PDHonline Course M490 (8 PDH)

When Boats Had Wings: The Golden Age of Flying Boats

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There are two main types of seaplane: ***flying boats*** (often called "hull seaplanes") and ***floatplanes***. The bottom of a flying boat's fuselage is its main landing gear. This is usually supplemented with smaller floats near the wingtips, called wing or tip floats. Some flying boats have "sponsons," which are short, wing-like projections from the sides of the hull near the waterline. Their purpose is to stabilize the hull from rolling motion when the flying boat is on the water and they may also provide some aerodynamic lift in flight. Tip floats are sometimes known as sponsons. The hull of a flying boat holds the crew, passengers and cargo; it has many features in common with the hull of a ship or boat. On the other hand, floatplanes typically are conventional landplanes that have been fitted with separate floats (sometimes called "pontoons") in place of their wheels. The fuselage of a floatplane is supported well above the water's surface. Some flying boats and/or floatplanes are equipped with retractable wheels for landing on dry land. These aircraft are called *amphibians.* On an amphibious flying boat, the main wheels generally retract into the sides of the hull above the waterline. The main wheels for amphibious float planes retract upward into the floats themselves, just behind the step.

__Above__: left-to-right: flying boat / floatplane / amphibious flying boat

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"…When a seaplane or flying boat – the former having pontoons, the latter a boat-like hull – is in the air, it operates exactly like a land plane. But on the water, it handles differently. For instance, in taking off in a land machine, the pilot pushes ahead the stick at the start to lift the tail. On a water machine, he does exactly the reverse, pulling it back to raise the forward part of the pontoons or hull out of water to lift it up on its hydroplane step as quickly as possible. The step is an upward indentation, or notch, in the bottom of the float that prevents the water from sticking to the bottom of the hull, thus reducing resistance and increasing speed. On a big flying boat, it is sometimes hard to hold back the controls far enough to keep the tail down…In the early days, pilots of underpowered planes often had difficulty in getting up on the step for a take-off run…In skimming along the water, a seaplane or flying boat rides on its step, sunk only a few inches below the surface. So it is only the top 'skin' of the water that resists sidewise movement, and this is insufficient to do damage. For this reason, a seaplane is able to land without difficulty at right angles to a current…"

Popular Science Monthly, December 1931

__Above__: flying boat hull components

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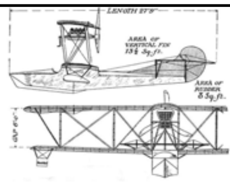

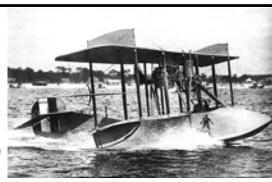

"…the flying boat with its large surplus of buoyancy has all the advantages of a motorboat and a flying machine combined. It is as seaworthy as any motorboat of its size, and flies as well as any aeroplane of equal proportions…When the throttle is opened, the machine gradually climbs on top of the water, and after the first hundred feet is planing on the water much the same as a hydroplane. In this manner it runs on the water until a speed of 45 or 50 miles an hour is attained, when a slight movement of the elevating device will bring it into the air…The standard machine flies at about 60 miles an hour. To alight, the operator simply sails along close over the surface of the water and throttles his engine. The boat descends until it touches the water, and if the engine is kept throttled, the boat glides over the water until it has lost its speed, when it settles down and once more becomes an ordinary motorboat. The flying boat used has a hull 25 ft. long by 2.5 ft. beam, it has 250 sq. ft. of wing surface and has a carrying capacity of 600 lbs. It will carry fuel supply for a flight of 400 miles. It is fitted with dual control, so that either operator or passenger, who sit side-by-side, may assume full control of the machine…"

Glenn H. Curtiss, **January 1913**

Left: front/side elevation/s of the famous *Curtiss Model F* flying boat (1913)

Right: Curtiss Model F on the water

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"Another thought that influenced my desire to build a water plane was that the need for speedy transportation over water routes was greater than over land routes. Railroads made fast time on land; steamships were slow in comparison."

Glenn H. Curtiss, **1927**

Left: Glenn H. Curtis in *France* in 1909 for a flying competition (he won). Frenchman *Alphonse Penauld* filed the first patent for a flying machine with a boat hull in 1876, but Austrian *Wilhelm Kress* is credited with building the first sea-plane; *Drachenflieger,* in 1898 (its two 30 hp *Daimler* engines were inadequate for take-off and it later sank when one of its two floats collapsed). On June 6th 1905, another Frenchman; *Gabriel Voisin,* took off and landed on the *River Seine* with a towed kite glider on floats. The first of his unpowered flights was 150 yards. Using the information gained, he approached pioneer French aviator *Louis Bleriot* to design a powered aircraft, but they were unable to achieve take-off speed. American pioneering aviator Glenn Curtiss modified his "June Bug" for water in 1908 but, like Voisin and Bleriot, was also unable to overcome the hydrodynamic drag on the seaplane's floats.

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"…Glenn Curtiss began to experiment with the precursor of the hydroaeroplane and flying boat…Curtiss was building light pontoons on which the 'June Bug,' renamed the 'Loon,' was mounted. Safety was one of the things he was seeking; landing on water seemed safer than landing on the ground. If flying were to develop into a world-wide means of transportation, then there must be found some way to alight on water instead of on the few cleared and leveled spots of ground available. Glenn Curtiss was looking far ahead. But the 'Loon' did not rise from the water. It weighed, with its pontoons, nearly a thousand pounds. The combination of weight and skin friction was too much for its 40-h.p. engine. It made twenty-five miles an hour on the water, and observers thought at times it was actually clear. Only against a strong head wind, however, was there a chance of really getting it into the air, and Glenn Curtiss was not yet ready to attempt to fly in a wind. Nor was anybody else…"

Popular Science Monthly, **May 1927**

Above: rare photograph of Glenn Curtiss' "Loon" (the "June Bug" on floats), which failed to become airborne during tests in 1908

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On March 28th 1910, Frenchman *Henri Fabre* successfully flight-tested his powered *hydravion*, a "trimaran" floatplane (left) which he named *Le Canard* ("The Duck"). Fabre's first successful take-off and landing by a powered seaplane inspired other aviators and he designed "Fabre floats" for several other flyers. The first hydroaeroplane competition was held in *Monaco* in March 1912 featuring aircraft using floats from Fabre, Curtiss and others. This led to the first scheduled seaplane passenger services at *Aix-les-Bains* using a five-seat *Sanchez-Besa* starting August 1st 1912. In 1911-12, *François Denhaut* constructed the first seaplane with a hull using various designs to give hydrodynamic lift at take-off. Its first successful flight was on April 13th 1912. Throughout 1910 and 1911, Curtiss continued his floatplane experiments with a larger version of his successful *Curtiss Model D* land-plane using a larger central float and sponsons. Combining floats with wheels, he made the first amphibian flights in February 1911 and was awarded the first *Collier Trophy* (right) for aviation achievement (originally named the "Aero Club of America Trophy"). From 1912, his experiments with a hulled seaplane resulted in the 1913 "Model E" and "Model F" which he called "flying-boats". In February 1911, the *U.S. Navy* took delivery of its first airplane; a Curtiss Model E and soon tested landings and take-offs from ships using the Curtiss Model D.

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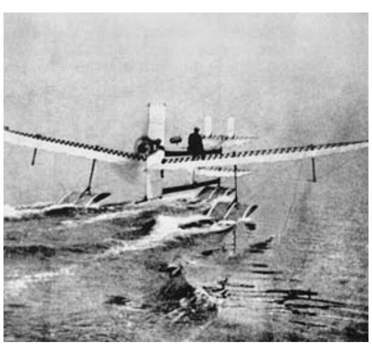

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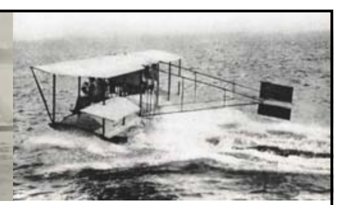

"I had no idea of going into the air at that time, though I knew it was possible. Nobody had ever risen from the surface of the water. But this machine handled so beautifully that my action in elevating the plane was more instinctive than intentional. One second I was skimming the surface of the bay and in another I found myself in the air. It rose with a suddenness and ease that surprised me. I flew a half a mile over land, turned and alighted on the water. Several naval craft in the bay tooted their sirens in applause. I rose again from the water, this time intentionally, and again alighted. I had got what I was after."

Glenn H. Curtiss, **1927**

RE: recalling his first water-borne flight in February 1911

Left: experimental Curtiss floatplane (engine in hull drove two tractor propellers)

Right: first successful flight of a Curtiss floatplane on January 10th 1912

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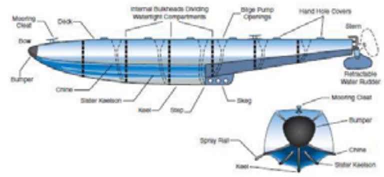

"…When Glenn Curtis took off from the water near San Diego, Calif., in 1911, in the world's first seaplane, his machine was equipped with a single boxlike, flat-bottomed wooden float. A little later, the hydroplane step was introduced, increasing its efficiency. The next advance was the substitution of a V-bottom for a flat one. In landing, the knife-edge of the V cut into the water and reduced the shock. But suction around the sides of the first V-floats threw spray into the propeller and cockpit. So spray-strips, like automobile mudguards, were attached to the sides of the pontoons. However, a new type of V-bottom soon made them unnecessary. By curving the legs of the V inward in the form of two scallops, the spray-producing suction was eliminated…"

Popular Science Monthly, **December 1931** 14

<u>Above</u>: float components

"The latest Curtiss hydroaeroplane, shown flying over Lake Keuka at Hammondsport, N.Y., deserves the title of 'flying-boat' more than any type of aerial machine. Instead of being supplied with the ordinary pontoon, this machine is practically a speed motorboat provided with planes. The boat, which has a spray hood to protect pilot and passengers from water, and in which the engine itself is located, is attached directly to the lower plane instead of hanging some distance beneath it, as in the ordinary hydroaeroplane. There is no front elevating plane, and the rudder and rear elevating planes are parts of the stern of the boat. The boat is 26 ft. long, and has a width of 3 ft. with a depth of hull amidship about equal to the width. The planes are 5.5 ft. deep and about 30 ft. wide. The pilot and passengers sit well down in the hull. The boat itself is so strongly built that it can be beached with safety even through a surf, and is capable of being handled as a fisherman handles his dory, or anchored to a buoy like a yacht."

Popular Science Monthly, **October 1912** 15

<u>Above</u>: color postcard/s showing the Curtiss "flying boat" above *Lake Keuka* in upstate NY

We've Only Just Begun

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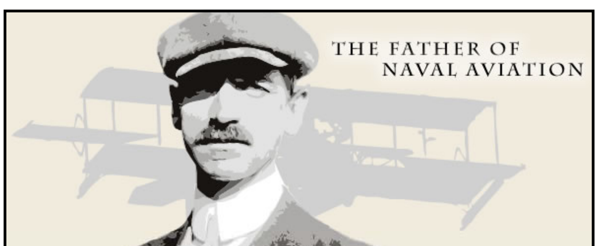

"We have only just begun to learn how to fly, this is only 1927. It was less than nineteen years ago that I made my first flight. More has been done in the eight years since the war ended, toward the real development of aviation, than in the eleven years of flying before that. War called for high power, light weight, great maneuverability – the essentials of stunt flying. It put a stop for years to developments looking towards safety, endurance, stability in the air, the essentials of commercial air navigation…"

Glenn Hammond Curtiss, **1927**

<u>Above</u>: for his outstanding contributions to naval aviation, *Glenn H. Curtiss* is considered to be: "The Father of Naval Aviation" 17

On December 17^{th} 1913, the world's first airline contract for heavier-than-air planes - ten years to the day after the Wright brothers had first flown successfully at *Kitty Hawk*, was signed. With their fleet of "hydroaeroplanes," the cities of *St. Petersburg* and *Tampa, Florida* would be linked by a scheduled airline. 18

Captain Frank

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"…The two characteristics of a good pontoon or flying boat hull are 'clean running' – that is, throwing up little spray – and having the least possible amount of resistance in traveling through the water. At Cowes, England, in 1925, I tested a huge multi-motored flying boat that had an inverted V-bottom like a sea sled. It gave clean running in heavy seas, but its water resistance was so great that the design was abandoned…"
***Captain Frank T. Courtney*, 1931**
Left: Frank T. Courtney (1894-1982)

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"…The greater the water resistance, the greater the power required to get a ship into the air. Because of this fact, my transatlantic plans were almost wrecked by one of the strangest cases of added resistance on record. At the Azores, we made our final tests and found out just what the Dornier would lift. Then there was a month's delay, repairing the radio and waiting for good weather. A perfect day arrived. We filled the tanks, stored aboard our equipment, and charged into the Atlantic for the take-off. The ship wouldn't rise. We tried again and again. It had risen before with the same load, but now it wouldn't get out of the water. In the harbor, I was sitting dejectedly on a wing-stub with my hand dangling in the warm water when a hard little lump on the side of the hull came off in my fingers. I looked at it and the mystery was solved. The whole bottom of the hull was covered with barnacles and small mussels that has attached themselves during the month's delay. The increased water resistance of the rough hull, rather than the weight of the shellfish, prevented the take-off. When a diver cleaned off the bottom of the boat, the Dornier lifted easily from the water…"
***Captain Frank T. Courtney*, 1931**

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"…Practically all the earlier flying boats I piloted had to be 'rocked up on the step' every time the water was calm. By alternately shoving ahead and pulling back on the controls, as we plowed along the water, I would get the ship rocking back and forth until it lifted itself up and hydroplaned on the surface. At other times, we would have a motorboat charge back and forth across our path, creating swells and ripples that helped us start hydroplaning…"
***Captain Frank T. Courtney*, 1931**

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The U-Boat

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"…In developing air-and-water craft, designers were dealing with two elements. Sometimes they would produce machines that flew like birds in the air, but on water were tricky and dangerous. At other times the opposite would be true. I remember one treacherous machine the pilots nicknamed 'The U-Boat.' Every time it would near flying speed, the nose of the boat would be sucked down into the water and only by cutting the gun could the pilot avoid a 'crash dive' to the bottom. Nobody knew what was wrong. The ship was one of the most beautiful I ever saw, its hull having smooth, curving lines. In the end, it was found that these lines caused all the trouble. The curve extended too far back. The bottom of the boat was like the top of an airplane wing. As speed increased, the water produced a down-suction just as the partial vacuum above a wing increases its upward lift…"
***Captain Frank T. Courtney*, 1931**

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Propulsion

"…Spray can damage a propeller as seriously as sand or gravel. To keep them clear of heavy spray they had to be placed high. But if they are mounted high, their line of thrust relative to the center of resistance of the plane is offset. Attach the string to the very top of a kite and it immediately takes a nose dive. It's the same with a flying boat, whether a World War I MF boat or a supercolossal airliner. With the propellers high – and they have to be high – the plane wants to nose dive when the power is applied…"

***Popular Mechanics*, December 1955**

<u>Left</u>: caption: "Engines of flying boats and amphibians are mounted high above water to avoid spray"

"…Another difficulty in early water planes concerned the necessity of putting the propeller high up to avoid the spray. When a pilot opened the throttle on these machines, the nose of the plane pointed down, and when he shut off the motor, it pointed up. This meant that if the engine cut out unexpectedly in the air, the ship was likely to pull up into a dangerous stall unless the man at the stick did some hair-trigger piloting. Being high above the center of weight, the push of the propeller tended to drive the top of the plane ahead before the bottom, thus nosing the ship down. And when the propeller's push was suddenly removed, the nose naturally came up. On the latest boats the motor is mounted so it slants downward to the rear. This sends the slipstream, or wake, of the propeller down on the tail surfaces, holding the tail down and the nose up when the motor is running, and letting the tail rise and the nose go down when the blast from the propeller ceases…"

***Captain Frank T. Courtney*, 1931**

<u>Left</u>: *Curtiss Model F* flyng boat (1917) with high-mounted engine/propeller

<u>Right</u>: model of a WWII vintage *PBY Catalina* amphibious flying boat showing downward-to-the-rear sloping engines/propellers

Propeller Development

"…Most manufacturers of high speed planes this year have sought to cut down the drag of the landing gear by fitting streamlined 'pants' over the wheels. A safe and efficient retractable landing gear would be a great step further. At the 1930 air races there were two things of especial interest shown. One was a ship fitted with a reversible propeller, to check the landing speed of the ship and enable it to be backed on the ground. The other was a variable wing ship, a low-wing monoplane equipped with hydraulic cylinders enabling the wings to be raised or lowered in flight, changing the dihedral, and at the same time the angle of incidence. Of still more importance will be the development of a practical variable pitch propeller and variable chord wing. When those come the airplane will have different speeds or weight lifts and can be geared for the job just like an automobile. The Schroeder–Wentworth plane which was built for the Guggenheim competition, but which crashed owing to a fault in construction, had both those things. The propeller could be set for high pitch to get the load off the ground, and then changed to low pitch for high speed in flight. At the same time the chord of the wing could be changed, using a thick, weight-lifting wing to get off the ground, and gradually changing to a thinner, high speed wing in flight. Landing, the process could be reversed, using a thick cord wing to sustain the load at lower speed for an easy landing. In effect there was a two-speed wing and a two-speed propeller, but in each case speed could be converted into weight-lifting if desired…"

***Popular Mechanics*, January 1931**

<u>Caption</u>: "Major Schroeder is shown with his Schroeder-Wentworth Plane entered in the Guggenheim safety contest. Top photo shows how the wing was built in three flexible sections permitting changing the camber at the will of the pilot."

<u>Above</u>: caption: "Centrifugal force is made use of in major Schroeder's variable-pitch propeller device, shown above, to change the pitch of the blades by simply throttling down the motor revolutions"

"The airplane of the immediate future is going to be as efficient as the modern automobile. It will have a two speed wing and a two speed prop, the one for climbing with a load and landing at fairly low speeds, and the other a high speed for straight-away flying. That is the ultimate aim just now in airplane design, and the thing we were working at in the Schroeder-Wentworth ship entered in the Guggenheim competition. Unfortunately, because of a lack of time to thoroughly test out the plane before we entered the competition, a minor weakness in design led to a crack-up before I had finished the preliminary trials, and put us out of the running…"

***Major Schroeder* (*Popular Mechanics*, March 1930)**

"Under the most favorable conditions, the prop is capable of translating 86 percent of the engine's horsepower into useful thrust…For emergency operation in the case of multi-motored airplanes, this business of changing blade pitch has been carried a step further to permit the 'feathering' of the prop. The blades are turned in their hub through highest pitch until they are edge-on into the wind. The propeller is, of course, useless for thrusting in this position, but feathering is an expedient for flying with one or more engines out of operation, either by design or accident. Four engined transports frequently cruise on only two of their engines, but this would not be considered good flying practice if full-feathering propellers were not available. Should an engine go dead in an emergency, the prop is feathered into the wind immediately; the prop in this position acts as a brake on the dead engine. In normal operating pitch, the prop would be subjected to 'pinwheeling,' just as the toy pinwheel spins when held to the wind, and this might result in a damaged engine. A windmilling prop, however, would create more than 20 times this drag…even a single-engined airplane is at an advantage when fitted with a feathering prop because, in emergency, the plane's gliding range is half again as great with this type as it would be with a windmilling, unfeathered prop…"

***Popular Science Monthly*, November 1943**

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"…Carrying the pitch angle beyond the 90-degree feathered position into reverse pitch was a logical step in propeller development made first by Curtiss-Wright. The reversible-pitch prop, which delivers negative thrust, is extremely useful as an air brake. In some instances, it may be used to slow the landing run of planes, but its most practical application is found on multi-engined flying boats. Maneuvering a flying boat in water is, at best, a tricky operation. The reversible prop facilitates maneuvering in general and turning in particular. By reversing the two inboard propellers and leaving the outboard propellers in normal pitch, the pilot of a four-engined flying boat can 'come about' in one-fourth the turning radius of a smaller craft with conventional propellers…"

***Popular Science Monthly*, November 1943**

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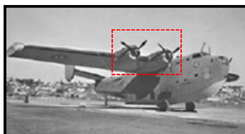

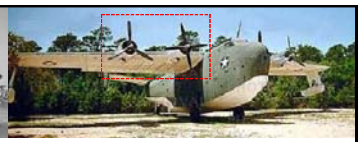

Above: four-engined *PB2Y Coronado* flying boat used by the *U.S. Navy* during WWII. At left is an early production model which used three-bladed non-reversible props on all four engines. A total of five production models of the PB2Y Coronado were produced during the war. The fifth version; PB2Y-5 (right) used two different propellers. The outboard engine props remained the non-reversible three bladed type while the inboard engine props used reversible-pitch four-bladed propellers. Though the props varied, all four engines were of the same type. The term "reversible-pitch" means that the blades are able to rotate along their axis. This motion allows the blades to change the "angle of attack" at which they meet the oncoming air so that they will produce more or less thrust depending on the new pitch angle. In particular, the blades could be rotated to a position where they produce high drag or reverse thrust, to slow the aircraft down or make it easier to steer. Many land-based aircraft also use the same technique to reduce the runway length needed for landing. In the case of the PB2Y-5, these reversible-pitch propellers gave the aircraft better maneuverability on water allowing it to taxi to pick up a buoy or steer its way to a floating gas dock.

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"Two-Way Propellers Lessen Air Torque. The latest development in airplane propellers, the product of English inventors, is called the Rotol Constant-Speed Contra-Rotating Airscrew, shown at the left. Although appearing to be a six-bladed propeller, the contrivance actually consists of two three-bladed propellers which rotate in opposite directions. Among the advantages claimed for the new type prop are complete elimination of torque and improved handling during aerial acrobatics."

***Popular Mechanics*, December 1941**

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Flying Wind Tunnels

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"What is most certainly one of the strangest airplanes ever built is shown on this page and on this month's cover of Modern Mechanics and Inventions. The plane, which its designer, Paul Maiwurm of San Diego, California, has hailed the Fly worm, will have no propellers to pull it through the air. Instead, it will depend on a barrel-like tube between the wing and the fuselage, fitted with spiral fins which, when the tube is rotated rapidly, are expected to act like a screw in forcing the craft through the air. Both forward thrust and upward pull are expected to be provided by this unique method. The tube, which is six feet in diameter, will he powered by an 80-horsepower air-cooled motor. The pilot and passengers sit in a fuselage shaped like an airfoil. Lateral control is secured by a conventional rudder. It is expected that the plane will be completed and test flights made sometime in the near future."

***Modern Mechanics*, December 1930**

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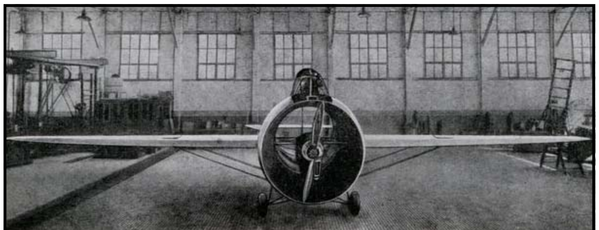

"This odd machine, the Stipa-Caproni, which has just been completed in Italy, and has passed severe tests, is expected to be the type of future record-breakers. The propeller, it will be seen, is located in a cylinder, through which the air-stream is driven. This 'Venturi tube,' all of wood, concentrates the pressure. The span of the model shown is 50 feet; pilot and passenger occupy a stream-lined cabin above the tunnel-shaped body, which the wing bisects."

***Everyday Science and Mechanics,* January 1933**

<u>Above</u>: caption: "The fuselage is a 'Venturi tube' into which the entire stream of the propeller is driven, minimizing vibration, and reducing the friction of the slip-stream"

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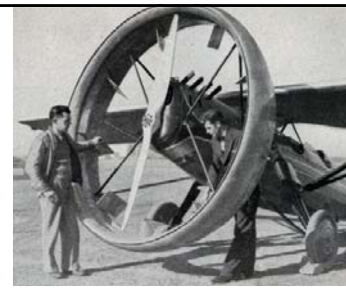

"That the speed of an airplane may be increased from thirty-nine to 140 percent by putting a ring around the propeller is the discovery announced by two Compton, Calif., inventors. The circular cowling is said to straighten out the air blast of the propeller and increase its effectiveness. Vanes within the ring, which the inventors are indicating in the picture above, may be adjusted during flight to increase the air drag and so serve as brakes in landing."

***Popular Science Monthly,* April 1933**

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"Pierced by a battery of tunnels a flying wing airplane is proposed by an engineer at the famous Caproni airplane works in Italy. Streamlined motors and four-bladed propellers will drive air blasts through the tunnels, each of which forms a Venturi tube, expanding toward the rear. Thus, according to the inventor, the air will give a forward push something in the manner of rocket propulsion. Aided by the Italian government, the designer recently completed a single-engined experimental craft incorporating his ideas. This odd flying barrel was put through successful tests near Rome…Details of the huge machine he proposes to build for transatlantic travel are shown in the pictures above. A half-dozen tunnels or more will run through the immense flying wing. Rudders and elevators will be mounted so they will move in the blasts issuing from the tubes…"

***Popular Science Monthly,* June 1933**

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"Jets of air, sucked in at the front and expelled at the rear of huge tubes, are the unconventional means advanced by a Glendale, Calif., inventor for lifting and propelling an airplane. He has designed and patented a wingless craft, employing this principle, which he maintains will be able to rise and descend vertically and to hover motionless aloft. According to the inventor's plans, a propeller and motor are installed within each of two tubes, which in turn are so mounted above a standard airplane fuselage that they may be swung by the pilot to any angle. For a take-off, the tubes are to be operated in a perpendicular position, thus providing a vertical lifting force. Once in the air, the pilot would tilt the tubes ahead, in order to cause the plane to travel forward. An auxiliary propeller on the fuselage is provided to aid in forward travel, while rudders steer the plane."

***Popular Science Monthly,* February 1934**

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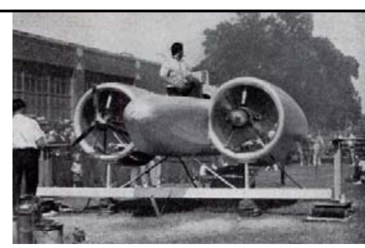

"Following successful ground tests of a wooden model, a Stillwater, Okla., inventor has begun construction of a full-sized airplane of radical design that he expects to show unprecedented speed. The craft's twin propellers will blow a tornado of air through a pair of cylindrical ducts, shaped to enhance the propulsive effect obtained, so that its two 100-horse-power motors will do the work of much larger power plants in standard planes."

***Popular Science Monthly,* May 1936**

<u>Above</u>: caption: "The inventor making a ground test of a full-size model of his unusual plane. Air ducts enhance the power of the craft's two propellers."

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Take-Offs

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"…a seaplane pilot does not have to take off facing the wind as does a flyer at an airport. Usually, in heavy swells, the boat pilot takes off cross wind, running parallel to the waves and lands the same way. In rough weather, a pilot is likely to be too anxious to get his plane into the air. If he stalls the ship off the water, it will nose down and begin 'porpoising' along in jumps, crashing onto the water at the end of each hop. The instant a ship begins to porpoise, I cut the gun. The chances of crashing are too great…"
***Captain Frank T. Courtney*, 1931**

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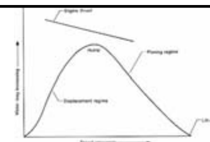
The design of the hull is important in determining the characteristics of the flying boat in all phases of its operation on the water. The importance of the hydrodynamic characteristics of the hull can be illustrated by considering the influence of hull water drag and aircraft weight on the takeoff distance and on the conditions under which the boat will not lift off at all. As is the case with a landplane, the seaplane must accelerate to a speed sufficiently high, determined by the wing loading and maximum lift coefficient, for the wings to support the weight of the aircraft in flight. The aerodynamic drag of the aircraft together with the rolling friction on the wheels on the runway constitute the resistance to acceleration of the landplane in its takeoff run. In addition to the aerodynamic drag, the flying boat must overcome the water drag associated with the hull. The manner in which this drag varies with speed makes the takeoff problem of a flying boat uniquely different from that of a landplane.

45



The variation of water drag with speed, along with the accompanying variation of engine thrust, is shown by the conceptual curves in the figure above (characteristic variation of water drag with speed for a hypothetical flying-boat hull). The water drag of the boat is separated into two distinct speed phases. Below the hump speed (the speed for maximum drag) the aircraft is operating as a displacement boat with both the afterbody and the forebody assisting in providing the necessary buoyancy. Under these circumstances, the drag results primarily from the generation of water waves. At the hump speed, the boat may be thought of as climbing over its bow wave and beginning operation as a planing hull. In this latter phase, the weight of the boat is supported primarily by the dynamic reaction of the water against the forebody and displacement buoyancy is relatively unimportant. The water drag in this speed range results primarily from skin friction between the water and the forebody. In addition to the support provided by the planing forebody, an increasing proportion of the aircraft weight is supported by the wings until, finally, the water drag becomes zero as the aircraft lifts off. Also shown in the figure above is the hypothetical variation of engine thrust with speed. At speeds well below and above the hump speed, a large margin exists between the drag and the thrust. The thrust margin at the hump speed, however, is a minimum, as is the acceleration. If the thrust is less than the drag at the hump speed, takeoff will not be possible. In actual performance calculations, the air drag must be added to the water drag to obtain the total drag.

46

In addition to the high drag associated with passage through the hump speed, a longitudinal pitching instability can occur. This instability is characterized by a pitch oscillation in which the boat rocks back and forth between the forebody and afterbody. A too-high or too-low pitch attitude can induce the onset of this instability. The range of stable pitch attitudes varies with speed and is a minimum in the vicinity of the hump speed. Thus, careful control of pitch attitude is required when traversing this critical speed range. The attitude at which the flying boat trims is influenced by both the aerodynamic and hydrodynamic design of the aircraft, the center-of-gravity position and the pilot's manipulation of the elevator control.

47

"Even more exciting than a landing is a rough-water take-off. Just how you do it all depends on the wind and waves. In a heavy storm you may have to ride it until things calm down a bit. Usually you try to take off into the wind although sometimes you make a downward take-off. Other times the boat may lift easiest in a cross wind and then you guide the plane to follow along a wave crest while you get up flying speed. In a take off directly into the wind and waves you get what amounts to a high-speed roller-coaster ride. One minute you are on a crest looking down into a deep valley right under the boat and next you are down in the hollow climbing the next wave. The motors are on full and the high scream of the propellers seems to go right through your head. As you get up flying speed the boat begins to skip across the hollows and land on the other slopes. You hit a wave crest and the crash of the water against the hull below and behind the cockpit sounds like the boom of a canon. The plane staggers. Sheets of spray explode upward over the wings. You can't see through the flying water but you have already pulled the nose of the boat up to prevent it and now you nose down again to regain speed. You have to remember to keep the wings level because to get a wing under just now would mean the end of the trip. You smash into a few more wave crests and then begin to pull up over them. Finally you are safely in the air."
Flying Boat Test Pilot, 1937
Above: a *Short Sunderland* flying boat taking off

48

Running Around in Circles

49

"…The big boat pilots haven't any convenient wind socks to tell them which way the wind is blowing. The smoke from a steamer may be a guide and otherwise they have to read wind direction by hunting for streaks of foam on the surface or by watching the spray pulled off of wave crests…In a dead calm a pilot may have a hard time getting off again. When the water is flat a boat sometimes can't break itself loose from the surface. In that case the pilot taxis around in fast tight circles to stir up the water, then makes a fast take-off run across the circles…"

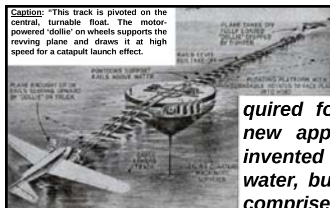
Popular Science Monthly, **August 1937**

Above: PAA's famous "Dixie Clipper" takes-off from *Manhasset Bay, LI, NY* 50

Floating Runway

51

Caption: "This track is pivoted on the central, turnable float. The motor-powered 'dollie' on wheels supports the revving plane and draws it at high speed for a catapult launch effect.



"To enable take-off of seaplanes with heavy loads - especially the additional fuel which is required for transoceanic flights - a new apparatus has recently been invented to launch them on the water, but not from it. As shown, it comprises a track, supported above the water by pontoons; so that the seaplane is given the advantage, not only of its own power, but also of a mechanical pull. It can maneuver itself, in the water, up the track; and the latter, being pivoted, can turn to the wind at the moment prevailing. The seaplane thus obtains the advantages of land planes, without the added weight of amphibian construction. It is not, of course, intended for deep-sea operation, like the proposed floating seadromes, but for the quiet water of harbors." 52

***Everyday Science and Mechanics*, March 1936**

Landings

53

"…Under ordinary conditions, landing a water craft is far easier than bringing down a land plane. But on days when a light haze hangs over a river or lake it is almost impossible to tell where the air ends and the water begins…Even an old-timer often misjudges the position of the water when coming down in a light haze. The best plan is to glide within forty feet of where you think the water is and then switch on the motor. Keeping the plane running just above stalling speed, you can fly it onto the water in a long gradual descent that avoids the risk of 'pancaking' or bouncing…When the water is perfectly flat, without a ripple, it is also difficult to judge your height above the surface…flying seaplanes in a calm is one thing, and piloting them from rough water is another. The latter is the real test of a flyer's skill. Rough water is of two kinds, swells and waves. The worst of all combinations is waves on top of swells…The danger is that the ship will reach the crest of a swell with almost flying speed. Then it will hop off like a glider and sail down, crashing into the side of the next advancing wall of water…"

Captain Frank T. Courtney, **1931**

54

"…A dead calm in which the water is glassy still calls for a 'hot' landing that takes nearly as much skill as sitting down on rough water. The surface looks like a mirror to the pilot and he can't tell whether he is two or fifty feet in the air. If he levels off too soon his bad guess would wreck the boat, so he flies downhill as slowly as he can with power on until he hits. The shape of the hull helps absorb the shock…"
***Popular Mechanics,* August 1937**

55

Rough Water Proving Ground

56

"…What happens to a twenty-ton flying boat if it is slammed into mountainous waves while going seventy miles per hour? Nothing, if the boat is as sturdy as her designers think and the pilot is one of the best in the world. Tumbling a big transport around in the sky is just routine to a test pilot, but taking a big flying boat out for her rough-water landings is something that always packs a thrill. This supreme test is part of the Navy's requirements because when one of the big 'Ducks' goes to the rescue of a plane or ship in distress it is usually in bad weather. The pilot has to know that his boat can take a terrific beating and get back up into the air again safely. That's why the pilot picks rough water for his proving ground…"
***Popular Mechanics,* Aug. 1937**
Left: test pilot at the controls

57

"…Waves twenty or thirty feet high are ideal. Smacking into hills of solid water will rip the bottom out if the hull is poorly built. The crash of landing may bend the wings down in a permanent curve or even tear the motors loose from their mountings. If something goes wrong the pilot may be able to taxi back home on the surface, or he may have to send out a radio plea for help…"
***Popular Mechanics,* August 1937**
Above: a big flying boat getting up speed for take-off during testing

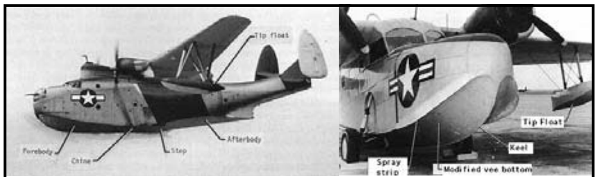
58

"…What's it like to crash one of the big boats on purpose? For one thing, your safety belt must be around you and tightly fastened. The boat hits with a smash and throwing motion that tosses everything around. Men who have tried to stand up during a rough landing have broken their ankles. Mingled with the thunder of the impact is the screech of metal as it strains under the shock. The jar of landing imposes the same terrific strains that a terminal velocity pull-out gives to a fighting plane. In test pilot lingo, the impact may amount to eight or nine 'Gs,' which means the boat and crew are subjected to a pull of eight or nine times normal gravity…"
***Popular Mechanics,* August 1937**

59

"Getting down safely is a touch-and-go maneuver that you can't plan out ahead of time. It all depends on the directions the wind and waves are running. Sometimes it's best to land into the wind and take your chances with the waves. But if they are running too high you have to land parallel with them and fight the cross wind. If you catch the bow in a wave it may cave in like an eggshell. A stray wave crest may flick off a wing pontoon cleanly. The best way to land is between the crests and you try to drop the boat in solidly. A good landing is a two-point landing and the pilot can pick out the 'slap slap' of the hull as it touches first on the heel and then on the toe. One minute you are flying a big airplane and the next you are struggling with the controls of a bouncing boat, trying to kill its speed and face around into the waves without getting a wing over."
Flying Boat Test Pilot, 1937
Above: an RAF *PBY Catalina* flying boat landing

60



A flying boat must satisfy many of the same requirements for performance, efficiency, strength, and reliability as a landplane but, in addition, must possess some qualities of a boat in water and some qualities unique to the flying boat itself. It must be seaworthy, maneuverable, and stable on the water and have low water and air drag. The hull must be designed and the aircraft configured in such a way that the amount of spray passing through the propellers, striking the tail and passing over the windshield is minimized. The hull must be designed with sufficient structural strength to withstand the various loads imposed by rough water in landing, taking off and taxiing. Some of the design features characteristic of a flying boat are illustrated by the *Martin Mariner* (left) and *Grumman Goose* (right). Both of these WWII aircraft, which may be considered as relatively modern flying-boat designs, feature a high wing mounted atop a deep, voluminous hull, a high tail position and wingtip stabilizing floats. In both aircraft, the engines are mounted in the wings to minimize spray problems and reduce aerodynamic drag. The Mariner had a gull wing configuration with the engines mounted in the wing break to place them in a high position. The tip, or stabilizing floats, are necessary because the narrow beam hull coupled with a high center of gravity make the flying boat laterally unstable on the water. In naval architecture terminology, it has a negative metacentric height. The aircraft is usually designed so that it heels about one-degree when one float touches the water. When laterally level, as in takeoff from relatively smooth water, neither float touches the water. The floats are designed and mounted in such a way as to give a large dynamic lateral restoring moment when one float touches the water on takeoff or landing. Tip floats have historically been the most used form of lateral stabilization.

61

The voluminous hull of a flying boat is usually designed with from 70% to 100% reserve buoyancy. When floating as a displacement boat, a 100% reserve buoyancy means that the hull will support twice the design weight of the aircraft without sinking. The reserve buoyancy is provided as a safety factor, particularly for operation in rough seas. The cross-sectional shape of the forward portion of the hull is usually in the form of a "V" or modified-V. The outside angle of the V is called the "angle of deadrise." The larger this angle, the lower will be the impact loads imposed by operation in heavy seas. The friction drag on the forward part of the hull, however, increases with deadrise angle, as does the spray problem. The *Grumman Goose* had a distinct modified V-bottom. The intersections of the sides of the forward part of the hull with the V-bottom are called the "chines" and form a sharp angle. The design of the chines is important in determining the spray characteristics of the hull. To assist in controlling the spray, special spray strips are sometimes attached to the chines. The *Martin Mariner* flying boat possesed the characteristic manner in which the hull bottom is separated by a transverse step into a forebody and afterbody. At low speeds the hull operates as a displacement boat with both the forebody and afterbody sharing the support of the aircraft in the water. Beyond a certain speed; called the hump speed, the hull planes on the forebody with the afterbody contributing little or nothing to the support of the aircraft. The step, acting somewhat like a spoiler on an airplane wing, causes the flow to break away from the afterbody and allows the boat to transition into the planing phase. The step is essential to the successful operation of the flying boat since lift-off from the water is normally not possible without it. This design feature was first introduced by aviation pioneer *Glenn H. Curtiss*. Two transverse steps have sometimes been employed in the design of flying-boat hulls, particularly on older boats. The more usual practice in later boats was to taper the afterbody to a point which effectively terminates the hull. The tail assembly was then carried on a fuselage extension above the hull. The overall length-beam ratio of the hull as well as the value of this ratio for the forebody and afterbody individually were important design variables, as were the height and location of the step.

62

"…Pilots find the best way is to drop the boat into the water from a three or four-foot height so that the water can get a good grip on the hull and slow it down. If the pilot makes a bad guess and hits the heaving surface with too much speed or at the wrong angle the huge boat slams through the water like a skipping stone. It may bounce back up into the air time after time…"
Popular Mechanics, **August 1937**
Above: watercolor painting of a *Sikorsky S-42A* "Antilles Clipper" landing at *Dinner Key, Miami*

63

Test Flight

64

"…A good duck should handle just like a boat on the surface. First, the test pilot simply taxis around on the water and makes left and right turns across the wind. He wants to know how much rudder control is needed to swing the boat. Then he tries turns using one engine as well as the rudder to turn the plane. From the cabin windows the engineers watch the wing pontoons which are retractable into the wings these days, to find out whether they are large enough and strong enough to keep a wing from dipping under. No airplane has a reverse on it but the big boats can sail backward down wind by allowing the engines to idle. Another test is to turn tail to the breeze and taxi slowly down wind. The big control surfaces of the tail are apt to catch the wind and make the plane yaw around, and the pilot has to know how much control is necessary to hold a straight course. Next come the high-speed taxi tests with the plane churning along through the water on its step just under fifty miles per hour. No turns are made at these high speeds and the courses are straight runs into the wind and out of it. With unlimited water in front of him a pilot can take off with the wind behind, something not recommended for land planes. The first few flights are made with no other load but the crew, merely to learn how the boat handles in the air and to check the instruments and controls. Usually small details have to be adjusted and after that whole groups of tests are made while the boat carries increasingly larger loads of lead bars. The engineers want to know the safe minimum flying speeds for all loads, rates of climb and descent, take-off time, ceiling and maximum speeds…"
Popular Mechanics, **August 1937**

65

"…To check and calibrate the air-speed indicators the pilot races along a speed course marked out on the beach with a stop watch in his hand to mark the elapsed time. With a full load of 28,500 pounds on board, one of the new Douglas boats climbs 600 feet per minute and has a high speed of 185 miles per hour. Flying boats can lift heavier loads into the air than land planes because they have all the take-off room in the world. Just like other large surface boats, flying boats have watertight doors in their hulls. On the Douglas the six different compartments are sealed with light strong doors that can be closed or opened in a few seconds. A lightweight collapsible anchor, life belts, boat hook, and signaling flare are included in the marine equipment."
Popular Mechanics, **August 1937**
Left: working on the interior framework of a *Boeing 314* flying boat at the *Seattle* plant (ca. 1938)
Right: pilot (left) confers with engineer (right) after engine testing of a *Douglas* flying boat (1937)

66

Storm Kite

67

"…One of the strangest facts to those who do not understand flying boats is what they will stand in a storm. Once a fleet of winged boats stopped for the night at the flying base at the wild Scilly Isles, off Land's End, the southern tip of England. While they were riding at anchor, a storm swept in from the sea. White-topped ridges of water battered the hulls while a screeching gale howled through the rigging of their big wings. Then, as the violence of the gusts increased, the huge seven-ton boats lifted themselves bodily from the crest of an unusually high wave and flew at the ends of their big anchor cables like kites!..."

***Captain Frank T. Courtney*, 1931**

68

Flying Fools

69

"To join the famous Flying Jackass Club, one has to earn the title of 'Flying Fool,' by being proved guilty of some outstandingly silly piece of piloting. Related here are some of the thrills which have made men eligible for initiation…"

***Modern Mechanics*, July 1929**

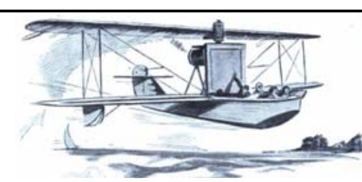
70

The pilot threw caution to the winds and took off in the teeth of a gale. His gas ran out as he lifted off, and only after a battle with the elements was the ship saved.

"For instance, Gene Shank, one of Modern Mechanics' aviation editors, tells of the time he was barnstorming an Aeromarine flying boat on one of the lakes in the northern summer resort region. The day had been clear, but gusty, with an east wind blowing across the narrow part of the lake, making a takeoff difficult. The sun was sinking, the day was nearly over, when a load of passengers drove up to the shore base, paid for a ride, and insisted on a 'hop.' Pilot Shank loaded them in, headed down wind, gave her the gun, and was barely clear when the motor quit, out of gas! The sun was soon down, it was dark, and the boat was at the mercy of the strong easterly wind…After drifting past one island, into the lee, the plane started drifting for the windward shore of the lake, where the water was rougher and the plane would surely suffer grief…one man crawled out on the wing nearest shore, and hanging in the water from the wing, kicked vigorously so as to stop the drift in that direction. As on a pivot the other wing swung around, and by sending a man over the opposite wing from which the panting, kicking, dragging swimmer was pendent, the second man was able to step off a few feet of water and nose the ship ashore, thus saving the fair cargo!

***Modern Mechanics*, July 1929**

71



"…At another time, with a Curtiss flying boat, a pilot was hopping passengers on the well known two-for-five plan. Two girls, giggling, thrilled, and scared, boarded the plane and seriously asked the pilot if he thought he would bring them down alive. Jokingly he remarked that he had a premonition that this would be his last trip - that he felt his end near. Imagine the lump in his throat when, upon taking off, he found his tail surface control gone! Cut wires, plots! Other possibilities raced through his mind, until, upon looking back, he saw that a large hatch, about five feet square, had not been clamped down, and was standing up, supported by wind pressure, dancing daintily against the motor struts and waiting at any lime to slip off into the pusher propeller! The hatch had blanketed the air stream so that no solid air was going past the tail surfaces, and there was no tail control at all. The pilot gingerly closed the loose hatch with one hand, while standing up and flying with the other, all the time praying that the flimsy pegs which held the hatch would not slip loose and mix the hatch up with the prop…"

***Modern Mechanics*, July 1929**

72

Flying Lifeboat

73

"I look forward, too, to a steady development and increased use of flying boats, for crossing the Great Lakes, wide bays and gulfs, and flight along river courses. This is the safest form of air travel yet devised, for in case of a forced landing from any cause there is the buoyant medium of the water to float upon. The chief danger here is from storms so severe as to wreck the craft by the action of the wind upon the wings. Nine times out of ten flying boats forced to land on a rough sea have been unable to rise again, because of the waves, of damage to propellers or wings, or of being out of gas. To overcome this handicap, we built, during the war, what may be called the flying lifeboat. This is a flying boat with discardable wings, with a small auxiliary motor and a water propeller. After alighting on the rough water, the wings are detached and left behind. The hull is built like an unsinkable lifeboat. If the air propellers are not damaged, they may furnish motive power to get the craft to land; otherwise they can be thrown over and reliance placed upon the auxiliary motive power and sea propeller to keep the boat head-on to the waves and eventually bring it into port."
Glenn H. Curtiss, 1927

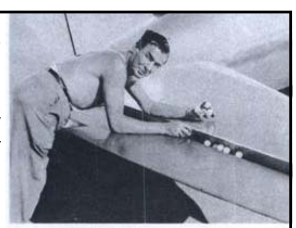
74

The unique *Curtiss BT* "flying lifeboat" (above) originated early in 1917 following discussions between *Glenn Curtiss* and *U.S. Coast Guard* personnel concerning the possible use of aircraft to deliver lifeboats from shore stations to ships in distress beyond the breakers or at sea. Having a conventional aeroplane carry a boat was ruled impractical. Curtiss then designed what was essentially a winged lifeboat, with a hull more boat-like than on previous flying-boats. The BT had two unconventional features. The 200 hp Curtiss V-2-3 engine was installed in the hull and drove two tractor propellers through shafts and gears, and the tri-plane wings and boom-mounted tail surfaces could be jettisoned if necessary to allow the hull to operate as a pure boat driven by a marine propeller and a small auxiliary motor. The pilots sat in a side-by-side cockpit behind the wings. The power transmission system of the BT proved unworkable from the start. The engine was then installed ahead of the middle wing and turned a single direct-drive tractor propeller. The *U.S. Navy* bought the modified BT in December 1917. The BT was of no use to the Navy, which encountered problems of hull strength, spray protection for the crew, the proximity of the propeller to the relocated front cockpit and the danger of hand-starting engines in seaplanes. The BT was surveyed ("surveyed" is a military term meaning written-off and ordered to be scrapped) on June 9th 1919.
It had a span of 57-feet; length of 40-feet and a height 16-feet.

75

Ping-Pong Anyone?

76



Harry Richman, singer, stuffing ping pong balls in the tail o plane he and Dick Merrill, pilot, flew from N. Y. to London 10,000 balls insured buoyancy in case of a forced sea landing

"More than 10,000 ping pong balls were in the wings and tail of the Vultee airplane in which Harry Richman, orchestra leader, and Dick Merrill, former Eastern Air Lines pilot, flew from New York to London on Sept. 3. Their unique purpose was to supply buoyancy to the airplane in the event that engine trouble caused a forced landing at sea. The tiny celluloid balls added less than 30 pounds weight to the plane, but pre-flight tests indicated that their combined buoyancy would support the plane on the water indefinitely. The flying team ordered 30,000 balls but dealers could supply only 10,000."
***Modern Mechanix,* November 1937**
<u>Above</u>: caption: "Harry Richman, singer, stuffing ping pong balls in the tail of plane he and Dick Merrill, pilot, flew from N.Y. to London. 10,000 balls insured buoyancy in case of forced sea landing.

77

Glider Lifeboat

78

"In its unceasing efforts to save lives at sea, the Coast Guard is developing the glider-boat rescue unit illustrated here. Towed by powerful aircraft, the device would be released over the scene of disaster. After gliding to the water, it would jettison its wings and tail and take on the function of a motor boat. Designers hope eventually to make use of the wings and tail of CG4A gliders, produced in quantity during the war. The craft will be built so that it can be hoisted aboard rescue ships arriving upon the scene."

***Modern Mechanix,* September 1947**

79

Three-Wheeled Amphibian

80

"Landing on dry ground, a dangerous operation for most amphibian planes, is made safer by the unusual construction of a new craft of this type designed and built by Captain Frank T. Courtney, noted airplane designer. The use of an auxiliary swiveled landing wheel well back, preventing ground-looping without the usual risk of nosing over. Other construction details give this plane a speed and maneuverability not commonly found in amphibians…"

***Popular Science Monthly,* February 1935**

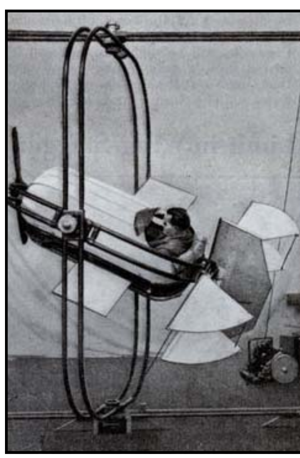
81

St. Louis' *Curtiss-Wright Airplane Company*, which in 1936 had been renamed the *St. Louis Airplane Division of Curtiss-Wright Corporation*, began to concentrate strictly on military aircraft in the mid-1930s. In 1935, the St. Louis plant built the "Courtney Amphibian," (above) a large, single-engine bi-plane flying boat equipped with tricycle gear for land use. It was designed by *Captain Frank Courtney*, a celebrated RAF WWI ace, who was a close friend of *Richard Hoyt*, the Curtiss-Wright board chairman. Courtney persuaded Hoyt to give his model a trial. Two prototypes were constructed at the St. Louis plant (one of which was sold to Japan). The model held little promise thus, it was discontinued.

82

Training Day

83



"All the sensations of looping the loop. going into a tail spin, and flying blind through fog are afforded students of the Array Air Corps at Wright Field, Dayton, Ohio, by an ingenious "primer plane" that never leaves the ground. A miniature fuselage, fitted with a propeller, ailerons, elevators, and rudder, is attached to an electrically-operated framework, and in the cockpit a prospective pilot does his first 'flying' in safety. With his feet on the rudder bar and his hand on the 'joy' stick, with the propeller roaring before him and the air rushing past, the student puts the device through various evolutions. Each movement of the control stick or rudder bar results in the same reaction that follows such a movement in actual flight. Thus, the beginner becomes familiar with the controls without risking a crash. A second lever and bar allows an instructor, outside the device, to maneuver it suddenly into all sorts of positions to test the student's ability to react coolly in a crisis. If an error is made, the motor is shut off and a conference takes place. On the instrument board of the 'primer plane' practically all the instruments carried in a regular airplane are mounted. 'Blind' flying is taught by placing over the student's head a hood that shuts off the horizon but permits him to watch his instruments."

***Popular Science Monthly,* May 1929**

Left: caption: "Learning to climb in the 'primer plane.' The student experiences all the sensations of a real flight."

84

"A blind flying trainer, assembled from miscellaneous player piano, automobile and airplane parts, is furnishing efficient blind flying instruction to army pilots at March Field, California. The 'synthetic' airplane is mounted atop a ball joint and pivot. Lateral and longitudinal stability is controlled by four banks of bellows which function according to the movements of a regulation airplane control stick. A backward pull on the stick, for example, raises the elevators and throws the tail of the 'plane' down by releasing the pressure in the rear bellows while the forward bellows retains its pressure. The process is reversed when the stick is moved forward. Moving the stick right or left moves the ailerons and balances the plane laterally by controlling the two side bellows. The rudder bar moves the rudder as it would normally move on an airplane in flight and simultaneously controls an electric turning motor that turns the 'plane' to the right or left according to the position of the rudder bar. Underneath the hood, when it is closed, is an electric lighted instrument panel carrying all the regulation airplane instruments requisite to blind flying. Another instrument previously unheard-of in any blind flying trainer of any sort is a mechanical altimeter that simulates the registration of altitude according to the student's operation of the controls. Still another instrument that adds greatly to the efficiency of the trainer is a rough air adjustment that causes the 'plane' to bounce and roll. It simulates the movement of an airplane under conditions of bumpy air flight. In the hangar where the trainer is located are five, simulated, local radio beams which students 'flying blind' are trained to pick up and follow. By learning blind flying in the ground trainer men and officers qualify as blind-flying pilots with far fewer hours in the air than were formerly required."

***Modern Mechanix*, January 1936**

85

"…This year, 1931, is the twentieth anniversary of the first successful flight in an air-and-water plane. During these twelve months, the Do-X, capable of carrying more passengers than any other plane in the world, has crossed the Atlantic and flown in both Americas; the Supermarine racer has rocketed through the air at 415 miles an hour; and the pontoon equipped Lockheed, flown by Col. Lindbergh, has followed a new northern trail to the Orient. In passenger service, record-setting, and sport, the machines that are at home in the air or on the water have come to the fore…"

***Captain Frank T. Courtney*, 1931**

86

<u>Part 2</u>

19 Days From New York

87

"Trans-Atlantic flight on regular schedules is bound to come. It might have come sooner but for the war. We were just getting ready for the first real attempt to fly across the ocean in 1914; then everything had to be subordinated to war needs – speed, maneuverability, altitude. The development of the airplane and the flying boat took a direction then from which it is only beginning to return. But it is inevitable that trans-Atlantic flying service will be established as it was that trans-Atlantic telephony was."

***Glenn H. Curtiss*, 1927**

88

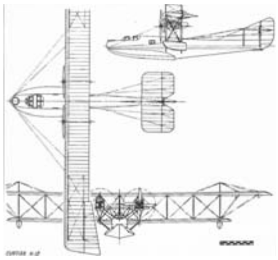
The AMERICA

89

"The first man who gave really serious thought to flying across the Atlantic – serious in the sense that he actually built a flying machine to carry out his intentions – was Glenn H. Curtiss. He decided that his machine must have an enormous radius of action, and to obtain it he considered it necessary not only to increase the size of the airplane, but also to improve its efficiency. The chief obstacle to an increase in efficiency was the landing gear. The sheer weight and air resistance of that appendage wasted fuel. But when Curtiss considered the crew, particularly their comfort and safety, he went to the other extreme, and decided to turn the landing gear into a vessel as big as a sea-going launch. The boat or launch proved to be so heavy that before the machine could get into the air it was found necessary to leave behind most of the fuel. Later he adopted the 'sea-sled' type of boat. While Curtiss was still experimenting the world war broke out. He sold his experimental craft – the 'America' – to the British Government, which used it very successfully in patrolling the waters around the British Isles…"

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

<u>Above</u>: *Curtiss H-12* flying boat of 1917-18; a larger and more powerful development of the 1914-1915 "H-4" *America* type. 90



"…Immediately before the outbreak of the war, the eyes of the world were upon a flying boat named the 'America,' built for the first trans-Atlantic flight, but destined to cross the ocean in the hold of a steamship, to play an important part in British operations against enemy submarines…Equipped with two motors, and with a comfortable cabin for the operators, this aeroplane was at the time a distinct advance over anything previously built. Under war conditions this machine proved so successful that Glen H. Curtiss is now building them at a rate of one every day…"

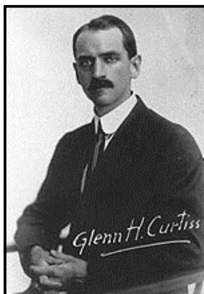
***Popular Science Monthly,* March 1916** 91

<u>Above</u>: plan and elevation/s of the *Curtiss H-12* flying boat

"…Curtiss gave to the world a craft that had some of the attributes of both airplane and dirigible, alternately flying and resting on the water. Small flying boats cannot live on the ocean, and to become relatively seaworthy, seaplanes must have sealed catamaran floats, and the men must be raised high above the waves. Only a mammoth craft, something with a huge hull, something that will transform the flying boat into a flying galleon…From their rounded compact hulls waves dash off harmlessly…Their high tails, when they rest on the water, head them into the teeth of the wind. If the descent is too steep, the nose may be tilted up, yet the high tail drops clear of the water without splashing and without breakage. Alighting is a more delicate operation in a seaplane than in a landplane. It is only too easy to come down nose first. Let the pilot beware lest the prow be caught in the water and the machine turn a somersault…"

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

<u>Left T&B</u>: full-scale replica of the Curtiss flying boat "America" on display at the *Glenn Curtiss Museum* in *Hammondsport, NY* 92

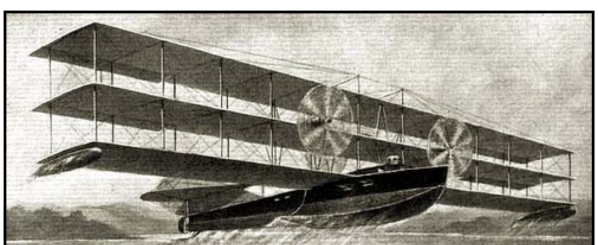


"AMERICA: The Curtiss-Wanamaker Flying Boat, 1914. The largest flying boat of its day and the first twin-engine flying boat, the Model II was built for the first aerial crossing of the Atlantic Ocean. After a prize of $50,000 was offered by the London Daily Mail of London, England in 1913 for the first transatlantic crossing of a heavier-than-air aircraft, Rodman Wannamaker, a wealthy department store owner, put up $25,000 to start construction at the Cutiss Aeroplane Company…Constructed and christened the AMERICA in Hammondsport, N.Y. in the summer of 1914, the flying boat was scheduled for the historic flight on August 5th of that year. Painted bright red for visibility, the plane was disassembled and shipped to St. John's, Newfoundland, Canada, for the start of the journey. However, with the outbreak of WWI taking place at that time, the attempt was cancelled…" 93

RE: excerpts from plaque inscription

Rise Like a Gull

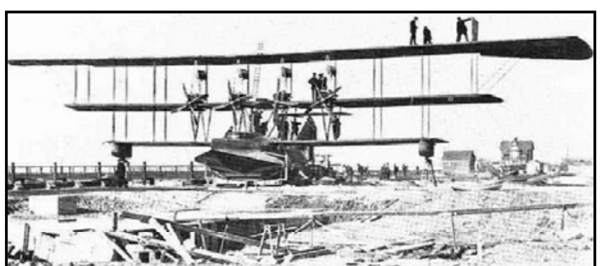
94



"…The newest designs of Curtiss call for a triplane, with a wingspan of one hundred and thirty-three feet. This great flying boat weighs, fully equipped, nearly eleven tons. When on the water it is driven by a propeller similar to those used on large motor boats, but when it is to be lifted into the air, the great power of its two heavy engines is transmitted directly to the aerial propellers, and the huge machine rises like a seagull. A crew of several men is sheltered by an ample cabin, and a number of guns project from the sides of the compartments. The speed of this craft is probably high, and its cruising radius, when fully loaded should be about six hundred and seventy-five miles…"

***Popular Science Monthly,* March 1916** 95

<u>Above</u>: artist's impression of the *Curtiss Triplane* flying boat, (*FLIGHT* magazine (UK), 1916)



In 1915, *Rodman Wanamaker* commissioned *Glenn Curtiss* to build a new, larger flying boat, which became known as the *Wanamaker Triplane*, or *Curtiss Model T* in Curtiss's then-current designation scheme. Early press reports showed a large triplane, 68-feet in length and with equal-span six-bay wings of 133-foot span. The aircraft, to be capable of carrying heavy armament, was estimated with an "all-up" weight of 21,450 pounds and was to be powered by six 140 hp engines driving three propellers, two of which were to be of tractor configuration and the third a pusher. The *British Royal Naval Air Service* (RNAS) placed an order for twenty of the new triplanes with the first one being completed at Curtiss' factory at *Buffalo, New York* in 1916; the first four-engined aircraft to be built in the U.S. and one of the largest aircraft in the world, at the time. The two pilots and flight engineer were provided with an enclosed cabin, similar to that in the Curtiss *America*, while to reduce control loads small windmills could be connected to the aileron cables by electrically operated clutches to act as a form of power assis- 96 **ted control. The engines were installed individually on the middle wing, unusual for the time.**

The Flight of the Nancy Boats

97

In September of 1917, the chief of the U.S. Navy's Construction Corps, Admiral *David W.Taylor*, called in his key men; Commanders *G. C. Westervelt, Holden C. Richardson* and *Jerome C. Hunsaker*. These naval constructors were ordered, in effect, to create what the combined efforts of *England, France* and *Italy* had been unable to achieve in three years of war: long range flying boats capable of carrying adequate loads of bombs and depth charges as well as defensive armament sufficient to counteract the operations of enemy submarines. After the meeting, *Glenn Curtiss* was summoned.

Left: caption: "The men responsible for the NC flying boats"

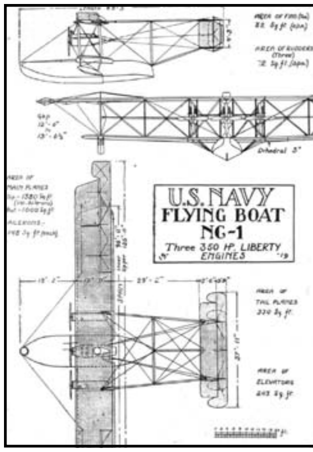
98

"…The designation NC stood for Navy-Curtiss…weighing over 14 tons loaded, they were the heaviest craft flown. Their wingspan was 126 feet. The wooden hull was both a boat and a cramped cabin for the men. It was reinforced so that, the Navy hoped, it would stand up in heavy seas. The tail was held in place in place by booms from the hull and superstructure…"

***Popular Science,* May 1964**

RE: within three days of his meeting in *Washington D.C.,* Curtiss and his engineers submitted general plans based on two different proposals. One was a three-motored machine, the other a behemoth with five engines. Both were similar in appearance, but they opposed conventional flying boats of the period in that the hulls were much shorter, vaguely resembling a Dutch wooden shoe. The tail assembly, for which there were several alternates, was to be supported by hollow wooden booms rooted in the wings and hull. This tail, twice the size of an ordinary single-seat fighter aeroplane, would be braced by steel cables and was situated high enough to remain clear of breaking seas during surface operations. It also permitted machinegun fire directly aft from the stern compartment without the usual danger of blasting the controls to pieces. This interesting concept had been embodied in a previous Curtiss design for the BT "flying lifeboat." The keys to success lay in two factors: a seaworthy hull which had good "planing" characteristics and reliable engines which provided sufficient power for their weight. The entire machine had to be relatively light yet strong enough to withstand the severe treatment frequently encountered at sea. It was not practical to build larger and larger airplanes and keep adding more engines to keep the craft in the sky unless the load-carrying potential also increased. This "useful load" included crew, fuel, equipment, accessories and armaments - things not part of the basic aeroplane. Thus, the plan for the smaller, three-engined aeroboat was decided upon and the light "Liberty" engine solved the power problem.

99



"…The NC-1 is a flying-boat of the short-hull type, with the tail-planes carried from the hull and the top main planes by means of outriggers. The hull is 44 feet 8.75 inches…The top plane center section is 25 feet 4 inch span, and each lower plane center section mounted on either side of the hull is 10 feet 8 inch span. The outer extensions of the lower plane have a 3 degree dihedral, all other plane sections being 'flat.' The angle of incidence is 3 degrees top and bottom…"

***FLIGHT* magazine, May 1919**

Left: plan and front/side elevation/s of *Curtiss NC-1* flying boat

100

"…Midway between the top and bottom planes are located the three engine nacelles, each supported by two pairs of interplane struts. The central nacelle, which is larger than the other two, contains the pilot's cockpit and control. Each of the outer engine nacelles are situated 11 ft. from the centre of the machine, and two pairs of interplane struts, located respectively 26 ft. 11 in. and 41 ft. 6 in. from the center separate the top and bottom planes of the outer extensions. The overhang of the top plane is 15 ft. 6 in., and that of the lower plane 6 ft. 6 in. Balanced ailerons are fitted to the top planes only. Cockpits for the crew are provided in the nose and the center of the hull…"

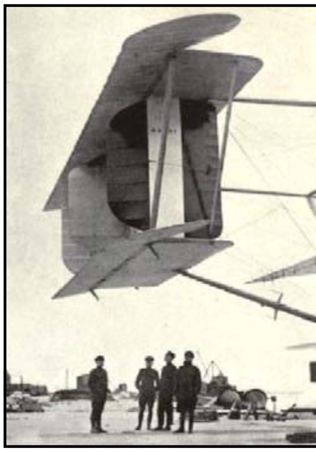
***FLIGHT magazine,* July 1919**

Above: view/s of NC-4's three engines (museum display)

101

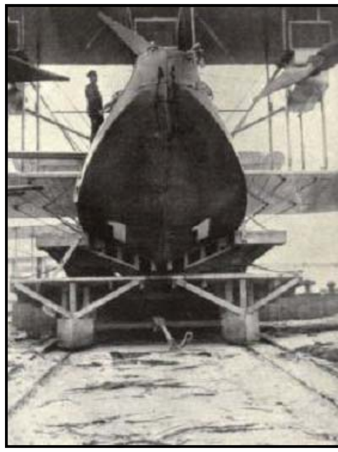
1. Forward part of hull. The ladder leads to pilots' cockpits
2. One of the power units, showing streamline engine nacelle
3. The commander's cockpit at the extreme front of the hull
4. The pilots' compartments showing special compass installation
5. Wing tip float under the lower left main plane
6. Pilots' compartments as seen from the front showing windshields
7. The bi-plane tail group. There are two fins and three rudders
8. Side view of front of hull, showing placement of the navigator

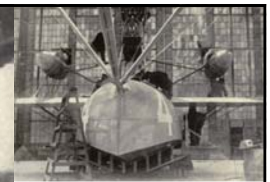
102



"…The tail is of the bi-plane type, carried on three hollow spruce outriggers, braced by wire cable and struts. There are three rudders mounted between the tail planes, one of which, in the center, is balanced, and the other two being hinged to vertical panels at each extremity of the tail. One-piece balanced elevators are fitted to both top and bottom tail planes. The gap of the tail is 9 feet 3 inches, and the overall span of the upper and lower planes is 37 feet 11 inches and 26 feet, respectively…"
FLIGHT magazine, **May 1919**
Left: NC-1 tail section close-up view

103





Above: close-up of the after-part (rear) of NC-4's wooden hull
Left: forward (front) view of the underside of NC-1's bow

104

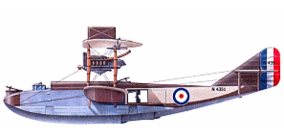
"…Cockpits for the crew are provided in the nose and the center of the hull…"
FLIGHT magazine, **July 1919**
Top Left: looking down into the Pilot's (lower left) and navigator's (upper right) cockpit
Top Right: testing the wireless set's generator

105

The pressure was on. The German U-boat situation was reaching ominous proportions. The *United States* was producing patrol planes as fast as possible, but the matter of shipment was an endless frustration. Even when good fortune allocated the use of a large cargo ship, its entire cargo consisting of crated flying boats and their accessories, the total manifest would be only twenty-five machines. The *Royal Navy* was grinding out planes under the supervision of Commander *John C. Porte*, but his relatively small flying boats, operating from coastal stations, had a fuel and depth charge capacity limiting them to only a few hours on station. If a convoy was more than one-hundred miles at sea, their use became impractical. In view of the urgency of the problem, chief naval constructor Taylor knew he had to cut corners. Under normal circumstances, development of a navy flying machine; the engines, hull, wings, fittings and armaments would require study and sanction by respective divisions within the Navy, a time consuming process. Admiral Taylor centralized the project. A design contract was let with the Curtiss Company and Commanders Westervelt and Richardson were sent to the *Buffalo, NY* plant. Without red tape, the Navy engineers would work closely with the Curtiss people at full speed.

106

Above: *Curtiss Model H-12* (1917) RNAS anti-submarine patrol aircraft



The *Felixstowe F-2* (Left) was a 1917 British flying boat class designed and developed by Lieutenant Commander *John Cyril Porte* of the *Royal Navy* at the *Seaplane Experimental Station*. Adapting a larger version of his superior *Felixstowe F-1* hull design married with the larger *Curtiss H-12* flying boat, the Felixstowe hull had superior water contacting attributes and became a key base technology in most seaplane designs thereafter. The *Felixstowe F-2A* was widely used as a patrol aircraft over the *North Sea* until the end of the war. Its excellent performance and maneuverability made it an effective and popular type, often fighting enemy patrol and fighter aircraft as well as hunting U-boats and Zeppelins. The larger *Felixstowe F-3* (right), which was less popular with its crews than the more maneuverable F-2A, served in the *Mediterranean* as well as the North Sea.

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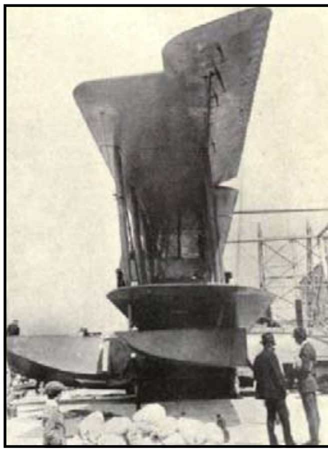
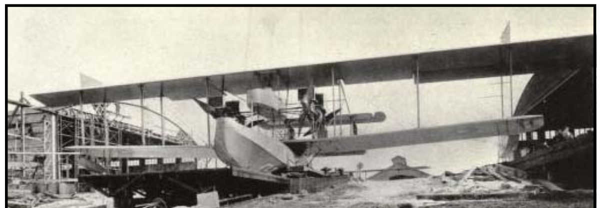
Also designed by *John C. Porte*, the *Felixstowe F-5* (above) was intended to combine the good qualities of the F-2 and F-3, with the prototype first flying in May 1918. The prototype showed superior qualities to its predecessors but the production version was modified to make extensive use of components from the F-3, in order to ease production, giving lower performance than either the F-2A or F-3. The F-5 did not enter service until after the end of WWI, but replaced the earlier Felixstowe boats (together with Curtiss flying boats) to serve as the RAF's standard flying boat until being replaced by the *Supermarine Southampton* in 1925. The "dazzle" paint scheme was designed to make them highly visible from the air should the flying boat be forced to land at sea.

108



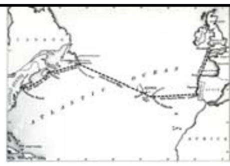
One of the first problems readily resolved was the plane's name. At first, Westervelt applied the initials of his boss: DWT. A little reflection brought realization that Taylor might take a dim view of that, so Westervelt changed it to "Navy-Curtiss Number One," or simply, "NC-1." Even by 1917 there was a wealth of aerodynamic data available from both wind tunnel testing and practical application. The Navy-Curtiss team drew heavily on the experience of others, especially the British. Never-theless, the construction of a boat with wings large enough to cross the Atlantic presented unique problems of its own. Foremost was the hull. The "wooden shoe" was Commander Richardson's burdensome responsibility. 109

__Above & Left__: side views of NC-1's hull



The hydroplane hull design was critical. Unless properly fashioned, a high speed surface established a suction effect with water (some early seaplanes had been known to leave the bottoms of their hulls upon the sea as the remainder took to the sky). Richardson, working with the Curtiss engineers and using his own experience along with the ideas of Commander Porte, had a small scale model built. When it was tested in the towing tank, results were so poor he discarded the plan and drew up a new design. Light weight was a basic requirement, yet enormous strength was necessary to support the wings, engines and tail structure, while at the same time enclosing gas tanks, the crew and all their equipment. When Richardson's new design was tried out in the towing tank, it performed very well. But when construction of the full-size hull was observed by Commander Porte during a visit to the U.S, the British seaplane authority would only comment that it was "very interesting." Soon afterward, word filtered back from *England* that the project was not to be taken seriously; the hull was considered heretical. Richardson remained undaunted. 110

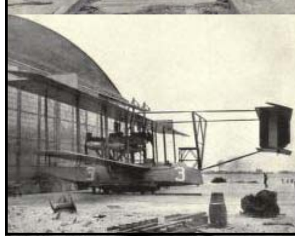
__Above__: view of NC-2's hull



"…Mr. Glenn Curtiss has predicted that the NC flying-boats would succeed in crossing the Atlantic. He described the advantages of the southern route over the northern, saying that during their flight to the Azores the planes will be in the path of winds which under normal circumstances would increase the speed by 40 per cent, and allow of the flight between Trepassey and the Azores to be made in 20 hours…"

FLIGHT **magazine, May 1919**

__RE__: by the time Cmdr. Richardson (a naval aviator himself and considered the hydro-aeroplane expert of the Navy) arrived at the Curtiss *Buffalo, NY* plant in the fall of 1917, the preliminary design of NC-1 was half complete. One look at the drawings for a three-engined, 140-foot biplane convinced Richardson that the craft was under-powered. Armed with new scientific data fresh from *Great Britain*, *Jerry Hunsaker* backed him up. Such a machine, with the Liberty engines then available, would not have the range sufficient to fly the 1,900 miles from *Newfoundland* to *Ireland* unless provision were made for mid-ocean refueling from a ship, a dubious proposition in view of the notorious *North Atlantic*. Richardson was right. A decision was made to plan something smaller and use the *Azores* route to *Europe* (above). 111



By December 1917, design work by the Navy-Curtiss team had progressed to the satisfaction of Washington. Secretary of the Navy *Josephus Daniels* put his approval on a contract calling for four flying boats of the NC type. Manufacturers were engaged to produce various components; the hulls, wings, tanks and engines, all of which would be shipped to the Curtiss plant at *Garden City, Long Island*, for assembly. At the nearby *Naval Air Station, Rockaway Beach*, a huge hangar was built to house two of the NC's and a special marine railway was constructed to facilitate movement and beaching.

__Above__: NC-1 in her cradle at Rockaway NAS (NC-3 on marine railway at left) 112

__Left__: NC-3 and her hangar at Rockaway NAS

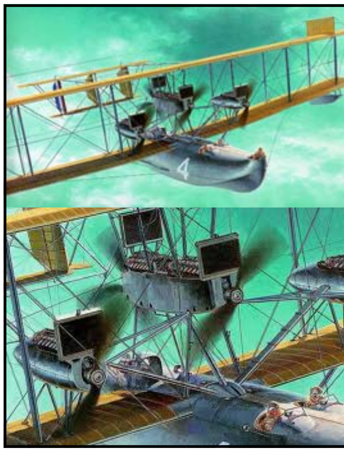
"…Each plane had four 400-horsepower Liberty engines. One, a pusher, was right behind the center-forward engine. It had been added as an afterthought…"

Popular Science, **May 1964**

__Above__: the NC-4's four engines being installed

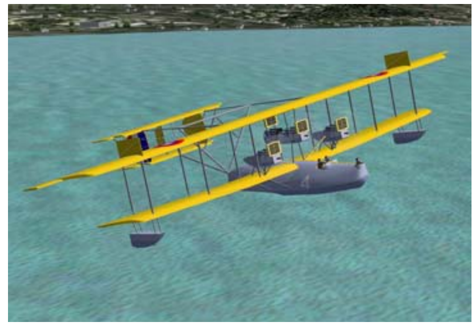
__Left__: caption: "Weighing, doping, measuring and finishing the NC wing panels and ailerons" 113

114



"…The engines are of the Liberty, low compression, Navy type, developing about 350 hp each. The gross weight of this particular type of machine is 21,560 lbs., the useful load being 7,750 lbs. The speed range is about 81 to 61 m.p.h., and climb 2,000 ft. in 10 minutes…"
***FLIGHT magazine*, May 1919**

115



116

"The hull of this machine was examined. The machine is impossible and is not likely to be of any use whatever."
RE: comments in report. In July 1918, construction of the NC-l was far enough along to warrant scrutiny by the head of the *British Aviation Commission* who was not impressed. Near the end of August, just as Westervelt was preparing to sail to *England* on an inspection trip of his own, Richardson paid him a visit. Things had been going well: the NC-1 was almost finished, enough flying boats had been delivered to European patrol stations to ease the submarine menace, and the Allies were winning the war. But Cmdr. Richardson was depressed. He had been reviewing the data from the towing tank tests and now calculated that the NC-1 would be unable to get off the water with the fuel load required to reach the *Azores*. America's foremost authority on pontoons and hulls had lost faith in his own design.

117

A close-up of Pilot's cockpit, showing compass, windshield and ventilator

A close-up of the NC engines

The drift-indicator above and landing flares below bow of one of the NC's

During September 1918, the NC-1 was delivered to Rockaway NAS and on the 4th of October, she was ready for her first flight. The test pilot in charge of the flight was Cmdr. Richardson. Before a crowd of spectators, the crew of five clambered aboard the flying boat which was nestled in its cradle at the top of the ramp, the gray and yellow biplane looked impressive. Climbing through a hole in the bottom of the center engine nacelle, the pilots took their places. The cockpit was situated between the wings, behind the middle engine. Thus the two pilots were surrounded - on the bottom by the hull wherein crew members and the main fuel tanks resided, on the sides by the outboard engines and on top by the upper wing with its open station for the lookout watch or machine gunner. Engines were started and when Richardson waved his arm, the carriage was eased down the inclined railway and into the water until the NC-1 floated free. Back and forth it taxied as Richardson felt out the controls. The crowd waited silently. Then he swung into the wind and, within moments, a rising cheer accompanied the world's largest flying boat into the air. In just one year from the time they had started, the Navy-Curtiss team had met with success: the "Nancy" flew. Richardson's fears were allayed; his design was vindicated. Soon the NC-1 would establish a record by carrying fifty-one men aloft, including the first deliberate stowaway in aviation history. But on the 11th of November 1918, WWI ended and with it the need for a long-range, anti-submarine flying boat. However, not long afterward, the $50K *Daily Mail* prize for a transatlantic flight was revived.

118

<u>Above</u>: NC-1 takes-off for test flight off of *Rockaway Beach, Long Island*
<u>Left</u>: rolling out NC-1 for her first trial flight

119

<u>Above</u>: NC-1 takes-off (left) and in-flight (right) off of *Rockaway Beach, LI* during test flight
<u>Left</u>: checking navigation instruments before test flight

120

The Time Has Come

121

"It is requested that I be detailed to make a trans-Atlantic flight in an NC-l type of flying boat when this boat is completed."

Lt. Richard E. Byrd, **Naval Aviator**

RE: within the Navy, there had been growing interest in the trans-Atlantic flight. On July 9th 1918, Lt. Richard E. Byrd, then engaged in the study of crashes at Pensacola NAS, wrote to Washington requesting participation in the trans-Atlantic quest. His request had been forwarded, with approving endorsement, by Byrd's commanding officer. Two weeks later he was in *Washington D.C.* where, with mixed emotions, he accepted orders sending him to *Nova Scotia* as commander of U.S. Naval Air Forces in *Canada*. His disappointment at not being assigned to the trans-Atlantic flight was tempered by instructions to seek out, on the coast of *Newfoundland*, a rest and refueling station suitable for the handling and maintenance of large seaplanes. Byrd spent every spare minute on navigational problems associated with a flight across the *Atlantic*. He thought there might yet be a chance to join the team. But someone else was ahead of him.

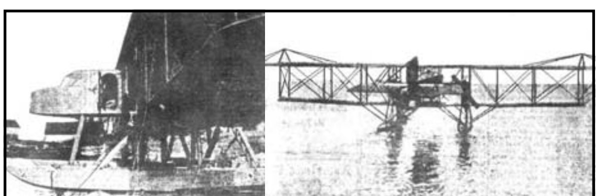
122

U.S. Navy Commander John Henry Towers **(left) was the third officer to be designated a "naval aviator" (he was personally trained by *Glenn Curtiss* to fly in *Hammondsport, NY* in 1911), Towers' career covered the early period of aviation development in the Navy. As a close associate of Glenn Curtiss, he had been a natural choice for participation in the abortive 1914 plans for the trans-Atlantic flight of the "America." In 1916, after diplomatic duty in *London*, Towers was ordered to *Washington D.C.* where he had little time to think about flying the Atlantic, that is, until the design for the NC boat came to his attention. At first, he didn't care for NC-1's unconventional appearance. The short hull looked strange and he disliked it. Regardless, Commander Towers requested and received assignment to the NC project as officer-in-charge.**

123

In December 1918, Westervelt returned from *Europe* and found that test flights of the NC-l indicated a need for major modifications. Urgency of the anti-submarine mission was no longer in effect, so changes were being made in the NC-l at a leisurely pace. The NC-2 would be based on knowledge gained from the first boat. Until problems were solved, construction of the NC-3 and NC-4 would be held up; a frustrating development. In Europe, Westervelt had learned that several organizations were making preparations for a trans-Atlantic flight. He knew that *Great Britain* had long been anxious and now had aeroplanes large enough to do the job. *France* and *Italy* were considering the venture and there were at least four independent private interests active in the U.S.

124



"As we go to press there are more candidates for the honor of making the first transatlantic flight than there used to be for a position of judge at a beauty contest…The 'Sunrise,' as Captain Hugo Sunstedt christened his seaplane, has an upper wing spread of 100 feet and a lower of 71 feet…the wings of the 'Sunrise' have been designed to give as much lifting power as possible without cutting down the speed below eighty miles an hour, flying with a full load…there is nearly always a twenty-mile air current from west to east on the ocean air lanes and Captain Sunstedt figures that eighty miles an hour and 750 gallons of gasoline will see him through…At eighty miles an hour, Captain Sunstedt estimates that he can fly from New York to Newfoundland, and from Newfoundland over the short route to Ireland, without stopping on either leg to replenish his fuel. The over-water distance in an air line from Newfoundland to Ireland is 1,860 miles…"

Popular Science Monthly, **April 1919**

Above L&R: the "Sunrise" seaplane

125

"With three, and possibly four, aviators ready to fly across the Atlantic from the American side to the British Isles, the American Aero Club, from their headquarters in New York, have announced that three airmen in England have already filed their entries for the trans-ocean event. A prize of $50,000 has been offered by the London 'Daily Mail' for the first successful flight. An additional $50,000 is offered if the trip be made in a British-built machine, and the start is from British soil. Captain Hugo Sunstedt entered for the $50,000 on February 14. Since that time the three English entries have been made, according to a cablegram to the United States Aero Club. In addition to Sunstedt, who is experimenting with a powerful aeroplane at Bayonne, New Jersey, those who are contemplating essaying the flight from the American side are Brigadier-general Kenly, chief of aeronautics of the United States Army, and Commander Towers, of the United States Navy. Navy arrangements provide that the course shall be patrolled by destroyers. Sunstedt, the independent, claims that he can fly from New York to St. John's, Newfoundland, and after replenishing his fuel tank make the jump from Newfoundland to Ireland, or possibly the English coast, in 21 hours. He has deposited his $500 forfeit in entering for the 'Daily Mail' prize. According to the terms of the contract, entrants cannot make the flight until 14 days after filing the entry. In that time they must allow a thorough inspection of their machine by Aero Club officials. Sunstedt, it has been stated, might possibly sacrifice the prize money rather than wait 14 days before making the attempt. Canada has developed some remarkable aviators in the war service, and Lieutenant-Colonel William O. Bishop, the Canadian ace of aces, is now contemplating a trip from Newfoundland to Ireland…"

The Colonist, **April 19th 1919**

126

"…To the man who makes the first flight will come riches as well as fame. More than $125,000 in prizes have already been offered, and more than half are without restriction. The great handicap is the lack of knowledge concerning the air roads. What kind of weather prevails at various altitudes? What is the direction and force of the air currents? But men like Captain Sunstedt brush aside all such suggestions. 'The time has come to make a trial,' they say. 'We will Succeed.'"

***Popular Science Monthly,* April 1919**

<u>Left</u>: *Captain Hugo Sunstedt* (1886-1966). Sundstedt, a Swedish national, was the second person in *Sweden* to fly and the first to receive a flying certificate issued in Sweden.

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Upon his return to *Washington D.C.*, Westervelt found that a *Trans-Atlantic Flight Planning Committee* had been set up within the Navy. He lost no time in submitting a detailed recommendation. His 5K-word report expressed the need for government backing and said: *"The first accomplishment of this feat will give to the organization of the government achieving it a considerable amount of deserved prestige."* He outlined the most logical route and the best time of year. His proposal included "stake boats" at l00-mile intervals along the path to serve as navigational aids, weather stations and points of replenishment or rescue in case something went wrong. He explored the possibility of using oil from a destroyer to smooth the waters of a possible emergency landing area. His plan was complete down to the thermos bottles, refreshments and sleeping bags for the crews.

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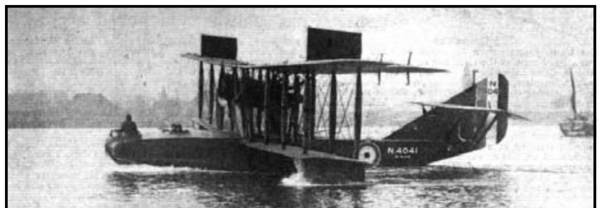
"As it seems probable that Great Britain will make every effort to attain the same relative standing in aerial strength as she has in naval strength, the prestige that she would attain by successfully carrying out the first trans-Atlantic flight would be of great assistance to her…In view of the fact that the first successful airplane was produced in this country and that the United States developed the first seaplane, it would seem most fitting that the first trans-Atlantic flight should be carried out upon the initiative of the United States Navy…It is believed that the prestige obtained by the United States Navy in thus initiating and making possible a great international flight of this nature will equal or exceed that obtained by attempting the flight alone and all chance of international jealousies will be avoided"

RE: excerpt from *Trans-Atlantic Flight Planning Committee* report. The committee also concluded that, since the flight involved the use of *St. John's, Newfoundland* - a British colonial port, and that *Great Britain* was also contemplating a similar expedition at about the same time of year and from the same place, an awkward situation might develop unless there were to be mutual cooperation in the utilization of patrols, ships and facilities. Furthermore, the governments of *France* and *Italy* should also be invited to participate.

129

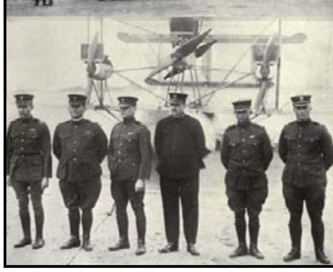


"…Messrs. Boulton and Paul of Norwich have officially entered a second machine for the Daily Mail Transatlantic flight, in continuance of their policy to take every possible precaution to ensure against failure, and it will be in readiness to take up the flight in event of any breakdown or accident to 'Boulton-Paul First.' Both machines will be shipped together for the start from Newfoundland, and if only the one is required to make the flight the other may go on a tour of Canada or America. The names of pilots and crew of both machines will probably be announced shortly. This second entry is exactly the same type of machine as Messrs. Boulton and Paul entered some weeks ago, i.e., a twin-engined biplane - fitted with 'Napier Aero' engines. The R.A.F. flying-boat is to start from Cape Broyle Harbour about 30 miles south of St. John's…"

***FLIGHT magazine,* May 15th 1919**

<u>Above</u>: RAF flying boat

130



Work on *Long Island* progressed at a feverish pace. Since the NC boat cruised at about seventy-five miles per hour, the 1,300-mile hop from *Newfoundland* to the *Azores* would have to be at night in order to arrive during daytime. A target date in May was set, when the ice would be broken up and the period of darkness not too long. There would also be a full moon. Trials on the NC-l had resulted in many changes. A four-engine configuration had worked so well-on the NC-2 that the concept was adapted for the other planes. The cockpit was moved from the center engine-nacelle to the hull. The NC-3 and NC-4 were far from complete, so the Navy-Curtiss team began to work past midnight every day of the week. Invitations to the Allies to participate were handled through the *State Department*. The same channels secured permits for the use of the Canadian, Portuguese and British ports. All personnel had to be selected not only for the seaplanes but also for the handling crews on base ships. Voluminous lists of necessary materials were drawn up, some for equipment not yet in existence. The largest problem was that of the ships.

<u>Top</u>: NC-3 at Rockaway NAS

<u>Bottom</u>: crew of NC-3 (Cmdr. J.H. Towers at far left)

131

Guiding Fingers of Light

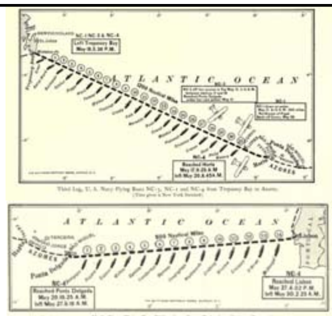
132

"…The Americans have 27 destroyers stationed between Newfoundland and the Azores, and five battleships, five cruisers, and two tankers between the Azores and Portugal…"
FLIGHT **magazine, May 1919**

133

"…When Kipling wrote his 'Night Mail,' little did he realize that his idea of using searchlights to guide the nocturnal flyer would be practically applied in the transatlantic flight of the American seaplanes. Each one of the destroyers stationed in the path of flight to guide the argonauts of the air became a visible beacon at night. For miles and miles the long, rigid fingers of searchlights pointed high in the air to guide the men in the planes. But the searchlights served not only as mile-posts to indicate the course. They were also used to indicate the true direction of the wind. Every scientific precaution was taken to help the men in the air. Since searchlights cannot penetrate a fog, the commanders of the destroyers received instructions to fire star-shells above the fog. Flares with a candle-power of several hundred power each were also used in emergencies…"
Popular Science, **July 1919**

134



"Base ships had to be selected that could meet requirements, be fitted with gasoline tanks and special equipment. The destroyers had to have special radio installations, star shells and meteorological apparatus. The number of dreadnaughts was astonishing. Our final plan called for a ship every 50 miles, and there were approximately 4,000 miles to be covered."
Cmdr. J.H. Towers**, USN**

135

"…It was one of these machines that, in November last, carried 45 passengers in addition to a crew of five at Rockaway, N.Y., and also flew from New York to Washington with a crew of five and ten passengers…"
FLIGHT magazine, **May 1919**
RE: late in March 1919, a violent storm caught the NC-1 at anchor. Dragged from her moorings, she was battered against the beach for three days. Her hull was damaged and her lower left wing shattered, and so were the hopes of a four-boat flight. It was decided to use the NC-2 for experiments until the latest possible date, then shift one of her wings to the NC-l, which would meanwhile be repaired and converted to a configuration similar to the NC-3 and NC-4. The near-wrecking of the NC-1 served a good purpose. Inspection of the damage revealed that the pilots' dual control column had torn loose and the critical wing and tail surfaces were flapping freely. Installation had been faulty. In retrospect, the record flight on which the NC-1 carried fifty men into the air could easily have been the world's first great air catastrophe.
Above: front view of NC-3 at Rockaway NAS

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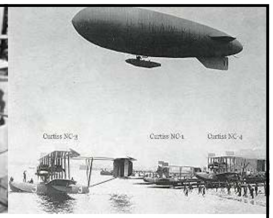
Eastward Ho!

137

"…The United States dirigible, C-5, has been detailed to accompany the flying-boats, and she is to leave her station at Montank Point, Long Island, at the first opportunity. She will make her headquarters in Newfoundland at Quidi Vidi, near St. John's, the Martinsyde ground. The C-5 is of the Blimp type with an envelope 200 ft. long, and her 40-ft. car carries two motors, which give her a speed of 55 miles an hour…"
FLIGHT **magazine, May 15th 1919**

138

"…The three heavily loaded planes under Comdr. John H. Towers (an admiral in WWII) went into the surf at Rockaway Beach at 10 a.m. on May 8, 1919. The public had given up on the oft-postponed flight, so there were few spectators as the cumbersome craft taxied into Jamaica Bay and took off. They climbed slowly to 500 feet and set course for the northeast. One of the planes left behind a crewman who had lost his hand to a turning propeller the day before…"

Popular Science, **May 1964**

<u>Left</u>: the fleet of three NC flying boats begin their historic journey

<u>Right</u>: from left-to-right, NC-3, NC-1 and NC-4 enter the surf from their base at Rockaway NAS with Navy "Blimp" C-5 overhead; May 8th 1919

139

140

First Leg

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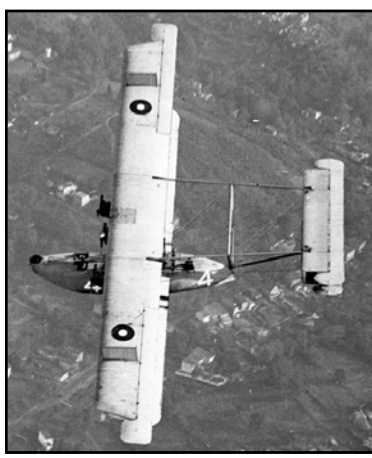
142

"…Towers' NC-1 and NC-3 made it to their first stop, Halifax, Nova Scotia, without incident. But the Nc-4 ran into a string of bad luck. Its skipper, Lt. Cmdr. Albert C. (Putty) Read wrote in his log: 'Sun came out…weather clearing.' Then everything went wrong – his after-center engine sent up a shower of steam and water. Then it tossed a connecting rod into the sea. The plane began to drop. Lt. Jim Reese shouted to Putty Read: Commander, we're jinxed!' As they ditched on the choppy sea, two big waves shook up the drenched plane and men, but the spruce hull held up. Read managed to start up two good engines and taxied to the naval Air Station at Chatham, Mass., on Cape Cod. He lost precious time scrounging a new engine to replace the ruined pusher. Breese installed it, but a storm held them in Chatham for four days…"

Popular Science, **May 1964**

143

<u>Above</u>: crew of NC-4. Lt. Reese is third from right and Lt. Cmdr. Read is second from right




<u>Above & Left</u>: NC-4

144

Second Leg

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146

"…Everyone counted read out of the race, while his sister planes continued to Trepassey, Newfoundland. But Read surprised the world, and flew into Trepassey just as the others were ready to take off for the Azores. The two planes, overloaded, couldn't make it, but next day all three struggled aloft…"
Popular Science, **May 1964**
Above: NC-4 as photographed from another NC flying boat
Left T&B: NC-4 near shore

147

"…Three of the American flying-boats, NC-1, NC-3, and NC-4 left Rockaway, N.Y., on May 8, and the first two reached Halifax safely. The NC-4, however, had to descend, off the coast of Maine, owing to engine trouble. The NC-1 and NC-3 flew to Trepassey Bay, Newfoundland, on Saturday. It is stated that the engines of NC-1 were so hot she could not have flown another hundred miles, while the NC-3 had to return to Halifax owing to trouble with a propeller, but she made the journey later…"
Flight **magazine, May 15th 1919**

148

"…Not one of the machines that earned transatlantic glory in 1919 was specifically designed for the purpose of flying over the ocean…Six hundred miles is the maximum range for which both the British machines and the American NC planes were designed. Much of the elaborate preparation for the flight can be explained by the provision that had to be made for carrying extraordinary loads of fuel for a voyage far exceeding in length that for which any machine built today is really designed…"
Popular Science Monthly, **July 1919**

149

The Three NC Boats in the Bay of Trepassey

Departures and Arrivals of the Navy-Curtiss Flying Boats, on the Trans-Atlantic Flight, May 8 to May 31, 1919

Far Rockaway, New York, to Trepassey Bay, Newfoundland

	NC-1	NC-3	NC-4
May 8, 1919			
Took off, Far Rockaway	10.04 A.M.	10.02 A.M.	10.03 A.M.
Passed Chatham Light	1.47 P.M.	1.47 P.M.	1.47 P.M.
May 9, 1919			
Passed No. 1	......	......	......
Passed No. 2	3.10 P.M.	3.10 P.M.	......
Passed Cape Sable	5.10 P.M.	5.10 P.M.	......
Arrived, Halifax	7.10 P.M.	7.00 P.M.	......
May 10, 1919			
Took off, Halifax	7.47 A.M.	11.40 A.M.	......
Arrived, Trepassey	2.45 P.M.	6.30 P.M.	......
May 14, 1919			
Took off, Chatham	......	......	9.25 A.M.
Arrived, Halifax	......	......	1.13 P.M.
May 15, 1919			
Took off, Halifax	......	......	9.52 A.M.
Arrived, Trepassey	......	......	5.37 P.M.

Distance: 1,000 nautical miles.
Flying Time: 14 hours, 13 minutes (NC-4).

150

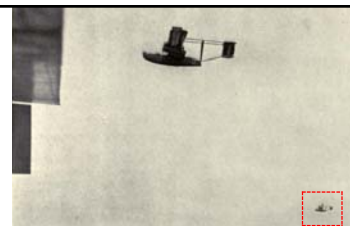
Third Leg

151

152

Deadliest Peril

153



"…Lt. Cmdr. Patrick N.L. Bellinger in the NC-3 had only 10 feet of altitude over miles of iceberg-filled ocean. Later his plane was spotted by a destroyer. Darkness closed in on the lumbering skyboats. Clouds, fog, and turbulent air added to the peril of the flight. Towers plane was in the lead, but the others couldn't see him because his tail lights were broken. When the clouds departed, Towers saw the NC-4 500 feet below and 100 feet ahead. He climbed to avoid her. Then he looked up and saw the NC-3 coming right at him. He could do nothing but shiver as it whizzed by 50 feet above…"

***Popular Science,* May 1964**

154

Above: NC-3 (left-center) and NC-1 (lower right) in flight as seen from NC-4

"…Ten days after they took off from New York, the flying boats were two-thirds of the way to the Azores. Then Bellinger's NC-3 ran into fog so thick it hid his panel board. He dived to find a clear spot, but couldn't and had to ditch. The crew bailed desperately to keep afloat. Marc Mitscher (later WWII Navy hero), got violently sick before the radioless freighter Ionia happened on the scene and picked them up. The wreckage of the plane sank…"

155

***Popular Science,* May 1964**

"…The flight has also taught us the vital importance of maintaining radio communication under all conditions. The commander of the NC-3 had left his ground set ashore. He paid dearly for that. After he had alighted he became dumb, wirelessly speaking. He was able to send messages only in the air with a trailing antenna. Although half a dozen destroyers were near enough to help him, his seaplane was as hard to see on the ocean as a speck of dust on a plate-glass window. Eyes and ears are appallingly limited in range. Only radio communication makes it possible to protect a transatlantic flying boat in distress. To lay a true course for the small islands in the Azores in mid-ocean is at best a navigation problem of no mean order. But to lay that course through the air in a fog requires all the aid that can be given by modern radio apparatus…"

***Popular Science Monthly,* July 1919**

156

"…Towers' NC-1 also ditched at sea, taxied 205 miles to the Azores, but its flying days were over…"

Popular Science, **May 1964**

RE: NC-1 was off course in fog and went down in a twelve-foot sea that damaged her hull, struts and control connections. One of the floats was ripped off a wing tip. A crewman had to sit on the wing to balance the missing float. They fixed their position at about twenty-five miles southwest of *Horta*. Drifting with the wind they thought would bring them to *San Miguel*. Rescue was improbable thus the NC-1 had to save herself. After sailing fifty-two hours on a 205 mile journey over open seas, they calculated that they could make *Ponta Delgada* in two hours. Land was sighted and the *USS Harding* offered to help but was refused by Cmdr. Towers. NC-1 would enter harbor unassisted.

157

"…By using the wings for sails, the pilot of a disabled flying boat can sometimes steer for a distant point of land. When one wing is dragged and the other lifted, the craft veers from the direct line in which the wind is blowing it, taking a tack toward the side of the lower wing. The most famous case of this occurred in 1919 when the NC-1, in a transatlantic attempt, landed with a broken engine nearly a hundred miles from the Azores Islands. Commander Towers, in charge of the flying boat, began sailing for the islands, steering a diagonal course by means of tilted wings. Three days later, they floated safely into the harbor of Ponta Delgada…"

Popular Science Monthly, **December 1931**

158

"…The navigators of the NC flying boats knew that fog is the aviator's deadliest peril. It may be questioned, however, whether they were quite prepared for the peculiar variety of extensive, obstinate, high-sea fog, combined with a heavy sea, that proved the undoing of two of the planes on the way to the Azores. It is the old, old story, but it is told with a new thrill. The pilot of the NC-4, suddenly deprived of all his subconscious visible indications of horizontal direction, became confused. The semi-circular canals of the middle ear (the spirit level in our heads) tells us whether or not we are on an even keel. Yet, for some curious psychological reason, he could not tell his vessel was banked – in other words, tilted sidewise so that it tended to run around in a circle. In a fog a flyer's sense of direction and sense of verticality are so far destroyed that he cannot tell at what angle the machine is banked. He guesses at the angle. The compass is supposed to indicate direction; but when the needle wanders navigation is demoralized. If a machine executes one flying maneuver unbidden and unperceived, it may execute any other equally unbidden, even a nose dive. It was the appearance of the sun through the clouds that saved the NC-4 from running around in narrow circles. Clearly, it is unsafe to cross the ocean in an airplane without the aid of some positive indicator of horizontal direction, some instrument which, unlike the labyrinth of the ear, is not affected by centrifugal force if a mist obscures the sea. Such an instrument is Sperry's gyroscopic level-indicator…"

Popular Science Monthly, **July 1919**

159

TREPASSEY BAY, NEWFOUNDLAND, TO HORTA, FAYAL ISLAND, THE AZORES

MAY 16-17, 1919

	NC-1	NC-3	NC-4
Took off, Trepassey	6.09 P. M.	6.06 P. M.	6.07 P. M.
Out of sight	6.20 P. M.	6.20 P. M.	6.20 P. M.
Passed No. 1	.....	.....	.....
Passed No. 2	7.35 P. M.	7.35 P. M.	7.35 P. M.
Passed No. 3	8.03 P. M.	.....	.....
Passed No. 4	.....	.....	.....
Passed No. 5	.....	.....	.....
Passed No. 6	10.05 P. M.	10.05 P. M.	10.05 P. M.
Passed No. 7	.....	10.58 P. M.	.....
Passed No. 8	.....	.....	11.29 P. M.
Passed No. 9	.....	12.10 A. M.	.....
Passed No. 10	.....	.....	.....
Passed No. 11	.....	.....	1.50 A. M.
Passed No. 12	.....	.....	.....
Passed No. 13	3.13 A. M.	2.23 A. M.	.....
Passed No. 14	.....	.....	[illegible]
Passed No. 15	.....	.....	.....
Passed No. 16	5.17 A. M.	.....	4.30 A. M.
Passed No. 17	.....	5.15 A. M.	.....
Passed No. 18	6.14 A. M.	.....	5.45 A. M.
Passed No. 19	.....	.....	6.14 A. M.
Passed No. 20	8.10 A. M.	.....	.....
Sighted land	.....	.....	7.35 A. M.
Passed No. 21	.....	.....	.....
Passed No. 22	.....	.....	8.10 A. M.
Arrived Horta	.....	.....	9.25 A. M.

Distance: 1,200 nautical miles.
Flying Time: 15 hours, 18 minutes.

HORTA, FAYAL ISLAND, THE AZORES, TO PONTA DELGADA, SAN MIGUEL ISLAND, THE AZORES

MAY 20, 1919

	NC-4
Took off, Horta	8.40 A. M.
Arrived, Ponta Delgada	10.24 A. M.

Distance: 150 nautical miles.
Flying Time: 1 hour, 44 minutes.

160

Fourth Leg

161

Fourth Leg, U. S. Navy Flying Boat NC-4 from Horta to Ponta Delgada, Azores

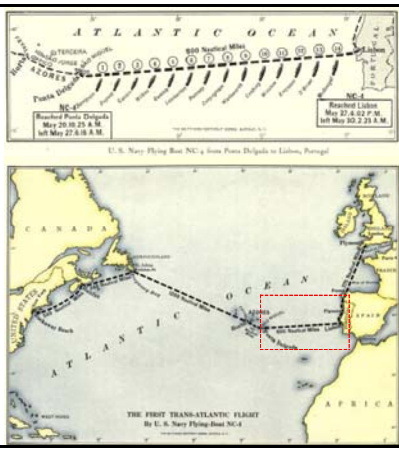
162

Above: caption: "The NC-4 taxiing to her moorings, Ponta Delgada Harbor, Azores"

163

Fifth Leg

164

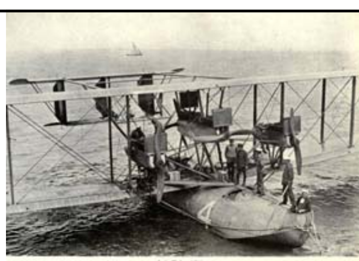


165

"…The NC-4 was the squadron's last hope to beat the British. Read came through: His plane landed at Horta in the Azores. While he waited to take off from Portugal, a British team crashed 1,100 miles out from Newfoundland. Others were about to attempt the crossing. But on May 27, the NC-4 splashed down off Lisbon, 19 days from New York, to complete the first Atlantic air crossing. The flight marked the first use in aviation of the radio compass, air-to-ground, air-to-air and intercom radio systems, the bubble sextant, the wind-and-drift indicator, and the Great Circle air route to Europe. In 1954, Breese flew the Atlantic again. He was asked by a stewardess if it was his first ocean hop. 'No,' he said, 'I flew across once before – 35 years ago.'"

***Popular Science*, May 1964**

166



Ponta Delgada, San Miguel Island, the Azores to Lisbon, Portugal

May 27, 1919

	NC-4
Took off, Ponta Delgada, Azores	6.18 A.M.
Passed No. 1	7.13 A.M.
Passed No. 2	7.38 A.M.
Passed No. 3	———
Passed No. 4	8.54 A.M.
Passed No. 5	9.33 A.M.
Passed No. 6	10.05 A.M.
Passed No. 7	10.40 A.M.
Passed No. 8	11.16 A.M.
Passed No. 9	12.18 P.M.
Passed No. 10	———
Passed No. 11	1.10 P.M.
Passed No. 12	2.04 P.M.
Passed No. 13	2.38 P.M.
Passed No. 14	3.16 P.M.
Arrived Lisbon	4.01 P.M.

Distance: 800 nautical miles.
Flying time: 9 hours, 43 minutes.

167

The NC-4 left *Horta* in the *Azores* on May 27th 1919 at 6:18 AM. She flew eight-hundred nautical miles in nine hours and forty-three minutes reaching *Lisbon, Portugal* at 4:01 PM on May 27th 1919.

Top Left: NC-4 taking on fuel at Lisbon

Top Right: NC-4 prepares to leave Lisbon en-route to *Plymouth, England*

Left: newspaper headline

168

169

Hail the Conquering Heroes

170

There remained one more "Leg" - a flight to *Plymouth, England*. There, on May 31st 1919, after a flight of 3,936 nautical miles, the crew of NC-4 were welcomed as conquering heroes by the populace for their great achievement. The world was starting to get a little smaller.

171

Top Left: NC-4 arrives at *Plymouth, England*
Top Right: the crew of NC-4 get a well-deserved heroes welcome while driven through the streets of Plymouth
Left: the Mayor of Plymouth (at center) congratulates the gallant crew of NC-4

172

Above: official ceremonies greeting the crew of NC-4 at Plymouth harbor
Left: Lt. Cmdr. A.C. Read, USN is carried on the shoulders of admiring soldiers and sailors upon his arrival at *Paddington* station, *London*, on June 1st 1919

173

Inscription: *"This tablet was erected by the Plymouth Borough Council to commemorate the arrival on the 31st day of May 1919, of the American Seaplane N.C. 4, in Plymouth Sound, on the completion of the first transatlantic flight, and the reception by the Mayor of Plymouth of the Commander, Pilots and Crew, on their landing at the Barbican."*

174


The Flight, by Lieut. Commander Albert C. Read, U.S.N.

175

"It is not merely by a poetic fiction that the daring men who vaulted into the air from Newfoundland to cross the Atlantic are likened to Columbus…the ocean air through which they traveled is as uncharted as was the ocean of water in Columbus' time. Meteorologically, it was a real voyage of discovery. The American Navy has reason to be proud of its transatlantic experiment. It was not imbued with the desire to win a rich sporting prize or disprove a proposition scientifically…"
Popular Science Monthly, **July 1919**
Left: crew of the NC-4 arrive in *New York* harbor aboard the *SS Zeppelin* escorted by smaller craft
Right: Naval officials (including FDR, second from right) greet the crew of NC-4

176

"…The American seaplanes were not prepared to fight head-winds. They were slow, heavy, cumbersome. Essentially winged sea-boats, they were not streamlined with that scientific care which is so much in evidence with fast fighting planes…The NC planes are merely large copies of the old Curtiss flying-boat. The engines are mounted outside of the hull – an objectional procedure because of the air resistance encountered. Aeronautical engineers are well aware of this, but they have been forced to continue the practice because the propellers must clear the waves…The NC type has proved itself decidedly too slow for transatlantic commercial flying. Its speed of sixty to seventy-five mph is not what we expect…"
Popular Science Monthly, **July 1919**
Left: NC-4 at the *National Naval Aviation Museum* in *Pensacola, Florida*

177

Part 3

Lessons Learned

178

"…So competent an authority as the late professor A. Lawrence Rotch predicted, long before our vastly improved flying-machines appeared, that it would be feasible to cross the Atlantic every day of the year in northern latitudes if the permanent western planetary winds that prevail above ten-thousand feet could be used…By skillfully selecting his level, Rotch argued, the transatlantic flyer may avoid head-winds; a sufficient number of more or less favorable following winds are always available at medium altitude. This theory of Rotch's, one of the pioneers, be it remembered, must be verified by systematic weather studies and by numerous transatlantic voyages by both airplanes and dirigibles. If the successful trips of many machines vindicate Professor Rotch, commercial transatlantic flying is a matter of but a few years…"
Popular Science Monthly, **July 1919**
Left: *Abbott Lawrence Rotch* (1861-1912)

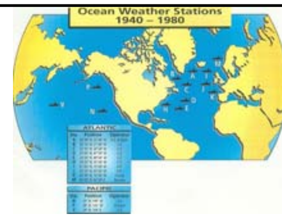
179

"…One great lesson was learned in the great American effort to cross the Atlantic. It is this: The art of flying is in advance of oceanic meteorology. If vessels of the NC type are to be employed for the crossing of the Atlantic – vessels lumbering and slow in comparison with the swift passenger-carrying transatlantic flyer of the future - we must be able to predict Atlantic weather twenty-four hours in advance…Before regular transatlantic flying becomes a reality, the United States and Europe must systematically explore the atmosphere over the ocean, just as the atmosphere over the land has been explored from the ground to a height of about twenty miles…"
Popular Science Monthly, **July 1919**

180

The idea of ocean weather stations goes back to the early days of radio communications and trans-oceanic aviation air service. It was customary to set up temporary stations for special purposes such as the *U.S. Navy* NC-4 trans-Atlantic flight in 1919 and the ill-fated *Amelia Earhart* flight over the *Pacific* in 1937. As early as 1921, the director of the Meteorological Service of *France* proposed establishing a ship stationed continuously in the *North Atlantic* for purposes of weather observations to benefit merchant shipping and the anticipated inauguration of trans-Atlantic air service. The loss of a Pan-American aircraft in 1938 due to weather while on a trans-Pacific flight prompted the *Coast Guard* and *Weather Bureau,* in 1939, to begin tests of upper air observations using instrumented balloons from Coast Guard cutters of the *International Ice Patrol*. The success of these tests resulted in a recommendation by *Commander E. H. Smith* of the *International Ice Patrol* to establish a network of ships in the *Atlantic Ocean*. The advent of WWII brought about a dramatic increase in trans-Atlantic air navigation. Wartime radio blackouts ended what little weather information was available from ships at sea. The transoceanic airlines, chiefly PAA, supported by the *U.S. Weather Bureau* strongly advocated weather reporting ships. In January of 1940, President Roosevelt directed the establishment of the *Atlantic Weather Observation Service* using Coast Guard cutters of the 327-ft "Secretary-class" and Weather Bureau observers. Announcement of this service and descriptions of the ships were given to the belligerent nations. Most flights at this time were using southern routes and the stations selected were on the tracks from the U.S. to the *Azores*. With the U.S. entering the war, in 1942 the 327-ft Coast Guard cutters were withdrawn from weather patrol and diverted to anti-submarine duties. Replacements were five old WWI cargo ships, 247-ft, obsolete and scarcely able to make ten-knots speed. These ships lasted barely a year, and one; the *Muskeget*, was torpedoed while on Station I, about 400 miles south of the *Grand Banks*. Early in 1945, the demand for more stations grew as they demonstrated their usefulness to the burgeoning trans-Atlantic air traffic. By May, there were a total of sixteen stations in the North Atlantic and nine in the *South Atlantic* A total of twenty-six frigates were now assigned. This was the peak number of stations and ships either before or since. At war's end, weather ship operations were maintained to support the huge demobilization program, but weather ships themselves were subject to the same reduction pressures and cutbacks were effected throughout 1946. In March 1946, the Atlantic stations had been reduced to eight U.S. and one British. By year's end, all frigates were taken out of service, the number of U.S. stations occupied varied from one to four depending on the availability of older cutters. The British withdrew entirely.

181



A typical weather patrol was twenty-one days on-station plus en-route time and about ten days in port. Four or five *U.S. Weather Bureau* observers joined the *Coast Guard* crews during each voyage. A "station" was a 210-mile grid of ten-mile squares each with alphabetic designations. The center square, which the ship usually occupied, was "OS" (for "on-station"). A radio beacon transmitted the call sign of the station and the square in which the ship was located. Over-flying aircraft would check in with the ship and receive its position, course and speed by radar tracking, and weather data. Surface weather observations were made and transmitted every three hours and upper winds every six hours by radar tracked balloons with a known ascension rate. Using "Radio Sonde" transmitters and radar tracking, air temperature, humidity, pressure, wind direction and speed were obtained every twelve hours to elevations up to 50K-feet. By 1974 the U.S. operation was reduced to three *Atlantic* and one *Pacific* station and that year the *Coast Guard* announced the termination of the U.S. stations. At the end of 1975, only station "H" remained and the last ship on that station was replaced by a newly developed buoy in 1976. European stations and the Canadian station "P" continued for a short time after, but by the end of the decade they too were discontinued. The international program ended when the Dutch ship *Cumulus* departed station "M" in 1981. *Norway* continued to operate station M unilaterally and on a part time basis until 1999 when that station was finally terminated.

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Radio Sonde

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"…the steamship company, of which the air line is a subsidiary, American Export Lines, is already at work, in cooperation with the U.S. Weather Bureau, making daily observations of weather conditions over the sea…The weather apparatus which the steamship company has installed on its three ships plying between new York and Lisbon is similar to that used at land stations of the Weather Bureau, and by the Navy, to study air conditions in the upper levels. Its installation, however, marks the first time that such observations have been available to the Weather Bureau from ships at sea on a daily basis. The equipment itself is supplied by the Weather Bureau, but the air line supplies the meteorologists who use it…."

***Popular Science,* November 1941**

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"…The most important piece of this equipment is known as a radio 'sonde' or sounding machine. Actually, it is an accurate weather observatory and radio transmitter combined, which weighs only two pounds. In use, this device is first placed in a conditioning chamber on the bridge of the ship, where it is tested to see that it is functioning properly, and calibrated so that its recordings of upper atmospheric conditions will be in proper relation to conditions at sea level. Then it is attached by a cord to the bottom of a helium-inflated rubber balloon, five feet in diameter and six feet high. Balloon and sonde are then released. As the balloon rises, the transmitter, powered by a dry-cell battery and connected to three recording devices within the unit, sends out a steady stream of signals on a wave length of 72.5 megacycles. These signals are picked up by a receiver on the ship, which automatically records the information on a graph. The signals continue to reach the ship until the balloon has risen so high or has drifted so far laterally that they become too weak for the receiver to pick up. Recordings have been made successfully from as high up as 68,000 feet, and over distances of 75 miles. In ordinary practice, however, 60,000 feet is about the maximum effective range of the sonde, while the lateral distance is controlled by atmospheric conditions. It may take an hour for the sonde to reach the point where its signals fade out…"

***Popular Science,* November 1941**

185

"…The instruments within the sonde measure temperature, humidity, and height. For the first condition, a thermocouple is used. This is a device consisting of strips of two different kinds of metal, fastened together in such a way that temperature changes set up slight electrical currents between them. The currents generated by the thermocouple control one set of signals. Human hair, preferably from the head of a blond female, is used to measure humidity. This type of hair has been found to be more responsive than any other kind. When the humidity increases, the length of the hair increases; when the air becomes drier, it contracts. This expansion and contraction controls another set of signals…"

***Popular Science,* November 1941**

<u>Left</u>: period advertisement for *Dewey Meteorological Balloons* launched from a ship at sea

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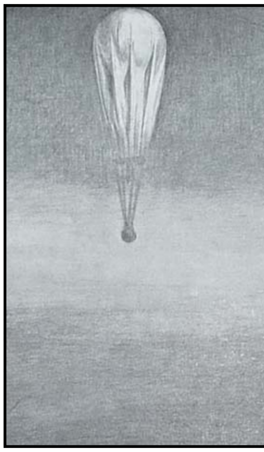

"…The third instrument is a barometer. This measures atmospheric pressure by expansion and contraction of hollow metal wafers inside of which a vacuum has been created to make them more responsive to pressure changes. Since atmospheric pressure is directly related to height, becoming less the higher you go, a third set of signals controlled by the barometer, interspersed with the others, tells at what height each set of recordings was made. When the last of the soundings has been received, the meteorologist takes the information from the graph in the receiver and sends it by radio to the Weather Bureau, where it becomes available to anyone. This work, therefore, will aid ocean-flying planes of other lines as well as those of American Export Airlines…"

***Popular Science,* November 1941**

Left: radio sonde balloon in the stratosphere

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"…Radio sonde observations are at present made once a day from each of the ships at sea, usually about midnight. Then at noon each day, a 'pilot' balloon, three feet in diameter and carrying no instruments, is released. This is watched from the ship with a theodolite, an instrument for measuring horizontal and vertical angles, as it rises. From the observed angles the meteorologist can compute the wind direction and velocity at various levels. This information is also radioed to the Weather Bureau. When a radio sonde is used over land, a silk parachute is attached to it so that it can be recovered and used again. When used at sea, however, a complete instrument costing about $40 goes to the bottom as the price of each set of observations."

***Popular Science,* May 1941**

Left: a female meteorological officer adjusts her theodolite while an assistant awaits the order to release the pilot balloon she is holding (ca. 1942)

188

Radio Telephony

189

"…When we consider the mishaps that befell the NC-1, it is evident that without radio apparatus of fair range transatlantic journeys should not be undertaken. So efficient must the radio apparatus be that it can be used for reckoning latitude and longitude even though the machine may be compelled to float for hours, and even days, on the water. Since the Azores are likely to become of future aeronautical importance, they will surely become the site of a huge radio station, a veritable beacon of electromagnetic waves to guide transatlantic flyers as surely as a moth flies into a flame. At any moment, when the station is completed, the transatlantic aero-navigator may determine his location and then head for the Azores…"

***Popular Science Monthly,* July 1919**

190

"…Herbert Hoover, Jr., son of the nation's chief executive, is chief engineer of the Western Air Express radio service, and is directly in charge of comm-unications. For the past year he and his staff of radio-trained assistants have been at work conducting a series of experiments that have made radio and aviation history. As a result of his labors every plane of the Western Air Express is now eq-uipped with two-way radio telephones. The whereabouts of every airplane in the company's vast network of western air lines is known during every minute of their flights. Every pilot of the various lines, while in the air, is constantly within 'speaking distance' of his home airport, of weather stations, and of terminals, and intermediate fields. If anoth-er plane of the Western Air Express is ever forced down, every office of the entire system would know about it almost instantly. They would know almost the exact spot at which such a ship makes contact with the ground. Gone are the days of the 'needle-in-the-hay-stack-hunts' for aviators 'down in the rough,' as in the case of Maurice Graham, famous mail pilot…"

***Modern Mechanics,* June 1931**

191

"…Finding and rendering assistance to the radio telephone-equipped airplane is placed in the class with answering the 'S. 0. S.' call of an ocean ship, with her latitude and longitude known to the rescue ships. Radio telephony gives aviation an entirely new set of values for weather science. The danger of collision between airplanes in the air is virtually eliminated. Pilots are no longer forced to rely wholly upon their own judgment, and aerial passengers are given a new sense of security in the safety and reliability of modern air line service. A transport pilot has plenty to occupy his time and attention when in the air. Thus, out of necessity, conversations with the dispatcher are rendered in the simplest possible terms. The pilot, in reporting his position as 'L-9,' is using a code language developed for the purpose. The maps of the air routes are all divided up into squares, and these squares are designated in the manner of a city map. Alphabetic letters indicate distances on the map north and south, and the numbers represent distances east and west. Thus, when a pilot reports his position as 'K-4,' 'G-2.' 'B-14,' or whatever the designation may be, the location is as definite to the dispatcher as if the pilot were present, and pointing out a location on a map on the wall. The beacon lights are all designated by number, and flash their own identifications to pilots in the air. This gives a very definite location when a pilot reports in to say that he is five miles north of beacon 27…"

***Modern Mechanics,* June 1931**

Left: caption: "Sitting at his desk before a microphone, the operator can warn passenger or mail plane pilot of severe storms or direct landing operations. The above drawing shows the hookup with which signals are transmitted to and received from the pilot."

192

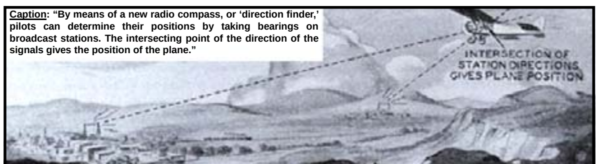
"…the radio used by Colonel Lindbergh on his recent aerial survey defied the aurora borealis, tropical storms, and electrical disturbances to interrupt its operation. Its power and range are almost uncanny, and its value in commercial overseas operations will be tremendous. Whether seadromes or mother ships are stationed across the Atlantic will make little difference. American craft will keep in touch with sea-level stations constantly…"
Popular Mechanics, **March 1934**

193

Radio Navigation

194

Caption: "By means of a new radio compass, or 'direction finder,' pilots can determine their positions by taking bearings on broadcast stations. The intersecting point of the direction of the signals gives the position of the plane."

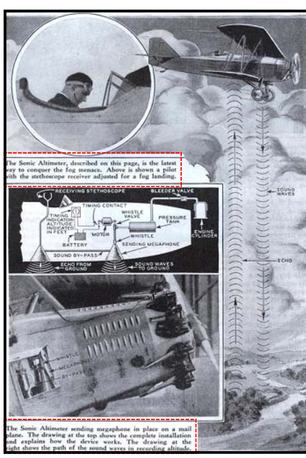


"…Radio compass and radio beacon experiments are now also going forward at the Alhambra airport. A radio beacon is already in operation to inform pilots when they're over the field, even during conditions of obscured visibility. Aviators approaching the field come within its sphere of influence twenty miles away. The beacon impulses are recorded by an instrument with an oscillating pendulum. These impulses become stronger as the field is approached, and turn on a colored light on the pilot's instrument board when the plane gets over the field. A radio compass has now been developed with which the pilot can take bearings on any station transmitting any kind of signals, either broadcast or code. By determining the directions of two or more broadcast stations, the pilot can chart out his own position, which will be at the point of intersection of the directions from which the signals come…"
Modern Mechanics, **June 1931**

195

Conquering the Fog Menace

196



Top: caption: "The Sonic Altimeter, described on this page, is the latest way to conquer the fog menace. Above is shown a pilot with the stethoscope receiver adjusted for a fog landing."
Bottom: caption: "The Sonic Altimeter sending megaphone in place on a mail plane. The drawing at the top shows the complete installation and explains how the device works. The drawing at the right shows the path of the sound waves in recording altitude."

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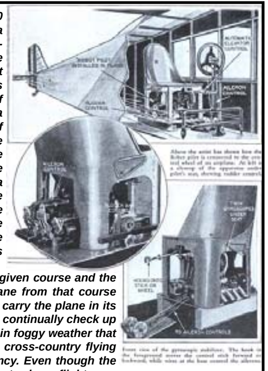
Metal Man

198



"A mechanical pilot, a small instrument weighing only 50 pounds and small enough to be stowed away under a chair, recently piloted a tri-motored airplane on a three-hour flight between Dayton and Washington far more accurately and with greater precision than the most accomplished human pilot. The gyroscopic stabilizer, as the metal pilot is called, employs the familiar principle of the gyroscope in its operation, in which the motion of a free-mounted, rapid spinning disk eliminates the action of gravity. One horizontal and one vertical gyroscope are used in combination in the mechanical pilot. If the airplane equipped with this device turns of its own volition to the right, the horizontal wheel immediately tends to assume a vertical position directly equal and opposite to the degree of the turn. The force thus set up is communicated to the rudder controls by means of electromagnets, and the plane brought back to its true course. In the same manner, if the nose of the plane tends to dip or rise, or if one wing starts to dip, the vertical gyroscope actuates the controls and keeps it on even keel…Once the plane has been set on a given course and the mechanical pilot set to guide it, nothing can turn the plane from that course provided the instrument is left alone. Wind, of course, will carry the plane in its own direction, and to counteract this the human pilot must continually check up on the ship's drift and make correction for it. It is not only in foggy weather that the gyroscopic stabilizer is of value. Even on clear days cross-country flying puts more or less strain on the pilot, reducing his efficiency. Even though the pilot's attention is divided among innumerable instruments, long flights are likely to be tedious at best. The gyroscopic control maintains an automatic watch over the three axes on which an airplane moves, freeing the pilot for the more important task of navigation. The gyroscopes of the automatic pilot revolve at a speed of 15,000 r.p.m. " ***Modern Mechanics*, February 1930**

199

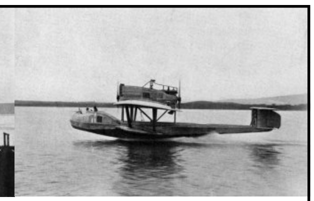
Transatlantic Flyer of the Future

200

"…What will be the aspect of the transatlantic flyer of the future? It must be an evolution of the fast fighting airplane if it is to depend on power and speed. Exactly what form it will take no man may safely predict. This much at least is certain: It will have a completely enclosed body or fuselage; it will have a speed of one hundred and fifty miles, possibly of two hundred miles, an hour…Since the machine must cross the ocean, it must also carry much fuel; but the carrying of a heavy load and the attainment of high speed are almost incompatible. An enormous lifting surface must be provided to raise the load, and much of this lifting surface is not only useless in the air, but decidedly detrimental because of the air resistance it offers…"

***Popular Science Monthly,* July 1919**

201



"…Since there must be the utmost economy of surface and power…the machine ought to be a monoplane of about one hundred feet span. Curiously enough, the late Count von Zeppelin, after devoting the last months of his life to the construction of a mammoth seaplane, also arrived at the conclusion that a monoplane is the correct type…"

***Popular Science Monthly,* July 1919**

Above: *Zeppelin* giant seaplane built at the *Potsdam* plant in 1917 at left, *Zeppelin-Dornier* twin (tandem) motored all metal commercial flying boat (1919), at right. Count von Zeppelin was working on his post-war plans for commercial aerial transport when he died in March 1917. His latest ships had demonstrated their worth as cargo carriers, not only in war but in peace. Before hostilities commenced, he had seen thousands of passengers carried in his lighter-than-air rigid airships (a.k.a. "Zeppelins").

202

"…Now, in any transatlantic flyer, speed is dependent particularly on perfect streamlining, which means that every projecting surface must be so designed that the air is parted with the least possible resistance…The narrow high fuselage of the Loening construction is a great advantage because the engines can be placed within the streamlined hull. Because the machine has but a single surface it encounters less resistance in its onward progress than a biplane. At the start of a flight with full load it is practically impossible to vary speed; but toward the end of the voyage the speed becomes more adjustable as fuel is consumed. Moreover, the flying angle can be reduced from that of the utmost efficiency for lifting to a flatter angle, which means still higher speed…"

***Popular Science Monthly,* July 1919**

203

"…inspired by the monoplane of Mr. Grover Cleveland Loening, probably the fastest that has thus far been designed and built. The Loening construction lends itself well for the purpose because it is so staunch, because it does away will fuel-wasting projections, and because it consumes little power for the speed attained…"

***Popular Science Monthly,* July 1919**

Above: Loening monoplanes were a daring innovation in their day, since the field of military aviation in 1918 was dominated almost entirely by biplane-minded pilots, engineers and procurement personnel. After forming his own company in 1918, G.C. Loening was asked to design a two-seat fighter that would out-perform the famous British "Bristol" fighter. The result was the M-8 (above), a strut-braced high-wing monoplane built around the new 300 hp *Hispano-Suiza* engine then going into production in the *United States* as the *Wright H-3*.

204

"…the flyer must be a flying-boat, for it is impossible to make a preliminary run at high speed on wheels in so large and heavy a machine…So long as the preliminary run is fast enough, the heavy load can be lifted. A way must be found to run or glide over liquid water as fast as possible. Much has been done in this direction by the hydroplane…"
Popular Science Monthly, **July 1919**

205

"…This solution is offered; Increase the hydroplane speed by reducing the long, wetted, adhesive hydroplane surface, and give that surface such a shape that the maximum lift is attained with the least drag. This becomes possible if the machine is able to rise clear of the water on one step in front – a step of correct design. Now, this small hydroplane area will lift the whole load only at very high speed, and very high speed cannot be attained until the whole weight is lifted. We seem to be running around in circles. The only solution is to make this same small surface lift exceedingly even at slow speed, while the hull of the flying-boat is still in the water and offering therefore much resistance to onward progress. This end can be attained by what the airplane designer calls a variable camber surface. By camber is meant the curvature. It is hard to change this camber in the wing of an airplane; in fact, it has not been successfully done, because the complex construction necessary makes the wing either too heavy or too flimsy. But in a hydroplane variation of camber becomes feasible. Remember that in the water steel can be used, something solid and thick; the construction can be simplified. A hydroplane with a variable surface would act like a kind of crow-bar, a long lever to lift the craft…"
Popular Science Monthly, **July 1919**

206

"…The hull of the flying-boat must be given a better streamline than is to be found in the hulls of the famous NC planes. And, above all, it must be possible to fold away the side floats or pontoons that support the outer wings…floats can be swung back into recesses in the wings and covered with sliding screens when the machine is in motion. With the slip-stream side control just described, they are required only when the craft is at rest on the water… The very size of the monoplane solves the propeller problem. The propellers can be mounted out on the wings…so solid and thick is a monoplane wing of the Loening type that there is ample strength and space for the propeller shaft mountings… "
Popular Science Monthly, **July 1919**

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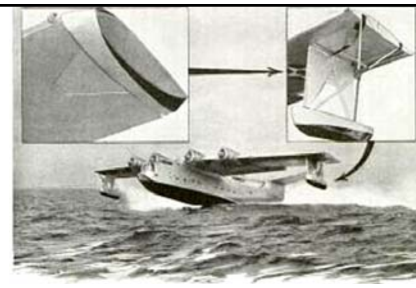


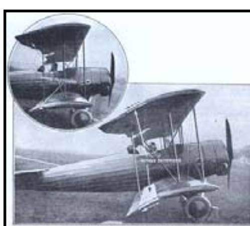
"To cut down their drag while in flight, the skiff-like floats of the giant 'XPB2Y-1' flying boat withdraw into the wing tips, and it takes just thirty seconds to raise or lower them. The torque-tubes of the retracting mechanism travel through 100 feet of wings from the power source and must turn 3,000 revolutions per minute. As the ship prepares to alight on the water, the lowered floats act as air brakes to slow the approach…"
Popular Mechanics, **1939**

208

Above: caption: "Insets show wing-tip floats in retracted and lowered positions"

Telescoping Wings

209



"One of the most difficult problems of flying - that of reducing the speed of a high powered airplane to a minimum without slowing down the engine - has been solved to some extent by a Frenchman, M. Bille, who has invented an airplane in which the wing surface can be mechanically increased, thus cutting down the speed of the machine. Early inventions for varying the size of wings in flight lacked wing rigidity necessary for safe flying. Bille's invention overcomes this handicap by means of two pairs of extension wings that telescope snugly into the main wings of the plane, so that they can be extended or taken in at will during flight. At a recent demonstration of the plane Maneyrol, the French record making aviator, flew 100 miles an hour, then slowed down to 35 miles, and finally to 12 miles, simply by extending the wings. This was done in six seconds."
Popular Science Monthly, **April 1923**

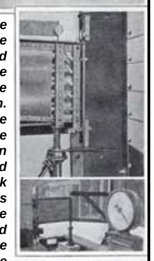
Above: caption: "To reduce speed in flight, the telescoping wings are extended, as shown above, increasing wind resistance. Inset shows the Bille plane with wings telescoped."

210

Metal Skinned

211

"Every day that passes sees more airplanes in which cloth and wood construction has been discarded and metal substituted. At first the metal was used in wing and fuselage truss construction only but recently metal sheets have found great favor as wing and fuselage covering. The German engineers were the first to take advantage of duralumin in air-plane design abroad and the Ford company the first to make extensive use of it in this country. The strength varies with the thickness of the sheets used. Additional strength is obtained by utilizing corrugated metal as the corrugations act as small trusses. As modern airplane design contemplates the skin carrying a considerable portion of the load, the strength of the sheet metal must be very accurately known. Furthermore as it is impossible to secure sheets of the size and shape of the airplane parts, the strength of all joints in the skin and the points of attachment of the skin to the framework is important. In certain modern planes as the Ford, Junker, Thomas Morse and Breguet every effort has been made to eliminate as much truss work in the wings and fuselage as possible. Thus the stresses and strains may be carried almost entirely by the skin. From the above the necessity for having strength tests made of metal sheets, their riveted or bolted joints and the points of attachments of sheets to plane members is apparent. The accompanying photograph shows a piece of corrugated sheet duralumin mounted in a form for strength test. The pressure from the jack is gradually increased until the metal loses its original shape and becomes distorted. The reading on the scales at that point of the test gives the sheer strength."
***Modern Mechanics,* March 1931**



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Testing

213

"…The first practical step toward the elimination of airplane bodies probably will be a sharp reduction in the size of the hulls of flying boats of the type used in transatlantic service, to reduce water resistance in taking off and drag in flight. Even if the engines were left in their present position, it would be possible to reduce the size of the hull by placing passenger accommodations in the wings of very large planes. Experiments pointing the way toward improvements in the design of seaplane hulls are being carried on in the N.A.C.A. 2,900-foot testing tank at Langley Field, in which large scale hull models are towed through the water at rates of speed up to eighty miles an hour…"
***Popular Science Monthly,* February 1940**

214

The hydrodynamic characteristics of a flying boat, such as the variation of drag with speed, depend in a complex way on the detailed configuration of the hull and have been the subject of much study and research. An extensive literature exists on the subject. The large body of experimental information available on the hydrodynamic design of flying-boat hulls has been accumulated with the use of a specialized type of experimental facility called a "towing basin," or "towing tank." Such a facility can be likened to a very long, narrow, indoor swimming pool. The test model is towed in the basin by means of a powered carriage, mounted on wheels, which is located above and across the channel of water. The model is connected to the carriage by struts that contain instrumentation for measuring the pressures, forces and moments of interest, as well as attitude and position of the model. Since the latter part of the *19th Century*, towing basins have been used in the design of surface ships. Although early hydrodynamic studies of flying boats were made with the use of such ship facilities, they were unsuited for that purpose because of the large differences in speed and size between surface ships and flying boats. In 1931, N.A.C.A. (*National Advisory Committee for Aeronautics,* established in 1915) put into operation at its *Langley Laboratory* a towing basin especially designed for the study of the hydrodynamic characteristics of seaplane hulls. This unique facility was 2,020-feet long, 24-feet wide and 12-feet deep. When filled it contained four million gallons of water. The test carriage was capable of attaining a speed of 60 mph. To keep pace with increases in seaplane performance, the capabilities of the basin were expanded in 1936; the length was increased to 2,920 feet and the carriage speed was increased to 80 mph. Another feature of the Langley basin was the provision of apparatus for producing artificial waves for use in the study of the rough-water characteristics of flying-boat hulls. The Langley towing basin was employed both for basic studies related to hull design and for tests of specific flying-boat designs. During its active life, no large flying boat was built in the *United States* without supporting tests in the Langley facility. The basin was operated by NACA/NASA from 1931 until the end of the era of large flying boat development (about 1960).

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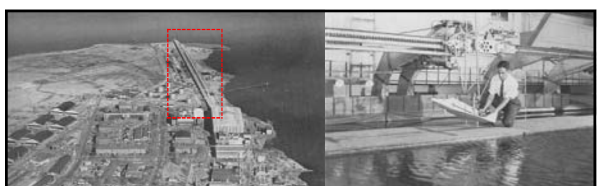

The NACA's original hydrodynamics research program had begun in "Tank No. 1" - a unique +2K-foot indoor seaplane towing basin on the shore of the *Back River* in the east area of the *Langley Research Laboratory* (left). This tank was designed in 1930 to test floats that were eventually used on several American seaplanes, including the *Sikorsky* twin-float "Amphibian, which set speed records in the 1930s. Data gained from work in this facility also contributed to the development of the famous Clipper flying boats. In the big water tank, the NACA studied the design characteristics of most American floatplanes and the performance of nearly all the early *U.S. Navy* flying boats that would be used for air-sea rescue, anti-submarine patrol and troop transport in WWII. In the enlarged version of the tank and in its 1,800-foot-long little brother; Tank No. 2 (built adjacent to it in 1942), Langley engineers discovered ways to ease the shock on a landplane when crash-landing or ditching in the water. Both tanks were equipped with an overhead electric carriage from which a dynamic model (right) could be suspended and towed at up to 80 mph, which was sufficient to make a model take off from the water and fly at scale speed. As the model was moving along the surface, researchers took motion pictures and recorded measurements demonstrating the aircraft's stability, controllability, water resistance, drag and spray characteristics. The tanks were equipped with catapult devices for the study of the free launched landing characteristics of airplanes and with mechanical wave-makers simulating takeoff and/or landing in rough water.

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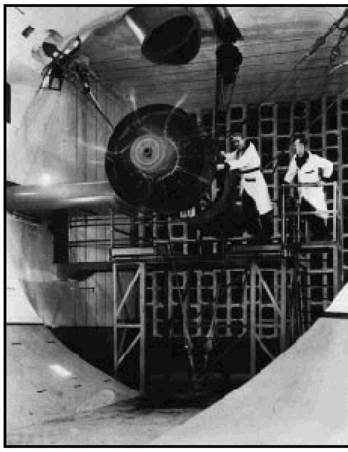

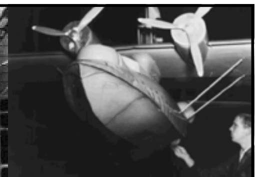

Above: model of a ***Consolidated PBY Catalina*** **flying-boat is prepared the for tests in the NACA Langley hydrodynamic facility**
Left: on May 8th 1942, the ***Wright R-2600 Cyclone*** **14-cylinder engine became the first test subject to be evaluated in the** ***Engine Propeller Research Building*** **at the NACA's** ***Aircraft Engine Research Laboratory***

217

"…These days no designer merely hopes that his new plane will fly. He knows that it will. Formulas, backed up by wind tunnel tests of models, give him an accurate idea of a plane's capabilities even before the raw materials are ordered. The latest wind tunnel test is to use a model equipped with an electrically driven propeller so that the actual effect of the slip stream may be measured. Another test is to fasten short pieces of string to the wings. When the strings begin to flutter in the wind tunnel, observers know that the stalling angle of the wing has been reached. Much of the success of the flying boats will depend on the hot-wire anemometer, a small piece of hot wire used instead of smoke to measure the flow of air around wind-tunnel models. The electrically heated wire, placed near some part of the model, loses temperature according to the speed of the wind that flows past it, and these temperature changes in turn affect the conductivity of the wire. This allows electrical fluctuations to be translated directly into terms that show the efficiency of the model's shape…"
Popular Mechanics, **December 1936**
Left: scale model of a jet airplane being tested in the Langley high-speed wind tunnel during the 1950s. The 16-foot diameter wind tunnel opened in 1941.

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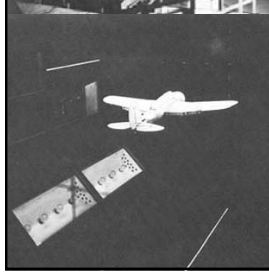
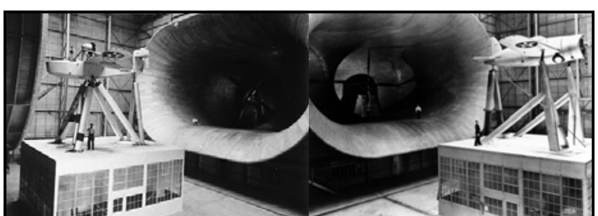
The aerodynamic drag of the large, bulky flying boat hulls equipped with steps and sharp chines tended to be higher than that of the fuselage of a well-streamlined landplane of comparable capability. In recognition of the need to reduce hull aerodynamic drag, both hydrodynamic and aerodynamic studies were made at Langley of hulls that were systematically varied in shape. From such studies, the hull for a given application that represented the best compromise between aerodynamic and hydrodynamic performance could be identified, or at least the direction to take in hull development was indicated. Much progress was made in the reduction of hull aerodynamic drag while at the same time, acceptable hydrodynamic characteristics were maintained. The high length-beam ratio hulls developed late in the era of the flying boat represented a large step in narrowing the gap between seaplane and landplane performance.

219



Top Left: a speed-flash photograph of a scale model of a seaplane flying in Langley's "Gust Tunnel" (April 1946)
Top Right: model of the ***Northrop XB-85*** **"flying wing" being tested in Langley's 20-foot "Spin Tunnel" (1948)**
Left: testing a 1/12th-scale model in Langley's 12-foot "Free-Flight Tunnel" (1940)

220



Above: on May 27th 1931, the world's first full-scale wind tunnel opened at ***Langley Field*** near ***Hampton, Virginia***. With a test area 60-feet wide and 30-feet high, aerodynamic testing was performed on everything from flying boats (left) to WWII fighters (right). In a massive building covering more than two acres, the wind tunnel used a pair of 35-foot propellers connected to 4K-horsepower electric motors. Air was sucked through large funnel-like structures that directed a smooth (a.k.a. "Laminar") flow of air past the staging area where airplanes, helicopters, jets, race cars and even a submarine were tested. During WWII, every American fighter aircraft was tested in the facility. Word spread about its engineering capabilities, adding to the prowess of the American military. The Langley wind tunnel remained the world's largest until 1944. The wind tunnel was critical in drag reduction, allowing engineers and designers to clean up an airplane aerodynamically, allowing it to fly faster while using less fuel. As aircraft speeds increased after WWII, there was a need for wind tunnels that could provide faster-moving air. The 30-by-60-foot facility at Langley was limited to about 125 mph.

221

Size Matters

222

"An interesting illustration of this super-stability idea may be observed in nature. The large ocean flying birds have a much heavier wing loading as compared to birds of similar size and weight that live on land. Because of their wing loading, ocean birds have an extraordinary ability to remain in the air for longer periods, even in stormy weather…"
Igor Sikorsky
RE: the weight of an airplane in flight is supported by its wings thus, a prime consideration in designing an aircraft is a factor called "wing loading." Wing loading can be determined by dividing gross weight by wing area. For example, an airplane with a gross weight of 100K pounds and a wing area of 5K square feet will have a wing loading of twenty pounds per square foot. A wing's efficiency depends largely on its shape and area; the smaller the wing the lower the air resistance thus efficiency is increased. Aside from aerodynamic improvements, higher wing loading increases stability in flight giving an airplane greater protection in rough air and/or stormy weather and decreasing motion sickness among passengers and crew on transoceanic flights.

223

"…only a few years ago the wing loading of transport planes was ten pounds per square foot or less. These transports behaved like bronchos in rough air, and many a passenger came down to earth with a vow of 'Never again!' The present Douglas DC-3 transports have a wing load of twenty-four and three-tenths pounds, which gives them remarkable stability in flight. The Douglas DC-2 had a wing loading of nineteen and four-tenths pounds. The new Douglas DC-4 will have a wing loading greater than twenty-five pounds when it goes into service before the end of 1937. Sikorsky, who has done much research in wing loading, foresees that it will soon be raised up to forty pounds per square foot. Tomorrow's fifty-five and 100-ton transports may be expected to be quite stable in stormy weather…"
***Popular Mechanics,* September 1937**

224

"In no craft are the drawbacks of small size so manifest as in aircraft. Flying in a disturbed atmosphere is never less severe than navigating an angry ocean. The altitude, the indescribable emptiness of the air, and the off-drift caused by the wind make it difficult to follow a set course. Yet an airplane must be humored in gusts even more than the trickiest sailboat. War demands, in addition, the most intricate observations; shells must be dodged, exact aim with bombs and machine guns taken, and rapid maneuvers carried out in aerial combat. Increase the size of the airplane and at one stroke seemingly insurmountable difficulties are overcome. Exacting duties may be divided among a more numerous crew. Strong celluloid windows protect the men from storm and cold; no hampering clothing or goggles are required; there is space to move about; numerous instruments and conveniences can be provided and handled at ease. Airmen have to thank the ocean for all these blessings. No mere cockle shell of an airplane can ride the waves as a naval airplane must. The old 'flying boat' had eventually not only to be vastly enlarged, but also completely decked over and turned into a true 'whaleback' to become at least really seaworthy. In its new extreme size and shape it promises to supersede that homely compromise, the 'seaplane,' a moderately enlarged airplane mounted on high stilts on a catamaran 'surfboat.' Not infrequently, these stilted boats were broken off by the waves through which they cut better than small flying boats…"
***Popular Science Monthly,* August 1917**

225

"…The smooth, shapely hull of the new flying yacht which Glenn Curtiss has built for our Navy, is one piece with the extremely strongly built planes like the auxiliary floats on the wing tips, and promises to defy the ocean successfully. The difficulty of making any large airplane strong enough, although partly overcome because the unobstructed sea is an ideal starting and landing surface, still lingers in a certain relative deficiency in carrying capacity. On the other hand, there is a most welcome improvement in equipment and comfort which permits, among other things. A liberal utilization of electric lights. Heavy loads, however, cannot be carried without materially cutting down the radius of action – loads such as heavy guns and ammunition. With motors of 400 aggregate horsepower, a span of 92 feet and a total weight of 7,000-8,000 pounds, this machine is expected to make from 55 to 85 miles an hour. So low a minimum speed is not objectionable on water. With only two men aboard, fuel for five hours might be carried. All rudders and controls are worked by electricity, and controlled most of the time, gyroscopically."
***Popular Science Monthly,* August 1917**
<u>Above</u>: *Curtiss H-12* under construction (left) and in-flight (right). The H-12 design of late 1916 was a significantly scaled-up version of earlier Curtiss "H-boat" designs.

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The Highball Express

227

"In the most complete and luxurious flying boat ever constructed, six nationally known American sportsmen, accompanied by four newspaper and movie men and a crew of three, will fly from New York to the Arctic circle next summer in an effort to establish an aeromarine line that will bring New York within 72 hours of the Arctic…The flying boat, for which the hull and cabin are now complete, will have a wing spread of 104 feet, and will be driven by two 400-horsepower Liberty engines. The entire machine will weigh 7.5 tons, and will attain a maximum speed of 100 miles an hour…Complete equipment, an electric range for cooking, convertible beds that change into chairs in the daytime, and an enclosed observation compartment at the nose of the machine will be just a few of the conveniences embodied in the boat…"
***Popular Science Monthly,* March 1923**
<u>Above</u>: *Aeromarine Airways* flying boat

228

In October 1920, a merger was concluded between *Aeromarine Sightseeing and Navigation Company*, one of the subsidiaries of *Aeromarine Plane and Motor Company*, and *Florida West Indies Airways, Inc.*, which had just won an airmail contract from the USPS for the *Key West* to *Havana* route. On November 1st 1920, the resulting company; *Aeromarine West Indies Airways*, began the first scheduled international passenger and air mail service in the *United States*, which was operated daily between Key West and Havana on a sixty minute flight schedule (versus over eight hours by boat). The aircraft used were converted USN *Curtiss F5L* flying boats. They had been modified for civilian usage and renamed "Model 75" by the Aeromarine Plane and Motor Company of *Keyport, New Jersey*. They featured luxurious accommodations for eleven passengers in two compartments and were manned by three crewmen - a pilot and mechanic/copilot in an open cockpit (above the enclosed cabin) and a bowman. Powered by two 420 hp "Liberty" engines, the 75's had a top speed of 85 mph and range of 340 miles. Fully loaded, they could also carry about three-hundred pounds of freight. The Aeromarine flying boats were advertised to the public as being the height of safety, because they carried their landing field with them and were operated by skilled ex-Navy pilots. During this first season of operations, Aeromarine West Indies Airways also began flying between *Miami* and *Bimini* in the *Bahamas*.

Left: *Aeromarine Airways* poster (ca. 1920)

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In the spring of 1921, *Aeromarine Airways* (company having been renamed after a management reorganization) moved north, and began to offer regular service during the summer months between *New York City, Atlantic City, Southampton* and additional destinations on *Long Island, Newport, Lake George* and other regional resort destinations. The following winter, it returned to *Florida* - expanding its service to *Palm Beach* and *Nassau*, in addition to *Havana, Key West, Miami* and *Bimini*, and became widely known as the "Highball Express" for taking "dry" wealthy Americans to the "wet" islands of the *Caribbean* during the *Prohibition* years (1919-1933). This south-in-winter and north-in-summer operation continued until late 1923, with a successful *Cleveland* to *Detroit* route added to the northern operations in July of 1922. At its peak, Aeromarine Airways operated eight of the Model 75's and at least twelve four to six passenger flying boats, known as Model 85's. The company was headquartered in the *Times Building* in *Times Square*, NYC and had its city operating base at the *Columbia Yacht Basin* on the *Hudson River*. It received generous private funding ($500K) from its Chairman *Inglis Moore Uppercu*, who was the exclusive distributor of *Cadillac* automobiles in the NYC area and enjoyed strong executive leadership under the guidance of *Charles Fraser Redden*.

Above: formal christening of the *Pinta* and the *Santa Maria*. The ceremony was held at the Columbia Yacht Club basin in late October 1920

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Above: *Aeromarine Airways* brochure (ca. 1921)

232

"…the one great commercial air transportation company now operating in the United States has not had a fatal accident to passengers on its flying boats in two years of flying history. In fact, one of the most encouraging signs that the day of profitable and reliable air lines – linking our cities with scheduled passenger, freight, and mail service – may not be far distant, is to be found in the report recently submitted to the Director of Naval Aviation by this company, owning the Aeromarine passenger planes. It operates a daily mail and passenger service between key West and Havana, Cuba, according to the report; also between Miami, Fla., and Bimini, and between Miami and Key West. Its fleet consists of eleven-passenger converted navy flying cruisers and six five-passenger flying boats. In addition to scheduled service, the company engages in special charter flights. The Aeromarine flying boats made 735 complete flights, the report points out, in the four months from November 15, 1921, to March 15,1922, with a record of 640 hours flown, 268,538 passenger miles. Of these flights, 171 were on the 100-mile Key West-Havana route, while the charter and miscellaneous flights totaled 359. During these flights, not a passenger nor employee was injured, and only five boats were forced to return to their bases. The schedules were maintained throughout, with the exception of these five flights, according to the report. In two years of operation, the report discloses, the company's flying boats in passenger service have flown a distance of more than 150,000 miles, and have carried 10,700 passengers, without a mishap."

Popular Science Monthly, July 1922

233

Before ceasing operations early in 1924, Aeromarine had carried over 30K passengers, flown well over a million passenger miles and hauled close to 100K pounds of freight, while only suffering one serious fatal accident (loss of the *Columbus* in January 1923 between *Key West* and *Havana*). In just over three years of operations, Aeromarine instituted many "airline procedures" including pilot training, maintenance programs, passenger services and seasonal rotation of equipment. Aeromarine also enjoyed many firsts:

- first U.S. international air mail service and first scheduled U.S. international passenger service;
- first total service U.S. airline (passenger, mail, express cargo);
- first in-flight movie (*Chicago*, August 1921);
- first airline baggage label (1921);
- first U.S. airline ticket office (*Cleveland*, July 1922)

Nevertheless, it was too early for a scheduled airline to be financially successful, especially without regular government subsidies for such a young industry. The modern airline transportation system with its worldwide connections, speed, and comfort is a direct successor of the pioneering efforts of *Aeromarine Airways*.

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The Daily Commuter

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"Flying from city to city, or from suburbs to the city and back, will be one of the most important developments of aviation in the near future. Aviation will greatly extend the urban areas of our cities. Already many men of means are using flying boats for 'commuting' between their waterside suburban homes and water-front cities. The first flying boat which I sold to a private customer was purchased by Harold F. McCormick, I think in 1914. Mr. McCormick used it for several years for his daily trip from his home in Lake Forest, Ill., to his office in the Harvester Building, landing and departing from the Chicago Yacht Club Basin in the heart of downtown Chicago."
Glenn H. Curtiss, **1927**
<u>Above</u>: private flying boat arrives offshore at the *Breakers Hotel*, *Cedar Point, OH* (ca. 1914)

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Par Avion

237

"…In 1928 Boeing began pioneering in the field of commercial aviation with the production of the B-l flying boat. This three-place job was constructed of spruce and ash framework with a two-ply cedar hull. Equipped with a 200 h.p. Hall-Scott, this flying boat had a top speed of approximately 95 m.p.h. It was with this boat that Edward Hubbard opened the nation's first privately contracted airmail service and the first international airmail service, between Seattle, Wash., and Victoria, B. C. By the time it was retired from active service, still airworthy, it had flown some 350,000 miles and had worn out six engines…"
Modern Mechanix, **March 1938**
<u>Above</u>: caption: "The Boeing B-1 flying boat, a pioneer mail carrier, was built in 1919. Still airworthy, it was retired from service after flying approximately 150,000 miles and wearing out six engines"

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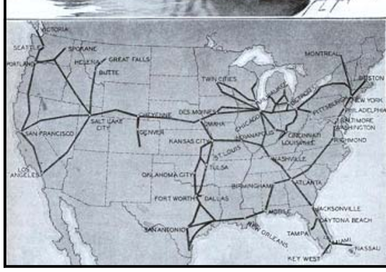

<u>Left</u>: caption: "The first mail carrier – the N-ABNA – one of the Boeing flying boats, carried air mail on the Seattle-Victoria route. This was the first commercial air line. This ship, which is still frequently used, has covered more than a half-million miles. It has worn out six motors. The map graphically represents the air-mail network today. Many other lines will soon be in operation."
***Modern Mechanics*, July 1930**

239


"..It is interesting to note that the founding of the Boeing organization was the result of an accident. Back in 1916, William E. Boeing, who had become interested in aviation as a hobby, and had learned to fly in California, had a crack-up with his plane. In contemplating the possibility that the damaged craft might be repaired in Seattle, he finally decided that an entire new plane should be built. Gathering a small group of interested men, he formed the Pacific Aero Products Company and in a small one room plant production was begun on the first Boeing ship, the B & W seaplane trainer of 1916. An unequal span twin-float biplane fitted with a 125 h.p. Hall-Scott motor, it had a cruising speed of some 60 m.p.h. In 1917 the name of the organization was changed to the Boeing Airplane Company and the plant continued to produce training planes in the hope that they might prove acceptable to the U. S. Navy. The following year the first sizeable order was received from the Navy for fifty training planes of the 'C' series. These two-place, twin-float biplanes were powered with A-7A Hall-Scott water-cooled engines…"
Modern Mechanix, **March 1938**
<u>Above</u>: at left, *William E. Boeing* and, at right, the *Boeing B & W Seaplane Trainer*

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Trans-Pacific

241

In 1924, Rear Admiral ***William E. Moffett***, head of the ***Naval Bureau of Aeronautics***, decided that the Navy needed a sensational event to convince the public that naval aviation had unique requirements that could only be met if the fleet maintained an integral air arm. It was decided that a suitable demonstration of the Navy's requirements would be a non-stop flight from ***San Francisco*** to ***Honolulu***. In 1925, the Navy turned to the commander of the Naval Air Station at ***Pearl Harbor***; Commander ***John Rodgers***. Rodgers was the second Naval Officer in history to qualify as a "Naval Aviator." This flight would provide an important breakthrough, the first flight across any significant portion of the ***Pacific Ocean***. A San Francisco to Honolulu crossing would cover about 2,100 nautical miles, a distance a bit farther than that across the ***Atlantic*** between the northeast coast of ***North America*** and ***Europe***. A long transoceanic flight would also provide a test of how far the state of the art had advanced in flying boats. Rodgers decided on a mass flight of three flying boats, the ***Naval Aircraft Factory*** "PN-9-1" and "PN-9-3" and an experimental ***Boeing*** model called the "PB-1."

Above: ***Admiral William H. Moffett*** **(center) confers with pilots of the inaugural Navy flight from *California* to *Hawaii* on August 26th 1925**

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Though each of the PN-9's were prototypes and test airplanes, some did serve in Navy squadrons. The PN-9 flying boats were constructed with newly redesigned tail surfaces and aluminum alloy hulls. They also had revised engine nacelles with large nose radiators and two ***Packard 1A-2500*** engines, producing 475 hp each. The plane's rated cruising speed was seventy knots, which when applied to the 2,100-mile distance between ***San Francisco*** and ***Honolulu*** would require thirty hours of flight time. It was recognized from the onset that weather would play a key role in the success of the flight.

Left: ***Boeing PB-1*** **flying boat**
Right: ***PN-9*** **flying boat**

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"We picked up the first destroyer two hundred miles out of San Francisco, right ahead, and that was a great relief to me. It certainly gave me the assurance that my compass and methods were all right. Soon after we passed the first - about an hour, I think, after we passed the first ship - the other plane, the PN-9 No. 3 was forced down, and a successful landing was made, although of course that plane was still very fully loaded with gasoline, and that full load was - gross load - was 20,000 pounds, ten tons. That plane made a successful landing at night on a rough sea; and I think it is one of the greatest pieces of seagoing airmanship that has ever been accomplished. The hull stood up very well under the strain, but the flow was so great that the gasoline tanks, which originally were square, were bulged out so they were perfectly cylindrical…"

RE: excerpts from Commander John Rodgers' story as told to the *National Aeronautic Association* on October 9th 1925. The planners apparently gambled and assumed that tail winds in the form of the required northeast trades would give a 15% increase in speed over the route, thus providing the necessary margin of safety for the range. Under the command of *John Rodgers*, the two PN-9's left *San Francisco* in the early afternoon of August 31st 1925. On the day of the flight, the PB-1 wasn't ready. The PN-9 carried 1,328 gallons of fuel at roughly seven pounds per gallon amounting to 9,298 pounds, while the five crewmen added roughly another 850 pounds. One of the pilots later recalled that: *"We were so heavy we had to fly 50 miles before we could climb to 300 feet."* PN-9-3 suffered an engine oil leak about three-hundred miles out, landed at sea, and was towed back to San Francisco. The remaining PN-9-1 flew on alone with Rodgers in command.

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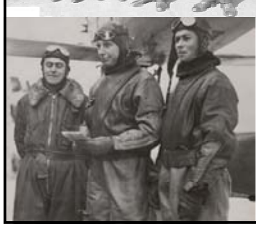

Top Left: **the PN-9 crew: *B. J. Connell, W. H. Bowlin, Commander John Rodgers, O.G. Stantz***
Top Right: **waving before their departure from *San Pablo Bay*, John Rodgers (center) and his crew attempted the difficult and dangerous feat of flying over the *Pacific Ocean* for the first time**
Left: **Commander John Rodgers (center) won his wings in 1911**

245

"We continued the flight and picked up all the station ships without any trouble during the night. In the morning, the clouds cleared up; the sun came out fine and bright; everything was fine. But there wasn't any of that wind that we needed to push us along. Well, we passed the eighth station ship, the 1,600 mile mark, and decided to land at the 1,800 mile mark. It never occurred to me, that having picked up all these other ships without any difficulty, we would have any difficulty in picking up the one that we really wanted to pick up. It really didn't make much difference whether we picked up the others or not. Something happened to the navigator or something; I don't know what it was; but anyway when we got to the place where I thought we ought to see this ship, we didn't see her. We flew down a radio bearing, and chased around for about an hour, following different radio bearings, and finally the gasoline gave out, and so naturally the engine wouldn't run any more and we came down…"

RE: excerpts from Commander John Rodgers' story as told to the *National Aeronautic Association* on October 9th 1925. Ships were stationed at 200-mile intervals along the *Great Circle Route* to *Honolulu*, providing communication links and potential assistance that was never more than about an hour of flying time away. These ships also provided visual navigational aids by use of black smoke by day and searchlights at night. For radio navigation, the ships had direction finders with which to take bearings on the planes. The two ships stationed nearest to *Hawaii* were capable of refueling the planes if necessary. At about the halfway point, the crew realized that their average ground speed had only been seventy knots and the anticipated trade winds had not materialized. Their fuel consumption was greater than anticipated. Rodgers knew that he would have to land and refuel the plane at some point. However, encouraged by improved speeds nearer the Hawaiian Islands, Rodgers bypassed the nearby station ships and decided to fly closer to Hawaii. Though they carried sextants, Rodgers' crew lacked confidence in the sightings they made and instead, relied on radio navigation, finding their bearing by determining the direction of signals transmitted by support ships along the route. But the technology behind these ship-based direction finders was still sub-par and combined with operator error, led the PN-9-1 to miss the refueling ship.

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"The landing was made under very difficult circumstances, since there was no power. That means that we only had one chance. The pilot, Lieutenant Connell, was at the wheel, and he did it perfectly…Well, I kept a record of our courses and I plotted them up, and I found we were about 50 miles north of the Aroostock's position, and a little later I got some sights, and I found it was right. And then we rigged an antenna, so we could hear messages all right, but we couldn't send because we required the engines to drive the generator, which made the juice, to do the sending; and we didn't have any gas to make the engines go; so we didn't have any juice to send. Well, we didn't worry very much about that. We thought some fellow would come and pick us up pretty soon, and give us a little gas, and we would get off, and go merrily on our way. So we held everything together then; we could see what was going on; we could see when the ships came near, and when they went back and it did not take us long to find out that we were not probably going to get picked up at all…"

RE: excerpts from Commander John Rodgers' story as told to the *National Aeronautic Association* on October 9th 1925. At this point, several miscommunications and miscalulations began to build upon each other. With fuel running low, the commander of the PN-9-1 requested radio position finding from the closest naval ship. Rodgers was apparently confused by the radio position reports and concluded that he would have to depart from his course to find the ship. He turned north, looking for the ship. In reality, the ship was south of him. Rodgers circled in the PN-9-1, hoping to find the ship that he believed was somewhere below him in the squally weather. At 4:09pm the engines quit; the plane had run out of gas. During the glide, the reduced airspeed of the plane caused the wind-driven generators to quit making power, thus shutting down the radio transmitter. The PN-9-1 was able to make a smooth landing in the rough sea. Rodgers had set down on the ocean about 450 miles short of his goal. The plane came down at sea after flying 1,841 miles, a new non-stop distance record. At 4:15pm on September 1st 1925, the fliers became sailors.

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The crew of PN-9-1 was not alarmed at first, they thought they would be rescued soon, it did not occur to any of them that they might be in the water for a long time. They believed that ships were close and they were confident that it was only a matter of a few hours before they would be found. The plane's radio operator jury-rigged an antenna on the wings and was able to hear messages from the ships, but was unable to transmit. At the end of a few hours it became apparent that the ships were indeed searching for them, but it was also clear that they were looking in the wrong place. The Navy mounted a massive and intense search for the plane and crew. All the ships along the route were dispatched to the area, and a large group of submarines was sent out from *Hawaii*. The search conducted by the Navy assumed that the plane was drifting at about eight knots towards the Hawaiian islands. The plane was actually drifting at about three knots and as a result of this miscalculation the search was moving westward all the time, well out ahead of the plane. It was also assumed that the drift of the plane would be generally along the original trackline or farther south, making *Maui* or the big island of *Hawaii* the likely island/s for the plane to reach. Again, in reality, the plane was farther north, drifting toward *Kauai* on the western end of the island chain. The PN-9-1 had vanished into the great *Pacific Ocean.*

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PN-9 NO. 1, COMMANDER AND 4 COMPANIONS ARE LOST AT SEA; PLANE'S STORE OF FUEL IS GONE

Giant Airship PN-9 No. 3 Brought Into Golden Gate By U.S. Destroyer After Collapse 300 Miles off Coast

No Word Received Since Yesterday Afternoon — Flight Commander Rodgers on Board Airship

NOW 25 HOURS SINCE CONTACT WAS LOST

When Last Heard from, PN-9 No. 1 Was Believed to Be 150 Miles from the Island of Maui

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"So along about the second day, we stripped the fabric off the lower wing, and rigged them up for sails between the wings, and we started the sails for Nawiliwili, Hawaii. That was the last stopping place in the Hawaiian Islands; and we had to pick that out, because the wind blew in that direction. We would have had a very pleasant trip of it, but we didn't have any water, or not much water. We had two quarts a piece when we started. It wasn't until the eighth day that a rainstorm came right over us. Then we got quite a lot of water, a couple of gallons. We were fixed up fine, although the fabric we caught it in had been painted with aluminum paint, and that chipped off and mixed with the water, and it didn't taste very good. But still it didn't prevent us from drinking it. On the seventh night we were about 40 miles north of the island of Oahu. That's where all the Army is in the City of Honolulu, and that night we saw the Army searchlights at Brill, reflected on the prow. So that refreshed everybody, and checked up my navigation all right, which was more of a relief to me than it was to anybody else I think. And then in the morning, we could see through the haze or rain - we could see part of the Island of Oahu; but it did not seem possible that we could make it, although by that time Connell had invented leadboards. He had dug up some metal floor boards and hung them over the sides, so that instead of going just before the wind, we could make 15 degrees on either side of it. And if he had only been smart enough to think of that about four or five days before, we might have gotten into Honolulu, and gone ashore, and telegraphed to the commandant that we were there. That night - that was the last night; it was a rather hard night for me, because I had made the decision to go on, and the responsibility was mine for getting over to the Island of Kauai. And sure enough, in the morning, we picked up this Island of Kauai, just where we thought we were going to get it, and we headed down for the harbor of Nawiliwili under full sail."

***Commander John Rodgers,* USN**

RE: excerpts from Commander Rodgers story as told to the *National Aeronautic Association* on October 9th 1925

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All food and water ran out after four days and the crew became weak and dehydrated as they drifted west. Dispite the situation, the crew became very resourceful to survive. After a day or so of drifting, Rodgers and his men began to think about a more extended stay in the water. Rodgers ordered that fabric on the wings be removed and rigged as a primitive square sail between the engines. The crew devised a still using wood from the wings as fuel to distill water, but it only produced about a quart of water. The crew also rigged lee boards from flat metal floorboards in the hull to make steering easier, however marginal steering capability prevented the aircraft from reaching the much nearer island of *Maui*. On the evening of the seventh day of the ordeal, lights were spotted in the distance and morale improved aboard the plane for the first time since landing. Rescue was near on the eight day of the ordeal. In the morning, the profile of *Oahu* was clearly visible about fifty miles away. Later that same day the crew was able to collect rain water from a squall and the physical condition of the men improved dramaticly. The crew steered towards *Kauai* because they believed that it was their best chance of reaching land. On the moning of the ninth day, Kauai was directly ahead of them only about fifteen miles away and they made plans for making a landing. As they drew near they tried signaling by waving fabric and burning oily rags in a bucket to attract attention. The plan worked, within a few minutes the submarine *R-4* (SS 81) appeared in the Kauai channel and rescued them. John Rodgers and crew stayed with their plane until they were safety towed into the port of Nawiliwili harbor on the Island of Kauai. Rodgers and his crew received a hero's welcome in *Hawaii*. At the ensuing celebration, Cmdr. Rodgers handed Governor Farrington the first letter to arrive in Hawaii by air. With that action the ambitious flight came to an end.

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The Navy's attempt to reach *Hawaii* from the west coast is considered by many historians to have been premature. The Navy did not complete the mission as planned, but it did learn some valuable lessons. Commander Rodgers did achieve a remarkable feat. He navigated to within ten miles of *Kauai*, the seaworthiness of the new all-metal hull and the seamanship of the crew were clearly demonstrated. Many lessons were learned including the need for better fuel planning, the assumptions about the weather conditions, the need to stock adequate emergency provisions, the requirement for improved radio equipment, the dependence on bearings obtained from the radio direction equipment and, lastly, the overly optimistic estimates of the drift of the plane, which meant that the Navy search efforts were always well ahead of the PN-9-1's position.

Left: Cmdr. Rodgers and crew in Hawaii
Right: PN-9-1 beached on Kauai

252

The airport now known as ***Honolulu International Airport*** originally took the name ***John Rodgers Field*** in honor of the naval aviator. In 1925 the ***Honolulu Chamber of Commerce*** raised $20K and the ***City of Honolulu*** appropriated $45K for airport construction. The Rodgers name was dropped in 1947 and, instead, the main terminal building was named in his honor. In recognition of his qualities as an aviator and his ability as a seaman and navigator, Rodgers was appointed assistant chief of the ***Bureau of Naval Aeronautics***. He was killed in an airplane crash on the ***Delaware River*** near the ***Philadelphia Navy Yard*** on August 27th 1927. The PN-9-1 aircraft was subsequently repaired and returned to service within a week as a token indication that the flight had succeeded. The aircraft did a repeat performance in 1928 while on a flight to ***South America***. Engine problems forced it down in the ***Caribbean***, where pilot ***Byron Connell*** and crew drifted for several days before being rescued. Because the towing distance to shore was too great, the plane was sunk by gunfire as a hazard to navigation.

Left: Commander *John Rodgers*, USN

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Left: poem entitled: "To Commander John Rodgers and his Gallant Crew," by Honolulu poet *Margaret Kirby Morgan*

254

Far East Flight

255

The RAF's *Far East Flight* consisted of four *Short Southampton* flying boats on a flight from *England*, which took them through *Egypt, India, Hong Kong, Japan* and *Australia*. They arrived in *Singapore* on December 10th 1928. The flight flew a total of 27,950 miles.

Above: RAF Southampton flying boat on water (left) and in the air (right)

Left: the four flying boats over the *China Sea*

256

The Condor Syndicate

257

"…the Condor Syndicate, a German firm, has inaugurated a successful service along the Brazil coast. Its Dornier and Junkers flying boats carry passengers, mail, and freight between Rio de Janiero and Porto Alegre, northern and southern limits of the route, respectively, in one day, as against five by steamer…"

***Popular Science Monthly*, June 1929**

Above: a *Condor Syndicate* flying boat over *Rio de Janiero*

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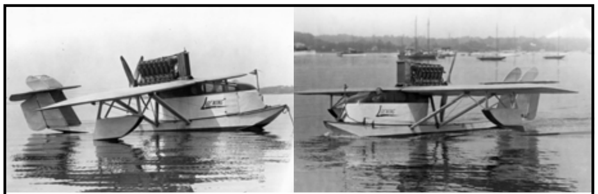
Flying Yacht

259



"…The speedy air yacht developed by Grover C. Loening for operation on a Newport-New York passenger airline proved so successful that a number of planes of the same model have been adopted by the U.S. Army. It carries a pilot and four passengers…"
Popular Science Monthly, **March 1925**
<u>Above</u>: G.C. Loening's S-1 "Flying Yacht" seaplane was an advanced airplane for 1921. The monoplane won the *Collier Trophy* and set an altitude record. Loening sold three to an airline and nine to the *U.S. Army Air Service* (USAAS). *Grover C. Loening*, who had acquired an aeronautical engineering degree from *Columbia University* in 1911, was able to see the inherent speed and structural simplicity advantages of the monoplane and had the tenacity to fight for his beliefs against adamant opposition. Loening got his chance in 1918 with the M-8, by which time he was a thoroughly experienced engineer having worked for the *Wright Brothers,* former chief engineer of the *U.S. Army* flying school in *San Diego* and later chief engineer of the *Sturtevant Aeroplane Co.*

260

"…latest of Fokker creations is this graceful flying boat with cabin for eight passengers. Driven by a 550-horsepower engine, with 'pusher' propeller above wings, it is designed for a speed of 125 miles an hour. A kitchen and sleeping quarters permit week-end trips or long cruises in comfort…"
Popular Science Monthly, **July 1929**
<u>Above</u>: *Fokker F-11* "flying yacht." After the Dutch-built *Fokker B-III* bi-plane flying boat had been offered unsuccessfully for sale to the Dutch Navy, it was converted to a six passenger aircraft in 1927, and re-designated "B-IIIC." *Anthony Fokker* shipped the flying boat to the U.S. where it served as a model for a new amphibious monoplane design designated "F-11," which became a new aircraft of mixed Dutch-American construction. Designated the "F-11 Flying Yacht" by Fokker in the USA, the prototype was a six-passenger amphibian with retractable landing gear sponsons.

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Across the Atlantic on Many Wings

262

"Caproni, the famous Italian designer and builder of airplanes, a man who dreams of aerial navigation on a grand scale, has built the biggest airplane that anyone has yet ventured to construct. Those who saw the huge bombers he built during the war, multi-planed machines with spans of about 100 feet, gasped at his daring. But now he exhibits to us a flying-ship with which, he believes, the Atlantic ocean may be crossed in not more than a day, and in the completely enclosed hull of which a hundred passengers find comfortable accommodation…"
Popular Science Monthly, **June 1921**
<u>Above</u>: caption: "Caproni, world-famous as designer and builder of huge flying machines, has surpassed himself with this new giant. Nine planes support a sixty-six foot hull in which one hundred passengers take their seats. Eight engines, developing 3,200 horsepower, will drive the craft across the ocean at a speed of at least sixty miles an hour."

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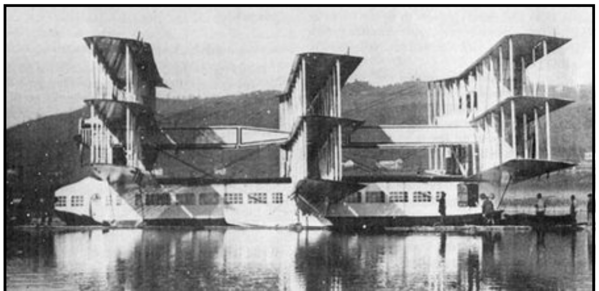
"…The building of so huge a craft means more than the magnification of an ordinary biplane or triplane. This machine weighs twenty-four and one half tons, we are told. If it were to alight on land at so low a speed as forty miles an hour, the impact would be terrific. Indeed, this problem of landing has been one of the most difficult to solve by the designer of big land planes. Curtiss, who built the 'America' which was to have flown across the Atlantic just before the war broke out, and which had a span of about 130 feet, appreciated the difficulties correctly. Accordingly, he made 'America' a seaplane. It is easier to alight on water than on land. Caproni, looking back on his own experiences with heavy land machines has evidently decided that Curtiss' policy is right; for his huge craft starts from the water and alights upon it…"
Popular Science Monthly, **June 1921**

264



"…This mammoth Caproni flying boat, largest airplane ever built, is undergoing tests in Milan, Italy. Nine wings, arranged in triplanes in tandem, are to lift the huge houseboat-like body. Benches along the cabin provide seats for 100 passengers – more than the capacity of the dirigible 'Graf Zeppelin.' Motors are at front and rear."
Popular Science Monthly, **July 1929**
Above: *Caproni CA60 Transaereo.* It was a nine wing flying boat intended to be a prototype for a 100-passenger trans-Atlantic airliner. It featured eight engines and three sets of triple wings.

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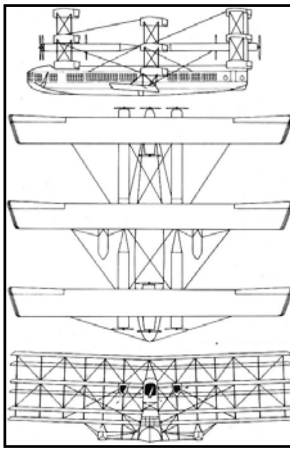

"…To lift a weight of twenty-four and a half tons, a huge wing surface must be provided, in this case 7,150 square feet. A single pair of superposed wings, such as we find in the ordinary biplane, could hardly carry so huge a load. The span would be enormous, so much so that it would be far more difficult to make the wings strong and stiff enough than to build a bridge. Hence, Caproni built three superposed wings, thereby cutting down the span. But evidently two sets of triplanes were not enough, according to his figures. He has supplied three sets, with a veritable forest of struts to tie them together and a maze of wires between. All this means wind resistance, and therefore low speed, despite eight engines developing at total of 32,000 horsepower. No definite figures of performance has reached us from Italy, but it is doubtful whether more than sixty miles an hour can be made…"
Popular Science Monthly, **June 1921**
Left: front, side and plan views of the CA60

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Advantage Zeppelin

267

"…Those who have studied the commercial possibilities of aerial navigation will naturally compare Caproni's nine-planed flying-ship with a rigid dirigible of the Zeppelin type. Caproni can probably build a transatlantic flying-ship at a smaller cost than the Zeppelin Company can turn out one of its 600-foot dirigibles. But it is a question whether, in the end, the dirigible will prove commercially more practicable. The speed of the Zeppelin would certainly be as great as, if not greater than, that of the giant Caproni. It could carry fully as many passengers. It is not utterly dependent on engine power for support…all things considered, the advantage lies all with the dirigible for long-distance commercial flying."
Popular Science Monthly, **June 1921**

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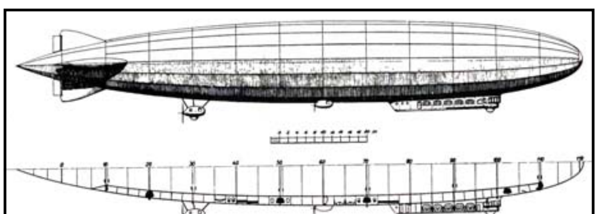

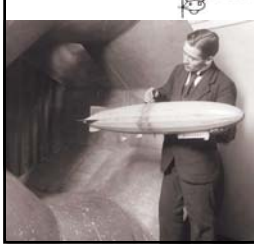

LZ-120 (a.k.a. "Bodensee") was the first civilian airship built after WWI. She was designed to provide fast air service between *Friedrichshafen* and *Berlin*. Construction was completed within six months and she made her first flight on August 20th 1919. LZ-120's advanced aerodynamic (wind-tunnel tested, 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 and was highly successful commercially.

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"…In one of the first short trial flights on Lake Maggiore in Italy, the hull was damaged as it struck the water, showing that even impact with a fluid that can easily be displaced is not without its dangers…"
Popular Science Monthly, **June 1921**
RE: *Count Gianni Caproni* was the builder of some very fine aircraft in his day. With the CA60 (or an even bigger version) he hoped to fly over 100-passengers across the *Atlantic*. Amidst all the struts and wings, the absence of any tail surfaces could easily be overlooked. Reportedly making a short hop without incident, the official first flight was less successful. Rising to about 18-meters above *Lake Maggiore*, the CA60 suddenly nosed down and dived into the water (above). Some said that testing had shown the need for a lot of lead ballast and that this had shifted in flight. The test pilot crawled out of the wreck unscathed. Later a mysterious fire destroyed the wreck and ended the Count's trans-Atlantic dream.

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Italy Vindicated

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<u>Above L&R</u>: *Savoia-Marchetti S-66* (*Italy*, 1934). During the decade before WWII, a fleet of at least twenty-three S-66 flying boats connected the countries of the *Mediterranean*. The beautiful three-engined successor of the "S-55X" served a number of Italian companies before they were absorbed by *Ala Littoria*. The handsome aircraft could carry up to eighteen passengers in the two large cabin floats. It was widely shown in the popular images of the era. Some of the S-66's found a wartime role as rescue aircraft.

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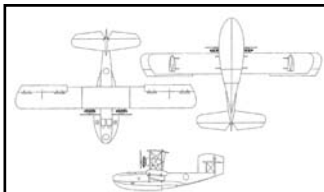
A Stroll in the Clouds

273



"…So large is the Navy's PN-12 patrol plane that the top of its great fishlike body serves as a promenade deck for members of the crew. Here the pilot or mechanic can stretch his legs by taking a stroll between the forward and rear cockpits…This improved type of Navy flying boat is driven by twin air-cooled motors. In the nose are twin cockpits, side by side…"

***Popular Science Monthly*, November 1929**

<u>Above</u>: top/bottom plan view/s and side elevation (left) and PN-12 in the water and in the air (right). The PN-12 was a twin-engined bi-plane with a metal hull, fabric-covered metal-framed wings (the engines were mounted in nacelles between the wings).

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Rohrbach

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The Rohrbach Romar, which, until the DO-X was built, was the largest flying boat in the world.

The passenger compartment of the Rohrbach Rocco, in use on many of the European air lines.

"As designer to the German government during the war, when some 5,500 airplanes were built under royalty rights from me, and as chief engineer of the Rohrbach all-metal airplane factory, which produced the Roland, Rocco and Romar ships - the latter a giant three engines flying boat – I have had considerable experience with this type of craft…"

***Hans Rohrbach*, 1931**

"The name of Rohrbach is well known in the aviation world because of the giant planes which he has designed. He built 5,500 airplanes for the German army during the World War, including four giant bombers with eight engines each. Since then he has designed most of the large European transport planes used on passenger lines."

***Modern Mechanix*, March 1931**

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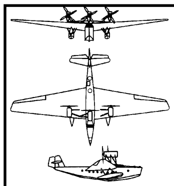

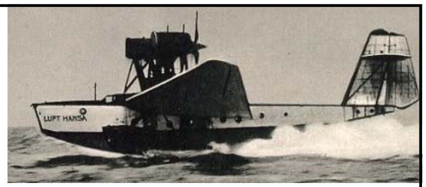

"…The 'Romar,' an enormous new Rohrbach flying boat, built in Germany as one unit of a projected fleet of air liners for transatlantic passenger service. Powered by three motors. It is said to develop a speed of more than 120 miles an hour. This photo shows the great ship skimming the waters of the Baltic at the start of a test flight…"

***Popular Science Monthly*, November 1929**

<u>Above</u>: plan and front/side elevation/s (left), *Ro-X Romar* during test flight (right). The first prototype flew on August 7th 1928. A total of four were built.

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"The conquest of the Atlantic by air, both from America to Europe and Europe to America, has become almost a commonplace since Col. Lindbergh's great flight. But, as a recent article in Modern Mechanics pointed out, there is no airplane built today capable of flying the ocean non-stop while carrying a sufficient payload of passengers and freight to make the trip financially worth while. For a non-stop trans-ocean air line a flying boat is needed, one so built that it can land at sea, ride out bad weather, and, in event of damage to the wings or tail surfaces, navigate to shore under the power of a marine propeller. It must have speed sufficient to make the crossing in a reasonable number of hours, excess fuel capacity to give a wide safety margin, and sufficient load capacity to accommodate enough passengers so that the fees received will pay expenses and profits. I have designed such a ship, a thirty passenger flying boat that is radically different from anything yet built, but based, as I will demonstrate, on sound technical facts…The ship is for me the culmination of a life-time of airplane building…giant airplane designing is just a return to my first love, and if, as I hope, I build the first practical trans-Atlantic air liner, my goal will have been reached."

The beautiful streamlining of the huge craft is shown in this picture.

A portrait of the author, Hans Rohrbach, the well-known German designer of airplanes, automobiles and many types of gasoline and heavy oil engines.

***Hans Rohrbach*, 1931**

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"…But all big flying boats yet built, from such craft as the two-engined Rocco to the twelve-motored Do-X have one serious defect, in my eyes. Their engines are placed, to keep them from getting wet, high above the wings, in a position impossible to work on during flight, in a place where they, with their supporting jacks, create enormous wind resistance, and at a point where an enormous weight is concentrated far above the ship's center of gravity. To offset this advantage I have designed a flying boat with four engines placed deep down in the hull, actually below the water line. Above the wing and fuselage, the four propellers are supported on stream-lined jacks, with shaft drive from the engines down in the hull. Four tons of motors and five tons of fuel are thus concentrated where the weight belongs, at the lowest possible point below the wings, and the center of gravity of the engines is lowered by at least five yards. All the wind resistance of the motors, and most of the resistance due to the supporting motor structure, is thus removed. Next, I have eliminated the cumbersome pontoons and their supporting structure, placed under the wings of all big flying boats to give them lateral stability. Not only have I eliminated their weight and their wind resistance, but I have likewise done away with the strains on the wing structure caused by seas striking these supporting pontoons. They are not needed on my ship because I have broadened the hull, fitted it with a deep sea keel, and with side, or bilge keels, like those on some big sailing ships, only even more pronounced…"

The Rohrbach Rocco is shown taking off from the water. Compare this photo with the drawing of the new liner and note the similarity of line.

This photo shows the Romar, formerly the world's largest flying boat, gracefully taking off, amid a cloud of spray, from the surface of a choppy sea.

***Hans Rohrbach*, 1931**

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"…The width of the hull and the keel arrangement gives it ample lateral stability without supports under the wings. Getting such a wide hull off the water offers no particular difficulty, because compressed air from the engine room can be injected into the space between the true keel and the side keels, reducing friction to the minimum and breaking the cohesion between hull and water…The hull as I have designed it approaches very closely to the standard practices of ordinary sea going ship building. The engines, for example, rest on the keel members, instead of on special engine beds, thus permitting a considerable saving in weight. Their position permits the engineers and oilers to go about their tasks just as they would on a ship at sea…The hull has a width of 16 feet 6 inches and is 33 feet long…The hull has two levels, with the engine room, wireless cabin and kitchen below and the pilot's and navigator's compartments, passenger and supply space above. The wireless cabin is placed in the bow, separated from the engine room by a solid, insulated wall. Over it is the pilot and navigation rooms, and behind them the passenger compartment, with accommodations for thirty people, and back of that the baggage and supply compartments.

***Hans Rohrbach*, 1931**

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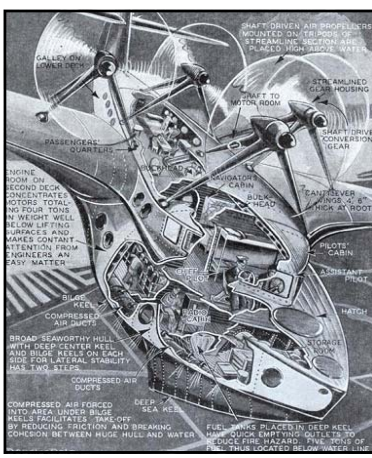

<u>Left</u>: caption: "A phantom view of Hans Rohrbach's projected Atlantic air liner, drawn from plans, models, and a description by the author. The most unusual feature of this huge flying boat will be the central engine room, with the propellers connected to the motors by shafts run through streamline struts. The main advantage of this method pf power transmission will be the keeping of weight below the center of lift, making for easy riding both in the air and on the water. This advantage will be accentuated by placing the gasoline tanks at the bottom of the hull, well below the water line in case the ship is forced to descend while at sea. The flying boat will also be provided with a water propeller and a deep sea keel, making fairly rapid progress possible, even if forced to descend in a heavy sea." 281

"…Some people may question the practicability of the shaft drive for aerial propellers. Actually there is nothing so revolutionary about it. It has been the practice for a long time in planes with extremely high powered engines to gear the propeller down, permitting use of a slow, high efficiency, air screw, so the gear problem is not new. And shafts of length equal to those I propose are in common use in large trucks and extremely powerful speed boats, where, in the latter case, they have been used to transmit power from 1,000 h.p. engines, larger than the 800 h.p. B.M.W. motors I propose to use. Hollow steel tube shafts on large trucks are subjected to enormous shocks, yet come through without distortion. Placing the motors in line deep down in the hull also permits use of a marine propeller, geared to the rear engine, where it can be used for taxiing in harbors, as an aid in getting under way before taking to the air, and as an emergency safeguard in event of a forced landing at sea under conditions preventing the ship taking the air again. The first step in the hull is just at the rear of the engine room, so it will be a simple matter to prolong the shaft of the rear engine and provide for the marine propeller and gear. Owing to the slight draught of the boat and the high power of 800 h.p. a high cruising speed can be developed on the water, giving quick acceleration and cutting down the space needed for a take-off run…"

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***Hans Rohrbach*, 1931**

"…Some designers have questioned the placing of motors and fuel within the hull on the ground of fire hazard. Actually there is no more danger than with any other arrangement. Quick emptying tanks as a protection against fire are in common use, and such tanks would be fitted so that, by means of flap valves, they can be emptied almost instantaneously. The chief reliance, however, would be a good fire extinguishing apparatus, plus a horizontal bulkhead or fire wall. Most ocean going liners nowadays are fitted with complete carbon dioxide fire extinguishing apparatus in every compartment, with controls both automatic and manually operated, and the same system would be fitted here. The ceiling of the engine room, which has six foot headroom, enabling the mechanics to work on the engines during flight, would act both as fire wall and the inner wall of a double bottom. In event of rupture of the outside hull the engine room can be turned instantly into an air tight compartment…"
***Hans Rohrbach,* 1931**

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"…As designed the ship will weigh approximately 33,000 pounds and carry a load of fuel, crew, passengers, baggage and supplies of 44,000 pounds, or a total weight of about 38.5 tons. Of this approximately 6,600 pounds is assigned to passengers and luggage, or to mails and freight, 33,000 pounds to fuel, and the rest to supplies, equipment and the crew of five men…The crew of five includes two pilots and a navigation officer, an engineer and a wireless operator. Duralumin will be employed throughout, with the exception of some parts which require high test structural steels…The wings, of cantilever type and tapered form, have a thickness of 4.5 feet where they join the body, and a depth at the same point of 39 feet, tapering toward the outer end in a V-figure of about 3.5 degrees. The ailerons are 27 feet long. The wing span is 147.8 feet and the overall length 85.28 feet, while the height of the ship is 31.16 feet. The total wing surface is 2,158.8 square feet. As designed, with its four propellers, two placed near the wing roots and two in tandem over the hull, the craft should have a maximum speed of 250 kilometers, or 155.25 m.p.h. and a cruising speed of 124 m.p.h. It will be able to climb to 1,000 meters, or 3,280 feet in seven minutes, have a ceiling of more than 18,000 feet, a cruising range of approximately 3,400 miles and carry enough fuel for a 25-hour flight. That is sufficient for a non-stop flight from New York to London or Paris, or, by stopping for fuel at one of the Newfoundland ports to replenish gasoline consumed to that point, the range can be considerably extended…"
***Hans Rohrbach,* 1931**

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<u>Part 4</u>

What Dreams May Come

285

Supermarine Travel

286

"The commercial airliner of the future will probably resemble closely the airplane pictured here, especially if intended for supermarine travel. Radical as the design may seem, it will be observed that in its essentials – in cantilever wings, hull profile, retractable chassis – the airplane is simply an embodiment of engineering practices already sanctioned in America and abroad."
Captain Eddie Rickenbacker

"This superliner of the skies, for passenger and freight transportation, which Captain Rickenbacker predicts will be realized 'with the passing of but a very few years,' will be a giant monoplane, perhaps 300 feet from wing tip to wing tip. The motors will be approximately 1,000 horsepower each, several motors to a unit, and each unit driving a great propeller with three blades from 15 to 20 feet long. The motor units will be set in the wings, which will be very thick – from five to ten feet on the leading edge – and will be internally braced cantilever construction. The fuselage will be in the form of a boat, but landing wheels that draw into the body during flight will also be provided. This will enable it to alight on land and water."
***Popular Science Monthly,* July 1922**

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Steamship of the Skies

288

"…The airplane of today bears scant resemblance in outward features to the first successful machine of the Wright brothers; new types of wings, propellers and bodies have been devised; but the motive power still is furnished by an internal combustion engine – an improved engine, of course, but one which still retains the element of un-reliability…Aeronautical engineers have long recognized that the development of a motor that will combine lightness of weight with high power efficiency but that will lack the uneven performance of the present internal combustion engine probably is the principle problem confronting them in pushing the commercial possibilities of aircraft…"
Popular Science Monthly, **August 1923**

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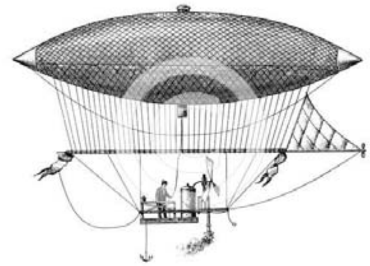

"…Ever since Henri Giffard, in 1852, navigated the air in the world's first dirigible, creeping along near the outskirts of Paris at seven miles an hour propelled by a clumsy three-horsepower steam engine weighing 462 pounds, there have been proponents of steam power for aircraft…"
Popular Science Monthly, **July 1933**
Above: Henri Giffard's dirigible (steerable) steam-powered airship of 1852

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"…From Germany, however, comes a report of the development of a steam driven airplane…The engine is an adaptation of the Diesel engine…It burns a combination of crude oil and other oils, which is broken up under a forced air feed and sprayed against the boiler. Here it ignites, giving terrific heat considering the relatively small quantity of oil consumed in the operation. Ten gallons of oil are said the be sufficient to run the plane's 750 horse-power engine for eight hours…only 1,000 pounds of water are said to be used in a flight of 95 hours…The water used to generate steam in the new plane is carried in the metal wings, in compartments so arranged that the water may be shifted to 'trim ship' if desired. The steam is condensed after exhaust and conveyed back to the wings in the form of water…"
Popular Science Monthly, **August 1923**
Left: caption: "The new steam-propelled airplane, developed in Germany, which is arousing the interest of American aeronautical engineers seeking to develop better engines"

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"Every once in a while we have to 'get back to nature' - get back to the simple things our dads used. Often we find that we've been on an engineering merry-go-round and that the old gentlemen who were our forbears had some right good ideas in design, but were unable to use them to the fullest extent of their theories because the right materials were not available in iron, or steel, or something else. And every so often the subject of what tomorrow's airplane will look like bobs up in some writer's mind. He is usually hard pressed to get something really new to write about, so he lays it on thick and the resulting pipe dream generally makes an air-minded man who has any air 'savvy' pretty sick. Recent developments in engineering activities have brought these two phenomena together again: steam and tomorrow's airplane. Strangely, some real progress has been made, and we find that steam, used by our grand-dads as an old reliable medium, has been put into new clothes by the developments in materials to the point where it can be considered within reach on all engineering points to make an ideal power plant for a new airplane which will bristle with logical departures…"
Earl D. Hilburn**, Aeronautical Engineer (1932)**

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"…Let us take a fundamental consideration: The power plant of the future Leviathan of the air by necessity must be more powerful than is at present practical to build with the present day highly complicated internal combustion engine. The limit is approached in gas engines when such ships as the Dornier Do-X must use twelve 600 h.p. engines separately mounted with all the mess of gauges, magnetos and so forth that must be duplicated time after time. Airplane designers are far ahead of engine designers in aircraft developments and many of the leading minds of the engineering world are striving to develop engines of suitable design for tomorrow's airplane needs. Among them is Capt. Richardson, of the Great Lakes Aircraft Corporation, for whom the aeronautical world has profound respect. Also, working along different lines in this search which points toward steam as tomorrow's motive power is Abner Doble, one of the world's leading authorities on steam. Whether or not the ultimate power plant will be of the turbine type such as Richardson is developing, or whether the engine will be of the reciprocating expansion type as is being developed by Doble remains to be determined…"
Earl D. Hilburn **(1932)**

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"…These are the advantages which may be derived from the steam in the operation of controls, combination shock absorbers and retracting devices for landing gear, single throttle for all engines, heating of leading edge and propeller to prevent the formation of ice, heating of cabins, cooking of meals, generation of electricity for lighting and for radio equipment…The exhaust steam from engines and cylinders will be condensed and returned to its original state through the process of cooling effected by series of tubes which form the leading edge of the entire wing. This device not only serves as a condenser preventing the loss of water but acts as a heater to prevent the formation of ice on the leading edge of the wing, also warms the air which is conducted along the air ducts in the girders of the wing spars which furnishes heat and ventilation for the cabins…"
Earl D. Hilburn **(1932)**

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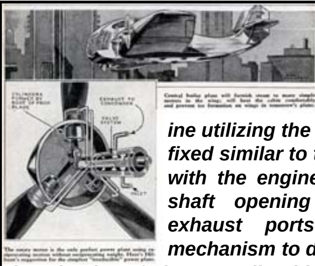

"…The propeller and engine may be combined as a single unit as shown in the illustration. The engine utilizing the hub as a crankshaft which is fixed similar to that of the old Gnome rotary, with the engine revolving about the crank shaft opening and closing intake and exhaust ports which form the valve mechanism to drive the pistons operating in the shanks of the propeller blades which would carry off sufficient heat to prevent the formation of ice on the propeller. The generation of electricity will doubtless be accomplished by a direct drive turbine generator set which like the other steam devices will exhaust directly into the condenser on the leading edge of the wing…"

***Earl D. Hilburn*, Aeronautical Engineer (1932)**

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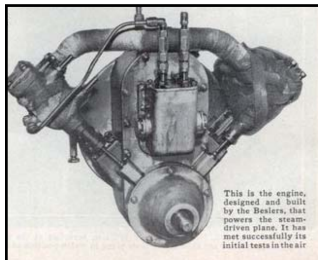

Right: caption: "Drawing shows the arrangement of the V-type engine in the nose of the Besler plane. All parts of the power plant are ahead of the cockpit."

Left: caption: "George Besler, left, with his brother William, inventors of the first successful steam engine for planes"

"Over the Oakland, Calif., Airport, a few days ago, a silent plane slanted across the sky trailing a thin ribbon of white vapor. Spectators heard the pilot shout a greeting from the air. They saw him flash past, skimming the ground at a hundred miles an hour. They watched him bank into a turn, slide to a landing, and, with the propeller spinning backward, roll to a stop in less than a hundred feet. They had seen, for the first time in history, a man fly on wings powered by steam! Two brothers, George and William Besler, the former a geologist thirty-one years old, and the latter a mechanical engineer, two years younger, have achieved the dream of Maxim, Langley, and other pioneers of flight. Through their work, the steam-driven airplane, long talked about, long planned, has become a reality. This spectacular development in the field of aeronautics is the result of three years of secret experiment. The inventors began their work in 1930, in a machine shop at Emeryville, Calif. A few weeks ago, they brought the product of their researches, a 180-pound engine developing 150 horsepower, to the Oakland Airport and installed it at the nose of a conventional Travel Air biplane…"

***Popular Science Monthly*, July 1933**

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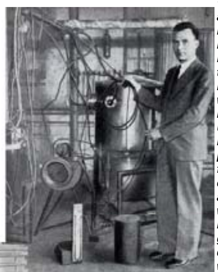

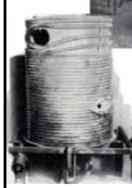

Caption: "Here is William preparing power plant for a test run in the workshop. At left, the interior of the boiler exposed to show coiled pipe used in generating steam."

"…The engine is a two-cylinder, compound, double-acting, V-type power plant. Its high-pressure cylinder has a three-inch bore and a three-inch stroke; its low-pressure cylinder has five and a quarter-inch bore and a three-inch stroke. Just behind the engine, the inventors showed me the barrel-shaped metal boiler which, with its super-efficient burner, explains why they have succeeded where others have failed in attempting to drive planes with a steam engine. Using vaporized fuel oil, the patented burner releases as much as 3,000,000 British thermal units per cubic foot of firebox space. This, they told me, is far in excess of anything hitherto attained. An electric blower drives this tremendous heat down among the flat spirals of a single 500-foot pipe coiled within the boiler. Three-eighths of an inch thick, inside measurement, at the bottom, the pipe gradually increases in size until it has an inside diameter of five-eighths of an inch at the top. The water supply to the coiled pipe is thermostatically controlled to keep the temperature constant regardless of pressure. Under the fuselage nose is the condenser which looks like an ordinary radiator for a water-cooled motor and which is said to recover more than ninety percent of the water from the used steam. By using a steam-feed water-pump, the inventors employ the exhaust vapor to pre-heat the feed water entering the boiler and thus decrease the time required to build up pressure within the coils…"

***Popular Science Monthly*, July 1933**

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"…At 800 degrees F., the steam pressure built up within the coils reaches 1,500 pounds. With a 1,200-pound pressure, the engine will deliver 150 horse-power, whirling the propeller at 1,625 revolutions a minute. Tests have shown that ten gallons of water is sufficient for a flight of 400 miles. By increasing the size and efficiency of the condenser, the experimenters told me, they believe they can make this amount of water last indefinitely…"

***Popular Science Monthly*, July 1933**

Left: caption: "Besler's plane enveloped in its own steam"

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"…Because, above a thousand feet, steam-driven planes would be as silent as soaring birds, they would have particular value in military work. Noiseless war planes have long been sought. But muffling gasoline engines reduces their power to such an extent that the plan is impractical. The new power plant, silent by nature, would permit long-distance raids above the clouds by ghost ships giving off no telltale drone of motors to warn the enemy or to aid in directing anti-aircraft fire. Most spectacular of all are the possibilities of steam on the airways of the stratosphere. In the thin atmosphere of this region, ten miles or more above the surface of the earth, experts agree, the high speed transport ships of the future will fly. Here there are no clouds, no storms, and the steady trade winds of the upper blue will increase the speed of long distance passenger, mail, and freight machines. Already, here and abroad, stratosphere ships, with pressure cabins and variable-pitch propellers, have been designed and are under construction. Test hops have been made in such highflying experimental craft in France and Germany. The chief stumbling block at present is the gasoline motor. It steadily loses power as it ascends. Climb to 20,000 feet and a motor that delivers 150 horsepower at sea level will retain only half its power. Spiral on up to 30,000 feet and your engine will have but three-tenths of its sea-level horsepower. And you are then only half way to the stratosphere! Superchargers, driving a blast of air into the carburetor to make up for the reduced pressure in rarefied atmospheres, help these gasoline motors. They are heavy, however, adding to the weight of the plane, and they never completely prevent loss of power at high altitudes. Now consider the steam engine. It loses no power at all with altitude and gains in efficiency the higher it goes! This is because the pressure on the exhaust is less in thin air than at sea level. Thus the perfection of the flying steam engine is a vital step toward conquering the stratosphere…"

***Popular Science Monthly*, July 1933**

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The Big Wing Concept

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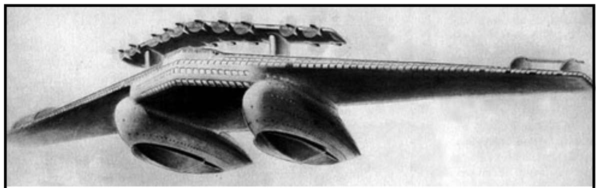

"Air liners of a size that is not easily visualized today will eventually supplant ocean liners in intercontinental transportation of express traffic - passengers and mail, but not freight…She has a total wing spread of 528-feet. On the water she is supported by two pontoons 104-feet apart, 235-feet long and 60-feet high...Total power required, 38,000 horse power - 20 motors, each 1,900 horse power; maximum speed, 150 miles per hour; cruising speed, 100 miles per hour; normal flying ceiling, 5,000 feet; absolute ceiling, 10,000 feet; time of climb to ceiling, 1 hour; speed at ceiling 87.5 miles per hour; cruising range without refueling, 7,500 miles, gross weight, 1,275,300 pounds...The flying time between Chicago and Plymouth, England is forty-two hours. She is refueled in flight while passing over Newfoundland…"
Norman Bel Geddes

RE: Bel Geddes designed "Air Liner No. 4" (above) with the assistance of aeronautical engineer *Otto Koller* in 1929. Accommodations were for 451 passengers and a crew of 155. The giant stream-lined seaplane would carry six extra motors for in-flight replacement, if necessary.

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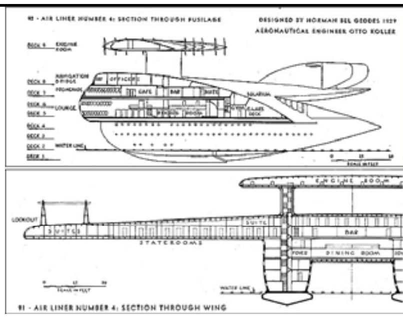
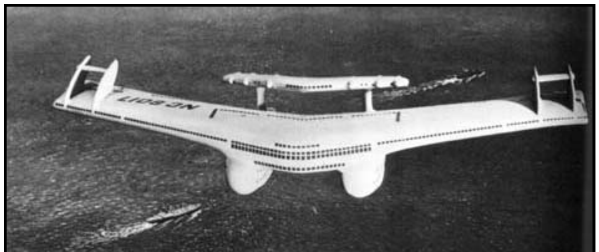


"…substantially as the hull of a yacht, in order to withstand tremendous pounding when the plane rests on a rough sea."
Norman Bel Geddes

Above: "Air Liner No. 4" section/s. The craft would be supported on the water by two enormous pontoons, both 60-feet high and with all the strength of an ocean-going yacht

303



"If it were possible to stand her upon one wing tip against the Washington Monument, she would lack only 23-feet of reaching the top. Or imagine that the Public Library was removed from its site in Bryant Park at Forty-second Street and Fifth Avenue, New York. The plane could then settle comfortably in the park with a clearance of about 35-feet all around."
Norman Bel Geddes

Above: rendering of "Air Liner Number 4." Her 451 passengers would range over nine decks containing 180 apartments, three kitchens, three private dining rooms, an orchestra platform, a gym, six shuffleboard courts, a dance floor, a library, separate solaria for men and women, a writing room, and a promenade deck. The 155-person crew would include two telephone operators, 24 waiters, two masseuses, a manicurist, and a gymnast.

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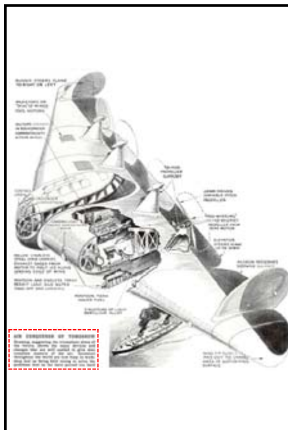
Above: center caption: "From photographs of designs copyright by Norman Bel Geddes & Co., and published in 'Horizons'"
Above: bottom caption: "The designs shown above indicate the undoubted future trend of the high-speed transportation means of the future; they show how the graceful curves of beauty combine with those of efficiency. The lines of the bus and car have already been approached in actual use."

305



In 1932, this is what airplanes would look like once we perfected their design, according to *Captain Frank T. Courtney*. In addition to expandable wings and free-wheeling propellers (in case the motor failed), Courtney recommended making amphibious landing gear a standard feature for airplanes. Not all areas had a usable runaway and landing on rough ground took such a toll on airplanes that it only made sense to make them capable of taking off and landing in water. Although seaplanes had already existed for two decades, engineers had difficulty making a folding device that was strong enough to lift the wheels yet light enough to keep the plane airborne. He recommended scrapping previous designs and staring anew, perhaps by substituting wheels with endless treads. Once an inventor figured out how to reduce the resistance of tread landing gears, engineers could feasibly combine pontoons and treads to facilitate takeoffs and landings. The perfect seaplane would also have a device that would speed up takeoffs by minimizing water resistance against the hull. Previous designers suggested that "hydrovanes," which resemble venetian blinds, could provide a bit of lift by tilting upward during takeoff, but Courtney warned that fish or seaweed could clog the panels.

Left: caption: "Air Conqueror of Tomorrow. Drawing suggesting the triumphant plane of the future, shows the many devices and changes that are still needed to give man complete mastery of the air. Inventors throughout the world are now busy in workshops and flying field trying to solve the problems that so far have proved too hard."

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"Give me wings large enough and sufficient motive power and I'll take the earth for an airplane ride."
Dr. Edmund Rumpler

RE: flying the *Atlantic* in a giant airliner was also the dream of the Austrian engineer *Dr. Edmund Rumpler*. Builder of the well-known "Taube" series of WWI fighters designed by *Igo Etrich*, Dr. Rumpler also saw the utility of a large wing to house passengers, cargo and engines. However, he did see a limit to increasing the span and size of airplanes designed according to conventional practice. If aircraft progressed in size beyond a certain limit Rumpler theorized, the weight of wings increased out of proportion to the increased size of the airplane. In other words, the larger the airplane became, the smaller the payload capacity and range. Dr. Rumpler believed that the weight could be kept within reasonable limits if it were distributed evenly over the wing span instead of being concentrated in a single fuselage or hull. His plan was to arrange a number of small airplanes side by side and join their wings. The larger aircraft that evolved would have high load capacity and very long range. Rumpler shared only some of the theories advanced by the purists; he advocated eliminating the fuselage, but retained the tail surfaces. Rumpler publicized his concept of a transoceanic airliner in 1926 and, over the next four years, worked on the detailed design while searching for financial backing in *Europe* and the *United States* for full scale production.

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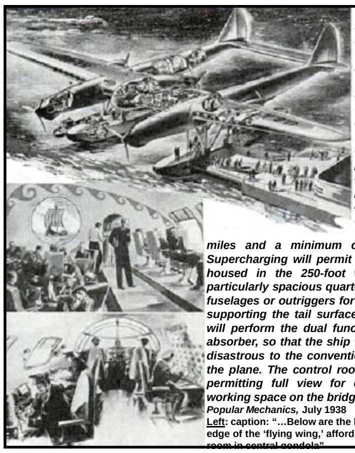
Above: the all-metal, twin-hulled Rumpler flying boat was to have a single wing with a span of 289-feet and a height of eight-feet at its thickest point. Sixty-five tons of fuel would be carried in the twin hulls; fuel would be fed by pumps to ten 1000-hp engines which would give the gigantic craft a cruising speed of 185 mph. The accommodations for the thirty-five man crew and 135 passengers were lavish. Cabins were to be situated in the wing interior at the leading edge. Cabins would seat six, each with a breathtaking view forward. A wide passageway extending the entire span of the wing would separate the passenger cabins from the engine compartments at the trailing edge. The passageway, over six feet high, would serve as a promenade deck as well as sound buffer for the passengers. Dr. Rumpler planned to build an entire fleet of these boats to ply the oceans of the world. Like so many other similar schemes, however, the Rumpler "Double Flying Boat" was only a paper airplane. He failed to gain the necessary funds for the project at home or abroad and was not in favor with the German government after Hitler's rise to power.

308



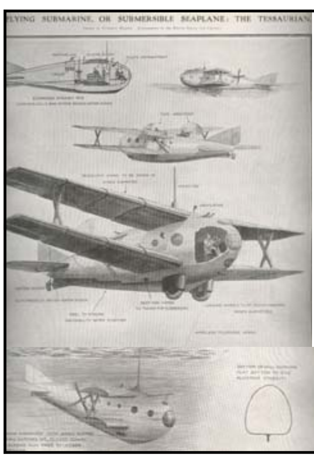
"Passenger accommodations aboard a super-clipper planned for transatlantic service will offer new luxury in air travel. The huge plane, literally a flying wing, will have a dining saloon and promenade in two-sections, each connected by a cocktail lounge and an observation deck. Observation windows in the leading edge of the wing will afford an excellent forward view. The two sections will have comfortable accommodations for fifty people, so that meals may be served quickly. The clipper is designed to carry a payload of 43,000 pounds and to accommodate 120 passengers. A crew of sixteen will operate the great craft, which will have a cruising range of more than 5K miles and a minimum cruising speed of 250 miles per hour. Supercharging will permit flight at high altitude. Passengers will be housed in the 250-foot wing, which is large enough to afford particularly spacious quarters. Attached to this wing will be two large fuselages or outriggers for housing retractable landing pontoons and supporting the tail surfaces. Hydraulic mechanism of the pontoons will perform the dual function of a retractable device and a shock absorber, so that the ship will be able to weather seas that would be disastrous to the conventional flying boat. Eight engines will propel the plane. The control room will be situated in the central gondola, permitting full view for captain and pilots and affording ample working space on the bridge for radio officer and chief engineer…"
***Popular Mechanics,* July 1938**

Left: caption: "…Below are the lounge-observation room in the leading edge of the 'flying wing,' affording direct view ahead for passengers, and control room in central gondola"

309

Flying Submarines (?)

310



"…not only runs and swims, but also flies and dives. It might, it is suggested, be called a 'tessaurian' – implying, in an adaption from the Greek, a creature which has four modes of life. When on the surface of the water it will look like a squat torpedo-boat, reefed metallic wings being visible along its sides. These wings, when extended, will lift it from sea to air, where it will have high speed. For a descent on land, a wheeled chasis can be lowered. The machine can dive like a submarine. Larger ones might carry torpedoes."
***The Illustrated London News,* January 24th 1920**

Left: caption: "Flying Submarine, or Submersible Seaplane: The Tessaurian – designed by a leading aircraft company"

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"At last the flying submarine has been invented. This hybrid craft which has already undergone successful tests off the Danish coast, will travel over land, run down a beach and launch itself into the sea, and then it is able to turn itself into a submarine and continue to travel underwater. This important military invention, developed by the Danish Navy, can then rise to the surface, unfold its telescopic wings and fly away from the scene of operations. The four-element craft has a tapering metal hull resembling the well known Dormer flying boat hulls - in fact it is rumored that the invention is the work of the Dornier factory - and on each side are the folding metal wings which are telescoped when not in use. This telescoping is done by a worm gear mechanism within the hull of the strange craft. Floats and wheels under-rigged on the wing stubs perform their functions when called upon to make water or field landings. Afloat, after closing the water-tight compartments of the ship, the crews can submerge her and operate her like a submarine by flooding the tanks provided for the purpose. The submarine characteristics of the craft are further enhanced by the folding of the tail surfaces of the airplane, which function is performed after the manner of the pocket knives known to every small boy. The stabilizer and vertical fins fold into the hull like knife blades, the blades of the propellers are removed by a special quick-demounting device, a periscope is run up, and presto! The airplane is ready to dive!
***Modern Mechanix,* September 1930**

Left: caption: "Amazing in the daringness of conception, and expected to be far reaching in strategic value from a military standpoint is the remarkable new submarine-amphibian airplane secretly tested by Denmark"

312

The wings of the Danish Navy's triple-threat plane fold like the elements of a telescope when it is desired to submerge. The tail surfaces fold into the hull like knife blades.

"…Sounds like a real Jules Verne dream, doesn't it? Yet the device is an actuality. Pictures in the form of photographs are not available for obvious military reasons, but a representative of Modern Mechanics has drawn the ship from information gained by close contact with reliable sources. As a submarine, the craft is propelled by a small gasoline engine, exhausting and taking in fresh air from the periscope tubes when the craft is running under the surface - immune from gunfire and of such extremely low visibility that it is highly effective as a scout. The vessel can be further submerged, but cannot then be operated by the power of a propeller. When submerged, pumps are manually operated. Small battery-plant is carried for the lighting of the ship. The crew comprises five men. Exact details as to the armament carried are not available, though logic would indicate that aerial bombs would be the most easily carried and the most destructive weapons possible. Light torpedoes are carried, however. Among the interesting accessories of the machine are a combined wheel skid and rudder, removable railing, retractable wheels. The fact that such a plane is now actually built and operated is no less amazing to present day folk than was the announcement of Simon Lake's first successful undersea trip."

***Modern Mechanix,* September 1930**

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"The development of a practical flying submarine prototype will be both complex and laborious, but the potential returns are substantial and valuable. Consequently the concept of such a vehicle merits careful engineering examination rather than the overly optimistic accolade of a few imaginative enthusiasts and the simultaneous cold shoulder denial of the hard headed realist…It could fly from a favorable location to its destination at minimum altitude to avoid detection by radar. At the completion of its underwater mission it could travel as a submersible to a location best suited for takeoff, become airborne and return to base."

Eugene H. Handler - Hydrodynamics Engineer, *Bureau of Naval Weapons* (1965)

"…The thought of a flying submarine is one, which has been kicked around in the Navy off and on for a good many years. But this time it has gone further than talk. A contract for analytical and design studies has been given to the Convair and Electric Boat Divisions of General Dynamics Corp. The $36,000 contract sets no time limit…a possible craft with an operating depth of 25 to 75-feet, a submerged speed of five to 10 knots for four to ten hours, airspeed of 150 to 225 knots for two or three hours and a payload of 500 to 1,500 pounds…it is believed these characteristics can be attained within a vehicle weighing 12,000 to 15,000 pounds. The Japanese used midget submarines, though not with particular success, in combination with their air attack on Pearl Harbor. The Italians carried out a highly damaging raid in that same month with midget submarines against British battleships in the Mediterranean harbor of Alexandria. Those World War II craft, however, provided little hope for anything except a suicide mission. A little flying sub might carry out its mission and take its crew back."

***The Wilmington Morning News,* March 11th 1965**

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Super Clipper

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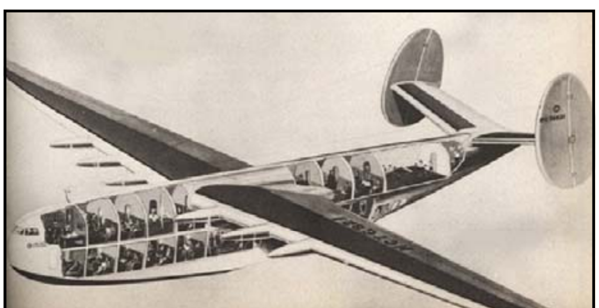
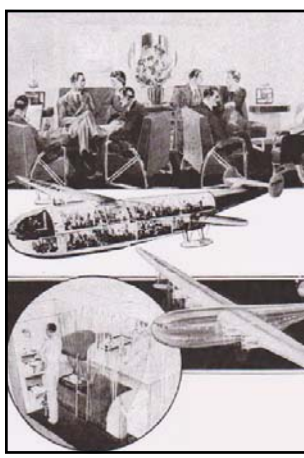
Above: the Boeing "Super Clipper." This six-engine flying boat was designed for PAA as a follow-up to the successful *Boeing 314* flying boat. The Super Clipper proposed to fly one-hundred passengers a distance of 5K-miles at a speed of three-hundred mph.

316



Above: another six-engine flying boat design from the *Martin Company* was competing with the *Boeing* proposal. Like the Boeing, it would have carried one-hundred passengers between *New York* and *London* in twelve hours. These giant flying boat designs simply couldn't compete with the more versatile, simpler and more economical post-WWII land planes like the *DC-4* and *Constellation*.

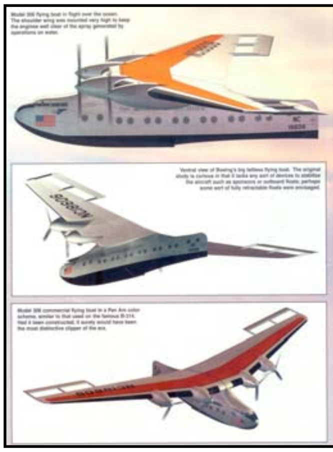
317



Left: caption: "'Giant Flying Boat to Carry Sixty-Four.' Here is an artist's ideas about how the transatlantic flying boat designed by Glenn L. Martin will look upon its completion. Top, lounge of the sixty-four passenger ship. Center, cross-section of the craft, and, below, night view of the fifty-five ton boat. Left, typical stateroom. Passenger accommodations include sixteen compartments, bar and lounge, observation deck and ping-pong room. Four engines will propel the great ship at a cruising speed of 170 miles per hour."

***Popular Mechanics,* December 1937**

318



Above: plan and front/side elevation/s of the ***Boeing Model 306*** flying boat which was never realized
Left: various views of the proposed Model 306 with PAA flying boat color schemes

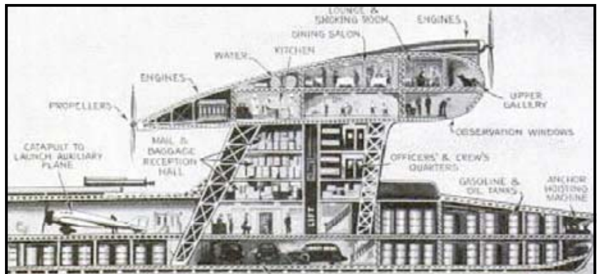
319

Ocean Air Liner

320

"Both Germany and England are visioning future transatlantic aircraft as big as the ocean liners of today, and aeronautical engineers of these two countries are designing and planning for such hydroplanes. British engineers are dreaming of an ocean air liner which would carry 1,500 passengers and hundreds of tons of cargo at a speed of 220 miles per hour, making the trip from Southampton to New York in less than fifteen hours. Drawing depicting such a craft show engines and propellers fore and aft and an auxiliary plane which would be launched from the air liner by means of a catapult. A German air company also is said to be backing a venture to build a transatlantic aircraft which would carry 200 passengers and several tons of freight at 187 miles an hour."
Popular Mechanics, **April 1934**
Left: caption: "Artist's conception of giant transatlantic plane of future visioned by British aeronautical engineers"

321



Above: caption: "Cross-section of contemplated aircraft as big as an ocean liner; note catapult for launching auxiliary plane and propellers and engines fore and aft"
Popular Mechanics, **April 1934**

322

Dynamic Control

323

"The tendency at the present time in airplane building is toward constantly increasing size. It is probably realized by all who have concerned themselves with aircraft that the larger machines are not very far in the future. From the earliest Wright airplane, which weighed approximately 1/2 ton, to the present record holder, the Do-X, which weighed fifty tons, took a period of some 26 years. The 10,000 ton airplane, projected on a like time-scale, would, therefore, make its appearance not later than the year 1952. However, with the nature of the present-day technique, it is quite possible, at this moment, that the 10,000 ton plane will be here much sooner. It is already becoming apparent that ideas of the ordinary ocean liners are more and more embodied in airplane construction; and in all probability this tendency will be followed in years to come. In other words, what we will have is a flying ocean liner that is not only airworthy, but is seaworthy as well…"
Hugo Gernsback
Everyday Science and Mechanics, **November 1934**
Left: cover of ES&M depicting the proposed "Dynamic Control Ocean Airliner"

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"….It is also a foregone conclusion that when a 10,000-ton aircraft is built, it will not be a land-type plane but for obvious reasons will have to land in water. This makes the landing and taking off much easier and more practical; because it would be most difficult to take off with, or land, a 10,000-ton weight on terra firma. The question may be raised, why such a large craft? The same principle that holds good for large ocean liners holds good for large airplanes. In the first place, in order to make it as economical as possible, the craft must carry a sufficient amount of freight and passengers, and it must also be sufficiently speedy; and, if past history is a teacher, it will be found that higher and higher transatlantic speeds are needed. The new French express steamer, Normandie, will make the Atlantic crossing from Cherbourg to New York in less than four days. The aircraft of the future, in order to compete at all, must make it in less than a day. This calls for high speed, and safety as well, which can only be accomplished by great speed…"
Hugo Gernsback
Everyday Science and Mechanics, **November 1934**

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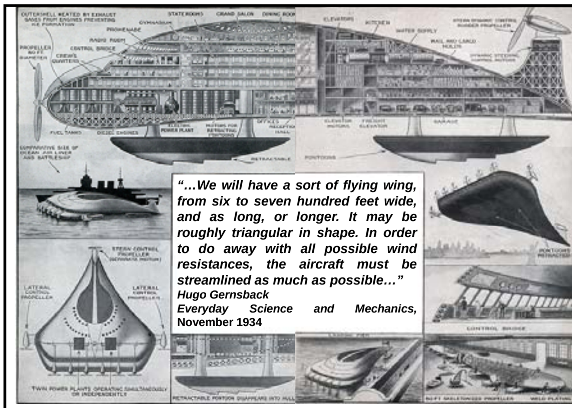

"…We will have a sort of flying wing, from six to seven hundred feet wide, and as long, or longer. It may be roughly triangular in shape. In order to do away with all possible wind resistances, the aircraft must be streamlined as much as possible…"
Hugo Gernsback
Everyday Science and Mechanics, **November 1934**

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"…Now a word as to the propellers themselves. In order to lift and drive a machine of this type, huge propellers must be used. At the present time, the largest propeller that has been developed is about 12 feet across. The airliner calls for truly gigantic propellers, which are between 75 and 80 feet in diameter. Now then, if you were to turn such a huge propeller, at even 1,000 revolutions per minute, the tip speed of the propeller would be so great that it would fly to pieces; because there is no material that man knows of that could withstand the tremendous pressure set up at such speeds. But it is not necessary, nor desirable, to drive such a huge propeller at so high a speed. Indeed, if you drive it at from 200 to 250 revolutions per minute, you get a tip speed of 2,000 miles per hour, which compares well with the speed of our present-day propellers, and the efficiency of this large propeller should be the same, if not higher, than that of the 15 foot type…"
Hugo Gernsback
Everyday Science and Mechanics, **November 1934**

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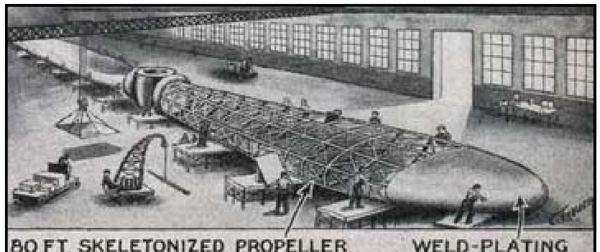

"…In order to reduce the weight, I propose that the propeller of the future airliner be built on the cantilever-bridge principle, as shown in the illustration. It is made in the form of a skeleton, and the material, the toughest known today, could be chromemolybdenum steel, or even some newer alloy, not yet commercially available, such as those of beryllium. By making the propeller hollow, an enormous amount of weight is saved. This becomes important at the huge speed with which these propellers revolve, even when geared down to 200 to 250 revolutions per minute. When the propeller skeleton is finished, it is covered with a 'tungsten-molybdenum' steel sheet, which is welded to the framework in such a manner as to make the entire propeller integral; and it becomes, in fact, almost a solid steel propeller of tremendous strength…"
Hugo Gernsback
Everyday Science and Mechanics, **November 1934**

328

"…In the November, 1932 issue of Everyday Science and Mechanics, I presented a gigantic flying liner, which had two huge pontoons to support the upper structure. Liners of this kind are under construction this very minute, although not of the very large size which I visualized in 1932, yet we are getting there gradually. There is one disadvantage with this type, however, and that is the two pontoons offer a tremendous air resistance. In the design which I present herewith, I still use the pontoons; but I have made them retractable; so that, as soon as the airplane has taken off, they will be pulled into the body of the airliner, where they will no longer offer air resistance. This is accomplished by pneumatic-hydraulic action when the machine has to land in water…"
Hugo Gernsback
Everyday Science and Mechanics, **November 1934**
Left: inventor Hugo Gernsback (1884-1967)

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"…The outstanding novelty of my present design, however, is in the dynamic controls of the airliner. In the normal airplane, we have the movable wing surfaces or ailerons for banking and turning the plane, as well as the tail and rudder to guide it in the various directions. In the present design, I have done away with these entirely, and used propellers for these purposes entirely. A number of small 'line' illustrations show the principle. The tail becomes a huge 75-foot propeller, which is arranged in such a way that the propeller can point either forward, sideways, up, or down. The direction of the propeller is, of course, handled by controls from the bridge of the airliner. Similarly, the ailerons, which are now used to tip or bank the machine, are dispensed with; and we now have huge propellers with engines which also can be either raised or pointed down, or sideways, or in any direction the pilot finds necessary. By means of this 'dynamic control' it should be possible to fly such a machine in any kind of weather or storm; because the machine will be too heavy to be influenced by anything except a typhoon. Any ordinary wind or storm would not much affect a 10,000-ton weight in the air…"
Hugo Gernsback
Everyday Science and Mechanics, **November 1934**

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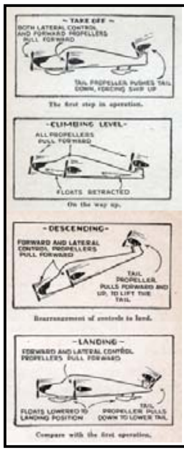

"…It will also be noted from the small illustrations that the stern propeller, as well as the side propellers, can be used to assist the airliner in rising, as well as descending. The rear propeller, indeed, by reversing its rotation, that is, by turning it around completely, is used very nicely to act as a brake in order to check the flight of the machine entirely…"
Hugo Gernsback
***Everyday Science and Mechanics,* November 1934**

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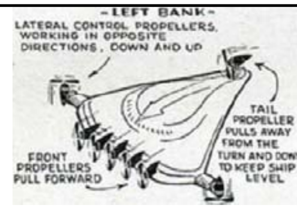

"…In the interior of the airliner, we again are using steamship principles. Instead of having separate engines for each of the huge propellers, we have two main power plants located forward in the machine. These power plants, as will be noted, each operate a set of propellers, which are geared down. Each power plant, therefore, is responsible to furnish power for one set of propellers; and should one plant break down, an arrangement is made whereby all propellers can be driven from the other when necessary. The rear propeller, from its large size, requires a power plant of its own, and is, therefore, independent of the forward propellers…"
Hugo Gernsback
***Everyday Science and Mechanics,* November 1934**
Above: caption: "How the 'dynamic controls' work"

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"…The future airliner of this type, in order to be commercially feasible, must make at least 200 miles an hour, and possibly a higher speed. It will probably fly at an altitude above 20,000 feet for maximum efficiency…There is no question that an airliner of this type will prove a formidable competitor to steamships in the future…"
Hugo Gernsback
***Everyday Science and Mechanics,* November 1934**

333

The Stratosphere's the Limit

334

"Why fly in the stratosphere? Simply because there's a free 200 mile an hour boost up there that aeronautical engineers want to take advantage of. If one could plan a railway that would run down hill all the way from coast to coast, think of the transcontinental speeds he could attain. Flying in the stratosphere is not as simple as building a downhill railway, but it is a subject which has intrigued airplane designers for a long time. Much data has been accumulated about it. Many rumors have seeped through the daily press about the wonderful trans-oceanic speeds we are going to get. All that is in the offing. Right this minute, however, enough material has been accumulated through pioneer experiments and flights to turn the minds of those of us who are engaged in the business of developing airplanes toward the possibility of building a stratosphere plane today. Under existing conditions, with existing materials, we plan to double our present speed by the simple expedient of welding this 200 mile an hour stratosphere boost to our cause. Up in the stratosphere - that layer of air between 50,000 and 75,000 feet altitude - there are steady winds that blow from West to East, opposite the direction of the earth's rotation. By these winds alone we can gain a measurable increase in our overland speed. But there is another factor. As we ascend, the density of the air becomes less and less. This eventually diminishes to a point where we have gained the effect of reducing our fuselage and wing drag; which is the same as saying we have reduced our wing surface to the minimum. At the same time, through supercharging or forcing air into the carburetor to increase performance, we have maintained our motor power output. The result is naturally a big jump in speed…"
***Allan Lockheed,* April 1935**

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"…Take today's airplane up to 50,000 - 75,000 feet (supposing you could get it there) and what would happen? A number of ridiculous things. For one thing, the engine would slow down and die. If you happened to supercharge it so it could breathe sufficient air to burn a normal amount of gas, it would run away with the propeller and would wind up at a fearful rate, probably breaking a crankshaft and throwing connecting rods all over the countryside. It would be a problem to keep the motor warm. Oils, to be effective, must run at 350-450 degrees, and the cylinders themselves must be that warm to obtain thermal efficiency from the gasoline heat energy which is doing the work. The tires of an ordinary ship would probably blow out. The people in the cabin would suffer the bends - nausea and bleeding due to insufficient oxygen and deficient air pressure. And the ship itself would load up with a ton of ice in no time…Temperatures are way down, about 50 degrees below zero - this means we've got to build a flying ice box to keep the passengers warm. And we must keep the engines warm - normal operating conditions must be artificially supplied. We'll have to design something that will take the ice off wings as fast as it is formed. The sweating of windows, the forming of fog within the cabin, all will have to be accounted for by a separate de-icing, cabin warming, pressure furnishing plant that will run independently of the main motors. This pressure furnishing feature will probably have to function in the manner of the air conditioner. It will not do to use air bottles, because they are too heavy. The cabin space must be a chamber which has intakes and exhausts for conditioned air. The link between the cabin and the outer air will be a conditioning plant. Because of the low pressures, variable area as well as variable pitch propellers will have to be used. Such devices on the business end of an engine will be comparable to the gear shift on a car…"
***Allan Lockheed,* April 1935**

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Above: caption: "A double-decked passenger plane following Lockheed's design for Stratosphere air-liners. Note the 'in-line' type motors faired into the wings, the retractable landing gear, and the wings set in the middle of the ship."

"…Purely in the matter of borrowing from terrestrial aviation what appears to be good practice, I would use two motors in my stratosphere plane design. They would be super-charged, air cooled, and of the in-line type. This type is slightly cheaper to manufacture, is more robust, and easier to service. The major qualifying point which is now bringing such motors back into their own is that they streamline into a wing so well. By putting the wing at the middle of the fuselage, making it a mid-wing ship, streamlining the motors into the wing, and allowing a retractible landing gear which can be folded to the wings to lessen air resistance, we will arrive at the design of the ultimate airplane.

Allan Lockheed, **April 1935**

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Five Hours Out of New York

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"Five hours out of New York and the flasher lights of the Central London Air Terminal are blinking their welcome to the Trans-Oceanic express as it glides to a swift, effortless landing. Five hours out of New York! This and similar pictures of future transportation have been painted ever since man first flew, but today it can be said that this is no idle fancy or paper prophecy. Even the most casual review of various activities in the United States, Great Britain and France show the vast number of experiments that are now being conducted towards this very end. Whether the final success of trans-oceanic flying lies in the development of huge flying boats such as the 'China Clipper,' or in some radically different type of boat is a question no truly progressive engineer would care to answer. This much they will say - that speeds of 500 miles an hour or more must be regarded as commonplace…"

Modern Mechanix, **May 1936**

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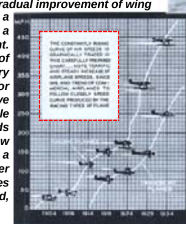
"…Fantastic and dangerous as such speeds appear to us now, it must be remembered that 20 miles an hour was regarded as being equally dangerous not so many years ago. The entire history of the motor car and airplane has been one of increasing speed. Again; the history of car and plane alike points to the fact that speeds developed in racing models are rapidly transferred and absorbed by the commercial patterns. So swift has commerce been to adapt the lines of speed planes that today in the United States there is the extraordinary situation of regular air liners being miles faster than the majority of the world's best military pursuit planes. Racing planes are now assaulting the 500 miles per hour mark. It is reasonably certain that the time is not fare off when purely commercial planes will be equaling if not actually surpassing this figure. That speeds like this will be attained with the conventional plane of today with it's numerous power plants strung like beads along the large-spanned wings is dubious. What is more likely and probable is the gradual improvement of wing sections (which is constantly in process) attaining a point whereby it will be possible to dispense with a great deal of the area now essential to safe flight. Then; what today forms the predominant portion of a plane may well become a mere rudimentary member with, possibly, extensible surfaces for landing and other maneuvers which involve reduced speed. As a matter of plain fact the whole tendency of wing design today is directed towards this goal as pictured on the cover. To bring New York within five hours of London would mean a facility almost beyond our imagination. Other complications, such as the continual threat in times of war to countries erstwhile virtually isolated, would attain fantastic proportions."

Modern Mechanix, **May 1936**

Above: caption: "With wings reduced to a minimum this trans-oceanic plane is planned to span the Atlantic in five hours. In place of numerous motors blanketing over-sized wings, this craft uses a single power plant installed in the hull to drive a series of small, variable pitch blades constantly revolving about the circular ship"



Right: caption: "The constantly rising curve of air speed is carefully traced in this carefully prepared chart…note terrific and steady increase of airplane speeds since 1919 and trend of commercial airplanes to follow closely speed curve produced by the racing type of plane"

340

Colossus of the Air

341

"'All ashore that's going ashore! The ship flies in five minutes!' From your porthole four decks above the water you watch the last of the 500 passengers come onboard the plane. Sea doors clang shut, lines are cast off, and the captain's pouch containing last-minute mail is drawn up from the wharf. A faint throb indicates that the engineers in the wing are speeding up the engines. A small policing plane dashes out to sea and returns, it's powerful green 'all clear' light signals that the take-off course is clear. Then the monster liner gets under way. Spray beats against the portholes as the boat plows along to attain its take-off speed of 170 miles per hour. In two and a half minutes the 1,500-ton titan lifts itself out of the water and the navigating officer is methodically setting a course for London, eleven hours away. It sounds fantastic, but engineers think you will be buying tickets for a one-day ride to Europe is such a giant within twenty years. The fare will be about as little as you pay now for a middle-class cabin…"

Popular Mechanics, **December 1936**

342

"…This 1500-ton colossus of the air would weigh about the same as a modern destroyer. Its 200,00-horsepower plant is approximately that of the 'Queen Mary' or the U.S.S. 'Saratoga.' The hull would be 375 feet long and the monoplane wing would be 350 feet long. The wing would be sixteen feet high, leaving plenty of room inside for engines and engineers. The boat would have a cruising speed of 300 miles per hour at 10,000 feet altitude and it would need a run of nearly five miles to get into the air. The hull would be a modified 'V' design to help absorb the landing shock and the boat would need three-quarters of a mile in which to land. The cost would be about $20,000,000, about half the price of the 'Queen Mary'…"
Popular Mechanics, **December 1936**

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"…the tail group would weigh forty-five tons. The wing would weigh 165 tons, the hull, which would have to be strong enough to smash through seas at 170 miles per hour, 150 tons, the power plant, 300 tons, and fixed equipment such as interior furnishings, another ninety tons. This places the total empty weight of the boat at 750 tons and allows a useful load of the same weight, of which about a third, on a long ocean crossing, would be pay load. Fuel and oil for one trip amount to 500 tons, and twelve and nine-half tons are allotted for the crew. It would take 100 people to operate the boat and take care of the passengers and the crew would live on board permanently. Passengers and their luggage are estimated at sixty-seven and one-half tons, leaving 170 tons available as cargo, including mail and express matter. With a full load the boat would have a cruising radius of 4,800 miles, enough to cross the Atlantic non-stop with a very comfortable reserve. The boat would be able to fly 7,000 miles non-stop if passengers and cargo were replaced with fuel…"
Popular Mechanics, **December 1936**

344

"As we see it now the flying boats of the future will be simple geometric enlargements of our present types with any minor improvements that may be developed. Actually, an efficient boat in the 1,500-ton class could be built at once if the demand existed."
Schuyler Kleinhaus, **Flying Boat Designer (1936)**
RE: paradoxically, large commercial planes are faster than small ones. Doubling an airplane's size multiplies its air resistance four times and its weight eight times. To carry this weight, eight times as much power is required but since the air resistance is only increased four times, the plane can fly faster. Thus, doubling the size results in an increased speed of 26-30%.

345

"Capable of carrying 500 passengers, the flying boat of the future will be as large as a destroyer, according to Schuyler Kleinhaus, designer for one of the leading aircraft companies. More than 375 feet long, with a wing spread of 550 feet, the 1,500-ton air liner would be powered by a 200,000-horsepower engine system which would propel the craft at 300 miles per hour at an altitude of 12,000 feet. Such a plane could cross from New York to Liverpool in eleven hours. It would be multi-decked, deep hulled. A crew of 100 would be required, according to the designer, who has prepared a sketch of the flying boat. This sketch pictures the liner hawsered to a steamship dock, with a destroyer of about the same length in the background to give some idea of the size of the flying boat. Powered by four engines, possibly of the Diesel type, the craft would cost about $20,000,000."
Popular Mechanics, **October 1936**
Above: caption: "Here is the designer's idea of how the giant transatlantic air liner of the future will appear. Note the great wing spreading over the deck. Destroyer in the background helps to illustrate the plane's size."

346

"…Instead of being assembled in factories the flying boats would have to be assembled in shipyards or 'planeyards.' The hulls would be launched like any other kind of ship. Flying boats adjacent to the open ocean would be necessary because it might take half as long to taxi at legal speed down the length of New York harbor as it would to fly the rest of the way to Europe…"
Popular Mechanics, **December 1936**

347

"…The type of power plant that would be used would depend upon the outcome of the unceasing competition between the designers of gasoline engines, Diesels, and steam. Right now gasoline engines have the advantage in light weight per horsepower. In this theoretical liner three pounds per horsepower are allotted for engines, enough to permit heavier Diesels to be used, and even admitting steam as a strong contender. A revolutionary system of manufacturing steam eliminates the heavy boilers and many engineers think that steam will be the most practical source of power for heavy airplanes…"
Popular Mechanics, **December 1936**

348

"…Engineers generally agree that the big boats will have four propellers, each operated by a 50,000-horsepower engine unit. The big airplanes will theoretically cruise at seventy per cent of full power, and by dividing the power into four packages, this division permits total failure of one engine unit without crippling the ship. Figuring out the propellers for the super air liner brought a real surprise. They must be five-bladed, it was concluded, and sixty feet in diameter. They will revolve at only 200 revolutions per minute at cruising speed. This seems a dangerously slow speed but it is tip speed that counts instead of revolutions per minute, and with such long blades the tip speeds will be more than enough. The propellers will need to be mounted on hollow shafts twenty inches in diameter and will cost about $3,000,000. A large part of this amount will go for preliminary research…"

Popular Mechanics, **December 1936**

349

"…Will the future giants of the air pay their way? Yes, the flying boat designers declare. Not only that, they should show higher profits than the large surface ships. Comparing the 1,500-ton flying boat with the 'Queen Mary,' in two weeks of operation the plane would make five round trips while the surface ship accomplishes one round trip. Yet each could transport the same number of passengers in that time…on a schedule of two round trips per week in the Atlantic service, carrying an average of sixty per cent passenger capacity, the flying boat should show a net profit of $3,000,000 at the end of five years…based on a charge of about $350 per round-trip ticket…"

Popular Mechanics, **December 1936**

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Left: in the minds of conceptual artists, bigger was better when it came to the future of flying boats. This liner-sized flying boat from 1943 for the mythical "World Skyways" is a fine example of this mindset

Right: rendering by illustrator *George Shepherd*, representing a utopian vision of the giant flying boat of the post-WWII era, also an excellent example of 1940s streamlining.

351

Beachhead Flying Boat

352

"Giant twin-hull flying boats, weighing 250 tons or more may be the amphibious craft for beach landings on hostile shores in future wars. Such huge seaplanes could carry 1,000 men plus equipment, would fly at speeds approaching the top speeds of the fastest land aircraft, and upon approaching a hostile shore would land in the water, taxi up to the beach and open armored bow doors to discharge their troops…"

Popular Mechanics, **September 1949**

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The Aeromarine

355

The Aeromarine, which is still in the workshop stages, will be a high performance plane that can be operated from land or water or driven like an automobile—making it ideal for the all-around weekend sportsman…As a car it will be a power tricycle with a top speed of 50 mph. Power for humming down the highway will be fed to the rear wheels of the landing gear; steering will be through the single front wheel. As a boat—well, it'll float fine. If you want to go up the lake for more bait, why not let down the hydro-ski under the hull and make a short hop of it? As a plane the Aeromarine is expected to show considerable class. It will have a range of 800 miles on 80 gallons of gas, a top speed of 225 mph. Cruising speed, with five aboard, will be 200 mph. It will take off with a run of 800 feet, land at 57 mph…"

Mechanix Illustrated, June 1956

Aeromarine's rear-mounted engine and prop will mean an unusually quiet cabin.

Ability to operate off water should insure Aeromarine's popularity among sport flyers.

As a car it will be a medium performer with an estimated top speed of 50 mph.

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Part 5

Transoceanic

357

Flying Down to Rio

358

As the 1930's began, commercial aircraft still did not have the ability to cross the *Atlantic*. *Charles Lindbergh* had shown that it was possible, but a lone airman's risky flight didn't yet qualify for regularly scheduled transatlantic service. Most heavier-than-air aircraft were flying boats. By 1934, commercial air transportation had begun between the U.S. and the islands of the *Caribbean*. It was possible to fly from *Miami* to *Rio De Janeiro* in the *Sikorsky* flying boats made famous in the film "Flying Down to Rio" (movie poster at left). At the same time, German Zeppelins were plying a profitable trade transporting passengers from Rio to *Dakar* (the closest point between the eastern and western hemispheres) and then on to *Europe*. The stormy Atlantic was as yet impassible, so travelers returned on luxury steamships.

Above: medallion of the *Railway Express Building* (1929) in *Baltimore* (located next to the railroad station.). Note the mixed symbolism of air, wheels and wings plus a federal shield.

359

"Crossing the Atlantic ocean by air has been removed from the category of high adventure to a regular form of transportation running on schedule. For the traveler who is in a hurry, one steamship line has established, as a part of its regular service, a trip by air, rail and water which permits the tourist to cover three continents, or about 16,500 miles, in from nineteen to twenty-one days, depending on the speed of the steamer he uses. The three weeks' trip spanning three continents covers North America, South America and Europe. From Miami the traveler goes by plane to Rio de Janeiro or Pernambuco, then he boards the 'Graf Zeppelin' which makes regular trips from Rio de Janeiro to Friedrichshafen, Germany. From Germany the tourist travels by rail to Cherbourg, France, where he boards a liner for the trip to New York."

Popular Mechanics, September 1934

Above: caption: "Route from New York to Europe and return, showing the parts traveled by plane, dirigible, train and boat"

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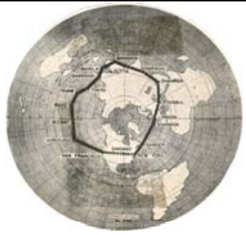

"…The American government foreseeing the immense advantage of a merchant air marine….transatlantic air service may be in effect before the end of 1934. What chance have American interests to obtain and hold leadership in aerial commerce across the Atlantic? By all indications, they appear to have an advantage over all foreign competitors…"
***Popular Mechanics*, March 1934**
Above: caption: "Proposed round-the-world air route"

361

Three Flights

362

"Trans-Atlantic flyers are getting less and less acclaim with each successive crossing. Those who made the trip in 1930 created scarcely a ripple when compared to the sea of honors which swamped Lindbergh in 1927. This is as it should be, for it shows that the public is accepting the air as a logical medium of transportation. Three successful east to west crossings of the North Atlantic during the past summer of 1930 revived the old question of how soon the old and new worlds will be linked by air. The Southern Cross hopped from Ireland to the Canadian coast, carrying four men. Coste and Bellonte in the Question Mark flew non-stop from Paris to New York, reversing Lindbergh's flight. And a Dornier Wal boat, piloted by Captain Wolfgang von Gronau, with three companions, made the trip from northern Germany to New York in a series of easy stages. Of the three flights the last was the least spectacular and the most important. In fact, spectacular flights have little importance in the development of commercial aviation, except insofar as they center public attention on flying and point to its high safety factor. The reason the von Gronau flight should take precedence over the others is because given reasonable landing, refueling and repair facilities in Iceland, Greenland and on the Labrador coast, there are any number of ships in existence today that could operate a regular passenger, mail and express air line over the same route with a reasonable degree of regularity…"
***Popular Mechanics*, January 1931**
Above: flags on the world map mark the 52 landings over 126 days covering 44,392 km made by von Granau's flying boat

363

"…A remarkable example is the old Dornier-Wal, D1422, which recently was retired from service and placed on exhibit in the museum of Munich, Germany. It began its career in 1925 above the Arctic ice when Roald Amundsen and Lincoln Ellsworth tried to fly to the North Pole. Two years later, Capt. Frank T. Courtney, the British war ace and test pilot, used it in an attempt to fly the Atlantic from east to west, starting from the Azores. Finally, in 1930, the veteran of the air carried Wolfgang von Gronau and his companions on their pioneer flight from Germany to America, in which they followed the trail of the Norsemen, flying by way of Iceland, Greenland and Labrador. After seven years of exploring uncharted skyways, D1422 was still flying when it was retired from service…"
***Popular Mechanics*, February 1933**

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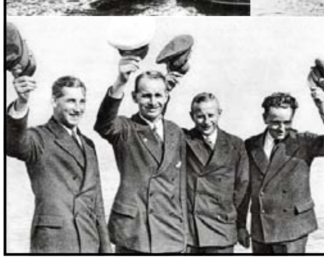


Top Left: the "Whale" safely landed on the Hudson River near *Battery Park* in lower *Manhattan*: August 26th 1930
Top Right: the *Dornier* "Wal" flying boat of Captain Gronau
Left: the crew (left to right): *Gert von Roth, Wolfgang von Gronau, Fritz* and *Franz Albrecht Hack*

365

A Great Circle Course

366

"…A non-stop hop across the Atlantic from New York to any of the European capitals is something to excite the imagination, but there isn't a plane in existence today that can make that trip and carry an adequate pay load…That is why the route blazed by von Gronau, and twice attempted in the opposite direction by American planes - one a Stinson land craft and the other a Sikorsky amphibian - is attracting the attention of aviation leaders in both continents. With proper facilities along the route, and using two land planes and a flying boat or amphibian, it offers possibilities for regular operation with existing aircraft. From New York to Chicago fast air liners could transport passengers, mail or express, to a flying field on the Labrador coast. Transferring there to a flying boat, the next hop would be to a sheltered harbor on the south coast of Greenland, and from there to Iceland and either the Orkney Islands or northern Scotland. Another land plane from there would connect with all the continental air lines at London, or, for northern Europe, a line could run from the Orkneys to Berlin or the Scandinavian capitals. Nature, in laying out the land masses of the world, seems to have provided an ideal round the world route in the northern hemisphere. Few landsmen, brought up on the Mercator projections used in school geographies and other flat maps, realize its possibilities. For example, the shortest distance between Berlin and Mexico City is a line passing through Chicago. The shortest route from Chicago to Tokyo is a line passing through Winnipeg, Canada and Nome, Alaska. You can prove that, if you have a globe, by taking a piece of string, holding one end at Chicago and stretching the string to Tokyo. That's what the mariner and the aerial navigator call a great circle course. A great circle is a line passing around the world and the shortest distance between any two points will be the great circle passing through both of them…"
Popular Mechanics, **January 1931**

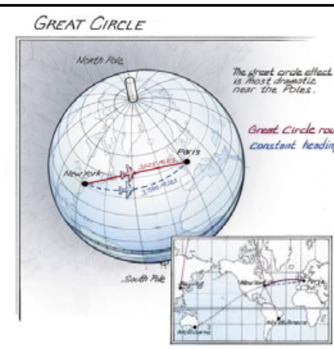
367

"…the great circle courses, which are the shortest distances between two points, appear as straight lines. Thus Berlin, Chicago and Mexico City are virtually on a line, and the great triangle of Chicago, Warsaw, Tokyo and back to Chicago represents the nearest approach to an all land route around the world. Chicago, it will be seen, is the logical focal point for air lines from North America to Europe and Asia. This map shows the routes suggested and in addition points out many of the existing airways which would serve as connecting links…"
Modern Mechanics, **January 1931**
Left: projected great circle course routes

368

"I have been away two years, and I came home from the South Pole that much behind in the development of aviation. But I found most of the air lines still using virtually the same Ford ships I flew to the North Pole three years ago and the same Fokkers I flew to the South Pole last year. In big transport ships there has been virtually no development, and, unless the manufacturer can show some reason for continuing with the present tri-motored craft, which are admittedly less than 50 per cent as efficient as a single motor job, he should seek development along some other line. If some manufacturer will produce a fast transport with engines in the wing and retractable landing gear, virtually a flying wing, I have a use for it right now and am ready to order the first one."
Admiral *Richard E. Byrd,* USN
RE: the widening depression hit the air transport and airplane manufacturing business harder than most other burgeoning industries of the era. Because of this, airplane design – for both land planes and flying boats, began to lag behind for the expansion of commercial aerial transport. However, aerial survey flights continued in earnest. "Shorty" *Cramer* and *Bert Hassell* attempted to fly to *Europe* by way of *Greenland* and were forced down on the Greenland ice cap when they lost their way and failed to find their gas cache. In a later flight, they flew to *Nome* in a *Cessna* and flew over to *Siberia* to survey the possibilities of that air route. Even in late winter, Cramer found no obstacles to a regular airline route. From the Siberian coast down to *Vladivostok,* he found no particular obstacles and from there to *Moscow* and *Berlin,* the route was flown many times. This round the world northern route was mostly over land, with the longest ocean hop not more than six-hundred miles. There was a short jump across the *Bering Strait* (between *Alaska* and Siberia) and the over-water hops from *Labrador* to Greenland and from *Iceland* to *Scotland*.

369



Above: caption: "When aviators navigate long distances, they plot their courses using the "Great Circle" which compensates for the errors of two-dimensional map projection. The constant-heading path from *New York* to *Paris* on a flat map (dotted line) is longer than the variable-heading Great Circle path."

370

All Aboard for Europe by Air!

371

"…All aboard for Europe by air! The long-awaited plans for transatlantic flight routes have crystallized beyond the blueprint stage and are now up for immediate action. Five major operating companies of Europe and America have donated all transatlantic information to a common pool, from which any participant may take whatever data are needed. As a result, Pan American Airways, collaborating with Imperial Airways, Lufthansa, Air France, and K.L.M., the Royal Dutch Lines, will be in a position to decide at once which is the most favorable route. Lindbergh's report on his North Atlantic survey is also available to the foreign operators…"
Popular Mechanics, **March 1934**

372

"…There will be two routes to Europe, one by the great circle course between Newfoundland and Ireland, the other by the Azores. The great circle route has the advantage of being shorter, while the Azores lane offers safety from winter storms and provides a point at which the journey may be interrupted for servicing the ships. Still a third route, by way of Greenland, Iceland and the Orkney islands is available, but the distance is greater and travel would be almost impossible in winter. The third route was surveyed by Col. Charles A. Lindbergh several years ago…"
Popular Mechanics, **December 1936**

373

Above: caption: "Chart of the Transatlantic Fliers. This shows graphically the course of the first airplanes and airships which crossed the Atlantic. The U.S. Navy seaplane, NC-4 (Read), was first to make the flight, May 16-27, 1919, making a stop at the Azores (actual flying time 26 hours, 45 minutes). A British biplane (Alcock and Brown) made a non-stop flight, June 14-15, 1919, in 16 hours, 12 minutes. The British dirigible R-34 made a round trip from Great Britain to America and back, in July 1919. The ZR-3 (now the 'Los Angeles'), built in Germany, flew from there to Lakehurst, N.J., in October, 1924. The American round-the-world fliers crossed the North Atlantic by way of Iceland, Greenland, and Canada in 1924."

374

The Immutable Law of Averages

375

"No less than 11 trans-Atlantic flights, carrying 28 passengers, are being planned for this summer. Cold mathematics, based on a record of past performances, prove that 40% of these flights will fail and that upwards of 11 persons will die in them - unless recent advances in airplane construction afford this season's pilots new factors of safety. Despite the fact that the immutable law of averages decrees certain death for several of their number, more than two dozen pilots and passengers and 11 airplanes are going ahead with preparations to fly the Atlantic this summer. Some of the flyers are making the trans-Atlantic flight for scientific reasons; others frankly have no regard for science, but look on the matter as a joy flight and a sporting proposition; others are probably thirsty for the newspaper fame which will surround them with a halo of national glory if they succeed. But, regardless of their purposes, every man and woman who heads out to sea in an airplane is fighting the law of averages which says that 40% of the flyers who have attempted Atlantic crossings have landed in watery graves. Grim and inexorable is the law of averages. It can't he repealed. It is about as amenable to flattery, bribery, coaxing and persuasion as an Egyptian Sphinx. Its personality is as friendly as a set of multiplication tables from an arithmetic book. When it says something, it means it. And it says - make no mistake about it - that 11 trans-Atlantic flyers are going to die if they carry out their plans. Maybe you don't believe it. Maybe the trans-Atlantic flyers don't believe it. But the law of averages doesn't care. It will simply produce some such piece of irrefutable logic as this: Nine trans-Atlantic flights have failed, bringing death to pilots and passengers. Twenty-one persons perished on these expeditions. At the same time, 15 similar flights succeeded. Out of 24 attempts, therefore, 9 failed - slightly less than 40%. Applying this 40% average to the forthcoming flights, therefore, it is easy to predict that 4 or 5 flights will fail and that 40% of the 28 passengers - about 11 - will perish…"
Popular Mechanics, **August 1931**

376

Above: list of previous trans-Atlantic flight/s fatalities and successes
Left: caption: "Composite map of the trans-Atlantic and round-the-world flights planned for this summer. Note how time to travel around globe has shortened."
Popular Mechanics, **August 1931**

377

Ruth Nichols and the fast Lockheed Plane in which she hopes to make a 13-hour Atlantic crossing. Comparison of her plane's performance with Lindbergh's Spirit of St. Louis, shown graphically in the corner drawing, indicates how improved plane design has bettered the chances of ocean flyers by increasing the speeds and reliability of their machines.

"…There is a slight joker concealed in this statement, however, which you may have ferreted out for yourself. It is this: These averages were compiled on planes which made their trips, mostly, between 1927 and 1930. There is a vast difference between Lindbergh's Spirit of St. Louis, for instance, and the Lockheed plane which Ruth Nichols hopes to pilot to Paris. Lindbergh's ship had a 225 horsepower motor and a cruising speed of 95 miles per hour. The trans-Atlantic Lockheed has a 660 horsepower motor - almost three times as powerful as Lindbergh's. The motor itself is slightly larger than Lindbergh's, but most of the increase in horsepower is attributable to supercharging. With a cruising speed of 175 miles an hour, therefore, the hazards of an Atlantic crossing are considerably lessened. And there are other improvements, which will be mentioned a little later, that give the 1931 crop of flyers an advantage over their pioneering brothers…"
Popular Mechanics, **August 1931**

378

"…to a coldly scientific mind, a successful flight by Ruth Nichols to Paris would not be deserving of the same acclaim which greeted Lindbergh, may be found in the fact that the Lockheed plane which Miss Nichols flies has a cruising speed 80 miles an hour faster than Lindbergh's; it has an engine three times as powerful which is extremely unlikely to fail in the air; it has a variable pitch propeller which enables a heavily loaded ship to take off easily, changing back to high speed pitch when in the air; it has a Sperry artificial horizon, which tells the position of the plane in fog or snow - that is, whether it is climbing, diving, or whether one wing is low; it has three compasses to warn of deviation from the course; it has warning instruments to indicate when ice is forming on the wings, giving the pilot a chance to climb to a stratum of air where ice cannot form. What Miss Nichols' flight may prove, therefore, is not that she is a feminine runner-up to Lindbergh, but that a modern airplane is too well powered and so well equipped that much of the danger of an ocean flight has been eliminated. Miss Nichols, in other words, is all set to start the law of averages working again on a new set of facts…"
Popular Mechanics, **August 1931**

379

Let's turn to some of the projected flights and see what spectacular sort of fare will be offered to the aviation public this summer. First comes the round-the-world trip of Clyde Pangborn and Hugh Herndon. They plan to circle the globe in two weeks, setting all sorts of new records, but they're doing it purely for the fun of it…Then there are John Henry Mears and Vance Breese, all set to give Herndon and Pangborn a race for their money. They're going around the world, too, following much the same trail as Herndon and Pangborn. The object is to lower the round-the-world speed record, which Mears has held twice, but which is now claimed by the Graf Zeppelin…A third round-the-world entrant is Wylie V. Post of Oklahoma City, who is flying a Lockheed ship furnished him by Winnie Mae Hall, daughter of an oil magnate. Harold Catty is Post's navigator. That makes three planes planning to circle the globe…Now for the lady claimants to trans-Atlantic honors. There are two of them, Ruth Nichols and Laura Ingalls, both of whom plan solo flights to Paris. Miss Ingalls is completing arrangements for a solo hop across the Atlantic in a Lockheed ship similar to that of Miss Nichols. Patrick McCarty is planning a hop from Newfoundland to London, by way of Greenland and Iceland. His plan appeals to the imagination, for he is not taking off alone. He will use a tri-motored Bellanca seaplane, carrying eight passengers and a crew of four. There is a substantial purpose behind this flight, which is to prove the practicability of trans-Atlantic airplane passenger carriers. All of the flights thus far made have been by planes stripped down to bare essentials, where every person carried was a member of the crew, helping out in the piloting as the need arose. Two-thirds of the McCarty plane's load will be passengers who will have nothing whatever to do with piloting the ship. But, pilots or not, they're fighting the law of averages just the same. Otto Hillig, a wealthy photographer of Liberty, N. Y., plans a 3,100-mile hop from Newfoundland to Copenhagen with his pilot, Holgar Hoiriis. Russell Boardman of Boston aspires to new non-stop distance honors in a flight to Constantinople or Moscow. Roy W. Ammel of Chicago plans a solo New York to Paris hop in a low wing Lockheed…Capt. Donald B. MacMillan, famous Arctic explorer, and his pilot, Charles F. Rocheville, plan to fly across Labrador, Greenland, Iceland, and on to London to blaze a commercial air trail across the ocean…"

Popular Mechanics, **August 1931**

380

Ego-Tripping (?)

381

"…Every trans-Atlantic pilot, it is safe to say, has all sorts of confidence in his ability to carry out his plans successfully. The United States government, however, as semi-officially represented by its weather bureau, doesn't share this enthusiasm. In fact, it frowns upon these flights as suicidal, purposeless from a scientific point of view, and inspired by a desire for notoriety. It issues weather forecasts to flyers because it has done so in the past, but it does so grudgingly, realizing that it would be in for considerable criticism if a flight failed because of adverse weather conditions which the bureau failed to warn against. Without mentioning any names, it frowns also on the 'sex competition' which the projected solo flights of women have injected into the trans-Atlantic game. Being the first woman to fly the Atlantic, or to reach a certain altitude, or to do a dozen outside loops, doesn't mean a thing to the coldly scientific bureau except that the women concerned have snatched a laurel wreath which may temporarily decorate their brows until some other woman snatches it off. When men have set and held all maximum air records, there is little scientific glory left for the woman who comes closest to matching the marks, in the view of the weather bureau, however much human interest there may be in her feat…"
Popular Mechanics, **August 1931**

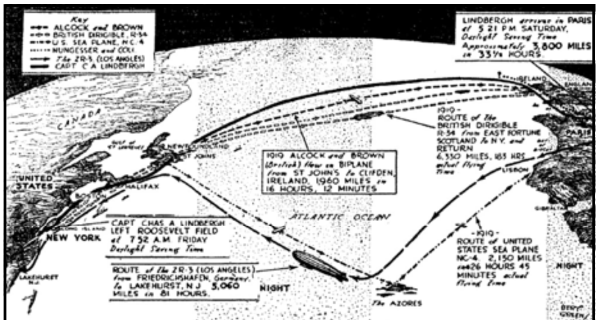
382

Lucky Lindy

383

"It will be news to millions that Colonel Lindbergh needs to be taught navigation…If the Colonel doesn't know how to navigate, who knows anything about anything?"
New York Times**, 1928**
RE: in spite of all the obstacles, Lindbergh made landfall in *Ireland* within three miles of his intended site, an extraordinary feat. His skill in maintaining a heading while exhausted is an indisputable achievement, but the *National Aeronautic Association* (NAA) observer for the flight; *John Heinmuller*, also noted that the pressure distribution over the *Atlantic* on the two days of the flight was such that the net wind drift was zero: *"the first time such unusual weather conditions have been recorded by weather experts."* The magnitude of Lindbergh's accomplishment led many to believe that transoceanic air navigation was simply a matter of will and determination. In fact, he relied entirely on "dead reckoning" - calculating his position from point-to-point by tracking his airspeed. He used a clock and compass just as he had between checkpoints while flying airmail. Through the rest of 1927, at least fifteen people died in ocean-crossing attempts leading to calls for federal regulation. While inexperience played a role in many of these accidents, inadequate navigation technology had let nearly everyone down, causing everything from inconvenience to fatalities.

384



Above: caption: "The Conquest of the North Atlantic by Airplane and Dirigible. The various crossings that have been made by airplane from Portugal, Spain, and Italy across the South Atlantic to South America, consisted of a series of short 'hops.' Those flights began in 1922, when Cabral and Coutinbo flew from Lisbon to Rio de Janeiro. Early in 1926 Commander Ramon Franco flew from Palos, Spain, to Buenos Aires, a distance of 6,230 miles, and since then Colonel De Pinedo has negotiated the distance between Rome and the Argentine city."
***The Literary Digest*, June 4th 1927**

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"Over the Straits of Florida my magnetic compass rotated without stopping…I had no notion whether I was flying north, south, east, or west. A few stars directly overhead were dimly visible through haze, but they formed no constellation I could recognize. I started climbing toward the clear sky that had to exist somewhere above me. If I could see Polaris, that northern point of light, I could navigate by it with reasonable accuracy. But haze thickened as my altitude increased…Nothing on my map of Florida corresponded with the earth's features I had seen…where could I be? I unfolded my hydrographic chart (a topographic map of water with coastlines, reefs, wrecks and other structures)…. I had flown at almost a right angle to my proper heading and it put me close to three hundred miles off route!"
Charles Lindbergh
RE: in 1928, *Charles Lindbergh,* once again piloting the *Spirit of St. Louis*, lost his way somewhere between *Havana, Cuba* and the southwest coast of *Florida*. It happened in the middle of the night and it alarmed Lindbergh enough that years later he recalled the incident in his memoir: "The Autobiography of Values." His nearly tragic *Caribbean* trip, however, turned out to be a critical moment in time, not only for Lindbergh's understanding of navigation but also for the advancement of the practice for all aviators. It may be hard to believe Lindbergh didn't learn to navigate until the year after his nonstop *New York*-to-*Paris* flight, but in 1927 the practice was still more art than science. Aviators had attempted to cross the *Atlantic* with various degrees of success since 1919, but they were still using tools and methods designed for seafaring, and those were proving unsuitable for the skies.

386

Shooting the Sun

387

"It was a lot of fun 'shooting the sun' with the Memphis sextant. I was fortunate enough to hit it with a fair degree of accuracy."
Charles Lindbergh
RE: Lindbergh watched in anguish as others attempting his feat disappeared at sea. After finishing his *Latin America* and *Caribbean* tour with the *Spirit of St. Louis* in early 1928, he was eager to find better equipment and procedures for future flights. Though he had dismissed celestial navigation for his 1927 trip to *Paris* (fixing position with sun and star sextant sightings), he resolved to pick up the skill. Upon his return, Lindbergh began planning an around-the-world flight, scheduled to kick off a few months later in a *Ford Tri-motor* provided by *Henry Ford* and copiloted by his close friend, *Thomas Lanphier*. That April, he went to observe air operations aboard the *USS Langley* – the U.S. Navy's experimental aircraft carrier, where he encountered an enthusiastic Navy Lieutenant Commander; *Philip Van Horn Weems*, who was conducting navigation experiments for carrier-based aircraft. Weems demonstrated several of his innovations to Lindbergh including a bubble sextant that he was helping the *National Bureau of Standards* (NBS) to improve and his prototype "Second-Setting Watch" - the first true aviator "hack" watch that could be set precisely to the second. Later, the U.S. military realized the benefit of this precision and began to synchronize multiple watches for field operations, thus making famous the line: "Gentleman, synchronize your watches."

388

Avigation

389

Several weeks later, after donating the *Spirit of St. Louis* to the *Smithsonian Institution*, Lindbergh decided he would set out from *Washington D.C.* for *Detroit* to finalize his plans with *Henry Ford* and Lanphier. He felt the trip would be an ideal time to learn "avigation" - a popular term used in the 1920's and '30s to differentiate air navigation from maritime practice. He asked polar explorer *Lincoln Ellsworth* for suitable tutors. Ellsworth recommended Weems. Weems approached Lindbergh's training with items from his bag of tricks, including his hack watch. Previous chronometers could be set only to the minute; this was an acceptable error for nineteenth century mariners who might go weeks or more before stopping and making an adjustment, but not for twentieth century pilots who could use radio broadcasts to synchronize their timepieces. A watch error of thirty seconds could throw off a position calculation as much as seven miles, so Weems' innovation was significant. Weems used most of the lessons to teach Lindbergh how to find his position by shooting the sun with a very rare sextant. It was a 1924 *Bausch & Lomb* model, of which only six were made, and Weems believed it was still the best model available in the *United States*. Bubble sextants had been around for more than a decade, but because so little attention had been paid to aerial navigation, their design had not advanced much. During his sessions with Lindbergh, Weems carefully studied the sextant's deficiencies, later taking his notes to the NBS, which worked with Bausch & Lomb to produce an improved version that saw wide service in the 1930's.

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Above: U.S. Patent drawing for Weems' "hack" watch
Left: Weems used this sextant in training ***Charles Lindbergh*** and ***Lincoln Ellsworth***. The NBS designed it for the USN in 1924, and ***Bausch & Lomb*** manufactured it. 391

Left: the "Lindbergh Hour Angle Watch" was a popular item during the height of Lindbergh's celebrity

392

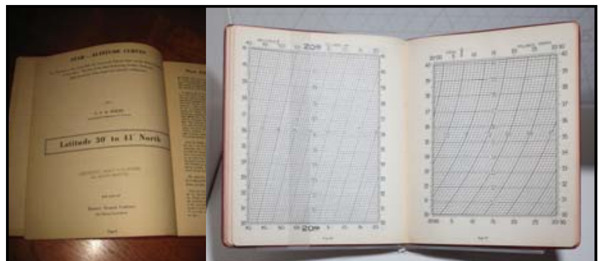
Teaching "Lindy" Navigation

Why the World's Greatest Pilot Is Learning from a Tutor the A B C's of the Science of Finding His Way

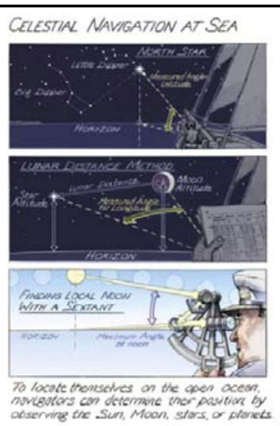
"…toiled cheerfully for days over head-splitting mathematics...Lindbergh makes a fine student. He studies till twelve or one o'clock and does not get 'fussed' or rushed…didn't really do much instructing…was brilliant and caught on quickly. He instructed himself."
Philip Van Horn Weems
Right: caption: "Lindbergh's tutor in the science of navigation, Lieutenant Commander Philip V.W. Weems, U.S.N., demonstrates the simplest method of taking bearings, using a sextant and the wrist watch seen on his left arm."

Lindbergh's tutor in the science of navigation, Lieutenant Commander Philip V. W. Weems, U.S.N., demonstrates the simplest method of taking bearings, using a sextant and the wrist watch seen on his left arm.

393



Another Weems innovation used in Lindbergh's training was his "Star Altitude Curves" (above); a revolutionary set of charts that let a navigator find his position using two stars (one was usually the north star, *Polaris*). The graphs helped cut the calculation time from fifteen minutes to forty seconds. During the day, instead of triangulating position using two stars, a navigator could use the sun to determine a line of position. By measuring the angle between the horizon and the location of the sun on its daily path, a navigator could draw a line on the globe and be assured that his position was a point somewhere on that line. In "Line of Position," Weems published a comprehensive guide for this more difficult calculation. 394



Above: Weems using a bubble sextant. Note the large "Second-Setting Watch" on his arm.
Left: caption: "Sailors can find their locations by using a sextant to observe the angle of the sun, moon or stars off the horizon, then using this measurement to calculate their line of position. Aviators can do this with a bubble sextant, which gives them an artificial horizon at altitude." 395

"Lindbergh flew his ship with one hand and took a sextant altitude of the sun with the other! I am confident that this was the first time in history such a thing had ever been done."
Philip Van Horn Weems
RE: Weems' system was still a work in progress. He noted that Lindbergh's accuracy could be off by as much as fifteen or twenty miles. Shooting the sun next to the pilot, however, Weems was eventually able to fix position to an accuracy of within three miles - a margin of error unacceptable today, but the position was certainly good enough to put a pilot within sight of an island. Although Lindbergh never made the around-the-world flight, his lessons were not in vain. He helped establish cross-country air routes for *Trans-continental Air Transport* - known as the "Lindbergh Line" and later as *Trans World Airlines* (TWA) and was also courted by *Juan Trippe* of PAA to establish transatlantic air routes. Because the continental *United States* was covered by a network of radio beacons, celestial navigation had little application over land, but the method became essential for the overseas routes that PAA was considering. With Lindbergh as its first disciple, the "Weems System of Navigation" quickly attracted a broad range of aviators who were eager to learn the latest techniques. Armed with a set of tools, including the bubble sextant, the second-setting watch and celestial plotting forms for making calculations from the *Star Altitude Curves* and *Line of Position* books (and by the mid-1930's, an *Air Almanac*, *Lunar Ephemeris for Aviators*, and a *Mark II plotter* - which every student pilot still receives), Weems' pupils now had everything they needed to find their position while in flight.

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Above: on flights in his ***Ryan Brougham***, ***Charles Lindbergh*** **(second from left) learned how to use a sextant during his lessons with Weems**

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"We used one of your sextants and a great deal from your System of Navigation on our last transcontinental trip. Mrs. Lindbergh took all of the sextant readings in addition to working them out and doing most of the nav-igation."
Charles Lindbergh
RE: April 1930 transcontinental survey flight
Left: ***Charles Lindbergh*** **(right) with his wife** ***Anne Morrow Lindbergh*** **(left), and** ***Philip Van Horn Weems*** **(center)**

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Weems hired Australian navigator *Harold Gatty* as chief instructor at his new school in *San Diego, California*, the first dedicated to aerial navigation. The two collaborated on numerous advances in navigation, including the *Gatty Drift Meter*, used to measure an aircraft's drift from a track. Gatty taught *Anne Morrow Lindbergh* the Weems system. When Lindbergh took *Juan Trippe* up on his offer and began planning overseas survey flights for PAA, he realized that his wife Anne would have to assist with navigation. These flights were textbook examples of the Weems System. In fact, Weems became the Lindberghs' official chronicler for the 1933 airline survey flight and used it as a case study for his "Air Navigation" textbook. Lindbergh and Gatty spread the Weems System through much of the aviation community in the *United States* and elsewhere. Gatty persuaded Lindbergh to bring PAA on as a client for the Weems System. *American Airlines* and *TWA* also adopted the Weems System in the late 1930's as they began considering transatlantic routes. Paradoxically, the only entity not heavily influenced by Weems was his own branch of the service - the *U.S. Navy*. Focused on carrier-based aviation, the service largely ignored the needs of its long-range patrol squadrons until the late 1930's when it had to race to catch up. The military services lacked enough instructors to train cadets during WWII so PAA's school served as a leading source of navigators for the *U.S. Army Air Force* (USAAF) and *Royal Air Force* (RAF) at the start of the war.

399

The Grand Old Man of Navigation

400

For many decades, the *Weems System* was the principal means of fixing position in over-water navigation for the U.S. military and airlines, along with many of the famed record setters and endurance fliers. In 1937, the transpolar flights that the *Soviet Union* achieved in Tupolev ANT-25's were made by aviators who were using the Weems System. U.S. observers noted that the Soviet aircraft had a hand-copied version of Weems' *Star Altitude Curves* on board. Weems created a community of aerial navigation experts and practitioners where none had existed before. Weems continued to be fascinated by navigational problems throughout his life. He began to adapt his aerial navigation techniques for the unique challenges of orbital mech-anics and the adaptations were put to use in the *Apollo* program. Weems also founded the *Institute of Navigation*, which is still the leading professional society devoted to the advancement of navigation.

Left: ***Philip Van Horn Weems*** **(1889-1979)**

401

"…Since 1937, when survey flights across the Atlantic were begun by Pan American pilots in smaller flying boats, careful preparations have been made for the inauguration of regular service on the ocean airway. America, England, Germany, and France are racing for priority honors in starting the service. Refinements in detail and improvements for safety have been stimulated by this race for a rich trade route of the air…"
Popular Mechanics, **June 1939**

402

Part 6

Birth of an Era

403

"…The romantic era of crossing oceans in boats with wings had barely begun. No land-based airliner then had range enough to make such long, dangerous hops. None had anywhere near enough room inside to make an ocean flight economically practical, anyway. Besides, there were few airports. On the other hand, most of the world's major cities lay close to bodies of water. Flying boats could land and take off there easily. They could also alight with reasonable safety on any ocean if they got into trouble above it. Flying boats made sense. For nearly twenty years, they were to be queens of the oceanic airways…"
***Popular Science*, June 1963**

404

405

"…American aviators, flying American made planes, have had long and varied experience in long-distance ocean hops. The present Pan American system covers the longest over-water route on any commercial air line, the 600 miles between Kingston, Jamaica, and Barranquilla, Columbia. The same system operates about 2,000 miles of airways in Alaska and a great network of lines in the Caribbean Sea and tropical South America…"
***Popular Mechanics*, March 1934**
Left: PAA period poster

406

A Golden Subsidy

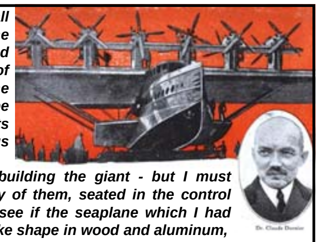
407

"…The immediate success of commercial lines will depend largely on mail contracts, and when they are awarded, service will commence at once. A mail contract is a golden subsidy, and a prize worth fighting for because transatlantic mail is very heavy. With letters written on thin paper, it is possible to write about forty to the pound – at twenty-five cents per letter. This a 500-pound mail load would yield $5,000 each trip. Present international air mail subsidies pay operators two dollars per mile. The cost of operations across the Atlantic is uncertain, but experts point out its initial cost can be reduced after a short experience in operation. Transcontinental lines succeeded in cutting the mileage cost of operations from $2.21 in 1929 to forty to sixty cents in 1932…"
***Popular Mechanics*, March 1932**

408

A Short, Unhappy Life

409



"On a memorable bright day last fall the largest airplane in the world, the flying boat, Do-X, which I designed and built in my factory on the shores of Lake Constance, was hauled out of the workshops where it had taken shape and launched into the lake ready for its trial flight. There were many anxious spectators along the shore - many of them workmen who had helped in building the giant - but I must confess that I was as anxious as any of them, seated in the control room alongside the pilot, waiting to see if the seaplane which I had dreamed out on paper and watched take shape in wood and aluminum, would actually fly. I knew, of course, that it would fly, despite its loaded weight of more than twenty tons, for every detail had been figured out carefully in advance. There was no reason why I should feel at all nervous, sitting there, waiting - but there is always a tenseness at such a moment, and I can only hope I did not look the way I felt. The pilot flashed back his signals to the engine room - the 12 motors roared - the graceful hull cut through the water, and in 28 seconds the great wing had borne us up into the sky! The Do-X was a success, and I felt a natural thrill of pride as its designer…."
Dr. Claude Dornier, **February 1930**

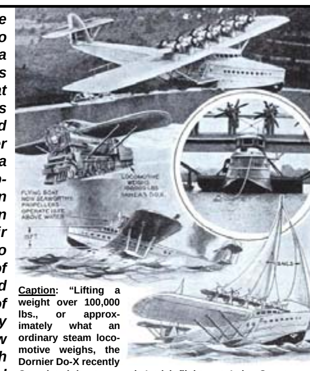
Above: caption: "The all-metal flying wonder of the day – the Dornier Do-X. Note the high propellers. Inset, Dr. Claude Dornier."

410

"…In order to form a complete picture of what the recent ten weeks tests we have conducted with the 200-passenger Do-X may mean, one must consider that repeatedly, without the slightest difficulty, we have taken off from Lake Constance (1,200 feet above sea level) a load of 20,000 kilogrammes, or 44,000 pounds. This is done in less than 60 seconds. We think that we can say with absolute certainty that reliable flight can be made with a load of at least 24,000 kilogrammes, or 52,000 pounds. This load is 20,000 pounds more than the weight of 200 passengers, who would weigh 30,000 pounds. That means there is a 20,000 pound margin for fuel. Such a load means that the wings are supporting a total weight of well over 100,000 pounds, or 45,900 kilogrammes. It is a weight equal to the average American passenger locomotive!..."
Dr. Claude Dornier, **February 1930**

411

"…You may wonder how we knew we could build a plane like the Do-X - so huge and so heavy. In order to form a picture of what lies back of this design one must first consider that the importance of the flying boat was first realized in England, and generally developed there. No other country can look back on so long a continuous and systematic development of building flying boats. Too, in Germany we had built many. So when we came to design a huge flying air liner, we had many good designs to depart from. To get this picture of what the Do-X is and what is behind her…the data of a large family of flying boats that were all thoroughly tried and tested was used. We knew we could use these loadings with success. They had made other good flying boats and we knew the information would serve us accurately…"
Dr. Claude Dornier, **February 1930**



Caption: "Lifting a weight over 100,000 lbs., or approximately what an ordinary steam locomotive weighs, the Dornier Do-X recently Completed its ten weeks' trial flights at Lake Constance, Switzerland. Above you see salient features described here by Dr. Dornier; namely, the airfoil shaped pontoons which give great stability and help flight; the high motor mounting, the whirling propellers placed 18 ft. above water level, and sail used in forced landings."

412

"…The construction of the Do-X type differs in having more than two wing spars. The possibility of finer and lighter wing construction are exploited in this type and entirely new lines are followed. One of the most notable new features is that the wing covering is no longer permanently attached to the spars and ribs, but consists of large stiff self contained plates, which are attached to the wing frames in an easily detachable manner. The engines are installed in pairs above the wings. The wings are of semi-cantilever construction…"
Dr. Claude Donier, February 1930

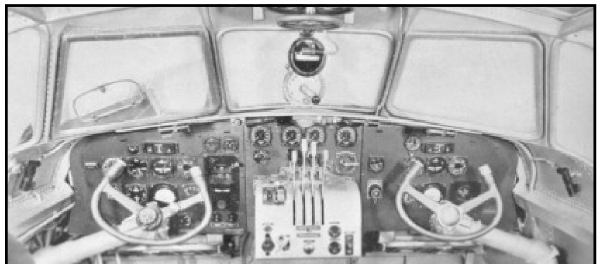
413

"…Besides the question of carrying capacity, speed and radius of action, it is of special importance to form some view of the seaworthiness…Seaworthiness is not a simple thing to define, and it is not at all clear what qualities are desirable. For the present and, it would seem, for a long time to come, most experts would think it rash to lay down precise requirements. As a personal opinion, the seaplane must be able to fly and to meet prescribed civil or military requirements. It must be able, with full equipment, instruments and crew, to carry prescribed loads to a given place in a given time (with reasonable latitude). This implies ability to start under normal conditions. Next in importance is the ability to make a forced landing, with skillful handling, and to ride all day in a sea of from 52 feet to 18 feet. Starting under such abnormal circumstances is not necessary and not worth striving after, taking a sea exceeding 12 to 16 feet as abnormal. The reason for this opinion is that the materials of construction available at present do not afford the means of building flying boats in a rational way, strong enough to get off in a heavy sea without risk. To meet such requirements the useful load and range would be so heavily reduced that such flying boats would answer no civil or military purpose and would therefore be practically worthless. It is difficult to meet the one-sided demands of sea pilots for continuously increasing seaworthiness in view of the tare weight imposed by economic considerations, yet increase of size opens prospects of removing more or less completely the causes which very often lead to damage in a sea. This refers especially to the frequent damage to running airscrews by waves…"
Dr. Claude Dornier, **February 1930**

414

"…On the top deck was a pilots' compartment where the pilot and co-pilot looked out through plate-glass windows. Behind this were a bridge, for the captain and navigators; an engine control room, for the flight engineer and three assistants; and a radio room. The crew slept in quarters aft of the passenger deck…"
***Popular Science*, June 1963**
Above: Do-X's flight deck

415



Above: Dornier Do-X's cockpit. The flight deck had a crew of five: pilot, co-pilot, navigator, radio operator and flight engineer.
Left: one of two sets of engine controls inside Do-X's wing

416

Above: caption: "The huge air liner, Do-X, flying over the water in a test flight at 125 miles an hour"

Above: caption: "The central engine control room of the Do-X. From this station the speed of the 12 engines is regulated."
Right: caption: "First Officer Merz is shown at the wheel of the giant seaplane"

417

"…There was a buzz of talk, too, about the remarkable appointments of the big flying boat. It had a spacious 'saloon' for dining or card-playing. It had an electric kitchen, a cozy bar, and shower baths. The passenger deck was divided into attractive compartments containing divans that converted into beds. There was lots of comfort but little privacy: a corridor cut through all compartments…"
***Popular Science*, June 1963**
Above: view of central corridor through the lounge

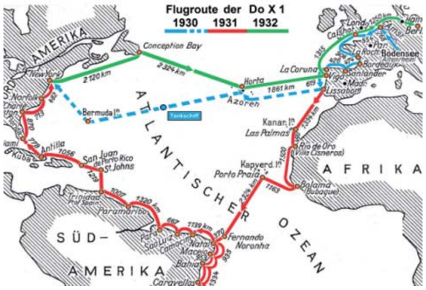
418

Top: the Do-X's lounge-restaurant
Bottom: passenger cabin. Passengers were only required to stay seated during take-offs and landings, at all other times they were allowed to move freely about the cabin.

419

"…On Nov. 4, 1930, the huge craft set forth from Germany on its first and only flight to the U.S. Winter was coming. The North Atlantic route was too risky to try. The Do-X took a widely circuitous, southerly course. At the start, it carried no passengers. This was fortunate…"
***Popular Science*, June 1963**

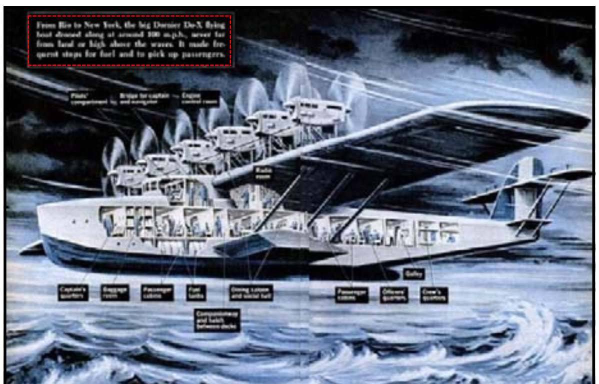
420



421

"…Between Southampton and Bourdeaux, it was forced down at sea in bad weather. It had to taxi 60 miles through darkness and rough water to an alternate port. At Lisbon, its wing caught fire and was half destroyed. Repairs consumed more than two months. By the end of January 1931, the Do-X had got only as far as the Canary Islands, off the northwest coast of Africa. There, preparing to cross the South Atlantic to Brazil, it began a series of takeoff and landing tests with ever increasing loads. At a gross weight of 55 tons, the hull caved in. Finally, in May, the star-crossed craft was ready to go again. Before it took off, however, it was stripped of all its finery. The crew, some of them later complained, were told to take nothing with them but a toothbrush and a razor. Every spare pound of cargo capacity was reserved for carrying extra fuel. Boosted by an obliging tail wind, the Do-X made the 1,400-mile flight to Brazil without stopping and without a hitch. Then it was entirely refitted, in Brazilian elegance, and ambled down to Rio to pick up its first paying customers. From Rio to New York, the big Dornier droned along, never far from land, or high above the water, at around 100 m.p.h. It stopped frequently to refuel. In the U.S., it touched down at Miami, Charleston, and Norfolk, adding passengers at each halt…"
***Popular Science,* June 1963**

422



Above: caption: "From Rio to New York, the big Dornier Do-X flying boat droned along at around 100 m.p.h., never far from land or high above the waves. It made frequent stops for fuel and to pick up passengers."

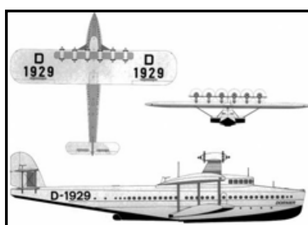
423

"…A non-stop hop across the Atlantic from New York to any of the European capitals is something to excite the imagination, but there isn't a plane in existence today that can make that trip and carry an adequate pay load, not even excepting the giant Dornier X, with its twelve Curtiss Conqueror motors. Before this appears in print the 'X' may also have crossed the Atlantic, but by easy stages from Germany to Portugal, to the Azores, Bermuda and New York. And even to make that hop, from Lisbon to the Azores and the Azores to Bermuda, it was necessary to remove a large part of the passenger carrying facilities of this aerial giant, which has carried 170 people into the air and is regularly fitted with seats for seventy, and substitute extra gas and oil tanks. The 'X' is a marvelous creation for the work for which it was built, carrying a large pay load on comparatively short hops of around 600 miles, such as an air line from New York to Bermuda. But beyond that distance the gas consumption of its twelve great motors requires such a sacrifice of pay load space as to render its operation impractical…"
***Popular Mechanics,* January 1931**

424

"Fifty thousand people crammed New York's little Battery Park. They peered down the busy harbor through a haze of August heat. Suddenly, a few minutes past noon, they spotted what they had been eagerly expecting. Out of the seaward murk emerged the biggest, noisiest airplane that anybody had ever seen or heard. The perspiring crowd burst into wild shouts and cheers. Bands struck up 'Die Wacht am Rhein' and 'Deutschland uber Alles.' Tugboat and ferry captains tied down their whistles. This raucous welcome, on Aug. 27, 1931, was for the German republic's monstrous, 12-engined Do-X. It was the world's largest flying boat. It was also, up to that time, the biggest heavier-than-air craft ever built. Escorting planes looked like gnats beside it, an observer wrote. Its great wing, with six pairs of engines perched back to back in a row along the top, stretched nearly 158 feet. Its three-decker hull, made of duralumin braced with steel girders, was 131 feet long. Loaded to capacity, it weighed 52 tons…"
***Popular Science,* June 1963**

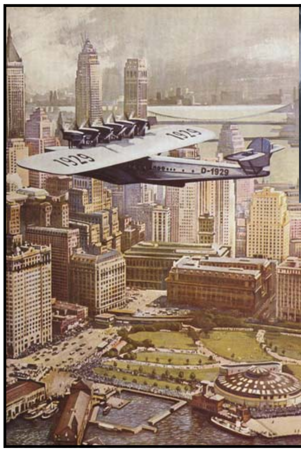
425



"…The throbbing, silvery Do-X slowly settled to a sedate landing off the Battery. Seventy-two passengers and crewmen – an astonishing number for the time – climbed out. Their stories were conflicting. Passengers (some had just been dancing to accordion music over the ocean) said they'd had great fun. But they had shared only the easiest part of a long, troubled journey. The crew, which had nursed the flying boat all the way from its home berth on Lake Constance, were far less enthusiastic. They had plenty of reasons to be sour. The Do-X, said to be capable of crossing the Atlantic in 40 hours, had taken nearly 10 months for its first trip…"
***Popular Science,* June 1963**

426

427



"We lounged in luxury, played bridge, danced, stretched our legs, strolled to the bar – outside the 12-mile limit, of course – and dined on the fat of the land"
Lady Drummond Hay
Above: caption: "Lady Drummond Hay and Karl von Wiegand, noted writers, in a passenger compartment on the Do-X"
Left: the Do-X flies over the *Hudson River* near *Battery Park* in lower *Manhattan*

428

"…For more than ten years aircraft engineers have been studying the possibilities for larger commercial transports. The multi-engined 'Do-X' was a colossus, but did not live up to expectations. For the time being, designers have definitely receded from the idea of having as many as twelve engines. A reduction in the number of engines is now made possible by the recent increase in horsepower. Within the next five years we may see aircraft engines weighing less than one pound per horsepower. Fuel consumption will be reduced to thirty-five hundredths pound per brake horsepower per hour, as compared with fifty hundredths or forty-five hundredths pound at present. Liquid-cooled engines will also be much improved…"
***Popular Mechanics,* September 1937**

429

"…The 'Do' of Do-X was plucked from the last name of its famed designer, Dr. Claude Dornier. Nobody seemed to know what the 'X' stood for. It turned out to be a prophetic symbol. The Do-X (the Germans pronounced it 'Dough-Iks') was a washout. After one transatlantic round trip, spread over a year and a half, its career ended. The short, unhappy life of the Do-X began with a spectacular stunt. On Oct. 21, 1929, the newly completed flying boat took up 169 people – 14 tons of human beings – for an hours ride around Lake Constance. Even the largest dirigibles hadn't carried that many passengers. The Do-X had regular accommodations for only 72, but enough folding benches and chairs were taken to seat everybody. Luckily, the craft hit no sizable air pockets during its dramatic debut. The flight made news around the world…After its brief but stirring maiden flight, the Do-X was not heard from again for 11 months. Meanwhile, it got a new wing. Its 12 air-cooled German engines were removed. A dozen water-cooled American engines, developing a total of 7,200 hp (compared with an equivalent 30,000 hp for today's four-engine 707 jets), took their places. They were mounted back-to-back along the top of the wing. The front propellers were pullers, the rear ones pushers…"
***Popular Science,* June 1963**
RE: after Do-X arrived in NYC, *Claude Donier* arrived by ship to discuss with *General Motors* and *Fokker Aircraft* the possibilities of building more and bigger Do-X's. However, the deepening worldwide depression killed all chances of the scheme ever being realized. After its day of glory in NYC, Do-X was retired to a sheltered anchorage on the north shore of *Long Island* where it remained for nearly nine months

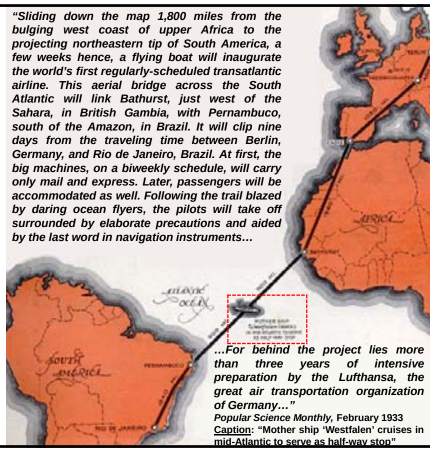
430

"…In May, 1932, the Do-X flew home. This time it crossed the Atlantic in two days, but the flight was no recommendation. Though the gawky craft was supposed to have a service ceiling of 17,000 feet, it was hardly able to clear the water. For eight hours out of Newfoundland, battling strong head winds, it never rose above 50 feet. Amelia Earhart flew eastward across the Atlantic alone that same day, May 20, 1932. She was the first woman to do so. The altimeter in her red-and-gold monoplane failed en route, but she landed safely in an Irish cow pasture. The Do-X, on the other hand, ran out of fuel in the dark, seven miles short of its port in the Azores, made an emergency landing. The chief pilot said afterward that he couldn't see either water or land as he set the big plane down. Two days later, the Do-X reached home. It got a big welcome from Berliners, but promptly disappeared from aviation history. It was abandoned as too heavy and too costly to run. Twelve years later, it was blown to bits during an allied bombing raid on Berlin…"
***Popular Science,* June 1963**

431

Two Continents as One

432



"Sliding down the map 1,800 miles from the bulging west coast of upper Africa to the projecting northeastern tip of South America, a few weeks hence, a flying boat will inaugurate the world's first regularly-scheduled transatlantic airline. This aerial bridge across the South Atlantic will link Bathurst, just west of the Sahara, in British Gambia, with Pernambuco, south of the Amazon, in Brazil. It will clip nine days from the traveling time between Berlin, Germany, and Rio de Janeiro, Brazil. At first, the big machines, on a biweekly schedule, will carry only mail and express. Later, passengers will be accommodated as well. Following the trail blazed by daring ocean flyers, the pilots will take off surrounded by elaborate precautions and aided by the last word in navigation instruments…

…For behind the project lies more than three years of intensive preparation by the Lufthansa, the great air transportation organization of Germany…"

Popular Science Monthly, **February 1933**

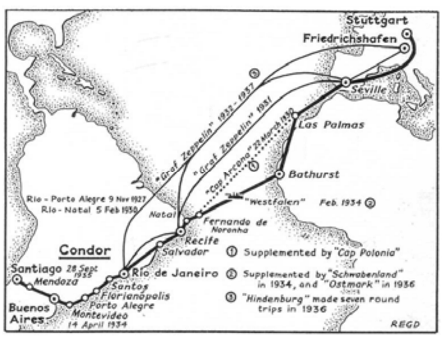
Caption: "Mother ship 'Westfalen' cruises in mid-Atlantic to serve as half-way stop"

433

"…While German ships will be the first to shuttle back and forth in an air service over the South Atlantic, the planes of other nations will be close behind. Both France and Italy have entered the lists and at this writing are putting finishing touches on plans for similar links across the sea to South America. Four large flying boats are nearing completion in French factories for use in a transatlantic airline which will connect Paris with Buenos Aires, 8,200 miles away in the Argentine. On this route, the hop-off for the ocean crossing will be made from the African coast at Dakar, on Cape Verde, a hundred miles north of Bathurst. For the last two years, Italian experts have been busy compiling weather data and other information vital to a transoceanic airline. They have even worked out time-tables and elaborate cost figures. Latest advices from Rome indicate that the construction of the Italian planes will be pushed forward at top speed…"

Popular Science Monthly, **February 1933**

434



435

Mother Ship

436

"…The most unusual feature of the German plan is the Westfalen, a 6,000-ton North German Lloyd liner, which will cruise about in circles 900 miles from shore and act as a refueling station and repair depot for the aerial fleet in mid-ocean. The 409-foot vessel will carry tools, spare parts, fuel and oil. Expert mechanics will stand ready to repair or tune up an incoming plane at a moment's notice. From a powerful broadcasting station on board, signals will flash to the airliners speeding toward the circling ship, giving its position and hourly weather reports. In storms or heavy weather, the Westfalen will form a mid-ocean harbor of refuge for the planes…"

Popular Science Monthly, **February 1933**

Above: *SS Westfalen*

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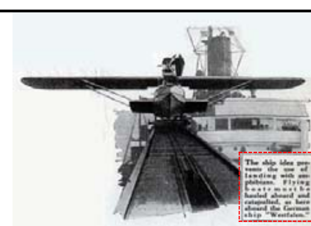


"…Present plans of Deutsche Lufthansa call for the 'Schwabenland' and another, but larger, catapult ship to be stationed in the North Atlantic, one at the Azores and another off Bermuda. These ships will be able to handle the twin-motored Dornier Wal flying boats with which the service will be started, possibly in the spring of 1937…"

Popular Mechanics, **December 1936**

Above: caption: "The ship idea prevents the use of landing with amphibians. Flying boats must be hauled aboard the German ship 'Westfalen.'"

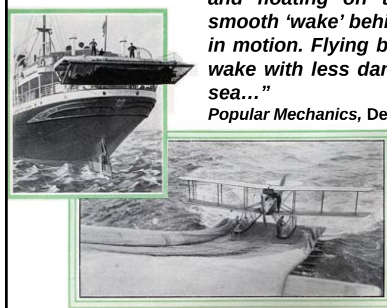
438

"…Under such conditions, one part of the unique vessel's equipment will be of special value. This is an immense drag sail of heavy canvas, similar to the one carried by the Swedish cruiser Gotland, which served as the basis of the cover design of last month's issue of Popular Science Monthly. Fifty feet wide and more than half a block long, it will trail over the water from the stern of the vessel, allowing the ship to pick up seaplanes from the water while traveling at full speed. Crosswise pontoons near the end have a braking effect, keeping the canvas taut. The flying boats, with engines running, land in the wake of the steamer, slide up on the trailing edge of the canvas, and then are hauled up the incline to the deck by a powerful crane of special design. In stormy weather the dragging canvas will create a strip of relatively smooth water behind it, thus aiding the pilot in landing his heavy ship…"

Popular Science Monthly, **February 1933**

Left: cover of *Popular Science Monthly* for January 1933 showing drag sail trailing behind the Swedish cruiser *Gotland*

439



"…A 'towing sail,' attached to the stern and floating on the water, creates a smooth 'wake' behind the ship when it is in motion. Flying boats can land on this wake with less danger than in the open sea…"

Popular Mechanics, **December 1936**

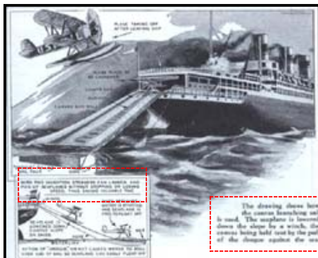
Above: caption: "Landing Field Trailed by Big Ship. Cruising in the middle of the ocean, the German ship will be equipped with a canvas landing field like the one upon which a plane is seen alighting at the right. Above, the canvas field is rolled up when not needed by a plane."

440

A few days ago German liners, steaming out into the North Sea from Hamburg and Bremen, passed the Westfalen off the island of Helgoland. It was dragging its long white train behind it, carrying out painstaking experiments to determine the best speeds for different water conditions. Time and again, during this three-day test, a big Dornier-Wal flying boat swooped down, skimmed over the water and slid up on the canvas while the Westfalen was being driven ahead at full speed by her 2,700-horsepower engines…"

Popular Science Monthly, **February 1933**

Above: caption: "Refueling a seaplane at mother ship 900 miles from land. Drawing shows how the transatlantic flyers will be able to land in mid-ocean, refuel and take-off again on second leg of the journey." 441



"Mail-Steamers not equipped with expensive catapults for launching airplanes at sea will welcome the invention of the Kiwull watersail, so named after its inventor, which is shown in operation in the above drawing. The invention is simple, consisting of a length of canvas 100 feet long and 32 feet wide which is unrolled from the stern of the ship, as shown, to form an incline down which a seaplane can be lowered to the water. The canvas is held taut by water pulling against a 'drogue' or net at the trailing end. Seaplanes can also return aboard deck by this means."

Modern Mechanix, **March 1930**

Above: caption left: "With this invention steamers can launch and pick-up seaplanes without stopping or losing speed, thus saving valuable time"

Above: caption right: "The drawing shows how the canvas launching sail is used. The seaplane is lowered down the slope by a winch, the canvas being held taut by the pull of the drogue against the sea"

442

"…The flying boats 'Zephyr' and 'Aeolus' also are equipped with Diesel engines, two to each plane. Each engine is rated at 600 horsepower. Mounted in tandem above the wing, one engine drives a tractor propeller and the other a pusher. Fuel economy of these power plants is unusually high, in contrast to that of gasoline motors…"

Popular Mechanics, **December 1936**

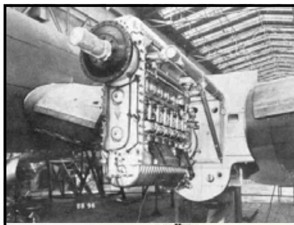
443

Above: *Donier Wal* flying boat

"…From Bathurst, Deutsche Lufthansa operates a fleet of four Dornier Do-18 flying boats across the 1,900-mile stretch of the South Atlantic to Natal, in Brazil. These planes are named the 'Aeolus,' the 'Zephyr,' the 'Pampera' and the 'Zyklon.' Their engine installation is noteworthy in that it consists of two 600-horsepower 'Jumo' 205 Diesels mounted in tandem, back to back, along the axis of the plane. This makes possible excellent streamlining of the engine nacelle, and as the propellers then revolve in opposite directions, their torque is neutralized. The Do-18 carries a crew of four, has a cruising speed of 125 miles per hour, and can carry a 1,000-pound payload a distance of 2,400 miles. The 'Aeolus' and the 'Zephyr' will be remembered for their survey flights across the North Atlantic in 1936, when they made eight scheduled flights between New York and the Azores…"

Popular Mechanics, **August 1938**

444



"…So well did their engines perform over the 2,400 miles between these points, that two larger planes with similar power plants were ordered by Deutsche Lufthansa for their 1937 flights. These powerful Hamburg HA 139 seaplanes, the 'Nordmeer' and the 'Nordwind,' were equipped with four 600-horsepower engines. Once again, they demonstrated the reliability of the Diesel by making fourteen trips over the same route…"

***Popular Mechanics,* August 1938**

Top: inboard port *Junkers Jumo 205 Diesel engine mounted to wing of an HA 139* seaplane

Bottom: *Hamburg HA 139* "Nordmeer" ready for catapult launch (ca. 1934)

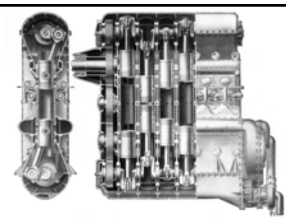
445

"…For long-range flights, the Diesel is particularly economical. This was demonstrated when a Dornier Do-18 flying boat made a 5,200-mile non-stop flight from the English Channel to Caravellas, in Brazil. This broke the world's long-distance seaplane record by nearly 1,000 miles, thanks to the remarkable fuel economy of the Junkers 'Jumo' 205 engines. A fuel saving of approximately 23 per cent, compared with gasoline operation, is now obtained under average conditions. Another advantage is the saving in fuel cost. Aviation gasoline costs about eleven cents a gallon at refinery, compared with five cents a gallon for Diesel fuel. Perhaps the most important factor is that Diesel fuel does not give off inflammable vapor at ordinary temperatures like gasoline, so there is no danger from an explosion from this source…"

***Popular Mechanics,* August 1938**

Above: *Dornier Do-26A* flying boat powered by four (two back-to-back pusher/puller arrangement) *Junkers Jumo 205* Diesels, each with six double-ended cylinders and twelve opposed pistons achieving 600 hp per engine

446



The *Junkers Jumo 205* aircraft engine was the most famous of a series of diesel engines that were the first, and for more than half a century, the only successful aircraft diesel engines. The *Jumo 204* first entered service in 1932. Later engines in the series were styled *Jumo 206*, *Jumo 207* and *Jumo 208* and differed in stroke and bore and supercharging arrangements. In all, more than nine-hundred of these engines were produced. They all used a two-stroke cycle with six cylinders and twelve pistons in an opposed piston configuration with two crankshafts, one at the bottom of the cylinder block and the other at the top, geared together. The pistons moved towards each other during the operating cycle. Intake and exhaust manifolds were duplicated on both sides of the block. There were two cam-operated injection pumps per cylinder, each feeding two nozzles, for four nozzles per cylinder in all. All of the accessories, such as fuel pumps, injectors and the scavenging compressor, were run from the lower shaft, meaning over half of its power was already used up. What was left over was then geared to the upper shaft, which ran the propellers. In all, about three-quarters of the power to the propellers came from the upper crankshaft. In theory, the flat layout of the engine could have allowed it to be installed inside thick wings of larger aircraft, such as airliners and bombers. Details of the oil scavenging system suggest this was not possible and the engine had to be run vertically, as it was on all designs using it.

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Above: Junkers Jumo 205cm engine cut-away sectional view/s

Schleuderschiffe

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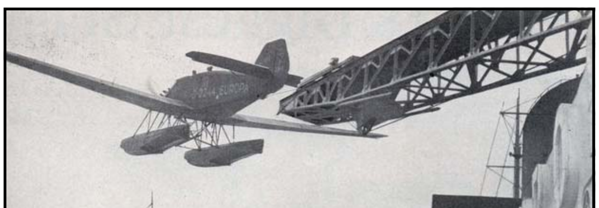


"…Immediately afterwards, the big ship docked at Bremen. Here, workmen began installing the world's biggest aerial catapult on her deck. Driven by giant blasts of compressed air from a battery of heavy steel cylinders, this 150-foot gun will have sufficient power to shoot a loaded fifteen-ton flying boat into the air at takeoff speed. After the machines of the ocean service have been pulled up the canvas drag sail and refueled, they will be shot off the deck from the catapult to begin the second leg of their over-water journey to Pernambuco. The present catapult launching record is held by England. In the summer of 1931, at the Farnborough flying field of the Royal Air Force, near London, a land catapult, with a 4,000-horsepower compressed air engine, hurled a nine-ton bombing plane into the air with a run of ninety feet. The Westfalen catapult, mightiest of all, will be similar in general design to those now used on the North German Lloyd liners, Europa and Bremen, to launch mail planes as the vessels draw near to the coasts of either North America or of Europe…"

***Popular Science Monthly,* February 1933**

Above: caption: "World's Biggest Catapult. By means of a giant catapult, similar to the one shown above, the planes will be hurled into the air from the deck of the big liner."

449

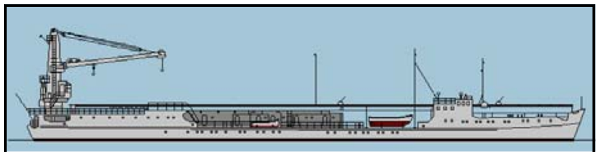
"…The catapult ship is equipped with Diesel engines. Its equipment for launching the ten-ton planes weighs more than 100 tons and is designed to handle aircraft up to sixteen and one-half tons gross weight. Air compressed to a pressure of 2,300 pounds per square inch is used to give an acceleration of about 112 feet per second to the plane, resulting in a speed of ninety miles per hour at the point where the plane leaves the runway. This remarkable speed is built-up in a run of slightly more than 100 feet. An electric crane hoists the flying boats from the water. In rough weather the crane can be folded on deck. A powerful searchlight, necessary for spotting the planes on the water in night landings, also is part of the equipment…"

***Popular Mechanics,* December 1936**

450

"…catapulting is used extensively for launching these Diesel-engined mail planes as Germany lacks bases from which to operate. Although this involves the use of catapult ships, it has the advantage that the plane can take to the air with full load without risking a take-off from a choppy sea. At present, catapulting is not suitable for passenger planes as the rate of acceleration is too rapid…"
Popular Mechanics, **August 1938**

451



"…Choice of the catapult ship and flying boat for the new service probably resulted from Lufthansa's operation of similar equipment in the South Atlantic. From Berlin to Santiago, Chile, a distance of 9,500 miles, planes have been making bi-weekly trips with mail for several months. The 1,900-mile jump across the Atlantic to the nearest point in South America is accomplished by catapulting the flying boats from ships stationed near each end of the water hop. Thus, the flying boats have been able to start their flights with a maximum load without risking a takeoff from the open sea…"
Popular Mechanics, **December 1936**
Above: "Schleuderschiffe" - catapult ships, were used as floating bases in the *South Atlantic* to enable flying boats to cross the *Atlantic* for mail delivery. Stationed at the African and South American coast, they were used to refuel and re-supply the small flying boats like the *Dornier Wal* on their way across the ocean. Equipped with a catapult, they were able to launch the flying boats instead of doing a manual takeoff from the water. This allowed the flying boats to carry more fuel thus increasing flying range.

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Superwal

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"…For the ocean leg of the journey, winged boats produced by the famous Dornier factory are used exclusively. The first machines put in service will be twin-engined Dornier 'Whales.' Later, it is planned to substitute giant twelve-engined Do-X models, fitted with special staterooms and Pullman beds for passengers. The twin-engined machines have the motors placed in tandem above the high monoplane wing, one pushing, the other pulling. In the hull, below the wing, immense gasoline tanks hold sufficient fuel to drive the two 400-horse-power engines for nearly fourteen hours. With throttles wide open, the Whales will rush through the air at more than two miles a minute. Both on tropical airways and in northern Siberia, these sturdy machines have demonstrated their endurance…"
Popular Science Monthly, **February 1933**
Above: *Dornier-Superwal.* After the success of the single-engined *Dornier-Wal D1422* (a.k.a. "Whale") Dornier developed this type into an enlarged version with a capacity of up to nineteen passengers. Fitted with two tandem-mounted engines of up to 800 hp (each with a set of pusher/puller props), it was named the "Superwal." It made its first flight on September 30th 1926.

454

"…On the top of the white hull is something looking like a barrel hoop standing upright and pointing straight ahead. It is the loop antenna of the radio compass. Like a bloodhound's nose, it will lead to the goal, following the radio waves coming from the Westfalen. The strength of the signals received depends upon the position of the loop, which can be moved on a vertical axis. When it is edgewise to the direction from which the signals come, the volume is greatest; when the opening of the loop faces the direction of source, the volume is least. By adjusting the loop to keep the signals at their maximum volume, the radio operator guides the boat through the sky to its moving target…"
Popular Science Monthly, **February 1933**
Above: caption: "Great seaplanes of this type will be used when the first regular flying service over the Atlantic is inaugurated. Note loop aerial on nose of craft for the radio compass that guides flyers."

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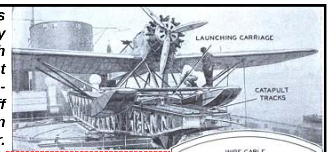
"…At the nose of the long hull, the pilot sits behind a control wheel. In front of the cockpit is an empty anti-collision chamber to reduce the hazards of a head-on smash. Just back of the pilot is the radio room. Here the operator, with his 2,500-mile short-wave transmitter, and his receiving set, will keep in touch with the shore and the Westfalen during the flight. Back of the radio room is the mail and express compartment and back of it a storage space for extra gasoline supply and motor oil…"
Popular Science Monthly, **February 1933**
Above: caption: "The radio room of the transatlantic plane is located directly behind the pilot and the operator is in constant communication with the far-distant mother ship"

456

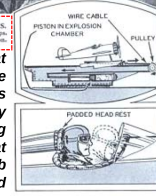
Slingshots of the Navy

457

"Fighting seaplanes of Uncle Sam's navy are launched into the air by means of powerful catapults which throw them into the air like giant slingshots…Planes aboard battle-ships are seaplanes. They take off from the catapult after having been 'shot' by powder or compressed air. The powder catapult operates much like a big gun. Exploding powder ex-pands the air in a cylinder which operates a piston that picks up and propels the carriage along the runway. In the compressed air catapult the air is built up to an enormous pressure and suddenly released. The plane is held securely to the carriage to prevent its soaring away before reaching the end. A tripping mechanism automatically releases it at the proper moment, however, and plane and pilot climb rapidly into the air. In a catapult takeoff the pilot must guard against the sudden jolt by holding his head firmly against a cushion. The sensation resembles that of being struck sharply by a human hand just below the base of the neck…"



This airplane launching catapult on the S. S. Bremen is typical of those used on battleships. Note the bridge type steel girder construction.



The top drawing shows the method by which a charge of powder, exploded in a cylinder, pro pels a piston to the end of which is attached a cable which jerks forward the carriage on which the plane rests, throwing the plane off the cata pult. In the lower drawing is shown the head rest which protects the pilot from a stunning blow when the plane is moved suddenly forward by the launching device. The head must be held firmly against the cushion to absorb the jolt

Modern Mechanics, February 1930

<u>Above</u>: top caption: "This airplane launching catapult on the S.S. Bremen is typical of those used on battleships. Note the bridge type steel girder construction."

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Time Saver

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Stern of the Ile de France with its plane-launching catapult is shown above. The cable which launches the plane can be seen in the picture at the right.

"Passengers aboard the Ile de France, luxurious new passenger steamer plying between New York and Cherbourg, can now speed up their ocean journey by hopping off the ship in an airplane when a few hundred miles off the French coast, the plane carrying them directly to Paris. This is made possible by a 60-ton catapult installed on the deck of the steamer, which launches an amphibian plane. On a recent test flight, the airplane left the ship 450 miles at sea and flew to New York with a mail cargo, clipping 18 hours from the regular sailing time of the vessel. Perishable express matter and other types of cargo requiring fast delivery will be carried by the airplane."

Modern Mechanics, November 1928

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Ocean Airdromes

461

"The signing of Construction Contracts definitely assures the building of islands in Mid-Atlantic to service transatlantic seaplanes and to furnish hotel and restaurant facilities for their passengers…"

The American Architect, December 1930

RE: excerpt from an article entitled: "Transatlantic Flying a Commercial Reality through Man-made Islands"

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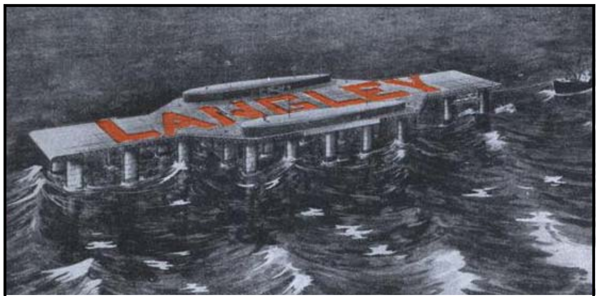
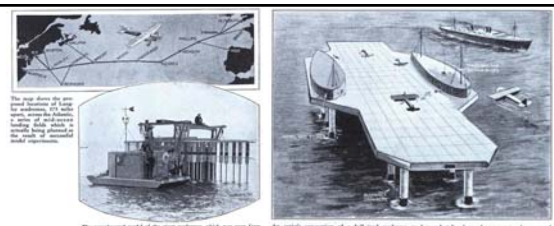


"The seadrome, designed by Edward R. Armstrong, may solve the problem of providing safety over long water hops. The first seadrome, to be launched between New York and Bermuda, will cost $1,500,000. A chain of dromes placed every 400 miles across the ocean would provide a means of safe air transport."
Popular Mechanics, **January 1931**
Above: rendering of the proposed "Seadrome"

463

"…Stability of the airport, even in the roughest seas, is assured by the fact that the supporting floats extend for 50 feet beneath the ocean's surface, a depth at which the motion of the largest waves is not felt…Through a system of winches and drums for paying out and dragging in the cables, the airdrome will move with the wind so that pilots can always land into the breeze…"
Modern Mechanix, **August 1929**

464



"An experimental model has proved a success, plans are now being made for the anchoring between New York and Bermuda of the first seadrome for ocean flying airplanes and it is the hope of the supporters that as a result such seadromes will eventually dot the oceans providing safe landings for aircraft. The one-ton steel model of the seadrome was placed in the Choptank River at Cambridge, Md. The model was one-thirty-second the size of the intended dromes. It is essentially a large platform supported by hollow steel columns, each ending in a circular disk. Air in the cylinders supports the platform well above the water and beyond wave action. Speedboats flashed around the model without rocking it and it is expected that the large dromes will not be affected at all by wave action. The inventor of the seadrome which he calls the 'Langley' after the late Samuel P. Langley, designer of one of the first airplanes, was confident of the success of his model. He was formerly a navy engineer and now is consulting engineer for an eastern concern. After devoting sixteen years to his schemes and experiments for safe sea bases for aircraft he succeeded in interesting the du Pont and General Motors financiers in his plans. They have provided Armstrong with three quarters of a million dollars to finance his first seadrome which is now under construction…"
Modern Mechanix, **February 1930**

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"A model of the proposed seadrome was constructed and tested together with a model of the steamship Majestic, built to the same scale. Under test conditions it was found that the seadrome was unaffected by any combination of waves up to and including those equivalent to 180 feet in height. The model of the Majestic on the contrary was practically swamped in waves exceeding 80 feet in height."
Edward R. Armstrong

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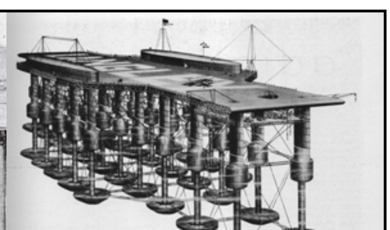

Above: caption: "Here is what the full-sized Armstrong seadrome will look like when completed. At first but one-fourth of it will be built, the more economically to test the flotation principles of the submerged ballast tanks. Later the complete six-acre field may be built, with hotels at the side as shown or on a lower deck, according to what tests prove."
Left: caption: "The seadrome will be anchored to a huge buoy, secured by a 1,500 ton anchor. Inset shows Mr. Armstrong, the inventor, with a working model."
Modern Mechanix, **February 1934**

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"…The engineer, Armstrong, plans to anchor his first full-size seadrome halfway between New York and Bermuda. He studied hydro-graphic charts of the region he had in mind and calculated that there must be a high place in the ocean floor and with the aid of a navy survey ship he found the location desired some 400 miles from Manhattan and 375 miles from Bermuda in a virtually straight line. The table on the ocean floor is six miles long and four miles wide. It is only two miles below sea level. The surrounding depth is three to four miles. The difference in depth will make a considerable saving in securing the 3-1/2 inch steel cable which will be laid to hold the seadrome in place. The huge anchors of the round bobbin type will dig into the sea floor and prevent drifting of the seadrome. Mr. Armstrong hopes to have the Langley completed and in place by next fall before Bermuda's tourist season begins…"
Modern Mechanix, **February 1930**

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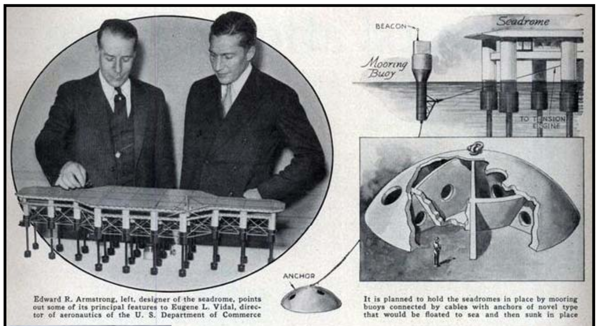

Left: caption: "Floating landing fields may be used on the trans-Atlantic route. Photo shows Edward R. Armstrong with a model of his seadrome."

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"…The engineer expects that as the Langley makes financial returns he will construct eight similar seadromes between the thirty-fifth and fortieth parallels and some 375 miles apart between New York and Plymouth, England. The 375-mile distance has been determined upon because it is an easy jump for any airplane and would be sufficient to safeguard trans-oceanic air tourists. Mr. Armstrong, who is seeing his dream come true estimates that with these seadromes and the servicing made possible by them there will be safe Atlantic air crossings in as fast a time as 20 hours. If his plans materialize as he confidently expects and his experiments would indicate, it is possible that before many years have passed dangers of air travel over the seven seas will have been enormously reduced…"

***Modern Mechanix,* February 1930**

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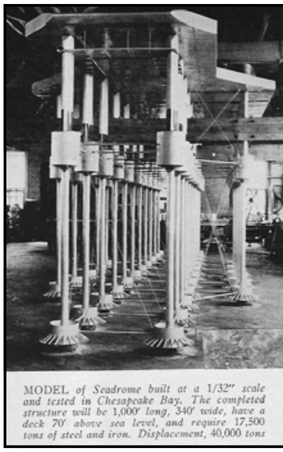

Engineer *Edward Robert Armstrong* (1876-1955) conceived and advocated the "Seadrome" concept. A Seadrome was to be a stopping point for transatlantic flights between *Europe* and *North America*. It was basically a stationary aircraft carrier with amenities for transatlantic passengers. It was to have hotels, restaurants as well as facilities to refuel and repair airplanes. At the time it was conceived, the largest passenger airplane held nine passengers, with a crew of three. The initial plans called for the Seadrome to be 1,100-feet long, 340-feet wide at the middle and 180-feet wide at the ends. The deck would be 70-feet above sea level.

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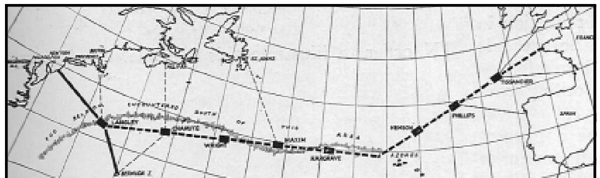

"…The resulting bending moments are thus reduced to a few percent of those incurred by a large steamer…"

***The American Architect*, December 1930**

RE: the seadrome hull was to be open between buoyancy chambers thus allowing waves to pass through. Seadromes were planned to be anchored semi-permanently at no fewer than eight locations along the route between *Europe* and *North America* (see map above). A truss system of anchorage would hold the big deck by means of cables to a 1,500-ton weight on the bottom of the ocean. The truss-like arrangement consisted of twenty-eight buoyancy tanks floating far beneath the ocean's surface. In turn, these were to be linked to the deck by means of cast iron columns streamlined into an oval shape above the mean level of the waves and circular below. Underneath the buoyancy tanks these columns were to continue downward one-hundred feet to the ballast chambers which would be be stabilized by iron ore. The complete column, including the ballast sections, was to be over 300-feet in depth. Armstrong – a consulting engineer for the *du Pont* corporation, took advantage of a well-known principle in the construction of his ocean island; ocean waves are surface disturbances only while water in the depths is still.

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"Funds recently appropriated by the government have put the United States Department of Commerce, Aviation Branch, squarely behind the immediate development of a chain of five floating airports which will span the Atlantic for regular airways service. This recently announced appropriation, amounting to $1,500,000 was negotiated by Eugene L. Vidal, Director of Aeronautics of the Department of Commerce, in behalf of Edward R. Armstrong, inventor of the seadrome, and completes a 16 year fight to gain recognition for a project which both Mr. Vidal, a competent and experienced airways operator, and Mr. Armstrong solidly believe in. As well, it will provide work for a great number of unemployed, as 80 per cent of the cost of such development projects goes to labor. This $1,500,000 is for immediate experiments with a quarter-section ocean landing-field and ends a sixteen-year struggle for recognition of the seadrome system. The final plan calls for a $30,000,000 outlay by the government, contingent on the success of the preliminary experiments now under way. According to information gathered by this member of the staff of Modern Mechanix and Inventions, the ultimate plan calls for similar seadrome stations in the Pacific and other oceans, giving the United States an international supremacy of the air lanes. Great Britain and France both gave the Armstrong plan serious consideration but failed to adopt it…"

***Modern Mechanix and Inventions,* February 1934**

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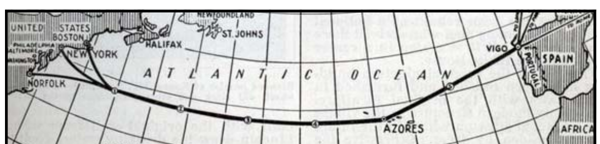

"…The proposed system calls for five Armstrong seadromes at 500 mile intervals from the Atlantic seaboard here to the western coast of Europe. Each drome will cost $6,000,000. Back in 1927 when Armstrong completed his first models of the floating deck, he intended to have hangars and hotels on the six-acre surface. But the design which has been accepted by the government calls for a vacant deck, with hangar and hotel accommodations confined to two or three decks below the surface. The seadromes will be 1,225 feet long and 300 feet wide. An elevator will take planes from the surface to the underdeck hangars. This specially-designed elevator will adequately handle planes with wing spans up to 120 feet This flying deck will be supported in place by a number of ballast tanks sunk sufficiently below the water so that the flotation arrangement will be unaffected. That was the inventor's predominant problem, constructing his float so that it would not shift and toss with the huge waves…"

***Modern Mechanix and Inventions,* February 1934**

Above: caption: "Eventually, if tests prove successful, the government seadrome chain would dot the Atlantic as shown for 10-hour service between Europe and America. These five seadromes would be situated in fair weather latitudes 500 miles apart.

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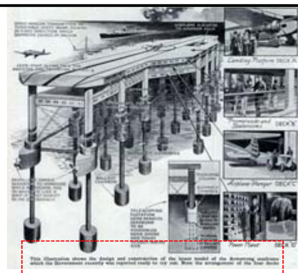

"…Another innovation not found in his earlier plans is an emergency propulsion system that enables the seadrome to navigate like a ship if it is necessary to cast the seadrome adrift to ride out a storm of phenomenal severity, or if it should break loose from its moorings. This is provided by four propellers, each operated by a 500-horsepower electric motor that is supplied with current from the seadrome's gasoline-electric power plant…"
Popular Science Monthly, **February 1934**
Above: caption: "This illustration shows the design and construction of the latest model of the Armstrong seadrome which the government was recently reported ready to try out. Note the arrangement of the four decks." 475

"…The engineers of the Seadrome Ocean Dock Corporation associated with Mr. Armstrong estimate that 125,000 tons of iron and steel will be required to erect five airports and anchorages. The seadromes will have radio stations and radio beams to guide the air-liners in inclement weather. Attached to each seadrome there will also be sea-going cutters of the Coast Guard type for emergency as well as auxiliary duty. The floating decks will have weather stations. At the present time the quarter section of a seadrome is being constructed behind the Delaware Breakwater. When it is finished early next summer it will be towed out to sea for the tests. If it comes up to the expectations of its sponsors, the three other sections will be built and the entire seadrome assembled. In turn work will then be started on the rest of the ocean airports. Mr. Armstrong estimates that a 24-hour service can be maintained on the Atlantic Ocean, but he further modifies that calculation in plotting the trip between New York and London. He intends to make that journey a 30-hour trip in eight jumps of 160 miles per hour."
Modern Mechanix and Inventions, **February 1934**
RE: as the decade of the 1930's progressed, both land plane and flying boat range increased dramatically negating the need for these "ocean airdromes." Though a contract was let for a seadrome on the *Bermuda* route in 1930, it - like those across the *Atlantic*, was never realized. 476

All the work of constructing the seadrome shown above, invented by Gustave M. Sachs of Minneapolis, Minn., can be carried out on shore. It is built of units 48 feet square which are carried out to sea on ships and then coupled together to form a landing field of any desired size. Ballast tanks and buoyancy chambers provide support for the platform even in the severest storms.

"…A second type of seadrome, varying from Mr. Armstrong's design in that it is constructed in units on shore and assembled at sea in any desired combinations, has recently been patented by Gustave M. Sachs, of Minneapolis, Minn…Each unit will be 48 feet square. The platform will be supported by a series of cylindrical tanks, with the largest tank at the bottom filled with ballast to maintain stability. In assembling the landing field, the units are secured to one another by means of couplings and steel, cables…" 477
Modern Mechanix, **August 1929**

Bridge of Boats

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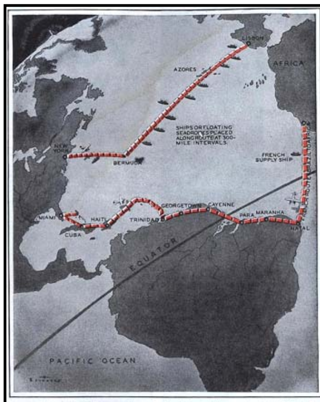

Two trans-Atlantic air mail routes are shown in red on this map. The route from New York to Lisbon is the one for which the government has requested bids from air mail operators. Vessels of wartime construction, now lying idle, would be stationed at intervals of 300 miles along the route, to guide airplanes by radio beacons and to serve as rescue ships in case of forced landings. Huge floating seadromes on which planes could land may be used instead of ships. The Pan-American airways now carry mail from Miami to Brazil. From Brazil to Africa a French company carries mail by steamer and plane.

"The 'bridge of boats' which America rushed to completion thirteen years ago to carry an American army to France and help win the war, may become a bridge again to guide the first trans-oceanic air mail line across the North Atlantic. Irving Glover, second assistant postmaster general, in charge of all air mail activities, is sponsor for the suggestion that some of the old war-time vessels, laid up by the shipping board years ago, be refitted and anchored at intervals across the Atlantic to form service stations, radio beacons and mile posts for the air mail line. Ten ships anchored at intervals would be sufficient to safeguard the route from New York to Bermuda and Bermuda to Lisbon, Portugal, by way of Fayal, in the Azores. The use of the old ships as radio and light ships and spare parts and fuel stations would be only a temporary expedient until the 'floating islands' designed by Edward R. Armstrong can be built and placed along the route, as his company plans to do…" 479
Modern Mechanics, **May 1931**

"…If carried out, however, a single ship anchored midway between New York and Bermuda would divide the first leg of the ocean hop into sections of slightly less than 400 miles each. From the ship constant radio bearings could be sent day and night, assisted by a beacon light at night. Seven ships anchored between Bermuda and the Azores would be sufficient to divide the longest leg of the flight into 300 mile sections. With ships at those intervals the planes would never be more than 150 miles from a radio direction beacon, and a fuel and repair station, while in event of a forced landing between ships the nearest vessel could drop its moorings and proceed to the rescue. Two, or possibly three ships, would be needed between the Azores and Lisbon. From the Portuguese city a land route via Bordeaux and Havre would connect with London, or a shorter land and sea route could be laid out up the Portuguese coast, across the Bay of Biscay to Brest, and from there to Southampton, England…Regardless of whether or not Glover's suggestion to use the war-time ships as floating islands is adopted, it is practically certain the successful bidder for the first north Atlantic air line will use either flying boats or amphibians with boat hulls, and not land planes. The experience of the Pan-American air lines, operating, with its subsidiaries, a total of 19,190 miles of air mail and passenger routes, has shown that multi-motored amphibians, such as the Sikorsky, are sufficient for the fairly short hops between the islands of the West Indies and across the Caribbean."
Modern Mechanics, **May 1931**
480

Safe Haven

481

"Ocean stepping-stones in the form of floating seadromes bid fair to cut down the hazards of trans-Atlantic flights. Regular airplane service across the Atlantic is brought a step nearer reality by the projection of plans for a series of floating landing fields which can be anchored at intervals of a thousand miles between America and Europe, affording a safe place for passenger carrying planes to come down for refueling and mechanical attention…A third type of airport, pictured in the photo above, and also shown on the cover of this month's Modern Mechanics, is of French design. It resembles a huge floating lighthouse, as the model shows, and is equipped with propellers and driving machinery to move it about as may be required."

***Modern Mechanix*, August 1929**

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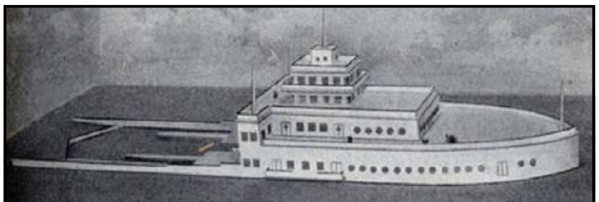

"A giant, mobile seaplane base recently proposed provides a protected basin 150 feet long and eighty feet wide as a landing harbor for transoceanic planes. As shown in a model just completed, the floating base has a commodious terminal at its forward end, while a water gate at the open end of the basin would permit the latter to be emptied for use as a repair drydock."

***Modern Mechanix*, October 1937**

Above: caption: "The basin at the stern is a landing place for seaplanes, while hotel accommodations are forward"

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Ice Island

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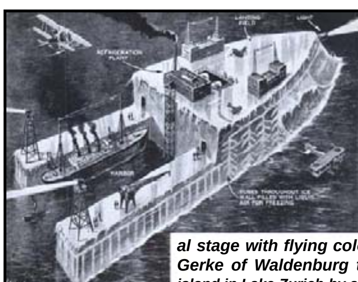

"Seadromes for ocean landing fields are not a new idea, a steel drome designed by Edward Armstrong, recently described in these pages, being well on the road to practical accept-ance. But the proposal to build seadromes of ice, recently advanced from Germany, seems fantastic until one realizes that the idea has already passed the experiment-al stage with flying colors. The German scientist Dr. Gerke of Waldenburg two years ago erected an ice island in Lake Zurich by artificial means, which endured six days after the refrigerating machinery was switched off. His proposal for a mid-Atlantic way station of ice involves the construction of a framework of hollow tubing which; when filled with liquid air manufactured in a refrigerating plant, freezes the water surrounding it into a solid mass. Design of the island would call for a section on which a landing field and buildings for offices and refrigerating plants could be built."

***Modern Mechanix*, October 1932**

Above: caption: "Drawing shows the island, frozen by liquid air; a floating harbor & airfield"

485

Fill'er Up!

486

"In the future, when airplane travel comes to be as commonplace as automobile travel, we may expect to see floating filling stations, such as shown in the drawing above, dotting the airplane travel lanes of the Atlantic and Pacific oceans. This is by no means a fantastic project of dreamers, for already just such floating service stations are to be seen scattered along the Pacific coast; and a west coast oil company, looking to the future, has announced its intentions of establishing a chain of 99 such stations for the accommodation of planes journeying up and down the seaboard. These floating service stations are marked by neon lighted towers and are equipped to service a plane in any way necessary, their chief function, however, being refueling. A wireless transmitter and receiver keeps the station in constant communication with land, so that weather information and emergency orders can be provided for the pilots. When a pilot wants to take on fuel he brings his ship up alongside the barge, fastens his mooring lines to the mooring post, and swings the hose, which is attached to the projecting fuel arm, into position and signals to the attendant to begin pumping. The barge is moored in place by means of anchors. All fuel tanks are below decks, with no projection above save for the office at the stern. The fueling pumps are sunk in pits to safeguard the wings of planes moored alongside."

Modern Mechanix, **January 1931**

Above: caption: "On the west coast a chain of filling stations as shown above is being established for seaplanes. The plane taxis alongside, moors to the ship, and takes on gas from fuel arm as shown."

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Part 7

Pioneering Flights

488

"…The most careful survey of conditions over the ocean airway between Africa and South America was made during the past two years by the Graf Zeppelin. Under the direction of Lufthansa officials this famous German dirigible made ten round trips between Friedrichshafen and Brazil. During the previous summer it had crossed the South Atlantic six times. From these pioneering flights information was gathered which will be of value to the daring men who lead the way on a regularly-scheduled transatlantic air service. When the Santa Maria of this service, the first Dornier-Wal, takes off and heads out to sea, it will mark an important step toward dramatic possibilities which lie ahead."

Popular Science Monthly, **February 1933**

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"…The trip in the reverse direction, crossing the Atlantic from west to east, takes from half a day to a day longer. Near the Equator, where the ocean crossing is made, trade winds blow steadily from the east, speeding up planes flying west and slowing them down flying east. This is exactly the reverse of conditions over the North Atlantic…While the race is thus on over the South Atlantic, the powerful Pan-American Airways, in the United States, announces it is building six giant flying boats, larger than anything hitherto flown on commercial airlines, for use over the North Atlantic between America and Europe. These fifty-passenger planes, designed to fly 2,500 miles with full load, will probably go by way of Greenland and Iceland. They may also pioneer an airway to the Orient, crossing the Pacific with one stop at the Hawaiian Islands. The keels of these superplanes have already been laid and work on them is progressing at the Sikorsky plant, Bridgeport, Conn., and at the Glenn L. Martin factory, Baltimore, Md. In 1927, when Charles A. Lindbergh made his historic thirty-three-hour dash to Paris, the possibility of transatlantic airlines was discussed on all sides. Predictions were made that they would be in operation at dates that ranged from a decade to a century hence. The average between the time set by the most optimistic and the most conservative prophets indicated that a generation would pass before they became a reality. Yet children born in 1927 will hardly be in first grade when the German boat climbs into the air on its first scheduled transatlantic run to South America in March or April of this year!..."

Popular Science Monthly, **February 1933**

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Wings Over the Spanish Main

491

"…The first pilots who bridged the South Atlantic on wings all made the westward passage to get full advantage of steady tail winds. It is interesting to note that the first machine to blaze an air trail from Europe to South America was an early model of the Dornier-Wal, the type of ship to be employed on the new airway. In 1926, Capt. Ramon Franco and three companions flew from Spain to Buenos Aires, taking two weeks for the journey and making frequent stops. The takeoff of the historic flight was made from the very bay of Huelva out of which Christopher Columbus, 434 years before, had sailed in his Santa Maria on his voyage to the New World. The first non-stop crossing came in October 1927, five months after Lindbergh's dash to Paris. With one companion, the famous French flyer, Capt. Dieudonne Costes, left St. Louis, Senegal, Africa, and headed his Breguet land plane southwest over the Atlantic, landing nineteen hours and twenty minutes later at Natal, Brazil. In the two years after Costes' exploit three pilots flew non-stop from Europe to South America. Two started from Seville, Spain, while the third, Major Carlo del Prete, took off from Rome, Italy, remained in the air fifty-one hours and fifty-nine minutes, and covered 4,450 miles before he brought his record-breaking monoplane to earth at Natal…"

Popular Science Monthly, **February 1933**

492

"…The most careful survey of conditions over the ocean airway between Africa and South America was made during the past two years by the Graf Zeppelin. Under the direction of Lufthansa officials this famous German dirigible made ten round trips between Friedrichshafen and Brazil. During the previous summer it had crossed the South Atlantic six times…"

***Popular Mechanics,* February 1933**

<u>Left</u>: caption: "LZ 127 before the South American coast on the journey from Rio to Friedrichshafen" 493

<u>Above</u>: caption: "Top, giant silver-winged clipper ship taking on passengers and mail at one of the ports of call where pirate ships once flaunted the 'Jolly Roger.' Left, native woman and child of the type frequently glimpsed by the clipper's passengers as they visit sections of Caribbean towns. Right, fiesta time in old Mexico brings the brave caballero to woo his senorita beneath a soft southern moon; a scene besides the waters of the Caribbean."

<u>Left</u>: caption: "Christophe's Citadel overlooking hills of the island of Haiti, grim reminder of the olden days to passengers of the great clipper ship flashing by at high speed." 494

Gallic Contender

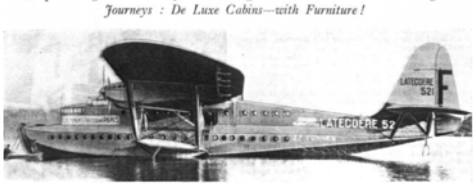
495

"…The French had a try, too, at producing the 'world's largest' flying boat. It made its bow on Jan. 15, 1935. With the Do-X no longer in the running, the French entry in the transoceanic sweepstakes seemed to deserve the title, even at a somewhat lower gross weight, 37 tons. Its name – Lieutenant de Vaisseau Paris – was in keeping with its size. Its wingspan was 162 feet. Its double-decked hull, 30 feet high, was 104 feet long. Its six engines, with four tractor and two pusher propellers, produced 5,100 hp…" 496

***Popular Science,* June 1963**

THIRTY-SEVEN TONS in the AIR

First Tests of the French Latécoère Transatlantic Flying Boat : Six 860 h.p. Hispano Engines : Seventy-two Passengers to be Carried on Short-range Journeys : De Luxe Cabins—with Furniture!



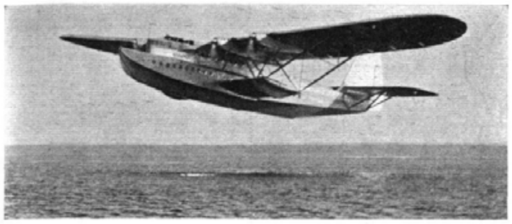
"…The largest heavier-than-air craft now operating is the 'Lieutenant Vaisseau' of Paris whose gross weight loaded is 81,400 pounds. It weighs thirty-seven tons unloaded. This transport crossed the South Atlantic once and flew north to Miami, where she capsized but was salvaged…"

***Popular Mechanics,* September 1937**

<u>Above</u>: caption: "An outsize in aircraft: the big Latecoere flying boat at the Biscarosse seaplane base during its trials" (*FLIGHT*, Jan. 1935) 497

498

COMMERCIAL AVIATION



RECORD-BREAKER: The Latécoère flying boat *Lieutenant de Vaisseau Paris*, looked upon in many quarters as a white elephant, has just proved its particular efficiencies by breaking the world's flying-boat long-distance record, which was previously held by an American Consolidated boat. The *Lieutenant* flew 3,612 miles from Kenitra (Morocco) to Maceio (Brazil) in 36 hours. At the time of going to press she was on her return journey.

<u>Above</u>: caption: "RECORD-BREAKER: The Latecoere flying boat *Lieutenant de Vaisseau Paris,* looked upon in many quarters as a white elephant, has just proved its particular efficiencies by breaking the world's flying-boat long-distance record, which was previously held by an American Consolidated boat. The *Lieutenant* flew 3,612 miles from Kenitra (Morocco) to Maceio (Brazil) in 36 hours. At the time of going to press she was on her return journey."

***FLIGHT* magazine, November 4th 1937**

499

"…In one respect, the big Gallic bird was unique among all aircraft of every era. It had 12 bathrooms. They went with 12-deluxe, double-bedded cabins – 'as big as those on transatlantic liners' – the press said. There were seats for 42 second-class passengers, a bar, and a kitchen. A crew of seven operated the plane. The Lieutenant de Vaisseau Paris was built to fly across the Atlantic in 20 hours. It never quite lived up to that promise, and it never went into actual service. After three prolonged Atlantic survey flights in the years from 1935 through 1939, it vanished as completely as the Do-X. It paid a last, flurried call at New York in late August, 1939. Hitler was then screaming at Poland, and France was supporting its eastern ally. On Aug. 27, the Lieutenant de Vaisseau Paris abruptly left New York, undoubtedly summoned home by its government. It never appeared in the news again…"

***Popular Science,* June 1963**

500

501

Pickaback Takeoff

502

"…The most radical innovation proposed for transoceanic airways is undergoing its initial tests this summer in England. It is the Mayo Composite Aircraft consisting of two machines, a seaplane riding on the back of a powerful flying boat. At the take-off, the seaplane will be loaded to the limit with fuel and cargo, while the flying boat will carry no cargo and only a moderate amount of fuel. Roaring across the water, with its four big engines at full throttle, the boat will gain flying speed and both machines, locked together, will climb into the air. Once aloft, the special locking device holding the seaplane in place will be released and the heavily loaded ship will soar away on the transatlantic run, while the flying boat returns for a landing…"

***Popular Mechanics,* September 1937**

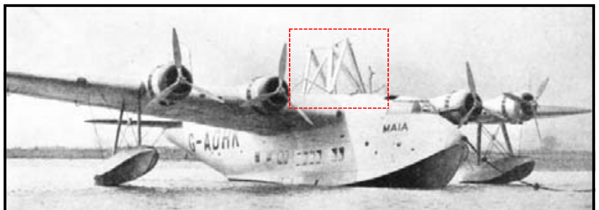
<u>Above</u>: *Maia* (flying boat) at bottom, *Mercury* (floatplane) atop (August 1938)

503

"The modern demand for long range flying at high cruising speeds has presented a take-off problem for highly loaded airplanes. As one solution to the problem, Major Robert Mayo, of England, has designed a composite aircraft, which consists of a small, fast, heavily-loaded seaplane mounted atop a huge, lightly loaded seaplane, the larger plane serving to carry the smaller one aloft to an altitude of about 10,000 feet before launching it. The powerful four-engined lower component of the Mayo Composite Aircraft, as the novel craft is officially named, is equipped with a special strut-type structure to which the smaller, but heavily loaded, seaplane is firmly attached. Until the actual planned separation of the two aircraft has been made in mid-air, the controls of the smaller plane are locked to prevent a premature launching. The combined wing area of the small and large seaplanes enables a take-off to be made from the water with a minimum run. Use of the larger seaplane as the launching medium enables the smaller plane to be loaded to its maximum of 20,500 pounds (mail, cargo and fuel), providing a cruising range of about 3,800 miles at 180 m.p.h., which will enable the mail carrying plane to fly non-stop from Southampton, England, to New York, N.Y. Trial flights of the composite aircraft are now being conducted and on the cover of this issue a Modern Mechanix artist has depicted the aerial launching as it will appear to observers."

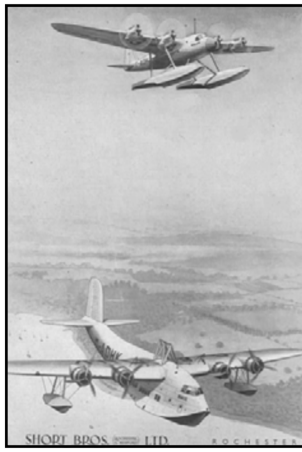
***Popular Mechanix,* March 1938**

504



The *Short-Mayo Composite Aircraft* consisted of two units, one the lower component, a flying boat, known as the *Maia*, and the other, the upper component, a twin-float seaplane, known as the *Mercury*. The upper machine was loaded with more fuel and cargo than it could lift from the surface under its own power; but it was supported by a trestled device (highlighted above) on the top of the more powerful but lightly-loaded *Maia*. The two components, with their eight engines working together, took to the air, allowing *Mercury* to obtain the necessary lift that would normally be beyond its powers. When a suitable operating height and a safe flying speed were obtained, the two units parted company. Originated by Major *R.H. Mayo*, technical general manager of *Imperial Airways*, the scheme was first worked out in detail in 1932 - two years before the *Short Empire* flying boats were designed for *Imperial Airways.*

505



506

The two aircraft, when joined, were rigidly linked so that they could be considered as one. When thus linked, they became an eight-engined, bi-plane flying boat. All eight engines were used for the take-off, and the surplus wing area and engine power of the lower component made up for corresponding deficiencies in the upper component. When the suitable height and speed were attained and the two components separated, the upper continued to climb and the lower descended. There was no jerk on separation. Aerodynamically, the reason for the successful separation of the two machines was, perhaps, the most interesting part of the design. The wings of the two machines had to be built so that the changes in their wing lift coefficients varied at different rates with changes in the angles of incidence.

Above: the upper component; *Mercury*, was a twin-float, four-engine seaplane crewed by a single pilot and a navigator, who sat in tandem in an enclosed cockpit. It could carry 1K lbs. of mail and 1,200 IG (Imperial Gallons) of fuel

507

"…In this unique 'pickaback' take-off, Imperial Airways engineers expect to achieve the same results as are now obtained by means of the mother ships of the German air line. During regular runs, the launching plane will fly several hundred miles out to sea while the transatlantic machine conserves its fuel for the rest of the journey…"

***Popular Mechanics,* September 1937**

RE: the mechanism that held the two aircraft together allowed for a small degree of movement. Lights indicated when the upper component was in fore-aft balance so trim could be adjusted prior to release. The pilots could then release their respective locks. At this point, the two aircraft remained held together by a third lock which released automatically at 3K lbs. The design was such that at separation, *Maia* would tend to drop while *Mercury* would climb.

Left: starboard side view of wings and engines of *Maia* and *Mercury*

508

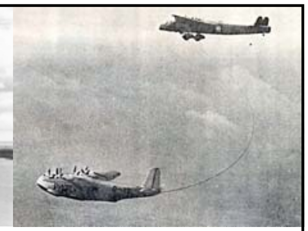
The first successful in-flight separation was carried out from the Shorts works at *Borstal*, on February 6th 1938 (above L&R). Following further successful tests, the first transatlantic flight was made on July 21st 1938 from *Foynes*, on the west coast of *Ireland*, to *Boucherville, Montreal, Canada* - a flight of 2,930 miles. *Maia,* carrying ten passengers and their luggage, took off from *Southampton* carrying *Mercury.* Mercury separated successfully from her carrier at 8:00 PM to continue what was to become the first commercial non-stop east-to-west transatlantic flight by a heavier-than-air flying machine. This initial journey took 20 hours, 21 minutes at an average ground speed of 144 mph. The *Maia-Mercury* composite continued in use with *Imperial Airways*, including Mercury flying to *Alexandria, Egypt*, in December 1938. After modifications to extend Mercury's range, it subsequently established a record flight for a seaplane of 6,045 miles from *Dundee* in *Scotland* to *Alexander Bay*, in *South Africa* between October 6-8th 1938. However, only one example of the Short-Mayo composite was ever built. The development of a more powerful and longer-range Empire boat (the *Short S-26*), increase in allowable weights, further development of in-flight refueling and the outbreak of WWII combined to render the approach obsolete.

509

510

"…Still another innovation which is being tested in Great Britain's race for supremacy on the ocean airways is a system of refueling in mid-air. The noted long-distance pilot, Sir Alan Cobham, is working with Imperial Airways engineers on a plan which would permit the transatlantic ships to take off with only a small amount of fuel in the tanks and then, while heading out to sea, take on a full load of gasoline from a 'nurse ship' soaring overhead…"
***Popular Mechanics,* September 1937**

511

<u>Above</u>: to make heavier payloads possible, *British Imperial Airways* flying boats were fueled in mid-air after taking off on a transatlantic flight. After making a safe and easy take-off with their fuel tanks only partially filled, the *Empire* flying boat would take on an additional 1K-gallons of gasoline from a converted bomber serving as a flying fuel tanker. The extreme end of the tail cone of the Empire flying boat was modified to catch the refueling cup (with spring-loaded locking claws around its periphery). The locking mechanism was hydraulic, operated by a manual pump connected through a pressure release unit. The system was designed to break the locking arrangement if the force on the hose exceeded a pull of 1K-foot pounds. Fuel transfers in bumpy or gusty weather could cause the hose nozzle to momentarily break clear of the receiver cup.

512

A Helluva Boat

513

"…Brightest example of the worth of flying boats was the development of Pan American World Airways. Though one of Pan Am's early models caused a sailor to exclaim, 'That's a helluva way to carry a boat,' flying boats pioneered all the transoceanic routes of that system. During World War II alone, they flew a total of more than 201 million miles, including nearly 18,500 ocean crossings. The most famous, and the biggest of Pan Am's clippers was the Boeing 314, the first Yankee Clipper. It made its maiden flight across the Atlantic on May 20, 1939, exactly twelve years after Lindbergh…"
***Popular Science,* June 1963**
<u>Above</u>: cut-away view of the Boeing 314

514


"Pan American Airways 82,500-pound 'super-clipper' flying boat will soon lift from Long Island Sound on its initial passenger run to Europe. Built at the Boeing plant in Seattle, Wash., the new transatlantic sky boat – the first of a fleet of six – is the biggest airplane in the world. Its hull is 105 feet in length with a wingspan of 152 feet. A quartet of 1,500-horsepower Wright-Cyclone engines drags the boat through the air at more than 200 miles per hour. Catwalks through the wings enable mechanics to reach the engines and make repairs in flight."
***Popular Science Monthly,* June 1939**
<u>Left</u>: the first Boeing B314 "Yankee Clipper" being christened on March 3rd 1939 in *Washington D.C.*
<u>Right</u>: First Lady *Eleanor Roosevelt* officially christens the first Yankee Clipper (03/03/1939)

515

"…Sometime this month, with spray glistening on its metal hull, the super-clipper will lift from the water off North Beach Airport, New York City, and head out over the ocean, taking the southern route to Europe. The coastline will drop behind the triple stabilizers at the tail; 2,422 miles of tossing water will slip beneath the wide-spread wings. Then, on a long slant, the ship will slide down, skim the waves, and wallow to a stop at the Azores. Charging away again in a cloud of spray, it will take to the air, winging on to Lisbon, Portugal, before the final, quick hop to its destination, Marseilles, France, or Southampton, England. Later in the summer, the great-circle route to Ireland and England, the path followed by Lindbergh, will be used by the super-clipper. The tentative fare for the transatlantic journey is $450. Mail and express will go for twenty-five cents a half ounce…"
***Popular Mechanics,* June 1939**

516

Greyhound of the Air

517

"…Scarcely will the first clipper roar eastward, within a few weeks, before a second ocean-going greyhound of the air will be hauled from a hangar at Baltimore, Md., and prepared for the start of the second scheduled voyage. Other sister clippers, now being constructed, will be added to Pan American's Atlantic fleet within a short time, enabling the company to offer service to Europe several times a week. While the clippers will be serviced at Baltimore, the takeoff terminal will be at North Beach on Long Island Sound or at Pan American's temporary base at Port Washington, N.Y. From there a northern route, which will be used in summer, is by Shediac, New Brunswick, to Botwood, Newfoundland, thence across a 1,996-mile over-water jump to Foynes, Ireland, and finally to Southampton, England. Passengers may reach London by air taxi or train. Flying time will be approximately twenty-four hours…"
***Popular Mechanics*, 1939**

518

519

"On wings sixty-two feet longer than the ship in which Columbus sailed to the New World, Pan American Airways' 82,500-pound 'super-clipper' flying boat will soon lift from Long Island Sound on its initial passenger run to Europe. In twenty-four hours, it will cross the sea on which Columbus's Santa Maria tossed for ninety-two days. Half a hundred passengers and a cargo of 5,000 pounds will ride in the great silver-colored hull of this aerial luxury liner. No other craft ever rode the air with as many aids to comfort and safety as the new machine will carry. Instruments so clever that they almost think will assist the pilots and protect the passengers. Throughout the flight, a delicate analyzing mechanism will suck air from all parts of the ship, flashing a red warning light if carbon monoxide gas or other impurities are present. Soundproofing will reduce the noise within the cabin to less than that of a railway coach. The whole interior will be air-conditioned and kept at a constant temperature. Five seven-room houses could be warmed by the plane's heating system…"
***Popular Mechanics*, June 1939**
Above: *Boeing B314* "Atlantic Clipper" at *Port Washington* (1939)

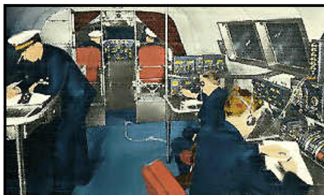
520

"…Built at the Boeing plant in Seattle, Wash., the new transatlantic sky boat - the first of a fleet of six - is the biggest airplane in the world. Its hull is 105 feet in length and its wings stretch 152 feet from tip to tip. With all four of its 1,500-horsepower Wright Cyclone engines thundering at full throttle, the all-metal craft can climb to 21,000 feet with a useful load greater than the weight of the ship itself. Spinning fourteen-foot, three-bladed steel propellers, the quartet of engines can drag the big boat through the air at a top speed of more than 200 miles an hour. At cruising speed, 150 miles an hour, one filling of the tanks will carry the transatlantic sky liner 4,275 miles. An average automobile could travel more than twice around the world on the 4,300 gallons of high-test fuel the tanks will hold…"
Popular Mechanics, June 1939
Above: flight engineer's station of a *Boeing 314 Flying Boat* (left). At right, Boeing 314 supper clipper under construction at the Boeing factory, *Seattle, WA* (1939)

521

The *Boeing Model 314* was a combination of the Wellwood E. Beall's design and the *Boeing XB-15* bomber. The aircraft first flew on June 7th 1938. A total of twelve aircraft were built with the last one retired in 1951. To the public, *China Clipper* became a generic name and originally was applied to all three of the Martin M-130's in PAA's fleet and, later, to the Boeing 314's.

522




"…The 42-ton flying boat, with four 1,500-hp engines, was very different from the Spirit of St. Louis. Its 152 foot wing was the same type that the huge B-29 Air Force bomber later used. Its double-decked hull was 109 feet long. The 'flight deck,' as it was called, was an eye-popping sight to the pilot of any lesser craft. It was nearly 22 feet long, 9&1/2 feet wide, and provide 6&1/2 foot headroom. It had wall-to-wall carpeting. The flight officers sat at their controls or instrument panels in handsome leather-upholstered chairs…"

***Popular Science,* June 1963**

RE: the flight deck (above L&R) was one of the most luxurious ever made. Behind the cockpit was a complete flight operations room. Two heavy maroon curtains were drawn behind the pilots at night so as not to diminish their night vision. Between the pilots was a trap door leading into the bow compartment in the nose of the plane. On the port side was the navigator's seven foot long chart table. Beyond that was a small conference table and an oval hatch leading to the crawlway inside the wing. The engines could be reached for simple maintenance or repairs during the flight, if necessary, through this crawlway. On the side, behind the cockpit, was a circular staircase that led down to the passenger compartment. Then came the radio operator's station then the oval hatch that led to the starboard wing crawlway. Along the back wall of the flight deck was a doorway that led to the cargo hold/s.

523



<u>Top Left</u>: *Boeing B-314* rear of cockpit. Left to right: navigator (extreme left), flight engineer (with headphones), reserve officers center-rear (at planning tables), Navigator (next to plotting table)
<u>Top Right</u>: navigator at work on plotting table (pilot and co-pilot beyond)
<u>Left</u>: flight engineers' control panel

524

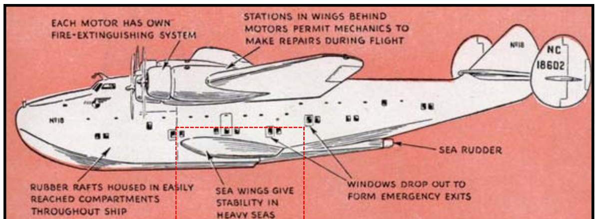

<u>Above</u>: caption: "At this big panel, the flight engineer controls the motors. The door at right leads to a motor-inspection passageway."

<u>Left</u>: caption: "A view of the spacious cockpit, showing the station of the first pilot, second pilot, and the radio operator"

"Fifteen times as large as the cockpit of a modern twin-motor transport, the huge control room pictured on this page is the nerve center of a seventy-four-passenger clipper plane, one of a fleet of six being constructed at Seattle, Wash., for trans-oceanic service. In the photo-graph at the left, four of the six stations within the spacious cockpit are visible: the chief pilot's, the second pilot's, the navigator's, and the radio operator's. The ship's captain has a desk at the left rear of the cockpit, while the right rear section is occupied by the flight engineer, shown above con-trolling the operations of the four 1,500-horsepower motors."

***Popular Science,* April 1939**

525



"…Two other innovations help control the boat on the water. To increase the ease of maneuvering about before a take-off and after a landing, an underwater rudder operates in conjunction with the air rudders. 'Sea wings,' technically known as hydro-stabilizers, give the machine greater side-to-side stability, especially in heavy seas. These sturdy, wing-like floats jut out from either side of the hull…"

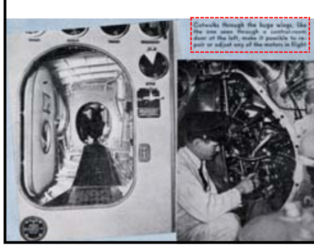
***Popular Mechanics,* June 1939**

526

"…Throughout the ocean voyage, instruments will show the temperature of each of the fifty-six cylinder heads in the air-cooled power plants. Every motor has its own fire extinguisher built into the wings of the plane, and catwalks through the interior of the great supporting surfaces enable mechanics to reach the engines and make adjustments and repairs in flight. With two of its four motors out of commission, the flying boat can still remain in the air…"

***Popular Mechanics,* June 1939**

<u>Below</u>: caption: "Catwalk through the huge wings, like the one seen through a control-room door at the left, make it possible to repair or adjust any of the motors in flight"

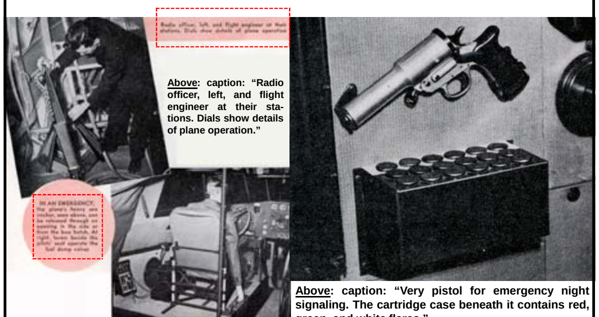



<u>Above</u>: caption: "All that the pilots need to look after; one of the control boxes in the pilots' compartment, with the throttle levers on the left and the trimming controls and indicators on the right, with master controls for the mixture and manifold pressures. On the extreme right is a remote-control panel for intercommunication and radio homing purposes."

527


<u>Above</u>: caption: "Radio officer, left, and flight engineer at their stations. Dials show details of plane operation."
<u>Left</u>: caption: "The Clipper's Ears and Voice – the Radio Officer's post. Every half hour these clicks to the guarding ground bases complete position and weather reports."

528



Above: caption: "Radio officer, left, and flight engineer at their stations. Dials show details of plane operation."

Above: caption: "Very pistol for emergency night signaling. The cartridge case beneath it contains red, green, and white flares."

Above: caption: "In an emergency, the plane's heavy sea anchor, seen above, can be released from an opening in the side or from the bow hatch. At right, levers beside the pilots' seat operate the fuel dump valves."

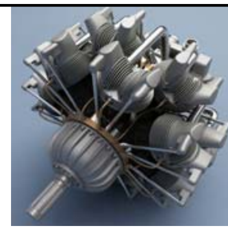
529

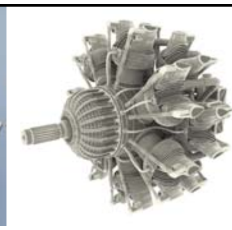
"…To provide every possible convenience for the man who handles the controls, various innovations have been incorporated in the design of the new ship. A small button on the control wheel permits the pilot to illuminate the instrument panel without taking his hands from the controls. An automobile-type sun visor can be swung down when the machine is flying toward the rising or setting sun. By pulling down a lever overhead, the pilot can lift a powerful searchlight into position to aid in taxiing about after a night landing…"
***Popular Mechanics*, June 1939**

530

The Day of the Aerial Monsters

531

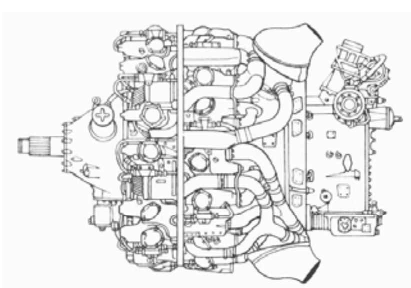




"…For years aviation engineers have been discussing giant airplanes of the future. This year they have caught up with their prophecies and the day of the aerial monsters is here. One thing that has helped make the dream come true is the perfection of aviation engines far more powerful than any of the past. One engine of a 1938 four-motored airplane develops more power than the total horsepower of a tri-motored transport of ten years ago. Four such engines provide as much as 6,000 horsepower for take-offs, more power than is required by a streamline engine to pull twelve railroad coaches. These tremendous air-cooled motors, the latest developments of the engine manufacturing companies, are on the 'military secret' list and are not available to everyone, nor may they be exported abroad. They are twin row radials of improved design, consisting essentially of two radial engines, one placed right behind the other, and attached to a common crankshaft. They develop one horsepower for every pound and a quarter of weight…"
***Popular Mechanics*, June 1938**

Above: view/s of the twin-row radial air-cooled radial aircraft engine

532



Above: the ***Wright R-3350 Duplex-Cyclone*** **was one of the most powerful radial aircraft engines produced in the *United States*. It was a twin row, supercharged, air-cooled, radial engine with eighteen cylinders. Power ranged from 2,200 to over 3,700 hp, depending on the model. Developed before WWII, the R-3350's design required a long time to mature before finally being used to power the *Boeing B-29 Superfortress*. After the war, the engine had matured sufficiently to become a major civilian airliner design, notably in its "Turbo-Compound" forms.**

533

"…The power of aviation engines has been climbing upward for years. In 1930 the Pratt & Whitney Wasp was rated at 420 horsepower but today the same engine delivers 600 horsepower with hardly any change in size. The increased output is due to improvements that include refinement of cylinder design and higher compression ratios and supercharging. These last two improvements are possible because of the better fuels that are available today and in turn permit a higher number of engine revolutions per minute, which results in greater horsepower. Other engine improvements include hollow valves filled with sodium to promote cooling, tougher alloys that are better able to withstand the higher crank speeds, and redesigned fins on the air-cooled cylinders which together with pressure baffles that force the air to circulate between the fins result in better control of engine temperatures. The trend in engine design seems to be toward more and smaller cylinders, providing a smoother flow of power with less vibration. The two-row radial engines are a development of this trend, as well as an answer to the cry for greater horsepower. The new R-2180 Twin Hornet, made by Pratt & Whitney, is a fourteen-cylinder twin-row radial with a displacement of2,180 cubic inches…Even more powerful than the Twin Hornets are the new 1,500-horsepower Wright Cyclones of similar radial type that are being used to power the new four-engined flying boats that carry seventy-two passengers…"
***Popular Mechanics*, June 1938**

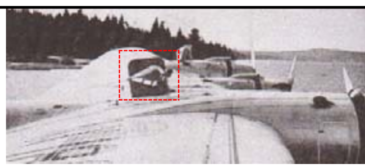
534

Above: the *R-2600 Wright Cyclone* series engine was introduced in 1939, initially rated at 1,500 hp. With improvements, it later reached a rating of 1,800 hp. In military use, it was used on *U.S. Army Air Force* A-20s, A-24s and B-25s as well as some *U.S. Navy* torpedo and patrol bombers. It gained fame powering the *Boeing Model 314* "Clipper" flying boats. It held fourteen cylinders in two rows in an air-cooled radial configuration. Maximum horsepower and rpm was 1,700 and 2,600 respectively. It weighed 1,980 lbs. and cost $16,500. After the end of WWII, the R-2600 was superseded by larger radial engines.

535

Queen Mary of the Air

536



"…This 'Queen Mary of the Air' is the first airplane with two decks connected by a spiral staircase. It has eighteen separate rooms within the hull proper, not counting the four 'engine rooms.' The ship measures 100 feet long and has a wing span of 152 feet, nearly one-half the length of a city block. The hull has an inside volume equal to that of a five-room house including basement, and the craft's thermostatically controlled system produces nearly five times as much heat as the heating plant of a modern seven-room house. Fuel tanks hold enough gasoline to drive an automobile two and one-half times around the world, 4,300 gallons, and the cargo holds have a capacity of 10,000 pounds of mail and air express. There are approximately 50,000 different parts in the clipper, assembled with 15,200 bolts and 1,000,000 rivets. The electrical system contains eleven and one-half miles of wiring, installed in 400 runs of conduit, and outlets for 160 light bulbs…"

***Popular Mechanics,* March 1939**

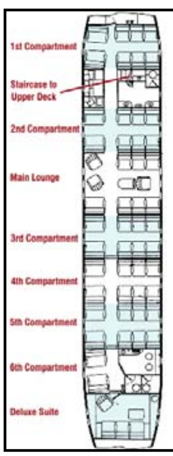
Above: view from the clippers starboard wing looking to port (note open hatch from fuselage)

537

"…Inside the double-decked metal hull, life during a transatlantic flight will be like life in an up-to-date hotel. A galley, complete with ice boxes and steam tables, will permit stewards to prepare food for ninety people. To conserve weight, special lightweight silverware will be used at mealtime. During the voyage, passengers will read, smoke, walk about from room to room. Different parts of the plane will be connected by telephone. There will be lounges, dressing rooms, smoking rooms, private compartments - even a honeymoon suite - on board the aerial leviathan…"

***Popular Mechanics,* June 1939**

538



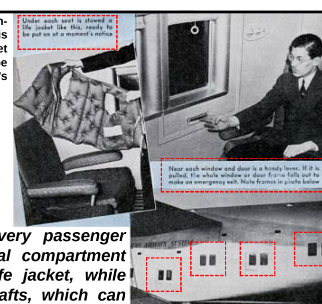
"…Below, the passenger compartment was divided into 11 compartments. One was a dining room, seating 14 at 5 tables. On the early, pre-war flights, English passengers usually dressed for dinner. The cabin farthest aft was a luxurious bridal suite. The Yankee Clipper usually flew only 40 passengers on overnight flights, when its eight-foot berths were made up. By day, it could accommodate 74…"

***Popular Science,* June 1963**

Left: passenger compartment plan. Passengers could expect to have all their needs catered to by the ever-attentive stewards. Food and drink were always available on demand. Curtained bunks were made up for the passengers at night. The thick carpeting, soft lighting, comfortable upholstery in soothing colors and the heavy soundproofing in the walls all helped to create a special world set apart from the weather and world rushing by outside the windows. The series of lounges were decorated in alternating color schemes; turquoise carpet with pale green walls or rust carpet with beige walls. The compartments could seat up to ten passengers each on a daytime flight, but overnight flights carried less as they could only sleep six passengers.

539

Right: caption: "Under each seat is stored a life jacket like this, ready to be put on at a moment's notice"

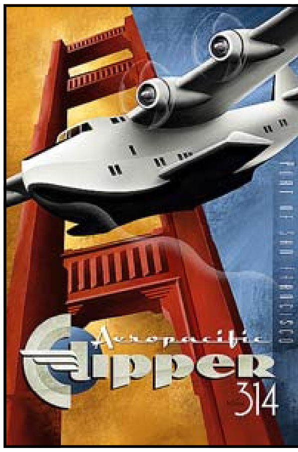


Left: caption: "Near each window and door is a handy lever. If it is pulled, the whole window or door frame falls out to make an emergency exit. Note frames in photo below."

"…Beneath every passenger seat, a special compartment will hold a life jacket, while ten-man life rafts, which can be quickly inflated by built-in gas cartridges, will be carried at strategic points within the hull. In a few seconds, thirty doors and windows can be converted into emergency exits. Jerking out a small lever near-by will cause the window or door, frame and all, to drop from its place…"

***Popular Mechanics,* June 1939**

540



541

<u>Top</u>: caption: "The Clipper's Lounge is the central recreation room aboard ship. Here, in spacious comfort, one may while away the brief hours between continents. Here the stewards will bring you tasteful drinks from the little bar set up in the galley – or games, or cards, or writing materials. The lounge seats fourteen people."
<u>Bottom</u>: caption: "Meal-Time on transoceanic flights in these super-clippers is an event. The lounge converted into a dining salon, the stewards serve hot, full-course meals from their efficient galleys. Polished black walnut tables are set with snowy linens and specially-designed silverware and china to make meals even more delightful."

542

<u>Above</u>: caption: "Private suite at the rear of the cabin. This cabin was often called the honeymoon suite."
<u>Left</u>: caption: "Dressing Rooms aboard the Clipper are separate for women and men. Each boasts hot and cold running water, plate glass mirrors, and plenty of room. Men's dressing room even has an outlet for electric shavers."

543

<u>Above</u>: caption: "Boeing 314 passenger cabin"
<u>Left</u>: caption: "One of the best ways to gauge the size of these 42-ton Clippers is to stand in the forward cabin and look aft down the long aisle. The ship measures 106 feet from stem to stern."

544

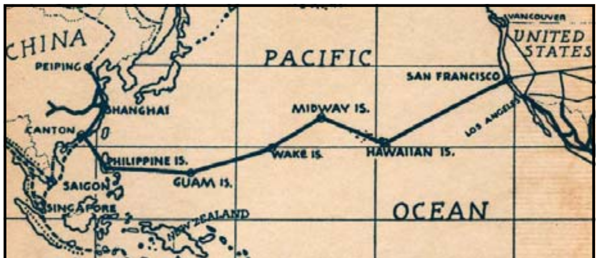
<u>Part 8</u>

Wings Over the Pacific

545

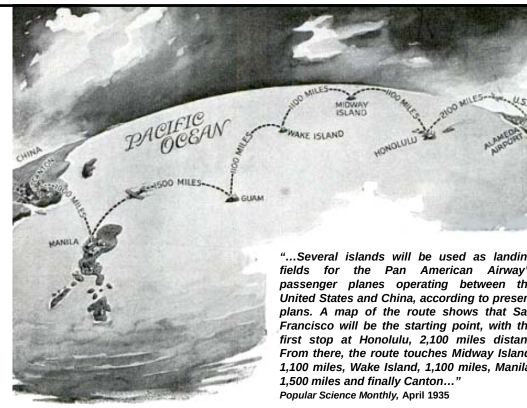
"In my opinion trans-Atlantic service via Bermuda and the Azores will be in existence within three years with heavier-than-air planes and without stop by dirigibles. Trans-Pacific service is also feasible today with Douglas airplanes. Within three years there will be a service between Los Angeles and Hawaii; San Francisco and Hawaii; Portland, Oregon, and Hawaii, and from there it will be projected to the Far East, New Zealand and Australia, with service to the Philippine Islands and to Japan and China. With commercial establishment of these airways the last links will be completed in practical circumnavigation of the world by air. Definite plans for establishment of these airlines are now under way…"
***Captain Eddie Rickenbacker,* February 1935**

546



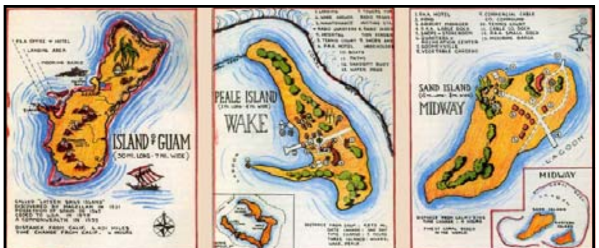
"…Pan American was operating 25,000 miles of aerial trade routes between the Americas when it began to cast a speculative eye on the Pacific. And at first glance, the thousands of miles of trackless ocean wastes seemed unconquerable. Who ever heard of flying on regular schedules over an ocean extending over about one-third the circumference of the globe? But then, who ever heard of a transcontinental railway until one was built? Pan American decided to conquer the Pacific…"
***Popular Mechanics,* 1937**

547



"…Several islands will be used as landing fields for the Pan American Airway's passenger planes operating between the United States and China, according to present plans. A map of the route shows that San Francisco will be the starting point, with the first stop at Honolulu, 2,100 miles distant. From there, the route touches Midway Island, 1,100 miles, Wake Island, 1,100 miles, Manila, 1,500 miles and finally Canton…"
***Popular Science Monthly,* April 1935**

548



"…A survey revealed that fate or destiny had taken a hand in the matter by dotting the only logical route with four little islands – Hawaii, Midway, Wake and Guam. What could be more practical than to convert these specks of land, and all possessions of the United States into intermediate air bases? But even after the route had been broken up into laps by these islands, the task of flying the Pacific still challenged the imagination…"
***Popular Mechanics,* 1937**

549

"…Stations in such remote spots as Midway, Wake, and Guam are wholly or partly dependent on supplies from the outside. But soon the land surrounding these newly established bases will be yielding fruits and vegetables the year round. Hundreds of tons of rich soil have been carried to the islands…"
***Popular Mechanics,* December 1936**

550

"…Some of the islands were nothing more than barren stretches of coral and sand…Thousands of tons of supplies were taken to the little dots of land. Ground crews were left there to build everything from hotels to weather stations and air beacons…"
***Popular Mechanics,* 1937**
<u>Above</u>: period PAA advertisement showing their *Wake Island* base

551

Conquering the Unconquerable

552

"…To conquer the Pacific, Pan American first used its Caribbean lines as a laboratory in which to perfect men and methods. Four-engined flying boats larger than ever used in regular service before were built and tested. Then, while the mid-Pacific bases were still under construction, flight after flight was made to Honolulu, to Midway, then to Wake, then to Guam. Nearly a half million miles were flown before the airway was opened to passengers…"
Popular Mechanics, **March 1939**

553

"…Better power plants were necessary…precision methods of navigation were necessary if seaplanes were to fly over thousands of miles of trackless ocean. No flying crews were trained for trans-oceanic service. No ground organization existed for servicing ocean airliners from the island bases. Each of these problems was faced and solved before there were any wings over the Pacific…Then there was the matter of developing lightweight, low-powered radio to cover the whole Pacific and extending the range of aircraft radio direction-finding devices. Crews were trained so that each man could perform the duties of every other member as well as his own…"
Popular Mechanics, **1937**

554

"…the design and construction of the Clipper ships was an epic in itself. Pan American wanted seaworthy flying boats able to cruise 3,000 miles, even against a head wind, at 150 miles an hour. Also they must carry a profitable pay load. Igor Sikorsky built a nineteen-ton flying boat to fulfill transoceanic conditions and Glenn Martin built a twenty-five and one-half ton ship. Both planes emerged from flight tests with flying colors. The Brazilian Clipper, Sikorsky's ship, was licensed to carry 99.8 per cent of its own dead weight, the China Clipper produced by Martin 102.1 per cent. Each had a top speed of more than 180 miles an hour and a cruising speed of 157 miles…Test flights were made to prove the plans and everything went off like clockwork…"
Popular Mechanics, **1937**

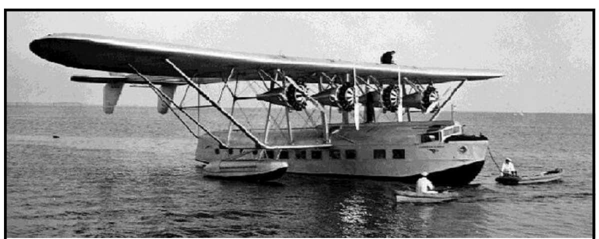
555

"…the first American example of the great airliner of tomorrow that will speed trade and good will among nations."
Juan Trippe, **PAA Chairman**
RE: after the overwhelming success of Sikorsky's S-38, PAA wanted a plane with greater range, better performance and a greater payload capacity. Sikorsky's opportunity came and the result was the "S-40" (being rolled out in the spring of 1931, at left). The first S-40 was delivered to PAA on October 10th 1931. It was flown to the *Anacostia Naval Air Station* at *Washington D.C.* to be christened by *Mrs. Herbert Hoover* as the *American Clipper*. "Flying Clippers" became one of the most famous names in aviation history. Many of the flight paths of these flying boats were based on navigational routes that originated in the days of "Clipper" sailing ships. *Flying Clipper* pilots had to keep the same keen "weather eye" that enabled captains of Clipper ships to make port safely. Even after the age of the flying boats had ended, PAA continued to name their planes "Clippers." It was during the inaugural flight of the S-40 on November 19th 1931 that *Igor Sikorsky* and *Charles Lindbergh* began discussing an improved and larger aircraft. In the ship's lounge, they began making preliminary sketches on the back of a menu. The new plane called for an increased lifting capacity that would permit carrying fuel for a 2,500 mile nonstop flight against a 30 mile-an-hour head-wind at a cruising speed far in excess of the average operating speed of any flying boat at that time. Juan Trippe's challenge was also answered by *Glenn L. Martin,* but Sikorsky's S-42 (right) was to be delivered first since Martin's plane was still almost a year away from completion. The *Sikorsky S-42* is regarded as the first truly American seaplane and was described as: "the most beautiful aircraft of its time."

556

Like Flying a Forest Through the Air

557

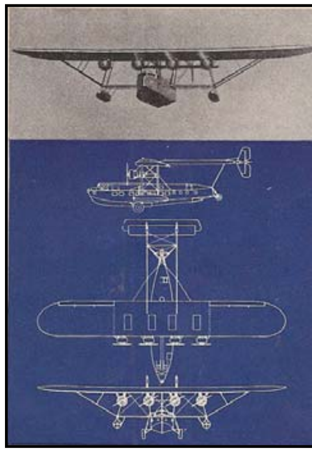


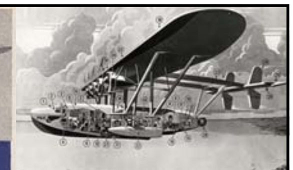
Based on the tried-and-true design of the eight passenger *Sikorsky S-38*, the S-40 was a giant leap forward in terms of size and range, but the plane was not especially streamlined, and the drag from its exposed struts, wires, and engines limited its speed, range and fuel efficiency. Unhappy with the S-40's design from the time it was first proposed, PAA technical advisor *Charles Lindbergh* said it would be like: "flying a forest through the air." Although primarily operated as a flying boat, the S-40 was built as an amphibian to allow for emergency landings when flying over land, and had retractable landing gear (using shock absorbers adapted from railway cars) which added to the aircraft's weight and further reduced its performance. Never completely satisfied with the relatively primitive nature of its design, PAA asked Sikorsky to work on an improved model (the *Sikorsky S-42*) even as the S-40 was first entering service. When PAA retired the S-40 in 1940, all three went to the *U.S. Navy* for training purposes and were scrapped in 1943.

558

The first PAA plane to be called a "Clipper," the S-40 grew out of the need for a strong, sturdy, high-capacity four-engine transport to serve as an ocean liner of the air. Originally conceived in late 1928, the S-40 (above & left) made its first test flight in April 1931

559





__Above & Left__: the largest plane built in America at the time, the S-40 had a gross take-off weight of 34K-lbs. and could carry 38 passengers in luxurious wood-paneled compartments on flights of up to 500 miles, or 24 passengers on flights of up to 900 miles. It was with the S-40 that PAA first pioneered the maritime theme that became so strongly associated with the airline, not only calling the ships "Clippers," but dressing its crew in naval-style uniforms and using maritime terminology to give passengers a sense of security and professionalism and encourage people to think of airliners as an alternative to ocean liners.

560

S-40 Technical Details;

- **Length: 77-feet**
- **Wingspan: 114-feet**
- **Gross Weight: 34K-lbs.**
- **Engines: four *Pratt & Whitney* "Hornet" radial engines (initially 575 hp, later 660 hp)**
- **Range: 900 miles**
- **Max Speed: 137 MPH**
- **Cruise speed: 115 MPH**

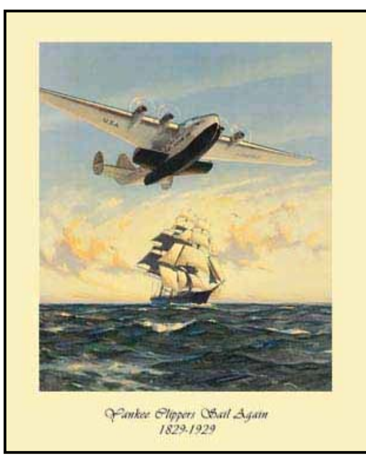
Only three S-40 Clippers were ever built:

- **NC-80V: *American Clipper***
- **NC-81V: *Caribbean Clipper***
- **NC-752V: *Southern Clipper***

561

__Above L&R__: S-40 passenger compartment/s. Used throughout PAA's extensive Latin American route system, the S-40 became a familiar sight at PAA's *Miami, Florida* base (left) and flew to destinations throughout *South* and *Central America* including *Buenos Aires, Santiago, Rio de Janeiro, Bogota* and *Lima*. The three S-40s operated by PAA eventually flew approximately ten million miles over the course of their careers.

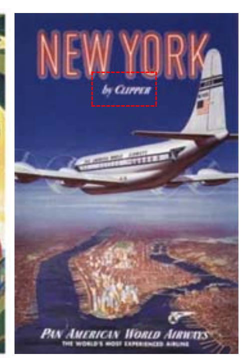
562



"…A big feather in the American hat at present is the fleet of fast clipper ships built especially for transatlantic service by Sikorsky and Martin. None of the foreign companies has equipment which compares with that now under construction for Pan American. The transatlantic clippers embody improvements which have been flight-tested for years in the great laboratory for ocean flying, the Caribbean sea. The experience gained there has given American aviators an advantage that will make the flying clippers as famous as the Yankee sailing clippers in their day…"

***Popular Mechanics*, March 1934**

563



564

"…the S-42 is credited with being able to fly 3,800 miles nonstop with thirty-two passengers, a crew of five, and 1,000 pounds of mail and express. Piloted by Col. Charles A. Lindbergh in a test with thirty-one on board, at 190 miles an hour. The span is 114 ft., length 76 ft., and weight 19 tons. Its engines develop 2,600 hp. This great 'Brazilian Clipper,' as it is called, has already broken two world's records. It is one of six ships ordered for the Pan American Airways…"

***Popular Science Monthly,* September 1934**

RE: the first S-42 was built in 1933 and first flew in March 1934. The S-42 had a full-length hull, unlike the cut off hulls of the prior Sikorsky models. It was powered by four *Pratt & Whitney Hornet* 750-HP radial engines and utilized the new *Hamilton Standard* variable pitch props. The aluminum skin of the S-42 was flush riveted to reduce drag. The S-42 was a true flying boat and its fuselage was broken up into nine watertight compartments. It set several world records (for weight-to-altitude) with *Charles Lindbergh* at the controls for several of the record-setting flights. A total of ten S-42s were produced and PAA purchased all of them. The total wing area was 1,340 square feet and the aircraft had a gross weight capacity of 42K pounds. The S-42 could attain a top speed of 190 mph in level flight and had a service ceiling of 16K-feet. A typical cruising altitude and speed would be 140-150 mph at 5K-feet. The S-42 was also used on survey flights for PAA's *Pacific* routes. The S-42 cut nearly 50% off the total travel time for PAA's South American long distance routes because the aircraft required fewer stops with its range of 1,120 miles.

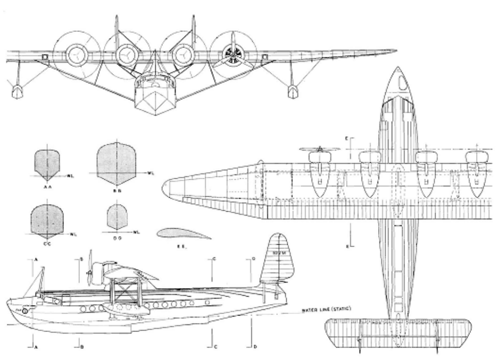
565

"…The S-42; flagship of the fleet, just launched, is the first of three sister ships under construction by Sikorsky. Three others will soon be launched by the Glenn L. Martin Company, in Baltimore. Specifications called for a flying boat capable of transporting a full mail load more than 2,500 miles against head-wind conditions of thirty miles per hour. Actually, the S-42 has a greater range. She is now fitted out as a thirty-two passenger airliner. With these passengers, a crew of five, and 1,000 pounds of mail, the S-42 has a range of 1,200 miles. The same clipper in transatlantic service would have a smaller passenger capacity on account of the space demanded by fuel tanks. Her fuel capacity will give her a range thirty percent more than is necessary to cross the ocean at its widest point…"

***Popular Mechanics,* March 1934**

<u>Above</u>: *Sikorsky S-42* flying boat

566



<u>Above</u>: Sikorsky S-42 plan, front/side elevations and hull/wing sections

567

China Clipper

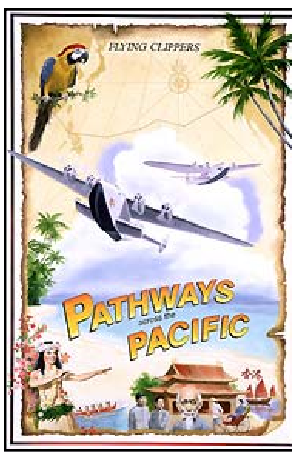
568

"With the completion in a few months of the new Pan American Clipper ships, it is the plan of the Pan American Airways to begin its projected air transport service across the Pacific to Canton, China. Traveling by train and steamship now, it takes about one month to Canton from New York City. With this new Clipper ship, equipped as a trans-oceanic training ship, with a range of 3,000 miles and top speed of 191 miles an hour, a service combined with the present transcontinental service from New York to Los Angeles will enable you to reach Canton in less than a week…"

***Captain Eddie Rickenbacker,* February 1935**

<u>Above</u>: caption: "After two years of closely guarded construction, this huge flying boat, built in the Glenn L. Martin Co. plant near Baltimore, is the largest air liner in the world. Pan-American airways may use it on a proposed trans-Atlantic line. It can carry 50 passengers, a crew of six, and two tons of mail. Pan American will name the plane Clipper Number 7."

569



"…Pan Am had Pacific Clippers, too – Martin M-130's – one of which, a China Clipper, made the first scheduled air-mail flight from California to Manila in November, 1935…"

***Popular Science,* June 1963**

RE: no plane of the day had the range capability needed to cross the *Pacific* nonstop. However, *Hawaii, Guam* and *Manila* formed a line of "stepping stones" to *Asia*. Further investigation revealed the islands of *Midway* and *Wake* broke-up the prohibitive 4K-mile expanse of ocean between Hawaii and Guam. PAA's pioneering survey flights were made using the *Sikorsky S-42*. Having a range of only 1,200 miles, this four-engine flying boat was outfitted with extra fuel tanks to make the journey possible. Passenger service would not begin until PAA received the first *Martin M-130*, which had a range of 3,200 miles and seating for 36 passengers. Powered by four *Pratt & Whitney* "Wasp" engines, the *China Clipper* began the first commercial transpacific flight on November 23rd 1935, landing in *Honolulu*. Five days later it arrived in Manila, via Midway, Wake and Guam.

570

Above: in 1935, PAA began trans-Pacific service to ***Manila*** in the ***Philippines*** via ***Hawaii***, ***Midway Island, Wake Island*** and ***Guam***. Soon thereafter the Manila service would be extended onto ***Macau*** and then ***Hong Kong***. The ***Pacific*** service was inaugurated with the famous ***Martin-130*** "China Clipper" flying boat.

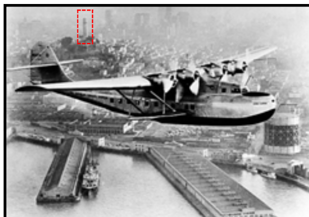
571

"…Between San Francisco bay and Manila the airway uses three twenty-six ton Martin flying boats…The great ninety-foot hull of one of these boats is divided into six watertight compartments, any two of which can keep the boat afloat if necessary. A clipper can cruise and climb on any three of its four engines…"

Popular Mechanics, **March 1939**

RE: built by the *Glenn L. Martin Company*, they were known by the company as "Martin Ocean Transports." The M-130 first flew on December 30^{th} 1934. Only three of these aircraft were ever built; the *China Clipper* (above & left), the *Philippine Clipper* and the *Hawaii Clipper*. From *Manila* to *China*, S-42s were used.

572



Top Left: a PAA ***Martin M-130*** flying boat; the "China Clipper," leaves ***San Francisco Bay*** for ***Manila*** carrying the first trans-Pacific air mail on November 22^{nd} 1935. In the background is ***Coit Tower*** (highlighted) and the ***San Francisco*** skyline.
Top Right: fully loaded with fuel, over 110K pieces of airmail and its seven-man crew, the ***China Clipper*** struggled to clear the yet-to-be completed ***San Francisco-Oakland Bay Bridge*** on it inaugural transpacific flight of November 22, 1935. At the last moment, Capt. ***Edwin C. Musick***, PAA's Chief Pilot and a "Master of Ocean Flying Boats" veered under the bridge cable. By the time they reached the ***Golden Gate Bridge***, also under construction, the China Clipper had gained enough altitude to clear the south tower.

573

Five Days and Five Hours to Asia

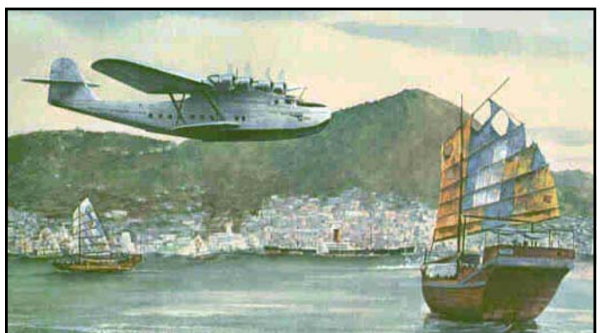
574

"Nine thousand miles and less than six days to get there? Two years ago that was an impossible trip. Today you can cross the Pacific in less than a week, flying in safety and comfort and sleeping ashore every night but one on the islands that dot Pan American's trans-Pacific route. It's five days and five hours to Asia this year…"

Popular Mechanics, **March 1939**

Left: caption: "Launching the beaching gear for clipper to be brought ashore"
Right: caption: "Crew going aboard a clipper**

575



Above: the ***Philippine Clipper*** arriving in ***Hong Kong*** to establish the first commercial air service between ***North America*** and ***Asia***; October 23^{rd} 1936. PAA used ***Macao*** as a western base until terminal landing rights could be acquired from the British, who controlled Hong Kong and were heavily influenced by PAA's British competitor ***Imperial Airways.***

576

Airworthy and Seaworthy

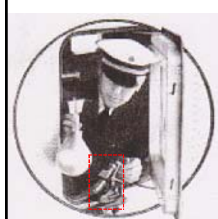
577

"…Pan American operates on the principle that when one of its clippers goes to sea it must take care of itself as ably as a big liner. The flying boat has to be both airworthy and seaworthy, able to make a landfall without outside aid. The great clippers are navigated over the ocean exactly the same way as are surface vessels. The captain uses dead reckoning, celestial observations, radio bearings, and combinations of these methods for making his way across the sea. There is no flying the beam on the ocean. The clippers use the same basic principles of celestial navigation that were used in the old days of the sailing clippers, simplified for convenience in the air. The navigator often combines this art with radio in a number of ways, such as crossing a radio bearing with a sun line to get his position or by taking a radio bearing on a near-by ship whose position is known. If all radio communication should fail the clipper could make its way home…"
Popular Mechanics, **March 1939**

578

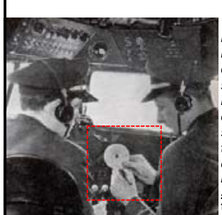
"…The navigator has just returned to the chart room on the lower deck after making a celestial observation. To do this he walked through the plane to the after companionway where he slid back the hatch and obtained a 'star fix' by sighting the star through the eyepiece of his octant and bringing it down to the level of his instrument's artificial horizon. The master compass and chronometer in the chart room, as well as air speed indicators and altimeters duplicating those on the bridge, will help him work out the problem…"
Popular Mechanics, **March 1939**
Left: caption: "Clipper navigator demonstrating use of octant"

579



"…If the navigator finds that a cross wind is setting him off course he tosses a glass bomb filled with aluminum powder out of a cabin window, shattering on the surface, the bomb spreads the light powder out into a shimmering spot and this can be followed by means of a drift indicator set up in the window. After dark a chemical that flames on the water, instead of aluminum powder, is used. When he has estimated his drift, the navigator can calculate a course that compensates for the cross wind…"
Popular Mechanics, **March 1939**
Left: caption: "Releasing aluminum powder bomb. Drift indicator on window (highlighted) is used to site the bright spot the powder makes on water"

580



"Simplifying aerial navigation problems to a point never before possible, an entirely new type navigation computer has been perfected by engineers and adopted as standard equipment by many pilots on the nationwide air travel systems. Designed to provide an immediate answer to navigation questions the pilot must face during the course of a flight, the new instrument combines features of a slide rule with a series of special scales in the form of three celluloid discs which rotate around a common center."
Modern Mechanix, **August 1937**
Above: caption: "New type of navigation computer in use during flight. With this instrument the pilot may quickly determine answers to flight problems arising during the course of the trip."

581

For the Record

582

Above: caption: "Radio communications between plane pilots and airport dispatchers are now permanently recorded on wax cylinders by an electrical machine recently installed by the U. S. Bureau of Air Commerce at a California landing field. Reports made by pilots and orders given by dispatchers, kept on file in record form, are thus available to examiners investigating the causes of any accident to a plane."
***Popular Science Monthly*, July 1937**

Above: caption: "Flight analyzers in-stalled on passenger planes of a leading American air line will record the craft's altitude during flight, the amount of time a 'gyro' or automatic pilot is in use, and the number and time of radio reports to the ground. In case of a crash, the records may help shed light on the cause."
***Popular Science Monthly*, November 1937**

583

Radio Eyes

584

"Teleran – 'radio eyes' for blind flying! Teleran (a contraction of TELE-vision — Radar Air Navigation) collects all of the necessary information on the ground by radar, and then instantly transmits a television picture of the assembled data to the pilot aloft in the airplane. On his receiver the pilot sees a picture showing the position of his airplane and the position of all other aircraft near his altitude. This is superimposed upon a terrain map complete with route markings, weather conditions and unmistakable visual instructions to make his job easier. Teleran - another achievement of RCA - is being developed with Army Air Forces co-operation by RCA Laboratories and RCA Victor…"
***Popular Mechanix*, October 1946**

Left: caption: "Instrument Panel of the Future. The Teleran indicator, mounted in the cockpit, greatly simplifies the pilot's job with its quickly understood picture showing his position relative to the airport and to other planes in the vicinity"

585

Radio Watch

586

"…The radio operator stands watch constantly while the plane is in the air and he can receive and transmit on eleven different frequencies. He uses two receiving sets and two transmitting sets in which wavelength changes are made with fixed coils. He guards the 600-meter band and one of the short-wave bands with split receivers. The equipment permits communication on twenty-four, thirty-six, fifty-eight and 100 meters as well as 'working' waves for those frequencies. Six hundred meters are used for working ships at sea, and 183 meters and 800 meters are used for radio compass and directional signals. The plane also is equipped for communicating on 1,000 meters, the international calling band for aircraft. Like all other aircraft, the planes have call letters of five symbols. The China Clipper, for instance, is KHAGV and the Hawaii Clipper is KHABZ…"
***Popular Mechanics*, March 1939**

587

"…The fifty-watt transmitters take their power from a dynamotor operating off the ship's batteries which are charged in flight by generators attached to the engines. A small gasoline motor provides a charging source for the batteries if the plane comes down on the water. The flying boat carries two fixed fore-and-aft antennas for short-wave work and a trailing antenna for 600-meter communication. A kite is carried for raising the 600-meter aerial into the air while the plane is on the surface. Two operators are on constant watch at each of Pan American's land bases, one guarding the communication frequency and the other standing by on the direction-finding set. Radio bearings are taken on an approaching clipper every half hour and these are stepped up to several bearings per minute as the plane approaches the station…"
***Popular Mechanics*, March 1939**

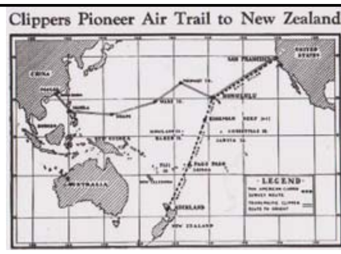
588

"…At the radio officer's request the naval radio compass stations at Point Reyes, Montara Point, and the Farallon Islands swing their loops to tune into his signals. They triangulate their bearings and radio back to the flying boat its exact position. At the same time Pan American's own direction-finding station takes a series of radio bearings on the plane and radios back the 'on course' report. As long as the bearings remain the same, the captain knows that he is flying directly toward the direction finding station. In thick weather the plane operator locks his key fifty miles offshore so that the air line's shore station can take continuous bearings until the plane arrives overhead, when the signal 'R' is sent to the plane to indicate its position…"
Popular Mechanics, **March 1939**

589

Air-Trail to New Zealand

590



"Pan-American clipper ships are blazing a new trade route through the air between the United States and New Zealand. The first 'hop' of this 7,000-mile route is already a part of the trans-Pacific lane, the 2,410-mile flight from San Francisco to Honolulu. Thence the clippers would fly 1,100 miles to Kingman Reef, another 1,600 miles to Pago Pago, and a final 1,800-mile lap to Auckland, New Zealand."
Popular Mechanics, **June 1937**
Above: caption: "Dotted line traces projected Pan-American Airways route between San Francisco and Auckland, New Zealand, blazed by clipper ship on pioneer flight. Stops are planned at Kingman Reef and Pago Pago."

591

Giant of the Air

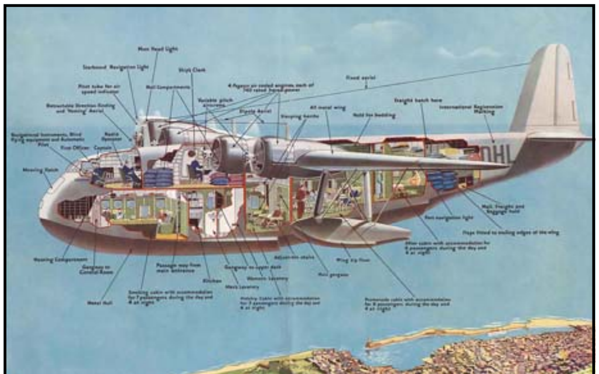
592

"A giant of the air, the new Empire flying boat 'Canopus' is one of the twenty-eight craft designed for service on Empire air routes. The flying boat has a length of 88 feet from nose to tail and a wing span of 114 feet. She has a maximum speed of 200 miles an hour and a ceiling of 20,000 feet. Navigation and wireless transmission and reception are carried out on the upper deck, where the mail compartments are also situated. The lower deck is mainly occupied by passenger accommodation. The Canopus is driven by four Bristol 'Pegasus' engines, each developing 920 horse-power. Fuel tanks with a standard capacity of 600 gallons are embodied in the wings…"
Wonders of World Engineering, **March 1937**

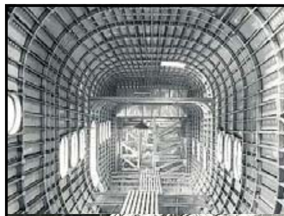
593

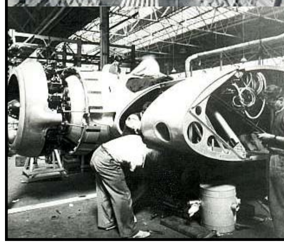
"…First of the new fleet to be completed, the Canopus measures 88 feet from nose to tail and has a wing span of 114 feet. Her overall height is 31 ft. 9.75 in. and she weighs 40,500 lbs. when fully loaded. She has a range of 760 miles in still air. The huge adjustable launching wheels of the Caledonia, shown at Rochester immediately before beginning her trial flights, give an impression of the great size of the new craft. The smooth finish imparted to the hull and wings by the use of sheet alloy and flush-fitting rivets is also clearly shown."
Wonders of World Engineering, **March 1937**

594



Above: cut-away view of the *Short C-class* "Empire" flying Boat 595



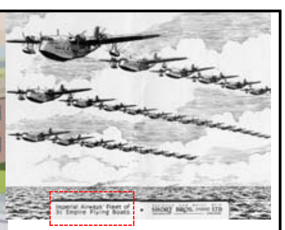


Top Left: caption: "Interior of Canopus looking forward"
Top Right: caption: "Starboard long-range wing"
Left: caption: "First Bristol Pegasus engine installed on starboard wing of Canopus". 596



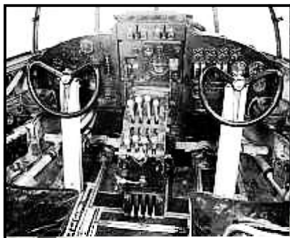
Top Left: caption: "Canopus on the ramp outside No. 3 Shop at Rochester ready for engine tests"
Top Right: caption: "The completed aircraft with the interior trimmed ready to be delivered to Imperial Airways Ltd."
Left: caption: "View of Canopus from the top of No. 3 Shop" 597

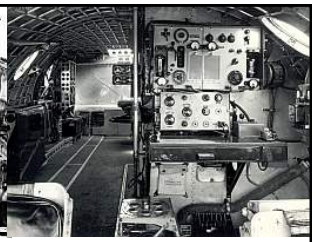
Above: caption: "Photograph of the first Empire flying boat off the line at Rochester 'HL Canopus' gathering speed on the River Medway for take off on the first official flight 4 July 1936"
Left: caption: "Challenger in the pontoon at Berth 101 at Southampton" 598



"…Twenty-eight flying boats of advanced design, each weighing 18 tons and having a speed of 200 miles an hour, have been designed for use on important overseas air routes in the British Empire…"
Wonders of World Engineering, March 1937
Above: caption: "Imperial Airways fleet of 31 Empire Flying Boats" 599

600



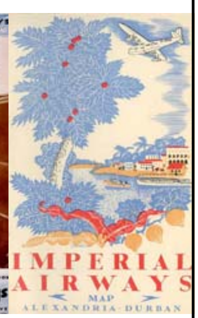


Top Left: caption: "Control Deck of an Empire flying boat. Throttles in the centre with the mixture controls. The Sperry autopilot in the centre of the dashboard."
Top Right: caption: "The Radio Officer's domain, immediately behind the Captain's position"
Left: caption: "Freight hatch in starboard side"

601

Above: caption: "An interior view of the Smoking Cabin before it was converted to the Flight Clerk's office and forward mail hold."
Left: caption: "Promenade space"

602



603

604

Ocean Flying School

605

"…Flying crews for Pan American clippers pass through the most intensive training ever given to men in charge of land, sea or air craft. Now five years old, the first ocean-flyers' school was organized by Colonel Charles A. Lindbergh and other ranking officers of P.A.A. The school began in the Caribbean area, but now PAA's operations have been extended to the Pacific, and soon they may include the Atlantic. Anticipating a boom in transoceanic passenger, express and mail service, the company is training enough officers to handle the clipper ships when they are ready to go. More than 100 men have already taken their final examinations for responsible posts. They are the nucleus of a small army of expert pilots, engineers, radio operators, mechanics and navigators who will be in charge of America's destiny on the ocean airways…"
Popular Mechanics, **December 1936**
Left: caption: "Trim clipper ship crew, at top, ready for flight. Center, two of the engines of a clipper. Bottom, officer in navigation room of clipper ship

606

"…Five years ago, engineers of this international air line were convinced that long-distance ocean flying was not only practicable, but that it would become an accepted fact within a relatively short period of time. That was when Col. Lindbergh and his associates mapped out a course of training for ocean flyers. They worked out the first conception of a 'flying boat crew,' as it is known today: captain, co-pilot, navigator, radio officer and flight engineer. All must be specialists in their chosen field, but in addition, they must be interchangeable. At a moment's notice, one officer must be able to assume complete responsibility for another's duties…"

Popular Mechanics, **December 1936**

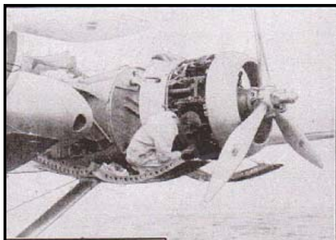
<u>Right</u>: caption: "Crew servicing a clipper ship with the aid of a portable scaffold and, below, pilot and radio operator in cabin of clipper"

607

"…Pilots, no matter how extensive their experience, passed through instruction in blind flying, and were given a chance at the controls of all the common types of aircraft. All flying personnel took courses in meteorology, navigation, and radio. New pilots were given long training periods in engine shop work. For years after joining the line, they served as assistant pilots, as junior officers, and clerks in charge of every detail of clearing cargoes and caring for passengers. The requirements for becoming an apprentice pilot in the ocean-flying school are unusually high. To qualify for training, a candidate must be a graduate aeronautical engineer, the holder of a transport pilot's license, and not over twenty-four years old. If he passes the preliminaries, he receives a thorough education in the international transport business. This takes in a lot of ground. It begins with traffic handling and clearances, then leads to radio construction, radio operation, engine mechanics, airplane mechanics, and piloting. To become a finished clipper-ship officer, he is also schooled in foreign languages, international law, international maritime law, seamanship and kindred subjects. If these courses are passed, the candidate is in line for a rating as a junior pilot. This rating implies that he is a qualified traffic man, a licensed engine mechanic, a radio operator, a licensed mariner and a master seaman…"

Popular Mechanics, **December 1936**

608



"…The next rating is flight engineer, for which the requirements are still higher. To become a first officer on an ocean clipper, you need at least 5,000 hours of transport flying and at least three years of service with the company. You must also have a supervisory knowledge of engines, airplane mechanics and radio operation, besides being a graduate navigator. The next biggest rating, captain, requires 7K hours of experience in transport flying and four or five years with the company. Officers who give evidence of superior judgment and ability, and who have all the foregoing qualifications, are in line for the highest rating – master of ocean flying boats. This title implies that the holder knows how to man every post on an ocean clipper…"

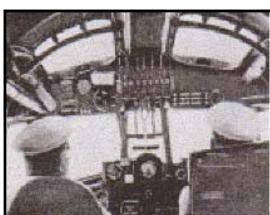
Popular Mechanics, **December 1936**

<u>Left</u>: caption: "Junior officer, top, working on one of the clipper engines and, below, a student studying the mechanics of a clipper power plant"

609

Master of Ocean Flying Boats

610



"…To command its aerial liners, Pan American has trained a corps of men up to the highest ranking possible in aviation. Each captain holds the rank of 'Master of Ocean Flying Boats.' To win such a ticket you start with nothing except a college degree and a transport flying license. You become an apprentice pilot, starting at Pan American's Eastern Division base at Miami. A flyer may need three to six years to climb to the highest rating. When he has gone to school all over again with Pan American and has served in the Caribbean coastwise service, he is given a junior pilot rating. After examinations he may be promoted to a senior pilot for coastwise flights. Then he is transferred to the Pacific for training on a trans-oceanic clipper in the capacity of junior navigator or junior flight officer. The next step is that of senior pilot, or first officer, on one of the ocean clippers. Next he is transferred back to Miami and is given command of a Sikorsky with the rating of 'Master of Coastwise Flying Boats.' Next to the last step is a return to the Pacific where he becomes first officer on the permanent run. One more examination brings him the title of 'Master of Ocean Flying Boats.'"

Popular Mechanics, **March 1939**

<u>Above</u>: caption: "First officer and junior flight officer at the controls of clipper in flight"

611

"…The flying personnel are not the only men trained especially for duties connected with the running of an ocean air line. There are scores of men in the ground crews – meteorologists, radio operators, operations men and inspectors. More and more, the air-transport business is becoming a complex organization whose activities call for the best men and the highest possible skill…The success of this first ocean air line is largely due to the intensive training and rehearsal of the men in their assigned duties...officers were rotated from trip to trip, until six full crews had been trained…These men have amazed the world by the precision and near-perfection of their performance across the globe's widest ocean…"

Popular Mechanics, **December 1936**

<u>Right</u>: caption: "An international airport where clipper ships land and depart and, below, signal light for an approaching clipper"

612

Weather Watch

613

"…The captain of a clipper always knows the best altitudes at which to fly, the speeds that he is going to make, and even the exact time he will arrive at the next stop. This precise knowledge is made possible by studying the weather as far as a week in advance. A few hours before a westbound flight, the chief meteorologist turns over to Operations the final weather map of the whole airway, together with a flight forecast and a flight time analysis. On the long 2,400-mile Alameda-Honolulu leg one of three optional routes will be selected, depending upon the forthcoming weather. These are a northern 'Jones corner' route that has been used by sailing ships for hundreds of years, a shorter great circle course used by steamships, and a southern route…"
Popular Mechanics, **March 1939**

614

SAN FRANCISCO
U. S. A.-Hawaii-Guam-Philippines

Orient Exp.		Pan American Airways Co. (PAAP)	Orient Exp.	
(a) Wed. Thur.	PM 3 00 / 8 30	Lv SAN FRANCISCO, (Alameda) Cal.….(PST) Ar / Ar HONOLULU, (Pearl Harbor), H. I.…(HLT) Lv	AM 10 30 / *12 00	(a) Tues. Mon.
Fri.	6 30 / 3 00	Lv HONOLULU, (Pearl Harbor), H. I.…(HLT) Ar / Ar MIDWAY ISLAND…(MLT) Lv	5 30 / 6 00	Sun.
Sat. / Sun.	6 00 / 3 00	Lv MIDWAY ISLAND…(MLT) Ar (International Date Line) / Ar WAKE ISLANDS…165° Lv	5 00 / 6 00	Sat. / Sun.
Mon.	6 00 / 5 00	Lv WAKE ISLANDS…165° Ar / Ar GUAM ISLAND…150° Lv	7 00 / 6 00	Sat.
Tues. (a)	6 00 / 5 00	Lv GUAM ISLAND…150° Ar / Ar MANILA (Cavite), P. I.…120° Lv	6 30 / *4 00	Fri. (a)
(b) Wed.	8 30 / 1 00 / 3 00	Lv MANILA, (Cavite), P. I.…120° Ar / Ar MACAO…" Lv / Ar HONG KONG…" Lv	1 45 / -- / 8 30	(a) Thur.

*—Departure from Manila subject to advancement to previous afternoon as occasion demands.
All times are approximate other than at San Francisco westbound and at Honolulu eastbound.

"…A strong wind west of Manila, a storm far at sea, a twenty-mile wind 10,000 feet above San Francisco – unrelated bits of weather information like these govern departures and arrivals of trans-Pacific flying clippers. What the weather happens to be in Hawaii influences the hour at which one of the big flying boats will leave its base at Alameda on San Francisco bay. The weather regulates the amount of cargo the plane can carry and even fixes the hour it will arrive in Honolulu. But far from allowing the weather to run the airway, Pan Americans meteorologists have almost reversed the process. Instead of running the weather, they have put it to work. By getting an upper hand on the elements they are able to maintain transoceanic flights as regular as steamship schedules. No matter which direction a plane is bound they usually find a tail wind to boost it along…"
Popular Mechanics, **May 1938**
Left: the *Hawaii Clipper* gets the once-over before flight
Right: PAA *Pacific* flight schedule (ca. 1939)

615

"…At Alameda the Pan American Airways Pacific division meteorologist outlines the way that the clippers take advantage of the elements. On the desk in front of him he has a large map on which storm centers and wind directions on all parts of the Pacific have been marked. He has just finished the forecast and flight-time analysis for the last leg of trip 160, the Honolulu-Alameda jump marking the completion of the eighteenth round trip across the Pacific…"
Popular Mechanics, **May 1938**
Above: left; PAA pilots and meteorologists consult latest weather information (note large weather map on wall), center; gathering weather data, right; releasing balloon to determine wind direction and speed

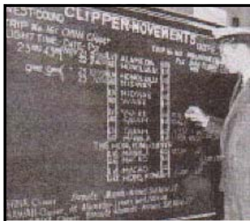
616

"…Data for this map were gathered at four o'clock this morning. The clipper will not leave Honolulu until two o'clock this afternoon but already we can tell what the weather is going to do in the meantime and what conditions will be while the plane is in the air. It's 2,400 miles to Hawaii. Over such long distance one might expect to encounter a storm or strong head winds. So there are three alternative routes that the clipper can fly. First is the short great-circle route used by steamships. Next is a northern route, 250 miles longer, that takes the clippers considerably north of the steamer track. Then there is the southern route, also consisting of two legs, on which a San Francisco-bound clipper flies directly toward Mexico for half the hop, then heads up towards its destination. On today's map here you can see a high-pressure area centered about half way between the coast and the islands. There's a twenty-knot east wind blowing toward Honolulu from the storm center. That means head winds half way across and the chances of running into rough weather on the direct great-circle course. On this direct route, figuring from the present weather conditions, today's flight would require twenty-two hours. But north of this storm center we find some arrows showing a westerly wind with speeds of up to twenty-six knots. That means a tail wind instead of a head wind. Obviously, we are routing the eastbound clipper over the northern route. The boat will fly 250 mile farther and get here quicker…"
PAA Meteorologist, May 1938
RE: each route was divided into four zones whereby the weather in each zone was carefully analyzed for the Captain of a departing Clipper

617

"…Continuing this analysis of the weather, the wind flags on the map indicate that at 4,000 feet the flight will take 19.9 hours. At 7,800 feet better winds would cut this time by an hour and a half. At 11,500 feet there are even stronger tail winds, permitting a flight of only 17.8 hours. But because of passenger comfort in the thin upper air the flight is going to be made at 7,800 feet. That will permit a saving of three and a half hours over the time possible on the shorter direct route. Incidentally, because less fuel will be carried to fly the longer distance, about three-quarters of a ton more payload can be carried…"
PAA Meteorologist, May 1938

618



"…Often the best time can be made by changing altitude to take advantage of local winds. Instructions may read: 'Fly the first 700 miles at 7,800 feet, go up to 10,000 feet for 800 miles, and complete the balance of the flight at 7,800 feet.' After such a calculation the operations department can tell to within a few minutes how long a flight should last…Frequently a plane can carry greater cargo and make faster time by flying one of the longer routes because favoring winds help boost it along…As soon as the experts know how long the plane will have to be in the air they can gauge the amount of fuel and oil needed, adding a reserve supply sufficient for six hours additional flight. This fuel weight, subtracted from the total permissible load, gives them the exact possible payload. Next step is to phone the post office to find out how much mail is to be carried. Subtracting that poundage from the payload leaves a balance that can be used for passengers and express…"

***Popular Mechanics*, March 1939**

<u>Above</u>: caption: "Schedule board of the Alameda station shows movements of all the flying boats

619

"…This smart way of anticipating the weather and putting it to work is based on analysis of the major air masses that control Pacific weather. The chief meteorologist and his four assistants at Alameda draw maps every day that show the weather at every point on practically half of the northern hemisphere from ninety degrees east longitude to ninety degrees west longitude and from the equator to the artic circle. They make forecasts covering the airway as far away as Guam, 6,000 miles to the west, up to thirty-six hours in advance. Three men at Manila prepare similar forecasts covering the route from Guam to China. So ably can the meteorologist gauge the weather that their estimates of flight time are always within one hour of the actual time made by a clipper and often the clippers land within a few minutes of the time predicted for their arrival…"

***Popular Mechanics*, May 1938**

620

"…With all its storms, weather over the broad Pacific is not so difficult to follow and predict as weather over land areas. This helps to make up for the great distances that are covered in the forecasts. Lack of terrain to create friction and absence of vertical disturbances characteristic of mountainous areas permit storms to follow more or less natural courses, allowing forecasts of extreme accuracy. The meteorological departments draw two maps per day of the Pacific, checking up on their own forecasts by weather reports sent in from ships at sea…"

***Popular Mechanics*, May 1938**

621

"…Pan American draws the information for making its maps and forecasts by fast radio service from about 400 different reporting stations. It maintains fifteen completely equipped meteorological depots on the Pacific and receives data from some sixty stations in the Orient, even the weather in Siberia having an important effect upon future conditions over the ocean. Weather in the eastern United States also may have some effect and has to be considered even though the normal weather trend runs from west to east. An average of thirty ships at sea report their local weather, two of the Matson liners on the Pacific conducting three upper air balloon runs every day and reporting wind directions and velocities at different altitudes. In addition to all this, radioed weather reports from the clippers themselves are used for checking and correcting the maps…"

***Popular Mechanics*, May 1938**

622

"…Between Alameda and Honolulu the operator may contact as many as a dozen surface ships and exchange weather and bearings with them. Every fifteen minutes he radios a flight 'O.K.' to the terminal bases, sends a position report every half hour, and the complete weather and position report on the even hours… The report the radio officer will pound out on his key will include the temperature and altitude, wind velocity and turbulence of the air, latitude and longitude and how the position was ascertained such as by dead reckoning or by a line of position crossed by a radio bearing, the ground speed in knots, the general state of the weather, the intended course for the next half hour, kind and height of cloud masses, and condition of the sea if visible…To insure the utmost reliability over long distances, the clippers communicate with dot-and-dash code instead of by voice. All radio work and, in fact, all operations work is based on Greenwich time…"

***Popular Mechanics*, March 1939**

623

Pressure Pattern Navigation

624

"…Typhoons have been the bane of mariners ever since the oceans were first sailed, but instead of dreading them the captains of the clippers often welcome these violent circular storms. They offer no hazard to airway operation because they are so small in area that the fast flying boats can skirt them without trouble. Often a typhoon on the route simply means that a clipper will make better time than it would in still air. North of the equator the winds revolving around these storms move counterclockwise, so a westbound clipper sets a course to pass north of the storm center and thus gets a favorable tail wind. Bound east, the clipper flies south of the center and is boosted along by the same wind, which by now has circled the storm center and is traveling in the opposite direction…South of the equator storms normally travel to the southeast instead of toward the northeast and the circulation of wind around the storm centers is reversed from those in the northern hemisphere…"

***Popular Mechanics*, May 1938**

Left: *Pacific* typhoon/s as seen by satellite from space. Using cyclical storms to navigate; a.k.a. "Pressure Pattern Navigation," was pioneered by *Dr. Hugo Eckener* – commander of the *Graf Zeppelin*

625

Top Left: PAA chairman Juan Trippe consults a globe (ca. 1939)
Top Right: PAA poster promoting *Pacific* travel via their Clipper flying boats
Left: a PAA Clipper above *San Francisco.* In 1939, a one-way ticket from San Francisco to *Honolulu* cost $278 and a one-way ticket to *Hong Kong* cost $1,368.

626

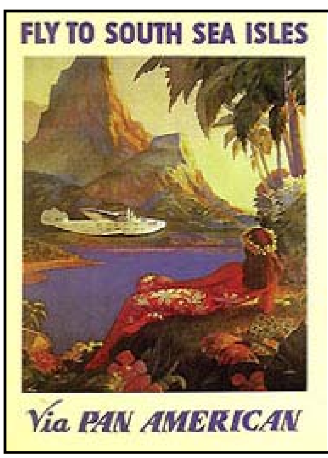
Safety Factor

627

"…Simply as a safety factor, the clippers have flown thousands of gallons of excess fuel back and forth across the Pacific. This is because of the slight possibility that unanticipated weather changes might keep the flying boats in the air longer than expected. A clipper always carries enough fuel for the expected flight time plus a reserve for another six hours. If the weather analysis for the long hop to Honolulu shows that a flight would require longer than twenty-three and one-half hours to complete, the trip is postponed until the weather improves. Finally, if a captain gets half way across and finds that he has used half of his fuel, his instructions are to turn around and go back. The head wind that has run up his fuel consumption then will be on his tail and he returns in a hurry…"

***Popular Mechanics*, May 1938**

628



"…Soon clipper ships were making regular trips over the ocean – the Pacific had been con-quered…And now the Clippers are carrying passengers in five days over a route which the old sailing clippers required two months or more to travel…"

***Popular Mechanics*, 1937**

629

Part 9

Marine Air Terminal

630

"Reached from the heart of the metropolis by a 28-minute drive over a route which crosses the famous Triborough Bridge and leads to the site of the 1939 World's Fair, North Beach Airport in the Queens section of New York, N. Y., is being enlarged in area from 105 acres to 429 acres and will be provided with every facility for the handling of giant transcontinental and transoceanic air liners. Exclusive of land, the construction cost of the enlarged airport will represent a cost of about 12 million dollars. The completed airport, as shown in the artist's sketch at left, will feature four main runways, one of which will be 4,160 feet long, to accommodate land planes while a vast seaplane basin will provide landing and takeoff facilities for flying 'clippers.' Plans for the reconstruction of the airport were prepared by engineers of the Works Progress Administration in co-operation with the city's Department of Docks. The airport's hangars and administration buildings will represent the latest ideas in airport architecture."

Mechanix Illustrated, **September 1938**

631

<u>Above</u>: caption: "In the sketch above, an MI artist has depicted the seaplane base administration building as it might appear from beneath a flying clipper's wing as it rides at anchor in the landing basin. The building will be circular in shape with a diameter of 136 feet. The landplane and seaplane hangars will feature electrically-operated doors. Construction of the airport is a WPA project."

***Mechanix Illustrated*, September 1938**

<u>Left</u>: WPA poster ca. 1937 for New Yorks City's two municipal airports at the time: *Floyd Bennett Field*, in *Brooklyn* and *North Beach*, in *Queens*. The latter was home to the *Marine Air Terminal* and was later renamed "La Guardia Airport" in honor of NYC's depression-era mayor *Fiorello La Guardia.*

632

<u>Top Left</u>: the *Marine Air Terminal* and hanger at NYC's *North Beach Airport* soon after construction was completed with one *Boeing B-314* flying boat moored to the dock in *Flushing Bay*

<u>Top Right</u>: close-up view of the Marine Air Terminal at North Beach. Note the flying boat in the bay

<u>Left</u>: a PAA *Yankee Clipper* moored to the dock at the Marine Air Terminal

633

<u>Top</u>: *Boeing B-314* "Yankee Clipper" undergoing an extensive maintenance overhaul in the hangar at the *Marine Air Terminal* at *North Beach Airport*

<u>Bottom</u>: tail-end of the *Atlantic Clipper* as it was being pulled up the beaching ramp at the Marine Air Terminal, North Beach

634

"…In coming in for a landing, the largest of the aerial merchantmen touch the water at from eighty to ninety miles an hour. Consequently, wide stretches of sheltered water are essential for an ocean terminal. Port Washington, on Long Island Sound, is the aerial transatlantic pier of New York. Here the air and water liners of the Imperial Airways, the Pan American Airways and the Deutsche Lufthansa all end their westward flights and take off for their eastward crossings…"

***Popular Mechanics*, September 1937**

635

"The hangar floors were absolutely without a grease spot on them anywhere, the docks and floats were freshly painted, and a big signal mast with the national colors flying. It was quite a handsome base altogether."

William Masland

<u>Top</u>: aerial view of *Manhasset Isle* (ca. 1927)

<u>Bottom</u>: view of *Manhasset Bay*, in front of PAA hangar on Manhasset Isle. Note the flying boat that has just landed and is taxing to the hangar (ca. 1938)

636

"…Here also, on a twice-a-week schedule, the 42,000-pound Sikorsky 'Bermuda Clipper' and the 38,000-pound Short flying boat 'Cavalier,' are taking off and landing on regular trips between Bermuda and New York. Pan American and Imperial Airways are cooperating in the service. In about five hours, their big ships cover the 783-mile run. Sixteen passengers ride in the English boat, twenty-three in the American…"
Popular Mechanics, **Sept. 1937**
L&R: *Bermuda Air Cruises* brochure, 1938. Top plane: PAA's *Bermuda Clipper*. Bottom plane: IA's *Cavalier*

The NEW Travel Hit!

NOT JUST A CRUISE, not just the treasure isles of Bermuda, not alone the fact that you travel there by air (in 5 hours from New York) but all three put together . . . . AIR CRUISES to BERMUDA. Where could be found a more perfect combination, a more perfect vacation?

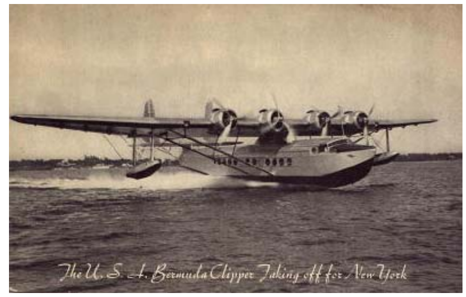
A typical itinerary takes you out of New York (Port Washington) aboard America's giant ocean-going flying boat, the U. S. A. Bermuda Clipper or Great Britain's ocean airliner, the R. M. A. Cavalier. Reclining in the easy comfort of your sky-chair first come colorful aerial views of continental coastline, ocean and fairy castles in the clouds; next that famous "300 mile luncheon"; and in a few minutes less than 5 hours aloft you are in old-world Bermuda.

Simultaneously gayest and most simple, quaintest and most comfortable, Bermuda is the playground of the north Atlantic. Waft by the ocean's cool breezes in summer, by the warm waters of the Gulf Stream in winter, the islands abound in opportunities for sport, for gaiety and for relaxation.

There is so much time to spend . . . because so much time has been saved in transit! Almost all is yours to be passed on the glistening beaches, at golf, sailing, fishing, or in leisurely trips over the islands. And whenever you plan to return you are whisked back to New York within another five hours.

Cruises from 7 to 16 days, cruises within 2 thrilling flights and more than 94 per cent of your time to spend in Bermuda. And all for little more than it costs to live at home. Where else an equal travel treat? Where else a more delightful vacation? Glance at the itineraries outlined within, choose your cruise, then call your travel agent for details and your ticket.

637



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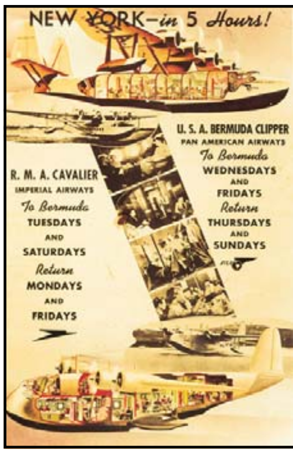


639

Above: manufactured by the *Short Brothers* and called the *Cavalier* (each individual plane was given a name that started with "C"), she carried passengers between *Long Island* and *Bermuda* from 1937 until it was lost on January 21st 1939 en route to Bermuda. There were ten survivors and three fatalities.

Above: PAA's Sikorsky S-42B "Bermuda Clipper" in her hangar (left) and on the water at *Port Washington, NY* (ca. 1937)

640

"…At the mouth of the River Shanon, in Ireland, and at Ganders Lake, Newfoundland, British interests are establishing terminal bases for the ocean air line. The Newfoundland port, now nearing completion, cost $3,500,000. Early in July, a joint 'experimental' service linked America and Europe when Capt. Harold E. Gray, at the controls of a Sikorsky clipper, headed east from Newfoundland with six companions. At the same time, Capt. A.S. Wilcockson and a crew of four, in the Imperial Airways 'Caledonia,' Great Britain's entry for aerial honors on the Atlantic, began the 'uphill' westward crossing. Neither ship carried passengers or cargo, the flights being trial runs in preparation for the later inauguration of regular service. With the preliminary flights successfully completed, data gathered by pilots and observers will be studied and plans will be formulated for the inauguration of scheduled runs. It is expected that air-mail service will begin during the coming winter, and by next summer, in all probability, it will be possible for travelers to book plane passage from New York to London…"
Popular Mechanics, **September 1937**

641

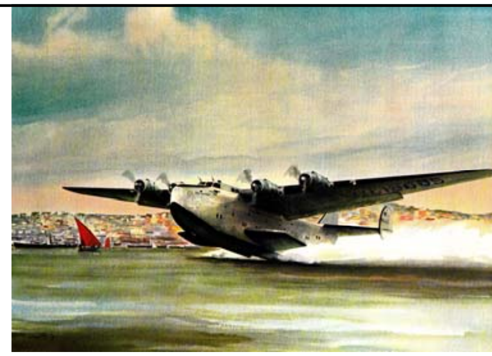
"…Just recently, two giant flying boats, one operated by Pan American Airways of the United States and the other by Imperial Airways of Great Britain, conquered the Atlantic in both directions on round-trip surveys, each flying 7,000 miles. None of the fanfare of previous trans-Atlantic flights marked these tests. Instead, Pan American's 'Clipper III' and Imperial's 'Caledonia' quietly took off from the terminals of the 1,995-mile water jump between Newfoundland and Ireland, flew a few hours and quietly landed on the other side, all without accident…Port Washington, N.Y. is the western base of the line and Southampton, England, the eastern. Southampton is the seaport base for London…"
Popular Mechanics, **1937**

642

"TO COMMEMORATE: The Achievement of the First Commercial Survey Flights made across the North Atlantic jointly by PAN AMERICAN AIRWAYS and IMPERIAL AIRWAYS (forerunner of British Overseas Airways Corporation). Piloted by Captain Harold E. Gray, the Pan American Sikorsky S-42B Clipper Flying Boat departed from Port Washington and arrived at Foynes, Ireland, July 9, 1937. Piloted by Captain Arthur S. Wilcockson, the Imperial Airways Short 'C' Class Flying Boat 'Caledonia' Arrived at Port Washington on this date from Foynes. Thus was Pioneered the beginning of a New Era in Communications between the Peoples of the World. Erected by the Wings Club, 1969."

RE: plaque inscription (left) for the flight of the *Caledonia* (above)

643



Above: *John T. McCoy* painting of PAA's historic "Dixie Clipper." Caption: "Dixie Clipper completes first transatlantic passenger flight / New York to Lisbon, Portugal, June 29, 1939 / Boeing B-314." The flight left from *Port Washington* the day before with twenty-two passengers aboard.

644

Top Left: *Treasure Island* base *San Francisco* with *Boeing B314* moored (ca. 1943) Treasure Island was one of three large PAA flying boat bases along with the *Marine Air Terminal* in NYC and *Dinner Key* in *Miami*
Top Right: Four Boeing B314 flying boats (in wartime camouflage paint scheme) moored at Treasure Island base (July 1944)
Left: Boeing B314 moored at Treasure Island, San Francisco

645

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Above: Boeing B314 flying boat *Honolulu Clipper* moored at *San Pedro, Los Angeles, California* with ground crew servicing in process (ca. 1940)

647

Top Left: first Arrival of a *Boeing B314* in *Honolulu, HI*. The Aircraft was named "California Clipper"
Top Right: Boeing B314 California Clipper Christening ceremony in Honolulu (1939)
Left: ground crew service Boeing B314 at Honolulu (1939)

648

<u>Above</u>: *Boeing B314* "Capetown Clipper" moored in *Bermuda* harbor (ca. 1939)

649

650

<u>Above</u>: passengers deplane in *Lisbon, Portugal* from Boeing B314 *American Clipper* while ground crew unload luggage from the bow hatch

651

652

Part 10

Seaplanes at War

653

Merchant Marine of the Air

654

"…With the coming of war, all Clippers immediately joined the Navy, though keeping their civilian crews. The news of Pearl Harbor was flashed to the Philippine Clipper just after it had taken off from Wake Island, headed for Guam. It swung back to Wake, minutes ahead of the first Jap attack. Before it was ready for takeoff again, it was punctured by 97 bullets. Still, stripped of all furnishings and carrying 70 civilians, it managed to hobble safely to Midway and Honolulu…"

Popular Science, **June 1963**

655

"JAPANESE ATTACKING PEARL HARBOR...RETURN TO WAKE AT ONCE...CLIPPER NEEDED FOR PATROL DUTY."

RE: message received by the *Philippine Clipper* while on a routine flight to *Guam* from *Wake Island.* Upon its return to Wake Island, a Japanese fighter spotted the big *Martin M-130* flying boat tied to the dock. It was an easy target. Swooping down the plane opened fire, raking the defenseless Clipper from nose to tail with machine gun fire. In five minutes it was all over. The Japanese left as abruptly as they came. Nine PAA base employees had been killed and all base facilities destroyed. Hurriedly, the crew rounded up the rest of the PAA personnel who had been stationed there and loaded them onto the Clipper. They knew the Japanese would be back soon. Riddled with 97 bullet holes, the crippled and overloaded Philippine Clipper made two unsuccessful tries to take-off. Then, on the third attempt, managed to struggle into the air. Three days later, after stops at *Midway* and *Honolulu*, it was in *San Francisco* where the crew gave one of the first eyewitness accounts of the *Pacific* war. Anchored in *Hong Kong* harbor on December 7th (December 8th in Honk Kong time) and fueled for a flight to *Manila*, *Hong Kong Clipper II* was hit by incendiary bullets from attacking Japanese fighters, caught fire and burned to the water line. She had only been in Pacific service for seven weeks. The *Pacific Clipper,* out of San Francisco, was on its way from *New Caledonia* to *Auckland* when it got the news of the Japanese attack. Deciding against trying to make it back over an ocean now patrolled by an enemy, it refueled in *New Zealand* and then headed west. Following a route close to the equator, it flew across *Australia, India*, the *Middle East*, across *Africa* and the *South Atlantic*, along the northern coast of *South America* and then on to the *Marine Air Terminal* at New York City's *North Beach Airport*. The incredible month-long, 31,500-mile journey was the longest ever made by a commercial aircraft and the first around the world. The Pacific Clipper had flown over three oceans, made eighteen stops in twelve different countries and crossed the equator six times.

656

Above: wartime PAA *Boeing B-314*. The plush interiors of the flying boats were stripped to wartime austerity and priority cargo was packed into every available inch of space. The exteriors were camouflaged by painting them with drab sea-gray paint. The PAA crews wore khaki when under Army command and green when flying for the Navy

Left: 1941 PAA ad to communicate to the American public its role in the security of the country and its status as "America's Merchant Marine of the Air"

657

Left: advertising illustration from the *Saturday Evening Post* shows workers unloading much-needed engines for use on military planes. During the war years, PAA built some fifty airports in fifteen different countries, almost all of them in remote often hostile areas. As the largest air transport contractor to the army and the navy, PAA flew over 90 million aircraft miles for the government and made more than 18,000 ocean crossings. PAA also trained more than 5K military pilots and thousands of mechanics. More then two-hundred PAA employees lost their lives, an unknown number were imprisoned in enemy prison camps and at least a dozen aircraft were lost.

Right: military personnel aboard a PAA flying boat during WWII. In 1942 PAA Clippers made 1,219 *Atlantic* crossings. The amount of cargo carried increased sharply also; from 16,500 pounds in 1941 to over three million in 1942.

658

"…The Atlantic Clippers carried a dazzling roster of VIPs during the war years, and incredible tons of high-priority mail. One took President Roosevelt to Casablanca…"

Popular Science, **June 1963**

Above: POTUS *Franklin Delano Roosevelt* celebrates his sixty-first birthday aboard the *Dixie Clipper* on January 30th 1943 while over the *Caribbean*, on his return trip from his secret meeting in *Casablanca* with *Winston Churchill* and *Charles De Gaulle.* In addition to its regular flights across the *Atlantic* and the *Pacific* and into *Africa* and the *Orient*, PAA allocated aircraft to special, often secret, missions. PAA aircraft carried top U.S. generals and admirals, Britain's Prime Minister Churchill, the Netherland's *Queen Wilhelmina*, Greece's *King George* and scores of other high-ranking diplomats and military personnel. PAA flew over seven-hundred of these special missions during WWII.

659

Above: in 1945, the *Honolulu Clipper* lost two engines and had to land on the ocean 650 miles east of *Hawaii*. The passengers and crew were evacuated by ships in the area. The seaplane tender *San Pablo* attempted to take the Clipper in tow, but accidentally ran into the Clipper, damaging her beyond repair. The San Pablo sunk the Clipper with 20 mm cannon fire, but it took 1,200 rounds and thirty minutes of fire to finally sink the flying boat.

660

After the war, the government offered to sell the Clippers back to PAA, but the company declined. The war had brought many more airports around the world, and four-engine land planes could fly faster than the Clipper flying boats. DC-4s and Boeing 307's had begun to appear even before the war. Shortly after the war, PAA Lockheed Constellations, DC-5's and Boeing 377's took over the routes that the Clippers had pioneered. Other companies bought the remaining Clippers from the military, but in 1951, the last of the huge Boeing Clippers reached the end of its career. Sadly, none of these beautiful and historic aircraft remain.

661

VPB

662

"…In 1937 the Navy, officially recognizing the worth of patrol planes for scouting purposes, transferred all scouting-force destroyers to the battle force, and all patrol-plane squadrons to the scouting force…"
***Popular Science Monthly,* October 1943**

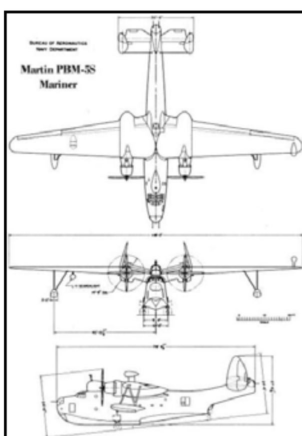
663

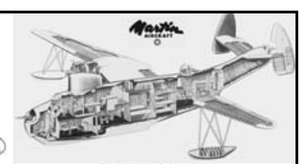
"A span of thirty years, from the first seaplane flight, encompasses the life history of American VPB aviation…In 1930, five years after the memorable transpacific flight of Commander Rodgers in a Navy-designed patrol plane (the PN-9), the flying boat once more came into its own. Progress in the metallurgical and engineering fields permitted the employment of higher powered air-cooled engines, metal propellers and duralumin hulls. The reviving influence of these scientific advancements enabled the VPB plane to develop rapidly into the multi-engined, streamlined monoplane of the present. Today's modern giants of the air are powered by two or four 1,200 to 2,000 hp air-cooled engines. Each power plant drives a three-bladed, 17-foot 6-inch diameter propeller of duralumin, whose pitch can be varied at the will of the pilot, from the normal positive for high speed or climb in flight to reverse for backing purposes on the water. A metal-clad hull and fuselage and glass enclosed cabins protect the crew from tropical heat at sea level and artic cold at 25,000 feet. There are bunks in which members of the crew may rest or sleep when not on watch…Overnight flights from San Diego to Panama or Hawaii are now of routine nature…"
Rear Admiral *John S. McCain* (1942)
RE: *U.S. Navy* VPB (Patrol Bomber) aircraft

664

"Bomb bays for flying boats open from the side of the craft, in a patent assigned to Boeing. This offers a solution to the problem of dropping bombs from big patrol bombers which must have water-tight hulls. Inclined rails leading from the bomb racks guide released missiles to the ports, where they are deflected from their outward course to preserve their aim."
***Popular Science Monthly,* June 1942**
Above: the big, tough *Martin Mariner* flying boats were already in service prior to America's entry into WWII and were real workhorses throughout the war, in both the *Atlantic* and *Pacific* theaters. Mariners were quickly adapted to the role of anti-submarine warfare against the U-boat menace in early 1942. Production of Mariners continued until 1949 and they served with the *U.S. Navy* into the 1950's during the *Korean War* before being phased out. This painting shows a Mariner over calm seas attacking a submerged U-boat with a low-level depth charge run. Later versions of the Mariner allowed ordnance to be carried in a unique bomb bay located in the engine nacelle/s. It also had the capability of carrying torpedoes under the wings.

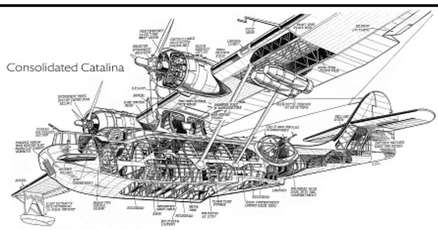
665





Above & Left: twin-engined *Martin Mariner* VPB

666



"…Despite her lack of speed, the Cat is among the best seaboats ever built, her hull can stay in the water for weeks on end, requiring only cursory service. She waddles through heavy weather, ever prowling in search of German and Japanese warcraft. One found the German battleship 'Bismarck' and hung on grimly, riddled by gunfire but not downed, until British forces could be dispatched…Resting on the beach or in the water, the Catalina is known to the Navy as the PBY-5 (flying-boat version) and the PBY-5A (amphibian)…she can fly over enemy infested waters for a total distance of 2,520 miles, starting with 1,463 gallons in her tanks…Her gunners must man their weapons and try to outshoot enemy attackers, for a top speed of 185 m.p.h. gives them no other choice…"

Popular Science Monthly, **October 1943**

Above: cut-away view of the twin-engined *Consolidated Catalina* VPB

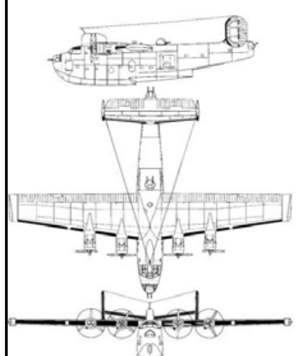
667

668

"…The VPB type aircraft is designed primarily for long range, overseas scouting from shore bases or tenders. A multi-engined flying boat with accommodations for a crew of seven to fifteen, depending on its type, is capable of remaining in the air for relatively long periods regardless of the vagaries of the weather. Besides being seaworthy, it is sufficiently habitable to permit operating singly for extended periods. As compensation for a speed performance that is, in general, inferior to that of other fighting aircraft, its armament design includes powerful defensive forces. Offensively, the VPB plane is equipped to carry heavy loads of bombs, torpedoes and mines, with possibly some sacrifice in its fuel load, and hence in its range and endurance. In brief, the patrol plane is the dreadnought of the Navy's air arm…"

Rear Admiral *John S. McCain* (1942)

669



"…while the Cats promise to give added years of service, their 'big sister,' the 33-ton long-range patrol boat, is now in production…take shape on a four-part moving production line, making them the largest mass-produced flying boats now in the U.S. naval service. Known in the combat version as the PB2Y-3 and the cargo carrier as PB2Y-3R, the Coronado can fly long distances on patrol or carry needed goods to distant battle areas…Up to 5,000 pounds of cargo may be carried long distances with a heavy gasoline load…"

Popular Science Monthly, **October 1943**

<u>Above & Left</u>: four-engined *Consolidated Coronado*

670

"…The evolution of the modern patrol bomber has been a gradual procedure, but it has far surpassed the development of other types. Perhaps it was so far behind its rivals that it <u>had</u> to go faster to catch up. Nevertheless, it <u>has</u> caught, if not surpassed them. Your modern patrol plane has none of the 'built-in head wind' of its predecessor. Its cruising speed now compares favorably with the fastest carrier types and in range it has left all other types far behind. Transoceanic and non-stop flights of well over 3,000 miles now are commonplace…The modern patrol plane is a command of which any junior officer may well be proud. It demands more varied ability, intelligence, ingenuity and resource of its commander than any other type…past and present performances give rise to a logical assumption – that the 'flying boat' will ever be in the fore as this country's actual 'first line of defense!'"

Rear Admiral *John S. McCain* (1942)

671

Workhorse of the Navy

672


"…All previous flying boats were put in the shadow by Glen L. Martin's whopping, 70-ton Mars, produced for the U.S. Navy in July, 1942. It was intended to be a bomber. Instead, like many a war recruit with dreams of heroism, it was obliged to accept a much humbler, though useful, role. The Mars became the Navy's biggest flying cargo carrier. On its first mission, hauling as much as 35,000 pounds at a hop, it covered 8,972 miles in 55 hours and 31 minutes of flight. During the trip, to bases in South America, it did one nonstop stretch of 4,375 miles, a world record at the time…"
Popular Science, **June 1963**

673

"…The wings of the Mars spread 200 feet. A two-deck hull contained as much space as a 15-room house and was slightly more than 117 feet long. Its four 2,000 hp engines drove it through the skies at speeds up to 180 m.p.h. They spun three-bladed propellers 17.5 feet in diameter, the biggest then made…"
Popular Science, **June 1963**
Above: the "Marshall Mars" with sailors atop its enormous wing

674

Days to Come

675

"…Hawaii knows that flying is here for all time. The war has made this island people intensely air-minded. Steamship companies are already planning to supplement their service with fast air lines. They speak of bringing passengers from the mainland here by air for as little as $125, and Hawaiians are intent on learning what kind of ships will be landing here in those days to come. Some believe they will be big land planes like the Douglas C-54, or big, fast ships like the Liberator, which can span the distance to the mainland in nine hours. But many feel they will be giant sea birds like the Mars. They point out that the big land transports must carry four or more tons of landing gear not needed on an ocean hop, that they are voracious gas-eaters; that they require tremendous, deep-laid runways on which to land with a full load, while the big flying boats can land on any good sized lagoon – of which there are many not only in these islands but all through the South Pacific. Not very fast, but roomy and comfortable, able to carry more weight than any other plane yet seen, ships like the Mars may be our luxury airliners for trans-ocean travel after the war."
Popular Science Monthly, **April 1944**

676

"…Martin followed up this huge workhorse with an even bigger one – an 82.5-ton model called the Caroline Mars. It had four 3,000 hp engines and a top speed of 238 m.p.h. It performed a spectacular feat that may never be equaled. On May 19, 1949, the Caroline Mars transported 301 passengers and seven crewmen on a single flight from San Francisco to San Diego. The passengers were naval personnel. They made the 500-mile trip in 2 hours, 54 minutes, probably all breathing shallowly. This was, and may forever be, the world passenger record for airplanes…"
Popular Science, **June 1963**
Above: a Martin *Caroline Mars* in flight

677

Water Bomber

678

"Three giant Martin Mars flying boats are being converted by a group of Canadian lumber companies to combat seasonal fires in the immense forests of British Columbia. Each is equipped with two 3,500 gallon tanks into which it can scoop water from a lake. Speeding to flaming woods, it can dump a third of an inch on an acre of ground every fifteen minutes."

Popular Science, **September 1961**

Left: *Martin Mars* "water bomber" scoops up 7K gallons from a lake

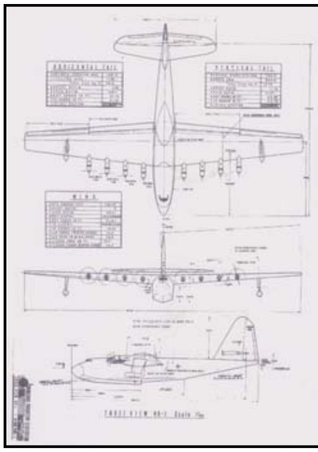
Right: dumping the 7K gallons on a forest fire below

679

Part 11

Spruce Goose

680



In July 1942, the world was at war. *America* had lost 800K tons of shipping to German U-boats. *Henry Kaiser*, famed industrialist and builder of "Liberty" ships, proposed a fleet of flying transports to safely move troops and materiel across the *Atlantic*. Kaiser approached *Howard Hughes* with his idea. Together they formed the *Hughes Kaiser Corporation* and obtained an $18 million government contract to construct three flying boats. Hughes and his team of skilled engineers designed a single hull flying boat capable of carrying 750 troops. The plans called for eight 3K-horsepower engines, a mammoth fuel storage and supply system and wings twenty-feet longer than a football field. The aircraft was dubbed the "HK-1," for the "Hughes Kaiser (design number) 1."

Left: original plan/elevation/s

681

"…It has eight engines with a horsepower of at least 24,000. The giant's wingspread is 320 feet – longer than a football field. Its hull – it's a flying boat – is 220 feet long and almost three stories high. Gross weight will be 400,000 pounds, or 200 tons. It will be able to carry 650 passengers, with plenty of baggage, across the Atlantic nonstop, or across the Pacific with one stop, Or it can carry a 60-ton Sherman tank, or two medium tanks, or three light tanks. It could take 400 soldiers with five tons of ammunition and equipment across the ocean and bring back 350 wounded with 40 or 50 nurses and doctors…"

Popular Science Monthly, **September 1945**

Above: HK-1

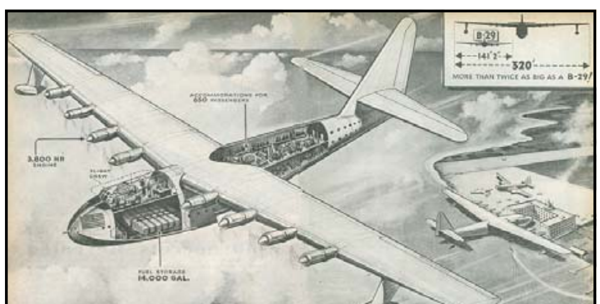
682

"Under secret conditions for almost three years, the world's biggest airplane has just been revealed in all its giant proportions. It's the $20,000,000 mystery ship on which Howard Hughes has been working, with Henry Kaiser as a partner until a while back, and is now called merely the H-4…"

Popular Science Monthly, **September 1945**

RE: adhering to the government mandate not to use materials critical to the war effort (such as steel and aluminum), the Hughes team constructed the HK-1 out of wood. Testing new concepts for large-scale hulls and control surfaces, plus the incorporation of complex power boost systems, delayed the construction process. In mid-1944, *Henry Kaiser* withdrew from the project, and Hughes renamed the seaplane "H-4," (a.k.a. "Hercules") representing his aircraft company's fourth design. After the war's end in 1945, criticism of the project mounted. The H-4 prototype had exceeded the government's funding allowance and the *U.S. Senate* formed an investigation committee to probe alleged misappropriation of funds. Hughes invested $7 million of his own into the project to keep it going.

683



Above: caption: "This cut-away drawing of Howard Hughes' H-4 shows the vast interior that could hold a payload of 60 tons. The giant could be a cargo carrier, transport, or hospital ship, and fly nonstop from Honolulu to Tokyo."

Left: caption: "Each pontoon is taller than a man. Mounted on two such floats and the high, deep struts, the wings would clear a two-story building with room to spare."

684

Top: caption: "This is the hull of the Hughes Hercules, called by its builders the largest plane in the world, in construction at the Hughes Aircraft Co. plant at Culver City. The hull is 220-feet long, 30-feet high and 24-feet wide (July 1945)."
Bottom: caption: "Two workmen stand in the interior of the hull of the Hughes Hercules seaplane, which will have a cargo space equivalent to that of two railroad boxcars when it is completed at the Hughes Aircraft Co. plant in Culver City (July 1945)."

685

"The Hercules was a monumental undertaking. It is the largest aircraft ever built. It is over five stories tall with a wingspan longer than a football field. That's more than a city block. Now, I put the sweat of my life into this thing. I have my reputation all rolled up in it and I have stated several times that if it's a failure, I'll probably leave this country and never come back. And I mean it."
Howard Hughes
RE: excerpt from Hughes' testimony before the *Senate War Investigating Committee* on August 6th 1947
Left: caption: "Howard Hughes inside his H-4 Hercules troop transport plane, the 'Spruce Goose,' 1947."

686

687

"…Now in this particular airplane, however, the increase in size beyond the largest airplane ever designed or built prior thereto, was three times. In other words, I think this airplane was roughly three times larger than the largest airplane that had ever been built or designed thereto. Now this made such an enormous increment of increase that it carried us beyond the point on any available curves of known design criteria - beyond the point where extrapolation was possible. In other words, we were just way off the end of the paper and there was no way to take existing design information, design criteria, and extrapolate the curves a little ways beyond and say this is what ought to happen if it is this much bigger than the one before. This airplane was so much bigger than the one before, than anything that anybody had ever conceived up to that time, that we were working in a complete vacuum as to information based upon prior performance and prior design…"
Howard Hughes
RE: excerpt from his 1947 Senate testimony. Above, *Howard Hughes* (center) studying diagrams for the H-4 flying boat (ca. 1946)

688

Biggest Airplane Moving Job in History

689

"Inching carefully along a close-guarded route from which 2100 individual power and telephone lines had been raised or lowered to provide clearance, the two mammoth wing sections of the Hughes Aircraft Co.'s $20,000,000 flying boat H-4 last night completed 'the biggest airplane moving job in history' – 28 miles from Culver City to Terminal Island…The second day of the moving job, which began Tuesday, wound up without mishap and somewhat ahead of schedule. Fifteen Los Angeles motorcycle officers headed by Lt. L.J. Fuller, and equal force from the California Highway Patrol led by Sgt. Clarence Martin, and details from half a dozen other cities and towns rode herd on the novel procession, which traveled two miles an hour. The wings reached the mainland end of the Navy's pontoon bridge spanning the Long Beach channel at 1 p.m. and halted until nightfall, when a high tide raised the structure to near-level with the approaches. Before the wings could be moved across the bridge to their destination at the graving dock on the east end of Terminal Island, Navy workmen had to remove railings, signs and a post from the floating roadway. Following the wings were two pontoons held in a huge wood crate. The airplane, built almost entirely of plywood, will weigh 200 tons. Powered by eight 3,000-horsepower engines, it will exceed 200 miles an hour, carrying more than 60 tons of payload."
Los Angeles Times, June 13th 1946

690



<u>Top Left</u>: caption: "The wings of the Hughes H-4 Hercules aircraft, now known as the Spruce Goose, are moved from the Hughes Aircraft plant in Culver City to Long Beach. The move took two days as movers traveled at 2 m.p.h. (June 1946)."
<u>Top Right</u>: caption: "The wings of the Hughes Hercules aircraft sit in Hermosa Beach as the move is halted for a lunch break (June 1946)"
<u>Left</u>: caption: "The hull of the H-4 being transported to Long Beach, CA"

691

<u>Above</u>: caption: "The Hughes H-4 under final construction at Long Beach California"

692



"…Moving huge sections of the plane 35 miles to the harbor for assembly was an engineering feat in itself. It was accomplished for less than $100,000, well under the cost of erecting another plant near the water…"
***Popular Mechanics,* January 1948**
<u>Above & Left</u>: caption: "Howard Hughes' H-4 Hercules troop transport plane, the 'Spruce Goose,' Long Beach Harbor, Calif., November 1947"

693

Meanwhile, the Hughes team assembled the flying boat in the *Long Beach* dry dock. Wishing to vindicate himself after a being interrogated by the Senate committee in *Washington, D.C.*, Hughes returned to *California* and immediately ordered the flying boat readied for taxi tests. On November 2nd 1947, a crowd of expectant observers and newsmen gathered. With Hughes at the controls, the giant flying boat glided smoothly across a three-mile stretch of harbor. From thirty-five mph, it cruised to ninety during the second taxi test when eager newsmen began filing their stories. During the third taxi test, catching the media and crowd unaware, Hughes lowered the wing flaps and lifted the seaplane off the water flying her a little over a mile at an altitude of seventy-feet for approximately one minute. The short hop proved to skeptics that the gigantic machine could, indeed, fly.

694


<u>Left</u>: caption: "Howard Hughes' H-4 Hercules troop transport plane, the 'Spruce Goose,' Long Beach Harbor, Calif., November 2, 1947."
<u>Right</u>: caption: "Leaving a broad wake in the sun-flecked surface of Long Beach Harbor, the world's biggest plane taxis majestically just before its flight."

695


696

ADVERTISEMENT

LEOMINSTER DAILY EN

RD 4

FLYING BOAT WINGS GIVEN TEST IN AIR

Thousands Watch Hughes Craft In Flight

VOTE MAY BE ELECTION

"…If you can imagine a 32-story building, stretched out on its side and flying, you'll appreciate how onlookers at Long Beach, Calif., harbor felt when this Gargantua of the skies first rose from the water…"

Popular Mechanics, **January 1948**

Left: caption: "Howard Hughes' H-4 Hercules troop transport plane, the 'Spruce Goose,' on inaugural (and only) flight, Long Beach Harbor, Calif., November 2, 1947."

Right: newspaper story (dated 11/03/1947) about H-4's flight test

697

"…No major flights are planned for the big boat until March or April. Until then there'll be only brief, cautious trials close to the water, 'feeling out' the craft's handling qualities. Questions that once existed only on paper will begin to get answers in the air. The giant's assignment will likely remain undecided until Hughes completes tests and turns it over to the government, its owner. But, regardless of its final role, the NX-37602 is slated to be for many years the biggest plane that ever flew!"

Popular Mechanics, **January 1948**

Left: H-4's Flight Log (with one and only entry for 11/02/1947)

698

"…The H-4 is not a speedy plane. Its climbing rate is 675 feet per minute, cruising speed 145 miles, ceiling 17,000 feet. Its tanks will hold 14,000 gallons of gasoline. It requires a run of 5,600 feet to obtain a speed of 86 m.p.h. for the take-off, and this takes 67 seconds…"

Popular Science Monthly, **September 1945**

RE: the creation of the Hughes H-4 flying boat involved many engineering disciplines. Not only did aeronautical engineers participate in the numerous aspects of the aircraft project, but their efforts ranged in breadth from the models constructed for wind tunnel evaluation and towing basin tests through to the final launching details of the completed flying boat. Hughes and his team of electrical engineers discarded the idea of using the conventional 24-volt direct current (DC) system for the aircraft, primarily because of weight, and designed a new 120-volt, three wire, redundant DC system which brought about a weight reduction of 75%. Care also was taken to insure that all the electrical relays would perform at high altitudes. Two 30-kilowatt generators provided backup electrical power and emergency battery power consisted of ten 12-volt batteries in two banks.

699

"…Eight 3,000-horsepower engines give it a total of 24,000-horsepower, double that of any other aircraft, After initial take-off, when it left the water at about 80 miles an hour, Hughes said he used only 2,200-horsepoweer on each in taxing and 1,200 in the air…"

Popular Mechanics, **January 1948**

RE: originally designed with four throttles; one for each pair of engines, Hughes changed the design to eight after the flight, one for each individual engine. At first, all engines operated by Pneudyne's pneumatic system, or compressed air in place of hydraulic fluid. However, it was difficult to control them precisely and no two valves would operate the same with identical pressure. After the flight, Hughes had electric throttles installed, along with servos for throttle control on all eight engines, which gave them a response time of 1/300th of a second. Each of the eight *Pratt & Whitney* "Wasp Major R-4360" air-cooled radial engines drove a *Hamilton* standard four-bladed, hydromatic, full-feather propeller measuring 17-feet 2-inches in diameter. The four inboard propellers could provide reverse thrust. The thrust reversing capability would assist the H-4 in backing off the beachhead after loading or unloading its cargo. 700

To attain a range of 3K miles, the H-4 was equipped with fourteen tanks, complete with baffles to minimize fuel sloshing. Each fuel tank had a 1,020-gallon capacity, but to allow for expansion each was filled to only 900 gallons. Fuel was transferred from the tanks, located below the cargo deck, to two 300-gallon wing tanks. One wing tank fed the four inboard engines, and the other wing tank fed the four outboard. The H-4 was also equipped with an emergency fuel transfer and supply system in case of leakage or pump failure. Each of H-4's eight engines had a thirty-one gallon oil lubricating tank. Each of these tanks was replenished from a central 281-gallon tank located in the rear of the flight deck. The oil supply system operated automatically with a float in each individual tank or manually. The oil piping in each engine nacelle consisted of a main engine-oil pipe, reserve-oil supply lines, vent lines and propeller-feathering piping. Carburetor inlet scoops were placed below each engine nacelle, and oil coolers were placed in the inlets, which were enclosed by the air-scoop fairings and temperature regulating doors.

701

The Flying Lumberyard

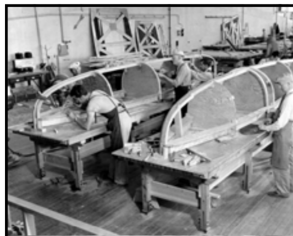
702

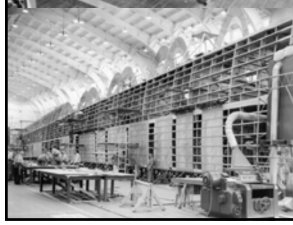
"…Since the plane was begun in 1943, when the metal shortage was still acute, engineers had to use laminated wood, with each thin sheet carefully inspected before gluing, to form the heavy sections. Solid beams weren't acceptable because there was no way to examine them inside to detect possible weaknesses and semi-rot. In the gluing, very high frequency electrical current was used in applying high pressures and temperatures uniformly to the laminated members…"

Popular Mechanics, **January 1948**

RE: H-4 would be made primarily of wood, saving materials critical to the war effort. The difficulties creating such a large airframe made of wood were unknown at the beginning of construction and would prove to be many. The final product is a tribute to the efforts of the team in overcoming the problems they faced. A structure made of lumber was created that, even on close inspection, bears little resemblance to any form of wood. Hughes would prove to be a demanding taskmaster during the period of development and construction. His attention to detail and insistence that everything on the new plane be perfect was largely responsible for both the beauty of the finished product and its not being ready to fly until after the war had ended. During one of the 1947 Senate hearings, one disgruntled Senator referred to H-4 as: "The Flying Lumberyard."

703





"…The plane is almost entirely constructed of wood strips, glued together. The metal in it, aside from the engines, is negligible. Skin and structural parts are built up of birch and spruce, layer on layer, formed into durable units by modern techniques and the use of new waterproof glues. Thinnest parts of the H-4 are 3/64 of an inch, built up of three 1/64-inch veneers. The thickest part is ten inches, built of 200 veneers 1/20 of an inch thick. The workers are mostly skilled cabinetmakers, who know their wood and their glue…"

Popular Science Monthly, **September 1945**

<u>Left</u>: skilled carpenters work on wing components (top) and a wing section is formed (right)

704

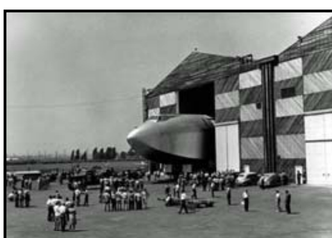
The principal structural material used for the H-4 was *Birch* veneer. Members were built up using several plies of thin veneer bonded together. When glued and steam heated, Birch held up better than *Spruce*, and it took the bolting stresses better. By laminating birch in multiple grain directions, the necessary grip for bolts proved practical. Birch was also superior in terms of weight reduction in high stress applications. *Duramold*, a lamination bonding process, was originally created for molding parts for smaller aircraft. The contoured surfaces were very smooth and provided great aerodynamics. Originally developed by *Fairchild Aircraft Company*, Hughes purchased the rights to use it in large aircraft. Because the pieces required were so big and the materials for steel dies costly and in short supply, Hughes fabricated and experimented with "Gunite" dies. Gunite is a patented process for placing concrete mortar with compressed air. The Gunite process produced difficult shapes easily at a relatively low cost. Intensive research resulted in one of the earliest practical uses of epoxy resins. The main structural material for the huge craft was built up by bonding several plies of Birch veneer with a *Urea Formaldehyde* adhesive. In addition, some Spruce, *Poplar, Maple*, and *Balsa* were employed. Special corner angles were developed to replace glue blocks. Glue blocks were a serious problem for the aircraft builders because of differential expansion across and with the grain. Thousands (about eight tons) of small nails were used to provide pressure for attaching the hull and wing skin. After the adhesive had cured, they were removed with specially designed nail pullers. The result was an immense wooden airframe capable of withstanding the stresses of flight without being too heavy.

705

<u>Above</u>: caption: "Interior of Howard Hughes' H-4 Hercules troop transport plane, the 'Spruce Goose,' 1947"

<u>Left</u>: caption: "Finishing touches are put on plywood plane two days before the run. Workmen are in rear part of main deck, which holds most of the passengers."

706



The wooden construction made fire protection a high priority. The amount of fire protection equipment aboard the H-4 was impressive. A total of thirty-six CO2 (*Carbon Dioxide*) pressure containers were located on the cargo deck. They provided both primary and auxiliary fire control to the fourteen fuel tanks and to each of the eight engines. A complex manifold allowed the gas to be directed to the plane's various areas as needed. If required, all thirty-six bottles could be discharged into one area for maximum effectiveness.

<u>Above</u>: the forward hull section of H-4 protrudes out of her *Culver City, CA* Hangar (left) ca. 1946. The hangar (right) now serves as a movie soundstage

707

<u>Above L&R</u>: the H-4 was built in a huge, 315K square foot, climate-controlled hangar known as "Building 15." After the November 1947 flight, it remained carefully stored there.

<u>Left</u>: Building 15 as a soundstage for Hollywood movies, present day

708


Top: caption: "Wings of the H-4 under Construction, 1946"
Bottom: caption: "This is the wing of the Hughes Hercules, called by its builders the biggest plane in the world, nearing completion in the Hughes Aircraft Company plant in Culver City. The wing is 320 feet from tip to tip (July 1945)."

709

Flight Controls

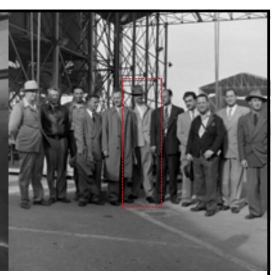
710

"…Many problems were licked in converting it from a drawing board dream to something that actually flew. For the first time on any airplane, the control surfaces are so large that no man in the world can operate them. The customary steel cables from the pilot's rudder pedals and control wheel to the tail and wing tips were useless, yet their job had to be done. As a result, a sensitive power-operated control system, providing 26,000 pounds of pressure and as reliable as the structure of the plane itself, had to be devised. Engine failures, even all eight, would permit a forced landing. But if the controls failed, a crash, death and destruction were inevitable…"
***Popular Mechanics,* January 1948**

711

"…Now, furthermore, I may say that this airplane for the very first time in history reached into a size where manual control was utterly impossible, and this was just as important a barrier to cross as crossing the sonic barrier in speed. Now in the case of this aircraft, the Hughes flying boat, the controls were so large, so much larger than any designed before, that for the first time we crossed into the area wherein it is absolutely impossible for any human being, whether he be Jack Dempsey or Joe Lewis rolled into one, it's utterly impossible for any human being to move the controls of this airplane - consequently it became necessary for the first time to design power control system which was as safe, let's say, as the structure of the airplane…"
***Howard Hughes,* 1947**
RE: excerpt from his Senate testimony. Hughes and his team of engineers developed the first "artificial feel system" in the control yoke, which gave the pilot the feeling he was flying a smaller aircraft, but with a force multiplied two hundred times. For example, for each pound of pressure exerted on the control yoke by the pilot, the elevator received 1,500 pounds of pressure to move it. The flying boat required two auto-pilot systems but Howard Hughes' passion for safety required five hydraulic control systems, which included two main systems, two auxiliary systems, a hand pump system plus an emergency flying tab system in case of complete hydraulic failure. Conventional control cables directly connected cockpit controls to the control surfaces however, they did not move the control surfaces. They only provided a follow-up to ensure the proper relationship between the pilot's control positions and the actual deflections of the control surfaces. The Hughes engineers used electrically driven, high-pressure hydraulic pumps that provided the operating power for the systems. When the pilot moved the controls, he actuated sensitive relay valves that transmitted metered, pressurized hydraulic fluid into tubing that led to receiving relay valves located at the control surfaces. The receiving valves in turn permitted pressurized oil to flow to the power cylinders which actually moved the control surfaces. To insure complete safety, each control surface was operated by two independent, self-contained "telecontrol" systems, which were supplied with electric power from two separate generators. The H-4 was the first aircraft to utilize "flareless" tubing connectors in the hydraulic lines. Fuel lines were equipped with "slip-joints" and "floating fairleads" to allow for the deflection of the wings.

712

"…Length from the nose to the tip of the tail measures 219 feet…Its thin rudder towers 80-feet above the keel and the wings are about 11-feet thick at their roots. Fully loaded, it draws eight feet of water. Pilot and co-pilot are 28 feet above the waterline in a compartment larger than an ordinary living room. Its normal operating crew will be about 15 men…"
Above: Hughes at the pilot's controls of his H-4 flying boat (left) and with his crew (highlighted) and engineers in November 1947 (right). The enormous control areas (ailerons, flaps, elevators and rudder) covered 4,414 square feet and all were fabric covered, except for the flaps.

713

The pilot and co-pilot's cockpit flight controls were each equipped with a control column and wheel, pedal operated rudder control and engine throttles between the two positions, plus essential engine and navigation instruments. A starboard-side flight engineer's station was immediately behind the co-pilot's seat and contained dials and gauges to monitor the eight engines, throttles, alarm annunciators, fuel indicators and hydraulic status gauges. The radio operator's console was located on the port side, directly behind the pilot's seat and the flight test temperature recorder's desk was behind it. Also on the port side was a table for the strain gauge calibration equipment. On the port side aft was the assistant flight engineer's station, complete with the more essential dials and gauges. The console for the propeller test equipment was located on the starboard side aft. In addition, a number of chairs were provided as a "crew rest area." A novel "Bocking" elevator equipped with guardrails, located in the rear of the flight deck, was designed to lift personnel through a top opening hatch. Equipped with a microphone connected to the aircraft's communications network, the personnel could supervise docking and mooring of the flying boat from a vantage point atop the fuselage.

714

Above: caption: "Flight-deck seats, put in for military observers expected to go along on test, go unused. Nobody showed up for the occasion but a CAA (California Aviation Alliance) observer)."
Left: caption: "Instruments in octuplicate, one for each of the eight engines, are examined by Hughes over engineer's shoulder during check-ups before test."

715

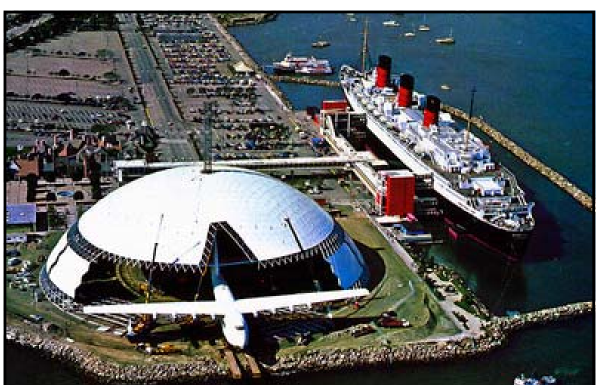
716

Looking for a Home

717

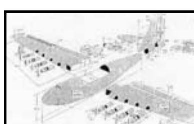
After the test flight in November 1947, H-4 was put in storage in the hangar where she was built, hidden from public view but carefully preserved. Not long after Howard Hughes' death in 1976, efforts began to preserve and display the historic flying boat. By 1980 it had been acquired by the ***California Aero Club*** and would be featured on the ***Long Beach, California*** waterfront. A specially designed building was constructed to house the giant plane. A popular tourist attraction, it seemed the ***Spruce Goose*** would be a permanent fixture at the ***Southern California*** site beside the famed luxury liner ***Queen Mary***. In 1988, the ***Disney Corporation*** acquired the company holding the lease on the exhibit. After two years of what they considered less than acceptable financial returns from the ***Spruce Goose*** exhibit, Disney decided to remove their financial burden. Plans for a theme park at the location were announced but there was no provision for the old flying boat; the Spruce Goose had been evicted. This announcement brought about a scramble to save this one-of-a-kind example of aviation history. There was talk of dismantling it and displaying parts in different sites across the country. Dozens of locations across the U.S. were interested in hosting the Goose but at this point, the difficulty of moving something so large and of such historic importance had to be considered carefully. The candidates for hosting the H-4 were narrowed to three locations; ***Oceanside, California Tourism Foundation***, a firm in ***Tampa, Florida*** and ***Evergreen International Aviation*** in ***McMinville, Oregon***. Evergreen was chosen to make a new permanent home in its "to be built" ***Air Venture Museum***. A key player in the decision to get the plane moved to the Oregon site was the president of the Air Venture Museum, long time Hughes associate and aviation pioneer ***Jack Real***.

718



Above: caption: "After Hughes's death in 1976 the Spruce Goose was installed in a special hangar in Los Angeles alongside the Queen Mary"

719



Once it was decided the Goose would go north, the problems of moving such a large aircraft would have to be identified and dealt with. Weighing in at over 170K pounds with a wing span of 320-feet and a tail towering over 80-feet above the ground, the task would not be an easy one. Since flying it to ***Oregon*** was out of the question, disassembly for transport would be necessary. Some of the original team that built the H-4 were brought in to help. A plan was carefully drawn up to get H-4 into manageable sections while maintaining structural integrity (left). Disassembly began on August 10th 1992. It would take more than a month to complete preparations for the move. Sections too large for overland transport were loaded onto a barge to be towed up the ***Pacific*** coast. Then inland via the ***Columbia*** and ***Willamette*** river/s. After a stop in ***Portland***, continuing upriver to ***McMinnville, Oregon***. Smaller parts were transported by truck. The final leg of the move to McMinnville was finally completed February 27th 1993. Towed the last few miles overland by powerful vehicles used for house moving (center) and, accompanied by much fanfare, the move to the her new, temporary home (in a large greenhouse, at right) was complete.

720

***Above*: *transporting the H-4 in 1993 to her new home in* Oregon. Restoration of the Goose was completed in 2001.**

721

Now commonly called the "Spruce Goose," the Hughes H-4 flying boat has endured to become a popular cultural icon of American history. She tells a story of wartime sacrifice, determination and technological development. She still is the largest wooden flying boat ever built and proved that jumbo flying aircraft and large lift capability were possible. H-4 was decades ahead of her time and today, thanks to the many people dedicated to her survival, she is proudly displayed among other historic aircraft at the *Evergreen Aviation & Space Museum* (above), about forty mile southwest of *Portland, Oregon.*

722

The Goose on display at the *Evergreen Aviation & Space Museum*

723

Historic Engineering Landmark

Hughes Flying Boat, "Spruce Goose"

Inscription: "Constructed: 1943–1946. Assembled: 1946–1947. Designed and built by Hughes Aircraft Company, this is the largest wood constructed and the largest wingspan airplane ever built. Originally designated the HK-1 in 1942, the Flying Boat was designed to meet wartime troop and materiel transportation needs. Laminated wood (mostly Birch) forms the airframe and surface structures of the seaplane, minimizing the use of critical war materials, such as aluminum. It was powered by eight Pratt and Whitney 3,000 horsepower engines. Howard Hughes piloted the Flying Boat on its only flight November 2, 1947, in Long Beach Harbor, Long Beach, California. The flight covered approximately one mile and reached an altitude of approximately 70-feet above the water's surface."

724

Part 12

Last Hurrah

725

End of an Era

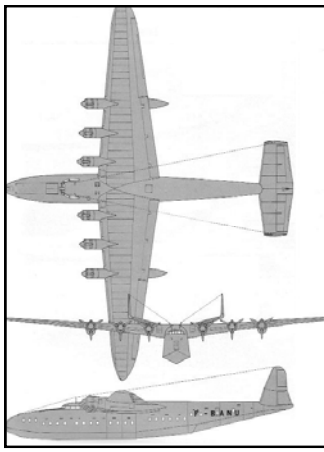
726

"…World War II brought about vast improvements in land-plane power plants and airframes. It also left hundreds of new airfields scattered around the globe. All at once, there was no need for flying boats. They faded away. In their heyday, though, some bizarre birds were hatched…"
Popular Science, **June 1963**

727

Le Latecoere 631

728



"France's six-engine Latecoere 631, destined for the South Atlantic run, has a wing span of 188 feet, a cruising speed of 185 m.p.h., and carries 46 passengers on long range flights. Ten of the flying boats are being built."
Popular Science, **November 1947**
RE: the *Latecoere 631* was intended to meet an official French specification which called for a large transatlantic flying boat capable of carrying forty passengers over a distance of 6K-km at an average speed of 300 km/h against a 60 km/h headwind. The 631 prototype flew for the first time on November 4th 1942. It was a graceful high-wing monoplane flying-boat powered by six radial engines. Accommodation was provided for 46 passengers in two or four-berth cabins. However, this aircraft was confiscated by the Germans during the occupation of *France*.

729

After the war ended, three 631s were built and inaugurated transatlantic services to *Fort de France, Martinique* on July 26th 1947. One was lost on August 1st 1948 and the 631's were subsequently withdrawn from commercial service. It is believed that a total of eight 631 aircraft were built. In 1951, Latecoere flying boats staged through *China Bay, Trincomalee, Ceylon* en-route to *French Indochina.* The *Societe France-Hydro* (SEMAF) operated one on cargo services in *French Equatorial Africa* for three years, but it also crashed after which all remaining Latecoere 631's were broken up.

730

731

Royal Family of Flying Boats

732

In post-WWII Britain, there was considerable time, money and effort spent on trying to keep the empire accessible. The British saw large flying boats as the solution to the distance problem. As her former colonies declared independence, ***Great Britain*** sought ways to keep those that were still part of the empire within reach. To do this, a competition was held which would create some of the largest aircraft the world had yet seen, both real and imagined. To create an aircraft with a five-thousand mile range would require a tremendous amount of fuel, which requires a large structure which requires multiple engines. The easiest place to start was with a flying boat since runway length is not an issue and, in an emergency, there were more options to make an unscheduled landing on the broad oceans of the world than on disparate airfields. Due to its size and weight, ten engines were to be coupled to six propellers. However, even with ten engines, the design would prove underpowered.

733

The Princess

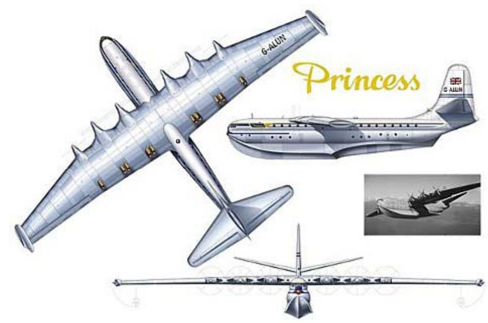
734

"…The forlorn distinction of being the last of the great flying boats belongs to Britain's Princess. This two-deck craft has a curious, curvaceous 'double-bubble' hull 148 feet long; a wingspan of 219.5 feet; a gross weight of 172.5 tons. With 10 turboprop engines, she was expected to carry as many as 220 passengers across the Atlantic. Instead, the Princess had the misfortune to be ordered in 1946, just when Lockheed Constellations and other comparable land planes were beginning to put flying boats out of business…"

Popular Science, **June 1963**

Above: *Saunders Roe SR-45* "Princess" flying boat

735



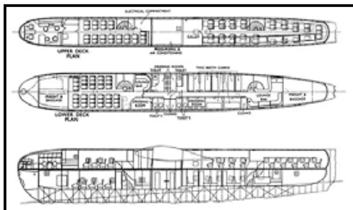
736

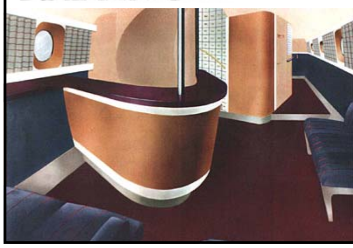
Above: "The Flying Walrus" in flight

Left: caption: "Engineer's throttle and propeller controls"

737

738

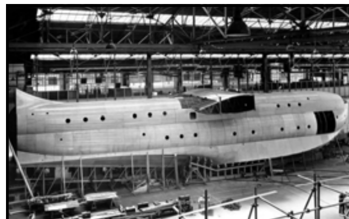




The Princess was created after WWII, but displays the pre-war approach to flying that signified the privileged situation of most inter-continental passengers. It's interesting to note the proximity of the tourist class passengers to the ten very large propellers. Even with this split configuration, the tourist cabin had a dressing room as well as a "bar-lounge." The First Class passengers had seats as well as berths, with some passengers afforded the luxury of lower deck berths. BOAC, the original airline scheduled to operate the Princess, had opted to use a twin class configuration, for what was proposed as a primarily trans-Atlantic route. This cabin layout is still in vogue with many wide-bodied aircraft on the same routes.

<u>Top</u>: deck plan/s and longitudinal section
<u>Bottom</u>: bar-lounge rendering

739



<u>Above & Left</u>: the *Saunders Roe* (a.k.a. "Saro") Princess did bring two very important developments to aircraft design. One of these was the structural feasibility of large twin deck pressurized metal aircraft. The other, and more important one, was that a large metal aircraft could be manufactured from major sub-assemblies.

740

<u>Above</u>: "cocooned" (protective covering) *Princess* hull. By the time the three contracted aircraft were complete, the need for them had passed. One airframe was allowed to continue test flights but the other two were never to be flown. The era of the large-scale passenger flying boat had come to an anti-climactic end.

741

"…The first of three Princesses made her debut Aug. 22, 1952. Her engines were felt to be inadequate. B.O.A.C., which had ordered the turboprop giants, meanwhile had retired its last regular flying boat from service and decided to use only big land planes for transoceanic flights. The story got around that the R.A.F. would take over the Princesses for military transport. That never happened, either. Instead, the only Princess that ever flew, and her two sister ships, went into cocoons on the Isle of Wight. There, at last check, they still were. But an American Prince Charming may awaken them. The Winder Aircraft Corp., of Dunnellon, Fla., bought all three from the British government last year. Joel Henry, head of Winder Aircraft, has told POPULAR SCIENCE that he plans to convert them into nuclear-powered flying boats. Certain modifications will first be made on them in England, and then Henry plans to have them flown to Florida for the main conversion. Will the giant flying boats, mated to atomic engines, emerge again as queens of the transoceanic air lanes? Only time can tell."

***Popular Science,* June 1963**

742

The Duchess

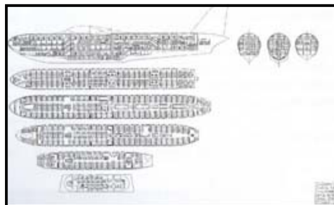
743

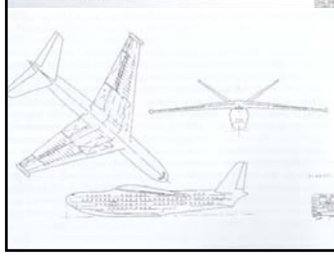
<u>Left</u>: in conjunction with developing the *Princess*, Saro was also considering the next generation. A flying boat too, the design parameters of the "Duchess" were directly comparable to the 707 and DC-8 transports of just a few years later. At the time, it was felt there would be a market for flying boat transports going forward into the future and *TEA* of *Tasmania* were actually negotiating an order at one point. However, the project was never realized.

744

The Queen

745





Left T&B: the *SARO P-192* flying boat was designed at the behest of shipping line "P&O" (*Peninsula & Orient*) who believed the coming post-WWII age of jet transportation was going to undermine their transoceanic passenger liner business. At the time. the enormous flying boat was seriously seen as the future by P&O and was by far the biggest and most ambitious aircraft ever seriously con-sidered by the British aviation industry, up to that time.

746

Above: slated for the *London-Sydney* run, the P-192 (to be known as "The Saro Queen," though never officially named) was required by P&O to seat up to 1K passengers in comfort. In addition, it was to include bars, dining rooms and lounges for the elite passengers. To meet this demand, Saro created a huge design with six passenger compartments on five decks, it was to be powered by twenty-four *Rolls Royce* "Conway" engines (four of which were used on the 707) and to be able to maintain cruise with up to six of them shut down for maintenance. As can be seen from the rendering, they were mounted within the wing but well outboard so as to avoid the spray from the hull. The wings were deep enough for the engineers to be able to carry out maintenance standing up while the aircraft was in flight. Besides the many engineering obstacles, money to produce it was never found thus, the P-192 was never realized.

747

Air-Sea Fighter

748

" From the Saunders-Roe back room comes the single seater SR/A1 jet fighter, one of the most interesting as well as prophetic aircraft of recent times (see drawing at right). This amazing little 'pint-size clipper' with a nasty sting is the first boat-hulled aircraft to be powered with jet engines…the SR/A1 is a high-wing designed all-metal flying boat with a two-step hull, single rudder and fin and a high-set stabilizer-elevator. The single seat is set just about amidship the leading edges of the wings and is canopied with a sleek blister giving 360-degree visibility. The cockpit is pressurized for high altitude and there is an emergency pilot ejector device for a quick escape in case the other fellow beats the SR/A1 pilot to the draw. The jet engine exhausts are aft of the trailing edge of the wing and are sleekly streamlined into the hull sides. The two Metrovick jet engines were selected for the powering of this fighter because of the small overall diameter of each power plant. This fact enabled them to be submerged within the hull without increasing the width of the boat other than ordinarily required for good hydrodynamic **consideration…*The two-step hull breaks the smooth over-all lines, but the steps, are of a low-drag form. The front step is of a 'V' design in plan form and the aft step is a vertical knife edge. The over-all length of the SR/A1 is 50-feet while the span is 46-feet. The height is 17-feet and the hull beam width is just under seven feet. The wing area is approximately 415 square feet…"***

***Mechanix Illustrated*, September 1947**

749

In theory, seaplanes were ideally suited to conditions in the *Pacific* theater. Their main disadvantage came from the way in which the bulk of their floatation gear penalized their performance compared to other fighters (an automatic mooring system was incorporated so the pilot could moor the aircraft without external aid or leaving the cockpit). *Saunders-Roe* realized that the new turbojet engine presented an opportunity to overcome this drawback. Not requiring clearance for a propeller, the fuselage could sit lower in the water and utilize a flying boat-type hull. The company first presented their idea – SR-44 - to the *Air Ministry* in mid-1943. With the end of the war, Saunders-Roe concentrated its efforts on their *Princess* long range civilian flying boat project. The first prototype flew on July 16th 1947 and, while it and its two sisters proved to have good performance and handling, the need for such aircraft had completely evaporated with the end of the war. Furthermore, the success of the aircraft carrier in the *Pacific* had demonstrated a far more effective way to project air-power over the oceans of the world.

750

751

Dynamically Similar

752

"Convair's flying boats are not ordinary models. They are complete miniature aircraft that are powered by their own tiny engines and controlled by radio from a ground station. They can be taxied on the water, turned, driven at full power so that they take-off and climb into the air for maneuverability tests, and then made to land on water again exactly as if they had human pilots on board. Experts of the company's hydrodynamics research laboratory test the small craft on an estuary of San Diego Bay. Motion pictures of the miniature flying boats in action, particularly during water take-offs and landings, provide information that can't be learned theoretically or in wind tunnels or conventional towing basins. Everything is built precisely to scale. Thus the balance, weight-carrying ability, rate of climb, top speed and other needed information about a huge flying boat can be learned accurately by flying the models. Changes are made in the models to test new ideas, which then can be adopted or discarded at much less cost than cut-and-try alterations to a full-size experimental craft. At the same time, a model serves to test performance under conditions that might be hazardous to a human crew. One of the miniature boats is built to 1/10 full scale and weighs 123 pounds. It is powered by four two-cylinder engines that develop 1.5 horsepower each at 5,000 revolutions per minute…The small engines are of special design and have complete throttle control…"

***Popular Mechanics*, September 1949**

753

"…The radio-control cockpit has a typical set of full-size flight controls for operating the model, including flaps, ailerons, elevator, rudder, throttles and ignition. A thumb switch is used to cut in the model's automatic pilot. All the pilots actions are relayed by a 63-watt six-channel transmitter to a receiver in the model, which in turn actuates the flight and engine controls. For some experiments an 8-mm camera placed inside the model's fuselage photo-graphs the dials of a tiny instrument panel on which air speed, trim, hull pre-ssure and time are indicated. Exteriors of some of the hulls are painted with black grid markings to aid in study of the motion pictures that are made from the beach. Black and white crosses and targets are painted on different parts of the fuselages to show the attitudes of the models in the air during maneuvers. One non-powered model, with a wingspan of 14-feet, is thrown from a catapult so that its landing characteristics may be studied under different flap settings. Virtually any information that is desired concerning a full-size flying boat can be obtained from the 'dynamically similar' free-flight models. Convair is continuing its model research program for acquiring basic data on future sea-and-air craft."

***Popular Mechanics*, September 1949**

Above: model of the XP5Y-1 in San Diego Bay. Full-size prototype is beached in background

754

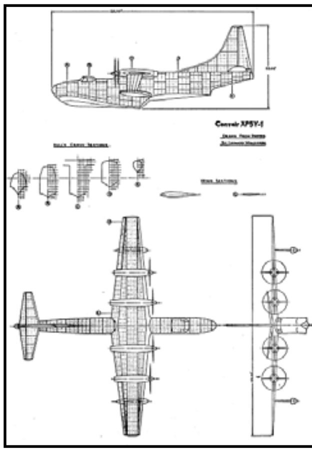
Considerable Progress

755

"…Flying-boat research was practically abandoned during the last war because of the emphasis on land planes. Since then designers have made considerable progress in refining that type of aircraft. A case in point is the new Convair XP5Y-1 patrol flying boat, powered with four turboprop engines. Larger than any flying boat previously built by Consolidated-Vultee, the aircraft has twice the seaworthiness and carries 2.5 the load of the Coronado flying boat. The total increase in efficiency amounts to 300 percent, an advance that grew out of a program of flight testing models of flying-boat shapes, including numerous different combinations of hull and wing designs…"

***Popular Mechanics*, September 1949**

756



In March 1943, ***Reuben Fleet*** **sold his interest in the *Consolidated Aircraft Corporation* and the company was reorganized as *Consolidated Vultee* (a.k.a. "Convair"). Shortly after this re-organization, the *U.S. Navy* expressed interest in a new long-range multi-role flying-boat and Convair's proposal for an aircraft powered by four turboprop engines was the subject of a contract for two prototypes, awarded on May 27th 1946. Designated "XP5Y-1," the new aircraft featured an unusually slim fuselage for an aircraft of this class with a length-to-beam ratio of 10 to 1. It was powered by four *Allison T40-A4* turboprops, each driving two contra-rotating propellers through a common gearbox. The type's main role was anti-submarine warfare (ASW), and it was to have been fitted with advanced radar, ECM and MAD equipment in addition to carrying a heavy load of bombs, mines, rockets and torpedoes. The first aircraft was flown from *San Diego* on April 18th 1950 and in August, the type set a turboprop endurance record of eight hours, six minutes. Also that August the Navy decided to discontinue development of the XP5Y-1 (left) for maritime patrol, but to persevere with the basic design for use as a passenger and cargo aircraft. The name "Tradewind" would only apply to these latter models (R3Y-1/ R3Y-2).**

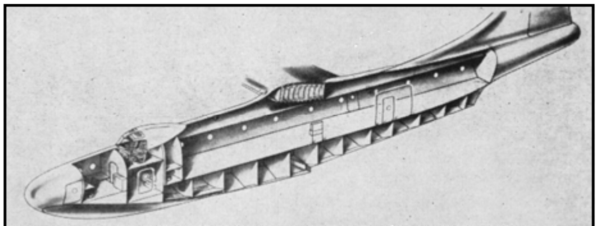
757

"It is always an unpopular business to pick favorites, but we think the new Convair flying boat has everything. It should have come as little surprise to anyone that the Navy has decided to call for production models of the airplane as a transport rather than as a combat plane airplane and the ten airplanes now under contract will be Convair R3Y-1's, instead of P5Y-1's. Actually, the airplane was carefully planned from the start with transportation operations as an alternate arrangement, although it had much to recommend it as a search airplane. Convair has recently revealed that the new version 'will carry a greater operational payload than any previous water-based aircraft,' which brings it smack up against the Martin JRM 'Mars' flying boat. This was assuredly not true of the XP5Y-1 or in a combat version of the airplane at a gross weight of 138,000 lbs. However, the navy now plans to load the sleek new flying boat up to better than 160,000 lbs. The big 'Carolina Mars' with Pratt & Whitney 'Wasp Major' engines had a gross weight of 175,00 lbs., giving it a useful load, at any rate, of 95,000 lbs., much better than its empty weight. The new R3Y will have a useful load of something on the order of 85,000 lbs., so when it comes to sheer lifting power we think venerable Glenn L. Martin still holds the medal…"

***Aero Digest*, November 1950**

Left: XP5Y-1 's on cover of *Air Trails*, April 1952

758



"…One of the innovations in the flying boat line displayed by the R3Y (among many others) is the use of a sealed deck. Flying boats have always been built like ships (which they are in many respects) in that the hull has been divided into a series of water-tight compartments extending vertically from keel to upper mold line. The idea was that a stove-in hull would result in the flooding of only one vertical compartment. Convair engineers used the water-tight idea alright but confined the compartments to that they are below the main-deck which, itself, was sealed along its buttock line with the hull skin plating. Water entering a stove-in hull can still be confined to one or two compartments, but these latter lie entirely below the deck, giving the airplane a long, clean area for cargo and passengers."

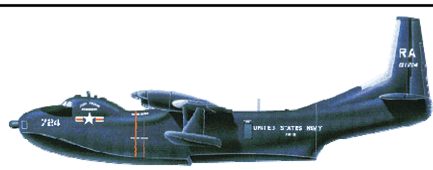
***Aero Digest,* November 1950**

Above: cut-away view of the R3Y hull compartmentalization below the main deck

759

The R3Y-1 first flew on February 25th 1954. Five of the -1's were built; the -1 retained most of the appealing lines of the XP5Y-1 and became the first operational Navy turboprop flying boat. The -2 version (six were built) had a bulbous nose containing a nose-loading door (above). It later became a four-point tanker before being scrapped. The *Allison T-40* engine, with its gear box and counter-rotating props, was a disaster. The engine was unreliable and was never fixed during its service life. *U.S. Navy* transport squadron VR-2 received first deliveries of the R3Y-1 "Tradewind" in March 1956.

760



Despite the loss of an XP5Y-1 in a non-fatal crash off San Diego on July 15th 1953, the first R3Y-1 "Tradewind" flew on February 25th 1954. Major changes included the deletion of all armament and of the tail-plane dihedral, the addition of a large port side cargo hatch (aft of the wing) and the provision of redesigned engine nacelles to accept the improved T40-A-10 engines. Cabin sound-proofing and air-conditioning were installed and pressurized accommodation was provided for up to 103 passengers or, in medevac configuration, for 72 stretcher cases and 12 attendants. Cargo payload was 24 tons. *U.S. Navy* transport squadron VR-2 received the first of its mixed fleet of R3Y-1 and R3Y-2 flying-boats on March 31st 1956, but financial considerations and continuing problems with the engine/propeller combination, culminating in two in-flight separations of propellers and gearbox from an engine led to a curtailment of Tradewind operations. Squadron strength was first cut to two R3Y-1's and two R3Y-2's and the unit was finally disbanded on April 16th 1958.

Above: USN R3Y-1 flying boat

761

Seaplanes on Skis

762

"After months of top-secret tests, the Navy has partially lifted the wraps on its XF2Y-1 Sea-Dart, world's first delta-wing seaplane, which uses retractable hydro-skis for take-off and landing. MI's cover shows what this sensational development may mean to commercial air travel of the future. Imagine a supersonic jetliner, too large to be handled efficiently at even our largest airports but perfectly capable of squatting at any of our innumerable seaports and being nuzzled to its dock by tugs! In addition to passenger con-venience and greater capacity is the extra safety factor in trans-oceanic hops."
Mechanix Illustrated, **November 1953**

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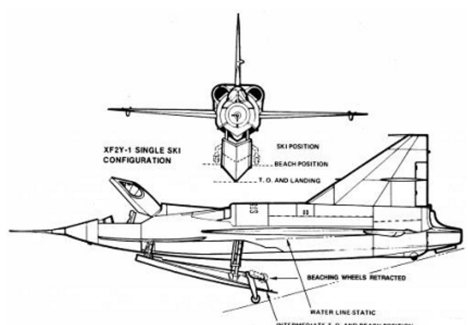
764

The *U.S. Navy* began experimenting with aircraft carriers shortly after the invention of heavier-than-air flight, but as aircraft became stronger and heavier, the Navy became increasingly concerned. They feared that landings and take-offs aboard an aircraft carrier would invite disaster. So in 1948 the Navy held a competition for a supersonic seaplane interceptor design. Convair won the competition with their "Sea Dart" design. This sleek, delta-winged fighter had two retractable water skis on the bottom, which would enable it to cruise along the surface of the water in essentially the same way that a water skier would. A special watertight hull and turbojet intakes mounted high above the wings would make the Sea Dart a fully sea-worthy aircraft that could take-off from the surface of the water. The Sea Dart was able to take-off and land successfully but wasn't able to do much else. It was unable to break the sound barrier with its under-powered engines and the skis created intense vibrations on take-off and landing. The Navy already had plenty of subsonic aircraft that could safely operate aboard an aircraft carrier, so a slow seaborne subsonic jet was considered unnecessary. The Navy cancelled a second prototype and went with a redesign, resulting in the *YF2Y-1 Sea Dart*. The Navy was hopeful with this second version, but the aircraft disintegrated during a low-level demonstration in 1954 which resulted in the death of the pilot. That was the final nail in the coffin of the Sea Dart. The Navy suspended the program and the whole project was eventually dissolved.

Left: caption: "The Sea-Dart ready for take-off. Wings and tail are triangular. Elevons take place of ailerons.
Center: caption: "Hydro skis, shown extended immediately after water take-off, retract when plane is in flight."
Right: caption: "Convair's new fighter needs no special beaching gear. It runs up on its skids and own power."

765



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Atomic Flying Boat

768

"The buckaroos of science are breaking the atom to harness at a fantastic rate. In just 15 short years, fission has grown from a super-secret equation whispered in a President's ear to a solidly established 14-billion dollar industry. The hectic stage of A-and H-bomb monopoly is fast giving way to a happier and less explosive phase of atomic development. Late last year Congress enacted the Atomic Energy Act of 1954; directing that the atom's neglected humanitarian potential be put to work 'to promote world peace, promote the general welfare and increase the standard of living.' Along with this, President Eisenhower launched his world 'Atoms-for-Peace' program to spur the exchange of knowledge and the rapid development of international atomic power projects of all kinds…The success of the submarine Nautilus and the navy's plans for atomic airplane carriers, etc., has sparked the imagination of the transportation industry. Steamship operators are toying with the idea of fission-propelled passenger liners and freighters. Atomic locomotives are on the drawing boards and even such unlikely notions as A-engines for trucks and cars have been seriously discussed. In most of these cases, the weight problem is not too critical. In the field of aviation, however, shield tonnage has been a grade-A headache. Early types of reactors were enclosed in a shell of solid lead or concrete to protect their operators from deadly radiation. This meant that only an elephantine aircraft could carry it aloft and even then its flight performance would be decidedly hampered…Within the past year, engineer-scientists have evolved shield designs which whittle down the weight to manageable proportions. The new, lighter shields differ from yesterday's monolithic types by being a composite of various materials, each selected for its efficiency in screening an individual fraction of atomic radiation. These 'plies' include comparatively thin, four-inch layers of lead, hydrogen-containing materials, etc., etc. Their exact composition and design is, of course, one of our most precious military secrets, but the shield's successful development is said to more than meet the target specification at which the researchers were shooting - a shielded reactor weighing no more than today's transport fuel loads. These represent about one-third of the average plane's gross take-off-weight for craft with reciprocating engines and around 45 per cent for jet jobs. This generally accepted fact inclines A-plane designers to favor the flying-boat type rather than a landplane model…"
***Mechanix Illustrated,* August 1955**

769

"…There are several good reasons for this. First of all, we have the little matter of landing wheels, now already nudging the economic weight limit. The boat hull, while structurally heavier than the landplane fuselage, is still a lot lighter, than the fuselage-plus-wheels. Also, the landplane normally ends its trip with its fuel tanks nearly empty. Its gear is therefore designed to take around a third less landing jolt - a considerable saving in tonnage. The A-transport, on the other hand, will expend only half a pound or so of nuclear material on even the longest flights and will land just as heavy as it took off. Consequently, its wheels would have to be at least one-third heftier than those of a fuel-burning sister of similar size and weight. It is obvious that the extra burden makes wheel gear impractical. There is also the problem of the extreme runway length required. We simply cannot afford to go on extending our runway and airport areas indefinitely. It has been estimated that the facilities offered by a hundred-million dollar land airport could be duplicated in a water base costing not more than a fifth as much - with no bad weather 'stack-up' of waiting planes or runway traffic tie ups. In addition to being cheaper and far safer, water bases are more convenient. Most major cities, both here and abroad, have ocean, river or lake frontages, complete with existing pier and harbor facilities. Instead of dumping passengers at distant airports and then forcing them to waste time and money on long bus or taxi trips to town, the flying-boat is warped into a city dock and passengers debarked practically in the center of town…"
***Mechanix Illustrated,* August 1955**

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"…These big, unlimited range flying-boats are naturals for high speed, civil transport. Hence, MI has chosen the flying-boat for its atomic passenger plane design. The wide hull and deep, blended-in wing roots, offer unparalleled interior space for comfortable seating, luxury lounges and room to move about. In the luxury design shown, 192 passengers are accommodated in wide reclining seats, facing rearward for maximum safety in rough water landings. When they weary of just sitting there are broad aisles to promenade, a salon in which to lounge and chat, a bar and grill catering to the inner man and a library/writing room for that last minute letter or executive conference. Liberal space is provided for lavatories, galley, stores and rest rooms for the off-duty crew. At the rear of the passenger cabins, emergency exits unfold to form boat launching platforms. The exit corridors are flanked by stowage space for life preservers, outsize rubber rafts, etc…"
***Mechanix Illustrated,* August 1955**

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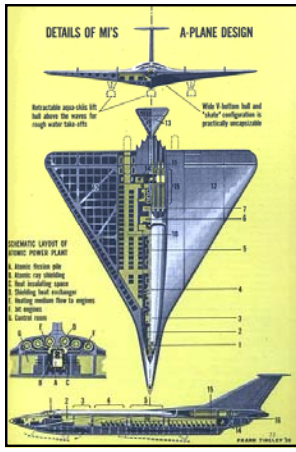

"…The atomic power plant is situated on the ship's center line, back in the extreme tail section. It follows the latest trend in aircraft A-design in which nuclear heat simply replaces the conventional fuel burners in jet engine combustion chambers. To keep the center of gravity low, the reactor is placed just above the keel, as far as possible from the plane's passenger areas. In operation, molten metal is circulated through the super-hot atomic pile and then pumped into a heat exchanger mounted atop the reactor. The two form a unit, enveloped by a single, composite type shield to enclose dangerous radiation. Surrounding the exchanger shielding is a manifold in which non-radioactive water picks up the heat, transmitting it to the engine combustion chambers through insulated, high-pressure pipes. The jets - six of them - function in the usual way, drawing in air, compressing it and forcing it into the combustion chamber. Here it is expanded by nuclear heat, turns the engine-operating turbines and is expelled through the tailpipes in a propulsive blast. The water - or other heat transmitting medium - is then returned to the exchanger in a continuous, closed-circulation system. In addition to the jets, a liquid fuel rocket engine may be mounted in the tail for emergency or booster power…"
***Mechanix Illustrated,* August 1955**

Left: caption: "1. Bridge; 2. Crew; 3. Library; 4. Lounge; 5. Bar-grill; 6. Galley; 7. Stores; 8. Lavatories; 9. Passage; 10. Main cabins; 11. Emergency exits; 12. Multi-cell wing; 13. Stabilizer; 14. Atomic-pile/control station; 15. Six atomic jet engines; 16. Auxiliary liquid rocket engine

772

"…These giant boats, capable of almost unlimited flight and able to take off or land in the open sea under the severest weather conditions, offer trans-oceanic travelers a degree of speed, comfort and security now unattainable. Equally efficient over land routes - their rugged keel structures are better able to sustain 'belly landing' than any landplane fuselage - they promise eventually to take over all long distance runs. You'll be riding in them within ten years. Atomic planes are closer than you think!"
***Mechanix Illustrated,* Aug. 1955**

773

Birth of an Amphibian

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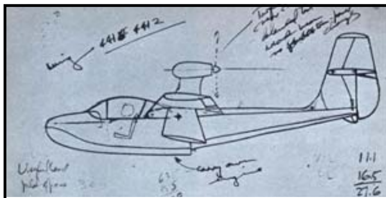
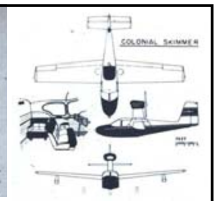




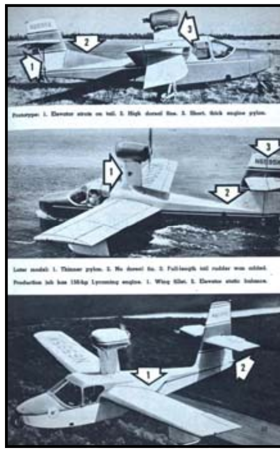
"It takes more than a pair of wings to get a plane off the ground and the new Colonial Skimmer Amphibian is a perfect example of the complications that plague designers from the initial plans until the ship takes to the air. Back in 1945 David Thurston, a young aeronautical engineer, put down on paper his idea for a small, two-place amphibian. The first step was to design a ship capable of operation from both land and water yet have the plans conform to CAA regulations. It also had to have pleasing lines, be safe and give good performance. Cost had to be kept to a minimum, maintenance easy and operation simple. Once flight tests began a myriad of changes had to be made in hull design, engine placement and a host of other infinite details. After nearly 11 years of work, the Skimmer was ready for production. The 1,400-lb. amphibian has a wingspan of 34 ft., a length of 24 ft., and a top speed of 127 mph. It will cost $15,750 with standard equipment. Ten planes are planned for 1956 in the company's new plant at Deer Park Airport in Long Island, N.Y."

***Mechanix Illustrated*, November 1956**

<u>Left</u>: caption: "Thurston's first doodle of plans in 1945 look amazingly like final production model"

<u>Right</u>: caption: "Initial plans of the skimmer underwent plenty of changes before its completion"

775



Designed by *David Thurston*, the prototype *C-1 Skimmer* was built in the mid-1940s and first flew in July 1948. At the time, Thurston was employed by *Grumman* and several aviation specialists were enlisted to help build the prototype "Lake Amphibian." Thurston formed the *Colonial Aircraft Corporation* with the intention of producing the aircraft, but the *Korean War* interrupted the flight testing, A type certificate was finally issued and production started in 1956. They were well-built and fun to fly, but slow due to insufficient engine horsepower and lacking in useful load.

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The Albatross

778

First flown in 1947, 305 *Grumman SA-16A* "Albatross" amphibious flying boats were built in the next few years. An improved version of the Albatross was developed in 1955 and about 240 "A" versions were converted to the "B" configuration. The first production "B" configuration was delivered in January 1957. This version of the Albatross had a longer wing (96-feet, 8-inches) and larger tail surfaces and was re-designated as the "HU-16B" in 1962. The HU-16B *Air Force Air Rescue Service* Albatross (above) was active during the *Vietnam War*. They flew over the *Gulf of Tonkin*, operating out of *Da Nang*. The A.R.S. aircraft were piloted by PAA pilots who were members of the USAF Reserve.

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<u>Above</u>: *Grumman HU-16B Albatross* in the *Air Force Museum*

<u>Left</u>: a *Coast Guard* HU-16B air-sea rescue plane making a water landing

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SSF

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In its last major aircraft design, *Martin* returned to an earlier concept of the flying boat as a bomber. By the end of the 1940's, the *Soviet Union* had tested a nuclear bomb and the *Cold War* was in full swing. The newly created *Air Force* was busy buying and deploying long-range bombers to deliver nuclear weapons, a monopoly viewed by the *U.S. Navy* as unacceptable. Noting the inherent limitations of its force of short-range carrier attack and maritime patrol aircraft, the Navy looked at several means of joining the Air Force as a strategic deterrent. A super-carrier (the *United States*) was designed to handle larger propeller and jet aircraft then under design. The United States ran afoul of military budget limitations and vehement opposition from the Air Force "bomber lobby." The *Navy Bureau of Aeronautics* then developed the concept of a "Seaplane Striking Force" (SSF) centered around the development of large jet-powered seaplanes that could offer performance equal to that of land-based jets. Capable of operating from most of the earth's surface, a small number of these seaplanes could perform mining, conventional and/or nuclear strike and photo reconnaissance missions that would complement those of the new *Strategic Air Command* (SAC). With only a tender or submarine needed for re-arming and re-fueling, the SSF promised an economical means of force projection. Requests to industry were let in April 1951. After a short but fierce design competition with *Convair*, Martin was awarded contracts for two prototype XP6M-1's, six pre-production service-test YP6M-1's, and up to twenty-four production P6M-2's. Martin named the SSF aircraft the "SeaMaster." The Navy was now in the long-range strategic bomber business.

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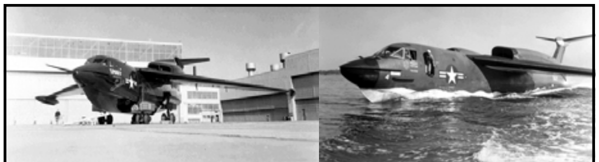

Design specifications for the *SeaMaster* were demanding. Required to carry 30K pounds of payload to a target 1,500 miles away, the plane was also required to be capable of a high-speed dash at 0.9 Mach at low altitude and its hull had to be stressed for open-ocean operations. Refining work already done on the hull design, a new length-to-beam ratio of 15 to 1 was adopted as most efficient in both air and water. The XP5M-1 airframe was rebuilt to test the new hull, re-designated "Martin Model 270." Hydroflaps, like those on the *Martin Marlin,* were fitted for dual use as air brakes. A compound turbo/ramjet from *Curtiss-Wright* was initially designated as the SeaMaster's power plant. After several failures in testing, this engine was dropped in favor of modified Allison J71's, mounted in tandem "overwing" nacelles. The P6M had a variable-incidence "flying T-tail" and spoiler ailerons. Its payload was carried in a rotating bomb-bay, pneumatically sealed to be watertight. Swept wings with slight anhedral drooped close enough to the water for wingtip tanks to serve as stabilizing floats, without the drag of struts. The overall result was an airplane with sleek and simple proportions.

Left: prototype XP6M-1
Right: production *YP6M-1 SeaMaster* on the water

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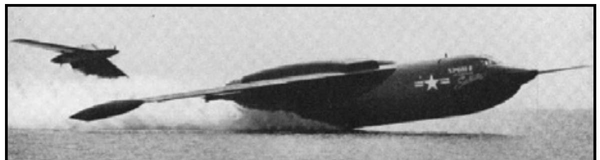

The first prototype was rolled out in secrecy on December 21st 1954 and, after several months of load-verification tests, the XP6M-1 finally took to the air on July 14th 1955. After keeping the plane's development secret, the Navy invited the press for the roll-out in November of the second prototype, which was outfitted with a complete set of navigation and bombing equipment. All went well with the testing program until December 7th 1955 (two days after the death of *Glenn L. Martin*), when the first XP6M-1 prototype crashed into the *Chesapeake Bay* during a routine check ride for the first Navy pilot. All four members of the crew were lost. Without onboard data recorders to help, the accident-investigation team was unable to find a specific fault. Months were lost re-configuring the second prototype with test instrumentation and ejection seats for all the crew. It was not until May 1956 that flight testing resumed with Ship No. 2. A test flight on November 9th 1956 verified that improvement in an airframe vibration problem. However, in recovering from a shallow dive at high speed, the test pilot lost pitch control of the aircraft which started a violent outside loop. The crew ejected safely as the airframe broke up. Information from the flight data recorders indicated that the modified tail configuration had been overpowered by dynamic forces at high speed.

Above: XP6M-1 during flight testing

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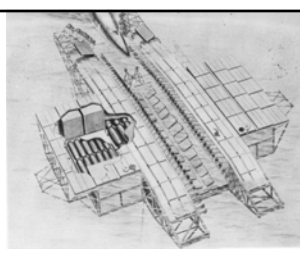

Even at this low point in the program, the Navy *Bureau of Aeronautics* still saw promise in the concept and optimistically continued funding for the SeaMaster and a number of expensive "options." A beaching cradle (above) was designed that allowed SeaMasters to taxi in and out of the water on their own power. Two old amphibious-warfare dock ships and two conventional seaplane tenders began shipyard conversions as support ships for the SSF. The submarine *U.S.S. Guavina* was equipped to refuel SeaMasters at secret seadromes. There were also plans to use an old escort carrier equipped with a retractable rear ramp for "beaching" P6M's, which were too heavy to be hoisted aboard by cranes. Finally, an auxiliary naval air station near *Elizabeth City, NC* was refurbished to serve as the SeaMasters' home base.

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A year after the second crash, the first YP6M-1 was rolled out and flight testing resumed in January 1958. Five other YP's joined the program during 1958 and tests were carried out at a feverish pace. Early in 1959 production P6M-2's began to emerge from the Martin plant and the full potential of the design was realized. Installation of newly developed *Pratt & Whitney J75* engines gave the P6M-2's nearly 12K more pounds of static thrust. This allowed the gross weight to be increased to 195K pounds from 171K pounds in the YP's. Increased weight meant a greater draft for the hull, which in turn necessitated raising the wing anhedral to zero degrees. Pilots reported that the planes handled well and were capable of flying Mach 0.89 "on the deck." This was important, as the development of radar-guided surface-to-air missiles had made low-level flying an essential part of strategic penetration missions. By the summer of 1959, all-Navy crews had begun flying the three P6M-2's completed to date and it appeared that operations could begin by early 1960. However, rising costs had led to two cutbacks, reducing the number of production items to eighteen, then eight. Then the bottom dropped out altogether. Citing "unforeseen technical difficulties," the Navy cancelled the entire program on August 21st 1960.

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The decision was highly controversial. More than $400 million had been spent on equipping the SSF, but during its long gestation period newer technologies had emerged. The development of the *Polaris* ballistic missile and submarine had finally given the Navy its strategic deterrent. Further, the atomic powered carrier *Enterprise* was going into service with long range nuclear capable strike aircraft. Martin engineers and executives tried to generate interest in an eight-jet transport version of the P6M dubbed the "SeaMistress," a huge nuclear-powered flying boat and a supersonic seaplane somewhat resembling the Air Force's *Canberra*, but there were no takers. Martin Chairman *George Bunker* announced that the company was now in the missile and electronics business. Fifty years of innovative aircraft design and production by the *Martin Company* was at an end. 787

Beriev

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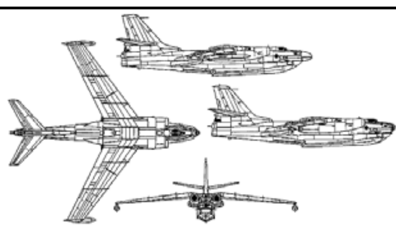
At the end of WWII, design work began on a request from the Soviet Navy for a jet-powered flying boat. Starting with the wing design of the Be-6, Beriev began in-house design work in May 1947, even before the official specifications were issued in June 1948. The specifications called for a radar-equipped aircraft with a three-man crew, capable of a speed of 800 kph and a range of 2000-2500 kilometers. The aircraft was to be armed with 2K kg of bombs and four 20mm cannons. The first prototype was completed in November 1951. However, the prototype experienced severe vibrations and hydrodynamic instability at 165 km/hr and was nearly destroyed in testing. After much modification, flight testing began at the end of 1951. The prototype crash landed on October 3rd 1953 and was once again repaired. Extensive testing continued to 1956, however, the development of land-based long-range reconnaissance aircraft put the project in jeopardy. After another crash in February 1956, the R-1 was never repaired and subsequently scrapped. The "R" designation is believed to have stood for *Reaktivnyy* (jet-propelled). Experience gained during the test program with the R-1 was used in the development of the *Beriev Be-10*. 789

On August 7th 1961, the *Beriev M-10* (a.k.a. the Be-10 and codenamed "Mallow" by the West) reached 567 mph. The record-setting craft was designed in the *Soviet Union* by *Georgii Michailovich Beriev* and built by his design bureau. The Be-10 was first unveiled to the public at the *Soviet Aviation Day* in 1961 and the aircraft soon captured no fewer than twelve world class records for seaplanes. Most of the records set by the M-10 still stand to the present day. Beriev had become the Soviet Union's primary manufacturer of flying boats during the 1930's and most of its designs were generally similar to those developed by other nations around the world. However, the Be-10 was a significant departure because it was one of the first seaplanes to be powered by turbojet engines. The aircraft also built on early experience designing jet aircraft and incorporated swept wings, swept tail surfaces, wing fences and other streamlined characteristics to improve high-speed performance. The Be-10 airframe was built entirely of metal, and its high-mounted swept wings with large anhedral featured stabilizing floats at each tip. Two *Lyul'ka AL-7PB* turbojet engines mounted near the wing root powered the aircraft. Carrying a crew of four or five, the Be-10 (above) was designed for long-range maritime reconnaissance and anti-submarine patrols while carrying up to 4,400 lbs. of weapons. 790



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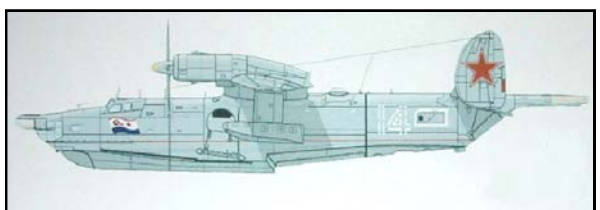

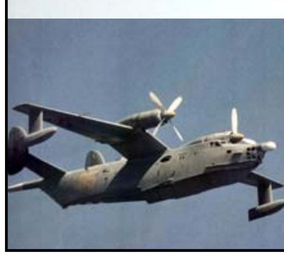

The Be-10 is still considered the only jet-powered flying boat to ever achieve production status. However, despite its revolutionary design and many records, the type saw only limited production. The Soviets instead favored the Be-12 that used much the same fuselage as the Be-10 mated to a more conventional wing and tail unit. Furthermore, the Be-12 "Chaika" (above & left) was equipped with turboprop engines to provide much better efficiency than the fuel-hungry turbojets of the Be-10. This change in power plant gave the Be-12 much better endurance for its maritime patrol duties. 792



<u>Above & Left</u>: the Beriev A-42 "Albatross" is one of the largest seaplanes ever built. Two large turbofan engines provide a tremendous amount of power, particularly noticeable during take-off runs. The A-42 is capable of fire-fighting and there's plenty of room inside for passengers and cargo, the refuelling probe on its nose betrays its main purpose as a maritime patrol and ASW aircraft.

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<u>Above & Left</u>: the Be-200 is a more recent design than the A-42 and is intended to give Beriev a foothold in the civil market. As well as acting as a water bomber for firefighting, it's also being marketed for cargo transport and as a passenger aircraft, especially for maritime countries or other markets which lack regulation airports and other infrastructure, but have suitable aquatic landing areas.

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At $25 million an aircraft, the Be-200 costs the same amount as its main competitor, the turbo-prop powered *Bombardier CL-415* (above & Left). Both the Beriev and the Bombardier have an advantage over land-based water bombers by being able to refill on any convenient lake while still moving, but the Be-200 can carry twice as much water as the CL-415 and its higher speed potentially makes it capable of dropping water more often.

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<u>Above</u>: the *Beriev Be-200* at top and the *Beriev A-42* below

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<u>Above & Left</u>: the Be-103 is another Beriev creation. Like its big brother Be-200 (taking off behind the Be-130 in the photo at left), the Be-103 is an attempt to capture part of the civil market. Beriev pitches the Be-103, which in English is called the "Snipe," as a six-seat private or commercial transport or as an air ambulance. The Be-103 received FAA certification in 2003.

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No Horizon So Far

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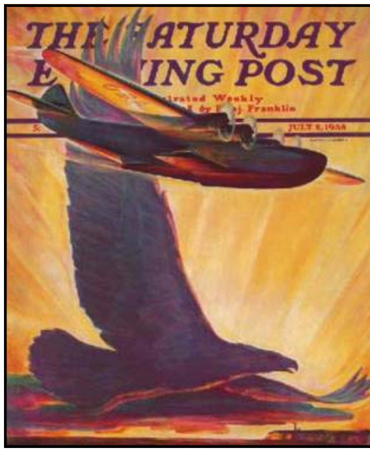

"…We fly, but we have not 'conquered' the air. Nature presides in all her dignity, permitting us the study and the use of such of her forces as we may understand. It is when we presume to intimacy, having been granted only tolerance, that the harsh stick falls across our impudent knuckles and we rub the pain, staring upward, startled by our ignorance... One day the stars will be as familiar to each man as the landmarks, the curves, and the hills on the road that leads to his door, and one day this will be an airborne life. But by then men will have forgotten how to fly; they will be passengers on machines whose conductors are carefully promoted to a familiarity with labeled buttons, and in whose minds knowledge of the sky and the wind and the way of weather will be extraneous as passing fiction…I learned what every dream-ing child needs to know - that no horizon is so far that you cannot get above it or beyond it…"

Beryl Markham, **Aviator**

RE: excerpt from her 1942 memoir entitled: "West with the Night."

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