BULLETINS

OF THE

Aerial Experiment Association

Bulletin No. XXVIII Issued MONDAY, JAN 18, 1909

MR. McCURDY'S COPY.

BEINN BHREAGH, NEAR BADDECK, NOVA SCOTIA

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Bulletins of the Aerial Experiment Association.

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Beinn Bhreagh, Near Baddeck, Nova Scotia.

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EDITORIAL NOTES AND COMMENTS.

Conferences.

Jan. 8, 1909:- The New Year is always a time for making good resolutions, and the members of the A.E.A., present at Beinn Bhreagh, have come to the conclusion that it would be a good plan in the future that the desultory meetings they have held in the headquarters building should become regular daily meetings at 4 P.M., to talk over the work of the Laboratory and that a journal should be kept recording the points discussed.

The first regular conference was held Wednesday Jan. 6; present, the Chairman Dr. A.G. Bell, and Mr. F.W. Baldwin. Also Mr. William F. Bedwin, Superintendent of the Laboratory, and Mr. Gardiner H. Bell, Asst. Editor of the Bulletin.

Mr. J.A.D. McCurdy, Secretary of the A.E.A., arrived at Beinn Bhreagh this morning (Jan. 8) and was present at the third conference held this afternoon. A.G.B.

"Where are we at".

Jan. 11, 1909:- Where are we at! It will be a good plan for us to look back over the line of experiments to see clearly at what point we have arrived and what are the chief points we have now to consider. This is more particularly necessary now because we have arrived at a period of depression. We have had our ups and downs and we have now arrived at a point when we are, all of us, decidedly down.

Curtiss has had an aggravating time with his engine.

McCurdy couldn't fly his "Silver-Dart" when he had important witnesses present and the "Loon" failed to rise from the water.

Baldwin has been unable to get his new hydredrome, the "Query", to rise on her hydro-surfaces.

I have planned Drome No. 5 to carry a man and an engine of the weight of a man, and the engine for which I have been waiting weighs two or three men, so that there does not seem much prospect for flying the machine as a kite as intended.

Now there is one thing that strikes me in looking back over our difficulties. That we have, all of us, struck the same snag - a difficulty in propulsion. This subject then should, I think, be carefully considered and discussed by us. I am not myself familiar with the subject of motors and therefore submit with diffidence a few elementary thoughts for discussion, relating to the propulsion of a flying machine; and I have asked Mr. McCurdy to prepare also a short statement of certain views he has expressed to me upon the same subject which appear to me to be novel and to be very important if well founded. A.G.B.

<u>McCurdy's proposition relating to Propulsion.</u>

<u>Jan. 11, 1909</u>:- As I get McCurdy's idea it is this:-

(1) Given a weightless aeroplane of a specified area and tilted up in front at a specified angle it will take a certain propeller thrust to move it <u>horisontally</u> against the resistance of the air at a specified speed.

(2) If this weightless aeroplane travels horizontally through the air at the specified velocity and with the specified inclination it will be capable of supporting a certain load.

(3) It will take ~~no~~ more power to drive the loaded aeroplane at the supporting velocity than to drive the unloaded one. The propeller thrust will be the same in both cases.

This is an important proposition if true. A.G.B.

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Telegrams from Members.

Curtiss to Bell.

Hammondsport, N.Y., Jan. 1, 1909:- Expect to try "Loon" to-day. Have seventy miles pitch speed, and two hundred and seventy-five lbs. pull. Seven and one-half foot propeller. Direct drive. Revolutions nine hundred and sixty.

(Signed) G.H. Curtiss

Curtiss and McCurdy to Bell.

Hammondsport, N.Y., Jan. 2, 1909:- Gave vaudeville performance to-night by moonlight with "Loon". First hydro test successful, second aerodrome test fairly successful, third submarine test most successful of all. Experiments ended.

(Signed) Curtiss and McCurdy.

Bell to Curtiss and McCurdy.

Baddeck, N.S., Jan. 4, 1909:- Sorry for vaudeville performance. Hope McCurdy O.K. Patent matters at a standstill waiting your arrival here. Please come on at once.

(Signed) Graham Bell.

Curtiss to Mrs. Bell.

Hammondsport, N.Y., Jan. 4, 1909:-Everything fight here. McCurdy left to-day via Toronto. Have written.

(Signed) G.H. Curtiss.

Curtiss to Bell.

Hammondsport, N.Y., Jan. 5, 1909:-Will come at once if absolutely necessary; but have to return by the fourteenth for Director's Meeting, and other important business. See letter. You have my proxy in patent matters.

(Signed) G.H. Curtiss.

McCurdy to Bell.

Truro, N.S., Jan. 7, 1909:- Arrive at Iona by Sydney Flyer to-night.

(Signed) J.A.D. McCurdy.

Bell to Curtiss.

Baddeck, N.S., Jan. 12, 1909:-Your presence necessary to determine the names to be signed to the application for a patent. No proxy will meet the case. Please come immediately after your Director's Meeting if possible.

(Signed) Graham Bell.

Bell to Mauro, Cameron, Lewis & Massie.

Baddeck, N.S., Jan. 12, 1909:- Hammondsport members made no comments on specification. Please forward ammended claims for our consideration as to names of inventors. All members will be here at the end of this week.

(Signed) Graham Bell.

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Curtiss to Mrs. Bell.

To Mrs. A.G. Bell,
Baddeck, N.S.

Hammondsport, N.Y., Jan. 2, 1909:- John is planning to leave this afternoon for Baddeck, although we have not had an opportunity to try the "Loon". Everything has been ready now for some time awaiting favorable weather conditions.

Lucien and his school-mate were here for a day or two last week, and I believe John is going by way of Toronto. I am sorry we could not have made the tests with the "Loon", but it is pretty slow business in the winter time when you have to wait a week or more at a time for a good day and then something may happen to prevent a successful trial. We are preparing to ship the "Silver-Dart" to Baddeck. The crates are made and we will start taking it down to-morrow. We have delayed this a little thinking we might get a chance to give it another trial. There has been a lot of problems, especially with propellers, which were hard to figure out.

We have had no trouble with the engine of late, except for the freezing up at the time Mr. Bell was here; in fact, the only real engine trouble we have had was the cylinders blowing off. We will bring the engine to the shops and give it a thorough test before shipping it to Baddeck. We have kept the motor in one machine or the other nearly all of the time, and have not had any opportunity to make any long runs. As soon as this can be done I will come to Baddeck.

(Signed) G.H. Curtiss.

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Curtiss to Bell.

To A.G. Bell,
Baddeck, N.S.

Hammondsport, N.Y., Jan. 9, 1909:- Since reading in the last Bulletin about Baldwin's brake test of the four cylinder motor, I am convinced that it will be best to make a thorough test of the eight cylinder before shipping it to Baddeck. We will also test a motor similar to the one you have as it is evident that Baldwin was not getting full power, although 10 H.P. at 1000 is not so bad considering that the engine at the time would speed only to 1400 idle.

All the parts of the "Silver-Dart", together with materials, tools, silk, etc., belonging to the Association, went forward by express Jan. 6th. After reaching Bath it was found necessary to send by freight as far as Niagara Falls on account of the size of the package. If the Canadian Express cars will accommodate it, it will go by express from there, otherwise it will go all the way through by freight.

(Signed) G.H. Curtiss.

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TRIAL OF THE LOON, JAN. 2, 1909: By J.A.D. McCurdy.

Beinn Bhreagh, Jan. 9, 1909:- On January 2, 1909 the "Loon", fitted with its hydro-surfaces, was taken from the shed over to the head of the Lake. After she was placed in the water between her docks the engine was started by Mr. Curtiss and the operator's seat taken by McCurdy. At the signal to let go she started sluggishly forward, and after running for about 100 yards rose on her hydro-surfaces with the pontoons completely out of water.

Immediately it was noticed that instead of running smoothly as was anticipated, gradually gaining in speed, a tremendous commotion was created in the water by the hydro-surfaces, and the maximum speed attained by the machine seemed to be about 8 or 10 miles an hour.

After running down the Lake for a short distance the machine showing no increase of lift, the engine was accidentally shut off by the breaking of an electric wire; there being no wind, however, she was easily towed back to the dock by means of a row-boat.

Newspaper men on shore reported that the machine was seen flying over the Lake and were very enthusiastic about what they thought a flight. Their impression, however, was derived from the fact that, although the boats themselves were out of the water, they didn't realise that the hydro-surfaces were still on the water.

We were satisfied by this time that the hydro-surfaces, as had already been suggested by Mr. Bell, were "ten times too large". They had been made to fit to the boats in sockets so that they could be easily removed. With the aid of this construction and the help of a saw the hydro-surfaces were entirely removed from the boats.

The first trial had been made after five o'clock in the afternoon and it was, therefore, quite dark; but by the time everything was in readiness for a second trial the moon had come up and the whole Lake flooded with light.

About seven o'clock the second trial of the "Loon" without hydro-surfaces was made. As she shot from the docks after the signal was given to let go, I felt a sudden jar and realized at the time that she had struck something projecting from the docks, however thought nothing more about it at the time as in a second or two we were well out on the Lake. She had her old speed back again this time and, although not measured, seemed to be about the same as in former experiments (27 miles an hour).

The course taken was about half a mile down the Lake, turning and coming back. By this time the wind had risen to about, I should judge, 15 miles an hour, and so, before the row-boat could get up to me, I drifted to leeward of the dock about 100 feet. The machine was, however, easily towed to the dock, canal boat fashion, men walking along the shore pulling by means of a rope. No sooner, however, had we brought her abreast of the piers (the port pontoon being adjacent to the piers) than she began to sink, the starboard boat and wing going completely down in about 12 feet of water.

The boat had sprung a leak, that was a certainty, and it was a question among the men at the time whether the leak was caused by the jar as she was let go from the docks or whether I had run into some floating ice which was quite abundant. By means of rope and pries the "Loon" was hauled from the water without causing any damage to the machine, and investigation showed that the stern post of the starboard pontoon had been entirely ripped out by coming in contact with one of the posts of the piers as she was getting away. This left a hole about 18 inches high by 4 inches broad. While the machine was kept under way the water found not time to enter this hole but as soon as the machine was brought to a stand-still the water poured in and as it was comparatively dark it was unnoticed by the spectators.

The machine was left on the shore for the night and taken to the shed early the next morning, January 3, where she was dismantled and put away for the winter.

J.A.D. McC.

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BEINN BHREAGH EXPERIMENTS: Reported by the Editor.

Drome No. 5.

Jan. 4, 1909:- Aerodrome No. 5 has been still further strengthened by wiring from the ridge-pole to the keel stick, and by putting tension wires in at other parts of the structure. The two banks of cells which had been prepared to fill in the spaces on either side of the central body frame (see Bulletin XXIV p. 46) no longer fit, on account of the heavy beading there and Mr. Baldwin recommends omitting them altogether and substituting some open framework which will not interfere with the aviator's view below and on either side. He thinks the aerodrome is now sufficiently strong, and he tested its rigidity to-day by getting into it while it was supported from below at only four points four meters apart, there being no support directly beneath the center. He reports that the whole structure seemed solid and stood his weight of 175 lbs. perfectly well. The aerodrome is now ready to receive the engine bed and propeller which will now be fitted in. A.G.B.

Testing the Stability of the "Query".

Jan. 4, 1909:- Experiments were made to-day in Beinn Bhreagh Harbor to test the stability of Baldwin's new hydrodrome "The Query" without any hydro-surfaces upon her. The engine had been provided with a balance wheel of smaller diameter than before so that it could be placed nearer the bottom of the boat thus lowering the center of gravity. The process of testing was as follows:-

The "Query" was hauled over on her beam ends in the water until a position was reached such that a very little further tip would have upset her. She was held steadily in this critical position of unstable equilibrium while a plumb-line was dropped from the top of the structure to the water to ascertain the vertical height of this point. The horizontal distance of the plumb-line from the boat at the water level was also measured, so as to obtain horizontal and vertical readings from which the angle of tip could be calculated.

With Mr. Baldwin on board the critical position was reached when the base-line measured 23 inches, and the plumb-line 41 inches. Without any one on board the base-line measured 18 inches and the vertical 41. A.G.B.

First Trial of the "Query".

Jan. 5, 1909:- On account of ice in Beinn Bhreagh Harbor and Baddeck Bay it was necessary to carry the "Query" over to the Central Wharf to reach open water. Here she made her first trial to-day. It is also noteworthy that this was the first time an attempt had been made to steer a boat with the rudder in the bow instead of in the stern. The aerial rudder formerly used on the Dhonnas Beag was employed. It measured three feet by three and was placed five feet from the bow. There was no submerged rudder.

Propellers:- Two propellers were employed 88 inches in diameter, 22° 30' at tip; gearing 8:24.

Weight:- Total weight 647 lbs, (Hull with surfaces etc 225 lbs, engine and frame 173 lbs, propellers and chain 60 lbs, battery and coil 14 lbs, Mr. Baldwin 175 lbs, total 647 lbs).

Hydro-surfaces:- Two sets forward 5 feet from bow, one set aft five feet from stern. Each set consisted of three blades, curvature 1:15, spaced 6 inches apart, and the hydro-curves were all set at an angle of 5 degrees. The blades were all 3 3/16 inches wide from fore to aft. In the front sets the top blades were 30 inches long from side to side, the middle blades 24 inches and the bottom blades 18 inches. In the after set the top blade measured 26 inches from side to side, the middle blade 24 inches, and the bottom blade 18 inches.

Exp. 1 The "Query", running under her own power with double propellers covered 100 meters in 28 seconds.

The engine however was not running very well. The "Query" did not lift out of the water, although her bow lifted to about amidships. The stability was all that could be desired, but the aerial rudder did not steer her. This was probably due to the fact that the rudder had been placed almost directly over the front set of hydro-surfaces which would naturally prevent her from turning. In this experiment the auxiliary ports of the engine were open.

Exp. 2 The auxiliary ports were then closed and the engine did much better; but, as the rudder was useless, no estimate of speed could be taken. During the course of this experiment Baldwin shifted his position as far forward as possible to correct the lifting by the bow. This improved the longitudinal balance but the boat did not rise clear of the water.

Exp. 3 The hydro-surfaces were then removed and the "Query" tried again without them. The speed was much improved but no measurements were made. Baldwin thinks it was probably more than 15 miles an hour. Steering however proved to be impossible although in this case there were no hydro-surfaces to interfere with the steering action. The omission of the hydro-surfaces materially impaired the stability of the boat. A.G.B.

Flexible hydro-surfaces on the Dhonnas Beag.

Jan. 5, 1909:- The Dhonnas Beag no longer being needed for Baldwin's experiments, she was to-day fitted with flexible hydro-surfaces as suggested in Editorial Oct. 17, 1908 (see Bulletin XVI pp 8-9).

Mr. Bedwin designed and made the hydro-surfaces from the general description given in the Editorial, and without any specific instructions concerning dimensions etc. He has supplied the following details illustrated by a blue print.

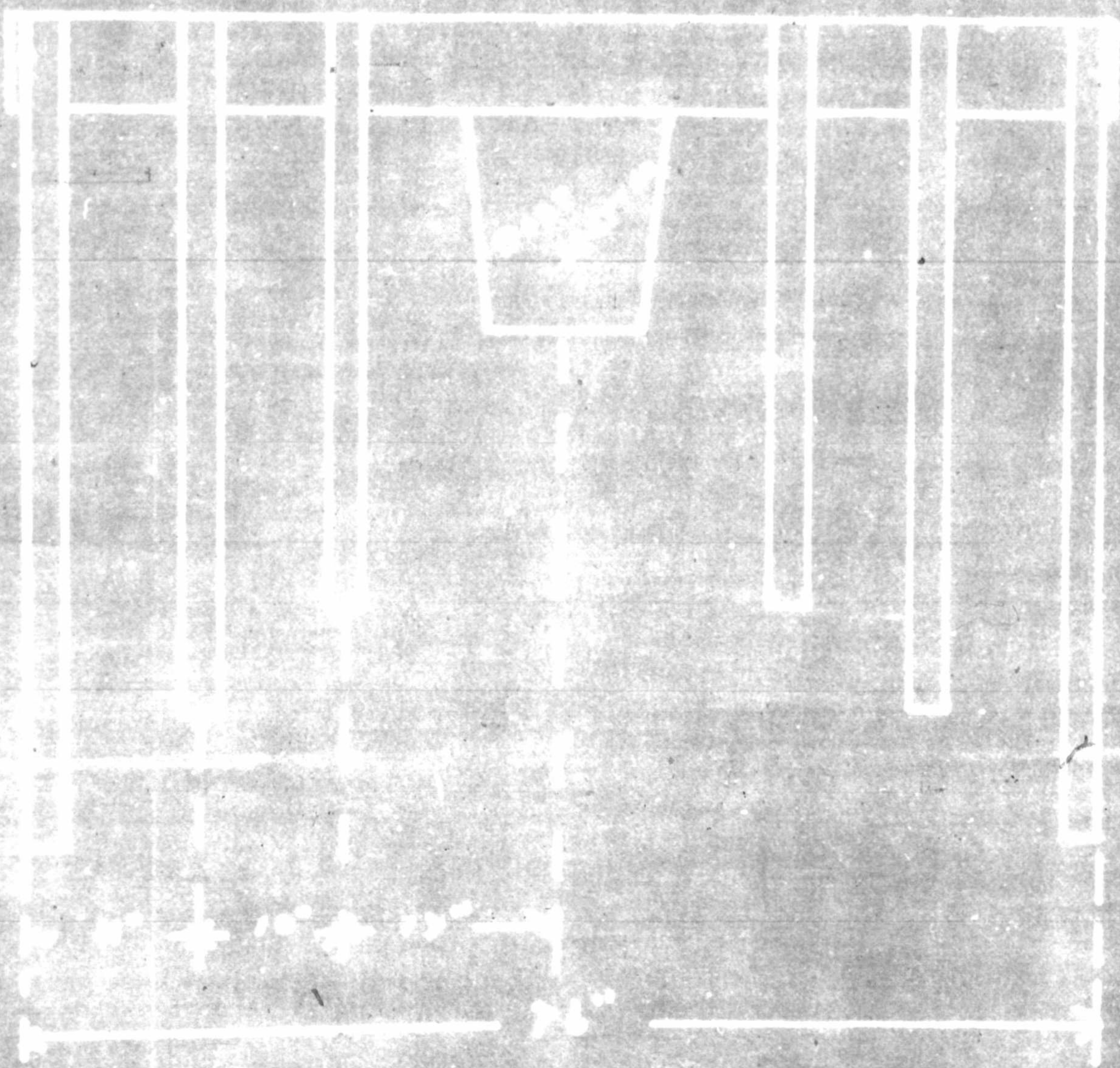
Dimensions:- Hull 20 ft. long; distance between the trusses supporting the hydro-surfaces 8 ft. 6.5 inches; normal angle made by the hydro-surfaces with the deck of the boat 60°. There were six hydro-surfaces in the front set, and two in the after set - made of wood.

In the front set the outer pair of surfaces were 4 feet 9 inches long and two and a half inches wide. They were 11/16 of an inch thick at the top tapering to 3 /16 of an inch thick at the bottom. The intermediate pair were four feet long, two and a half inches wide, and 5/8 of an inch thick at the top tapering to 3/16 of an inch thick at the bottom. The inner pair were three and a half feet long, two and a half inches wide, and 7/8 of an inch thick at the top tapering to 3/16 of an inch at the bottom.

In the after set there was a single pair each four feet nine inches long, two and a half inches wide, and 11/16 of an inch thick at the top tapering to 3/16 of an inch thick at the bottom.

Weight:- Total weight of Dhonnas Beag fitted with flexible hydro-surfaces 200 lbs. (Hull 90 lbs, outriggers and floats 28 lbs, forward truss and attached hydro-surfaces 41 lbs, after truss and hydro-surfaces 26 lbs, piece of iron used to balance boat properly 15 lbs. total 200 lbs).

Forward Hyd. Surfaces



Aft set same as forward set with only one (the outer) surface on [illegible] side

[illegible] Hydro Surfaces
on "Dhonnas Beag"

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Experiment:- The Dhonnas Beag provided with flexible hydro-surfaces as above described, was taken to-day (Jan.5) to the Central Wharf and launched upon Baddeck Bay. She was then towed by the Gauldrie, and the following observations of speed and pull were made.

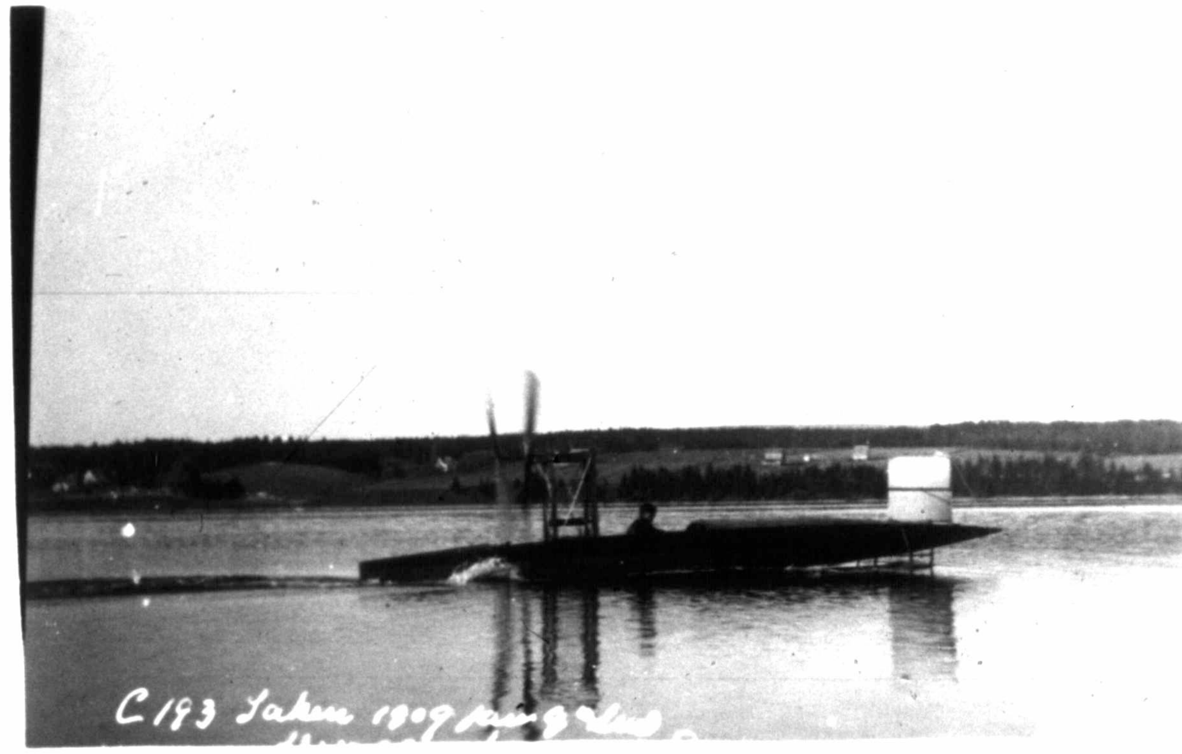
	Speed	Pull
	100 m. in 39 sec.	95 lbs.
	100 m. in 42 sec.	100 lbs.
	100 m. in 40 sec.	100 lbs.
	100 m. in 37 sec.	90 lbs.
	100 m. in 39 sec.	95 lbs.
Aggregate	500 m. in 197 sec.	480 lbs.
Average	100 m. in 39.4 sec.	Pull 96 lbs.

The Dhonnas Beag did not succeed in rising clear of the water on her flexible hydro-surfaces. She rose however every time the towing-line was pulled rapidly in by hand showing she was near her supporting speed.

It became obvious that the whole arrangement was too heavy to be supported upon these surfaces at the speed of the Gauldrie and it was decided to attach them to a light frame instead of the Dhonnas Beag and try them again another day. A.G.B.

Second Trial of the "Query".

Jan. 9, 1909:- In the experiments (Jan.5) the "Query" had failed to rise out of water, indicating that her submerged surfaces were not large enough. She had been provided with three sets of hydro-surfaces two at the bow and one at the stern, and she had shown a tendency to rise at the bow more than the stern. It was then decided to increase the area of her submerged surfaces by giving her another set at the stern.


C 193 Taken 1909

To-day (Jan.9) she was tried with four sets of hydro-surfaces like those described in notes Jan.5, two in front and two behind (see photographs in this Bulletin).

Exp. 1:- The "Query" made a run from the Central Wharf under her own motive power propelled by two propellers as on the former occasion (Jan.5). She did not seem to go at any great speed the hydro-surfaces seeming to act as a drag more than a help: Nor did she rise from the water.

It is somewhat remarkable that so far even in Baldwin's most successful experiments with the Dhonnas Beag, with the boat well out of water, and with only the hydro-surfaces submerged, no great speed has been obtained. In fact the speed without the hydro-surfaces has been greater than with them. The same thing seems to be true of the "Query". We only hope that the new Curtiss engine we expect from Hammondsport may give us sufficient power to make these small surfaces show what there may be in them. With our present engine power it is obvious that we cannot lift the "Query" out of the water without enlarging the area of the submerged surfaces which is inadvisable from the speed point of view, or without lightening the boat which is impracticable.

Exp. 2:- An experiment was made to ascertain whether the boat would rise out of the water at the speed of the Gauldrie if relieved of the weight of the engine and man. The engine was taken out of her, and the empty hull towed by the Gauldrie at a speed of about seven miles an hour. The speed proved to be insufficient and she did not rise. The pull on the towing-line was steady at 40 lbs.

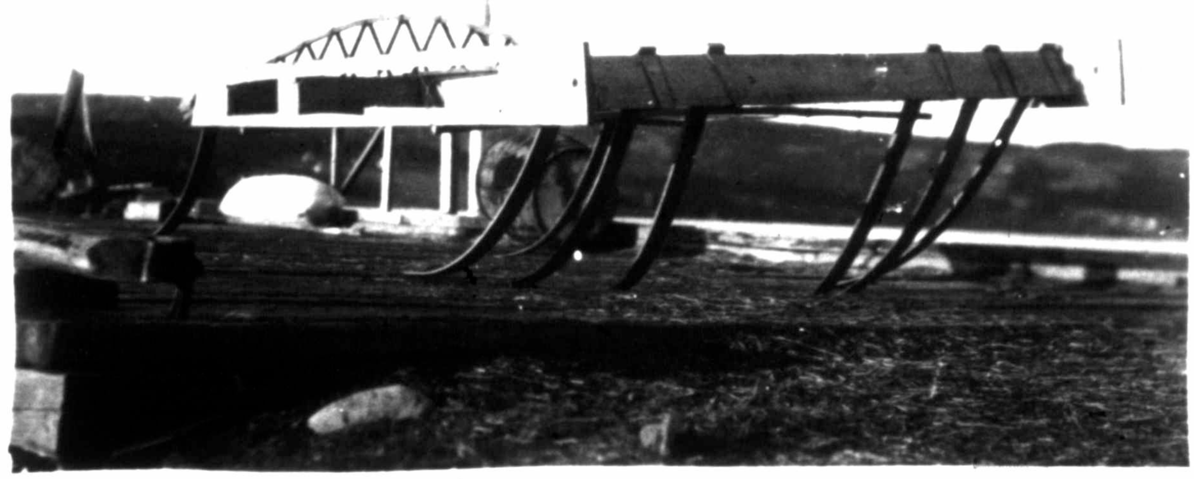
It is hoped that better results may be obtained with the new engine, but we can hardly expect different results with the present engine unless we use larger submerged surfaces. A.G.B.

Flexible hydro-surfaces upon "The Crab".

Jan. 9, 1909:- The "light frame" decided upon for the flexible hydro-surfaces Jan. 5 in place of the Dhonnas Beag turns out to be not so very light after all. Weight 146 lbs. It consists of a rough wooden framework made of thick boards to which the trusses carrying the flexible rods are attached. It is a very clumsy crude contrivance and when it was placed upon the Central Wharf to have its photograph taken we all laughed heartily at the ridiculous appearance it made wobbling about on its fleixible legs and named it at once "The Crab". (See photograph in this Bulletin)

When the "Crab" was placed to-day in the water it floated low not being provided with special floats. When towed by the Gauldrie however, the framework rose out of the water about 18 inches supported upon its flexible hydro-surfaces (see photograph in this Bulletin). Pull about 70 lbs.

When we look at the crude construction of the present apparatus and note that it rose out of the water at the low speed of 7 miles, one cannot avoid wishing to see the experiment tried again with a more carefully made machine. We cannot interrupt more important experiments, but we may perhaps be able to spare time to test an apparatus possessing a large number of thinner and more flexible rods, a




Taken

regular tooth-comb sort of arrangement, making up in number of rods for the weakness of the individual members. In order to have flexibility the rods should individually be thin and supple, and the load should be distributed through a large number of them, instead of being concentrated upon a few as in the eight-legged "Crab". A.G.B.

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THOUGHTS CONCERNING PROPULSION: By J.A.D. McCurdy.

Jan. 11, 1909:- To get an idea of the carrying power of the "Silver-Dart" and of the propeller thrust required to maintain the machine in flight I employed the tables and figures given us by Langley and Lilienthal and arrived at the following results.

Assume a speed of travel relatively to the air of 35 miles an hour.

The machine flies at an angle of attack of 6° and there are 420 sq. ft. of supporting surface. The equivalent flat surface of the machine from its structural point of view including the surface area which the operator and power plant present amounts to 17.94 sq. ft.

Under these conditions the machine will support a total load of 1424 lbs. and the propeller thrust required would be 192.9 lbs.

We are only causing the machine to carry 860 lbs. Is this an economical state of affairs or not, or could we just as well carry the full capacity of the machine from our theoretical conclusions.?

In general terms here is the proposition. Suppose a purely theoretical plane - which will be weightless - to advance horizontally through the air at a given speed and maintaining a definite angle of attack. The reaction of the normal pressure of the air on this plane will produce two results which we call lift and drift.

The plane traveling horizontally at this angle of attack and at the speed will necessarily support a certain definite load.

The plane traveling horizontally at the angle of attack and at this speed will require a definite propeller thrust.

Now do we gain anything in efficiency by having our machine weigh less than the carrying power of the planes. The only difference noticed by the spectators at Fort Meyer, between the flight of the Wright machine when carrying one man, and carrying two men was that the machine took longer to acquire its necessary speed before taking the air, when it carried two men, because its mass was then greater than with one man.

The propeller push was just the same in both cases, and the speed of the machine when flying was the same in both cases.

<u>QUERY</u>:- Does the flying machine adjust itself automatically in reference to the angle of attack according to the load which it is required to lift.

J.A.D. McC.

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THOUGHTS CONCERNING PROPULSION FROM THE STAND-POINT OF PURE PHYSICS: By A. G. Bell.

Jan. 11, 1909:- All flying machines depend for their propulsion upon the inertia of the air.

The usual method of propulsion consists in pushing air backwards by means of an extended surface, or propeller blade. The reaction then pushes the machine forwards.

In order to typify the essential action in its simplest form, imagine a couple of balls with a compressed spiral spring between them. In this conception one ball represents the machine, the other the air that is pushed backwards, and the spiral spring between them typifies the engine power employed. Release the spring, and the balls are pushed apart, the machine going one way, and the air the other.

Relatively to one another, each ball moves with the same velocity. That is: One ball moves away from the other just as fast as the other moves away from it: But, relatively to the surrounding quiescent air or to the earth, they move with different velocities dependent upon their mass or weight, the heavier body moving with slower velocity. They move in opposite directions with equal momenta (not equal velocities), which is simply another way of saying that "action and reaction are equal and opposite".

Let M represent the mass or weight of the machine, and V its velocity: Let m represent the mass or weight of the air that is pushed backwards by the propeller and v its velocity: And let the direction which the machine moves be considered as + and the opposite direction as − : Then $M(+V) = m(-v)$ or:-

$$MV = -mv$$

Our object is to propel the machine at a certain velocity sufficient to sustain it in the air. The values of M and V are therefore fixed. The machine has a certain known weight or mass (M) and must acquire a certain known velocity (V) in order to be self supporting. Our problem then is to obtain values for m and v such that $MV = -mv$.

We have two elements here to consider: m, the mass or weight of the air pushed back by the propeller and v, the velocity of the displaced air.

If the weight of the displaced air is equal to the weight of the machine, then the velocity of the displaced air will be equal to the velocity of the machine. If m is less than M, then v will be greater than V; and <u>vice versa</u>.

From the standpoint of pure physics we have only two elements to consider, m and v; but from the mechanical point of view we have three elements that produce and control the motion of the displaced air.

Considering our propeller as forming a portion of a perfect screw having the same pitch from center to circumference the three mechanical elements involved are:-

(1) The amount of surface in our propeller blades; (2) The pitch of the propeller; and (3) The speed of its rotation.

It may be well then to translate the two physical elements m and v in terms of the surface, pitch, and speed of rotation of the propeller.

<u>Value of m</u>

<u>Surface</u>:- The value of m varies directly with the surface of the propeller. Keeping the pitch and speed of rotation constant then the larger the surface the greater will be the mass of air pushed back by it, and proportionally greater.

<u>Pitch</u>:- It also varies directly with the pitch. Keeping the surface and speed of rotation constant the greater the pitch the greater will be the mass of air pushed back at each rotation, and proportionally greater.

<u>Rotation</u>:- It also varies directly with the speed of rotation. Keeping the surface and pitch constant then the greater the speed of rotation the greater will be the mass of air thrown back per second, and proportionally greater.

<u>Value of v</u>.

<u>Surface</u>:- The value of v does not depend at all upon the surface of the propeller.

Keeping the pitch and speed of rotation constant then the larger the surface the greater will be the mass of air thrown back by the propeller, but the velocity of the displaced air will not be affected.

<u>Pitch</u>:- The velocity of the displaced air varies directly with the pitch.

Keeping the surface and the speed of rotation constant then the greater the pitch the greater the velocity of the displaced air and proportionally greater. For example:- Suppose the propeller to make one rotation per second; then, if the pitch is one meter, the velocity of the displaced air will be one meter per second. If the pitch is two meters, then the velocity will be two meters per second etc.

<u>Rotation</u>:- The velocity of the displaced air varies directly with the speed of rotation.

Keeping the surface and pitch of the propeller constant then the greater the speed of rotation, the greater will be the velocity of the displaced air and proportionally greater. For example:- Let the pitch of the propeller be one meter, then if the propeller rotates once per second the velocity of the displaced air will be one meter per second. If it rotates twice per second the velocity will be two meters per second etc.

It is noteworthy that the value of m depends upon all three elements, surface, pitch and speed of rotation; whereas the value of v depends upon only two - the pitch and speed of rotation. Variations in the amount of surface can only affect the <u>amount</u> of air thrown back and not its velocity.

Value of mv.

Surface:- The propelling force (or mv) is directly proportional to the surface of the propeller.

Keeping the pitch and speed of rotation constant the greater the surface the greater the mass (m) of the displaced air, but its velocity is unchanged, so that changes in the amount of surface affect only the m element of the propelling force mv. Thus the total value of mv varies directly as the surface.

Pitch:- The propelling force mv varies directly as the square of the pitch.

Keeping the surface and speed of rotation constant then the greater the pitch the greater the mass (m) of the air thrown back and the greater its velocity (v). Thus both the m and v elements vary with the pitch. If we double the pitch we move twice the mass of air at double the velocity and the value of mv is four fold etc.

Rotation:- The propelling force or mv varies directly as the square of the speed of rotation.

Keeping the surface and pitch constant, then the greater the speed of rotation, the greater will be the mass (m) of the air thrown back and the greater its velocity (v). Thus both the m and v elements vary with the speed of rotation. If we double the speed of rotation we move twice the mass of air at double the velocity; and the value of mv would be four fold etc.

Thus the value of mv varies in simple proportion to the surface of the propeller, and in double proportion to the pitch and speed of rotation.

Does this indicate that great pitch and great speed of rotation, rather than great surface, is what is wanted in the propeller of a flying machine? A.G.B.

(To be continued).

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Extracts from "Marine Propellers"*: By F.W. Baldwin .

A few points taken from Mr. Barnaby's book on Marine Propellers* seem to be directly applicable to aerial propulsion. F.W.B.

(p.1) The principle upon which nearly all marine propellers work is the projection of a mass of water in a direction opposite to that of the required motion of the vessel.

If the weight of the mass of water acted upon by the propeller in pounds per second = W, and if the sternward velocity in feet per second imparted to it in relation to still water = S, then the reaction which constitutes the propelling force is

$\frac{WS}{g}$ where g = 32.2 feet per second; and this is

independent of the form of propelling apparatus altogether. S is commonly known as the real slip, but will here be generally referred to as the rate of acceleration, or more shortly, as the acceleration.

When the vessel is in motion at a regular speed,

the reaction $\frac{WS}{g}$ is equal to the resistance.

So long as there is a resistance to be overcome by the propeller, there is no possibility of reducing the real slip or acceleration S to zero, since a necessary condition would be that W, the weight of water acted upon, was infinitely large.

* Marine Propellers by Sydney W. Barnaby (Spon and Chamberlin, 12 Cortland St. N.Y. 1900).

When a propeller is to be designed for any given set of conditions, it is of the first importance that the relation between the mass of water acted upon and the acceleration imparted to it should be such,

That while the product $\frac{WS}{g}$ shall equal the estimated resistance of the ship, and the size and rate of motion of the propelling apparatus such as shall suit the conditions of the case, the economic result may yet be the best attainable, or may only fall short of the maximum by an amount which is calculable, and which it may be desirable to sacrifice in order to obtain other advantages.

(p. 3) There is a certain quantity of work which must be lost under all circumstances, and it is equal to the amount of energy of the discharged water moving astern with a velocity S relative to still water.

As this energy varies as the weight multiplied by the square of the velocity, it follows that if the quantity of water acted upon is doubled, the loss from this cause is doubled, but if the acceleration is doubled, the loss is increased fourfold. This explains why the hydraulic propeller, which is forced to act upon a much less area of column than the screw, appears at such a disadvantage when compared with it.

Pulling versus Pushing.

(p.44) In the well-known Mersey ferry boats there are four screws, but in some of those built in America two only are employed, one forward and one aft, driven by the same shaft, an arrangement which appears to be inferior.

The forward screw of one of these latter vessels was estimated to augment the resistance of the hull by 23.5 per cent and its propelling efficiency was only 43 per cent of that of the after screw.

Negative Propulsion.

(p.48) If a screw is placed behind a stern so bluff that the supply of water is impeded, it will draw in water at the center of the driving force and throw it off from the tips of the blades like a centrifugal pump. It is recorded that an attempt to propel a square-ended caisson by means of a screw resulted in the caisson going astern, which ever way the screw was driven.

Inclination of line of Thrust.

(p.47) There is a disadvantage connected with an inclined screw shaft which points to the advisability of placing the shaft nearly horizontal as possible.

The result of depressing the end of the shaft is to cause the effective pitch to vary through every part of the revolution. If the inclination be supposed to be 45° for example, that part of the blade which is intended to have a pitch of three diameters has in reality an effective pitch varying from nothing to infinity.

It is of course obvious that the pitch of the blades in relation to the axis is unchanged by any alteration in the direction of the shaft, but whatever the pitch in relation to the axis may be, if the axis were to pass vertically out through the bottom of the ship, the virtual or effective pitch, measured in the direction of motion is nil. If a screw does not move along but has a motion of rotation only the resistance of the water to the blades is the same whatever be the direction of the shaft; but if the propeller be allowed to move forward, while at the same time it be constrained to move horizontally, the shaft being inclined to the horizontal, then the resistance of the water to the blades is not uniform, but varies over every part of the revolution. This will perhaps be made clearer by an examination of the phases through which a blade passes during one revolution. It is convenient and suitable to consider the action of a screw as similar to that of an inclined plane moving past the stern.

Fig. 21

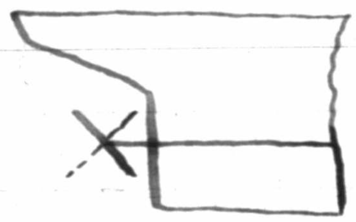


Fig. 22

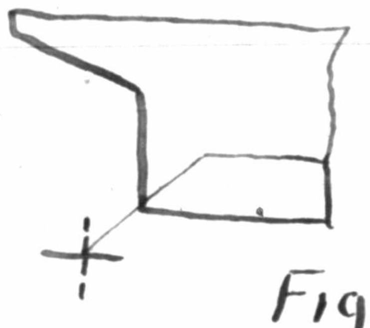


Fig. 23

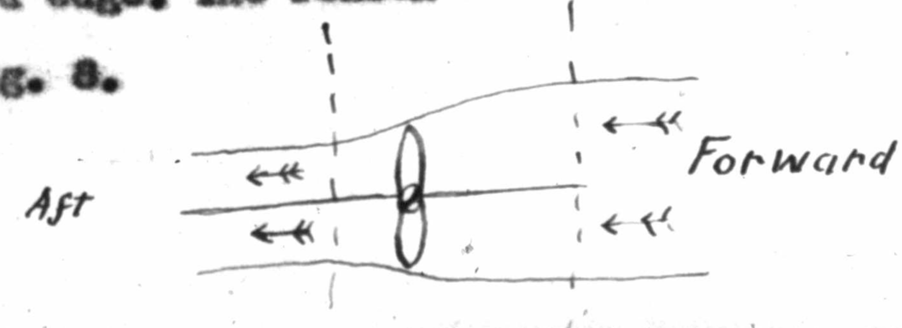
In Fig. 21 the full line represents the upper blade as a plane moving from port to starboard; the dotted line represents the lower blade as a plane moving from starboard to port.

In Fig. 22 the shaft is horizontal and the full line shows the blade going down, and the dotted line the blade coming up.

In Fig. 23 the shaft is inclined at 45°, the full line again showing the blade going down, and the dotted line the blade coming up. As the ship moves forward the water may be supposed to flow to the screw in approximately horizontal lines, and the blade which at one part of the revolution is edgewise to the water, at another is square on to it, and the result is an irregular pressure causing vibration. Another way of looking at it is this: A particle of water meeting the ascending blade has its motion relative to the vessel arrested completely, while aparticle on meeting the forward edge of the descending blade would require to have its velocity infinitely accelerated in a horizontal direction, to enable it to escape from under the blade. This is what is meant by saying, that in the above example, the effective pitch varies from nothing to infinity during each revolution.

Variable Pitch.

(p 49) When the length of the propeller in the direction of the axis is small, that is, when the blades are narrow, there is probably not much to be gained by departing from a true helical surface, or what is called a uniform pitch; but when the bladds are wide the pitch should increase in the direction of the length of the propeller, that is, the after edge of the blade should have a coarser pitch than the forward edge. The reason for this may be seen by referring to Fig. 8.



The column of water passing through the screw is contracting in area and increasing in velocity.

Blades of uniform-pitch would only be strictly appropriate if the column while passing through the screw were parallel and maintained a constant speed.

If the length of column occupied by the screw is sufficient to allow a sensibl contraction to take place within its limits, then the pitch of the screw surface should augment at the same rate as the speed of the column of water is accelerated, in order that all parts of the blade may keep touch with it during its passage. It was an early practice introduced by Woodcroft to vary the pitch in this manner (see p. 21), the supposition being that by so doing a gradual acceleration would be produced and not a sudden one. It is probable that in no case could water be accelerated suddenly by a submerged propeller, and all that is required is that the surface of the screw should be adapted as nearly as possible to the rate of flow through it, which rate is determined by the mean pitch of the screw surface. What the variation on each side of the mean should be is very difficult to say, as it has not yet been determined at what distance ahead of the screw acceleration of the water commences, or at what distance astern it is completed, and the full velocity or race attained.

Although we know that the <u>vena contracta</u> of the race must be somewhat of the form shown in Fig. 8, it is not possible at present to define its boundaries, and it can therefore only be stated in general terms that the greater the slip ratio the greater would be the contraction, and consequently the greater should be the variation of pitch on each side of the mean. Since the slip ratio at a given efficiency increases with pitch ratio, the variation should also bear some proportion to the pitch ratio. As the use of wide blades is frequently associated with high slip ratio, as for example, when diameter is restricted by the draught of water, not only do they occupy a considerable length of the contracting column Fig. 8, but also the amount of the contraction is greater; and if this reasoning is correct, there is a twofold advantage to be gained by giving an increasing pitch to screws with wide blades.

Propeller Balance.

(p. 51) In order to prevent vibration from being set up by the propeller in long fine vessels of high power, two things should be considered. The propeller should have a good running balance, and the center of pressure should be in the center of the disc. To ensure that the first condition is realised, each blade must be of the same weight, and the center of gravity of each must be at the same distance from the axis of the shaft. To satisfy the second condition is more difficult. If the screw works in undisturbed water and the surface of each blade is disposed symmetrically about the shaft, then the center of pressure will be in the center of the disc if the screw is caused to advance in the direction of the line of its shaft.

Any inclination of the shaft from the line of advance tends to throw the center of pressure out of the center of the disc, for the reason already explained (see page 48), and the same effect is produced to some extent by the inequality of the onward motion of the water in the frictional wake in which thepropeller works.

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Bulletin No.XXVIII

THE OUTLOOK ON AVIATION: by Asst. Editor.

An extract from Major Squier's speech delivered before the American Association of Mechanical Engineers is given in the Scientific American for January 2.

Items from Newspapers.

Santos Dumont vouchsafed the following information in connection with his monoplane, to a reporter on the Paris edition of the London Mail:- "I have entirely abandoned the bi-plane system of aeroplane in favor of the monoplane which I consider has immense advantages over the former. The one I have constructed in my shed at Neuilly, is extremely light. Its weight when completed will not exceed 150 kilograms including the motor. As I do not weigh more than 50 kilograms myself you will see that the total weight it will have to lift will not exceed 200 kilos. I expect it to be very rapid, for the initial speed I will require to leave the ground will be 36 miles an hour. My propellers will revolve 700 revolutions to the minute. My motor is 24 H.P. The entire machine is only 15 ft. in width. Its total surface is 9 square yards. I have already experimented with the machine over a distance of 400 yards while in its incomplete state and with very satisfactory results. Most decidedly I shall enter for the Daily Mail Cross-Channel prize if my machine comes up to expectation, but for the present, at any rate, I have no intention of trying to break anybody's record.

Paris, France, Dec. 9:- Twenty-eight Wright aeroplanes have already been sold at the Aeronautic salon which closes to-morrow night after a week's existence. The machines were ordered mostly by rich amateurs at $5000.00 a piece. They will be constructed by the French Society of Aviation at Dunkirk.

Paris, Jan. 2, 1909:- The airship show has closed in a blaze of glory, with Wilbur Wright in his machine reaping the greatest praise.

Mr. Wright being asked to give his opinion as to the future of aeroplanes said:- "It is impossible to predict, you know the fate of prophets. I do not however expect to see the aeroplane come into commercial use soon".

New York, Dec. 31, 1908:- Mark Antony, an inventor, has perfected a dirigible balloon which can be operated by wireless electricity. By a combination of dots and dashes Mr. Antony says a change can be effected in the movements of his balloon in two seconds.

Le Mans, Saturday, Jan. 2, 1909:- Mr. Wilbur Wright to-day held his last trial here. He then took down the aeroplane which will be transported on Monday to the Hallee Works where it will be taken apart and sent to Pau. Mr. Wright expects to stop at Pau for a few weeks only.

Rome, Dec. 26, 1908:- The date for trials to be made here by Wilbur Wright with his aeroplane has not been fixed, but it will probably be next month. Instead of flying on a level with the ground the aeroplane will start from the summit of Monte Mario, a hill over looking the parade ground, and the flight will be over the right bank of the Tiber, where the buildings are low.

New York, Jan. 4, 1909:- A Swedish inventor, Oscar Ostergren, designer of the U.S. torpedo boat Bailey is building a flying machine. It will be completed at Worcester, Mass. by the end of the month. The papers do not say of what type this machine will be. G.H.B.

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