Isaac M. Laddon (1894–1976) and the PBY Catalina
by Rit Staalman

Introduction

The history of long distance flight is also the story of the evolution of the big flying boats between the two World Wars. The designers of these ships had to find the perfect shape, matched with perfect construction and efficient propulsion. After an initial lead by the Germans, American engineers took over in the 1930’s. Company names that come to mind are Curtiss and the Naval Aircraft Factory, Sikorsky, Consolidated, Glenn Martin and Boeing. Leading designers were Grover Loening, Holden C. Richardson, Igor Sikorsky, Michael Gluhareff, Isaac Machlin Laddon, Ken Ebel and Wellwood Beall. This article follows the initial creative career of Isaac ‘Mac’ Laddon of the Consolidated Aircraft Corporation, culminating in the design of his perfect long distance flying boat: the PBY Catalina.

Education and initial work

Isaac M. Laddon was born on Christmas Day, 1894 in Garfield, New Jersey. He moved to Canada with his family and studied at McGill University in Montreal, graduating in structural engineering in 1915. His first job was with the experimental engineering department of an automobile manufacturer, the Cadillac Corporation.1

In Europe the First World War was unfolding and, although not directly involved yet, the U.S.A. was preparing its army and navy. The Air Force as such was not a separate service entity; it existed in preliminary form as the Aviation Section of the Signal Corps of the U.S. Army. At the request of the Equipment Division of the U.S. Signal Corp, which leaned heavily on the automobile industry, Laddon moved to Washington to do experimental work on airplanes, the group of engineers in Washington having been recruited from all over the States. He went to work in a barn-like hangar called “the Greenhouse”, located in the Smithsonian Institution, under the supervision of a man who

1) Read the full remarkable story of the Liberty engine: http://en.wikipedia.org/wiki/Liberty_engine

“... As the United States prepared for World War I, the Cadillac division of General Motors was asked to produce the new Liberty aircraft engine, but William C. Durant was a pacifist who did not want General Motors or Cadillac facilities to be used for producing war material. This led to Henry Leland leaving Cadillac to form the Lincoln Motor Company to make Liberty engines. He quickly gained a $10,000,000 government contract to build 6,000 engines. Subsequently the order was increased to 9,000 units, with the option to produce 8,000 more if the government needed them. Lincoln had delivered 6,500 of the 400 hp, V-12, overhead camshaft engines when production ceased in January 1919. Durant later changed his mind and both Cadillac and Buick produced the engines....” [photo below: Wiki]

Major “Hap” Arnold with the first V-12 Liberty engine 1917?
would become even more famous than he himself: Donald Douglas. “…The automotive field had suddenly become tremendously useful. The whole field of aerodynamics was to be explored. It was the vastness of this opportunity that appealed so strongly to Laddon: the chance to start putting down scientific knowledge where heretofore there had been only a blank…”² It was at this place that he first saw airplanes at close range for the first time – a DeHavilland DH-4 and a Bristol fighter, for which he had to design a radiator.³ In 1917, when the U.S.A. declared war, Laddon transferred with the Air Service to their Airplane Engineering Department at McCook Field, Dayton, Ohio.

An enormous effort got under way to equip the fledging air force with sufficient people, airplanes, engines and armament as well as a supporting organization. As ‘Mac’ Laddon belonged to that rare class of American engineers who spoke French, he was assigned to Detroit, to work with the French Air Mission as an Aeronautical Engineer under Captain George LePère, developing the LePère C-11, O-11 and GH-1 airplanes. The C-11 was later called the LePère USAC-11 or LUSAC-11 and, if I am not mistaken, the wing struts and wheel supports definitely bear the mark of some thorough structural engineering. 4500 of these fighters would have been built for the American campaign in France by the Packard Motor Company if the war had not ended in 1918. Although the French in France did not really like the LUSAC-11, it was an interesting airplane with which two altitude records around 30,000 ft were set thanks to a supercharger developed at McCook, albeit not without a blackout of one of the pilots for a lack of oxygen (the supercharger serving the engine).

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²) Tom M. Girdler, “Bootstraps”, 1943
³) Dorothy Fleet: “Our Flight To Destiny”; 1964, Vantage Press, NY
The Engineering Division, Bureau of Aircraft Production
A division of the U.S. War Department, created in 1918. Responsible for U.S developments of de Havilland designs of which a large number (14,000?) were ordered, although not delivered. The Division also experimented with types of original design. In 1920 it completed its most remarkable product, the GAX (GA-1) very large heavily armored pusher triplane (one 37mm cannon and eight Lewis guns).

The Bureau was later called Engineering Division, Air Service; subsequently Material Division Air Corps (1926). Moved from McCook Field to Wright Field October 1927.

[source: http://all-aero.com/index]

After the war, ‘Mac’ Laddon returned to McCook Field as Chief of Design, Branch No. 2, developing bombardment and larger aircraft. One of his creations was the large two-engine triplane bomber GA-1 (see box). Several of these giant ground attack machines were built, although the oversized armor (1000 kg) and armament really made them too heavy to fly combat missions effectively. (In this respect they differed markedly from the R-class bombers which the Germans had developed during World War I.) The Boeing Corporation produced ten of the GA-1. They were assigned to the 3rd Attack Group at Kelly Field, Texas.

Wikipedia states: “... It was rumored that the GA-1’s survived until January 1926, so that Kelly Field pilots could be threatened with being forced to fly them for disciplinary infractions. All were scrapped in April 1926…” [http://en.wikipedia.org/wiki/Boeing_GA-1]
Experiments in Corps Observation, 1922-1924

Mac Laddon deserves the honor of designing the first all-metal monoplane constructed in the U.S., the CO-1. Two prototypes were built by the Army; thereafter the Gallaudet Company in Connecticut built a third one. Apparently it had corrugated dural skin, possibly inspired by the German Junkers machines. (After the First World War, the Army had imported a number of German aircraft from Junkers and Dornier as objects for detailed scrutiny. The airplanes of the defeated enemy were test flown and taken apart at McCook airfield.)

[photographs and following text by Ray Wagner, http://www.americancombatplanes.com/co1]
“...For the top Army leadership, the most important role of aviation was still that of the observation squadrons. Improvements in speed or firepower were secondary to the ability to respond to needs of the ground units. A prototype development program of two-seat Corps Observation (CO) aircraft, aimed at missions up to 12 miles behind the enemy lines, explored the technical means of serving artillery and infantry forces. All of these prototypes were Liberty-powered biplanes, except the first, the CO-I. Designed by I. M. Laddon, of the Engineering Division. The CO-I was the Army’s first all-metal, high-wing monoplane. Two prototypes of the CO-I were built at McCook Field, one for static test, and the other first flown on July 26, 1922. Two crewmen were carried along with 287 pounds of observation equipment and 300 pounds of defensive armament; two fixed Browning and two flexible Lewis guns.

On June 22, 1922, the Gallaudet Aircraft Corporation received a contract to develop a production version. This firm had proved itself in metal construction with its low-wing, all-metal DB-I bomber. Their version of the CO-I, improved with balanced ailerons and strengthened landing gear, first flew June 20, 1923, but only one example was built. The wing arrangement was considered bad for the observer’s vision. A projected improved model, replacing the corrugated dural skin with fabric-covering, was dropped...” (The fact that the metal skin could be replaced with fabric implied that it apparently did not contribute to the strength of the wing. This serves to illustrate that ‘all-metal’ construction is not synonymous with ‘stressed skin’ construction.)

Work for the Navy
In September 1924, the Naval Aircraft Factory in Philadelphia was tasked with designing a long-range twin-engine flying boat, capable of flying the 2,400 mi (3,860 km) between San Francisco and Hawaii. The initial design was carried out by Isaac Laddon\(^5\) together with Navy Captain Holden C. “Dick” Richardson and then passed to the Boeing Corporation for detailed design and construction. [Wiki]

Wiki writes about pioneer pilot/naval constructor Richardson:

Holden Richardson learned to fly from Glenn Curtiss in 1913 and was designated Naval Aviator No. 13. He was the Navy’s first engineering test pilot and helped develop the first Navy-built seaplane, pontoons and hulls that overcame water suction, and a catapult to launch aircraft.

On October 4, 1918, Richardson performed the crucial test flight of the NC-1 flying boat from Jamaica Bay. He then took the plane, with a full crew, for a shakedown flight to the Washington Navy Yard for inspection by Navy leadership. Four days later, the Armistice ended World War I and the military’s need for flying boats abruptly ended.

While Chief Engineer of the Naval Aircraft Factory, Richardson developed a rotatable catapult enabling aircraft to operate from capital ships. In 1925 he led efforts to develop carrier aircraft and patrol planes. He was the first secretary of the National Advisory Committee for Aeronautics (NACA, later NASA).

Especially the design of the flying boat hull would have been a formidable challenge to Laddon had he not had the assistance of Navy expert Richardson. “... Richardson exemplified a new breed of naval constructor, dedicated to aeronautical engineering. Born in Shamokin in 1878, in the hard-coal region of Pennsylvania, Richardson graduated from the Naval Academy in 1901 and received his

4) When tested, this particular single engine airplane (a design by Gallaudet) proved too heavy to fly.
5) Laddon was moonlighting, according to Roscoe Creed in “PBY The Catalina Flying Boat”; Naval Institute Press, Annapolis, 1985
master's degrees in *aeronautics* from MIT ...”6 He had studied the latest advances in German all-metal construction, had used duralumin himself for airplane floats and cooperated with Glenn Curtiss on the famous NC-1 type flying boat that traversed the Atlantic Ocean in 1919.

![Boeing/Laddon Model 50 flying boat.](image)

Looking at his creation as it floated in Philadelphia waters, *Laddon* felt of two minds. The hull was a true work of art, but the superstructure somehow resembled a messy railway bridge. Still, it held, it was strong; it withstood the bending forces of the airstream and the pull of the engines. The engines were ugly. There must be a better solution...

The Boeing Model 50 flying boat, built in 1925, six years after the NC-1, was a two-bay biplane with a beautifully streamlined hull design 7. The wings were of metal construction, with wooden wingtips and leading edges. The fuselage had a metal lower part, with the upper half made of laminated wooden frames with a wood veneer covering. Two 800 hp (600 kW) Packard 2A-2500 V12 engines, driving four-bladed propellers, were mounted in tandem between the wings above the fuselage. [Wiki]


7) It was intended to be used to lead a pair of Naval Aircraft Factory PN-9s flying boats in an attempt to fly to Hawaii on 31 August 1925. Engine trouble led to its participation in the flight being cancelled. [Wiki]
From 1923-1927 Isaac M. Laddon was granted patents on airplane wheels, brakes and aerodynamic and structural developments. In 1927 he said farewell to the Army to join the Consolidated Aircraft Company.

**Consolidated Aircraft**

The founder and principal stockholder of Consolidated Aircraft Corporation was *Reuben Hollis Fleet*. Reuben was born in Montesano, Washington in 1887.8 His early exploits give the impression of an active and self-assured, athletic young man. He attended Culver Military Academy. By the age of 20 he had established his own real estate firm. He made profits by buying tracts of land and selling them off in parcels for timber or railroad use. It wasn’t long before he got involved in politics and was elected to the Washington State Legislature. He enlisted with the Washington National Guard as a Captain. In that capacity he had to quell a disturbance caused by a militant labor organization called the ‘Industrial Workers of the World’. He apparently had little sympathy for this movement, which was active among the forest workers in the state. For two months the organizers were subsequently pursued south along the West Coast as far as San Diego. Captain Fleet was very impressed with this city and vowed to return.

In 1917, as the USA entered World War I, he closed his office and enlisted with the *Aviation Section of the Signal Corps* at San Diego with the rank of Major. He graduated as Junior Military Aviator No.74. After a short episode of being stationed overseas at Gosport, UK, he returned to the USA to become Executive Officer for the Flying Training Program, involving the management of pilot training at 34 Army airfields. During his tenure, as well as during his own training, he learned to distrust the flying equipment used for pilot instruction. Particularly for the novice, the Curtiss

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8) based on Wiki and Dorothy Fleet: “Our Flight To Destiny”; 1964, Vantage Press, New York
“Jenny”\textsuperscript{9} was tricky to fly. After some lethal accidents, he vowed to produce a safer training airplane himself at some time in the future.

For a short time, he was involved in the ill-fated Government initiative to let the Army Service Corps fly the US Air Mail. In 1918, he became contracting officer of the Engineering Division based at McCook Field. In this function he was involved with the development of the supercharger, the Loening PW-2A (the first American pursuit monoplane) and the de Bothezat helicopter. In his work he could not avoid meeting Isaac Mac Laddon, senior engineer at McCook. There was, at their first meeting, no love lost between the two men. Laddon thought of the major as a gabby windbag, while Fleet thought the engineer to be a dogmatic, egotistical punk and smart-Alec.\textsuperscript{10}

When the Armistice was signed in Europe in 1918, the whole funding for military aircraft collapsed and the huge production orders still in the works were cancelled. Large and small factories suddenly found themselves with large investments and cut-off income. The Gallaudet Co. had few orders left and found itself with $3,000,000 debt. The Dayton-Wright company was also in dire straits and its parent company, General Motors, wanted to close it.

Major Fleet bided his time, waiting until 1922 before taking his leave from the military. He added $10,000 of his own to $25,000 from his sister to start Consolidated Aircraft Corporation, leasing factory space in East Greenwich from Gallaudet. When that company closed up shop, Fleet took over the inventory and the few orders that were still on the books. Somehow he also managed the same deal with the Dayton-Wright company. Consolidated ended up with equipment, skilled personnel, interesting prototypes for trainers and some orders that were still being processed. Among the staff he acquired was a rather famous chief engineer: Colonel Virginius E. Clark, well-known for his popular and widely used ‘Clark-Y’ wing section (and later to be known for Duramold, the process that turns wood into a durable material for building airplanes).

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9) The ‘Jenny’ was to be found everywhere in the armed services. During the war nearly 7000 were built.
10) At first, Reuben Fleet called Laddon a dogmatic ‘egotistical’ punk. [Tom M. Girdler, “Bootstraps”, 1943].

His own success Reuben attributed to a Divine intervention which had its beginnings in an idea, in a creative thought, which had been conceived, not by Reuben Fleet, but by an Infinite Power. His conviction of this was responsible for his own freedom from doubt, for his continuing certainty that the course he had chosen, the decisions he had made, were inalterably correct. [Comment by Dorothy Mitchell Fleet, his wife from 1931-1944.]
The formidable task that was facing Fleet was exactly the challenge that he had been waiting for all his life. He knew better than anyone else what the Air Corps needed in the way of training equipment. He launched his so-called PT line of trainer airplanes, based on inherited designs from Dayton-Wright and started to apply his sales skill to well-known Army territory. He managed to get more and more orders, also from the Navy. Soon he had to move from Rhode Island to larger factory facilities, which he found at the former Curtiss-Wright plant in Buffalo, NY, the very place where the Jenny’s had been built.

The new company not only occupied itself with the construction of a series of highly appreciated bi-plane trainers for the Army and Navy, but soon also got involved in designing and building aircraft for civilian use. It was the time of a major re-think in aircraft design. Planes were built with new materials and construction ideas. Light-weight, well-cowled radial engine made their appearance on the market at the right moment to enable designers to find the definitive streamlined shape for their single- and multi-engine airplanes.

The high wing monoplane Model 17 Fleetster, which dated from 1927, proved to be a 'state of the art' product. This single-engine, fully cantilevered monoplane resembled in more than one way the Lockheed (Northrop) Vega, except for the fact that the fuselage was of stressed-skin metal construction. It fitted well into the time period when all major manufacturers were producing small high performance single-engine airliners for feeder and airmail routes. In 1930, the Fleetster design was modernized for the Navy and equipped with metal wings which had integral fuel tanks in the leading edge (See picture above).

In 1923, at the start of Consolidated, one of the orders still outstanding at Gallaudet had been Laddon’s all-metal creation, the CO-1. It had caused a confrontation. Fleet had dared to make some modifications to the design and Laddon had come to inspect them. To Fleet’s surprise, the changes were accepted, even called improvements in Laddon’s report. The renewed acquaintance marked a change in mutual respect between the two men. Now, four years later in 1927, having a soundly established commercial base, Fleet decided to branch out into larger aircraft and to bid for the construction of large patrol flying boats for the US Navy. Of course his thoughts went to the remarkable engineer he had dealt with at McCook and who had recently designed a patrol boat for the Navy. He did not wait long to make a job offer to Isaac ‘Mac’ Laddon. Laddon, who had felt at a dead end in his career as a civilian in the Army, did not hesitate to accept it.
The first project Laddon got to tackle at Consolidated was a structural check of the *Sikorsky Gladiator* bomber, the S-37.

Quoting Roscoe Creed: “... When the army announced a design competition for a heavy night bomber in early 1927, Fleet set Laddon and his heavy aircraft engineers to work on Consolidated Model 11. Shortly afterwards Fleet was approached by Igor Sikorsky who, up to that point, had been a competitor. He explained to Fleet that the Sikorsky Company, housed in an old hangar at Roosevelt Field, Long Island, NY, could build only the prototype of the design they proposed for the Army. If his firm and Fleet’s could team up and win the competition, he would turn over future production orders for the plane to Consolidated. The two reached an agreement whereby Sikorsky would design and produce the prototype; Consolidated would furnish engines and instruments and would be responsible for armament installations and stress analysis. ...”

“...The S-37 was a boxy, open cockpit sesquiplane design with a 100 ft. wingspan. Its most outstanding features were elongated nacelles behind twin Pratt & Whitney 525 hp Hornet air-cooled engines. These nacelles contained the fuel tanks. Showing extreme faith in their product, Igor, six of his men, and Mac Laddon climbed aboard the Guardian for its first flight. After a stop to reverse the
rudder cables—Sikorsky’s mechanics had hooked them up Russian-style - the Guardian took off. According to Laddon, the flight was successful, but the plane was extremely slow. Other problems showed up in stress analysis. The Guardian was the first plane to use large aluminum tubes as structural members. Consolidated engineers found some were twice as strong as necessary, while others were only half as strong as army specifications called for. The airplane finished third among four competing designs and was not produced…”¹¹

Patrol Boats

In 1927, the Navy sent out a call for bids on a monoplane flying boat, all metal, except for fabric-covered wings, with radial engines, a 100 ft. wingspan, a 110 mph cruising speed, a range of 2,000 miles and starting weight of 13,764 lbs.

The specs for this flying boat were remarkable in that they asked for a metal monoplane configuration. This implied a metal supporting structure completely contained inside the wing itself, a design practice followed notably in Germany, but so far only by a few, like Stout and his Ford Trimotor, in the U.S.A.

Consolidated/Laddon XPY-1 Admiral 1929

Creed writes: “…Even though Consolidated had never bid on a flying boat, it had the advantage of the experience of its heavy aircraft design chief, Mac Laddon. Armed with specifications supplied by the Navy’s Bureau of Aeronautics [and the cooperation of Captain Dick Richardson], Laddon and a 30-man team set to work on Consolidated’s first flying boat design proposal. It was good work. The corporation was awarded a $150,000 contract for the detailed design of a prototype. The design was ready in February 1928. The Navy designation for the plane was XPY-1. Rubin Fleet called the boat “The Admiral…”

“…Construction of the prototype commenced in March and Consolidated people soon found the project fraught with “learning opportunities.” Many of the problems they solved arose from the sheer size of the plane, the largest they had worked on. Although the original specifications called for a

¹¹ This portion of my story leans heavily on: Roscoe Creed, “PBY The Catalina Flying Boat”, 1985, Naval Institute Press
cruising speed of 110 mph, [at a time well into the project] the requirement for a top speed of 135 mph was added. As a precaution, Laddon added mounts on top of the wing center-section for a third engine in case it would be needed. In November 1928, Consolidated was promised the Navy would buy 32 production models for use in Hawaii…"

Laddon looked at the finished ship and thought: well this is obviously a big step forward compared with what I did for Boeing. Nice small, radial engines; the hull has the same superb lines, but this time I am proud of the wing too. A single sweeping plane, with strong spines inside. Very nice, if I may say so. Pity that the wing has to be so high above the hull. The engines and the props have to be clear of the water spray, that’s obvious. All these struts are needed to get the wing up and for the engines and for the floats also. I must say, that still looks messy. That third engine is nonsense of course. [picture: http://www.americancombatplanes.com/]

The first flight was an unqualified success. A Navy pilot lifted off the big boat from the Anacostia River for the first time. His observer was Mac Laddon, who was following his practice of riding along on the first flight of all the planes he designed…” The third engine did not help to obtain the desired maximum speed, but the Navy decided to accept the prototype anyway. The development had cost Fleet much more than the $150,000 he received. He counted on recovering the extra costs with the production work that would follow.

Fleet had the habit of buying raw materials in quantity and preparing for assembly line techniques to hold down production costs. In this way he was usually able to underbid his competitors for the right to build his own designs. For the PY-1’s he had made large-volume buys of duralumin sheet in anticipation of that first order. The order never came. The Glenn Martin Company undercut Consolidated and received the production order. As it turned out, in the end, Martin lost heavily on the order. Not having built the prototype themselves, they had great problems producing the detailed drawings and constructing the big boats. To Reuben Fleet this was a meager consolation. Laddon’s design was built by Glenn Martin in 1930 and it was called the P2M.
Commercial Orders

“...Fleet’s recovery was swift, as usual. He simply shifted Consolidated’s flying boat emphasis from the military to the civilian market. He had had the XPY-1 Admiral designed in such a manner that with relatively few changes it could become the commercial Model 16 Commodore...”12 This proved to be a remarkable foresight when a certain Mr. Ralph O’Neill, World War I fighter ace, turned up on the scene. Fleet became a major stockholder in O’Neill’s venture, the NYRBA (New York, Rio and Buenos Aires Airlines). The airline route O’Neill had arranged was the world’s longest: 7,000 miles, from Miami down the east coast of South America to Argentina’s capital city. The intention was to create a network of government-sponsored airmail connections between Miami and the major cities of South America.

An initial order for six Commodore flying boats was the result. After redesigning the hull cross section and giving it flat topsides, a large, roomy boat resulted. “...The Commodores became the luxury airliners of their day. Fleet hired a decorator to give the planes’ interiors style and comfort beyond anything in the air. The planes themselves were eye-catchers, with coral-colored wings and cream-colored hulls. They could carry 22 passengers. In actual operation, a gross weight of 17,600 lbs determined the number of passengers. With a full fuel load of 650 gallons and a 600 lb. cargo, only 10 passengers could be carried. So laden, the Commodores had a range of 1,000 miles at 108 mph...”13

The NYRBA was a huge success and it took slightly more than one-and-one-half years before it merged, in August 1930, with Pan American Airways. By that time Consolidated had had orders for 14 Commodores, which it built in the record time of fifteen months.

Laddon’s Model 16 Commodore, 1929

[Photos this page thanks to www.cnac.org/aircraft16.htm]

12) Roscoe Creed
13) Roscoe Creed
Back to the Navy

Fleet set his engineers to improve their first patrol boat design, the XPY-1 and in May 1931 the Navy awarded him a contract to build a prototype of the improved flying boat, the XP2Y-1 Ranger. It sported the same 100 ft. parasol wing and 62 ft. long hull as the previous boat, but beyond that there were major differences. Most notably, short wings had sprouted at the shoulders of the hull, replacing the assembly of struts that had supported the XPY-1’s outrigger floats. It in fact made the Ranger into a sesquiplane, now carrying its floats below the wing stubs.

In fact, Consolidated had come full circle, using the Commodore as inspiration for an improved Navy patrol boat. In July, 1931, the Navy ordered production of twenty-three boats of this type, the P2Y-1.

1929 NACA awarded Collier Trophy for development of cowling for radial engines. Congress increased NACA membership from 12 to 15.

1930 NACA reported to industry results of its studies of optimum position of engine nacelles. First applications: Boeing 247; Douglas DC-2; Martin B-10.

Source: “50 years NACA “

In 1932, on the last machine of the series, Laddon raised the engines into the leading edge of the wing (as NACA had recommended). The overall effect was a 10-mph cruising speed increase, with a corresponding increase in range. The Navy was so impressed by the improvement that it ordered twenty-three more aircraft. The original machines were refurbished. In the end the flying boats carried the designation P2Y-3. In October 1933, six P2Y-3’s were flown from San Francisco to Pearl Harbor in what the Navy modestly called “routine transfer of aircraft.” Flying at altitudes from 500 to 5,000 ft, depending on cloud height [and wind direction], the six planes covered the 2,400-mile distance without stops in 24 hours and 35 minutes, setting a long-distance record for mass flight14. The crews of the patrol boats were welcomed in Hawaii by an enthusiastic crowd.

14) In subsequent years this record would be broken time and time again by transfer flights of PBY’s. It finally stood at 17 hrs 17 min at the end of 1938.
Laddon (1931): Well, now, that’s beginning to look better. Engines now mounted in leading edge of wings. Looks good, less air resistance. I used the closed cockpit of the Commodore. Parasol wing also from the Commodore, but I’ve added two half-wings to carry the floats, that’s an improvement. They can also be used for other things that the Navy cares to take along, like depth charges. All those struts that carry the wing are still damned ugly, though…

The Consolidated/Laddon P2Y-3 (on beaching gear) in Navy service at Hawaii
Sikorsky, meanwhile

Meanwhile, Consolidated colleague and competitor, Sikorsky, had discovered and cultivated its own niche in the aviation market. It had found that there was a considerable amount of interest among private operators, small airlines and even the Army and Navy for not too large an airplane that could land equally well on water as on land. Sikorsky had developed a whole line of flexible little aircraft of this sort, called ‘amphibians’ and was catering to a group of satisfied customers. They ranged from single engine Model 36 (4 persons) to two engine Model S-39. (8 persons). The last type was among others used by Pan Am for their service between islands in the Caribbean.

The basic configuration of these unique little boats went back to the old pioneer Curtiss flying boats, such as the NC-1, that had flown the Atlantic. In this design the short boat hull was carried by sesquiplanes, the top one of which was lifted high above the waves by a number of sturdy struts. The tail was attached by out-runners to the top wing. The radial engines were hung between the wings.
A Bigger Model for Pan Am

The small machines performed so well that Pan American Airways asked Sikorsky to develop a larger version for a maximum of 40 passengers. The Sikorsky engineers duly produced the Model S-40. It had exactly the same arrangement of hull, wings, tail and engines and looked like a scaled-up version of the smaller types. Sikorsky himself was rather proud of this fact: he had not taken any path in his thinking that had not been proven before. He was certain of all aspects of its design and stated that the S-40 ‘American Clipper’ would be ‘a successful and satisfactory airplane that compared favorably with the best flying boats’ 15. Some unkind critics however, pointed to the bewildering number of speed-hampering braces and struts and called the boat a “collection of loose parts, flying in formation!” This did not deter the great designer from being very proud of his latest creation. It ought to be said that the passenger accommodation was very carefully laid out and finished with great attention to personal comfort. When Sikorsky was aboard the test flight and sat in one of the passenger compartments he had a strong experience of ‘déjà vu’. These were the sensations, he wrote later, that he had felt in a dream long ago, when he was a little boy.

The Sikorsky S-40 in one of its elements

Upon acceptance of the new ship in the fall of 1931, Pan American organized a special tour of the West Indies, under command of Colonel Charles Lindbergh, who had joined the airline in the capacity of consultant. During this flight, so goes the story, Lindbergh and André Priester, the engineering VP of Pan American, had a close consultation with Igor Sikorsky, outlining to him the requirements for an even more modern ship than the S-40. The Pan Am representatives had strong opinions and suggestions about what the new plane should look like:

...The four fully cowled radial engines should be in the leading edge of the (single) parasol wing. There should be maximum streamlining of the hull and all superfluous struts should be avoided. The hull should be as sleek as a motor launch. How then to mount the single wing with sufficient clearance between the propellers and the water surface?

“Look”, said Priester, and he turned the S-40 menu card over on its back. He sketched a rectangular hull cross section with on top a pointed roof. “This is an A-frame”, he explained, “and the center of the wing is placed on top of the apex. Actually, there two A-frames, one behind the other, right under the two wing girders. The frames will be faired in by a streamlined cover. What you’ll see is a streamlined pylon that carries the wing. And there are two diagonal struts on either side of the hull, see.” Sikorsky studied the sketch. “A pylon,” he said pensively, “Yes, I guess it would work”.

This was on November 19, 1931. Two years later his engineers had worked it out and produced the revolutionary long range S-42 “Flying Clipper Ship”. By March 1936 he had taken a patent on the pylon construction.
The Sikorsky S-42 was a commercial flying boat designed and built by Sikorsky Aircraft to meet a 1931 requirement from Pan American World Airways (Pan Am) for a long-range transatlantic flying boat. Shown is a patent drawing for its wing mounting by means of a pylon.
The final Sikorsky design had been settled in 1933, resulting in an initial order for seven boats from Pan Am. The first test flight was made on March 30, 1934. In the same year, Igor Sikorsky was invited to give a lecture before the Royal Aeronautical Society in London about his remarkable design. Its revolutionary high wing-loading was considered ground-breaking. As a result, the British aircraft designers abandoned their long-held dogmatic belief in ......
The "Flying Clipper" and the "Pan Am Clipper" were other names used for the S-42; it made its first flight in 1934 [Wiki].

...biplane design and turned for the construction of flying boats to the all-metal, monoplane formula of Sikorsky. British market leader Short Brothers launched not long thereafter their Empire and Sunderland series of designs. Sikorsky’s impact on the design practice of large aircraft cannot be underestimated. The S-42B had four 750 hp engines and a maximum starting weight of 42,600 lbs. It could carry 32 passengers at an average speed of 188 mph over 1200 miles.

The next year, in 1935, one more U.S. pylon-mounted monowing flying boat would appear on the scene, the Glenn Martin M-130, with a wingspan just as well proportioned for long distance flight as the S-42. The M-130, however, was a much more sophisticated aircraft than the S-42. Its designers had made a great effort to ensure that the largest airplane built to that date in the United States would also be the lightest in terms of structure, its empty weight only 48 per cent of its maximum starting weight. In this way the machine could hold proportionally more fuel and travel farther. In fact Glenn Martin did succeed in meeting the original 1931 requirements of Pan American, where Sikorsky had fallen short. With a starting weight of 53,000 lbs the M-130 could carry 9 to 12 passengers from San Francisco to Honolulu. It was capable of flying 3,200 miles non stop at 165 mph. It had four 830 horsepower engines.
The PBY Catalina

While Sikorsky and his engineers were designing their revolutionary S-42 flying boat, Consolidated worked on the development of a worthy successor to the XP2Y-3 patrol boat. This successor was initially known as the XP3Y-1 (later PBY Catalina). At the same time, Consolidated prepared to move its complete factory from Buffalo, NY, to San Diego, CA.

Reuben: That looks nice, you got rid of those damn struts.

Mac Laddon: Yep.

Reuben: Actually it looks pretty smart. What’s supporting the wing in the middle?

Mac L.: A pylon

Reuben: A pylon? Where did you get that idea?

Mac L.: These ideas float around...

Reuben: And what happened to the floats?

Mac L.: I retracted them as wing tips... No extra drag.

Reuben: Are you sure that will work?

Mac L.: We’ll see.

Reuben: You should patent it.

Mac L.: I did, I filed a design patent on September 26, 1933.16

16) Wiki: In the United States, a design patent is a form of legal protection granted to the ornamental design of a functional item. Design patents are a type of industrial design right. Ornamental designs of jewelry, furniture, beverage containers (e.g. Coca Cola bottle) and computer icons are examples of objects that are covered by design patents.
1933-1935

The ball started really rolling on June 1, 1933, when the Navy contracted with Consolidated to deliver drawings for a new flying boat. In August of that year an inspection of a mock-up took place. After intensive consultations about design modifications, Consolidated received a development contract for a prototype of its Model 28 flying boat, designated XP3Y-1 by the Navy, in October 1933.

The proposed airplane had the cleanest lines ever. Laddon said: “I’ve taken advantage of all the mistakes I’ve made on previous ones.” But he had clearly done more than that. The XP3Y (later to be called PBY Catalina) had beautiful lines; the parasol wing was mounted on a streamlined pylon, all struts but four having been eliminated. The floats could be folded upward to become wing tips.

The wing construction itself consisted of plate and stringers. By the use of seals and gaskets, the internal space could be used as integral fuel tanks with a capacity of 1,750 gallons. This allowed for a weight saving of 875 lbs, which added substantially to the plane’s payload and range.

In November 1934, while the prototype was being built, various major changes were still under discussion, such as using liquid cooled engines and adding landing flaps. These proposals were discarded and the prototype was finally scheduled for delivery on 15 February 1935. Because of the Niagara River being frozen solid, this date could not be met and the first flight had to wait until 21 March 1935. Later that day, at the Consolidated plant in Buffalo, VP Lawrence Bell made this announcement to the employees: “Just received preliminary reports of the first flight of the XP3Y-1 at Norfolk this afternoon. Wheatley, Laddon and crew flew the boat for an hour and reported in the preliminary tests everything functioned satisfactorily. The entire structure was without vibration[!] and is rigid in all respects; the floats were operated in the air electrically and by hand several times with complete success. Wheatly reports ship has excellent flying characteristics…”[Roscoe Creed]
On June 29, 1935, the government awarded Consolidated a contract for 60 patrol boats (now designated PBY-1) for the total value of $6,000,000, the biggest order in aviation since World War I. Fleet’s company had outbid Douglas; the PBY cost $90,000 apiece against the Douglas machine $110,000.

**Initial Performance and testing**

Roscoe Creed gives the following performance data of the prototype:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Guaranteed</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight empty</td>
<td>13,180 lbs</td>
<td>12,570 lbs</td>
</tr>
<tr>
<td>Stall speed</td>
<td>60 mph</td>
<td>50 mph</td>
</tr>
<tr>
<td>Top speed</td>
<td>150 mph</td>
<td>171 mph</td>
</tr>
<tr>
<td>Service ceiling</td>
<td>15,000 ft</td>
<td>15,000 ft</td>
</tr>
<tr>
<td>Takeoff time</td>
<td>60 sec</td>
<td>15 sec (in wind of 6 knots)</td>
</tr>
</tbody>
</table>

(for final performance data of advanced version of advanced version PBY-5A, see foot note 17)

Two years later, at the end of January, 1937, Bill Wheatley, Consolidated’s chief test pilot, was aboard a flight of 12 new PBY’s transferring to Hawaii. He had high praise for the operational use of the boat that offered enough space for pilots and crew to rest while off duty on long flights. He was equally enthusiastic about the benefits of the Sperry autopilot, which... “holds the plane so much steadier than the human pilot can, that navigation is better and blind flight safer.” His only complaint was the universal one: even between mild San Diego and even milder Hawaii, “it is so damn cold at 10,000 ft that serious attention should be given to a heating system.”

Bill Wheatley set a record of his own in a PBY. The plane had been designed to fly on only one engine, but whether it could take off on one was open to speculation. Wheatley ended the guessing game by putting on a demonstration in which he not only took off using a single engine, but did so carrying enough fuel to fly for 1,300 miles.

At the conclusion of a major war game exercise in 1938, Fleet and Laddon were invited to be present at the official evaluation. They were chagrined to find out that in one squadron of 11 PBY’s the hulls often had been damaged in open sea take-offs at a location 600 miles west of Pearl Harbor. The minor damage, mostly wrinkled skin and popped rivets, resulted from the planes rocking back on their tails beyond the rear step in takeoffs in heavy seas. Consolidated reinforced the hulls, adding about 25 percent more strength but only 17 pounds more weight.

On the next page the essence of Mac Laddon’s wing support with pylons and struts is clearly visible. Direct below the engine cowling a little window is shown through which the flight engineer can observe the engine in flight. In fact his position is right inside the pylon (see next page).

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17) Performance PBY-5A: Gross Weight: 34,000 lbs; Power plant: R-1830-92; 1200 hp; Maximum speed: 180 mph; Cruising speed: 117 mph; Ceiling 15,000 ft; Range: 2,500 miles.[Roscoe Creed p.312]
The forceful combination of struts and pylon

The above pictures are from the amazing French website: LES CATALINA EN FRANCE
Do not forget to visit:  http://cansonet.free.fr/Les_origines/WALK/body_walk.html

The flight engineers work station
The PBY-5A with side blisters; beaching/landing gear (dinghy not included) 1939

A Navy PBY-5A in its sea rescue role
Epilogue
The PBY Catalina went on to play a most remarkable role in maritime and aviation history. For years on end during the Second World War, its crews performed feats of endurance, skill, courage and heroism. After the war, the Catalina gained its place in civilian life with rescue missions, research and exploration flights, fire fighting and diverse general usage.

More than 3,300 were built in the U.S. and Canada. [Wiki] As production progressed, more features were added, such as the characteristic ‘gun blisters’ on the sides of the hull and, in the version PBY-5A, the surprisingly ingenious tricycle landing gear that turned the boat into an amphibian.

Mac Laddon went on to design other remarkable aircraft, such as the renowned B-24 Liberator bomber, of which 18,482 were built by September 1945 [wiki].

In 1939, Isaac Machlin Laddon became Vice President of Consolidated in charge of Engineering. Later on, after Reuben Fleet had sold his majority stock to Vultee 18, Laddon became one of the directors of the Consolidated-Vultee Aircraft Corporation, popularly known as Convair.

As such, he was responsible for the design and development of great airplanes like the B-36 Intercontinental bomber and the Convair two-engine passenger aircraft that became very popular worldwide with the airlines and the travelling public immediately after the Second World War.

The Jetliners 880 and 990 were a financial fiasco, turning a loss of more than 400 million dollars and signaling the end of Convair’s activity in civil aviation. From then on Convair became an aerospace and armament builder; the corporation went through several reorganizations and mergers, finally becoming part of General Dynamics.

Reuben fleet died in San Diego on October 29, 1975 at the age of 88
Isaac Machlin Laddon died in San Diego on January 15, 1976 at the age of 81.

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18) In 1941, Reuben Fleet became disgruntled with measures that the Federal government took to regulate the aircraft industry and to strengthen the position of its workers. In Reuben’s opinion, he had always delivered fair value to the company’s customers and he had had fair dealings with the unions. He sold his shares for $10,000,000, — to a financial group that carried the name of Vultee, a pioneer designer/aircraft builder who had crashed and died with his wife while flying a Stinson airplane in a snowstorm near Sedona, Arizona in 1938.
July 31, 1934.

I. M. LADDON

PATROL TYPE OF FLYING BOAT

Filed Sept. 26, 1933

4 Sheets-Sheet 2

APPENDIX
UNITED STATES PATENT OFFICE

DESIGN FOR A PATROL TYPE OF FLYING BOAT

Isaac M. Ladden, Buffalo, N. Y., assignor to Consolidated Aircraft Corporation, a corporation of Delaware

Application September 26, 1933, Serial No. 49,348

Term of patent 7 years

To all whom it may concern:

Be it known that I, ISAAC M. LADDON, a citizen of the United States, residing at Buffalo, in the county of Erie and State of New York, have invented a new, original, and ornamental Design for a Patrol Type of Flying Boat, of which the following is a specification, reference being had to the accompanying drawings, forming part thereof:

Fig. 1 is a plan view of the patrol type of flying boat showing my new design;

Fig. 2 is a front elevation of the same as it would appear in flight;

Fig. 3 is a side elevation of the patrol type of flying boat also as the same would appear while in flight.

Fig. 4 is a top perspective view of the flying boat; while

Fig. 5 is a bottom perspective view of the said flying boat as the same would appear in flight.

I claim:

The ornamental design for a patrol type of flying boat as shown.

In testimony whereof, I hereunto affix my signature.

ISAAC M. LADDON.