BULLETINS

OF THE

Aerial Experiment Association

Bulletin No. IV Issued MONDAY, AUG. 3, 1908

MR. McCURDY'S COPY.

BEINN BHREAGH, NEAR BADDECK, NOVA SCOTIA

Bulletins of The Aerial Experiment Association.

BULLETIN NO.XV ISSUED MONDAY AUGUST 3, 1908.

Baddeck, Nova Scotia.

TABLE OF CONTENTS.

EXPERIMENTS WITH KITES, A,B & C, 1908, July 11:
by A. G. Bell.

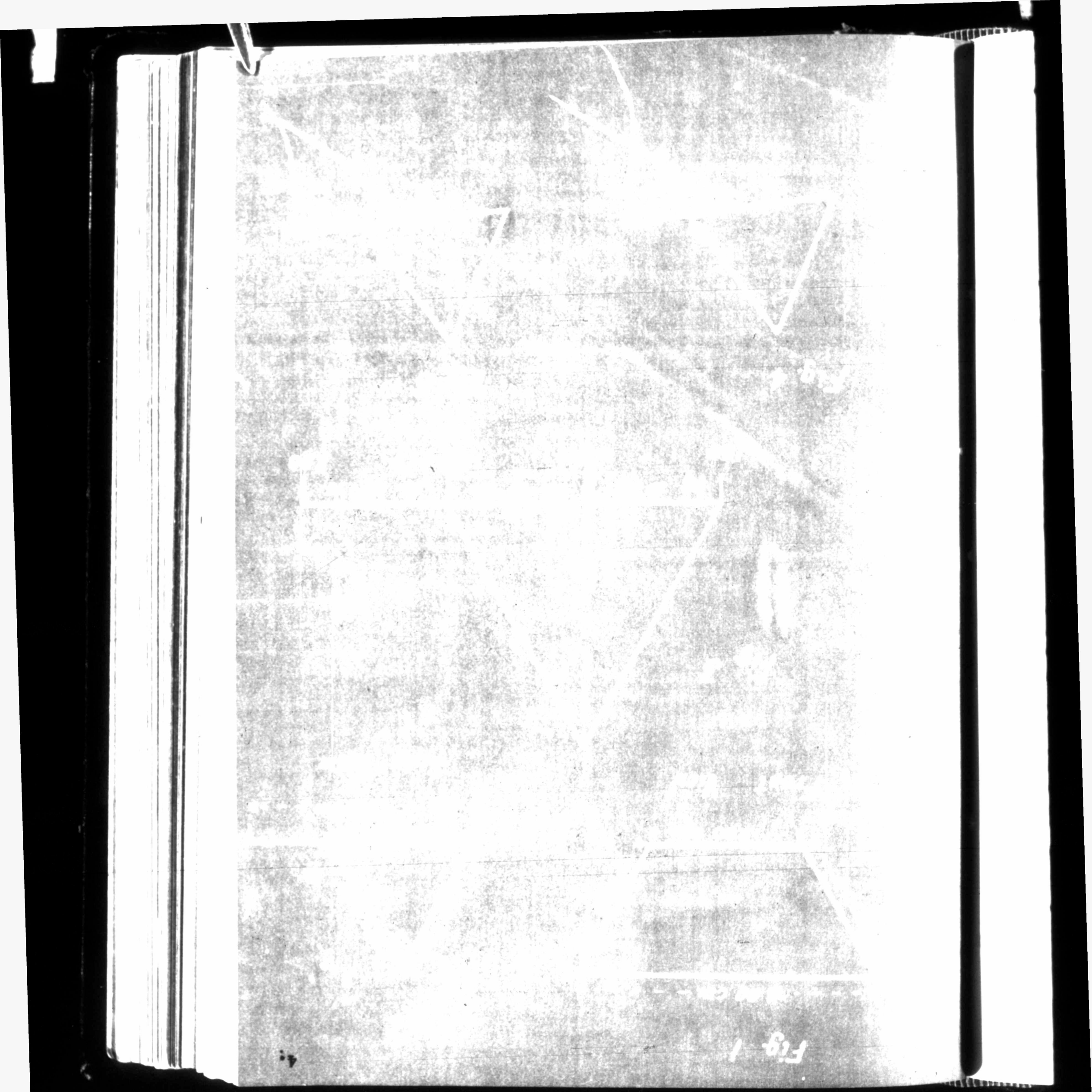
Preliminary Remarks: Experiments with Kites, A,B & C are being pushed at Beinn Bhreagh as rapidly as wind conditions permit, as it is hoped that the results may be used in determining the arrangement of cells in the tetrahedral aerodrome No. 5. Some details concerning these kites have already been given in preceding Bulletins (I, 30,31,34,35,36; III, 22,23).

The Kites A,B &C are alike in external shape and cross-section, the differences being internal (Fig.1,Fig.2).

Kite A is of full tetrahedral construction, and is composed of four hundred and eight winged cells with simple beading. This kite is considered as the standard with which the others are to be compared (see Bulletin I,34).

Kite B is also composed of four hundred and eight cells but there are no silk surfaces on the rear and internal cells, a mere shell of winged cells being retained on the front face, bottom, and sides. Total:- 253 winged cells, 155 empty cells, beading the same as in Kite A (see photograph Bulletin I,35).

Kite C is built in three sections. Each section is of full tetrahedral construction; but, from the manner of attaching the sections together, a hollow space, triangular in cross-section, appears between them running right through the middle of the kite from one side to the other. Total 340 winged cells, no empty frames. The Beading differs from that in Kites A & B by a horisontal strip running from side to side along the middle of the front and rear faces; and by beading on the



bottom of the upper section running from fore to aft (see photograph in Bulletin I, 36).

The keel stick for the attachment of the flying lines is 300 cm long. That part of the keel stick directly under the ridge pole is taken as the point of origin from which to measure the places of attachment of the flying lines. Distances forwards from that point are considered as plus, distances backwards as minus (Fig.3).

The flying lines are each 100 meters long. The main line, of one-quarter-inch Manilla rope, weighs 5121 gms. The bow-line, of stout cord, weighs 507 gms.

In experiments, 1906 July 11, the main-line was attached 75 cm in advance of the central or zero point of the keel-stick (25 cm behind the front edge of the kite structure); and the bow-line 200 cm from the zero point (or 100 cm beyond the front edge of the kite structure). The experiments were made with main-line tight, bow-line slack (Fig.4).

In experiments 1906 July 16 and 17, the points of attachment for the flying-lines were respectively:- main-line 50 cm, bow-line 200 cm. main-line tight, bow-line slack (Fig 5).

Weights.

	Kite A	Kite B	Kite C
Kite Structure	9036 gms	8576 gms	8766 gms
Main-line	5121 gms	5121 gms	5121 gms
Bow-line	507 gms	507 gms	507 gms
Total	14,664 gms	14, 204	14,394 gms

-3-

Surfaces/

Kite A 22.0 square meters oblique.
Kite B 13.7 square meters oblique.
Kite C 18.4 square meters oblique.

Flying-Weights.

(Including the weights of the flying-lines, and considering all of the surfaces as efficient).

Kite A 667 gms. per sq m oblique.
Kite B 1037 gms. per sq m oblique.
Kite C 782 gms. per sq m oblique.

EXPERIMENTS MADE 1908 JULY 11.

Experiment 1:- Kite A was raised into the air by main-line attached 75 cm from zero point of keelstick. Three observations of wind velocity were then made.

623 ft in 30 sec or 14.2 miles per hr.
572 ft in 30 sec or 13.0 miles per hr.
544 ft in 30 sec or 12.4 miles per hr.

After this the altitude of the kite in the air and the pull of the flying-line were observed simultaneously and ten successive readings were obtained

Obs.	Altitude	Pull
1st	28°	45 lbs.
2nd	27°	40 lbs.
3rd	27°	38 lbs.
4th	30°	48 lbs.
5th	29°	55 lbs.
6th	28°	50 lbs.
7th	27°	45 lbs.
8th	27°	35 lbs.
9th	29°	45 lbs.
10th	32°	60 lbs.
Summation 10 Obs.	284°	445 lbs.
Average 1	28°.4	44.5 lbs.

-4-

After the conclusion of these observations another reading of wind-velocity was taken.

651 ft in 30 sec., or 14.8 miles per hr.

Field Notes:— Wind puffy. Kite steady when wind was steady. Some swaying during lulls or variations of force, but no regular oscillations. Kite could support itself on bow-line. Brought down safely into the hands of the men without touching the ground. Wind seemed about SSW but exact direction uncertain as it was partly reflected from side of mountain as well as blowing directly on testing-field. Fluctuations perhaps caused or helped by interferences between direct and indirect impulses.

Experiment 2:—Kite B flown by main-line attached 75 cm from zero point.

Initial wind-velocity 519 ft in 30 sec or 11.8 miles per hr.

Obs.	Altitude	Pull.
1st	27°	60 lbs.
2nd	30°	30 lbs.
3rd	25°	60 lbs.
4th	24°	35 lbs.
5th	24°	30 lbs.
6th	23°	50 lbs.
7th	25°	40 lbs.
8th	27°	65 lbs.
9th	26°	50 lbs.
10th	24°	20 lbs.
Summation 10 obs.	245°	450 lbs.
Average 1	24°.5	45.0 lbs.

Final wind-velocity 688 ft in 30 sec or 15.6 miles per hr.

Field Notes:—Kite B acted much as Kite A did, being steady in steady wind, and moving about in unsteady, but not showing any tendency to regular oscillation. Would not support itself on bow-line, and is evidently a heavier-flying Kite than Kite A.

-3-

Experiment 3: Kite C flown by main-line attached 75 cm from zero point.

Initial Wind Velocity 541 ft in 30 sec or 12.3 miles per hr.

Obs.	Altitude	Pull.
1st	34°	60 lbs.
2nd	29°	45 lbs.
3rd	30°	60 lbs.
4th	31°	60 lbs.
5th	29°	55 lbs.
6th	28°	50 lbs.
7th	30°	60 lbs.
8th	34°	70 lbs.
9th	31°	60 lbs.
10th	30°	55 lbs.
Summation 10 obs.	296°	575 lbs.
Average 1	29°.6	57.5 lbs.

Final Wind Velocity 613 ft in 30 sec or 13.9 miles per hr.

Field Notes:- Not much difference between kites A, B and C so far as steadiness goes in steady winds, but Kite C seemed to respond more quickly to changes of wind velocity than the others. No regular oscillation. Swaying motions greater than A or B, but wind variations were also greater. Before taking observations of altitude and pull the wind lulled, followed by a considerable puff, and kite C made a complete somersault in the air, regaining its equilibrium again and flying well so that we were able to complete our set of observations.

Experiment 4:- Kites A and C were next flown simultaneously, upon similar lines sufficiently far apart to prevent the kites from coming together in the air. In this way it was hoped to test their relative behavior under identical wind-conditions. No observations of altitude or wind velocity were made; but, while observations upon steadiness were being made the Laboratory assistants utilized their time by taking several series of observations of pull in the following order:-

-6-

First ten observations of C, and 10 of A; then 10 of A, and 10 of C; and finally 10 of C and 10 of A. The results are shown below:-

Pull in Pounds.

Obs.	1st C	2nd A	3rd A	4th C	5th C	6th A
1st	50	50	60	70	50	35
2nd	45	45	50	60	40	40
3rd	40	55	40	65	30	30
4th	50	65	45	55	30	20
5th	55	90	55	45	35	15
6th	45	60	50	40	30	20
7th	40	50	70	45	35	25
8th	20	55	45	50	25	50
9th	20	50	55	40	20	45
10th	40	45	50	30	25	55
Sum. 10 Obs.	405	565	520	500	320	335
Av. 1	40.5	56.5	52.0	50.0	32.0	33.5

Field Notes:-Hardly any question that A is a steadier Kite than C although both flew well. C seemed to respond quickly to fluctuations of wind by movements in the air; while A appeared to be more sluggish, acting somewhat like a water-logged vessel which does not lift readily to the waves. Occasionally one Kite would be rising in the air while the other was falling, or one would give evidence of being struck by a squall which the other did not feel, thus showing that the Kites were by no means under indentical wind conditions, although both were in the air at the same time and only a short distance apart.

Kite C was then taken down; and Kite B raised in its place. Kite A was left flying continuously for comparison.

Experiment 8:- Kites A and B flown simultaneously. The following observations of pull were made while the comparative behavior of the Kites in the air was being studied:-

Pull in Pounds.

Obs.	1st A	2nd B	3rd B	4th A	5th A	6th B
1st	45	30	60	50	35	40
2nd	30	40	50	45	30	45
3rd	60	35	40	40	25	60
4th	60	45	50	35	25	55
5th	50	30	55	40	25	40
6th	40	30	50	30	20	45
7th	45	25	45	30	20	50
8th	50	20	50	35	25	40
9th	50	15	55	20	45	35
10th	45	30	45	20	25	35
Sum. 10 Obs.	510	320	500	355	275	445
Av. 1	51.0	32.0	50.0	35.5	27.5	44.5

Field Notes:- No decided difference of behavior observed between Kites A and B in the air, excepting that Kite B flew at a lower altitude than A, and has every indication of being heavier-flying kite than A, requiring more wind to sustain it. After the ninth observation in the sixth series (when a pull of 35 lbs. was obtained) Kite B came down of itself, leaving Kite A still flying. It was raised again and the tenth reading of pull was obtained (35 lbs.) after which Kite B came down again, Kite A remaining in the air. After Kite B had fallen for the second time a reading of wind-velocity showed 363 ft in 30 sec or 15.1 miles per hr., but it seems hardly possible that the wind was blowing at this rate when the Kite began to fall. So far as steadiness was concerned there was little to choose between Kites A and B. The impression has been created that Kite B is more sensitive to gusts than A, but if there is really any difference between them in this respect it is slight, and not nearly so noticeable as in the case of Kite C.

-8-

Experiment 61- Kites A and B were then taken down, and an unsuccessful attempt was made to fly the Old Frost-King Kite in its present empty condition. The wind-velocity was first taken and found to be 512 ft in 30 sec or 11.6 miles per hr. Then three men ran with the flying-line and thus raised the Frost-King into the air. The wind was not sufficient to support it there, and after it came down another reading of wind-velocity was taken, 585 ft in 30 sec or 13.3 miles per hr. This ended the experiments for the day.

Summary of Observations July 11, 1908.

Summarizing all observations of wind-velocity and pull made during the afternoon of July 11, we obtain the following results:-

Wind-Velocity.

No of 30 sec Obs.	Aggregate wind in feet	Average in feet	Average Wind in miles per hr.
11	6511	591.9	13.5

Summary of Pulls.

Kite	No of Obs	Aggregate pull in lbs.	Average pull in lbs.
Kite A	70	2966	42.6
Kite B	40	1715	42.9
Kite C	40	1800	45.0

Thus, in an average wind of 13.5 miles per hour:-
Kite A pulled 42.6 lbs.
Kite B pulled 42.9 lbs.
Kite C pulled 45.0 lbs.

Summarising all cases in which the angular altitude of the Kites in the air was observed we obtain the results shown in the following table, which also summarises the pulls obtained simultaneously with each observation of altitude, and the wind-velocities observed immediately before, and immediately after each series of observations. The table shows the results of experiments 1, 2 and 3.

Summary of Results of Runs, 1,2 &3, July 11, 1908.
Attachment of Flying-lines: Main line 75 cm; bow-line 200 cm.

Flown by main-line	Wind-velocity: No of 30 sec Obs.	Wind-velocity: Wind in feet	Altitude: No of Obs.	Altitude: Altitude in degrees	Pull: No of Obs.	Pull: Pull in lbs.
Kite A	2	1198	10	284°	10	445
Kite B	2	1207	10	245°	10	450
Kite C	2	1154	10	296°	10	575

Averages derived from above table.

Kite	Wind in miles per hr.	Altitude in degrees	pull in lbs.
Kite A	13.6	28°.4	44.5
Kite B	13.7	24°.5	45.0
Kite C	13.1	29°.6	57.5

Taking Kite A as our basis of comparison we may note that Kite B, while having about the same pull in nearly the same wind, flew at a sensibly lower angle than Kite A.

Kite C, flying in a wind of slightly less velocity than Kite A flew at a greater altitude with a greater pull.

These results suggest that possibly Kite C is more efficient than Kite A; and Kite B less efficient.

The indications are however, derived from the above table of averages alone, and do not take into account the total load lifted, including the weights of the Kites, the weights of the flying-lines, and the resolved vertical element of the pull.

In steadiness of flight there was little observable difference between Kite A and B; but C was apparently not quite as steady in the air; and the somersault executed by Kite C during the course of experiment 3, should lead us to very sure of the results before accepting Kite C as a model for aerodrome No. 8 as we would naturally do if we judged by efficiency of lift alone.

The experiments should evidently be multiplied before reaching final conclusions.

---oOo---

EXPERIMENTS WITH KITE A JULY 16, 1908:
By A. G. Bell.

On Thursday, July 16, 1908, an attempt was made to obtain simultaneous observations of wind-velocity, altitude and pull. It was found practicable to take three or four observations of altitude and pull during the time taken to observe and record a single observation of wind-velocity. At a given signal the anemometer was started by an assistant and after 30 seconds was stopped. When the anemometer was started Mr. Bedwin directed the clinometer at the kite while a third assistant kept his eyes fixed upon the fluctuating needle of the dynamometer. As Mr. Bedwin caught the angle he called to his assistant who noted the reading of the dynamometer at that moment. Then the readings of the three instruments were recorded, and another set of similar observations taken.

The following are the results obtained with Kite A flown with the main-line attached to the keel-stick at 50 cm from the zero point.

Kite A July 16, 1908

Wind Velocity		Altitude		Pull	
No of Obs.	ft. in 30 sec.	No of Obs.	Altitude in degrees	No of Obs.	Pull in lbs.
1	524	1	30°	1	30
		1	39°	1	40
		1	34°	1	50
1	501	1	34°	1	40
		1	36°	1	40
		1	36°	1	40
1	423	1	35°	1	50
		1	34°	1	40
		1	36°	1	30
		1	31°	1	20
3	1448	10	345°	10	380

Averages.

Wind-velocity 482.7 ft in 30 sec or 11.0 miles per hr
Altitude 34°.5
Pull 38.0 lbs.

EXPERIMENTS WITH KITES A & B JULY 17, 1908:
by A. G. Bell.

On Friday July 17, 1908, eight series of observations were made with Kites A & B. Both kites were in the air at the same time and the observations were made upon them successively as shown below: Kite A was tethered to the lower cleat in the testing field, Kite B to the upper. In all cases the main-line was attached to the keel-stick at 30 cm from the zeropoint and the kites were flown by the main-line, the bow-line being slack.

Exp. 1. Kite A (at lower cleat)

Wind Velocity		Altitude		Pull	
No of Obs.	Ft. in 30 sec.	No of Obs.	Altitude in degrees	No of Obs.	Pull in lbs.
1	562	1	42°	1	55
		1	40°	1	55
		1	39°	1	50
1	523	1	38°	1	55
		1	31°	1	45
		1	37°	1	40
		1	34°	1	40
1	558	1	34°	1	35
		1	36°	1	40
		1	39°	1	50
3	1643	10	370°	10	465

Exp. 2. Kite B (at upper cleat).

Wind Velocity		Altitude		Pull	
No of Obs.	Ft. in 30 sec.	No of Obs.	Altitude in degrees	No of Obs.	Pull in lbs.
1	536	1	35°	1	40
		1	32°	1	40
		1	30°	1	35
		1	29°	1	45
1	624	1	33°	1	45
		1	33°	1	40
		1	35°	1	45
1	621	1	28°	1	35
		1	26°	1	35
		1	21°	1	35
3	1761	10	302°	10	395

Exp. 3. Kite A (at lower cleat)

Wind Velocity		Altitude		Pull	
No of Obs.	Ft. in 30 sec.	No of Obs.	Altitude in degrees	No of Obs.	Pull in lbs.
1	556	1	41°	1	50
		1	40°	1	50
		1	39°	1	40
		1	38°	1	45
1	512	1	37°	1	40
		1	36°	1	40
		1	37°	1	45
1	530	1	39°	1	30
		1	40°	1	35
		1	40°	1	50
3	1598	10	387°	10	425

Exp. 4. Kite B (at upper cleat).

Wind Velocity		Altitude		Pull	
No of Obs.	ft. in 30 sec.	No of Obs.	Altitude in degrees	No. of Obs.	Pull in lbs.
1	573	1	29°	1	40
		1	22°	1	30
		1	26°	1	45
		1	29°	1	50
1	543	1	29°	1	35
		1	28°	1	40
		1	28°	1	35
1	639	1	32°	1	45
		1	33°	1	50
		1	33°	1	50
3	1755	10	289°	10	420

The kites were now taken down and reversed in position that is Kite A was taken to the upper cleat and fastened to the flying-lines used with Kite B in the former experiments (2 and 4); and Kite B was taken to the lower cleat and attached to A's lines. Both kites were then allowed to fly from their new position and four other series of observations were made.

Exp. 5. Kite A (at upper cleat)

Wind Velocity		Altitude		Pull	
No of Obs.	ft. in 30 sec.	No of Obs.	Altitude in degrees	No of Obs.	Pull in lbs.
1	600	1	41°	1	40
		1	40°	1	45
		1	39°	1	45
		1	42°	1	65
1	654	1	40°	1	40
		1	39°	1	45
		1	38°	1	80
1	636	1	37°	1	35
		1	36°	1	40
		1	37°	1	5
3	1889	10	386°	10	450

Exp. 6. Kite B (at Lower cleat)

Wind Velocity		Altitude		Pull	
No of Obs.	ft. in 30 sec.	No of Obs.	Altitude in degrees	No of Obs.	Pull in lbs.
1	536	1	33°	1	55
		1	27°	1	40
		1	26°	1	45
		1	31°	1	50
1	505	1	29°	1	40
		1	29°	1	40
		1	23°	1	30
1	479	1	26°	1	45
		1	28°	1	40
		1	32°	1	50
3	1522	10	288°	10	435

After this series of observations Kite B came down by itself while A continued flying. Kite B was left upon the ground while a new series of observations was made with Kite A.

Exp. 7 Kite A (at upper cleat).

Wind Velocity		Altitude		Pull	
No of Obs	ft. in 30 sec	No of Obs	Altitude in degrees	No of Obs	Pull in lbs.
1	836	1	34°	1	40
		1	33°	1	40
		1	31°	1	35
		1	32°	1	30
1	589	1	27°	1	35
		1	36°	1	45
		1	37°	1	45
1	487	1	33°	1	35
		1	28°	1	25
		Kite came down			
3	1572	9	291°	9	330

An attempt was made to raise Kite A into the air so as to complete the series of observations but the kite would not support itself. An anemometer reading was taken and wind-velocity was found to be 411 ft in 30 seconds or 9.3 miles per hour. The wind seemed to freshen a little so an attempt was made to raise Kite B for a final series of readings. Wind-velocity 512 ft in 30 seconds or 11.6 miles per hr. Kite B remained in the air for a short time but came down before the readings could be made. Another attempt with wind at 378 ft

in 30 seconds or 8.5 miles per hr was even less successful. Kite B would not support itself. A third attempt with velocity 469 in 30 seconds or 10.7 miles per hr succeeded. Kite B rose into the air and remained there for a sufficient length of time to enable us to complete the series.

Exp. 8 Kite B (at lower cleat).

Wind Velocity		Altitude		Pull	
No of Obs	ft. in 30 sec.	No of Obs	Altitude in degrees	No of Obs	Pull in lbs.
1	448	1	23°	1	40
		1	25°	1	40
1	511	1	26°	1	45
		1	30°	1	45
		1	26°	1	40
		1	28°	1	45
1	478	1	27°	1	45
		1	20°	1	30
		1	15°	1	30
		1	23°	1	50
3	1437	10	24.3°	10	410

Kite B came down after conclusion of experiment. A final reading of the anemometer was then taken. Wind- velocity 468 ft or 10.6 miles per hr. This concluded the experiments for the day.

Summary of results with kite A, July 17, 1908.

Reference	Wind Velocity: No of Obs.	Wind Velocity: Aggregate feet	Altitude: No of Obs.	Altitude: Aggregate degrees	Pull: No of Obs.	Pull: Aggregate lbs.
Exp.1	3	1643	10	370°	10	465
Exp.3	3	1598	10	387°	10	425
Exp.5	3	1669	10	386°	10	450
Exp.7	3	1872	9	291°	9	330
Summation	12	6702	39	1434°	39	1670
Average		558.50		36.8°		42.8

Summary of results with Kite B, July 17, 1908.

Reference	Wind Velocity: No of Obs.	Wind Velocity: Aggregate feet	Altitude: No of Obs.	Altitude: Aggregate degrees	Pull: No of Obs.	Pull: Aggregate lbs.
Exp.2	3	1781	10	302°	10	395
Exp.4	3	1755	10	289°	10	420
Exp.6	3	1522	10	208°	10	435
Exp.8	3	1437	10	243°	10	410
Summation	12	6495	40	1122	40	1660
Average		541.25		28.1		41.5

Averages.

Derived from above Tables. Kites flown by main-line attached at 50 cm from apex.

Kite	Wind Velocity in miles per hour	Altitude in degrees	Pull in lbs.
Kite A	12.7	36°.8	42.8
Kite B	12.3	38°.1	41.3

Conclusions:- These results are confirmatory of those reached July 11 1908 when the kites were flown from a point 75 cm from the apex on the keel-stick. In the above experiments July 17, 1908 the attachment was 50 cm from the apex point.

In both cases Kite B while having nearly the same pull as Kite A in a wind of approximately the same velocity, flew at a lower elevation.

Kite A with its flying-lines weighed 14,664 gms, Kite B 14,304 gms so it appears that under the same conditions of experiment Kite A lifted a greater load than Kite B; and to a greater elevation.

It is obvious then that the silk surfaces which were present in Kite A and which were absent in Kite B were not entirely useless. However much they may have been shielded by the winged cells in front of them some of them certainly aided in the support of Kite A.

There can no longer be any question that the full tetrahedral construction as exemplified by Kite A is superior to the empty form of construction typified by Kite B in which the supposedly superfluous surfaces are removed, without

removing the frameworks upon which they were stretched.

No sufficient reason exists for adopting the B type of construction in Aerodrome No.5 in place of the full construction employed in the Cygnet, which is exemplified by Kite A.

It is hoped that an opportunity may soon present itself for making equally decisive tests of the relative merits of Kites A and C.

---oOo---

EXPERIMENTS WITH KITES A & C, 1908, JULY 29:
By A. G. Bell.

Experiments with Kites A & C were made on the Beinn Bhreagh Testing-field, Wednesday, July 29, 1908.

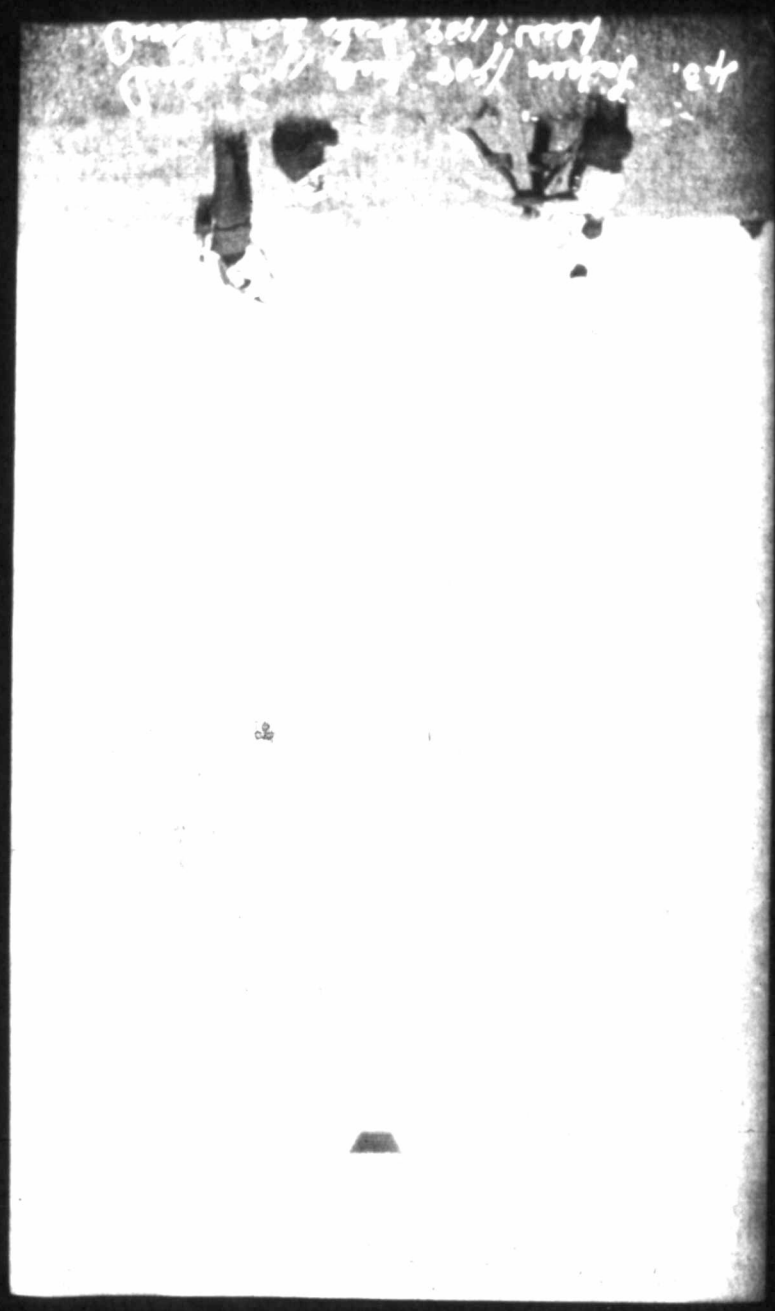
Kite C was first raised by running in a wind of 10.5 miles per hour. It stayed up for a short time but came down before instrumental readings could be obtained.

After waiting some time Kite C was raised again and this time it remained in the air. We then let the anemometer run for 68 seconds while simultaneous observations of altitude and pull were made. Anemometer registered 1048 ft of wind in 68 seconds. We have therefore noted wind-velocity as 10.48 miles per hour following Baldwin's rule in Bulletin III p.45.

The photograph appended shows the Beinn Bhreagh experimenters taking simultaneous observations of the anemometer, clinometer, and dynamometer; and also incidentally shows one of the kites in the air.

In all the experiments 1908, July 29, the attachment of main-line was at point plus 30, bow-line plus 200, main-line tight; bow-line slack.

The following tables show the results of the experiments:



Exp.1 Kite C flown by main-line attached at ♦ 30. Wind 10,48 miles per hr.

Obs.	Altitude	Pull.
1st	29°	50 lbs.
2nd	25°	50 lbs.
3rd	28°	30 lbs.
4th	31°	60 lbs.
5th	25°	30 lbs.
6th	32°	70 lbs.
7th	33°	50 lbs.
8th	32°	40 lbs.
9th	33°	60 lbs.
10th	29°	40 lbs.
10 obs.	301°	480 lbs.

Exp.2 Kite C flown by main-line attached at ♦ 30. Wind 11.85 miles per hr.

Obs.	Altitude	Pull
1st	25°	40 lbs.
2nd	26°	30 lbs.
3rd	28°	60 lbs.
4th	33°	50 lbs.
5th	32°	40 lbs.
6th	28°	40 lbs.
7th	34°	40 lbs.
8th	33°	50 lbs.
9th	33°	40 lbs.
10th	34°	40 lbs.
10 Obs	306°	430 lbs.

Kite C was now taken down and Kite A was raised by running with main-line. It was with difficulty that Kite A was kept in the air by careful nursing. The only observation made was wind 11.10 miles per hr.

After a while Kite supported itself for a short time Altitude 18°, pull 20 lbs; wind 11.08 miles. Wind then freshened to 14.09 miles but lulled again before observations of altitude and pull could be taken. For several minutes the kite was almost supported but not quite. It was kept up however by nursing until observations could be made.

Exp.3 Kite A flown by main-line attached at + 50 cm. Wind 11.79 miles per hr.

Obs.	Altitude	Pull
1st	30°	70 lbs.
2nd	31°	70 lbs.
3rd	35°	60 lbs.
4th	30°	40 lbs.
5th	36°	70 lbs.
6th	35°	60 lbs.
7th	35°	70 lbs.
8th	29°	20 lbs.
9th	33°	70 lbs.
10th	32°	40 lbs.
10 Obs	329°	610 lbs.

Exp.4 Kite A flown by main-line attached at + 50 cm. Wind 14.76 miles per hr.

Obs.	Altitude	Pull
1st	34°	60 lbs.
2nd	30°	70 lbs.
3rd	32°	60 lbs.
4th	31°	40 lbs.
5th	33°	50 lbs.
6th	36°	70 lbs.
7th	36°	60 lbs.
8th	36°	70 lbs.
9th	33°	60 lbs.
10th	35°	70lbs
10 Obs	336°	630 lbs.

Exp.5 Kite A flown by main-line attached at + 50 cm. Wind 12.51 miles per hr.

Obs.	Altitude	Pull.
1st	33°	50 lbs.
2nd	35°	70 lbs.
3rd	36°	70 lbs.
4th	32°	40 lbs.
5th	37°	70 lbs.
6th	36°	40 lbs.
7th	32°	50 lbs.
8th	35°	60 lbs.
9th	35°	60 lbs.
10th	30°	60 lbs.
10 Obs.	345°	570 lbs.

Kite A was then taken down and Kite C raised in its stead.

Exp 6. Kite C flown by main-line attached at + 30 cm. Wind 13.94 miles per hr.

Obs.	Altitude	Pull
1st	37°	90 lbs.
2nd	36°	70 lbs.
3rd	38°	60 lbs.
4th	31°	60 lbs.
5th	26°	50 lbs.
6th	34°	90 lbs.
7th	36°	90 lbs.
8th	39°	100 lbs.
9th	37°	80 lbs.
10th	36°	70 lbs.
10 Obs.	350°	770 lbs.

Exp. 7. Kite C flown by main-line attached at + 30 cm. Wind 12.87 miles per hr.

Obs.	Altitude	Pull
1st	37°	60 lbs.
2nd	36°	70 lbs.
3rd	32°	45 lbs.
4th	34°	50 lbs.
5th	36°	60 lbs.
6th	35°	50 lbs.
7th	38°	60 lbs.
8th	36°	70 lbs.
9th	36°	60 lbs.
10th	36°	70 lbs.
10 Obs	361°	593 lbs.

Exp. 8. Kite C flown by main-line attached at + 30 cm. Wind 16.35 miles per hr.

Obs.	Altitude.	Pulls.
1st	34°	60 lbs.
2nd	30°	50 lbs.
3rd	28°	60 lbs.
4th	31°	50 lbs.
5th	34°	70 lbs.
6th	33°	40 lbs.
7th	35°	60 lbs.
8th	36°	80 lbs.
9th	36°	80 lbs.
10th	[illegible]°	60 lbs.
10 Obs.	332°	630 lbs.

Exp. 9. Kite C flown by main-line attached at + 50 cm. Wind 14.3 miles per hr.

Obs.	Altitude	Pull
1st	23°	40 lbs.
2nd	36°	70 lbs.
3rd	34°	60 lbs.
4th	33°	60 lbs.
5th	37°	70 lbs.
6th	35°	70 lbs.
7th	38°	70 lbs.
8th	37°	60 lbs.
9th	36°	70 lbs.
10th	38°	60 lbs.
10 Obs.	343°	650 lbs.

Kite C was then taken down and Kite A raised in its place.

Exp. 10. Kite A flown by main-line attached at + 50 cm. Wind 13.50 miles per hr.

Obs.	Altitude	Pull.
1st	35°	70 lbs.
2nd	33°	60 lbs.
3rd	36°	60 lbs.
4th	33°	60 lbs.
5th	35°	70 lbs.
6th	34°	60 lbs.
7th	27°	60 lbs.
8th	22°	60 lbs.
9th	23°	30 lbs.
10th	32°	70 lbs.
10 Obs.	310°	630 lbs.

Exp. 11. Kite A flown by main-line attached at + 50 cm. Wind 11.90 miles per hr.

Obs.	Altitude	Pulls.
1st	25°	40 lbs.
2nd	26°	50 lbs.
3rd	27°	60 lbs.
4th	30°	50 lbs.
5th	31°	40 lbs.
6th	29°	40 lbs.
7th	30°	60 lbs.
8th	22°	50 lbs.
8 Obs.	220°	390 lbs.

The Kite came down after the 8th observation. After waiting some time it was again raised by hand and sustained

itself for a short time. Wind 12.11 miles per hr; altitude 25°; pull 30 lbs. The Kite then came down again. Another attempt was made shortly afterwards wind 11.25 miles per hr, but Kite A would not support itself.

Kite C was then raised by hand. Wind 9.16 miles per hr. Kite C would not support itself. This ended the experiments for the day.

SUMMARY OF OBSERVATIONS JULY 29, 1908.

Kite A.

	Wind		Altitude & pull.		
	Obs.	Miles	Obs.	Alt.	Pull
Exp.3	1	11.79	10	329°	610 lbs.
Exp.4	1	14.76	10	338°	630 lbs.
Exp.5	1	12.51	10	345°	570 lbs.
Exp.10	1	13.50	10	310°	630 lbs.
Exp.11	1	11.98	8	220°	390 lbs.
	5	64.54	48	1542°	2830 lbs.

Kite C

	Wind		Altitude & Pull.		
	Obs.	Miles	Obs.	Alt.	Pull
Exp.1	1	10.48	10	301°	480 lbs.
Exp.2	1	11.84	10	306°	430 lbs.
Exp.6	1	13.94	10	350°	770 lbs.
Exp.7	1	12.37	10	361°	595 lbs.
Exp.8	1	16.35	10	332°	630 lbs.
Exp.9	1	14.13	10	343°	650 lbs.
	6	79.31	60	1993°	3555 lbs.

Averages.

	Wind	Altitude	Pull.
Kite A	12.91 miles	32°.12	59.00 lbs.
Kite C	13.22 miles	33°.22	59.25 lbs.

General Conclusions-There seems to be no substantial difference between kites A & C. What little difference there is seems to be in favor of Kite C, but the wind-velocity was slightly greater.

11 observations of wind-velocity, made simultaneously with the observations of altitude and pull, yield a total of 148.89 miles of wind. The average velocity during the experiments, 1908 July 29, was therefore 13.1 miles per hour.

Summarising all the observations made upon Kite A, 1908, July 16, 17, and 29, in which the Kite was flown by the main-line attached at + 90 cm we obtain the following results:-

Kite A.
(Summary of Observations 1908, July 16,17 & 29).

	Wind		Altitude & pull		
	Obs.	Miles	Obs.	Alt.	Pull
July 16	3	32.89	10	345°	360 lbs.
July 17	12	152.26	39	1434°	1670 lbs.
July 29	5	64.54	48	1542°	2830 lbs.
Total	20	249.69	97	3321°	4860 lbs.
Average		12.5 miles		34°.2	50.5 lbs.

All of the above data have been submitted to Mr. F. W. Baldwin. He will make calculations and report upon the efficiency of Kites A,B, & C in the above experiments. After the reception of his report we can judge better of the bearing of the experiments upon the form of structure to be adopted in the tetrahedral aerodrome A.E.A. No. 5.

REPORT UPON THE EFFICIENCY OF KITES A B & C.- by W.W. Baldwin.

The measure of efficiency of a Kite is generally considered as the ratio between lift and drift. The lift is the sum of the forces acting in a vertical direction at the kite; and drift the sum of the forces acting in a horizontal direction at the kite.

If the drift be considered as the horizontal force (comparable to the thrust exerted by the propeller of an aerodrome) then the lift represents the weight sustained.

The most efficient aero-surfaces are those that support the greatest weight for a given drift; or, in other words those in which the ratio lift divided by drift is greatest.

In our case the lift includes the weight of the kite, the weight of the flying-lines, and the vertical component of the pull; and the drift is the horizontal component of the pull.

The vertical and horizontal components of the pull are proportional respectively to the sine and cosine of the angle of altitude.

Interpreting the data relating to Kites A B & C in this way we arrive at the following conclusions concerning the relative efficiencies:-

---

DATA SUPPLIED.

(Average wind-velocity, altitude & pull).

Kite 1908	Attachment of flying line	Weight of Kite & lines in lbs.	Wind No of Obs	Wind Miles per hour	Altitude No of Obs	Altitude Angle in degrees	Pull No of Obs	Pull Pull in lbs.
July 11								
A	75	32.3	2	13.6	10	28°.4	10	44.5
B	75	31.3	2	13.7	10	24°.5	10	45.0
C	75	31.7	2	13.1	10	29°.6	10	37.5
July 16								
A	50	32.3	3	11.0	10	34°.3	10	38.0
July 17								
A	50	32.3	12	12.7	39	36°.8	39	42.8
B	50	31.3	12	12.3	40	28°.1	40	41.5
July 29								
A	50	32.3	5	12.9	48	32°.1	48	39.0
C	50	31.7	6	13.2	60	33°.2	60	39.2
Summary								
A	50	32.3	20	12.5	97	34°.2	97	90.3

CALCULATED RESULTS.

Kite 1908	Lift in lbs.	Drift in lbs.	Efficiency
July 11			
A	53.46	39.14	1.37
B	49.95	40.95	1.22
C	60.10	50.00	1.20
July 16			
A	53.62	31.32	1.72
July 17			
A	57.93	34.29	1.69
B	50.80	36.62	1.39
July 29			
A	63.45	49.98	1.27
C	64.15	49.58	1.29
Summary			
A	60.57	41.60	1.46

THE BEARING OF THE EXPERIMENTS WITH KITES A B & C UPON THE CONSTRUCTION OF AEROPLANE NO.5: by F.W. Baldwin.

The general impressions made upon me by the experiments with Kites A B & C are as follows:-

As tests to determine whether or not the solid tetrahedral construction can be improved upon they seem to me conclusive. There is so little to choose between the flying abilities of Kites A B & C that I would say no reasonable doubt can still exist as to the inefficiency of a large number of cells when banked as in the Frost-King or Cygnet model (on a large scale).

Of course Kite B is an extreme case but I think Kite A is also extreme in the other direction and the happy mean lies somewhere between them (perhaps in the Kite C form).

Kite A has a flying weight of 411 gms per sq m (oblique). Kite B a flying weight of 626 gms per sq m (oblique and has the disadvantage of uncovered cells in its interior. These uncovered cells surely offer a head resistance much greater than do the covered ones.

Now taking all this into consideration is there enough difference in the flying qualities of A & B to justify leaving cells in, where they are only an incumberance structurally adding practically nothing to the strength of the machine, making it harder to build and inaccessible for repair and inspection after it has been built?

The results of comparison between Kite C and Kite A in which Kite C actually proved to be as light, if not a lighter flying kite than A, although of considerably heavier

flying weight still more strongly point to the existence of such marked blanketting in the solid form that we cannot shut our eyes to it.

There is one point which should not be lost sight of in making deductions from these experiments and that is, that what is true of these Kites on a small scale need not necessarily apply to larger Kites of similar design.

Because cells may be efficient in the interior of Kite A is no reason for assuming that similarly situated cells are efficient in a Kite the size of the Frost-King. The question of interference which is the one with which we are dealing depends directly upon the number of cells which deflect the wind, before it reaches the interior and rear cells, and not upon its position relative to some other kite of the same form but of different dimensions.

Let it be granted that Kite A is a better Kite than Kite B. What does it prove? Not that type A is any better than type B but simply that more than two rows of cells can be banked advantageously.

How many cells deep the shell should be is still a question which experiment alone can settle, but undoubtedly there is a limit. Last year the Frost-King had 705 cells cut out from its interior leaving a shell of 595 cells, that is 54% of its surface was removed yet in the only experiment made with it in this condition it flew in about the same wind and carried substantially the same load with a slightly higher

efficiency.

Now I do not claim that this particular form of shell is the best one but every experiment points very clearly to the fact that a large number of the cells in the interior of the big Kites are practically useless, or at least contribute so slightly to the lift of the machine as in no way to justify putting them in.

The onus of proof seems to me to fall heavily upon the solid form of construction. Unless good reason can be shown for putting them in why not leave them out?

---oOo---

THE BEARING OF THE EXPERIMENTS WITH KITES A B & C UPON THE CONSTRUCTION OF AERODROME NO.3 by A.G. Bell.

It is a little surprising to find so little difference in the efficiencies of Kites A B & C. Taking Kite A as our standard for comparison there can be no doubt, I think, that the efficiency of B is slightly less than that of A. This came out both in the experiments of July 11 and July 17 when the kites were directly compared (page 34).

In relation to Kites A & C the answer is not so conclusive. In the experiments July 11 the efficiency of C was slightly less than the efficiency of A; and in the experiments July 29 it was slightly greater (page 34).

I take it therefore that there is no substantial difference in efficiency between Kites A & C; and so slight a difference between Kites A & B that it is hardly worth considering. For the purposes of this inquiry we may consider that Kites A B & C are of substantially equal efficiency.

What bearing then have the experiments upon the type of structure to be adopted in aerodrome No.3? The efficiencies being substantially the same, our choice of structure will depend upon other conditions than efficiency.

The type of structure employed in the Cygnet, typified by the A kite, was developed at Beinn Bhreagh as the result of numerous experiments which demonstrated that Kites composed of large aggregates of cells arranged in full construction were extremely steady in quite fluctuating winds.

It developed that while the lifting power of winged cells was markedly inferior to the same surfaces arranged horizontally, a structure composed of multitudinous winged cells possessed the important quality of automatic stability, which was lacking in structures employing horizontal surfaces.

In comparing these different arrangements of winged cells efficiency is not the only desideratum involved, nor indeed the main desideratum at all. I have no doubt that from the point of view of efficiency horizontal surfaces are superior to oblique, but they are very unstable in the air.

Automatic stability is the great feature of the pure tetrahedral construction, so that I feel that this feature must not be sacrificed for any other consideration.

Mr. Baldwin and I seem to look at the matter from two different points of view which is a good thing for the development of true and just conclusions.

He desires to secure what would be technically termed the most efficient structure: That is, the structure in which the ratio of lift to drift is greatest (pp.35-37).

While I am equally anxious to secure this point, I consider it only of secondary importance, stability, to my mind, being of the first consequence. I quite agree with all of Mr. Baldwin's conclusions provided that proposed modifications of the structure in the interests of efficiency, ease of construction, repair and inspection, etc., do not interfere with the demonstrated quality of stability possessed by the Cygnet construction (type A).

While I am inclined to think that the type of structure shown in Kite C has many advantages over A, especially when used in a structure of large size, I must confess that I am not yet satisfied that it is as stable in the air as Kites of the A type.

While in experiments July 29 Kite C seemed to fly as steadily as Kite A, it should not be forgotten that in experiment 3, July 11, (page 8) Kite C executed a complete somersault in the air. Whether this indicates that its automatic stability is inferior to that of Kite A is a matter for serious consideration. This point, I think, should be developed experimentally before finally deciding to adopt it. If it can be shown that the C type of construction is equally stable with that of type A, it should, I think, be adopted in aerodrome No.5, or some modification of it involving the omission of the least efficient surfaces.

In conclusion I assume the position that the stability of the A type of Kite in large constructions having been abundantly demonstrated by experiment, we should not depart from it unless the other types of structure considered are demonstrably equal to it in stability. The onus of proof lies with the other forms of structure.

---oOo---