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#4

UNITED STATES
EXPERIMENTAL MODEL BASIN

NAVY YARD, WASHINGTON, D.C.

TEST OF TRANSOM STERNS ON DESTROYERS

EXPERIMENTAL MODEL BASIN
ERECTED 1898
BUREAU OF
CONSTRUCTION AND REPAIR
NAVY DEPARTMENT

~~RESTRICTED~~

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TEST of TRANSOM STERNS on DESTROYERS

U. S. Experimental Model Basin
Navy Yard, Washington, D. C.

November, 1932 Report No. 339.

TEST of TRANSOM STERNS on DESTROYERS

Summary

A series of nine 20-ft. models of destroyers was made in which the bows were identical, the dimensions, including displacement, were constant, and the stern load water lines were practically alike. The models differed by variations in the immersion of their transom sterns and in the shape of their buttock lines.

The models were towed for resistance at the designed trim and at other conditions of trim and the curves of resistance plotted on speed.

The resistances of the models at selected speeds were plotted on variations in transom immersion and shape of sectional area curves. Contour curves of resistance were used to prepare diagrams showing the influence of the variations on resistance.

Introduction

The transom stern has been embodied in the design of destroyers for many years and a systematic test of some of its characteristics was considered desirable. Of these characteristics the depth of immersion of the transom and the shape of the buttock lines as they approach the transom were chosen for this investigation.

Of previous destroyer models, No. 3092 had given the best results as regards resistance so it was decided to use the bow of this model with nine different sterns, the variations in which were restricted as far as possible to the features under investigation.

Methods and Apparatus

For this test nine 20-ft. models were made. The bows of these models, from the midship section forward, were identical, copied from the Model Basin lines of a destroyer for the FARRAGUT class tested as model No. 3092. The bow sectional area curve is shown in Fig. 2.

Aft of the midship section (which is 60 per cent of the l.w.l. length from the F.P.) the general shape of the stern was made as much like the lines of model No. 3092 as the desired variations would allow. The length, displacement, drag of keel, lowest point of keel and the load water line were held constant except that when the transom had no immersion the l.w.l. was necessarily cut away near the transom, but the knuckle immediately above continued the curve to the transom so that the load water lines when under way were practically the same for all models.

The transom of each model was simply a straight vertical cut normal to the center plane of the model.

The depths of immersion chosen for the transoms were such as to give areas below the l.w.l equal to 0, 10 per cent and 20 per cent of the area of the immersed midship section.

Each of these depths of transom was combined with three sectional area curves as shown on Fig. 1; these curves produced buttock lines of corresponding curvature, hollow, normal or full, as they approached the transom.

Figs. 3 and 4 show the type of sterns used; the bossings shown were added for subsequent tests.

These models were run for resistance up to a speed of 10 knots, corresponding to a speed of 41 knots for a 334-ft. ship. They were without appendages and were tested at three trims, namely, designed water line, 3 in. by bow and 3 in. by stern (for the model).

After drawing the curves of resistance plotted on speed, the resistances were read off at speeds of 6 knots, 7.5 knots, and 9 knots. These values are tabulated on Fig. 5.

For each of the three speeds and the three trims a diagram was made, plotting contours of resistance on values of immersed transom area and fullness of sectional area curve. In these diagrams the abscissae are relative only as the changes in sectional area curves, could not be plotted quantitatively.

These diagrams, Figs. 6 to 14 inclusive, show the effect on resistance of variations in the immersion of transom and in fullness of sectional area curve as it approaches the transom.

As the comparative results of tests of models run bare hull for resistance only do not always agree with those of the same models run self-propelled, two of the models, 3144 and 3143, showing the best and the worst performance respectively, were selected for comparison when self-propelled. The bossings were made similar to those on model 3092 and the same propellers were used. The results are shown on Figs. 15 and 16.

Discussion of Results

The contour sheets, Figs. 6 to 14, show in a general way the effect of the immersion of the transom and the shape of the buttock lines on resistance.

From these contours it may be seen that as the speed is increased the optimum immersed transom area is increased, and that at speeds corresponding to 25 to 30 knots for the 334-ft. ship, the best area is about 10 per cent of the area of the midship section. The advantage of hollow buttocks is also shown for speeds of 30 knots and above.

A comparison of the self-propelled tests with the resistance tests run in bare hull condition shows a greater relative difference in SHP than EHP. The propulsive coefficient of the best model is higher except at the highest speed, where the propulsive coefficients are about the same. It is considered safe to apply the conclusions drawn from the resistance tests to the self-propelled tests, and thence to the design of the ships, in so far as such design may be based on model tests.

Conclusion

For destroyers of the general design and speed investigated, the transom should have an immersed area about 10 per cent of the immersed midship section and the buttock lines immediately forward of the transom should be hollow, especially when the design requires the best performance at the highest speeds.

If economical performance at cruising speeds is to govern, the transom stern should not be considered. At the lower speeds selected for cruising, say 16 knots, there is a disadvantage in submerging the transom, as shown by the table in Fig. 5a.

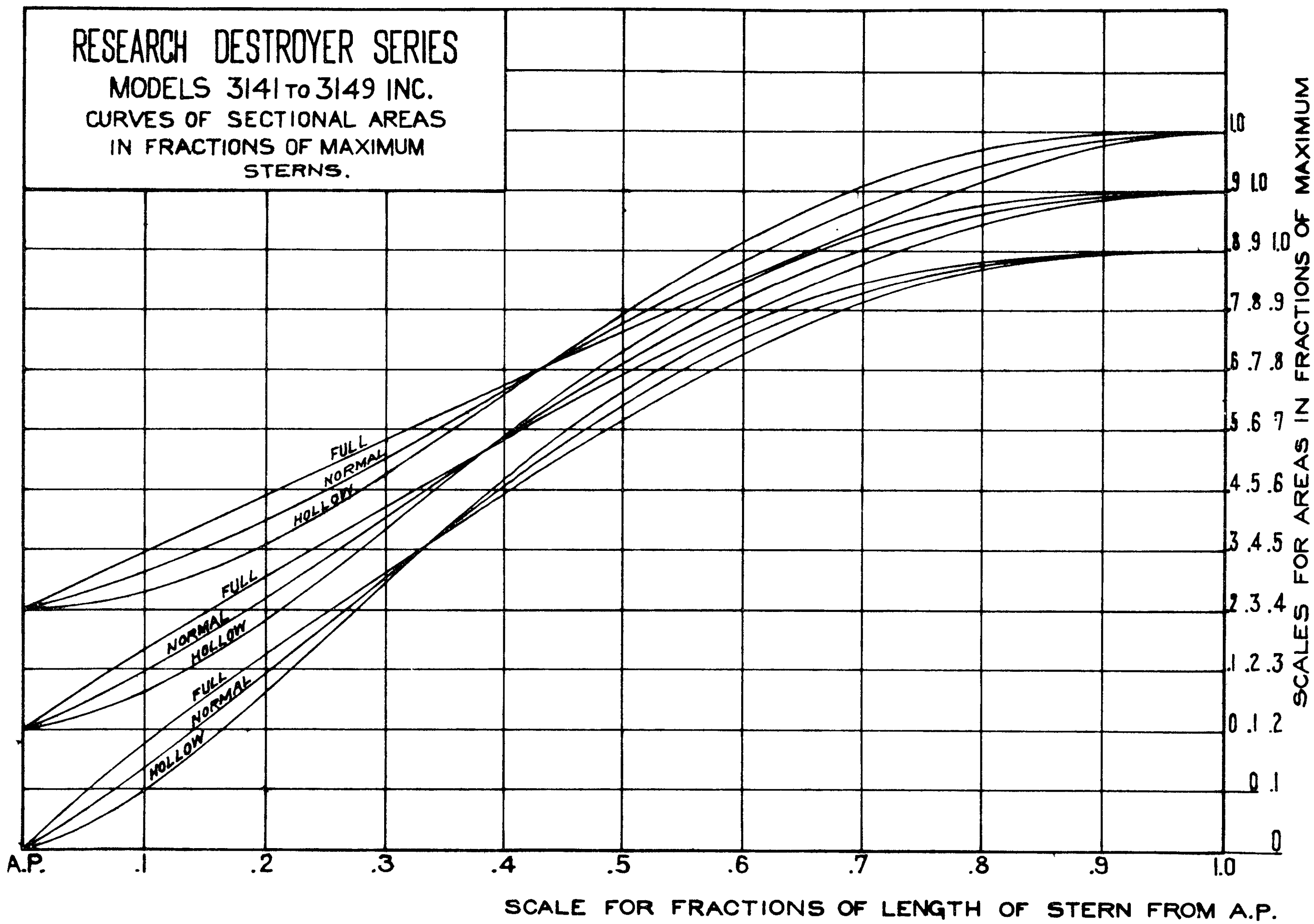

RESEARCH DESTROYER SERIES
MODELS 3141 TO 3149 INC.
CURVES OF SECTIONAL AREAS
IN FRACTIONS OF MAXIMUM
STERNS.
FULL
NORMAL
HOLLOW
FULL
NORMAL
HOLLOW
FULL
NORMAL
HOLLOW
A.P.
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
SCALE FOR FRACTIONS OF LENGTH OF STERN FROM A.P.
SCALES FOR AREAS IN FRACTIONS OF MAXIMUM

FIG. 1

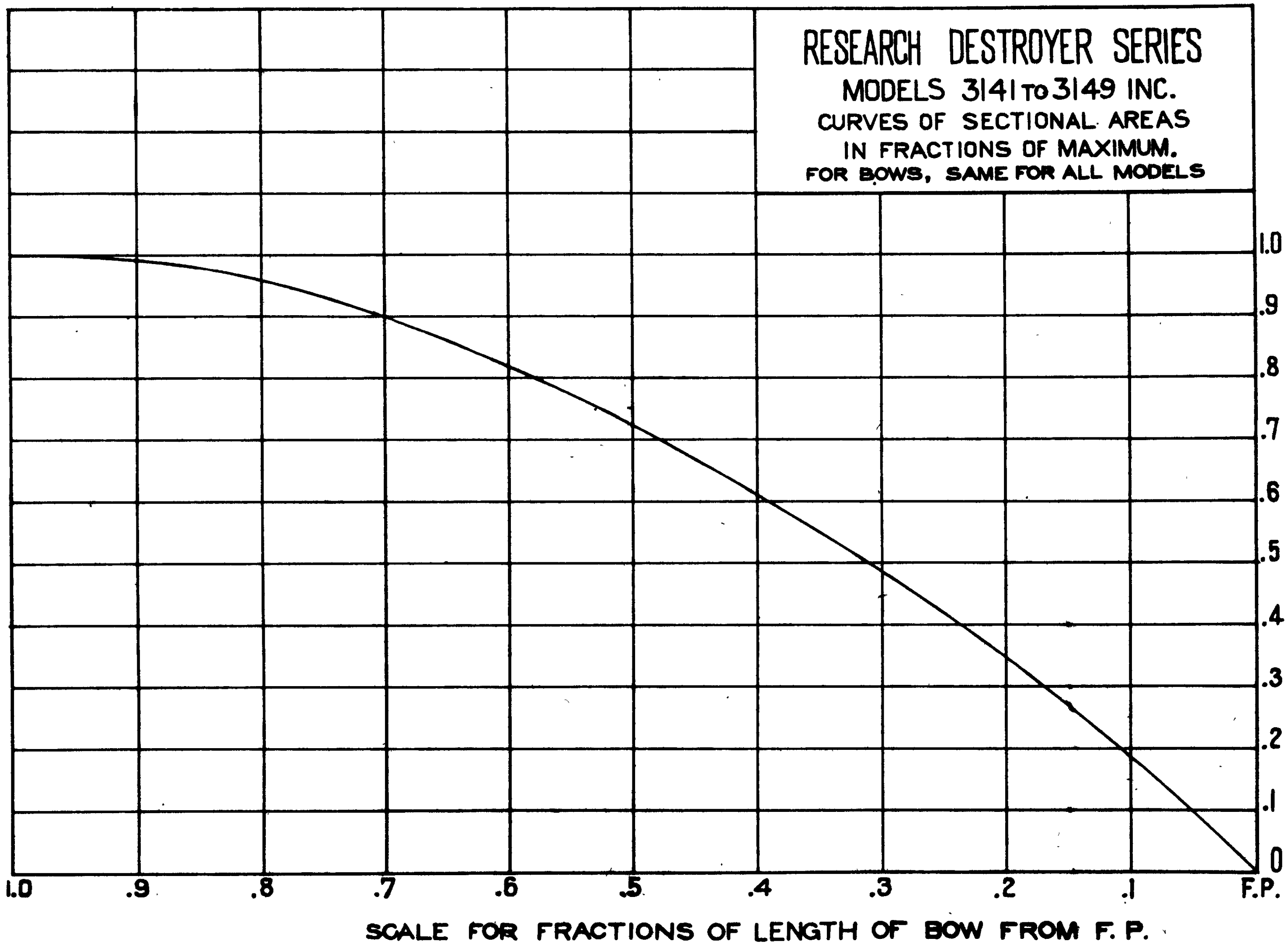
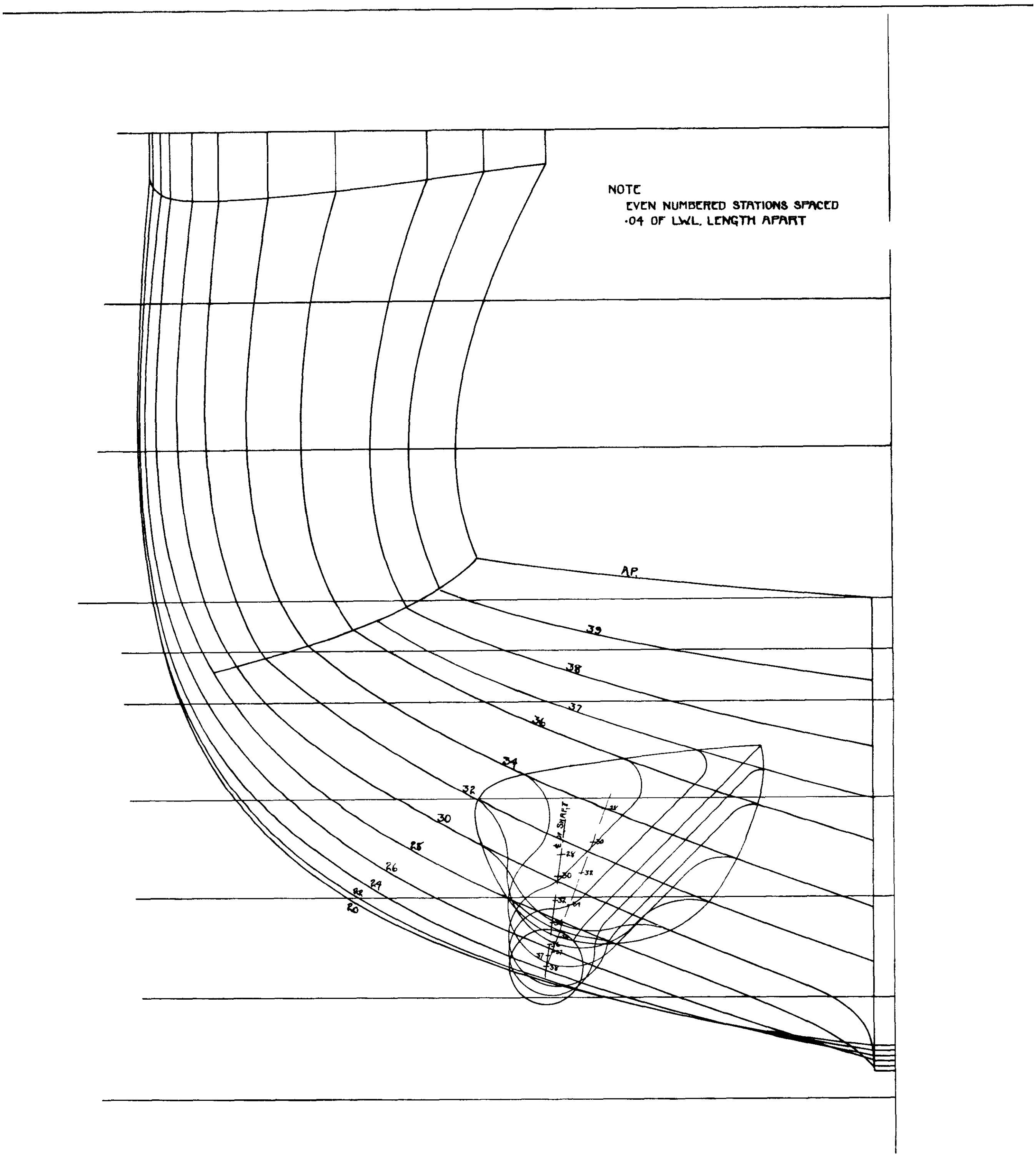

RESEARCH DESTROYER SERIES
MODELS 3141 TO 3149 INC.
CURVES OF SECTIONAL AREAS
IN FRACTIONS OF MAXIMUM.
FOR BOWS, SAME FOR ALL MODELS
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
SCALES FOR AREAS IN FRACTIONS OF MAXIMUM
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
F.P.
SCALE FOR FRACTIONS OF LENGTH OF BOW FROM F. P.

FIG. 2

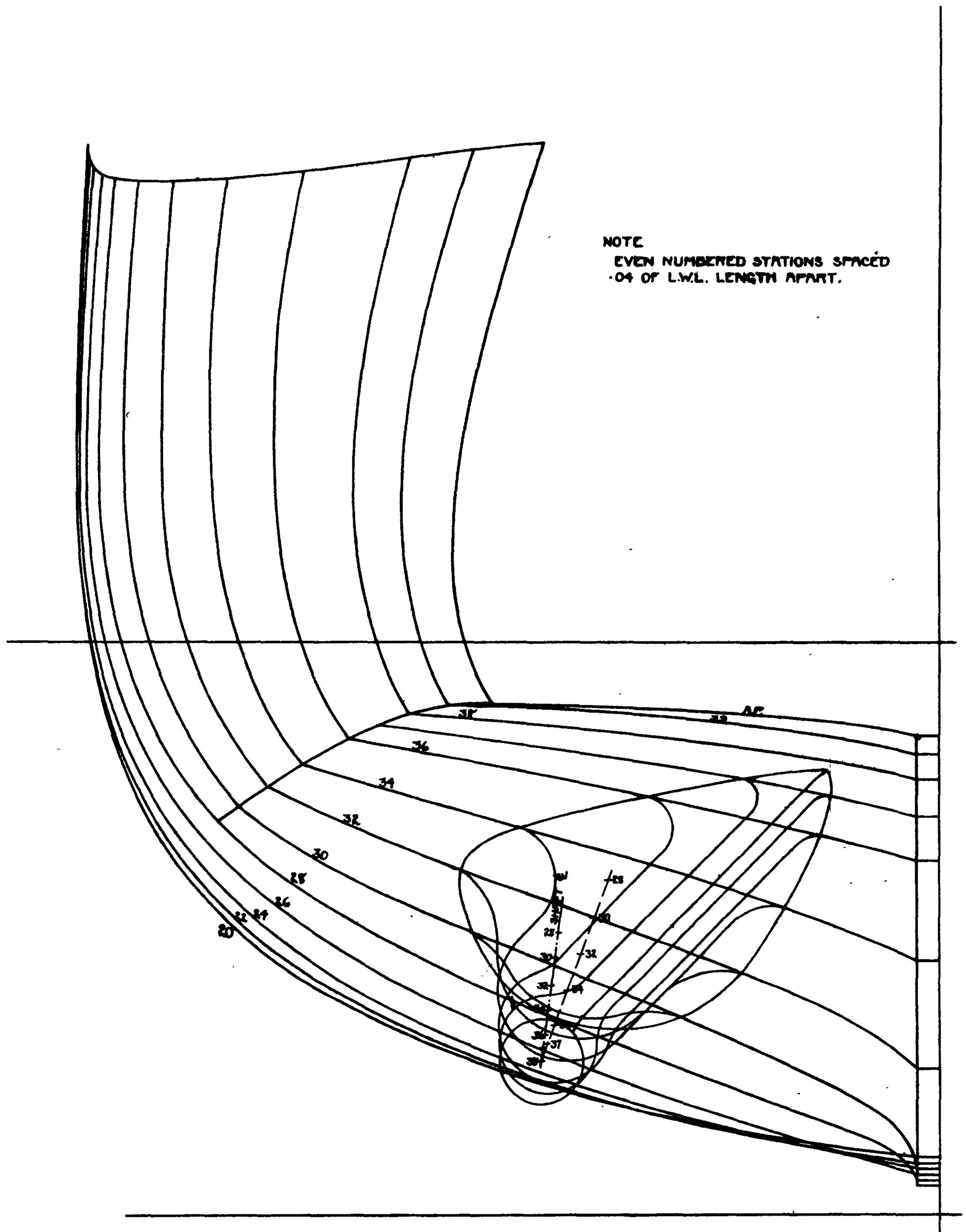


MODEL N° 3143

STERN BODY PLAN WITH BOSSING

BOSS DIAM TO SUIT PROP'S 1182 & 1183
PROP CLEARANCE SAME AS # 3092
SHAFT SLOPE " "
TAPER OF BOSS SIMILAR TO "

FIG. 3



MODEL No. 3144
STERN BODY PLAN WITH BOSSING

BOSS DIAM. TO SUIT PROP'S #1182 & 1183
PROP CLEARANCE SAME AS #3092
SHAFT SLOPE " " "
TAPER OF BOSS SIMILAR TO "

FIG. 4.

RESEARCH DESTROYER SERIES

MODELS 3141 TO 3149 INC.

DISPLACEMENT 810 LBS

VALUES OF TOTAL RESISTANCE AT VARIOUS SPEEDS

MEAN TEMP. OF WATER = 56°

T = IMMERSED AREA OF TRANSOM AT ZERO TRIM

A = AREA OF MIDSHIP SECTION

SAME BOW FOR ALL MODELS

HOLLOW, NORMAL, FULL, STERNS

			V = 6.0 KNOTS.			V = 7.5 KNOTS.			V = 9.0 KNOTS		
MODEL NO.	CHARACTER OF STERN	$\frac{T}{A}$	RESISTANCE IN LBS.			RESISTANCE IN LBS			RESISTANCE IN LBS.		
			DESIGNED W.L.	3" BY BOW	3" BY STERN	DESIGNED W.L.	3" BY BOW	3" BY STERN	DESIGNED W.L.	3" BY BOW	3" BY STERN
3141	HOLLOW	0	19.85	20.30	21.60	36.30	37.00	37.80	50.35	50.90	50.60
3142	NORMAL	"	20.15	20.50	21.65	36.75	37.60	37.95	49.95	50.95	50.20
3143	FULL	"	21.50	21.15	23.45	39.00	38.70	41.30	52.95	52.50	53.95
3144	HOLLOW	.10	19.30	19.55	20.75	34.60	35.30	37.00	46.55	47.70	48.50
3145	NORMAL	"	18.00	18.15	20.80	34.80	36.05	36.70	47.10	49.50	47.70
3146	FULL	"	20.10	19.75	23.00	36.00	36.30	38.20	48.75	49.90	50.20
3147	HOLLOW	.20	20.40	19.80	22.75	35.70	35.50	37.50	47.00	48.40	48.00
3148	NORMAL	"	20.25	19.80	23.15	35.60	36.10	37.80	48.25	49.25	49.30
3149	FULL	"	20.55	19.99	22.90	35.40	35.40	37.75	47.40	48.20	48.65

FIG. 5

RESEARCH DESTROYER SERIES

MODELS 3141 TO 3149 INC.

DISPLACEMENT 810 LBS.

VALUES OF TOTAL RESISTANCE AT CRUISING SPEEDS

MEAN TEMP. OF WATER = 56°

2.94 KN. ∝ 12 KN. & 3.91 KN. ∝ 16 KN. FOR 334' SHIP

T = IMMERSED AREA OF TRANSOM

A = AREA OF MIDSHIP SECTION

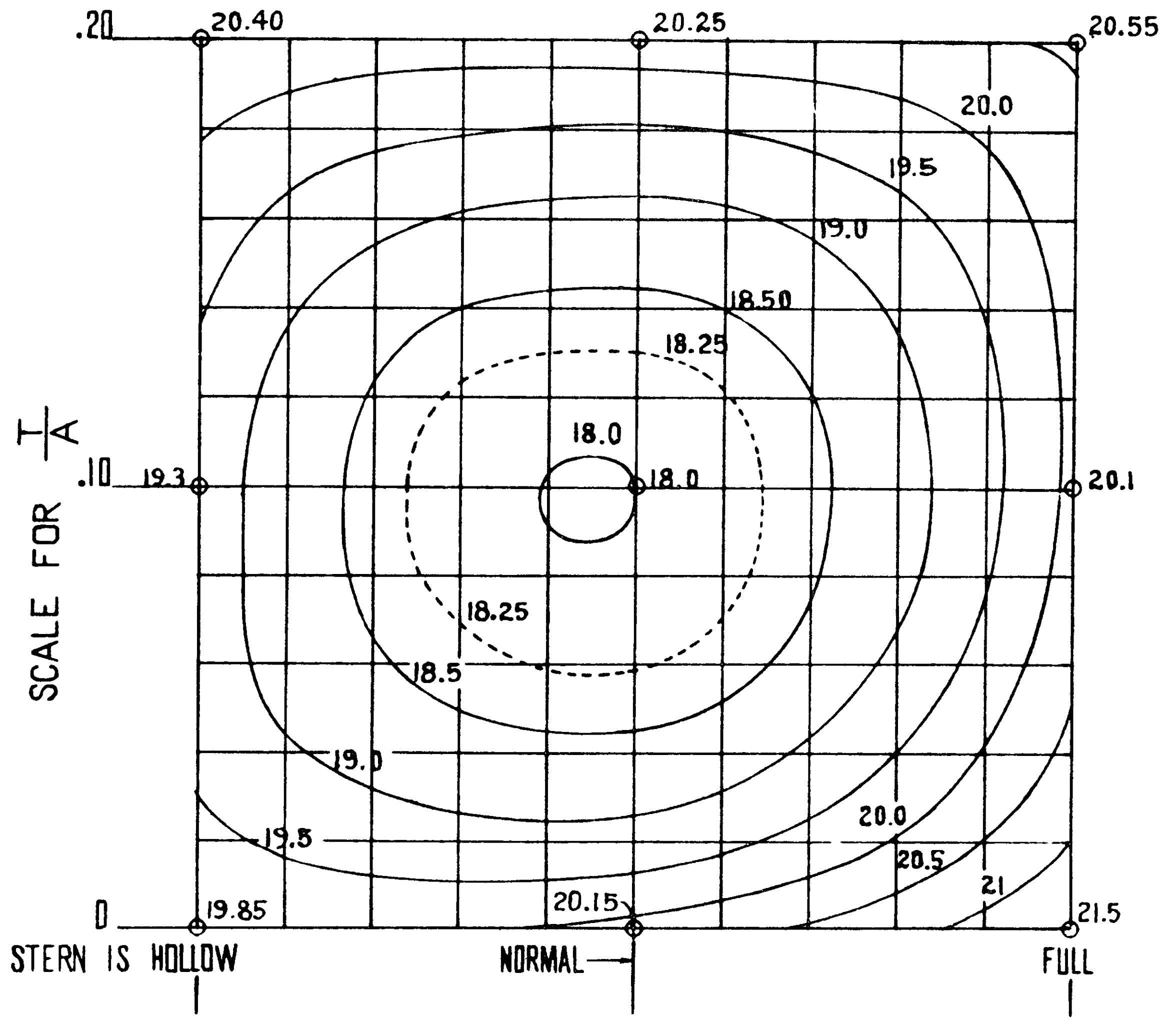
SAME BOW FOR ALL MODELS

HOLLOW, NORMAL, FULL, STERNS

			RESISTANCE IN POUNDS MODELS AT DESIGNED L.W.L.	
MODEL Nº.	CHARACTER OF STERN	$\frac{T}{A}$	V = 2.94 KNOTS (12 KN.)	V = 3.91 KNOTS (16 KN.)
3141	HOLLOW	0	3.55	6.70
3142	NORMAL	"	3.48	6.67
3143	FULL	"	3.80	6.81
3144	HOLLOW	.10	3.73	6.90
3145	NORMAL	"	3.91	6.96
3146	FULL	"	3.68	7.29
3147	HOLLOW	.20	4.11	7.42
3148	NORMAL	"	4.07	7.45
3149	FULL	"	3.78	7.22

FIG. 5a

CONTOURS OF TOTAL RESISTANCE, LBS.

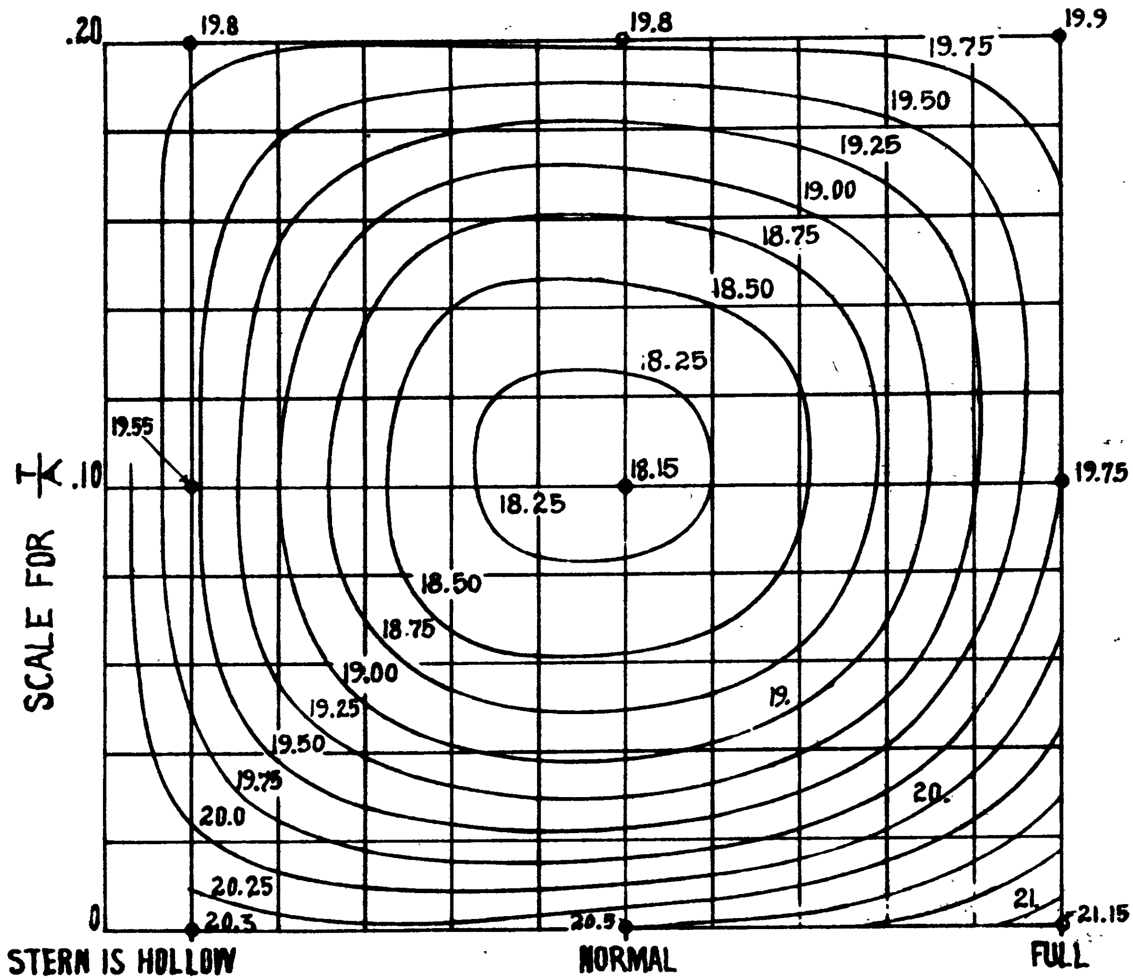


V = 6.0 KNOTS

DESIGNED W. L.

FIG. 6

CONTOURS OF TOTAL RESISTANCE, LBS.

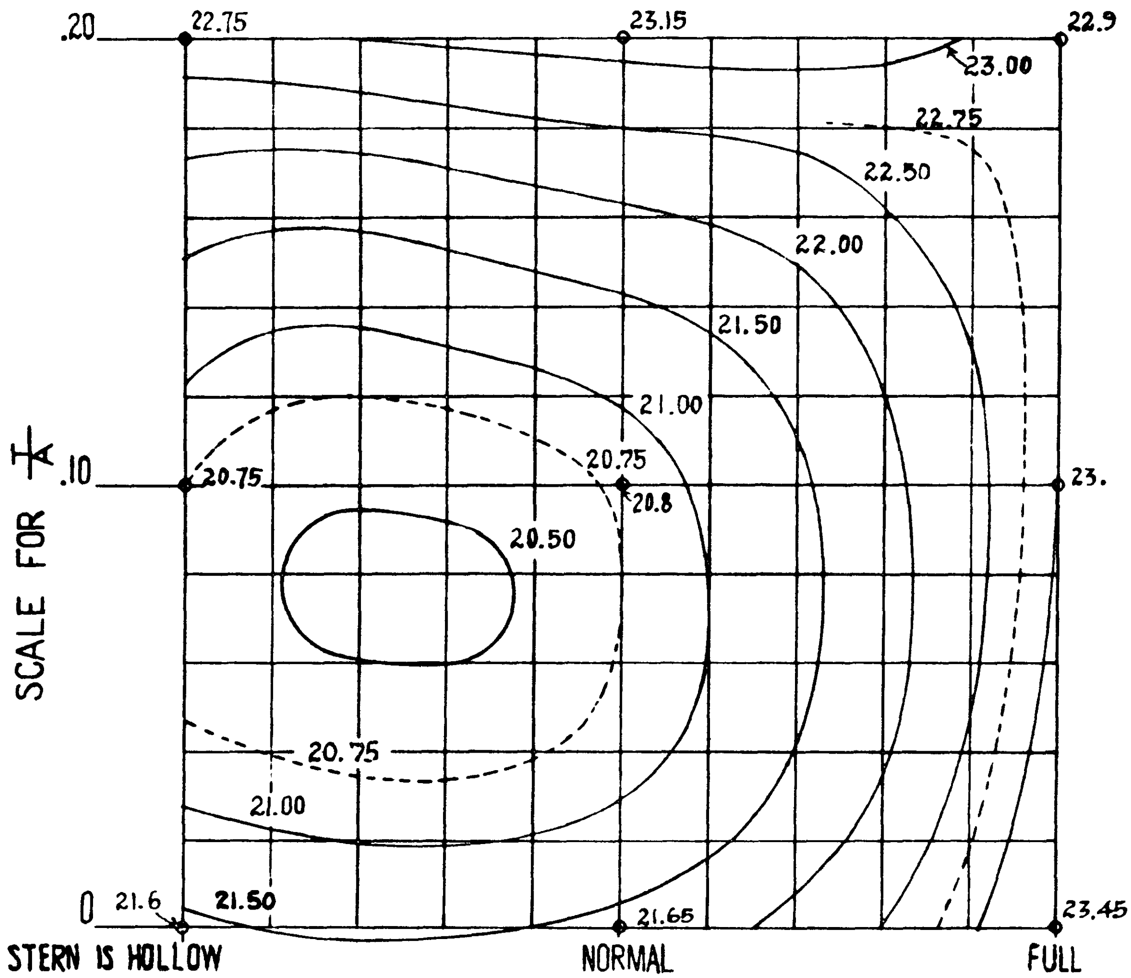


V= 6.0 KNOTS

3" BY BOW

FIG. 7

CONTOURS OF TOTAL RESISTANCE, LBS.

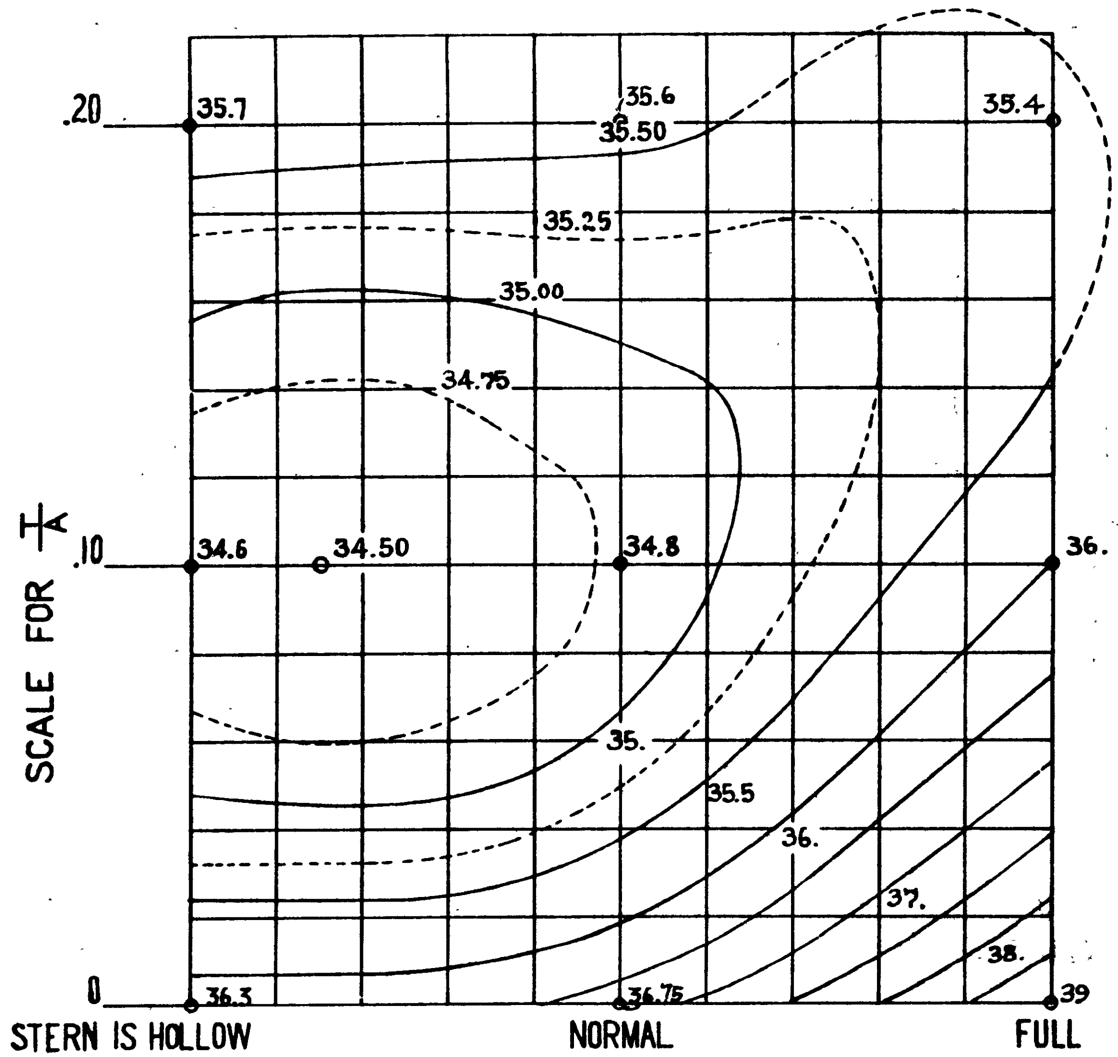


V= 6.0 KNOTS

3" BY STERN

FIG. 8

CONTOURS OF TOTAL RESISTANCE, LBS.

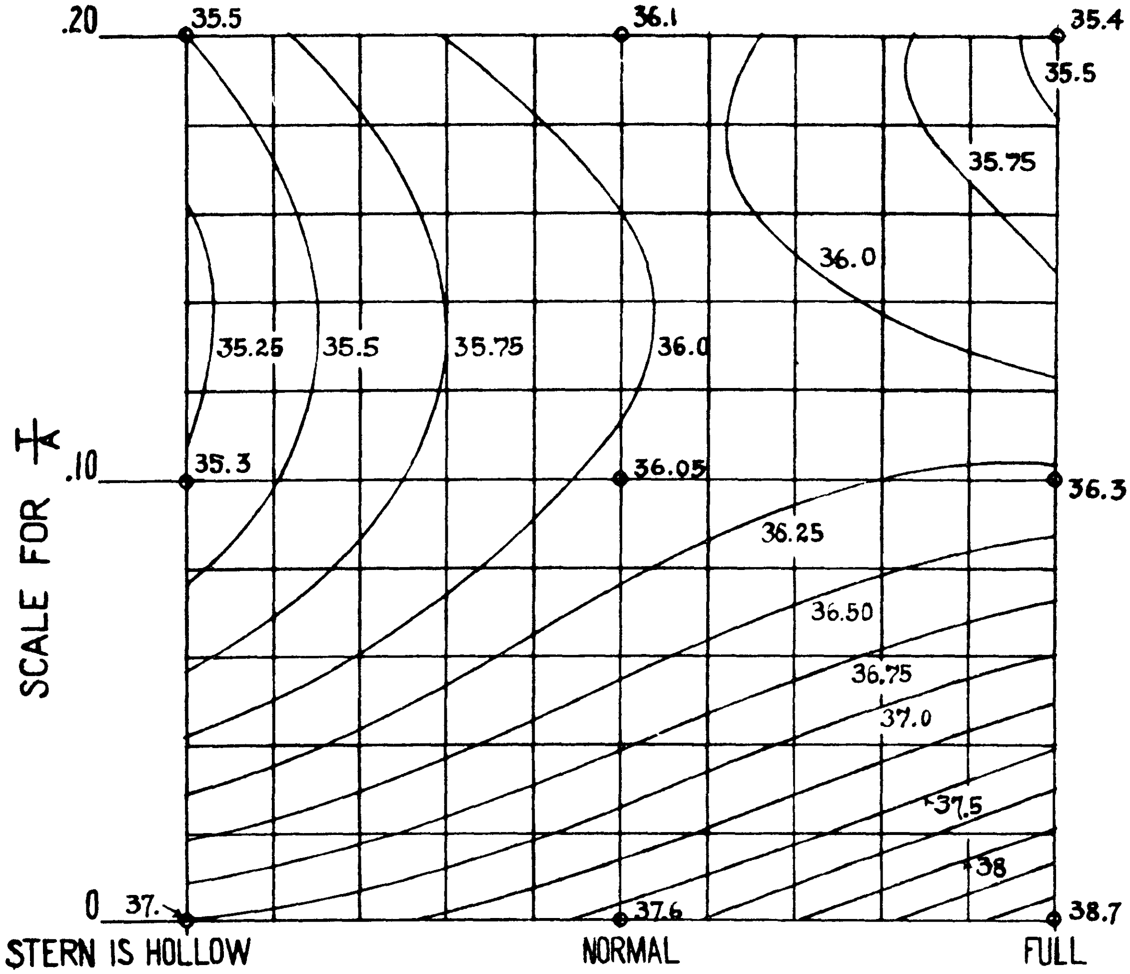


V = 7.5 KNOTS

DESIGNED W. L.

FIG. 9

CONTOURS OF TOTAL RESISTANCE, LBS.

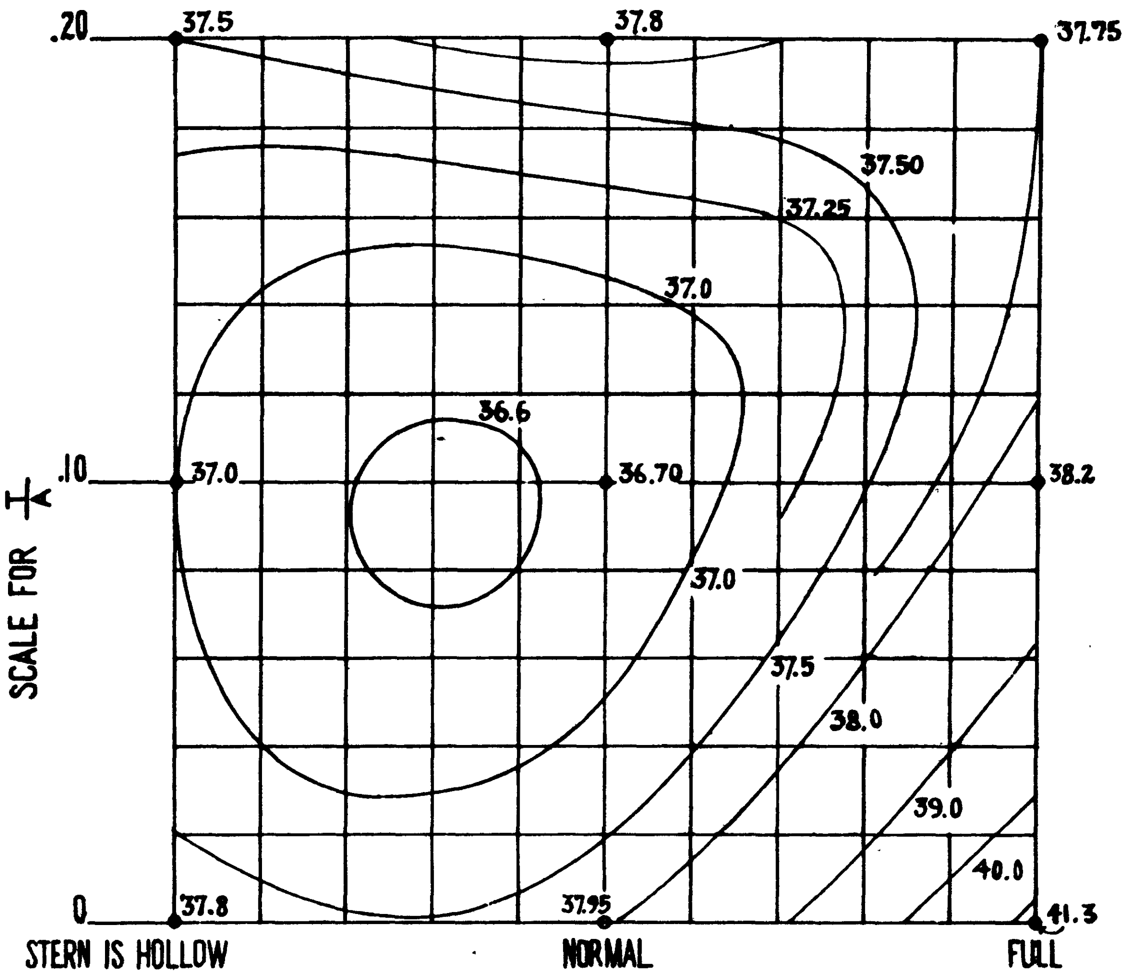


V = 7.5 KNOTS

3" BY BOW

FIG. 10

CONTOURS OF TOTAL RESISTANCE, LBS.

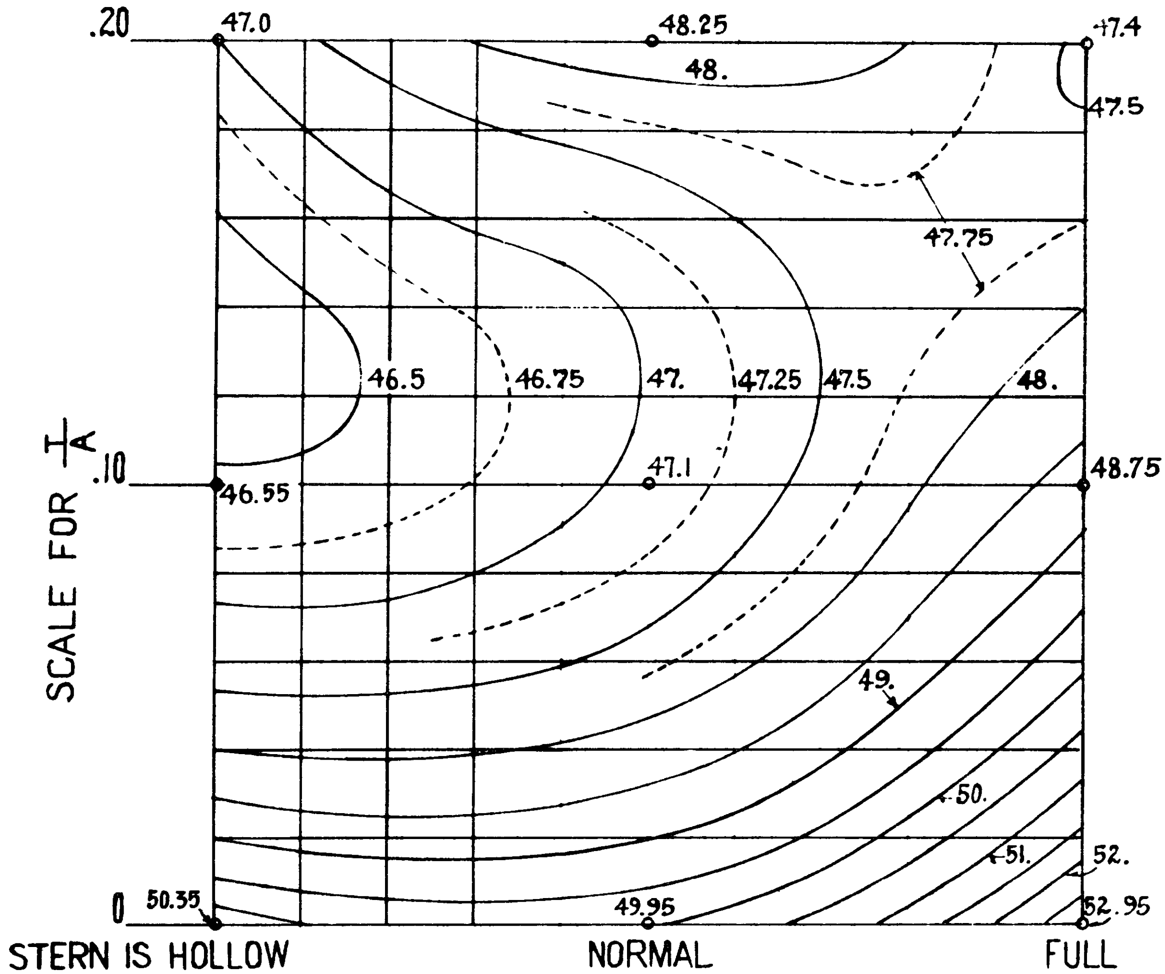


V= 7.5 KNOTS

3" BY STERN

FIG. 11

CONTOURS OF TOTAL RESISTANCE, LBS.

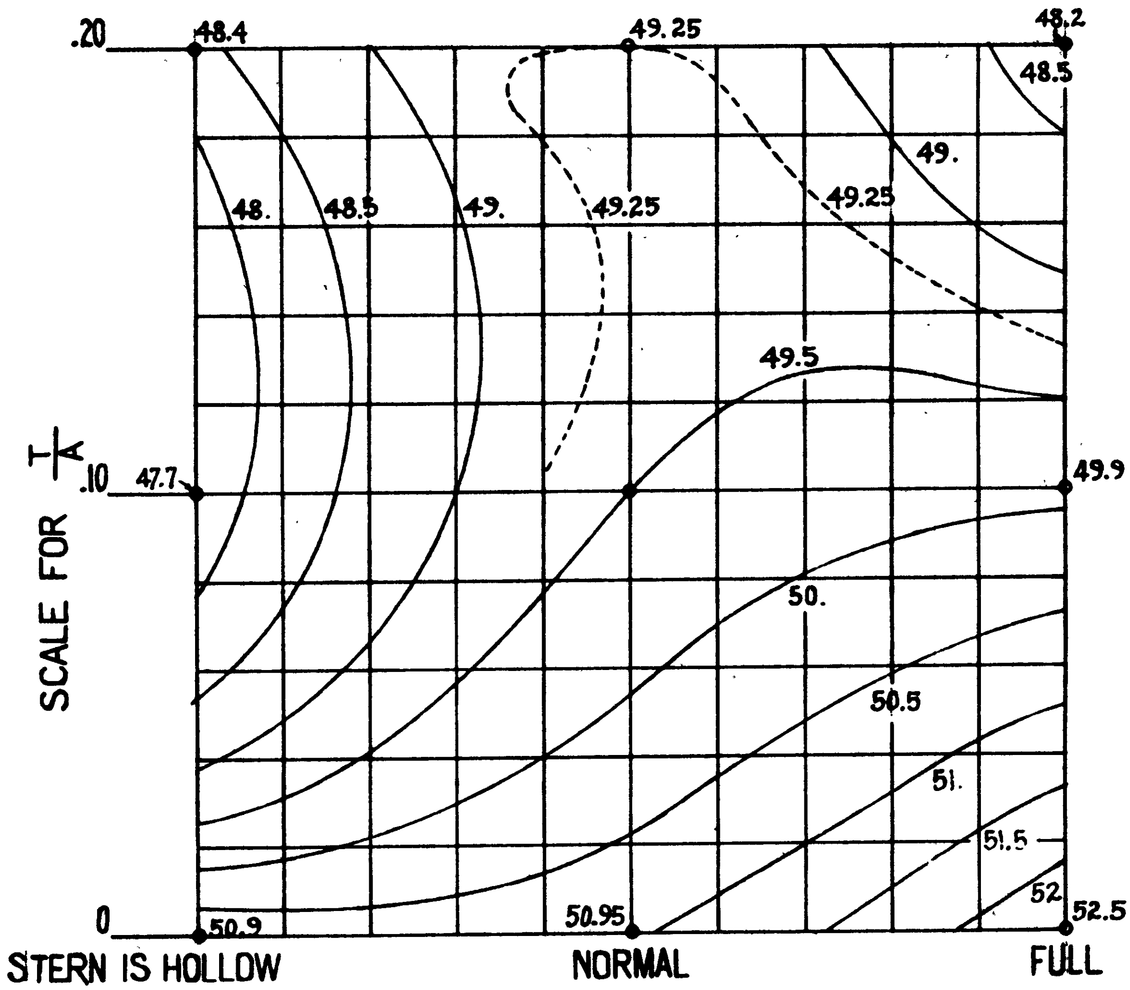


V = 9.0 KNOTS

DESIGNED W. L.

FIG. 12

CONTOURS OF TOTAL RESISTANCE, LBS.

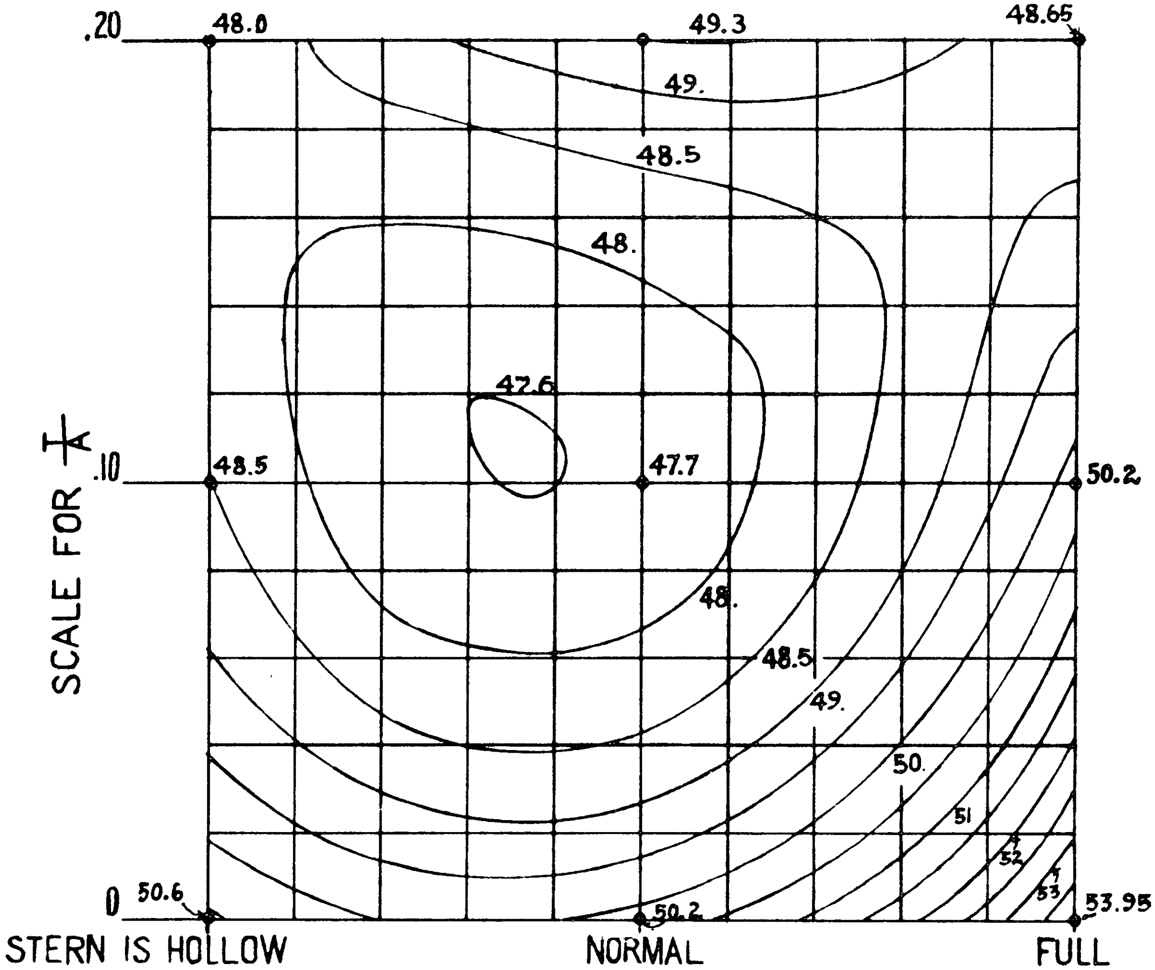


V= 9.0 KNOTS

3" BY BOW

FIG.13

CONTOURS OF TOTAL RESISTANCE, LBS.



V= 9.0 KNOTS

3" BY STERN

FIG. 14

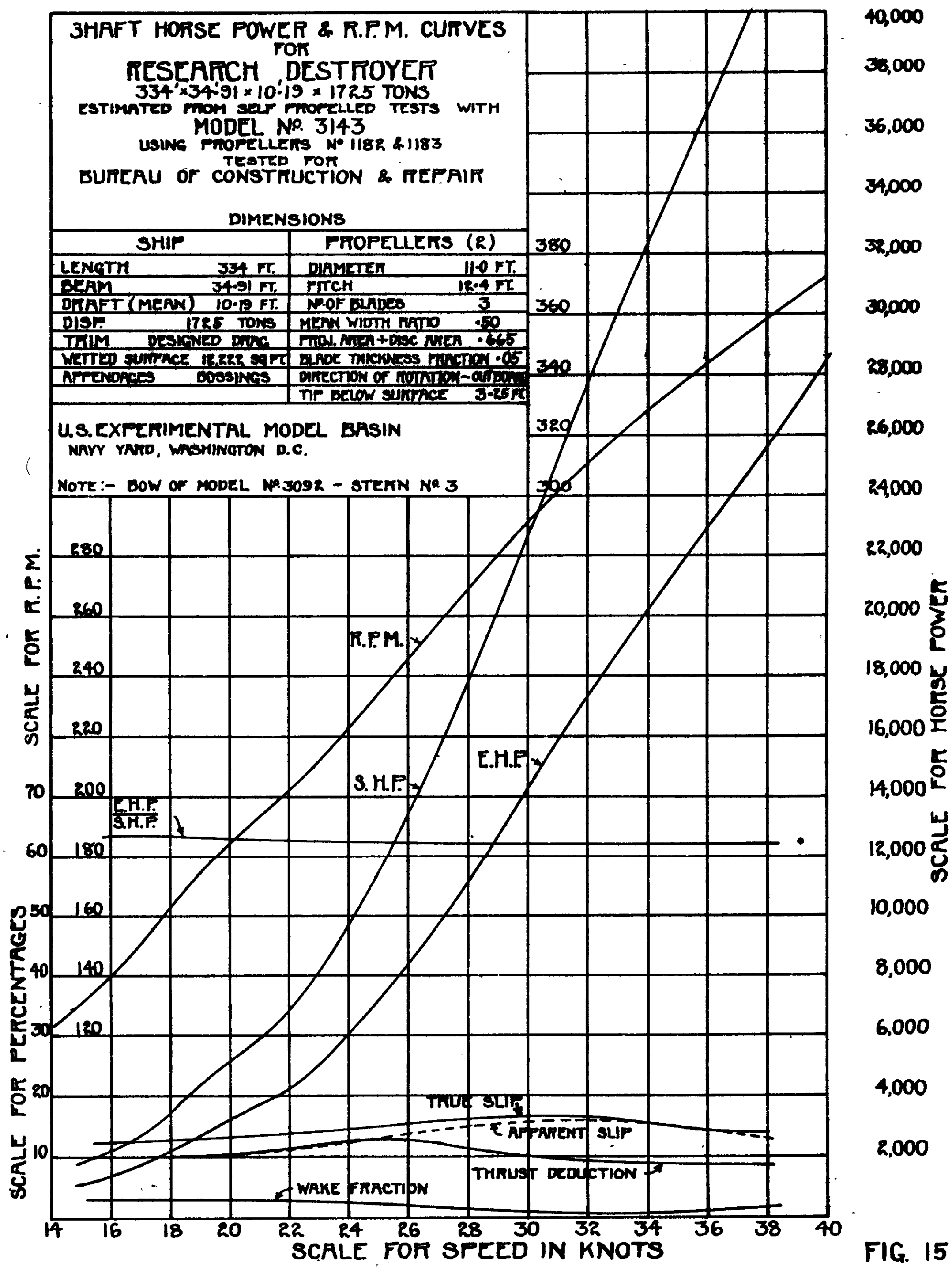

SHAFT HORSE POWER & R.P.M. CURVES
FOR
RESEARCH DESTROYER
334'×34'-91 × 10'-19 × 1725 TONS
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL Nº 3143
USING PROPELLERS Nº 1182 & 1183
TESTED FOR
BUREAU OF CONSTRUCTION & REPAIR
DIMENSIONS
SHIP
PROPELLERS (2)
LENGTH 334 FT.
BEAM 34-91 FT.
DRAFT (MEAN) 10-19 FT.
DISP. 1725 TONS
TRIM DESIGNED DRAG
WETTED SURFACE 12,222 SQ.FT.
APPENDAGES BOSSINGS
DIAMETER 11-0 FT.
PITCH 12-4 FT.
Nº OF BLADES 3
MEAN WIDTH RATIO ·50
PROJ. AREA ÷ DISC AREA ·665
BLADE THICKNESS FRACTION ·05
DIRECTION OF ROTATION – OUTBOARD
TIP BELOW SURFACE 3-25 FT.
U.S. EXPERIMENTAL MODEL BASIN
NAVY YARD, WASHINGTON D.C.
NOTE:– BOW OF MODEL Nº 3092 – STERN Nº 3
R.P.M.
S.H.P.
E.H.P.
E.H.P. / S.H.P.
TRUE SLIP
APPARENT SLIP
THRUST DEDUCTION
WAKE FRACTION
SCALE FOR R.P.M.
120
140
160
180
200
220
240
260
280
300
320
340
360
380
SCALE FOR PERCENTAGES
10
20
30
40
50
60
70
SCALE FOR HORSE POWER
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000
20,000
22,000
24,000
26,000
28,000
30,000
32,000
34,000
36,000
38,000
40,000
14
16
18
20
22
24
26
28
30
32
34
36
38
40
SCALE FOR SPEED IN KNOTS

FIG. 15

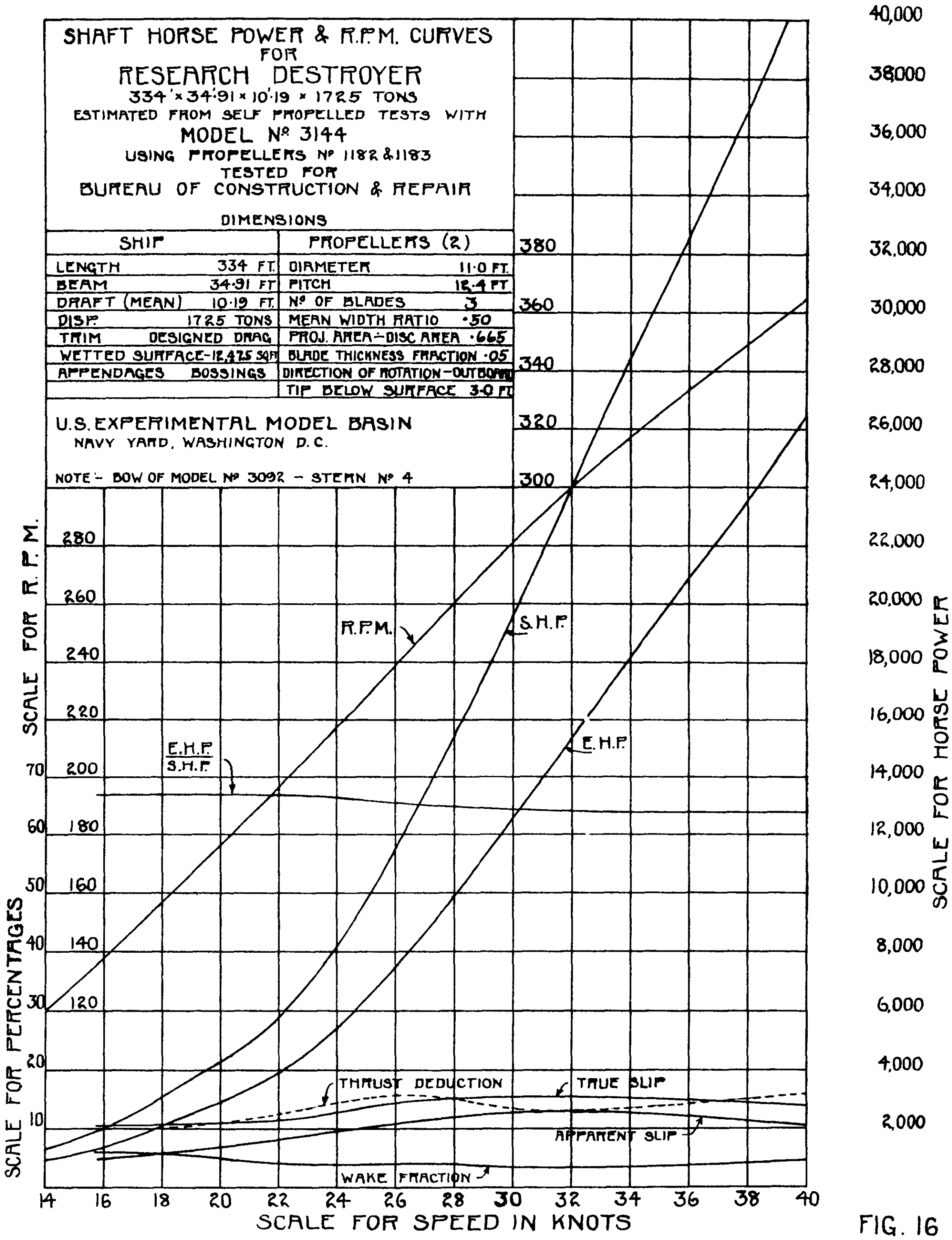

SHAFT HORSE POWER & R.P.M. CURVES
FOR
RESEARCH DESTROYER
334'×34'91×10'19 × 1725 TONS
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL Nº 3144
USING PROPELLERS Nº 1182 & 1183
TESTED FOR
BUREAU OF CONSTRUCTION & REPAIR
DIMENSIONS
SHIP
LENGTH 334 FT.
BEAM 34·91 FT
DRAFT (MEAN) 10·19 FT.
DISP. 1725 TONS
TRIM DESIGNED DRAG
WETTED SURFACE-12,425 SQ.FT.
APPENDAGES BOSSINGS
PROPELLERS (2)
DIAMETER 11·0 FT.
PITCH 12·4 FT
Nº OF BLADES 3
MEAN WIDTH RATIO ·50
PROJ. AREA÷DISC AREA ·665
BLADE THICKNESS FRACTION ·05
DIRECTION OF ROTATION—OUTBOARD
TIP BELOW SURFACE 3·0 FT.
U.S. EXPERIMENTAL MODEL BASIN
NAVY YARD, WASHINGTON D.C.
NOTE:- BOW OF MODEL Nº 3092 — STERN Nº 4
R.P.M.
S.H.P.
E.H.P.
E.H.P. / S.H.P.
THRUST DEDUCTION
TRUE SLIP
APPARENT SLIP
WAKE FRACTION
SCALE FOR R.P.M.
SCALE FOR PERCENTAGES
SCALE FOR HORSE POWER
SCALE FOR SPEED IN KNOTS
14 16 18 20 22 24 26 28 30 32 34 36 38 40
120 140 160 180 200 220 240 260 280 300 320 340 360 380
10 20 30 40 50 60 70
2,000 4,000 6,000 8,000 10,000 12,000 14,000 16,000 18,000 20,000 22,000 24,000 26,000 28,000 30,000 32,000 34,000 36,000 38,000 40,000

FIG. 16