4th Part of Report No. A.&.A.E.E./819,a

- 9 APR 1946

AIRCRAFT AND ARMAMENT EXPERIMENTAL ESTABLISHMENT
BOSCOMBE DOWN.

This report deals with the a/c or equipment as tested. Action to remedy defects or decisions to accept items not in strict compliance with the spec. are matters for decision & action by the M.A.P.

Vampire F Mk. I TG.274 (Goblin I)

Level Speed and Position Error Trials.

A.&.A.E.E. ref: AAEE/5719,c/1/ARJ
M.A.P. ref: SB.56746/RDL1(d)
Period of Tests: July - October, 1945.

Progress of Issue of Report.

Report No.	Title
1st Part of AAEE/819,a	TG.274 - Weights and loading data.
2nd do.	TG.274 - Carbon monoxide contamination tests.
3rd do.	TG.274 - Preliminary handling trials of first production aircraft.

Summary.

The combat level speed performance of this aircraft and the position error of the pitot-static head have been measured.

The results of the tests showed that, using combat engine conditions of 10,000 rpm and at a weight of 8,180 lb., the maximum level speed which could be attained without exceeding the critical Mach number (0.76) was 526 mph TAS, at 25,500 ft. Above this height it was necessary to throttle back to avoid exceeding this limitation, which arose from a deterioration in handling qualities due to compressibility effects.

The position error correction varied from +2 mph at 140 mph ASI to +17.5 mph at 489 mph ASI, agreeing approximately with that measured on the prototype Vampire MP.838.

1. Introduction.

Measurements of combat level speed of Vampire F Mk.I TG.274, the first production aircraft, have been made.

These tests were necessarily of a brief nature due to the urgency of completing full handling tests on the aircraft for clearance of the type to the Service. The static and pitot errors of the aircraft pressure head were also determined, and the results are included in this Report.

The results were briefly reported by letter dated 15.9.45, reference: AAEE/5719,c/1/JJQ.

2. Condition of Aircraft Relevant to Tests.

2.1 General. The aircraft's condition was similar to that described in 3rd part of Report No. A.&.A.E.E./819,a.

2.2 Engine Details and Limitations. A De Havilland Goblin I, Serial No. 1112 DGN 27-2, A.M. No.A/465335, was installed in the aircraft giving a maximum static thrust rating of 2700 lb.

The following engine limitations applied at the time of the tests:-

Engine speed.

Maximum rpm for take-off and combat	-	10,000 (5 mins. limit).
" " " climb	-	9,500 (30 " ")
" " " cruise	-	8,500

/Jet Pipe...

Jet Pipe temperatures.

Maximum for take-off and combat	- 670°C	(5 min. limit)
" " climb	- 610°C	(30 min. limit)
" " cruise	- 540°C	

2.3 ASI System. All indicated airspeeds quoted in this Report were obtained from an airspeed indicator which was connected across the pitot and static sides of a Mk.VIII pressure head. Fig. 1 at the end of this Report gives details of the pressure head, which was fitted to the leading edge of the port fin.

2.4 Loading. The tests were made at a take-off weight of 8,610 lb. which represented the aircraft's full fighter load with full internal fuel and ammunition.

2.5 Instrumentation. The following test instruments were fitted for the purpose of the tests :-

K.B.B. Mk.IX GS ASI, Kollsman Mk.XIV(c) altimeter, Smith Mk.VII A engine speed indicator (20 turn), balanced bridge type air thermometer, calibrated fuel contents gauges.

A venturi pitot head was fitted under the nose of the aircraft and a differential pressure gauge was connected between the venturi pitot head and the normal aircraft pitot head for the purpose of measuring the pitot error of the latter.

3. Tests Made.

3.1 The static position error correction was determined in level flight by the aneroid method over the aircraft's speed range of 140 to 480 mph ASI with flaps and undercarriage retracted.

3.2 A determination of the pitot error of the normal aircraft pitot head was made in level flight by comparing the pitot pressures produced by the venturi pitot and the Mk.VIII head over the speed range of the aircraft.

3.3 Level speed tests were made over a range of engine speeds from 8,500 and 10,000 rpm at nominal heights of 5,000, 15,000, 25,000 and 35,000 ft. At each nominal height the level speed runs were carried out keeping the ratio $\left(\frac{W}{P}\right)$ constant, the test height being increased as the weight of the aircraft decreased, due to consumption of fuel.

$$\frac{\text{aircraft weight}}{\text{atmospheric relative pressure}}$$

4. Results of Tests.

4.1 Position Error Correction. The static position error correction and static correction to the altimeter are shown in Figs. 2 and 3 respectively. The static position error correction was corrected to two different weights, viz., 95% of the take-off weight (8180 lb.) and the take-off weight less 95% disposable load (6710 lb.). The correction varied from +2 mph at 140 mph ASI to +17.5 mph at 480 mph ASI at a weight of 8180 lb.

The pitot error correction was negligible over the aircraft's speed range of 140-480 mph ASI. The static position error given in Fig. 2 therefore constitutes the position error correction of the pitot-static head.

4.2 Speed Calibration of Air Thermometer. Due to the brief nature of the tests, a speed calibration of the air thermometer was not made. A speed correction of 80% of the adiabatic temperature rise was used to correct the readings of the balanced bridge air thermometer. This figure was a mean of results recently obtained on similar thermometer installations.

4.3 Level Speeds. The tests were planned and performed to enable the results to be presented in a "non-dimensional" form according to the methods given in R.A.E. Technical Notes Aero. 1348 and Aero. 1348a. This "non-dimensional" presentation is given in the Appendix (Table I and Fig. 1A). The results given in Fig. 4 of the Report have been extracted from the "non-dimensional" presentation and are those appropriate to ICAN standard atmospheric conditions at a weight corresponding to 95% of the take-off weight.

In giving these results it is assumed that the aircraft's critical Mach number of 0.76 is not exceeded. In order that this Mach number is not exceeded, it is assumed that, under ICAN standard atmospheric conditions, the engine speed is reduced progressively with increase of altitude above 25,500 ft.

The following table shows the maximum level speed together with Mach number and rpm under ICAN conditions for heights from 5,000 to 35,000 ft. for a weight corresponding to 95% of the take-off weight (8,180 lb.).

Height ft.	5,000	10,000	15,000	20,000	25,000	30,000	35,000
TAS mph	495	505	513	520	525	516	505
Mach No.	0.660	0.686	0.710	0.734	0.756	0.760	0.760
R.P.M.	10,000	→	→	→	→	9,900	9,710

No engine surging was apparent throughout the level speed tests.

5. Discussion of Results.

5.1 Position Error Correction. The position of the pressure head on Vampire I TG.274 was on the leading edge of the port fin. This differed from the prototype Vampire MP.838/G, where it was fitted to the starboard fin (see 2nd part of this Report).

When the position error correction curves of these two aircraft were corrected to the same weight, viz., 8,180 lb., they agreed to within 1 mph, this difference only occurring at the higher speeds.

5.2 Level Speeds. It was noted during the level speed tests at combat engine conditions that above 35,000 ft. it was possible to exceed the aircraft's critical Mach number of 0.76. The highest Mach number obtained during these tests was 0.768 at 36,600 ft., and during this particular speed run the onset of compressibility effects was just noticeable in the form of aileron overbalance.

The air temperature at the time of this speed run was 5°C above ICAN standard with the result that the ICAN value of $\frac{N}{\sqrt{\theta}}$ for combat conditions was not obtainable. In order to obtain the maximum level speed performance under ICAN standard atmospheric conditions it is therefore necessary to extrapolate along the $\frac{N}{\sqrt{\theta}}$, $\frac{V}{\sqrt{\sigma}}$ lines (see Fig. 1A of Appendix). If a linear relationship between $\frac{N}{\sqrt{\theta}}$ and $\frac{V}{\sqrt{\theta}}$ were assumed (as indicated at lower Mach numbers), the combat level speed thus obtained under ICAN conditions would exceed the aircraft's critical Mach number by an increasing amount at heights above 25,500 ft.

The validity of this form of extrapolation is obviously questionable since it involves entering the region where abrupt changes of aircraft drag are liable to occur (see wind tunnel tests on Vampire, R.A.E. Ref. Aero/H/1263R/96). With the aircraft capable of reaching their critical Mach number in level flight, the level speed performance can at present only be quoted under conditions of test or under conditions of air temperatures higher than those obtained during the tests or at reduced engine speed in order to keep the corrected value of $\frac{N}{\sqrt{\theta}}$ not greater than that obtained on test.

/Notation.

Notation.

N = actual engine speed, rpm.

V = true air speed, mph.

W = aircraft weight, lb.

T = ambient air temperature, ^{o}K.

θ = relative air temperature $\frac{T}{288}$

P = relative atmospheric pressure

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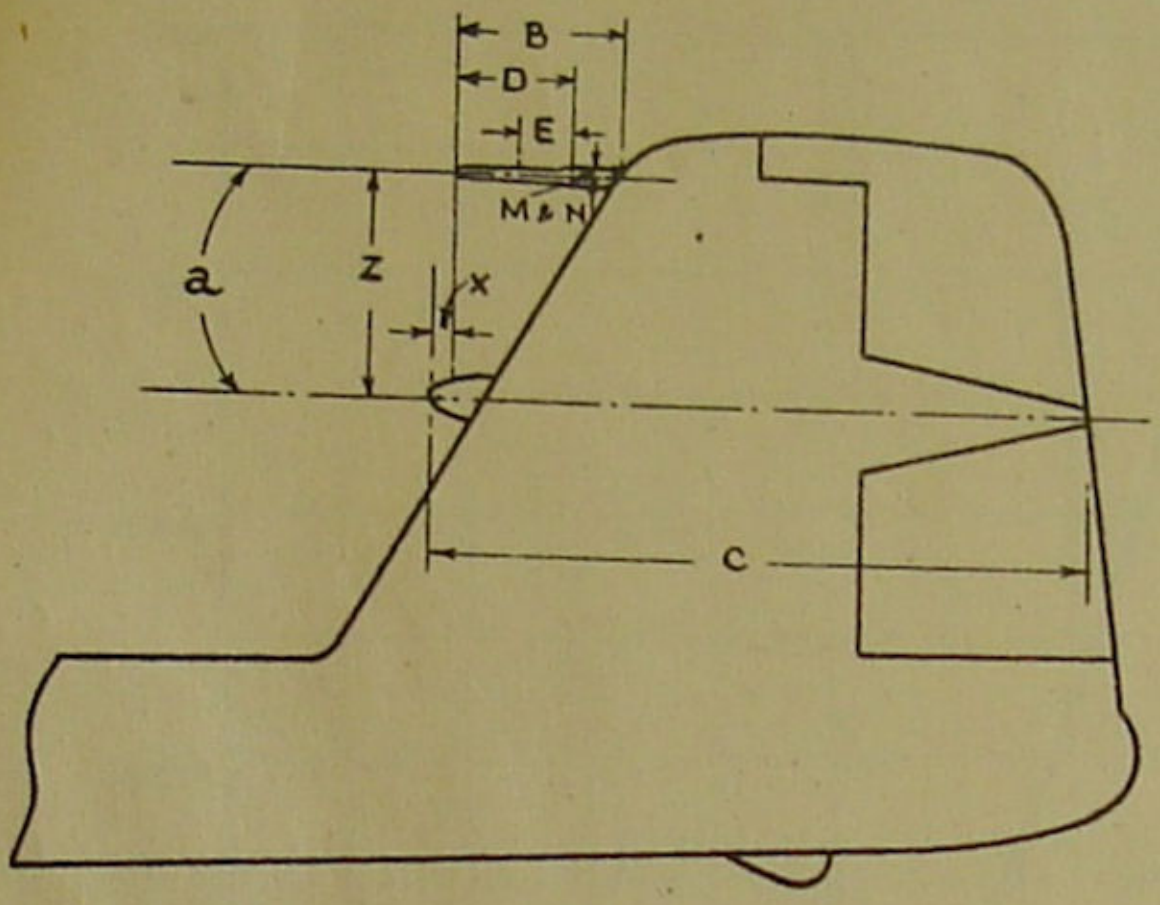
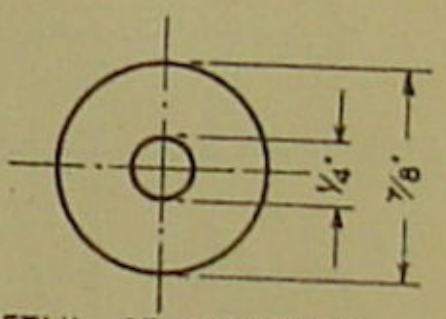
FIG. 1.





DETAIL OF APERTURE

TYPE OF PRESSURE HEAD MK. VIII B - 24 VOLT - REF Nº 6A/729

RATIO OF APERTURE OF TUBE TO EXTERNAL DIA. OF STATIC TUBE. 28·6%

INCIDENCE OF TAIL PLANE. (AT ROOT) +0° 25'

a ANGLE OF HEAD TO CHORD OF TAIL PLANE. -0° 20'

D NOSE OF HEAD TO SUPPORTING STRUT. 7½"

B " " " " FIN (MINIMUM DISTANCE) 11½"

N " " " " CHORD LINE OF T.P. 14¾

X " " " " T.P. LEADING EDGE (PARALLEL TO CHORD) -1½"

C LENGTH OF CHORD OF T.P. (AT ROOT) 3' 7½"

E STATIC HOLES TO STRUT. (MEAN) 4⅜"

M MAJOR AXIS OF STRUT. 1¼"

N MINOR " " " 1¼"

DISTANCE FROM PLANE OF SYMMETRY 4' 10"

POSITION LEADING EDGE PORT FIN

SEMI-SPAN OF TAILPLANE 4' 8"

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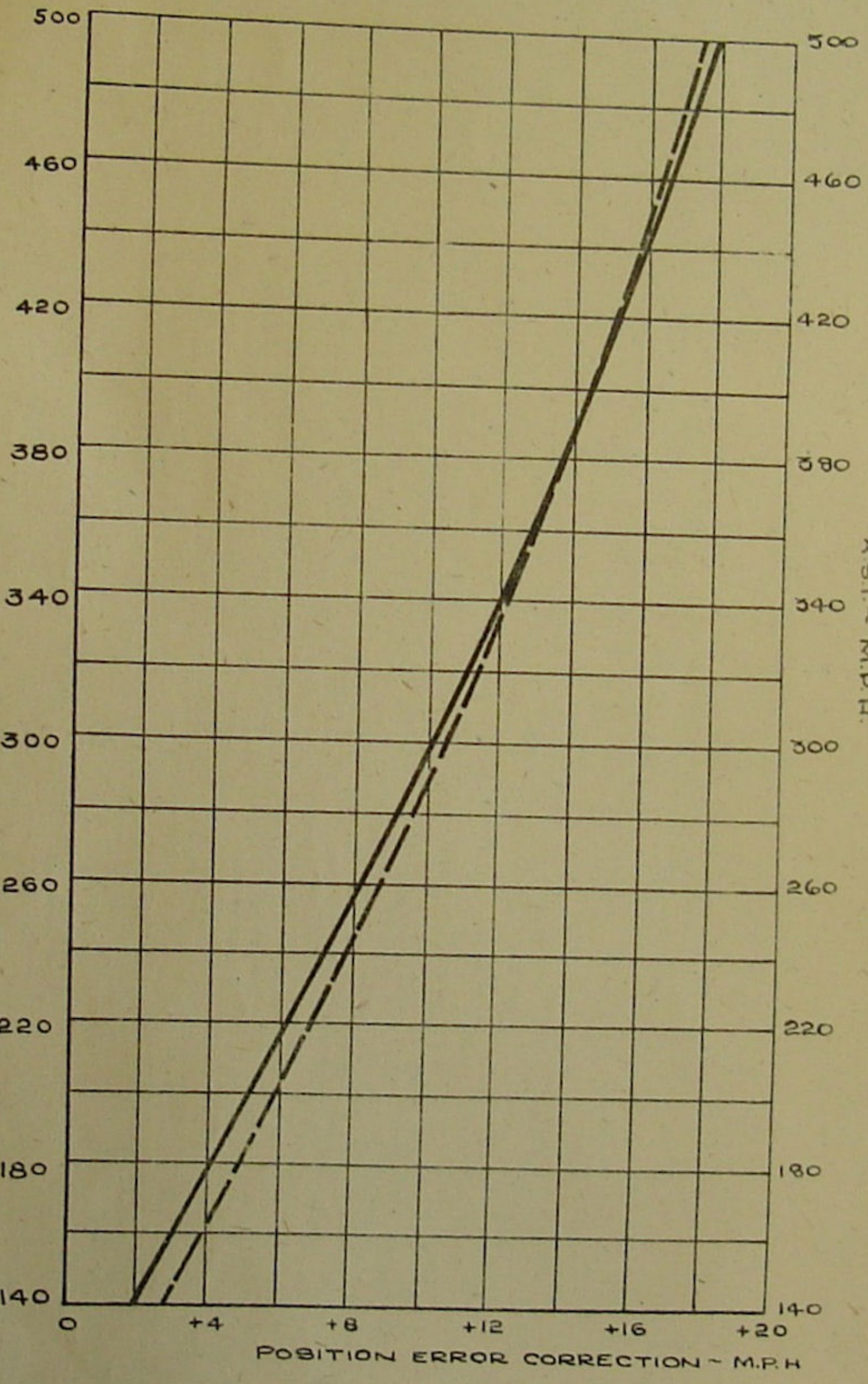
PRESSURE HEAD POSITION.

FIG.2.

FLAPS AND UNDERCARRIAGE UP
CORRECTED TO THE FOLLOWING WEIGHTS:-
—— 95% T.O.WT. (8180 lb)
- - - - - T.O.WT. MINUS 95% OF NORMAL DISPOSABLE LOAD (6710lb.)

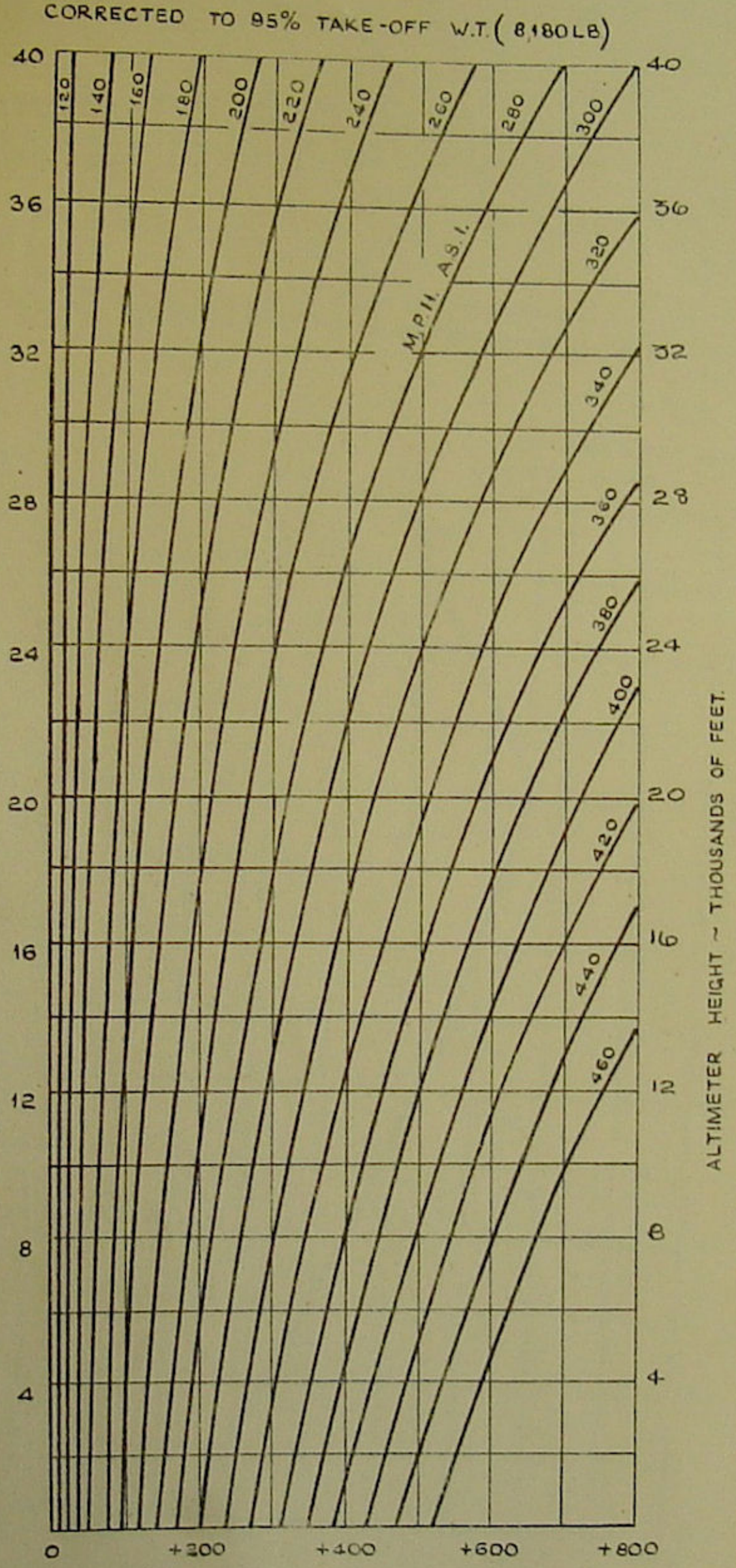


SK. Nº P436 | 4th PART OF REPORT Nº A&AEE/819A | VAMPIRE I TG274 | TR. J.C. | CH. | APP.

STATIC POSITION ERROR CORRECTION

FIG. 3.

SK. Nº 437 | 4TH PART OF REPORT Nº A&AEE/ 818A. | VAMPIRE I T.G.274. | TR.J.F. | CH. [illegible] | APP. [illegible]

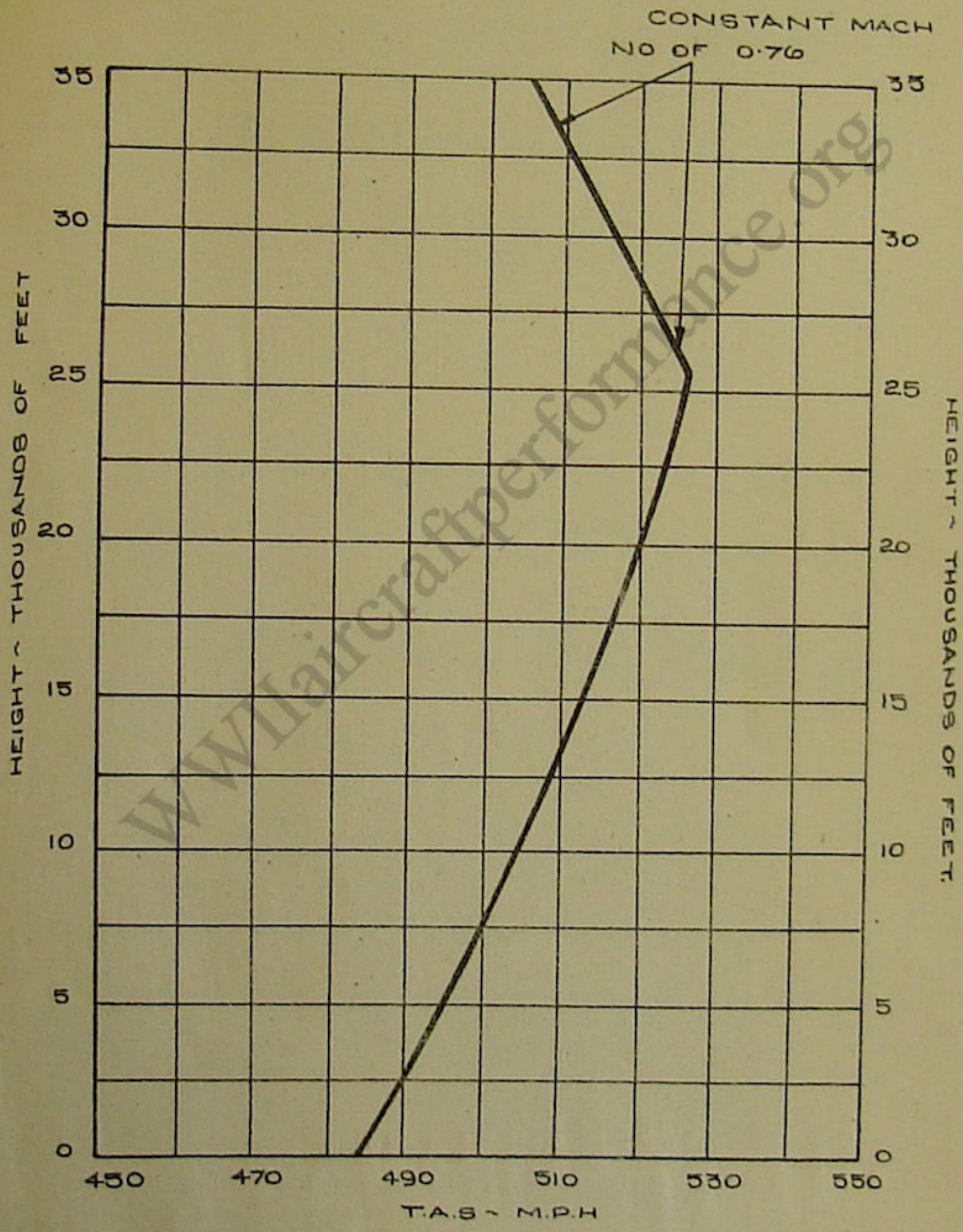


CORRECTION TO ALTIMETER WHEN CONNECTED TO THE STATIC HEAD

FIG.4.

ICAN STANDARD
ATMOSPHERIC CONDITIONS

WEIGHT 8180 lb.



Courtesy of Neil Stirling

MAXIMUM LEVEL SPEED PERFORMANCE