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ROPE TRAWL DEVELOPMENT

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SUMMARY

During November 1977 full scale tests on rope trawls have been carried out aboard the F.R.V. "Tridens".
This trip was a joint project between the Netherlands Institute for Fishery Investigations, the Marine Laboratory (Aberdeen-Scotland), and the White Fish Authority (Hull-England).
Three configurations of a rope trawl were tested: a rope trawl with meshes in the top panel (net A), a trawl with ropes in all the forward panels (net B) and the same trawl as net B with flotation on the headline.
For each net several parameters were varied such as: the speed or horsepower-setting, the length of the warps paid out, the weights at the lower wing tips and the bridle extension at the lower wing tips.
Measurements were taken on: speed, forces aboard and at the gear, gear geometry and position of the gear.
Because of lack of data in some cases and inaccuracies in the speed measurement, the influence of the parameters mentioned on the performance of the trawl is hard to derive.
The major differences of the three configurations were found with the depth measurements. Both the floats and the meshed upper square do lift the gear in comparison with the standard configuration.
This effect is most significant with the floats on the headline.
A penalty however is a substantial increase in drag (up to 20%).
A computer program written by R.S.T. Ferro of the Marine Laboratory was used to analyse the data. Instrumentation was supplied both by the Dutch Institute and the Marine Laboratory.
To overcome problems with speed measurements and setting of the gear and to extent the set of data further experiments will still be needed.

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Then I'd like to mention Bill Leys, Angus MacDonald and Ron de Silva (also of the Marine Laboratory) for the way they took care of their instruments, calibrated them en prepared them for each haul.

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I should not forget to include all the crew members of the F.R.V. "Tridens" who did a wonderful job and were always ready to assist in whatever possible way.

Finally I'd like to thank Nico Pronk and Willem van der Hak for the way they conducted the trials and Engel Jan de Boer for his overall guidance of this trip.

Last but not least I would like to thank Mrs. Marja Lechermann for typing this report.

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Bob van Marlen

INTRODUCTION

The Technical Research Department of the Netherlands Institute for Fishery Investigations have been conducting a research program into the design of pelagic trawl with ropes instead of big meshes in the forward sections of the net for the past couple of years.
The main aim of the research is to produce a trawl suitable for catching herring close to the bottom over rough ground. An additional requirement is that the gear should be able to fish in fairly restricted water depth (about 40 m).

The trials were carried out aboard the Fishery Research Vessel "Tridens", November 1977. This trip was a joint project between the Dutch Institute, the Marine Laboratory (Aberdeen-Scotland) which also supplied staff and instrumentation and the White Fish Authority (Hull-England).

The main issue of this report is the comparison of different configurations of a rope trawl in order to find the one best suitable to the design requirements.
For each net several parameters have been varied in order to derive the influence of these variables on the performance of the trawl.
In addition to these trials model experiments on scales 1 : 4 and 1 : 25 were conducted in cooperation with the Institut für Fangtechnik, Hamburg, Western Germany and the White Fish Authority (Flume Tank, Hull-England) but unfortunately they are only partly comparable to the full scale tests dealed with in this report.

A detailed analysis of the relationship between the full scale results and the results found from the model experiments will be discussed in a separate report.

The analysis of the data is done with the aid of computer programs which are especially written for this purpose at the Marine Laboratory by R.S.T. Ferro.
The reading of traces is done both by Marine Laboratory staff and Dutch staff.

I. EQUIPMENT AND MEASURING METHODS

I.a. Description of fishing gears tested

Three different variations of a rope trawl were tested. The basic design is made for vessels of 1000-1200 H.P. and is equal to a rectangular pelagic trawl 120 x 80 cm (32") meshes across the top and bottom panels and 80 x 80 cm meshes across the side panels i.e. a "1600 mesh" trawl. There is no extra length in the lower wings.

The three variations will be denoted as follows:

NET A. (see figures 1,2 and 3)
In this trawl the 80 cm mesh section at the top panel and the wings is maintained, while the meshes in the side panels and the lower panels are replaced by polypropylene ropes. A vee of 40 cm mesh netting was also fixed to the top half of the side panel (see fig. 3) to fit under the square and strengthen it.

NET B. (see fig. 1 and 2)
In this trawl the whole 80 cm mesh section at the head of the main body and the wings have been replaced with ropes. There are 13 ropes of 10 mm spaced across the lower and upper panel and 9 ropes spaced across the side panels. In addition there are 2 thicker ropes (18 mm) lashed together at each of the 4 selvedges.
To ensure, that the strain is spread evenly where the ropes are joined to the head of the netting a series of "shark's teeth" are cut with each rope attached to the point of a tooth. All the ropes were marked at metre intervals in the factory before being under any load.
The permanent elongation of these intervals was measured after haul T77.7 in order to calculate the load on each rope (see chapter: IV Rope elongation tests).

NET C.
This version is the same as net B, but in this case 190 floats with a diameter of 6" = 152.4 mm (1.75 ltr) are attached to the headline in strings of 10 floats packed together giving a total lift of approximately 340 kgf.

DOORS (figure 6)
4.76 m2 (3.50 x 1.36 m) Süberkrüb doors were used for the trials, with a weight of 540 kgf each and with an additional weight of 200 kgf, giving a total weight of 740 kgf each. The warp brackets are fitted 45% of the way down the door.

RIGS
Bridle weights, wire diameters and weights used are shown in figure 4.

I.b. Trials technique

Table I shows the parameters varied and the instrumentation used for each haul.
The main parameters are:

1) warplength; range; (350)-450-550-650-(750) meters

2) bridle weights: 450-600-750 kgf
3) horsepower setting: 800-900-1000-1100-1200 H.P.
4) bridle extension: 4.4 m (14.44 ft) and 2.4 m (7.87 ft)

The various ways of comparing net A, B and C will be discussed in Chapter II.

The basic trials routine used for most hauls was as follows:

1) to do a straight tow in one direction only
2) to take measurements at three different horsepower settings
3) to test three different warplengths: 450 m, 550 m and 650 m at each horsepower setting

It is common practice when conducting, instrumentated gear trials to repeat sets of readings towing along a reciprocal course in order to eliminate the effect of tide on the speed readings. This was judged to be unnecessary as there is known to be very little tide in the areas where the trials took place. A check on this statement was done however in haul T 77.4. The tide adjustment was found to be only 0.1 knots, within the accuracy of the reading from the speed log trace.

I.c. Instrumentation (figure 5)

Instrument	Location	Parameter
1) Doppler Log	Ship	Speed relative to water
2) Warp tension meters	Aft deck of ship (port and starboard)	Warp tension as measured on deck (TOP and TOS)
3) ELAC type LSE 108 netsonde transducers (30 KC)	Port door. One looking upward fixed to the top and one looking across the other door on the third bracket from above	Depth of the port door. Door spread
4) Multi-netsonde with two transducers in it	Headline centre	Headline centre depth Headline height
5) Transducers	Upper wing-ends Centre of sideline (P. and S.)	Wing-end spread Horizontal netopening
6) Furuno transducer and transponder	Upper and lower wing-end (Port)	Wing-end height
7) Marine Laboratory load cells (self recording)	a) Warp forward of doors	Tension before doors (T2) at end of warp
	b) Top and lower backstrops	T34,T3L tensions at beginning of bridles
	c) Between bridle weights and lower wing-ends	Tensions at lower wing-ends (T6)
8) Marine Laboratory Heel/tilt/depth meters (self recording)	On both doors at the lower side of warp attachment bracket	Heel angle of doors Tilt angle of doors Door depth at warp attachment point

9) Marine Laboratory Japanese depthmeters (self recording)	Centre bracket of both doors	Door depth (P/S)
10) Marine Laboratory spread meters (self recording)	3 fm forehead of doors attached to the warps 50 m from wing-ends	Spread of warps 3 fm before doors and 50 m from wing-ends
11) Shaft horsepower recorder	On the propeller shaft measured by two teeth cogs (some distant apart) driving generators S.h.p. is related to a phase shift	Shaft horsepower (recorded)

II COMPARISON OF DIFFERENT TYPES OF NETS

The three basic net designs -the standard rope trawl (net B), the rope trawl with meshed upper square (net A) and the rope trawl with flotation (net C)- may be compared by considering three sets of three hauls each set at a different bridle weight.

These are as follows: (see appendix A)

Hauls	4,5	net A	with 450 kgf weights
	9	net B	
Hauls	6	net A	with 600 kgf weights
	10	net B	
	15	net C	
Hauls	3	net A	with 750 kgf weights
	8	net B	
	14	net C	

II.a. Depth of net

This gear is being developed for a fishery in the North Sea. It should be able to fish at very restricted depths, without lifting the doors to the surface. A minimum depth requirement is about 40 m. This limits the vertical distance between the doors and the net. With 600 kgf weights net C (with flotation) is fishing at the smallest depth at any speed and net A (with meshed upper square) is deeper than net C, but not as deep as net B (standard). This applies to all the warplengths used (450-550-650 m) (figures 7e,h,m). For the 750 kgf case net C also shows the smallest depth values followed by net A and net B is fishing deepest, although the depth decreases fastest with higher speeds (figures 7b,f,l). For both weights adding floats to the headline rises the gear appr. 50 m and (adding a meshed top panel) replacing the ropes in the top panel by a meshed square rises the gear ca. 30 m. There is not sufficient data to compare the three nets A, B and C for the 450 kgf case, but the standard trawl also seems to be fishing at the largest depths (figures 7c,d,g).

II.b. Difference in depth between doors and net

As stated before the gear should be able to fish at very small depths. For this reason the vertical distance between doors and net should be as small as possible.

This depth difference is, as could be expected, very much depending on bridle weights.
With 600 kgf weights the biggest differences in depth are found with net B and the smallest values with net C, while those of net A are only slightly bigger than the ones found with net C (fig. 8b).
For the 750 kgf case the differences in depth are somewhat smaller for net C in comparison with net B. Net A shows the smallest differences. This might indicate that for the gear with flotation on the headline the 750 kgf weights are too heavy if the objective is to minimize the depth difference between the doors and the net (fig. 8c).
Although the lack of data makes conclusions rather dubious, it seems that net A has smaller depth differences than net B with 450 kgf weights. There are no data available for net C in this case (fig. 8a).
A reduction in depth difference between the doors and the net would be expected as warp length is increased.
However, the effect may be small and certainly this tendency is not very clear from the data.

II.c. Warp length

Gear geometry and in particular door spread changes with warp length. At very short warp lengths the doors are prevented from spreading by the inwards component of the warp tension but as warp length increases this component reduces allowing the doors to spread the net more.
However, a point is reached when increasing warp length produces no further significant improvement in spread.
A useful indication of how the spreading force of the doors is transferred to the net is the ratio of the sweep spreading force to the door spreading force.
Figures 9f and 11f show, that this ratio is still increasing with warp length. Although the doors are more efficient at these longer warp lengths, there is a penalty in the increase in time taken to shoot and haul. There seems to be no distinct relationship between mouth area and warp length for all three types of nets. Only the 450 kgf case shows a slight tendency of the headline mouth area to increase with warp length (see figures 9d, 10d and 11d).

II.d. Gear drag (figures 9a, 10a and 11a)

The gear drag with net C is greater than with net B by approximately 20% due mainly to the extra drag of the floats (1 tonne at 4 knots).
The gear drag with net A is 15% to 20% greater than with net B mainly due to the increased drag of meshes compared to ropes in the upper square, rather than any change in net mouth geometry.
The net drag is approximately 85% of the gear drag and the drag of both doors will be about 12% of the gear drag.

II.e. Net mouth area (figures 9d, 10d and 11d)

At all three bridle weights the substitution of a meshed upper square for the ropes of net B results in increased drag as discussed above and reduced net spread.
The relationship between headline height and speed is less consistent, possibly because of the uncertainty in the speed measurements.
The headline height for net A is greater than that for net B in the 750 kgf case. With 600 kgf weights there is little difference between the nets and with 450 kgf weights net A may have a slightly smaller headline height than net B (figures 9b, 10b and 11b).
For the 750 kgf case the main effect of adding flotation (net C) or substituting a meshed upper square (net A) compared to the standard rope trawl (net B) may be to reduce the change in mouth area

as speed is increased (see figure 11d).
A similar effect is observed in the 450 kgf case for nets A and B. However with 600 kgf weights, while net A again behaves in the same way, the performance of net C is similar to that of net B. The lack of a systematic relationship between headline height and speed for each bridle weight value must cost doubt on any conclusions about the relationship between headline mouth area and speed.

II.f. Swept volume per time per total warp load

The parameter swept volume per time per warp load was chosen as a criterion by which to judge net performance.
It is a more engineering criterion and the relationship between this value and the catching capabilities, which is very much depending on the reaction of the fish on the gear, still needs to be found.
In view of the uncertainties in headline height mentioned in the previous section, definite statements about figures 9e, 10e and 11e can not be made, but it would seem, that the standard net (B) has a higher swept volume per time per load than the other two nets except for the 750 kgf case which does not show such distinct differences.

III INFLUENCE OF DIFFERENT PARAMETERS ON TRAWL PERFORMANCE

IIIa. Bridle weights

Plots of headline mouth area and swept volume/time/load for net A, hauls 3, 4, 5 and 6 versus speed show an increase in area and swept volume with bridle weights of 750 kgf.
There is, however, little difference between the 450 kgf and 600 kgf cases (figures 12c,d).
There is no such clear relationship for nets B or C.
From figures 13b,c; 14b,c it can be seen, that the influence of bridle weights on headline height and horizontal netopening is not very distinct for net B and net C.
The mouth area in both cases doesnot change much and the same applies to the swept volume per time per load (figures 13d,e; 14d,e).
Only for net A the headline height shows a definite increase with bridle weights of 750 kgf, but the difference between the 450 and 600 kgf cases is not very clear (figure 12a).
This increase in headline height is responsible for the increase in mouth area and swept volume/time/warpload at 750 kgf weights.

The gear drag seems to be largest for the 750 kgf case (figure 13a) for net N and also for net C at low speeds (figure 14a). This is obvious when looking at the headline centre depth, which is larger for the 600 kgf case at low speeds. The gear drag, being the horizontal component of the warp tension, decreases with increasing depth of the gear due to the increase in warp inclination angle.

III.b. Bridle extension

The following hauls can be compared to check the influence of the bridle extension on the performance of the trawl.

Net B	Haul T 77.8	4.4 m bridle extension	with 750 kgf weights
	Haul T 77.11	2.4 m bridle extension	
Net C	Haul T 77.13	2.4 m bridle extension	with 750 kgf weights
	Haul T 77.14	4.4 m bridle extension	

Plots of headline mouth area and swept volume/time/load show a great scatter of data both for net B and net C (figures 15a,b,c;16a,b). A definite conclusion about which configuration is better cannot be made.

IV. ROPE ELONGATION TESTS (Haul T.77.7)

The forces in each rope are determined from load-elongation tests on wet pieces of polypropylene ropes.
These pieces of rope were new and like the ropes of the rope trawl never been loaded before. The results are given in figures 17a and 17b.

Hence, the total tensile force will be:

for the upper panel (without the selvedges)	:	1995
for the lower panel	:	2855
for the port side panel	:	895
for the starboard side panel	:	1650 kgf
		7395 kgf
and for the selvedges 1	:	1250
2	:	860
3	:	540
4	:	495
		3145 kgf

In total we find: Σ = 10540 kgf or 10.54 tonnes (of a 1000 kgf)

From the H.P.-recorder traces of haul T 77.7 we find for the maximum forces, taking the calibrations into account:

TO_P = 6.025 tonnes

TO_S = 6.222 tonnes = Σ TO = 12.247 tonnes

The difference between the total warp load measured aboard the ship and the summation of the load in the ropes of the trawl is due to the drag of the warps, the doors, the bridles and the wing-end weights.
In this case it is not taken into account that in the calculation of the total load only the components in the direction of tow of all the forces should be used.
Due to the divergence of the ropes, the total force in the direction of tow will be slightly smaller.

The elongation of the ropes does show substantial differences from one rope to the other. With an elongation smaller than 3% for the 10 mm diameter polypropylene rope and smaller than 1.7% for the 18 mm diameter rope of the same material the reading of the load becomes very inaccurate.
It should be stated also, that the method of measurement of the elongation is not very accurate either, due to the large size of the marks made on the ropes.

The results should be interpretated in a qualitive rather than a quantitive way.

Basic conclusions are:

- the forces are not equally distributed along the ropes
- the lower panel is the heaviest loaded one
- the port and starboard panels show a clear asymmetry, but the warp loads are for this haul almost equal in magnitude

V. CONCLUSIONS AND RECOMMENDATIONS

V.a. Difference in behaviour of port and starboard doors

The heel and pitch readings throughout the cruise indicate that one door was at a very different attitude to the flow compared to the other door.
One possible explanation was that the netsonde cable to the door transducers was affecting the balance of the door.
However, plots of headline depth against speed do not show any conclusive difference in behaviour of the gear when the netsonde cable is attached to the port door.
The doors were measured carefully after the trip but no significant differences in the dimensions or position of the centre of gravity were found.
The other possible causes of this behaviour might be a difference in the lengths of the sweeps or some asymmetry of the net giving rise to different ratios of upper and lower backstrop tensions on the port and starboard side.
In order to check this, the bridles were measured up before shooting haul T 77.13. There seemed to be very little difference in length (starboard: upper 100.0 m; lower 99.8 m; Port: upper 100.1 m; lower 100.4 m). All four bridles were made equal at 100.4 m.

It is unlikely, that the instruments measuring the heel were malfunctioning as the two instruments were interchanged from one door to the other and the incorrect heeling of the port door was apparently confirmed on haul T 77.15, when the spread netsonde transducer, mounted on the face at the door, seemed to pick up a surface echo.

The influence of the netsonde cable to the port door on the tensions in the sweeps can only be examined for hauls T 77.4 and T 77.5.
The upper sweeps are heavier loaded than the lower sweeps. There is a slight tendency of decreasing the sweep tensions at the port side sweeps by attaching the netsonde cable to the port door. However the lack of data for other cases makes this conclusion rather arbitrarely (see fig. 18).

In order to make more reliable calculations, based on less assumptions measurements should be extended in the future. The depth of both wing-ends and both doors will give information about asymmetrical behaviour of the gear and back up data collected from heel/tilt angle meters on the doors.

On many points it is hard to draw definite conclusions from the data obtained so far, although some major tendencies did show up from these trials. Therefore further experiments on these trawls will be needed.

Adding floats mainly influences the depth of the gear and the same applies to using a meshed upper square although to a smaller extent. The headline mouth area is not very dependant on these lifting devices. A penalty is a substantial increase in drag

V.b. Reliability of speed readings

A very accurate measurement of speed is of very great importance because most of the parameters are plotted against speed and errors in speed readings can influence the conclusions to a very large extent.
For comparison against tension (ΣTO) were made in some cases because the tension measurements showed to be more accurate.
For parameters such as depth of the gear, mouth area and swept volume per time per total warp load tendencies seen from these graphs can differ from the ones found when plotted against speed.

It is of primary interest to use a speed log mounted at the opening of the net. Speed readings on a ship may fluctuate strongly due to the seaway and it is the speed at the net itself that determines its performance.

Plotting against horsepower includes the performance of the vessel and its response to weather conditions which is also dependant on the ships course. There is no clear relationship between horsepower setting and actual speed.

HAUL NUMBER	TYPE OF NET	BRIDLE EXTENSION (M.)	BRIDLE WEIGHT (KGF.)	MULTI-NETSONDE	NETSONDE ON P. DOOR	T1	T2	T3 (UPPER)	T3 (LOWER)	T5	T6	SPREADMETERS	HEEL/TILT METERS	JAPANESE DEPTHMETER	WARPLENGTH (M.)	HORSEPOWER
T77 1	ROPE TRAWL WITH MESHED UPPER SQUARE (NETA)	4.4	750	V	–	V	–	–	–	–	–	–	V	–	450,550 650,750	800
T77 2	NET A	4.4	750	V	V	V	–	–	–	–	–	V	V	–	450,550 650,750	800,900 1000,1100
T77 3	NET A	4.4	750	V	V	V	V	V	V	–	V	V	V	–	450,550	800,900 1000,1100
T77 4	NET A	4.4	450	V	V	V	V	V	V	–	V	–	V	–	350,450 550,650	800
T77 5	NET A	4.4	450	V	–	V	V	V	V	–	V	–	V	V	550,650	850,1150 1250
T77 6	NET A	4.4	600	V	–	V	V	V	V	–	V	–	V	V	450,550 650	850,1100 1250
T77 7	ROPE ELONGATION TEST (NET B)	4.4	600	–	–	V	V	V	V	–	–	–	V	V	650	1100
T77 8	STANDARD ROPE TRAWL (NET B)	4.4	750	V	V	V	V	V	V	–	V	–	V	V	450,550 650	850,1000 1100
T77 9	NET B	4.4	450	V	V	V	V	V	V	–	V	–	V	V	450,550 650	850,1000 1100
T77 10	NET B	4.4	600	V	V	V	–	–	–	–	–	–	V	V	450,550 650	850,1000 1100
T77 11	NET B	2.4	750	V	V	V	V	V	V	–	V	–	V	V	450,550 650	850,1000 1100
T77 12	ROPE TRAWL WITH FLOTATION (NETC)	2.4	750	V	V	V	V	V	V	–	V	–	V	V	450,550 650	850,1000 1100
T77 13	NETC	2.4	750	V	V	V	V	V	V	–	V	–	V	V	450,550 650	850,1000 1100
T77 14	NETC	4.4	750	V	V	V	V	V	V	–	V	–	V	V	450,550 650	850,1000 1100
T77 15	NETC	4.4	600	V	V	V	V	V	V	–	V	–	V	V	450,550 650	850,1000 1100
T77 16	NETC	4.4	750	V	–	V	V	V	V	–	V	V	V	V	450,550 650	850,1000 1100

APPENDIX A
TABLE OF HAULS

Appendix B

1. Instrumentation

The measuring instruments used during the trials, their locations on the gear and the parameters they measured are tabulated below.

Instrument	Location	Parameter
Load cells	(a) Warps, forward doors, T2 (b) Aft end of backstrops, T3U and T3L (c) Aft end of lower sweeps near wing ends, T6 (see figure).	Wire tensions
Spreadmeter*	On warp 5.5 m from doors	Spread
Heel and tilt meters	On doors	Angles of heel and tilt of doors (see figure)
Depth meters	On doors	Door depth

* This spreadmeter was used on haul 16 only

2. Data Retrieval

All instruments except the heel, tilt meters on the doors produced continuous trace recordings either on recorders on board the ship (eg warp tension meters on ship, doppler speed log, shaft horse-power, multi net-sonde) or on self-contained recorders in the underwater instruments (load cells, spreadmeter).

The heel-tilt meters stored the data in the form of a "mark to space ratio" signal on magnetic tape in standard tape cassettes.

The standard procedure during an instrumented haul was to tow the gear at three different settings of shaft rpm which gave a reasonable range of towing speeds between 3.5 and 5 knots. At each rpm setting three warp lengths were used (450m, 550m and 650m). Warp length or rpm was changed only after the gear was seen to have settled for a period of at least five minutes. Average readings from the trace recordings were taken over the periods when the gear was in equilibrium. The resulting set of parameter values was taken to represent the gear performance at the given speed.

The complete set of data for all the hauls together with numerical and descriptive information to specify in detail the trawl gear used in each haul was stored on a computer data bank.

3. Data Analysis (Appendix C)

A suite of programs was written in BASIC-PLUS for running on a PDP11/55 computer. The programs access the data held on the data bank for each haul in turn and calculate the major parameters describing the geometry and loading throughout the trawl gear. The significant parameters are, for example, gear drag, net drag, door spreading force, net mouth area and swept volume.

The shape of each warp in three dimensions can be calculated given the tension at the ship, the depth of the lower end and the spread of the lower end of the warp from the gear longitudinal centre line. The tension and depth are known for each individual warp. However, the spread was measured between the two doors so that it is necessary to make an assumption about the symmetry of the two sides of the gear in the horizontal plane. It has been assumed here that each door has the same spread from the gear centre line.

The bridle wires are assumed to be straight and to have no drop in tension along their length. The geometry of the lower sweep is calculated from the depths and spreads at each end together with the equation of vertical force equilibrium at the bridle weight. Because spread was measured at the upper wing-end only the angle in the horizontal plane, of the lower wire to the direction of motion was assumed to be equal to that of the upper bridle wire.

For all measured tensions, if the tension on one side of the gear is not available it is put equal to that on the other side.

If insufficient data are available to complete the calculation of any quantity then it is output as zero except in the case of heel and tilt angles which are left blank in the tables.

APPENDIX D

Definition of Parameters in Table

1. Block Number. A block of data is one describing the configuration of the trawl gear in steady state at a given set of conditions - in this case a given warp length and engine shaft horse power.

2. Warp length. The length of warp from the mark at the stern to the door attachment point. No allowance is made for extension under load, but the fact that the warp upper ends are 9 m apart at the ship is taken into account in the calculation.

3. Bridle weight. The weight in water of the masses near the wingends.

4. Ship speed. The speed of the ship relative to the mass of water at an unspecified depth below the ship.

5. Door spread. The distance between the doors as measured between the transducer and transponder positioned on the doors as indicated in Figure 5 .

6. Wing-end spread. Distance between the transducer and transponder positioned at the upper wing-ends. (or measured with transducers only)

7. Horizontal net opening. Distance between the transducer and transponder positioned at the centres of the side-lines.

8. Door depth. Depth of the transducer or depth meter positioned on each door as shown in Figure 5 .

9. Headline centre depth. Depth of headline transducer.

10. Wing-end height. Distance measured by the transducer at the upper wing-end looking towards the lower wing-end. (or measured with Furuno)

11. Headline height. Distance measured by the headline transducer looking towards the centre of the footrope.

12. Door heel and tilt. Angles as defined in Figure 5a.

13. Warp load. Tensions measured in the warps by meters incorporated in sheaves on the deck of the ship.

14. Total warp load. The sum of port and starboard warp loads.

15. Gear drag. Horizontal component, parallel to the gear centre-line, of the total warp load using angles of the upper ends of the warps calculated in the warp shape computation.

16. Door drag. The difference between the horizontal components, parallel to the gear centre-line, of the warp and bridle tensions.

17. Net drag. Horizontal component, parallel to the gear centre-line, of the bridle tensions at the net.

18. Door spread force. The sum of the horizontal components, perpendicular to the gear centre-line, of the warp and bridle tensions.

19. Sweep spread force. The sum of the horizontal components, perpendicular to the gear centre-line, of the sweep (bridle) tensions at the upper and lower wing-ends. This force can be considered to be the main force which

opens the net mouth horizontally.

20. Door lift force. The resultant of the vertical components of the warp and bridle tensions at the door and the door weight in water. This force can be considered to be an indication of the vertical hydrodynamic force supplied by the door.

21. Upper wing-end depth. This depth is calculated from the sum of the headline depth and an empirical function depending on the headline and wing-end heights and the number of floats on the headline.

22. Height of door above headline. The difference between the depth of the headline centre and the depth of the warp attachment point on the door.

23. Wing-end mouth area. The product of wing-end height and wing-end spread.

24. Headline mouth area. The product of headline height and horizontal net opening.

25. Net drag per area. Net drag divided by the appropriate mouth area.

26. Swept Volume (headline) per time per load. This criterion for judging gear performance is obtained by multiplying the headline mouth area by the speed and dividing by the total warp load.

27. Shaft horsepower. Measured horsepower at the propeller shaft.

28. Total gear horsepower. The product of gear drag and ship speed in appropriate units.

29. Door normal coefficient. The resultant force generated by the door is obtained from the door drag, spread force and lift force. This resultant is converted to coefficient form in the standard way by dividing by door area and dynamic pressure.

HAUL NUMBER : T77.2 APPENDIX D RUN ON 06-APR-78

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)
1	450	750	3.60	84.0	36.2	26.2	125.5	125.5	133.0	17.9	20.7	-3.2	29.6	-2.3	-3.9
2	550	750	3.53	85.0	37.1	26.4	165.1	165.1	173.6	18.4	22.4	-7.5	30.3	-4.2	-1.9
3	650	750	3.60	87.0	37.8	26.8	204.6	204.6	210.1	18.8	22.3	-9.8	30.6	-0.1	-1.7
4	750	750	3.45	87.0	38.0	26.6	251.6	251.6	258.1	19.6	22.3	-9.1	33.5	-0.7	-0.3
5	450	750	4.00	83.0	36.4	26.3	110.0	110.0	117.0	16.8	19.1	1.6	34.4	2.4	-2.6
6	550	750	3.95	86.0	36.7	26.6	140.1	140.1	150.1	17.7	20.0	0.0	34.3	3.2	-3.2
7	650	750	3.95	87.5	38.3	27.0	172.3	172.3	179.1	17.9	20.0	-2.8	35.9	2.9	-1.3
8	750	750	3.95	87.0	37.0	26.5	219.1	219.1	227.1	18.6	19.4	-3.2	33.1	2.2	0.1
9	450	750	4.20	84.0	36.4	26.4	93.5	93.5	102.0	16.3	19.0	4.3	36.7	1.8	-2.8
10	550	750	4.40	85.5	37.4	26.4	126.5	126.5	135.0	16.8	19.0	0.7	38.0	-0.1	-2.1
11	650	750	4.20	87.5	37.1	26.9	160.1	160.1	168.1	16.6	18.5	2.5	36.0	5.5	-1.3
12	750	750	4.10	90.0	38.2	27.2	193.1	193.1	200.1	17.2	18.2	-2.8	38.6	4.0	-2.1
13	450	750	4.60	81.0	36.0	26.1	85.0	85.0	93.0	15.7	18.6	5.8	37.1	5.9	-2.3
14	550	750	4.55	84.0	36.8	26.9	106.0	106.0	112.5	15.5	18.6	5.3	40.2	6.2	-2.8
15	650	750	4.50	88.5	37.5	27.0	140.1	140.1	147.0	15.9	18.1	4.2	40.1	5.5	-0.2
16	750	750	4.60	92.0	38.0	27.4	165.1	165.1	166.1	15.4	18.0	3.1	37.9	0.6	-0.9

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	SPREAD GEAR DRAG (TON)	DOOR DRAG (TON)	DOOR LIFT DOOR DRAG (TON)	NET DRAG (TON)	FORCE PORT (TON)	FORCE STBD (TON)	FORCE PORT (TON)	FORCE STBD (TON)	FORCE PORT (TON)	FORCE STBD (TON)
1	450	750	3.60	4.74	5.70	10.44	9.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	550	750	3.53	4.48	5.39	9.87	9.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	650	750	3.60	4.70	5.16	9.86	9.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	750	750	3.45	4.70	5.39	10.08	9.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	450	750	4.00	5.27	6.24	11.52	11.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	550	750	3.95	5.06	6.04	11.10	10.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	650	750	3.95	5.27	5.81	11.09	10.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	750	750	3.95	5.17	6.19	11.36	10.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	450	750	4.20	5.59	6.57	12.16	11.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	550	750	4.40	5.48	6.24	11.72	11.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	650	750	4.20	5.48	6.04	11.52	10.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	750	750	4.10	5.70	6.35	12.05	11.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	450	750	4.60	5.70	6.72	12.42	12.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	550	750	4.55	5.59	6.75	12.34	11.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	650	750	4.50	5.59	6.46	12.05	11.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	750	750	4.60	5.75	6.72	12.47	11.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	450	750	3.60	134.4	7.4	647.6	542.0	0.000	0.000	96.2	810.0	240.4	0.00	0.00
2	550	750	3.53	175.6	8.4	682.2	591.0	0.000	0.000	108.8	810.0	220.8	0.00	0.00
3	650	750	3.60	211.8	5.4	710.2	597.3	0.000	0.000	112.3	810.0	223.6	0.00	0.00
4	750	750	3.45	259.4	6.4	744.3	592.8	0.000	0.000	104.4	800.0	216.9	0.00	0.00
5	450	750	4.00	118.2	6.9	611.2	502.0	0.000	0.000	89.8	918.0	298.3	0.00	0.00
6	550	750	3.95	151.2	9.9	649.2	531.7	0.000	0.000	97.4	910.0	282.5	0.00	0.00
7	650	750	3.95	180.1	6.6	685.2	539.7	0.000	0.000	99.8	910.0	280.9	0.00	0.00
8	750	750	3.95	227.5	7.9	687.8	513.8	0.000	0.000	92.0	910.0	285.5	0.00	0.00
9	450	750	4.20	103.4	8.4	593.0	501.3	0.000	0.000	89.2	1020.0	333.8	0.00	0.00
10	550	750	4.40	136.1	8.4	628.0	501.3	0.000	0.000	96.9	1020.0	335.1	0.00	0.00

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11	650	750	4.20	169.0	7.9	615.4	497.4	0.000	0.000	93.4	1030.0	312.2	0.00	0.00
12	750	750	4.10	200.6	6.9	656.6	494.7	0.000	0.000	86.6	1030.0	317.6	0.00	0.00
13	450	750	4.60	94.5	7.9	564.9	485.1	0.000	0.000	92.5	1090.0	375.4	0.00	0.00
14	550	750	4.55	114.1	6.4	570.1	500.0	0.000	0.000	94.9	1090.0	368.1	0.00	0.00
15	650	750	4.50	148.1	6.9	595.9	488.4	0.000	0.000	93.9	1090.0	353.2	0.00	0.00
16	750	750	4.60	167.4	0.9	584.9	492.9	0.000	0.000	93.6	1090.0	372.8	0.00	0.00

HAUL NUMBER : T77.3 RUN ON 21-APR-78

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)
1	450	750	4.00	83.0	35.6	25.0	128.5	128.5	138.1	17.4	22.1	-5.2	25.4	2.0	4.6
2	550	750	3.80	84.5	36.1	25.3	160.6	160.6	168.1	18.3	23.0	-5.9	30.0	0.2	2.6
3	450	750	4.00	79.5	32.0	25.1	117.0	117.0	128.1	17.0	23.0	1.8	33.8	0.0	1.2
4	550	750	4.00	83.0	33.0	25.4	149.0	149.0	156.1	17.6	22.0	0.8	33.7	0.4	0.3
5	450	750	4.20	79.5	34.8	25.8	109.5	109.5	119.0	16.1	21.0	5.4	36.6	2.7	1.4
6	550	750	4.30	87.2	34.3	26.8	130.0	130.0	138.1	17.2	20.5	5.2	37.5	2.5	0.3
7	450	750	4.50	88.0	35.0	26.0	94.0	94.0	105.0	15.5	20.0	10.5	37.6	11.0	1.3
8	550	750	4.45	86.0	34.0	26.3	113.7	113.7	123.0	16.1	19.1	10.6	36.8	11.5	1.5

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	450	750	4.00	4.11	5.59	9.70	9.17	0.38	0.48	7.79	0.73	0.85	0.38	0.43	0.52	0.35
2	550	750	3.80	4.22	5.54	9.76	9.18	0.42	0.42	7.96	0.73	0.78	0.40	0.43	0.48	0.34
3	450	750	4.00	4.43	5.93	10.36	9.86	0.32	0.40	8.53	0.77	0.92	0.41	0.47	0.59	0.56
4	550	750	4.00	4.43	5.81	10.24	9.71	0.36	0.43	8.56	0.78	0.86	0.44	0.48	0.53	0.36
5	450	750	4.20	4.85	6.24	11.09	10.62	0.42	0.32	9.19	0.83	0.95	0.42	0.47	0.63	0.53
6	550	750	4.30	4.96	5.81	10.77	10.31	0.46	0.41	9.21	0.90	0.96	0.51	0.55	0.65	0.58
7	450	750	4.50	5.27	6.57	11.84	11.43	0.48	0.41	9.89	1.04	1.16	0.54	0.60	0.82	0.77
8	550	750	4.45	5.27	6.41	11.68	11.27	0.45	0.50	9.95	0.94	1.04	0.54	0.58	0.83	0.75

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	450	750	4.00	140.4	9.5	620.9	552.2	12.551	14.112	117.2	790.0	248.2	0.92	0.99
2	550	750	3.80	170.4	7.4	660.2	581.6	12.855	13.685	116.6	800.0	236.0	1.02	1.03
3	450	750	4.00	131.1	10.9	543.7	577.0	15.685	14.782	114.7	880.0	266.9	1.03	1.09
4	550	750	4.00	158.3	6.9	579.2	558.5	14.774	15.322	112.3	900.0	262.8	0.96	0.98
5	450	750	4.20	121.5	9.4	559.7	541.5	16.412	16.963	105.6	980.0	301.9	0.96	0.98
6	550	750	4.30	139.7	7.9	589.7	549.1	15.623	16.778	112.8	980.0	300.1	0.99	0.98
7	450	750	4.50	107.3	10.9	542.2	519.7	18.246	19.035	101.7	1090.0	348.2	1.06	1.09
8	550	750	4.45	124.5	9.2	547.2	502.1	18.189	19.822	98.4	1090.0	339.6	1.03	1.05

HAUL NUMBER 1 T77.4 RUN ON 21-APR-78

GEOMETRY

HL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)
1	350	450	4.00	82.0	35.5	24.8	82.7	82.7	96.0	13.7	16.3	7.6	27.8	19.7	7.8
2	450	450	3.80	87.3	37.5	25.2	112.0	112.0	122.0	14.4	17.8	4.7	30.1	17.0	3.9
3	550	450	3.60	87.5	36.2	25.2	152.0	152.0	161.1	14.6	17.6	4.6	31.2	15.9	0.9
4	650	450	3.60	91.0	37.0	25.6	183.1	183.1	192.1	14.1	17.2	4.6	34.2	14.9	0.8
5	650	450	3.80	88.0	36.5	25.3	167.2	167.2	177.1	13.7	16.8	8.3	35.4	17.0	0.2
6	650	450	4.50	89.7	38.5	25.6	124.0	124.0	137.1	12.8	15.0	15.9	41.6	19.9	3.3
7	650	450	3.40	93.0	39.0	27.7	213.1	213.1	217.1	17.2	20.3	0.8	36.2	12.9	-0.8
8	650	450	3.80	96.0	39.5	27.0	199.1	199.1	201.1	17.4	18.8	11.8	42.5	15.7	-0.6
9	650	450	4.50	92.7	39.5	27.0	136.0	136.0	145.0	15.7	17.0	11.4	43.5	15.8	0.8

FORCES

HL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	350	450	4.00	3.90	4.73	8.63	8.26	0.27	0.88	7.80	0.85	0.78	0.37	0.33	0.71	0.59
2	450	450	3.80	4.11	4.73	8.84	8.41	0.33	0.89	6.99	0.79	0.74	0.40	0.36	0.63	0.52
3	550	450	3.60	4.01	4.73	8.74	8.22	0.19	0.68	6.89	0.73	0.67	0.40	0.36	0.57	0.45
4	650	450	3.60	4.11	4.95	9.06	8.49	0.16	0.69	6.99	0.73	0.65	0.44	0.38	0.61	0.47
5	650	450	3.80	4.43	5.27	9.70	9.18	-0.16	0.48	7.44	0.76	0.68	0.44	0.39	0.77	0.61
6	650	450	4.50	5.27	5.70	10.97	10.59	0.34	1.24	8.43	0.87	0.79	0.50	0.43	1.09	0.93
7	650	450	3.40	4.01	4.30	8.31	7.68	0.27	0.56	6.60	0.67	0.65	0.39	0.38	0.30	0.24
8	650	450	3.80	4.64	4.63	9.27	8.65	-0.35	0.43	8.14	0.88	0.81	0.53	0.46	0.19	0.16
9	650	450	4.50	5.27	5.38	10.65	10.24	0.39	1.35	8.62	0.92	0.83	0.53	0.45	0.82	0.73

DERIVED QUANTITIES

HL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	350	450	4.00	97.3	13.3	486.8	404.0	14.381	17.328	96.4	800.0	223.6	1.08	1.25
2	450	450	3.80	123.7	10.0	541.7	448.3	12.914	15.604	99.2	800.0	216.4	1.12	1.34
3	550	450	3.60	162.5	9.0	529.4	443.3	13.018	15.546	94.0	800.0	200.4	1.11	1.24
4	650	450	3.60	193.6	8.9	520.7	440.1	13.418	15.875	90.0	800.0	206.9	1.13	1.24
5	650	450	3.80	178.6	9.8	500.5	424.8	14.865	17.516	85.7	870.0	236.1	1.15	1.09
6	650	450	4.50	138.2	13.0	492.5	383.8	17.114	21.962	81.0	1085.0	322.5	1.08	1.30
7	650	450	3.40	218.6	3.9	670.5	561.5	9.848	11.761	116.3	810.0	176.2	1.03	1.17
8	650	450	3.80	201.8	1.9	685.7	507.3	11.873	16.049	107.1	885.0	222.6	1.02	0.98
9	650	450	4.50	145.7	8.9	620.8	458.8	13.884	18.782	99.8	1120.0	311.8	0.97	1.31

HAUL NUMBER : T77.5 RUN ON 21-APR-78

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)
1	650	450	3.95	86.0	37.5	26.0	180.3	168.1	170.1	17.6	18.6	1.0		15.5	
2	650	450	4.40	75.0	38.0	0.0	132.9	116.0	122.0	17.8	19.0	8.1		15.4	
3	650	450	4.75	45.7	37.0	0.0	107.0	83.0	94.0	17.2	19.4	20.7		19.3	
4	650	450	3.95	75.0	36.5	0.0	141.0	127.0	133.0	17.6	19.8	6.9		11.6	
5	650	450	4.40	62.2	36.2	0.0	110.7	90.0	98.0	17.1	20.0	8.2		11.4	

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	650	450	3.95	4.59	5.47	10.06	9.51	0.72	-0.05	7.95	0.70	0.76	0.36	0.46	-0.13	0.37
2	650	450	4.40	5.75	6.03	11.78	11.39	0.95	0.55	0.00	0.68	0.72	0.00	0.00	-0.04	0.87
3	650	450	4.75	6.64	6.24	12.88	12.59	1.02	1.36	0.00	0.16	0.21	0.00	0.00	-0.01	1.42
4	650	450	3.95	4.59	5.38	9.97	9.51	0.57	0.26	8.19	0.62	0.67	0.30	0.36	-0.01	0.60
5	650	450	4.40	5.85	5.81	11.66	11.32	0.59	0.35	0.00	0.53	0.52	0.00	0.00	-0.21	1.03

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	650	450	3.95	170.6	-4.1	659.7	483.4	12.053	16.449	97.7	855.0	254.3	0.99	0.82
2	650	450	4.40	122.6	-2.4	676.0	0.0	0.000	0.000	0.0	1100.0	339.1	0.91	0.99
3	650	450	4.75	95.1	-1.0	636.1	0.0	0.000	0.000	0.0	1247.0	404.6	0.69	1.34
4	650	450	3.95	134.1	-1.0	642.1	0.0	12.760	0.000	0.0	852.0	254.2	0.83	0.91
5	650	450	4.40	99.5	-2.4	618.7	0.0	0.000	0.000	0.0	1085.0	337.0	0.64	0.95

HAUL NUMBER : T77.8 RUN ON 21-APR-78

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE HEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)
1	450	750	4.20	87.0	31.0	27.2	143.1	150.5	155.0	19.4	22.0		20.8		4.1
2	550	750	4.10	100.0	32.3	29.0	181.1	196.9	193.1	19.2	21.3		32.5		-3.0
3	650	750	4.00	106.0	34.0	29.7	211.6	231.1	225.1	19.7	22.3		31.8		-7.6
4	450	750	4.60	96.7	32.3	28.3	101.5	112.2	118.0	16.6	15.3				
5	550	750	4.40	99.0	33.0	29.0	132.0	145.4	144.0	17.2	18.0				
6	650	750	4.30	108.0	34.0	30.7	167.0	179.6	182.1	17.4	17.2				
7	450	750	4.30	95.0	32.6	29.0	134.8	145.4	152.0	17.0	16.4				
8	550	750	4.25	106.0	34.0	31.0	166.1	174.5	182.1	17.4	16.3				
9	650	750	4.30	100.0	33.7	30.3	203.1	221.2	225.1	17.9	17.2				
10	650	750	4.30	102.0	33.0	29.3	213.7	226.9	226.1	19.0	18.0				

FORCES

BL NO	WARP LENGTH (M)	BRIDLE HEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	450	750	4.20	4.01	4.73	8.74	8.17	0.58	0.62	6.96	0.89	0.90	0.41	0.43	0.34	-0.06
2	550	750	4.10	4.05	4.73	8.79	8.16	0.56	0.48	6.92	0.96	0.98	0.49	0.51	0.32	-0.42
3	650	750	4.00	4.01	5.06	9.07	8.40	0.80	0.38	6.94	0.92	0.99	0.50	0.56	0.44	-0.46
4	450	750	4.60	5.06	5.81	10.87	10.42	0.74	0.37	9.11	1.19	1.27	0.61	0.67	0.81	0.24
5	550	750	4.40	5.01	5.86	10.87	10.37	0.67	0.50	8.86	1.11	1.21	0.60	0.66	0.70	-0.07
6	650	750	4.30	5.27	5.92	11.19	10.62	0.83	0.54	8.92	1.20	1.24	0.70	0.74	0.72	0.07
7	450	750	4.30	4.43	5.38	9.81	9.22	0.82	0.47	7.68	0.98	1.15	0.46	0.58	0.44	-0.14
8	550	750	4.25	4.68	5.27	9.95	9.34	0.72	0.59	7.64	1.12	1.15	0.58	0.62	0.43	0.01
9	650	750	4.30	4.75	5.16	9.91	9.26	0.69	0.55	7.45	0.93	0.99	0.51	0.55	0.64	-0.21
10	650	750	4.30	5.17	4.73	9.90	9.23	0.75	0.61	7.22	1.02	0.95	0.56	0.51	0.09	-0.27

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE HEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	450	750	4.20	156.3	8.2	601.1	598.1	11.582	11.640	148.0	854.0	232.2	0.96	0.94
2	550	750	4.10	194.1	4.0	619.9	617.4	11.168	11.213	148.2	853.0	226.4	1.05	1.06
3	650	750	4.00	226.3	3.6	671.2	661.9	10.334	10.478	150.3	858.0	227.5	1.23	1.10
4	450	750	4.60	117.4	11.1	535.9	432.7	17.003	21.058	94.3	1090.0	324.5	1.16	0.97
5	550	750	4.40	144.4	5.3	567.4	521.7	15.614	16.979	108.7	1090.0	308.7	1.16	1.03
6	650	750	4.30	182.0	8.7	591.3	527.8	15.092	16.908	104.4	1088.0	309.0	1.34	1.11
7	450	750	4.30	151.7	11.9	553.9	475.4	13.860	16.150	107.3	980.0	268.3	1.11	1.03
8	550	750	4.25	181.5	11.7	591.3	505.0	12.925	15.133	111.0	980.0	268.7	1.17	1.09
9	650	750	4.30	224.7	12.9	602.9	520.9	12.361	14.306	116.4	980.0	269.6	1.08	0.94
10	650	750	4.30	225.6	5.7	626.7	527.1	11.526	13.704	117.9	983.0	268.6	1.04	0.95

HAUL NUMBER : T77.9 RUN ON 21-APR-78

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)
1	450	450	4.20	101.0	32.6	29.5	109.5	124.9	125.0	16.5	17.8	-2.5	39.4	11.2	5.7
2	550	450	4.30	98.0	32.4	29.2	161.4	170.5	172.1	17.4	20.3	-8.2	38.6	6.7	6.4
3	650	450	4.20	102.0	32.7	30.2	210.6	216.5	218.1	19.0	21.6	-11.6	38.3	15.2	1.2
4	450	450	4.70	98.0	32.8	29.8	100.5	108.0	118.0	14.6	13.3	2.4	42.9	15.2	4.3
5	550	450	4.67	99.0	32.2	29.7	127.0	127.7	137.0	16.5	15.5	-4.2		15.9	14.1
6	650	450	4.60	106.3	33.1	31.2	156.1	166.3	167.0	16.5	16.5	-3.6	38.9	16.0	14.6
7	450	450	5.10	105.0	33.3	31.0	65.0	66.3	76.0	14.6	13.6	6.8		9.0	17.9
8	550	450	5.20	101.5	32.8	30.2	109.0	116.2	122.0	14.6	14.7	3.5	37.2	18.7	2.4
9	650	450	5.00	103.5	32.7	31.0	135.0	142.1	148.0	14.6	13.8	1.1		18.6	4.7

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	450	450	4.20	4.22	4.52	8.74	8.30	0.61	0.66	6.71	0.96	1.02	0.48	0.50	0.79	0.10
2	550	450	4.30	4.01	4.57	8.58	8.06	0.42	0.42	6.58	0.87	0.89	0.45	0.48	0.52	0.08
3	650	450	4.20	4.22	4.25	8.47	7.89	0.54	0.30	6.35	0.85	0.84	0.48	0.48	0.27	0.12
4	450	450	4.70	4.85	4.73	9.58	9.20	0.28	0.35	7.68	1.02	1.06	0.55	0.54	0.89	0.62
5	550	450	4.67	5.22	4.46	9.68	9.28	-0.18	0.47	7.90	0.93	0.95	0.62	0.53	0.71	0.69
6	650	450	4.60	5.06	4.73	9.79	9.33	0.05	0.43	7.81	0.98	1.01	0.65	0.59	0.77	0.34
7	450	450	5.10	5.27	5.16	10.43	10.18	0.52	0.85	8.45	1.26	1.26	0.69	0.64	1.06	0.99
8	550	450	5.20	5.01	5.16	10.17	9.82	0.65	0.70	8.39	1.12	1.15	0.63	0.62	0.92	0.53
9	650	450	5.00	5.48	5.06	10.54	10.14	0.26	0.54	8.31	1.02	1.08	0.64	0.64	0.93	0.61

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	450	450	4.20	125.7	7.8	537.6	524.8	12.480	12.784	129.8	830.0	236.0	1.19	1.05
2	550	450	4.30	173.5	6.0	563.5	592.4	11.671	11.101	152.9	830.0	234.7	0.90	0.81
3	650	450	4.20	219.4	4.5	621.0	652.0	10.226	9.740	166.4	830.0	224.4	0.90	0.77
4	450	450	4.70	117.4	14.7	478.6	396.1	16.054	19.401	100.0	990.0	292.5	0.95	0.88
5	550	450	4.67	136.5	9.7	531.0	460.1	14.876	17.169	114.3	1000.0	293.2	0.83	0.68
6	650	450	4.60	167.0	5.9	545.8	514.5	14.305	15.176	124.4	1000.0	290.5	0.90	0.83
7	450	450	5.10	75.5	10.4	486.2	421.4	17.370	20.041	106.1	1095.0	351.4	1.01	1.06
8	550	450	5.20	122.1	9.4	478.6	443.7	17.536	18.916	116.8	1090.0	345.6	0.89	0.82
9	650	450	5.00	147.6	9.5	477.2	427.6	17.407	19.427	104.4	1095.0	343.3	0.85	0.82

HAUL NUMBER : T77.10 RUN ON 21-APR-78

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)
1	450	600	4.20	95.5	32.7	28.9	132.4	137.8	147.0	17.9	18.6				
2	550	600	4.00	102.0	33.2	30.0	167.0	176.1	182.1	17.0	16.4				
3	650	600	4.00	106.0	34.0	31.2	210.1	215.1	223.1	17.4	17.2				
4	450	600	4.60	100.0	33.3	29.5	110.0	119.8	125.0	16.1	15.3				
5	550	600	4.30	96.0	32.5	29.3	151.0	159.2	163.1	17.2	17.2				
6	650	600	4.40	100.0	33.0	29.6	173.8	181.7	186.1	17.4	18.2				
7	450	600	4.90	95.0	32.3	29.0	93.0	96.5	106.0	15.2	15.5				
8	550	600	4.68	97.2	32.5	29.0	114.0	122.0	128.0	15.9	15.0				
9	650	600	4.65	103.5	33.3	30.3	138.5	145.7	153.1	15.9	15.7				

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	450	600	4.20	4.27	4.52	8.79	8.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	550	600	4.00	4.32	4.63	8.95	8.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	650	600	4.00	4.32	4.73	9.05	8.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	450	600	4.60	4.64	5.06	9.70	9.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	550	600	4.30	4.69	4.95	9.64	9.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	650	600	4.40	4.64	5.16	9.80	9.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	450	600	4.90	5.13	5.45	10.58	10.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	550	600	4.68	5.27	5.43	10.70	10.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	650	600	4.65	5.06	5.59	10.65	10.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	450	600	4.20	147.4	11.8	585.0	537.2	0.000	0.000	132.1	844.0	235.1	0.00	0.00
2	550	600	4.00	181.8	10.4	564.1	491.7	0.000	0.000	113.1	848.0	226.6	0.00	0.00
3	650	600	4.00	223.0	10.4	591.3	536.3	0.000	0.000	122.0	849.0	227.9	0.00	0.00
4	450	600	4.60	124.6	10.0	535.8	451.1	0.000	0.000	110.1	990.0	286.1	0.00	0.00
5	550	600	4.30	163.1	7.9	558.7	503.6	0.000	0.000	115.6	990.0	265.3	0.00	0.00
6	650	600	4.40	186.5	8.2	573.9	538.1	0.000	0.000	124.4	990.0	276.3	0.00	0.00
7	450	600	4.90	106.2	11.2	490.6	449.3	0.000	0.000	107.1	1100.0	338.7	0.00	0.00
8	550	600	4.68	127.6	10.0	516.5	434.8	0.000	0.000	97.9	1104.0	326.3	0.00	0.00
9	650	600	4.65	153.0	10.9	529.2	475.4	0.000	0.000	106.9	1101.0	321.7	0.00	0.00

HAUL NUMBER : T77.11 RUN ON 21-APR-78

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)
1	450	750	4.15	101.0	33.0	29.3	160.4	178.1	175.1	17.6	18.9	-16.8	27.1	5.0	0.8
2	550	750	3.80	101.5	32.8	30.0	196.1	208.4	206.1	17.4	19.8	-16.4	34.5	3.8	4.3
3	650	750	3.90	103.0	33.0	30.3	240.1	248.8	247.1	18.7	20.8	-21.0	37.5	0.4	5.0
4	450	750	4.60	97.4	31.8	28.2	139.0	154.9	154.0	15.0	14.6	-5.9	33.2	-0.5	5.3
5	550	750	4.50	105.0	33.5	31.0	171.0	183.9	184.1	16.1	16.0	-12.9	35.4	-2.2	7.6
6	650	750	4.40	106.0	33.0	30.4	209.1	221.2	218.1	17.0	19.3	-12.9	34.3	-2.2	6.2
7	450	750	4.80	102.0	33.0	30.0	132.0	173.1	147.0	14.4	13.6	-7.3	34.6	2.5	8.9
8	550	750	4.70	106.4	33.6	31.2	159.1	192.6	175.1	15.5	15.2	-6.7	33.1	1.2	9.8
9	650	750	4.70	102.0	32.8	30.2	199.1	214.1	209.1	17.2	18.9	-10.0	33.3	3.9	8.0

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	450	750	4.15	4.27	4.73	9.00	8.28	0.65	0.46	6.67	0.97	1.07	0.43	0.54	0.16	-0.70
2	550	750	3.80	4.32	4.84	9.16	8.42	0.64	0.34	6.90	0.94	1.00	0.47	0.56	0.11	-0.46
3	650	750	3.90	4.53	4.57	9.10	8.35	0.66	0.12	6.67	0.92	0.94	0.49	0.53	-0.06	-0.28
4	450	750	4.60	4.85	5.38	10.23	9.60	1.05	0.30	7.62	1.04	1.18	0.45	0.63	0.21	-0.57
5	550	750	4.50	5.01	5.36	10.39	9.75	0.57	0.15	7.94	1.11	1.20	0.56	0.68	0.28	-0.35
6	650	750	4.40	4.75	5.38	10.13	9.47	0.68	0.26	7.72	1.04	1.09	0.56	0.67	0.18	-0.40
7	450	750	4.80	5.01	5.70	10.71	10.03	0.66	0.18	8.12	1.05	1.21	0.48	0.60	0.31	-1.98
8	550	750	4.70	5.06	5.59	10.65	10.02	0.65	0.33	8.26	1.08	1.21	0.56	0.66	0.47	-1.31
9	650	750	4.70	5.06	5.54	10.60	9.98	0.86	0.44	8.17	1.05	1.11	0.56	0.66	0.18	-0.56

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	450	750	4.15	175.7	5.7	580.4	553.5	11.489	12.049	131.4	840.0	232.7	1.04	1.20
2	550	750	3.80	207.3	3.8	570.4	593.7	12.098	11.623	126.8	840.0	216.4	1.20	1.22
3	650	750	3.90	248.1	2.6	616.7	629.9	10.817	10.591	139.0	840.0	220.3	1.13	0.98
4	450	750	4.60	153.8	7.0	476.7	411.4	15.985	18.523	95.2	1009.0	298.8	1.07	0.97
5	550	750	4.50	184.0	6.5	539.0	495.8	14.723	16.007	110.5	1011.0	296.9	0.96	0.94
6	650	750	4.40	219.2	2.9	560.7	586.4	13.763	13.161	131.1	1012.0	282.0	0.99	0.94
7	450	750	4.80	146.6	-5.6	474.9	407.7	17.094	19.912	94.1	1090.0	325.7	0.84	1.53
8	550	750	4.70	174.9	-0.8	520.5	473.9	15.871	17.432	107.7	1100.0	318.7	0.92	1.25
9	650	750	4.70	209.9	2.5	563.8	570.4	14.499	14.330	130.2	1080.0	317.4	0.94	0.90

HAUL NUMBER : T77.12 RUN ON 21-APR-78

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)
1	450	750	3.93	102.0	35.4	32.7	130.0	140.2	136.0	22.0	26.6	-13.2	27.0	4.8	8.5
2	550	750	3.80	101.1	35.1	32.0	173.1	182.5	178.1	22.9	28.3	-13.6	30.4	2.9	8.2
3	650	750	3.85	104.0	34.5	32.1	211.1	219.8	212.1	23.2	29.5	-12.7	31.9	1.5	8.8
4	450	750	4.30	103.0	35.2	32.6	129.0	138.8	133.0	20.5	21.7	-13.1	36.1	1.7	11.0
5	550	750	4.40	105.0	35.5	33.0	155.0	163.6	162.1	20.8	23.5	-11.0	34.7	3.3	10.0
6	650	750	4.20	107.7	35.6	33.2	186.1	193.3	189.1	22.1	25.6	-12.4	33.9	5.4	9.2
7	450	750	4.60	105.3	34.6	33.3	107.4	118.8	118.0	19.7	20.0	-3.8	32.8	7.6	9.4
8	550	750	4.60	106.5	34.7	33.6	139.7	149.8	150.1	19.7	20.8	-8.2	33.6	6.5	9.5
9	650	750	4.45	109.2	35.5	34.3	172.5	180.3	181.1	20.5	21.0	-9.2	36.2	3.8	9.6

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	450	750	3.93	4.01	4.73	8.74	8.20	1.05	0.36	6.75	1.02	1.10	0.44	0.54	0.38	-0.02
2	550	750	3.80	4.01	4.46	8.47	7.87	0.86	0.21	6.65	0.89	0.98	0.43	0.53	0.35	0.02
3	650	750	3.85	4.01	4.57	8.58	7.95	0.50	0.08	6.77	0.90	0.94	0.48	0.55	0.29	-0.03
4	450	750	4.30	4.69	5.11	9.80	9.24	0.25	0.25	7.74	1.14	1.15	0.55	0.60	0.28	-0.22
5	550	750	4.40	4.64	5.16	9.80	9.26	0.41	0.37	7.73	1.09	1.09	0.56	0.62	0.48	0.04
6	650	750	4.20	4.75	5.27	10.02	9.43	0.41	0.19	7.69	1.05	1.07	0.58	0.64	0.42	0.10
7	450	750	4.60	5.17	5.47	10.64	10.16	0.58	0.23	8.62	1.28	1.37	0.62	0.71	0.66	0.09
8	550	750	4.60	5.01	5.49	10.50	10.00	0.77	0.45	8.51	1.23	1.29	0.63	0.71	0.60	0.10
9	650	750	4.45	5.17	5.49	10.66	10.11	0.74	0.50	8.29	1.18	1.23	0.64	0.70	0.54	0.18

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	450	750	3.93	139.1	0.9	778.2	869.3	8.675	7.766	201.2	830.0	218.1	1.49	1.14
2	550	750	3.80	181.5	0.2	801.9	905.1	8.292	7.347	209.1	830.0	202.5	1.35	1.05
3	650	750	3.85	216.0	-3.4	799.9	946.4	8.457	7.148	218.6	829.0	207.1	1.10	0.97
4	450	750	4.30	134.4	-0.9	721.2	707.0	10.738	10.954	159.7	984.0	268.9	0.99	0.99
5	550	750	4.40	164.1	2.7	739.7	775.1	10.455	9.977	179.2	985.0	275.6	0.99	0.99
6	650	750	4.20	191.6	-0.7	786.2	849.4	9.775	9.048	183.3	990.0	268.2	1.04	0.94
7	450	750	4.60	118.9	4.9	681.2	665.7	12.848	12.943	148.1	1090.0	316.5	1.12	1.00
8	550	750	4.60	151.2	5.3	665.0	691.7	12.430	12.309	156.0	1087.0	311.2	1.13	0.99
9	650	750	4.45	182.1	4.6	727.4	719.9	11.396	11.515	154.7	1090.0	304.5	1.14	1.03

HAUL NUMBER 1 T77.13 RUN ON 21-APR-78

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)
1	450	750	3.85	86.5	30.6	27.4	136.5	147.6	144.0	20.1	24.2		27.3		5.5
2	550	750	3.80	90.5	31.2	28.0	171.4	182.5	180.1	20.1	23.4		28.6		3.6
3	650	750	3.60	92.5	31.4	28.0	210.3	216.9	215.1	20.5	22.5		32.8		4.9
4	450	750	4.44	90.0	31.2	28.0	109.5	121.1	118.0	18.3	18.7		34.2		7.1
5	550	750	4.30	91.5	31.2	27.8	141.0	153.4	151.0	18.3	20.0		30.7		6.2
6	650	750	4.20	95.0	31.8	28.8	182.6	194.0	192.1	19.0	19.6		30.0		5.3
7	450	750	4.60	88.2	31.0	27.3	108.0	116.6	115.0	17.9	17.8		34.7		10.0
8	550	750	4.60	91.5	31.3	28.0	135.0	146.1	143.1	18.8	21.7		32.8		9.5
9	650	750	4.40	97.5	32.2	29.2	166.3	177.4	171.0	19.0	20.3		33.0		7.0

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP FORCE PORT (TON)	SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	450	750	3.85	4.64	4.86	9.50	8.89	0.58	0.25	7.40	0.91	0.91	0.42	0.47	0.32	-0.13
2	550	750	3.80	4.69	4.90	9.59	8.94	0.46	0.21	7.35	0.87	0.88	0.44	0.49	0.42	-0.05
3	650	750	3.60	4.96	4.90	9.86	9.14	0.52	0.18	7.45	0.87	0.85	0.47	0.52	0.21	0.02
4	450	750	4.44	5.70	5.56	11.26	10.76	0.68	0.31	8.78	1.13	1.13	0.53	0.58	0.49	-0.09
5	550	750	4.30	5.38	5.59	10.97	10.43	0.68	0.45	8.61	1.04	1.05	0.53	0.59	0.58	-0.05
6	650	750	4.20	5.47	5.59	11.06	10.44	0.73	0.53	8.43	1.02	1.02	0.55	0.60	0.43	-0.11
7	450	750	4.60	5.76	5.43	11.19	10.71	0.77	0.57	9.01	1.15	1.14	0.54	0.57	0.38	-0.04
8	550	750	4.60	5.59	5.49	11.08	10.58	0.78	0.58	8.75	1.07	1.08	0.55	0.59	0.57	0.02
9	650	750	4.40	5.80	5.59	11.39	10.83	0.71	0.43	8.88	1.10	1.11	0.60	0.66	0.39	-0.12

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	450	750	3.85	146.8	1.9	615.3	662.7	12.019	11.160	138.3	800.0	231.6	1.15	0.98
2	550	750	3.80	182.5	3.1	627.4	654.9	11.719	11.227	133.6	805.0	229.9	1.12	0.95
3	650	750	3.60	216.8	1.4	642.7	629.7	11.585	11.825	118.4	810.0	222.7	1.22	1.02
4	450	750	4.44	119.0	2.7	570.3	523.3	15.402	16.787	106.2	1000.0	323.2	1.08	0.91
5	550	750	4.30	152.7	3.7	570.3	555.7	15.101	15.498	112.1	1007.0	303.4	1.13	0.94
6	650	750	4.20	193.1	3.7	603.9	564.1	13.952	14.935	110.2	1006.0	296.7	1.14	1.00
7	450	750	4.60	115.7	2.6	554.6	485.6	16.252	18.560	102.8	1095.0	333.5	1.03	0.92
8	550	750	4.60	145.2	2.4	589.3	607.3	14.846	14.408	129.8	1095.0	329.4	1.04	0.88
9	650	750	4.40	172.5	-0.9	611.5	592.4	14.520	14.988	117.8	1093.0	322.5	1.08	0.94

HAUL NUMBER : T77.14 RUN ON 21-APR-78

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)
1	450	750	3.40	87.0	31.7	27.0	102.0	107.5	114.0	20.1	22.0		34.7		26.9
2	550	750	3.50	93.1	32.5	27.8	134.0	147.8	146.0	22.8	22.8		34.4		25.0
3	650	750	3.30	93.0	32.0	28.0	176.1	188.8	188.1	22.6	22.8		33.8		22.5
4	450	750	4.30	86.0	31.5	26.8	84.0	96.5	96.0	19.8	19.8		32.6		23.3
5	550	750	4.25	91.0	32.0	27.5	111.0	119.1	122.0	21.3	21.3		35.0		23.9
6	650	750	3.60	95.5	33.0	28.5	145.0	157.1	157.0	21.2	21.2		39.1		22.2
7	450	750	4.20	89.3	32.0	27.4	75.0	88.5	89.0	20.2	20.2		34.8		21.8
8	550	750	4.40	92.0	32.5	27.6	102.0	115.5	115.0	21.0	21.0		35.5		20.6
9	650	750	4.20	92.5	32.5	28.0	137.3	147.8	148.0	20.6	20.6		36.6		20.2

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	450	750	3.40	4.43	5.38	9.81	9.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	550	750	3.50	4.43	5.43	9.86	9.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	650	750	3.30	4.56	5.27	9.83	9.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	450	750	4.30	4.99	6.08	11.07	10.70	1.56	1.50	8.08	1.06	1.07	0.48	0.49	0.89	0.16
5	550	750	4.25	5.06	5.92	10.98	10.57	1.27	1.35	7.77	1.02	1.01	0.49	0.51	0.91	0.42
6	650	750	3.60	5.64	5.38	11.02	10.51	0.93	1.45	6.44	0.89	0.88	0.42	0.45	0.95	0.33
7	450	750	4.20	5.06	6.03	11.09	10.76	1.51	1.55	7.96	1.09	1.10	0.48	0.50	1.13	0.33
8	550	750	4.40	5.06	6.03	11.09	10.71	1.52	1.63	7.75	1.04	1.03	0.49	0.51	1.07	0.28
9	650	750	4.20	5.17	6.03	11.20	10.74	1.38	1.57	7.91	1.01	0.98	0.51	0.52	0.91	0.26

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	450	750	3.40	115.7	9.3	637.4	593.7	0.000	0.000	105.9	840.0	215.7	0.00	0.00
2	550	750	3.50	146.8	5.1	740.6	633.5	0.000	0.000	115.7	805.0	221.3	0.00	0.00
3	650	750	3.30	188.8	5.6	729.2	638.1	0.000	0.000	110.3	800.0	205.7	0.00	0.00
4	450	750	4.30	96.8	5.8	623.4	530.3	12.965	15.239	106.0	1000.0	311.3	1.71	1.52
5	550	750	4.25	122.8	7.0	681.2	585.4	11.400	13.265	116.6	1000.0	304.1	1.57	1.46
6	650	750	3.60	157.8	6.0	699.2	603.9	9.214	10.669	101.6	995.0	256.0	1.88	2.02
7	450	750	4.20	89.8	7.3	646.0	553.1	12.321	14.390	107.8	1085.0	305.7	1.88	1.67
8	550	750	4.40	115.8	6.3	682.2	579.3	11.362	13.381	118.3	1090.0	318.9	1.67	1.53
9	650	750	4.20	148.8	5.4	669.1	576.5	11.828	13.729	111.3	1090.0	305.3	1.67	1.61

HAUL NUMBER 1 T77.15 RUN ON 21-APR-78

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)
1	450	600	3.80	91.0	32.0	27.7	123.5	132.1	129.0	21.0	22.5	-12.4		12.0	
2	550	600	3.70	97.0	32.8	28.6	162.1	168.7	169.1	21.6	22.3	-16.8		12.2	
3	650	600	3.80	96.0	32.8	28.2	195.1	204.1	200.1	21.8	22.7	-15.6		16.3	
4	450	600	4.20	90.0	32.0	27.4	93.5	102.5	100.0	20.2	20.2	-2.2		19.5	
5	550	600	4.00	92.0	32.5	28.2	125.0	132.9	130.0	20.0	20.0	-8.5		17.6	
6	650	600	4.10	92.5	32.0	28.0	142.0	147.6	147.0	19.6	19.6	-8.5		18.6	
7	450	600	4.50	89.5	32.2	27.7	64.0	76.3	73.0	17.8	17.8	4.9		22.0	
8	550	600	4.30	88.0	32.0	27.6	96.0	104.7	99.0	18.5	18.5	0.7		22.4	
9	650	600	4.30	93.5	32.8	28.0	112.0	119.6	115.0	19.0	19.0	-1.4		19.8	

FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	450	600	3.80	4.22	4.84	9.06	8.54	1.05	0.09	6.71	0.79	0.93	0.34	0.51	0.42	0.04
2	550	600	3.70	4.43	4.68	9.11	8.53	1.08	0.34	6.63	0.79	0.92	0.40	0.53	0.38	0.12
3	650	600	3.80	4.64	4.84	9.48	8.85	0.93	0.16	6.84	0.74	0.87	0.39	0.54	0.37	0.09
4	450	600	4.20	5.06	5.27	10.33	9.94	0.99	0.35	8.20	0.93	1.05	0.45	0.57	0.66	0.21
5	550	600	4.00	5.27	5.09	10.36	9.90	1.20	0.63	8.18	0.88	1.02	0.47	0.58	0.51	0.16
6	650	600	4.10	5.85	5.16	11.01	10.54	1.55	1.35	8.61	0.89	1.01	0.54	0.58	0.51	0.31
7	450	600	4.50	5.27	6.08	11.35	11.07	1.17	0.11	9.31	1.03	1.20	0.47	0.67	1.10	0.36
8	550	600	4.30	5.54	6.08	11.62	11.26	1.30	0.53	9.38	0.96	1.10	0.48	0.65	0.72	0.19
9	650	600	4.30	5.75	5.81	11.56	11.19	0.75	0.27	9.30	0.91	1.03	0.56	0.66	0.85	0.45

DERIVED QUANTITIES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	450	600	3.80	130.6	1.2	671.7	622.9	9.988	10.770	134.5	830.0	219.7	1.45	0.98
2	550	600	3.70	170.2	3.7	708.0	637.4	9.367	10.406	133.3	836.0	213.5	1.55	1.09
3	650	600	3.80	201.3	0.5	714.6	639.7	9.571	10.691	132.0	840.0	227.6	1.31	0.93
4	450	600	4.20	100.8	2.0	646.0	553.1	12.691	14.822	115.8	990.0	282.4	1.30	0.97
5	550	600	4.00	130.8	1.1	649.7	563.7	12.589	14.529	112.0	1000.0	268.1	1.50	1.14
6	650	600	4.10	147.8	2.2	626.8	548.5	13.741	15.703	105.1	1000.0	292.6	1.68	1.55
7	450	600	4.50	73.8	2.9	572.8	492.8	16.256	18.897	100.6	1130.0	337.1	1.43	0.95
8	550	600	4.30	99.8	-1.3	591.7	510.3	15.848	18.378	97.2	1130.0	327.8	1.46	1.01
9	650	600	4.30	115.8	-0.8	622.9	531.7	14.936	17.495	101.8	1130.0	325.7	1.20	0.85

HAUL NUMBER 1 T77.16 RUN ON 21-APR-78

GEOMETRY

BL NO	WARP LENGTH (M)	BRIDLE HEIGHT (KGF)	SHIP SPEED (KN)	DOOR SPREAD (M)	WINGEND SPREAD (M)	HORIZ NET OPENING (M)	PORT DOOR DEPTH (M)	STBD DOOR DEPTH (M)	H/L CENTRE DEPTH (M)	WINGEND HEIGHT (M)	H/L HEIGHT (M)	PORT DOOR HEEL (DEG)	STBD DOOR HEEL (DEG)	PORT DOOR TILT (DEG)	STBD DOOR TILT (DEG)
1	450	750	3.60	88.1	31.0	29.1	162.0	162.2	163.1	23.3	24.5	-12.7		20.5	
2	550	750	3.70	98.0	44.0	31.0	195.7	196.2	197.1	24.5	24.8	-13.6		18.8	
3	650	750	3.40	92.4	44.2	30.0	255.9	259.3	255.1	26.0	26.7	-18.1		18.2	
4	450	750	4.10	89.9	44.5	30.6	140.0	141.7	138.0	24.0	24.6	-9.1		20.3	
5	550	750	4.20	98.6	44.5	31.0	164.9	169.4	166.1	23.0	23.0	-8.6		21.6	
6	650	750	4.15	95.3	43.0	30.0	195.7	199.8	194.1	23.0	23.4	-8.4		22.1	
7	450	750	4.45	89.9	39.0	22.2	110.4	118.1	113.5	20.0	19.7	-2.1		23.8	
8	550	750	4.45	95.7	42.5	22.8	150.5	150.5	150.1	21.5	21.5	-6.3		22.5	
9	650	750	4.50	101.5	44.3	23.6	170.9	170.9	174.0	23.6	21.3	-4.2		22.8	

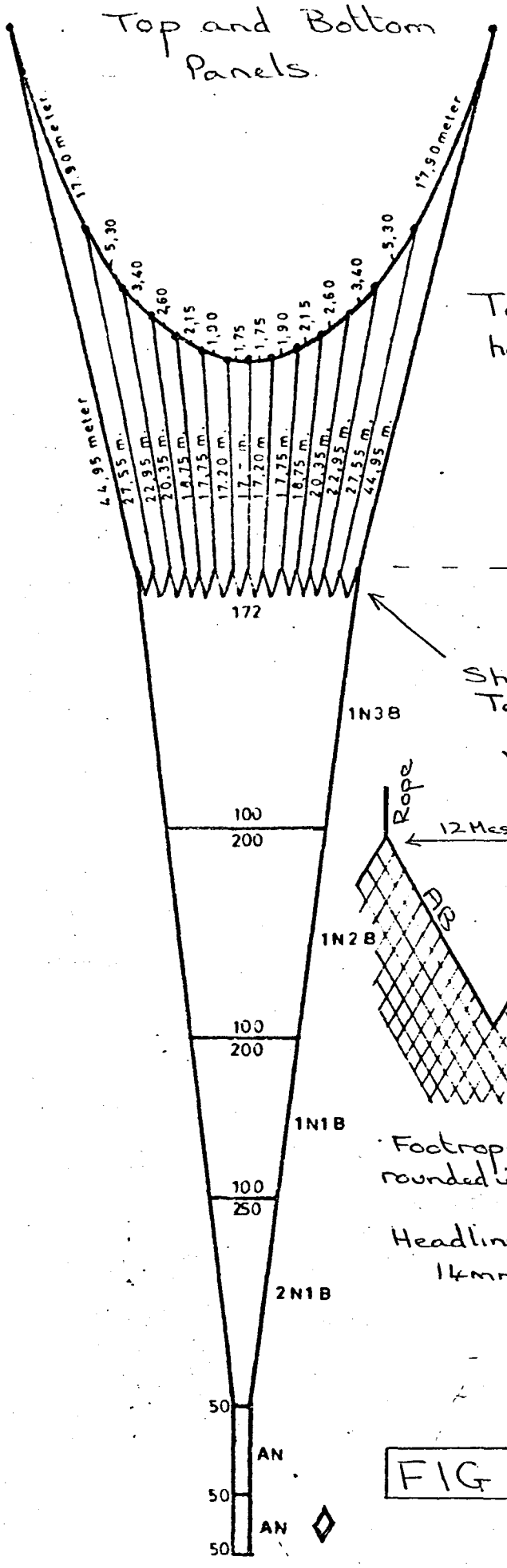
FORCES

BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	PORT WARP LOAD (TON)	STBD WARP LOAD (TON)	TOTAL WARP LOAD (TON)	GEAR DRAG (TON)	PORT DOOR DRAG (TON)	STBD DOOR DRAG (TON)	NET DRAG (TON)	DOOR SPREAD FORCE PORT (TON)	DOOR SPREAD FORCE STBD (TON)	SWEEP SPREAD FORCE PORT (TON)	SWEEP SPREAD FORCE STBD (TON)	DOOR LIFT FORCE PORT (TON)	DOOR LIFT FORCE STBD (TON)
1	450	750	3.60	4.01	4.50	8.51	7.83	0.05	0.19	6.72	0.88	0.87	0.41	0.41	-0.02	-0.06
2	550	750	3.70	3.80	4.63	8.43	7.76	0.40	0.16	6.44	0.84	0.83	0.36	0.38	0.03	-0.01
3	650	750	3.40	3.85	4.30	8.15	7.35	0.07	0.08	5.90	0.67	0.66	0.30	0.30	-0.00	-0.15
4	450	750	4.10	4.43	4.73	9.16	8.59	0.08	0.49	7.10	0.87	0.85	0.34	0.35	0.02	-0.13
5	550	750	4.20	4.43	4.95	9.38	8.81	0.31	0.36	7.38	0.94	0.94	0.42	0.43	0.17	-0.09
6	650	750	4.15	4.56	5.38	9.94	9.33	0.53	0.44	7.83	0.90	0.88	0.43	0.45	0.05	-0.21
7	450	750	4.45	4.85	5.92	10.77	10.29	1.05	0.99	8.48	1.05	1.05	0.45	0.47	0.25	-0.23
8	550	750	4.45	4.94	5.43	10.37	9.85	0.18	0.22	8.31	0.98	0.99	0.46	0.49	0.16	0.12
9	650	750	4.50	5.27	5.55	10.82	10.29	0.01	0.13	8.61	1.00	1.01	0.51	0.55	0.43	0.37

DERIVED QUANTITIES

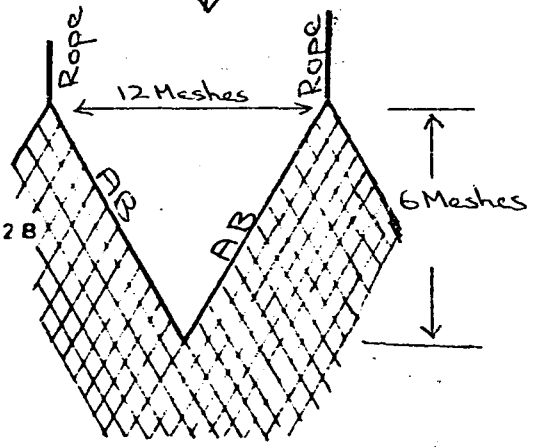
BL NO	WARP LENGTH (M)	BRIDLE WEIGHT (KGF)	SHIP SPEED (KN)	UPPER WINGEND DEPTH (M)	HEIGHT OF DOOR ABOVE H/L (M)	WINGEND MOUTH AREA (SQ.M)	H/L MOUTH AREA (SQ.M)	NET DRAG PER AREA (WINGEND) (KGF/SQ.M)	NET DRAG PER AREA (H/L) (KGF/SQ.M)	SWEPT VOLUME H/L PER TIME PER LOAD (CU.M/S/TON)	SHAFT HP	TOTAL GEAR HP	PORT DOOR NORMAL COEFF	STBD DOOR NORMAL COEFF
1	450	750	3.60	164.4	1.0	721.9	712.5	9.308	9.431	155.2	850.0	190.7	1.03	1.05
2	550	750	3.70	198.0	1.1	1077.5	768.4	5.976	8.380	173.6	850.0	194.3	1.03	0.93
3	650	750	3.40	257.2	-2.5	1148.6	860.5	5.139	6.859	184.8	845.0	169.2	0.88	0.90
4	450	750	4.10	139.1	-2.8	1067.5	752.3	6.652	9.440	173.3	990.0	238.4	0.79	0.90
5	550	750	4.20	166.8	-1.1	1023.0	712.7	7.215	10.356	164.3	995.0	250.5	0.87	0.87
6	650	750	4.15	195.0	-3.7	988.5	701.6	7.917	11.155	150.8	995.0	262.0	0.92	0.89
7	450	750	4.45	114.1	-0.7	779.6	437.1	10.881	19.409	92.9	1117.0	309.9	1.16	1.13
8	550	750	4.45	150.8	-0.4	913.3	489.9	9.095	16.955	108.2	1100.0	296.5	0.78	0.78
9	650	750	4.50	173.7	3.2	1044.8	502.4	8.238	17.133	107.6	1100.0	313.4	0.82	0.82

Top and Bottom Panels.



Total length of headline and footrope: 70 metres. ie. 38 fathoms.

Sharks Teeth



Footrope 20mm ϕ wire rounded with 24mm ϕ rope.

Headline and sidepanel lines 14mm ϕ wire

FIG 1

Meshes Deep	Mesh Size mm	Twine	Length m
			44,95
60	400	210/18	24.-
100	200	210/18	20.-
150	100	210/39	15.-
500	40	210/39	20.-
200	40	210/48	8.-
130	40	210/60	5,20
		Total	137,15

The ropes are made of polypropylene 12 mm ϕ Selvedges of 16mm ϕ Polyamide

Benaming: ROPE TRAWL FOR A 1000 – 1200 H.P. TRAWLER		Afgeleid van A4 263	
TECHNISCH VISSERIJONDERZOEK.	Schaal 1:500	Gecontroleerd	Formaat A4 — 734 b
	Getekend W Toet	Datum 12-4-1976	Rangschikmerk 76 A-05-07-70

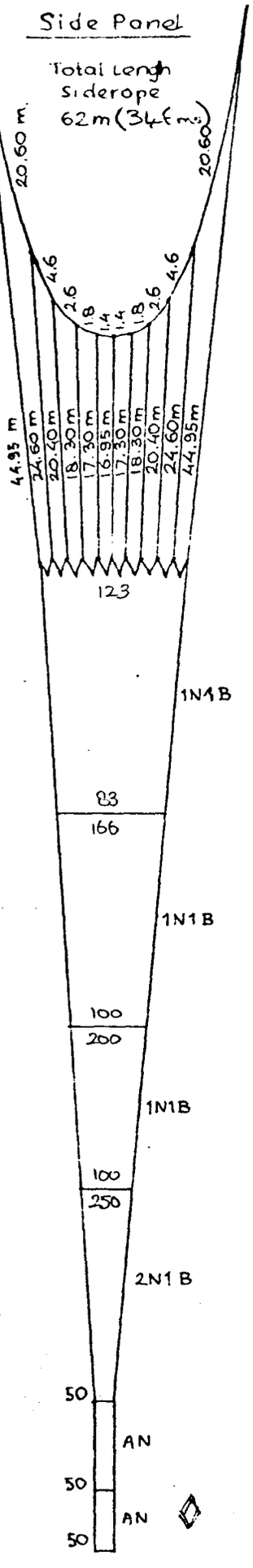
Upper- and lowerside

Total length
Headline and Footrope
70 m.

Same as nr. 734[a]

Side Panel

Total length
Siderope
62 m (34 fms)



Length in meshes	Mesh size in mm	Twine size	Nr. of mesh
	The ropes are made of polypropylene 12 mm ø The selvedges are made of polypropylene 16 mm ø.		44.
60	400	210/180	24.-
100	200	210/108	20.-
150	100	210/39	15.-
500	40	210/39	20.-
200	40	210/48	8.-
		210/60	5.20
		Total	137.15

Derived from A4/263

FIG 2

ROPE TRAWL FOR A 1000-1200 H.P. TRAWLER

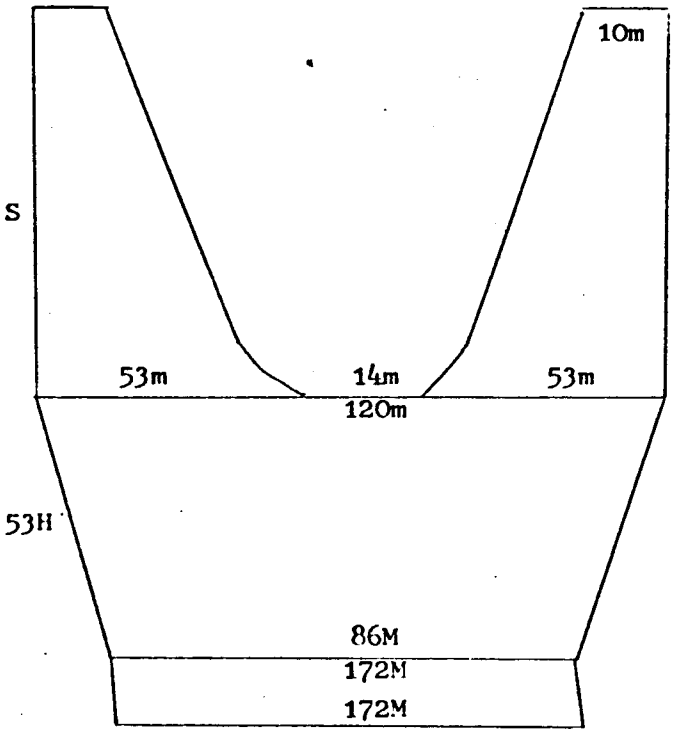
734[c]

TECHNICAL RESEARCH DEPARTMENT Scale 1:500

B. VAN MARLEN 19-10-1977

NET WITHOUT ROPES IN THE TOP PANEL

NETTING FORESECTIONS TO TOP PANEL



34 Meshes Deep
80 cms./32" mesh
210/240s twine

28 Meshes Deep
80 cms./32" mesh
210/240s
6 Meshes x 40 cms. x 210/180s

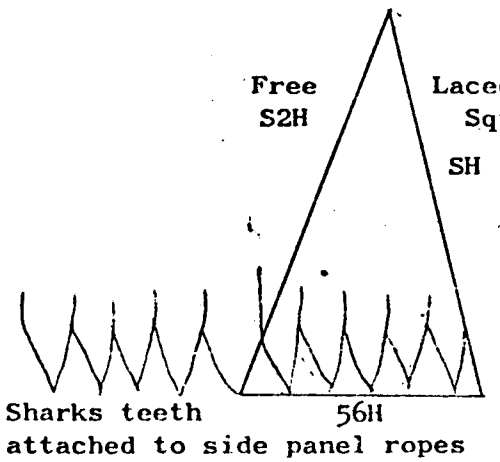
Cutting of inside edges to wings:-

60 x Halfers, 2 x (Pickup + 2 Halfers), 2 x (Pickup + Halfer), 2 x (2 Pickups + Halfer)

Headline 65.5m. (2 m extension + 23.1 (halfers) + 2m. (P2H) + 1.4m (P1H) + 2m (2P1H) + 4.5m bosom)

NETTING FORESECTIONS TO SIDE PANEL

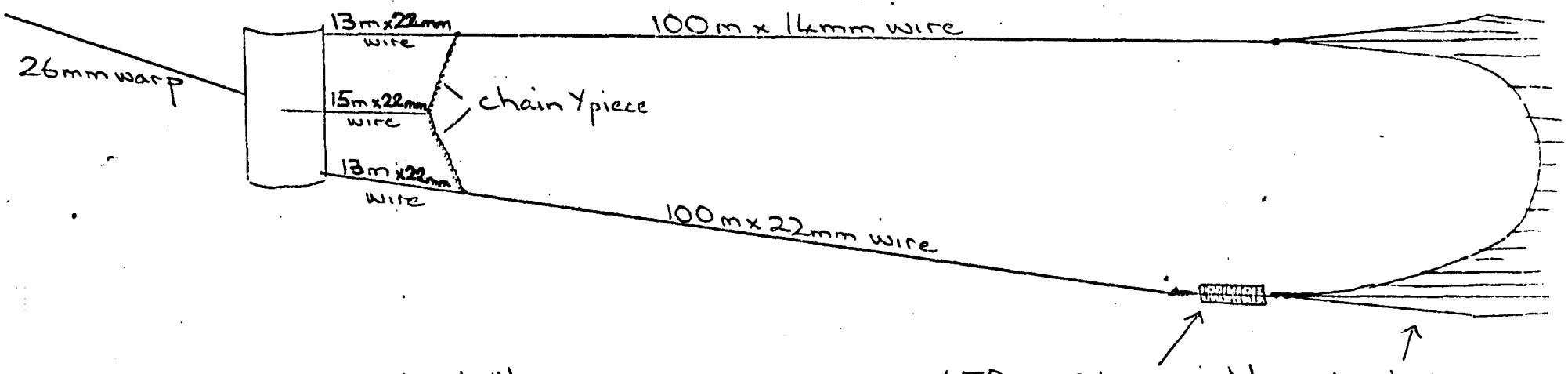
TO GIVE STRENGTHENING UNDER SQUARE



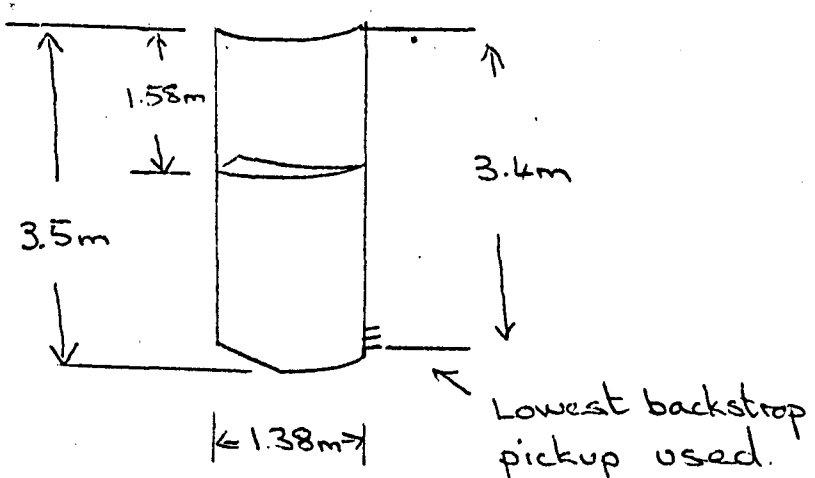
62 meshes deep
40 cms. mesh
210/180s twine

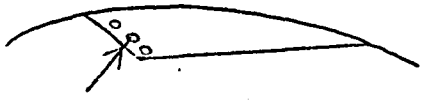
F I G 3

WIRES & WEIGHTS.



DOORS: 4.76 m^2 Süberkrübs.





Centre warp pickup point used.

T 164

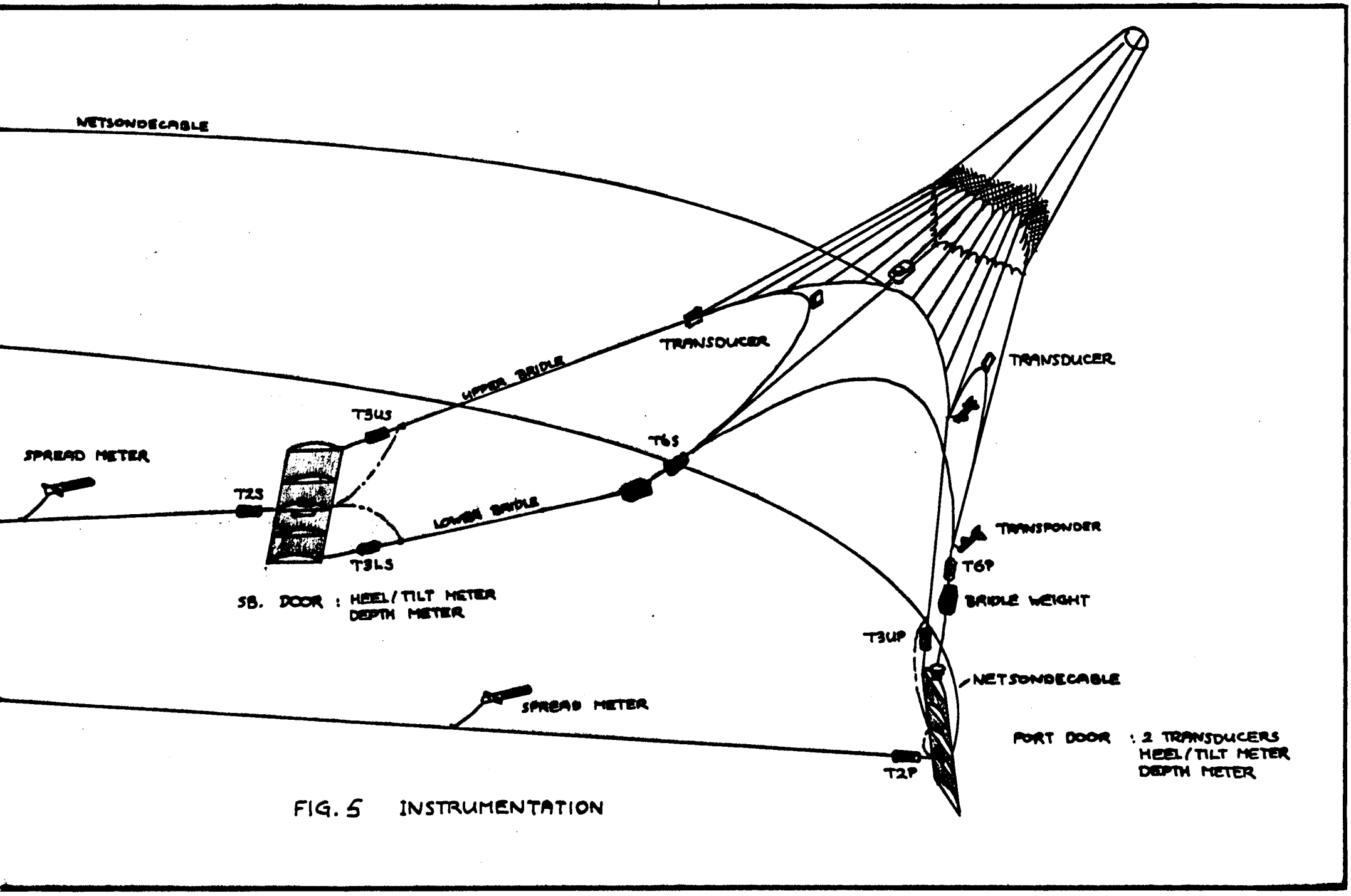


FIG. 5 INSTRUMENTATION

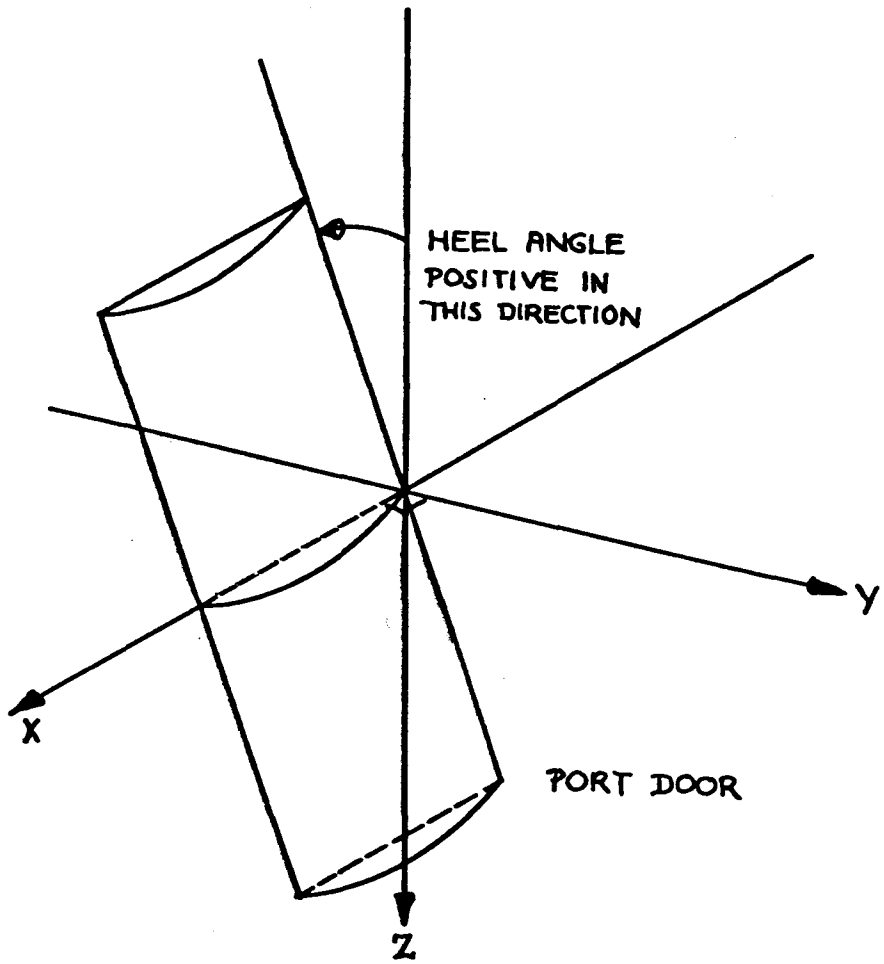
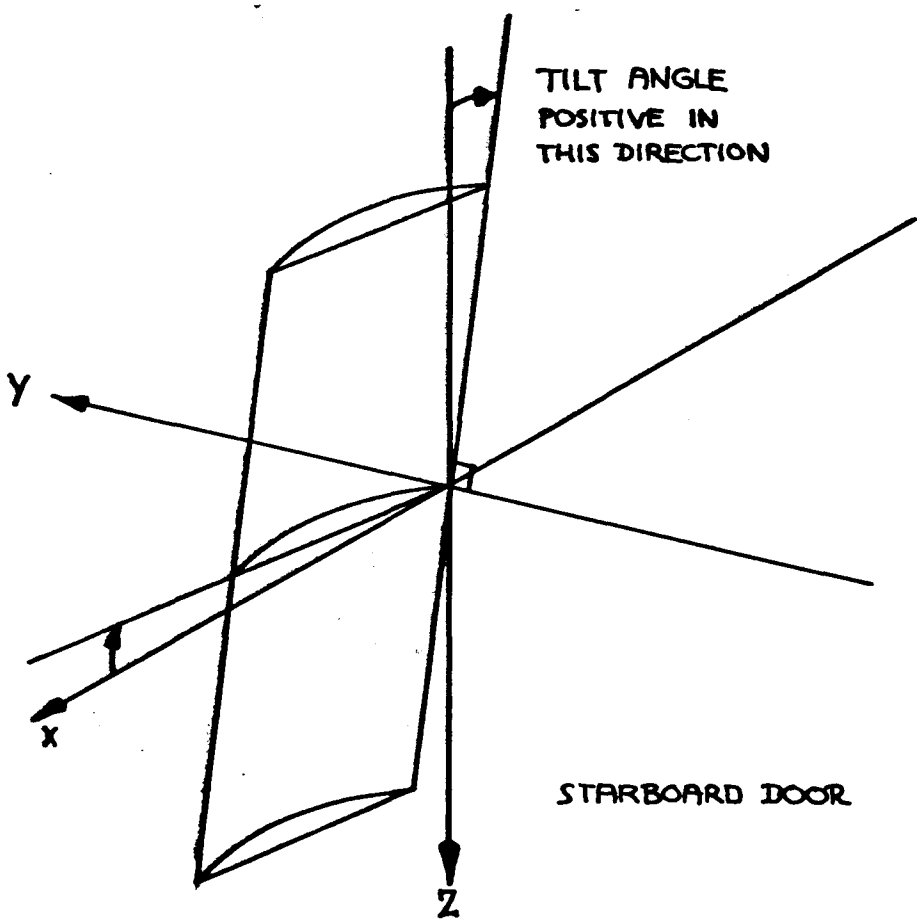


FIG. 5A : DEFINITION OF DOOR ORIENTATION ANGLES



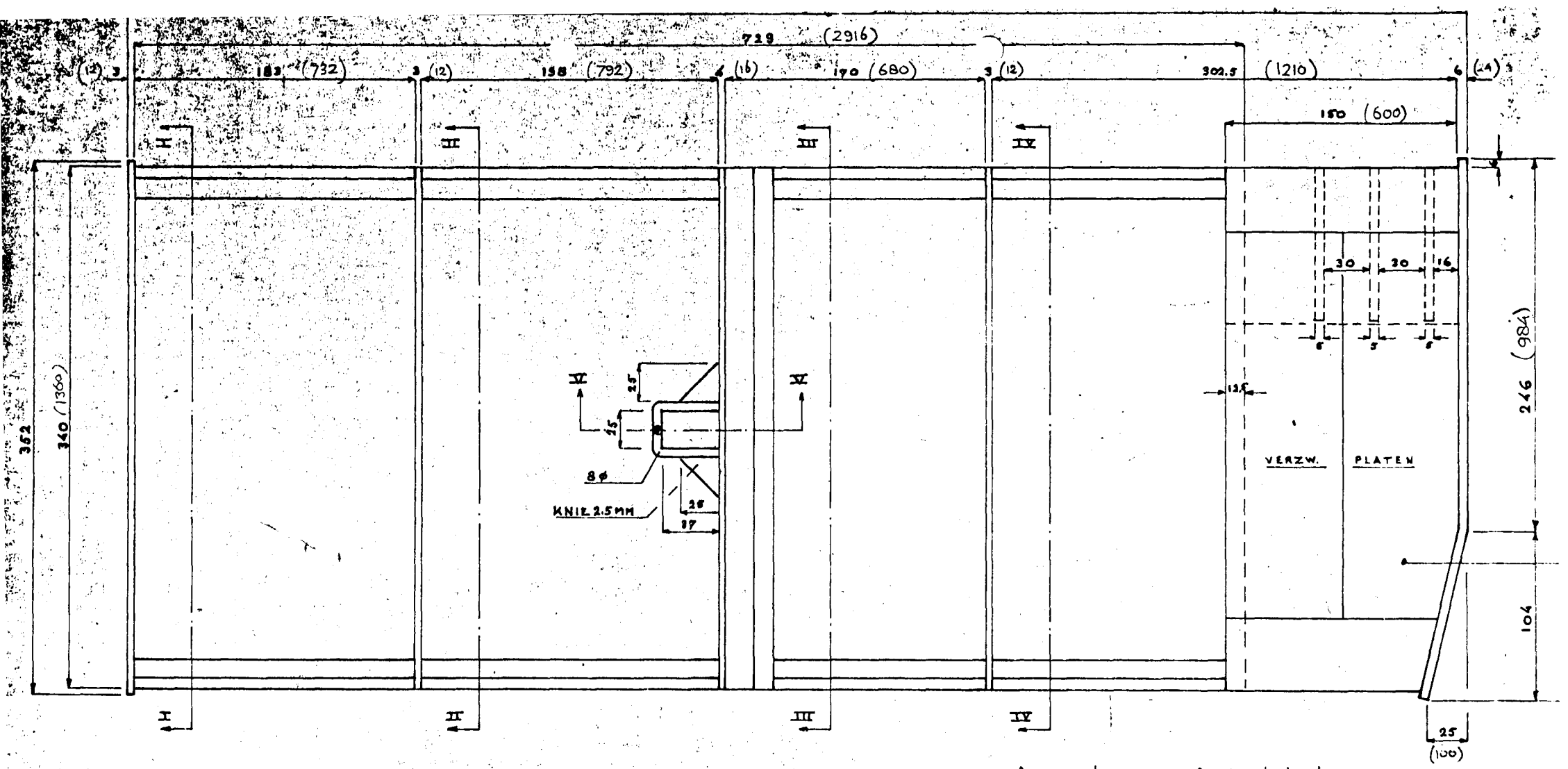
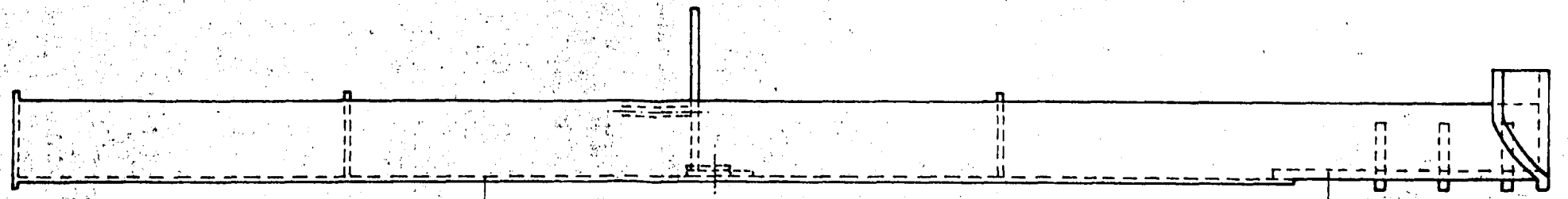


FIG. 6

BOVENAANZICHT
UPPER SIDE

{ measured weight of Suberknub doors
P.S : 820 kgf
S.S.: 810 kgf

(---) : full scale values



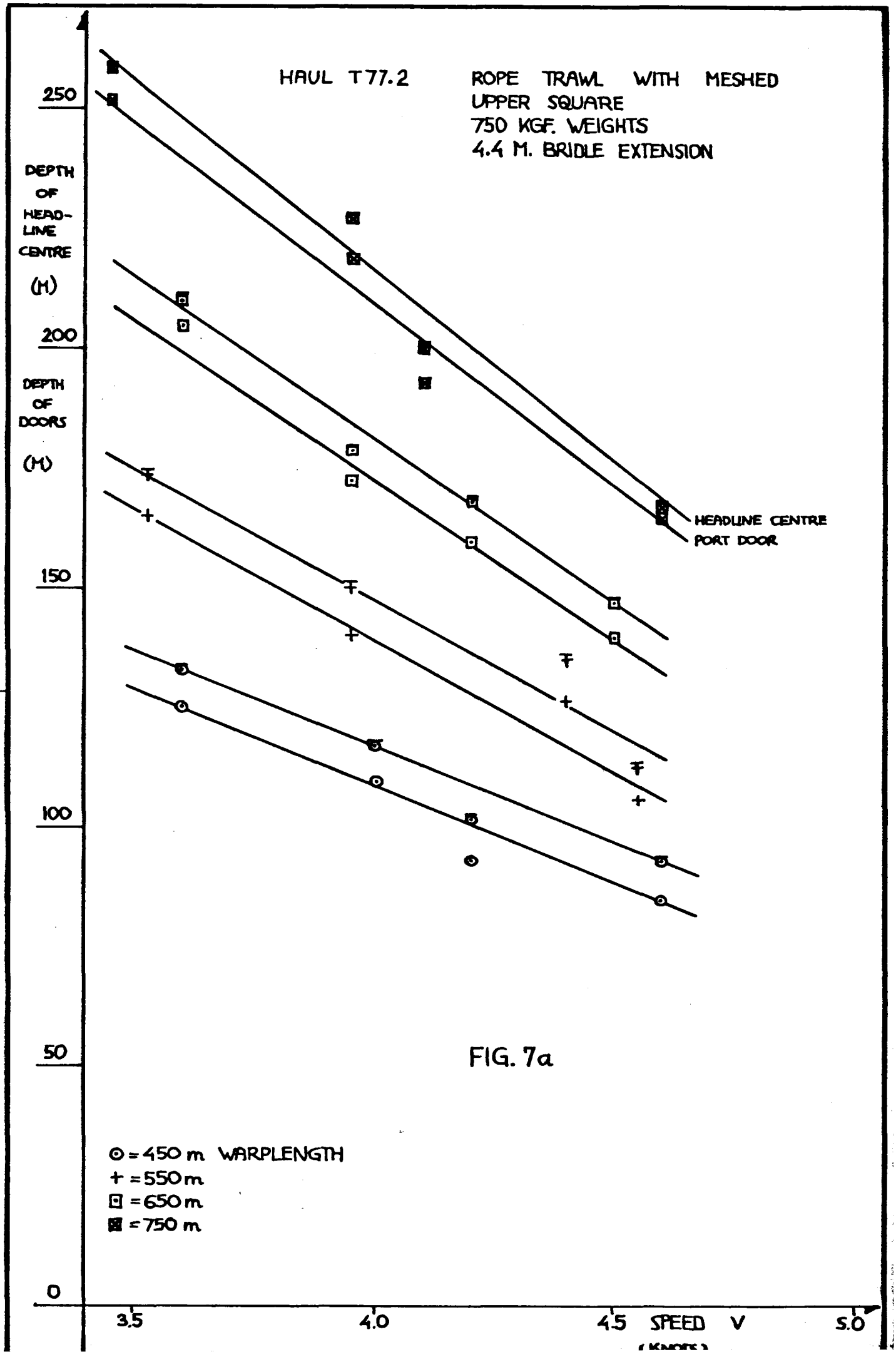
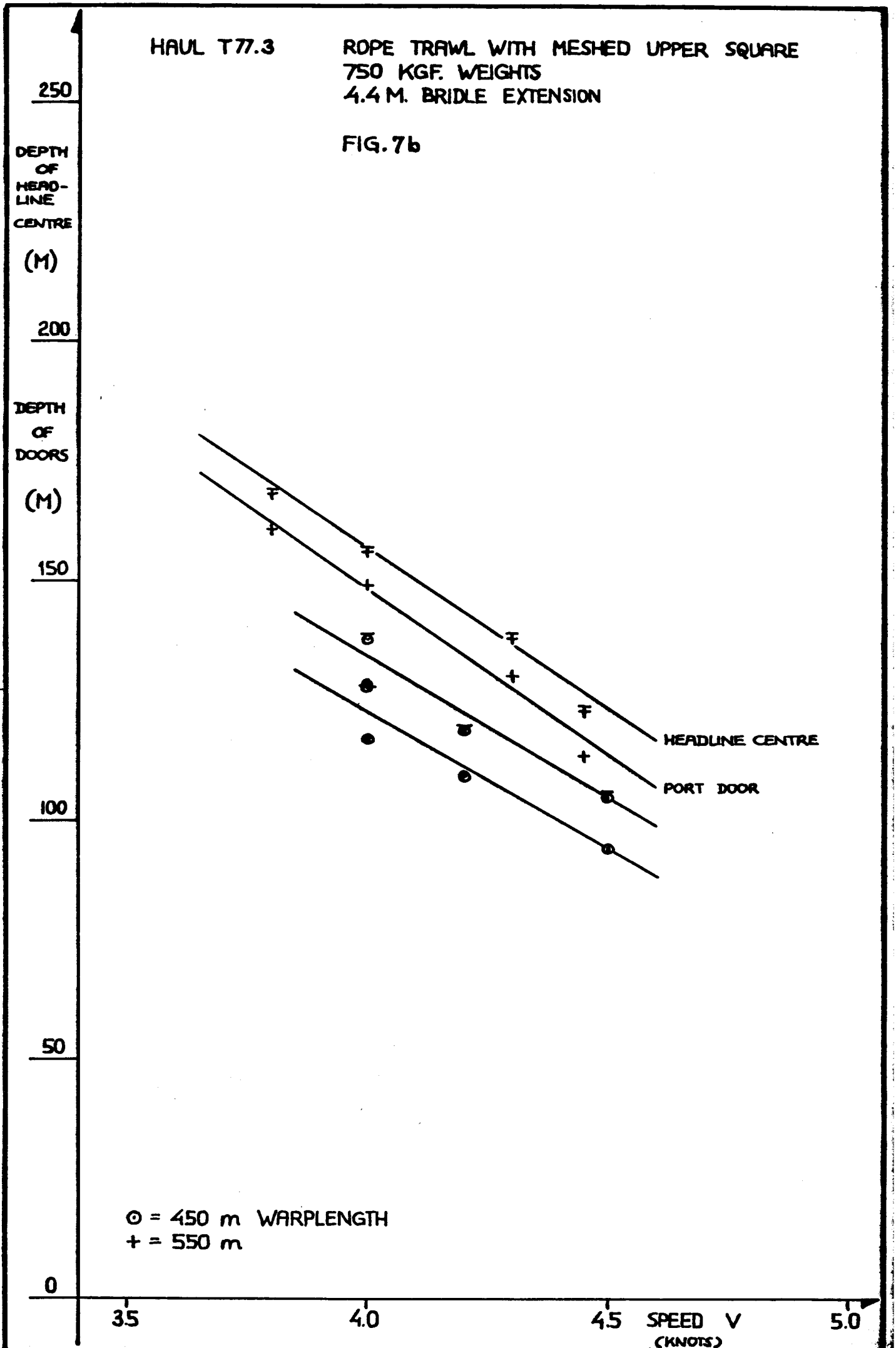

HAUL T77.2
ROPE TRAWL WITH MESHED UPPER SQUARE
750 KGF. WEIGHTS
4.4 M. BRIDLE EXTENSION
DEPTH OF HEAD-LINE CENTRE (M)
DEPTH OF DOORS (M)
250
200
150
100
50
0
HEADLINE CENTRE
PORT DOOR
⊙ = 450 m WARPLENGTH
+ = 550 m
⊡ = 650 m
▩ = 750 m
3.5
4.0
4.5
SPEED V (KNOTS)
5.0

FIG. 7a

HAUL T77.3

ROPE TRAWL WITH MESHED UPPER SQUARE
750 KGF. WEIGHTS
4.4 M. BRIDLE EXTENSION

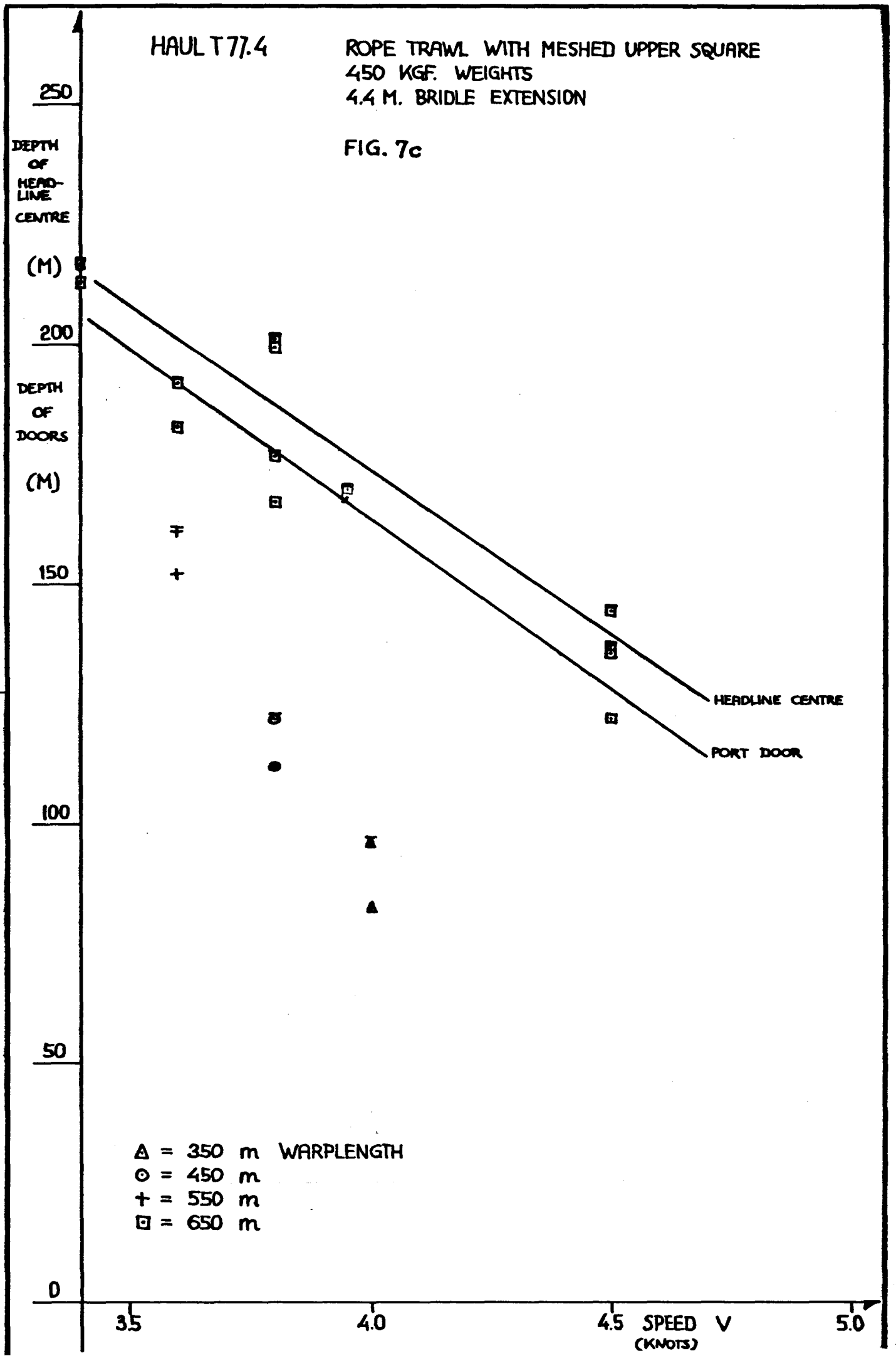
FIG. 7b



HAUL T77.4

ROPE TRAWL WITH MESHED UPPER SQUARE
450 KGF. WEIGHTS
4.4 M. BRIDLE EXTENSION

FIG. 7c



HAUL T 77.5 ROPE TRAWL WITH MESHED UPPER SQUARE
450 KGF. WEIGHTS
4.4 M. BRIDLE EXTENSION

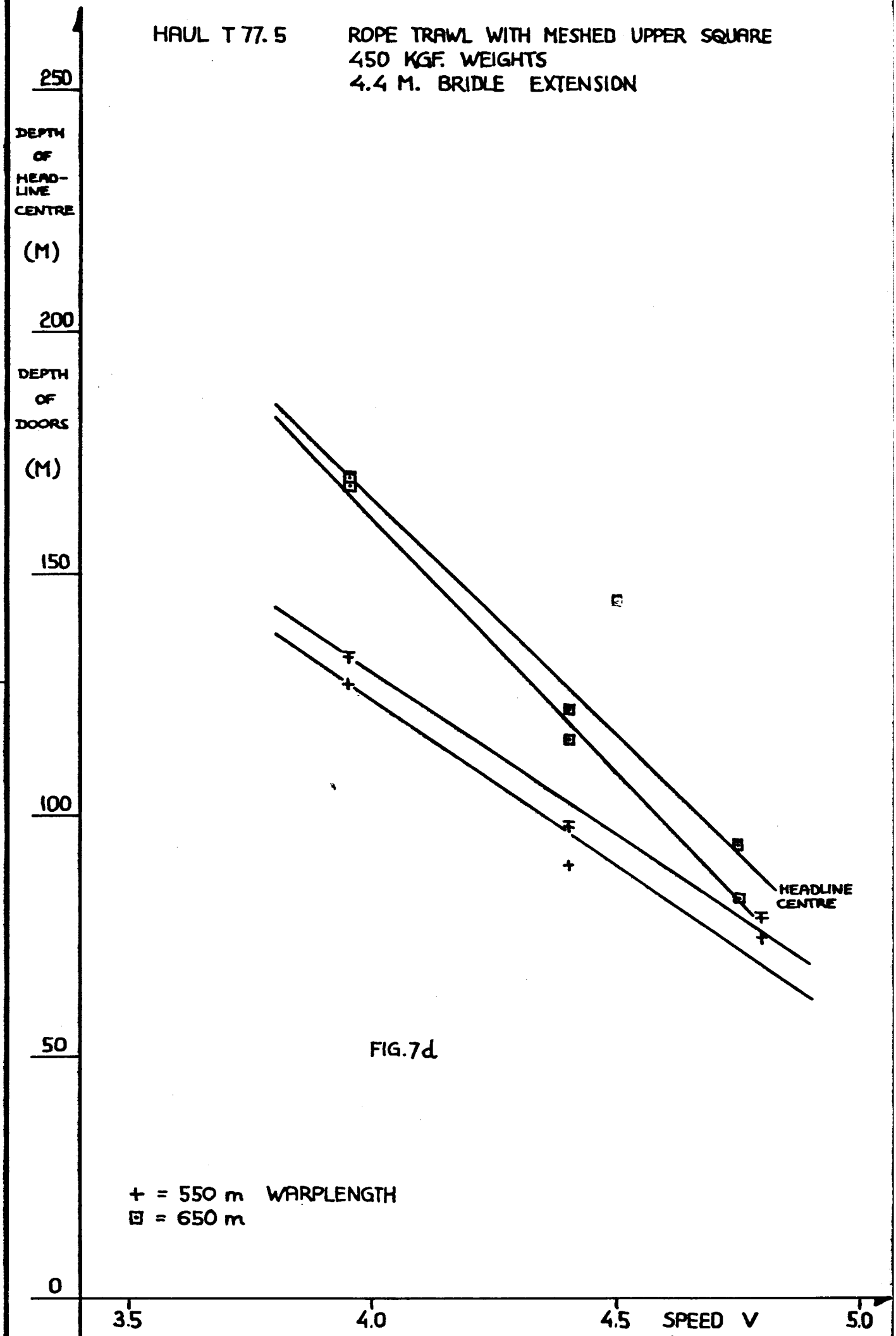


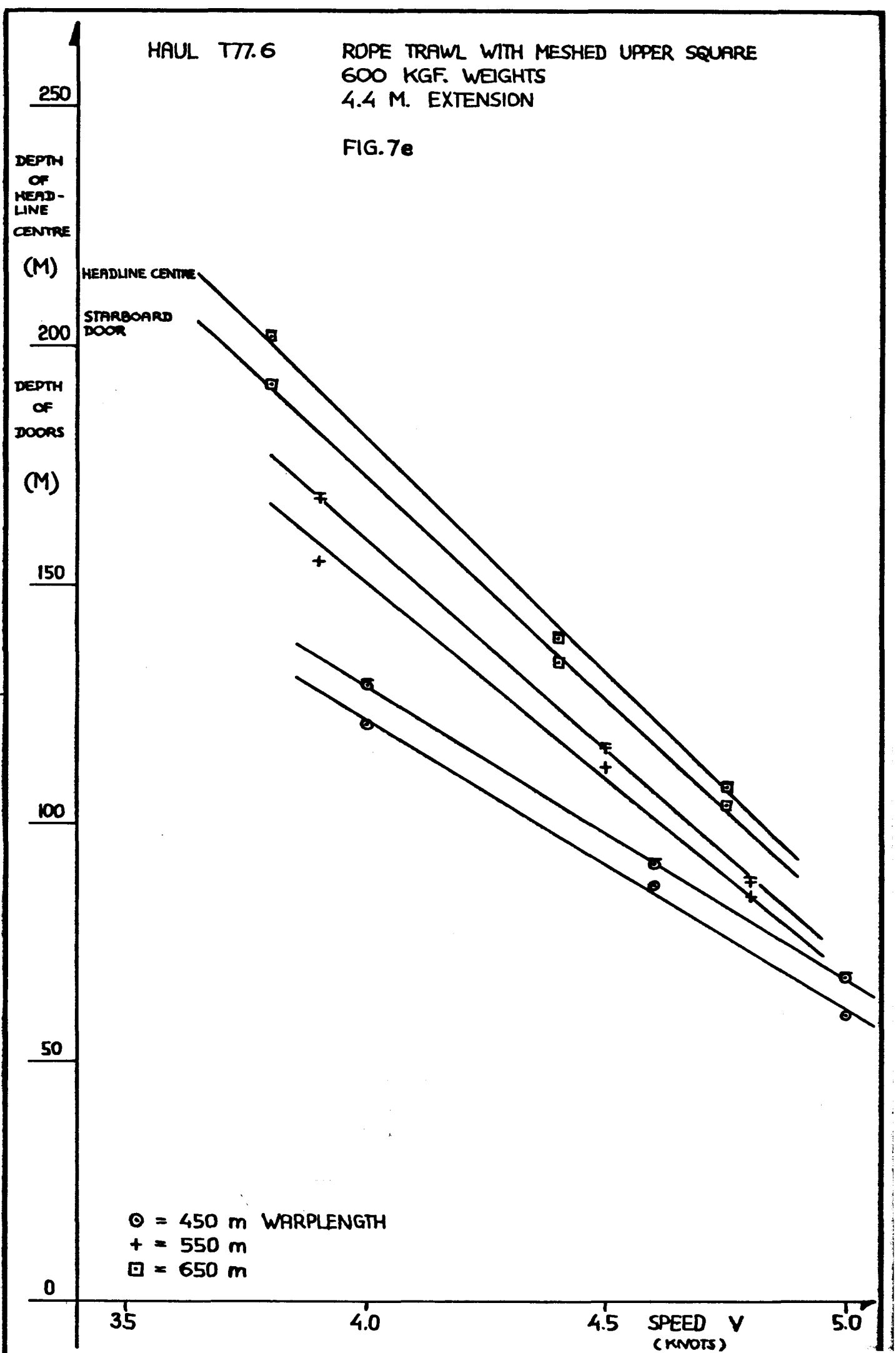
FIG. 7d

+ = 550 m WARPLENGTH
⊡ = 650 m

HAUL T77.6

ROPE TRAWL WITH MESHED UPPER SQUARE
600 KGF. WEIGHTS
4.4 M. EXTENSION

FIG. 7e



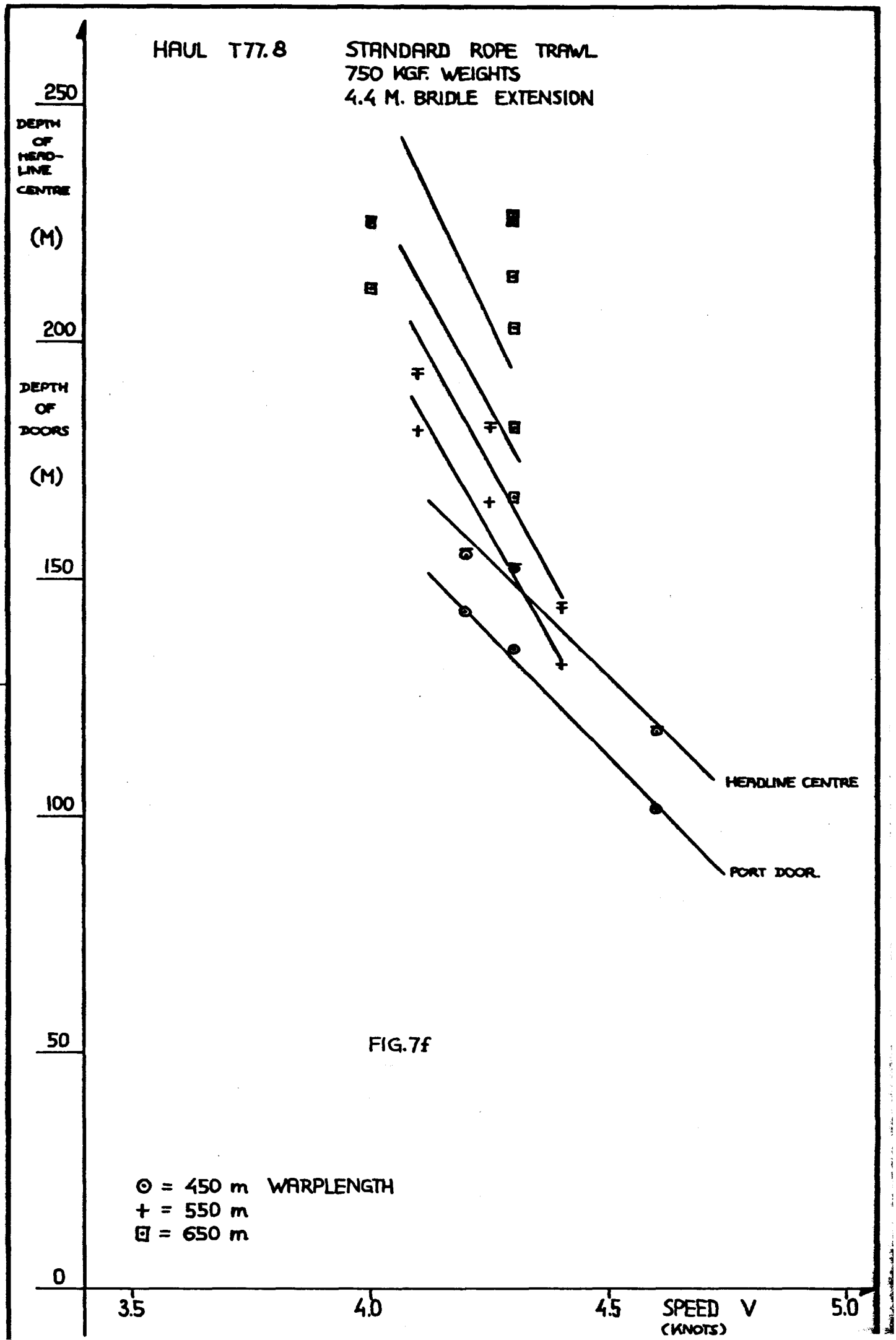

HAUL T77.8
STANDARD ROPE TRAWL
750 KGF. WEIGHTS
4.4 M. BRIDLE EXTENSION
250
DEPTH OF HEAD-LINE CENTRE (M)
200
DEPTH OF DOORS (M)
150
100
50
0
HEADLINE CENTRE
PORT DOOR
⊙ = 450 m WARPLENGTH
+ = 550 m
⊡ = 650 m
3.5
4.0
4.5
SPEED V (KNOTS)
5.0

FIG. 7f

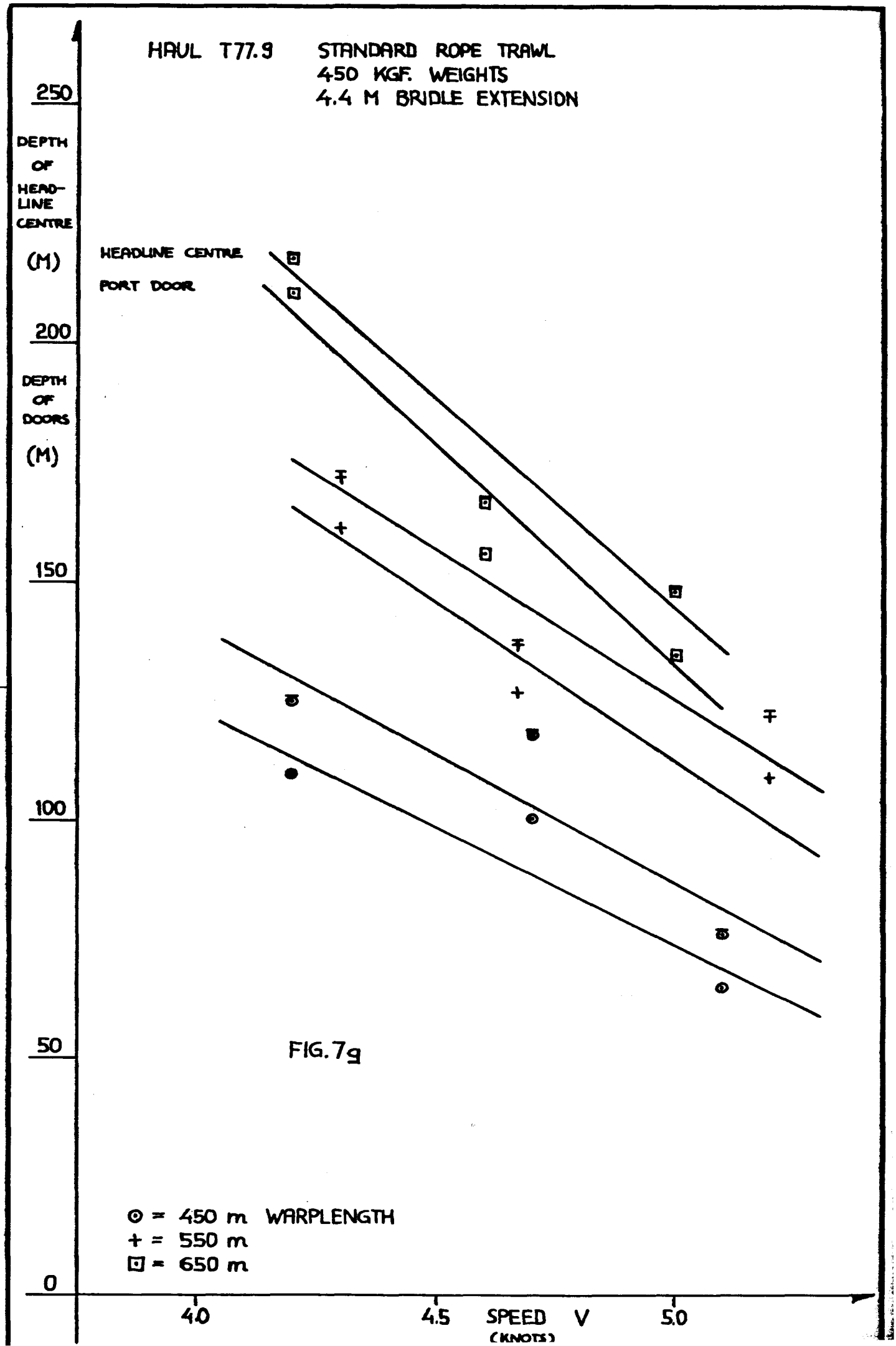
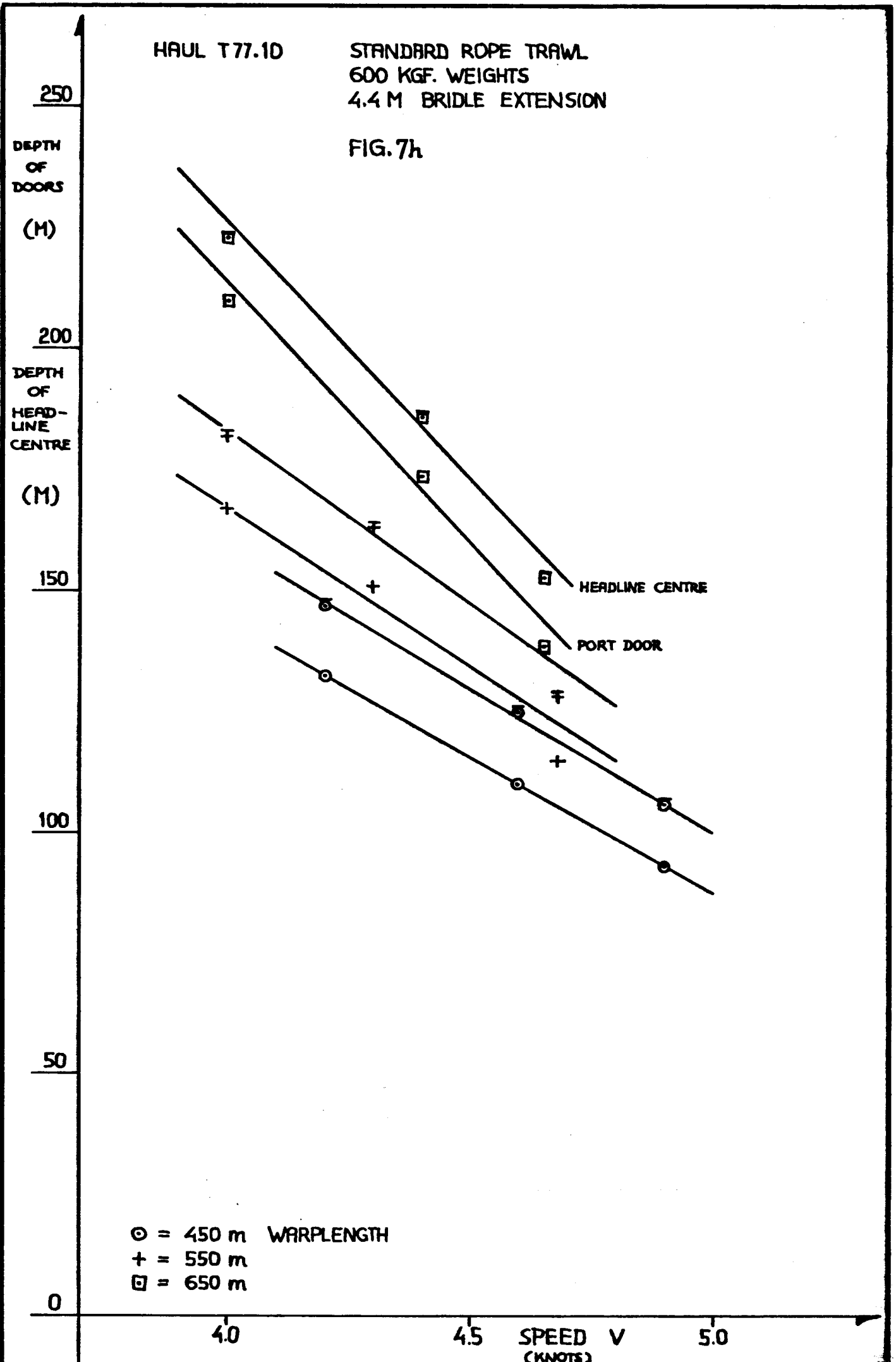

HAUL T77.9
STANDARD ROPE TRAWL
450 KGF. WEIGHTS
4.4 M BRIDLE EXTENSION
250
DEPTH OF HEAD-LINE CENTRE (M)
200
DEPTH OF DOORS (M)
150
100
50
0
HEADLINE CENTRE
PORT DOOR
⊙ = 450 m WARPLENGTH
+ = 550 m
⊡ = 650 m
4.0
4.5
SPEED V (KNOTS)
5.0

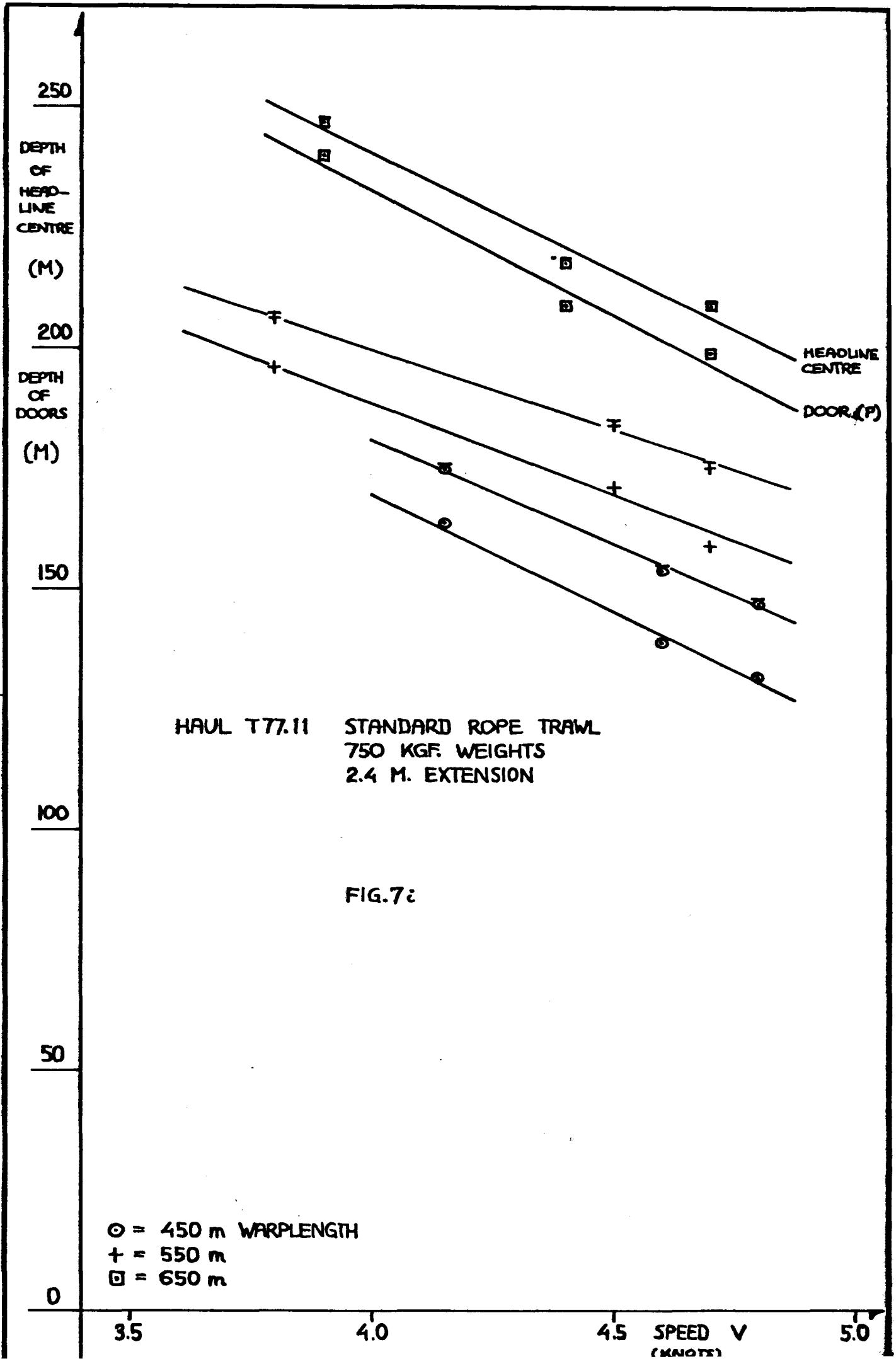
FIG. 7g

HAUL T77.1D

STANDARD ROPE TRAWL
600 KGF. WEIGHTS
4.4 M BRIDLE EXTENSION

FIG. 7h





HAUL T77.11 STANDARD ROPE TRAWL
750 KGF. WEIGHTS
2.4 M. EXTENSION

FIG. 7c

HAUL T77.12 ROPE TRAWL WITH FLOTATION
750 KGF. WEIGHTS
2.4 M. BRIDLE EXTENSION

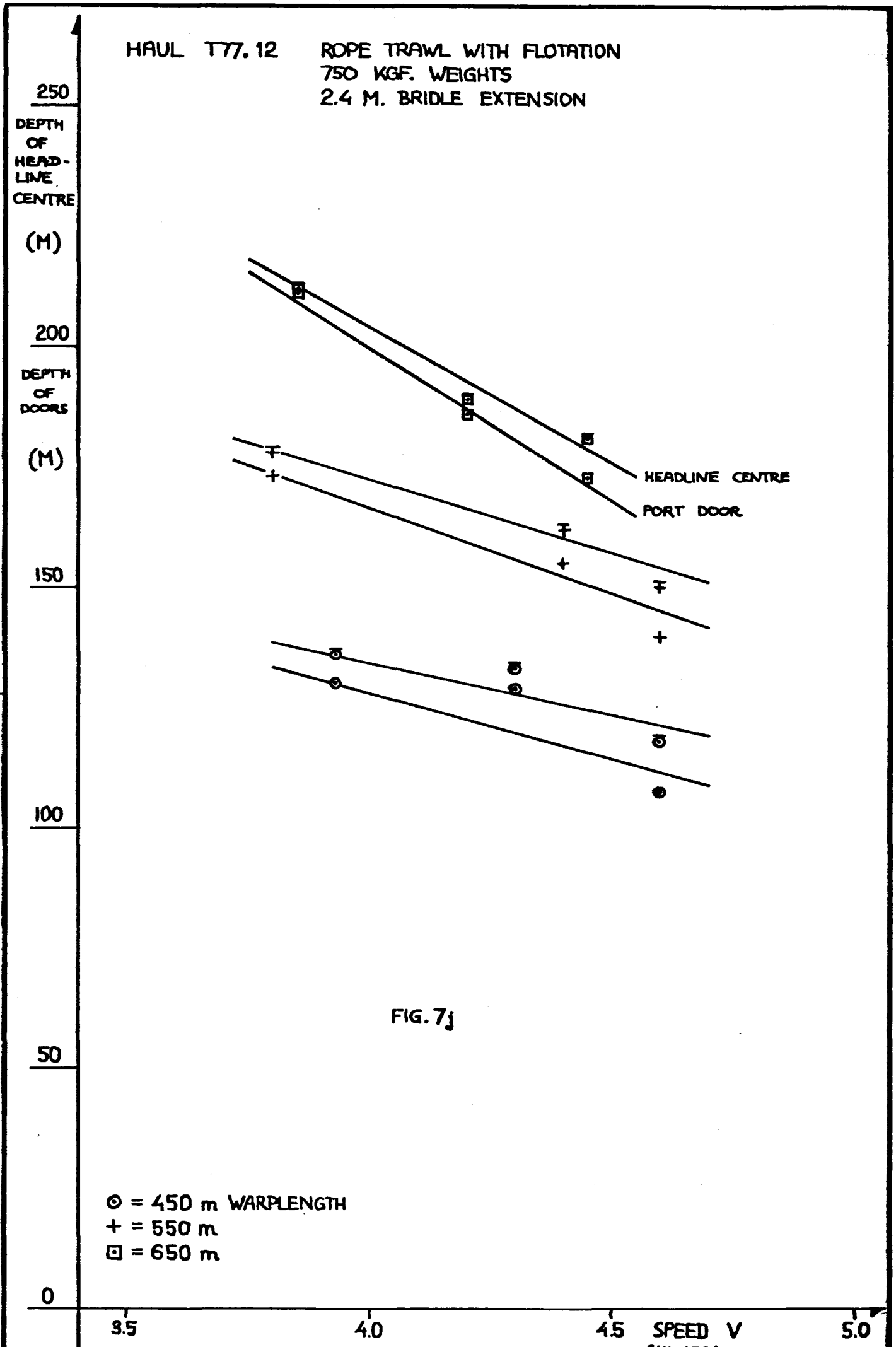


FIG. 7j

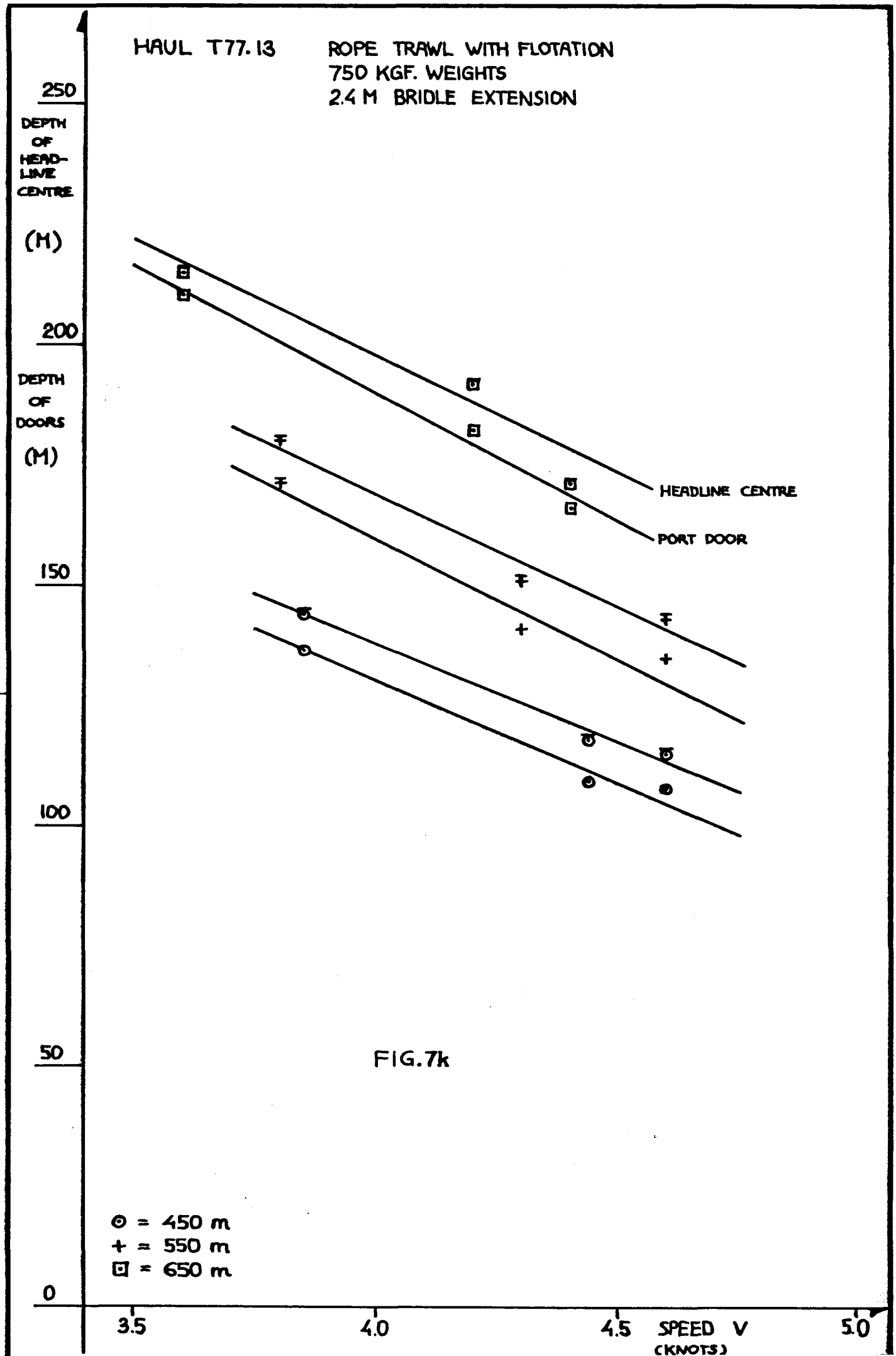

HAUL T77.13
ROPE TRAWL WITH FLOTATION
750 KGF. WEIGHTS
2.4 M BRIDLE EXTENSION
250
DEPTH OF HEAD-LINE CENTRE (M)
200
DEPTH OF DOORS (M)
150
100
50
0
HEADLINE CENTRE
PORT DOOR
⊙ = 450 m
+ = 550 m
⊡ = 650 m
3.5
4.0
4.5
5.0
SPEED V (KNOTS)

FIG. 7k

HAUL T77.14 ROPE TRAWL WITH FLOTATION
750 KGF. WEIGHTS
4.4 M. BRIDLE EXTENSION

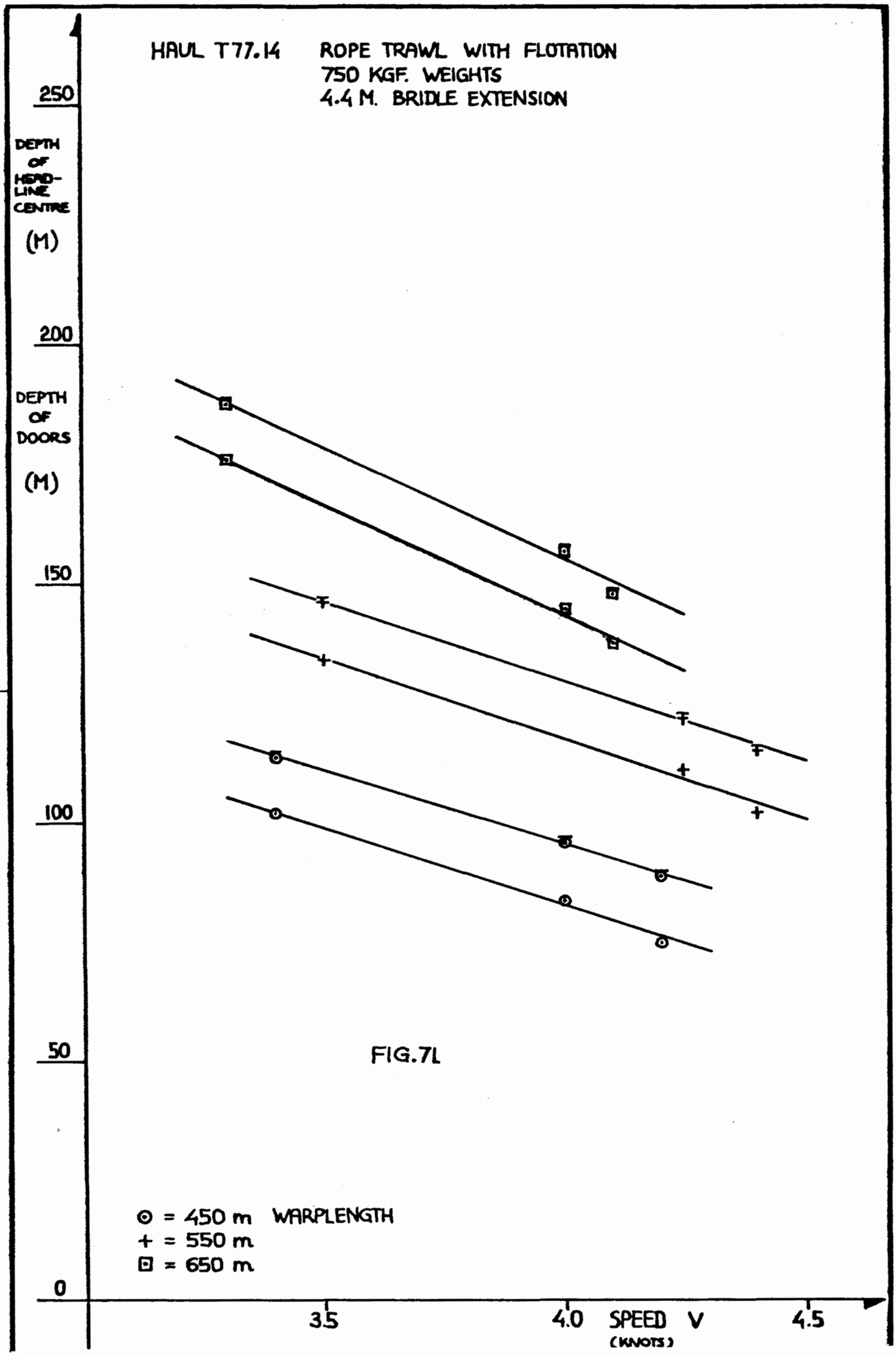


FIG.7L

HAUL T77.15 ROPE TRAWL WITH FLOTATION
600 KGF. WEIGHTS
4.4 M. EXTENSION

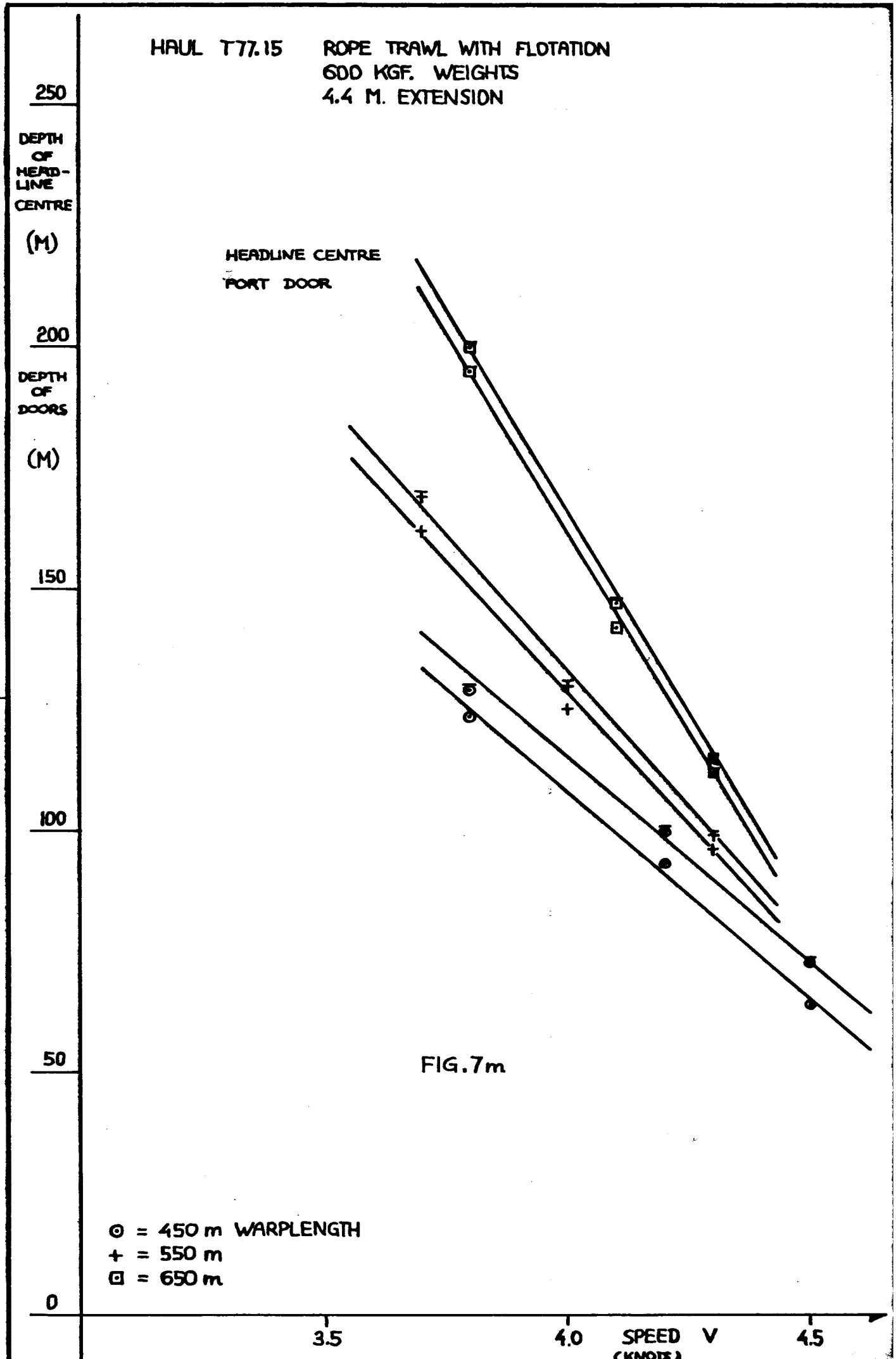
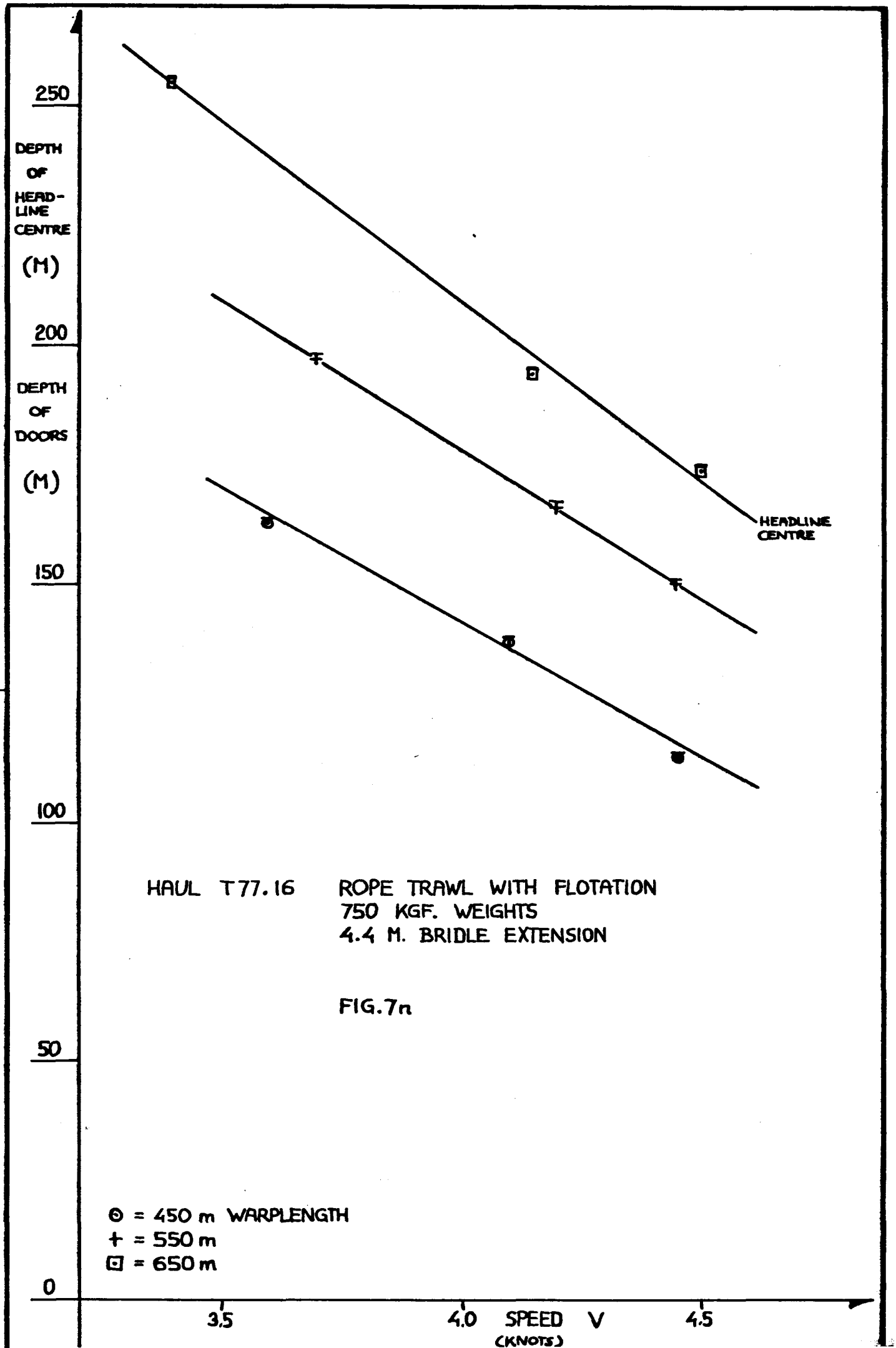


FIG.7m

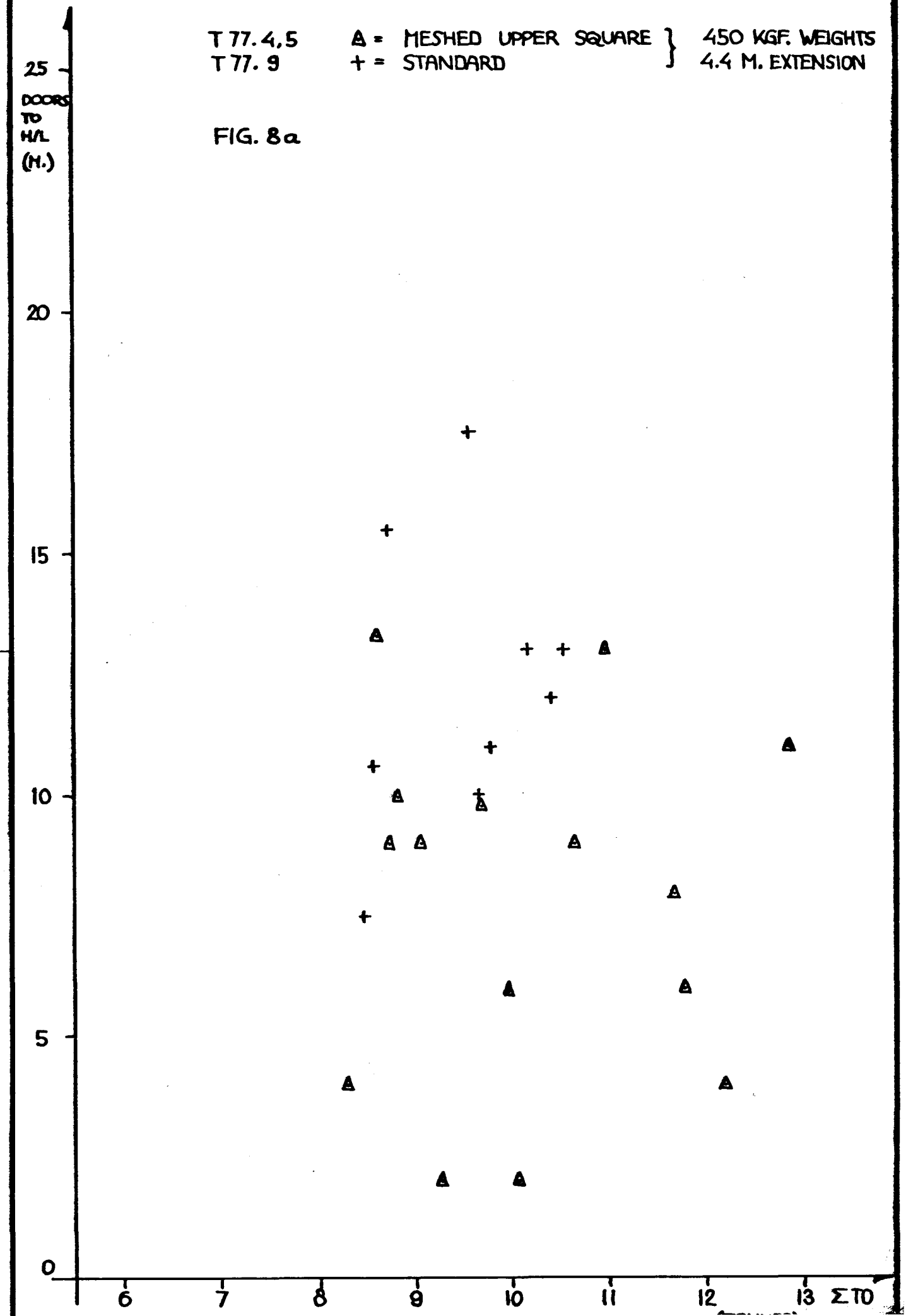


HAUL T77.16 ROPE TRAWL WITH FLOTATION
750 KGF. WEIGHTS
4.4 M. BRIDLE EXTENSION

FIG.7n

T 77.4,5 Δ = MESHED UPPER SQUARE } 450 KGF. WEIGHTS
T 77.9 + = STANDARD } 4.4 M. EXTENSION

FIG. 8a



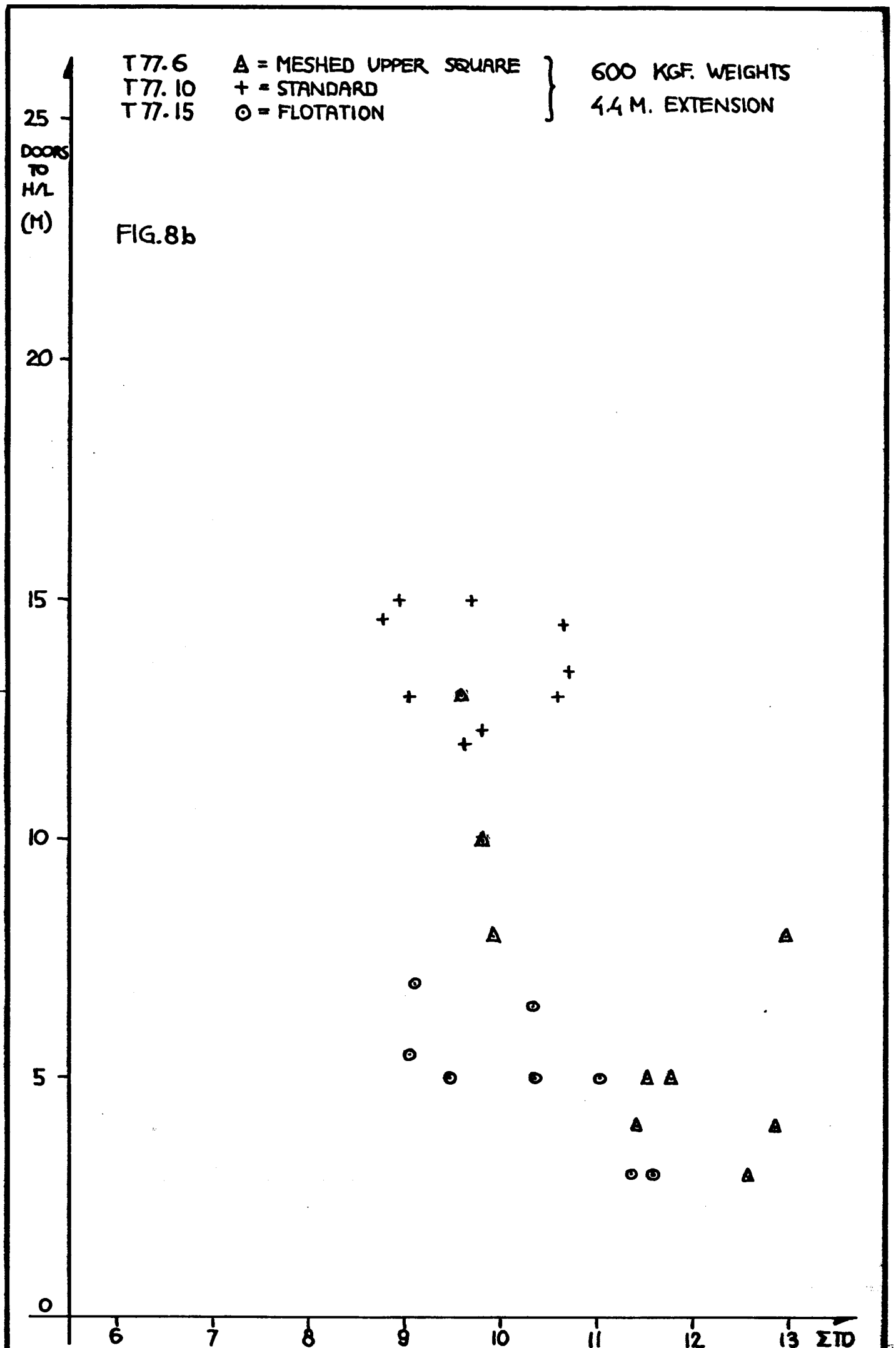

T 77.6 Δ = MESHED UPPER SQUARE
T 77.10 + = STANDARD
T 77.15 ⊙ = FLOTATION
600 KGF. WEIGHTS
4.4 M. EXTENSION
25
DOORS TO H/L (M)
20
15
10
5
0
6
7
8
9
10
11
12
13
ΣTD

FIG. 8b

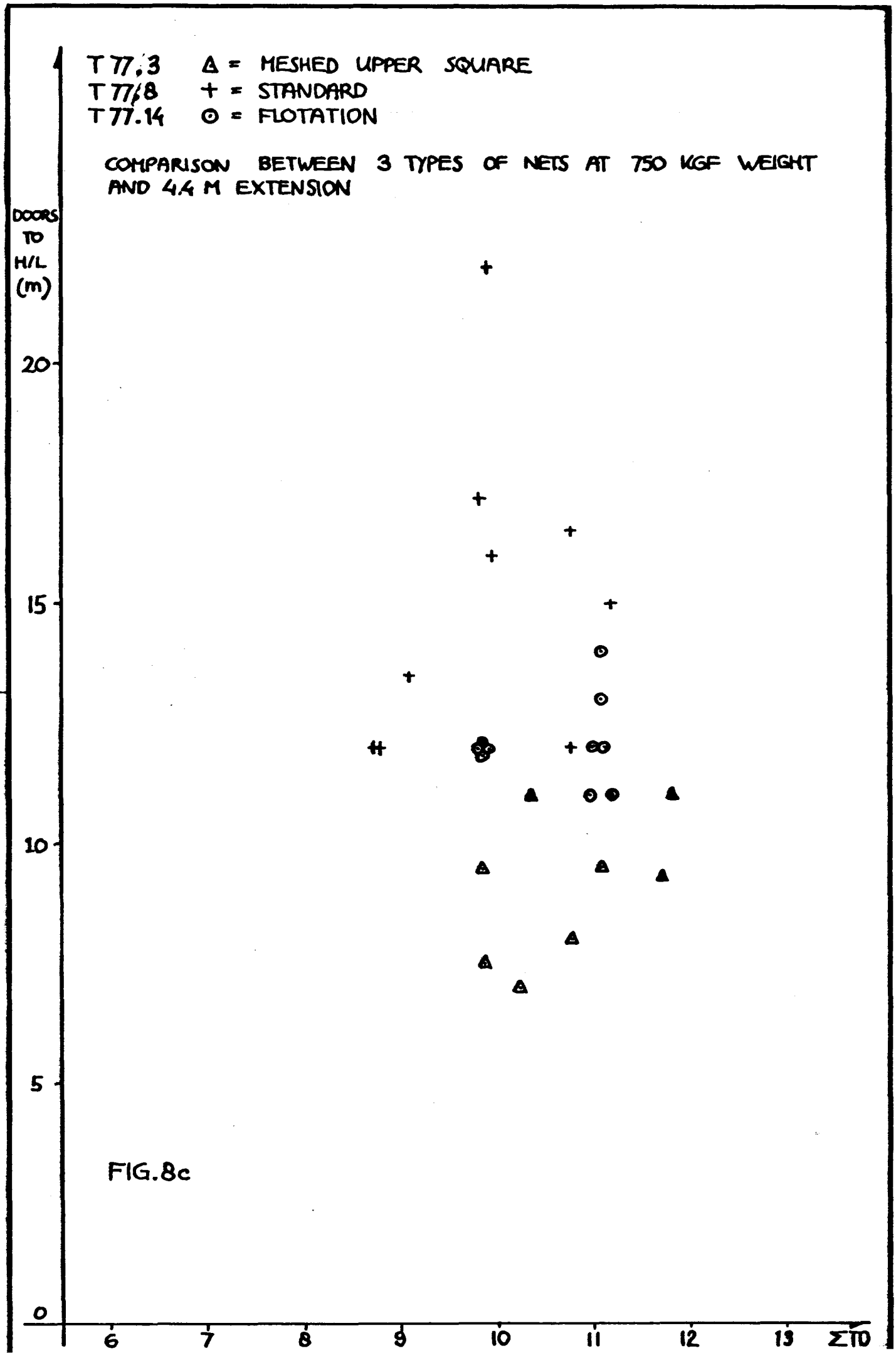

T 77.3 Δ = MESHED UPPER SQUARE
T 77.8 + = STANDARD
T 77.14 ⊙ = FLOTATION
COMPARISON BETWEEN 3 TYPES OF NETS AT 750 KGF WEIGHT AND 4.4 M EXTENSION
DOORS TO H/L (m)
20
15
10
5
0
6
7
8
9
10
11
12
13
ΣTD

FIG.8c

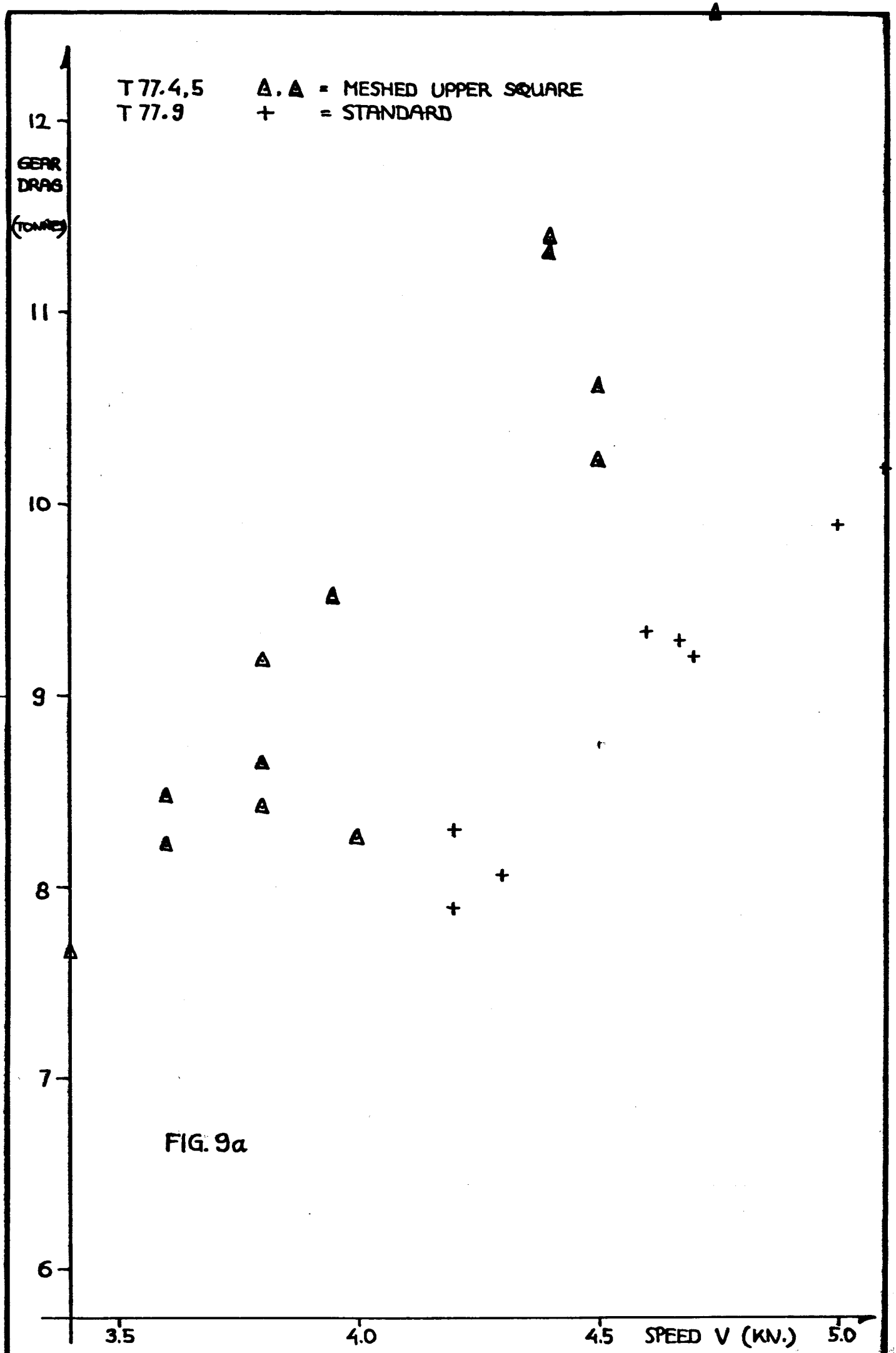
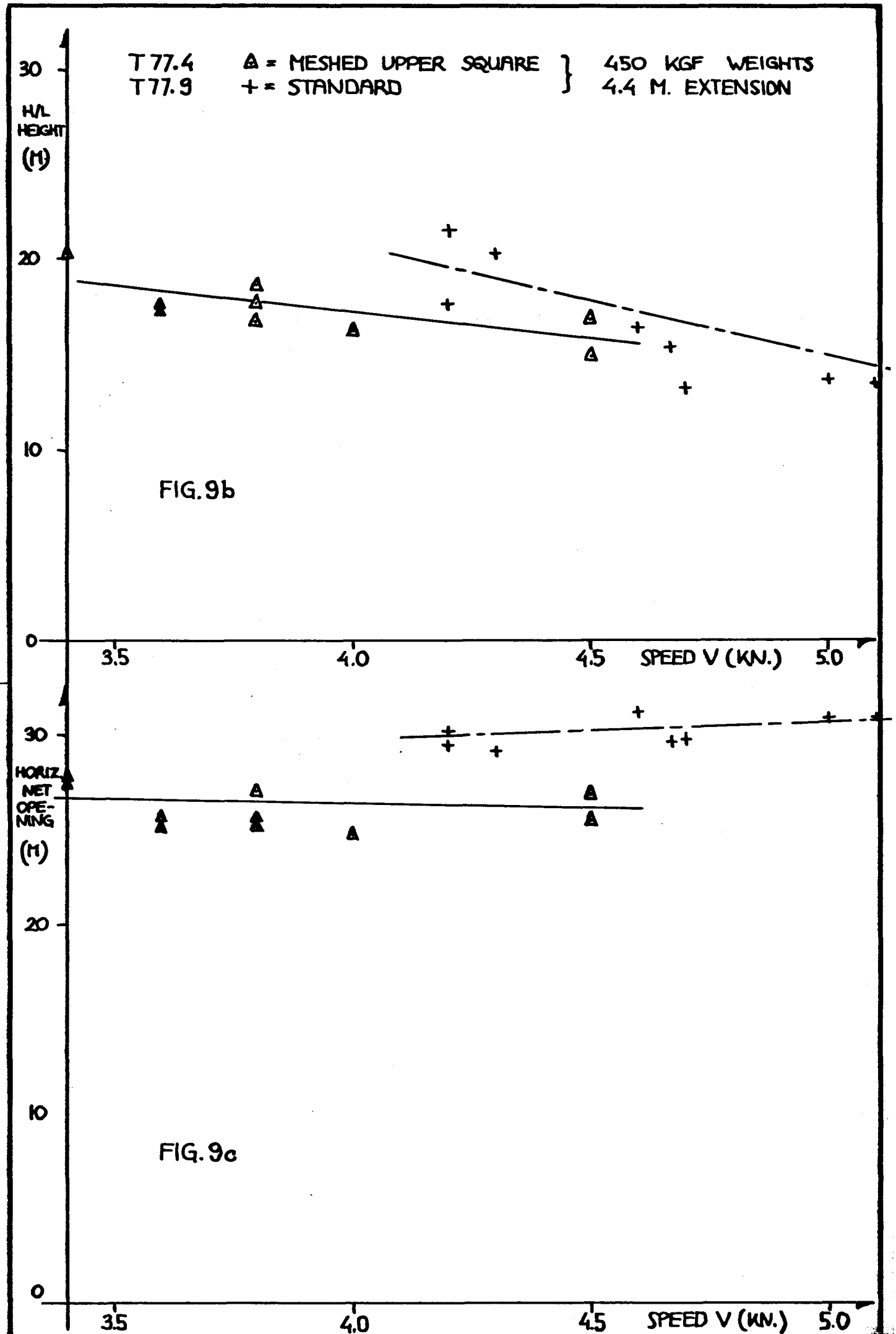
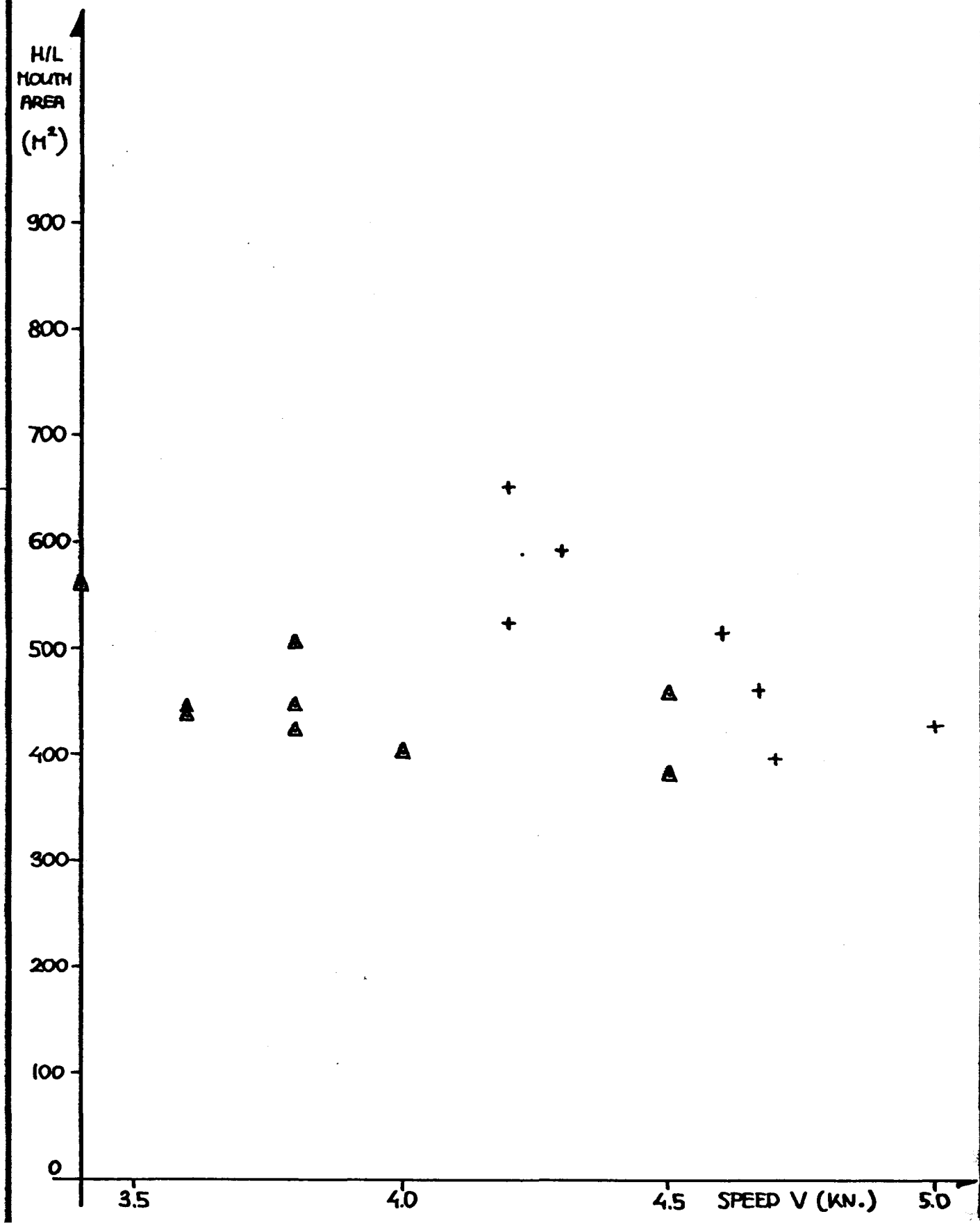

T 77.4,5 Δ.Δ = MESHED UPPER SQUARE
T 77.9 + = STANDARD
GEAR DRAG (TONNES)
12
11
10
9
8
7
6
3.5
4.0
4.5
SPEED V (KN.)
5.0

FIG. 9a


T 77.4 Δ = MESHED UPPER SQUARE } 450 KGF WEIGHTS
T 77.9 + = STANDARD } 4.4 M. EXTENSION
30
H/L HEIGHT (M)
20
10
0
3.5
4.0
4.5
SPEED V (KN.)
5.0
FIG. 9b
30
HORIZ NET OPE-NING (M)
20
10
0
3.5
4.0
4.5
SPEED V (KN.)
5.0
FIG. 9c

T 77.4 Δ = MESHED UPPER SQUARE } 450 KGF. WEIGHTS
T 77.9 + = STANDARD } 4.4 M EXTENSION

FIG.9d



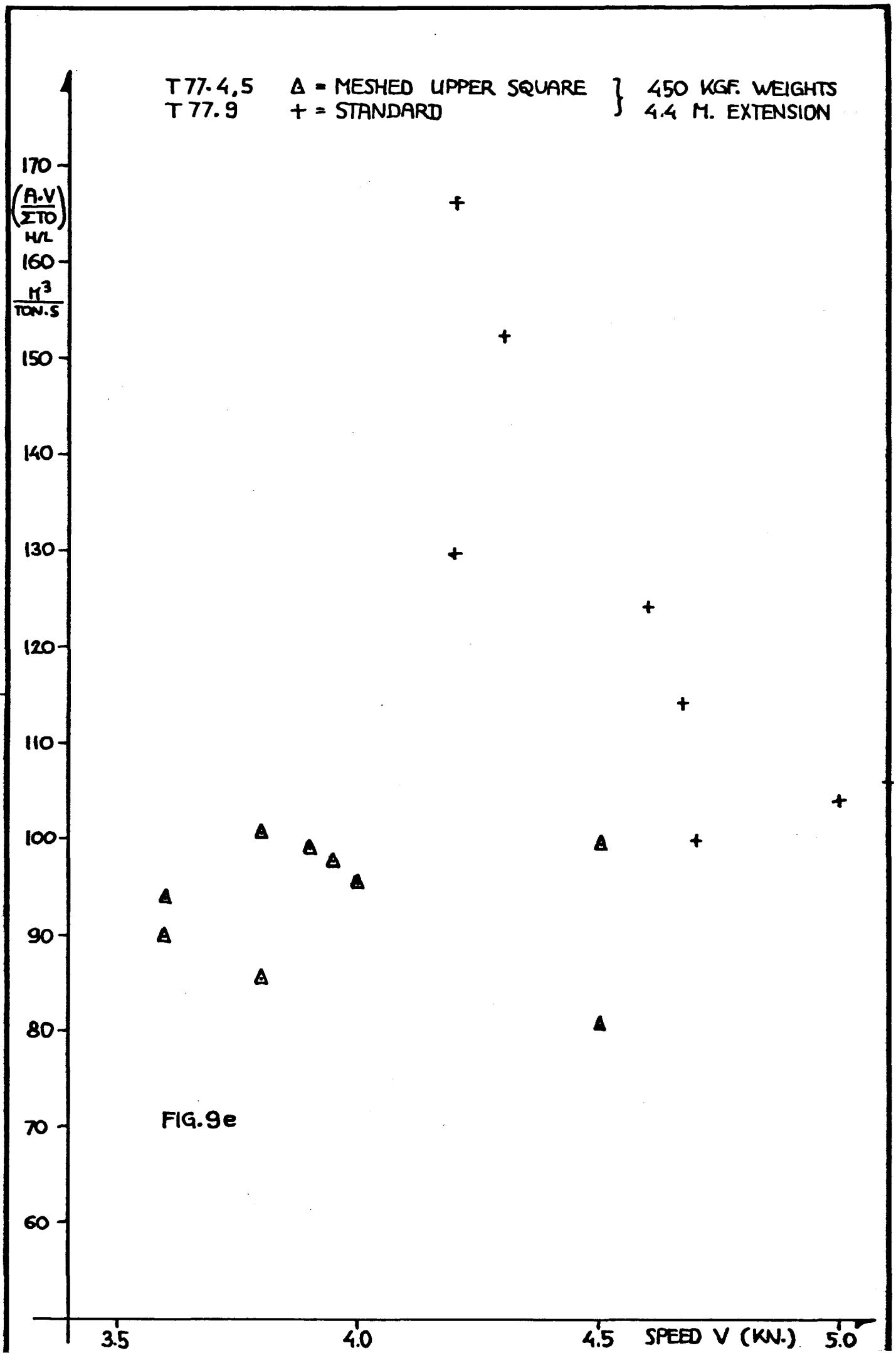

T 77.4,5 Δ = MESHED UPPER SQUARE } 450 KGF. WEIGHTS
T 77.9 + = STANDARD } 4.4 M. EXTENSION
170
(A.V/ΣTO) H/L
160
M³/TON.S
150
140
130
120
110
100
90
80
70
60
3.5
4.0
4.5
SPEED V (KN.)
5.0

FIG.9e

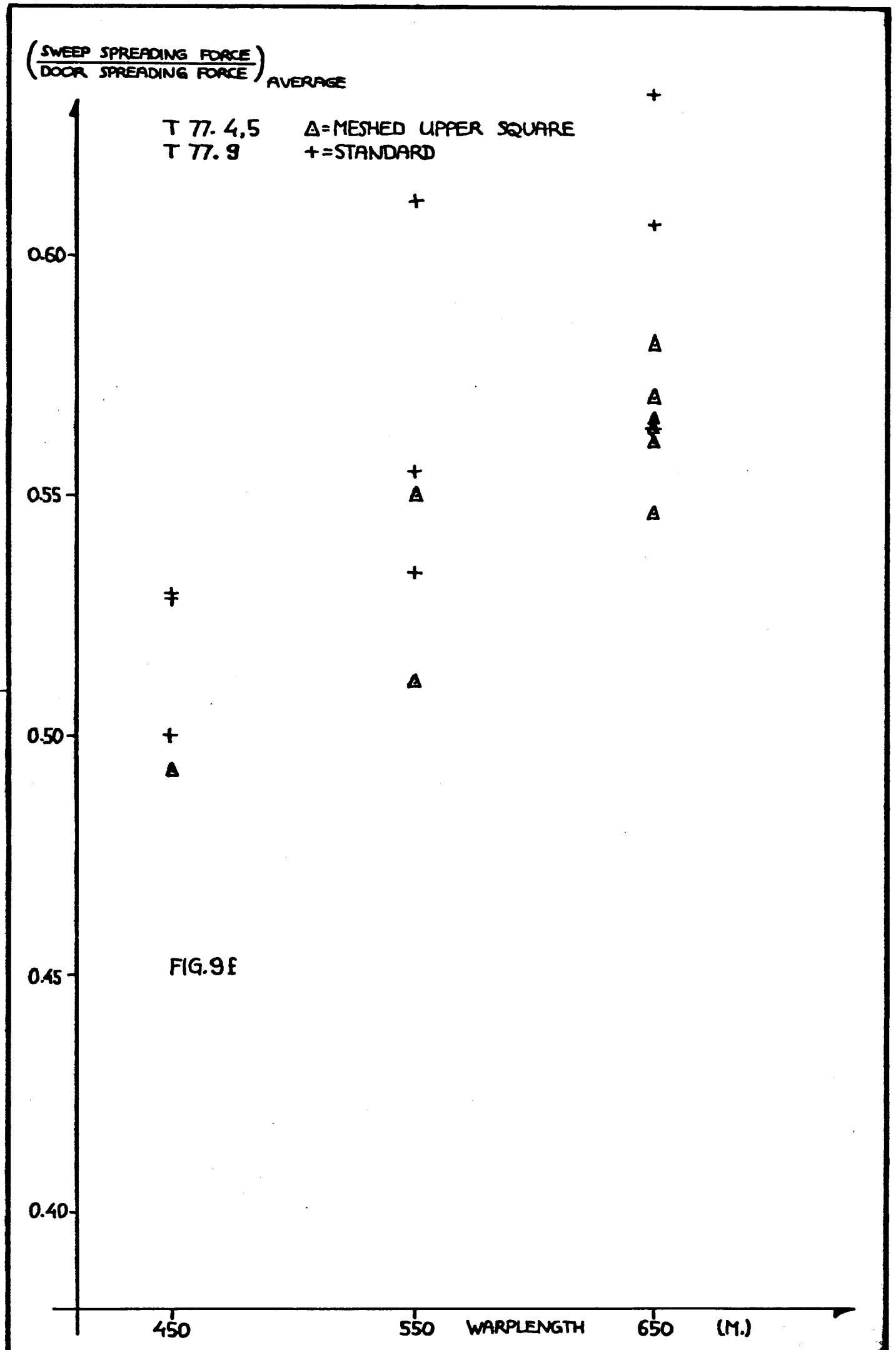

(SWEEP SPREADING FORCE / DOOR SPREADING FORCE) AVERAGE
T 77. 4,5 Δ=MESHED UPPER SQUARE
T 77. 9 +=STANDARD
0.60
0.55
0.50
0.45
0.40
450
550
WARPLENGTH
650
(M.)

FIG. 9 E

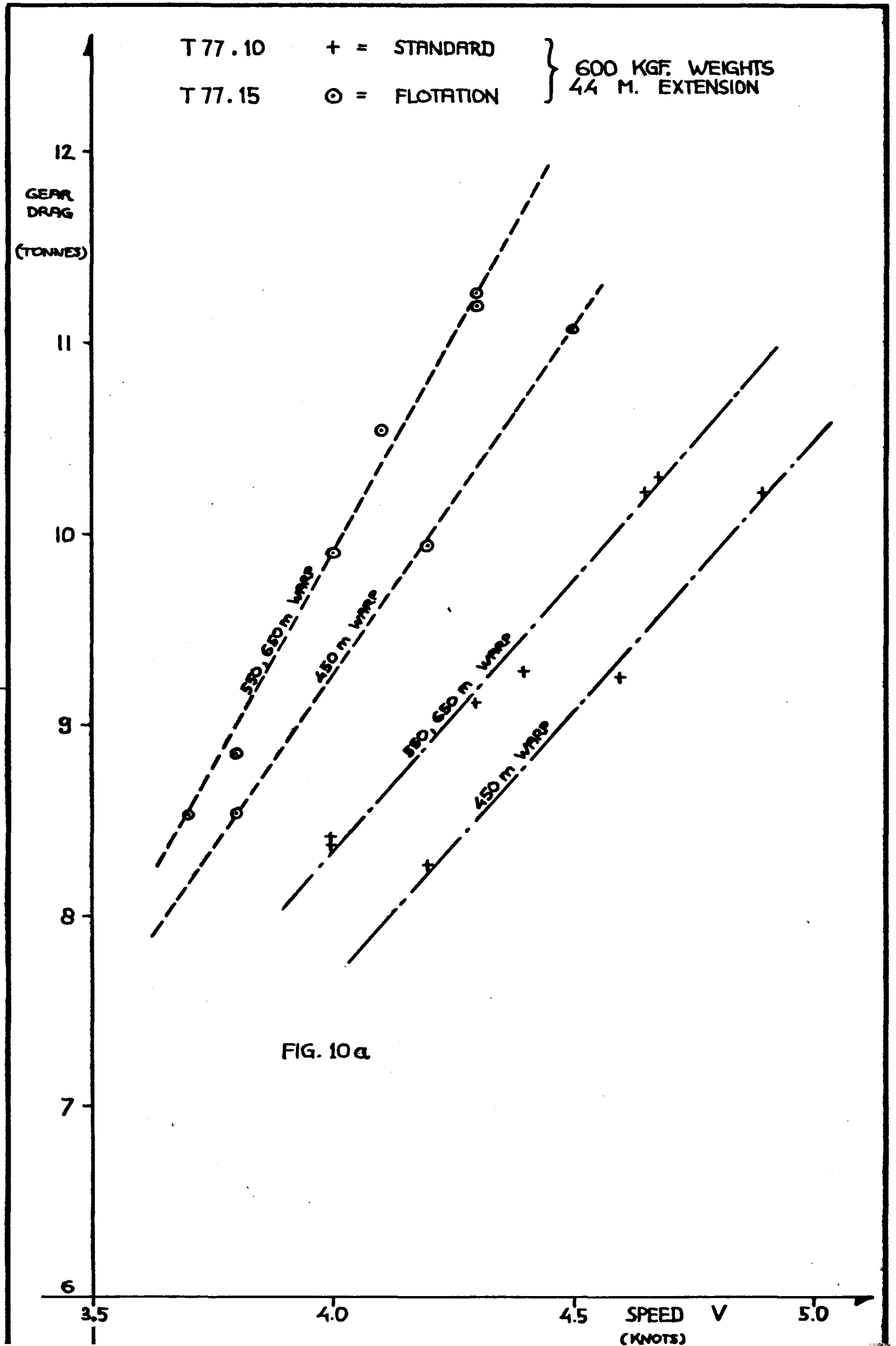

T 77.10 + = STANDARD
T 77.15 ⊙ = FLOTATION
600 KGF. WEIGHTS
44 M. EXTENSION
GEAR DRAG (TONNES)
12
11
10
9
8
7
6
550, 650 m WARP
450 m WARP
550, 650 m WARP
450 m WARP
3.5
4.0
4.5
5.0
SPEED V (KNOTS)

FIG. 10a

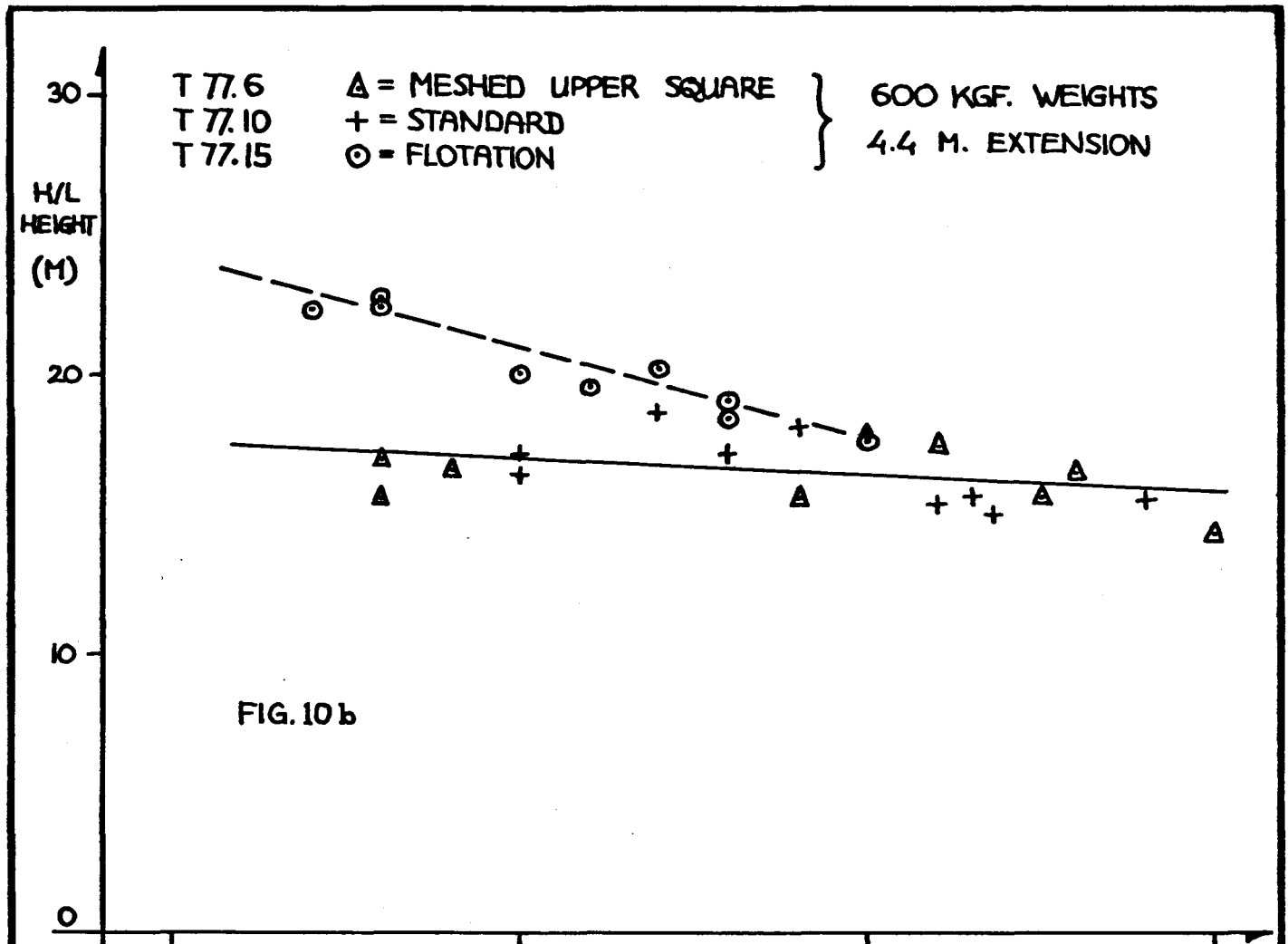


FIG. 10 b

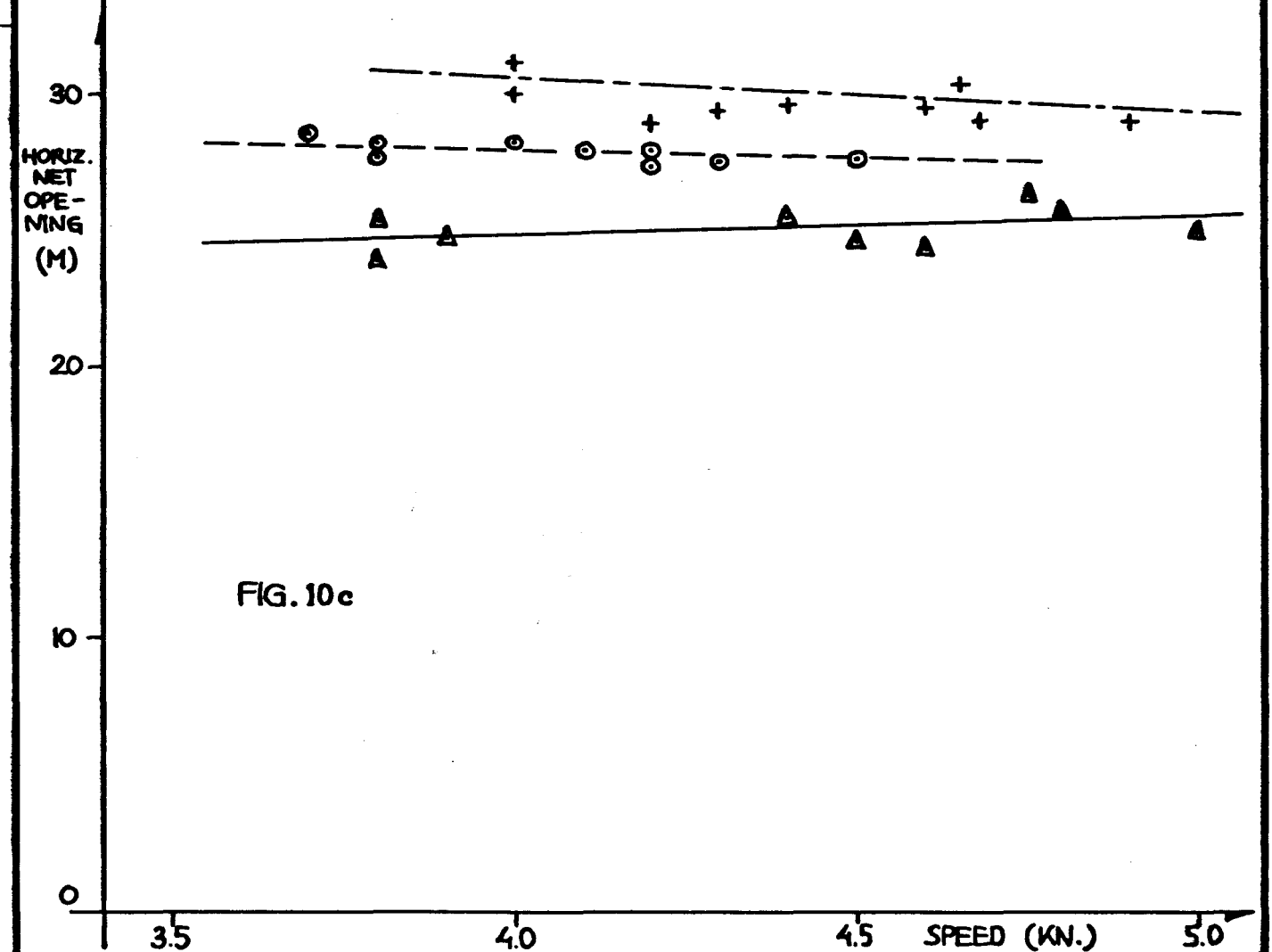
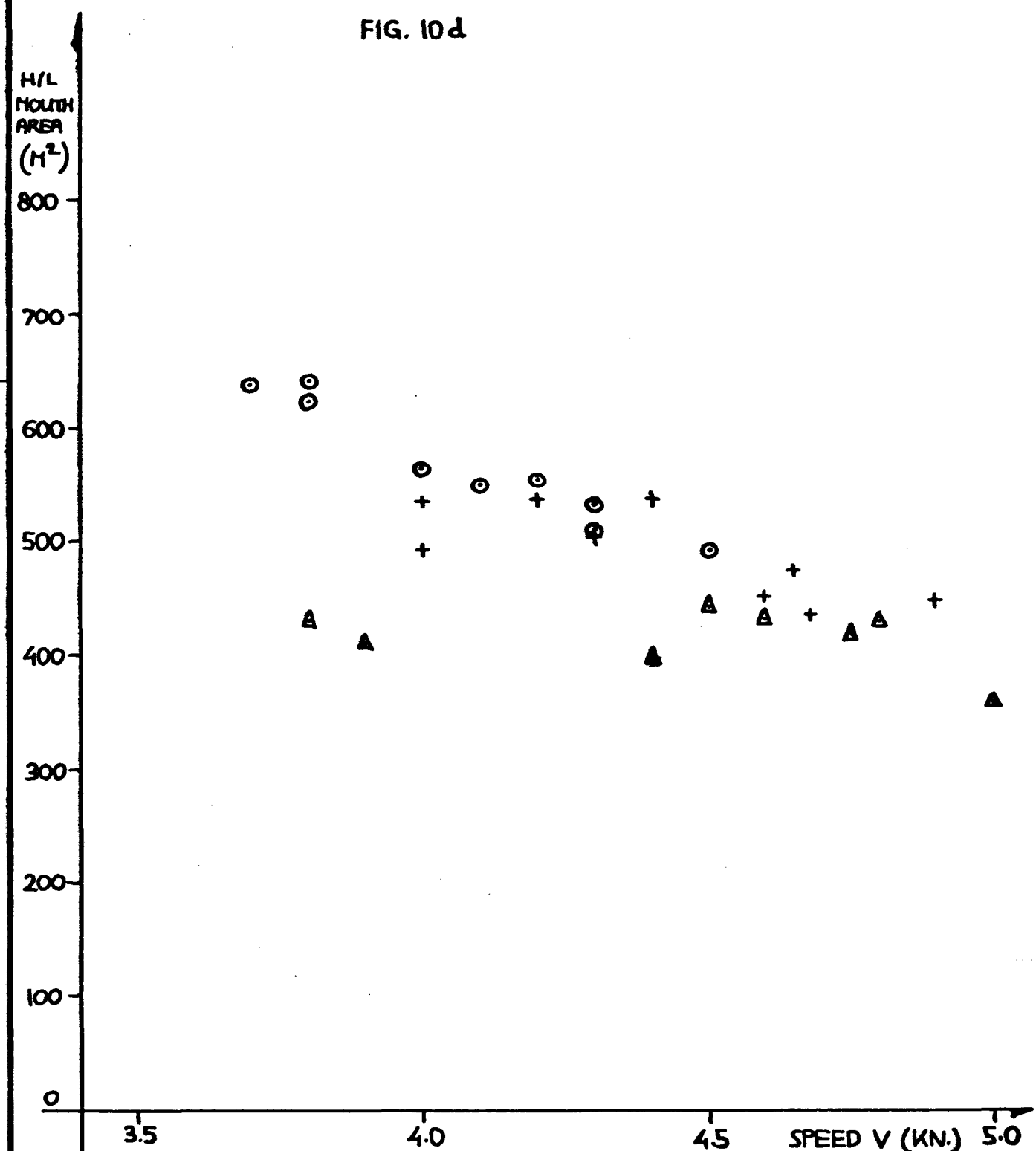


FIG. 10 c

T 77.6 Δ = MESHED UPPER SQUARE
T 77.10 + = STANDARD
T 77.15 ⊙ = FLOTATION

} 600 KGF. WEIGHTS
4.4 M. EXTENSION

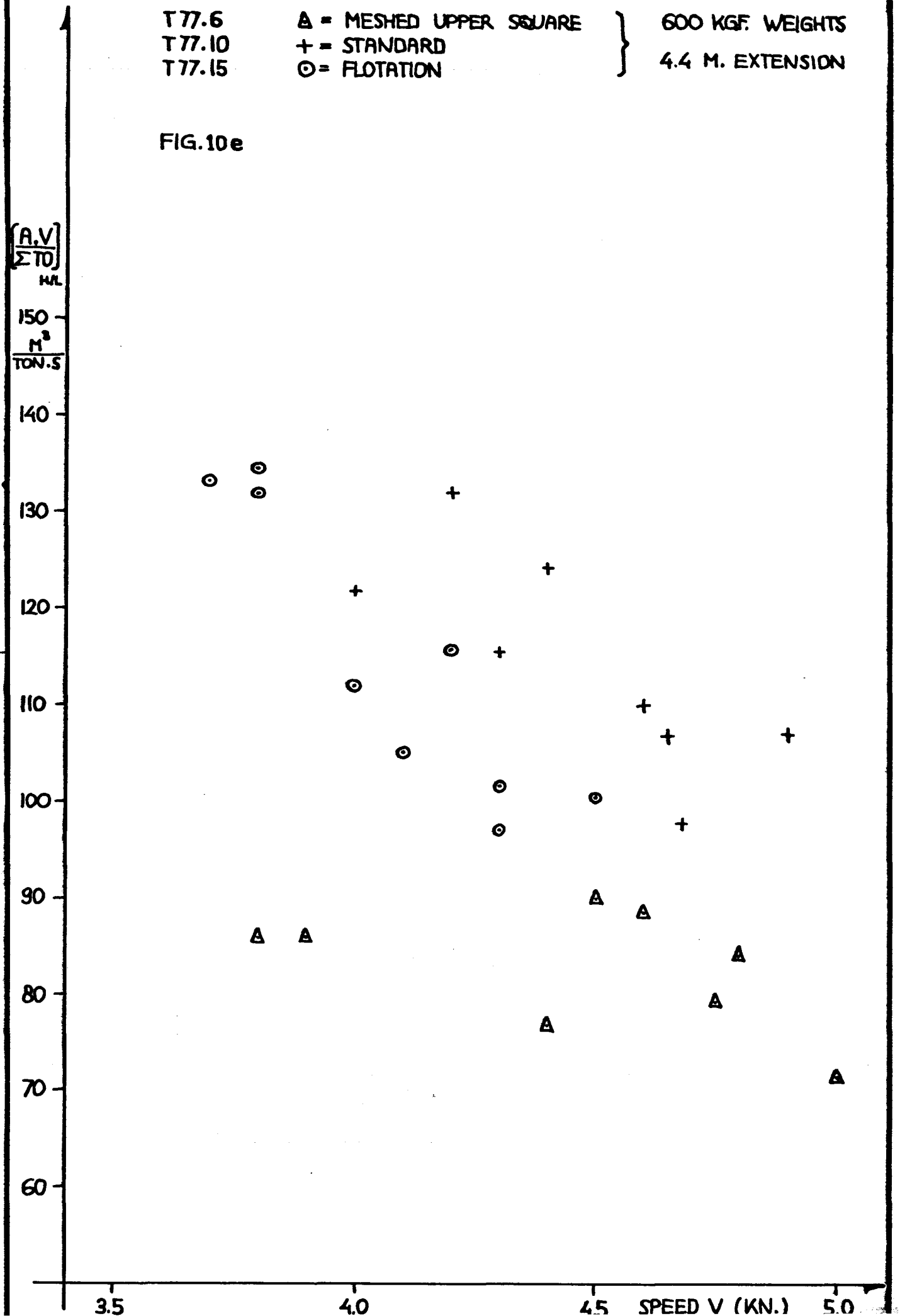
FIG. 10d



T77.6 ▲ = MESHED UPPER SQUARE
T77.10 + = STANDARD
T77.15 ⊙ = FLOTATION

} 600 KGF. WEIGHTS
4.4 M. EXTENSION

FIG. 10e



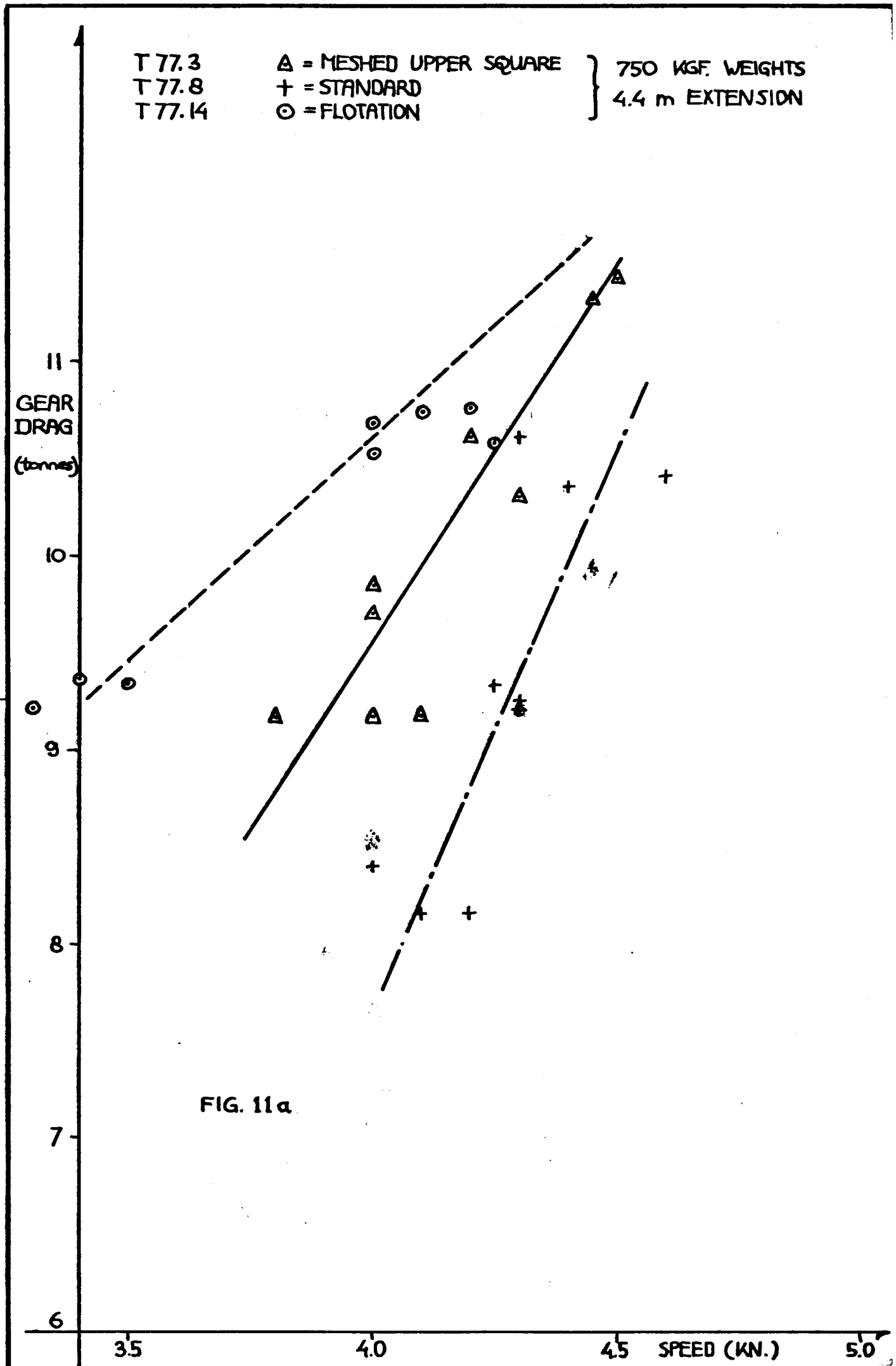

T 77.3
T 77.8
T 77.14
Δ = MESHED UPPER SQUARE
+ = STANDARD
⊙ = FLOTATION
750 KGF. WEIGHTS
4.4 m EXTENSION
GEAR DRAG (tonnes)
11
10
9
8
7
6
3.5
4.0
4.5
5.0
SPEED (KN.)

FIG. 11a

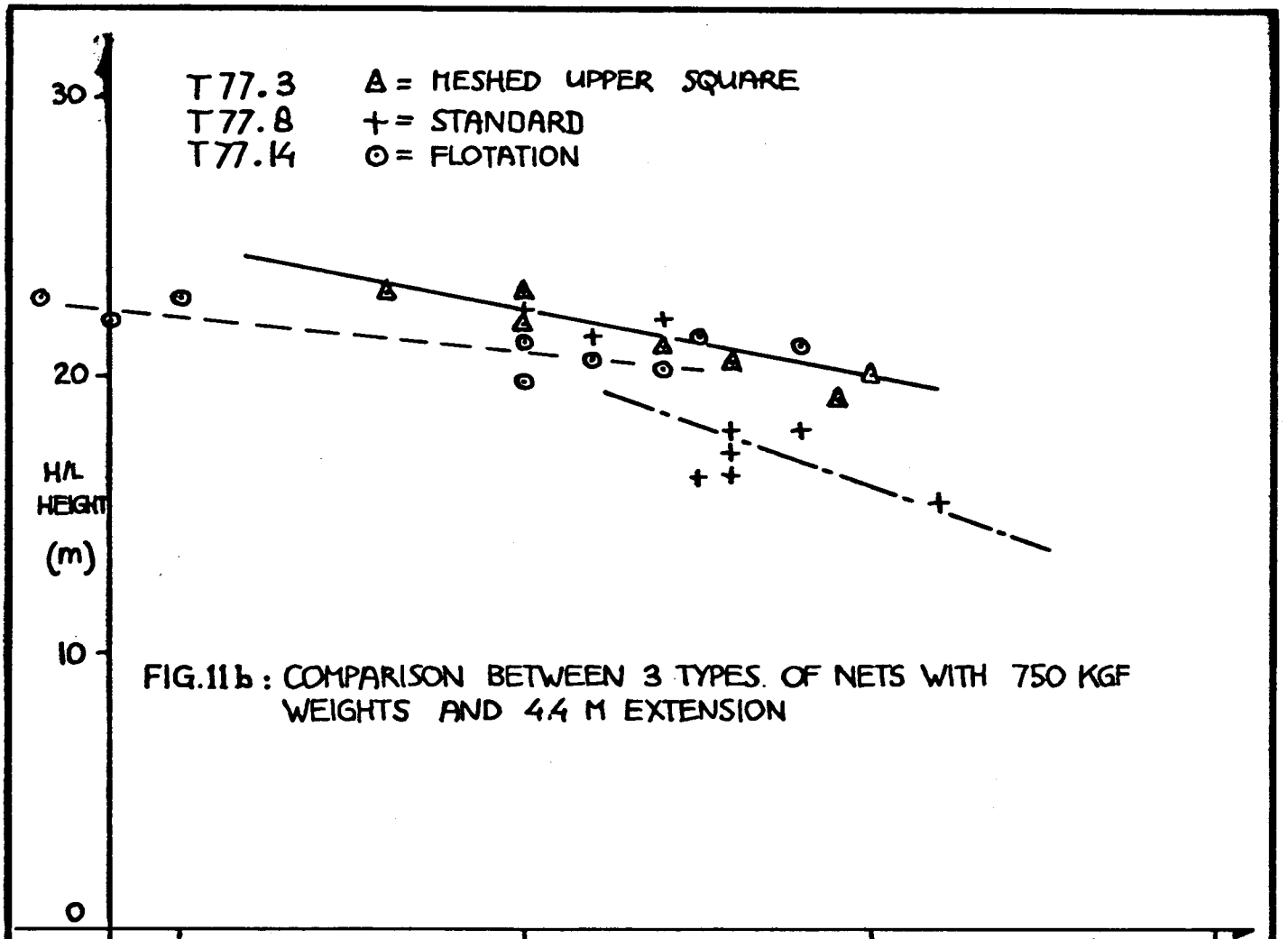


FIG.11b : COMPARISON BETWEEN 3 TYPES OF NETS WITH 750 KGF WEIGHTS AND 4.4 M EXTENSION

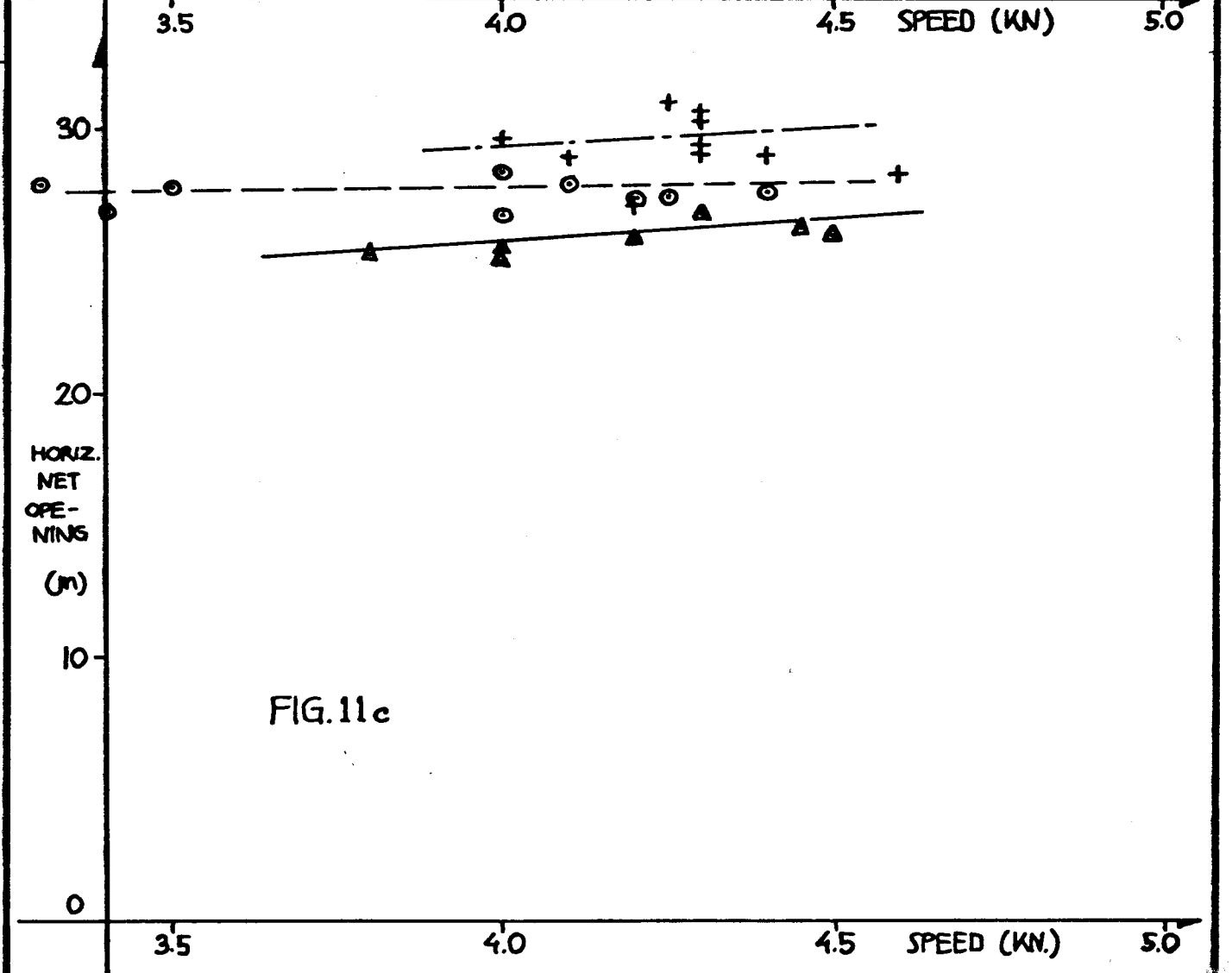
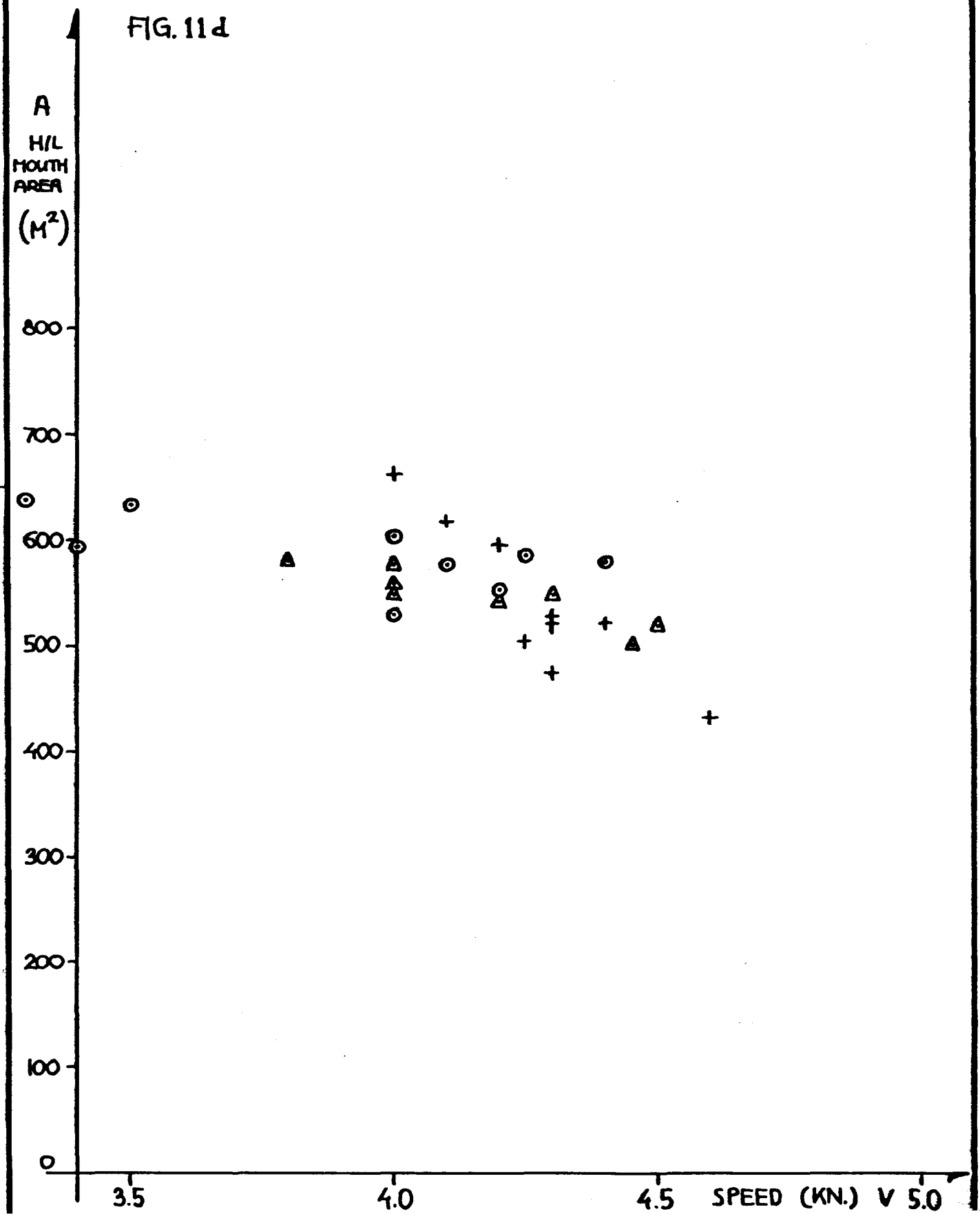


FIG.11c

T 77.3 ▲ = MESHED UPPER SQUARE
T 77.8 + = STANDARD
T 77.14 ⊙ = FLOTATION

} 750 KGF. WEIGHTS
4.4 M. EXTENSION

FIG. 11d



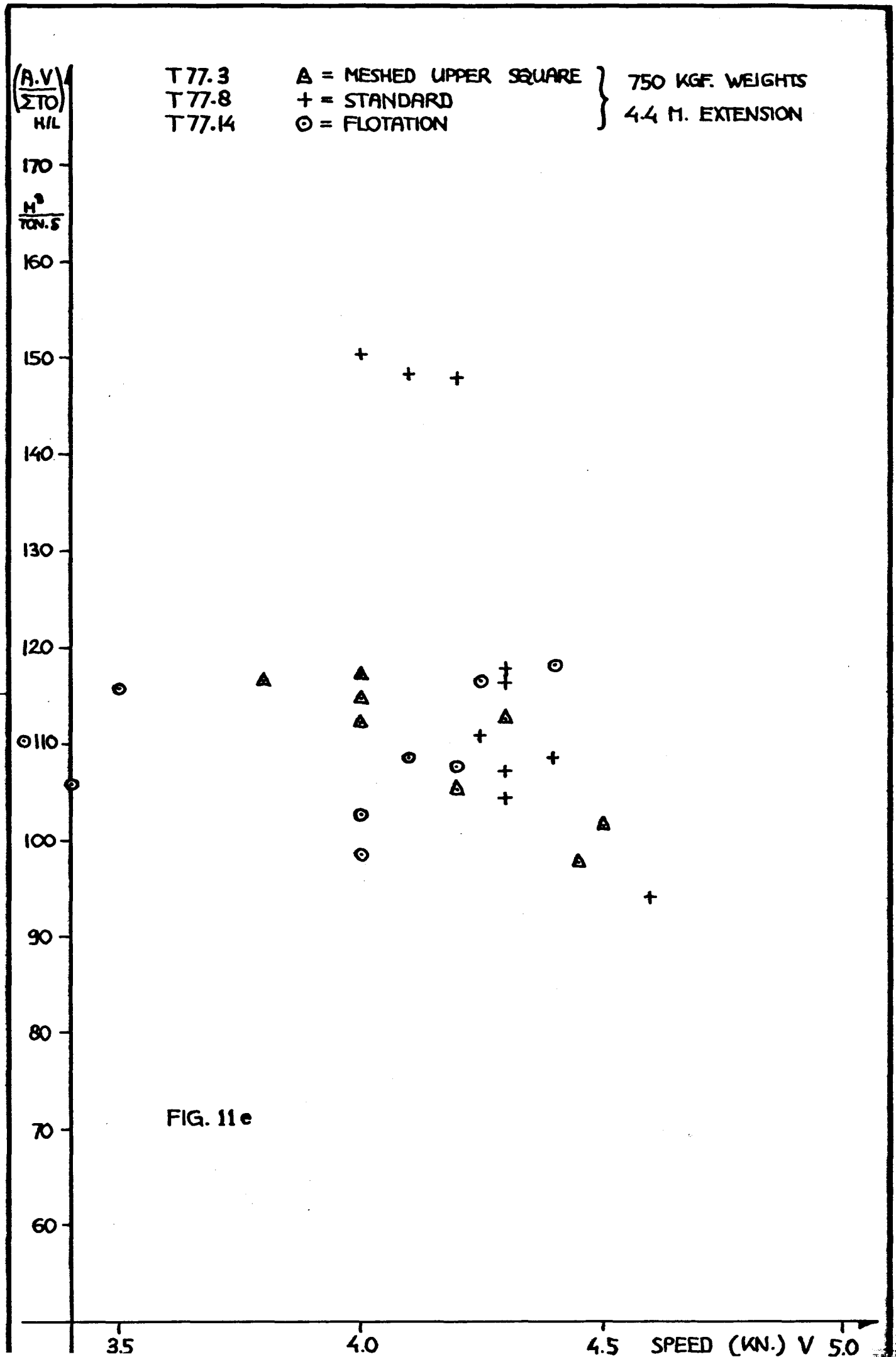

T 77.3
T 77-8
T 77.14
Δ = MESHED UPPER SQUARE
+ = STANDARD
⊙ = FLOTATION
750 KGF. WEIGHTS
4.4 M. EXTENSION
(A.V/ΣTO) H/L
M³/TON.S
170
160
150
140
130
120
110
100
90
80
70
60
3.5
4.0
4.5
SPEED (KN.) V
5.0

FIG. 11 e

$\left(\frac{\text{SWEEP SPREADING FORCE}}{\text{DOOR SPREADING FORCE}}\right)_{\text{AVERAGE}}$

T77.3 Δ = MESHED UPPER SQUARE
T77.8 + = STANDARD
T77.14 ⊙ = FLOTATION

} 750 KGF. WEIGHTS
4.4 M. EXTENSION

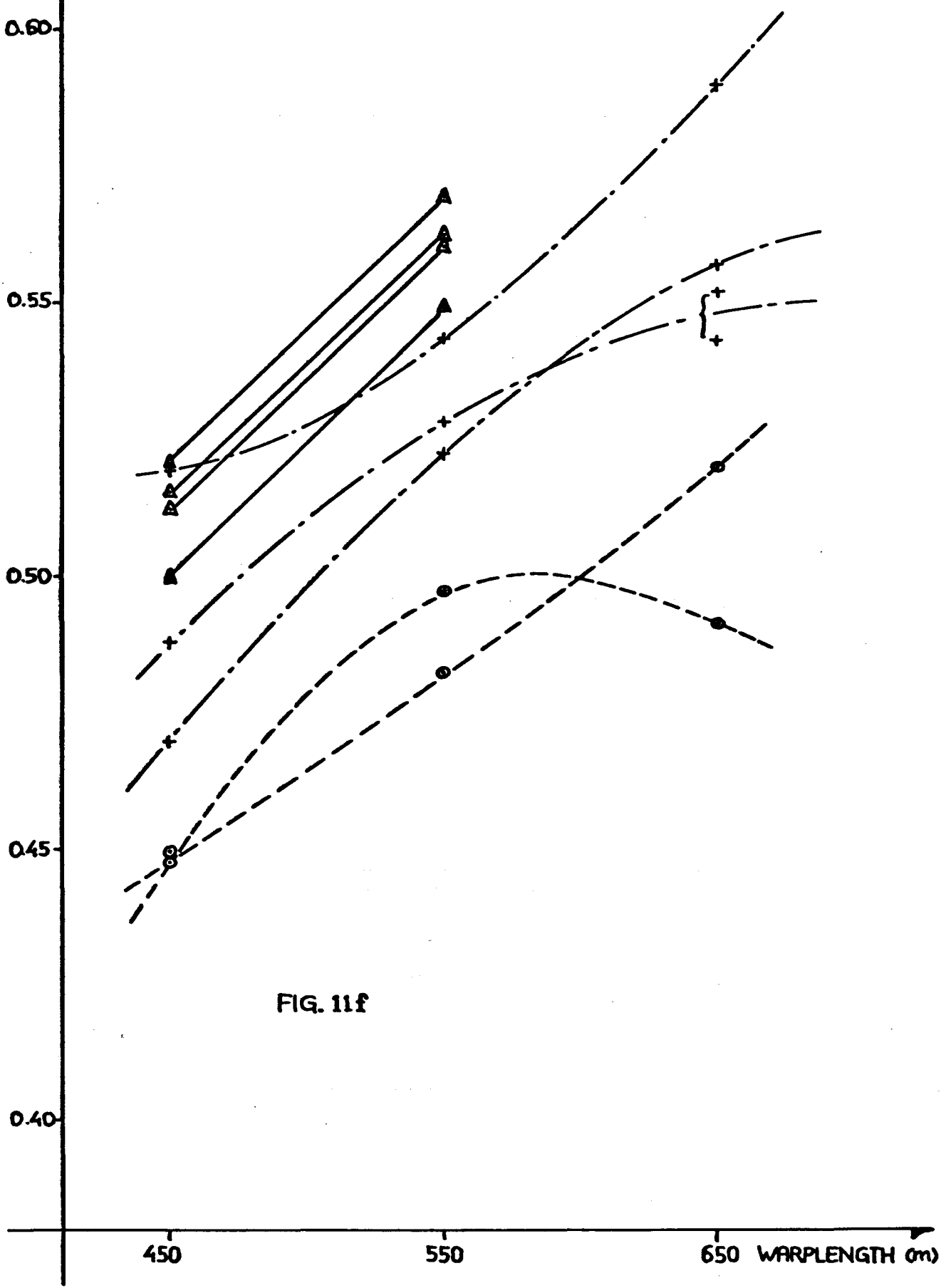


FIG. 11f

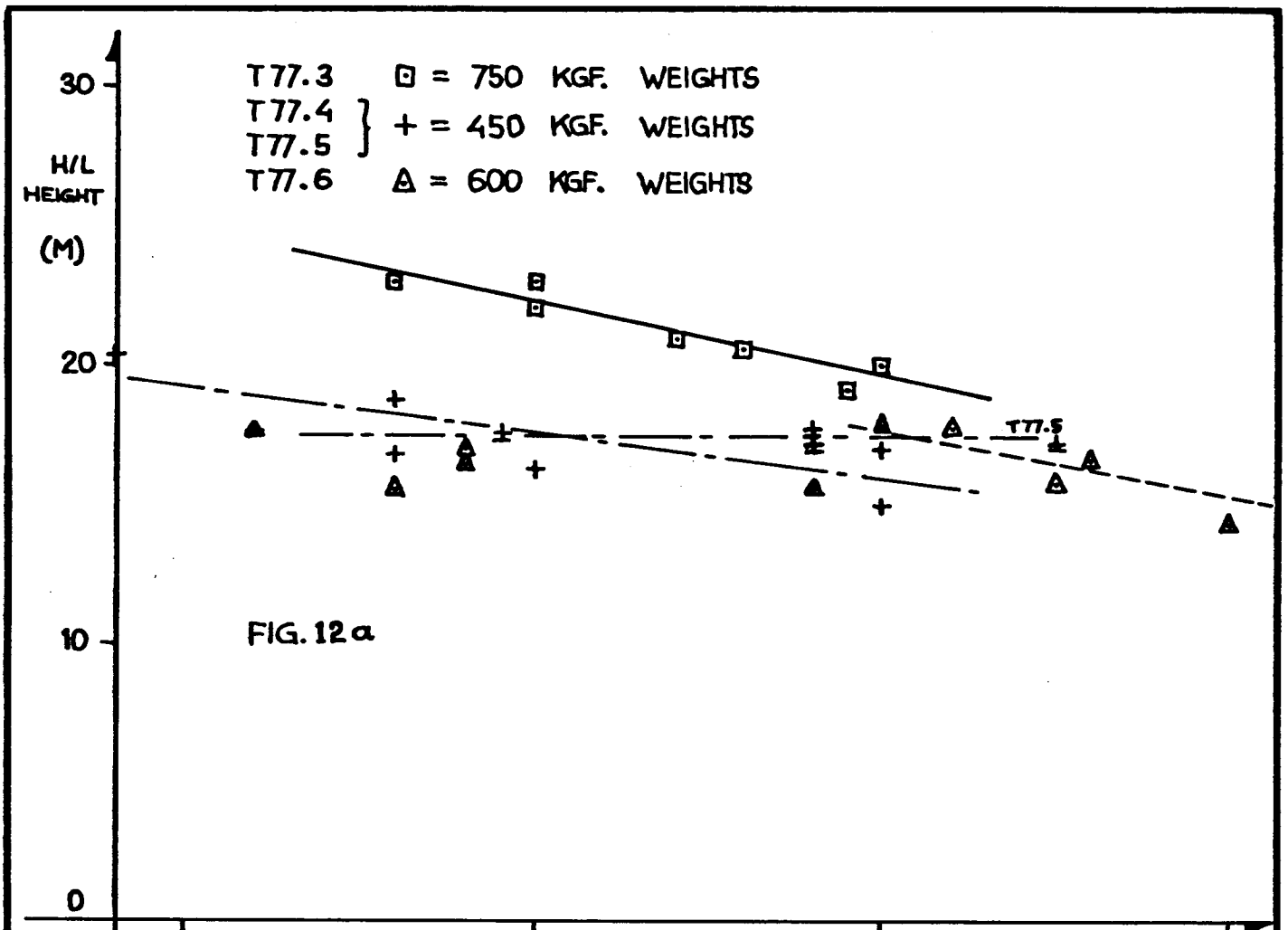


FIG. 12 a

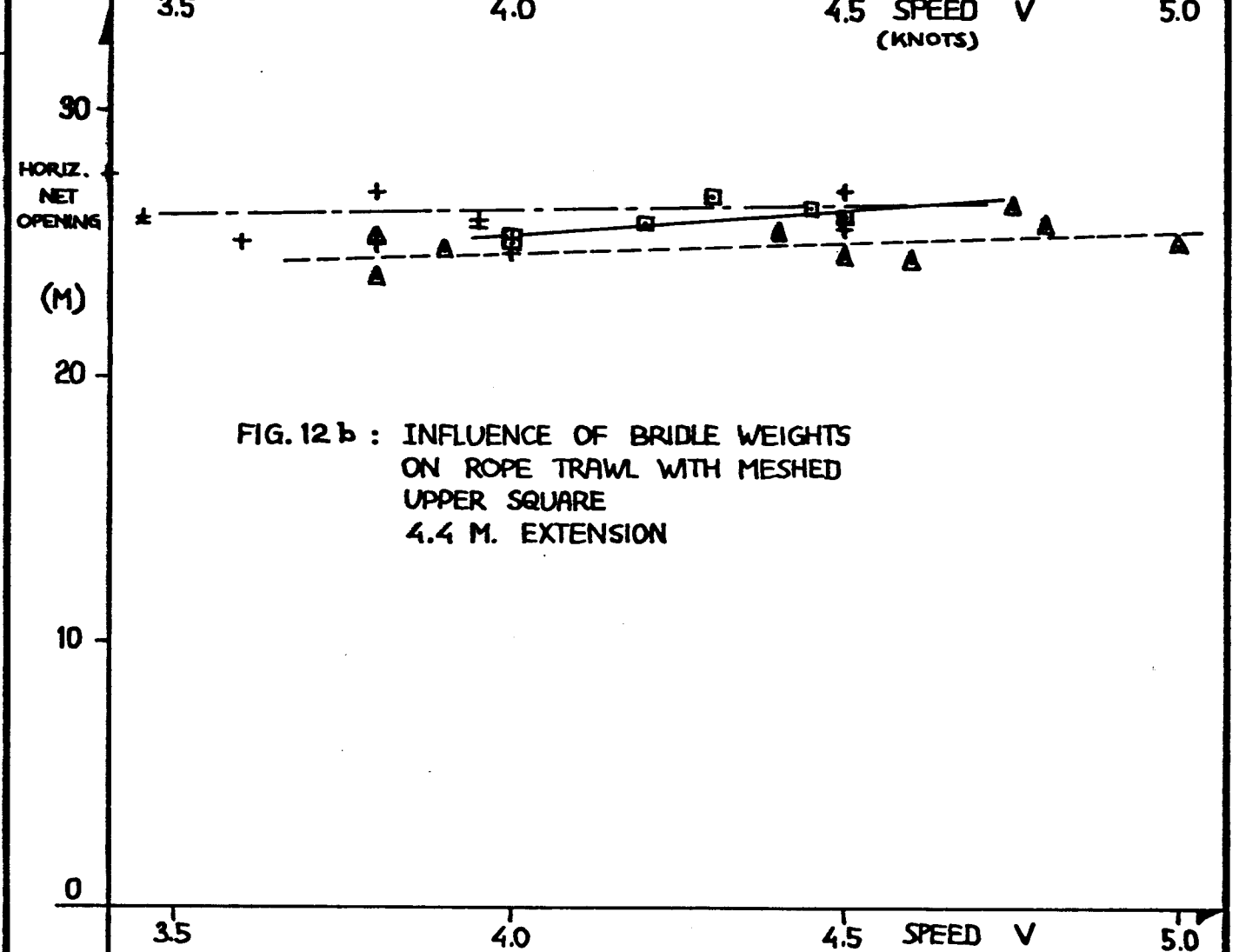
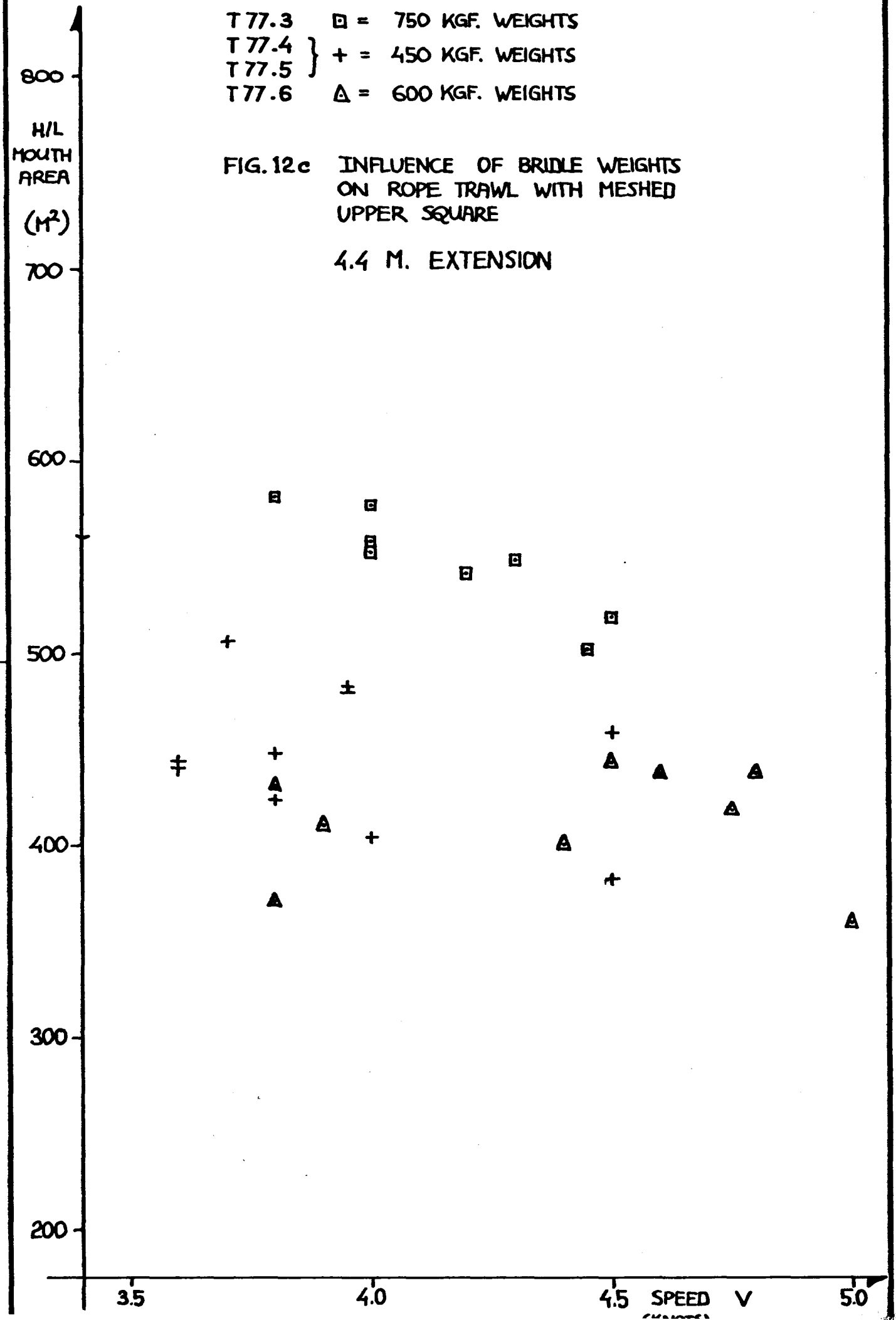


FIG. 12 b : INFLUENCE OF BRIDLE WEIGHTS ON ROPE TRAWL WITH MESHED UPPER SQUARE 4.4 M. EXTENSION

T 77.3 ⊡ = 750 KGF. WEIGHTS
T 77.4, T 77.5 } + = 450 KGF. WEIGHTS
T 77.6 Δ = 600 KGF. WEIGHTS

FIG. 12c INFLUENCE OF BRIDLE WEIGHTS ON ROPE TRAWL WITH MESHED UPPER SQUARE

4.4 M. EXTENSION



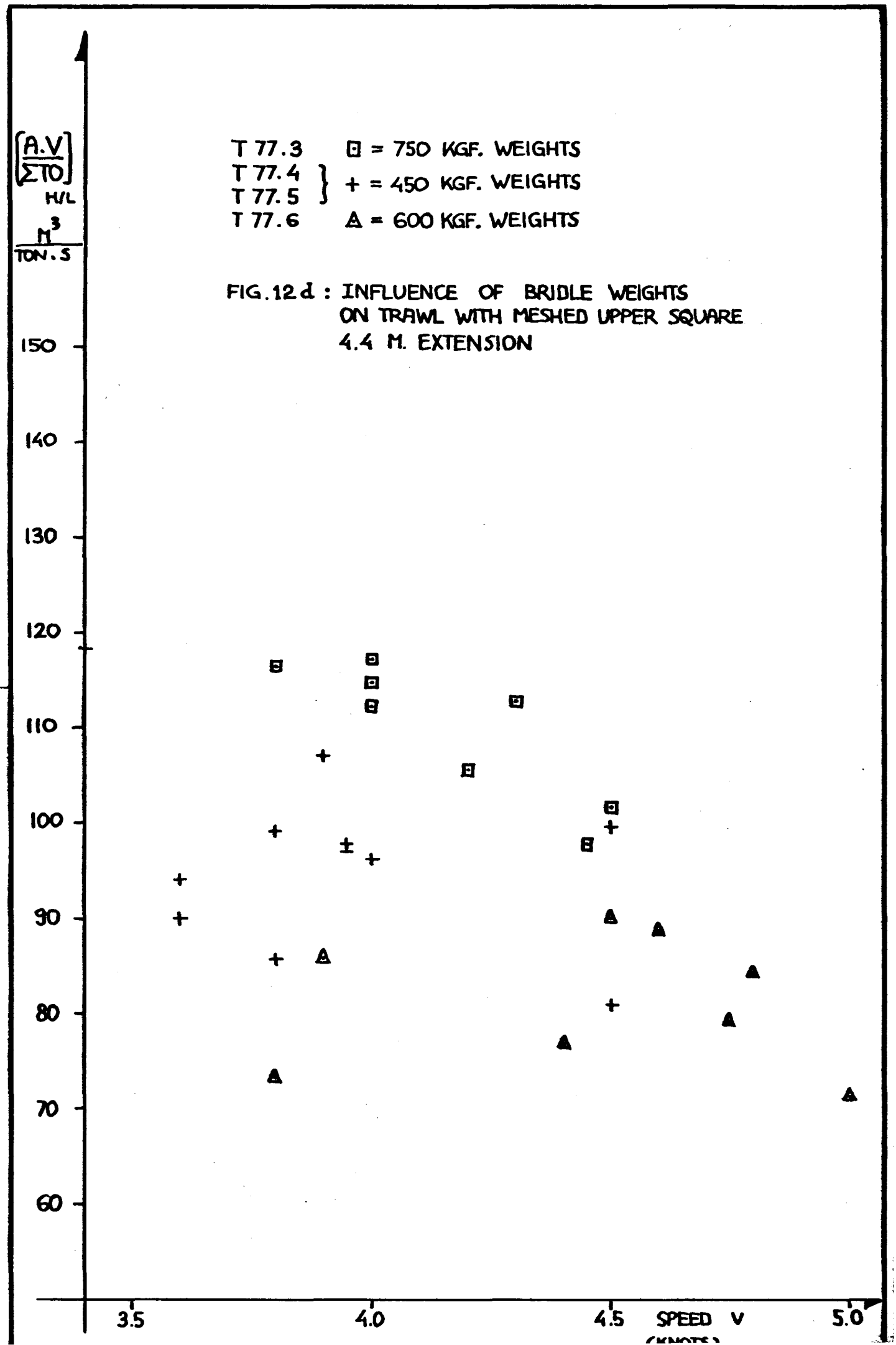


FIG. 12 d : INFLUENCE OF BRIDLE WEIGHTS ON TRAWL WITH MESHED UPPER SQUARE 4.4 M. EXTENSION

T 77.8 ⊟ = 750 KGF. WEIGHTS
T 77.9 + = 450 KGF. WEIGHTS
T 77.10 △ = 600 KGF. WEIGHTS

4.4 M. EXTENSION

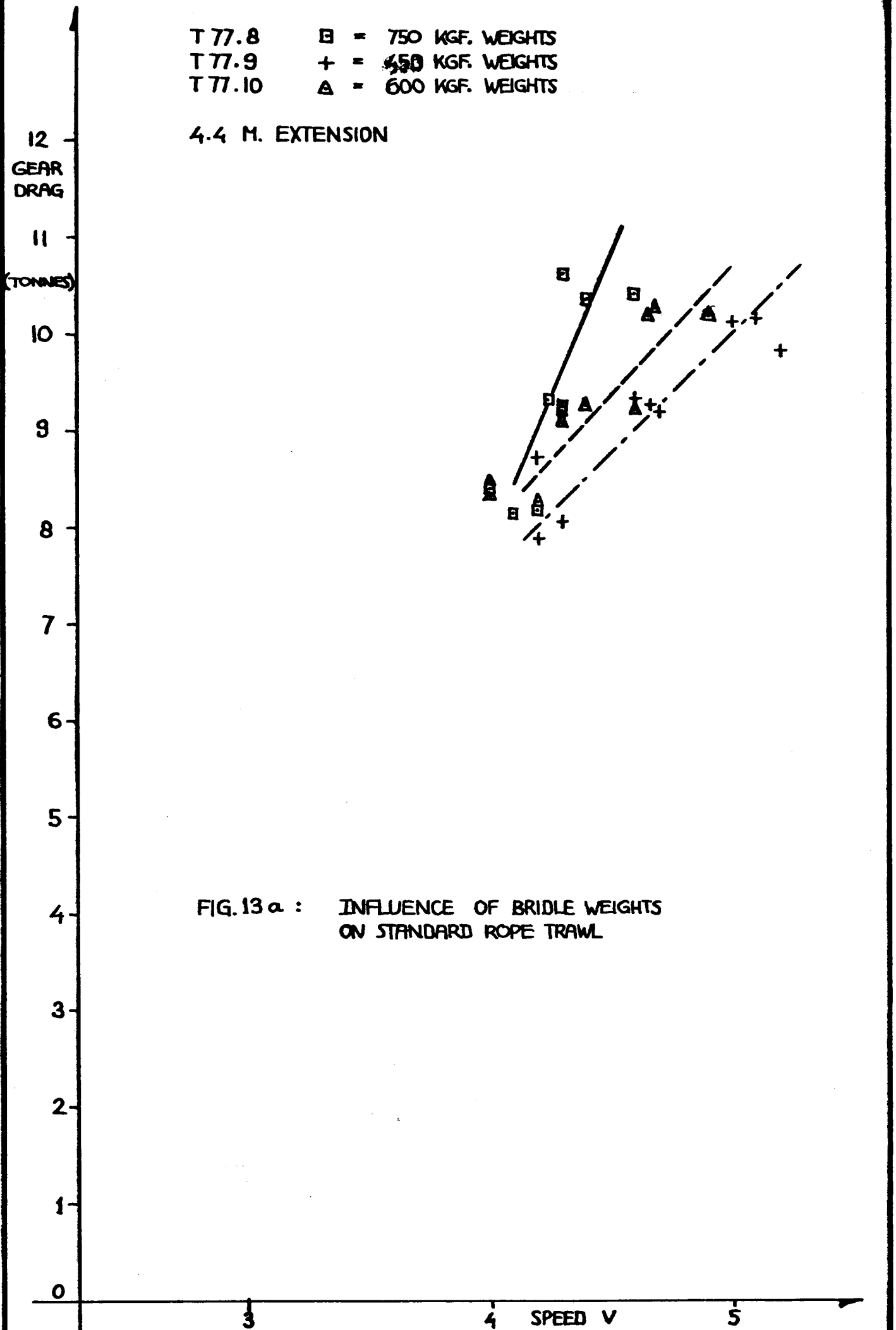


FIG. 13 a : INFLUENCE OF BRIDLE WEIGHTS ON STANDARD ROPE TRAWL

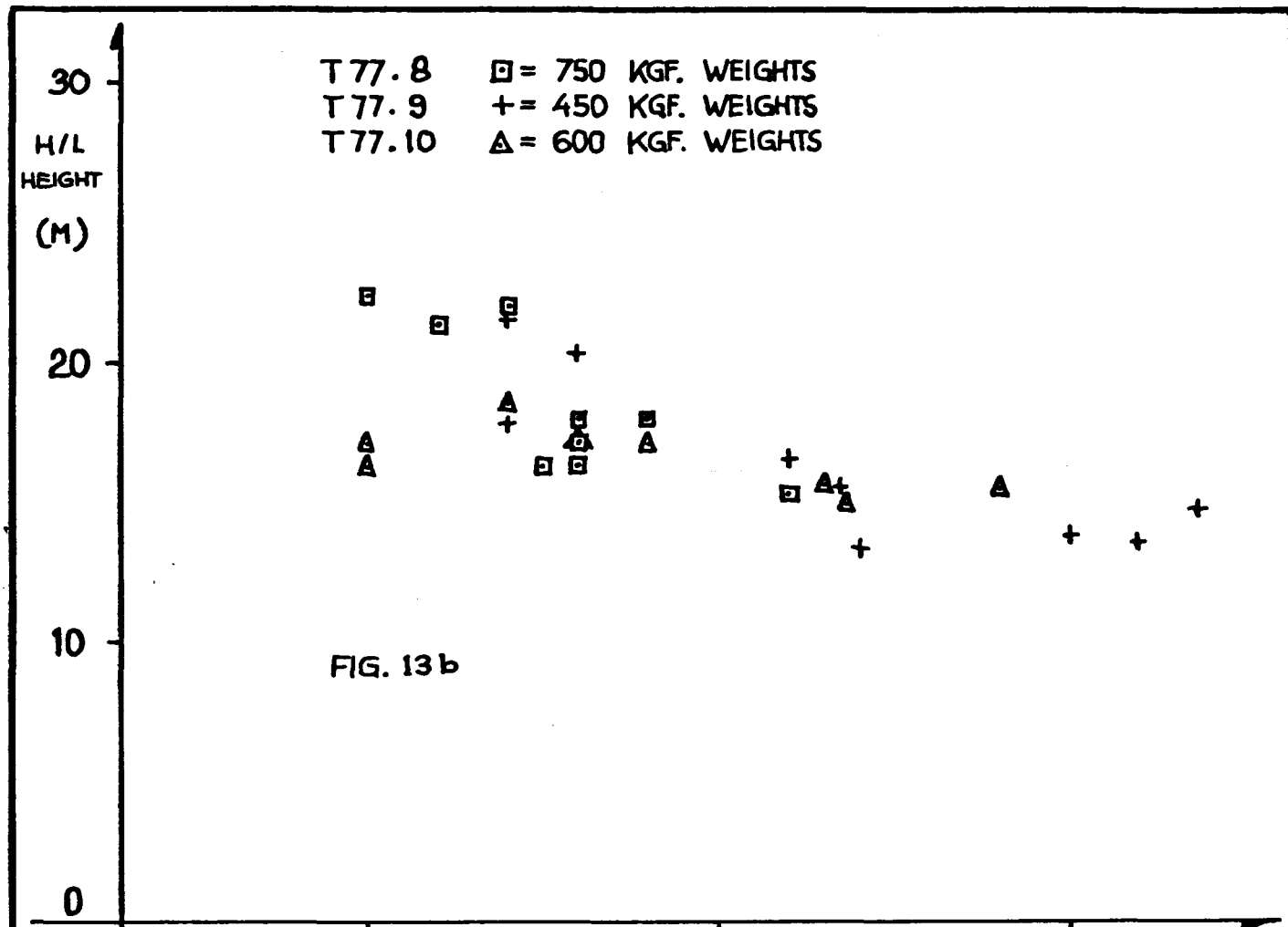


FIG. 13b

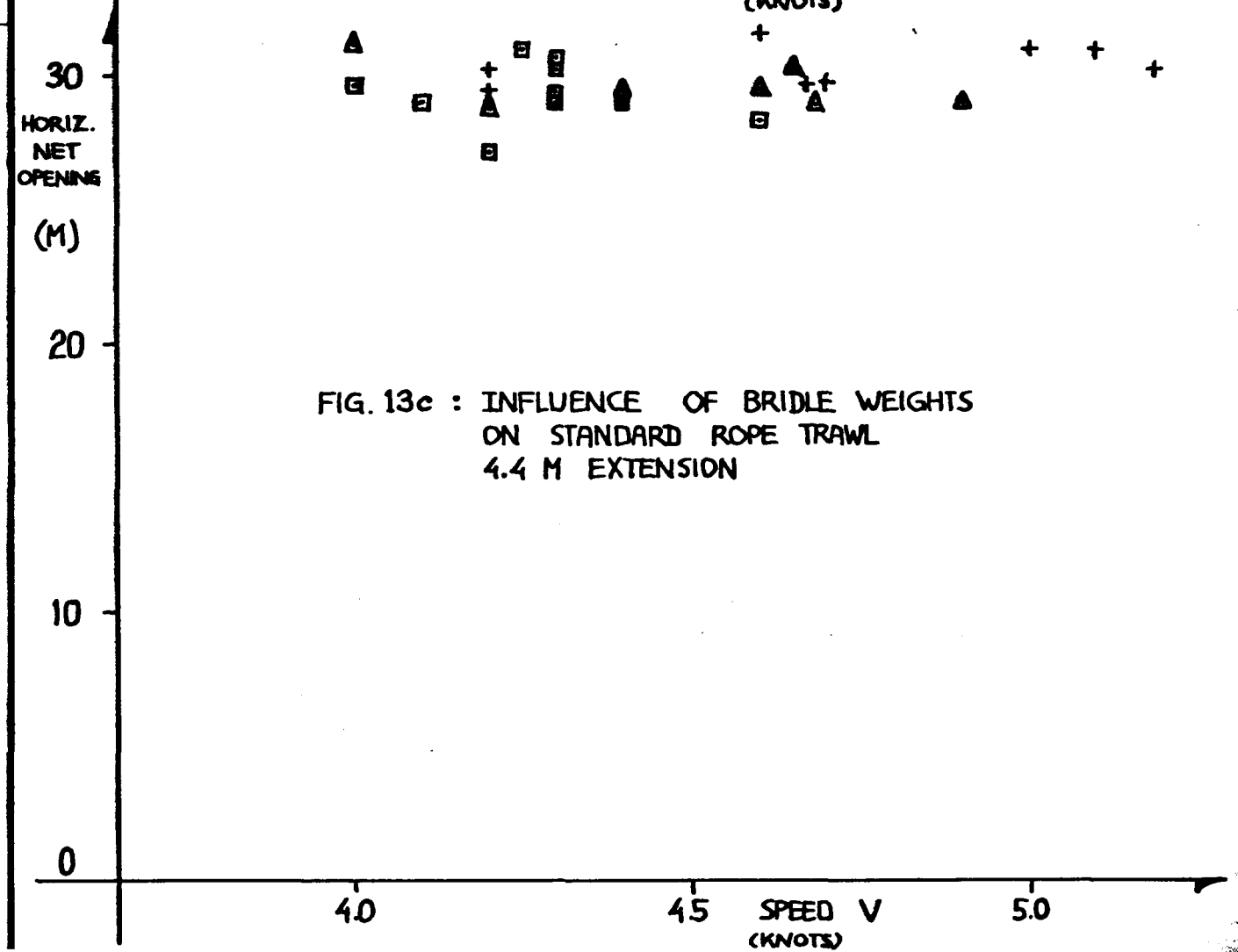
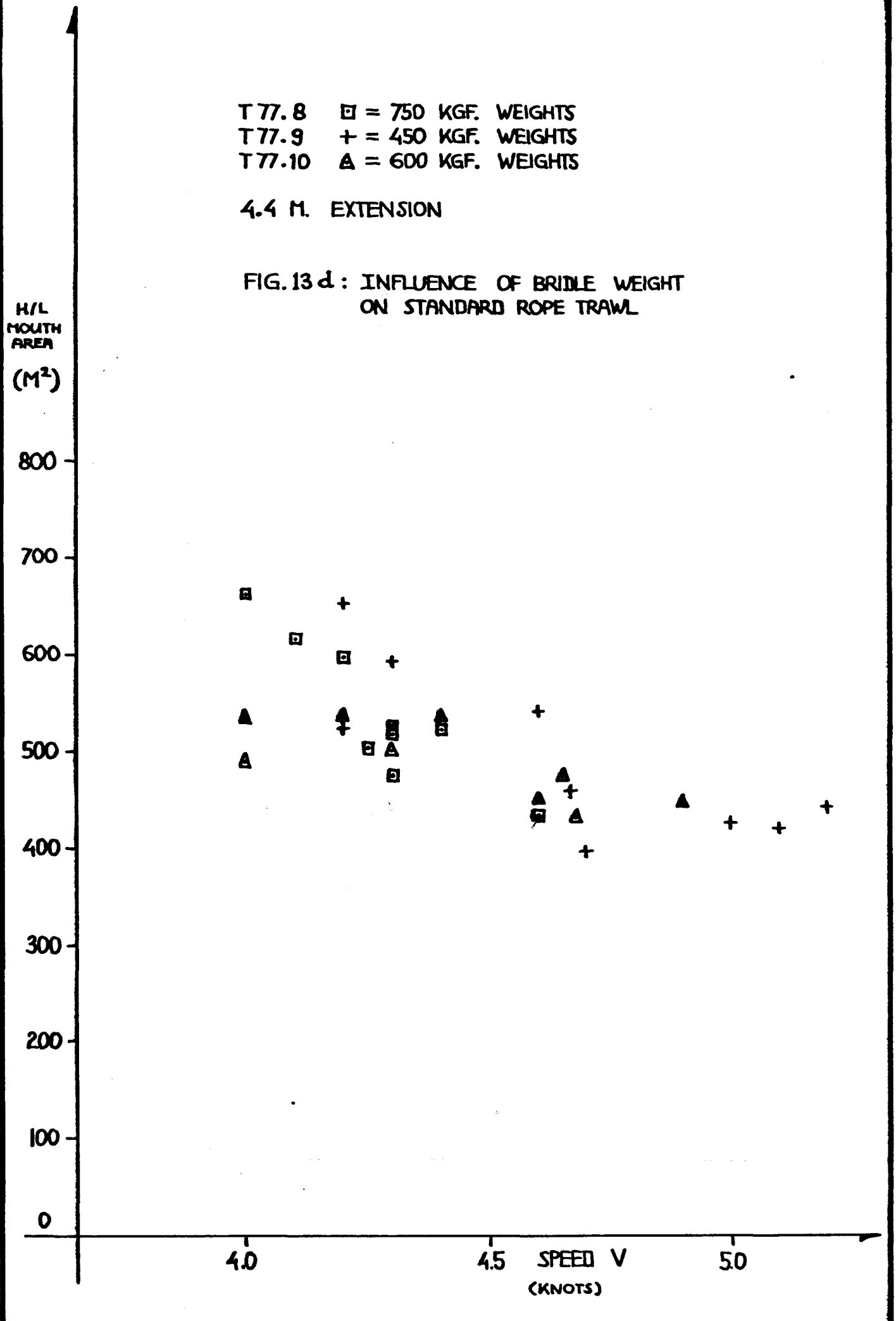


FIG. 13c : INFLUENCE OF BRIDLE WEIGHTS ON STANDARD ROPE TRAWL 4.4 M EXTENSION

T 77.8 ⊡ = 750 KGF. WEIGHTS
T 77.9 + = 450 KGF. WEIGHTS
T 77.10 ▲ = 600 KGF. WEIGHTS

4.4 M. EXTENSION

FIG. 13 d : INFLUENCE OF BRIDLE WEIGHT ON STANDARD ROPE TRAWL



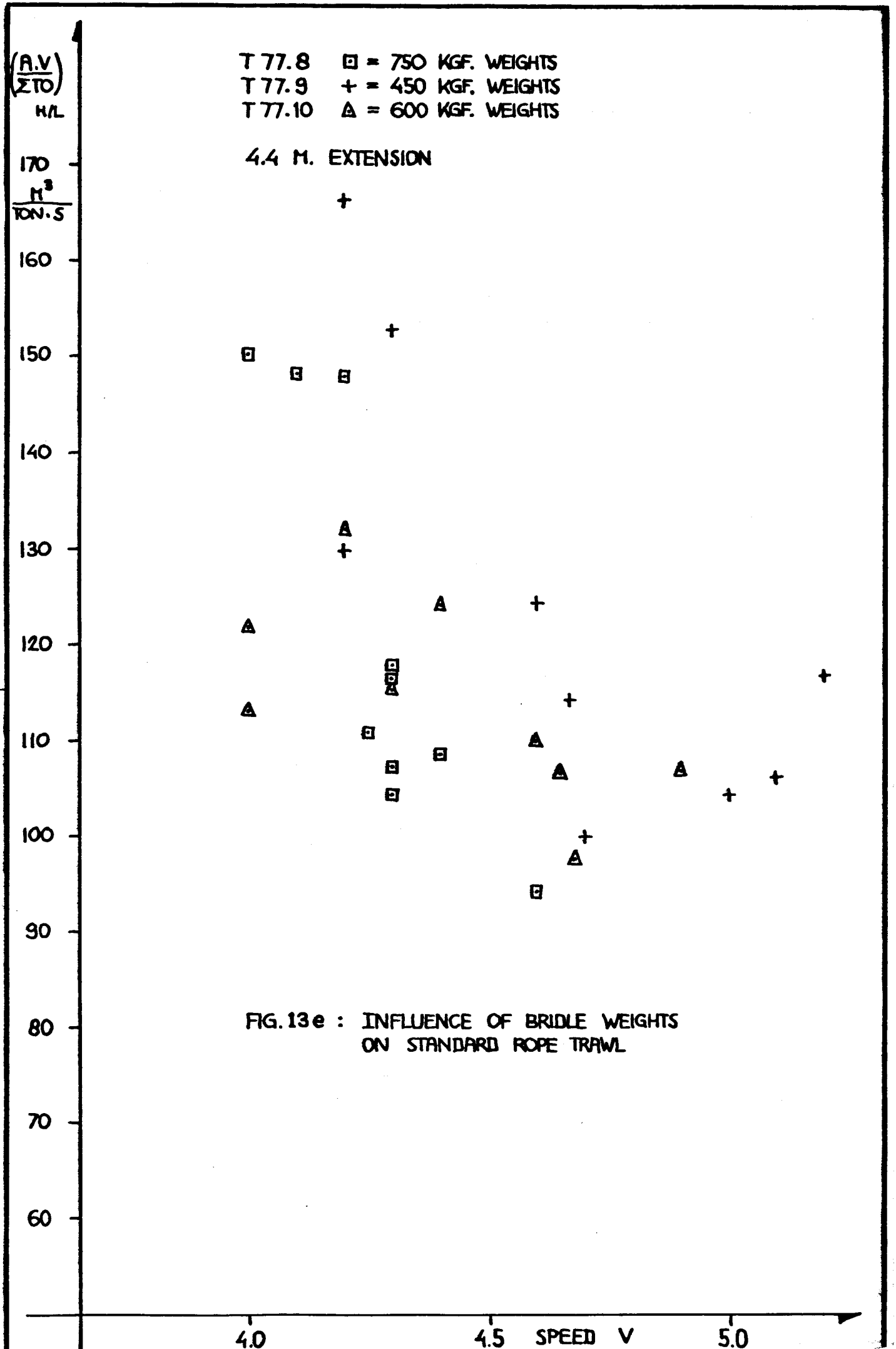


FIG. 13e : INFLUENCE OF BRIDLE WEIGHTS ON STANDARD ROPE TRAWL

T 77.14 750 KGF WEIGHTS : ⊡

T 77.15 600 KGF WEIGHTS : △

4.4 M EXTENSION

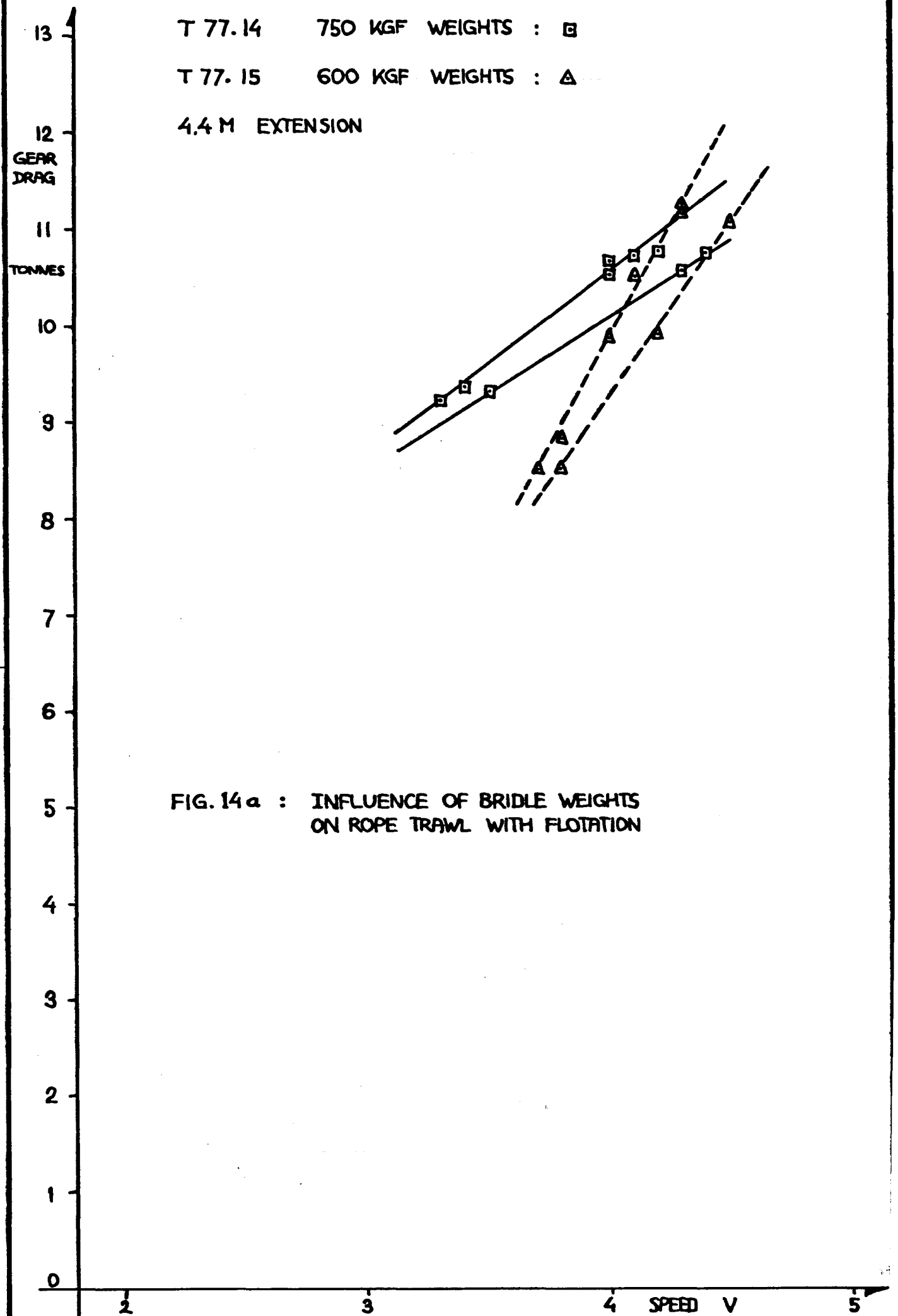


FIG. 14a : INFLUENCE OF BRIDLE WEIGHTS ON ROPE TRAWL WITH FLOTATION

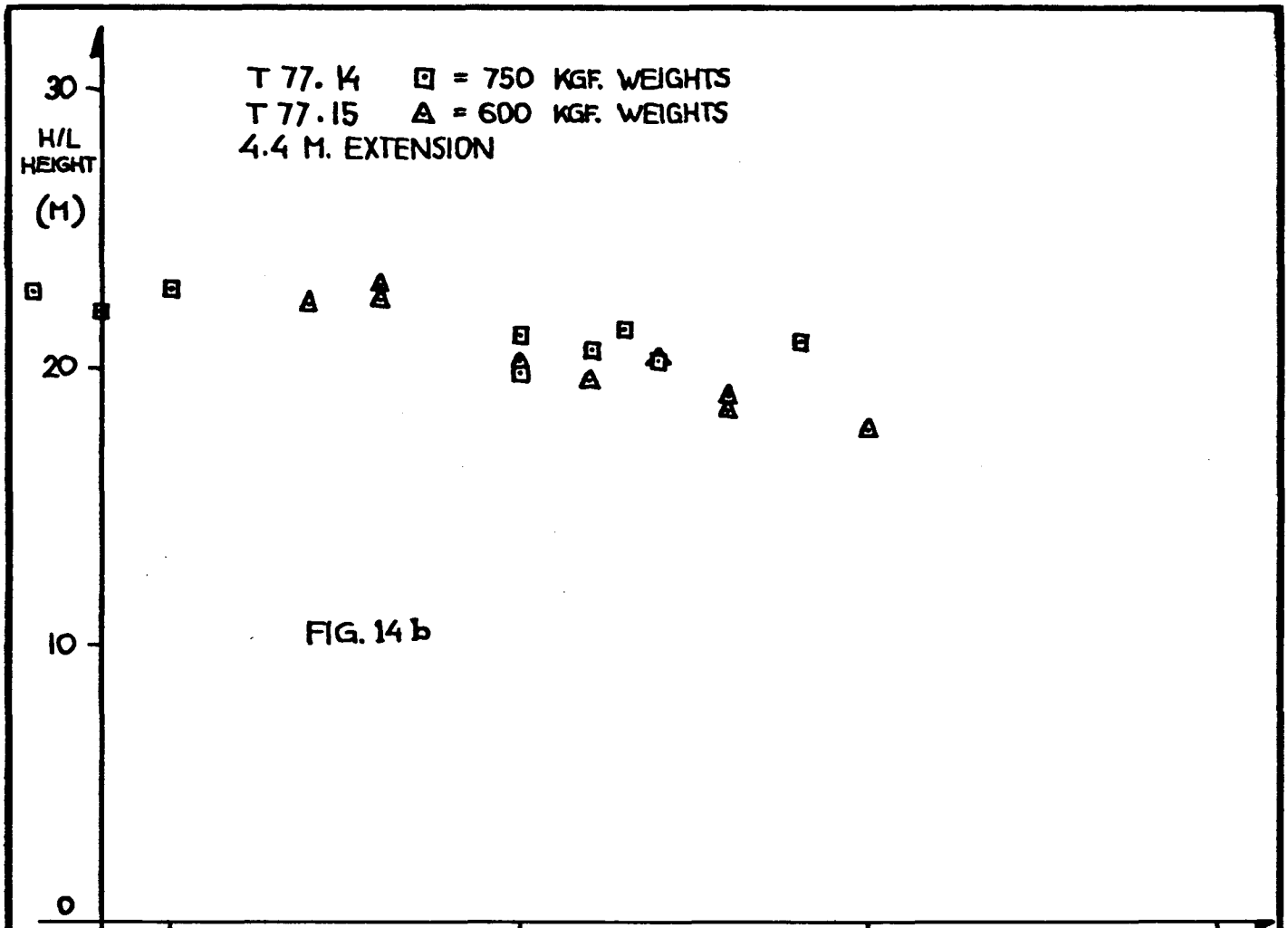


FIG. 14 b

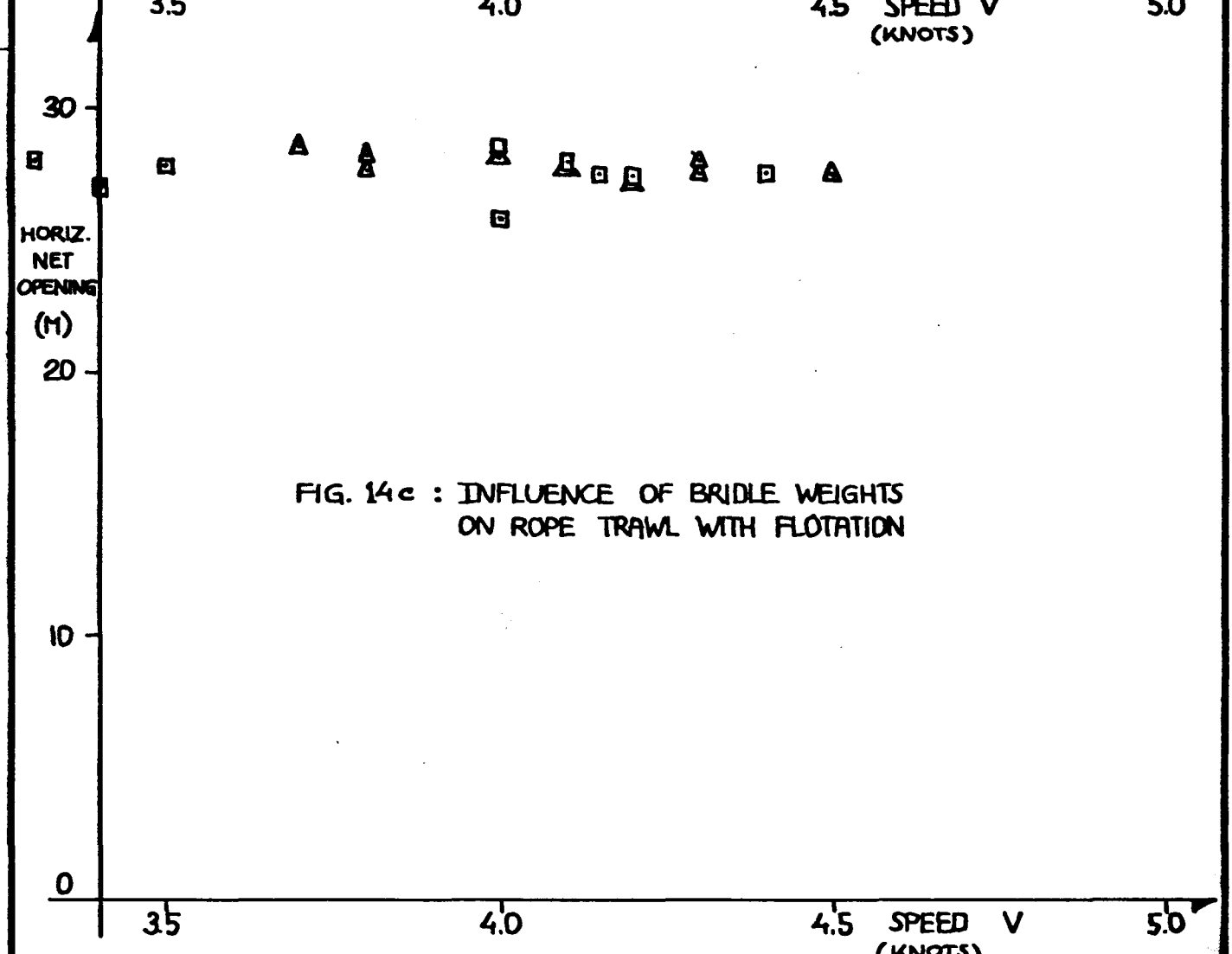


FIG. 14 c : INFLUENCE OF BRIDLE WEIGHTS ON ROPE TRAWL WITH FLOTATION

T 77.14 ⊡ = 750 KGF. WEIGHTS

T 77.15 △ = 600 KGF. WEIGHTS

4.4 M. EXTENSION

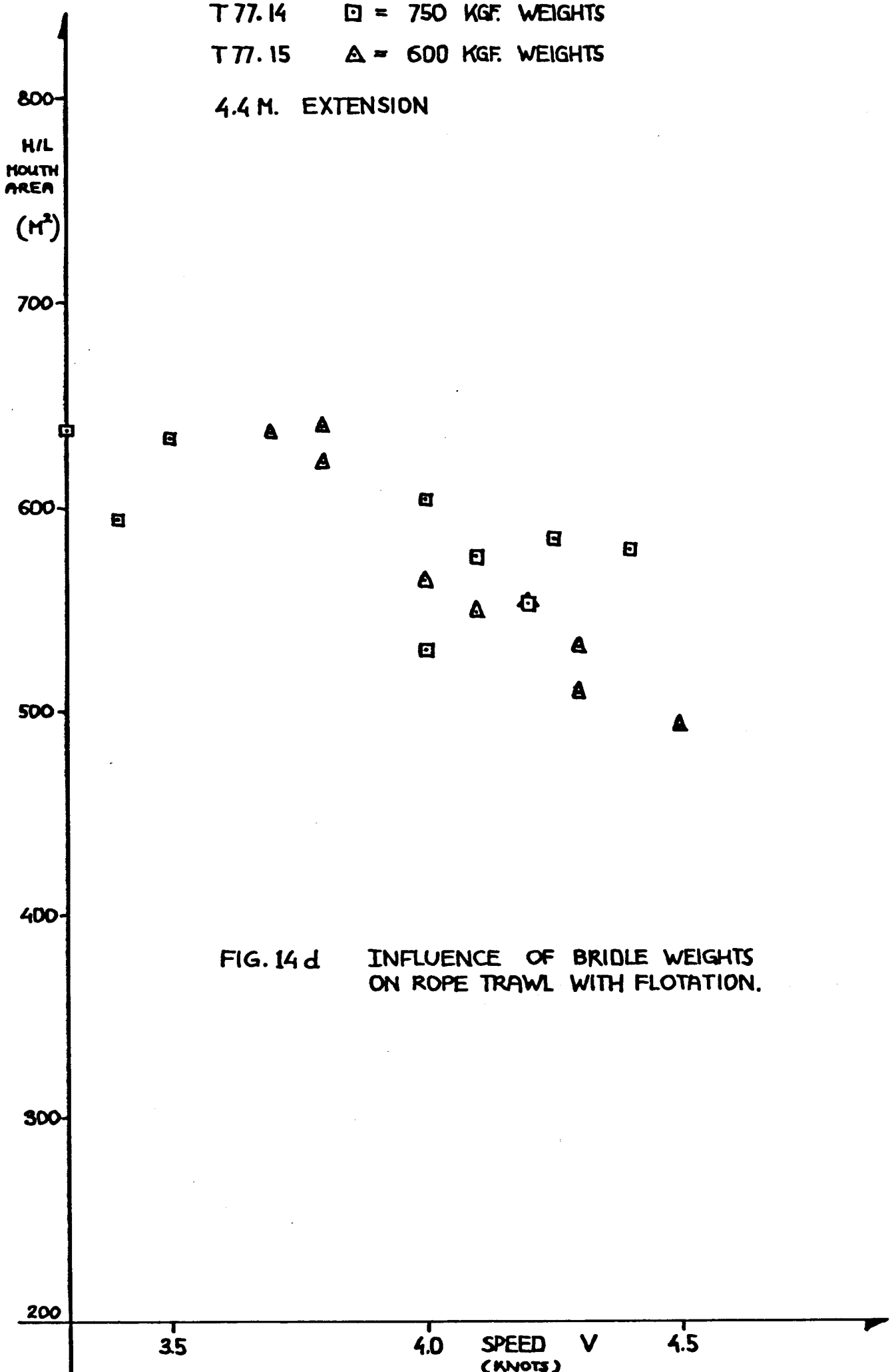


FIG. 14 d INFLUENCE OF BRIDLE WEIGHTS ON ROPE TRAWL WITH FLOTATION.

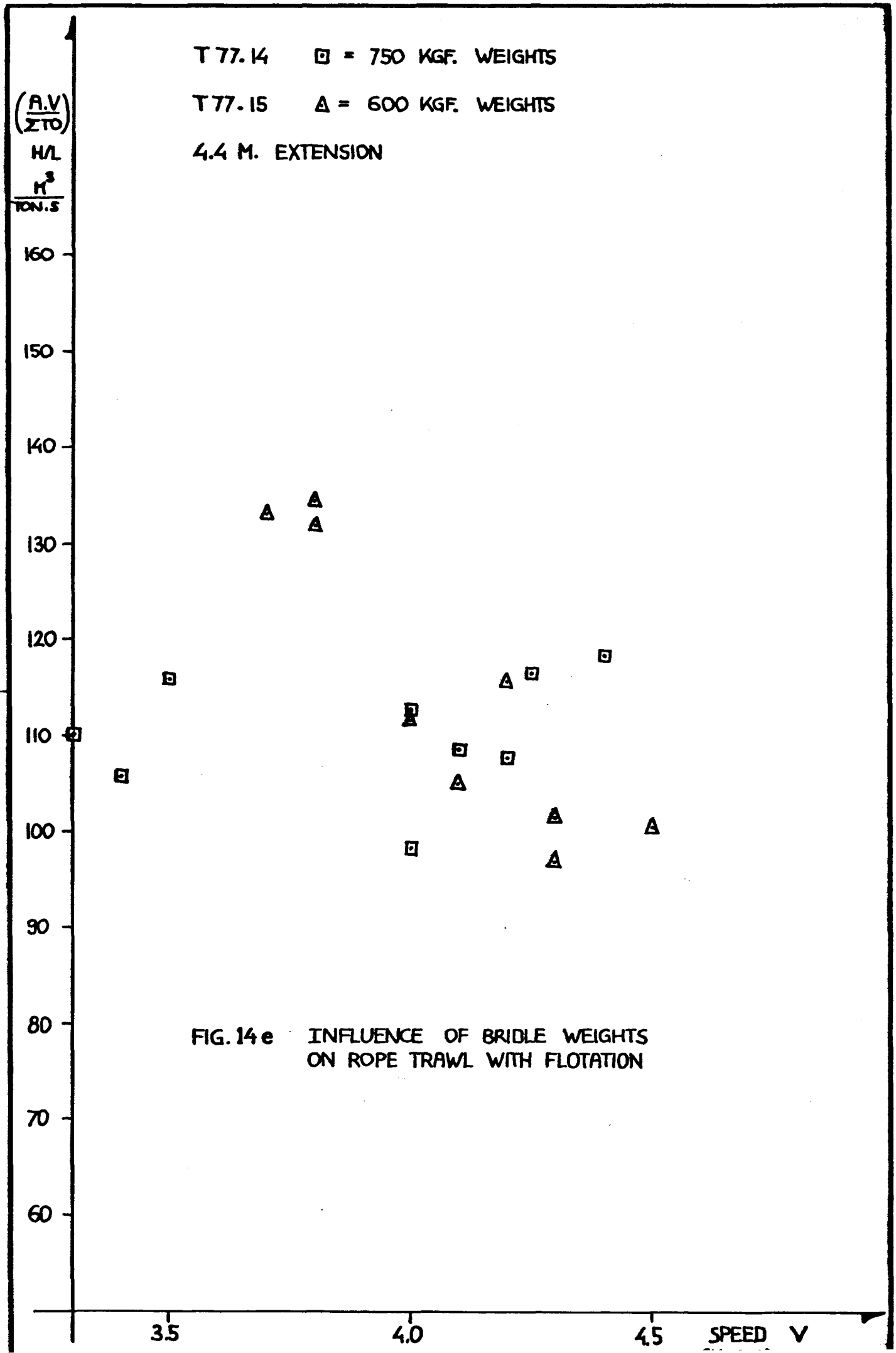


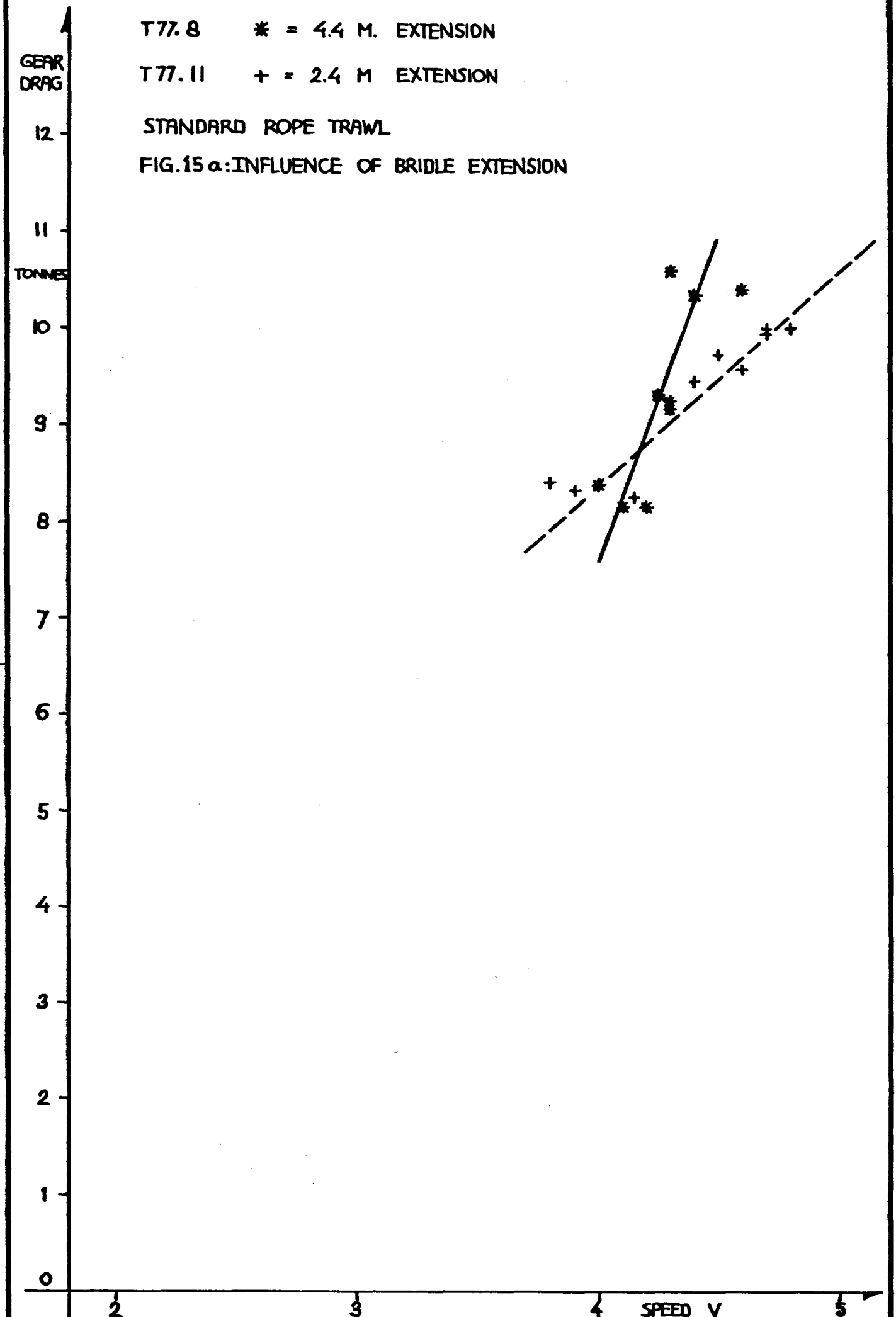
FIG. 14 e INFLUENCE OF BRIDLE WEIGHTS ON ROPE TRAWL WITH FLOTATION

T77.8 * = 4.4 M. EXTENSION

T77.11 + = 2.4 M EXTENSION

STANDARD ROPE TRAWL

FIG.15a: INFLUENCE OF BRIDLE EXTENSION

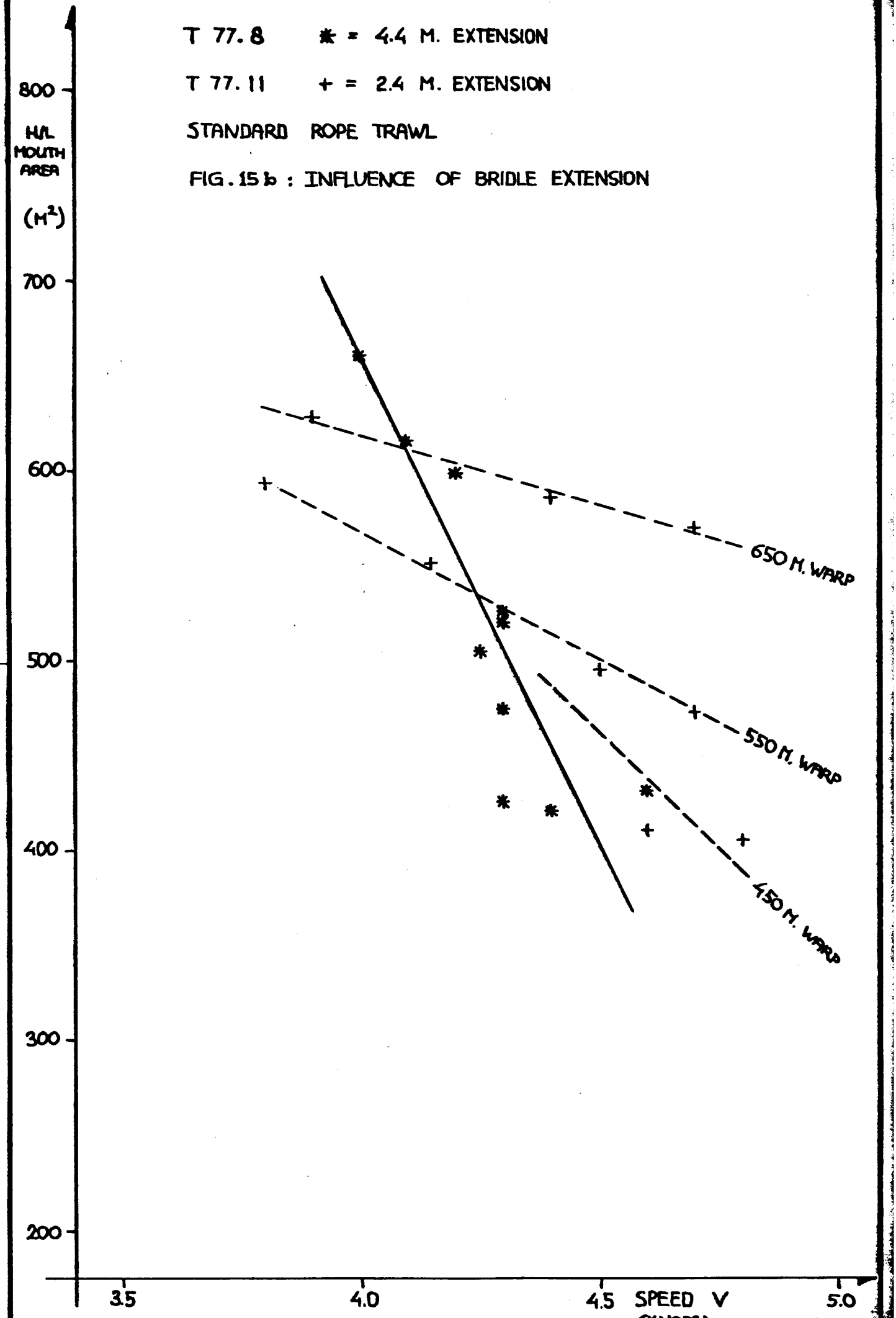


T 77.8 * = 4.4 M. EXTENSION

T 77.11 + = 2.4 M. EXTENSION

STANDARD ROPE TRAWL

FIG. 15 b : INFLUENCE OF BRIDLE EXTENSION

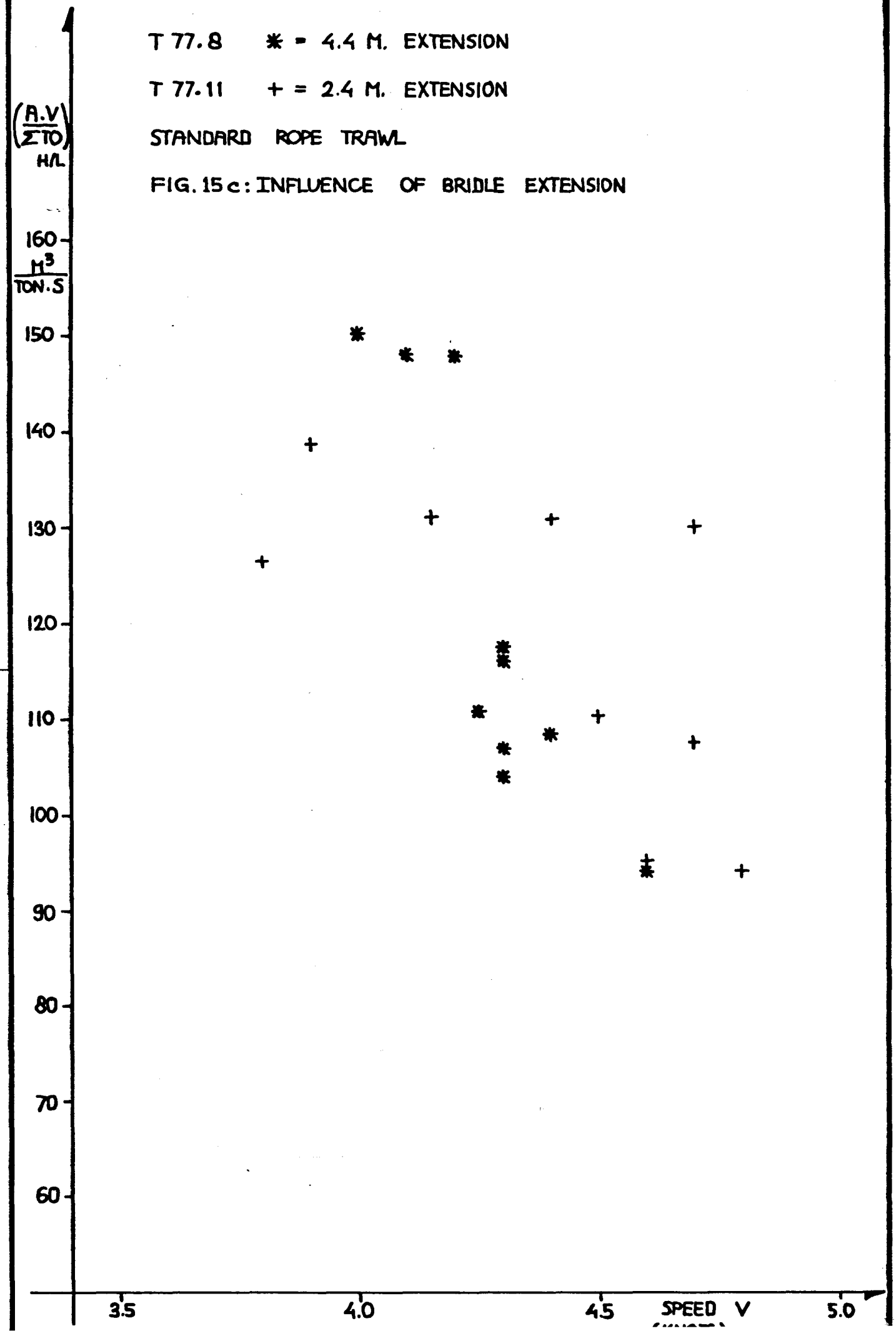


T 77.8 * = 4.4 M. EXTENSION

T 77.11 + = 2.4 M. EXTENSION

STANDARD ROPE TRAWL

FIG. 15c: INFLUENCE OF BRIDLE EXTENSION

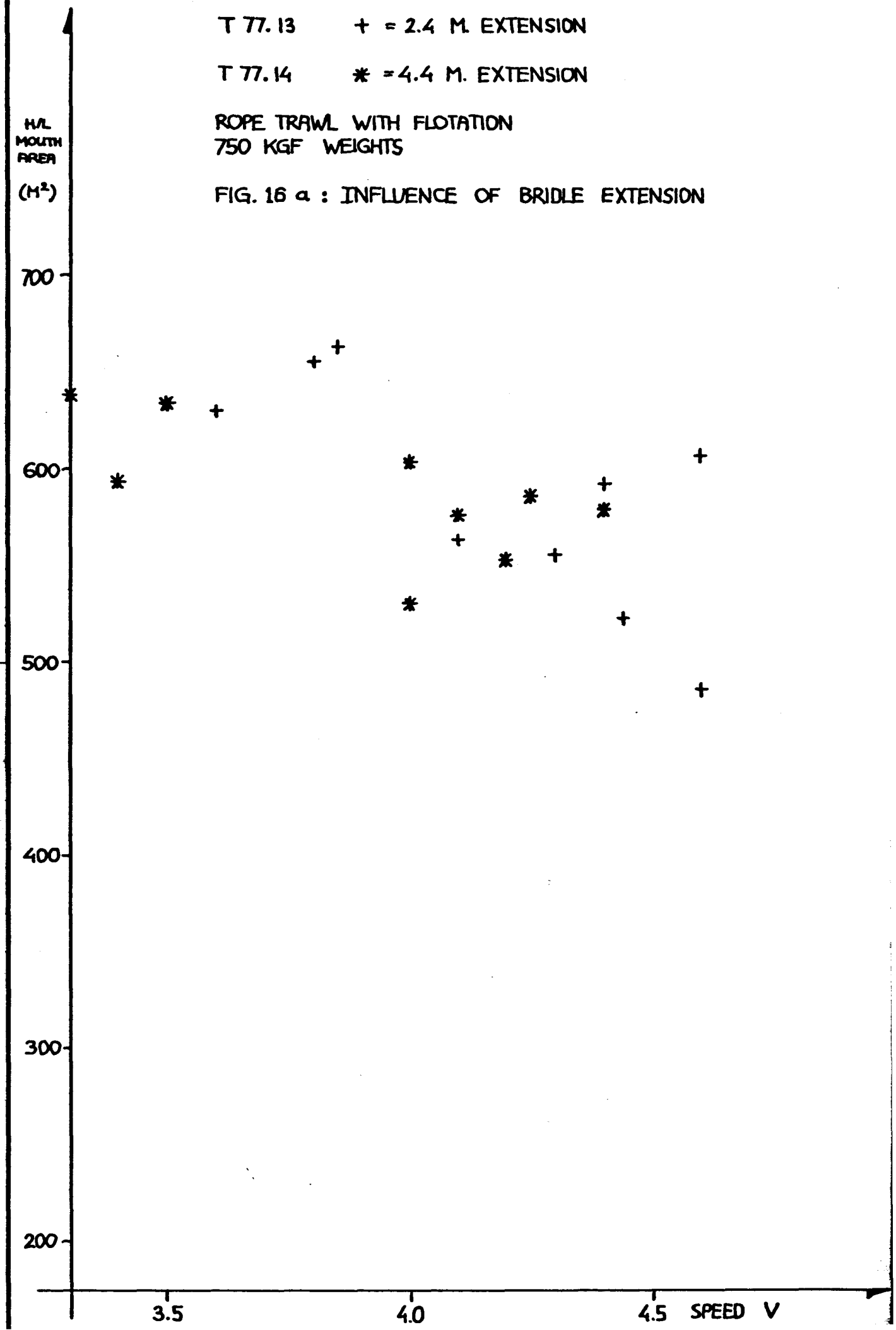


T 77.13 + = 2.4 M. EXTENSION

T 77.14 * = 4.4 M. EXTENSION

ROPE TRAWL WITH FLOTATION
750 KGF WEIGHTS

FIG. 16 a : INFLUENCE OF BRIDLE EXTENSION

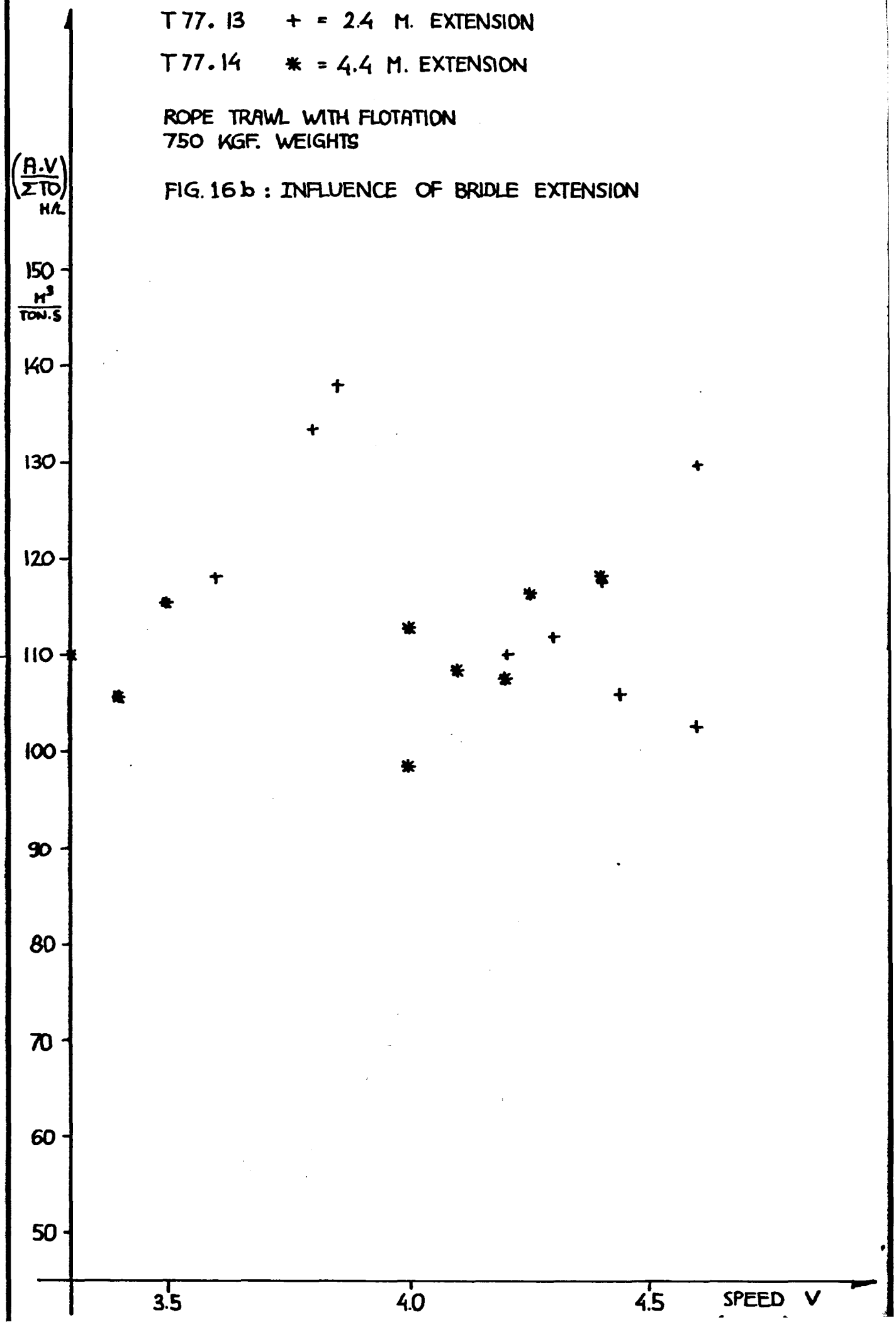


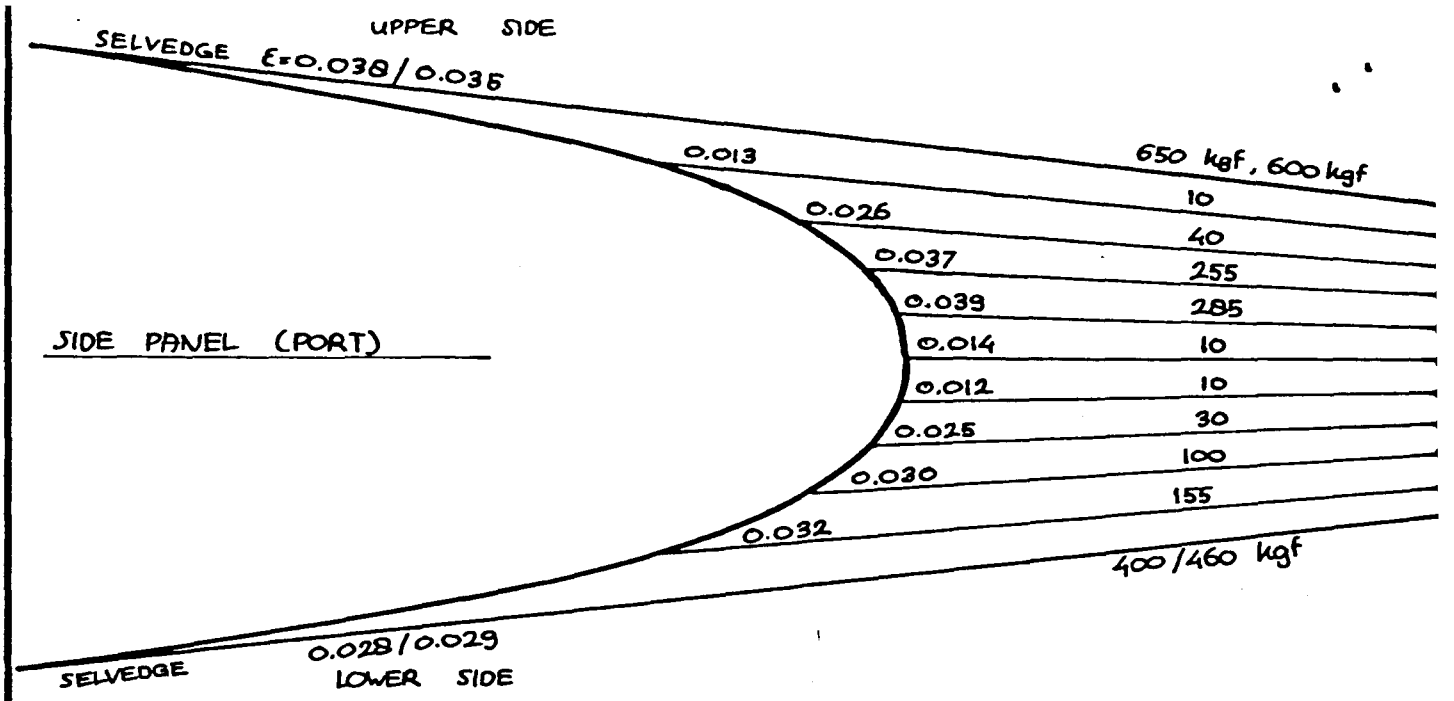
T 77. 13 + = 2.4 M. EXTENSION

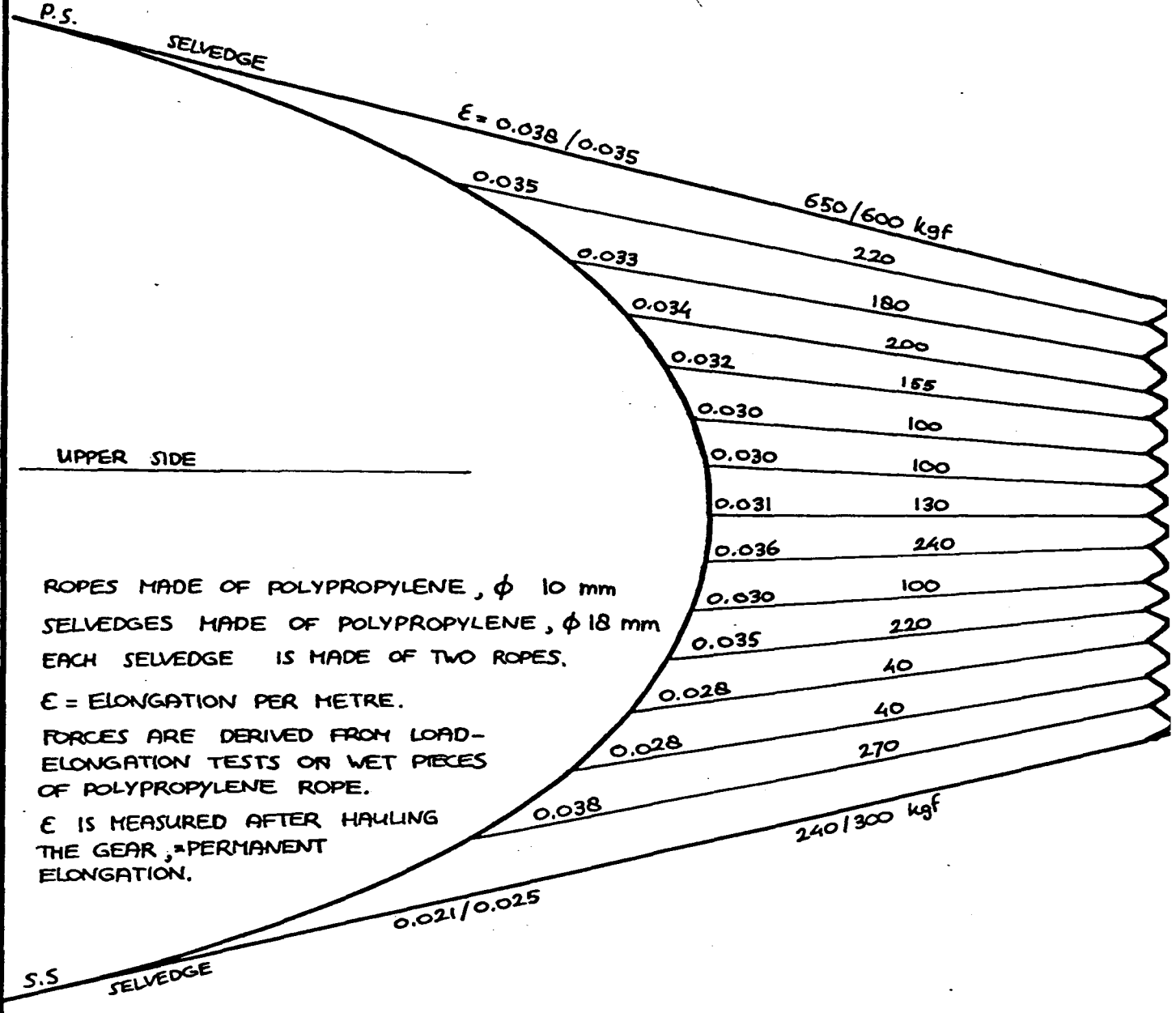
T 77. 14 * = 4.4 M. EXTENSION

ROPE TRAWL WITH FLOTATION
750 KGF. WEIGHTS

FIG. 16 b : INFLUENCE OF BRIDLE EXTENSION







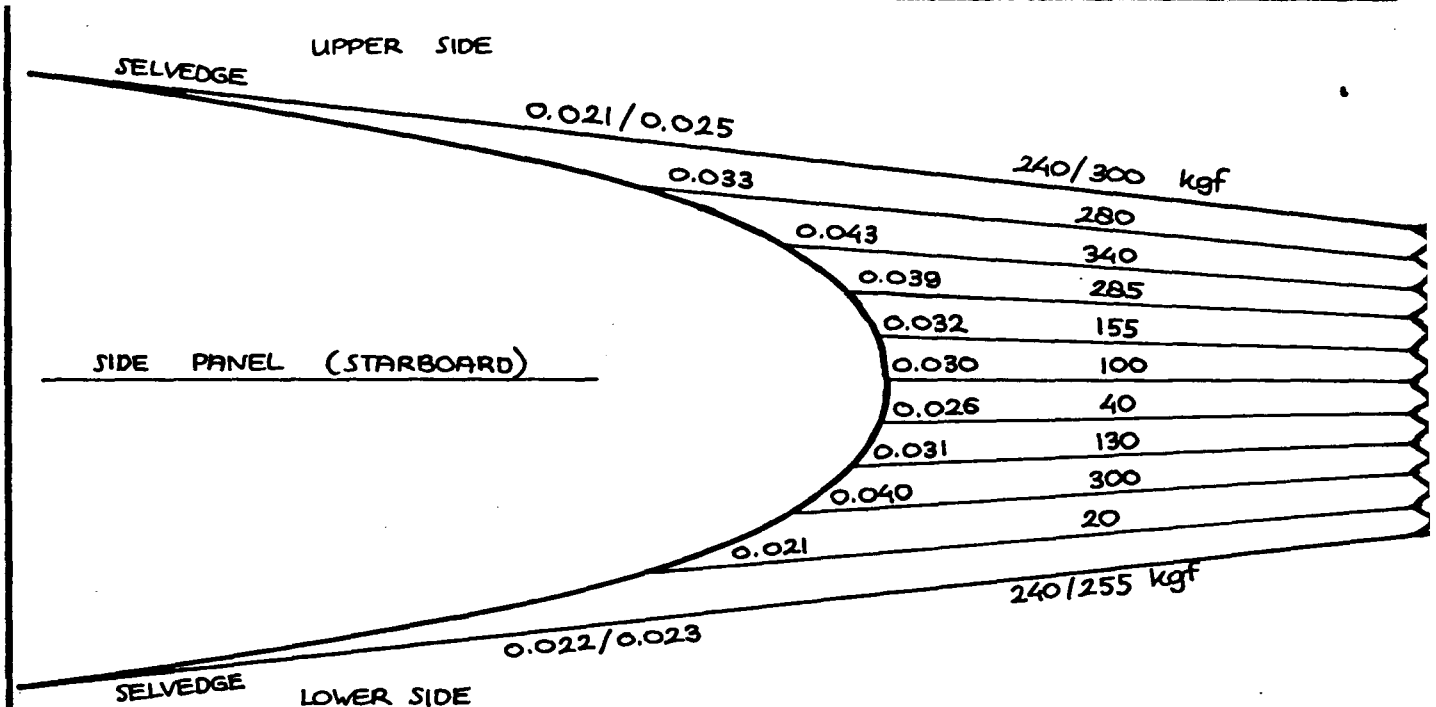
ROPES MADE OF POLYPROPYLENE, ϕ 10 mm
SELVEDGES MADE OF POLYPROPYLENE, ϕ 18 mm
EACH SELVEDGE IS MADE OF TWO ROPES.

ε = ELONGATION PER METRE.

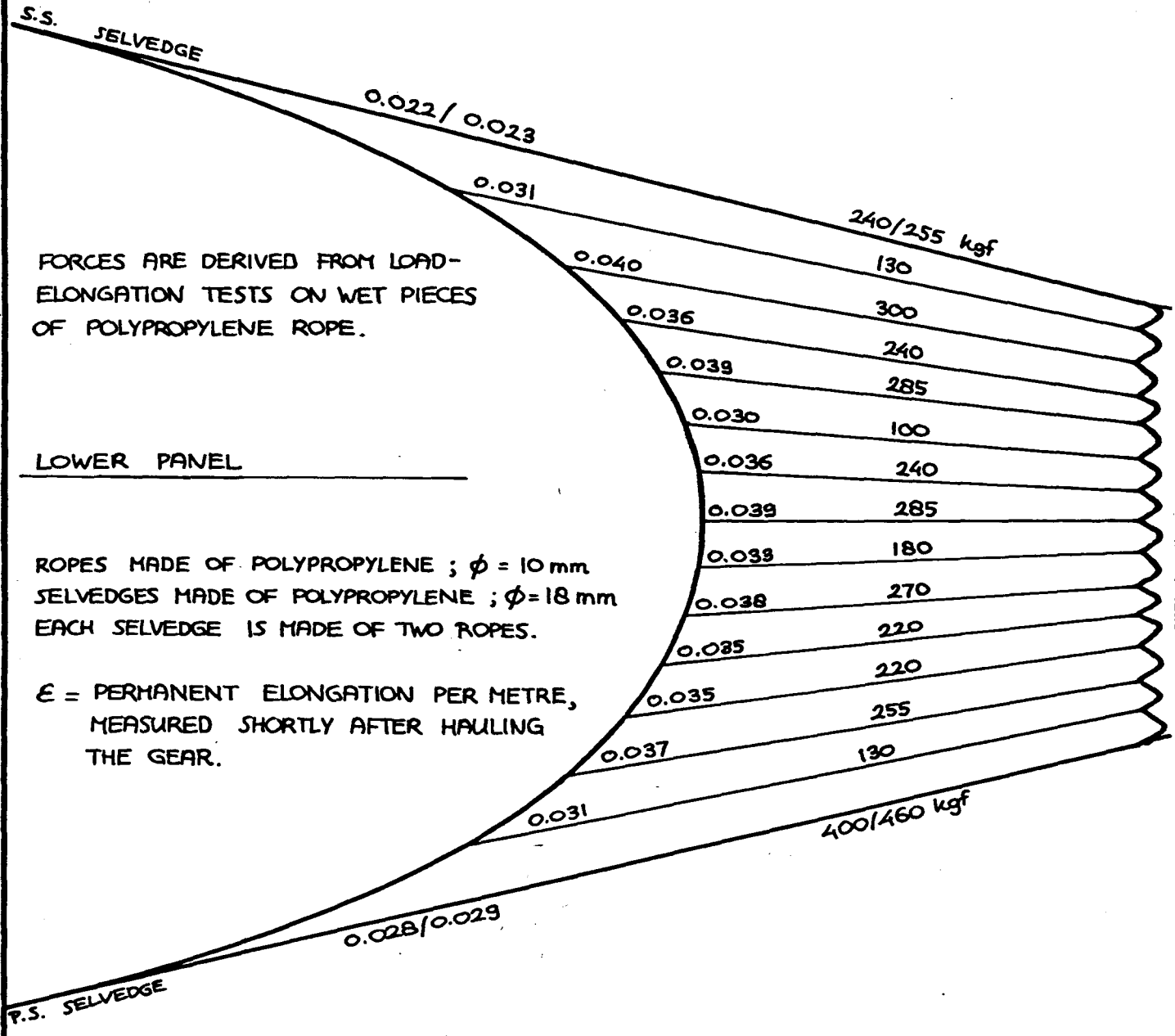
FORCES ARE DERIVED FROM LOAD-ELONGATION TESTS ON WET PIECES OF POLYPROPYLENE ROPE.

ε IS MEASURED AFTER HAULING THE GEAR, =PERMANENT ELONGATION.

Benaming DIMENSIONS OF ROPES FOR A ROPE-TRAWL			Formaat A4	FIG. 17a
TECHNICAL RESEARCH DEPARTMENT	Schaal	Gecontroleerd		
	Getekend BVM	Gezien 8-2-'78	Rangschikmerk	



SIDE PANEL (STARBOARD)



FORCES ARE DERIVED FROM LOAD-ELONGATION TESTS ON WET PIECES OF POLYPROPYLENE ROPE.

LOWER PANEL

ROPES MADE OF POLYPROPYLENE ; ϕ = 10 mm
SELVEDGES MADE OF POLYPROPYLENE ; ϕ = 18 mm
EACH SELVEDGE IS MADE OF TWO ROPES.

ϵ = PERMANENT ELONGATION PER METRE, MEASURED SHORTLY AFTER HAULING THE GEAR.

Benaming	DIMENSIONS OF ROPES FOR A ROPE-TRAWL		Formaat A4	FIG. 17b
TECHNICAL RESEARCH DEPARTMENT	Schaal	Gecontroleerd		
Auteursrecht voorbehouden volgens de wet	Getekend BVM	Gezien 8-2-'78	Rangschikmerk	

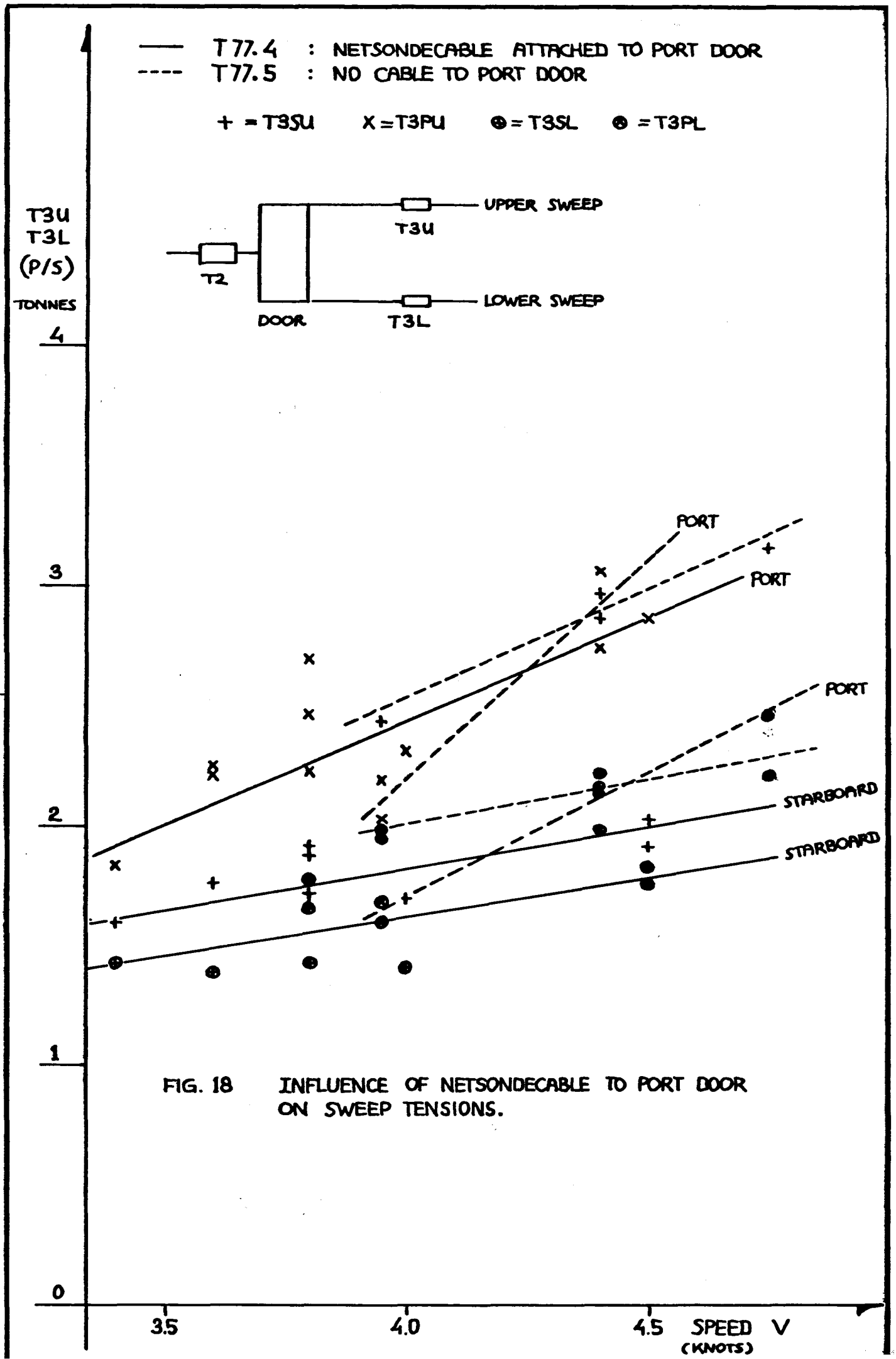


FIG. 18 INFLUENCE OF NETSONDECABLE TO PORT DOOR ON SWEEP TENSIONS.