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By

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SUMMARY

Measurements have been made of the air flow under the two carriages in the R.A.E. Seaplane Tank with a screen or large flap set at varying attitudes at the rear of the working section. The flap was used in an attempt to reduce the air speed under the carriage to that of the carriage, so that investigations on the seaplane hull afterbody ventilation characteristics and interference between air flow and water flow could be made with the correct air flow round the model.

By suitably adjusting the setting of the rear flap, it was found possible to obtain a mean air speed under either carriage the same as the carriage speed. The flap also served to stabilise the flow.

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1 Introduction

It has been the normal routine in water force measurements made in air flow to apply corrections for the air forces on the model. To determine these corrections, the model was towed just above the water surface, and the air forces and moments measured under these conditions were subtracted from the corresponding quantities measured with the model in the water. The differences were regarded as being due to water forces only

R.A.E. tank tests[1,2] showed that the forces on a model are affected by the air flow round the model and that this method of allowing for air forces was often incorrect. These tests were summarised by Gott[3], who concluded that for more correct measurements on a stable hull, a screened resistance model could be used, where the screen reduces the air speed to a negligible figure. This method makes no allowance for air-water interference effects, but was considered satisfactory for normal hulls, when such interference should be negligible Tests on screened models have been made on the No.1 towing carriage in the R.A.E. Seaplane Tank, the No 2 carriage having been retained in the unscreened condition.

In research on step and afterbody ventilation, however, these air-water interference effects are required. Gott states that the air speed under the towing carriages in the R A.E. tank is up to 40% greater than the carriage speed It is necessary, therefore, to reduce the air speed under the towing carriage to that of the carriage itself.

This note describes an investigation of the air flow under the carriages in the R.A.E. Seaplane Tank, and methods for (a) reducing its speed to that of the carriage under both No 1 and 2 carriages and (b) stopping it altogether under No.2 carriage.

2 Range of investigation

A preliminary investigation of the air flow under No.2 carriage unscreened was made using a single pitot. The air speed relative to the carriage was measured in the region normally occupied by the model (Fig 1), and it was found that, with the drag balance (Fig.1) close to the water, the air flow was far from uniform Hence the tests were repeated with the balance at a series of heights above the water The air flow was fairly uniform when the balance was 18 inches above the water surface.

Flaps were now fitted to the carriage, one at the front and one at the rear. The steadiness of the flow was investigated with wool tufts for various settings of the flaps.

These tests showed the air to be fairly steady with the front screen up and the rear screen partly down, so that only the rear screen was used to reduce the air speed under the carriages.

The air speed was now measured for various settings of the rear flap to the horizontal using a bank of five pitot tubes set 6 inches apart symmetrically about the centre line (Fig 4) Two positions chosen for the pitots, correspond to the air entry and air exit positions of a model to be used in research on step ventilation At each longitudinal position of the pitots measurements of the air speed were made at heights of 2 inches, 6 inches and 12 inches above the water surface. The drag balance was set at 18 inches above the water throughout these tests. To check these results measurements have also been made at the step position of the ventilated model tests.

The measurements were repeated on the No 1 carriage at pitot positions corresponding to the bow, step and stern model positions (Fig. 2).

3 Description of Apparatus

In preliminary measurements of the air speed a single N.P.L. standard pitot-static tube was used. To measure the small pressure differences obtained at such low speeds as 10 f.p.s , a "step-up" gauge was constructed[4]. This is essentially a divided V-tube, but instead of restoring the balance by raising one leg through a measured distance as in the Chattock gauge, the out-of balance movement is measured. The gauge is shown in Fig. 3, and consists of two vertical brass tubes of large bore connected across the bottom by a horizontal fine-bore glass tube, into which is let a tee-piece connected to a stop-cock. In the first instance the instrument was filled with ether but this was later replaced by hexane because of rapid vapourisation losses. An air bubble was introduced into the glass tube, by means of the tee-piece, to act as a division. Calibration was made against a master gauge used for calibrating A.S.I's. The step-up gauge was found to have a speed range of 0 to 45 f.p.s.

For the major investigation of the air flow in the region of resistance models, a stack of five pitot static tubes was used, and the five gauges were read photographically. Views of the auto-observer, and the pitot-static mountings are given in Fig. 4 and Fig. 5.

The two wooden flaps for modifying the air flow were mounted as shown in Figs. 1, 2 and 6. These screens were pivoted at their connection with the carriage, and could be set at any angle to the horizontal over the range 0° to 40° For the final control of air speeds, only the rear flap was used, the front flap being locked in the horizontal position.

4 Results

4.1 Air flow with no screens

The results of measurements made under No. 2 carriage with a single pitot in the longitudinal position normally occupied by the bow of the model, are given in Table I.

The velocity field interpolated from these results is given in Fig. 8, and the tests show that:-

(1) Whilst the drag balance was in its normal position near the water surface, the air flow behind it was unsteady and non-uniform;

(2) raising the balance caused the flow, in the region occupied by the model, to be steadied. The air flow was almost uniform to a height of 6 inches above the water, and equal to 1.2 times the carriage speed

It was decided from these results to test models in air flow with the drag balance at a height of 18 inches above water surface.

4.2 Nature of the air flow

The front and rear flaps were fitted on No. 2 carriage and the steadiness of the air flow was ascertained using wool tufts. Runs were made with both flaps down, rear flap only down, and front flap only down, and photographs were taken of the wool tufts. Results are given in Fig. 7, and show that the steadiest flow is obtained when the rear flap only is used to slow down the air under the carriage.

An attempt was made to measure the air speed relative to the carriage when both screens were fully down. Whilst not being very consistent, the measurements show that the air speed is reduced to about 10% of the carriage speed up to 30 f.p.s.

4.3 Effect of flap setting on air flow under No. 2 carriage

Measurements of air flow were made with the rear flap set at 20°, 30° and 40° to the horizontal - the front flap being set horizontally throughout. Complete results are given in Table II. The readings showed that there was only a small variation in air speed transversely. The two outer pitots gave consistently high readings and were neglected when evaluating the mean air speed. Readings made in the forward position differed from those made in the aft position, but no consistent variation was found.

The results obtained for a given flap setting and speed were meaned and the points are shown plotted in Fig 9. Individual readings may be 10% different from the mean readings, but the majority are within ±4% of the mean.

A working curve showing the flap setting required over a range of air speeds to give correct mean air flow is deduced from Fig. 9 and shown in Fig. 10.

To check these results further measurements were made later at the step position of the ventilated model. The results are given in Table III. Variation with height of the ratio, air speed to carriage speed, for the bow, stern and step positions are given in Fig. 11 for 20 and 28 f.p.s. carriage speed.

4.4 Effect of balance position on resistance measurements on No. 2 carriage

Tests have been made to examine the effects of air flow on the zero of the resistance balance on No. 2 carriage. These tests were made with three positions of the balance (12 inches, 18 inches and 24 inches above water level) and at carriage speeds of 16, 28 and 36 ft/sec., both with and without air flow. The results show that, without air flow the effect on the balance is negligible but with "correct" air flow there is a small effect which varies with forward speed and the height of the balance above the water. The effect of balance position on resistance measurement gives the following correction for resistance over the range of carriage speed 16 to 40 f.p.s.

Carriage Speed f.p.s.	Correction to resistance measurement (LB) for balance position above water surface		
	12 inches	18 inches	24 inches
16	-0.04	-0.03	-0.02
28	-0.09	-0.075	-0.045
36	-0.14	-0.12	-0.075

The results are plotted in Fig 12 to give curves for the correction to resistance readings over the whole speed range and for three positions of balance.

4.5 Effect of flap setting on air flow under No.1 carriage

Air flow measurements were made with the following settings of the rear flap, 20°, 25°, 30° and 40° to the horizontal - the front flap being set horizontally throughout. A diagram of the flap arrangement is given in Fig.2 and a view of the rear flap used to control the air flow is given in Fig.6.

Complete results are given in Table IV. In the evaluation of the mean air speed the two outer pitots were neglected. In the forward position the speed of the air flow even at a 40° flap setting was higher than the speed of the carriage. Fig.13 shows the flap setting as a function of carriage speed for constant values of $\frac{Va}{Vc}$ at the bow, step and stern model positions. A flap setting of 32° gives the following values of $\frac{Va}{Vc}$ over the range of carriage speed 16 to 40 f.p.s.

Distance of transverse plane from datum (Inches)	$\frac{Va}{Vc}$
43.5 (bow)	$\nless$ 0.9
57.0 (step)	$\hat{=}$ 1.0
94.5 (stern)	$\ngtr$ 1.1

Variation of the ratio of air speed to carriage speed with height for transverse vertical planes at the same positions are given in Fig.14 for 16, 20, 28 and 36 f.p.s. carriage speeds.

5 Conclusions

It is possible to considerably improve the air flow under both the R.A.E. towing tank carriages by means of a large flap positioned at the rear of the working section. Lowering this flap about its upper edge working line enables the mean air speed in the region of the model to be reduced to that of the carriage. The air flow is also made more steady.

Under No.2 carriage the present drag balance has also to be raised so that interference with the air flow over the model may be avoided.

There is however a resultant fore and aft pressure or velocity gradient which is considerably larger under No.1 than No.2 carriage, possibly because of the presence of the retracted screen used for fully screened tests. It is hoped to reduce this gradient in the future by transferring the balance on No.1 carriage, the better one, to No.2 carriage. Then all force measurements, with and without air flow will be done on No.2 carriage and dynamic model tests on No.1 carriage. The present drag balance design on No.2 carriage, by which the model is towed by a long tow bar, is not considered satisfactory for tests in air flow because of air flow and air drag interference.

REFERENCES

No.	Author	Title etc
1	Gott	Comparison of Results of tests of the Singapore IIC model hull in five tanks R and M. 1785. 1937
2	Clark, Hills	Tank and Wind tunnel tests on the Short Sunderland to compare attitudes with full scale during take-off and landing. 1622, A.R.C. 4782 July, 1940.
3	Gott	Interference between air flow and water flow in Seaplane Tank testing. A.R.C. 7906 July, 1944.
4	Walker, Hardman	The Prestatyn Wind Tunnel Pt.II - Instruments. Aeromodeller Vol.X No.111. February, 1945

TABLE I

Air Speed Measurements under No.2 Carriage with different positions of drag balance, no flaps

Balance ht. above water	Pitot ht. above water	Carriage speed, f.p.s.	Ratio of air speed to carriage speed				
			Pitot $11\frac{1}{4}$" port	Pitot 6" port	Pitot cantral	Pitot 6" starbd.	Pitot $10\frac{5}{8}$" starbd.
6 in.	2 in.	10	1.13	1.08	1.10	-	1.15
		20	1.24	1.20	1.15	1.10	1.21
		30	1.23	1.23	1.15	1.17	1.21
		34	1.19	1.20	1.10	1.15	1.19
	6 in.	10	0.95	0.75	-	0.90	1.10
		20	0.97	0.93	0.78	0.97	1.20
		30	1.03	0.98	0.78	1.02	1.18
		34	0.90	0.96	0.78	1.01	1.18
	12 in.	10	0.70	-	-	0.55	1.00
		20	0.78	0.55	0.45	0.78	1.00
		30	0.83	0.57	0.57	0.83	1.02
		34	0.82	0.56	0.53	0.84	1.01
12 in.	2 in.	10	1.15	1.10	1.15	1.40	1.05
		20	1.24	1.22	1.24	1.23	1.19
		30	1.22	1.23	1.23	1.22	1.20
		34	1.94	1.19	1.20	1.20	1.19
	6 in.	10	1.16	1.25	1.16	1.12	1.06
		20	1.21	1.22	1.23	1.24	1.18
		30	1.22	1.23	1.23	1.23	1.20
		34	1.99	1.19	1.18	1.19	1.19
	12 in.	10	1.03	-	-	0.80	1.12
		20	1.06	0.90	0.70	0.96	1.23
		30	1.10	0.88	0.77	1.02	1.24
		34	1.04	0.91	0.73	1.00	1.20

TABLE I (Continued)

Balance ht. above water	Pitot ht. above water	Carriage speed f.p.s.	Ratio of air speed to carriage speed				
			Pitot $11\frac{1}{4}$" port	Pitot 6" port	Pitot central	Pitot 6" starbd.	Pitot $10\frac{5}{8}$" starbd.
18 in.	2 in.	10	1.24	1.12	1.10	1.10	1.12
		20	1.23	1.24	1.17	1.20	1.25
		30	1.28	1.21	1.20	1.21	1.25
		34	1.21	1.21	1.21	1.19	1.22
	6 in.	10	1.15	1.20	1.10	1.14	1.10
		20	1.22	1.23	1.17	1.25	1.17
		30	1.23	1.23	1.17	1.24	1.17
		34	1.20	1.19	1.18	1.22	1.18
	12 in.	10	1.20	1.15	0.91	1.00	1.20
		20	1.20	1.18	0.96	1.04	1.24
		30	1.23	1.17	1.00	1.07	1.25
		34	1.19	1.15	1.02	1.04	1.19

Pitot set perpendicular to the vertical plane through a point 84 inches forward of the datum (Fig.1).

TABLE II

Summary of Air Speed Measurements under No. 2 Towing Carriage for Different Flap Positions, at Model Bow and Afterbody Positions

Carriage Speed = Vc (f.p.s.)	Angle of Flap (deg.)	Height of Pitots above water level (ins.)	Va/Vc in Transverse Vertical Plane 85 ins. forward of Datum							Va/Vc in Transverse Vertical Plane 57 ins. forward of Datum							Overall mean between the two planes of measurements
			Pitot I 12"port	Pitot II 6"port	Pitot III central	Pitot IV 6"stbd.	Pitot V 12"stbd.	Mean of Pitots II, III & IV	Mean over the area	Pitot I 12"port	Pitot II 6"port	Pitot III central	Pitot IV 6"stbd.	Pitot V 12"stbd.	Mean of Pitots II, III & IV	Mean over the area	
10	20	2	1.05	0.90	0.92	0.975	1.00	0.93	0.85	1.05	0.865	0.88	0.95	0.98	0.90	0.88	0.86
		6	1.00	0.88	0.85	0.88	0.90	0.863		1.05	0.84	0.85	0.90	1.04	0.86		
		12	0.90	0.68	0.70	0.88	0.94	0.744		–	–	–	–	–	–		
	30	2	1.10	0.93	0.94	1.01	1.04	0.96	0.85	0.90	0.75	0.74	0.78	0.85	0.76	0.76	0.80
		6	1.10	0.90	0.84	0.86	0.97	0.87		0.99	0.76	0.75	0.78	0.85	0.76		
		12	0.96	0.65	0.70	0.80	0.90	0.716		–	–	–	–	–	–		
	39	2	1.05	0.95	0.95	1.03	1.11	1.00	0.85	0.85	0.71	0.77	0.78	0.80	0.75	0.74	0.79
		6	0.94	0.73	0.75	0.78	0.80	0.84		0.95	0.67	0.79	0.70	0.76	0.72		
		12	1.00	0.65	0.68	0.76	0.90	0.698		–	–	–	–	–	–		
20	20	2	1.19	1.16	1.14	1.18	1.18	1.16	1.09	1.14	1.10	1.09	1.09	1.13	1.10	1.09	1.09
		6	1.12	1.06	1.10	1.17	1.15	1.09		1.13	1.08	1.06	1.11	1.14	1.08		
		12	1.17	1.015	0.98	1.09	1.18	1.03		–	–	–	–	–	–		
	30	2	1.13	1.07	1.08	1.07	1.06	1.07	1.02	0.98	0.98	0.96	0.96	0.99	0.97	0.98	1.00
		6	1.09	1.015	0.98	1.09	1.18	1.03		1.02	0.98	0.99	0.97	1.01	0.98		
		12	1.095	0.94	0.88	1.04	1.10	0.95		–	–	–	–	–	–		
	39	2	1.01	1.00	0.99	1.02	1.05	1.00	0.98	0.85	0.84	0.82	0.78	0.82	0.82	0.85	0.91
		6	1.032	1.01	0.98	1.01	1.02	1.00		0.81	0.88	0.86	0.88	0.83	0.88		
		12	1.057	0.88	0.90	1.02	1.08	0.93		–	–	–	–	–	–		
30	20	2	1.18	1.18	1.15	1.15	1.17	1.16	1.12	1.15	1.12	1.12	1.13	1.13	1.13	1.12	1.12
		6	1.17	1.17	1.15	1.10	1.18	1.16		1.15	1.12	1.12	1.14	1.15	1.12		
		12	1.125	1.01	0.96	1.11	1.16	1.025		–	–	–	–	–	–		
	30	2	1.115	1.14	1.11	1.12	1.13	1.13	1.07	1.02	1.03	1.02	1.01	1.01	1.02	1.02	1.04
		6	1.113	1.11	1.08	1.11	1.10	1.10		1.04	1.01	0.98	1.02	1.04	1.01		
		12	1.15	0.96	0.92	1.08	1.13	0.99		–	–	–	–	–	–		
	39	2	1.04	1.06	1.02	1.04	1.06	1.04	1.02	0.89	0.89	0.85	0.85	0.85	0.87	0.88	0.95
		6	1.033	1.03	1.00	1.03	1.05	1.02		0.90	0.91	0.88	0.90	0.88	0.90		
		12	1.08	0.96	0.93	1.08	1.09	0.99		–	–	–	–	–	–		

TABLE III

Summary of Air Speed Measurements under No. 2 Carriage for different Flap Positions at Model Step Position

Carriage Speed = Vc (f.p.s.)	Angle of flap (deg.)	Height of pitots above water level (ins.)	$\frac{Va}{Vc}$ in Transverse Vertical Plane 60 ins. forward of Datum						
			Pitot I 12"port	Pitot II 6" port	Pitot III central	Pitot IV 6" stbd.	Pitot V 12"stbd.	Mean of Pitots II, III, IV	Mean over the area
10	20	2	1.00	0.92	0.95	1.07	1.07	0.98	0.96
		6	1.10	1.05	1.05	1.20	1.20	1.10	
		12	1.00	0.75	0.74	0.94	1.10	0.81	
	30	2	0.92	0.85	0.91	0.96	1.05	0.91	0.93
		6	1.02	0.98	0.92	1.11	1.11	1.00	
		12	1.00	0.75	0.83	1.07	1.15	0.88	
	40	2	0.80	0.77	0.78	0.90	0.94	0.82	0.81
		6	0.86	0.85	0.87	0.94	1.05	0.88	
		12	0.87	0.70	0.66	0.85	0.95	0.74	
20	20	2	1.14	1.14	1.12	1.15	1.15	1.14	1.09
		6	1.16	1.16	1.13	1.16	1.17	1.15	
		12	1.11	0.93	0.91	1.08	1.14	0.97	
	30	2	1.02	1.04	1.03	1.05	0.99	1.04	1.03
		6	1.10	1.10	1.04	1.10	1.10	1.08	
		12	1.10	0.95	0.89	1.06	1.12	0.97	
	40	2	0.92	0.94	0.92	0.93	0.92	0.93	0.93
		6	0.93	0.95	0.93	0.94	0.90	0.97	
		12	0.96	0.88	0.84	0.99	0.93	0.90	
30	20	2	1.15	1.17	1.16	1.14	1.14	1.16	1.10
		6	1.17	1.16	1.14	1.19	1.16	1.16	
		12	1.11	0.93	0.91	1.08	1.11	0.97	
	30	2	1.02	1.04	1.03	1.05	0.99	1.04	1.03
		6	1.02	1.04	1.02	1.05	1.03	1.04	
		12	1.07	0.93	0.88	1.04	1.07	0.98	
	40	2	0.92	0.94	0.92	0.93	0.92	0.93	0.91
		6	0.91	0.93	0.91	0.93	0.92	0.92	
		12	0.94	0.85	0.83	0.94	0.94	0.87	

TABLE III (Continued)

Carriage Speed = Vc (f.p.s.)	Angle of flap (deg.)	Height of pitots above water level (ins.)	$\frac{Va}{Vc}$ in Transverse Vertical Plane 60 ins. forward of Datum						
			Pitot I 12" port	Pitot II 6" port	Pitot III central	Pitot IV 6" stbd.	Pitot V 12" stbd	Mean of pitots II, III, IV	Mean over the area
40	20	2	1.11	1.13	1.12	1.13	1.08	1.13	1.08
		6	1.10	1.11	1.09	1.12	1.05	1.11	
		12	1.10	0.97	0.90	1.09	1.07	0.99	
	30	2	1.04	1.06	1.04	1.06	0.98	1.05	1 01
		6	1.04	1.05	1.03	1.06	0.96	1.05	
		12	1.04	0.91	0.85	1.03	1.00	0.93	
	40	2	0.92	0.94	0.93	0.94	0.85	0.94	0.93
		6	0.92	0.94	0.92	0.94	0.85	0.97	
		12	0.93	0.84	0.83	0.96	0.90	0.84	

TABLE IV

Summary of Air Flow Measurements under No.1 Carriage for different Flap Positions, at Model Bow, Step and Stern Positions

Carriage Speed = Vc (f.p.s.)	Angle of flap (deg.)	Height of pitots above water level (ins.)	$\frac{Va}{Vc}$ in Transverse Vertical Plane 43.5 ins. forward of Datum						
			Pitot I 12"port	Pitot II 6" port	Pitot III central	Pitot IV 6" stbd.	Pitot V 12" stbd.	Mean of Pitots II, III, IV	Mean over the area
12	20	2	0.950	1.100	1.133	1.133	1.133	1.122	1.132
		6	1.125	1.150	1.133	1.146	1.108	1.143	
	25	2	1.000	0.979	0.996	1.029	1.029	1.001	1.006
		6	1.033	0.983	1.021	1.033	1.021	1.012	
	30	2	0.791	0.762	0.796	0.875	0.775	0.811	0.883
		6	0.945	0.958	0.925	0.983	0.966	0.955	
16	20	2	1.150	1.175	1.200	1.166	1.166	1.180	1.176
		6	1.162	1.166	1.187	1.162	1.181	1.172	
	25	2	1.056	1.091	1.100	1.075	1.072	1.089	1.095
		6	1.059	1.087	1.103	1.115	1.094	1.101	
	30	2	0.925	0.937	0.953	0.966	0.937	0.952	0.983
		6	0.981	1.006	1.025	1.015	0.994	1.015	
20	20	2	1.142	1.150	1.155	1.155	1.165	1.153	1.153
		6	1.142	1.145	1.160	1.155	1.172	1.153	
	25	2	1.050	1.067	1.082	1.075	1.050	1.075	1.071
		6	1.060	1.070	1.060	1.075	1.097	1.068	
	30	2	0.922	0.937	0.965	0.960	0.927	0.954	0.985
		6	0.960	1.005	1.032	1.015	1.010	1 017	
24	20	2	1 127	1.137	1.139	1.152	1.146	1.143	1.148
		6	1.129	1.160	1.150	1.152	1.179	1.154	
	25	2	1.039	1.050	1.060	1.062	1.058	1.057	1.055
		6	1.033	1.048	1.054	1.056	1.073	1.053	
	30	2	0.927	0.946	0.958	0.958	0.937	0.954	0.957
		6	0.933	0.952	0.964	0.962	0.937	0.959	

TABLE IV (Continued)

Carriage Speed = Vc (f.p.s.)	Angle of flap (deg.)	Height of pitots above water level (ins.)	$\frac{Va}{Vc}$ in Transverse Vertical Plane 43.5 ins. forward of Datum						
			Pitot I 12"port	Pitot II 6"port	Pitot III central	Pitot IV 6" stbd	Pitot V 12"stbd.	Mean at Pitots II, III, IV	Mean over the area
28	20	2	1.128	1.139	1.148	1.148	1.146	1.145	1.144
		6	1.128	1.139	1.148	1.143	1.145	1.143	
	25	2	1.018	1.036	1.045	1.055	1.028	1.045	1.051
		6	1.030	1.053	1.061	1.061	1.055	1.058	
	30	2	0.911	0.936	0.941	0.955	0.955	0.944	0.950
		6	0.925	0.952	0.962	0.957	0.948	0.957	
32	20	2	1.122	1.129	1.134	1.141	1.100	1.135	1.140
		6	1.129	1.140	1.144	1.153	1.114	1.146	
	25	2	1.016	1.031	1.039	1.047	1.015	1.039	1.047
		6	1.025	1.045	1.061	1.058	1.026	1.055	
	30	2	0.908	0.931	0.953	0.951	0.914	0 945	0.951
		6	0.916	0.947	0.964	0.961	0.934	0.957	
36	20	2	1.100	1.125	1.125	1.126	1.073	1.125	1.119
		6	1.096	1.111	1.112	1.119	1.079	1.114	
	25	2	1.010	1.021	1.028	1.040	1.007	1.026	1.032
		6	1.008	1.033	1.037	1.043	1.000	1.038	
	30	2	0.911	0.930	0.944	0.951	0.904	0.942	0.949
		6	0.908	0.946	0.961	0.961	0.919	0.956	
40	20	2	1.079	1.082	1.095	1.107	1.036	1.095	1.094
		6	1.069	1.085	1.096	1.095	1.046	1.093	
	25	2	1.006	1.021	1.022	1.042	0.975	1.028	1.029
		6	1.000	1.021	1.031	1.037	0.978	1.029	
	30	2	-	-	-	-	-	-	0.960
		6	0.916	0.950	0.957	0.972	0.902	0.960	

TABLE IV (Continued)

Carriage Speed = Vc (f.p.s.)	Angle of flap (deg.)	Height of pitots above water level (ins.)	$\frac{Va}{Vc}$ in Transverse Vertical Plane 57" forward of Datum						
			Pitot I 12"port	Pitot II 6" port	Pitot III central	Pitot IV 6" stbd.	Pitot V 12"stbd.	Mean of Pitots II, III, IV	Mean over the area
12	30	2	0.946	0.946	1.016	1.000	0.929	1.020	1.014
		6	0.958	0.979	1.016	1.033	1.025	1.009	
	35	2	0.946	0.942	0.987	1.004	0.916	0.977	0.985
		6	0.946	0.962	0.987	1.033	0.962	0.994	
	40	2	0.708	0.708	0.842	0.812	0.742	0.787	0.821
		6	0.833	0.816	0.833	0.916	0.833	0.855	
16	30	2	1.044	1.087	1.097	1.062	1.075	1.082	1.086
		6	1.078	1.112	1.119	1.112	1.112	1.114	
		12	1.031	1.094	-	1.050	1.081	1.072	
	35	2	0.953	1.000	1.000	0.969	0.987	0.989	1.000
		6	1.006	1.031	1.012	1.015	1.025	1.019	
		12	0.953	0.984	-	1.000	0.975	0.992	
	40	2	0.840	0.862	0.872	0.859	0.887	0.864	0.909
		6	0.937	0.953	0.941	0.966	0.969	0.960	
		12	0.825	0.862	-	0.906	0.859	0.884	
20	25	2	1.125	1.150	1.157	1.140	1.157	1.149	1.134
		6	1.100	1.122	1.122	1.112	1.125	1.119	
	30	2	-	1.062	1.077	1.062	1.060	1.067	1.054
		6	1.025	1.035	1.035	1.035	1.042	1.035	
		12	1.025	1.075	-	1.045	1.060	1.060	
	35	2	0.960	0.975	0.987	0.975	0.975	0.979	0.982
		6	0.930	0.950	0.950	0.950	0.940	0.950	
		12	0.975	1.002	-	1.035	1.022	1.018	
	40	2	0.860	0.887	0.912	0.887	0.890	0.895	0.906
		6	-	-	-	-	-	-	
		12	0.860	0.912	-	0 925	0.900	0.918	

TABLE IV (Continued)

Carriage Speed = Vc (f.p.s.)	Angle of flap (deg.)	Height of pitots above water level (ins.)	$\frac{Va}{Vc}$ in Transverse Vertical Plane 57" forward of Datum						
			Pitot I 12"port	Pitot II 6" port	Pitot III central	Pitot IV 6" stbd.	Pitot V 12" stbd.	Mean of Pitots II, III, IV	Mean over the area
24	25	2	1.096	1.104	1.116	1.121	1.094	1.113	1.115
		6	1.096	1.104	1.125	1.123	1.108	1.117	
	30	2	1.019	1.029	1.041	1.041	1.025	1.033	1.047
		6	1.025	1.031	1.041	1.050	1.041	1.061	
	35	2	0.956	0.960	0.973	0.973	0.952	0.970	0.975
		6	0.964	0.977	0.983	0.983	0.975	0.981	
28	25	2	1.087	1.103	1.107	1.116	1.102	1.113	1.132
		6	1.068	1.087	1.071	1.093	1.087	1.084	
		12	1.107	1.178	-	1.221	1.150	1.199	
	30	2	1.005	1.028	1.036	1.039	1.027	1.034	1.037
		6	0.993	1.000	1.025	1.016	1.010	1.014	
		12	0.986	1.050	-	1.078	1.036	1.064	
	35	2	0.928	0.946	0.946	0.964	0.946	0.952	0.955
		6	0.920	0.937	0.925	0.939	0.946	0.934	
		12	0.928	0.966	-	0.991	0.953	0.978	
32	25	2	1.086	1.093	1.103	1.059	1.089	1.085	1.102
		6	1.095	1.109	1.125	1.125	1.080	1.120	
	30	2	1.000	1.012	1 019	1.031	0.976	1.019	1.023
		6	1.000	1.019	1.031	1.031	0.984	1.027	
	35	2	0.912	0.925	0.936	0.939	0.902	0.933	0 940
		6	0.922	0.937	0.951	0.956	0.919	0.948	
36	25	2	1.039	1.111	1.105	1.110	1.086	1.109	1.131
		6	1.080	1.108	1.083	1.108	1.072	1.099	
		12	1.083	1.169	-	1.203	1.096	1.186	
	30	2	1.005	1.025	1.023	1.028	1.003	1.025	1.046
		6	1.008	1.028	1.011	1.033	1.015	1.024	
		12	1.005	1.076	-	1.103	1.008	1.089	
	35	2	0.930	0.950	0.954	0.958	0.939	0.954	0.959
		6	0.917	0.942	0.924	0.951	0.928	0.939	
		12	0.910	0.972	-	0.994	0.922	0.983	
40	25	6	1.077	1.096	1.111	1.105	1.031	1.104	
	30		1.000	1.020	1.024	1.035	0.957	1.026	
	35		0.931	0.952	0.956	0.970	0.900	0.959	

TABLE IV (Continued)

Carriage Speed = Vc (f.p.s.)	Angle of flap (deg.)	Height of pitots above water level (ins.)	$\frac{Va}{Vc}$ in Transverse Vertical Plane 94.5 ins. forward of Datum						
			Pitot I 12"port	Pitot II 6" port	Pitot III central	Pitot IV 6" stbd.	Pitot V 12"stbd.	Mean of Pitots II,III,IV	Mean over the area
12	20	2	1.183	1.166	1.166	1.192	1.200	1.175	1.168
		6	1.183	1.175	1.166	1.146	1.183	1.162	
	30	2	1.033	1.025	1.066	1.075	1.083	1.055	1.100
		6	1.146	1.150	1.154	1.133	1.146	1.145	
	40	2	1.041	0.991	1.000	1.041	-	1.011	1.058
		6	1.116	1.066	1.116	1.137	1.125	1.106	
16	20	2	1.131	1.203	1.219	1.206	1.190	1.209	1.213
		6	1.200	1.222	1.231	1.209	1.194	1.218	
	30	2	1.119	1.125	1.140	1.094	1.119	1.119	1.138
		6	1.144	1.162	1.172	1.137	1.134	1.157	
	40	2	1.109	1.119	1.134	1.106	1.122	1.119	1.135
		6	1.156	1.159	1.140	1.156	1.156	1.152	
20	20	2	1.200	1.192	1.197	1.200	1.207	1.196	1.198
		6	1.200	1.200	1.202	1.202	1.212	1.201	
	30	2	1.115	1.110	1.125	1.110	1.125	1.115	1.121
		6	1.125	1.130	1.135	1.117	1.127	1.127	
	40	2	1.100	1.100	1.100	1.102	1.100	1.101	1.090
		6	1.097	1.082	1.082	1.075	1.110	1.079	
24	20	2	1.187	1.181	1.187	1.181	1.202	1.183	1.189
		6	1.191	1.191	1.198	1.196	1.210	1.196	
	30	2	1.106	1.104	1.104	1.104	1.125	1.104	1.108
		6	1.114	1.112	1.110	1.116	1.110	1.113	
	40	2	1.068	1.060	1.064	1.071	1.070	1.065	1.077
		6	1.083	1.093	1.087	1.089	1.098	1.089	
28	20	2	1.186	1.182	1.182	1.186	1.187	1.183	1.190
		6	1.198	1.196	1.194	1.200	1.212	1.197	
	30	2	1.116	1.110	1.107	1.110	1.123	1.109	1.108
		6	1.107	1.107	1.102	1.114	1.091	1.108	
	40	2	1.046	1.036	1.046	1.053	1.030	1.045	1.060
		6	1.071	1.073	1.073	1.077	1.066	1.074	

TABLE IV (Continued)

Carriage Speed = Vc (f.p.s.)	Angle of flap (deg.)	Height of pitots above water level (ins.)	$\frac{Va}{Vc}$ in Transverse Vertical Plane 94.5 ins. forward of Datum						
			Pitot I 12"port	Pitot II 6" port	Pitot III central	Pitot IV 6" stbd.	Pitot V 12"stbd.	Mean of pitots II,III,IV	Mean over the area
32	20	2	1.184	1.178	1.173	1.179	1.181	1.177	1.183
		6	1.183	1.192	1.184	1.195	1.156	1.190	
	30	2	1.109	1.106	1.100	1.108	1.094	1.105	1.110
		6	1.118	1.114	1.114	1.120	1.089	1.116	
	40	2	1.047	1.037	1.039	1.050	1.005	1.042	1 048
		6	1.056	1.051	1.053	1.062	1.020	1.055	
36	20	2	1.152	1.152	1.151	1.158	1.152	1.154	1.156
		6	1.154	1.157	1.155	1.162	1.115	1.158	
	30	2	1.111	1.111	1.105	1.111	1.105	1.108	1.110
		6	1.111	1.114	1.105	1.115	1.074	1.111	
	40	2	1.035	1.033	1.025	1.044	1.978	1.034	1.042
		6	1.050	1.050	1.046	1.050	1.016	1.049	
40	20	2	-	-	-	-	-	-	-
		6	-	-	-	-	-	-	
	30	2	1.094	1.089	1.095	1.100	1.087	1.095	1.095
		6	1.087	1.090	1.092	1.102	1.042	1.095	
	40	2	1.035	1.030	1.027	1.040	0.980	1.032	1.034
		6	1.037	1.037	1.035	1.046	0.990	1.036	

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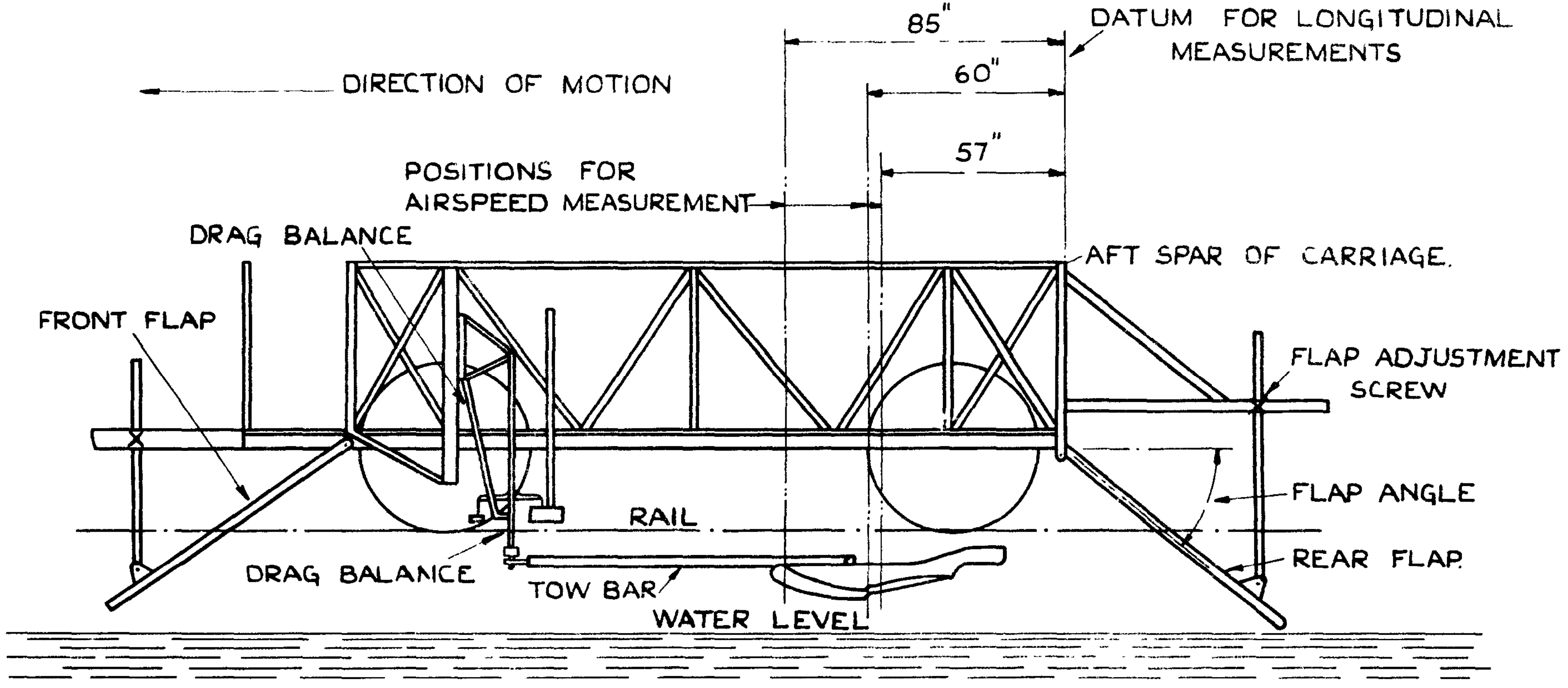


DIAGRAM SHEWING FLAP ARRANGEMENT AND POSITIONS FOR AIR SPEED MEASUREMENT ON THE No. 2 TOWING CARRIAGE IN THE R.A.E. SEAPLANE TANK.

FIG. 1.

FIG. 2.

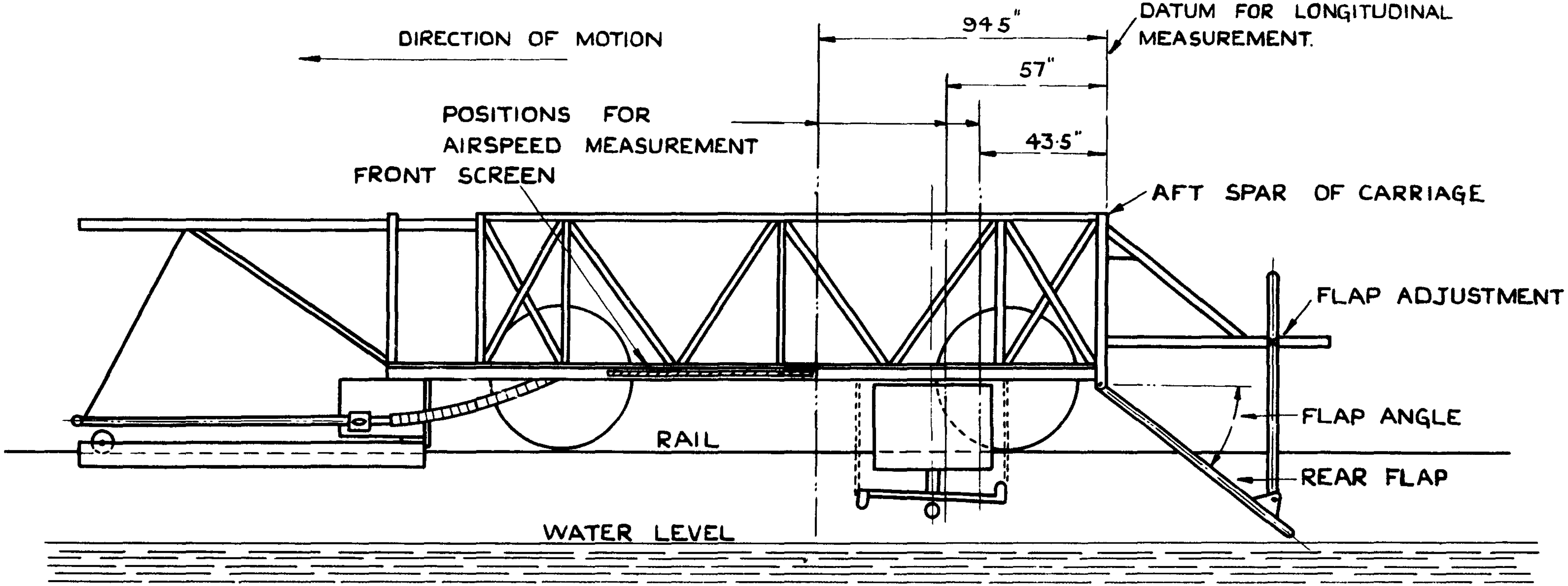
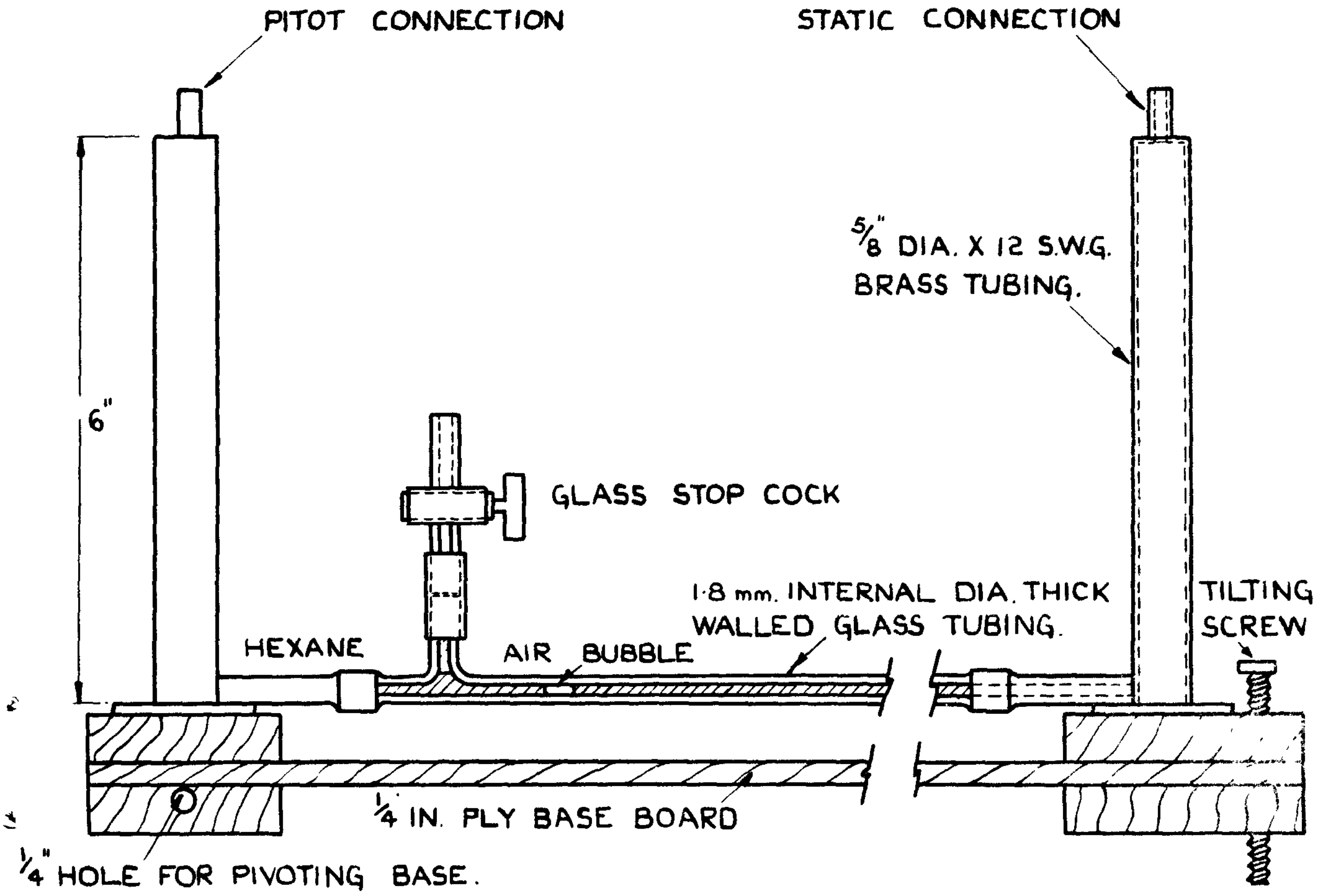
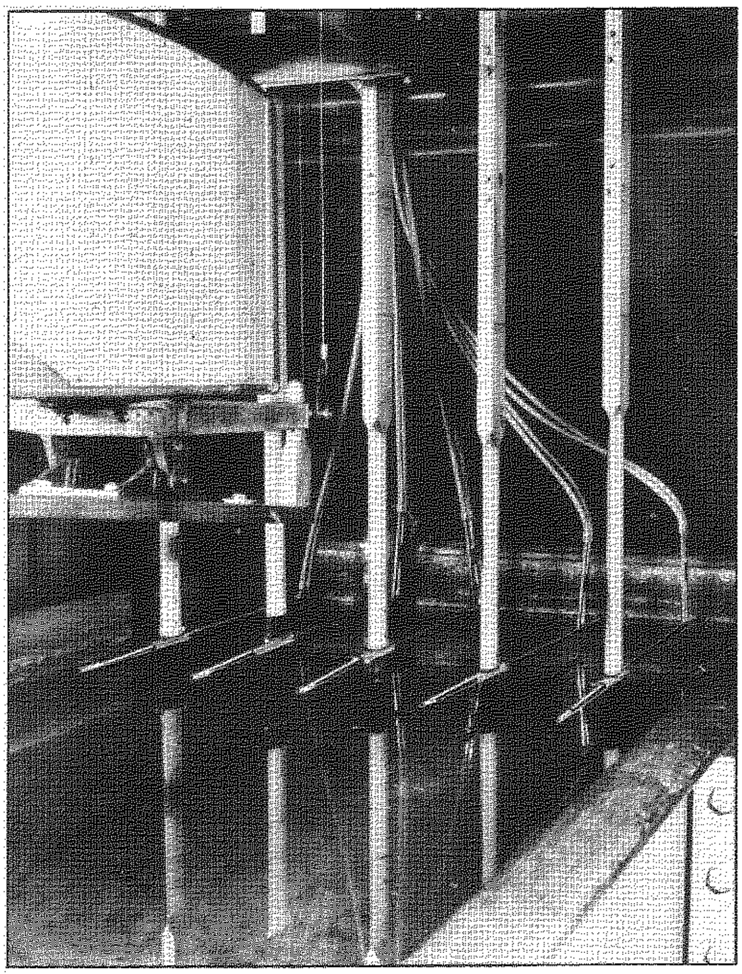


DIAGRAM SHEWING FLAP ARRANGEMENT AND POSITIONS OF AIR SPEED MEASUREMENT ON No.1 TOWING CARRIAGE IN R.A.E SEAPLANE TANK.

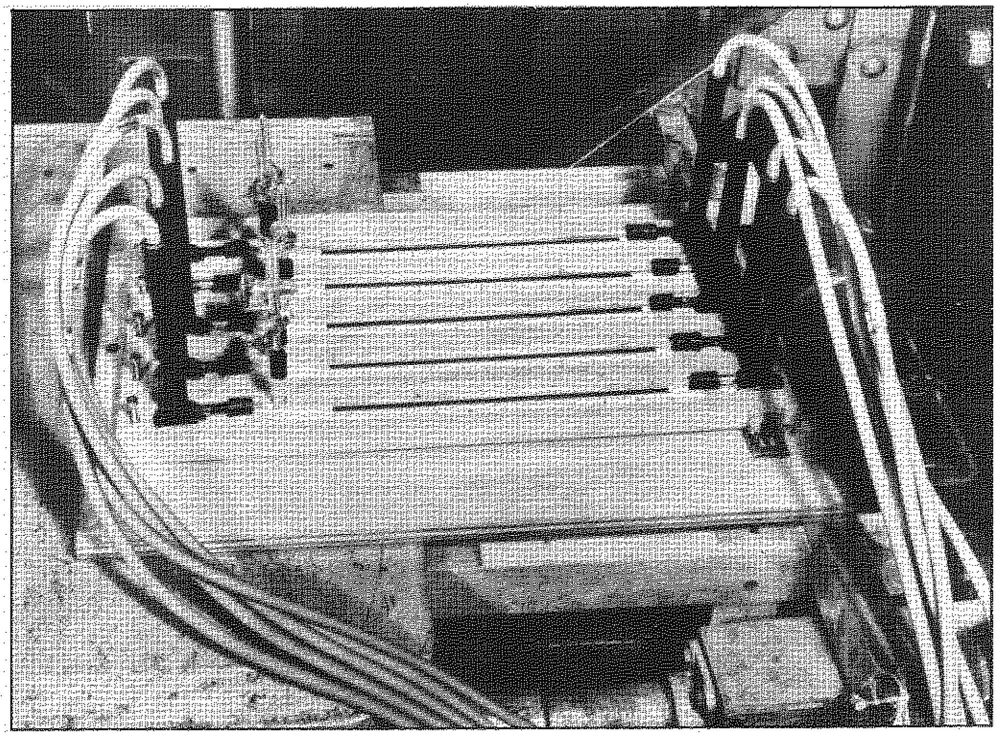
FIG. 3.



SIDE VIEW OF PRESSURE GAUGE
USED IN AIR SPEED MEASUREMENT



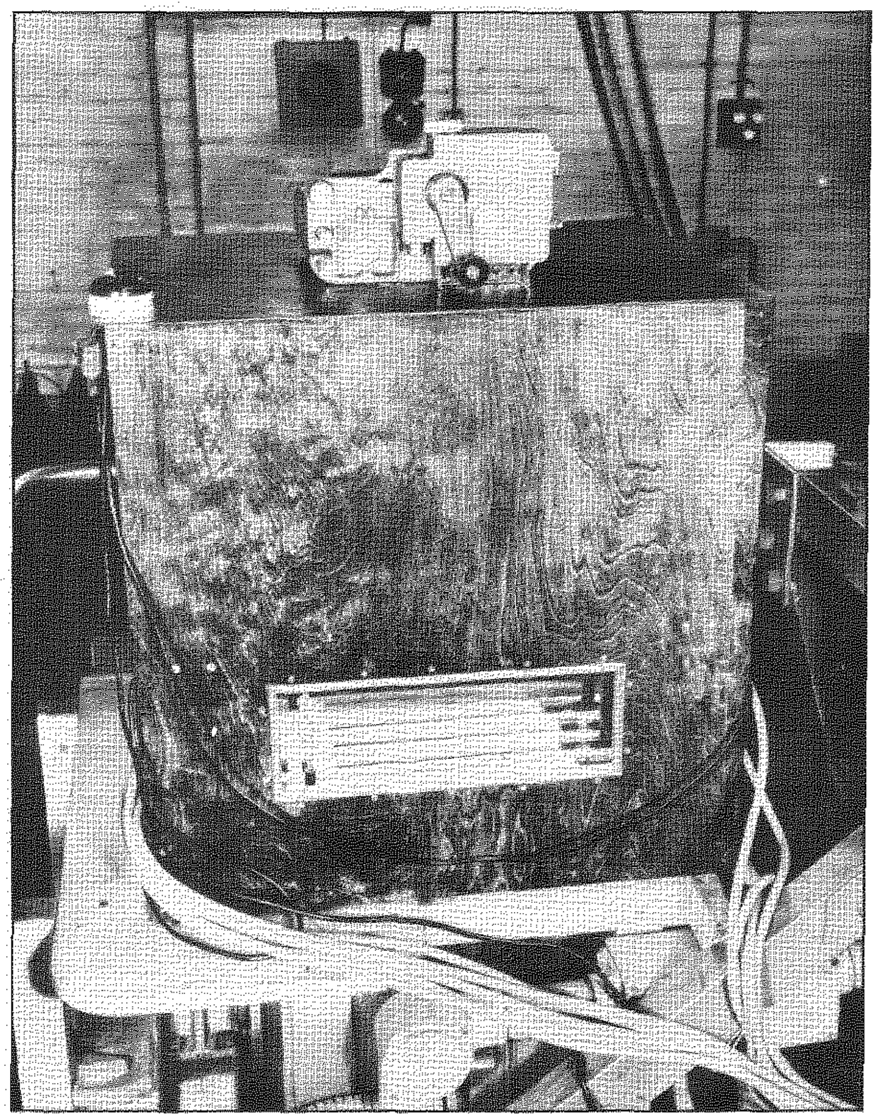
VIEW OF PITOTS
MOUNTED UNDER THE TOWING CARRIAGE



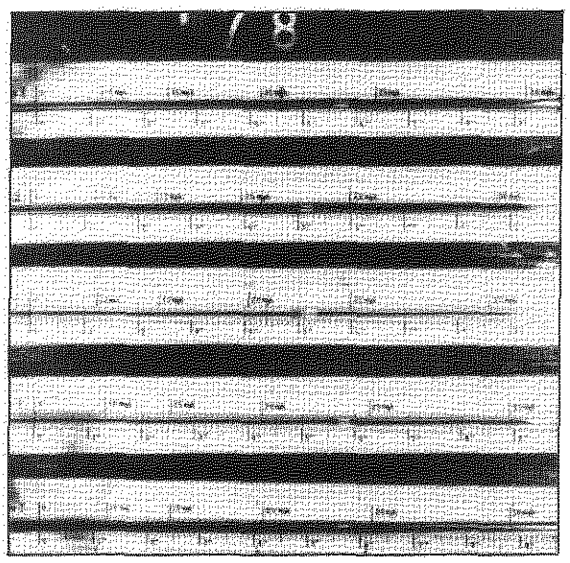
PRESSURE GAUGES
USED FOR MEASURING AIR SPEED

FIG.4

FIG.5

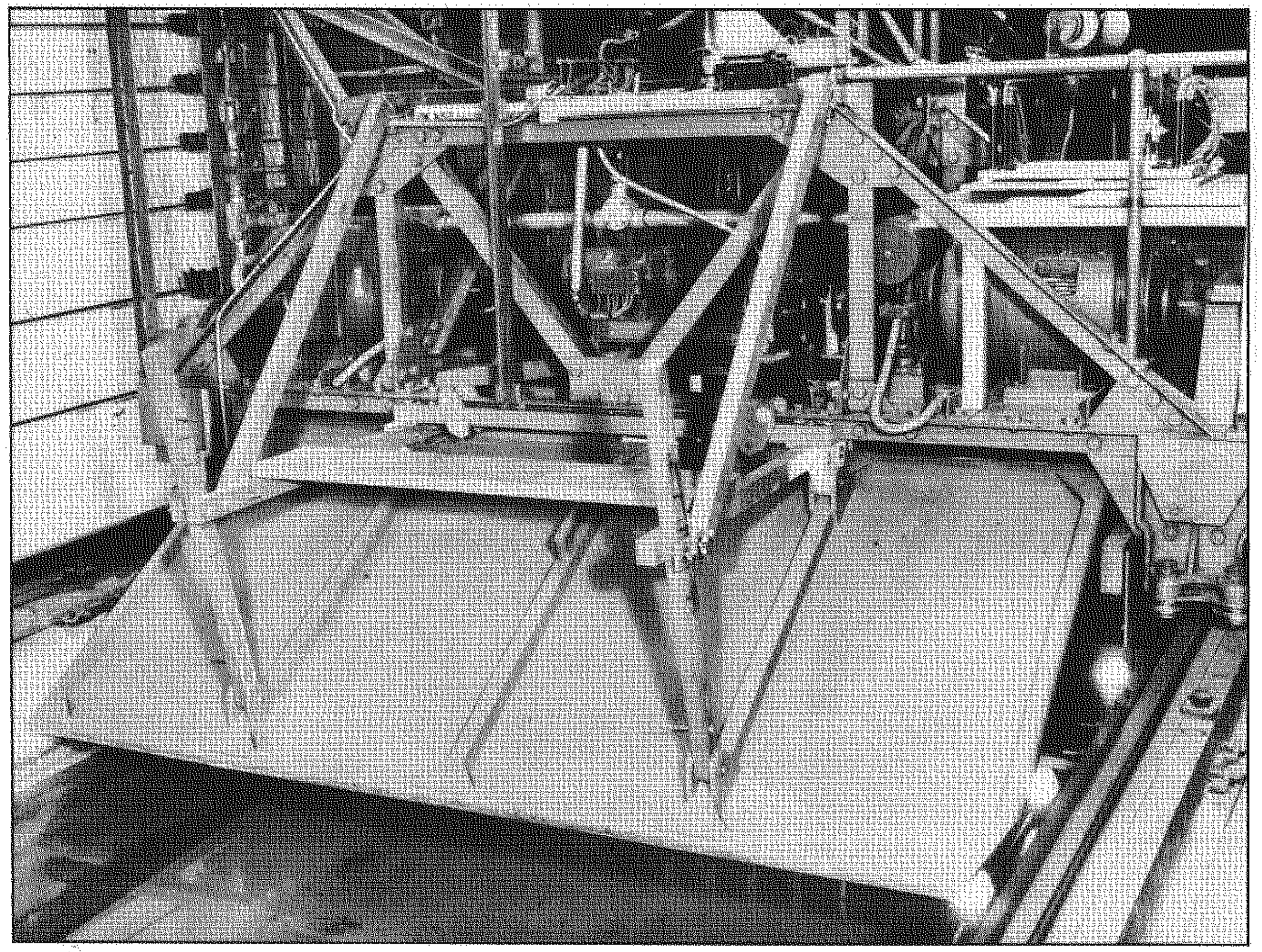


AUTO-OBSERVER
USED TO PHOTOGRAPH PRESSURE GAUGES



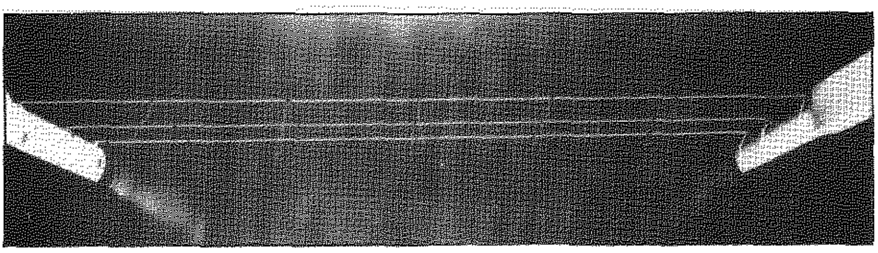
TYPICAL FILM RECORD
FROM AUTO-OBSERVER

FIG.5

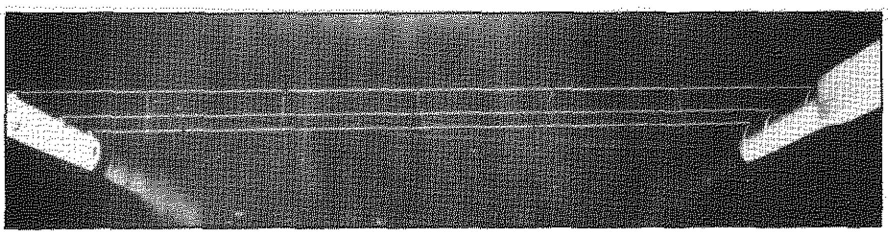


VIEW OF No.1 TOWING CARRIAGE
SHOWING REAR FLAP USED TO CONTROL AIRFLOW

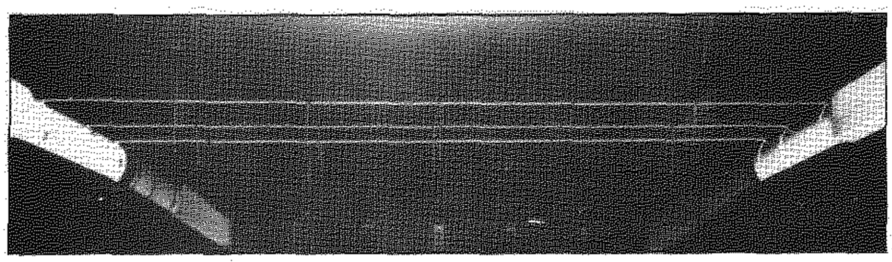
FIG.6



NATURE OF AIRFLOW WITH BOTH
FLAPS DOWN. FLOW UNSTEADY
CARRIAGE SPEED, 20 F.P.S.



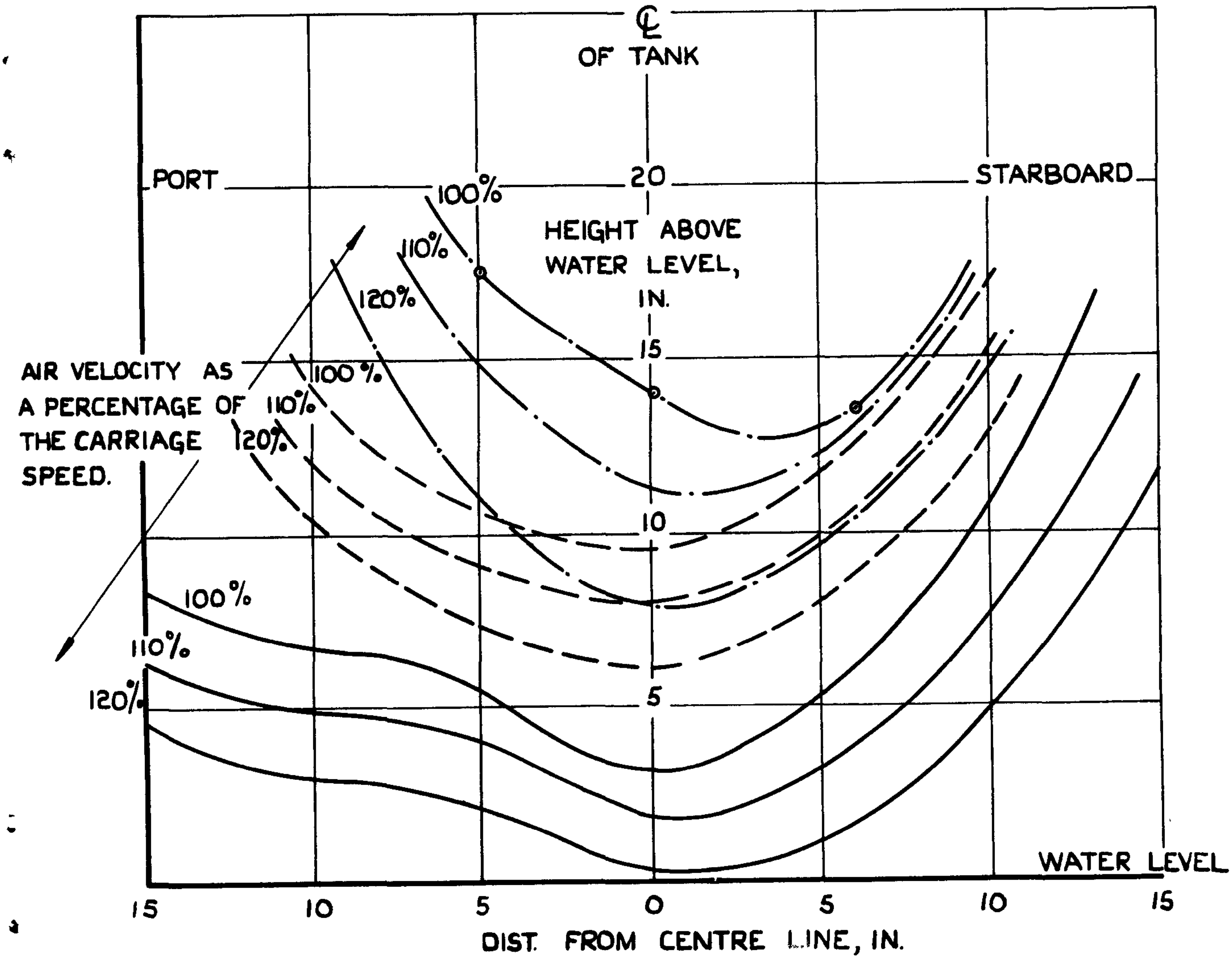
NATURE OF AIRFLOW WITH
FRONT FLAP DOWN. FLOW UNSTEADY
CARRIAGE SPEED, 20 F.P.S.



NATURE OF AIRFLOW WITH
REAR FLAP DOWN. FLOW QUITE STEADY
CARRIAGE SPEED, 20 F.P.S.

FIG.7. WOOL TUFT INVESTIGATIONS OF
AIRFLOW UNDER TOWING CARRIAGE

FIG. 8.



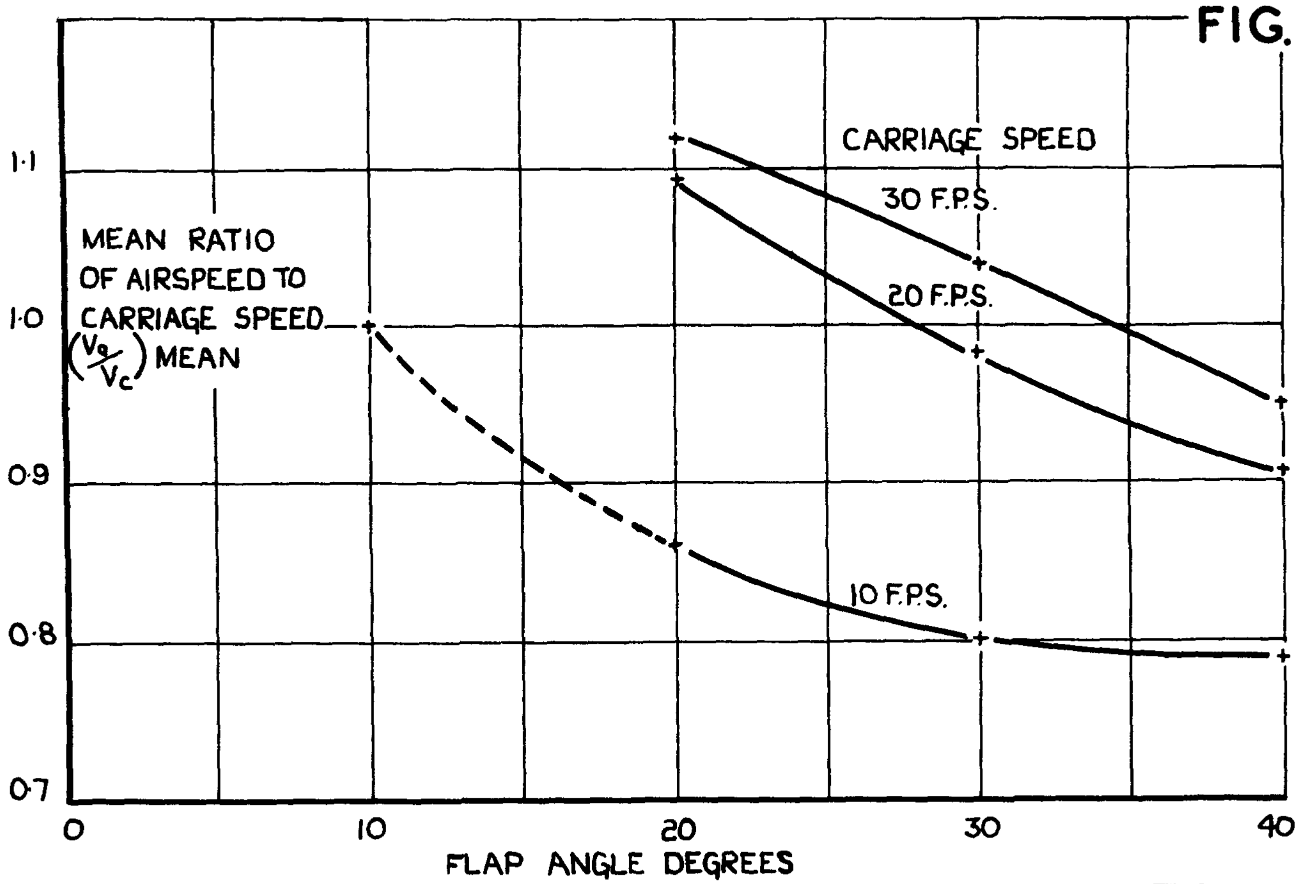
————————	BALANCE 6" ABOVE WATER SURFACE
— — — — — —	12" ABOVE WATER SURFACE
——— · ——— · ———	18" ABOVE WATER SURFACE

VELOCITY FIELD UNDER No 2 TOWING CARRIAGE IN PLANE OF MODEL.

BOW - DRAG BALANCE AT
DIFFERENT HEIGHTS - NO FLAPS

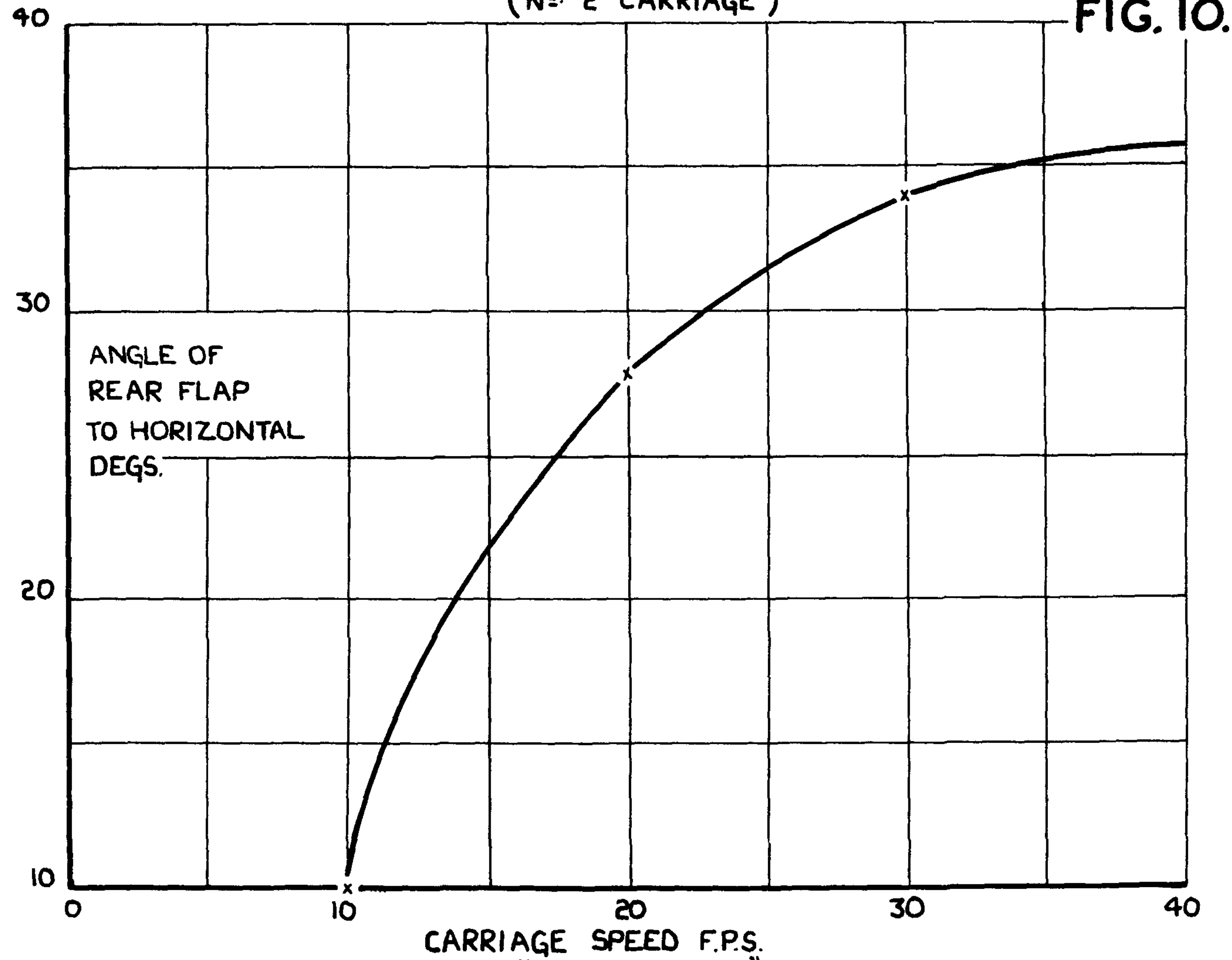
FIGS. 9 & 10.

FIG. 9.



VARIATION OF MEAN RATIO AIR SPEED TO CARRIAGE SPEED WITH FLAP ANGLE.
(Nº 2 CARRIAGE)

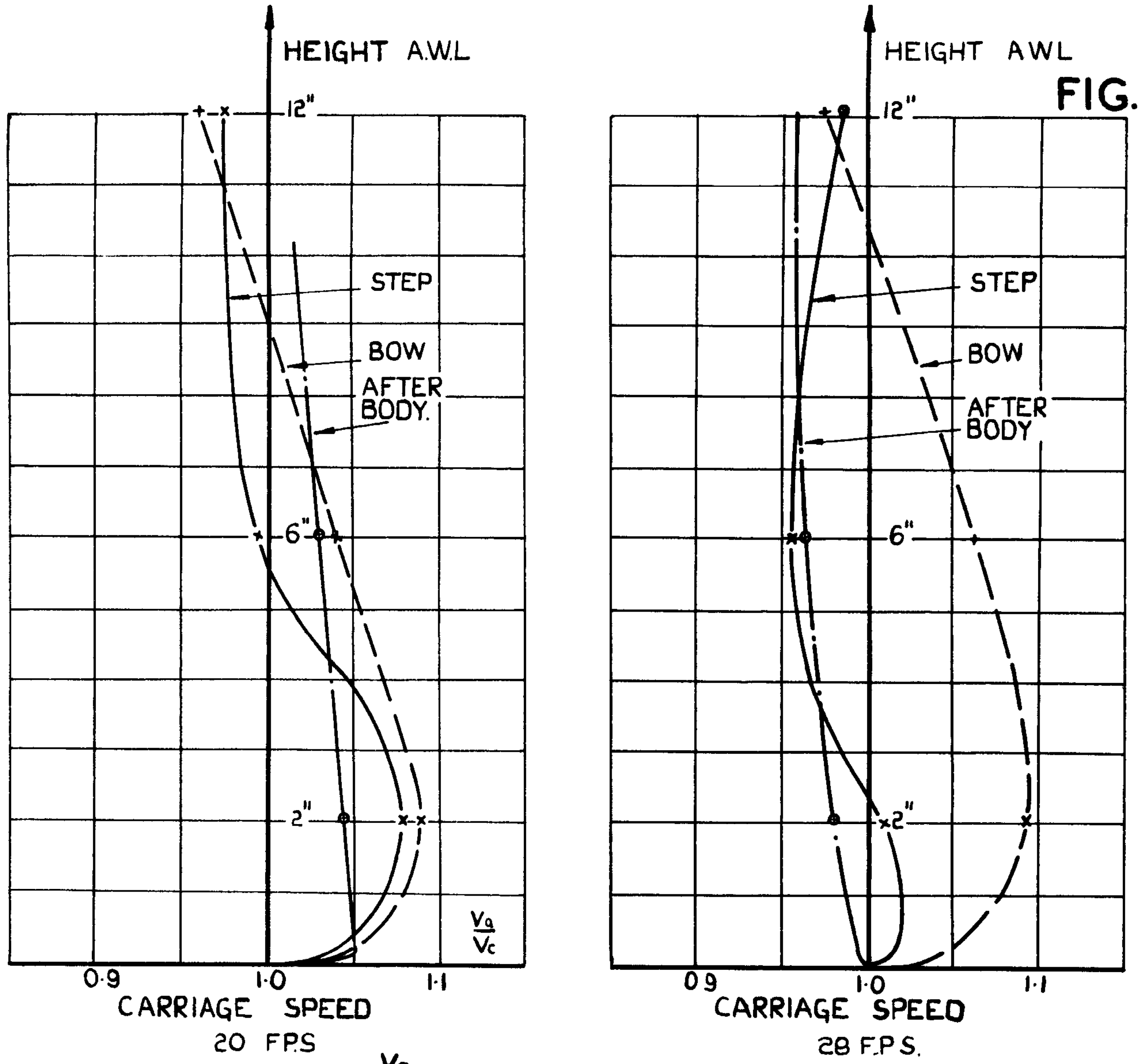
FIG. 10.



FLAP ANGLE FOR "CORRECT" MEAN AIRSPEED AT DIFFERENT CARRIAGE SPEEDS.
(Nº. 2 CARRIAGE)

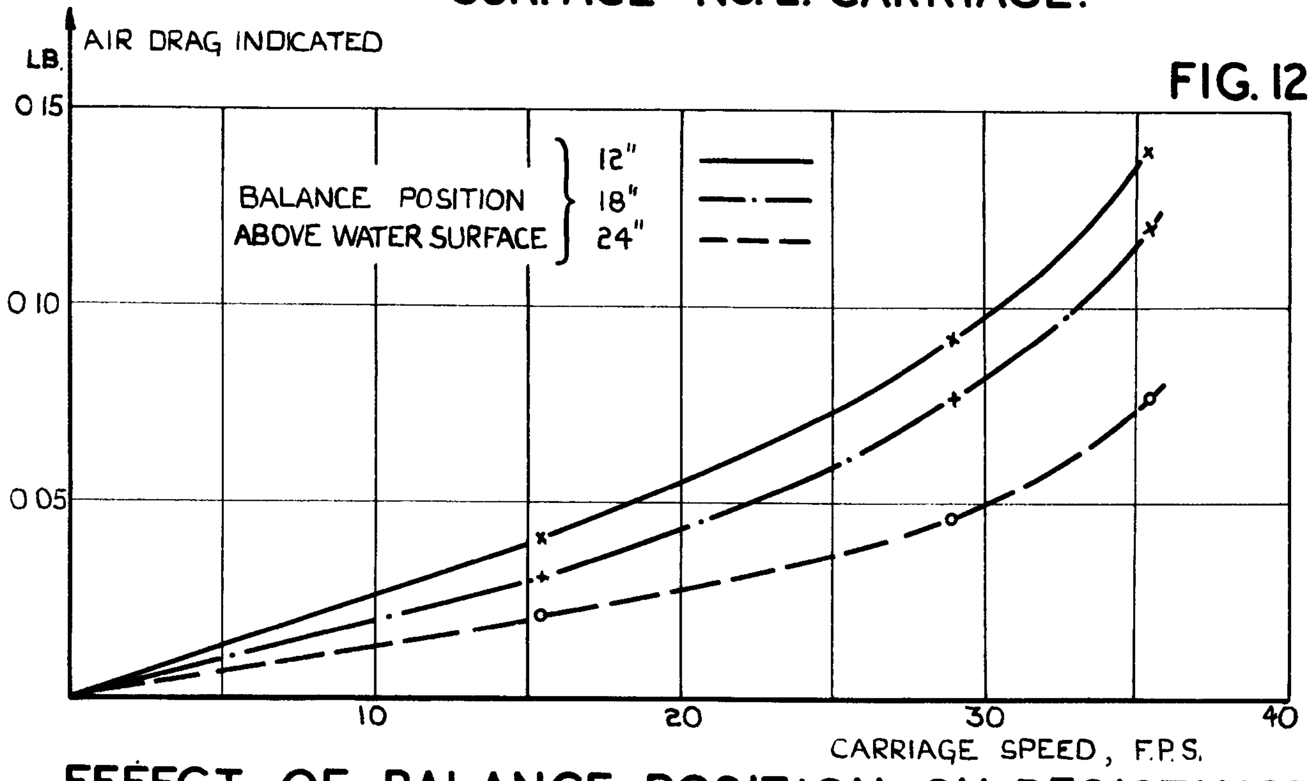
FIGS. 11&12.

FIG. 11.



VARIATION OF $\frac{V_a}{V_c}$ WITH HEIGHT ABOVE WATER SURFACE No. 2. CARRIAGE.

FIG. 12.



EFFECT OF BALANCE POSITION ON RESISTANCE MEASUREMENT ON No. 2 CARRIAGE

FIGS. 13 & 14.

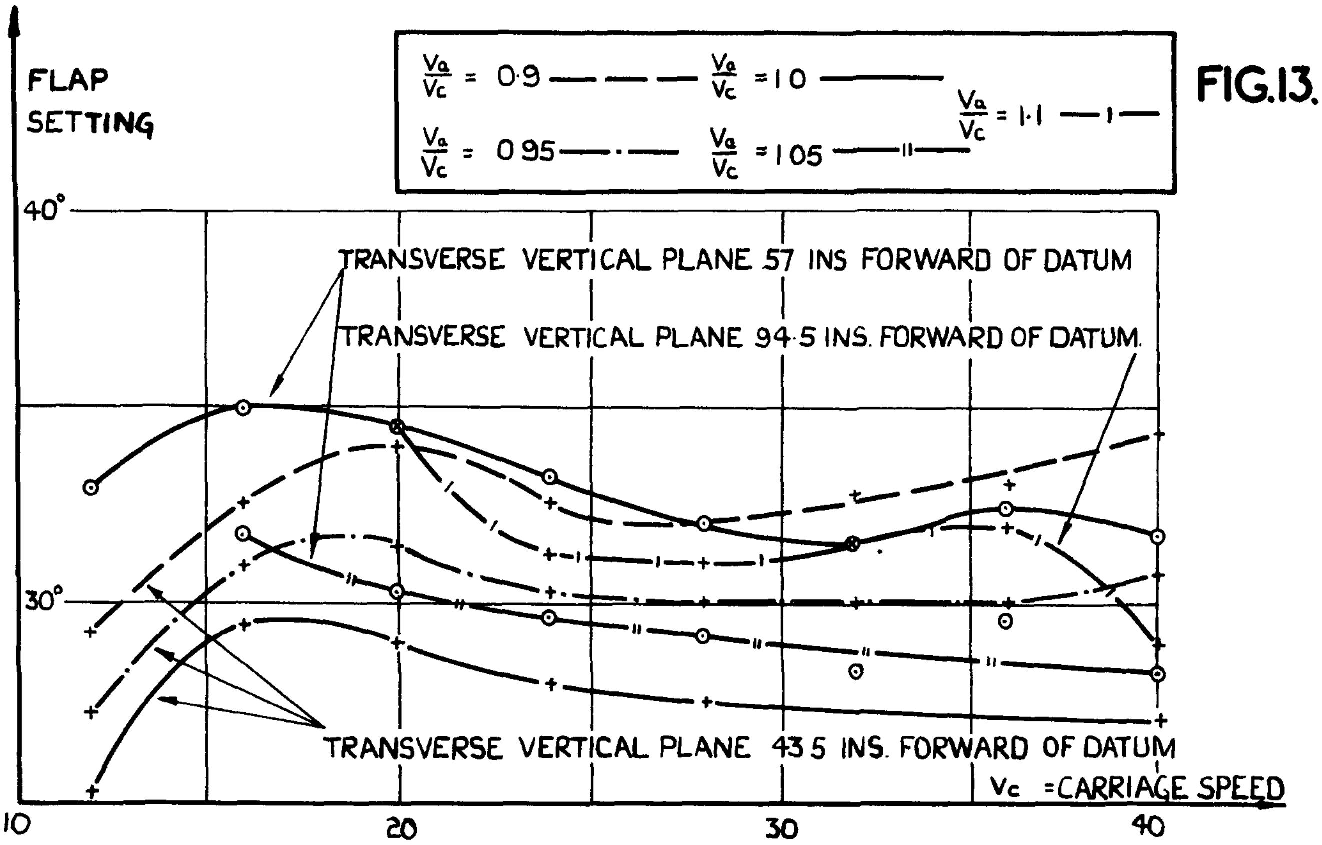


FIG.13.

VARIATION OF AIR SPEED WITH FLAP SETTING No.1. CARRIAGE.

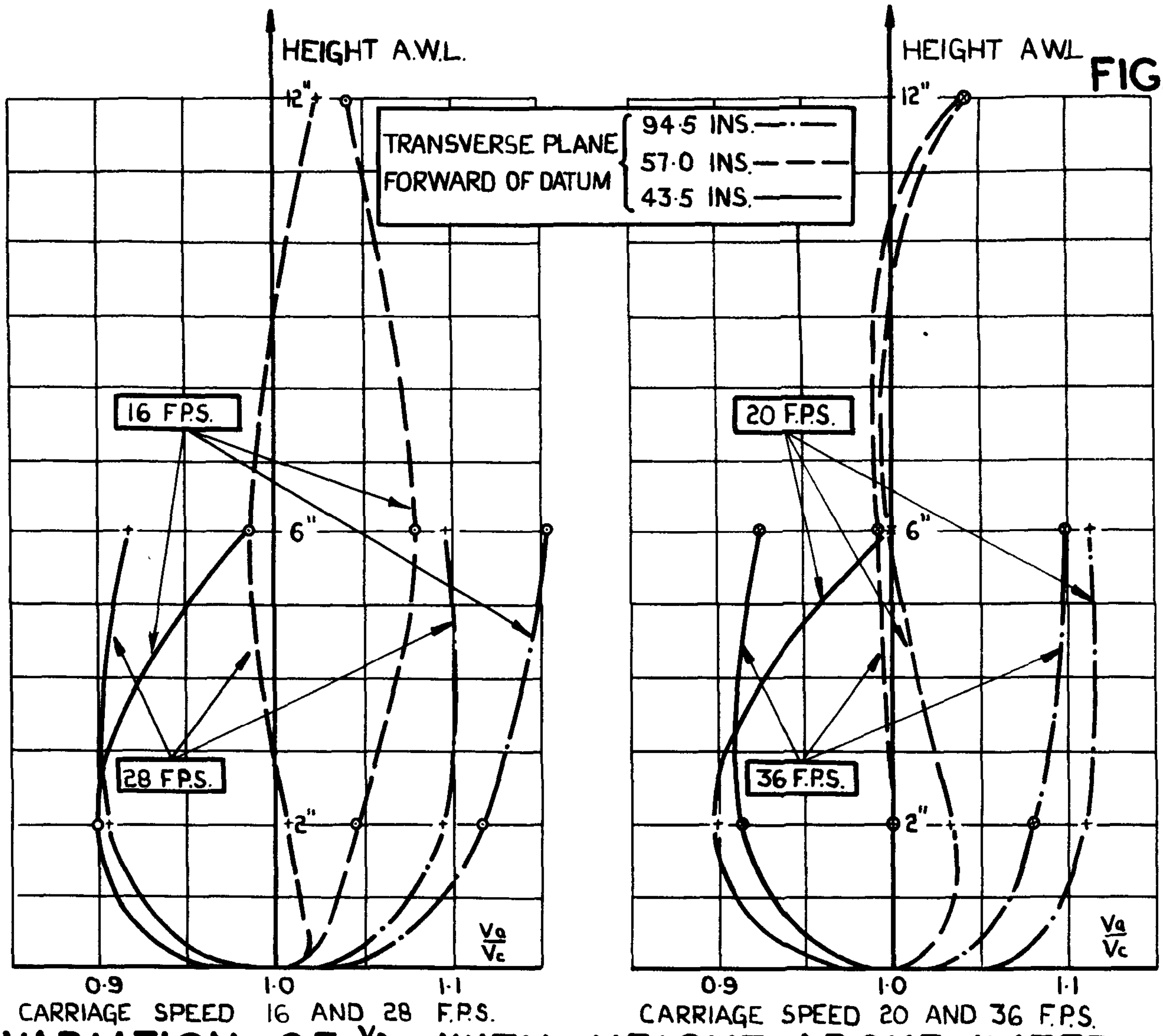


FIG.14.

CARRIAGE SPEED 16 AND 28 F.P.S.

CARRIAGE SPEED 20 AND 36 F.P.S.

VARIATION OF $\frac{V_a}{V_c}$ WITH HEIGHT ABOVE WATER SURFACE FLAP SETTING 32° No.1. CARRIAGE.

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