THE NAME SPERRY *is inseparably linked with the word gyroscope. Above, Elmer A. Sperry inventor in the field of stabilization and radio control, holds a model. At left is his son, Lawrence, who worked with his father as an engineer and test pilot for the flying bomb in WW I.*

Developing the Flying Bomb

One of the antecedents of the guided missile, generally considered a WW II development, was the flying bomb of WW I. In 1936, over a decade after the WW I efforts lapsed, LCdr. D. S. Fahrney (now Rear Admiral, USN, Ret.) was assigned the task of developing radio-controlled target aircraft. Out of this effort emerged the assault drone of WW II, a forerunner of the modern missile. In developing radio-controlled target aircraft, Fahrney first reviewed at the Naval Research Laboratory the radio aspects of the flying bomb of WW I days and the early 1920's. Thus, the work done in WW I, as well as the experience acquired by NRL and the Sperry Gyroscope Co., contributed to the development of guided missiles. This article is based on RAdm. Fahrney's 'History of Radio-Controlled Aircraft and Guided Missiles.'

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THE DEVELOPMENT of guided missils was one of the more obscure and interesting areas of endeavor during World War I. Marconi's first successful wireless transmission in 1896 and the invention of the airplane less than a decade later opened the technological field of electronics and aviation. Of the many areas of utilization in which these two fields have merged, none is more obvious nor more complex than that of the guided missile.

Before WW I, the possibility of using radio to control aircraft intrigued many an able man. One of these, Elmer Sperry, succeeded in arousing the Navy's interest. Although his efforts were visionary, they also had a serendipitous effect and made contributions to such fields as automatic pilots, gyro-stabilized bombsights, flight instruments and catapults.

Sperry was, in many ways, the epitome of the Yankee inventor—with a college education added. His varied and widespread interests included mining machinery, automotive and street railways and electro-chemistry. By 1896, he had added to these an interest in gyroscopes which, during the next 15 years, he adapted to naval use —gyro-compasses for battleships and gyro-stabilizers for destroyers. In 1911, the application of radio control to aircraft intrigued him.

He realized at once that for radio control to be effective, automatic stabilization would be essential, so he again turned to the gyroscope as a promising device. Two years later, in the summer of 1913, the Navy provided assistance in the form of a flying boat, piloted by Lt. P. N. L. Bellinger, which was used to test and evaluate the gyroscopic stabilizer or autopilot. Elmer Sperry's son, Lawrence, served as engineer during these trials.

The next year, using an improved autopilot, Lawrence won a French prize of 15,000 gold francs. The instrument, though placed in production, proved to be too crude for operational use. On a second trip to Europe, Lawrence, observing the developing techniques of aerial warfare, became convinced that the gyroscope had many applications in military aircraft. Acting upon this recommendation, the Navy Department awarded contracts for the development of such diverse devices as a bombsight, a stable reference line (called a "base line indicator," but the forerunner of the turn and bank indicator) and a gyro-com-

pass. By 1916, the Sperrys had not only had five years of experience in attempting to develop aeronautical uses for gyroscopes but also had achieved some degree of success with their gyrostabilizers.

At this time, they temporarily joined Peter Cooper Hewitt to develop an aerial torpedo or explosive-laden, pilotless aircraft. Hewitt, best known as the inventor of the mercury vapor lamp, worked on other electrical and radio devices and contributed to the development of the vacuum tube. Thus by combining the ability of Hewitt in radio with that of the Sperrys in gyroscopes, early success was anticipated.

Hewitt and Elmer Sperry were both members of various committees of the Naval Consulting Board which Secretary Josephus Daniels had established in 1915 to provide "machinery and facilities for utilizing the natural inventive genius of Americans to meet the new conditions of warfare." Sperry belonged to four committees; Hewitt to three. They were both members of the Committee on Aeronautics and Aeronautical Motors, Elmer Sperry eventually succeeding to its chairmanship.

In the summer of 1916, Hewitt and Sperry arranged for a representative of the Navy's Bureau of Ordnance, Lt. T. S. Wilkinson, to examine their aerial torpedo. This torpedo consisted of a gyroscopic stabilizer, a directive gyroscope, an aneroid barometer to regulate height, servo-motors for control of rudders and ailerons, and a device for distance gearing. These were installed in an airplane which could be catapulted or flown from the water and would mount to a predetermined altitude, fly a pre-set course, and, after traveling a pre-set distance, drop its bombs or dive to the ground. Wilkinson reported that the aerial torpedo did not possess a degree of accuracy sufficient to hit a ship, but, because of its range of 50 to 100 miles, it might be of interest to the Army.

Immediately after the declaration of war upon Germany, Sperry began urging the Navy to embark on the development of an aerial torpedo. In this he was supported by the Naval Consulting Board which requested that SecNav apportion $50,000 to carry out experimental work with aerial torpedoes in the form of automatically controlled machines capable of carrying explosives. With this recommendation, the government included development of a flying bomb, or aerial torpedo, in its war preparations. Elmer Sperry later recalled, "It was settled in the [Senate} that the torpedo should be of two classes," one of which would be completely automatic and the other rigged for wireless control.

The details were settled by May 17 when Elmer and Lawrence Sperry met with the Secretary and other Navy officials. The Navy would furnish five N-9 seaplanes and purchase six sets of Sperry automatic control gear. Sperry would construct hangars, furnish testing grounds and secure a staff. Secretary Daniels approved spending $200,000 on this project, half to be administered by the Bureau of Ordnance and half by the Bureau of Construction and Repair and the Bureau of Engineering.

Once a course of action had been determined, the Sperrys went to work. As they got underway, seven large planes were turned over to them and a flying field at Copiague, Long Island, was obtained. A number of hangars were established there with a Marine guard for security. Aerial torpedoes were tried out in well over a hundred shots before the Armistice was signed November 11, 1918.

OBTAINING a field, erecting hangars, obtaining aircraft and constructing the control gears took time. In the interim, Sperry proceeded upon the second phase, development of radio control gear. He employed a radio engineer to design some of the necessary apparatus. The fact that Western Electric was working on audion amplifiers and other radio devices led Sperry to believe that the solution to the "wireless end of the aerial torpedo" was in sight. Thus encouraged, he purchased rights to other radio inventions.

(To look ahead, these radio control systems were not tried out in the Navy's aerial torpedo. However, under the auspices of the Naval Consulting Board, the Sperrys applied radio control to a conventional bomb by which a parachute, or "black umbrella," was attached to the bomb and marked with a big aluminum arrow. Thus the aircraft crew could observe the trajectory of the falling bomb and send out corrections via radio. A receiver in the bomb set a mechanism in motion to adjust the trajectory. In tests, this mechanism was controlled from a distance of four miles.

(Later, in 1922, the Sperrys constructed "messenger" planes to A. V. Verville's design for the Army and fitted some of them with aerial torpedo gear and a radio control system developed by the Army Air Services engineering division. These craft "hit" targets at 30, 60 and 90 miles from the point of takeoff.)

To return to the 1917 flying bomb, aside from the development of radio, Sperry's initial work dealt with testing and perfecting mechanisms for maintaining course and measuring distance.

Test flights in which the pilot took the Navy-furnished N-9 off and then turned control over to the automatic gear commenced in mid-September. This gear, it was reported, would fly the plane to the designated target and drop a bag of sand on command from the distance gear. By mid-November, 30-mile test flights were being made regularly with an error in range of about two miles.

During this phase, Rear Admiral Ralph Earle, Chief of the Bureau of Ordnance, submitted his ideas on the best ways to win the war quickly. Most important was nullification of the submarine menace by destroying these vessels and their home bases. One of his suggestions was that vessels carrying flying bombs could take station off shore from the German submarine bases of Wilhelmshaven, Cuxhaven and Helgoland. The flying bombs, which were little more expensive than water torpedoes and could carry one-and-a-half times their explosive load, would then be launched. RAdm. Earle described these bombs as capable of destroying docks, submarines, destroyers, floating docks, gun factories and so on. (This suggestion contained an element of prophecy: In September 1944, a B-24 drone attacked the WW II submarine installations at Helgoland after an earlier attempt had resulted in the death of Lt. Joseph P. Kennedy, Jr., and Lt. Willford J. Willy when their explosive-laden plane exploded in mid-air before they could set the controls and parachute to the ground.)

Despite the Chief of BuOrd's recommendation and the early tests, the Chief of Naval Operations laid down this policy: While the flying bomb was to be developed to the point of complete readiness for production, no

facilities were to be obligated in order to manufacture it for the Navy. BuOrd therefore sought by some means to obtain airframes and engines in large quantity without interfering with scheduled aircraft production. In addition, the Navy invited Major General George O. Squier, Chief Signal Officer of the Army, to witness a demonstration of the flying bomb. Squier caused a somewhat parallel project to be set up by the Army at McCook Field, Dayton, Ohio, although with much greater emphasis upon producibility and low cost.

Development of the flying bomb involved solution of several serious problems. It was necessary to obtain a practicable airframe, find means of launching a pilotless vehicle and make sure that the control mechanism would operate effectively after a pilotless launch. Since these problems were interrelated, difficulties with the launching device obscured the aerodynamic inadequacies of the airframe, and both served to blur short-comings of the control mechanism.

With regard to the airframe, little was done to obtain a more efficient machine until Sperry began demonstrations with the N-9 in September 1917. Then, in October, a rush order was sent to the Curtiss Aeroplane and Motor Company for six planes of special design with an empty weight of 500 pounds, a top speed of 90 miles per hour, a range of 50 miles and the capability of carrying an explosive load of 1,000 pounds. The engine was to be as light as possible and the plane was to be fitted for special control equipment.

The first of these planes (hereinafter identified as the Curtiss or the Curtiss-Sperry flying bomb) was delivered on November 10, just within the 30-day deadline specified in the contract. It had never been flown as a piloted craft nor checked in a wind tunnel. Even had the flying bomb been based upon a proven design, it would still have constituted a radical departure and required additional testing.

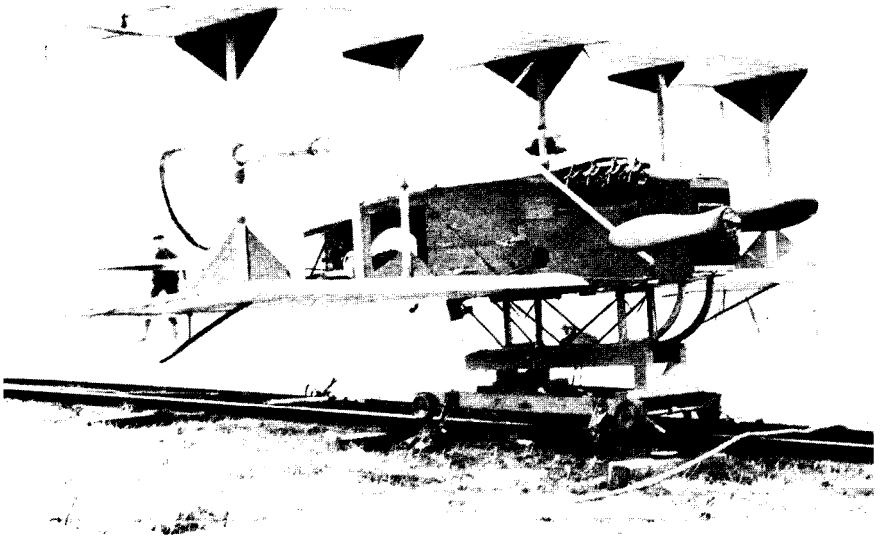
A couple of abortive attempts to launch the craft as a flying bomb led to the realization that some knowledge had be to obtained of the craft's flying characteristics. One of the planes was then fitted with 2 ski-type landing gear and taxied over the ice for the purpose of adjusting the ailerons and elevators. Lawrence Sperry, rashly deciding he would be the test pilot, had the plane fitted with a seat and standard stick control. While taxying for his first takeoff, the plane struck a bank of slushy snow, turned two somersaults and was completely wrecked. Sperry walked away unhurt. Undaunted he tried again and this time got plane #2 into the air. When he cut in his automatic controls, they wrested the plane away from him and turned it over laterally twice. Fortunately, he succeeded in righting it and in landing safely.

Clearly something more was required than flight test of the airplane. With true Yankee ingenuity, Lawrence Sperry and his assistant, N. W. Dalton, fitted a Marmon automobile with an airplane motor and attached to it a frame on which they could fasten the flying bomb, With this rig, they drove over the Long Island Motor Parkway at 80 miles per hour to make a kind of open-air wind tunnel test. Finally, they succeeded in getting what they considered to be satisfactory adjustments to the plane's control surfaces and automatic gear. This led to two launching attempts, one successful and one unsuccessful.

In August and September 1918, two tests of the Curtiss flying bomb were made; two flights of 100 yards were achieved before the planes crashed to the ground. Of these, only one was blamed upon the flimsy aircraft structure, but disgust was complete. The Curtiss flying bomb was abandoned in favor of a return to the N-9. In the meantime, the Sperrys had built a model for wind tunnel tests and these were eventually carried out at the Washington Navy Yard, but not until after cessation of work with the Curtiss flying bomb.

THE PROBLEM of launching a pilotless aircraft or flying bomb was as complex as that of determining the flight characteristics of the airframe. The initial Hewitt-Sperry concept—Wilkinson examined their aerial torpedo in September 1916—was that the device would be launched by catapult or from the surface of the water. In any event, when the Sperrys made the first pilotless tests of the flying bomb late in 1917, they launched it by sliding it down a wire cable. In this launch, a wing was damaged. On the second trial, the plane arose from the wire but immediately plunged to the ground.

These failures led to the abandonment of the wire-launching apparatus in favor of a more conventional catapult consisting of a 150-foot track. Power was obtained by dropping a three-ton weight from a height of 30 feet. Troubles continued. On the first attempt to use this device, the flying bomb lagged the car, damaged its propeller and then the plane turned over on its nose. A month later the catapult worked satisfactorily and the plane seemed to respond to its automatic controls, but proved to be tail-



A CURTISS-SPERRY FLYING BOMB IS SHOWN HERE MOUNTED FOR A CATAPULT LAUNCH

heavy when it took to the air, stalled, side-slipped and fell to the ground.

These failures were followed by the already recounted hair-raising experiences when the flying bomb was put on sled runners. Then came the trials with the Marmon automobile. After the controls were satisfactorily adjusted, a launch was actually made from the car on March 6, 1918. The machine left the car cleanly and flew the thousand yards for which the distance gear had been set, descended and struck the water with only moderate damage. This was epoch-making in that for the first time in history an unmanned plane had made a smooth, stabilized flight in response to automatic control. The feat could not be duplicated on a second attempt, so a decision was made to use a smoother roadway.

The Marmon was fitted with railroad wheels and an idle spur of the Long Island Railroad, four miles east of Farmingdale, was brought into service. A run was made down the track but, before flying speed was obtained, the plane developed sufficient lift to raise the front railroad wheels of the car so that they came free and another crash resulted.

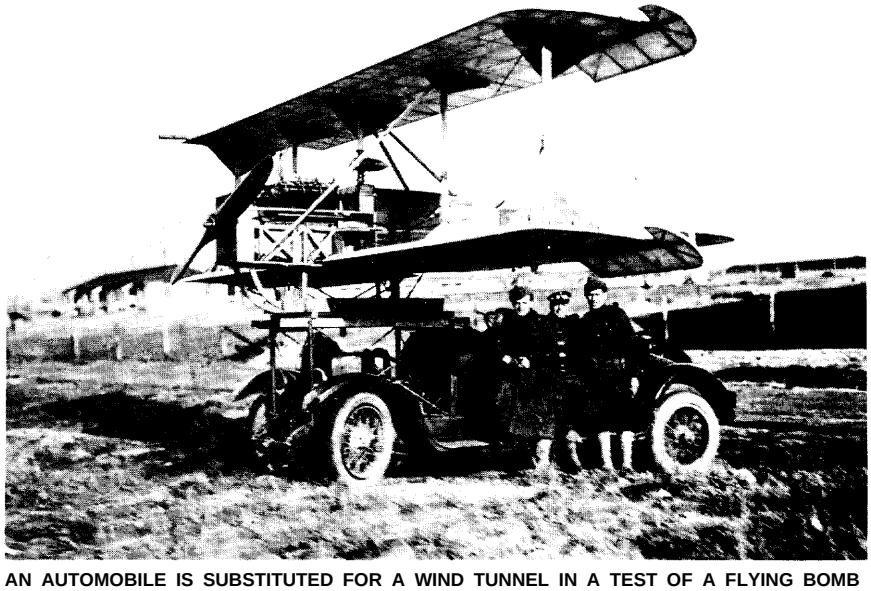
The deficiencies of these three methods of launching led the Sperrys to try a new type of catapult in which a heavy flywheel was spun at high speed. Through a clutch and drum arrangement, the flywheel imparted a constant acceleration to the car carrying the flying bomb. (To perform the detailed design work, the Sperry Company employed a young consulting engineer, Carl L. Norden.) This device was not completed until August when its first test ended in failure. Two more trials the next month were only partially successful. After this the N-9 returned to favor. Preparations were finally completed in mid-October and on the 17th a launch was made. The plane was catapulted cleanly. It climbed steadily, flying in a perfectly straight line at an angle of about two degrees to the proposed line of flight. The distance gear had been set for eight miles, but it failed to function, so the plane continued on course and was last seen over Bayshore air station heading east at a height of about 4,000 feet.

The third area of problems connected with the flying bomb was the stabilization system. In the various unsuccessful attempts to launch the craft, behavior of this gear could not be checked. It had misbehaved during Lawrence Sperry's piloted test flight. One of the purposes of the tests on the Marmon automobile had been to observe its functioning at flight speed. Satisfactory settings were made for the one successful flight. The acceleration imparted to the plane by the flywheel catapult would have caused the gyroscope to precess. To prevent this—at least for the last flight—the gyroscopes were not released until the launch was completed. At the same time, additional batteries were provided to insure adequate power for the gyroscopes.

In the last launch, on September 26, 1918, the flying bomb made a straight climbing flight of about 100 yards, spiraled and crashed. Either the stabilization system or the airframe was at fault and changes were made to both. The stabilization gear which had been used for all work with the flying bomb was abandoned in favor of the four-gyroscope unit tested earlier in the N-9. The single gyroscope system adapted from the underwater torpedo gear was retained for course, or azimuth, control in order to operate the vertical rudder. For the successful flight of the N-9 on October 17, this course and stabilization gear functioned satisfactorily. Even so, the Navy requested Carl Norden to examine the various Sperry devices and to recommend improvement.

The Navy continued to press its view on how to proceed and was actually contemplating purchase of new flying-bomb airplanes on its own, rather than through the Sperrys. The flight with the N-9 may have been an effort in part to restore Navy confidence; if so, it was to no avail. Sperry made various attempts to stir up additional enthusiasm by calling the flying bomb "the gun of the future" and an important step towards "making war so extremely hazardous and expensive no nation will dare go into it." Despite this, at war's end, the Navy took over from Sperry complete control of the flying bomb development.

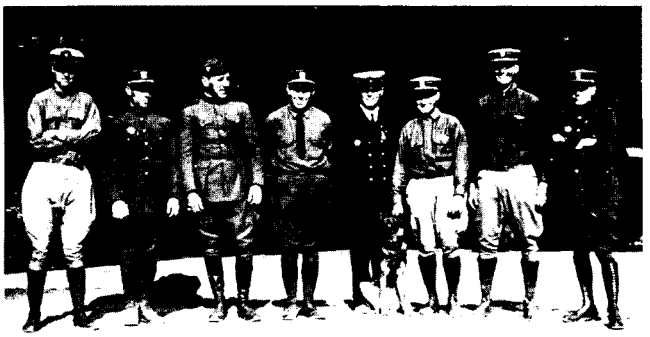
DURING the early post-war years, the Navy sponsored similar projects. For the first of these, Witteman-Lewis aircraft and Norden-designed gyro-stabilizers were used. Demonstrations at Dahlgren were no more successful than those achieved by the Sperrys. In 1921, the project was again reoriented to emphasize the radio control aspect. The control gear was developed at the Radio Laboratory at NAS ANACOSTIA (later the Naval Research Laboratory). Aircraft installations were made, beginning in 1923, and, despite relatively successful demonstrations of technical features, interest waned and the project lapsed in 1925. Over a decade was to pass before the Navy seriously undertook the development of target drones and military versions of pilotless aircraft.



AN AUTOMOBILE IS SUBSTITUTED FOR A WIND TUNNEL IN A TEST OF A FLYING BOMB

U.S. NAVY PILOTS IN ENGLAND POSED FOR JULY 1918 PICTURE IN WHICH UNIFORM VARIETY CLEARLY APPEARS

The Evolution of the Aviation Green Working Uniform



AT NAS LE CROISIC IN THE UNIFORM ADJUSTMENT DAYS

Until 1917, any "serviceable" uniform could be worn for Naval Aviation duty and, judging from photographs taken in early 1917-1918, they ran the gamut. Aviators were shown in khakis, blues, greens, leggings and puttees, and two and four-pocketed coats.

June 22, 1917, a summer service flying uniform for officers detailed for aviation duty and officers of the Naval Reserve Flying Corps was prescribed to be worn "when on immediate and active duty with aircraft." The uniform was khaki, designed in line with summer dress whites. Leggins of drab were worn with breeches and high, laced, tan leather shoes. The prescribed "working dress" uniform was a one-piece overall suit, capable of being worn over the summer service uniform. It was the same color, made of canvas, khaki or moleskin.

On September 7, 1917, a winter service flying uniform was prescribed. It was to be the same as the summer service in design, but forestry green cloth was substituted for khaki. At the same time, a Naval Aviator's device was adopted. In October, brown gloves and an overcoat were added as well.

In 1920, the first indication that the aviation green uniform was not here to stay appeared in a letter from the Bureau of Navigation that advised aviation officers that they could anticipate a possible discontinuance of the forestry green uniform.

A Bureau of Navigation circular letter, dated October 13, 1922, announced a new set of uniform regulations and detailed some of the changes that would be in effect: "uniforms for aviation will be the same as for other naval officers, doing away with the green and khaki, which may be worn until June 1, 1923, but only at air stations."

The abolishment turned out to be temporary. Aviation uniforms, both khaki and green, of somewhat different design were reinstated April 8, 1925, and eventually influenced the design of the summer khaki today.

The Origin of Navy Wings

A NAVAL AVIATOR's device, a winged foul anchor with the letters 'U.S.,' is hereby adopted to be worn by qualified Naval Aviators. This device will be issued by the Bureau of Navigation to Officers and Men of the Navy and Marine Corps who qualify as Naval Aviators, and will be worn on the left brest." So stated Change 12 to Uniform Regulations approved by the Secretary of the Navy on September 7, 1917. A second change, approved Oct. 12, 1917, removed the letters "U.S." from the design and Navy Wings became a part of the uniform. The official act of adoption is clear; much of what led to it is not.

It appears likely that need for a distinguishing mark was voiced by the aviators themselves, particularly after Army aviators began wearing "badges" in 1913. But it also appears that outside influence provided some of the initial impetus. A letter, datcd June 29, 1917, from the G. F. Hemsley Co., stating that the sender "takes the liberty" of forwarding a design for an aviation cap and collar ornament, may well have started official action. In forwarding it to the Bureau of Navigation, the Chief of Naval Operations rejected the ornament but went on to say that since foreign countries and the U.S. Army had adopted an aviation device, Naval Aviators also should be given "some form of mark or badge to indicate their qualification, in order that they have standing with other aviation services." The letter, which had been prepared in the Aviation Section and in which LCdr. John H. Towers had a hand, enclosed a design for wings as representative of what was wanted.

From this date the subject was kept very much alive by the exchange of correspondence with a number of firms interested in producing the wings. Bailey, Banks and Biddle of Philadelphia was one of them. By October that company seems to have taken the lead over its competitors and on the 24th submitted its first sample pin. In early November it submitted other samples and was ready to make "prompt delivery of such number of devices as you may desire,"

The design passed through a number of changes. Bronze, the first metal proposed, was quickly rejected in favor of a gold and silver combination which in turn was changed to all silver and finally, in October, the decision was for all gold. Size changcd from over three inches to the final of two and three-quarters. Stars on the shield were proposed and rejected as violating the laws of heraldry.

Lt. Henry Reuterdahl, later assigned as an artist to record the NC trans-Atlantic flight, played an important part in design development. In a letter of September 28th, he recommended simplifying the wings by bolder chasing and a reduction in the number of feathers, noting that "most naval ornaments are too fine and not broad enough in character." He also recommended changes in the anchor and rope and the introduction of a slight curve to conform to the shape of the body. He summarized his remarks by saying, "My idea has been to reduce all corners so that there will be no points which might catch in the clothing."

On the final decision to place an order, the record is obscure but it may have been a BuNav letter to the Supply Officer dated November 21, 1917, selecting "the higher priced pin" (the price was $1.15 each). The company was not named. That it was Bailey, Banks and Biddle, however, seems fairly certain. Its letter to BuNav dated December 19 confirms a telegram quoted in part as "balance aviator insignia shipped tomorrow."

CHANGES *through the years (from the top) show the original design, the 1920's model, the present wings and those worn by astronauts.*

That the first pins were delivered in this month is also confirmed in a December 26 letter from BuNav to Pensacola, reporting that the new pins had been received and "will be sent out as soon as they can be engraved to show the Aviator's number, his name and branch of service."

Engraving the aviator's number posed a problem, however, that was solved only by preparation of an aviators' precedence list, covering numbers 1 through 282, by the Aviation Section of CNO. Thus, wings were responsible for the first precedence list and, in addition, were a factor in the later assignment of fractional numbers to many aviators omitted from this first compilation. When forwardcd to BuNav on January 19, 1918, distribution of the first wings could begin. It seems likely that Towers, as Senior Naval Aviator in Washington at the time, was an early, if not the earliest, recipient.

After almost eight years of Naval Aviation and nine months of war, Naval Aviators had Wings—a badge of qualification that would set them apart from all men.

THE WAR AGAINST THE U-BOAT

THE UNITED STATES Naval Air Force, Foreign Service, executed 30 attacks against enemy submarines, of which ten were considered to have been at least partially successful; it dropped 100 tons of high explosives on enemy objectives, and it had to its credit a total of 22,000 flights in the course of which it patrolled more than 800,000 nautical miles of submarine-infested areas. In point of fact, it did immeasurably more than this, for these figures are very far from being a just or fair method of appraising the value of aircraft in naval warfare. I say this because almost always the damage inflicted by aircraft, when operating against surface craft, was of a contributory and indirect nature—'the seaplane summoned destroyers to the scene of action and the submarine was destroyed' describes what is meant by 'indirect' in this sense. The destroyers almost always got the credit, wherein the aircraft, the indirect destructive agency, was really responsible for bringing about the action in which the submarine was destroyed."

So spake LCdr. W. Atlee Edwards, former aid for aviation on the staff of Admiral W. S. Sims, testifying before the Lampert Committee in 1925.

The primary role of Naval Aviation in WW I was antisubmarine warfare. The first recorded attack on an enemy submarine by a U.S. Naval Aviator was made by Ens. John F. McNamara on March 25, 1918, while serving at the Royal Navy Air Station, Portland, England. Although his attack was successful enough to warant special commendations from the Secretary of the Navy and Adm. Sims, the later evaluation was "possibly damaged."

The first attack from a U.S. Naval Air Station was from Ile Tudy, France, which, perhaps because of its location, had more antisubmarine action than any of our overseas stations. Two coastal convoys passed through its sector daily, one bound north, the other south. Around Penmarch Point, the water was deep near shore, free of reefs and sand bars and ideally suited to submarine operations. A majority of the "allos" received at Ile Tudy were from this area.

The operating routine was described by the station historian. "The sector was marked off into 25-mile squares, subdivided into squares of five miles. By this means planes were able to report position every half hour and be quickly and accurately located. Communication was maintained with shore bases by radio and pigeons, and with vessels by message buoys, phosphorous buoys, Very pistols and the blinker system. . . .

"A section of two planes escorted each convoy. As the sector was too long to be covered entirely by two planes, it was necessary to send out another section to relieve the first, when the convoy was approximately halfway through the area. This necessitated using at least eight planes per day for convoy work alone. In addition, there was always a section known as the 'Alert' ready to take the air from daybreak to dark in response to any 'allos' received. When the convoy was picked up, the planes would first circle over it. Then while one plane would remain around the convoy the other would fly as far as 10 to 15 miles ahead, zigzagging broadly on both sides. This plane would return, again circle the convoy, repeating the same maneuver again and again. Before leaving a convoy, the planes circled a last time in its neighborhood. In this way the convoy was well protected from surprise."

On April 23, 1918, a convoy escort of two Donnet-Denhaut seaplanes, piloted by Ens. K. R. Smith and R. H. Harrell, QM1c, saw the first action. They joined the southbound convoy of about 20 ships, approximately six miles north of Penmarch Point. As the weather was very foggy, they first flew to the rear of the convoy to look for stragglers, then flew a wide circle toward the main body. Shortly after, they sighted a suspicious wake, apparently being made by a submarine moving at good speed, and went in to attack. Smith dropped two bombs, the first landing on the fore part of the wake and the second ten feet ahead. The explosions created a heavy disturbance in the water followed by many air bubbles and appeared so successful that Harrell did not drop his bombs. Instead, he marked the spot with a phosphorous buoy and circled. Smith then flew to a destroyer, USS *Stewart*, and dropped a message buoy. *Stewart* arrived in the target area, followed soon after by the French gunboat *Ardente*, and dropped three depth charges. The pilots circling overhead saw small pieces of wreckage, particles of sea growth and large quantities of oil coming to the surface, and shortly after returned to their base. The oil was still visible from the air as late as the sixth of May.

Ens. Smith and his observer, Chief O. E. Williams, were officially credited by the French naval authorities with a submarine, were cited in the Order of the Day and awarded Croix de Guerre with Palm.

The North Sea coast of England, where NAS KILLINGHOLME was located, was also a favorite sub-hunting ground. In the month before the station was under U.S. command, Ens. J. J. Schieffelin attacked a submarine which, possibly because of damage, surfaced after he left the scene and was sunk by gunfire from British destroyers. Ten days later he was again in action. While he was en route to the Whitby area, extremely rough air over Flamborough Head bounced his plane so hard that one of the suspending bomb hooks was bent and he was forced to jettison half his bmb load. Off Whitby, he sighted a surfaced submarine and attacked. His one bomb exploded under the stern of the submarine, kicking it clear of the water and exposing its rotating screw to view. The sub then disappeared under water at a steep angle. Later that day, after he had directed surface craft to the position, a submarine surfaced in the general area only to be rammed and sunk by the destroyer HMS *Garry*. There was initial confusion over whether this submarine was the one attacked by Schieffelin,

but later information confirmed that his submarine returned to base in damaged condition. The evaluation of both attacks was "probably seriously damaged."

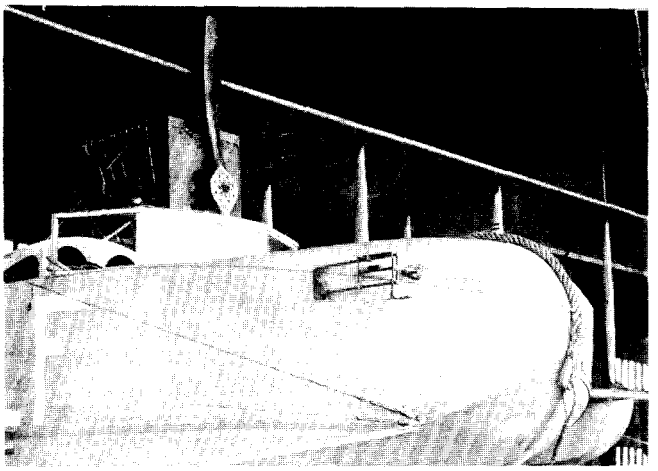
NAS LOUGH FOYLE in northern Ireland, which guarded the north entrance to the Irish Sea, made its first attack October 19, 1918. Ens. George S. Montgomery, in seaplane LF-4, was escorting a 32-ship convoy when he sighted and successfully bombed a submarine apparently moving into position for an attack. Both bombs functioned, one striking 30 feet to the right of the periscope and the other ten feet forward. The assessment was "probably damaged" and the station history reported that "undoubtedly at least one ship in the convoy was saved by the timely bombing."

Submarines did not always react passively to these attacks. On at least one occasion against a seaplane and once against an airship, the U-boats fought back. On August 13, 1918, four seaplanes, one piloted by Ens. J. F. Carson, left NAS DUNKIRK on patrol. A short distance off the coast, a large submarine was sighted proceeding on the surface at high speed. Since it carried no identification marks, Carson fired a challenging signal. At that point, the submarine apparently spotted the planes and opened fire with its four-inch gun. Five shots were fired, three passing close to Carson's plane, and several pieces of shrapnel pierced his fuselage and wings. Carson immediately returned fire with his machine guns and moved into bombing position. The submarine cleared the deck and dived. As she went down, Carson dropped two bombs, one exploding in the swirl and the second slightly forward of it. The submarine reappeared, her bow projecting from the water at a sharp angle. Within four minutes she again submerged, sliding stern first under water. Carson was credited with a sinking by the French government and awarded the Croix de Guerre.

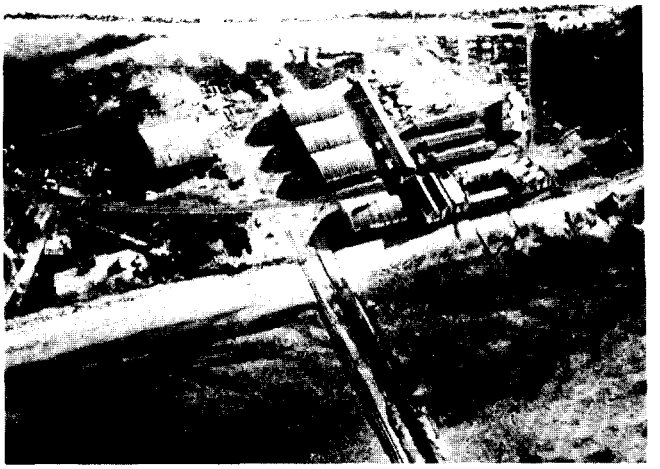
THE AIRSHIP involved was the AT-13 out of NAS PAIMBOEUF. On October 1, 1918, after escorting one convoy through the area, the airship turned to meet another. On the way, she fired two shots on a rock for target practice. On the second shot the firing spring broke, putting her only gun out of action and reducing her offensive capability to bombs. At about two-thirty, the convoy was picked up and the airship made the usual circle overhead. Then, as two storms were observed approaching from the north and northeast, the airship took a heading to pass between them. Shortly after, a suspicious object sighted to the north was investigated. While still a mile away, it was made out to be a submarine and when it opened fire there was no doubt that it was enemy. Thirteen shells burst near the airship but none struck her. The airship took up the chase to get into bombing position but the head wind was so strong that the submarine could not be overtaken. Signals by radio and Aldis lamp informed the convoy of the situation and the chase continued until the submarine disappeared in the darkness.

Action against the U-boat was not confined to overseas waters. On a Sunday morning, July 21, 1918, the U-156 surfaced off Nauset Beach, Cape Cod, and began what has since been called the Battle of Chatham. It was tersely reported in the weekly Aviation Bulletin as: "Sunday morning off Chatham, German submarine of the latest type appeared. She had two 6-inch guns with which she shelled and sank some barges. Seaplanes were sent out and submarine submerged." There was more to it. Details were reported by dispatch and telephone. The gist of it was that an enemy submarine was reported at 10:10, three miles off Coast Guard Station 50. Four minutes later, an HS-2, piloted by Ens. Eric Lingard, left the station, flew over the submarine at 400 feet and dropped a bomb which failed to explode. At 11:15, the C.O. of the station, Lt. Philip Eaton, USCG, took off in an R-9, reached the scene a few minutes later and bombed from 500 feet. The bomb hit about 100 feet off the starboard quarter. It too failed to explode. After firing four shots at the seaplanes, the sub submerged and was lost in thick smoke.

These are but a few of the 30 attacks reported by LCdr. Edwards. The evaluation of results was difficult, even as it was in a later war. The appearance of oil and sea growth on the surface after an attack was a common feature of reports in both wars. Then, as later, early assessments leaned toward the optimistic; post-war records gave the hard, cold facts. But more important than confirmed destruction was the extent to which Naval Aviators met the challenge of their first test in combat and presented a real threat to submarine commanders and kept them from their appointed tasks.



BOW SHOWS BOMB SIGHT DESIGNED AND BUILT AT LOUGH FOYLE.



STATION AT ILE TUDY SAW GREATEST NUMBER OF ASW MISSIONS.

A MEDAL OF HONOR EXPLOIT

NARROW CANAL AT PORTO CORSINI

IN THE ANNALS of Naval Aviation in World War I, no exploit for daring of execution and success in pulling it off is exceeded by that starring Naval Aviator #1494, Ens. Charles Hazeltine Hammann, USNRF. He and his fellow pilots were a unit of Naval Aviators who operated out of Porto Corsini in Italian planes.

This combination of American fliers and Italian aircraft had come about when the Italian government arranged for the U.S. Navy to take over and operate the air station at Porto Corsini, some 50 miles south of Venice. The take-over was accomplished July 24, 1918. Hoisting the flag, Lt. Willis B. Haviland, USNRF, put the new station in commission and air operations commenced. So successfully did the station carry out its mission that Admiral H. T. Mayo, USN, stated on the basis of his inspection November 10, 1918, that the station had "the distinction of being the most heavily engaged unit of the U.S. Naval Forces in Europe."

Lt. Haviland had come from Pauillac, France, in a special train which transported 331 men, certain officers and over 250 tons of supplies for the station. A detachment of officers and petty officer pilots arrived a little later from Lake Bolsena, 60 miles northeast of Rome, where they had been trained in the handling of Italian aircraft at the Naval Flying School. The school had been formally opened February 21, 1918, under the direction of Ens. W. B. Atwater. The courses, taught largely by Italians, included ground work and flying. Seventy-three men in all completed the curriculum. To back up maintenance, the Italian government had arranged for a special draft of mechanics selected from men training at the various Italian seaplane and motor factories.

That the Austrians were aware of the Americans' arrival at Porto Corsini was signaled by their carrying out a bombing attack, fortunately harmless, on the station on July 25th.

In accordance with the agreement with the Italian government, the U.S. forces were supplied with everything but food and clothing for the personnel. In the beginning, three planes were made available and the number of planes quickly increased, but there were never more than 21 altogether.

The planes the Navy used at Porto Corsini were Macchi types. Some of the bombing planes were M-8's, two-seater flying boats capable of carrying four 24-pound bombs and one machine gun. The M-5 Macchi fighters were one-seater flying boats, carrying two machine guns; two light bombs were occasionally added.

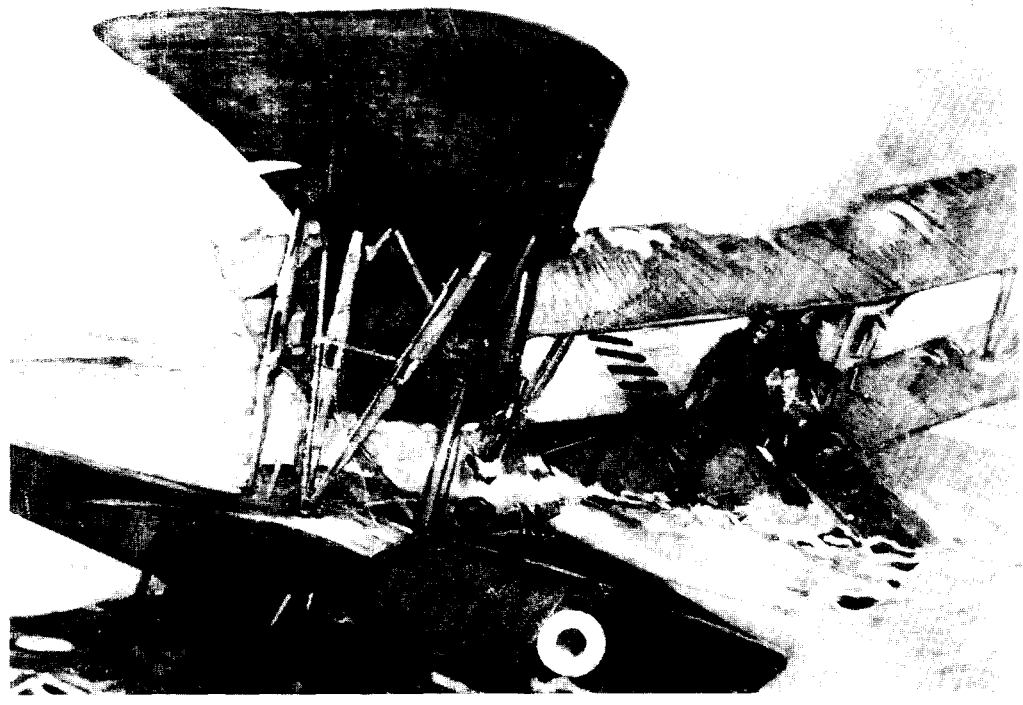
Porto Corsini was located in a strategic position in relation to Pola, the Austrian naval base which was, of course, the main objective of the U.S. Naval Aviators and their opposite numbers at the Italian Air Station in Venice. Since Venice was only about 50 miles north of Porto Corsini and 64 miles from Pola, air squadrons from both stations could rendezvous easily for a combined attack on the Austrian naval base. The battleships and cruisers of the High Sea Fleet were anchored at Pola and German and Austrian submarines went out from there in the Mediterranean campaign. The base and city were defended by 18 forts and batteries and there were no less than 114 antiaircraft guns in position. It was a formidable bastion.

Though Porto Corsini was in the right spot to launch an offensive, it had one tremendous disadvantage. All landings had to be made on a canal about 100 feet wide. This, combined with the necessity of taking off and landing directly into the wind, made for a real handicap since the prevailing wind was at right angles to the direction of the canal. This disadvantage was counteracted to some extent by training the pilots at Lake Bolsena to land on an area, marked off by buoys, which equaled the width of the Porto Corsini canal.

On August 21, the station at Porto Corsini carried out its first mission, In the middle of the morning, five fighters and two bombers set out with the purpose of dropping propaganda leaflets on Pola across the Adriatic. So popular had this mission become on the Italian Front at this time that the Austrians had announced that anyone caught engaged in this activity would

be regarded as a spy and summarily executed.

After the seven-plane group had been underway for about 15 minutes, one of the bombers and one of the fighters had to return on account of motor trouble. One bomber and the four fighters, the fighters flown by Ensigns George H. Ludlow, E. H. (Pete) Parker, Dudley A. Vorhees and Hammann, continued on, approaching Pola from the south in order to avoid fire from AA batteries at the harbor entrance. At 1120, the fighters arrived over the city at 12,000 feet, but the bomber was only able to get up to 8,000 feet. The leaflets were thrown down and the Austrians sent up AA fire. Five fighters of the *Albatross* type immediately took off, two seaplanes following them. The latter were soon lost to sight, but the enemy landplanes climbed rapidly and in five minutes neared the Navy's Macchi fighters. The enemy was coming in two sections, the first of which was made up of three planes.



ARTIST DEPICTS LUDLOW OUT OF COCKPIT ON WAY TO HAMMANN'S PLANE

ENS. LUDLOW gave the signal to attack to protect the bombing plane. Followed by Parker, Voorhees and Hammann, Ludlow went into a dive toward the three Austrian planes and the dog fight was on at 8,000 feet.

Ludlow attacked the lead plane with a quick burst of fire, then swung over to engage the plane to his left. Parker then took on the leader who tried to escape by diving. Parker followed him down. His right gun jammed, so he pulled out, firing from his one good gun on another Austrian which swept into view, and broke out of the fight. Vorhees no sooner got into action than his guns jammed and he was forced to leave. The bomber also departed. This left Ludlow and Hammann to carry on the fight. While Hammann took on the two planes of the second section, Ludlow was in a fight with three. He drove one down smoking and in the next instant he himself was shot down. He took hits in his propeller and engine, oil streamed out and broke into flames. He went into a spin but managed to pull out of it and make a landing five miles off the harbor entrance.

Looking down, Hammann saw Ludlow's wrecked plane in the water and determined to try rescuing him, an exceedingly daring decision since the wind was blowing at the rate of about 20 miles per hour and the sea was choppy. To land his plane in such a sea was bad enough, but worse still was the fact that Hammann's flying boat was damaged and he might not be able to take off. Furthermore, he was near the harbor and enemy planes were still in the vicinity. It seemed unlikely in these circumstances that Hammann could rescue Ludlow and make a getaway, for the enemy might easily capture them and the fate of spies would be theirs—execution.

Undeterred by these considerations, Hammann spiraled down and drew up beside Ludlow's crippled plane. Thereupon Ludlow opened the port in the bottom of the hull, kicked holes in the wings to make the Macchi sink faster and jumped over to Hammann's plane. He climbed up behind the pilot's seat and sat under the motor holding the struts to keep from being swept into the propeller or off into the sea.

The tiny Macchi was built to carry but one man. How he was going to get into the air, Hammann had no idea. The bow of the plane, already damaged by machine gun fire, was smashed in as the craft gathered speed, but finally the little seaplane got off.

After becoming airborne, Hammann fired his remaining ammo into the wrecked plane and watched it sink; he was not going to leave the enemy that trophy. He began his 60-mile flight back to Porto Corsini, momentarily expecting to be attacked. For reasons never discovered, the Austrians made no attempt to follow the damaged plane, a pursuit they could have undertaken with no hazard to themselves.

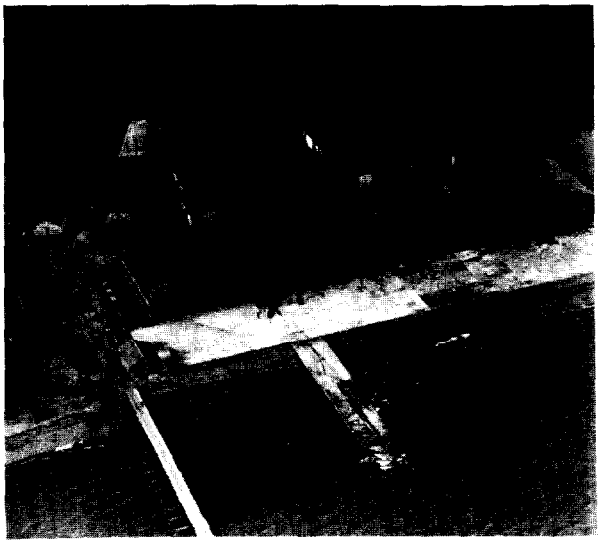
At Porto Corsini, Hammann made a good landing in the canal, but the water poured through the bow and turned the Macchi over, a complete wreck. The fliers climbed out with the assistance of boats that had come to help them. Ludlow had suffered a bad gash on his forehead and Hammann was badly bruised, but both were fit for duty within a few days.

The Italian government awarded the Silver Medal of Valor to Ens. Hammann and a similar bronze medal to Ens. Ludlow. Ens. Ludlow also received the Navy Cross.

The President of the United States presented Hammann the Medal of Honor, the first awarded a U.S. Naval Aviator. He was cited for heroism in landing on the water alongside Ludlow's disabled airplane. "Although his machine was not designed for the double load to which it was subjected and although there was danger of attack by Austrian planes, he made his way to Porto Corsini."

It is one of life's bitter ironies that less than a year later, on June 24, 1919, Ens. Hammann met his death in a Macchi plane of the same type he had used in his exploit over Pola.

JULY, AUGUST, SEPTEMBER, 1918



NAS ST. TROJAN NEAR GIRONDE RIVER IN FRANCE

The growth and expansion of Naval Aviation was in full stride. More stations were placed in commission and, as patrols were extended and intensified, U-boat commanders found the going progressively more difficult. Marine air units reached France; the Northern Bombing Group offensive began. The 1,000th Naval Aviator won his wings and many others neared that goal while training continued to expand. Although still too early to predict when the war would end, there was no doubt about the winning, and there was much to show that the end nearly was in sight.

JULY

1–NAS Lough Foyle, Ireland, was commissioned to provide seaplane patrol over the North Channel entrance to the Irish Sea. Commander H. D. Cooke, in command at commissioning, was relieved by Lt. Carl T. Hull later.

1–Ground school classes began at the University of Washington, Seattle, in a program similar to that established one year earlier at MIT.

4–NAS Whiddy Island, located on Bantry Bay, Ireland, was placed in commission. Westernmost of our seaplane stations, its planes met Atlantic convoys as they approached the British Isles.

5–Seaplanes piloted by Ens. Harold J. Rowen and QM1C C. J. Boylan left NAS Ile Tudy in answer to an "allo" off Point L'Ervilly. Both attacked what was assumed to be a submarine, but there was no evidence of damage.

7–The Naval Aircraft Factory completed its first contract for 50 H-16 flying boats.

9–Ens. J. J. Schieffelin, on a flight out of Killingholme, attacked a U-boat which surfaced after he left the scene and was sunk by gunfire from British destroyers.

14–NAS St. Trojan, France, near the mouth of the Gironde River, was commissioned, Lt. V. C. Griffin commanding.

15–The first F5L completed at the Naval Aircraft Factory made its maiden flight with FltCdr. MacGill, pilot, and LCol. Porte, Maj. Partridge and Maj. Wadsworth on board. It was an all-British crew except for Wadsworth who was a U.S. Army major on duty at the factory.

19–Pilots of two planes on patrol out of NAS Montauk sighted the USS *San Diego* after she had struck a mine off Fire Island and sent the first reports of her sinking.

19–Ens. J. J. Schieffelin, on a flight out of Killingholme, sighted a surfaced submarine off Whitby and attacked. His bomb kicked the stern clear of the water and the sub disappeared at a steep angle. The assessment, as on his earlier attack, was "probably seriously damaged."

20–The RAF station, Killingholme, England, from which U.S. pilots had been flying since February, was turned over to American forces and placed in commission as a naval air station. LCdr. Kenneth Whiting in command.

21–A surfaced U-boat, firing on a tugboat and three barges in full view of bathers on Nauset Beach, Cape Cod, was attacked by two seaplanes from NAS Chatham which dropped bombs that failed to explode. After firing on both aircraft, the submarine submerged and escaped,

23–The RAF facility at Eastleigh, England, was commissioned as an NAS for use as a supply, assembly and repair station supporting the Northern Bombing Group.

24–NAS Porto Corsini, Italy, was placed in commission with Lt. Willis B. Haviland in command.

25–The Secretary of War approved a recommendation of the Joint Army and Navy Airship Board, thus completing an inter-service agreement assigning responsibility for the development of rigid airships to the Navy.

27–The N-1, first experimental aircraft built at the Naval Aircraft Factory, made its first test of the Davis recoilless gun for which it had been designed. Lt. Victor Vernon piloted and Lt. Sheppard operated the gun which gave "a very satisfactory performance" against a target moored in the Delaware River near the factory.

30–Headquarters Company and Squadrons A, B, and C of the First Marine Aviation Force, arrived at Brest, France, on board the USS *DeKalb*. Upon disembarking, the squadrons were redesignated 7, 8, and 9 respectively, and the force proceeded to airdromes between Calais and Dunkirk for operations as the Day Wing, Northern Bombing Group.

31–A naval air detachment was established at Dunwoody Institute, Minneapolis, to conduct a ground school similar to those at MIT and the University of Washington.

AUGUST

5–A flying boat, piloted by Ens. A. W. Hawkins with Ltjg. G. F. Lawrence as second pilot, took off from NAS Killingholme in rain and poor visibility at 10:30 p.m. to patrol a course intercepting a reported Zeppelin raid. The patrol was made above the clouds without sighting the enemy and came down through heavy weather at South Shields, England, at 5:30 a.m., almost out of fuel. It was the first U.S. night patrol out of Killingholme and may have been the first of the war by a U.S. Naval Aviator.

11—Ens. J. B. Taylor made the initial flight in the Loening M-2 *Kitten* landplane at Mineola, L.I. It was the

first monoplane developed under Navy contract, one of the smallest planes ever built for the Navy (empty weight under 300 pounds) and, although initially equipped with a British ABC motor, was designed for the Lawrance 2-cylinder, 30-hp engine that was the forerunner of the American air-cooled radial engine.

13–Ens. Frank E. Wade was designated Naval Aviator No. 1,000 at NAS Pensacola. Because of fractional numbers assigned to many who preceeded him, however, he was not the 1,000th Naval Aviator.

13–Ens. Julian F. Carson on patrol out of Dunkirk, sighted a surfaced submarine which when challenged opened fire with its deck gun. Carson's plane was hit by shrapnel in several places, but he returned fire and moved into bombing position. His bombs hit as the submarine was submerging, forcing it to the surface at a sharp angle. It stayed there briefly, then slid stern first underwater. Carson was credited with a sinking by the French government and awarded the Croix de Guerre.

15–Independent offensive operations of the Northern Bombing Group began as Ens. Leslie R. Taber of Air Squadron One piloted a Caproni bomber on a night raid on the submarine repair docks at Ostend. On the flight, Ens. Charles Fahy was copilot; D. C. Hale rear gunner.

17–While on a tour of overseas facilities, Assistant SecNav Franklin D. Roosevelt visited NAS Paimboeuf and was taken up as a passenger in the AT-1 blimp.

19–Naval Air Station Halifax, Nova Scotia, was placed in commission, Lt. Richard E. Byrd commanding.

19–In trial runs observed by Naval Constructors H. C. Richardson and C. N. Liqued, the Kirkham 18-T experimental triplane fighter, built by the Curtiss Company, achieved speeds of over 160 mph on a measured course.

21–A flight of bombers and fighters from NAS Porto Corsini was intercepted by a superior force of Austrian planes over the naval base at Pola. During the fight, Ens. George H. Ludlow was hit and forced down off the harbor entrance. Ens. Charles H. Hammann, whose fighter was also damaged, evaded his pursuers, landed alongside the downed pilot, took him aboard, and flew back to base. For his extraordinary heroism, Hammann was awarded the Medal of Honor–the first Naval Aviator to be so honored.

27–After having been in operation for almost a year, the NAS Hampton Roads was placed in commission with LCdr. P.N.L. Bellinger in command.

27–The Secretary of the Navy signed General order No. 418 directing that "Applicable alike to regulars and reservists, the uniform of any given rank or rating in the Navy shall hereafter be identical in every respect throughout except for the necessary distinguishing corps devices and every officer of the Navy shall be designated and addressed by the title of his rank without discrimination whatever."

31–NAS North Sydney, a seaplane station on Cape Breton Island, Nova Scotia, was commissioned with Lt. Robert Donahue, USCG, in command.

In August, the Navy Department moved from the State, War, and Navy Building to quarters in a temporary structure on Constitution Avenue, now known as "Main Navy."

SEPTEMBER

1–The Commander U.S. Naval Aviation Forces, Foreign Service, assumed duty as Aid for Aviation to Admiral Sims, and new commands were set up for France, England, Ireland, Italy, and the Northern Bombing Group to control and direct operations in their respective areas.

3–An inspection and test department was established at NAS Pauillac, France, under command of Lt. C. P. Mason.

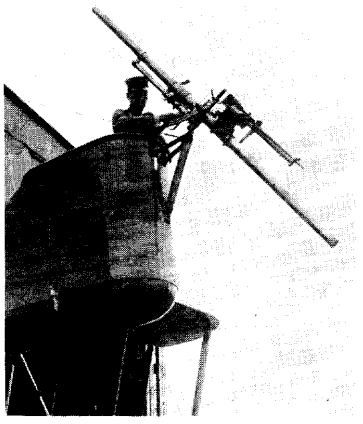
3–The first F5L assigned to service was delivered to NAS Hampton Roads. This twin-engine flying boat, built from a British design by the Naval Aircraft Factory and other manufacturers, was produced too late for use in the war, but saw extensive service in post-war years.

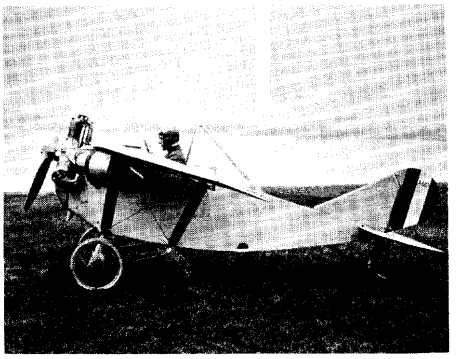
24–Ltjg. David S. Ingalls, while on a test flight in a Sopwith *Camel*, sighted an enemy two-seat *Rumpler* over Nieuport. He attacked and scored his fifth aerial victory in six weeks to become the Navy's first Ace.

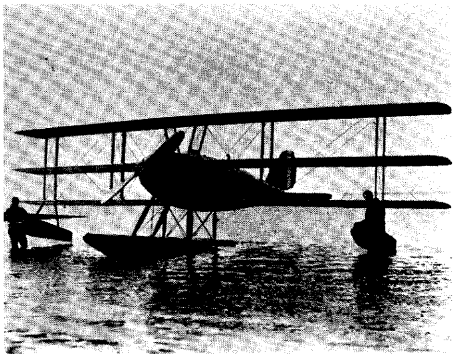
25–Chief Machinist Mate Francis E. Ormsbee went to the rescue of two men in a plane which had crashed in Pensacola Bay, pulled out the gunner, and held him above water until help arrived, then made repeated dives into the wreckage in an unsuccessful attempt to rescue the pilot. For his heroism, Ormsbee received the Medal of Honor.

27–Ens. Edwin S. Pou and QM2C F. H. Tittle, piloting two seaplanes from NAS Ile Tudy on convoy patrol near Point Penmarch, sighted a possible submarine and dropped bombs which set off violent underwater turbulence. The assessment was "probably damaged."

28–Lt. Everett Brewer and Sgt. Harry Wershiner, flying with RAF Squadron 218, shot down a Fokker, scoring the first Marine Corps victory in aerial combat.







DAVIS GUN *(left), here mounted on the N-l, fired a charge of birdshot or sand rearward to compensate for the projectile and eliminate recoil. Lewis machine gun zeroed in on target. Pilot of the Loening Kitten (center) is not a giant; the plane is a midget. Kirkham 18-T, a two-seat experimental fighter (right) adaptable to sea or land and built by the Curtiss Company, made better than 160 mph on tests.*