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"AERODROME"

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(PUBLICATION 3699)

CITY OF WASHINGTON
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THE 1914 TESTS OF THE LANGLEY "AERODROME"¹

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NOTE—This paper has been submitted to Dr. Orville Wright, and under date of October 8, 1942, he states that the paper as now prepared will be acceptable to him if given adequate publication.

It is everywhere acknowledged that the Wright brothers were the first to make sustained flights in a heavier-than-air machine at Kitty Hawk, North Carolina, on December 17, 1903.

Mainly because of acts and statements of former officers of the Smithsonian Institution, arising from tests made with the reconditioned Langley plane of 1903 at Hammondsport, New York, in 1914, Dr. Orville Wright feels that the Institution adopted an unfair and injurious attitude. He therefore sent the original Wright Kitty Hawk plane to England in 1928. The nature of the acts and statements referred to are as follows:

In March 1914, Secretary Walcott contracted with Glenn H. Curtiss to attempt a flight with the Langley machine. This action seems ill considered and open to criticism. For in January 1914, the United States Court of Appeals, Second Circuit, had handed down a decision recognizing the Wrights as "pioneers in the practical art of flying with heavier-than-air machines" and pronouncing Glenn H. Curtiss an infringer of their patent. Hence, in view of probable further litigation, the Wrights stood to lose in fame and revenue and Curtiss stood to gain pecuniarily, should the experiments at Hammondsport indicate that Langley's plane was capable of sustained flight in 1903, previous to the successful flights made December 17, 1903, by the Wrights at Kitty Hawk, N. C.

The machine was shipped to Curtiss at Hammondsport, N. Y. in April. Dr. Zahm, the Recorder of the Langley Aerodynamical Laboratory and expert witness for Curtiss in the patent litigation, was at Hammondsport as official representative of the Smithsonian Institution during the time the machine was being reconstructed and tested. In the reconstruction the machine was changed from what it was in 1903 in a number of particulars as given in Dr. Wright's

¹ For an account of early Langley and Wright aeronautical investigations, see Smithsonian Report for 1900 and *The Century Magazine* of September 1908.

list of differences which appears later in this paper. On the 28th of May and the 2d of June, 1914, attempts to fly were made. After acquiring speed by running on hydroplane floats on the surface of Lake Keuka the machine lifted into the air several different times. The longest time off the water with the Langley motor was approximately five seconds. Dr. Zahn stated that "it was apparent that owing to the great weight which had been given to the structure by adding the floats it was necessary to increase the propeller thrust". So no further attempts were made to fly with the Langley 52 HP engine.

It is to be regretted that the Institution published statements repeatedly ² to the effect that these experiments of 1914 demonstrated that Langley's plane of 1903 without essential modification was the first heavier-than-air machine capable of maintaining sustained human flight.

As first exhibited in the United States National Museum, January 15, 1918, the restored Langley plane of 1903 bore the following label:

THE ORIGINAL, FULL-SIZE
LANGLEY FLYING MACHINE, 1903

For this simple label others were later substituted containing the claim that Langley's machine "was the first man-carrying aeroplane in the history of the world capable of sustained free flight."

Though the matter of the label is not now an issue, it seems only fair to the Institution to say that in September 1928, Secretary Abbot finally caused the label of the Langley machine to be changed to read simply as follows:

LANGLEY AERODROME
THE ORIGINAL SAMUEL PIERPONT LANGLEY
FLYING MACHINE OF 1903, RESTORED.

Deposited by
The Smithsonian Institution

301,613

This change has frequently been overlooked by writers on the controversy.

² Smithsonian Reports: 1914, pp. 9, 219, 221, 222; 1915, pp. 14, 121; 1917, p. 4; 1918, pp. 3, 28, 114, 166. Report of U. S. National Museum, 1914, pp. 46 and 47.

In January 1942, Mr. Fred C. Kelly, of Peninsula, Ohio, communicated to me a list of differences between the Langley plane as tested in 1914 and as tested in 1903, which he had received from Dr. Wright. This list is given verbatim below. The Institution accepts Dr. Wright's statement as correct in point of facts. Inferences from the comparisons are primarily the province of interested experts and are not discussed here.

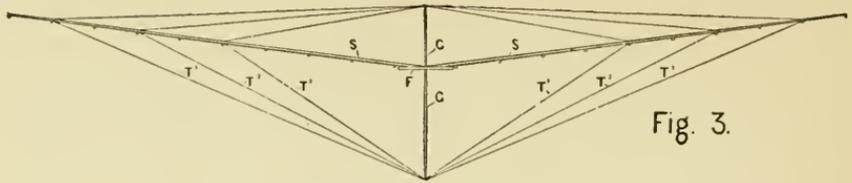
COMPARISON OF THE LANGLEY MACHINE OF 1903 WITH THE
HAMMONDSPORT MACHINE OF MAY-JUNE, 1914.

LANGLEY, 1903.

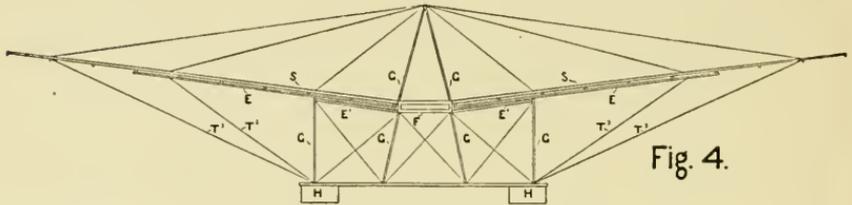
HAMMONDSPORT, 1914.

WINGS.

- | | | |
|---|---|--|
| 1 | SIZE: 11'6" x 22'6" (L.M. p. 206) | SIZE: 10'11 $\frac{3}{4}$ " x 22'6" |
| 2 | AREA: 1040 sq. ft. (L.M. p. 206) | AREA: 988 sq. ft. |
| 3 | ASPECT RATIO: 1.96 | ASPECT RATIO: 2.05 |
| 4 | CAMBER: 1/12 (L.M. p. 205) | CAMBER: 1/18 |
| 5 | LEADING EDGE: Wire 1/16" diameter (L.M. Pl.66) | LEADING EDGE: Cylindrical spar 1 $\frac{1}{2}$ " dia. at inner end, tapering to 1" dia. at outer end. |
| 6 | COVERING: Cotton fabric, not varnished. | COVERING: Cotton fabric, varnished. |
| 7 | CENTER SPAR: Cylindrical wooden spar, measuring 1 $\frac{1}{2}$ " dia. for half its length and tapering to 1" at its tip. (L.M. p. 204). Located on upper side of wing. | CENTER SPAR: Cylindrical spar about 1 $\frac{1}{2}$ " dia. at inner end, tapering to about 1" dia. at outer end. Located on upper side of wing. This center spar was reinforced (1) by an extra wooden member on the under side of the wing, which measured 1" x 1 $\frac{1}{2}$ " and extended to the 7th rib from the center of the machine; and (2) by another wooden reinforcement on the under side extending out about one-fourth of the length of the wing. |
| 8 | RIBS: Hollow box construction. (L. M. Plates 66,67) | RIBS: Most of the original Langley box ribs were replaced with others made at Hammondsport. (Manly letter, 1914). The Hammondsport ribs were of solid construction and made of laminated wood. That part of the rib in front of the forward spar was entirely omitted. |



LANGLEY WING TRUSSING 1903.



HAMMONDSPORT WING TRUSSING 1914.

- 9 LOWER GUY-POSTS: A single round wooden post for each pair of wings (see Fig. 3), 1 $\frac{1}{4}$ " in dia. 6 $\frac{1}{2}$ ' long. (L.M. Plate 62, p. 184).
- 10 The front wing guy-post was located 28 $\frac{1}{2}$ " in front of the main center spar. (L.M. Plate 53).
- 11 The rear wing guy-post was located 31 $\frac{1}{2}$ " in front of the main center spar. (L.M. Plate 53).
- 12 UPPER GUY-POSTS: For each pair of wings a single steel tube $\frac{3}{4}$ " dia., 43" long. (L.M. p. 184, pl. 62).
- 13 Front wing upper guy-post located 28 $\frac{1}{2}$ " in front of the main center spar. (L.M. pl. 53).
- 14 The rear wing upper guy-post was located 31 $\frac{1}{2}$ " in front of the main center spar. (L.M. pl. 53).
- 15 TRUSSING: The wing trussing wires were attached to the spars at the 5th, 7th and 9th ribs out from the center (L.M. pl. 54). The angles between these wires
- LOWER GUY-POSTS: Four for each pair of wings (see Fig. 4), two of which were of streamline form measuring 1 $\frac{1}{4}$ " x 3 $\frac{1}{2}$ " x 54" long; and two measuring 2" x 2" with rounded corners, 3'9" long.
- The front wing guy-posts were located directly underneath the main center spar, 28 $\frac{1}{2}$ " further rearward than in 1903.
- The rear wing guy-posts were located directly under the main center spar, 31 $\frac{1}{2}$ " further rearward than in 1903.
- UPPER GUY-POSTS: For each pair of wings, two streamline wooden posts each 1 $\frac{1}{4}$ " x 3 $\frac{1}{2}$ ", 76" long, forming an inverted V. (See Fig. 4).
- Front wing upper guy-posts located directly over main spar, 28 $\frac{1}{2}$ " further rearward than in 1903.
- The rear wing guy-posts were located directly over the main center spar, 31 $\frac{1}{2}$ " further rearward than in 1903.
- TRUSSING: A different system of wing trussing was used, and the wing trussing wires were attached to the spars at the 3rd, 6th and 9th ribs from the center. The angles between these wires

and the spars to which they were attached are shown in Fig. 3.

and the spars to which they were attached were all different from those in the original Langley machine. (See Fig. 4).

CONTROL SURFACES.

- 16 VANE RUDDER: A split vane composed of two surfaces united at their leading edges and separated 15" at their trailing edges, thus forming a wedge. Each surface measured 2'3" x 4'6", with aspect ratio .5. (L.M. p. 214, pls. 53,54).
- VERTICAL RUDDER: The Langley vane rudder was replaced by a single plane vertical rudder which measured 3'6" x 5', with aspect ratio of .7.
- 17 Operated by means of a wheel located slightly in front of the pilot at his right side and at the height of his shoulder (L.M. p. 216, pls. 53,54).
- Operated at Hammondsport through the Curtiss steering wheel in some tests, (Zahm affidavit pp. 5, 6), through the Curtiss shoulder yoke in some others (Manly letter, 1914), and fixed so as not to be operable at all in still others, (Zahm affidavit p. 7).
- 18 Used for steering only. (L.M. p. 214).
- Used "as a vertical aileron to control the lateral poise of the machine", (Zahm affidavit p. 6) as well as for steering, (Zahm affidavit p. 7).
- 19 PENAUD TAIL: This was a dart-shaped tail having a vertical and a horizontal surface (Penaud tail), each measuring 95 sq. ft. It was located in the rear of the main frame.
- TAIL RUDDER: Same size and construction as in 1903.
- 20 Attached to a bracket extending below the main frame.
- Attached to same bracket at a point about 8" higher than in 1903.
- 21 "Normally inactive", (L. M. p. 216) but adjustable about a transverse horizontal axis by means of a self-locking wheel located at the right side of the pilot, even with his back, and at the height of his shoulder. (L.M. pls. 51, 53).
- Operable about a transverse horizontal axis and connected to a regular Curtiss elevator control post directly in front of the pilot (Zahm affidavit p. 5).
- 22 Immovable about a vertical axis. (L.M. p. 214, pl.56, Fig. 1). No means were provided for adjusting this rudder about a vertical axis in flight. "Although it was
- Immovable about a vertical axis on May 28, 1914, only. Thereafter it was made movable about a vertical axis and was connected through cables to a Curtiss steering wheel mounted on a

- necessary that the large aerodrome should be capable of being steered in a horizontal direction, it was felt to be unwise to give the Penaud tail and rudder motion in the horizontal plane in order to attain this end". (L.M. p. 214).
- 23 KEEL: A fixed vertical surface underneath the main frame measuring 3'2" in height by 6' average length. Area 19 sq. ft. (L.M. pl. 53).
- Curtiss control post directly in front of the pilot.
- KEEL: Entirely omitted.

SYSTEM OF CONTROL.

- 24 LATERAL STABILITY: The dihedral only was used for maintaining lateral balance. (L.M. p. 45).
- LATERAL STABILITY: Three means were used for securing lateral balance at Hammondsport: The dihedral angle as used by Langley, a rudder which "serves as a vertical aileron" (Zahm affidavit p. 6), and the Penaud tail rudder. The last two constituted a system "identical in principle with that of Complainant's [Wright] combined warping of the wings and the use of the vertical rudder". (Zahm affidavit p. 6).
- 25 LONGITUDINAL STABILITY: Langley relied upon the Penaud system of inherent stability for maintaining the longitudinal equilibrium. "For the preservation of the equilibrium [longitudinal] of the aerodrome, though the aviator might assist by such slight movements as he was able to make in the limited space of the aviator's car, the main reliance was upon the Penaud tail." (L.M. p. 215).
- LONGITUDINAL STABILITY: At Hammondsport the Penaud inherent longitudinal stability was supplemented with an elevator system of control.
- 26 STEERING: Steering in the horizontal plane was done entirely by the split-vane steering rudder located underneath the main frame. (L.M. p. 214).
- STEERING: On one day, May 28, 1914, steering in the horizontal plane was done with the vertical rudder which had been substituted for the original Langley split-vane steering rudder. After May 28th the steering was done by the vertical surface of the tail rudder (Zahm affidavit p. 7), which in 1903 was immovable about a vertical axis, (L.M. p. 214).

POWER PLANT.

- | | | |
|----|---|---|
| 27 | MOTOR: Langley 5 cylinder radial. | MOTOR: Langley motor modified. |
| 28 | IGNITION: Jump spark with dry cell batteries. (L.M. p. 262). | IGNITION: Jump spark with magneto. |
| 29 | CARBURETOR: Balzer carburetor consisting of a chamber filled with lumps of porous cellular wood saturated with gasoline. The air was drawn through this wood. There was no float feed. (L.M. p. 225). | CARBURETOR: Automobile type with float feed. |
| 30 | RADIATOR: Tubes with radiating fins. | RADIATOR: Automobile radiator of honeycomb type. |
| 31 | PROPELLERS: Langley propellers (L.M. pl.53, pp. 178-182). | PROPELLERS: Langley propellers modified "after fashion of early Wright blades". |

LAUNCHING AND FLOATS.

- | | | |
|----|---|--|
| 32 | LAUNCHING: Catapult mounted on a houseboat. | LAUNCHING: Hydroplanes, developed 1909-1914, attached to the machine. |
| 33 | FLOATS: Five cylindrical tin floats, with conical ends, attached to underside of main frame at appropriate points, and about six feet above lowest part of machine. | FLOATS: Two wooden hydroplane floats, mounted beneath and about 6 feet to either side of the center of the machine at the lateral extremities of the Pratt system of trussing used for bracing the wing spars of the forward wings; and one (part of the time two) tin cylindrical floats with conical ends, similar to but larger than the Langley floats, mounted at the center of the Pratt system of trussing used for bracing the rear wings. All of the floats were mounted from four to five feet lower than the floats of the original Langley, thus keeping the entire machine above the water. |

WEIGHT.

- | | | |
|----|--|--|
| 34 | TOTAL WEIGHT: With pilot 850 pounds (L.M. p. 256). | TOTAL WEIGHT: With pilot, 1170 pounds. |
| 35 | CENTER GRAVITY: 3/8" above line of thrust. | CENTER GRAVITY: About one foot below line of thrust. |

Since I became Secretary, in 1928, I have made many efforts to compose the Smithsonian-Wright controversy, which I inherited. I will now, speaking for the Smithsonian Institution, make the following statement in an attempt to correct as far as now possible acts and assertions of former Smithsonian officials that may have been misleading or are held to be detrimental to the Wrights.

1. I sincerely regret that the Institution employed to make the tests of 1914 an agent who had been an unsuccessful defendant in patent litigation brought against him by the Wrights.

2. I sincerely regret that statements were repeatedly made by officers of the Institution that the Langley machine was flown in 1914 "with certain changes of the machine necessary to use pontoons", without mentioning the other changes included in Dr. Wright's list.

3. I point out that Assistant Secretary Rathbun was misinformed when he stated that the Langley machine "without modification" made "successful flights".

4. I sincerely regret the public statement by officers of the Institution that "The tests" [of 1914] showed "that the late Secretary Langley had succeeded in building the first aeroplane capable of sustained free flight with a man."

5. Leaving to experts to formulate the conclusions arising from the 1914 tests as a whole, in view of all the facts, I repeat in substance, but with amendments, what I have already published in Smithsonian Scientific Series, Vol. 12, 1932, page 227:

The flights of the Langley aerodrome at Hammondsport in 1914, having been made long after flying had become a common art, and with changes of the machine indicated by Dr. Wright's comparison as given above, did not warrant the statements published by the Smithsonian Institution that these tests proved that the large Langley machine of 1903 was capable of sustained flight carrying a man.

6. If the publication of this paper should clear the way for Dr. Wright to bring back to America the Kitty Hawk machine to which all the world awards first place, it will be a source of profound and enduring gratification to his countrymen everywhere. Should he decide to deposit the plane in the United States National Museum, it would be given the highest place of honor, which is its due.