DAVIDSON LABORATORY
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SERIES 63
ROUND BOTTOM BOATS

by

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NOMENCLATURE

A = wetted area, ft^2

A_x = cross-sectional area at midships

B = breadth at Buttock No. 6, ft

B_x = breadth at the LWL, ft

B_{max} = maximum breadth, ft

CG = LCG aft of Station No. 6

EHP = effective horsepower

F_V = Froude Number based on volume $v/\sqrt{g\nabla^{1/3}}$

g = acceleration due to gravity

H = draft

L = length at the waterline, ft

L (in L/B, length at LBP)

P = effective power, ft-lb/sec

R_t = total resistance, lbs

T = water temperature, °F

v = speed, ft/sec

V = speed in knots

w = density of water (weight per unit volume)

δ = block coefficient = $\frac{\nabla}{L\ B_x\ H}$

Δ = displacement at rest, weight of, lbs

λ = linear ratio, ship to model

τ = trim angle, with reference to baseline

∇ = displacement at rest, volume of, ft^3

ϕ = prismatic coefficient $\frac{\nabla}{L\ A_x}$

INTRODUCTION

This report presents the results of experimental testing to determine the calm water performance of five round-bottom utility boats. The models were all 1/16-scale, furnished by the David Taylor Model Basin. The purpose of this investigation is to provide BuShips with systematic resistance data for round-bottom hull forms operating in the displacement and semi-planing speed ranges.

DESCRIPTION OF MODELS

The 1/16-scale models were constructed by the David Taylor Model Basin from their drawings of Models 4777A, 4778, 4779, 4780 and 4781. The parent form of this series (Model 4777) is a U. S. Navy 50-ft utility boat design, which has a nominal length-beam ratio $(\frac{L}{B})^*$ of 4. The other four models have nominal length-beam ratios of 2.5, 3, 5 and 6 (Models 4778, 4779, 4780, 4781). All models were constructed to the same station spacing and the same overall length. Each model of the series was derived from the parent form by multiplying the waterline and buttock spacings of the parent by a constant. Accordingly, the body plans of the five models are all geometrically similar, and were in fact, obtained by photographic expansion or reduction from the same drawing. For all models, the thrust line intersects the keel .0506L forward of Sta. 10, and makes an angle of 7.2° with the baseline. Full size and model particulars and offsets are found in Tables I and II. Typical body plan for the series, profiles of all models, Bonjean's, sectional area, and displacement curves are shown in Figs. 1-4.

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* In this term L represents the length between perpendiculars and B the breadth to the No. 6 Buttock. Buttock No. 6 is located at 84% of the extreme beam at the gunwales.

DESCRIPTION OF EXPERIMENTS

Each of the five models was tested at displacements corresponding to values of $L/\nabla^{1/3}$ equal to 4.5, 4.8, 5.15, 5.6 and 6.4. All tests were run in the level trim condition. That is, in each case, the static water line was parallel to the zero draft line. Each test began at model speed of approximately 1 knot and continued up to the speed at which the water reached the deck edge. The two narrow models (4780 and 4781) had insufficient freeboard to be tested at the heavier loads, so some tests had to be deleted. On the other hand, the more beamy models (4778 and 4779) were too heavy to be tested at the lightest of the specified loads. In this case the model weight was reduced to the desired value by applying a vertical upward force through the center of gravity. This was accomplished by hanging weights on a cord attached at the model center of gravity and acting over a pulley about 5 ft above the model.

All tests were run in Tank No. 1 of Davidson Laboratory (100'x9'x4.5'). Model resistance was measured in the horizontal plane using a deadweight-spring balance. The models were towed from a point at the bow on the extended thrust line. A vertical force applied at the tow point was adjusted in magnitude to give a resultant towing force acting along the thrust line. Trim and rise of CG values were determined using two heave indicators mounted at the FP and AP in each model. To induce turbulence, a wire strut (.04" D.) was placed 5" ahead of the FP and to a depth equal to the draft of the model. At the end of each test, five photographs were taken showing the model under way. An effort was made to take the photographs at the same model speeds in order to facilitate comparison, but in some cases different speeds had to be chosen due to the fact that the upper limit of the speed range was not the same for all models.

RESULTS

Model results and data are presented in the Appendix (Tables A-I to A-V). Data are presented to facilitate expansions to any size. The model test results have been expanded to full-scale for $\lambda = 16$ in all cases. Predictions are for salt water at 59°F, based on Schoenherr's Friction formulation for both model and ship. An addition for surface roughness of clean hull of 0.40×10^{-3} has been used unless otherwise specified on the charts.

Figures 5 through 14 present the results of the tests for each model. Powering characteristics are shown as curves of the powering coefficient, $\frac{10P}{wg^{1/2}\nabla^{7/6}}$, versus volume Froude Number, F_∇. Curves of running trim, rise of CG and R/Δ versus F_∇ are plotted for the specified values of $\frac{L}{\nabla^{1/3}}$. Figure 15 summarizes the powering characteristics for all the models. Figures 16-18 show plots of R/Δ vs F_∇ for zero roughness allowance. Figure 19 is similar to Fig. 15 except that the model results have been expanded using zero roughness.

Photographs of the models under way are shown in Figs. 20-28. They have been arranged so that the effect of displacement and speed can readily be seen. All photographs for each model have been displayed together in order to point out differences in wave profile and spray formation.

ACKNOWLEDGMENT

The author is indebted to Mr. Paul R. Van Mater for his supervision and to Mrs. Helen Sheridan for her assistance in analyzing the data.

REFERENCE

1. Nordström, H. F.: "Some Tests with Models of Small Vessels," Publication of the Swedish State Shipbuilding Experimental Tank, 1951.

TABLE Ia. FULL-SIZE PARTICULARS

L/B Ft/Ft LBP/B	$L/\nabla^{1/3}$ Ft/Ft $LWL/\nabla^{1/3}$	LOA Ft	LBP Ft	B Ft Beam at Butt 6	∇ Ft^3 Vol	Δ Lb Displ	LWL Ft	B_x Ft Beam at Waterline	H Ft Draft	A Ft^2
6	6.4	50.0	48.0	8.0	446.5	28,820	48.93	8.51	1.96	409.6
	5.6				675.8	43,330	49.23	8.81	2.62	478.7
	5.15				884.7	55,530	49.41	9.02	3.12	537.6
5	6.4	50.0	48.0	9.6	438.3	28,400	48.69	9.90	1.77	427.5
	5.6				667.6	42,490	48.93	10.24	2.33	486.4
	5.15				868.4	55,320	49.12	10.45	2.83	537.6
	4.8				1085	68,995	49.28	10.67	3.32	593.4
4	6.4	50.0	48.0	12.0	434.2	27,770	48.38	11.79	1.65	471.0
	5.6				655.4	42,280	48.64	12.23	2.16	532.5
	5.15				847.9	54,690	48.82	12.64	2.59	576.0
	4.8				1065	68,150	48.96	12.85	3.03	619.5
	4.5				1298	82,880	49.10	13.04	3.47	665.6
3.0	6.4	50.0	48.0	16.0	421.9	28,400	48.05	14.54	1.53	542.7
	5.6				643.1	41,020	48.26	15.39	2.01	601.6
	5.15				831.5	53,010	48.42	15.87	2.32	640.0
	4.8				1032	66,050	48.54	16.24	2.63	678.4
	4.5				1266	81,200	48.69	16.53	3.03	721.9
2.5	5.6	50.0	48.0	19.2	618.5	39,550	47.68	17.66	1.92	627.2
	5.15				815.1	51,750	48.16	18.34	2.24	691.2
	4.8				1020	65,210	48.32	18.83	2.57	745.0
	4.5				1249	79,510	48.46	19.20	2.89	788.5

TABLE Ib. 1/16 SCALE MODEL PARTICULARS

L/B	$L/\nabla^{1/3}$	∇ ft^3	$B_x/\nabla^{1/3}$	$H/\nabla^{1/3}$	B_x/H	$A/\nabla^{2/3}$	δ	ϕ	$CG^*/\nabla^{1/3}$	CG^*/L %	B_x/B_{max}
6	6.4	.109	1.11	.255	4.36	7.02	.549	.740	.347	5.43	.896
	5.6	.165	1.00	.299	3.36	6.21	.594	.745	.299	5.33	.928
	5.15	.216	0.94	.325	2.89	5.83	.636	.774	.298	5.80	.950
5	6.4	.107	1.30	.234	5.58	7.39	.512	.690	.227	3.55	.864
	5.6	.163	1.17	.267	4.38	6.38	.571	.701	.236	4.22	.893
	5.15	.212	1.10	.297	3.69	5.92	.597	.735	.260	5.05	.911
	4.8	.265	1.04	.322	3.22	5.63	.623	.764	.237	4.94	.930
4	6.4	.106	1.56	.218	7.16	8.21	.462	.647	.199	3.11	.823
	5.6	.160	1.41	.249	5.69	7.05	.508	.677	.236	4.21	.858
	5.15	.207	1.33	.274	4.88	6.43	.530	.695	.240	4.65	.882
	4.8	.260	1.26	.296	4.25	5.95	.560	.712	.207	4.31	.897
	4.5	.317	1.20	.318	3.76	5.59	.584	.734	.223	4.95	.910
3.0	6.4	.103	1.94	.205	9.47	9.64	.393	.591	0	0.0	.764
	5.6	.157	1.78	.234	7.63	8.08	.430	.620	.134	2.39	.808
	5.15	.203	1.69	.247	6.84	7.23	.466	.639	.172	3.34	.834
	4.8	.252	1.61	.259	6.19	6.64	.499	.659	.210	4.38	.853
	4.5	.309	1.53	.280	5.47	6.17	.520	.690	.209	4.63	.868
2.5	5.6	.151	2.08	.225	9.20	8.66	.383	.577	-.017	-0.30	.772
	5.15	.199	1.96	.240	8.19	7.92	.412	.601	.123	2.39	.801
	4.8	.249	1.87	.256	7.31	7.35	.435	.613	.132	2.75	.823
	4.5	.305	1.78	.269	6.63	6.80	.464	.642	.153	3.40	.839

$B_{max}/B = 1.19$

* CG = LCG aft of St. 6, ft

TABLE II. OFFSETS

$B_{max}/B = 1.19$

Waterline and Buttock Spacing = 8.333% B
Zero Draft Line, 9% B below Waterline 0.

	HALF-BREADTH, % B						
	WATERLINES						
STA. NO.	0	1	2	3	4	5	KNUCKLE
-1/4	0	0	0	0.44	1.55	3.22	8.56
0	0	1.89	3.67	5.56	7.44	9.78	17.33
1/4	1.89	5.11	7.78	10.33	12.89	16.22	25.00
1/2	4.11	8.44	11.56	14.44	17.56	21.44	31.44
1	8.00	14.00	18.44	22.22	26.22	31.11	41.00
1-1/2	12.33	19.56	24.44	29.00	33.22	38.56	47.56
2	17.11	24.89	30.11	34.67	39.22	44.56	51.56
3	25.89	34.00	39.11	43.44	47.56	52.33	56.22
4	35.56	41.11	45.56	49.11	53.00	56.67	58.44
5	39.44	46.78	50.00	52.78	55.78	-	59.44
6	43.56	50.00	52.89	54.89	57.22	-	59.67
7	46.22	51.78	54.44	56.00	57.44	-	59.00
8	45.56	52.22	54.22	56.00	57.78	-	58.11
9	41.67	51.33	53.78	55.11	56.22	-	57.00
10	34.89	49.56	52.44	54.00	54.89	-	55.22
11	21.22	46.89	50.67	52.00	52.89	-	53.33
12	-	43.33	48.44	50.00	50.89	-	51.56

	HEIGHTS ABOVE BASELINE, % B							
			BUTTOCKS					
STA. NO.	KEEL	KNUCKLE	1	2	3	4	5	6
-1/4	30.22	64.67	64.67	-	-	-	-	-
0	9.89	63.78	46.22	63.33	-	-	-	-
1/4	5.11	62.89	27.44	51.89	62.89	-	-	-
1/2	3.00	62.22	17.11	40.22	55.56	-	-	-
1	1.78	60.89	9.11	21.78	40.00	53.33	-	-
1-1/2	1.33	59.33	5.67	13.33	26.22	42.56	54.00	-
2	0.89	58.11	3.56	8.67	17.22	31.78	46.44	56.89
3	0.44	55.33	1.78	4.00	8.22	16.33	30.78	46.89
4	0.11	52.89	1.00	2.44	4.67	8.78	18.00	36.44
5	0	50.33	0.89	2.11	3.56	5.78	10.67	25.78
6	0	48.67	0.78	1.78	2.89	4.44	7.67	17.11
7	0.67	47.11	1.56	2.22	3.22	4.44	6.78	14.00
8	1.78	46.33	2.33	3.22	4.11	5.33	7.44	13.44
9	3.11	46.00	4.00	4.67	5.56	6.89	8.89	15.11
10	5.22	46.00	5.67	6.33	7.22	8.67	11.11	18.56
11	7.33	47.00	7.78	8.56	9.56	11.11	13.78	23.78
12	10.00	48.22	10.11	10.78	11.89	13.22	16.22	34.00

Line of tow force intersects keel 5.06% L forward of Sta. 10 with 7.2° angle with the baseline.

TABLE III*

ft - lb - sec

$g = 32.19$ ft/sec^2 $w = 64$ lb/ft^3

∇ ft^3	$\frac{10x}{\sqrt{g\,\nabla^{1/3}}}$	$\frac{100x}{\nabla^{1/3}}$	$\frac{10x}{\nabla^{2/3}}$	$\frac{0.001x}{w\,g^{1/2}\nabla^{7/6}}$
300	147	669	448	282
320	148	684	468	303
340	150	698	487	326
360	151	711	506	349
380	153	724	525	371
400	154	737	543	395
420	155	749	561	417
440	157	761	579	441
460	158	772	596	464
480	159	783	613	488
500	160	794	630	511
520	161	804	647	535
540	162	814	663	560
560	163	824	679	584
580	164	834	696	608
600	165	843	711	632
620	166	853	727	657
640	167	862	743	683
660	167	871	758	707
680	168	879	773	732
700	169	888	788	757
720	170	896	803	783
740	171	905	818	808
760	171	913	833	833
780	172	921	847	859
800	173	928	862	886
820	174	936	876	911
840	174	944	890	937
860	175	951	904	964
880	176	958	918	989
900	176	965	932	1,016
920	177	973	946	1,042
940	178	980	960	1,068
960	178	986	973	1,095
980	179	993	987	1,121
1,000	179	1,000	1,000	1,148
1,020	180	1,007	1,013	1,175
1,040	181	1,013	1,027	1,202
1,060	181	1,020	1,040	1,229
1,080	182	1,026	1,053	1,256
1,100	182	1,032	1,066	1,283
1,120	183	1,039	1,079	1,311
1,140	183	1,045	1,091	1,338
1,160	184	1,051	1,104	1,365
1,180	184	1,057	1,117	1,393
1,200	185	1,063	1,129	1,421

* Reprinted from ref. 1.

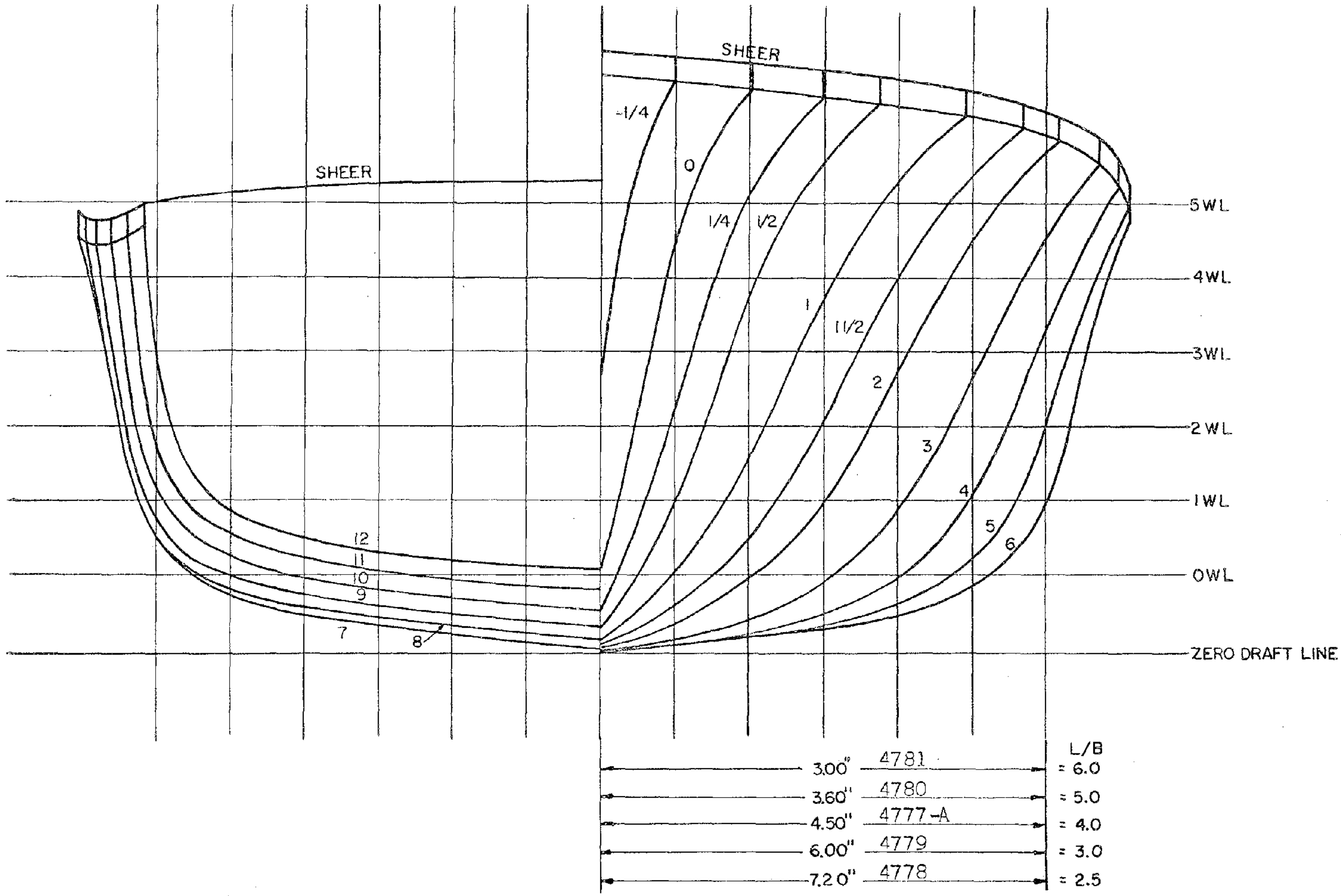
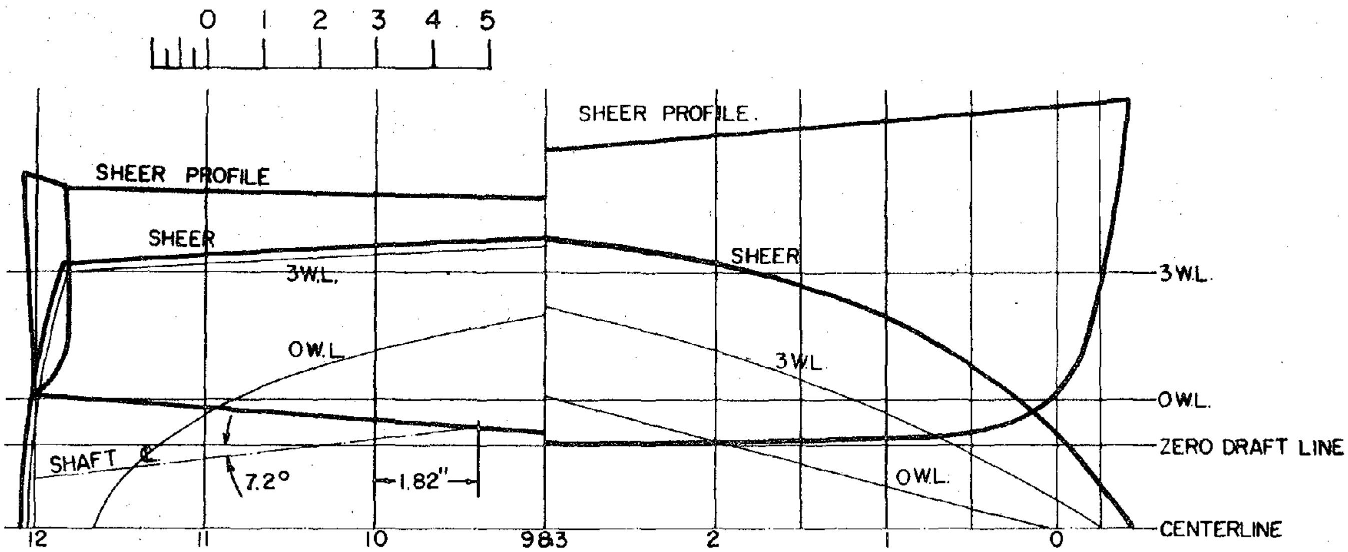
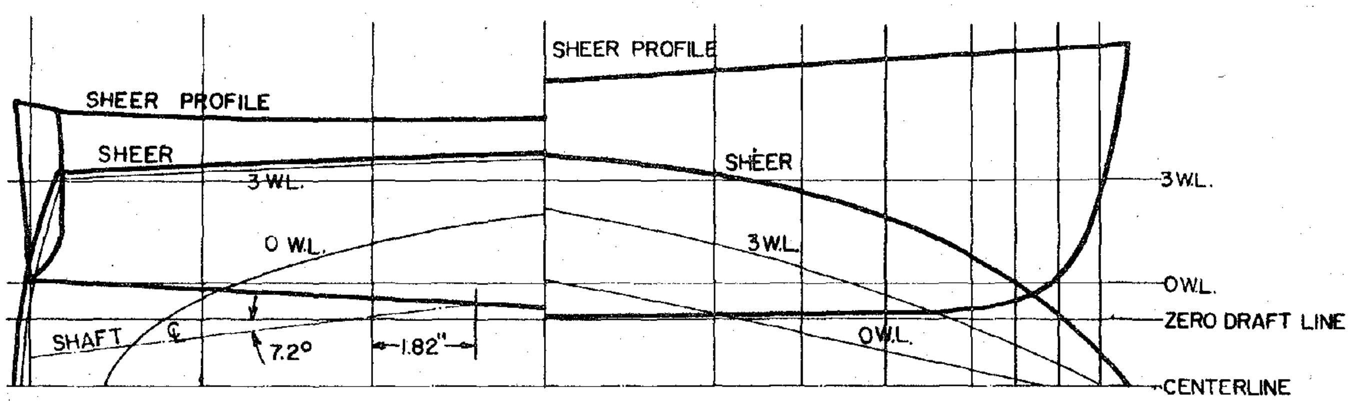


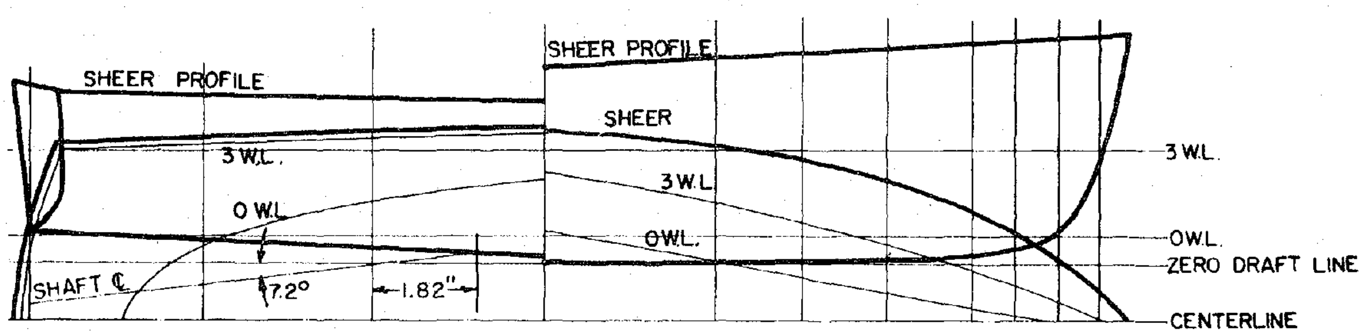
FIGURE 1. BODY PLAN FOR SERIES 63 MODELS



MODEL 4777A L/B = 4



MODEL 4780 L/B = 5



MODEL 4781 L/B = 6

FIGURE 2. PROFILES AND W.L. ENDINGS FOR SERIES 63 MODELS

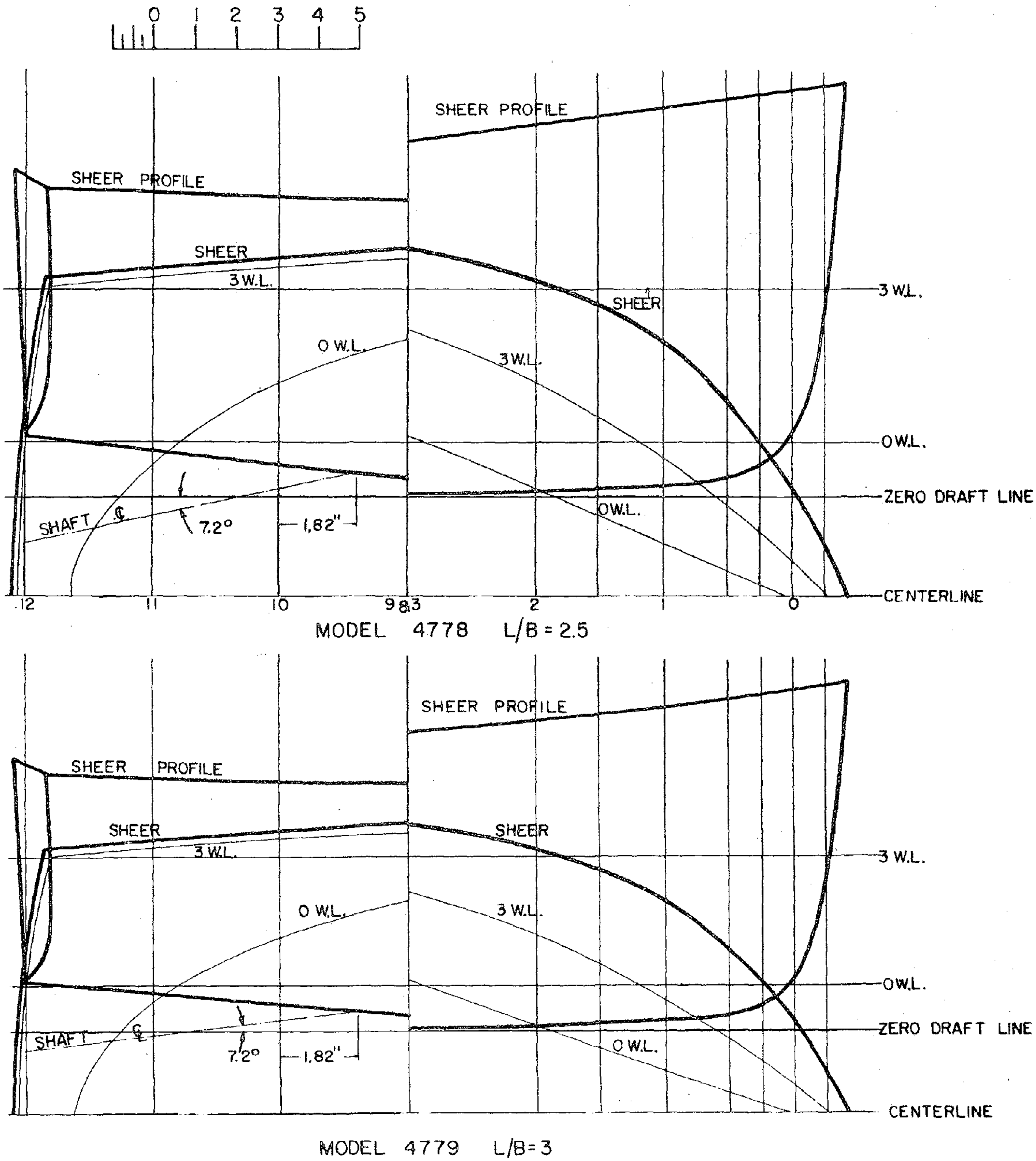
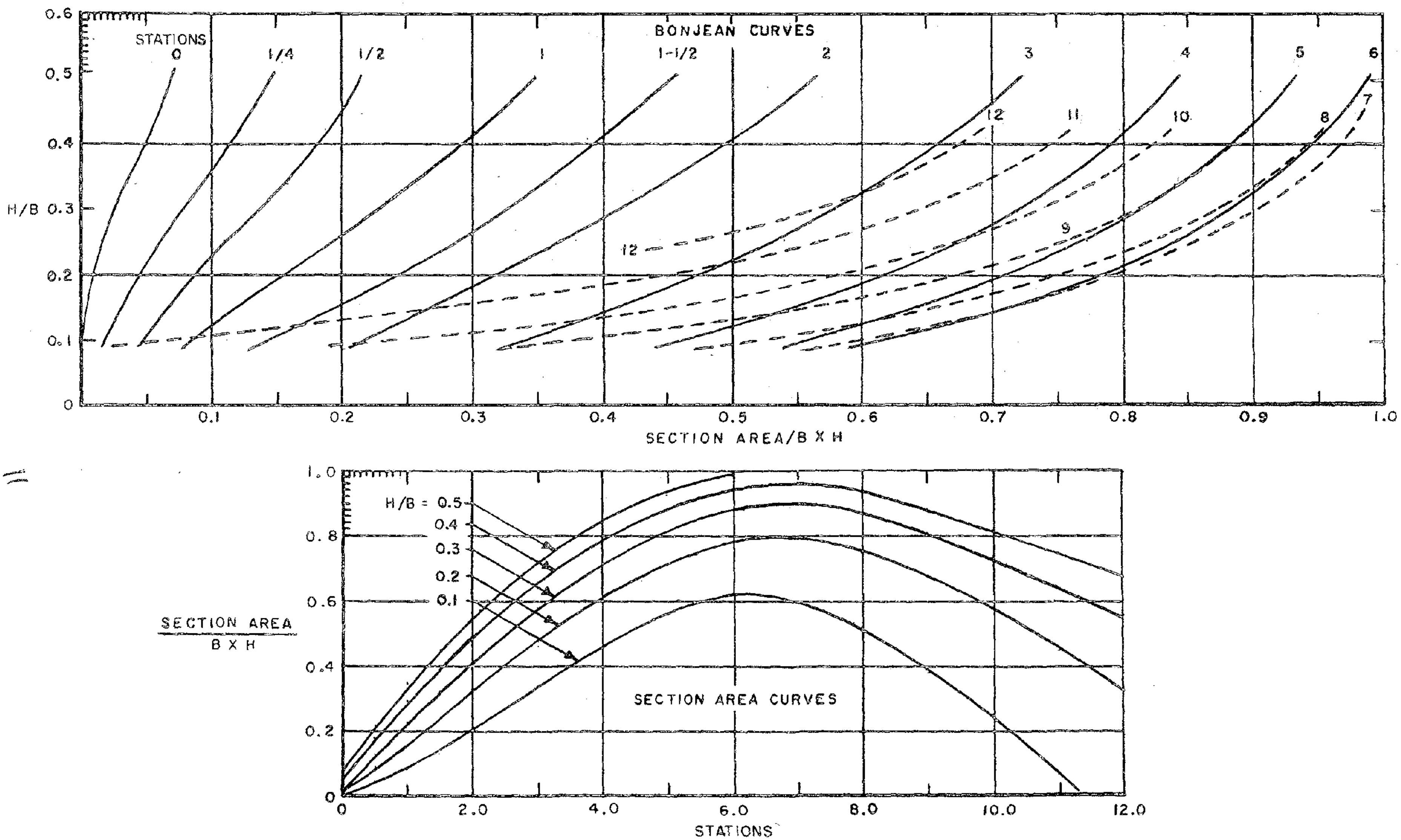


FIGURE 3. PROFILES AND W.L. ENDINGS FOR SERIES 63 MODELS



SECTION AREA AND BONJEAN CURVES

FIGURE 4a. SERIES 63 - ROUND BOTTOM BOATS

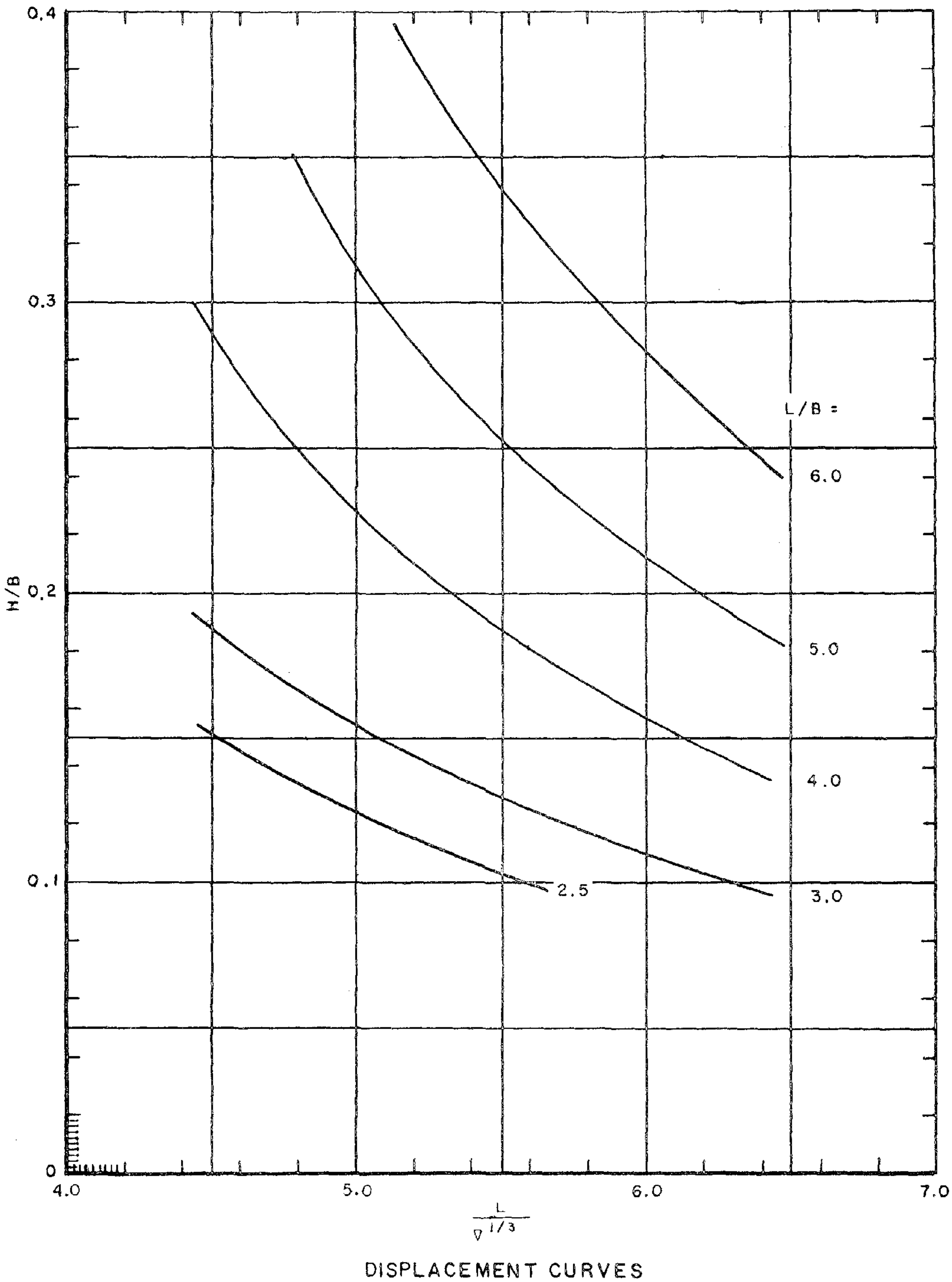


FIGURE 4b. SERIES 63-ROUND BOTTOM BOATS

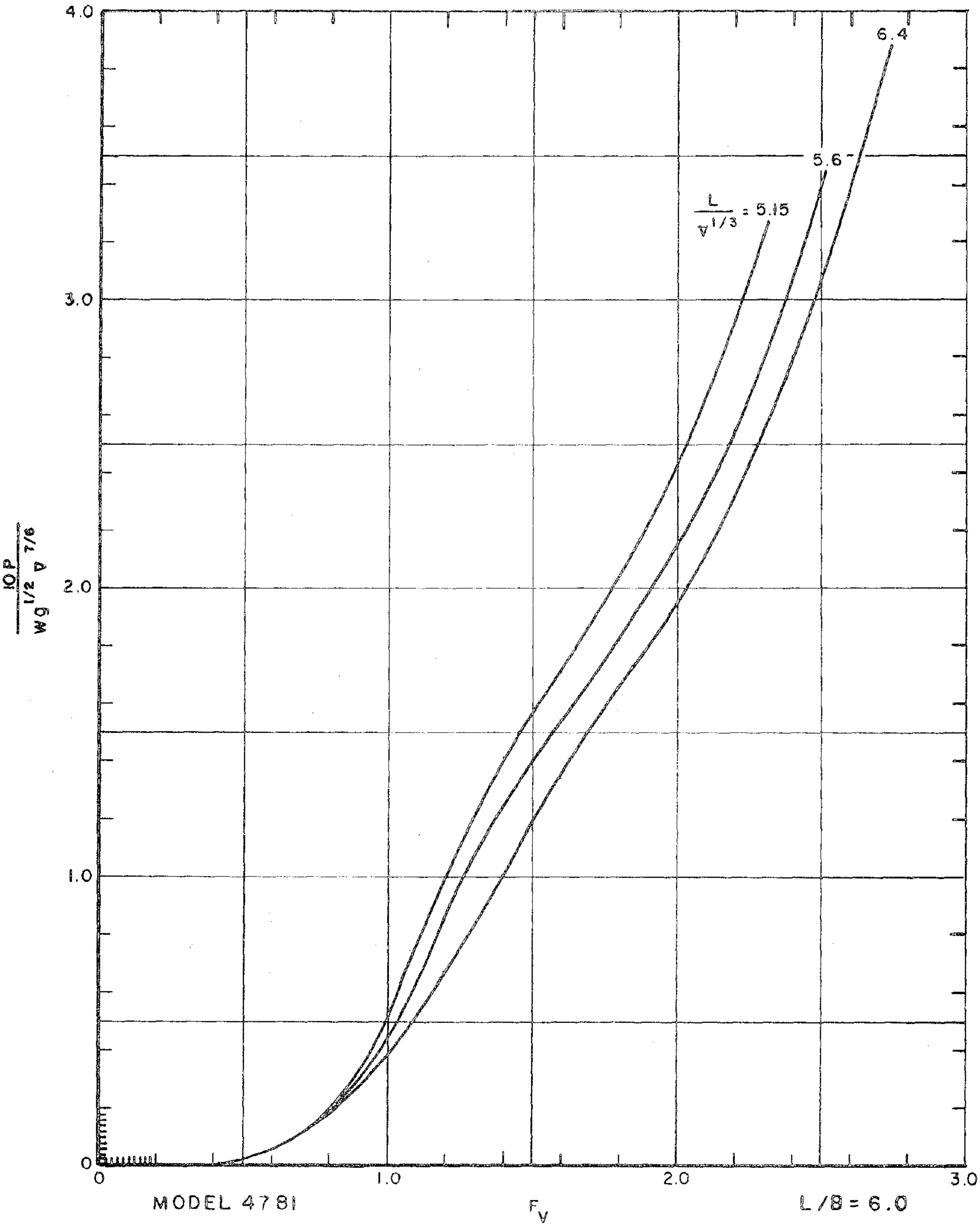
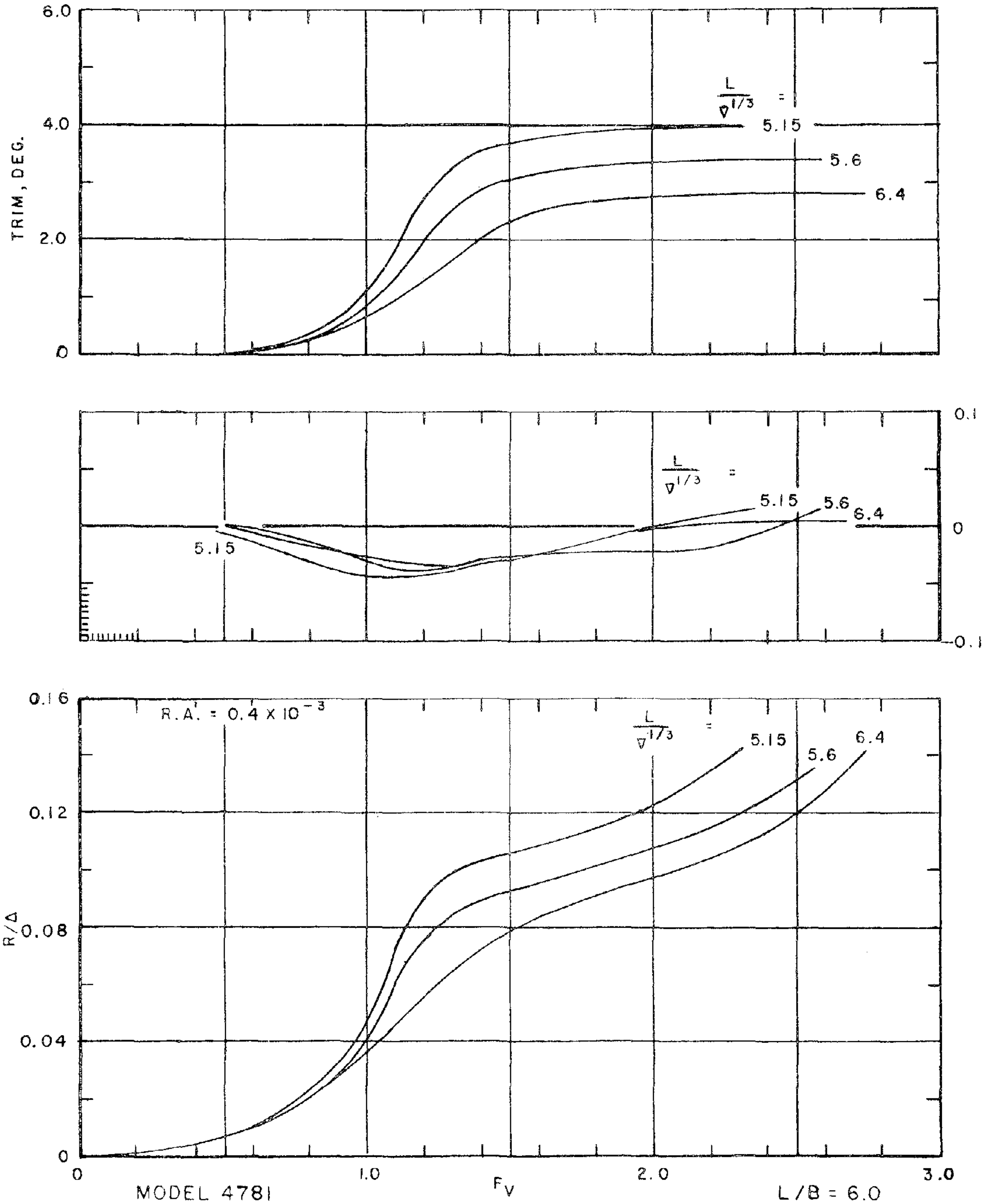


FIGURE 5. SERIES 63 - ROUND BOTTOM BOATS



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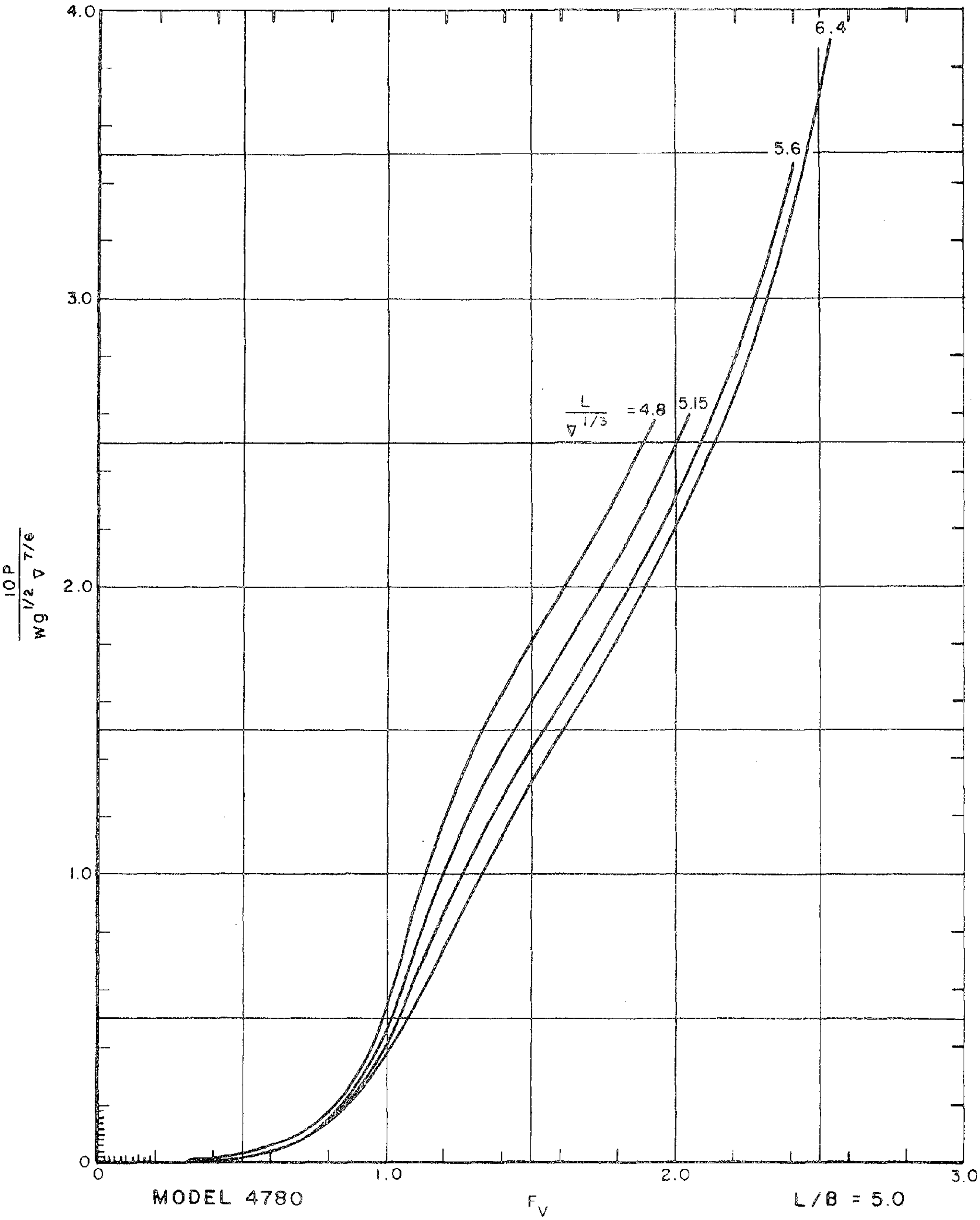
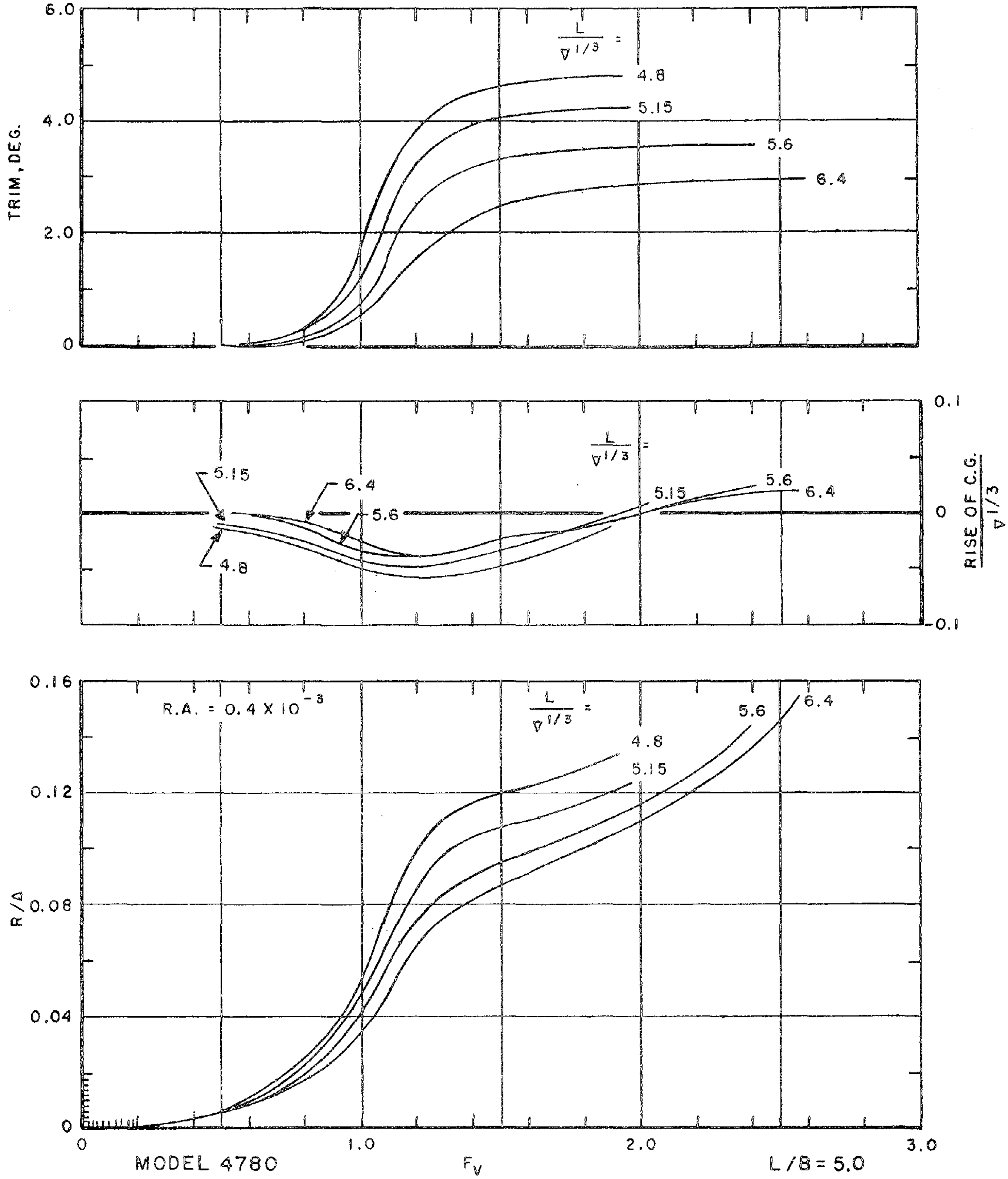


FIGURE 7. SERIES 63-ROUND BOTTOM BOATS



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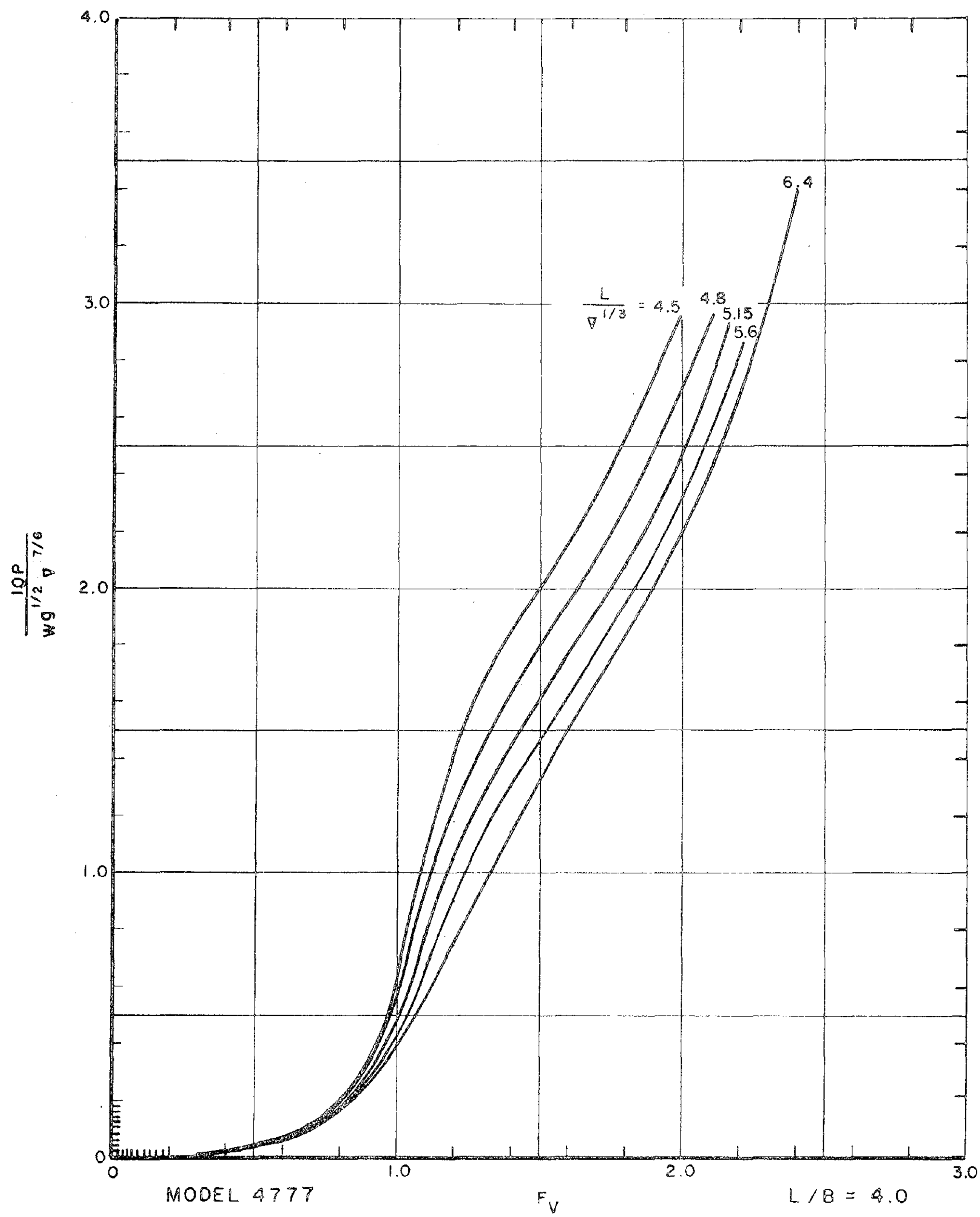
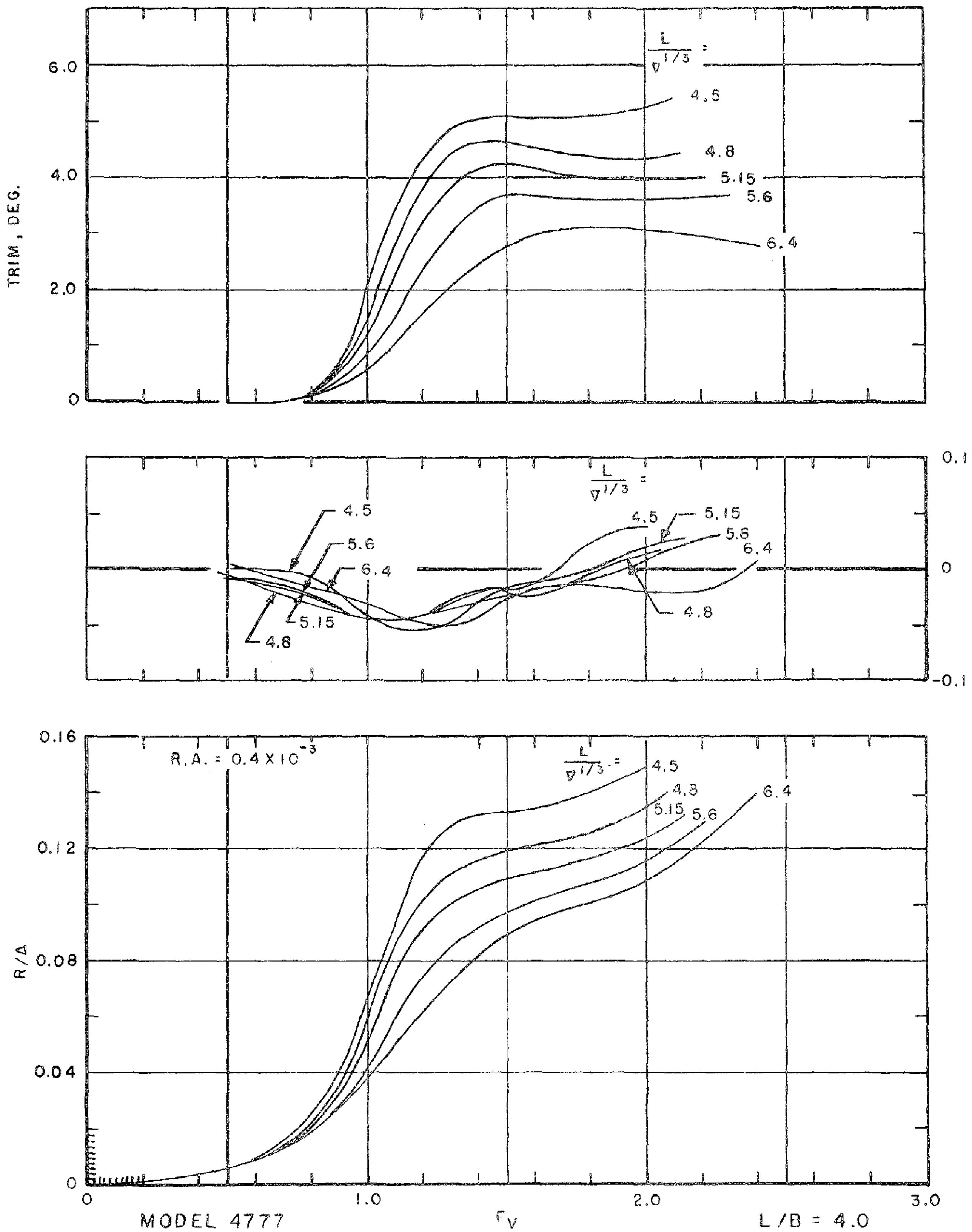


FIGURE 9. SERIES 63 - ROUND BOTTOM BOATS



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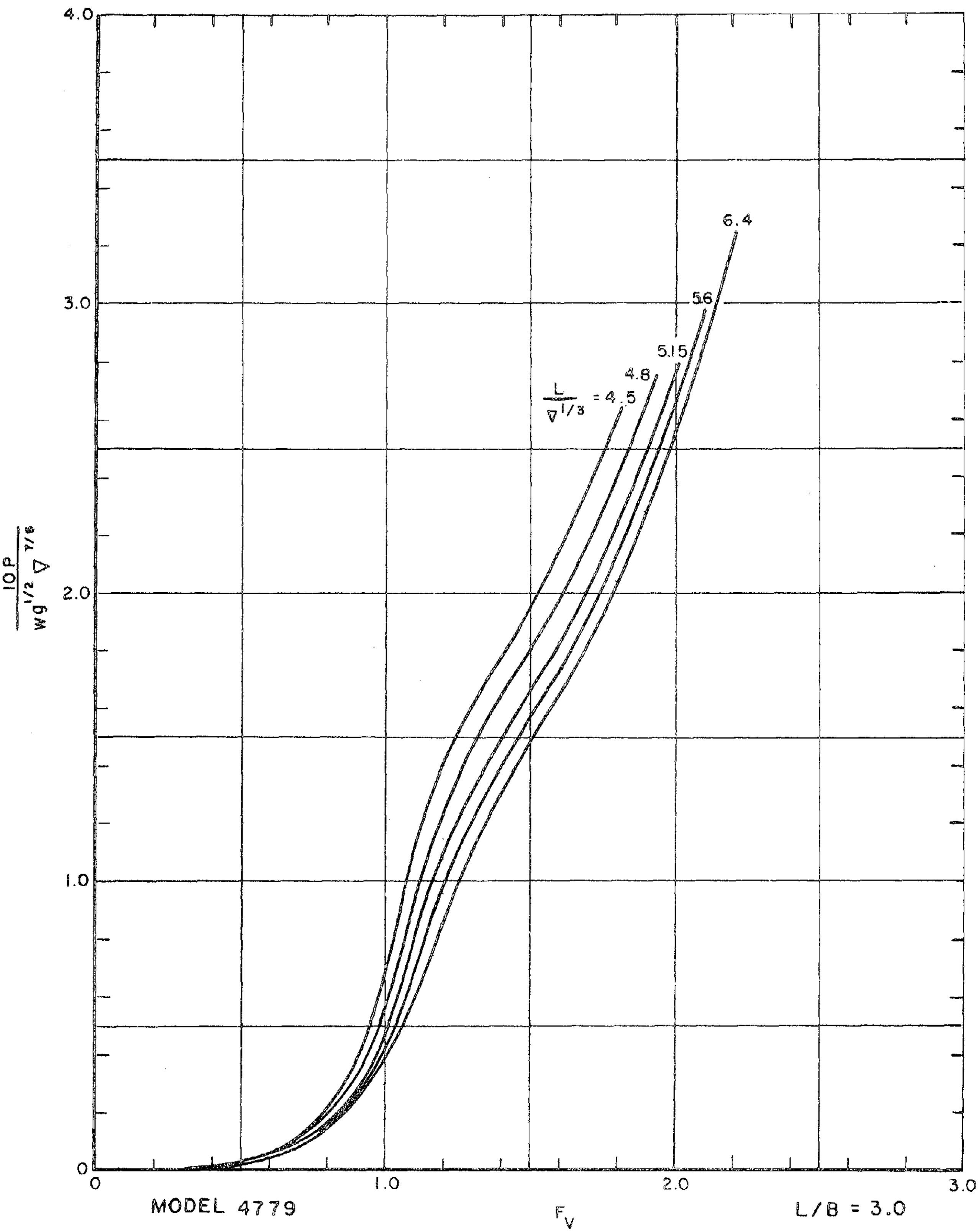

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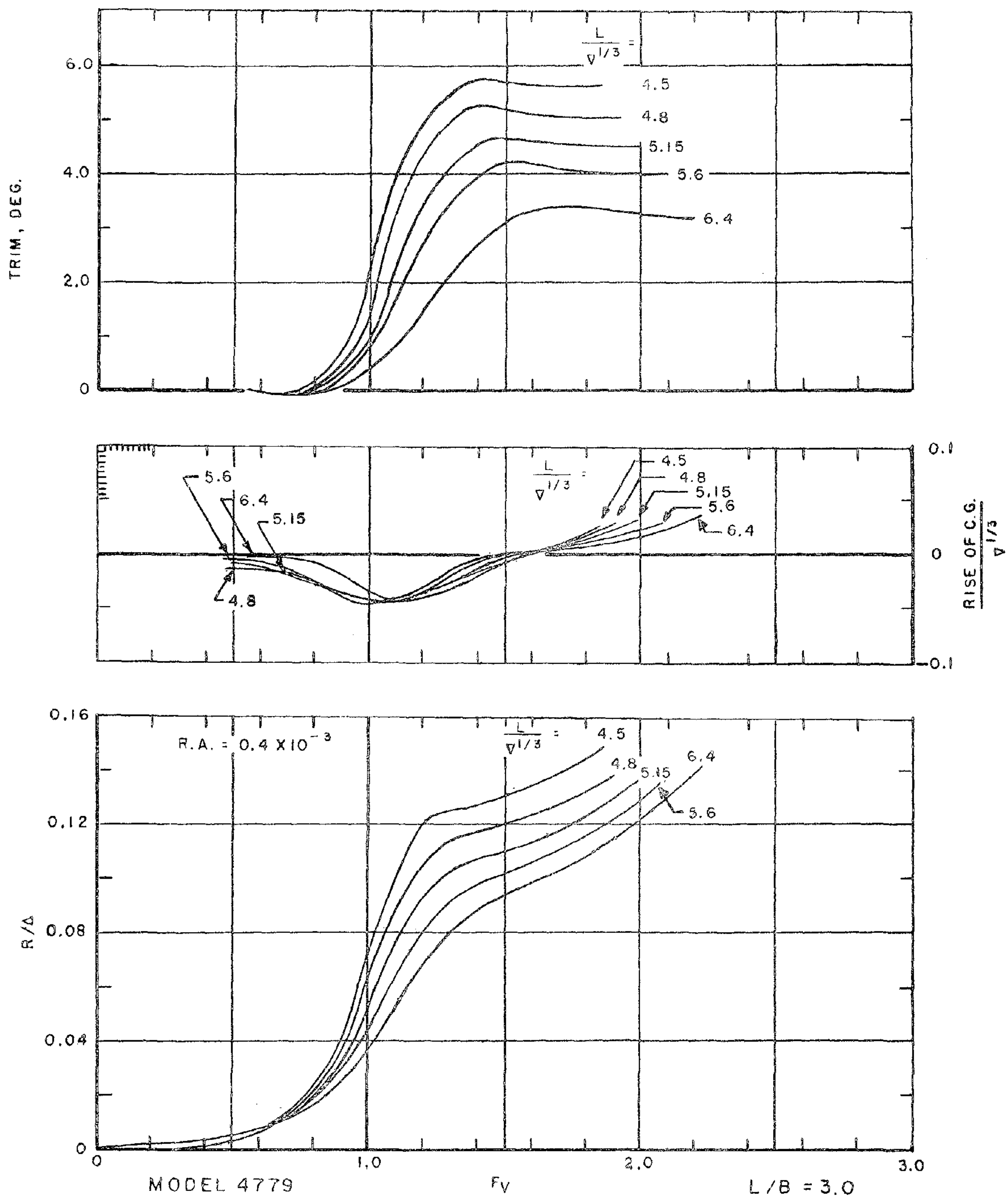


FIGURE 12. SERIES 63 – ROUND BOTTOM BOATS

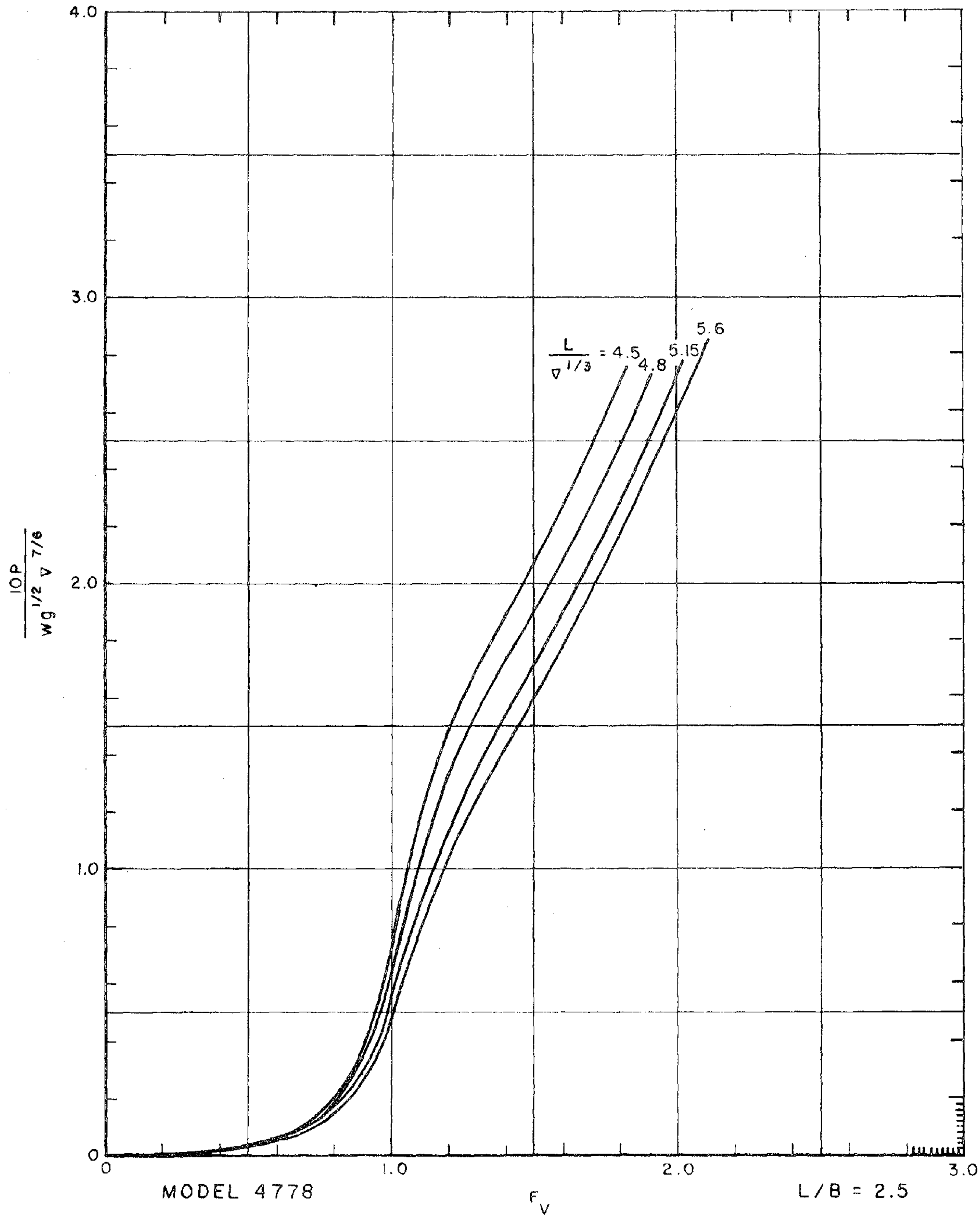


FIGURE 13. SERIES 63 - ROUND BOTTOM BOATS

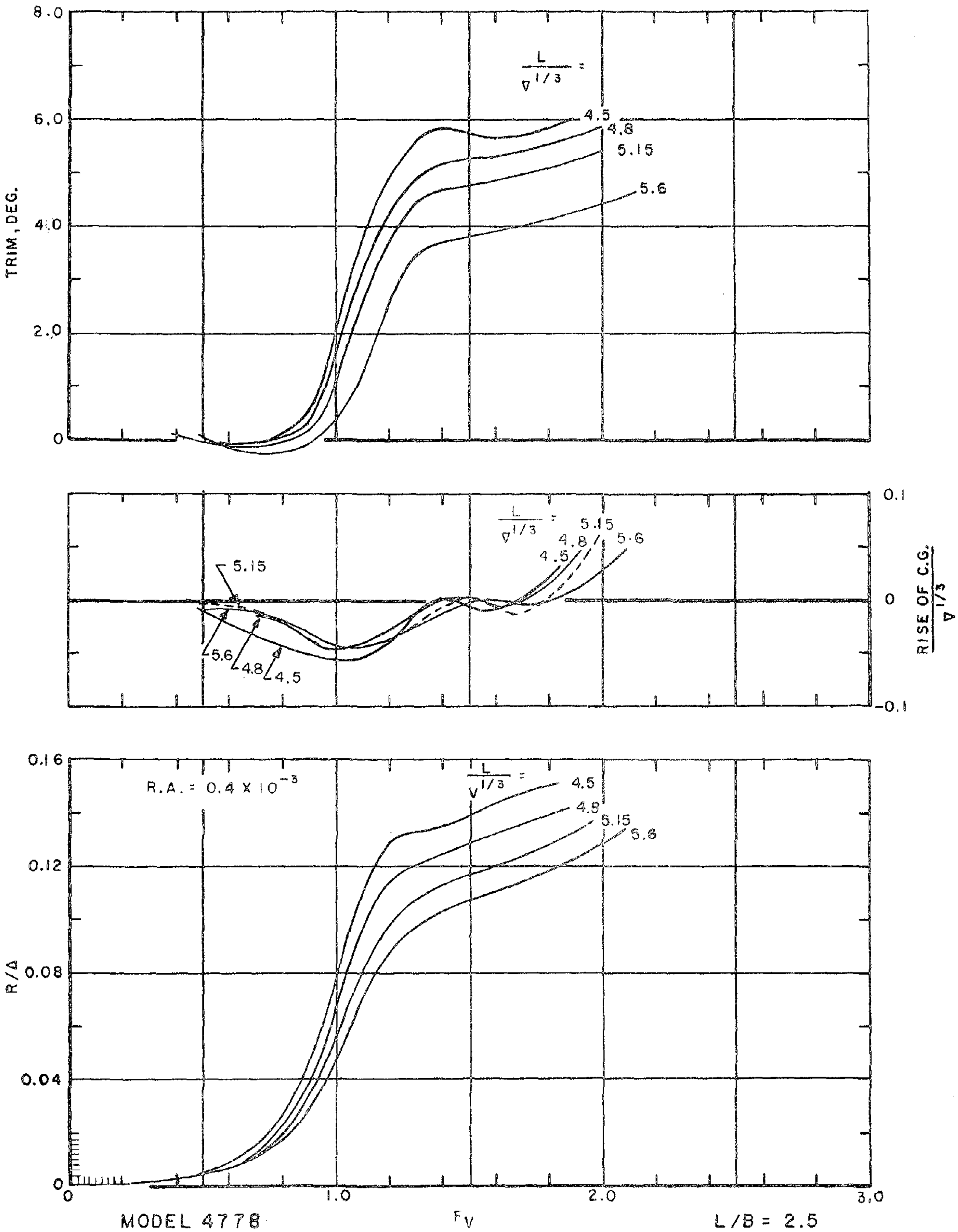


FIGURE 14. SERIES 63 - ROUND BOTTOM BOATS

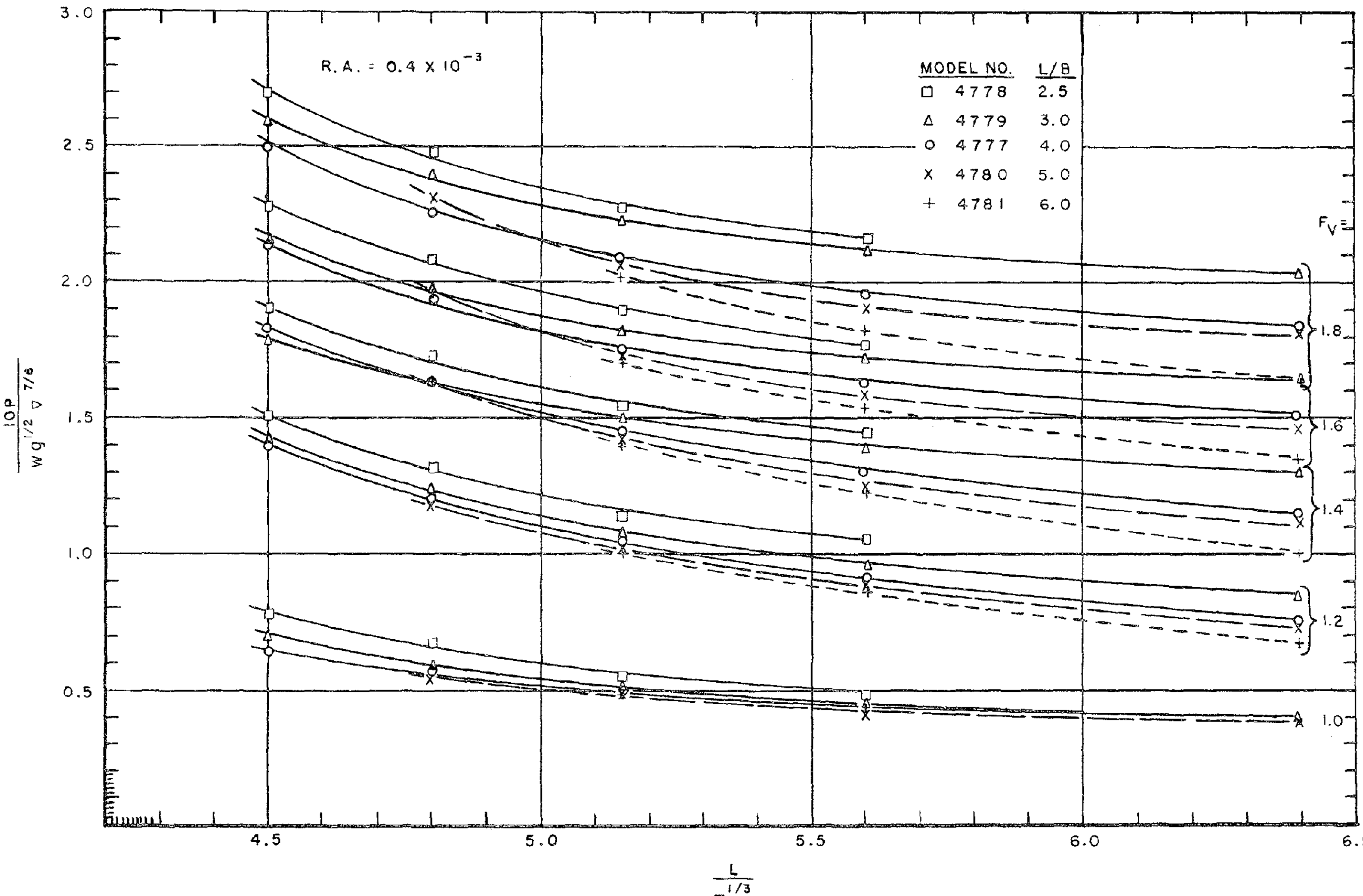


FIGURE 15. SERIES 63 - ROUND BOTTOM BOATS

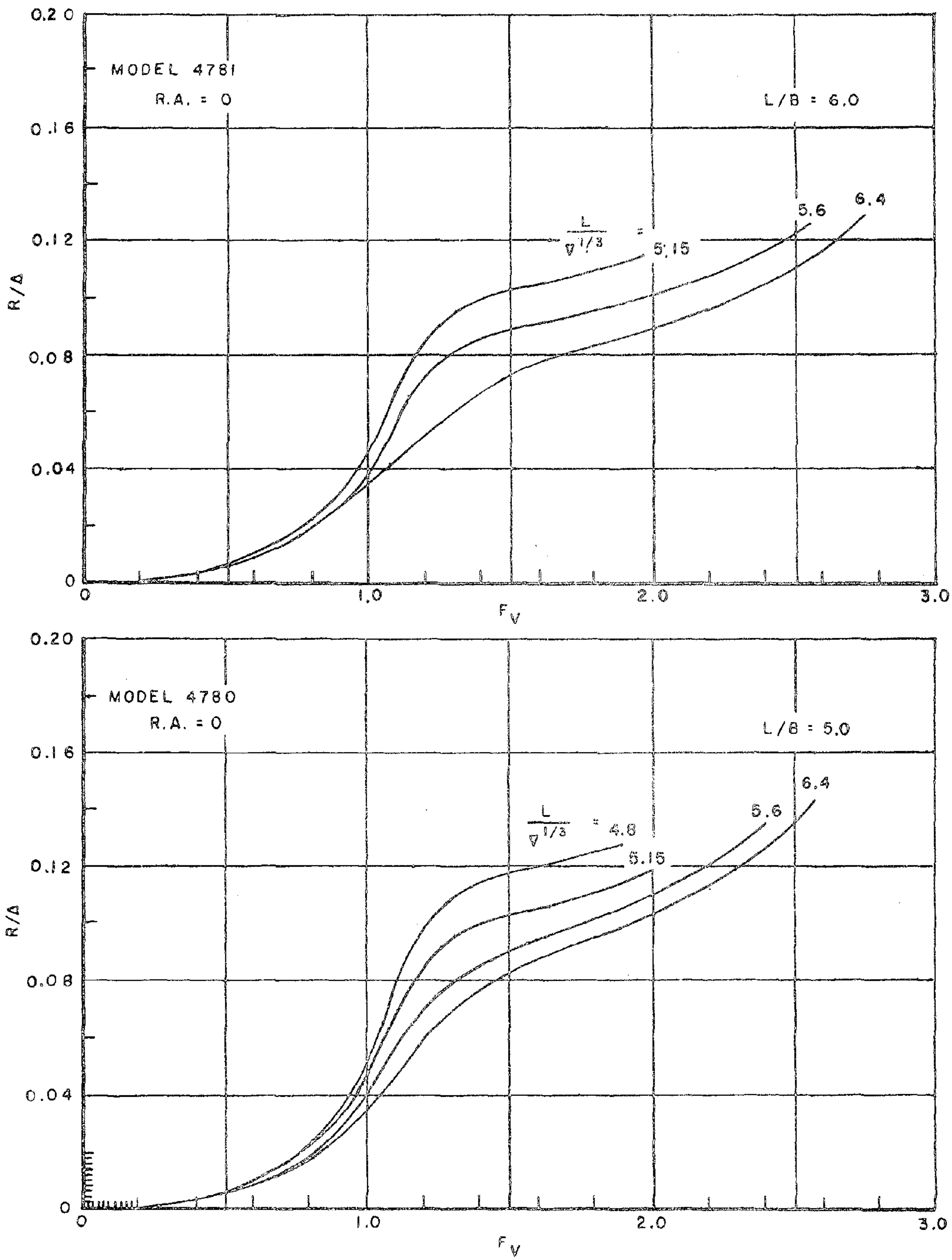


FIGURE 16. SERIES 63 – ROUND BOTTOM BOATS

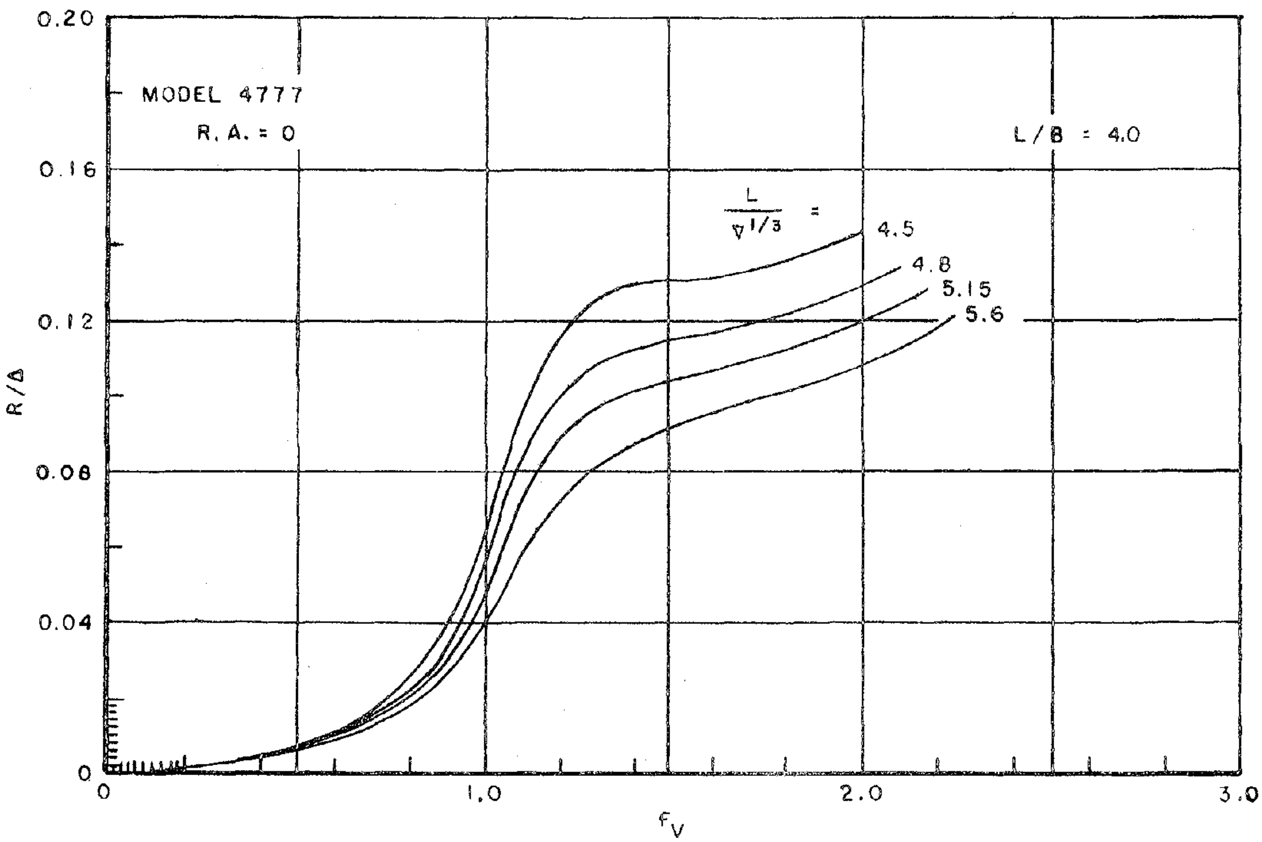
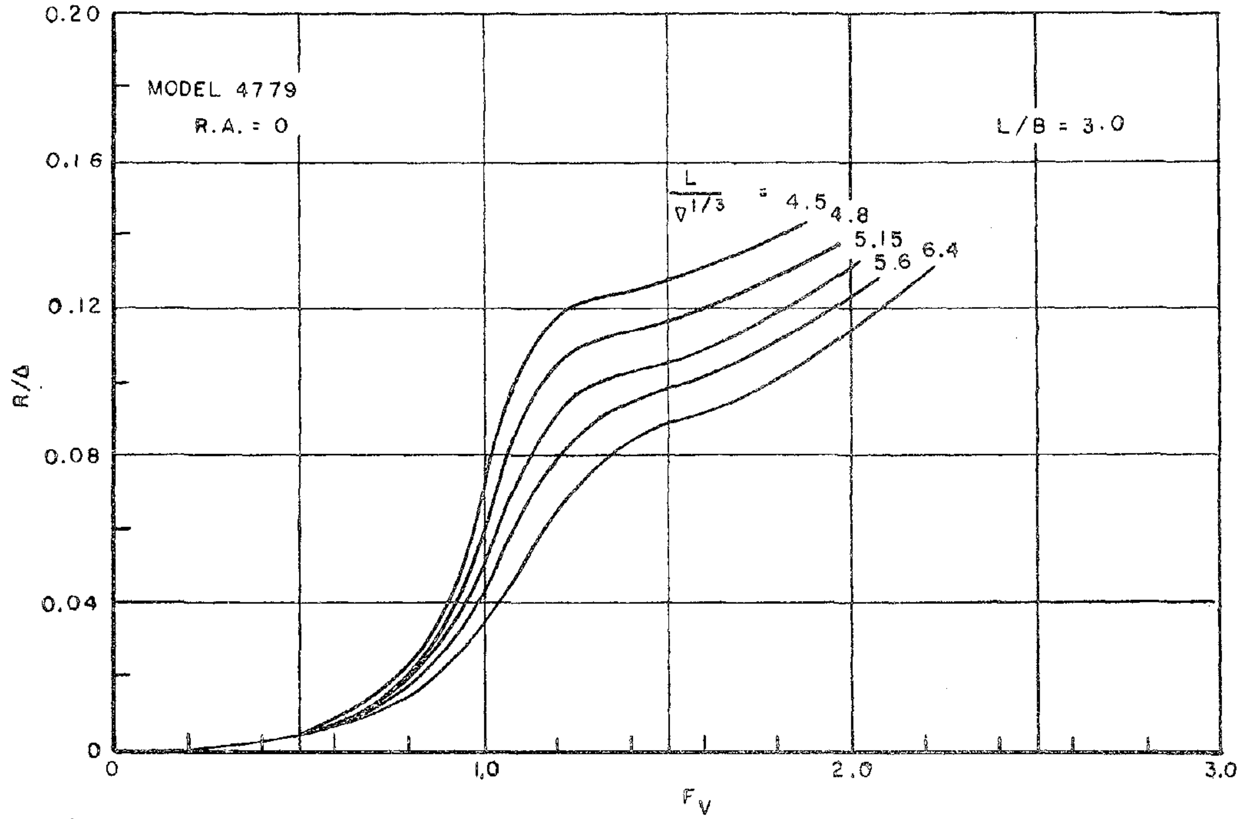


FIGURE 17. SERIES 63 - ROUND BOTTOM BOATS



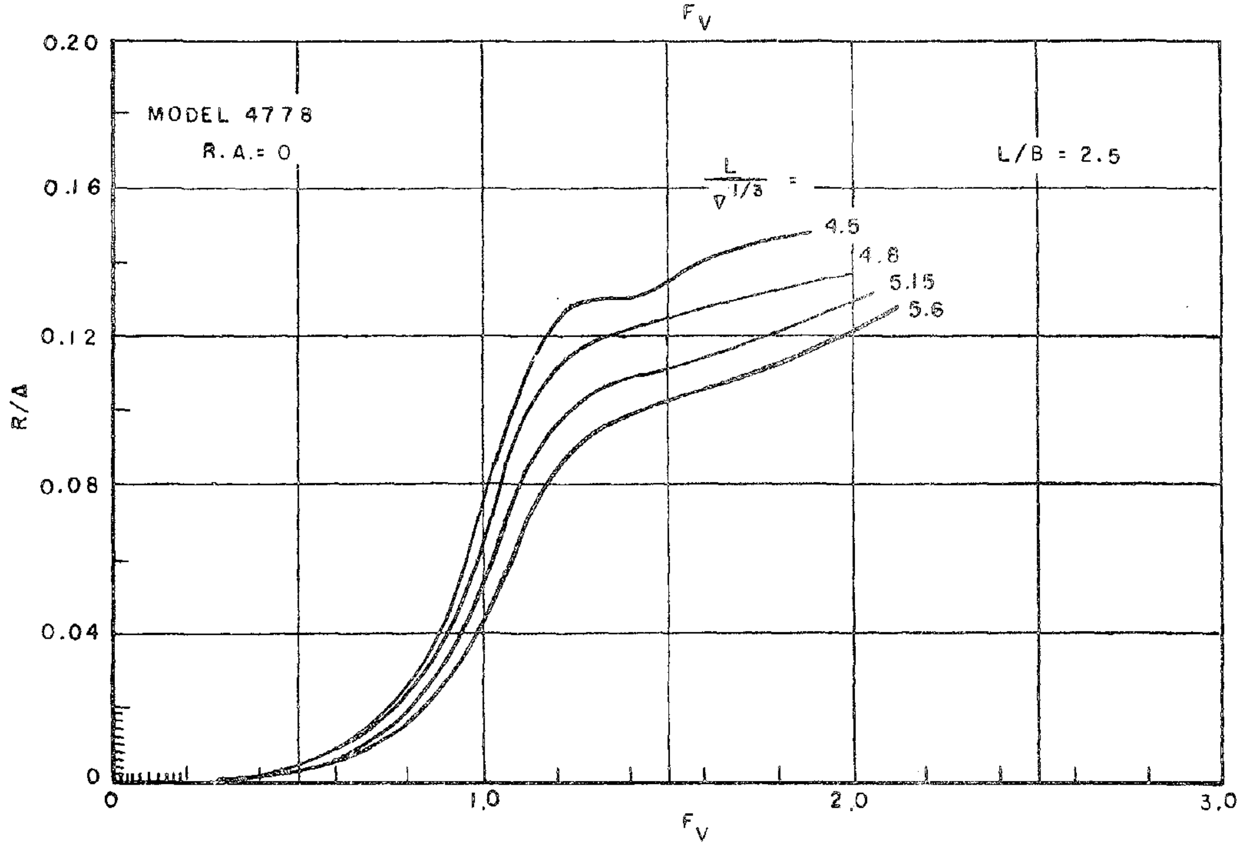


FIGURE 18. SERIES 63 - ROUND BOTTOM BOATS

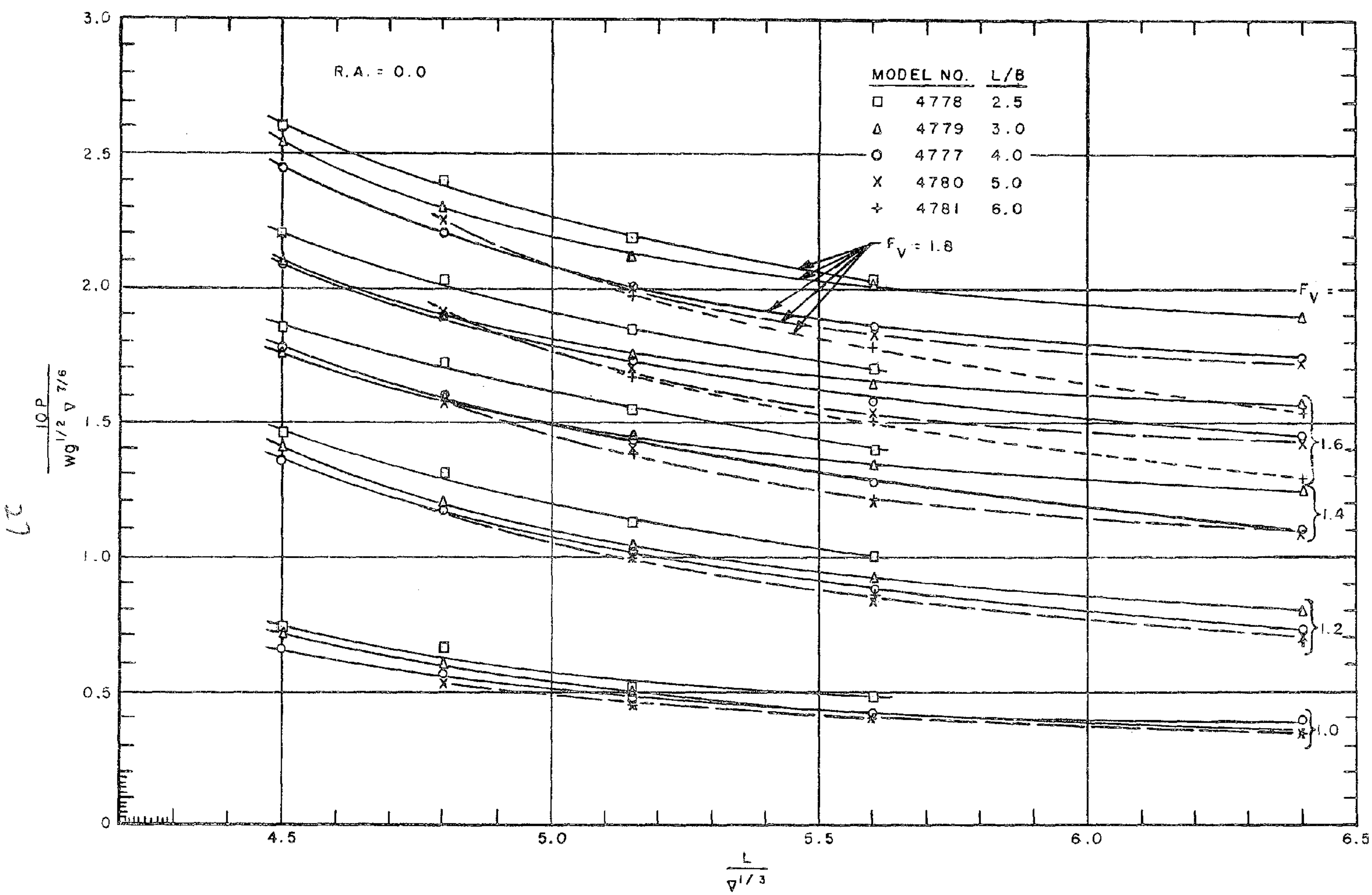
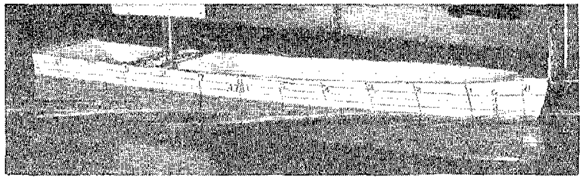


FIGURE 19. SERIES 63 – ROUND BOTTOM BOATS

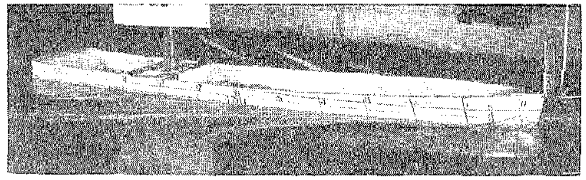
SERIES 63 - ROUND BOTTOM BOATS

$L/B = 6.0$

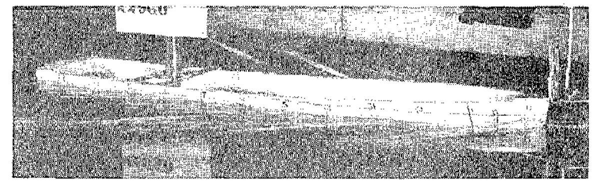
$L/\nabla^{1/3} = 6.4$ | $L/\nabla^{1/3} = 5.6$ | $L/\nabla^{1/3} = 5.15$



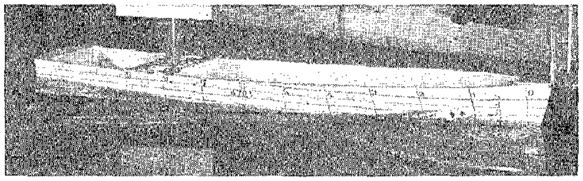
$F_v = .543$



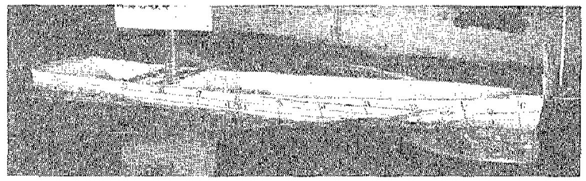
$F_v = .506$



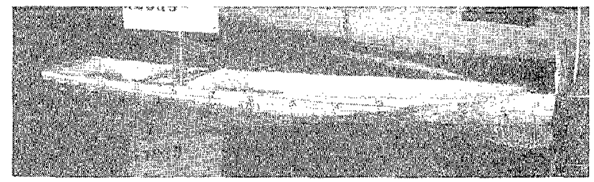
$F_v = .485$



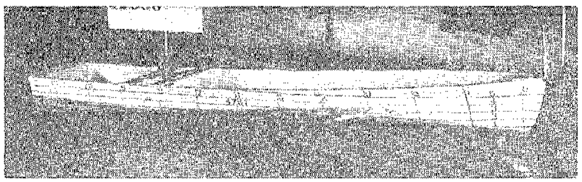
$F_v = 1.083$



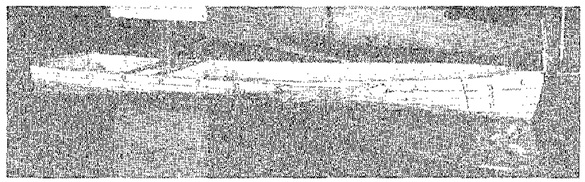
$F_v = 1.010$



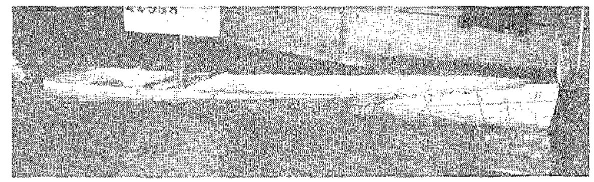
$F_v = .967$



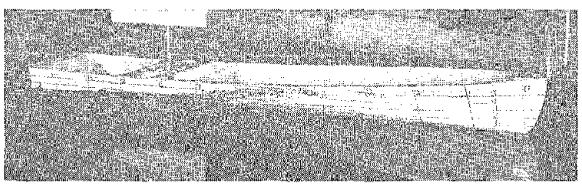
$F_v = 1.654$



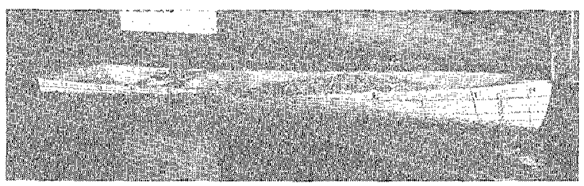
$F_v = 1.542$



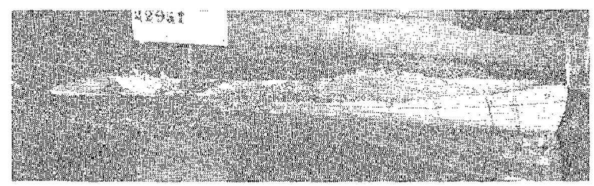
$F_v = 1.477$



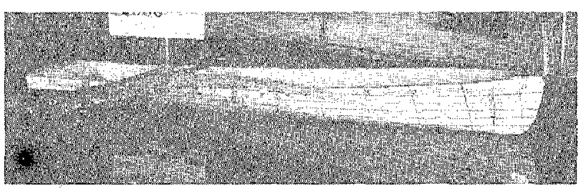
$F_v = 2.201$



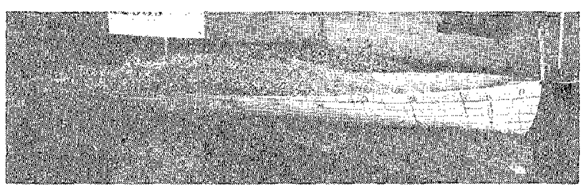
$F_v = 2.052$



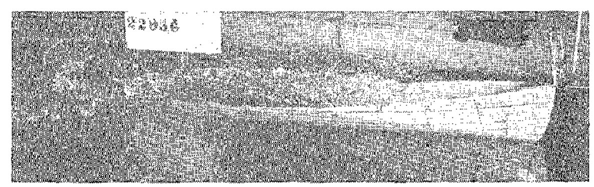
$F_v = 1.965$



$F_v = 2.750$



$F_v = 2.564$



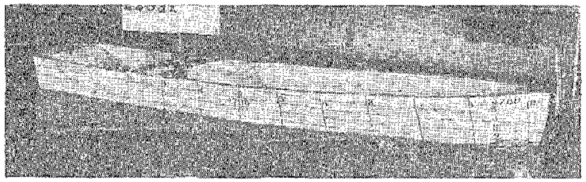
$F_v = 2.293$

FIGURE 20

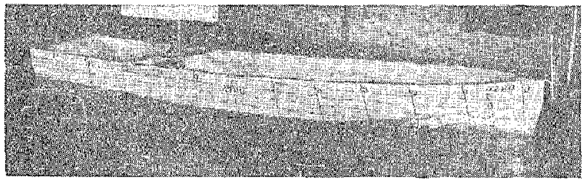
SERIES 63 - ROUND BOTTOM BOATS

$L/B = 5.0$

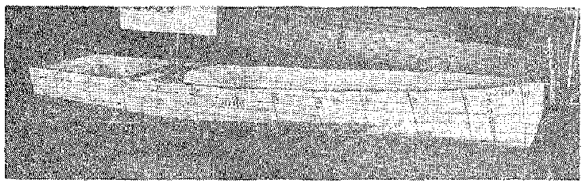
$L/\nabla^{1/3} = 6.4$



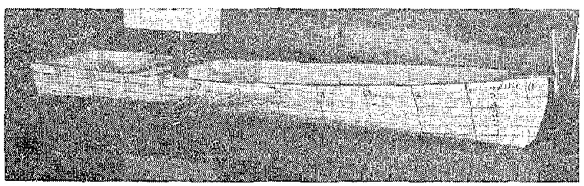
$F_v = .544$



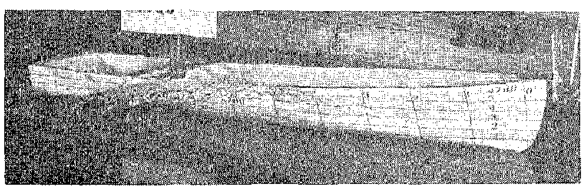
$F_v = 1.085$



$F_v = 1.472$

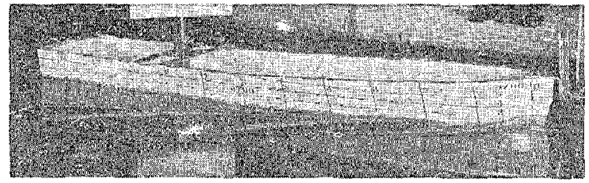


$F_v = 2.205$

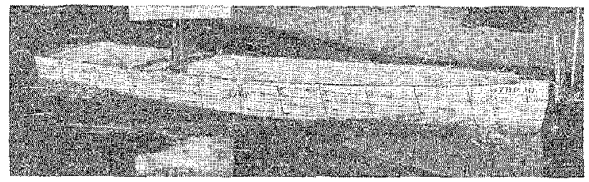


$F_v = 2.572$

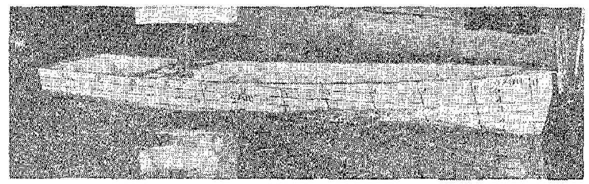
$L/\nabla^{1/3} = 5.6$



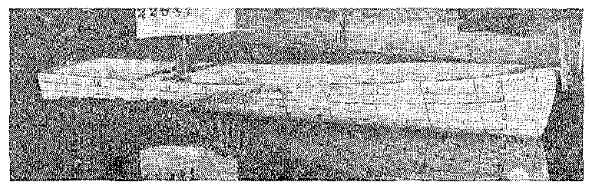
$F_v = .508$



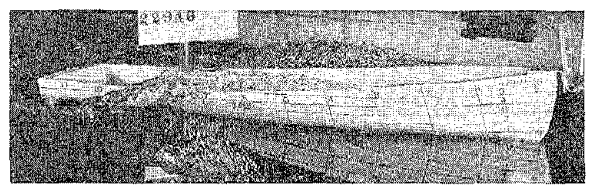
$F_v = 1.013$



$F_v = 1.374$



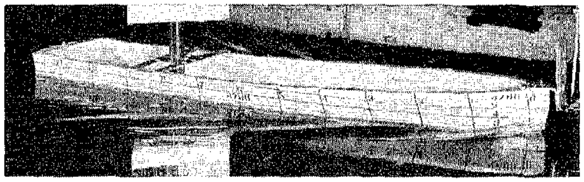
$F_v = 2.058$



$F_v = 2.401$

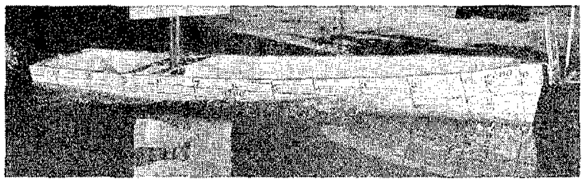
FIGURE 21

$L/\nabla^{1/3} = 5.15$

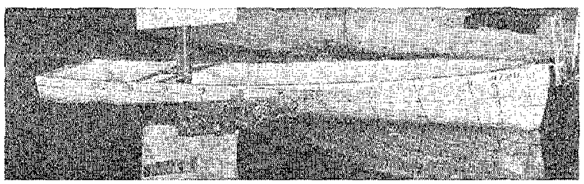


F_v = .486

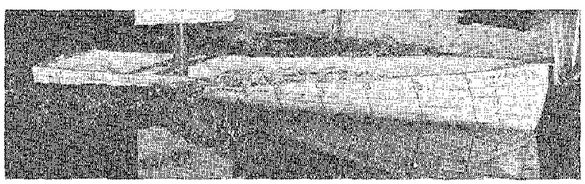
F_v = .969



F_v = 1.314

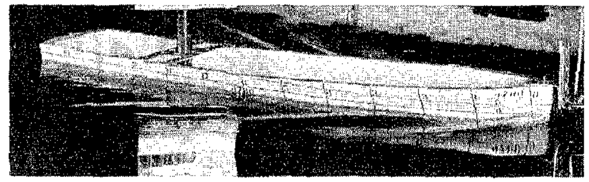


F_v = 1.642

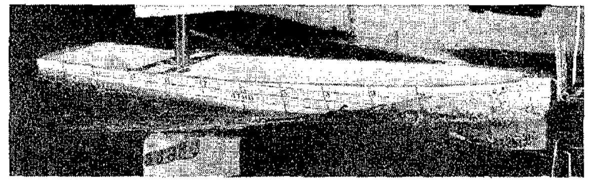


F_v = 1.969

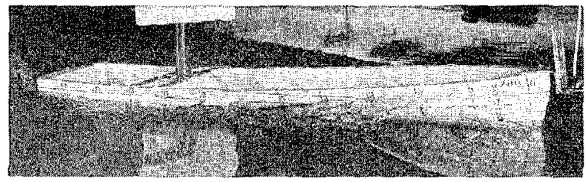
$L/\nabla^{1/3} = 4.8$



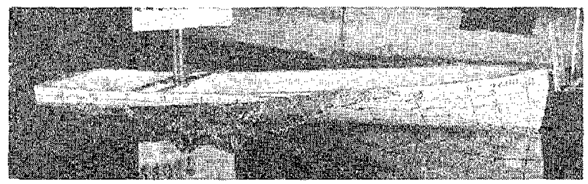
F_v = .468



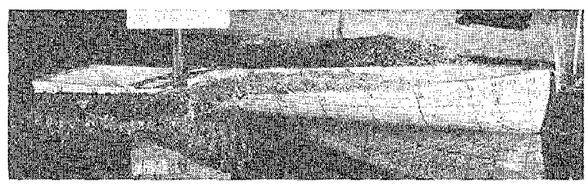
F_v = .934



F_v = 1.267



F_v = 1.582



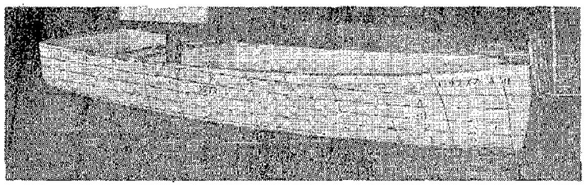
F_v = 1.898

FIGURE 22

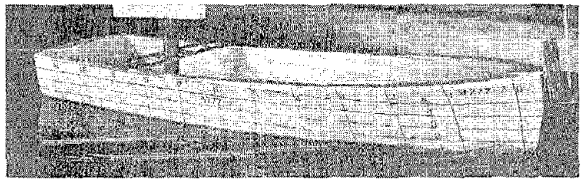
SERIES 63 - ROUND BOTTOM BOATS

$L/B = 4.0$

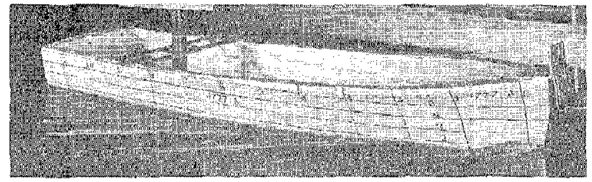
$L/\nabla^{1/3} = 6.4$	$L/\nabla^{1/3} = 5.6$	$L/\nabla^{1/3} = 5.15$



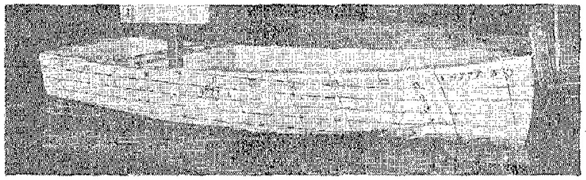
$F_v = .546$



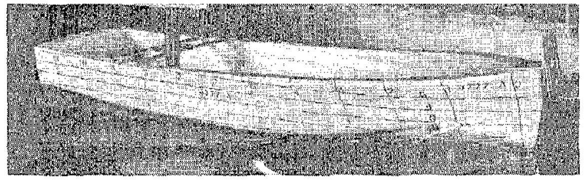
$F_v = .509$



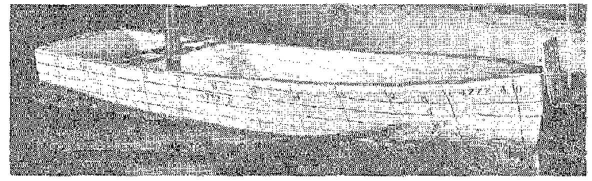
$F_v = .487$



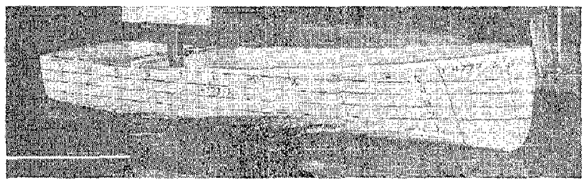
$F_v = 1.089$



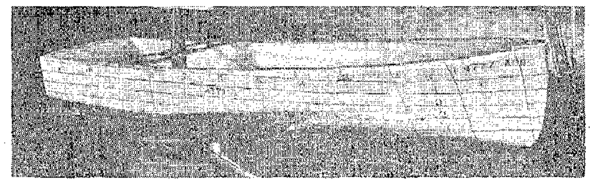
$F_v = 1.016$



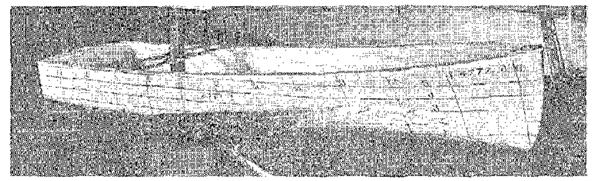
$F_v = .972$



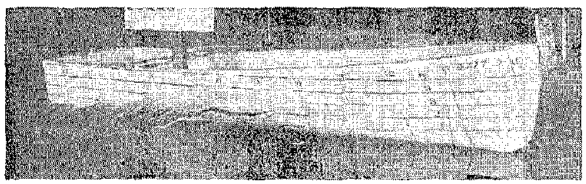
$F_v = 1.663$



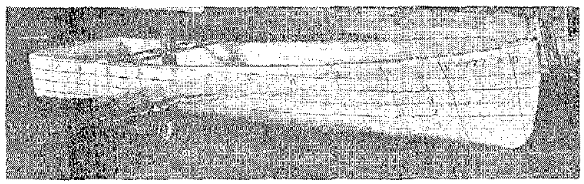
$F_v = 1.551$



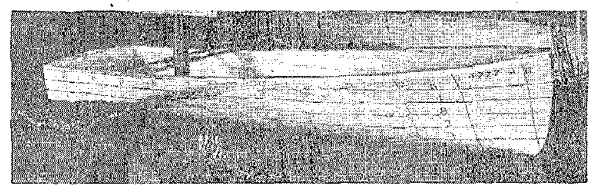
$F_v = 1.485$



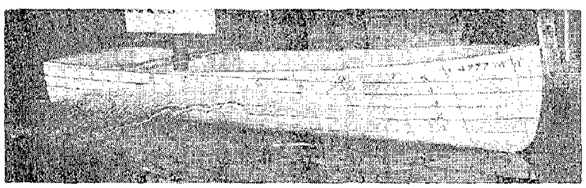
$F_v = 2.213$



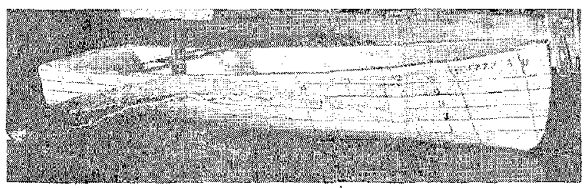
$F_v = 2.064$



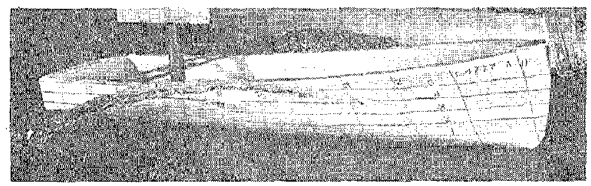
$F_v = 1.976$



$F_v = 2.397$



$F_v = 2.236$

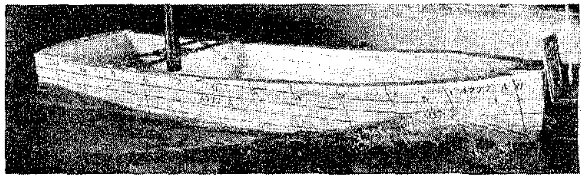


$F_v = 2.140$

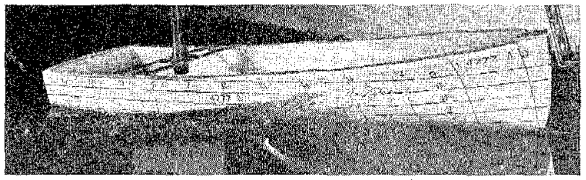
FIGURE 23

$L/\nabla^{1/3} = 4.8$

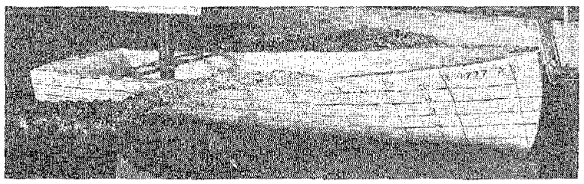
$F_v = .470$



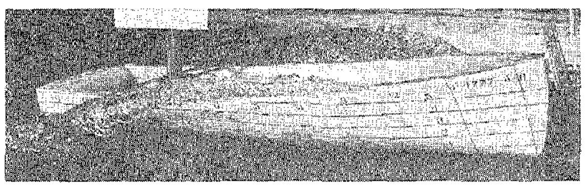
$F_v = .938$



$F_v = 1.432$

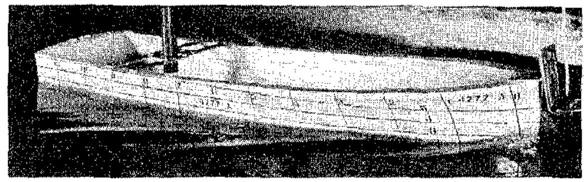


$F_v = 1.906$

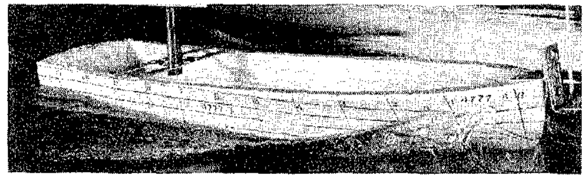


$F_v = 2.064$

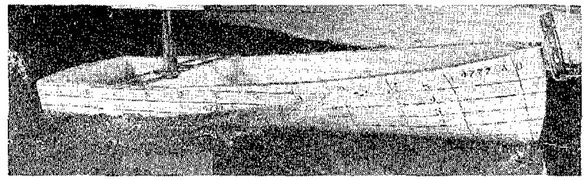
$L/\nabla^{1/3} = 4.5$



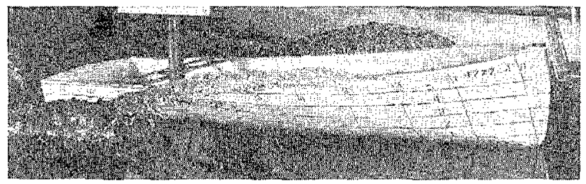
$F_v = .454$



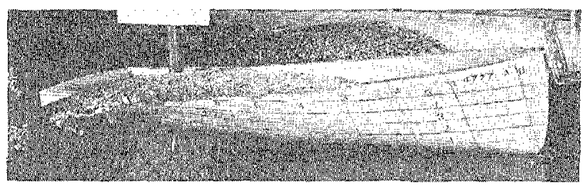
$F_v = .906$



$F_v = 1.384$



$F_v = 1.842$



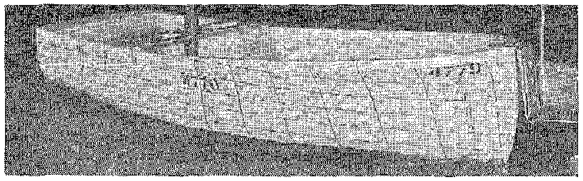
$F_v = 1.995$

FIGURE 24

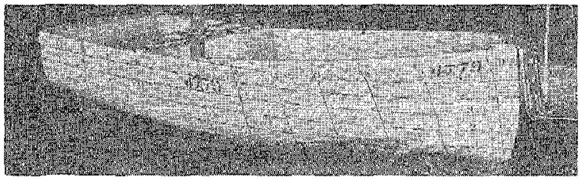
SERIES 63 - ROUND BOTTOM BOATS

$L/B = 3.0$

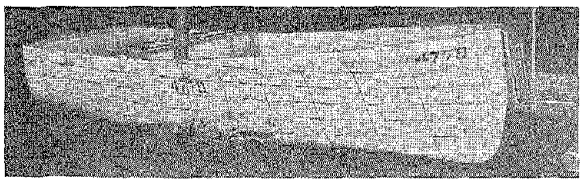
$L/\nabla^{1/3} = 6.4$



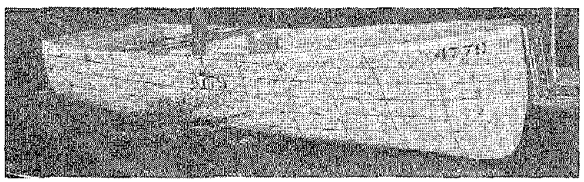
$F_v = .548$



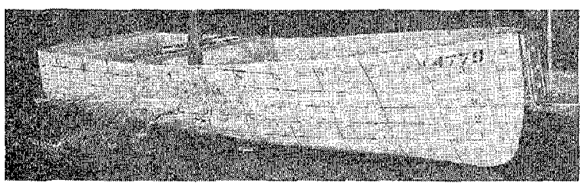
$F_v = 1.093$



$F_v = 1.669$

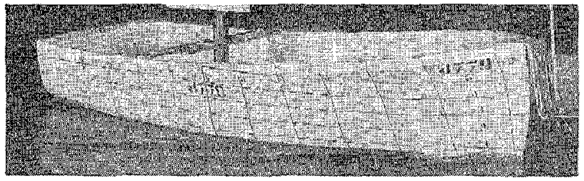


$F_v = 1.851$

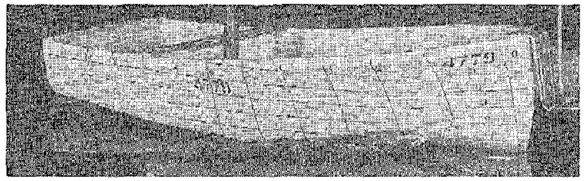


$F_v = 2.221$

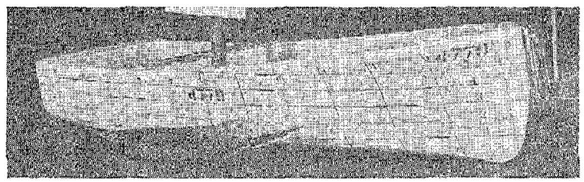
$L/\nabla^{1/3} = 5.6$



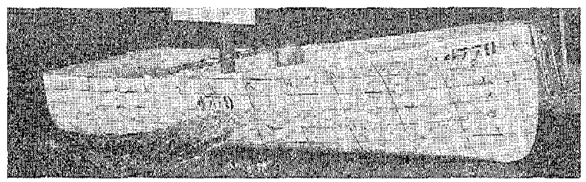
$F_v = .511$



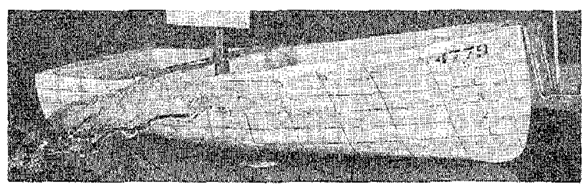
$F_v = 1.020$



$F_v = 1.558$

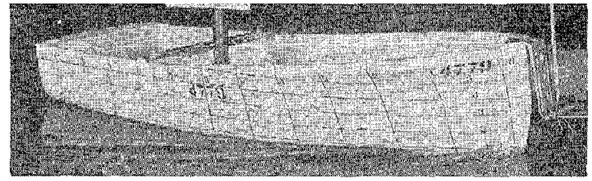


$F_v = 1.728$

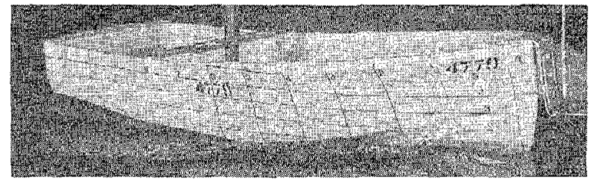


$F_v = 2.073$

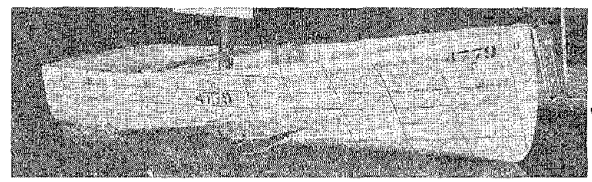
$L/\nabla^{1/3} = 5.15$



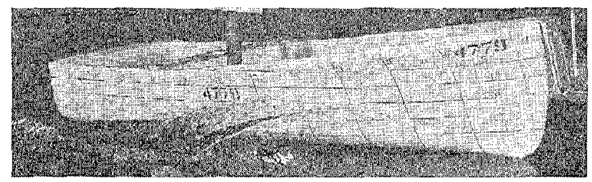
$F_v = .489$



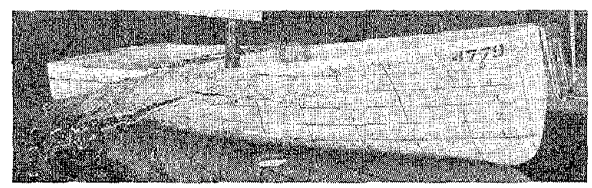
$F_v = .977$



$F_v = 1.492$



$F_v = 1.655$



$F_v = 1.985$

FIGURE 25

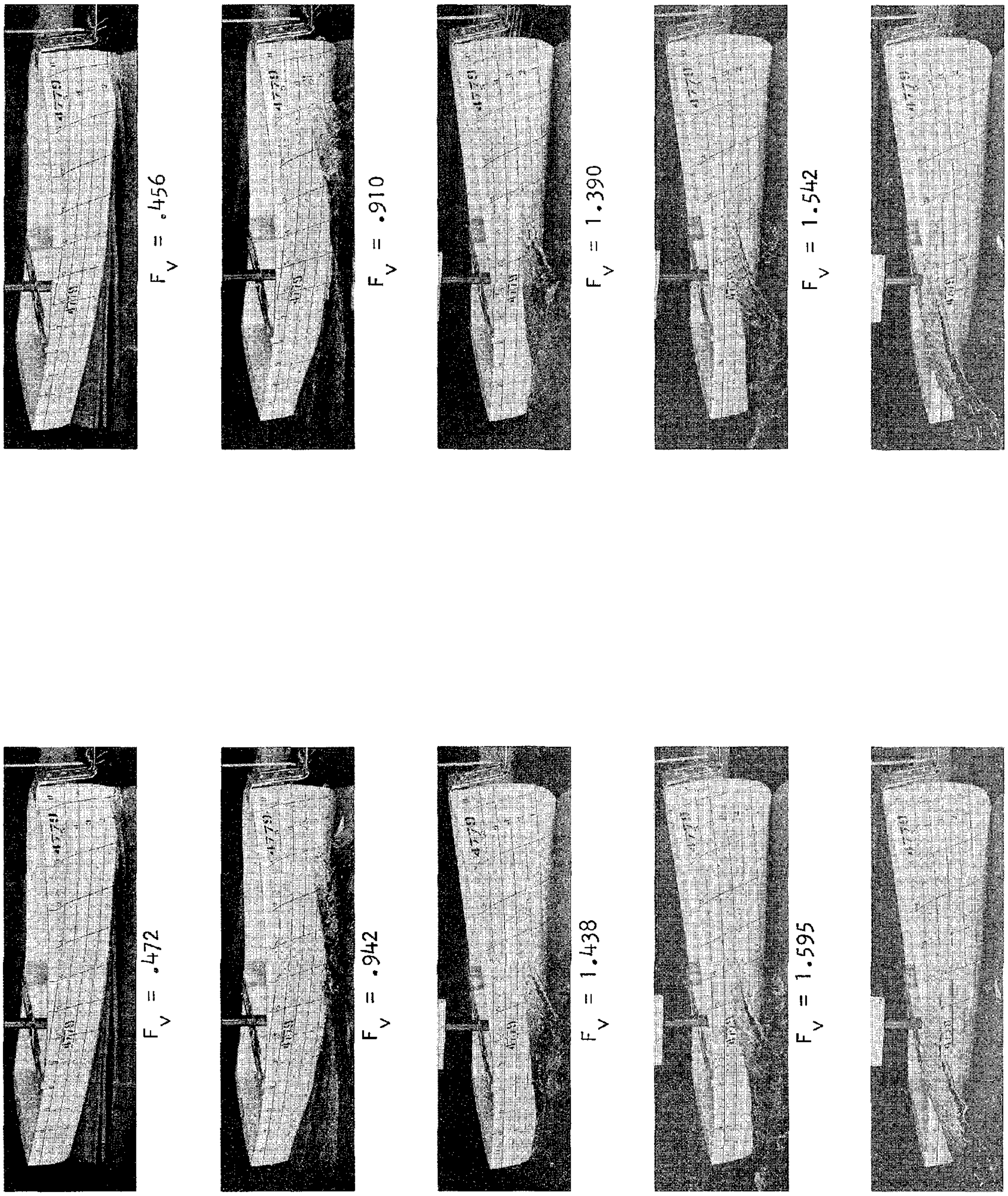
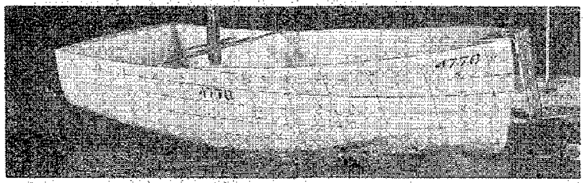

$L/\nabla^{1/3} = 4.8$
$F_v = .472$
$F_v = .942$
$F_v = 1.438$
$F_v = 1.595$
$F_v = 1.913$
$L/\nabla^{1/3} = 4.5$
$F_v = .456$
$F_v = .910$
$F_v = 1.390$
$F_v = 1.542$
$F_v = 1.850$

FIGURE 27

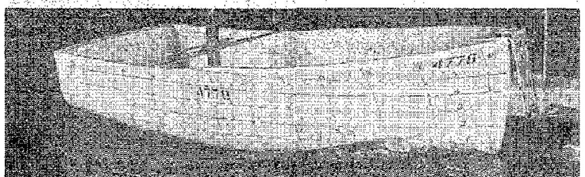
SERIES 63 - ROUND BOTTOM BOATS

$L/B = 2.5$

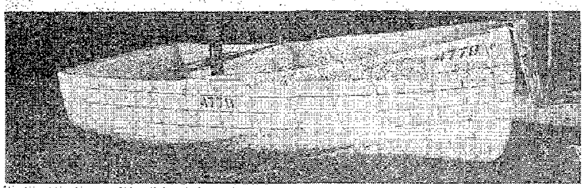
$L/\nabla^{1/3} = 5.6$



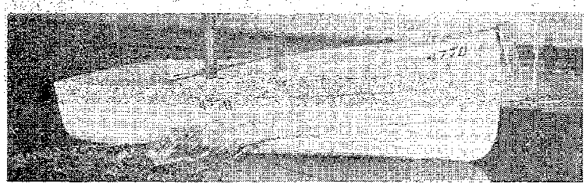
$F_v = .514$



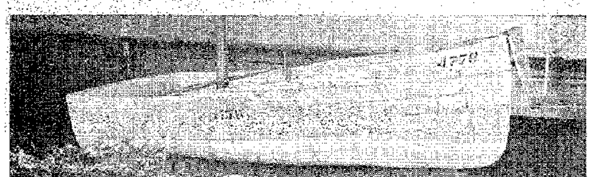
$F_v = 1.026$



$F_v = 1.567$

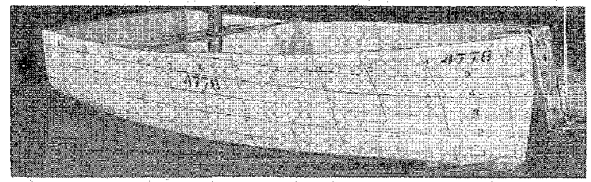


$F_v = 1.738$

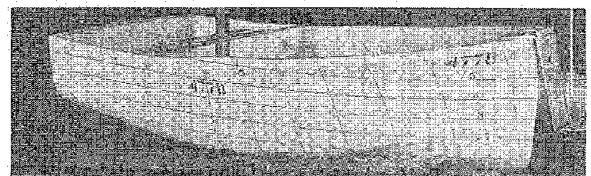


$F_v = 2.085$

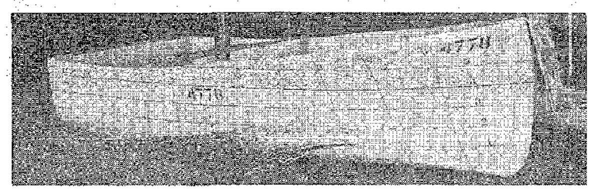
$L/\nabla^{1/3} = 5.15$



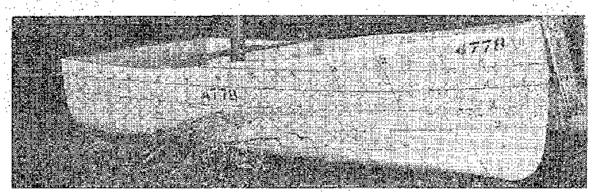
$F_v = .491$



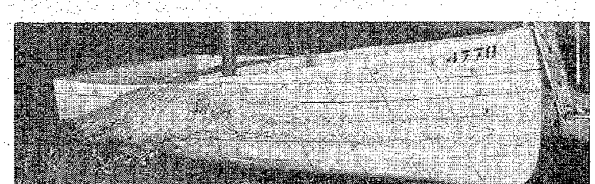
$F_v = .979$



$Fv = 1.495$

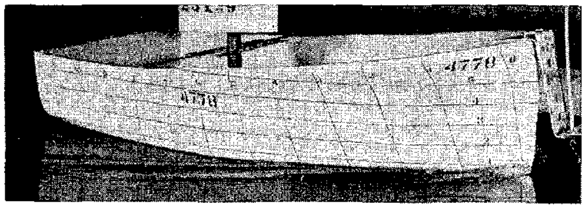


$F_v = 1.659$



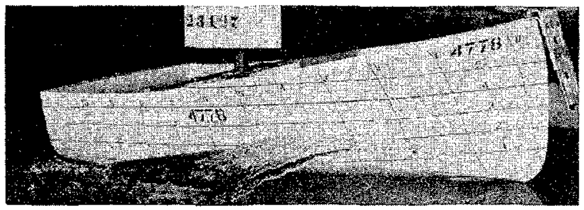
$F_v = 1.989$

$L/\nabla^{1/3} = 4.8$

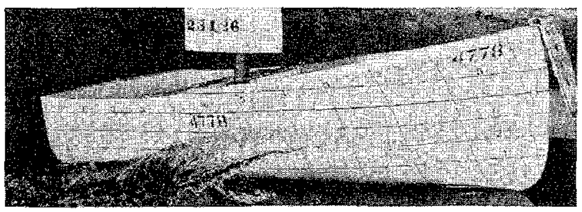


$F_v = .473$

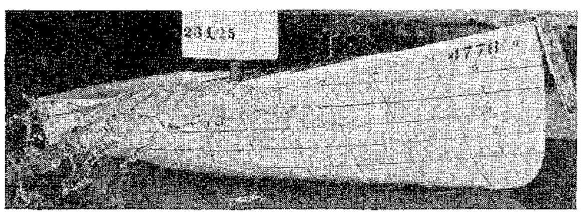
$F_v = .943$



$F_v = 1.440$

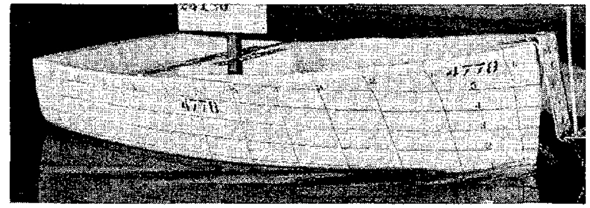


$F_v = 1.598$



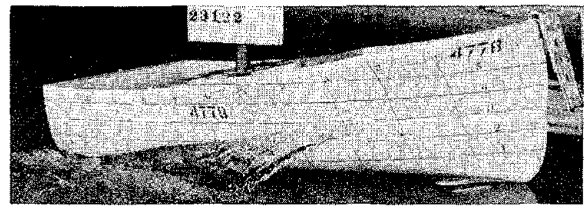
$F_v = 1.917$

$L/\nabla^{1/3} = 4.5$

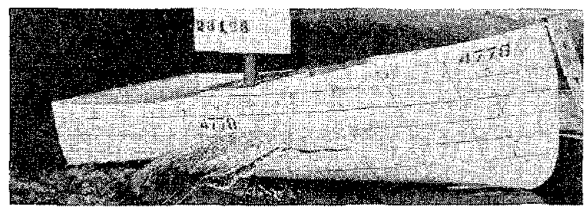


$F_v = .457$

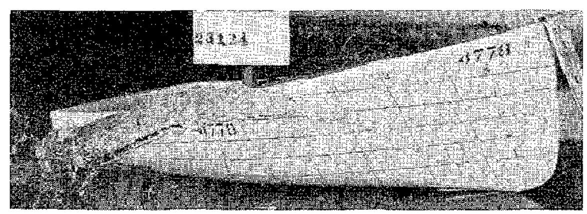
$F_v = .912$



$F_v = 1.393$



$F_v = 1.545$



$F_v = 1.854$

APPENDIX
MODEL RESULTS

TABLE A-I. MODEL RESULTS
MODEL No. 4781
L/B = 6.0

Δ , lbs = 6.85   L , ft = 3.058
A , ft^2 = 1.60 $L/\nabla^{1/3}$ = 6.4
T , deg = 71.0 $\frac{C.G.}{L}$ % = 5.43 (aft St. 6)

V knots	R_t lbs	R_e $x10^{-6}$	C_t $x10^3$	τ deg	C.G. RISE in.	F_v
1.260	.059	.6247	8.402	0	0	.543
2.516	.349	1.247	12.47	.95	-.18	1.083
3.411	.599	1.691	11.64	2.20	-.18	1.469
3.837	.677	1.902	10.40	2.60	-.12	1.654
5.109	.865	2.533	7.495	2.80	+.03	2.201
6.384	1.185	3.165	6.576	2.80	+.03	2.750

Δ , lbs = 10.30   L , ft = 3.077
A , ft^2 = 1.87 $L/\nabla^{1/3}$ = 5.6
T , deg = 71.0 $\frac{C.G.}{L}$ % = 5.33 (aft St. 6)

V knots	R_t lbs	R_e $x10^{-6}$	C_t $x10^3$	τ deg	C.G. RISE in.	F_v
1.260	.081	.6285	9.874	0	0	.506
1.888	.215	.9414	11.68	.25	-.08	.758
2.516	.472	1.255	14.43	.87	-.21	1.010
2.830	.7605	1.412	18.39	1.90	-.27	1.136
3.411	.991	1.701	16.49	2.85	-.20	1.369
3.837	1.075	1.914	14.14	3.30	-.17	1.542
5.109	1.296	2.548	9.611	3.50	-.17	2.052
6.384	1.646	3.184	7.817	3.15	+.09	2.564

Δ , lbs = 13.20   L , ft = 3.088
A , ft^2 = 2.10 $L/\nabla^{1/3}$ = 5.15
T , deg = 71.5 $\frac{C.G.}{L}$ % = 5.80 (aft St. 6)

V knots	R_t lbs	R_e $x10^{-6}$	C_t $x10^3$	τ deg	C.G. RISE in.	F_v
1.260	.100	.6351	10.85	0	-.05	.485
1.888	.270	.9513	13.06	.10	-.18	.726
2.516	.611	1.268	16.63	.88	-.31	.967
2.830	.989	1.427	21.27	2.00	-.30	1.089
3.411	1.415	1.719	20.96	3.35	-.28	1.312
3.837	1.515	1.934	17.73	3.80	-.19	1.477
5.109	1.795	2.575	11.85	3.55	-.01	1.965
5.959	2.125	3.003	10.31	3.98	+.10	2.293

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TABLE A-II. MODEL RESULTS
MODEL NO. 4780
L/B = 5.0

Δ , lbs = 6.75 L , ft = 3.043
A , ft^2 = 1.67 $L/\nabla^{1/3}$ = 6.4
τ , deg = 71.5 $\frac{C.G.}{L}$ % = 3.55 (aft St. 6)

V knots	R_t lbs	R_e $x10^{-6}$	C_t $x10^3$	τ deg	C.G. RISE in.	F_v
1.260	.055	.6258	7.507	0	0	.544
1.888	.145	.9373	8.825	0	-.05	.815
2.516	.330	1.249	11.30	.85	-.19	1.085
2.830	.451	1.405	12.21	1.67	-.21	1.221
3.411	.599	1.694	11.16	2.40	-.15	1.472
4.260	.761	2.116	9.090	2.85	-.06	1.838
5.109	.916	2.537	7.606	2.95	+.06	2.205
5.959	1.185	2.959	7.235	2.95	+.11	2.572

Δ , lbs = 10.10 L , ft = 3.058
A , ft^2 = 1.90 $L/\nabla^{1/3}$ = 5.6
τ , deg = 71.5 $\frac{C.G.}{L}$ % = 4.22 (aft St. 6)

V knots	R_t lbs	R_e $x10^{-6}$	C_t $x10^3$	τ deg	C.G. RISE in.	F_v
1.260	.076	.6290	9.114	0	0	.508
1.888	.206	.9421	11.02	.1	-.08	.761
2.516	.482	1.256	14.51	.95	-.23	1.013
2.830	.744	1.413	17.70	2.15	-.23	1.140
3.411	.963	1.702	15.77	3.25	-.21	1.374
4.260	1.164	2.126	12.22	3.40	-.12	1.716
5.109	1.336	2.550	9.75	3.55	+.03	2.058
5.959	1.678	2.974	9.00	3.65	+.15	2.401

TABLE A-II. MODEL RESULTS
MODEL NO. 4780
L/B = 5.0

Δ, lbs = 13.15 L, ft = 3.070
A, ft^2 = 2.10 $L/\nabla^{1/3}$ = 5.15
T, deg = 70.0 $\frac{C.G.}{L}$% = 5.05 (aft St. 6)

V knots	R_t lbs	R_e $x10^{-6}$	C_t $x10^3$	τ deg	C.G. RISE in.	F_v
1.260	.094	.6194	10.18	.1	-.08	.486
1.888	.265	.9277	12.82	.15	-.16	.728
2.516	.6075	1.237	16.54	.88	-.30	.969
2.830	1.000	1.391	21.52	2.30	-.35	1.091
3.411	1.398	1.676	20.71	3.80	-.32	1.314
4.260	1.590	2.094	15.09	4.35	-.17	1.642
5.109	1.818	2.511	12.00	3.98	+.02	1.969

Δ, lbs = 16.40 L, ft = 3.080
A, ft^2 = 2.32 $L/\nabla^{1/3}$ = 4.8
T, deg = 71.5 $\frac{C.G.}{L}$% = 4.94 (aft St. 6)

V knots	R_t lbs	R_e $x10^{-6}$	C_t $x10^3$	τ deg	C.G. RISE in.	F_v
1.260	.103	.6334	10.11	0	-.10	.468
1.888	.311	.9488	13.62	0	-.20	.702
2.516	.725	1.265	17.86	.95	-.33	.934
2.830	1.165	1.423	22.69	2.40	-.43	1.051
3.411	1.905	1.714	25.54	4.20	-.41	1.267
4.260	2.170	2.142	18.65	4.45	-.34	1.582
5.109	2.395	2.568	14.31	4.92	-.11	1.898

TABLE A-III. MODEL RESULTS
MODEL NO. 4777
L/B = 4.0

Δ , lbs = 6.60 L , ft = 3.024
A , ft^2 = 1.84 $L/\nabla^{1/3}$ = 6.4
T , deg = 72.0 $\frac{C.G.}{L}$ % = 3.11 (aft St. 6)

V knots	R_t lbs	R_e $x10^{-6}$	C_t $x10^3$	τ deg	C.G. RISE in.	F_v
1.260	.075	.6262	9.293	0	0	.546
1.888	.177	.9379	9.774	.08	-.103	.818
2.516	.374	1.250	11.62	.95	-.219	1.089
2.830	.499	1.406	12.26	1.75	-.284	1.226
3.411	.653	1.695	11.04	2.60	-.176	1.477
3.837	.754	1.907	10.07	3.10	-.085	1.663
4.260	.803	2.117	8.705	3.10	-.085	1.845
5.109	.988	2.539	7.447	3.00	-.109	2.213
5.534	1.123	2.750	7.215	2.85	+.044	2.397

Δ , lbs = 10.05 L , ft = 3.040
A , ft^2 = 2.08 $L/\nabla^{1/3}$ = 5.6
T , deg = 72.0 $\frac{C.G.}{L}$ % = 4.21 (aft St. 6)

V knots	R_t lbs	R_e $x10^{-6}$	C_t $x10^3$	τ deg.	C.G. RISE in.	F_v
1.260	.0715	.6294	7.821	0	0	.509
1.888	.200	.9427	9.753	0	-.15	.763
2.516	.504	1.257	13.83	.86	-.30	1.016
2.830	.746	1.414	16.18	2.05	-.30	1.143
3.411	1.006	1.704	15.02	3.25	-.21	1.378
3.837	1.106	1.916	13.05	3.75	-.13	1.551
4.260	1.207	2.128	11.55	3.65	-.10	1.721
5.109	1.386	2.552	9.223	3.80	+.10	2.064
5.534	1.526	2.764	8.658	3.55	+.18	2.236

Δ , lbs = 13.00 L , ft = 3.051
A , ft^2 = 2.25 $L/\nabla^{1/3}$ = 5.15
T , deg = 72.0 $\frac{C.G.}{L}$ % = 4.65 (aft St. 6)

V knots	R_t lbs	R_e $x10^{-6}$	C_t $x10^3$	τ deg	C.G. RISE in.	F_v
1.260	.077	.6317	7.797	0	-.05	.487
1.888	.252	.9462	11.38	0	-.15	.730
2.516	.636	1.261	16.16	.87	-.30	.972
2.830	1.016	1.419	20.40	2.25	-.37	1.094
3.411	1.426	1.710	19.71	3.80	-.32	1.319
3.837	1.526	1.924	16.67	4.45	-.13	1.485
4.260	1.625	2.136	14.40	3.95	-.07	1.647
5.109	1.796	2.561	11.07	3.95	+.13	1.976
5.534	1.956	2.774	10.27	4.05	+.20	2.140

TABLE A-III. MODEL RESULTS
MODEL NO. 4777
L/B = 4.0

Δ , lbs = 16.20 L , ft = 3.060
A , ft^2 = 2.42 $L/\nabla^{1/3}$ = 4.8
T , deg = 72.0 $\frac{C.G.}{L}$ % = 4.31 (aft St. 6)

V knots	R_t lbs	R_e $x10^{-6}$	C_t $x10^3$	τ deg	C.G. RISE in.	F_v
1.260	.098	.6337	9.227	-.08	-.02	.470
1.888	.303	.9491	12.72	+.08	-.18	.704
2.516	.742	1.265	17.53	.55	-.29	.938
2.830	1.271	1.423	23.73	2.25	-.39	1.055
3.411	1.876	1.715	24.11	4.25	-.27	1.272
3.837	2.016	1.929	20.48	4.75	-.13	1.432
4.260	2.135	2.142	17.59	4.60	-.18	1.589
5.109	2.365	2.569	13.55	4.35	+.05	1.906
5.534	2.515	2.783	12.28	4.25	+.13	2.064

Δ , lbs = 19.70 L , ft = 3.069
A , ft^2 = 2.60 $L/\nabla^{1/3}$ = 4.5
T , deg = 71.0 $\frac{C.G.}{L}$% = 4.91 (aft St. 6)

V knots	R_t lbs	R_e $x10^{-6}$	C_t $x10^3$	τ deg	C.G. RISE in.	F_v
1.260	.120	.6268	10.52	-.08	-.08	.454
1.888	.375	.9389	14.65	0	-.10	.681
2.516	.890	1.252	19.57	+.08	-.30	.906
2.830	1.505	1.408	26.15	2.25	-.37	1.020
3.411	2.515	1.697	30.09	4.60	-.30	1.229
3.837	2.755	1.909	26.05	5.10	-.16	1.384
4.260	2.805	2.119	21.51	5.10	-.16	1.535
5.109	3.045	2.541	16.24	5.10	+.24	1.842
5.534	3.205	2.753	14.57	5.40	+.33	1.995

TABLE A-IV. MODEL RESULTS
MODEL NO. 4779
L/B = 3.0

Δ , lbs = 6.75 L , ft = 3.003

A , ft^2 = 2.12 $L/\nabla^{1/3}$ = 6.4

T , deg = 72.0 $\frac{C.G.}{L}$ % = 0.0

V knots	R_t lbs	R_e $x10^{-6}$	C_t $x10^3$	τ deg	C.G. RISE in.	F_v
1.260	.058	.6217	6.235	-.083	-.02	.548
1.888	.1545	.9312	7.405	0	-.05	.821
2.516	.397	1.241	10.71	+.80	-.25	1.093
2.830	.550	1.396	11.73	1.75	-.20	1.230
3.411	.729	1.683	10.7	2.95	-.08	1.482
3.837	.802	1.893	9.3	3.40	+.02	1.669
4.260	.904	2.102	8.5	3.33	+.05	1.851
5.109	1.153	2.521	7.55	3.18	+.20	2.221

Δ , lbs = 9.75 L , ft = 3.016

A , ft^2 = 2.35 $L/\nabla^{1/3}$ = 5.6

T , deg = 71.0 $\frac{C.G.}{L}$ % = 2.39 (aft St. 6)

V knots	R_t lbs	R_e $x10^{-6}$	C_t $x10^3$	τ deg	C.G. RISE in.	F_v
1.260	.0701	.6160	6.789	0	-.05	.511
1.888	.187	.9226	8.085	-.083	-.18	.766
2.516	.521	1.230	12.68	+.88	-.29	1.020
2.830	.806	1.383	15.50	2.30	-.26	1.148
3.411	1.056	1.667	13.98	3.80	-.16	1.384
3.837	1.157	1.876	12.1	4.30	-.01	1.558
4.260	1.261	2.083	10.7	4.12	+.04	1.728
5.109	1.542	2.497	9.1	3.98	+.19	2.073

Δ , lbs = 12.60 L , ft = 3.026

A , ft^2 = 2.50 $L/\nabla^{1/3}$ = 5.15

T , deg = 72.0 $\frac{C.G.}{L}$ % = 3.34 (aft St. 6)

V knots	R_t lbs	R_e $x10^{-6}$	C_t $x10^3$	τ deg	C.G. RISE in.	F_v
1.260	.075	.6266	6.837	-.083	-.07	.489
1.888	.218	.9386	8.861	-.15	-.15	.734
2.516	.654	1.251	14.96	+.80	-.32	.977
2.830	1.057	1.407	19.11	2.55	-.30	1.099
3.411	1.424	1.696	17.73	4.20	-.17	1.325
3.837	1.510	1.908	14.85	4.70	-.03	1.492
4.260	1.635	2.119	13.05	4.55	-.02	1.655
5.109	1.944	2.540	10.79	4.55	+.23	1.985

TABLE A-IV. MODEL RESULTS
MODEL NO. 4779
$L/B = 3.0$

Δ, lbs = 15.70   L, ft = 3.034
A, ft^2 = 2.65 $L/\nabla^{1/3}$ = 4.8
T, deg = 72.0 $\frac{C.G.}{L}$ % = 4.38 (aft St. 6)

V knots	R_t lbs	R_e $x10^{-6}$	C_t $x10^3$	τ deg	C.G. RISE in.	F_v
1.260	.090	.6281	7.737	-.083	-.13	.472
1.888	.271	.9408	10.39	0	-.15	.707
2.516	.783	1.254	16.89	+.95	-.33	.942
2.830	1.374	1.411	23.43	2.85	-.33	1.060
3.411	1.903	1.700	22.34	5.00	-.11	1.277
3.837	2.005	1.913	18.60	5.25	0	1.438
4.260	2.133	2.124	16.05	5.00	-.01	1.595
5.109	2.437	2.546	12.75	5.17	+.23	1.913

Δ, lbs = 19.30   L, ft = 3.043
A, ft^2 = 2.82 $L/\nabla^{1/3}$ = 4.5
T, deg = 71.5 $\frac{C.G.}{L}$ % = 4.63 (aft St. 6)

V knots	R_t lbs	R_e $x10^{-6}$	C_t $x10^3$	τ deg	C.G. RISE in.	F_v
1.260	.102	.6258	8.243	0	-.05	.456
1.888	.3305	.9373	11.91	-.15	-.15	.684
2.516	.918	1.249	18.61	+.80	-.37	.910
2.830	1.651	1.405	26.46	2.45	-.40	1.024
3.411	2.503	1.694	27.62	5.30	-.28	1.234
3.837	2.601	1.905	22.68	5.73	-.07	1.390
4.260	2.757	2.116	19.50	5.65	-.09	1.542
5.109	3.103	2.537	15.26	5.65	+.16	1.850

TABLE A-V. MODEL RESULTS
MODEL NO. 4778
L/B = 2.5

Δ , lbs = 9.40 L , ft = 2.980
A , ft^2 = 2.45 $L/\nabla^{1/3}$ = 5.6
T , deg = 72.0 $\frac{C.G.}{L}$ % = -0.30 (Fwd St. 6)

V knots	R_t lbs	R_e $x10^{-6}$	C_t $x10^3$	τ deg	C.G. RISE in.	F_v
1.260	.070	.6113	6.510	0	-.05	.514
1.888	.185	.9242	7.672	-.325	-.10	.771
2.516	.564	1.234	13.10	+.633	-.30	1.026
2.830	.844	1.386	15.56	2.067	-.25	1.155
3.411	1.079	1.670	13.70	3.82	-.09	1.392
3.837	1.171	1.879	11.75	3.82	+.01	1.567
4.260	1.247	2.086	10.15	4.28	-.04	1.738
5.109	1.502	2.502	8.50	4.45	+.31	2.085

Δ , lbs = 12.30 L , ft = 3.010
A , ft^2 = 2.70 $L/\nabla^{1/3}$ = 5.15
T , deg = 72.0 $\frac{C.G.}{L}$ % = 2.39 (aft St. 6)

V knots	R_t lbs	R_e $x10^{-6}$	C_t $x10^3$	τ deg	C.G. RISE in.	F_v
1.260	.067	.6232	5.655	-.083	-.02	.491
1.888	.207	.9335	7.789	-.242	-.12	.735
2.516	.685	1.244	14.50	+.875	-.29	.979
2.830	1.083	1.400	18.12	2.63	-.31	1.102
3.411	1.483	1.687	17.08	4.61	-.12	1.328
3.837	1.568	1.898	14.28	4.75	+.03	1.495
4.260	1.693	2.107	12.50	5.00	-.10	1.659
5.109	1.943	2.527	9.979	5.40	+.42	1.989

TABLE A-V. MODEL RESULTS
MODEL NO. 4778
L/B = 2.5

Δ , lbs = 15.50 L , ft = 3.020
A , ft² = 2.91 $L/\nabla^{1/3}$ = 4.8
T , deg = 72.0 $\frac{C.G.}{L}$ % = 2.79 (aft St. 6)

V knots	R_t lbs	R_e $\times 10^{-6}$	C_t $\times 10^3$	τ deg	C.G. RISE in.	F_v
1.260	.089	.6254	6.971	-	-	.473
1.888	.271	.9367	9.463	-.25	-.12	.709
2.516	.847	1.249	16.64	+.70	-.34	.943
2.830	1.455	1.405	22.60	2.95	-.33	1.062
3.411	2.000	1.693	21.38	4.85	-.11	1.279
3.837	2.127	1.904	17.97	5.25	+.01	1.440
4.260	2.242	2.114	15.36	5.25	-.04	1.598
5.109	2.469	2.535	11.77	5.90	+.35	1.917

Δ , lbs = 18.90 L , ft = 3.029
A , ft² = 3.08 $L/\nabla^{1/3}$ = 4.5
T , deg = 72.0 $\frac{C.G.}{L}$ % = 3.40 (aft St. 6)

V knots	R_t lbs	R_e $\times 10^{-6}$	C_t $\times 10^3$	τ deg	C.G. RISE in.	F_v
1.260	.102	.6271	7.546	-.083	-.07	.457
1.888	.323	.9392	10.65	-.15	-.25	.685
2.516	.978	1.252	18.15	+.63	-.41	.912
2.830	1.743	1.408	25.57	2.55	-.46	1.027
3.411	2.633	1.697	26.59	5.25	-.27	1.237
3.837	2.704	1.909	21.58	5.90	+.02	1.393
4.260	2.883	2.120	18.66	5.57	-.07	1.545
5.109	3.173	2.542	14.28	5.90	+.25	1.854