THIS DOCUMENT PROVIDED BY THE ABBOTT AEROSPACE
TECHNICAL LIBRARY
ABBOTTAEROSPACE.COM

For Official Use

ROYAL ...
BEDFORD.

R. & M. No. 1753
(2358)
A.R.C. Technical Report, 1936

AIR MINISTRY

AERONAUTICAL RESEARCH COMMITTEE
REPORTS AND MEMORANDA

Full Scale Trials on Scion M.3 with a Gouge Flap

By
J. COHEN, B.A., B.SC.

Crown Copyright Reserved

LONDON: HIS MAJESTY'S STATIONERY OFFICE
Price 2*s.* 6*d.* net

This Document Provided by the Abbott Aerospace
TECHNICAL LIBRARY
ABBOTTAEROSPACE.COM

AERODYNAMIC SYMBOLS.

1. GENERAL

m	Mass
t	Time
V	Resultant linear velocity
Ω	Resultant angular velocity
ρ	Density, σ relative density
ν	Kinematic coefficient of viscosity
R	Reynolds number, $R = lV/\nu$ (where l is a suitable linear dimension)

Normal temperature and pressure for aeronautical work are 15°C and 760 mm.

For air under these conditions $\rho = 0.002378$ slug/cu.ft., $\nu = 1.59 \times 10^{-4}$ sq.ft./sec.

The slug is taken to be 32.2 lb. — mass.

α	Angle of incidence
ϵ	Angle of downwash
S	Area
b	Span
c	Chord
A	Aspect ratio, $A = b^2/S$
L	Lift, with coefficient $C_L = L/\frac{1}{2}\rho V^2 S$
D	Drag, with coefficient $C_D = D/\frac{1}{2}\rho V^2 S$
γ	Gliding angle, $\tan\gamma = D/L$
L	Rolling moment, with coefficient $C_l = L/\frac{1}{2}\rho V^2 bS$
M	Pitching moment, with coefficient $C_m = M/\frac{1}{2}\rho V^2 cS$
N	Yawing moment, with coefficient $C_n = N/\frac{1}{2}\rho V^2 bS$

2. AIRSCREWS.

n	Revolutions per second
D	Diameter
J	V/nD
P	Power
T	Thrust, with coefficient $k_T = T/\rho n^2 D^4$
Q	Torque, with coefficient $k_Q = Q/\rho n^2 D^5$
η	Efficiency, $\eta = TV/P = Jk_T/2\pi k_Q$

THIS DOCUMENT PROVIDED BY THE ABBOTT AEROSPACE
TECHNICAL LIBRARY
ABBOTTAEROSPACE.COM

Full scale trials on Scion M.3 with a Gouge flap

By
J. COHEN, B.A., B.Sc.

COMMUNICATED BY THE DIRECTOR OF SCIENTIFIC RESEARCH. AIR MINISTRY

Reports and Memoranda No. 1753
30*th April*, 1936*

SUMMARY. Introductory (*Purpose of Investigation*).—The Scion is a twin-engined, high wing monoplane of 3,000 lb. maximum weight with a 46 per cent. span Gouge flap. The changes in the aerodynamic characteristics, take-off and landing qualities, caused by the flap, were required.

Range of Investigation.—Lift, drag, gliding angle and attitude curves were determined with flaps closed and open. Take-offs and landings with the flap closed, half and fully open, were analysed from cinematograph pictures. The effect of the flap on stability and control was found qualitatively.

Conclusions.—The flap increases C_L max. from 1·17† to 1·65 both at $\alpha = 16°$ (approx.) and reduces the stalling speed from 66 to 56 m.p.h. for a mean weight of 2,750 lb. The flap reduces the total drag at a given speed for speeds less than 85 m.p.h. but the flap profile drag coefficient is about 0·03.

The flap decreases the minimum gliding angle from $7\frac{1}{2}°$ to 7°. To trim at constant speed, when the flap is opened, the elevator has to be moved down about 7° to correct tail heaviness, and the attitude is changed $-6°$.

The flap half and fully open decreases the distance from rest to take-off by 14 per cent. and 23 per cent., and also decreases the distance from take-off to clear a 50 ft. obstacle by 21 per cent. and 23 per cent. respectively. The speed at take-off is reduced by 3 and 8 m.p.h. respectively. These same flap positions for landing increase the distance from a 50 ft. obstacle to touch by 10 per cent. and 7 per cent., decrease the distance from touch to rest by 27 per cent. and 34 per cent. and reduce the total distance by 13 per cent. and 18 per cent.; the touch speed is reduced by 6 and 9 m.p.h. respectively. The flap effect quickly falls off after the half open position.

Lateral stability, which is poor near the stall, is improved when the flap is open, the ailerons becoming more positive. The elevator is affected adversely, and the rudder which near the stall is weak, is unaffected by the flap; there is a trace of buffeting with flap open.

---

* R.A.E. Report, March, 1936.

† These coefficients are calculated on the gross wing area and will be increased 15 per cent. if the centre section area is excluded.

This Document Provided by the Abbott Aerospace
Technical Library
abbottaerospace.com

1. *Description of aeroplane.*--The Scion M.3 is a light, twin-engined, high wing cantilever monoplane, with the wing tapering in thickness-chord ratio and chord to the tip. The ailerons are long and narrow, inset from the wing tip, and have no balancing provision.* The flap which extends from aileron to body is situated in the slipstreams of the engines, which are attached to the underside of the wing. The non-retractable undercarriage takes the landing forces mainly on the long vertical spring member attached to the front spar of the wing. There are low pressure wheels with differential brakes.

The wing is ply-wood covered and highly polished, with the upper surface faired into the fuselage. The engine nacelles are faired into the lower surface. There are otherwise no excrescences.

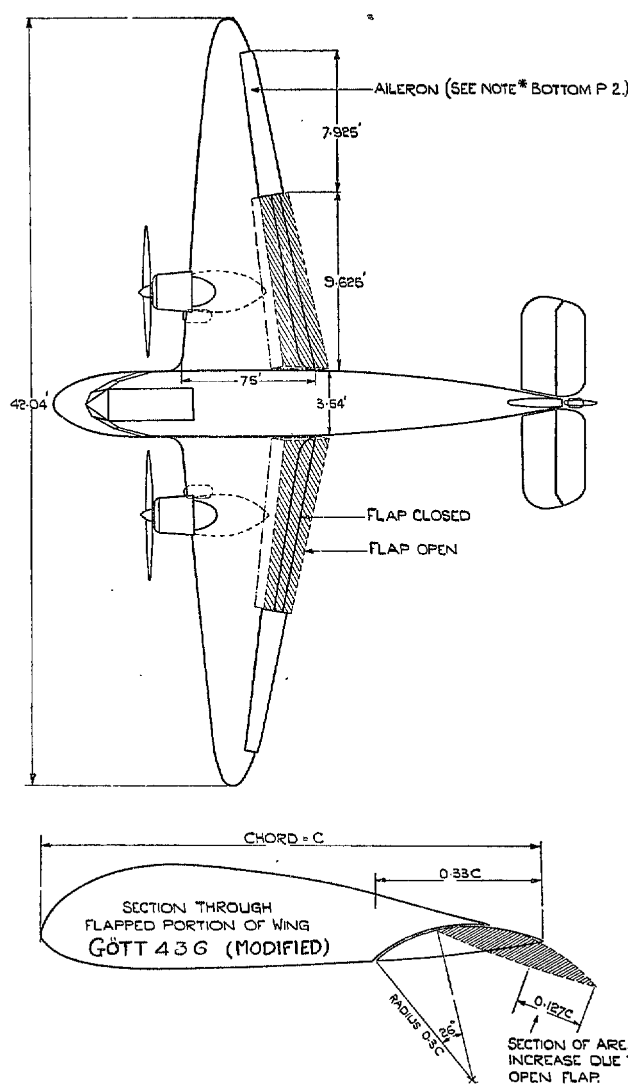


FIG. 1.—Scion M.3.—Scale drawing showing flap position.

---

* The makers had increased the aileron chord by adding along the whole of the trailing edge a strip about 3 in. wide. This addition is included in the total wing area.

THIS DOCUMENT PROVIDED BY THE ABBOTT AEROSPACE
TECHNICAL LIBRARY
ABBOTTAEROSPACE.COM

2. *Flap*.—This is referred to as the Gouge flap and is of the low drag type. It consists of a sharp nosed aerofoil, which in the closed position, forms part of the wing profile (Fig. 1). The flap tapers with the wing, i.e. the width of the flap at any point is a constant proportion of the wing chord at that point ; when open the extended portion also varies with the chord. All sections through the flapped portion of the wing are similar in shape and proportion. The flap moves on tracks, rotating conically about an imaginary axis below the wing, nearly parallel to the trailing edge. When open the flap increases the wing chord and the wing area. The increase in chord when the flap is open is 0·127c (Fig. 1) obtained by projection on to the chord of the flap, in the open position. Between flap and wing surface the clearance is only just sufficient to allow for smooth motion, and does not act as a slot.

A plan view of the aircraft and a wing cross section, the shaded portions showing the flap open position, are given in Fig. 1. Views of the aircraft are given in Figs. 2, 3 and 4. Particulars of the aircraft and flap are given below.

Mean weight during glides	2,750 lb.
Gross wing area (used for C_L, C_D), flap closed (centre section included).	208 sq. ft.
Wing loading	13·2 lb./sq. ft.
Fuselage centre section	27 sq. ft.
Total wing span (2s)	42·04 ft.
Mean chord	4·9 ft.
Wing taper	4 : 1.
Wing aspect ratio	8·5.
Wing section	Gött. 436 (modified).
Wing incidence on ground	16·2°.
Thrust line, below chord	5°.
C.G. distance from L.E. Parallel to thrust line (L.E. of chord 112·2 in. from centre line).	20·2 in.
Engines (2)	Pobjoy Niagara.
Horse power, each at 3,200 r.p.m.	84.
" " " 3,500 "	90.
Airscrew	Drg. No. Z.2310/2.
Diameter	7·38 ft.
Pitch	6·78 ft.

Flap Dimensions—

Length, 9·63 ft. each	45·7 per cent. wing span.
Chord..	33 per cent. local chord.
Chord of extended portion (due to open flap)	12·7 per cent. local chord.
Radius of rotation	30 per cent. local chord.
Angle of rotation	26°.
Increase in area due to flap 13·7 sq. ft.	6·6 per cent. of wing area.
Mean chord of area increase	0·71 ft.
Wing area in front of flap	56 per cent. gross wing area.

Flap area = 9.63 × 0.33 × 6.25 = 20.4 sq ft
Flap area/wing area = 0.103   0.103 sin 26° = 0.045

THIS DOCUMENT PROVIDED BY THE ABBOTT AEROSPACE
TECHNICAL LIBRARY
ABBOTTAEROSPACE.COM

To open the flap the pilot operates a pump handle with his right hand and generates the oil pressure in a small Dowty jack in the wing; a series of levers and universal links operate the flap. A torque tube ensures that both the left and right parts of the flap are moved simultaneously. The pump handle is 15 in. long and the pilot exerts a force of 10 lb. on it; twenty strokes are required to open the flap fully, and this can be done in 10 to 15 seconds. The flap can also be opened to any intermediate position, and a simple indicator in the wing leading edge shows that position. The whole is neatly arranged in the wing so that no levers are seen externally in the closed or open flap position.

3. *Tests*.—The characteristic curves, flap closed and open, were determined from a series of glides, with the engines throttled back. The speed was obtained by means of a suspended static and the aircraft fixed pitot. The position error curves were determined. The elevator angles to trim were established from a control column position indicator. Stability and control, also the nature of the stall for different flap angles, were investigated qualitatively by three pilots. Finally, landings and take-offs with flap closed, half and fully open were recorded by cinematograph and analysed.

Discussion of results

4. *Lift*.—Curves for lift against incidence are shown in Fig. 5. It will be seen that the flap shifts the lift curve about 6° and changes the max. C_L from 1·17 to 1·65, an increase of 0·48. The stalling speed for a weight of 2,750 lb., changes from 66 to 56 m.p.h. and the stalling incidence of 16° appears to be unaffected. This latter fact is advantageous as the full increase of max. C_L can be employed in landing. The aircraft could not be held in a glide very near the stall (see pilot's report in Appendix), and the max. C_L's are means of values obtained from the stalling speeds; the horizontal lines in Fig. 5 represent these values.

The ΔC_L due to the flap, has been compared with that calculated from a consideration of the increase of wing area and rotation of a hinged flap. A rough estimate of the increase is afforded by R. & M. 1095[1] which suggests that

$$C_{Lp} = 1{\cdot}07\ C_{Lc} + 0{\cdot}49$$

where C_{Lp}, C_{Lc} are the lift coefficients with flap open and closed respectively. Table 1 gives the theoretical values of C_{Lp} thus obtained and plotted in Fig. 6.

Tests were carried out by the N.P.L.* on a model which had a wing and flap similar to that on the Scion. The flap was 44·6 per cent. span, the rotation was 28° and the tests were made at $R = 0{\cdot}22 \times 10^6$. The proportional ΔC_L due to the model flap has been added to the C_L of the Scion, flap closed, and the result plotted in Fig. 6.

---

* Unpublished.

THIS DOCUMENT PROVIDED BY THE ABBOTT AEROSPACE
TECHNICAL LIBRARY
ABBOTTAEROSPACE.COM

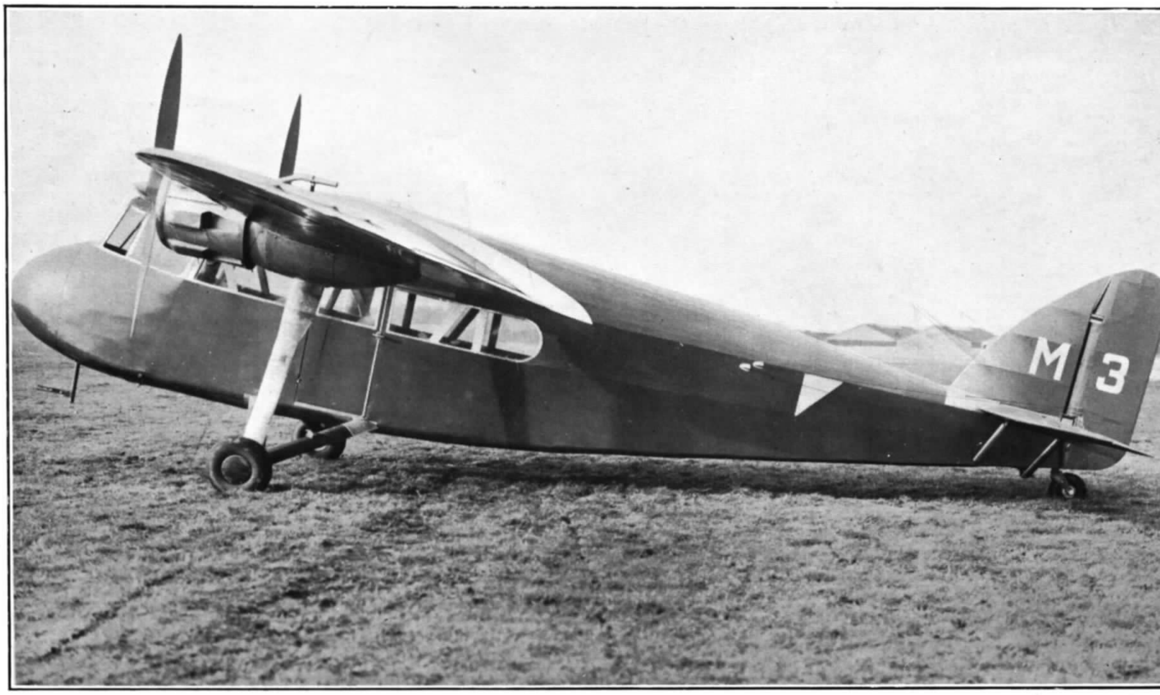


FIG. 2.—Scion M.3—Side View.

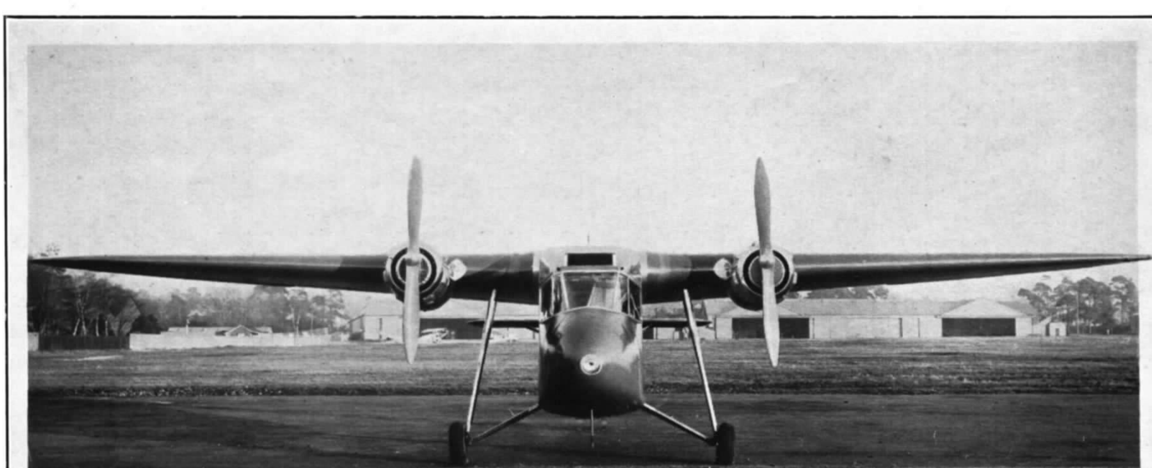


FIG 3.—Scion M.3—Front View.

This Document Provided by the Abbott Aerospace
Technical Library
abbottaerospace.com

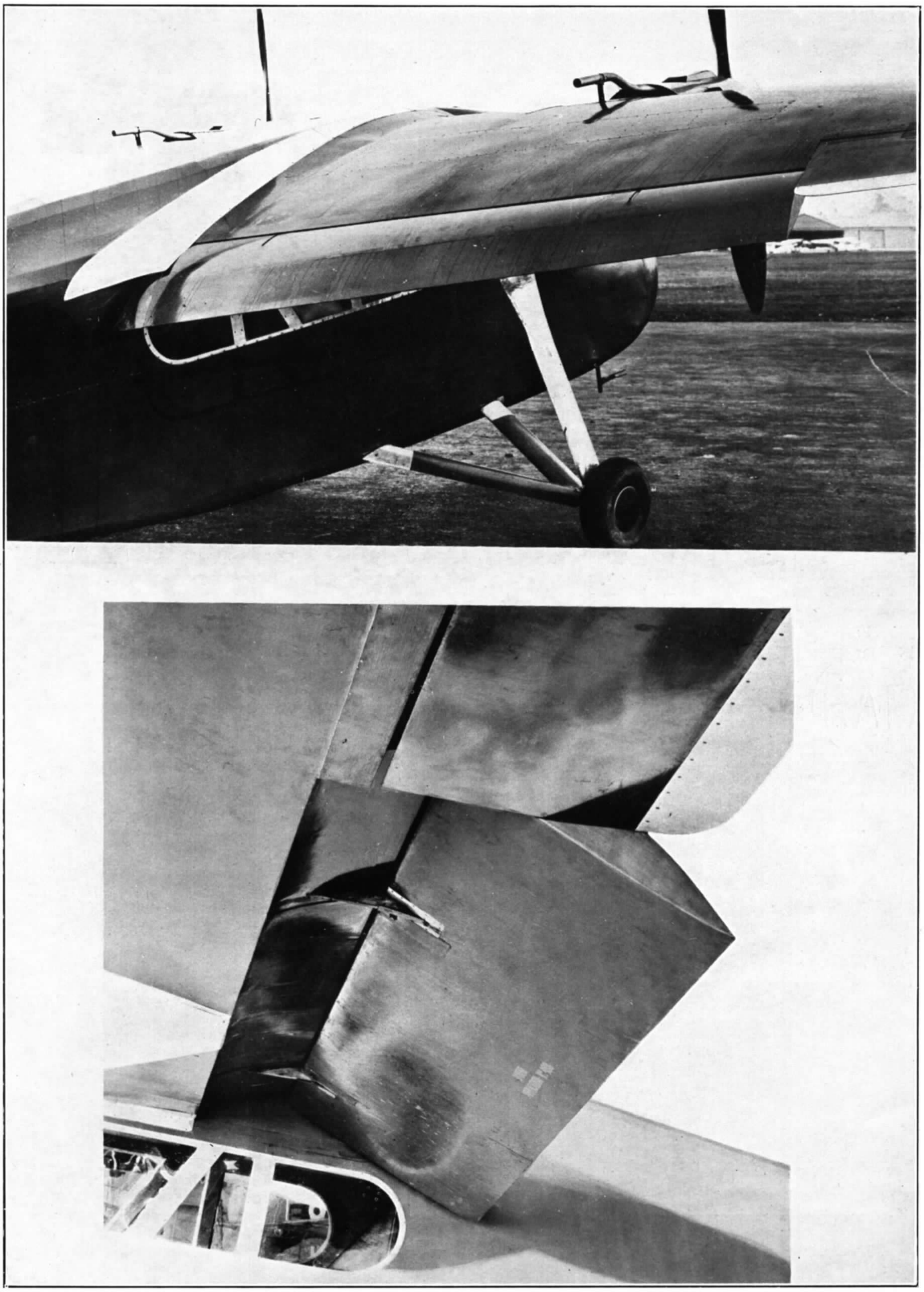


Fig. 4.—Upper and Lower View of Fully Open Gouge Flap on Scion M.3.

THIS DOCUMENT PROVIDED BY THE ABBOTT AEROSPACE
TECHNICAL LIBRARY
ABBOTTAEROSPACE.COM

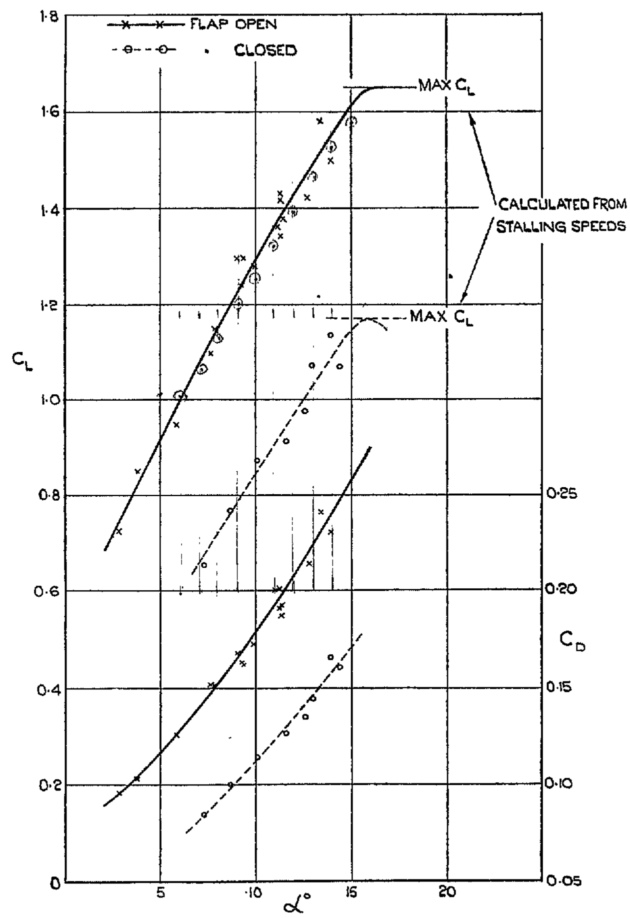


FIG. 5.—Lift and Drag Curves Flap Closed and Open, based on Gross Wing Area, 208 sq. ft. (Coeffs. increase by 15 per cent. if Centre Section is excluded).

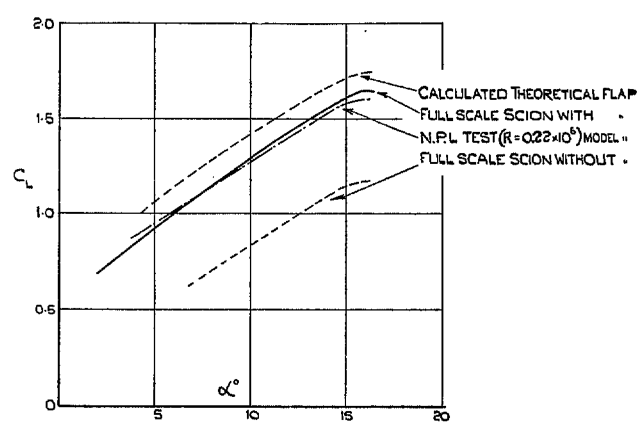


FIG. 6.—Theoretical and Model Comparisons for C_L.

THIS DOCUMENT PROVIDED BY THE ABBOTT AEROSPACE
TECHNICAL LIBRARY
ABBOTTAEROSPACE.COM

We see in Fig. 6 that C_L full scale is about 0·13 less than the values calculated from theory. This is probably due to the body interruption in the wing span. There is good agreement between N.P.L. model tests and full scale.

The stalling speeds and max. C_L's for various flap angles are given in Table 2 and Fig. 7. The effect of the flap is seen to fall off rapidly after the half open position.

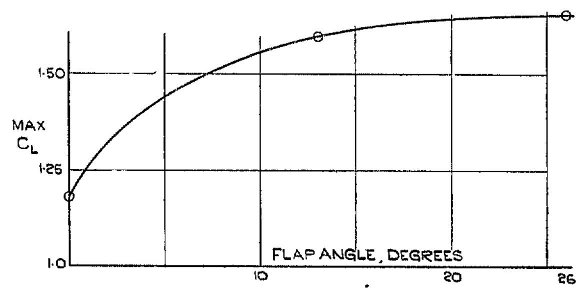


FIG. 7.—Max C_L Variation with Flap Angle.

5. *Drag*.—Drag curves are given in Fig. 5 and they are replotted on a C_L basis in Fig. 8. When a given lift coefficient or speed is considered, the flap decreases the drag coefficient if C_L is greater than about 0·75 and vice versa, but the change is small (Fig 8). (C_D — C_{Di}) for flap closed and open has been calculated in the usual way, no allowance being made for the probable change of lift distribution across the span caused by the flap. The curves are shown in Fig. 9, and suggest that the profile drag of the flap is about 0·03. The cross-over of the drag curves in Fig. 8 and the low value of the flap profile drag are typical of a flap which produces low drag but comparatively high lift. This has been referred to in R. & M. 1719[2].

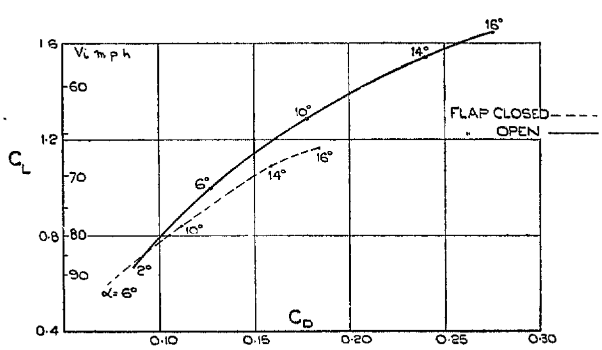


FIG. 8.—C_L/C_D Curves.

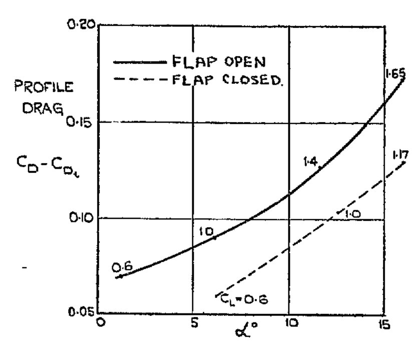


FIG. 9.—Profile Drag / α.

6. *Gliding angle and attitude*.—The small *decrease* in gliding angle of $\frac{1}{2}°$ to 1° caused by the flap again emphasises its low drag nature (Fig. 10). The flap would tend to be less useful in landing the aircraft than it would be for take-off. The

THIS DOCUMENT PROVIDED BY THE ABBOTT AEROSPACE
TECHNICAL LIBRARY
ABBOTTAEROSPACE.COM

flat nature of both curves shows that the gliding angle does not vary much with speed—a feature which would tend to make it difficult to correct overshooting.

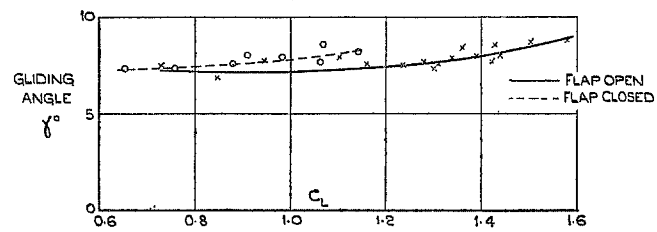


FIG. 10.—Gliding Angle Variation with C_L.

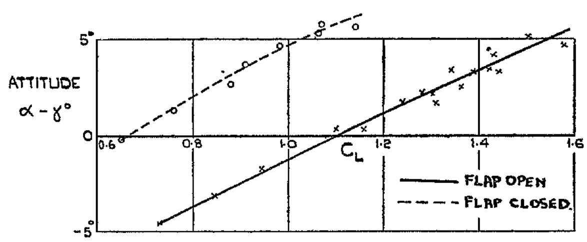


FIG. 11.—Attitude Curves.

In Fig. 11, wing attitude, $(\alpha - \gamma)$ is plotted against C_L. We see that when the flap is put down and the aircraft trimmed at the same speed, the nose drops about 6°. This change is particularly useful as it gives the pilot a better view when landing.

7. *Trim.*—Lowering the flap makes the aircraft tail heavy. A downward elevator movement of between 6° and 9° is required to keep the speed constant (Fig. 12). It would appear from this, that the reduction of tail incidence or increased downwash must be more effective than the backward shift of the wing C.P.

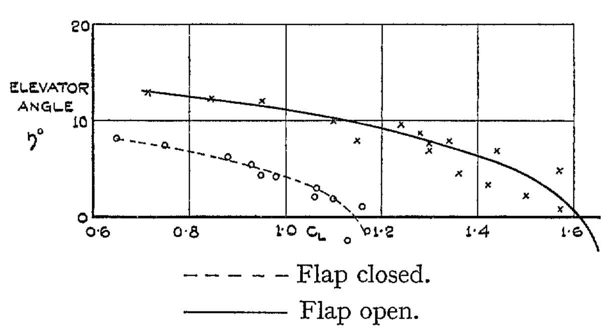


FIG. 12.—Trimming Curves.
Tail Plane is —6·7° relative to wing chord datum.

THIS DOCUMENT PROVIDED BY THE ABBOTT AEROSPACE
TECHNICAL LIBRARY
ABBOTTAEROSPACE.COM

8. *Take-offs and landings.*—Sets of these were made with the flap closed, half open and fully open, and cinematograph records obtained. Ground run and distance in the air from take-off or touch up to 50 ft. were measured from these records. Timing marks on the film were used to obtain the mean speed on the climb up to 50 ft. and for the glide-in from 50 ft. The velocity at take-off was obtained from the mean speed during two or three seconds just after leaving the ground ; conversely for velocity at touch.

The wind speed was obtained from an anemometer fitted 6 ft. above the aerodrome, the speed increase up to 50 ft. being deduced from the one-seventh power law. The wind varied between 3 and 5 m.p.h. along the flight path and corrections were made to air distances to allow for this wind. The correction for aerodrome slope was ignored. Wheel brakes were fitted to the aircraft but they were not used on these experiments. Tables 3 and 4 show the results obtained from the film measurements.

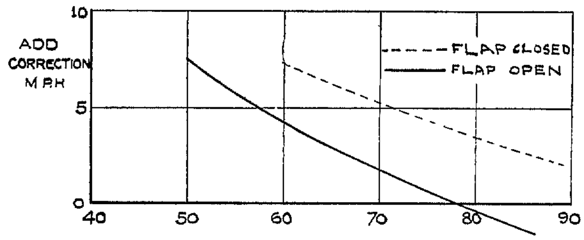
In Table 3 we see that the mean rate of decrease in the total distance from rest to a 50 ft. height, with respect to flap angle, is rapidly falling off after the flap half open position. This tends to indicate that 26° is nearing the best position. We also notice that the distance from take-off to 50 ft. *decreases* as the flap is opened. This higher angle of climb is explicable in view of the lower values of D/L with the flap open and a possible increase of thrust at a lower climbing speed.

The mean decrease in take-off speed is good but as seen from the individual experiments, the decrease seems to depend a good deal on the piloting. The take-off speeds are low compared with the stalling speeds with engines throttled back. This may be accounted for by slipstream.

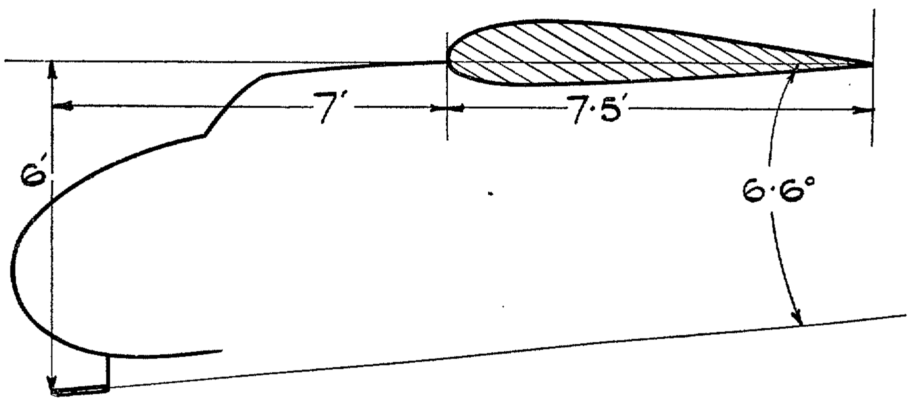
From the landing results in Table 4, we see that the flap causes a useful reduction in the total landing distance. There is actually an increase in the 50 ft. to touch distance, denoting a flatter gliding angle, as is confirmed by Fig. 10. The large reduction in ground run and distance from 50 ft. to rest is due mainly to the fall in touch speed. The mean touch speeds fall consistently with increase of flap angle, although the scattering between individual landings of the same set is considerable. The touch speeds in addition, are sometimes lower than the corresponding stalling speeds. This discrepancy is due to a combination of ground effect, rate of change of incidence and to possible inaccuracies in stalling speed determinations.

THIS DOCUMENT PROVIDED BY THE ABBOTT AEROSPACE
TECHNICAL LIBRARY
ABBOTTAEROSPACE.COM

9. *Position error.*—The flap reduces the position error by about 4 m.p.h. as shown below.



A.S.I. Reading m.p.h.



The Pitot-Static tube is on the centre line at 7′ in front and 6′ below the centre section L.E., set −6·6° relative to the Wing Chord.

FIG. 13.—Position Error Curves.

THIS DOCUMENT PROVIDED BY THE ABBOTT AEROSPACE
TECHNICAL LIBRARY
ABBOTTAEROSPACE.COM

APPENDIX

A questionnaire on handling trials of the aircraft was put to three pilots. In their replies they agreed as to the nature of the effect of the flap, but not always as to its magnitude. Below is a summary of these replies :—

1. As the stall is approached the lateral stability falls off and with control column held central the aircraft develops a gently rolling oscillation. At the stall whichever wing happens to be down drops further and this is followed by a gentle dropping of the nose. There is a decided improvement in lateral stability with the flap open, and the lateral control is also slightly improved while the control heaviness remains the same. In both flap conditions there appears to be a rapid increase in drag just before the stall as evidenced by a decided sinking when landing from a glide at low speed. This points to a stall which though not vicious from a wing dropping point of view, is sudden.

2. The elevator control is good up to the stall, but is rather adversely affected by the flap. The effectiveness of the rudder falls off towards the stall, and this is not changed with flap open.

3. The aircraft becomes tail heavy when flap is opened, i.e. to maintain a constant speed the control column must be pushed forward (see trimming curve Fig. 12). The change in trim is not sudden or unpleasant in any way.

4. As any vibration produces rather a lot of noise in the cabin it is difficult to be sure how much tail buffeting takes place. There are signs of tail shudder with the flap closed, just before the stall and this is increased, though still not bad, when the flap is open.

5. The flap makes the landing easier mainly on account of the improved lateral stability ; the approach speed is reduced by about 10 m.p.h. A.S.I., and the run after touch is shortened (Table 4).

6. The take-off in this aeroplane is good, and is improved with the flap (Table 3).

REFERENCES

No.	*Authors.*	*Title, etc.*
1	H. Glauert	Theoretical relationship for an aerofoil with hinged flap. R. & M. 1095. April, 1927.
2	A. E. Woodward Nutt and P. A. Hufton.	Full scale tests of the Hendy Heck. R. & M. 1719. November, 1935.

THIS DOCUMENT PROVIDED BY THE ABBOTT AEROSPACE
TECHNICAL LIBRARY
ABBOTTAEROSPACE.COM

TABLE 1

Theoretical lift values due to flap from relation $C_{Lp} = 1 \cdot 07\, C_{Lc} + 0 \cdot 49$

$\alpha°$	C_{Lc} full scale.	C_{Lp} theory.
5	0·53	1·06
10	0·84	1·39
12	0·97	1·53
14	1·09	1·66
16	1·17	1·74

These coefficients have been plotted in Fig. 6.

TABLE 2

Stalling speeds for a weight $W = 2{,}750$ *lb.*

Flap.	Stalling speed.	Max. C_L
Closed 0°	66·2 m.p.h... ..	1·17
½ open 13°	57·1 m.p.h... ..	1·59
Fully open 26° ..	56·0 m.p.h... ..	1·65

TABLE 3

Take-offs, corrected to zero wind

Flap position.	Start to T.O., ft.	T.O. to 50 ft., ft.	Total, ft.	Airspeed at T.O., m.p.h.	Mean airspeed on climb, m.p.h.
Closed 0°	477	744	1,221	58	64
Do.	508	780	1,288	56	69
Do.	487	676	1,163	55	66
Do.	489	609	1,098	53	63
½ open 13°	405	556	961	52	59
Do.	389	524	913	50	60
Do.	472	603	1,075	53	63
Do.	432	520	952	51	60
Fully open 26° ..	328	528	856	42	53
Do.	414	537	951	48	58
Do.	394	572	966	51	55
Do.	385	523	908	46	55
1. Mean closed ..	491	702	1,191	55	66
2. Mean 13° open ..	424	551	975	52	61
3. Mean 26° open ..	380	540	920	47	55
2. Mean decrease ..	14 per cent.	21 per cent.	18 per cent.	3	5
3. Mean decrease ..	23 per cent.	23 per cent.	23 per cent.	8	11

THIS DOCUMENT PROVIDED BY THE ABBOTT AEROSPACE
TECHNICAL LIBRARY
ABBOTTAEROSPACE.COM

TABLE 4

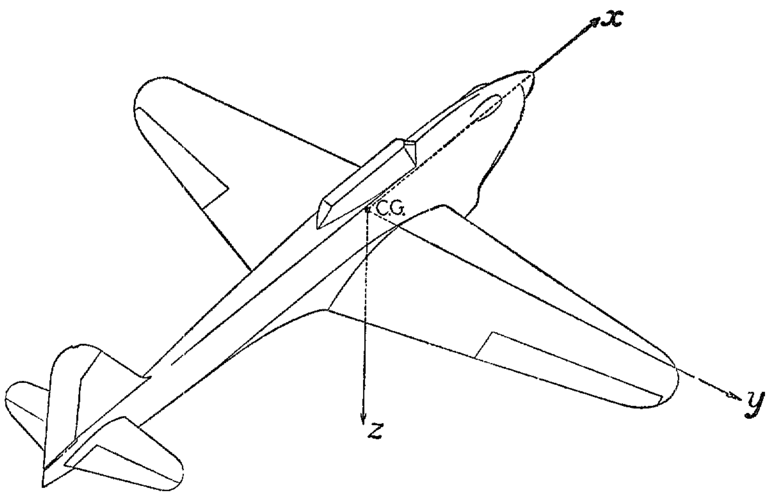
Landings, corrected to zero wind

Flap position.	50 ft. to touch, ft.	Touch to rest, ft.	Total, ft.	Airspeed at touch, m.p.h.	Mean airspeed on glide, m.p.h.
Closed 0°	614	1,424	2,038	—	—
Do.	814	903	1,717	70	72
Do.	733	1,132	1,865	60	68
Do.	625	1,030	1,655	—	—
½ open 13°	597	780	1,377	56	68
Do.	805	880	1,685	61	69
Do.	867	845	1,712	60	69
Do.	788	780	1,568	58	66
Fully open 26° ..	795	678	1,473	54	63
Do.	723	725	1,448	55	64
Do.	601	750	1,351	51	62
Do.	863	828	1,691	64	68
1. Mean closed ..	696	1,122	1,819	65	70
2. Mean 13° open ..	764	821	1,585	59	68
3. Mean 26° open ..	746	745	1,491	56	64
2. Mean decrease ..	−10 per cent.	27 per cent.	13 per cent.	6	2
3. Mean decrease ..	− 7 per cent.	34 per cent.	18 per cent.	9	6

(35063) Wt. 1505/137/6024 500 3/37 Hw. G.377

THIS DOCUMENT PROVIDED BY THE ABBOTT AEROSPACE
TECHNICAL LIBRARY
ABBOTTAEROSPACE.COM

SYSTEM OF AXES.



Axes	Symbol Designation Positive direction	x longitudinal forward	y lateral starboard	z normal downward
Force	Symbol	X	Y	Z
Moment	Symbol Designation	L rolling	M pitching	N yawing
Angle of Rotation	Symbol	ϕ	θ	ψ
Velocity	Linear Angular	u p	v q	w r
Moment of Inertia		A	B	C

Components of linear velocity and force are positive in the positive direction of the corresponding axis.
Components of angular velocity and moment are positive in the cyclic order y to z about the axis of x, z to x about the axis of y, and x to y about the axis of z.

The angular movement of a control surface (elevator or rudder) is governed by the same convention, the elevator angle being positive downwards and the rudder angle positive to port. The aileron angle is positive when the starboard aileron is down and the port aileron is up. A positive control angle normally gives rise to a negative moment about the corresponding axis
The symbols for the control angles are :-

ξ aileron angle
η elevator angle
η_T tail setting angle
ζ rudder angle

THIS DOCUMENT PROVIDED BY THE ABBOTT AEROSPACE
TECHNICAL LIBRARY
ABBOTTAEROSPACE.COM

Publications of the Aeronautical Research Committee

TECHNICAL REPORTS OF THE AERONAUTICAL RESEARCH COMMITTEE—

1933-34 Vol. I. Aerodynamics. £1 5*s.*
Vol. II. Structures, Engines, Instruments, etc. £1 10*s.*

1934-35 Vol. I. Aerodynamics. £2.
Vol. II. Seaplanes, Structures, Engines, Materials, etc. £2.

ANNUAL REPORTS OF THE AERONAUTICAL RESEARCH COMMITTEE—

1933-34 1*s.* 6*d.*
1934-35 1*s.* 6*d.*

INDEX TO THE TECHNICAL REPORTS OF THE ADVISORY COMMITTEE ON AERONAUTICS—

1909-1919 Reports and Memoranda No. 1600. 8*s.*

NUMERICAL LISTS OF REPORTS AND MEMORANDA published between 1909 and 1936—

Reports and Memoranda Nos. 650 (9*d.*), 750 (6*d.*), 850 (1*d.*), 950 (4*d.*), 1050 (4*d.*), 1150 (4*d.*), 1250 (6*d.*), 1350 (6*d.*), 1450 (6*d.*), 1550 (6*d.*), 1650 (6*d.*), 1750 (1*s.* 3*d.*)

LIST OF PUBLICATIONS ON AERONAUTICS—

(1) Air Ministry Publications.
(2) Aeronautical Research Committee Publications (classified under subjects). Post free on application.

Prices are net and postage extra.

His Majesty's Stationery Office

London W.C.2 : Adastral House, Kingsway

Edinburgh 2 : 120 George Street
Manchester 1 : 26 York Street
Cardiff : 1 St. Andrew's Crescent
Belfast : 80 Chichester Street

or through any bookseller.

S.O. Code No. 23-1753