TECHNICAL MEMORANDUMS

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 418

INVESTIGATION OF A WING WITH AN AUXILIARY UPPER PART

By R. Seiferth

From Report III of the Göttingen Aerodynamic Institute, 1927

Washington
June, 1927

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

TECHNICAL MEMORANDUM NO. 418.

INVESTIGATION OF A WING WITH AN AUXILIARY UPPER PART.*

By R. Seiferth.

The wing used in these experiments was a normal one of rectangular shape with a span of 1 meter (39.37 inches) and a chord of 0.2 m (7.87 in.). Fig. 1 shows the profile in its original condition, i.e., with the position 0 of the upper part. A normal test was first made of the wing in this position, its polar curve being given in Fig. 3 and the numerical values of c_a, c_w and c_m in Table I.

The two parts of the wing were then arranged so as to form a biplane, which was subjected to normal three-component measurements, the two parts being placed in various relative positions with respect to the gap a and the stagger b.

Arrangement	0	1	2
a (gap)	0	7 mm (0.28 in.)	20 mm (0.79 in.)
b (stagger)	0	0	1 " (0.04 ")

Arrangement	0	3	4
a (gap)	0	50 mm (1.97 in.)	80 mm (3.15 in.)
b (stagger)		10 " (0.39 ")	33 " (1.30 ")

* "Untersuchung eines Flügels mit geteiltem Profil." "Ergebnisse der Aerodynamischen Versuchsanstalt zu Göttingen," Report III, 1927, pp. 99-102.

In the first series of tests, the total force on both parts (which were bound firmly together for this purpose) was measured. The results of other tests are shown in Fig. 4 and in Tables II-V, the c_a, c_w and c_m values being referred to the projection area and chord of the lower part. The axis of reference for the moments passes through the foremost point of the chord of the lower part, or, more exactly, through the intersection point of the chord with the thereto-perpendicular tangent to the leading edge (See definition on p. 32 of Report I). In regard to the plotting of the results in Fig. 4, it is naturally not feasible to take the induced drag of the closed wing (i.e., of the monoplane) for that of the open wing, but instead, the induced drag must be calculated separately for each individual biplane arrangement. For the sake of clearness, we have refrained from plotting the drag parabolas. They can, however, be easily plotted according to the multiplane theory (Cf. Report II, Chapter III, "Der induzierte Widerstand der Mehrdecker").

In order to determine the effect of the upper or auxiliary part of the wing on the total force, the lift and drag of this part were measured alone in another series of experiments, in which the lower or main part of the wing served as a deflector in the corresponding biplane arrangements. The results of these measurements (only the most important points being thoroughly tested) are plotted in Fig. 5. The angles of attack and the coefficients are again referred to the main wing and the reference point for the moments is the same as above. Since the wind pressure caused slight displacements in the main wing, the gap and stagger were again measured after turning on the air stream, the exact measurements being given separately in Tables VI-IX.

As shown by the tables, the lift of the upper wing alone is greater, for small gaps and angles of attack, than the combined lift of the upper and lower wings together. In these arrangements, therefore, the lower wing is given a negative lift by the proximity of the upper wing. Likewise the drag of the upper wing is relatively high at small angles of attack, which is probably due chiefly to its greater profile drag.

I. Main Wing and Auxiliary Wing Tested Together.

TABLE I.
Arrangement 0; a = 0 mm, b = 0 mm

α	100 c_a	100 c_w	100 c_m
- 9.0°	- 3.8	1.96	9.9
- 6.1	+ 14.9	1.84	14.3
- 3.1	35.6	2.41	19.6
- 0.2	55.4	3.60	25.0
+ 2.7	75.6	5.47	30.2
5.6	96.0	7.77	35.7
8.6	114.6	10.8	41.0
11.5	124.2	14.4	43.1
14.5	125.4	19.6	45.4
17.5	126.7	25.7	47.3
20.6	122.0	31.8	48.4

TABLE II.
Arrangement 1; a = 7 mm, b = 0 mm

α	100 c_a	100 c_w	100 c_m
- 9.0°	- 5.1	3.53	9.3
- 6.1	+ 14.8	3.44	14.2
- 3.1	36.1	4.12	20.0
- 0.2	57.6	5.27	26.3
+ 2.7	80.2	7.46	32.3
5.6	101.5	9.85	38.3
8.6	122.2	13.4	44.4
11.5	141.0	17.5	50.1
14.4	154.7	21.7	53.8
17.4	154.5	26.6	54.6
20.4	151.4	34.0	56.9

TABLE III.
Arrangement 2; a = 20 mm, b = 1 mm

α	100 c_a	100 c_w	100 c_m
- 9.0°	- 7.6	6.05	9.4
- 6.1	+ 14.3	5.56	14.9
- 3.1	36.7	5.84	21.4
- 0.2	60.6	6.77	28.1
+ 2.7	83.0	8.35	34.4
5.6	106.8	10.9	41.6
8.5	130.4	14.3	48.5
11.4	152.3	18.5	55.5
14.0	168.2	23.6	60.0
17.3	179.7	30.2	63.7
20.4	172.8	37.0	63.4
24.4	160.5	44.7	61.3

TABLE IV.
Arrangement 3; a = 50 mm, b = 10 mm

α	100 c_a	100 c_w	100 c_m
- 9.0°	- 3.0	7.74	9.6
- 6.1	+ 22.1	6.72	15.8
- 3.2	47.6	6.85	23.1
- 0.3	74.2	8.28	29.9
+ 2.6	100.7	10.4	37.0
5.5	128.0	13.5	44.4
8.4	154.0	18.0	51.8
11.3	179.8	23.7	59.9
14.3	200.5	29.5	67.0
17.2	212.0	36.4	71.3
20.2	210.6	45.0	72.8
24.2	206.8	59.6	77.5

TABLE V.
Arrangement 4; a = 80 mm, b = 33 mm

α	100 c_a	100 c_w	100 c_m
- 9.0°	- 5.8	8.29	6.4
- 6.1	+ 18.5	7.00	11.8
- 3.2	46.4	6.87	17.8
- 0.3	77.0	8.49	23.8
+ 2.6	108.0	11.4	30.1
5.5	135.0	14.0	37.1
8.4	169.5	20.2	45.2
11.3	197.1	26.9	52.2
14.2	217.5	31.4	59.7
17.2	231.5	42.7	65.7
20.1	236.5	50.9	71.2
21.1	237.0	56.1	72.7
24.2	225.2	66.0	74.0

II. Auxiliary Wing Tested Alone, with Main Wing as a Deflector.

TABLE VI.
Arrangement 1.

α	a mm	b mm	100 c_a	100 c_w	100 c_m
2.7°	7	0	109.0	6.44	41.1
8.6	7	1	123.3	10.1	43.1
14.4	8	0	119.4	13.1	39.7
17.4	7	1	107.6	14.0	35.6

TABLE VII.
Arrangement 2.

α	a mm	b mm	100 c_a	100 c_w	100 c_m
2.7°	20.5	0	66.5	9.38	28.4
8.5	22	2	99.6	11.3	36.6
14.4	20	2	139.0	15.9	43.7
17.3	19	4	118.1	16.0	39.8
20.4	19	3	102.3	14.8	33.5

TABLE VIII.
Arrangement 3.

α	a mm	b mm	100 c_a	100 c_w	100 c_m
2.6°	50	9	80.2	8.78	28.4
8.4	50	11	120.9	13.6	40.0
14.3	51	12	151.9	21.7	48.6
17.2	50	12	149.0	24.4	47.6

TABLE IX.
Arrangement 3.

α	a mm	b mm	100 c_a	100 c_w	100 c_m
-0.3°	79	33	51.0	7.60	22.3
+2.6	81	34	97.1	8.88	21.7
8.4	79	34	137.3	14.8	29.9
14.2	82	35	164.3	22.7	36.8
17.2	81	32	156.6	26.8	36.4
20.1	81	32	144.0	30.8	35.4

Translation by Dwight M. Miner,
National Advisory Committee for Aeronautics.

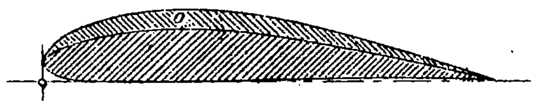

Fig.1

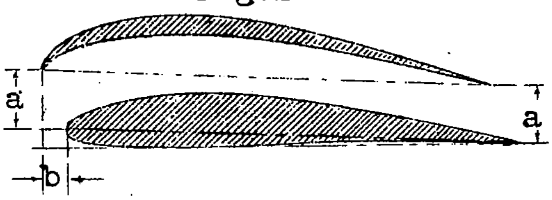

Fig.2

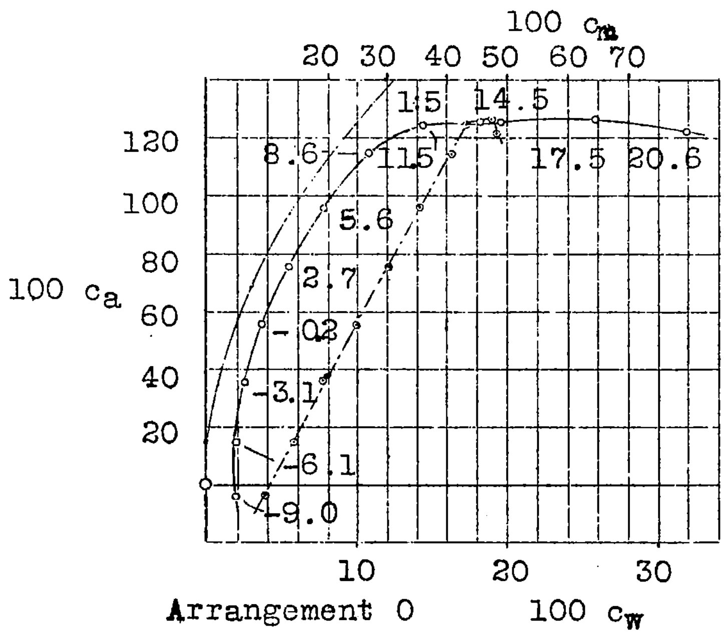

Fig.3

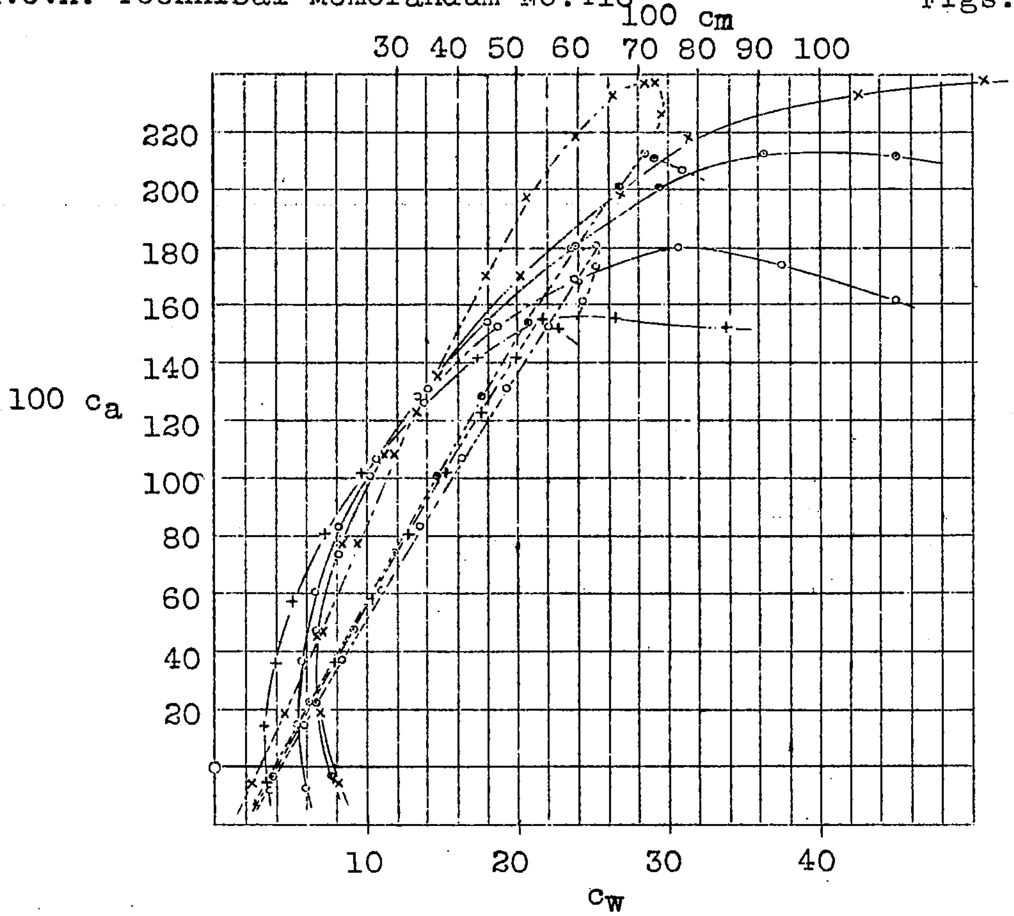
100 cm
30 40 50 60 70 80 90 100
220
200
180
160
140
120
100
80
60
40
20
100 ca
10 20 30 40
cw

Fig.4

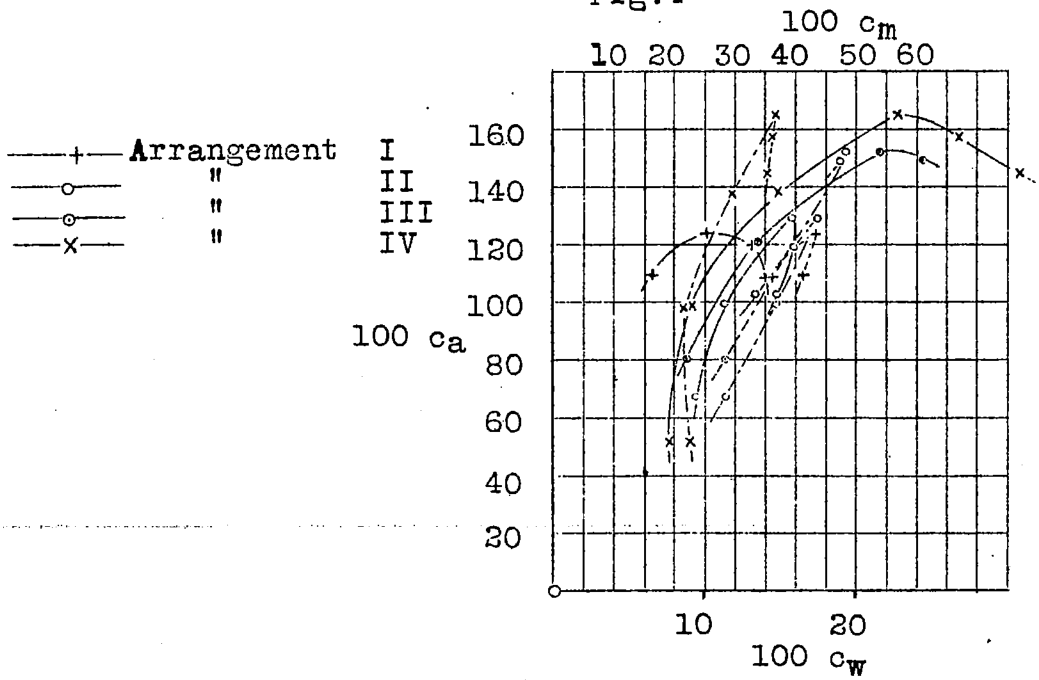
Arrangement I
" II
" III
" IV
100 cm
10 20 30 40 50 60
160
140
120
100
80
60
40
20
100 ca
10 20
100 cw

Fig.5