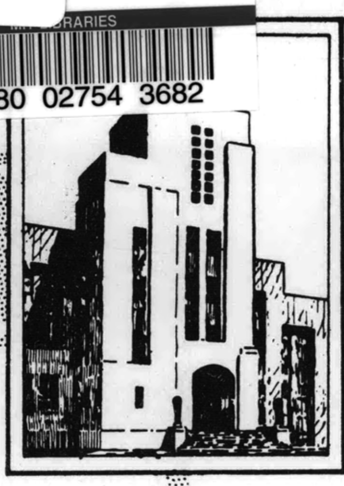

DEPARTMENT OF THE NAVY

DAVID TAYLOR MODEL BASIN

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HYDRODYNAMIC DESIGN AND EVALUATION OF A SIZE 5G, MOD O, REINFORCED-PLASTIC MINESWEEPING FLOAT

by

Peter K. Spangler

[redacted]

HYDROMECHANICS LABORATORY
RESEARCH AND DEVELOPMENT REPORT

September 1960

Report 1462

HYDRODYNAMIC DESIGN AND EVALUATION OF A SIZE 5G, MOD 0, REINFORCED-PLASTIC MINESWEEPING FLOAT

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REPORT 1462
S-R007-03-04

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ABSTRACT

A Size 5G, Mod 0, Reinforced-Plastic Minesweeping Float was designed and fabricated at the David Taylor Model Basin. Tests were conducted to determine the net buoyancy, lift, drag, and towing characteristics. The float was equipped with adjustable wings and tails and the best combination of wing and tail positions was determined. The float towed in a stable manner over the speed range of 0 to 10 knots. It is concluded that the plastic float will have satisfactory towing characteristics and will allow a substantial reduction in the handling weight over the steel float now in use by the Fleet.

INTRODUCTION

The Bureau of Ships[1] requested the David Taylor Model Basin to design, fabricate, and evaluate the performance of a reinforced-plastic minesweeping float to replace the stainless steel Size 5G Float which is a component of the O Type, Size 5G Sweep described in Reference 2.

Recently, the Bureau of Ships has become interested in the use of the filament-winding process to construct fiberglas-reinforced-plastic floats.[3] Some expected advantages are lighter weight, lower cost, greater strength, improved quality control, increased corrosion resistance, and easier handling in operational use. To facilitate the use of the filament-winding process, it was found necessary to modify the basic body design of the float. Therefore, the Model Basin conducted tests to determine the net buoyancy, lift, drag, and towing characteristics of the resulting design.

This report presents the results of the hydrodynamic tests conducted on the Size 5G, Mod 0, Reinforced-Plastic Minesweeping Float both in the Circulating Water Channel and the Towing Basin at the Model Basin. The physical dimensions and hydrodynamic characteristics of the plastic float are presented.

DESCRIPTION OF THE FLOAT

The Size 5G, Mod 0, Reinforced-Plastic Float used for the experimental investigations described by this report is shown by Figure 1. The nondimensional offsets describing the body shape are given in Table 1 and an assembly drawing of the complete float is given in Figure 2. It may be seen that the float has an overall length of 82.25 inches and a maximum diameter of 17.5 inches. The drilled plate attached to the underside of the body is centered about a point 32.86 inches aft of the nose and allows for fore and aft adjustment of the towpoint. The wings are located along the centerline of the body and have a total projected area of 485 square

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[1]References are listed on page 15

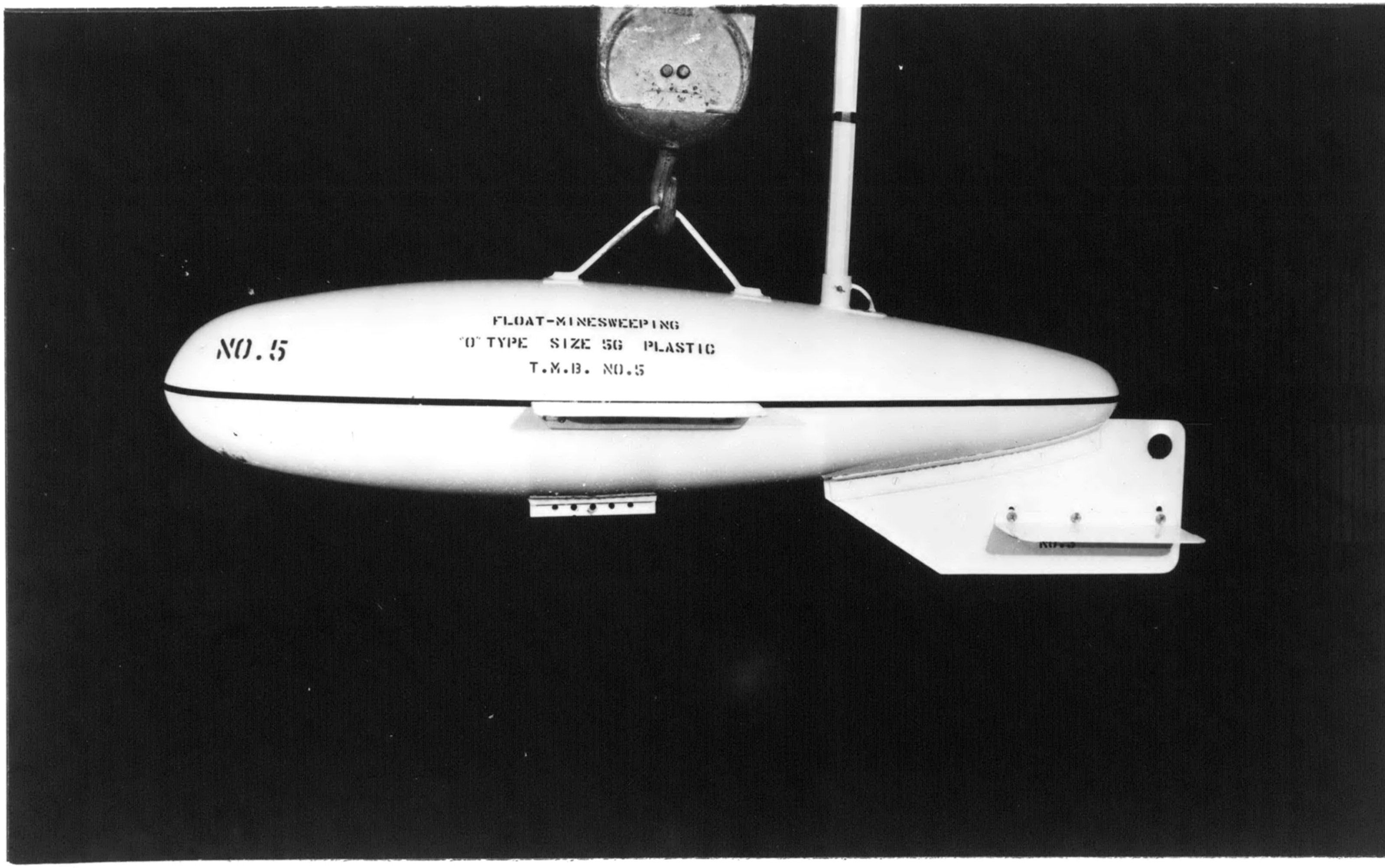

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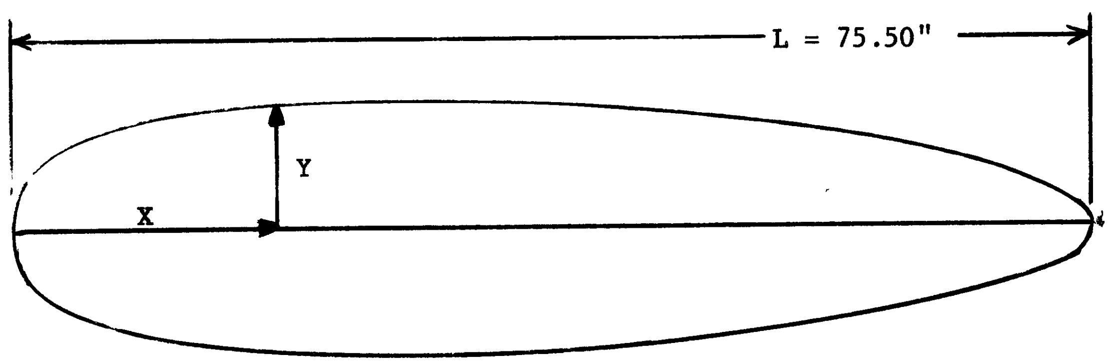
Figure 1 - Size 5G, Mod 0, Reinforced-Plastic Minesweeping Float

TABLE 1

Nondimensional Body Offsets of the Plastic Float

X/L	Y/L
0	0
0.05	0.070
0.10	0.088
0.20	0.105
0.30	0.114
0.40*	0.116
0.50	0.111
0.60	0.102
0.70	0.090
0.80	0.075
0.90	0.057
0.95	0.045
1.00	0
Nose radius = 0.073L Tail radius = 0.040L	
*Location of Maximum Diameter	



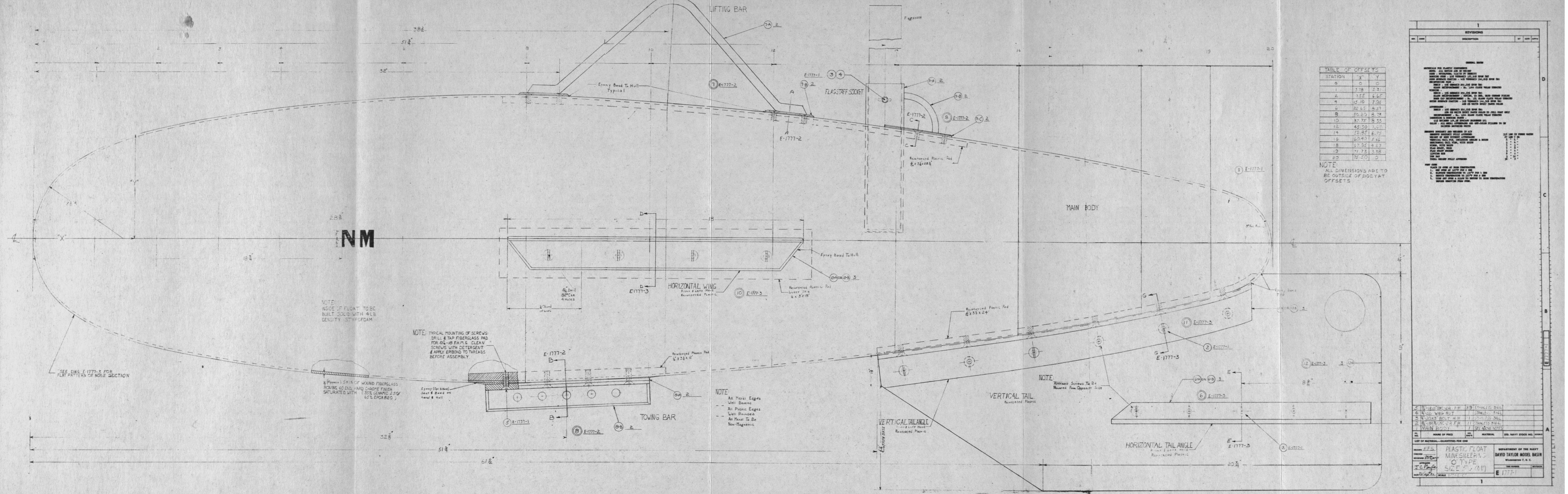


Figure 2 - Assembly Drawing of the Size 5G, Mod 0, Plastic Float

inches. The wings are detachable and can be positioned in a fore and aft direction with respect to the towpoint. The 2.0-inch diameter wooden flagstaff is mounted in a stainless steel socket bonded into the body at a position 51.75 inches aft of the nose. The horizontal tail consists of a pair of flat plates mounted on the vertical fin at a position 10.88 inches below the body centerline. Allowance was made for adjustment of incidence angle. Several tails having a constant chord but with various spans were constructed for the test program.

The subject float was constructed of reinforced plastic using the filament-winding process. To facilitate construction, it was found necessary to modify the basic body design of the steel float in a manner similar to that described in Reference 4. The physical characteristics of the resulting plastic float and the original steel float are compared in Table 2. It may be noted that the plastic float, although considerably smaller in volume, has almost as much reserve buoyancy as the steel float because of its much lighter weight in air.

CIRCULATING WATER CHANNEL TESTS

The float was tested in the Circulating Water Channel over a 0 to 7-knot speed range. A water depth of 9 feet was available. A sketch of the towing configuration is shown in Figure 3. Towline tensions were measured with an SR-4 Baldwin Load Cell inserted in the tow cable and recorded on a Brown Strip-Chart Electronik Recorder. Towline angles, for various speeds, were determined from photographs of the float taken through a window in the side of the channel with the top of the float approximately 15 inches below the water surface. A 3/16-inch diameter cable was used for the towline. The cable scope could be varied while under tow.

The horizontal tail incidence angle, the fore-aft position of the wings, the location of the towpoint, and the horizontal tailspan were varied to determine the combination of settings that gave the best towing performance at any given speed within the speed range. The best overall results were obtained with a tail incidence angle of 0 degrees, the towpoint located 32.86 inches aft of the nose, the quarter chord of the wings located vertically above the towpoint, and a tailspan of 14.25 inches. In this configuration, the float trimmed approximately 3 degrees bow up at rest. Tests were also made without the wings to determine their effect on the float's hydrodynamic performance.

The float towed in a stable manner throughout the speed range of 0 to 7 knots, whether with or without the wings. It was allowed to come to the surface and was then pulled under to a depth of approximately 2 feet, at all speeds, without adversely affecting the towing characteristics. The float is shown under tow in the Water Channel in Figures 4 and 5.

TABLE 2

Comparison of the Physical Characteristics of the Plastic and Steel Floats

Dimension	Plastic Float	Steel Float
Overall length, inches	82 1/4	72
Maximum diameter, inches	17 1/2	19 1/4
Horizontal tail area, $inches^{2*}$	224	219
Wing area, $inches^{2*}$	485	492
Weight in air, pounds	97	200
Reserve buoyancy, pounds**	327	350

*Area = Span x Chord

**Salt Water

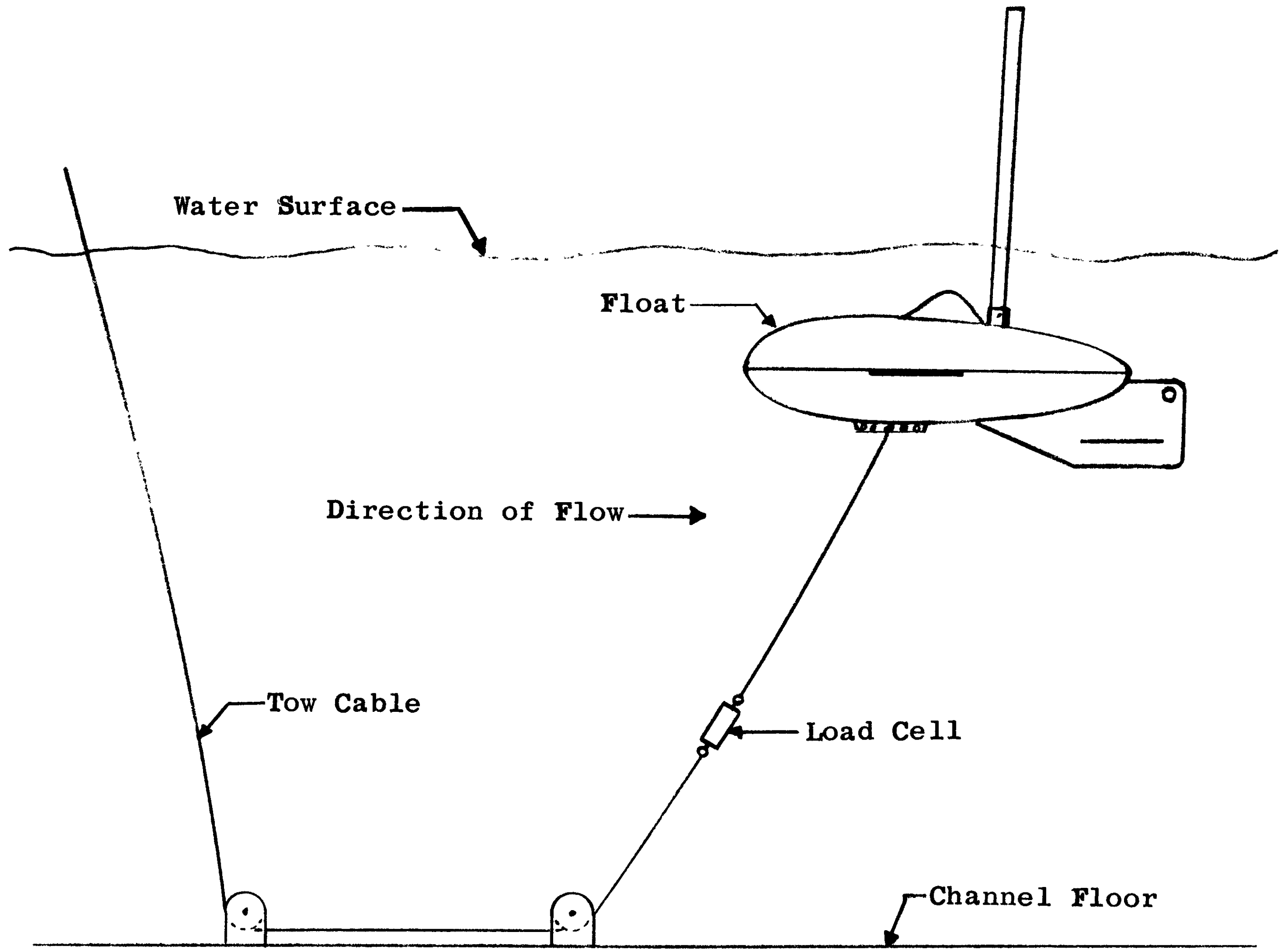


Figure 3 - Schematic of the Towing Configuration in the Circulating Water Channel

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Figure 4 - The Float under Tow in the Circulating Water Channel at a Speed of 5 Knots

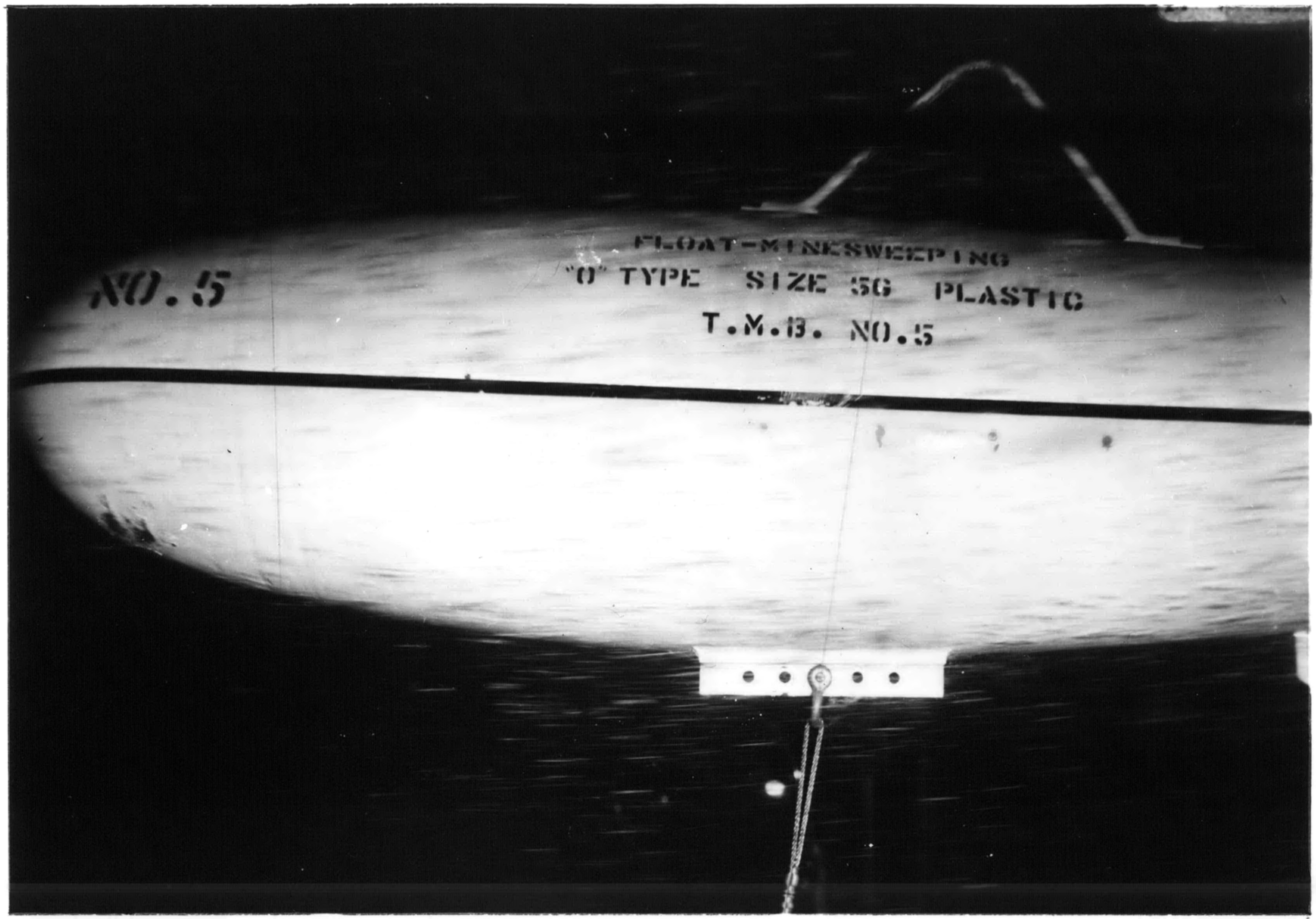

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Figure 5 - The Float, without Wings, under Tow in the Circulating Water Channel at a Speed of 5.15 Knots

The tension force was resolved into components normal and parallel to the stream to obtain the required values of lift and drag. Figures 6 and 7 compare the lift and drag of the float with and without wings. It may be noted particularly at speeds above 6 knots that the wings develop a large lift with a relatively small increase in drag.

TOWING BASIN TESTS

The float was also towed in the Deep-Water Towing Basin in the 0 to 10-knot speed range. As shown schematically in Figure 8, the towing configuration consisted of the float which was towed on a variable length of 3/16-inch diameter cable from a streamlined towed weight which in turn was towed on a Vee-bridle by the towing carriage. The towed weight weighed 1700 pounds in air. The final float configuration selected on the basis of the Circulating Water Channel tests was used in all of the basin tests except that the flagstaff length was reduced from 8.5 feet to 6 feet. Figure 9 shows the float under tow in the Towing Basin.

The float towed in a stable manner throughout the speed range of 0 to 10 knots. The 2-inch diameter flagstaff performed, in effect, as a depth control. For example, if the depth of the float increases, more of the flagstaff becomes submerged and the additional drag force increases the bow-up moment. This results in an increase in angle of attack and the body and wings produce more hydrodynamic lift to decrease the depth of the float until the equilibrium depth is again established. The opposite occurs if the depth decreases.

CONCLUSIONS

On the basis of the foregoing test program, it is concluded that a Size 5G, Reinforced-Plastic Float has been developed which will have satisfactory steady-state towing characteristics over a range of speeds from 0 to 10 knots. The float will tow properly either with or without the wings. It is recommended, however, that the wings be retained because of their large lifting capacity compared with a relatively small increase in drag. The plastic float should reduce handling problems since it weighs 52 percent less than the existing steel float.

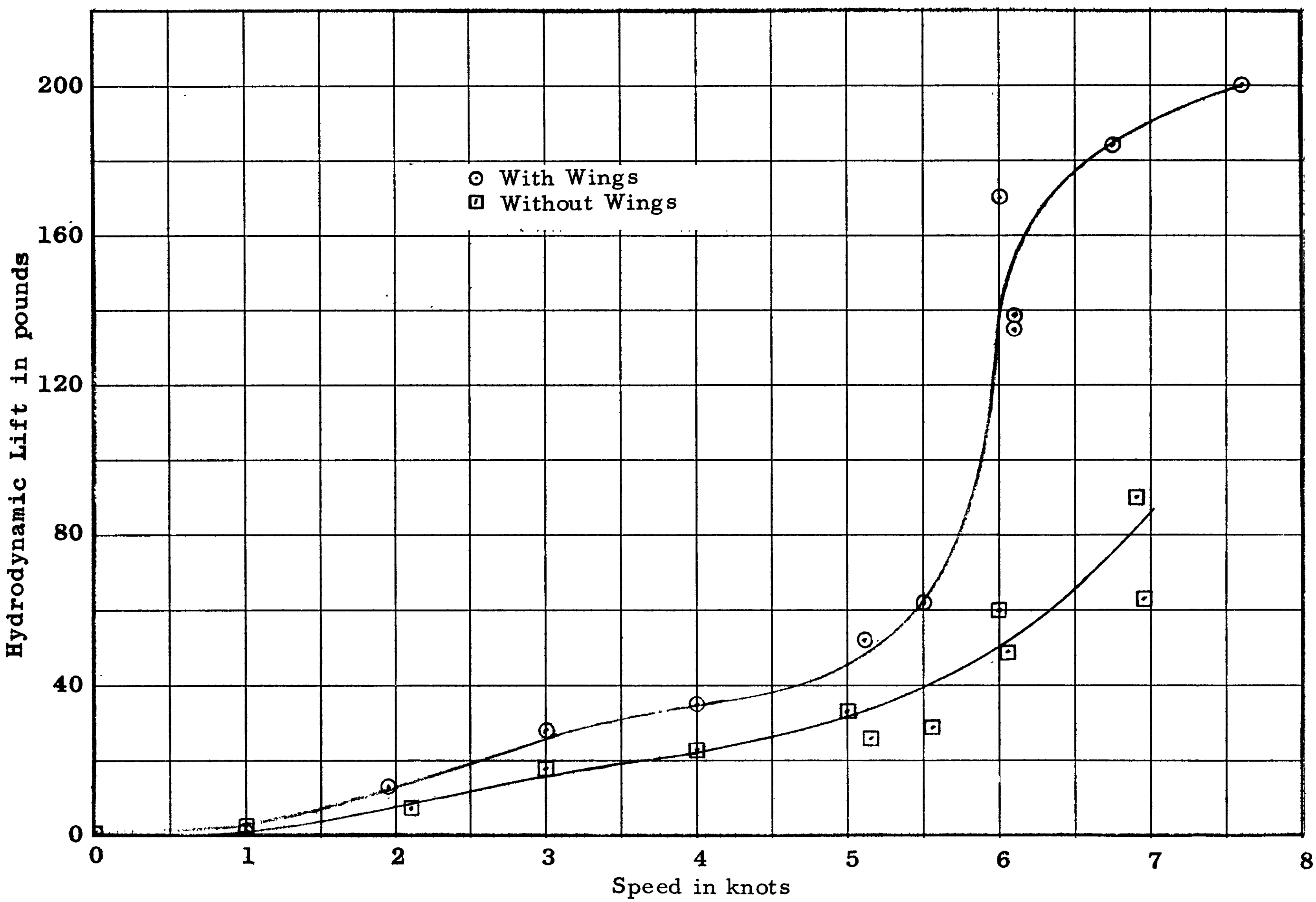

Figure 6 - Comparison of the Hydrodynamic Lift of the Float with and without Wings

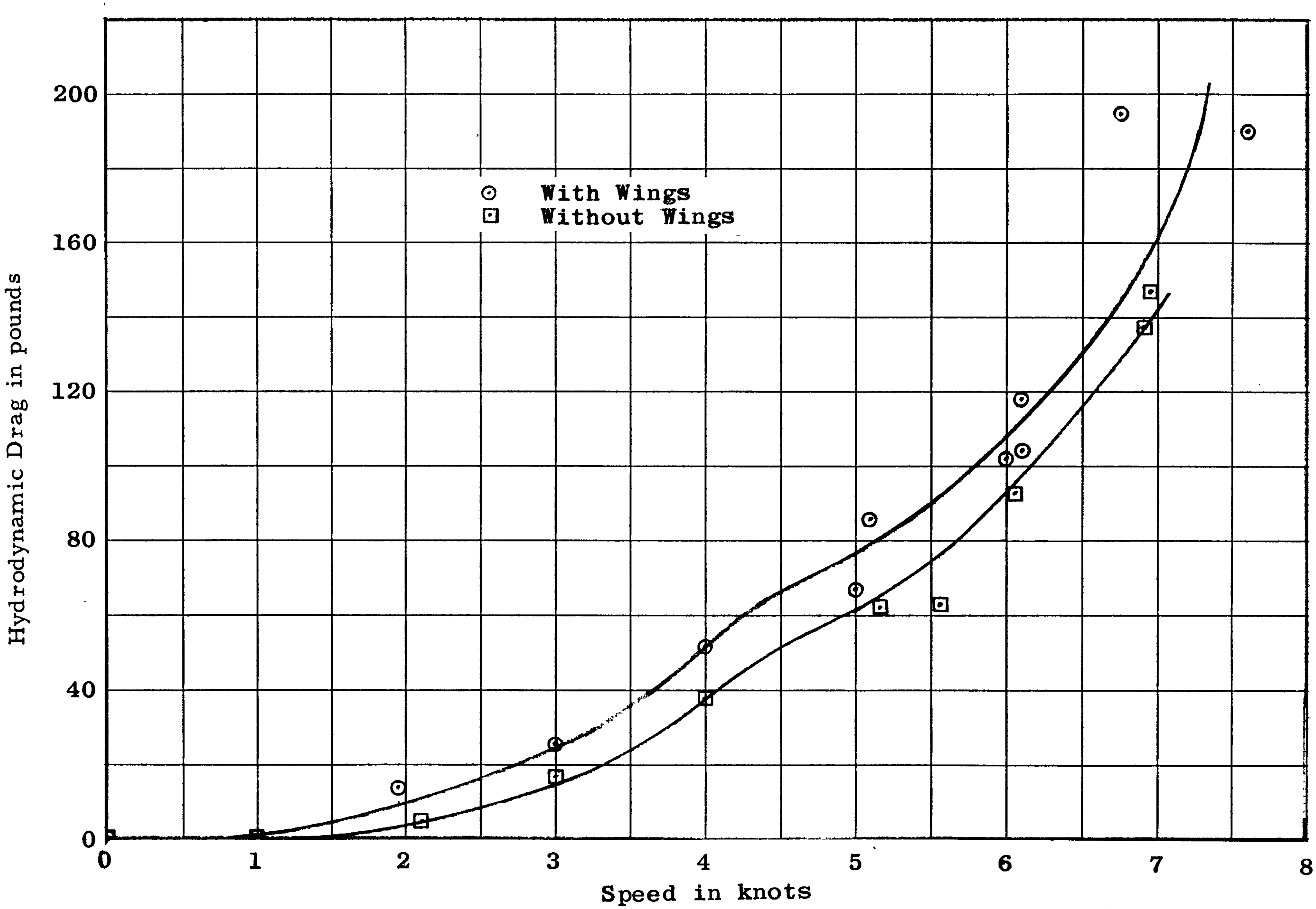

Figure 7 - Comparison of the Hydrodynamic Drag of the Float with and without Wings

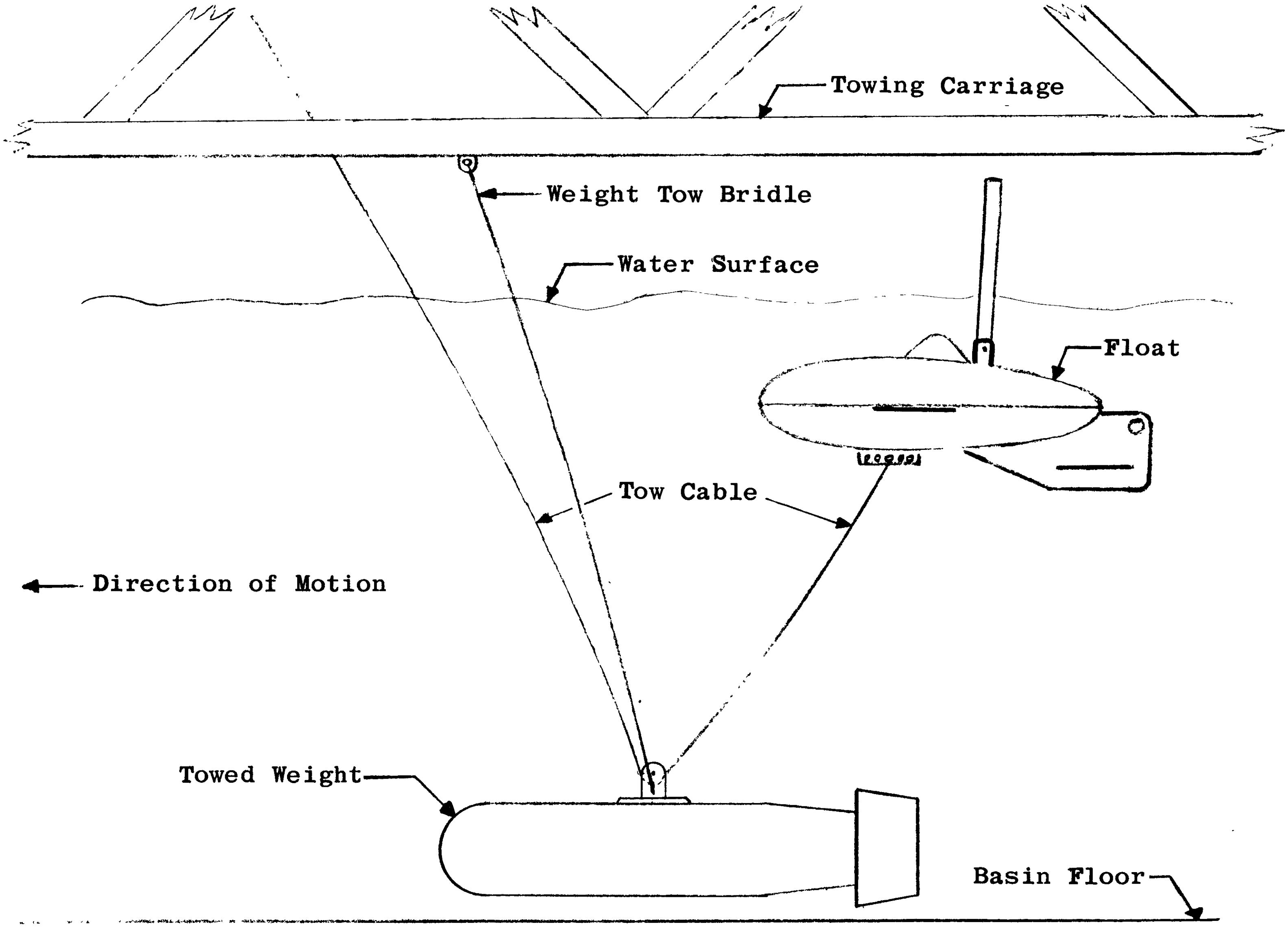

Figure 8 - Schematic of the Towing Configuration in the Towing Basin

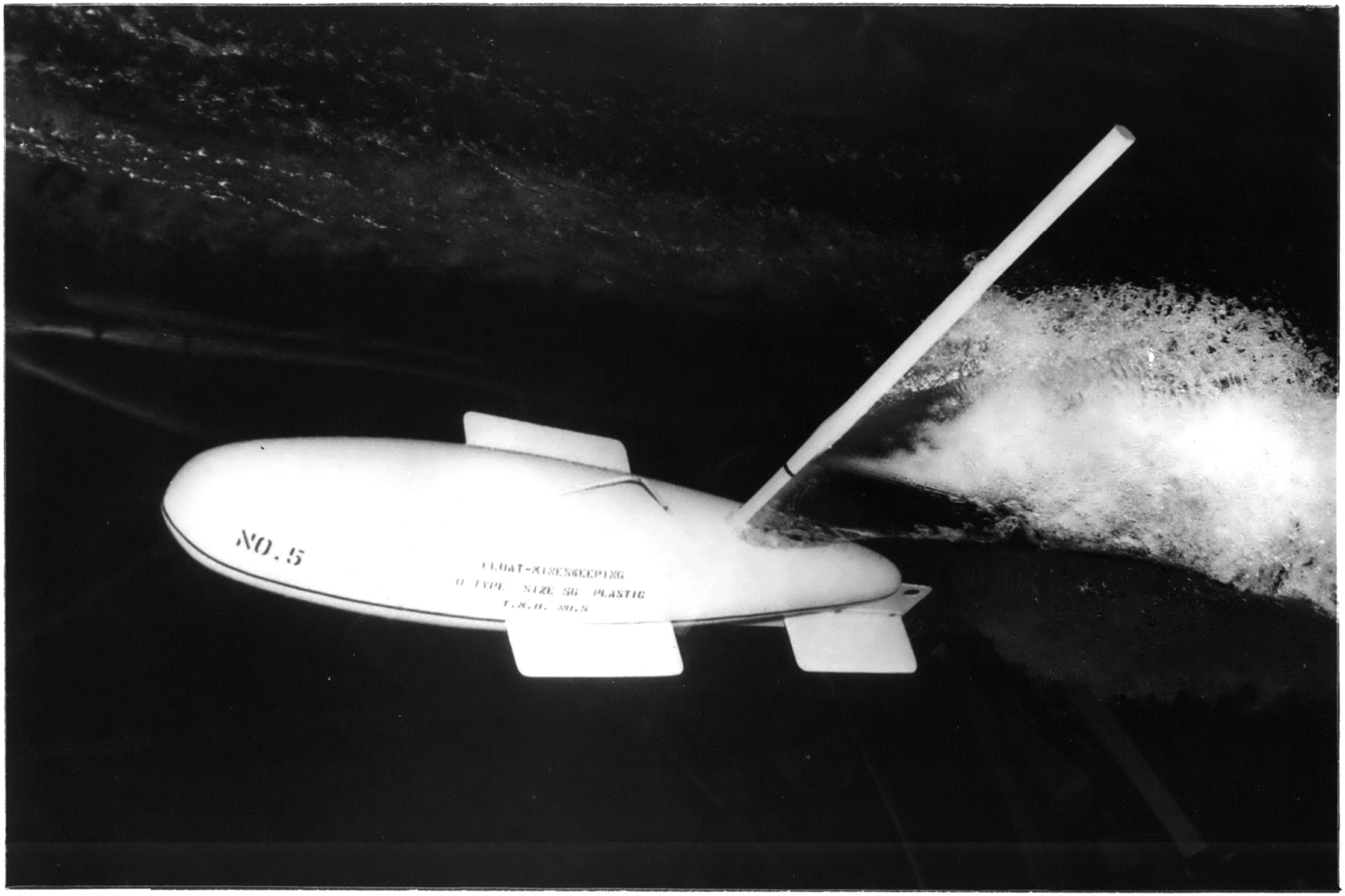

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Figure 9 - The Float under Tow in the Towing Basin at a Speed of 9 Knots

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1. Bureau of Ships letter All/NS-034-045(342C4), Serial 342C-65 of 25 August 1959 to David Taylor Model Basin.

2. NAVSHIPS 250-620-30, "Index of Mine Countermeasures Material," (October 1954).

3. Bureau of Ships letter All/NS-034-045(346), Serial 346-135 of 4 March 1959 to David Taylor Model Basin.

4. Spangler, Peter K., "Hydrodynamic Design and Evaluation of a Size 5 Reinforced-Plastic Minesweeping Float," David Taylor Model Basin Report 1422 (April 1960).

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