RESULT OF TESTS OF A MODEL OF THE PROPOSED FLOATING DRY DOCK

U.S. EXPERIMENTAL MODEL BASIN
Navy Yard, Washington,D.C.

April 1923

Report 74

RESULTS OF TESTS
OF A MODEL OF THE PROPOSED
FLOATING DRY DOCK

Experiments with the model of the proposed floating dry dock have been made throughout the year as occasion permitted. The model was fitted with alternative sterns, one adapted to propulsion by propellers in midship tunnels and the other with propellers at the stern. The sketch appended shows an outline of the different experimental tunnels in profile and in section, the tunnels originally planned being marked No. 1.

The model was made 30 feet long, fitted with the usual apparatus for self-propulsion and run at speeds up to 2.1 knots, corresponding to a speed of 12 knots for the dry dock. The propellers used were dimensioned as follows:-

Propellers No. 386 and 387

Diameter = 5.84 inches

Pitch = 6.00 inches

$$\frac{\text{Developed area}}{\text{Disc area}} = 0.41$$

The case of midship tunnels was first tried out and in th first three experiments the model was run at drafts correspondin to 15, 20 and 25 feet and the results are shown on Sheets No. 1, II and III, respectively.

The outstanding feature of these tests was the low propul sive efficiency. This is due to three factors; the very high sl the small wake fraction and the very great thrust deduction.

It was considered improbable that the wake could be increased the tunnels were near the midship section of the model, but attempts were made to improve the other two detrimental factors.

The first attempt was to try to decrease the slip by using propellers with wider blades. With this in view, the model was agai run at the same draft as in Experiment No. 1, but with propellers of the following dimensions:-

Propellers No. 388 and 389
Diameter = 5.84 inches
Pitch = 6.00 inches
$\frac{\text{Developed area}}{\text{Disc area}} = 0.56$

The results, on Sheet IV, show the slip increased instead of diminished and the efficiency practically unchanged as compared with Sheet No. 1.

Propellers of a smaller pitch were then tried in a second attempt to reduce the slip.

Propellers No. 382 and 383
Diameter = 5.84 inches
Pitch = 4.50 inches
$\frac{\text{Developed area}}{\text{Disc area}} = 0.56$

In this experiment the slip was reduced as hoped, but the efficiency was not improved. See Sheet V.

Experiments were then conducted to see if the thrust deductio could not be reduced by a change in the shape of the tunnels. Propellers No. 388 and 389, with the dimensions as given above were the used, and the draft retained as in Experiment No. 1, but the tunnels forward of the propellers, were widened out as shown in the sketch

for tunnel No. 2. Sheet VI gives the results of this experiment and a smaller thrust deduction is at once apparent as compared w Sheet No. 1. A slight increase of efficiency is also indicated.

The next step was to enlarge the tunnels aft of the propell in the same way, as shown on sketch for tunnel No. 3. The model was run with the same propellers and at the same draft as in the previous experiment with results as shown on Sheet VII. These indicate sufficient drop in the slip to offset a small rise in the thrust deduction and to increase the efficiency.

An attempt to lessen the thrust deduction was then made by changing the length of the tunnels aft of the propellers. The length was doubled but the sections were changed back to the original shape as shown in sketch for tunnel No. 4.

The results of this change, other conditions remaining the same, is shown on Sheet VIII. The thrust deduction was reduced so much that there was a noticeable increase in the efficiency even though the slip was made somewhat greater.

The last experiment was to try the effect of increasing the diameter of the propellers. The tunnels were enlarged as per tunnel No. 5, on the sketch and the model run with:-

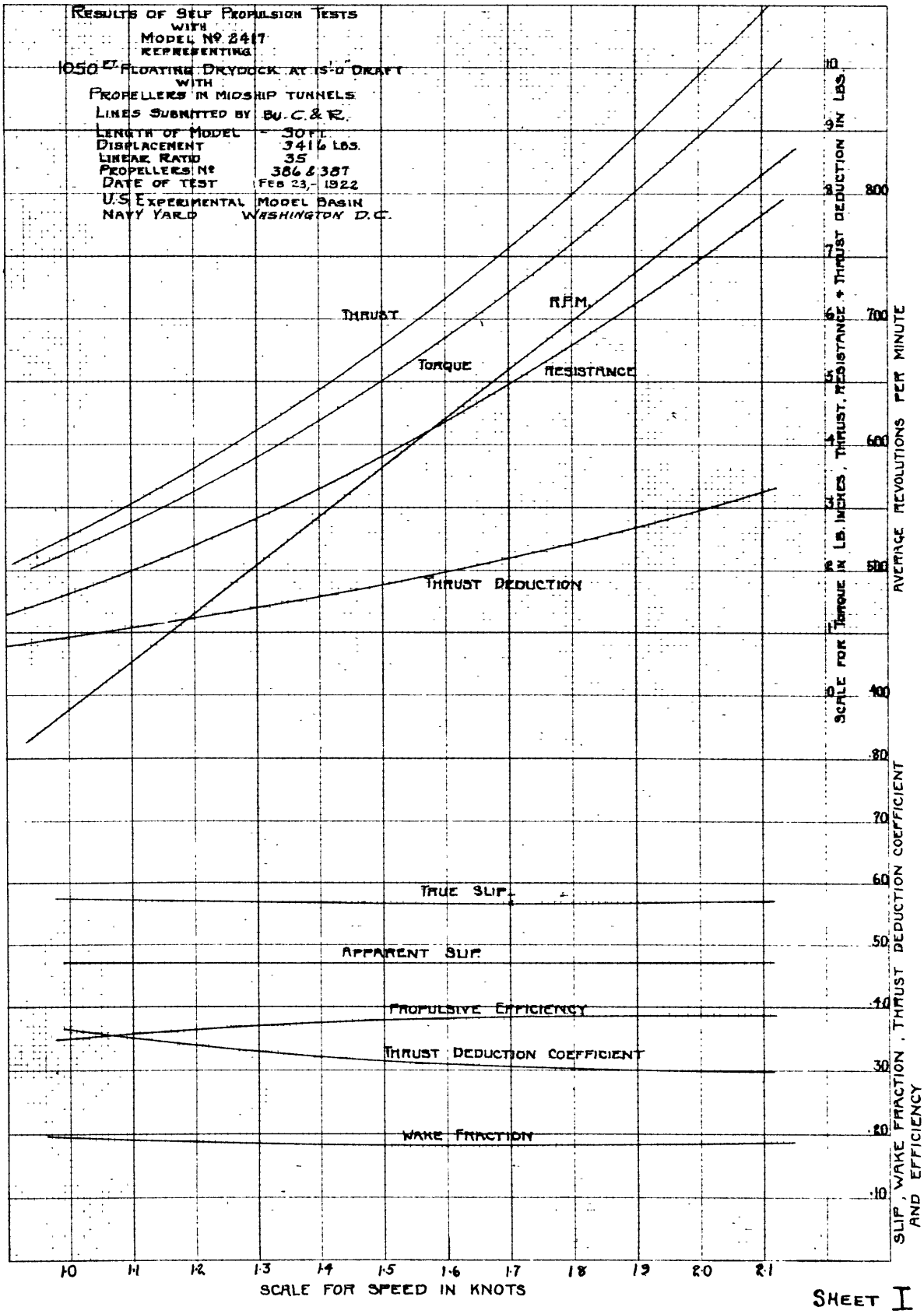
Propellers No. 412 and 413
Diameter = 6.70 inches
Pitch = 7.00 inches
$\frac{\text{Developed area}}{\text{Disc area}} = 0.57$

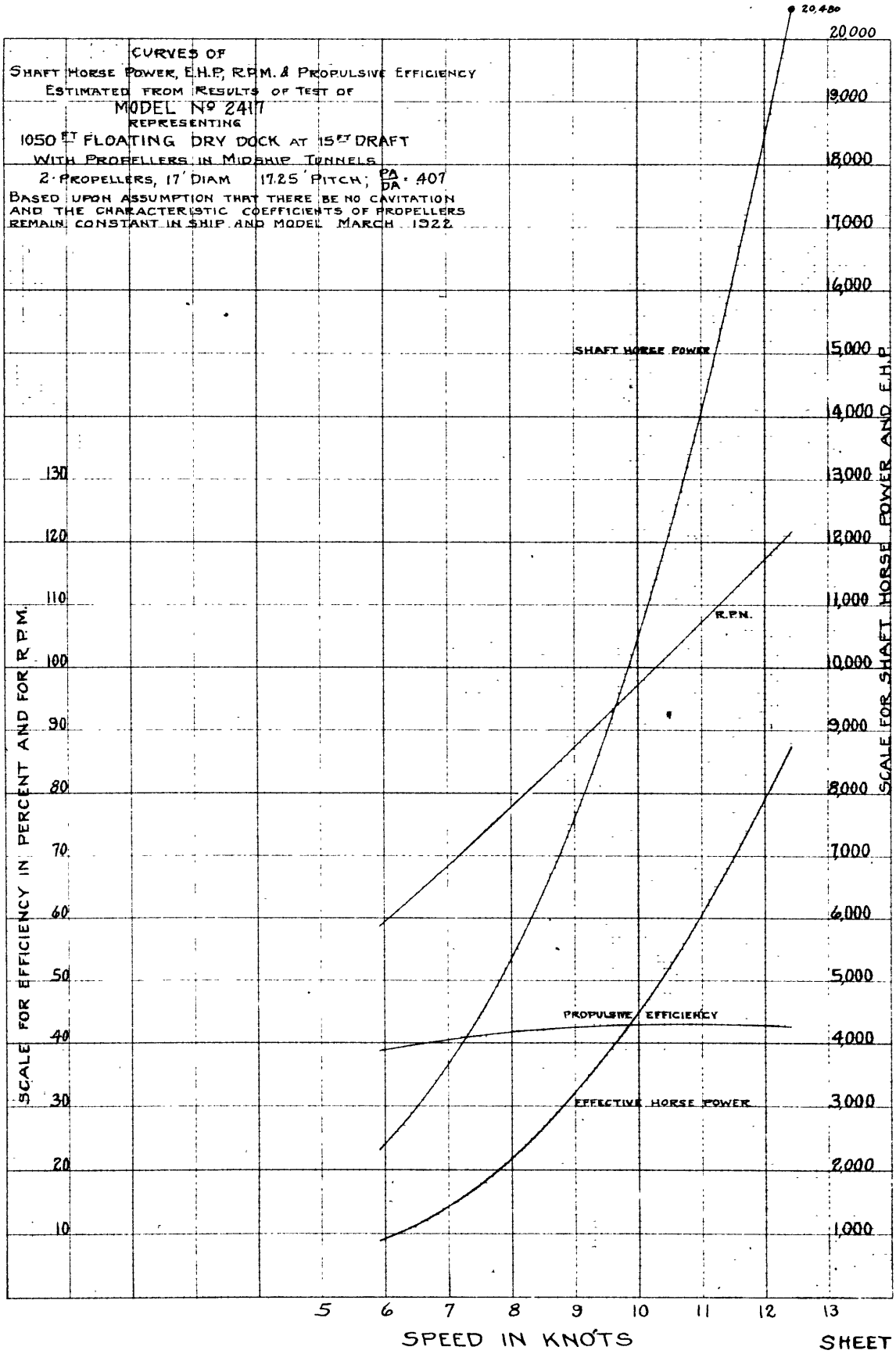
The results, on Sheet IX, indicate such an increase in thru deduction that although the slip was lessened, there was a loss efficiency.

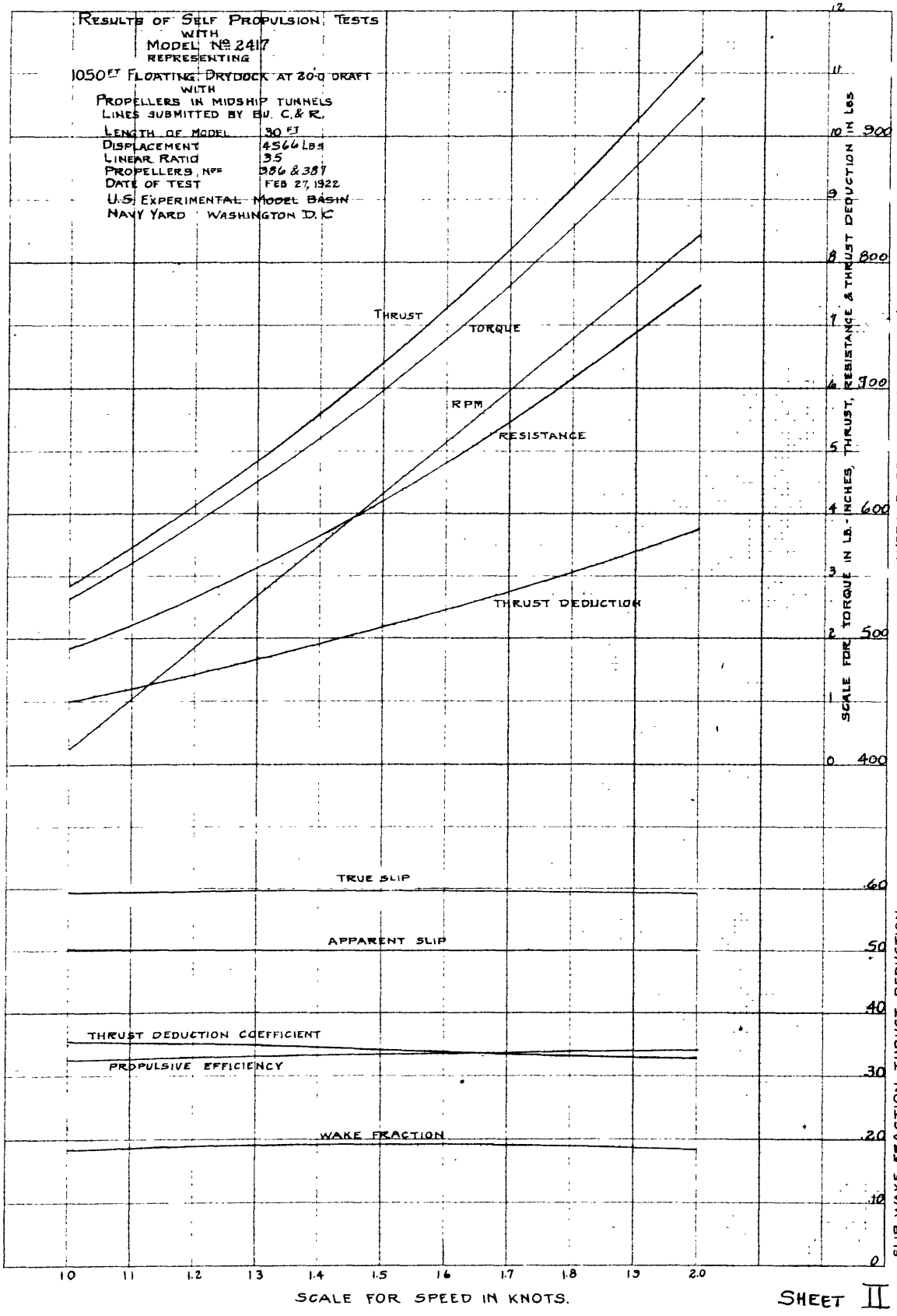
Finally, the alternative stern was used, requiring much less power, but still with low efficiency as is shown on Sheet X.

It is concluded that the propellers were all too small for both types of sterns, resulting in low efficiency, but that larger propellers in correspondingly larger tunnels, at least at amidship would not increase the efficiency, and in the full sized dry dock might fall down to a greater extent than in the model tests.

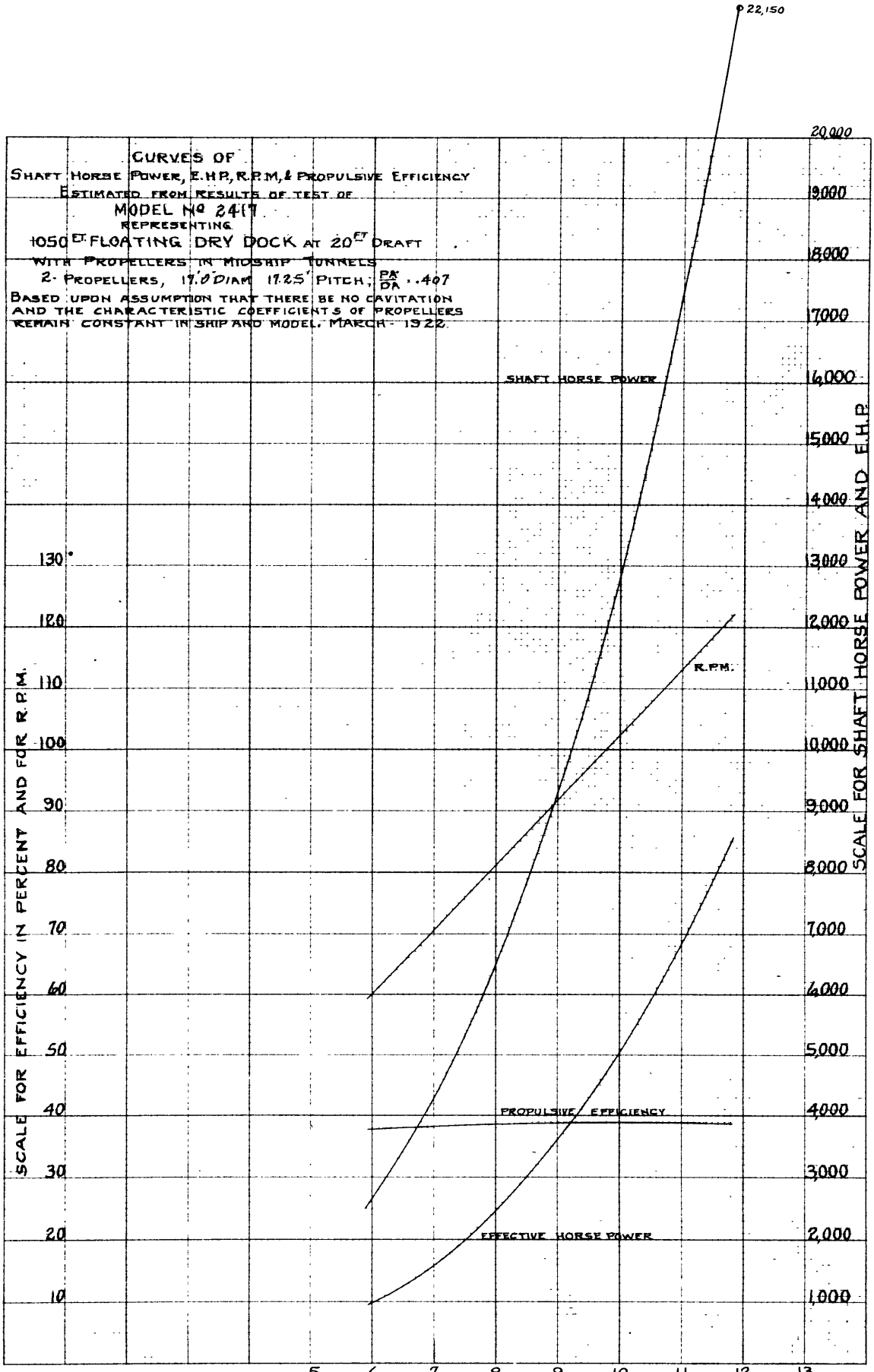
Conditions I, II, III, V, IX and X, were worked up for the full sized dock and the results are shown on Sheets I_s, II_s, III_s, V_s, IX_s, and X_s.


RESULTS OF SELF PROPULSION TESTS
WITH
MODEL Nº 2417
REPRESENTING
1050 FT. FLOATING DRYDOCK AT 15'-0" DRAFT
WITH
PROPELLERS IN MIDSHIP TUNNELS
LINES SUBMITTED BY BU. C. & R.
LENGTH OF MODEL - 30 FT.
DISPLACEMENT 3416 LBS.
LINEAR RATIO 35
PROPELLERS Nº 386 & 387
DATE OF TEST FEB 23, - 1922
U.S. EXPERIMENTAL MODEL BASIN
NAVY YARD WASHINGTON D.C.
THRUST
TORQUE
R.P.M.
RESISTANCE
THRUST DEDUCTION
TRUE SLIP
APPARENT SLIP
PROPULSIVE EFFICIENCY
THRUST DEDUCTION COEFFICIENT
WAKE FRACTION
SCALE FOR TORQUE IN LB. INCHES, THRUST, RESISTANCE & THRUST DEDUCTION IN LBS.
AVERAGE REVOLUTIONS PER MINUTE
SLIP, WAKE FRACTION, THRUST DEDUCTION COEFFICIENT AND EFFICIENCY
SCALE FOR SPEED IN KNOTS
1·0 1·1 1·2 1·3 1·4 1·5 1·6 1·7 1·8 1·9 2·0 2·1
SHEET I

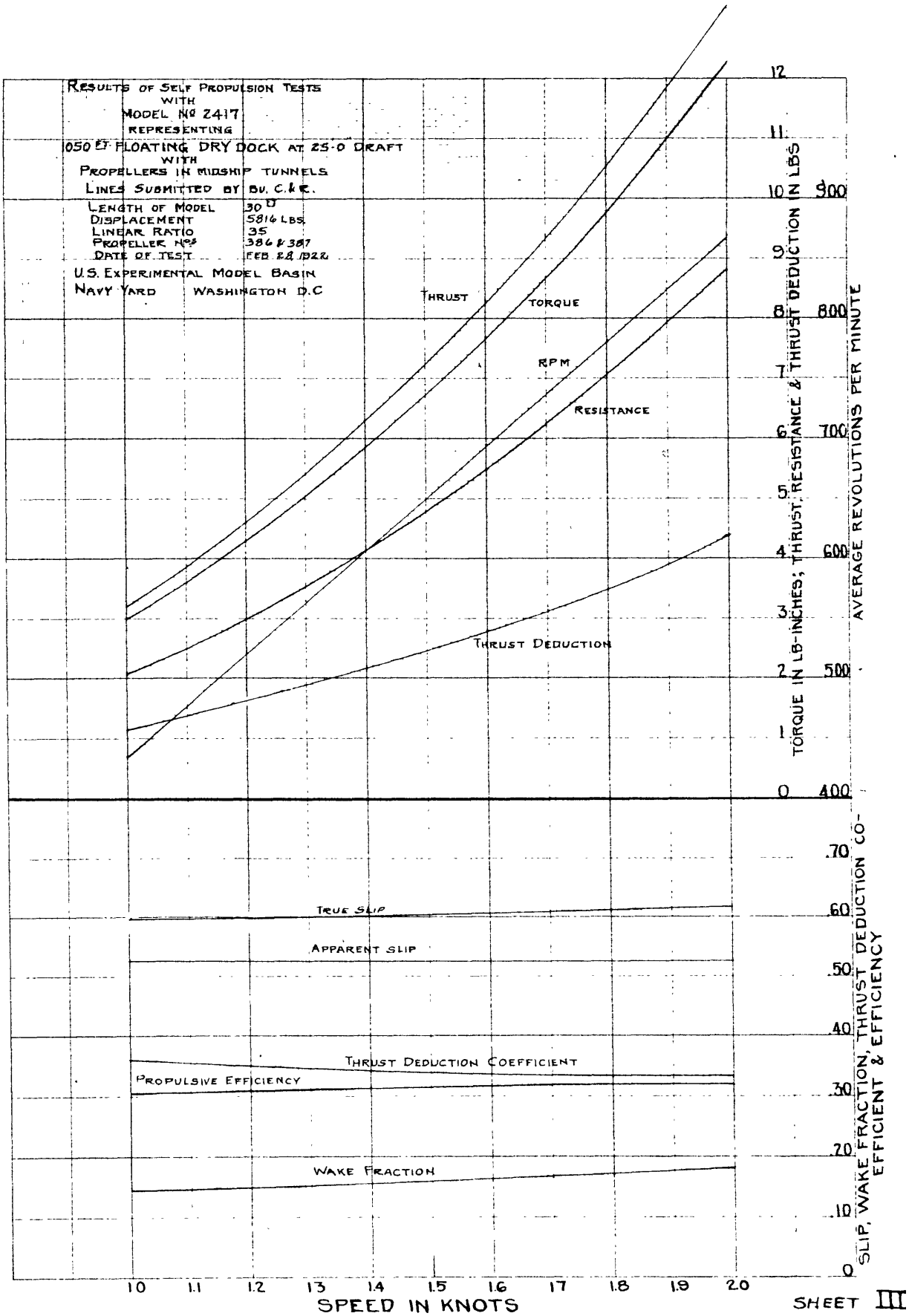

CURVES OF
SHAFT HORSE POWER, E.H.P, R.P.M. & PROPULSIVE EFFICIENCY
ESTIMATED FROM RESULTS OF TEST OF
MODEL Nº 2417
REPRESENTING
1050 FT FLOATING DRY DOCK AT 15 FT DRAFT
WITH PROPELLERS IN MIDSHIP TUNNELS
2 PROPELLERS, 17' DIAM 17.25' PITCH; PA/DA = .407
BASED UPON ASSUMPTION THAT THERE BE NO CAVITATION
AND THE CHARACTERISTIC COEFFICIENTS OF PROPELLERS
REMAIN CONSTANT IN SHIP AND MODEL MARCH 1922
20,480
SHAFT HORSE POWER
R.P.M.
PROPULSIVE EFFICIENCY
EFFECTIVE HORSE POWER
SCALE FOR EFFICIENCY IN PERCENT AND FOR R.P.M.
SCALE FOR SHAFT HORSE POWER AND E.H.P.
SPEED IN KNOTS
SHEET 1s

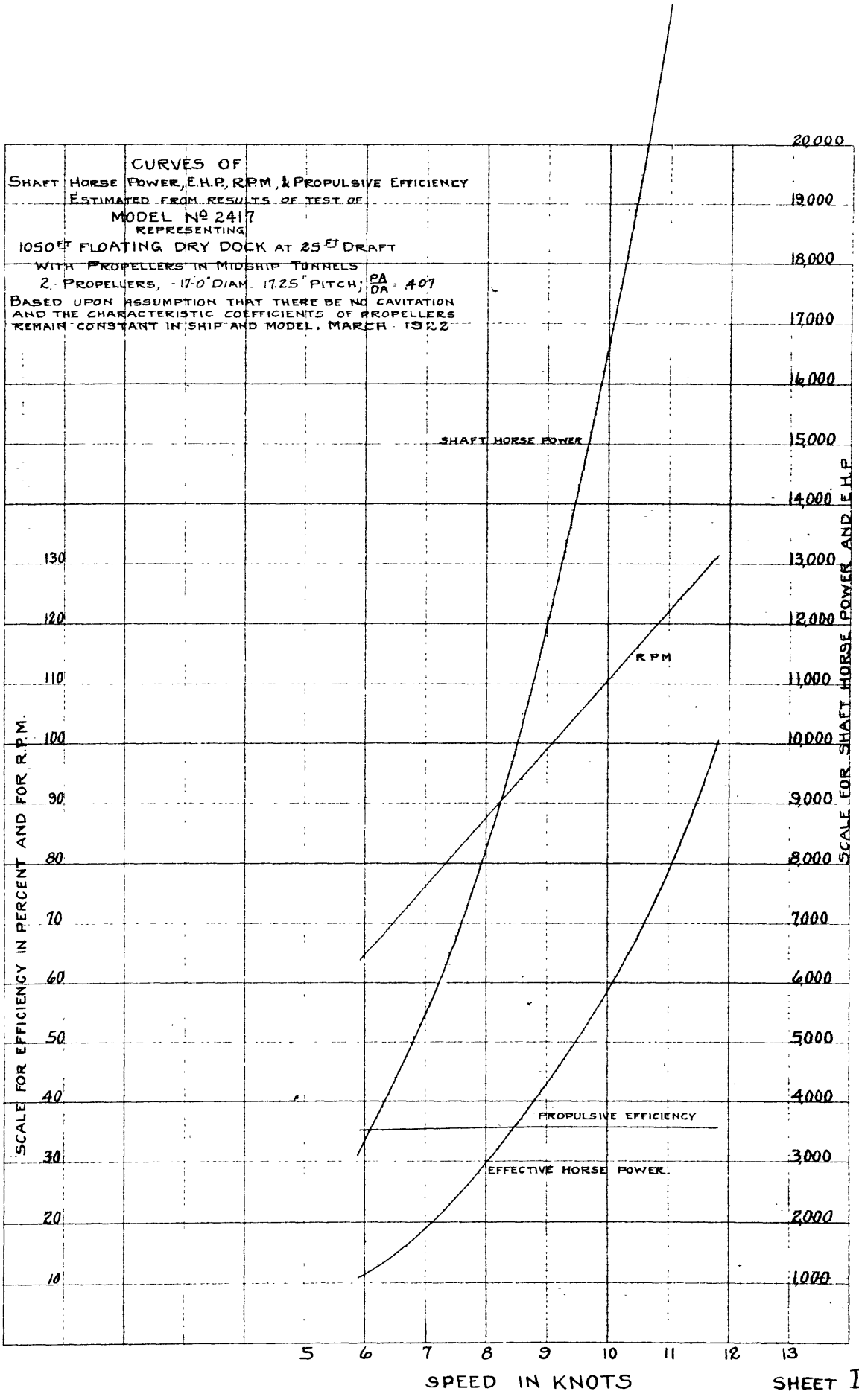

RESULTS OF SELF PROPULSION TESTS
WITH
MODEL No 2417
REPRESENTING
1050 FT FLOATING DRYDOCK AT 30-0 DRAFT
WITH
PROPELLERS IN MIDSHIP TUNNELS
LINES SUBMITTED BY BU. C.& R.
LENGTH OF MODEL 30 FT
DISPLACEMENT 4566 LBS
LINEAR RATIO 35
PROPELLERS Nos 386 & 387
DATE OF TEST FEB 27, 1922
U.S. EXPERIMENTAL MODEL BASIN
NAVY YARD WASHINGTON D.C
THRUST
TORQUE
RPM
RESISTANCE
THRUST DEDUCTION
TRUE SLIP
APPARENT SLIP
THRUST DEDUCTION COEFFICIENT
PROPULSIVE EFFICIENCY
WAKE FRACTION
SCALE FOR TORQUE IN LB.-INCHES, THRUST, RESISTANCE & THRUST DEDUCTION IN LBS
AVERAGE REVOLUTIONS PER MINUTE
SLIP, WAKE FRACTION, THRUST DEDUCTION COEFFICIENT AND EFFICIENCY
SCALE FOR SPEED IN KNOTS.

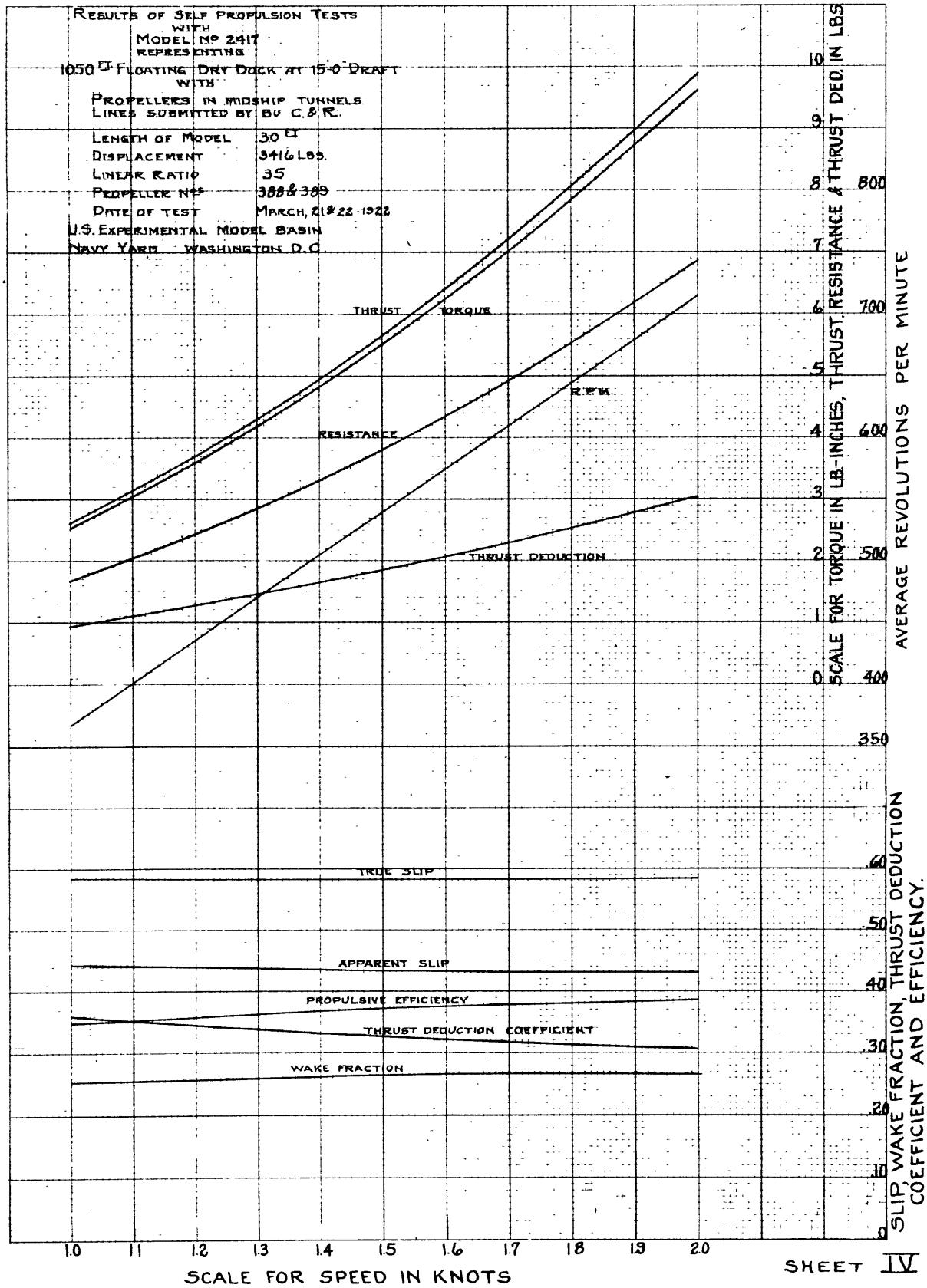
SHEET II

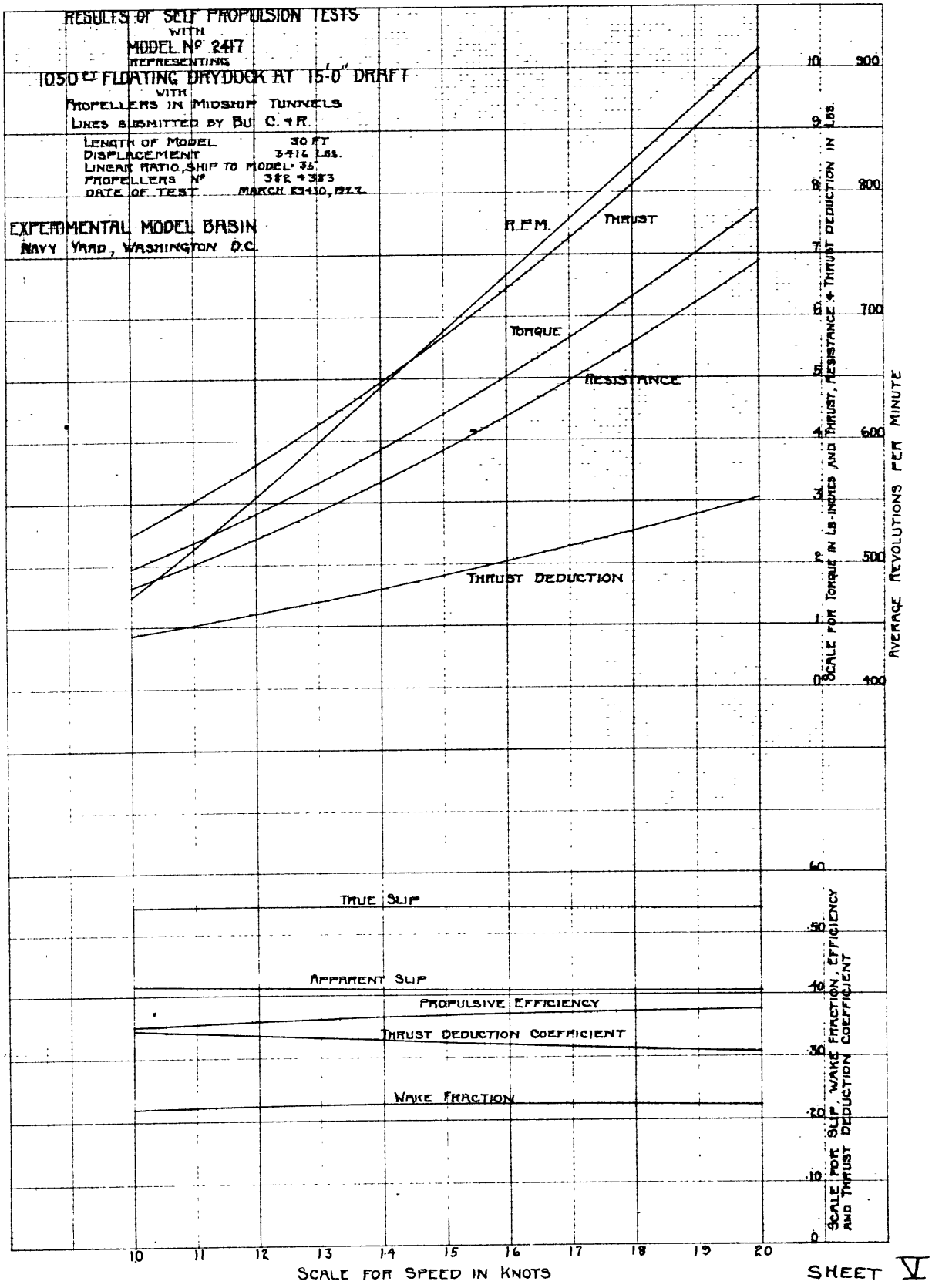

CURVES OF
SHAFT HORSE POWER, E.H.P, R.P.M, & PROPULSIVE EFFICIENCY
ESTIMATED FROM RESULTS OF TEST OF
MODEL Nº 2417
REPRESENTING
1050 FT. FLOATING DRY DOCK AT 20 FT DRAFT
WITH PROPELLERS IN MIDSHIP TUNNELS
2- PROPELLERS, 17.0 DIAM 17.25' PITCH, PA/DA .407
BASED UPON ASSUMPTION THAT THERE BE NO CAVITATION
AND THE CHARACTERISTIC COEFFICIENTS OF PROPELLERS
REMAIN CONSTANT IN SHIP AND MODEL. MARCH - 1922.
22,150
SHAFT HORSE POWER
R.P.M.
PROPULSIVE EFFICIENCY
EFFECTIVE HORSE POWER
SCALE FOR EFFICIENCY IN PERCENT AND FOR R.P.M.
SCALE FOR SHAFT HORSE POWER AND E.H.P.
SPEED IN KNOTS

SHEET 2s

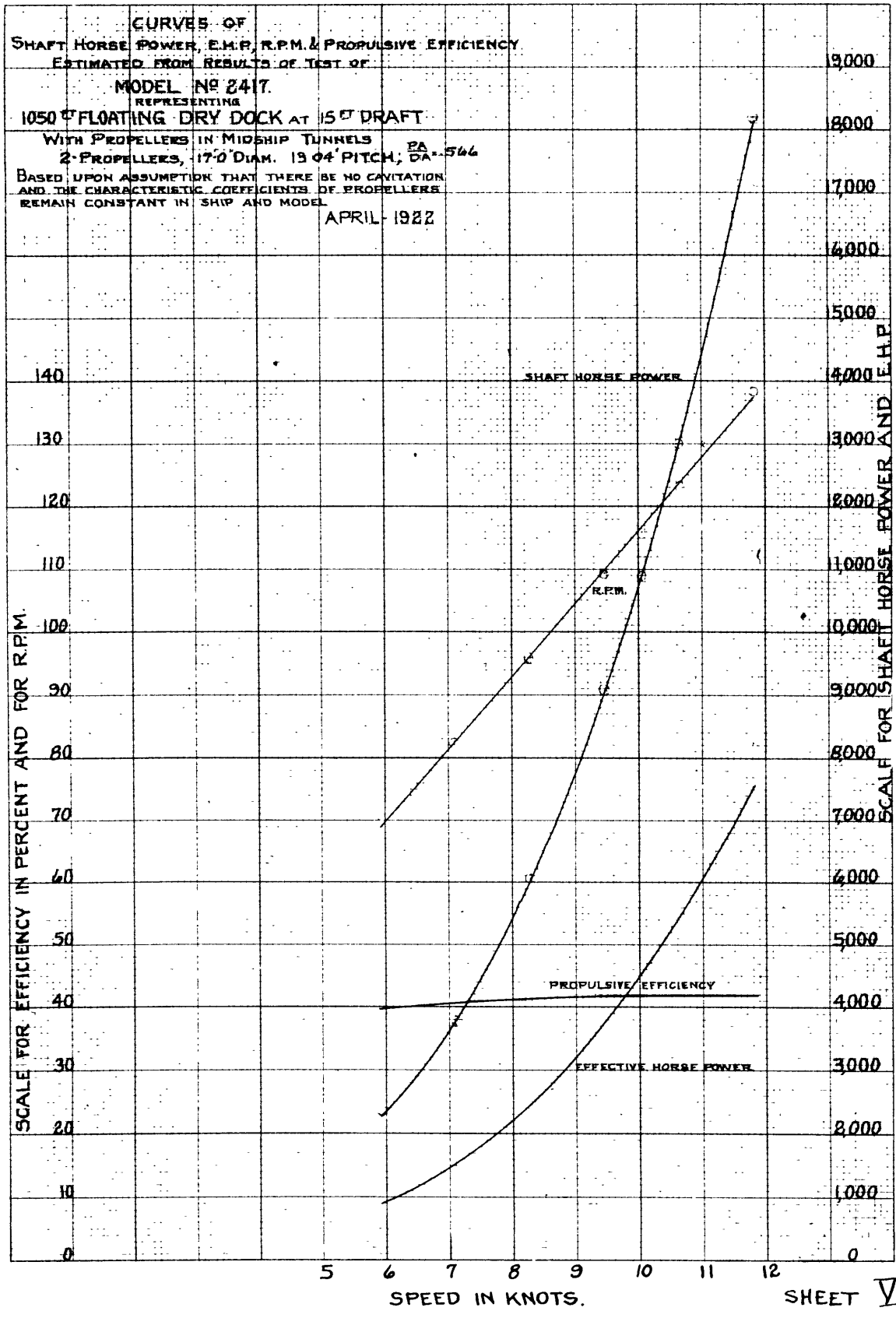

RESULTS OF SELF PROPULSION TESTS
WITH
MODEL No 2417
REPRESENTING
050 ET FLOATING DRY DOCK AT 25-0 DRAFT
WITH
PROPELLERS IN MIDSHIP TUNNELS
LINES SUBMITTED BY BU. C. & R.
LENGTH OF MODEL 30 0
DISPLACEMENT 5816 LBS.
LINEAR RATIO 35
PROPELLER Nos 386 & 387
DATE OF TEST FEB 22 1922
U.S. EXPERIMENTAL MODEL BASIN
NAVY YARD WASHINGTON D.C
THRUST
TORQUE
RPM
RESISTANCE
THRUST DEDUCTION
TORQUE IN LB-INCHES; THRUST, RESISTANCE & THRUST DEDUCTION IN LBS
AVERAGE REVOLUTIONS PER MINUTE
TRUE SLIP
APPARENT SLIP
THRUST DEDUCTION COEFFICIENT
PROPULSIVE EFFICIENCY
WAKE FRACTION
SLIP, WAKE FRACTION, THRUST DEDUCTION CO-EFFICIENT & EFFICIENCY
SPEED IN KNOTS
SHEET III

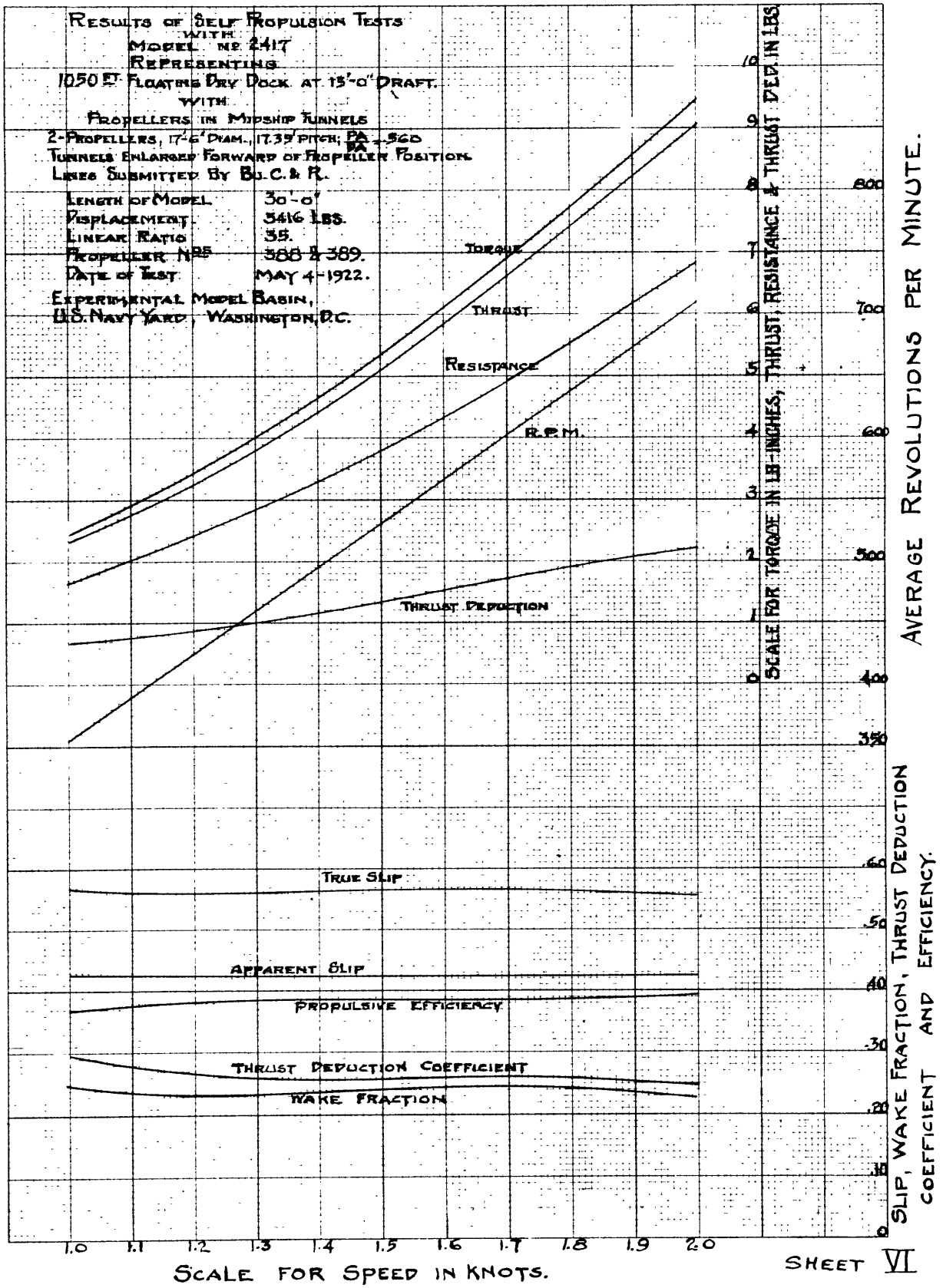

CURVES OF
SHAFT HORSE POWER, E.H.P, R.P.M, & PROPULSIVE EFFICIENCY
ESTIMATED FROM RESULTS OF TEST OF
MODEL Nº 2417
REPRESENTING
1050 FT FLOATING DRY DOCK AT 25 FT DRAFT
WITH PROPELLERS IN MIDSHIP TUNNELS
2 PROPELLERS, 17'0" DIAM. 17.25" PITCH; PA/DA = .407
BASED UPON ASSUMPTION THAT THERE BE NO CAVITATION AND THE CHARACTERISTIC COEFFICIENTS OF PROPELLERS REMAIN CONSTANT IN SHIP AND MODEL. MARCH 1922
SHAFT HORSE POWER
R P M
PROPULSIVE EFFICIENCY
EFFECTIVE HORSE POWER
SCALE FOR EFFICIENCY IN PERCENT AND FOR R.P.M.
SCALE FOR SHAFT HORSE POWER AND E.H.P
SPEED IN KNOTS
SHEET III3


RESULTS OF SELF PROPULSION TESTS
WITH
MODEL No 2417
REPRESENTING
1050 FT FLOATING DRY DOCK AT 15-0 DRAFT
WITH
PROPELLERS IN MIDSHIP TUNNELS.
LINES SUBMITTED BY BU C.&R.
LENGTH OF MODEL 30 FT
DISPLACEMENT 3416 LBS.
LINEAR RATIO 35
PROPELLER Nos 388 & 389
DATE OF TEST MARCH, 21 & 22 1922
U.S. EXPERIMENTAL MODEL BASIN
NAVY YARD, WASHINGTON D.C.
THRUST
TORQUE
R.P.M.
RESISTANCE
THRUST DEDUCTION
TRUE SLIP
APPARENT SLIP
PROPULSIVE EFFICIENCY
THRUST DEDUCTION COEFFICIENT
WAKE FRACTION
SCALE FOR TORQUE IN LB-INCHES, THRUST, RESISTANCE & THRUST DED. IN LBS
AVERAGE REVOLUTIONS PER MINUTE
SLIP, WAKE FRACTION, THRUST DEDUCTION COEFFICIENT AND EFFICIENCY.
SCALE FOR SPEED IN KNOTS
SHEET IV

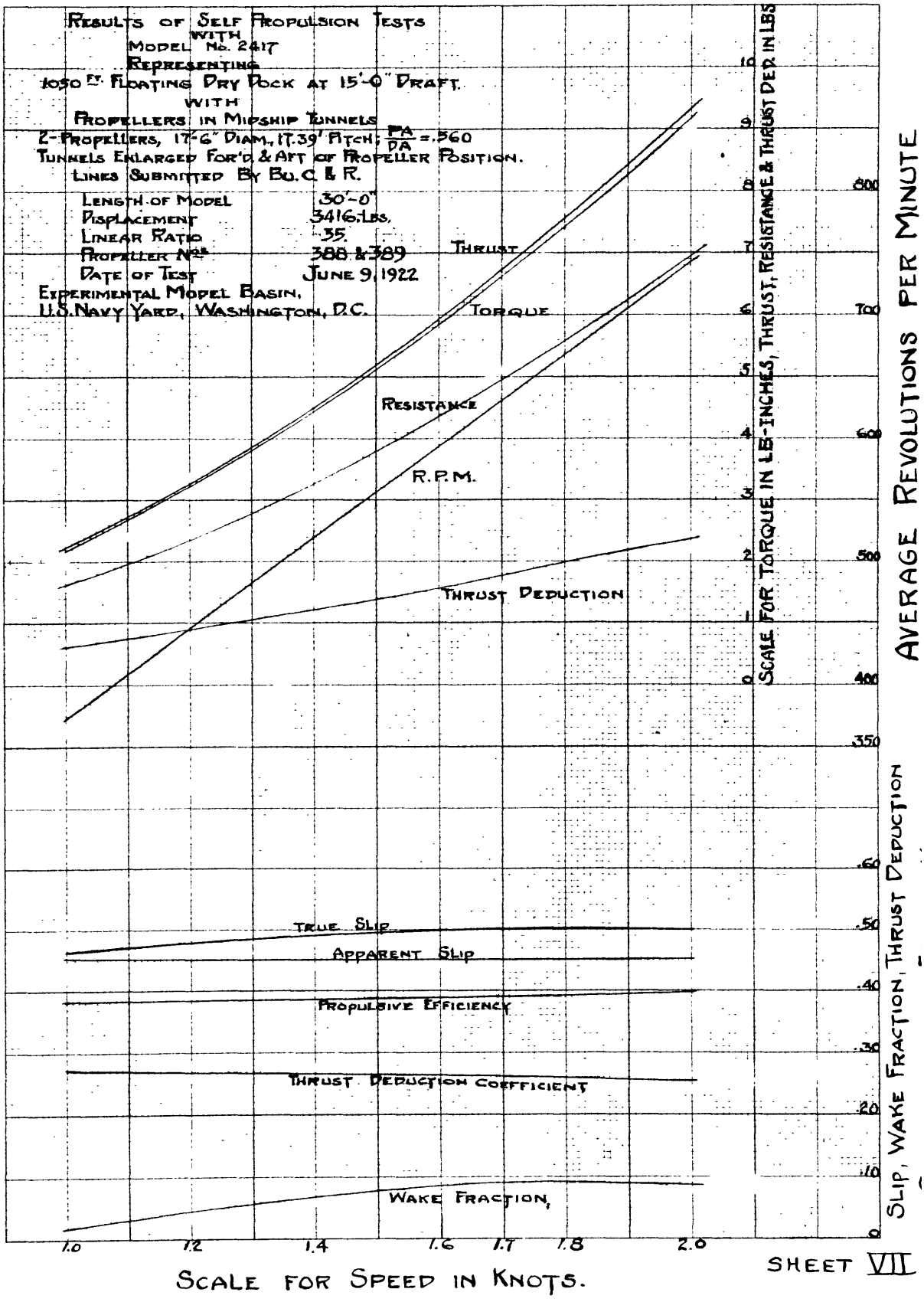

RESULTS OF SELF PROPULSION TESTS
WITH
MODEL Nº 2417
REPRESENTING
1050 FT FLOATING DRYDOCK AT 15'-0" DRAFT
WITH
PROPELLERS IN MIDSHIP TUNNELS
LINES SUBMITTED BY BU C. & R.
LENGTH OF MODEL 30 FT
DISPLACEMENT 3416 LBS.
LINEAR RATIO, SHIP TO MODEL 35
PROPELLERS Nº 3382 & 3383
DATE OF TEST MARCH 23 & 30, 1917.
EXPERIMENTAL MODEL BASIN
NAVY YARD, WASHINGTON D.C.
R.P.M.
THRUST
TORQUE
RESISTANCE
THRUST DEDUCTION
TRUE SLIP
APPARENT SLIP
PROPULSIVE EFFICIENCY
THRUST DEDUCTION COEFFICIENT
WAKE FRACTION
SCALE FOR SPEED IN KNOTS
10 11 12 13 14 15 16 17 18 19 20
SCALE FOR TORQUE IN LB-INCHES AND THRUST, RESISTANCE & THRUST DEDUCTION IN LBS.
0 1 2 3 4 5 6 7 8 9 10
100 200 300 400 500 600 700 800 900 1000
AVERAGE REVOLUTIONS PER MINUTE
SCALE FOR SLIP, WAKE FRACTION, EFFICIENCY AND THRUST DEDUCTION COEFFICIENT
0 10 20 30 40 50 60

SHEET V

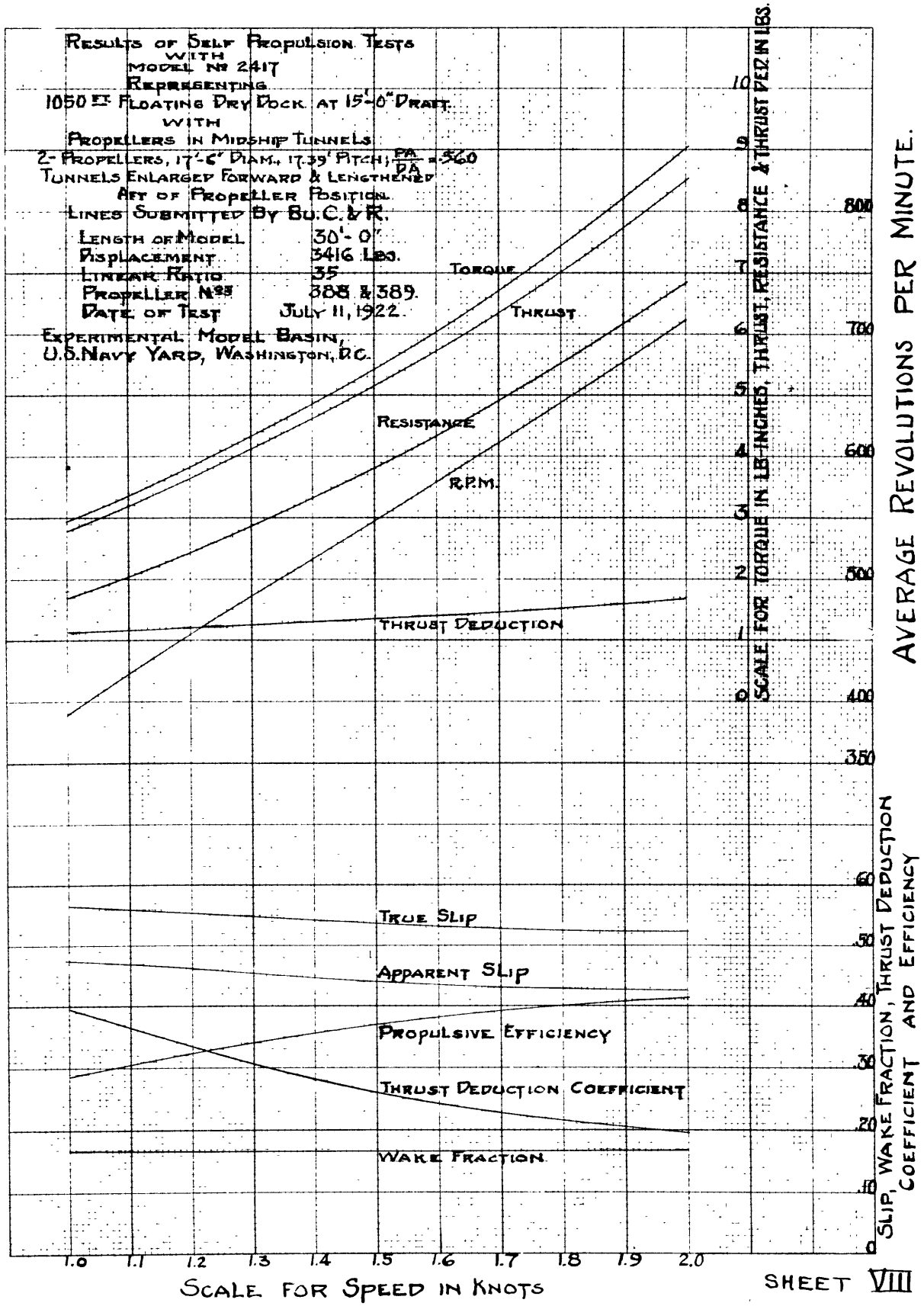

CURVES OF
SHAFT HORSE POWER, E.H.P, R.P.M. & PROPULSIVE EFFICIENCY
ESTIMATED FROM RESULTS OF TEST OF
MODEL Nº 2417.
REPRESENTING
1050 FT FLOATING DRY DOCK AT 15 FT DRAFT
WITH PROPELLERS IN MIDSHIP TUNNELS
2-PROPELLERS, 17'0" DIAM. 19'04" PITCH; PA/DA = .566
BASED UPON ASSUMPTION THAT THERE BE NO CAVITATION AND THE CHARACTERISTIC COEFFICIENTS OF PROPELLERS REMAIN CONSTANT IN SHIP AND MODEL
APRIL - 1922
SHAFT HORSE POWER
R.P.M.
PROPULSIVE EFFICIENCY
EFFECTIVE HORSE POWER
SCALE FOR EFFICIENCY IN PERCENT AND FOR R.P.M.
SCALE FOR SHAFT HORSE POWER AND E.H.P.
SPEED IN KNOTS.
SHEET V S


RESULTS OF SELF PROPULSION TESTS
WITH
MODEL NO. 2417
REPRESENTING
1050 FT. FLOATING DRY DOCK AT 15'-0" DRAFT.
WITH
PROPELLERS IN MIDSHIP TUNNELS
2-PROPELLERS, 17'-6" DIAM., 17.35' PITCH; PA/PA = .560
TUNNELS ENLARGED FORWARD OF PROPELLER POSITION.
LINES SUBMITTED BY BU. C. & R.
LENGTH OF MODEL 30'-0"
DISPLACEMENT 5416 LBS.
LINEAR RATIO 35.
PROPELLER NOS 388 & 389.
DATE OF TEST MAY 4-1922.
EXPERIMENTAL MODEL BASIN,
U.S. NAVY YARD, WASHINGTON, D.C.
TORQUE
THRUST
RESISTANCE
R.P.M.
THRUST DEDUCTION
TRUE SLIP
APPARENT SLIP
PROPULSIVE EFFICIENCY
THRUST DEDUCTION COEFFICIENT
WAKE FRACTION
SCALE FOR TORQUE IN LB.-INCHES, THRUST, RESISTANCE & THRUST DED. IN LBS.
AVERAGE REVOLUTIONS PER MINUTE.
SLIP, WAKE FRACTION, THRUST DEDUCTION COEFFICIENT AND EFFICIENCY.
SCALE FOR SPEED IN KNOTS.
1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
0 1 2 3 4 5 6 7 8 9 10
400 500 600 700 800
.350 .40 .50 .60
.30 .20 .10 0

SHEET VI


RESULTS OF SELF PROPULSION TESTS
WITH
MODEL No. 2417
REPRESENTING
1050 Ft. FLOATING DRY DOCK AT 15'-0" DRAFT.
WITH
PROPELLERS IN MIDSHIP TUNNELS
2-PROPELLERS, 17'-6" DIAM., 17.39' PITCH; PA/DA = .560
TUNNELS ENLARGED FOR'D & AFT OF PROPELLER POSITION.
LINES SUBMITTED BY BU. C & R.
LENGTH OF MODEL 30'-0"
DISPLACEMENT 3416 LBS.
LINEAR RATIO 35.
PROPELLER Nos 388 & 389
DATE OF TEST JUNE 9, 1922
EXPERIMENTAL MODEL BASIN,
U.S. NAVY YARD, WASHINGTON, D.C.
THRUST
TORQUE
RESISTANCE
R.P.M.
THRUST DEDUCTION
TRUE SLIP
APPARENT SLIP
PROPULSIVE EFFICIENCY
THRUST DEDUCTION COEFFICIENT
WAKE FRACTION,
SCALE FOR TORQUE IN LB-INCHES, THRUST, RESISTANCE & THRUST DED. IN LBS
AVERAGE REVOLUTIONS PER MINUTE
SLIP, WAKE FRACTION, THRUST DEDUCTION
1.0
1.2
1.4
1.6
1.7
1.8
2.0
SCALE FOR SPEED IN KNOTS.

SHEET VII


RESULTS OF SELF PROPULSION TESTS
WITH
MODEL Nº 2417
REPRESENTING
1050 Ft FLOATING DRY DOCK AT 15'-0" DRAFT.
WITH
PROPELLERS IN MIDSHIP TUNNELS
2- PROPELLERS, 17'-6" DIAM., 17.39' PITCH; PA/PA = .560
TUNNELS ENLARGED FORWARD & LENGTHENED
AFT OF PROPELLER POSITION.
LINES SUBMITTED BY BU. C. & R.
LENGTH OF MODEL 30'-0"
DISPLACEMENT 3416 Lbs.
LINEAR RATIO 35
PROPELLER Nºs 388 & 389.
DATE OF TEST JULY 11, 1922.
EXPERIMENTAL MODEL BASIN,
U.S. NAVY YARD, WASHINGTON, D.C.
TORQUE
THRUST
RESISTANCE
R.P.M.
THRUST DEDUCTION
TRUE SLIP
APPARENT SLIP
PROPULSIVE EFFICIENCY
THRUST DEDUCTION COEFFICIENT
WAKE FRACTION
SCALE FOR TORQUE IN LB-INCHES, THRUST, RESISTANCE & THRUST HP IN LBS.
AVERAGE REVOLUTIONS PER MINUTE.
SLIP, WAKE FRACTION, THRUST DEDUCTION COEFFICIENT AND EFFICIENCY
SCALE FOR SPEED IN KNOTS
SHEET VIII

RESULTS OF SELF PROPULSION TEST
WITH
MODEL No. 2417
REPRESENTING
1050 FT FLOATING DRYDOCK AT 15 FT DRAFT
WITH
PROPELLERS IN MIDSHIP TUNNELS.*
2 PROPELLERS - 19.54 FT DIAM., 20.32 FT PITCH

LENGTH OF MODEL	30 FT
DISPLACEMENT	3416 LBS
LINEAR RATIO	35
PROPELLERS Nos	412 & 413
DATE OF TEST	DEC 6, 1922

U.S. EXPERIMENTAL MODEL BASIN
NAVY YARD, WASHINGTON, D.C.

*TUNNELS ENLARGED TO TAKE LARGER PROPELLERS.
TUNNELS BELL SHAPED FORD. OF PROPELLERS AND STRAIGHT SIDED ABAFT PROPELLERS.
ENTRANCE OF TUNNEL ONE-HALF THE LENGTH OF THE RUN.

TORQUE
THRUST
RESISTANCE
R.P.M.
THRUST DEDUCTION
TRUE SLIP
APPARENT SLIP
PROPULSIVE EFFICIENCY
THRUST DEDUCTION COEFFICIENT
WAKE FRACTION

700
600
500
400
300

12
11
10
9
8
7
6
5
4
3
2
1
0

.60
.50
.40
.30
.20
.10
0

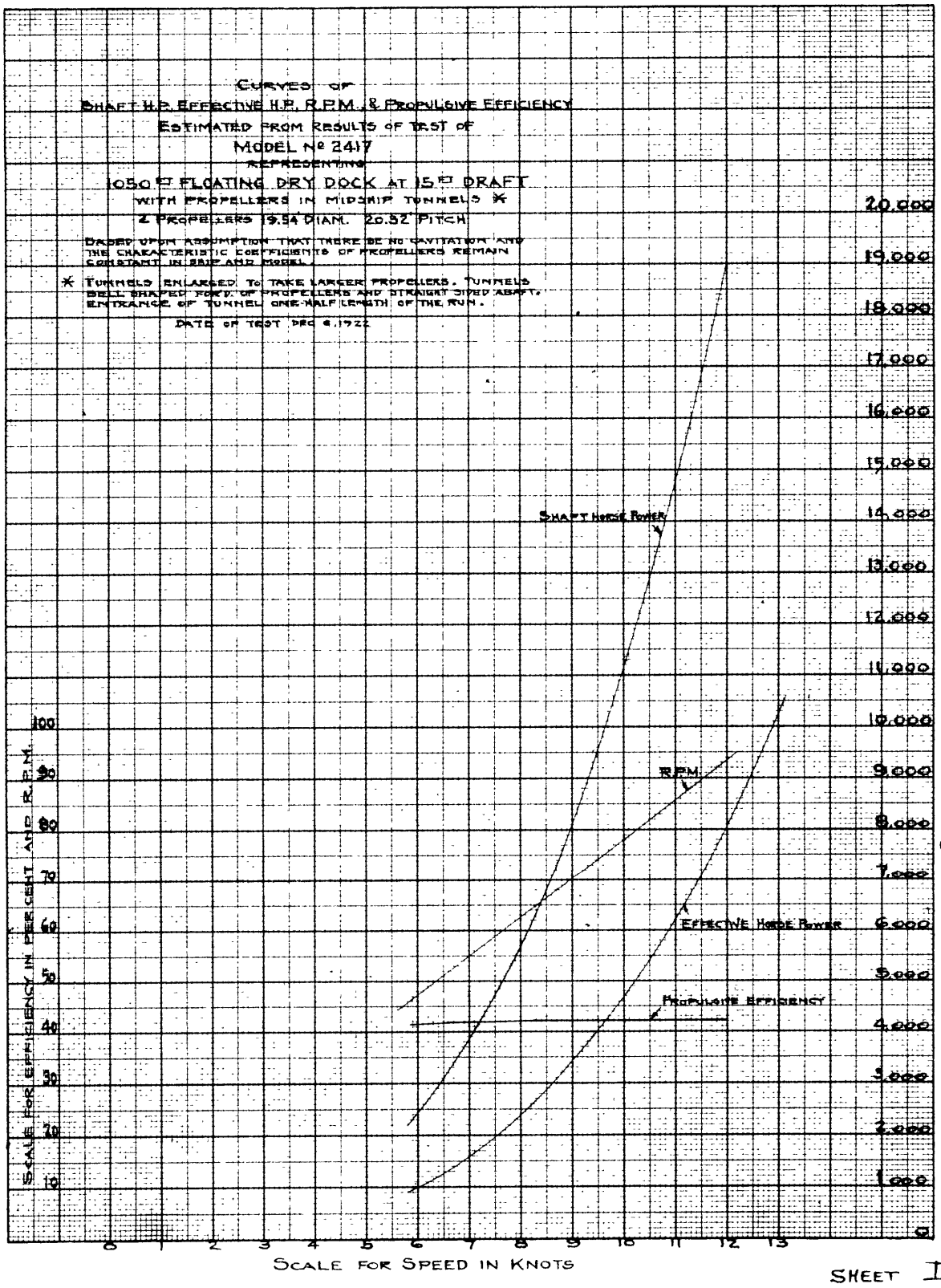
1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0

SPEED IN KNOTS

TORQUE IN IN-LBS, RESISTANCE, THRUST, AND THRUST DEDUCTION IN LBS.

SLIP, WAKE FRACTION, THRUST DEDUCTION COEFFICIENT, AND EFFICIENCY.

SHEET IX


CURVES OF
SHAFT H.P. EFFECTIVE H.P. R.P.M. & PROPULSIVE EFFICIENCY
ESTIMATED FROM RESULTS OF TEST OF
MODEL Nº 2417
REPRESENTING
1050 FT FLOATING DRY DOCK AT 15 FT DRAFT
WITH PROPELLERS IN MIDSHIP TUNNELS *
2 PROPELLERS 19.54 DIAM. 20.52 PITCH
BASED UPON ASSUMPTION THAT THERE BE NO CAVITATION AND THE CHARACTERISTIC COEFFICIENTS OF PROPELLERS REMAIN CONSTANT IN SHIP AND MODEL
* TUNNELS ENLARGED TO TAKE LARGER PROPELLERS. TUNNELS BELL SHAPED FORE OF PROPELLERS AND STRAIGHT SIDED ABAFT. ENTRANCE OF TUNNEL ONE-HALF LENGTH OF THE RUN.
DATE OF TEST DEC 6.1922
SHAFT HORSE POWER
R.P.M.
EFFECTIVE HORSE POWER
PROPULSIVE EFFICIENCY
SCALE FOR EFFICIENCY IN PERCENT AND R.P.M.
SCALE FOR HORSE POWER
SCALE FOR SPEED IN KNOTS

SHEET IX S

RESULTS OF SELF PROPULSION TEST

WITH MODEL Nº 2417

REPRESENTING

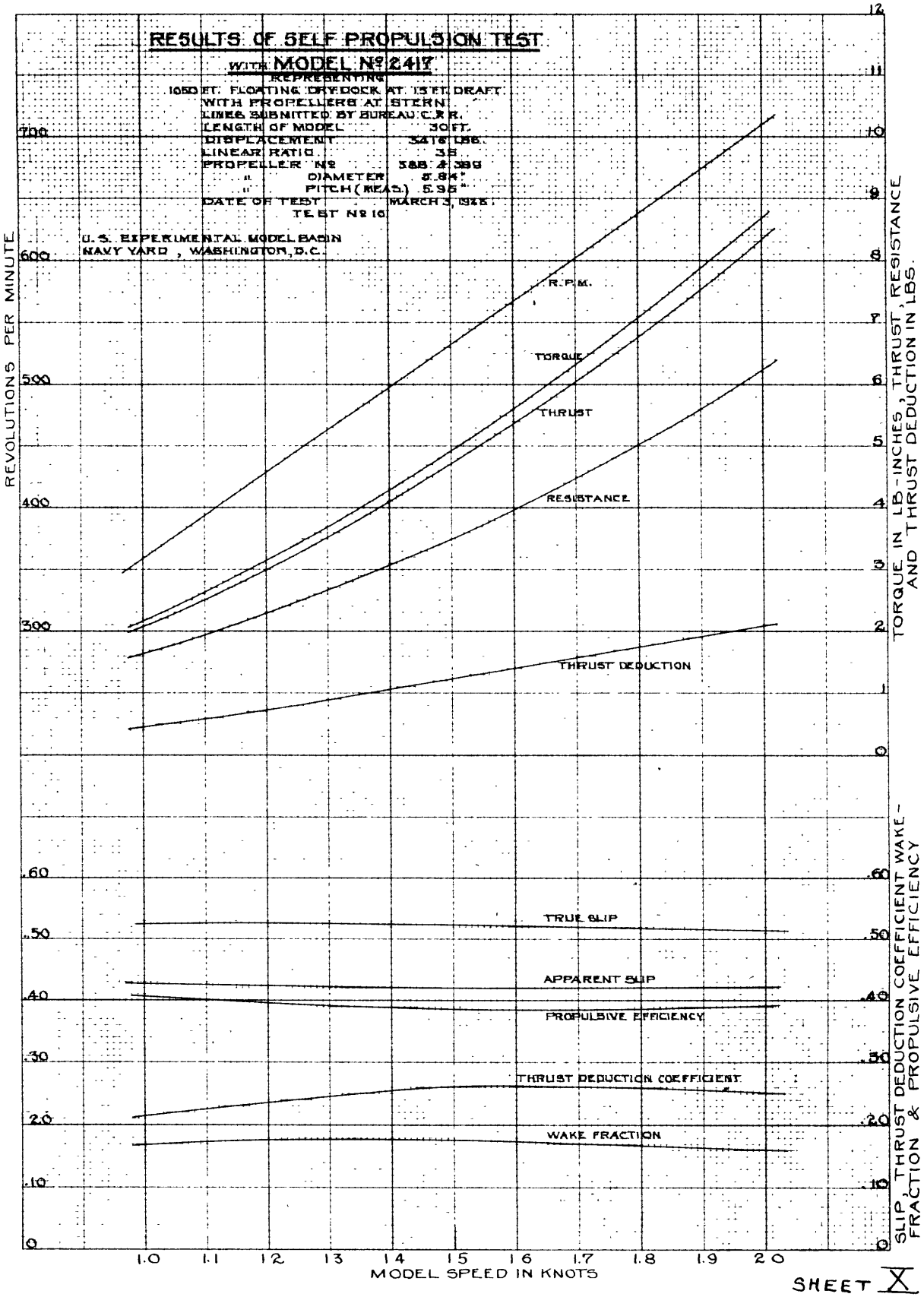
1050 FT. FLOATING DRYDOCK AT 15 FT. DRAFT

WITH PROPELLERS AT STERN

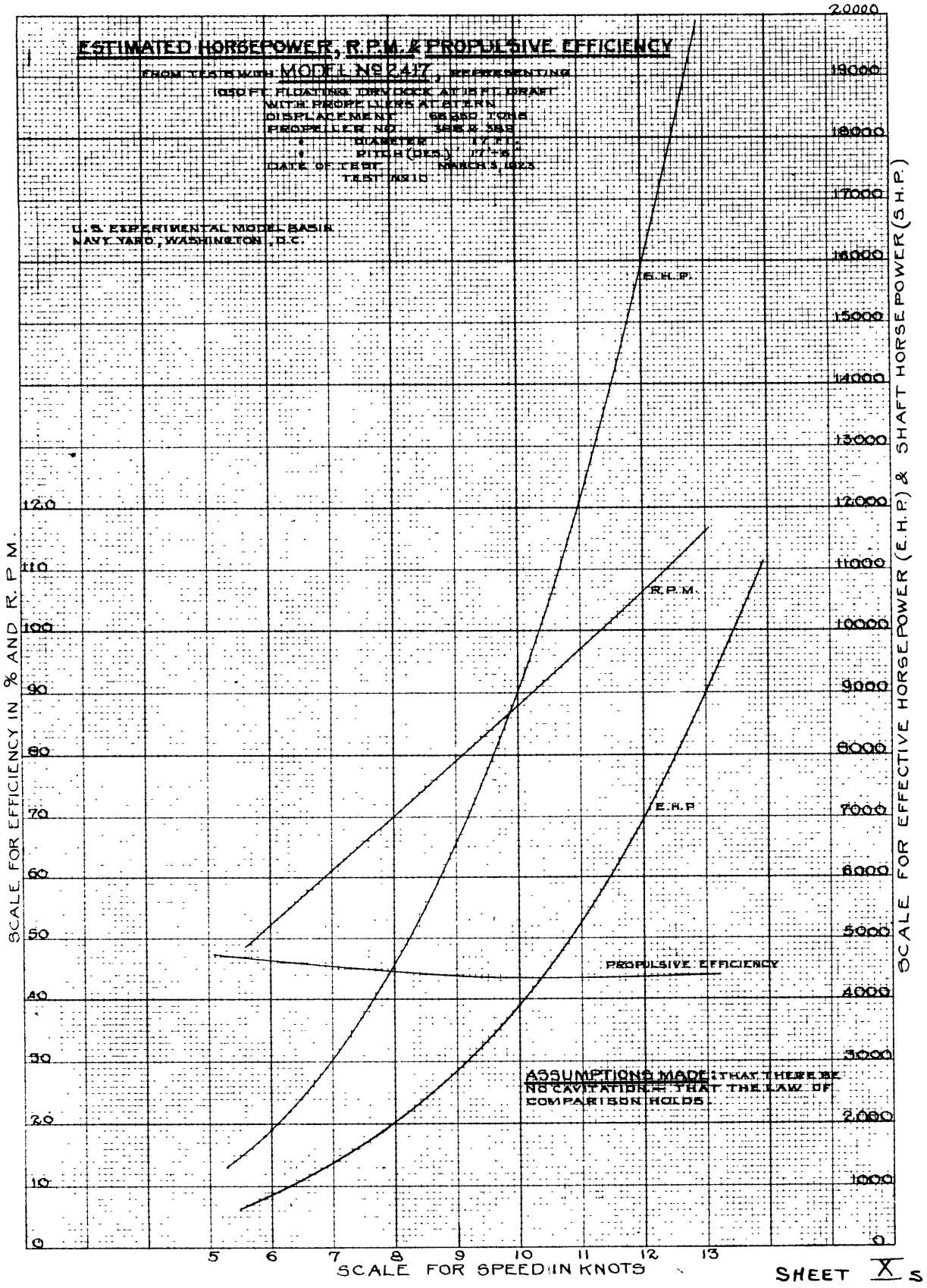
LINES SUBMITTED BY BUREAU C.& R.

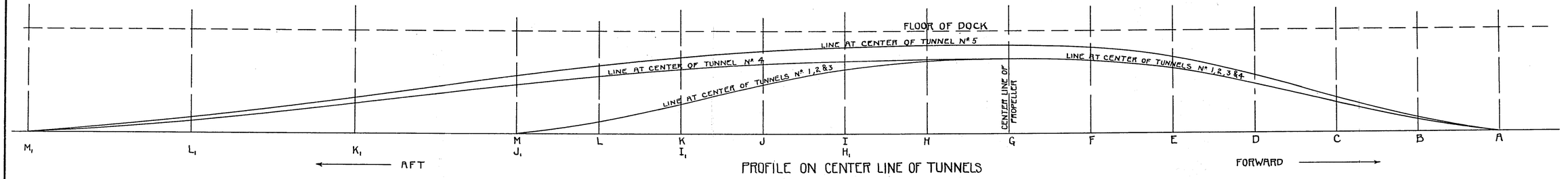
LENGTH OF MODEL	30 FT.
DISPLACEMENT	3416 LBS.
LINEAR RATIO	35
PROPELLER Nº	388 & 389
" DIAMETER	5.84"
" PITCH (MEAS.)	5.95"
DATE OF TEST	MARCH 3, 1925.
TEST Nº 16	

U. S. EXPERIMENTAL MODEL BASIN
NAVY YARD, WASHINGTON, D.C.

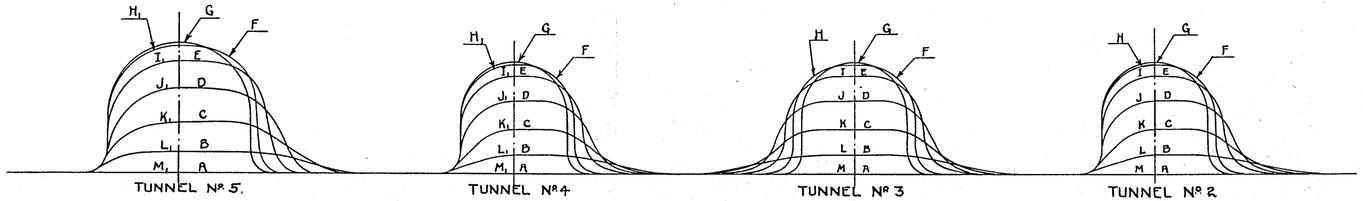


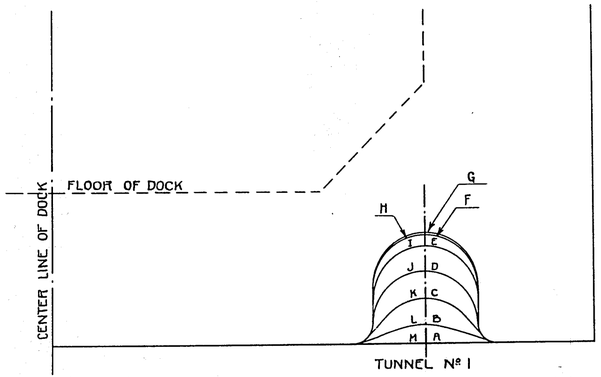
SHEET X


ESTIMATED HORSEPOWER, R.P.M. & PROPULSIVE EFFICIENCY
FROM TESTS WITH MODEL No 2417, REPRESENTING
1050 FT. FLOATING DRYDOCK AT 18 FT. DRAFT
WITH PROPELLERS AT STERN
DISPLACEMENT 68380 TONS
PROPELLER NO. 388 & 389
DIAMETER 17 FT.
PITCH (DES.) 17'-6"
DATE OF TEST MARCH 3, 1923
TEST No 10
U.S. EXPERIMENTAL MODEL BASIN
NAVY YARD, WASHINGTON, D.C.
E.H.P.
R.P.M.
E.H.P
PROPULSIVE EFFICIENCY
ASSUMPTIONS MADE: THAT THERE BE NO CAVITATION. THAT THE LAW OF COMPARISON HOLDS.
SCALE FOR EFFICIENCY IN % AND R.P.M.
SCALE FOR EFFECTIVE HORSEPOWER (E.H.P.) & SHAFT HORSE POWER (S.H.P.)
SCALE FOR SPEED IN KNOTS
SHEET X



PROFILE ON CENTER LINE OF TUNNELS





PROPELLER TUNNELS
FOR
FLOATING DRY DOCK
SCALE $\frac{1}{16}$ INCH = 1 FOOT