

Notes by Alexander Graham Bell, December 19, 1907

1907, Dec. 19 Thursday At B. B.

(Dictation by A. G. B. taken down by F. W. B.)

Mrs. Bell left for Washington at noon to-day accompanied by Mabel and Lilian Grosvenor and their nurses Agnes and Christina Watson.

Mr. Ingraham joined them on Steamer Blue Hill and will accompany them as far as Boston. He is on his way to Hammondsport, N. Y.

Mr. Baldwin, Mr. Douglas McCurdy and I expect to leave to-morrow morning for Hammondsport via Montreal, Toronto and Buffalo. I have only time now to allude briefly to the few experiments made within the last few days that remain unnoted in my dictated notes.

The celluloid balloon made by Mr. McNeil under instructions from Mr. McCurdy was completed yesterday (Wednesday, Dec. 18) and was blown up with air and photographed hanging from the roof of the kite house. Douglas McCurdy made an attempt to-day to fill it with hydrogen, but the process of manufacture was so slow with his facilities that it became obvious that it would take many days to manufacture the gas required. The attempt was therefore abandoned for this season and the balloon has been left, flattened out upon the floor of the kite-house and we hope that experiments may be made with it when we return here.

The kite in the form of a ring was completed yesterday and tried in a calm by running with the flying line. The surfaces consisted of two superposed horizontal rings of silk 50 2 cms. wide, the circumference of each ring from the median point being a little more than 12 meters (I think 12.12). The space between superposed surfaces was occupied by two

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layers of empty 25 cm. cells standing upon their bases and Mr. Baldwin estimates the space between the two surfaces as about 40 cms. Fifty-four 25 cm. cells formed the outer ring of the circle so that the external circumference was 13.5 m.

The weight of the whole structure lightly beaded was 11 lbs. (4994 gms.) or approximately 5000 gms.. We estimate the amount of horizontal surface as 12 M. 2 . and the flying weight so small as about 417 gms. per m 2 . horizontal.

Finding the flying weight so small I determined to try the kite although it seemed to be absolutely calm. The cord was attached to the inner part of the front frame-work and when Mr. Baldwin ran with the cord, the kite rose very steadily into the air. As it would not sustain itself, however, without running, we were unable to get observations of angular altitude or pull. The above experiment was made yesterday, Wednesday Dec. 18.

To-day (Thursday, Dec. 19) the kite was tried again in a wind of about 7.9 miles per hour.

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Two keel sticks had been added somewhat as shown in above diagram, one at the front and one at the rear and the frame-work especially at the bow was strengthened by some stout beading as shown above; so that the weight of the kite was increased to 13.5 lbs. (6129 gms.), surface was as before 12 sq. m. Flying weight 510.7 gms. per sq. m. horizontal. The wind was very light — 7.9 miles per hour — and variable. After raising the kite into the air it sustained itself for some time. The angular altitude was at a maximum 15°; no observation of pull was made as we decided to make a change in the point of attachment of the flying line, shifting it in on the keel stick 50 cms. as shown below

This, as Mr. Baldwin remarks, was all right for the flying line but not so good for the kite. It went up well in a breeze of 8.5 miles per hour and the strain on the flying line twisted and broke the front of the kite. So ended the experiment.

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The wind speedily died down and there was not wind 4 enough to support any of the other kites we desired to try. But we thought it important to try the checker-board kite and the half-size model of the Cygnet comparatively by running with the flying line cord.

The half-size model was composed of 560 tetrahedral winged cells and weighed 27 lbs.

The checker-board kite weighed 24 lbs. and was of identical construction so far as the cellular frame-work was concerned but there were no oblique surfaces. Horizontal surfaces being substituted in the form of pieces of silk 25 cms. sq.. There were 270 of these squares arranged checker-board fashion in successive tiers. Both kites were easily raised into the air by running with the line against the wind. Mr. Douglas McCurdy made 5 observations of wind velocity; the sum of the readings of the Anemometer gave 1009 ft. mean 201.8 ft. per 30 seconds from which the mean wind velocity was estimated as 4.6 miles per hour. As the kites would not sustain themselves in this wind no pull was recorded but Mr. Bedwin, who ran with the flying cord, reported that the checker-board kite with surfaces horizontal and none oblique seemed to pull twice as hard as the other model having oblique but no horizontal surfaces. It was obvious to the eye that the surfaces of the checker-board kite were inclined at a greater angle to the horizon than those of the other kite. The lack of wind forced us to stop the experiments without having reached any definite conclusions concerning the respective behavior of the kites. So far as we could judge both kites flew 5 steadily when pulled and hence we are encouraged to believe that the kite with horizontal surfaces above — many of them and well separated — may fly steadily in a supporting breeze. But this has not yet been demonstrated.

Mr. McNeil made for me a set of metallic corner pieces showing the latent development in the construction together with the cross shaped connecting piece to be taken to the States. We also placed in a jar a large number of paper and metallic models of corner pieces and sealed it up for preservation in the Laboratory museum.

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Mr. Bedwin reported upon the stock of cells in hand available for further experiments as follows:—

About 6000 winged cells

About 200 empty cells

Sticks enough for 700 cells

100 000 ft. of sticks ready to be cut to suitable length for cell sticks. The whole sufficient for 12000 cells.

There are sufficient metal corner pieces on hand for 450 cells and he is expecting every day the filling of an order for 500 lbs. of steel ribbon for making corner pieces.

Beinn Bhreagh Laboratory will now close for the season.

3

The following observations of angle and pull were made:—

FLOWN BY FLYING LINE

Angle Pull

25° 140 lbs.

30° 150 lbs.

30° 170 lbs.

28° 140 lbs.

634° 130 lbs.

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5 obs. 147° 730 lbs.

FLOWN BY BOW LINE

Angle Pull

17° 120 lbs.

18° 160 lbs.

24° 140 lbs.

26° 130 lbs.

27° 120 lbs.

20° 150 lbs.

20° 160 lbs.

8 observations 178° 1030 lbs.

The following observations of wind velocity were made:—

ANEMOMETER READING

9 714 201 normal reading to begin with.

9 715 244 1043 ft. per ½ minute

9 716 334 1090 ft. per ½ minute

9 717 325 1091 ft. per ½ minute Wind velocity

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9 718 512 1187 ft. per ½ minute

9 719 730 1218 ft. per ½ minute

The bow line and the flying line (each about 90 meters in length) weighed together 27 lbs.

I have not time to add up these figures to calculate means and compare results with those obtained with the Frost King with its full complement of cells but the essential observations are recorded above and calculations may be made subsequently.

1907, Dec. 18 Wednesday At B. B.

(Dictation by A. G. B. taken down by J. A. D. McC.)

On Friday, Dec. 13 (p. 35 & 42) we made experiments with the kite "Frost King" over the water although it was not adapted for floating upon the water. Believing, however, that we could land the kite safely upon the Ugly Duckling without putting her in the water at all, We had the Steamer Blue Hill come to her old mooring place on Baddeck Bay and take the Ugly Duckling in tow with the "Frost King" on board. The experiment was made satisfactorily. The flying line was attached at a point 75 cm. behind the front edge of the kite and the bow line was attached one meter in advance of the front edge of the kite. Mr. Bedwin reported that when the "Frost King" left the Laboratory the kite weighed 65 lbs. and two lines, each about 90 meters in length, were of 1/9 inch rope weighing 70 grams per meter were used. Surface consisted of 1300 winged cells.

The kite rose well from the Ugly Duckling when towed by the Blue Hill against the wind, and at the conclusion of the experiment was landed safely on the Ugly Duckling and brought home without being wet.

The following observations of angular altitude, pull, and wind velocity were made:—

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FLOWN BY FLYING LINE

Angular altitude 3 observations, Sum 90°, mean 30°

Pull 6 observations, Sum 805 lbs., mean 139.17 lbs.

2

Readings of Anemometer showing wind velocity relatively to the Steamer Blue Hill—

2 observations— 1st. as kite rose, 22.7 miles per hour.

2nd. while kite was flying by flying line and just before being flown by bow line, 26.4 miles per hour. Mean of both observations 24.55 miles per hour.

The “Frost King” on this occasion carried up a swinging pendulum, the bob of which could be fixed in position by releasing a clamp, which was accomplished by pulling a string. This apparatus showed that while flying by the flying line the inclination of the kite surfaces to the horizon was $22 \frac{1}{2}^\circ$.

FLOWN BY THE BOW LINE

One observation of altitude and pull was made—

Angular altitude 13°, Pull 80 lbs.

When flown by the flying line the average pull was 134.17 lbs. at an average angle of 30° from which I calculate the resolved lift as 67.085 lbs. and the drift as 116.2 lbs. Adding the weight of the kite and the weight of the flying ropes to the resolved lift we get a total lift of about 160 lbs. Considering the efficiency of the kite to be equal to $\frac{\text{Lift}}{\text{Drift}}$

Efficiency= $\frac{160}{116.2} = 1.37$

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When flown by the bow line the total lift is estimated at 111 lbs. and drift 78 lbs. Efficiency
= $\frac{111}{78} = 1.42$

KITE FROST KING

Efficiency when flown by flying line= $\frac{160}{116.2} = 1.37$

Efficiency when flown by bow line = $\frac{111}{78} = 1.42$

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Mr. Bedwin made independent calculations and came to the general conclusion that—

“The Frost King requires a horizontal propeller thrust of 116.15 lbs. to support itself and a load of 67.06 lbs. when flying with kite surface at an angle of $22\frac{1}{2}^\circ$ to the horizontal, and that the head resistance is equal to 49.88 lbs. at a velocity of 24.55 miles per hour.”

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In order to ascertain whether the removal of theoretically inefficient cells — that is cells apparently blanketed by other cells in front of them — Mr. Baldwin was requested to have all cells removed from the Frost King which seemed to him to be blanketed by other cells.

This was done and the surgical operation resulted in the removal of the majority of the cells in the Frost King. Out of 1300 cells 705 were removed and only 595 remained (p.54) The frame-work of the Frost King was left intact two cells deep from the outside and all the interior was scooped out, framework and all, leaving quite a respectably sized room in the kite. The back cells were replaced by two trusses of empty cells to support the top. Thus while the form of the Frost King was retained, the kite became the mere shell of its former self. The floor, the front face and the two sides built up of cells two cells deep thick and the back wall being replaced by two trusses. Some of the silk was even removed from

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the frames that remained. The winged cells were two cells deep upon the floor but only one cell deep upon the front and side faces of the kite and there were none at all on the rear face. The amount of material removed reduced the weight by ten pounds. This weight was restored to the structure by heavy beading on the back trusses and by the insertion of a long iron rod with some pieces of lead weighing 8 lbs.. This iron rod was fastened transversely at the very bottom of the kite and at a distance of 75cm. in front of the rear of the kite. The centre of gravity of the load was 2 thus a considerable distance below the centre of surface and it was so arranged as to extend from side to side like the balancing pole of an Acrobat.

The centre of gravity of the whole kite was slightly in front of the centre of surface so that when the kite was suspended by its ridge pole the head was depressed making an angle of one in twenty.

The experiment with the Frost King shell was made Monday, December 16 during a snowstorm so that the silk surfaces were wet. The kite rose into the air from the Ugly Duckling and was brought safely down again without getting into the water. In order to ascertain the weight of the kite in the air, while flying with wet surfaces, it was weighed immediately upon the return to the Laboratory (p. 54).

Weight before experiment 65 lbs.

Weight after experiment 79 lbs.

Difference (water absorbed) 14 lbs.

The clamp on the swinging pendulum unfortunately failed to release so that we failed to obtain the inclination of the kite surfaces. When flown by the flying line (which was attached at a point 75cm. behind the front edge of the kite) the Frost King shell flew very unsteadily, swaying from side to side like an imprisoned bear.

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When flown by the Bow line (attached at a point one meter in advance of the front edge of the kite) it flew very steadily.