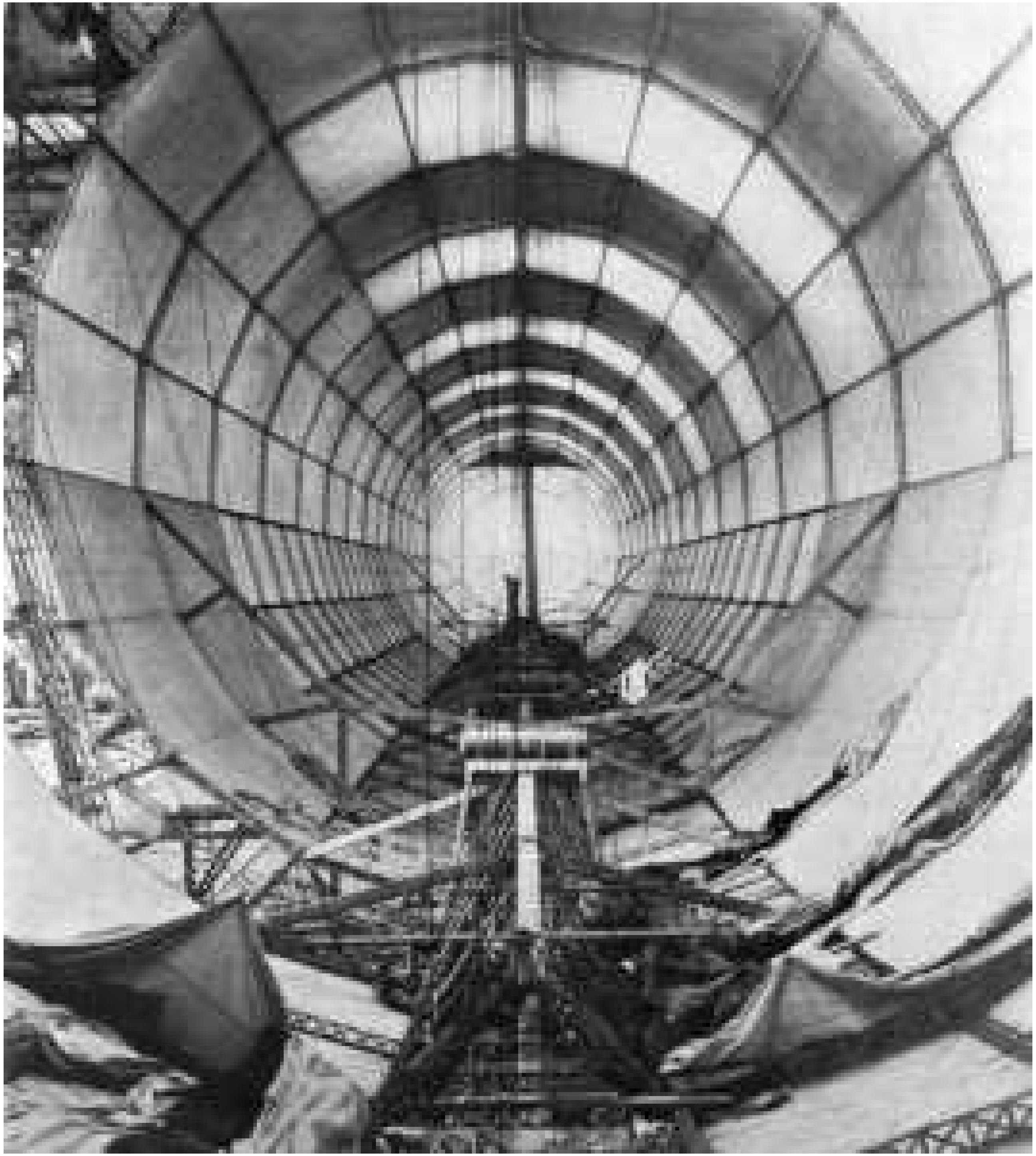
LZ-2



"…In his early ventures, Zeppelin was handicapped by lack of reliable motors. In 1905 he built the LZ-2, with two eighty-five horsepower engines. It made a forced landing in a field and a storm tore it to pieces before it could be repaired…"

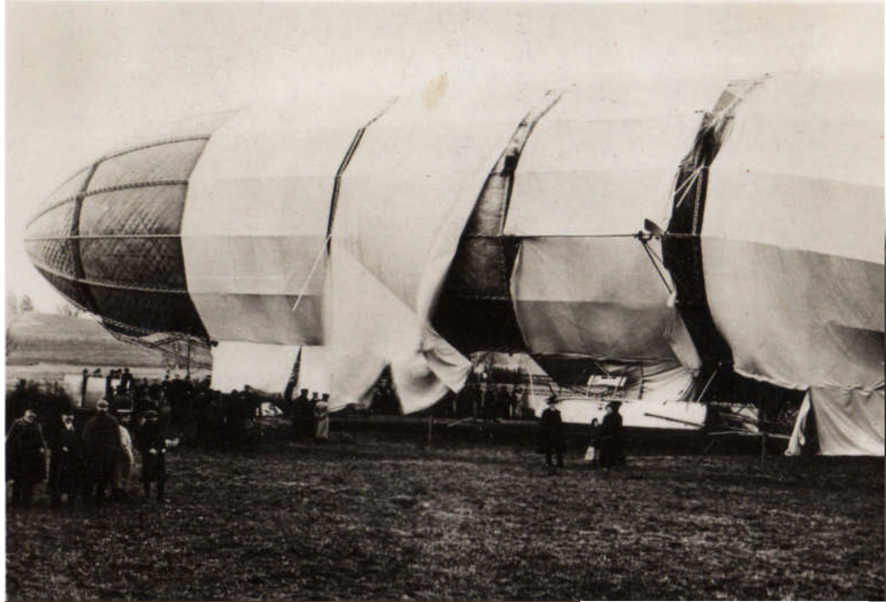
Popular Science Monthly, **October 1929**

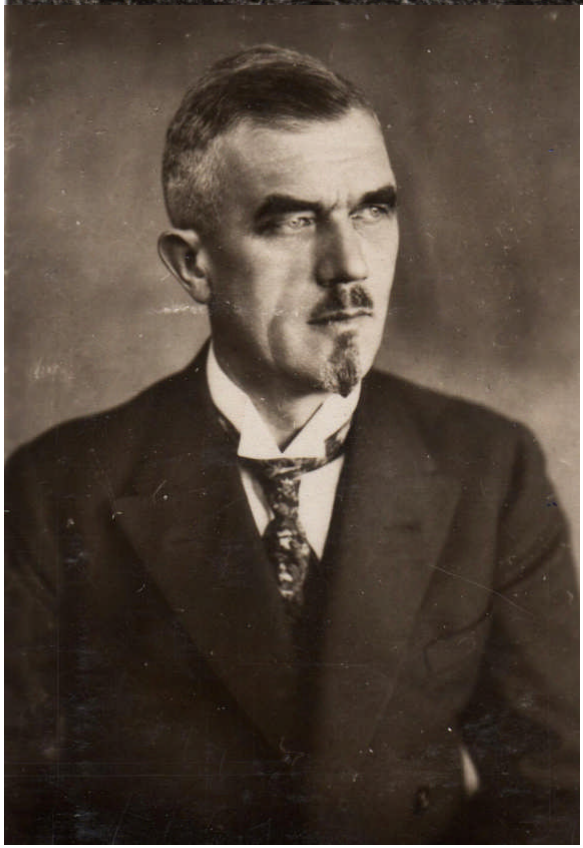
RE: Count von Zeppelin's second ship; LZ-2 (above), was built five years later with funds raised from a state lottery and the mortgaging of Countess von Zeppelin's family estates. An improvement over LZ-1, the Count's second airship still lacked basic design elements which would later be recognized as essential to flight stability and control such as vertical/horizontal stabilizers and/or control surfaces.



The weak tubular girders of LZ-1 were replaced by triangular girders which provided significantly improved rigidity and strength. Triangular girders similar to those used on LZ-2 would be used on every subsequent Zeppelin airship.

<u>Left</u>: LZ-2 under construction



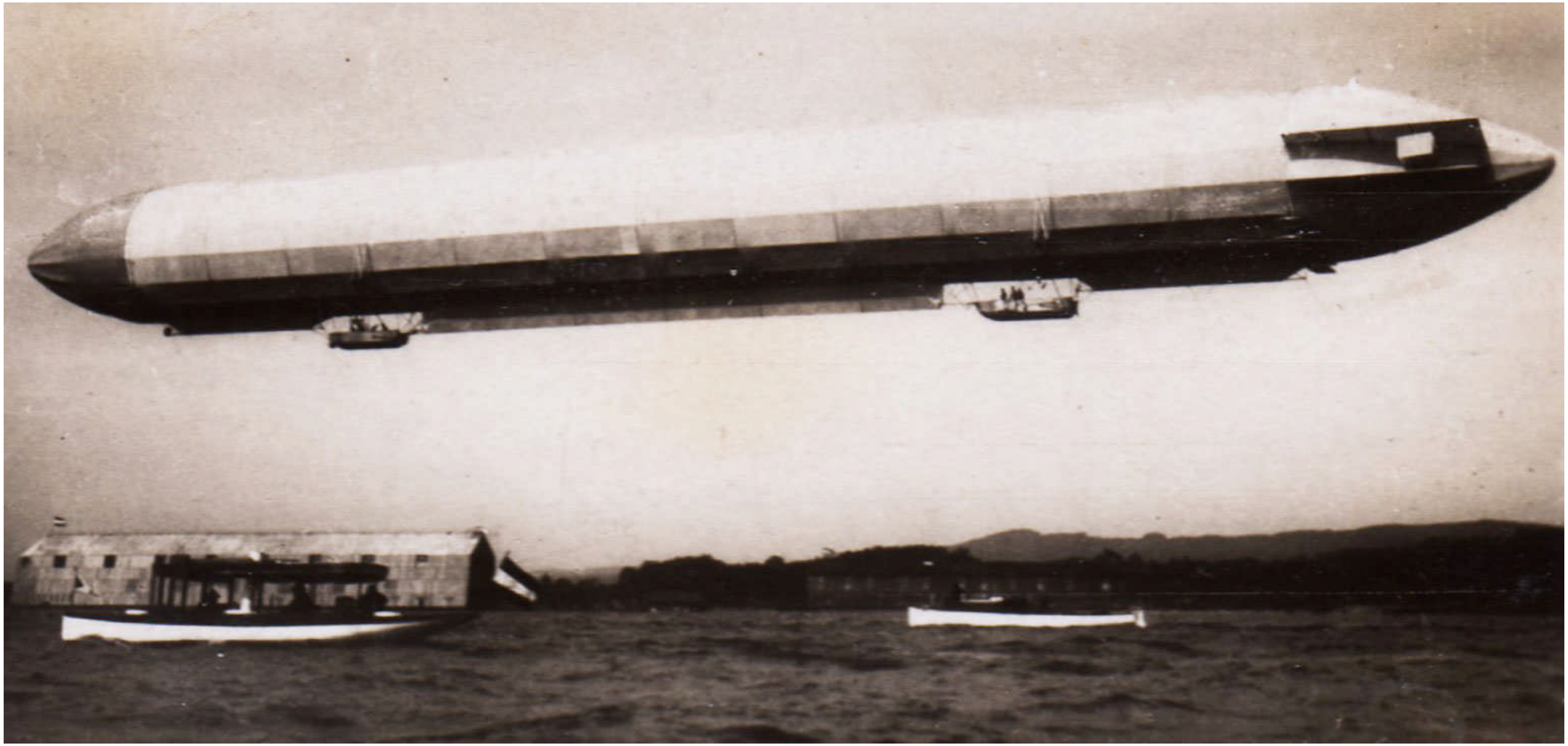


LZ-2 made its one and only flight on January 17th 1906 representing a dramatic technical advance due largely to the work of engineer *Ludwig Durr* (1878-1956). Durr (left) would long serve as Chief Engineer of the *Zeppelin Company,* designing every airship built after LZ-2. The fourteen horsepower engines used on LZ-1 were replaced with eighty horsepower *Daimler* engines, which gave LZ-2 sufficient speed to maneuver in light winds, but engine failure forced an emergency landing during the first flight and it was destroyed on the ground by a storm that evening.

<u>Above L&R</u>: the wreck of LZ-2

<u>Above</u>: *Dr. Hugo Eckener* (left) and Chief Engineer *Ludwig Durr* (right) aboard LZ-126 (a.k.a. *USS Los Angeles*)

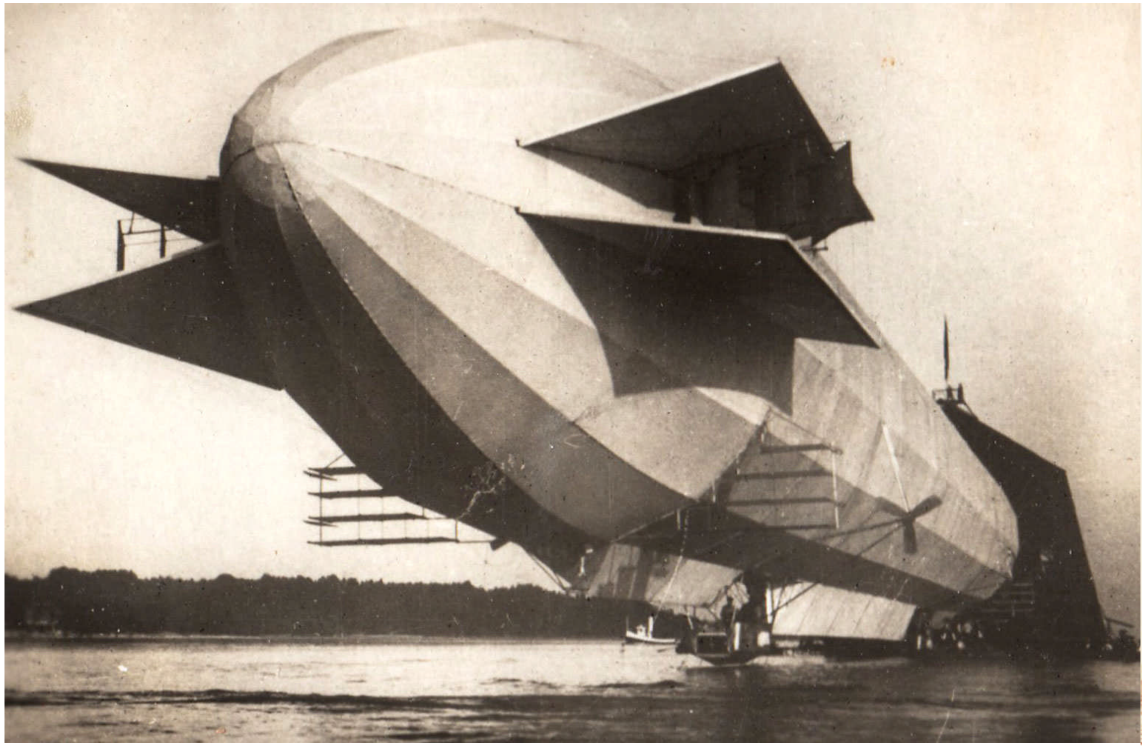
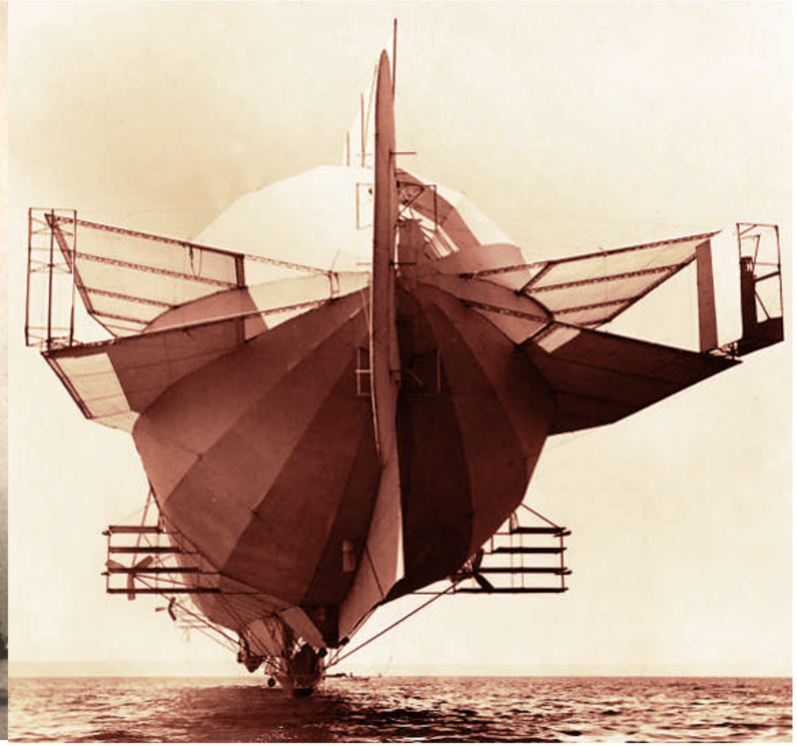
LZ-3 and LZ-4



"…Zeppelin built a third ship almost exactly like it, but with stabilizers added to the stern. It developed a speed of twenty-nine miles an hour…"

***Popular Science Monthly,* October 1929**

RE: both LZ-3 (above) and LZ-4 achieved greater advances in technology with huge increases in controllability, power, speed, range and payload. Large horizontal fins and elevators provided greater pitch control and stability and both airships were capable of producing aerodynamic lift thus longer and more reliable flights were now possible. In 1907, LZ-3 made a flight of eight hours and on July 1st 1908, LZ-4 made a flight of twelve hours over *Switzerland*.

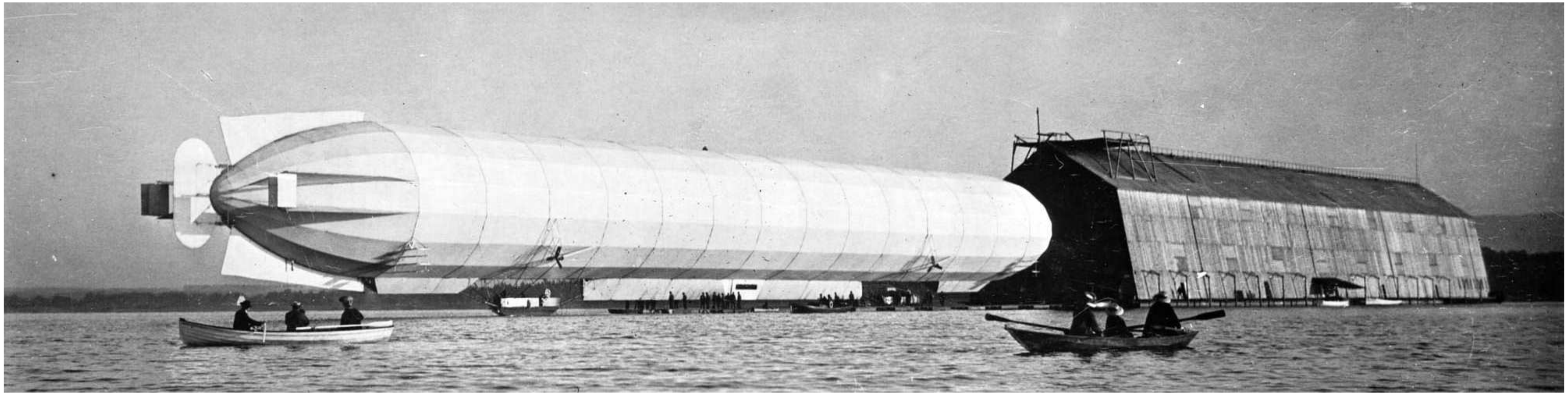



"…The German government became interested and commissioned him to build a larger ship, the ill-fated LZ-4, with 100-horsepower motors…"

***Popular Science Monthly,* October 1929**

Left: tail of LZ-3, showing horizontal stabilizers which were lacking on its predecessors; LZ-1 and LZ-2

Right: tail of LZ-4 showing horizontal stabilizers (1908)

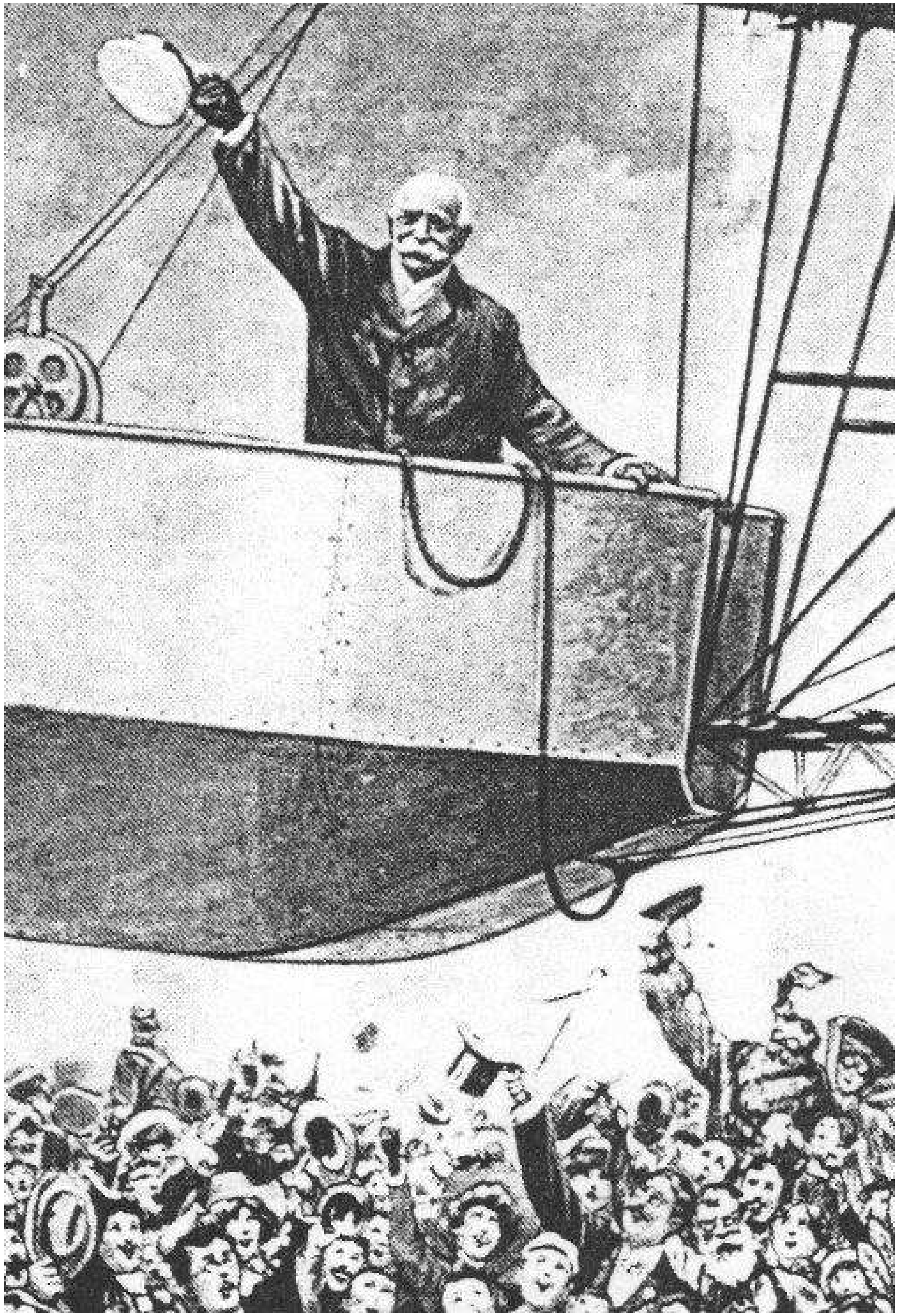


LZ-4's record-breaking July 1908 *Switzerland* flight brought national attention to the success of Count von Zeppelin and his airship. The public now began to look on it as a practical invention. Further credence was given when on July 3rd 1908, *King Wilhelm II of Wurttemberg* and his wife; *Queen Charlotte*, were passengers on the fifth flight of LZ-4. The German government promised financial support for Count von Zeppelin's efforts if his ship could make an endurance flight of twenty-four hours. Confidant in his airship's ability, he agreed to the challenge. LZ-4 departed the *Bodensee* on August 4th 1908 for the twenty-four hour trial.

<u>Above</u>: LZ-4 leaving its hangar on *Lake Constance* for its 24-hour test flight


Graf Zeppelins
lenkbares Luftschiff
in voller Fahrt.

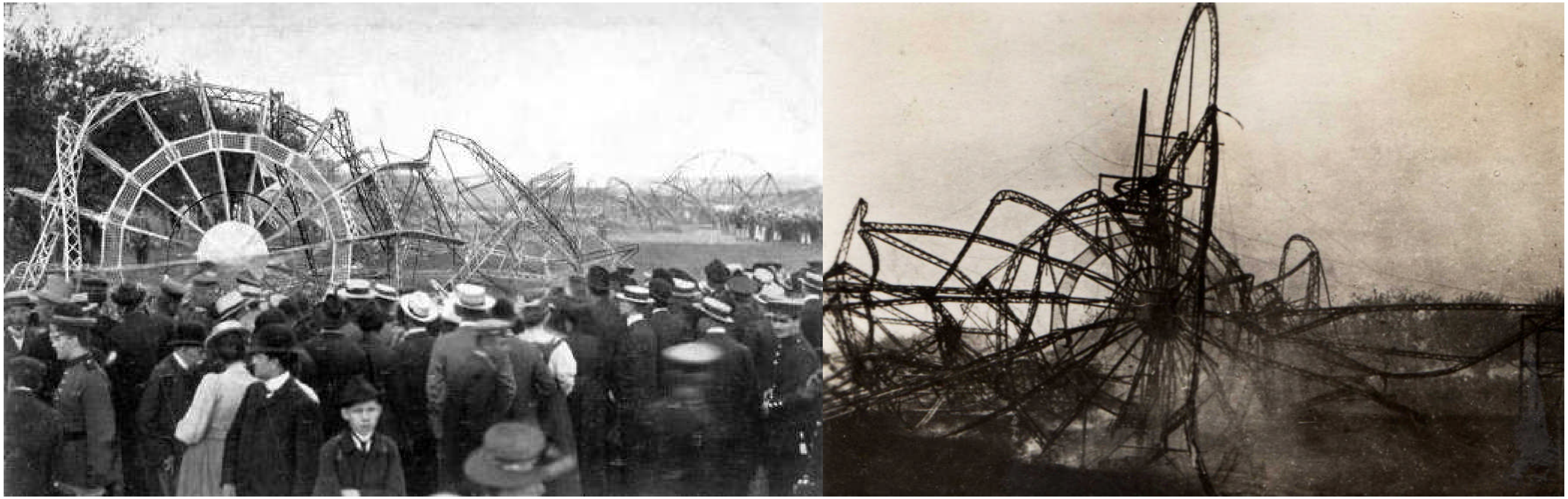
Miracle at Echterdingen



"…Zeppelin flew it over the Swiss Alps to Lucerne and back again on July 1, 1908, attracting world attention. This triumph he proposed to follow with a trip down the Rhine Valley. But another storm caused another forced landing – and this time the ship was torn from its moorings and sailed aloft with no one aboard. As it whirled skyward, something ignited the hydrogen. Instantly the bag was enveloped in flame. A few moments later Zeppelin was staring at the twisted skeleton of his latest efforts…"

***Popular Science Monthly*, October 1929**

Left: illustration of Count von Zeppelin waving to the crowd from the open car of LZ-4 as it departed on its last voyage in August 1908



Just as everything seemed to be going right for the Zeppelin team, on August 5th 1908, during the 24-hour endurance flight, LZ-4 was forced to make an emergency landing in a field near the town of *Echterdingen*. Pulled by a sudden storm from its temporary mooring, the airship crashed and was soon destroyed by a fiery explosion of hydrogen (above). Rather than lose faith in Count von Zeppelin's work, the German public rallied behind the courageous Count's efforts in what became known as the "Miracle at Echterdingen." Ordinary German citizens contributed six million marks for the construction of a new airship giving new life and incentive to the enterprise.

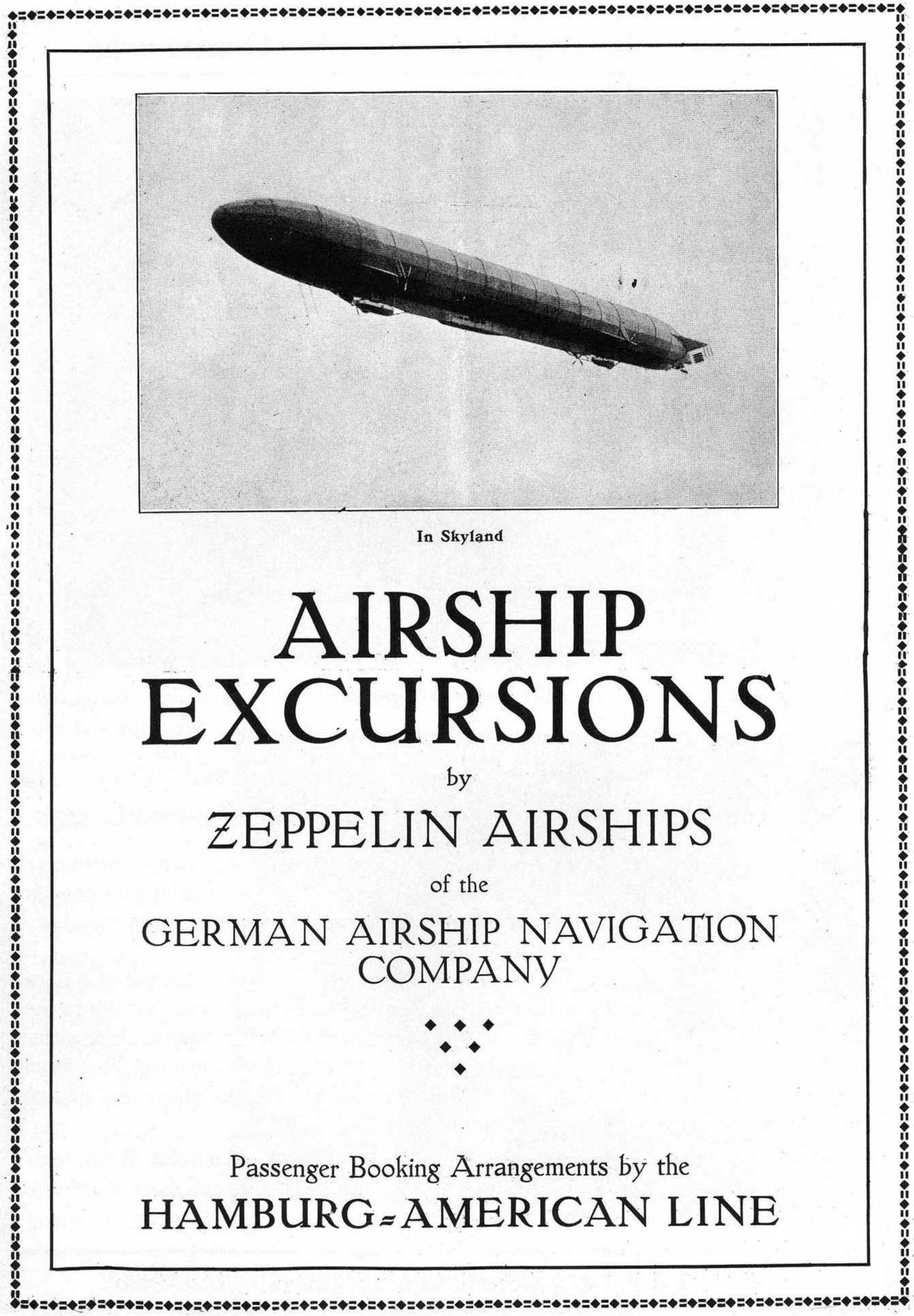
"…Many thought then that Count Zeppelin would never build another dirigible. But, aided by the financial support of the German people, he had reached the turn of his fortunes. In the years that followed, before the war, six of his dirigibles, put in commercial service, carried 37,200 passengers safely on 1,600 flights, covering 90,000 miles and remaining aloft a total of 3,200 hours…"

***Popular Science Monthly*, October 1929**

Luftschiffbau Zeppelin

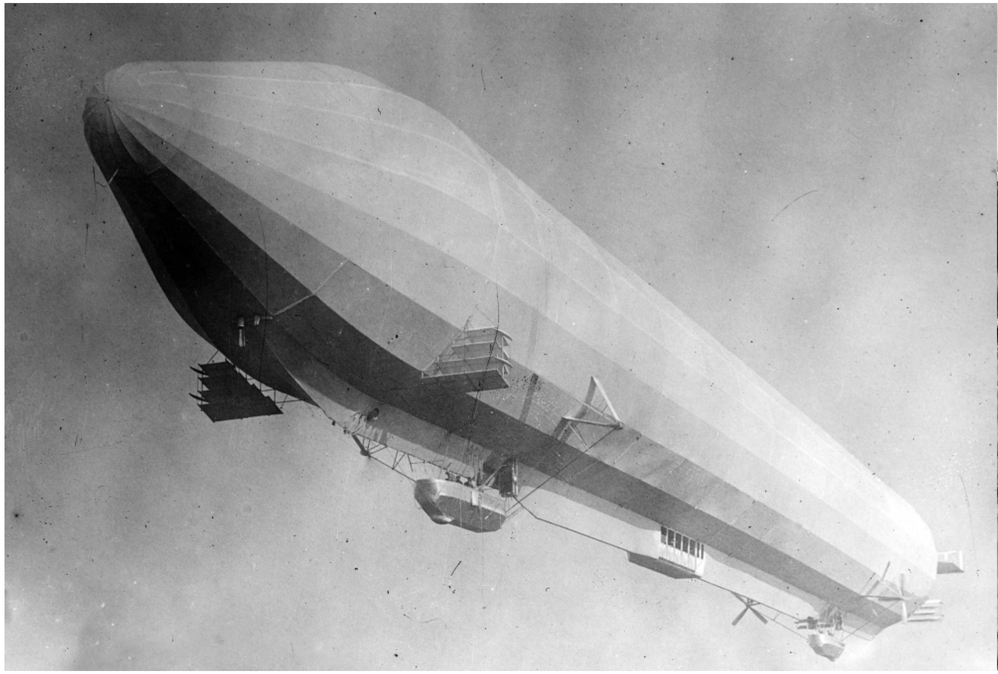
The enthusiastic financial, political and moral support of the German public and, in turn, government, following the crash at *Echterdingen* allowed Count von Zeppelin to establish the *Luftschiffbau Zeppelin* (*Zeppelin Construction Company*) in September 1908. In 1909, journalist *Hugo Eckener* joined the company as director of public relations. Within two years, Eckener would be an airship commander. Business Manager *Alfred Colsman* established *DELAG*; the *Deutsche Luftschiffahrts-Aktiengesellschaft* (*German Airship Transportation Corporation Ltd*.) as a affiliate of the *Zeppelin Company* for the purpose of commercializing airship travel by providing passenger service. Hugo Eckener's formal education was in economics and psychology, the latter in which he earned his doctoral degree. He had no formal training in physics, engineering or aeronautics. He moved to *Friedrichshafen* (on the shore of the *Lake Constance* for its healthy climate and the opportunity to continue his love of sailing. Working as an economics journalist for the *Frankforter Zeitung*, Eckener first saw an airship when he was assigned to cover the second flight of LZ-1 on October 7th 1900. Eckener found himself inspired by Count von Zeppelin and agreed to work for Zeppelin as a writer and publicist. Before long, Eckener was deeply involved in the technical and operational aspects of Zeppelin flight and by 1911 he was given his first airship command; the Zeppelin LZ-8 (*Deutschland II*). Dr. Eckener's contribution to airship aviation had two equally crucial aspects. First, his skill in technical matters such as the development of operating standards as well as his understanding of meteorology and *pressure pattern navigation*. Secondly, his business acumen (he was a trained economist) and personal ability to inspire public enthusiasm and support for airship travel.

The World’s First Airline



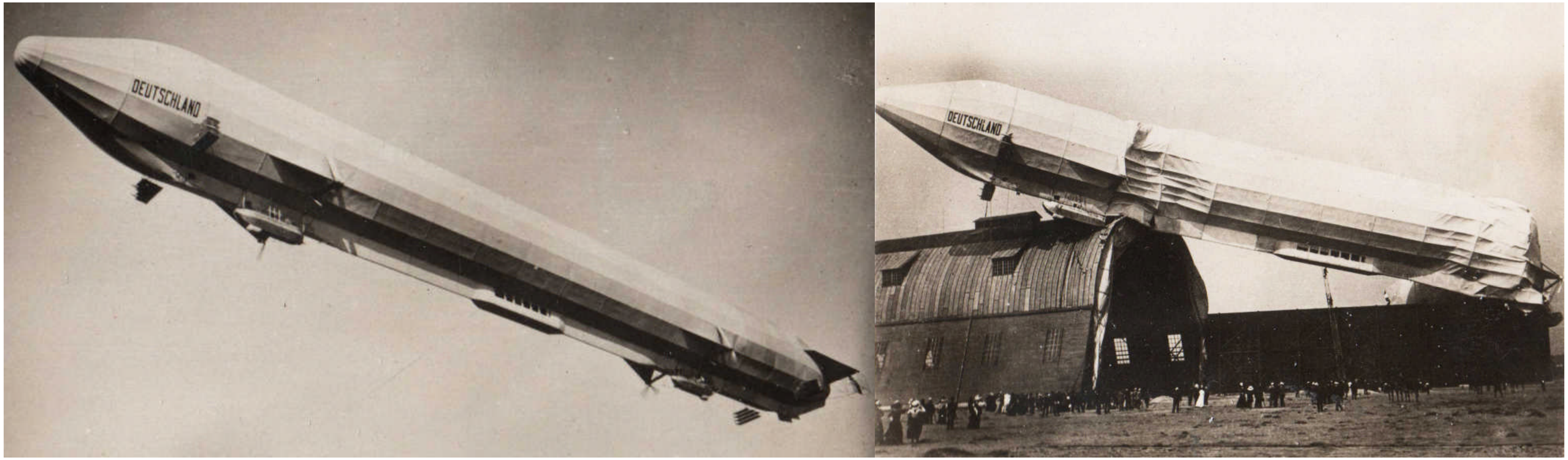
The world's first passenger airline, *DELAG,* was established in 1909 as an offshoot of the *Zeppelin Company*. While most of the early flights were sightseeing tours, in 1919 the DELAG airship *Bodensee* began scheduled service between *Berlin* and southern *Germany*; the flight from Berlin to *Friedrichshafen* took from 4-9 hours, compared to 18-24 hours by train. Between 1910 and the outbreak of WWI in August 1914, DELAG airships carried 34,228 passengers on over 1,500 flights (144K miles), without a single injury. The majority of the passengers were given free flights to publicize the airship industry, especially members of German royalty, military officers, aristocrats, government officials and business leaders. However, DELAG also carried 10,197 paying passengers before having to cease operations at the beginning of the world war.

DELAG’s Airships

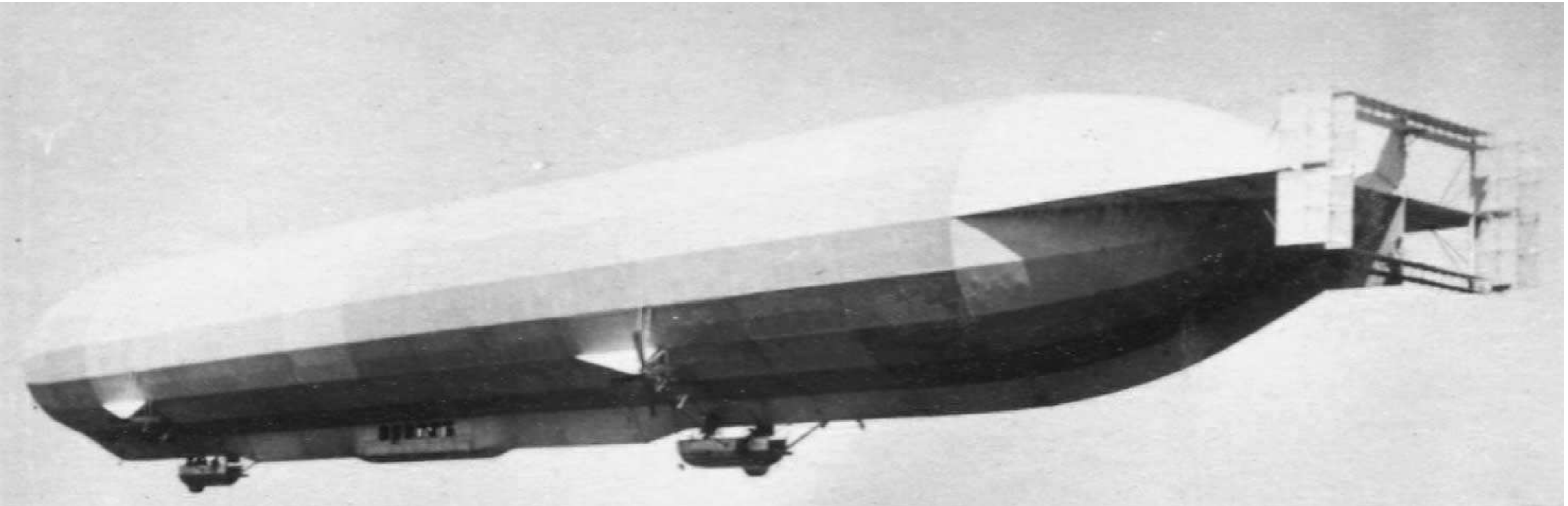
 

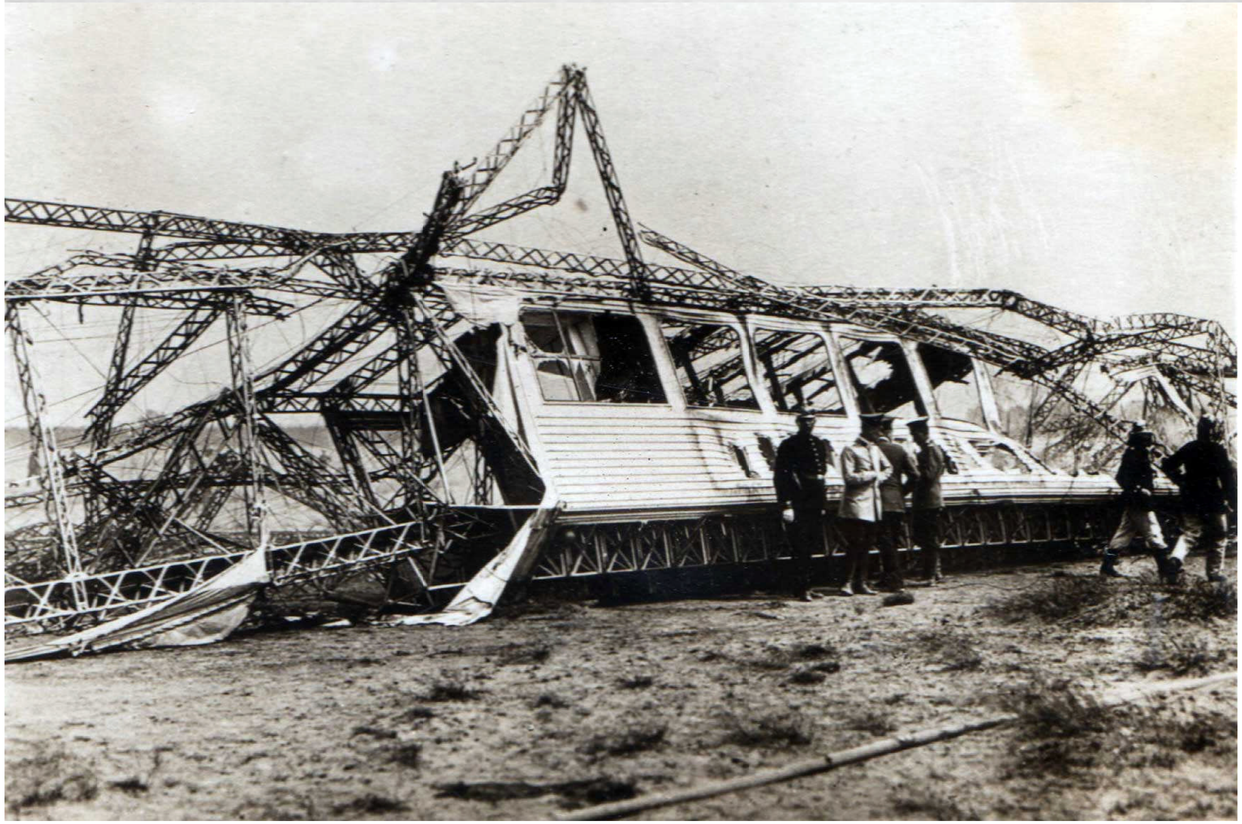
LZ-7 (*Deutschland*) has the distinction of making the first commercial flight of the first commercial aircraft in history, but it was a flight which, unfortunately, ended tragically. On June 28th 1910, LZ-7 departed *Dusseldorf* on its seventh flight with *Zeppelin Company* director *Alfred Colsman* aboard and a full complement of twenty-three passengers, mainly journalists covering the flight. Before long, due to a combination of engine trouble, weather and the relative inexperience of the airship's military pilot, LZ-7 crashed into the *Teutoburger Forest* and was destroyed. Fortunately, there were no serious injuries.

Left: LZ-7 in flight
Right: wreckage of LZ-7

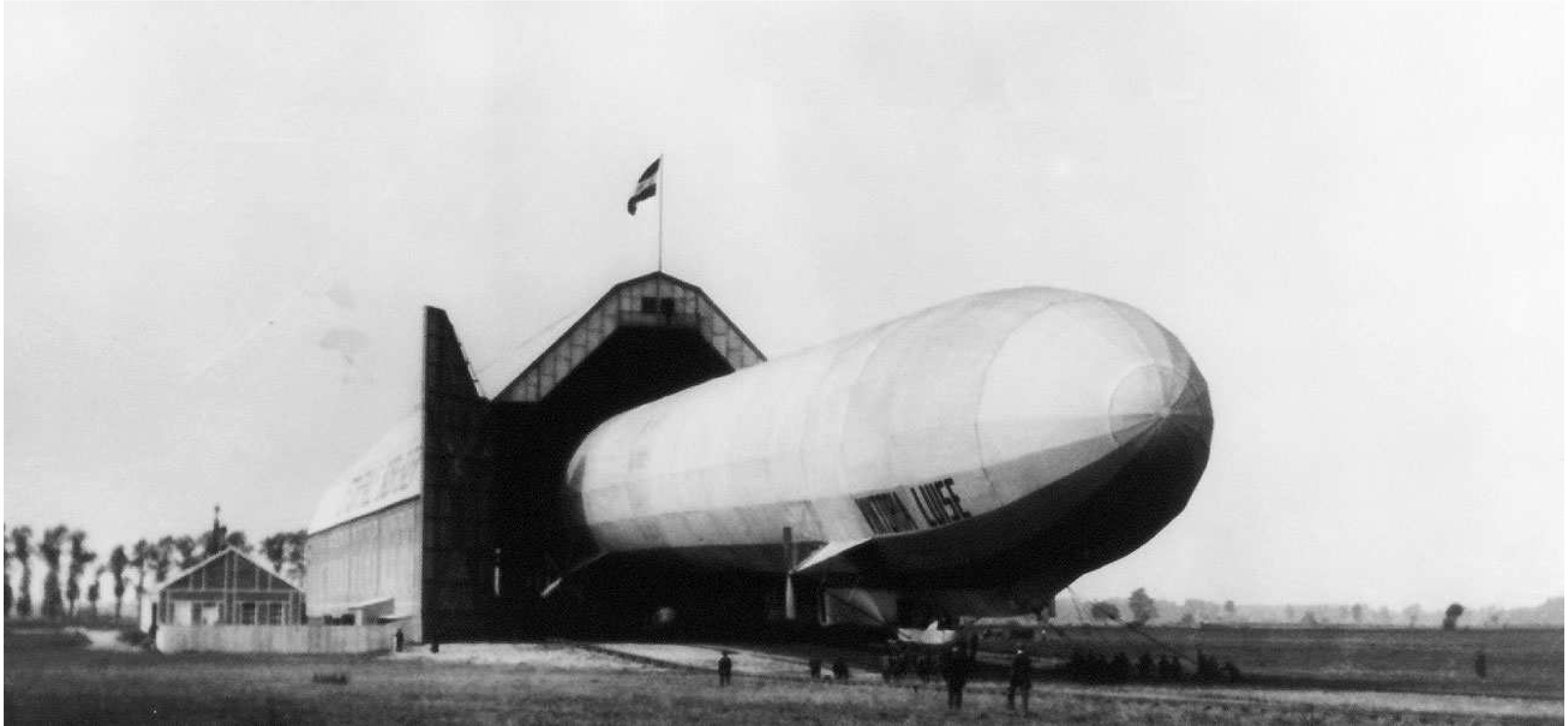


Intended to replace the wrecked LZ-7, LZ-8 (left) was launched March 30th 1911. Named “Deutschland II,” it had a similarly short career. On May 16th 1911, with *Hugo Eckener* in command of an airship for the first time, LZ-8 had barely left its hangar when it was pulled from its handling crew by a gust of wind and smashed against the roof of the hangar (right). The passengers and crew were able to escape without injury by climbing down a long fire ladder, but the ship was a total loss. The day’s gusty wind conditions made the flight ill-advised from the start. It’s likely that the crash contributed greatly to Eckener’s future caution as an airship commander and obsession with safety.

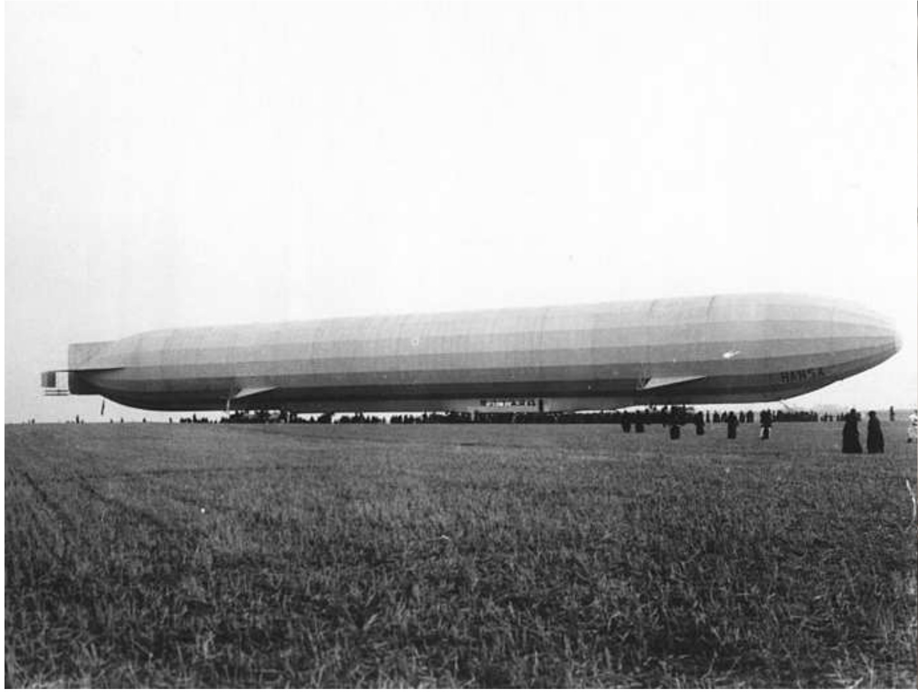




LZ-10 (*Schwaben*) entered DELAG passenger service on July 16th 1911. Frequently commanded by *Hugo Eckener*, LZ-10 made over two-hundred flights and carried over 4,300 passengers, mostly on local flights from the hangar at *Oos* (*Baden-Baden*) but also from *Dusseldorf, Potsdam* and *Frankfort* and occasionally from other cities. LZ-10 (above) was destroyed by a fire and hydrogen explosion at Dusseldorf on June 28th 1912 (left).



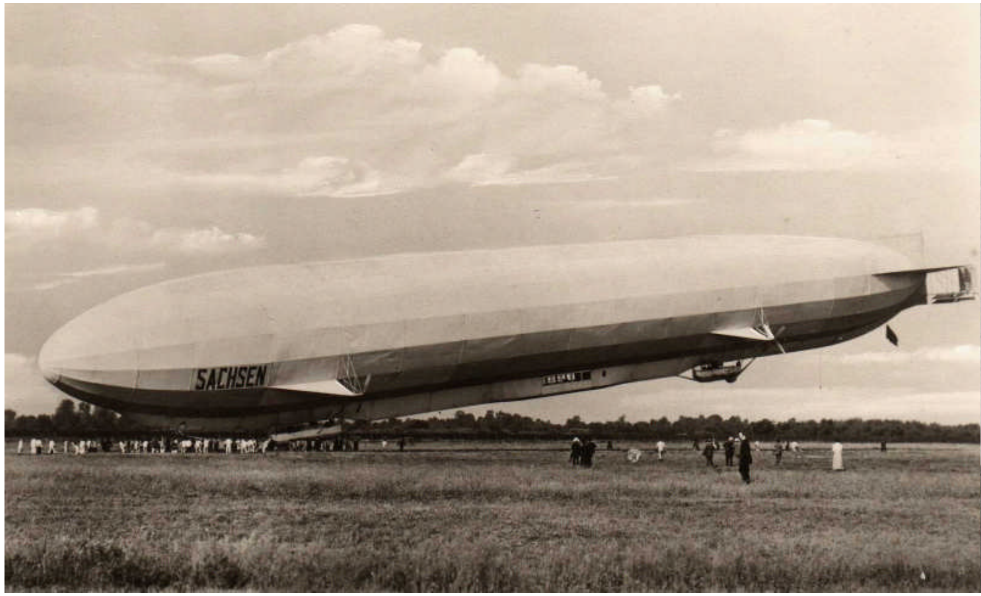
LZ-11 (*Viktoria Luise*) was named after *Princess Viktoria Luise of Prussia*, the only daughter of *Kaiser Wilhem II*. She first flew on February 14th 1912 making local sightseeing flights from *Frankfort* for most of her career of almost five-hundred flights

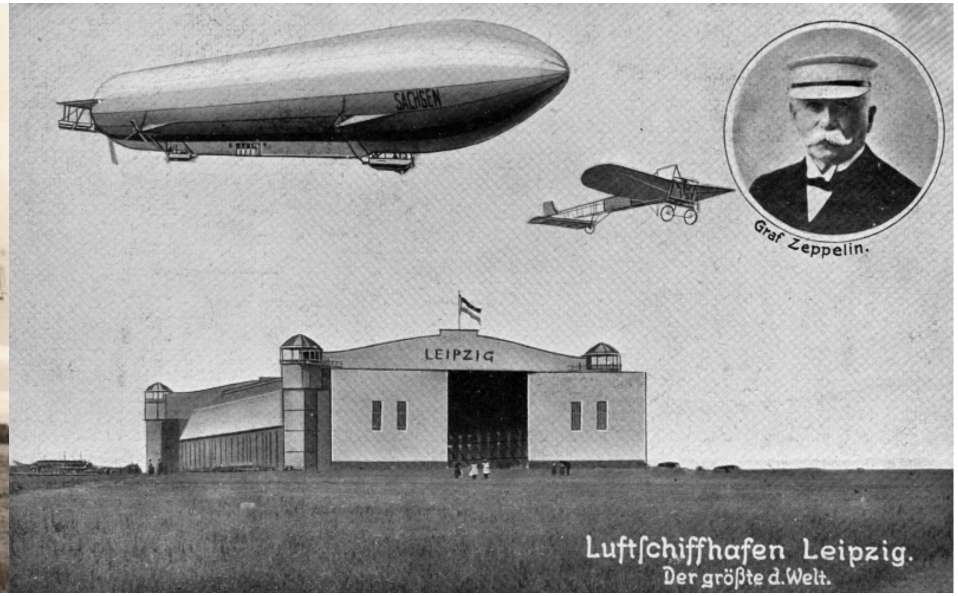


LZ-13 (*Hansa*) made its first flight was on July 12th 1912 and had the distinction of making the first international flight by a DELAG airship on September 19th 1912, traveling from *Hamburg* to *Copenhagen* and back. She carried over 8,200 people on almost 400 flights; mostly from *Hamburg* and *Postdam*, but on occasion from other cities such as *Leipzig, Gotha* and *Berlin*. Hansa was last airship based in *Dresden* until the outbreak of WWI, when it was transferred to the Army as a training ship.

<u>Left</u>: LZ-13

<u>Right</u>: passenger cabin of LZ-13





LZ-17 (*Sachsen*) made its first flight on May 13th 1913. She was the first ship commanded by *Ernst Lehmann*, who received his training on the ship from *Hugo Eckener.* During 1913, Sachsen was used mainly for local sightseeing flights at *Oos* (*Baden-Baden*) and *Leipzig*, with occasional flights from *Hamburg, Dresden* and other cities. LZ-17 proved to be an extraordinarily successful ship for DELAG carrying 9,836 passengers on 419 flights in civilian service. With the outbreak of war in August 1914, LZ-17 was transferred to the Army as a training ship. The leader of the German Navy's airship service; *Peter Strasser*, received his training from Eckener and Lehmann aboard LZ-17. The airship was later modified to incorporate bomb racks and machine guns and made numerous bombing attacks on targets in *Belgium, France* and *England*. She was dismantled in 1916.

<u>Left</u>: LZ-17

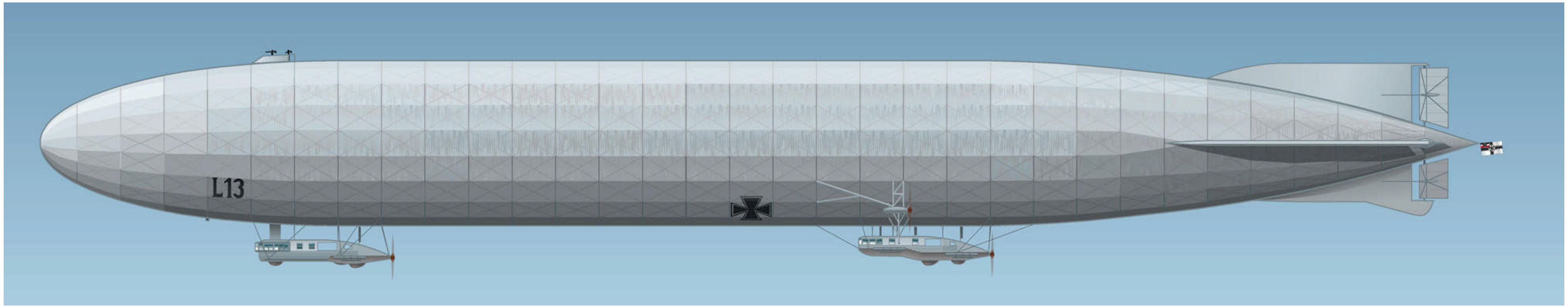
<u>Right</u>: LZ-17 and the Leipzig hanger (Luftschiffhafen)

War in Heaven

"…At the outset of the war, the German government commandeered all of Zeppelin's commercial ships for military service. Several military Zeppelins were already in use by the German army and navy, and more were ordered. Not everyone knows that during the four years of fighting, the four great Zeppelin plants then in operation built eighty-eight of the air leviathans. More than 1,000 men labored at one factory, at Staaken, Germany, to turn out the giant night bombers that raided London and Paris in 1917 and 1918. But casualties were heavy among them, and some of the lessons learned in the war played an important part in the improvement of modern airships…"

***Popular Science Monthly*, October 1929**

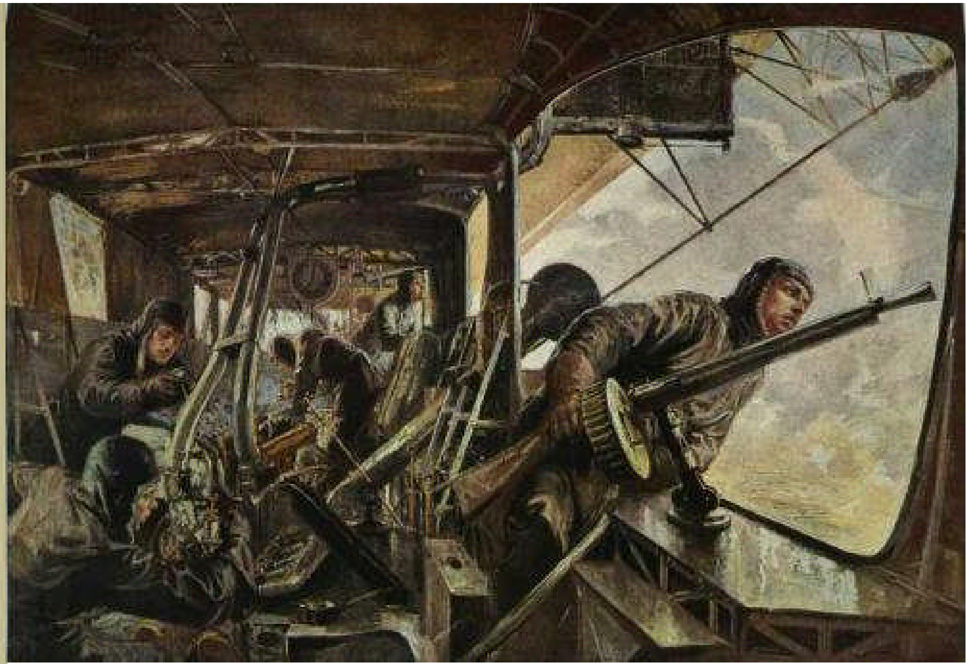
<u>Above</u>: postcard showing a German military Zeppelin bombing a French town during WWI with an inset of Count von Zeppelin



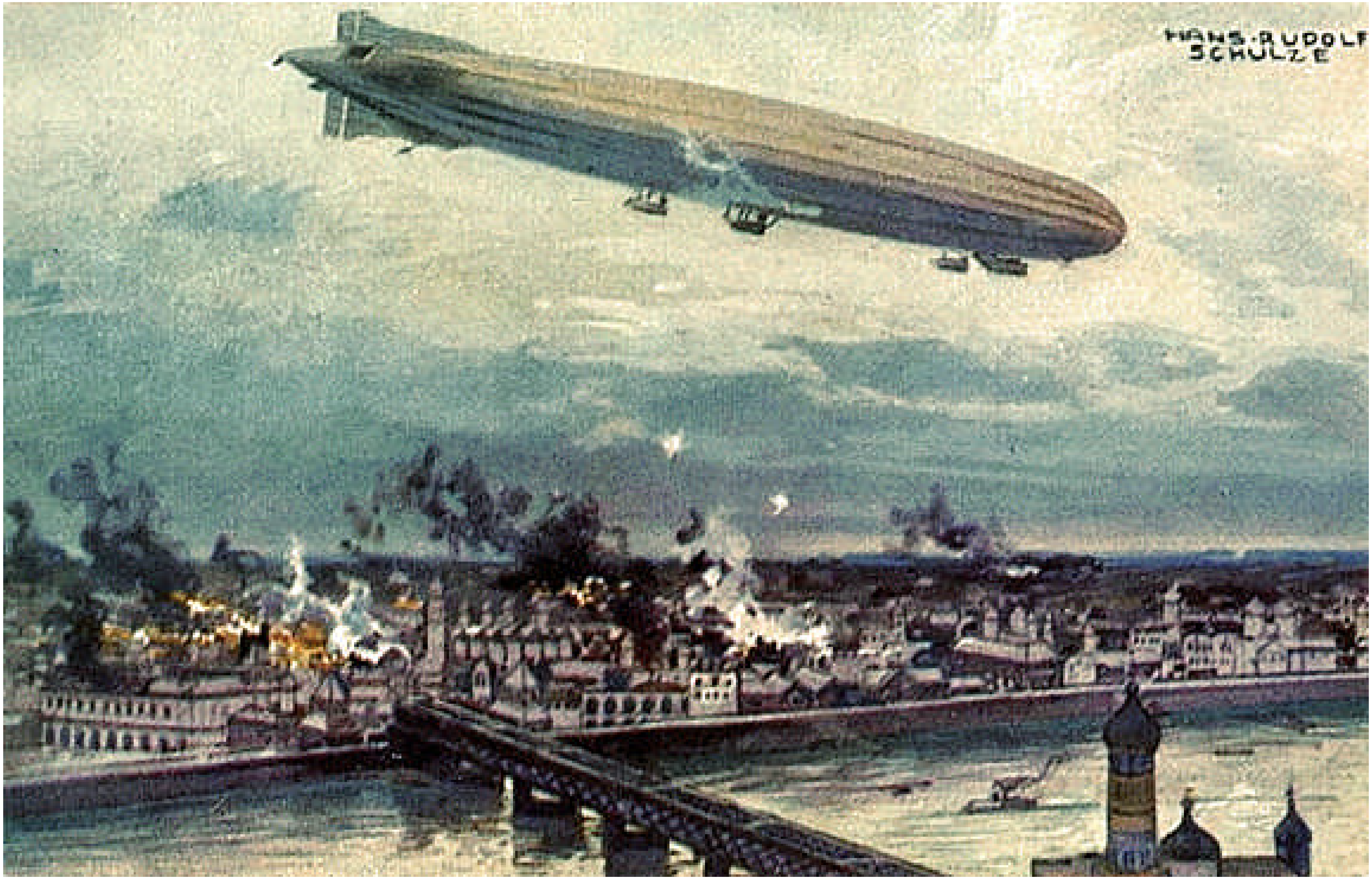
"…The Germans flew 72 Zeppelins during World War I and sent them on 311 bombing raids. The bomb casualties in England alone came to 1,882 people, not counting a very substantial number hurt by falling shells from Briton's own ack-ack. The biggest of these warcraft, the 700-foot L-72, was poised to cross the Atlantic and strike New York, but peace came just in time…"

***Popular Science,* May 1962**

<u>Above</u>: drawing of German Navy Zeppelin L-13 (LZ-45)



Above: a 1917 watercolor painting by *Felix Schwormstadt* entitled: “In the rear engine gondola of a Zeppelin airship during the flight through enemy airspace after a successful attack on England”
Left : WWI British recruiting poster of a Zeppelin airship raid on *London* by night



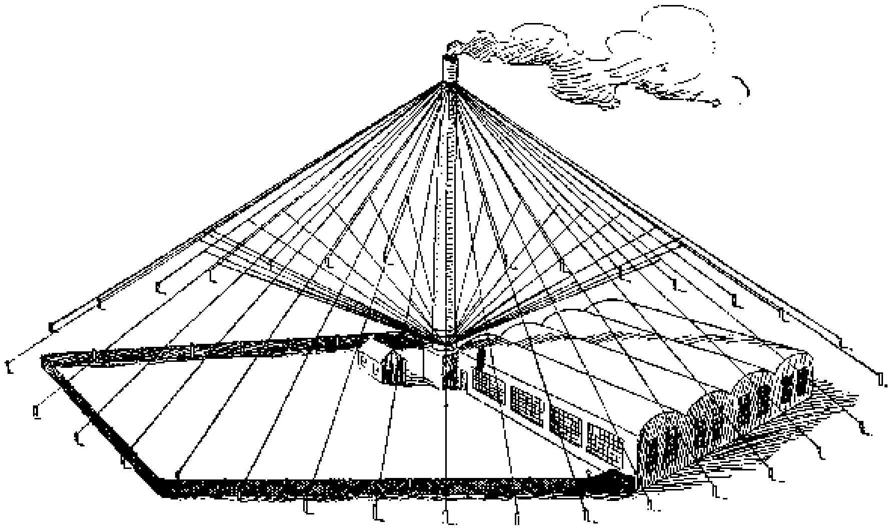
<u>Above</u>: German military Zeppelin bombing *Warsaw*

"…A Zeppelin which is sent from Germany to bomb England on a bomb-dropping expedition must travel by the shortest route. Only a limited amount of fuel is carried in order that the load of bombs may be as great as possible. But how does the captain of that ship determine the route? In time of war cities are darkened and all guiding lights are extinguished. The stars may help him. The trouble is that he travels so fast that he would have to read them at least ten times as often as would be necessary on board a ship at sea. Again, the sky may be overcast with no stars visible at all, although a war Zeppelin capable of flying four miles high could escape by rising above the clouds. This is very plausible in the lay mind, but perhaps too far from the real facts. Actually, the darkening of cities has never prevented finding the route. Rather invisibility of the ground due to 'thick' air or actual fog, has. Even then a fairly true course might be steered by 'dead reckoning'; i.e., by computing distance and direction from log and compass, and then tracing the results on a map. But the unknown and variable wind-drift prevents this. Measuring the earth's magnetism would prevent getting far astray, but the needed apparatus would be heavy, measurements must be very numerous, and each measurement means extremely difficult and accurate work. Radio communication was soon found to offer by far the most convenient solution of the problem…"

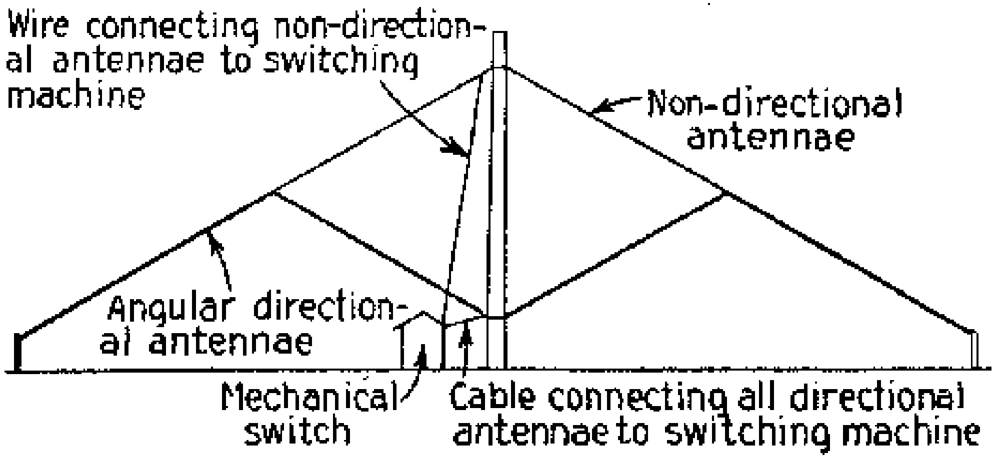
***Popular Science Monthly,* April 1918**

"…The powerful sending stations in Germany have thirty-two very long, slanting antennae radiating from a tall central mast. These antennae are exact equivalents of the rays to be found on every ship's compass, and, like them, represent the thirty-two fixed points of the compass. A mechanically operated switch connects with opposite pairs of these separate aerials once every thirty seconds. A single telegraphic dot is flashed out at each connection. In this way, all points of the compass are reached every half-minute. Any German aircraft, whether it is a Zeppelin or a small reconnaissance bi-plane, is able to pick up these dots, and by this means it can determine its direction relative to the sending station. No other addition to its regular receiving apparatus is required. However, a calibrated pocket stop watch must be referred to. By 'calibrated' we mean that the hand of the watch runs like the previously described switch, and that it makes a complete revolution around the dial in thirty seconds. The dial is, of course, marked like that of a navigator's compass with the thirty-two points instead of with ordinary minutes and seconds…The signals can radiate out over long distances, the sending station can be entirely automatic, and on board the airship the commander need only listen for loudest signals (or weakest, whichever he prefers), hold a one-handed stop-watch, and he gets his direction almost at once…the Zeppelins using the Telefunken-compass are equipped with ordinary non-directional aerials for receiving the signals…"

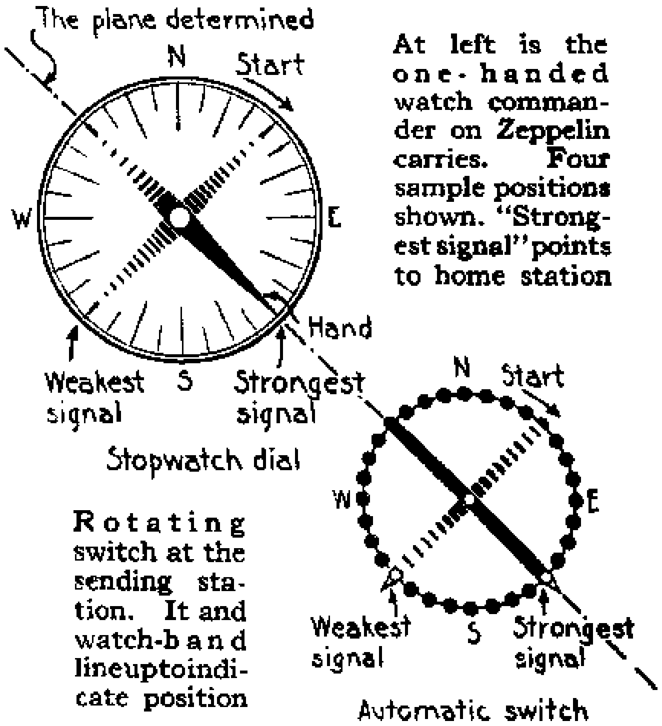
Popular Science Monthly, **April 1918**



<u>Above</u>: caption: “A Telefunken-compass sending station. Factory chimneys frequently serve as aerial supports as in this case. Germany thus effects a savings of metals valuable for other war needs”



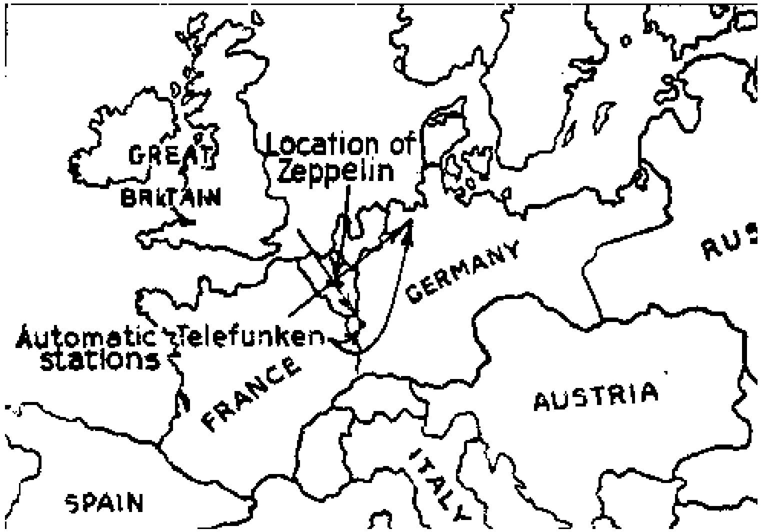
<u>Above</u>: caption: “Section of Telefunken-compass sending station. Sixteen such sets from the aerial shown above”



"…In actual operation the sending station mechanically rotates its switch and sends its dots as continuously as a lighthouse with a rotating lantern flashes out beams of light. But there is a short stop before each new rotation, which commences with the first dot flashed by the north-pointing antenna. During this short stop another but different signal is sent - a non-directional signal which is flashed over all the antennae and which is heard clearly and loudly in any direction. This signal identifies a station by giving its name or its number and supplies the information that in another moment another cycle of dots will be sent out toward east, south, and west, commencing at the north. The aircraft commander thereupon sets the hand of his stop watch to the north. He may press the starting button as soon as he hears the first dot, and the stopping button as soon as he hears the weakest dot, or he may press the button at the strongest dot. In actual practice, he pushes the button at the dot immediately following the weakest (or strongest) signal. The difference in loudness is considerable from dot to dot. Indeed, the loudness progresses or decreases around the circle of the compass, depending upon the direction in which one reads…"

Popular Science Monthly, **April 1918**

<u>Left</u>: caption: "Since commander's watch-hand and the sending switch rotate in unison, loudest signal determines plane in which sender is located"



"…Imagine what a sensation it must be to be up in a Zeppelin high over an impenetrable cloud bank, the sky overhead obscured by the bulk of the gas bag, and for these reasons all the landmarks by which a man ordinarily locates himself obscured. Yet from somewhere beyond the clouds beneath comes that clear radio call indicating that in this direction at least lies a home station. The beacon is welcome. All the Zeppelin commander needs to do now is to tune a bit differently and go through the same performance with another automatic station. In a minute or two he has read on his stop watch dial his direction relative to two different stations whose identity he knows. Drawing lines in these two directions from the locations of these stations on his map, he sees his own location plainly marked on the same map at the point where both lines intersect. More he could hardly demand, but he may repeat the procedure many times in order to check up his location as frequently as the rapid progress of his craft demands. In peace time the range was intentionally cut down to fifty miles in order to prevent interference with regular wireless traffic. But in war, especially during a raid, a vastly greater amount of current may pass through the switches and the antennae may be worked to full capacity…"

Popular Science Monthly, **April 1918**

<u>Above</u>: caption: "Intersecting lines from sending stations tell a Zeppelin commander his position accurately"

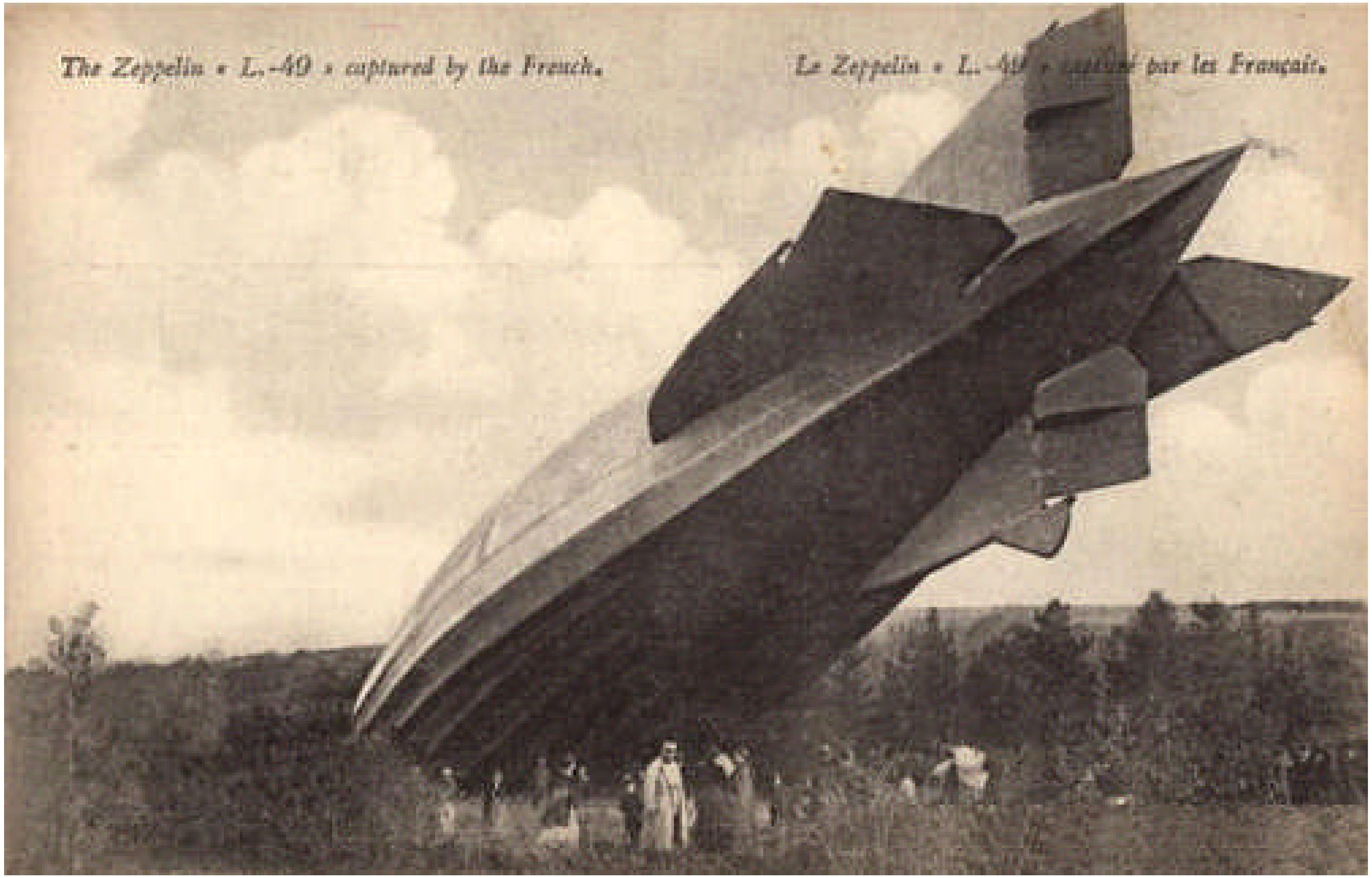
"…One day four German Zeppelins, returning from a military mission, were caught in a storm at 18,000 feet altitude and swept over Allied lines, where all were shot or forced down. The engines, designed for sea-level conditions, had failed in the rare of high altitudes. Out of this experience came the present high-altitude airship motor, over-dimensioned with surplus compression, which develops maximum power at about 10,000 feet…"

***Popular Science Monthly*, October 1929**

"…Of a fog-bound raiding squadron of a dozen or more ships, two returned safely on their regular course; six lost their way, drifted temporarily over France, luckily for them unobserved, and succeeded in stemming a frigid, violent northeasterly gale that had sprung up enough to regain German territory. The rest succumbed to attack and came to the end of their supplies which they had had to buffet with a limited amount of fuel. Rising to an altitude of 16,000 feet to escape shells and pursuing airplanes, they encountered an upper wind so violent that they drifted farther and farther into France in spite of all their fuel-wasting efforts. One vessel had been ignited in the air by an anti-aircraft battery into the range of which it had blundered. One senselessly kept on fleeing until it was literally swallowed up by the Mediterranean. Two wisely landed and surrendered. One of them was the L-49 which was so oddly prevented from hiding its secret by self destruction; the other was reduced to a mere mass of wreckage by its commander. A fifth of uncertain identity, is supposed to have gained Switzerland (possibly Friedrichshafen) in a damaged condition…"

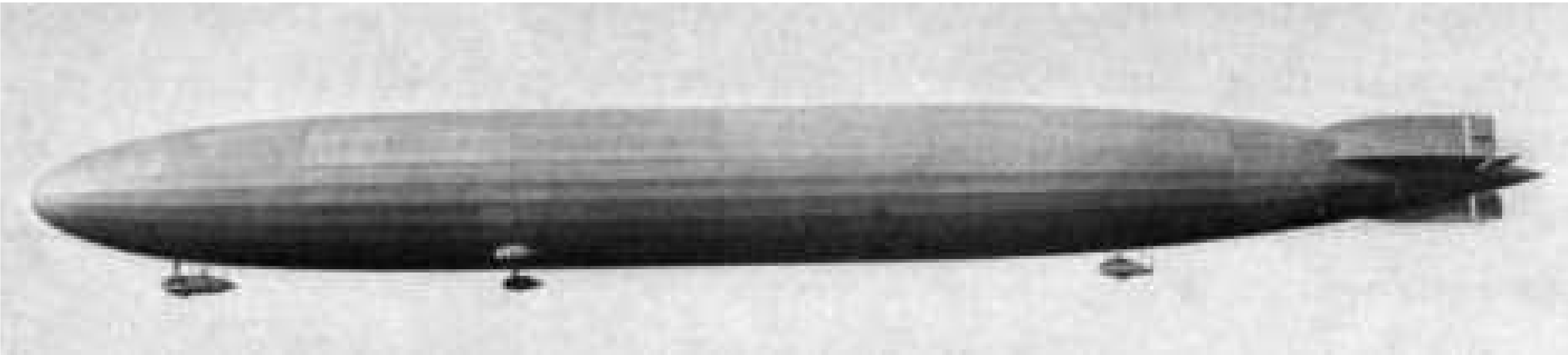
Popular Science Monthly, **March 1918**

RE: L-49 was captured completely intact on French territory. The commander was about to set it afire with a flare pistol when a French farmer wielding a shotgun stopped him. It had run of fuel and made a forced landing.


The Zeppelin « L.-49 » captured by the French.
Le Zeppelin « L.-4 par les Français.

"…Her gasoline supply exhausted, she was compelled to descend in the heart of France…A super-Zeppelin has a radius of action and a bomb carrying capacity far exceeding that of any other kind of aircraft…Because of its enormous carrying capacity, a super-Zeppelin is in many respects a better bombing apparatus than a flock of airplanes. But the L-49 could not carry tons of explosives from Oldenburg to London without sacrificing some of her fuel-carrying capacity. Her fuel load had to be reduced to an unsafe minimum. This juggling of loads also has its effect on the maneuvering power of a Zeppelin…a huge dirigible flies not only as an airship but also as an airplane. In other words, it is buoyed up not only by its gas but also by the upward pressure of the air against its enormous surface. Indeed, were it not for the pressure of the air against its thousands of square feet of exposed area – a pressure comparable in every respect with that which keeps an airplane aloft – the giant rigid dirigible would be an impossibility. It is the air pressure which is relied upon to control the craft when the gas expands at great height and is dissipated, or when it shrinks in volume in a cold layer of the atmosphere, or when tons of weight are added by dew, rain, snow or sleet. Moreover, descending or ascending currents of air force the ship up or down, and these currents must be counteracted by flying the ship airplane-style. All this means that much is expected of the engines. The ship must be driven through the air at high speed if the most is to be made of the airplane effect. Since so much depends on mere motive power, the L-49 had been reduced to a huge cylinder of gas, a few cars for the crew, an enormous load of bombs, and the most powerful engines that air can support…"

Popular Science Monthly, **March 1918**



"…All the lessons that the war has taught the airplane designer have borne fruit in the L-49. There is the same enclosing of structural and mechanical parts, the same streamlining everywhere, the same simplification of rudders, the same reduction of surface friction, the same disregard of mere bulk, provided it is correctly designed…the L-49 is but a naked, immense fish-shaped envelope of perfect stream-line form, with single monoplane fins and rudders, and with absolutely no appendages save four cars, each entirely enclosed and each torpedo-shaped. Only a rigid hull permits such ultra-refinement of form…"

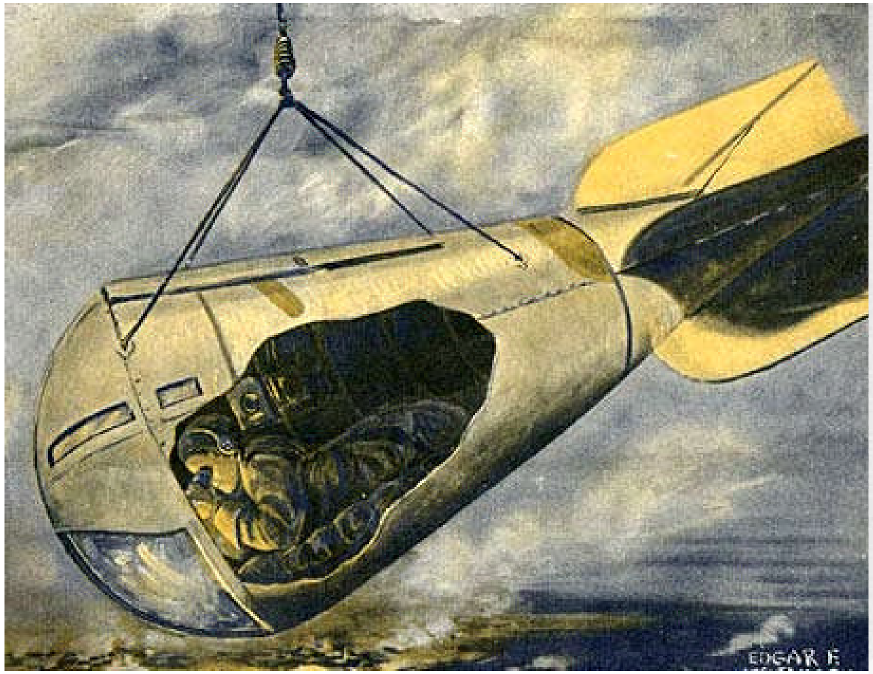
Popular Science Monthly, **March 1918**

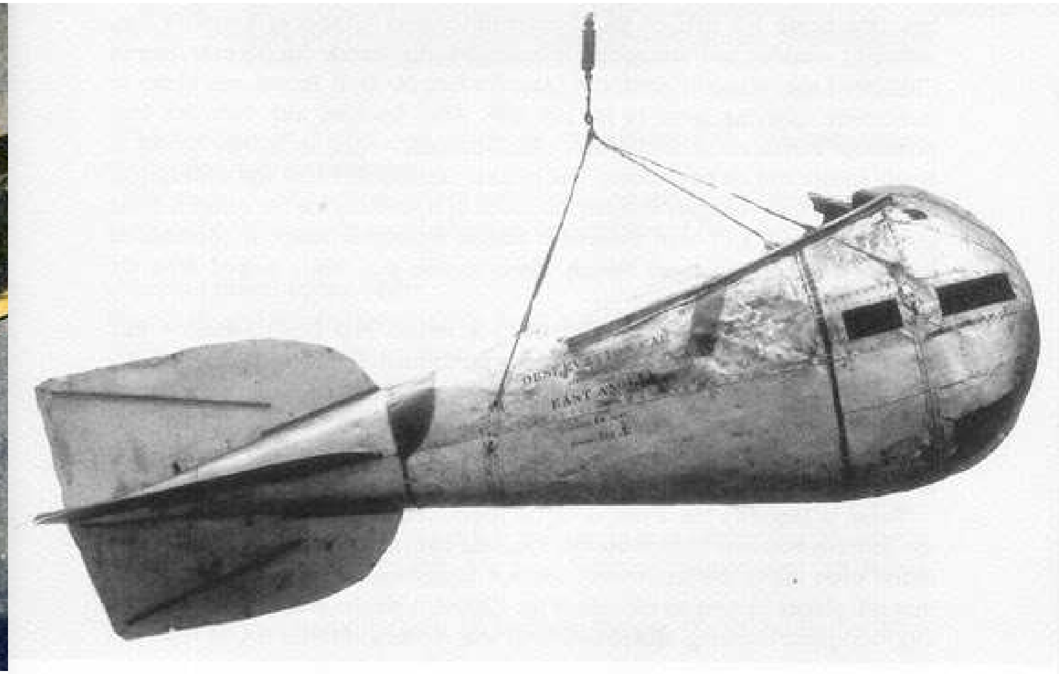
<u>Above</u>: Zeppelin L-59 Naval Airship. Similar in design, L-49 was 650-feet long by 78-feet wide (beam) displacing 58-tons. Her eighteen gas bags held up to 157K cubic-feet of hydrogen each and her five motors were 240 HP each, making her capable of achieving a speed of fifty-seven knots. She carried eighteen 120-pound bombs and two machine guns.

"…Why were not the cars and engines moved into the envelope as well? There was no necessity for that. Modern science teaches that a stream-lined bulk affords no more wind resistance than slender irregular appendages. The cars were given the shapes of torpedoes. Hence they offered no serious impediment to speed and dispensed with the weight of special apparatus for insulation and ventilation that would be needed for engine rooms inside the gas-inflated hull…"

Popular Science Monthly, **March 1918**

<u>Above</u>: torpedo-shaped engine gondola of the captured L-49 on display in *Paris*





"…One of Count Zeppelin's inventions during the war was the Zeppelin observation car – a sort of upside-down periscope. While the airship lay hidden from the enemy above a bank of clouds, an observer in a tiny enclosed car would be lowered to the end of a cable five-eighths of a mile long. Just below the clouds, he could direct the operation of the ship and even signal for bomb releases by telephone – praying meanwhile, no doubt, that the bomb would not hit him…"

***Popular Science Monthly*, October 1929**

<u>Above</u>: the Zeppelin observation car (a.k.a. "spy basket")

"…the ship's whole belly is painted coal black to make it invisible at night. The upper surface of the hull is painted white and gray to blend with the clouds as seen from an airplane…"

***Popular Science Monthly,* March 1918**

Above: bomb crater in a *Paris* street after a Zeppelin raid

Left: British WWI poster

CONSTITUTION

ASSOCIATED PRESS SERVICE

JANUARY 31, 1918.—TEN PAGES.

Second Raid Made on Paris By Death-Dealing Zeppelin; Crowds Watch for Raider

TURK STRONGHOLD BEING SURROUNDED BY RUSSIAN FORCES

Erzerum Reported in Danger of Capture—The Turkish Authorities Have Fled From the City.

TWO GERMAN ATTACKS REPULSED BY FRENCH

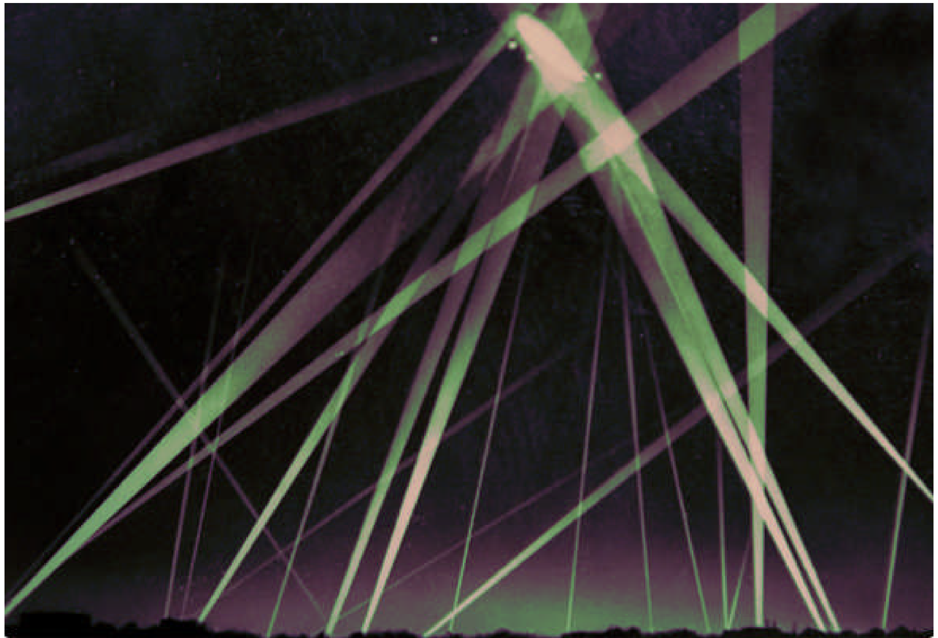
PUT AMERICA FIRST, WILSON WILL URGE

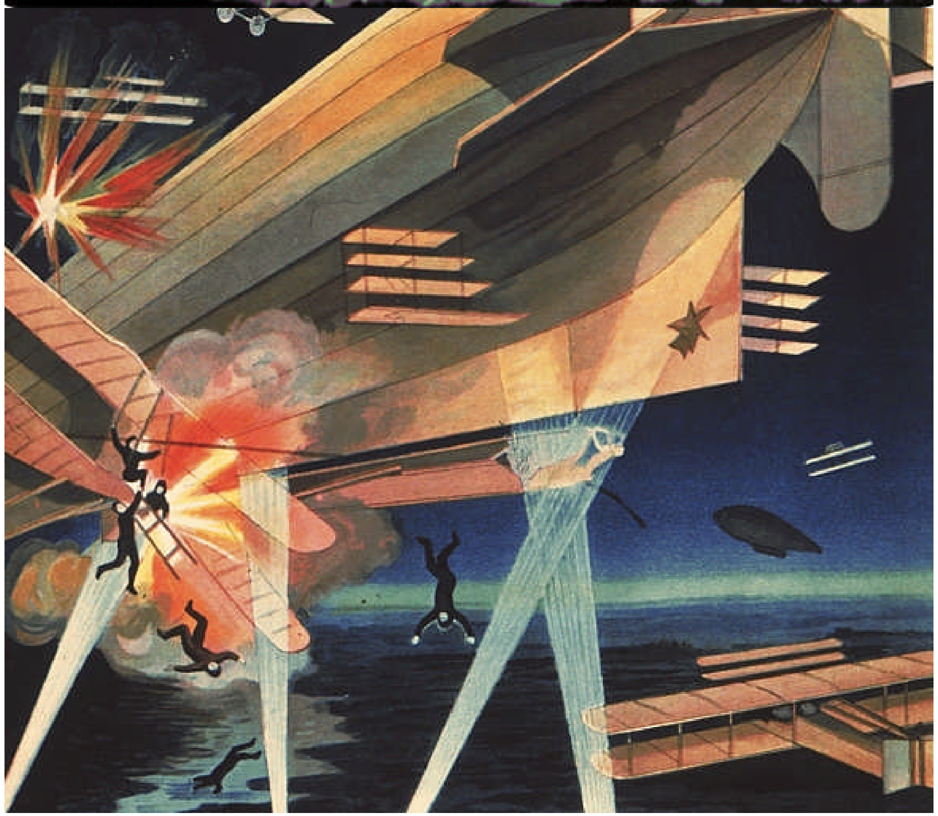
That Will Be Keynote of Address at Milwaukee Today Because of the City's Large Foreign-Born Population.

24 PERSONS KILLED AND 25 OTHERS HURT BY FIRST ZEPPELIN

The Airship That Attacked the French Capital Saturday Night Dropped More Than Three Tons of Bombs at Random.

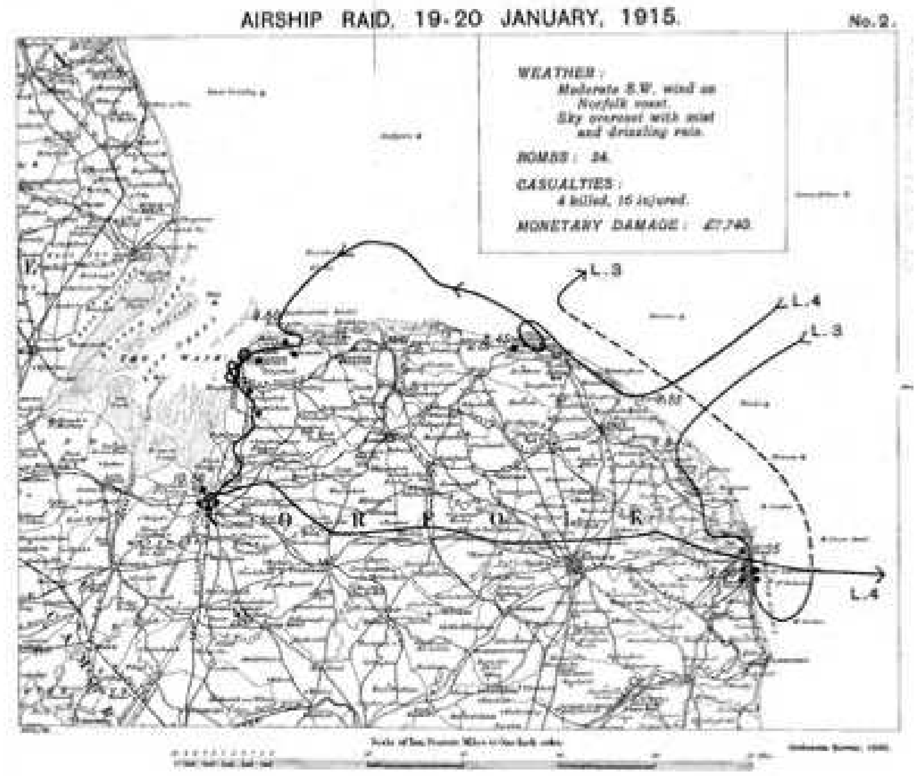
MAJORITY OF VICTIMS





"…Then we saw the Zeppelin above us, just ahead, amid a gleaming of clouds: high up, like a bright golden finger, quite small…Then there was flashes near the ground — and the shaking noise. It was like Milton — then there was war in heaven…I cannot get over it, that the moon is not Queen of the sky by night, and the stars the lesser lights. It seems the Zeppelin is in the zenith of the night, golden like a moon, having taken control of the sky; and the bursting shells are the lesser lights."

***D.H. Lawrence,* Poet**



Zeppelins L-3 and L-4 (the "L" designation stood for "Luftschiff") conducted the first dirigible raid on *England* (*Yarmouth* and *King's Lynn* on England's southeast coast were their targets) on January 19-20th 1915. Their flight paths over the countryside (above) covered over 130 miles for L-3 and somewhat less for L-4 before returning to *Germany*. Both L-3 and L-4 had a ceiling of 9,300-feet and a speed of 53 mph. Twenty-four bombs were dropped, killing four people and injuring sixteen. Over the course of the war there would be fifty-one raids on England, either by a single Zeppelin or a fleet of up to fourteen Zeppelins. A total of 5,751 bombs were dropped, killing 556 and injuring 1,357. Most raids by dirigibles took place at night while airplane raids, fewer in number, took place by day. Described later as the first "Blitz," *London* was targeted. Towards the end of the war, newer Zeppelins, described as the "high-climbing class," could soar beyond 24K-feet, but by that time British airplanes were able to fly up to 19,500-feet.

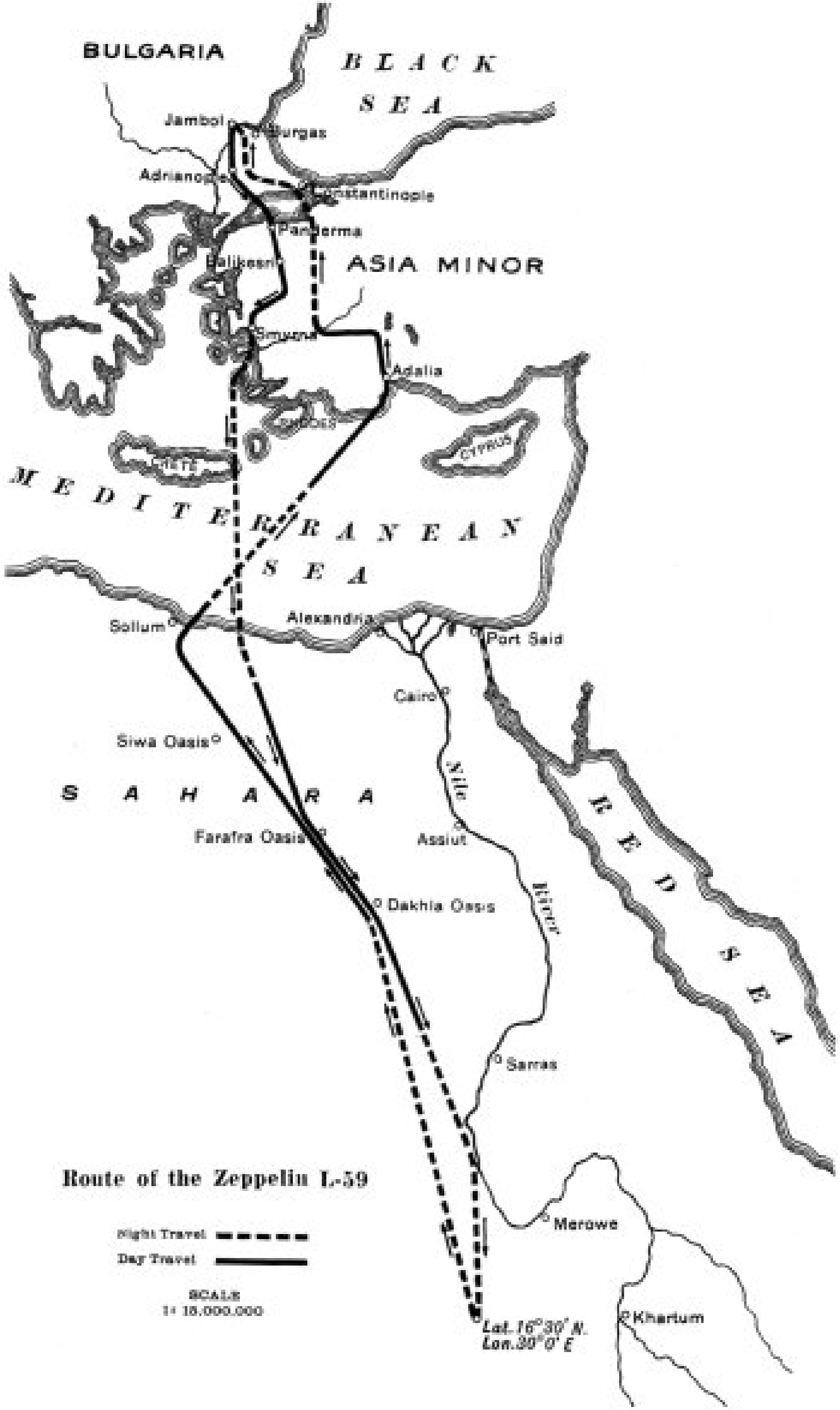
"I looked back in the direction from which we had come and I saw, far behind us, a bright ball of fire. Despite the distance, which I estimated at thirty-eight miles, we knew that the blazing meteor on the further rim of the city could only be one of our airships. As we later learned, fate had overtaken Commander Schramm's L-11, a rigid ship of the Schutte-Lanz type. The flaming mass hung in the sky for more than a minute; then single parts detached themselves from it and preceded it to the earth. Poor fellows, they were lost the moment the ship took fire."

Captain Ernst Lehmann, **L-98**

Left: photo of the L-11 as it fell in flames near *London* during a raid (accompanied by L-98) early on the morning of September 3rd 1916. She was shot down by a British biplane using incendiary bullets

"…it is no wonder that, when Germany determined to intimidate England by bombing London and other British towns from the air, she rejoiced in her Zeppelins. Their radius of action was well-nigh boundless; they could elude early air defense artillery with ease. There was a rude awakening when, later in the war, one great dirigible after another became literally a flaming altar on which a score of lives were sacrificed. German officers at last saw the truth. The Zeppelin was a good naval scout, but a vulnerable bomber…"

***Popular Science Monthly*, January 1919**

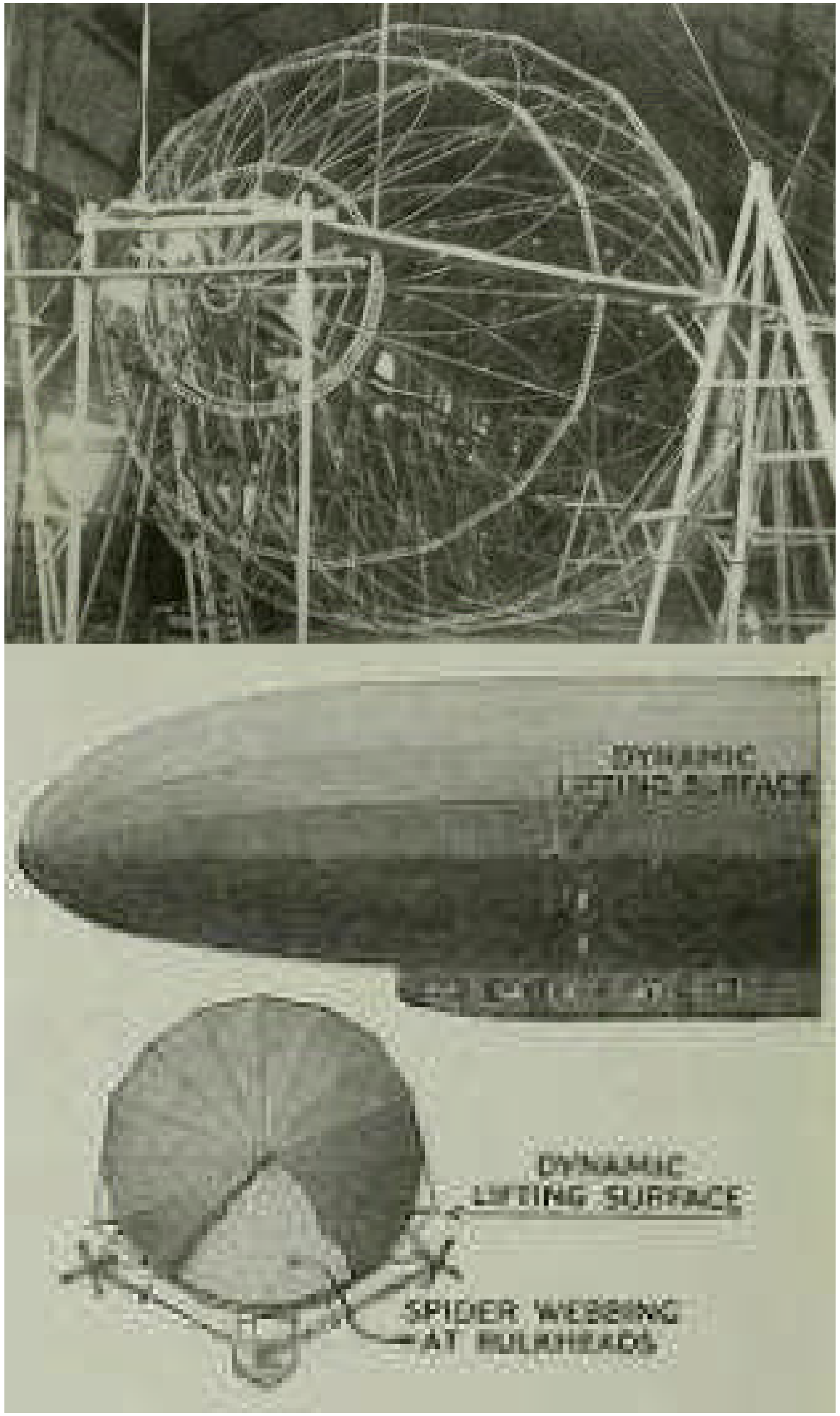


"…Count Zeppelin died in May, 1917, at seventy-eight, still dreaming of peace-time Zeppelins for world-wide transportation. Had he lived a little longer he would have seen a definite sign of the airship's future role in long-distance travel. British troops were besieging German colonials in German East Africa. The Zeppelin 'L-59' was sent to carry ammunition and medicine to the beleaguered defenders. Picking up nine tons of machine gun ammunition at Jambol, in southern Bulgaria, it set sail for Africa. Just as the ship was crossing the Sahara desert, the German intelligence officer intercepted a British radiogram that the Germans had surrendered. The 'L-59' had just passed through a storm and had taken in her wireless antenna. It was not until she was west of Khartum that she listened in and picked up Headquarter's frantic message not to land. The 'L-59' turned without stopping and, flying high over Asia Minor and the Black Sea, reached Jambol after having traveled, in four days, 4,225 miles non-stop. It was a world's record for any kind of aircraft, and at that the 'L-59' had enough fuel left in her tanks for two or three days more in the air…"

***Popular Science Monthly*, October 1929**

<u>Left</u>: caption: "Route of the Zeppelin L-59"

British Ingenuity



"…A pigmy Zeppelin which is being built for the British Government by a company of American constructors. The framework of this novel airship is made of ropes and laminated wood, so closely woven together as to resemble a huge mesh of wood and wire…"

***Popular Science Monthly,* April 1916**

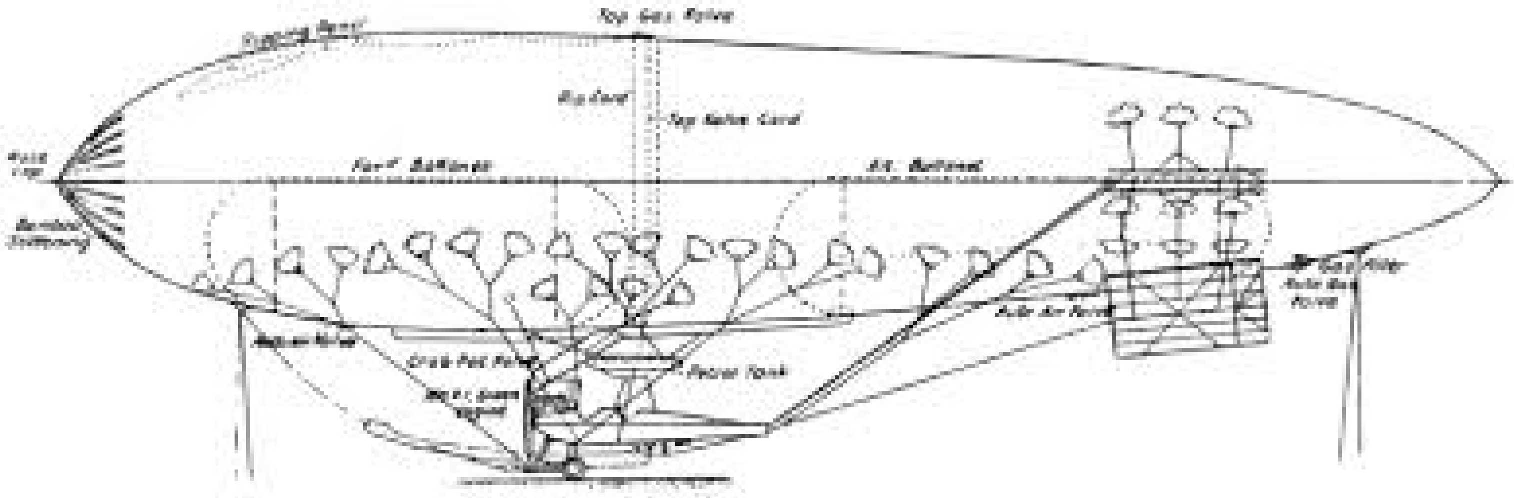
"…There are, in reality, two hulls, the inner enclosing thirteen ballonets or gas bags and the outer supporting a waterproof and airtight envelope or skin...In hot weather, or when the airship passes through a heated stratum of air, the gas expands, exerting more lifting power, and causing the airship to rise. To control this tendency, the gas has to be artificially cooled, or it will be necessary to release some of the valuable hydrogen to allow the ship to retake its proper altitude. On the contrary, if a sudden wave of cold air strikes the gas bag, the gas immediately contracts, and part of its lifting power is lost. If there is no means for heating the gas and expanding it, ballast will have to be dropped from the car, thus compensating the decreased lifting power of the gas by a lighter weight which it has to carry. The control of the lifting power of the gas in the MacMechen dirigible is in the heating and cooling process. To keep the hydrogen from cooling and losing its lifting power, hot vapor from the engine is blown into the foot-wide space between the ballonets and the outer skin of airtight cloth. To cool and condense the gas for descent, or to prevent its expansion to an extent that causes an undue inflation of the gas bags, cold air is introduced into the same space by means of aluminum disks with revolving shutters at the bow and stern. It is claimed that by this method of construction a rigid airship has been built which is one-third lighter than it is possible to build a Zeppelin of the same relative size. The hull and car weigh 2,190 pounds, and the gas capacity is 108,000 cubic feet, or about one-tenth that of the latest Zeppelin monster. As hydrogen is usually rated by aeronauts, this quantity will lift about three and one-half tons, or seven thousand pounds. With engine equipment and crew, the airship weighs about 5,300 pounds, leaving a margin of 1,800 pounds for ballast, explosives and additional fuel. The length of the hull is 236 feet over all. The designers claim that their airship will make about seventy miles an hour, or about ten miles an hour faster than the speed of a Zeppelin…"

***Popular Science Monthly,* April 1916**
RE: the *MacMechen* (a.k.a. "Pigmy") dirigible

"…When German submarines began to render even the high seas dangerous to shipping, England found herself in a very perilous position. To patrol the waters around England by small craft was the immediate remedy adopted. But the area to be covered was so vast that literally thousands of vessels would have been required. Airplanes were out of the question because they lacked the necessary endurance and because of the demands made on the pilot. It was clear that airships might answer, but England had only very small ones, so flying was very unhandy for the purpose. Some unknown genius hit upon the 'Blimp' as a solution of the problem. England was building airplane bodies, or fuselages, as they are called, by the thousands – building them as we build automobiles in this country. She was also producing hundreds of gas envelopes. Why not suspend an airplane fuselage from a gasbag? The question was brilliantly answered by the 'Blimp'…"

***Popular Science Monthly,* October 1917**

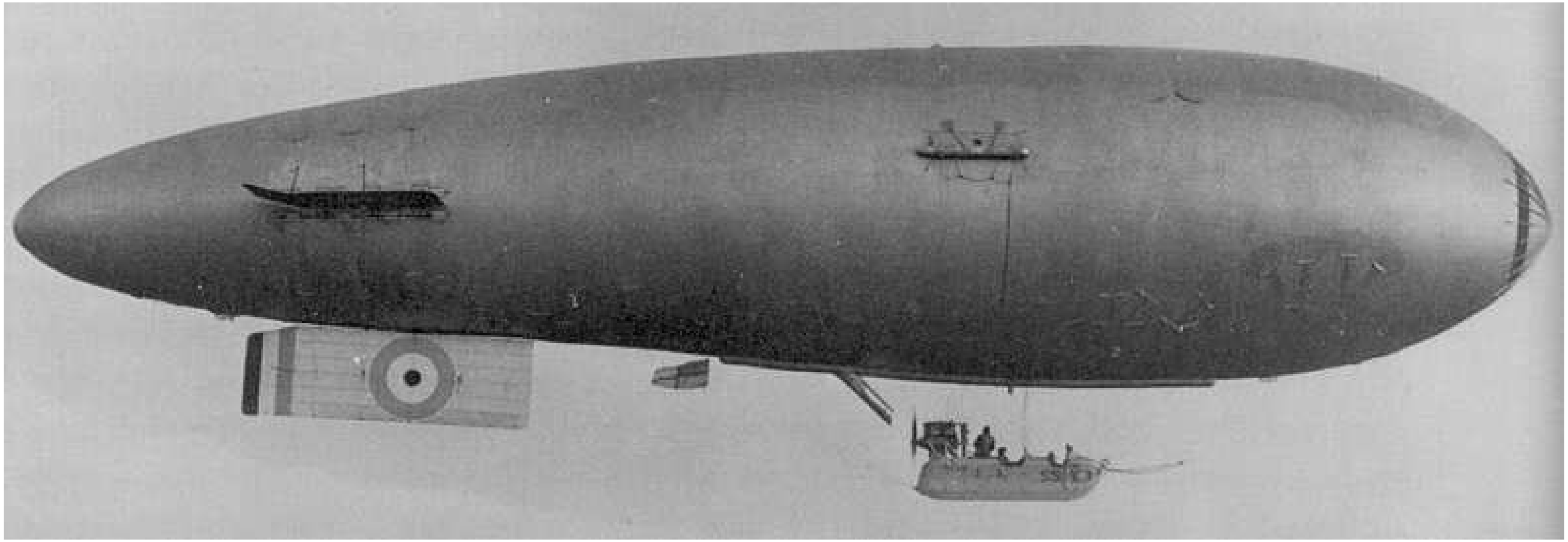
RE: as hostilities grew worse in the latter part of 1914, it was decided that airships would be useful for fleet observations following the loss of many ships to submarines in October and November 1914. By early 1915, First Sea Lord Fisher realized that the situation had become critical and rapid short term measures were required. A new smaller ship was required with the basic requirements that it should have a speed of between 40-50 mph, carry a crew of two, 160-pounds of bombs, wireless equipment, fuel for eight hours flying, be able to reach an altitude of 5K-feet and their design be simple in order to both ease production and facilitate training of the crews. The main requirement was that the new airship, designated the "Submarine Scout" class be in the air within weeks rather than months.



"…So little trouble was taken to adapt the airplane fuselage to the gas envelope that not even a motor-driven blower was provided for the airbag in the first Blimps. Part of the airplane propeller's slipstream, caught in a hose, sufficed…"

***Popular Science Monthly*, October 1917**

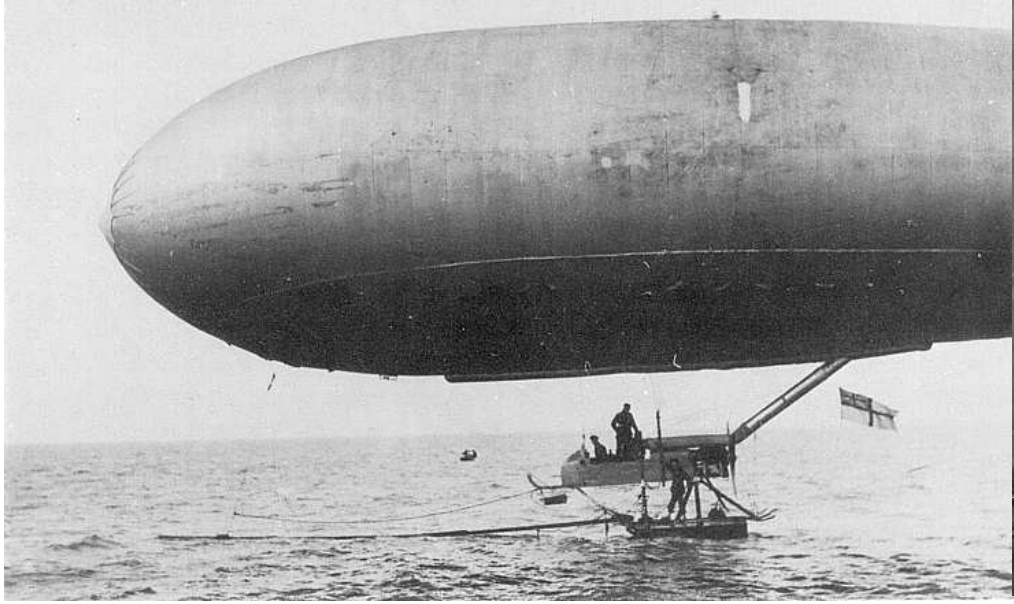
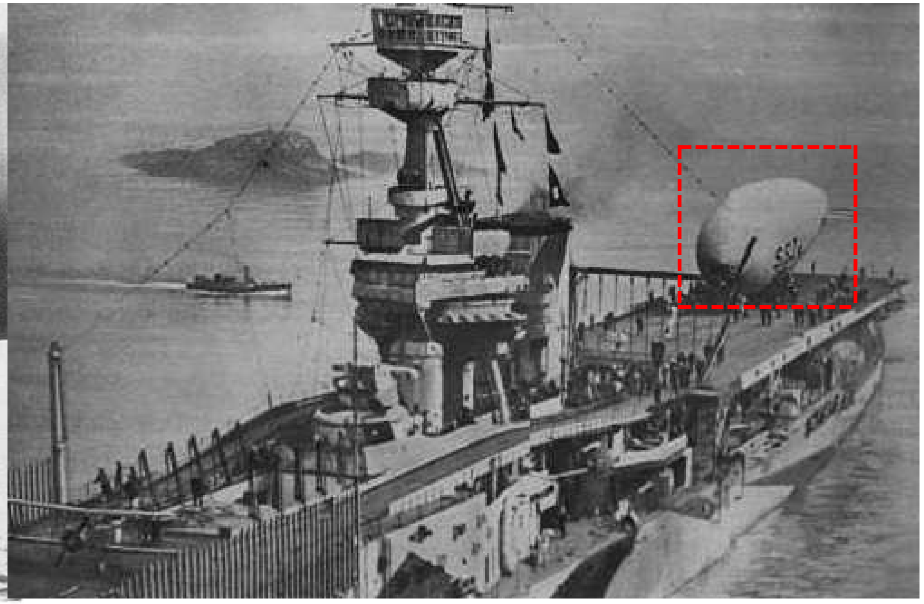
<u>Above</u>: caption: "The gas envelope is much like that of other non-rigid dirigibles. As the vessel rises the gas expands and some of it escapes through a safety valve to prevent bursting. To preserve the shape when the gas contracts, ballonets are used, one in front and one in the rear. A ballonet is simply an air bag within the main balloon. When the dirigible descends and the gas contracts the airbag is blown up with air by a little motor in the car below. Thus what buoyant gas remains is compressed and made to restore the envelope to its normal shape."



"…The hybrid 'Blimp' has shown itself incredibly superior to anything in its own class. It has a speed of forty-five miles an hour and a radius of action of several hundred miles. Its lift control approaches the seventy mile-an-hour Zeppelin's, because the 'Blimp's' surface is relatively greater, compared with its weight, than a Zeppelin's. Moreover, for the same speed the dirigible with a greater relative surface has more grip on the air in rising or descending by reason of the airplane effect of its gasbag than if it had a surface smaller in proportion to its weight. The United States has also built 'Blimps.' The main original features of the American 'Blimps' is the addition of a blower driven by a cycle motor and of a second airbag or ballonet with valves to shift the air at will from bag to bag. As a result, the ship can be 'trimmed' (that is, its flotation forward and aft can be varied at will by driving the gas where there is less air) even while it is at rest and the elevator or vertical rudder is powerless. The blast of the propeller will probably be used to inflate the ballonets, that being safer than a separate motor…"

***Popular Science Monthly*, October 1917**

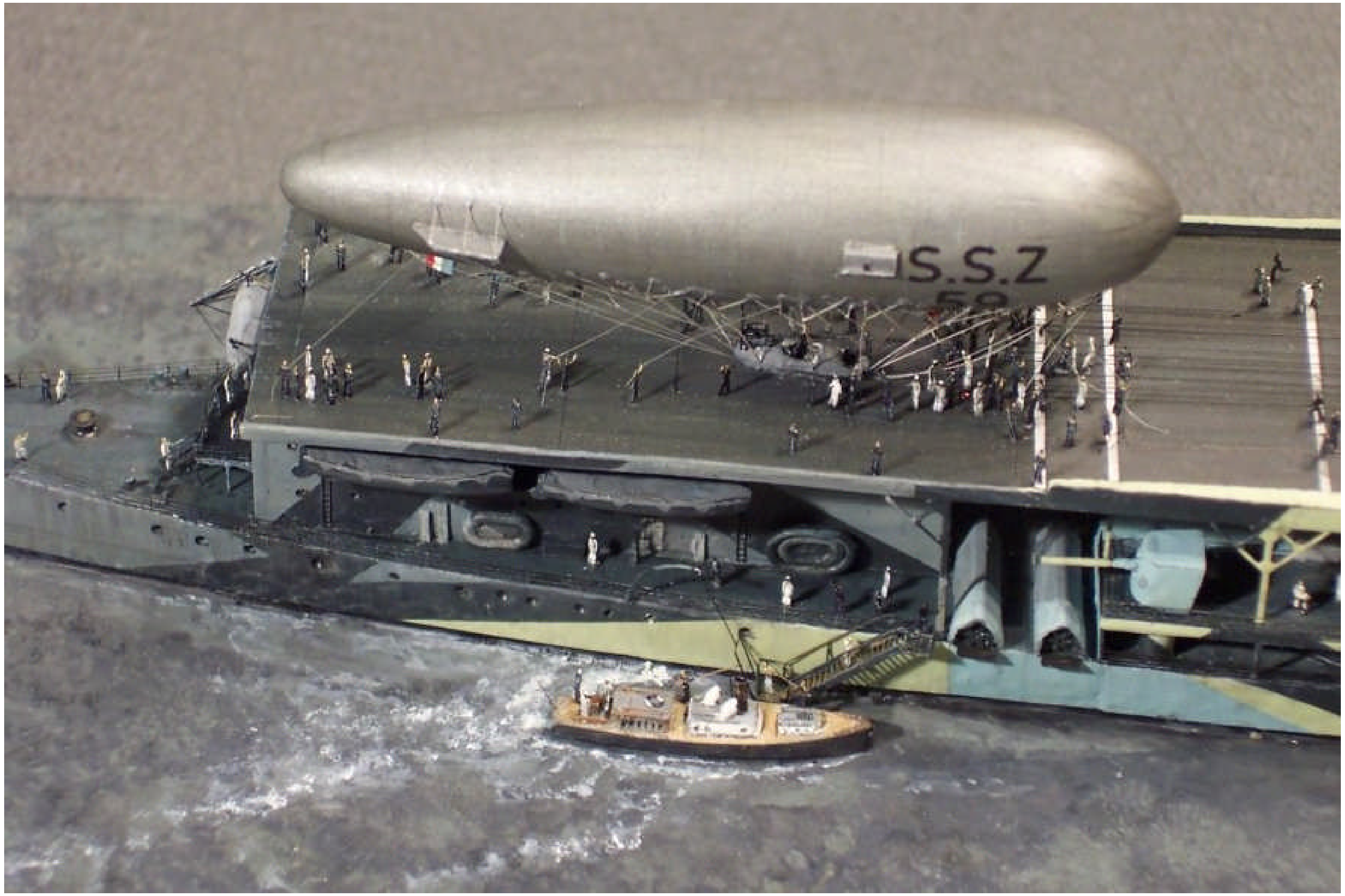
<u>Above</u>: British *Submarine Scout* (SS) class hybrid airship

"…There has been added an efficient device for anchoring the vessel safely in a storm. The equivalent of life belts, in the form of kapok buoys are fastened above the airplane's floats. Hence the entire aircraft can rest lightly on the water, supported by its gas. Enough water and sand ballast are carried to permit the craft to rise the better part of a mile; the safe altitude is given as 1&1/4 miles, but with the help of the powerful airplane action of the craft itself this may be doubled."

***Popular Science Monthly,* October 1917**

<u>Above</u>: SS class airship afloat (left) and landing on the stern section of *HMS Furious* – the world's first aircraft carrier (right). The *Submarine Scout* class were so successful on coastal patrols that the Admiralty wanted bigger and better ships fast. Thus, the "Coastal" (C) and "North Sea" (NS) class airships were developed, each having larger engines, envelopes and crews and the patrol duration increased. Costing only £2,500 each, a total of 158 SS class airships were produced.


S.S.Z

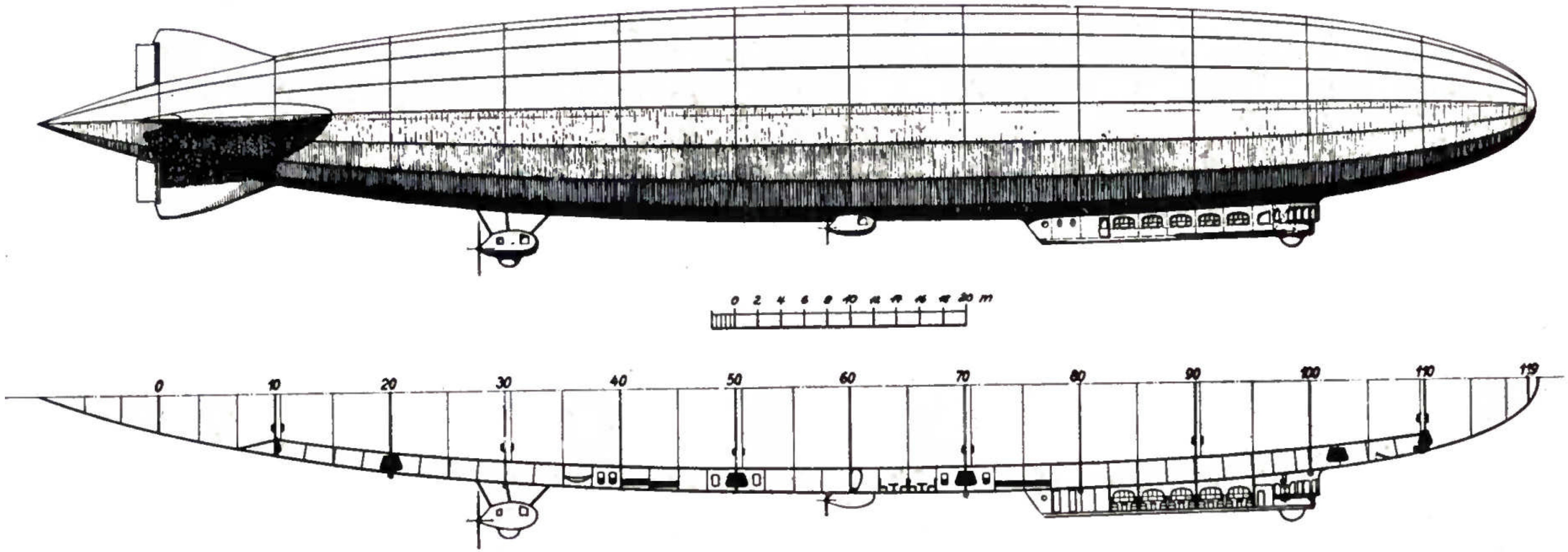
The Lessons of War

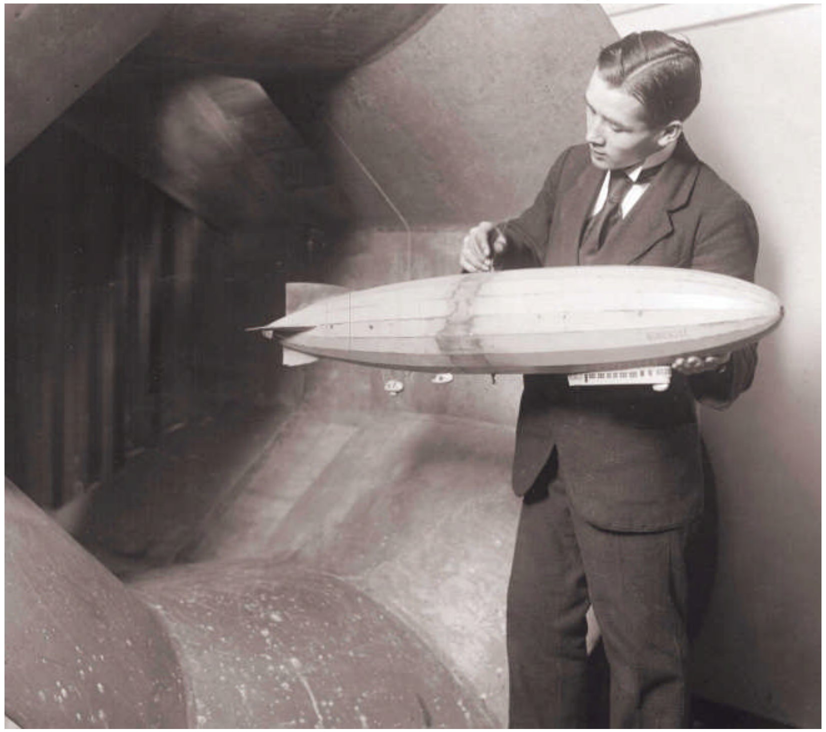
"…In the four years of the war the speed of Zeppelins had increased from forty-seven to eighty-eight miles an hour. To carry useful loads of forty-four tons, their hydrogen capacity had been raised from 706,000 to more than 2,000,000 cubic feet. Commercial ships were built after the war embodying these improvements. The Zeppelin was growing up…"

***Popular Science Monthly*, October 1929**

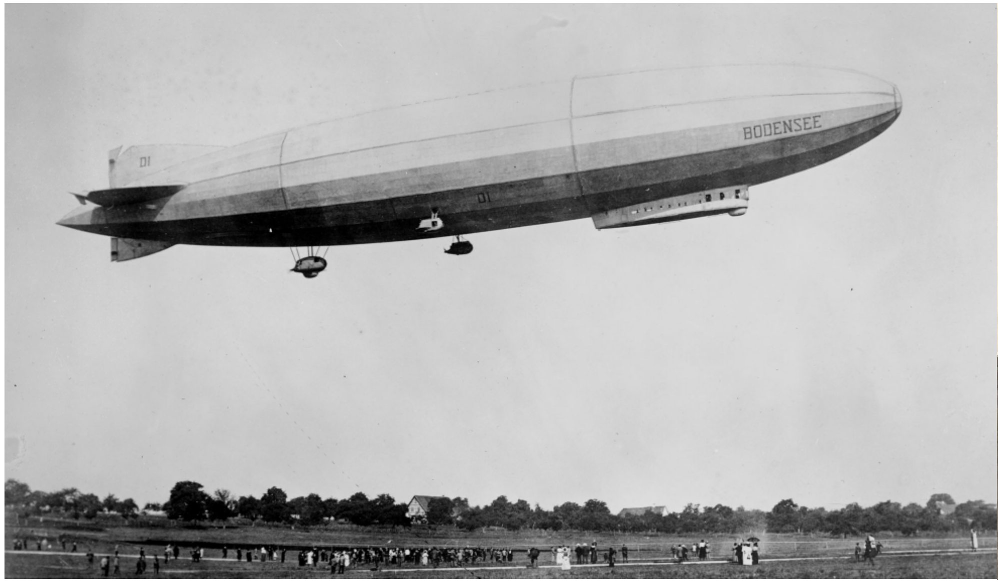
“Because the giant Zeppelin made no brilliant showing in its raids on England, the average man is apt to dismiss it with a wave of the hand, saying, ‘It’s a failure.’ When he thinks of air transportation he thinks of airplanes. It would profit him to read the report of Admiral Jellicoe on the great naval battle off Jutland, in which the Zeppelin showed how effective it can be as a naval scout, and to study the testimony recently given by Admiral Sims of our own navy before a Congressional Committee, pleading for the construction of titanic Zeppelins in this country. It would also profit that average man to ponder the fact that Great Britain now has a fleet of Zeppelins, and that one of them, in all likelihood, will be sent across the ocean to prove the practicability of transatlantic trips through the air…”

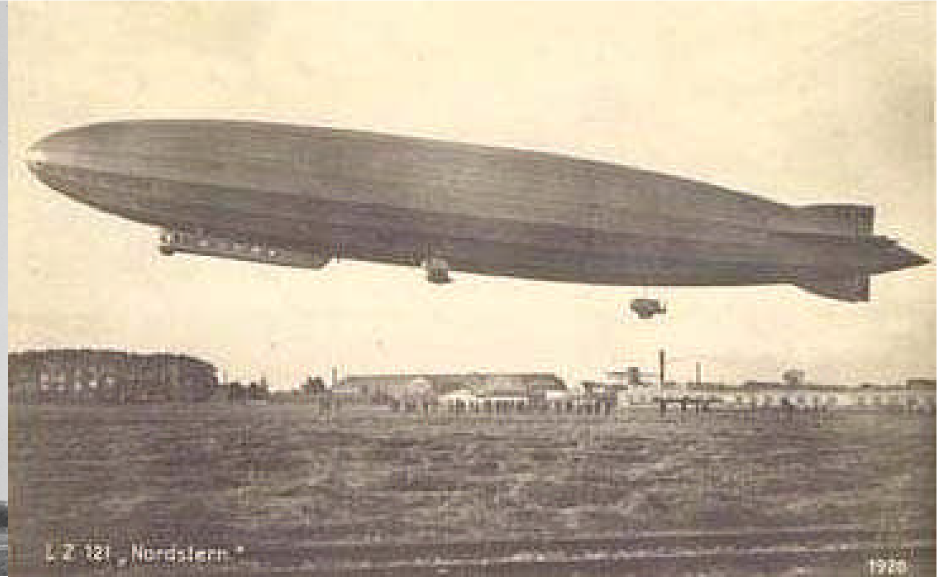
***Popular Science Monthly,* May 1919**





LZ-120 (*Bodensee*) was the first civilian airship built after WWI. She was designed to provide fast air service between *Friedrichshafen* and *Berlin*. Construction was completed within six months and she made her first flight on August 20th 1919. LZ-120's advanced aerodynamic (wind-tunnel tested, left) teardrop shape (above) which differed greatly from the thin, pencil-like shape of most previous Zeppelin airships, was a great leap forward in airship design, due primarily to the engineering theories of designer *Paul Jaray*. With its revolutionary design and four 245 HP *Maybach* MB-IVa engines, LZ-120 could reach a speed of 82 mph.





LZ-120's aerodynamically efficient tear-drop shape provided less drag, increased speed and greater lift. It became the basic model from which LZ-126 (*Los Angeles*), LZ-127 (*Graf Zeppelin*), and LZ-129 (*Hindenburg*) were designed and built. LZ-120 carried 706K cubic-feet of hydrogen (later increased to 796,300 during a refit). In the three months after her launch, LZ-120 made 103 flights and carried almost 2,500 passengers, 11K lbs of mail, and 6,600 lbs of cargo. LZ-120 (left) was taken from DELAG by the *Military Inter-Allied Commission of Control* and delivered to *Italy* on July 3rd 1921, where it was renamed *Esperia*. LZ-121 (*Nordstern*) was built to provide the first international passenger zeppelin service, with plans for scheduled flights between *Friedrichshafen, Berlin* and *Stockholm*. She was completed in 1920, but the ship was also taken from DELAG by the Military Inter-Allied Commission and delivered to *France* on June 13th 1921 and renamed *Mediterranee*.

Part 3

Triumph and Tragedy

A Decade and a Half of Disaster

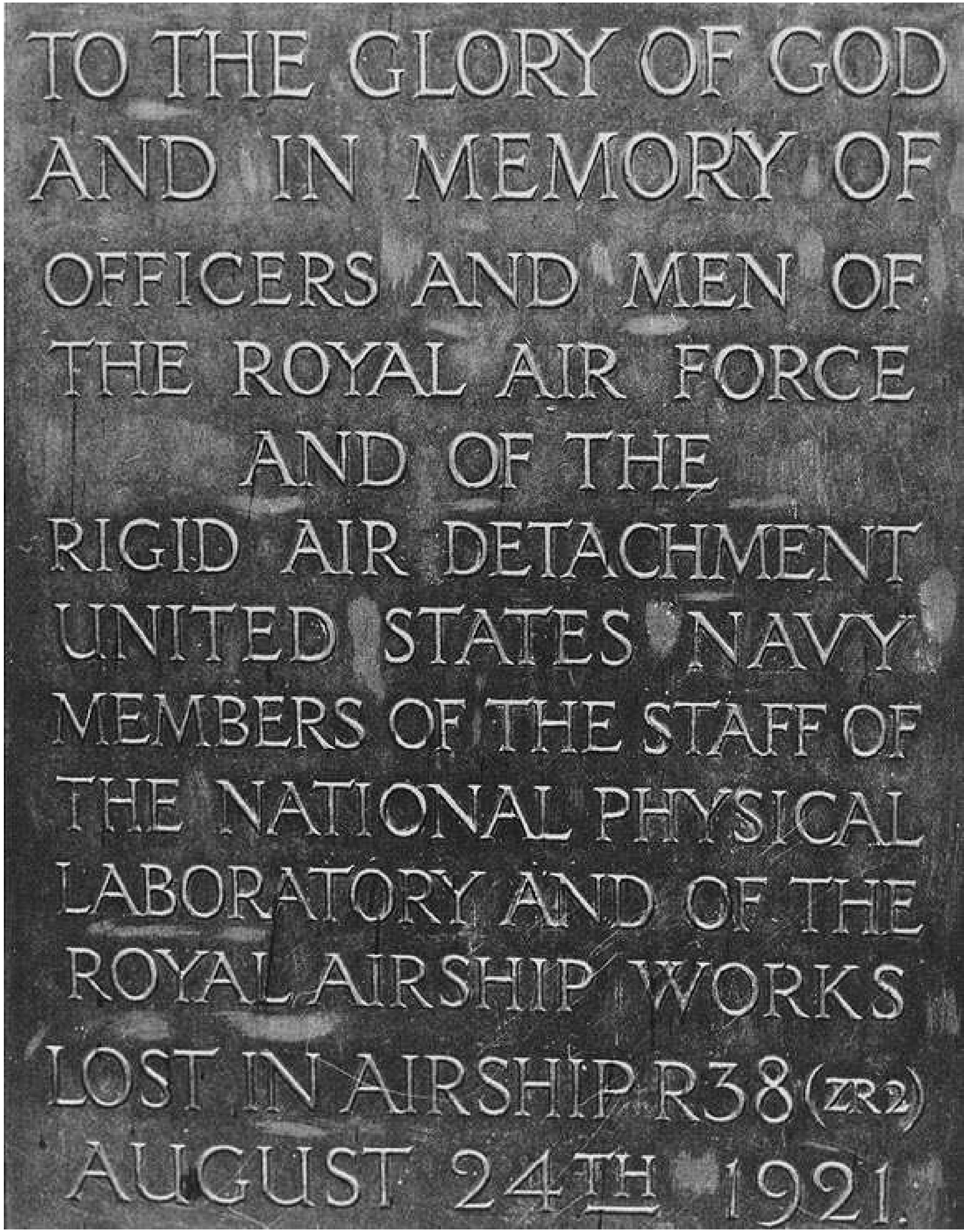
"…The victorious Allies, impressed by their record, took over the Luftschiffabteilung's Zeppelins, and rushed to build more of their own. A decade and a half of disaster followed…In 1921, the ZR-2, built for the U.S. Navy by the Royal Airship Works in England, broke its back and burned, killing 62. In 1923, the 'Dixmude' (the old L-72, seized and renamed by the French) disappeared on a flight to Africa. The only trace ever found was the body of her captain, Commander du Plessis de Grenedan, pulled out of the Mediterranean by fishermen. In 1925 the Shenandoah, an American made copy of the German L-49, broke up in a squall over Ohio, killing 14. In 1930, the R-101, pride of Britain, exploded against a hillside at Beauvais, France, killing 47 (including the Secretary of State for Air, the Director of Civil Aviation, and most of the Empire's airship experts). In 1933 the U.S. Navy's Akron, which could launch airplanes like an airborne aircraft carrier, plunged into the Atlantic off Barnegat, N.J., killing 73. In 1935 the 'Macon,' sister ship to the Akron, broke her stern and fell into the Pacific, killing two. That did it for everybody except the Germans. Back in Friedrichshafen things had gone swimmingly…"

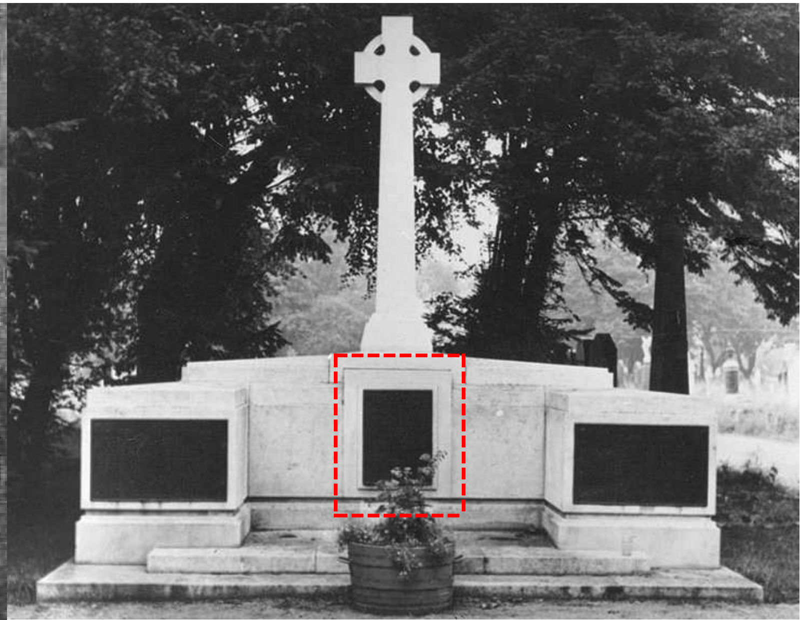
Popular Science, **May 1962**


Great Airship *ZR-2* and Its Crew Meet Disaster in Test Flight Over England

An American crew of intrepid balloonists and their British companions met death on August 24 with Commander Louis I. Maxfield, U. S. N. (at the right), and the English brigadier general, E. M. Maitland (at the left), when the *ZR-2* (above), the world's largest dirigible airship, built in England for the American Navy, exploded over Hull, England, and fell into the River Humber. Thousands of people, looking up from the streets of Hull, saw the giant balloon bend, sag at one end, and break in two; saw members of the crew leap from the gondolas, some with parachutes; saw the bow of the airship fall into the river and the stern upon a sandbar. Of the seventeen Americans on board, only one survived the catastrophe. The hangar (below) at Lakehurst, New Jersey, built especially for the *ZR-2*, has a volume seven times that of the Woolworth Building. It is nine hundred and forty-three feet long, three hundred and fifty feet wide, and two hundred feet high.

"An American crew of intrepid balloonists and their British companions met death on August 24th with commander Louis I. Maxfield, U.S.N. (at the right), and the English brigadier general, E.M. Maitland (at the left), when the ZR-2 (above), the world's largest dirigible airship, built in England for the American Navy, exploded over Hull, England, and fell into the River Humber. Thousands of people, looking up from the streets of Hull, saw the giant balloon bend, sag at one end, and break in two; saw members of the crew leap from the gondolas, some with parachutes; saw the bow of the airship fall into the river and the stern upon a sandbar. Of the seventeen Americans on board, only one survived the catastrophe. The hangar (below) at Lakehurst, N.J., built especially for the ZR-2, has a volume seven times that of the Woolworth Building. It is nine hundred and forty-three feet long, three hundred and fifty feet wide, and two hundred feet high."





R-38's fourth flight began on August 23rd 1921, amid growing questions about her performance and structural strength. After an overnight flight out to sea, the next day R-38 undertook full power and maneuvering trials. These proved too much for her and she broke up in mid-air. Some of her hydrogen lifting gas exploded and the wreckage fell into the *Humber River* near *Hull, England*. Of the forty-nine men on board, there were only five survivors, including one American. Sixteen *U.S. Navy* officers and men were killed essentially wiping out the service's small cadre of experienced rigid airship personnel.

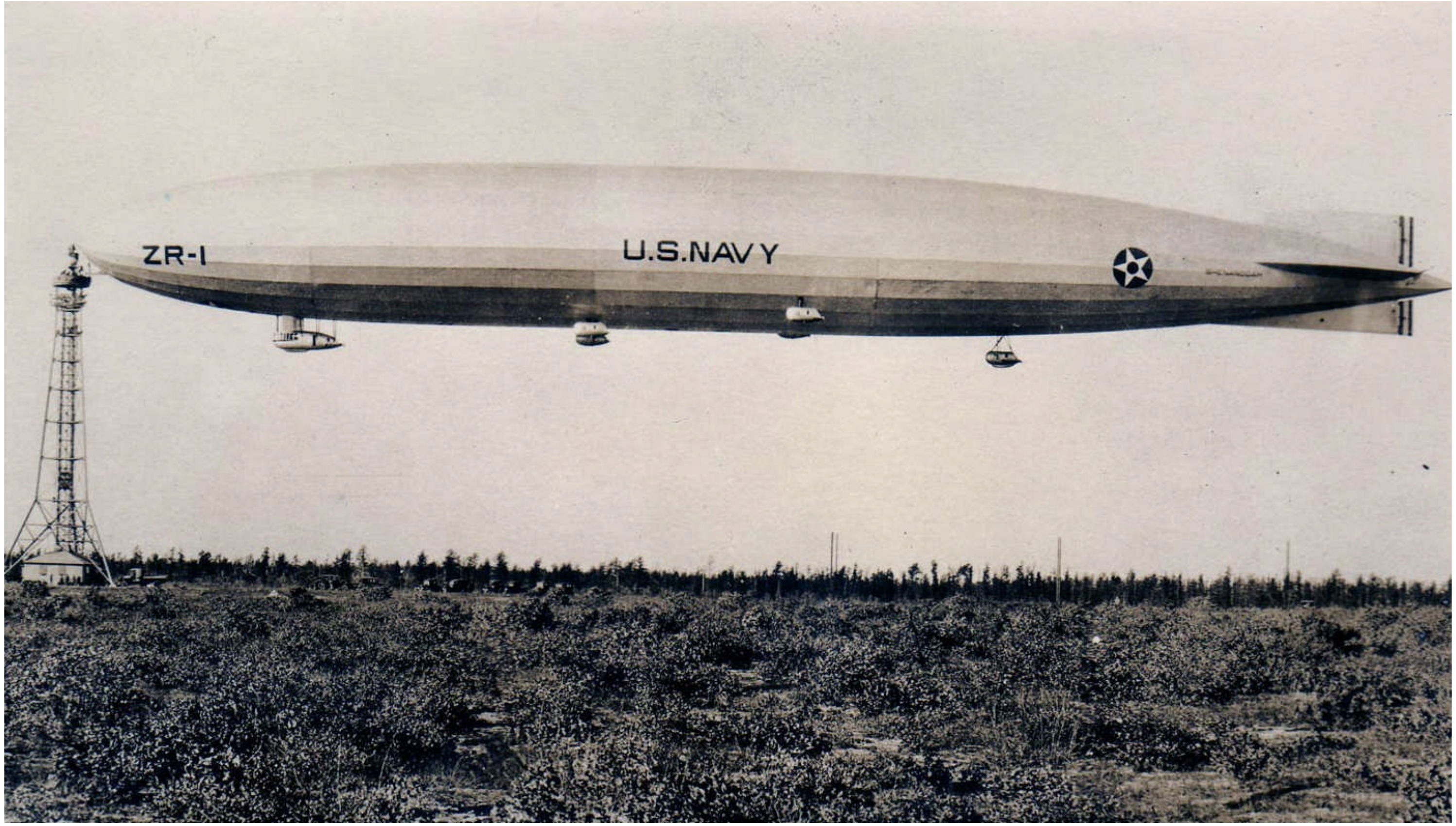
Above: R-38 (ZR-2) memorial in Hull

"…Undiscouraged by the fate of the 'ZR-2,' built for us in England, and wrecked in August 1921, on her trial trip; undeterred by the fatal smash of the semi-rigid 'Roma,' built for us in Italy and completely wrecked on what was to be a short trial trip over Langley Field, Va., the United States Navy is quietly going ahead with the building of enormous new rigid airships, capable of carrying scores of passengers on long distance flights. Why?...What can be the purpose of the government in developing these mammoth and apparently unwieldy ships after so many disasters? Why are we building colossal mooring masts and hangars for them? The answer is that authorities in Washington believe the use of helium gas will obviate accidents like those that wrecked the 'Roma' and the 'C-2,' while the use of mooring masts instead of sheds will lessen other perils. Also, back of the navy's plans is the desire to foster the development of great passenger airliners in this country in the near future, and the belief that they will prove commercially practical in transcontinental travel…"

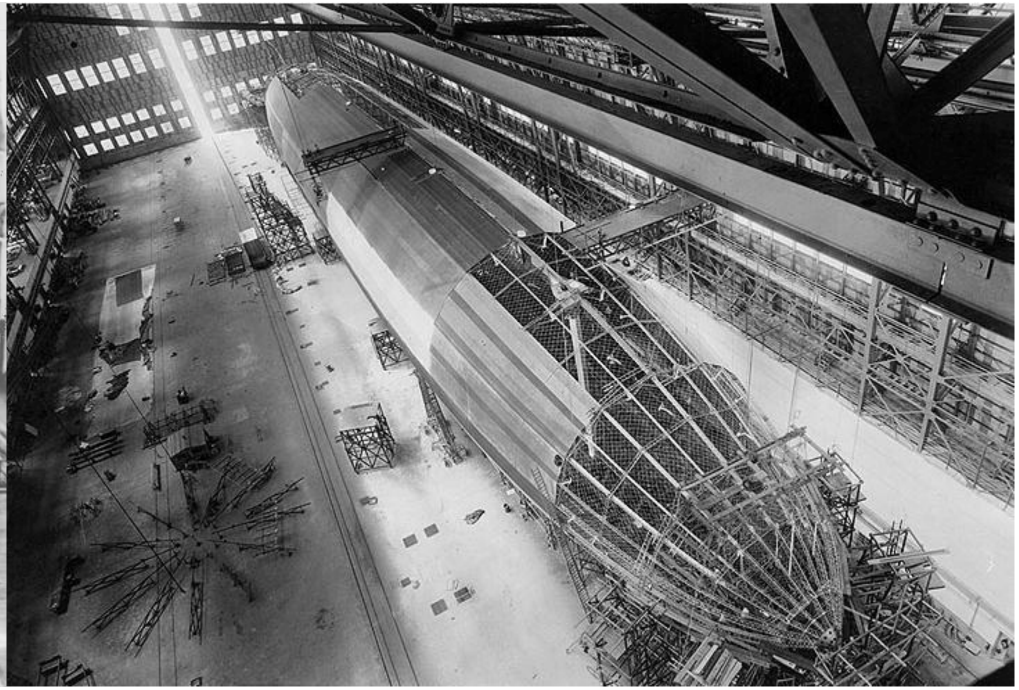
Popular Science Monthly, **January 1923**

"After the war, the General Board of the Navy recommended that we go ahead with two rigids – the 'ZR-1,' here, and the 'ZR-3,' due to us from Germany. By keeping accurate cost data, we felt that we could determine the commercial utility of great airships. The 'ZR-1,' when finished, will make trips across the continent, to show the practicability of rigids for commercial use. Development of the mooring mast, since the war, making it possible to anchor the rigid for weeks at a time without damage, and ensuring safe embarkation for passengers, adds greatly to the commercial future of these airships. The masts can be erected for $20,000 or $30,000, including passenger elevators. They can be placed in cities, or any other place where needed, and are economical substitutes for the huge sheds costing over $1,000,000. We believe strongly that rigid airships may be of great commercial value. Compare them with the railroads. They do not use tracks, roadbeds, way stations or any of the related paraphernalia, nor do they require personnel for maintenance of way. If the United States did not go ahead with the 'ZR-1' and the 'ZR-3,' world progress in aerial transportation would be set back one or two generations."

Admiral William A. Moffett - **Chief of the Bureau of Naval Aeronautics, January 1923**


ZR-1
U.S.NAVY

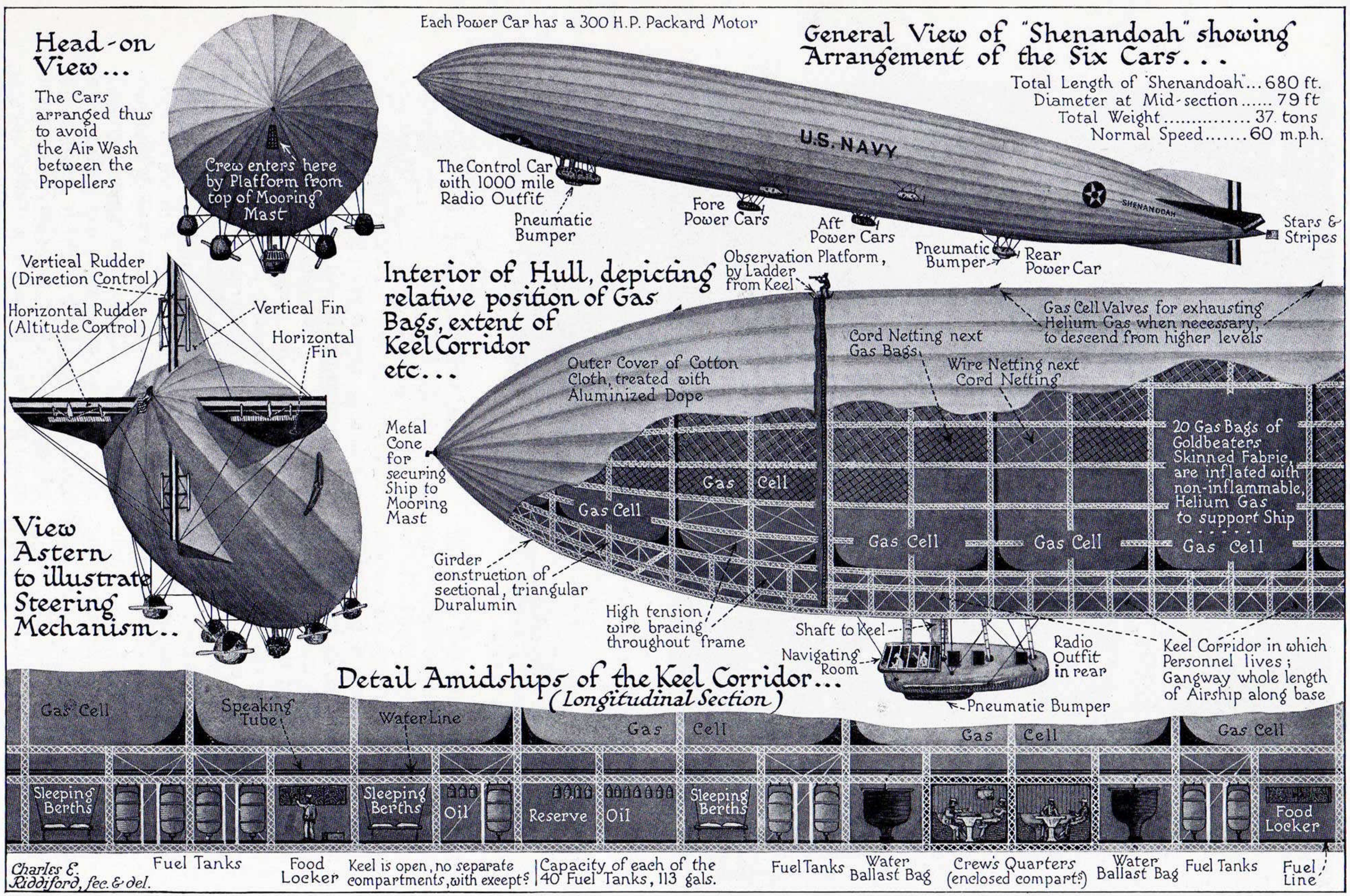
A Mighty Airship Ripped Asunder



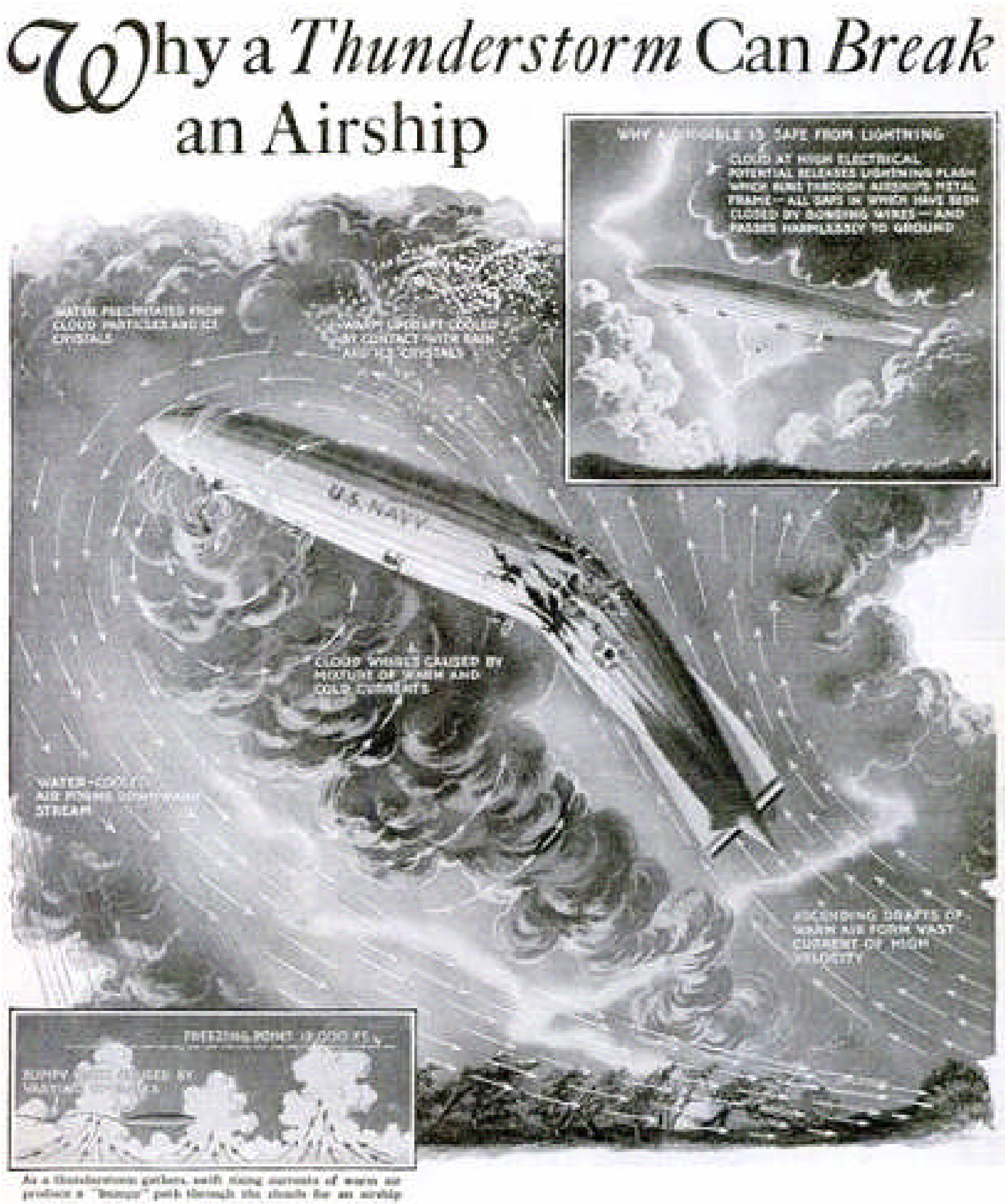
"…Moreover, the comparatively shorter and fatter type of construction, followed also in designs for future dirigibles, makes an inherently stronger ship than the 'Shenandoah,' which had a long, slim hull. The slenderness, I think, was the main reason why the 'Shenandoah,' bound for the midwest four years ago, was wrecked when it ran into a line squall near Ava, Ohio. Caught between sharp and conflicting vertical air currents – the most dangerous thing that can happen to any aircraft in the air – her structure broke from unusual aerodynamic forces too great for it…"

Lieut, Cmndr. C.E. Rosendahl, USS Los Angeles

RE: comments made in 1930. Above, the *USS Shenandoah* under construction in *Lakehurst, N.J.* (ca. 1922)

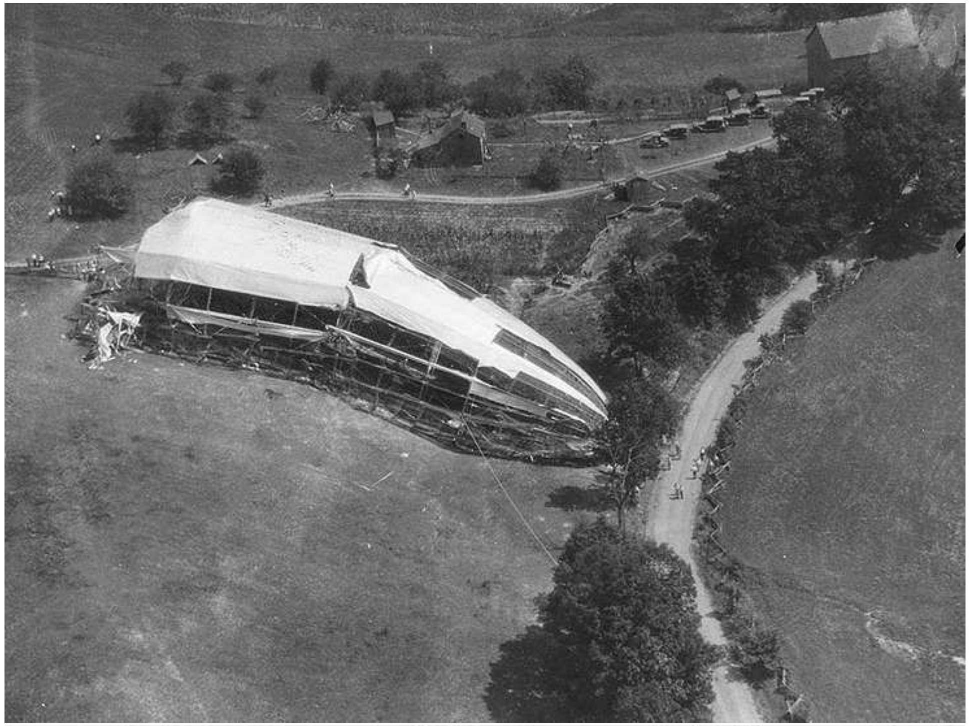


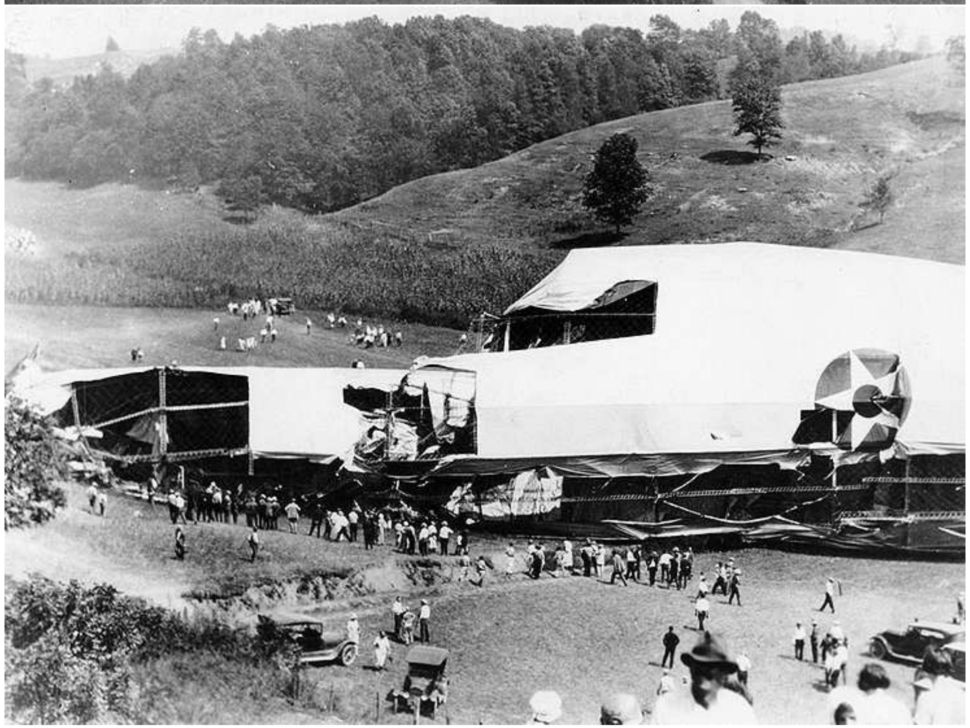
Above: caption: "General View of 'Shenandoah' showing Arrangement of the Six cars..."

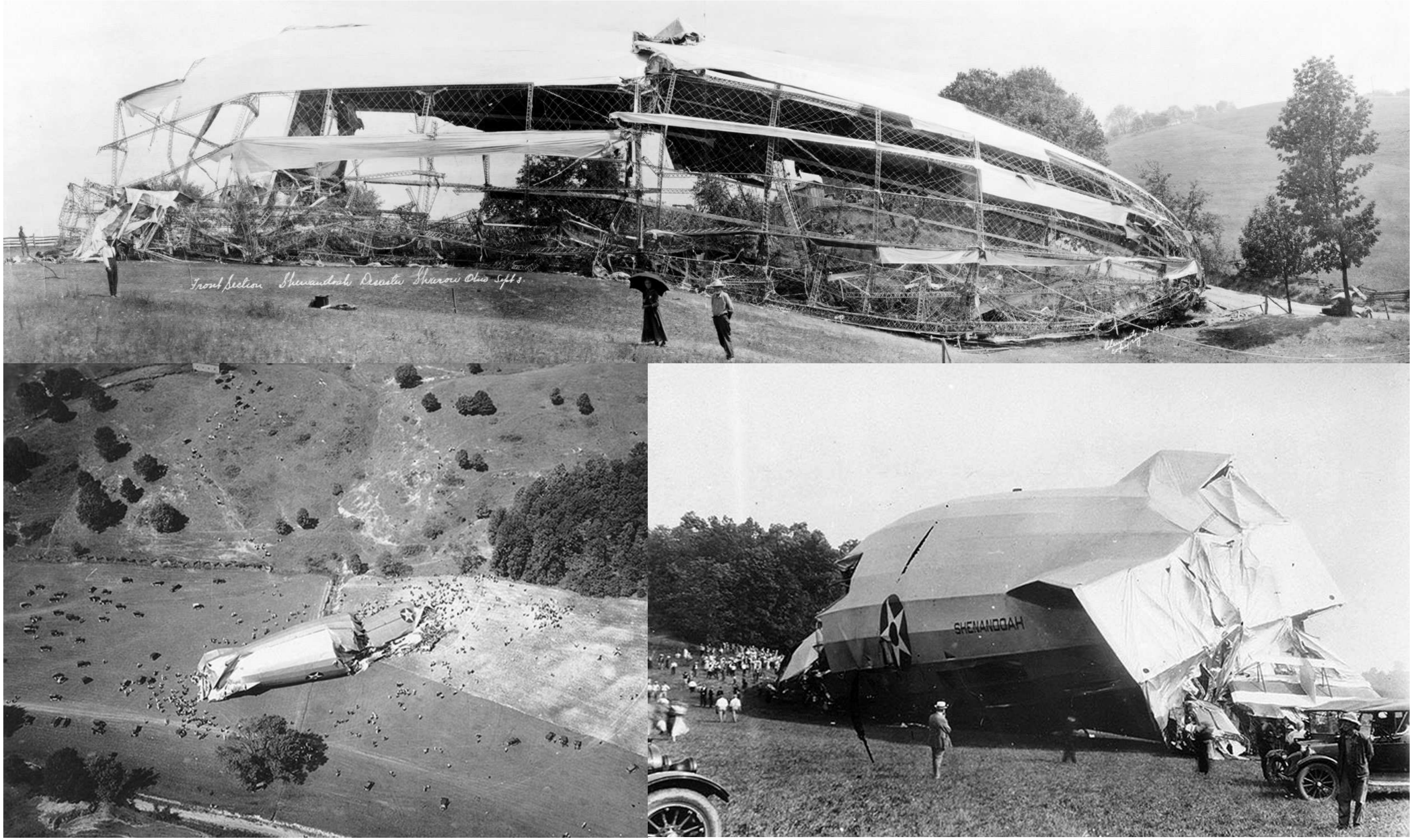


"In the remarkable drawings at left, our artist presents a graphic explanation of the effects upon an airship of a severe thunderstorm such as that responsible for the recent wreck of the 'Shenandoah.' In the largest picture is shown how a 'line squall' is formed by the meeting of uprushing warm air and descending currents that have been cooled by contact with raindrops and ice crystals of the upper atmosphere. Seized by these conflicting currents, a mighty airship is ripped asunder. The drawing at the lower left shows how a typical thundercloud is formed by the merging of small cumulus clouds pushed together by swiftly rising currents of warm air; the irregular motion makes for a 'bumpy' path. The picture in the upper right-hand corner demonstrates why lightning is of little danger to dirigibles. The discharge is carried along the metal framework and passes harmlessly to the ground."

***Popular Science Monthly,* Nov. 1925**

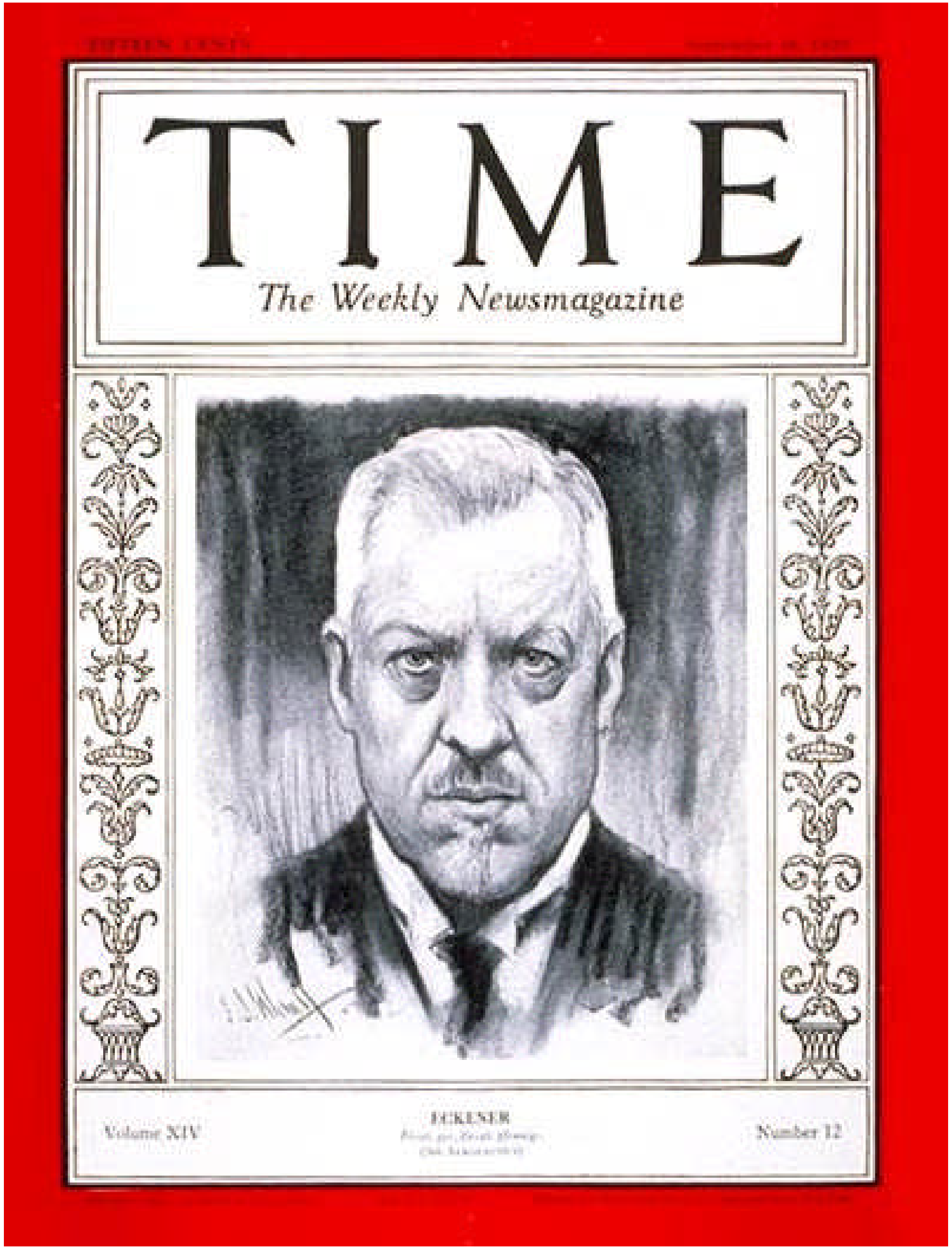






<u>Above</u>: views of the wreckage of *USS Shenandoah* (ZR-1)

LZ-126



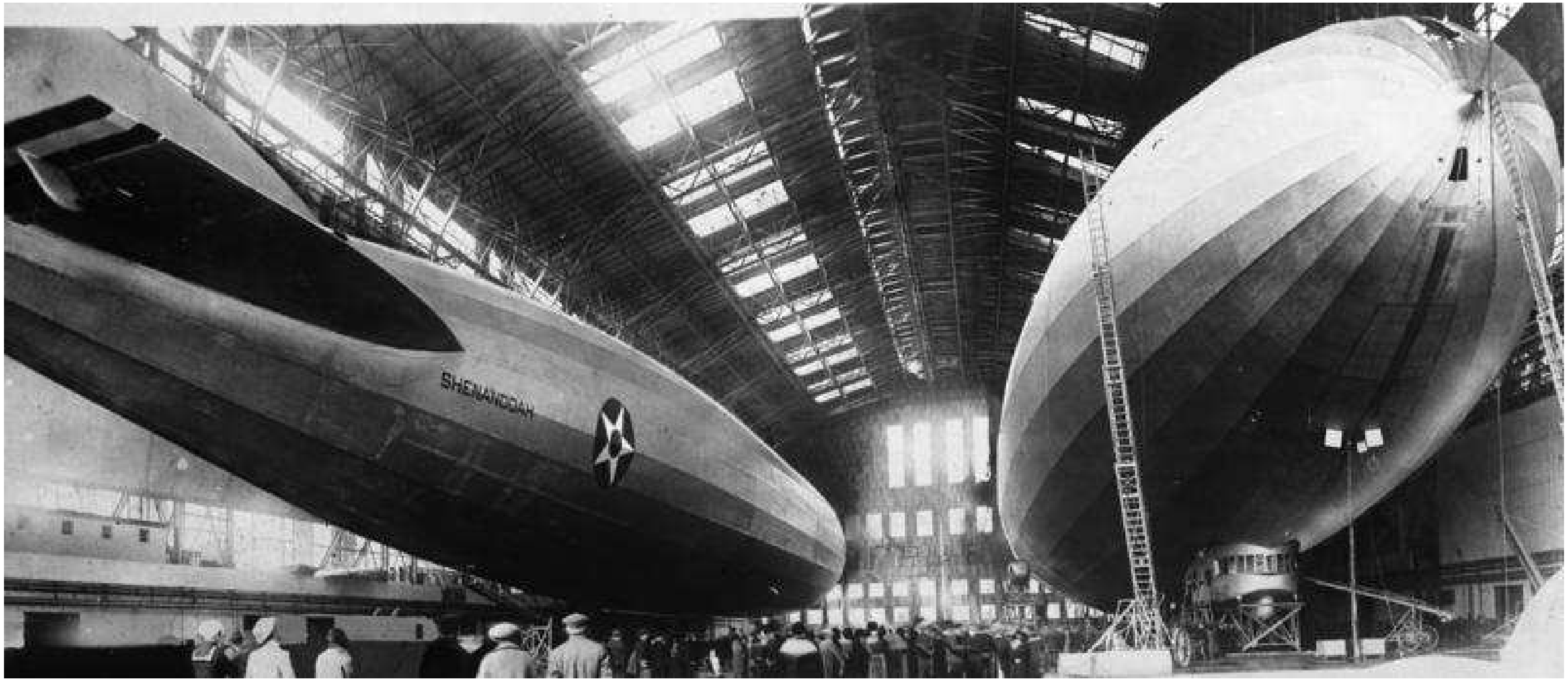
Though he remained a civilian during WWI, *Hugo Eckener* was deeply involved in Germany's use of airships during the war serving as senior advisor to the German Navy's airship chief *Peter Strasser* and as director of airship training for the German Navy. After the war, the allies' reaction to the bombing of civilians by German airships (both those of the *Zeppelin Company* and the other principal German dirigible builder *Schutte-Lanz*) caused the placing of harsh restrictions on all German aviation, in particular on airships. The *Zeppelin Company* was effectively put out of business by the *Versailles Treaty* which placed limits on the size of airships that could be built by the Germans, DELAG's two commercial airships; the highly successful LZ-120 (*Bodensee*) was given to *Italy* and the newly-built LZ-121 (*Nordstern*) was given to *France* as war reparations.

<u>Left</u>: Hugo Eckener on the cover of *Time* magazine, 1929

"…The world war helped tremendously, but it is only within the past year or two that the Zeppelin has become a transportation factor. The 'Graf's' world trip was a realization of Count Zeppelin's dream wherein he saw all countries of the earth linked by huge swift-flying air liners…"

***Popular Mechanics,* February 1930**

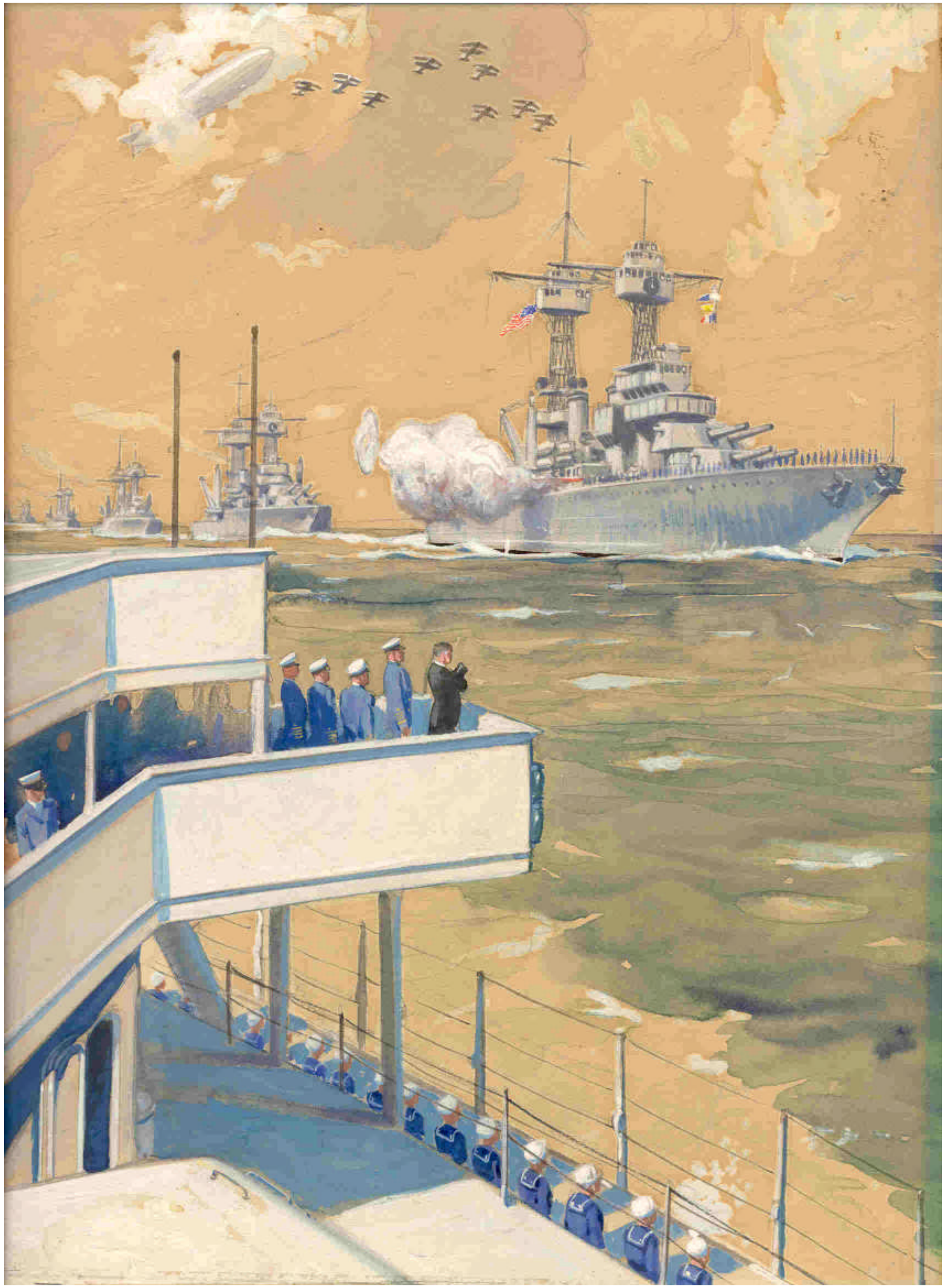
RE: in the wake of WWI, *Hugo Eckener* made perhaps his greatest contribution to the survival of the airship. After the war, *Germany* was required to pay heavy reparations, not only for the war itself but also for the destruction of German airships by their crews (who preferred to destroy them rather than allow them to fall into the hands of the allies). Eckener convinced the Allies to allow the *Zeppelin Company* to build a new airship; LZ-126, to be delivered to the Americans as ZR-3 (*USS Los Angeles*) in partial satisfaction of these reparation obligations. The construction of LZ-126 kept the Zeppelin Company alive, maintaining not only its plant and equipment but also its workforce of highly skilled employees. The construction and operation of LZ-126 also provided Eckener and his company with the knowledge and experience they would use to build *Graf Zeppelin* and *Hindenburg*.



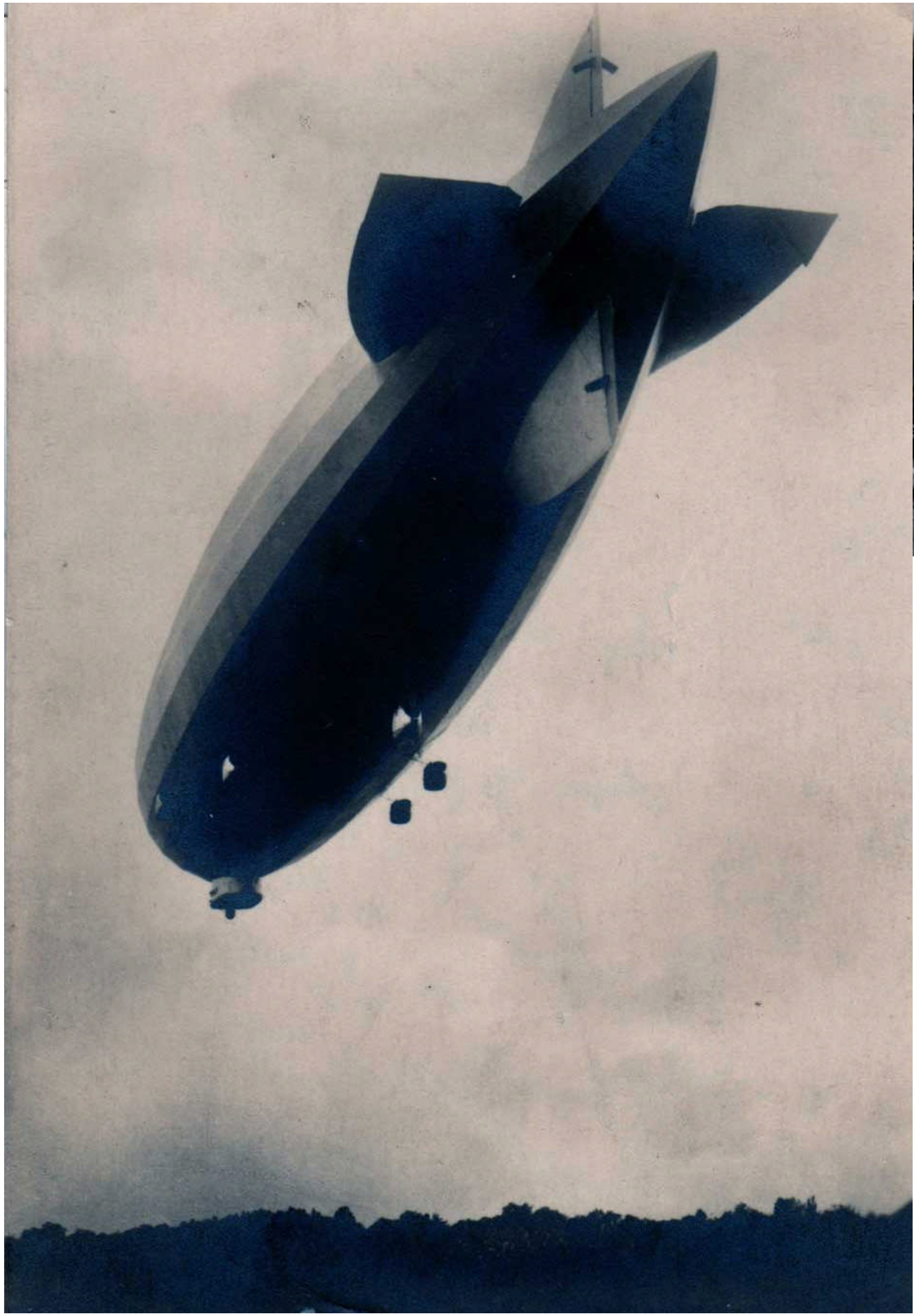
“The monster ZR-3, the United States naval dirigible now rapidly nearing completion at Friedrichshafen, Germany, birthplace of the Zeppelin, is to be sailed home across the Atlantic, some time this spring, by a picked crew of thirty men. In every way this latest aerial giant overshadows the famous dirigible ‘Shenandoah,’ formerly the ZR-1. She is 985-feet long and 130-feet high, as compared with the 680-foot length and 96-foot height of the ‘Shenandoah.’ Her 400-horsepower, reversible Maybach motors will drive her 80 miles an hour. The top speed of the ‘Shenandoah’ is 70 miles. The tremendous bulks now being achieved by dirigible designers are demonstrated strikingly by contrasting the length of the ZR-3 with that of the battleship ‘Colorado,’ the latest addition to the nation’s first line battle fleet. The length of the ‘Colorado’ is 624-feet – only about two-thirds as long as the world’s mightiest airship…”

***Popular Science Monthly*, May 1924**

Above: *USS Shenandoah* (ZR-1) at left, *USS Los Angeles* (ZR-3) at right (in Lakehurst NAS hangar)



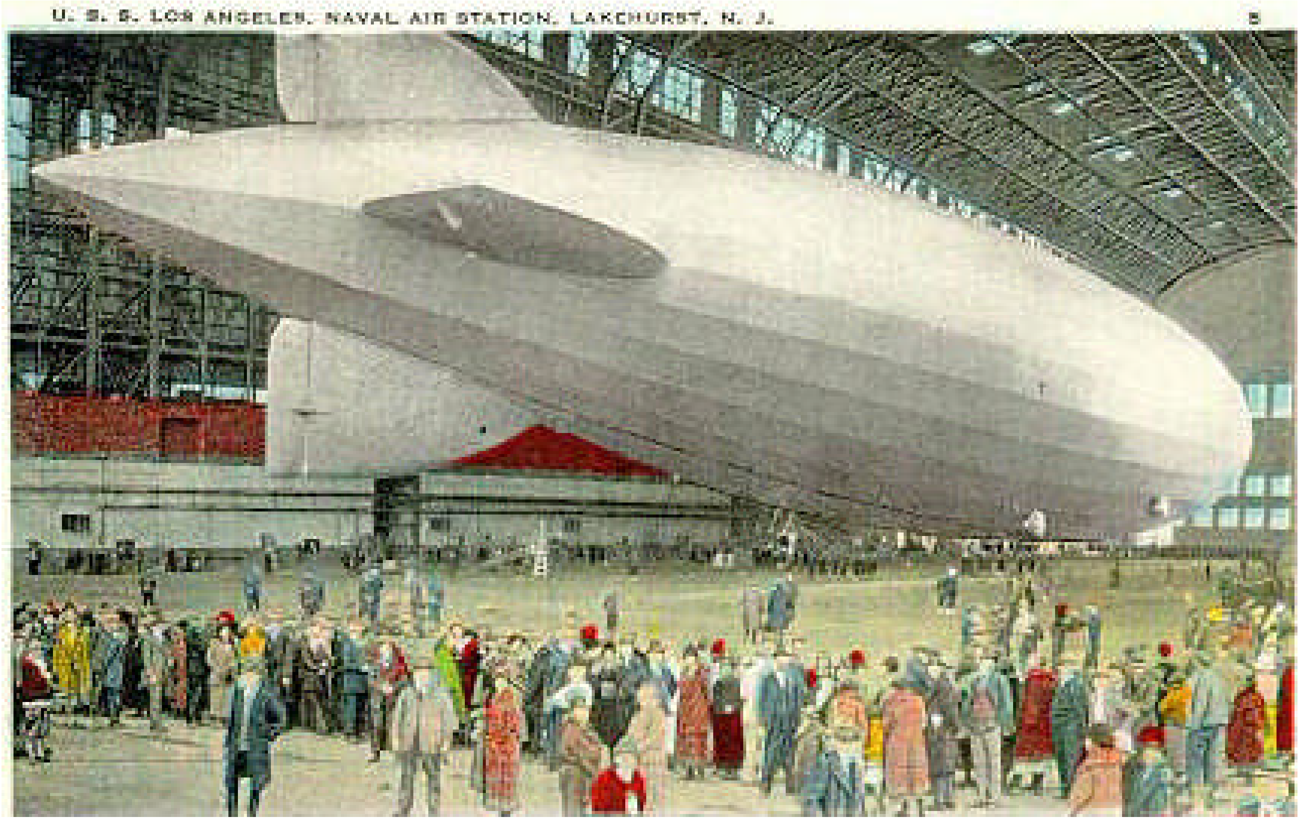
<u>Left</u>: caption: "Watercolor of a Presidential review for President Hoover, 20 May 1930, along the Virginia Capes near Lynnhaven Roads. Crews line the rails of a Colorado-class(BB 45-48) battleship as the ships pass in line astern of the reviewing stand - aboard USS Salt Lake City (CL-25) - with the airship Los Angeles (ZR-3) piercing the clouds (or maybe the smoke from 21-gun salutes) accompanied by 9 biplanes."



The nonstop transatlantic flight (October 12-15th 1924) of LZ-126 (left) from *Germany* to the *United States* was an aviation first not repeated until May 1927 when *Charles Lindbergh* flew the "Spirit of St. Louis" to *Paris* from *Long Island*. Eckener and his crew were greeted at the *White House* by POTUS *Calvin Coolidge* (above) and given a ticker-tape parade up *Broadway.*

"…On board an airship we use nautical language, for we regard the 'Los Angeles' as a real ship in every sense of the word. A day's run is even is even spoken of as the number of 'miles steamed,' ignoring the fact the ship runs on gasoline. A great airship has a sort of personality all its own. An experienced dirigible commander could identify the 'Los Angeles,' the 'Graf Zeppelin,' or the 'Shenandoah' partly by the way each answers its controls. The shape of the airship makes considerable difference, as do the size and location of the fins. The 'Los Angeles' responds quickly to outside air disturbances and also to her own controls, partly because her streamlined body is thick in proportion to her length – giving her what we call a 'low fineness ratio'…"

Lieut. Cmndr. C.E. Rosendahl, USS Los Angeles



"…It is a weighty responsibility, but few dirigible commanders would care to be relieved of it. There is a majesty about such a ship as the 'Los Angeles' that those who have looked at her in her hangar know. Taking the great ship through the clouds is a thrill that comes to few men. For all her bulk, she is a graceful, responsive ship of the air – the forerunner of even greater liners of the future…"

Lieut. Cmndr. C.E. Rosendahl, USS Los Angeles

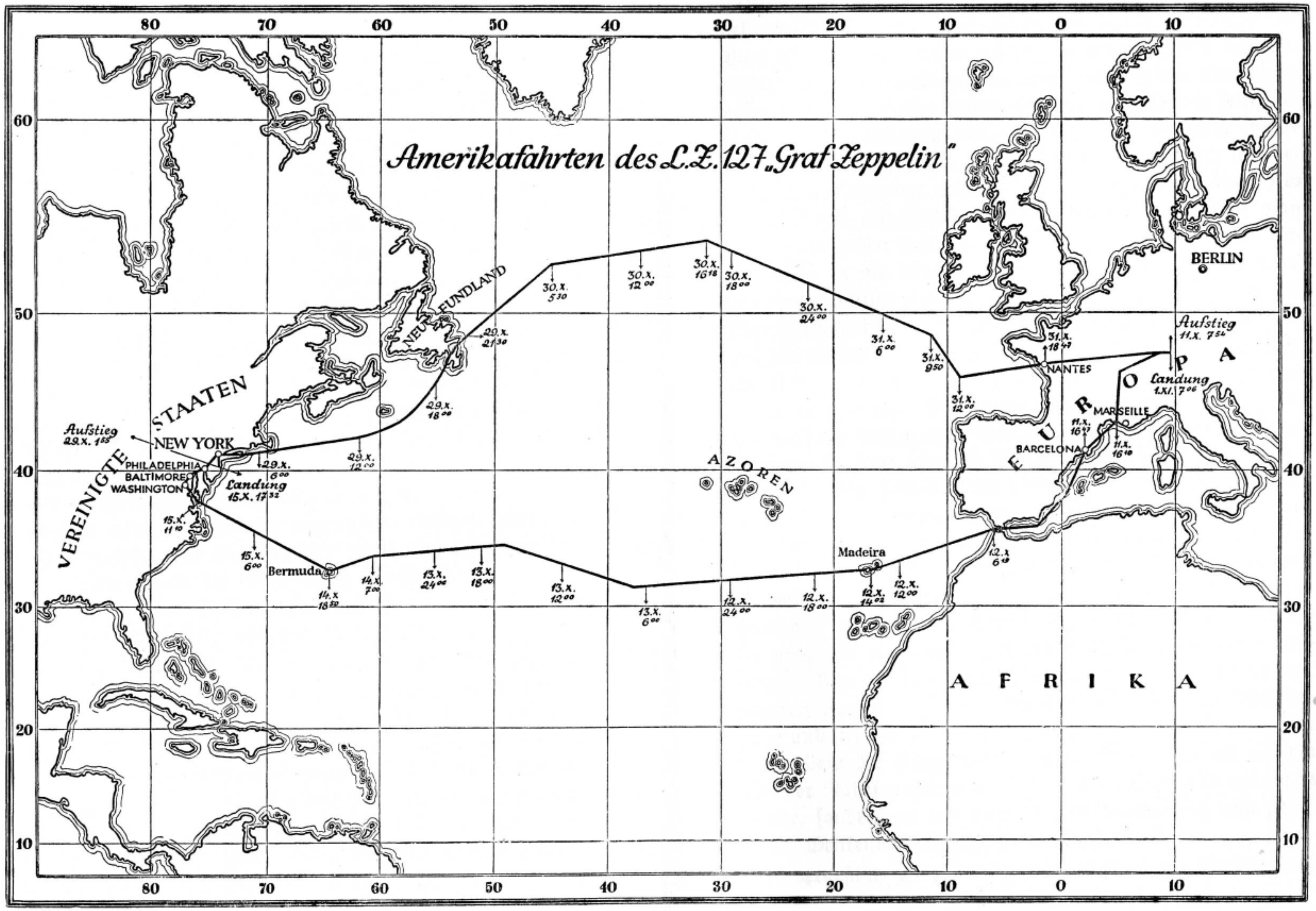
<u>Above</u>: caption (postcard): "The airship (German LZ-126, Navy ZR-3) was built by the Zeppelin Company in 1924 and flown to the U.S. from October, 12 to 15. It was there turned over to the Navy as part of German WWI reparations. The Navy flew it officially until decommissioning in June, 1932, and unofficially until 1938. It was broken up about 1939. Specifications were: length 658-feet; diameter 92-feet; gas volume 70,000 cubic meters."

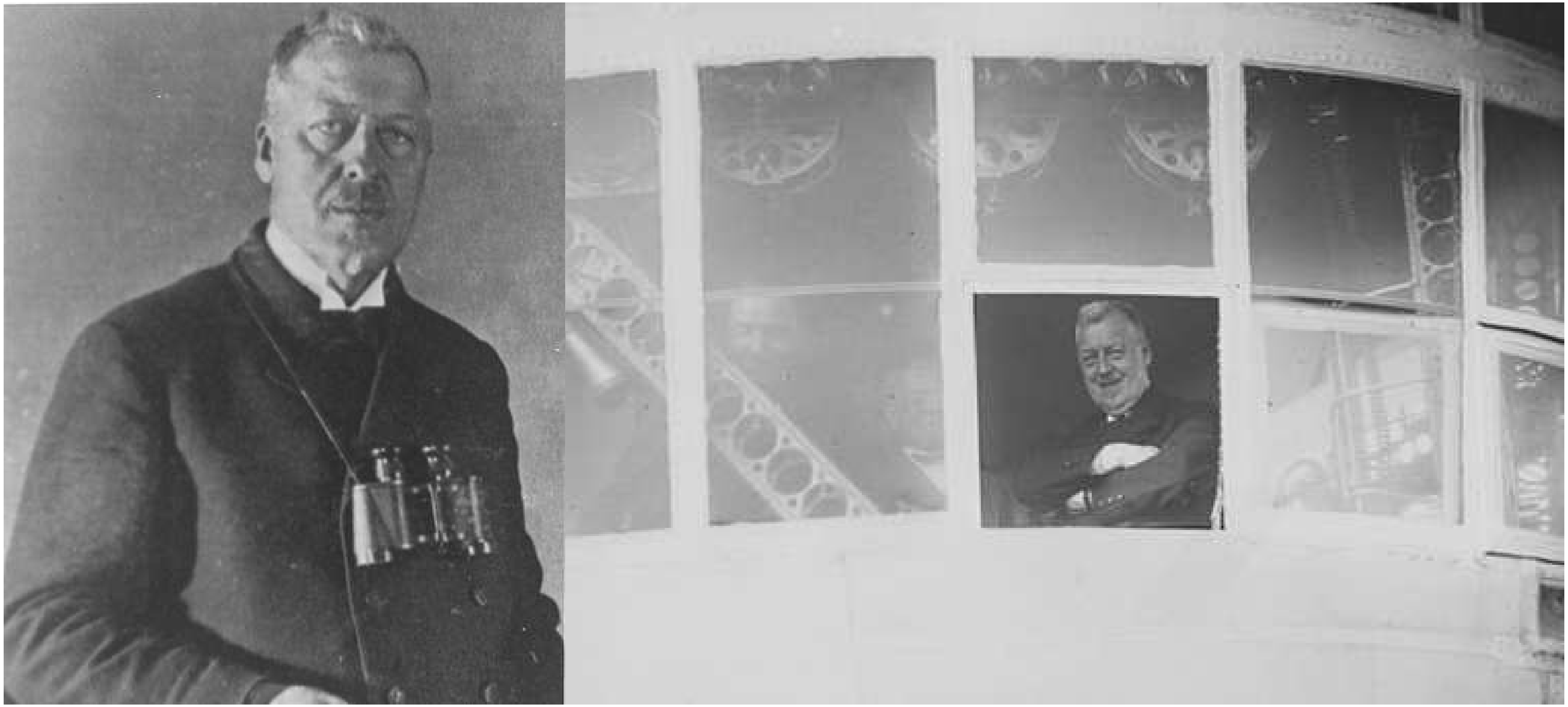
LZ-127

"Well, you know, that the weather over the Atlantic in the last few weeks had been very bad. So I had to make a special kind of trip. I could not go right out straight across the Atlantic, and yet I felt I must go, once our ship was completed. I was bold. I was bold enough to say that the weather would not keep me from starting out as soon as the ship was finished. That put me in the position of either being a liar or making the transatlantic voyage. So go we did. But because of the weather over the ocean, we had to go by way of Spain and Gibraltar, and that added 1,200 statute miles to the journey! From Gibraltar by the way we came, near the Azores, it was a little more than 5,000 miles to our destination in America…"

Hugo Eckener

RE: record-breaking trans-Atlantic voyage of the *Graf Zeppelin* (LZ-127) in October/November 1928


Amerikafahrten des L.Z. 127 „Graf Zeppelin"
VEREINIGTE STAATEN
NEUFUNDLAND
NEW YORK
PHILADELPHIA
BALTIMORE
WASHINGTON
Aufstieg 29.X. 1.55
Landung 15.X. 17.32
Bermuda
AZOREN
Madeira
EUROPA
AFRIKA
BERLIN
NANTES
MARSEILLE
BARCELONA
Aufstieg 11.X. 7.54
Landung 1.XI. 7.06



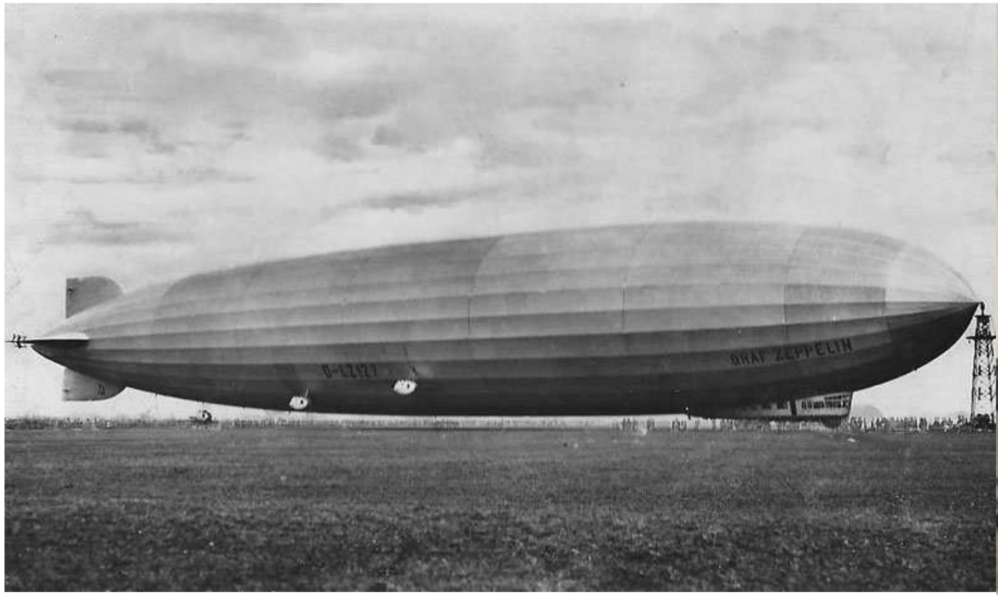
"…From France comes word that the Federation Aeronautique Internationale, the world-governing body of aviation, has recognized as official the 'Graf Zeppelin's' eastward distance record. The entry: 'Class B (Dirigibles): Distance (Germany). Dr. Eckener, with the dirigible Z-L.127, 'Graf Zeppelin': motors Maybach 450-550 HP, from Lakehurst, U.S.A., to Friedrichshafen, Germany, October 29-30-31, Nov. 1, 1928, 6,384.5 kilometers.' This is equivalent to 3,967 miles. The last previous record in this class was set by two Italians who made a 503-mile dirigible flight in 1913…"

***Popular Science Monthly,* April 1929**

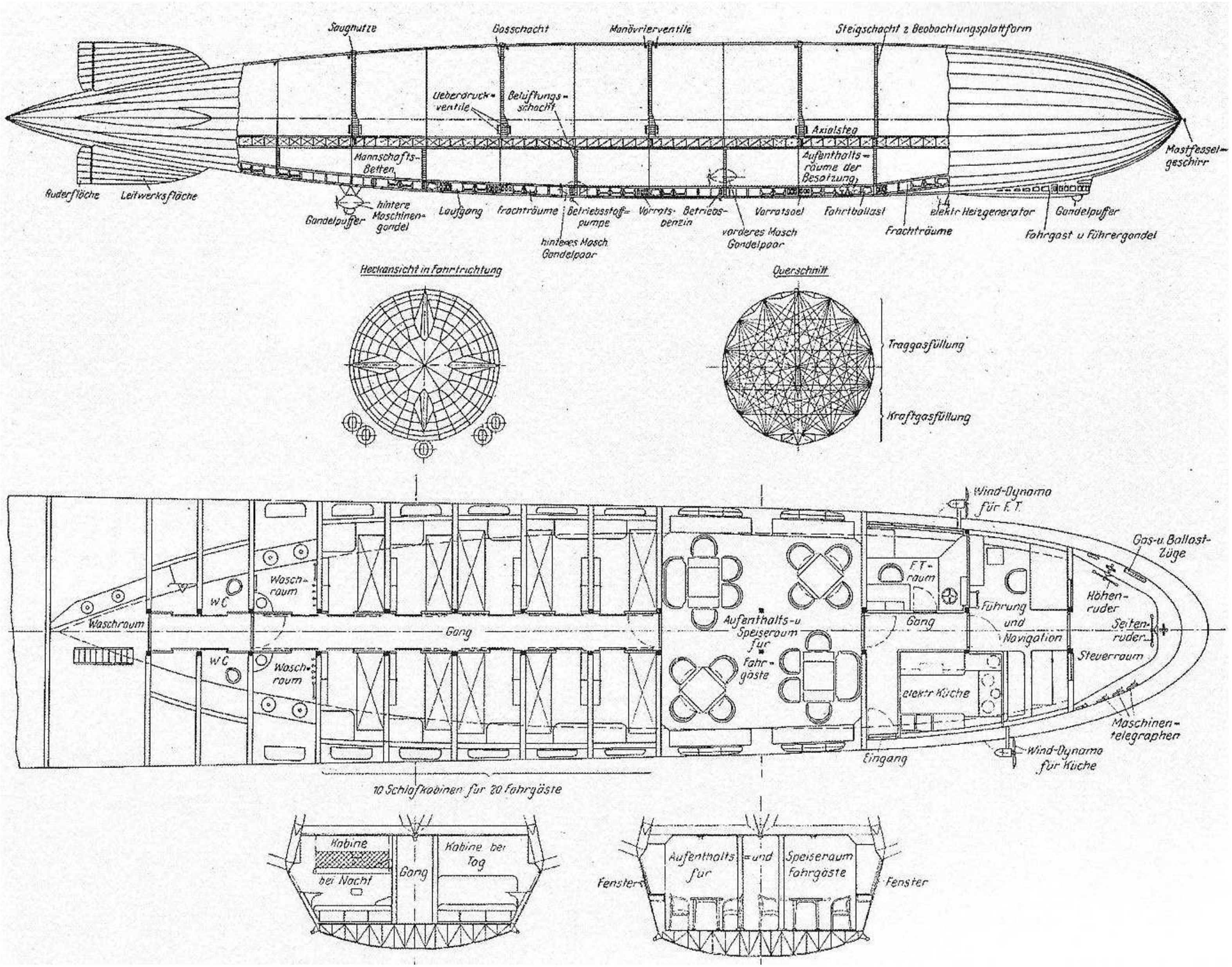
<u>**Above**</u>**:** ***Hugo Eckener***

“…In the autumn of 1928 the Graf (Count) Zeppelin – the LZ-127, 774 feet long, weighing 66 tons, able to haul a payload of 20 passengers and 13 tons of cargo – inaugurated commercial service. She followed a southern track to America, averaging not quite 60 miles an hour: 6,000 miles from Friedrichshafen to Lakehurst in four days and 16 hours. The New York Times gave nearly ten pages to the story. The following year the Graf flew around the world. In 1930, service to South America began. By 1936, she had transported 13,000 passengers on 575 trouble-free flights. Yet the crews became unbelievably careless. They smuggled contraband. They even sneaked cigarettes on catwalks, hiding behind bags billowing with touchy hydrogen. On one journey from South America, crewmen secreted monkeys in the hull. The monkeys escaped and swung, chattering and scolding, from girder to girder until the ship landed. Another time, tropical fruit, tucked high in the framework, dripped sticky juice on all who passed below. Cameras and radios, a special hazard because they might contain spark-causing batteries, were conveniently concealed in the folds of the floppy gas cells. Nonetheless, the Graf’s phenomenally charmed life held (she and the U.S. Navy’s ‘Los Angeles,’ also German-built were eventually dismantled)…”

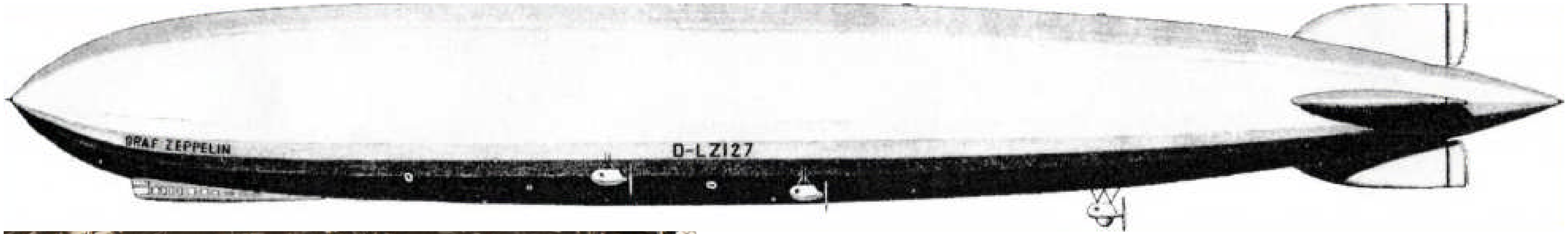
Popular Science, **May 1962**

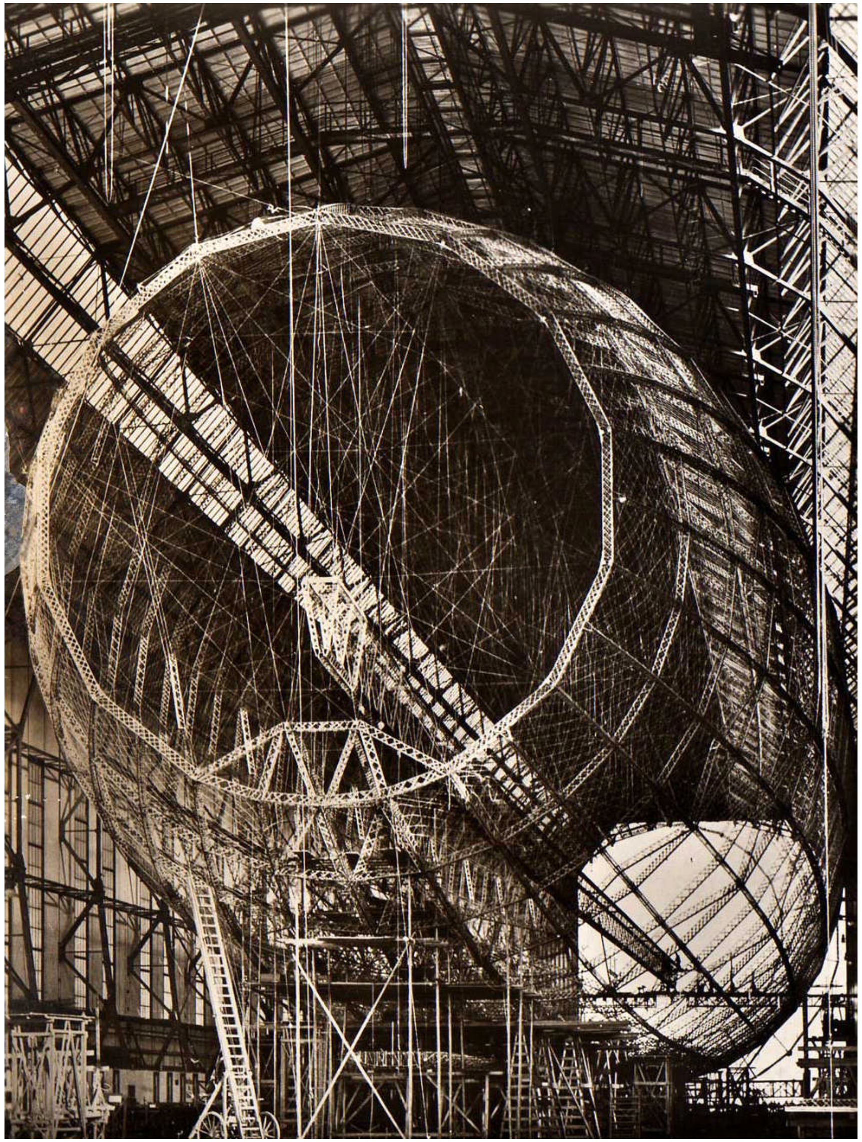


During its distinguished career, LZ-127 (*Graf Zeppelin*) flew more than one million miles making over 590 flights (144 ocean crossings) carrying +34K passengers with a perfect passenger safety record, making it the most successful rigid airship ever built. The ship flew for the first time on September 18th 1928. With a total length of 776-feet, diameter (beam) of 100-feet and a volume of 3.7 million cubic-feet, she was the largest airship up to that time. The LZ-127 was powered by five *Maybach* 550 HP engines achieving a maximum speed of 80 mph (70 knots) operating at total maximum thrust of 2,650 HP (which reduced to the normal cruising speed of 73 mph). During its nine year career, LZ-127 made the first commercial passenger flight across the *Atlantic*, the first commercial passenger flight around the world, flew a scientific mission over the *North Pole*, made the first regularly scheduled transatlantic passenger crossings by air and aroused intense public enthusiasm for airships around the globe.

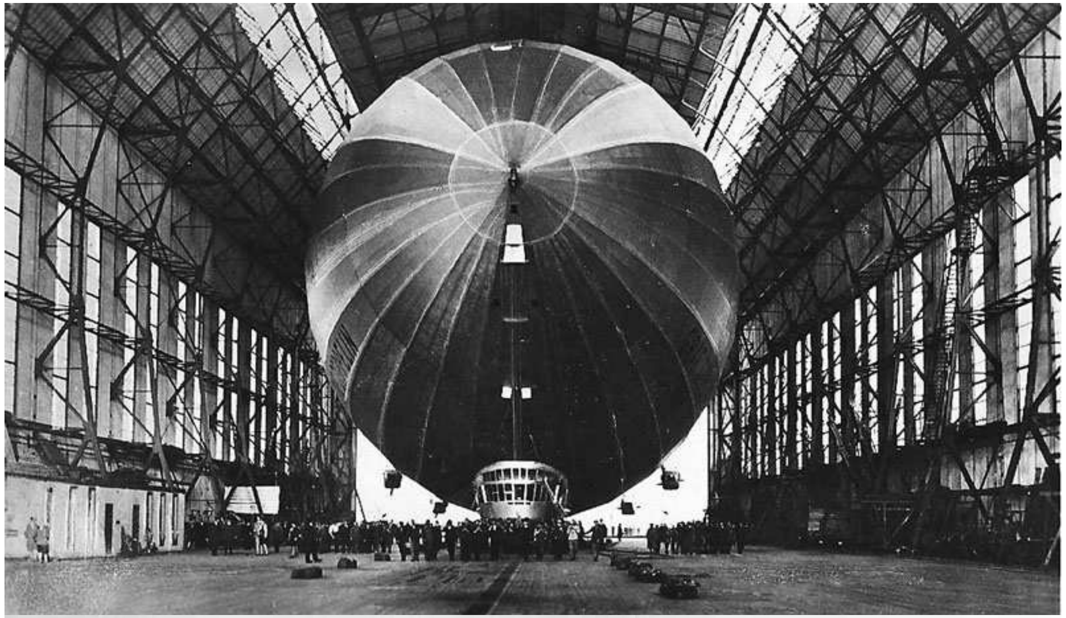


Above: profile/section, plan and cross-sections of LZ-127 (*Graf Zeppelin*)



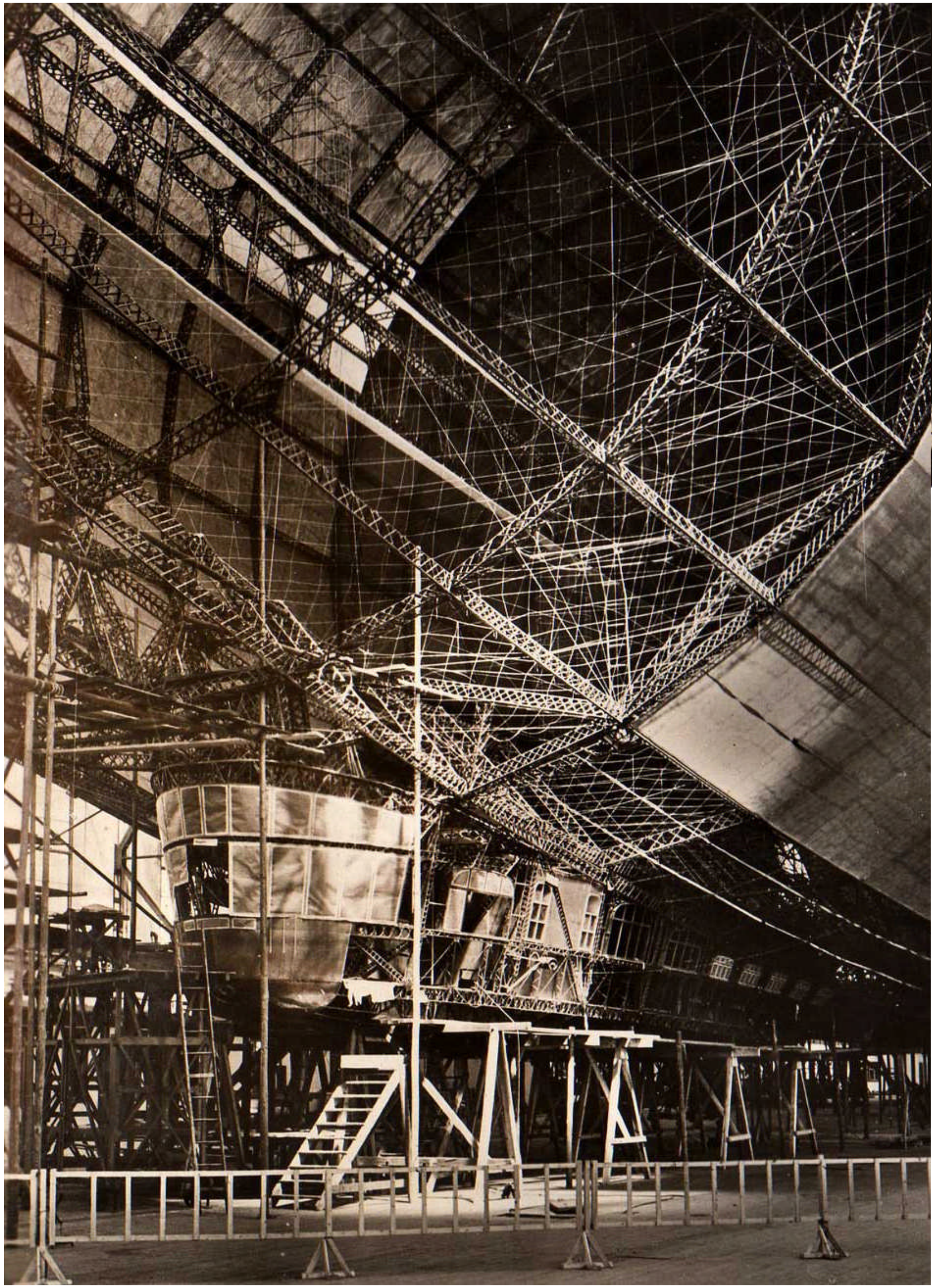


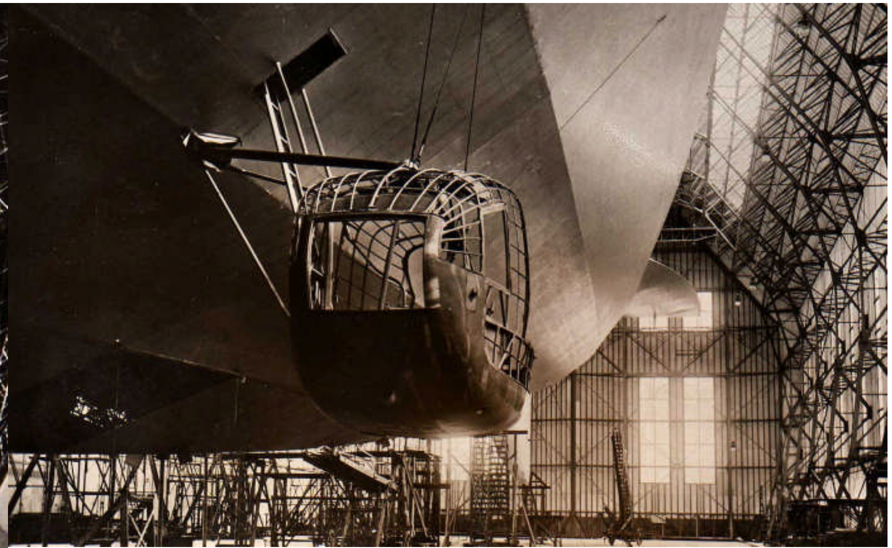
The design and construction of LZ-127 was based on time-tested, proven technology used on previous *Zeppelin Company* rigid airships. She was constructed of triangular duralumin girders with frames (a.k.a. "rings") spaced fifteen-meters apart. The shape and size was not ideal aerodynamically (a teardrop shape was most efficient), structurally (the thin hull was vulnerable to bending stresses) or economically (its relatively small size limited payload capacity on long flights). The design of the airship was determined by the size of the construction shed at *Friedrichshafen* which had inner dimensions of 787-feet in length and 115-feet in height. Since greater size meant greater efficiency in long distance operation, the challenge for *Ludwig Durr* and his design team was to create a ship with the largest possible gas capacity that could be built within the confines of the construction shed. The ship they designed was a long, thin cylinder with a gondola situated far forward (above) so that it could be slung under the hull where it began to rise toward the bow. The height of the ship from the bottom of the gondola to the top of the hull was 110-feet, just barely clearing the arches of the shed (left).



"…Builders of the 'Graf Zeppelin' had to make it to fit the only large hanger available in Germany. Therefore the ship is not of ideal proportions. Its steering mechanism is not entirely satisfactory, and its speed is too low. Doctor Eckener, following the world trip, declared that future long-distance airships ought to be fatter – have a lower ratio between length and diameter – than the 'Graf.' They also must be more powerful if they are to maintain reliable schedules regardless of weather. The 'Graf' also suffered from a kind of skin affliction. That is, its fabric covering became loosed in several places during a long flight. This was remedied by installing reefing frames. In future ships, adjustable bars will be provided so that the fabric can be loosened or tightened as desired…"

***Popular Mechanics,* February 1930**





<u>Above</u>: one of LZ-127 two port engine gondolas, under construction (above). Her five Maybach 12-cylinder engines, could develop 550 HP at maximum revolutions and 450 HP (at 1400 RPM) in cruise. LZ-127 typically cruised at 72 mph at an altitude of 650-feet, but she also flew as high as 6K-feet over mountain ranges (in eastern *Russia*). She also cruised well below 650-feet when necessary to reduce the stress of vertical gusts by flying low to the ground during storms, whenever possible.

<u>Left</u>: caption: "Graf Zeppelin under construction, showing Duralumin frames, 15 meters apart"

Blaugas

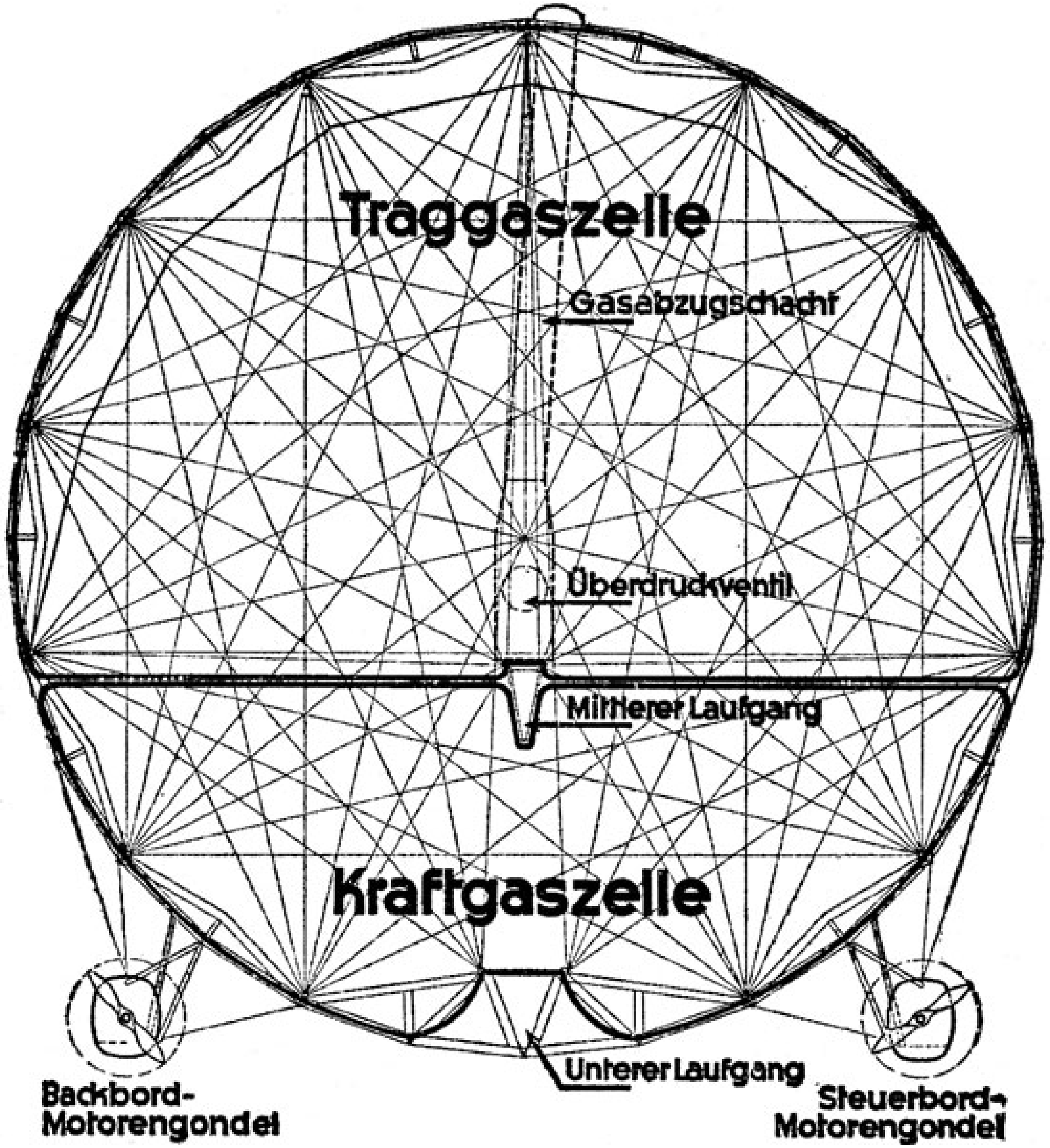
"…In the 'Graf Zeppelin' we have the 127th generation in the line of air giants. And when she leaves the ground she will swim in her natural element with propelling power that is as much of an innovation as was the steam that drove Robert Fulton's first steamboat. This new fuel is etan – a form of hydrogen gas having the weight of air, so that as it is expended there is no longer any necessity for valving away the precious sustaining gases contained in the envelope of the airship. Heretofore, as an airship's engines consumed gasoline, it has been necessary to compensate for this loss of weight by releasing or 'valving' hydrogen gas, or in the case of our 'Los Angeles,' helium. The loss of this lifting gas has been more costly even than consumption of engine fuel. With the new German fuel this waste is largely eliminated…"

***Popular Science Monthly,* October 1928**

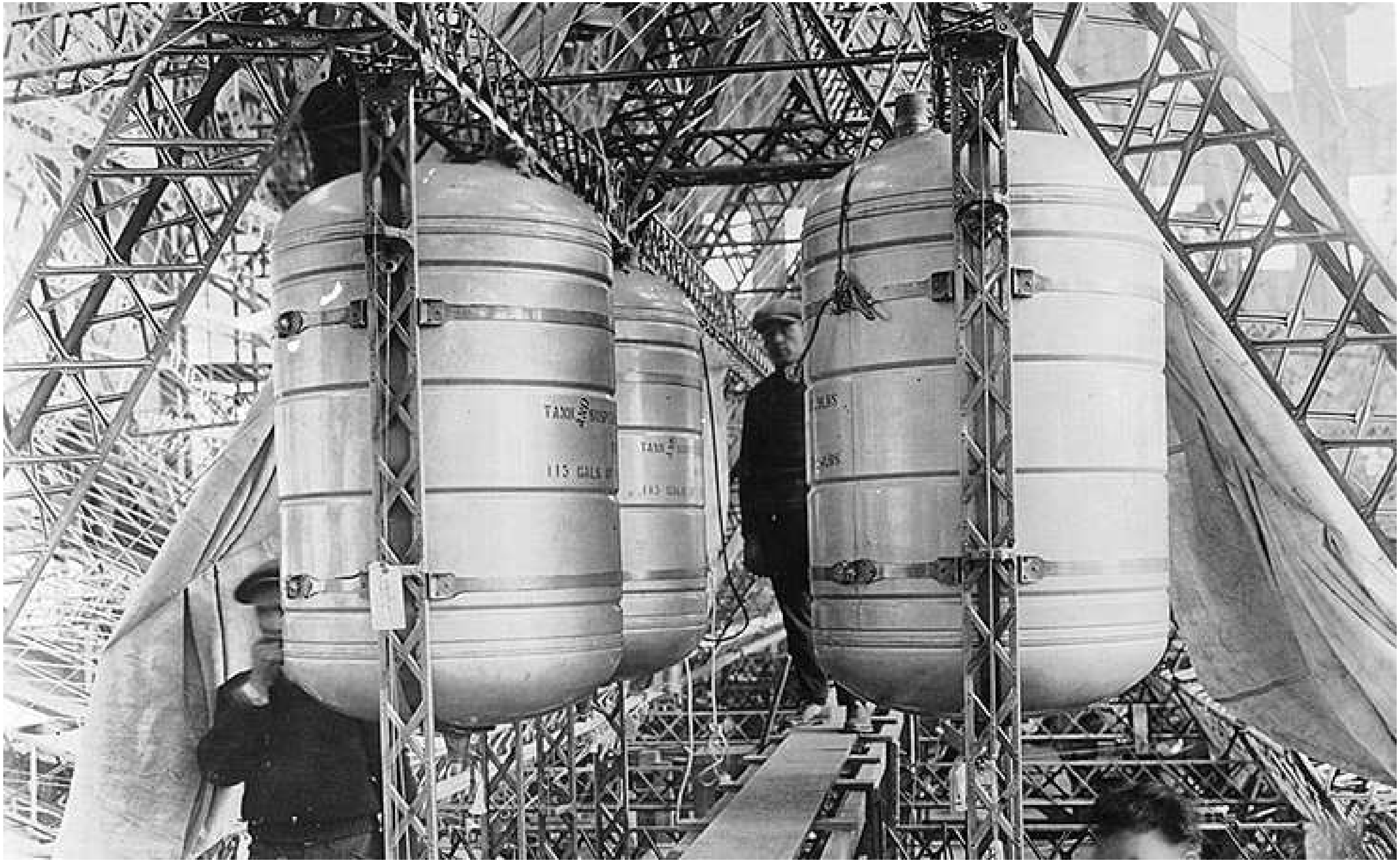
"…Originally it had been planned to fly the air giant to America last spring or summer. Delay followed attempts to produce the new 'blue gas," or blaugas, as it is known by the men who distill it from fuel oil, in quantities sufficient for the trip. Filled for a trans-Atlantic voyage, the fuel compartment within the gas bag proper holds nearly a million cubic feet of the gas – enough to keep the gas range in your home burning night and day for ten years! This gas is practically as light as air and therefore no appreciable load for the dirigible to carry. Consequently, when part of it is used up, there is little change in the whole craft's weight and it need not valve off its precious hydrogen to avoid bobbing upward in the sky, as it would tend to do were gasoline used. Blaugas contains a negligible percentage of high-inflammable gas, minimizing explosion hazard and danger of igniting the hydrogen-filled gas bag above…"

***Popular Science Monthly*, September 1929**

LZ-127 incorporated one especially notable innovation; the use of “blaugas” fuel for its five engines. One of the challenges of lighter-than-air powered flight has always been the need to account for the loss of weight as fuel is burned by the ship’s engines. As gasoline or diesel fuel is consumed during flight, the ship becomes lighter and without a means to compensate for this change, lifting gas must be vented to maintain the ship’s equilibrium. The Zeppelin Company’s innovative solution to this issue with LZ-127 was the use of a gaseous fuel, similar to propane, named “Blaugas” after its inventor, *Dr. Hermann Blau.* Since blaugas is similar in weight to air, its consumption during flight did not significantly change the aerostatic balance of the ship and so it was not necessary to valve lifting gas to compensate for blaugas burned by the engines. Blaugas was also more efficient to carry than gasoline and extended the airship’s range by over thirty hours of flying time. The approximately one million cubic-feet of blaugas carried by the *Graf Zeppelin* could power the ship for over one hundred hours. The blaugas was carried in twelve cells (*Kraftgaszelle*, or “power gas cells”), in the lower section of twelve of the airship’s seventeen gas cell bays, beneath the hydrogen cells (*Traggaszelle*, or “lift gas cells”). Of LZ-127’s total gas capacity of 3,707,550 cubic-feet, 1,059.300 cubic-feet was available for blaugas. The airship also carried a supply of gasoline in order that if the ship were heavy, the engines could burn gasoline instead of blaugas, lightening the ship without the need to drop ballast. The use of blaugas was quite hazardous presenting as great or greater a danger to safety as the airship’s hydrogen, in the opinion of many people. The gas cells of that era were not impermeable and always leaked to some extent and small tears and other minor leaks were also common. Since blaugas has a similar density to air, escaping blaugas did not rise like hydrogen but rather settled to the bottom of the hull, including the keel and into the gondola itself and could even flow out toward the engines. This was an even bigger problem when the ship was on the ground, especially inside an enclosed hangar, since there was no flow of air to carry the gas away.



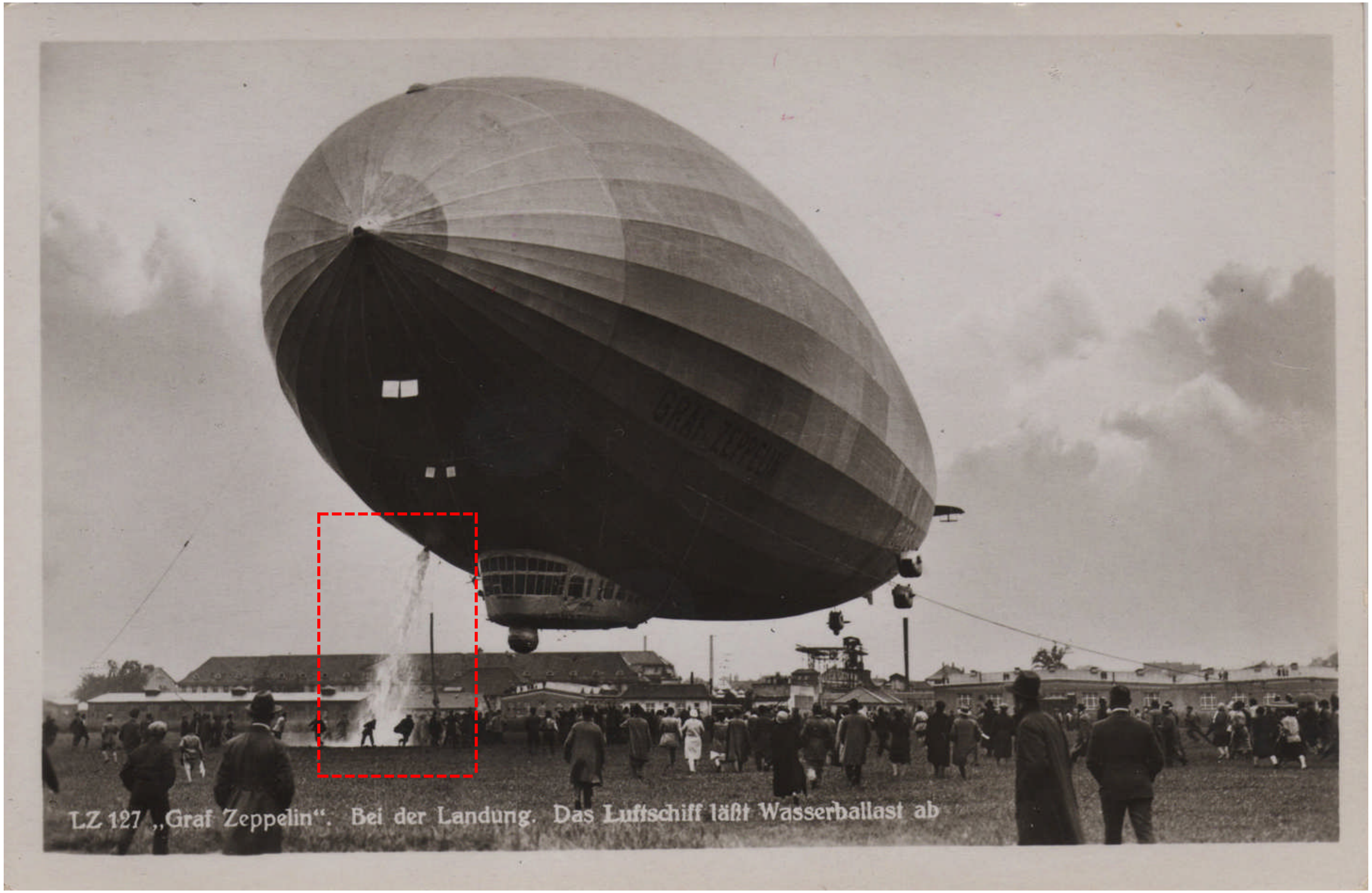
<u>Above</u>: cross-section of LZ-127 (*Graf Zeppelin*) showing *Kraftgaszelle* (power gas cells) at bottom and *Traggaszelle* (lift gas cells) at top



<u>Above</u>: caption: “View of the interior of the future USS Shenandoah (ZR-1), showing tanks for her gasoline fuel. Taken while she was under construction inside the airship hangar at Naval Air Station Lakehurst, New Jersey, 1923. Note weight and capacity (113 gallons) markings on the fuel tanks, details of her aluminum structure, and the narrow (10-inch wide) catwalk used for crew movement inside the air ship’s hull.

"…Blaugas is manufactured by distilling and decomposing crude oil in huge retorts, heated to a temperature of a thousand degrees F. – the heat of red-hot iron. There the oil decomposes and turns into a variety of gases which, after passing through cleaners, coolers, and scrubbers, are stored in tanks. Eight gallons of oil produce 1,000 cubic feet of gas. Powerful pumps then draw the gas from its holders and compress it, causing most of the gas to liquefy. It may then be transported in steel cylinders, and allowed to expand and re-gasify when needed…"

***Popular Science Monthly*, September 1929**

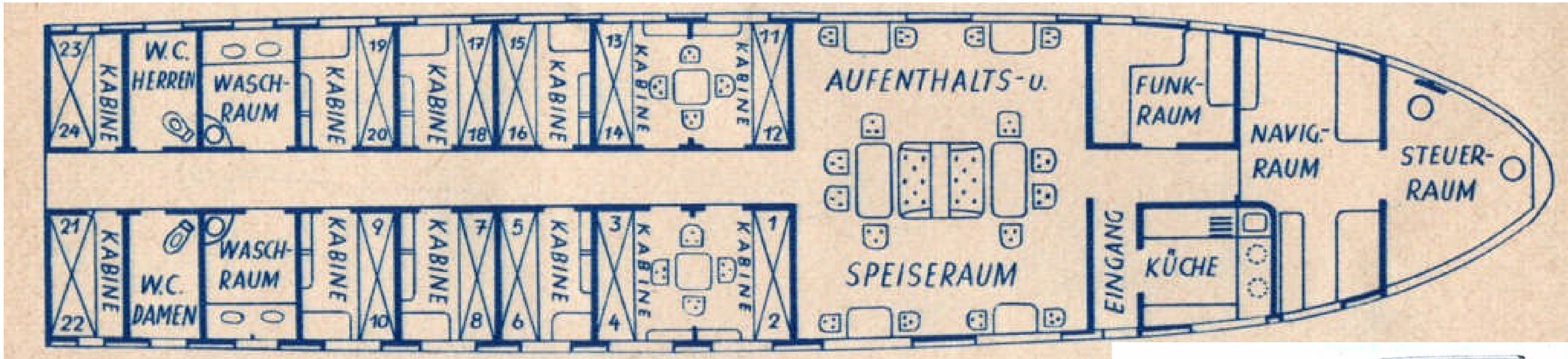


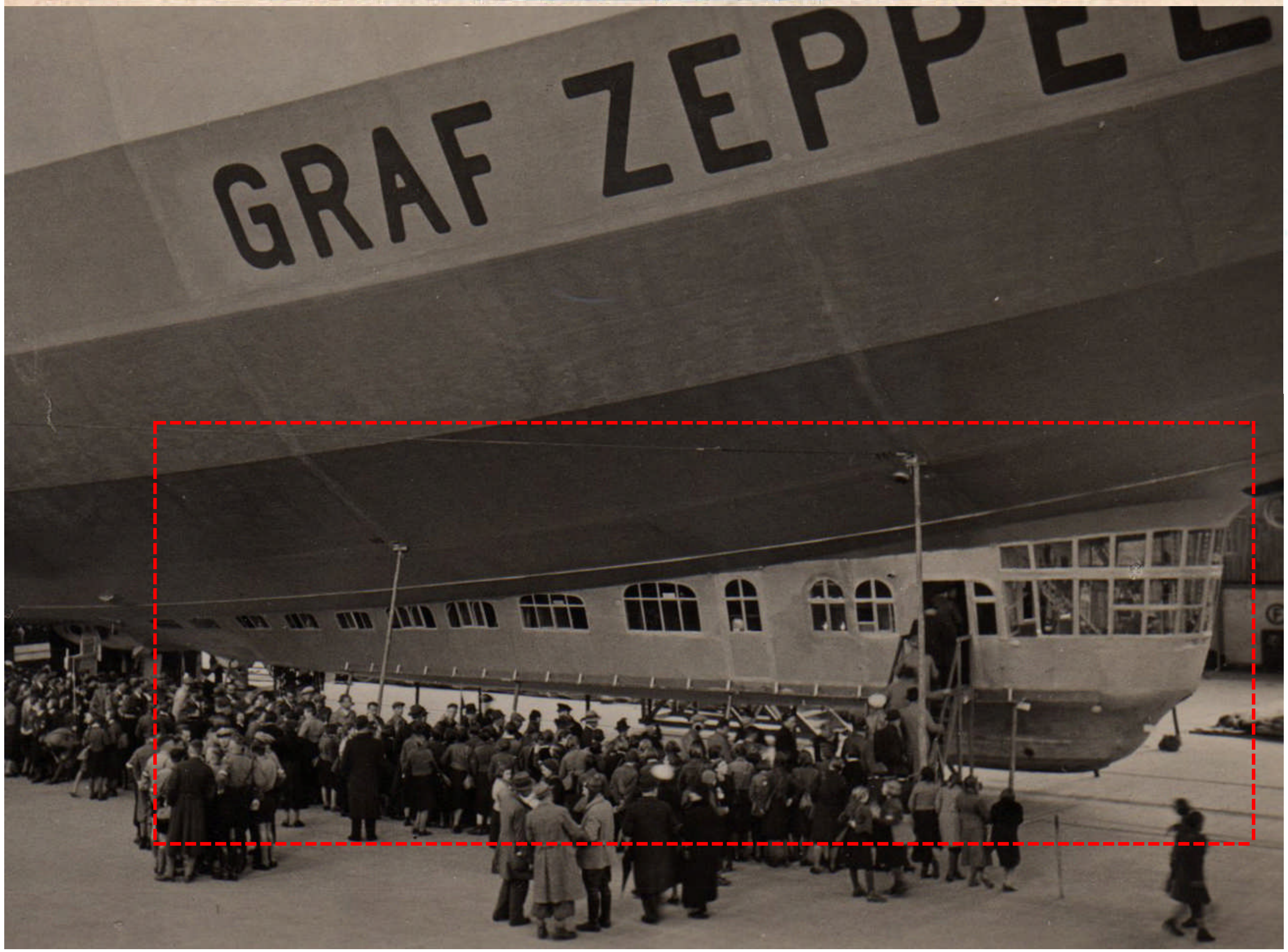
When it became necessary to drop ballast (to maintain equilibrium), LZ-127 could use the 17,640 lbs. of water it carried as trim ballast, 5,280 lbs. of water as emergency ballast and 3,520 lbs. of water carried for drinking, cooking, and washing (which was retained on-board after use).

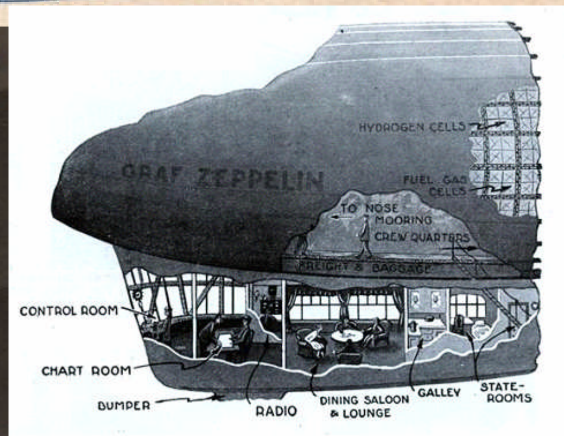
<u>Above</u>: caption: "LZ-127 Graf Zeppelin dropping water ballast during landing"

"…The U.S. Navy is experimenting with a means of solving one of the vexing problems of long-range dirigible flight. If a Navy-designed, water-pickup device works, airship men will not have to worry about balancing off the weight of their aircraft against the lift of the gas cells. Such a device would enable transoceanic airships to pump ballast from the ocean while traveling at top speed. As fuel is used, an airship becomes lighter. The crew either has to valve away precious helium, the lifting gas, or find a way to keep the weight constant. It is another version of the ballast problem in the surface vessel, except that in a lighter-than-air ship ballast is more critical. German dirigible men sometimes valved away inflammable hydrogen to offset weight with lift. Hydrogen was cheap. But helium, the non-inflammable gas used in American dirigibles and blimps, is too expensive to valve out. One means of maintaining balance has been to recapture moisture from exhaust gases. In addition to that system, trough's on the airship's skin have also been used to collect rain water. The condensing system for the exhaust gases was, of course, heavy and served to reduce the airship's payload. Cruising over Lake Erie, a Navy blimp has experimented with picking up water ballast from the lake surface. The airship tows along a hose line attached to a 'fish' containing a pump, Ballast tanks are filled to the point where the airship's lift exactly offsets it weight. Taking water 'on the fly' is similar to a locomotive scooping up water at high speed from a trough between the tracks…"

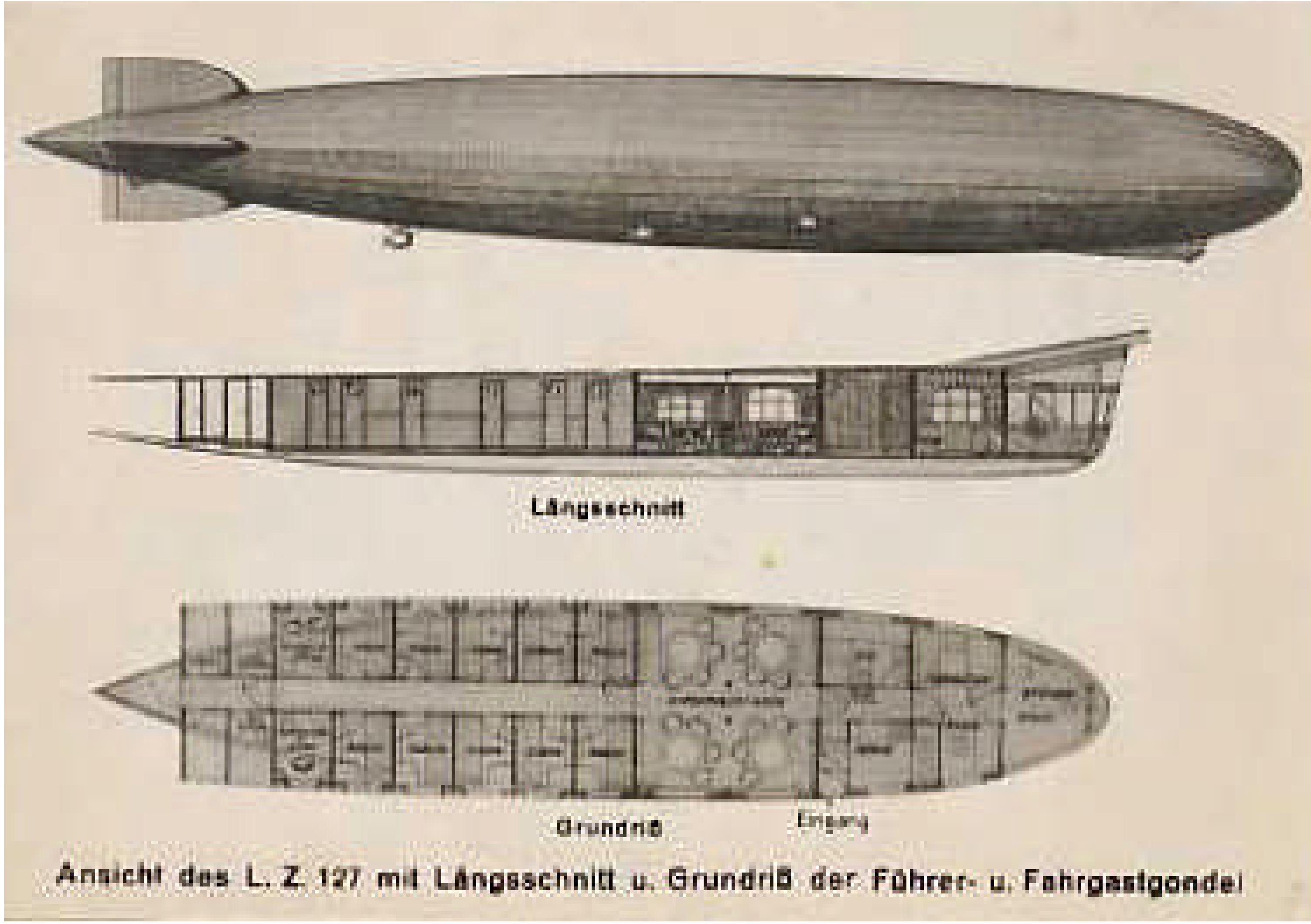
Popular Science Monthly, **February 1946**



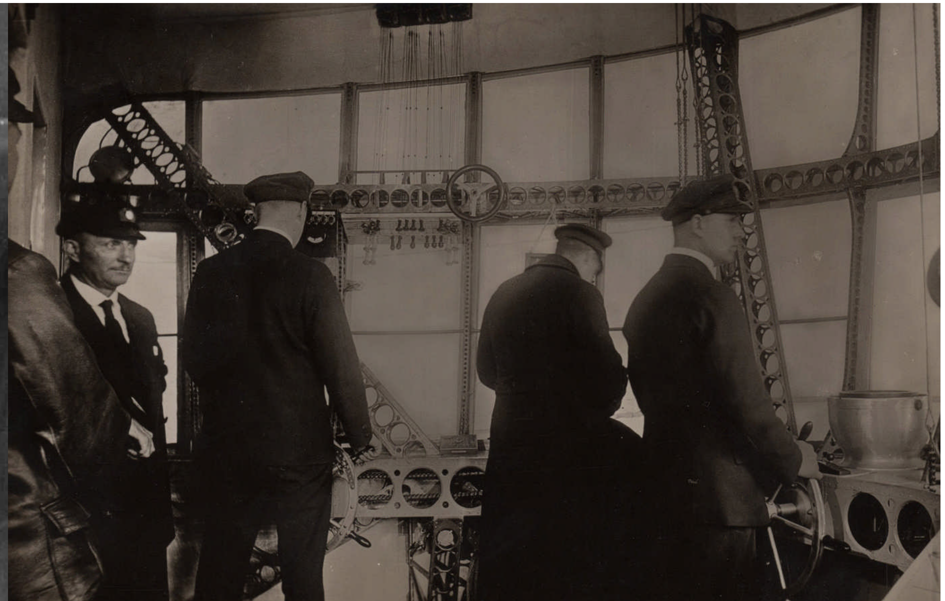


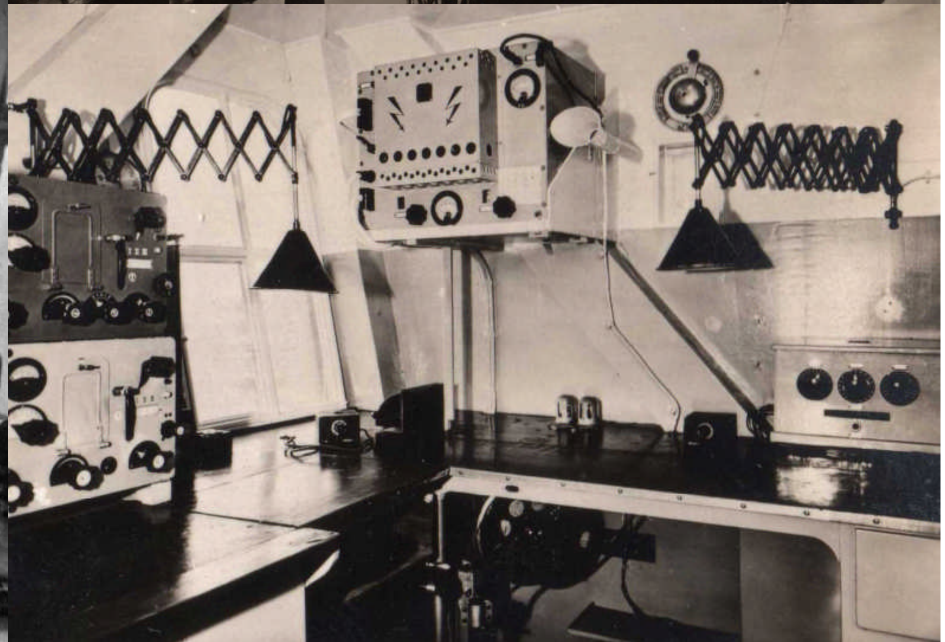


<u>Top</u>: deck plan of LZ-127's gondola
<u>Above</u>: cut-away section thru LZ-127's gondola
<u>Left</u>: gondola of LZ-127 (highlighted)



Ansicht des L. Z. 127 mit Längsschnitt u. Grundriß der Führer- u. Fahrgastgondel





<u>Above Top</u>: LZ-127's control car (gondola)
<u>Above Bottom</u>: radio room
<u>Left</u>: kitchen

<u>Above</u>: dinner service on LZ-127
<u>Left</u>: passenger cabin on LZ-127

"We have a million cubic feet of gas but no heat…Merciless cold driving through the canvas walls of this flying tent…I have visualized myself gracefully draped over a saloon window ledge romantically viewing the moonlit sky. The men have reminded each other not to forget evening jackets and boiled shirts in their baggage. We have drawn ourselves lovely pictures of dining elegantly in mid-air with Commodore Eckener at the head of a flower-decked table, but leather coats, woollies and furs will be our evening dress. Hot soup and steaming stew more welcome than cold caviar and chicken salad."

Lady Grace Drummond Hay

RE: while the surroundings of the *Graf Zeppelin* were quite luxurious, they were unheated. During the winter months or when the ship flew over the *North Atlantic* or during the flight over *Siberia*, passengers often spent much of their time wrapped in heavy winter coats or covered by layers of blankets while ice crystals formed on the windows.

"…Occasionally minor repairs are made in flight – patching a line, a rod, or a tear in the fabric…"

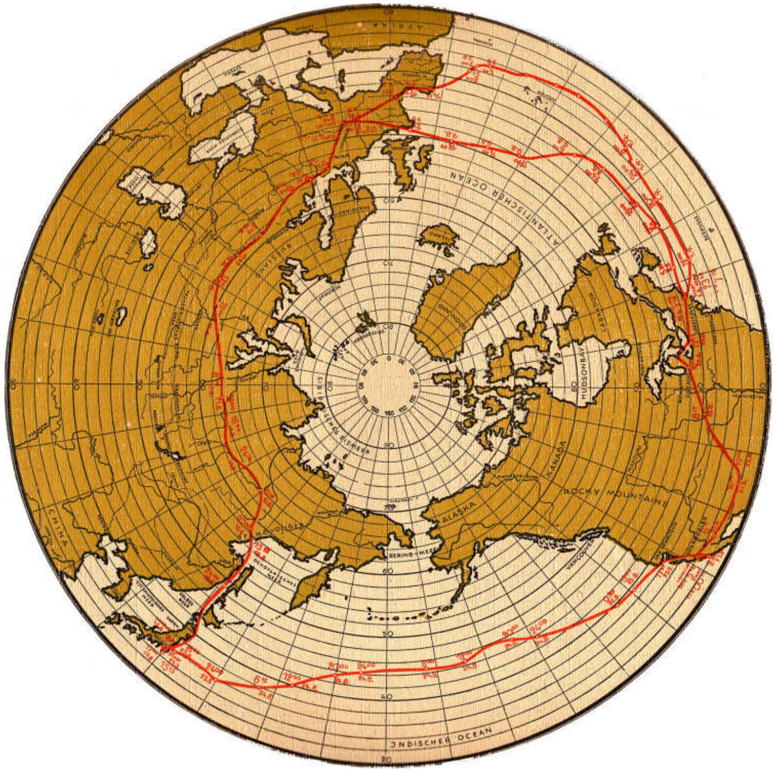
Lieut. Cmndr. C.E. Rosendahl, USS Los Angeles

<u>Above</u>: LZ-127 crewmen conduct an in-flight repair to the outer cover somewhere over the *South Atlantic* (ca. 1933)

Weltfahrt

"…When the Graf Zeppelin made its epochal journey around the world in twenty-one days with fifty-nine men and one woman aboard, ten million wonderstruck Americans gazed skyward and marveled at the enormous bulk of it. Newspapers informed us that its nose was three city blocks distant from its tail, the arch of its back as far from its bottom as the roof of a ten-story building is from the ground, and its sides so far apart they would be chafed by the confines of a street one hundred feet in width. Radio announcers ran out of adjectives and breath in trying to describe it. Trick photographers stood the Graf on end alongside the Woolworth Building to show that the latter had the better of the size argument by only sixteen feet. We of the googling populace agreed right down to the last skygazer that it was a mighty big achievement. We opened our mouths and exclaimed in pop-eyed unison, 'What next?'…"

***The American Magazine*, May 1930**



In 1929, LZ-127 made perhaps its most famous flight; a round-the-world ("Weltfahrt," in German) voyage covering 21,500 miles in five legs from *Lakehurst, N.J.* to *Friedrichshafen*, Friedrichshafen to *Tokyo*, Tokyo to *Los Angeles*, Los Angeles to Lakehurst and then Lakehurst to Friedrichshafen again. It was the first passenger-carrying flight around the world and received massive coverage in the world's press. The flight was partly sponsored by American newspaper publisher *William Randolph Hearst* who paid for about half the cost of the flight in return for exclusive media rights in the *United States* and *Great Britain*.

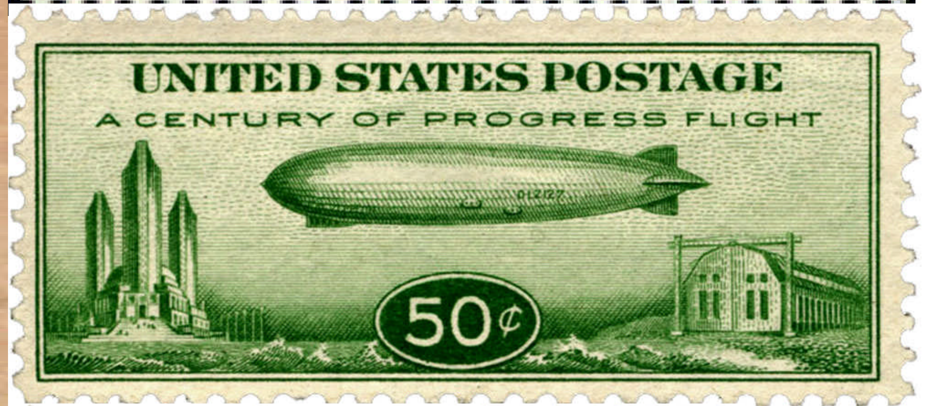
"…The voyages of the 'Graf' demonstrated many things about airship navigation over long distances. That there is need for obtaining better methods of obtaining reliable weather reports is one of the most outstanding. Throughout the twenty-one day world journey, Dr. Hugo Eckener had to rely largely on his own experience and perception of conditions to determine the best course. He received weather reports over Europe, America and the oceans, but this information was almost entirely lacking over Asia and left much to be desired at other points. Undoubtedly, when airship travel becomes an everyday matter, there will be a well-organized network of weather stations, radio transmitters, and like equipment covering the earth. Then the condition of weather will have only a limited effect on airship-line operation…"

***Popular Mechanics,* February 1930**

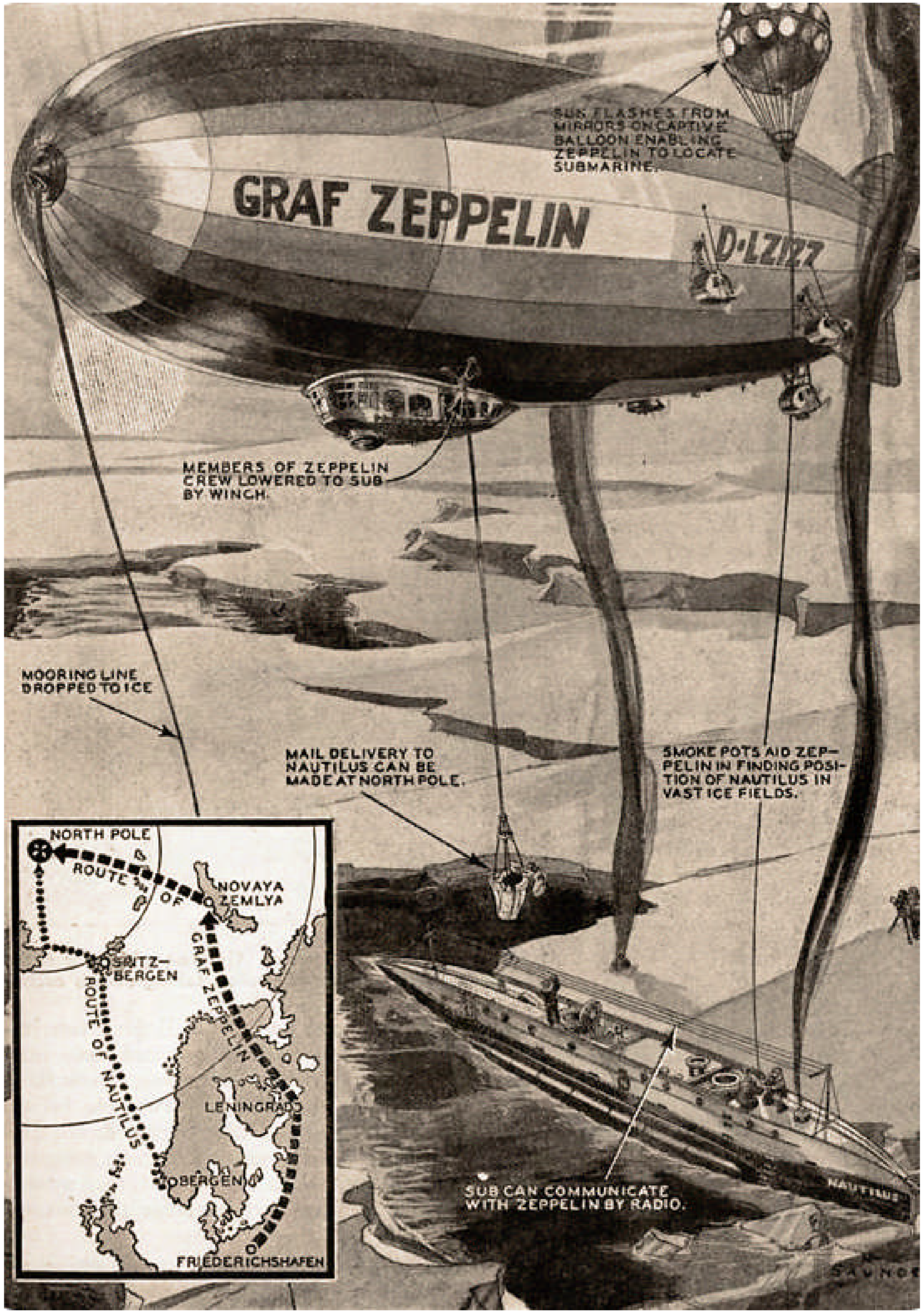
Left: ***Hugo Eckener***


GRAF ZEPPELIN
SUPPLEMENT TO THE AIRPOST JOURNAL
OCTOBER
LZ LUFTSCHIFFBAU ZEPPELIN
HAPAG HAMBURG-AMERIKA LINIE


GRAF ZEPPELIN
EUROPE-PAN AMERICA FLIGHT
65¢
65¢
UNITED STATES POSTAGE


UNITED STATES POSTAGE
A CENTURY OF PROGRESS FLIGHT
50¢

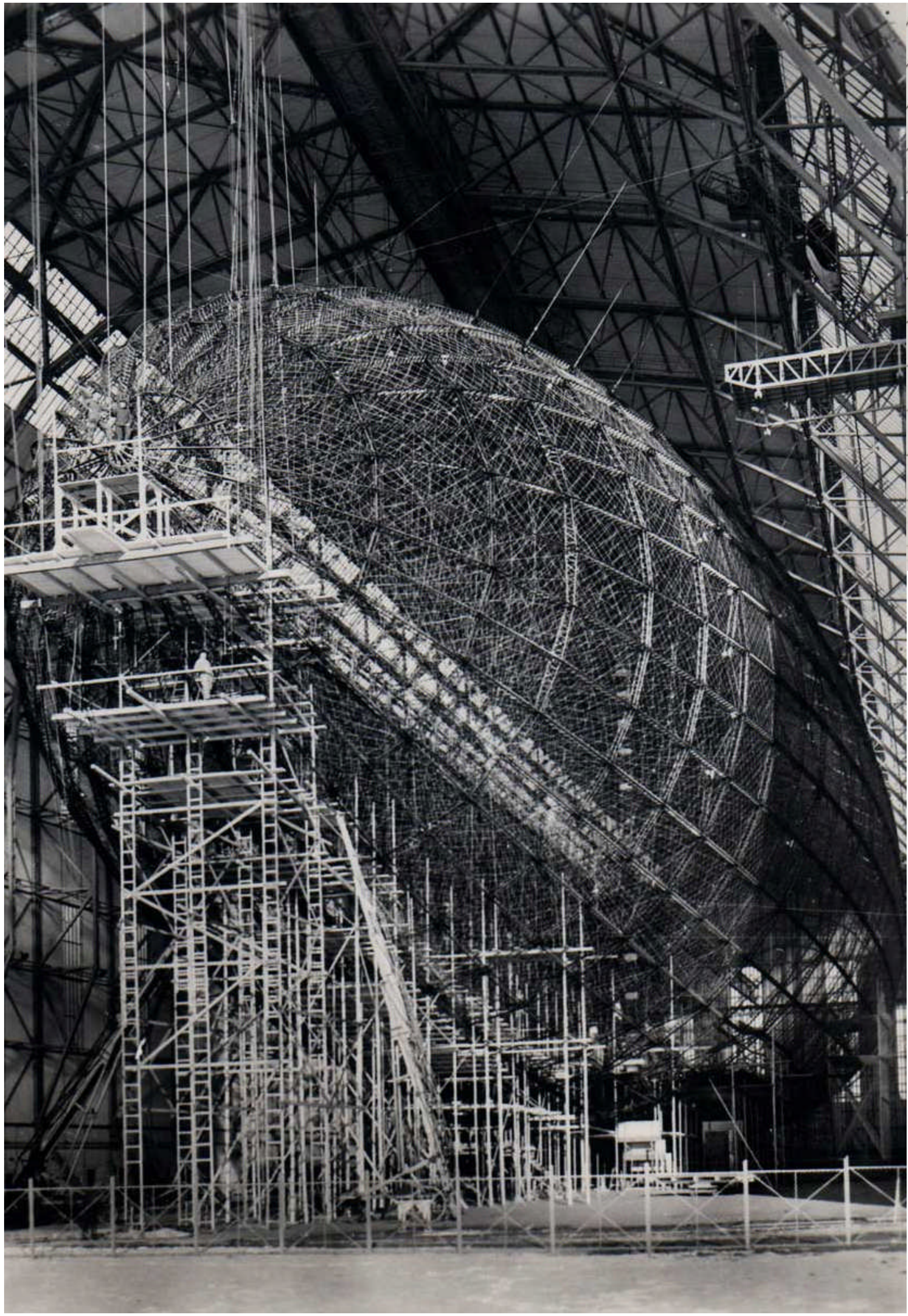

URSS-POLE DU NORD 1931
ВОЗДУШНАЯ ПОЧТА
35
КОП

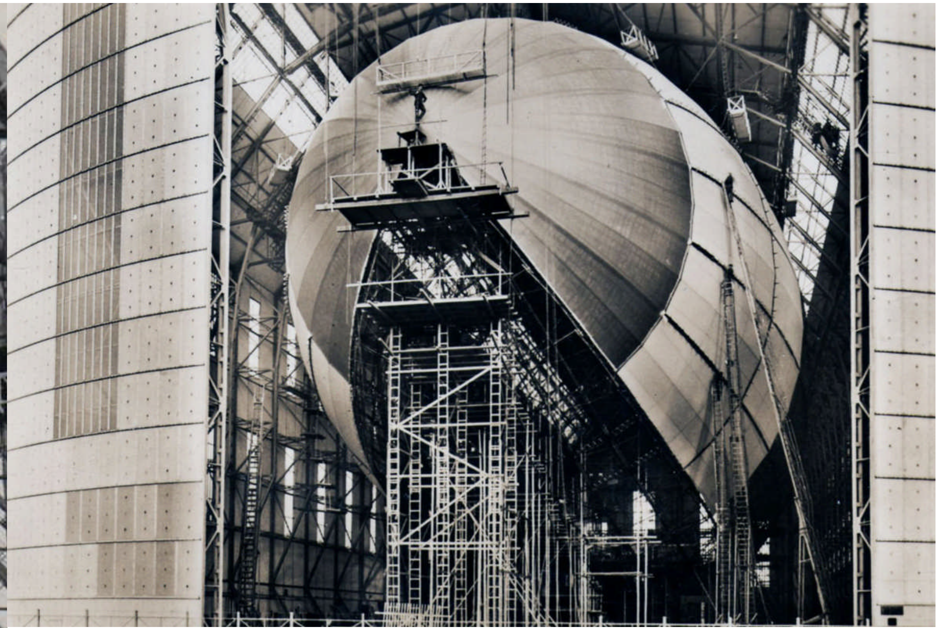


"Details of the methods by which the Graf Zeppelin and the Nautilus, Sir Hubert Wilkins' polar submarine, hope to complete at the North Pole the most amazing rendezvous in all history, are pictured in the drawing at left. The map shows the route these craft will follow. The Nautilus, described in detail in last month's issue of Modern Mechanics and Inventions, is now on its way to the North Pole…"

Modern Mechanix, **1931**

RE: the planned rendezvous of the *Graf Zeppelin* and Sir Wilkins' polar submarine did not occur due to a loss of the submarines' diving planes





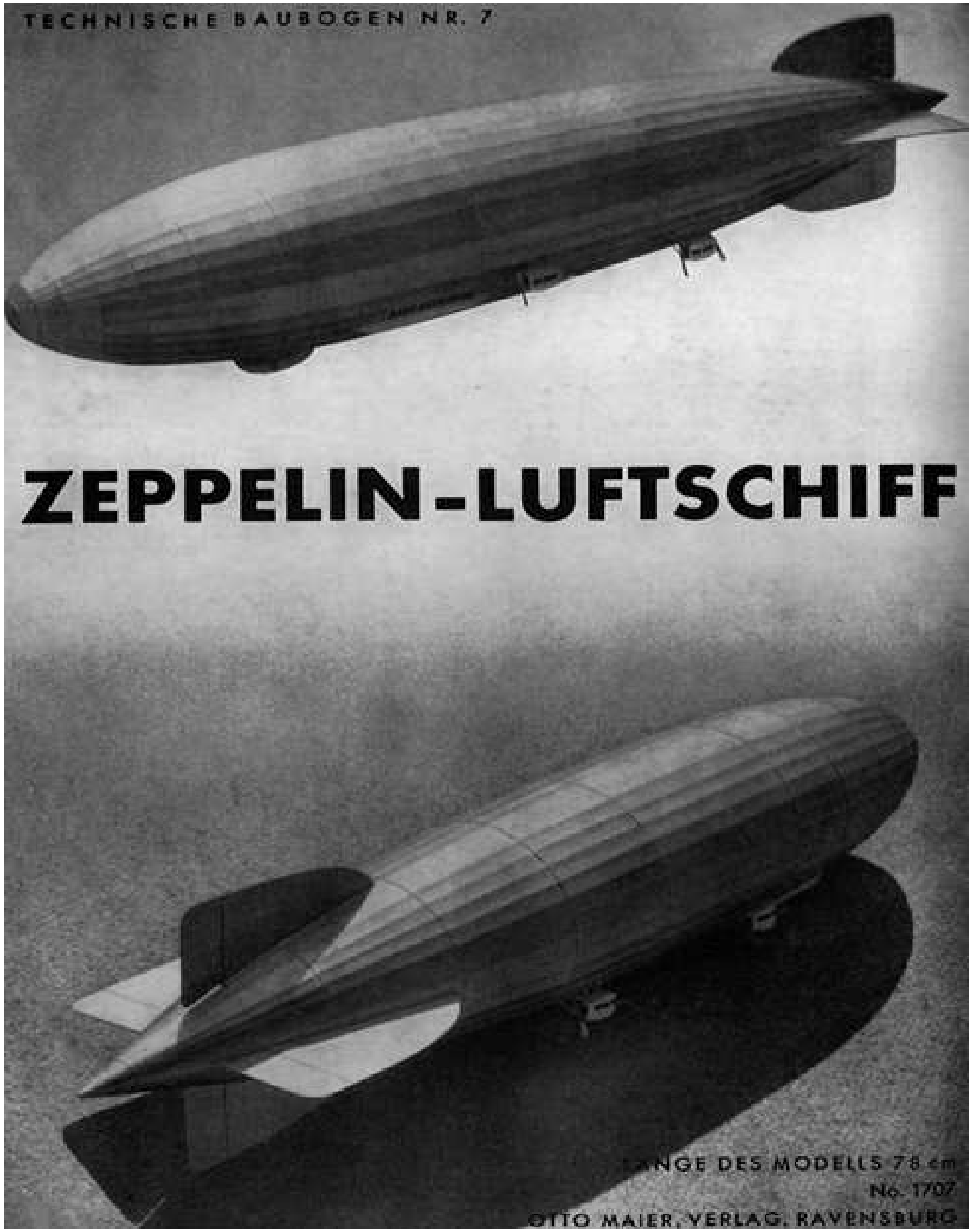
The great success of the *Graf Zeppelin* proved the viability of long range passenger transportation by airship and by the late 1920's, *Hugo Eckener* and the *Zeppelin Company* were enthusiastic about building a fleet of airships specifically designed for intercontinental passenger transportation.

<u>Above & Left</u>: the airship *Hindenburg* (LZ-129) under construction

"…Clark Howell, chairman of the Federal Aviation Commission, recently pointed to the value of dirigibles in commerce. 'Dr. Eckener,' he said, 'has made thirty-seven voyages across the ocean and circumnavigated the earth without missing a schedule in the 'Graf,' covering more than 625,000 miles without a serious accident. If the Germans can do it, we can. The record of the 'Graf Zeppelin' should be an object lesson and we should leave nothing undone to see to it that, whatever may be the shortcomings, either in construction or operation, of lighter-than-air craft, they can and will be surmounted.' Commander Charles E. Rosendahl, a veteran of many airship flights, said: 'the loss of 282 airships since 1919 was due almost entirely to naval and military operations. No attempt to cross the ocean by airship has ever come to grief.'"

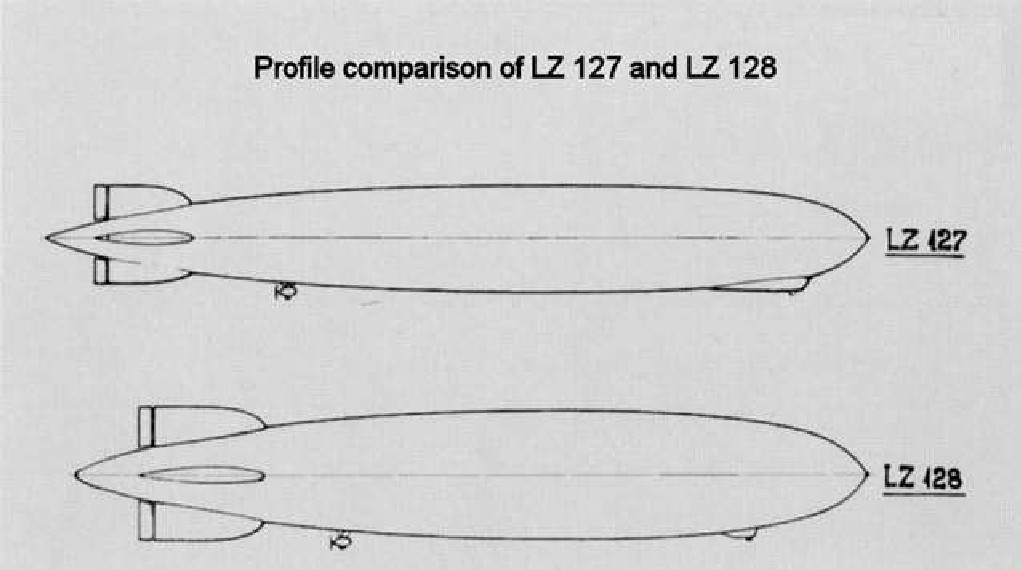
***Popular Mechanics,* June 1935**

LZ-128



Known only by its works number: "LZ-128," some contemporary press reports mentioned that it would boast a passenger capacity of 120 and showed artist's conceptions that included a wildly speculative hull design with a topside lounge. In fact, the LZ-128 was to have essentially been a refined version of her sister-ship; LZ-127. Lifted by hydrogen and powered by ten *Maybach* VL-2 engines in five tandem gondolas for a total of approximately 5600 HP, it was slated to be about the same length as the *Graf Zeppelin* (776-feet), only fatter. Whereas the volume of LZ-127 was 105K cubic meters (3.7 million cubic-feet) was dictated by the dimensions of the shed in which she was built, LZ-128 would be assembled in Luftschiffbau Zeppelin's brand new construction shed, which would measure 820-feet long, 164-feet wide and 151-feet high. This would allow for the construction of much larger airships and LZ-128 was to have had a volume of 5.5 million cubic-feet – a third again the volume of the *Graf Zeppelin*. It was also projected to carry ten-tons of freight.

Left: artist's rendering of the never realized LZ-128



Early reports indicated that the LZ-128 would have accommodations for twenty-five passengers contained in an external combination control/passenger gondola much like that of the *Graf Zeppelin.* However, it is unclear whether this was ever part of the actual design or whether the plans changed later in the process. Available information suggests that the LZ-128 was probably intended to have a passenger deck or decks contained up inside the airship's hull, as would later be found on LZ-129 (*Hindenburg*). It appears that as the LZ-128 project progressed throughout 1930, the airship that was beginning to take shape on the drawing board began to look less like its sister-ship and more like the airship that would ultimately replace it on the drawing board; the LZ-129. By mid-summer of 1930, *Luftshiffbau Zeppelin* began preparations for construction and by the end of September, production of rings for LZ-128's framework had begun. Then, on October 4th 1930 came the news that Great Britain's R-101, on its maiden overseas flight to *India*, had crashed and burned with heavy loss of life in northern *France*. The airship had been forced down in bad weather and caught fire shortly after impact. The resulting hydrogen fire completely destroyed R-101 and forty-eight of the fifty-four people aboard were killed, including Air Minister *Lord Thomson*. Suddenly, the prospect of inaugurating transatlantic passenger airship service with a hydrogen airship seemed far less appealing.

Left: caption: "Profile comparison of LZ-127 and LZ-128"
Right: model of the LZ-128 that was designed for wind-tunnel tests

"As regards the performance, size, etc. of the airships for trans-Atlantic work, Luftschiffbau Zeppelin had evidently given the matter little or no consideration. This hydrogen ship was designed for trans-Atlantic service either to North or South America without regard to traffic or other considerations. It was frankly a tramp airship good 'anywhere' which Dr. Eckener thought should be our first Atlantic ship to be run experimentally to train crews, establish operating schedules, etc. He would run it, perhaps, on mail and express only, both to North and South America…I was sure our group would never agree to build a terminal for the use of a hydrogen airship. I also pointed out that Goodyear-Zeppelin could not afford to wait a couple of years while his hydrogen airship operated as a tramp on special voyages with the danger of disaster always present."

***Dr. Jerome Hunsaker, International Zeppelin Transport Company* (IZT)**

RE: IZT had been founded on March 25th 1930 with the express purpose of facilitating regular transatlantic airship service. The organizations that had initially signed on included *Luftschiffbau Zeppelin*, *Goodyear-Zeppelin, National City Bank*, *United Aircraft and Transportation Corporation, Union Carbide Company* and the *Aluminum Company of America* (ALCOA). The plan was for airships to be built both by Luftschiffbau Zeppelin and Goodyear-Zeppelin, in their respective countries, for use on a passenger airship line to be run between *Europe* and the northeastern *United States*. Much depended upon LZ-128 and its ability to prove itself as a regular and reliable form of transit across the *North Atlantic*.

The LZ-128 project was at odds with what had previously been discussed and agreed upon by Dr. Eckener and the IZT stakeholders. The Americans had been using helium exclusively for their airships since the fiery crash of the U.S. Army's Italian-built semi-rigid ship *Roma* in 1922 and IZT was not inclined to kick-off its transatlantic passenger service using a hydrogen airship, let alone one that wasn't specifically designed for the rough weather conditions common to the *North Atlantic*. Dr. Hunsaker also wrote *Hugo Eckener* probing the possibility of buying American helium (foreign sales of the gas being banned by law at the time). On November 4th 1930, Dr. Eckener publicly announced that LZ-128 would be redesigned to fly on helium and made the first references to hydrogen "anti-ballast" cells contained within larger cells of helium to provide for economical valving. No mention however was made of any formal attempts to secure American helium. On December 29th 1930 an internal *Luftschiffbau Zeppelin* memo, entitled "Projekt LZ-129," mentioned the new works number LZ-129 for the first time and solicited technical opinions for the project. It had been determined that LZ-128 could not effectively be reworked for helium and that a fresh start was necessary. The LZ-128 was officially announced at the annual board meeting of DELAG on June 15th 1931, but it was a mere formality. LZ-128 would not be completed and its construction never progressed beyond the first few rings.

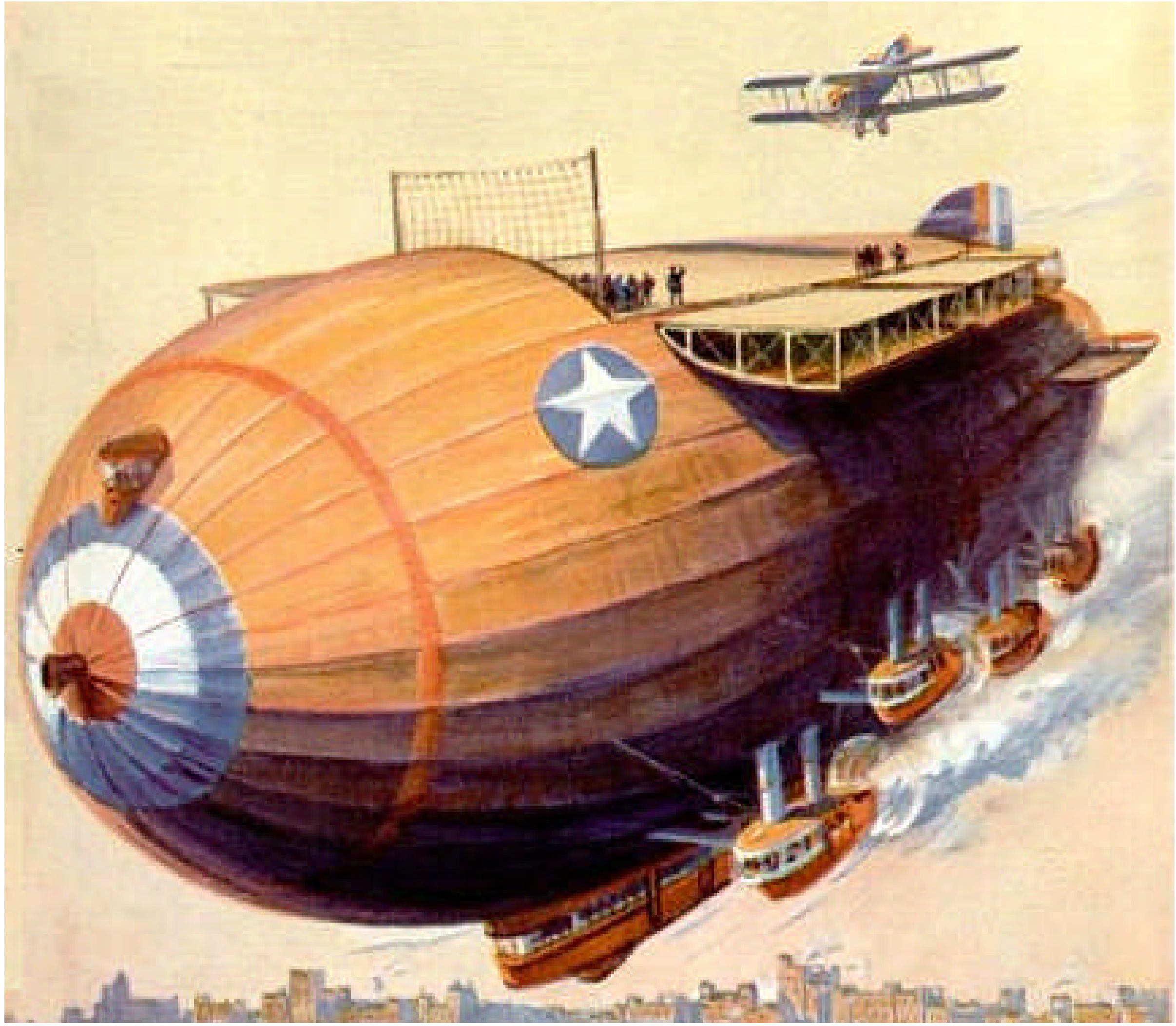
Mother Ship of the Air

"…Uncle Sam will soon own the first 'mother ship of the air.' Carrying beneath her huge 300-foot body a brood of speedy bombing and scouting planes that she can release or pick up while traveling at full speed, the 'R-1' – first semi-rigid airship to be built in America – will provide, when completed, an effective means of patrolling the Atlantic or Pacific seaboard…"

Popular Science Monthly, **February 1923**

"…the future airship, developed for naval use, will carry a sting that will make it one of the most formidable contenders for supremacy of the sea, air, and earth that has ever been conceived. Allowing 60 tons of useful load to our air giant, we may set aside one half of this for fuel, which will leave 30 tons for planes, landing gear, guns, ammunition, and bombs. Superior types of fighting planes now in service use weigh less than a ton each. Other types of planes have been developed which weigh less than 1,000 pounds. It is well within the bounds of reason to predict that the naval airship of the future will carry a dozen planes that will be capable of defending her against air attack, and in addition will mount a battery of guns that will command the respect of any enemy marauder…"

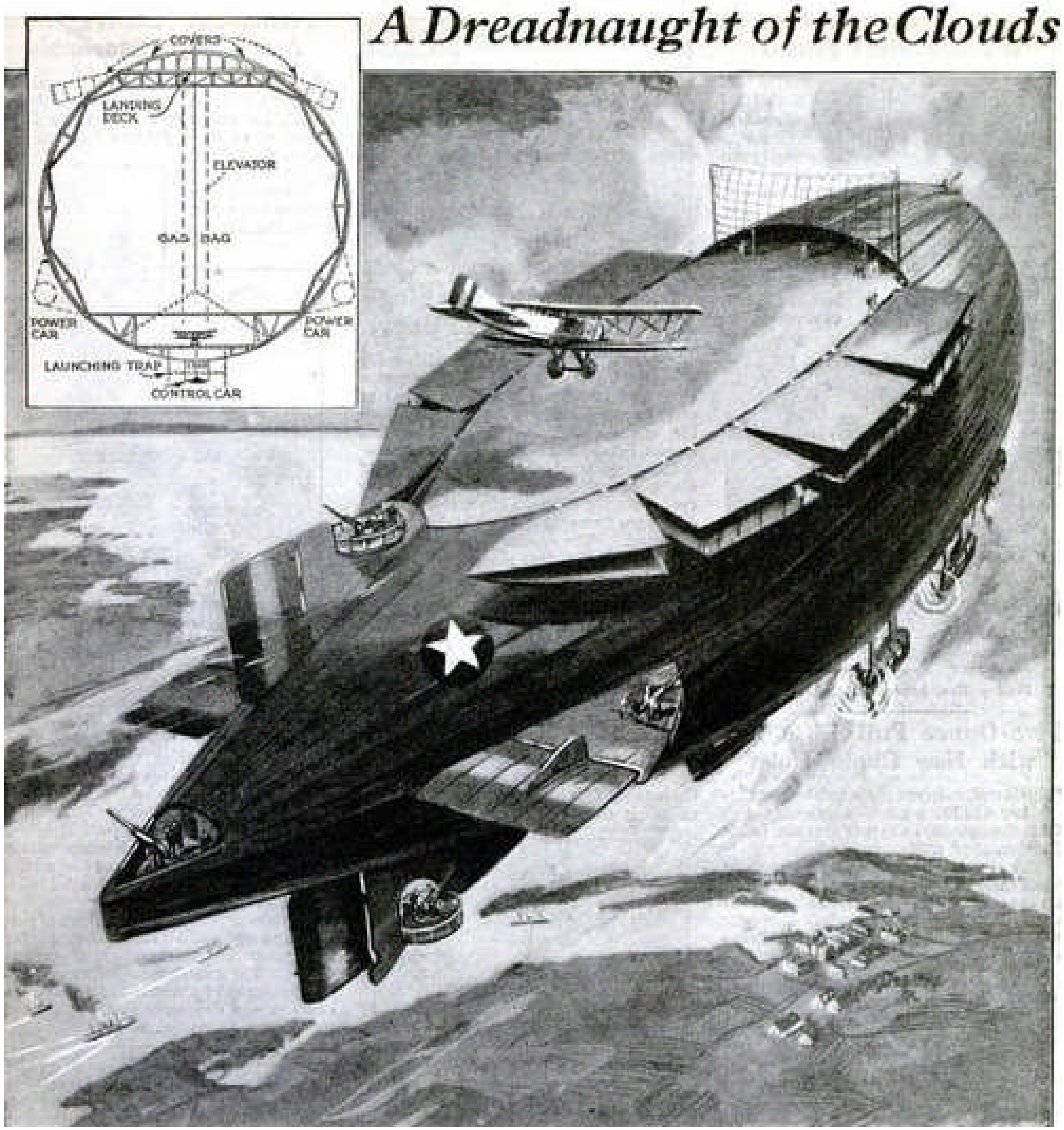
***Admiral William A. Moffett,* Chief of the Bureau of Naval Aeronautics**
RE: comments made in 1923



Dreadnoughts of the Clouds

"…An air battleship, the ZRS-4, which will be one hundred and sixty-one feet longer than our greatest water battleships and larger than the Graf Zeppelin and the Los Angeles combined, is even now being built for the Navy by the Goodyear-Zeppelin Corporation at Akron; and it will be flying in two years. A second air battleship, the ZRS-5, will be ready fifteen months later. Each of these superships will carry a squad of five fully assembled airplanes in her hull, will have a cruising range of 10,580 square miles of ocean in a day…"

***The American Magazine,* May 1930**



"…The airship filled with helium and defended by guns and airplanes, will be in effect a battleship with the sky as the limit. As the battleship is divided into watertight compartments, so the airship is made up of a number of gas cells. When a watertight compartment is punctured, the ship does not sink. This method of construction has saved ships even against the destructive effect of torpedo explosion. So the puncturing of a gas cell in the airship will not spell disaster. We may see these battleships of the air, riddled with shells, still fighting gallantly on to victory…"

Admiral William A. Moffett, **Chief of the Bureau of Naval Aeronautics RE: comments made in 1923** [253]

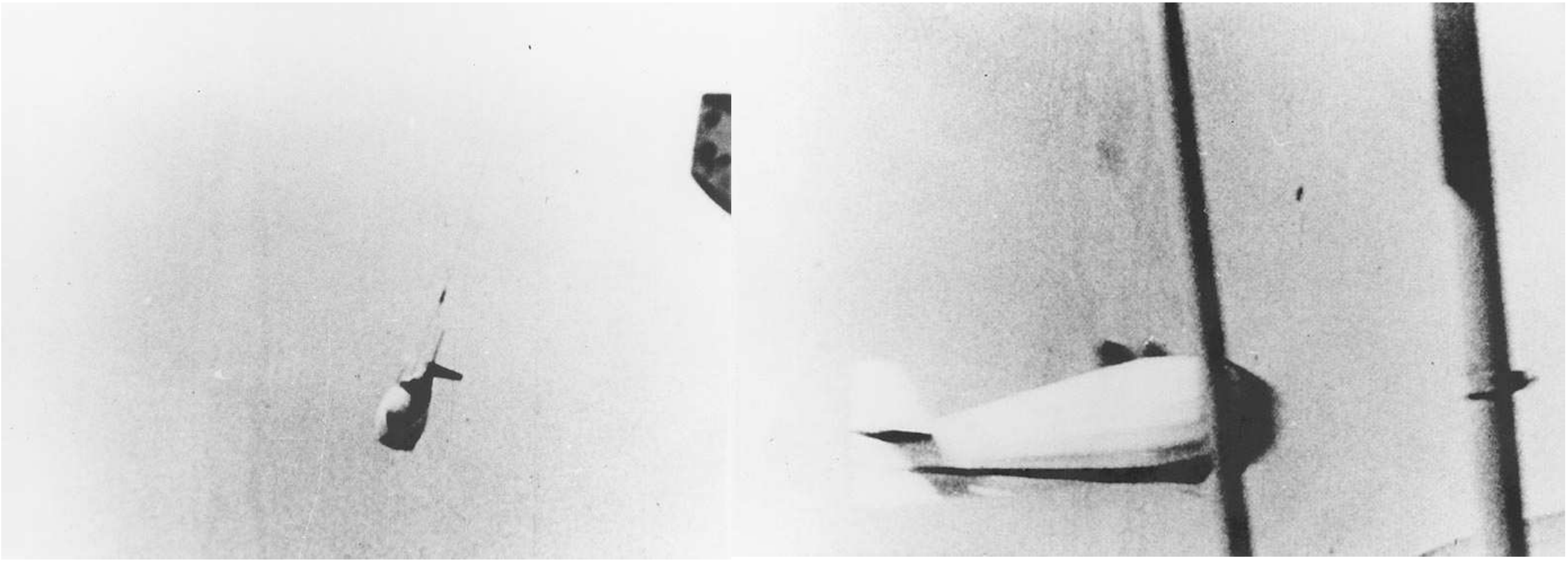
“…The ship will carry twenty-five machine guns and one automatic canon. Rear Admiral William A. Moffett, Chief of the Bureau of Aeronautics, says: ‘An enemy aircraft cannot approach from any angle without permitting a concentration of fire. The ship can be pierced with 200 holes and lose but 25 percent of gas volume in five hours.’ In climbing ability the dirigible surpasses, and therefore should be valuable for bombing operations. A fast flying plane requires forty-nine minutes to climb 21,000 feet; a dirigible can rise at twice that speed. The big bombing planes reach their ceiling at 10,000 feet. The new Navy ship will go to 26,000…”

Popular Science Monthly, **January 1928**

"In this air vessel, five hundred men, each with forty-five pounds of equip-ment, could be carried from San Francisco to Hawaii in thirty hours and arrive after that journey with a 24-hour reserve of fuel"

Admiral William A. Moffett, **Chief of the Bureau of Naval Aeronautics**

RE: *USS Akron*. Comments made in 1926. Admiral Moffitt (left) was known as "The Father of Naval Aviation." He was killed in the crash of the Akron on April 3rd 1933



"…Since the Akron will be a military craft, it will carry guns and bomb-dropping equipment. Two 'spy baskets' carrying an observer apiece can be dangled through the clouds on 1,000-foot lines while the airship remains hidden in a cloud bank. The Akron will also carry a fleet of scouting planes."

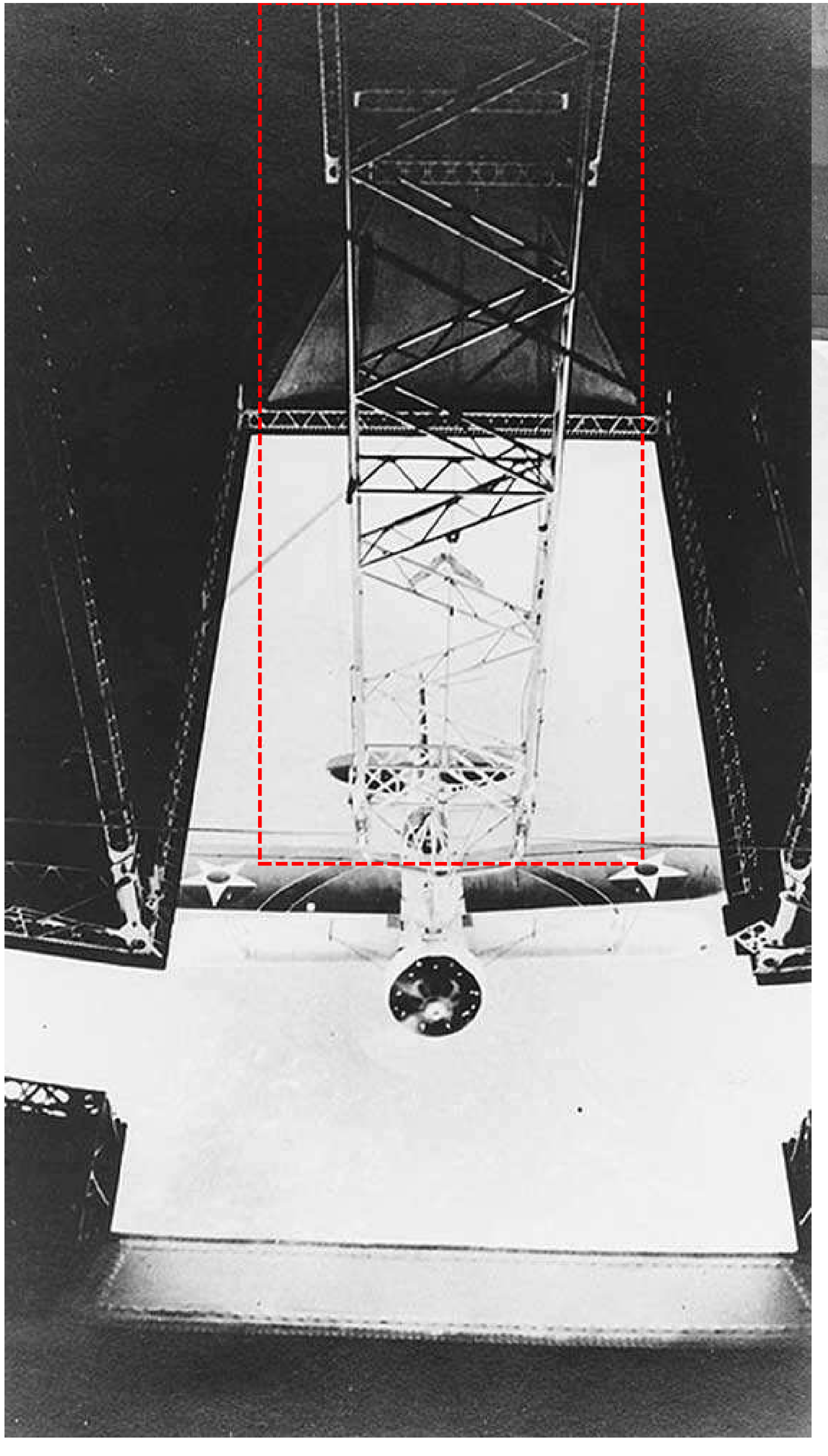
Popular Science Monthly, **May 1931**

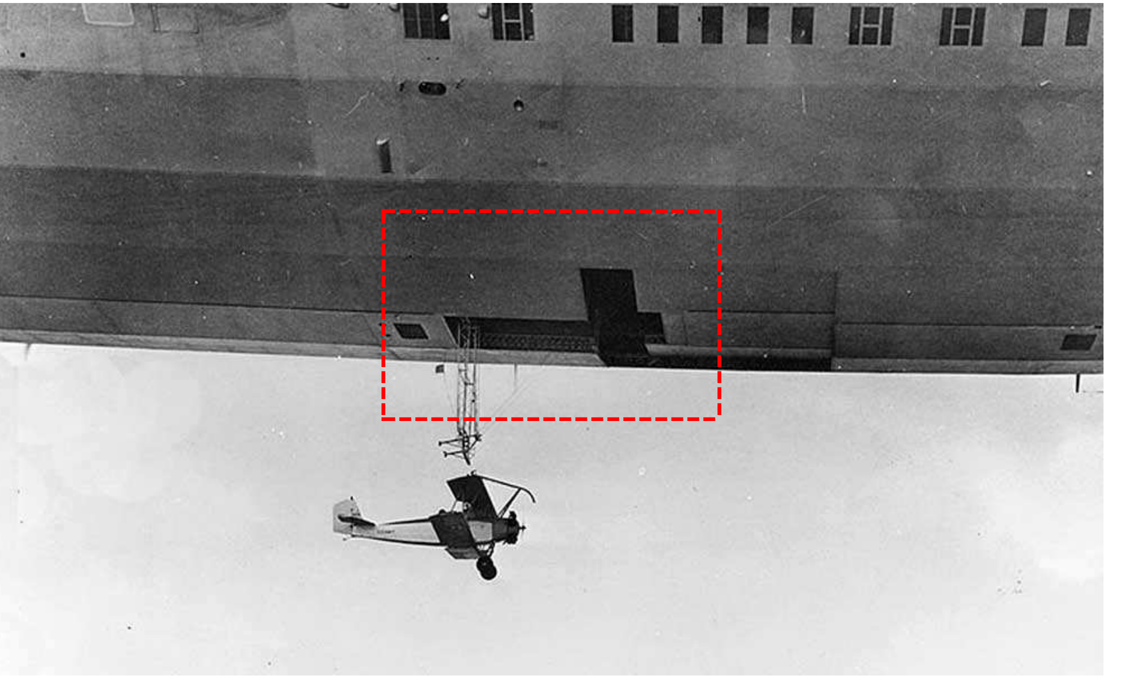
Above: "Spy Basket" of the *USS Macon* deployed (ca. 1934)

The *U.S. Navy* airships *U.S.S. Akron* (ZRS-4, above) and *U.S.S. Macon* (ZRS-5, left) were designed for long-range scouting in support of fleet operations. Often referred to as "flying aircraft carriers," each ship carried F9C-2 *Curtiss Sparrowhawk* biplanes which could be launched and recovered in flight, greatly extending the range over which the two rigid airships could scout the open ocean for enemy vessels.

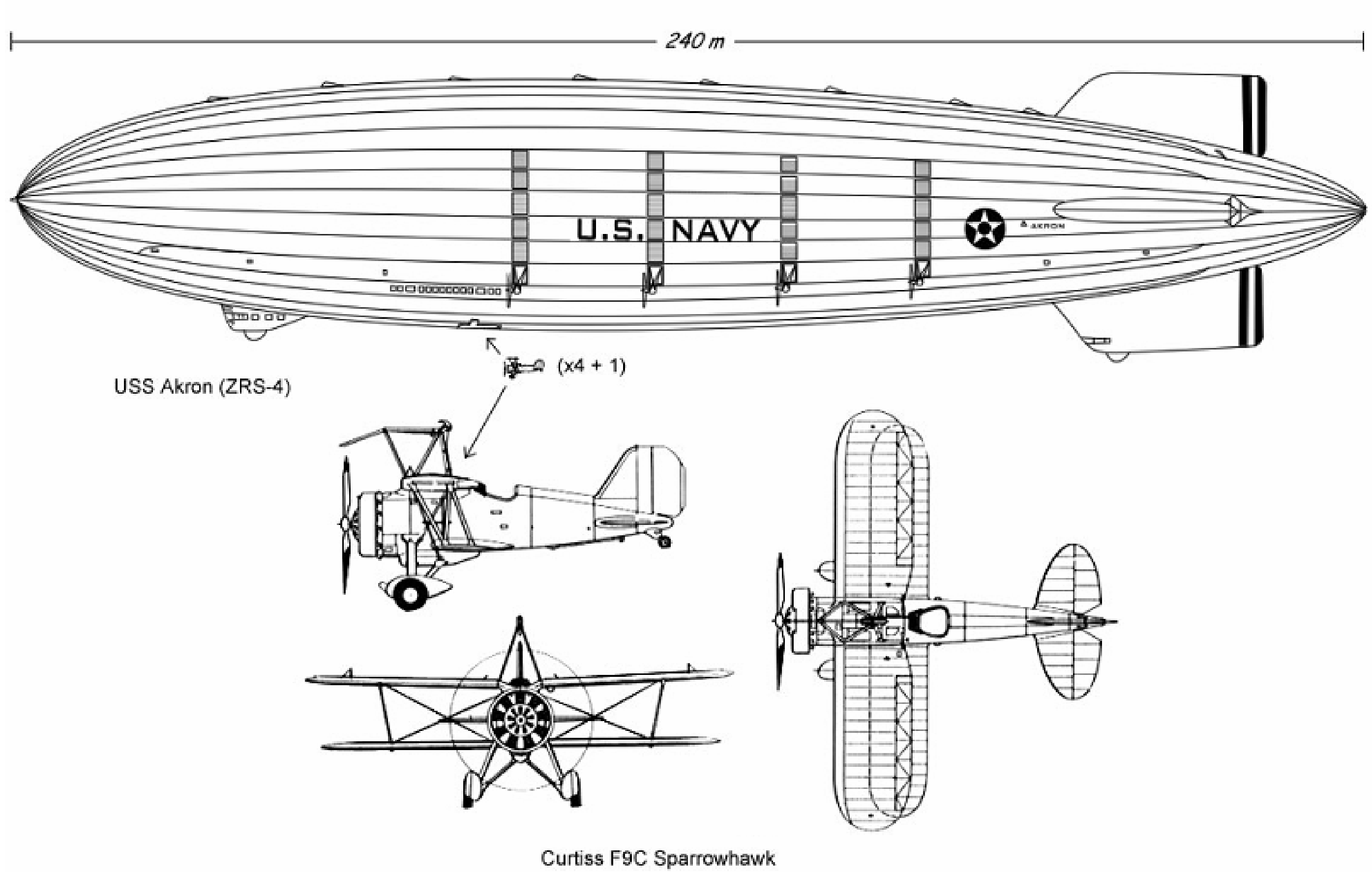
"…Perhaps the most spectacular phase of the airship's growth is its recently acquired ability to carry airplanes. The new British ships, it is reported, are designed primarily as mother ships for airplanes, and are equipped so that the planes can be used as auxiliary power plants. The American Zeppelins will have compartments within the hull that will hold five to seven planes, depending on size…"

Popular Mechanics, **February 1930**





***Akron* and *Macon* were both designed as airborne aircraft carriers which could launch and/or recover heavier-than-air biplanes for use in reconnaissance and/or self-defense. The airships were equipped with hangars; approximately 75-feet long by 60-feet wide by 16-feet high which could stow and service up to five aircraft. Aircraft were launched and retrieved by means of a “trapeze” (left), and could enter and exit the hangar though a large T-shaped opening at the bottom of the hull (above).**



"…Means of returning the planes to the parent ship could take the form of a landing deck, on top of the ship or suspended beneath it. Stowage space for the fighters could be provided in the body of the ship along the keel line. The launching of them is merely a matter of pushing the planes off into space, where they can recover themselves with the ease of a bird thrown into the air…"

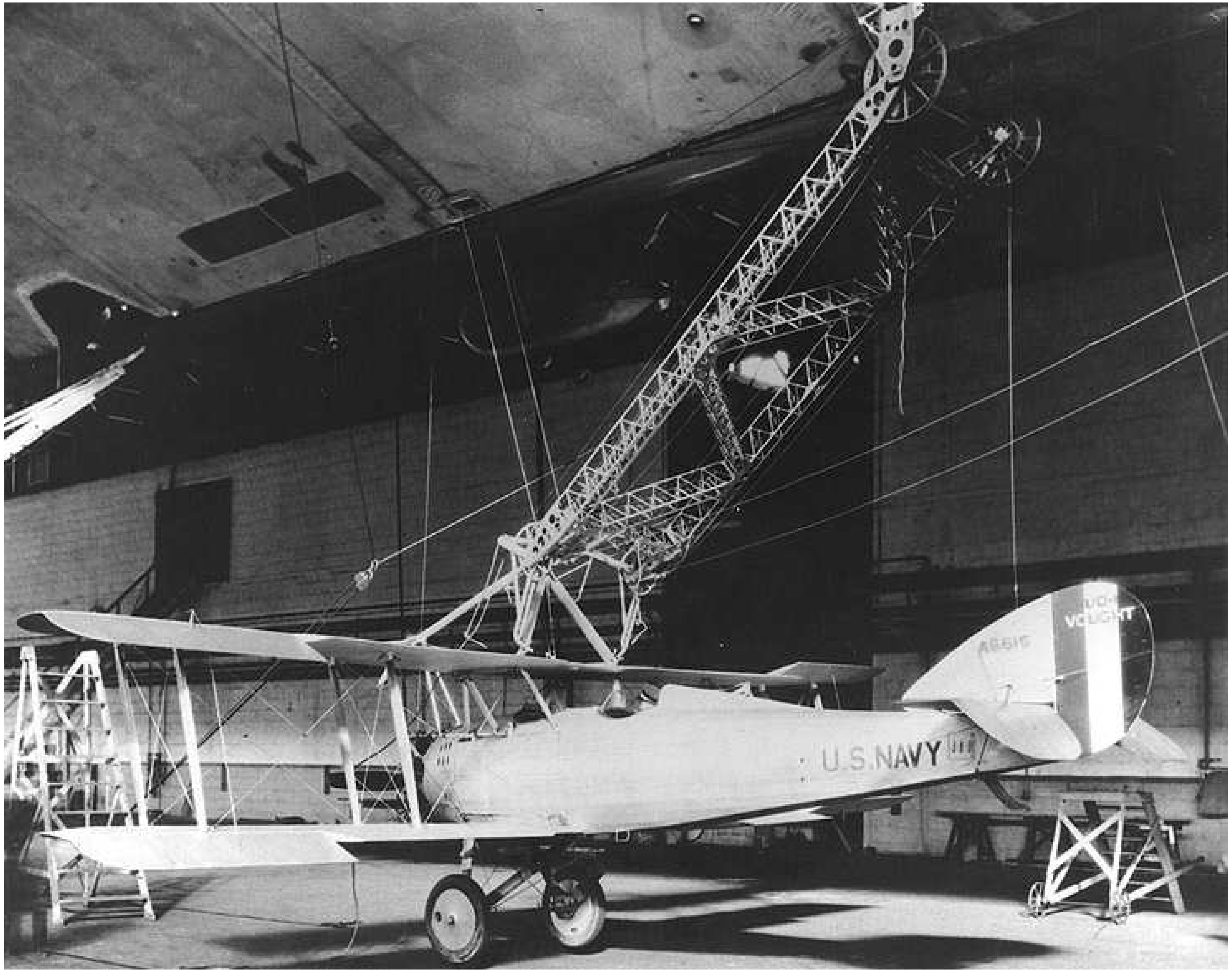
Admiral William A. Moffett, **Chief of the Bureau of Naval Aeronautics**

RE: comments made in 1923

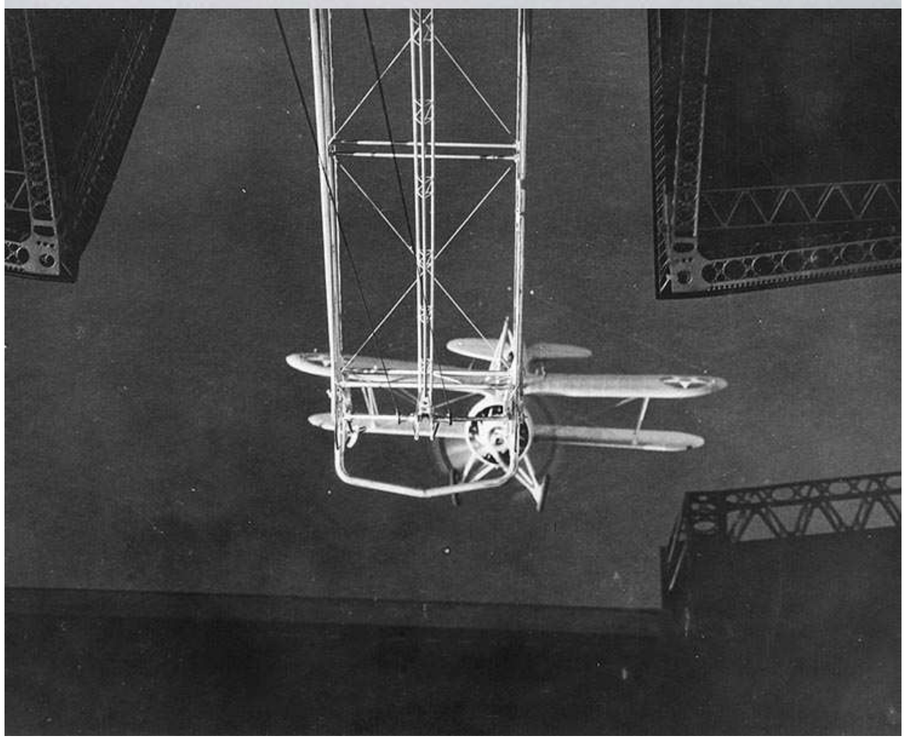
<u>Above</u>: caption: "Consolidated N2Y-1 training plane photographed while serving as "hook-on" familiarization trainer for USS Akron (ZRS-4), 1932. An O3U-1 is in the background."

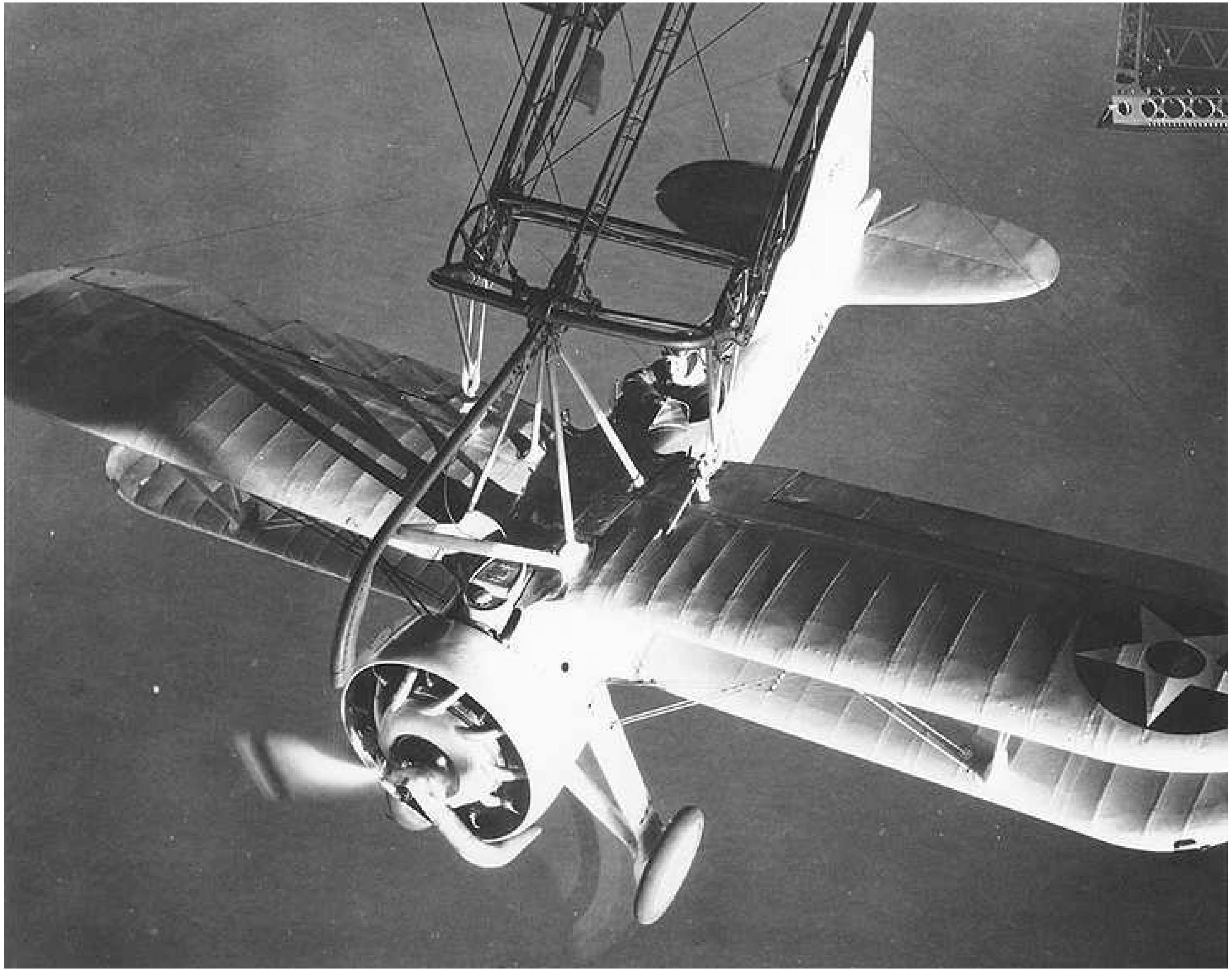
"…This country was among the first to investigate the possibility of airplanes being carried by airships…Four years ago at the Naval Air Station in Rockaway, New York, a non-rigid airship of the C-class was equipped with a cable and winch for carrying an airplane suspended from it…On the top of the wing, a ring was secured to the structure of the plane. On the end of the cable let down from the airship, a hook engaged the ring and the plane was suspended from the ship at a distance of about 50 feet below it. When the hook was released by a tripping device, the plane fell a vertical distance of about 200 feet, then recovered its equilibrium and flew to a safe landing…"

Admiral William A. Moffett, **Chief of the Bureau of Naval Aeronautics**
RE: comments made in 1923

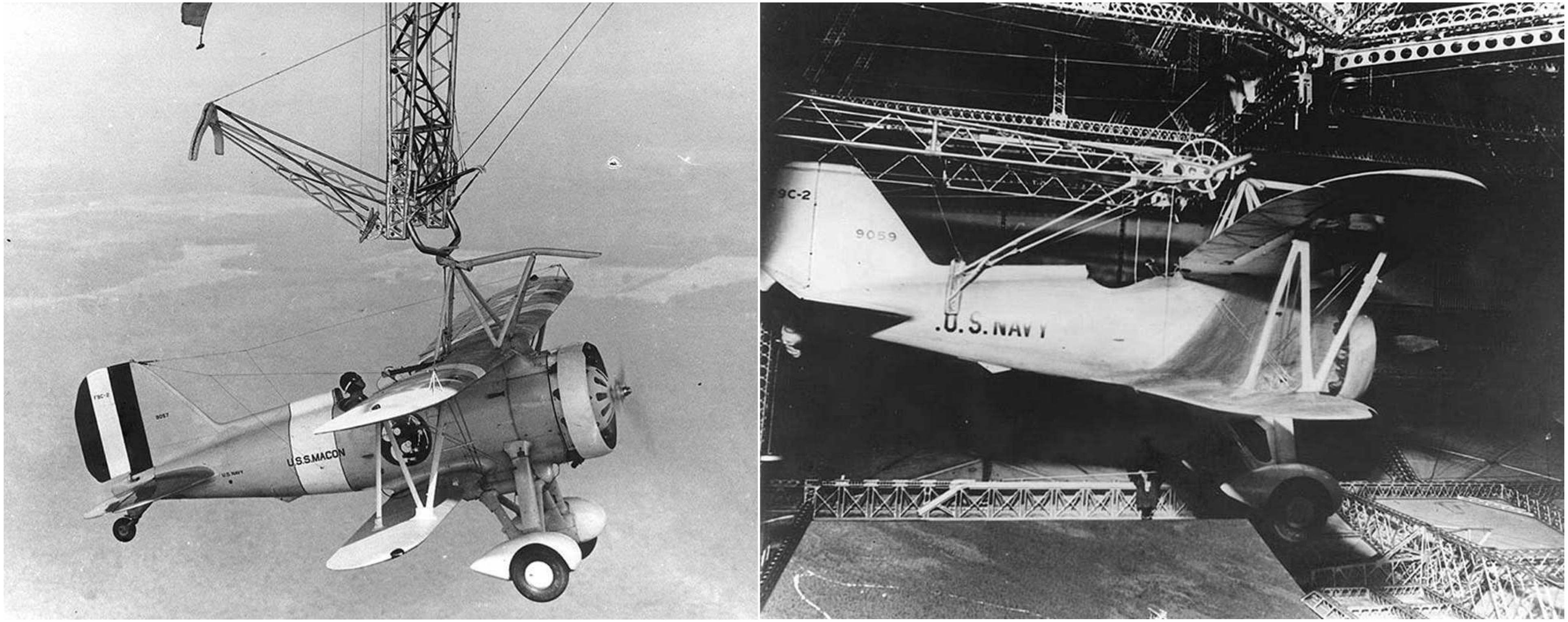


<u>Above</u>: caption: "Vought UO-1 observation airplane attached to the trapeze of USS Los Angeles (ZR-3) during mating experiments in the airship hangar at Naval Air Station Lakehurst, New Jersey, 15 December 1928."

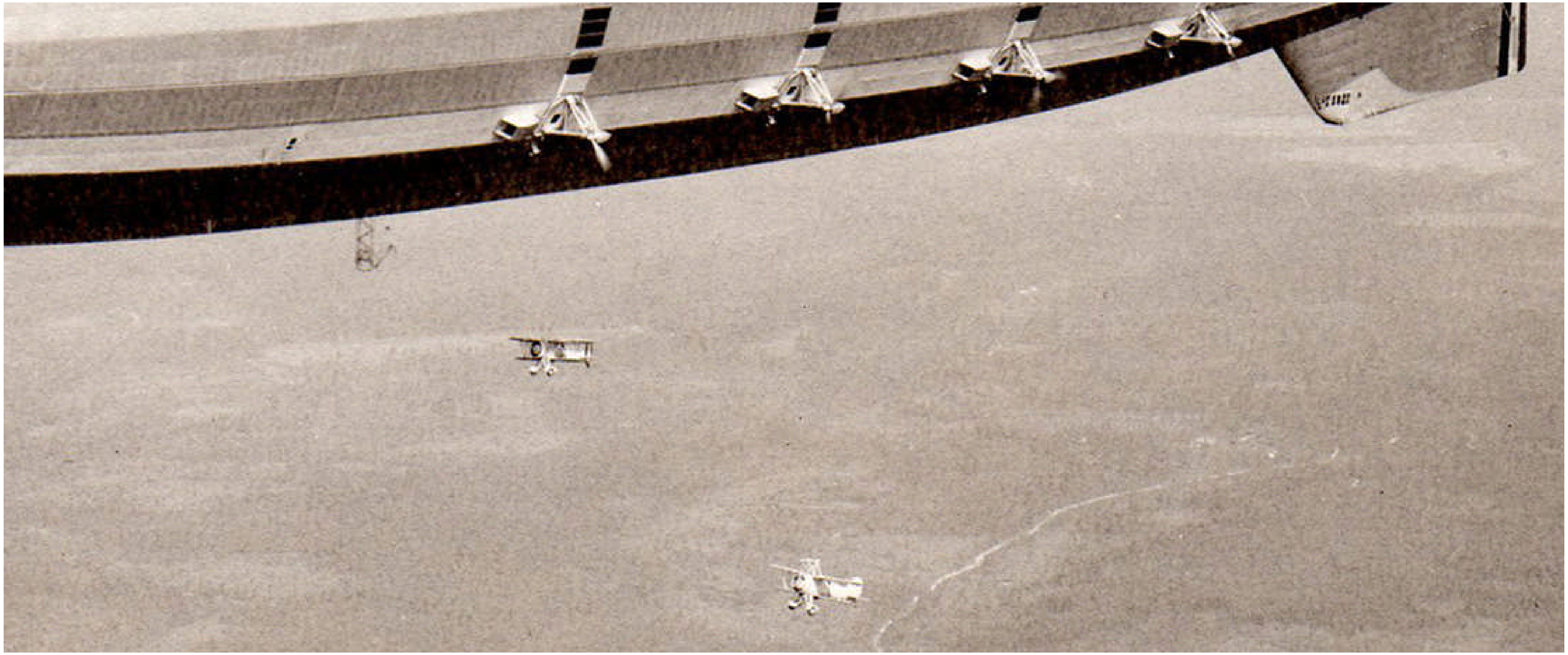




<u>Above</u>: caption: "Curtiss XF9C-1 Sparrowhawk is lifted into the hangar of USS Akron (ZRS-4), after hooking onto the airship's trapeze landing gear, circa May 1932."



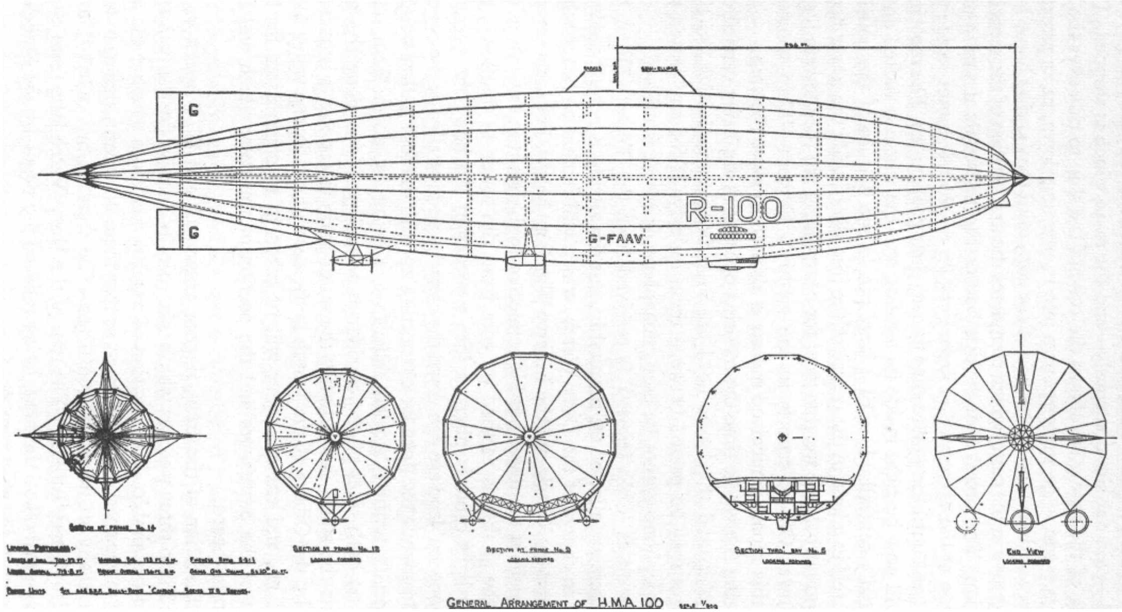
<u>Above</u>: F9C-2 biplane hooked on trapeze (left) and stowed on hangar deck (right). ZRS-4&5 *(Akron* and *Macon*) grew out of the five-year plan proposed by the U.S. Navy's *Bureau of Aeronautics* which had been approved by *Congress* in 1926 authorizing the construction of two large rigid airships.



The ability to launch and/or recover fixed-wing aircraft was the essential element of Akron and Macon's ability to serve as naval scouts. Airplanes greatly increased the range and area over which the airship could search for the enemy, but also addressed the airship's own inherent weakness; vulnerability to attack. The giant airships made large, slow targets which were extremely vulnerable to destruction by an enemy's aircraft. The Navy originally envisioned the airships as scouting vessels which carried airplanes for defense. However, over time the Navy eventually realized that the vulnerable airship itself was best employed out of range of a potential enemy. The airship's function would be to carry scouting planes within range of the enemy, but not itself come within range. As naval airship doctrine eventually developed, rather than the airplane extending the scouting range of the airship as first envisioned, it was the airship which extended the scouting range of the airplane.

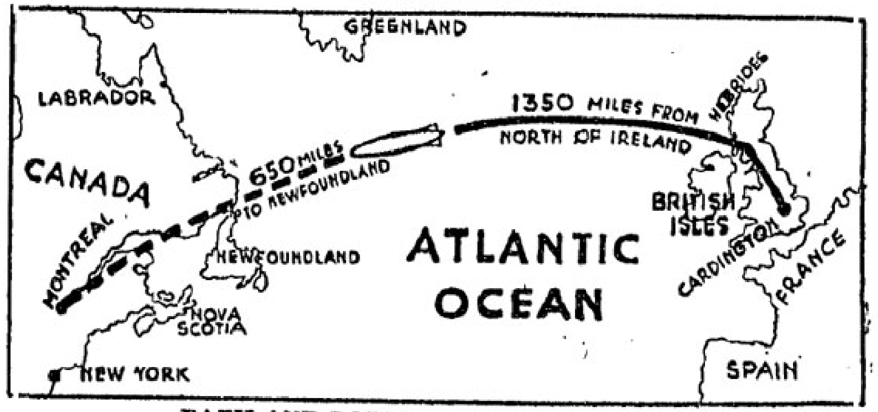
The Imperial Airship Service

In the mid-1920s, *Great Britain* was mired in a deep depression. The first world war had taken its financial toll and new technology was needed to kick-start a fresh period of growth. The *British Empire* was at its height, but transport technology still prevented rapid links between its major centers. It was at this time that dirigibles - large helium or hydrogen airships steered by gasoline engines - began to take shape as a viable means of transportation. The German, French, and Italian armies had used rigid airships as aerial bombers during the war and the enormous vessels had the potential to be long-distance passenger carriers provided they could be operated safely and with comfort comparable to transatlantic liners of the era. Airplanes of the 1920's were small, cramped, and capable of only short duration flights. Dirigibles, by comparison, had the potential to fly for days without stopping for fuel. With this in mind, the British government launched its *Imperial Airship Service*. Two vessels were to be built, one by a private company and the other by Britain's own engineers, to similar specifications. They were the R-100 and R-101, respectively.



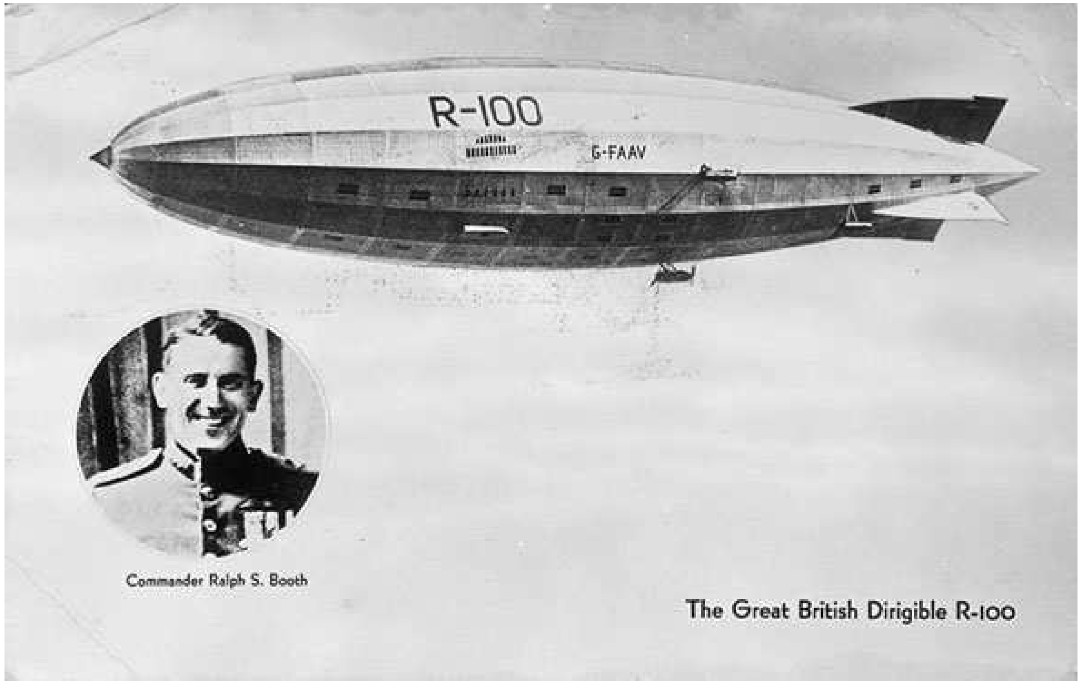
The decision to move way from the more traditional airship design lines was shown in the more oval, streamlined and aerodynamic shape of both the R-100 (above) and R-101. It was felt by the British government that having two prototypes built would lead to twice the level of innovation. One would be built by the *Royal Airship Works* and the other by a commercial contractor. The contract for the R-100 had been awarded to *Vickers* (a new subsidiary of Vickers; the *Airship Guarantee Company*, was set up purely for the construction of the airship). The airships were designed with only thirteen longitudinal girders compared to previous designs of up to twenty-five, hence the airships were lighter. An initial design problem was that the outer cover would ripple in flight, however this did not affect the performance of the ship. Also, there was a problem with the aerodynamic forces acting on the tail. This had shown up on wind tunnel tests but was dismissed as a scale anomaly. The original tail design was a very sharp tapering point, but the pressures built up and the tip broke off on one test flight. This was later replaced with the more traditional rounded tail. The *Imperial Airship Service* was the largest project of its kind and in 1929, the only competition was from the Zeppelin Company's smaller LZ-127 *Graf Zeppelin*.

Regular Routes Likely Between Old Land and Dominion Soon, as Fore-Runner of Great Empire Air Link System, Experts Believe



PATH AND POSITION OF DIRIGIBLE R-100

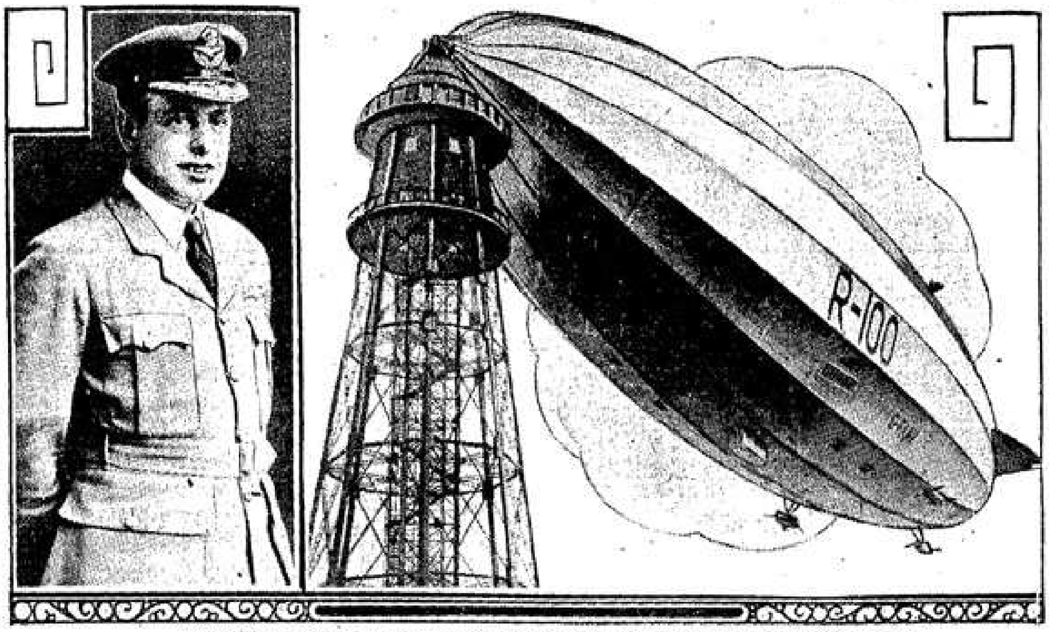
The Imperial Airship Service's first major test was an *Atlantic* crossing to be made by the R-100. The dirigible was supposed to take its first long-distance trip to *India*, but concerns over the effects of humidity in the region lead officials to prove their design with a visit to *North America* instead. The R-100 departed for *Canada* on Monday July 28th 1930, at 9:45 PM. It made its way northwest from its hangar at *Cardington, England*, and passed over the northern tip of *Ireland* in the early hours of July 29th. Forty-two crew members were aboard but only two passengers made the maiden trip.[271]



Commander Ralph S. Booth

The Great British Dirigible R-100

R-100 Ready for Transatlantic Trip to Canada



IF WEATHER PERMITS GIANT BRITISH DIRIGIBLE STARTS DOMINION FLIGHT NEXT SUNDAY

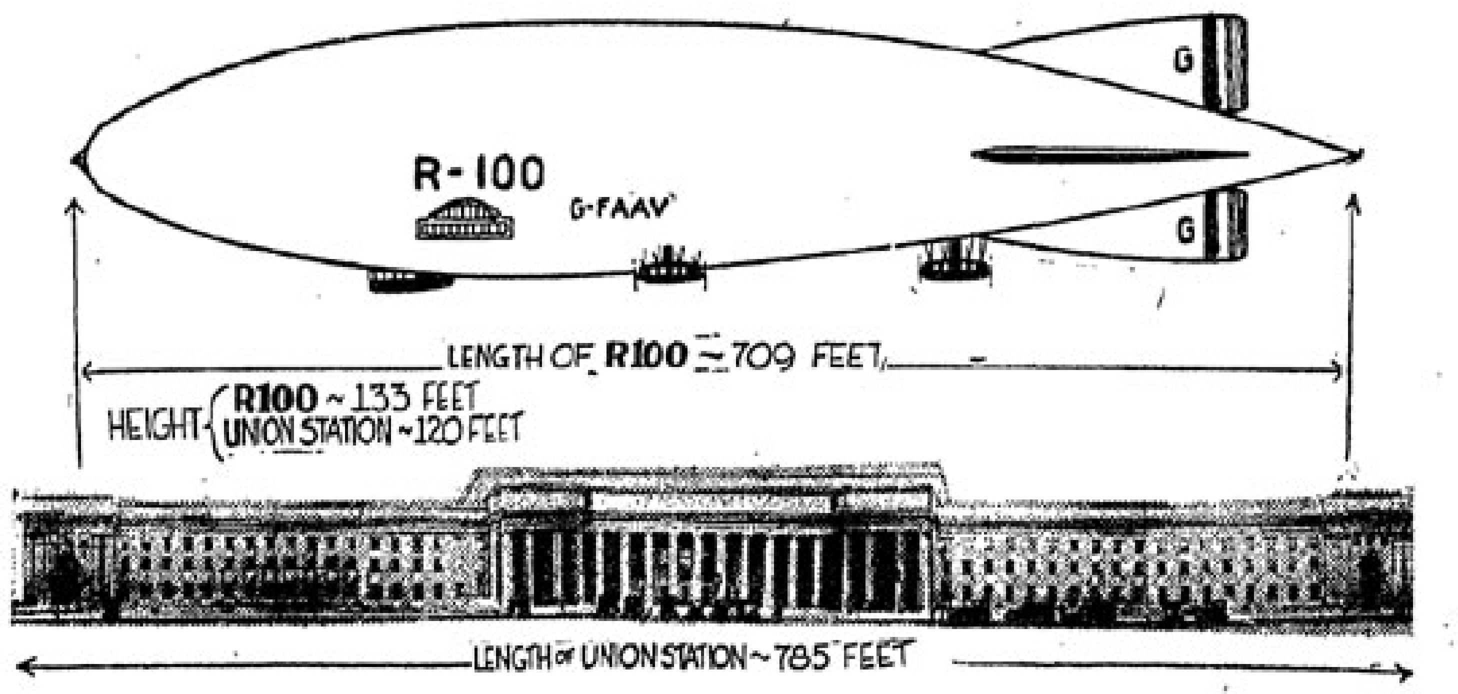
"…The 'R-101,' recently flown, is shorter than the 'Graf' but is fatter therefore has a greater useful load. It departs from previous practice by using stainless-steel girders. Both the British and German ships hold approximately 5,000,000 cubic feet of hydrogen…"

Popular Mechanics, **February 1930**

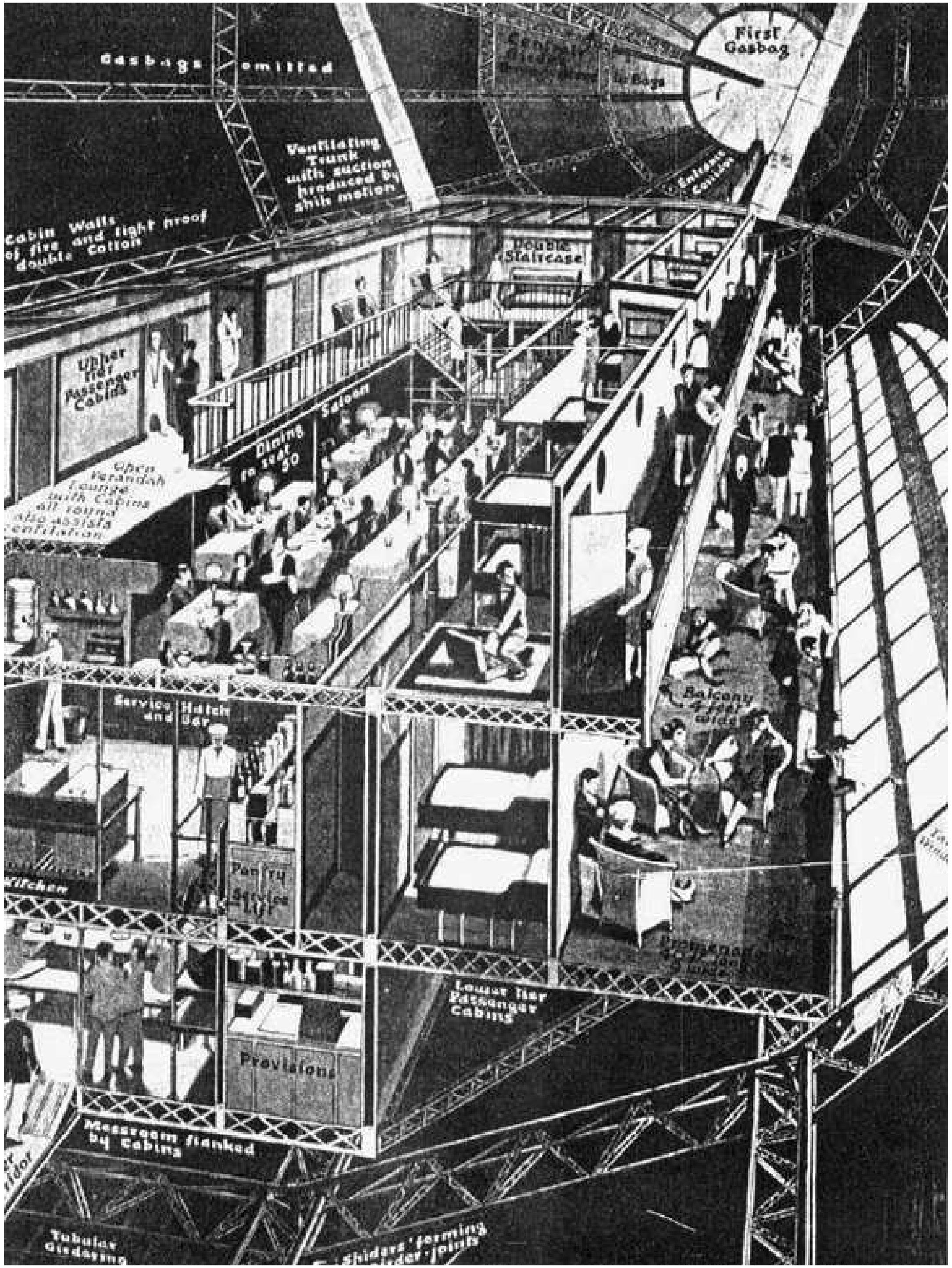
RE: *His Majesty's Airship/s* (HMA) R-100 and R-101 were +719-feet and 777-feet long respectively. R-100 was 133.33-feet in diameter (beam) and was driven by six *Rolls Royce Condor* 12-cylinder gasoline engines. R-101 was 131.33-feet in diameter and was driven by five *Beardmore Tornado* 8-cylinder diesel engines.

Left: the R-100 flies over the *Canadian Bank of Commerce Building* in *Toronto, Canada* (August 1930)

R-100 and Union Station Compared

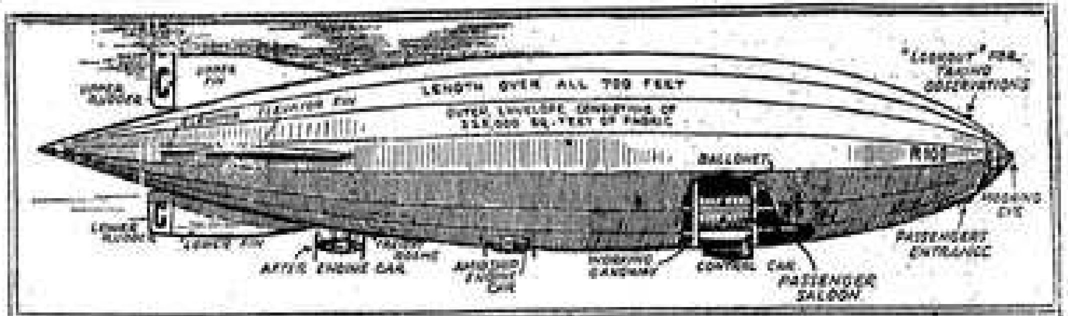


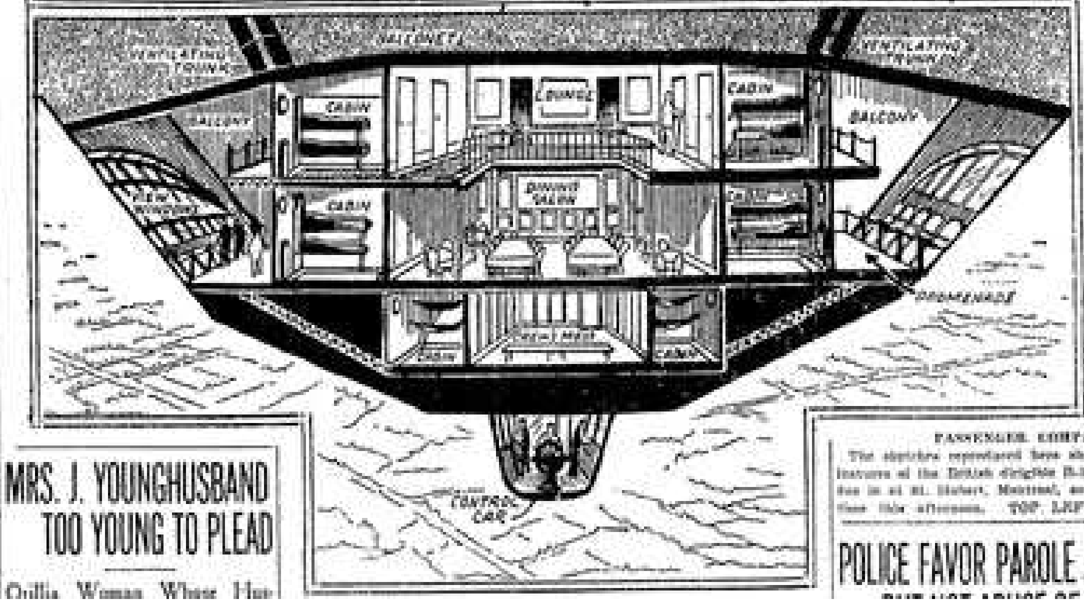
TORONTO TERMINAL ONLY 76 FEET LONGER THAN GIANT DIRIGIBLE

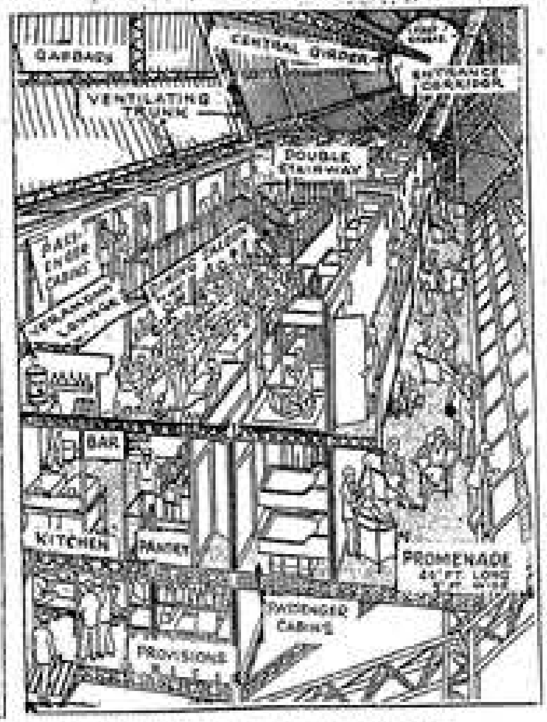


The R-100 was the first to be finished in *Howden, Yorkshire* in 1929. The airframe was made of duralumin and covered with a giant five-acre fabric coating stitched together in pieces and stretched into place. Inside the cavernous 146K cubic-meter shell, seventeen gas bags made from oxen intestines provided buoyancy. The gas bags were filled with a combined 500 million cubic-feet of hydrogen. The crew and passenger quarters were roughly in the center of the airship and were luxuriously appointed. There were guest rooms with portholes and balconies, a 30-seat dining room, saloon, kitchen, 40-foot wide promenade deck, lounge, and a grand double staircase (R-101 featured a smoking room).

Features of R-100, British Wonder Airship







PASSENGER COMPARTMENTS AND QUARTERS FOR MEN AND OFFICERS

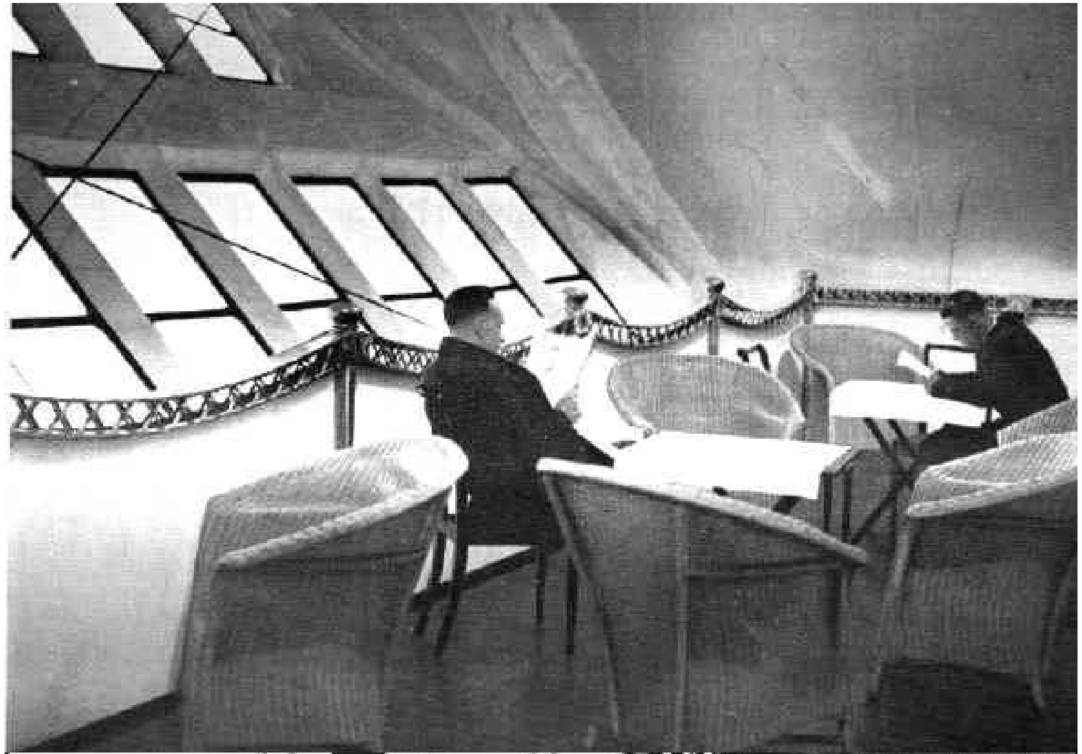
The airships reproduced here show features of the British dirigible R-100, due in at St. Hubert, Montreal, some time this afternoon. TOP LEFT—Profile view of R-100, showing passenger compartments cut away to illustrate their position and relative size. BOTTOM Cross-section sketch of quarters for crew and passengers. RIGHT—With a cruising speed of ... miles an hour, the R-100 has berths for 100 passengers. Cross-section view showing ship's interior.

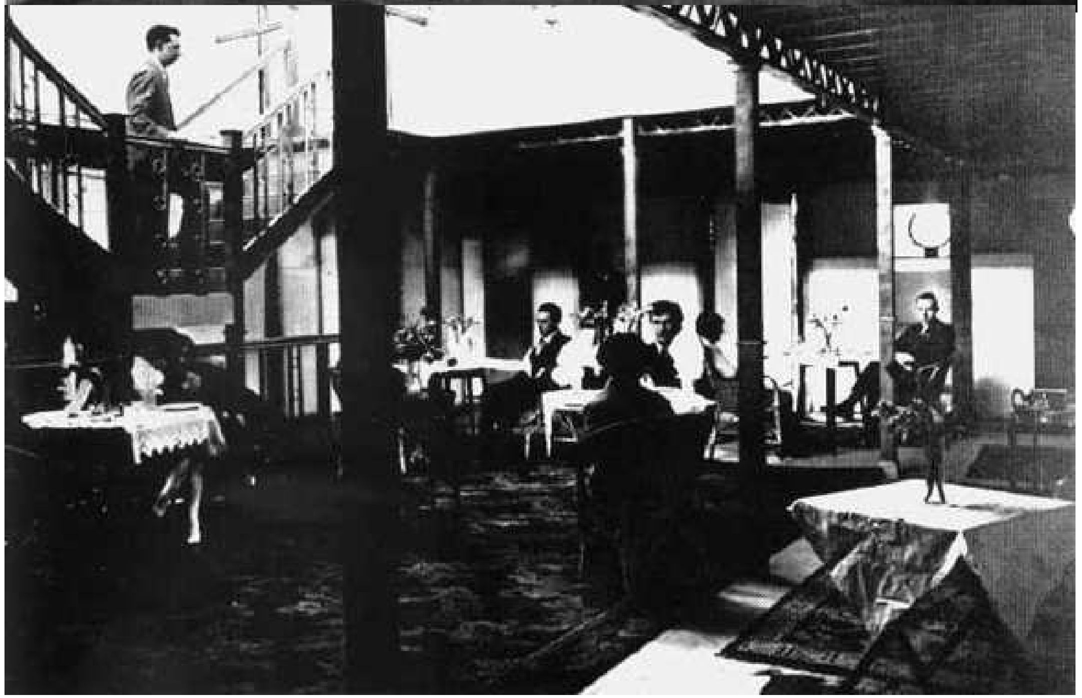
MRS. J. YOUNGHUSBAND TOO YOUNG TO PLEAD

Orillia Woman Whose Hus-

POLICE FAVOR PAROLE

ADVISES SANITORIUM

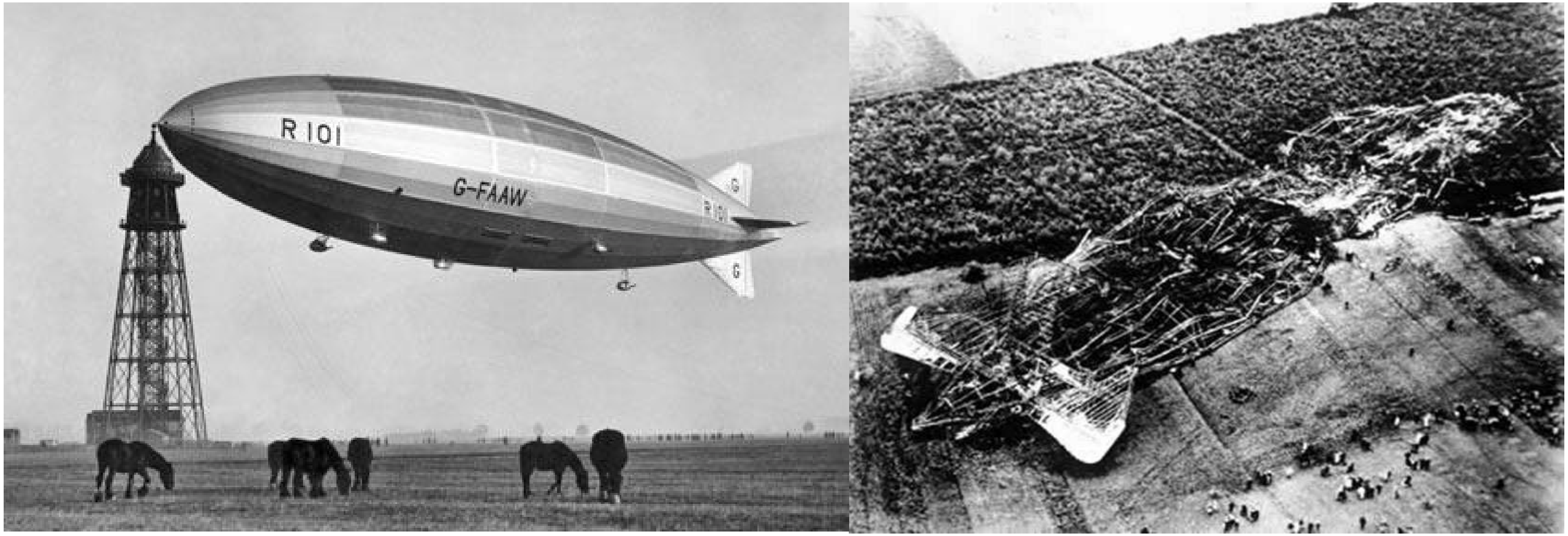




The first and only stop for R-100 would be a purpose built tethering mast twelve miles outside of *Montreal* at *St. Hubert, Quebec*. There, 250K excited spectators were expected to greet the airship amid a media frenzy. In response, three-hundred soldiers, provincial police and RCMP officers were called in for crowd control. It was imperative the R-100 be given a wide berth in Montreal considering the inherent difficulty of controlling her and the potential of a catastrophic hydrogen explosion. To illustrate the control problem, R-101 was praised during early trials for dipping its nose in salute to *King George V* midway through a ceremonial flyover. In fact, the pilots were struggling to control the giant airship and had to work feverishly to keep the nose level during almost every flight. A strict no-fly zone was established three miles around the airship and authorities on the ground were told to keep crowds strictly behind established barriers until it was safely moored to the mast. R-100 docked safely in the early morning of Friday, August 1st 1930 (left T&B). The airship stayed in Quebec for eleven days for press tours and minor repairs (one of the fins at the back of the R-100 was damaged as it passed through a storm). To help the airship avoid dangerous storms, she was equipped with devices capable of receiving transmissions of the latest weather maps from *London*. During its *Atlantic* crossing, R-100 had consumed more than 9,440 gallons of gasoline.

"Space dwindles, time quickens. Motherland and Canada come closer yet together as England's mighty Air-liner proves the practicability of inter-Empire flight. Dreams of centuries come true, and with millions of people here and abroad, we join in thanks and congratulations to the British Air Ministry and the gallant officers and men of the R-100 on the successful completion of her voyage."

***Imperial Oil Limited* (advertisement)**



On October 5th 1930, the R-101 (left) lost altitude and crashed-landed into a hillside near *Beauvais, France* (right). The impact was minimal and caused few injuries, but the ship's hydrogen ignited and the ensuing inferno killed forty-eight of the fifty-five passengers and crew. After the crash, R-100 was retired to her shed in August 1930 and deflated on December 11th 1930. The R-100 was considered to be very advanced and innovative for its time, so much so that the American Government had offered inexpensive and/or free helium to inflate the ship in return for technical data and assistance. Helium deposits had been discovered in *Canada* thus, an option for the sale of the airship to the Canadian Government emerged (Canada already had a mast from which the ship could be serviced). Also, helium had been found in *Ceylon* and *Singapore*, within the bounds of the *British Empire*. The future of R-100 and the *Imperial Airship Service* was debated for a long time. After deliberating, the final outcome was that the British Government could not afford to keep the project in place during the world-wide depression thus the R-100 was sold for scrap and work to dismantle her began on November 16th 1931.

"…The crash of the R-101, paradoxically, resulted from the fact that the huge dirigible was made 'too safe.' The designers used a metal framework that was superstrong – and unusually heavy – to overcome the danger of structural failure. They reduced the fire hazard by employing large – and heavy – Diesel engines. As a consequence, the airship had a very small margin of buoyancy when in flight. Even a relatively slight tear in one of the gas bags would be sufficient to let out enough hydrogen to bring the ship to earth. Had the great bags been filled with helium instead of hydrogen, one authority points out, there would have been no disaster – for the simple reason that the R-101 would never have left the ground!..."

Popular Science Monthly, **April 1938**

Part 4

Made in America

An All-American Product

"…In 1912, just before the world war, only fifteen cubic feet of helium were known to exist. This supply was owned by the cold temperature pioneer, Professor Onnes, of Leiden, and he valued it at $30,000. Helium was as costly, at that time, as diamonds, black pearls, and pigeon-blood rubies, and rare as radium. Only few scientists had heard of it…"

***Popular Science Monthly*, February 1929**

"…But during the war a curious incident is said to have occurred that set nations thinking. A Royal Flying Corps pilot, flying a pursuit plane, encountered a Zeppelin in the clouds one day in 1917, the story goes. He opened fire with incendiary bullets and watched to see the ship burst into flames – for he knew what happened when incendiary bullets and hydrogen get together. But the Zep didn't burn, and it kept right on going. Amazed, the pilot returned to his base and reported the mystery. The Germans had a dirigible that incendiary bullets could hit but not fire. Headquarters consulted Sir Richard Threllfall, eminent scientist. Sir Richard replied that undoubtedly the dirigible was inflated with helium gas. There were no more fireproof Zeppelins during the war, for this single 'mystery ship' probably exhausted the last cubic foot of the stuff in Germany. But it started world-wide hints for more of this strange and valuable gas…"

***Popular Science Monthly*, February 1929**

"…At the entry of the United States into the war, the War and Navy Departments called upon the Bureau of Mines to get some helium, at any price. Already the bureau's geologists had detected traces of helium in the natural gas of certain Texas wells. They set up the first helium-extraction plant at Fort Worth, and before the war ended 750 cylinders of helium gas were on the wharves at New Orleans ready to be shipped to France for Army observation balloons. But it was not until 1920 that the first helium-filled airship in the United States, the CR-7, took the air…"

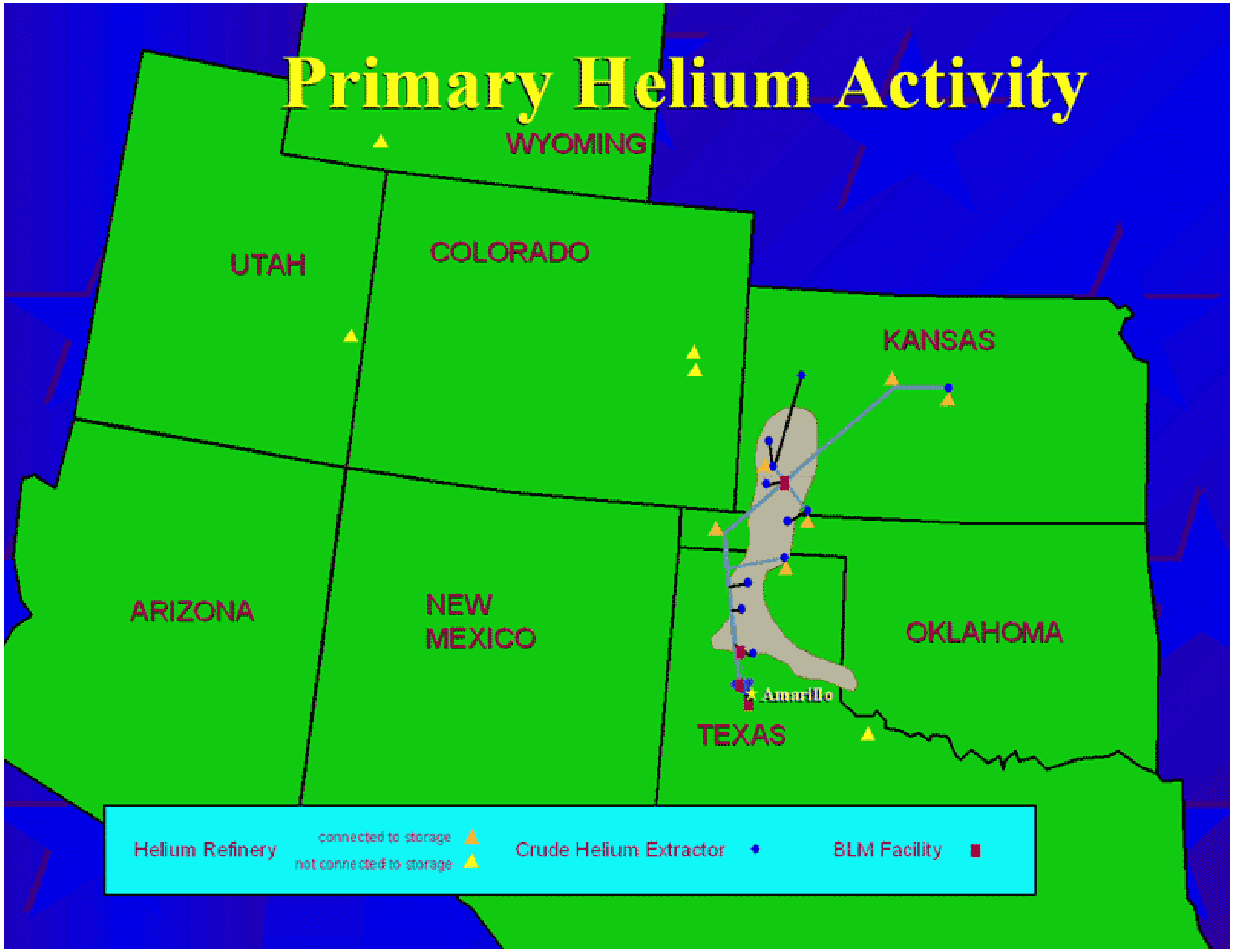
***Popular Science Monthly,* February 1929**

<u>Above</u>: "The Pilgrim" - Goodyear's first commercial, helium-filled airship. It was 110-feet long and 32-feet in diameter with a gas capacity of 56K cubic-feet. It debuted in 1925.

"…Construction of this remarkable 'mother airship' for the United States War Department will begin at an early date at the plant of the Goodyear Tire and Rubber Company at Akron, Ohio. And the most significant feature about her – especially from the standpoint of commercial development – is that she will be the first airship to be designed and built especially for the use of non-flammable, helium gas. Indeed, Dr. R.B. Moore, chief chemist of the United States Bureau of Mines, in charge of the government research work in connection with helium, declares that the future of lighter-than-air craft never has been brighter than it is today, and that the problems of helium production have been solved. Within the next decade, he adds, 99.9 per cent of helium will be produced at a cost as low as $20 the cubic foot…"

Popular Science, **February 1923**

"…A few weeks ago the little Navy blimp J-3, descending to its hangar at the Lakehurst, N.J., air station, ran afoul of a weather vane. With a ripping noise her gas cells parted, and 25,000 cubic feet of helium gas disappeared to wonder about among the elements, perhaps for ages before being captured and put to work again. Only ten years ago that little mishap would have cost the Navy approximately thirty-six million dollars. In fact, helium then, little known outside the laboratory, was so rare as to be virtually priceless…Yet today the loose change in your pocket might buy a barrel of helium, a cubic foot costing only about three cents. For within the last few years new fields of natural gas, from which come high percentages of helium, have been discovered and new and cheaper methods of extracting it have been developed. It is said, for example, that the new plant near Amarillo, Texas, in which the government is at the present time installing machinery, can supply the entire needs of the United States for many years to come. And the United States is the only nation having, so far as anyone knows, any considerable quantity of helium. It is an All-American product. Practically the world's entire supply – which is to say, the United States', for its export is forbidden by law…"
Popular Science Monthly, **February 1929**


Primary Helium Activity
WYOMING
UTAH
COLORADO
KANSAS
ARIZONA
NEW MEXICO
OKLAHOMA
Amarillo
TEXAS
Helium Refinery
connected to storage
not connected to storage
Crude Helium Extractor
BLM Facility

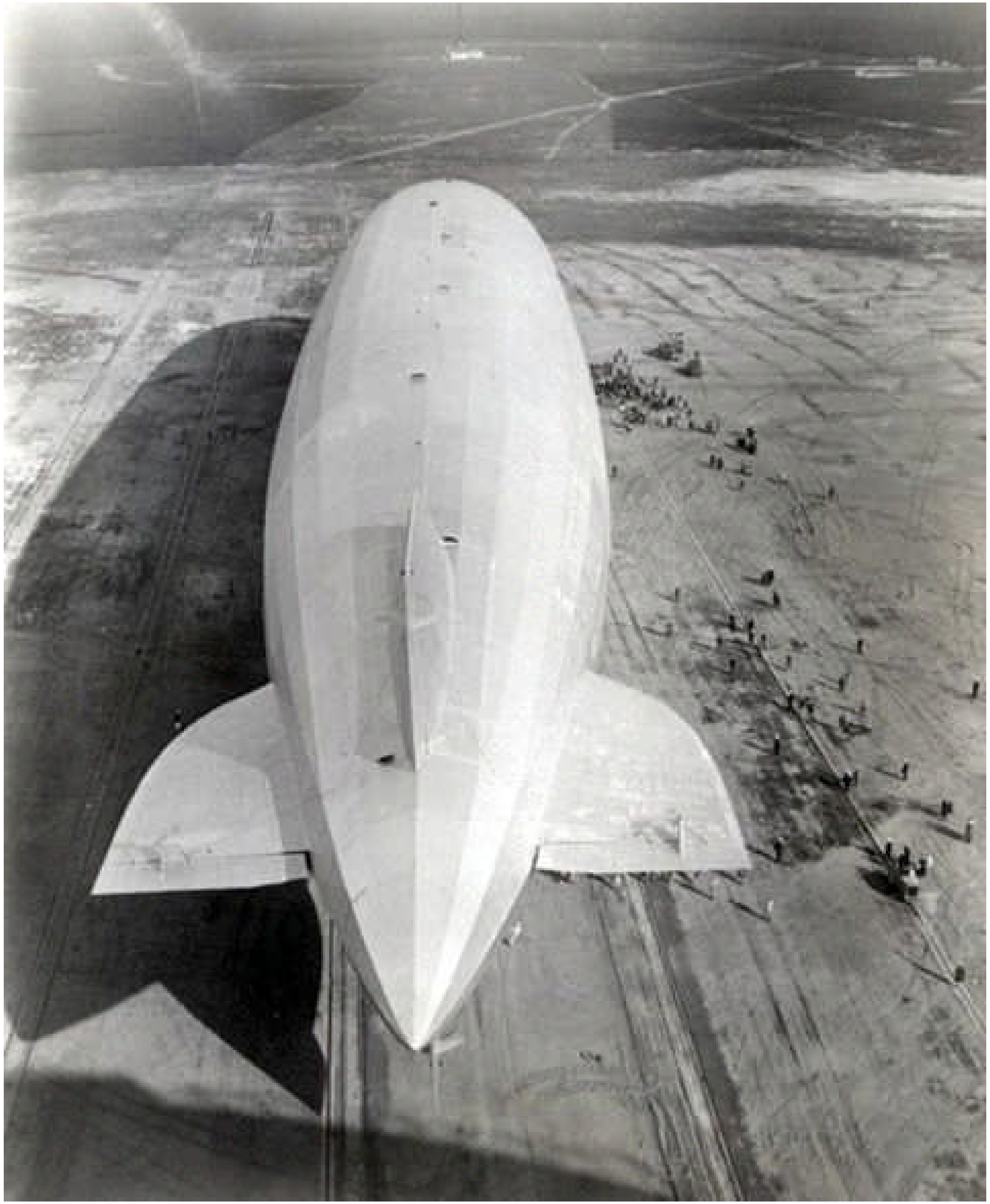
"…Meanwhile another plant had been erected at Dexter, Kansas, where helium was found in a curious way. For years the residents of Dexter had been smarting under the banter of their neighbors. In 1903, two drillers digging for oil, had struck a heavy flow of gas at less than 500-foot depth. Local boosters talked of an industrial boom and a celebration was prepared. But when the time came to light the gas, after appropriate oratory, it wouldn't burn. Visitors from surrounding towns snickered and went home. Their newspapers kidded Dexter wickedly. Later a way was found to light the gas, and use it for fuel, but it was worthless as an illuminant. By chance Prof. H.C. Cady, of the University of Kansas, tested the gas and found that it contained nearly two per cent of helium. A 15,000 cubic-foot-a-day plant went up, drills found still richer helium at greater depths, and at the end of 1917 the plant was running. A plant was also opened in Canada, where helium had also been discovered in smaller quantities but was shut down when the war ended. When news came that the Petrolia gas field of Texas, which included the Fort Worth plant and two others, was nearing exhaustion, a hasty search for new fields was made. The result of this is the new plant at Amarillo, Texas, which embodies in its machinery the latest methods of helium extraction developed by the Bureau of Mines…"

***Popular Science Monthly*, February 1929**


KANSAS
HISTORICAL MARKER
THE GAS THAT WOULDN'T BURN
Natural gas in this locality was first found in 1903 at Dexter, five miles north. The town, envisioning a prosperous future, advertised its discovery far and wide. Crowds gathered to see the well fired, then watched in dismay as the roaring gas blew out every flame brought near it. For two years it was scornfully called "wind gas." Then analysis revealed that it contained almost two per cent helium.
This primary discovery of helium in natural gas is credited to Professors H. P. Cady and D. F. McFarland of the University of Kansas. Helium was first used in balloons during World War I. For a few years, beginning in 1927, a privately owned commercial plant at Dexter supplied gas for Navy dirigibles. Later, valuable uses developed in industry. In the 1950's, demand soared when helium became essential to the operation of nuclear reactors and ballistic missiles. Though Dexter's well no longer produces, the torch that wouldn't burn lighted the way to a multi-million dollar industry.
Erected by Kansas Historical Society & State Highway Commission

"…Helium, named from the Greek word 'helios,' meaning 'the sun,' is a colorless, odorless, tasteless noninflammable gas with about 92.5 per cent of the lifting capacity of hydrogen, the lightest gas known. It was first discovered in the sun by means of the spectroscope, in 1868, and discovered on the earth, in supposedly infinitesimal quantities, in 1895. Because of its lightness and non-flammability, its chief use has been to fill the gasbags of balloons and airships…The gas has other queer characteristics, which some day may be put to work. Chilled until it changes from a gas to a liquid, for instance, helium is the coldest known fluid. It liquefies at about 450 degrees F. below zero, and has been chilled by Prof. Kamerlingh Onnes, at Leiden, Holland, to the coldest temperature ever produced by man – 457 degrees below zero, or within two degrees of that 'absolute zero' that physicists call the rock bottom of the temperature scale…"

***Popular Science Monthly*, February 1929**



"…When the giant dirigible 'Graf Zeppelin' made its recent flight from Germany to the United States, smoking was forbidden. No food was cooked. Precautions were taken even against the flashing of a tiny spark from a tack in the heel of a passenger's shoe by contact with metal in the ship's deck. At the Lakehurst, N.J., landing field every spectator was handed a printed request not to smoke, even in the open air. The huge silk, rubber, and metal sausage was filled with hydrogen, probably the most highly inflammable substance known. A chance spark might have caused a great catastrophe. Meanwhile the 'Los Angeles,' pride of the Navy, nestled safely in its hangar – its gasbags filled with fireproof helium…"

Popular Science Monthly, Feb. 1929

Left: _Graf Zeppelin_, which was modeled after the German-built _USS Los Angeles_, at Lakehurst NAS (ca. 1930)

"...To extract helium from natural gas, the gas is piped from the well into mighty compressors where it is squeezed and then chilled to a temperature of 300 degrees below zero. At this searing cold, everything but the helium turns to liquid. The helium is then drawn off, still a gas, and squeezed again into cylinders or tank cars for transportation to the air field…One of the few remaining difficulties was the transportation of the gas. Formerly it was shipped only in cylinders, of which it took 13,000 to fill the ill-fated 'Shenandoah' at her first inflation…a special tank car was devised that consists of three steel tanks forty feet long and nearly five feet in diameter, mounted on a flat base. They contain helium forced in under the crushing pressure of 2,000 pounds to the square inch. Twelve of these carloads will fill the 'Los Angeles.' A final problem was the purification of helium from an airship's gasbag, contaminated by air filtering through the envelope after a long flight. Three purifying plants have been built by the Bureau of Mines, one of them a mobile plant in a railroad car. A stationary plant, at Scott Field, Ill., can reclaim 10,000 cubic feet of pure helium in a hour."

***Popular Science Monthly,* February 1929**

“…Besides the inflation of airships, within the last year or two, other uses for helium have come to light. Helium, it has been found, will prevent the ‘bends’ or caisson disease that effects deep-sea divers…Helium is the least soluble of all gases in water or other liquids – a marked contrast, for instance, to the carbon-dioxide ‘fizz’ of charged water. It is this property that makes it a boon to deep-sea divers. The excessively painful cramps or ‘bends’ felt by a diver emerging too suddenly are believed due to bubbles of nitrogen gas, normally a part of the air, which are forced into his blood under high pressure and cause acute distress when they froth out as he reaches the surface. Since helium will not dissolve in blood, an oxygen-helium mixture is supplied to the diver instead of air, and experiments indicate that the menace of the ‘bends’ is ended…”

***Popular Science Monthly*, February 1929**

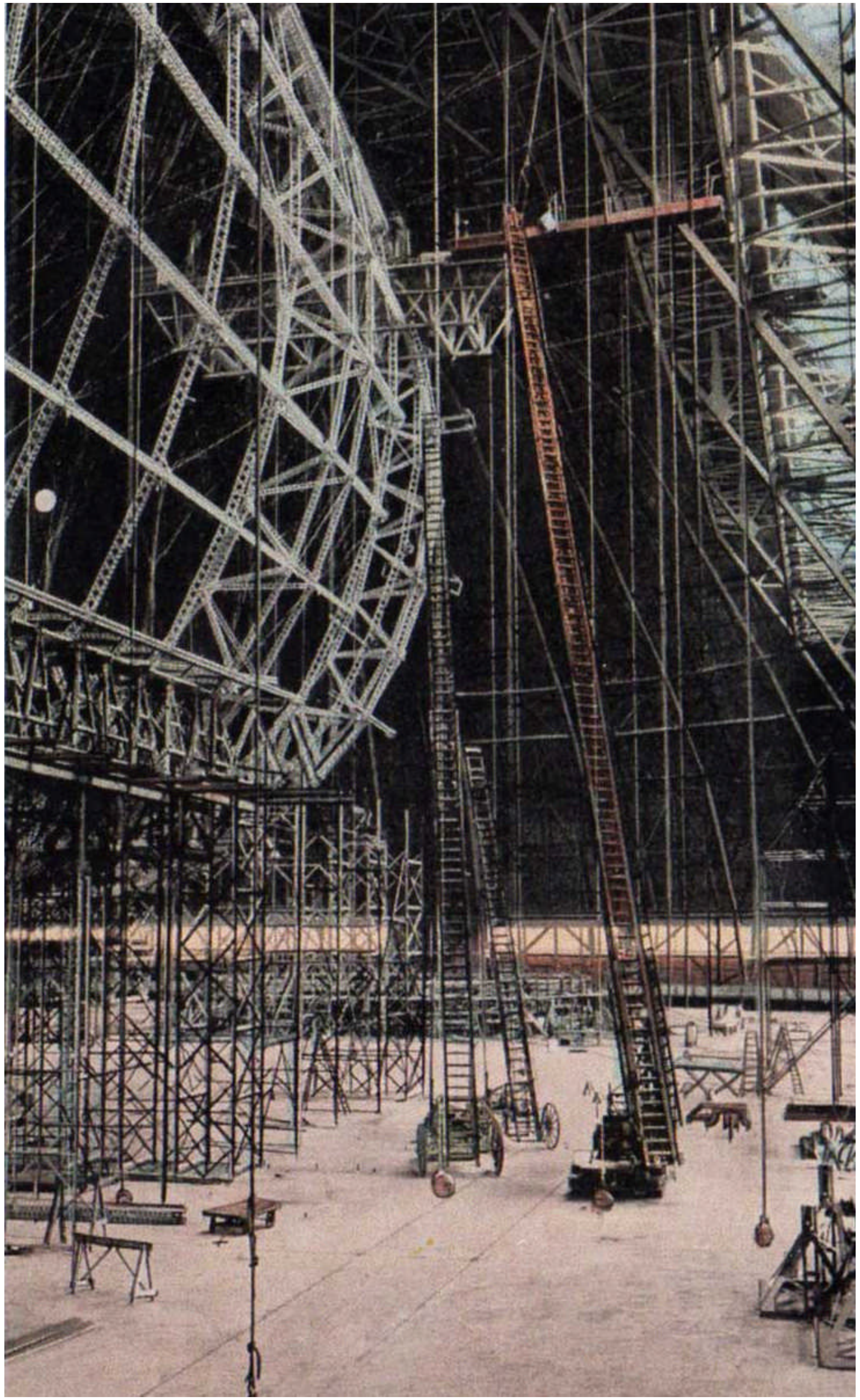
"…It is used in metallurgy, fills radio tubes and glow lamps, and finds a place in nautical and other scientific instruments. It cools electric transformers and high-speed generators. It is an important aid in chemical drying plants, and assists in the manufacture of cold cream and shaving soap…Helium is insoluble, too, in molten metals, a fact that makes it a valued tool in metallurgy. Helium, although lighter than air, is stickier. This peculiarity makes it ideal for filling the interior of nautical and other scientific instruments. In these, delicately balanced parts seem to swing interminably before they slow sufficiently for readings to be taken. An atmosphere of helium instead of air 'dampens' the vibrations and makes reading easy. Radio tubes and glow tubes such as are used in television are filled with helium gas, in the first instance because of its usefulness in permitting electrical current to pass in one direction only, and in the second, because of the brilliant glow produced by an electrified tube filled with low pressure helium. This glow is not unlike that of neon, whose scarlet light is familiar in advertising signs; but where neon gas gives a red light, that of helium is soft yellowish-white. Helium conducts heat six-times as well as air; you would shiver if you were surrounded by helium, for the gas, permeating your clothes, would draw off your body's warmth in no time. Moreover, it has a high specific heat, which means that it can absorb much warmth without itself rising appreciably in temperature. These facts, coupled with the advantage that it is a poor conductor of electricity and therefore proof against short circuits, make it an excellent cooling blanket for high-speed dynamos, and a safe substitute for oil as a contact breaker in transformers…"

***Popular Science Monthly*, February 1929**

The Goodyear-Zeppelin Company

"…America's activities in the design and construction of dirigibles are largely centered at Akron, O., where the Goodyear-Zeppelin Company has built an organization of experts including some of the former chief assistants of Count Zeppelin. Dr, Karl Arnstein, in charge of engineering there, had a part in building about seventy German Zeppelins. Captain Ernst Lehmann, vice-president of the company, directed many spectacular activities of the war-time Zeps. These two men have brought to America all that Germany learned about the construction and operation of dirigibles. The dirigibles they have projected will be produced by American factory methods, which means once the pattern and method are worked out, they can be turned out with a speed never achieved elsewhere, even at Friedrichshafen…"

***Popular Science Monthly*, October 1928**



The U.S. Navy's contest to design and build the two new airships was won by the *Goodyear-Zeppelin Corporation*, a joint venture and patent sharing arrangement (created in 1923) between the *Luftschiffbau Zeppelin* (LZ) and the *Goodyear Tire and Rubber Corporation.* In reality, there was no serious competition for the contract; Goodyear-Zeppelin was the only firm in existence with the ability to design and construct airships. Goodyear-Zeppelin and the Navy signed a contract for the construction of the two rigid airships on October 16th 1928.

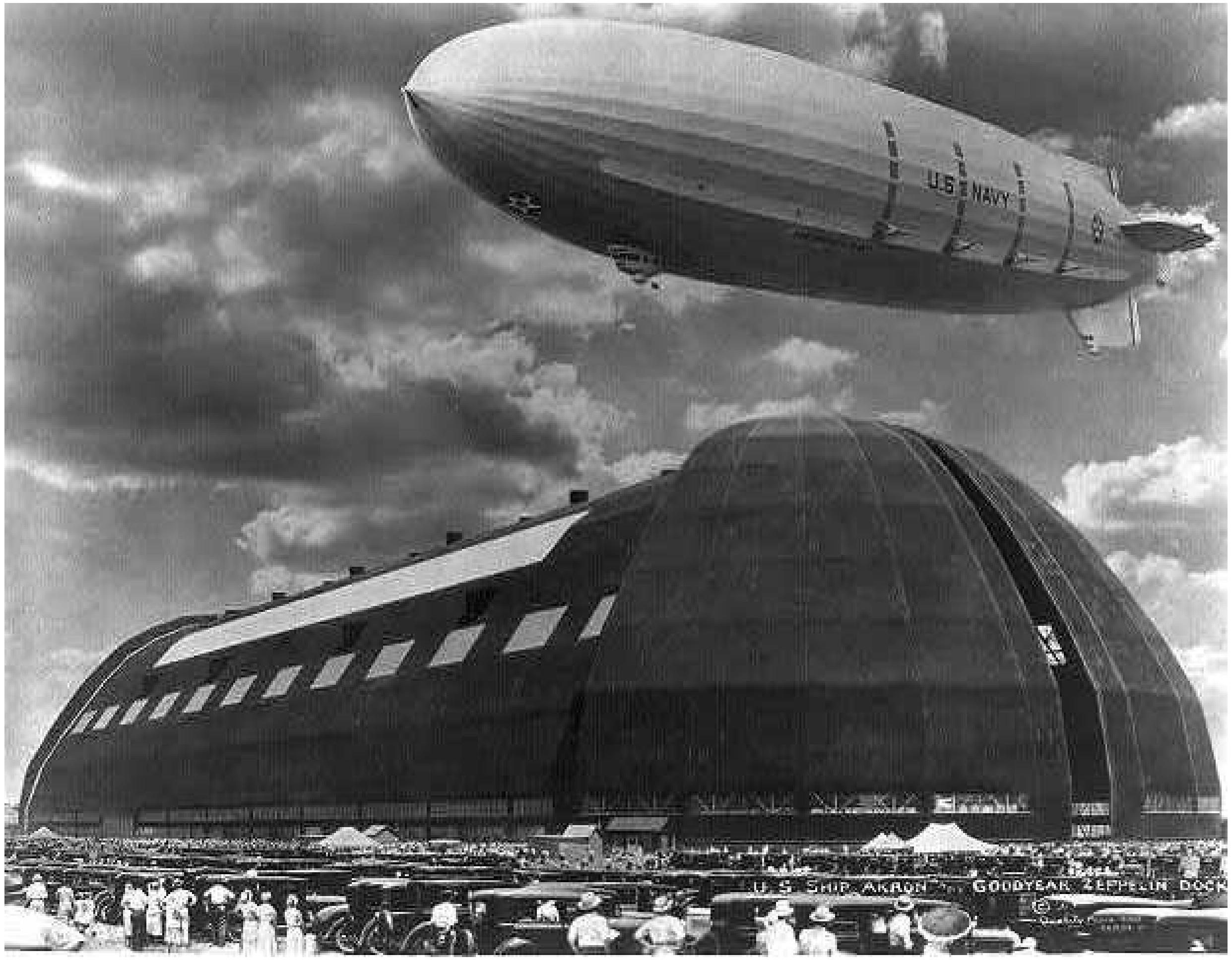
<u>Left</u>: caption (postcard): "Closeup of Construction of U.S.S. Akron, Navy Airship"

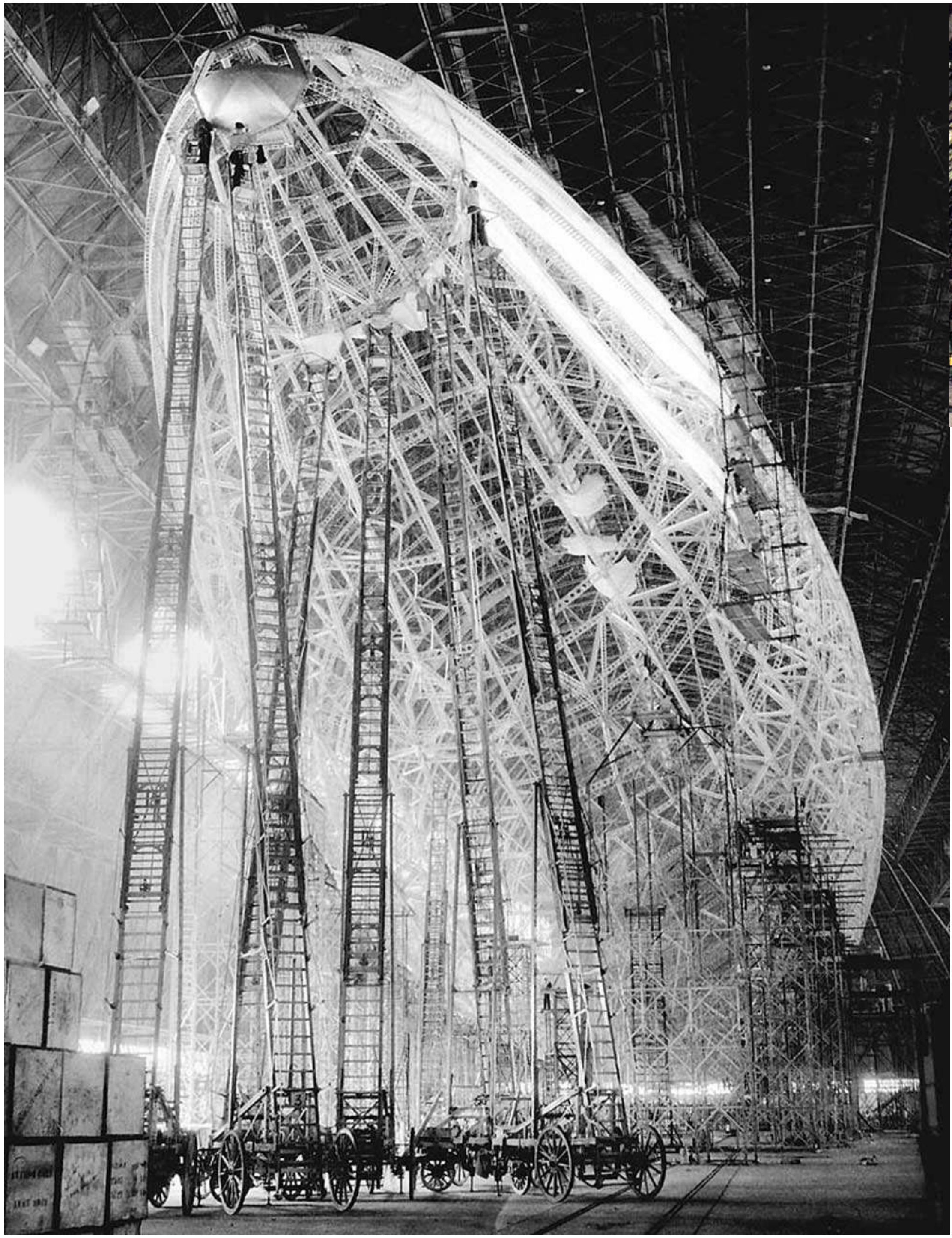
“…Many improvements which the ‘Graf’ lacked are being embodied in the two British ships ‘R-100’ and ‘R-101,’ and the United States Navy airships ‘ZRS-4’ and ‘ZRS-5,’ now being built at Akron, Ohio, by the Goodyear-Zeppelin Corporation…”

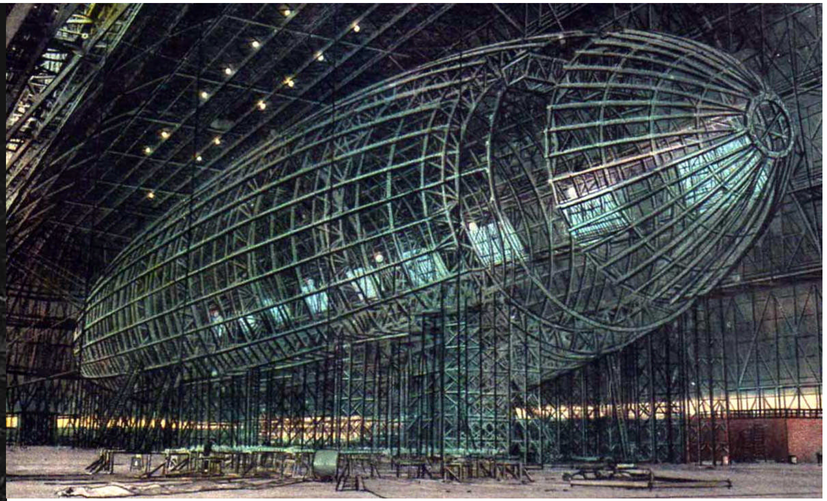
***Popular Mechanics,* February 1930**

"…Before these two mammoths of the sky can be built, a shed big enough to hold them must be constructed. For this purpose, the largest building in the world is rising in the center of a field on the outskirts of Akron, Ohio. Seen from afar, its fantastic design will suggest a monstrous metal caterpillar. For the sides of the long shed are to be rounded to prevent the formation of disturbing air currents and sudden wind gusts, such as are created by high vertical walls, and which would make dirigible launching hazardous. Nine acres of level floor space will lie under the single roof. Within the giant building fourteen football games could be played at the same time and the whole national Capitol at Washington, except the top of its dome, would be swallowed up within it! The highest skyscraper in the world, the Woolworth Building, and the Washington Monument both could lie side by side on the floor and leave space for a couple of steamships beside them!..."

***Popular Science Monthly*, September 1929**


U.S. NAVY
U.S. SHIP AKRON
GOODYEAR ZEPPELIN DOCK





"…It has been said that, whenever anything is built on a gigantic scale, something bigger must be made to house it. Before building the American airships, the Goodyear-Zeppelin Corporation had to erect a factory and dock at Akron which is the world's largest building without interior supports.…"

***Popular Mechanics*, February 1930**

<u>Above</u>: framework of *USS Akron* under construction

<u>Left</u>: *USS Macon* under construction

"…Supporting this mountain of steel, 1,200 feet long, 325 feet wide, and 205 feet high, will be concrete piles reaching to bedrock. The arched design of the building will leave the interior entirely free of obstructing pillars and columns, and will allow working platforms to be placed at various heights up the sides of the walls to permit inspection and repair of the dirigibles when they are 'docked.'…"

Popular Science Monthly, September 1929

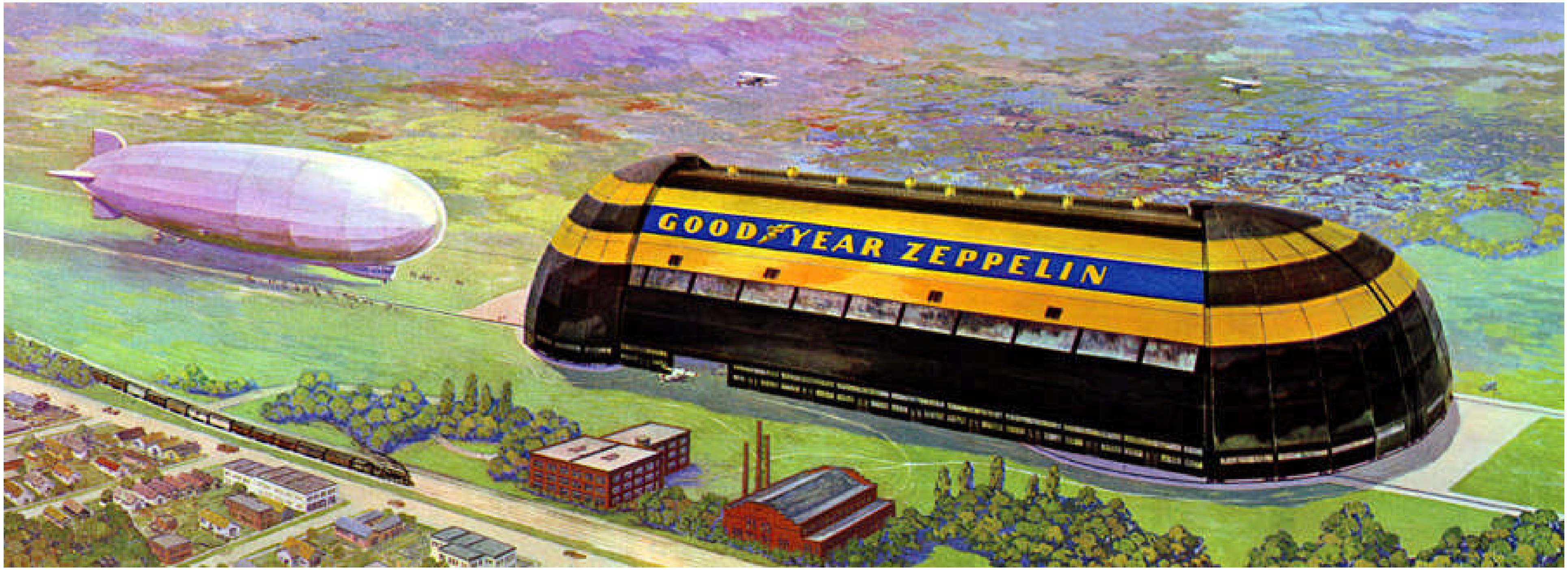
Above: caption: "Artist's drawing showing comparative size (starting at left) of non-rigid air yacht; RS-1, Army semi-rigid type ship; the Navy airship Los Angeles and the U.S.S. Akron, being completed by Goodyear-Zeppelin Corp. at Akron for the U.S. Navy."

“…To preserve the rounded contour of the structure, strange doors, each like the skin of a quarter of an orange, will open and close on semicircular tracks at the ends of the building. Each of the four doors – two at each end – will weigh 800 tons, three times as much as the average passenger locomotive! To move the massive portals, four 125-horsepower motors will be required; and, to slow them down, special electro-hydraulic brakes must be applied. The doors will be supported on the tracks by a series of trucks similar to those used on freight cars. Every time the great doors at one end of the building yawn, the opening is 180 feet high and 240 feet wide at the bottom – a space through which a fifteen-story building might pass…”

***Popular Science Monthly*, September 1929**

“…But perhaps the most amazing feature of the design is one that permits the whole structure, with its acres of corrugated steel roofing, to stretch and change its size, to expand and contract with alterations in temperature! This is made possible by placing rollers between the main arches and the concrete supporting piles and by hinging the arches at their bases. Under a blazing midsummer sun, with the thermometer standing at 100 degrees F., the metal building will stretch to a length a foot greater than in zero weather. This constant warping back and forth would shorten the life of the structure if no special arrangement were made to take care of it…”

***Popular Science Monthly*, September 1929**

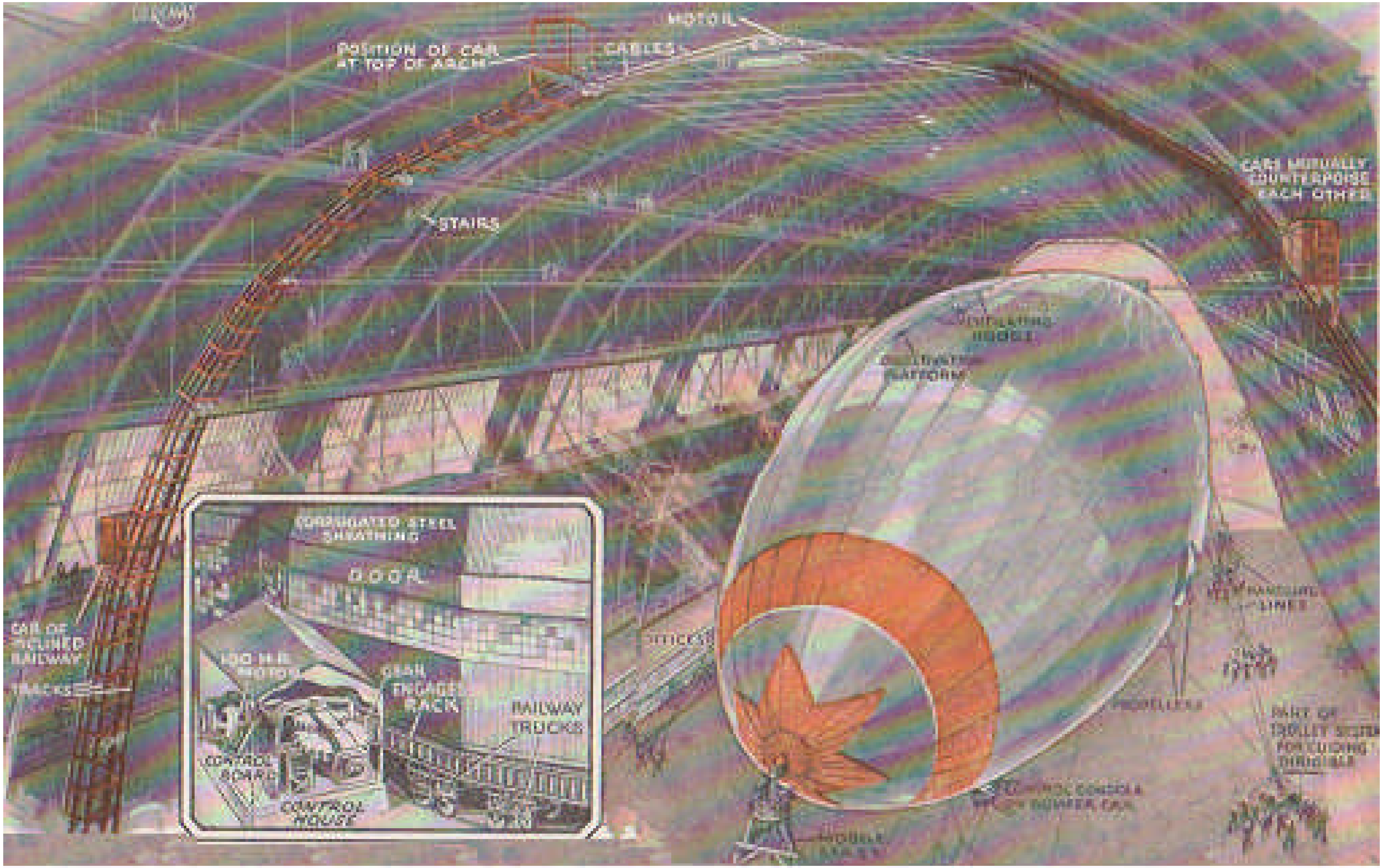


"…The dock is of steel and concrete construction. First, 1,300 concrete piles, averaging twenty-five feet long, were driven for the foundation. Then thirteen huge steel arches, each the shape of a parabola, were erected. Only the center three arches are firmly attached to their foundations. The others are arranged so that they can move as the building expands and contracts. The building will change its length about five inches between extremes of temperature. Doors that close the ends are the most interesting part of the dock. They are of the 'orange-peel' type. That is, each section is the shape of the peel you would obtain by quartering one-half of an orange…When wind is blowing against one side of the building, a vacuum is created on the opposite side, often causing a pressure against the inside of the covering greater than that from the wind on the outside. Along each side, about a third of the distance from the top, are four dormer-like projections, with colored glass windows. These are automatic louvers that open when pressure inside is ten pounds greater than the outside, preventing the steel plates from ripping off…"

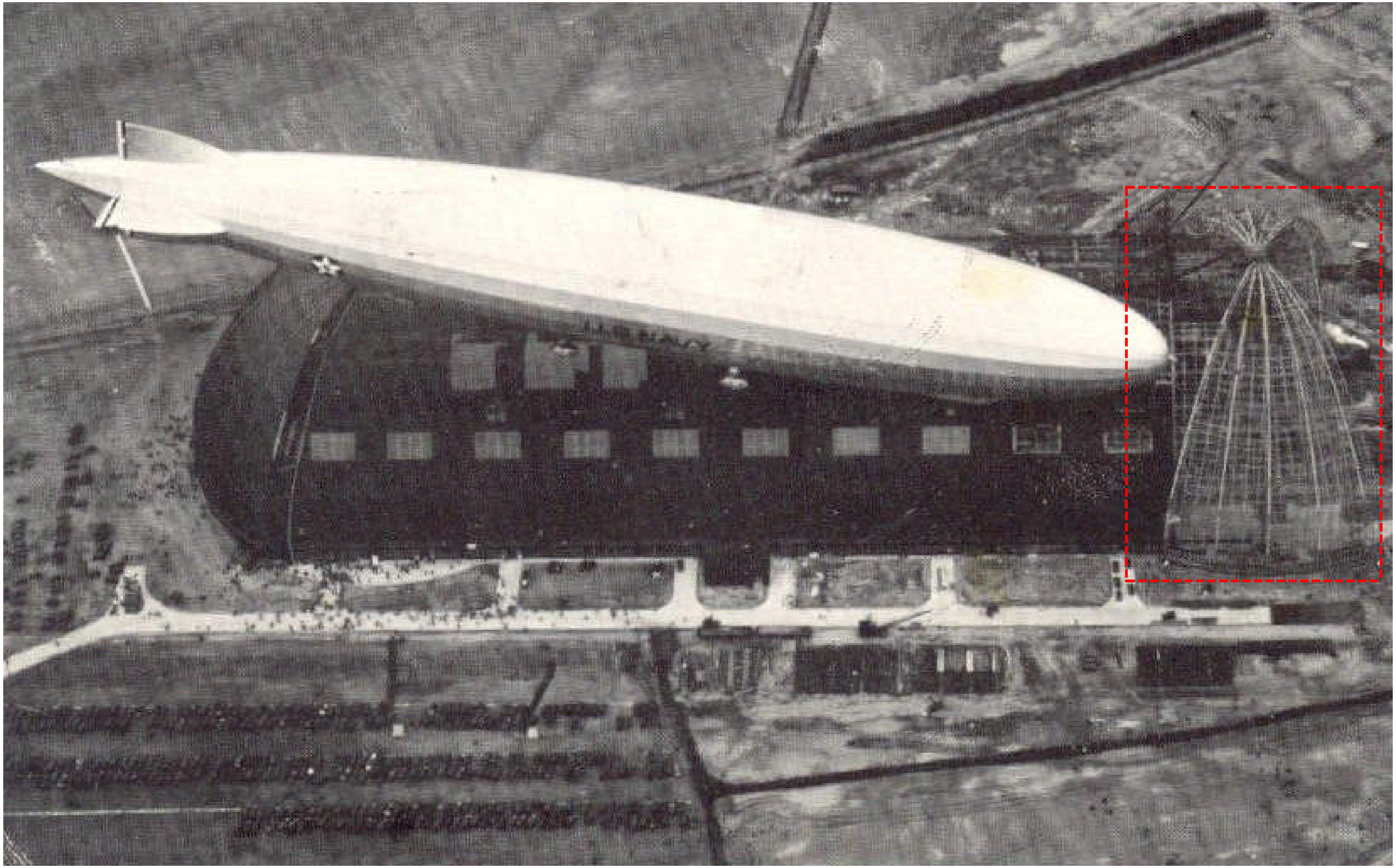
Popular Mechanics, **February 1930**

"…Fuel, power, and water will be supplied to the various parts of the farm-sized floor through an underground tunnel running beneath it. A mile of railway track will pass through the shed to the far sides of the landing field. Upon it will travel the wheeled 'land tugboats' – railway trucks to which the airships will be anchored for towing them to and from their huge berth…"

***Popular Science Monthly*, September 1929**



Above: caption: "How craft may be brought into the dock of the Goodyear-Zeppelin Corporation at Akron, Ohio, and a close view of the operating mechanism of the 'Orange Peel' doors; the first of two Dirigibles for the Navy is now under construction in this huge dock which was completed recently."
RE: Illustration from an article entitled: "The Air Liners of the Future" (*Popular Mechanics*, February 1930)



<u>Above</u>: *USS Los Angeles* flies over the Goodyear-Zeppelin dock while one set of "orange-peel" doors are still under construction (highlighted), Dec. 1929

"…While construction of this remarkable dirigible shed is being pushed forward in America, word comes from Germany that a five-million-dollar Zeppelin hangar of radical design is planned. This great airship shed is to revolve on a turntable so it can be pointed to avoid cross winds when sky liners leave or approach its doorway."
***Popular Science Monthly*, September 1929**

Under the *Goodyear-Zeppelin* arrangement, the *Luftshiffbau Zeppelin* sent technical experts to *Akron, Ohio* to train Goodyear employees in the design and construction of rigid airships. Goodyear insisted that the Zeppelin Company's chief stress engineer; *Dr. Karl Arnstein*, be included in the group of experts. In November 1924, Arnstein arrived in Akron along with a team of twelve hand-picked engineers. Under Arnstein's leadership Goodyear-Zeppelin developed the plans which became the *USS Akron* and *USS Macon*. Arnstein's design was radically different from the conventional airship designs he had worked on at *Friedrichshafen*. No longer under the direction of the conservative *Ludwig Durr* (the Zeppelin Company's chief designer since the LZ-2 of 1906), Arnstein was free to develop new designs and techniques for the *U.S. Navy* airships. Traditional airship design featured a series of main rings built of a single braced girder which were generally spaced fifteen-meters apart with un-braced rings in between. Arnstein's design for the navy airships utilized a series of "deep rings" which were large triangular structures - similar to the keel - spaced 22.5-meters apart. Arnstein's deep-ring, three-keel structure was considerably heavier than the framework of a traditional German airship, but it was also believed to provide greater structural strength which was very appealing to the Navy which had just seen the *U.S.S. Shenandoah* (ZR-1) crash after suffering in-flight structural failure during a storm. The deep-ring design also accommodated a Navy requirement that all areas of the structure be accessible during flight (the eight-foot deep rings were large enough for a man to climb their entire circumference).

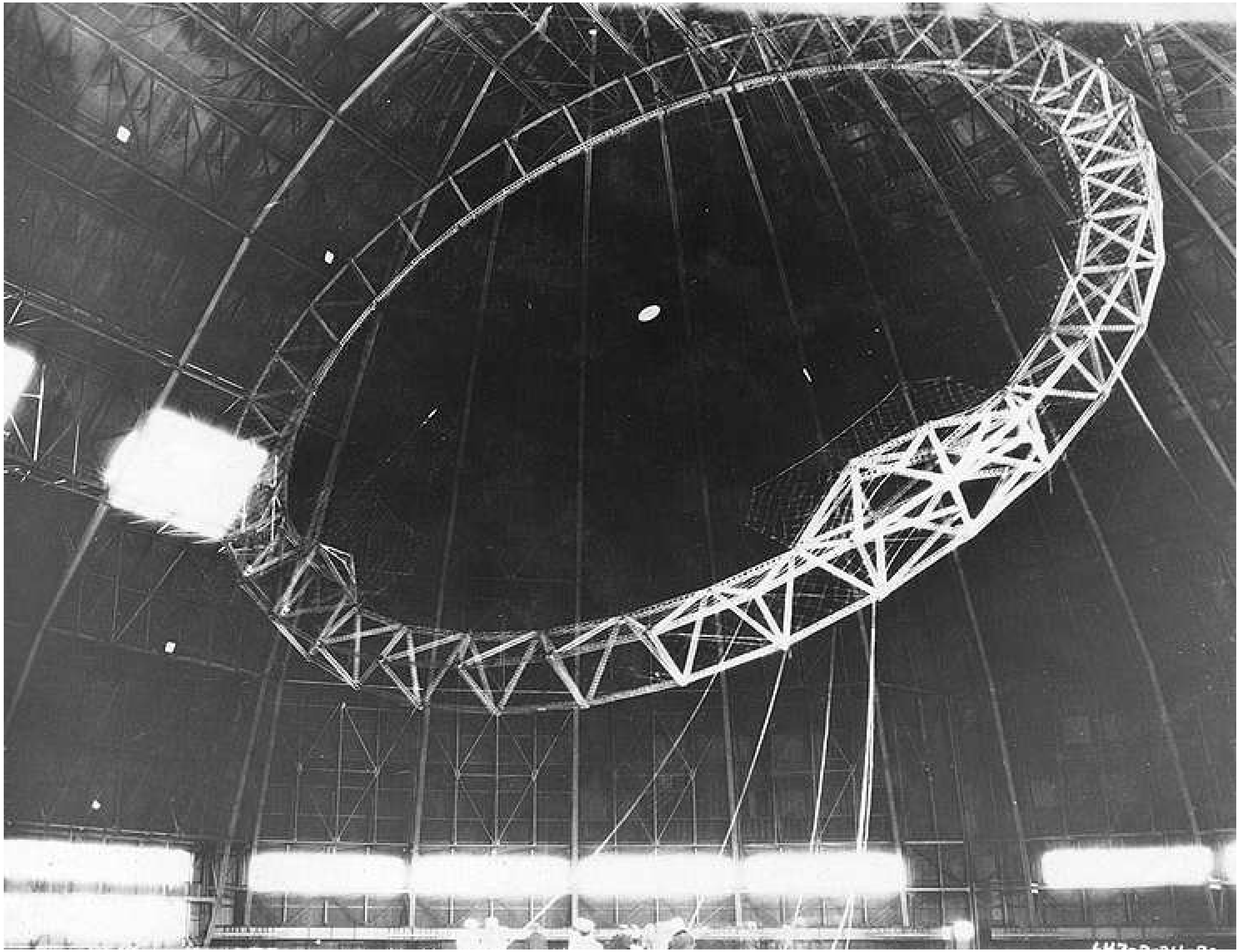
"…First of all, we will use a new and improved duralumin metal which will give greater rigidity and strength to the superstructure of the ship. And, in the second place, the structural design of the GZ-1 will be radically different from that of any other yet built. Along the bottom, two corridors of lattice work construction will run the entire length of the ship. Into these 'backbones' will be built the circular ribs, also of latticed construction, which will support the envelope. Between the ribs will be interwoven steel wire bracing, forming a network of fine wires which will add to the ship's rigidity and hold the ribs in place. An advantage of this corridor arrangement will be that it will make the interior of the bag accessible from almost any point. Thus if anything should go wrong or any break should occur while the ship was in flight, it could be remedied instantly, preventing the possible development of a serious weakness in the structure. Engineers now are able to figure stresses so exactly that a ship of this size can be designed to meet any conditions. In planning the GZ-1, we have taken into account every possible contingency. Even suppose we count on the dashing of the ship against a mountain, we know the only injury would be a slight bending of the girders. The helium cells within could not be damaged. And even if that were possible, we know that such a ship would operate efficiently with two cells empty…"

Dr. Karl Arnstein

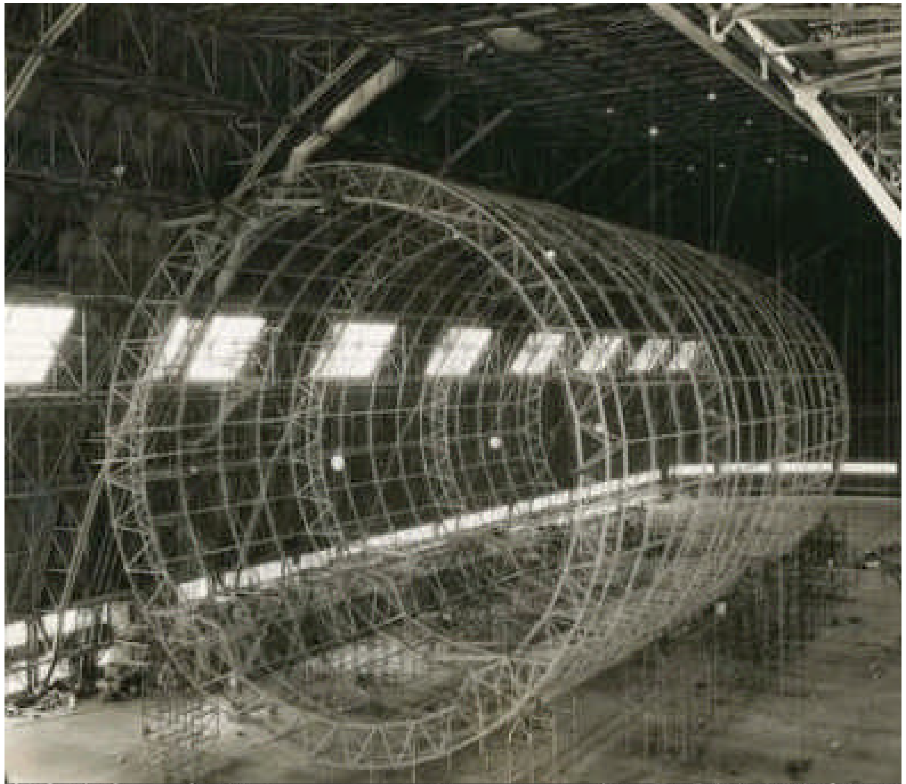
RE: ***USS Akron*** **(GZ-1)**

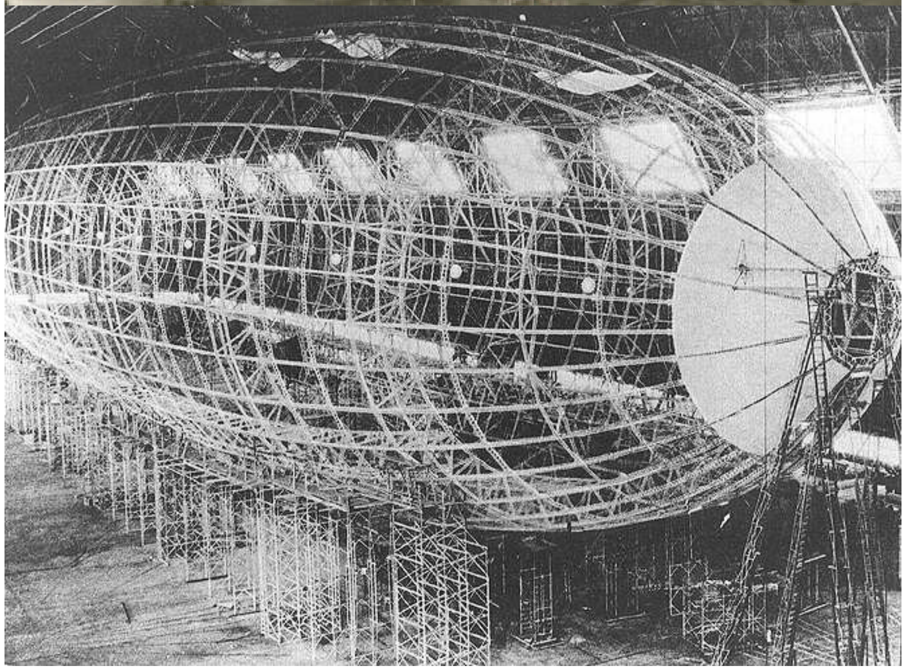
“…At the Goodyear-Zeppelin Corporation plant, a mile from the air dock, most of the manufacturing operations for the ship are carried out. Here, sheet duralumin is run through giant presses that form the sheets into strips, properly punched and ribbed. These strips are assembled in boxlike form, and the typical girder is the result. You can lift, with your little finger, a section that will support an average bridge party. The Navy expects to fly the new airship over salt water most of the time. So it was necessary to render the metal parts corrosion-proof…The girders are all treated electrically by the anodic process to render them immune to salt and other corrosive substances. To provide further protection, the girders are sprayed with an aluminum-flake pigmented varnish. At joints, where the metal must be cut, there is further spraying with corrosion-proof varnish…”

Popular Science Monthly, **February 1931**



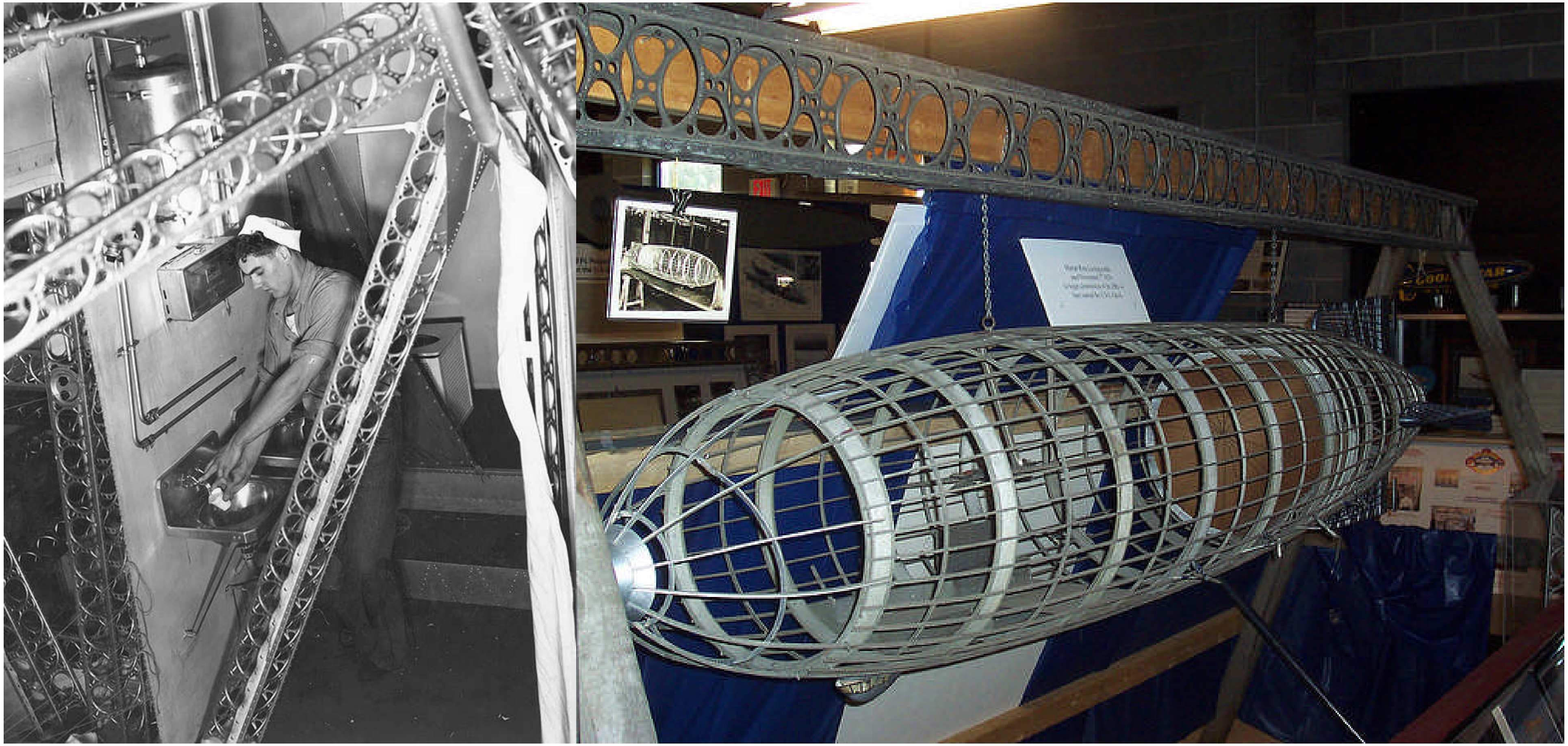
<u>Above</u>: caption: "Erecting the first main frame ring of the future USS Akron (ZRS-4), during her construction in the Goodyear-Zeppelin Corporation hangar at Akron, Ohio, 24 March 1930."





"…Almost everyone who drops in at the Akron air dock asks about the girders. These make up the eleven main frames, the thirty-two intermediate or stiffening frames, the longitudinal connecting members, and other various parts of the ship. There are several different types, but all are much alike; and each contains more space than solid material. This may seem a strange arrangement, but it has been found that the strongest girder is not always one having the most metal. By taking sheet duralumin and punching out three-fourths of it in the form of circular holes, engineers are able actually to increase the strength many fold. Essential to this is the curving of all edges inward…"

***Popular Science Monthly*, February 1931**



<u>Left</u>: caption: “Scene aboard USS Akron (ZRS-4), circa 1931–1932, showing a crew member getting a cup of water from a wash basin. Note the aluminum structural members.”
<u>Right</u>: a structural model of the *USS Akron*. Note that it is suspended from an original punched, duralumin girder

"…Perhaps you would ask, if you were visiting the dock, how the girders are fastened together. The answer is rivets – 6,500,000 of them. It is a coincidence that there is almost exactly one rivet for every cubic foot of helium lifting gas the 'Akron' will carry. There is a little story behind those rivets, For one thing, they are not driven into place by noisy hammers. They are too small, being either three thirty-seconds, one-eighth, or five thirty-seconds inch in diameter, depending on the load they must carry; and their lengths vary from 3/16 to 1&1/4 inch. They are pressed into place by hand operated riveting machines that remotely resemble the punches used by railway conductors for mutilating tickets. The airship builders could not find such riveting devices ready made, so they had to build their own. A shop in one corner of the air dock devotes most of its time to the making of rivet squeezers of numerous sizes and shapes. Thousands of dollars are being expended for these. The squeezers exert pressures up to 6,500 pounds. The rivets are of aluminum alloy, and must be annealed in heat-treating furnaces before they can be used. Then they must be pressed into place within an hour, or they may become crystallized and break. Fortunately, if workmen do not use up a batch of heat-treated rivets within the specified time, the treatment can be repeated…"

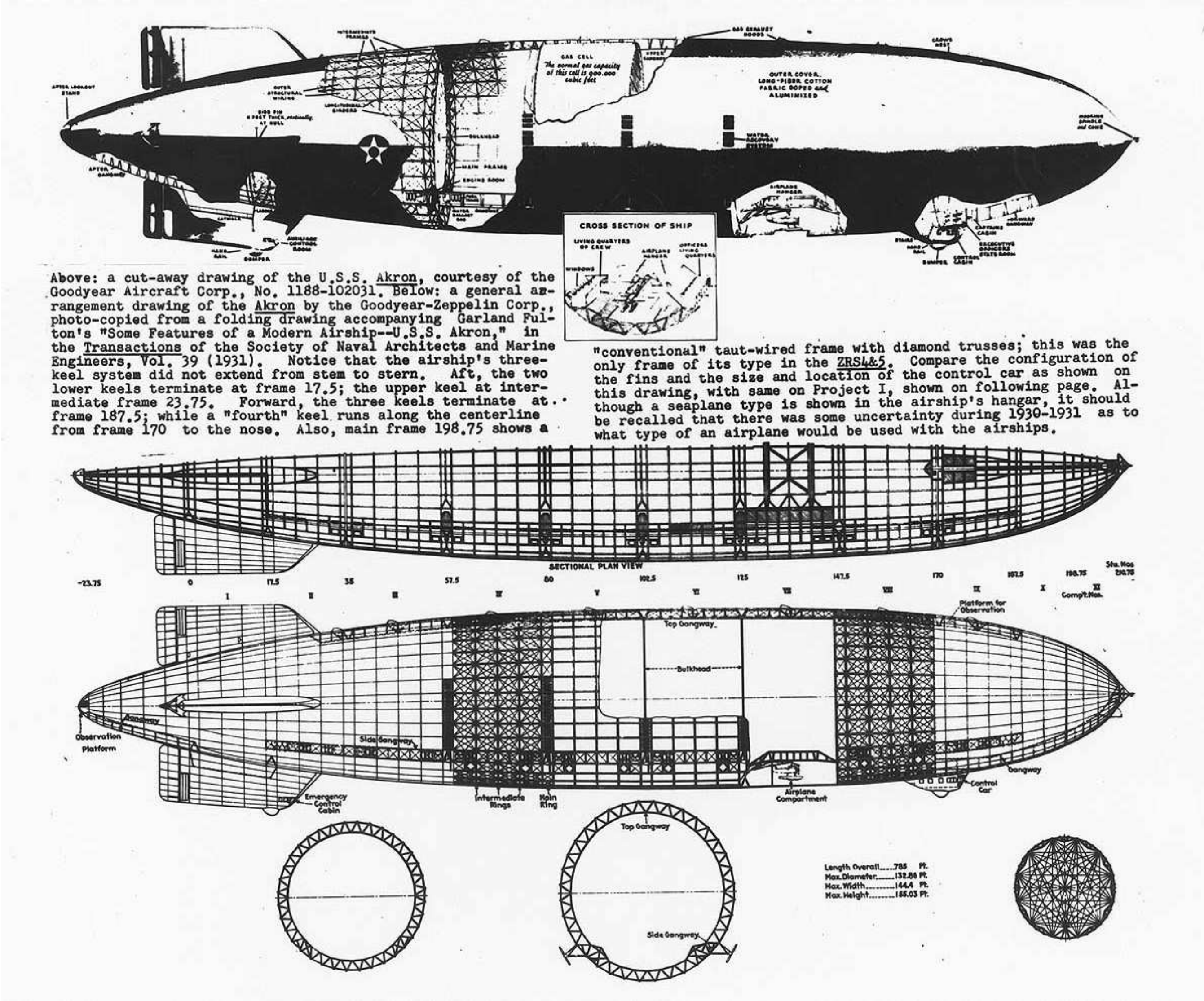
***Popular Science Monthly*, February 1931**

"…As an additional precaution, the parts of the metal frame are 'bonded' or connected together so that no small spark, induced by lightning, could start a fire. To test it, the entire hangar is darkened and electricity at ten or twenty thousand volts is applied to the frame. Sparks instantly reveal any loose connections. This was done to the 'Shenandoah' when it was built at Lakehurst, and the 'Los Angeles' had the same test in Germany…"

***Popular Science Monthly*, March 1930**

"…Someone inquires about the wires that look like the web of a giant spider. These wires are everywhere – lacing together the framework of duralumin girders that looks like a lacework of large threads. You could play a symphony on the bracing wires of the ship. The various lengths, diameters, and tensions employed cover a considerable portion of the musical scale. Steel piano wire, treated to make it corrosion-proof, is used throughout because it provides the greatest strength for a given weight. There will be between 1,250 and 1,500 miles of this wire in the completed ship! Nine different diameters, ranging from .047 to .135 inch, can be counted. The wire is all put under a tension that varies from fifty to two hundred pounds. As a result, the framework of the Zeppelin will have a rigidity and strength for all practical purposes as if it were made in a single solid piece. The largest wires are employed in the making of the bulkheads – the network that separates adjacent cells…"

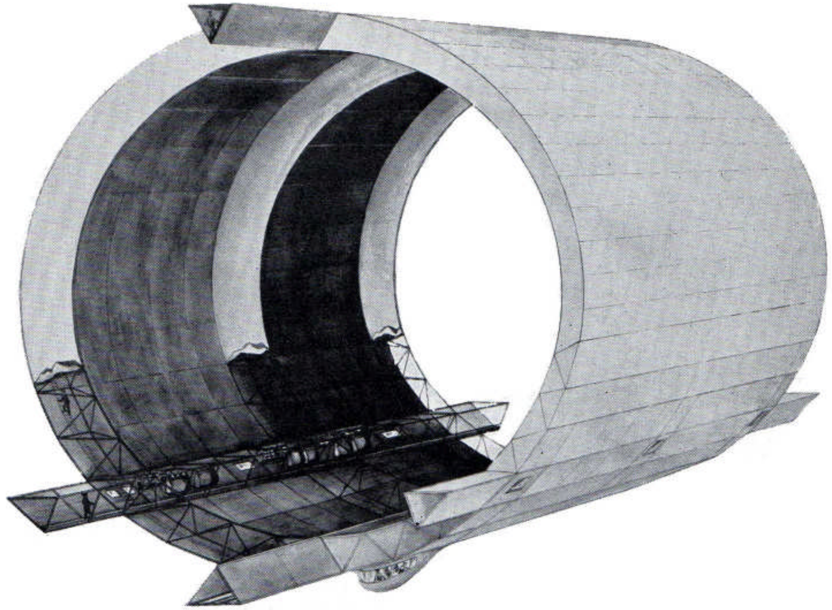
***Popular Science Monthly*, February 1931**

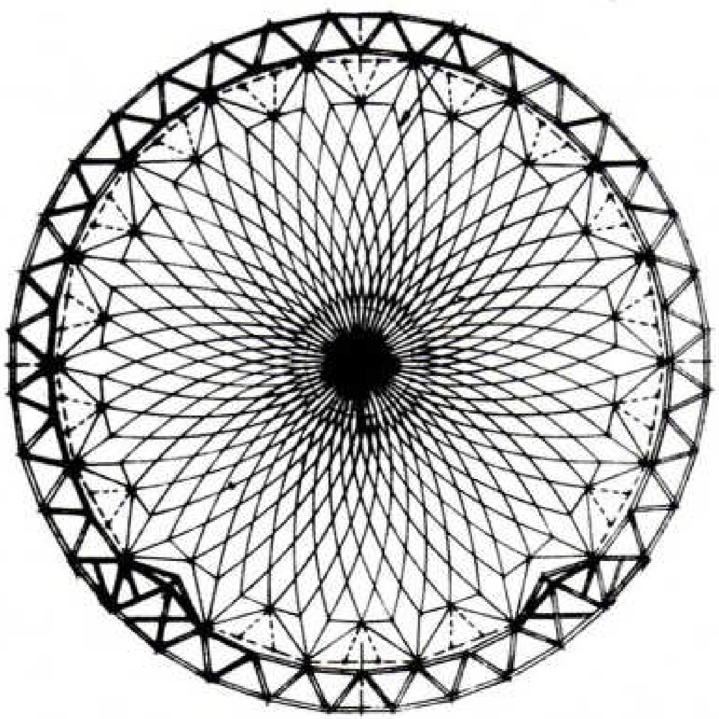


"…The ship's structural rigidity will be along its backbone, which will consist chiefly of a duralumin framework keel of triangular cross-section, running from nose to tail. Into this keel will be built the large frame of the nose cone and also the fins, forming one integral structure…"

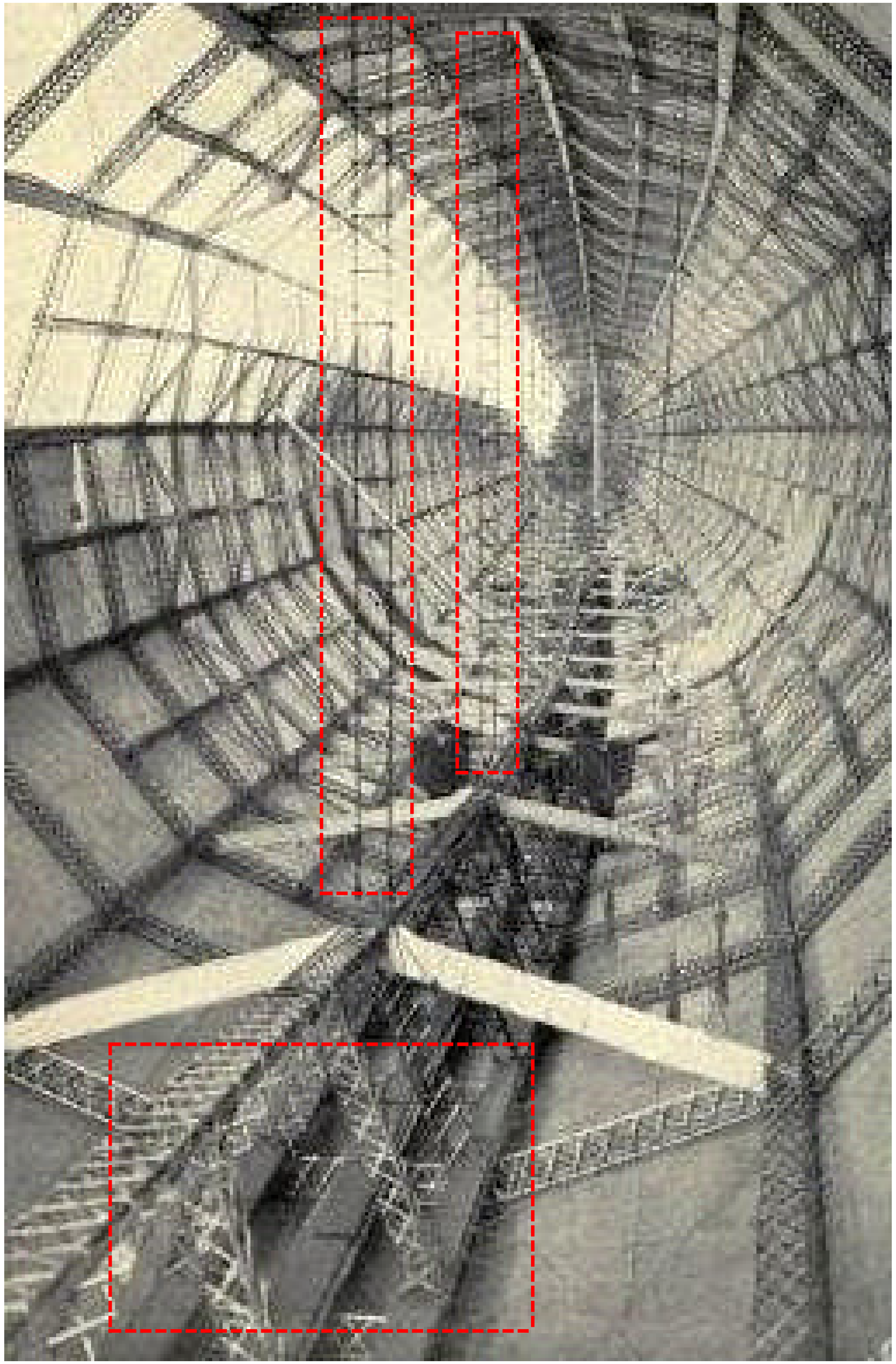
Popular Science, **February 1923**

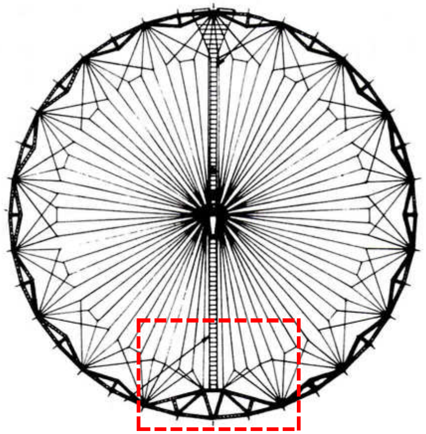
<u>Above</u>: caption: "Drawings of USS Akron, circa 1931"

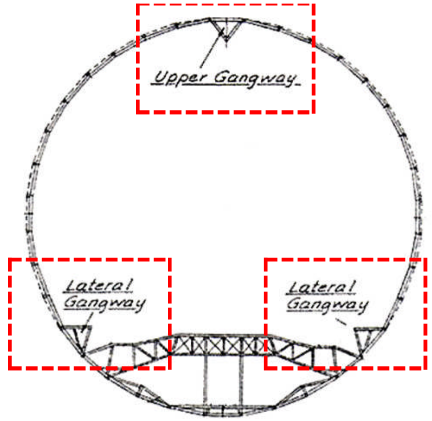




__Above__: **isometric sectional view of ZRS-4 and ZRS-5's "three-keel" structural system**
__Left__: **main ring under construction (top) and cross-sectional view of main ring design for Akron/Macon (bottom)**

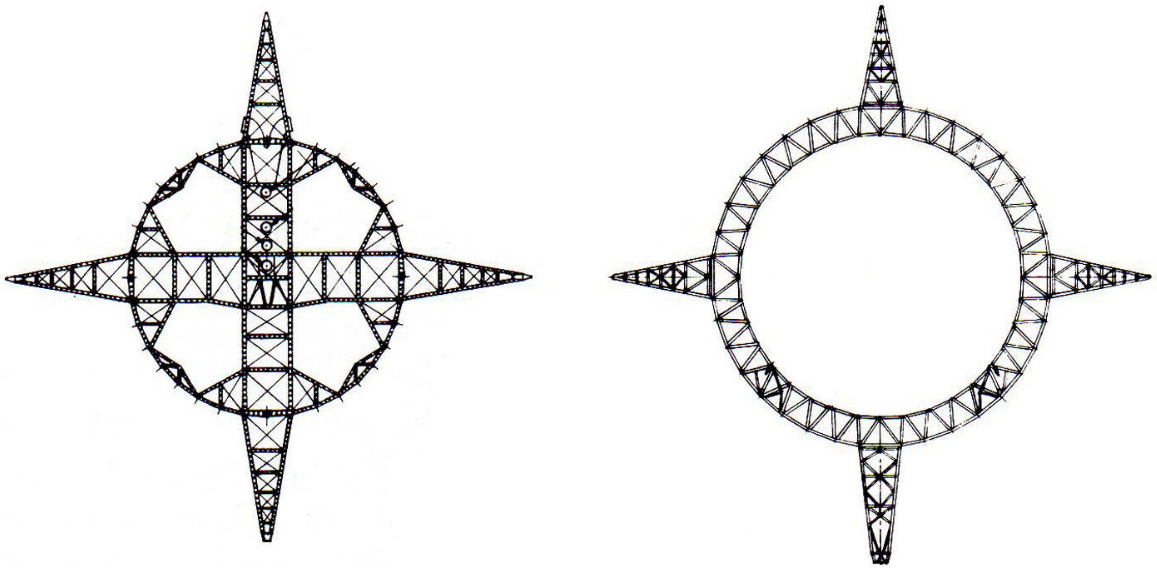






Traditional airship design was built around a single structural keel running the length of the ship along the bottom of the hull (above left). Arnstein's design was radically different featuring three large triangular keels; one at the top of the airship and two on either side at a 45-degree angle from the bottom of the hull (above right). The main keel, at the top of the ship, provided access to the valves for the gas cells and the two lower keels provided support for the engines and crew spaces.

__Left__: traditional rigid airship's hull prior to the lifting gas cells being installed. Note the ladder/s and walkway within the single structural keel at the hull's bottom.



Traditional German airship design included a cruciform tail structure for strength (left) which Arnstein and his design team eliminated in Akron/Macon (right). Another design element (which would have great significance in light of later events) was the shape and position of the stabilizing fins which were modified from their original design to accommodate a Navy request that the lower fin be visible from the control car. Experience had taught airship commanders that the lower fin was vulnerable to damage in operations near the ground. During LZ-127's (*Graf Zeppelin*) difficult overweight takeoff from *Los Angeles* during its 1929 round-the-world flight, the lower fin (which had not been visible from the control gondola) narrowly missed hitting power lines at the edge of the field. Thus, Eckener and other airship commanders believed an unobstructed view of the lower fin was necessary for safety. This requirement led to a modification of Arnstein's original design which would later have tragic consequences in the crash of the Macon.

"…The two new American ships are larger, being of 6,500,000 cubic-foot capacity, but the lift produced by the helium they will use will be about equal to that of a 5,000,000 cubic-foot hydrogen ship. Because helium will not burn, these ships will represent many innovations in design. Almost everything will be inside the hull, where wind resistance is nil. The propellers and their outriggers, control surfaces and control room will be practically the only protruding parts. Motor rooms, being inside the framework, can be larger and of stronger construction. Passenger and crew quarters will be more extensive than in any previous airship. Each ship will have three triangular keels. Corridors, state-rooms and other compartments will be located inside these keels…"

***Popular Mechanics*, February 1930**

The two primary lifting gases used by dirigible airships have traditionally been hydrogen and/or helium. Hydrogen (H) is the earth's lightest element and can be manufactured easily and inexpensively, but it is inflammable. Helium (HE) is a relatively rare and expensive as a natural resource, but is non-flammable. Because helium is much heavier than hydrogen, it can reduce a rigid airship's useful payload by more than half. Although helium weighs about twice as much hydrogen, both gases are so much lighter than the surrounding air that helium theoretically provides about 93% of hydrogen's lift. The actual lifting ability of both hydrogen and helium varies with temperature, pressure and humidity and in practical operation, it's impossible to achieve or maintain 100% purity of either gas thus giving helium about 88% of the lift of hydrogen in application. To take account of varying atmospheric conditions and gas impurities, airship designers conservatively estimate helium's lifting capacity at 60 pounds per 1K cubic-feet and hydrogen's at 68 pounds per 1K cubic-feet. Because so much of an airship's weight is fixed such as structure, engines etc. ("dead weight") and required payload (i.e. crew and ballast), a helium-inflated airship has a much lower useful payload and much less range (less fuel carried) than a hydrogen airship of the same size. As an airship rises, its lifting gas expands. An airship that begins a flight with its gas cells fully inflated must therefore release gas as it climbs to keep the cells from bursting. Because hydrogen is inexpensive, hydrogen airships often began flights fully inflated to maximize payload and released hydrogen as they rose. On the contrary, since helium has always been a rare and expensive gas, helium airships began their flights at only 90-95% inflation thus reducing payload to allow their gas cells to expand without releasing helium. Additionally, hydrogen airships compensated for fuel burned during flight simply by releasing hydrogen. Helium airships require heavy water-recovery apparatus (to recover water ballast from engine exhaust) which further reduces the useful payload. Though the use of helium presented operational challenges, sizable airships were able to operate effectively when inflated with helium. LZ-129 (*Hindenburg*) was designed to operate with helium and could have easily conducted transatlantic operations with non-flammable helium rather than hydrogen.

“…Forty years ago, when Count Zeppelin’s first dirigible was under construction in its floating shed on Lake Constance, helium was a rare laboratory gas. It commanded a price something like $2,000 a cubic foot. If that rate prevailed today, one filling of the LZ-130 would cost more than $14,000,000,000! However, in the intervening years, American scientists have devised methods of washing, cooling, and separation which enable them to extract helium in large quantities from the natural gas of several fields in the Southwest. As a result, the cost has steadily declined until now helium can be obtained for approximately a cent a cubic foot…”

Popular Science Monthly, **April 1938**

“…At the circumference of the huge, almost circular frames enclosing these cells, the bulkheads are attached to resiliency devices. These correspond to shock absorbers on an automobile. If a gas cell loses some of its helium, the adjacent cells will have a tendency to expand and fill up some of the space. The resiliency devices will serve to keep such expansion under control, yet permit an equalization of pressure…”

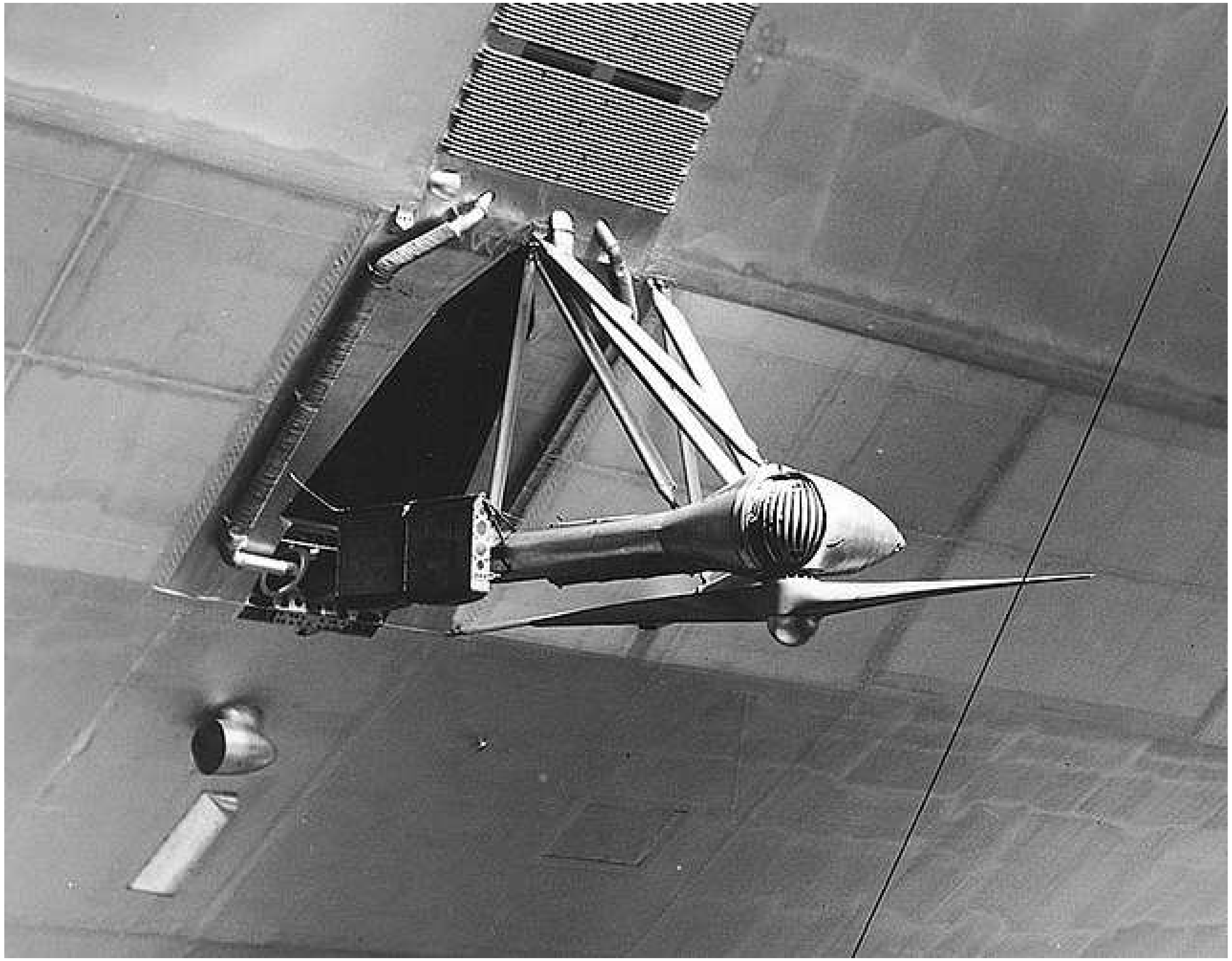
***Popular Science Monthly*, February 1931**

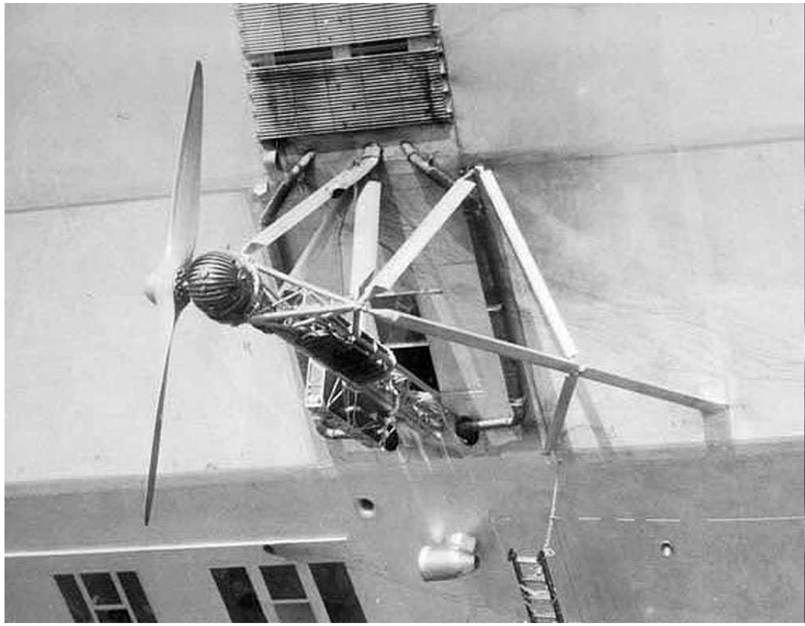
"…There has arrived in Akron a shipment from Germany of eight giant Maybach airship engines that will be installed in special compartments of the airship. It may seem peculiar that, while Germany imports American engines for her largest airplanes, Germany, in turn, sends across the Atlantic engines for America's greatest airship. The reason for using German power plants in the 'Akron' is that no satisfactory reversible engine has been developed in this country. A generation of engine development work is behind the German Maybach, designed specially for lighter-than-air craft…"

***Popular Science Monthly*, February 1931**

“…On a testing stand erected at the Zeppelin factory the engines and their propeller driving mechanism have been put through rigorous tests. Those familiar with the power units have declared that, had the British airship ‘R-101’ been equipped with a propeller arrangement such as that being built into the American Zeppelin, the recent destruction of the ship in France probably would not have happened. The engines are mounted inside the envelope, in special fireproof rooms contained in main frames of the hull. Running from each engine out through the side is a steel propeller shaft, supported by a stream-lined outrigger. The outer end terminates in a ball-like device that contains bevel gears. The propeller, driven through these gears, is at a right angle to the shaft. The gear housing is ridged with cooling vanes. The propeller – this is the important feature – can be rotated through an arc of ninety degrees, so that its axis is either vertical or horizontal. With the engine running in the forward direction, the propeller can be tilted so as to drive the ship vertically downward, horizontally forward, or at any angle between the two. With the engine reversed, the propeller will force the ship astern or upward. Thus the propellers can be used to move the ship in practically any direction, to a degree independently of the rudders or action of the gas or ballast. Thus an overloaded ship or one whose gas is leaking badly can be safely maneuvered simply by manipulating the propellers…”

***Popular Science Monthly,* February 1931**



The three-keel arrangement, along with the use of non-flammable helium, allowed the engines to be carried internally, along the lower keel/s, rather than in external gondolas. This significantly reduced aerodynamic drag and allowed for easier access and maintenance of the engines (right). The 560 HP *Maybach* VL-2 engines were connected to outrigger propellers by long shafts (left) with bevel gears which allowed the propellers to be rotated to provide thrust not only forward and reverse, but also vertically downward to assist in takeoffs and landings. The mounting of the engines on the two lower keels did create one design element which was accepted only as a compromise; the four engines on either side were mounted in a straight line, not staggered. In earlier airships, the staggering of engines at differing heights along the hull allowed each propeller to operate in clean air, undisturbed by the prop wash from the engine in front of it, whereas the propellers on Akron and Macon operated in the disturbed air created by the engines ahead of them. Placing the engines in a straight line along each of the lower keels, however, allowed for a much simpler and lighter design, and was accepted as a better alternative than the additional weight and complexity of the framework that would have been required to stagger them. Another notable feature of Akron and Macon was the water recovery apparatus designed to recover water from engine exhaust to compensate for the weight of fuel burned during flight (to avoid the need to valve helium to maintain aerostatic equilibrium as fuel was burned).

WEATHER Fair tonight. Wednesday cloudy followed by rain. Rising temperature tonight.

MANSFIELD NEWS-JOURNAL

FINAL EDITION

VOL. 49, NO. 25 — MANSFIELD, OHIO, TUESDAY, APRIL 4, 1933 — PRICE THREE CENTS

73 FEARED KILLED AS AKRON DIVES FLAMING INTO OCEAN

COUNCIL WILL VOTE TONIGHT ON BEER BILL

City Legislators Ready to Amend Ordinance to Permit Sale Here.

STUDY REVENUE MEASURE

Mansfield Officials Study Proposals to Tax Brew Distributors.

QUEEN OF SKIES FALLS TO DOOM IN ATLANTIC

The U. S. S. Akron, proud queen of the skies, pictured above, crashed to its doom in the Atlantic ocean this morning, carrying with it 77 officers and members of the crew. Only four had been picked up at noon today, and one of these had died. The other 73 are believed to have met their deaths when the ship crashed. Lower left shows Lieut. Comm. Herbert V. Wiley of the Akron, who was one of the four to be saved. He was taken aboard the German tanker Phoebus. Map at lower right shows the approximate position where the Akron went down, after being hit, according to dispatches, by a bolt of lightning which set fire to the craft. Naval destroyers and planes and coast guard craft were making a frantic search in the vicinity today for survivors of the disaster or their bodies. So far, only bits of wreckage have been sighted.

AIRSHIP BELIEVED HIT BY LIGHTNING DURING JERSEY COAST CRUISE

Four Picked Up at Sea, One Dies After Rescue; Planes, Ships Fail to Find Other Bodies; Rear Admiral Moffett Missing.

Personnel Of Akron

MICHIGAN VOTES ASSURE REPEAL

Referendum Returns Give 86 Out of 100 Ballots to Wet Factions.

Roosevelt Terms Loss of Akron 'National Disaster'

President Laments Death of Rear Admiral Moffett and Shipmates—Two Investigations Launched.

CAPTAIN TELLS OF SAVING FOUR

One Survivor of Akron Crash Dies After Rescue From Sea by Tanker.

Major Dirigible Disasters Cause High Death Toll

FORMER CRESTLINE BOY WAS ON AKRON

Commander's Radio Message Tells Graphic Story of Crash

OHIOAN MISSING

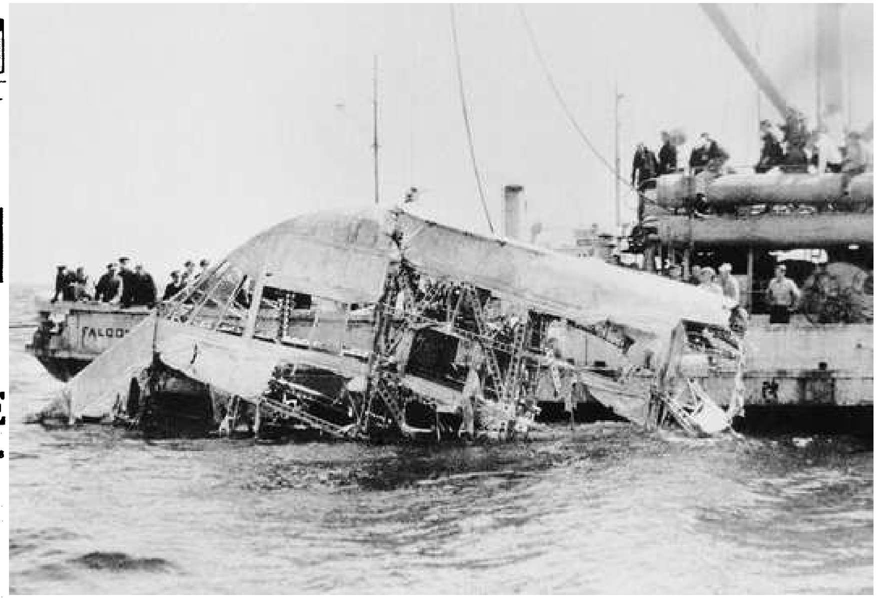
Misfortune Dogs Akron During Brief Career in Sky

DIRECTORS MEET

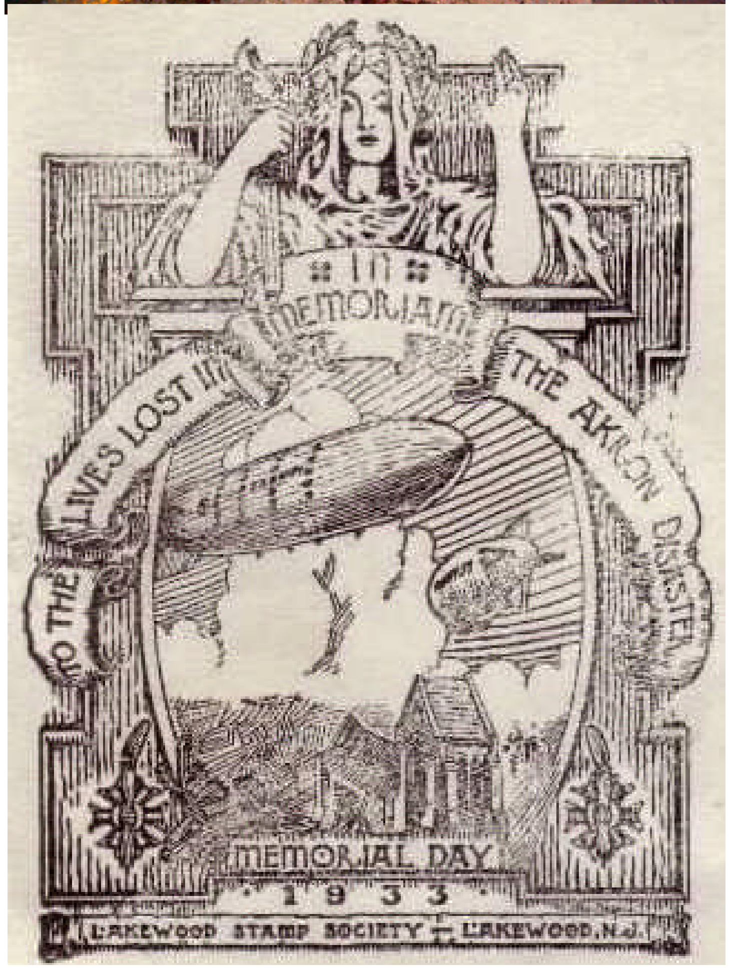
WALKER TO WED

REPORT RELIEF

BEAT PRISONERS



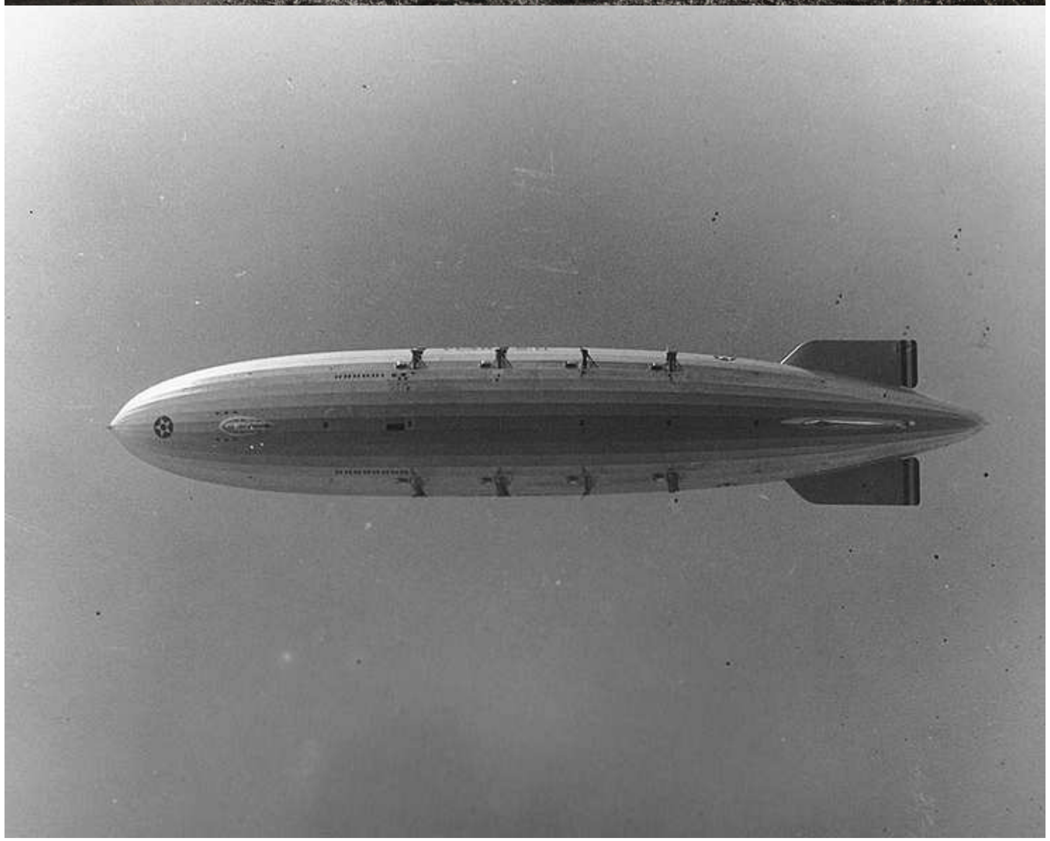
The *USS Akron* encountered a violent squall over the *Atlantic* ocean on April 4th 1933 and was lost at sea with 73 of its 76-man crew. During the search for other possible survivors, the *U.S. Navy* blimp J-3 also crashed, killing two more men. Soon after Akron's loss, Navy divers examined her wreckage (above), which was located about one hundred-feet below the ocean surface east of *Atlantic City, N.J.* In June of 2002, the research submarine NR-1 revisited the airship's crash site, where much of the framework remains visible on the *Continental Shelf*.

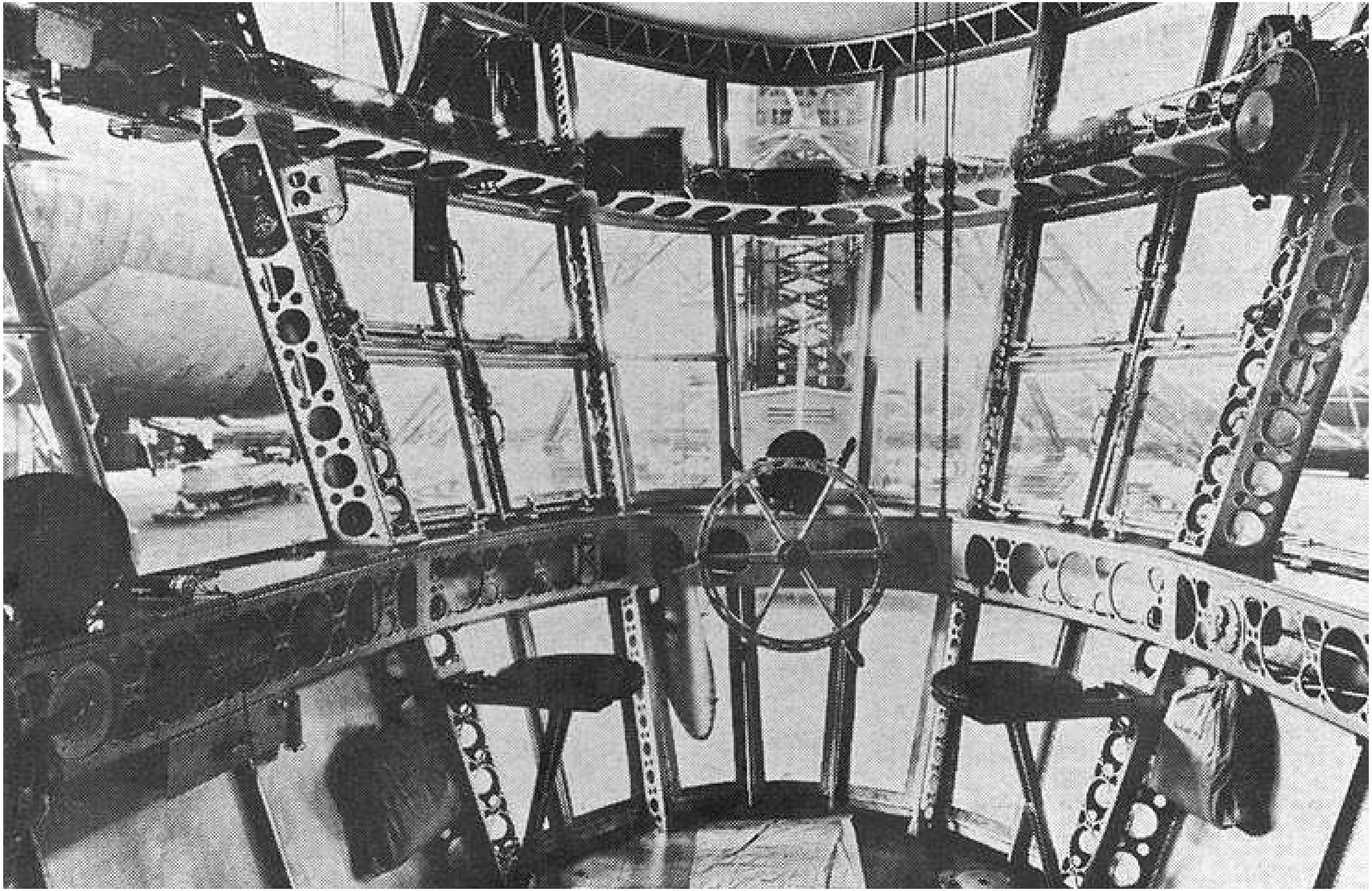

IN MEMORIAM
TO THE LIVES LOST IN THE AKRON DISASTER
MEMORIAL DAY
1933
LAKEWOOD STAMP SOCIETY LAKEWOOD, N.J.

“When the U.S.S. Macon, now being built at Akron, Ohio, is finished, it will look like its sister ship, the ‘Akron,’ but it will be different. Many changes, the most important of which are kept secret, will be made in the ‘Macon.’ The gas cells in the ‘Macon’ will be of gelatine-latex construction – a cell type that has been found superior to anything previously used. Its electrical system will differ from the ‘Akron,’ as generators of a new type will be used. Its telephone system will be automatic, with phones located at nineteen different stations. Other alterations will be found in the fuel and ballast arrangements and in the control and heating systems. Engine mountings will be lighter and of better design than those now in use, and provisions will be made for replacing the power plant with more powerful engines. In this connection there are indications that a perfected Diesel engine may, in the near future, supplant gasoline motors in airships. Many of the changes in the Macon are to reduce the weight, as it will be 8,000 pounds lighter than the ‘Akron.’”

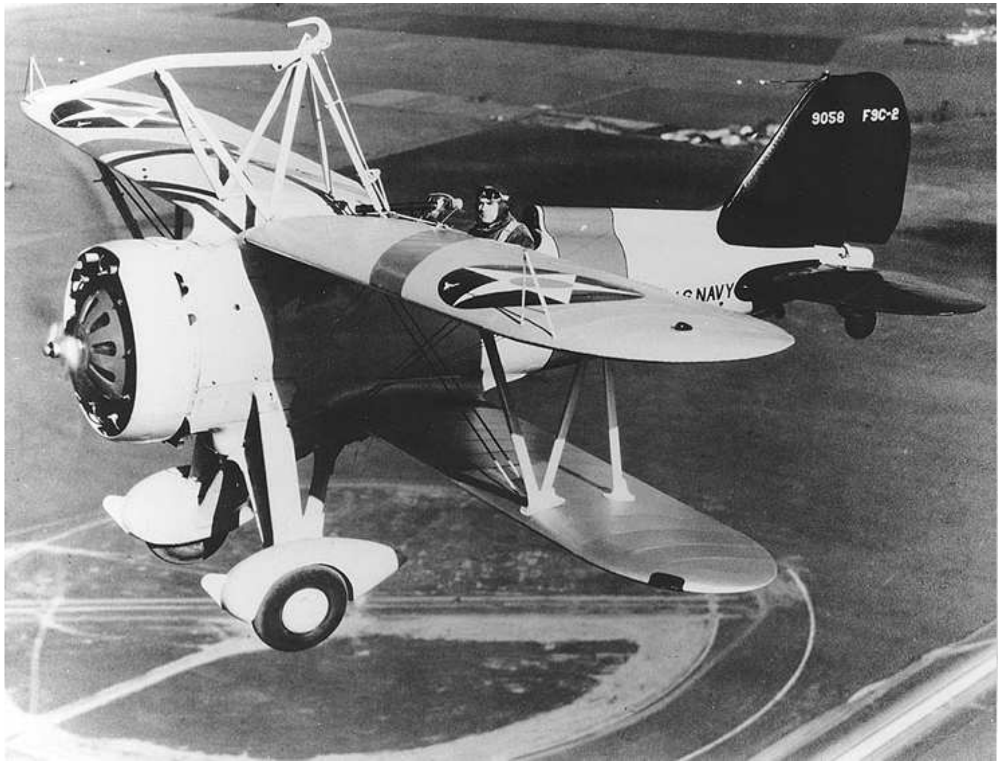
***Popular Science Monthly*, September 1932**

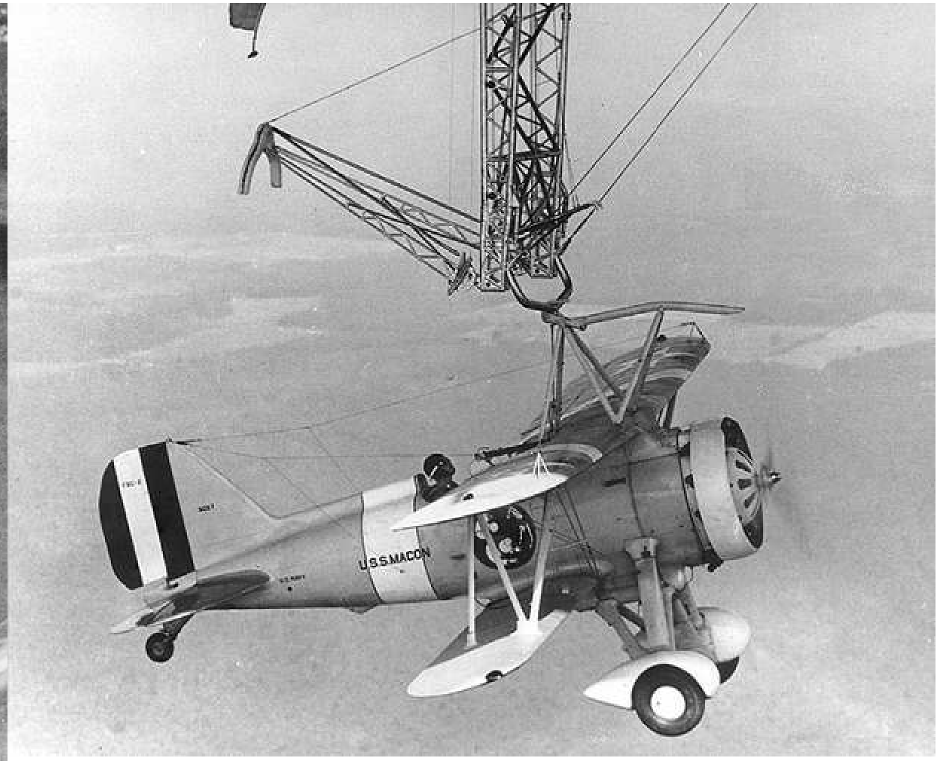

U.S. NAVY





<u>Above</u>: caption: "View in the airship's control car, looking forward, while she was in a hangar, circa 1933–1935."





Left: caption: “Curtiss F9C-2 *Sparrowhawk* fighter flying over Naval Air Station Moffett Field, California, in 1934. This plane was then assigned to USS Macon (ZRS-5).”
Right: caption: “Curtiss F9C-2 *Sparrowhawk* fighter hanging from the trapeze of USS *Macon* (ZRS-5) during flight operations in 1933.”

<u>Above</u>: caption: “Waco XJW-1 utility airplane parked at an airfield, circa 1934–1935. This airplane was assigned to USS Macon (ZRS-5).”

Los Angeles Times

MACON PLUNGES IN SEA; ALL BUT TWO SAVED

Hauptmann Trial Ends in Near Riot Over 'Confession'

Queen of Skies Before Losing Battle With Storm

Cruisers Rescue Survivors Before Wreckage Sinks

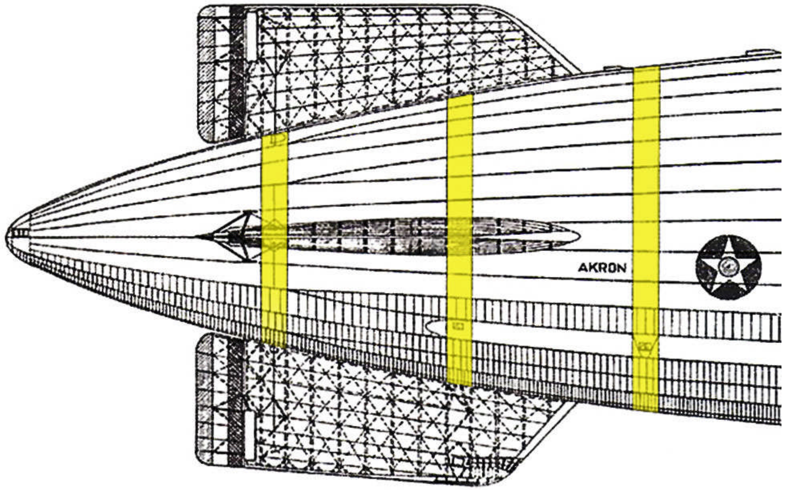
ETHIOPIANS DEFY ITALY

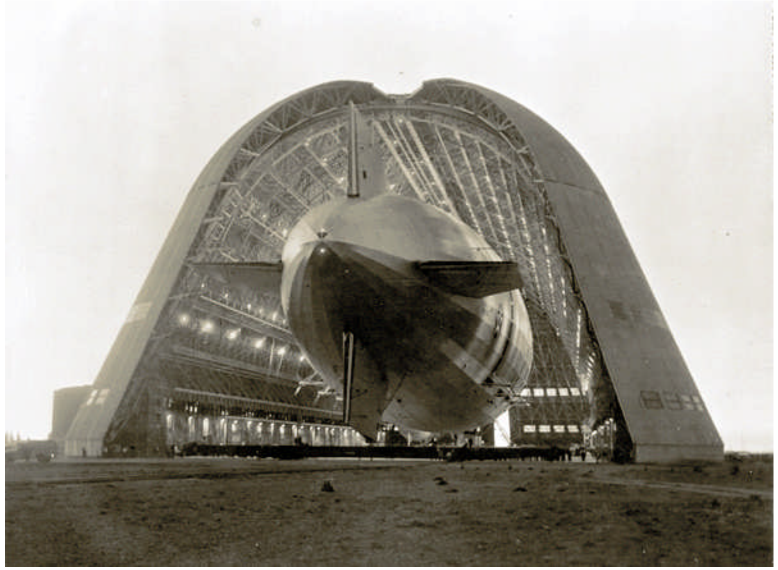
"…Thirteen miles west of Point Sur, Calif., eighty-one men, tossing in rubber life rafts, watched an immense silver cone sink slowly into the sea. It was the nose of the 'Macon,' the United States Navy's $2,600,000 airship – biggest in the world, slipping backward into 250 fathoms of water. For forty minutes, the men had endured a nightmare in the sky. With gas cells collapsing, framework breaking up, and controls out of order, the great dirigible had reared and plunged and finally had fallen 3,000 feet into the Pacific. An hour later, fighting ships, guided by red rockets shot up from the rafts, were sweeping their searchlights over the spot, rescuing survivors. All but two of the eighty-three men aboard the ill-fated craft were saved. Preparation, discipline and the nearness of the warships, with which the 'Macon' had been carrying out maneuvers, prevented greater loss of life…"

***Popular Science Monthly,* May 1935**

<u>Top</u>: the crash of the *USS Macon* off the *Big Sur* coast during a storm on February 12th 1935 was a major event and was featured on the front pages of newspapers, including the *Los Angeles Times*

<u>Bottom</u>: crew of the USS Macon





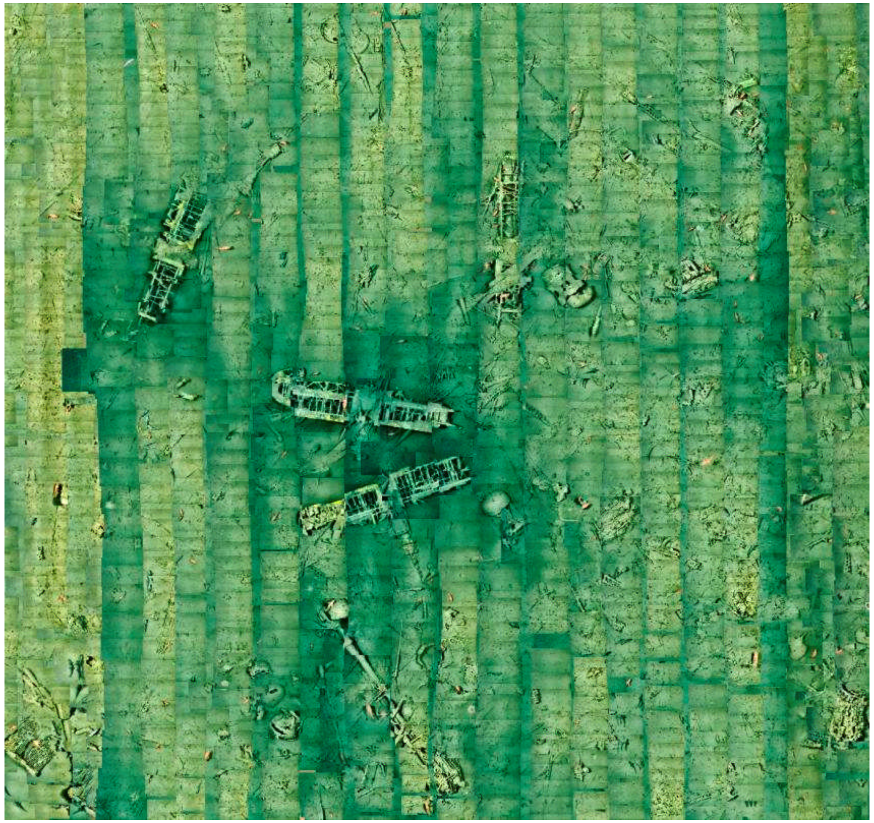
In Arnstein's original design, the fins were to have been attached to the hull at three main rings: Ring 0 (at the tail); Ring 17.5 (at the center of the fin); and Ring 35 (at the leading edge of the fin) which carried heavy loads. However, in order to make the lower fin visible from the control car, the design was changed to shorten the fins and the modified fins were attached to only two main rings (numbers 0 and 17.5). The leading edge of the fins, which were subject to very heavy aerodynamic loads, were not firmly attached to any main, load-bearing structural element but merely to weaker, intermediate framing. Given the in-flight structural failure of the tail section of *U.S.S. Macon*, there was considerable controversy regarding the decision to eliminate the cruciform structure of German airship designs and even more controversy regarding the decision to move the leading edge of the fin so that it was no longer anchored to a main ring.

Left: final, modified stabilizer arrangement of Akron/Macon showing main rings (highlighted in yellow)

Right: view of the protruding tail-section of *USS Macon* in her hangar

"…When the men on the rafts watched the 'Macon' drop beneath the waves, they also saw disappear present hopes for American supremacy in the reign of super-dirigibles. Twenty-two months before, almost to the day, the 'Akron,' sister ship of the 'Macon,' had crashed into the Atlantic twenty miles off Barnegat Light on the New Jersey coast, carrying all but three of its passengers to death. One of the survivors was Lt. Comdr. Herbert V. Wiley, the skipper of the 'Macon' who escaped again in the wreck off Point Sur. And, just ten years before, the first American-built rigid dirigible, the 'Shenandoah,' was caught in a line squall over Ohio, broken like a straw, and scattered in wreckage over the countryside. Fifteen men were killed. With the Atlantic claiming the 'Akron,' the Pacific the 'Macon,' and the Middle West the 'Shenandoah,' all of America's fighting dirigibles have disappeared. Only the 'Los Angeles,' condemned as structurally unsound and employed for experiments alone, remains at Lakehurst, N.J. Of more than 130 rigid dirigibles that have been built, only one, the famous 'Graf Zeppelin' with the veteran Dr. Hugo Eckener in command, remains in the sky…"

***Popular Science Monthly*, May 1935**



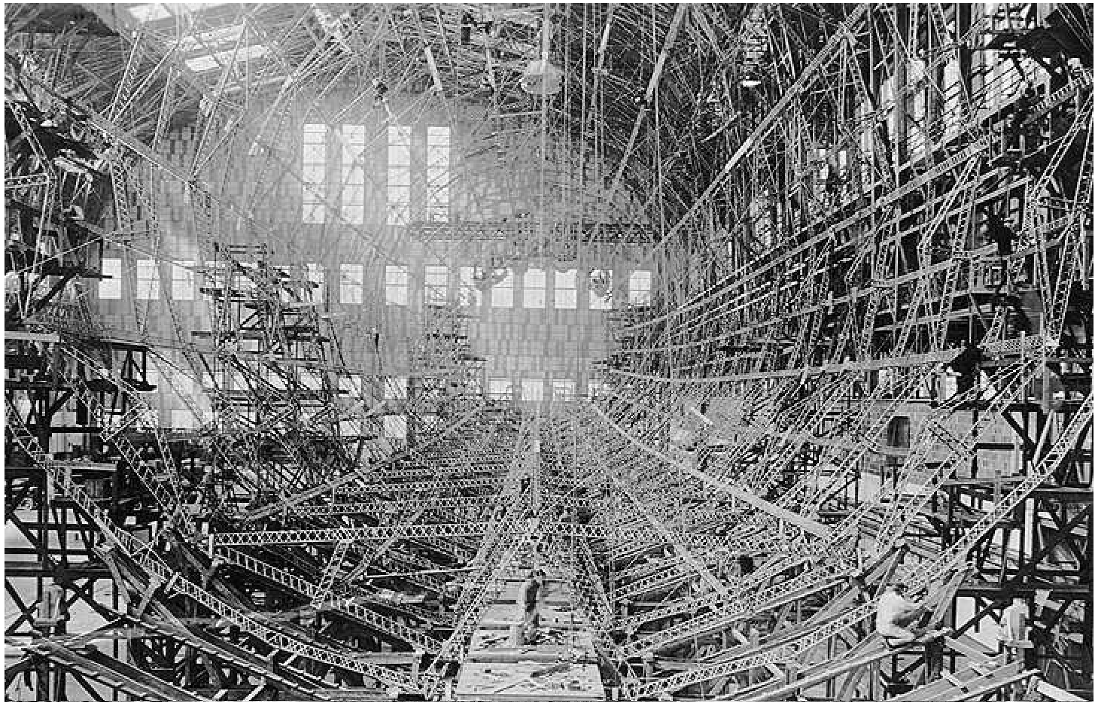
<u>Above</u>: caption: "This sophisticated photomontage shows the remains of USS *Macon* (ZRS-5) and her four fighters on the seabed. The wreckage of the *Macon* and four aircraft lie at a depth of more than 1,500 feet and were first documented in 1990 by the Monterey Bay Aquarium Research Institute (MBARI). Monterey Bay National Marine Sanctuary conducted a sonar survey in 2005 followed by the first archaeological expedition in 2006 that documented the Macon's remains. Commemorating the 75th anniversary of the loss of the U.S. Navy airship USS Macon, NOAA today (11 February 2010) announced that the wreck site on the seafloor within Monterey Bay National Marine Sanctuary has been added to the National Register of Historic Places."

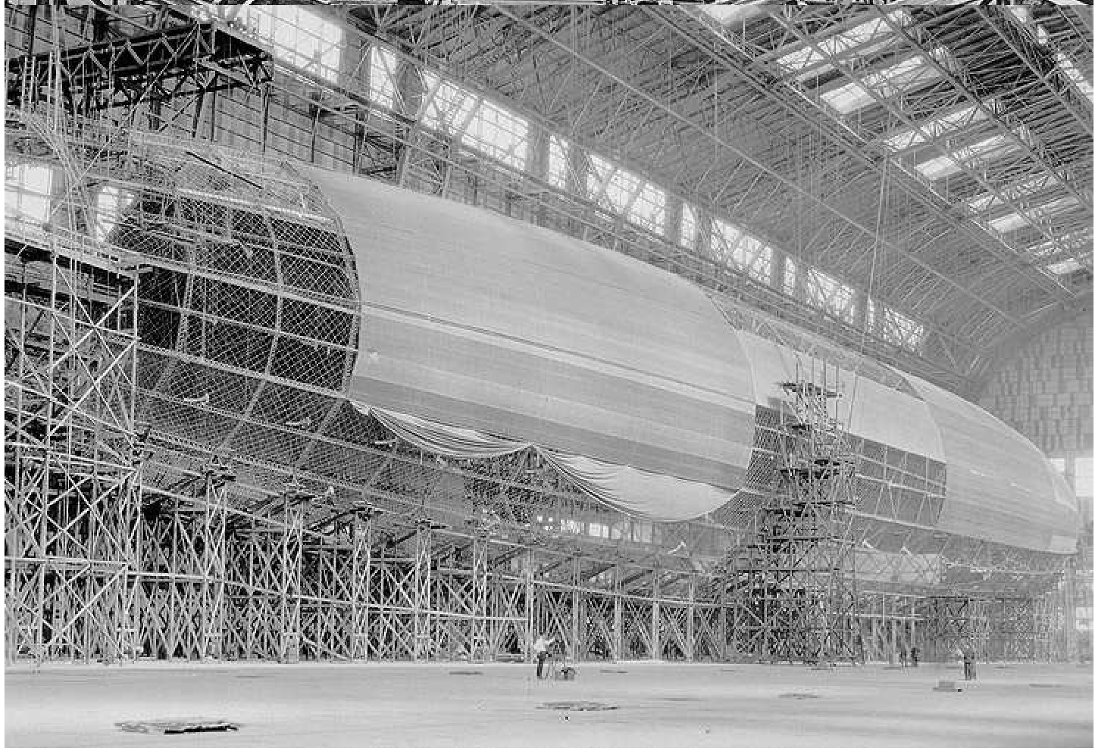
Marvel Metal

"…the story of duralumin, the marvel metal of the twentieth century – the metal invented especially for airships. It is a remarkable partnership, this between the airship and duralumin…The airship requires strength and lightness for its ribs and hull. Wood, while light, isn't strong enough. It won't stand the stress. Steel is strong enough, but too heavy. Duralumin is stronger than wood and much lighter than steel, in fact, about one-third the weight of the latter. So light and so strong is it that you can pick up with two fingers a girder of it that will support six men…"

***Popular Science Monthly*, December 1924**

<u>Above</u>: assembling the duralumin framework of the *USS Macon*





"…Duralumin is an alloy of copper, manganese and magnesium, with about 94 per cent of aluminum. In 'strength-weight' efficiency, that is, strength and lightness, it is 17 per cent greater than a good alloy steel and nearly three times better than mild steel or half hard aluminum. It was first made by Alfred Wilm in Germany in the development of Zeppelin airships, but it is now being made in England and the United States…"

***Popular Science Monthly*, December 1924**

Duralumin is the trade name of one of the earliest types of age-hardenable aluminum alloys. The main alloying constituents are copper, manganese and magnesium. A commonly used modern equivalent of this alloy type is AA2024, which contains 4.4% copper, 1.5% magnesium, 0.6% manganese and 93.5% aluminum by weight. Typical yield strength is 450 MPa, with variations depending on the composition and temper. Duralumin was developed by the German metallurgist *Alfred Wilm* at *Durener Metallwerke Aktien Gesellschaft*. In 1903, Wilm discovered that after quenching, an aluminum alloy containing 4% copper would slowly harden when left at room temperature for several days. Further improvements led to the introduction of duralumin in 1909. The name is obsolete today and mainly used in popular science to describe the Al-Cu alloy system, or 2000 series as designated by the *International Alloy Designation System* originally created in 1970 by the *Aluminum Association*. Its first use was in rigid airship frames eventually including all those of the "Great Airship" era of the 1920s and '30s. The German passenger Zeppelins LZ-127 (*Graf Zeppelin*), LZ-129 (*Hindenburg*), LZ-130 (*Graf Zeppelin II*) and *U.S. Navy* airships *USS Los Angeles* (LZ-126), *USS Akron* (ZRS-4) and *USS Macon* (ZRS-5). Its composition and heat treatment were a wartime secret. Duralumin quickly spread throughout the aircraft industry in the early 1930s where it was well suited to the new "monocoque" construction techniques that were being introduced at the time. Duralumin is popular for use in precision tools such as levels because of its light weight and strength.

The Duralumin Age

"…Engineers talk among themselves of a Duralumin Age. They speak of vast quantities of fuel saved by lighter engines, trains and motors; of buildings dizzily high; of mechanical wizardry in manufacture; of a world unshackled by ponderous iron and steel…"

***Popular Mechanics Monthly*, December 1924**

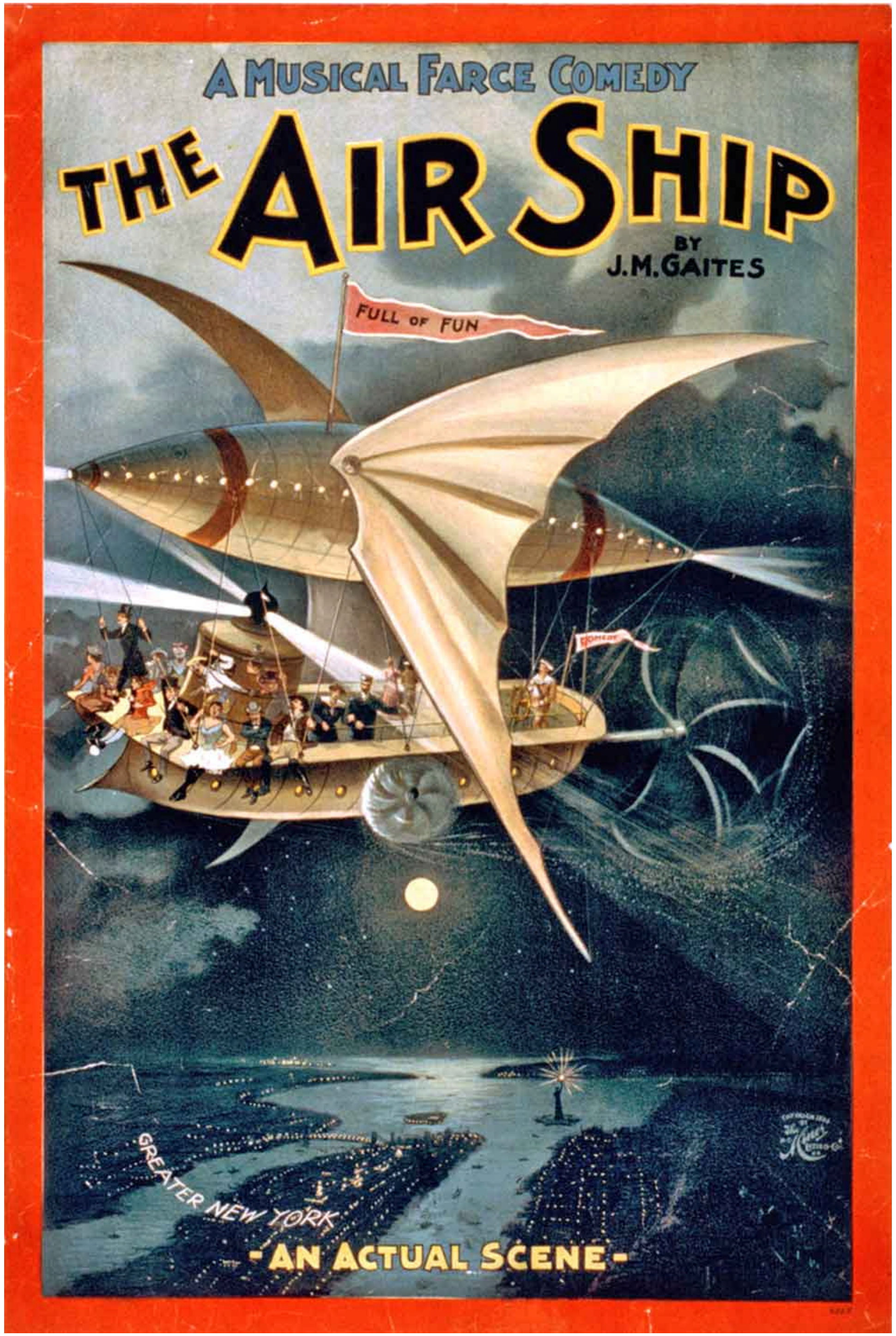
Part 5

The Future is Now

The Flights of Daring Pioneers

"Out of the sky over Lakehurst, N.J., a few days hence, the enormous silver Von Hindenburg, biggest Zeppelin ever built, is scheduled to nose down for a landing at the end of its maiden voyage to America. Not many weeks later, the four-engined, twenty-five-ton China Clipper will head out past the promontories of the Golden Gate on its first passenger flight to the Orient. Those two events will forge the final links in a vast chain of airways to encircle the globe. Before the end of this summer, you will be able to buy tickets for an aerial circuit of the earth as easily as you now purchase them for a round-the-world cruise by steamer. Years of preparation, the flights of daring pioneers, and the latest advances in engineering and radio have given a solid foundation to what, but a few short decades ago, was a seemingly impossible dream…"

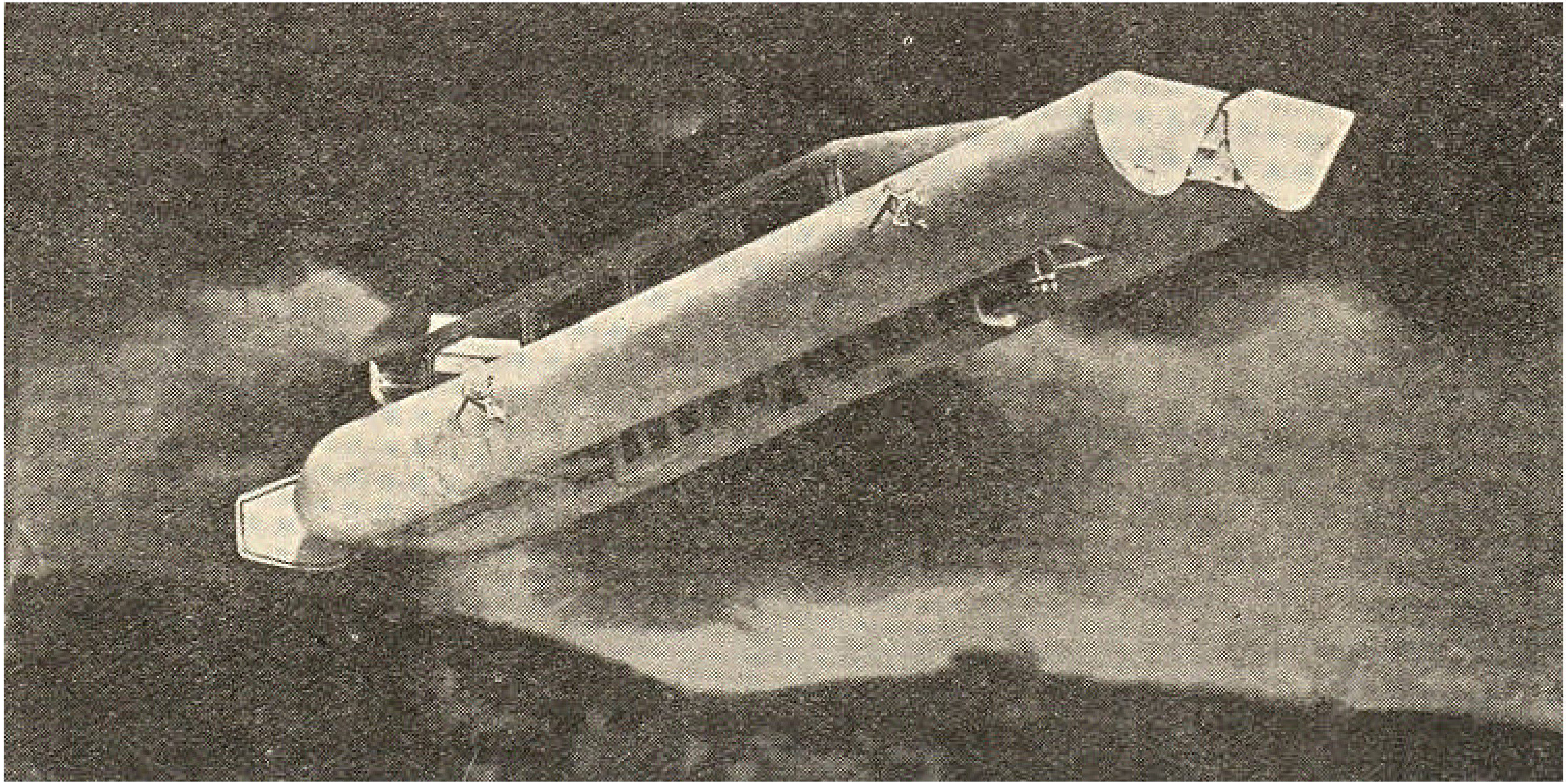
***Popular Science*, June 1936**



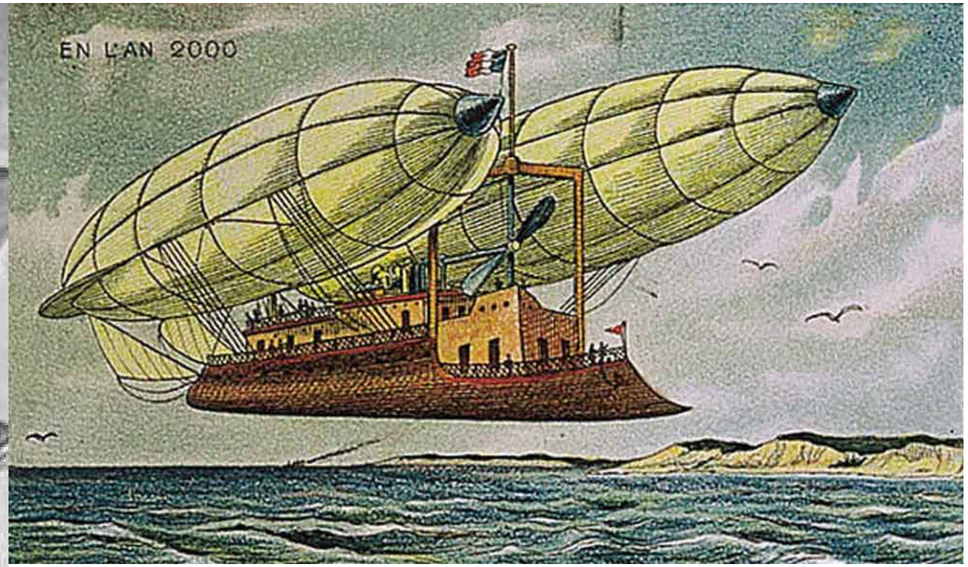
"…It is only sixty-four years since Jules Verne's classic 'Around the World in Eighty Days' appeared in American bookshops. That imaginary circuit of the globe initiated a long series of real-life dashes by train, automobile, boat, and aircraft. Beginning with Nellie Ely's seventy-two day journey, in 1889, and ending with Wiley Post's eight-day flight, in 1933, these races against the clock have dramatized the advancing speed of transportation…"

***Popular Science,* June 1936**

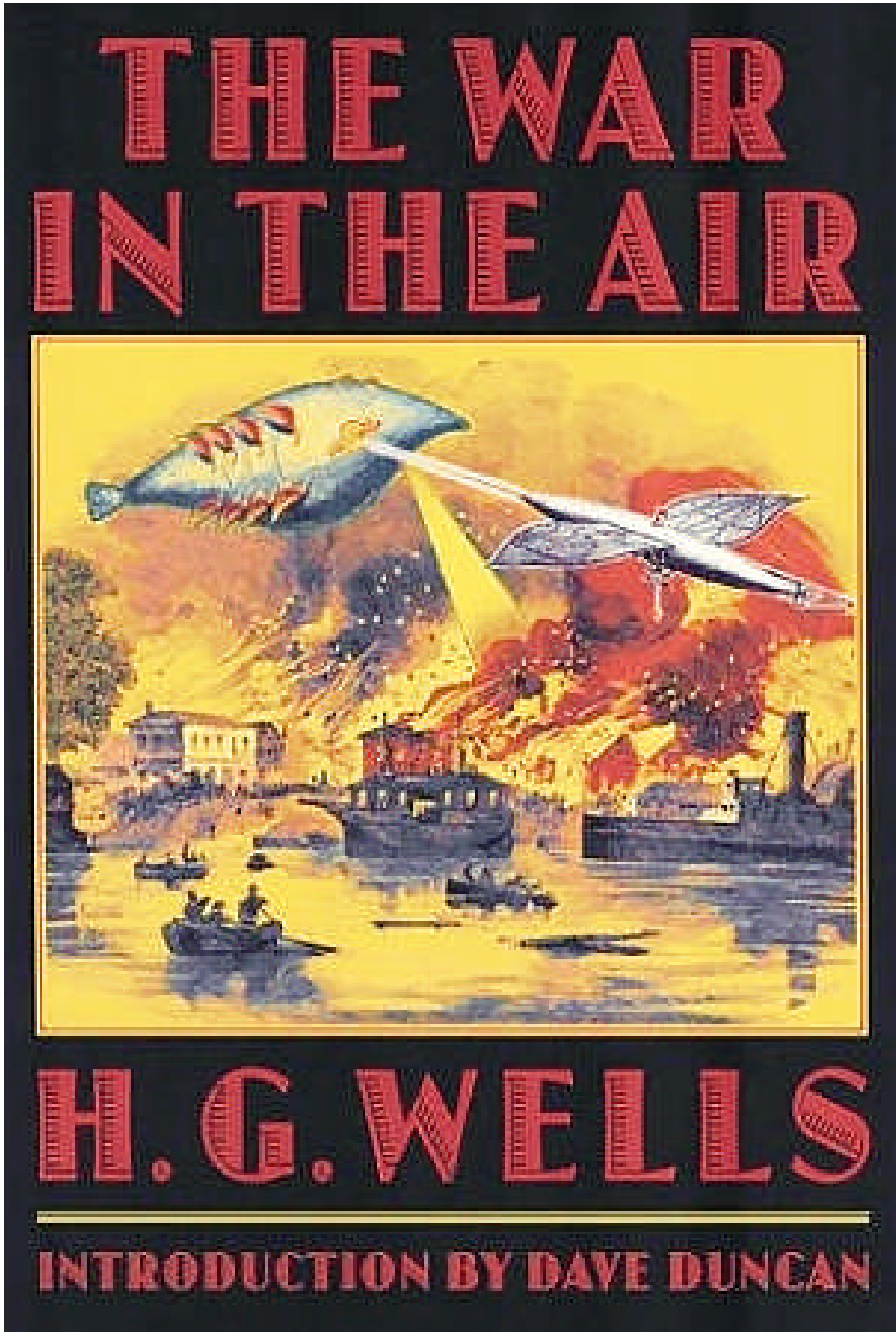
Left: musical theater poster, 1898[358]

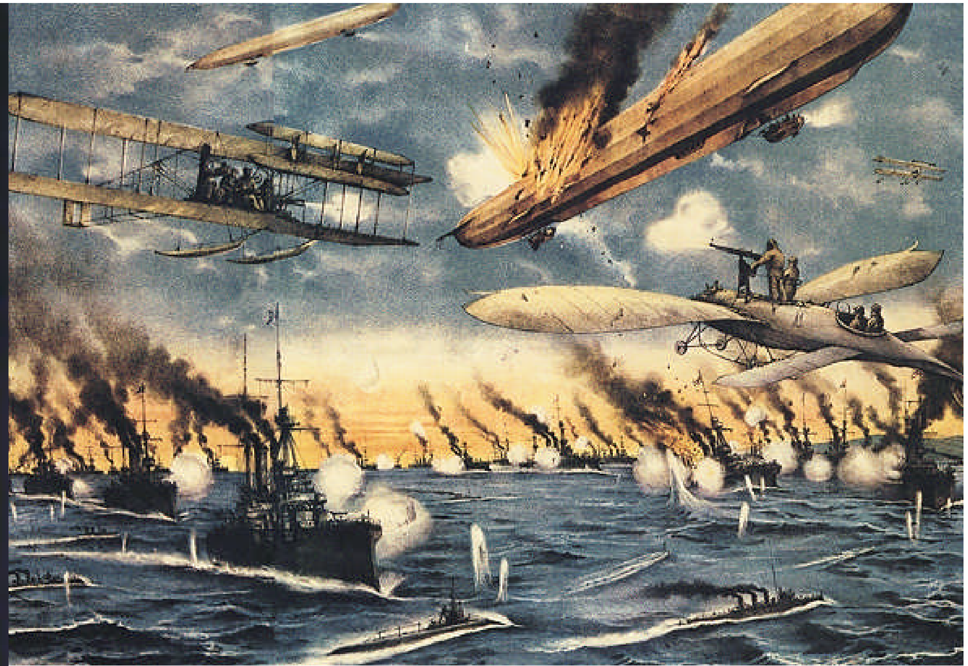


<u>Above</u>: the very unusual "Kueperle Dirigible" of 1909 was designed to carry fifty passengers

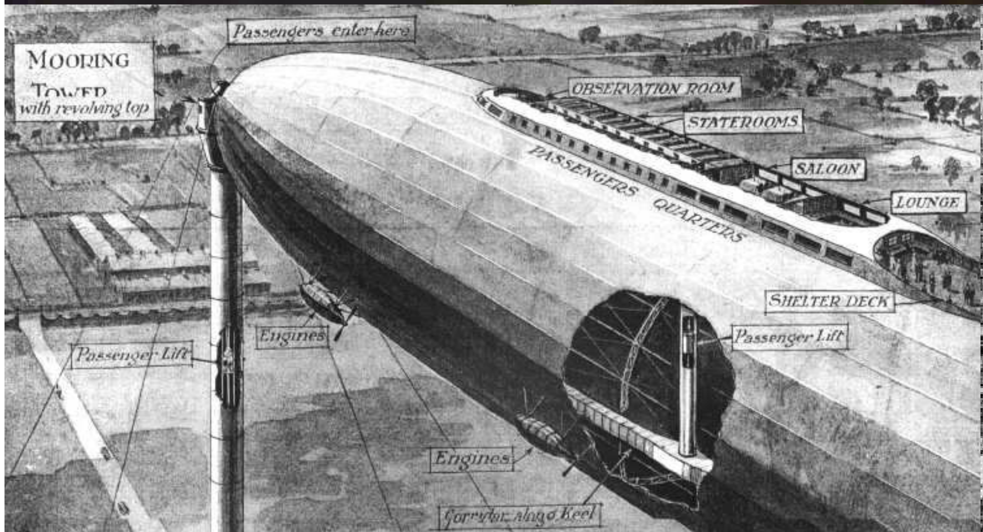


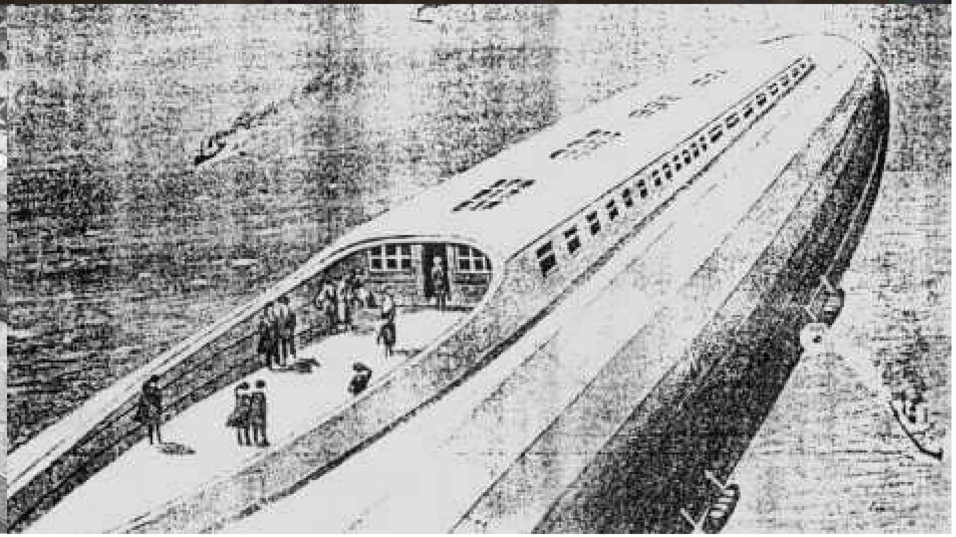
<u>Above</u>: 1910 postcard from *France illustrated* entitled: "Life in the Year 2000"
<u>Left</u>: "King's Dream of New York," from *Kings Views of New York*, 1908-1909

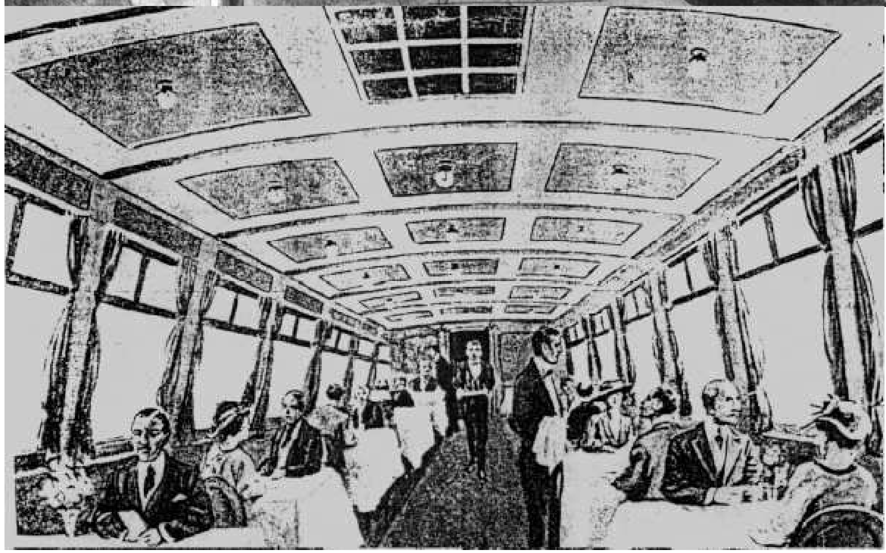




<u>Above</u>: an epic battle between German and British naval and air force/s is imagined in a 1915 Japanese lithograph
<u>Left</u>: in 1907, *H.G. Wells* published: "The War in the Air," which featured German Zeppelin-style dirigibles attacking the American fleet and raining bombs on *New York City*. It also featured a German airship shot down and washed over *Niagara Falls* by a Japanese air armada.





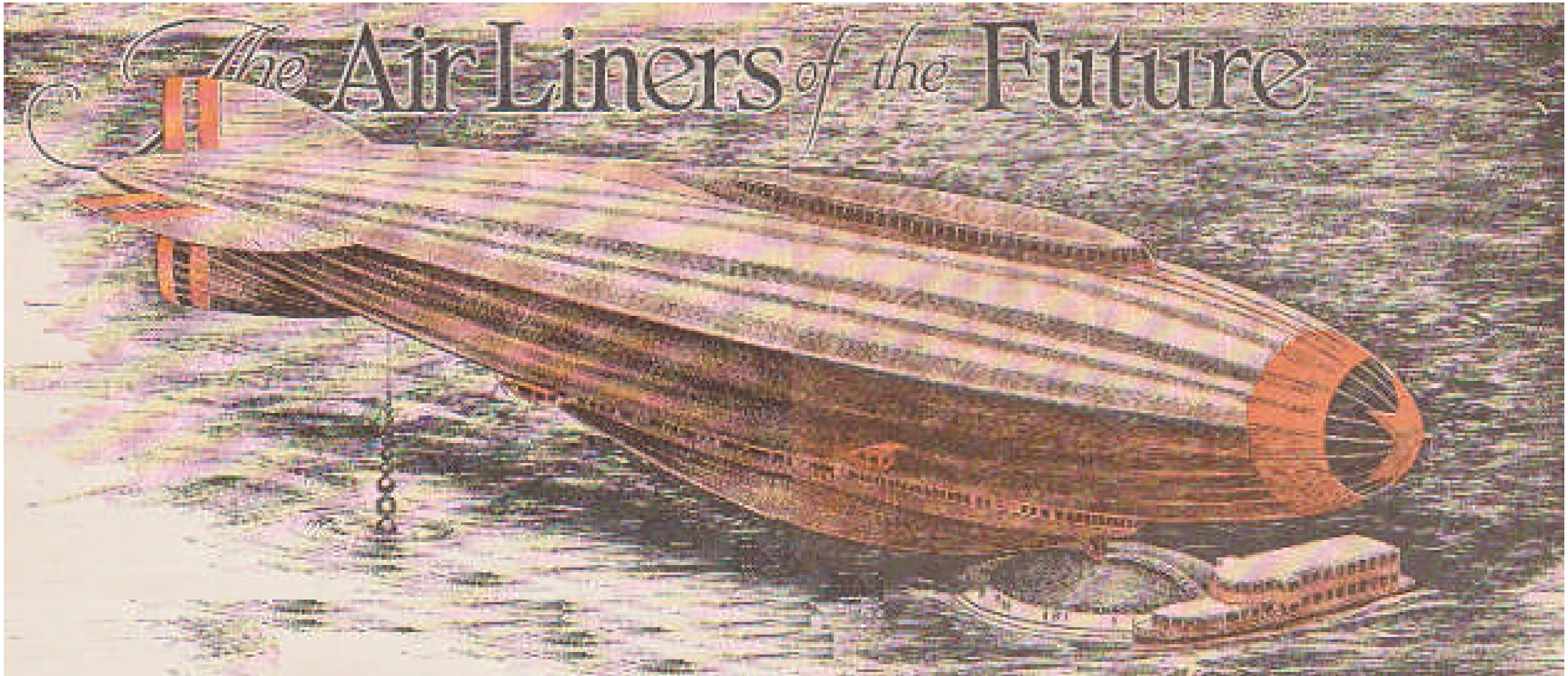


In 1919, the *Vickers Company Ltd.* drew up plans for the next step in airship evolution; the "Trans-Oceanic Airship." At 800-feet long and 100-feet in diameter, the airship would have been nearly as large as the *Hindenburg*, yet would have carried one-hundred passengers rather than fifty. The passenger compartment was situated on top rather than below the hull, keeping the passengers well-away from engine noise.[362]

"The rigid airship is at this moment a practical means of air service between America and Europe, offering passengers about the same conveniences as a Pullman train at an expense no greater than that on an ordinary steamer – perhaps less, when it is considered that the time consumed in a voyage is cut in half. There is a commercial need for the airship that the airplane does not fill. And there are rewards for those who recognize and meet this demand. More than practical rigid airships have been built by Germany, yet we are only at the beginning of airship development. The larger the ship becomes, the more economical it is. Safety is probably as great as with a steamship. Not a single passenger of more than 200,000 carried by Zeppelin airships has ever been injured. Besides carrying greater loads than the airplane, the airship can remain much longer in the air. The size of rigids during the war was limited by the sheds in which they were constructed and housed. The structural problems are merely problems for the engineer. An airship, like a house or bridge, if properly designed and manufactured, is strong enough to fulfill the purpose to which it is put. The fire hazard is negligible. No German airship was ever burned in the air save by enemy action. One ship was even struck by lightning and no injury resulted."

Dr. Max Munk, **Technical Assistant -** ***U.S. National Advisory Committee on Aeronautics*** **(also the former aerodynamics expert for the** ***Zeppelin Co*****.)**

RE: comments made in 1923



<u>Above</u>: caption: "Artist's conception of how Air Liners of the future might be anchored off shore on a special landing buoy in regions where construction of hangars is impractical. The 'Landing Foot' of the craft slips into slot of buoy while globelike buckets that fill with water are lowered from the rear to serve as anchors." Illustration from an article entitled: "The Air Liners of the Future" (*Popular Mechanics,* February 1930 – cover at left)

Dirigible on Pontoons

"A Dirigible on pontoons may seem, at first thought, a startling innovation. But it is not. It is a reversion to the first conception of the airship. The first Zeppelin and the British Mayfly were both designed to operate from the water. The first designers, however, had not hit upon the elliptical shape which would seem necessary to give stability to such a vessel in face of side wind pressure. The conception, however, is a fascinating one. The idea of enabling dirigibles to land and take off from the water, makes a vivid appeal to the imagination. Too, it also recommends itself by its inherent reasonableness and practical utility. Indeed the desirability of reverting to the old conception, if a practical means of carrying it out can be found, has long been apparent to dirigible designers. The question of its possibility has now become the most urgent problem in airship construction and I think I have devised the kind of vessel required…"

Lieut. Cmndr. *C. D. Burney,* C.M.G, R.N.

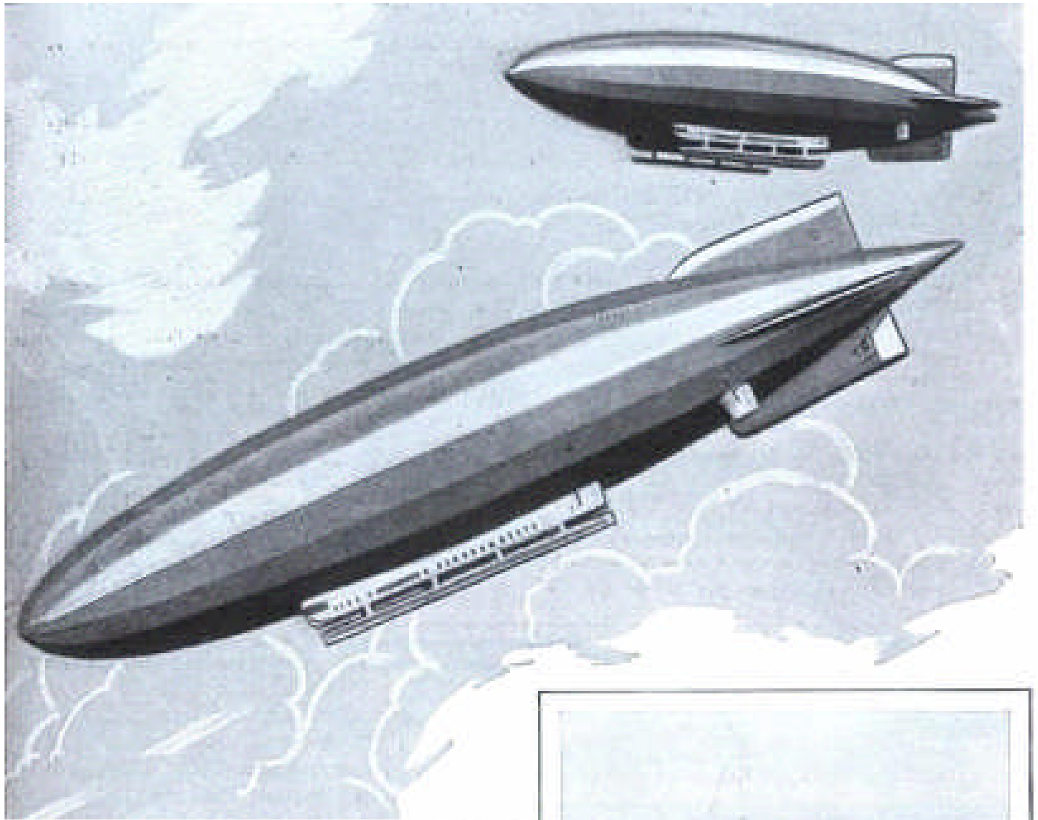
RE: excerpt from an article he authored entiltled: "My New Dirigible on Pontoons," appearing in the May 1930 issue of *Modern Mechanix* magazine. Burney was the designer of the ill-fated R-101

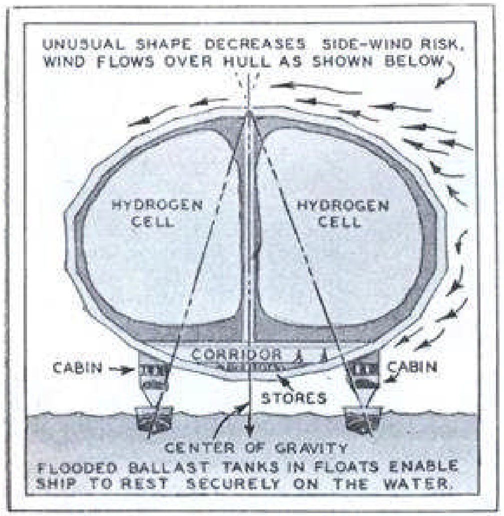
“…The important question is: Can the dirigible be put to effective use commercially? Unless it can, the case for development falls to the ground. The fact that we can now build dirigibles capable of the magnificent performances that stand to the credit of the Graf Zeppelin and can be anticipated from the British R101 and the R100, does not necessarily mean that it is worth our while to do so. The modern dirigible undoubtedly marks a great technical achievement. But that is not enough to justify its existence. It must, like any other technical invention, be able to pay its way commercially. The dirigible as at present designed does not fulfill all the requirements of a commercial vehicle. To begin with the dirigible can only make a landing at a specially prepared base. This means that engine trouble or other misadventure may be very serious indeed, particularly if it happens some hundreds of miles distant from the nearest base. The experience of the Graf Zeppelin in her attempted flight across the Atlantic in May, 1929, is a case in point. The ship’s engines broke down, and it was with the greatest difficulty that she managed to get back in safety. It is quite clear that so long as these conditions obtain, it will only be possible to run a regular airship service on a route with sufficient air traffic to pay the cost of erecting frequent intermediate bases. There is the additional fact that the mooring and docking of airships is, at present, an exceedingly difficult and expensive operation. The ship has first of all to be moored at a mooring mast - an elaborate structure which costs a great deal to erect; and may have to wait some days in this position before the direction of the wind permits docking in the hangar. Nor is this all. As the dirigible can only be handled by manpower, the actual operation necessitates the employment of several hundred men in the ground crew, who have to stand by for the purpose. The mooring and docking raft idea, which we devised at Howden during the building of the R100, will, I think, provide a practical solution to this difficulty. But the first difficulty of landing, except at a base specially prepared to receive her, still remains. And it is quite certain that this will never be overcome so long as airships can only operate on land. They must be made to operate from the water as well…” 367

Lieut. Cmndr. *C. D. Burney,* C.M.G, R.N.

“..The problem that lies before us is how to re-design dirigibles so that they will be able to come down in the manner of a flying boat and be moored to a buoy or lie at anchor like a marine vessel. I think that it is technically possible to construct an air-ship of the type suggested. The design which I have recently worked out, has passed preliminary model tests so satisfactorily as to leave little doubt about the practicability of the conception. A full description of my proposed new dirigible pontoons is contained in my book, ‘The World, the Air and the Future.’…The basic idea of the new pontoon-equipped dirigible is to enable it to land at unprepared places. Our object is to keep the ship under dynamic control by means of rudders and elevators, until it can be securely held, and is no longer in danger of being blown over by a side wind. To achieve this, two long floats, similar to the hulls of flying boats, but much larger, were constructed under midship. These are fitted with ballast tanks, and fixed to the hull, as far apart in a transverse direction as possible. At the same time the section is altered from the standard circular to an elliptical section. This reduces the overall height and lessens resistance to side winds. It also increases the dynamic lift at a given speed, and by enabling the boat hull to be more widely spread, increases the righting moment of the floats…”

Lieut. Cmndr. *C. D. Burney,* C.M.G, R.N.



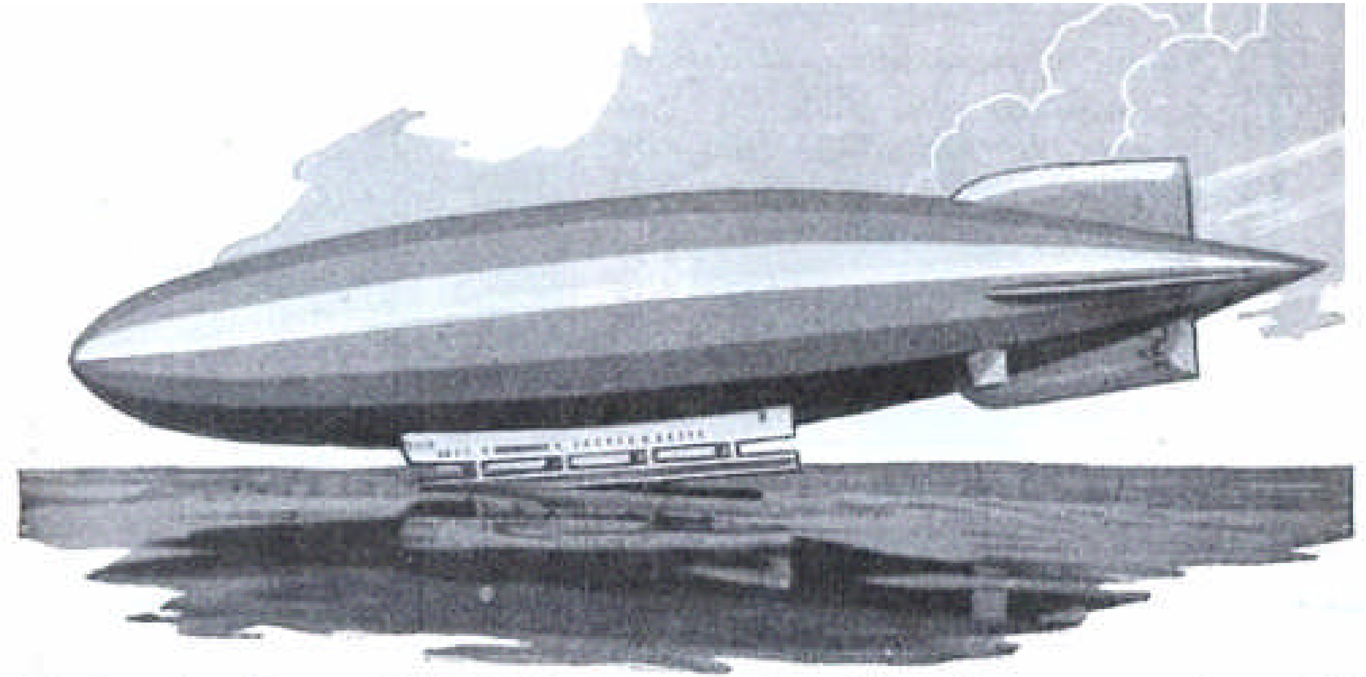


The egg-shaped section has far less wind drift than a round one. Note extreme stability due to the wide placing of the hulls, assuring safety.

The new egg-shaped, double hulled dirigible is driven toward the surface by her engines, losing no costly gas. The twin hulls pick up 120 tons of sea water each, securely anchoring the ship. Being elliptical, side windage is minimized.

"…A side wind of 35 m.p.h. exerts a force of just under 120 tons upon the ship's side. If it is to maintain equilibrium in a side wind of this velocity, we shall require one of the boat hulls to push up with not less than 120 tons. Each float must, therefore, have a buoyancy of more than 120 tons and, at the same time, acquire an actual weight of 120 tons. Accordingly, as the ship lands on the water, the ballast tanks in the hulls will be automatically filled with 120 tons of water by means of scoops, and as soon as they are full, it can be stopped. It will then float stably on the boat hulls and can be moored to a buoy…"

Lieut. Cmndr. *C. D. Burney,* C.M.G, R.N.



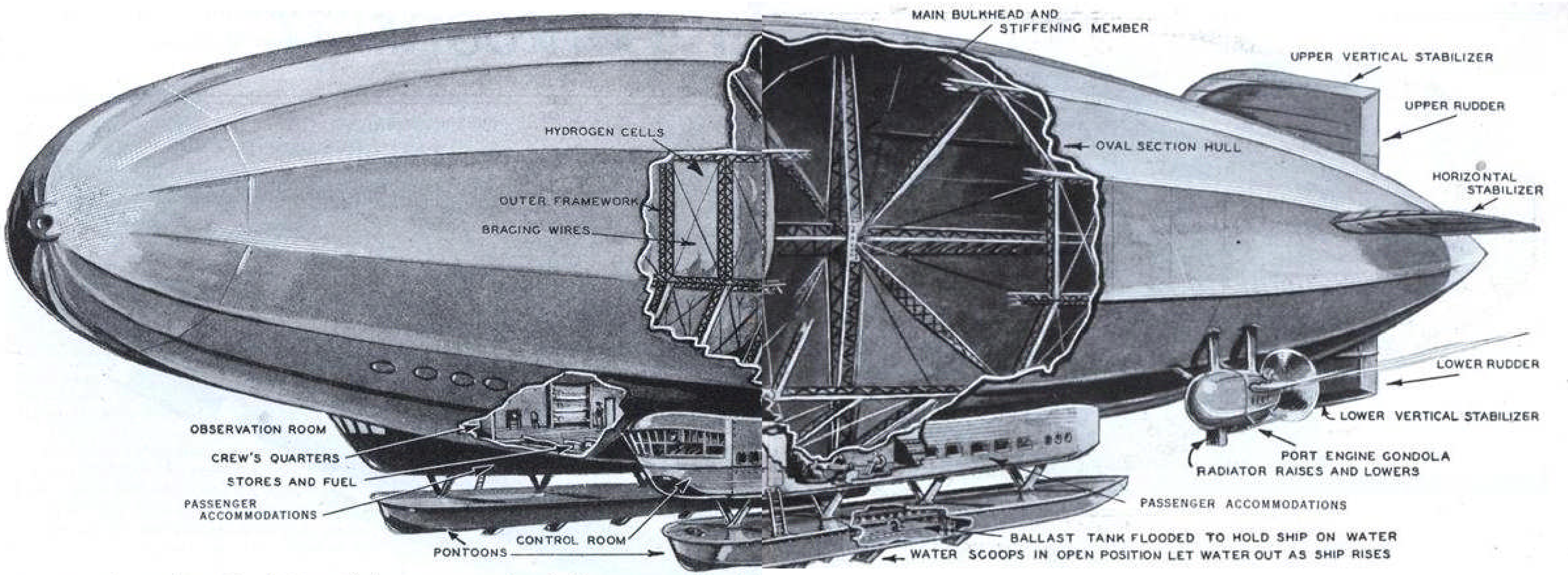
This shows how the new British dirigible approaches the surface under power, scooping up 120 tons of water ballast which, without need for valving, without loss of gas, will hold the ship at rest.

"…Now since the ship is being held down solely by the weight of water through the automatic filling of the ballast tanks, it will be at once realized that, as soon as the sluices in these tanks are opened, the dirigible will rise again. And here we come to an important advantage connected with this part of my pontoon-equipped dirigible. With the normal ship, it would be necessary to release gas in order to bring it down from flying level. The attachment of the floats, however, makes it possible to drive the ship down by the engines, which means that it can conserve gas, and is enabled to resume flying height without discharge of ballast. In other words, the ship is in this way given the mobility and ease of handling of the flying boat, while retaining its own specific advantages of great range and buoyancy…"

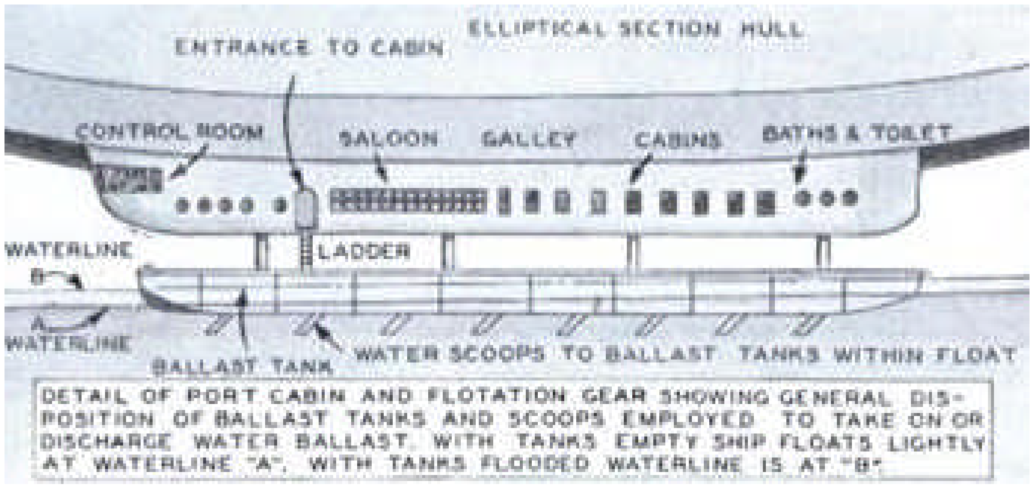
Lieut. Cmndr. *C. D. Burney,* C.M.G, R.N.

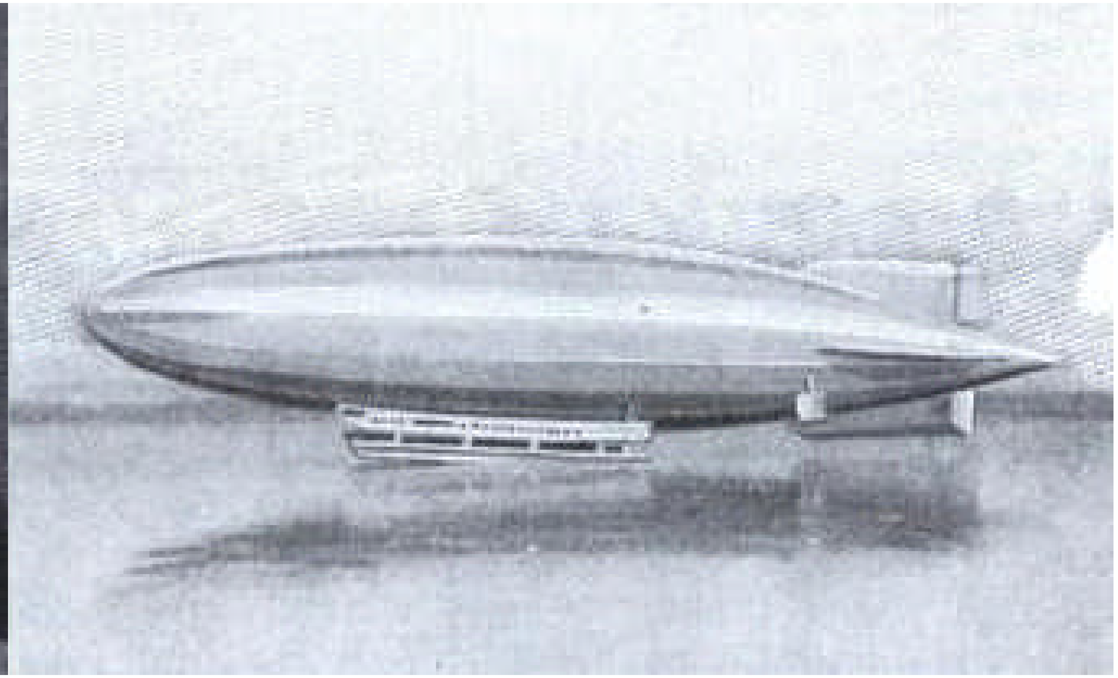
"…There are, of course, many minor problems connected with the development of the new dirigible. The advantages of the 'elliptical' ship by no means stop at mooring and handling. Owing to greater width of beam, it will have at any given speed a greater dynamic lift and therefore less difficulty in maintaining an approximately even keel in the air than is the case with a circular vessel. Again, as it will be able to dispense with the greater part of the ballast now carried, the equivalent weight of this can be added to the pay load. Nor must we forget the all-important question of size. A helpful factor in the construction of dirigibles is that efficiency increases with size. Hitherto, it has been impossible to increase size to any great extent, owing to the difficulty of handling and the fact they cannot make an unpremeditated landing. In the case of the pontoon-equipped ship, however, these hindrances will be removed, and it will be possible to build a ship of twice or even three times the capacity of R100 or R101. I have already examined the possibility of building an elliptical ship with a displacement of 450 tons, and there would seem to be no technical reason against it. On the other hand, the construction of so gigantic a vessel would be too great a step to take in one stride. It would be better, I think, to contemplate a 350-ton ship as a reasonable first step in the new development. Such a dirigible, whose displacement would be considerably more than double that of the largest airship yet built, would have a range of from 5000 to 7000 miles at a cruising speed of from 90 to 100 miles an hour…"

Lieut. Cmndr. *C. D. Burney,* C.M.G, R.N.



Plans are under way for a ship of 350 ton displacement—more than double any present ship. It i
to have a range of 7000 miles at a speed of 100 m.p.h. It will carry 150 passengers and 20 tons freight





"…Needless to say, I make no claim that this idea I have developed represents the best or the only conceivable method of designing a dirigible that can operate from water! What I do claim is that it is perfectly sound in theory and that it is the only type of design yet advanced that provides a fundamental solution to the all important landing problem. In a word, if a sound dirigible can be built on this principle, it will be able to alight and moor without extraneous aid and at places where no preparations have been made to receive it. Such a ship will have a commercial value which no amount of partisan fervor can fairly claim for the present day dirigible."

Lieut. Cmndr. C. D. Burney, C.M.G, R.N.

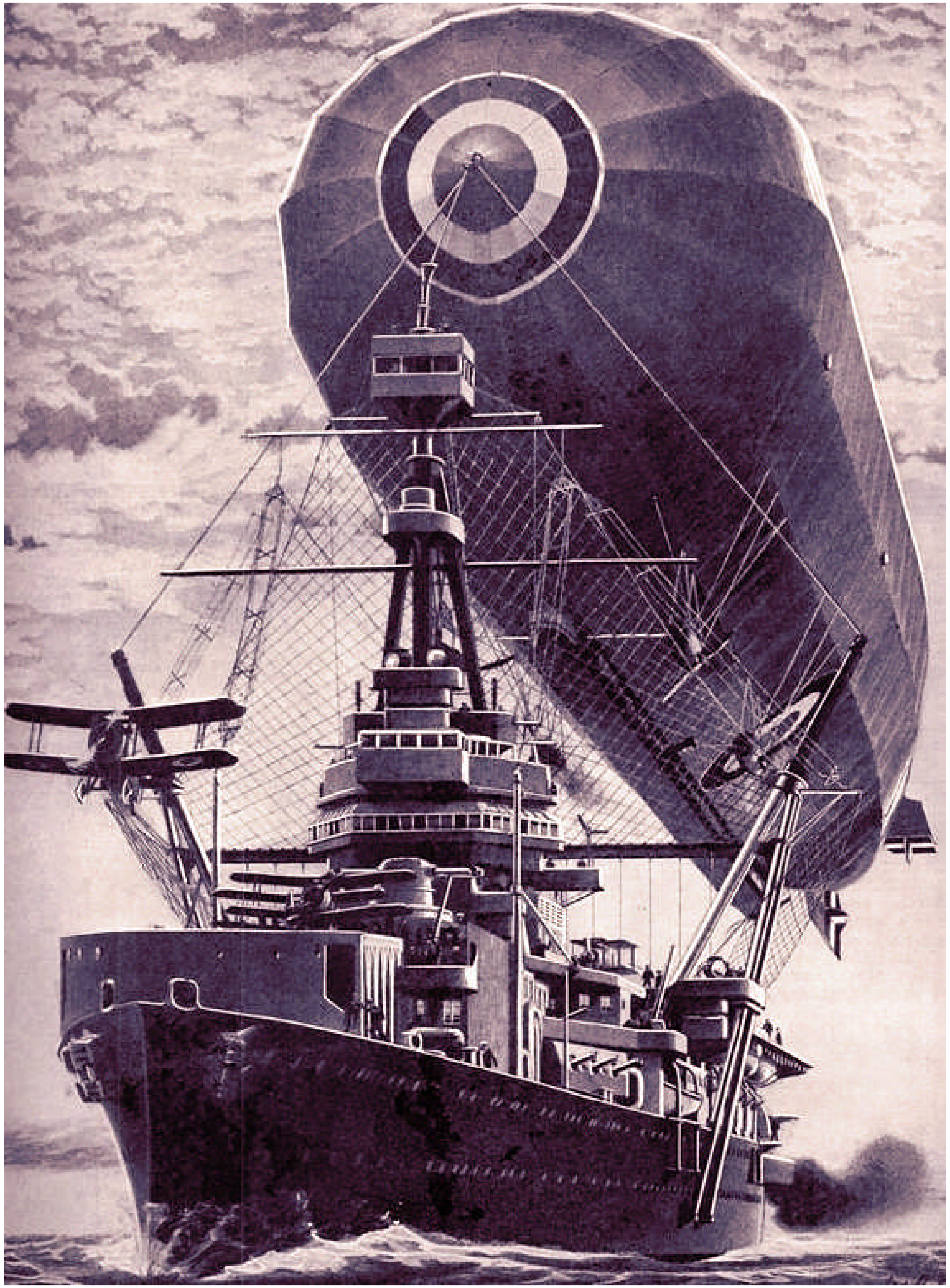
Nature’s Chosen Spot

“Commercial air navigation is no longer a subject for speculation, it is a present practicality. The luxury, economy, safety, and volume of airship transportation in Germany before and after the war are startling, when one is confronted with actual facts regarding the enterprise. America, with her far-flung territories and insular possessions, with her commercial possibilities in Central and South America, and with her centers of population demanding more rapid transportation, is nature’s chosen spot for civil airship navigation. Another year should see transcontinental routes underway, if not in actual operation.”

Fred S. Hardesty, Washington D.C. **representative of the** ***General Electric Company***

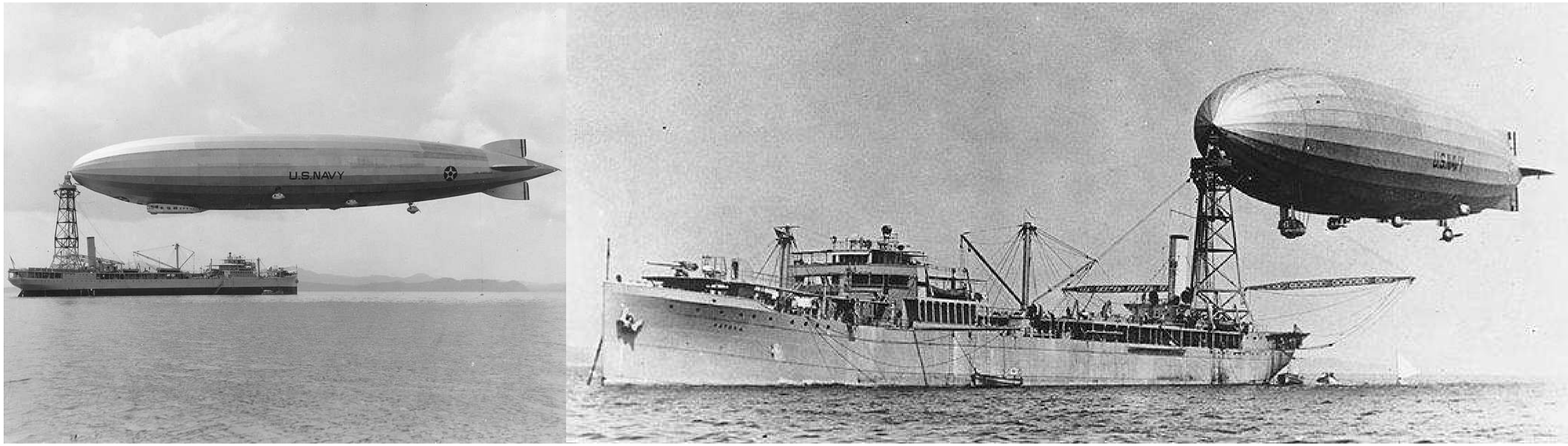
RE: comments made in 1923

Floating Mooring Mast



"Convinced that battle fleets of the future will require the aid of rigid airships as long range scouts, aeronautic experts recently have suggested an ingenious method of mooring rigids to the mast of a moving depot ship at sea, as pictured above. The depot ship, preferably a converted cruiser, has a hangar forward for small fighting planes, with a launching deck from which the planes are seen taking off to protect the rigid as it returns from a trip. Topping a raised tripod mast is a mooring device to which the airship is anchored, while projecting from each side of the vessel are other tripods carrying guide ropes that hold the airship's bow in position as its nose cone is hauled down to the mooring device. Immediately behind the mooring mast is stretched a wire curtain to prevent planes from overrunning the great landing deck seen projecting above the boiler smoke ducts aft. Above this curtain is net work to catch the mooring ropes when cast loose."[377]

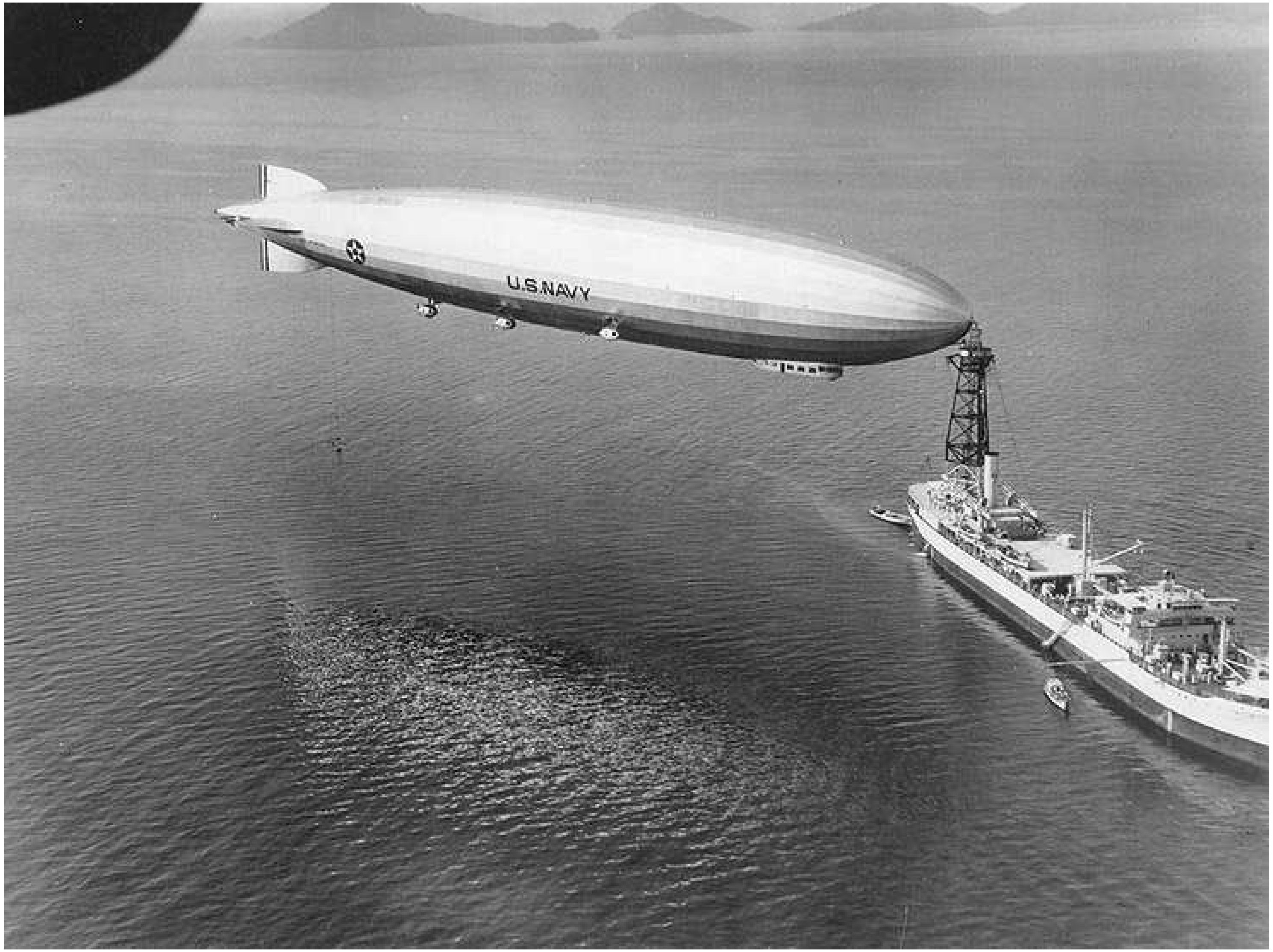
***Modern Mechanix,* April 1923**

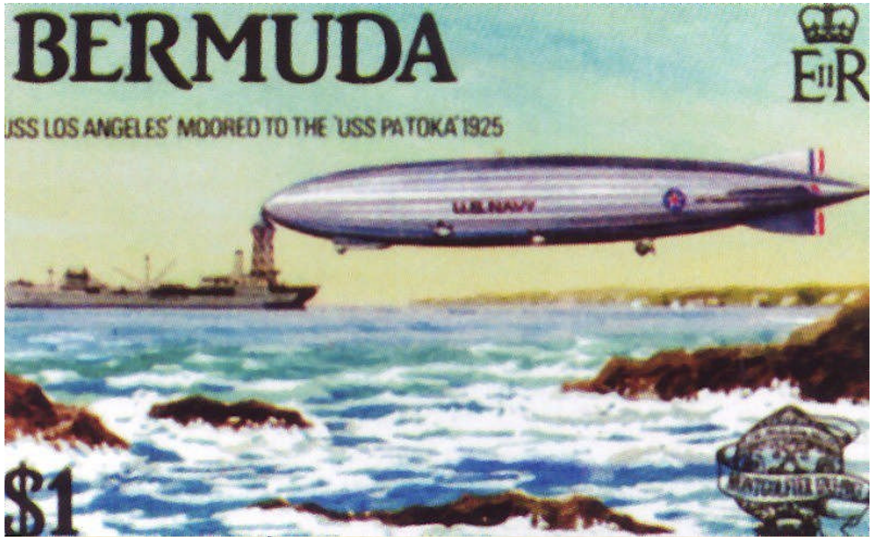


"…Our longest flight was the trip to Panama and back, more than 2,000 miles each way. We have landed the ship, at sea, at the mast of the tender 'Patoka' and on the deck of the airplane carrier 'Saratoga'…We spent all of one summer calibrating radio beacon stations along the Atlantic coast from Boston down past Hatteras, operating part of the time from the tender 'Patoka' as a base…"

Lieut. Cmndr. C.E. Rosendahl, USS Los Angeles **(1930)**

<u>Above</u>: USN dirigible *USS Los Angeles* moored to the mooring mast of the airship tender *USS Patoka*


U.S.NAVY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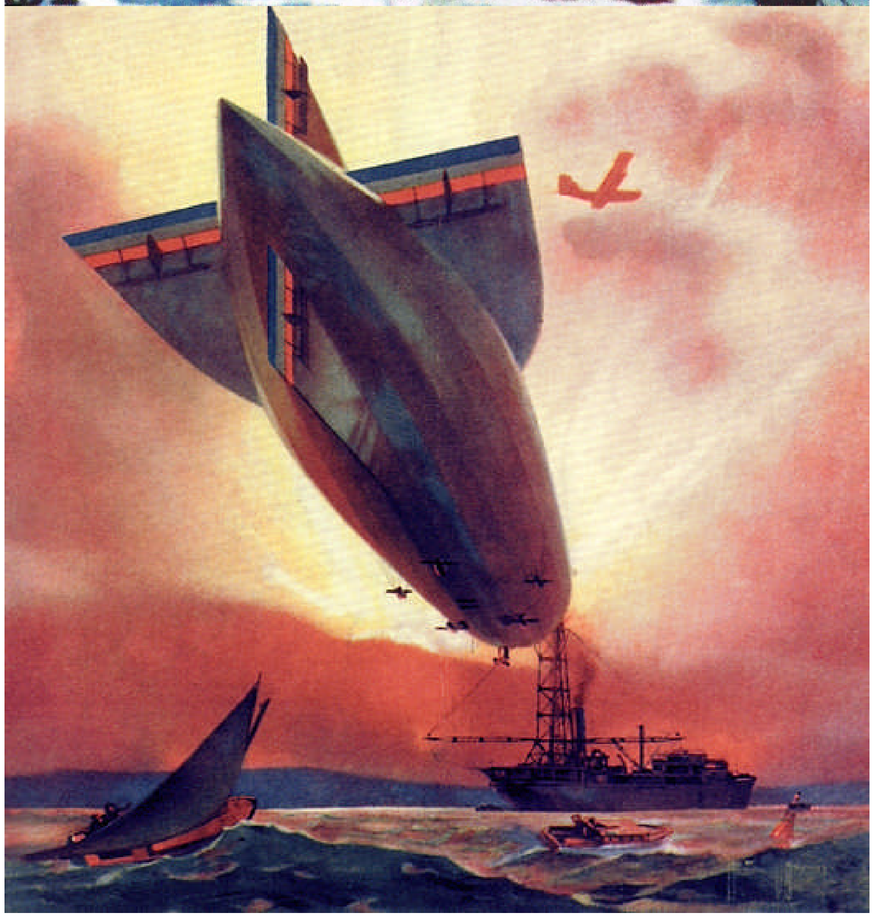
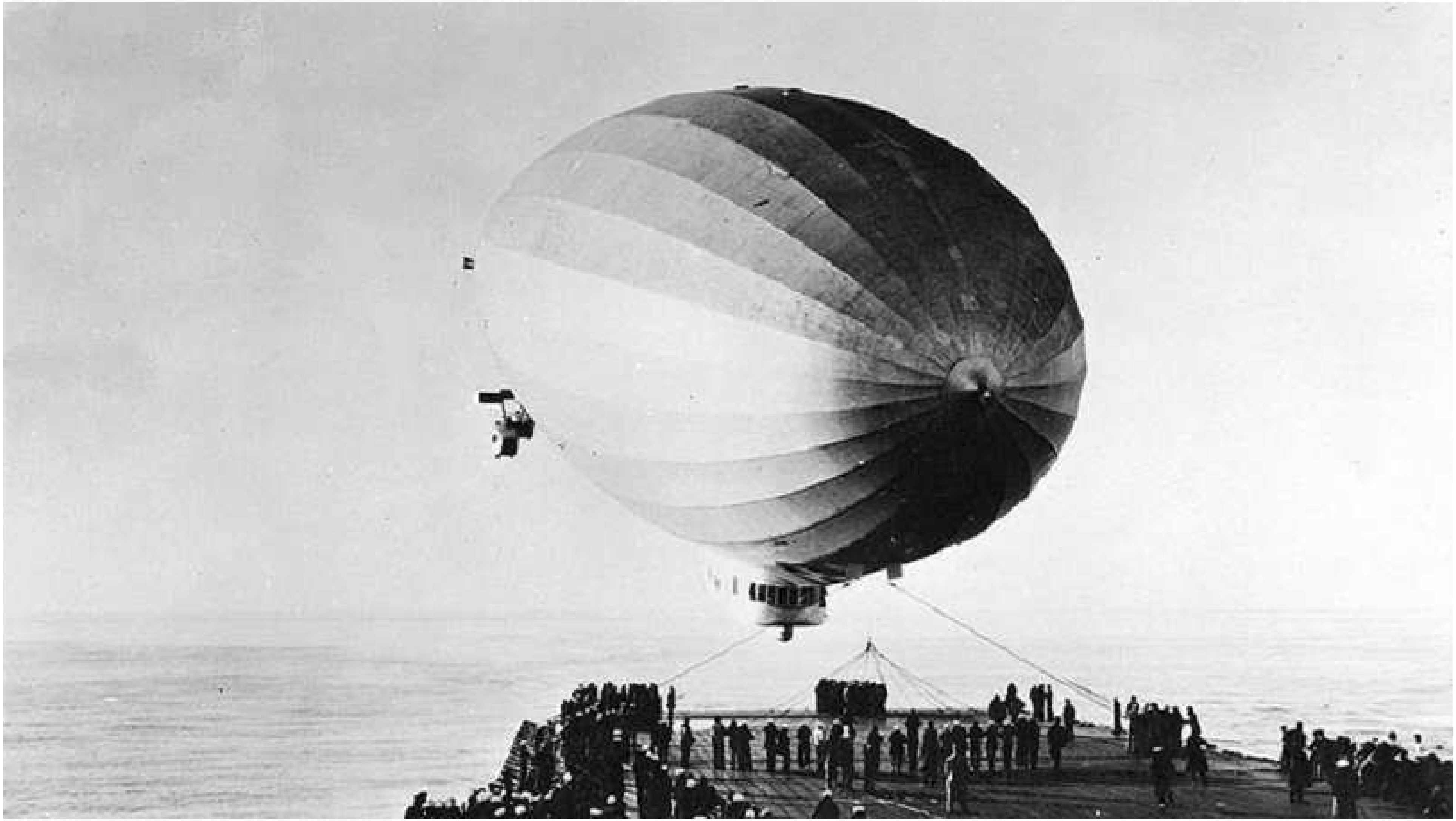
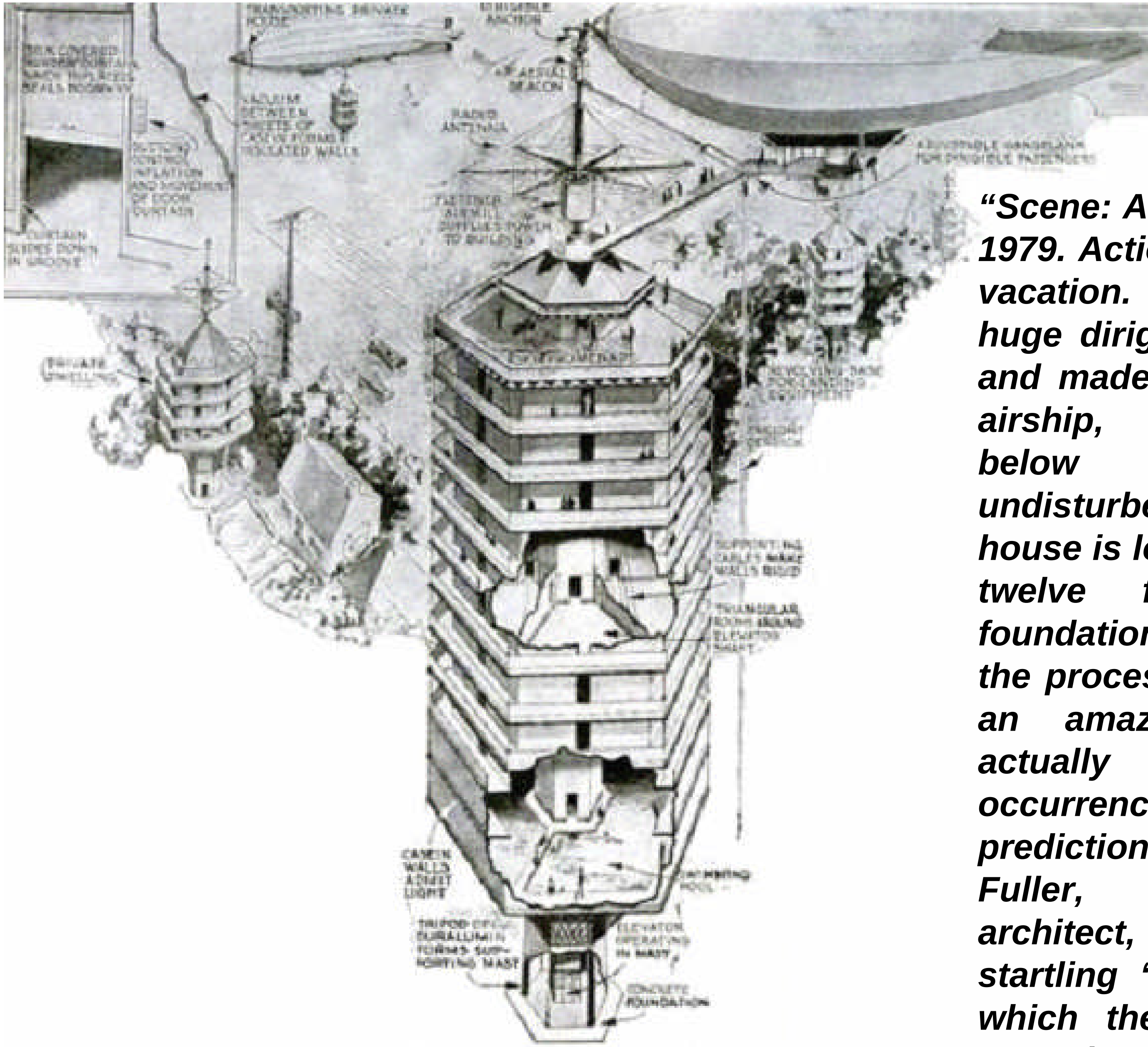




<u>Above</u>: caption: "USS Los Angeles (ZR-3) landing on USS Saratoga (CV-3), 27 January 1928. Note lines used to walk the airship forward from the aircraft carrier's stern."[381]

Scene, Time, Action



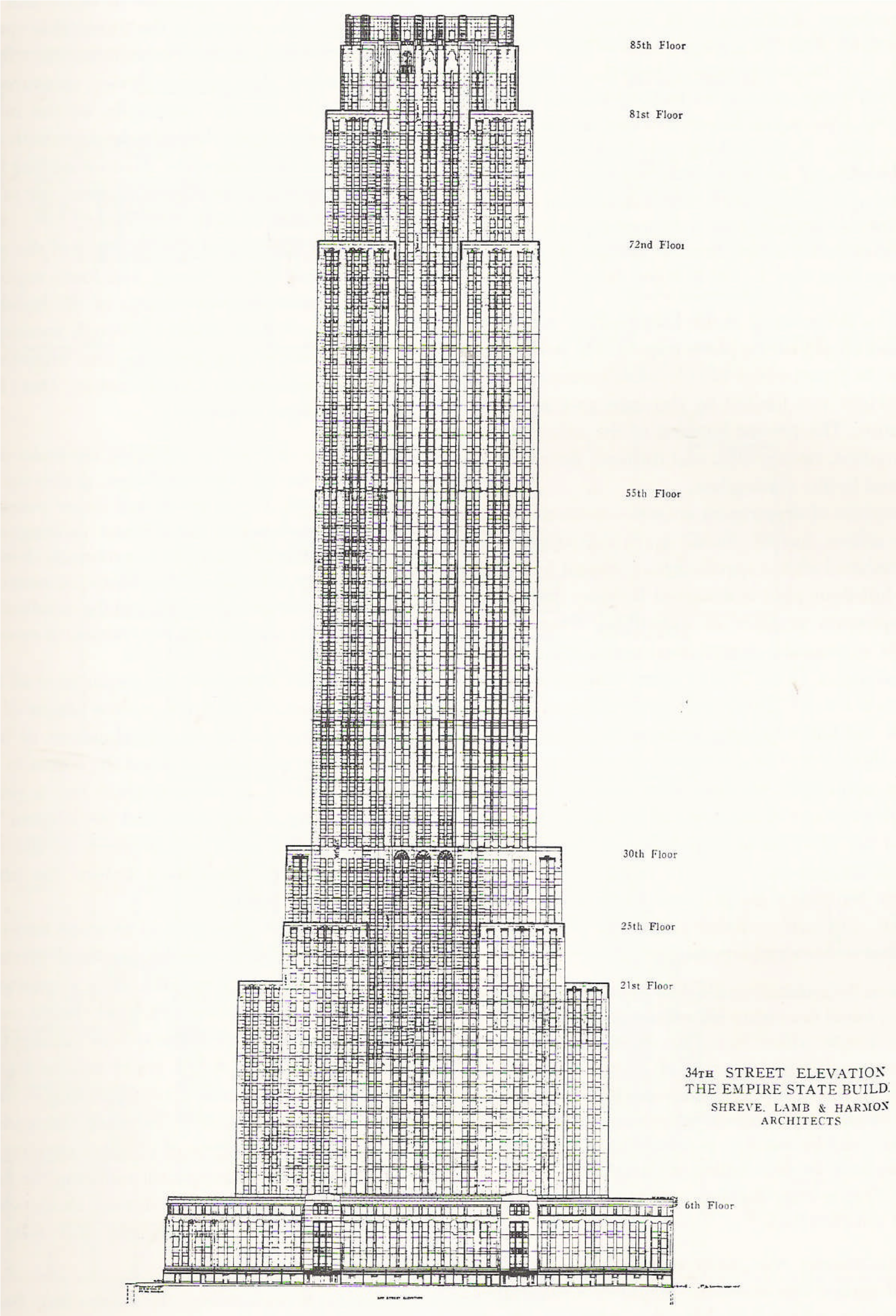
"Scene: Any American city. Time: 1979. Action: A family is leaving on vacation. Over the house hovers a huge dirigible. Cables are lowered and made fast and away sails the airship, the dwelling dangling below with the occupants undisturbed! At the seashore, the house is lowered and anchored to a twelve foot square concrete foundation. On the return to the city the process is reversed. That such an amazing performance may actually be a commonplace occurrence fifty years hence is the prediction of Richard Buckminster Fuller, well-known Chicago architect, who has designed a startling 'thermos bottle' home in which the floors branch from a central mast like the limbs of a tree…"

Popular Science Monthly, **September 1929**

This Building Needs a Hat!

"…Imagine every important American city fringed with titanic steel towers that resemble the famous Eiffel Tower of Paris – hitching posts to which Zeppelins are tied. They form integral parts of the skyscrapers that constitute their lower portions; for in the populous city of the future the utmost use must be made of every square inch of ground. You go up, of course, in an elevator. You step out on a broad platform that surrounds the tower. A gang-plank runs from the platform to the moored Zeppelin, stretching away for eight hundred or even a thousand feet. At the top of the tower is a curious semi-globular, vertical cup, gilded so that it flashes in the sun. Into this cup the nose of the Zeppelin is received and lashed to the tower. The cup on top of the tower and the platform from which the gang-plank runs to the ship constitute a structure independent of the tower. The cup and the platform revolve together. You can see at once what this means. As the Zeppelin, with its nose poked into the cup, is swung by the wind, just as an anchored ship swings with the current in a river, the platform swings with it. Even though the craft may be in the act of swinging in response to a passing gust, you step on board by way of the gang-plank just as you would climb the stairs lowered down the sides of a ship anchored in a stream…"

***Popular Science Monthly*, May 1919**

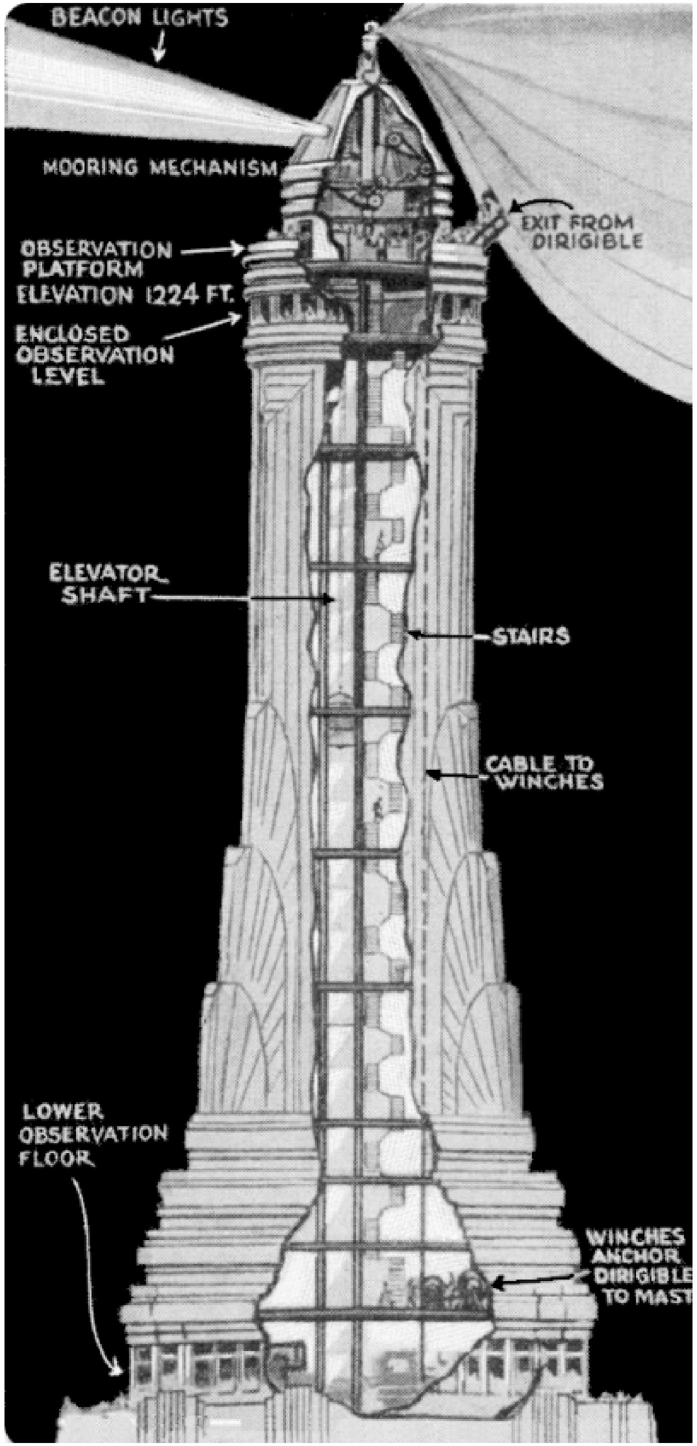


"What this building needs is a hat!"
John Jakob Raskob
RE: his idea for a 200-foot high mooring mast for transatlantic dirigibles atop the 85-stories of the *Empire State Building* below
<u>Left</u>: elevation of the ESB before the addition of the mooring mast

"The top of the Empire State Building would be more than ornamental, more than a spire or dome or pyramid put there to add a desired few feet to the building or to mask something as mun-dane as a water tank. Their top, they said, would serve a higher calling. The Empire State Building would be equipped for an age of transportation that was then only the dream of aviation pioneers."

***John Tauranac*, Author**

<u>Left</u>: superimposed image of the *Graf Zeppelin* moored to the top of the *Empire State Building* (1931)

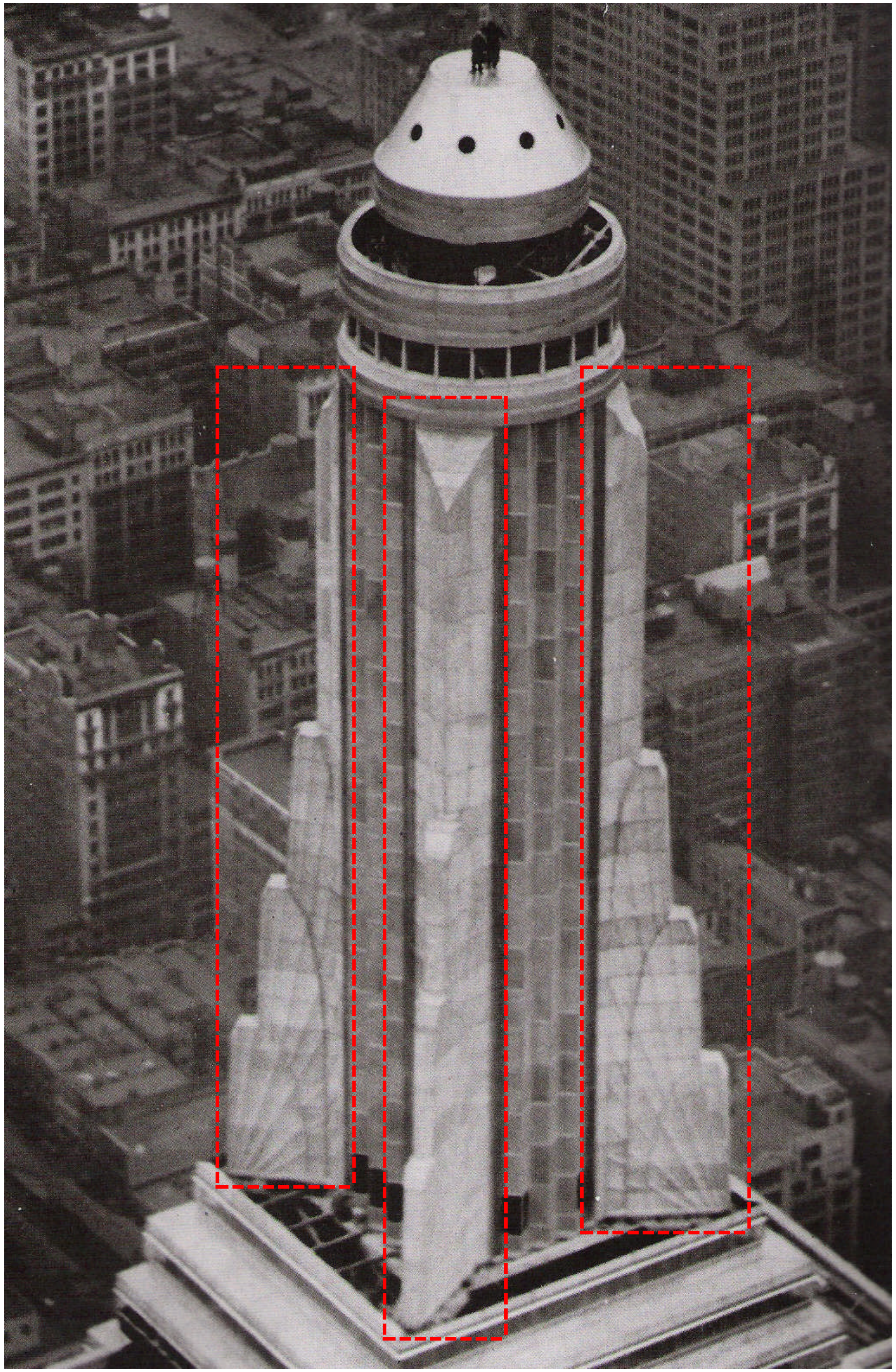


"On the level, all right. No kidding. We're working on the thing now. One set of engineers here in New York is trying to dope out a practical, workable arrangement and the government people in Washington are figuring on some safe way of mooring airships to this mast."

***Alfred E. Smith* – President, *Empire State, Inc.* (1929)**

RE: response to a question concerning the practicality of placing a dirigible mooring mast atop the ESB

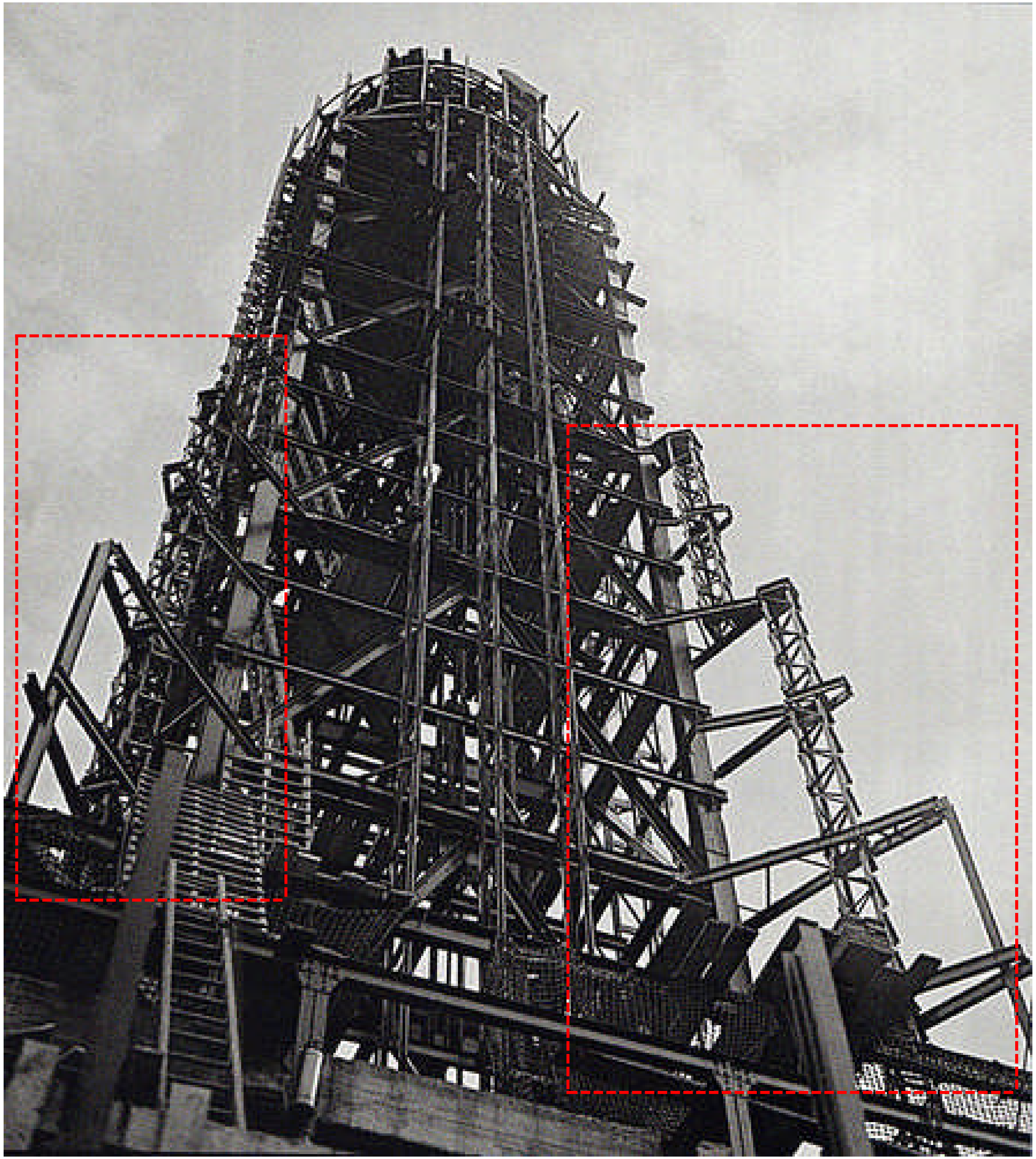
Left: cross-section of the Empire State Building's *Mooring Mast* (from *Popular Science,* April 1931). Giant searchlights would have guided the airship and winches (just above the 86th Floor *Observation Deck*) would have pulled in the mooring cables. Once secured to the mooring mast, passengers would disembark via a gangplank to the 103rd floor, then down a flight of stairs to the 102nd floor observatory then via elevator to the 86th floor to collect their luggage in the luggage room and pass *U.S. Customs*. Then, after taking in the view of *New York City* and its environs, down a high-speed elevator to terra firma. The plan was abandoned after three failed attempts to moor *U.S. Navy* airships to the mooring mast in the highly unstable air currents around skyscrapers in mid-town *Manhattan*.



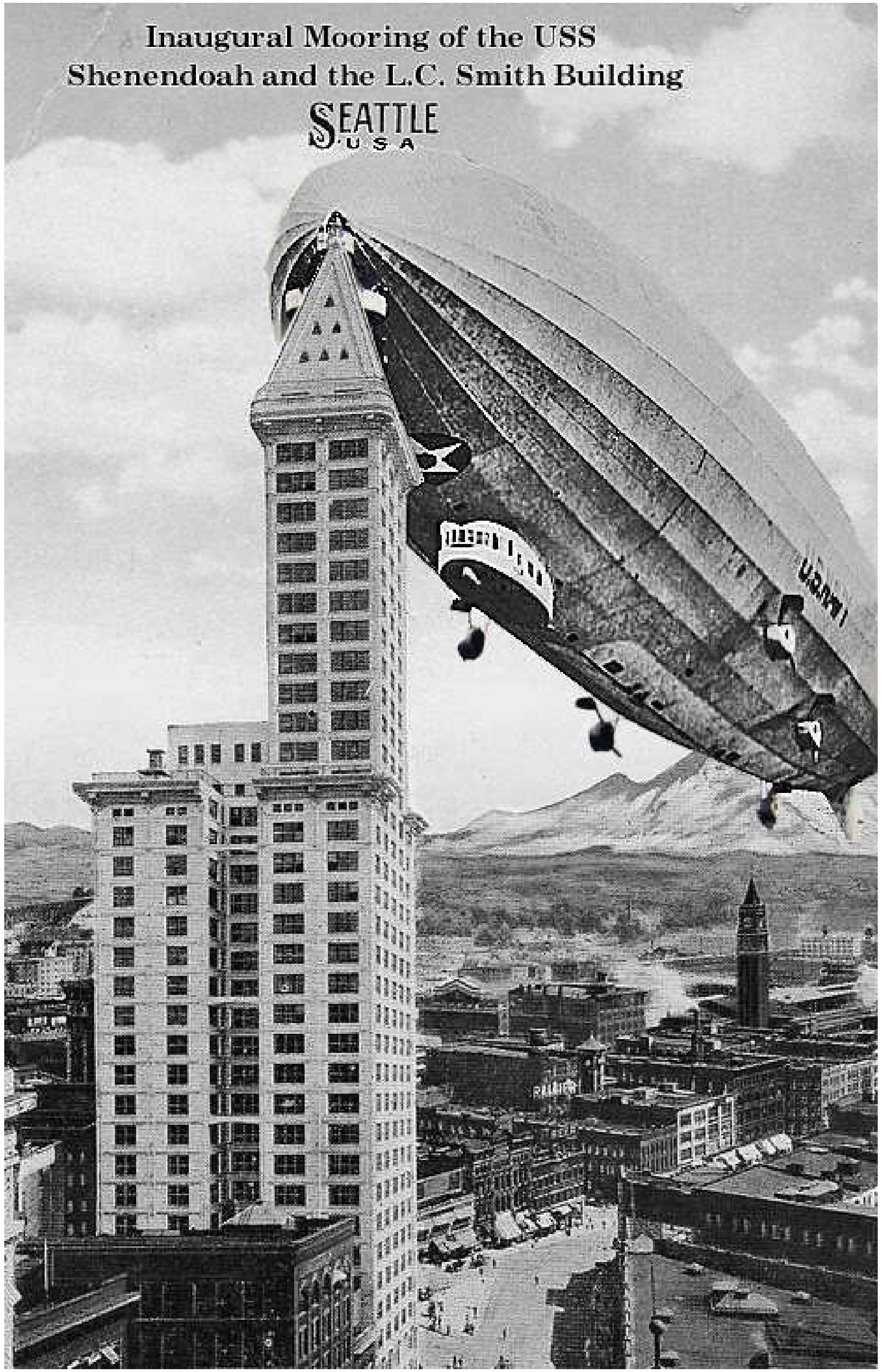
"Building with an eye to the future, we have determined to build a mooring tower 200-feet high on top of the new Empire State Building. The roof of the building itself will be 1,100-feet from the sidewalk. That will mean that the Zeppelin would be anchored more than 1,300-feet in the air, with elevator facilities through the tower to land passengers downstairs seven minutes after the ship is anchored."

***Alfred E. Smith*, 1929**

RE: ESB mooring mast. "Wings of Progress" were four aluminum freestanding art deco-style features set at 45-degree angles at the base of the mooring mast. They actually served a utilitarian purpose; enclosing the steel-framed buttressing of the mooring mast against the horizontal pull of a moored dirigible.



"The mooring mast had to have strength enough to withstand a horizontal pull of fifty-tons at its head. This required engineering changes to the entire frame. Four great wings flanking the mooring mast and serving as buttresses."
***John Tauranac*, Author**



The *Empire State Building* was not the first attempt to use a skyscraper as a dirigible mooring mast. In 1914, the newly completed *L.C. Smith Building* was the tallest structure west of the *Mississippi* at thirty-six stories, towering over the city and dominating the *Seattle* skyline well into the 1920s. In 1924, the *U.S. Navy* sent their newly completed giant dirigible *USS Shenandoah* on a publicity tour up the west coast. To welcome the pending arrival of the Shenandoah, the owners of the *Smith Tower* installed their own mooring rig to the building's peak. A steady and consistent breeze off of *Elliott Bay* made for a smooth approach to the tower. The mooring on the Smith Tower (left) was trouble-free. Afterwards, the officers of the Shenandoah were welcomed by Seattle's elites in the opulent *Chinese Room* on the building's thirty-fifth floor.

"…But what of currents and wind? They are almost negligible at the top of a lofty tower. But if they should occasionally make themselves manifest, and that so rapidly that it is impossible to shift ballast or gas quickly enough, then the vessel's own elevating rudders can be used. Oh, the crew must always be on duty, you argue? Not at all. The elevating rudders can be operated automatically. A mercury level will switch electric servo-motors on or off…"

***Popular Science,* May 1919**

Left: *U.S. Navy* blimp makes a fly-by of the ESB's mooring mast still under construction

“Some pretty smart fellows in the Navy Aviation outfit…You can hitch one of these babies all right, but they won’t stand hitched like a horse. If there’s a wind blowing – and there always is up here where we are – the dirigible would be whirled around like a top, and that wouldn’t be so good. Elsewhere when the airships are moored to masts they are weighted down at the stern, with enormous lead weights, so that they will stay hitched even against a stiff wind. But I don’t believe they would stand for that here. Half the population of Manhattan Island would get the heeby-jeebies at the thought of forty or fifty tons of lead swinging over their heads. But there must be some way to work the thing out, and if there is our engineers will find it.”

***Al Smith*, 1929**

RE: difficulties encountered trying to use the top of a skyscraper as a hitching post for unstable dirigibles

"The difficulties of mooring a great airship to a mast over New York City would be very great. The violent air currents up and down caused by your high buildings would, I think, make such a project almost impossible at this time…I would never try it with the Graf Zeppelin"

Dr. Hugh Eckener*, Commander of the *Graf Zeppelin

<u>Left</u>: the unstable wind patterns around skyscrapers (a.k.a. *Karmen-Vortex Effect*), as observed on the 86th floor *Observation Deck* of the ESB

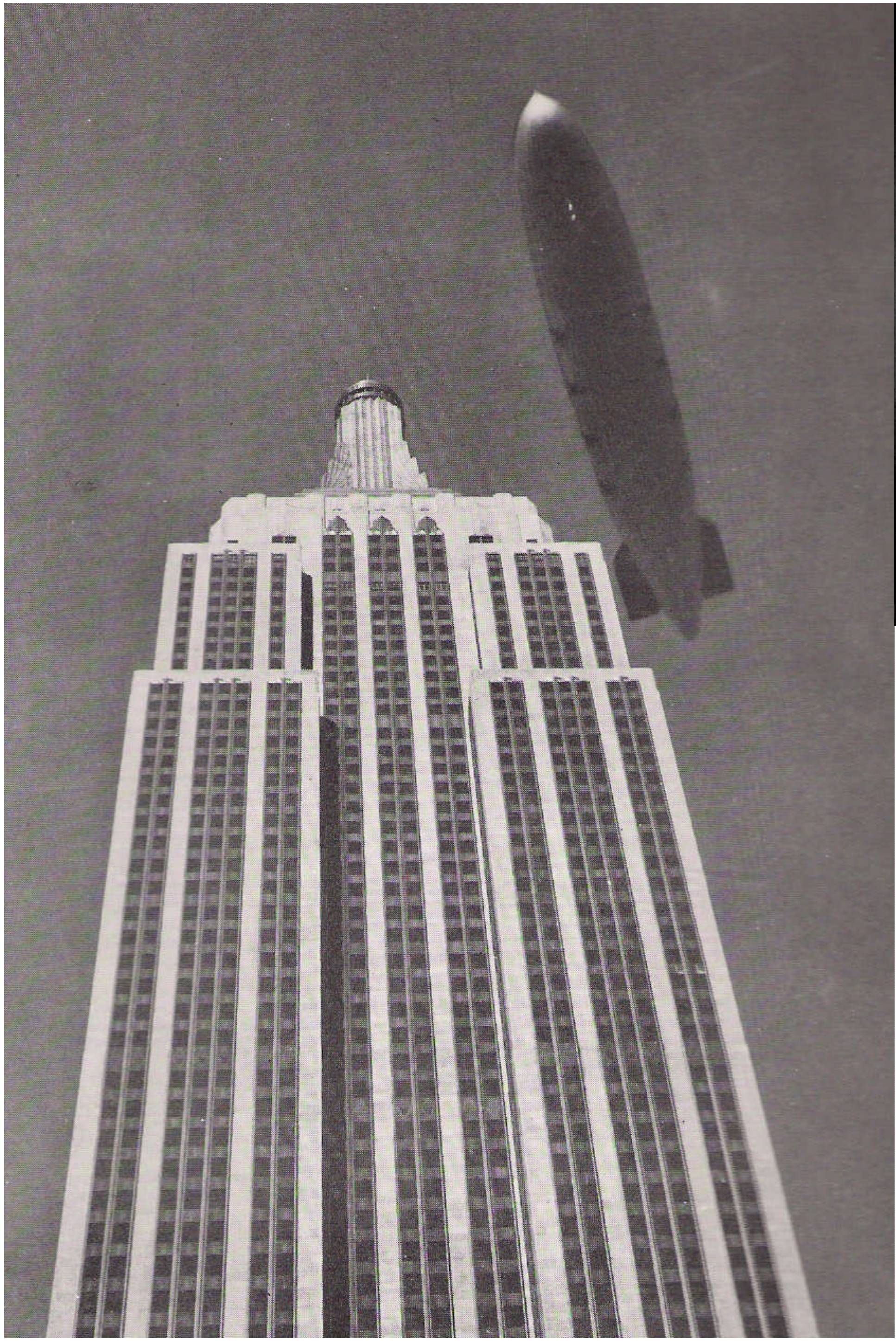
"…What a sight it will be when a transatlantic Zeppelin arrives at New York and heads for its tower, a long, beautifully modeled slim cylinder. Down she slides. See, she comes up slowly into the lee of the tower and against the wind. Thus she uses the wind as a kind of brake. She must fight it with her own engines, and fight it she does. By nicely regulating his own speed, the commander literally crawls up to the tower. Ah, a line has been thrown out and caught by the Zeppelin. The rest is easy. Curious seaman-like too, will be the airship's departure for Europe. She casts off. She drifts away with the wind, and sinks a little with the stern down (a kind of 'tail-slide' in airplane parlance), until the propellers reverse the motion past the tower. There she goes up, up, up into the air, and away to distant London, where her passengers will breakfast day after tomorrow…"

***Popular Science,* May 1919**

"Slowly and with its command on the alert lest the delicate fabric of its envelope be staked on the sharp spires of the tall buildings in the Pennsylvania zone, the semi-rigid dirigible J-4, auxiliary of the Los Angeles of the Lakehurst Naval Air Station, reconnoitered about the dirigible mooring mast at 3:15PM Tuesday, December 17th, while thousands watched from the streets below…A stiff wind was blowing as the dirigible hovered with throttled engines and approached the tower. In the cabin of the airship Lt. S.M. Bailey, the commander, kept his hands on the controls and ballast releases in case a gust threw him too close to the nearby buildings. Bailey declined to comment on the feasibility of attempting to tie-up to the mast and added that he was so busy at the controls while the ship oscillated in the treacherous air currents over the city that he had little time to notice the details of the mast."

The New York Times

<u>Left</u>: failed attempt on December 17th 1930 to secure a *U.S. Navy* dirigible to the ESB's mooring mast

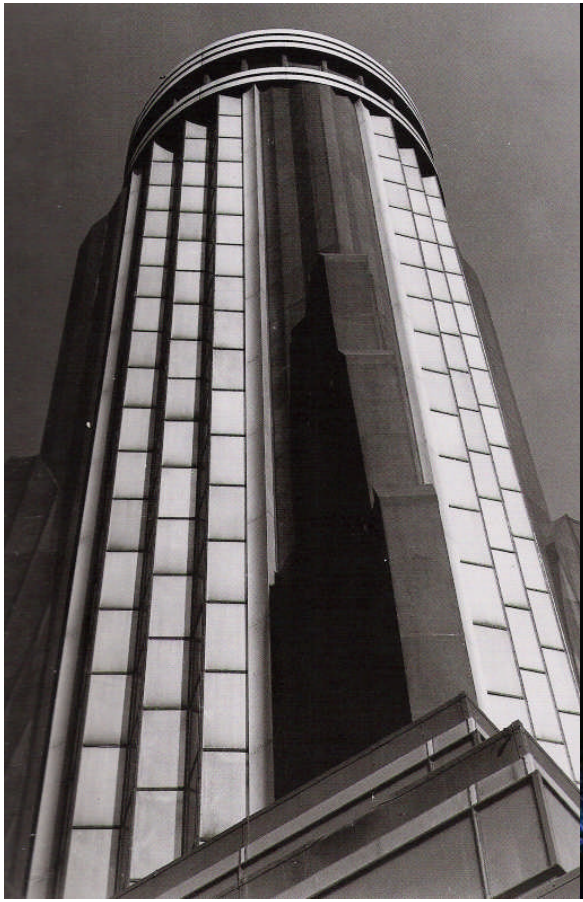


"The as yet unsolved problems of mooring air ships to a fixed mast at such a height made it desirable to postpone to a later date the final installation of the landing gear"

R.H. Hunter*, VP of ESB General Contractor *Starrett Bros. & Eken

RE: excerpt from an April 1931 speech to the *New York Building Congress* concerning the problems with the mooring mast (it remains incomplete to the present day)

<u>Above & Left</u>: LZ-127 (*Graf Zeppelin*) makes a fly-by over the completed ESB (ca. 1931)



The Silver Sliver in the Distance

"Pack your bag. it's 1934 and you are bound for Paris. That means you must catch the Berlin air liner. It left Cleveland an hour ago. There, a silver sliver in the distance, it comes. Already it has picked up your radiogram: 'Paris passenger waiting at Humptyville.' Your motorcar whirls you to the local airport. An airplane with a funny-looking hook sprouting from its back stands ready. The silver sliver in the distance becomes a cigar, then a shark, in size, then an airship, then a veritable shimmering and symmetrical mountain of motion droning like ten billion contented bees in the sun. 'Ready, sir!' says your local plane pilot. You get in the plane with the funny hook, and it darts aloft. Up, up, until the big liner is directly overhead – you feel as if you were riding on a fly underneath a silver-skinned elephant. A T-shaped trapdoor opens in the bottom of the air liner. A trapeze is let down; and, so gently that you barely notice it, because the speed of the plane has become synchronous with that of the ship, the hook in the plane's back is caught in the bar of the trapeze. Now the plane is lifted bodily, as easily as the fly it seems to resemble, up through the trapdoor into the hull of the liner itself. A uniformed attendant takes your bag as you step from the tiny cabin onto the solid floor of a spacious room. 'This way, sir!' You tarry a moment. The plane disappears slowly downward through the trapdoor, you hear the roar of its motor as it again takes off, a thousand feet above the ground level, and the trapdoor swings shut on greased hinges. And off you go through spacious corridors to your stateroom, with its real bed, hot and cold running water, and softly carpeted floor, to dress for dinner and the dance afterward, when you will race the clouds with the moon. Day after tomorrow you'll be in Paris, dropped there by airplane – in Paris, watching the Queen of the Air melt into a cloud as she drones on to Berlin. And before the week's end you may be back home in America, if you wish. Of course, this is only an imaginative trip you've taken, but by 1934 it should be a fact, by 1940 a commonplace…"

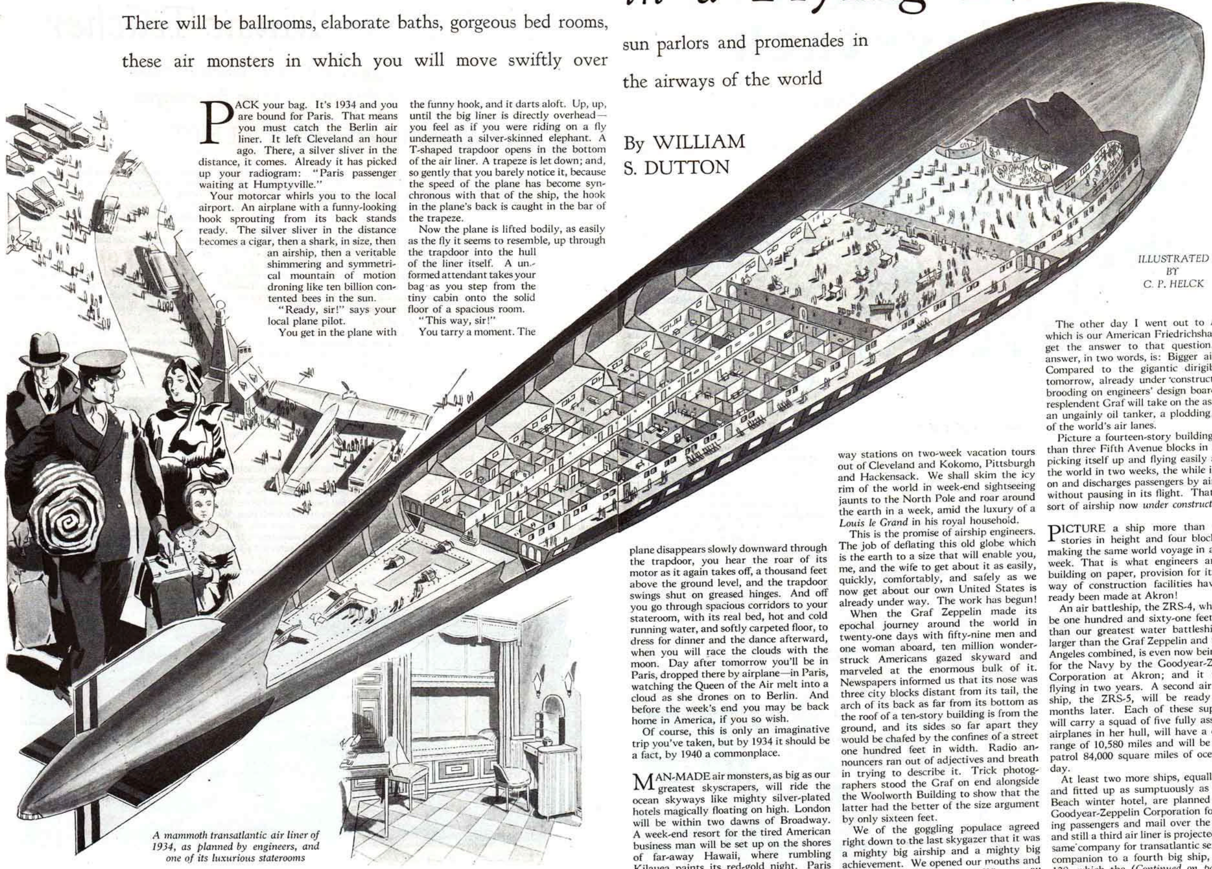
***The American Magazine,* May 1930**

RE: excerpt from article entitled: "Two Days to Europe in a Floating Hotel"

Two Days *to* Europe *in a* Flying Hotel

There will be ballrooms, elaborate baths, gorgeous bed rooms, these air monsters in which you will move swiftly over sun parlors and promenades in the airways of the world

By WILLIAM S. DUTTON



A mammoth transatlantic air liner of 1934, as planned by engineers, and one of its luxurious staterooms

ILLUSTRATED BY C. P. HELCK

PACK your bag. It's 1934 and you are bound for Paris. That means you must catch the Berlin air liner. It left Cleveland an hour ago. There, a silver sliver in the distance, it comes. Already it has picked up your radiogram: "Paris passenger waiting at Humptyville."

Your motorcar whirls you to the local airport. An airplane with a funny-looking hook sprouting from its back stands ready. The silver sliver in the distance becomes a cigar, then a shark, in size, then an airship, then a veritable shimmering and symmetrical mountain of motion droning like ten billion contented bees in the sun.

"Ready, sir!" says your local plane pilot.

You get in the plane with the funny hook, and it darts aloft. Up, up, until the big liner is directly overhead—you feel as if you were riding on a fly underneath a silver-skinned elephant. A T-shaped trapdoor opens in the bottom of the air liner. A trapeze is let down; and, so gently that you barely notice it, because the speed of the plane has become synchronous with that of the ship, the hook in the plane's back is caught in the bar of the trapeze.

Now the plane is lifted bodily, as easily as the fly it seems to resemble, up through the trapdoor into the hull of the liner itself. A uniformed attendant takes your bag as you step from the tiny cabin onto the solid floor of a spacious room.

"This way, sir!"

You tarry a moment. The plane disappears slowly downward through the trapdoor, you hear the roar of its motor as it again takes off, a thousand feet above the ground level, and the trapdoor swings shut on greased hinges. And off you go through spacious corridors to your stateroom, with its real bed, hot and cold running water, and softly carpeted floor, to dress for dinner and the dance afterward, when you will race the clouds with the moon. Day after tomorrow you'll be in Paris, dropped there by airplane—in Paris, watching the Queen of the Air melt into a cloud as she drones on to Berlin. And before the week's end you may be back home in America, if you so wish.

Of course, this is only an imaginative trip you've taken, but by 1934 it should be a fact, by 1940 a commonplace.

MAN-MADE air monsters, as big as our greatest skyscrapers, will ride the ocean skyways like mighty silver-plated hotels magically floating on high. London will be within two dawns of Broadway. A week-end resort for the tired American business man will be set up on the shores of far-away Hawaii, where rumbling Kilauea paints its red-gold night. Paris and Berlin, Barcelona and Cairo will be way stations on two-week vacation tours out of Cleveland and Kokomo, Pittsburgh and Hackensack. We shall skim the icy rim of the world in week-end sightseeing jaunts to the North Pole and roar around the earth in a week, amid the luxury of a *Louis le Grand* in his royal household.

This is the promise of airship engineers. The job of deflating this old globe which is the earth to a size that will enable you, me, and the wife to get about it as easily, quickly, comfortably, and safely as we now get about our own United States is already under way. The work has begun!

When the Graf Zeppelin made its epochal journey around the world in twenty-one days with fifty-nine men and one woman aboard, ten million wonder-struck Americans gazed skyward and marveled at the enormous bulk of it. Newspapers informed us that its nose was three city blocks distant from its tail, the arch of its back as far from its bottom as the roof of a ten-story building is from the ground, and its sides so far apart they would be chafed by the confines of a street one hundred feet in width. Radio announcers ran out of adjectives and breath in trying to describe it. Trick photographers stood the Graf on end alongside the Woolworth Building to show that the latter had the better of the size argument by only sixteen feet.

We of the goggling populace agreed right down to the last skygazer that it was a mighty big airship and a mighty big achievement. We opened our mouths and exclaimed in pop-eyed unison, "What next?"

The other day I went out to Akron, which is our American Friedrichshafen, to get the answer to that question. The answer, in two words, is: Bigger airships! Compared to the gigantic dirigibles of tomorrow, already under construction or brooding on engineers' design boards, the resplendent Graf will take on the aspect of an ungainly oil tanker, a plodding tramp of the world's air lanes.

Picture a fourteen-story building, more than three Fifth Avenue blocks in length, picking itself up and flying easily around the world in two weeks, the while it takes on and discharges passengers by airplanes without pausing in its flight. That is the sort of airship now *under construction.*

PICTURE a ship more than twenty stories in height and four blocks long making the same world voyage in a single week. That is what engineers are now building on paper, provision for it in the way of construction facilities having already been made at Akron!

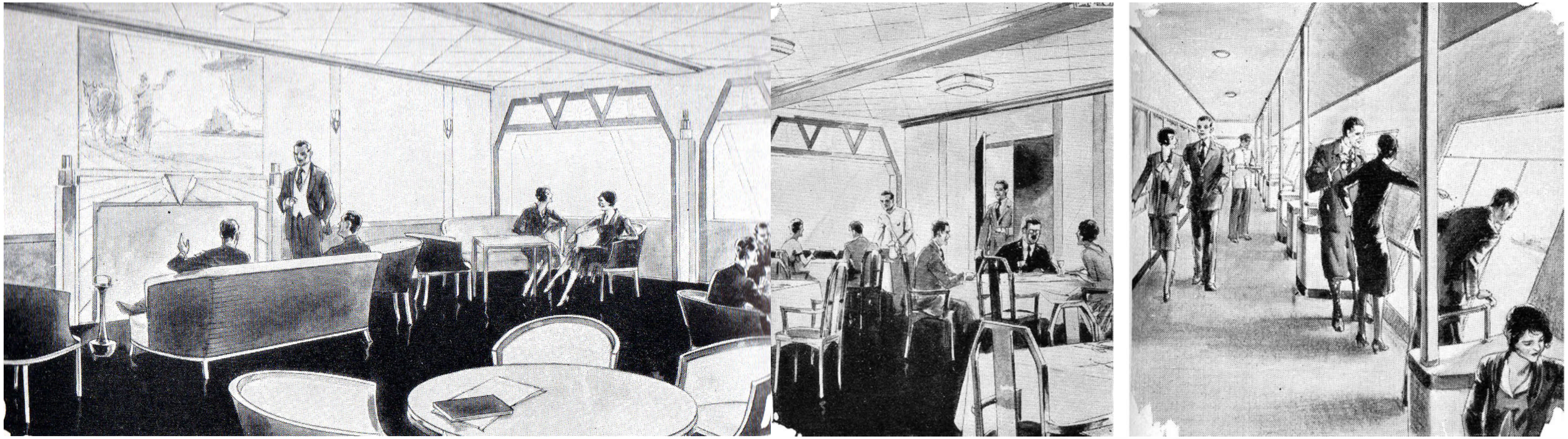
An air battleship, the ZRS-4, which will be one hundred and sixty-one feet longer than our greatest water battleships and larger than the Graf Zeppelin and the Los Angeles combined, is even now being built for the Navy by the Goodyear-Zeppelin Corporation at Akron; and it will be flying in two years. A second air battleship, the ZRS-5, will be ready fifteen months later. Each of these superships will carry a squad of five fully assembled airplanes in her hull, will have a cruising range of 10,580 miles and will be able to patrol 84,000 square miles of ocean in a day.

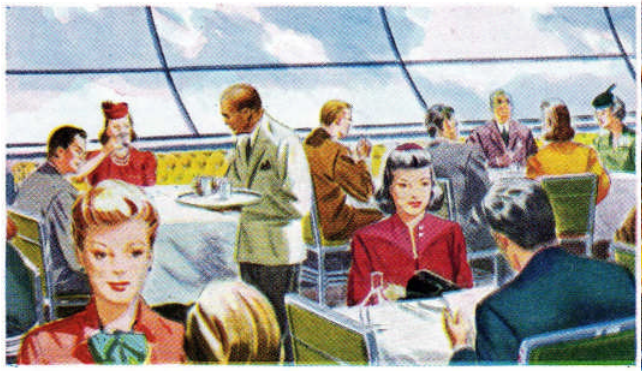
At least two more ships, equally large, and fitted up as sumptuously as a Palm Beach winter hotel, are planned by the Goodyear-Zeppelin Corporation for carrying passengers and mail over the Pacific; and still a third air liner is projected by the same company for transatlantic service, as companion to a fourth big ship, the LZ-128, which the (*Continued on page 182*)

"…Man-Made air monsters, as big as our greatest skyscrapers, will ride the ocean skyways like mighty silver-plated hotels magically floating on high. London will be within two dawns of Broadway. A week-end resort for the tired American business man will be set up on the shores of far-away Hawaii, where rumbling Kilauea paints its red-gold night. Paris and Berlin, Barcelona and Cairo will be way stations on two-week vacation tours out of Cleveland and Kokomo, Pittsburgh and Hackensack. We shall skim the icy rim of the world in week-end sightseeing jaunts to the North Pole and roar around the earth in a week, amid the luxury of a Louis le Grand in his royal household…"

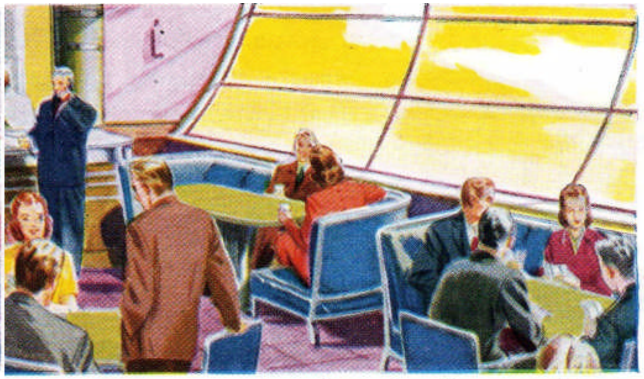
***The American Magazine,* May 1930**

RE: excerpt from article entitled: "Two Days to Europe in a Floating Hotel"





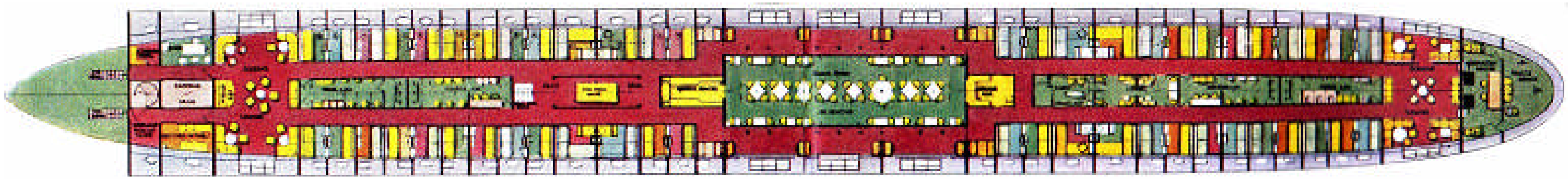
DINING SALON . . . as modern as a Park Ave. restaurant.



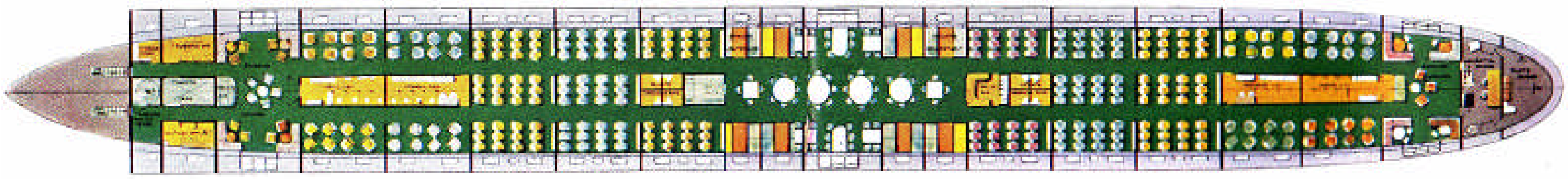
CLUB LOUNGE . . . matching the comfort of an ocean liner.

DELUXE CABIN . . . as private as your own bedroom.

The *Goodyear-Zeppelin Co*mpany had a financial interest in the promotion of transatlantic passenger airship service. Frequently, the company offered alluring illustrations of future airship travel. Goodyear publicist Hugh Allen's 1931 book: "The Story of the Airship," included drawings of airship interiors which even included a fireplace (above, in B&W). Goodyear president *Paul Litchfield* and Hugh Allen included color images (above) of luxurious airship travel rivaling any ocean liner in their 1945 book: "WHY? Why has America no Rigid Airships?"



The 112-passenger deluxe type airship, with staterooms all on the outside, dining salon in the center, large lounges at each end of the ship, and barber shop, bar, reading room also occupying part of center section.



The 288-passenger economy type, with eight outside staterooms. The other passengers use overnight reclining seats, as on an air transport. Note large lounge, at each end, dining salon in center for 64 passengers, ample corridors.

"…This is the promise of airship engineers. The job of deflating this old globe which is the earth to a size that will enable you, me, and the wife to get about it as easily, quickly, comfortably, and safely as we now get about our own United States is already under way. The work has begun!

***The American Magazine,* May 1930**

RE: excerpt from article entitled: "Two Days to Europe in a Floating Hotel"

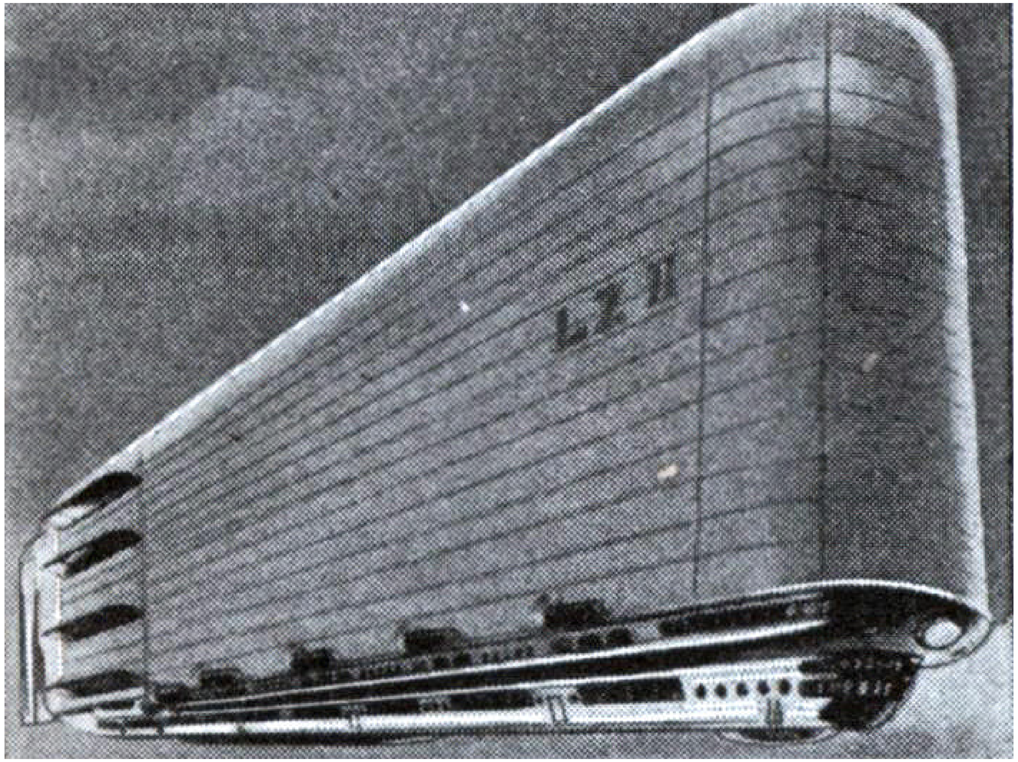
<u>Above</u>: deck plan/s for a "Deluxe Type" (luxury) airship (top) and "Economy Type" airship (bottom) – from: "WHY? Why has America no Rigid Airships?"

"…The other day I went out to Akron, which is our American Friedrichshafen…Compared to the gigantic dirigibles of tomorrow, already under construction or brooding on engineers' design boards, the resplendent Graf will take on the aspect of an ungainly oil tanker, a plodding tramp of the world's air lanes. Picture a fourteen-story building, more than three Fifth Avenue blocks in length, picking itself up and flying easily around the world in two weeks, the while it takes on and discharges passengers in its flight. That is the sort of airship now under construction. Picture a ship more than twenty stories in height and four blocks long making the same world voyage in a single week. That is what engineers are now building on paper, provision for it in the way of construction facilities having already been made at Akron!..."

***The American Magazine,* May 1930**

RE: excerpt from article entitled: "Two Days to Europe in a Floating Hotel"

Dirigible of the Future

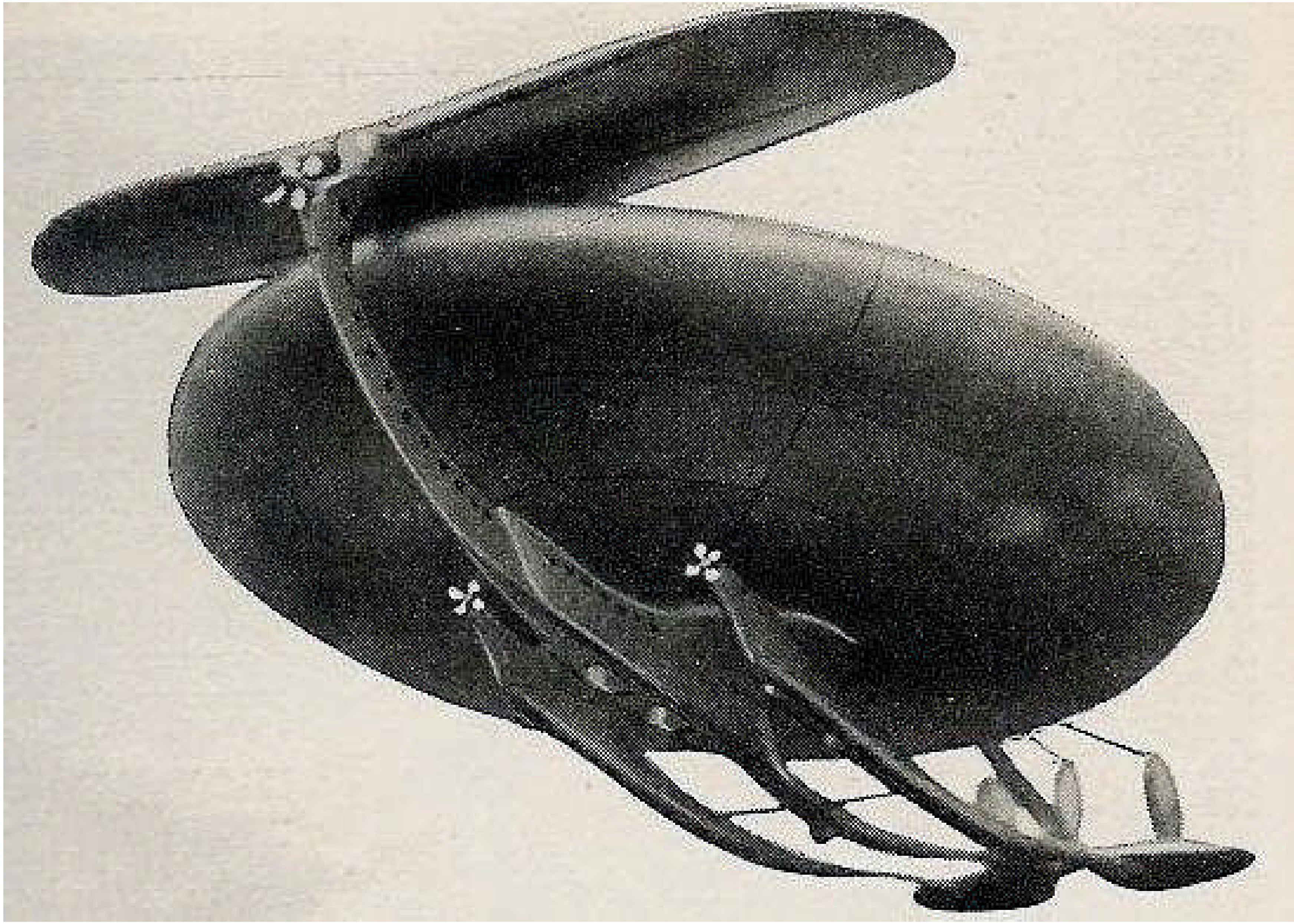


“A gigantic dirigible which would have an all metal body made of corrugated sheet steel, and which would be so durable as to eliminate the need of the customary hangar, is the novel craft recently designed by an eminent Russian inventor, Konstantin Ziolkowski. This craft will expand or contract according to the interior gas pressure.”

***Modern Mechanix,* July 1931**

RE: excerpt from an article entitled: “Future Dirigible Without Hangar”

<u>Above</u>: caption: “This artist’s sketch shows the ‘dirigible of the future,’ designed by an eminent Russian inventor. Covered with corrugated sheet iron it will be durable enough to eliminate need for hangar.”



<u>Above</u>: in 1932, *Guido Tallei imagined this* "Diri-Disk" as a combination airplane/dirigible

A Fleet of Airships

<u>Above</u>: Soviet stamp showing airship emerging from hangar

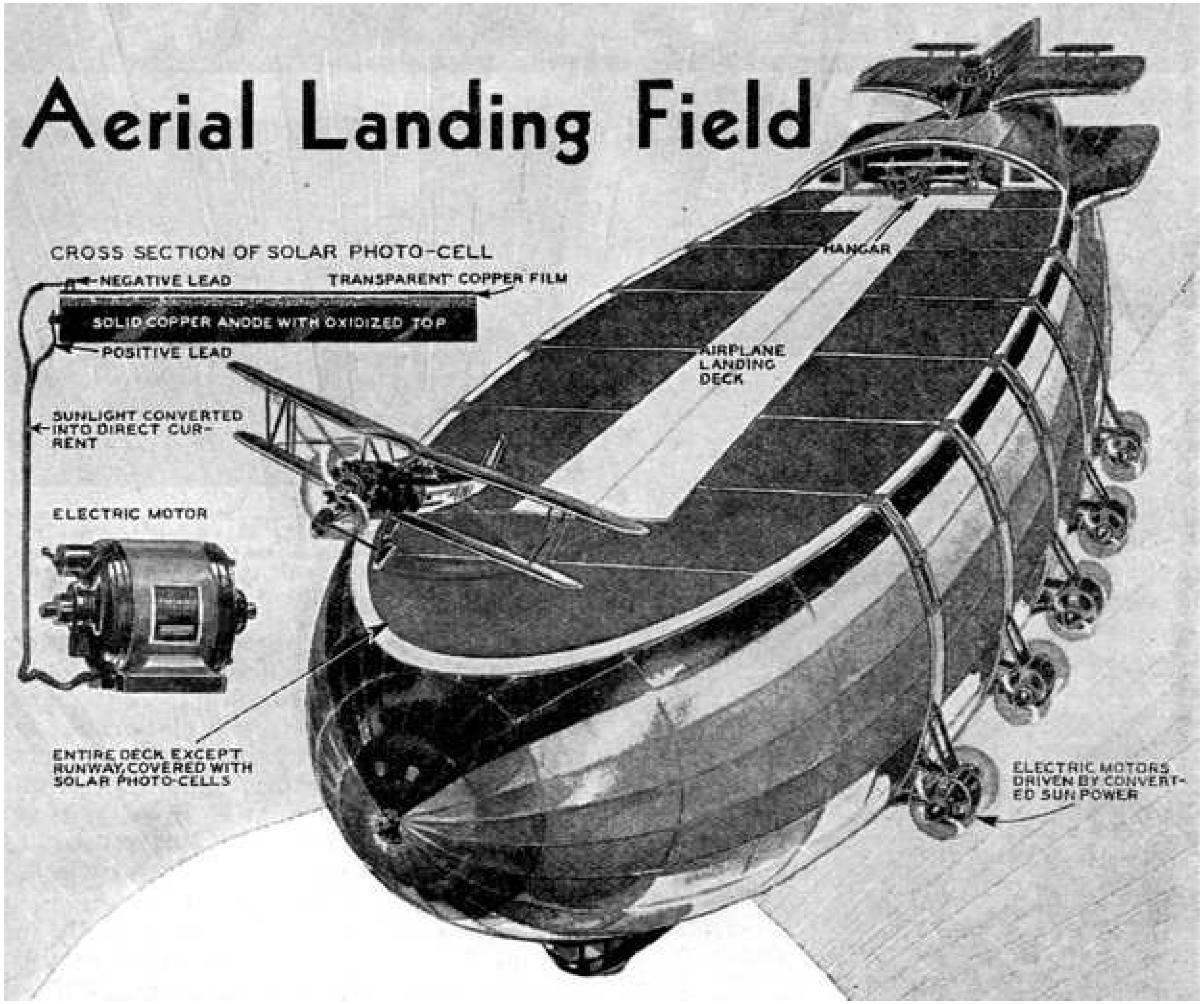
<u>Left</u>: caption (translated): "We Are Building a Fleet of Airships in the Name of Lenin" (from a *Soviet Union* propaganda poster, 1931). The Soviets were trying to enlist the "modernity" of the airship in their propaganda efforts.

<u>Left</u>: caption: "Society for the Promotion of Defense, Aviation and Chemical Construction supports peaceful labor and the defense of the USSR". The bottom line reads: "Let there be a Soviet dirigible!" (ca. early 1930s)

Aerial Landing Field

"Recent experiments in the conversion of the sun's rays into electric power have led to an unusual idea in aerial equipment. It is a dirigible that not only would get its power from the sun but also provide space for a landing field in the air. The ordinary cigar-shaped dirigible would in effect have a slice taken from the upper half of the gas bag. This would provide a large deck on which could be mounted solar photo cells, an airplane runway, and a hangar. Planes could land on the dirigible, floating over the sea, to refuel for trans-ocean passenger service. Another unusual feature of this design, in addition to the landing field, is the use of sun rays to power the motors of the dirigible. Scientists estimate that the sun can develop as much as 86,300 kilowatts or 115,000 horsepower per hour in an area of a square mile. Photo cells convert the sun's energy into electricity. When this can be done on a practical basis, the roof of an ordinary house can be used to develop electricity for the home."

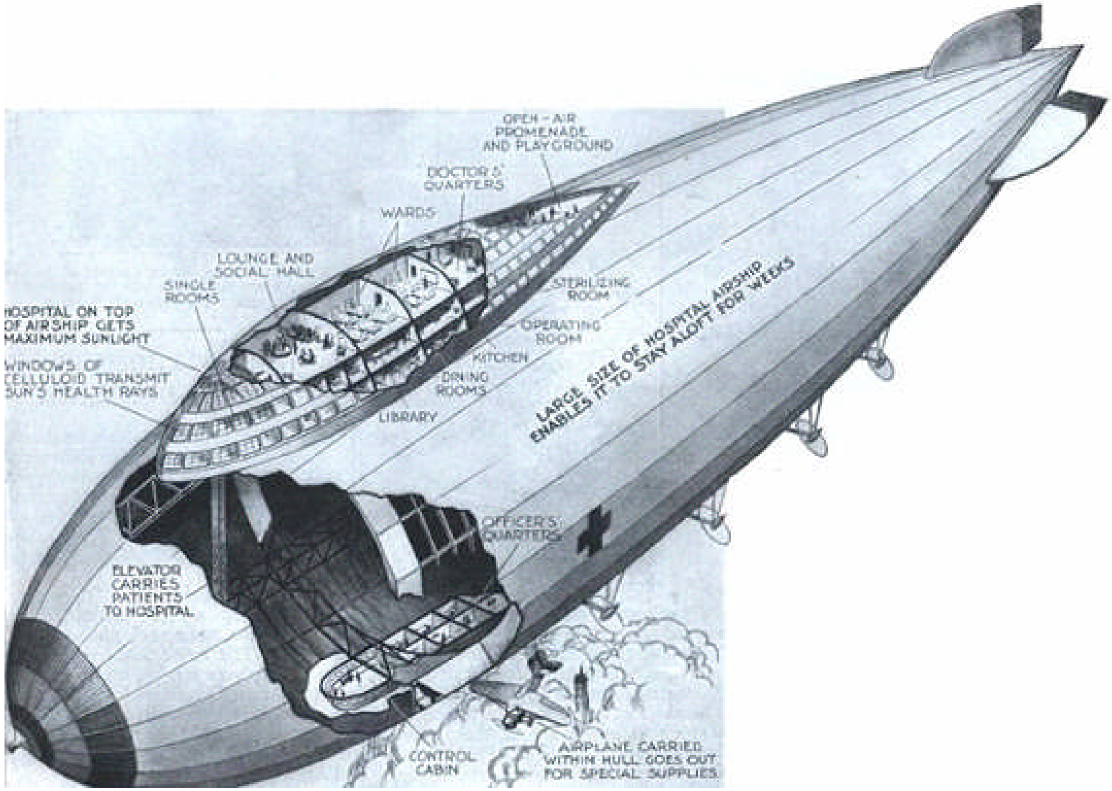
***Modern Mechanix*, October 1934**


Aerial Landing Field
CROSS SECTION OF SOLAR PHOTO-CELL
NEGATIVE LEAD
TRANSPARENT COPPER FILM
SOLID COPPER ANODE WITH OXIDIZED TOP
POSITIVE LEAD
SUNLIGHT CONVERTED INTO DIRECT CURRENT
ELECTRIC MOTOR
HANGAR
AIRPLANE LANDING DECK
ENTIRE DECK EXCEPT RUNWAY, COVERED WITH SOLAR PHOTO-CELLS
ELECTRIC MOTORS DRIVEN BY CONVERTED SUN POWER

"…One of the problems involved is that of keeping the ship's center of gravity below the center line of the envelope. Any extensive structure on the top of the airship involving weight would affect the stability and performance adversely. To offset this obvious difficulty, plane once landed could be quickly disassembled and the fuselage and wings quickly passed through a well in the body of the ship to the stowage space. In launching, they would be dropped into the air from the underside of the ship. It is no trick among airmen to recover equilibrium in flight from any position…"

Admiral William A. Moffett, **Chief of the Bureau of Naval Aeronautics**
RE: comments made in 1923

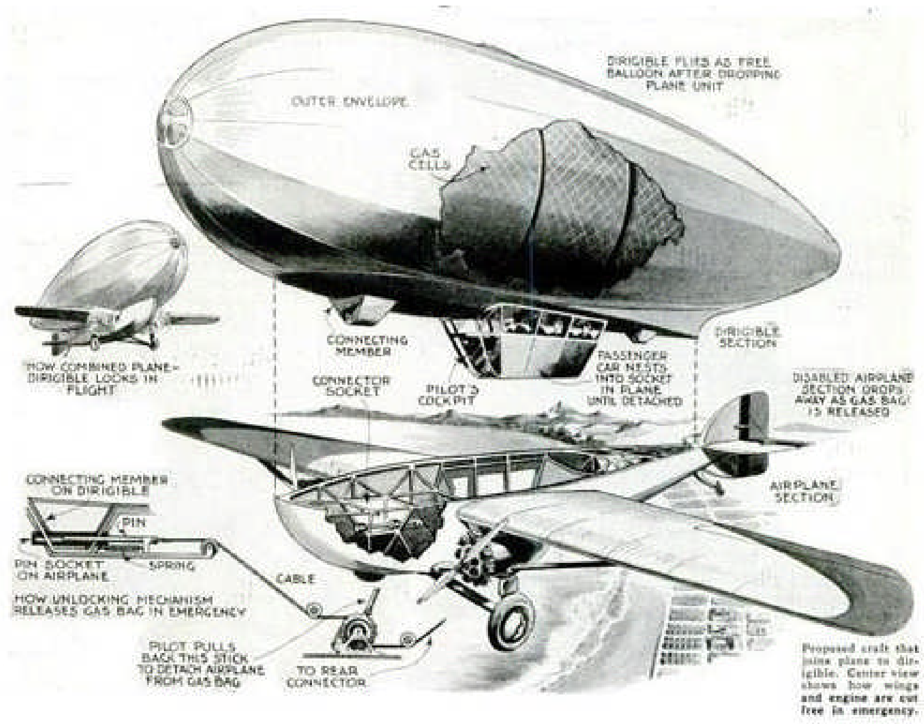
High Altitude Hospital



"For persons suffering with tuberculosis, or just from nerves, will physicians soon prescribe a trip to the clouds in a flying clinic instead of a trip to the mountains? Not long ago Charles L. Julliot, French lawyer, proposed that airplanes or dirigibles transport such patients above the clouds…high altitude and sunshine produce well-known changes in the blood, in many cases beneficial. Add to this the natural exhilaration of an air trip, he says, and the effect might be even better than that of a mountain vacation…Like a huge blister, on top of the airship, would rise the aerial sanatorium, with suitable provision for the care and comfort of the patients. In that position, it would receive the full benefits of sunshine…A hospital airship of this size would be able to stay aloft for weeks at a time. An airplane carried inside the hull would maintain communication with the ground and if necessary make trips for special medicines and supplies…"

***Popular Science Monthly*, July 1930**

Aerial Lifeboat



Proposed craft that joins plane to dirigible. Center view shows how wings and engine are cut free in emergency.

"…a strange hybrid aircraft, half dirigible and half airplane…A personal or family model would carry a commuter safely and swiftly between his home and his job, and take his family on weekend jaunts. Other models would carry freight, troops, or mail at 100 miles an hour. Pilot and passengers would ride in the upper, or gas bag, part of the machine. Should the airplane or lower section run out of gasoline or the motors fail, a forced landing is unnecessary. The pilot pulls a lever that drops off the airplane section, as shown in the diagram, and the gas bag floats away like a free balloon. In normal forward flight the wings give added support and maneuverability…thus forming a sort of aerial lifeboat."

Popular Science Monthly, **July 1931**

"…Another unexcelled safety feature that distinguishes the air cruiser that has the light duralumin framework is that she is virtually 'unsinkable.' She has 20 – she may have 50 – small balloons inside her metal hull. Each of these balloons is filled with gas and is independent of all the others. Each constitutes a lifting unit. Each can form an 'aerial raft' in case of shipwreck. Each can be controlled by valving so that survivors clinging to it can drift landward safely. Each is individually inspected, tested, filled, and lashed in place before the journey…"

Popular Science Monthly, **December 1924**

Aerotropolis

"…Airships, in all likelihood, will change the appearance of the city more than any other thing. The great apartment houses of the future will probably be flat, to accommodate airships. Centrally located, as the railroad terminals are today, there will be huge air docks for the trans-Atlantic air liners. These liners will probably be of two types – fast, passenger-carrying heavier-than-air machines, and huge dirigibles a quarter of a mile or more in length, to meet the need of slower passengers…"

***Popular Science Monthly*, October 1927**

“What the metropolitan skyport of tomorrow may look like, as conceived by Nicholas DeSantis…His remarkable proposal, embodied in a model that he has completed after five years’ study of the project, calls for a 200-story building capped by an airplane field eight city blocks long and three blocks wide. A lower level of his ‘aerotropolis,’ as he named it, offers a port for lighter-than-air craft. Hangars for planes and airships occupy the top fifty floors. Commuters living 100 miles or more from the city would fly to work in their private planes. Landing on the roof, they would descend by elevators and moving platforms to an indoor parking space for 250,000 private cars and taxis, whence they would be whisked without delay to their destination. Similar facilities would serve passengers arriving by transport planes and airship lines. By centralizing air and land terminals in one building, the ‘aerotropolis’ would save time now lost in journeying to and from airports far from the heart of a city. Other parts of the building provide space for offices and light industrial plants, theaters, two enormous arenas for football and baseball games, restaurants, and cafes.”

Popular Science, **November 1939**

RE: excerpt from an article entitled: “Skyscraper Airport for City of Tomorrow”

Skyscraper Airport for City of Tomorrow

WHAT the metropolitan skyport of tomorrow may look like, as conceived by Nicholas DeSantis, New York commercial artist, is shown in the illustration below. His remarkable proposal, embodied in a model that he has completed after five years' study of the project, calls for a 200-story building capped by an airplane field eight city blocks long and three blocks wide. A lower level of his "aerotropolis," as he has named it, offers a port for lighter-than-air craft. Hangars for planes and airships occupy the top fifty floors.

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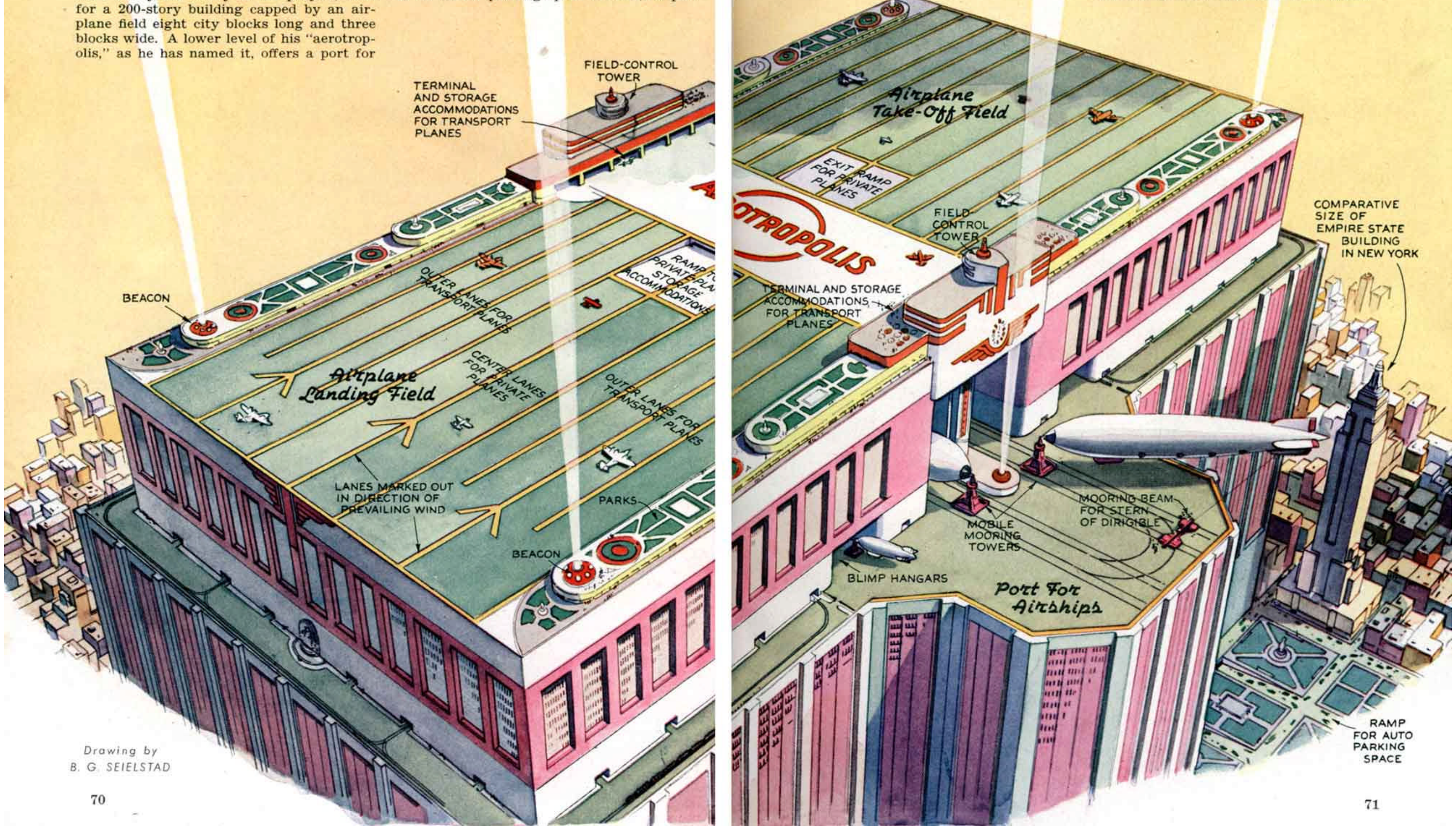


Drawing by B. G. SEIELSTAD

Up Ship!

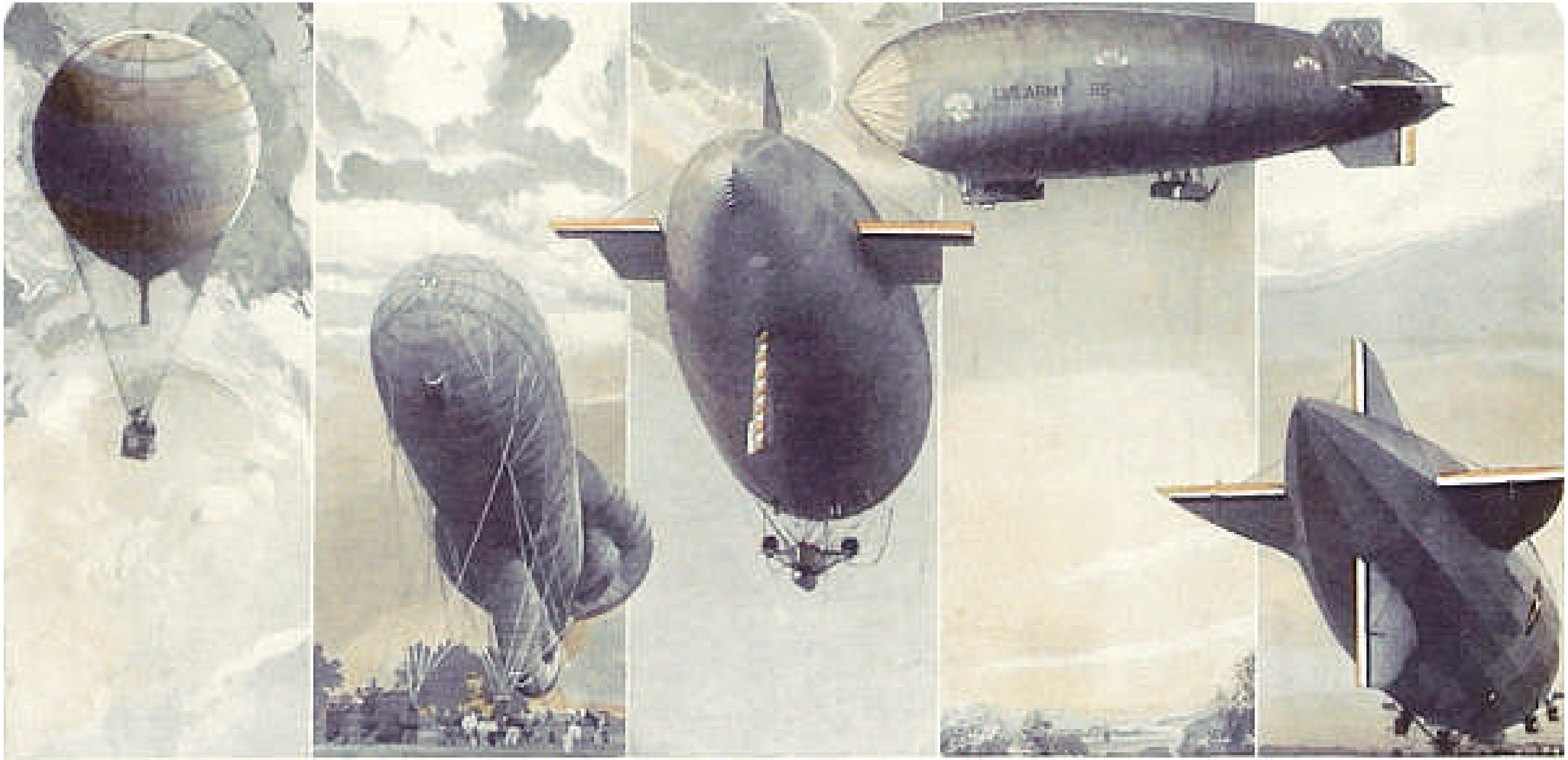
"…There is a final inspection, then, at midnight, the command: 'Up Ship!' The mooring cables drop away, and majestically the immense, silver cigar rises into the air. Almost noiselessly, its four 1,300 horse-power Diesel engines begin spinning their huge propellers. The ship gathers speed. The lights of Lakehurst drop to the rear. At eighty miles an hour, you are heading for the coast. Half an hour later, the vast cluster of pin-point lights marking New York City has slipped beneath you and faded away behind. The sky-liner is taking the great circle route to Europe, following the trail of Lindbergh. In stormy weather, it would head across the Azores along a 'bad weather route,' 600 miles longer but out of the path of the northern gales. Sunrise finds you well up the coast, and mid-afternoon reveals the rocks of Newfoundland below. By evening, you are out over the Atlantic making the 'down-hill run' to Europe. With prevailing winds at her tail, the big ship rushes on, hour after hour. An occasional steamer, the gleaming peak of an iceberg, alone break the monotony of tossing water. You have time to examine the great aerial hotel on which you are riding, to see the smoking rooms, the shower baths, the electric ranges, and even the full-size grand piano it carries. By evening of the second day, you are gliding across Belgium, up the Rhine to the new airship shed at Frankfort on the Main. Forty-seven hours after leaving Lakehurst, you step down at the European airport. The fare of this 3,900-mile, transatlantic trip via the airways is $400…"

***Popular Science*, June 1936**

The Language of Flight

"…An aerostat is an aircraft whose support is chiefly due to buoyancy derived from aerostatic forces – a lighter-than-air aircraft. In the language of flight as now adopted, aerostats are divided into airships and balloons. An airship is an aerostat provided with a propelling system and with means of controlling the ship's direction of motion. A balloon is an aerostat without a propelling system or steering gear and unable to move against the wind. There are four varieties of airships. The form of a rigid airship is maintained by a rigid framework. The shape of a semi-rigid airship is maintained by means of a rigid or jointed keel in conjunction with internal pressure in the gas containers and ballonets. A non-rigid airship, or blimp, is one whose form is maintained solely by the internal pressure in the gas bags and ballonets. The pilot of an aerostat is always an aeronaut, never an aviator. The pilot of an airplane is always an aviator, never an aeronaut. Aviation is the operation of aircraft that are heavier-than-air; aerostation the operation of aircraft that are lighter-than-air. An airplane is housed in a hangar; an airship in a dock…"

Popular Science Monthly, **July 1934**



FREE BALLOON

Scott Field Students Take Night and Day Trips in Balloons Until They Are Able to Maneuver the Bags Alone

CAPTIVE BALLOON

Captive Balloons Are Used Principally for Observation Purposes: Cables and Motor-Truck Winches Control Them

NON-RIGID AIRSHIP

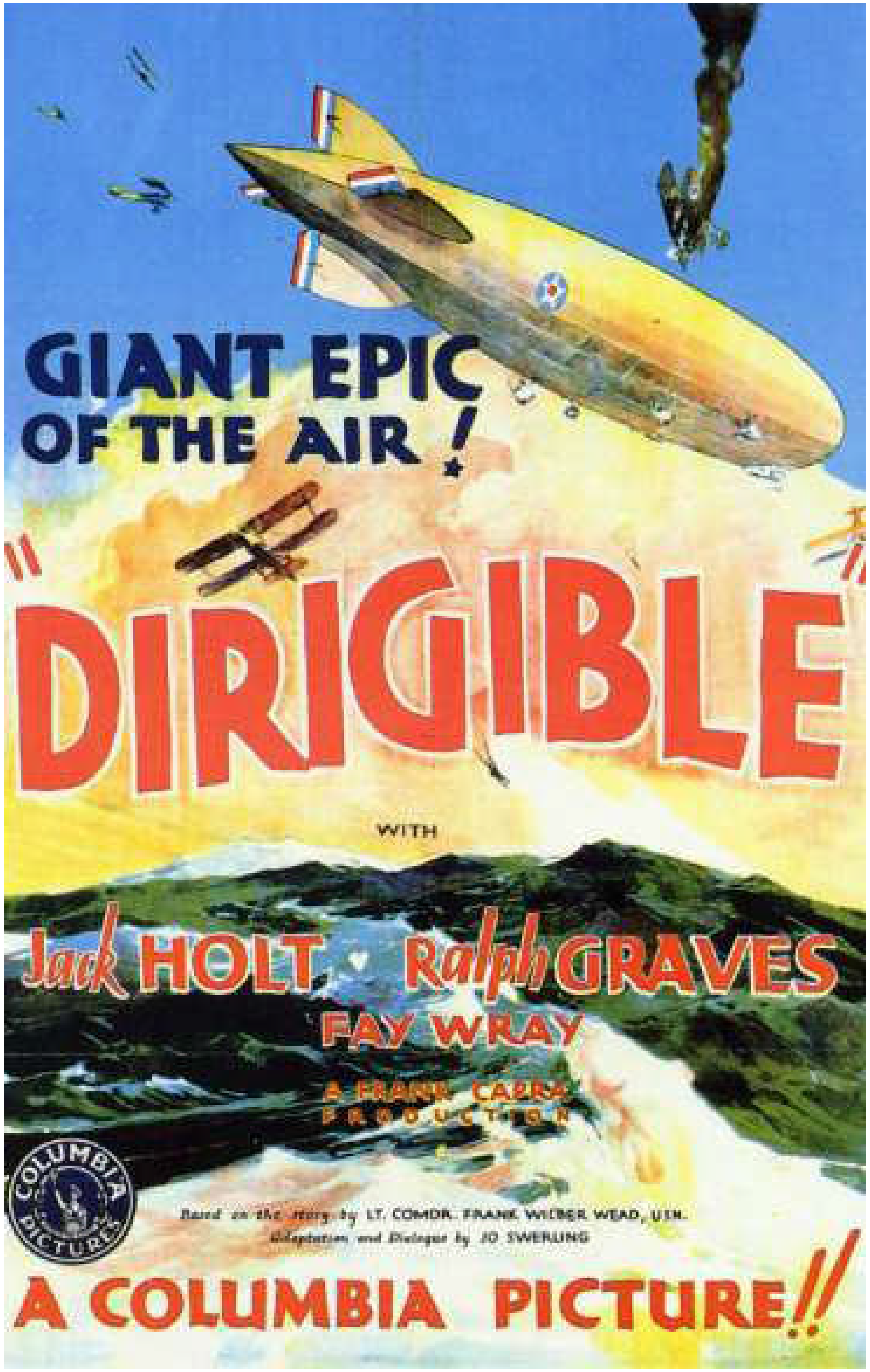
As the Name Suggests, This Type of Craft Has No Rigid Skeleton; It Consists Chiefly of Bag, Car and Two Motors

SEMI-RIGID AIRSHIP

Has a Framework on the Lower Portion of the Bag and Is Usually Much Larger Than the Non-Rigid Kind

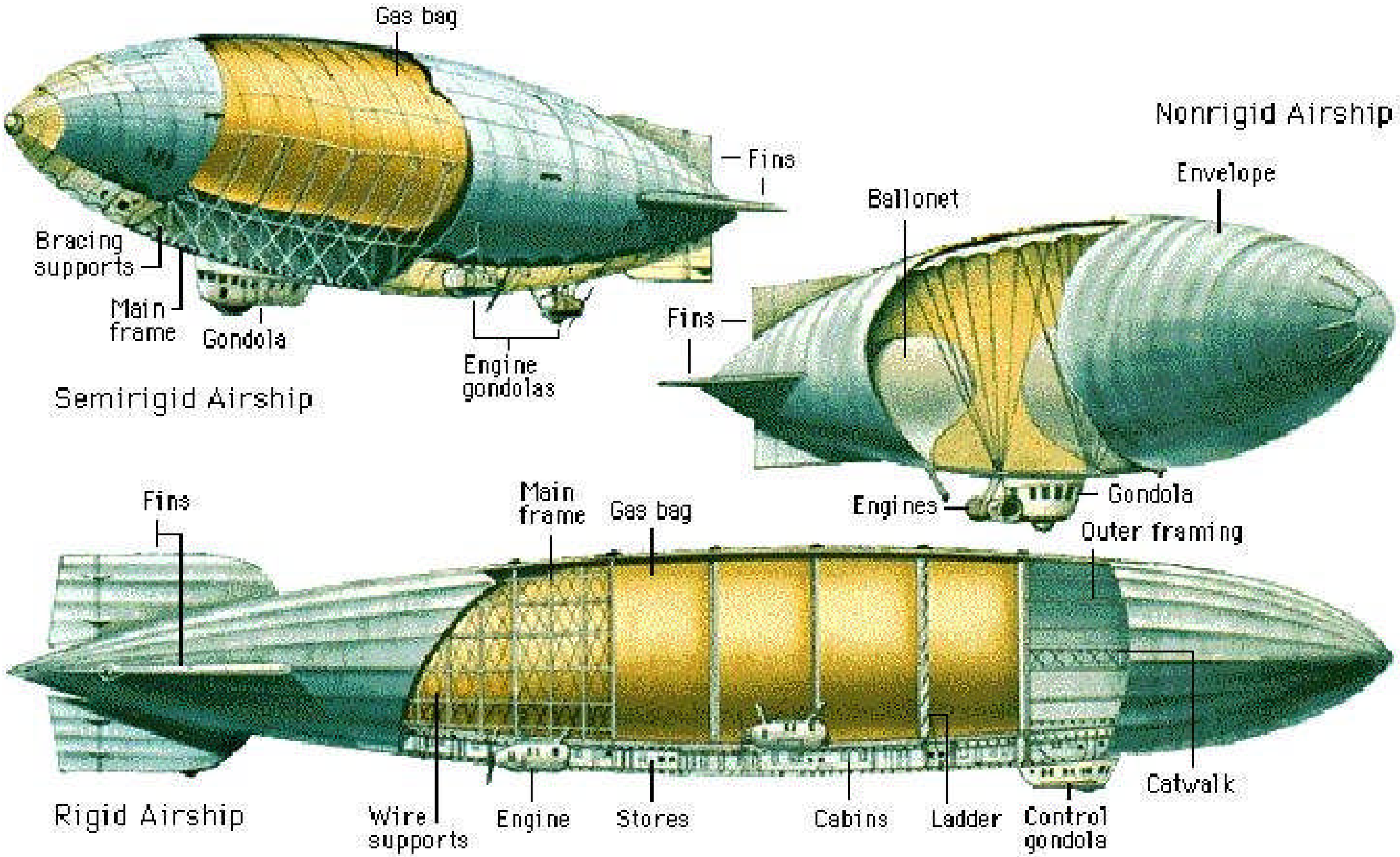
DIRIGIBLE

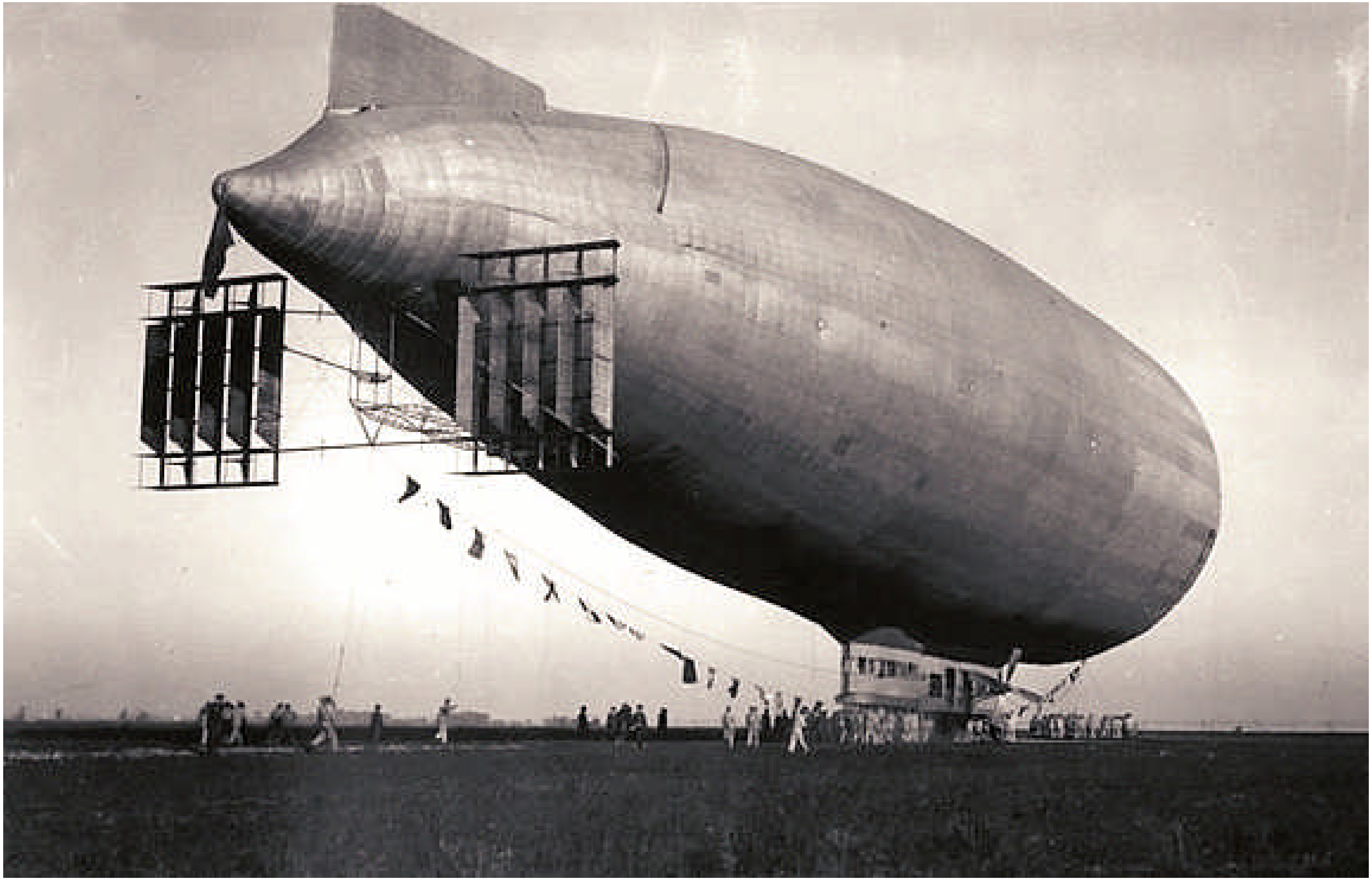
Has a Framework throughout the Bag; the "Graf Zeppelin" and the "Los Angeles" Are True Dirigibles



The word "dirigible" is often associated with large rigid airships, but the term does not come from the word "rigid" but, rather, from the French verb "diriger" ("to steer"). A dirigible is any lighter-than-air craft that is both powered and steerable (as opposed to a balloon which is free floating). Blimps like the *Goodyear Blimp*, rigid airships like the *Hindenburg* and semi-rigid airships are all classified as "dirigibles." A "blimp" (a.k.a. "pressure airship") is a powered, steerable, lighter-than-air craft whose shape is maintained by the pressure of the gases within its envelope. A blimp has no rigid internal structure thus if it deflates, it loses its shape. A "semi-rigid" airship, like a blimp, maintains its aerodynamic shape from internal gas pressure, but it has a partial rigid frame (usually in the form of a keel) which supports and distributes loads and provides structural integrity during maneuvering. A "rigid" airship has a framework surrounding one or more individual gas cells and maintains its shape by virtue of its rigid framework and not the pressure of its lifting gas.

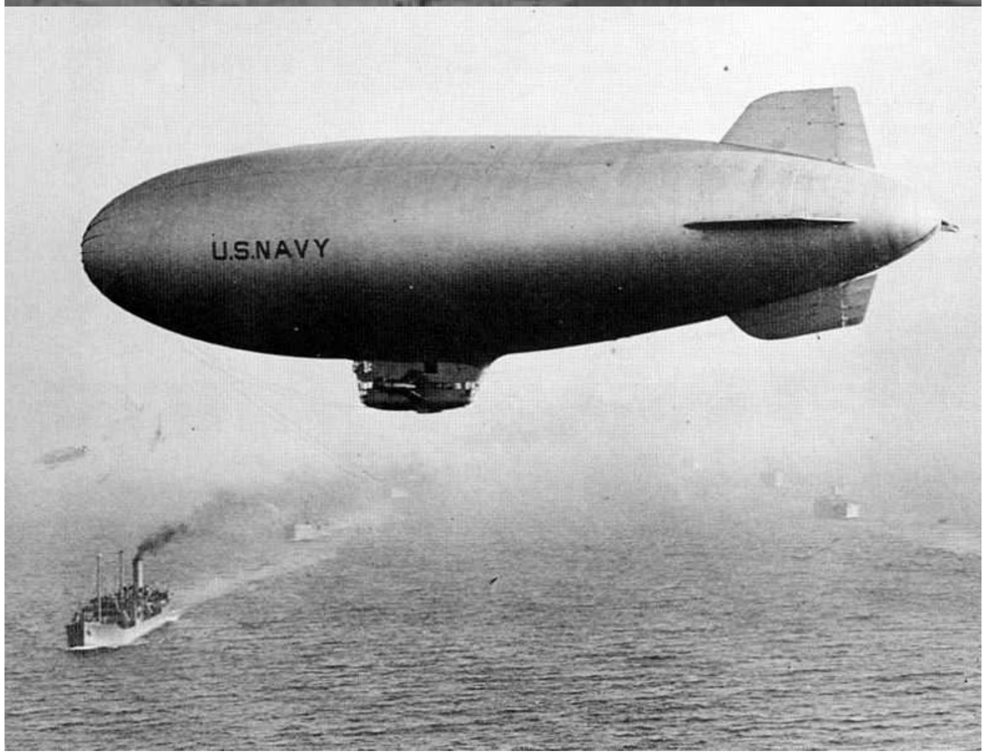
Left: poster for the 1931 film: "Dirigible"


Gas bag
Fins
Bracing supports
Main frame
Gondola
Engine gondolas
Semirigid Airship
Nonrigid Airship
Envelope
Ballonet
Fins
Engines
Gondola
Outer framing
Fins
Main frame
Gas bag
Rigid Airship
Wire supports
Engine
Stores
Cabins
Ladder
Control gondola
Catwalk



<u>Above</u>: the only *semi-rigid* airship ever used by the *U.S. Navy*; the *O-1,* which was purchased from *Italy*

Gas Bag Fleet



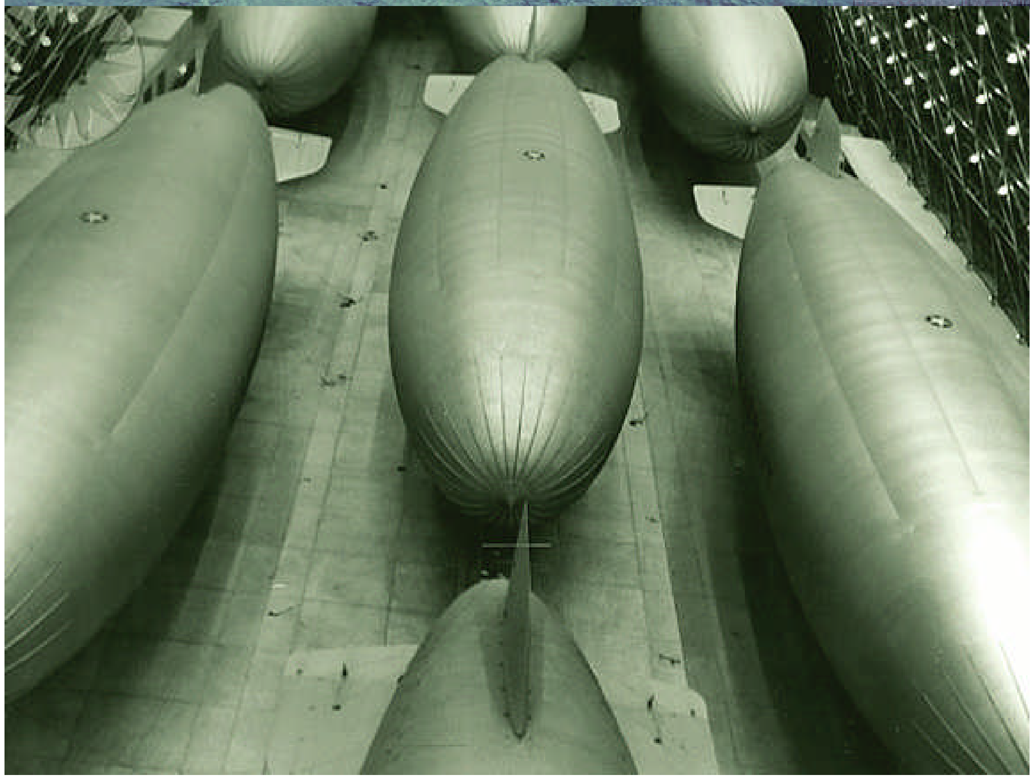
"…Nearly every morning, a great blimp rises in the dawn wind above the naval air station at Lakehurst, N.J., and heads out to sea across the curling rollers breaking on the New Jersey shore. In the little cabin attached to the belly of the ship her two officers and six men move about their tasks with the efficiency that comes from long and meticulous training. All day long the ship remains over the sea, perhaps 100 or 200 miles out, or hugging the shore. Her speed ranges from 75 miles an hour – twice that of the fastest surface vessel – to zero…An indication that lighter-than-air ships are destined to play an important part in the defense of America is the fact that the Navy has five ships on order, all non-rigid. Another is the $2,000,000 appropriation submitted to Congress for improvements at the Lakehurst station; including the building of two more hangars, crew barracks, and a general service building to house the ground school…"

***Popular Science Monthly,* July 1941**

<u>Left</u>: USN blimp/s at Lakehurst NAS (top) and escorting a convoy during WWII (bottom)

"…Because they can travel twice as fast as a surface vessel or can hover practically motionless over one spot, airships are particularly adapted to submarine search and depth-bomb attack, to convoy work, and to general coast patrol. Men in an airship can see farther and more clearly than men on a surface vessel. From an airship a submerged submarine can be spotted far more quickly than from a surface craft. From a surface vessel it is extremely difficult to sight a periscope in a moderate or heavy sea and fix its position. From an airship, the size of the waves makes no difference. Once a periscope is sighted, it can be kept in sight while the airship relays the position of the submarine to destroyers, or disposes of it by a couple of well-placed depth bombs. Lighter-than-air ships cannot be beaten for convoy work, in the belief of the men who serve them. Their greater speed, their much wider vision, their ability to stay motionless in the air make them superior to surface vessels. They can pick up a convoy 200 or more miles from the coast and escort it in to safe anchorage, shifting far ahead or behind to look for enemy planes or vessels, sending by radio the developments as they build up. Remember that the smaller airships have a cruising range of 1,000 miles and the bigger ones, the dirigibles, have a cruising range of 4,000 miles. Furthermore, experiments undertaken with non-rigid ships show that they can take on fuel and water ballast while riding to a sea anchor. Or an airship can anchor in a quiet harbor, or otherwise protected waters, where fuel can be taken on…a lighter-than-air ship is not intended to be used on a fighting line. Its particular mission of scouting and reconnaissance augmented by submarine search, convoy escort, and survey and protection of the shores would not be likely to place it in battle areas…"

***Popular Science Monthly*, July 1941**



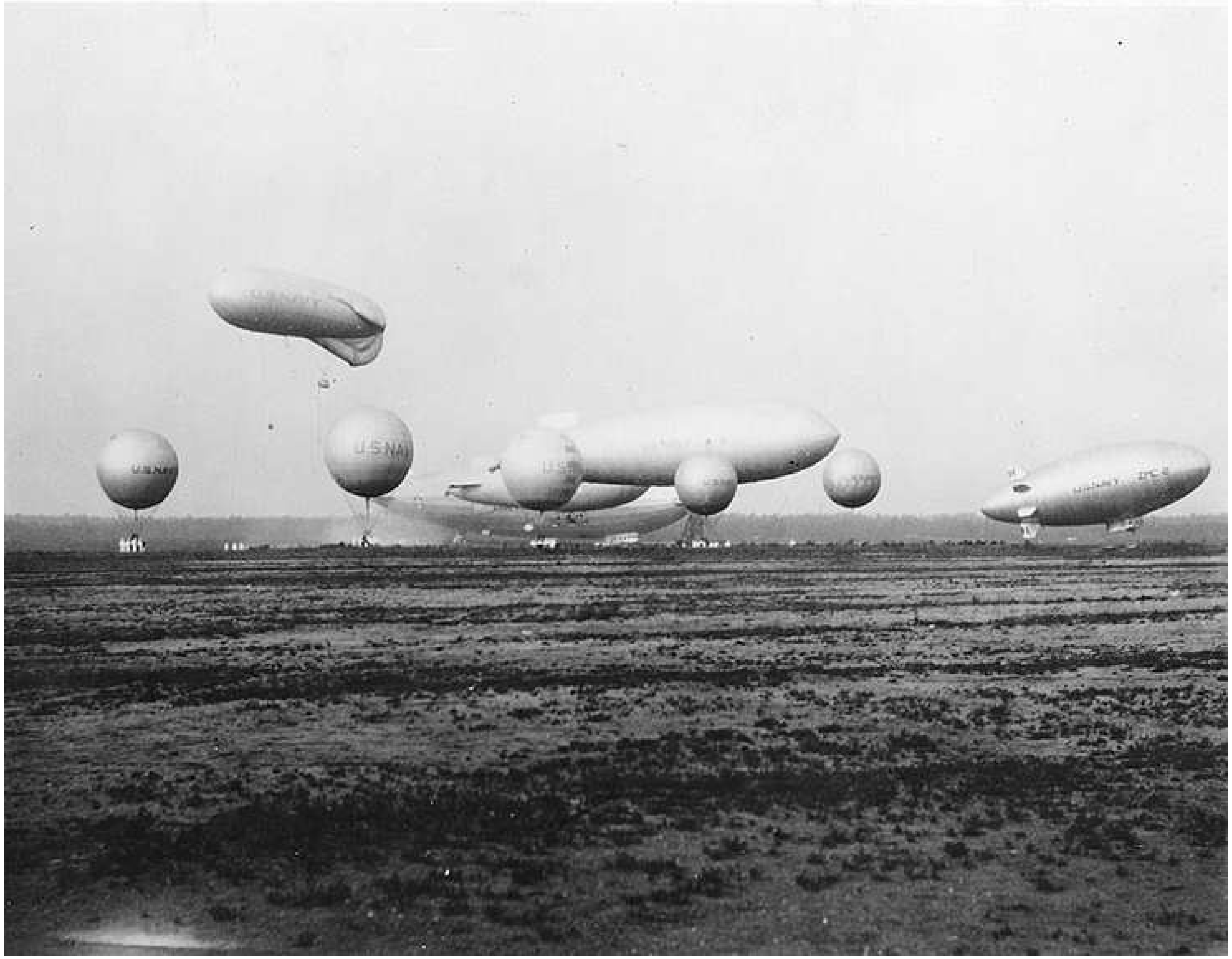
<u>Top Left</u>: USN anti-submarine patrol blimp lands on the deck of a “Jeep” escort carrier somewhere in the *North Atlantic* during WWII

<u>Top Right</u>: “M-class” non-rigid airship (blimp) of which four were built for the *U.S. Navy.* The first flight was in October 1943 and they were later re-designated as “ZPN” and again in 1954 as “ZPG”

<u>Left</u>: USN airship squadron 24 and their compliment of K-28 non-rigid airships in their Lakehurst NAS hangar

"…Our airship, on anti-sub patrol, caught a sub smack on the surface. For fifteen minutes, the two ships maneuvered at high speed, each in its element. The sub twisted to escape, writing its name in the wake as sailors say. The blimp jockeyed to get in attack position, making turn for turn. Talking with the pilot, after the simulated bombing, I learned that an airship is not really 'lighter-than-air.' It is run a little heavier than air, using its power and tail planes to fly up and down. Only when handling a blimp at low speeds is it necessary to lighten the ship by dropping ballast. To make a blimp heavier, you blow air (heavier than helium) into a fabric tank in the balloon. Submarines work the same way…

***Popular Science*, June 1949**



<u>Above</u>: caption: “Navy lighter-than-air craft at Naval Air Station Lakehurst, New Jersey, during what appears to be a demonstration, circa 1930-1931. Among the craft present are: a kite balloon (upper craft at left), five free balloons, USS Los Angeles (ZR-3) in the middle distance, two J-class blimps in the center, and blimp ZMC-2 at right.”

"…American airships, non-rigid blimps, were drafted into patrol duty along our coasts. Little was said then about what those airships were doing, and only a little more may be said today about what they have done. But it is known that literally hundreds of them have piled up a log of hundreds of thousands of hours of strenuous patrol and convoy duty with a phenomenally low casualty record…"

***Popular Science Monthly*, May 1945**

Future Promise

"…Edsel Ford, president of the Ford Motor Company, revealed a few weeks ago that he and his father are investigating metal dirigibles and their possible use for ocean passenger service…The first steamboat plowed its way through the water in 1807. The public wouldn't believe that steamers ever would cross the Atlantic. Twelve years later the little 'Savannah' sailed proudly into Liverpool from New York harbor, just as a learned lecturer was telling his audience that such a thing was impossible!"

***Popular Science Monthly*, June 1928**

“The rigid airship will occupy a definite place in the realm of aerial transportation, both naval and commercial. It will be equal to any but the most severe weather conditions, which it will avoid. Efficient and reliable, its particular field will be transoceanic. American airships will be among the foremost aerial carriers of the world. Some of their outstanding features will be:

- ***The use of helium for inflation;***
- ***Multiple heavy-oil power plants located within the hull;***
- ***Swiveling propellers for vertical thrust as well as fore-and-aft propulsion;***
- ***Eventual cruising speed of 100 miles an hour;***
- ***Size increased by gradual increments to more than ten million cubic feet***

Such ships of the future will carry airplanes as auxiliaries, just as surface craft may. In shape they will be more blunt than at present. Their strength will be increased several fold, and multiple longitudinal corridors will serve also as strength members. They will have increased travel comforts and luxuries equal to the best furnished by any type carrier, and highly improved navigational facilities, with solution of the fog problem. We are now on the threshold of obtaining these improvements. With the limited ships and facilities available for experimentation, progress is necessarily slow. But the airship is destined to become prominent and indispensable in the air.”

***Lieut. Cmndr. C.E. Rosendahl* – USN, June 1929**

"…At the banquet held in New York last year to celebrate the 'Graf Zeppelin's' round-the-world flight last year, Dr. Hugo Eckener, the commander, with whom I had flown long before the war, told me that it is only a matter of a few years until skyliners will leave for distant parts with the regularity of ocean steamboats. His fondest dream, which he predicts will become a reality in 1945, is a Zeppelin holding 20,000,000 cubic feet of helium, carrying 1,000 passengers and propelled by motors totaling 25,000 horsepower…"

Horace B. Wild, **1931**

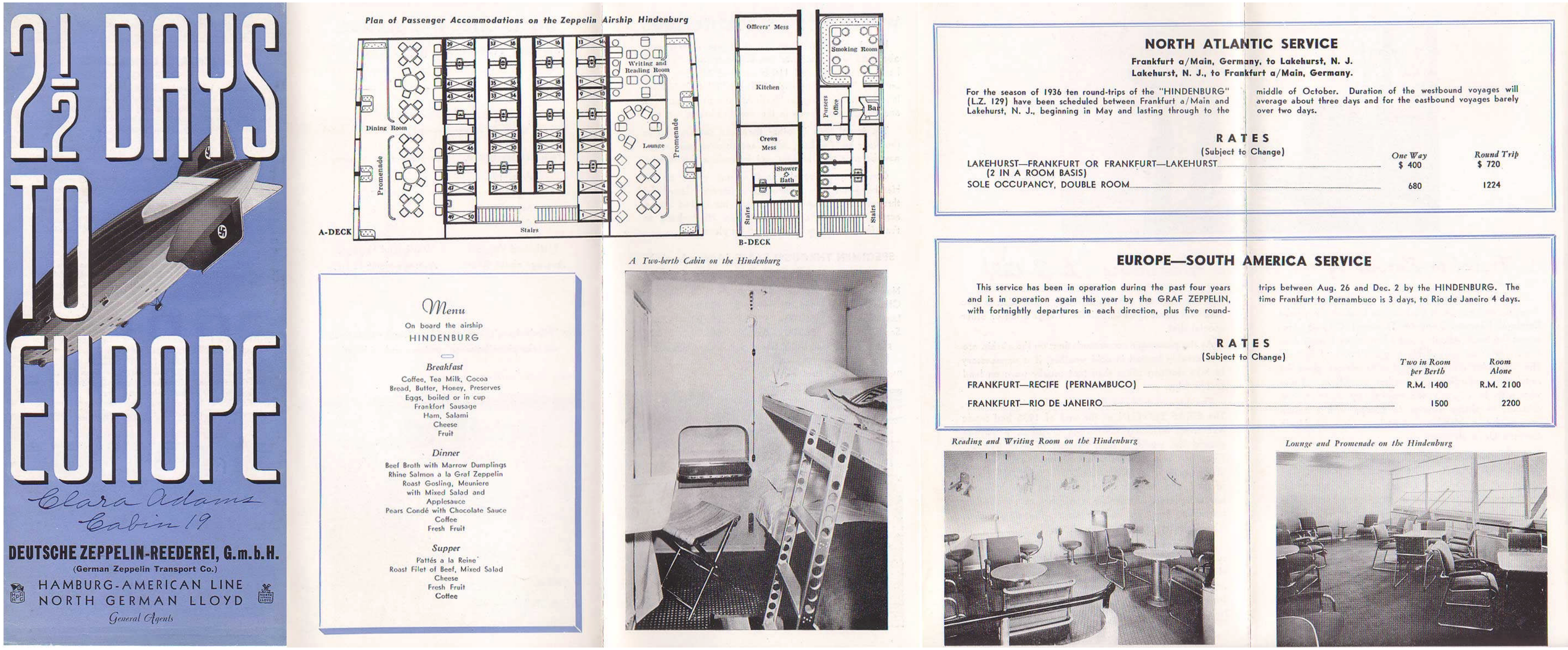
Part 6

LZ-129

Germany Rejoiced

"…The little town of Friedrichshafen, beside the placid Lake of Constance, close to where Austria, Switzerland, and Germany meet, seethed with excitement. The German nation regarded the inauguration of air service to the United States with justifiable national pride, for it had definitely gained supremacy in passenger, mail, and freight service to both North and South America by air. Only seventeen years before, the Treaty of Versailles had virtually swept Germany's shipping from the seas when the Allied Powers had seized her merchant marine and also crippled her air development by the treaty. Now the German flag had returned to the seven seas; the Bremen and Europa were two of the fastest and largest liners in the world, and the airship Graf Zeppelin was making her 100th crossing of the South Atlantic to South America. She had safely carried more than 12,000 passengers in her career and traveled nearly a million miles. The first flight of the Hindenburg would clinch German predominance in transoceanic air traffic, and a sister ship for the Atlantic services was under construction. Germany rejoiced…"

***Webb Miller,* Reporter - *United Press* (1936)**



EUROPEAN SAILINGS — Eastbound

From New York, Baltimore, Boston and Canadian Ports

Subject to Change Without Notice

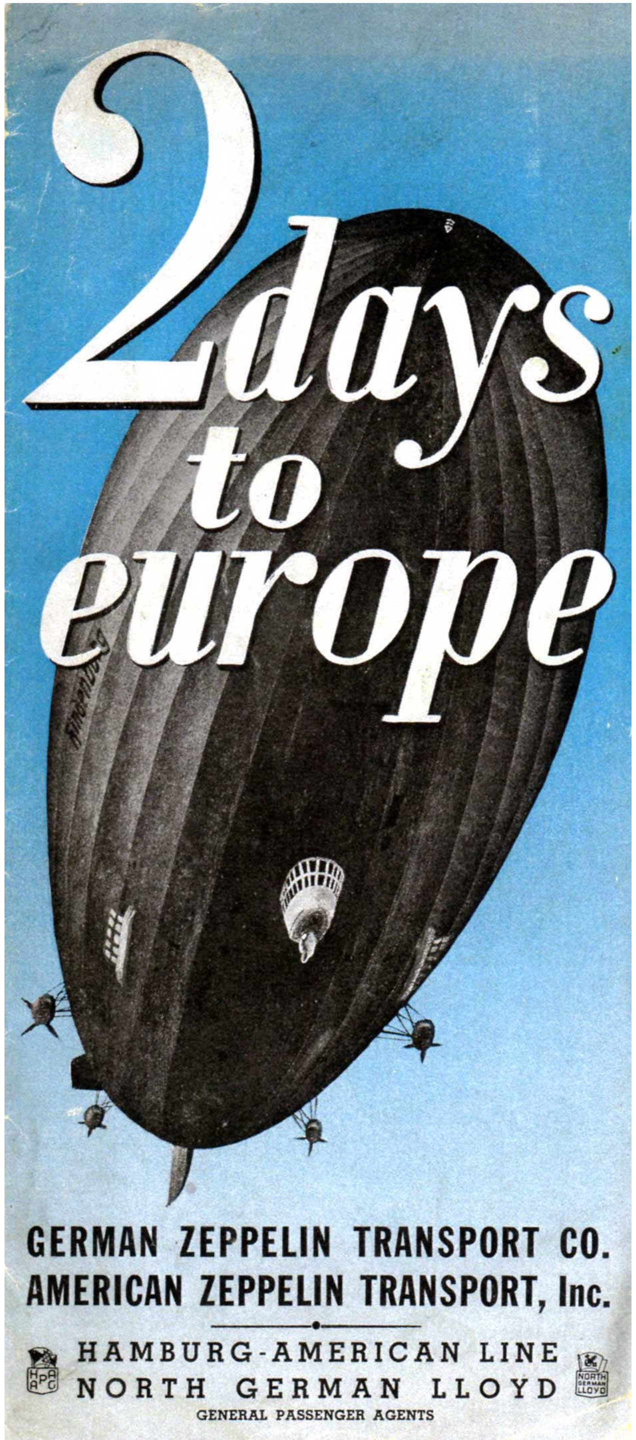
JUNE, 1936

Date	Day	Steamer	Days to First Port	From	To
14	Sun.	Bremen	5	New York	Cherbourg, Southampton, Bremen
14	Sun.	Pilsudski	8	New York	Halifax, Copenhagen, Gdynia
16	Tue.	Normandie	5	New York	Southampton, Havre
17	Wed.	Berengaria	5½	New York	Southampton, Cherbourg
17	Wed.	Manhattan	5½	New York	Cobh, Ply., Havre, Hamburg
17	Wed.	M. de Comillas	9	New York	Cadiz, Barcelona
17	Wed.	C. of Newport News	9	Baltimore	Norfolk, Havre, Hamburg
18	Thur.	Deutschland	7	New York	Cherbourg, South., Hamburg
19	Fri.	Duchess of Bedford	7	Montreal	Glasgow, Belfast, Liverpool
19	Fri.	Scythia	8	New York	Boston, Galway, Cobh, Liverpool
19	Fri.	Ascania	9	Montreal	Quebec, Ply., Havre, London
19	Fri.	Antonia	9	Montreal	Quebec, Glas., Belfast, Liverpool
19	Fri.	American Merchant	10	New York	Plymouth, London
19	Fri.	Scanstates	11	New York	Copenhagen
19	Fri.	Em. of Australia	7	Quebec	Cherbourg, Southampton
20	Sat.	California	8	New York	Dublin, Glasgow
20	Sat.	American Shipper	8	New York	Cobh, Liverpool
20	Sat.	Champlain	7	New York	Plymouth, Havre
20	Sat.	Berlin	9	New York	Galway, Cobh, South., Bremen
20	Sat.	Gerolstein	10	New York	Havre, Antwerp
21	Sun.	Europa	5	New York	Cherbourg, Southampton, Bremen
23	Tue.	Exeter	8½	New York	Gib., Palma, Marseilles, Naples, Alexandria, Jaffa, Haifa, Beirut
23	Tue.	Habana	7	New York	Vigo, Coruna, Gijon, Santander, Bilbao
23	Tue.	Hindenburg	2½	Lakehurst	Frankfort
24	Wed.	Stavangerfjord	7½	New York	Stav., Kristiansand, Bergen, Oslo
24	Wed.	Volendam	8	New York	Plymouth, Boulogne, Rotterdam
24	Wed.	Queen Mary	5	New York	Cherbourg, Southampton

JULY. 1936

Date	Day	Steamer	Days to First Port	From	To
17	Fri.	American Merchant	10	New York	London
17	Fri.	Bremen	5	New York	Cherbourg, Southampton, Bremen
17	Fri.	Scanpenn	11	New York	Copenhagen
18	Sat.	California	8	New York	Londonderry, Glasgow
18	Sat.	American Shipper	8	New York	Cobh, Liverpool
18	Sat.	Berlin	9	New York	Galway, Southampton, Bremen
18	Sat.	Gerolstein	10	New York	Havre, Antwerp
18	Sat.	Rex	5	New York	Gibraltar, Naples, Nice, Genoa
18	Sat.	Montcalm	7	Montreal	Glasgow, Belfast, Liverpool
19	Sun.	Manuel Arnus	9	New York	Cadiz, Barcelona
21	Tue.	Statendam	7	New York	Boston, Ply., Boulogne, Rotterdam
21	Tue.	Exochorda	8½	New York	Gibraltar, Palma, Mars., Naples Alexandria, Jaffa, Haifa, Beirut
22	Wed.	Pres. Harding	7	New York	Cobh, Ply., Havre, Hamburg
23	Thur.	Ile de France	5½	New York	Plymouth, Havre
23	Thur.	Britannic	8	New York	Cobh., South., Havre, London
23	Thur.	Berengaria	5½	New York	Cherbourg, Southampton
23	Thur.	New York	7	New York	Cherbourg, South., Hamburg
24	Fri.	Aurania	9	Montreal	Quebec, Plymouth, Havre, London
24	Fri.	Cameronia	8	New York	Boston, Dublin, Glasgow
24	Fri.	American Banker	10	New York	London
24	Fri.	Europa	5	New York	Cherbourg, Southampton, Bremen
24	Fri.	C. of Newport News	9	Baltimore	Norfolk, London, Hamburg
24	Fri.	Cristobal Colon	7	New York	Vigo, Coruna, Gijon, Santander, Bilbao
25	Sat.	Pennland	8	New York	Southampton, Antwerp
25	Sat.	Montclare	7	Montreal	Glasgow, Belfast, Liverpool
29	Wed.	Queen Mary	5	New York	Cherbourg, Southampton
29	Wed.	Washington	5½	New York	Cobh, Ply., Havre, Hamburg

Above: 1936 *Hindenburg* brochure
Left: 1936 transatlantic schedule

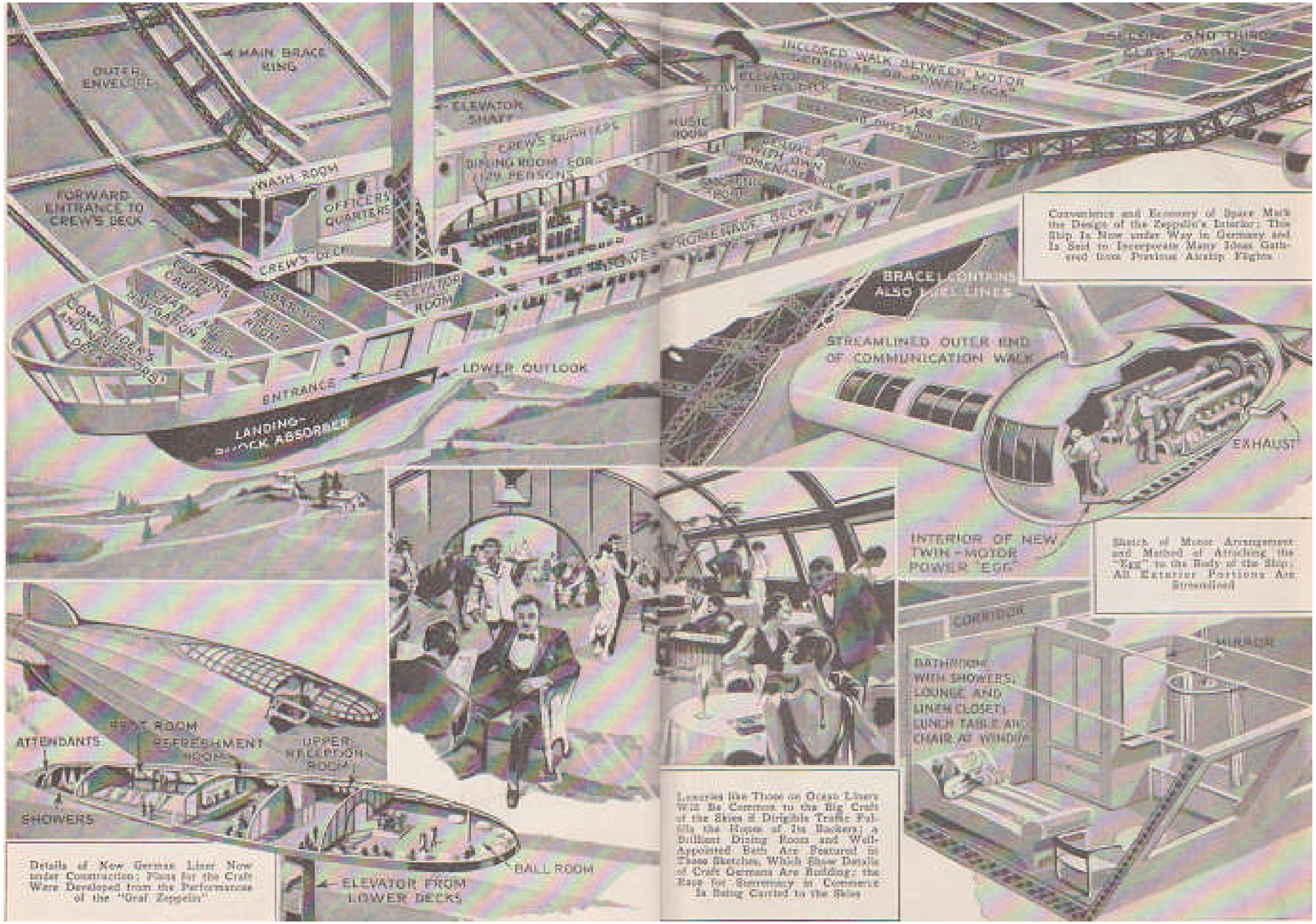


"…This was the largest and most extravagant aircraft ever flown. Her builders had labeled her LZ-129 – the 129th 'Luftschiff' (airship) Zeppelin – and christened her 'Hindenburg' (after the World War I field marshal who was conned by Hitler into surrendering control of Germany)…In 1937, this was THE way to travel – the quickest, most comfortable transatlantic crossing possible. The fastest ocean liners took nearly twice as long. Commercial airline flights were still two years in the future…"

***Popular Science,* May 1962**

"…Nearing completion in Germany, the LZ-129, world's largest airship, will make the dream of a U.S.-to-Europe airline a reality, if present plans mature. By early summer the huge Zeppelin is scheduled to start regular commercial flights between this country and Germany. Authority has been granted to use the naval air station at Lakehurst, N.J., as the United States terminus of the transatlantic line, and the U.S. Post Office Department is reported negotiating terms for carrying the overseas air mail. The new Zeppelin is expected to be able to fly mail to Europe in forty-eight hours. Lest the United States lag in developing its own ocean airways, a program for the construction of two giant airships for commercial transatlantic service is being urged upon the government by the National Advisory Committee for Aeronautics…"

***Popular Science Monthly*, January 1935**



<u>Above</u>: caption: "Details of the new German Liner now under construction; plans for the craft were developed from the performance of the 'Graf Zeppelin.'" From an article entitled: "The Air Liners of the Future" (*Popular Mechanics*, February 1930)


Nicht übertragbar. / Not transferable. / Intransferible. / Intransmissivel. / Personnel.

DEUTSCHE ZEPPELIN-REEDEREI G.M.B.H.
BERLIN W8 · FRANKFURT A. M. · FRIEDRICHSHAFEN A. B.

ZEPPELIN-FAHRSCHEIN NR. 0335
TICKET / BILLETE / BILHETE / CONTRAT DE PASSAGE

Die Deutsche Zeppelin-Reederei G.m.b.H. übernimmt auf Grund ihrer Beförderungsbedingungen die Beförderung von

In accordance with the passage conditions the Deutsche Zeppelin-Reederei G.m.b.H. is taking charge of the air transport of

Segundo as condições de transporte a Deutsche Zeppelin-Reederei G.m.b.H. encarrega-se do transporte aereo de

Según las condiciones de transporte la Deutsche Zeppelin-Reederei G.m.b.H. toma a su cargo el transporte aéreo del

Le Deutsche Zeppelin-Reederei G.m.b.H. s'engage à transporter, conformément aux termes énoncés dans ses Conditions de Transport

Mr.Norman Holden
(Name des Passagiers)

mit dem Luftschiff Hindenburg am 6.Mai 36.
by the airship / en el dirigible / no dirigivel / par le dirigeable — on / el dia / em / le

von Friedrichshafen nach Frankfurt a.M.
from / de — to / a / para / à destination de

über Lakehurst USA.
via

Fahrpreis / Fare / Importe del viaje / Importancia da viagem / Montant du passage
RM.1250.- & RM.800.-& RM.630.- $ 8.-

Zur Einschiffung versammeln sich die Fahrgäste / For embarkation passengers will meet / Para el embarque, los pasajeros deben reunirse / Para o embarque os passageiros devem reunir-se / Pour l'embarquement les passagers se réunissent

am 6.Mai 36. um 15.00 h
on / el / em / le — at / a las / ás / à

Kurgarten Hotel
im
at / en / no / à

Checked

UP-TOWN OFFICE 669 FIFTH AVENUE NEW YORK, N.Y.

Ort Friedrichshafen B. Datum 6.Mai 36.
Place / Lugar / Logar / Lieu d'émission — Date / Fecha / Data / Date

Deutsche Zeppelin-Reederei G.m.b.H., Friedrichshafen a. B.

Agentur: London
Int. Quittung: 2167 & 2320
Bett Nr. 33/34

BERTH NO. 34 RELEASED TO CAPT. THE HON. FRED. GUEST. REFUND OF DIFFERENCE TO BE SETTLED BY MAINOFFICE IN FRIEDRICHSHAFEN
HUBGHAPAG - LLOYD, NEW YORK

"…Dr. Hugo Eckener's latest venture with rigid airships promises to unfold endless possibilities of traveling safely and swiftly through the air in modern luxury. The 'LZ-129,' under construction since February, 1932, is about to make her maiden trip across the Atlantic, with Dr. Eckener as her master…"

***Popular Mechanics,* June 1935**

<u>Above</u>: registered letter carried on LZ-129's first transatlantic flight

<u>Left</u>: ticket for Hindenburg's maiden voyage to the *United States* (May 6-9th 1936)

"…I had difficulty convincing myself that we were actually making a historic flight, the first regular passenger service to North America. We slipped through the air with velvety smoothness and almost no vibration. The ship did not sway or buck, the motors hummed but faintly. It was only when you thrust a hand out of the open window into the eighty-miles-an-hour wind that you had any idea of our speed…Captain Ernst Lehmann conducted me through the interior of the craft. I reminded him that nineteen years before he had commanded a Zeppelin which bombed London. 'I was two miles below you dodging your bombs,' I said. He laughed: 'Well, that was a long time ago'…"

Webb Miller,* Reporter *- United Press

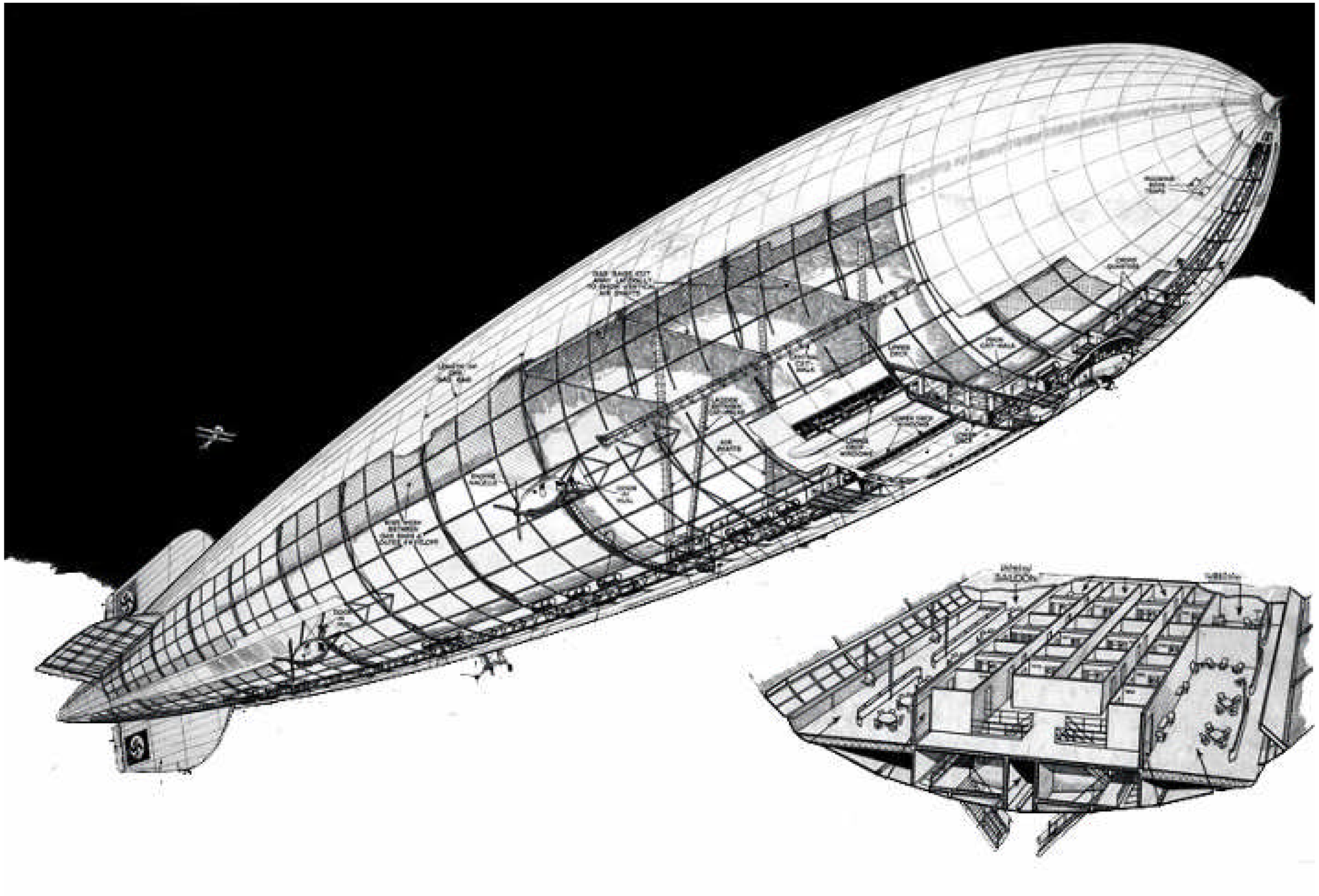
RE: excerpt from his writings about his experiences as a passenger on LZ-129's maiden flight to *America* in early May 1936. He was given a personal tour of the airship by Captain Lehmann.

“…Here are the main facts about the ship: length 812 feet; greatest diameter, 137 feet; gross lifting capacity, 418,000 pounds; payload, twenty-five to thirty tons; fuel load, 130,000 pounds; cruising speed, eighty miles per hour, which will carry it across the Atlantic in about two days…The engines will develop 4,400 horsepower in all. For the first time an airship will have the advantage of Diesel engines. They are hung on the outside, as on the ‘Graf,’ and each operates independent of the rest. The ‘LZ-129’s’ immense cruising range, 8,000 miles, enables her to travel around the world with only two refueling stops. The ship is equipped with an apparatus for extracting water vapor from the surrounding atmosphere at a rate of about 150 gallons per hour…”

***Popular Mechanics,* June 1935**

"…The hull is a streamlined body with a length six times its maximum diameter. It incorporates the typical Zeppelin construction of braced main rings, with auxiliary rings between. The metal used in the framework is an extremely light, strong aluminum alloy which had already been well tested in the 'Graf Zeppelin.' The main frames are of a flat wire-braced type using strong steel wire for bracing, and the outer cover which is stretched taut about the metallic hull is a strong cotton fabric made weatherproof by chemical treatment. In those particular places where unusual strength is needed linen cloth is used. The inside of the upper portion of the cover is colored red against the effects of ultra-violet rays…"

***Magazine of Art*, 1937**



Deutsche Zeppelin-Reederei

Construction of LZ-129 began in the autumn of 1931, but progress lagged due to a lack of sufficient funds. At first, the Nazi Party's assumption of power in January 1933 had little effect on the fortunes of the *Zeppelin Company*, due in part to Air Minister Hermann Goring's dislike of dirigibles. But Propaganda Minister *Joseph Goebbels* was aware of the potential symbolic value of LZ-129 as a showcase for German superiority and, in 1934, Goebbels offered *Hugo Eckener* two million marks toward the completion of LZ-129. Determined to overshadow his rival Goebbels, *Hermann Goring* offered an additional nine million marks from the Air Ministry, but the offer came with conditions. In March 1935, the Air Ministry split the Zeppelin Company into two firms; the original *Luftschiffbau Zeppelin*, which would be responsible solely for the construction of airships and the newly created *Deutsche Zeppelin-Reederei* (DZR); half-owned by the German national airline *Lufthansa,* which would be responsible for airship operations. The establishment of the DZR also served the interest of the Nazis by effectively removing Hugo Eckener from the leadership of German Zeppelin operations. *Ernst Lehmann*, who was much more amenable to the Nazi government than was Hugo Eckener (he despised Hitler) was put in charge of the DZR, and Eckener became mostly a figurehead. There was a plan to recover and launch fixed-wing aircraft (to speed the delivery of mail). Tests were conducted in which famed German ace and *Luftwaffe* official *Ernst Udet* attempted to hook an aircraft onto LZ-129 in flight, but these attempts were not successful and no such system was developed before LZ-129's catastrophic crash in May 1937.


ZEPPELIN-REEDEREI
LUFT-
EXPRESS-
GUT

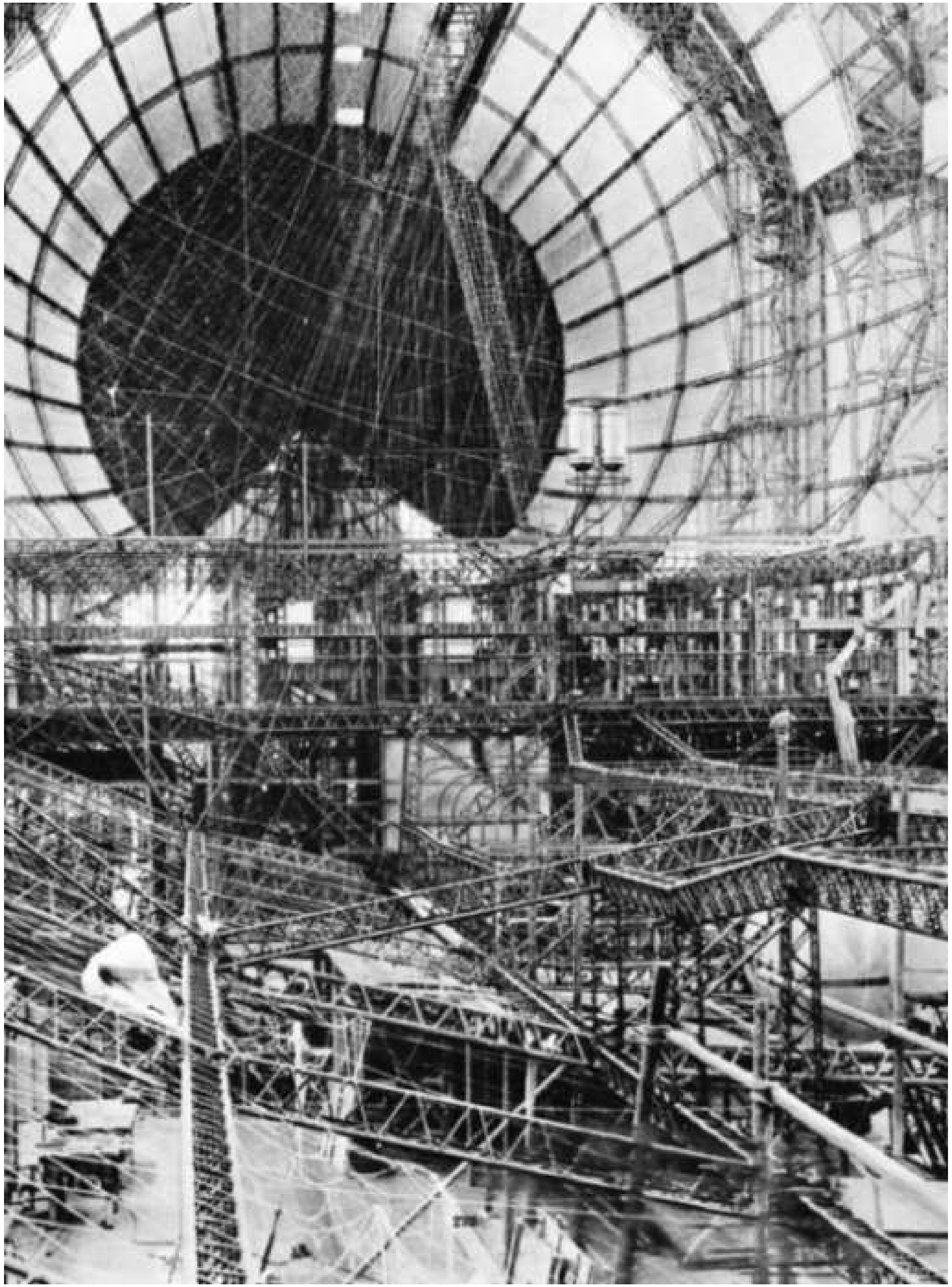
"…Many improvements which the 'Graf' lacked are being embodied in the new German dirigible now under construction at Friedrich-shafen…The new German dirigible is thirty per cent larger than the 'Graf'; has eight motors instead of five, and retains the outside motor gondolas because inflammable hydrogen gas will be used for lift. It will be completed in the spring of 1931…"

Popular Mechanics, **February 1930**

<u>Left</u>: ***Luftschiff Hindenburg*** **under construction (ca. 1930)**

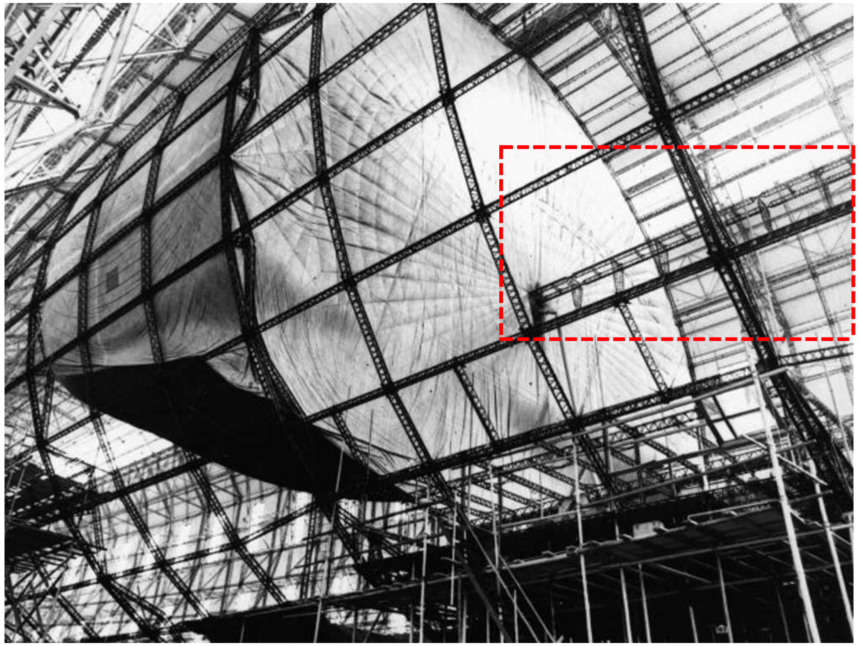
"…There are two main corridors which run throughout the ship, one along the very bottom which serves as the main unit and accommodates along its length the fuel and water tanks, storerooms, freight compartments, crews' quarters, and other service details. The other corridor goes through the actual center of the ship fore and aft, and serves to tie the bow and stern together. The lower aisle is used for the main traffic lane, while the upper gives access to the gas cells for the frequent and careful inspections…"

***Magazine of Art,* 1937**



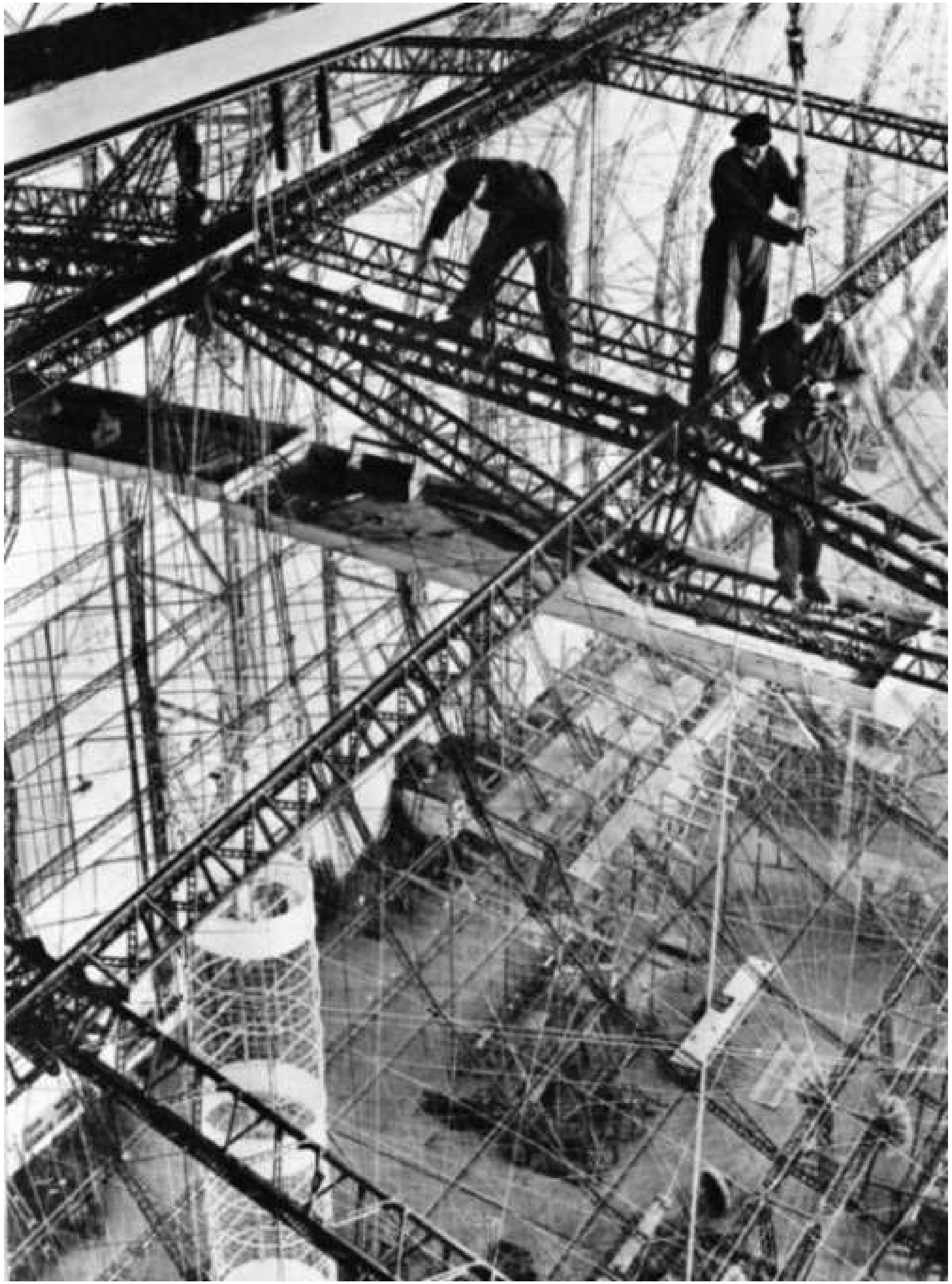
"…Fifteen main rings divide the hull into sixteen compartments which hold the gas-bags. The keel longitudinals run almost the whole length of the ship. The envelope fabric is of lightweight linen and cotton, treated with several coatings of cellon, or 'dope'…"

Wonders of World Engineering, **April 1937**



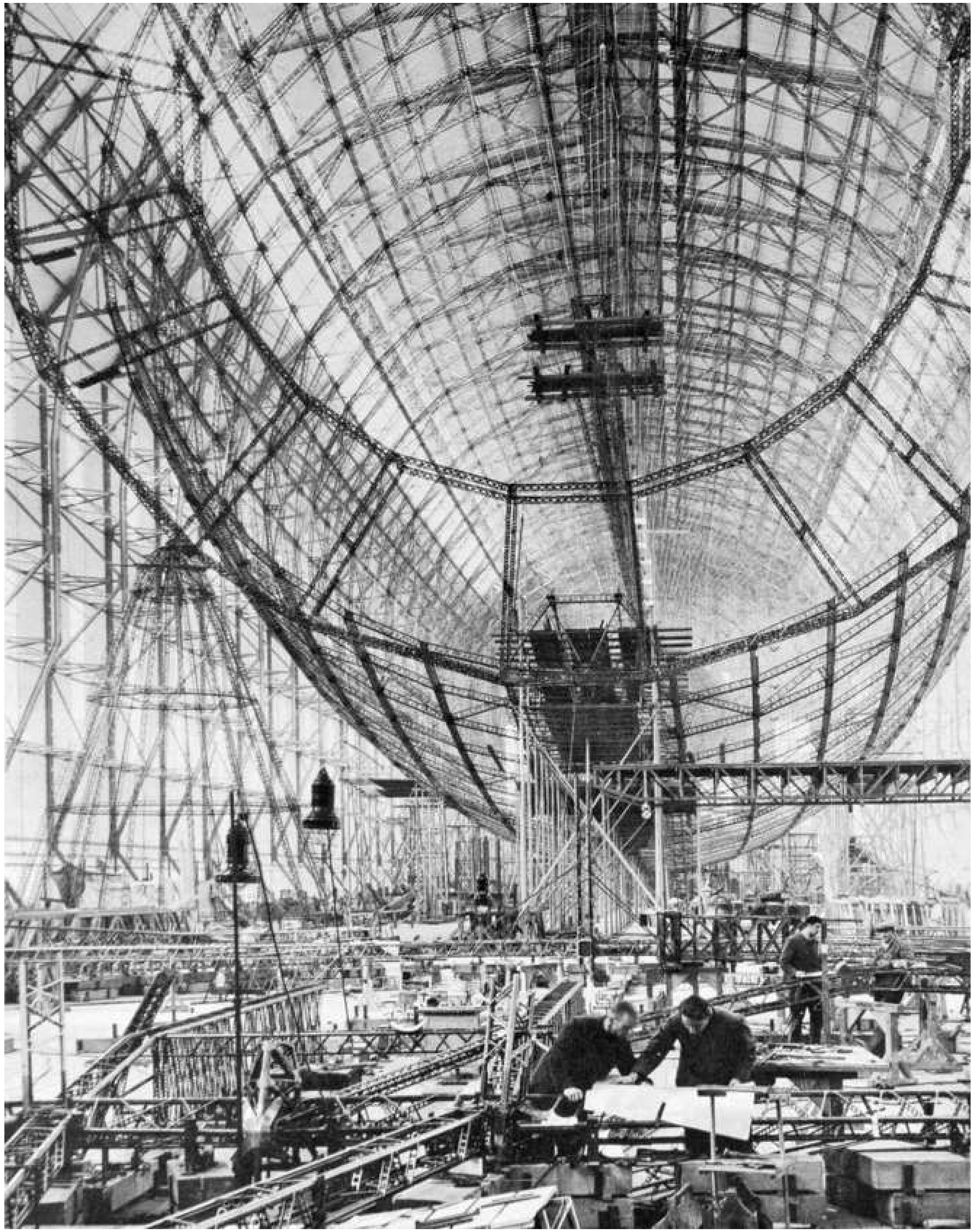
LZ-129's basic design was conventional, based on time-tested technology used by the *Zeppelin Company* for decades. The ship was built with triangular duralumin girders forming fifteen main rings connecting thirty-six longitudinal girders with a triangular keel at the bottom of the hull, an axial corridor at the center of the ship and a cruciform tail for strength. LZ-129's main rings (a.k.a. "frames") were numbered by their distance (in meters) from a reference point located roughly at the airship's tail. Her gas cells were numbered from one through sixteen, aft to forward respectively.

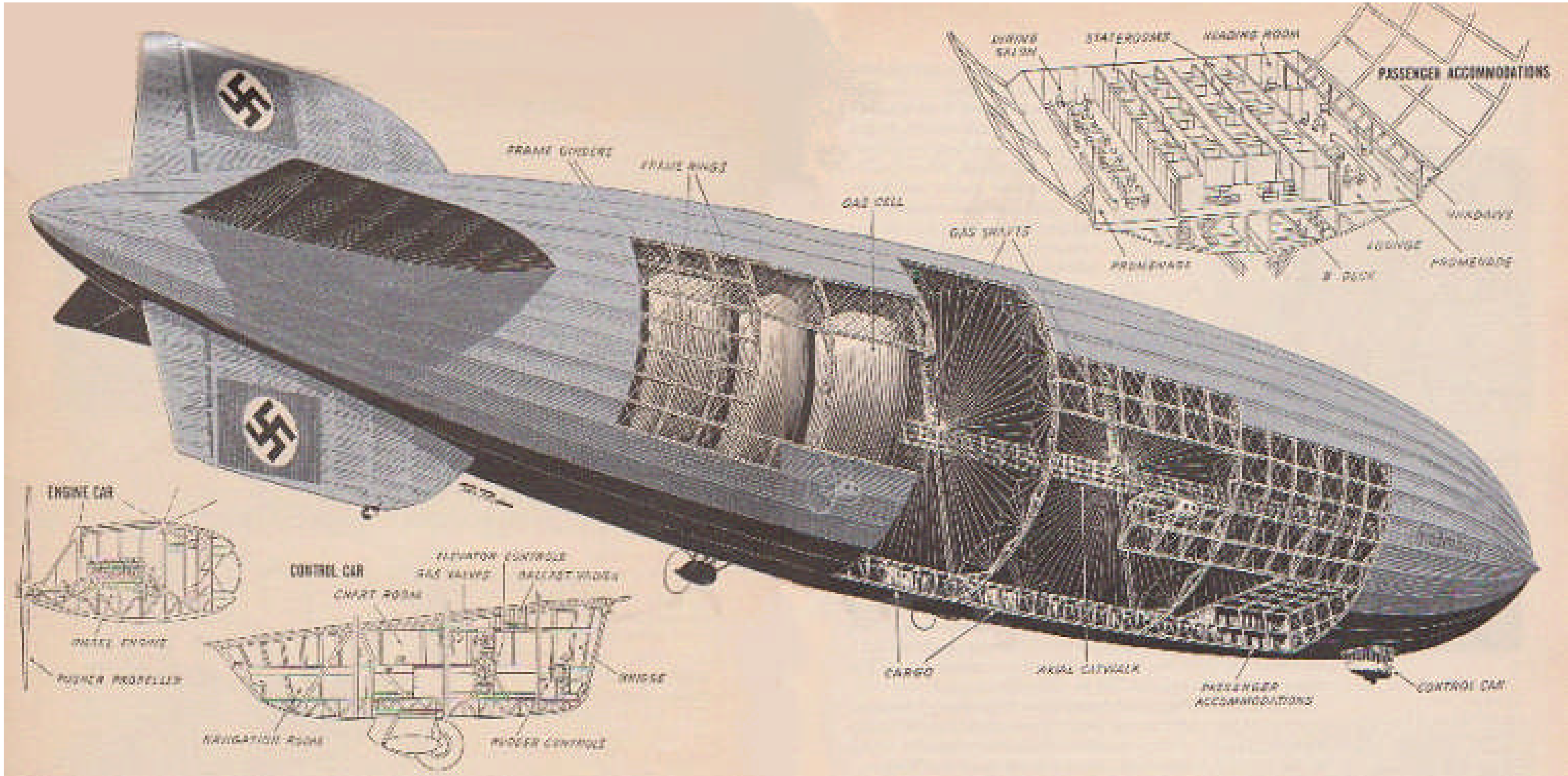
<u>Above</u>: caption: "Hindenburg under construction, showing the axial catwalk passing through the center of a gas cell, and the outline of the passenger compartment at lower right"



"…In the builder's hangar at Friedrichshafen, on Lake Constance (Boden See). The design of the Hindenburg followed that of the Graf Zeppelin, but because of the additional stresses due to her larger size, the Hindenburg's members are of greater depth and thickness…"

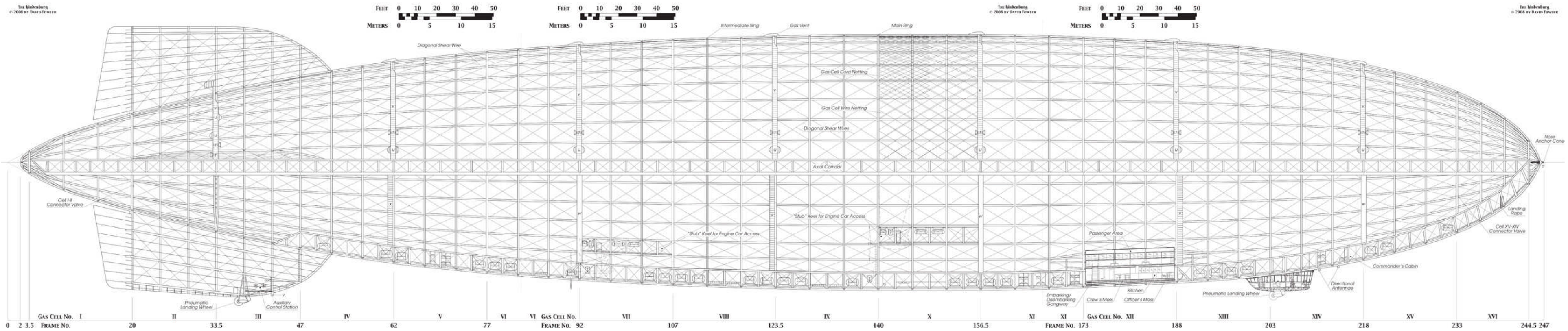
Wonders of World Engineering, **April 1937**



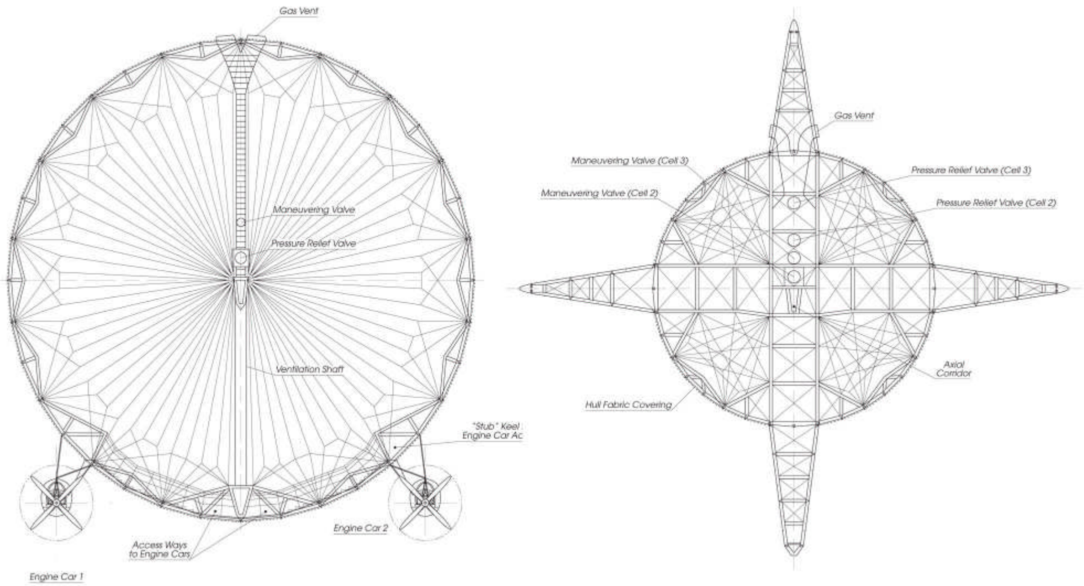


"…On a foot-wide catwalk a few inches above the fabric of the belly of the ship, we threaded our way from the stem down into the immense tail fin of the Hindenburg. Sixteen great hydrogen bags filled most of the interior. They contained nearly seven million cubic feet of gas ten times as light as air and so inflammable that one spark would explode the craft in an instant. The huge rings of aluminum alloy which formed the Zeppelin's out-line were braced by an intricate system of strong 'Swiss cheese' girders and finger-thick wires. On either side of the catwalk lay great tanks carrying 143,000 pounds of Diesel oil, water tanks, bays for food supplies, freight, and mail, and officers' and crew's quarters…"

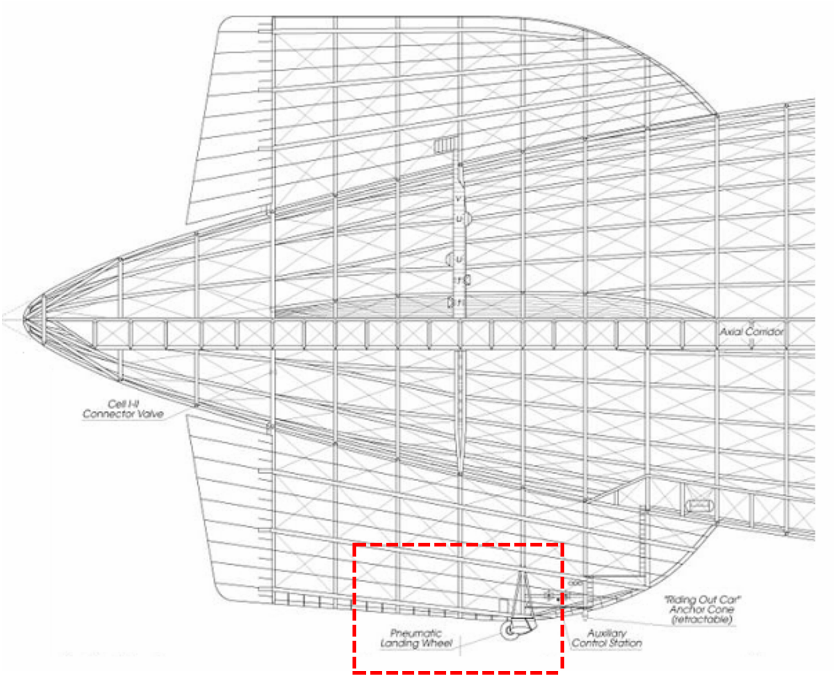
***Webb Miller,* Reporter - *United Press* (1936)**

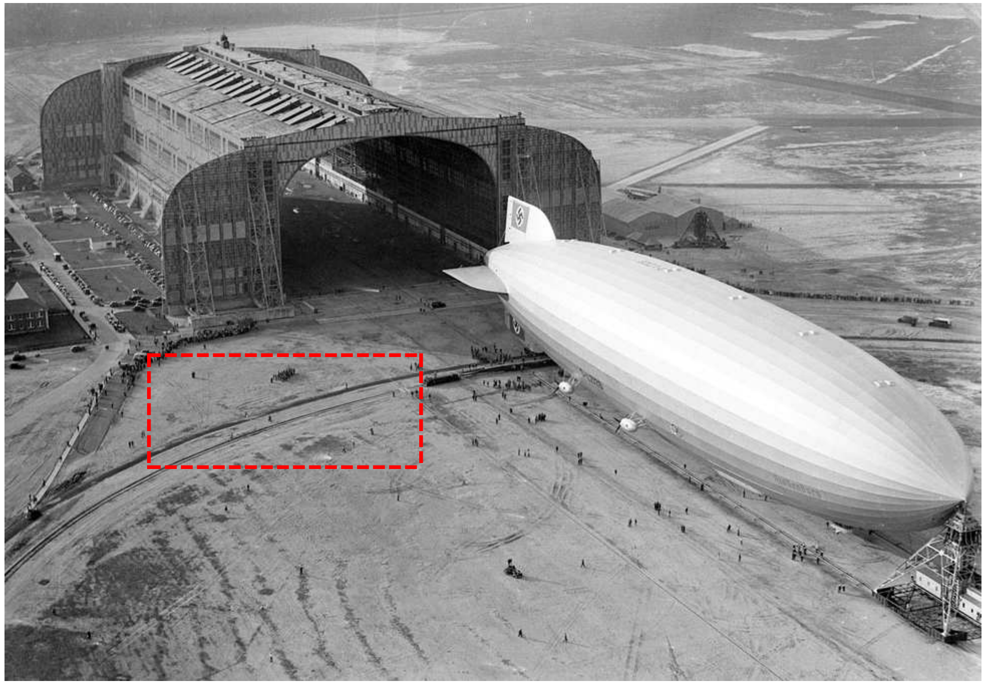


<u>Above</u>: LZ-129 profile showing major elements and numbering system for gas cells and frames



<u>Above</u>: LZ-129's Main Ring 92 (left), and Main Ring 33.5 (right) showing the airship's sturdy, cruciform tail structure





"…At the very stern inside the huge under fin was a retractable tail wheel, similar to one under the control car. At Lakehurst the tail wheel rested on a flat car that rolled around a circular track, allowing the airship to turn with the wind when she was tethered to her mooring mast…"

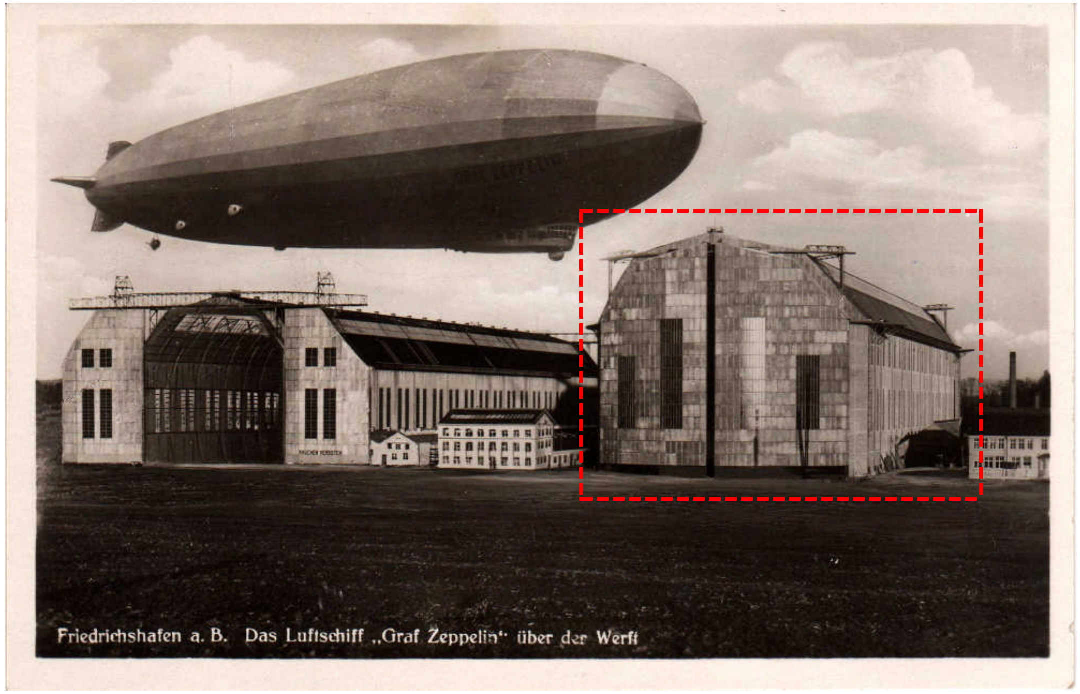
***Popular Science,* May 1962**

Left: LZ-129's tail fin showing retractable tail wheel (highlighted)

Right: LZ-129 moored to mobile mast at Lakehurst NAS (circular track highlighted)

"…The inside of this monstrous football was equally impressive. You walked to the nose along the Keillaufgang – a narrow aluminum catwalk atop the keel girder. There was no railing; except for a few guidelines, only a maze of cross-bracing wires and the thin fabric of the hull separated you from the Atlantic Ocean 600 feet below. From the nose, you look back on the elaborate blue-painted skeleton – 'It seems like a cathedral,' one captain had rhapsodized. The lateral support for the fabric skin was 50 aluminum rings (not truly round, but 36-sided polygons) graduated in size from the fat middle to the pointed bow and stern. Holding the rings were 35 flat girders running lengthwise, and an interlocking cobweb of steel wires. It took 5,500,000 rivets just to fasten the rings to the girders…"

***Popular Science,* May 1962**

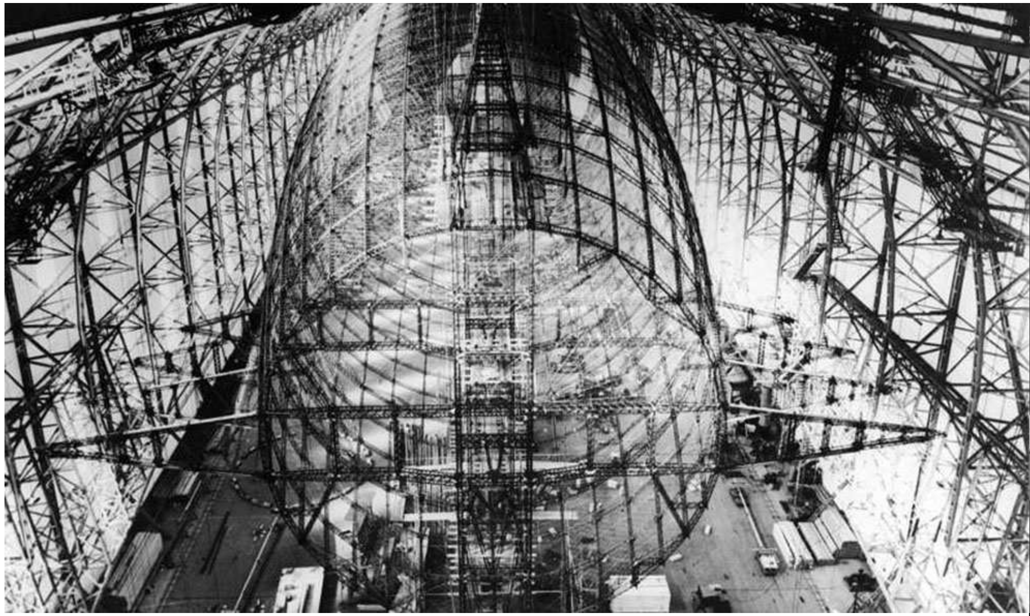
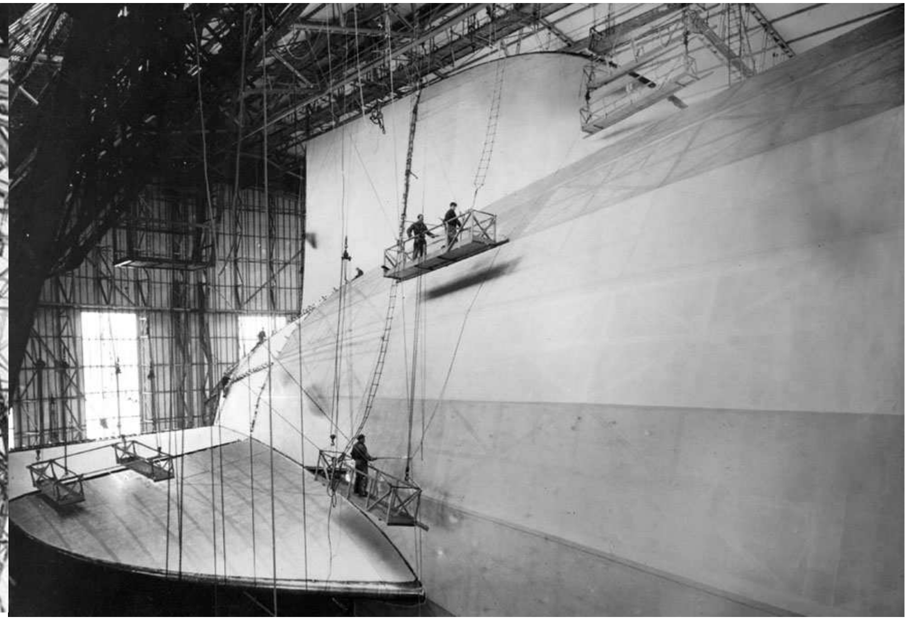


"…The Hindenburg was fatter across her midsection than previous Zeppelins – the Shenandoah had snapped in two, indicating the need for strength amidships, but the heftiest framework supported the bow, for it hooked onto the mooring mast and had to hold, no matter how gusty the conditions on the ground…"

***Popular Science,* May 1962**

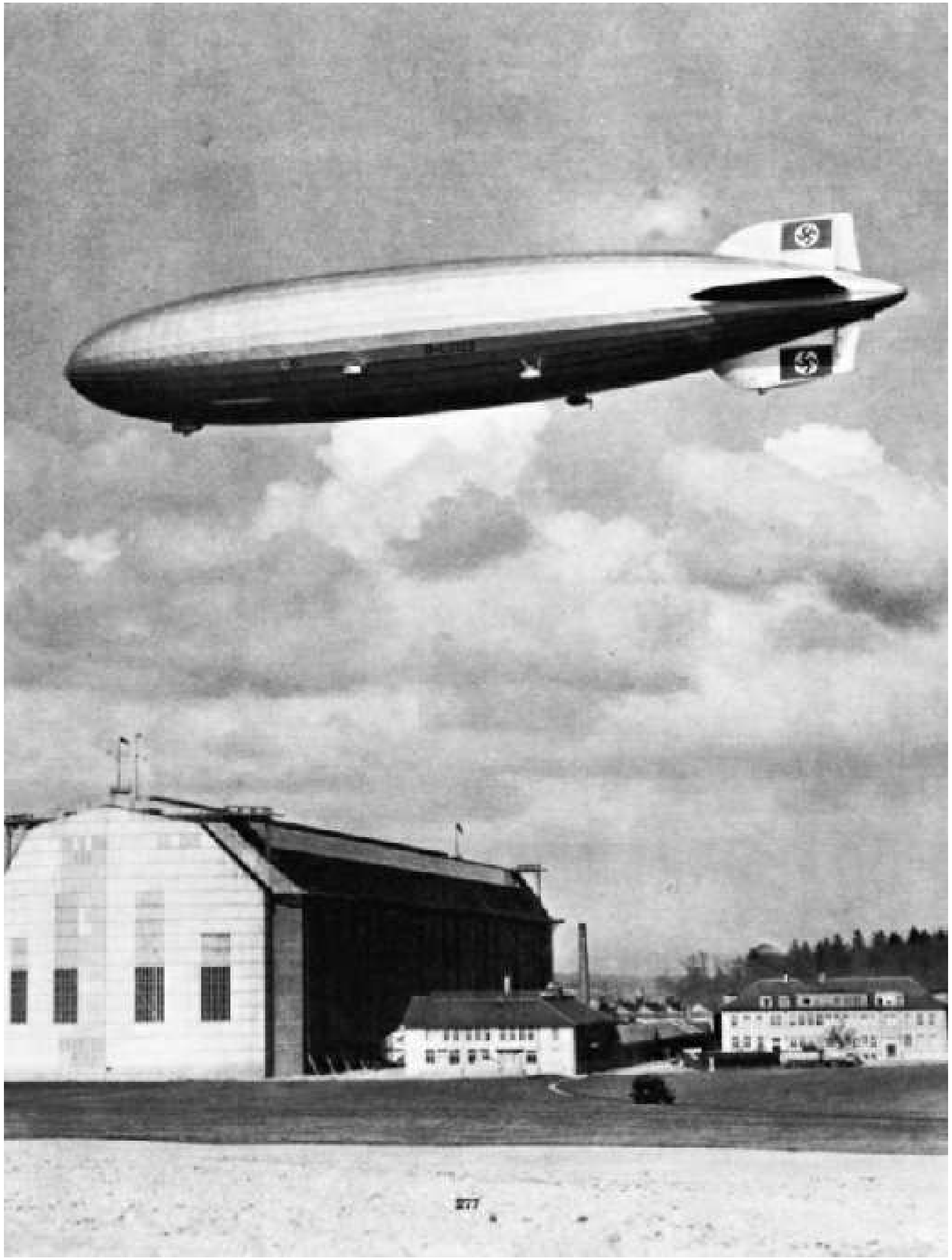
RE: although only about thirty-feet longer than the *Graf Zeppelin*, *Hindenburg* carried about twice the volume of lifting gas due to its larger diameter and "fatter" profile. Her thicker shape also provided greater resistance to bending stresses. The ability to build an airship with a much thicker profile was due to the construction of a new, larger shed at *Friedrichshafen* in 1929/30.

<u>Above</u>: the construction sheds at Friedrichshafen. The older Factory Shed II, whose height limited the dimensions of *Graf Zeppelin* (in photo) is on the left, and the new larger shed which allowed construction of *Hindenburg*, is on the right (highlighted). The height of the previous construction shed had limited the dimensions of Graf Zeppelin resulting in that airship's thin profile and the forward placement of her passenger gondola (to maximize use of the airship's diameter).

__Left__: **the steel skeleton of LZ-129 under construction in *Friedrichshafen*. The airship would later be named after the late Field Marshal *Paul von Hindenburg*, former president of *Germany***

__Right__: **finishing touches are applied to the *Luftschiff Hindenburg* in the huge construction hangar at Friedrichshafen. Workmen, dwarfed in comparison with the airship's huge tail surfaces, are chemically treating the fabric covering the huge hull.**



"…The completed airship LZ-129, named Hindenburg. Her overall length is 803 feet and her maximum diameter 135 feet. She has a maximum gas capacity of more than 7,000,000 cubic feet of hydrogen Her maximum width is 153 feet."

Wonders of World Engineering, April 1937

Buoyancy

"…This giant craft did not fly like a bird or an airplane. It floated in the air. The buoyancy came from 16 separate gas cells – tremendous bags that were shaped like gigantic pairs of pants. From below you saw only the floppy 'pants legs.' These gas cells pushed up against the 'ceiling' of the airship (a rope net kept cells from chafing against the hull)…those gas cells contained 7,000,000 cubic feet of hydrogen, the lightest gas known – and also the most powerfully explosive. U.S. airships used helium, not quite so buoyant but not at all inflammable. Germany had no helium. Already the black clouds of World War II loomed, and Americans were in no mood to supply a rare strategic material to a future enemy…"

Popular Science, **May 1962**

"…The material of the gas bags is cotton-lined goldbeaters' skin. The chief advantage of such a fabric lies in the fact that it remains gas-tight in the flabby, even crumpled condition that the gas bags so often must assume when they return to a low altitude after they have been inordinately expanded by a flight of 10,000 feet or more…"

***Popular Science Monthly*, March 1918**

"…Many visitors come with the impression that the gas cells are to be made from fabric lined with goldbeaters' skins, which are obtained from certain portions of a steer's intestinal tract. The fact that such skins are costly and difficult to use has led to the adoption of a specially prepared rubberized fabric, developed by the Goodyear-Zeppelin Corporation. The unprocessed fabric looks like a finely-woven cotton hankerchief, and is made from the highest grade of cotton obtainable. Similar but heavier cloth is employed for the outer fabric covering. But, instead of being coated with rubber to make it gastight, it is given four applications of a noncombustible lacquer. Two of these coats are clear, and the remaining two contain aluminum pigment to render the envelope heat-reflecting. This gives the airship a skin that is weatherproof, that is as strong as metal of equal thickness and weight, and that will not support combustion…"

***Popular Science,* February 1931**

RE: *USS Akron.* A new material was used for the construction of LZ-129's gas cells. Gas cells for previous German airships were made of "goldbeaters' skin" (the outer membrane of cattle intestines). The Hindenburg used a new material for the cells (similar to that used by the Americans for the Akron and Macon) which was made by brushing layers of gelatine onto a sheet of cotton. This gelatine film was sandwiched between 2 layers of cotton to create the fabric for the cells.

Goldbeaters' skin was made from part of a cow's intestine (the outer layer of the *caecum*) which is also called "blind-gut." The outer layers of the blind-gut were carefully stripped off into sheets of around 60 cm long by 25 cm wide. They were then cleaned of fat by dipping the gut in a mild alkaline solution and scraped with a blunt knife. The cleaned gut was then stretched over a frame. Separate sheets could be joined together seamlessly when wet by carefully rubbing the overlap of the two sheets. Several layers could be made this way. Airship gasbags usually consisted of up to seven layers of skin. The living tissue in the sheet/s grew together making a hydrogen-proof joint. As well as being impermeable to hydrogen, it was also light and very strong, making it the perfect gasbag material. However, it was very labor intensive and time consuming to produce. Supply of goldbeaters' skin ran out during WWI forcing the *Zeppelin Company* to recycle the material from older airships as well as the use of an inferior artificial substitute for the construction of the gasbags. The poor quality of these wartime gasbags were considered responsible for the loss of many airships and their crews.

Left: empty goldbeaters' skin gas bags hanging from the frame in the hull of the airship *Bodensee* (ca. 1919)

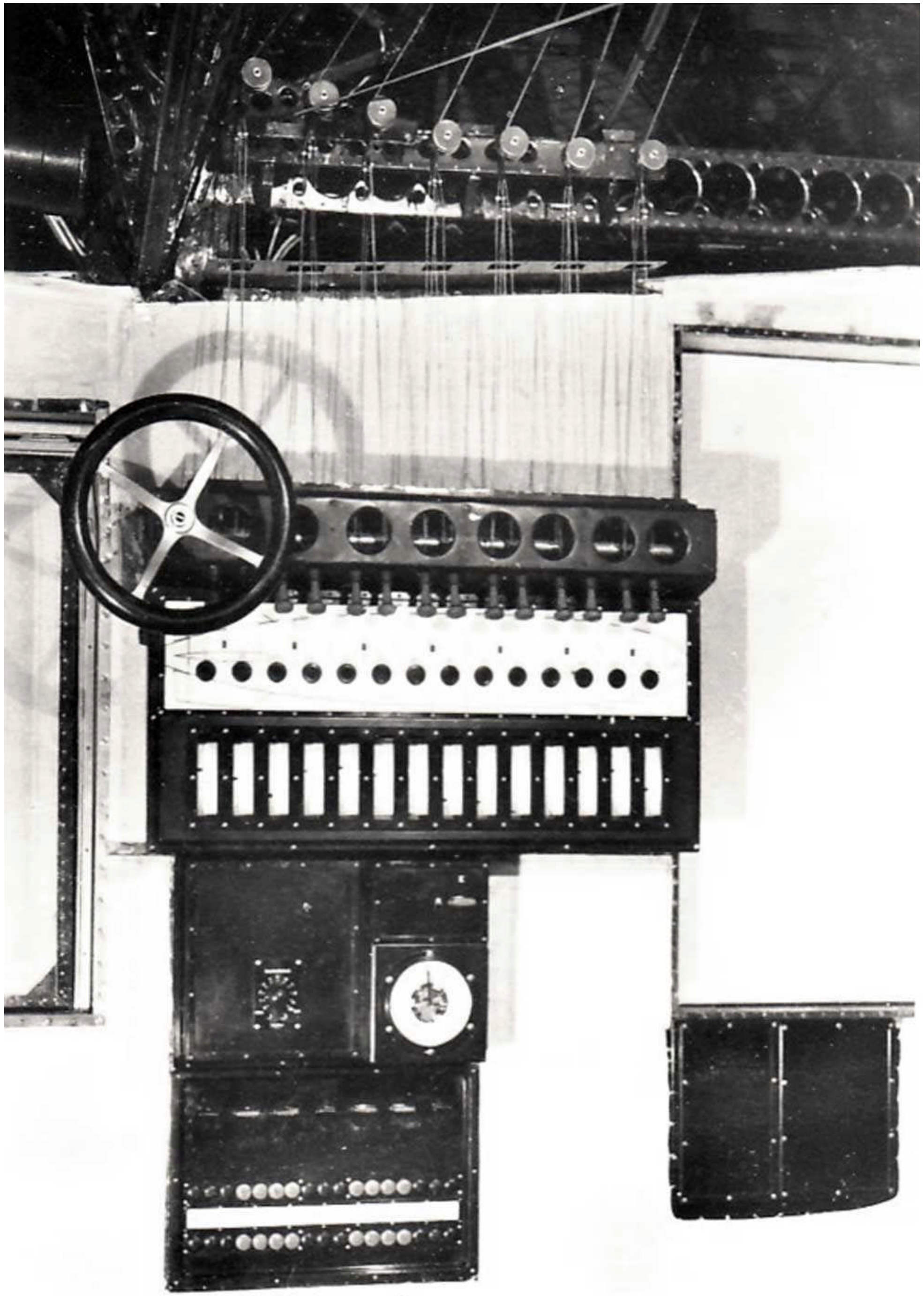
"…As I trod the narrow runway I clutched nervously at struts and girders, fearing that a misstep would plunge me through the thin fabric into the ocean half a mile below. 'You needn't be so concerned,' Lehmann said, noticing my expression. 'That fabric is strong enough to bear the weight of a man. You wouldn't go through if you slipped off on it.' He perceived my incredulous look. 'Here, I'll show you.' He jumped off the catwalk on to the fabric, only a fraction of an inch thick. It bore him easily, although it was not attached to the body structure anywhere within eight feet. He explained that the fabric was unbelievably strong, having been manufactured at great expense for this particular duty…"

Webb Miller, **Reporter - *United Press* (1936)**

“…Even an airplane pilot will see instruments that are new to him in the control room of an airship. One is a ‘gas pressure alarm.’ When an airship rises, the lifting gas in the cells expands because of the reduced atmospheric pressure. Automatic safety valves release it before the accumulated interior gas pressure would burst the cells. At the so called ‘pressure height’ where the safety valves are about to operate, the alarm rings a bell and lights a light in the control cabin. If the commander does not want to lose helium gas, he immediately check the ship’s ascent…”

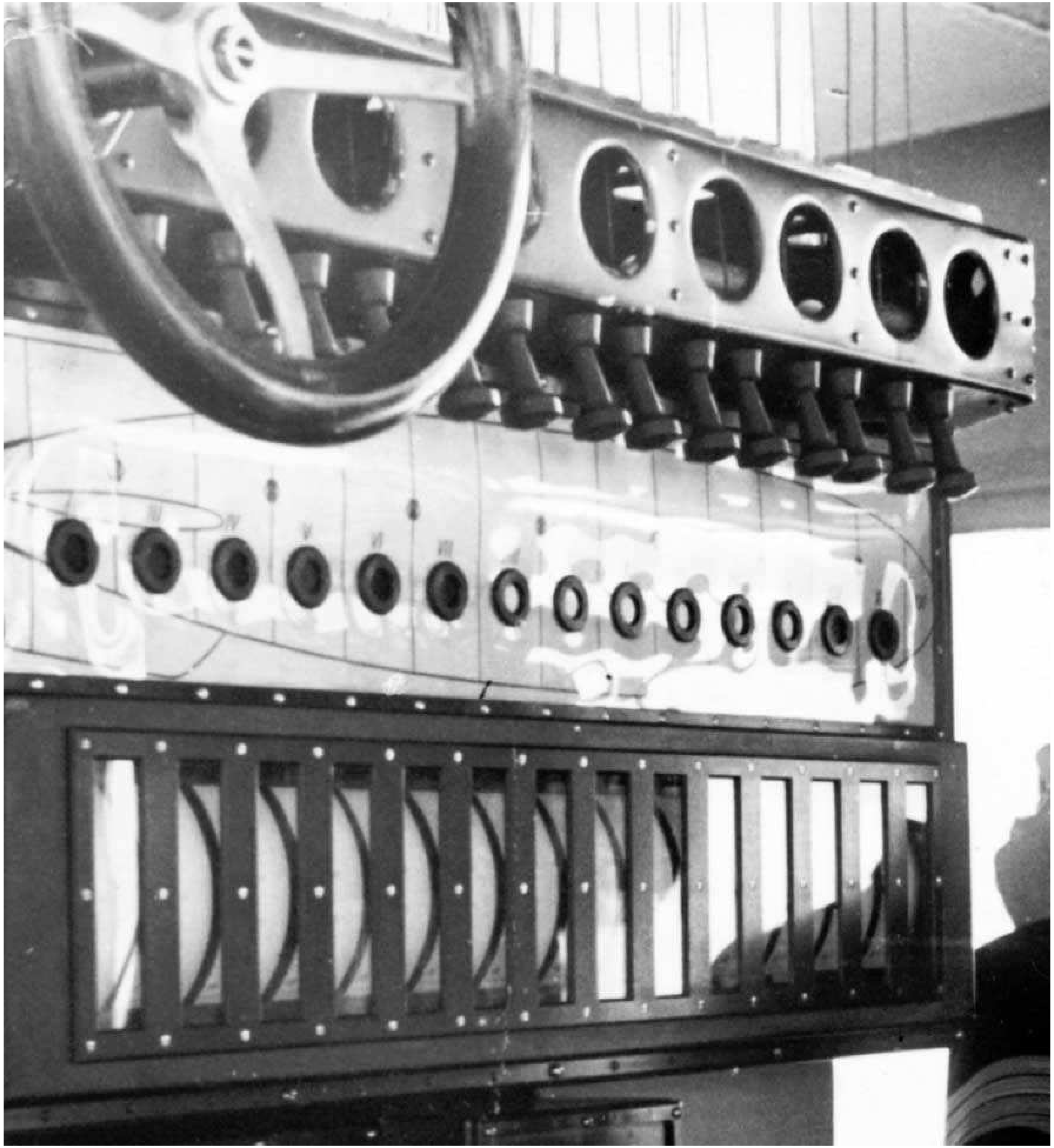
***Popular Science Monthly,* March 1930**

RE: *USS Los Angeles*



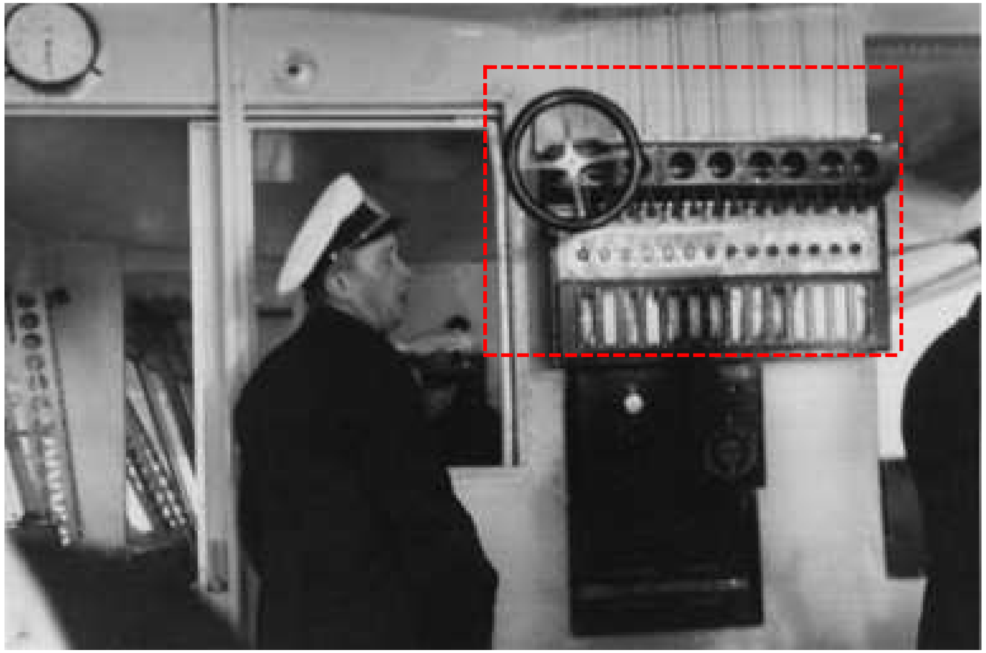
LZ-129's gas cells had fourteen manually-controlled maneuvering valves (located just above the axial walkway) which could be operated from the main gas board in the control car. Toggles controlled the airships fourteen maneuvering valves and could be used to release gas from individual cells. LZ-129 had sixteen gas cells, but the two cells at the stern of the ship; Cells 1 and 2, were interconnected and shared one maneuvering valve as did the two cells at the bow; Cells 15 and 16. A large wheel could also be turned, valving eleven of the large cells simultaneously (Cells 3 thru 11, 13 and 14) Electric meters measured the fullness of each cell and could be monitored in the control car. LZ-129 was also equipped with fourteen automatic valves which released gas whenever cell pressure became too high (to avoid damage to the cells themselves or to the framework of the ship).

Left: LZ-129's control car gas board, where hydrogen was monitored and valved



To indicate the inflation of the gas cells, the board had a diagram of the airship's cells, each containing a red light which was illuminated when the cell (or pair of cells) was at 100% capacity. Beneath the diagram were indicators showing the pressure within each cell.

<u>Left</u>: LZ-129's gas board



LZ-129 was originally designed for helium which was both difficult to obtain and too expensive to be vented (to compensate for the weight of fuel burned during flight to maintain static equilibrium). To avoid the need to valve helium, several innovative solutions were proposed. One involved a set of inner hydrogen gas cells to be installed at the center of fourteen of the ship's sixteen helium cells. The flammable hydrogen would be protected inside the larger cell containing inert helium. When it was necessary to valve lifting gas hydrogen, rather than helium, would be released. When it became obvious that helium would not be made available by the American government requiring the airship to be inflated with hydrogen, the inner cell concept was abandoned. LZ-129 did however retain the axial catwalk at the center of the ship that was installed to provide access to the valves for these inner cells. A second proposed innovation involved a water recovery system which would have used silica gel to capture water from engine exhaust thus obtaining water ballast to partly compensate for the fuel burned by the engines. This system was also abandoned.

Above: gas board used to valve hydrogen to keep the airship in trim

"…The Hindenburg's designers understood the danger. Chimney-like Gasschachte (shafts) vented any seeping hydrogen to the outside of the hull. You caught sight of riggers, wearing buttonless asbestos suits and felt-soled shoes to avoid any chance of static sparks, inspecting those shafts. They also checked the gas cells – they walked right through them through the 'Mittellaufgang' – the hull-bracing axial catwalk that pierced the cells by way of little canvas tunnels…"

***Popular Science,* May 1962**

RE: maintaining a high level of purity (avoiding contamination of hydrogen by air) was an important safety feature in dealing with the flammable gas. Pure hydrogen is practically incombustible, but hydrogen mixed with air is highly combustible thus the purity of the gas was closely monitored.

"…An airship flying at night carries running lights just as an ocean liner does – but double the number. That is so that other aircraft can see her and tell her heading. The wisdom of this was demonstrated one moonlit night when the 'Los Angeles' was flying between Philadelphia and Trenton, N.J. Out of the darkness a mail plane came roaring directly at the ship. None too soon the pilot spotted the lights and swerved out of the way. In a collision an airplane would no doubt suffer more than an airship. At most such a crash might puncture the envelope and rupture a gas cell or two, but there would be plenty of reserve buoyancy to make it to port. The reason an airship is hard to force down is that the lifting gas is carried in separate cells inside the outer envelope, just as a steamer is built with water-tight compartments…"

Popular Science Monthly, **March 1930**

<u>Above</u>: LZ-129 (left) mooring mast (center) and *Frankfort* Hangar (right)

Superheat

"…In the daytime, the sun's radiant heat raises the temperature of the gas in the cells above that of the surrounding air, and increase its lift – despite the fabric of the gas cells, a foot of air space, and the envelope with its reflecting layer of two coats of aluminum 'dope,' or paint. We call this temperature difference 'Superheat.' It is important for a dirigible commander to know it, so that he can avoid valving off gas to hold the ship down when the setting sun will soon make it heavy again – or dropping ballast, during the night, when the ship will tend to rise of its own accord in the morning. He reads this important temperature difference from a 'superheat meter' that the United States Bureau of Standards helped the navy to perfect. At the touch of a switch it gives the 'superheat' directly in degrees, at either the forward or after end of the ship…"

***Popular Science Monthly*, March 1930**

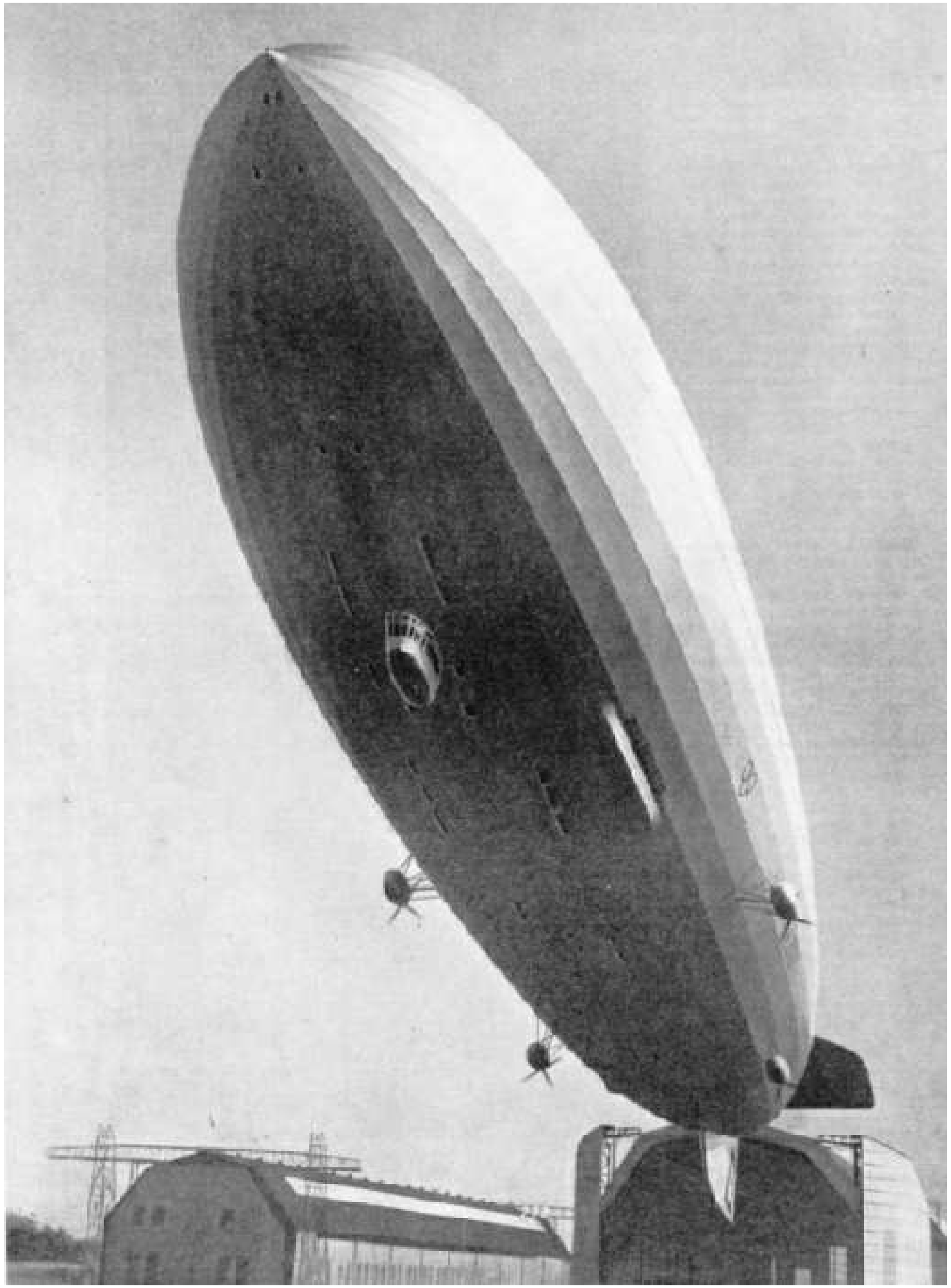
Static Equilibrium

"…dynamically to death; that is, to demand so much of her dynamically that in the event of a stoppage of the motors the static resources will not suffice to keep her airborne."

Hugo Eckener

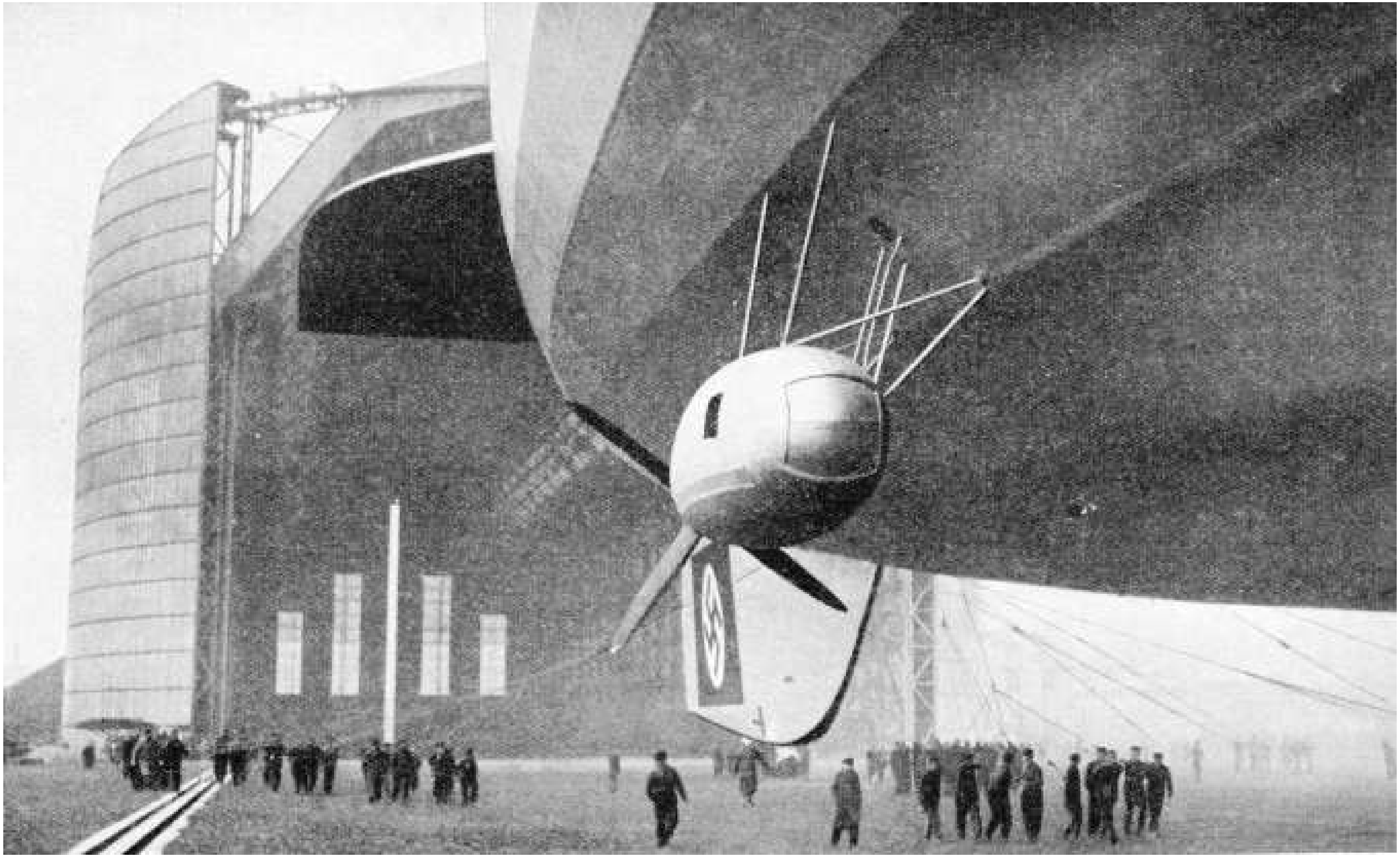
RE: LZ-129 would typically begin a transatlantic flight with its full capacity of slightly more than seven million cubic feet of hydrogen, landing with between five and six million cubic-feet of gas remaining in its multiple gas cells. The ship's officers kept the airship from flying more than three degrees heavy or two degrees light and the ship was generally flown within a half degree of static equilibrium. Valving (releasing) hydrogen gas from the cells during flight was an important part of this process. The ship's officers paid considerable attention to keeping the ship in equilibrium to avoid the need for steep angles of pitch which would disturb the passengers, decrease speed, increase fuel consumption and/or strain the airship. Having a level ship with full elevator control in both directions also made it safer to fly at lower altitudes. Since LZ-129 typically flew only a few hundred feet above the earth's surface (to stay under clouds and observe weather conditions in the ship's path) it was considered especially important to keep the ship in static equilibrium. Eckener had long warned airshipmen of the danger of driving a ship "dynamically to death." Since an airship becomes lighter as it burns fuel during flight, in order to maintain static equilibrium it was necessary either to generate additional ballast or to release lifting gas. LZ-129's engines were not equipped with water-recovery equipment (to create water from engine exhaust), and the airship's system of rain gutters did not provide a reliable supply of ballast. Without a dependable source of additional ballast, gas was valved freely to maintain equilibrium and the ship routinely valved up to 1.5 million cubic feet of hydrogen during a *North Atlantic* crossing. Hindenburg's liberal valving of hydrogen to maintain level trim required the addition of about 20% fresh hydrogen every seven to ten days, which increased operational expenses, but had the benefit of maintaining the hydrogen at a high level of purity.

Motorgondel



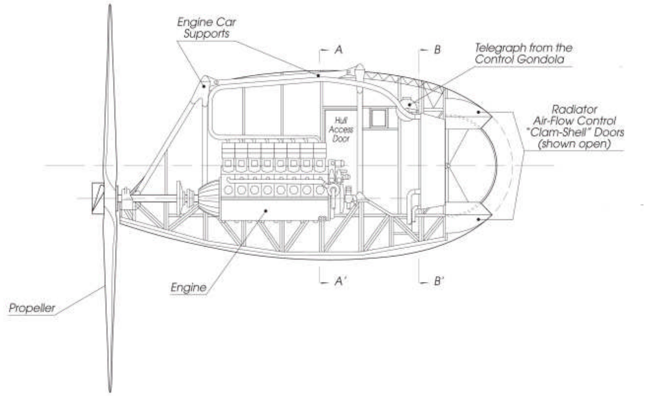
"…The four engine cars of the Hindenburg are suspended from the central section of her hull, as seen in this photograph of the airship leaving her hangar. Each car contains a Daimler-Benz diesel engine of about 900 horsepower. The four-bladed propellers have a diameter of 19 feet and are sheathed with brass on the front edges as a protection against the impact of rain…"

Wonders of World Engineering, **April 1937**



"…Braced and suspended from the lower part of the Hindenburg's hull, each engine car contains an electrically-heated oil tank. Fuel is stored in the keel frame. This photograph shows also the airship leaving her enormous hangar…" 492

***Wonders of World Engineering,* April 1937**

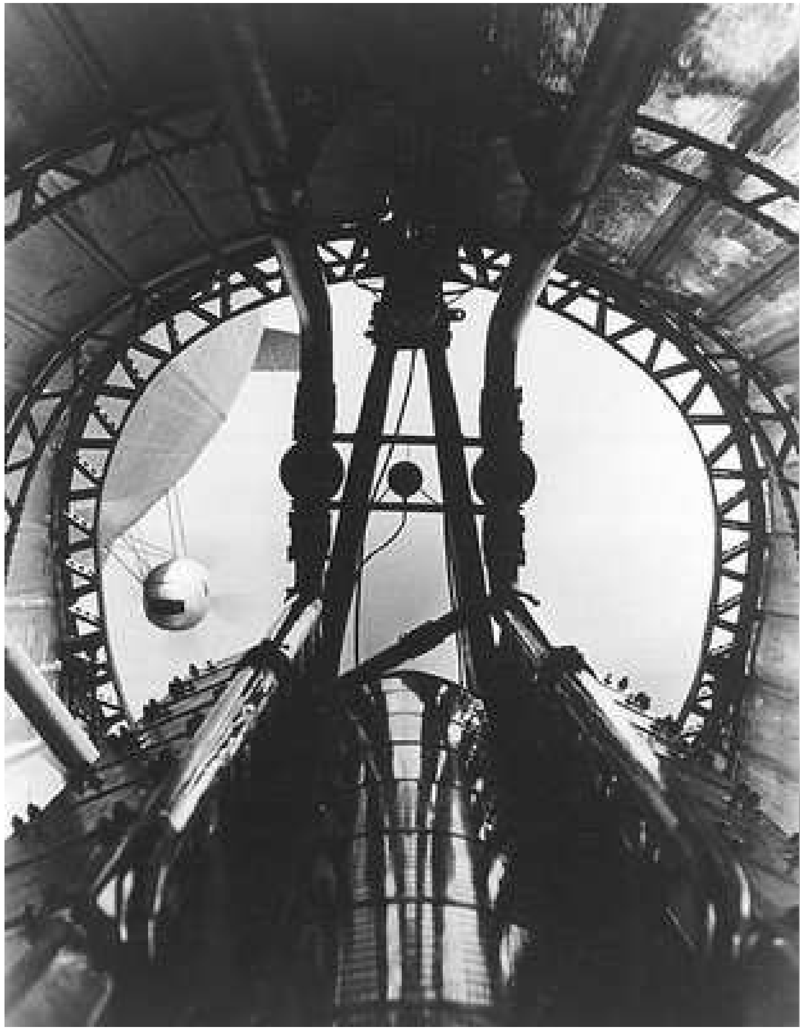


"…Each of the four engines – 1,100-hp Mercedes-Benz diesels driving 20-foot four-bladed wooden propellers – was carried with its operator in a Motorgondel, a little car hanging outside the hull, You climbed into it by a narrow ladder leading down from the lower catwalk. Inside, the roar was deafening – the telephone connection to the control room was useless, and instructions had to be signaled over an engine telegraph like those in steamships. The Hindenburg could make 84 knots top, and cruise at 77 knots – not too far behind commercial airplanes of the day. She also had something no airplane ever has – a spare engine stowed in a freight compartment…"

Popular Science, **May 1962**

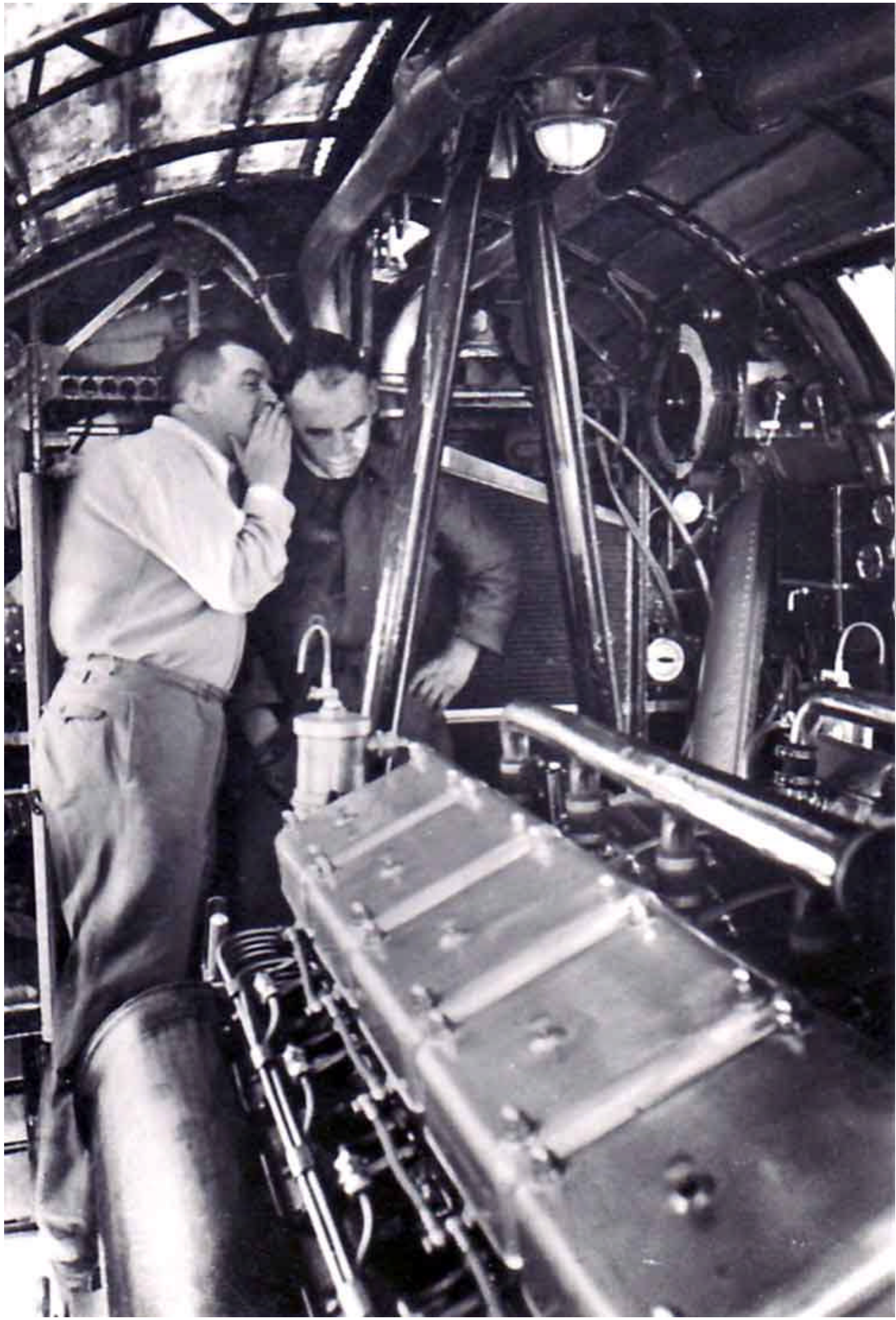
Above: cross-section of one of LZ-129's engine cars

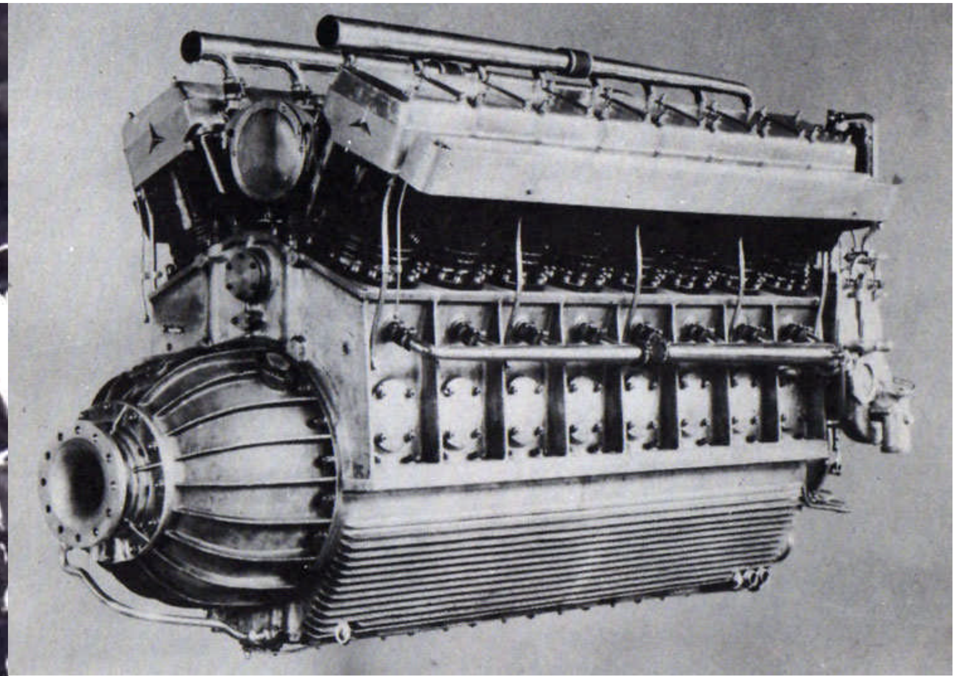
Left: looking aft through propeller




"…With Fritz Sturm, chief engineer, I visited one of the engine gondolas, suspended on struts fifteen feet in space outside the envelope of the craft. That was an experience I do not want to repeat, and when I asked Lehmann's permission I did not know what it entailed. To reach the gondola I climbed out over empty space on a collapsible ladder a foot wide slanting down from an opening in the envelope into the egg-shaped gondola. Before starting Sturm tied a helmet to my head, told me to leave my overcoat behind, and then showed me how to clutch the frail ladder on two sides, crooking my elbow around it to the windward and clutching the other edge with my fingers. This precaution was necessary to prevent the eighty-miles-an-hour wind from tearing me bodily off the ladder. I found it a ticklish, frightening business; each time I raised a foot the wind wrenched it away from the ladder rung and flung it back toward the stern of the ship. Nothing in the world could save you if the hurricane-like wind tore you off the ladder. Nothing but yawning space spread out on either side, and the ocean lay half a mile below. After a few steps down the slanting ladder I wished I hadn't conceived the foolhardy idea of visiting the gondola. Inside the gondola a narrow passage ran alongside the 1,100-horse-power Diesel engine, which drove a huge nineteen-foot propeller that deafened me with its thunder in spite of my padded helmet. Only a few struts the size of an ankle fastened this power plant to the craft, which loomed gigantically beside us. Once inside the gondola, Sturm closed the collapsible ladder. Empty space surrounded us on every side; we felt as if we were being shot through the air inside a huge artillery shell with open windows. An engineer remained continually on duty inside each of the four gondolas, shifts being changed every few hours…"

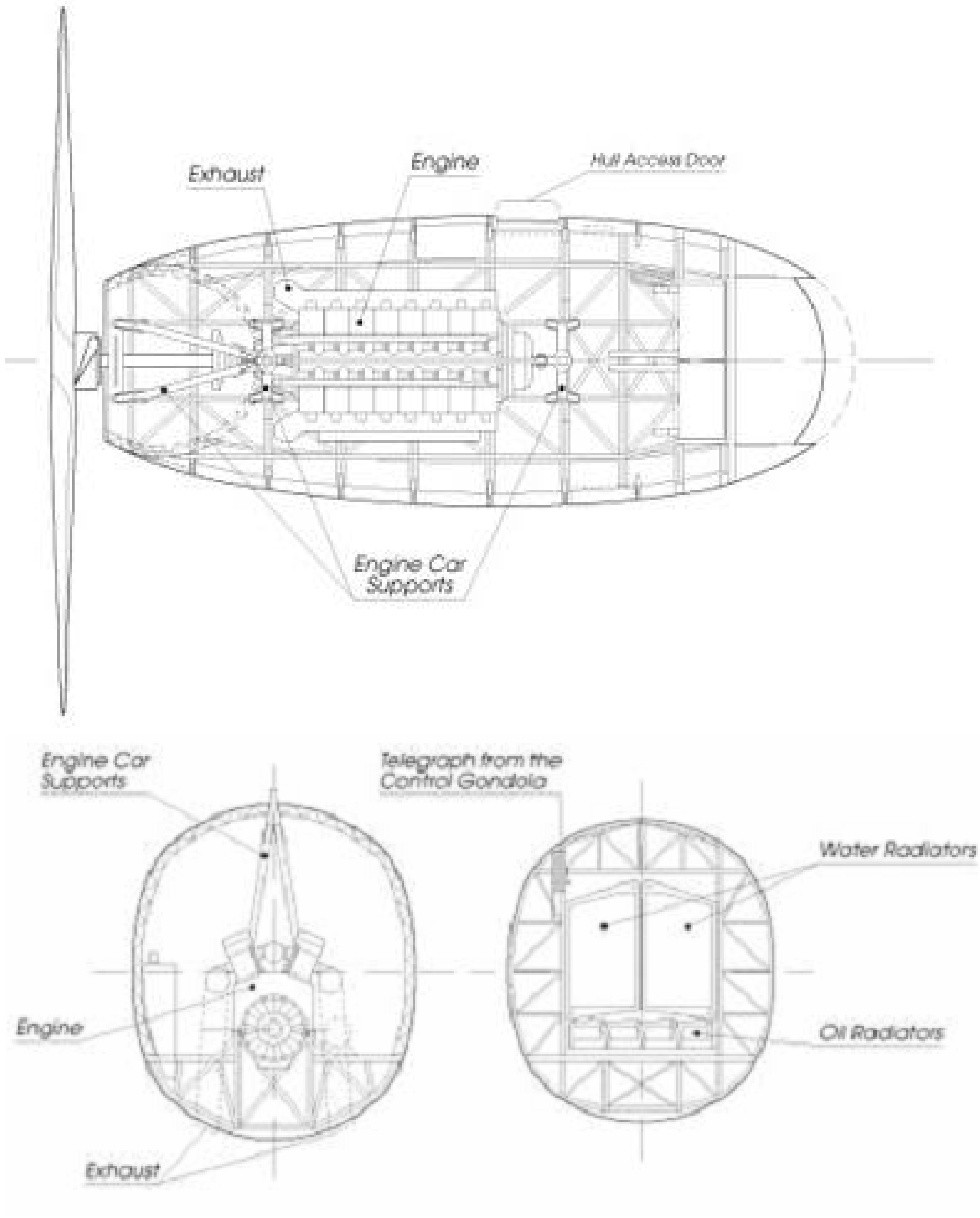
***Webb Miller,* Reporter - *United Press* (1936)**





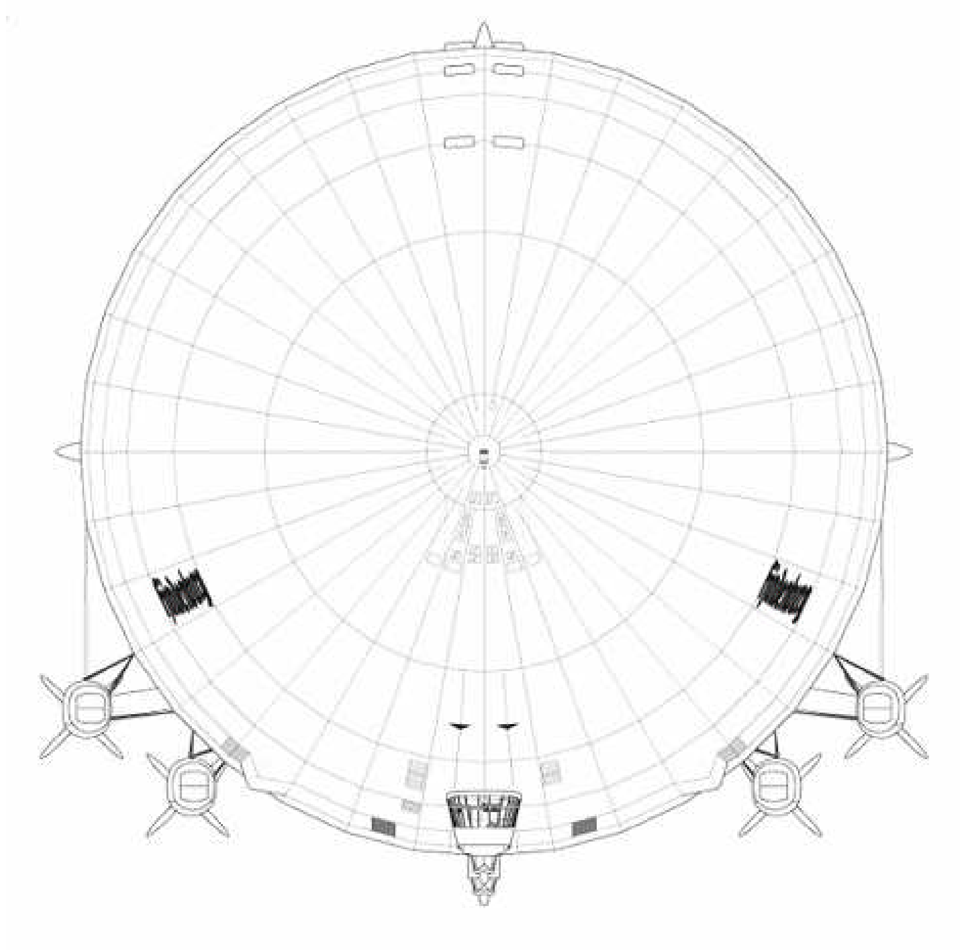
LZ-129's *Daimler-Benz* engines were based on the MB-502 engine designed for German navy E-boats (high-speed motor-torpedo boats). Each of her four LOF-6 (DB-602) 16-cylinder engines had an output of 1320 HP at 1650 rpm (maximum power) and 900 HP at 1480 rpm. The normal cruise setting was 1350 rpm, generating approximately 850 HP. The engines were started with compressed-air and could be started, stopped and reversed in flight.

Above: DB-602 16-cylinder airship engine
Left: interior of LZ-129's engine car

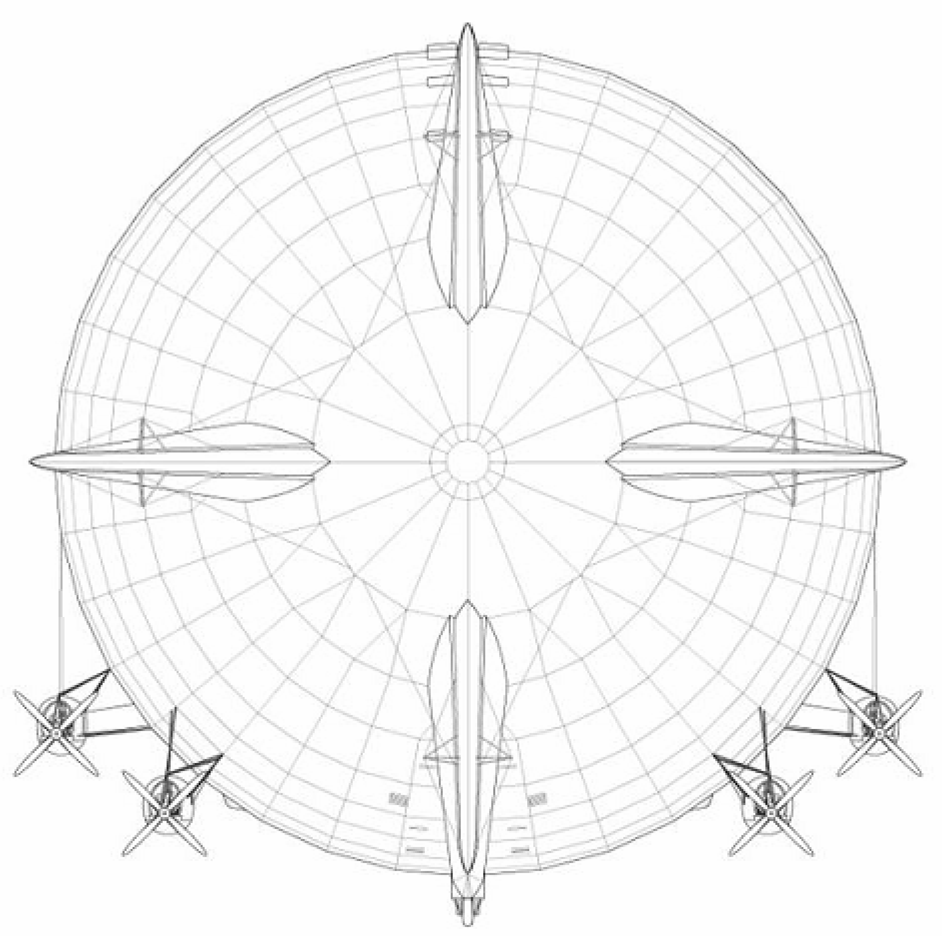


Using 2:1 reduction gearing, each engine drove a four-bladed, fixed-pitch, 19.7-foot diameter metal-sheathed wooden propeller (created from two, two-bladed propellers fused together). The engines were mounted in four engine cars; two at Ring 92 and two at Ring 140. To protect the ships fabric covering, the engines were angled slightly away from the hull so that the their propeller wash would not directly strike the ship's covering. The rear engine cars were mounted lower on the hull so that the propellers of the rear cars would operate in clean, undisturbed air. A mechanic was stationed in each engine car at all times to monitor the engine and carry out orders transmitted from the control car via telegraph. Consideration was also given to installing engines which could burn hydrogen, but tests indicated that such engines had a much more limited power output (approx. 300 HP). Plans were drawn up to add a fifth engine gondola to compensate for the lower power output of hydrogen-burning engines, but these plans were never realized. It was an attempt to make use of the waste hydrogen used to maintain static equilibrium during flight thereby increasing engine efficiency.

Left T&B: cross-section/s thru engine car



Front Elevation

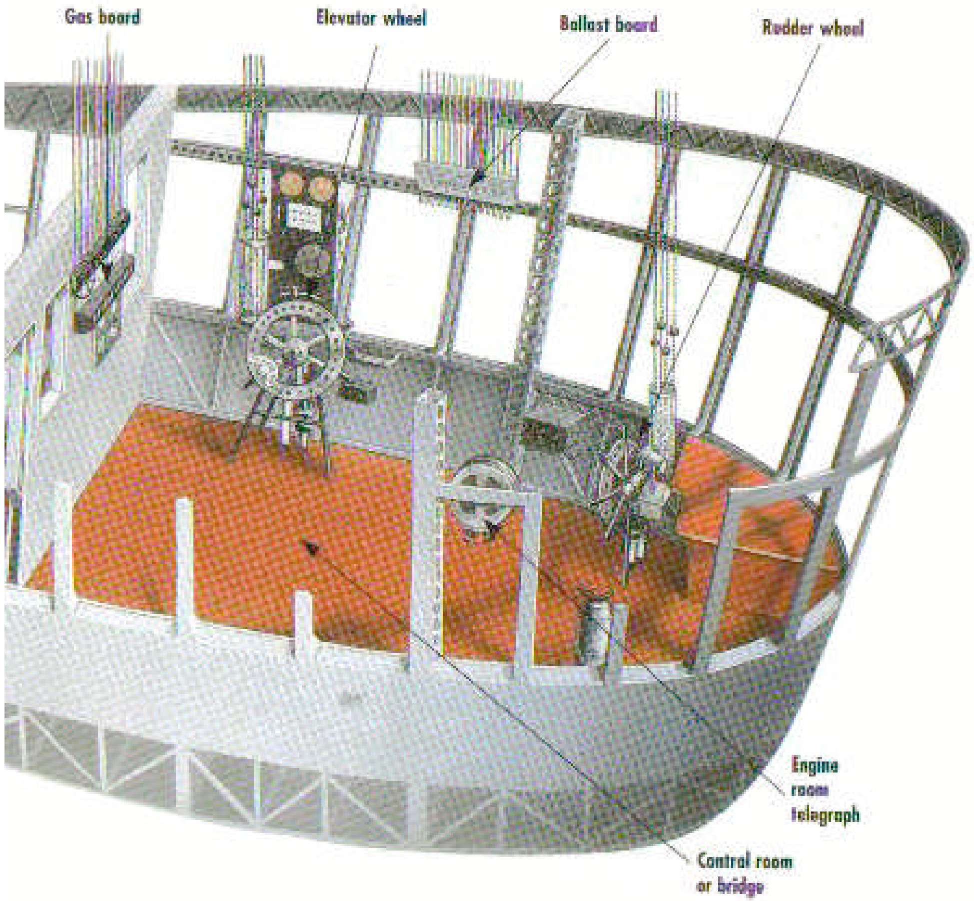


Rear Elevation

LZ-129's four engines were operated at a cruise setting of 1350 rpm during passenger operations, giving the airship an airspeed of approximately 67 knots or 76 mph. This setting was rarely adjusted during a normal passenger flight. Her normal cruise setting produced 820 HP and consumed 130 kg/hr of diesel fuel. If necessary, the engines could be operated up to 1520 rpm for full power which produced 1050 HP consuming 180 kg/hr of fuel.

Left: advertisement featuring the use of "Veedol" oil in German Zeppelin airships. The *Tide Water Oil Company* made the Veedol lubricating oil used by both the *Graf Zeppelin* and *Hindenburg* engines.

Fuhrergondel

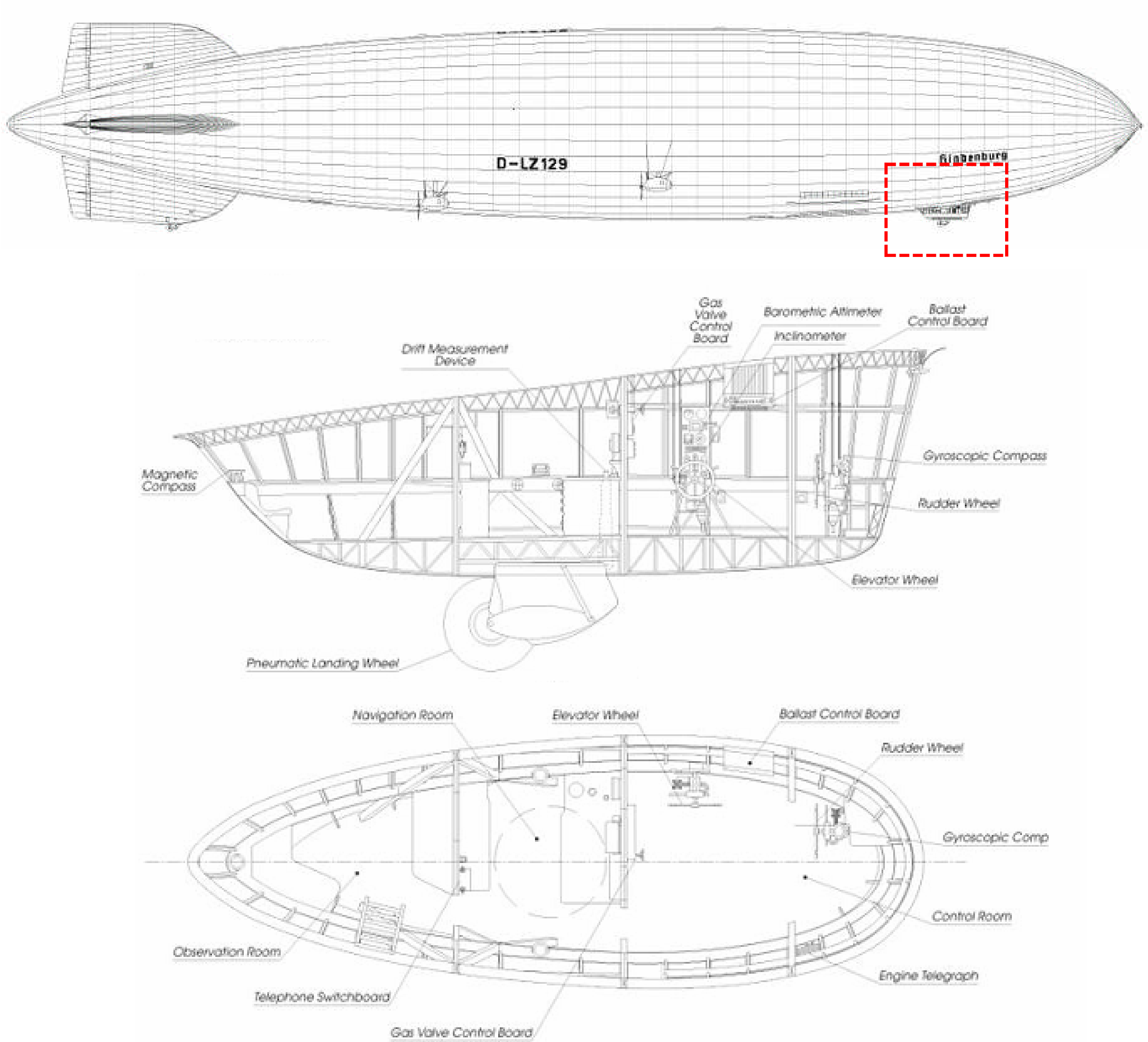


"…Walking aft past the officer's quarters, you came to the 'Fuhrergondel,' the control car. Window-walled, roomy, and impressive, it resembled the bridge of a ship. Right away, you noticed that it took two men to steer a Zeppelin. The rudderman, facing forward, kept her on course with his giant wheel. The elevatorman faced sideways, watching an inclinometer and altimeter to keep her at the charted altitude…"

Popular Science, **May 1962**

<u>Above</u>: cut-away view of LZ-129's "Fuhrergondel" (control car)

"…The pilot's cabin of the Hindenburg projects beneath the hull of the airship and is thirty feet long, with a maximum width of eight feet in the centre. The cabin contains the wheelhouse, the map and navigation room, and the direction-finding room…"
Wonders of World Engineering, **April 1937**



<u>Above</u>: full side elevation (top), control gondola longitudinal section (middle) and control gondola plan (bottom)

"…Lehmann took me down into the control cabin, suspended under the belly of the ship, whence the Zeppelin was navigated. From there we viewed a marvelous panorama of ocean in every direction, with the immense bulk of the Hindenburg above and behind us. Dials, gauges, meteorological and navigating instruments filled the cabin. He showed me the operation of devices which valved out gas or water ballast to lower or raise the ship, a duplicate steering apparatus, and signal telegraph and telephone to every vital part of the ship. He explained the weather charts, which were revised every few hours on the basis of wireless reports from ships at sea…"

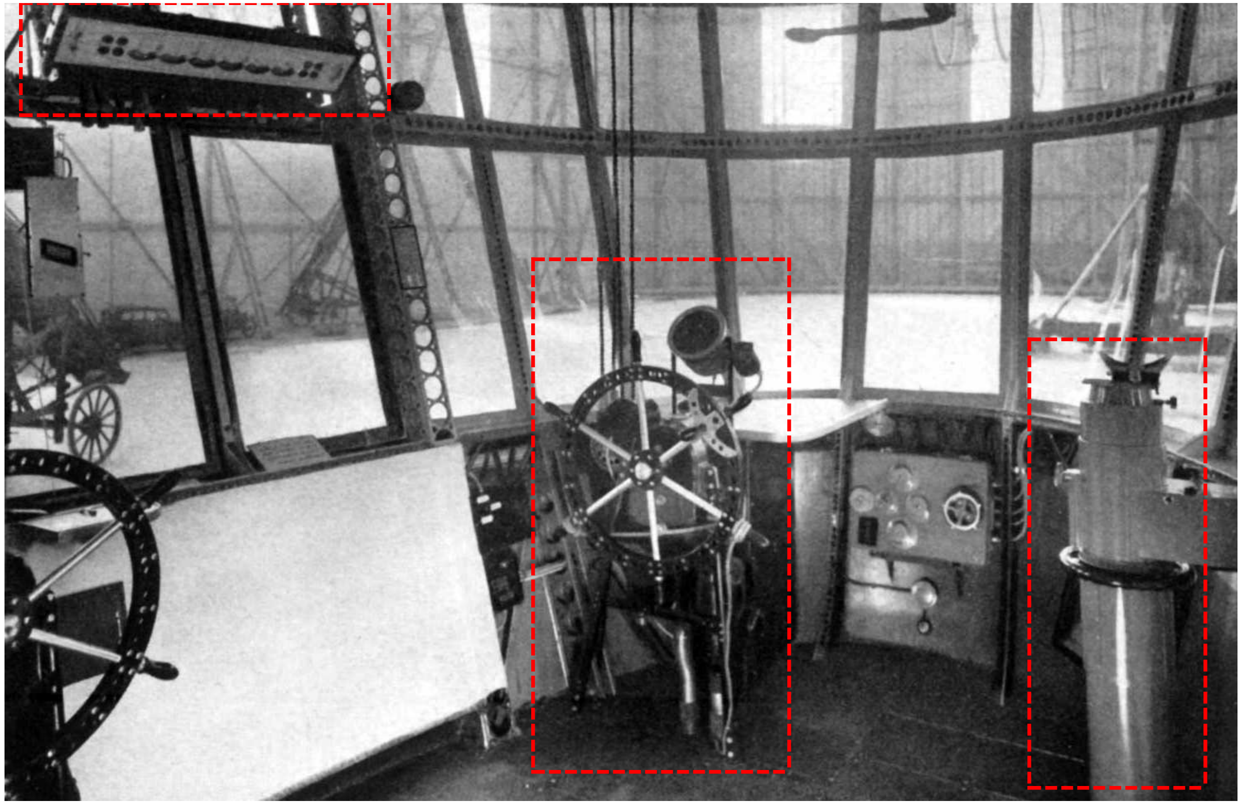
Webb Miller, **Reporter** ***- United Press*** **(1936)**

LZ-129's main flight controls were the rudder and elevator wheels for controlling heading and pitch, the gas board for valving hydrogen and the ballast board for releasing water ballast. Orders regarding engine speed and direction were transmitted to the engineering room along the keel and to the four power cars from an engine telegraph located at the starboard side of the control car. The telegraph had toggles to alert mechanics in each of the four engine cars and the engineer's room of changes in power settings and could transmit orders for four forward speeds; idle, slow, half and cruise, two reverse speeds; idle, full and stop. Adjacent to the engine telegraph was a tachometer, an altimeter and a variometer (vertical speed indicator). There was also a speaking tube to communicate with riggers along the axial catwalk. Communication throughout the ship was normally by telephone, but to avoid the risk of sparks, no electrical equipment was placed along the axial catwalk.

<u>Left</u>: LZ-129's control car
<u>Right</u>: control room forward view (in flight)

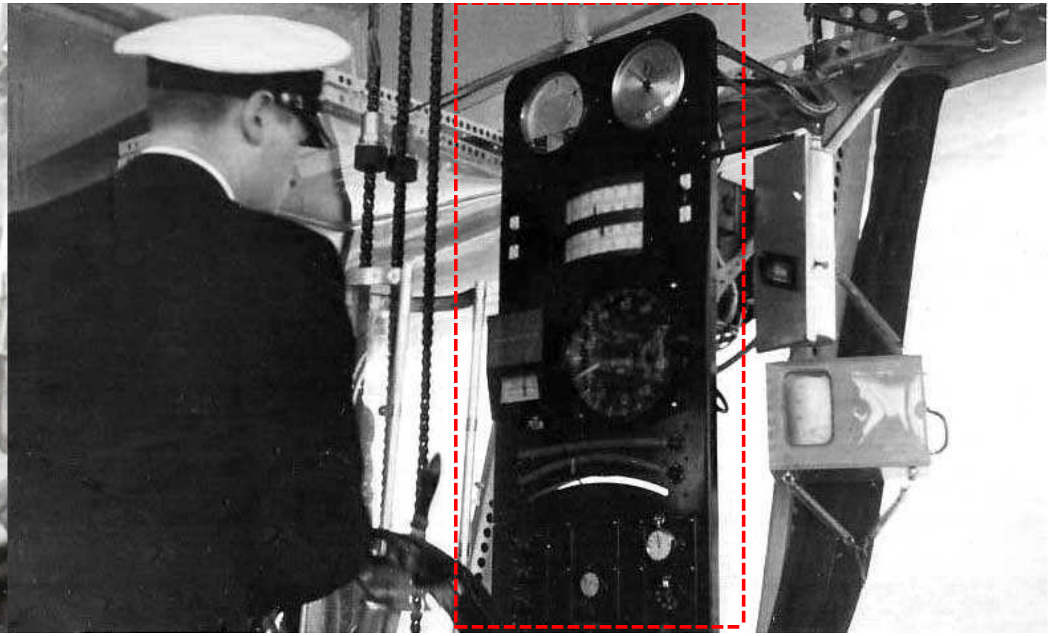
"…Once in the air, the ship ascends under power by pointing the nose upward, but can climb also by dropping water ballast. She comes down by either flying down or by valving of helium gas. Toggles in rows, small handles shaped like telephone receivers, line the side of the control cabin and govern the release of ballast and of gas. By pulling one of the handles and counting seconds, we estimate just how many pounds of water have been dropped from one of the ballast bags, or by how many pounds the lifting force of one of the gas cells has been decreased…"

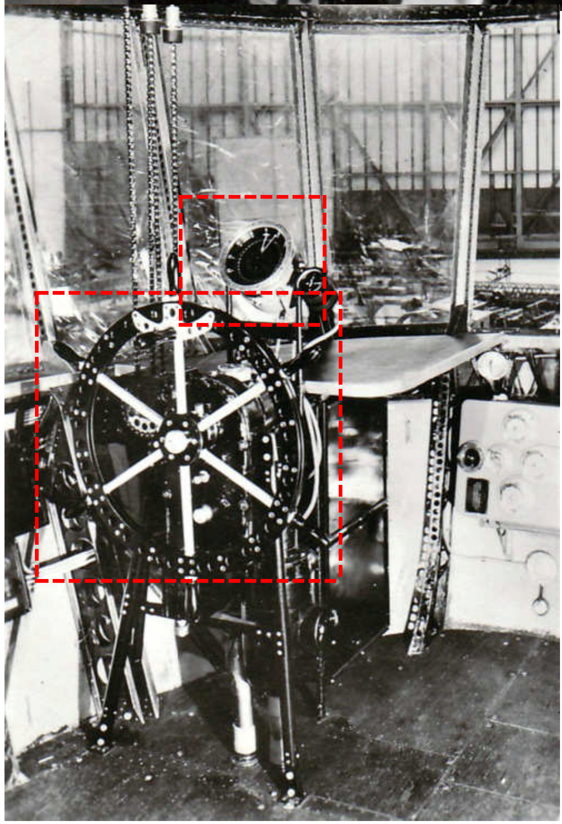
Lieut. Cmndr. C.E. Rosendahl, USS Los Angeles



The ballast board (highlighted), located just to the right of the elevator panel, allowed LZ-129's officers to reduce the static weight of the ship by using toggles to release water ballast. The ballast board indicated how much water was present in each of the airship's seven main 4,400 pound ballast tank/s and had red and green indicators for the eight 1,100 pound emergency ballast bag/s (four located at Ring 47 toward the tail and four located at Ring 218 toward the bow). The ballast board also had weigh-off indicators for the bow or stern, indicating up to 4,400 pounds heavy or light.

<u>Above</u>: control room forward view. At far left is ballast board, then rudder station (with gyro compass repeater). To the right is the eyepiece of a drift measuring telescope





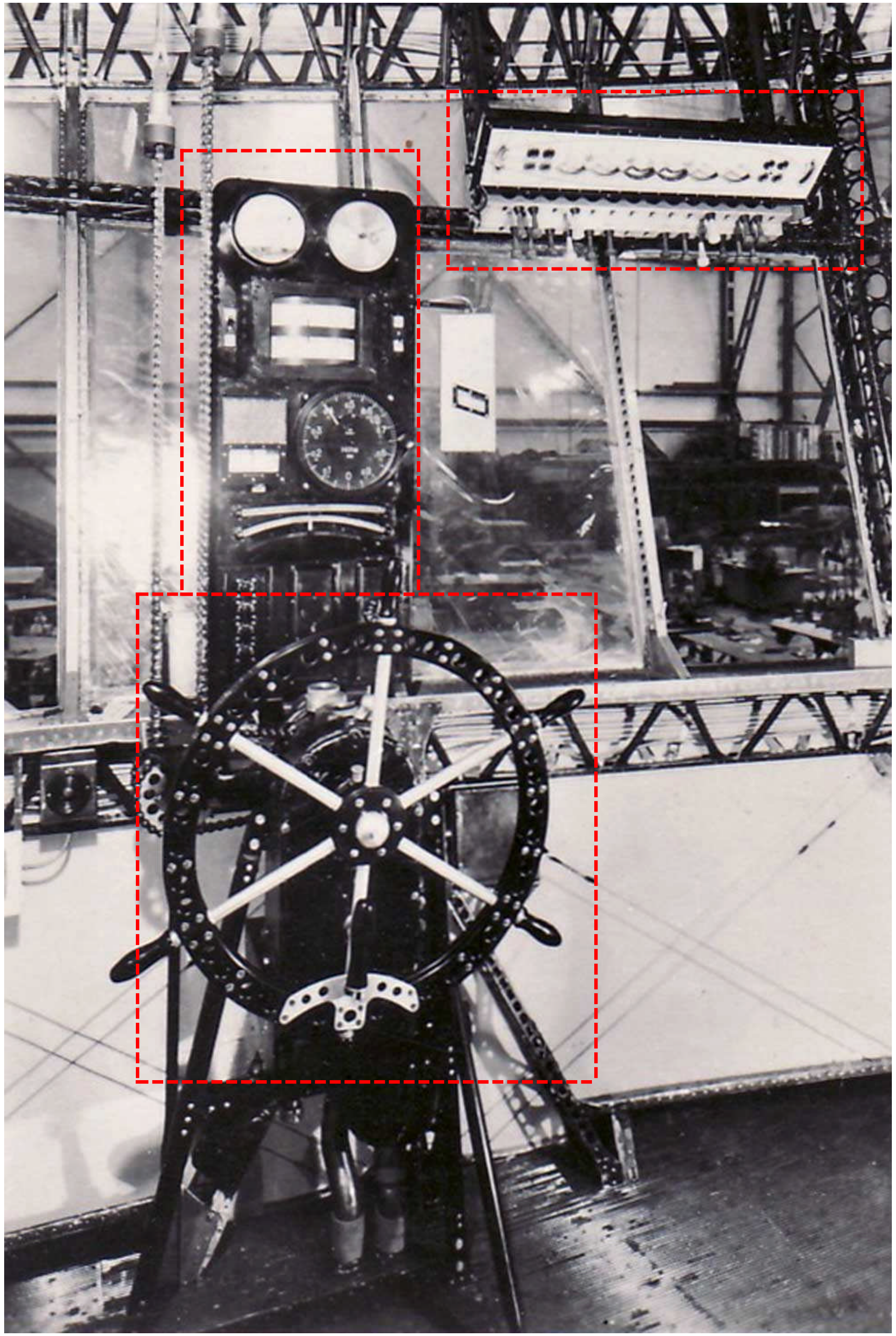
LZ-129's heading was controlled by its rudders which were manipulated by the helmsman (a.k.a. "rudderman") whose primary job was to keep the ship on its assigned heading. The airship's pitch was controlled by the elevators which were manipulated by the elevatorman whose primary job was to keep the airship as level (a.k.a. "trim") as possible. The rudderman stood at the front of the control room facing forward and steered by reference to a repeater compass ("daughter compass," as it was referred to by the Germans) mounted in front of the wheel which was controlled by the master gyroscopic compass located in the airship's electrical room. The rudder station also had a magnetic compass and pointers indicating the angle of deflection of the upper and/or lower rudders.

Top Left: "rudderman" at right, "elevatorman" at left
Top Right: elevator panel
Left: rudder wheel and gyro compass repeater

"During the flight over Washington, Captain Lehmann was asked by a passenger to change course to pass over a spot which was close aboard. In response to Captain Lehmann's orders to the steerman, full rudder angle was applied with maximum possible speed with no apparent questions by any of the officers in the control car. The air at the time was very rough….My impression from that observation is that the ship was turned in the rough air typical of a summer afternoon overland, as sharply as a turn could be made and that the maneuver which appeared to me to be undesirably rough use of the controls was taken as a matter of course by the several Hindenburg officers in the control car."

***Lt. Cdr. Francis Reichelderfer*, *U.S. Navy* observer aboard LZ-129 – August 1936**

RE: there were no specific procedures limiting the rate or angle of rudder and elevator deflection. There was, however, a general understanding among the crew that full rudder and elevator inputs should be used judiciously, especially in rough air. Despite this, the controls were sometimes put hard over as rapidly as the wheels could be spun. Sharp turns were occasionally made without significant concern for possible strain on the ship and rudder angles up to and exceeding fifteen-degrees were observed.

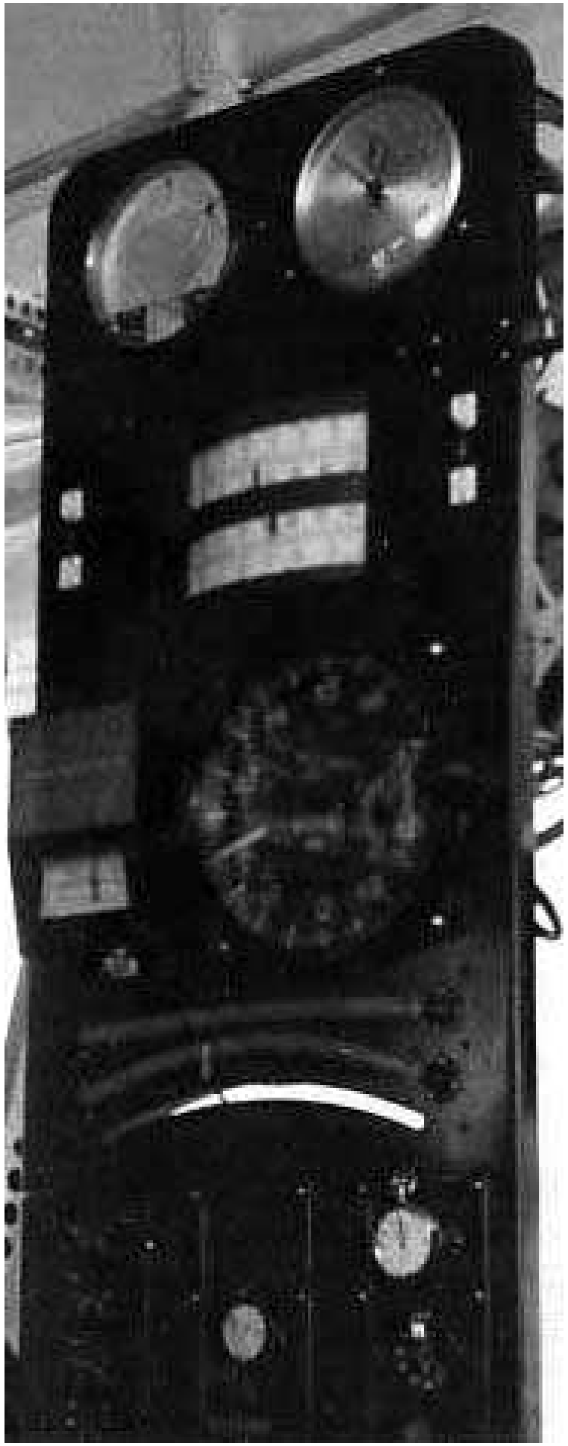


The rudder wheel was considered an easier position to master than the elevator wheel thus airshipmen began their training on the helm and only advanced to the elevators after gaining sufficient experience on the rudders. Pitch was controlled by the airship's elevators. Operating the elevators was much more challenging than operating the rudders and the position was assigned only to the more experienced crew members. The elevatorman stood sideways (facing port) with the elevator wheel and control panel in front of him. While he could watch the horizon from the side windows of the control car, the elevatorman was expected to control the elevators primarily by reference to the instruments on the panel in front of him, combined with a feel of the ship that could only be acquired through experience.

Left: elevator wheel, elevator panel and ballast board

Chasing the Bubble

The elevatorman (left) was also expected to keep the ship at its assigned altitude whenever possible, but a much higher priority was placed on maintaining level trim rather than holding a fixed altitude. Pitch angles exceeding five-degrees were considered to cause discomfort to passengers (an angle of eight-degrees or more would cause cups and glasses to slide off tables), increased fuel consumption and placed a strain on the airship’s structure. Even if it meant deviation from the assigned altitude or required severe control inputs to counter the movement of the ship, elevatormen were expected to keep the ship as level as possible at all times. The elevatorman maneuvered his wheel partly by feel, but primarily by reference to the instruments on the elevator panel which included pointers to indicate elevator deflection and inclinometers to indicate the airship’s pitch. Each inclinometer was a curved glass tube containing a bubble which moved with changes in pitch, The elevatorman was expected to “chase the bubble” - spin the elevator wheel so his reference pointers chased the bubble in the inclinometer to keep the airship level. The elevatorman also maintained a continuous scan on the other instruments on his panel which displayed information about factors which influenced the ship’s pitch and altitude.



The elevator panel contained various instruments to keep the elevatorman constantly aware of the position of the elevators, the pitch of the ship and the factors which could influence pitch and altitude. The panel's equipment included:

- ***Pointers* indicating the angle of deflection of the port and starboard elevators and both elevators together (graduated up to twenty-degrees deflection);**
- **Two *Inclinometers* (curved tubes similar to a spirit level), one with a rough scale showing plus or minus twenty-degrees of pitch and the other with a fine scale showing plus or minus five-degrees of pitch;**
- ***Thermometers* indicating ambient air temperature and the temperature in gas cells five and thirteen;**
- ***Thermohygrometer* indicating air temperature, relative humidity and absolute humidity;**
- ***Statoscope* indicating changes in barometric pressure (and thus altitude);**
- ***Variometer* (vertical speed indicator) indicating the airship's rate of climb or descent;**
- ***Altimeter*;**
- ***Clock*;**
- ***Stop watch***

Left: close-up view of LZ-129's elevator panel

"On several occasions the elevatorman was seen to change elevator angle from fifteen degrees up to fifteen degrees down just as fast as he could spin the wheel. Flying under bumpy conditions required a great deal of physical exertion…After about twenty minutes on the elevator the operator became soaked with perspiration…In order to reach eighteen degrees up elevator angle to counteract a down inclination of the ship it seemed to take all the strength that the operator could apply…The maximum angle of inclination the ship assumed…was about five degrees up by the bow."

***Lt. M.F.D. Flaherty*, *U.S. Navy* observer aboard LZ-129 (1936)**

RE: very often the elevators were put hard over, when necessary, to keep the airship level. Erroneously, the airship's officers believed that steep angles of pitch placed more strain on the ship than the hard maneuvering sometimes required to avoid them. Applying sufficient elevator input to keep the airship in trim often required great physical effort.

Echolot

"…The up-and-down steersman had an unusual and valuable instrument: a crude forerunner of today's radar altimeter. It was a compressed-air whistle. By timing the 'beep-beep' echoes bounced back from the surface below, he could tell exactly how high he was. A precise measure of altitude was vital in dirigibles, for they cruised ridiculously low by airplane standards – usually the height above the surface was less than the ship's length. This was a hazard: A vagary of wind might slam the tail down to disaster (the Akron apparently crashed just that way). However, high altitudes were uneconomical: Too much gas had to be expelled to come down again…"

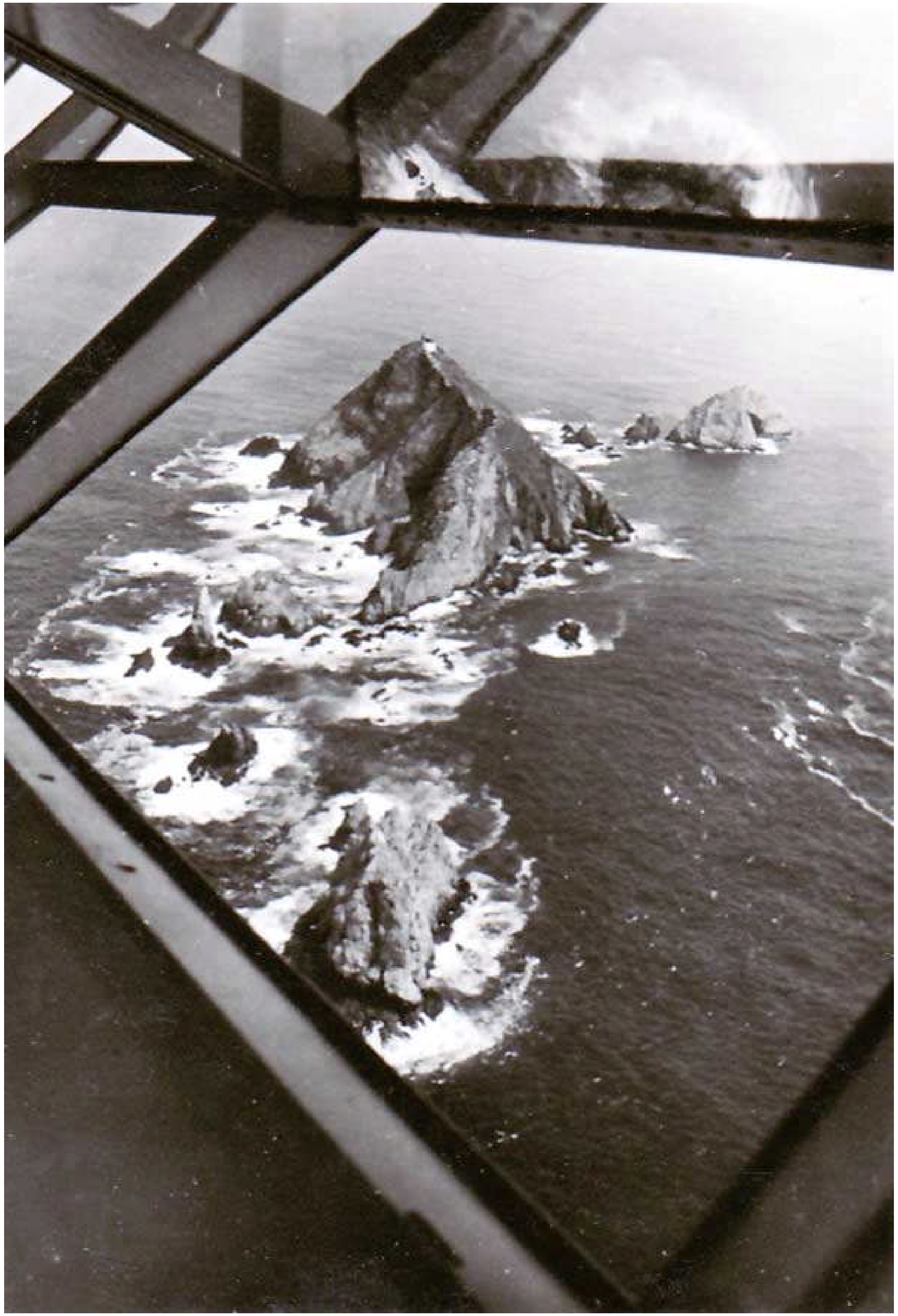
***Popular Science,* May 1962**

RE: LZ-129 was equipped with a sonic altimeter known as an "Echolot" (sometimes referred to as an "Echolade" by *U.S. Navy* observers) which used the principle of active sonar to measure the airship's height above the earth's surface. The Echolot consisted of a compressed-air siren (located near the bow) which gave off a whistling sound that bounced off the ground and was picked up by a receiver located behind the control car. The time it took for the signal to hit the surface and return was measured and indicated the distance above the ground. The Echolot had a clock-style indicator with a pointer to indicate the airship's actual height up to five-hundred meters. It operated with a high level of accuracy at various altitudes and airspeeds. The Echolot was used at least once per watch to calibrate the airship's aneroid altimeters which became inaccurate as the ship passed through areas of varying barometric pressure. The system itself was calibrated when the ship was over an object of known height such as the hangar at *Frankfort*.

Auto Pilot

An automatic pilot made by the *Anschutz Company* of *Kiel* utilized servo-motors to control the airship's rudder and elevators maintaining the ship's heading and pitch. The auto-pilot was used only in calm conditions. If LZ-129 was operating close to the ground or rough weather was encountered, the system was disengaged and the elevators and rudders were shifted back to hand control. The master gyroscopic compass controlled five repeater compasses; one at the rudder station, three in the navigation room and one at the rear of the control car. The automatic pilot system, after some initial adjustments, was accurate and effective and in smooth weather it could hold a straighter course with application of smaller rudder angles (usually less than three-degrees) than could be done by an experienced helmsman. When calm conditions prevailed, the auto-pilot sometimes remained engaged for as long as forty hours.

<u>Left</u>: advertisement for the Anshutz automatic pilot featuring its use on LZ-129



LZ-129 had a normal cruising altitude of 650-feet, but was often flown much lower to stay below the clouds. Her officers believed it was important to observe cloud formations before entering them, to be able to assess the nature of the clouds and avoid thunderstorms. Thus, LZ-129 flew as low as 330-feet when necessary to stay below the clouds. It was also a fundamental premise of airship operations taught by *Hugo Eckener* that airships should avoid traveling close to their pressure height because of the possibility of ascending above pressure height and valving hydrogen, which always presented a certain risk of fire, especially in electrically charged environments. On the bright side, her low cruising altitude provided passengers with spectacular views.

<u>Left</u>: LZ-129 off the coast of *Spain*

"…Next morning, from an altitude of about three-quarters of a mile, I actually detected the curvature of the globe with the naked eye. From that height we could see scores of miles; the atmosphere was remarkably clear and the horizon sharp as a knife. By following the horizon closely I perceived, or thought I did, the slight bend of the earth's surface. That provided one of the greatest thrills of the trip; I had always known that the earth was round, but it was deeply stirring actually to see an infinitesimal section of its rotunditv . Once before I had felt that same awesome sensation when I stood one night on the edge of the chasm of the Grand Canyon and watched the opposite lip of the abyss wheel up toward the stars. I saw the turning of the earth as the rim of the Canyon rose, covering star after star; I imagined I even felt the world whirling under my feet…"

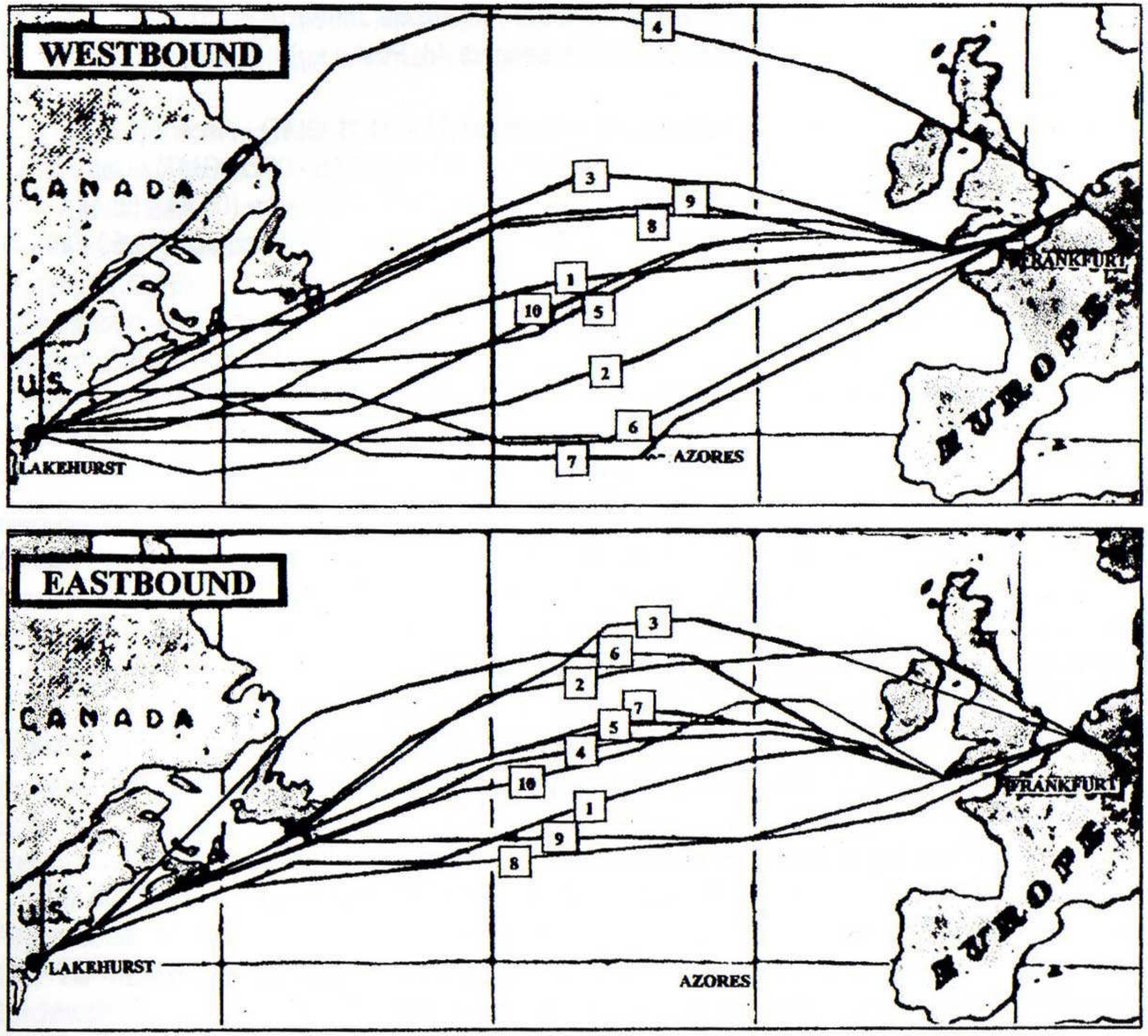
***Webb Miller,* Reporter - *United Press* (1936)**

Navigation

"…Captain Lehman made the remark that an Airship can 'pick it's weather' and has complete freedom of choice as to which route to follow in reaching its destination. The choice is of course determined by the localities of most favorable winds and weather. For us it is the 'Southern Course.' Heading West from Brest and we veer South and have clear skies but head winds. No motion, however, but a slow and almost imperceptable roll like a steamer on a calm sea…"

***Clarence Hall,* Attorney**

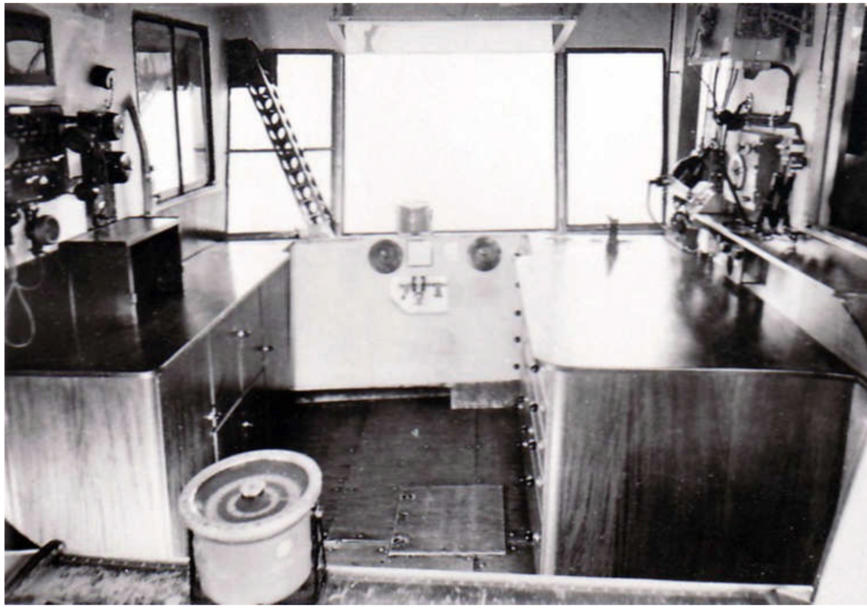
RE: excerpt from his diary. Hall and his wife (left) *Dorothy* (right) were passengers on LZ-129's flight from *Frankfort* to *Lakehurst, N.J.* on August 5-8th 1936.



<u>Above</u>: LZ-129's flight paths between Europe and North America (1936/37)

"…I think the roughest airship cruising I have ever done has been over the mountains in the southwestern part of the country, in both the 'Shenandoah' and the 'Graf Zeppelin.' When strong lateral gusts strike, an airship may roll a little from side to side as a surface ship does. Unlike an ocean liner however, an airship seldom lists more than an angle of three or four degrees. I have never seen anyone seasick on an airship…"

Lieut. Cmndr. C.E. Rosendahl, USS Los Angeles

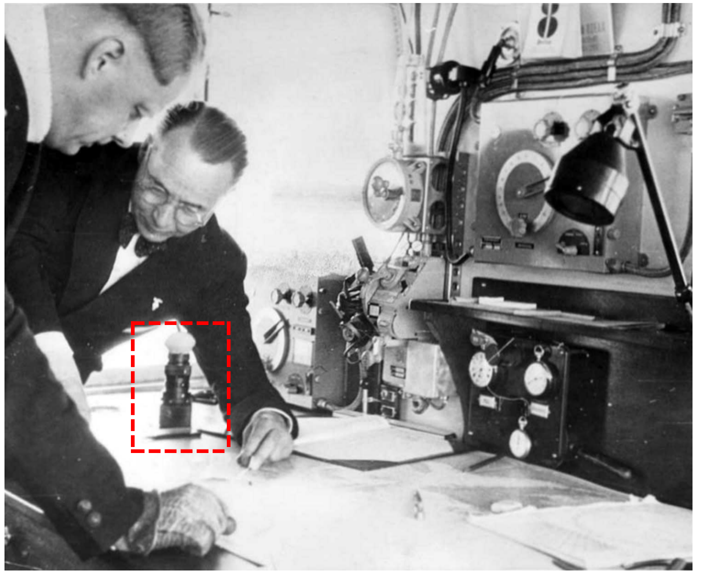



LZ-129 was navigated from the navigation room, which contained work tables for the officers, cases for charts and maps and navigation equipment including gyro compass repeaters, an optical drift indicator, radio direction finding equipment, an altimeter and a clock and stop watches. Navigation was primarily done by "dead reckoning" during trans-oceanic passenger flights. As such, the navigation officers' ability to accurately measure the airship's "angle of drift" was the key to precise navigation. Celestial navigation was rarely used and when sightings were taken they were almost always for training and/or instruction rather than for navigation purposes. She was also equipped with direction finding equipment which could take fixes on radio stations on land or at sea to confirm the airship's position, but radio navigation over the ocean in the mid-1930s was rather primitive and it was not considered nearly as accurate as dead reckoning. Extremely precise dead reckoning was made possible by the accuracy of the ship's drift measuring equipment, gyroscopic compass and by the fact that the ship generally flew at a pre-determined cruising speed.

Left: LZ-129's navigation room
Right: navigator's desk

"…The best illustration of the way that an airship is flown, to my mind, is the fact that fog does not disturb us in the least. An airship navigates, not solely by landmarks, but by instruments. The altimeter tells us we are a safe distance from the earth. A magnetic or gyro compass reports our direction, and the air speed is known from an air speed meter. We measure the drift by sighting on a point on the surface of the earth; or, if we are at sea, by dropping a flare that ignites when it strikes the water. It spouts smoke and flame for five minutes and serves as a point of reference…"

Lieut. Cmndr. C.E. Rosendahl, USS Los Angeles

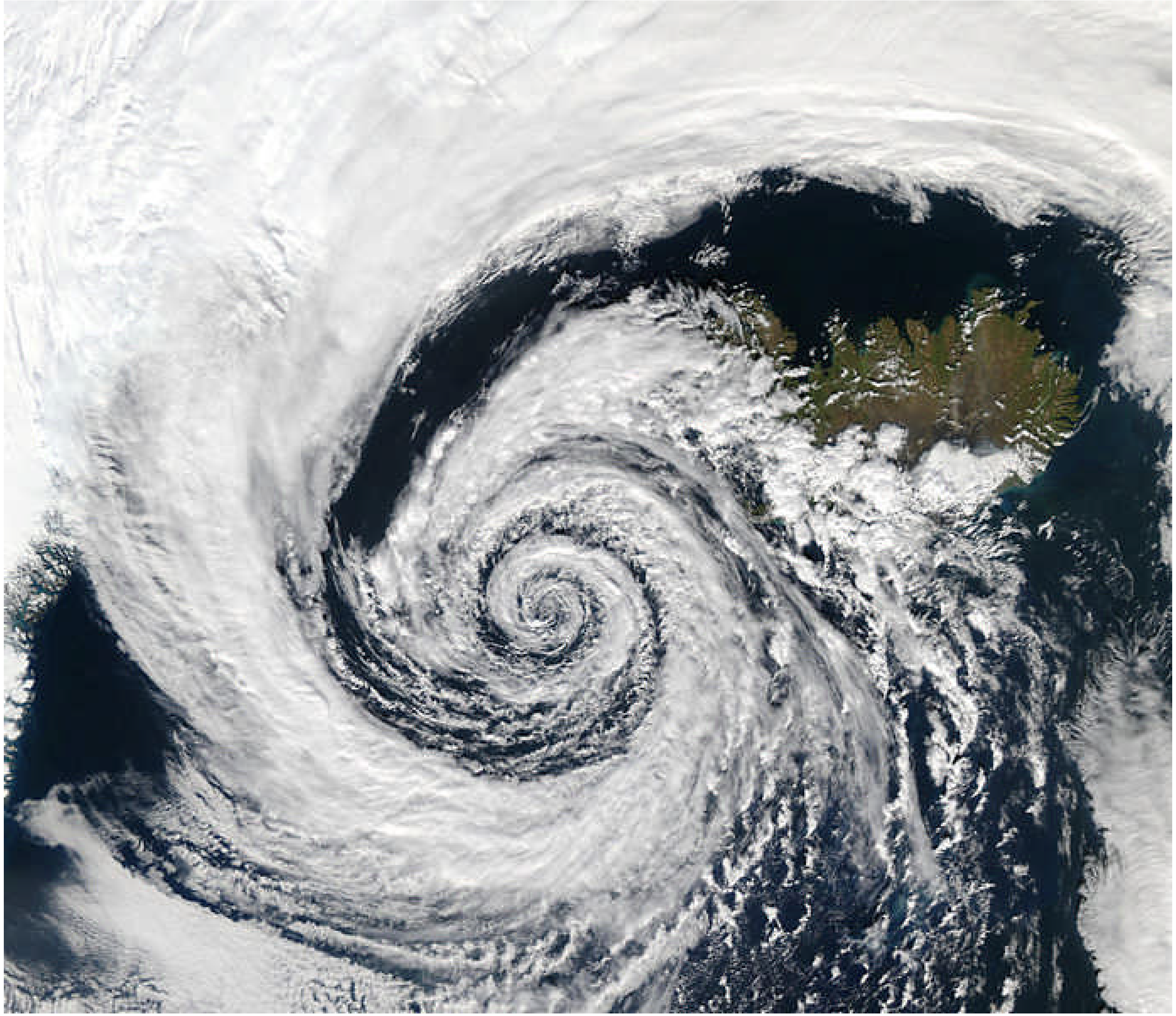


LZ-129's primary drift indicator was a *Carl Zeiss* instrument located in the navigation room (highlighted in the photo above) which featured a large telescope extending through the floor of the control car. The telescope provided a view of the surface below and the lens had a series of black parallel lines etched upon it. At the appropriate level of magnification for the airship's altitude, ripples on the ocean or objects on land would pass through the field of view so rapidly as to appear as a series of parallel streaks which were aligned with the etched lines to indicate the angle of drift. The eyepiece was located slightly above the navigator's desk and the telescope could be adjusted for magnification between four and twenty power. A gyro compass repeater controlled by the airship's master compass was placed next to the optical drift meter allowing drift measurements to be taken with one eye on the compass so that accurate course headings could be determined and relayed to the helmsman. There was a second optical drift indicator in the control room but it was considered unsatisfactory by LZ-129's officers thus the Zeiss drift indicator in the navigation room was much preferred. At night, a 5.7 million candlepower *Hefner* searchlight (located in the electrical room aft of the control car) illuminated the earth's surface and made drift measurements as simple and as accurate as observations made during the day. When visibility conditions prevented continuous observation of the surface allowing only momentary sightings of the land or water, less accurate but still usable drift measurements could be taken with a simple device consisting of several wires mounted in a V-shape through which glimpses of the surface could be observed.

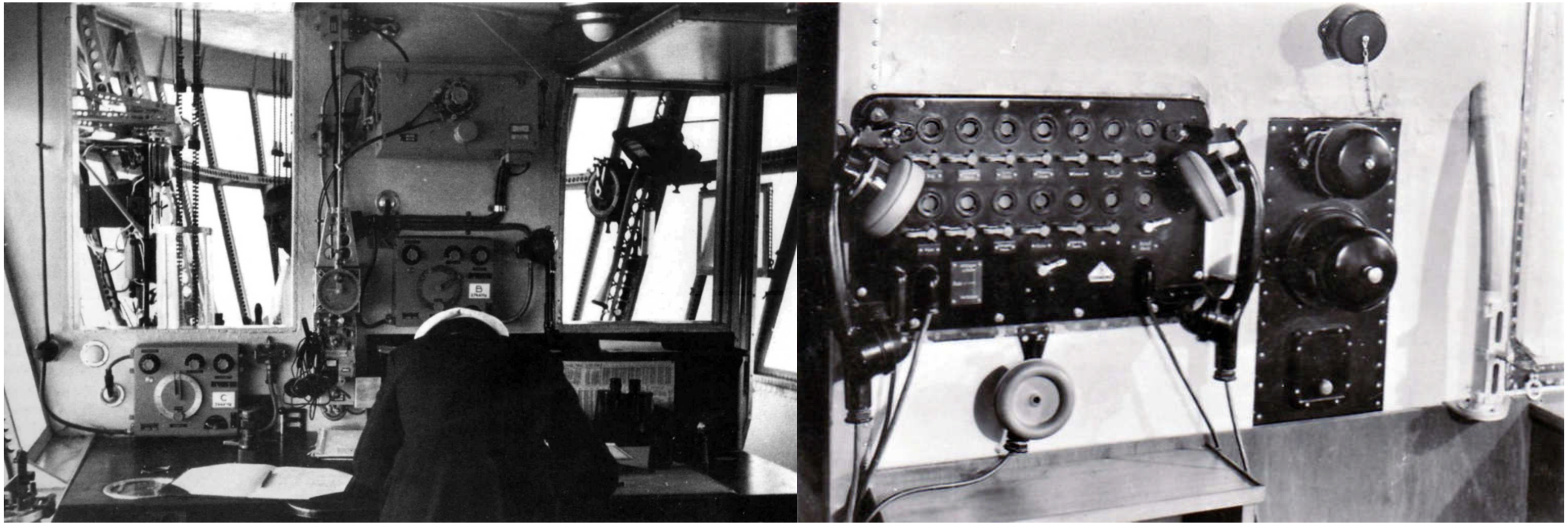
<u>Above</u>: examining charts in LZ-129's navigation room

Pressure Pattern Navigation

Like LZ-127 (*Graf Zeppelin*), LZ-129 (*Hindenburg*) often used the technique of "pressure pattern navigation" which had been pioneered by *Hugo Eckener* during LZ-126′s (*USS Los Angeles*) crossing to America in October 1924. Pressure pattern navigation takes advantage of the "Coriolis Effect" which causes wind to circulate in a counter-clockwise rotation around areas of low pressure in the northern hemisphere. During a westbound crossing of the *North Atlantic* an airship can pick up a tail wind by skirting the northern edge of a storm. During an eastbound crossing, the airship can do the same thing by skirting the southern edge of a storm. Therefore, rather than avoid storms and fronts completely, LZ-129's officers frequently took advantage of them to increase speed and efficiency.



Radio Navigation



The navigation room also contained radio direction-finding equipment (left) which used loop antennas that could take bearings on radio stations on land or aboard ships at sea. The navigation room also housed a fourteen-station telephone (right) with connections to various stations around the airship, controls and indicators for the control car landing wheel and spider lines and a pneumatic tube to convey messages between the control car and the radio room along the keel.

The Weather

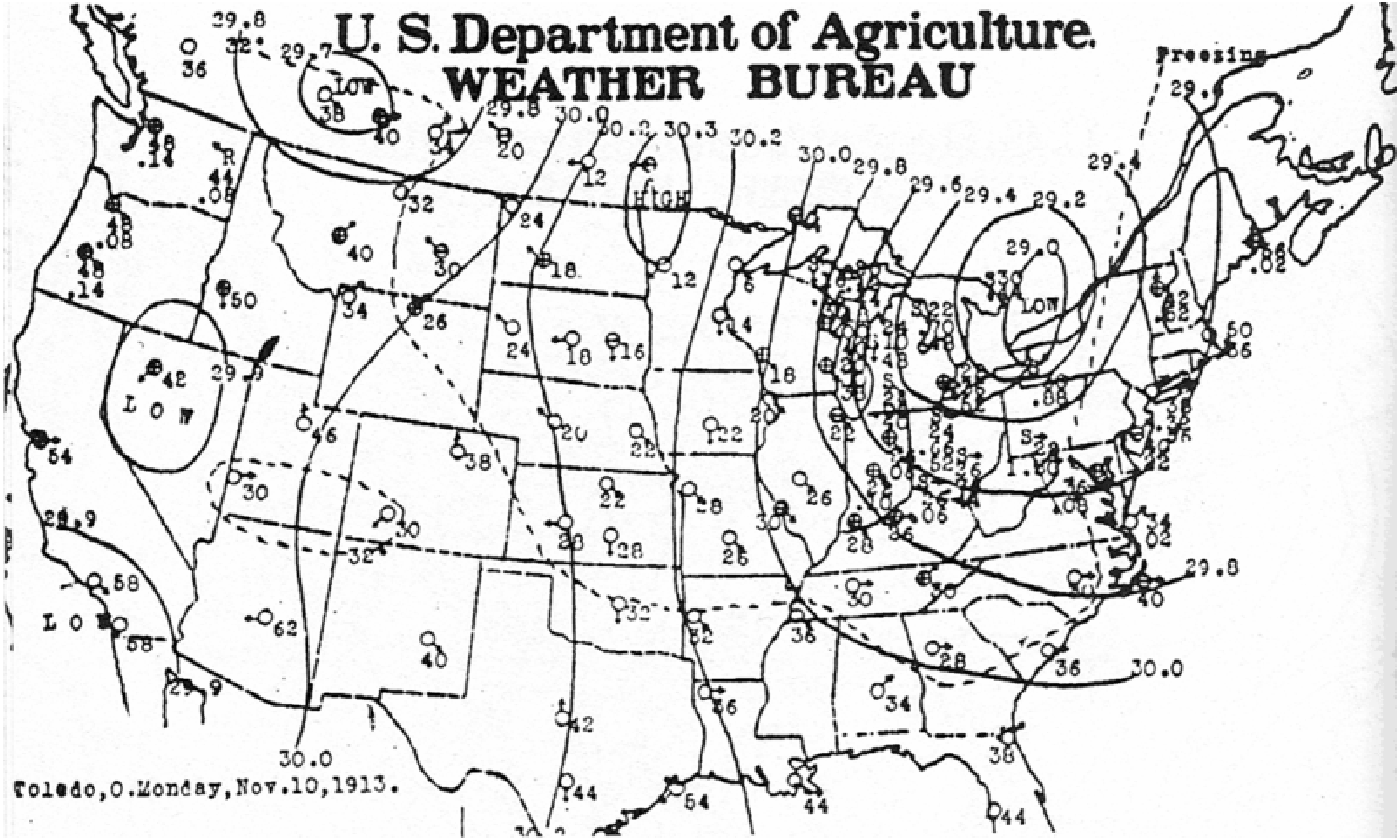
"…Much of the old-time sea captain's knowledge of wind and weather, reinforced by sound science, is demanded of the captain of a giant Zeppelin. As a rule, before starting out, the first thing that a Zeppelin commander does is to look at the indicator that is placed at the top of every Zeppelin shed. It tells him not only the direction of the wind, but also how many meters a second it is blowing. Thus informed of the local conditions, he next consults the charts especially prepared for aeronautical use by the German meteorological office. With the weather conditions all over Europe clearly set down, he sails off into the blue, knowing exactly what he has to expect…"

***Popular Science Monthly*, April 1919**

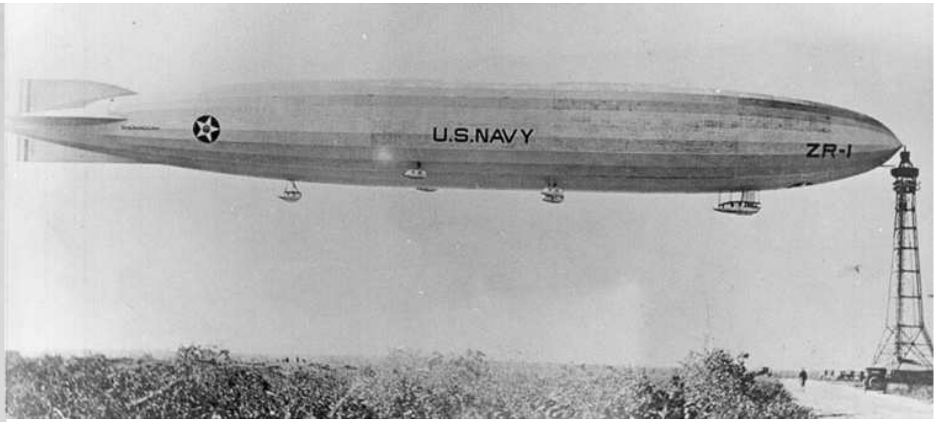
“…is where our mental processes begin; we study the weather and then we plan our flights.”

Captain Ernst Lehmann

RE: comment made by LZ-129’s commander. The weather was the single most important factor in airship operations. During a *North Atlantic* crossing, the airship’s officers drew four weather maps each day based on information received by radio from land stations and ships at sea, analyzed and relayed by the *Deutsche Seewarte* at *Hamburg* and radio station NAA of the *United States Weather Bureau*. LZ-129 would also contact ships sailing over its intended course for additional weather information and a chart showing the location of seagoing vessels was maintained for this purpose. The first duty of an officer beginning his watch was to make a detailed study of the most recent weather map. LZ-129’s officers spent much time preparing the daily weather maps and consulted them extensively during flight operations. The weather maps were used both to avoid dangerous fronts and squalls whenever possible, but also to take advantage of storms to increase speed and efficiency through the technique of *pressure pattern navigation.* Two of the daily maps were large scale, covering the entire area from the interior of the *United States* to the *Soviet Union*, while the other two maps were less extensive and covered primarily the *Atlantic* ocean. However, the relative scarcity and frequent inaccuracy of the weather reports passed on by ships at sea was problematic for the officers who relied on this information to chart the weather.



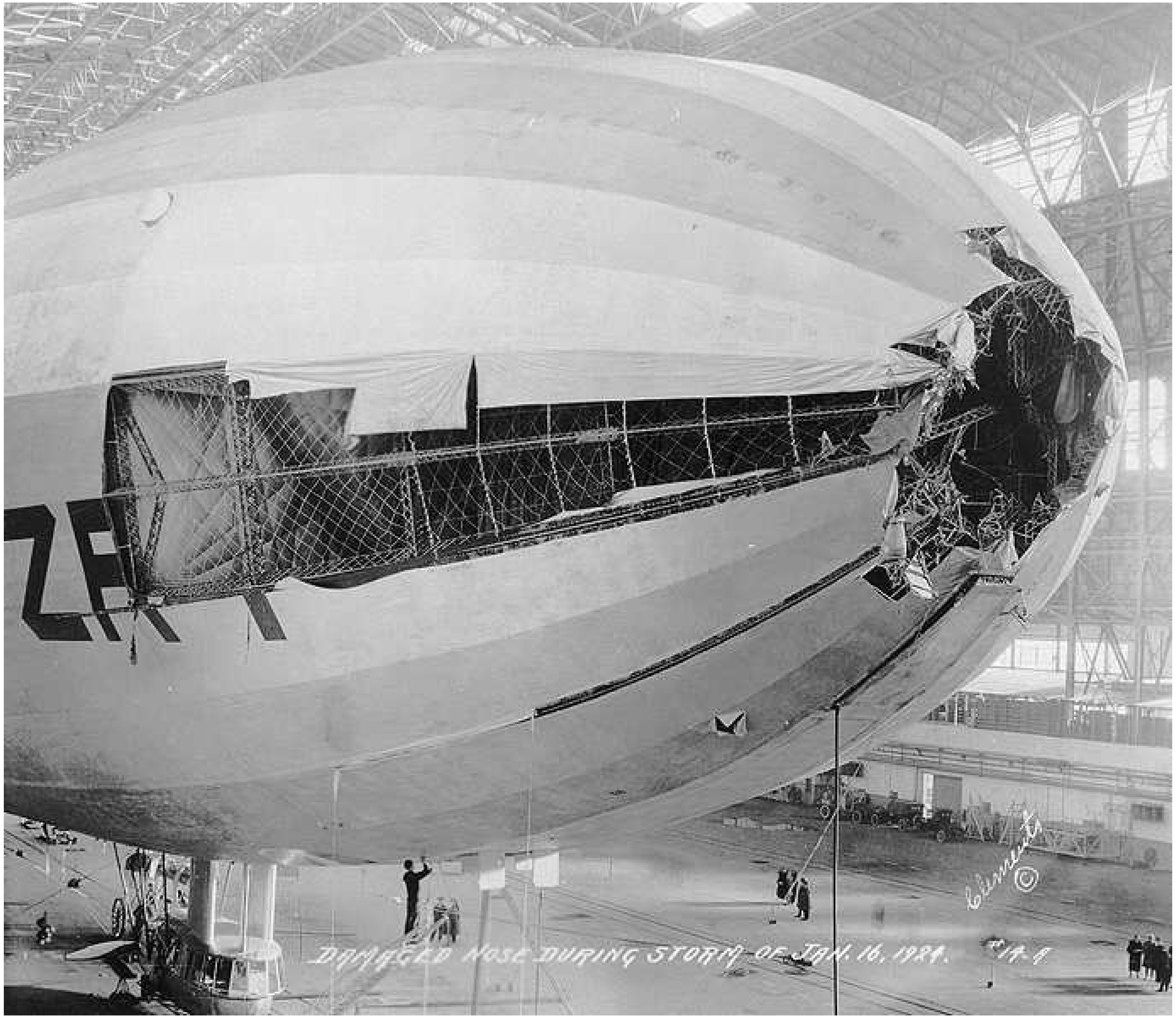
Above: weather map drawn by the USDA Weather Bureau's *Toledo, Ohio* observer and published in the *Toledo Blade* on November 10th 1913. It depicts the formation of the "Great Lakes Storm of 1913." Unlike modern weather maps, warm/cold fronts were not shown since frontal mechanisms were not yet understood.



"…Only when resisting an ordinary wind storm is a dirigible in danger. Many a dirigible has beaten a storm by riding it. Once the 'Shenandoah' was torn from her mooring mast at Lakehurst, N.J., and was swept away to what an anxious country thought would be her destruction. Instead, she rode the storm as gently as a feather, and throughout a long night her radio operator gave amateur wireless operators the details of what had become a mild adventure. The 'Shenandoah' was out of danger the instant her nose was torn, setting her free in that element where she was most at home; but what she rode, of course, was a gale and not a twister…"

***Popular Science Monthly*, October 1928**

<u>Left</u>: *USS Shenandoah's* nose remained secured to the high mooring mast (above) after the airship broke away in a gale on Jan. 16th 1924


DAMAGED NOSE DURING STORM OF JAN. 16, 1924.

"…About one o'clock Friday morning, in mid-Atlantic, the Hindenburg ran head on into a severe storm. In inky darkness as black as the inside of a black cat, the vast bulk of the Hindenburg swayed and bucked; hail and torrents of rain lashed at the windows of the promenade decks. With a few passengers I gazed down at the fascinating spectacle of the heaving ocean 2,000 feet below, one round area in the blackness illuminated by the spotlight in the belly of the craft. The downpour of rain and gale-force wind buffeted the craft about half an hour. This was the first time we had felt any deviation from the velvety motion of the ship. So far as I could tell, none of us watching the storm felt any trepidation or appreciable sense of danger. The passengers already asleep were not awakened, vases of sweet peas and carnations on the writing and dining tables did not turn over. In my cabin not a drop spilled from a full glass of water. But at last you realized you were flying the Atlantic and were out here alone and helpless, 1,500 miles from land, fighting the elements and beating them. Dr. Hugo Eckener, his deeply lined, weather-beaten face calm and composed, lumbered up from the control car. 'This is really a severe storm,' he said, 'but I am pleased by the behavior of the ship. As you see, the motion is gentle. We have collected in special tanks five tons of water from the storm to replace many tons of weight lost by consumption of fuel oil. That will be useful to us in landing. With that additional weight we shall not have to valve out so much gas to get her down at Lakehurst. Sometimes when we sight a rain storm on the horizon we go over and run through it for the purpose of collecting water ballast. Unless we collect water from rain storms during a flight, we sometimes have to valve out as much as one-third of our gas. That is expensive; it has to be replaced before we commence another flight. We collect in tanks all of the water used by the passengers for toilet and bathing purposes during the trip and use it for ballast.'…"

***Webb Miller,* Reporter - *United Press* (1936)**

"The fundamental principle covering squalls and thunderstorms is: If possible, avoid such cloud formations!"

Hugo Eckener

RE: excerpt from a 1919 instruction guide for zeppelin operations written by Eckener. Although LZ-129 was viewed as an "all-weather" airship, the officers were very sensitive to the danger of thunderstorms and generally kept their airship below the clouds so they could observe and assess threatening cloud formations before entering them. Thunderstorms presented two principal risks; the potential for structural damage and the possible ignition of hydrogen by electrical activity. LZ-129's officers were very sensitive to the possibility of structural damage caused by the violent convective activity in and around thunderstorms such as had caused the structural failure which destroyed the *U.S.S. Shenandoah*. They were also aware of the danger posed by thunderstorms when operating with hydrogen as a lifting gas. Since the strong updrafts of a thunderstorm could cause the ship to rise above pressure height (resulting in the automatic release of flammable hydrogen in an electrically charged environment) her officers generally went to great lengths to avoid operating in or near thunderstorms and one of Hugo Eckener's basic operating rules was that an airship should never valve hydrogen in a thunderstorm.

Part 7

Flight Operations

Take Off

"…The high spots of a flight for an airship captain are its start and its finish. Launching an airship requires extreme care. The crew – say eight officers and thirty enlisted men – are at their stations in the ship, while the ground crew walks it out of the hangar. The captain walks out beside the mooring officer, who, from the ground, will direct the maneuver. The most critical part is getting the ship past the hangar door. At that moment a sideward gust on the huge bag might sweep it with thousands of pounds force out of the ground crew's hands and against the wall. The take-off is purposely delayed until such danger is minimized, and when the ship is safely on the field the captain steps into the control cabin…"

***Popular Science Monthly,* March 1930**

"…A green flag, or at night a green lantern, in the hands of an orderly makes it easy to see where the mooring officer is. 'Give us a weigh-off!' is called out to him. The buoyancy of the ship has already been adjusted roughly in the hangar, and this is the final weighing before we ascend. 'Stand by to weigh-off!' commands the mooring officer. The order passes from mouth to mouth down the length of the 656-foot ship. The ground crew sets the control car and the after gondola down on the ground, holding them by the handrails along the sides. At a distance from the ship are the men on the handling lines…"

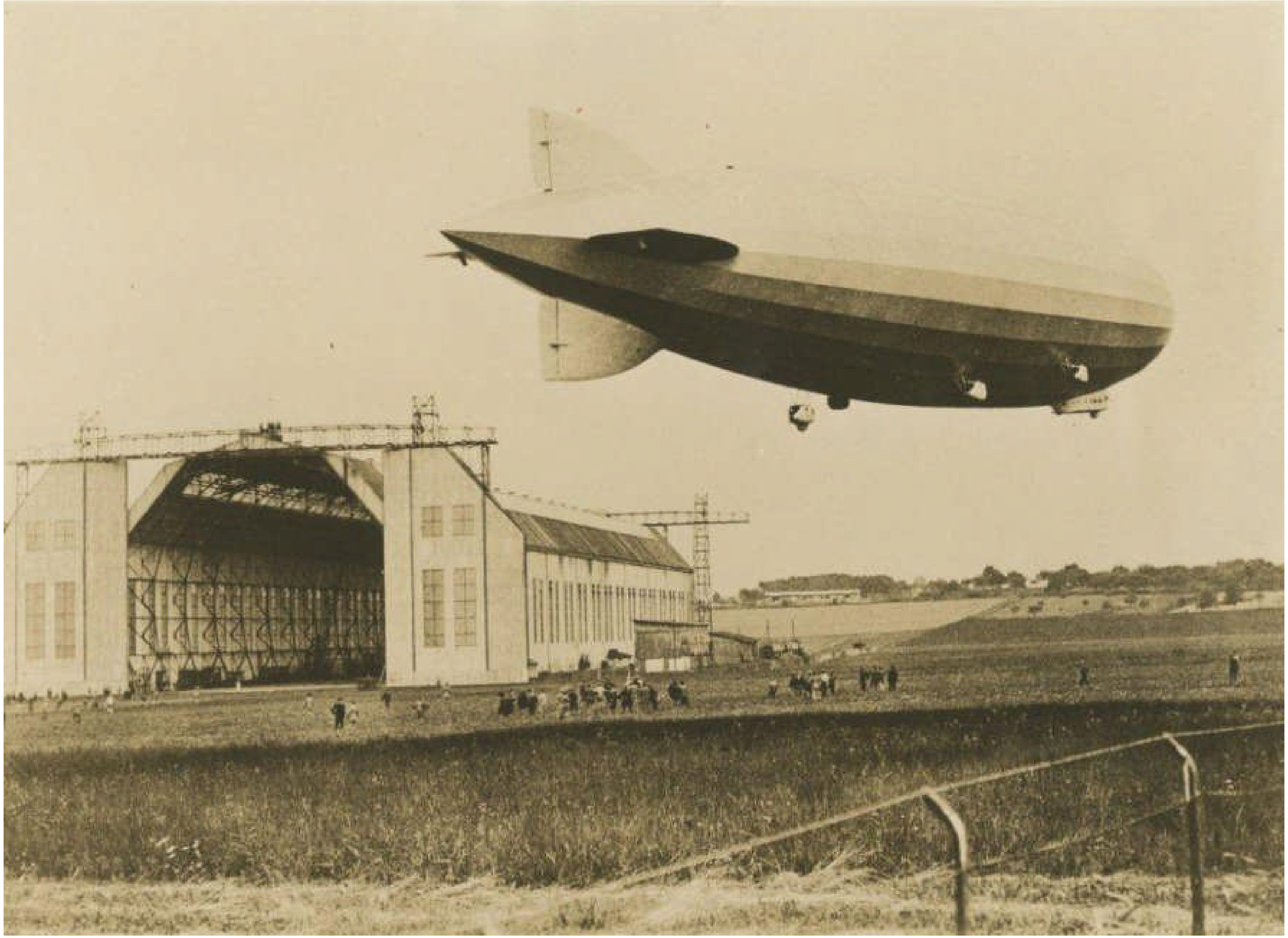
***Popular Science Monthly*, March 1930**

“…‘Hands off!’ They allow the ship to rise to arm’s height, then at ‘hold!’ they bring it back, estimating the buoyancy, if it tends to lift, by the weight of the men required to hold it down. The report comes in: ‘Four hundred pounds light, aft.’ ‘Three hundred pounds light forward.’ That means that each end can lift that many pounds; in this case the total buoyancy of the ship is 700 pounds, a good figure. But it is comparatively too heavy forward for the nose to rise first, as it should. A man aboard ship is sent from the forward end aft. The trim is now satisfactory…”

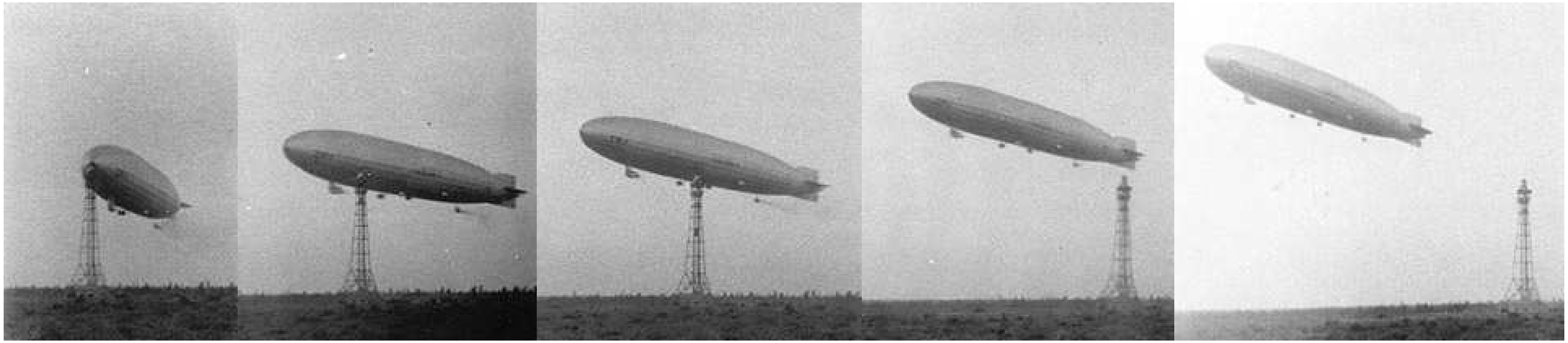
***Popular Science Monthly,* March 1930**

"…'Stand by for 'Up Ship!'' Ropes are cast off. In the control cabin the Engineer Officer pulls over the indicator of the engine telegraph to 'Two engines ahead, half speed.' A gong clangs in the motor gondolas. Compressed-air starters spin the motors. They fire. A stream of air shoots back past the elevators or 'flippers' that the elevator man is ready to raise, to force up the nose of the ship as soon as it is clear of the ground. The ground crew is tugging at the handrails along the cars to hold back the throbbing ship. 'Up Ship!' The ground crew literally throws the ship high in the air. We go up nose first. 'All engines ahead, cruising!' signal the engine telegraphs. We're off!..."

Popular Science Monthly, **March 1930**



<u>Above</u>: caption: "The dirigible ZR-3, built by the Zeppelin Company in Germany for America, starts her epoch making journey across the Atlantic. The great air cruiser is now the *Los Angeles*."

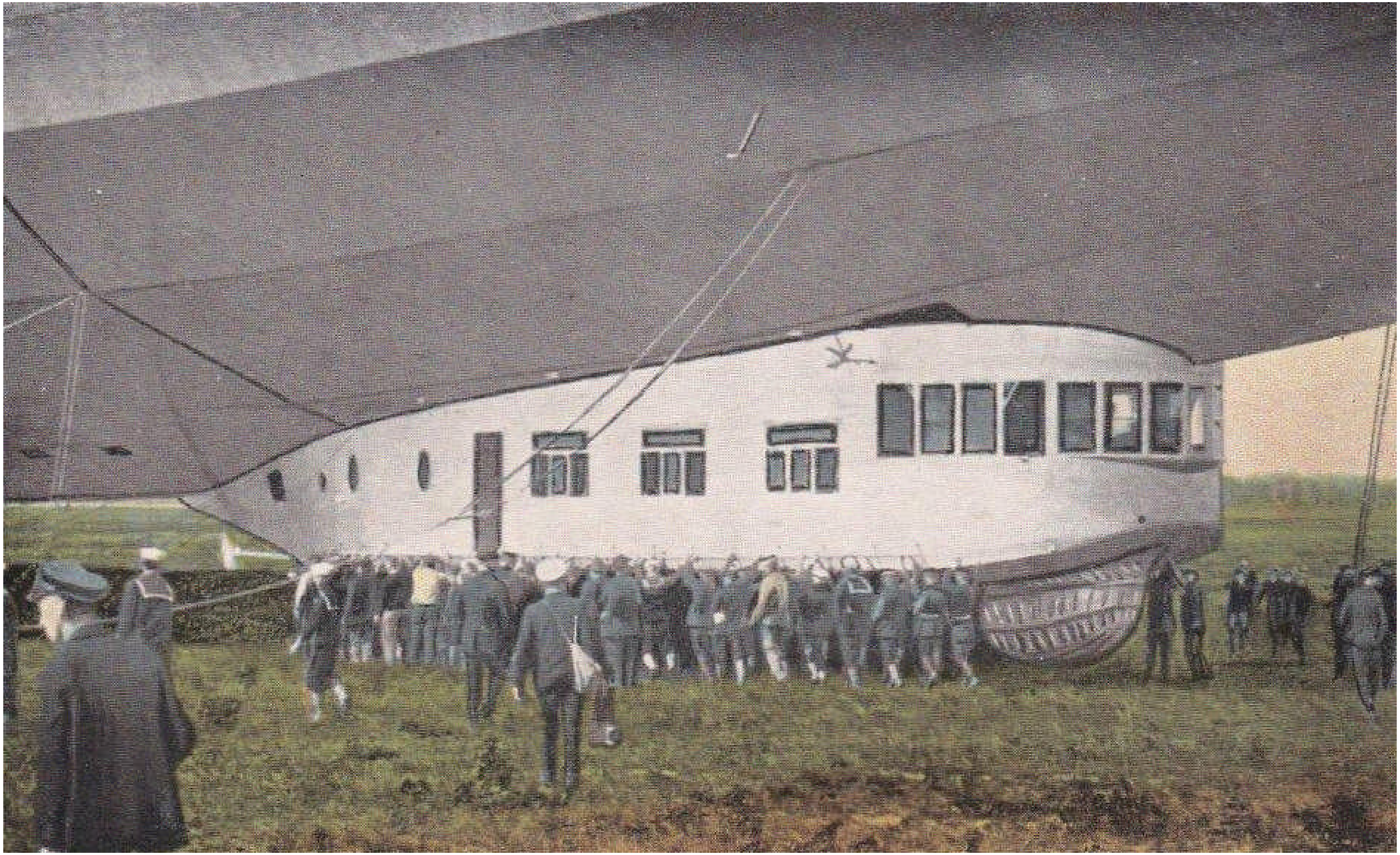


<u>Above</u>: caption: “Montage of five photographs, showing the airship USS Shenandoah (ZR-1) leaving her mooring mast at Naval Air Station Lakehurst, New Jersey, circa November 1923-January 1924.”

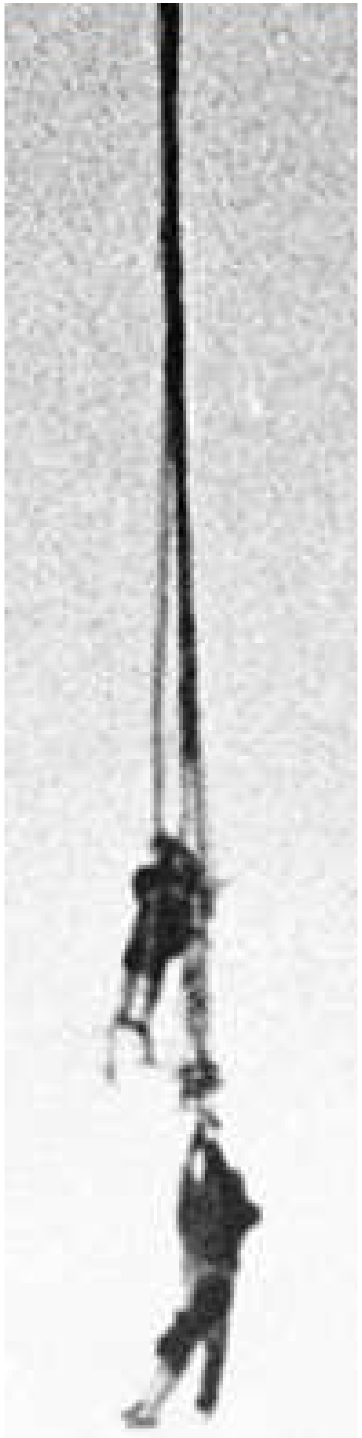
Landing

"…Let us admit at once that it is more difficult to handle a Zeppelin, both on the ground and in the air, than a giant flying-machine. Half a dozen men at most are required to swing a huge Caproni or Handley-Page airplane on the ground so that it heads in the proper direction. But when a Zeppelin comes down to be berthed in the 700-foot shed, a highly trained ground crew of from one hundred to two hundred men, each man knowing exactly what he has to do, must take the huge envelope in charge. More Zeppelins have been wrecked on the ground than in the air. A fabric composed of a wonderful lacelike aluminum framing cannot withstand terrific collisions with the ground. And so, Zeppelin after Zeppelin was wrecked until a special ground-handling technique was evolved…"

Popular Science Monthly, **May 1919**

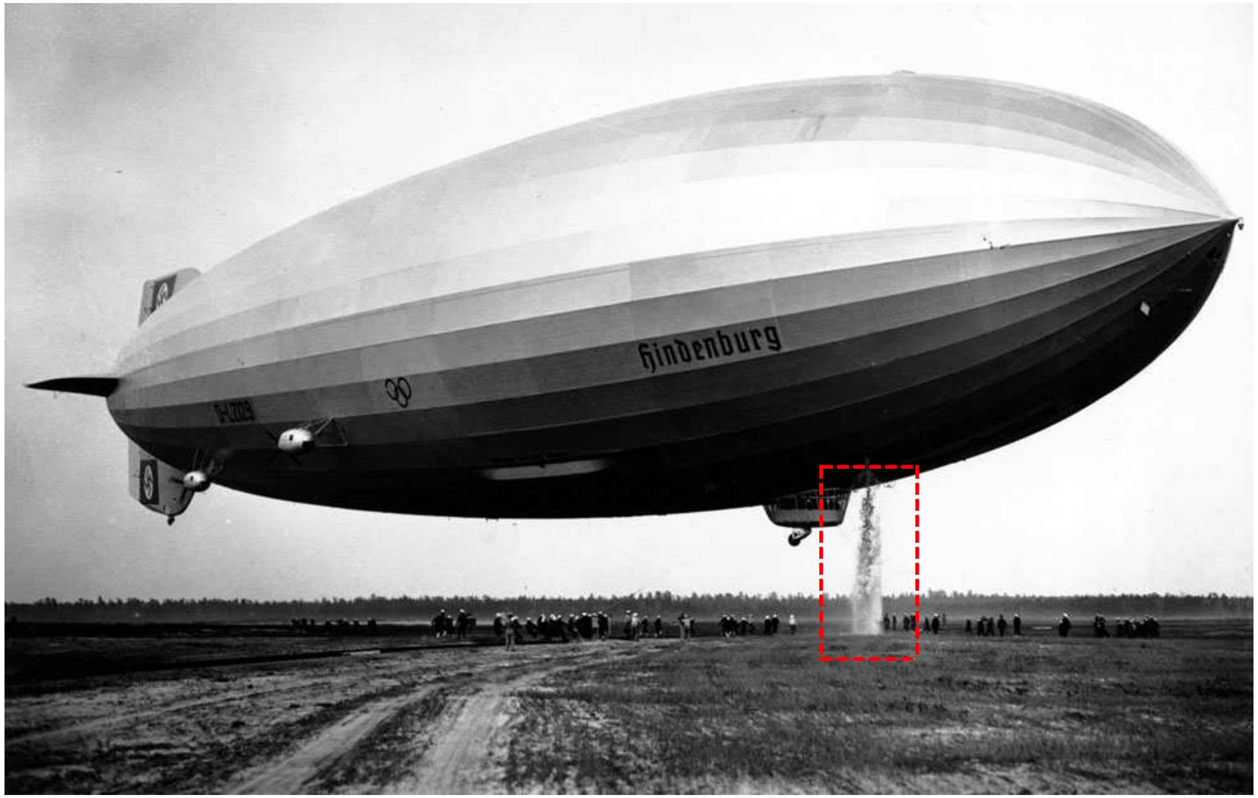


<u>Above</u>: caption: "ZR-3 (now the *Los Angeles*) arriving at U.S.N. Air Station, Lakehurst, N. J."



"We were just back from Panama, one march night, and the 'Los Angeles' was being hauled down to the ground in the second landing attempt. The men on the ropes and those holding the handrails on the outside of the cabins were walking the ship across the field to the hangar. Down the field a cloud of snow arose – a squall was approaching. It hit. The great ship swayed in the gust. Dragging the ground crew with her, she was swept toward the trees that border the field. 'Let go all lines!' Overboard went water ballast. The ship leaped into the air. Five or six of the ground crew had not been quick enough to let go. Then they were afraid to jump. They were carried up, clinging like flies to the outside of the cabin, their legs dangling in mid-air. Five hundred feet from the earth, they were pulled in through the cabin windows. Cruising about until the squall had passed, perhaps an hour later, the ship landed safely and was docked in the hangar…Only an hour or so before, in an attempt to tie to the mooring mast, rough winds had jerked the ship about so violently that a nine-sixteenth inch mooring cable snapped just in time to save the framework of the ship from damage…"

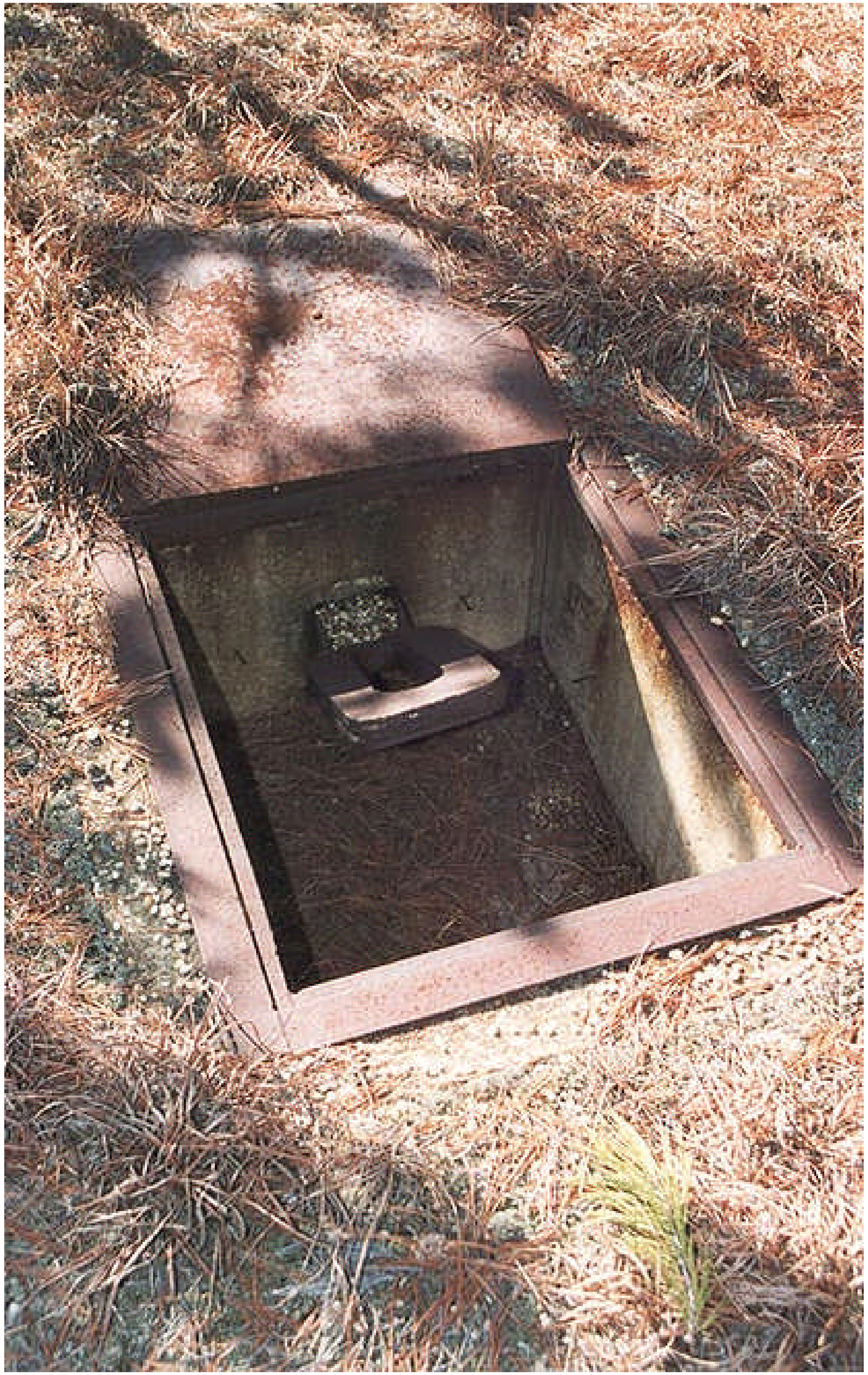
Lieut. Cmndr. C.E. Rosendahl, USS Los Angeles



"…Despite the wide impression that an airship usually comes down by releasing its lifting gas, the normal way of landing the 'Los Angeles' after a trip is to fly it right in. Heading into the wind, the motors are slowed until the ship is nearly stationary and then ropes are dropped to the ground crew. They haul us down by main force against the buoyancy of the ship. Occasionally some of the ground crew get a shower bath when the ship, coming down too fast, checks its fall by releasing a little of its water ballast…"

Lieut. Cmndr. C.E. Rosendahl, USS Los Angeles

Above: LZ-129 dumps water-ballast (highlighted) to slow its descent



"…The 'Los Angeles' provides an impromptu fireworks display when it lands at a mooring mast. She carries a Very light pistol, of possible use as a distress signal but principally used in the mooring maneuver. When the main cable is dropped we fire a white star. Dropping the starboard yaw wire is accompanied by a green star, and the port yaw wire by a red one. This calls attention to the dropping of the wires, which may be difficult to see, particularly at night. The ground crew respond with the same lights as they couple each wire to the corresponding ground wire. The Very lights are used both day and night, and the brilliantly colored balls are easily seen in broad daylight…"

Lieut. Cmndr. C.E. Rosendahl, USS Los Angeles

Left: tie-downs (near the center of the Lakehurst landing site) were located in recessed concrete boxes like this one

"…When landing in fog – as just a few weeks ago – the ship is sometimes brought down slowly by valving gas. It is a little ticklish, but usually there are holes in the fog through which the earth can be seen and the landing cable dropped. Abroad there was developed a way of marking the landing field by captive balloons tethered just above the fog layer. Whistles sounded or guns fired at intervals often help when landing a ship in the fog…"

Lieut. Cmndr. C.E. Rosendahl, USS Los Angeles

Left: tie-downs at the perimeter of the Lakehurst NAS landing site (several hundred feet from the center) consisted of eye-hooks secured to concrete blocks, like this one

Right: several concrete pits containing utility connections surrounded the center of the Lakehurst landing site (this one contained the four-inch helium supply line)

"Captain Lehmann of course would be on the bridge for the landing but generally acted in the capacity of observer and only gave an order when he considered that some phase of the landing was not going as it should. One officer handled the engines and he used his own judgment as to slowing, stopping, or backing the engines to have little or no ground speed at the instant of landing. Another officer had charge of the ballast and here also he exercised his own judgment as to when to drop ballast and also as to when to valve hydrogen…The remaining officer coached the elevator man as to altitude and sometimes would order the ship valved if it appeared necessary. He also watched the rudderman to some extent but in general the rudderman maneuvered the ship himself, as necessary, to keep in the wind and pointed towards the landing point."

***Lt. J.D. Reppy*, *U.S. Navy* observer aboard LZ-129**

RE: *U.S. Navy* officers who flew as observers on LZ-129 described the landing procedure as notably different from that followed on American naval airships in which the commanding officer actively directed the landing

“…Bringing an airship into its harbor has one big difference from guiding an ocean liner home. There is no ‘harbor pilot’ who takes responsibility for the maneuver. The mooring officer, on the ground, directs both the take-off and the landing, but the responsibility for the safety of the airship belongs to the captain alone. If the maneuver does not suit him, he can step in and give orders at any time…”

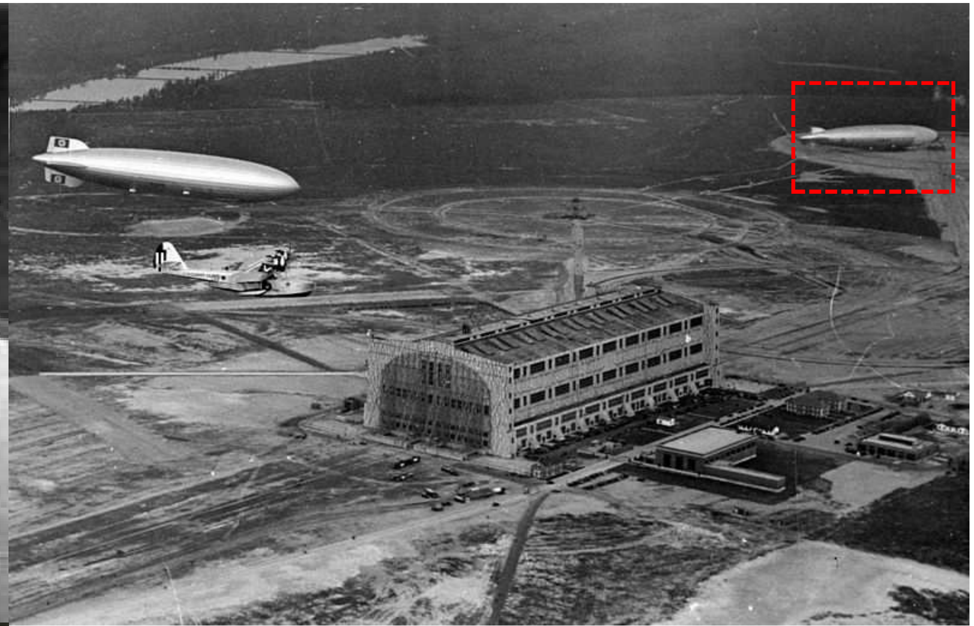
Lieut. Cmndr, C.E. Rosendahl, USS Los Angeles

In general, there was a great deal of autonomy and discretion entrusted to individual members of LZ-129's crew. For example, watch officers had the authority to valve gas, drop ballast, change the airship's assigned altitude and even alter course without the direct involvement of the captain. Many of her senior officers had decades of service in airships and watch officers were generally qualified as airship captains themselves. Similarly, elevatormen were usually highly experienced and were given wide discretion in the performance of their duties, as were ruddermen. The way landings were conducted in the control car exemplified the independence and responsibility entrusted to the airship's senior officers. Landing orders were given and executed by three watch officers acting on their own initiative, with the captain observing. Each officer, as well as the elevatorman and rudderman, had considerable discretion in performing their individual duties and the commanding officer seldom issued a direct order. The captain observed the entire operation as a whole, but generally intervened only in the case of difficulty or if he disagreed with the actions of his officers.

"At 'take offs' and 'landings' the three senior watch officers are in the control car, in addition to the Commanding Officer. The officer with the watch is charged with the maneuver and one of the other watch officers directs the use of the elevators, the valving of gas and the dropping of ballast; the remaining watch officer directs the rudderman. There is excellent team work between the three. The Commanding Officer is of course in charge but seldom issues an order."

***Lieut. Cmdr. Francis Gilmer*, USN observer aboard LZ-129**

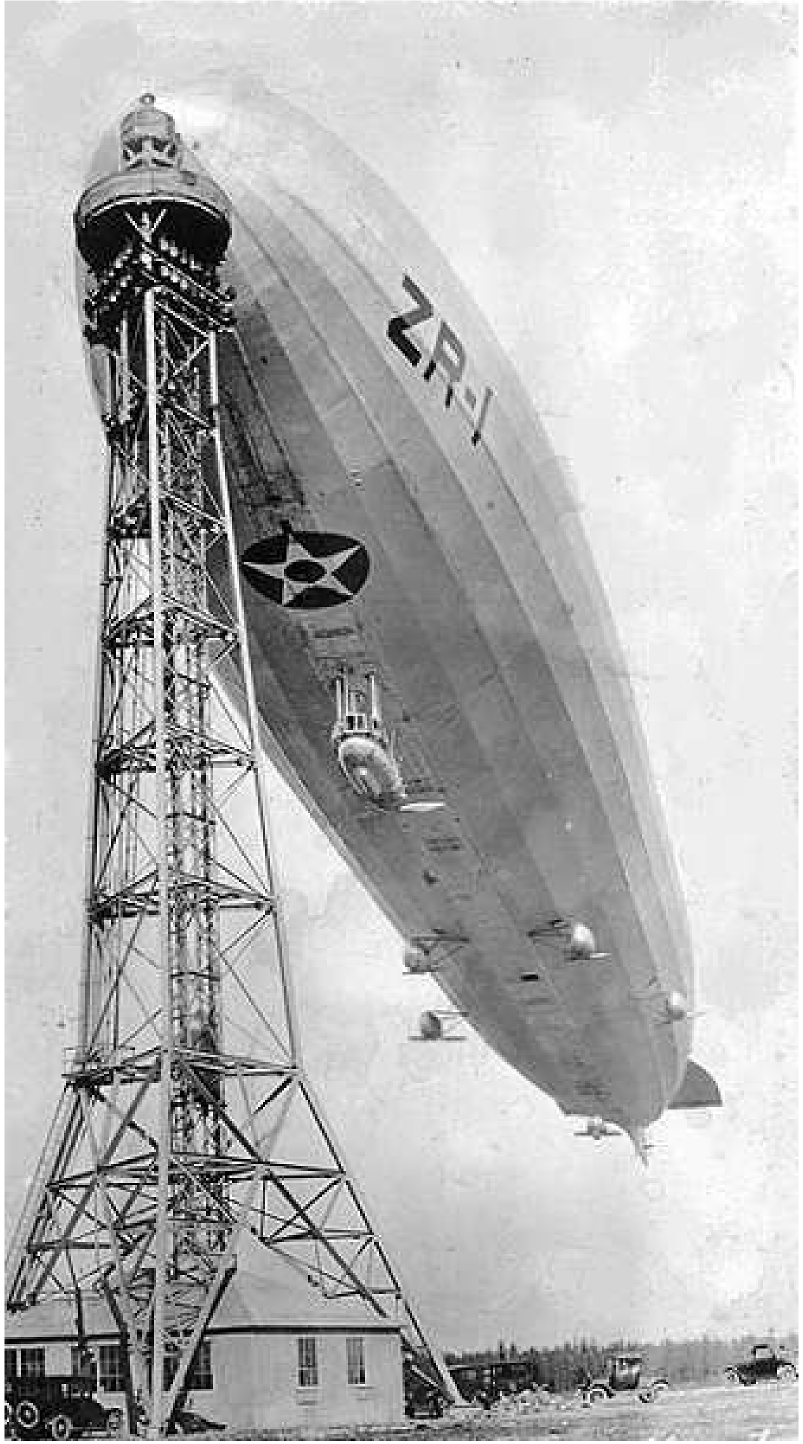
Above: *Captain Ernst Lehmann* (center) and three officers in LZ-129's "Fuhrergondel" during a landing operation (ca. 1936)



<u>Top Left</u>: lower *Manhattan* as seen from LZ-129's engine gondola

<u>Top Right</u>: LZ-129 arrives at Lakehurst NAS on May 9th 1936. USN airship *USS Los Angeles* is moored in the upper right (highlighted).

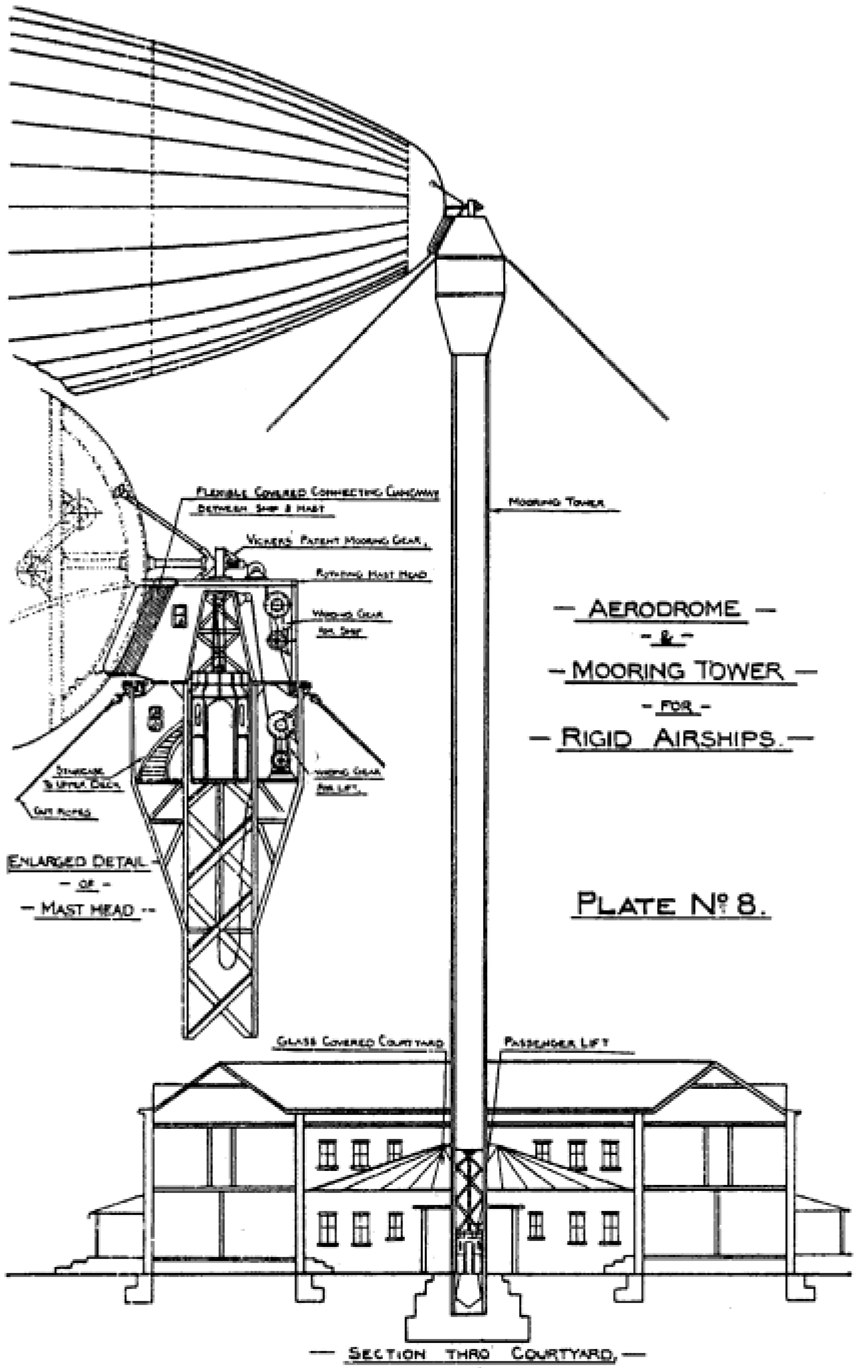
<u>Left</u>: *Lt. Cdr. Scott Peck* (left) with *Captain Ernst Lehmann* (right) in LZ-129's control car on arrival at the Lakehurst NAS, May 9th 1936



"…Now a real ship of the air should no more require a shed than does a ship of the sea…A shed for airships should only be required for repairs. Before Europe was embroiled in the bloodiest of all conflicts the British showed us a way out. They built towers of steel and tethered their small non-rigid dirigibles to them by the nose. Thus moored at a height from the ground so great so that they could not be dashed against the ground, the vessels swung like flags in the wind…"

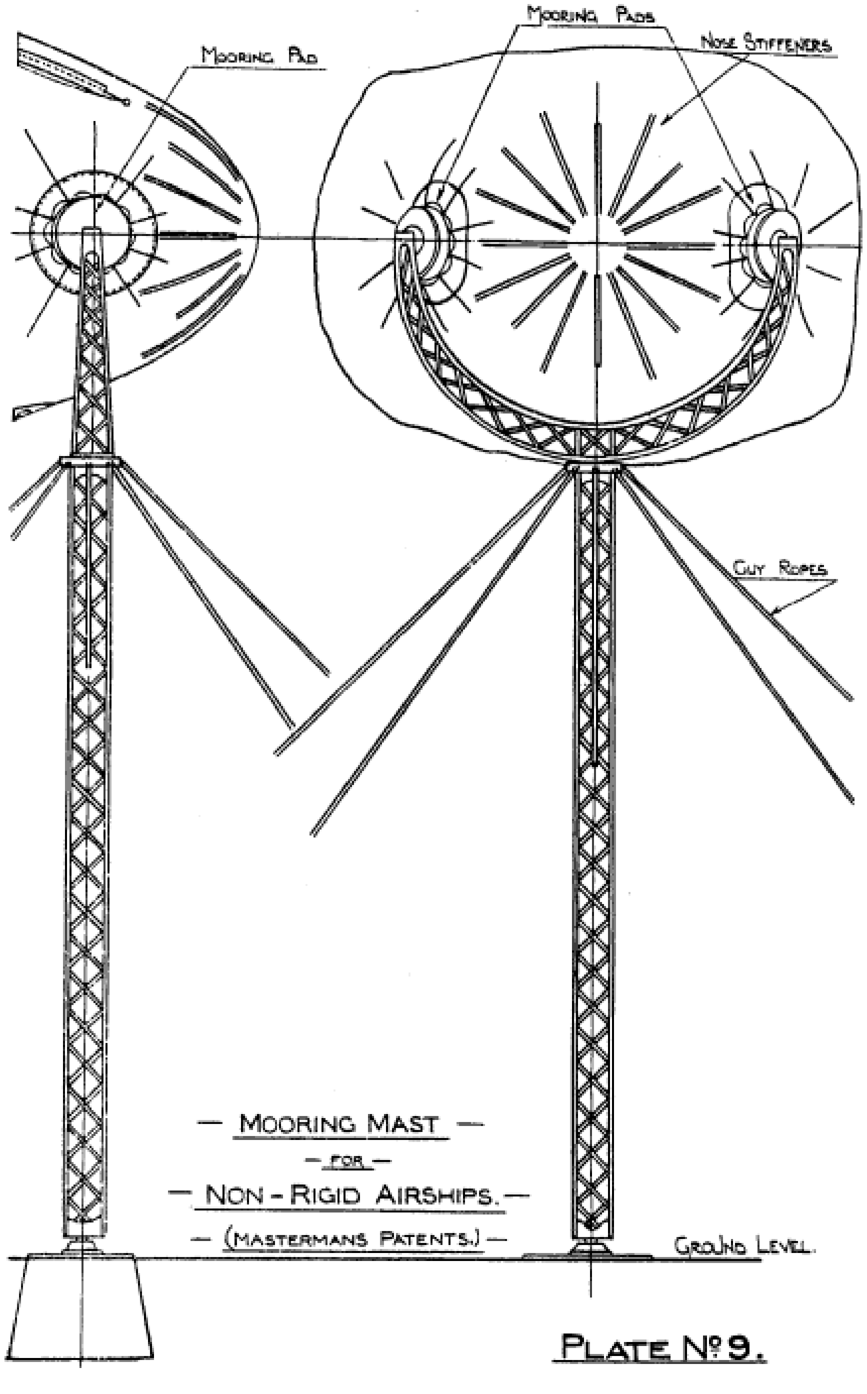
***Popular Science Monthly*, May 1919**

Left: *USS Shenandoah* (ZR-1) moored to mast



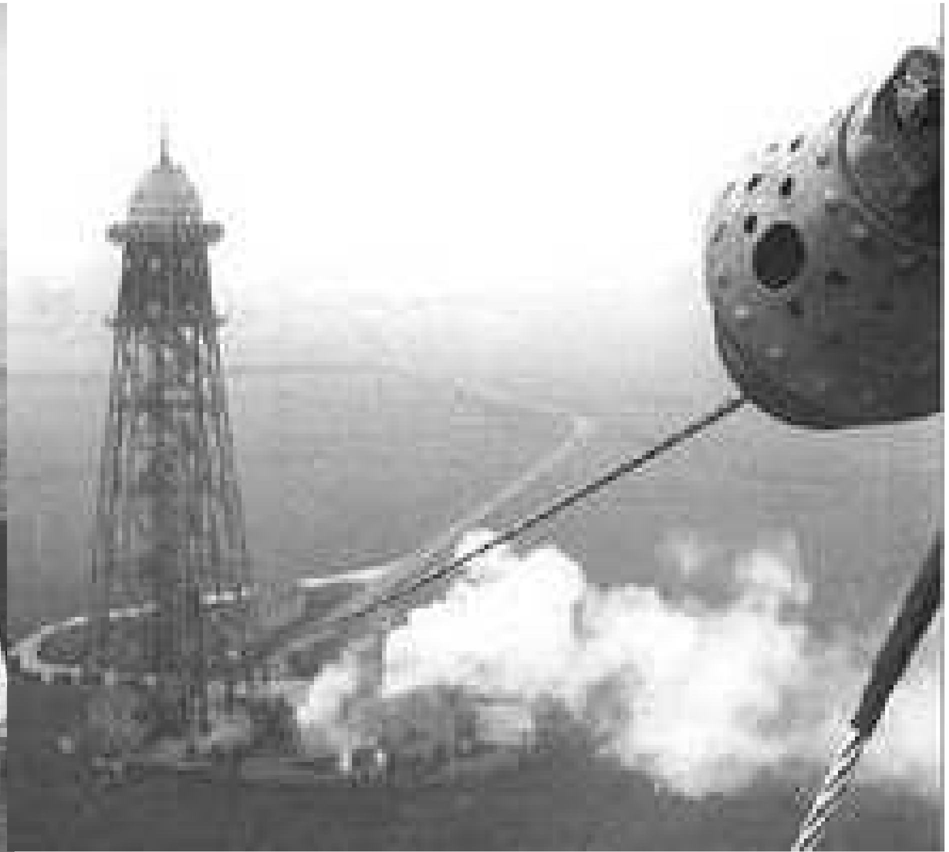
"The only experiments made with Mooring Masts for Rigid Airships have been carried out to our designs, and all gear in connection therewith has been designed and manufactured throughout at our Works. We are now able to arrange for the landing and mooring of rigid airships of any size by means of automatic devices for which we hold the Patents, entirely obviating the use of large bodies of men for handling parties. Designs for Commercial Aero-dromes complete in all details, equipped with Vickers Standard Mooring Mast suitable for passenger service, can be prepared to suit any requirements. Existing rigid airships may be modified to take our Patent Mooring and landing Gear, enabling them to land and remain moored at any Air Station provided with Mooring Masts."

<u>Left</u>: the Vickers "Masterman" airship mast for rigid airships

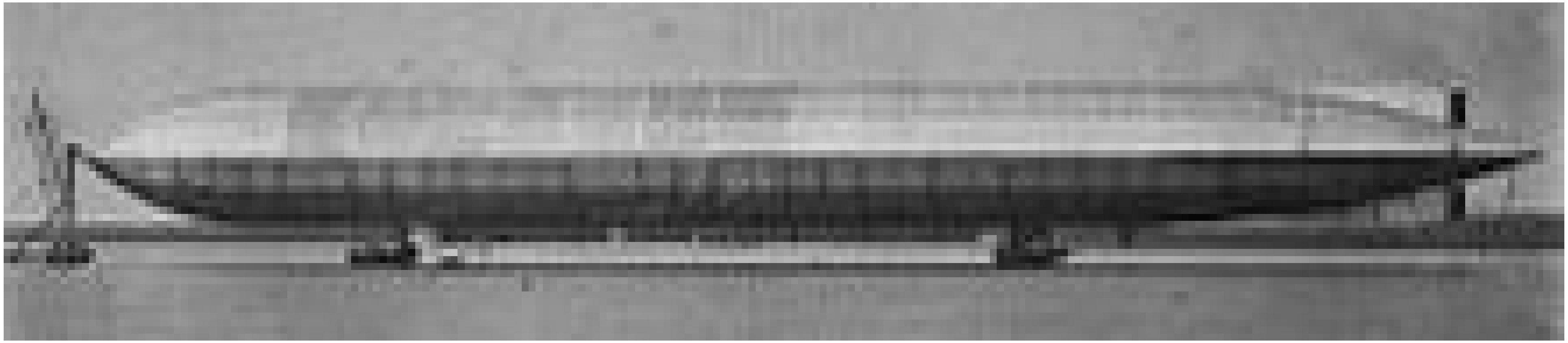


"Mooring Masts for Non-Rigid Airships have been designed and made by us in conjunction with Brigadier-General E.A. Masterman, C.M.G, R.A.F., the holder of the Patents for the only successful type of non-rigid mooring mast yet produced. Ships equipped with these mooring masts have withstood gales of over fifty mph without loss or damage, while landing at the mast and leaving for a flight are readily accomplished in winds of any average velocity. We are prepared to undertake the manufacture of mooring masts for non-rigid airships of any size under General Masterman's Patents."

Left: the Vickers "Masterman" airship mast for non-rigid airships



<u>Above</u>: view from the bow of R-101 as it is winched down to the *Cardington* mast. The steam exhaust from the winches is drifting away to the right.
<u>Left</u>: the R101 being handled on the ground, showing the size of the landing party required to manage a large airship. Another purpose of a mooring mast was to reduce the number of men needed to manage the landing process



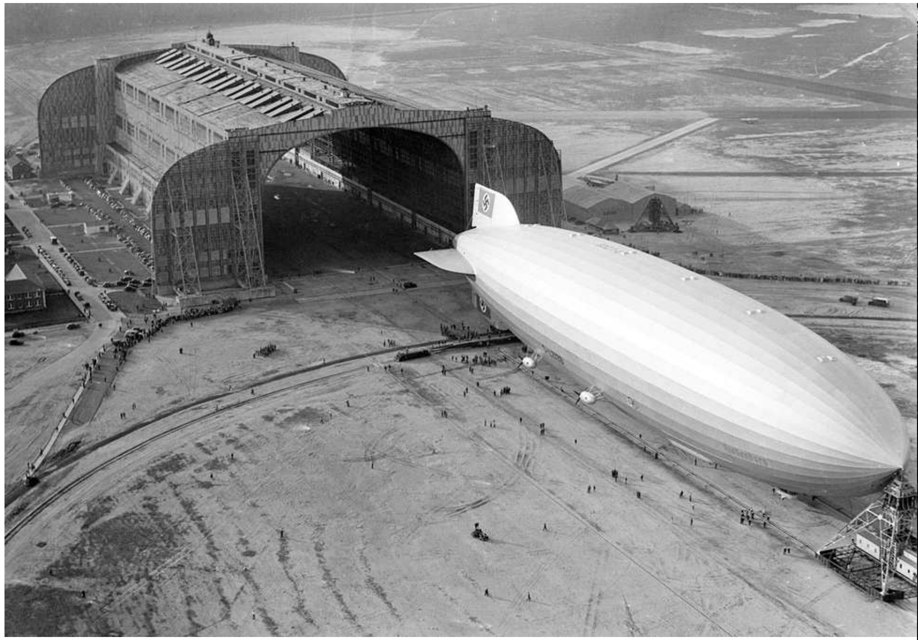
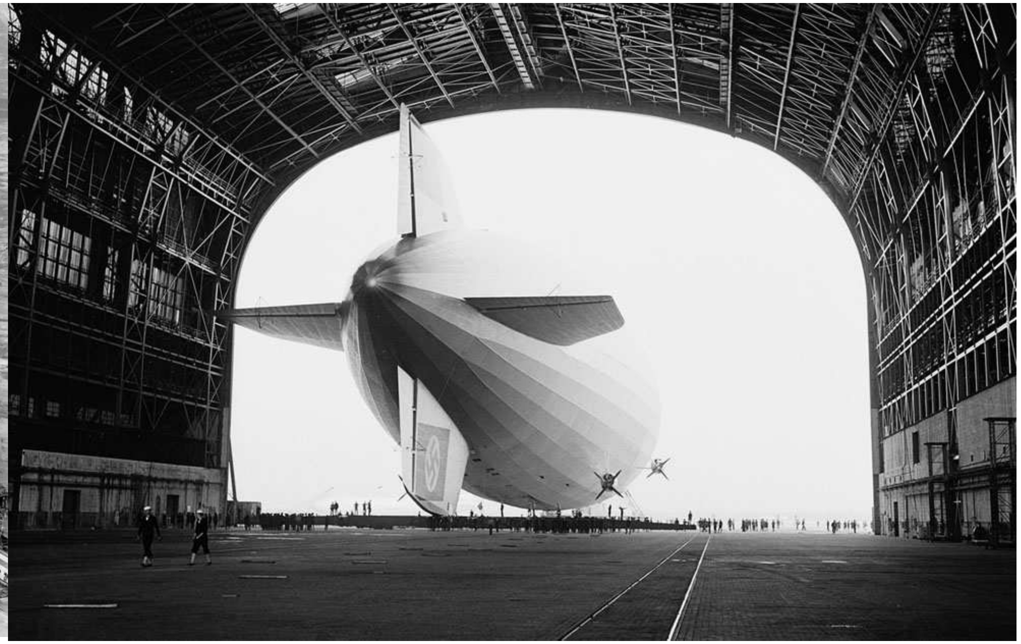
"…it is not enough to hitch a Zeppelin to a high tower and leave the craft to itself. Gas and ballast must be controlled at anchor as well as in the air. But that is no difficult matter. Water ballast can be pumped through pipes wherever it may be needed, and gas can be conveyed in a similar manner. Hence, we expect to find pumps on the towers so that an anchored vessel may be trimmed. Indeed, the pumps can be automatic. As for pipes, a part of the aluminum framing of the envelope may be used without adding an ounce of weight to the vessel…"

***Popular Science Monthly*, May 1919**

<u>Above</u>: "His Majesty's Airship (HMA) No. 1" (*Mayfly*) – the first airship known to have been moored to a mast

“…In Great Britain, the first attempts to construct a Zeppelin-type craft was made in 1911. When the $400,000 dirigible was completed it was christened the ‘Mayfly.’ Soon wits were dubbing it the ‘Won’t Fly.’ Unable to lift its own weight, it collapsed before it got off the ground…”

Popular Science Monthly, **May 1935**

<u>Left</u>: LZ-129 "trundles" into the hangar at Lakehurst NAS, its nose hooked to the mobile mooring tower on May 9th 1936. She had just set a record for her first *North Atlantic* crossing; the first of ten scheduled round trips between *Germany* and *America* in 1936.

<u>Right</u>: LZ-129 is shown from behind as the dirigible is partially enclosed by its hangar at the Lakehurst NAS, May 9th 1936

"...By eight o'clock, we passed over the tip of Cape Cod lying below like a cardboard map, yellow sands, green plots and ponds, little sailboats, cottages. Thence across Buzzards Bay to Montauk, along the south shore of Long Island, Great Sound, and finally two huge circles about the towers of New York and on to Lakehurst, arriving promptly at eleven. A test of the air proved that the landing might be bumpy, as a gusty wind was blowing from a bad quarter. Our good luck. Word was sent down that we would not land and away we flew through the clear sky of a bright summer day. Down the New Jersey coast - a circle around Atlantic City thence to Cape May - West across Maryland and the waters of the Chesapeake to Annapolis and on to Washington. The Nation's capitol never looked more beautiful as we circled twice around it and then headed North toward Baltimore. Shortly after leaving Baltimore, Capt. Lehmann sent an officer below to invite Dorothy and me down to the Control Car. After the usual precarious crawl along the catwalk, we climbed down the ladder to the little glass cage, nerve center of the great Ship. There was Captain Lehmann knowing us as Philadelphians, who said, 'Show me where you live and what part of Philadelphia you would like to have us go over.' On the map I pointed out the Main Line and a circuit was planned. From then on, until we had passed over the Delaware River, I directed the course of the ship. Approaching from the Southwest, we flew over Independence Hall and then described a large arc, followed below the left bank of the Schuylkill, Germantown, White Marsh to Norristown. Turning there we pointed out Bryn Mawr, following Lancaster Avenue to Wynnewood and passing directly over our place where we could clearly see the figures of the household on the lawn and waved to them. Over West Fairmount Park to Market Street and as a final thrill passed directly over the Packard Building where the offices of Orr, Hall and Williams are located - over the Delaware to head straight for Lakehurst…"

Clarence Hall, **Attorney (1936)**

<u>**Above**</u>**: champion boxer *Max Schmeling* aboard the *Hindenburg* in 1936, passing over *Philadelphia* as the great airship casts its giant shadow below**

Airship Lag

"…The gigantic bulk of the craft settled gently at Lakehurst sixty-one hours and thirty-eight minutes after leaving middle Europe, a flight of 4,381 miles. We had eaten only two luncheons, two dinners, and three breakfasts aboard. We had spanned the ocean so rapidly that we had difficulty keeping track of the time on board because our days were twenty-seven hours long. This led to constant confusion between Greenwich time, Central European time, ship's time, which roughly corresponded with our position on the globe, Eastern Standard time, and Eastern Daylight time; and a prankster who frequently set back the clock in the bar so he could celebrate longer introduced still another factor. Even the airship officers sometimes seemed a little uncertain about Eastern Standard and Eastern Daylight time and their relation to ship's time and Greenwich time. This rapid translation from continent to continent across 3,000 miles of ocean left in me an uncanny sense of confusion. The mind had not been able to keep pace with the body. Less than sixty-two hours before I had been in middle Europe. In that time 106 of us had been transported across one-fourth of the globe and my body, so it seemed, had left my mind behind. It took another day before I became orientated and fully grasped the idea that I was back in America."

Webb Miller, **Reporter - *United Press* (1936)**

Free Ballooning

“…One of the questions asked most frequently is what a dirigible commander would do if he ran out of fuel and no mooring place was near. In that case he would ‘free balloon’ the ship – that is, fly it as a balloon and drift with the wind – to an emergency landing spot. Over the landing spot, he would valve gas to bring the ship down, and check its fall near the ground by dropping ballast. For a landing place he would either choose the lee of a patch of woods or land the ship squarely on top of a grove of small trees. German airship men tell of landing wartime Zeppelins, out of fuel on their way back to their bases, on top of scrubby trees until a new fuel supply could be put aboard…”

***Popular Science Monthly*, March 1930**

Brief Notes and Practical Hints

"The new manual on airships, which has been in preparation by the Germans for some time, is not yet complete. Captain Lehmann hopes to see its completion next winter. Meanwhile, the old manual prepared in 1918 by Dr. Eckener ('Brief notes and practical hints for the piloting of Zeppelin Airships') is still a good guide as to German doctrines and practices…There is no 'ground school' as such."

***Garland Fulton*, USN officer**

RE: excerpt from a memo dated August 23rd 1936 concerning a conversation he had with Captain Lehmann about crew recruitment and training. No formal flight or operations manual existed for operational or training purposes from either the LZ or DZR company/s for LZ-129 or any previous airship (DZR did have a "crew manual," but it only briefly mentioned operational matters focusing more on job descriptions and crew duties). Dr. Eckener's 1918 treatise served informally. There was no formal ground school for flight personnel and all training was done by the apprentice method. Most of the officers and crew of LZ-129 had been flying on airships for decades (many having begun their careers during WWI and a few had even worked for DELAG). Training was all done hands-on, with new crew members learning their jobs from experienced hands. LZ-129 was the first in its proposed class and was used as a "flying laboratory" for the development and testing of both equipment and procedures. If the planned expansion of the *Zeppelin* airship fleet had taken place, more formalized training and reference materials would have been required, based on lessons learned on LZ-129, and these materials were apparently being prepared at the time of her demise.

Culture of Excellence

Like all large airships, LZ-129 was operated like an ocean-going vessel. Flying her was a complex operation which required the coordinated efforts of many skilled individuals. The airship was flown by a minimum flight crew of 39 officers and men (not including passenger service personnel such as cooks and stewards) under the command of the captain, broken down as follows:

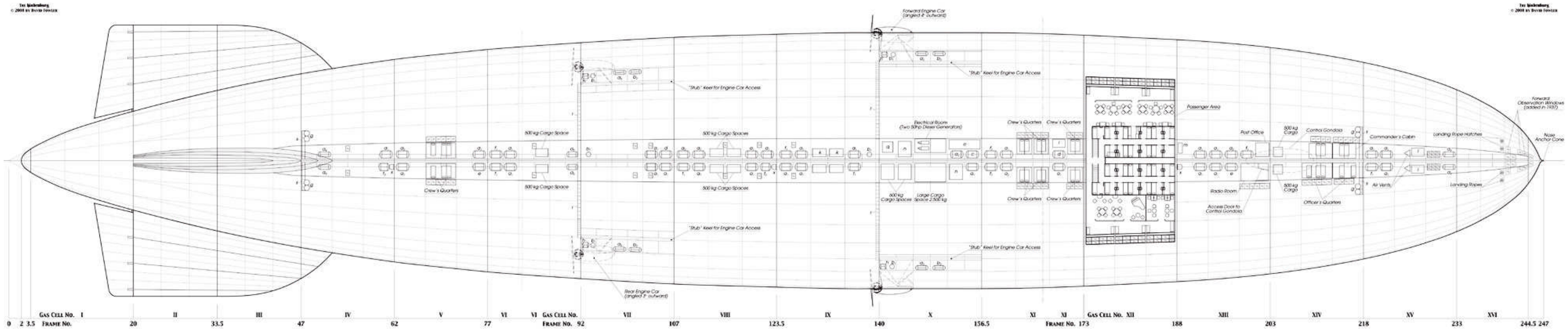
- **Captain**
- **3 Watch Officers**
- **3 Navigators**
- **3 Ruddermen (helmsmen)**
- **3 Elevatormen**
- **Chief Rigger (Sailmaker)**
- **3 Riggers (Sailmakers)**
- **Chief Radio Officer**
- **3 Assistant Radio Operators**
- **Chief Engineer**
- **3 Engineers**
- **12 Machinists/Mechanics (assigned to engine cars)**
- **Chief Electrician**
- **2 Assistant Electricians**

Additionally, the ship's passengers were served by a Chief Steward, Chief Cook and 10-12 stewards and assistant cooks. In 1937, LZ-129 began carrying a doctor on board all flights.

LZ-129's flight crew was divided into two divisions. The *Navigation Department* (akin to the "Deck Department on a steamship) who worked in and around the control car and who were responsible for flying and navigating the ship (this group included the captain, watch officers, elevatormen, ruddermen, navigators and radio operators) The E*ngineering Department*, who worked in the hull and engine cars, were responsible for the gas cells, power plant, fuel, ballast supply and the structure of the airship (this group included the engineers, mechanics, electricians, and riggers). Passenger services were provided by stewards headed by a Chief Steward and the cooks, headed by a Chief Cook.

<u>Left</u>: LZ-129's Chief Engineer *Rudolf Sauter*

Kingdom of the Crew



"…Beyond the passenger quarters stretched two-thirds of the giant craft. You walked past three foc'sles, one major and 14 lesser freight rooms, two dozen lockers for ship's gear, 15 water-ballast tanks, 42 tanks storing 64 tons of diesel fuel…"

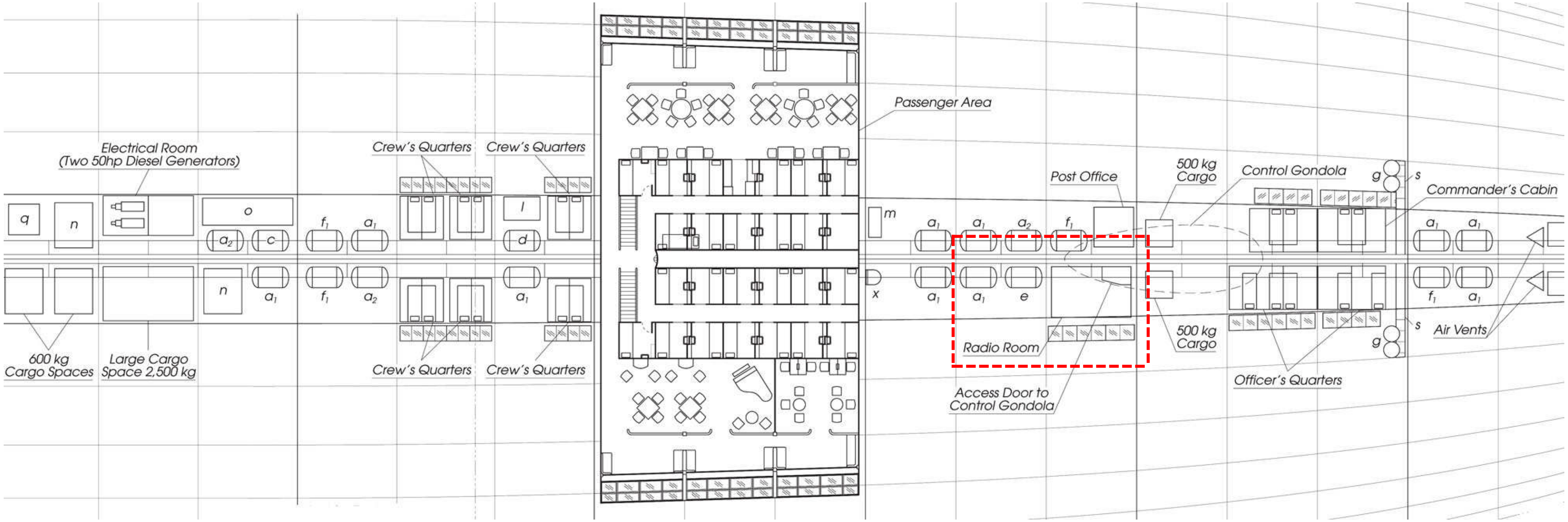
***Popular Science,* May 1962**

<u>Above</u>: plan of LZ-129's keel. Besides the control car, the crew and work areas were primarily located along the keel, including officer and crew sleeping quarters, radio room, post office, electrical room, work rooms and rope handling areas for the mooring lines. Fuel, fresh water and ballast tanks were also located along the keel, as were cargo storage areas. The keel also offered access to the engine cars and the auxiliary control and docking station in the tail. Ladders at Rings 62, 123.5 and 188 offered access to the axial catwalk at the center of the ship. "A-Section" of "B-Deck" included LZ-129's kitchen and separate mess areas for the officers and crew.

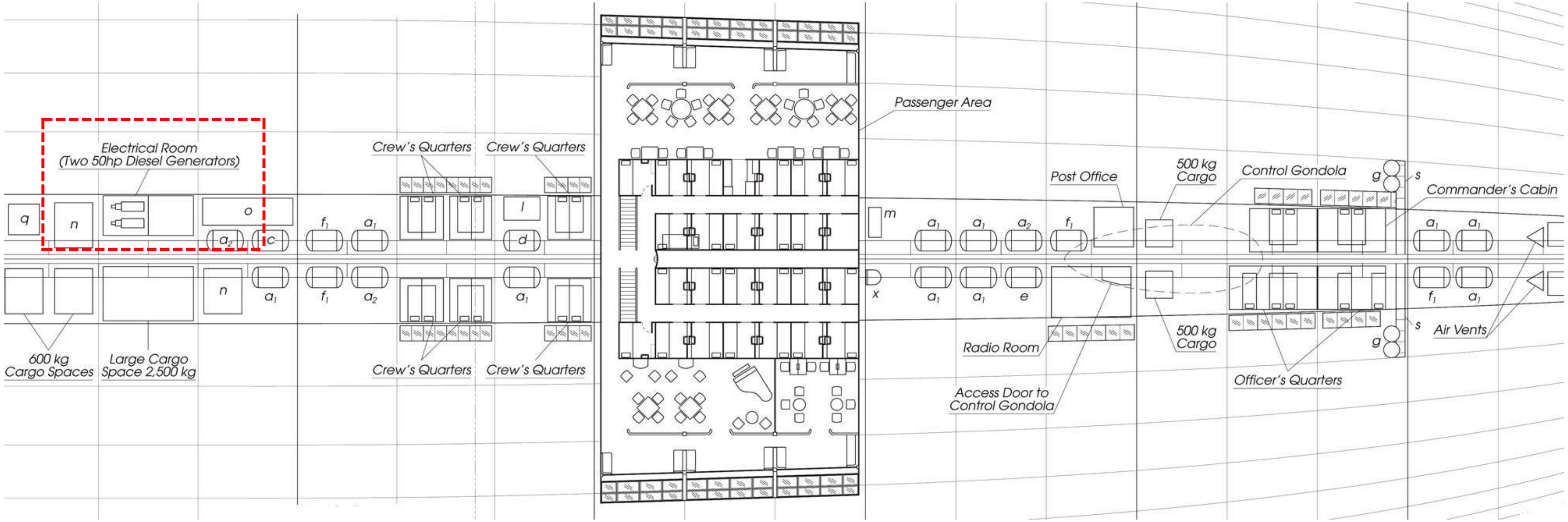
"…Above the control car which contains the machinery for manipulating the huge ship, there is a radio room containing equipment for wireless and long and short wave radio communication. Direction finding equipment is also placed here. An automatic telephone system with twenty-four stations at vital parts of the ship give perfect inter-communication through a common switchboard. The stateroom for captain and officers and the mail room are placed above the control car for accessibility…"

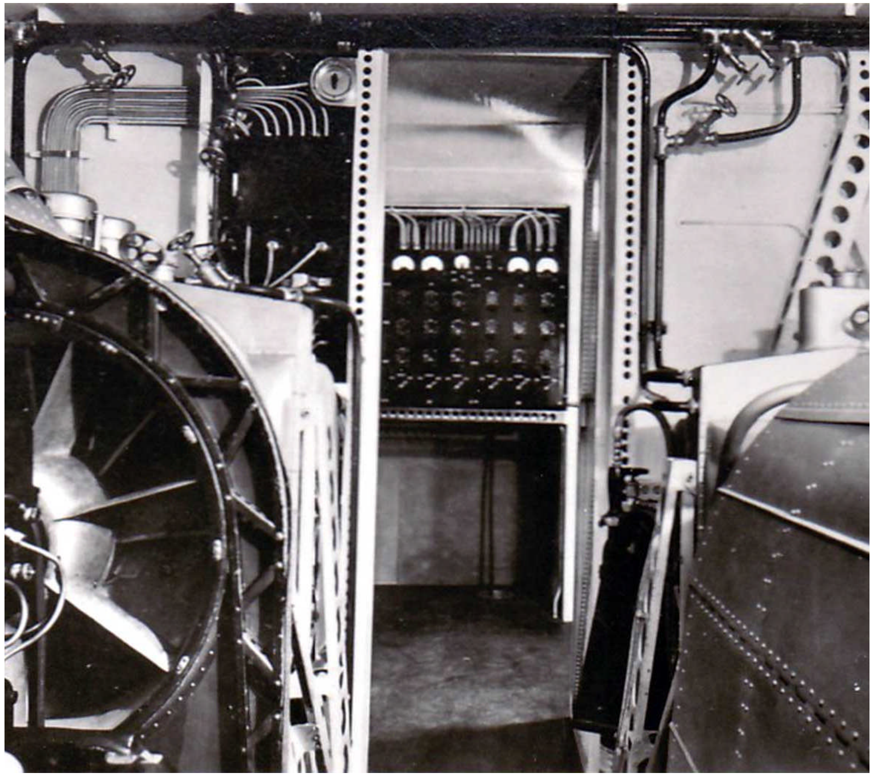
***Magazine of Art,* 1937**

<u>Above</u>: LZ-129's radio room (ca. 1936)

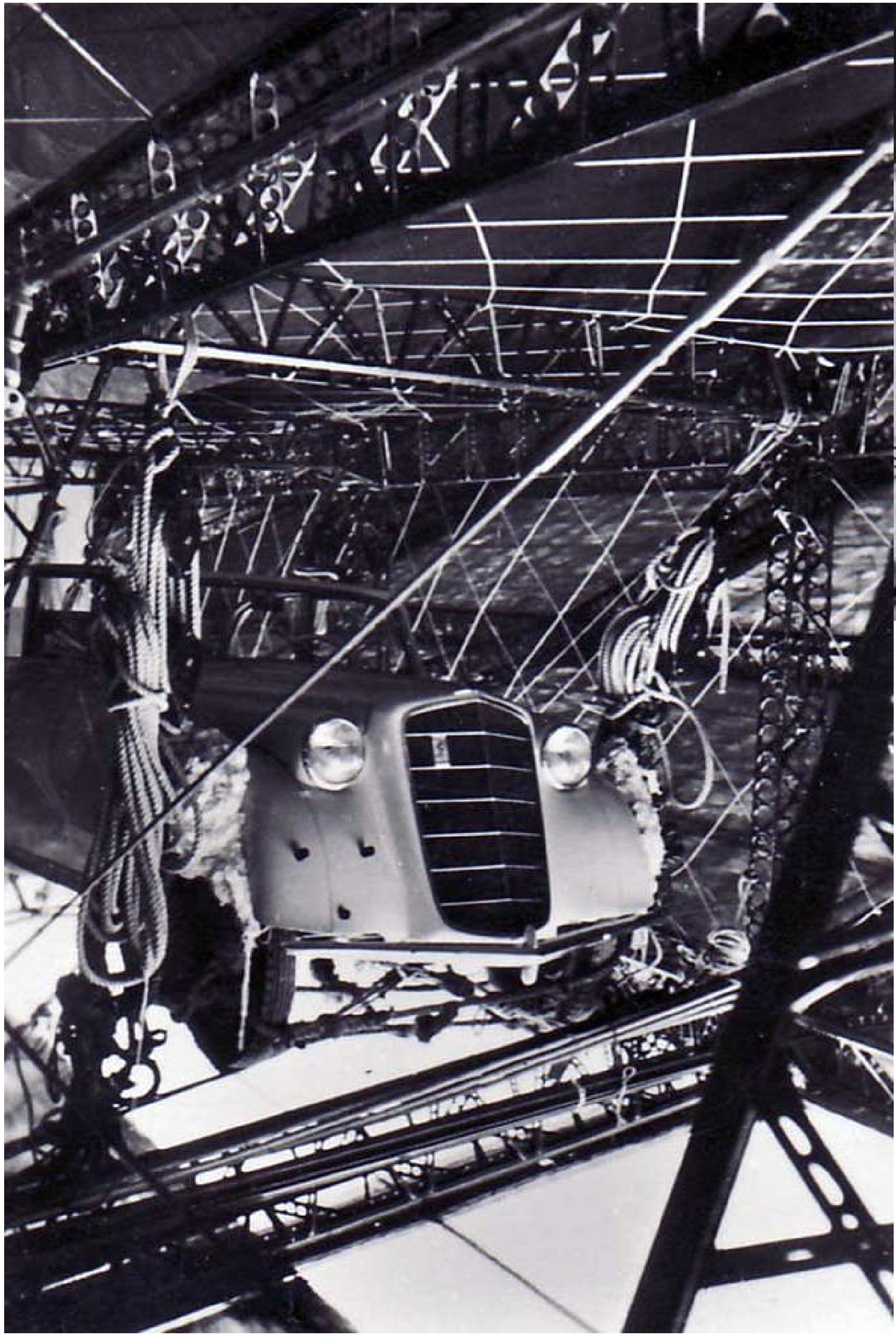


The area along the forward keel (above) toward the bow of the ship included LZ-129's radio room (left), electrical room and sleeping quarters for certain members of the crew. The radio room contained both long wave and short wave 200 watt radios, powered by batteries, which allowed the ship to communicate both telegraphically (by Morse-code) and also by voice. Her long wave transmitter had a 393-foot trailing antenna which could be deployed or retrieved with an electrically-powered winch. The short wave transmitter had an 85-foot trailing antenna which was manually deployed. There was also a 50-foot fixed antenna which was used only for receiving. In case of radio or electrical failure, there was a small emergency radio set in the bow which was powered by a stationary bicycle attached to a small generator.





Electrical power for LZ-129 was provided by two 50-65 HP *Daimler-Benz* OM-65 diesel engines connected to *Siemens* generators located in an electrical room. The generators could produce 35 KW of electricity which was fed through two systems; one at 220 volts and the other at 24 volts. Either motor by itself could produce enough electricity for the entire airship's needs, allowing one to be shut down for maintenance. The electrical room (left) also contained the master gyro compass and a 5.7 million candlepower *Hefner* searchlight which could illuminate the surface below. The room was made of thick aluminum sheets and was entered through an airlock and kept at positive pressure to prevent any free hydrogen from entering. The electrical room also had a hatch for access to the outside when the airship was on the ground.

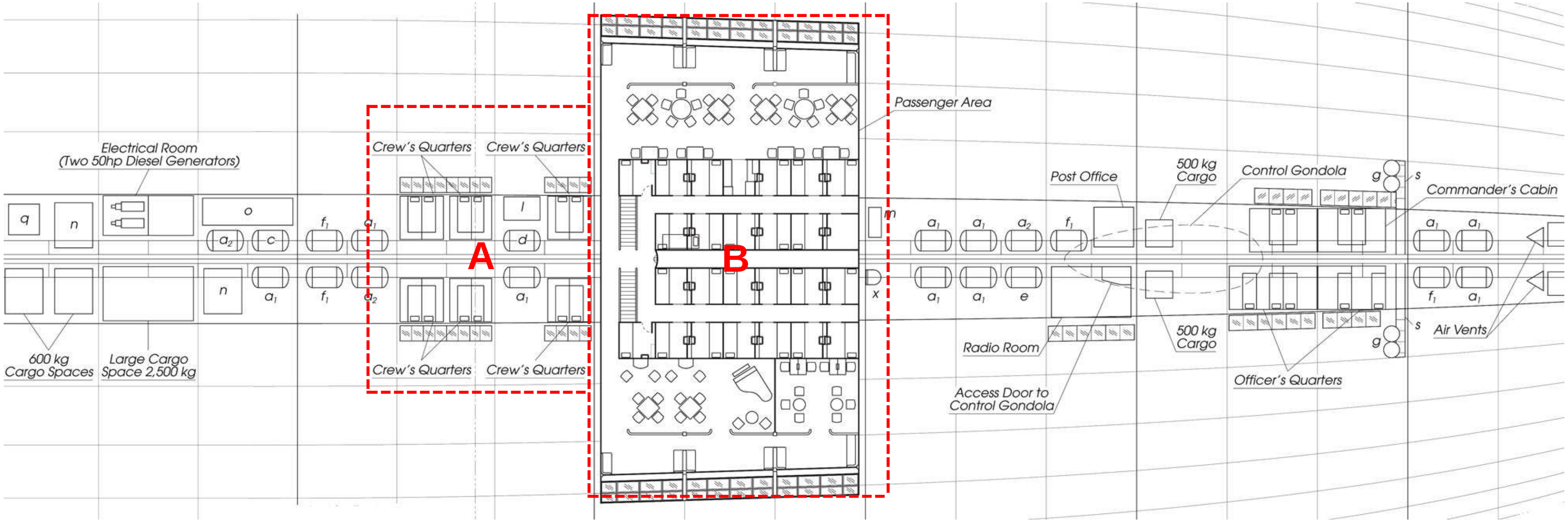


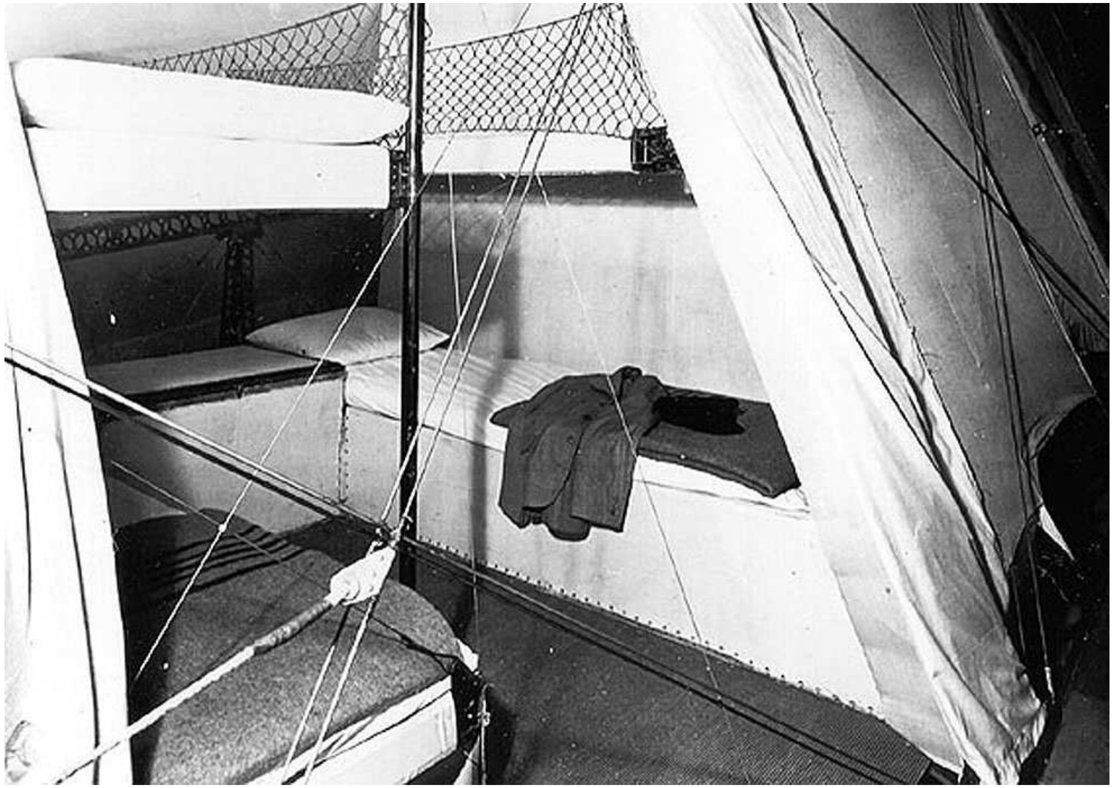
LG-129’s keel also contained several areas for storage of cargo and freight including automobiles (left & above)

"…The living quarters are in two decks, one above the other, connected by a broad staircase. The galley, with its electric stove and other equipment, is on the lower deck. Here also are the bathrooms, steward's office and crew's quarters…"

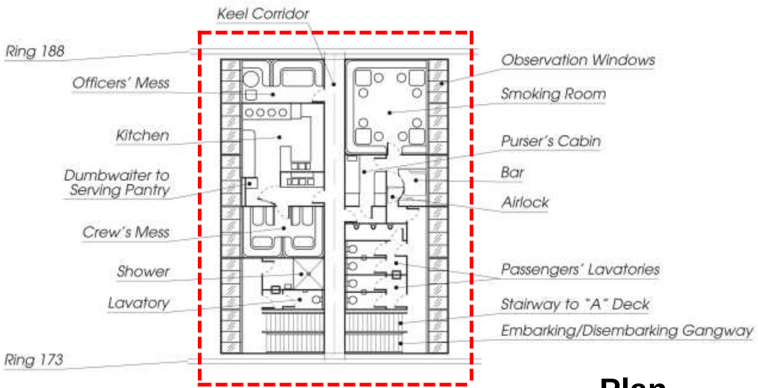
Popular Mechanics, **June 1935**

<u>Left</u>: mechanics' workstation alongside LZ-129's lower keel walkway

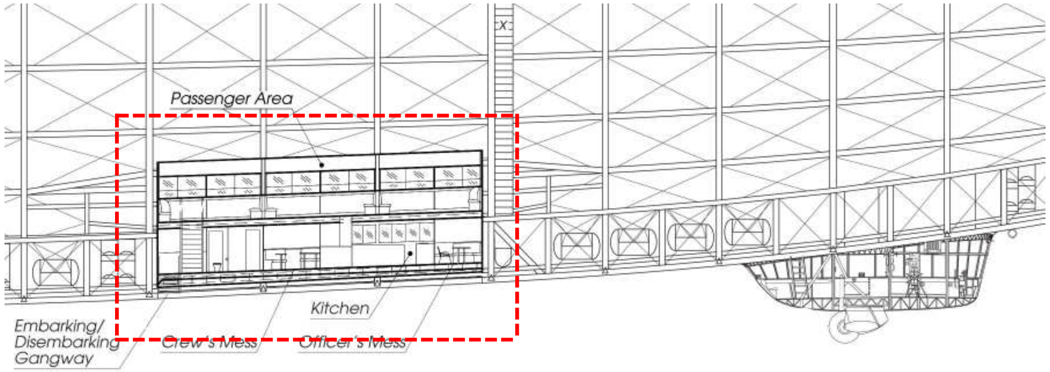




Sleeping quarters for the officers and crew were located within the hull of the ship along the keel (left). Officers shared a compartment with twelve bunks (A) located in Bay 14 (just forward of the control car) and the captain had a private cabin in the same area. There was a 22-bunk sleeping area (B) for the crew in Bay 11, just aft of the passenger accommodations. There were twelve additional bunks located toward the stern in Bay 5.



Plan



Section

The port section of "B-Deck," just below the main passenger deck, housed LZ-129's kitchen (above), connected by a dumbwaiter to the serving pantry on "A-Deck." There was also separate mess areas for the officers (left) and crew.

Zenith of the Zeppellin Builder's Art

"…Huge, complex, and beautiful, the Hindenburg was the supreme creation of the Zeppellin builder's art. Safe, too. Her designer, Dr. Ludwig Duerr, had boasted that she was as fireproof as man knew how to make any vehicle of transport…"

***Popular Science,* May 1962**

Part 8

Magic Carpet Ride

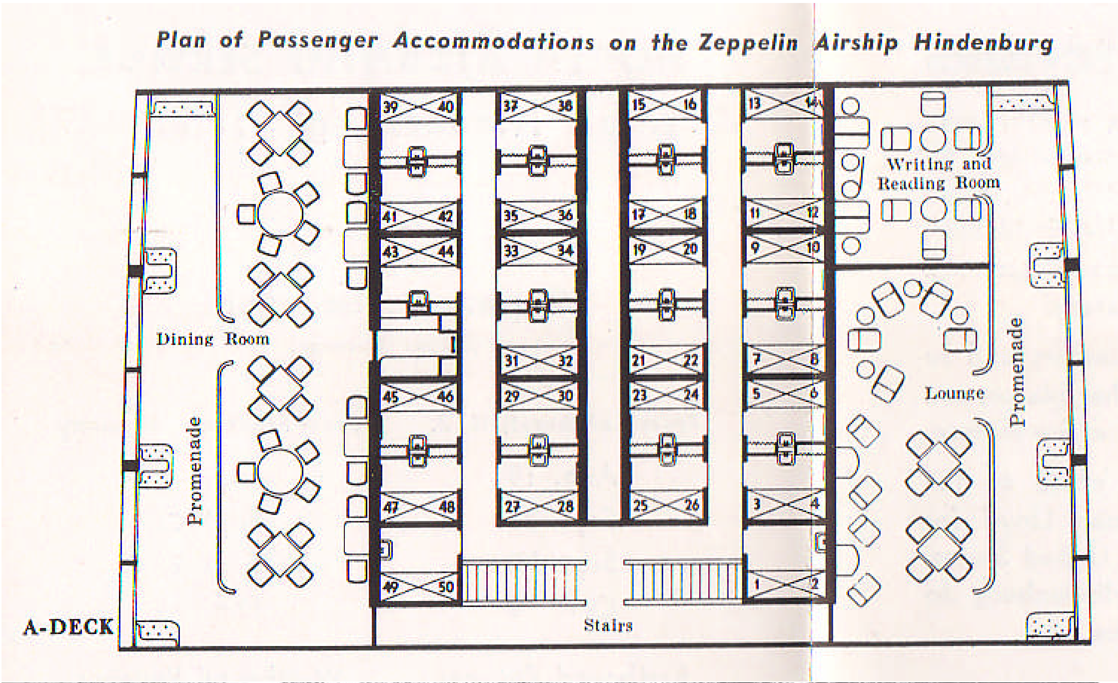
"…From the moment of going aboard the great flexibility of the ship's construction impresses one. The odd sensation of being suspended in the air and walking a tightrope is felt even when the ship is firmly anchored to the ground. A seemingly spongy resilience has been achieved in the flooring due to the fact that the passageways along which one walks (in fact the whole inside of the ship) are stretched firmly but springily along the frame. Light composition rubber flooring is topped with a narrow, light-weight carpet…"

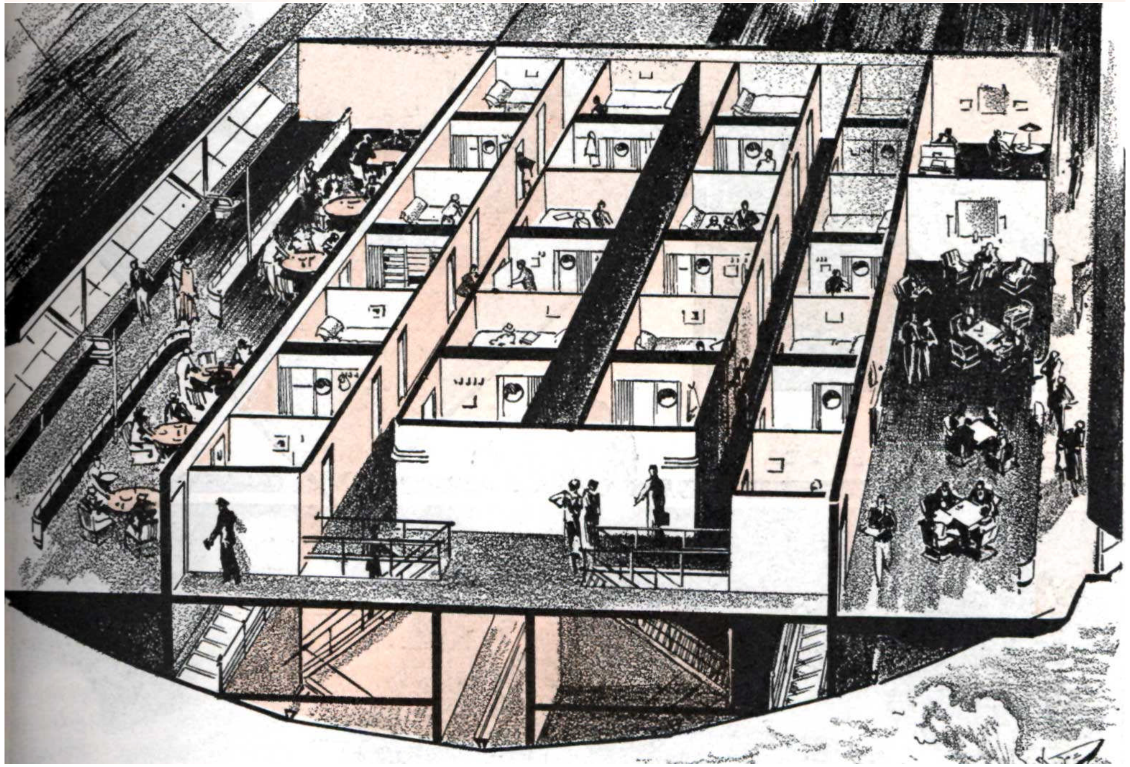
***Magazine of Art,* 1937**

Passenger Country

"…Beyond the 'Fuhrergondel' you came to passenger country. It was spectacular – an amazing replica of first-class ocean-liner accommodations, extending all the way across the width of the ship and one-third the depth up from the keel. There were two decks. The main A deck had promenades on either side lined with wide, slanting windows and overlooked by a lounge and the dining salon (hot biscuits, baked fresh in the galley, were a specialty). Off the foyer on A deck was a narrow corridor leading to the 25 Fahrgastraume. Each stateroom had two bunks, a stool, folding shelf, fold-up plastic washbasin, mirror, and electric light. You could even smoke aboard the airship. The bar was sealed off by double doors, which the steward unlocked when you rang the bell. Here the air pressure was maintained slightly above that in the rest of the ship so that no stray hydrogen could possibly leak inside. The smokers lit up with electric lighters (matches were verboten anywhere aboard)…"

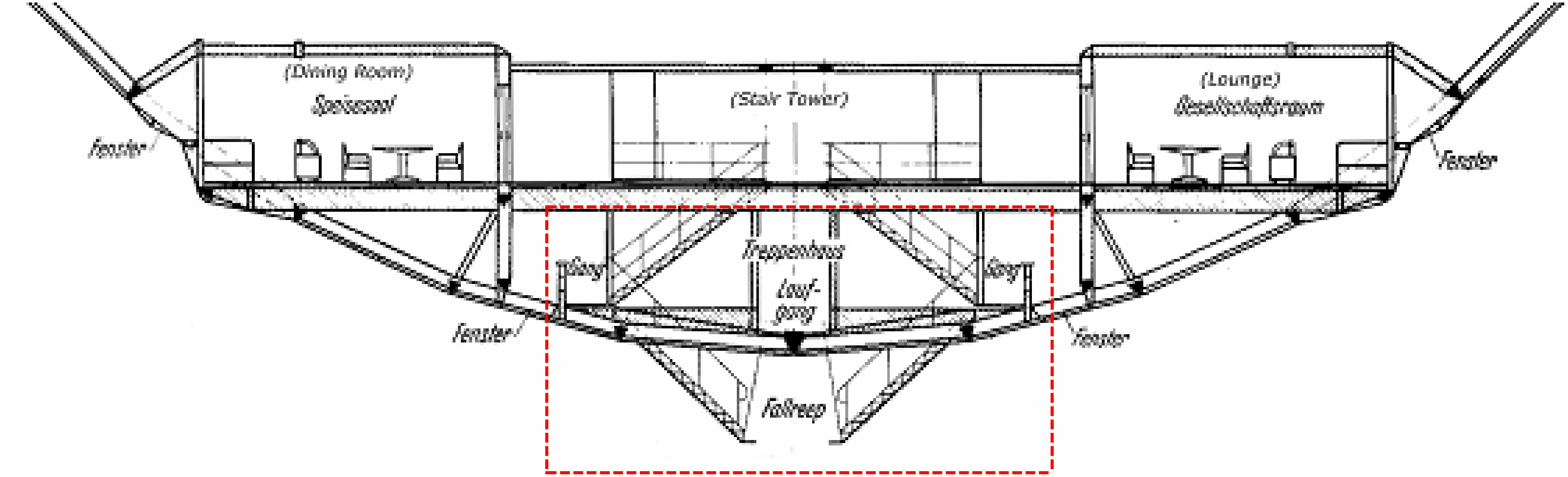
Popular Science, **May 1962**





LZ-129's "A-Deck" contained the airship's dining room, lounge, writing room, port and starboard promenades and 25 double-berth inside cabins (*Fahrgastraume*). The passenger accommodations were decorated in the clean, modern design of principal architect *Professor Fritz August Breuhaus* and in a major improvement over the unheated *Graf Zeppelin*, passenger areas on *Hindenburg* were heated using forced-air warmed by water from the cooling systems of the forward engines.

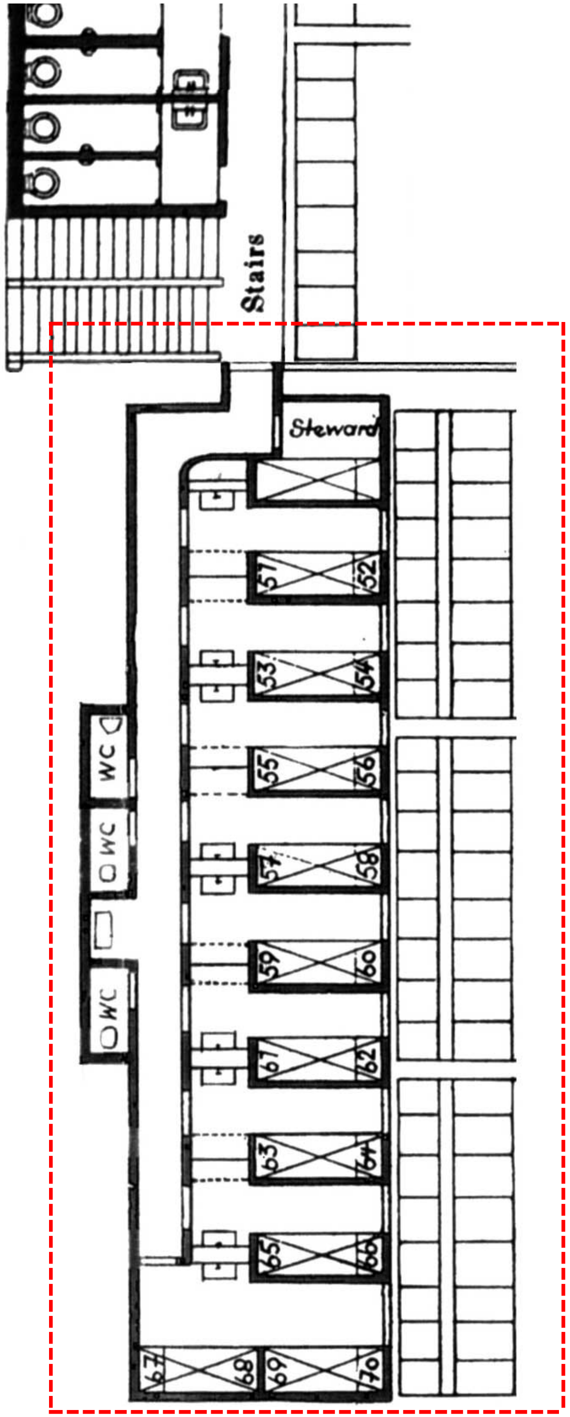
Architecture of the Air



"…The amazing and startling thing about the entire interior of the 'Hindenburg' to the lay visitor is the unsuspectedly capacious and comfortable space assigned to passengers. The accommodations for the fortunate travelers in this great ship of the air are much more impressive than those aboard any other aircraft. Going aboard one enters by means of two hinged gangways which lower from the regular passenger lounges, a bit aft of the control car…"

Magazine of Art, **1937**

<u>Above</u>: transverse section through stairs and gangway/s (highlighted)



"…Passenger accommodations are superior to those on any previous aircraft. The designer, Prof. F.A. Breuhaus, created an 'architecture of the air' in the interior decoration. He designed chairs, tables and beds as an engineer would design a bridge. Because so much dead weight was saved in the design, it is possible to accommodate fifty passengers and a crew of thirty-five in the ship's twenty-five staterooms, each with hot and cold running water. In addition, the ship will carry considerable express and mail…"

***Popular Mechanics,* June 1935**

RE: LZ-129 was originally built with twenty-five double-berthed cabins at the center of A-Deck, accommodating fifty passengers. After the inaugural 1936 season, nine more cabins were added to B-Deck, accommodating an additional twenty passengers. During the winter of 1936-1937, while the ship was laid-up in *Frankfort*, additional passenger cabins were also added in Bay 11, just aft of ring 173. The new cabins (highlighted at left) had windows offering an outside view and were slightly larger than the cabins on A-Deck. The addition of these new cabins was made possible by the unexpected need to operate the ship with hydrogen which has greater lifting power than the helium for which LZ-129 had been originally designed.

"…The staterooms are well-fitted with good beds and bedding, with curtained space and hangers for clothing. The cellulose washbasins, fitted with hot and cold water are rather shallow, and seem perhaps rather small after being used to deeper ones on board steamers. The cabin walls are covered with printed linen; but it is suggested that linen head covers be placed at the head of the beds, to avoid grease marks being left behind by passengers. Additional rooms, which are outside and are more commodious have been fitted on the lower deck, just aft of the smoking room, and receiving direct daylight, should prove very popular. This brings up capacity to seventy…"

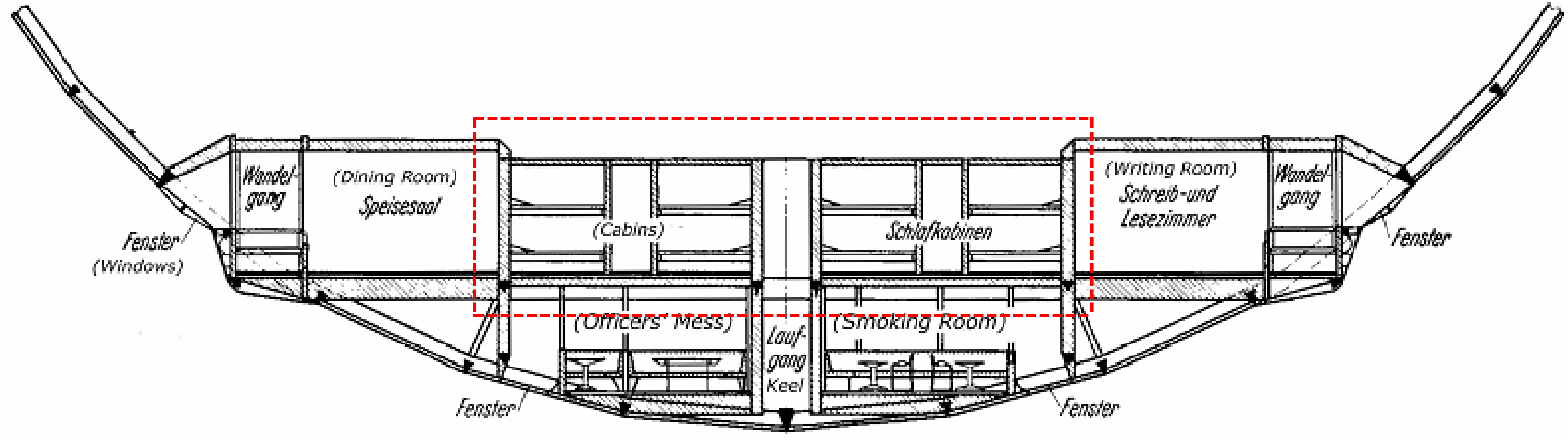
***George Grant*, LZ-129 passenger**

RE: excerpt from his: "Notes on a voyage of the Airship 'Hindenburg' under the Command of Captain Pruss; May 6th 1937, off the New England Coast"

"…Of course the great problem in designing the interior and its furnishings was to achieve comfort and durability without weight, since every ounce counts in handling the ship, keeping her on course, and making her steady in bad weather. As a consequence the subservience to functional requirements which has led to many developments in other fields of design was an absolute essential in creating the furniture for the 'Hindenburg.' Heavy articles of any sort are automatically barred; the metals and the textiles are always of the lightest weight. The furniture, for example, is made of duralumin; still more weight was saved by punching out all metal not needed for structural strength. This one requirement alone has brought to the furniture's design balance and a definite simplicity of line. A kindred efficiency has brought purposefulness even to the style of the table ware. But sufficient weight was saved in the furniture to make it possible to use good porcelain instead of composition substitutes…"

***Magazine of Art*, 1937**

Above: porcelain tea-set from LZ-129



The A-Deck cabins were small, comparable to railroad sleeper compartments of the era. The cabins measured approximately 78-inches by 66-inches and the walls and doors were made of a thin layer of lightweight foam covered by fabric. Cabins were decorated in one of three color schemes; either light blue, grey or beige. Each A-Deck cabin had one lower berth which was fixed in place and one upper berth which could be folded against the wall during the day (left). Each cabin had call buttons to summon a steward or stewardess, a small fold-down desk, a wash basin made of lightweight white plastic with taps for hot and cold running water and a small closet covered with a curtain in which a few suits or dresses could be hung. Because the A-Deck cabins were located in the center of the airship, they had no windows, unlike *Graf Zeppelin* where passengers had enjoyed the view from their berths.

<u>Above</u>: transverse section through passenger cabin area

"…Although you can always feel there are engines, which is perhaps slightly more noticeable in the cabins, the movement of the Airship hardly varies. An occasional slight roll is therefore hardly perceptible. AIR SICKNESS is quite unknown, a strong point which cannot be too strongly emphasized…"

***George Grant*, LZ-129 passenger**

RE: excerpt from his: "Notes on a voyage of the Airship 'Hindenburg' under the Command of Captain Pruss; May 6th 1937, off the New England Coast"

"…There are twenty-five cabins of adequate size for the passengers' sleeping quarters. Each room has two berths, an upper and a lower. Every upper is designed to be raised into a niche in the wall, thus converting the lower into a sofa lounge…"

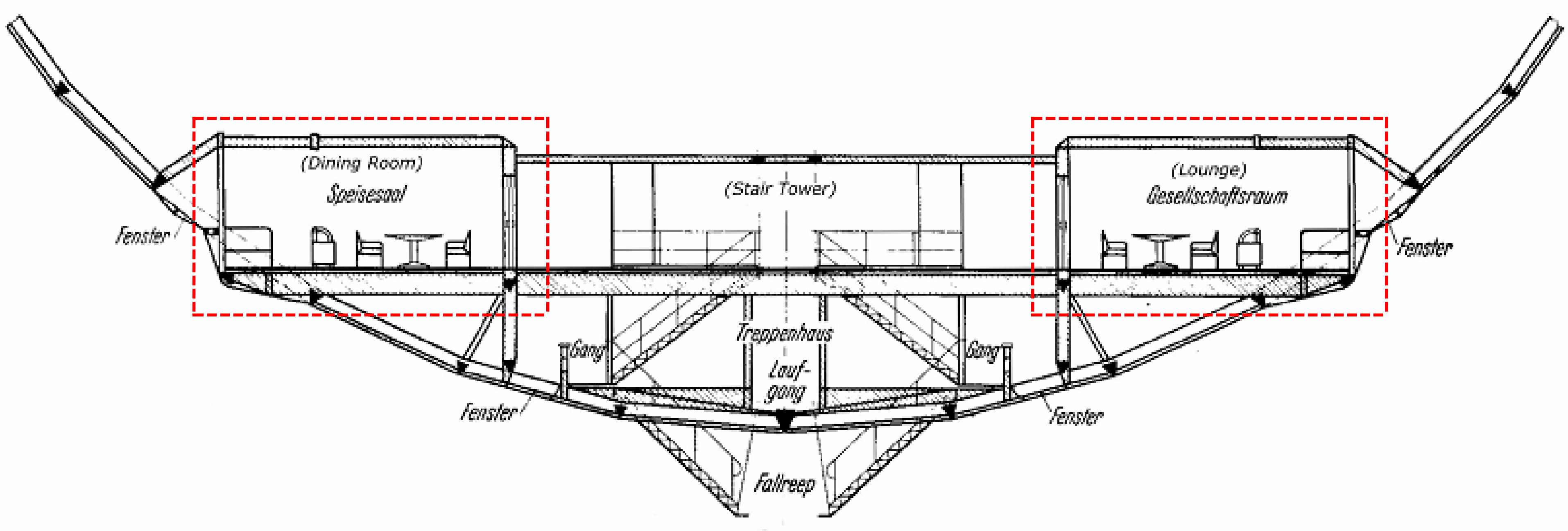
***Magazine of Art*, 1937**

A Many Roomed Tent

"…If you wanted to take a shower (imagine that aboard a jetliner!), you went down to the 'Badzimmer' on B deck. It gave a trickle of water until an automatic shutoff unmistakably told you 'time's up.' Water was too heavy to be carried in lavish supply – they augmented tank storage by collecting rain and dew that ran off Hindenburg's four-acre back. Everywhere, ingenious touches economized on weight. Each extra pound meant 13 more cubic feet of hydrogen. You could lift any of the chairs with the finger of one hand. You needed two hands to raise the piano which was made of aluminum. The partitions – even stateroom walls – were canvas; it was like living in a many-roomed tent…"

***Popular Science,* May 1962**

RE: none of the passenger cabins had toilet facilities. Male and female toilets were available on B-Deck below as was a single shower which provided a weak stream of water: *"like from a seltzer bottle,"* according to one passenger.



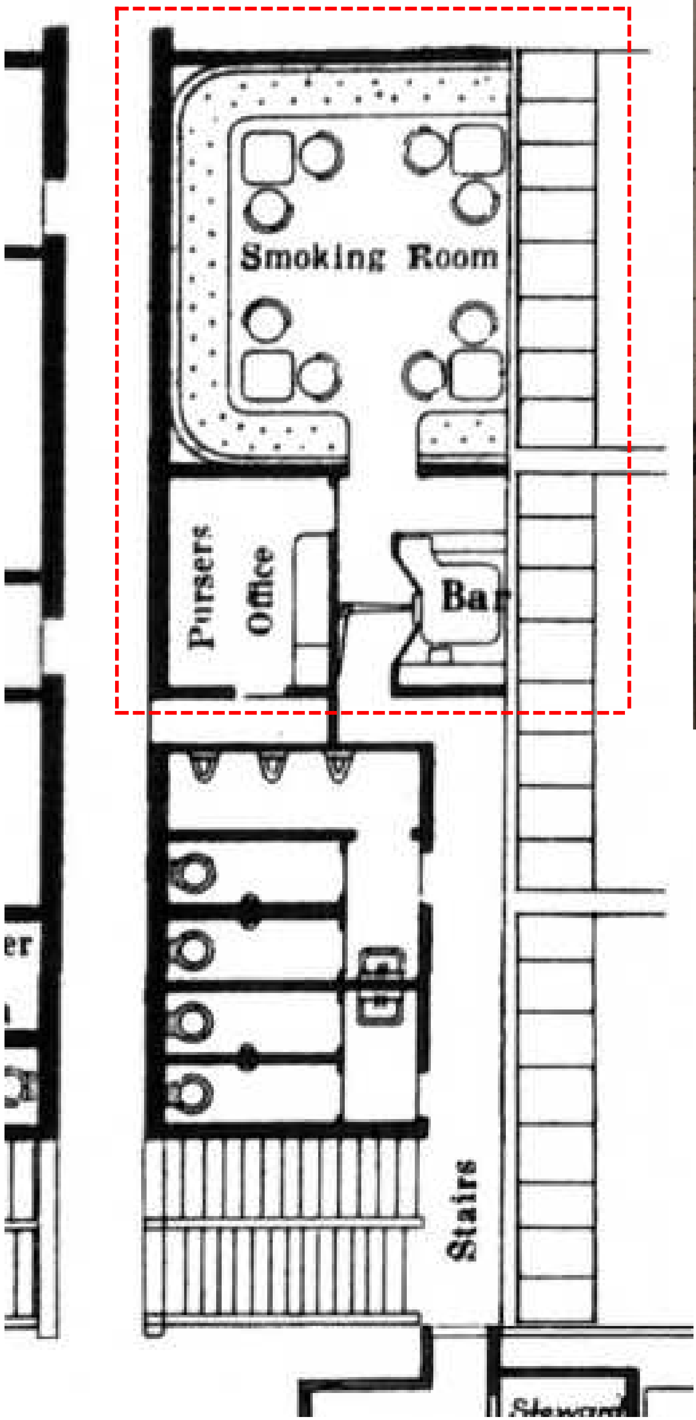
"…There are two groups of parlors, including two promenade decks, giving a total floor space of 5,380 square feet, of which one-half is available for social gatherings. The passengers will be permitted to smoke, a luxury denied on the 'Graf Zeppelin.' The social salons and promenades are in the sides of the ship to enable passengers to have a full view of the panorama...There is even enough room for certain deck games. Passengers will eat in comfort in a dining room with thirty-eight chairs and equipped with long tilted windows…In order to offset the coldness of metal furniture, the public rooms are decorated in soft pleasing colors. Wall paintings show the history and development of the airship, a bird's-eye panorama of the route traveled, and the constellations in both the northern and southern hemispheres…"

***Popular Mechanics,* June 1935**

<u>Above</u>: transverse section through dining room and lounge

"…There are two decks, A and B. The lower section contains the smoking room which is one of 'Hindenburg's' greatest innovations, since in commercial airships smoking has heretofore been forbidden. This room has been very cleverly designed. To arrive at the smoking room one must pass through the small bar and enter by means of a door which opens only from the inside. No one is allowed to leave until it is certain cigarettes, pipes, and cigars have been extinguished, and a steward is placed on door duty to make certain that no such catastrophic happening can occur, since the highly flammable gas with which the 'Hindenburg' is filled must be constantly remembered. The door is electrically controlled and can be only opened by this steward after he has made certain that those leaving are not endangering the ship. Special ash receivers are also distributed throughout the room, which automatically shut completely airtight to smother any glowing stubs of tobacco…"

***Magazine of Art*, 1937**



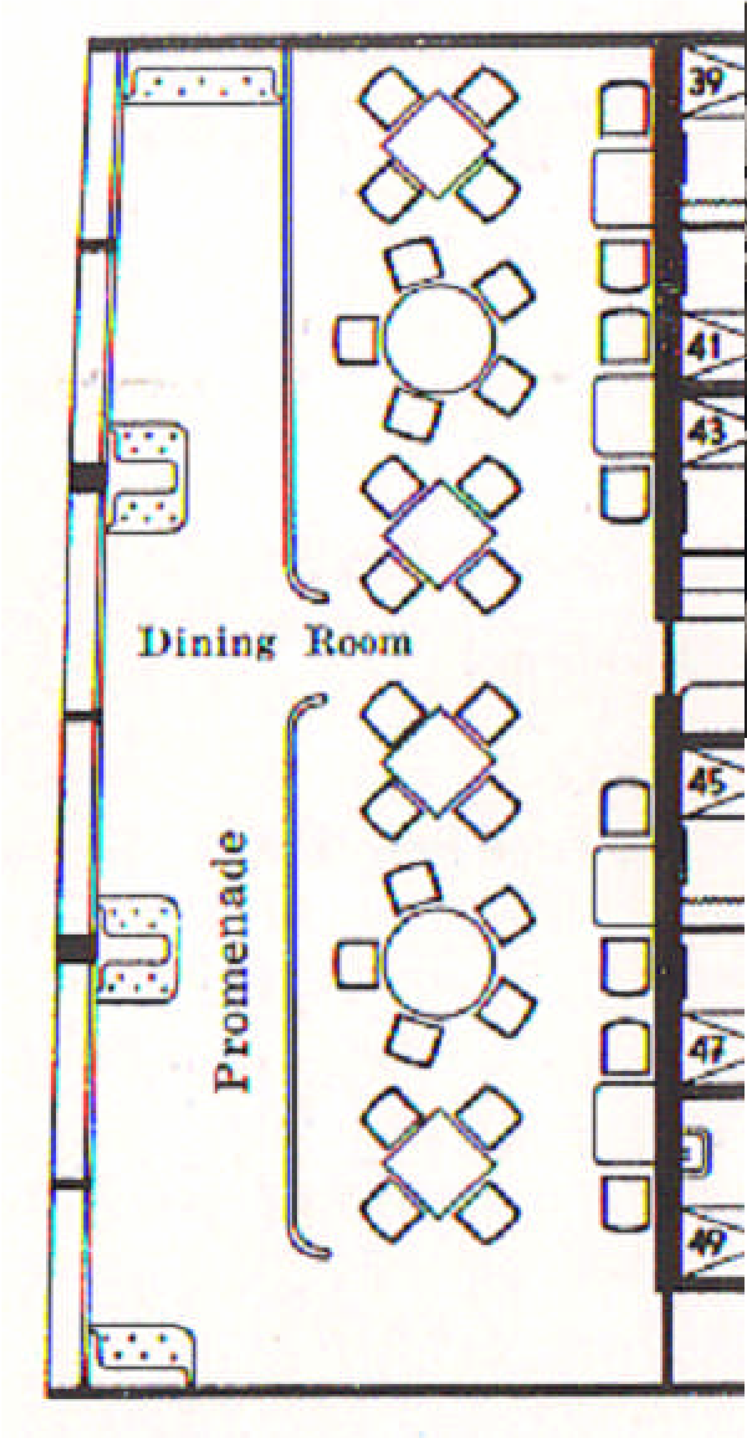
The smoking room (plan at left) was kept at higher than ambient air pressure in order that no leaking hydrogen enter the room. The B-Deck smoking room and its associated bar were separated from the rest of the ship by a double-door airlock. One electric lighter was provided, since no open flames were allowed aboard the airship. In an era when most people smoked, it's not surprising that it was the most popular public room on LZ-129. In the photo above can be see the door leading to the bar flanked by *Otto Arpke* pigskin illustrations and the constellations of the northern and southern hemisphere/s (on the wall at left).

“…The walls are decorated in a long panorama of travel, emphasizing the development of aircraft through the years. These decorations are done in small mural effects upon a background of washable leather. In the sequence in which the events actually occurred they illustrate the historical attempt of Francesco Lamas, Jesuit Father, who in 1670 tried to travel by a lighter-than-air ship; the first balloon ascent of the Montgolfier brothers; and several sketches of modern air travel…”

***Magazine of Art*, 1937**

The smoking room was painted blue, with dark blue-grey leather furniture. The walls were decorated with yellow pigskin and illustrations by *Otto Arpke* depicting the history of lighter-than-air flight from the Montgolfier brother's balloon (left) to the evolution of the *Zeppelin* (above). Along one side of the room was a railing above sealed windows through which passengers could look down on the ocean or landscape passing below.

The bar (above & left) was a small ante-room between the smoking room and the air-lock door leading to the corridor on B-Deck. The bartender monitored the air-lock to ensure that nobody left the smoking room with lit cigarettes, cigars or pipes.



"…At the entrance of the dining salon is a decorative panel of Hebe with her cornucopia. Inside are small murals recording vivid impressions of an aerial trip from Germany to Brazil…the large windows placed at an angle so that passengers may always see what they are passing over – whether they are far out over the Atlantic, above the towers of Manhattan, or about to land after a few days passage to Friedrichshafen…"

***Magazine of Art,* 1937**

<u>Above</u>: dining salon made up for the "Captain's Dinner" (port promenade in view)

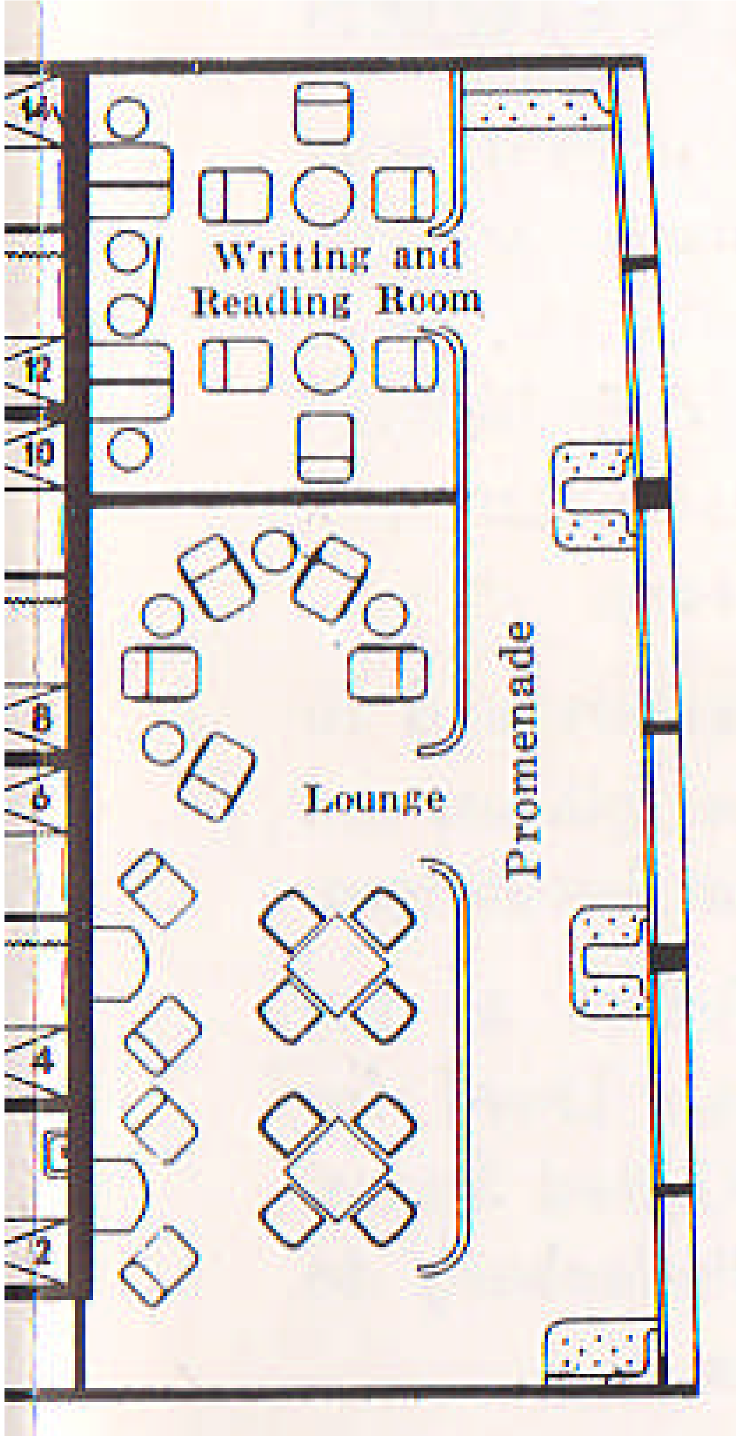
<u>Left</u>: A-Deck plan of dining room/salon

LZ-129's dining room occupied the entire length of the port (left) side of A-Deck. It measured approximately 47-feet long by 13-feet wide and was decorated with paintings on silk wallpaper by *Otto Arpke* depicting scenes from the Graf Zeppelin's many flights to *South America*. The fabric backs of the chairs were detachable for repair and/or inspection. The promenade windows on both the port and starboard side/s were operable and could be opened in flight.

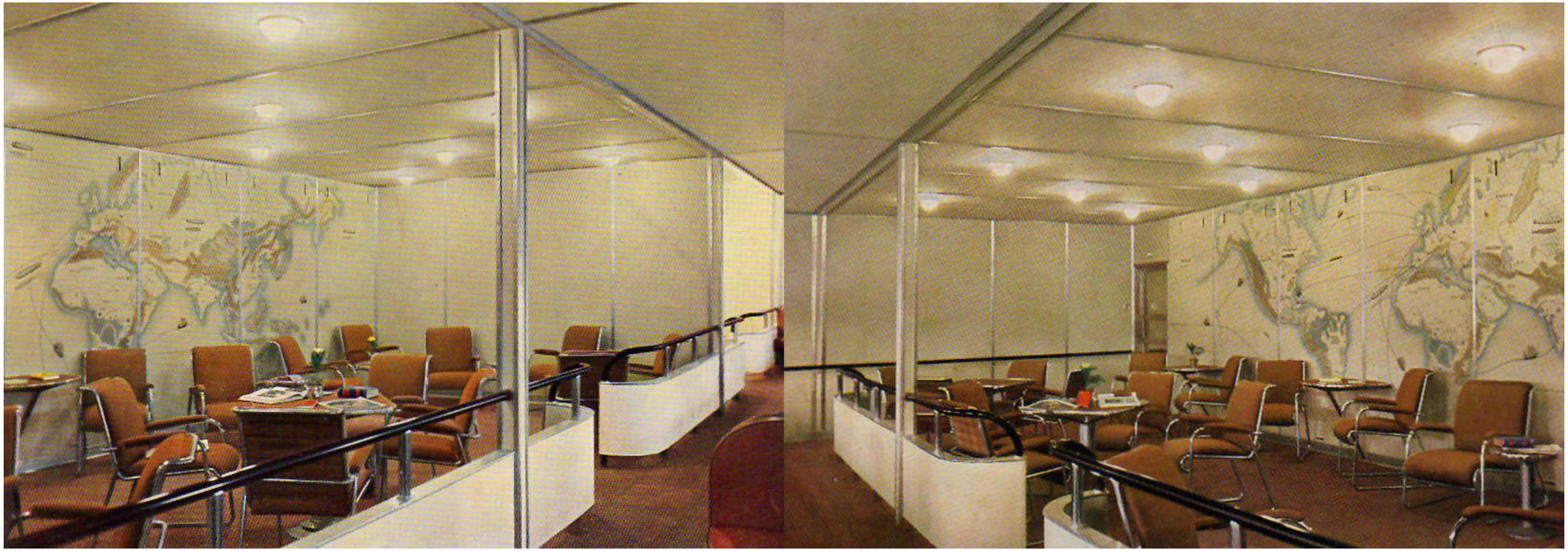
"…The chairs and tables throughout are of sturdy metal construction. Composition tops are used for tables and desks. Woven fabrics in smooth textures are used for some upholstery, varied by leather upon the pieces along the sides of the ship, since the designers very well knew that curious passengers would give most wear to the chairs placed near the windows where the impressive panorama of the world below may be seen…"

***Magazine of Art*, 1937**

<u>Above</u>: port promenade with seating (left) and dining room (right)



"…Great maps are used as mural decorations in the main lounge, so that the traveler may check his knowledge of geography while passing directly over the spot. In this main saloon there are facilities for broadcasting and for receiving radio programs. And there is a piano with a light metal frame. Ship's concerts and amusement schedules for the evening rival the entertainments found aboard ocean liners…"
***Magazine of Art,* 1937**

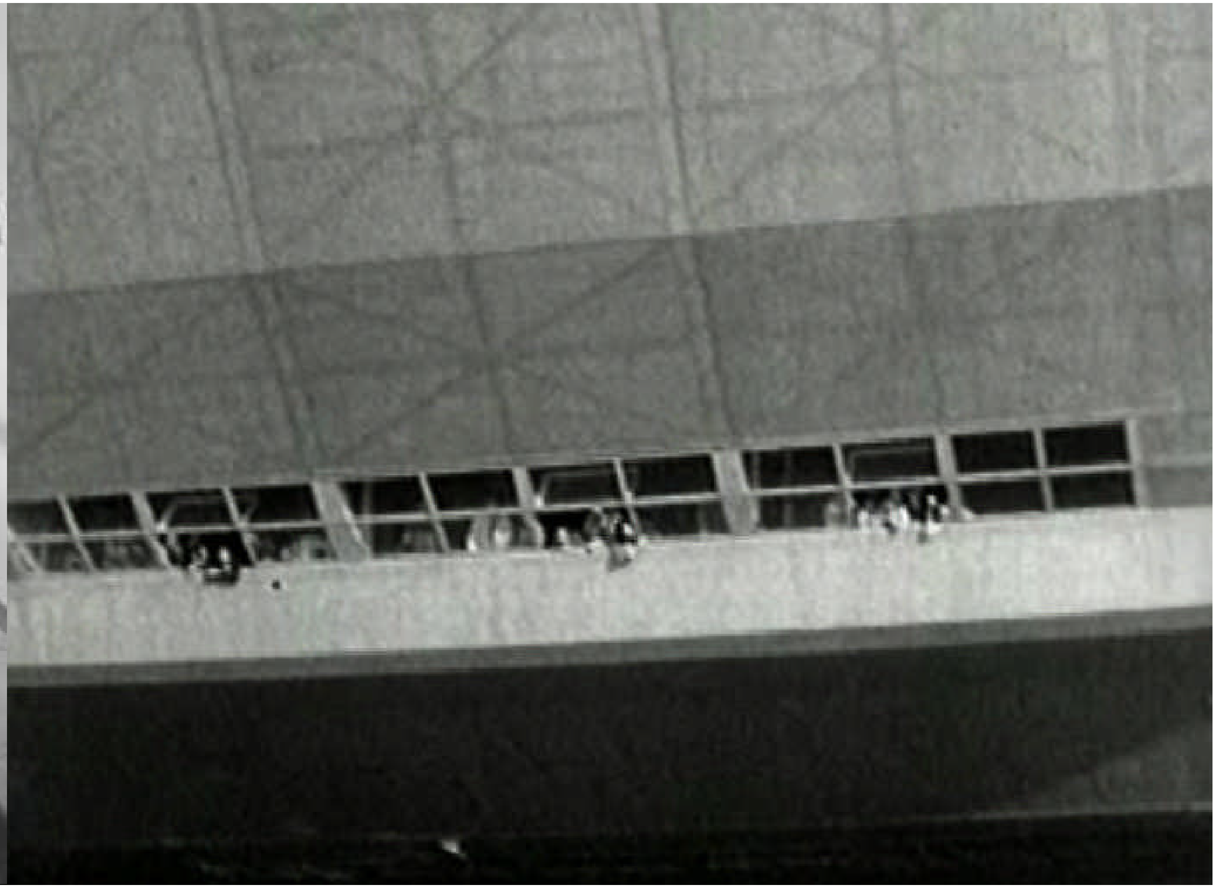


On the starboard side of A-Deck were the passenger lounge (above L&R), writing/reading room and starboard promenade. The lounge was approximately 34-feet long and was decorated with a mural by *Otto Arpke* depicting the routes and ships of the explorers *Ferdinand Magellan, Captain Cook, Vasco de Gama*, *Christopher Columbus*, the transatlantic crossing of LZ-126 (*USS Los Angeles*), the round-the-world flight and South American crossings of LZ-127 (*Graf Zeppelin*) and the *North Atlantic* tracks of the great German ocean liners *S.S. Bremen* and *S.S. Europa*. The furniture, like that in the dining room, was made of duralumin and designed by Professor Breuhaus.

"…The resulting air of spaciousness is further carried out by the surrounding promenade some fifty feet long. Here again are installed slanting windows which look down upon the surprisingly flat world beneath…"

***Magazine of Art,* 1937**

<u>Left</u>: starboard promenade



"…The public rooms are especially well-arranged and comfortably furnished, with large observation windows, there being three central windows on either side which can be opened, affording passengers every opportunity of seeing anything of interest – such for instance – an ice field and a huge Iceberg, which were passed directly over when in view of Newfoundland…"

***George Grant*, LZ-129 passenger**

RE: excerpt from his: "Notes on a voyage of the Airship 'Hindenburg' under the Command of Captain Pruss; May 6th 1937, off the New England Coast"

<u>Above & Left</u>: during the 1936 season, the lounge contained a 356-pound *Bluthner* baby grand piano made of duralumin and covered with yellow pigskin. The piano was removed before the 1937 season and was not aboard during her last flight. It was frequently played by passengers and *Captain Ernst Lehmann* who had entertained passengers on the *Graf Zeppelin* with his accordion.

Forward of the lounge was a small reading and writing room (left) whose walls were decorated with paintings by *Otto Arpke* depicting scenes from around the world (above).

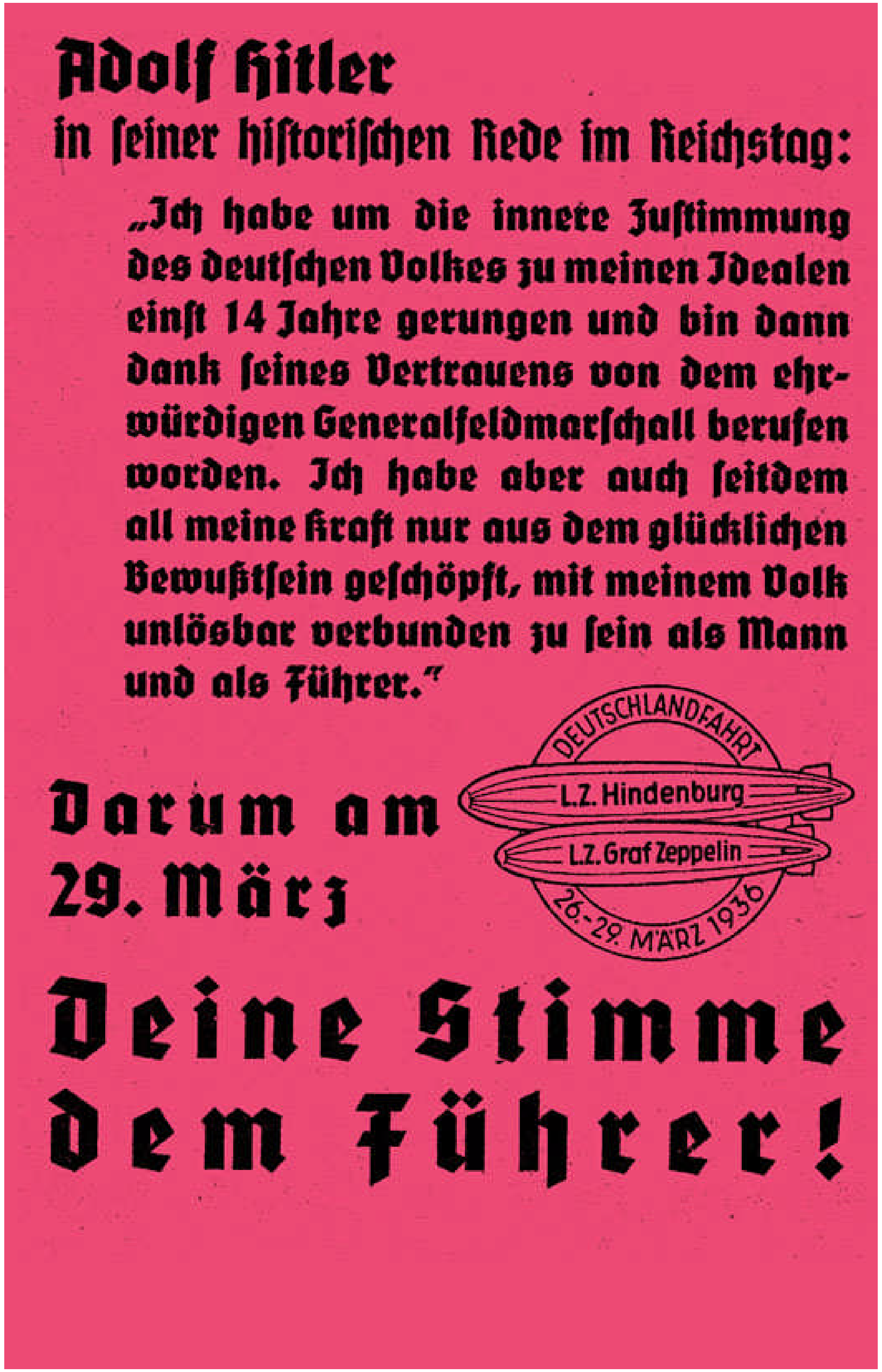
Brilliance of Decor

"…The color scheme of A deck is one of warm monotones. Walls are done in subtle gray tones. White dot-patterns on grey linen increase the daylight in the corridors. Black rails for the stair cases are of composition resembling our formica. These are also used on the collapsible, retractable gangplank. The upholstery in the living salon is also of one shade – a warm brown which contrasts well with the bright metal alloy of the frames. In the spacious dining room the leather chair coverings are bright red. The galley, which serves efficiently almost a hundred people, is appropriately finished in enamel and metal. The rugs used in the long passageways are of green and grey plaid. The whole decorative scheme of the 'Hindenburg' was executed under the direction of Professor Fritz August Breuhaus of Berlin…Everything possible has been done for the comfort of the passengers. Perhaps the future may see great fleets of lighter-than-air craft vying with one another, as do ocean liners, not only in speed, but in comfort and brilliance of decor…"

***Magazine of Art,* 1937**

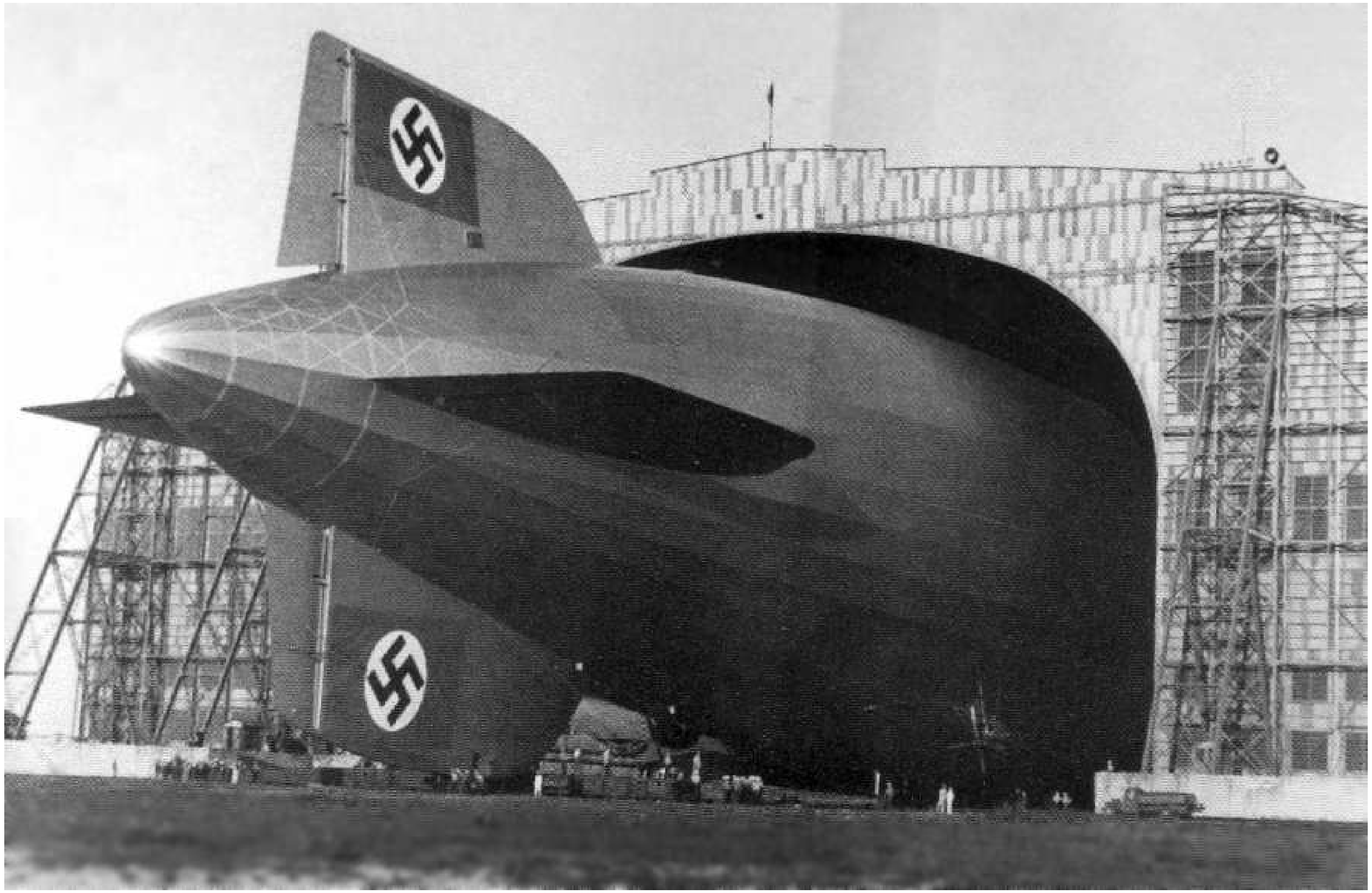
Voyages

After completing her basic test flights in early March 1936, LZ-129 was scheduled to make a series of endurance trials in preparation for her first transatlantic crossing on March 31st 1936. In place of the endurance trials, the *Ministry of Propaganda* requested that *Hindenburg* and *Graf Zeppelin* undertake a joint three day flight in support of the upcoming March 29th plebiscite on Hitler's remilitarization of the *Rhineland*. The trial flights were cancelled and the propaganda flights made instead. Despite unfavorable gusty conditions on the day of departure, the propaganda flight went ahead. Hindenburg's ground crew lost control of the airship while preparing her for take-off and the stern slammed into the ground damaging the lower fin (left). Despite the damage, the fin was quickly repaired and Hindenburg and Graf Zeppelin spent the next few days broadcasting music and pro-Hitler announcements from specially installed loudspeakers while dropping swastikas attached to tiny parachutes and propaganda leaflets encouraging German citizens to vote for the Fuhrer in the Rhineland referendum.



Hugo Eckener **was furious at *Ernst Lehmann* (who was beholden to the Nazis for making him head of DZR) for jeopardizing not only the brand new airship but the entire *Zeppelin* program. He chastised Lehmann and Propaganda Minister *Joseph Goebbels* for risking the airship to make a “scheissfahrt” (shit flight). LZ-129 made seventeen round-trips across the *Atlantic* in 1936, transporting 2,600 passengers in comfort at speeds up to 85 mph. The *Zeppelin Company* began constructing LZ-129 in 1931, several years before Adolf Hitler’s appointment as Chancellor. For the fourteen months it operated, the airship flew under the newly-changed German national flag; the Swastika of the Nazi party.**

<u>Left</u>: leaflet dropped by the *Hindenburg* and *Graf Zeppelin*



"All of the crew, those who weren't on watch at the time, watched through the lower windows as the airplane flew about half a meter below the ship's hull at the same airspeed as the airship, and with a very short distance between the hook and the trapeze. Then, Udet gradually increased his speed and approached the trapeze. This was the pivotal moment. We were all on edge: Would it work or not? There – a jolt, and the airplane hung there with its engine shut down, swinging to and fro, supported by its arrester hook. Everyone gave a sigh of relief, and Udet waved to us, laughing. Then he pulled a lever, and the airplane went into a glide. General Udet repeated this several times."

Werner Franz

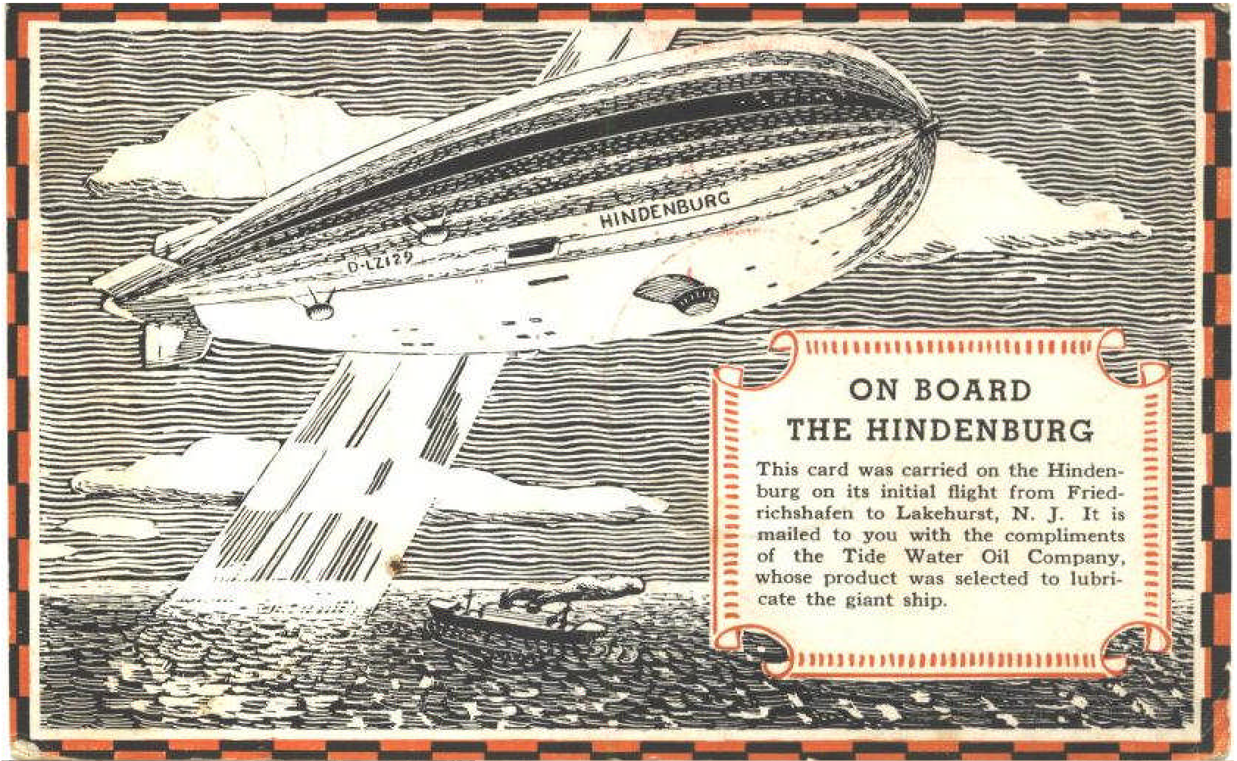
RE: recollection of 14yo LZ-129 crewmember. In March 1937, LZ-129 made several test flights including one in which the famous *Luftwaffe* WWI flying ace *Ernst Udet* attempted to hook his airplane onto a special trapeze that had been installed on the lower hull. The *U.S. Navy* had perfected this system on Macon and Akron. The DZR planned to incorporate a similar hook-on airplane to their passenger airships to allow for in-flight pickup of mail and passengers.

LZ-129's flight to *North America* on May 6-9th 1936 was not the airship's first passenger flight, or even its first international voyage. She made a number of flights after her initial test flight on March 3rd 1936 including a 74-hour propaganda flight around *Germany*. Airship Hindenburg's first international journey was a roundtrip to *South America* on March 31st to April 10th 1936. Because LZ-129 had been designed specifically for service between *Europe* and the *United States*, her first flight to *Lakehurst, New Jersey,* in May 1936, is often referred to as the great airship's "maiden voyage." The flight had all the traditional hallmarks of a maiden voyage, including a passenger list studded with notable personages and the excitement, glamour and media attention (including a live radio broadcast from mid-air). By other measures as well, such as the quantity of mail carried (much of it in the form of souvenir philatelic mail), the first flight to Lakehurst NAS certainly captured much more popular attention. In contrast, the first flight to South America carried 61 kg of mail while the maiden voyage flight to *North America* carried 1,059 kg of mail.

Left: *Max Jordan* (standing) was a pioneering radio broadcaster for the *National Broadcasting Company* (NBC). He directed a live radio broadcast from LZ-129 as it approached the American coast on her May 6-9th 1936 maiden voyage to *North America*

Right: AP reporter *Louis Lochner* (smiling, at far left) relaxing with fellow passengers in the lounge during the May 1936 maiden voyage

Father *Paul Schulte* was a missionary known as the “flying priest.” A German military pilot during WWI, he was ordained a Catholic priest after the war and used airplanes on his missionary work in *Africa* where transportation by ground was a serious challenge. He founded MIVA; an organization to provide transportation vehicles for missionary work. He was aboard LZ-129 on his way to *North America* to perform missionary work among Eskimos in *Canada*. Prior to the flight, Father Schulte obtained papal permission to perform the world’s first aerial mass which he conducted aboard *Hindenburg* during its North American maiden voyage on Sunday, May 6th 1936.


HINDENBURG
D-LZ129
ON BOARD
THE HINDENBURG
This card was carried on the Hindenburg on its initial flight from Friedrichshafen to Lakehurst, N. J. It is mailed to you with the compliments of the Tide Water Oil Company, whose product was selected to lubricate the giant ship.


First Flight
Of the New German Zeppelin
HINDENBURG
from
This is an IMPERIAL Cover
FÜRSTENTUM LIECHTENSTEIN
2 Fr
TRIESENBERG
4.V.36
R
Triesenberg
(Liechtenstein)
753
REGISTERED
VIA A
Ewing Noll,
36 Romney Road, Beech Glen,
Wheeling, West Virginia.
U.S.A.


Mit LZ 129 nach Nordamerika
50 Deutsche Luftpost 50

THE ZEPPELIN AIRSHIP

HINDENBURG

OF THE "DEUTSCHE ZEPPELIN-REEDEREI

(German Zeppelin Transport Company)

•

EASTBOUND CROSSING
from
LAKEHURST, NEW JERSEY
to
FRANKFORT on MAIN, GERMANY

JUNE 23 · 1936

•

Staff

DR. HUGO ECKENER
Commander

Watch Officers
Capt. M. PRUSS — Capt. A. SAMMT
Mr. H. BAUER

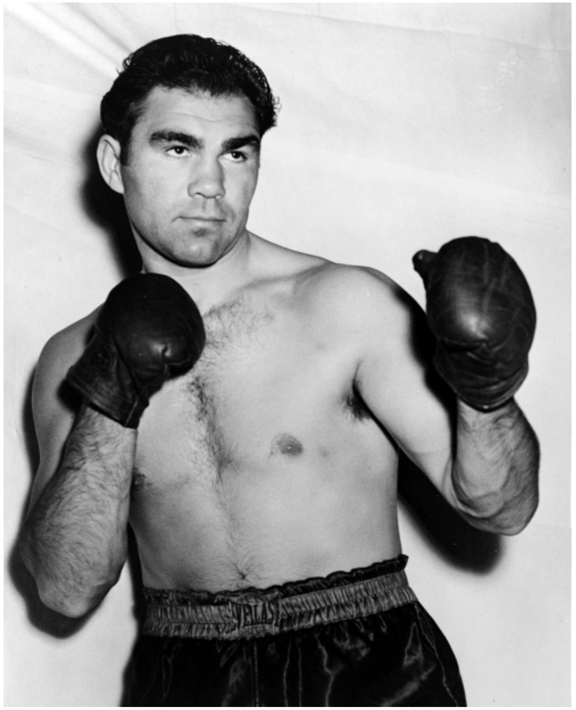
Chief Engineer — Mr. R. SAUTER
Radio Officer — Mr. W. SPECK

Mail and Sanitary Officer
Mr. K. SCHÖNHERR

Chief Steward — Mr. H. KUBIS
Chef — Mr. X. MAIER

LIST OF PASSENGERS

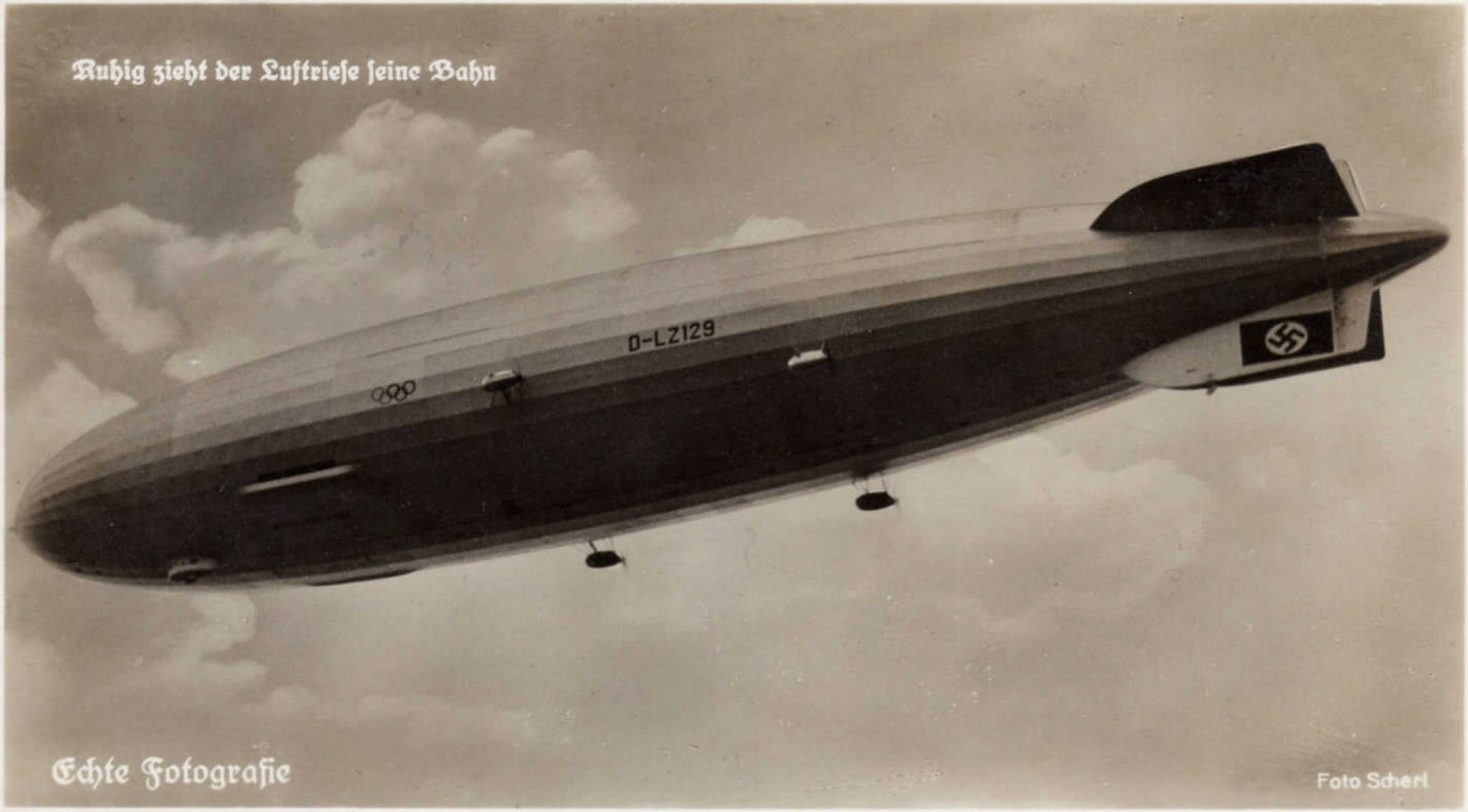
MRS. LYLE T. ALVERSON
MR. EDWIN J. BEINECKE
MRS. EDWIN J. BEINECKE
MR. C. F. BENSON
MR. ADRIEL BIRD
MRS. OLGA BOESCH
MR. CARL BRAUER
MR. HERMAN CRON
MRS. HERMAN CRON
MR. ALBERTO DODERO
MR. DOLLFUSS
LORD DONEGALL
MR. ALEXIS ELLISAULT
MR. PETER FLETCHER
MR. GUNNAR FROMEN
MR. MAURICE GOUDARD
MISS MICHELLE GOUDARD
REAR ADMIRAL JOHN W. GREENSLADE, *U.S.N.*
MR. K. V. HAGEN
MISS HAGSTRAND
DR. WALTER HOFFMANN
MR. JENS IVERSEN
MRS. R. O. JOHNSON
MR. E. KIPFMUELLER
PROFESSOR JEAN LABATUT
MRS. E. M. LATIN
MRS. ROSE LAUB
MISS PAULA LECLER
MR. A. J. MIRANDA, JR.
PROFESSOR ROBERT A. MAC LEAN
MR. O. T. NITZSCHMANN
MR. R. M. NITZSCHMANN
MR. GARDNER H. PRESCOTT
MR. H. A. PRYM
MR. GUSTAV A. ROETH
MR. ROWEHL
MR. MAX SCHMELING
MR. HARRY J. SCHNEIDERS
MR. HERMANN SCHROTH
CAPTAIN SCHULZ-HEYN
MR. ROBERT SMITH
MR. H. L. STUART
MR. ARTHUR C. STIFEL
MRS. ARTHUR C. STIFEL
MR. HUGO STINNES
MR. DIRK H. VAN DER STUCKEN
MISS ELIZABETH SUNDMARK
MR. HERMANN J. THEILIG
MR. VOGEL
MR. EUGENE VOIT
MRS. EUGENE VOIT
MRS. HELEN H. VOLCK
MRS. EDGAR B. WALTERS
MR. ERICH WARBURG
LIEUT. WALTER E. ZIMMERMAN, *U.S.N.*
LIEUT. GERALD D. ZURMUEHLEN, *U.S.N.*



German boxer *Max Schmeling* (left) returned to *Germany* in triumph after his victory over *Joe Louis* on the June 23rd 1936 voyage of the *Hindenburg* (passenger list above). When Schmeling beat Louis, Nazi officials decided that he should return to *Germany* on the Hindenburg rather than by ship as originally planned. Hindenburg was viewed as a symbol of German technological achievement and Schmeling's flight on the airship would create a more dramatic arrival in Germany and promote the concept of German superiority in all fields; from athletics to engineering. Schmeling made one more flight on LZ-129, returning to *New York* in August 1936. He planned to travel on the airship's first transatlantic flight of the 1937 season scheduled to arrive in Lakehurst on May 6th 1937. Schmeling's manager insisted that he travel to *New York* in time to appear at a meeting of the boxing commission held on May 4th 1937, so he canceled his flight and crossed the *Atlantic* by ship.

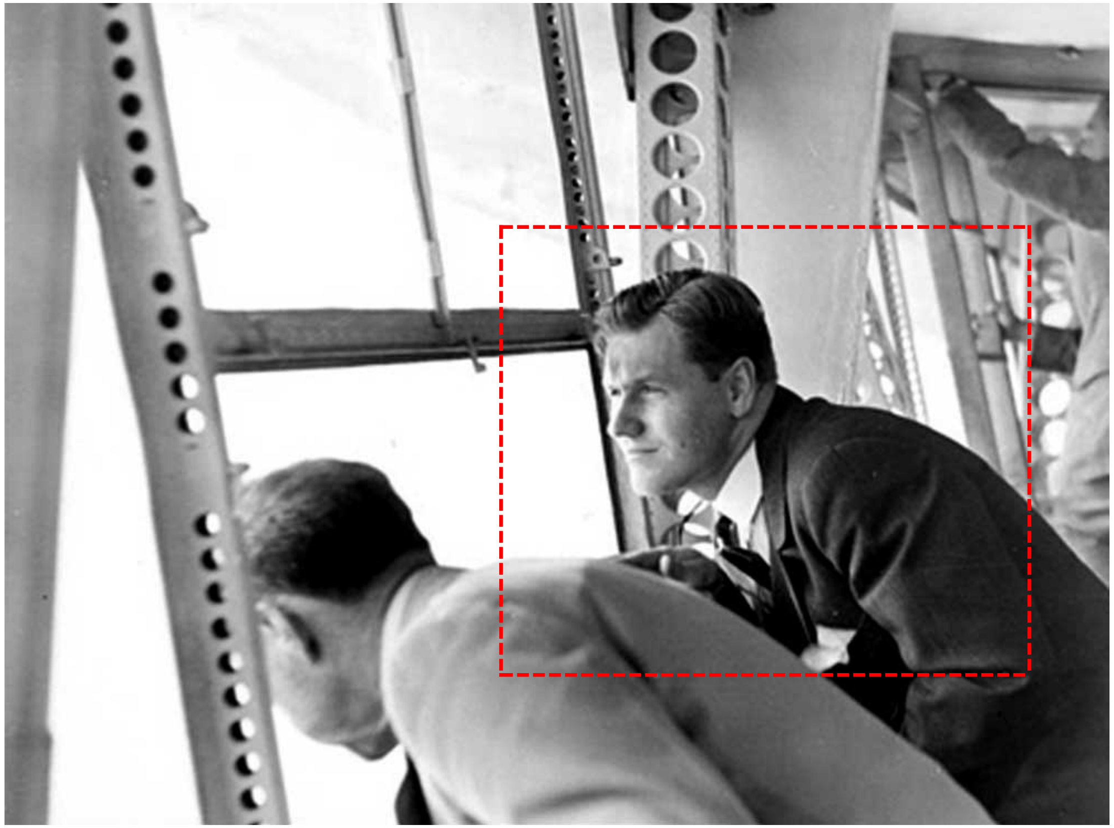
Luftschiff Hindenburg demonstrated its propaganda value on August 1st 1936, when she flew over the 1936 *Berlin Olympic Games*. Spectators in the Olympic stadium and large crowds of Germans and visitors from around the world watched Hindenburg cruise above the city for more than an hour at an altitude of approximately 750-feet. Under the command of *Max Pruss*, Hindenburg carried sixty-five passengers and 778 kg of mail (which was dropped by parachute over Berlin's *Tempelhof* airfield). The flight was a financial success for the DZR as well as a propaganda triumph for the Nazi government.

<u>Above</u>: *Hindenburg* docked at the *Lakehurst, NJ Naval Air Station* in May 1936. The Olympic rings on the side (highlighted) promoted the 1936 Berlin *Summer Olympics* (note the circumferential track for the retractable tail-wheel at right).

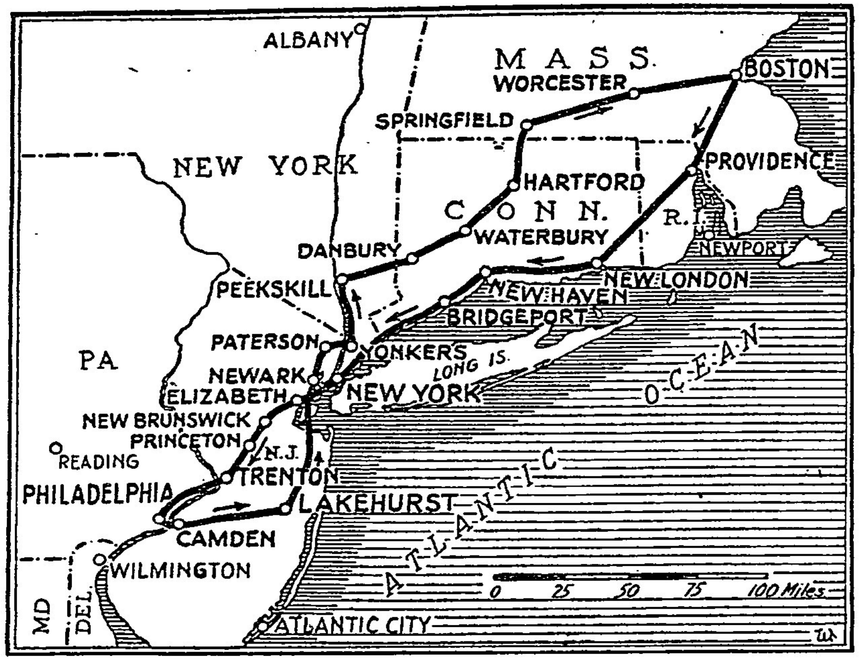


Das neue deutsche Zeppelin-Luftschiff L. Z. 129
Das größte Luftschiff der Welt.
Länge 248 m. Höhe 44,7 m, größter Durchmesser 41,2 m.
Vortriebsmaschinen: 4 Mercedes-Benz Dieselmotore von je 1100 PS Geschwindigkeit von etwa 130 Stdkm.

***Hindenburg* was enlisted as a propaganda vehicle once more on September 14th 1936 when the airship; following seventeen aircraft flying in a Swastika formation, flew over the final day of *Der Parteitag der Ehre* (the 8th NSDAP Congress) in *Nuremberg*.**



<u>Above</u>: ***Nelson Rockefeller*** **(highlighted) in navigation room of LZ-129 during the "Millionaire's Flight" - a 10.5 hour cruise over the fall foliage of** ***New England*** **on October 9th 1936 to which seventy-two wealthy and influential passengers had been invited as a way of generating support for a German-American transatlantic airship service. The flight was jointly organized by the DZR and** ***Standard Oil of New Jersey*** **(a.k.a.** ***Esso*****) which supplied hydrogen and diesel fuel to LZ-129. Each passenger was given a souvenir duralumin ashtray with a glass model of the airship filled with Esso diesel fuel (right). The flight took place before LZ-129's evening departure on its last transatlantic crossing of the 1936 season. Passengers included leaders in aviation, government, business and the military including such notables as** ***Juan T. Trippe*** **(head of** ***Pan American Airways*****),** ***Eddie Rickenbacker*** **(WWI fighter ace and General Manager of** ***Eastern Air Lines*****) and** ***Winthrop W. Aldrich*** **(Chairman of the** ***Chase National Bank*****). Auto industry tycoons** ***Henry Ford*** **and** ***Walter P. Chrysler*** **were among those who were invited but did not join the flight.**



"Thousands of Yonkers residents, craning their necks skyward and shading their eyes against a blazing sun, got their first view of the giant dirigible Hindenburg today…"

***Yonkers Statesman*, October 9th 1936**

<u>Above</u>: *New York Times* map showing the route of LZ-129's 10.5-hour "Millionaire's Cruise."

<u>Left</u>: LZ-129 above the *Hudson River* during the Millionaire's Cruise

1937 SCHEDULE of SAILINGS 1937

SUBJECT TO CHANGE

NORTH AMERICA

A. S. HINDENBURG

EASTBOUND LAKEHURST TO FRANKFURT Leave	Due	WESTBOUND FRANKFURT TO LAKEHURST Leave	Due
May 6	May 9	May 3	May 6
May 14	May 17	May 11	May 14
May 25	May 28	May 22	May 25
June 5	June 8	June 2	June 5
June 15	June 18	June 12	June 15
June 25	June 28	June 22	June 25
July 6	July 9	July 3	July 6
July 14	July 17	July 11	July 14
Aug. 16	Aug. 19	Aug. 13	Aug. 16
Aug. 23	Aug. 26	Aug. 20	Aug. 23
Aug. 30	Sept. 2	Aug. 27	Aug. 30
Sept. 6	Sept. 9	Sept. 3	Sept. 6
Sept. 13	Sept. 16	Sept. 10	Sept. 13
Sept. 20	Sept. 23	Sept. 17	Sept. 20
Oct. 1	Oct. 4	Sept. 28	Oct. 1
Oct. 11	Oct. 14	Oct. 8	Oct. 11
Oct. 22	Oct. 25	Oct. 19	Oct. 22
Nov. 2	Nov. 5	Oct. 30	Nov. 2

SOUTH AMERICA

A. S. GRAF ZEPPELIN

EASTBOUND RIO de JANEIRO TO FRANKFURT Leave	Due	WESTBOUND FRANKFURT TO RIO de JANEIRO Leave	Due
Mar. 22†	Mar. 27	Mar. 16	Mar. 20
April 19	*April 24	April 13*	April 17
May 3	*May 8	April 27*	May 1
May 17	*May 22	May 11*	May 15
May 31	*June 5	May 25*	May 29
June 14	*June 19	June 8*	June 12
June 28	*July 3	June 22*	June 26
July 12	*July 17	July 6*	July 10
July 27†	Aug. 1	July 19	July 23
Aug. 9	Aug. 14	Aug. 3*	Aug. 7
Aug. 23	Aug. 28	Aug. 17	Aug. 21
Sept. 6	Sept. 11	Aug. 31	Sept. 4
Sept. 20	*Sept. 25	Sept. 14	Sept. 18
Oct. 4	Oct. 9	Sept. 28*	Oct. 2
Oct. 18	*Oct. 23	Oct. 12	Oct. 16

†Voyage #1 and #9 by A. S. HINDENBURG, all others by A. S. GRAF ZEPPELIN.

*To and from Friedrichshafen.

A. S. GRAF ZEPPELIN calls at Recife (Pernambuco) both East and Westbound.

The L. Z. 130,

Latest addition to the airship service will make One Round Trip (Maiden Voyage) leaving Frankfurt or Friedrichshafen on October 27th for Rio de Janeiro and returning from Rio De Janeiro for Frankfurt on November 1st.

Rate (Subject to Change) RM 1600 each way, per person.

RATES (Subject to Change)

NORTH ATLANTIC SERVICE

Frankfurt a/Main, Germany to Lakehurst, New Jersey
or
Lakehurst, New Jersey to Frankfurt a/Main, Germany

	Eastbound May 1 to Aug 20 (incl.) Westbound Aug. 1 to Sept. 21 (incl.)		Eastbound Aug. 21 to April 30 (incl.) Westbound Sept. 22 to July 31 (incl.)	
	One Way	Round Trip	One Way	Round Trip
LAKEHURST - FRANKFURT or FRANKFURT - LAKEHURST (2 in Room basis)	$ 450	$ 810	$400	$ 720
*SOLE OCCUPANCY (Double Room)	$ 750	$ 1350	$ 680	$ 1224

*The Company reserves the right to refuse the sale of rooms at less than capacity, whenever deemed necessary.

Children under ten years pay half fare, provided a regular berth is not required, otherwise full fare is charged.

Infants under one year, $40.00.

Eastbound only, $5.00 per passenger must be added to above rates, for U. S. Revenue Tax.

Baggage allowance 65 pounds per adult passenger.

RATES (Subject to Change)

SOUTH ATLANTIC SERVICE

	Two in Room per Berth	Room Alone
FRANKFURT - RECIFE (Pernambuco) or RECIFE (Pernambuco) - FRANKFURT	RM 1400	2100
FRANKFURT - RIO de JANEIRO or RIO de JANEIRO - FRANKFURT	RM 1500	2200

Children under six years pay half fare, providing a regular berth is not required, otherwise a full fare is charged.

20% reduction on the return portion of roundtrip tickets.

Reservations arranged by cable are at passengers expense.

For this service 50% of the passage rate is payable in Register Marks, the balance in Reichsmark. To obtain the dollar exchange rate and other information please apply to your local agent or any office of the Hamburg-American Line — North German Lloyd.

AVERAGE TIME LAKEHURST TO FRANKFURT (1936) — 52 HOURS ● FRANKFURT TO LAKEHURST (1936) — 65 HOURS

With LZ-129's successful 1936 season concluded, eighteen round-trip flights between *Germany* and the *United States* were scheduled for 1937 (left). A companion ship; LZ-130, was nearing completion at the *Zeppelin Company* construction shed in *Friedrichshafen*. During the 1936/37 winter season, the airship underwent maint-enance and renovations at *Frankfort*. LZ-129 made six successful flights in 1937, including a round-trip from Germany to *Brazil*. The Hindenburg's first North American transatlantic flight of the 1937 season was scheduled for May 6-9th.

Part 9

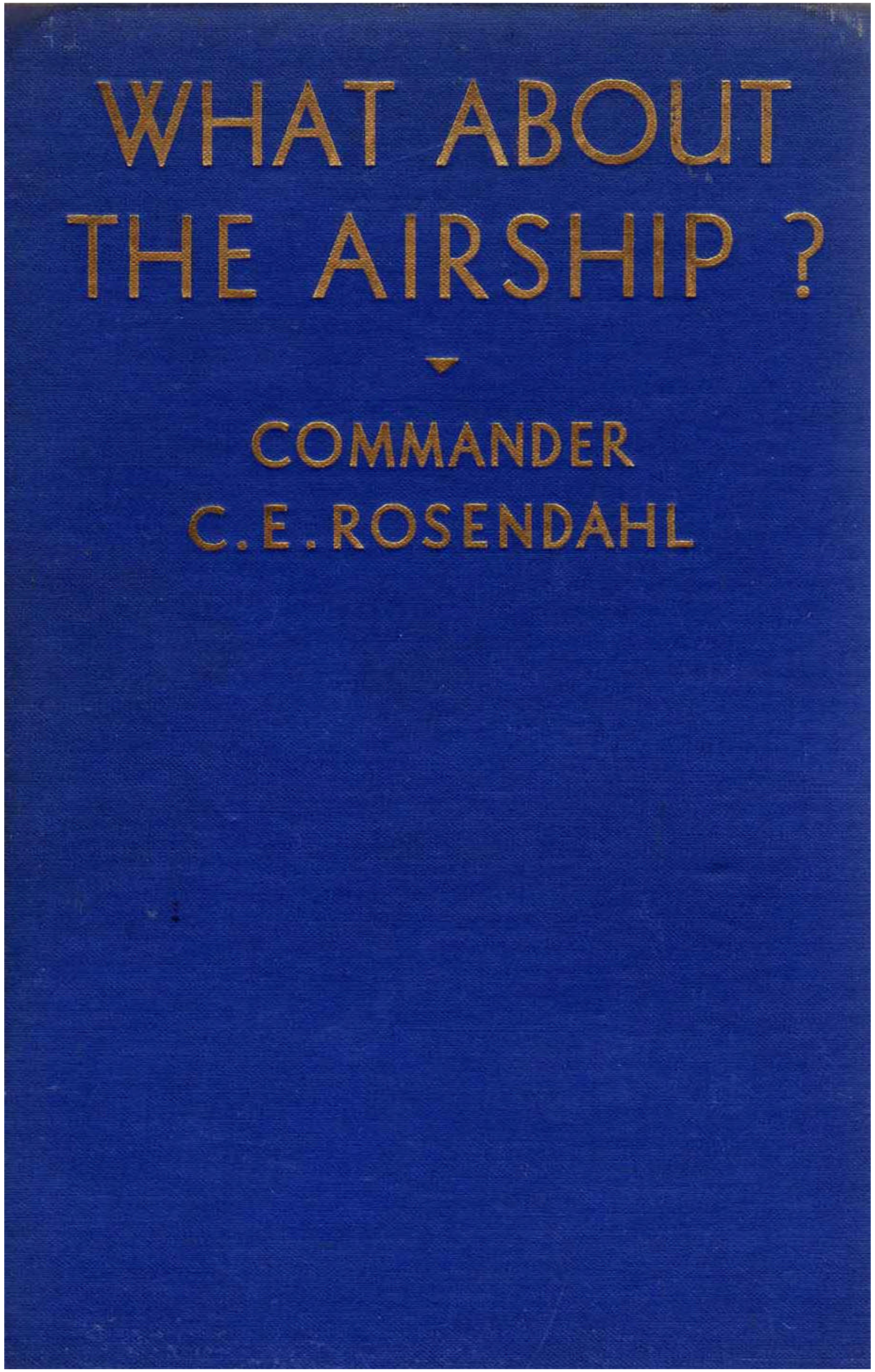
Oh, the Humanity!

Beginning of the End

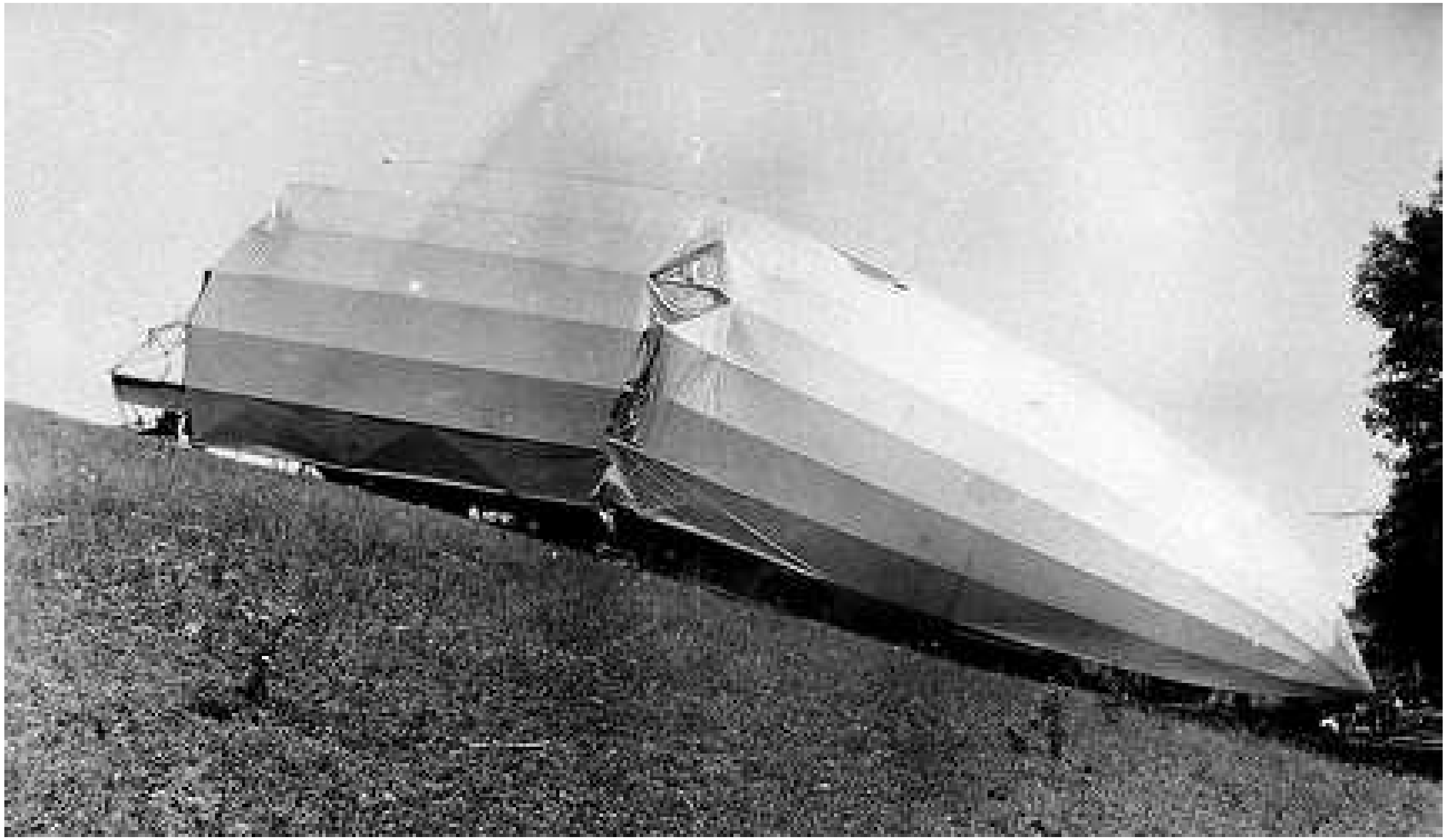
"…On Thursday, May 6, 1937, the great gray bird droned over the eastern coast of the United States, inbound at the start of her second season of regular transatlantic service. The day was warm and stormy. She was already ten hours late. And now she had to stooge over the Jersey beaches, waiting the forecasted clearing of the weather…In the staterooms, im-patient passengers tidied up their valises. At the Lakehurst, N.J., landing field waited a corps of reporters, photographers, even a special radio-broadcasting crew. Supervising ground operations was the U.S. Navy's foremost lighter-than-air expert, Cmdr. Charles E. Rosendahl. Now, in the twilight shortly after 7 p.m., the Hindenburg ponderously nuzzled up to the mooring mast…"

Popular Science, May 1962

Left: *Commander C.E. Rosendahl*



U.S. Navy **Commander** ***Charles E. Rosendahl*** **(1892-1977) was the leading figure in America's rigid airship program. He was one of the most experienced airship aviators in the** ***United States*** **and was a tireless proponent of lighter-than-air aviation. However, he is best remembered as the commander of** ***Lakehurst Naval Air Station*** **at the time of the** ***Hindenburg*** **crash. Rosendahl was aboard** ***USS Shenandoah*** **when the ship was caught in a storm over** ***Ohio*** **on September 3rd 1925. Rosendahl and six other men were in the bow section when the ship broke in two. Without the weight of the control car, which had broken away, the bow was highly bouyant and ascended rapidly. Under Rosendahl's leadership, the men in the bow released helium from the cells and free-ballooned to a relatively gentle landing, which they all survived. Fourteen other members of the crew were killed in the crash including the airship's captain. He served in various commands of airships as well as serving as a USN observer on British and German airships during the 1920s and '30s. In 1936, having been promoted to Navy Commander, Rosendahl served as a watch officer aboard LZ-129 during four transatlantic crossings between** ***Germany*** **and** ***North*** **and** ***South America*****. He authored a book in 1938 entitled: "What About the Airship?" (left), a year after the Hinderburg disaster. He served in the Navy's anti-submarine blimp program and as captain of the** ***USS Minneapolis*** **during WWII. He retired from the Navy as a Vice Admiral in 1946 after a long and distinguished career.**



"…Several of us, just above the control cabin when the crash came, heard a metallic noise of wrenching girders – and, in the gloom of daybreak, saw the after portion of the ship free itself and fall. Below, through the gap in the structure where the forward car had torn away, we saw the ground disappearing rapidly. Shouts disclosed that there were eight men in the rising section. With each man detailed to a station and a duty, we free-ballooned our section of the ship for more than an hour and then descended safely. Many of the men in the other part of the ship, we found, had escaped when it crashed. Of the forty-three men originally aboard, twenty-nine were safe and fourteen dead. Our non-inflammable helium undoubtedly accounts for the many survivors…"

Lieut. Cmndr. C.E. Rosendahl, USS Los Angeles

Above: the front (bow) section of the *USS Shenandoah* – in a field near *Shanon, Ohio*

"…The Hindenburg had departed Frankfort on Monday, May 3, to the customary fanfare of glowing press notices. Aboard climbed the passengers, surrendering their matches and cigarette lighters as they entered: Mrs. Marie Kleeman bound for a visit with her daughter in Massachusetts, Joseph Spah, an acrobat returning from European engagements, Poetess Margaret Mather flying home to New Jersey, and 33 others. The crew was headed by the veteran 'Luftschiffuhrer Kapitan' Max Pruss. There was no foreboding of historic tragedy as the command 'Up Ship!' resounded. This was a gay adventure. If you were a Very Important Passenger, you could count on a tour of the fantastic ship. It was an opportunity not to be missed, for the Hindenburg was a masterpiece of engineering…"

Popular Science, May 1962

"There was the old merchant from Hamburg (Otto Ernst) who was finally taking his wife on a trip to America. There was the good, motherly businesswoman from Hamburg (Marie Kleemann) anxiously counting the hours that separated her from her ailing daughter in Boston. The Swedish journalist with the rosy face (Birger Brinck) was on his way to Washington for an interview with Secretary of State Hull. The young artist with the gentle, deliberate way of walking (Joseph Spah) was going home to his wife and children on Long Island after a successful European tour. A family from Mexico (the Doehner family) was enjoying a wonderful conclusion to a visit to their old homeland. American and German merchants traveling on business. Air Force officers (Col. Fritz Erdmann, Maj. Hans-Hugo Witt, and Lt. Claus Hinkelbein) enjoying the luxurious amenities of airship travel, having been sent on this trip in recognition of meritorious service."

Gertrude Adelt, **Jounalist**

RE: excerpts from an article she wrote years later about her experiences as a passenger on the last flight of LZ-129. Above, a personalized postcard from passenger M. Feibusch.

"…On an airship you have a wonderful trip, not with an airplane about 1,200 meters high and so you can't see anything. In an airship, we have a height from 100 to 200 meters over the ocean. You have very nice islands, you have big ships. It's for passengers a very, very comfortable flight and a very nice flight. No seasickness."

Capitan Max Pruss

RE: excerpt from a 1960 interview. Max Pruss was in command of LZ-129 when it was destroyed on May 6th 1937. He survived the crash, but suffered very serious burns on much of his body, including his face and remained in a *New York* hospital for many months. Despite numerous operations, Pruss remained badly scarred for the rest of his life. To the end of his life (he died in 1960), Pruss believed the Hindenburg disaster was the result of sabotage.

"You see, we have on every flight to South America lightning and thunderstorms. In about four degrees north of the equator they have thunderstorms all the time, and we were going with a ship traveling right through the thunderstorms and never was there trouble. During the First War, we had lightning hit the ship. At the bow you have a little hole through was going lightning in, and then the lightning went through the framework and then the radio station and the antenna was blown up, and no more. This thing happened at Lakehurst two times – we had big thunderstorms before the start. Passengers which were coming with airplanes must come with buses, because flying was forbidden. And we were waiting outside the ship, because we are thinking not that the next lightning would go in the ship. And when the passengers were there, we took them inside, and we flew through the thunderstorm toward the sea…Yes, I think it was sabotage. If the sabotage was from the inside or from others, it's very difficult to say."

Captain Max Pruss

RE: excerpt for a 1960 interview. Above, *American Airlines* advertisement for connecting service with the *Hindenburg* (baggage label).

War Stories

“Then a terrific bolt crashed by my ears, filling the inside of the ship with a blinding light. The man on the upper lookout post telephoned down that the muzzle of his machine gun was spitting sparks. I climbed through the gun shaft to see what it was all about. To my astonishment, I found the platform brightly illuminated. In the center of this luminous circle sat the lookout, wet through to the skin, but sporting a veritable halo around his head. This extraordinary phenomenon is not unknown to mountain climbers as well as sailors; it is called Saint Elmo’s fire. The duralumin frame of the hull was charged with electricity and sent forth sparks at all connecting points and corners. When we looked up out of the control car, we could see the sparks coming from all protruding objects. Wires and cables glowed with a bluish-violet light; a wonderful sight, except that we were not exactly in a position to appreciate it. Our men were staggering like drunken tightrope walkers on the narrow walkway. And with lightning flashing by every two minutes at arm’s length, so to speak, our lives depended upon no hydrogen escaping from the gas cells.”

***Captain Hans von Schiller*, L-11**

RE: experiences in a lightning storm during a WWI raid on *London* in April 1916

“The heavens opened all their sluices at one time; the storm struck us from all directions. While we were moving the horizontal controls (elevators) in order to dive as steeply as possible, I remembered the man on the top of the ship. Just then, he called down through the speaking tube: ‘A lightning bolt struck the nose of the ship, thirty feet from my post. It almost knocked me down just as I was going to report that there were electrical discharges around me. Tongues of fire are licking around the muzzles of my machine guns, and around my head too. And when I spread my hand, little flames spurt out of my fingertips’…Lightning, too, obeys the laws of nature. It is distributed only on the enormous surface of the metallic airship frame which protectively encloses the gas cells like a Faraday cage. Thus, as long as the airship pilot himself – and it lies entirely within his power – takes care that no inflammable gas forms between the cells and the outer envelope, lightning is no danger at all for a Zeppelin.”

***Captain Ernst Lehmann,* L-98**

RE: experiences in a lightning storm during a WWI raid on *London* in April 1916

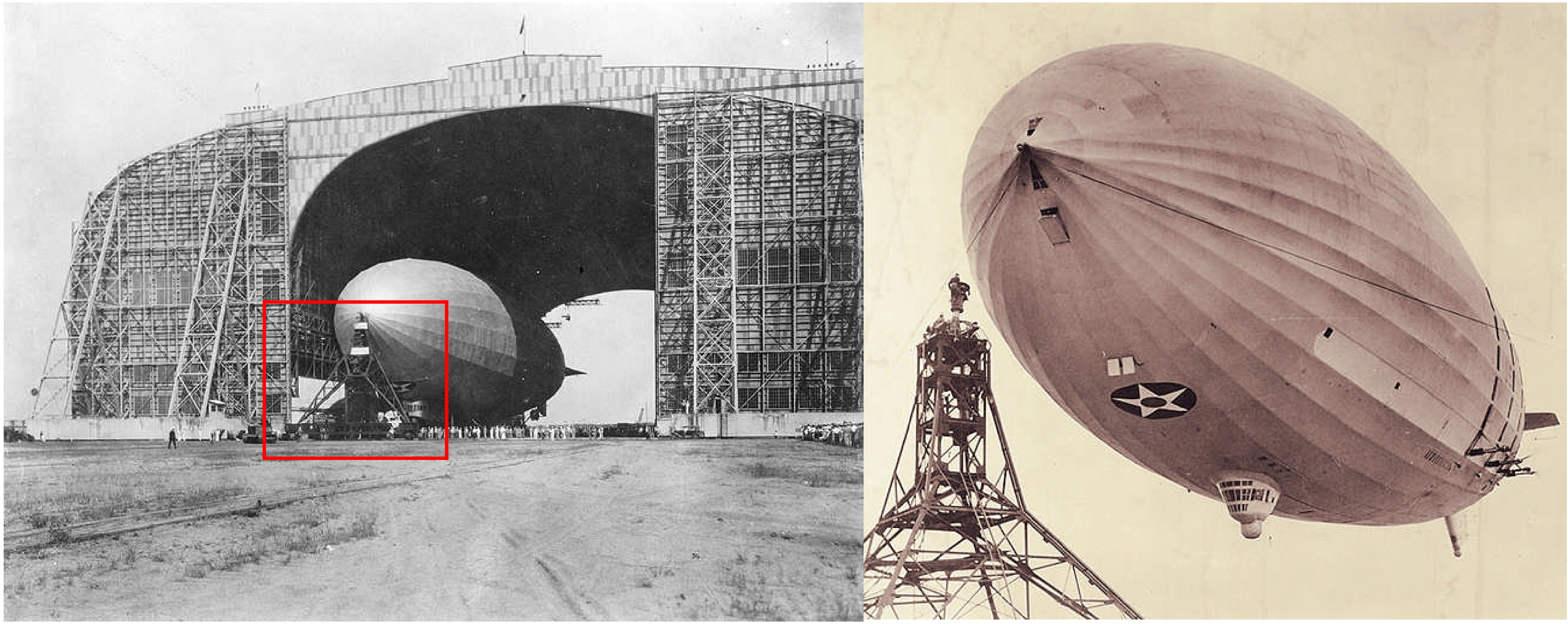
"…Lightning is popularly regarded as a terror to airships – but that is a fallacy. Even hydrogen-filled dirigibles have often been struck by lightning with no more damage than a small hole fused in the metal bow cap. The metallic frame absorbs the electricity…only one authentic case of an airship destroyed by lightning – a German ship that was valving off hydrogen in a thunderstorm when lightning ignited the escaping gas and set the ship afire…"

Popular Science Monthly, **March 1930**

A Delicate Task

"…The Graf was west of the Canary Islands, homeward bound from South America, as the Hindenburg prepared to moor that thunderstormy afternoon…At Lakehurst, Lt. Raymond F. Tyler and Chief 'Bull' Tobin – both lighter-than-air pros – directed the ground crew. They had rolled out the 75-foot tripod mast and deployed the line handlers. Theirs was a delicate task. It was up to 'Kapitan' Pruss to 'weigh off' his Hindenburg: get it nearly level and aerostatically balanced by valving off or adding gas into the various sections, depending on whether the ship needed to be heavier or lighter. But even after a perfect weigh-off, it took more than 200 strong men to haul the balky colossus down from the sky. Troops from Fort Dix had been drafted to help 138 civilian and 92 navy linesmen. The least gust of wind could – and often did – send the airship bounding like a kangaroo hundreds of feet skyward. On other occasions rope handlers had been lifted before they could let go, then dropped to their doom…"

***Popular Science,* May 1962**

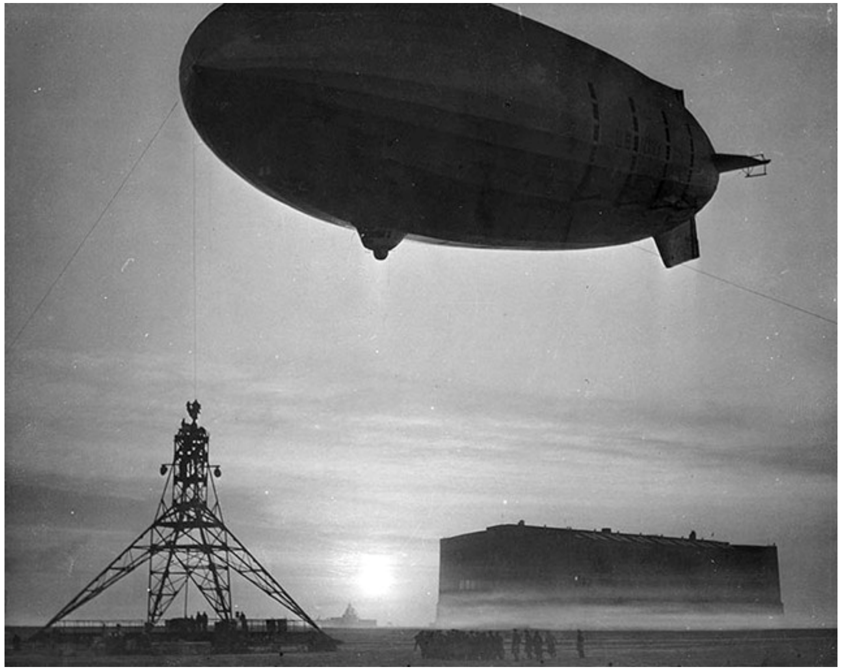


"…One of the surprises awaiting spectators is that the ship will be taken out of the dock and launched without the help of a young army. In fact, five men can launch or dock the air monster. The key piece will be a walking mooring mast that guides the nose of the ship, and then holds it out on the field. This mast, constructed at the dock, has three tractor tread feet, and is similar to that which the navy has been using at its air station at Lakehurst, N.J…"

***Popular Science Monthly,* February 1931**

Left: *USS Los Angeles* being towed out of her hangar at Lakehurst NAS by her mobile mooring mast (outlined)

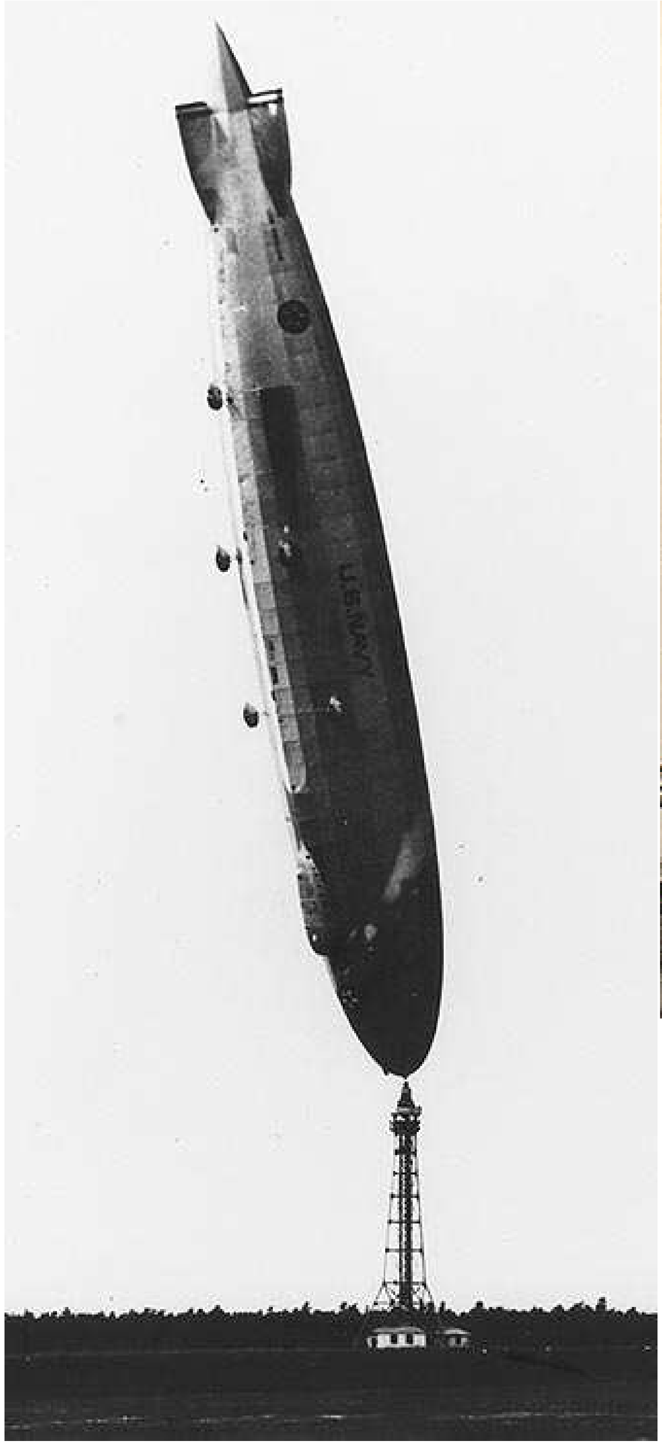
Right: *USS Akron* approaches her tripod, movable mooring mast

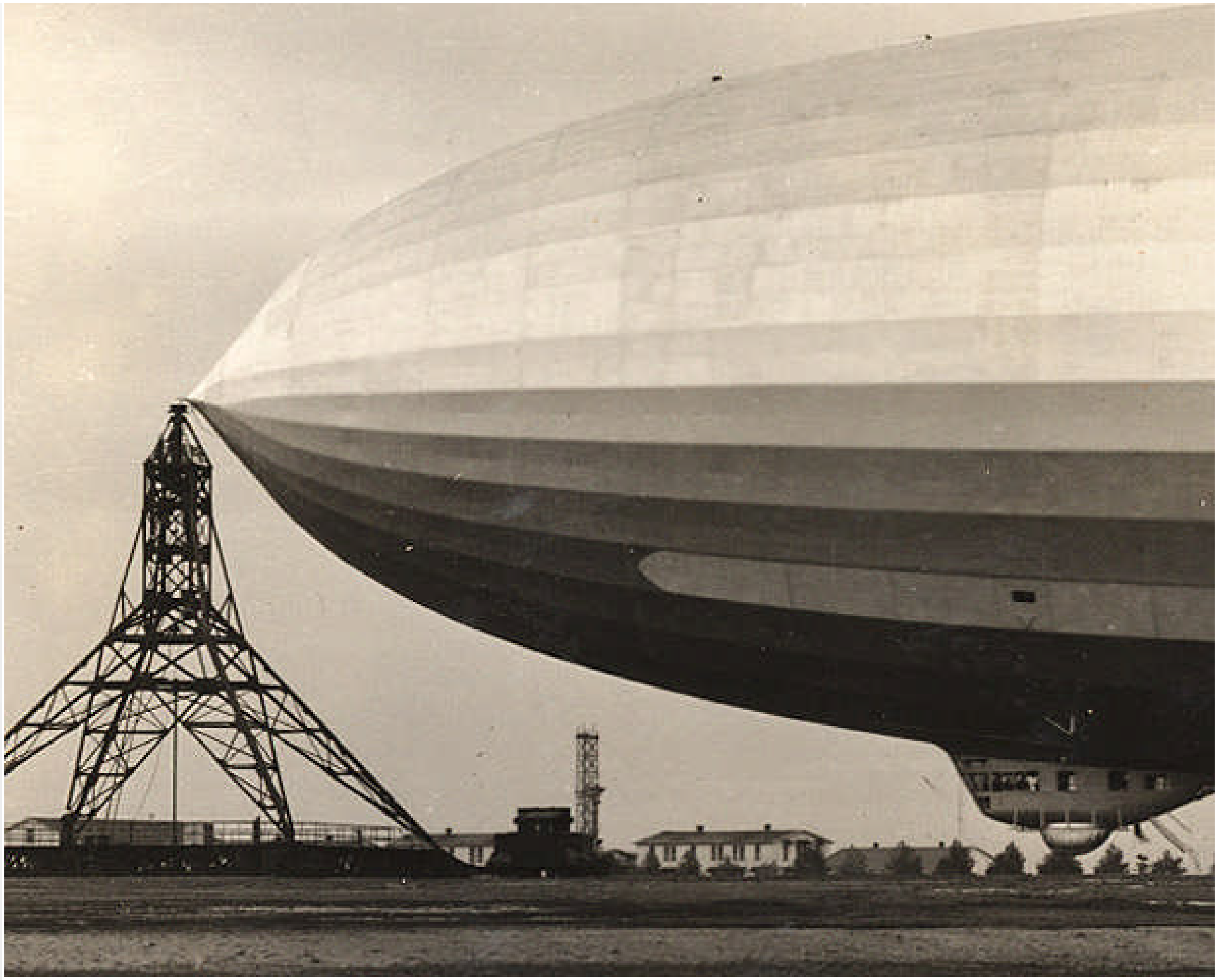


"…a mobile mooring mast – a 'land tugboat' for dirigibles, designed to meet a dirigible and tow it to a hangar. At Lakehurst the mast is mounted on rollers and pulled by a tractor. Caterpillar treads in the mast itself – an improvement, is being considered by the navy Department. When a dirigible approaches a mooring mast it makes first contact with the ground crew by dropping 325-foot trail ropes. The main mooring cable is lowered and secured to a line that passes down the hollow column of the mast. A winch draws the main cable taut until a cone-shaped spindle on the airship's nose nuzzles into a flexible post or 'ram' in the mooring mast itself…"

***Popular Science Monthly*, July 1929**

<u>**Above**</u>**: dirigible drops ropes while approaching a mobile mooring mast**





<u>Above</u>: the *USS Los Angeles* securely moored to a mobile tripod mast
<u>Left</u>: Los Angeles' tail lifted to a near vertical position by a sudden cold front at Lakehurst NAS while the bow remains moored to the fixed high mast, August 25th 1927

<u>**Above**</u>**: Great Britain's R-101 moored to her *Cardington* mast (200-feet high) and equipped with an elevator and staircase. The passengers and crew entered and/or exited the airship via the mast itself (a gangway let down from beneath her nose). Above is a party of MP's entering R-101 on an inspection tour.**

"…an international conference, at which the United States was represented, was held this year in London. The purpose of the meeting was to standardize the fittings and docking signals for airships. Mooring masts, it was decided, are to be fitted with standardized 'wharf' tops, to receive the conical bow of any airship of any country. Gasoline and gas lines are to be of uniform size for refueling. Other items, such as pulley blocks for hauling airships downward, and signal lights, will be standardized…"

Popular Science Monthly, **January 1923**

Top Left: crewmen stationed at the mooring shelf of LZ-129 during a landing at Lakehurst NAS in 1936

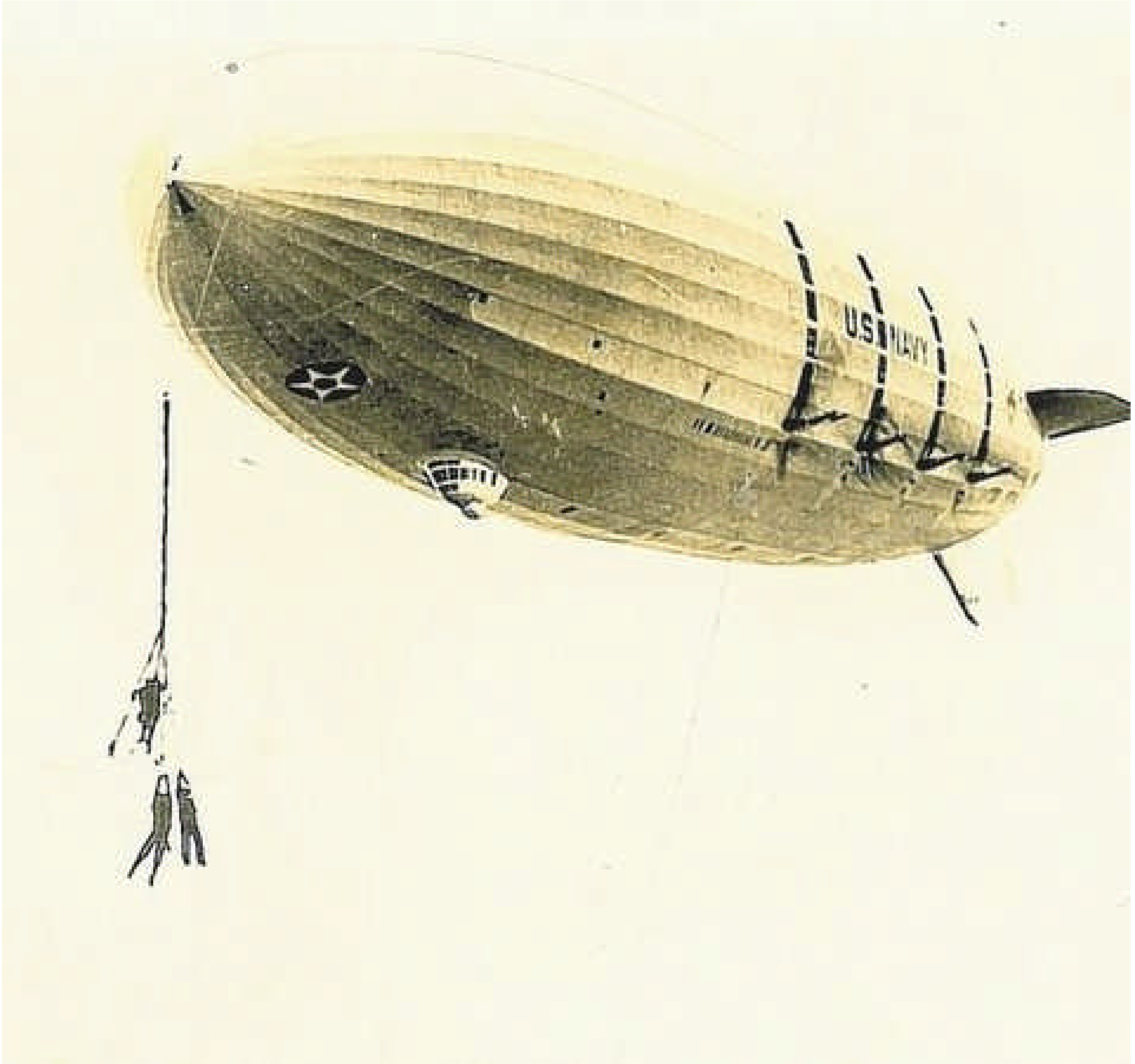
Top Right: LZ-129 crewman *Erich Spehl* (right) and Chief Engineer *Rudolf Sauter* (left) pose atop the mooring mast at Lakehurst NAS, 1936

Left: crewman Spehl looking out porthole on Starboard side of LZ-129's lower tail fin, near the emergency control stand.


Hindenburg

Hanging by a Thread

Thousands of people had gathered at *Camp Kearny*, a military base that is now part of *Marine Corps Air Station Miramar,* in the spring of 1932 to witness the arrival of the world's largest helium airship; *USS Akron*. Also awaiting the airships arrival was a complement of two-hundred naval recruits there to catch the spider lines that hung from rings on two dangling cables and hold down the massive, buoyant airship. Finally, on the fourth attempt the ground crew was able to grab the spider lines and hold it down. A cable from the airship's nose was attached to the mooring mast and slowly the Akron was winched in. Then a gust of air lifted the tail steeply. The airship was tilted nearly vertical, a dangerous position. Water spilled from its ballast tanks. The Akron began to rise. In desperation, some of the sailors climbed up onto the ropes to better haul the ship downward. But it was no use. The ship continued to rise. The crew was young and inexperienced, unfamiliar with the danger of this huge craft's tremendous power. As the craft rose the men jumped off, falling on one another in a big pile. One waited until he was twenty feet up before letting go, and broke his arm. As the Akron rose higher and higher, out of control, the crowd on the ground realized to its horror that three men still remained clinging to the lines.


U.S. NAVY

"…Struggling to keep their grip, they lashed about desperately. On the ground women screamed, men wept, officers shouted, sailors ran around wildly. Then Sailor Edfall shot down like a bag of sand, 150 ft. to his death. Two figures still clung to the end of the swinging ropes. One of these soon let go. 'It's the acrobat!' shouted an enlisted man. Kicking and waving his arms as he fell, Sailor Nigel M. Henton, the training station's best gymnast, bounced on the hard-packed earth in a little puff of dust. Ambulances which soon came shrieking up were not needed at all…"

***Time* magazine, 1932**

Amid the dangling lines just one man remained alive. The crowd watched as the Akron rose to 2K-feet. It seemed only a matter of time before he too would plummet to his death as the other two sailors had. But the sailor on the rope had not given up. The man, or rather the boy (he was only sixteen years old) had managed to straddle a toggle at the end of the cable and then to tie two bowline knots around his waist. Charles “Bud” Cowart was an unusually tough and strong fellow; a welterweight boxer who was training for the all-Navy championship. More importantly, he managed to keep from panicking. Several times, the airship’s captain tried to bring his ship back to the field, and firemen on the ground lifted nets to catch him. But the air turbulence was too great. Soon it was evident that the only hope for salvation was in going up. Once the Akron’s crew realized that they could not land with Cowart dangling on his line, they sent a man down in a bosun chair to attach a line to the sailor, then hauled him up with a winch. Cowart’s remarkable perseverance was the only thing that saved him that fateful day.

<u>Left</u>: Charles “Bud” Cowart – USN linesman and sole survivor

"…After two hours the lump at the end of the Akron's cable began to rise slowly spider-wise, toward a port in the forward part of the lifeless, floating ship. As the cable shortened Sailor Cowart's oscillations grew more violent. When he disappeared into the port, the crowd murmured with relief but no one cheered. Aboard the ship Sailor Cowart spurned spirits of ammonia. Said he: 'Gimme something to eat.'"

***Time* magazine, 1932**

The Earliest Possible Landing

LZ-129 followed a northern track across the *North Atlantic* passing the southern tip of *Greenland* and crossing the North American coast at *Newfoundland*. Headwinds delayed the airship's passage across the ocean and the *Lakehurst, NJ* arrival, which had been scheduled for 6:00 AM on May 6th. It was postponed to 6:00 PM that same day. By noon, LZ-129 had reached *Boston* and by 3:00 PM, she was over the skyscrapers of *Manhattan*. The airship flew south from *New York City* and arrived at the Lakehurst NAS at around 4:15 PM, but the poor weather conditions at the field concerned Captain Pruss and also Lakehurst's commanding officer, *C.E. Rosendahl*, who sent a message recommending a delay in landing until conditions improved. Captain Pruss departed the Lakehurst area and took LZ-129 over the beaches and coast of *New Jersey* to wait out the storm. By 6:00 PM, conditions had improved. At 6:12 PM, Rosendahl sent Pruss a message relaying temperature, pressure, visibility, and winds which Rosendahl considered "suitable for landing." At 6:22 PM, Rosendahl radioed Pruss: "recommend landing now." At 7:08 PM, Rosendahl sent a message to the ship strongly recommending: "the earliest possible landing."

<u>Above</u>: view of LZ-129 flying over the *Boston Common* from an airplane

"Since we had already passed over the steamship docks, we saw nothing but an ocean of buildings far and wide. Elevated trains, streetcars, and busses crisscrossed the wide streets, between which wound countless smaller automobiles. The sidewalks were swarming with people, like an anthill. Now and then you could see a subway train coming up from underground."

Werner Franz

RE: recollections of 14yo LZ-129 crewman

<u>Above</u>: LZ-129 flying over *Princeton University* on May 6th 1937

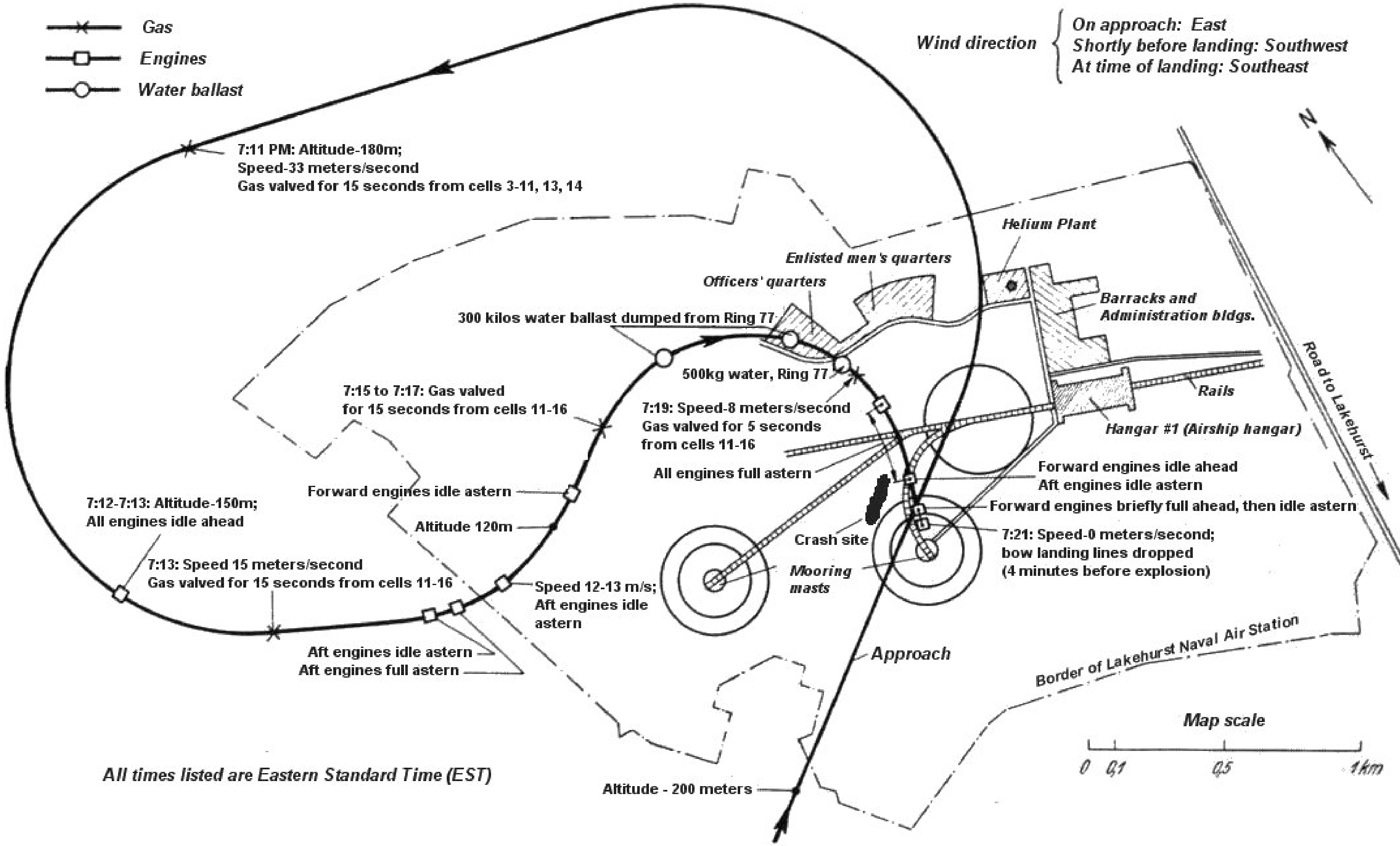
What a Sight it is!

"…May 6, 1937, the sky still appears moody after a stormy day. A stately, silvery marvel, the 240-ton 'Hindenburg' airship glides 200 feet above Lakehurst, New Jersey, at around 7:21 p.m. In a 6-knot wind, the Zeppelin is attempting its first 'high landing.' The crew throws the spider lines out, preparing for mooring. The giant ship, nearly three football fields in length, would be slowly winched down…"

***Popular Science,* November 1997**

"…the Hindenburg swept in over the south fence at a brisk 73 knots, 590 feet high. 'What a sight it is!' exulted Herb Morrison, the Chicago radio commentator who was making an eyewitness recording on the field. 'The sun is striking the windows of the observation deck and sparkling like glittering jewels on black velvet…' Kapitan Pruss crossed the field and turned to come in, valving gas from forward cells, dumping water ballast from the stern, shifting crewmen for an exact balance. At 7:21 PM the first handling rope hit the ground…"

***Popular Science*, May 1962**



Above: track of LZ-129's Lakehurst NAS approach pattern; May 6th 1937. LZ-129 approached the field at Lakehurst from the southwest shortly after 7:00 PM at an altitude of approximately 600-feet. Since the wind was from the east, after passing over the field to observe conditions on the ground, Captain Pruss initiated a wide left turn to fly a descending oval pattern around the north and west of the field; to line up for a landing into the wind to the east.

As Captain Pruss was directing the airship's heading and engine power settings to bring LZ-129 around the Lakehurst field, First Officer *Albert Sammt* (above, in chart room), who as elevatorman was responsible for the airship's trim and altitude, valved fifteen seconds of hydrogen along the length of the ship to reduce her buoyancy in preparation for landing. As Pruss continued the slow left turn of the oval landing pattern, first reducing then reversing the power from the engines, Sammt noticed that the ship was heavy in the tail and valved hydrogen from bow cells 11-16 for a total of thirty seconds (to reduce the buoyancy of the bow and keep the ship in level trim). When this failed to level the ship, Sammt ordered three drops of water ballast, totaling 2,420 pounds from Ring 77 (in the tail) and then valved an additional five seconds of hydrogen from the forward gas cells. When even these measures could not keep the ship in level trim, six crewmen were ordered to go forward to add their weight to the bow.

While helmsman Sammt was working to keep the ship in trim, the wind shifted direction from the east to the southwest. Captain Pruss now needed to land into the wind on a southwesterly heading rather than the easterly heading he had originally intended when he planned his oval landing pattern. However, LZ-129 was now close to the landing area and did not have a lot of room to maneuver before reaching the mooring mast. Anxious to land before weather conditions deteriorated, Captain Pruss decided to execute a tight "S-turn" to change the direction of the airship's landing. Pruss ordered a turn to port to swing out and then a sharp tight turn to starboard to line up for landing into the wind. Some experts speculated that this sharp S-turn overstressed the ship, causing a bracing wire to snap and slash a gas cell, thus allowing hydrogen to mix with air to form a highly explosive combination. After the S-turn, Pruss continued his approach to the mooring mast adjusting power from the two forward and two rear engines. At 7:21 PM, with the ship about 180-feet above the ground, the forward landing ropes were dropped.

"Rigger Hans Freund was pulling at the hauling-in line for that steel cable located in the fin. He called out to me that it was not running clear on the starboard side and that I was to release it. I proceeded up to unfasten this line that had fouled and passed by Rudolf Sauter, the ship's chief engineer who was looking out of the port window. I went up the first ladder, which is approximately two meters high, 6-1/2 feet. I then proceeded along the narrow catwalk that is on the port side of the fin, approximately 7 feet or 2 meters off the lower edge of the fin. I then got hold of the ladder that leads further up to the catwalk, with one hand, and with the other hand I released the steel cable that had fouled. I then waited to see if the cable would go over now that it was being pulled up, and was looking up and was facing the port side of the fin…"

Left: LZ-129 crewman *Helmut Lau*. Excerpt from his testimony to the Board of Inquiry, May 18th 1937

A View to a Kill

"…The rain still spatters the wet ground in starts and stops. The air is highly charged from the thunderstorms, investigators would rule later. Six and three-quarter acres of 'Hindenburg' fabric is kiting in the breeze. A witness later would recall a bluish electrical phenomenon that dances over the aft starboard side of the 'Hindenburg' for more than a minute…"

***Popular Science,* November 1997**

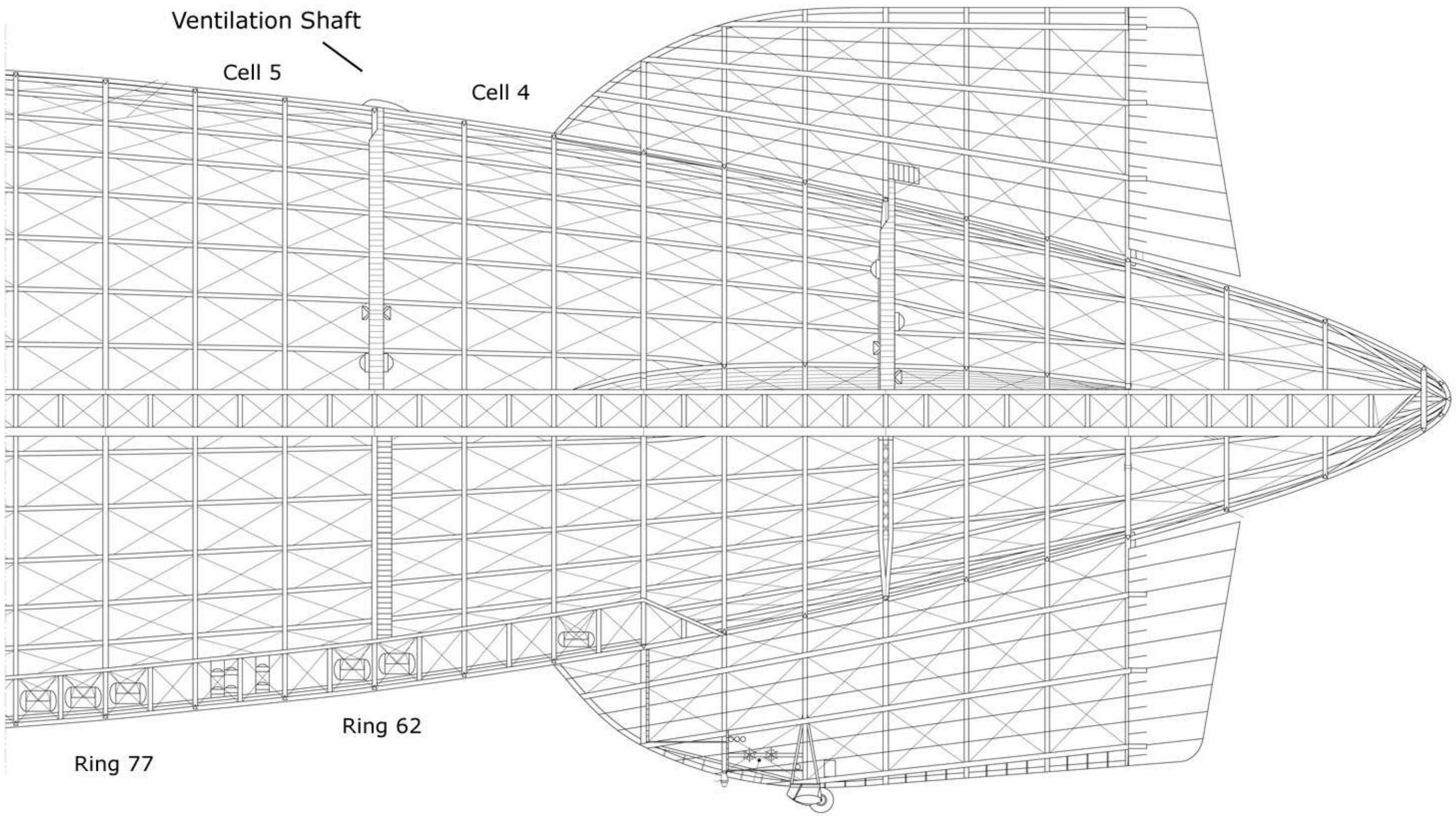
"…On her first transatlantic crossing of the 1937 season, the huge, grey German Zeppelin 'Hindenburg' nosed into the U.S. Naval Air Station at Lakehurst, N.J., at dusk on May 6. A severe thunderstorm had just subsided. Inside the dirigible were 36 passengers, 61 officers and men, a ton of mail and baggage and 6,700,000 cubic ft. of hydrogen. Landing lines had been dropped and the ground crew was pulling the big ship towards the mooring mast when a sheet of fire burst from her tail. In a twinkling the whole rear half of the 'Hindenburg' was aflame. Spectators 200 ft. below saw the huge ship buckle near the middle and settle slowly to earth. As the blazing stern smacked the ground several sharp explosions shook the ship. Passengers and crew, caught in an inferno, started to jump for their lives and the tiny men on the mooring mast were silhouetted against a cloud of living fire. Then the flames rushed forward and belched through the Hindenburg's nose. In five minutes the fire had burned itself out, leaving 35 dead and one more twisted wreck to add to the dismal history of lighter-than-air craft…"

LIFE **magazine, May 17th 1937**

"…In the passenger compartment, photographer Otto Clemens leaned out a window and worked his Leica to record the action below. He did not know it until his film was developed days later, but his negative showed flame reflecting in rain puddles on the ground. A bystander, Gage Mace, recalled later, 'A shower of sparks shot up from the top of the bag and to the rear, followed instantly by a column of yellow flame…'"

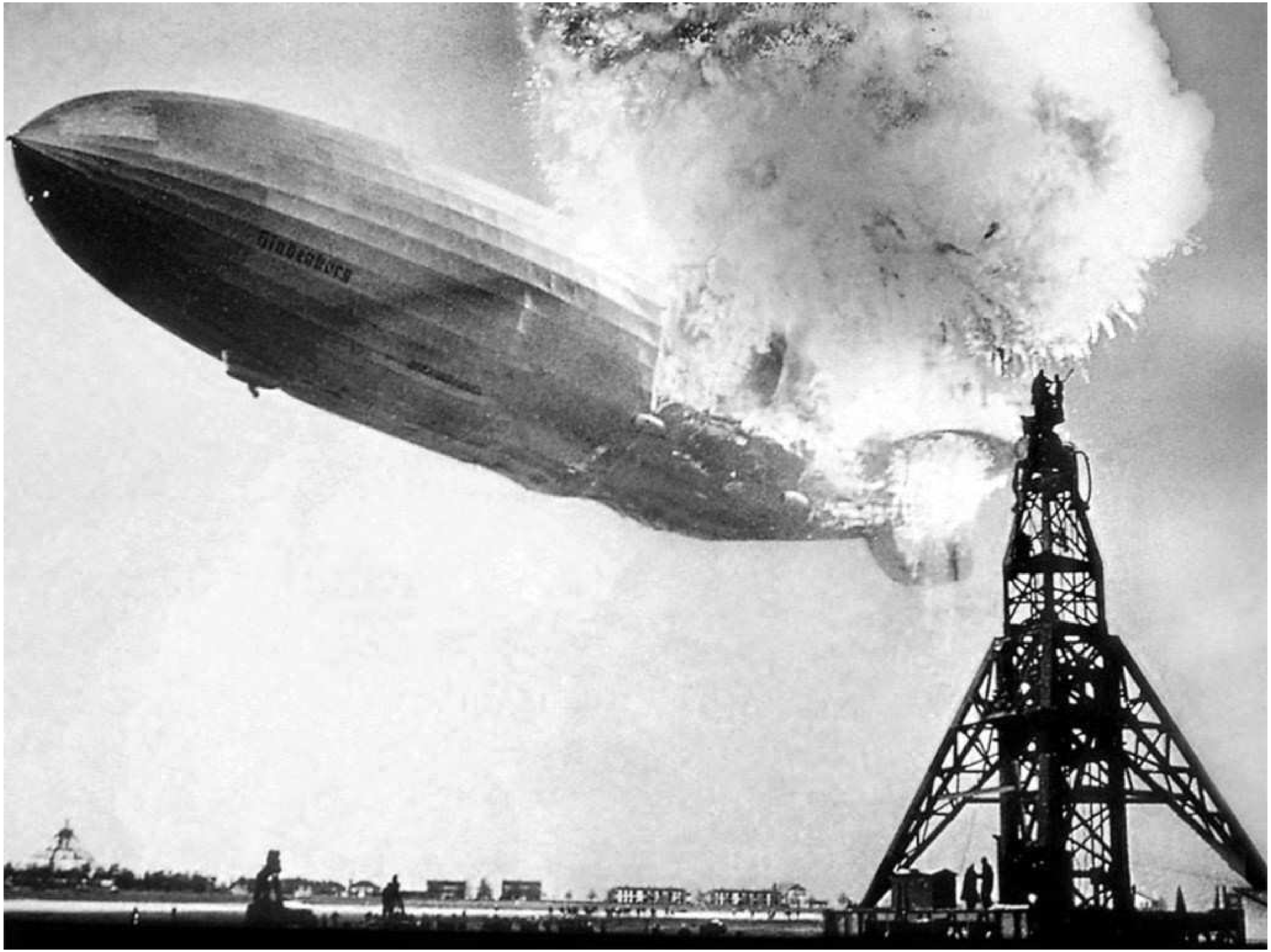
Popular Mechanics, **May 1962**

RE: after the landing lines were dropped, *R.H. Ward*, in charge of the port bow landing party, noticed what he described as a wave-like fluttering of the outer cover on the port side, between frames 62 and 77, which contained gas cell number 5. He testified at the commerce department inquiry that it appeared to him as if gas were pushing against the cover, having escaped from a gas cell. Ground crew member *R.W. Antrim*, who was at the top of the mooring mast, also testified that he saw that the covering behind the rear port engine fluttering. At 7:25 PM, the first visible external flames appeared. Reports vary, but most witnesses saw the first flames either at the top of the hull just forward of the vertical fin (near the ventilation shaft between cells 4 and 5) or between the rear port engine and the port fin; in the area of gas cells 4 and 5, where Ward and Antrim had seen the fluttering.



Lakehurst NAS Commander *C.E. Rosendahl* described a: "mushroom shaped flower" of flame bursting into bloom in front of the upper fin. Assistant Mooring officer *U.S. Navy Lt. Benjamin May*, who was atop the mooring mast, testified that an area just behind the rear port engine (where Ward and Antrim reported the fluttering): "seemed to collapse," after which he saw streaks of flame followed by a muffled explosion and then the entire tail was engulfed by flame. Navy ground crew member *William Bishop* described seeing flames inside the ship a little above and aft of the rear port engine car.

<u>Above</u>: LZ-129 port tail section

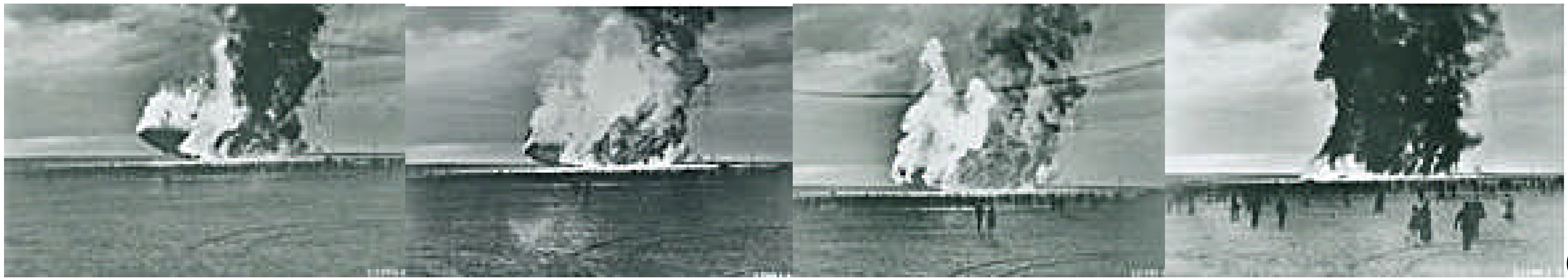


"…Get this, Charlie, get this. Charlie…it is burning…Oh, the humanity and all the passengers!"

***Herb Morrison,* Radio Reporter**

"…The 20-odd cameramen who were present when the 'Hindenburg' made its last landing at Lakehurst had gone to the airport expecting routine pictures of a routine landing. They came away with what is probably the most dramatic and spectacular record of a great disaster which the camera has ever made. The most complete of all however was made not by any of the professionals but by an amateur named Arthur Cofod, Jr., with a ten-year old Leica…He was waiting at Lakehurst to get a package of photographs arriving on the 'Hindenburg' for LIFE. He never got the pictures he went for, but he made the series reproduced below…"

***LIFE* magazine, May 17th 1937**



"…A jagged fire licks along the aft starboard side of the 'Hindenburg,' another witness later recalls. Crewman Helmut Lau, on the lower left of the craft, looks up through the translucent gas cells and sees a red glow. In moments, cells began to melt before his eyes. The fire crests the top of the 'Hindenburg' and spreads outward and downward, toward Lau and the others. Girders start cracking and wires snap. With hydrogen still in the cells, the giant airship maintains level trim…"

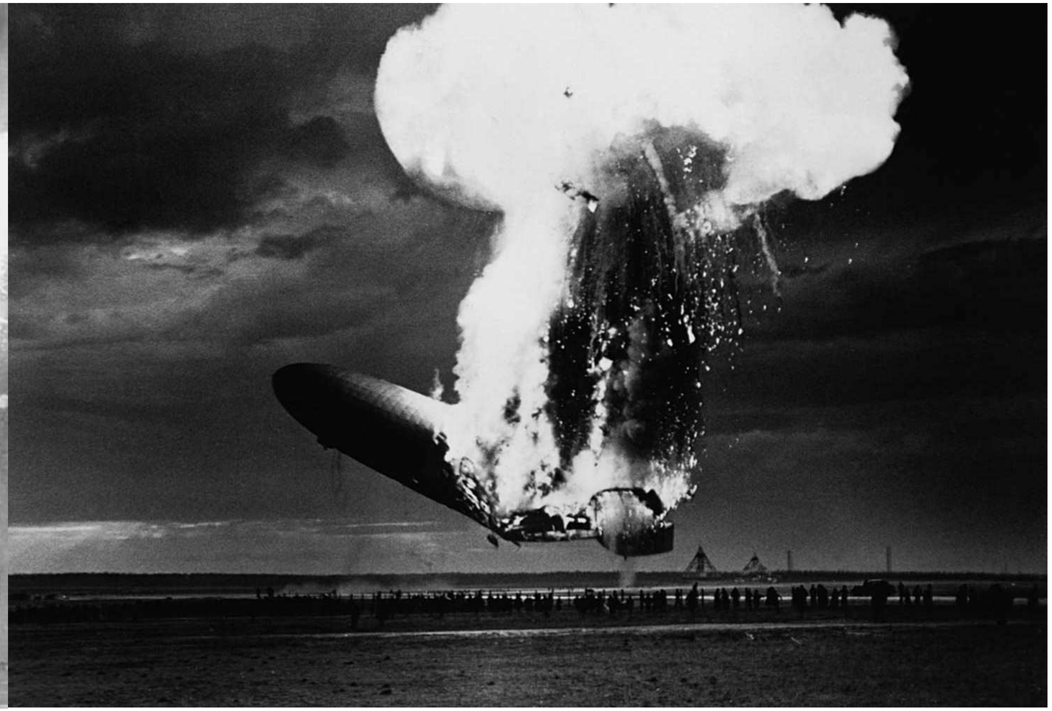
***Popular Science,* November 1997**

"…I heard over me a muffled detonation and looked up and saw from the starboard side down inside the gas cell a bright reflection on the front bulkhead of cell No. 4. The gas cell was approximately at the line that I have indicated on Exhibit 10. I therefore could see from there to the point that I am indicating. I could see from my position at this point to approximately the position indicated. Here and here I saw no fire at first. I saw it on the front side of cell 4. The bright reflection in the cell was inside. I saw it through the cell. It was at first red and yellow and there was smoke in it. The cell did not burst on the lower side. The cell suddenly disappeared by the heat. The fire proceeded further down and then it got air. The flame became very bright and the fire rose up to the side, more to the starboard side, as I remember seeing it, and I saw that with the flame aluminum parts and fabric parts were thrown up. In that same moment the forward cell and the back cell of cell 4 also caught fire, cell 3 and cell 5. At that time parts of girders, molten aluminum and fabric parts started to tumble down from the top. The whole thing only lasted a fraction of a second. I turned around and pulled in my head - I had no hat on - and jumped back underneath the girder to which the telephone is attached. Whilst I was jumping back, I noticed that the ship was dropping rapidly. The ship at the moment that the explosion went up had an acceleration down. As I ran back, I saw Mr. Sauter, who was lying on the floor and had his hands over his head, and I did not see the machinist, Richard Kollmer, at that moment, who operates the landing wheel. The reason that I did not see him was that I was looking out of the window, watching the ground to gauge the moment when the ship would hit. During the descent it was extremely bright in the lower fin. I did not feel the heat during the descent, only during the descent pieces of aluminum, molten aluminum, and bits of fabric were tumbling down constantly…"

RE: LZ-129 crewman *Helmut Lau*. Excerpt from his testimony to the Board of Inquiry, May 18th 1937

"…In seconds, the rear half of the 'Hindenburg' is engulfed in bright, writhing flames. Gas cells one and two expand and burst with explosive force; the released hydrogen adds fuel to the conflagration. The ship lurches forward, breaking off water tanks attached by light-release connectors near the bow of the craft. Having lost ballast, the airship's nose heads upward and people start jumping to escape the flames, some too far from the ground to survive the fall…"

***Popular Science*, November 1997**



The explosive fire quickly spread and soon engulfed the tail of LZ-129, but the airship remained level for a few more seconds (top left) before the tail began to sink (top right) and the nose pointed upward to the sky with a blowtorch of flame erupting from the bow (left) where twelve crew members were stationed, including the six who were sent forward to keep the ship in trim. In the port and starboard promenades on the passenger decks, where many of the passengers and some of the crew had gathered to watch the landing, the rapidly increasing angle of LZ-129 caused passengers and crew to tumble against the walls, furniture and each other. Passenger *Margaret Mather* recalled being hurled fifteen to twenty-feet against the rear wall of the dining room and being pinned against a bench by several other people.

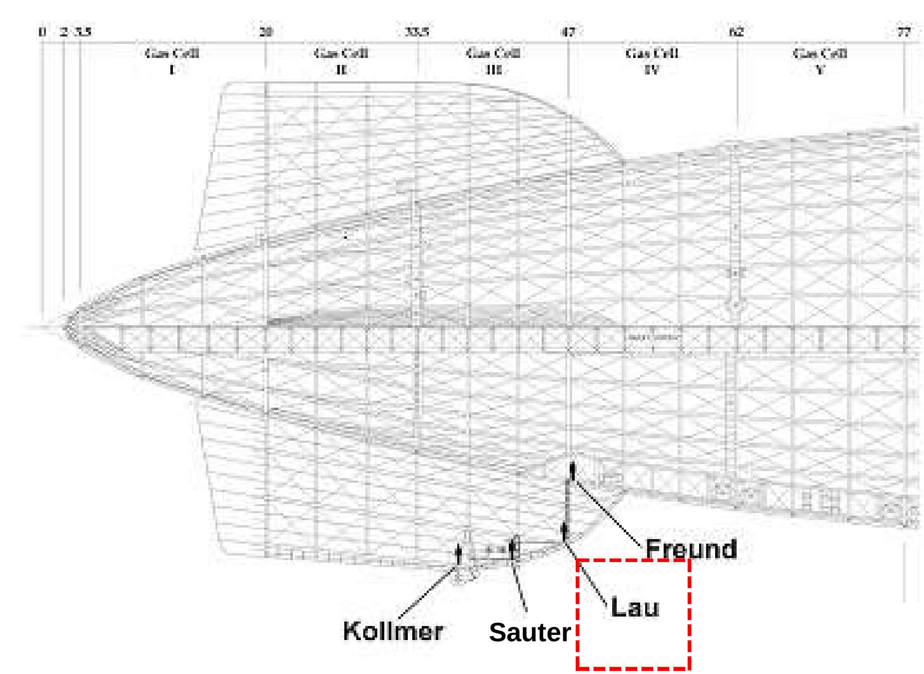
"…Above, passengers tumbled, one atop the other, a mass of shrieking, crying people. Joseph Spau, the acrobat, knocked out a window, climbed through, and dangled by one hand. When the ship started falling, he dropped – hard enough to bounce. Miss Mather was pulled out of the crumpling, flaming cabin by ground crewmen. Frau Kleeman just walked down the debarkation stairs. In half a minute, 35 people were killed or fatally hurt…"

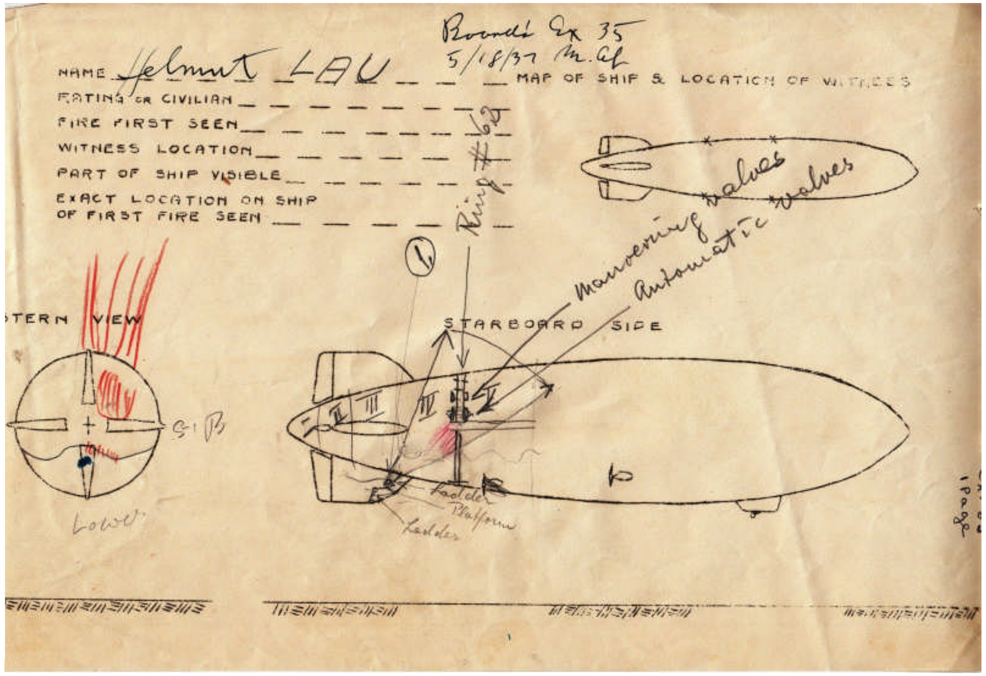
Popular Science, **May 1962**

<u>Left</u>: *Joseph Spah* hangs by one hand from forward portside observation window

<u>Right</u>: Joseph Spah drops to the ground

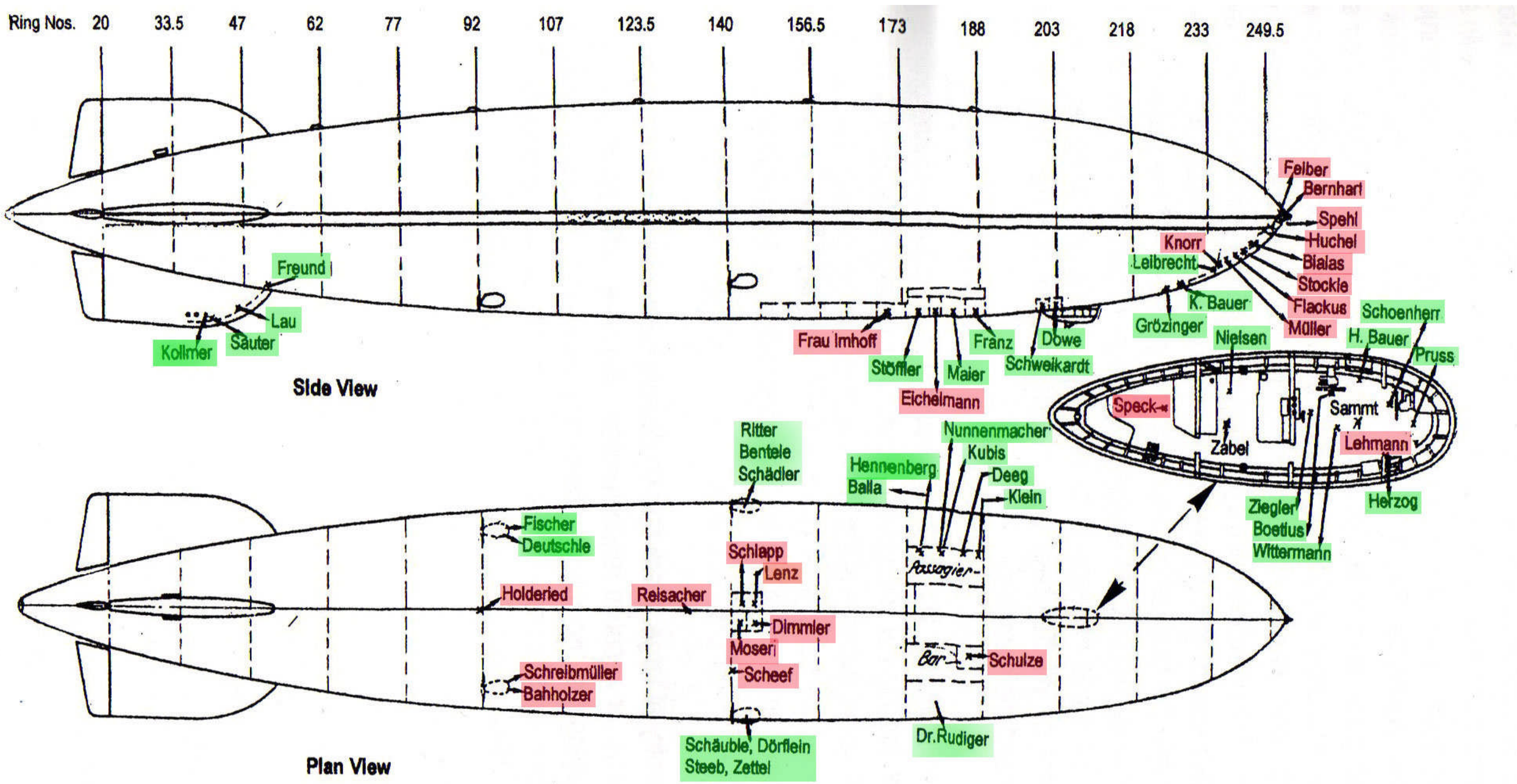
"…Like the mythical Icarus who ventured to close to the sun, the 'Hindenburg' goes down in flames. As it touches the ground, the ship bounces lightly, perhaps buoyant with remaining hydrogen…"
Popular Science, **November 1997**





"…During the descent I stood with my back to the direction of flight. That is, I was looking astern and down. The ship then cracked onto the ground with great force. I felt everything was collapsing from above, and I fell to the right. Freund, who must have been standing somewhere behind me, fell over me at that time, but I did not see him, only after we were lying on the ground I saw him…"

RE: LZ-129 crewman *Helmut Lau*. Excerpt from his testimony to the Board of Inquiry, May 18th 1937. Location of helmsmen Helmut Lau at the time of the explosion (left) and Helmut Lau's witness diagram; for the Board of Inquiry investigation (right)

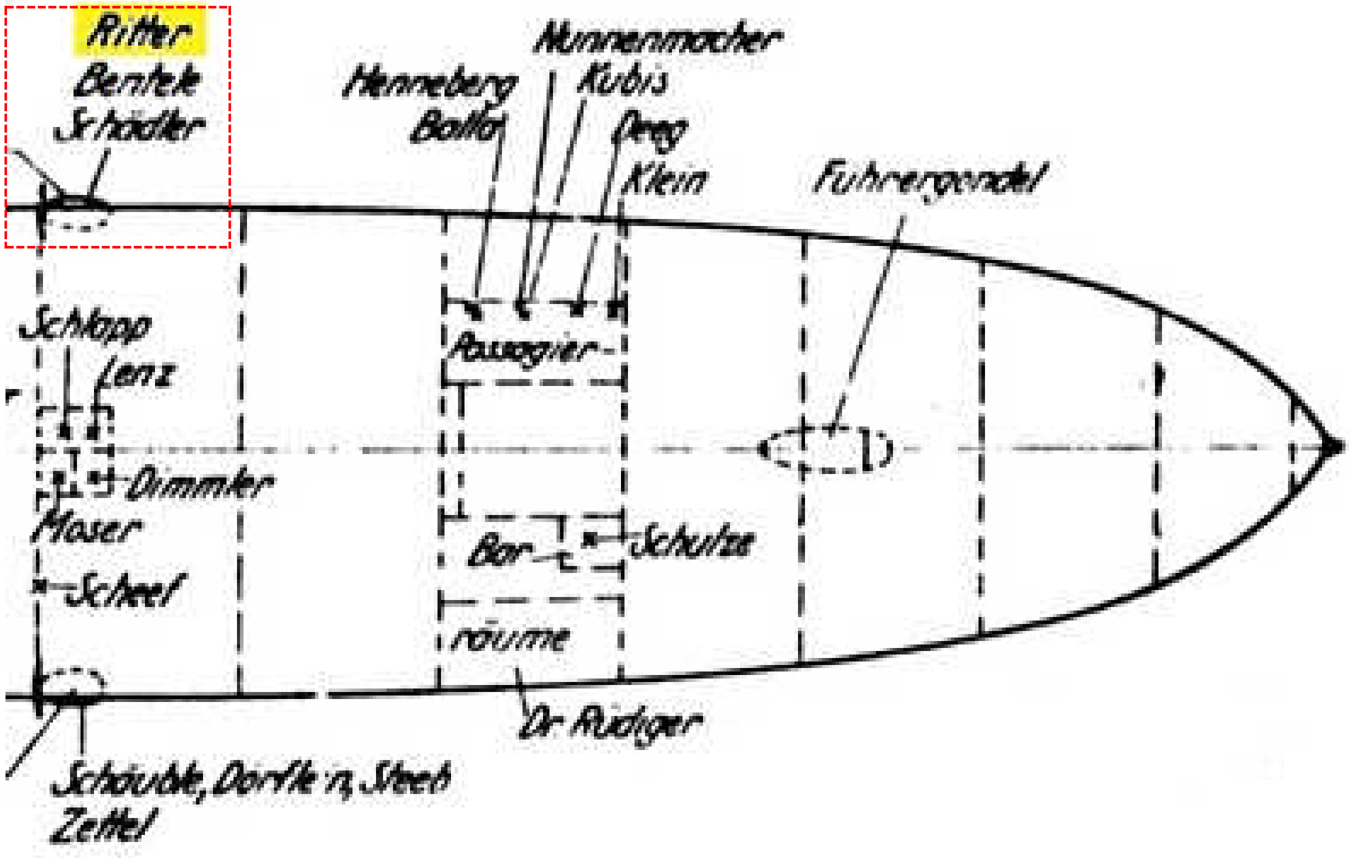


The fire spread quickly, consuming the ship in less than a minute. Survival was a matter of where one happened to be located when the fire broke out. Both passengers and crew members began jumping out the promenade windows to escape the burning airship. Most of the passengers and all of the crew who were in the public areas on A-Deck, close to the promenade windows, did, in fact, survive. Those who were deeper inside the ship, in the passenger cabins at the center of the decks or the crew spaces along the keel, were, in general, consumed by the fire.

Above: location of officers and crew at time of the explosion/s and ensuing fire. Those killed are in red, those who survived are in green.

"Everything was so sudden and so confusing. I was sitting next to the window, when it happened, all so suddenly. I was sitting in the social hall, looking out of the windows at the ground close below when two big explosions came. The detonation was schrecklich - horrible. Everything was mixed up. Big men were thrown against me. Everything was noise and shrieks and screams. I don't remember much of what happened until one of the stewards, who had jumped out at first but then returned, came into the burning dining hall and pulled me out."

***Marie Kleeman*, Passenger (left)**



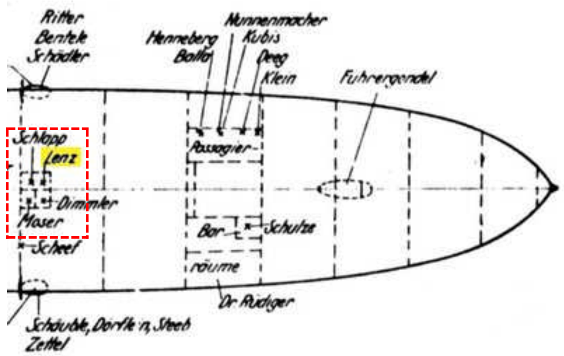
"The ground is coming up at us damned fast, and one of my comrades says something like 'Bail out!' But the gondola crashes into the ground and I think to myself, 'I'm dead. This is it.' Fire swirls around my eyes, and the impact causes me to lose my footing. I fly in an arc over the engine and out into the propeller, which hits me on the head."

***Theodor Ritter*, Engine Mechanic (trainee)**

"…For at least two minutes after the ship touched ground, survivors came running or staggering through the flames. Some escaped with slight injuries. Others, like the man at left, were stark naked, their clothes and hair burned away, their skin hanging in shreds…"

***LIFE magazine,* May 17th 1937**

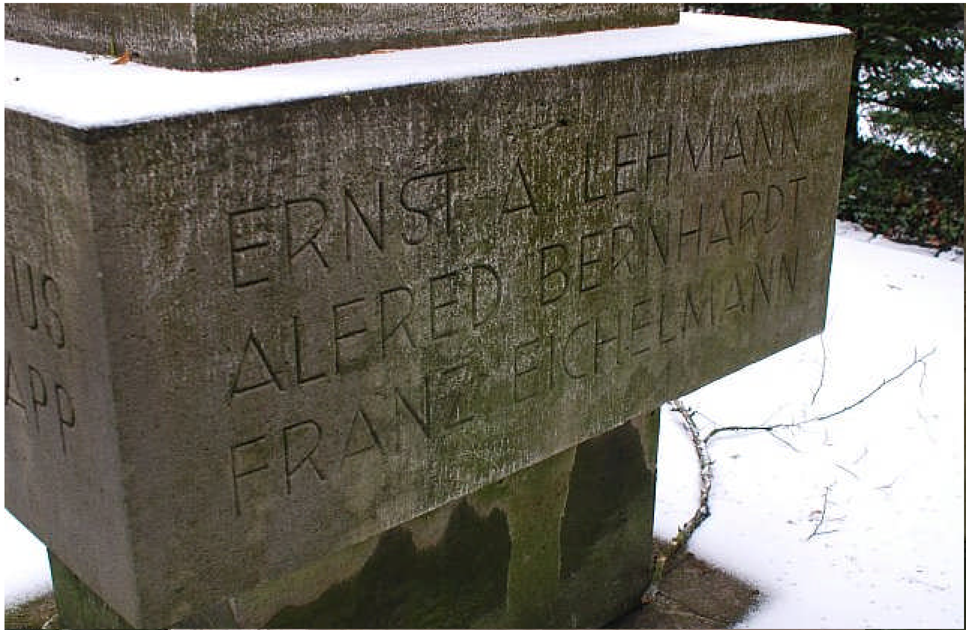
<u>Above & Left</u>: LZ-129 engine mechanic *Walter Banholzer.* He died at 3:20 AM, in hospital, on the morning of May 7th 1937



"Since the electrical center was built of aluminum, I survived the impact without injury. But then the fire from the burning fuel oil began to burn through the ceiling of my dungeon, threatening to bake me like a clay pipe. Apparently I had just enough time to keep the flames away from my head using the cover from the gyrocompass, but my clothes were already burning and as the fire consumed the oxygen I was in danger of suffocating. Only a miracle was going to save me now. With my last energy, I climbed through the window of my prison, then looked for and found a path through the ever growing sea of fire. Halfway out, I was caught in a tangle of wires and girders, but I was able to free myself again and burst outside into the arms of my friend."

***Philipp Lenz,* Chief Electrician**

RE: Lenz was trapped in the switch room, but was fortunate that - to prevent stray hydrogen from coming in contact with the electrical equipment - the entire power station was pressurized and insulated from the rest of the airship by layers of sheet metal. At first, the room held tight against the fire, likely buying Lenz some time. Eventually, flames began licking through the ceiling of the switch room and the air became incredibly hot and was growing even hotter. Lenz grabbed the large metal hood for the airship's gyrocompass and stuck his head inside it to shield his face. The air around him grew hotter still, to the point where he could barely breathe. Lenz suddenly turned around and saw a familiar face peering into the airship from the outside, just past the mass of wreckage that lay beyond what was left of the switch room's window. It was *Emil Hoff*, a representative from *Esso Oil* who had been on-hand to deliver the airship's supply of lubricating oil for the return flight. Hoff grabbed hold of Lenz and, aided by *Harry Thomas* - a naval electrician who was part of the ground crew, pulled the injured Lenz to safety.



<u>Above & Left</u>: LZ-129 crew member names inscribed on the crew memorial in *Frankforter Hauptfriedhof* cemetery

"…In the moment of the ship crashing on the ground, Mr. Sauter apparently regained consciousness and he yelled at us to get out. At that time, intense heat and smoke was also observed. We were lying on the inside of the outer cover and wanted to get out through the outer cover. This was not possible, however, because the outer cover was resting on the ground. In other words, the lower fin had laid itself over on the left side, on the ground, and I looked up. I saw Kollmer climbing out of the entrance hatch in the fin. Sauter yelled to us that we could get out at that point. Then Freund emerged and got out, and I got out, and Freund assisted me to get out, and Freund ran away, and I looked around once more and I saw Mr. Sauter coming out with blood streaming down his face. I got hold of him and pulled him out. We then ran about 20 meters away from the ship, and I did not see Mr. Kollmer anymore. Freund and Sauter were still with me…"

RE: LZ-129 crewman *Helmut Lau*. Excerpt from his testimony to the Board of Inquiry, May 18th 1937

Left: Chief Engineer *Rudolf Sauter*, his head hastily bandaged, leaves the Lakehurst Naval Air Station's infirmary, shortly after his escape from the burning LZ-129

Left: rigger *Hans Freund* in the hospital after his escape from the burning airship
Right: Hans Freund (outlined) explaining the locations of LZ-129's various landing lines using a diagram of the ship as a reference. Translator *Willy von Meister* (center) and Commander F. W. Knox (left) look on. Photograph taken from Freund's first appearance before the Board of Inquiry on May 15th 1937.

"…When we first examined each other to see if we were hurt, I had nothing the matter with me; Mr. Sauter had a bleeding wound on his head, and Freund had burns on the back of his head and on the side of his cheek. Kollmer was limping away from the wreck. We could not do anything because the wind was coming from port and was blowing the flames and the smoke to the starboard side. Sauter and Freund and myself then ran around the stern side of the ship to the port side, and I no longer saw Freund. I lost sight of him. Sauter ran for the port rear engine, and there were sailors from the Lakehurst ground crew. They wanted to hold Mr. Sauter back because I think they were afraid that the fuel tanks might still explode at that point. I was still a little further aft, and heard screaming from inside the wreck at approximately this point (indicating)."

RE: LZ-129 crewman *Helmut Lau*. Excerpt from his testimony to the Board of Inquiry, May 18th 1937

RE: *Helmut Lau* was the person with the clearest vantage point of the origin of the fire, although by his own admission he didn't literally see the initial burst of fire but rather heard the "pop" of the fire igniting and the glow of the fire through gas cell 4. Lau, Freund, Kollmer and Sauter were all very close to the fire's point of origin from their tail fin position. Lau was uninjured in the crash and returned to *Germany* via steamship not long after the disaster.

Navy Men, Stand Fast!!

As LZ-129 settled to the ground, less than thirty seconds after the first flames were observed, those who had jumped from the burning craft scrambled for safety, as did members of the ground crew who had been positioned on the field below the ship. The natural human instinct for self-preservation caused those on the ground to run from the burning wreck as fast as they could, but Chief Petty Officer *Frederick J*. “Bull” *Tobin*, a longtime airship veteran and airship pilot himself who was in charge of the Navy landing party, cried out to his sailors: “Navy Men, Stand Fast!!” Bull Tobin had survived the crash of *USS Shenandoah* and was not inclined to abandon those in peril on the burning airship, even at the risk of his crews’ and his own life. His sailors agreed. Films of the disaster clearly show sailors turning and running back toward the burning ship to rescue survivors providing a permanent tribute to the courage of the Navy detachment at Lakehurst NAS that terrible day in May.

<u>Above</u>: Navy ground crew at the Lakehurst NAS (ca. 1936)

"…Photographers at Lakehurst were not too stunned by the sight of the flaming airship to turn their lenses down. The scenes on the ground were fully as dramatic and horrible as the explosion itself…"

***LIFE* magazine, May 17th 1937**

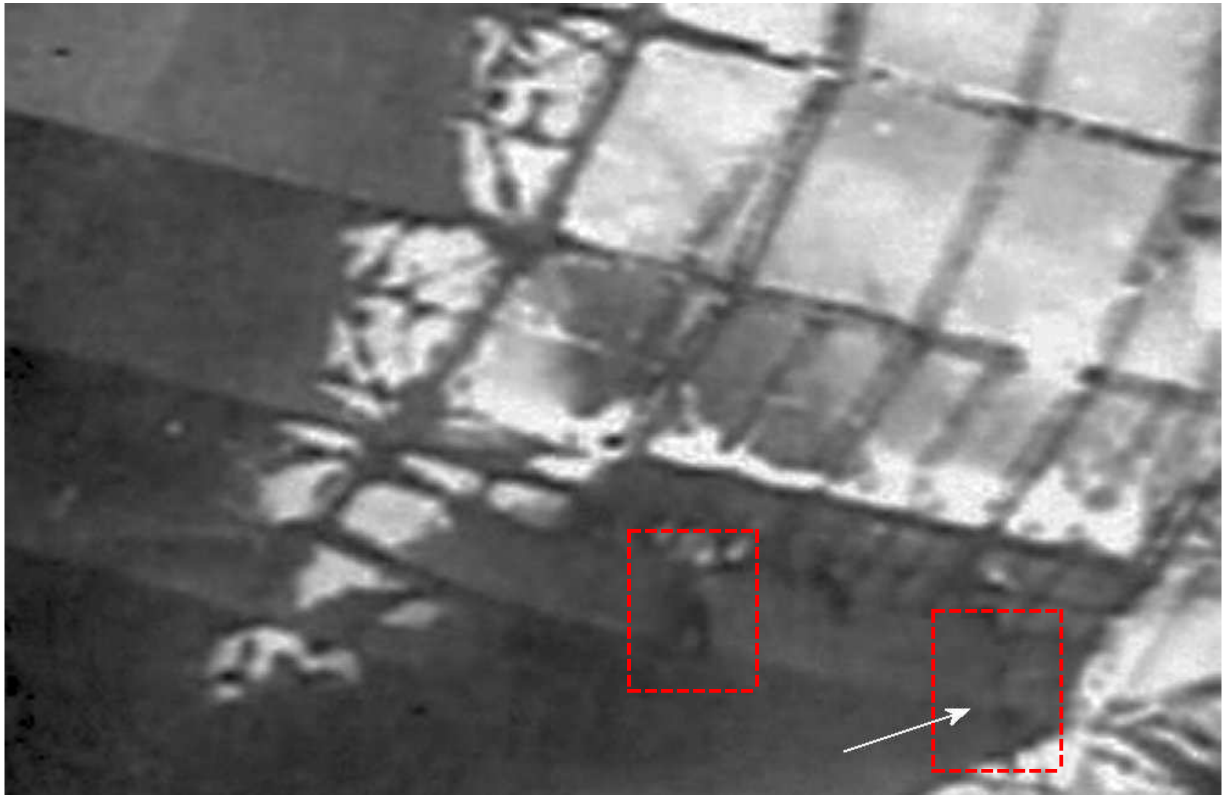


"Something drew me toward the wreckage; I cannot say whether it was the feeling that I must try to save others, or that demon-like urge of self-destruction which drives the moth into the flame. My wife called to me, called more urgently and ran back to me. She spoke persuasively; took me by the hand; led me away."

***Leonhard Adelt,* Journalist**

<u>Left</u>: *Gertrud* and *Leonhard Adelt* are led from the scene of the *Hindenburg* wreck

<u>Right</u>: Gertrud and Leonhard Adelt



"Well, ladies and gentlemen, I'm back again. I raced down to the burning ship, and just as I walked up to the ship, overclimbed those picket lines, I met a man coming out…dazed…dazed, he couldn't find his way. I grabbed ahold of him: it's Philip Mangone. Philip Mangone, M-A-N-G-O-N-E, of New York. Philip Mangone…he's burned terribly in the hands, and he's burned terribly in the face, his eyebrows and…all his hair is burned off, but he's walking and talking, plainly and distinctly, and he told me he jumped! He jumped with other passengers!

Herb Morrison, **Radio Announcer**

Above: arrow points to a passenger jumping from the burning airship

“Somehow, in the flashing second of the explosion, I retained my presence of mind. I grabbed a chair and smashed it through the window. I gripped the window sill and looked out. We seemed a little less than 200 feet high. I said to myself, ‘I can’t jump. We’re too high. I’ll break my legs.’ But I couldn’t wait. A moment or two later, as the wrecked ship sank downward, I jumped. The framework of the dirigible pinned me down. I lay flat in the tangle of wreckage, but my body wasn’t crushed. I worked frantically to get myself out of the wreckage. Desperately, I scraped a hole into the dirt. Somehow I burrowed myself out like a mole. I was conscious all the time. It seemed like an age before I squirmed through. I stood up, dazed. I wheeled around dizzily. The shock had been so great I didn't know what I was doing. I was navigating without thinking. All around me was the smell of burning flesh. Men were rushing about excitedly. Some were badly burned passengers, others members of the ground crew. The scene was indescribable. Everything was in a panic. Passengers were crying and screaming. I reeled under my own steam toward a building in the distance.”

Philip Mangone, **Clothing Designer**

"All the News That's Fit to Print."

The New York Times.

LATE CITY EDITION

HINDENBURG BURNS IN LAKEHURST CRASH; 21 KNOWN DEAD, 12 MISSING; 64 ESCAPE

ANARCHISTS RENEW BARCELONA STRIFE; 5,000 LEAVE BILBAO

NOTABLES ABOARD

Merchants, Students and Professional Men on the Dirigible

HUGHES SEES CHOICE IN LAW OR TYRANNY

SHIP FALLS ABLAZE

Great Dirigible Bursts Into Flames as It Is About to Land

THE HINDENBURG IN FLAMES ON THE FIELD AT LAKEHURST

DISASTER ASCRIBED TO GAS BY EXPERTS

Airship Like a Giant Torch On Darkening Jersey Field

GERMANY SHOCKED BY THE TRAGEDY

Aftermath

"…More than humanity perished that warm May evening. It was the end of an era. The great airships had become a part of history. Official investigations arrived at the 'least improbable' conclusion: static electricity had ignited leaking hydrogen. This verdict was not very convincing then, and is less so now. New evidence points to sabotage by a crew member allied with the Communist ant-Nazi underground…"

Popular Science, **May 1962**

RE: *Luftshiff Hindenburg* left *Frankfort* with ninety-seven souls aboard; sixty-two survived the crash at Lakehurst NAS, although many suffered serious injuries. Thirteen of the thirty-six passengers and twenty-two of the sixty-one crew members died as a result of the crash, along with one member of the civilian landing party.

<u>Top Left</u>: LZ-129 *Kapitan Max Pruss* in ambulance en route to *Columbia Presbyterian Hospital* in NYC, May 7th 1937

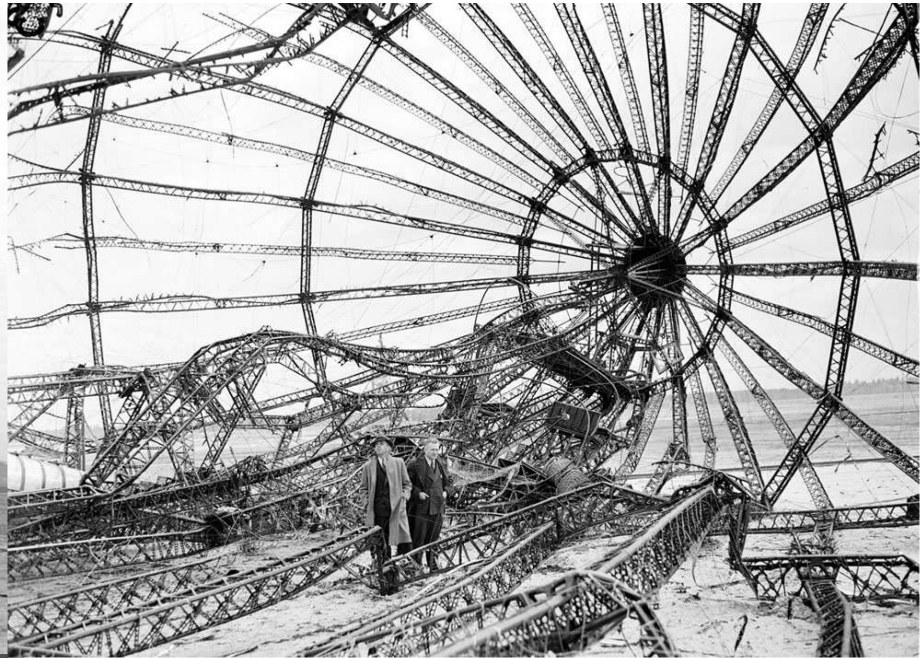
<u>Top Right</u>: a facially disfigured Max Pruss (at right) circa the early 1950s

<u>Left</u>: Chief Engineer *Rudolf Sauter* (at left, in dark uniform) and stewards *Fritz Deeg* (center) and *Wilhelm Balla* (right) leave Hangar One at Lakehurst NAS after identifying the bodies of fire victims, on May 7th 1937.


<u>Left</u>: LZ-129 electrician *Josef Leibrecht* being transferred via ambulance from *Paul Kimball Hospital* in *Lakewood, NJ* to *Lenox Hill Hospital* in NYC, the day after the disaster.
<u>Right</u>: Josef Leibrecht in his later years

"…On the morning of May 7, air travelers over Lakehurst looked down on the grim sight above, a charred and twisted duralumin skeleton. Biggest airship ever built, the 'Hindenburg' was the 129th in the line of Zeppelins. It cost $3,000,000 and offered the world's most luxurious air travel. Last year, from its base at Friedrichshafen, Germany, the 'Hindenburg' made ten round trips to Lakehurst, keeping its schedule in weather which grounded airplanes. It was filled with inflammable hydrogen instead of nonflammable helium because hydrogen costs much less and has greater lifting power. At the time of the tragedy the dirigible was valving hydrogen. Whether by static electricity, or by a spark from one of the motors, or even by sabotage, the gas became ignited. Experts agreed that the disaster could never have happened with helium, predicting that no future commercial airship will fly with hydrogen."

LIFE **magazine, May 17th 1937**



Top Left: members of the *U.S. Navy Board of Inquiry* inspect the wreckage of the *Hindenburg* on the field in *Lakehurst, New Jersey* on May 8th 1937

Top Right: two men inspect the twisted metal framework of the Hindenburg

Left: *U.S. Customs* officers search through baggage items salvaged from the Hindenburg

<u>Left</u>: in *New York City*, funeral services for the twenty-eight German nationals who lost their lives in the *Hindenburg* disaster were held on the *Hamburg-American* pier on May 11th 1937. About 10K members of German organizations lined the pier.
<u>Right</u>: German soldiers give the Nazi salute as they stand beside the casket of *Captain Ernst Lehmann*, former commander of the *Luftschiff Hindenburg*, during funeral services held on the Hamburg-American pier The swastika-draped caskets were placed on board the *SS Hamburg* for their return to *Germany*.

Surviving members of the LZ-129's crew pose for a photograph at the Lakehurst NAS on May 7th 1937. *Rudolph Sauter*, Chief Engineer, is at center (wearing white cap). Fourteen-year-old *Werner Franz*, cabin boy, is center front row (in front of Sauter). Several members of the airship's crew are wearing *U.S. Marine* summer clothing furnished to them to replace clothing burned from their bodies as they escaped from the flaming dirigible.

"…Air travel has certainly come to stay and the 'Hindenburg' is likely to go down to posterity as a fore-runner of what may eventually become regular world wide travel by Airship. Not even the most timid or nervous person need have any qualms about Airship Travel. It has been confirmed on this voyage that passengers who are always sea-sick on open liners have been absolutely free from any sickness and so even have been able to enjoy their meals…"

***George Grant*, LZ-129 passenger**

RE: excerpt from his: "Notes on a voyage of the Airship 'Hindenburg' under the Command of Captain Pruss; May 6th 1937, off the New England Coast"

“If you want to get there quickly, take an airplane. If you want to get there comfortably, take an airship.”

Max Pruss

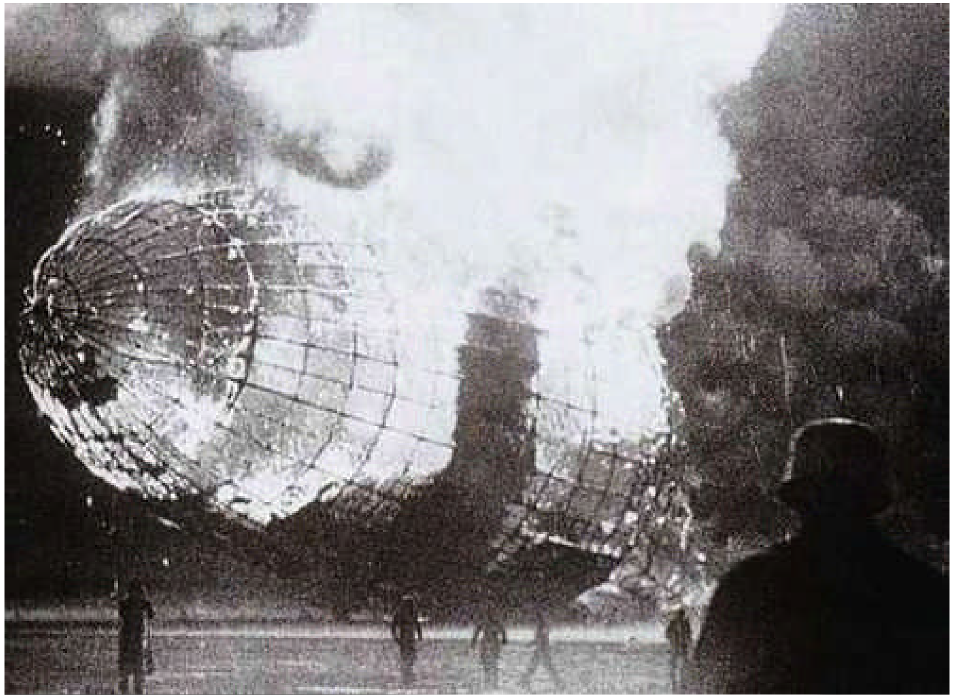
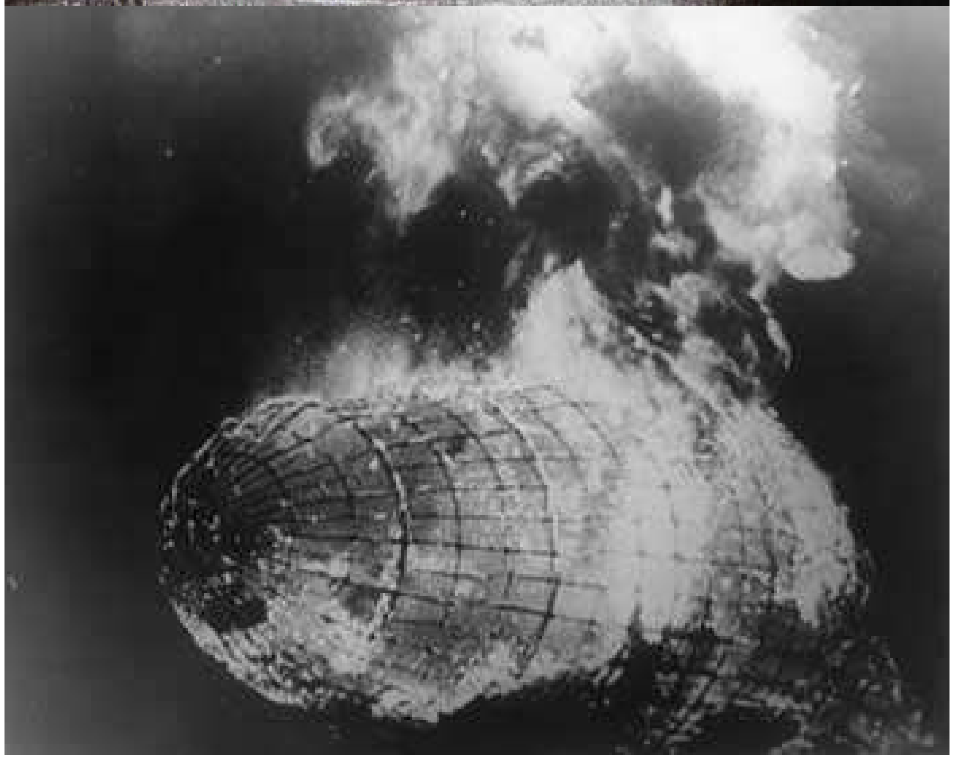
RE: before the *Hindenburg* disaster, the public seemed apathetic to the accident-prone rigid airship. The glamorous and swift Hindenburg was greeted with public enthusiasm despite a long list of previous airship accidents. But while airships like the British R-101, on which forty-eight people died, or the *USS Akron* on which seventy-three were killed, crashed at sea or in the darkness of night; far from witnesses or cameras, the crash of the Hindenburg was captured on film and millions of people around the world saw the dramatic explosion which consumed the ship and its passengers. It was an unforgettable image. Technologically, the Hindenburg was obsolete before it ever flew. On November 22nd 1935 - three months before Hindenburg first took to the air, *Pan American Airways*' M-130 *China Clipper* made the first scheduled flight across the *Pacific*. The longest leg, the 2,400 miles from *San Francisco* to *Honolulu*, was longer than the distance required to cross the *North Atlantic*. In fact, Pan Am's M-130 was designed for the *Atlantic*, not the Pacific. It would be political, not technological, considerations that prevented Pan Am from inaugurating transatlantic airline service in 1935 (the British refused to grant Pan Am landing rights until they had a plane of their own that could make the same flight, but *Great Britain* was far behind *America* in the development of a long-distance airliner). When Pan Am did start flying the Atlantic in 1939 (in *Boeing* B-314 clippers), the scheduled elapsed time of the multi-leg flight was 45-55 hours; about the same time as the Hindenburg, but with considerably less comfort. Also, the 40-passenger Boeing clipper required a flight crew of ten rather than the forty required to fly LZ-129.

“…Flames streaming upward into the darkening sky above Lakehurst, N.J., nearly a year ago, seemed to form a funeral pyre consuming the last hope of the rigid dirigible. The ‘Hindenburg’ disaster, claiming thirty-six lives and destroying the largest and most luxurious sklyliner ever built, was accepted by the world as bringing to a close the long and tragic story of the Zeppelin…Stunned by the catastrophe, most scientists agreed that ‘finis’ had been written to the history of the sky leviathan…”

Popular Science Monthly, **April 1938**

<u>Above</u>: remains of the *Hindenburg* under marine guard

We Must Have Helium!

"…Proponents of the big dirigibles were quick to point out that fire, and not structural failure, had produced the disaster. Photographs showed that, in spite of the fire and explosions, the framework of the Zeppelin remained intact and settled slowly to the ground. It showed that it could withstand tremendous strains, far in excess of those it would meet in flight. But, so long as the fire hazard remained, the proponents admitted, the Zeppelin was doomed. Approximately half of all the big dirigibles built have been destroyed by flames. Dr. Hugo Eckener, veteran commander of the lighter-than-air ships, expressed the general opinion when he said: 'We must have helium!'…"

***Popular Science Monthly,* April 1938**

<u>Left</u>: LZ-129's airframe remains intact

Fire Starter (?)

"They used a cellulose acetate or nitrate as a typical doping compound, which is flammable to begin with – a forest fire is a cellulose fire. OK, you coat that with cellulose nitrate – nitrate is used to make gunpowder. And then you put on aluminum powder. Now, aluminum powder is used on the solid rocket boosters of the space shuttle…I'm not saying hydrogen didn't contribute to the fire, it is after all a fuel. But it was a fuel-rich fire already; the hydrogen just added to it… I guess the moral of the story is don't paint your airship with rocket fuel."

Addison Bain, **retired engineer and manager of NASA's hydrogen programs**

RE: comments made in a *Popular Science* article; November 1997. His contention, based on extensive research and testing, that the fabric skin of the *Hindenburg* was highly flammable and the root cause of the disaster. The fabric skin was coated or "doped" to make it taut and reduce flutter for aerodynamic efficiency. The fabric skin was then painted with reflective red iron-oxide and aluminum to prevent solar radiation from expanding the hydrogen in the gas cells and to help prevent gas from escaping. He also concluded that the wood spacers and ramie cord used to bind the airship's structure together, along with the silk and other fabrics in the airship, added to the fuel-rich fire. To protect it from moisture, even the duralumin frame of Hindenburg was coated with a flammable lacquer.

“Based on the authors’ cover burn rate tests, it would have taken anywhere from fifteen minutes to probably an hour or more for the cover alone to burn off. The entire ship, on the other hand, was consumed in less than sixty seconds. Bain can demonstrate or argue that the cover was a brief link in the early ignition of the hydrogen, but he cannot prove even that.”

***Donald E. Overs,* retired lighter-than-air engineer**
RE: counter-argument to Addison Bain’s theory

Mystery Solved (?)

“The mystery of the Hindenburg disaster has finally been solved 76 years after the in-flight exposition occurred…They say that after the ship flew into a thunderstorm a build up of hydrogen led to the explosion. The iconic airship had reportedly become charged with static as a result of the electrical storm and broken wire or a sticking gas valve leaked the hydrogen into the ventilation shafts. When ground crew members ran to take the landing ropes they effectively ‘earthed’ the airship causing a spark. The fire is believed to have started on the tail of the airship, igniting the leaking hydrogen…”

The Daily Mail **newspaper, March 4th 2013**

Jem Stansfield, a British aeronautical engineer, and his team of researchers based at the Southwest Research Institute in San Antonio, Texas, blew up and set fire to scale models of blimps more than 24m long to prove the real cause…The researchers say their reason for conducting the experiments was to rule out theories ranging from a bomb planted by a terrorist to explosive properties in the paint used to coat the Hindenburg, the Independent reports…Investigations conducted after the disaster deemed that a sudden spark had ignited leaking hydrogen gas in the airship. However, investigators could not come to an agreement on what caused the spark, or the leaking gas. Conspiracy theories began to spread that the Hindenburg had been wiped out by a bomb or that someone had shot down the airship from below. Stansfield and his team were able to dispel those rumors after they recreated different scenarios with mini-replicas, studied archive footage of the disaster and collected eyewitness accounts…"

The Daily Mail **newspaper, March 4th 2013**

<u>Above</u>: 24-meter long hydrogen inflated model ignites from static electricity

"I think you had massive distribution of hydrogen throughout the aft half of the ship; you had an ignition source pull down into the ship, and that whole back portion of the ship went up almost at once"

***Dan Grossman,* Airship Historian**

LZ-130

"My friends and I want to let the world know that we are ready to start all over again. Count Zeppelin himself suffered numerous defeats, but he kept on. We as loyal Germans will do the same. We naturally feel sorry for those friends of ours who have passed on, but we are not going to let that deter us. We are ready to start anew and build a bigger and greater Zeppelin."

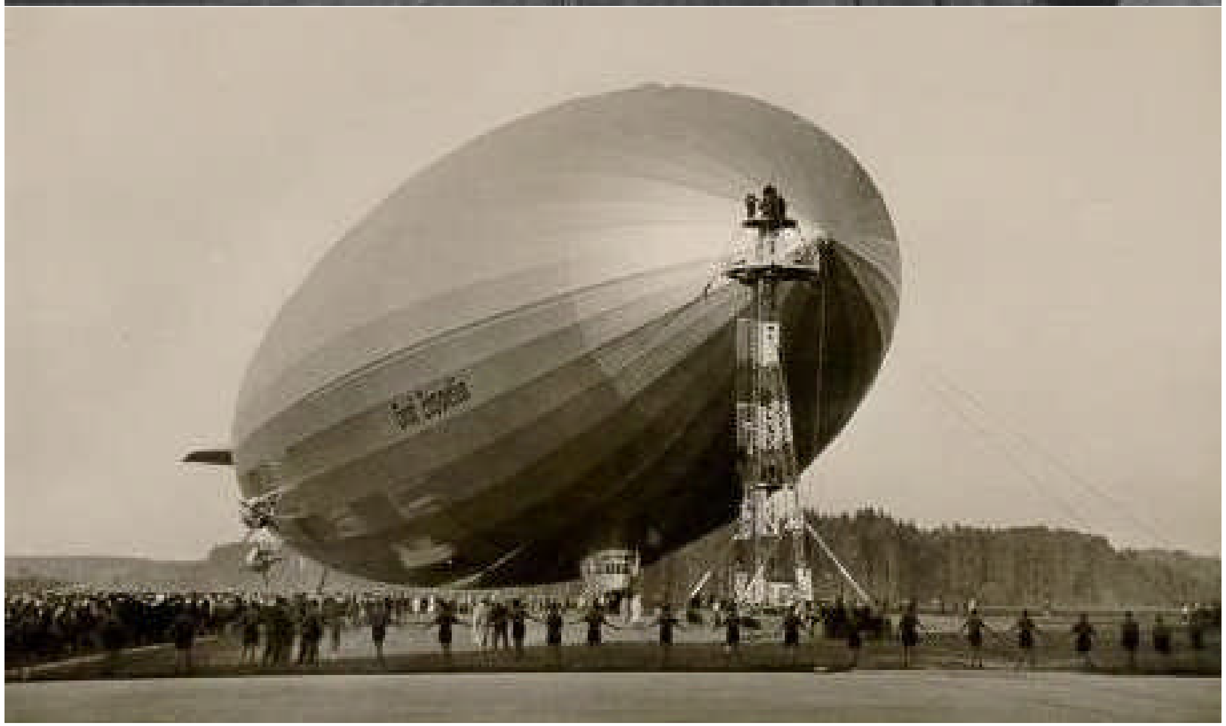
***Heinrich Kubis*, LLZ-129's Chief Steward (left)**

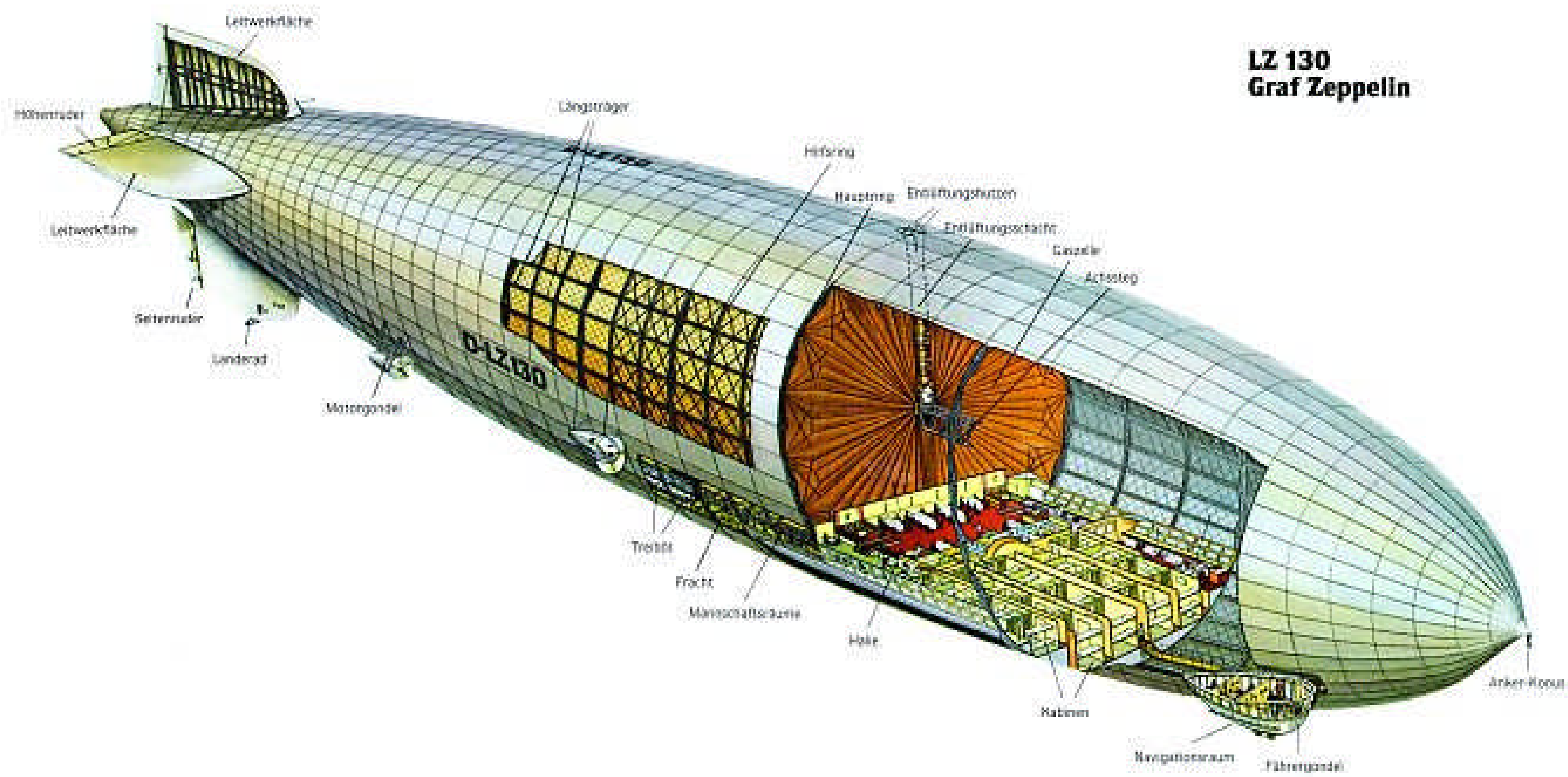
"…Months have passed. In the great sheds at Friedrichshafen, on the Swiss-German border, another giant, the LZ-130, is being groomed for its initial tests. A few weeks hence, its four 1,200-horsepower Diesel engines will roar into action and the pointed nose of the great 800-foot dirigible will turn to the west for the 2&1/2 day transatlantic crossing to Lakehurst. Once more, the Zeppelin is attempting a come-back…"

***Popular Science Monthly,* April 1938**

<u>Above</u>: color photograph of LZ-130 at her mooring mast

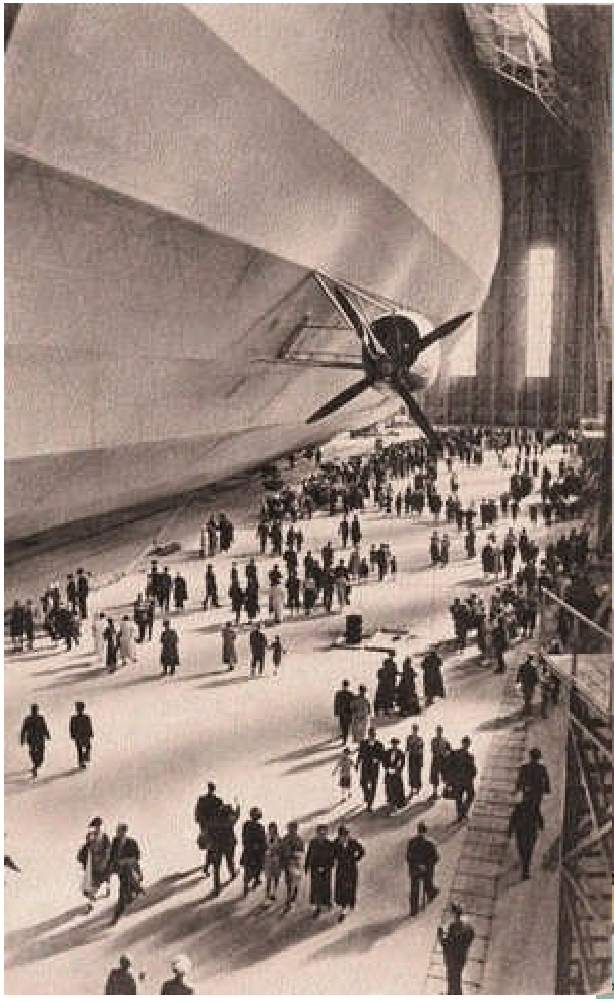
<u>Left</u>: LZ-130 (*Graf Zeppelin II*) in her hangar at *Friedrichshafen*

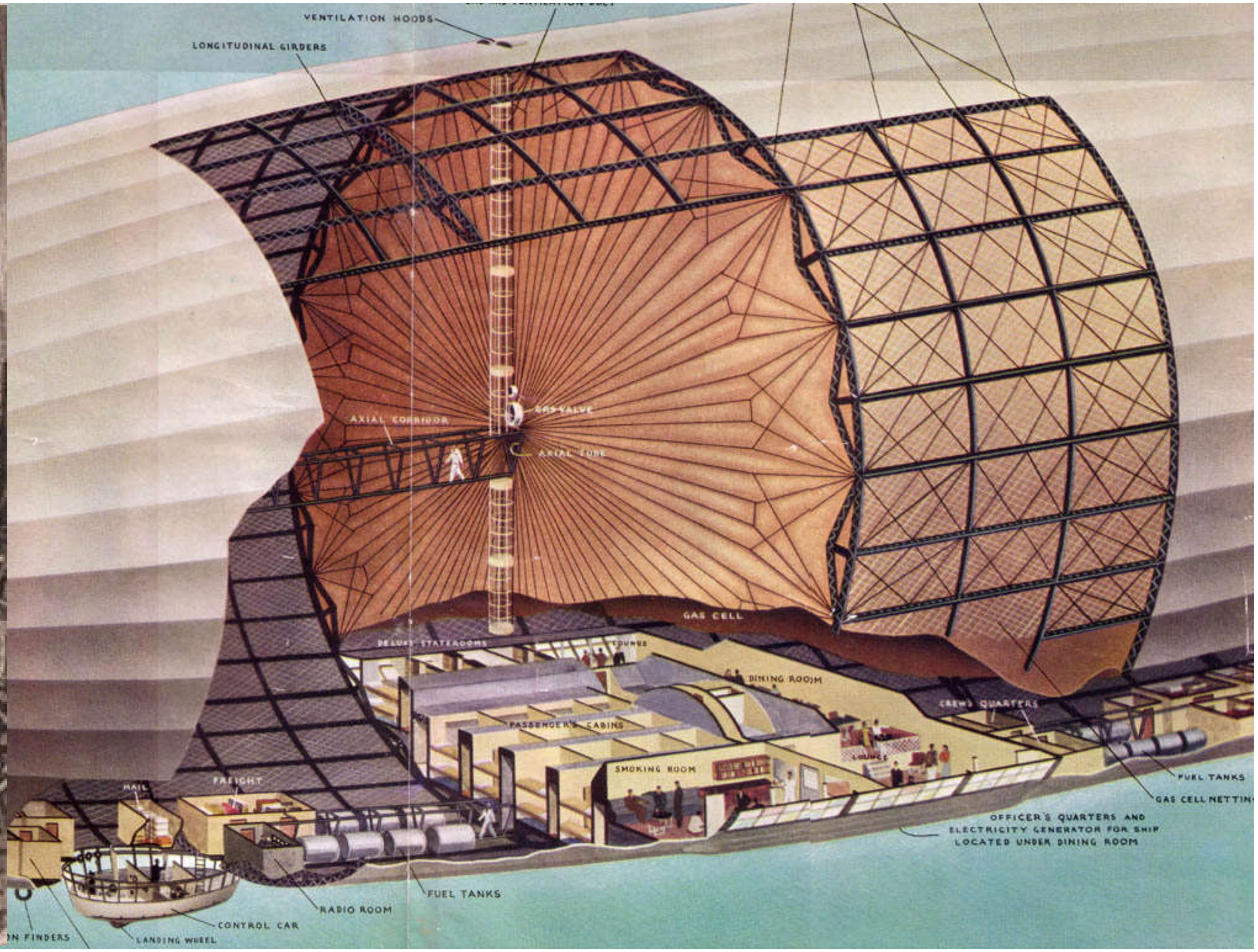




"…But one more Zeppelin flew: the LZ-130. She cruised the English Channel, ferreting out British radars before World War II, but was ignominiously scrapped for her aluminum…"

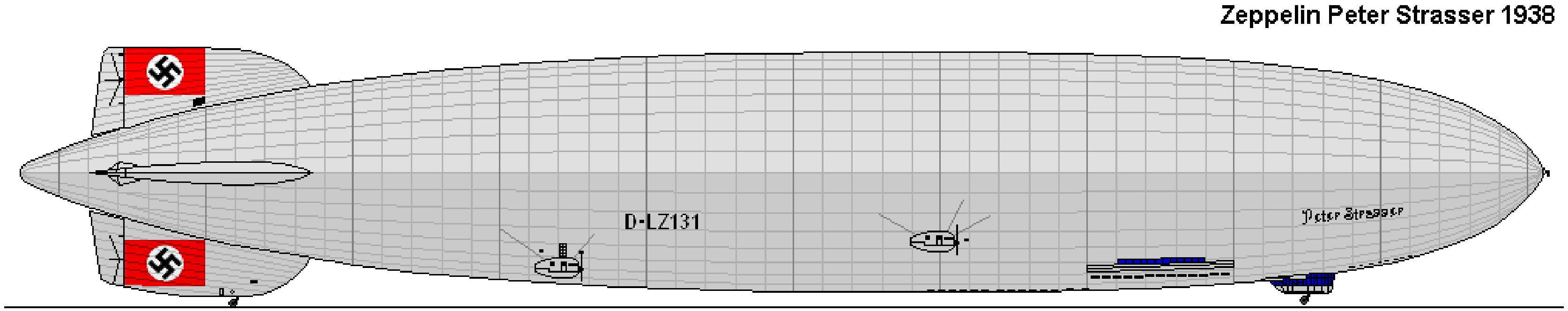
***Popular Science*, May 1962**




VENTILATION HOODS
LONGITUDINAL GIRDERS
AXIAL CORRIDOR
GAS VALVE
GAS CELL
DELUXE STATEROOMS
DINING ROOM
CREWS QUARTERS
PASSENGER'S CABINS
SMOKING ROOM
FUEL TANKS
OFFICER'S QUARTERS AND
ELECTRICITY GENERATOR FOR SHIP
LOCATED UNDER DINING ROOM
FREIGHT
MAIL
FUEL TANKS
RADIO ROOM
CONTROL CAR
LANDING WHEEL

Albert Sammt sailed home to *Germany* on the steamship *SS Europa* in mid-June 1937. Slightly more than a year later, in September 1938, the Zeppelin Company's newest airship; the LZ-130 *Graf Zeppelin,* made its first test flights. As Sammt suspected, the *United States* government had not agreed to sell helium to *Germany* thus the new airship's gas cells would have to be inflated with hydrogen. Despite his injuries, Sammt, like the rest of his comrades, readily agreed to fly on the new airship. Serving as before as a watch officer, Captain Sammt made three test flights under the command of *Dr. Hugo Eckener* and one under *Captain Hans von Schiller*. Captain Sammt had obtained his aviator's license on September 15th 1937 and was therefore qualified to serve as commanding officer of an airship. On September 27th 1938, he commanded the second Graf Zeppelin (left) for the first time and continued to do so for the last two test flights and for the airship's transfer flight from *Friedrichshafen* to its new base in *Frankfort*. On November 5th 1938, he was officially named commander of the LZ-130 Graf Zeppelin. He commanded every subsequent flight but one before the new ship was grounded due to the outbreak of WWII in September 1939 and scrapped for its valuable duralumin.

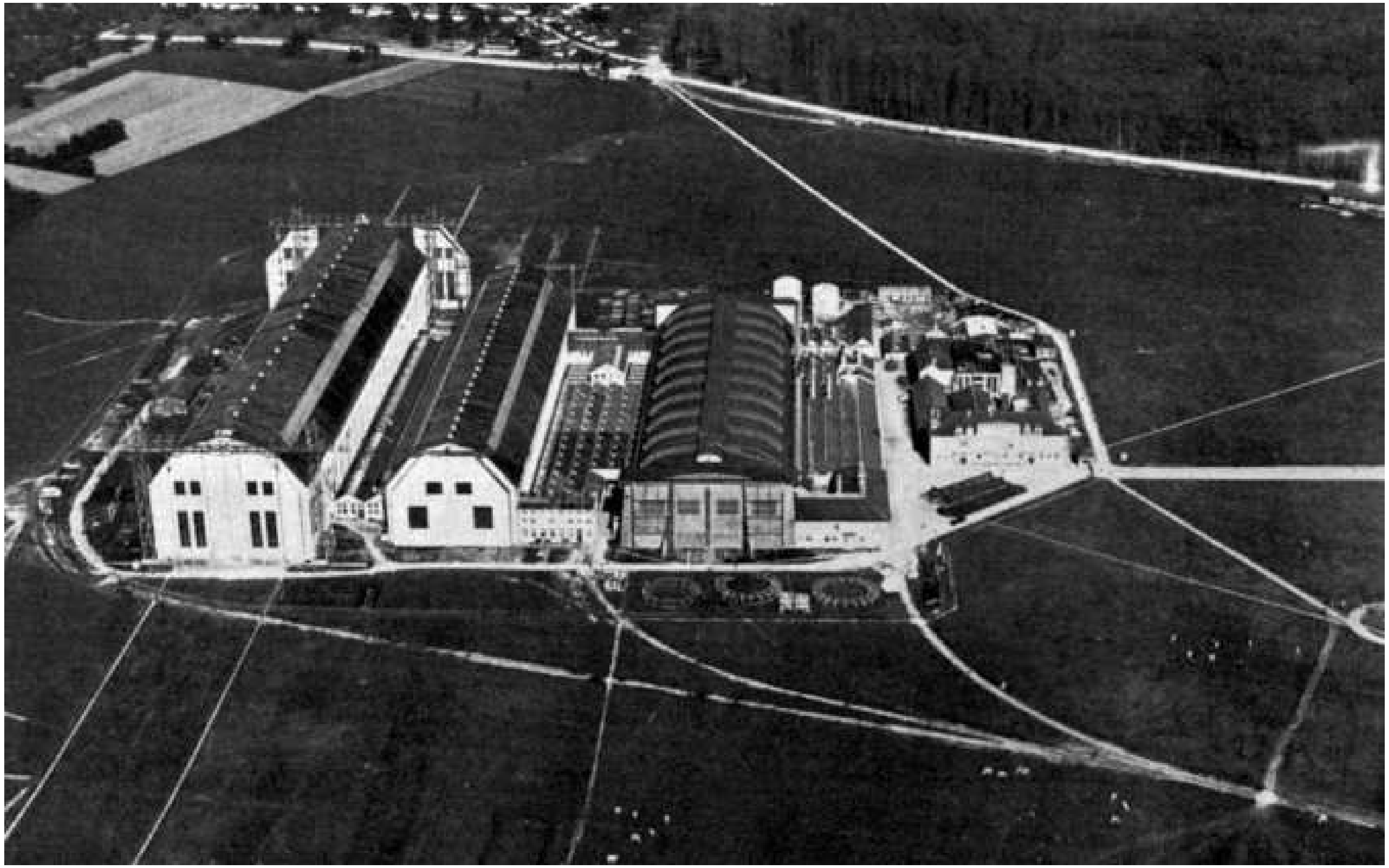
LZ-131



"…As the new dirigible plows through the sky on its westward trip, it will leave behind 500 workmen busily engaged in the construction of a still larger ship, the biggest Zeppelin ever built. This monster, the LZ-131, will carry seventy passengers on each North Atlantic run. It gets its name from the fact that it is the 131st dirigible made by the Luftschiffbau Zeppelin, or Zeppelin Airship Construction Corporation at Friedrichshafen. It is expected to be complete in late 1939…"

Popular Science Monthly, **April 1938**

RE: LZ-131, a.k.a. "Zeppelin Peter Strasser," never progressed beyond the production of some skeleton rings. (*Peter Strasser* was the chief of German Imperial Navy Zeppelins during WWI). In March 1940, Goring ordered both LZ-130 and LZ-131 to be dismantled for their valuable duralumin (for *Luftwaffe* use during WWII).



"…If you visit Friedrichshafen now, you can see the ruins of the 'Luftschiffbau,' leveled by bomb attacks. Weeds wave above rubble – jagged headstones of the Zeppelins own burying grounds…"

***Popular Science,* May 1962**

<u>Above</u>: caption: "Zeppelin Airship Bldg. Co.'s Plant, Friedrichshafen, 1919. Note the two large single sheds. The largest shed is 115-feet high, 151-feet wide and 787-feet long."

"…It's not that the Zeppelin Co. itself ever disappeared. After the 'Hindenburg,' the company continued along quietly, building such goods as pots and pans and then rockets. Today, Zeppelin also builds the dome cover on the liquid hydrogen tank for the U.S. space shuttle…"

Popular Science, **November 1997**

Advantage Airship

"…The airship's advantage comes from the fact that it does not have to make stops for refueling, that it can halt in mid-air for motor repairs, that it has sufficient range to go around bad weather areas and can even seek a clear area and cruise with only enough movement for steerageway until bad weather ahead clears up. In fact, the 'Hindenburg's' record shows that she never failed to make a scheduled commercial trip; she took off several times when the weather was so bad that all airplanes were grounded; and she was never more than twelve hours late on a scheduled North Atlantic westward crossing or six hours late on an eastward crossing. Also, its ability to hover permits an airship to delay its landing if that is necessary. Once, warned by radio of a revolution, a German airship postponed her landing at Recife, Brazil, and merely headed into the wind for two days…"

***Popular Science Monthly*, May 1945**

"…over a five-year period ending late in 1941 transpacific commercial planes on schedule between San Francisco and Hong Kong showed elapsed-time averages of about 35 miles an hour westward and 33 miles an hour eastward, bad-weather delays, circuitous routes, and overnight stops greatly reduced actual flying time and increased elapsed time…commercial air travelers bound across the North Atlantic just before the present war were taken in the winter months by a roundabout southern route requiring an average of four days and 16 hours per passage…gave them an average elapsed-time speed of only about 30 miles an hour…In 1929 the 'Graf Zeppelin' made the trip from Japan to San Francisco in 69 hours, at an average speed of nearly 75 miles an hour, elapsed time. The 'Hindenburg's' average operational speed, also elapsed time, was nearly 65 miles an hour for all her ocean passages. The passenger-plane schedule from San Francisco to Hong Kong was six days and seven hours. An airship with the 'Hindenburg's' average performance would make the trip in about four and a half days…"

***Popular Science Monthly*, May 1945**

"…For hauls of 1,000 to 2,000 miles the airship cannot compete with the airplane in speed, though it can offer stiff competition in economy of operation. Passenger revenue alone covered more than 75 percent of all costs of operating the 'Hindenburg', including amortization, and the ship never carried a capacity load of paying passengers. Passenger comfort is another notable factor. The 'Hindenburg' had 25 two-berth staterooms, smoking and writing rooms, promenades, three bars, and deck space totaling an eighth of an acre. Her noise level was rated at 61, lower than that of even a Pullman car. There was not enough vibration to ripple the surface of a glassful of water. And because of its size, the airship absorbs the air bumps which toss an airplane around to the discomfort of its passengers. According to the records, there was never a case of airsickness or seasickness on either the 'Graf Zeppelin' or the 'Hindenburg.'…"

***Popular Science Monthly*, May 1945**

The Plain Facts

"…The plain facts of transportation explain why. A jet airliner can fly the Atlantic in six hours instead of sixty. It can carry three times as many passengers each trip as the Hindenburg did. It costs only a fraction as much to build. The biggest birds that ever flew are gone – extinct as dinosaurs and pterodactyls, and no more likely to return."

***Popular Science,* May 1962**

Part 10

Back to the Future

A Great Question Mark

"…On the day following the burning of the 'Hindenburg,' a syndicated cartoon appeared in many American newspapers. Labeled 'The Future of the Dirigible,' it showed the smoldering ruins of the Zeppelin with smoke curling into the sky above it to form a great question mark. That question mark remains. Only the future can give us the concluding chapter in the story of Count Zeppelin's dream."

***Popular Science Monthly*, April 1938**

“…Professor J.C. Hunsaker of the Massachusetts Institute of Technology, a noted aeronautical scientist, sees the transatlantic services of the future falling into three categories: a five-day steamship service, a one-day airplane service, and a two-day airship schedule. ‘Consideration of the operating record of the ‘Hindenburg’ in North Atlantic service,’ he says, ‘leads to the conclusion that a similar airship of 28 percent greater displacement should have a payload of 100 passengers and 20,000 pounds of mail and express when inflated with helium…’”

***Popular Science Monthly*, May 1945**


P 23

"…American designers were the first to move the engines inboard to reduce drag, and to swivel the propellers for better control. Now it is suggested that both engine and propellers be placed in a central tunnel running the length of the ship, which would further reduce drag and improve control, and at the same time add a jet-propulsion effect. Also, it seems likely that tomorrow's airships will be using gas turbines for power, thus greatly increasing efficiency. These changes, experienced lighter-than-air authorities believe, could increase airship cruising speeds to as much as 125 miles an hour…"

***Popular Science Monthly,* May 1945**

"…Finally, America's monopoly on helium makes an American airship program a 'natural.' Add to that the fact that its shipment and storage are both complicated and expensive, which means it probably will remain here. Helium has nearly 93 percent as much lift as hydrogen, is an inert gas, and is foolproof and virtually accident-proof. Given capable handling, the weather information now available, and intelligent operation, American-built helium-filled airships would seem to demand a place in any international program of postwar commercial aviation."

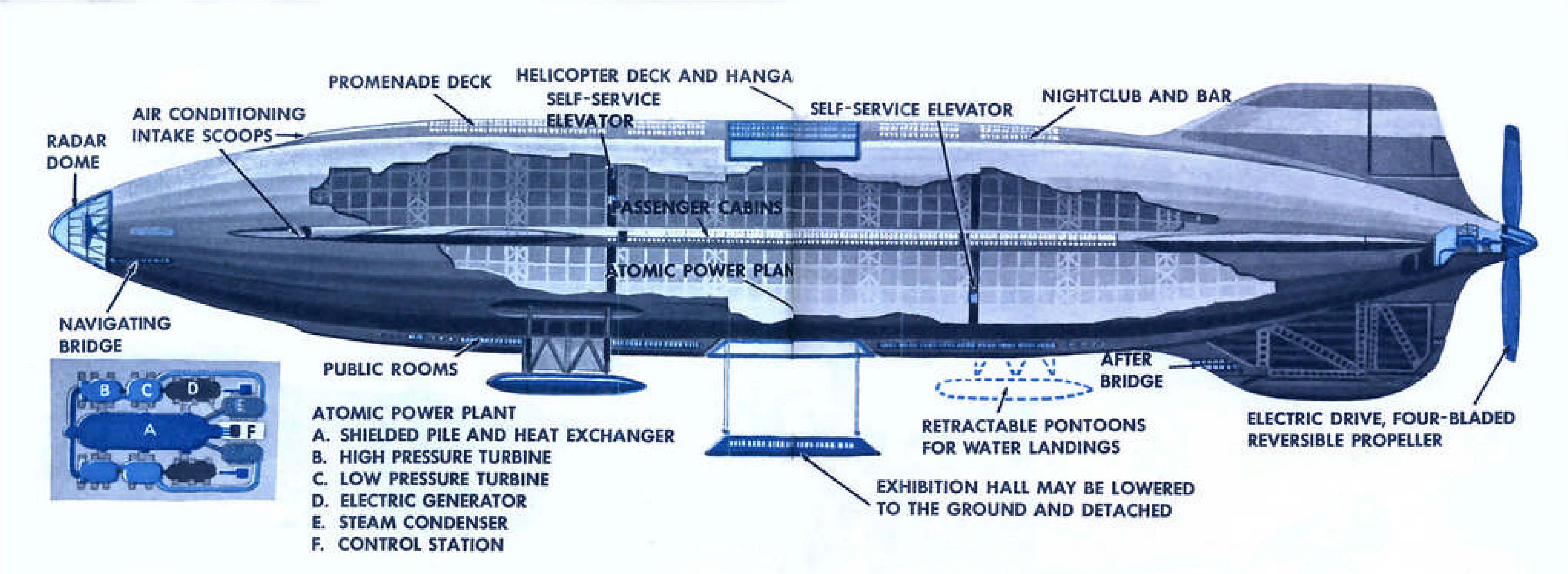
Popular Science Monthly, **May 1945**

Atoms for Peace

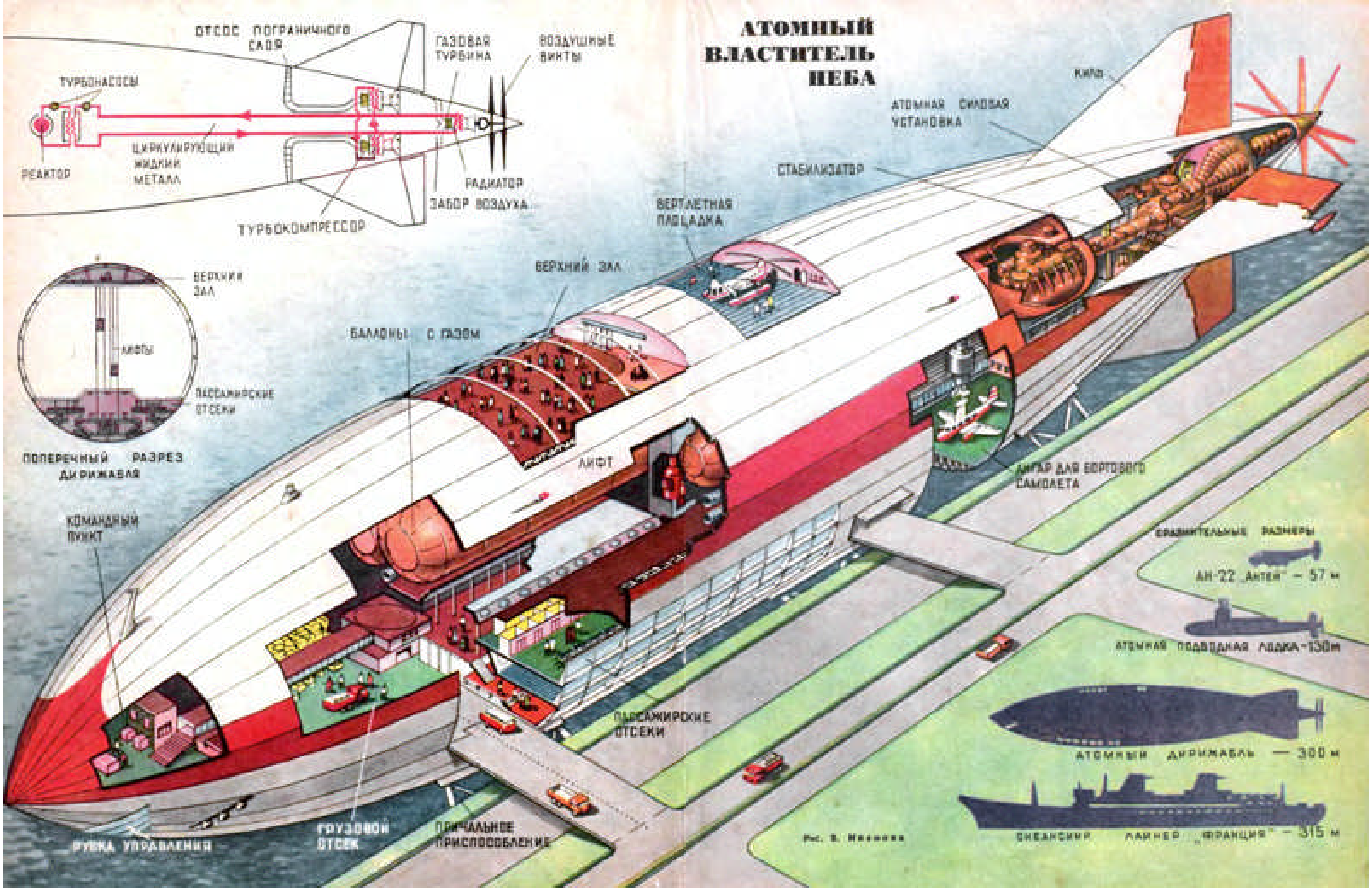
"…Until his death in 1960, Max Pruss had campaigned for a new airship company. He came close to winning approval for a 150-passenger Zeppelin even bigger than the Hindenburg. In the United States, Prof. Francis Morse of Boston University has blueprinted an atomic-engined dirigible – without much encouragement from anyone who might build it…"

***Popular Science,* May 1962**

<u>Above</u>: illustration of atomic dirigible appearing in the March 1956 *Mechanix Illustrated*



Above: caption: "Overall view of Atoms-for-Peace Dirigible shows its unique A-powered propeller drive and unique exhibition hall which could be lowered to the ground and detached to display the peaceful uses of atomic energy. All levels of the giant ship are interconnected by longitudinal and transverse gangways, stairs and self-service elevators."
***Mechanix Illustrated*, March 1956**



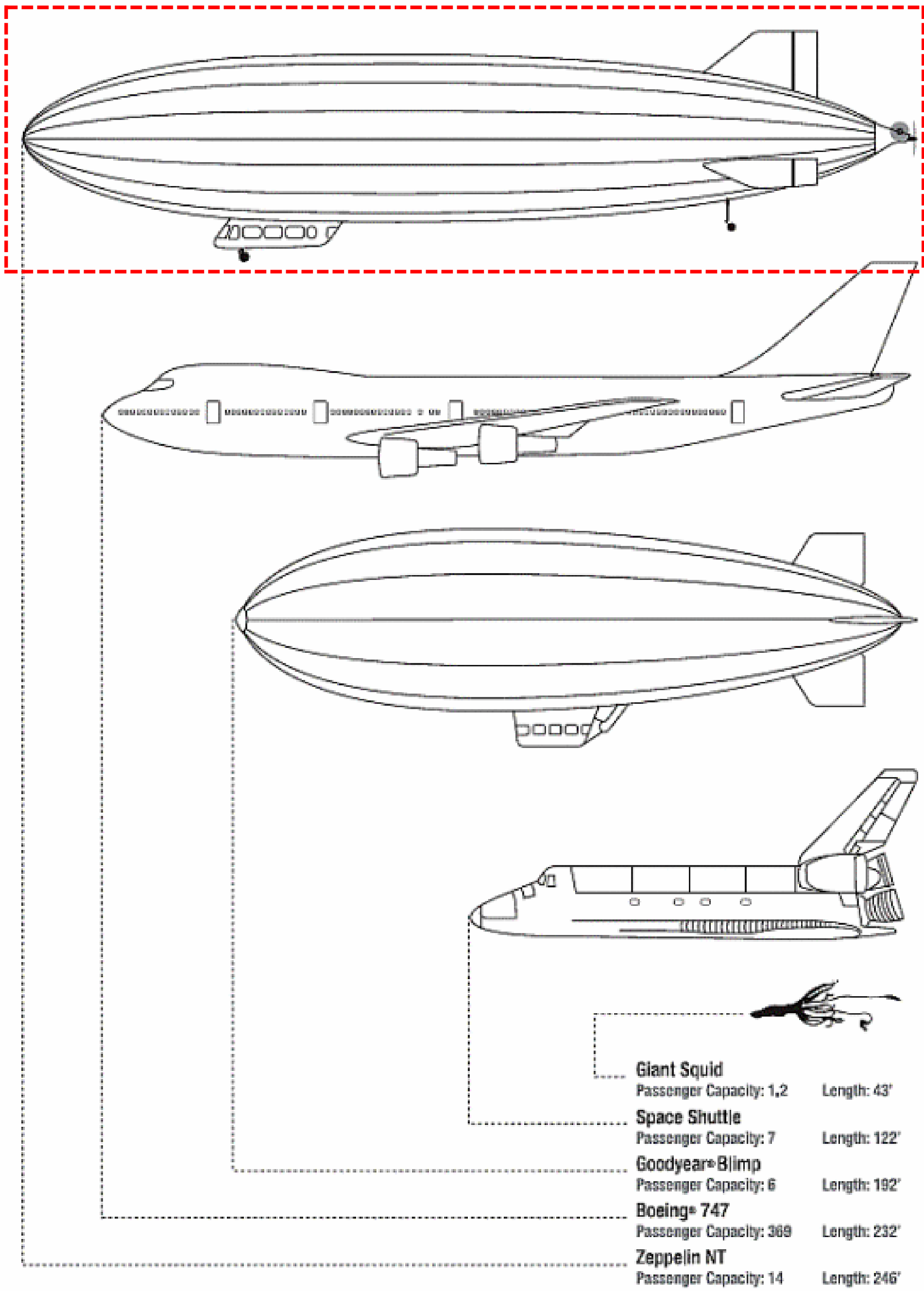
<u>Above</u>: illustration of a 300-meter long "Atomic Dirigible" with its own internal airport - from a Soviet magazine (ca. 1960's)

Out of the Ashes

"The Age of Airships ended in 1937, when the 245-meter long German Zeppelin 'Hindenburg' ignited and crashed at Lakehurst, New Jersey. Or…did it end? Thanks to a healthy economy, cheaper and stronger materials, and falling design costs, airships seem about to rise again, phoenix like, from the 'Hindenburg's' ashes. Led by the doyen itself – Zeppelin and its Zeppelin NT, which is already flying in Europe – at least seven companies are vying to return airships to the skies for hauling large cargo or for transporting passengers in luxury…"

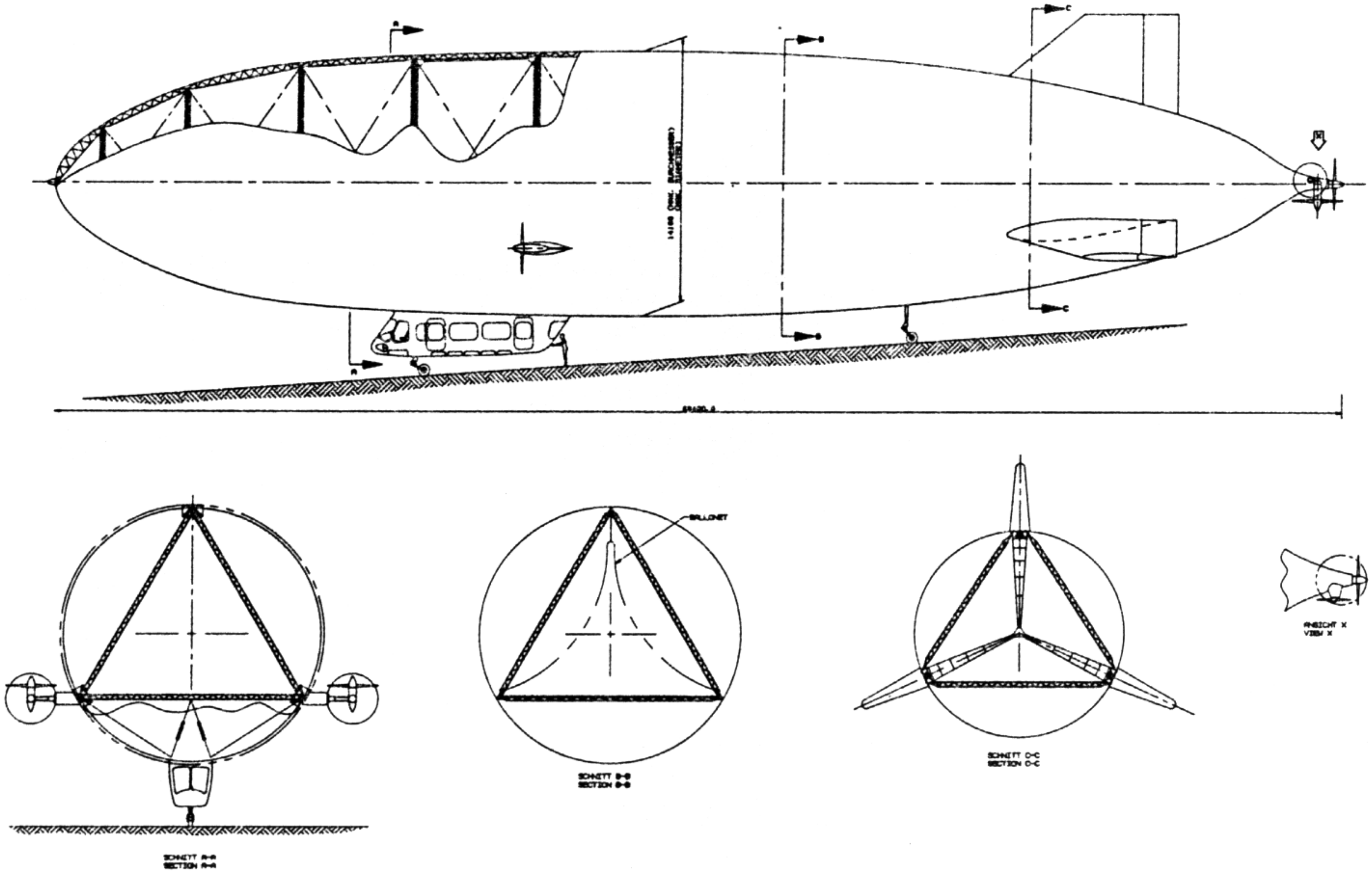
***Popular Science,* January 2001**

Zeppelin NT Relative Scale



<u>Above</u>: the "Zeppelin NT" (<u>N</u>ew <u>T</u>echnology) is 75-meters long. 8,200 cubic-meters of helium provide the lift and three motors with propellers provide the thrust. In the gondola under the envelope there is room for twelve pass-engers. The construction took two years.

<u>Left</u>: size comparison chart

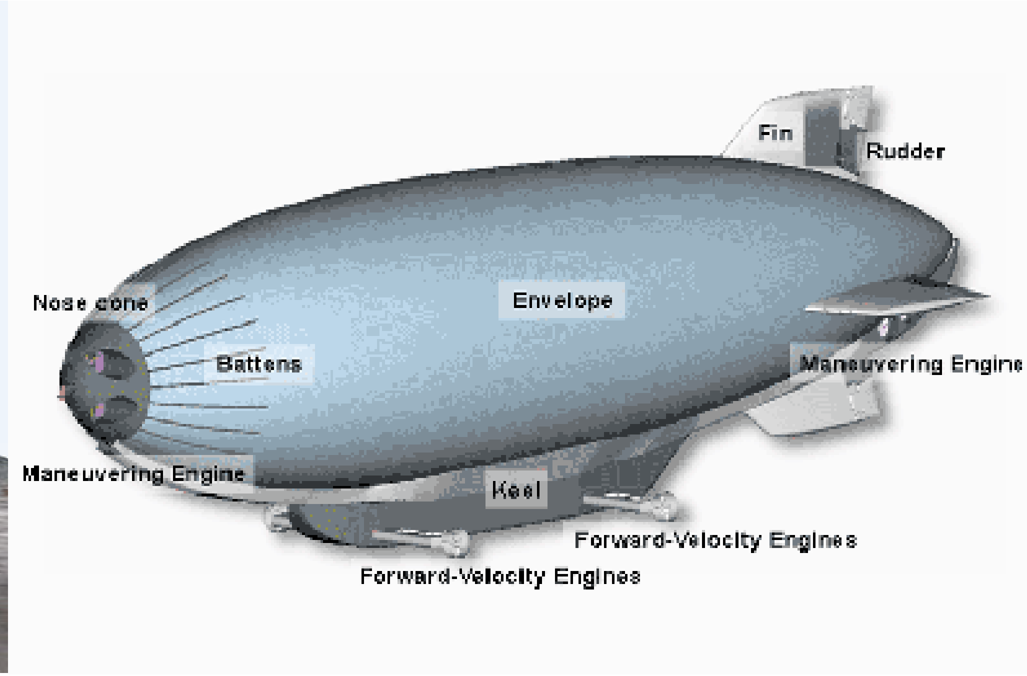


"…At the Zeppelin NT's heart are carbon-fiber composite frames attached to three aluminum longerons. Kevlar fiber is used to brace the frames. This semi-rigid design reduces total weight without compromising strength. Fins at the rear of the airship connect to the frame for added strength…"

***Popular Science,* January 2001**


FLY WITH ME!
www.nac-airship.com
ZEPPELIN NT
横浜 開国博Y150

CargoLifter

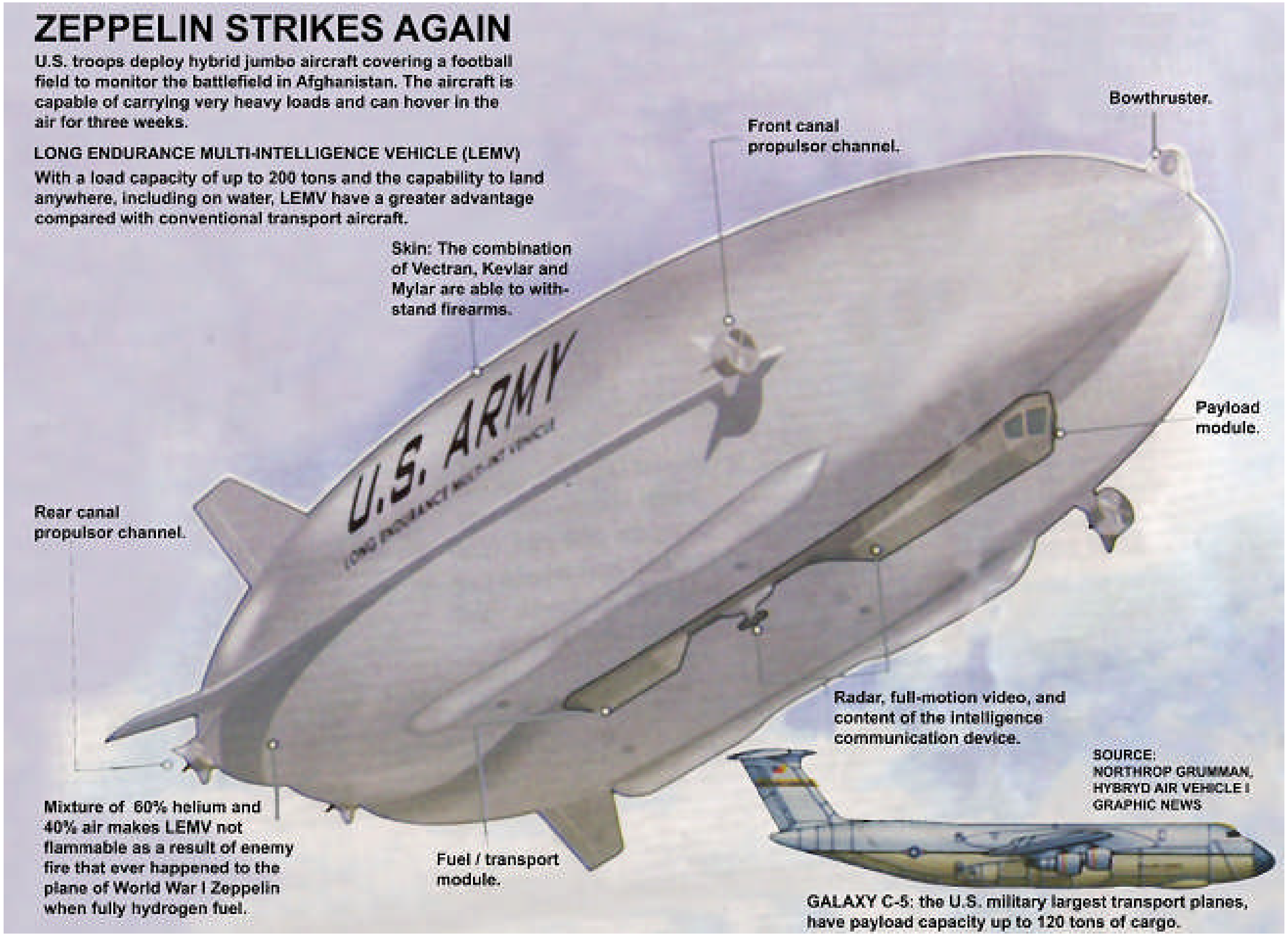


"It's an efficient vehicle; it doesn't need energy to float. It can carry immense cargoes into and out of remote areas without runways."

***J. Gordon Vaeth,* Airship Historian**

RE: *CargoLifter*, an airship company based in *Raleigh, NC.* Their "CargoLifter CL-160" (above, L&R) is 260-meters long, can lift 160 metric tons (538K cubic-meters) and operates at approximately one-third the cost of a cargo plane. It's heart-shaped to reduce wind resistance and a full-size prototype first flew in 2001. The *United Nations* planned to use it to bring hospitals to remote areas.

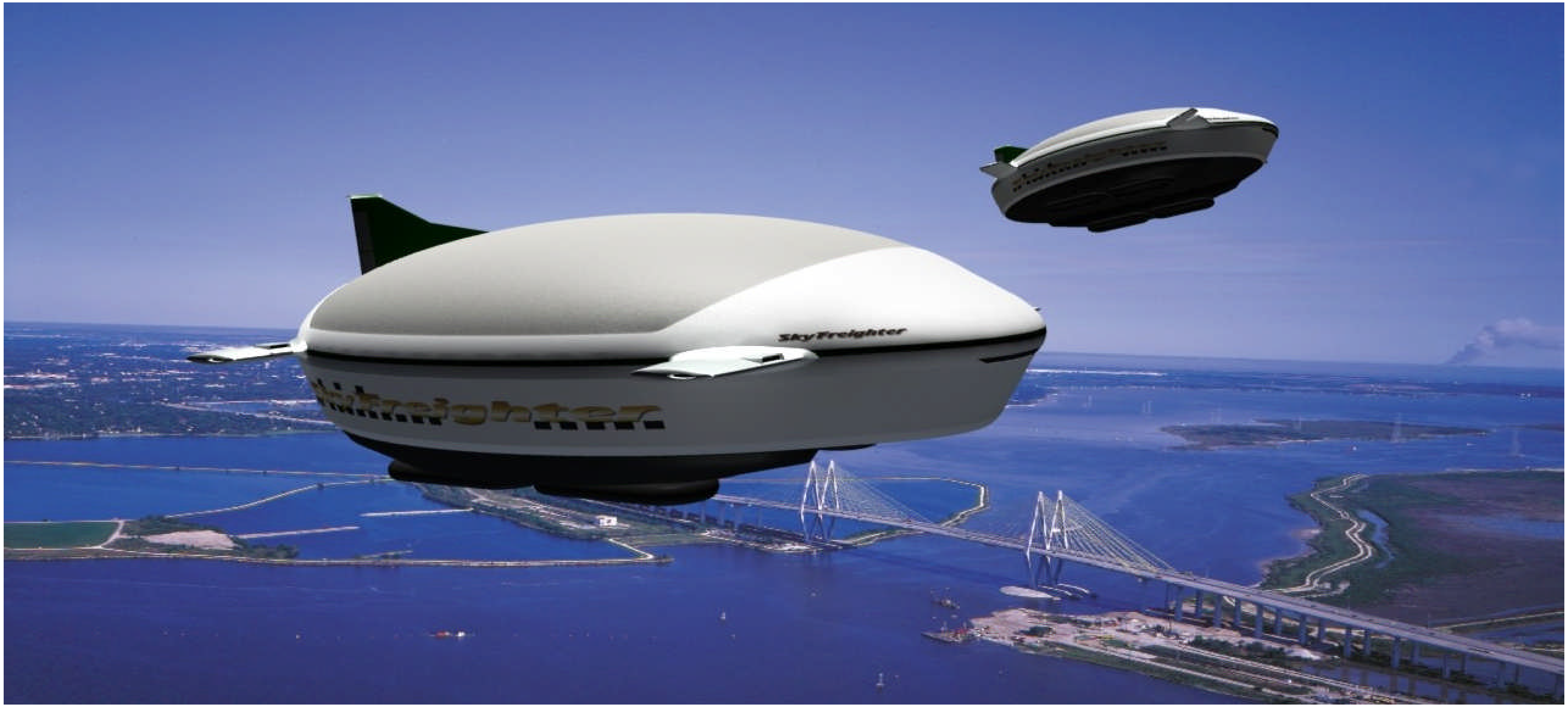
LEMV


ZEPPELIN STRIKES AGAIN
U.S. troops deploy hybrid jumbo aircraft covering a football field to monitor the battlefield in Afghanistan. The aircraft is capable of carrying very heavy loads and can hover in the air for three weeks.
LONG ENDURANCE MULTI-INTELLIGENCE VEHICLE (LEMV)
With a load capacity of up to 200 tons and the capability to land anywhere, including on water, LEMV have a greater advantage compared with conventional transport aircraft.
Skin: The combination of Vectran, Kevlar and Mylar are able to withstand firearms.
Front canal propulsor channel.
Bowthruster.
U.S. ARMY
Payload module.
Rear canal propulsor channel.
Radar, full-motion video, and content of the intelligence communication device.
SOURCE: NORTHROP GRUMMAN, HYBRYD AIR VEHICLE I GRAPHIC NEWS
Mixture of 60% helium and 40% air makes LEMV not flammable as a result of enemy fire that ever happened to the plane of World War I Zeppelin when fully hydrogen fuel.
Fuel / transport module.
GALAXY C-5: the U.S. military largest transport planes, have payload capacity up to 120 tons of cargo.

"…Computer aided design has cut development costs, while aramid fibers like Tedlar and Kevlar reduce manufacturing expenses as well as weight. Unlike the coated cotton and latex layers once used to retain helium, the ballonaise – the envelope inside the airship – is now covered with thin plastic laminate to prevent that Houdini-like molecule, helium, from escaping…"

***Popular Science,* January 2001**

Turtle Airship



"…At least one company has resolved the fabric issue by eliminating it. The Turtle Airship, from the company of the same name in Olympia, Washington, replaces the fabric outer skin with carbon fiber. 'The exoskeleton is made of honeycomb panels as in a geodesic dome,' says Darrell Campbell, the Turtle Airship's designer. On the inside of the dirigible, carbon fiber forms the framework. Kevlar cables support the internal trusses much as with a suspension bridge, making up for some of the weight added by using carbon fiber on the exterior instead of fabric…"

***Popular Science,* January 2001**

<u>Above</u>: conceptual rendering of the *Turtle Airship*

"…Clearly, a lot must happen before airships become common sights in our skies. Vaeth estimates that creating a modern version of the Hindenburg would cost upward of a billion dollars. If companies leap the financial hurdles, there will be another obstacle: a lack of experienced airship pilots. Vaeth, who served on an airship in World War II, puts the experience into perspective: 'Visualize yourself trying to drive a car that's a thousand feet long.'"

***Popular Science,* January 2001**

"Seven ascensions in free balloons are an essential part of the student's training. An airship, no matter how large, is simply a balloon with engines and steering devices added. If anything goes wrong with the controls, the dirigible becomes a free balloon and must be flown as such…Operation of an airship's controls is only one of the things its pilot must know. The huge gas bag upon which the craft's lift depends is a temperamental affair. Sun shining on the envelope makes the ship expand and become 'lighter'; a passing cloud upsets the balance. Landing an airship, too, is almost a science in itself. Aerostatics, which deals with the lifting power of hydrogen, helium, and other gases, is therefore an important part of the course. The prospective pilot is trained in aerodynamics, the science of the motion of bodies through air. In meteorology classes he learns about storms, clouds, lightning, and other whims of the weather. Besides these he masters practical and theoretical courses on engines, the design and use of instruments, navigation, free balloon design and construction, airship and balloon operation and maintenance, airship gases, aviation history, Department of Commerce rules, and radio and parachute operation. After the ground course and practical balloon flights, the student graduates to one of three 'pony blimps' used for training – one of 54,000 cubic feet and two of 86,000 cubic feet capacity. Numerous training flights make him adept at handling small dirigibles. Like an airplane pilot, he requires fifty hours in the air to qualify for a limited commercial airship license, and two hundred hours for a transport license. The entire course requires six months. It could be given in a shorter time, but the longer period permits the students to be familiar with varying weather conditions…"

***Popular Science Monthly*, January 1930**

RE: airship pilot training program located at the *Wingfoot Lake Air Station* in *Akron, Ohio*

High Altitude Airships

"…A Solar-Electric airship floating 13 miles above a city and remaining airborne for years at a time…Sky Station International has signed contracts with some of the world's leading aerospace and defense companies to build its airship-based communications system. Each Sky Station airship is designed to provide high-speed wireless communications services over an entire metropolitan area. Because the airship is far closer to its customers than a satellite, the system needs less power, and the ground equipment uses smaller antennas. The 70,000-foot cruising altitude keeps the ship above storms and clear of other air traffic, and allows the system to cover a 7,500-square-mile area. The Sky Station airship is being developed by Britain's Airship Technologies…Assembled from tapered segments of high-strength fabric, the helium-filled, non-rigid ship will be 515-feet long and 203-feet in diameter, and propelled by electric motors driving a pair of counter-rotating shrouded propellers in the tail. Solar cells on the envelope will convert sunlight into electricity, and fuel cells will store energy to power the motors and the communications package at night…"

Popular Science Monthly, **April 2000**

"The HAA delivers a persistent surveillance capability unmatched by any other platform," said Ron Browning, Lockheed Martin business development director responsible for the High Altitude Airship. The HAA combines a variety of advanced technologies to support air and ground missile defense needs and provide a near-space, multi-mission guardian in the sky that is easily relocatable and can be stationed where needed most."

Lockeheed Martin, **December 2005**

RE: award of a $149.2 million contract to develop a prototype *High Altitude Airship* (HAA). Operating at 60K-feet, the prototype (left): *"will demonstrate launch and recovery, station-keeping and flight-control capabilities while carrying mission re-configurable payloads. It will be about 400-feet long and 140-feet in diameter and will have a volume of 3.7 million cubic feet."*

The Aeroscroft Airship

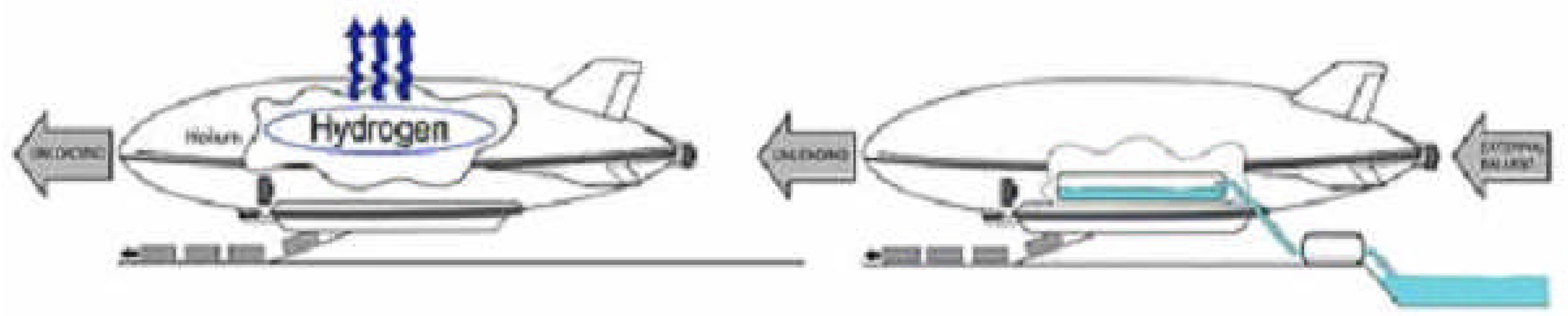
"…The Aeroscraft airship will carry three times as much as the biggest military cargo planes over thousands of miles, use a third of the fuel, and it doesn't even need a landing strip. It could also have major implications for cargo haulage, and almost everything now laboriously transported across the planet's surface by boat, train and lorry could within years be carried through the skies, its makers claim…California-based aviation firm Aeros, with heavy backing from the U.S. military, has been developing their revolutionary Aeroscraft for several years, and they say the airship is now in its final stages. They have built a prototype which they hope will finally prove the concept works in practice and allow them to fine tune their systems…The finished version of the Aeroscraft - expected to be ready in three years - will carry a payload of 66 tons at a speed of 120 knots, up to 18,000 ft. with a range of 3000 nautical miles…"

***The Daily Mail* newspaper, January 4th 2013**

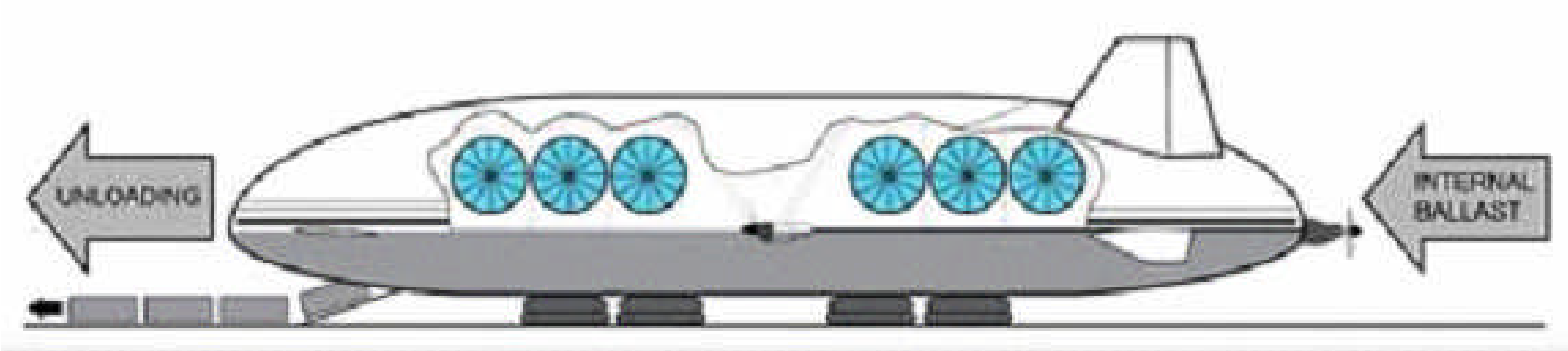
Above: artists' renderings showing the various potential uses of the *Aeroscroft Airship* including, from left to right; military, freight and remote construction

"…The key breakthrough has been the development of an internal system for managing ballast. Previous airships have been held back by the need to weigh them down or tie them up while cargo is unloaded, lest they are suddenly carried away on the breeze. But the Aeroscraft's internal ballast management system gives its operators the ability to control the aircraft's buoyancy by compressing the helium inside its tanks to make it heavier than air and bring down to the ground. Once cargo has been loaded, the airship can rise by re-releasing the compressed helium into its containment tanks, making it again lighter than air, then using turbo-prop engines to control its direction. Because of this revolutionary system, Aeroscraft needs no airfield to operate, only a cleared area large enough for it to vertically take off and land, and enough labour on hand to unload the cargo…"

***The Daily Mail* newspaper, January 4th 2013**



<u>Limited</u>: Conventional airships are held back by the need for infrastructure that can enable ground crews to fill them with ballast as they are unloaded to stop them from floating away on the breeze

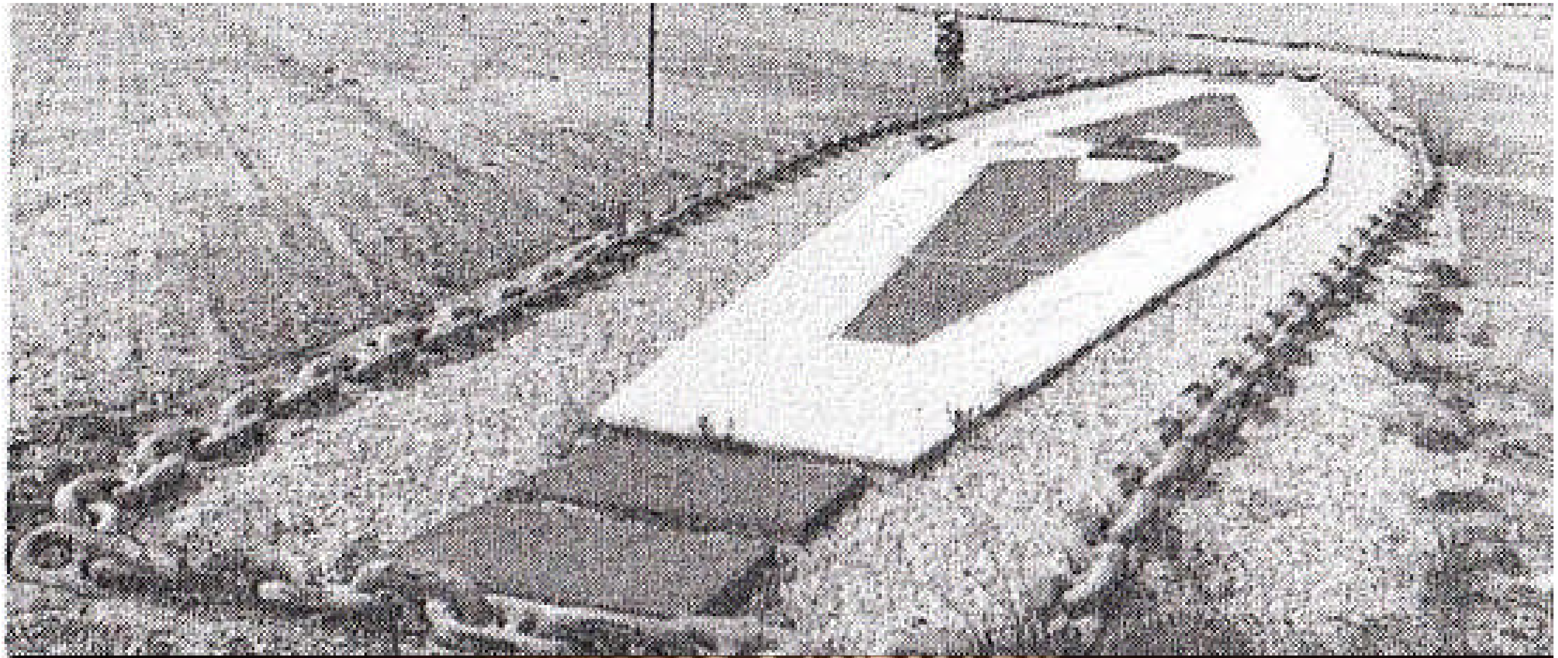


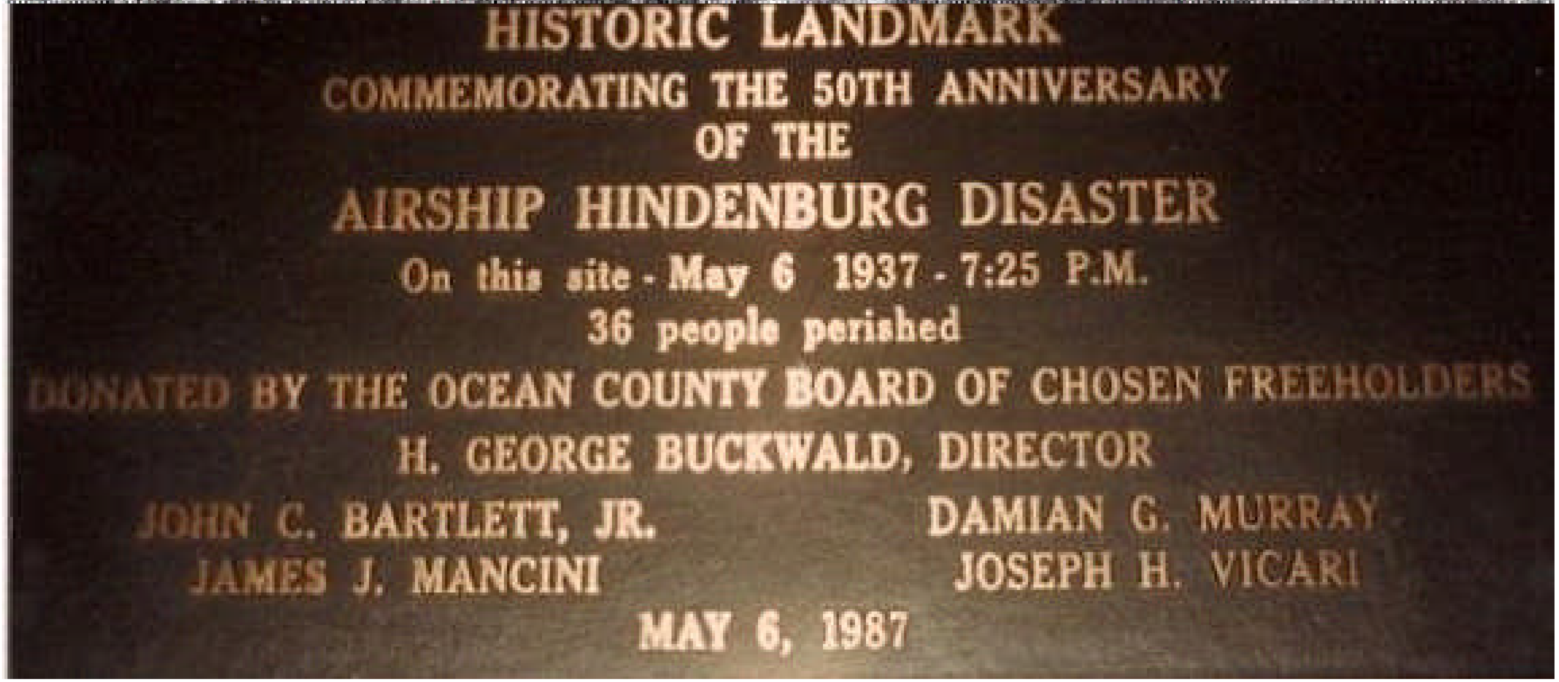
<u>Internal Ballast</u>: The Aeroscraft, by contrast, is able to control its buoyancy using an internal ballast management system which means it can land anywhere that there is space to touch down

In Remembrance


Hindenburg

The site where the *Hindenburg* crashed is still big and empty, a windswept expanse of crumbled asphalt and occasional scrubby weeds and it's still part of an active *U.S. Navy* base. The exact spot of the crash is marked by a metal wind-turned silhouette of the Hindenburg atop a pole (left), and an anchor-chain outline of the Zeppelin on the ground (above).




HISTORIC LANDMARK
COMMEMORATING THE 50TH ANNIVERSARY
OF THE
AIRSHIP HINDENBURG DISASTER
On this site - May 6 1937 - 7:25 P.M.
36 people perished
DONATED BY THE OCEAN COUNTY BOARD OF CHOSEN FREEHOLDERS
H. GEORGE BUCKWALD, DIRECTOR
JOHN C. BARTLETT, JR.
DAMIAN G. MURRAY
JAMES J. MANCINI
JOSEPH H. VICARI
MAY 6, 1987

<u>Above</u>: utensils (left) recovered from the 1937 fiery crash of the *Hindenburg* bearing the monogram of the *Deutsche Zeppelin-Reederei* (DZR) on display at the *Lakehurst Historical Society* museum housed in Hangar One (right) of the Lakehurst NAS
<u>Left</u>: model of the airship *Hindenburg* at the entrance to the gift shop of the *Smithsonian National Air & Space Museum*


DEN TOTEN DES LZ 129
SIE GABEN IHR LEBEN IN TREUER PFLICHT-
ERFÜLLUNG/DIENEND DER ALLGEMEINHEIT
AM 6. MAI 1937 IN LAKEHURST USA
UND DENNOCH
SIE LEBEN WEITER
DEUTSCHEN


LS·HINDENBURG