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WIND-TUNNEL TESTS OF FOUR FULL-SCALE SEAPLANE FLOATS

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SUMMARY

Wind-tunnel tests of four full-scale seaplane floats were made at the request of the Bureau of Aeronautics to determine the aerodynamic characteristics of the floats and to evaluate several drag-reducing refinements. The floats were designated Edo model OS2U-2-68F, Edo model OS2U-2-68, Vought-Sikorsky model OS2U-1, and Edo model 62-6560. The first two floats differed only in such external details as flush rivets. The last-named float was of the type used on twin-float installations.

The variation of lift, drag, and pitching moment with pitch angle is presented for each float. In addition, tabulated results show the change in drag of the floats caused by the presence of various float fittings and also the reduction in drag made possible by the application of step fairings and other less extensive modifications. The effect of decreasing the depth of the step is also shown.

The results of these tests indicated that a radical change in the float design was necessary to obtain a worthwhile reduction in float drag. A step fairing which might conceivably be made retractable reduced the drag of the Edo 68F float more than 10 percent, and a 4-foot tail extension on the blunt-stern Edo 62-6560 float reduced the drag 8 percent. The flow of air over the floats was shown to be so turbulent that minor refinements, such as flush rivets and recessed fittings, would not appreciably reduce the drag. The accumulated reduction in drag resulting from the use of several minor refinements might, however, be sufficient to justify their employment on a float to be used on a high-speed airplane.

INTRODUCTION

The aerodynamic design of seaplane floats is usually secondary to the requirements for desirable hydrodynamic characteristics. Although the resultant high drag may be acceptable in low-speed applications, it becomes a rapidly increasing liability for floats used on high-speed aircraft.

The purpose of this investigation was to determine the aerodynamic characteristics of four full-scale seaplane floats and to evaluate several step fairings and other modifications designed to reduce the drag. The tests were conducted in the NACA propeller-research tunnel of the Langley Memorial Aeronautical Laboratory.

Three floats of the type used on military single-float seaplanes and one float of the type used on twin-float installations were tested. The Edo model OS2U-2-68F was made to the same lines as the OS2U-2-68 (standard) float but had been assembled with flush rivets and with as few protuberances as possible. A third military-type float, the Vought-Sikorsky model OS2U-1, was tested for purposes of comparison with the previous two floats. These three floats were of the type normally connected to the airplane with two streamline struts. The fourth float, Edo model 62-6560, was a stock commercial model used in twin-float installations. A 4-foot tail extension, intended to reduce the drag of the blunt stern, was tested on this last float.

Hydrodynamic tests of a model flying-boat hull equipped with a planing flap instead of a fixed step are discussed in reference 1. The planing flap may be deflected, creating a step, for water operation and then retracted in flight to form a smooth-bottom contour. In the retracted position, the planing flap is approximately similar to step fairings I and II of the present report.

Several papers describing aerodynamic tests of seaplane floats and flying-boat hulls are given as references 2 to 6. Of particular interest is the compilation of reports concerning British aircraft entered in the 1927 Schneider Trophy Contest. (See reference 2.) Included in it are the results of investigations similar to the present one, although less extensive in scope.

APPARATUS

Name-plate and other data for the floats tested are given in the following table:

Make	Model	Weight (lb)	Length (in.)	Displacement (submerged) (lb of sea water)	Volume (cu ft)	Maximum cross section (sq ft)
Edo	OS2U-2-68	482	319.6	9860	154	9.25
Edo	OS2U-2-68F	515	319.6	9860	154	9.25
Edo	62-6560	-------	298	6560	104	6.63
Vought-Sikorsky	OS2U-1	410	303.5	9100	142	8.96 (approx.)

The floats designated OS2U were of the type used on a single-float seaplane. In normal use they were connected to the airplane fuselage by two streamline struts in tandem with wire bracing. The model 62-6560 float was a stock commercial model used in twin-float installations.

Sketches and photographs of the four floats are provided in figures 1 to 7. The Edo 68F float differed from the 68 float in that flush rivets and screws were used on all exterior surfaces, all exterior joints were butt joints, the snubbing hooks and bow chock were recessed and covered, and the bow bumper was covered by a smooth metal covering.

The Vought-Sikorsky float differed from the Edo OS2U floats in the keel design, which was without the keelsons of the Edo floats. Round-head rivets and lap joints were used in its construction.

The Edo model 62 float lacked many of the refinements of the 68 floats. As may be seen in figure 3(c), the deck of this float was nearly flat and the stern was cut off square. The exterior joints were lap joints, round-head rivets were used, and no attempt was made to recess fittings.

All the floats were mounted in an inverted position in the wind tunnel, as shown in figures 1 and 2. Attachment to the support strut was made with a fitting bolted to the deck of the float, so designed that the float would be free in pitch. This fitting was at the location of the removed forward strut on the OS2U floats and in the plane of the forward side bracket on the Edo 62 float, as may be seen in figure 3. In order to shield the fitting from the wind stream, a streamline fairing that did not interfere with the support-strut shielding was attached to the deck of the float. This fairing was the same as the base section of the regular strut fairing on the Edo 68 and 68F floats and similar to, but slightly larger than, the regular base section on the Vought-Sikorsky float. Both fairings were trimmed to clear the support-strut fairing when the floats were pitched. At the end of the rear strut of each float, a symmetrical body of revolution conforming to the plan form of that strut section was attached to reduce tip effects.

The tail was supported by a $\frac{3}{8}$-inch streamline wire attached to the afterkeel. Outside the air stream, the tail wire was connected to a flexible cable which wound over a winch mounted on a balance under the roof of the tunnel. The pitch angle of the float was changed by adjusting the winch. The winch-and-scale assembly was shifted longitudinally to keep the tail wire vertical for each pitch angle.

TEST CONDITIONS AND PROCEDURE

Force measurements were made over a range of speeds up to 100 miles per hour; at this speed, the Reynolds number based on float length was approximately 25,000,000. Lift, drag, and pitching moment were measured at pitch angles from -5° to 5°. These angles were measured with respect to the horizontal datum line from which vertical float dimensions are given. Drag increments resulting from minor modifications were determined only at a pitch angle of 0°.

OS2U Military-Type Floats

There were three conditions, designated A, B, and C, for which measurements were made over a range of pitch angles. All three OS2U floats were tested in condition A; only the Edo 68F float was tested in conditions B and C. In addition,

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measurements of lift, drag, and pitching moment were made on the Edo 68F float with three different step fairings.

Condition A. - Each float as received was completely fitted, ready for attachment to an airplane except for bracing wires and rudder cables. With the following qualifications, this condition was condition A for which lift, drag, and pitching moment were measured at pitch angles from -5° to 5°. On the Edo 68 float and on the Vought-Sikorsky float, the thumbscrews on the handhole covers were alined with the float center line. On Edo floats 68 and 68F, the boots normally used to fair the side wire fittings were attached. The rudders were removed and the recovery keel hook was closed.

Condition B. - Several modifications were made to the Edo 68F float to put it in condition B. These modifications were:

- Keel catapult fitting removed
- Catapult hold-down fittings removed
- Recovery keel hook removed
- Boots removed
- Surface depressions at bow faired
- Carborundum treads made smooth

Condition C. - The Edo 68F float in condition C differed from condition B in that the rear strut was removed, the light metal cap over the bow bumper was removed, and the material which had been used to smooth the bow was removed. In this condition lift, drag, and pitching moment were measured at pitch angles from -5° to 5°.

Step fairings. - Tests were made to determine the effect of step fairings on the aerodynamic characteristics of the Edo 68F float in condition C. Three step fairings, designated full-step fairing, half-step fairing, and fairing I, were installed and measurements of lift, drag, and pitching moment were made at pitch angles from -5° to 5°. The full-step and half-step fairings reproduced the contours of the afterbottom, extending from the step to a point slightly ahead of the rudder post. As may be seen in figure 6(a), the full-step fairing was designed to form a continuous bottom surface with a change in direction at the former step location. The offsets for the full-step fairing are given in table I. The half-step fairing (fig. 6(b)) was created by dropping the same bottom contour one-half the distance back to the actual afterbottom. The step fairing designated fairing I (figs. 6(c) and 8) was designed to provide a continuous curve from the step to a point 2 feet aft of the step.

Measurements of drag of fittings. - The drag of fittings was determined from measurements of float drag after successive removal of the fittings. These drag increments were all measured on the Edo 68F float. In addition, the effect of modifications to a few of the fittings was measured. A complete list of the fittings removed and of the modifications made is given in table II. The float on which each measurement was made is also indicated in the table. In each case, after a fitting was removed, the corresponding bolt holes on the float were covered with cellulose "Scotch" tape. In most cases, the changes consisted simply of the addition or the removal of the part listed.

The first seven items in table II are features by which the Edo 68 and 68F floats differed. An extra set of conventional bow chock and snubbing hooks was attached to the 68F float in locations similar to those on the 68 float. The drag of snubbing hooks was also measured on the 68 float by removing those attached to it. Round-head rivet and screwheads were formed on the 68F float over the flush rivets and screws for a distance of 4.5 feet aft of the bow. (See fig. 4(c).) The heads were formed of modeling clay using a wooden die for the purpose.

There were noticeable depressions in and just behind the bumper cap on the float. The filling of these depressions and the fairing of the keel flare at and immediately aft of the bumper cap was the condition referred to as "improved fairing on bow." When the metal bumper cap was removed, a ridge was present on the Edo 68F float at the joining line. This ridge was faired because it would not normally be present on a float not equipped with a bumper cap.

On the Edo 68F float, the handhole covers were not truly flush. A flush surface was obtained by removing the covers, mounting a flat plate in the well, and building up to deck contours with modeling clay. In order to determine the effect of smooth tread surfaces on drag, the carborundum step treads were given a thin smooth coating of modeling clay. The drag of name plates was determined by attaching reproductions on the opposite side of the bow.

The fittings for the side wires were not actually removed to measure the wire-fitting drag, but that condition was simulated by applying a streamline shape over each fitting. In tests made with the side wires attached, the

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clevises on the outer ends were removed, the pairs of wire ends were taped together, and the taped ends were left free in the wind stream. In order to determine whether the drag of the boots for the side wire fittings could be lessened, the boots were first modified and then replaced with a streamline body of revolution. The boots were modified (fig. 5) by increasing the fineness ratio, smoothing surface irregularities, and adding a fillet at the base. Streamline fairings (fig. 9(b) and table III), which were also employed on the Edo 62-6560 float, were used to replace the boots. These streamline fairings were made of wood to a modified NACA 111 section having a fineness ratio of 3.5.

Edo Model 62-6560 Commercial-Type Float

The Edo model 62 float was received with no rudder, bracing wires, nor attachment struts. For the wind-tunnel tests, the rudder fittings were also removed. Two aluminum fairings (fig. 9(a)) were furnished with the float to cover the two port-side attachment brackets. In the discussion of this float, condition A refers to the float as received without rudder fittings and side-bracket fairings.

Tests were made with two types of step fairing, which are designated I-a and II. Step fairing I-a, similar to fairing I installed on the Edo model 68F float, was designed to form a continuous surface from the step to a point 2 feet aft of the step (figs. 7(a) and 8). Step fairing II (figs. 7(b) and 10) also faired out the whole depth of the step but extended 4 feet aft of the step and was designed to provide a smooth curve in the bottom surface of the float. Lift, drag, and pitching moment were measured over the range of pitch angles from -5° to 5° with each type of step fairing installed on the float.

A 4-foot tail extension was attached to the blunt stern of the model 62 float to obtain a further reduction in drag. This extension (figs. 7 and 11) faired smoothly into the lines of the float at the tail section (cross-sectional area, 1.3 sq ft), bringing the deck and chine lines together to terminate in a thin vertical section. The effect of this tail extension on lift, drag, and pitching moment was measured over the range of pitch angles from -5° to 5°.

The drag of the port-side attachment brackets on the float was determined and also the drag of the original aluminum fairings for these brackets. The streamline fairings made to a modified NACA 111 section, previously mentioned, were also placed over the attachment brackets to determine what further reduction in drag could be obtained.

RESULTS AND DISCUSSION

The following symbols have been used in the presentation of the results:

D	drag, pounds
L	lift, pounds
M	pitching moment, foot-pounds
A	maximum cross-sectional area, square feet
q	dynamic pressure, pounds per square foot
Vol	displacement, cubic feet
C_D	drag coefficient, further defined where used
θ	pitch angle, degrees (positive, bow up)

A subscript 100 denotes 100 miles per hour, which corresponds to a dynamic pressure of 25.6 pounds per square foot.

The measured values of drag have been corrected for horizontal buoyancy (4 to 5 percent for the OS2U floats and 3.5 to 4.5 percent for the Edo model 62-6560 float) and for tare drag. The tare drag was 0.5 pound (at 100 mph) for the tail wire. There was no tare-drag correction for the support strut because it was completely shielded from the air stream. A correction has also been applied to pitching moment for the drag of the tail wire.

Test data were plotted against dynamic pressure and a straight line was drawn through the points. A typical plot (fig. 12), showing test points, gives an indication of the accuracy of the measurements. Values of lift, drag, and pitching force were read at a dynamic pressure of 25.6 pounds per square foot, which corresponds to a velocity of 100 miles per hour. After the corrections previously given were applied and the pitching moment was computed, the resultant values were cross-plotted against pitch angle. The curves of lift, drag, and pitching moment were obtained by fairing through these cross-plotted points.

Values of D_{100} and C_D at a pitch angle of 0° are given in table IV for all four floats in several representative conditions. Two forms of C_D are presented: one based on maximum cross-sectional area and the other based on volume to the two-thirds power. The values of area and volume used in computing drag coefficients are those given with name-plate data.

OS2U Military-Type Floats

The drag values of the various fittings and the reductions in drag resulting from modifications to the fittings are shown in table II. The drag of fittings, although small, was found to check when repeat tests were conducted and also to check when similar measurements were made on two floats. These values of fitting drag therefore are considered more accurate than the method of measurement would seem to indicate.

Round-head rivets were simulated only on the forward part of the flush float because experience indicated that the effect would be greatest in that region. Inasmuch as the measured drag of the applied rivet heads on this forward part of the float was small, no large increase in drag would have been found by extending the simulated heads to the rudder post.

The fairings applied to the bow and to the wire boots have not been dimensioned because the method of modification was not precise. The value of such modifications has been shown and, if it is found feasible to do so, the present results may be equaled in a practical installation.

From figure 13(a), it may be seen that the drag of the Edo 68F float was 2.8 pounds less than that of the 68 float at a pitch angle of 0°. This drag is distributed as follows:

	Drag (lb)
Irregularity at bumper joint	0.1
Bow chock	.2
Snubbing hooks	.4
Rivet heads (to 4.5-ft station)	.3
Thumbscrews	.2
"Hat" section longitudinals	.3
Total	1.5

This total leaves a drag of 1.3 pounds for the lap joints, deck rails, remaining rivet heads, and any other unintended differences.

The effect of the hat sections and wire boots on the drag of the Edo 68F float through a range of pitch angles from -5° to 5° is shown in figure 13(c). For these two fittings, the differences in float drag are approximately constant through the range of pitch angles.

In order to obtain the total drag of the floats plus fittings, the drag of each float in condition A at a pitch angle of 0° should be increased by the following amount:

	Drag (lb)
Forward-strut fairing (approx.)	2.3
Side wires	4.1
Rudder	.5
Total	6.9

The value of 2.3 pounds approximated for the forward-strut fairing does not include the drag of the base section of the fairing because this drag was included in the float drag as measured.

The effect of the three types of step fairing on the drag of the Edo 68F float in condition C is shown in figure 13(b). The full-step fairing reduced the drag 5.5 pounds at a pitch angle of 0°, and the half-step fairing reduced the drag 3.3 pounds. Step fairing I reduced the drag by the same amount as the full-step fairing at a pitch angle of 0°, by a smaller amount at negative pitch angles, and by a greater amount at positive pitch angles.

The variation in float lift with pitch angle is shown in figure 14. An increase in float lift is obtained by the use of the full-step and the half-step fairings on the Edo 68F float in condition C (fig. 14(b)). The effect of the hat sections and wire boots on float lift is shown in figure 14(c).

Values of float pitching moment as affected by pitch angle are shown in figure 15. It is evident that step fairings, the hat sections, and the wire boots also affected float pitching moment (figs. 15(b) and 15(c)).

The disposition of tufts placed on the side of the Edo 68F float near the chine is shown in figure 16. These tufts and others placed on the bottom of the float indicate that the air flows off the curved bottom at the chine and swirls back along the side of the float. This condition is more noticeable at positive pitch angles. Tufts placed on the bottom of the Edo 68F float showed that the flow of air was very turbulent for a distance of approximately 2 feet behind the step.

Edo Model 62-6560 Commercial-Type Float

The variation of float drag with pitch angle of the Edo 62-6560 float in several conditions is shown in figure 17. The reductions in drag at a pitch angle of 0° resulting from the various modifications to the float are given in table IV. In addition to the horizontal-buoyancy correction and tare drag of the tail wire, a correction of 4 pounds has been applied as the tare drag of the fairing fastened to the deck of the float at the top of the support strut, inasmuch as this fairing would not be part of an actual twin-float installation. The tare drag of the fairing was higher for these tests because its original streamline shape was deformed for installation on the Edo model 62 float.

Step fairings I-a and II reduced the drag of the model 62 float approximately 5 pounds at a pitch angle of 0°; fairing II had a slight advantage when used with the tail extension and fairing I-a had the advantage when used without the tail extension.

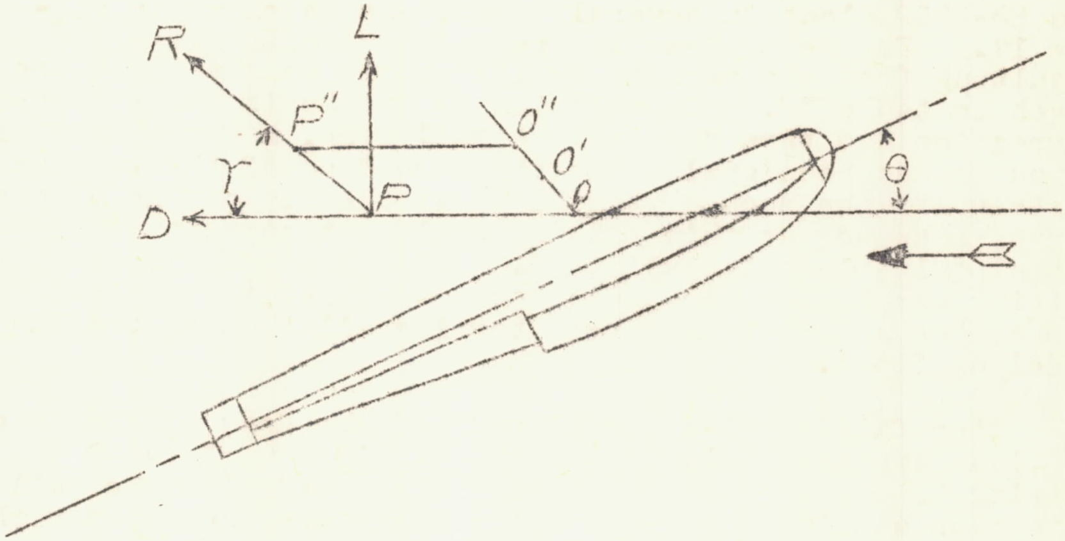
The tail extension reduced the drag of the float 2.7 pounds at a pitch angle of 0° with no step fairing. This drag reduction was decreased to 2.3 pounds when step fairing I-a was attached to the float and increased to 3.3 pounds when step fairing II was used.

The drag of the port-side attachment fittings was 2.8 pounds, and the results indicate that this drag may be reduced to 1 pound or less by use of a streamline fairing.

Variations of float lift with pitch angle as affected by step fairings and tail extension are shown in figure 18, and the corresponding values of float pitching moment are shown in figure 19.

Transfer of Pitching Moments

The values of pitching moment given in figures 15 and 19 have been taken about the axis of the wind-tunnel support fitting, located as shown in figures 1 and 2. A graphical method is herewith presented by which the given pitching moment may be transferred to any other moment center, such as the center of gravity of the float-equipped airplane. This solution may conveniently be performed using a Colby protractor.



Point O represents the center about which the pitching moment is given. In order to obtain the pitching moment about some other point O', proceed as follows:

Parallel to the relative wind, draw OP = M/L to some convenient scale. OP is positive in the direction opposite to the direction of the relative wind.

At P draw R at an angle $\gamma = \tan^{-1} \frac{L}{D}$ to OP.

R represents the line of action of the resultant force.

On the line through O and O', locate O" such that OO" represents the actual distance between the original and the new axis to the scale of OP.

Draw O"P" parallel to OP intersecting R at P". Then the pitching moment M' about O' is $M' = \frac{MO''P''}{OP}$.

CONCLUSIONS

The most significant conclusion indicated by the results of the tests of the four seaplane floats reported herein was that a radical change in float design was necessary to achieve any considerable reduction in float drag. The specific conclusions, in order of importance, may be summarized as follows:

1. A decrease in drag of approximately 5 pounds (at 100 mph) was obtained by the use of step fairings. This decrease was more than 10 percent of the drag of the Edo 68F float complete with fittings.

2. A short fairing might well be employed if it could be made retractable on production floats. A fairing of this type (fairing I) gave a higher drag than the full-step fairing at negative pitch angles but gave a lower drag at positive angles.

3. An 8-percent drag reduction was attained by the addition of a 4-foot tail extension to the Edo model 62 float.

4. The reduction in drag obtained by using the Edo 68F float instead of the 68 float could be profitably augmented by incorporating in the 68F float some of the modifications made to fittings during the tests.

5. The use of flush rivets aft of the step on the Edo OS2U-2-68F float does not appear to be justified.

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REFERENCES

1. Benson, James M., and Lina, Lindsay J.: The Use of a Retractable Planing Flap instead of a Fixed Step on a Seaplane. NACA A.R.R., May 1943.

2. Collected Reports on British High Speed Aircraft for the 1927 Schneider Trophy Contest. R. & M. No. 1300, British A.R.C., 1931.

3. Hartman, Edwin P.: The Aerodynamic Drag of Flying-Boat Hull Models as Measured in the N.A.C.A. 20-Foot Wind Tunnel - I. T.N. No. 525, NACA, 1935.

4. Parkinson, J. B., and House, R. O.: Hydrodynamic and Aerodynamic Tests of Models of Floats for Single-Float Seaplanes. N.A.C.A. Models 41-D, 41-E, 61-A, 73, and 73-A. T.N. No. 656, NACA, 1938.

5. Truscott, Starr, Parkinson, J. B., Ebert, John W., Jr., and Valentine, E. Floyd: Hydrodynamic and Aerodynamic Tests of Models of Flying-Boat Hulls Designed for Low Aerodynamic Drag. N.A.C.A. Models 74, 74-A, and 75. T.N. No. 668, NACA, 1938.

6. Parkinson, John B., Olson, Roland E., and House, Rufus O.: Hydrodynamic and Aerodynamic Tests of a Family of Models of Seaplane Floats with Varying Angles of Dead Rise. N.A.C.A. Models 57-A, 57-B, and 57-C. T.N. No. 716, NACA, 1939.

TABLE I.- OFFSETS FOR THE FULL-STEP FAIRING

USED ON EDO MODEL 68F FLOAT

[As shown on Edo Aircraft Corporation drawings, the datum line is a horizontal line tangent to the keel and parallel to the straight portion of the deck center line]

Distance aft of step, in.	Half-breadth, in.		Height above datum line, in.		
	Chine	Keelson	Keel	Chine	Keelson
0	23.25	13.59	0	10.87	5.62
19	22.25	12.00	2.18	12.66	7.41
44	20.37	10.06	4.97	14.37	9.75
69	17.87	8.12	7.75	15.75	12.06
94	14.41	6.16	10.62	16.62	14.41
119	9.75	--------	13.44	17.12	--------
143	3.87	--------	16.12	17.50	--------

TABLE II.- DRAG OF FITTINGS ON EDO 68 AND 68F FLOATS

[Values of drag are given for pitch angle of 0° and an airspeed of 100 mph, corresponding to $q = 25.6$ lb/sq ft. Measurements made on Edo 68 float denoted by subscript a. All other measurements made on Edo 68F float.]

Drag of fittings	
Fitting	Drag (lb)
Irregular bow-bumper joint, simulated by cord 1/8 in. in diam.	0.1
Bow chock	.2
Snubbing hooks (four)	.4
Round-head rivets and screws, from bow to 4.5-ft station	.3
Metal bumper cap	.0
Hat section longitudinals	.3
Thumbscrews in handhole covers (thumbscrews parallel to float center line)	$^{a}.2$
Increased drag created by turning thumbscrews 90°	$^{a}.6$
Name plates (two)	.2
Towing bar	.1
Recovery keel hook	.3
Keel catapult fitting	.3
Catapult hold-down fittings (two)	.2
Side wire fittings (four)	.9
Boots for side wire fittings (four)	1.6
Streamline fairings for side wire fittings (four); modified NACA 111 section	1.7
Side wires and boots (four)	4.8
Side wires mounted without boots	5.4
Rear strut	3.1
Rudder cables	$^{a}.0$
Rudder	$^{a}.5$

Drag reductions resulting from modifications	
Modifications	Drag reductions (lb)
Sealed openings for beaching gear	0.2
Closed recovery keel hook	.1
Improved fairing at bow	.4
Smoothed carborundum tread surfaces	.5
Removed handhole covers and replaced with smooth flush surface	.2
Improved streamlining of boots	.6
Boots on wires	.6
Front strut base fairing as used on Edo floats compared to a fairing without a fillet	3.0

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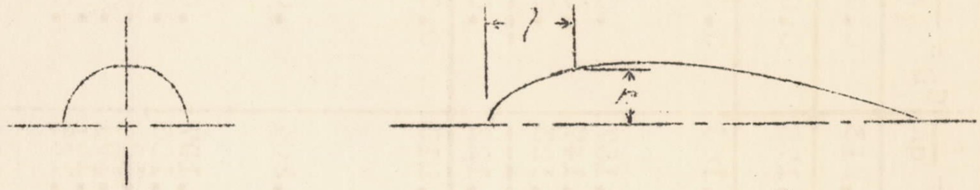
TABLE III.- ORDINATES FOR STREAMLINE FAIRINGS

OVER SIDE FITTINGS



Ordinates, in.	
l	r
0	0
.33	.73
.67	1.10
1.34	1.65
2.01	2.05
2.68	2.37
4.02	2.84
5.36	3.16
6.70	3.44
8.04	3.63
9.39	3.76
10.71	3.83
12.06	3.83
13.40	3.77
14.75	3.64
16.10	3.44
17.41	3.14
18.75	2.77
20.10	2.35
21.45	1.88
22.80	1.42
24.10	.95
25.50	.48
26.10	.24
26.80	0

TABLE IV.- VALUES OF FLOAT DRAG

[Values of drag are given for pitch angle of 0° and at $q = 25.6$ lb/sq ft corresponding to an airspeed of 100 mph]

Float	Condition	Drag reduction from condition A	Drag (lb)	$C_D = \frac{D}{qA}$	$C_D = \frac{D}{q(Vol)^{2/3}}$
ought-Sikorsky OS2U-1	A[1]		48.8	0.213	0.0695
Edo OS2U-2-68	A		42.1	0.178	0.0569
Edo OS2U-2-68F	A		39.3	0.166	0.0531
	B	2.2	37.1	.157	.0501
	C	4.7	34.6	.147	.0471
	C, with full-step fairing	10.2	29.1	.123	.0394
	C, with half-step fairing	8.0	31.3	-----	------
	C, with step fairing I	10.3	29.0	.122	.0392
Edo 62-6560	A		35.6	0.210	0.0629
	A				
	(1) With original fairings for side fittings	1.0	34.6	.204	.0610
	(2) With streamline fairings for side fittings	2.2	33.4	.197	.0590
	(3) With step fairing I-a	5.0	30.6	.180	.0541
	(4) With step fairing II	4.7	30.9	.182	.0545
	A with tail extension and	2.7	32.9	.194	.0581
	(1) With step fairing I-a	7.3	28.3	.167	.0500
	(2) With step fairing II	8.0	27.6	.163	.0488
	A with streamline fairings, step fairing II, and tail extension	10.2	25.4	.150	.0450

See "Test Conditions and Procedure."

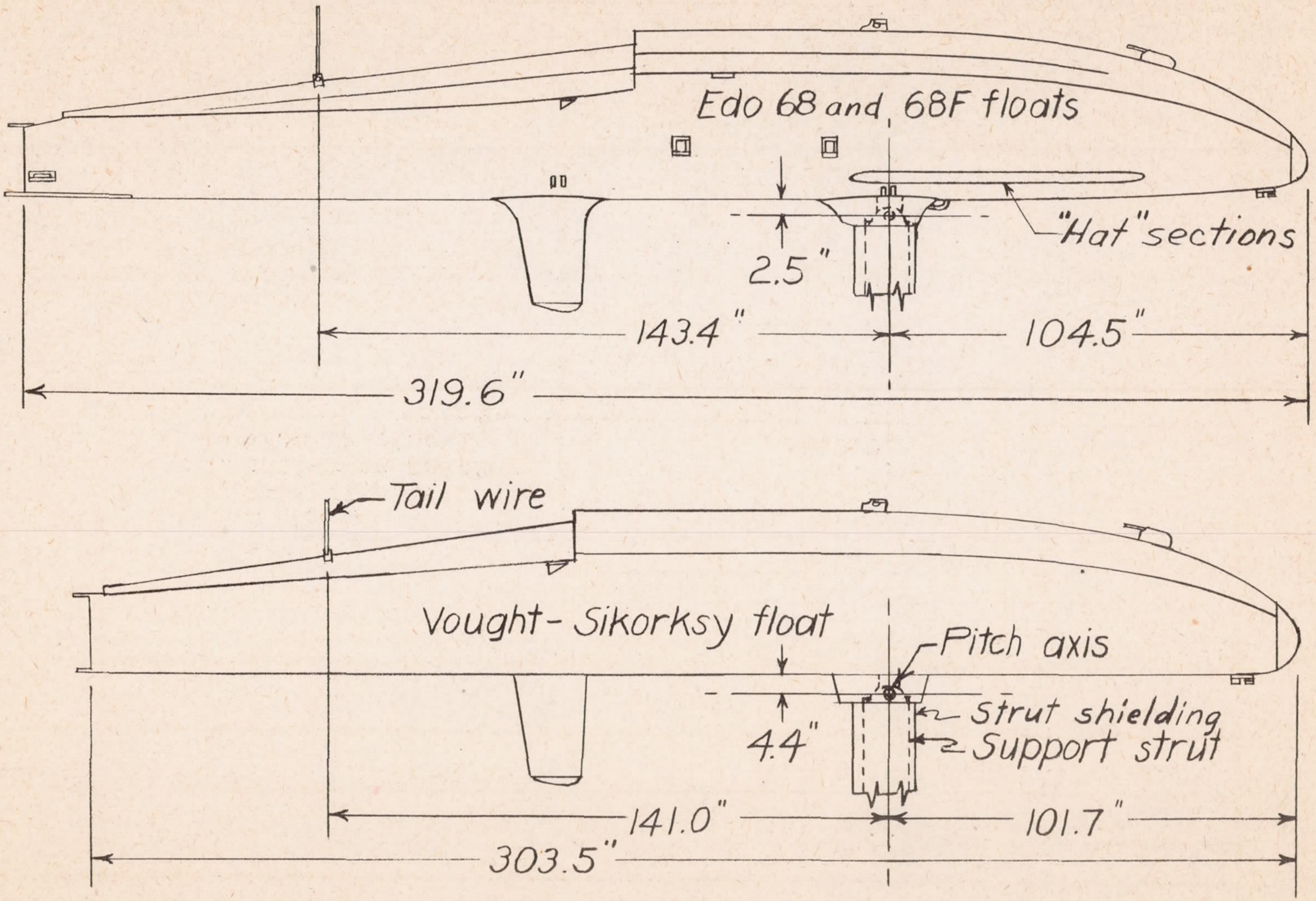


Figure 1.- Arrangement of test setup for OS2U military-type floats.

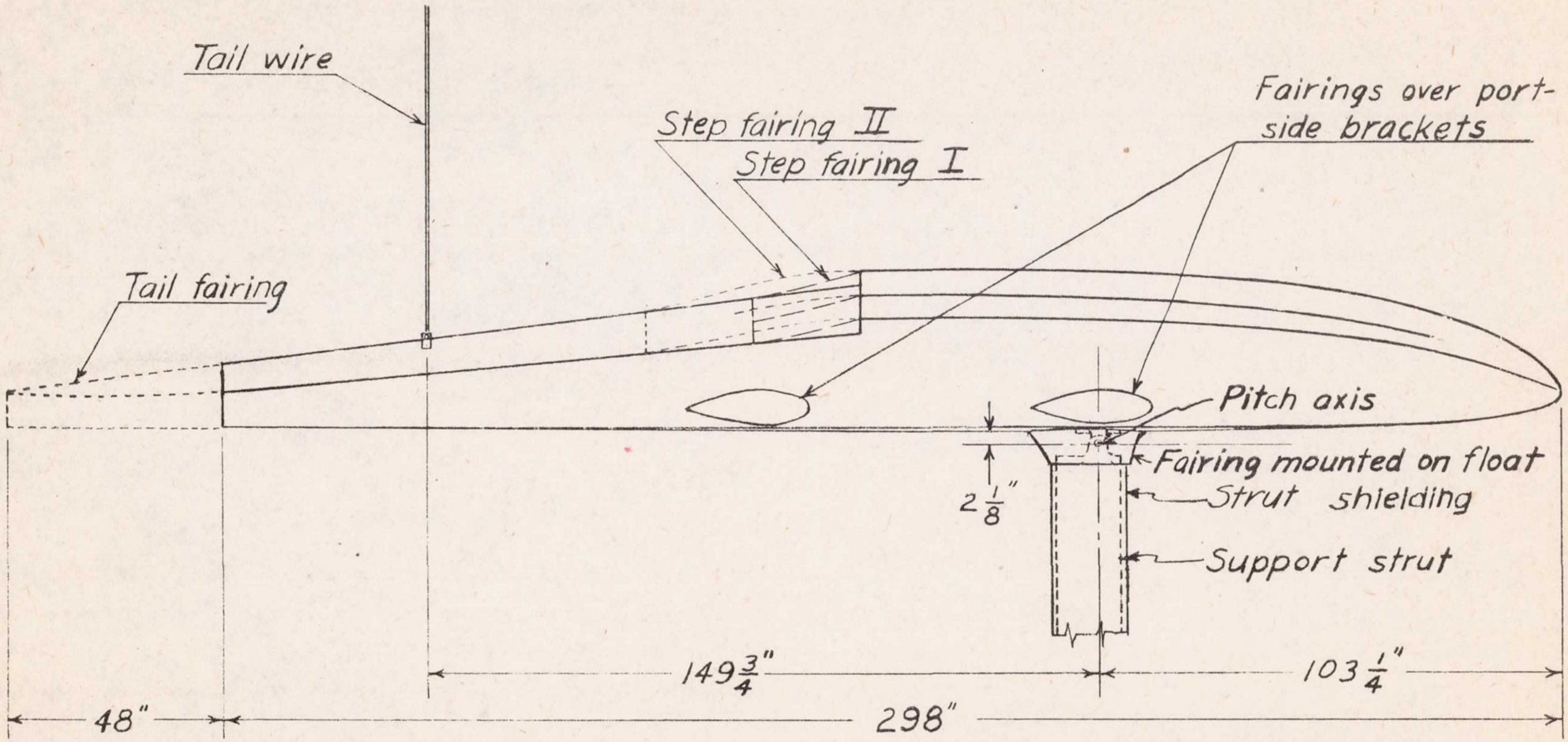
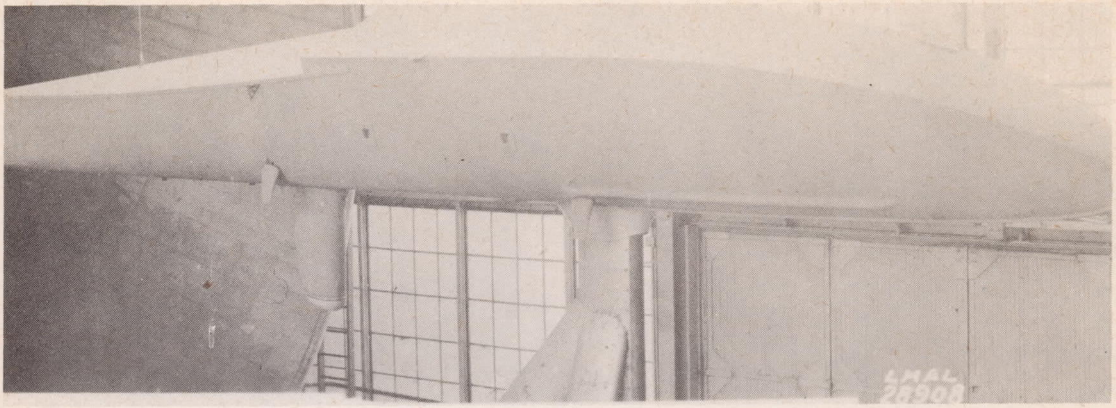
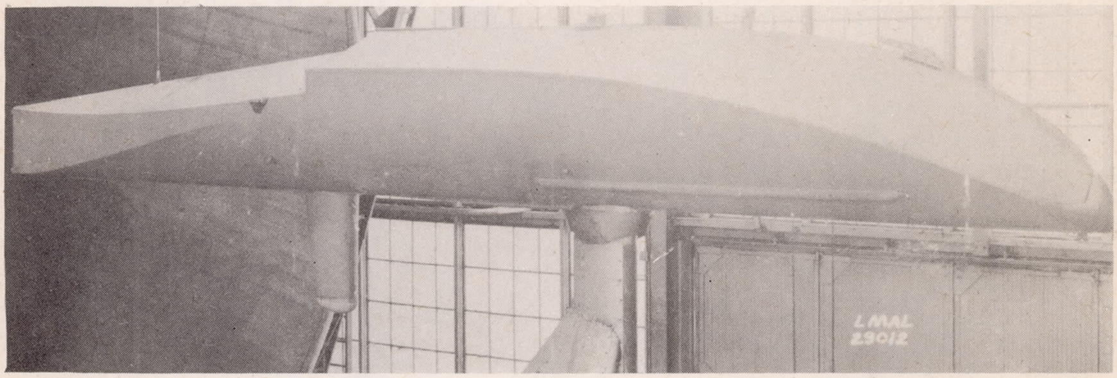


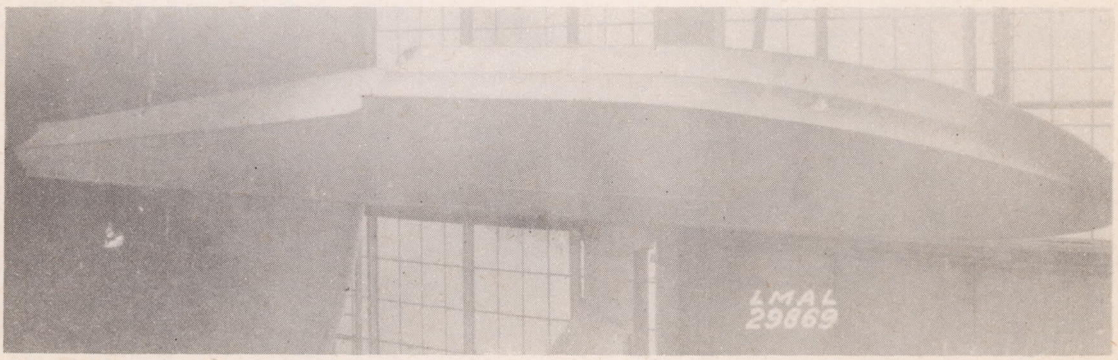
Figure 2.- Arrangement of test set up for Edo model 62-6560 commercial-type float.



(a) Edo OS2U-2-68.

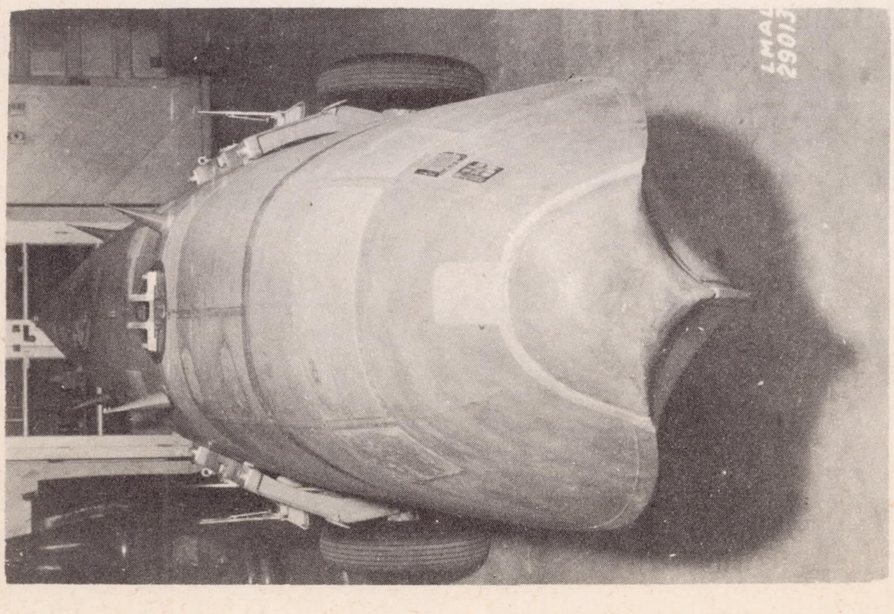


(b) Vought-Sikorsky OS2U-1.

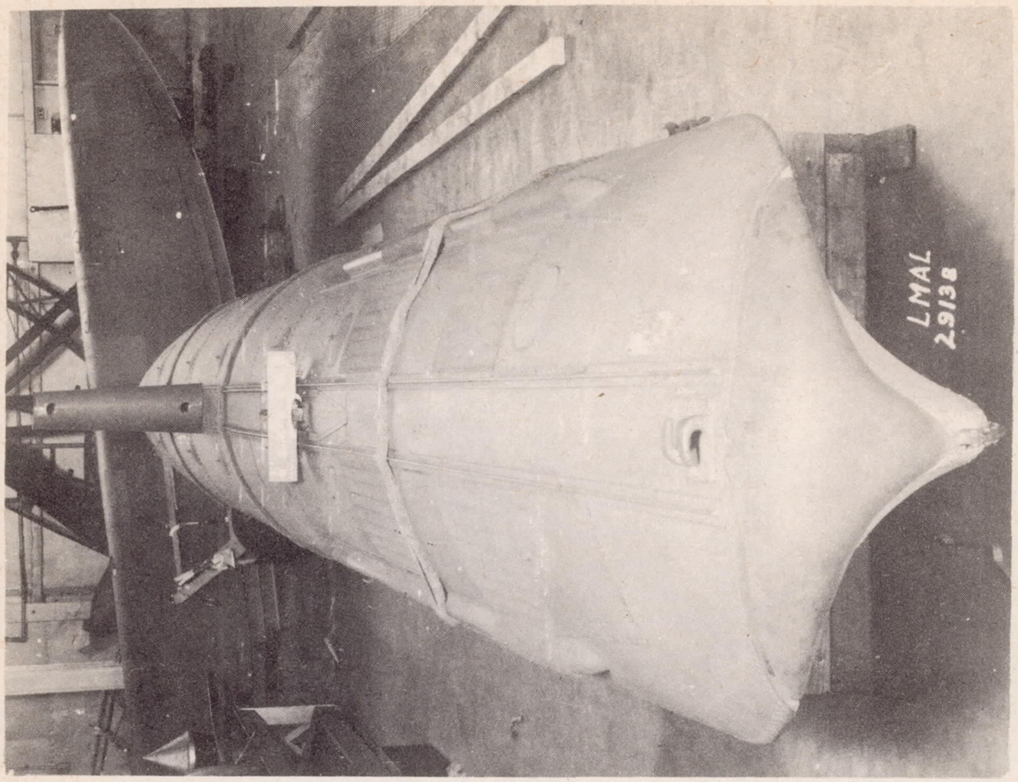


(c) Edo 62-6560.

Figure 3.- Installation of floats in NACA propeller-research tunnel.

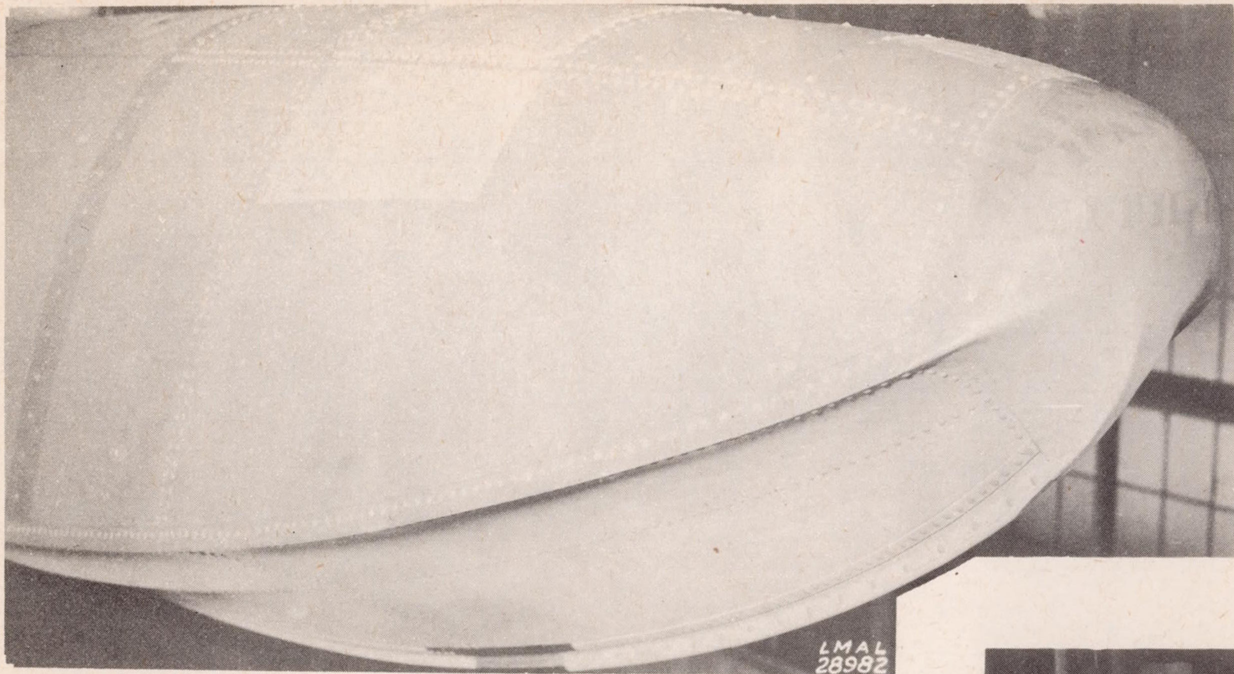


(a) Edo 68F.

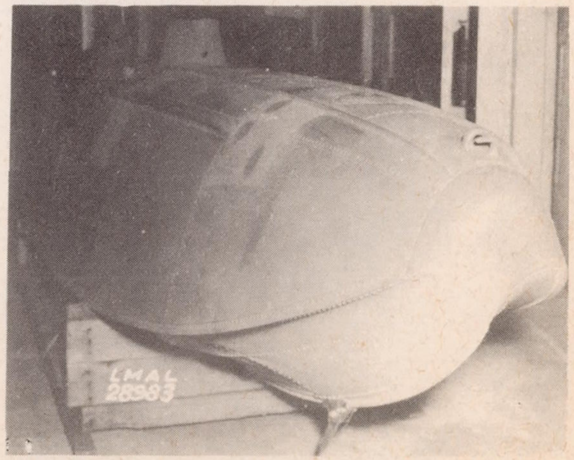


(b) Vought-Sikorsky.

Figure 4. - Bow-on views of OS2U military-type floats.



(c) Edo 68F with simulated rivets on bow.



(d) Edo 68 (showing "hat" sections).

Figure 4. - Concluded.

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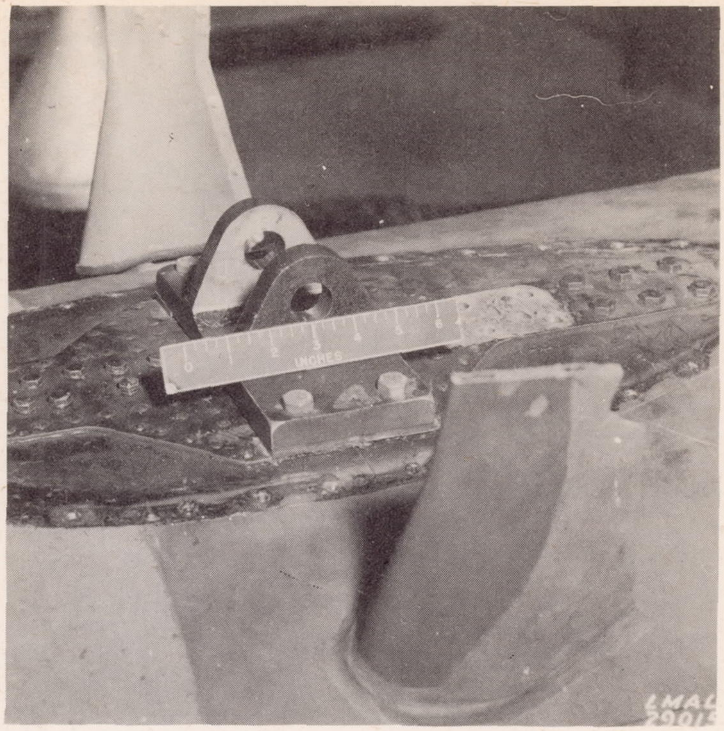
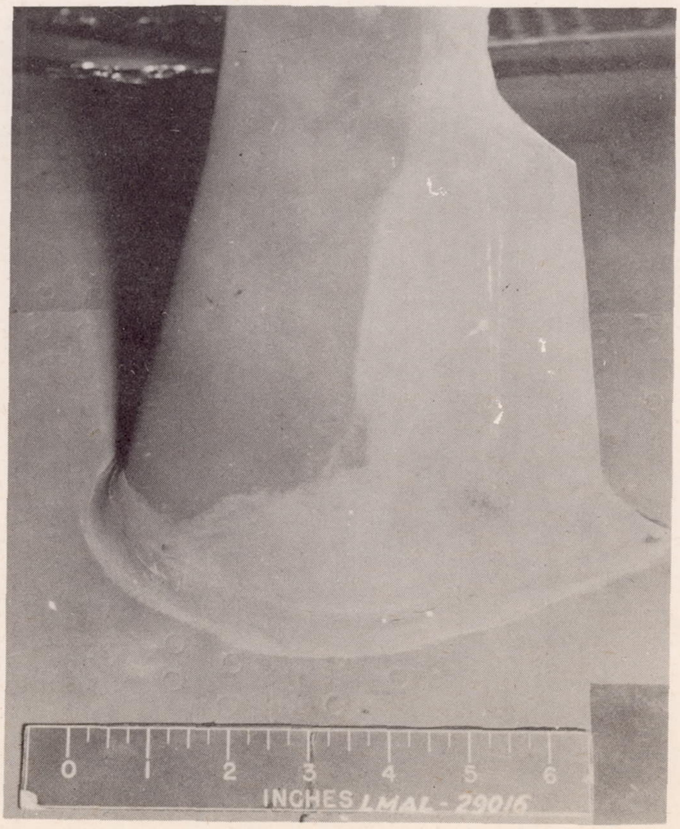


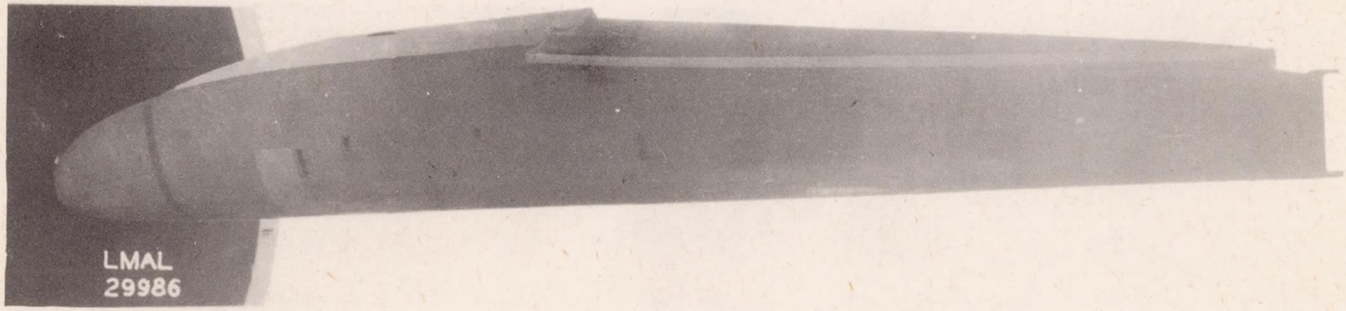
(a) Forward boots.



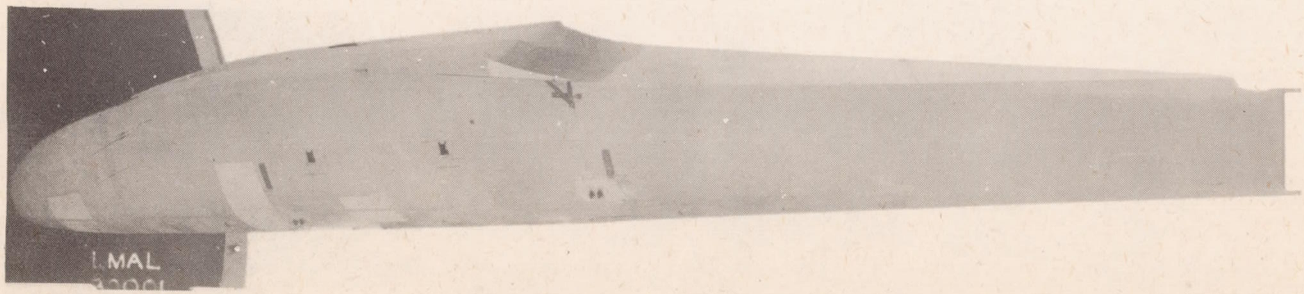
(b) After boots.

Figure 5. - Modifications to side wire boots on Edo 68F float.

(a) Full-step-fairing.

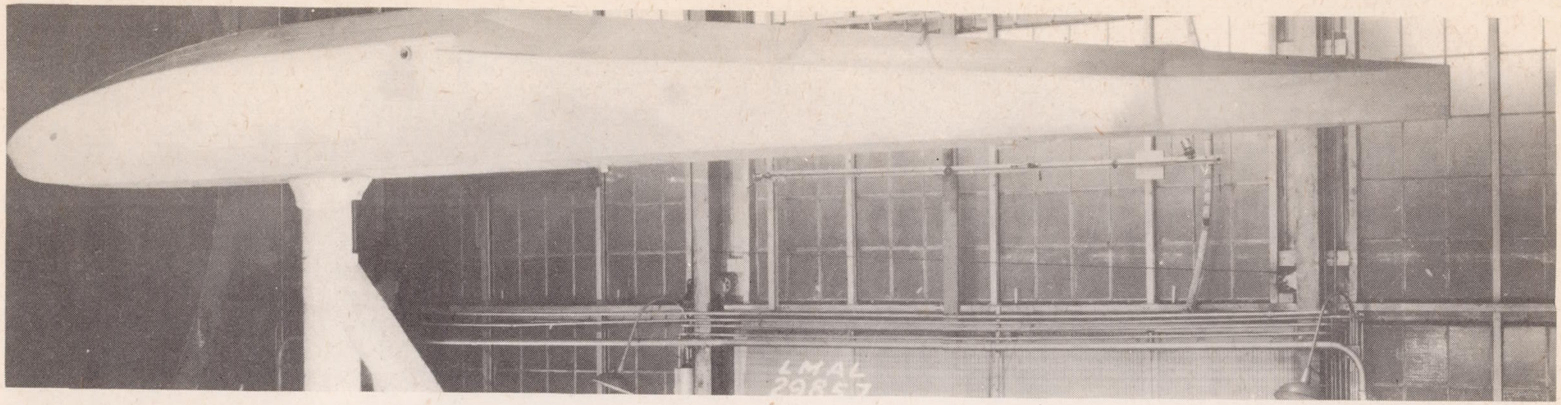


(b) Half-step-fairing.

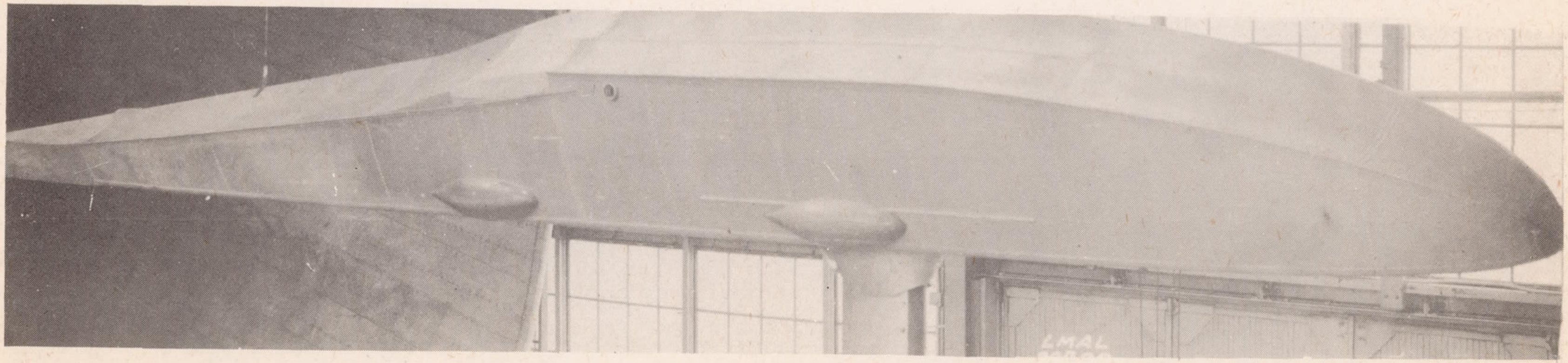


(c) Step fairing I.

Figure 6. - Step fairings applied to Edo 68F float.

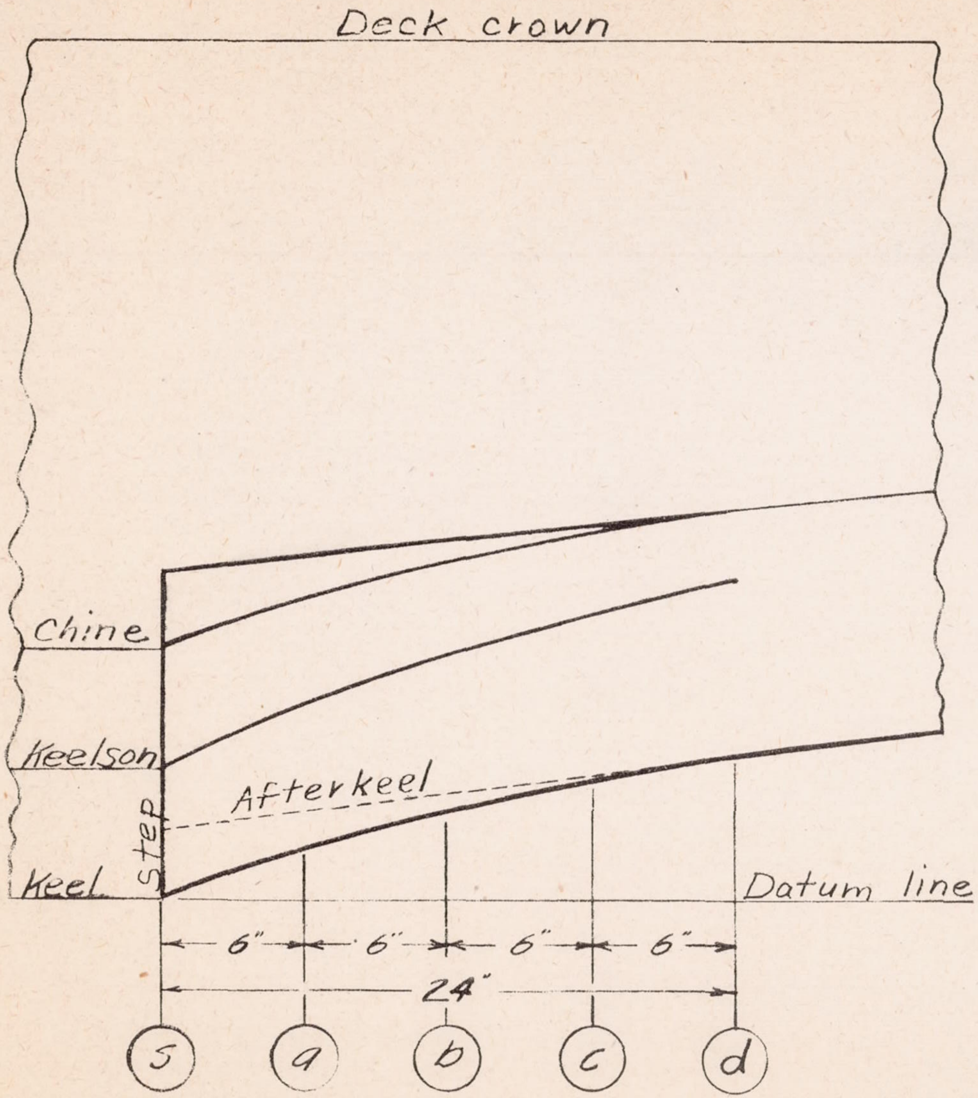


(a) Step fairing 1-a.



(b) Step fairing II with streamline fairings over port-side brackets.

Figure 7. - Step fairings and tail extension applied to Edo 62-6560 float.



Offsets for step fairing I

Station	Height above datum line, in.		
	Keel	Chine	Keelson
S	0	10.91	5.65
a	2.06	12.88	7.58
b	3.75	14.50	9.18
c	5.05	15.66	10.35
d	6.09	16.62	11.29

Offsets for step fairing I-a

Station	Height above datum line, in.		
	Keel	Chine	Keelson
S	0	10.41	5.41
a	2.03	12.38	7.97
b	3.63	14.00	10.13
c	4.87	15.28	11.91
d	5.94	16.28	13.38

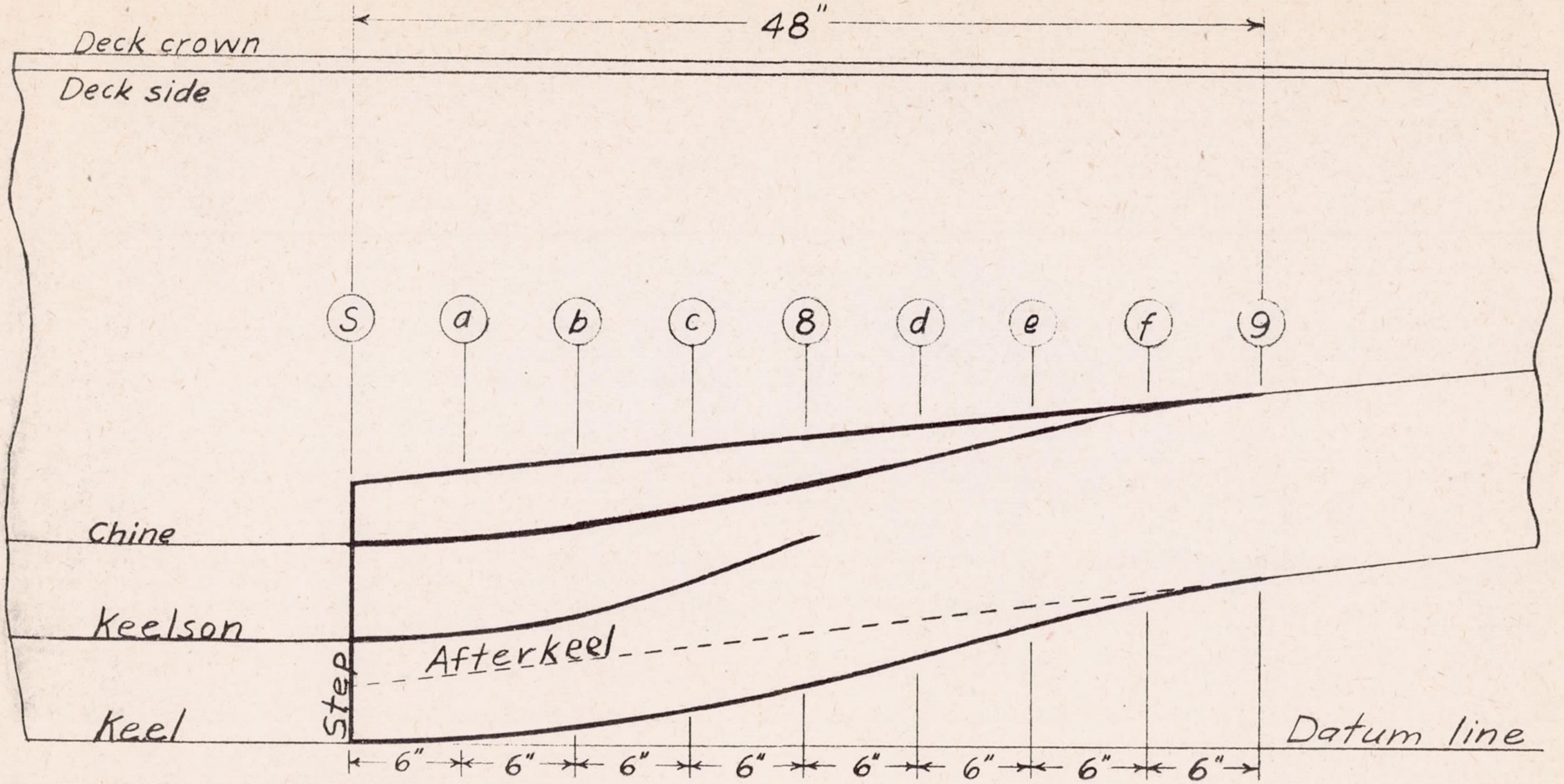
Figure 8.- Step fairings I and I-a.

Figure 8.- Step fairings I and I-a.

(a) Original fairings.

(b) Streamline fairings.
(also used on Edo 68F float).

Figure 9.- Fairings applied to port-side brackets on Edo 62-6560 float.

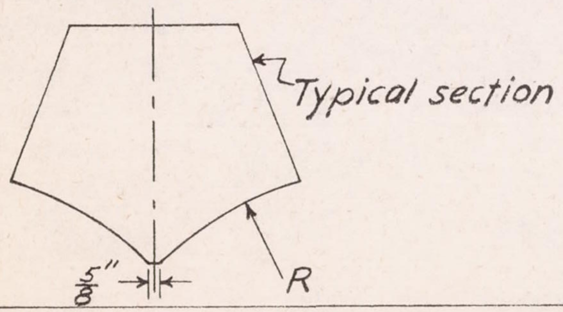


Station	Height above datum line, in.		
	Keel	Chine	Keelson
S	0	10 13/32	5 13/32
a	5/32	10 21/32	5 23/32
b	25/32	11 3/8	6 23/32
c	1 7/8	12 7/16	8 9/16
8	3 9/32	13 3/4	10 11/16
d	4 7/8	15 3/16	—
e	6 15/32	16 19/32	—
f	7 3/4	17 9/16	—
9	8 15/16	18 19/32	—

Figure 10.- Step fairing II.

Table of offsets, in.

Sta.	R	Half-breadth		Ht. above datum line		
		Deck	Chine	Keel	Chine	Deck
13	22	5 7/16	10 1/8	0	5 29/32	14 9/16
14	20 13/32	5 9/32	9 1/2	3/4	6 5/16	14 9/16
15	16 3/16	4 13/32	7 9/16	2 1/4	6 5/8	14 9/16
16	10 3/4	3 1/16	5 1/32	3 13/16	6 23/32	14 9/16
17	4 3/32	1 7/32	1 15/16	5 5/16	6 13/32	14 9/16
18	—	0	0	6	6	14 9/16



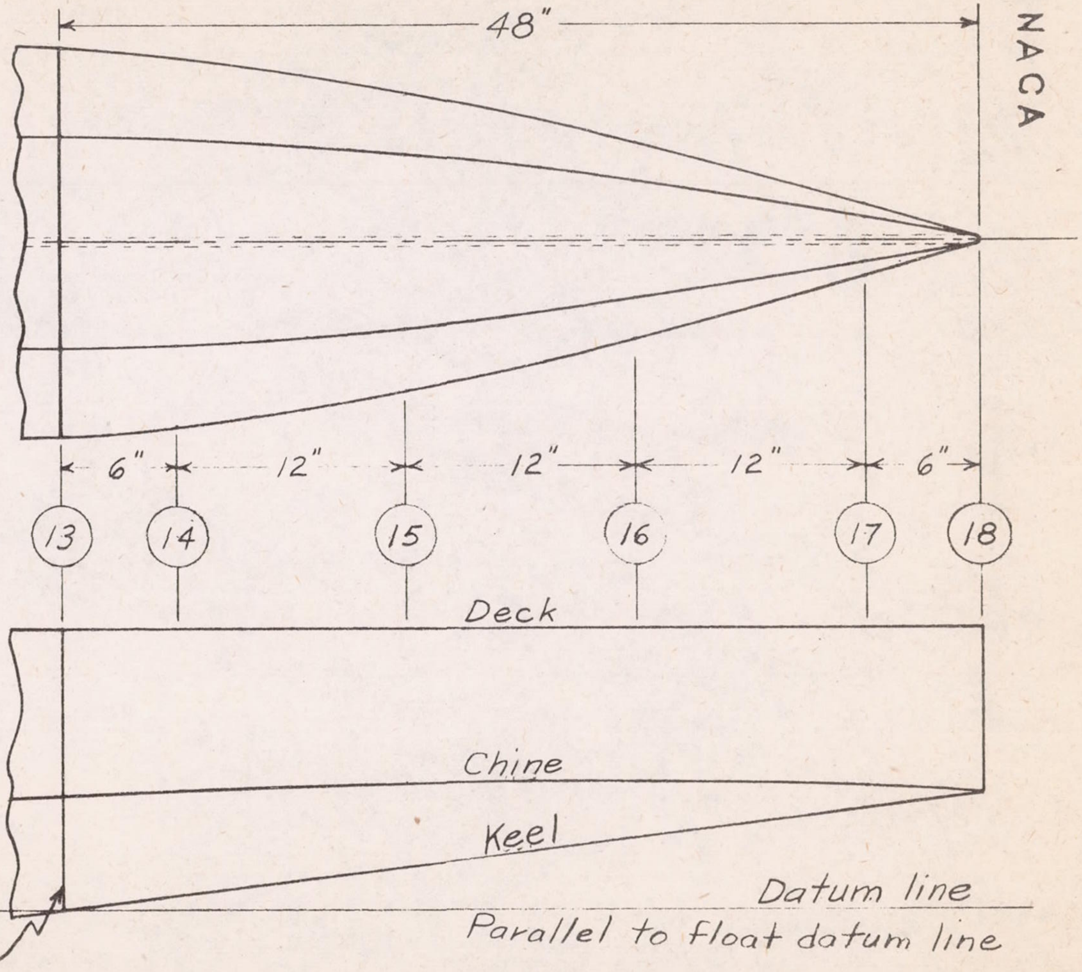


Figure 11.- Tail extension for Edo float model 62-6560.

Figure 11.- Tail extension for Edo float model 62-6560

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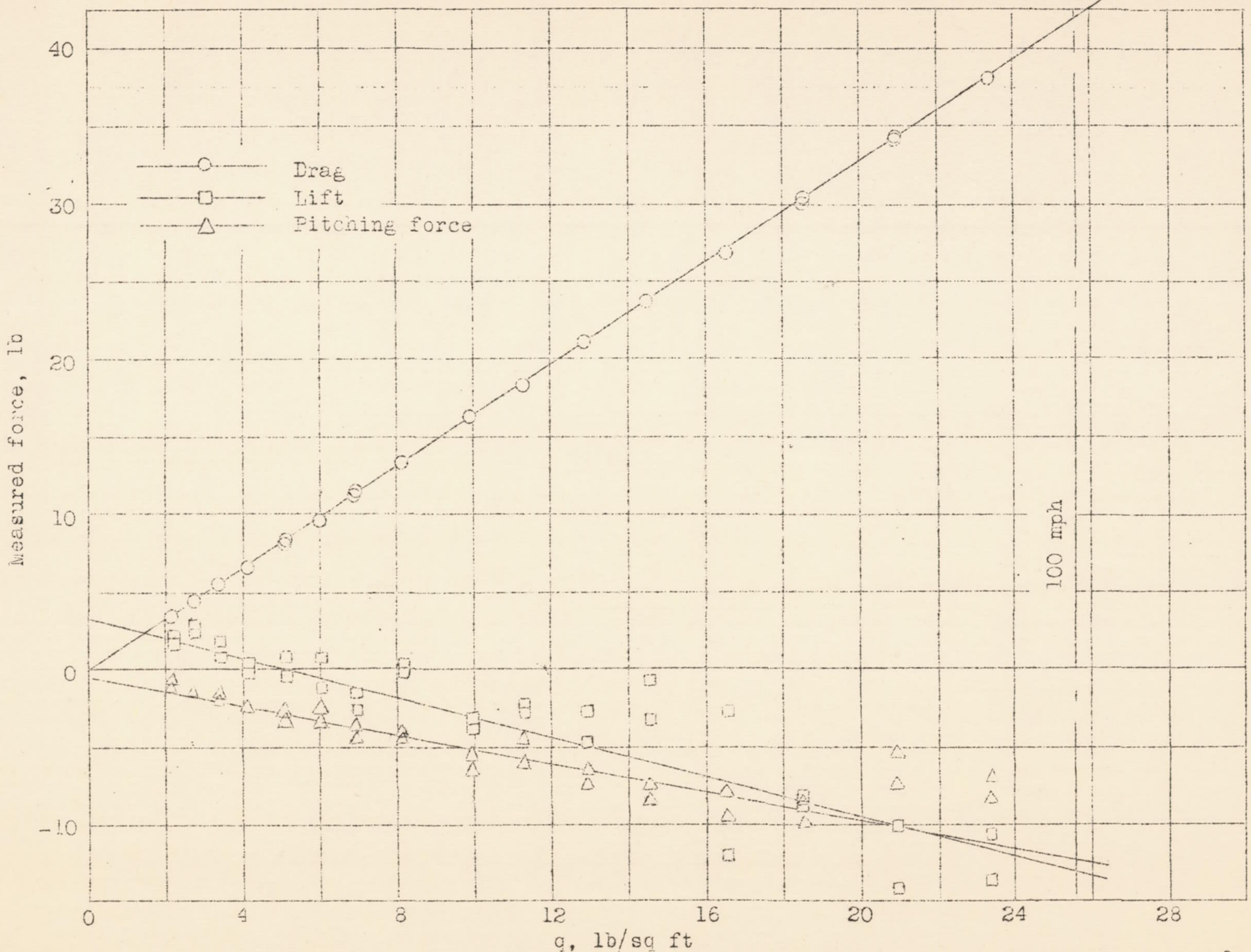
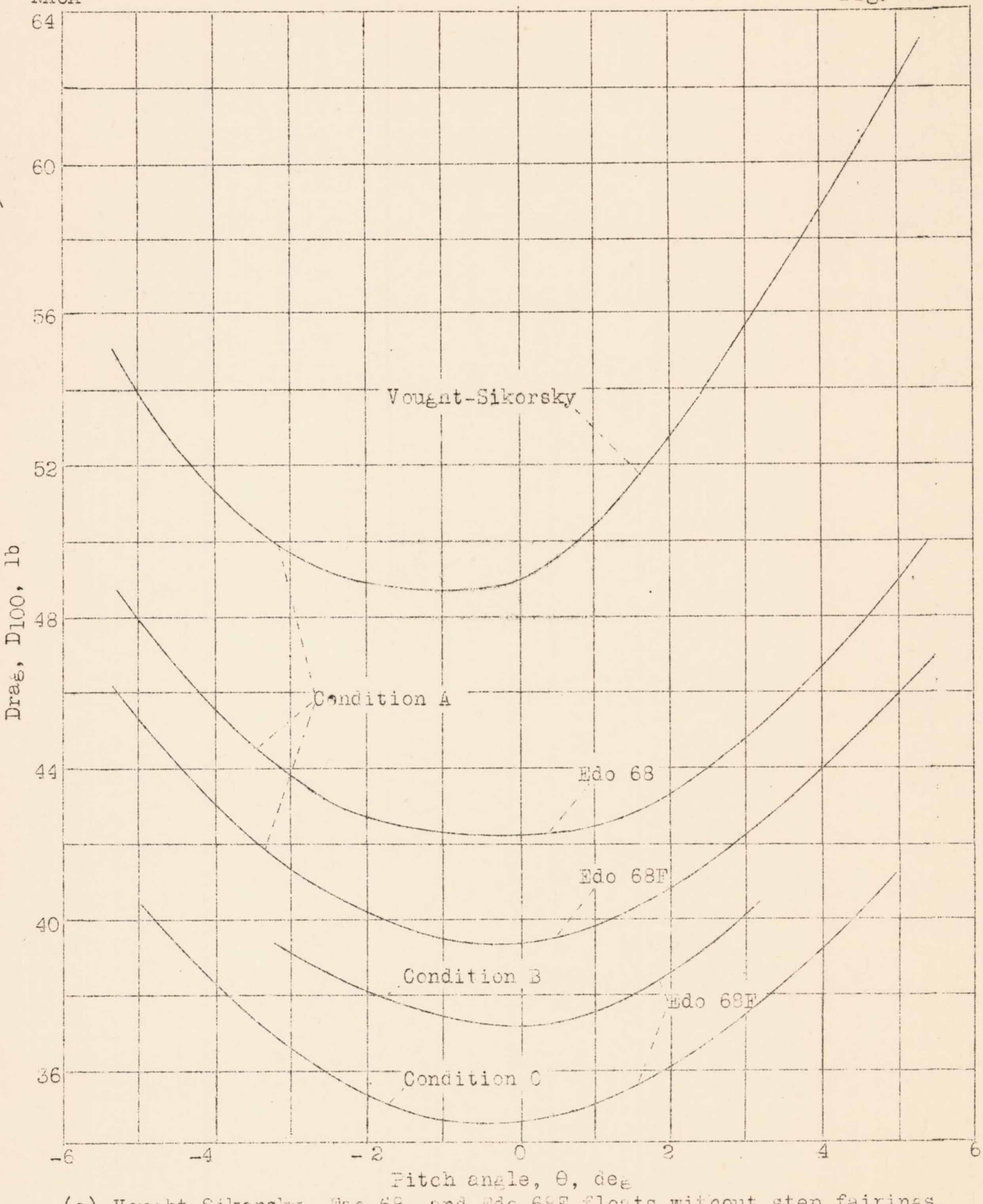


Figure 12.- Typical plot showing uncorrected test data. Edo 68F float in condition A. $\theta = -1^{\circ}$.



(a) Vought-Sikorsky, Edo 68, and Edo 68F floats without step fairings.

Figure 13 (a to c).- Variation of float drag with pitch angle. OS2U floats.

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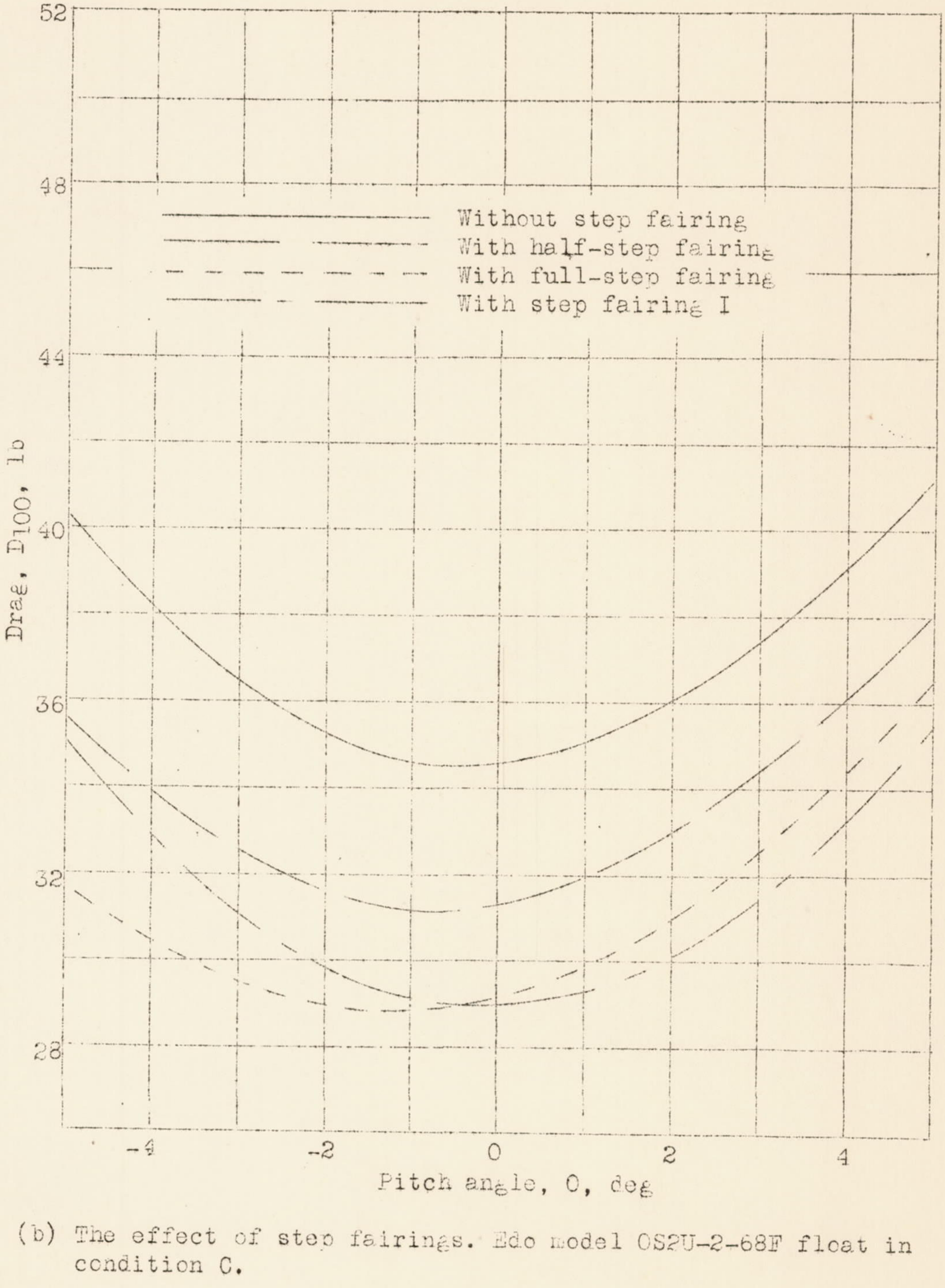

(b) The effect of step fairings. Edo model OS2U-2-68F float in condition C.

Figure 13b.

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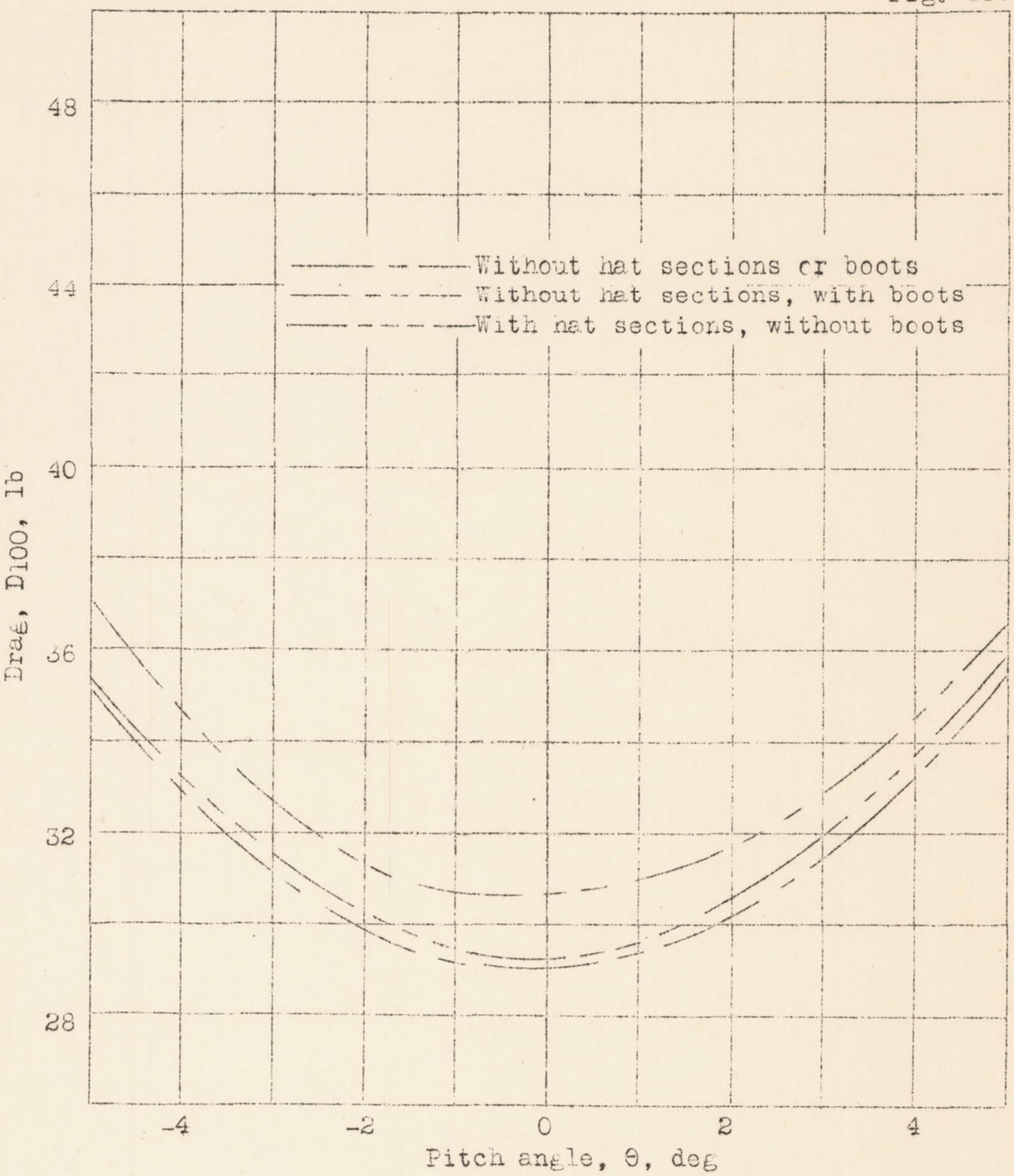
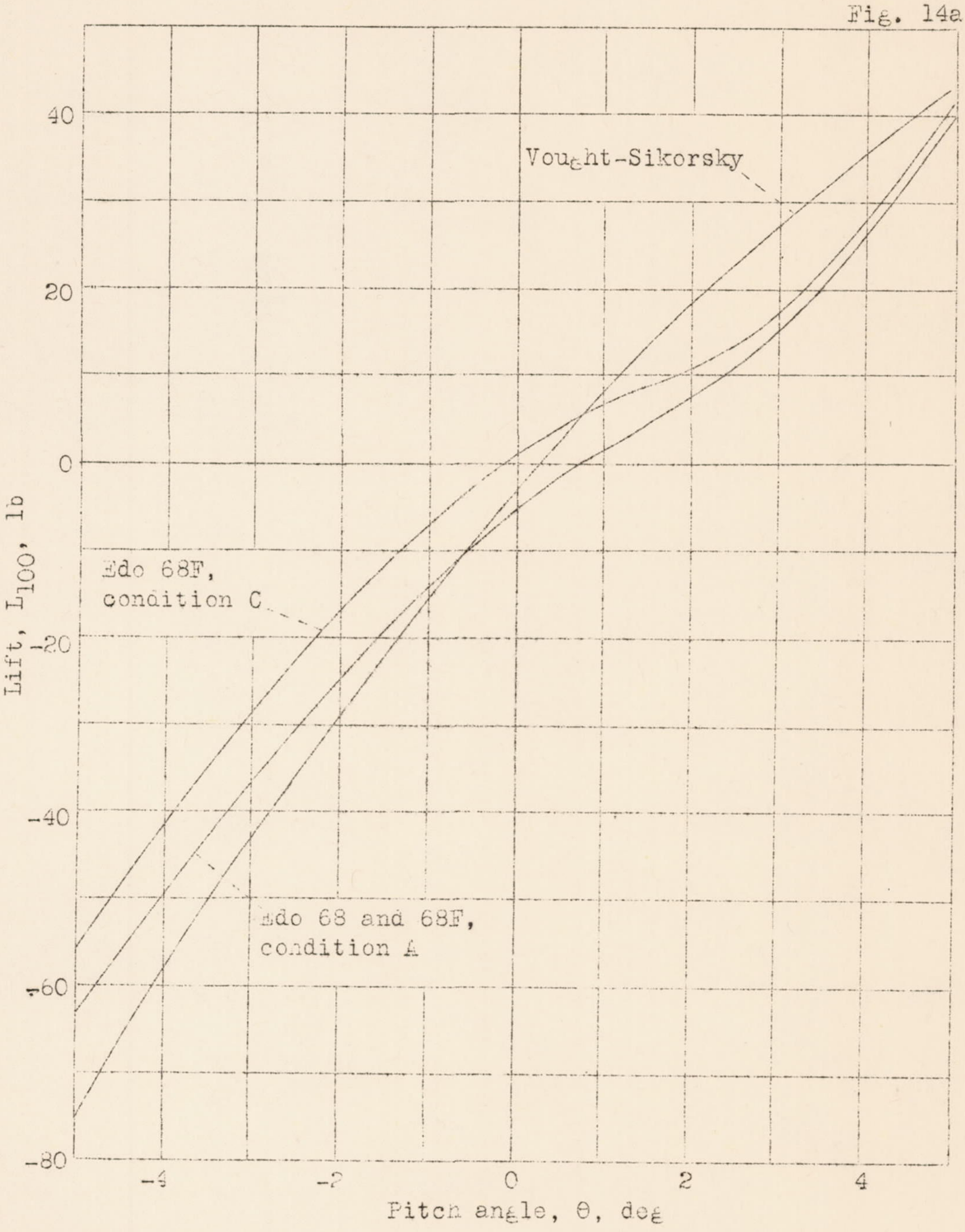


(c) The effect of wire boots and hat sections. Edo model OS2U-2-68F float with step fairing I.

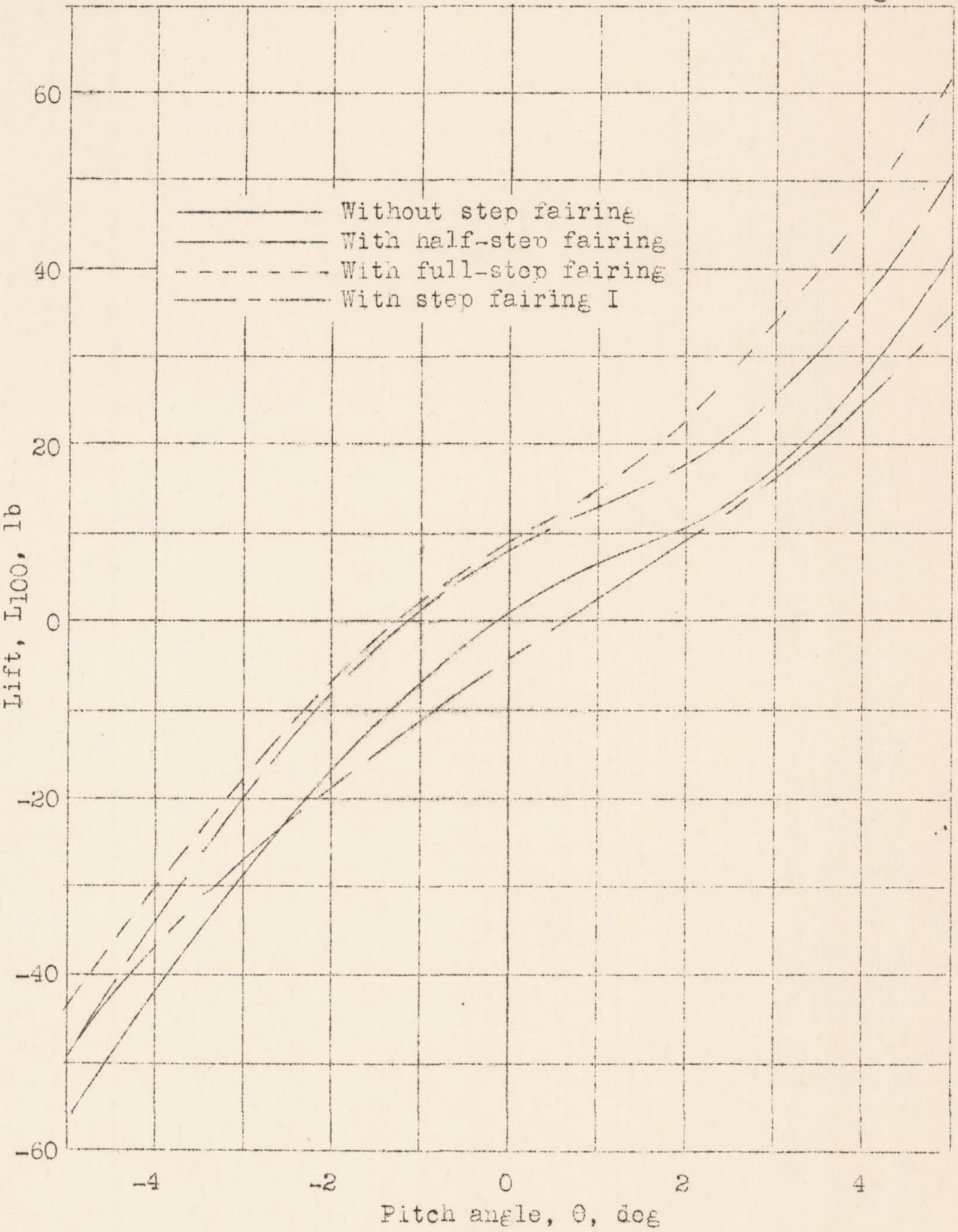
Figure 13c.

L-238



(a) Vought-Sikorsky, Edo 68, and 68F floats without step fairings.

Figure 14(a to c).- Variation of float lift with pitch angle. OS2U floats.



(b) The effect of step fairings. Edo model OSPU-2-68F float in condition C.

Figure 14b

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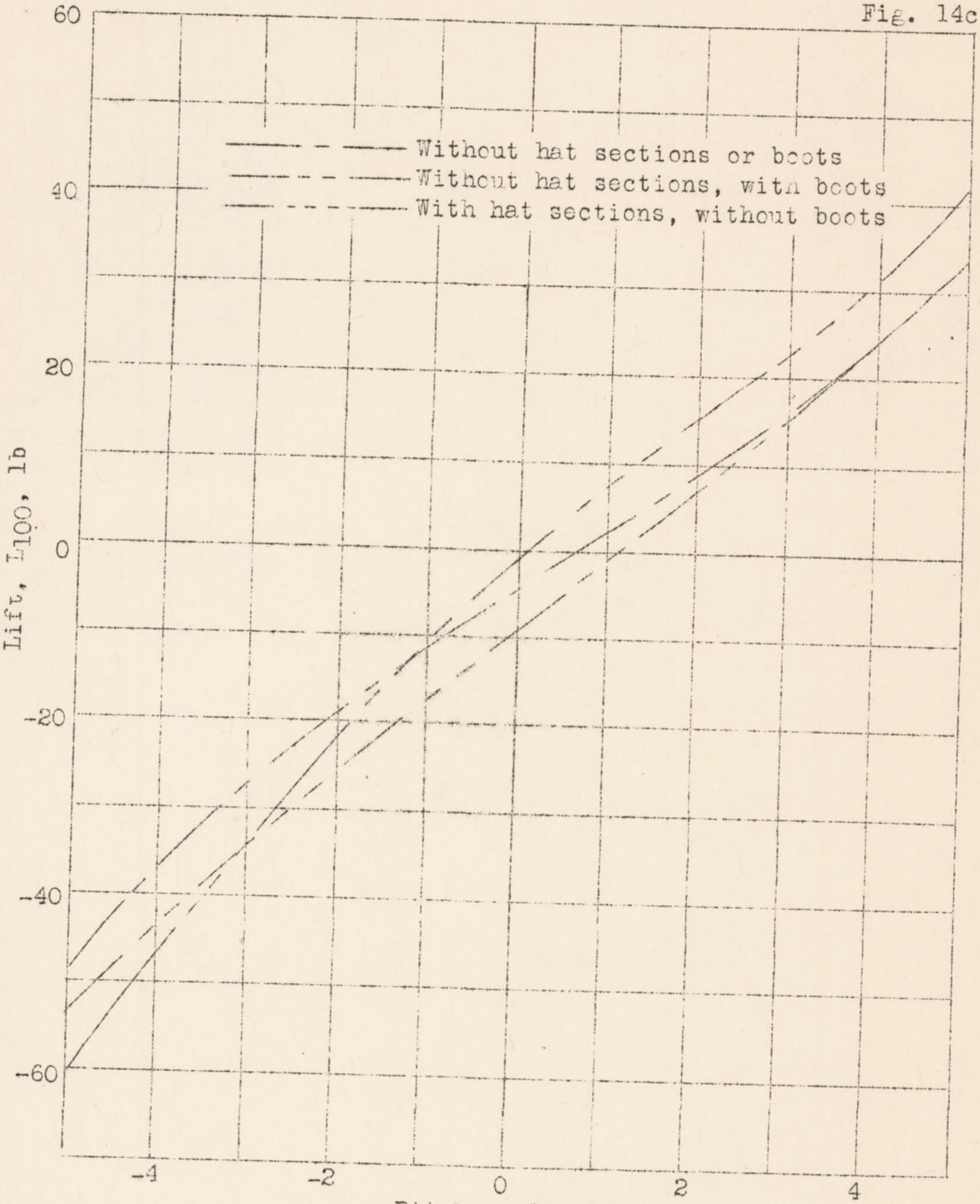

(c) The effect of wire boots and hat sections. Edo model OS2U-2-68F float with step fairing I.

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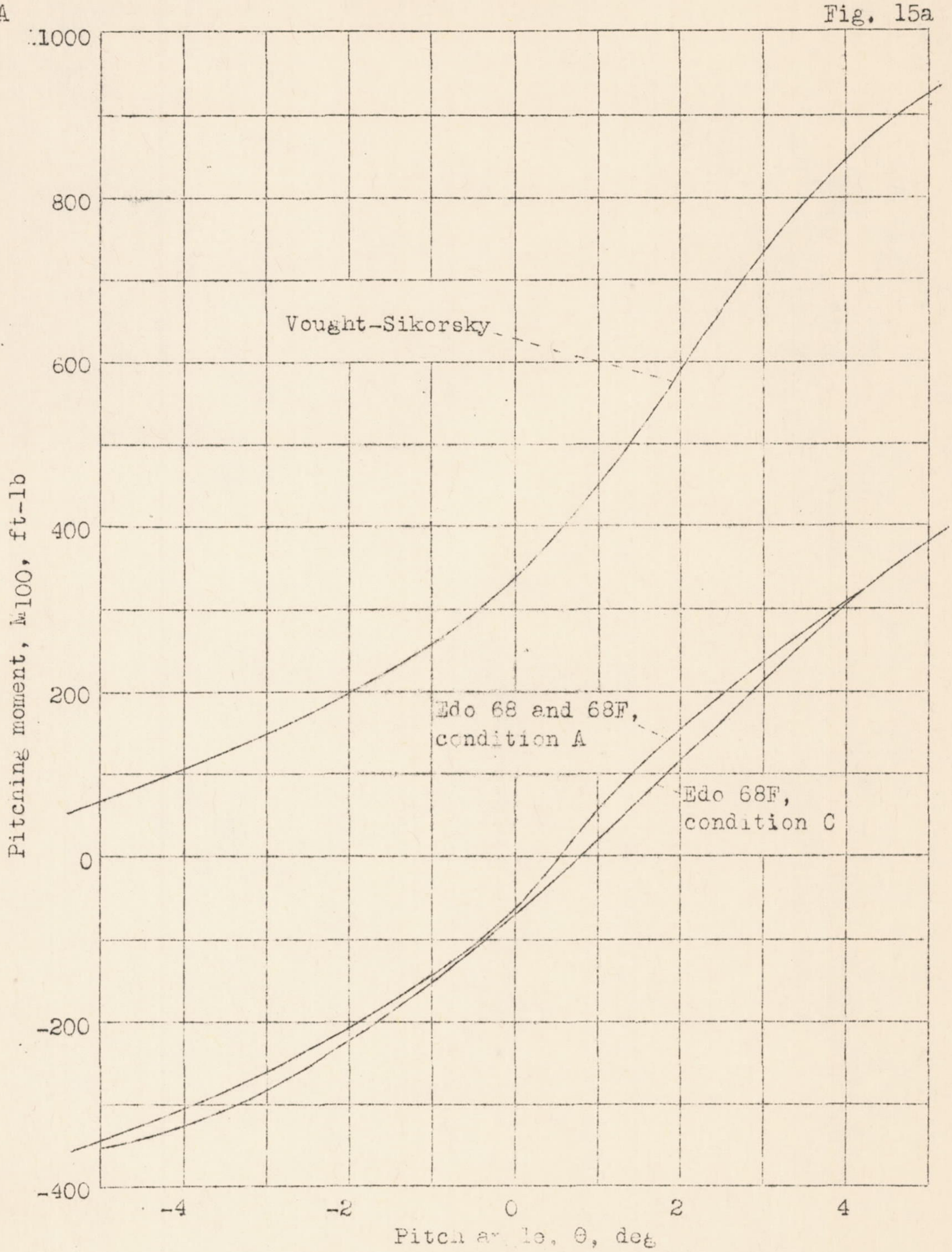

(a) Vought-Sikorsky, Edo 68, and 68F floats without step fairings.

Figure 15(a to c).- Variation of float pitching moment with pitch angle. OS2U floats.

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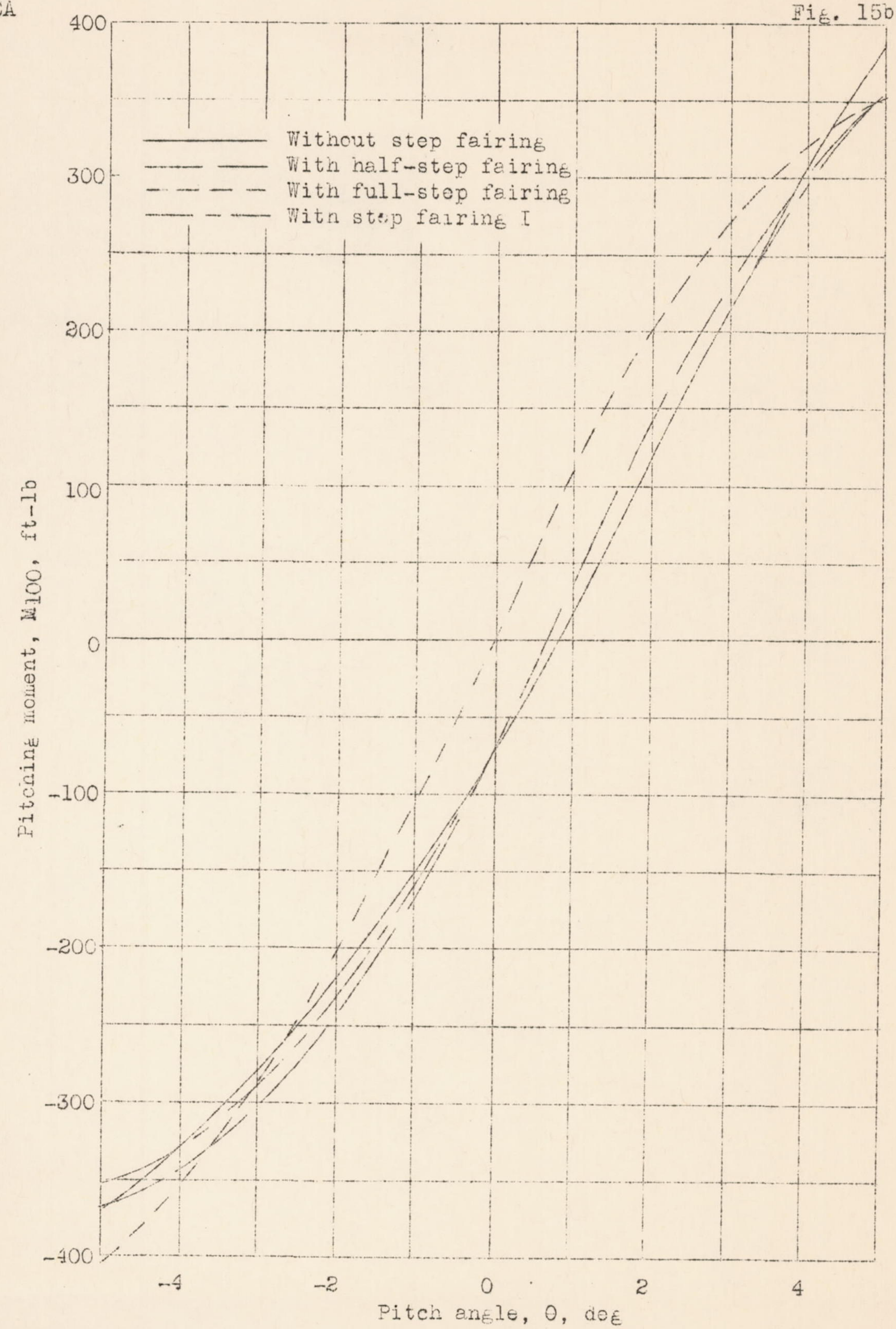
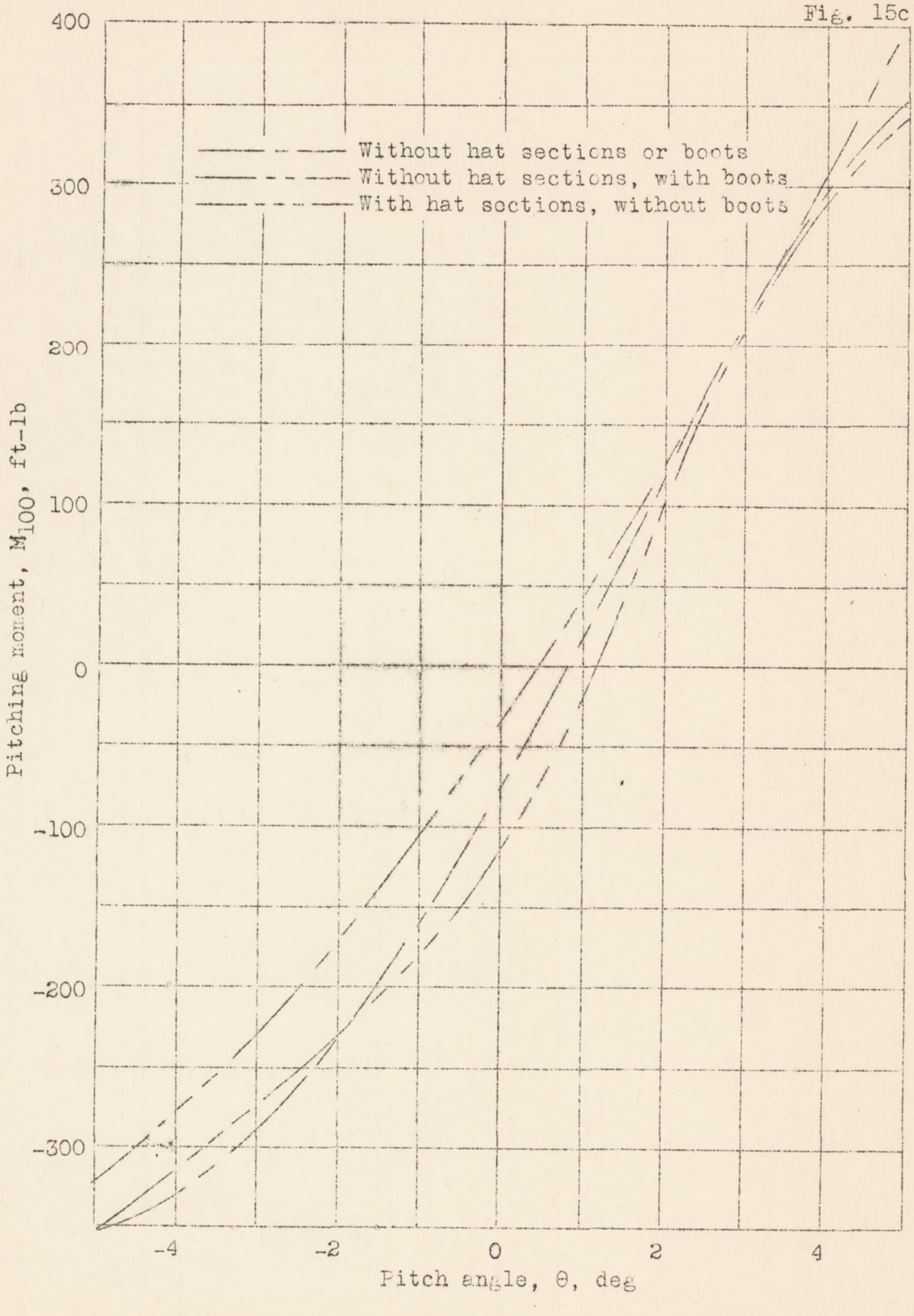


(b) The effect of step fairings. Edo model OS2U-2-68F float in condition C.

Figure 15b



(c) The effect of wire boots and hat sections. Edo model OS2U-2-68F float with step fairing I.

Figure 15c

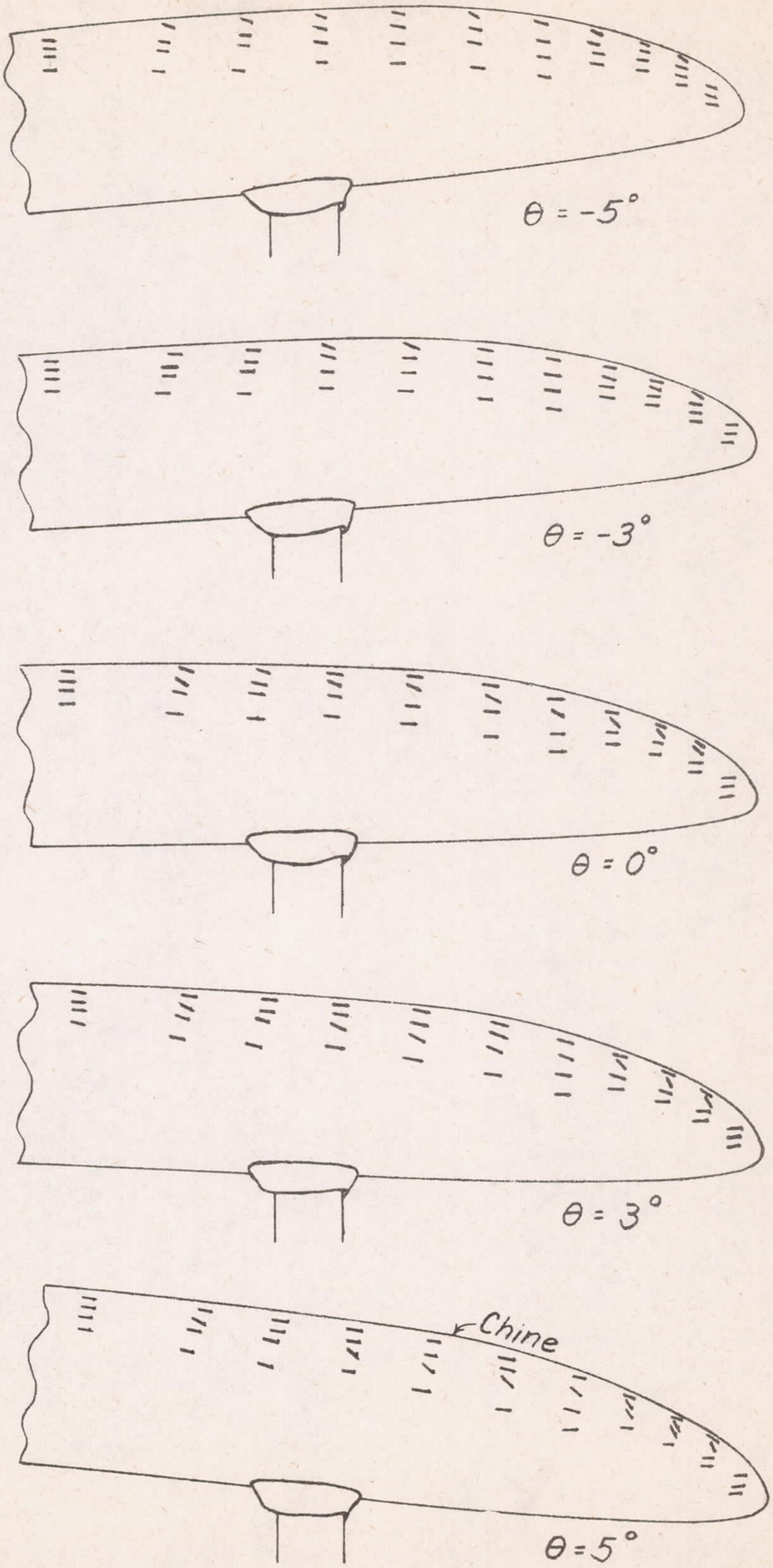


Figure 16.- Disposition of tufts on the side of the Edo model 68F float at various pitch angles.

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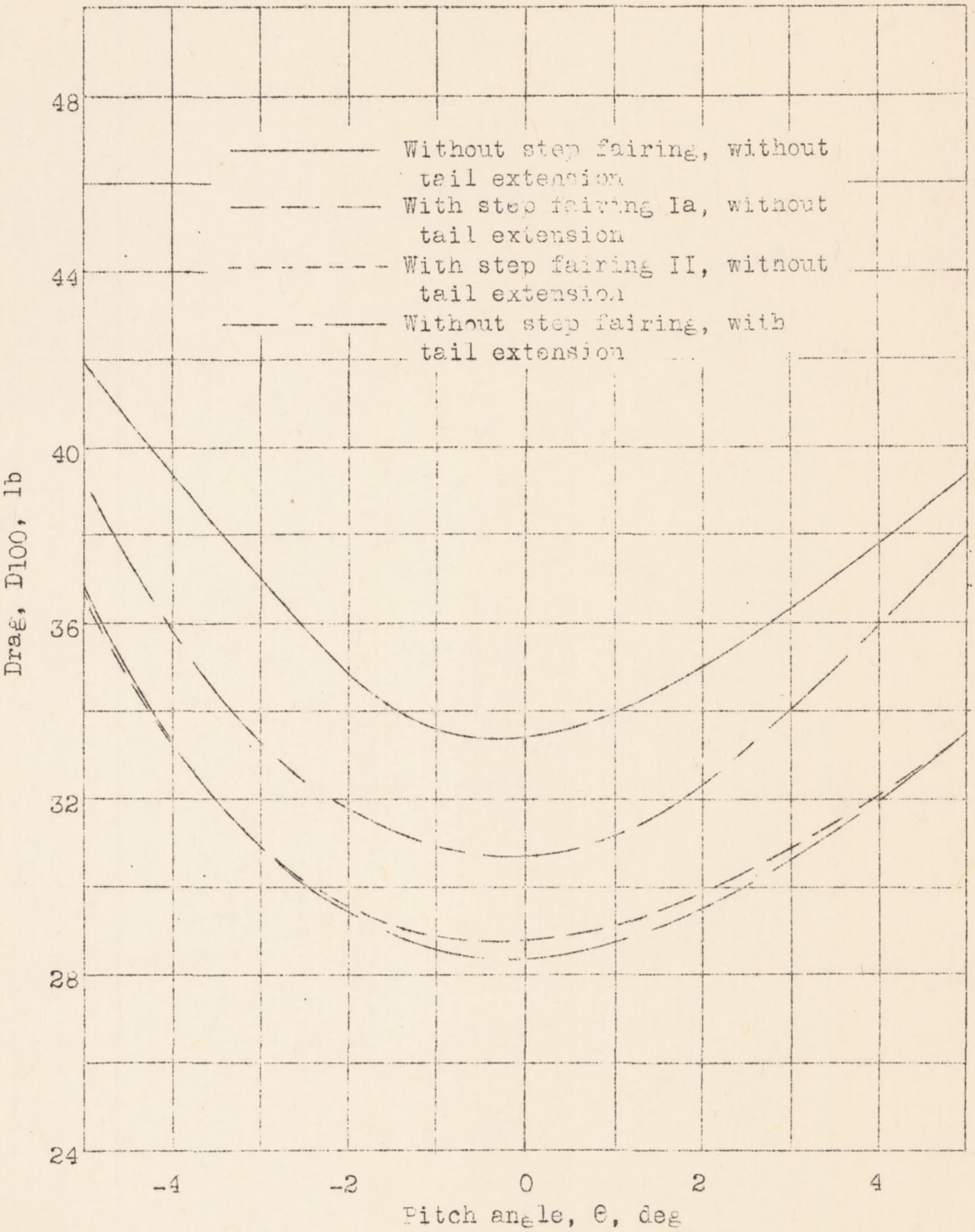

Figure 17.- Variation of float drag with pitch angle showing the effect of step fairings and tail extension. Edo model 62-6560 float with streamline fairings over side brackets.

NACA Fig. 18a

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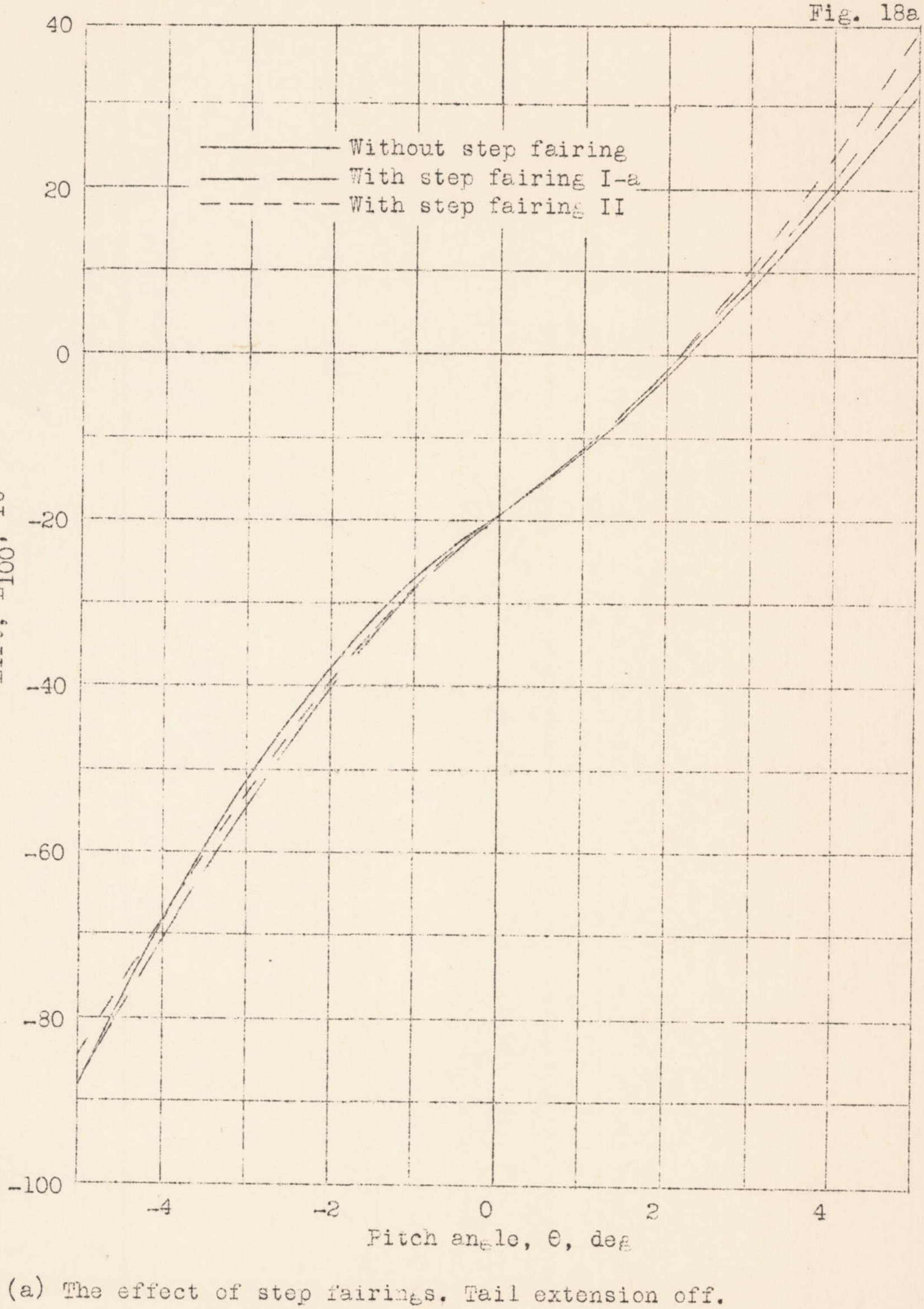

(a) The effect of step fairings. Tail extension off.

Figure 18(a to b).- Variation of float lift with pitch angle. Edo model 62-6560 float with streamline fairings over side brackets.

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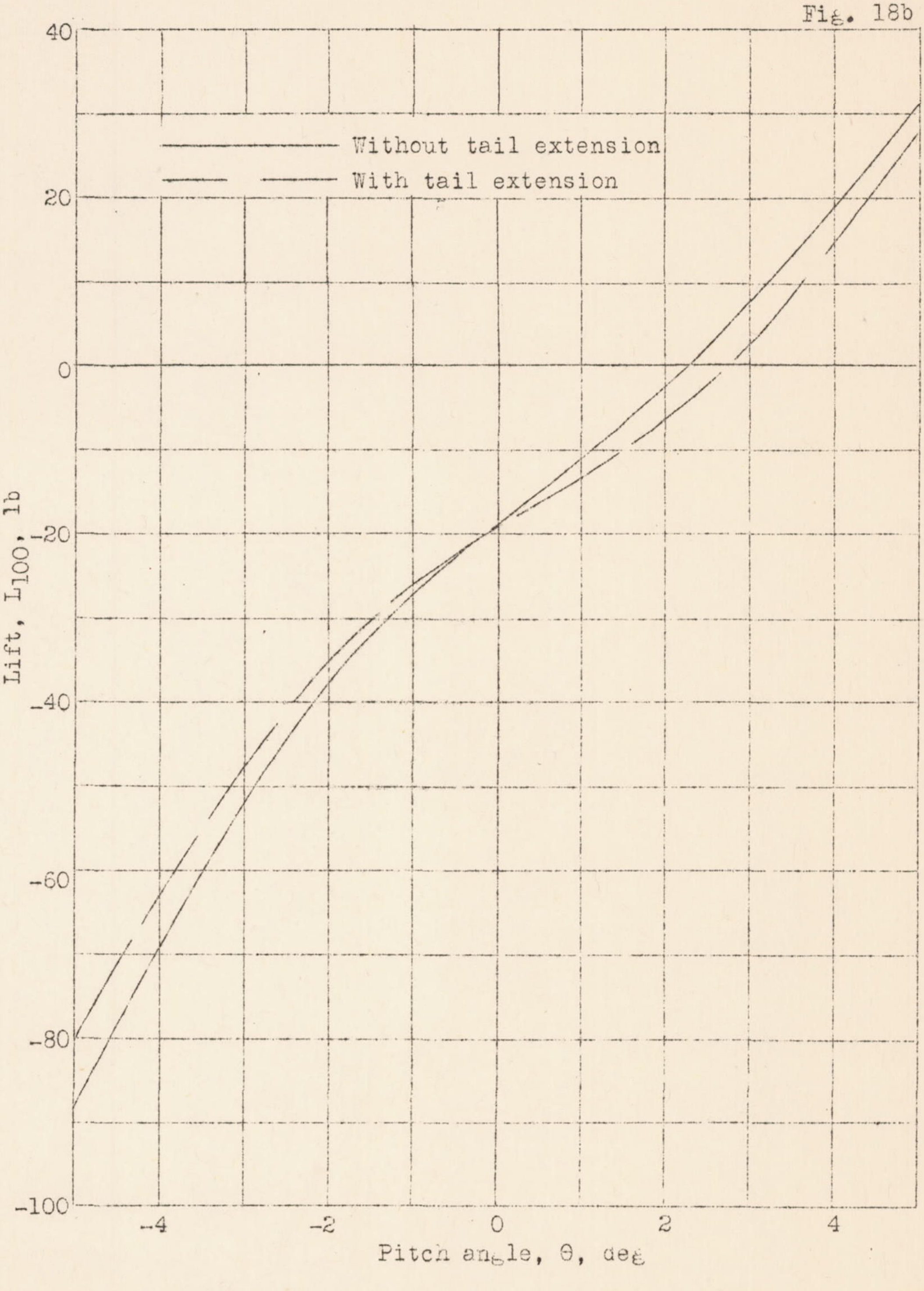

(b) The effect of a tail extension. Step fairing off.

Figure 18b

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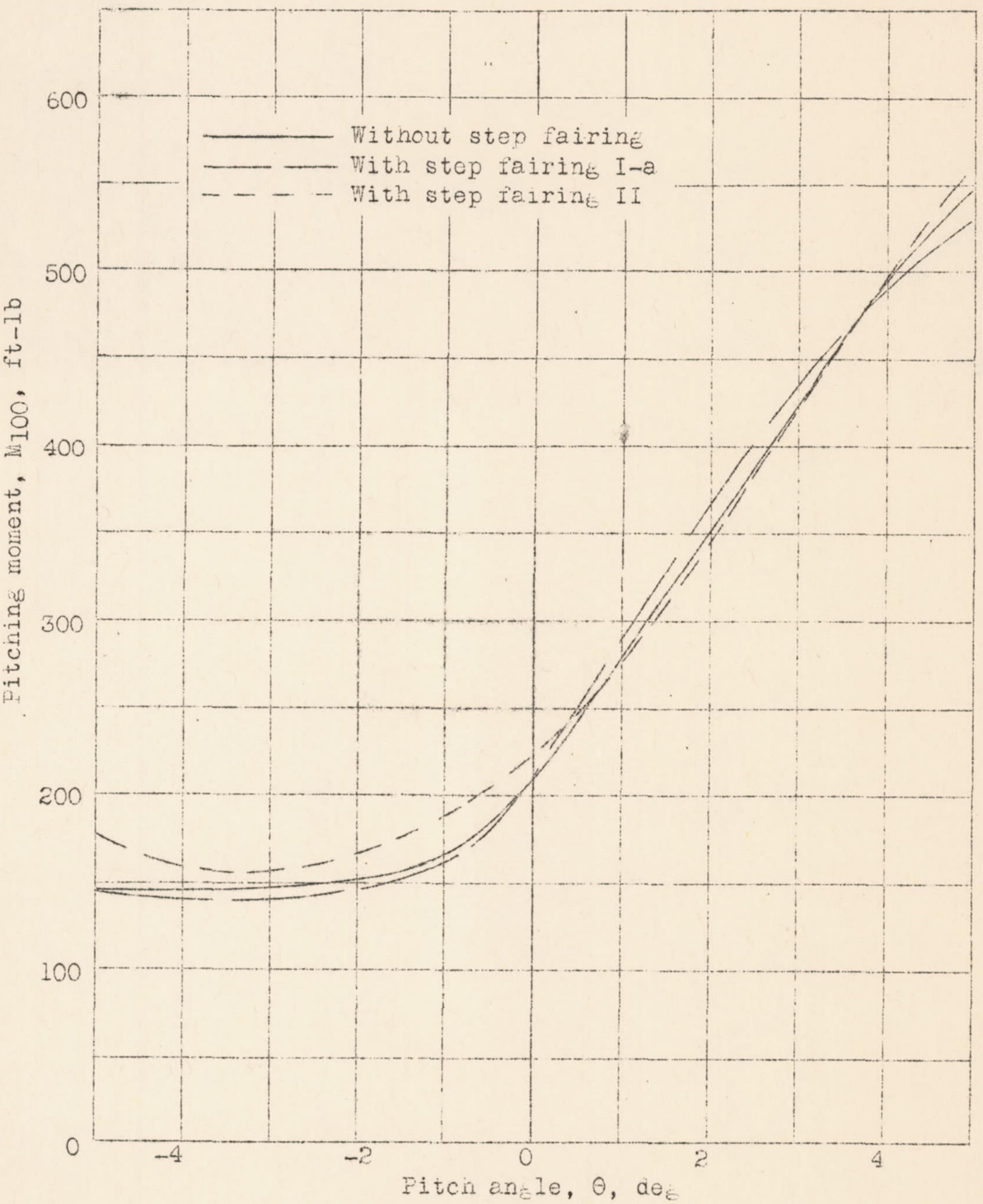

(a) The effect of step fairings. Tail extension off.

Figure 19(a to b).- Variation of float pitching moment with pitch angle. Edo model 62-6560 float with streamline fairings over side brackets.

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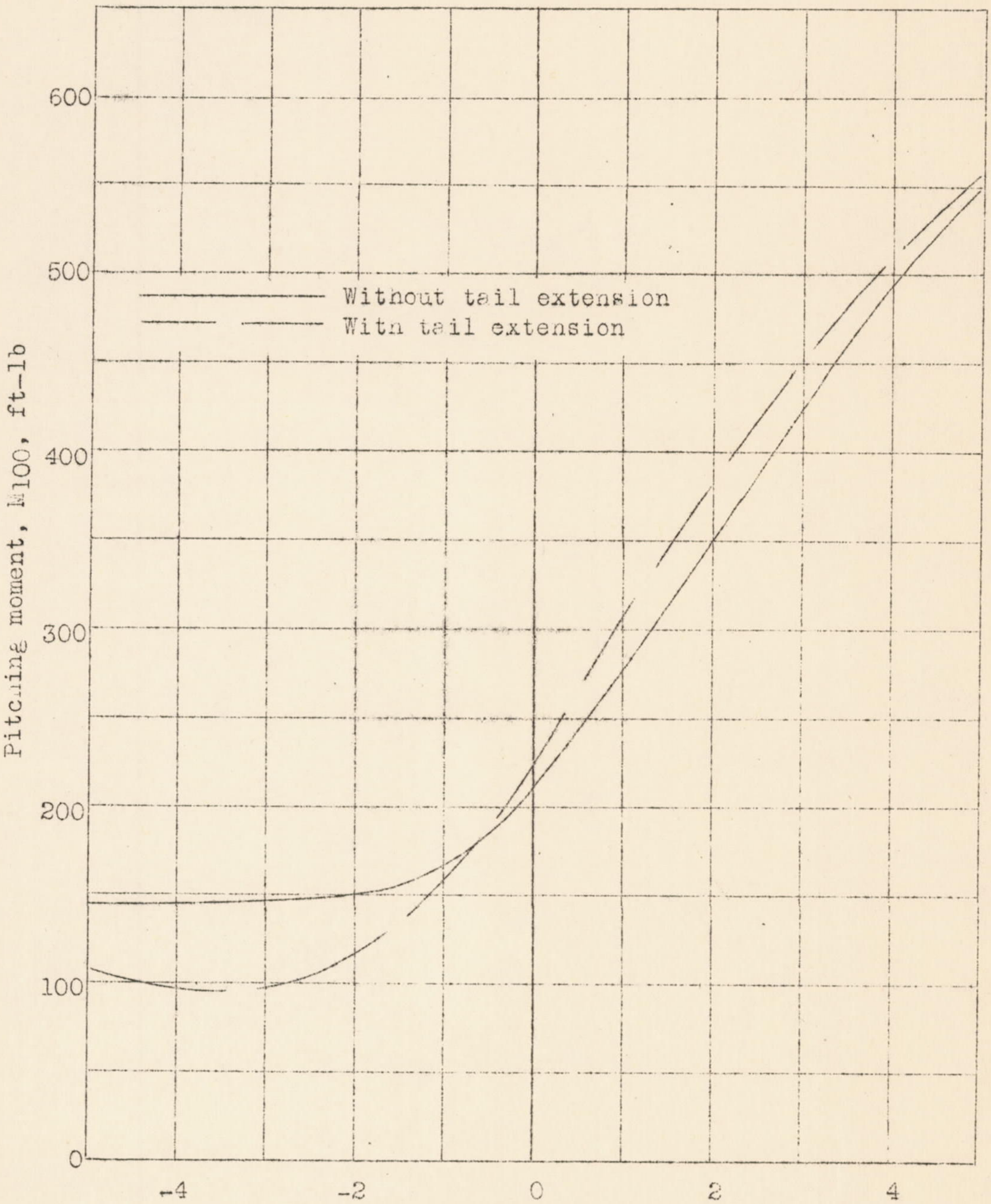

(b) The effect of a tail extension. Step fairing off.

Figure 19b