SELF-PROPELLED MODEL TESTS WITH MISSISSIPPI RIVER TOWBOATS AND BARGES

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The model tests described in this report were carried out in the U.S. Experimental Model Basin in April, 1928 for the Vesta Coal Company of Pittsburgh, Pennsylvania.

The object of the tests was to determine the relative power consumption and manoeuvering ability of proposed river towboats when pushing a fleet of barges.

The models were made of wood in the ratio ship to model of 12 : 1. All tests were carried out in 12 inches depth of water, corresponding to 12 feet for the ship. The fleet of barges pushed by the towboat was the same for all tests, namely, 11 barges lashed together 4 in tandem and 3 abreast, respectively two abreast for the last row. The barges had the following dimensions:

Length 132 feet
Breadth 35 feet
Draft 7 feet

Three different towboats were tested differing principally in the shape of the stern, the arrangement of the rudders and the number of propellers. Also alterations were made in the shape of the propeller tunnels and the length and location of the rudders as the tests progressed.

For purposes of identification the three towboats were named: "Three Screw Elsey", "Three Screw Ward-Elsey", and "Twin Screw Ward-Elsey". The eight appended photographs, figures 127-134, show the stern - halves of these three models and also the whole fleet under the towing carriage in testing position.

The tests carried out can be divided into two main classes, viz., power tests in which the propeller power, revolutions and the side thrust exerted on the stern of the model by the rudders were measured, and manoeuvering tests in which no forces were measured but successive positions of the tow, varying with time, was determined photographically. The first class can be subdivided into the four groups, denoted by the small letters a, b, c, d.

Group(a) The tow going ahead, with the rudders on the center.

(b) The tow going astern with the rudders on the center line.

(c) The tow going ahead with the rudders 40° to port.

(d) The tow going astern with the rudders 40° to starboard.

The manoeuvering tests can be divided into the following groups:

Group(a) Flanking tests, all propellers astern and all rudders at 40 degrees.

(b) Flanking tests, two propellers astern, one dead and all rudders at 40 degrees.

(c) Flanking tests, one propeller astern, two dead and all rudders at 40 degrees.

(d) Flanking tests, all propellers astern, after rudders straight and forward rudders at 40 degrees.

(e) Throwing front end of tow out by all propellers astern, all rudders at 40 degrees and flanking about corner of rear barge against a stationary fleet.

(f) Stopping side wise motion of fleet due to cross current by flanking. All propellers astern, all rudders at 40 degrees.

(g) Flanking tests, one respectively two propellers astern, one propeller ahead. Forward rudders 40 degrees to one side and after rudders 40 degrees to the opposite side.

(h) Flanking tests with towboat run up into fleet between the two side barges.

Other letters have been adopted for single or extraneous runs. The following list is a compendium of all the tests made together with the identification letters and the serial figure number.

POWER TESTS.

MODELS Nos. 2825, 2826, 2826-A.

	Figure No.
Group I - Elsey Stern without skegs	
A. Sealed stern - Common Tunnel.	
(a) Going ahead, rudders o degrees	1
(b) Going astern, rudders o degrees	2

POWER TESTS (continued)

MODELS Nos. 2825, 2826, 2826-A.

	Figure No.
Group I - Elsey stern without skegs	
A. Sealed stern - Common tunnel	
(c) Going ahead, rudders, 40 degrees	3
(d) Going astern, rudders, 40 degrees	4
B. Open Stern - Common tunnel	
(a) Going ahead, rudders o degrees	5
Group II- Elsey Stern with skegs	
A. Sealed Stern - Common tunnel	
s - Short skegs	
(c) Going ahead, rudders 40 degrees	6
(d) Going astern, rudders 40 degrees	7
l - Long skegs	
(c) Going ahead, rudders 40 degrees	6
(d) Going astern, rudders 40 degrees	7
C. Sealed stern - Individual tunnels	
s - Short skegs	
(a) Going ahead, rudders o degrees	8
(b) Going astern, rudders o degrees	9
(c) Going ahead, rudders 40 degrees	10
(d) Going astern, rudders 40 degrees	11
C_2. Stern "C" with deflector blocks	
s - Short skegs	
(c) Going ahead, forward rudders 37-1/2 after rudders 40 degrees	12
(d) Going astern, forward rudders 37-1/2 after rudders 40 degrees	13
Group III - Ward-Elsey triple screw stern	
A. Individual tunnels	
(a) Going ahead rudders o degrees	14
(b) Going astern rudders o degrees	15
(c) Going ahead rudders 40 degrees	16
(d) Going astern rudders 40 degrees	17

Figure No.

Group III_2 - Ward-Elsey triple Screw Stern. Forward rudders lengthened and fitted with shoes

A. Individual tunnels
(c) Going ahead, forward rudders 42 degrees, after rudders 40 degrees 18
(d) Going astern, forward rudders 42 degrees, after rudders 40 degrees 19
(a-light) Barges light displacement 20

Group IV - Ward-Elsey twin screw stern

A. Individual tunnels
(a) Going ahead, rudders o degrees 21
(b) Going astern, rudders o degrees 22
(c) Going ahead, rudders 40 degrees 23
(d) Going astern, rudders 40 degrees 24

Effective Horsepower curves of barges without towboat, light and heavy displacements 25

MANOEUVERING TESTS.

Figures 26 to 126 give the results of manoeuvering tests reduced from the photographic plates taken from above the fleet. The data are given as curves of change of heading or azimuth plotted on time and coordinates of position of the after starboard corner of the barge nearest to the tug from which the fleet position can always be obtained.

Group I - Triple screw Elsey stern — Figure No.

A. Sealed stern, common tunnel
(a) Flanking test; all rudders 40° to port, all propellers astern; voltage 90. 26
(a) Similar to conditions on figure 26 except 80 volts on dynamometers 27
(a) Repeat of figure 27 same voltage 28
(a) Similar conditions on figure 26 except 70 volts on dynamometers 29
(a) Similar to conditions on figure 26 except 60 volts on dynamometers 30

Group II - Triple screw Elsey stern with skegs — Figure No.

A. Sealed stern - common tunnel

s - Short skegs

(a) Flanking test; all rudders 40° to port, all propellers astern; voltage 60 — 31

(a) Conditions similar to figure 31 except voltage 70 — 32

(a) Conditions similar to figure 31 except voltage is 80 — 33

(a) Conditions similar to figure 31 except voltage is 50 — 34

(d) Flanking test — 35
Forward rudders 40° to port
After rudders 0°
All propellers astern, voltage 50

(d) Similar to figure 35 except 70 volts on dynamometers — 36

(d) Similar to figure 35 except 90 volts on dynamometers — 37

(e) Throwing the bow out - All rudders 40° degrees to starboard; all propellers astern, voltage 70 — 38

(e) Same as figure 38 except voltage is 80 — 39

(f) Push out and check test; All rudders 40° to starboard, all propellers astern voltage 70 — 40

(g) Flanking test - — 41
Starboard propellers ahead; port and center propeller astern
Forward rudders 40° to port
After rudders 40° to starboard
Voltage 70

l - Long skegs

(a) Flanking test — 42
All rudders 40° to port
All propellers astern
Voltage 60

Figure No.

Group II - Triple screw Elsey stern with skegs (continued

A. Sealed Stern - common tunnel

1 - Long skegs

(a) Same as figure 42 except voltage is 70 — 43

(a) Same as figure 42 except voltage is 80 — 44

A[1]. Seal increased so that top flat of common tunnel is on water line

s = short skegs

(a) Flanking tests
All rudders 40° to port
All propellers astern
Voltage 50 — 45

(a) Same as figure 45 except voltage is 60 — 46

(a) Same as figure 45 except voltage is 70 — 47

(b) Flanking test
All rudders 40° to port
Port and center propellers astern
Starboard propeller dead
Voltage 70 — 48

(c) Flanking test
Center and starboard propellers dead
Port propeller astern
All rudders 40° to port
Voltage 70 — 49

(c[1]) Flanking test
Center and port propellers dead
Starboard propeller astern
All rudders 40° to port
Voltage 70 — 50

(d) Flanking test
Forward rudders 40° to port
After rudders set at 0 degrees
All propellers astern
Voltage 70 — 51

(e) Throwing the head out
All rudders 40 degrees to starboard
All propellers astern
Voltage 70 — 52

(f) Stern pushed out and checked
All rudders 40 degrees to starboard
All propellers astern
Voltage 70 — 53

Group II - A^1 continued. Figure No.

(f) Same as figure 53 54

(g) Flanking test 55
Port and center propellers astern
Starboard propellers ahead
Forward rudders 40 degrees to port
After rudders 40 degrees to starboard
Voltage 70

(g^1) Flanking test
Starboard and center propellers astern 56
Port propeller ahead
Forward rudders 40 degrees to port
After rudders 40 degrees to starboard
Voltage 70

(h) Flanking test - towboat up between rear barges.
All rudders 40 degrees to port 57
All propellers astern
Voltage 70

(k) Going straight astern 58
All rudders 0 degrees
All propellers astern
Voltage 70

(k^1) Going straight ahead 59
All rudders 0 degrees
All propellers ahead
Voltage 70

(m) Flanking test - model moved from position at end of test indicated on figure 56 back to bank. 60

B. - Open stern - common tunnel

(a) Flanking test 61
All rudders 40 degrees to port
All propellers astern
Voltage 60

C. - Sealed stern - Individual tunnels
(s- Short skegs

(a) Flanking test
Forward rudders 37-1/2 degrees to port 62
After rudders 40 degrees to port
All propellers astern
Voltage 70

Group III - C. (continued) Figure No.

(b[1]) Flanking test
Forward rudders 37-1/2 degrees to port 63
After rudders 40 degrees to port
Port propeller dead, Starboard and center astern
Voltage 70

(c) Flanking test
Forward rudders 37-1/2 degrees to port 64
After rudders 40 degrees to port
Port and center propellers dead, starboard astern
Voltage 70

(d) Flanking test
Forward rudders 37-1/2 degrees to port 65
After rudders 0 degrees
All propellers astern
Voltage 70

(e) Bow pushed out
Forward rudders 37-1/2 degrees to starboard
After rudders 40 degrees to starboard 66
All propellers astern
Voltage 70

(f) Push out and checked 67
Forward rudders 37-1/2 degrees to starboard
After rudders 40 degrees to starboard
All propellers astern
Voltage 70

(g) Flanking test
Forward rudders 37-1/2 degrees to port 68
After rudders 40 degrees to starboard
Port propellers ahead
Center and starboard propellers astern
Voltage 70

(h) Flanking test
Forward rudders 37-1/2 degrees to port 69
After rudders 40 degrees to port
All propellers astern
Voltage 70

C_2. - Stern "C" with 20 degrees deflection blocks

s = short skegs

(a) Flanking test 70
Forward rudders set 37-1/2 degrees to port
After rudders set 40 degrees to port
All propellers astern
Voltage 70

Group III - C_2 (continued) Figure No.

(b) Flanking test
Forward rudders 37-1/2 degrees to port 71
After rudders 40 degrees to port
Center and port propellers astern
Starboard propeller dead

(b^1) Flanking test 72
Forward rudders 37-1/2 degrees to port
After rudders 40 degrees to port
Center and starboard propellers astern
Port propeller dead
Voltage 70

(c) Flanking test
Forward rudders 37-1/2 degrees to port 73
After rudders 40 degrees to port
Center and port propellers dead
Starboard engine astern
Voltage 70

(c^1) Flanking test
Forward rudders 37-1/2 degrees to port 74
After rudders 40 degrees to port
Port and starboard propellers dead
Center propeller astern
Voltage 70

(e) Pivoting about starboard quarter
Forward rudders 37-1/2 degrees to starboard 75
After rudders 40 degrees to starboard
All propellers astern
Voltage 70

(f) Push out and check test
Forward rudders 37-1/2 degrees starboard 76
After rudders 40 degrees to starboard
All propellers astern
Voltage 70

(g) Flanking Test
Forward rudders 37-1/2 degrees to port 77
After rudders 40 degrees to starboard
Center and starboard propellers astern
Port propeller ahead
Voltage 70

Group III - C_2 -(continued) Figure No.

(h) Flanking test - towboat moved up between barges.
Forward rudders 37-1/2 degrees to port 78
After rudders 40 degrees to port
All propellers astern
Voltage 70

(i) Tunnels covered over - no deflection blocks
Forward rudders 37-1/2 degrees to port 79
After rudders 40 degrees to port
All propellers astern
Voltage 70

Group III - Triple screw Ward-Elsey stern

A. Individual tunnels

(a) Flanking test 80
All rudders set 40 degrees to port
All propellers astern
Voltage 50

(a) Same as figure 80 except voltage is 60 81

(a) Flanking test
All rudders set 40 degrees to port
Tunnels empty
Dynamometers started from rest 82
All propellers astern
Voltage 70

(a) Same as figure 80 except voltage is 70 83

(a) Same as figure 80 except voltage is 80 84

(a) Same as figure 80 except voltage is 90 85

(c) Flanking test 86
All rudders set 40 degrees to port
Center and starboard propellers dead
Port propellers astern
Voltage 70

(c[1]) Flanking test 87
All rudders set 40 degrees to port
Port and starboard propellers dead
Center propeller astern
Voltage 70

Group III - A. (continued) Figure No.

(c[11]) Flanking test 88
All rudders 40 degrees to port
Center and port propellers dead
Starboard propeller astern
Voltage 70

(e) Pivoting about starboard quarter 89
All rudders set 40 degrees to starboard
All propellers astern
Voltage 50

(e) Same as above except voltage is 70 90

(f) Push out and check test 91
All rudders set 40 degrees to starboard
All propellers astern
Voltage 70

(g) Flanking test 92
Forward rudders set 40 degrees to port
After rudders set 40 degrees to starboard
Center and port propellers astern
Starboard propeller ahead
Voltage 70

(k) Straight astern 93
All rudders 0 degrees
All propellers astern
Voltage 50

(k) Same as figure 93 except voltage is 60 94

(k) Same as figure 93 except voltage is 70 95

Group III_2 - Triple screw Ward-Elsey stern with forward rudders lengthened 1-3/4 ft., and shoes attached to same.

A. - Individual tunnels

(a) Flanking test 96
Forward rudders set 42 degrees to port
After rudders set 40 degrees to port
All propellers astern
Voltage 70

(b) Flanking test 97
Forward rudders set 42 degrees to port
After rudders 40 degrees to port
Center and port propellers astern
Starboard propeller dead, Voltage 70

Group III_2 - A. (continued) Figure No.

(b^1) - Flanking test 98
Forward rudders set 42 degrees to port
After rudders set 40 degrees to port
Port propeller dead
Center and starboard propellers astern
Voltage 70

(c) Flanking test 99
Forward rudders set 42 degrees to port
After rudders set 40 degrees to port
Center and port propellers dead
Starboard propeller astern

(c^1) Flanking test 100
Forward rudders set 42 degrees to port
After rudders set 40 degrees to port
Port and starboard propellers dead
Center propeller astern
Voltage 70

(e) Pivoting on starboard quarter test 101
Forward rudders set 42 degrees to starboard
After rudders set 40 degrees to starboard
All propellers astern
Voltage 70

(f) Push out and check test 102
Forward rudders set 42 degrees to starboard
After rudders set 40 degrees to starboard
All propellers astern
Voltage 70

(g) Flanking test 103
Forward rudders set 42 degrees to port
After rudders set 40 degrees to starboard
Port propellers ahead
Center and starboard propellers astern

(h) Towboat moved up between barges 104
Forward rudders set 42 degrees to starboard
After rudders set 40 degrees to starboard
All propellers astern
Voltage 70

Group III_3 - Triple screw Ward-Elsey stern, same as group III_2 except outside forward rudders are removed.

A. Individual tunnels

Group III_3 - A. (continued) Figure No.

(a) Flanking test 105
Forward rudders 42 degrees to port
After rudders 40 degrees to port
All propellers astern
Voltage 70

(b) Flanking test 106
Forward rudders set 42 degrees to port
After rudders set 40 degrees to port
Port propellers dead
Center and starboard propellers astern
Voltage 70

(c) Flanking test 107
Forward rudders set 42 degrees to port
After rudders set 40 degrees to port
Port and starboard propellers dead
Center propellers astern
Voltage 70

(d) Flanking test 108
Forward rudders set 42 degrees to port
After rudders set 0 degrees
All propellers astern
Voltage 70

(e) Pivoting on starboard quarter test 109
Forward rudders set 42 degrees to starboard
After rudders set 40 degrees to starboard
All propellers astern
Voltage 70

(f) Push out and check test 110
Forward rudders set 42 degrees to starboard
After rudders set 40 degrees to starboard
All propellers astern
Voltage 70

(g) Flanking test 111
Forward rudders set 42 degrees to port
After rudders set 40 degrees to starboard
Port propellers ahead
Center and starboard propellers astern
Voltage 70

(h) Towboat moved up between barges 112
Forward rudders set 42 degrees to port
After rudders set 40 degrees to port
All propellers astern
Voltage 70

Group IV - Twin screw Ward-Elsey stern — Figure No.

A. Individual tunnels

Group IV - A. (continued) Figure No.

(h) Towboat moved up between barges
All rudders set 40 degrees to starboard 126
Both propellers astern
Voltage 70

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In order to facilitate comparison the results of the power tests as read off from the figures are given in tables I, II, III, IV, corresponding to the sub-groups a, b, c, d.

TABLE I

Sub-group a - Going Ahead - Rudders 0 degrees.

R. P. M.

V_{MPH}	I_A	I_B	II_C	III_A	III_{2A}	IV_A
3.0	167	165	166	162.5		141
3.5	195	192	195.5	189.5		164.5
4.0	223	219	223	217	150	187.5
4.5	251	247	251	244		211
5.0	279	274	279	272	188	236.5
6.0					225	
7.0					263	

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S. H. P.

V_{MPH}	I_A	I_B	II_C	III_A	III_{2A}	IV_A
3.0	410	400	420	405		460
3.5	650	630	665	650		740
4.0	970	920	990	965	272	1080
4.5	1390	1295	1395	1370		1530
5.0	1910	1790	1900	1890	535	2110
6.0					918	
7.0					1488	

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TOWING EFFICIENCY

V_{MPH}	I_A	I_B	II_C	III_A	III_{2A}	IV_A
3.0	.273	.298	.270	.277		.247
3.5	.273	.298	.270	.277		.247
4.0	.273	.298	.270	.277	.35	.247
4.5	.273	.298	.270	.277		.247
5.0	.273	.292	.270	.277	.35	.247
6.0					.342	
7.0					.332	

I_A - Elsey triple screw - common tunnel - sealed
I_B - Elsey triple screw - common tunnel - open
II_C - Elsey triple screw individual tunnel - sealed; skegs.
III_A - Ward-Elsey triple screw " " " "
III_{2A} - " " " Barges light - Individual tunnel sealed - skegs
IV_A - Ward-Elsey twin screw - Individual tunnel - sealed - Skegs

TABLE II

Sub-group "b" - Going Astern - Rudders 0 degrees.

	R. P. M.				
V_{MPH}	I_A	I_B	II_C	III_A	IV_A
2.0	185		183	185.5	154
2.5	231		229	232	193
3.0	278		275	279	232
3.5	325		320	325	271
4.0	370.5				
	S. H. P.				
2.0	399		380	399	390
2.5	799		750	775	755
3.0	1335		1270	1325	1300
3.5	2065		2060	2100	2060
4.0	3050				
	TOWING EFFICIENCY				
2.0	.078		.082	.078	.089
2.5	.081		.084	.081	.083
3.0	.084		.088	.084	.086
3.5	.087		.088	.087	.088
4.0	.088				

I_A - Elsey- Triple screw - common tunnel - sealed

I_B - " " " " " Open

II_C- " " " Individual tunnel - sealed- Skegs

III_A- Ward-Elsey- Triple screw - Individual tunnel - Sealed; skegs

IV_A - Ward-Elsey Twin screw - Individual tunnel, sealed- skegs

TABLE III

Sub-group "c" - Going Ahead - Rudders 40 degrees.

V_{MPH}	I_A	II_A	II_C	IIC_2	III_A	III_{2A}	IV_A
			R. P. M.				
2.0	183	183.5		183		162	116
2.5	229	229	227	229	199	202	146
3.0	275	275.5	274	276	239	244	175
3.5	321	321.5	320	321	279	285	205
			S. H. P.				
2.0	550	540	510	540	400	410	280
2.5	1040	1060	1020	1055	785	810	550
3.0	1800	1830	1770	1845	1310	1370	920
3.5	2860	2920	2910	2880	1995	2190	1440
			RUDDER PULL				
2.0	13500	13500	12400	13500	8000	9200	5700
2.5	21000	21000	19500	21000	12700	14500	8900
3.0	30200	30200	28900	30500	18100	21000	12800
3.5	41200	41000	41100	41200	24200	28500	17300

I_A - Elsey - Triple screw - common tunnel - sealed.

II_A- " " " " " " , skegs

II_C- " " " - Individual tunnel - sealed; skegs

IIC_2- " " " " " " "
with deflector blocks

III_A- Ward-Elsey - triple screw - Individual tunnel - sealed - skegs

III_{2A}- Ward-Elsey - triple screw - " " "
skegs, rudders lengthened

IV_A - Ward-Elsey - Twin screw- Individual tunnel - sealed, skegs/

TABLE IV

Sub-group "d" - Going Astern - Rudders 40 degrees.

V_{MPH}	I_A	II_A	II_C	$II\ C_2$	III_A	III_{2A}	IV_A
			R. P. M.				
2.0	242	239	245.5	243	242	243	194
2.5	303	300	307.5	304	303	304	243
3.0	364	385		363	363	364	291
3.5	422						
			S. H. P.				
2.0	750	890	980	910	920	990	840
2.5	1400	1810	1915	1860	1790	1950	1595
3.0	2720	2910				3450	2760
3.5							
			RUDDER PULL				
2.0	9300	8400	10000	9150	8500	9500	7600
2.5	14400	13200	15600	14700	13300	15000	11900
3.0	20500	18700	23400	22000	19300	21300	17000
3.5	27400						

I_A - Elsey - Triple screw - common tunnel - sealed

II_A - Elsey - " " " " " , skegs

II_C " " " Individual tunnel - sealed skegs

II_{C_2} " " " " " " "
with deflector blocks

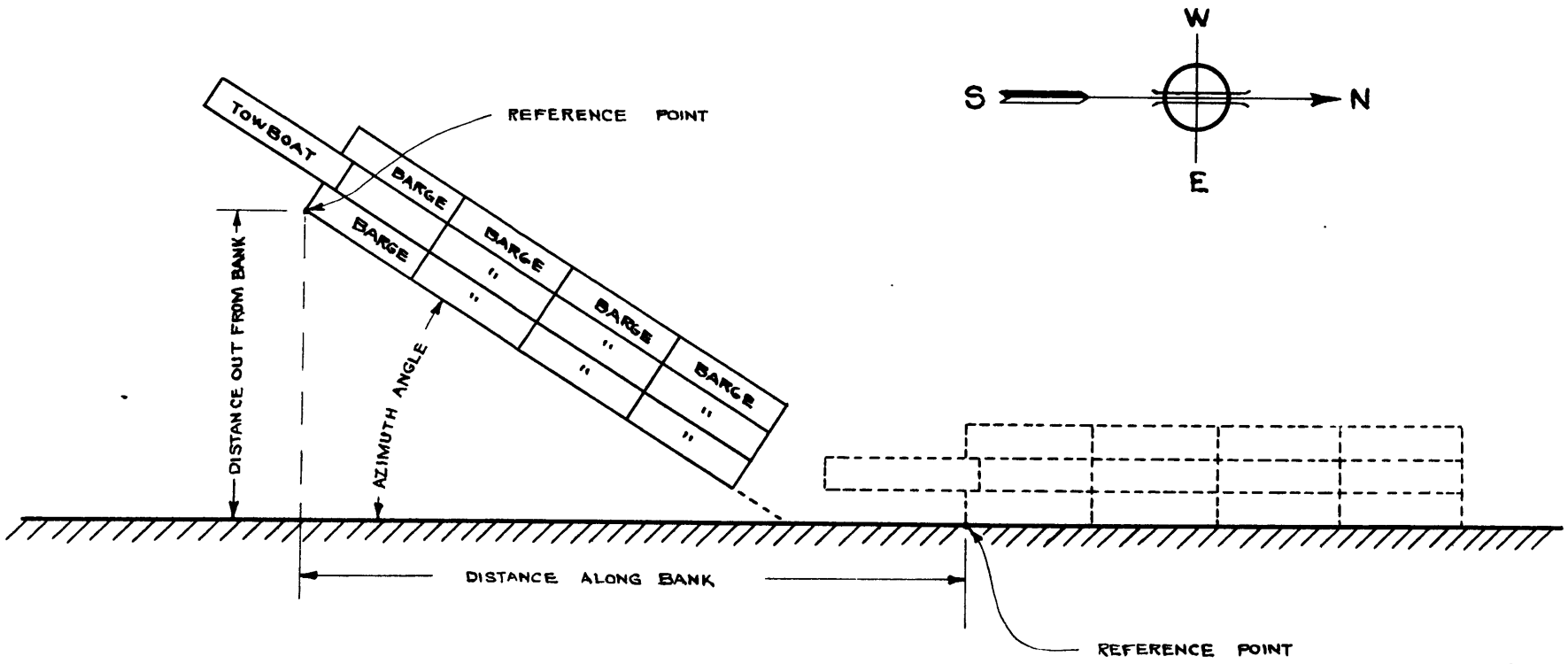
III_A Ward-Elsey - triple screw - Individual tunnel, sealed, skegs.

$III_{2\ A}$ - Ward-Elsey - triple screw- " " "
skegs, Rudders lengthened

IV_A - Ward-Elsey -Twin screw - Individual " " skegs

DIAGRAMMATIC SKETCH OF FLANKING TESTS
FOR
VESTA COAL COMPANY

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



BANK
OR
STATIONARY LINE OF BARGES

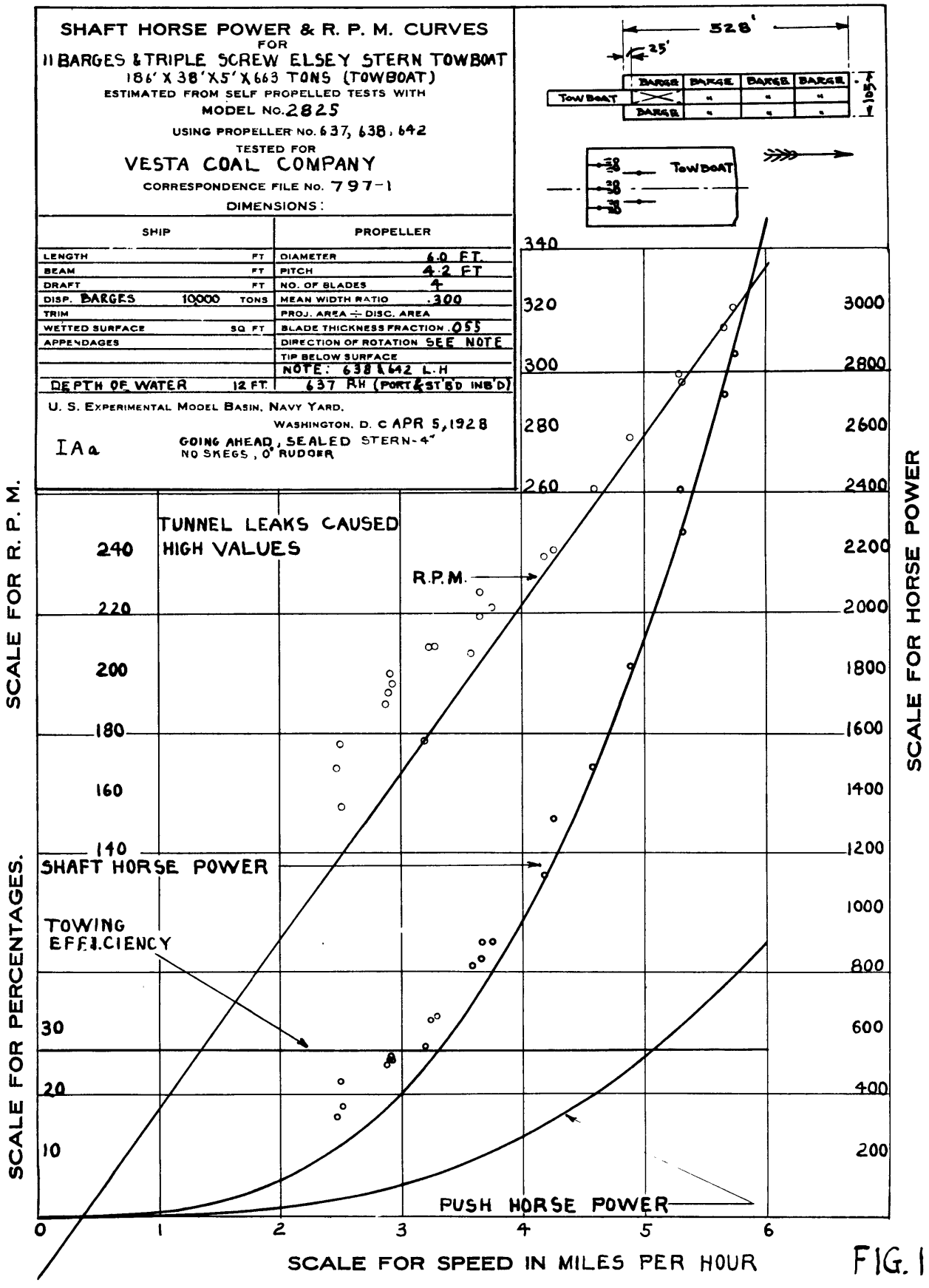

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW ELSEY STERN TOWBOAT
186' X 38' X 5' X 663 TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL No. 2825
USING PROPELLER No. 637, 638, 642
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE No. 797-1
DIMENSIONS:
SHIP
LENGTH FT
BEAM FT
DRAFT FT
DISP. BARGES 10000 TONS
TRIM
WETTED SURFACE SQ. FT
APPENDAGES
DEPTH OF WATER 12 FT.
PROPELLER
DIAMETER 6.0 FT.
PITCH 4.2 FT
NO. OF BLADES 4
MEAN WIDTH RATIO .300
PROJ. AREA ÷ DISC. AREA
BLADE THICKNESS FRACTION .055
DIRECTION OF ROTATION SEE NOTE
TIP BELOW SURFACE
NOTE: 638 & 642 L.H
637 R.H (PORT & ST'BD INB'D)
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD.
WASHINGTON, D. C APR 5, 1928
IAa
GOING AHEAD, SEALED STERN-4°
NO SKEGS, 0° RUDDER
528'
25'
BARGE
TOW BOAT
105'
TOW BOAT
SCALE FOR R. P. M.
SCALE FOR PERCENTAGES.
SCALE FOR HORSE POWER
TUNNEL LEAKS CAUSED HIGH VALUES
R.P.M.
SHAFT HORSE POWER
TOWING EFFICIENCY
PUSH HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR

FIG. 1

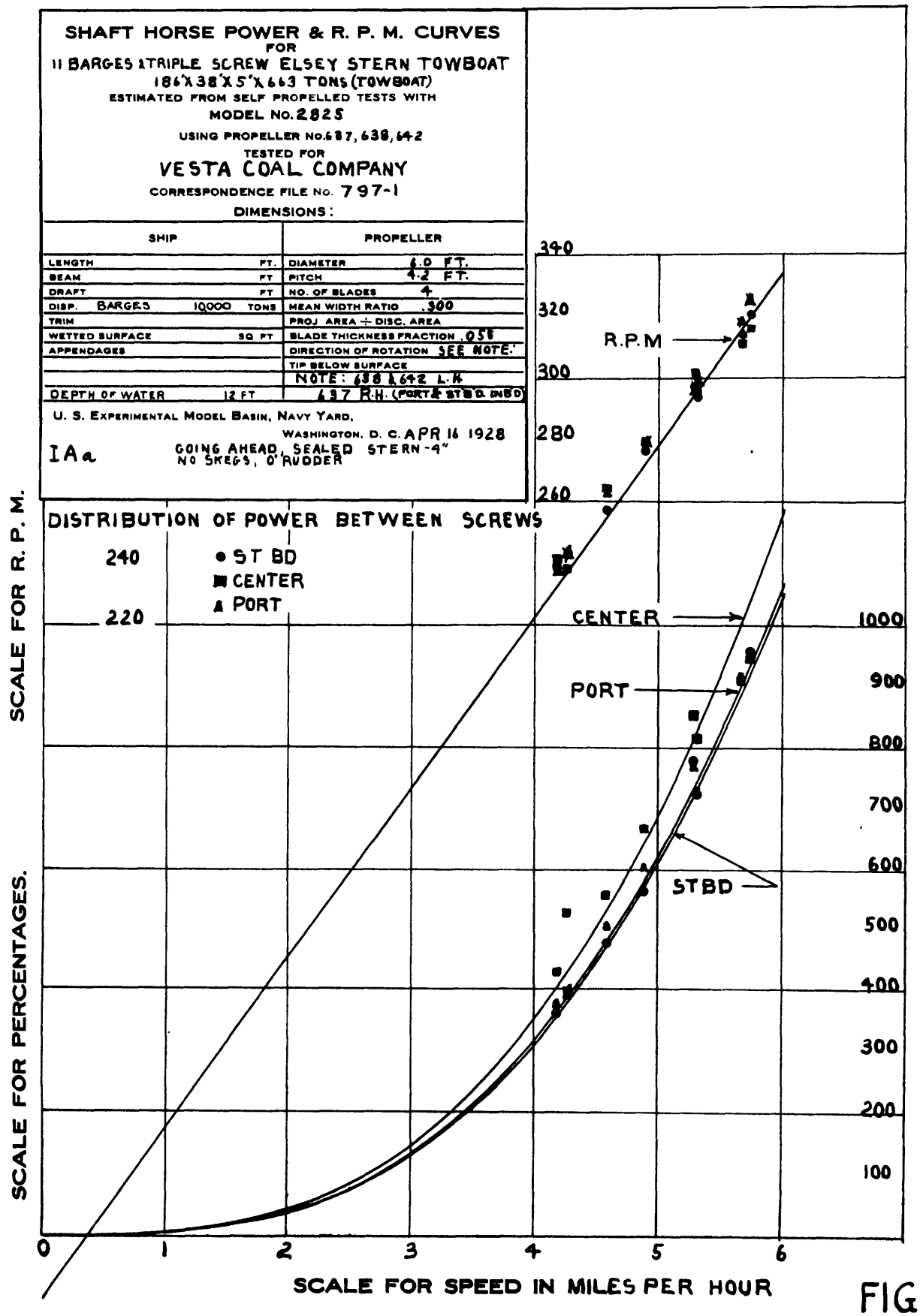

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW ELSEY STERN TOWBOAT
186'X 38'X 5'X 663 TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL NO. 2825
USING PROPELLER NO. 637, 638, 642
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE NO. 797-1
DIMENSIONS:
SHIP
LENGTH FT.
BEAM FT
DRAFT FT
DISP. BARGES 10000 TONS
TRIM
WETTED SURFACE SQ FT
APPENDAGES
DEPTH OF WATER 12 FT
PROPELLER
DIAMETER 6.0 FT.
PITCH 4.2 FT.
NO. OF BLADES 4
MEAN WIDTH RATIO .300
PROJ AREA ÷ DISC. AREA
BLADE THICKNESS FRACTION .056
DIRECTION OF ROTATION SEE NOTE.
TIP BELOW SURFACE
NOTE: 638 & 642 L.H.
637 R.H. (PORT & STBD. INBD)
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD,
WASHINGTON, D. C. APR 16 1928
IAa
GOING AHEAD, SEALED STERN -4"
NO SKEGS, 0° RUDDER
DISTRIBUTION OF POWER BETWEEN SCREWS
ST BD
CENTER
PORT
R.P.M
CENTER
PORT
STBD
SCALE FOR R. P. M.
SCALE FOR PERCENTAGES.
SCALE FOR HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR
340
320
300
280
260
240
220
1000
900
800
700
600
500
400
300
200
100
0
1
2
3
4
5
6

FIG. 1a

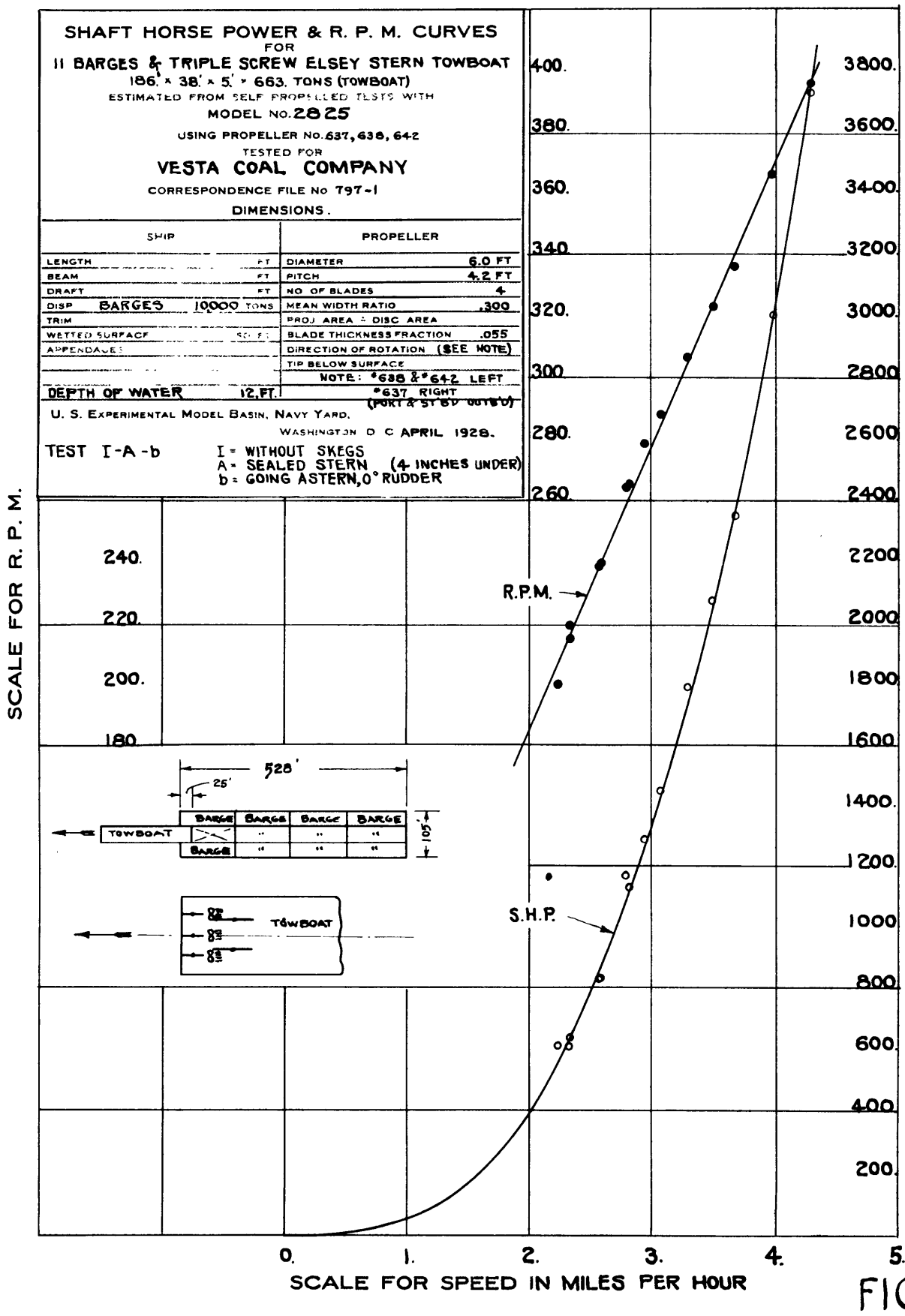

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW ELSEY STERN TOWBOAT
186' x 38' x 5' - 663. TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL NO. 2825
USING PROPELLER No. 637, 638, 642
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE No 797-1
DIMENSIONS.
SHIP
LENGTH FT
BEAM FT
DRAFT FT
DISP BARGES 10000 TONS
TRIM
WETTED SURFACE SQ. FT.
APPENDAGES
DEPTH OF WATER 12. FT.
PROPELLER
DIAMETER 6.0 FT
PITCH 4.2 FT
NO OF BLADES 4
MEAN WIDTH RATIO .300
PROJ AREA ÷ DISC AREA
BLADE THICKNESS FRACTION .055
DIRECTION OF ROTATION (SEE NOTE)
TIP BELOW SURFACE
NOTE: #638 & #642 LEFT
#637 RIGHT
(PORT & STBD OUTBD)
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD.
WASHINGTON D C APRIL 1928.
TEST I-A-b
I = WITHOUT SKEGS
A = SEALED STERN (4 INCHES UNDER)
b = GOING ASTERN, 0° RUDDER
528'
25'
BARGE
TOWBOAT
105'
TOWBOAT
R.P.M.
S.H.P.
SCALE FOR R. P. M.
SCALE FOR HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR
400.
380.
360.
340.
320.
300.
280.
260.
240.
220.
200.
180.
3800.
3600.
3400.
3200.
3000.
2800.
2600.
2400.
2200.
2000.
1800.
1600.
1400.
1200.
1000.
800.
600.
400.
200.
0.
1.
2.
3.
4.
5.

FIG. 2

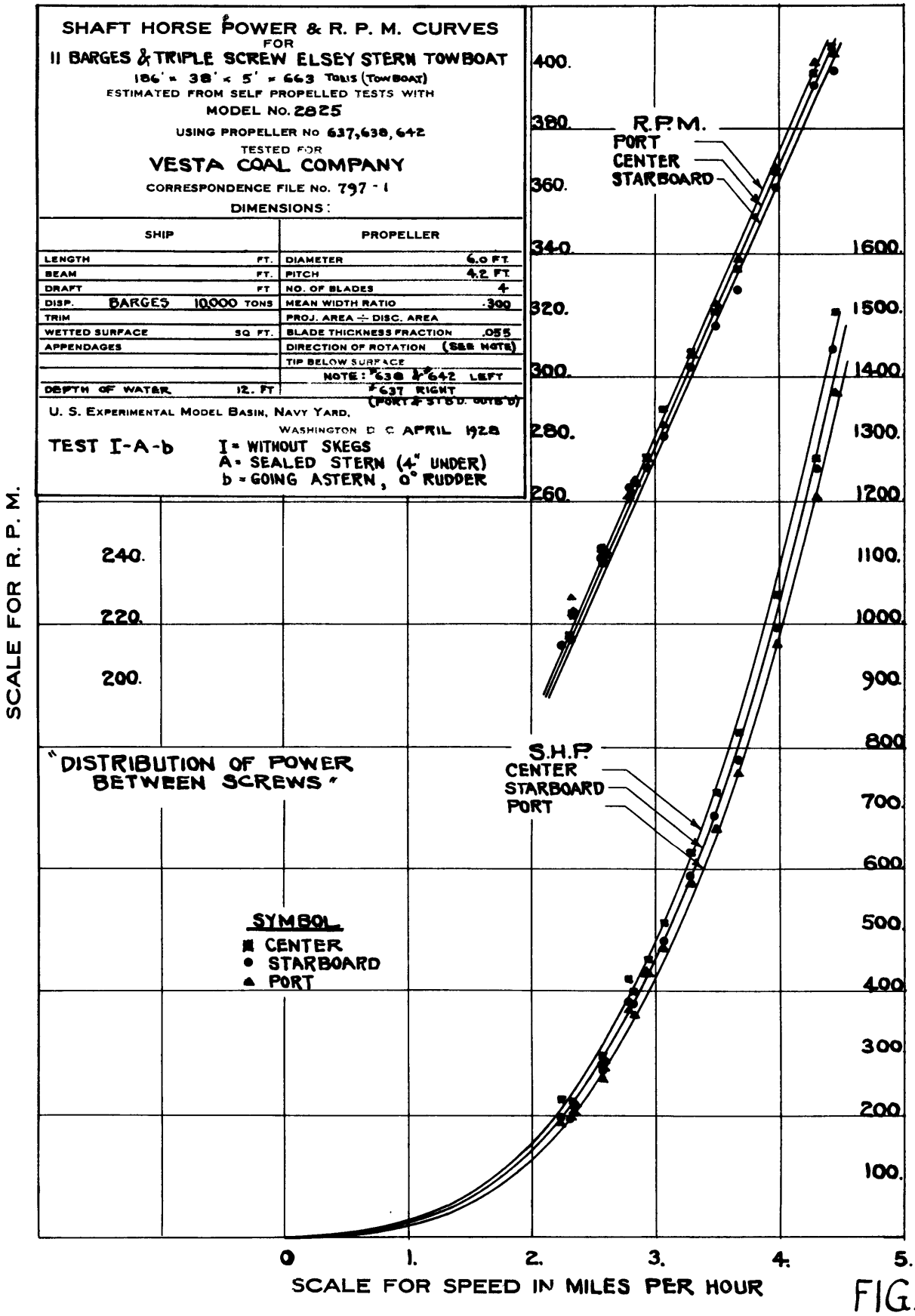

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW ELSEY STERN TOWBOAT
186' × 38' × 5' = 663 TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL NO. 2825
USING PROPELLER NO 637, 638, 642
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE NO. 797 - 1
DIMENSIONS:
SHIP
LENGTH FT.
BEAM FT.
DRAFT FT
DISP. BARGES 10000 TONS
TRIM
WETTED SURFACE SQ. FT.
APPENDAGES
DEPTH OF WATER 12. FT
PROPELLER
DIAMETER 6.0 FT.
PITCH 4.2 FT.
NO. OF BLADES 4
MEAN WIDTH RATIO .300
PROJ. AREA ÷ DISC. AREA
BLADE THICKNESS FRACTION .055
DIRECTION OF ROTATION (SEE NOTE)
TIP BELOW SURFACE
NOTE: #638 & #642 LEFT
#637 RIGHT
(PORT & STBD. OUTBD)
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD,
WASHINGTON D. C. APRIL 1928
TEST I-A-b
I = WITHOUT SKEGS
A = SEALED STERN (4" UNDER)
b = GOING ASTERN, 0° RUDDER
R.P.M.
PORT
CENTER
STARBOARD
S.H.P.
CENTER
STARBOARD
PORT
"DISTRIBUTION OF POWER BETWEEN SCREWS"
SYMBOL
CENTER
STARBOARD
PORT
SCALE FOR R. P. M.
SCALE FOR HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR
400.
380.
360.
340.
320.
300.
280.
260.
240.
220.
200.
1600.
1500.
1400.
1300.
1200.
1100.
1000.
900.
800.
700.
600.
500.
400.
300.
200.
100.
0
1.
2.
3.
4.
5.

FIG. 2a

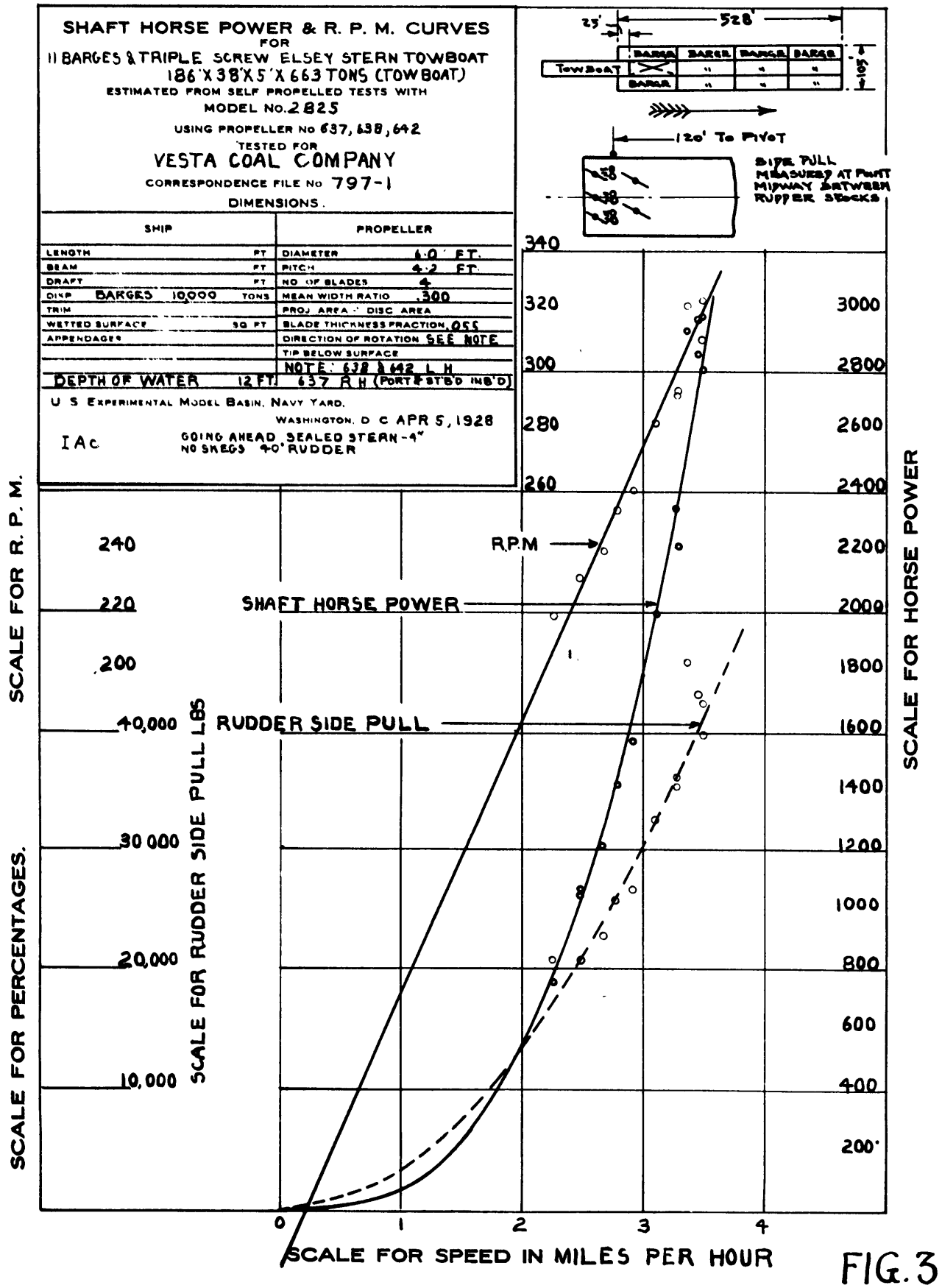

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW ELSEY STERN TOWBOAT
186'X38'X5'X663 TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL No. 2825
USING PROPELLER No 637, 638, 642
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE No 797-1
DIMENSIONS.
SHIP
LENGTH FT
BEAM FT
DRAFT FT
DISP BARGES 10,000 TONS
TRIM
WETTED SURFACE SQ FT
APPENDAGES
DEPTH OF WATER 12 FT
PROPELLER
DIAMETER 6.0 FT.
PITCH 4.2 FT.
NO OF BLADES 4
MEAN WIDTH RATIO .300
PROJ AREA ÷ DISC AREA
BLADE THICKNESS FRACTION .055
DIRECTION OF ROTATION SEE NOTE
TIP BELOW SURFACE
NOTE: 638 & 642 L H
637 R H (PORT STBD INB'D)
U S EXPERIMENTAL MODEL BASIN, NAVY YARD,
WASHINGTON, D C APR 5, 1928
IAc
GOING AHEAD SEALED STERN-4"
NO SKEGS 40° RUDDER
25'
528'
BARGE
TOW BOAT
105'
120' To PIVOT
SIDE PULL MEASURED AT POINT MIDWAY BETWEEN RUDDER STOCKS
340
320
300
280
260
240
220
200
40,000
30,000
20,000
10,000
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
R.P.M
SHAFT HORSE POWER
RUDDER SIDE PULL
SCALE FOR R. P. M.
SCALE FOR PERCENTAGES.
SCALE FOR RUDDER SIDE PULL LBS
SCALE FOR HORSE POWER
0
1
2
3
4
SCALE FOR SPEED IN MILES PER HOUR

FIG. 3

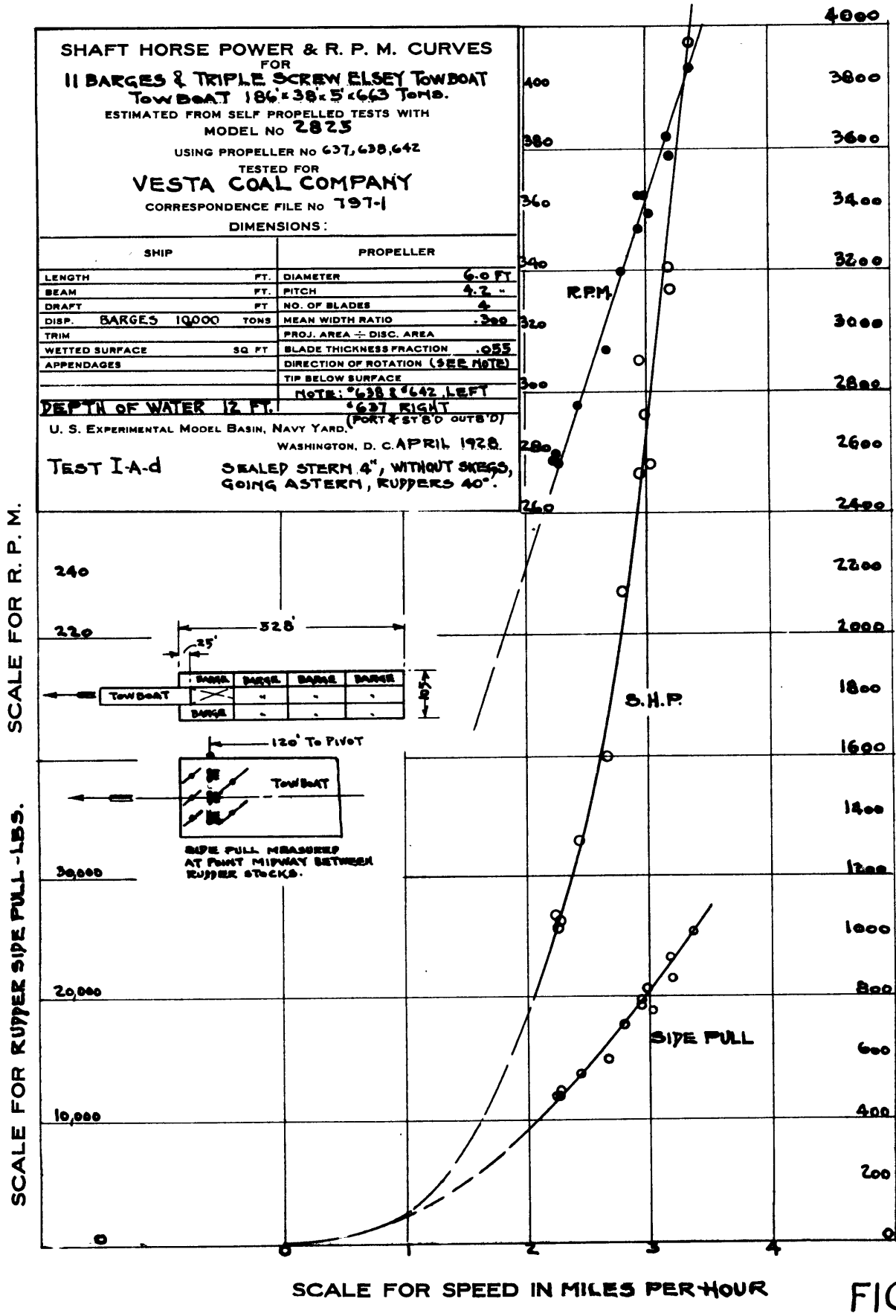

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW ELSEY TOWBOAT
TOWBOAT 186'×38'×5'<663 TONS.
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL NO 2825
USING PROPELLER NO 637, 638, 642
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE NO 797-1
DIMENSIONS:
SHIP
PROPELLER
LENGTH FT.
BEAM FT.
DRAFT FT
DISP. BARGES 10000 TONS
TRIM
WETTED SURFACE SQ FT
APPENDAGES
DIAMETER 6.0 FT
PITCH 4.2 "
NO. OF BLADES 4
MEAN WIDTH RATIO .300
PROJ. AREA ÷ DISC. AREA
BLADE THICKNESS FRACTION .055
DIRECTION OF ROTATION (SEE NOTE)
TIP BELOW SURFACE
NOTE: #638 & #642 LEFT
#637 RIGHT
(PORT & STBD OUTB'D)
DEPTH OF WATER 12 FT.
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD.
WASHINGTON, D. C. APRIL 1928.
TEST I-A-d
SEALED STERN 4", WITHOUT SKEGS, GOING ASTERN, RUDDERS 40°.
328'
25'
BARGE
TOW BOAT
120' TO PIVOT
SIDE PULL MEASURED AT POINT MIDWAY BETWEEN RUDDER STOCKS.
R.P.M.
S.H.P.
SIDE PULL
SCALE FOR R. P. M.
SCALE FOR RUDDER SIDE PULL - LBS.
SCALE FOR HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR
400
380
360
340
320
300
280
260
240
220
4000
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
30,000
20,000
10,000
0
1
2
3
4

FIG. 4

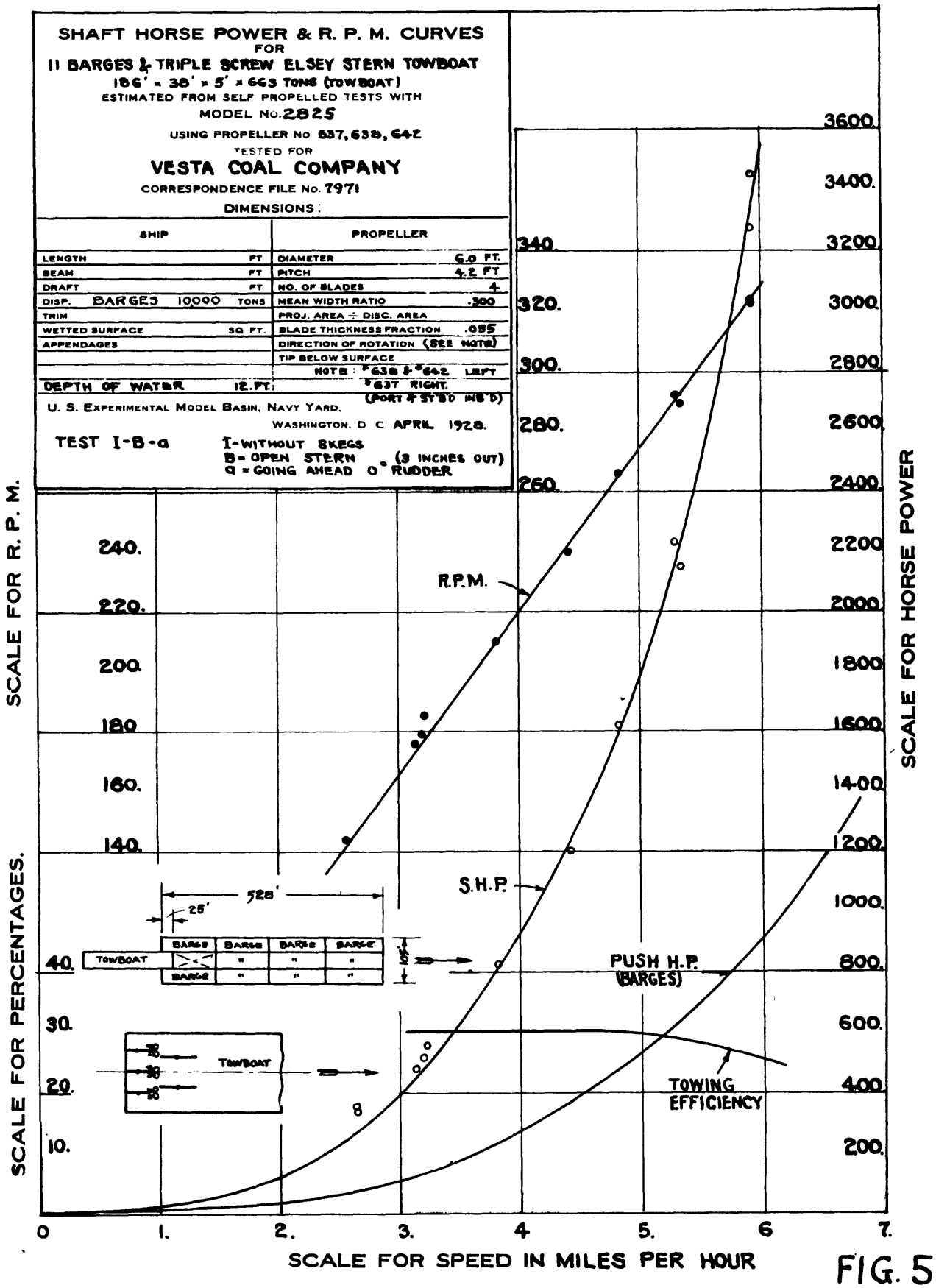

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW ELSEY STERN TOWBOAT
186' × 38' × 5' × 663 TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL NO. 2825
USING PROPELLER NO 637, 638, 642
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE No. 7971
DIMENSIONS:
SHIP
LENGTH FT
BEAM FT
DRAFT FT
DISP. BARGES 10000 TONS
TRIM
WETTED SURFACE SQ. FT.
APPENDAGES
DEPTH OF WATER 12. FT.
PROPELLER
DIAMETER 6.0 FT.
PITCH 4.2 FT
NO. OF BLADES 4
MEAN WIDTH RATIO .300
PROJ. AREA ÷ DISC. AREA
BLADE THICKNESS FRACTION .055
DIRECTION OF ROTATION (SEE NOTE)
TIP BELOW SURFACE
NOTE: #638 & #642 LEFT
#637 RIGHT.
(PORT & STBD INBD)
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD.
WASHINGTON, D. C. APRIL 1928.
TEST I-B-a
I-WITHOUT SKEGS
B-OPEN STERN (3 INCHES OUT)
a = GOING AHEAD 0° RUDDER
R.P.M.
S.H.P.
PUSH H.P. (BARGES)
TOWING EFFICIENCY
528'
25'
BARGE
TOWBOAT
TOWBOAT
SCALE FOR R. P. M.
SCALE FOR PERCENTAGES.
SCALE FOR HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR
240.
220.
200.
180
160.
140.
40.
30.
20.
10.
3600.
3400.
3200.
340.
320.
3000.
300.
2800.
280.
2600.
260.
2400.
2200
2000
1800
1600
1400
1200
1000.
800.
600.
400
200.
0
1.
2.
3.
4
5.
6
7.

FIG. 5

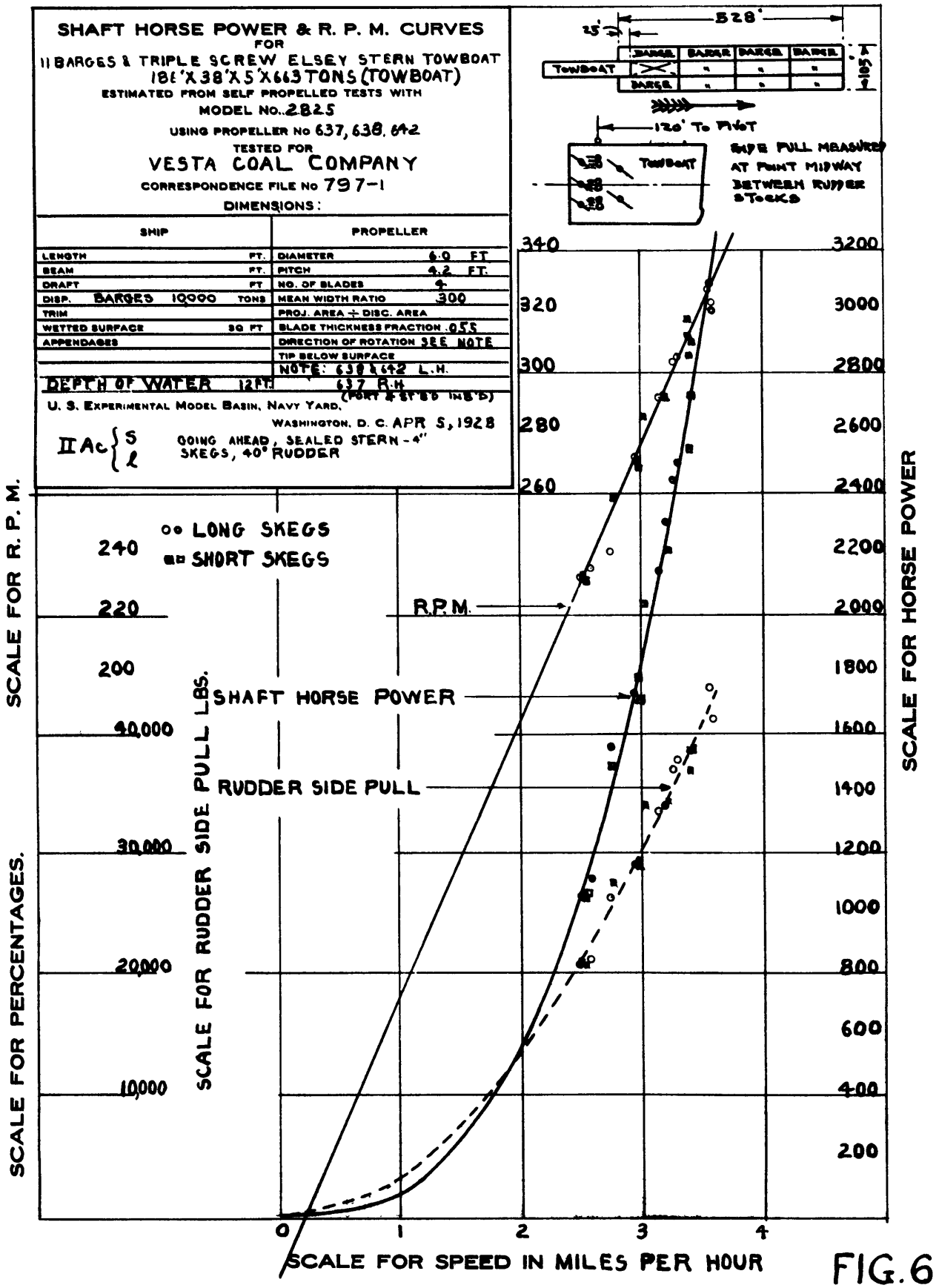

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW ELSEY STERN TOWBOAT
181'X38'X5'X663 TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL NO. 2825
USING PROPELLER No 637, 638, 642
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE No 797-1
DIMENSIONS:
SHIP
LENGTH FT.
BEAM FT.
DRAFT FT.
DISP. BARGES 10000 TONS
TRIM
WETTED SURFACE SQ FT
APPENDAGES
DEPTH OF WATER 12 FT.
PROPELLER
DIAMETER 6.0 FT.
PITCH 4.2 FT.
NO. OF BLADES 4
MEAN WIDTH RATIO .300
PROJ. AREA ÷ DISC. AREA
BLADE THICKNESS FRACTION .055
DIRECTION OF ROTATION SEE NOTE
TIP BELOW SURFACE
NOTE: 638 & 642 L.H.
637 R.H
(PORT & STBD INBD)
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD,
WASHINGTON, D. C. APR 5, 1928
IIAc { S, l
GOING AHEAD, SEALED STERN - 4" SKEGS, 40° RUDDER
528'
25'
BARGE
TOWBOAT
105'
120' To Pivot
SIDE PULL MEASURED AT POINT MIDWAY BETWEEN RUDDER STOCKS
oo LONG SKEGS
□□ SHORT SKEGS
R.P.M.
SHAFT HORSE POWER
RUDDER SIDE PULL
SCALE FOR R. P. M.
SCALE FOR PERCENTAGES.
SCALE FOR RUDDER SIDE PULL LBS.
SCALE FOR HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR
340
320
300
280
260
240
220
200
40,000
30,000
20,000
10,000
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1
2
3
4

FIG. 6

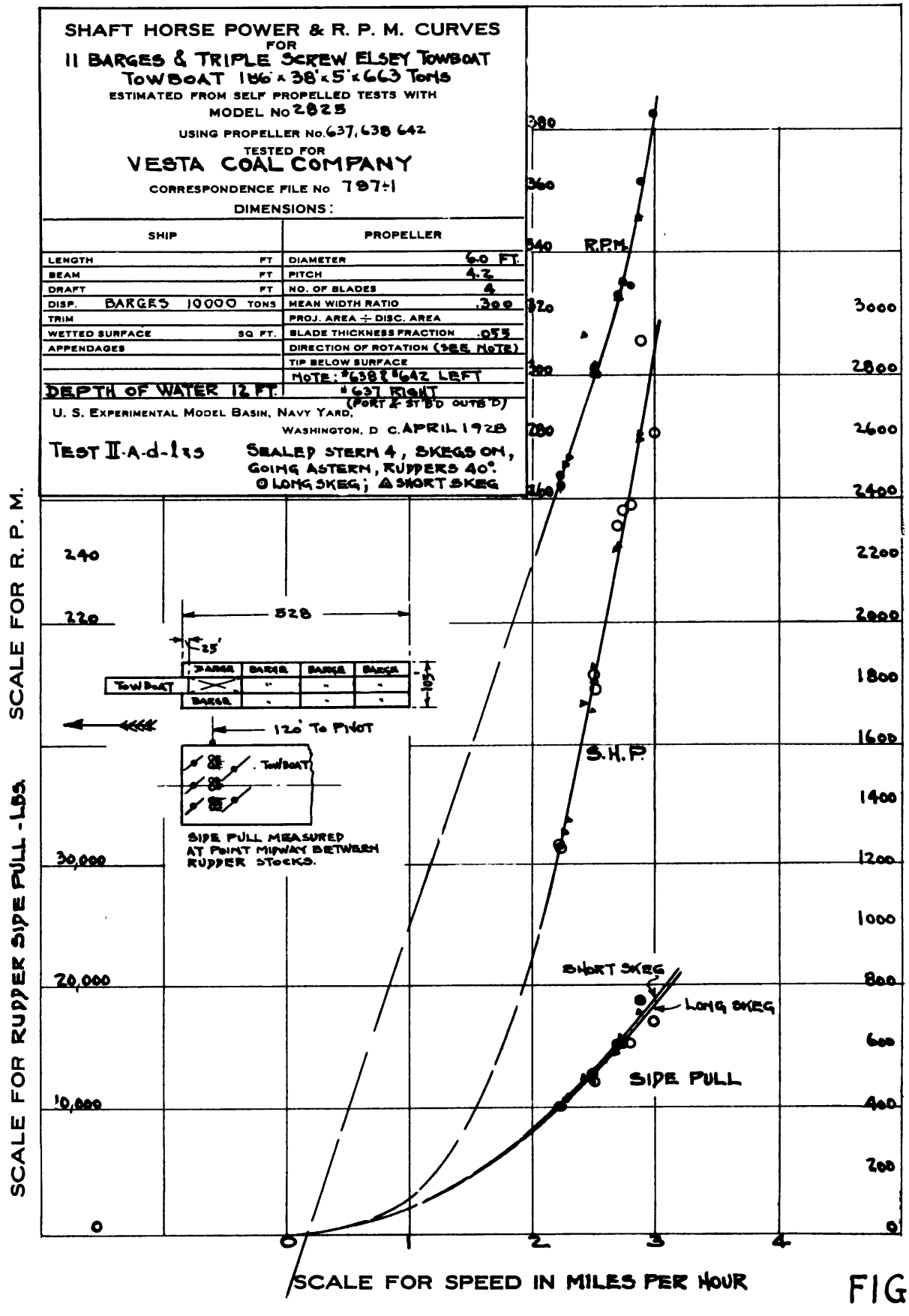

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW ELSEY TOWBOAT
TOWBOAT 186 x 38' x 5' x 663 TONS
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL NO 2825
USING PROPELLER No. 637, 638 642
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE No 797-1
DIMENSIONS:
SHIP
PROPELLER
LENGTH FT
BEAM FT
DRAFT FT
DISP. BARGES 10000 TONS
TRIM
WETTED SURFACE SQ FT.
APPENDAGES
DIAMETER 6.0 FT.
PITCH 4.2
NO. OF BLADES 4
MEAN WIDTH RATIO .300
PROJ. AREA ÷ DISC. AREA
BLADE THICKNESS FRACTION .055
DIRECTION OF ROTATION (SEE NOTE)
TIP BELOW SURFACE
NOTE: #638 #642 LEFT
#637 RIGHT
(PORT & STBD OUTBD)
DEPTH OF WATER 12 FT.
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD,
WASHINGTON, D C. APRIL 1928
TEST II-A-d-1 & 3
SEALED STERN 4, SKEGS ON,
GOING ASTERN, RUDDERS 40°.
O LONG SKEG; Δ SHORT SKEG
R.P.M.
S.H.P.
SIDE PULL
SHORT SKEG
LONG SKEG
528
25'
105'
BARGE
TOWBOAT
120' TO PIVOT
SIDE PULL MEASURED
AT POINT MIDWAY BETWEEN
RUDDER STOCKS.
SCALE FOR R. P. M.
SCALE FOR RUDDER SIDE PULL - LBS.
SCALE FOR HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR

FIG. 7

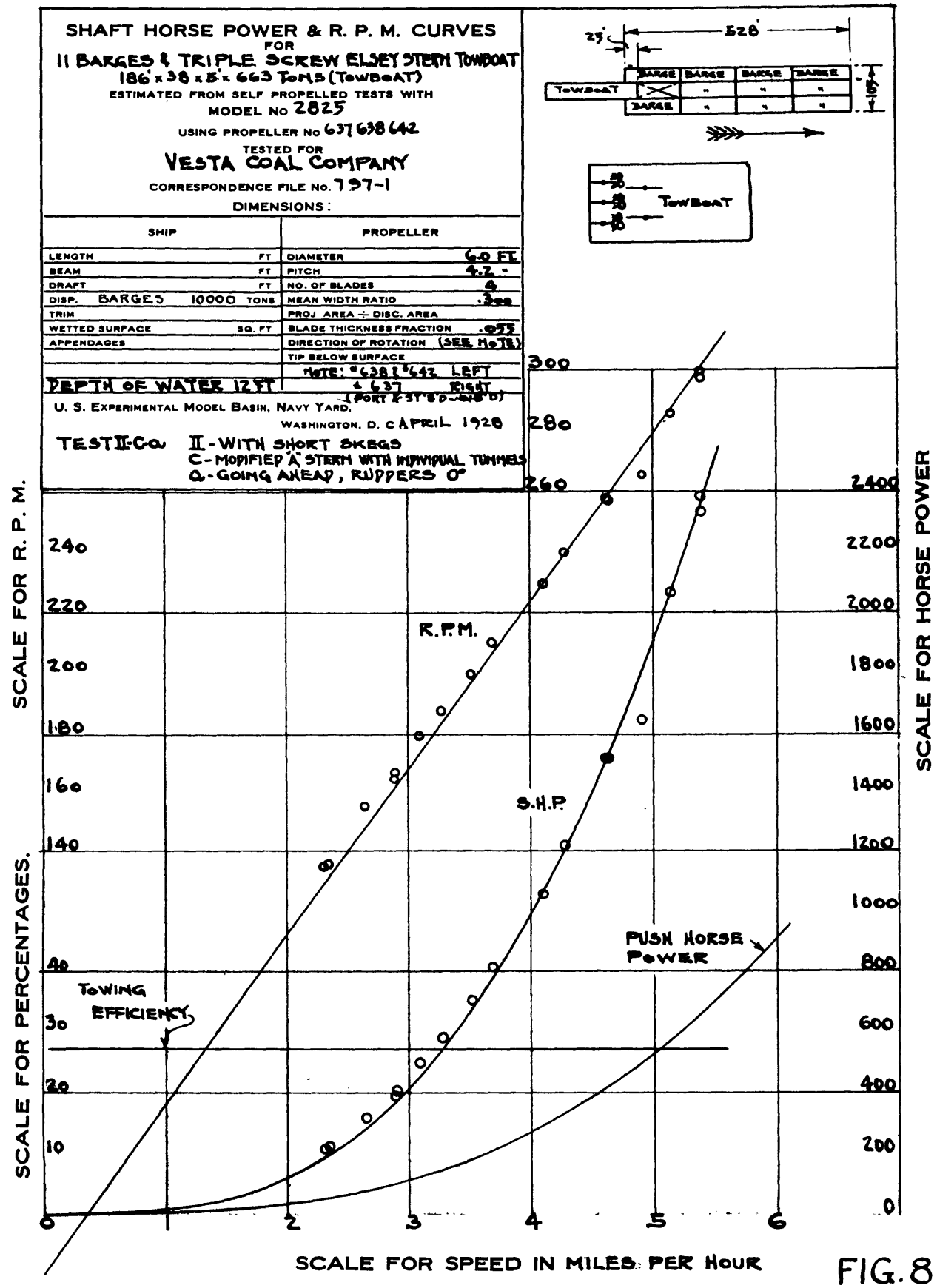

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW ELSEY STERN TOWBOAT
186' x 38 x 5' x 663 TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL NO 2825
USING PROPELLER NO 637 638 642
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE NO. 797-1
DIMENSIONS:
SHIP
LENGTH FT
BEAM FT
DRAFT FT
DISP. BARGES 10000 TONS
TRIM
WETTED SURFACE SQ. FT
APPENDAGES
DEPTH OF WATER 12 FT
PROPELLER
DIAMETER 6.0 FT.
PITCH 4.2 "
NO. OF BLADES 4
MEAN WIDTH RATIO .300
PROJ AREA ÷ DISC. AREA
BLADE THICKNESS FRACTION .055
DIRECTION OF ROTATION (SEE NOTE)
TIP BELOW SURFACE
NOTE: #638 & #642 LEFT
#637 RIGHT
(PORT & STBD - AHEAD)
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD,
WASHINGTON, D. C APRIL 1928
TEST II-Ca II - WITH SHORT SKEGS
C - MODIFIED 'A' STERN WITH INDIVIDUAL TUNNELS
a - GOING AHEAD, RUDDERS 0°
25'
528'
BARGE
TOWBOAT
TOWBOAT
R.P.M.
S.H.P.
PUSH HORSE POWER
TOWING EFFICIENCY
SCALE FOR R. P. M.
SCALE FOR PERCENTAGES.
SCALE FOR HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR

FIG. 8

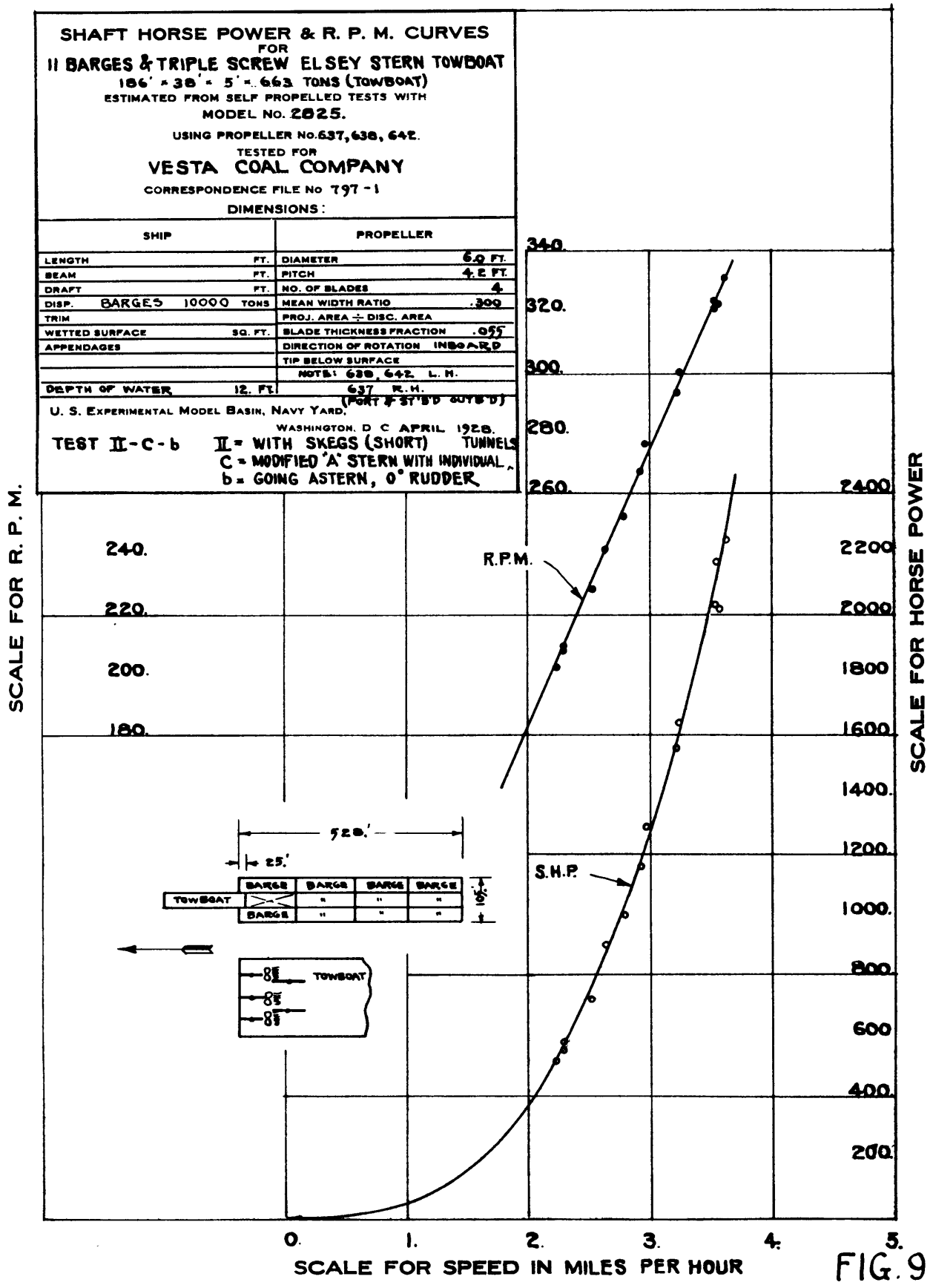

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW ELSEY STERN TOWBOAT
186' × 38' × 5' - 663 TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL No. 2825.
USING PROPELLER No. 637, 638, 642.
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE No 797 - 1
DIMENSIONS:
SHIP
LENGTH FT.
BEAM FT.
DRAFT FT.
DISP. BARGES 10000 TONS
TRIM
WETTED SURFACE SQ. FT.
APPENDAGES
DEPTH OF WATER 12. FT.
PROPELLER
DIAMETER 6.0 FT.
PITCH 4.2 FT.
NO. OF BLADES 4
MEAN WIDTH RATIO .309
PROJ. AREA ÷ DISC. AREA
BLADE THICKNESS FRACTION .055
DIRECTION OF ROTATION INBOARD
TIP BELOW SURFACE
NOTE: 638, 642 L. H.
637 R. H.
(PORT & STBD GUYS D)
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD,
WASHINGTON, D C APRIL 1928.
TEST II-C-b II = WITH SKEGS (SHORT) TUNNELS
C = MODIFIED 'A' STERN WITH INDIVIDUAL
b = GOING ASTERN, 0° RUDDER
SCALE FOR R. P. M.
340.
320.
300.
280.
260.
240.
220.
200.
180.
R.P.M.
S.H.P.
SCALE FOR HORSE POWER
2400
2200
2000
1800
1600
1400.
1200.
1000.
800.
600
400.
200
528.'
25.'
BARGE
TOWBOAT
TOWBOAT
0.
1.
2.
3.
4.
5.
SCALE FOR SPEED IN MILES PER HOUR

FIG. 9

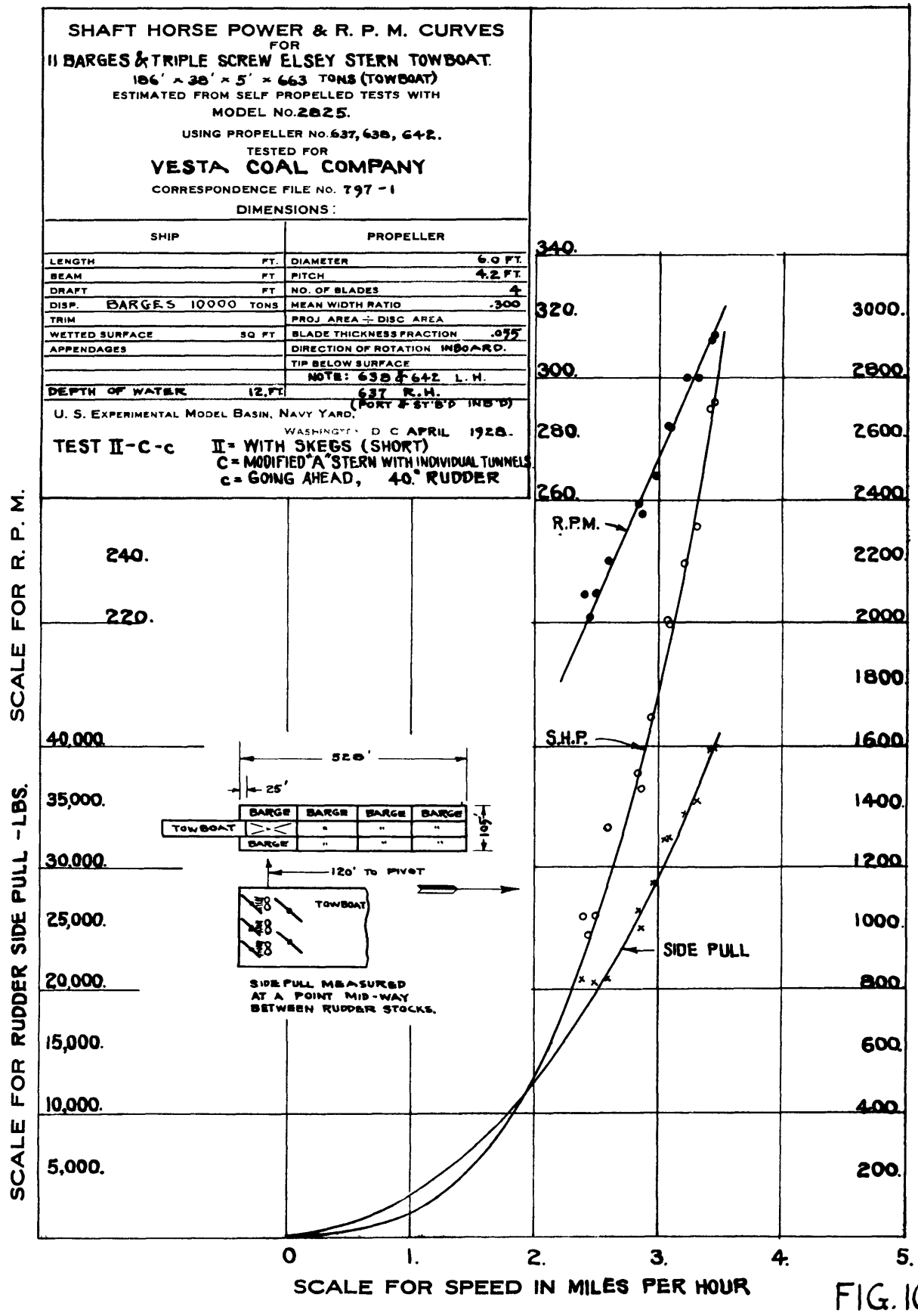

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW ELSEY STERN TOWBOAT.
186' × 38' × 5' × 663 TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL NO. 2825.
USING PROPELLER NO. 637, 638, 642.
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE NO. 797-1
DIMENSIONS:
SHIP
LENGTH FT.
BEAM FT
DRAFT FT
DISP. BARGES 10000 TONS
TRIM
WETTED SURFACE SQ FT
APPENDAGES
DEPTH OF WATER 12. FT.
PROPELLER
DIAMETER 6.0 FT.
PITCH 4.2 FT.
NO. OF BLADES 4
MEAN WIDTH RATIO .300
PROJ AREA ÷ DISC AREA
BLADE THICKNESS FRACTION .075
DIRECTION OF ROTATION INBOARD.
TIP BELOW SURFACE
NOTE: 638 & 642 L. H.
637 R.H.
(PORT & ST'B'D INB'D)
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD,
WASHINGTON, D. C. APRIL 1928.
TEST II-C-c II = WITH SKEGS (SHORT)
C = MODIFIED "A" STERN WITH INDIVIDUAL TUNNELS
c = GOING AHEAD, 40° RUDDER
SCALE FOR R. P. M.
SCALE FOR RUDDER SIDE PULL - LBS.
SCALE FOR HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR
R.P.M.
S.H.P.
SIDE PULL
340.
320.
300.
280.
260.
240.
220.
3000.
2800.
2600.
2400.
2200.
2000.
1800.
1600.
1400.
1200.
1000.
800
600.
400.
200.
40,000.
35,000.
30,000.
25,000.
20,000.
15,000.
10,000.
5,000.
0
1.
2.
3.
4.
5.
528'
25'
BARGE
TOWBOAT
105'
120' TO PIVOT
SIDE PULL MEASURED AT A POINT MID-WAY BETWEEN RUDDER STOCKS.

FIG. 10

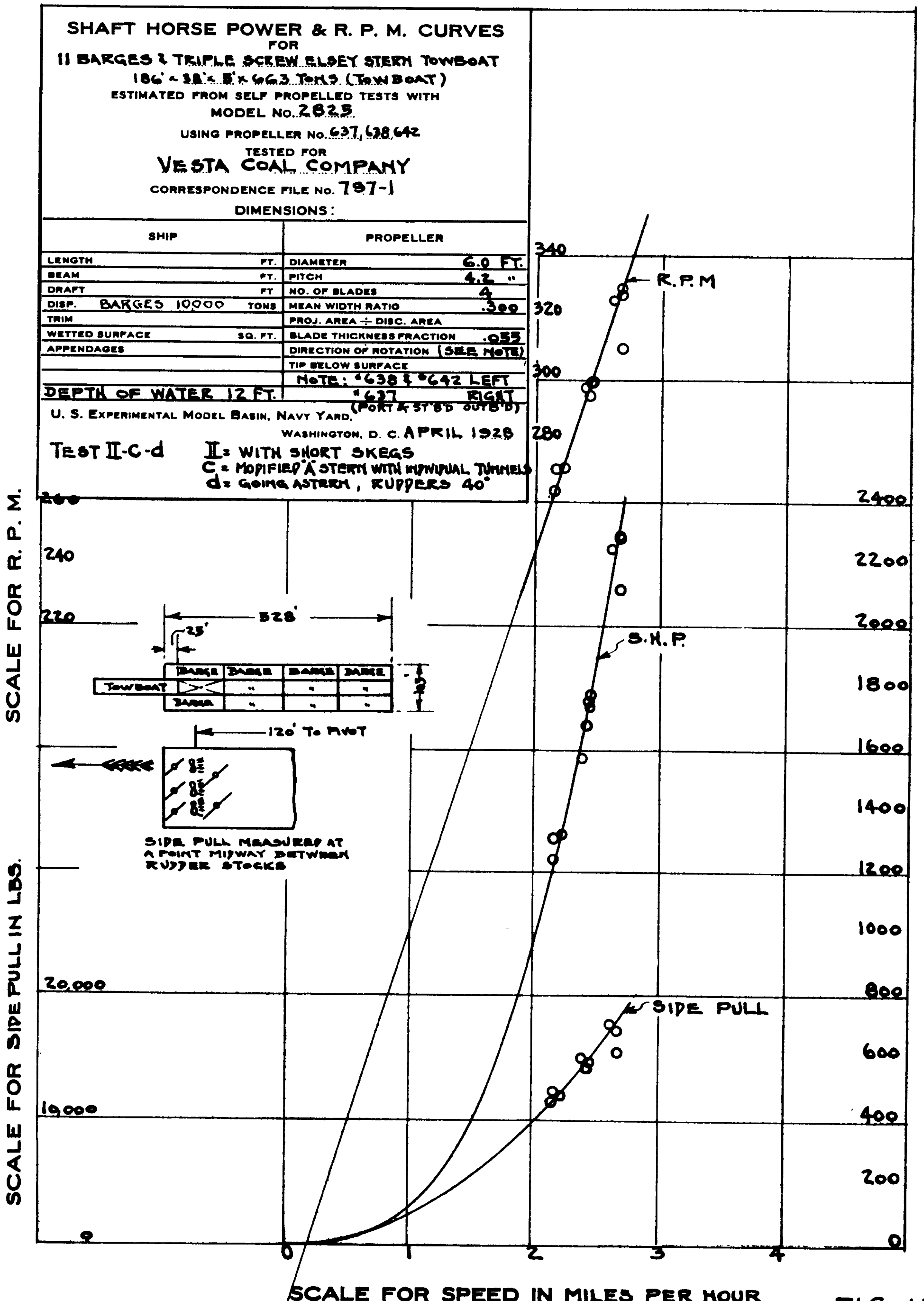

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW ELSEY STERN TOWBOAT
186' x 38' x 5' x 663 TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL No. 2825
USING PROPELLER No. 637, 638, 642
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE No. 797-1
DIMENSIONS:
SHIP
PROPELLER
LENGTH FT.
BEAM FT.
DRAFT FT
DISP. BARGES 10000 TONS
TRIM
WETTED SURFACE SQ. FT.
APPENDAGES
DIAMETER 6.0 FT.
PITCH 4.2 "
NO. OF BLADES 4
MEAN WIDTH RATIO .300
PROJ. AREA ÷ DISC. AREA
BLADE THICKNESS FRACTION .055
DIRECTION OF ROTATION (SEE NOTE)
TIP BELOW SURFACE
NOTE: #638 & #642 LEFT
#637 RIGHT
(PORT & ST'B'D OUTB'D)
DEPTH OF WATER 12 FT.
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD,
WASHINGTON, D. C. APRIL 1928
TEST II-C-d
II = WITH SHORT SKEGS
C = MODIFIED A STERN WITH INDIVIDUAL TUNNELS
d = GOING ASTERN, RUDDERS 40°
528'
25'
BARGE
TOWBOAT
45'
120' TO PIVOT
SIDE PULL MEASURED AT
A POINT MIDWAY BETWEEN
RUDDER STOCKS
R.P.M
S.H.P.
SIDE PULL
SCALE FOR R. P. M.
340
320
300
280
260
240
220
SCALE FOR SIDE PULL IN LBS.
20,000
10,000
0
SCALE FOR HORSE POWER
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
1
2
3
4
SCALE FOR SPEED IN MILES PER HOUR

FIG. 11

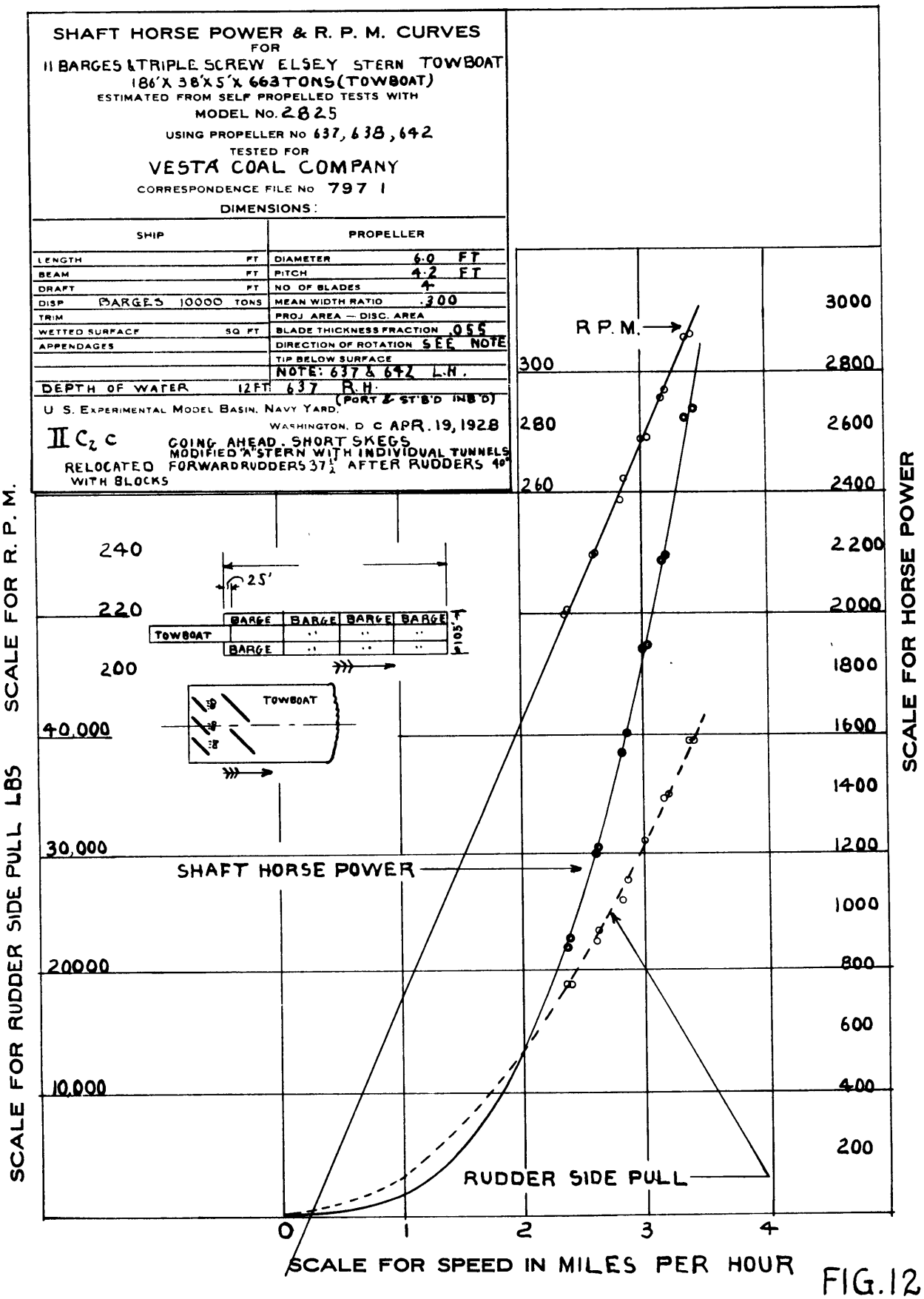

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW ELSEY STERN TOWBOAT
186'X 38'X 5'X 663 TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL No. 2825
USING PROPELLER No 637, 638, 642
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE No 797 1
DIMENSIONS:
SHIP
LENGTH FT
BEAM FT
DRAFT FT
DISP BARGES 10000 TONS
TRIM
WETTED SURFACE SQ FT
APPENDAGES
DEPTH OF WATER 12FT
PROPELLER
DIAMETER 6.0 FT
PITCH 4.2 FT
NO OF BLADES 4
MEAN WIDTH RATIO .300
PROJ AREA — DISC. AREA
BLADE THICKNESS FRACTION .055
DIRECTION OF ROTATION SEE NOTE
TIP BELOW SURFACE
NOTE: 637 & 642 L.H.
637 R.H.
(PORT & ST'B'D INB'D)
U S. EXPERIMENTAL MODEL BASIN, NAVY YARD,
WASHINGTON, D C APR. 19, 1928
II C2 c
GOING AHEAD. SHORT SKEGS
MODIFIED 'A' STERN WITH INDIVIDUAL TUNNELS
RELOCATED FORWARD RUDDERS 37½° AFTER RUDDERS 40°
WITH BLOCKS
25'
BARGE
TOWBOAT
105'
TOWBOAT
R P. M.
SHAFT HORSE POWER
RUDDER SIDE PULL
SCALE FOR R. P. M.
SCALE FOR RUDDER SIDE PULL LBS
SCALE FOR HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR
240
220
200
40,000
30,000
20000
10,000
300
280
260
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1
2
3
4

FIG. 12

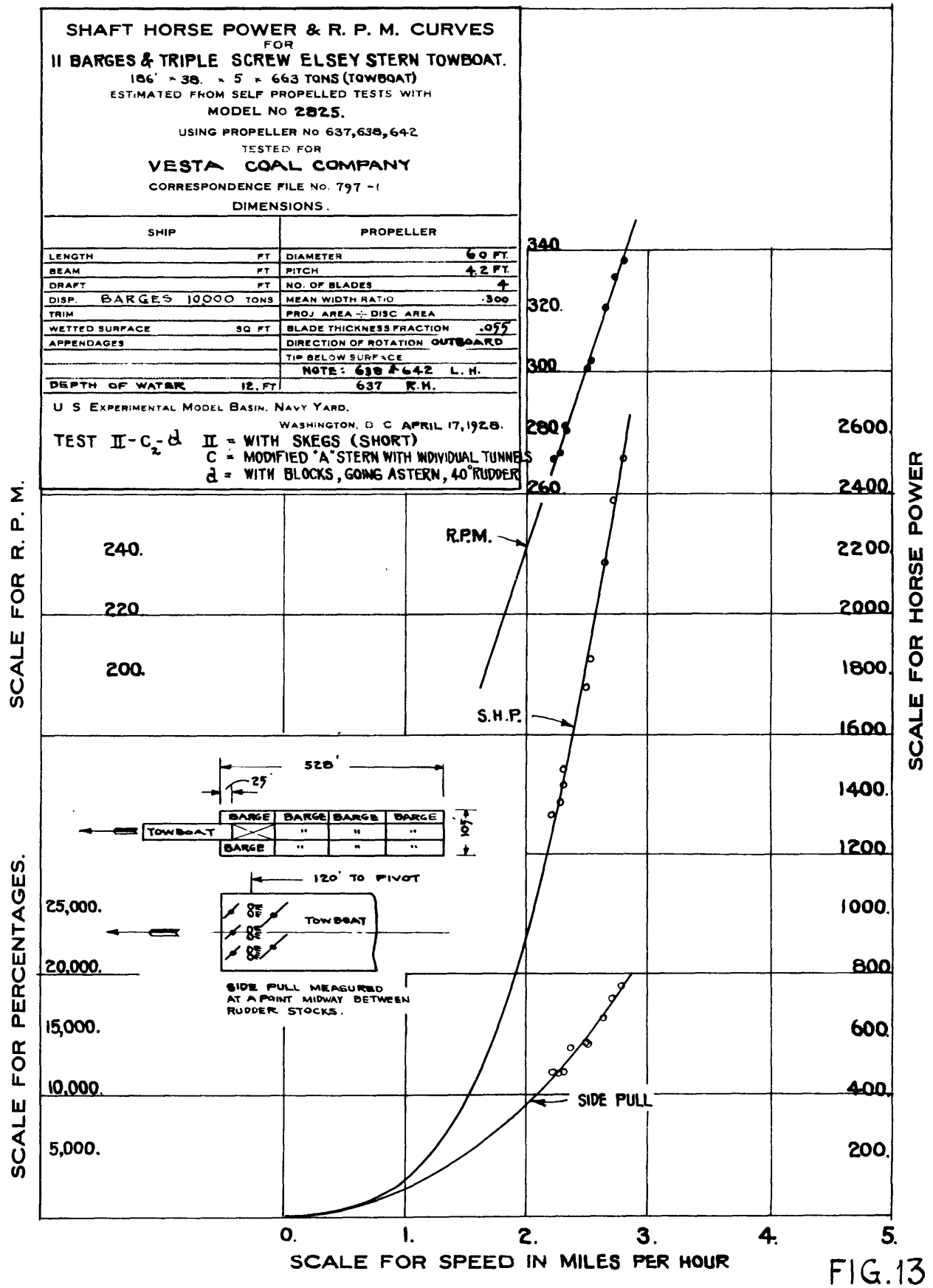

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW ELSEY STERN TOWBOAT.
186' × 38. × 5' × 663 TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL No 2825.
USING PROPELLER No 637,638,642
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE No. 797 -(
DIMENSIONS.
SHIP
LENGTH FT
BEAM FT
DRAFT FT
DISP. BARGES 10000 TONS
TRIM
WETTED SURFACE SQ FT
APPENDAGES
DEPTH OF WATER 12. FT
PROPELLER
DIAMETER 6 0 FT.
PITCH 4.2 FT.
NO. OF BLADES 4
MEAN WIDTH RATIO .300
PROJ AREA ÷ DISC AREA
BLADE THICKNESS FRACTION .055
DIRECTION OF ROTATION OUTBOARD
TIP BELOW SURFACE
NOTE: 638 & 642 L. H.
637 R.H.
U S EXPERIMENTAL MODEL BASIN, NAVY YARD.
WASHINGTON, D C APRIL 17, 1928.
TEST II-C2-d II = WITH SKEGS (SHORT)
C = MODIFIED "A" STERN WITH INDIVIDUAL TUNNELS
d = WITH BLOCKS, GOING ASTERN, 40° RUDDER
SCALE FOR R. P. M.
SCALE FOR PERCENTAGES.
SCALE FOR HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR
R.P.M.
S.H.P.
SIDE PULL
340
320.
300
280
260
240.
220
200.
2600.
2400.
2200.
2000.
1800.
1600.
1400.
1200.
1000.
800
600.
400.
200.
25,000.
20,000.
15,000.
10,000.
5,000.
0.
1.
2.
3.
4.
5.
528'
25'
BARGE
TOWBOAT
107'
120' TO PIVOT
SIDE PULL MEASURED AT A POINT MIDWAY BETWEEN RUDDER STOCKS.

FIG. 13

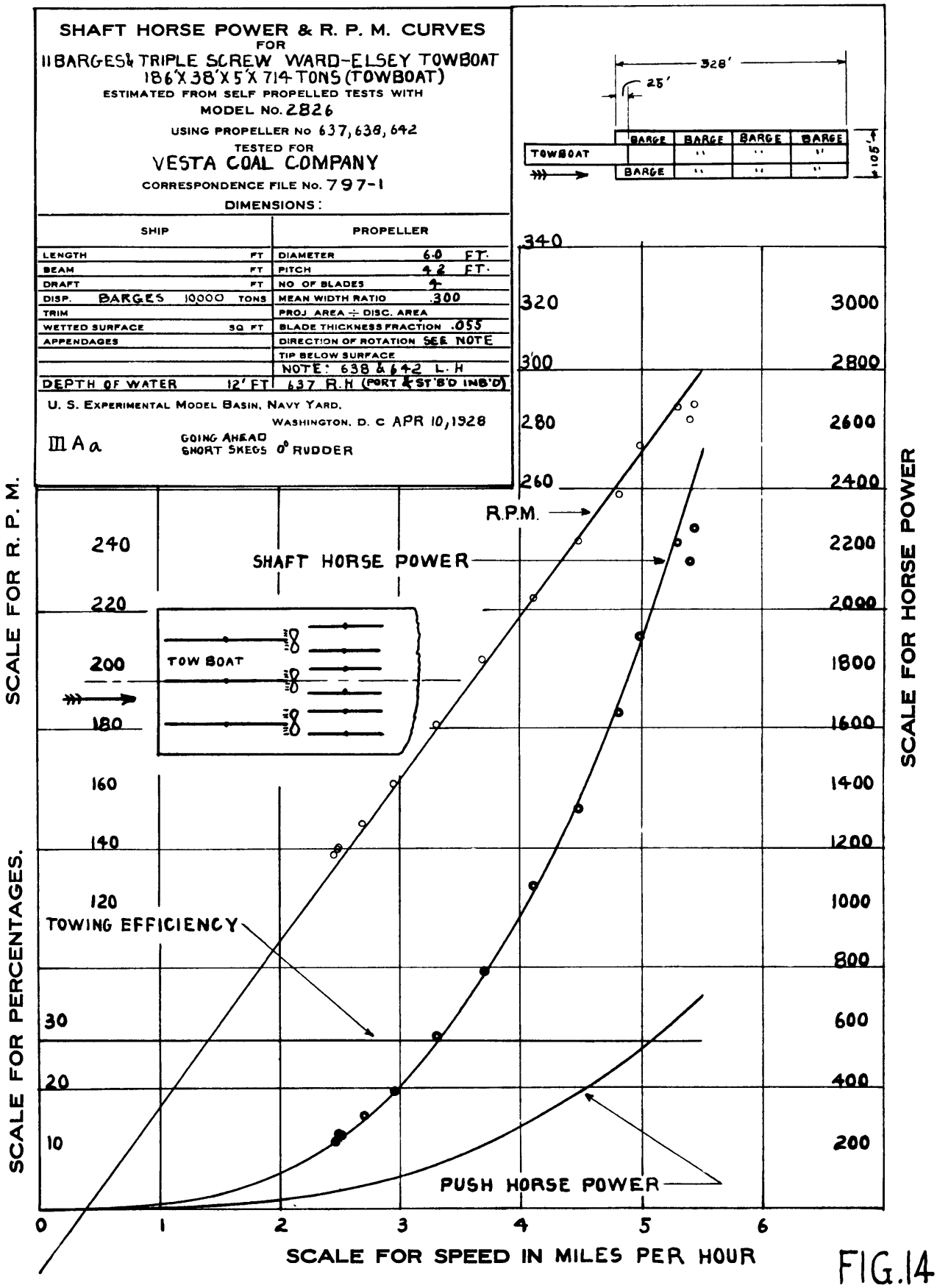

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW WARD-ELSEY TOWBOAT
186'X38'X5'X 714 TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL No. 2826
USING PROPELLER No 637, 638, 642
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE No. 797-1
DIMENSIONS:
SHIP
LENGTH FT
BEAM FT
DRAFT FT
DISP. BARGES 10000 TONS
TRIM
WETTED SURFACE SQ FT
APPENDAGES
DEPTH OF WATER 12' FT
PROPELLER
DIAMETER 6.0 FT.
PITCH 4.2 FT.
NO OF BLADES 4
MEAN WIDTH RATIO .300
PROJ AREA ÷ DISC. AREA
BLADE THICKNESS FRACTION .055
DIRECTION OF ROTATION SEE NOTE
TIP BELOW SURFACE
NOTE: 638 & 642 L.H
637 R.H (PORT & ST'B'D INB'D)
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD,
WASHINGTON, D. C APR 10, 1928
III A a
GOING AHEAD
SHORT SKEGS 0° RUDDER
328'
25'
BARGE
TOWBOAT
105'
340
320
300
280
260
240
220
200
180
160
140
120
30
20
10
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
R.P.M.
SHAFT HORSE POWER
TOW BOAT
TOWING EFFICIENCY
PUSH HORSE POWER
SCALE FOR R. P. M.
SCALE FOR PERCENTAGES.
SCALE FOR HORSE POWER
0
1
2
3
4
5
6
SCALE FOR SPEED IN MILES PER HOUR

FIG. 14

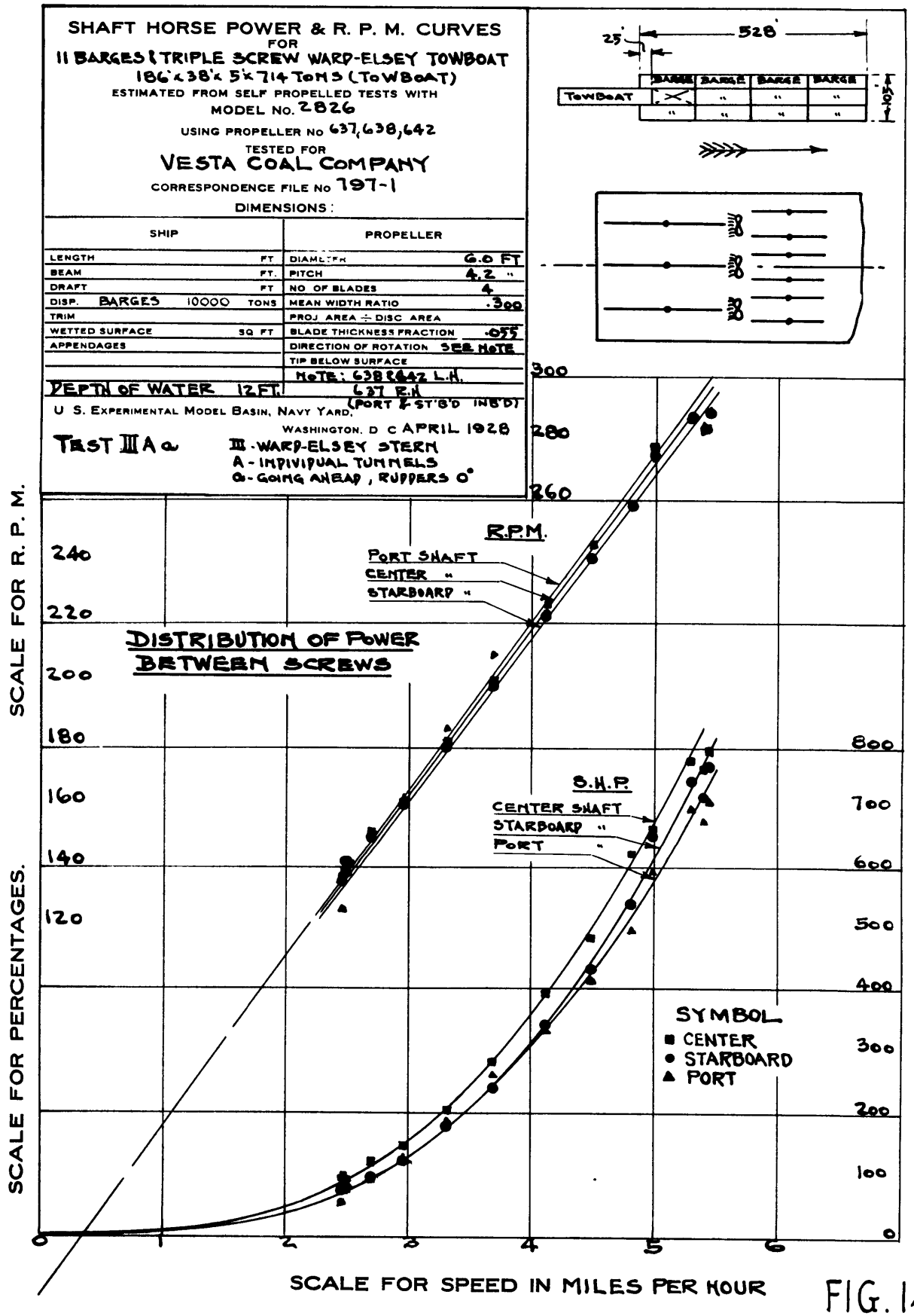

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW WARD-ELSEY TOWBOAT
186'x38'x 5'x 714 ToNS (ToWBoAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL NO. 2826
USING PROPELLER NO 637,638,642
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE NO 197-1
DIMENSIONS:
SHIP
LENGTH FT
BEAM FT.
DRAFT FT
DISP. BARGES 10000 TONS
TRIM
WETTED SURFACE SQ FT
APPENDAGES
PROPELLER
DIAMETER 6.0 FT
PITCH 4.2 "
NO OF BLADES 4
MEAN WIDTH RATIO .300
PROJ AREA ÷ DISC AREA
BLADE THICKNESS FRACTION .055
DIRECTION OF ROTATION SEE NOTE
TIP BELOW SURFACE
NOTE: 638 & 642 L.H.
637 R.H.
(PORT & ST'B'D INB'D)
DEPTH OF WATER 12 FT.
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD.
WASHINGTON, D C APRIL 1928
TEST III A a
III - WARD-ELSEY STERN
A - INDIVIDUAL TUNNELS
a - GOING AHEAD, RUDDERS 0°
25'
528'
BARGE
TOWBOAT
SCALE FOR R. P. M.
SCALE FOR PERCENTAGES.
SCALE FOR HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR
R.P.M.
PORT SHAFT
CENTER "
STARBOARD "
S.H.P.
CENTER SHAFT
STARBOARD "
PORT "
DISTRIBUTION OF POWER
BETWEEN SCREWS
SYMBOL
CENTER
STARBOARD
PORT

FIG. 14a

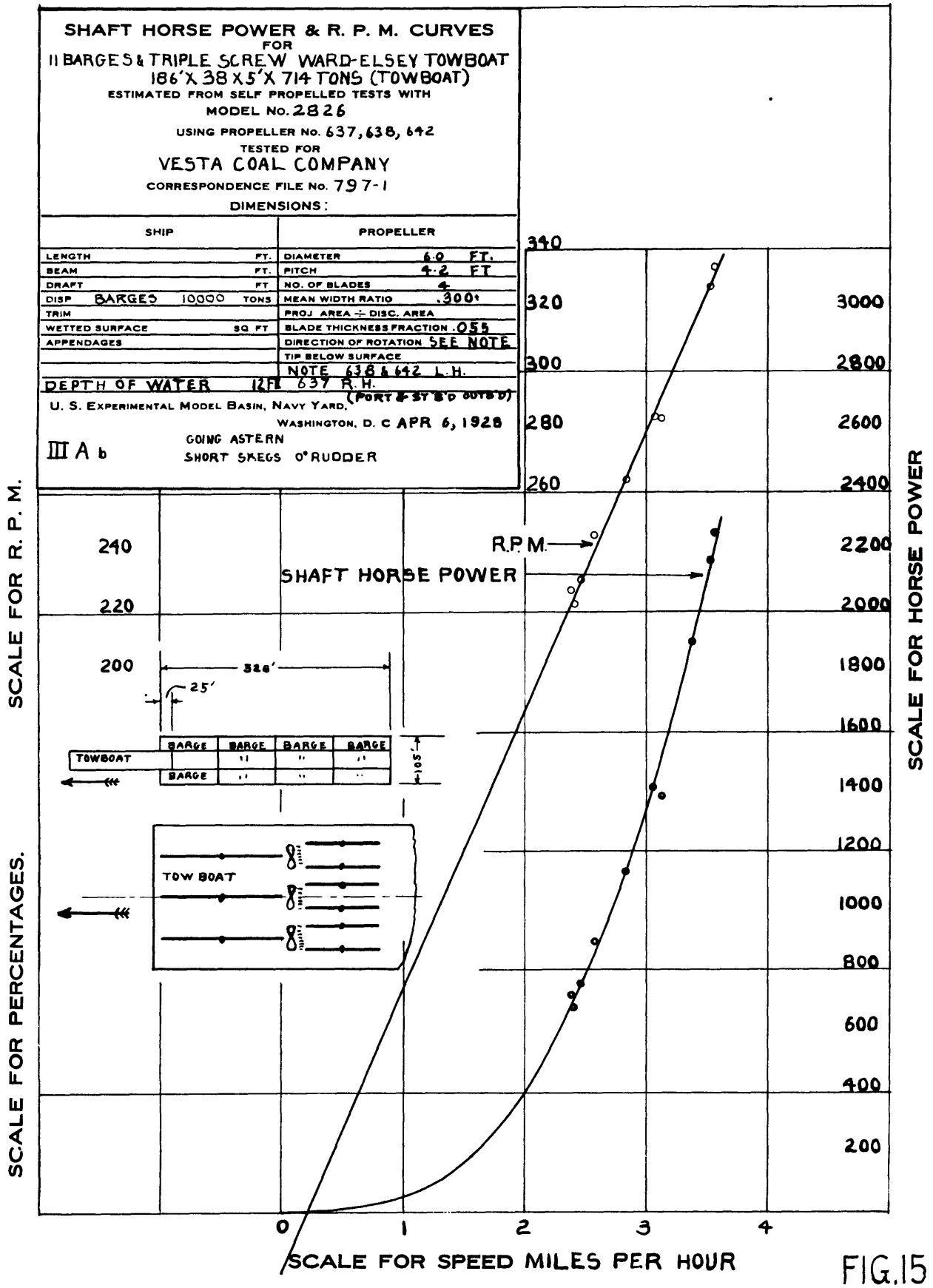

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW WARD-ELSEY TOWBOAT
186'X 38 X 5'X 714 TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL No. 2826
USING PROPELLER No. 637, 638, 642
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE No. 797-1
DIMENSIONS:
SHIP
LENGTH FT.
BEAM FT.
DRAFT FT
DISP BARGES 10000 TONS
TRIM
WETTED SURFACE SQ FT
APPENDAGES
PROPELLER
DIAMETER 6.0 FT.
PITCH 4.2 FT
NO. OF BLADES 4
MEAN WIDTH RATIO .300
PROJ AREA ÷ DISC. AREA
BLADE THICKNESS FRACTION .055
DIRECTION OF ROTATION SEE NOTE
TIP BELOW SURFACE
NOTE 638 & 642 L.H.
637 R.H.
(PORT & ST B'D OUTB'D)
DEPTH OF WATER 12Ft
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD,
WASHINGTON, D. C APR 6, 1928
III A b
GOING ASTERN
SHORT SKEGS 0° RUDDER
SCALE FOR R. P. M.
SCALE FOR PERCENTAGES.
SCALE FOR HORSE POWER
SCALE FOR SPEED MILES PER HOUR
R.P.M.
SHAFT HORSE POWER
340
320
300
280
260
240
220
200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1
2
3
4
526'
25'
BARGE
TOWBOAT
105'
TOW BOAT

FIG. 15

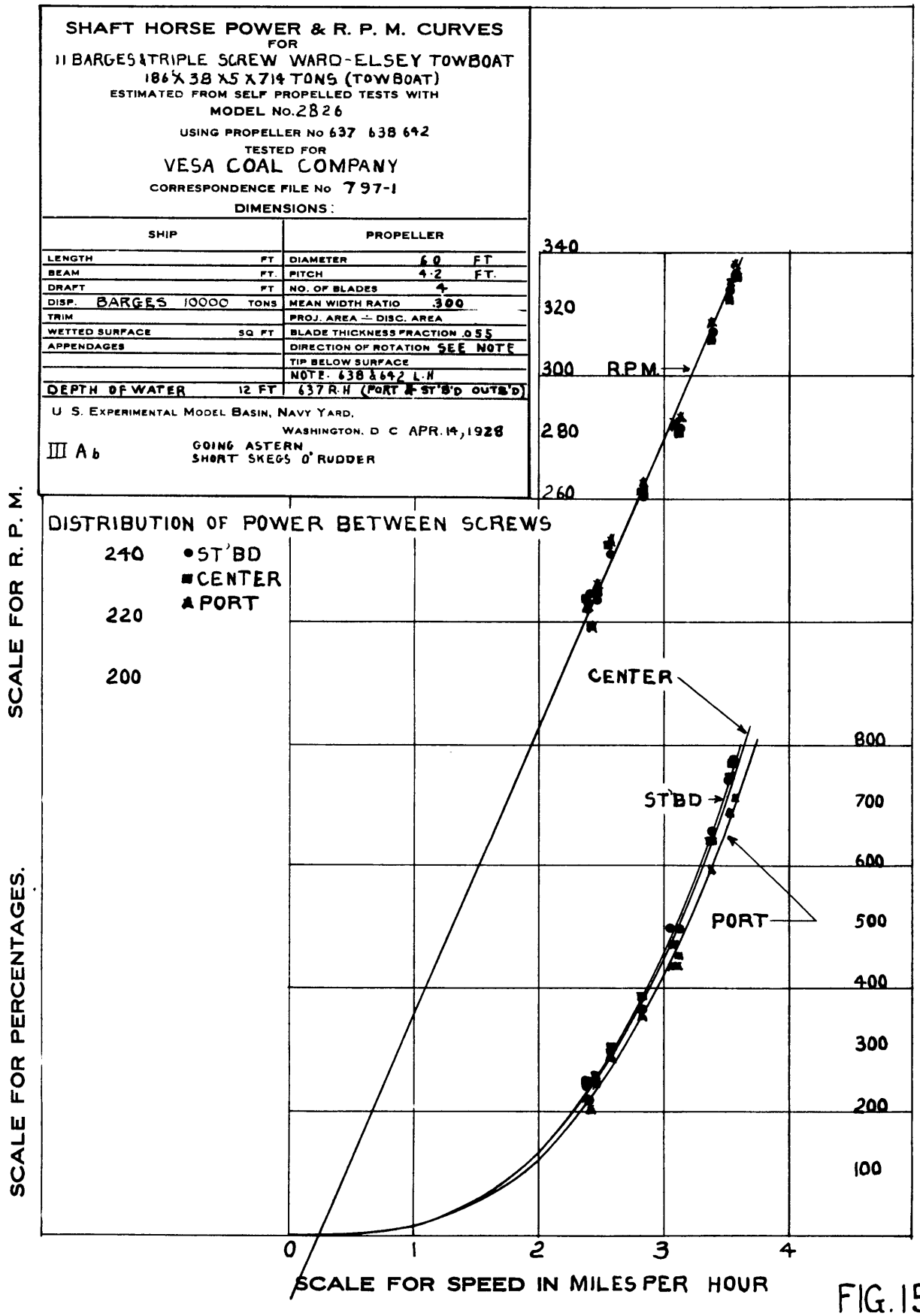

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW WARD-ELSEY TOWBOAT
186'X 38 X5 X714 TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL No. 2826
USING PROPELLER No 637 638 642
TESTED FOR
VESA COAL COMPANY
CORRESPONDENCE FILE No 797-1
DIMENSIONS:
SHIP
LENGTH FT
BEAM FT.
DRAFT FT
DISP. BARGES 10000 TONS
TRIM
WETTED SURFACE SQ FT
APPENDAGES
DEPTH OF WATER 12 FT
PROPELLER
DIAMETER 6 0 FT
PITCH 4·2 FT.
NO. OF BLADES 4
MEAN WIDTH RATIO .300
PROJ. AREA ÷ DISC. AREA
BLADE THICKNESS FRACTION .055
DIRECTION OF ROTATION SEE NOTE
TIP BELOW SURFACE
NOTE: 638 & 642 L.H
637 R.H (PORT & ST'B'D OUTB'D)
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD,
WASHINGTON, D C APR. 14, 1928
III A b
GOING ASTERN
SHORT SKEGS 0° RUDDER
DISTRIBUTION OF POWER BETWEEN SCREWS
ST'BD
CENTER
PORT
SCALE FOR R. P. M.
SCALE FOR PERCENTAGES.
SCALE FOR HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR
RPM
CENTER
ST'BD
PORT
340
320
300
280
260
240
220
200
800
700
600
500
400
300
200
100
0
1
2
3
4

FIG. 15 a

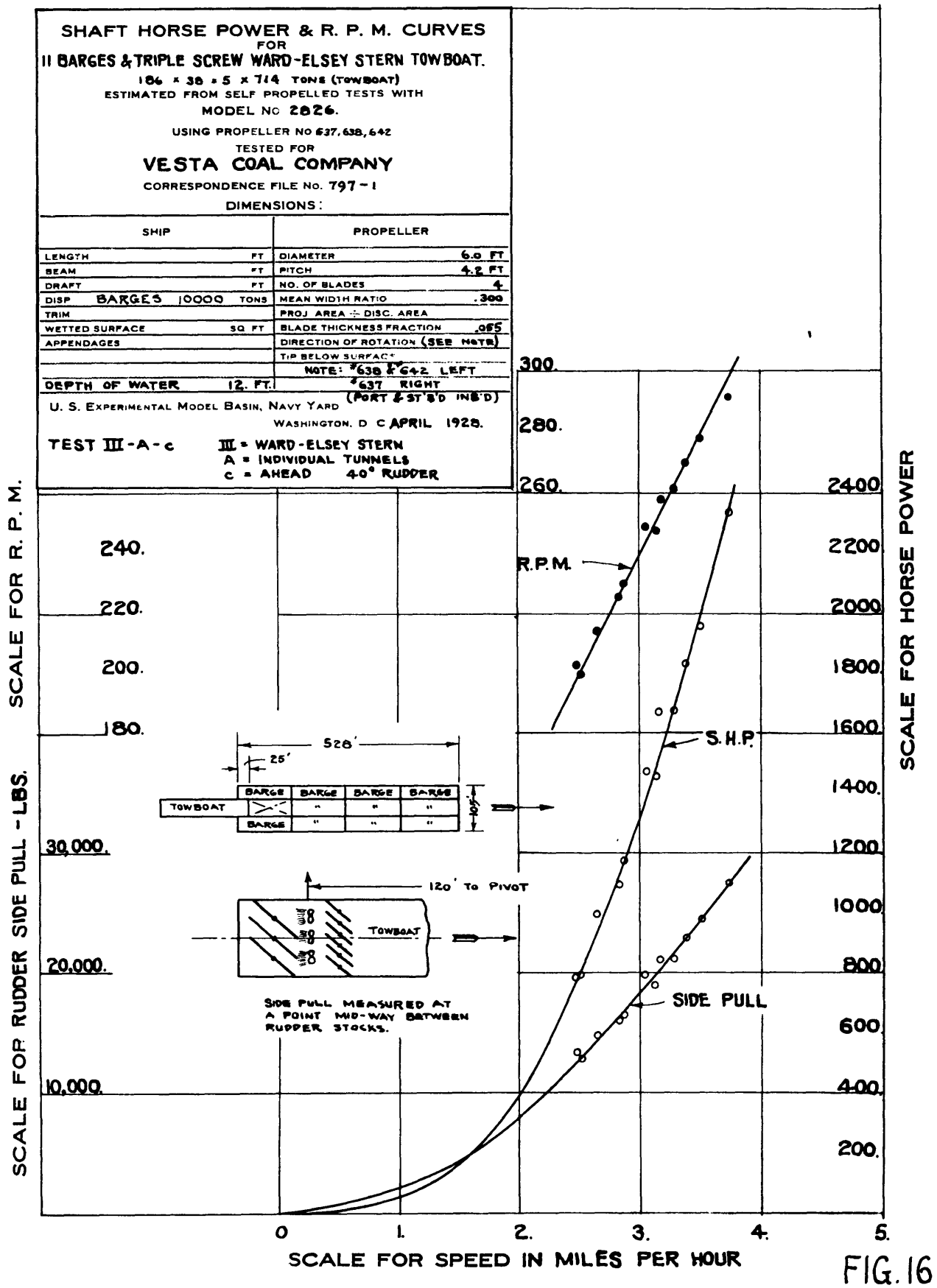

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW WARD-ELSEY STERN TOWBOAT.
186 x 38 x 5 x 714 TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL NO 2826.
USING PROPELLER NO 637, 638, 642
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE NO. 797-1
DIMENSIONS:
SHIP
PROPELLER
LENGTH FT
BEAM FT
DRAFT FT
DISP BARGES 10000 TONS
TRIM
WETTED SURFACE SQ FT
APPENDAGES
DEPTH OF WATER 12. FT.
DIAMETER 6.0 FT
PITCH 4.2 FT
NO. OF BLADES 4
MEAN WIDTH RATIO .300
PROJ AREA ÷ DISC. AREA
BLADE THICKNESS FRACTION .055
DIRECTION OF ROTATION (SEE NOTE)
TIP BELOW SURFACE
NOTE: #638 & #642 LEFT
#637 RIGHT
(PORT & ST'B'D INBD)
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD
WASHINGTON, D C APRIL 1928.
TEST III-A-c
III = WARD-ELSEY STERN
A = INDIVIDUAL TUNNELS
c = AHEAD 40° RUDDER
SCALE FOR R. P. M.
SCALE FOR RUDDER SIDE PULL - LBS.
SCALE FOR HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR
R.P.M.
S.H.P.
SIDE PULL
300.
280.
260.
240.
220.
200.
180.
2400
2200
2000
1800
1600
1400.
1200
1000
800
600
400
200
30,000.
20,000.
10,000.
0
1.
2.
3.
4.
5.
528'
25'
BARGE
TOWBOAT
105'
120' To PIVOT
TOWBOAT
SIDE PULL MEASURED AT
A POINT MID-WAY BETWEEN
RUDDER STOCKS.

FIG. 16

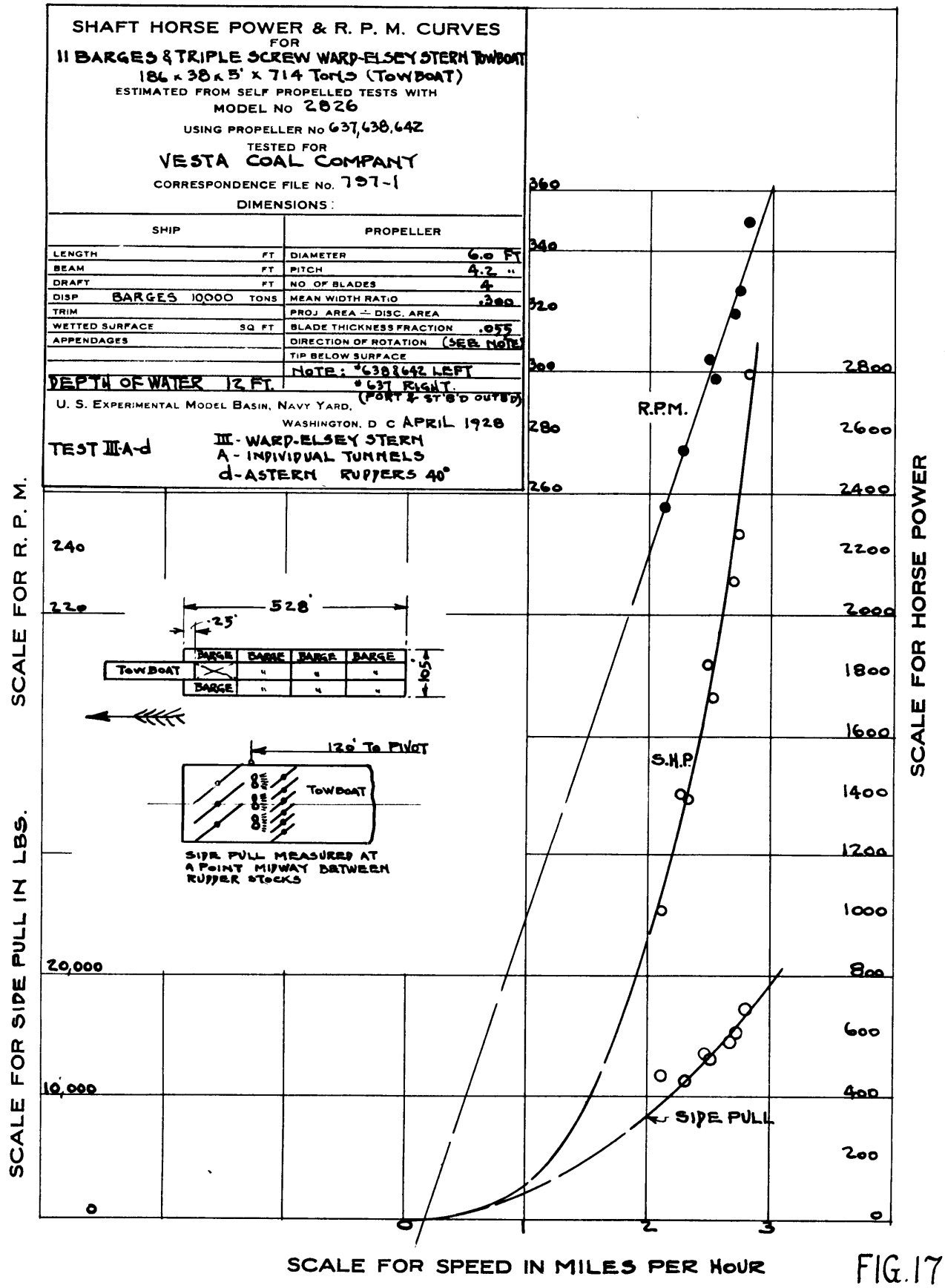

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW WARD-ELSEY STERN TOWBOAT
186 x 38 x 5' x 714 TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL NO 2826
USING PROPELLER NO 637, 638, 642
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE NO. 797-1
DIMENSIONS:
SHIP
PROPELLER
LENGTH FT
BEAM FT
DRAFT FT
DISP BARGES 10000 TONS
TRIM
WETTED SURFACE SQ FT
APPENDAGES
DIAMETER 6.0 FT
PITCH 4.2 "
NO OF BLADES 4
MEAN WIDTH RATIO .200
PROJ AREA ÷ DISC. AREA
BLADE THICKNESS FRACTION .055
DIRECTION OF ROTATION (SEE NOTE)
TIP BELOW SURFACE
NOTE: #638 & 642 LEFT
#637 RIGHT.
(PORT & ST'D OUTBD)
DEPTH OF WATER 12 FT.
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD,
WASHINGTON, D C APRIL 1928
TEST III-A-d
III - WARD-ELSEY STERN
A - INDIVIDUAL TUNNELS
d - ASTERN RUDDERS 40°
528'
25'
BARGE
TOWBOAT
105'
120' To PIVOT
TOWBOAT
SIDE PULL MEASURED AT A POINT MIDWAY BETWEEN RUDDER STOCKS
R.P.M.
S.H.P.
SIDE PULL
SCALE FOR R. P. M.
SCALE FOR SIDE PULL IN LBS.
SCALE FOR HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR
360
340
320
300
280
260
240
220
20,000
10,000
0
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1
2
3

FIG. 17

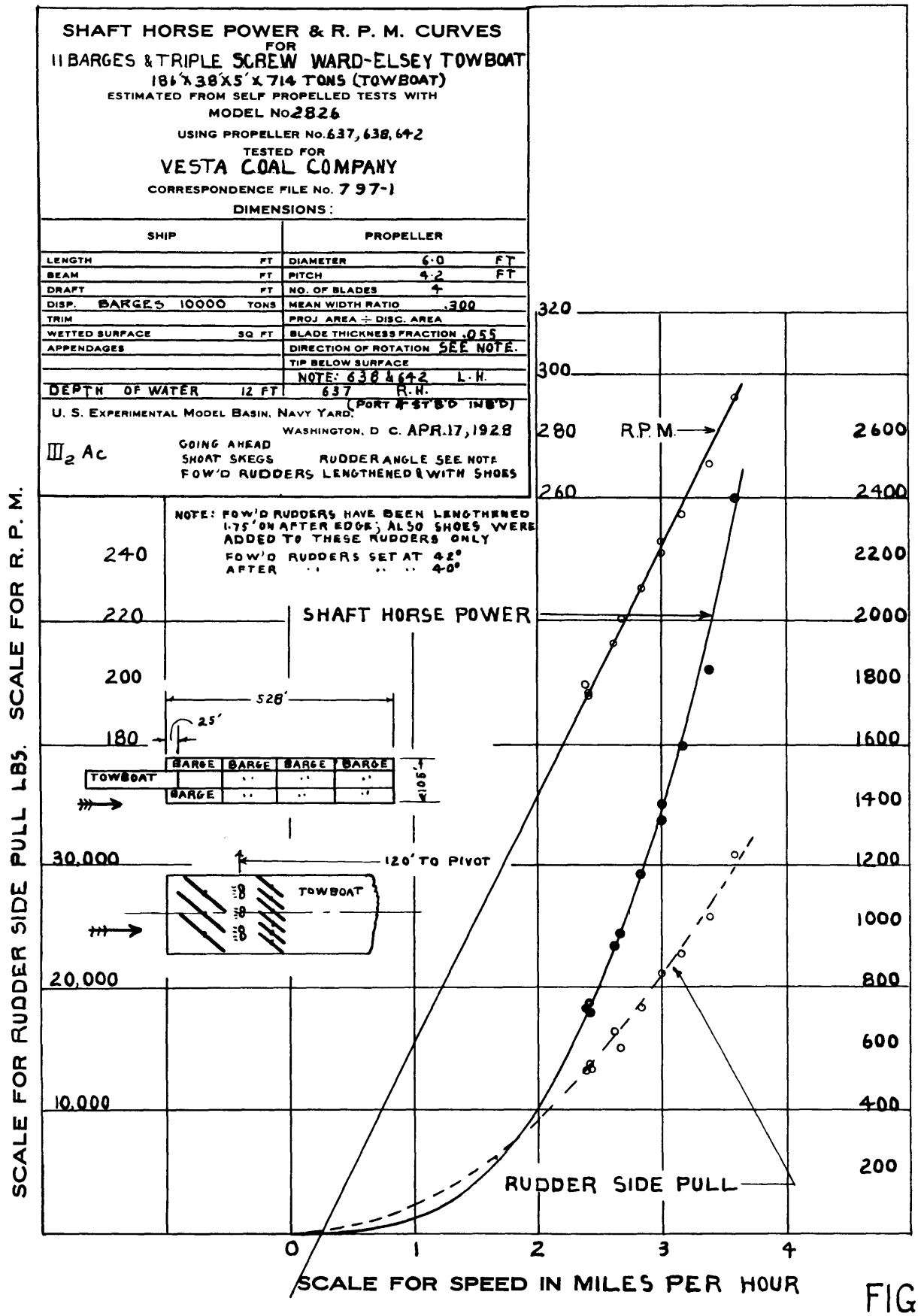

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW WARD-ELSEY TOWBOAT
186'X38'X5'X714 TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL NO. 2826
USING PROPELLER NO. 637, 638, 642
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE NO. 797-1
DIMENSIONS:
SHIP
LENGTH FT
BEAM FT
DRAFT FT
DISP. BARGES 10000 TONS
TRIM
WETTED SURFACE SQ FT
APPENDAGES
DEPTH OF WATER 12 FT
PROPELLER
DIAMETER 6·0 FT
PITCH 4·2 FT
NO. OF BLADES 4
MEAN WIDTH RATIO .300
PROJ AREA ÷ DISC. AREA
BLADE THICKNESS FRACTION .055
DIRECTION OF ROTATION SEE NOTE.
TIP BELOW SURFACE
NOTE: 638 & 642 L.H.
637 R.H.
(PORT & STB'D INB'D)
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD,
WASHINGTON, D. C. APR. 17, 1928
III_2 Ac
GOING AHEAD
SHOAT SKEGS RUDDER ANGLE SEE NOTE
FOW'D RUDDERS LENGTHENED & WITH SHOES
NOTE: FOW'D RUDDERS HAVE BEEN LENGTHENED 1.75' ON AFTER EDGE; ALSO SHOES WERE ADDED TO THESE RUDDERS ONLY
FOW'D RUDDERS SET AT 42°
AFTER " " " 40°
SHAFT HORSE POWER
R.P.M.
RUDDER SIDE PULL
528'
25'
BARGE
TOWBOAT
105'
120' TO PIVOT
SCALE FOR RUDDER SIDE PULL LBS.
SCALE FOR R. P. M.
SCALE FOR HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR
30,000
20,000
10,000
240
220
200
180
320
300
280
260
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1
2
3
4

FIG. 18

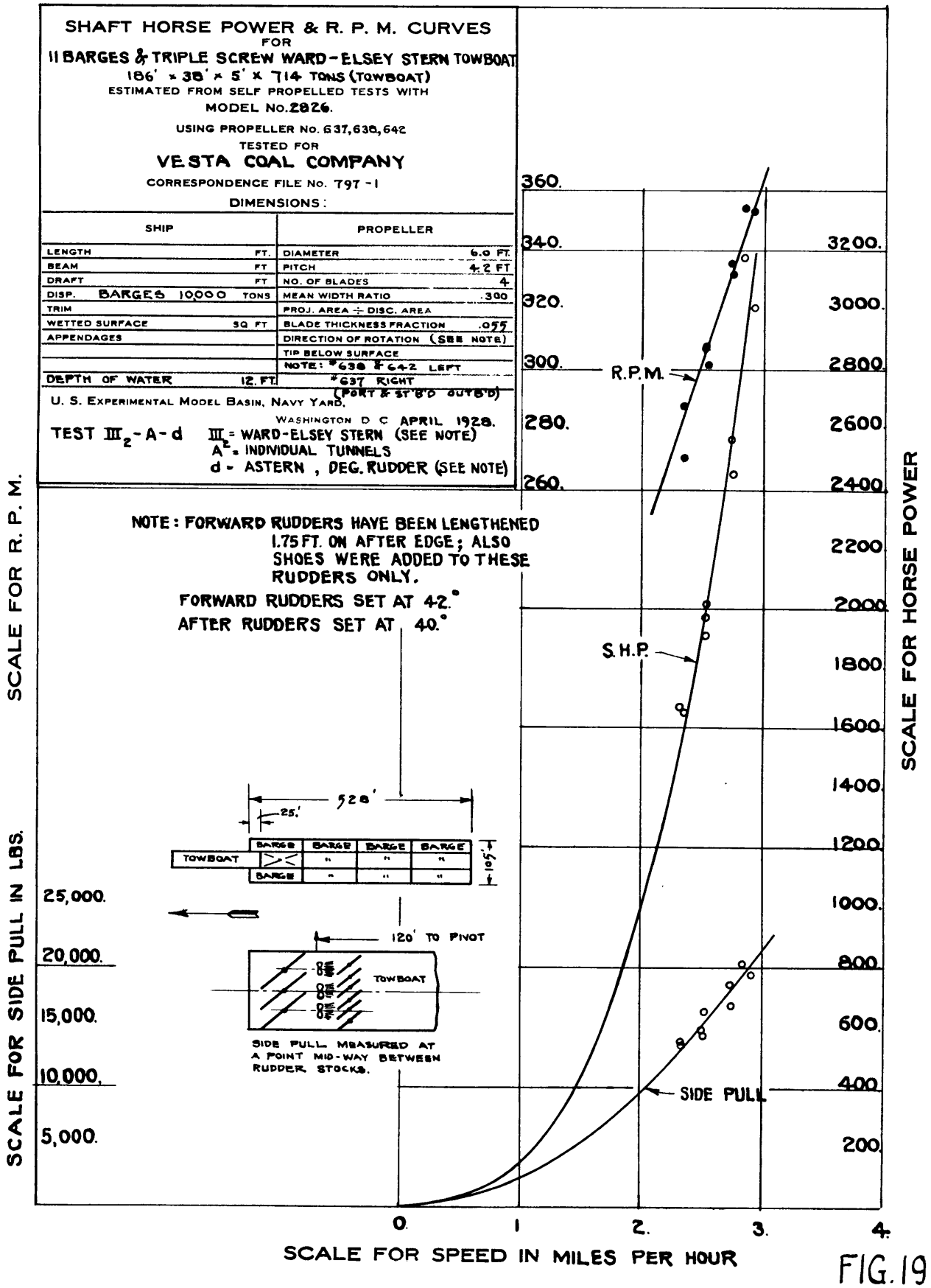

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW WARD-ELSEY STERN TOWBOAT
186' x 38' x 5' x 714 TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL No. 2826.
USING PROPELLER No. 637, 638, 642
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE No. 797-1
DIMENSIONS:
SHIP
LENGTH FT.
BEAM FT
DRAFT FT
DISP. BARGES 10000 TONS
TRIM
WETTED SURFACE SQ FT
APPENDAGES
DEPTH OF WATER 12. FT.
PROPELLER
DIAMETER 6.0 FT.
PITCH 4.2 FT
NO. OF BLADES 4
MEAN WIDTH RATIO .300
PROJ. AREA ÷ DISC. AREA
BLADE THICKNESS FRACTION .055
DIRECTION OF ROTATION (SEE NOTE)
TIP BELOW SURFACE
NOTE: #638 & 642 LEFT
#637 RIGHT
(PORT & ST'B'D OUTB'D)
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD.
WASHINGTON D C APRIL 1928.
TEST III2-A-d III2 = WARD-ELSEY STERN (SEE NOTE)
A2 = INDIVIDUAL TUNNELS
d = ASTERN, DEG. RUDDER (SEE NOTE)
NOTE: FORWARD RUDDERS HAVE BEEN LENGTHENED 1.75 FT. ON AFTER EDGE; ALSO SHOES WERE ADDED TO THESE RUDDERS ONLY.
FORWARD RUDDERS SET AT 42.°
AFTER RUDDERS SET AT 40.°
528'
25'
BARGE
TOWBOAT
105'
120' TO PIVOT
SIDE PULL MEASURED AT A POINT MID-WAY BETWEEN RUDDER STOCKS.
R.P.M.
S.H.P.
SIDE PULL
SCALE FOR R. P. M.
SCALE FOR SIDE PULL IN LBS.
SCALE FOR HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR
360.
340.
320.
300.
280.
260.
3200.
3000.
2800.
2600.
2400.
2200.
2000.
1800.
1600.
1400.
1200.
1000.
800.
600.
400.
200.
25,000.
20,000.
15,000.
10,000.
5,000.
0
1
2.
3.
4.

FIG. 19

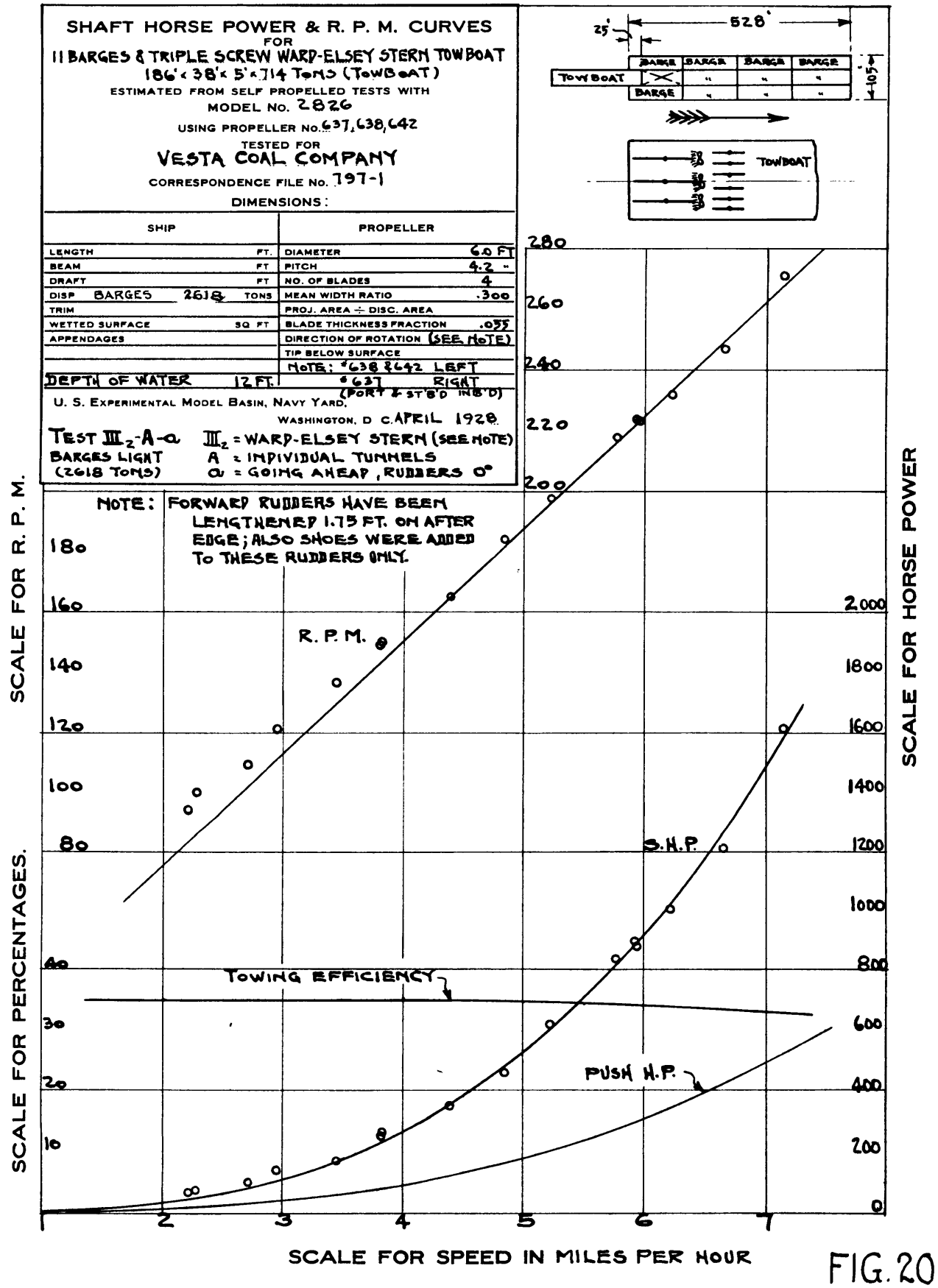

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TRIPLE SCREW WARD-ELSEY STERN TOWBOAT
186' x 38' x 5'-7 1/4 Tons (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL NO. 2826
USING PROPELLER NO. 637, 638, 642
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE NO. 197-1
DIMENSIONS:
SHIP
LENGTH FT.
BEAM FT
DRAFT FT
DISP BARGES 2618 TONS
TRIM
WETTED SURFACE SQ FT
APPENDAGES
DEPTH OF WATER 12 FT.
PROPELLER
DIAMETER 6.0 FT
PITCH 4.2 "
NO. OF BLADES 4
MEAN WIDTH RATIO .300
PROJ. AREA ÷ DISC. AREA
BLADE THICKNESS FRACTION .035
DIRECTION OF ROTATION (SEE NOTE)
TIP BELOW SURFACE
NOTE: #638 #642 LEFT
#637 RIGHT
(PORT & ST'B'D INB'D)
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD,
WASHINGTON, D C. APRIL 1928.
TEST III2-A-a
BARGES LIGHT
(2618 TONS)
III2 = WARD-ELSEY STERN (SEE NOTE)
A = INDIVIDUAL TUNNELS
a = GOING AHEAD, RUDDERS 0°
25'
528'
105'
BARGE
TOWBOAT
NOTE: FORWARD RUDDERS HAVE BEEN LENGTHENED 1.75 FT. ON AFTER EDGE; ALSO SHOES WERE ADDED TO THESE RUDDERS ONLY.
R. P. M.
S.H.P.
TOWING EFFICIENCY
PUSH H.P.
SCALE FOR R. P. M.
SCALE FOR PERCENTAGES.
SCALE FOR HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR
180
160
140
120
100
80
40
30
20
10
280
260
240
220
200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
2
3
4
5
6
7

FIG. 20

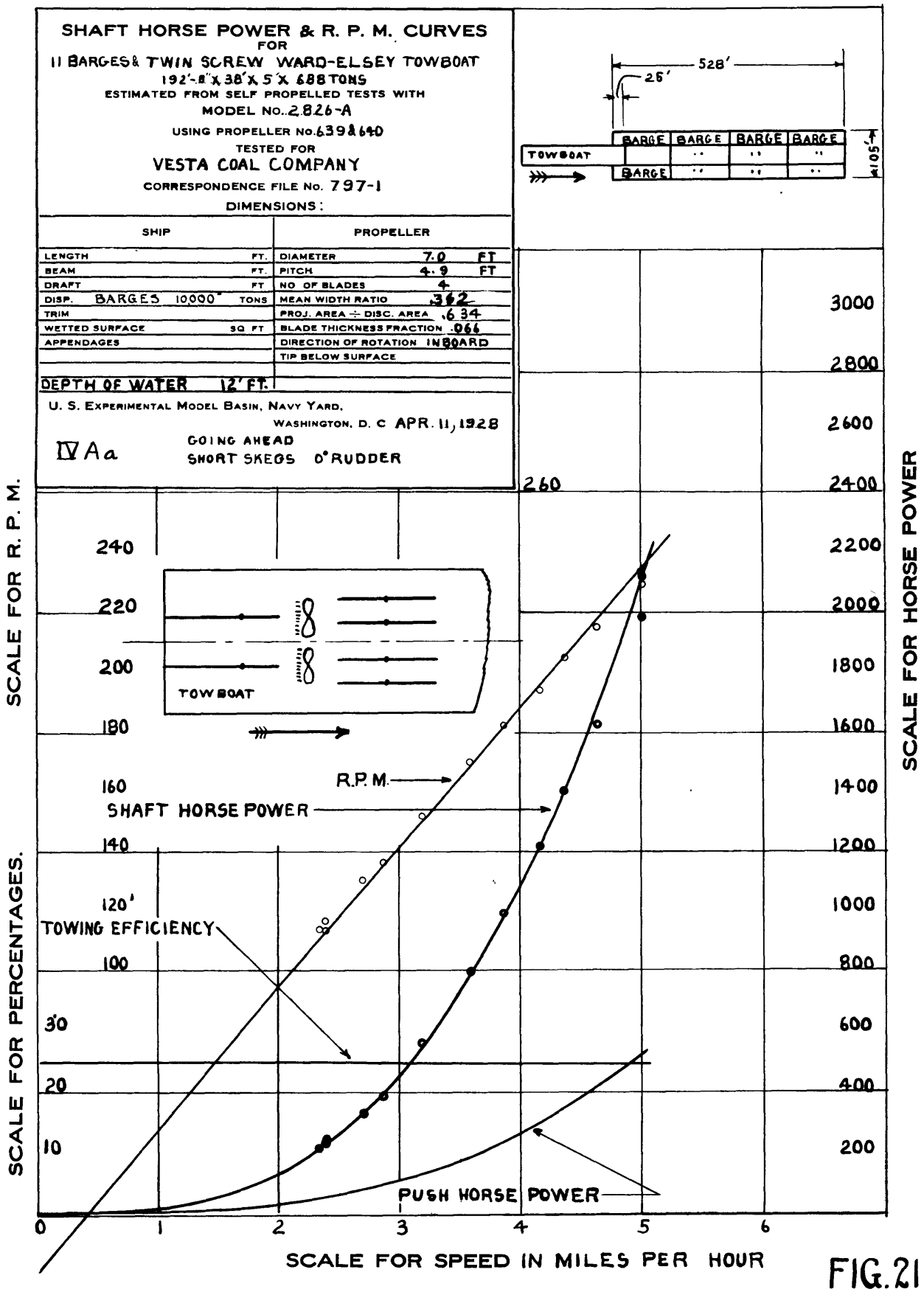

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TWIN SCREW WARD-ELSEY TOWBOAT
192'-8" X 38' X 5' X 688 TONS
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL NO. 2826-A
USING PROPELLER No. 639 & 640
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE No. 797-1
DIMENSIONS:
SHIP
LENGTH FT.
BEAM FT.
DRAFT FT.
DISP. BARGES 10000 TONS
TRIM
WETTED SURFACE SQ FT
APPENDAGES
PROPELLER
DIAMETER 7.0 FT
PITCH 4.9 FT
NO OF BLADES 4
MEAN WIDTH RATIO .362
PROJ. AREA ÷ DISC. AREA .634
BLADE THICKNESS FRACTION .066
DIRECTION OF ROTATION INBOARD
TIP BELOW SURFACE
DEPTH OF WATER 12' FT.
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD,
WASHINGTON, D. C APR. 11, 1928
IV Aa
GOING AHEAD
SHORT SKEGS 0° RUDDER
528'
26'
BARGE
TOWBOAT
105'
SCALE FOR R. P. M.
SCALE FOR PERCENTAGES.
SCALE FOR HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR
TOW BOAT
R.P.M.
SHAFT HORSE POWER
TOWING EFFICIENCY
PUSH HORSE POWER
240
220
200
180
160
140
120
100
30
20
10
260
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1
2
3
4
5
6

FIG. 21

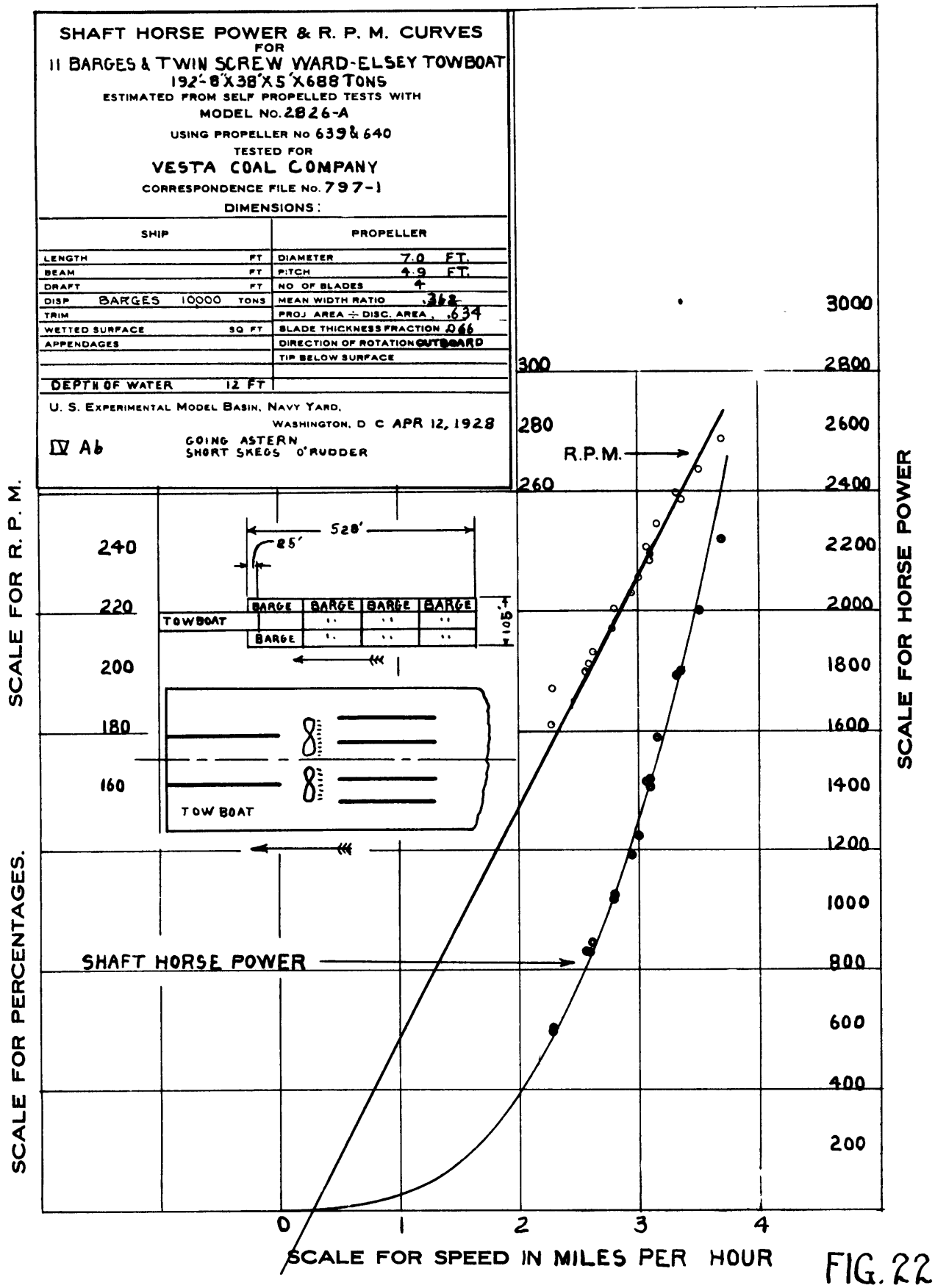

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TWIN SCREW WARD-ELSEY TOWBOAT
192'-8"X38'X5'X688 TONS
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL NO. 2826-A
USING PROPELLER No 639 & 640
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE No. 797-1
DIMENSIONS:
SHIP
PROPELLER
LENGTH FT
BEAM FT
DRAFT FT
DISP BARGES 10000 TONS
TRIM
WETTED SURFACE SQ FT
APPENDAGES
DIAMETER 7.0 FT.
PITCH 4.9 FT.
NO OF BLADES 4
MEAN WIDTH RATIO .368
PROJ AREA ÷ DISC. AREA .634
BLADE THICKNESS FRACTION .066
DIRECTION OF ROTATION OUTBOARD
TIP BELOW SURFACE
DEPTH OF WATER 12 FT
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD,
WASHINGTON, D C APR 12, 1928
IV Ab
GOING ASTERN.
SHORT SKEGS O'RUDDER
528'
85'
105'-4"
BARGE
TOWBOAT
TOW BOAT
SCALE FOR R. P. M.
SCALE FOR PERCENTAGES.
SCALE FOR HORSE POWER
R.P.M.
SHAFT HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR
300
280
260
240
220
200
180
160
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1
2
3
4

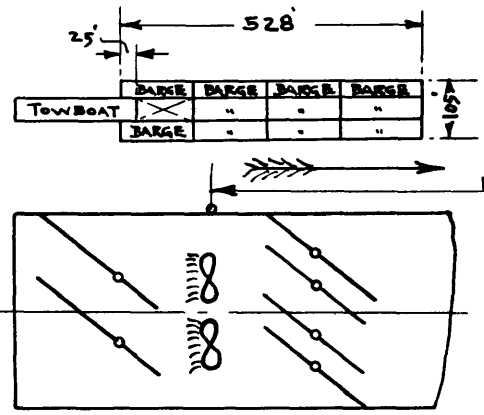
FIG. 22

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TWIN SCREW WARD-ELSEY TOWBOAT
192'-8" x 38 x 5' x 688 TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL NO. 2826 A
USING PROPELLER NO. 639 & 640
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE NO 797-1
DIMENSIONS:

SHIP		PROPELLER	
LENGTH	FT	DIAMETER	7.0 FT.
BEAM	FT	PITCH	4.9 "
DRAFT	FT	NO OF BLADES	4
DISP BARGES 10000	TONS	MEAN WIDTH RATIO	.362
TRIM		PROJ AREA ÷ DISC. AREA	.634
WETTED SURFACE	SQ FT	BLADE THICKNESS FRACTION	.066
APPENDAGES		DIRECTION OF ROTATION	INBOARD
		TIP BELOW SURFACE	
DEPTH OF WATER 12 FT.			

U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD,
WASHINGTON D C APRIL 1928

TEST IV AC
IV - WARD-ELSEY STERN
A - INDIVIDUAL TUNNELS
C - GOING AHEAD, RUDDERS 40°



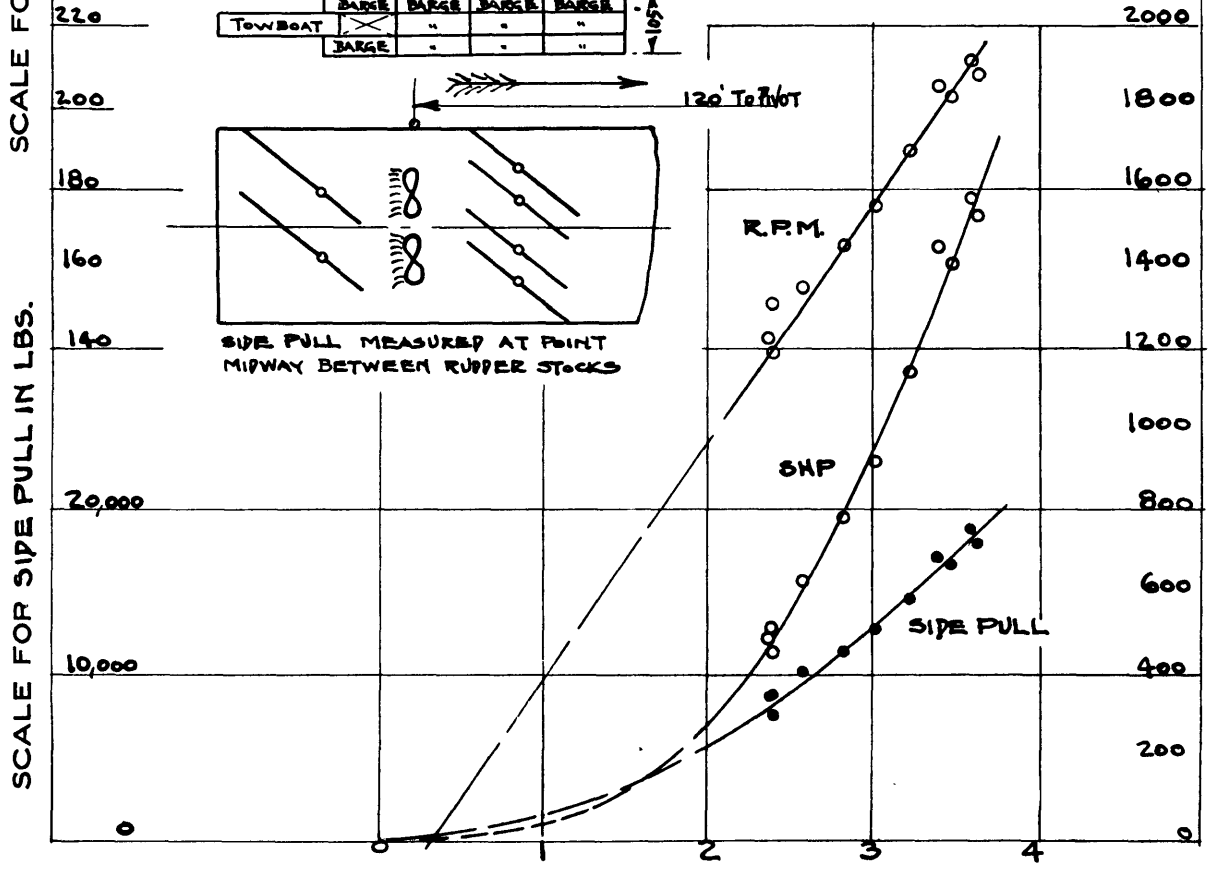


FIG. 23

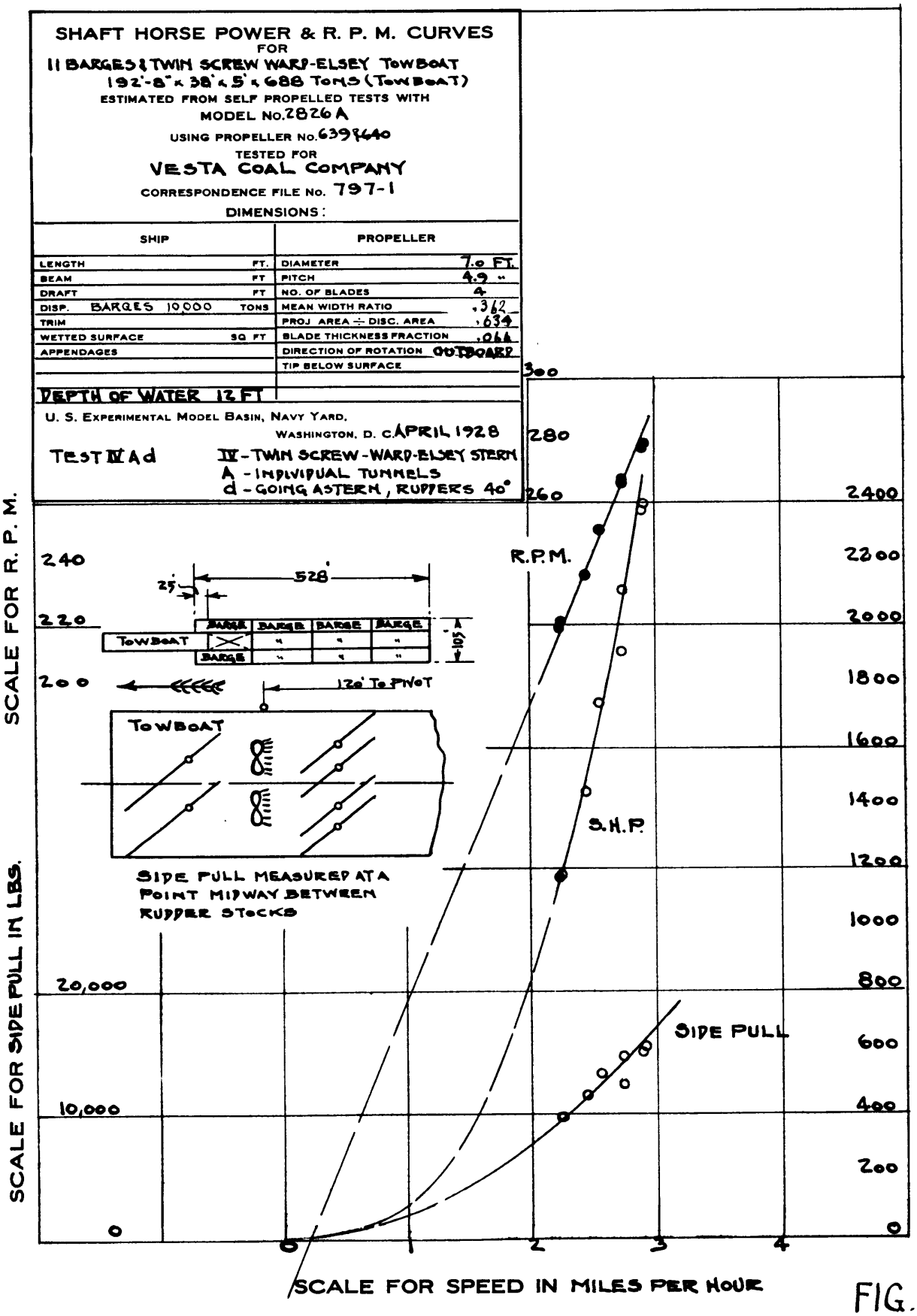

SHAFT HORSE POWER & R. P. M. CURVES
FOR
11 BARGES & TWIN SCREW WARD-ELSEY TOWBOAT
192'-8" x 38' x 5' x 688 TONS (TOWBOAT)
ESTIMATED FROM SELF PROPELLED TESTS WITH
MODEL NO. 2826 A
USING PROPELLER NO. 639 & 640
TESTED FOR
VESTA COAL COMPANY
CORRESPONDENCE FILE NO. 797-1
DIMENSIONS:
SHIP
LENGTH FT.
BEAM FT
DRAFT FT
DISP. BARGES 10000 TONS
TRIM
WETTED SURFACE SQ FT
APPENDAGES
PROPELLER
DIAMETER 7.0 FT.
PITCH 4.9 "
NO. OF BLADES 4
MEAN WIDTH RATIO .362
PROJ AREA ÷ DISC. AREA .634
BLADE THICKNESS FRACTION .044
DIRECTION OF ROTATION OUTBOARD
TIP BELOW SURFACE
DEPTH OF WATER 12 FT
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD,
WASHINGTON, D. C. APRIL 1928
TEST IV Ad
IV - TWIN SCREW - WARD-ELSEY STERN
A - INDIVIDUAL TUNNELS
d - GOING ASTERN, RUDDERS 40°
SCALE FOR R. P. M.
SCALE FOR SIDE PULL IN LBS.
SCALE FOR HORSE POWER
SCALE FOR SPEED IN MILES PER HOUR
R.P.M.
S.H.P.
SIDE PULL
300
280
260
240
220
200
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
20,000
10,000
0
1
2
3
4
528'
25'
105'
BARGE
TOWBOAT
120' TO PIVOT
SIDE PULL MEASURED AT A POINT MIDWAY BETWEEN RUDDER STOCKS

FIG. 24

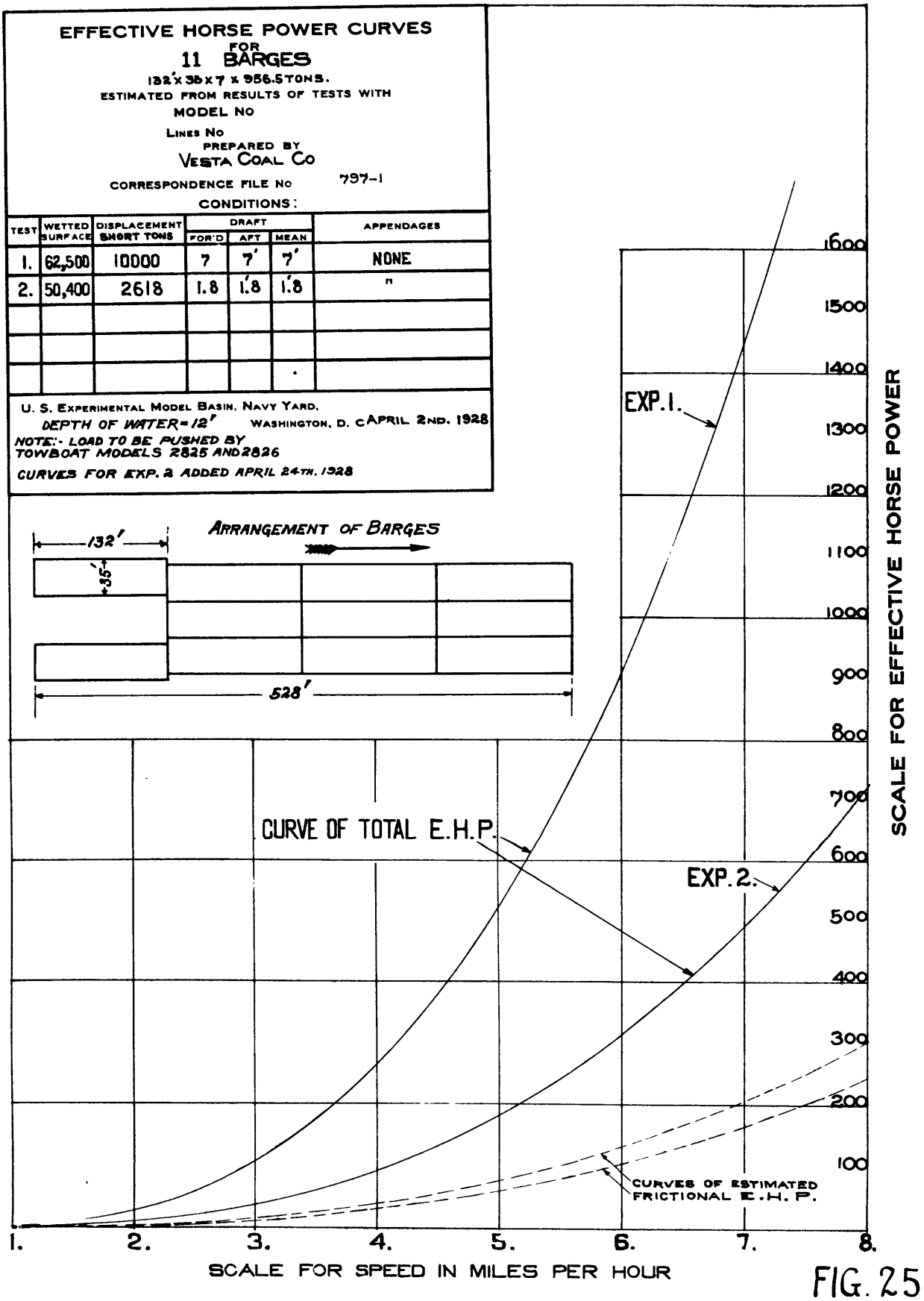

EFFECTIVE HORSE POWER CURVES
FOR
11 BARGES
132'x 35 x 7 x 956.5 TONS.
ESTIMATED FROM RESULTS OF TESTS WITH
MODEL NO
LINES NO
PREPARED BY
VESTA COAL CO
CORRESPONDENCE FILE NO 797-1
CONDITIONS:
TEST | WETTED SURFACE | DISPLACEMENT SHORT TONS | DRAFT FOR'D | DRAFT AFT | DRAFT MEAN | APPENDAGES
1. | 62,500 | 10000 | 7' | 7' | 7' | NONE
2. | 50,400 | 2618 | 1.8' | 1.8' | 1.8' | "
U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD,
DEPTH OF WATER = 12' WASHINGTON, D. C APRIL 2ND. 1928
NOTE:- LOAD TO BE PUSHED BY TOWBOAT MODELS 2825 AND 2826
CURVES FOR EXP. 2 ADDED APRIL 24TH. 1928
ARRANGEMENT OF BARGES
132'
35'
528'
EXP. 1.
CURVE OF TOTAL E.H.P.
EXP. 2.
CURVES OF ESTIMATED FRICTIONAL E.H.P.
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
SCALE FOR EFFECTIVE HORSE POWER
1.
2.
3.
4.
5.
6.
7.
8.
SCALE FOR SPEED IN MILES PER HOUR

FIG. 25

EFFECTIVE HORSE POWER CURVES

FOR

10 BARGES AND 6 BARGES

132'X35'X7'X 956.5TONS.

ESTIMATED FROM RESULTS OF TESTS WITH

MODEL NO.....

LINES NO .....

PREPARED BY

VESTA COAL CO.

CORRESPONDENCE FILE NO 797-1

CONDITIONS:

TEST	WETTED SURFACE	DISPLACEMENT TONS	DRAFT FOR D	DRAFT AFT	DRAFT MEAN	NO. OF BARGES	APPENDAGES
3.	56,961	9060	7'	7'	7'	10.	NONE
4.	3 177	5430	"	"	"	6.	"

U. S. EXPERIMENTAL MODEL BASIN, NAVY YARD,

WASHINGTON, D. C. MAY 10TH. 1928.

DEPTH OF WATER = 12'

NOTE:- LOAD TO BE PUSHED BY TOWBOAT MODELS 2825-2826

ARRANGEMENT OF BARGES EXP. 3.

EXP. 4.

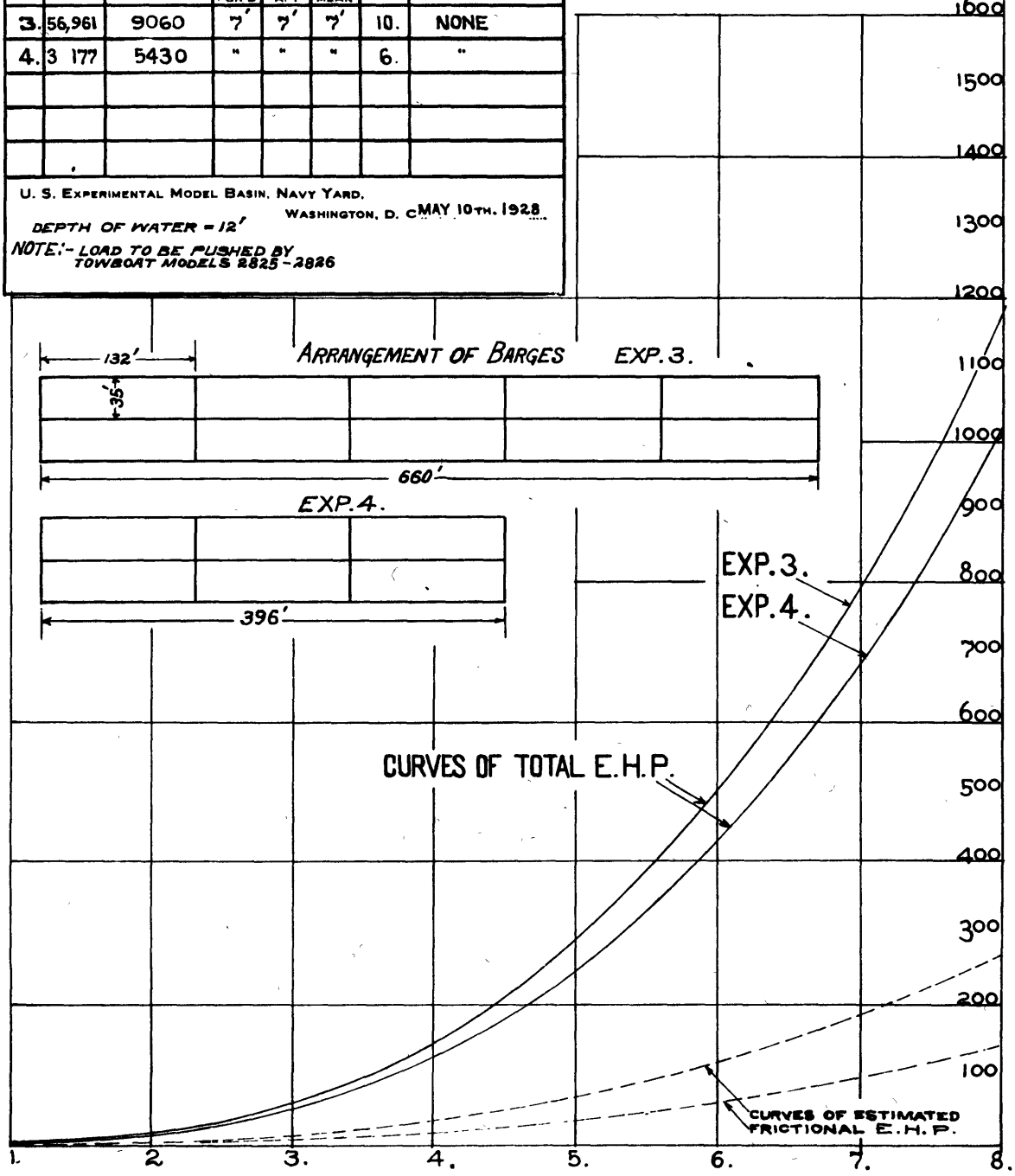


FIG. 25a

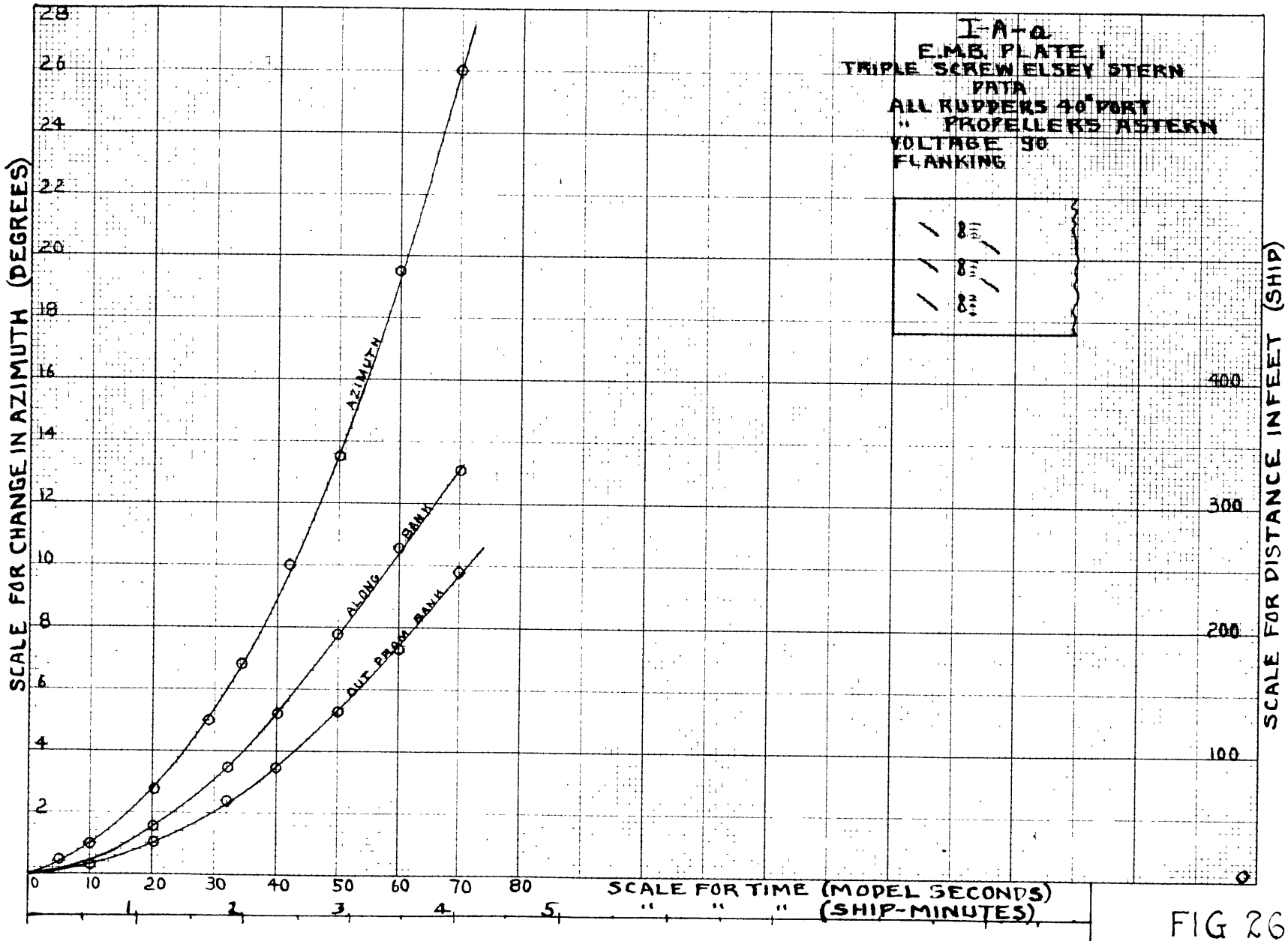

I-A-a
E.M.B. PLATE I
TRIPLE SCREW ELSEY STERN
DATA
ALL RUDDERS 40° PORT
" PROPELLERS ASTERN
VOLTAGE 90
FLANKING
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL SECONDS)
" " " (SHIP-MINUTES)
AZIMUTH
ALONG BANK
OUT FROM BANK
0 10 20 30 40 50 60 70 80
1 2 3 4 5
2 4 6 8 10 12 14 16 18 20 22 24 26 28
100 200 300 400

FIG 26

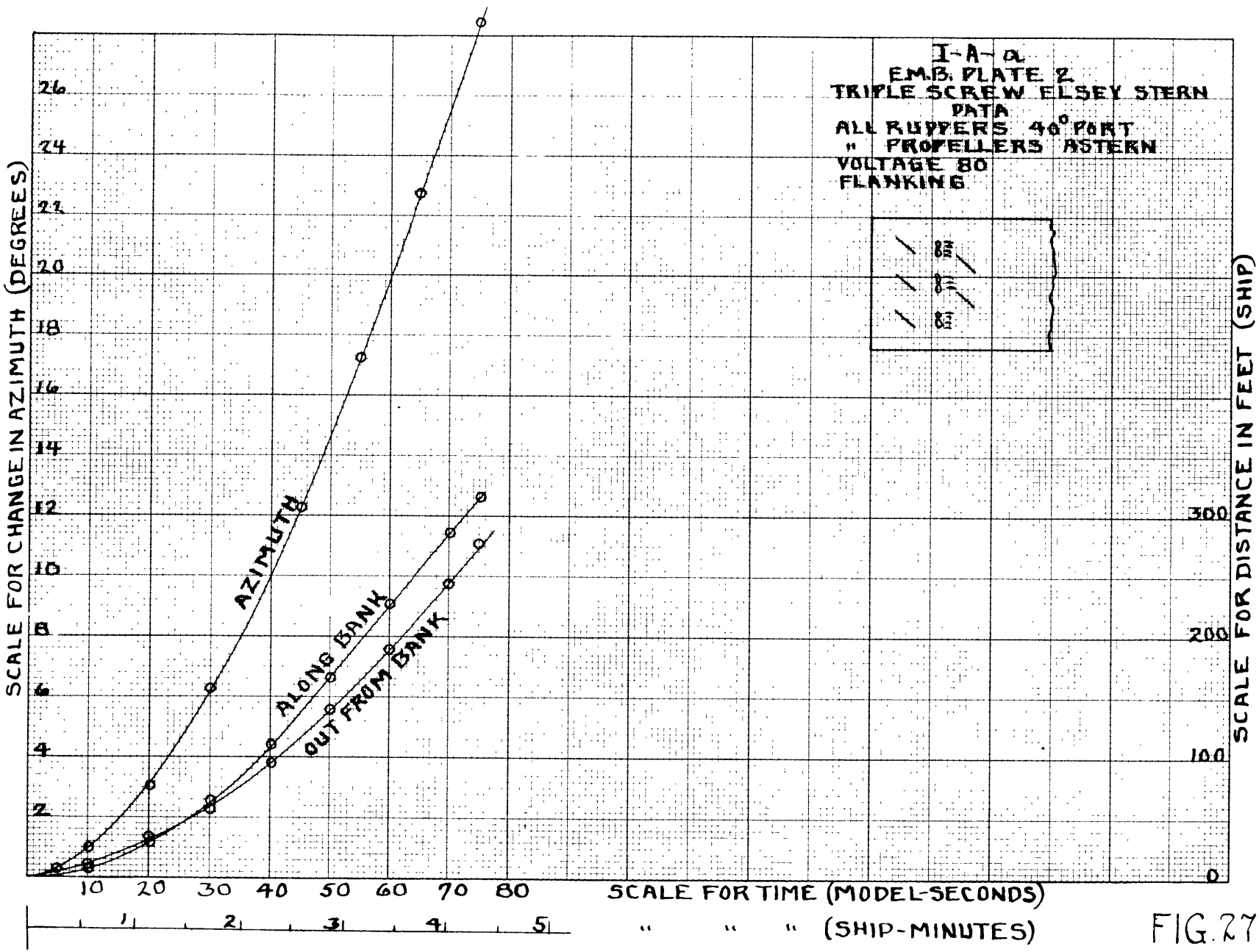

I-A-a
E.M.B. PLATE 2.
TRIPLE SCREW ELSEY STERN
DATA
ALL RUDDERS 40° PORT
" PROPELLERS ASTERN
VOLTAGE 80
FLANKING
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL-SECONDS)
" " " (SHIP-MINUTES)

FIG. 27

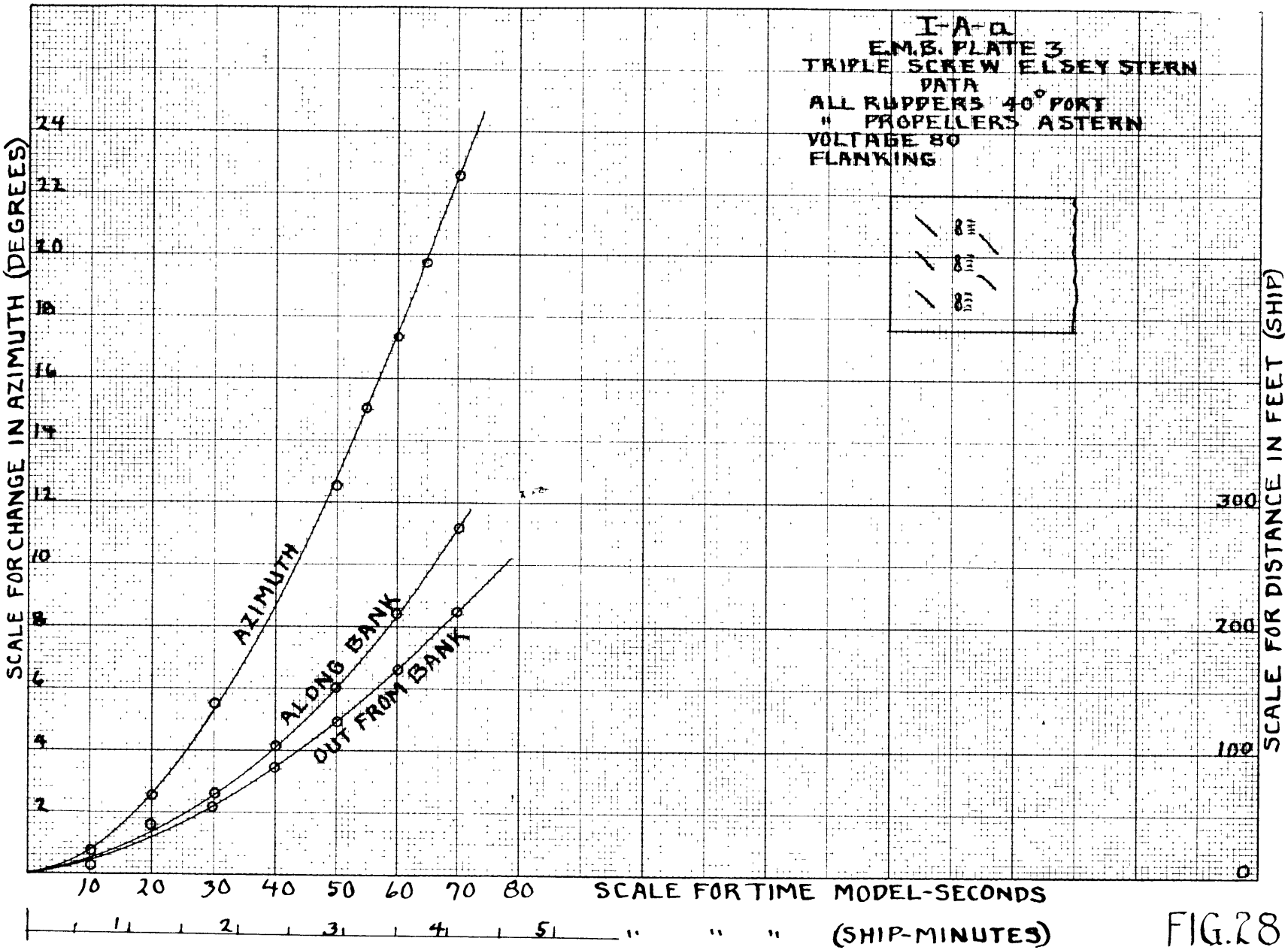

I-A-a
E.M.B. PLATE 3
TRIPLE SCREW ELSEY STERN
DATA
ALL RUDDERS 40° PORT
" PROPELLERS ASTERN
VOLTAGE 80
FLANKING
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
24
22
20
18
16
14
12
10
8
6
4
2
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR DISTANCE IN FEET (SHIP)
300
200
100
0
10 20 30 40 50 60 70 80
SCALE FOR TIME MODEL-SECONDS
1 2 3 4 5
" " "
(SHIP-MINUTES)

FIG. 28

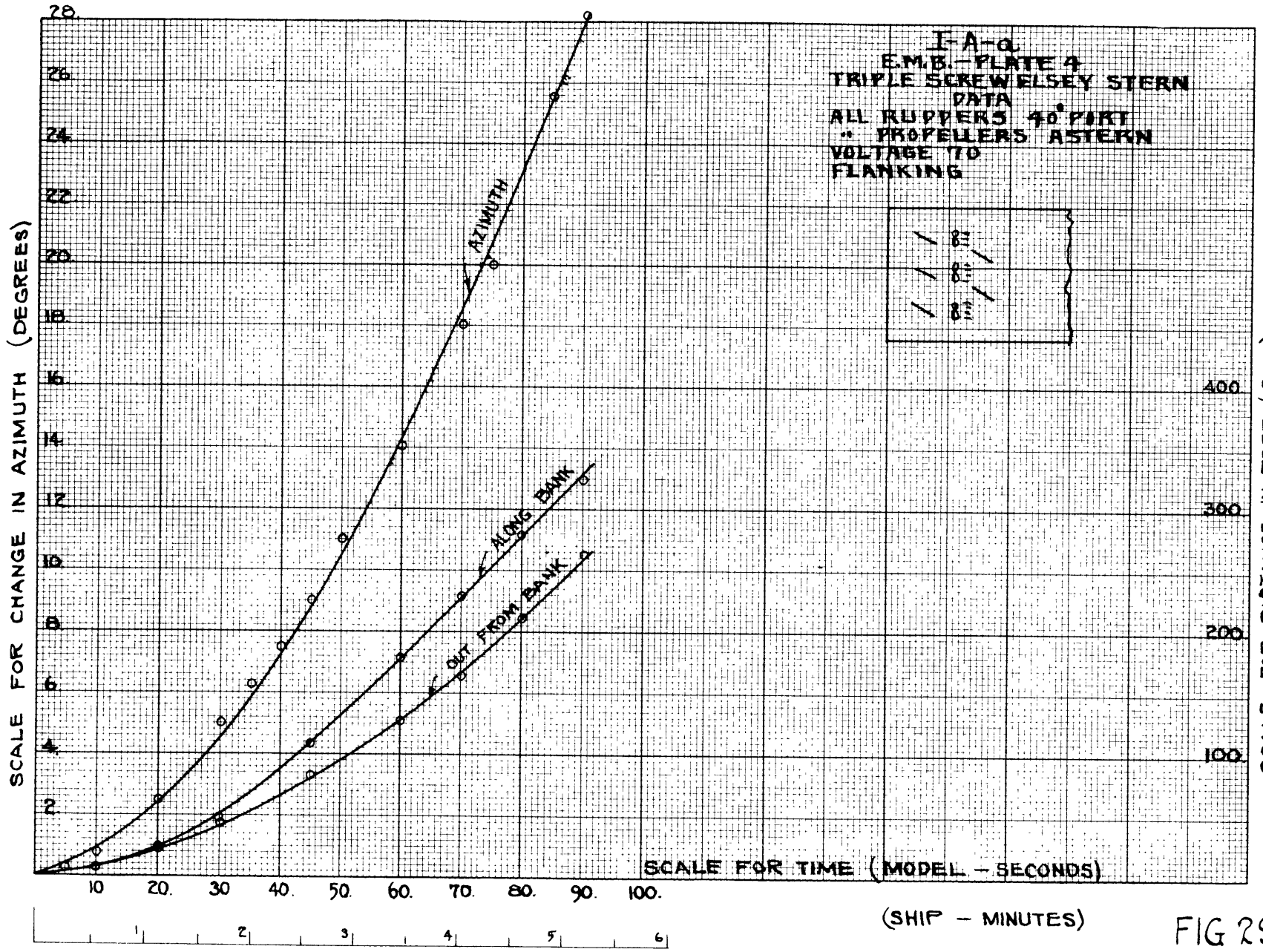

I-A-a
E.M.B.—PLATE 4
TRIPLE SCREW WELSEY STERN
DATA
ALL RUDDERS 40° PORT
" PROPELLERS ASTERN
VOLTAGE TO
FLANKING
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL — SECONDS)
(SHIP — MINUTES)
28
26
24
22
20
18
16
14
12
10
8
6
4
2
400
300
200
100
10
20
30
40
50
60
70
80
90
100
1
2
3
4
5
6

FIG 29

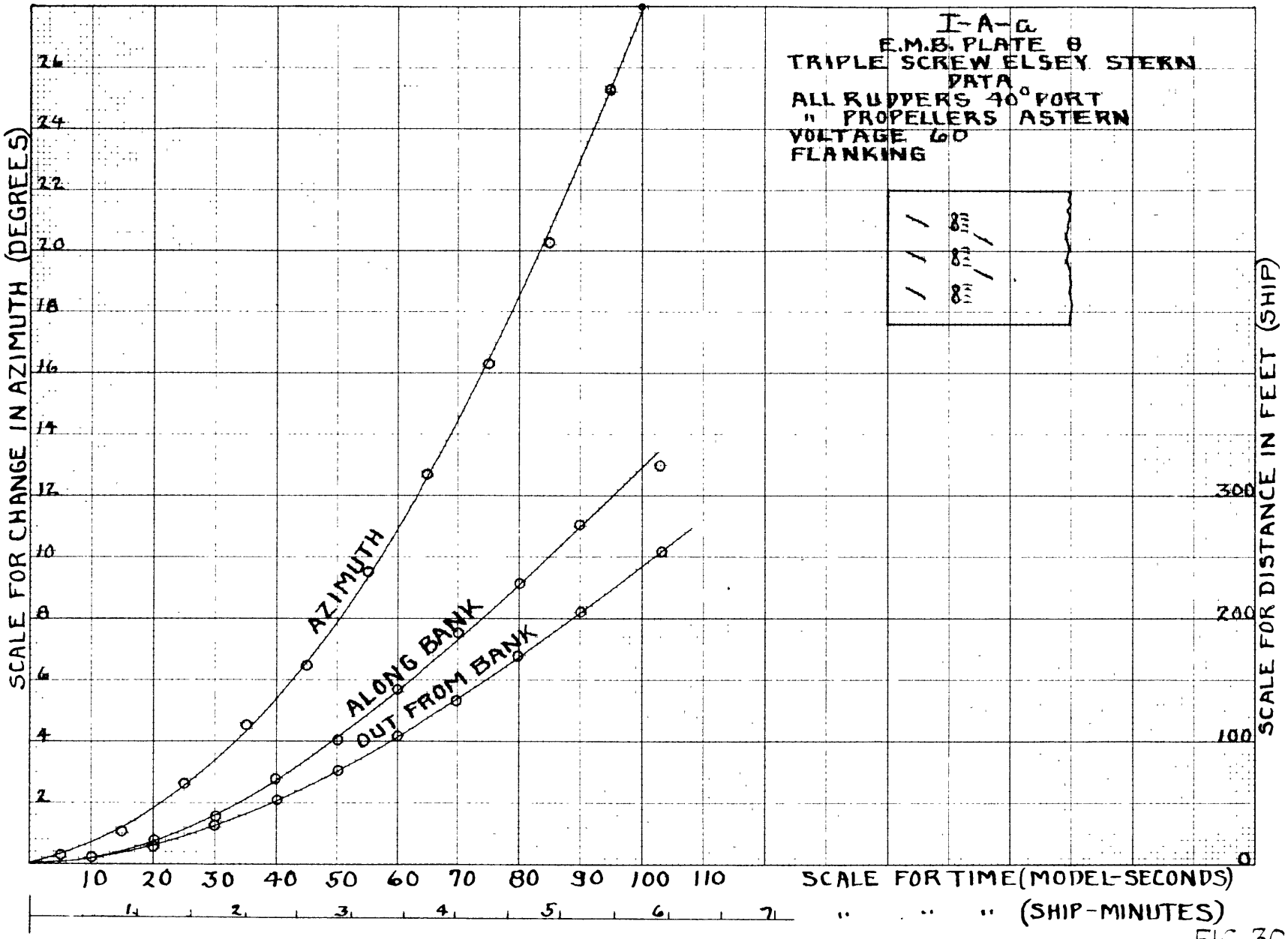

I-A-a
E.M.B. PLATE 8
TRIPLE SCREW ELSEY STERN
DATA
ALL RUDDERS 40° PORT
" PROPELLERS ASTERN
VOLTAGE 60
FLANKING
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL-SECONDS)
(SHIP-MINUTES)

FIG. 3C

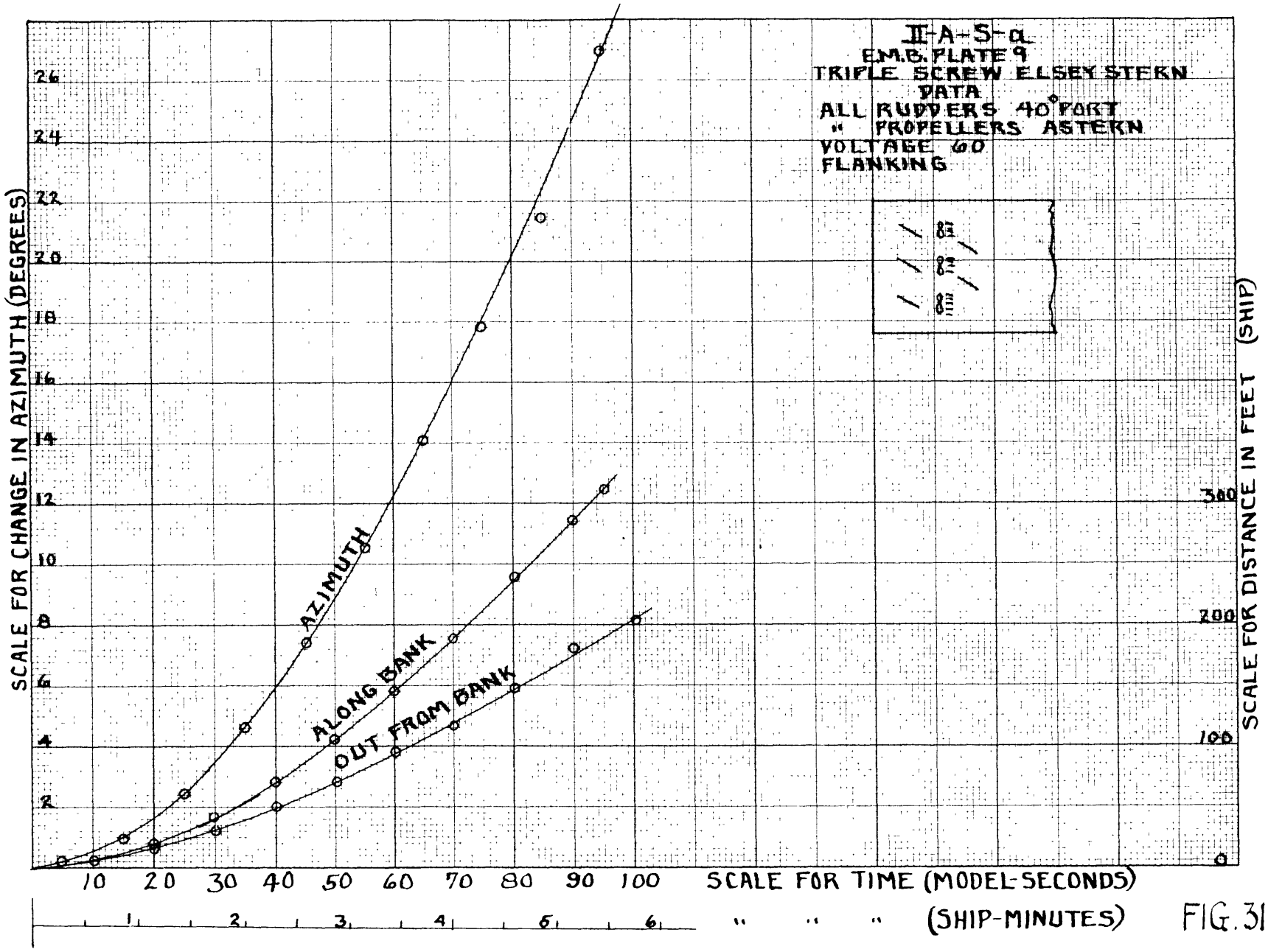

II-A-S-a
E.M.B. PLATE 9
TRIPLE SCREW ELSEY STERN
DATA
ALL RUDDERS 40° PORT
" PROPELLERS ASTERN
VOLTAGE 60
FLANKING
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL-SECONDS)
(SHIP-MINUTES)

FIG. 31

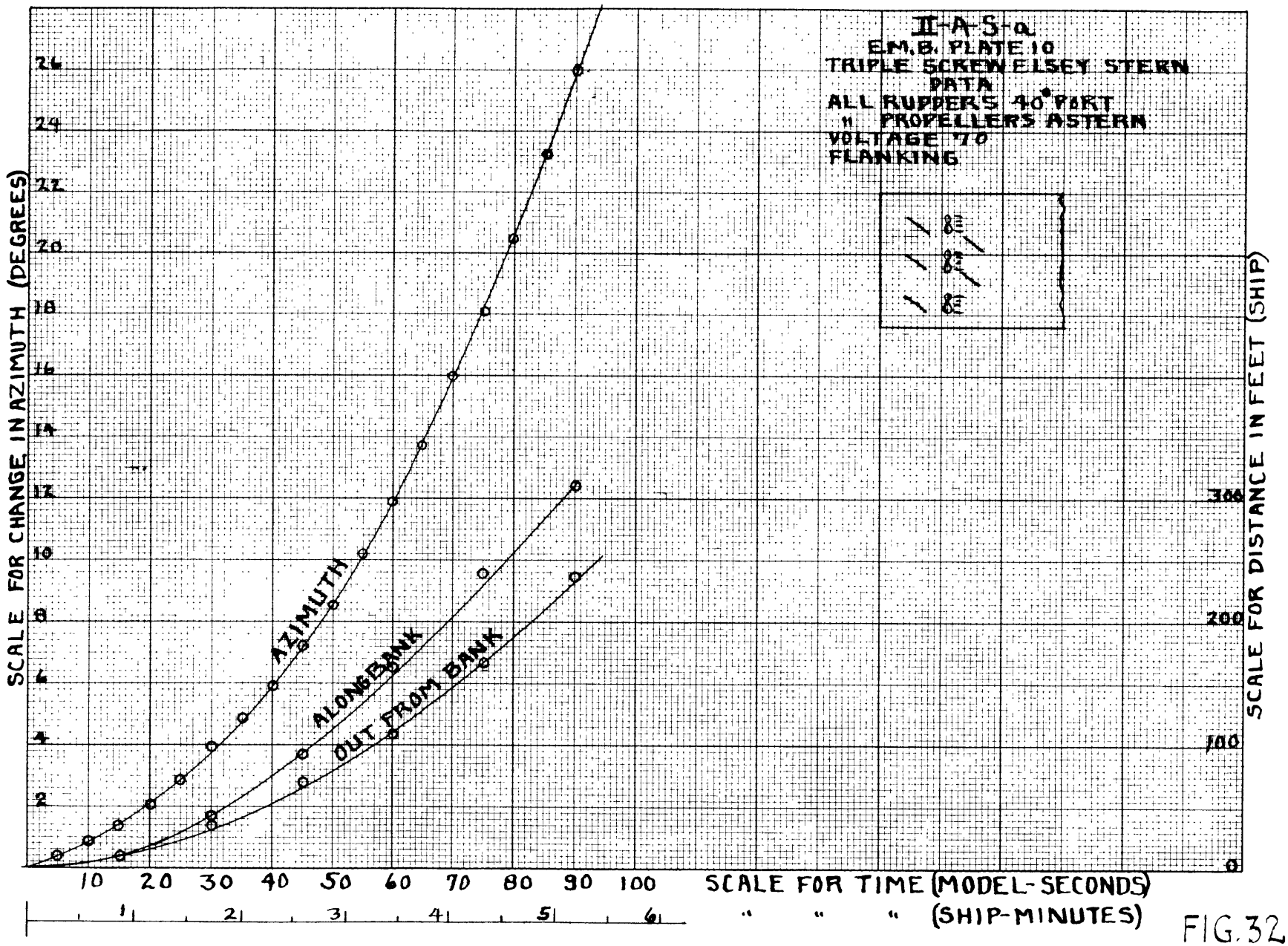

II-A-S-a
E.M.B. PLATE 10
TRIPLE SCREW ELSEY STERN
DATA
ALL RUDDERS 40° PORT
11 PROPELLERS ASTERN
VOLTAGE 70
FLANKING
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR TIME (MODEL-SECONDS)
" " " (SHIP-MINUTES)

FIG. 32

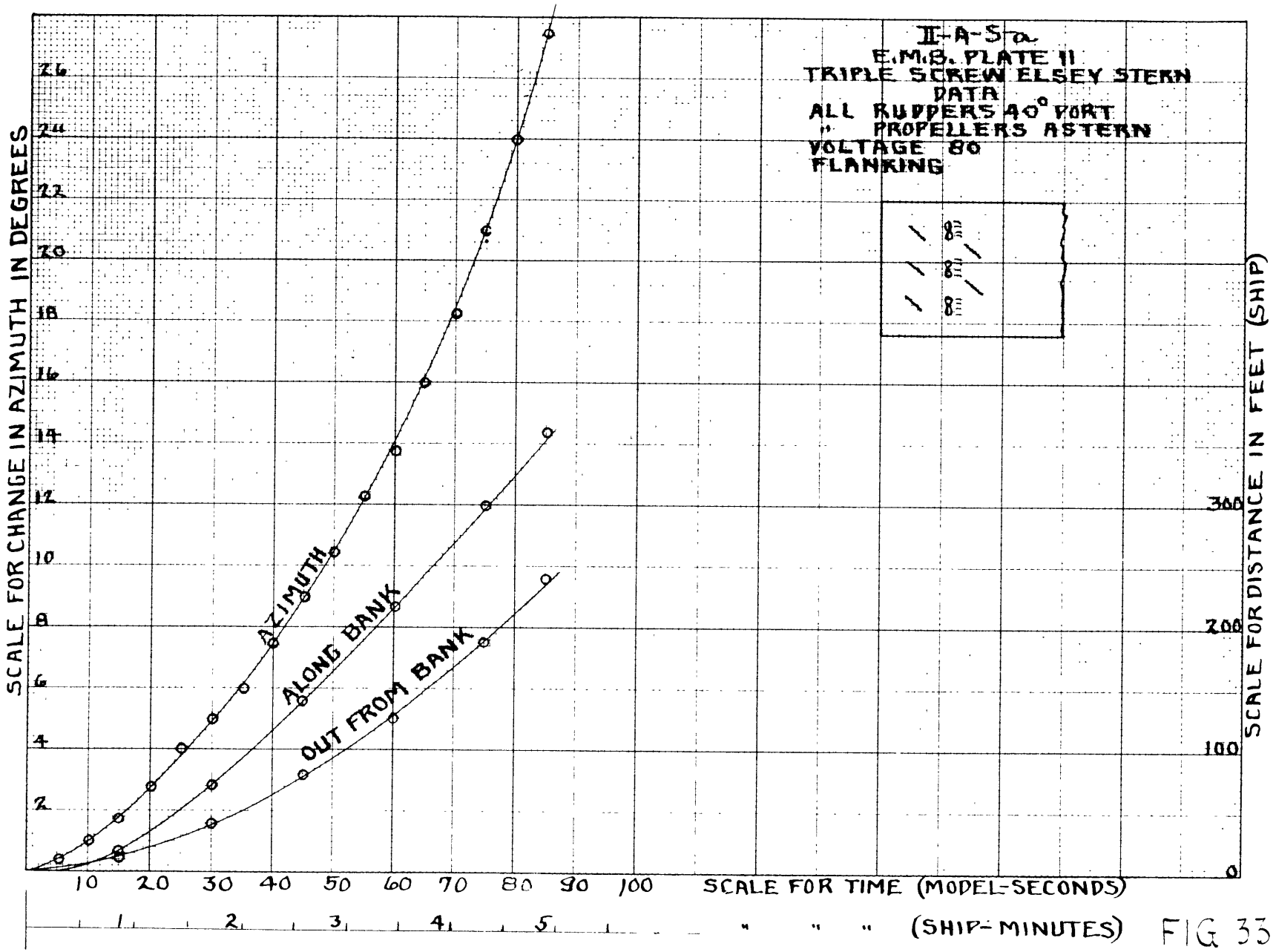

II-A-S a
E.M.B. PLATE II
TRIPLE SCREW ELSEY STERN
DATA
ALL RUDDERS 40° PORT
" PROPELLERS ASTERN
VOLTAGE 80
FLANKING
SCALE FOR CHANGE IN AZIMUTH IN DEGREES
26
24
22
20
18
16
14
12
10
8
6
4
2
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR DISTANCE IN FEET (SHIP)
300
200
100
0
10 20 30 40 50 60 70 80 90 100
SCALE FOR TIME (MODEL-SECONDS)
1 2 3 4 5
" " "
(SHIP-MINUTES)

FIG 33

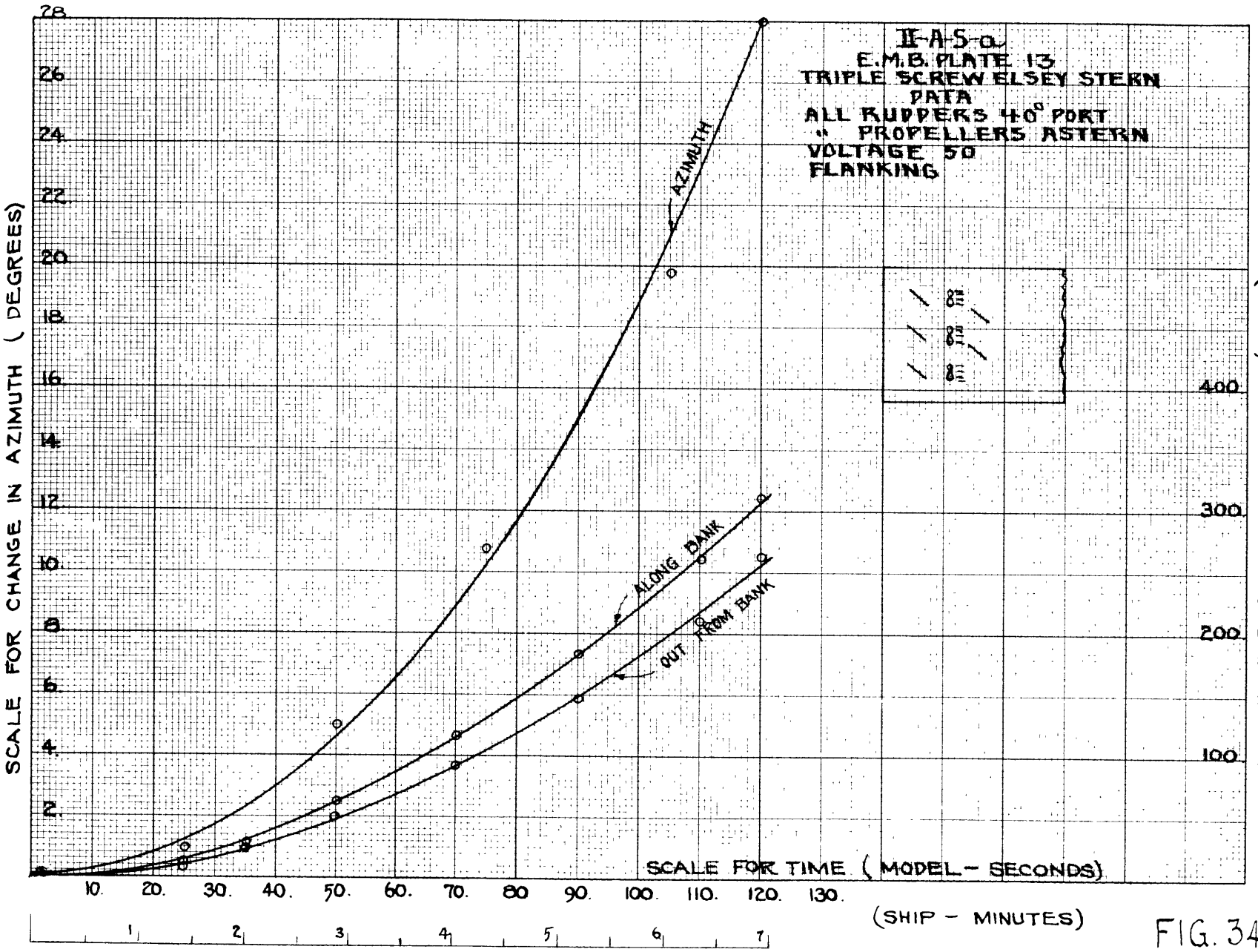

II-A-5-a.
E.M.B. PLATE 13
TRIPLE SCREW ELSEY STERN
DATA
ALL RUDDERS 40° PORT
" PROPELLERS ASTERN
VOLTAGE 50
FLANKING
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
28
26
24
22
20
18
16
14
12
10
8
6
4
2
400
300
200
100
10. 20. 30. 40. 50. 60. 70. 80 90. 100. 110. 120. 130.
1 2 3 4 5 6 7

FIG. 34

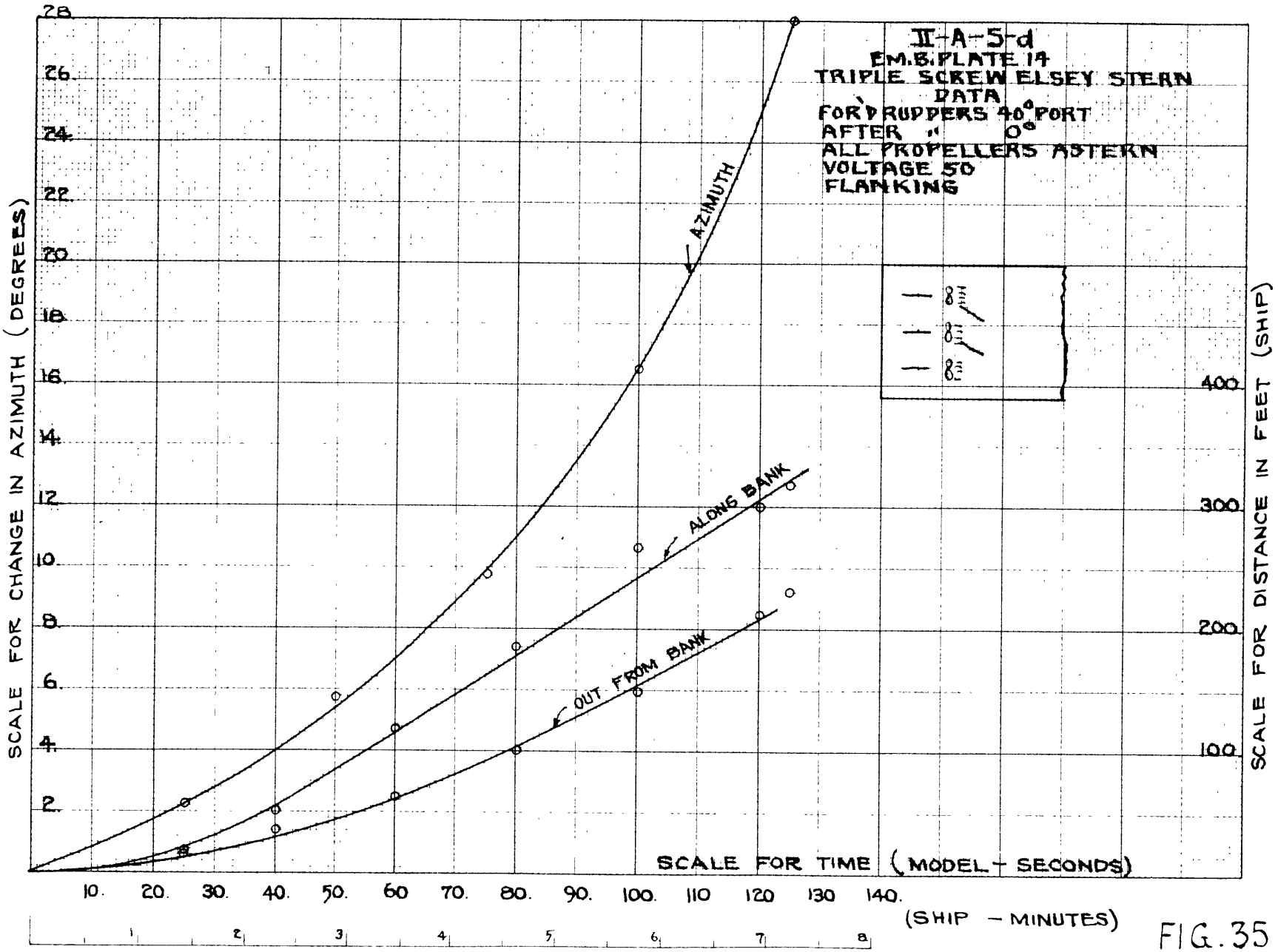

II-A-5-d
EM.B.PLATE 14
TRIPLE SCREW ELSEY STERN
DATA
FOR RUDDERS 40° PORT
AFTER " 0°
ALL PROPELLERS ASTERN
VOLTAGE 50
FLANKING
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)

FIG. 35

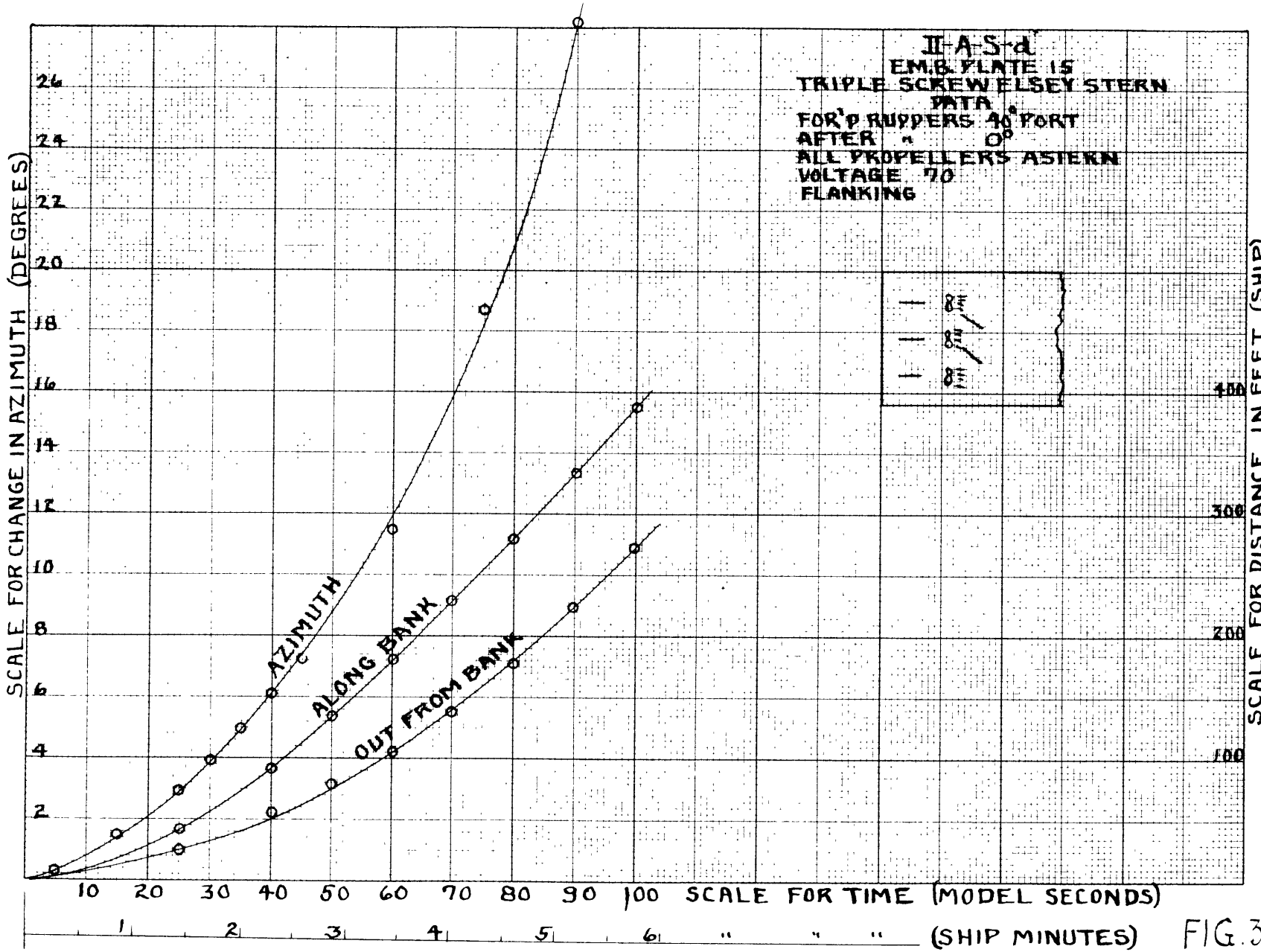

II-A-S-d
EM.& PLATE 15
TRIPLE SCREW ELSEY STERN
DATA
FOR'D RUDDERS 40° PORT
AFTER " 0°
ALL PROPELLERS ASTERN
VOLTAGE 70
FLANKING
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL SECONDS)
(SHIP MINUTES)

FIG. 36

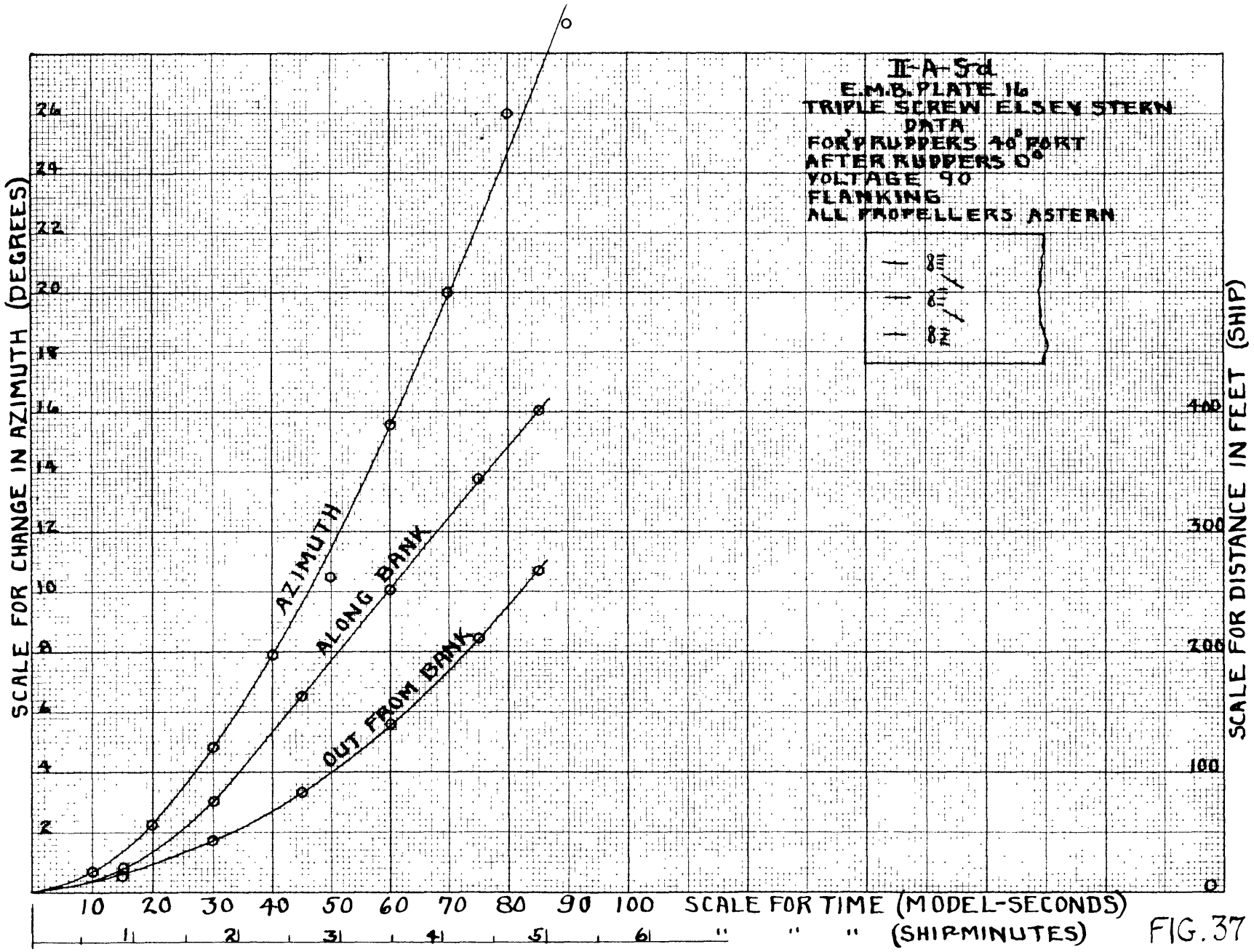

II-A-5d
E.M.B. PLATE 16
TRIPLE SCREW ELSEY STERN
DATA
FOR P RUDDERS 40° PORT
AFTER RUDDERS 0°
VOLTAGE 90
FLANKING
ALL PROPELLERS ASTERN
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL-SECONDS)
(SHIRMINUTES)

FIG. 37

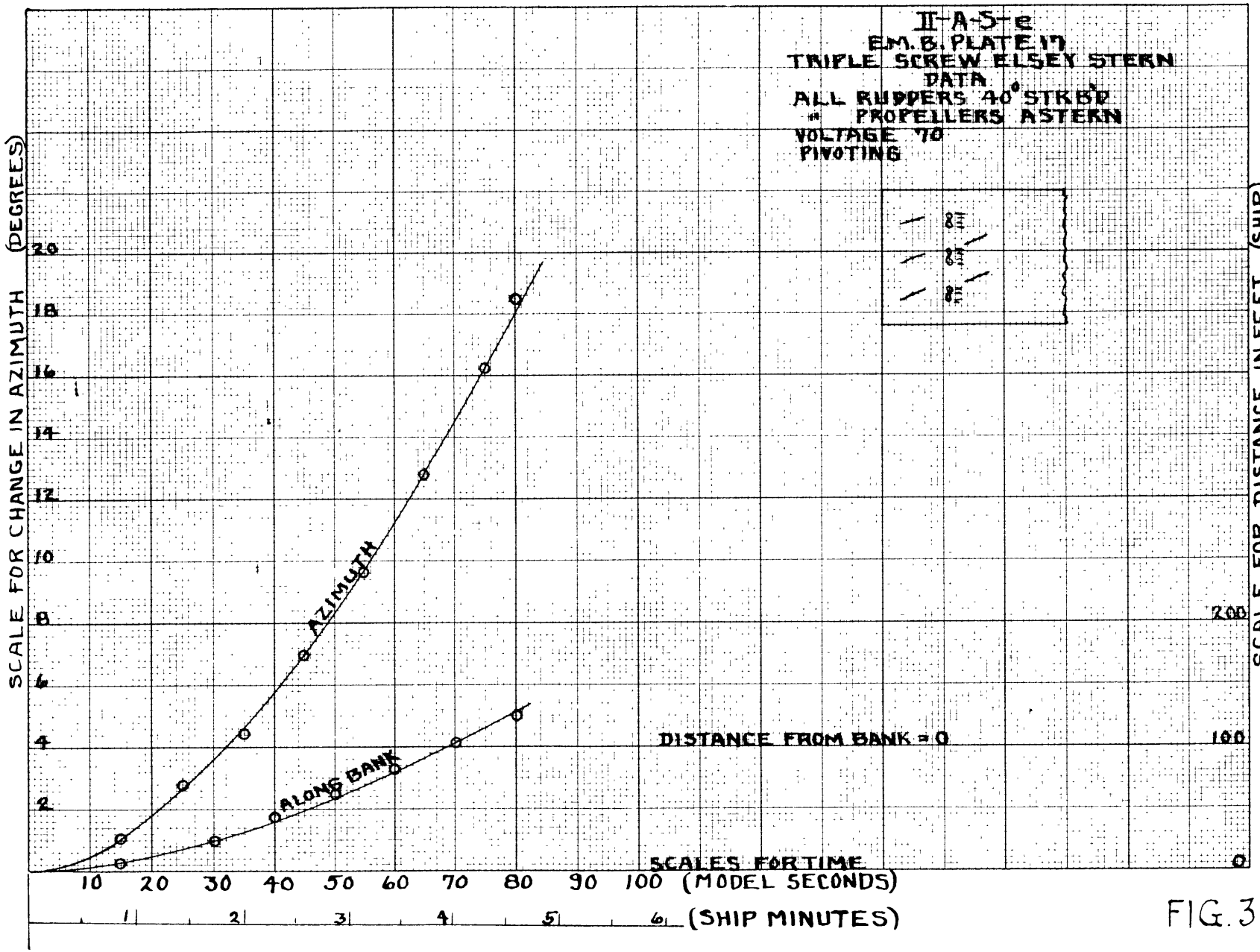

II-A-5-e
E.M.B. PLATE 17
TRIPLE SCREW ELSEY STERN
DATA
ALL RUDDERS 40° STRBD
" PROPELLERS ASTERN
VOLTAGE 70
PIVOTING
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
AZIMUTH
ALONG BANK
DISTANCE FROM BANK = 0
SCALES FOR TIME
(MODEL SECONDS)
(SHIP MINUTES)

FIG. 38

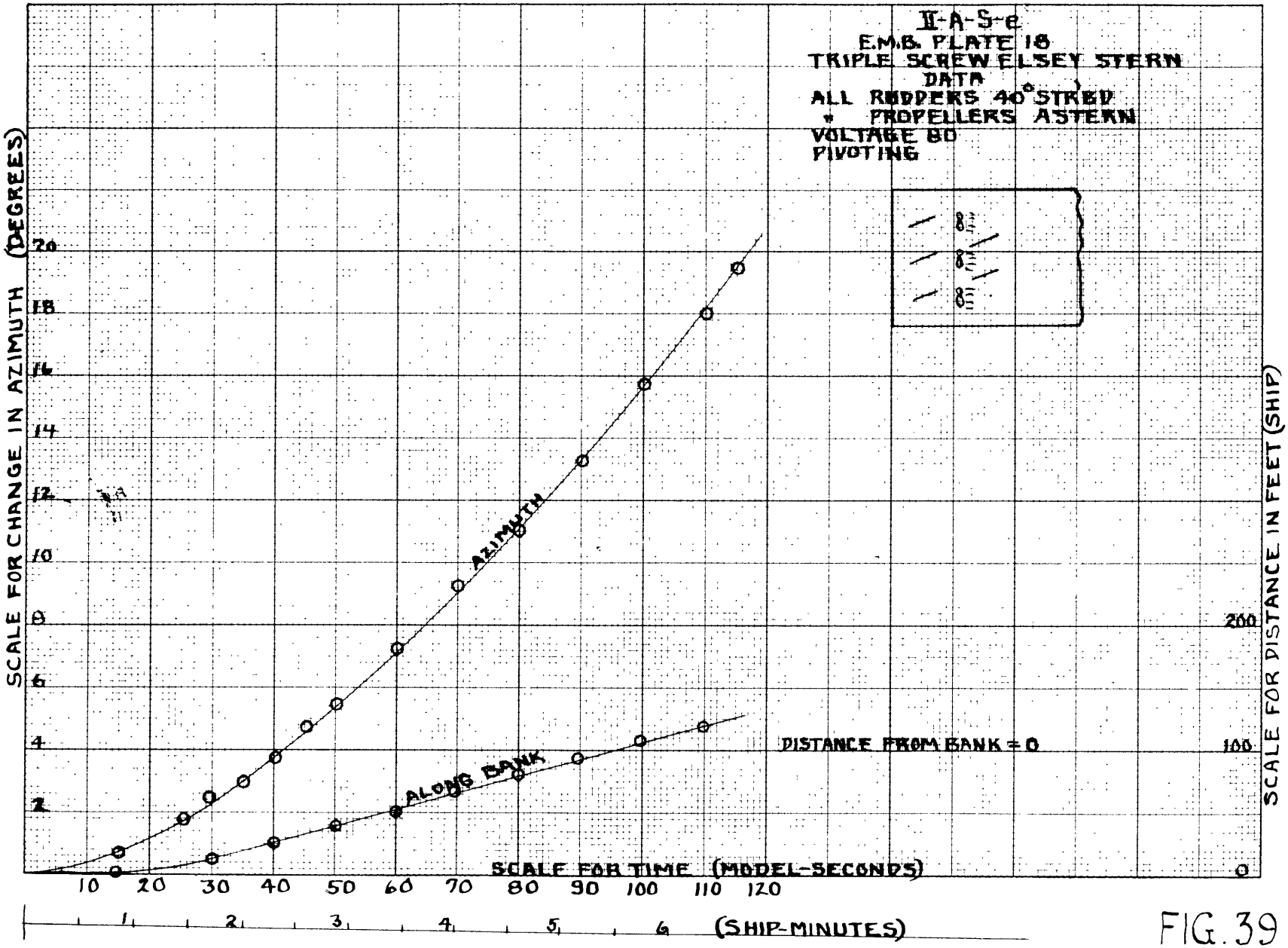

II-A-S-e
E.M.B. PLATE 18
TRIPLE SCREW ELSEY STERN
DATA
ALL RUDDERS 40° STBD
PROPELLERS ASTERN
VOLTAGE 80
PIVOTING
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
20
18
16
14
12
10
8
6
4
2
AZIMUTH
ALONG BANK
DISTANCE FROM BANK = 0
SCALE FOR DISTANCE IN FEET (SHIP)
200
100
0
SCALE FOR TIME (MODEL-SECONDS)
10 20 30 40 50 60 70 80 90 100 110 120
1 2 3 4 5 6 (SHIP-MINUTES)

FIG. 39

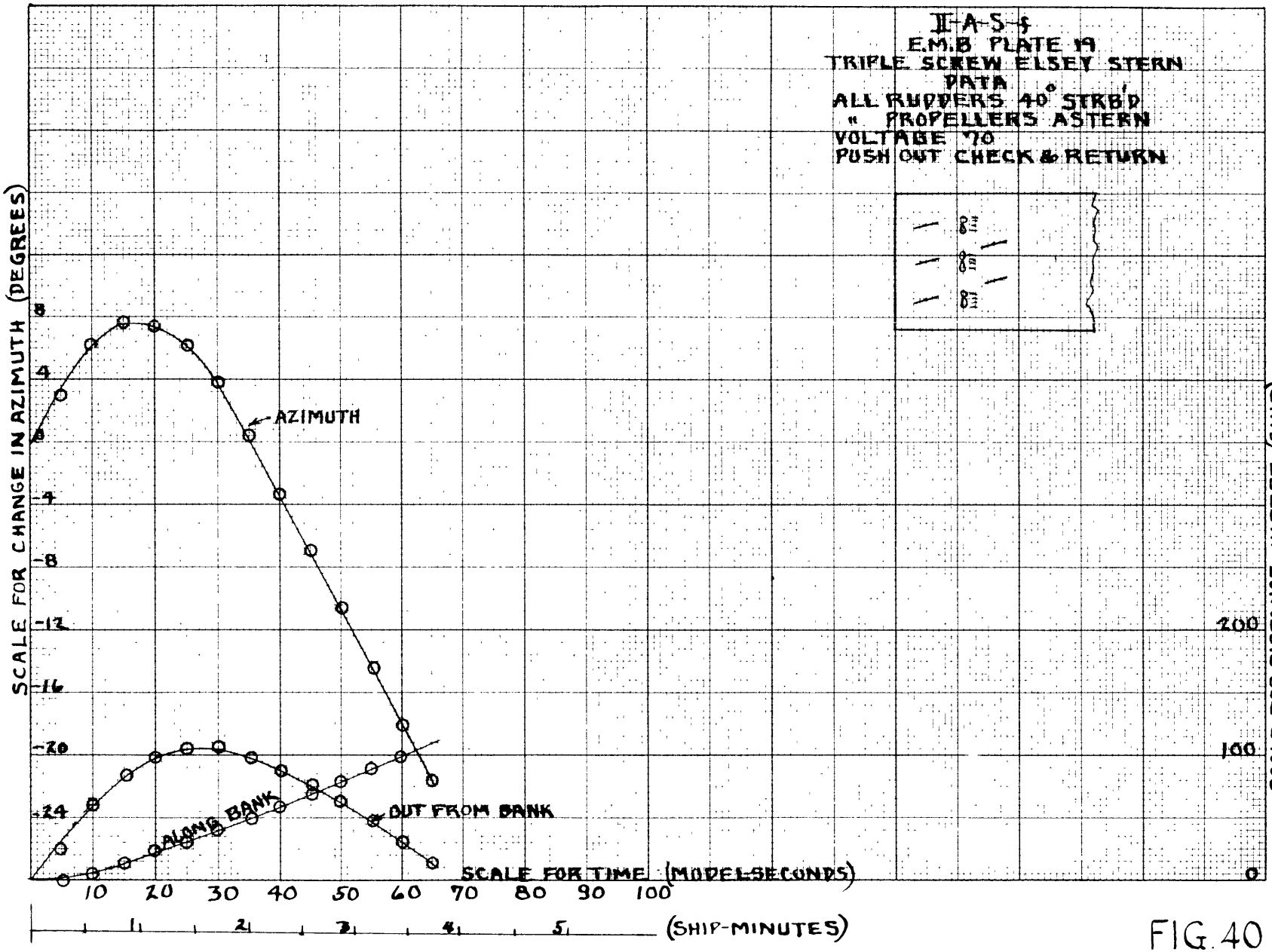

II-A-5-f
E.M.B PLATE 19
TRIPLE SCREW ELSEY STERN
DATA
ALL RUDDERS 40° STRB'D
" PROPELLERS ASTERN
VOLTAGE 70
PUSH OUT CHECK & RETURN
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
8
4
0
-4
-8
-12
-16
-20
-24
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR TIME (MODEL-SECONDS)
10 20 30 40 50 60 70 80 90 100
1 2 3 4 5
(SHIP-MINUTES)
SCALE FOR DISTANCE IN FEET (SHIP)
200
100
0

FIG. 40

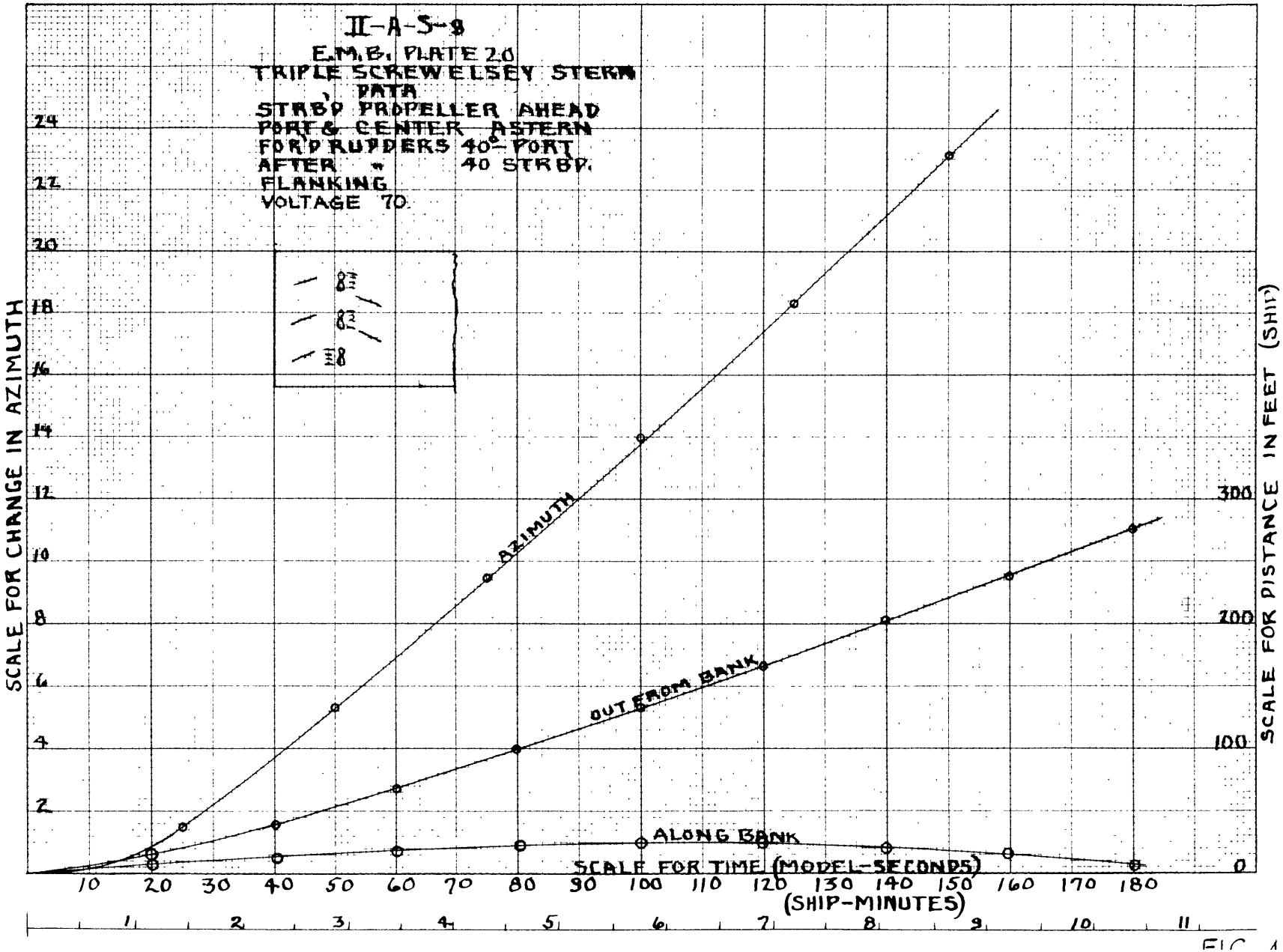

II-A-S-9
E.M.B. PLATE 20
TRIPLE SCREW ELSEY STERN
DATA
STRB'D PROPELLER AHEAD
PORT & CENTER ASTERN
FORD RUDDERS 40° PORT
AFTER " 40 STRB'D.
FLANKING
VOLTAGE 70.
AZIMUTH
OUT FROM BANK
ALONG BANK
SCALE FOR CHANGE IN AZIMUTH
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL-SECONDS)
(SHIP-MINUTES)

FIG. 41

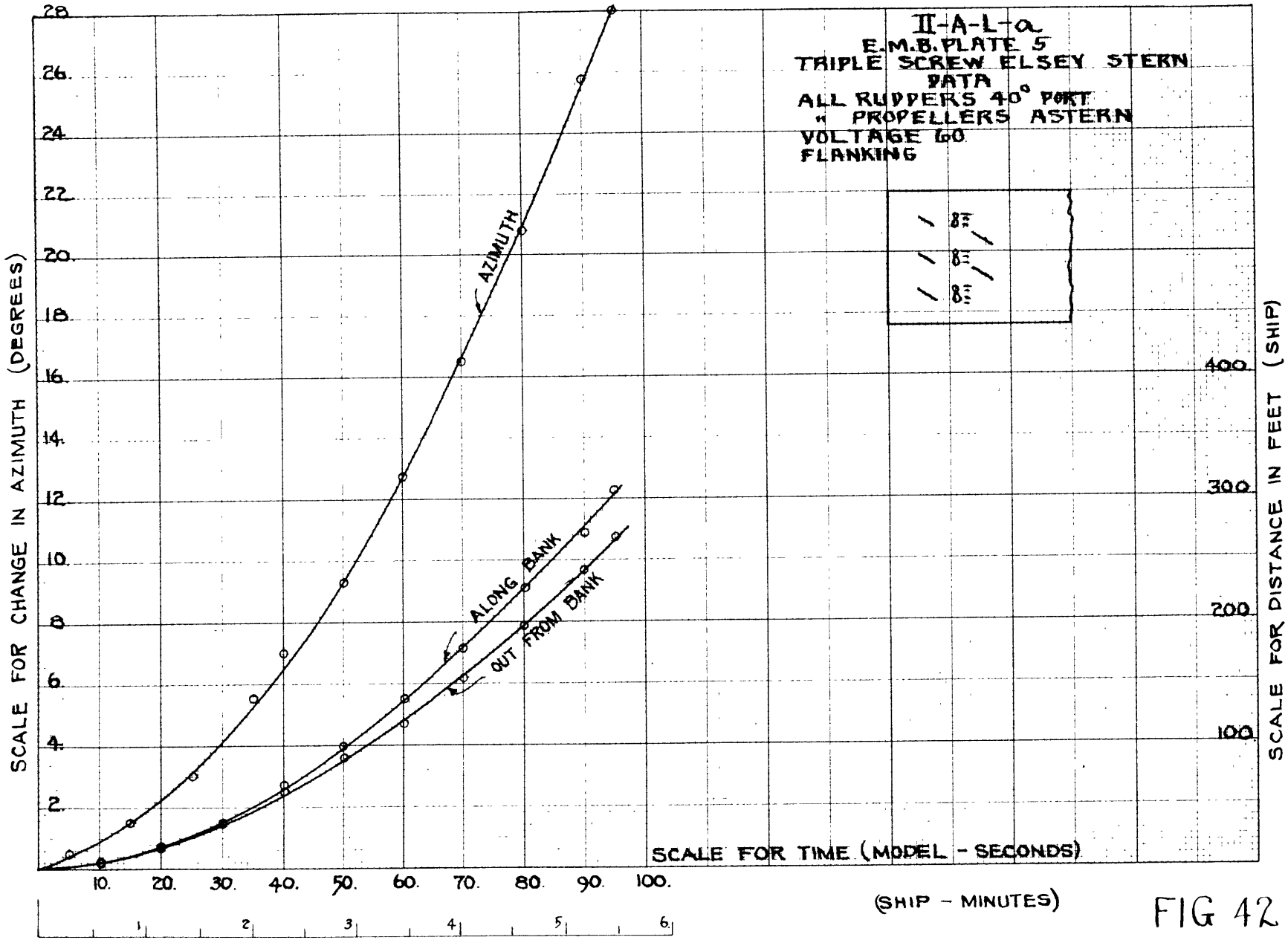

II-A-L-a
E.M.B. PLATE 5
TRIPLE SCREW ELSEY STERN
DATA
ALL RUDDERS 40° PORT
" PROPELLERS ASTERN
VOLTAGE 60
FLANKING
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
28
26
24
22
20
18
16
14
12
10
8
6
4
2
400
300
200
100
10.
20.
30.
40.
50.
60.
70.
80.
90.
100.
1
2
3
4
5
6

FIG 42

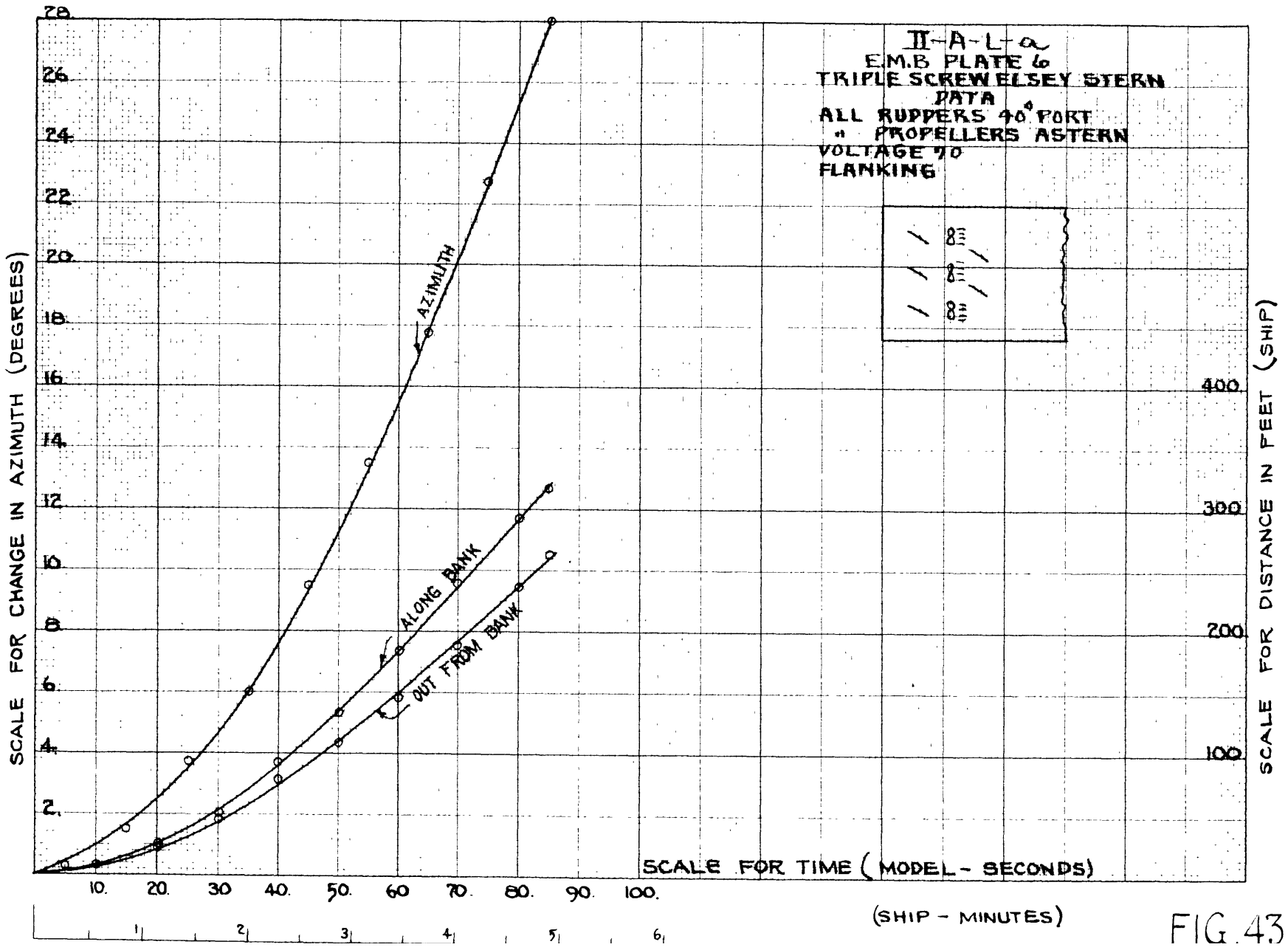

II-A-L-a
E.M.B PLATE 6
TRIPLE SCREW ELSEY STERN
DATA
ALL RUDDERS 40° PORT
" PROPELLERS ASTERN
VOLTAGE 70
FLANKING
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
28
26
24
22
20
18
16
14
12
10
8
6
4
2
400
300
200
100
10. 20. 30 40. 50. 60 70. 80. 90. 100.
1 2 3 4 5 6

FIG. 43

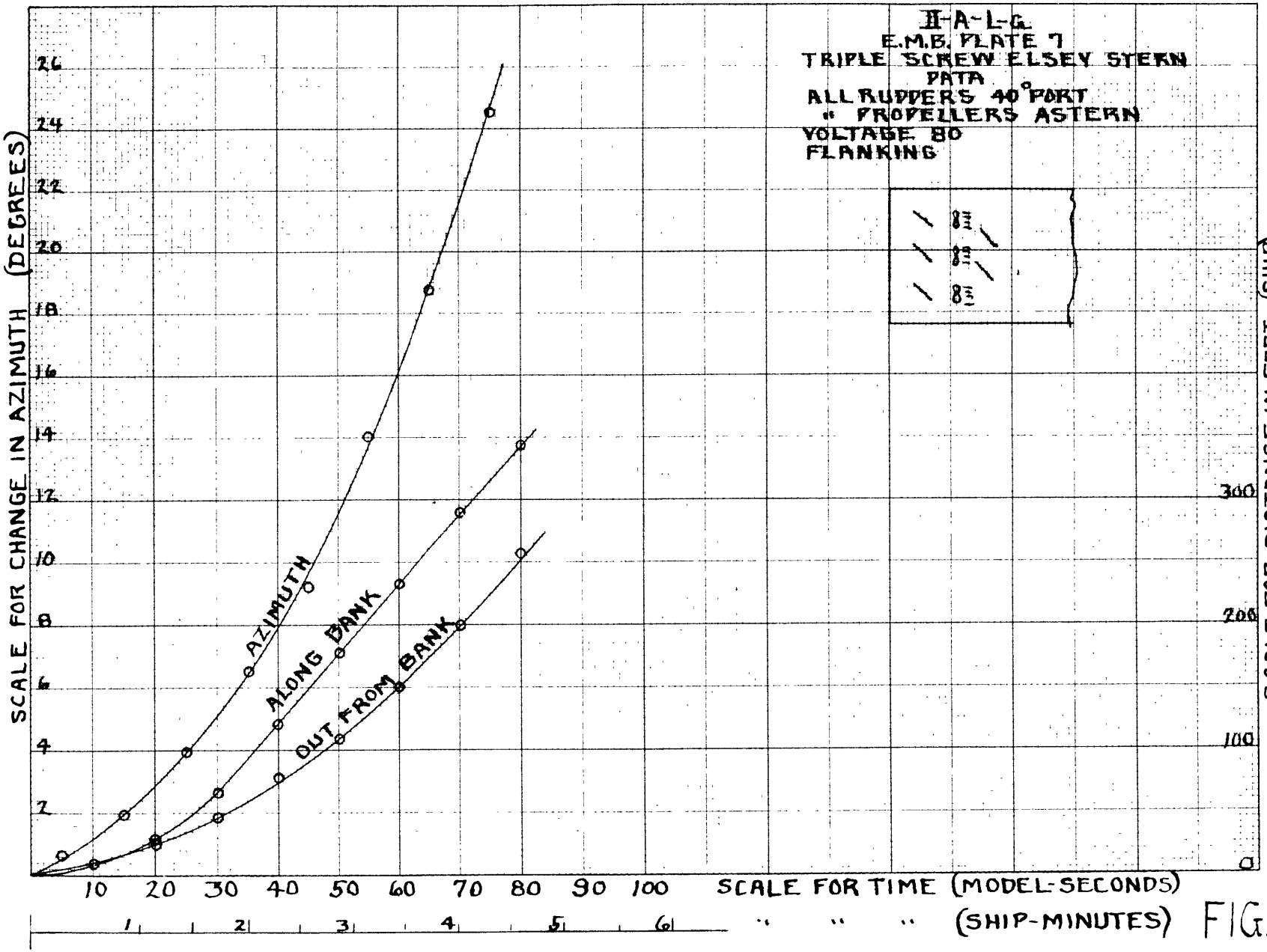

II-A-L-G.
E.M.B. PLATE 7
TRIPLE SCREW ELSEY STERN
DATA
ALL RUDDERS 40° PORT
" PROPELLERS ASTERN
VOLTAGE 80
FLANKING
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR TIME (MODEL-SECONDS)
(SHIP-MINUTES)

FIG. 44

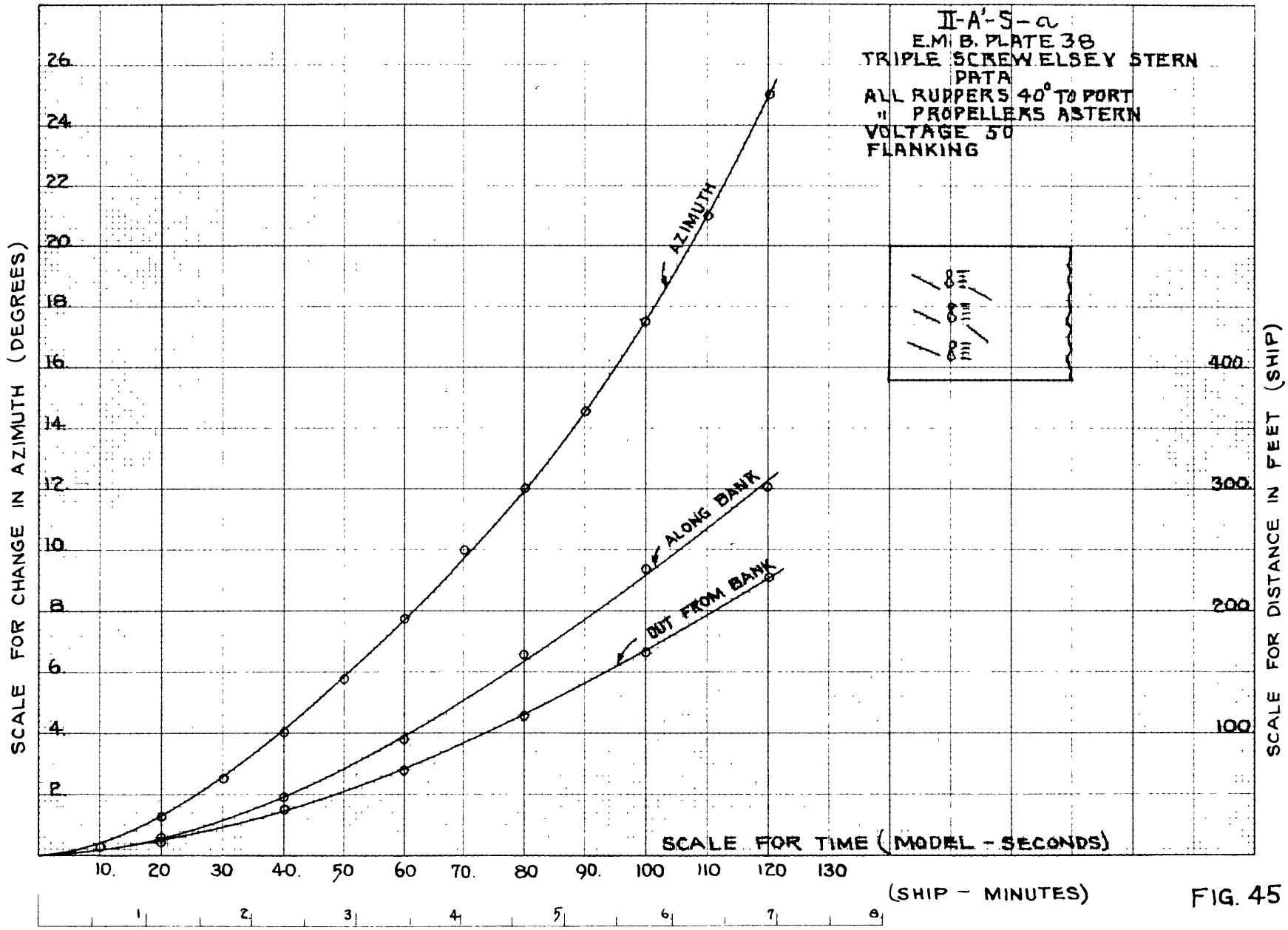

II-A'-5-a
E.M.B. PLATE 38
TRIPLE SCREW ELSEY STERN
PATA
ALL RUDDERS 40° TO PORT
" PROPELLERS ASTERN
VOLTAGE 50
FLANKING
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
26
24
22
20
18
16
14
12
10
8
6
4
2
400
300
200
100
10.
20
30
40.
50
60
70.
80
90.
100
110
120
130
1
2
3
4
5
6
7
8

FIG. 45

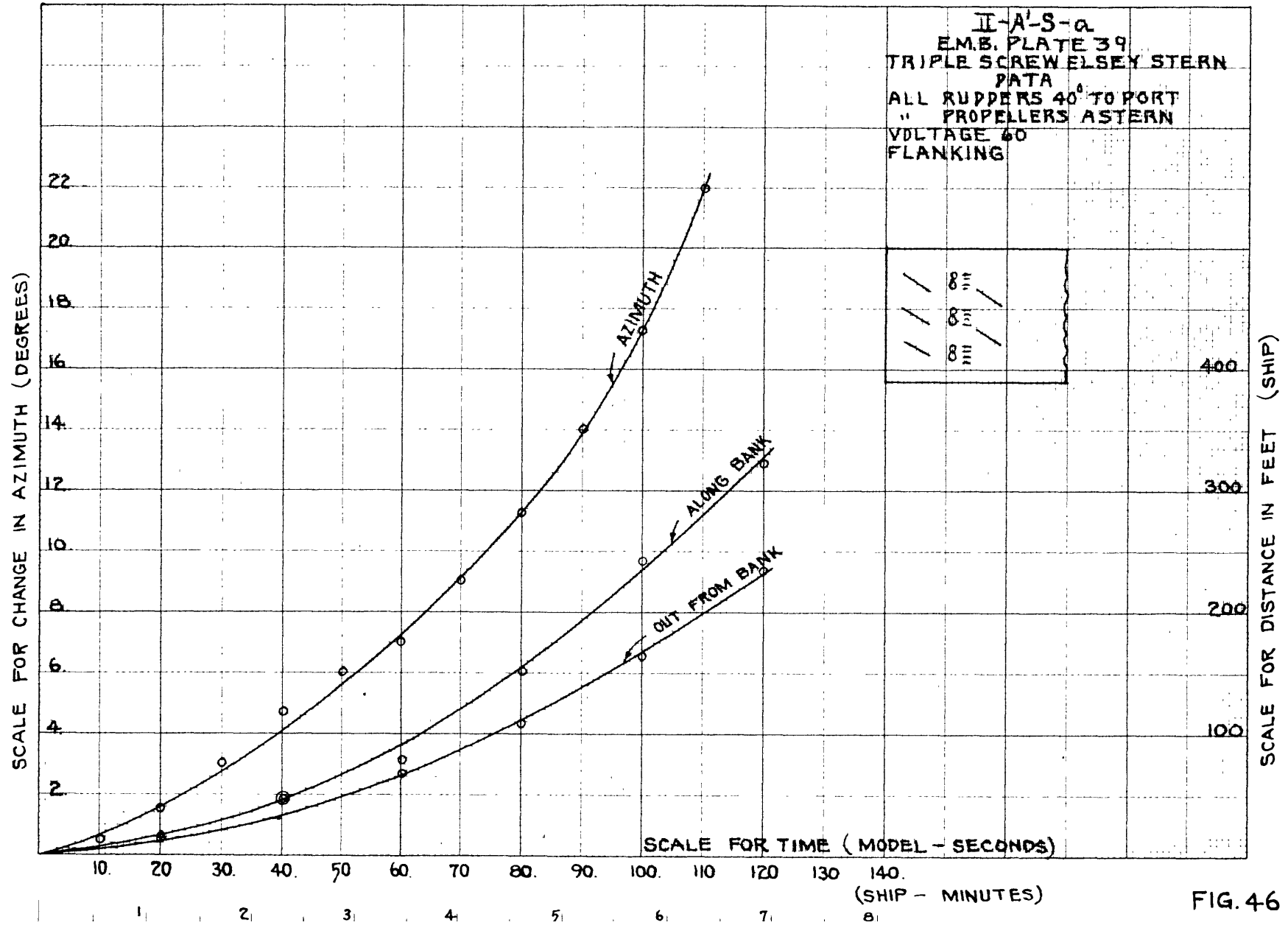

II-A'-S-a
E.M.B. PLATE 39
TRIPLE SCREW ELSEY STERN
DATA
ALL RUDDERS 40° TO PORT
" PROPELLERS ASTERN
VOLTAGE 40
FLANKING
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
22
20
18
16
14
12
10
8
6
4
2
400
300
200
100
10. 20 30. 40. 50 60. 70 80. 90. 100. 110 120 130 140.
1 2 3 4 5 6 7 8

FIG. 46

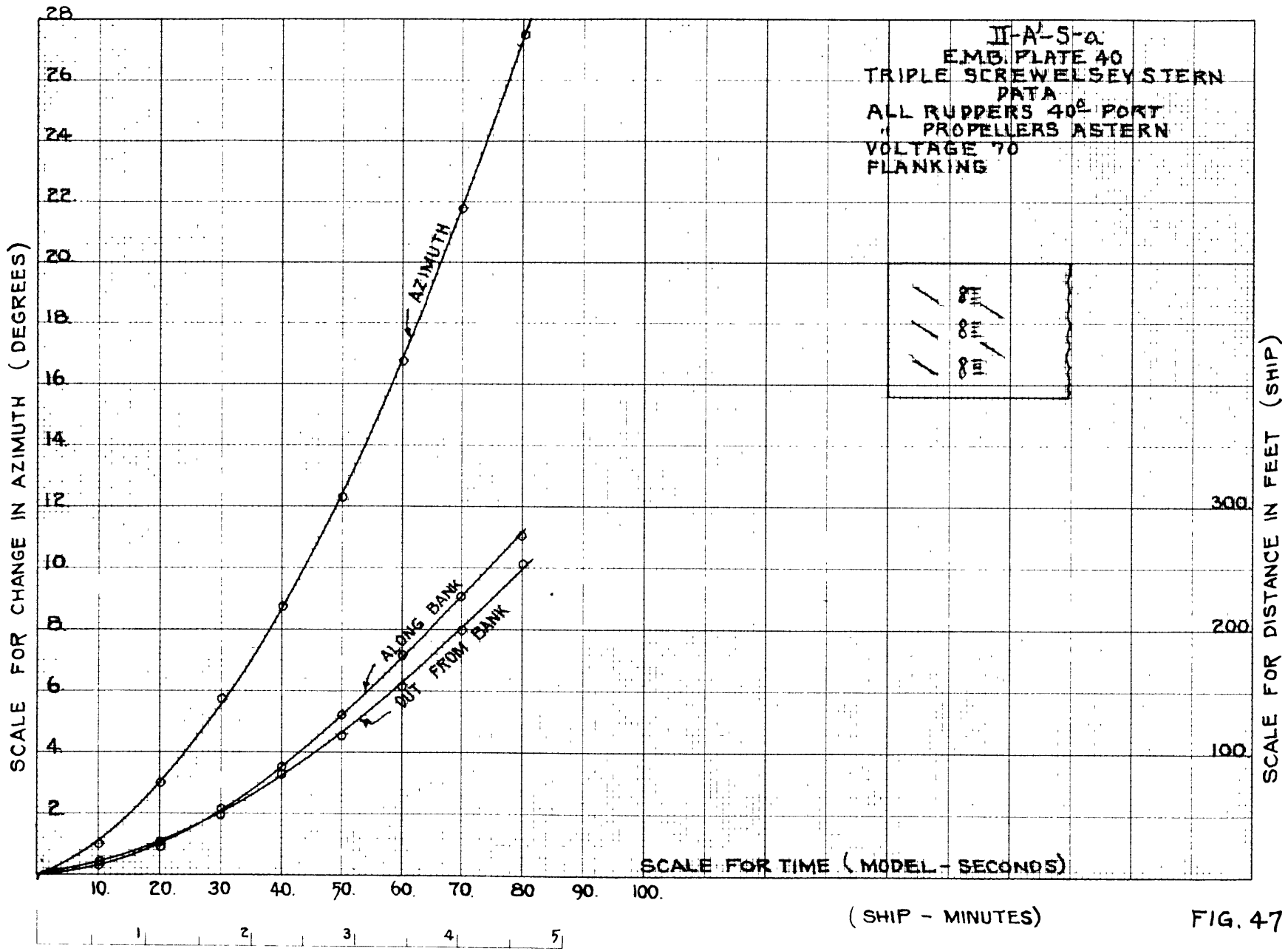

II-A'-S-a.
E.M.B. PLATE 40
TRIPLE SCREW ELSEY STERN
DATA
ALL RUDDERS 40° PORT
PROPELLERS ASTERN
VOLTAGE 70
FLANKING
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL-SECONDS)
(SHIP - MINUTES)
28
26
24
22
20
18
16
14
12
10
8
6
4
2
300
200
100
10. 20. 30 40. 50. 60. 70. 80 90. 100.
1 2 3 4 5

FIG. 47

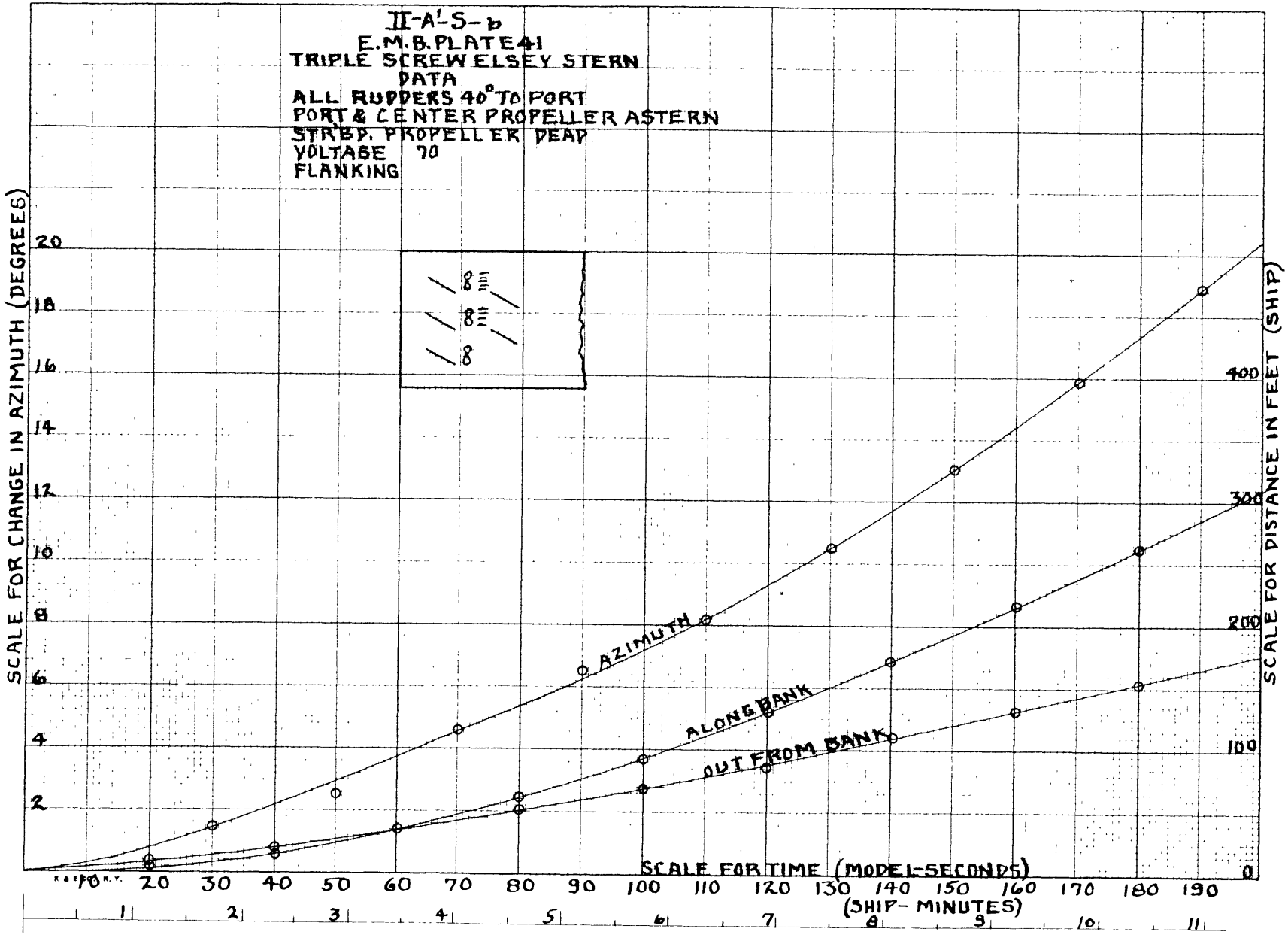

II-A'S-b
E.M.B. PLATE 41
TRIPLE SCREW ELSEY STERN
DATA
ALL RUDDERS 40° TO PORT
PORT & CENTER PROPELLER ASTERN
STR'BD. PROPELLER DEAD
VOLTAGE 70
FLANKING
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR TIME (MODEL-SECONDS)
(SHIP- MINUTES)

FIG. 48

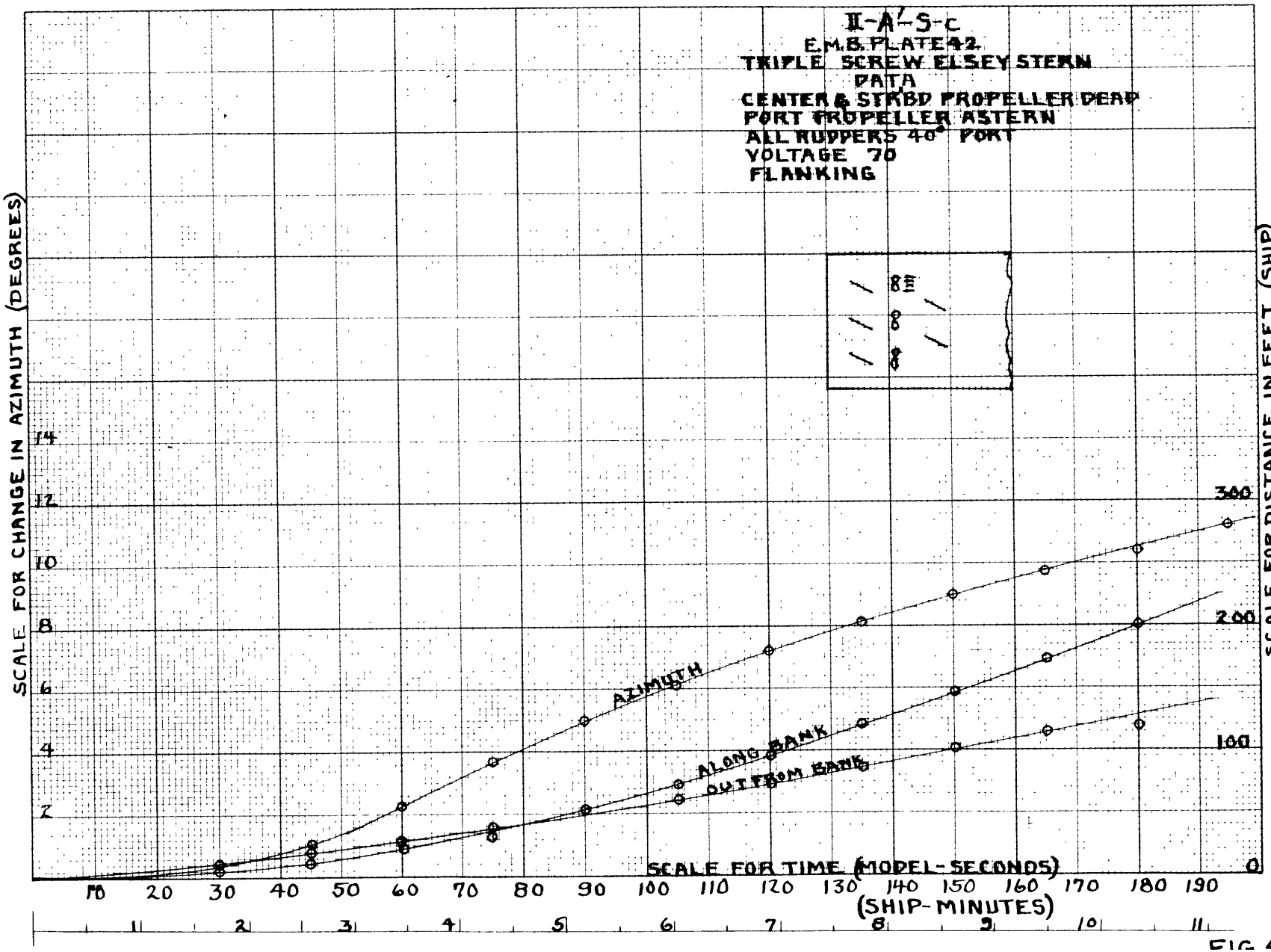
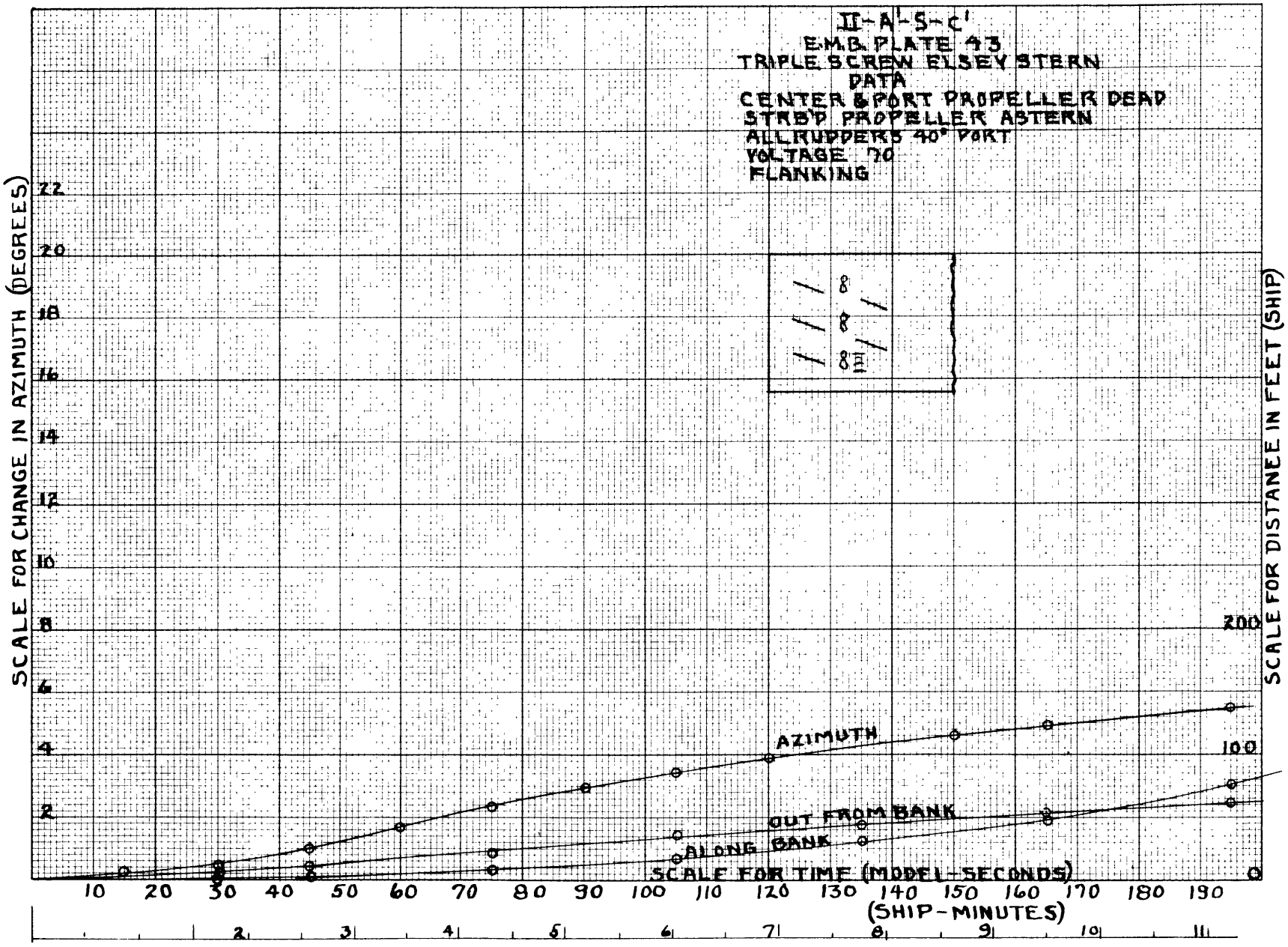

II-A'-S-c
E.M.B. PLATE 42
TRIPLE SCREW ELSEY STERN
DATA
CENTER & STBD PROPELLER DEAD
PORT PROPELLER ASTERN
ALL RUDDERS 40° PORT
VOLTAGE 70
FLANKING
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR TIME (MODEL-SECONDS)
(SHIP-MINUTES)

FIG 49


II-A-S-c'
E.M.B. PLATE 43
TRIPLE SCREW ELSEY STERN
DATA
CENTER & PORT PROPELLER DEAD
STRB'D PROPELLER ASTERN
ALL RUDDERS 40° PORT
VOLTAGE 70
FLANKING
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
AZIMUTH
OUT FROM BANK
ALONG BANK
SCALE FOR TIME (MODEL-SECONDS)
(SHIP-MINUTES)

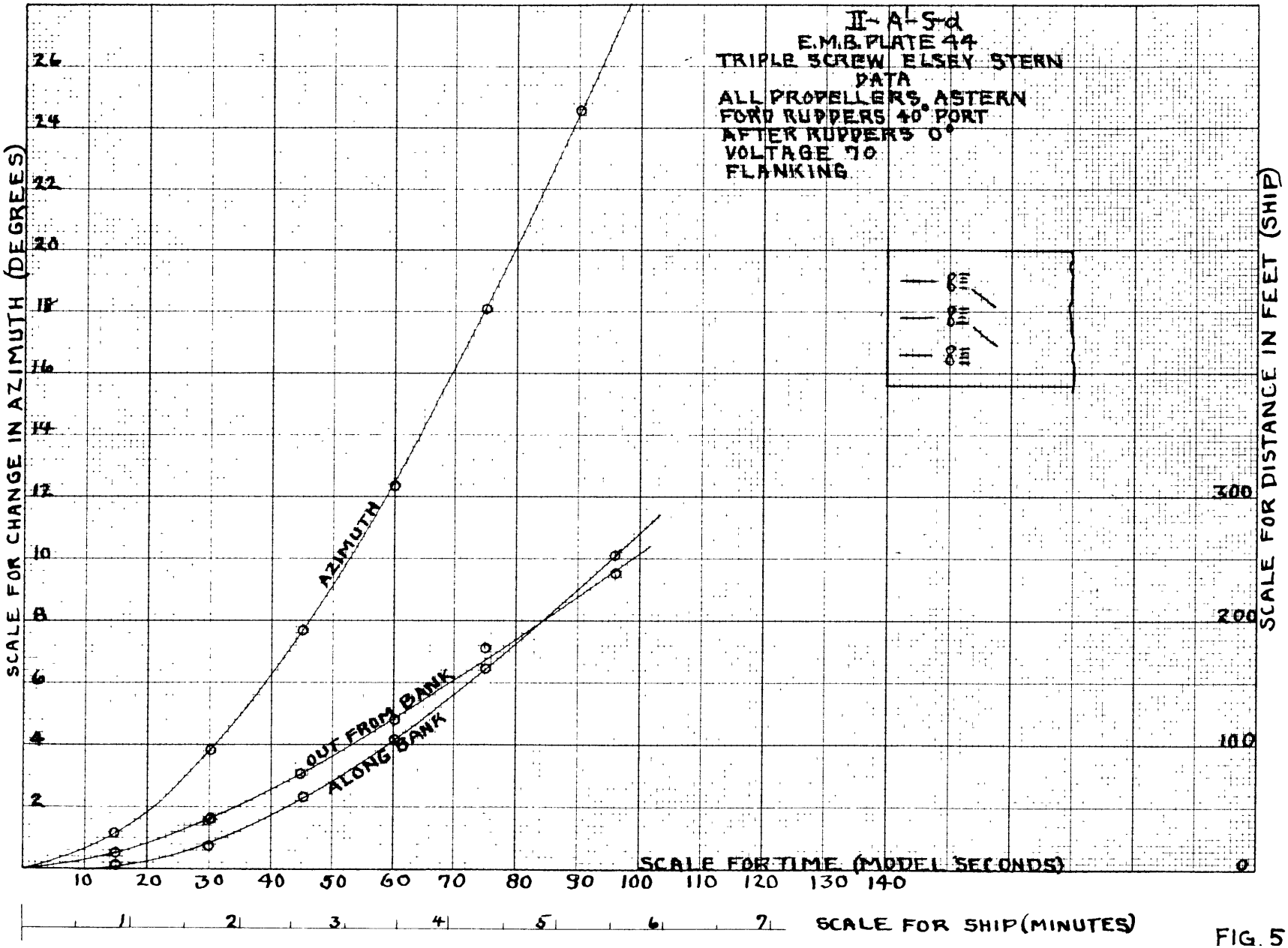

II-A-S-d
E.M.B. PLATE 44
TRIPLE SCREW ELSEY STERN
DATA
ALL PROPELLERS ASTERN
FORD RUDDERS 40° PORT
AFTER RUDDERS 0°
VOLTAGE 70
FLANKING
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
AZIMUTH
OUT FROM BANK
ALONG BANK
SCALE FOR TIME (MODEL SECONDS)
SCALE FOR SHIP (MINUTES)

FIG. 51

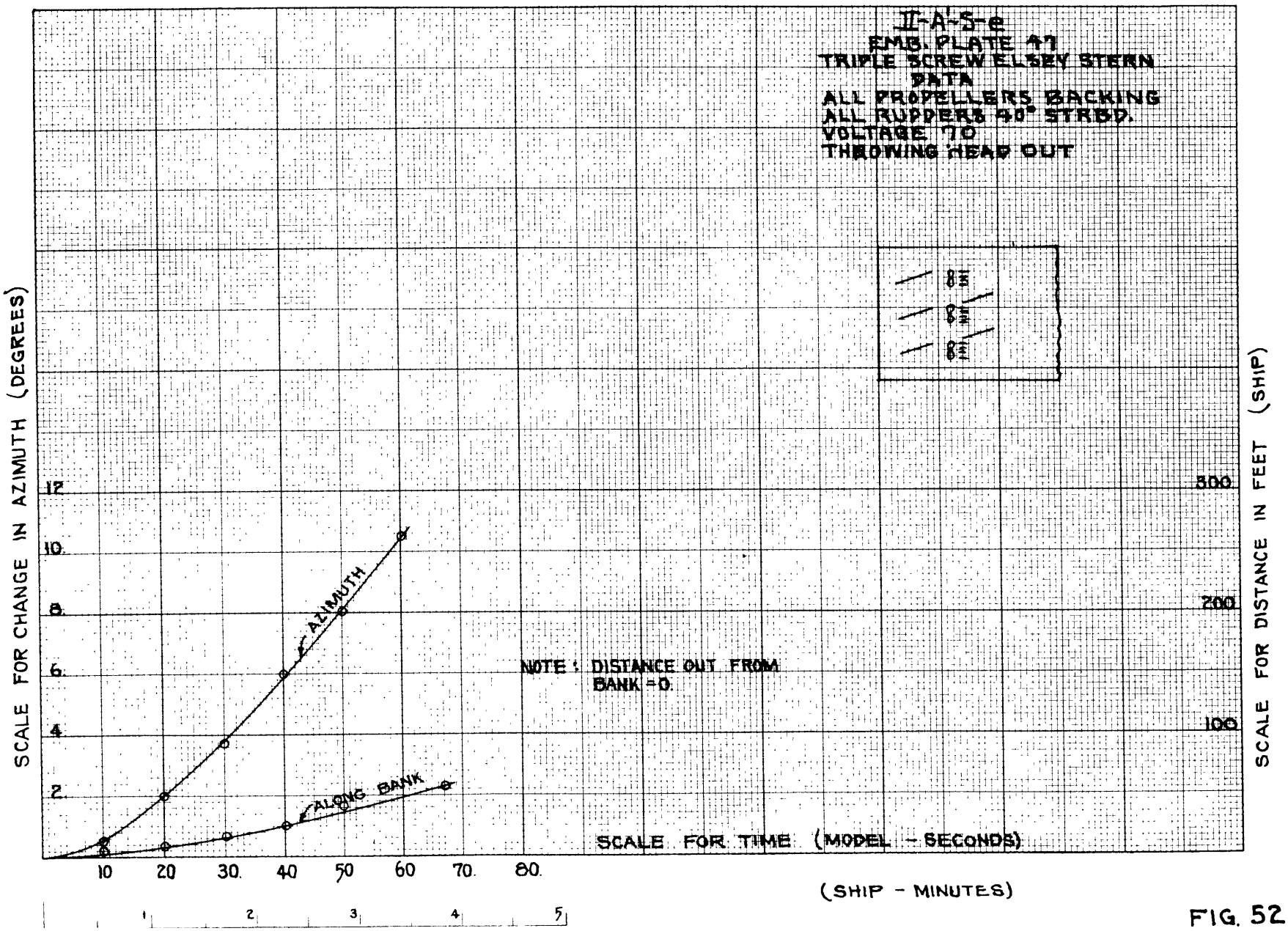

II-A-S-e
EMB. PLATE 41
TRIPLE SCREW ELSEY STERN
DATA
ALL PROPELLERS BACKING
ALL RUDDERS 40° STRBD.
VOLTAGE 70
THROWING HEAD OUT
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
12
10.
8.
6.
4.
2.
AZIMUTH
ALONG BANK
NOTE : DISTANCE OUT FROM BANK = 0
SCALE FOR TIME (MODEL - SECONDS)
10
20
30.
40
50
60
70.
80.
(SHIP - MINUTES)
1
2
3
4
5
SCALE FOR DISTANCE IN FEET (SHIP)
300
200
100

FIG. 52

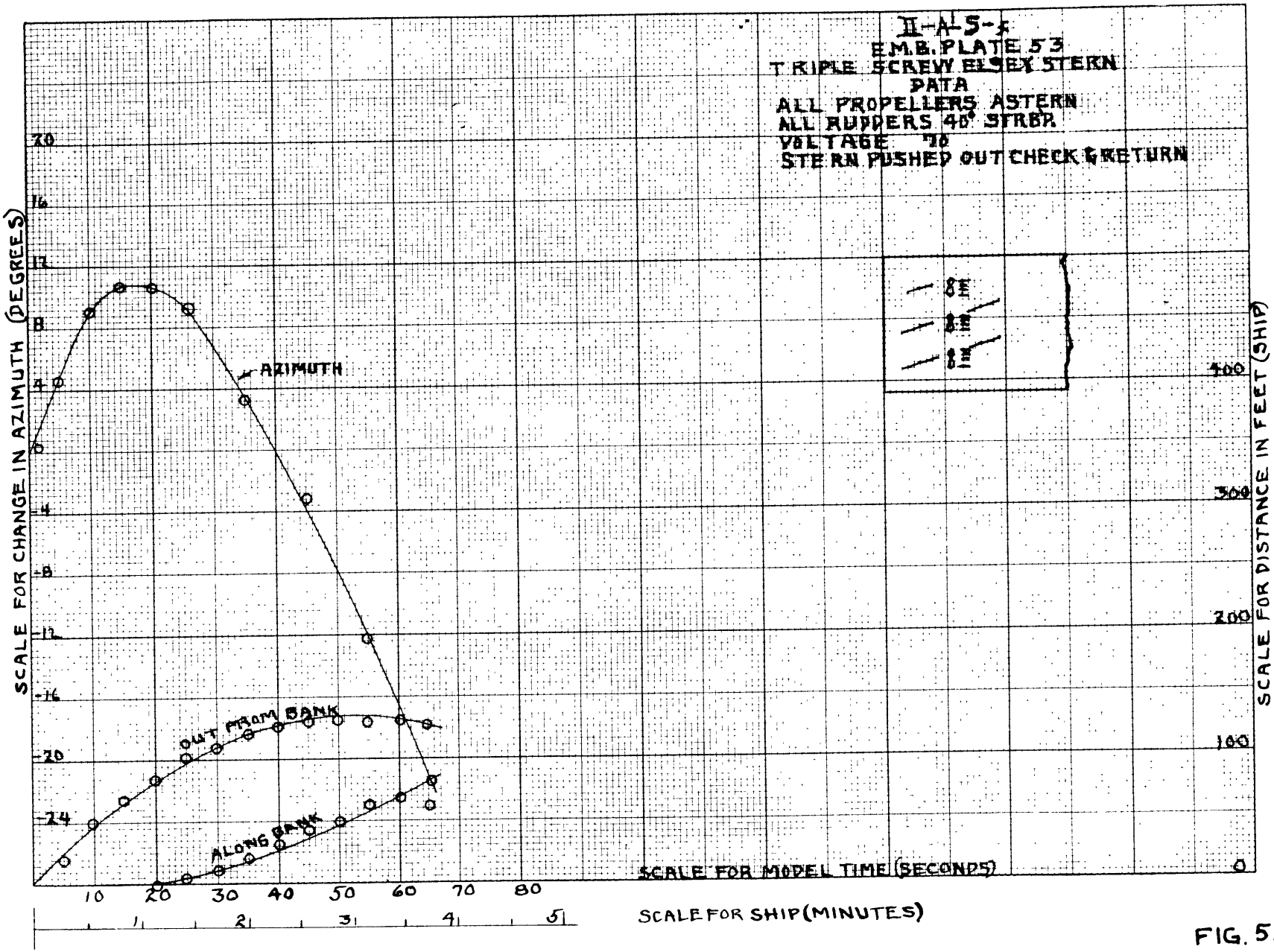

II-A-5-f
E.M.B. PLATE 53
TRIPLE SCREW ELSEX STERN
DATA
ALL PROPELLERS ASTERN
ALL RUDDERS 40° STRBD.
VOLTAGE 70
STERN PUSHED OUT CHECK & RETURN
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
AZIMUTH
OUT FROM BANK
ALONG BANK
SCALE FOR MODEL TIME (SECONDS)
SCALE FOR SHIP (MINUTES)

FIG. 53

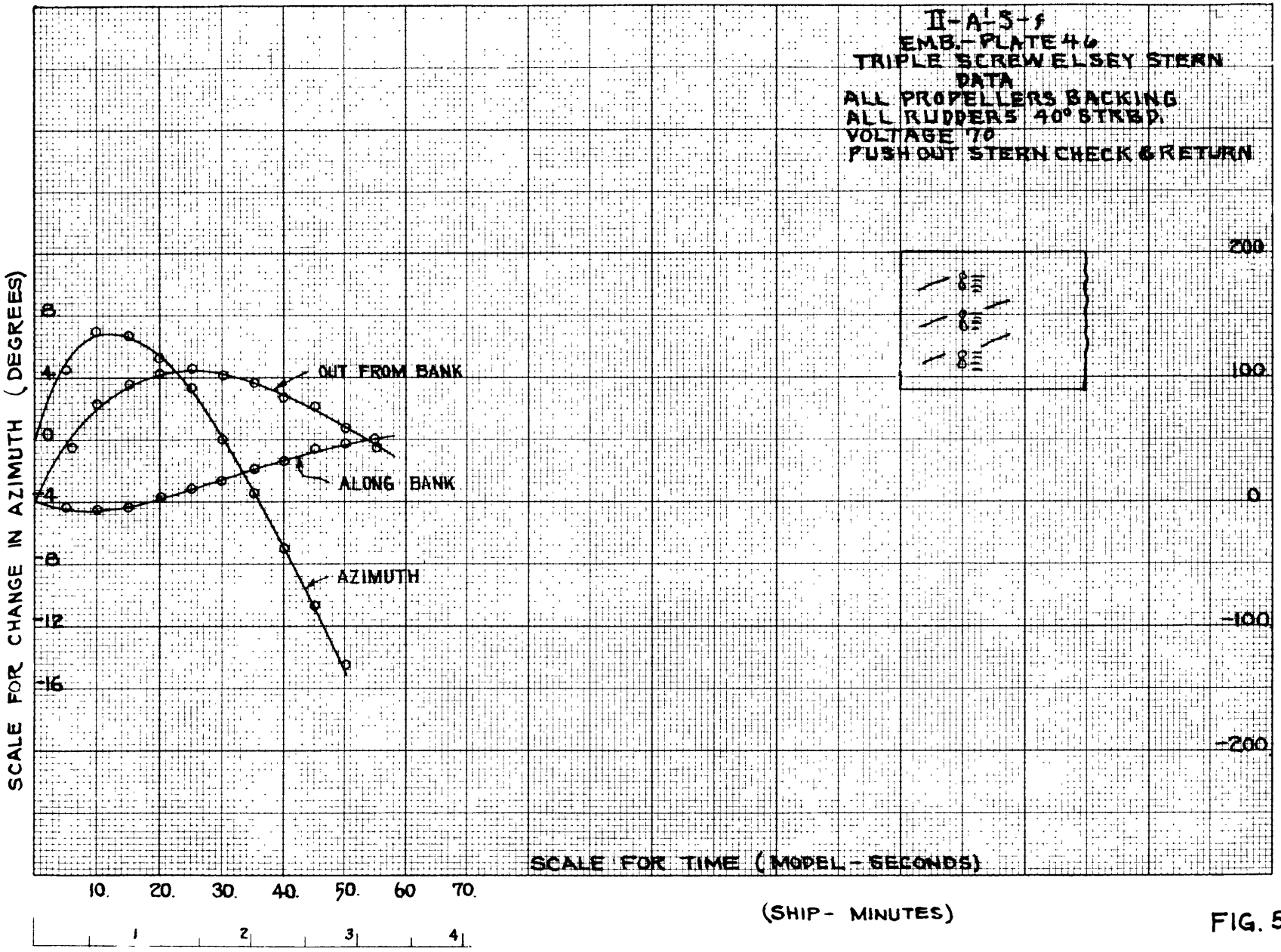

II-A-5-f
EMB.-PLATE 46
TRIPLE SCREW ELSEY STERN
DATA
ALL PROPELLERS BACKING
ALL RUDDERS 40° STRBD.
VOLTAGE 70
PUSH OUT STERN CHECK & RETURN
OUT FROM BANK
ALONG BANK
AZIMUTH
8
4
0
-4
-8
-12
-16
200
100
0
-100
-200
10.
20.
30.
40.
50.
60
70
1
2
3
4
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)

FIG. 54

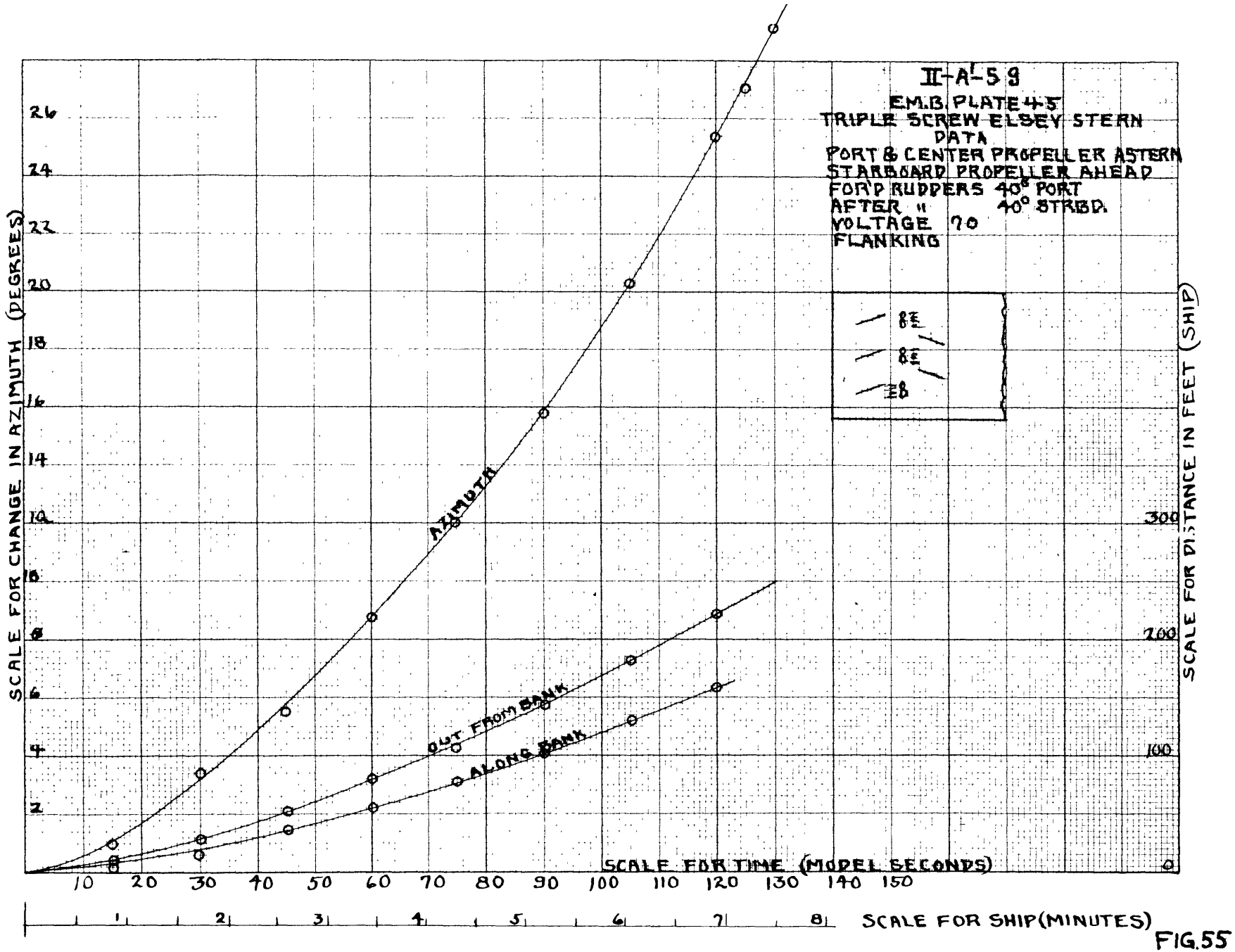

II-A-59
E.M.B. PLATE 45
TRIPLE SCREW ELSEY STERN
DATA
PORT & CENTER PROPELLER ASTERN
STARBOARD PROPELLER AHEAD
FOR'D RUDDERS 40° PORT
AFTER " 40° STRBD.
VOLTAGE 70
FLANKING
AZIMUTH
OUT FROM BANK
ALONG BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL SECONDS)
SCALE FOR SHIP (MINUTES)

FIG. 55

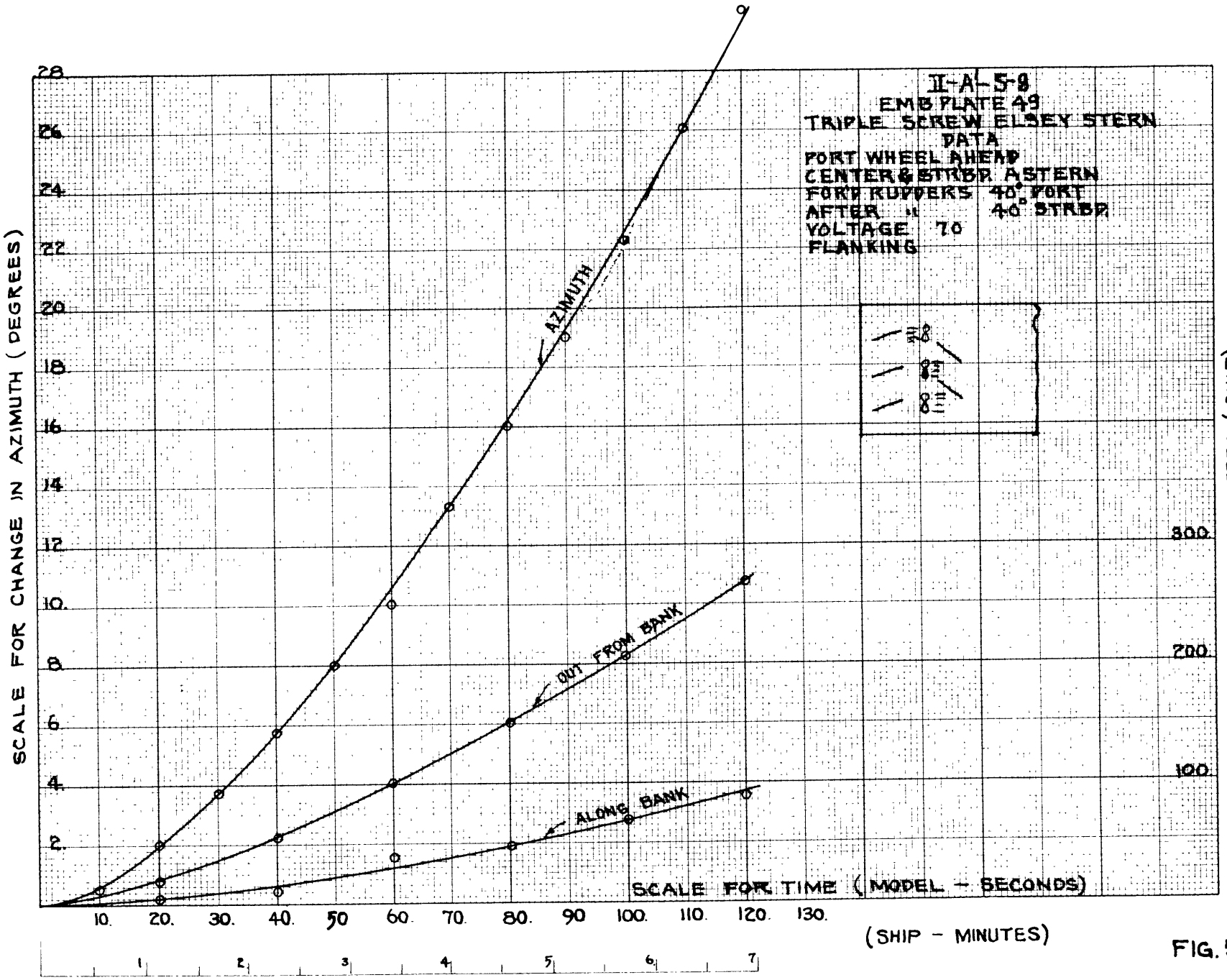

II-A-5-8
EMB PLATE 49
TRIPLE SCREW ELSEY STERN
DATA
PORT WHEEL AHEAD
CENTER & STRBD ASTERN
FORE RUDDERS 40° PORT
AFTER " 40° STRBD
VOLTAGE 7.0
FLANKING
AZIMUTH
OUT FROM BANK
ALONG BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
28
26
24
22
20
18
16
14
12
10.
8
6
4.
2.
300.
200.
100.
10. 20. 30. 40. 50 60. 70. 80. 90 100. 110. 120. 130.
1 2 3 4 5 6 7

FIG. 56

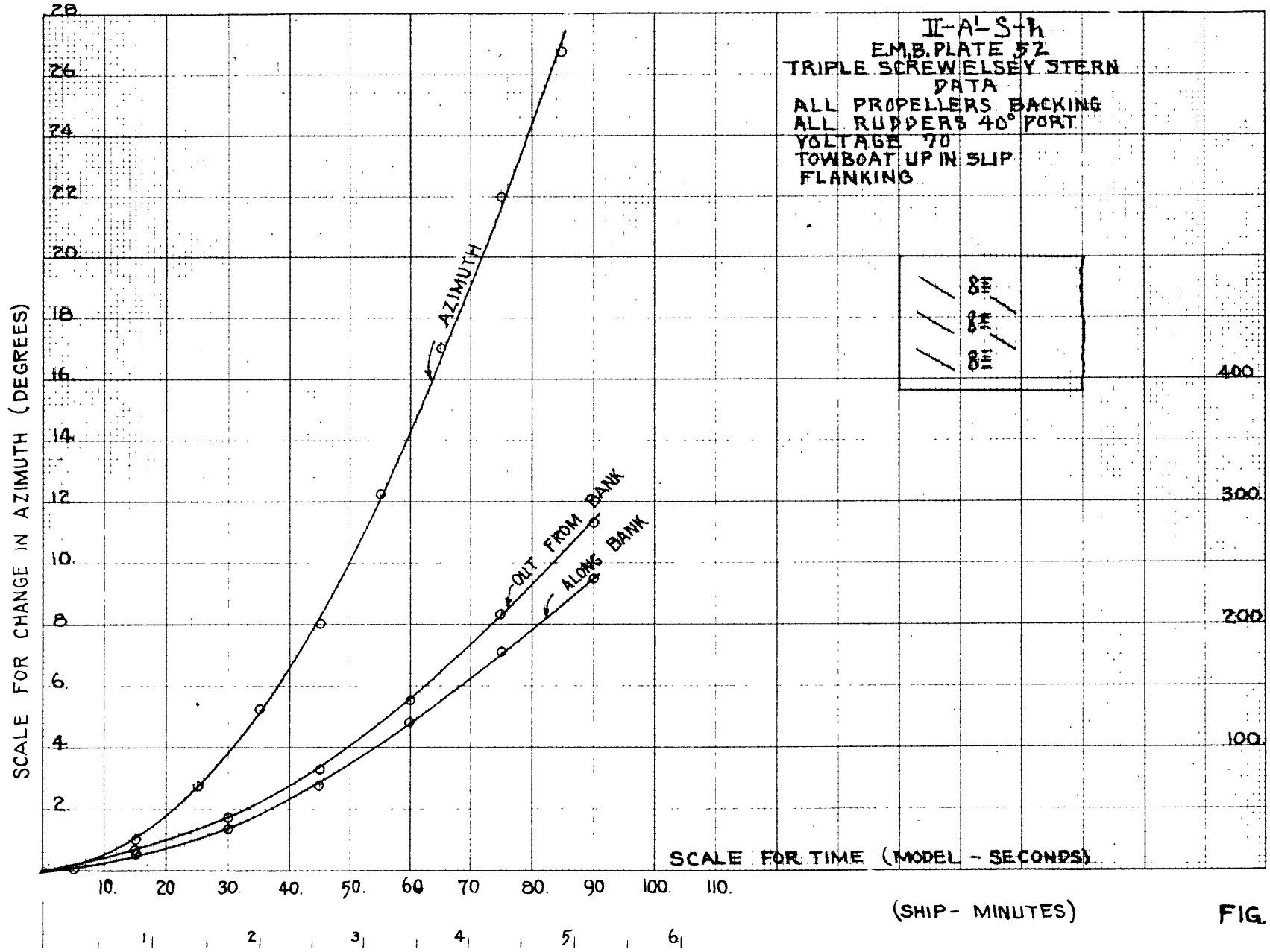

II-A-S-h
E.M.B. PLATE 52
TRIPLE SCREW ELSEY STERN
DATA
ALL PROPELLERS BACKING
ALL RUDDERS 40° PORT
VOLTAGE 70
TOWBOAT UP IN SLIP
FLANKING
AZIMUTH
OUT FROM BANK
ALONG BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
28
26
24
22
20
18
16
14
12
10
8
6
4
2
400
300
200
100
10.
20
30.
40.
50.
60
70
80.
90
100.
110.
1
2
3
4
5
6

FIG. 57

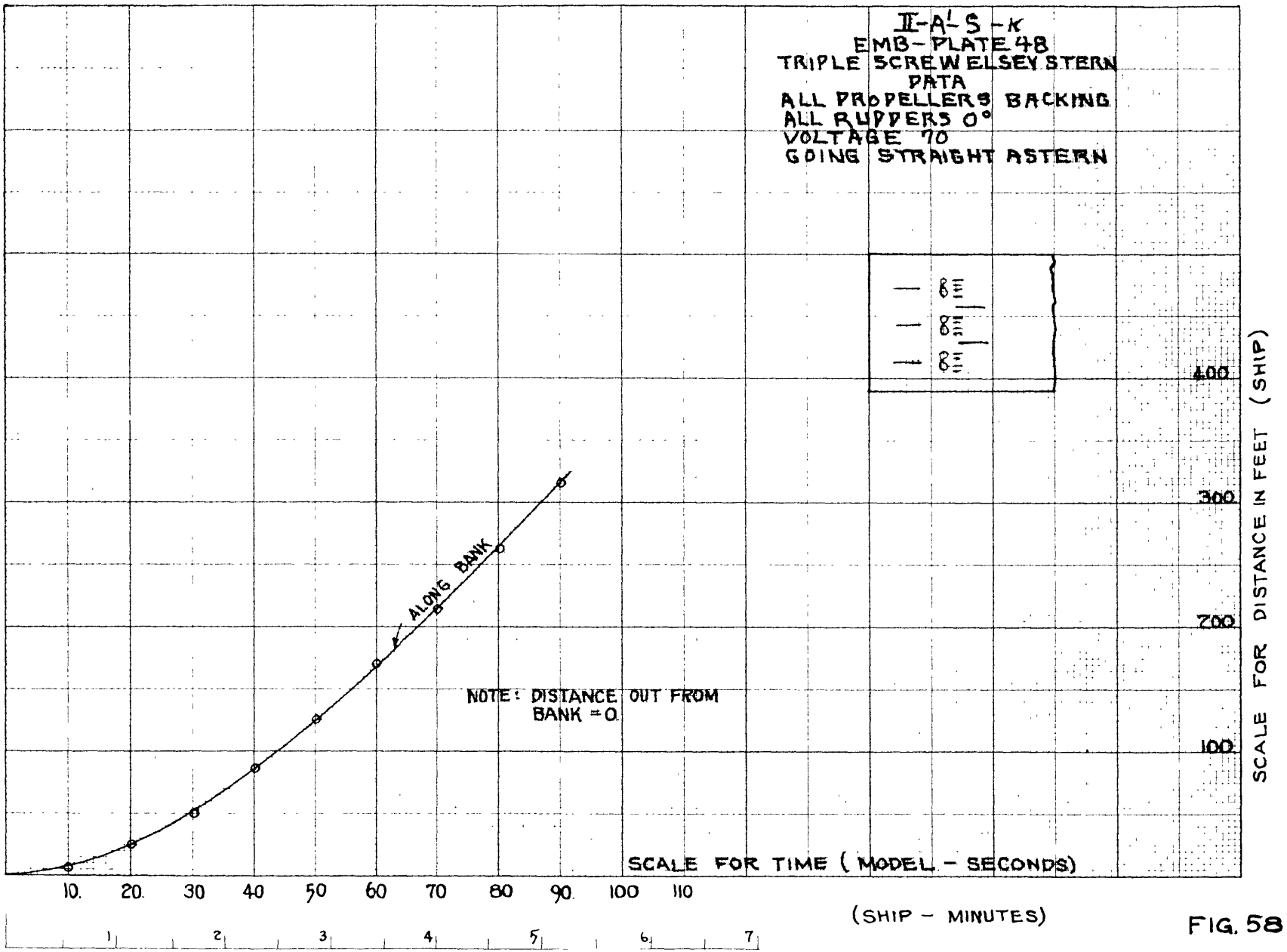

II-A-S-K
EMB-PLATE 48
TRIPLE SCREW ELSEY STERN
DATA
ALL PROPELLERS BACKING
ALL RUDDERS 0°
VOLTAGE 70
GOING STRAIGHT ASTERN
ALONG BANK
NOTE: DISTANCE OUT FROM BANK = 0.
SCALE FOR TIME (MODEL - SECONDS)
10. 20. 30 40 50 60 70 80 90. 100 110
(SHIP - MINUTES)
1 2 3 4 5 6 7
SCALE FOR DISTANCE IN FEET (SHIP)
400
300
200
100

FIG. 58

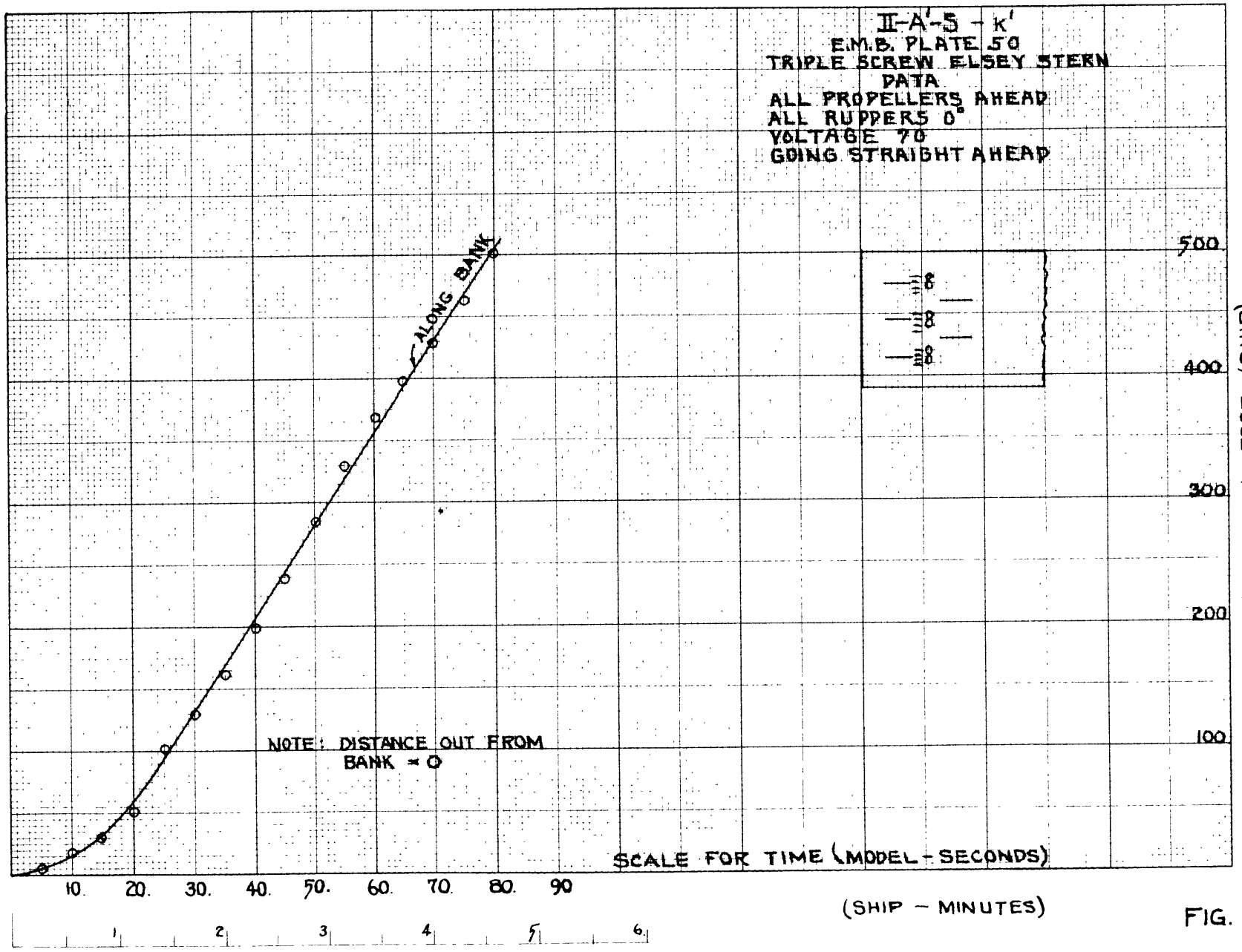

II-A'-5 - K'
E.M.B. PLATE 50
TRIPLE SCREW ELSEY STERN
DATA
ALL PROPELLERS AHEAD
ALL RUDDERS 0°
VOLTAGE 70
GOING STRAIGHT AHEAD
ALONG BANK
NOTE: DISTANCE OUT FROM BANK = 0
500
400
300
200
100
SCALE FOR DISTANCE IN FEET (SHIP)
10. 20. 30. 40. 50. 60. 70. 80. 90
SCALE FOR TIME (MODEL - SECONDS)
1 2 3 4 5 6
(SHIP - MINUTES)

FIG. 59

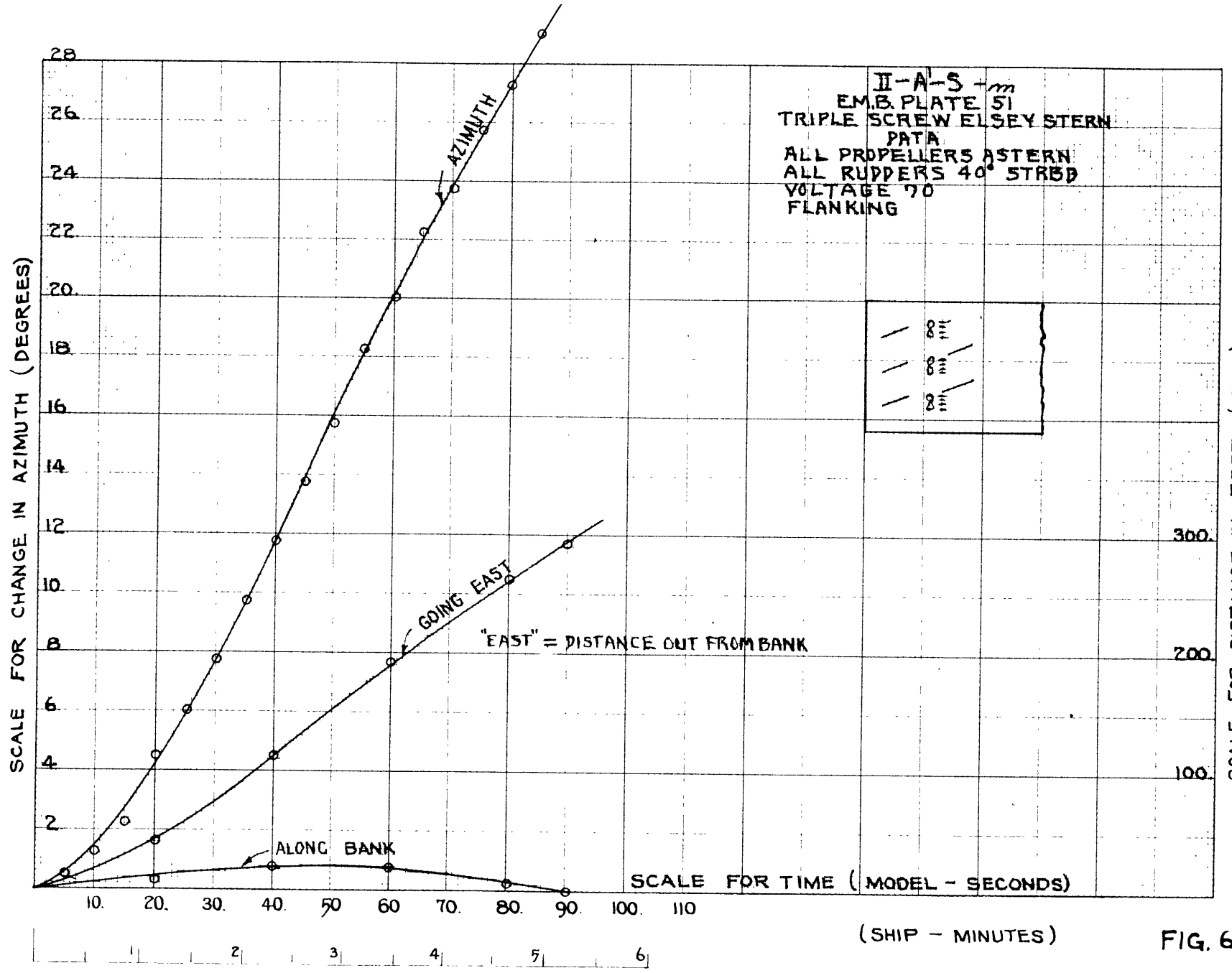

II-A-S-m
EM.B. PLATE 51
TRIPLE SCREW ELSEY STERN
PATA
ALL PROPELLERS ASTERN
ALL RUDDERS 40° STRBD
VOLTAGE 70
FLANKING
AZIMUTH
GOING EAST
"EAST" = DISTANCE OUT FROM BANK
ALONG BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
28
26
24
22
20
18
16
14
12
10
8
6
4
2
300.
200.
100.
10. 20. 30. 40. 50 60 70. 80. 90. 100. 110
2 3 4 5 6

FIG. 60

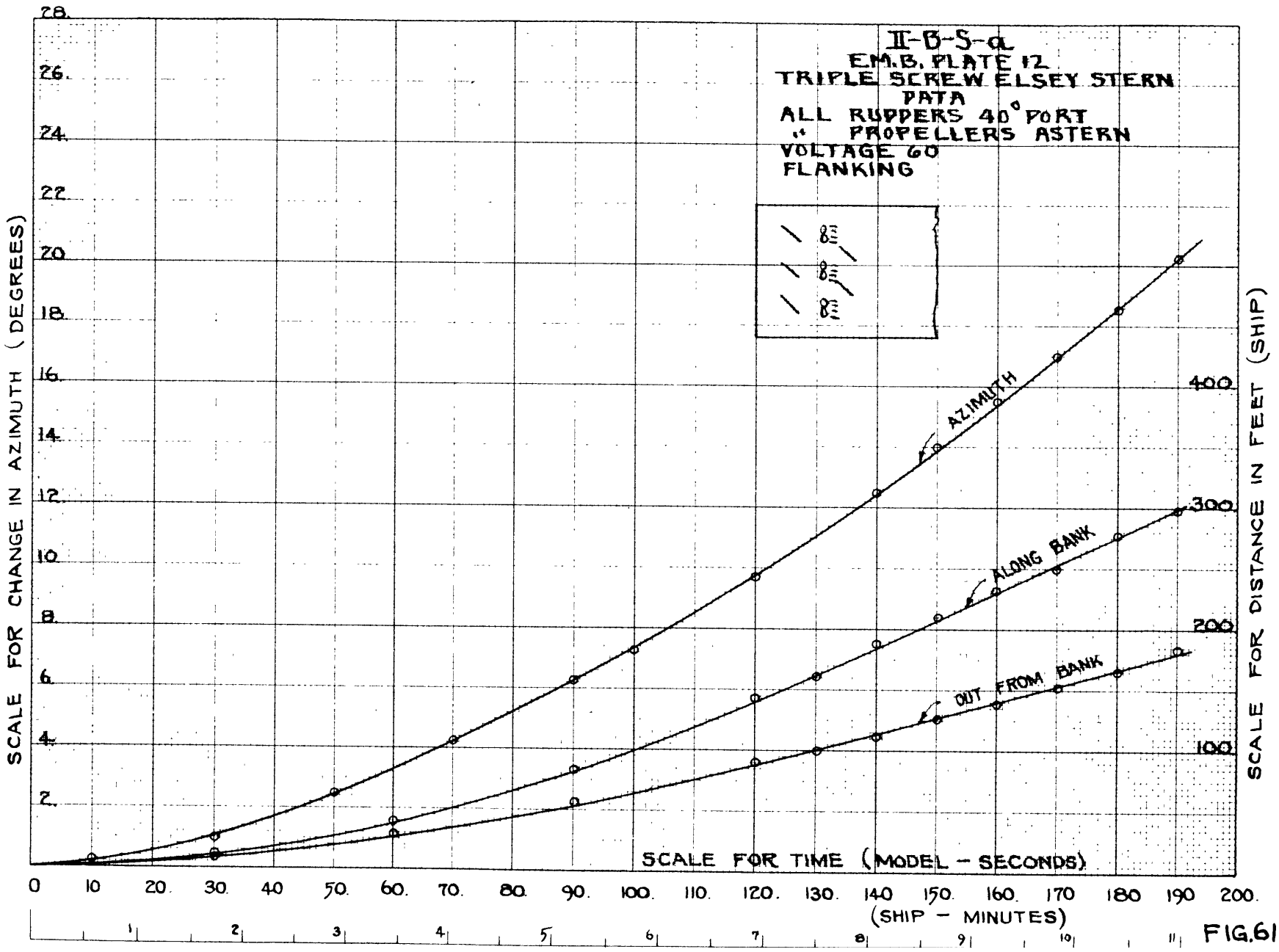

II-B-S-a
E.M.B. PLATE 12
TRIPLE SCREW ELSEY STERN
DATA
ALL RUDDERS 40° PORT
" PROPELLERS ASTERN
VOLTAGE 60
FLANKING
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
2 4 6 8 10 12 14 16 18 20 22 24 26 28
100 200 300 400
1 2 3 4 5 6 7 8 9 10 11

FIG. 61

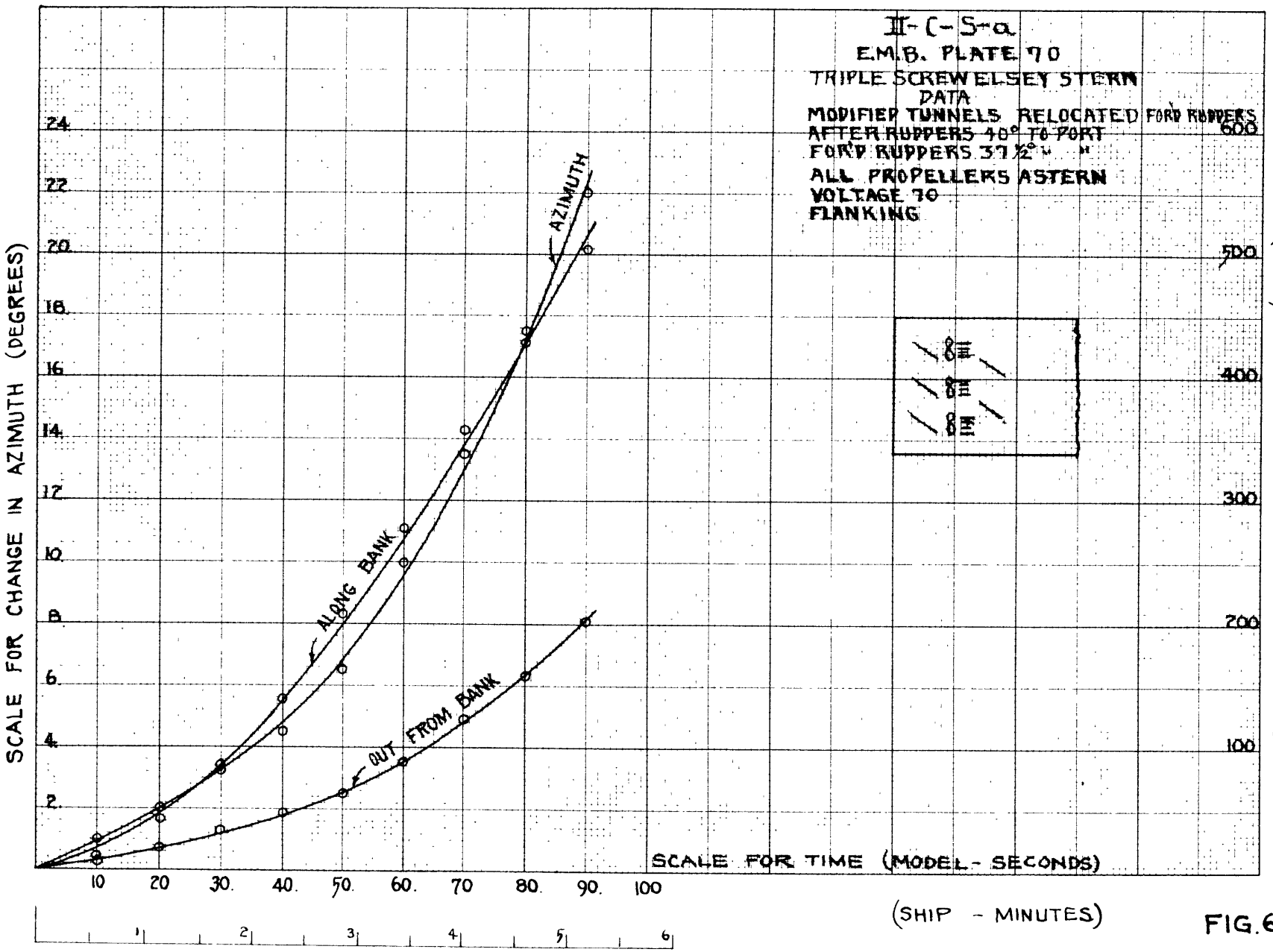

II-C-S-a
E.M.B. PLATE 70
TRIPLE SCREW ELSEY STERN
DATA
MODIFIER TUNNELS RELOCATED FORD RUDDERS
AFTER RUDDERS 40° TO PORT
FORD RUDDERS 37½° " "
ALL PROPELLERS ASTERN
VOLTAGE 70
FLANKING
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)

FIG. 62.

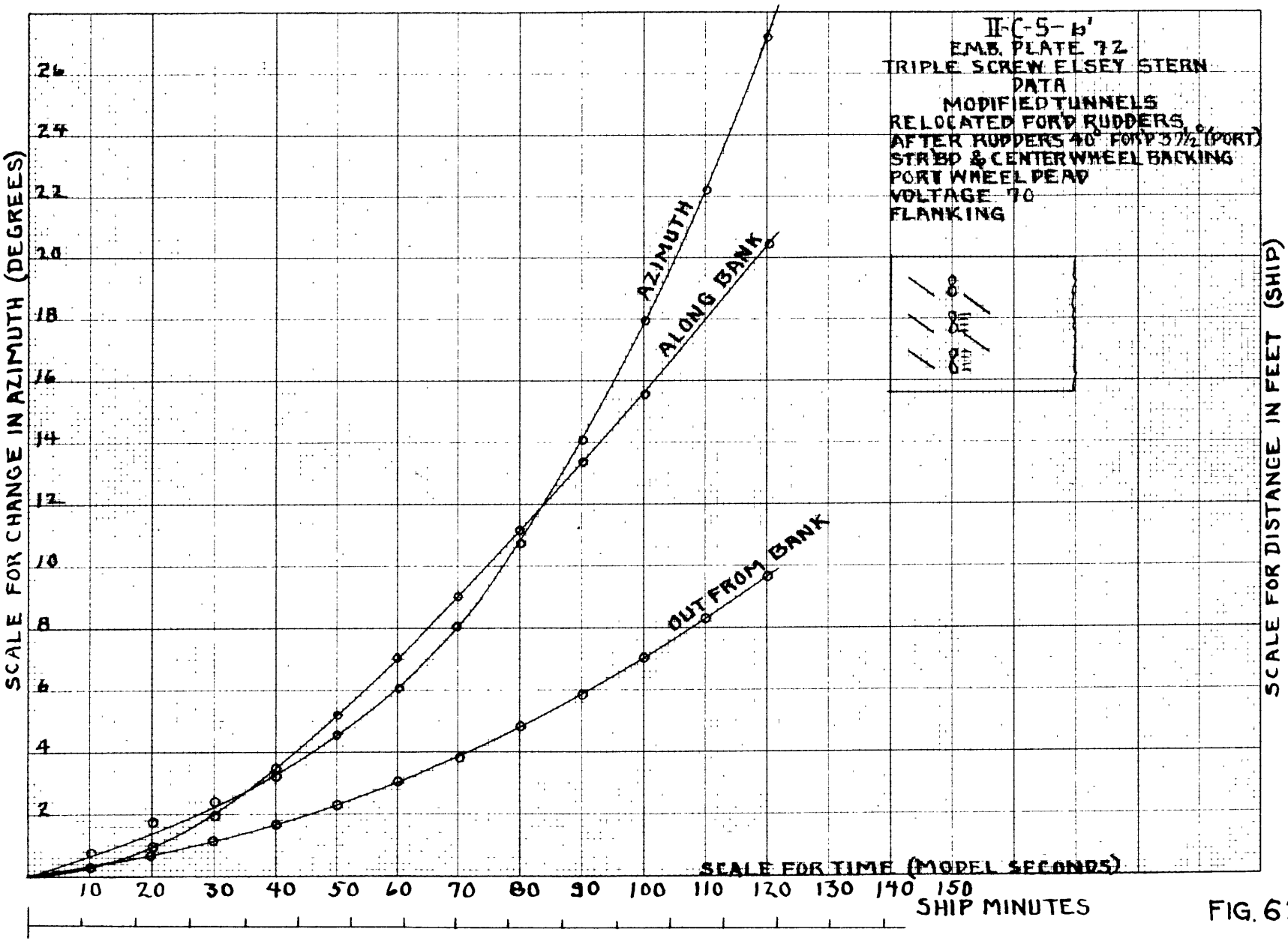

II-C-5-b'
E.M.B. PLATE 72
TRIPLE SCREW ELSEY STERN
DATA
MODIFIED TUNNELS
RELOCATED FORD RUDDERS
AFTER RUDDERS 40° FORE 37½° (PORT)
STR'BD & CENTER WHEEL BACKING
PORT WHEEL DEAD
VOLTAGE 70
FLANKING
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL SECONDS)
SHIP MINUTES
2
4
6
8
10
12
14
16
18
20
22
24
26
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150

FIG. 63

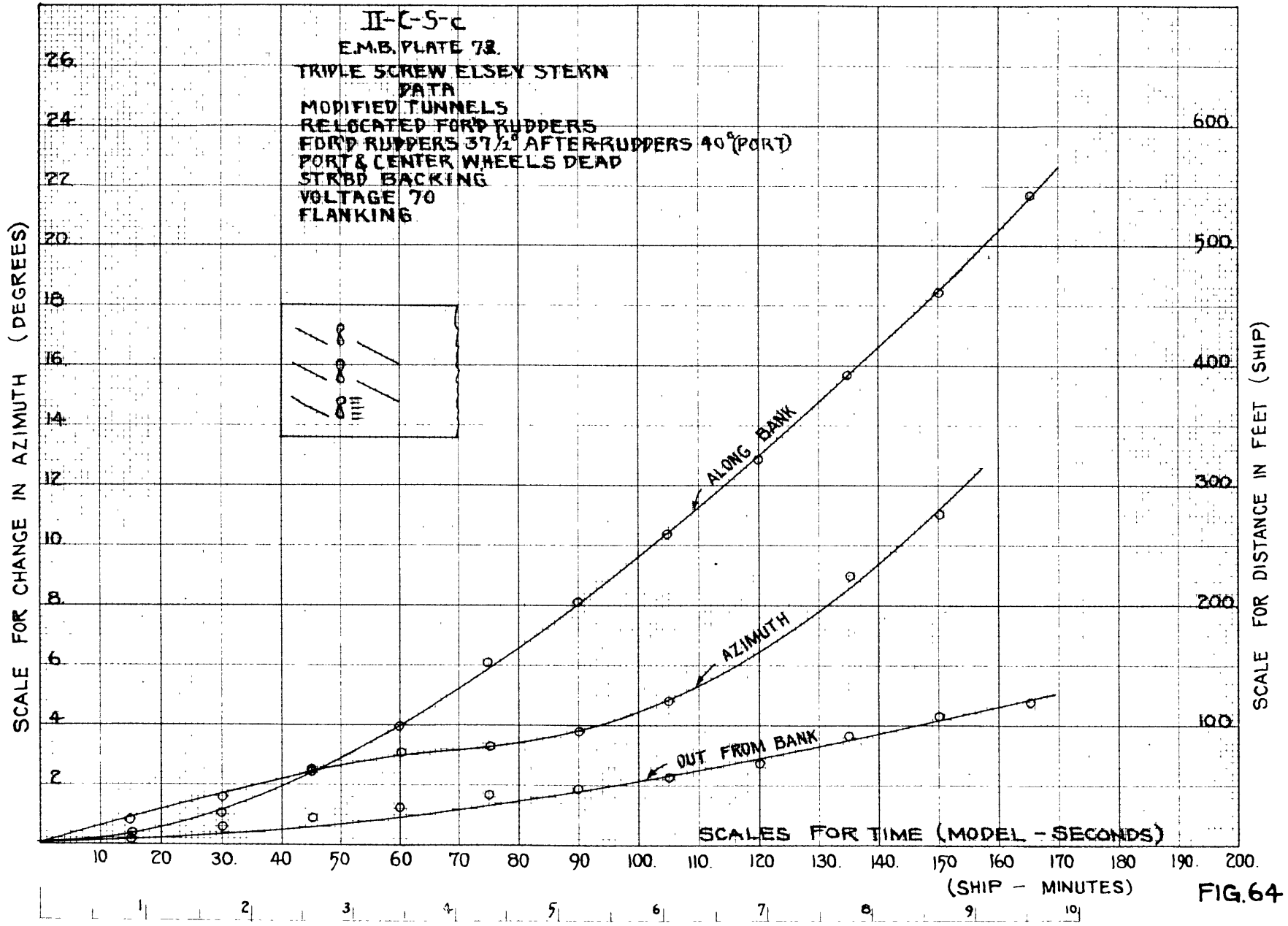

II-C-5-c
E.M.B. PLATE 78.
TRIPLE SCREW ELSEY STERN
DATA
MODIFIED TUNNELS
RELOCATED FORD RUDDERS
FORD RUDDERS 37½° AFTER RUDDERS 40° (PORT)
PORT & CENTER WHEELS DEAD
STRBD BACKING
VOLTAGE 70
FLANKING
ALONG BANK
AZIMUTH
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALES FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
26.
24
22
20
18
16
14
12
10
8.
6
4
2
600
500
400
300
200
100
10
20
30.
40
50
60
70
80
90
100.
110.
120
130.
140.
150
160
170
180
190.
200.
1
2
3
4
5
6
7
8
9
10

FIG. 64

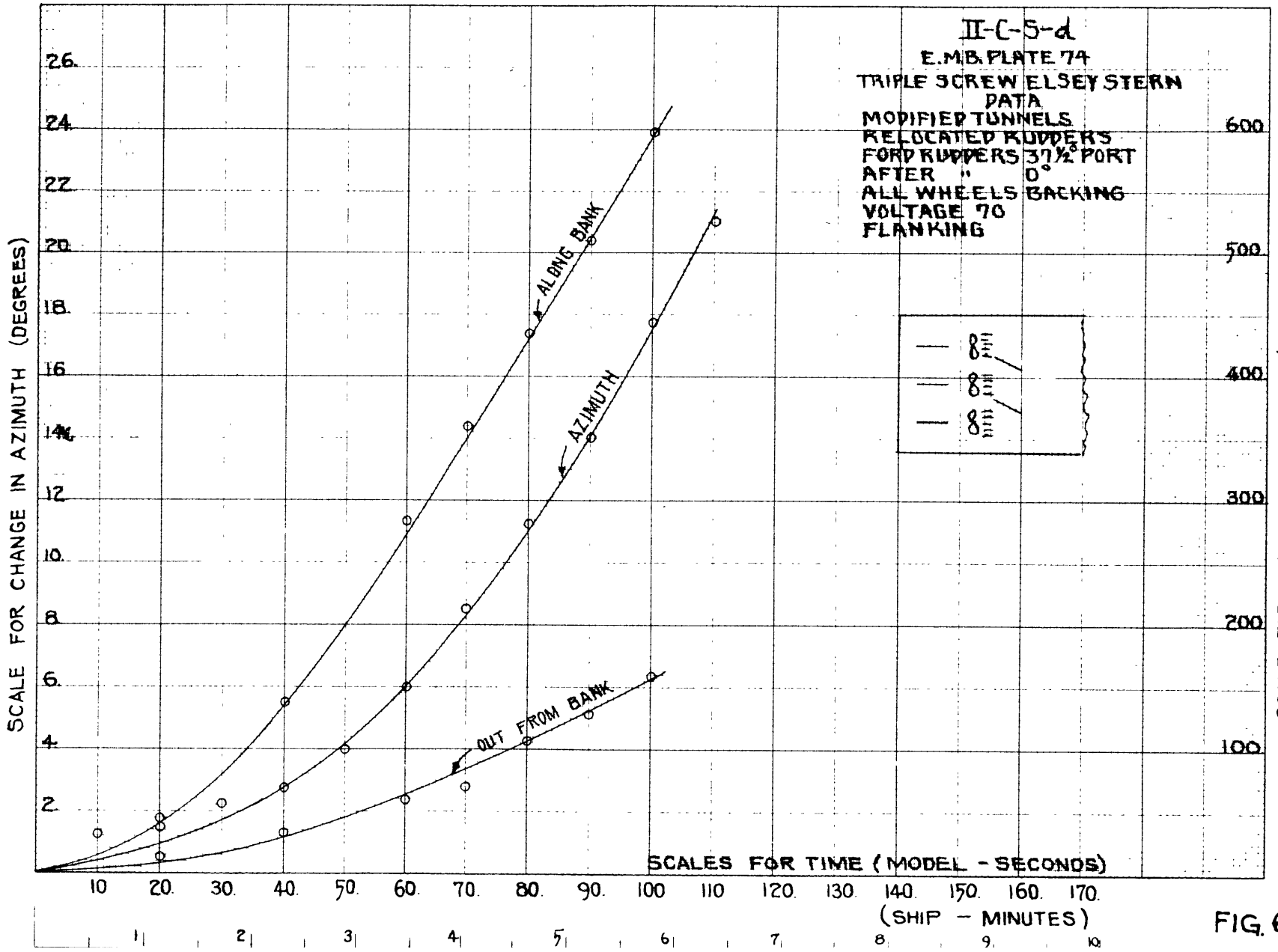

II-C-5-d
E.M.B. PLATE 74
TRIPLE SCREW ELSEY STERN
DATA
MODIFIED TUNNELS
RELOCATED RUDDERS
FORD RUDDERS 37½° PORT
AFTER " 0°
ALL WHEELS BACKING
VOLTAGE 70
FLANKING
ALONG BANK
AZIMUTH
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALES FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)

FIG. 65

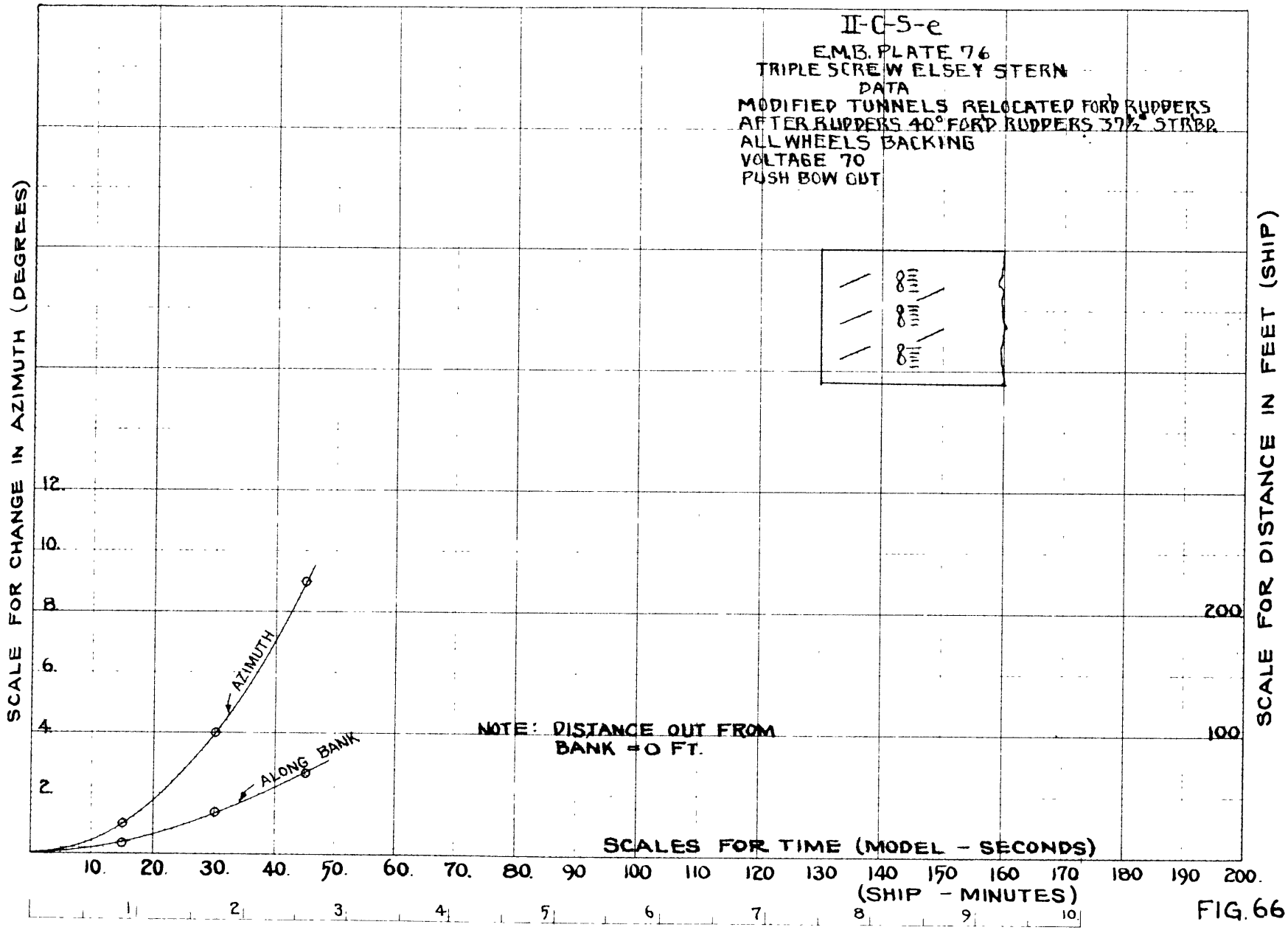

II-C-5-e
E.M.B. PLATE 76
TRIPLE SCREW ELSEY STERN
DATA
MODIFIED TUNNELS RELOCATED FORD RUDDERS
AFTER RUDDERS 40° FORD RUDDERS 37½ STRBD.
ALL WHEELS BACKING
VOLTAGE 70
PUSH BOW OUT
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
AZIMUTH
ALONG BANK
NOTE: DISTANCE OUT FROM BANK = 0 FT.
SCALES FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)

FIG. 66

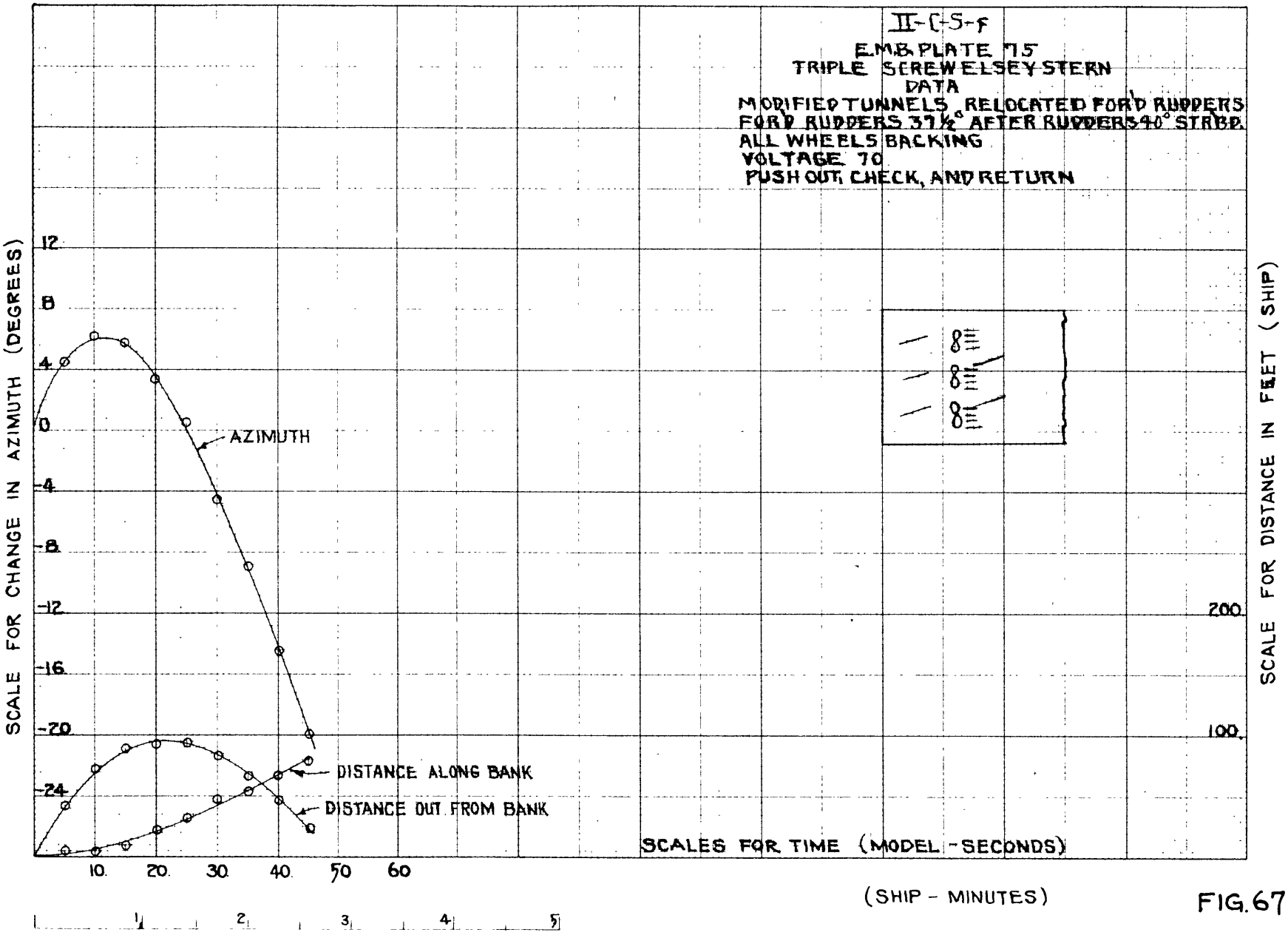

II-C-S-f
E.M.B. PLATE 75
TRIPLE SCREW ELSEY STERN
DATA
MODIFIED TUNNELS RELOCATED FORD RUDDERS
FORD RUDDERS 37½° AFTER RUDDERS 40° STRBD.
ALL WHEELS BACKING
VOLTAGE 70
PUSH OUT, CHECK, AND RETURN
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
12
8
4
0
-4
-8
-12
-16
-20
-24
AZIMUTH
DISTANCE ALONG BANK
DISTANCE OUT FROM BANK
10.
20.
30.
40.
50
60
SCALES FOR TIME (MODEL - SECONDS)
1
2
3
4
5
(SHIP - MINUTES)
SCALE FOR DISTANCE IN FEET (SHIP)
200.
100.

FIG. 67

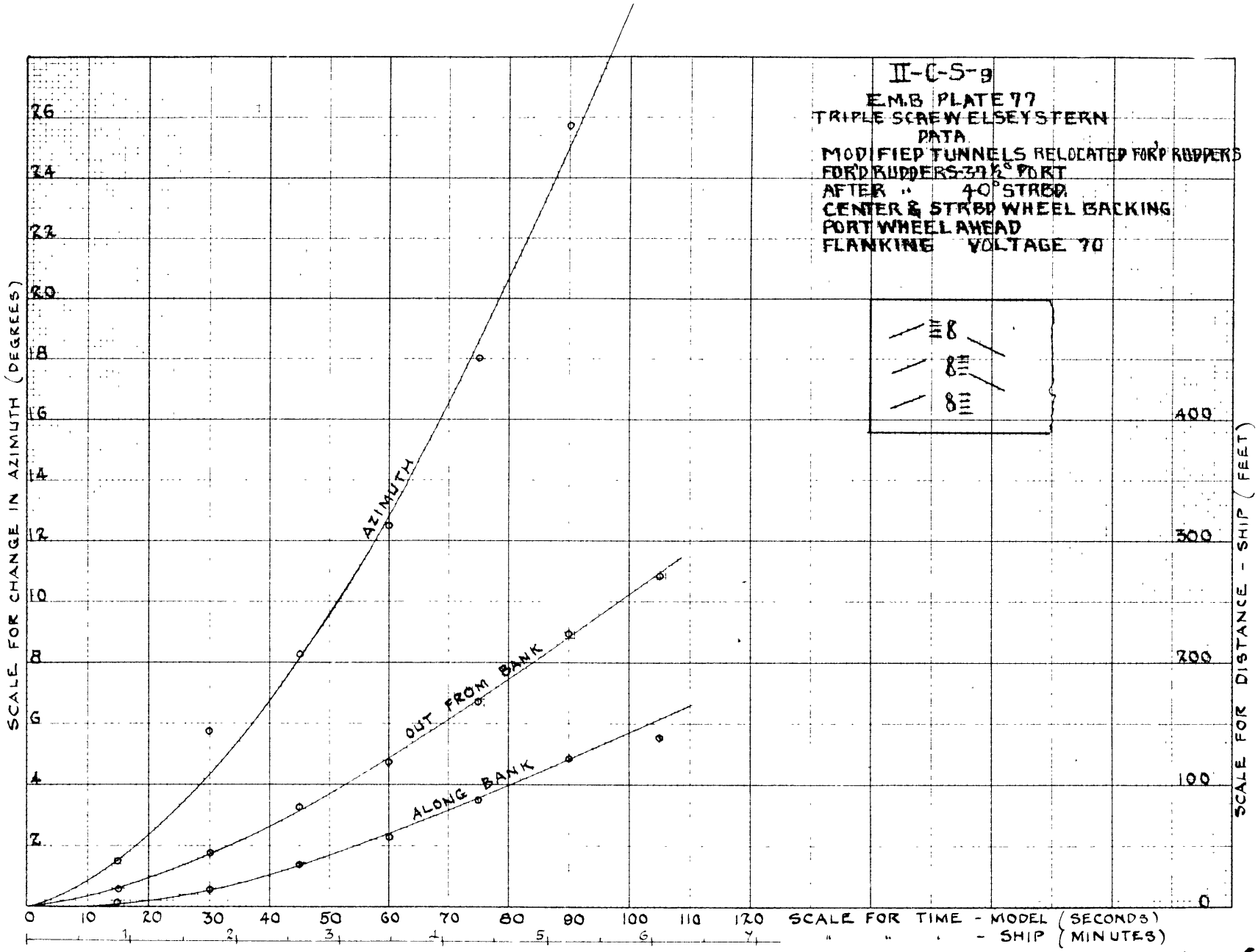

II-C-S-9
E.M.B PLATE 77
TRIPLE SCREW ELSEY STERN
DATA
MODIFIED TUNNELS RELOCATED FOR'D RUDDERS
FOR'D RUDDERS-39½° PORT
AFTER " 40° STRBD.
CENTER & STRBD WHEEL BACKING
PORT WHEEL AHEAD
FLANKING VOLTAGE 70
AZIMUTH
OUT FROM BANK
ALONG BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE - SHIP (FEET)
SCALE FOR TIME - MODEL (SECONDS)
" " " - SHIP (MINUTES)

FIG. 68

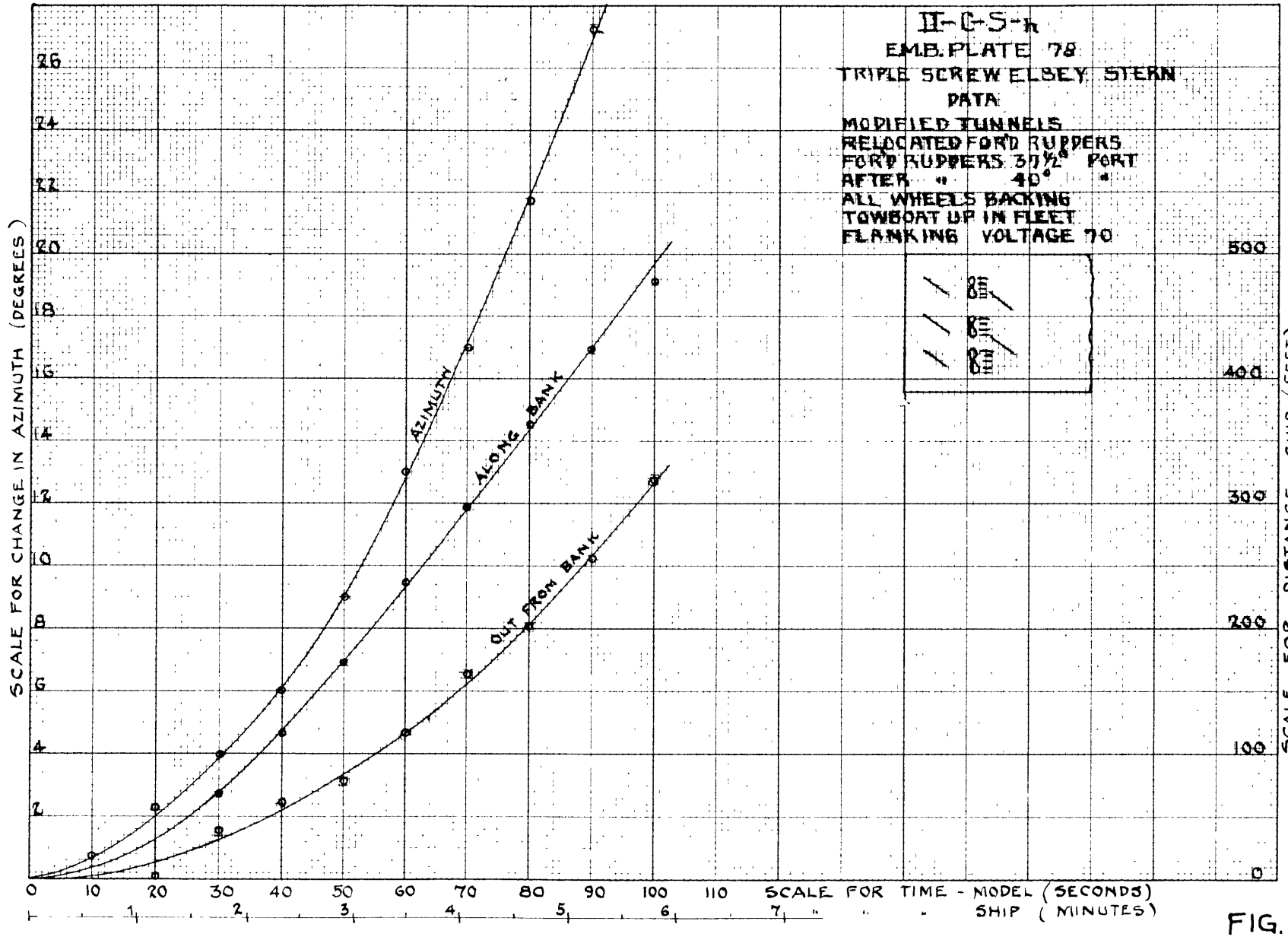

II-C-S-h
EMB. PLATE 78
TRIPLE SCREW ELSEY STERN
DATA
MODIFIED TUNNELS
RELOCATED FORD RUDDERS
FORD RUDDERS 37½° PORT
AFTER " 40° "
ALL WHEELS BACKING
TOWBOAT UP IN FLEET
FLANKING VOLTAGE 70
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE - SHIP (FEET)
SCALE FOR TIME - MODEL (SECONDS)
" " " SHIP (MINUTES)

FIG. 69

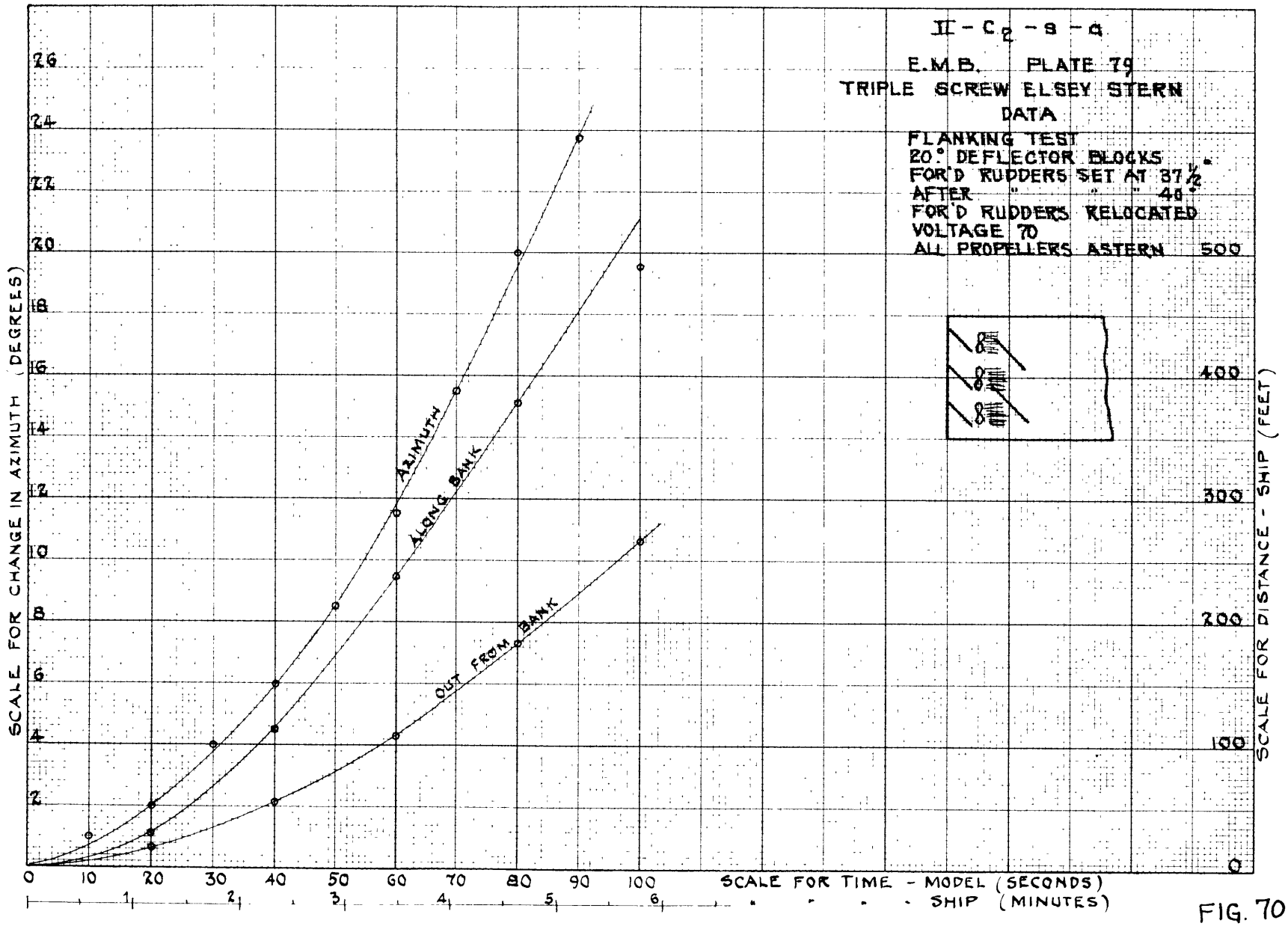

II - C2 - 8 - a
E.M.B. PLATE 79
TRIPLE SCREW ELSEY STERN
DATA
FLANKING TEST
20° DEFLECTOR BLOCKS
FOR'D RUDDERS SET AT 37½°
AFTER " " " 46°
FOR'D RUDDERS RELOCATED
VOLTAGE 70
ALL PROPELLERS ASTERN
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE - SHIP (FEET)
SCALE FOR TIME - MODEL (SECONDS)
SHIP (MINUTES)

FIG. 70

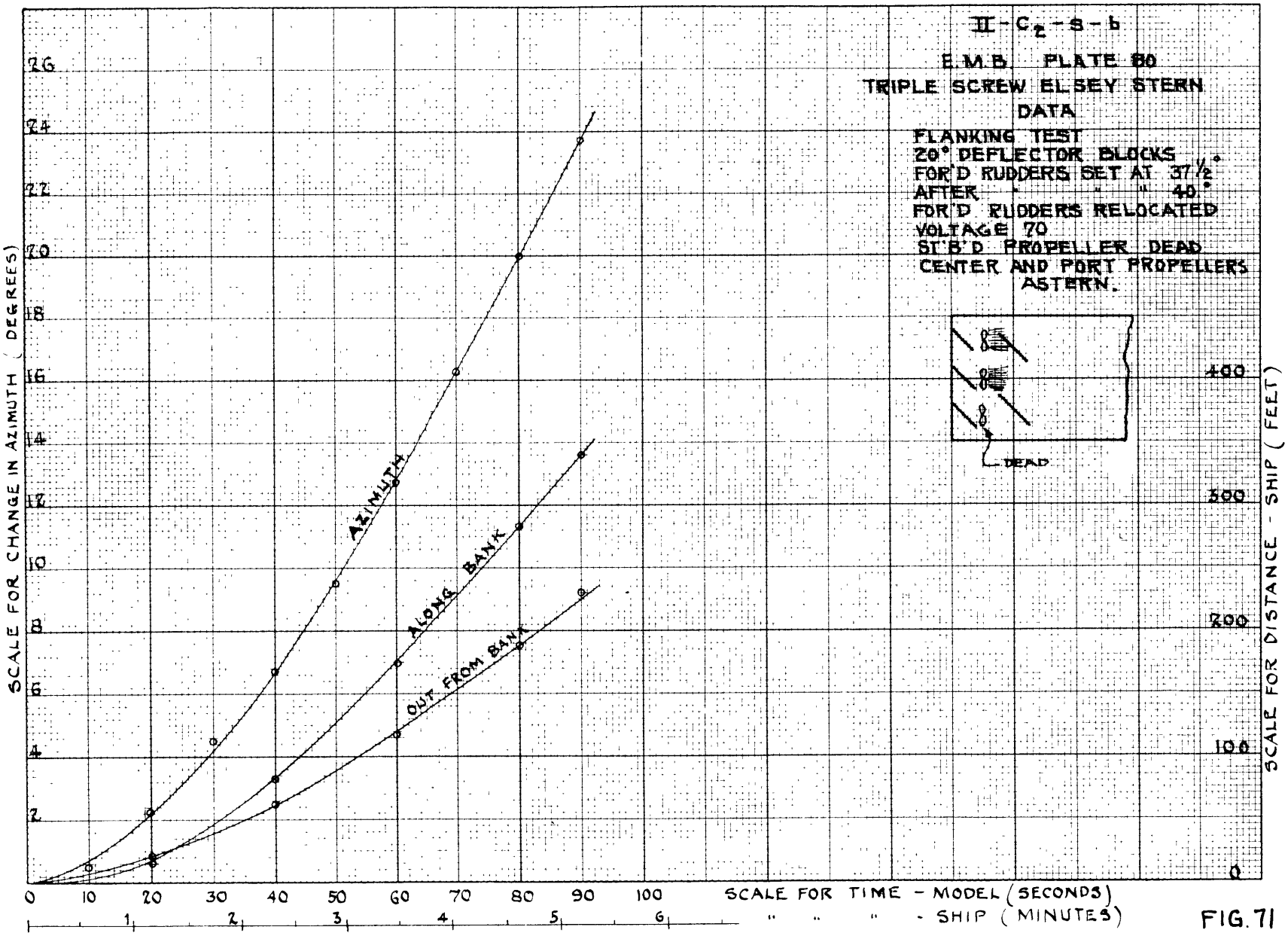

II - C₂ - S - b
E.M.B. PLATE 80
TRIPLE SCREW ELSEY STERN
DATA
FLANKING TEST
20° DEFLECTOR BLOCKS
FOR'D RUDDERS SET AT 37½°
AFTER " " " 40°
FOR'D RUDDERS RELOCATED
VOLTAGE 70
ST'B'D PROPELLER DEAD
CENTER AND PORT PROPELLERS
ASTERN.
DEAD
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE - SHIP (FEET)
SCALE FOR TIME - MODEL (SECONDS)
" " " - SHIP (MINUTES)

FIG. 71

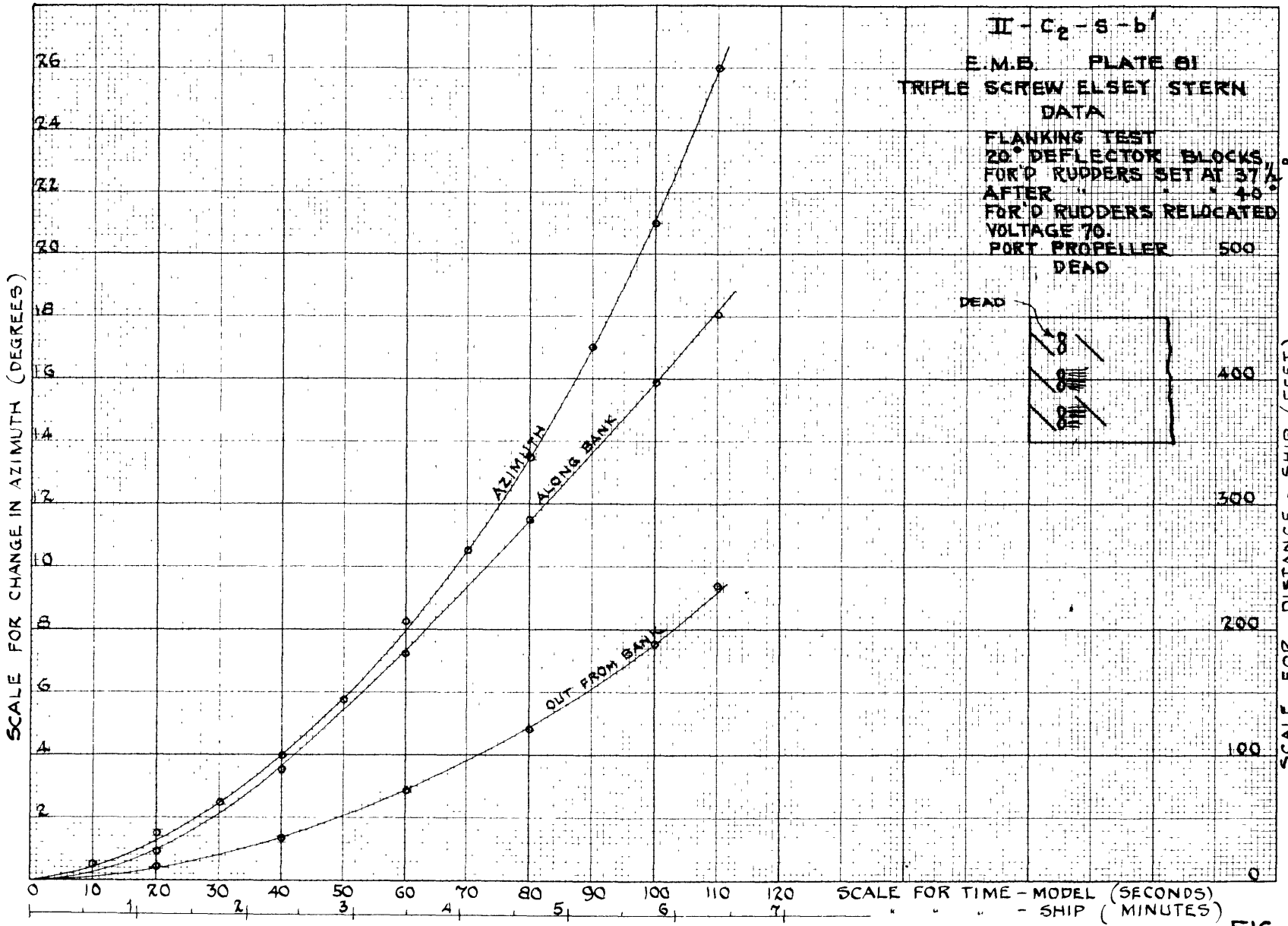

II - C2 - S - b'
E.M.B. PLATE 81
TRIPLE SCREW ELSEY STERN
DATA
FLANKING TEST
20° DEFLECTOR BLOCKS
FOR'D RUDDERS SET AT 37½°
AFTER " " " 40°
FOR'D RUDDERS RELOCATED
VOLTAGE 70.
PORT PROPELLER DEAD
DEAD
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE - SHIP (FEET)
SCALE FOR TIME - MODEL (SECONDS)
" " " - SHIP (MINUTES)

FIG. 72

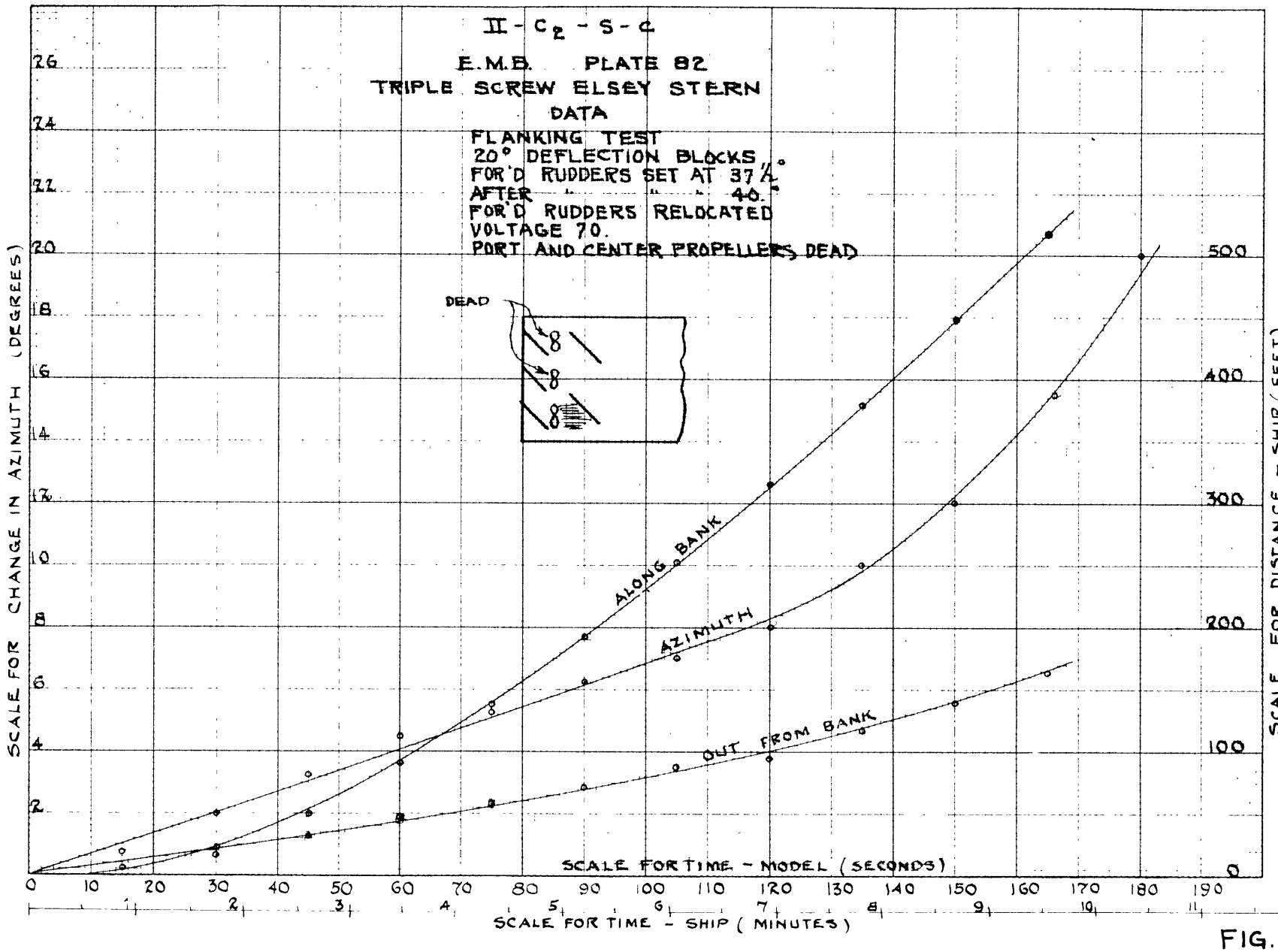

II - C2 - S - C
E.M.B. PLATE 82
TRIPLE SCREW ELSEY STERN
DATA
FLANKING TEST
20° DEFLECTION BLOCKS
FOR'D RUDDERS SET AT 37½°
AFTER " " " 40°
FOR'D RUDDERS RELOCATED
VOLTAGE 70.
PORT AND CENTER PROPELLERS DEAD
DEAD
ALONG BANK
AZIMUTH
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE - SHIP (FEET)
SCALE FOR TIME - MODEL (SECONDS)
SCALE FOR TIME - SHIP (MINUTES)

FIG. 73

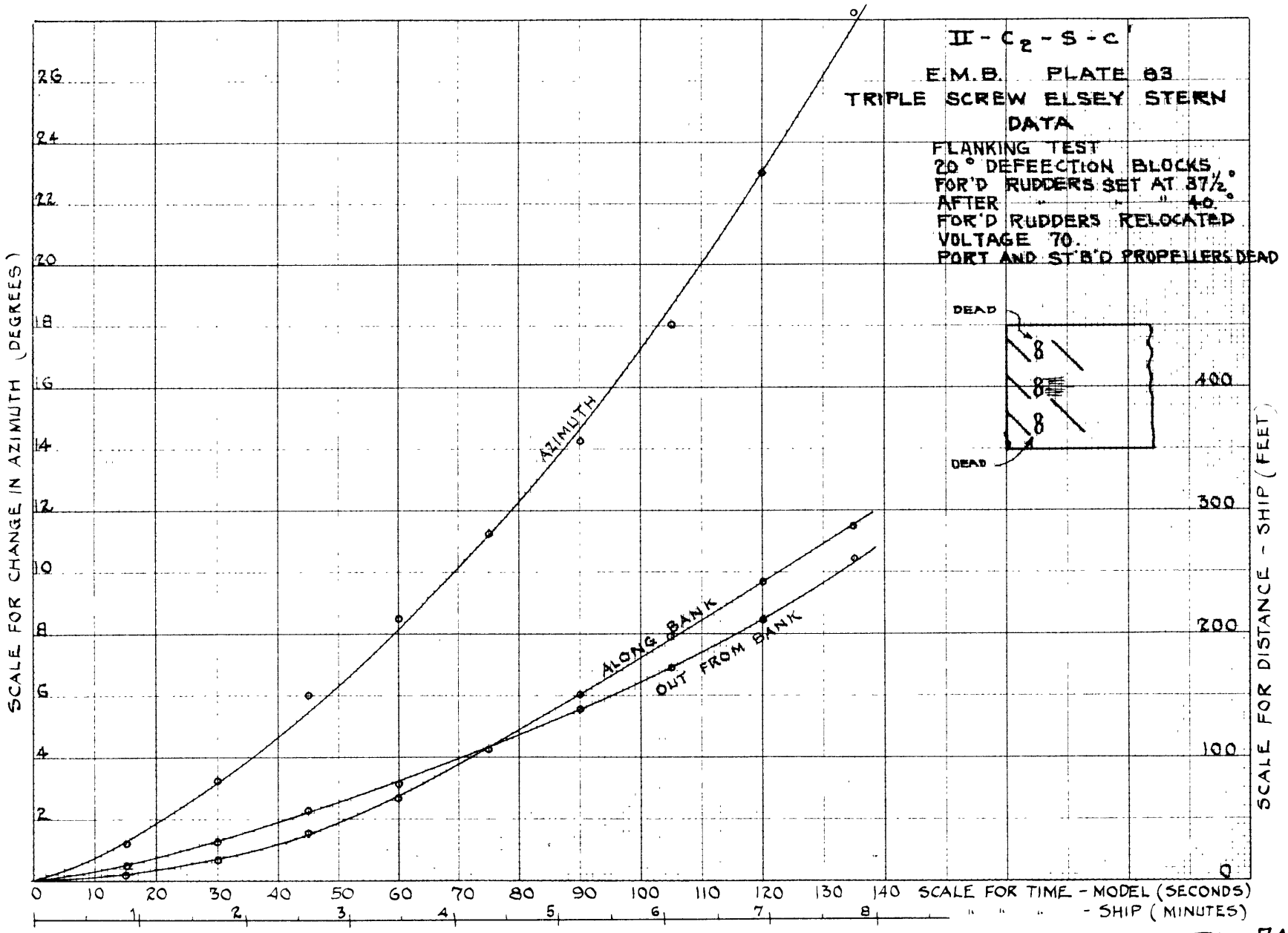

II - C2 - S - c
E.M.B. PLATE 83
TRIPLE SCREW ELSEY STERN
DATA
FLANKING TEST
20° DEFEECTION BLOCKS
FOR'D RUDDERS SET AT 37½°
AFTER " " " 40.
FOR'D RUDDERS RELOCATED
VOLTAGE 70.
PORT AND ST'B'D PROPELLERS DEAD
DEAD
DEAD
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE - SHIP (FEET)
SCALE FOR TIME - MODEL (SECONDS)
" " " - SHIP (MINUTES)

FIG. 74

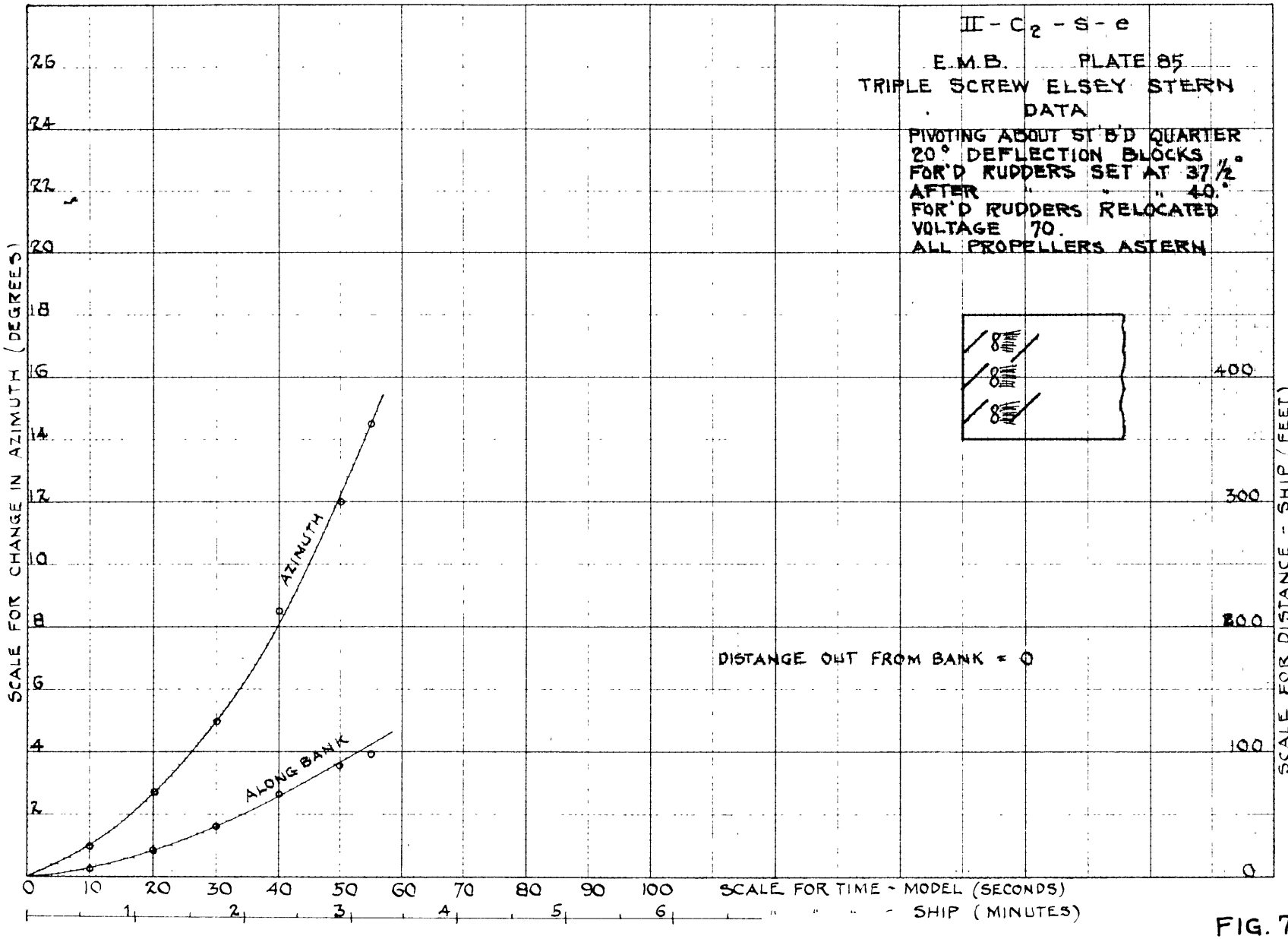

II - C2 - S - e
E.M.B. PLATE 85
TRIPLE SCREW ELSEY STERN
DATA
PIVOTING ABOUT ST'B'D QUARTER
20° DEFLECTION BLOCKS
FOR'D RUDDERS SET AT 37½°
AFTER " " " 40.°
FOR'D RUDDERS RELOCATED
VOLTAGE 70.
ALL PROPELLERS ASTERN
DISTANCE OUT FROM BANK = 0
AZIMUTH
ALONG BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE - SHIP (FEET)
SCALE FOR TIME - MODEL (SECONDS)
" " " - SHIP (MINUTES)

FIG. 75

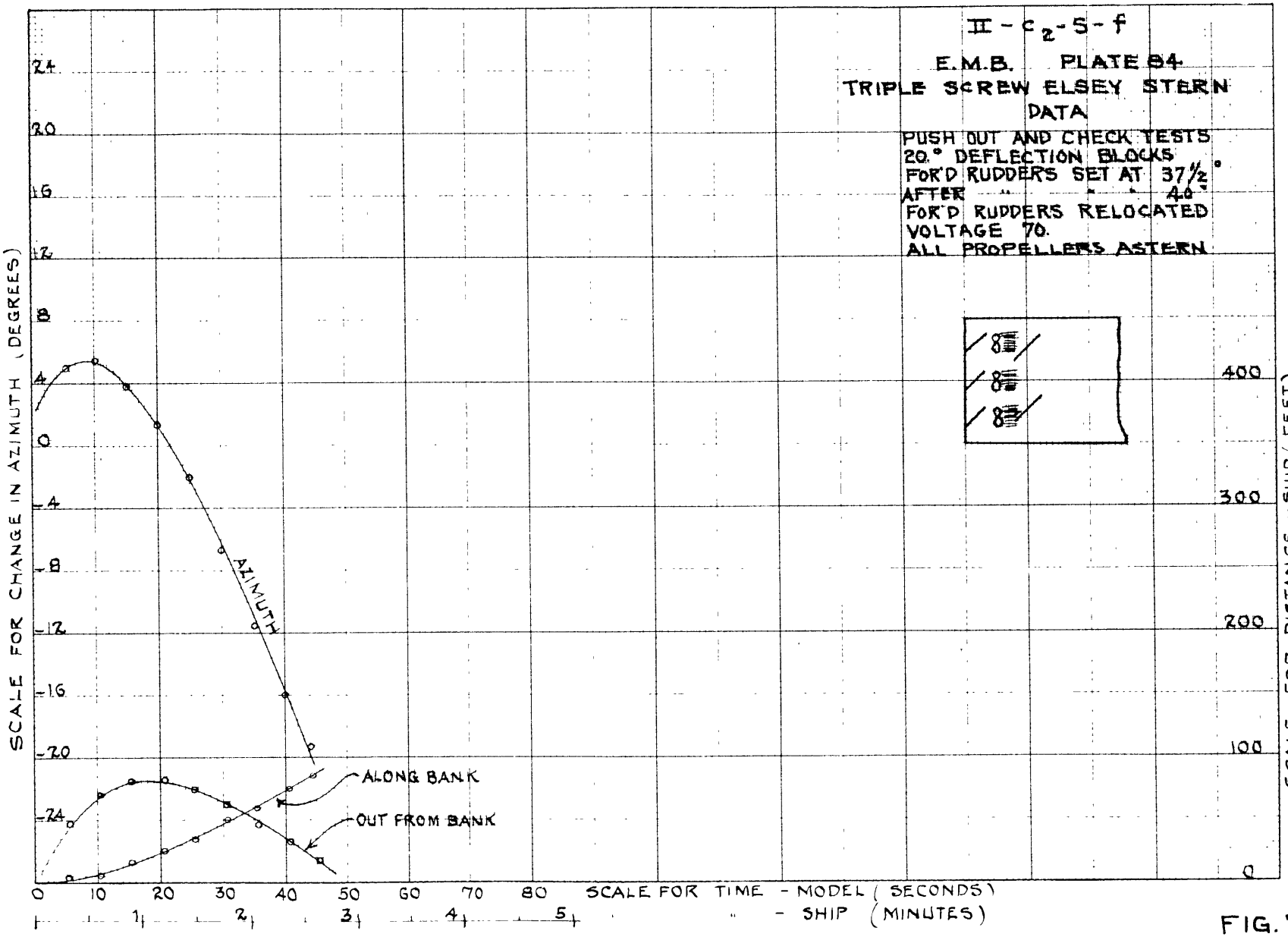

II - C2 - S - f
E.M.B. PLATE 84
TRIPLE SCREW ELSEY STERN
DATA
PUSH OUT AND CHECK TESTS
20.° DEFLECTION BLOCKS
FOR'D RUDDERS SET AT 37½°
AFTER " " " 40°
FOR'D RUDDERS RELOCATED
VOLTAGE 70.
ALL PROPELLERS ASTERN
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
24
20
16
12
8
4
0
-4
-8
-12
-16
-20
-24
AZIMUTH
ALONG BANK
OUT FROM BANK
0 10 20 30 40 50 60 70 80
SCALE FOR TIME - MODEL (SECONDS)
1¼ 2¼ 3¼ 4¼ 5¼
" - SHIP (MINUTES)
SCALE FOR DISTANCE - SHIP (FEET)
400
300
200
100
0

FIG. 76

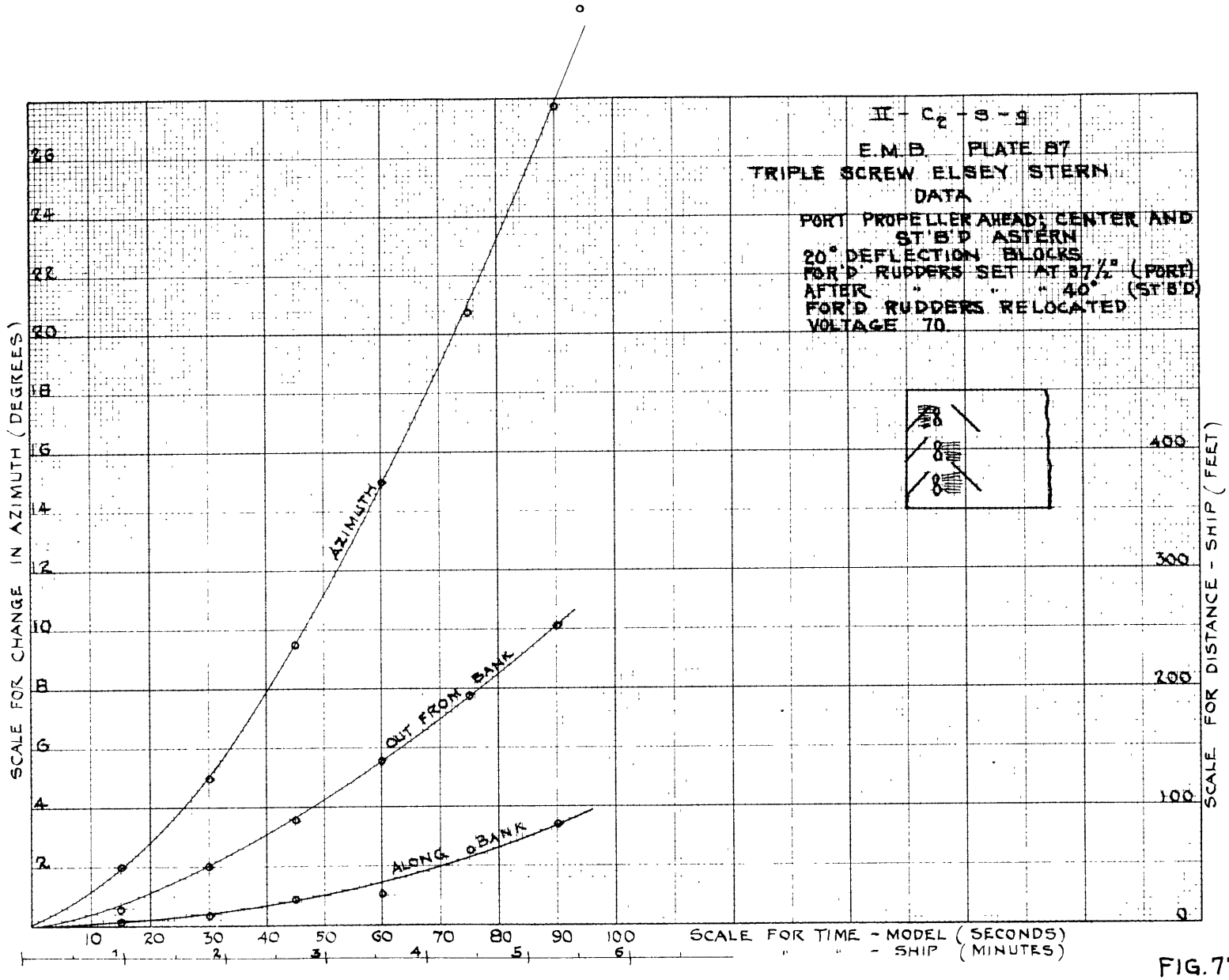

II - C_2 - S - 9
E.M.B. PLATE 87
TRIPLE SCREW ELSEY STERN
DATA
PORT PROPELLER AHEAD; CENTER AND ST'B'D ASTERN
20° DEFLECTION BLOCKS
FOR'D RUDDERS SET AT 37½° (PORT)
AFTER " " " 40° (ST'B'D)
FOR'D RUDDERS RELOCATED
VOLTAGE 70
AZIMUTH
OUT FROM BANK
ALONG BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE - SHIP (FEET)
SCALE FOR TIME - MODEL (SECONDS)
" " - SHIP (MINUTES)

FIG. 77

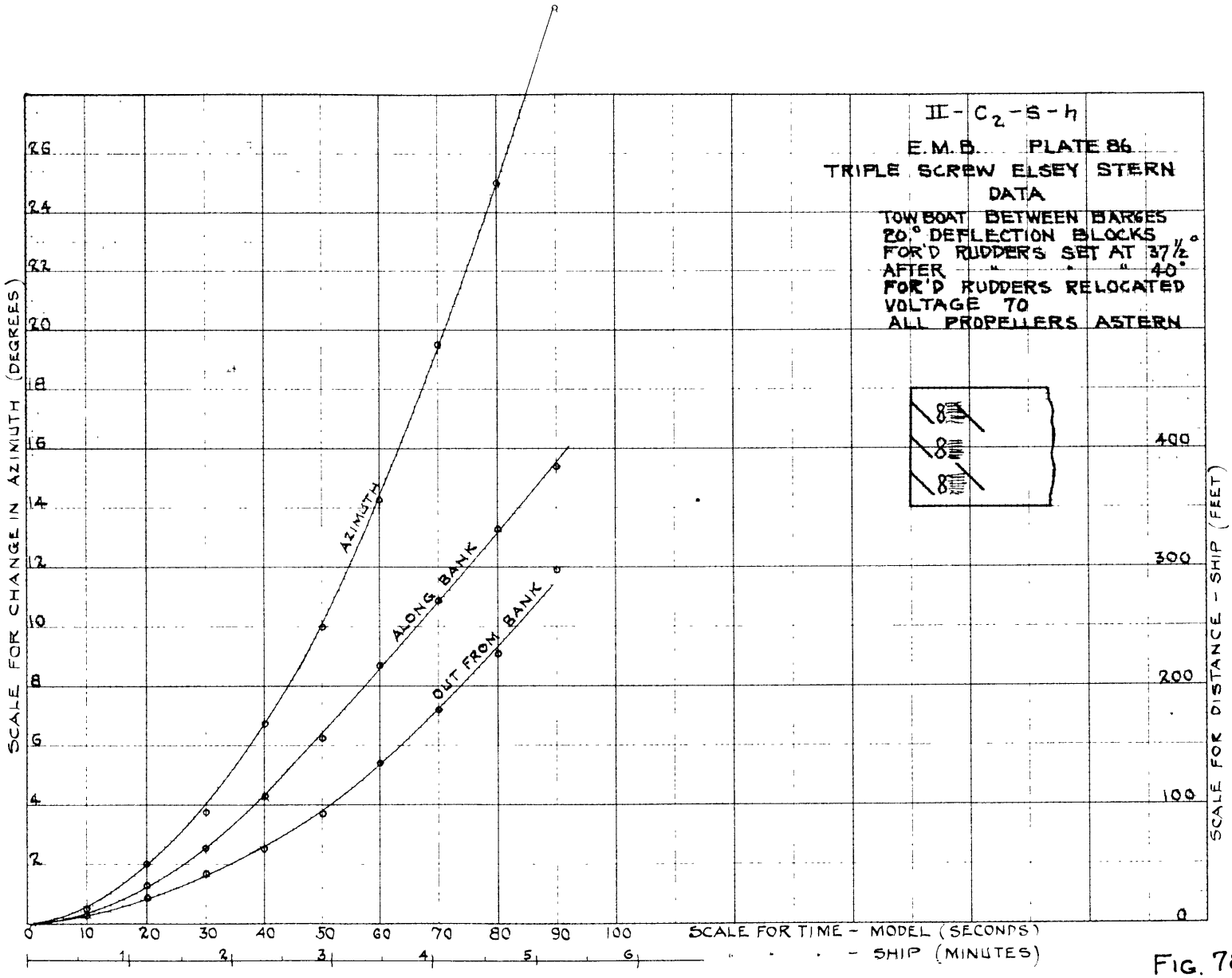

II - C2 - S - h
E.M.B. PLATE 86
TRIPLE SCREW ELSEY STERN
DATA
TOW BOAT BETWEEN BARGES
20.° DEFLECTION BLOCKS
FOR'D RUDDERS SET AT 37½°
AFTER " " " 40°
FOR'D RUDDERS RELOCATED
VOLTAGE 70
ALL PROPELLERS ASTERN
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE - SHIP (FEET)
SCALE FOR TIME - MODEL (SECONDS)
- SHIP (MINUTES)

FIG. 78

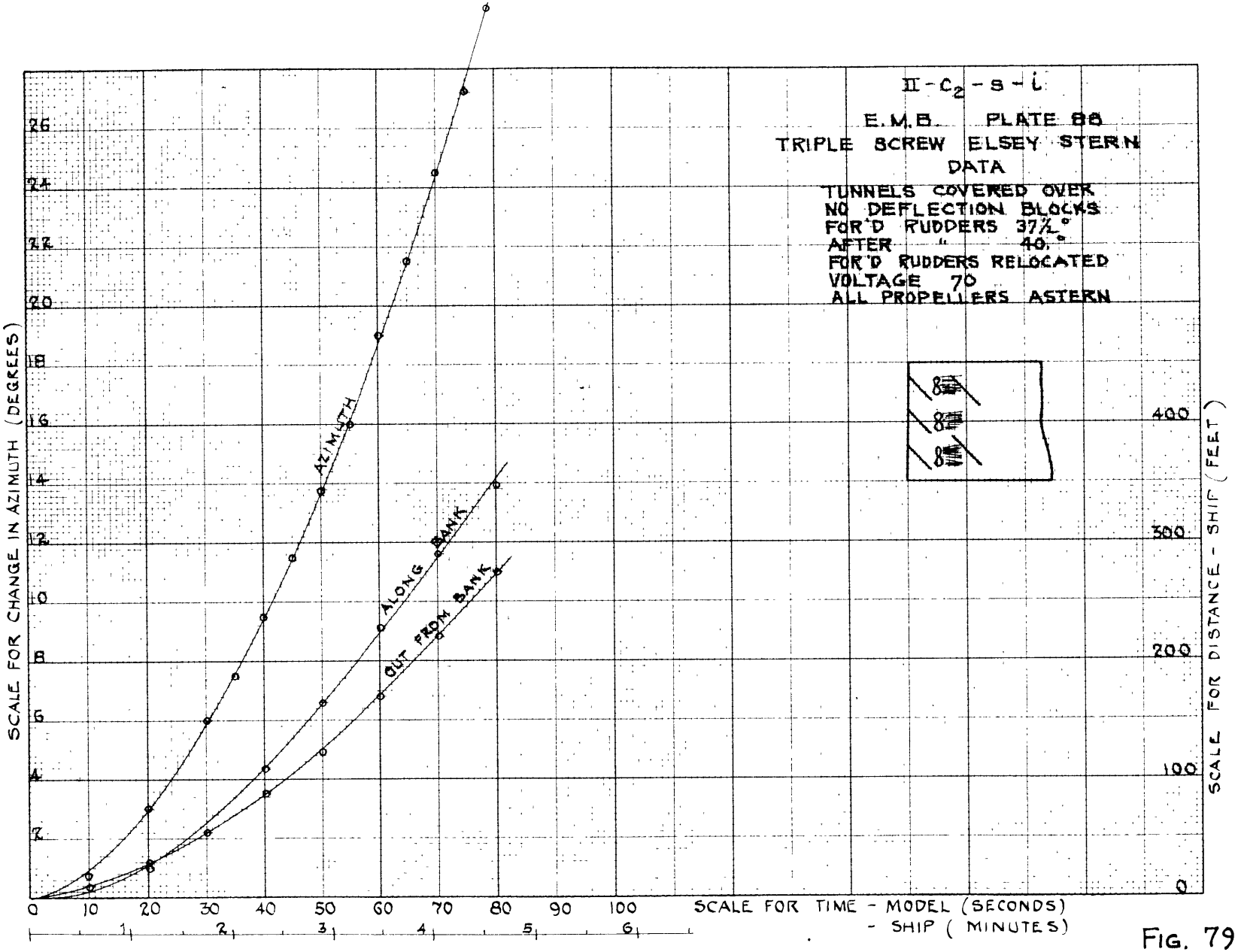

II - C2 - S - i
E.M.B. PLATE 88
TRIPLE SCREW ELSEY STERN
DATA
TUNNELS COVERED OVER
NO DEFLECTION BLOCKS
FOR'D RUDDERS 37½°
AFTER " 40°
FOR'D RUDDERS RELOCATED
VOLTAGE 70
ALL PROPELLERS ASTERN
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE - SHIP (FEET)
SCALE FOR TIME - MODEL (SECONDS)
- SHIP (MINUTES)

FIG. 79

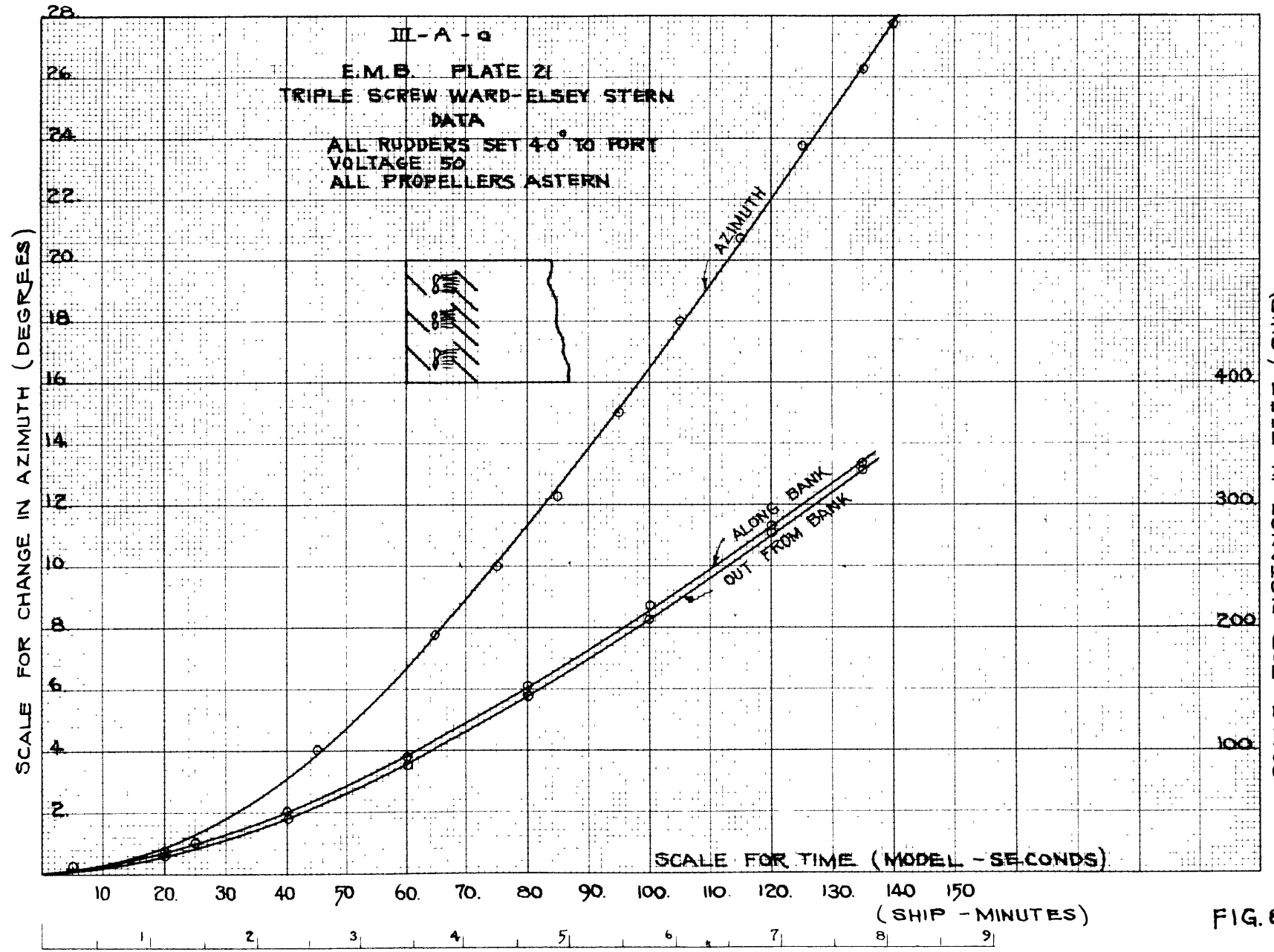

III-A-a
E.M.B. PLATE 21
TRIPLE SCREW WARD-ELSEY STERN
DATA
ALL RUDDERS SET 40° TO PORT
VOLTAGE 50
ALL PROPELLERS ASTERN
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
28
26
24
22
20
18
16
14
12
10
8
6
4
2
400
300
200
100
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
1 2 3 4 5 6 7 8 9

FIG. 80

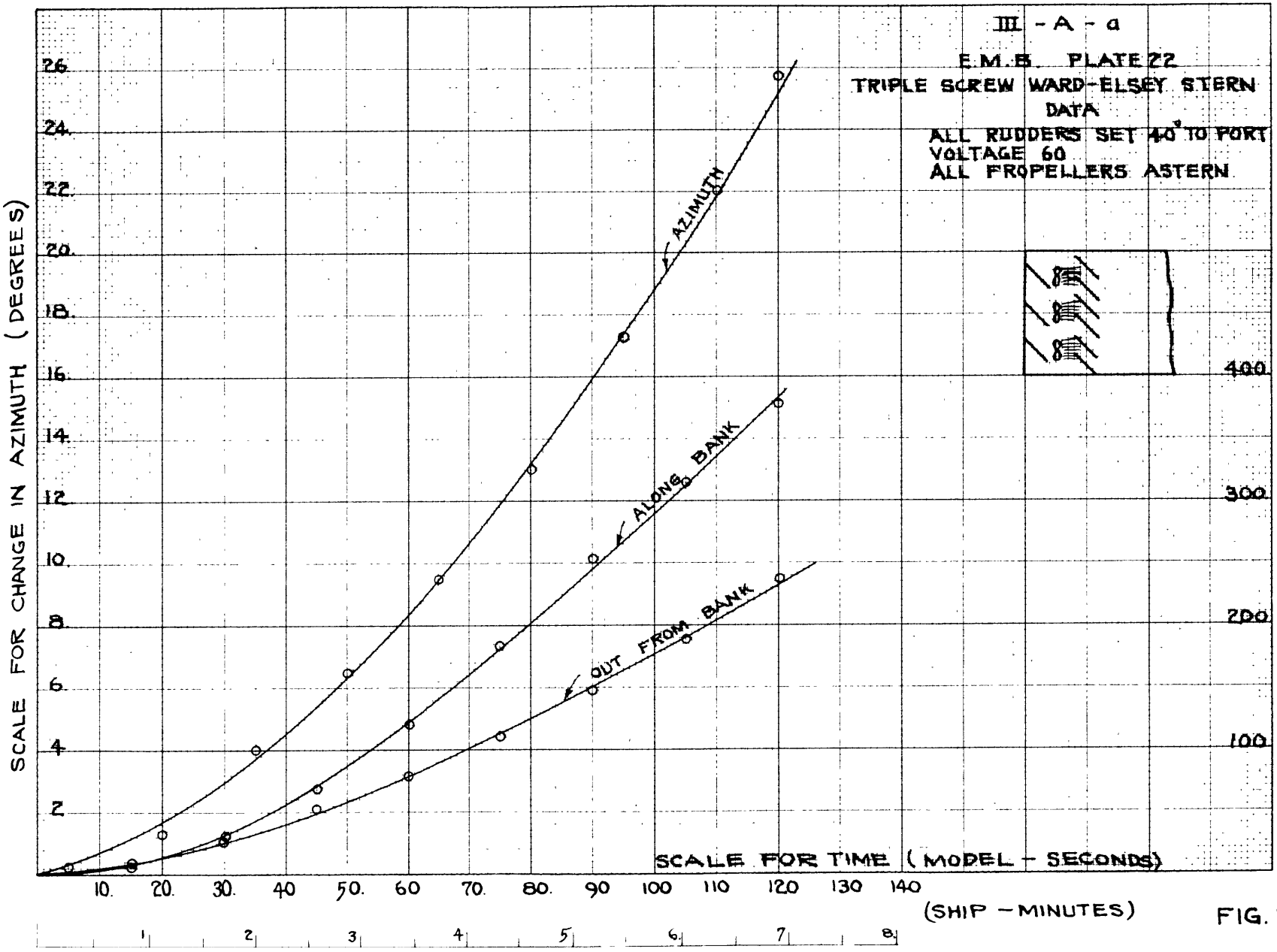

III - A - a
E.M.B. PLATE 22
TRIPLE SCREW WARD-ELSEY STERN
DATA
ALL RUDDERS SET 40° TO PORT
VOLTAGE 60
ALL PROPELLERS ASTERN
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
26
24
22
20
18
16
14
12
10
8
6
4
2
400
300
200
100
10. 20. 30. 40 50. 60 70. 80. 90 100 110 120 130 140
1 2 3 4 5 6 7 8

FIG. 81

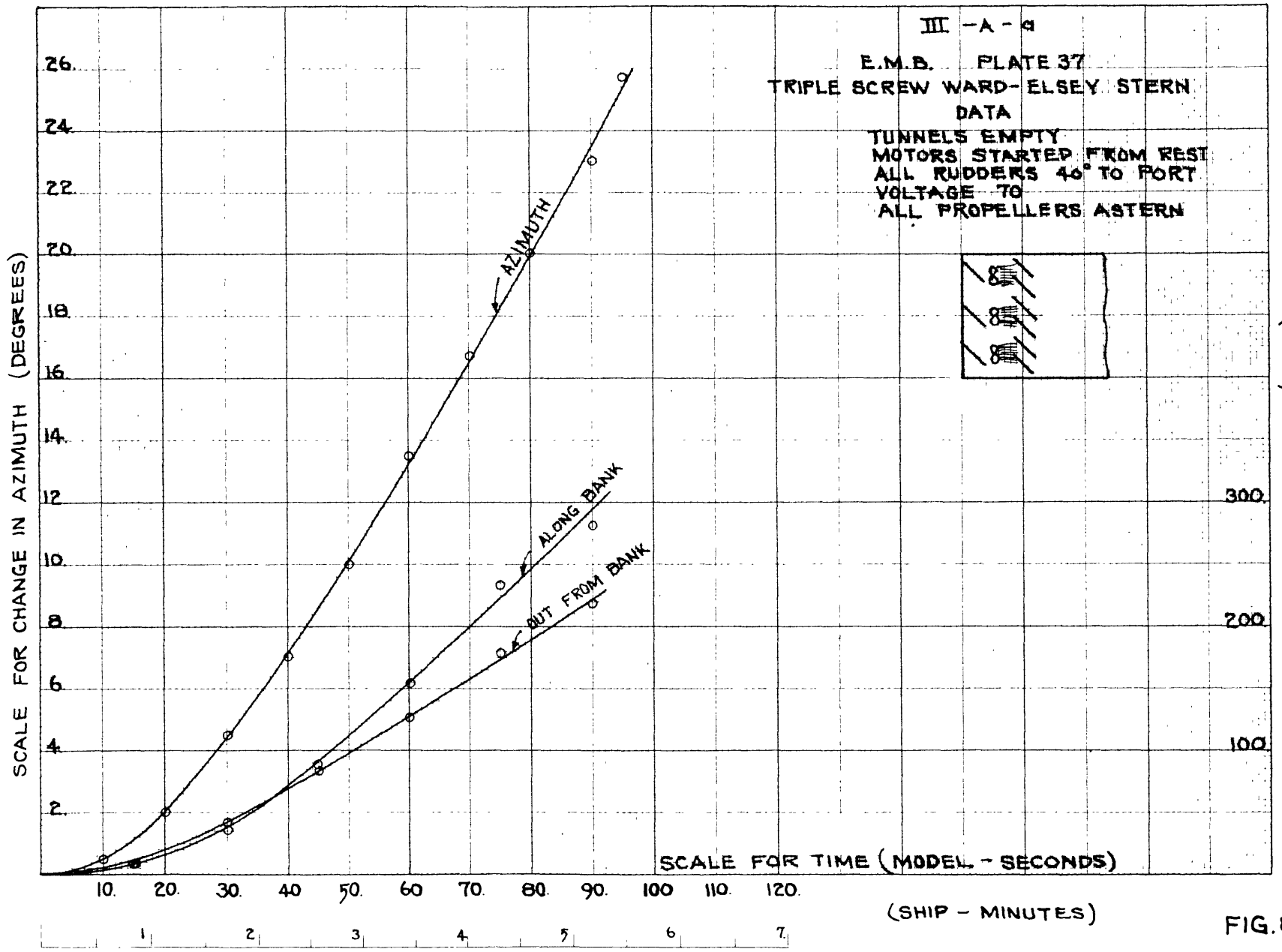

III -A - a
E.M.B. PLATE 37
TRIPLE SCREW WARD-ELSEY STERN
DATA
TUNNELS EMPTY
MOTORS STARTED FROM REST
ALL RUDDERS 46° TO PORT
VOLTAGE TO
ALL PROPELLERS ASTERN
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
26.
24.
22.
20.
18.
16.
14.
12.
10.
8.
6.
4.
2.
300.
200.
100.
10. 20. 30. 40 50. 60 70. 80. 90. 100 110. 120.
1 2 3 4 5 6 7

FIG. 82

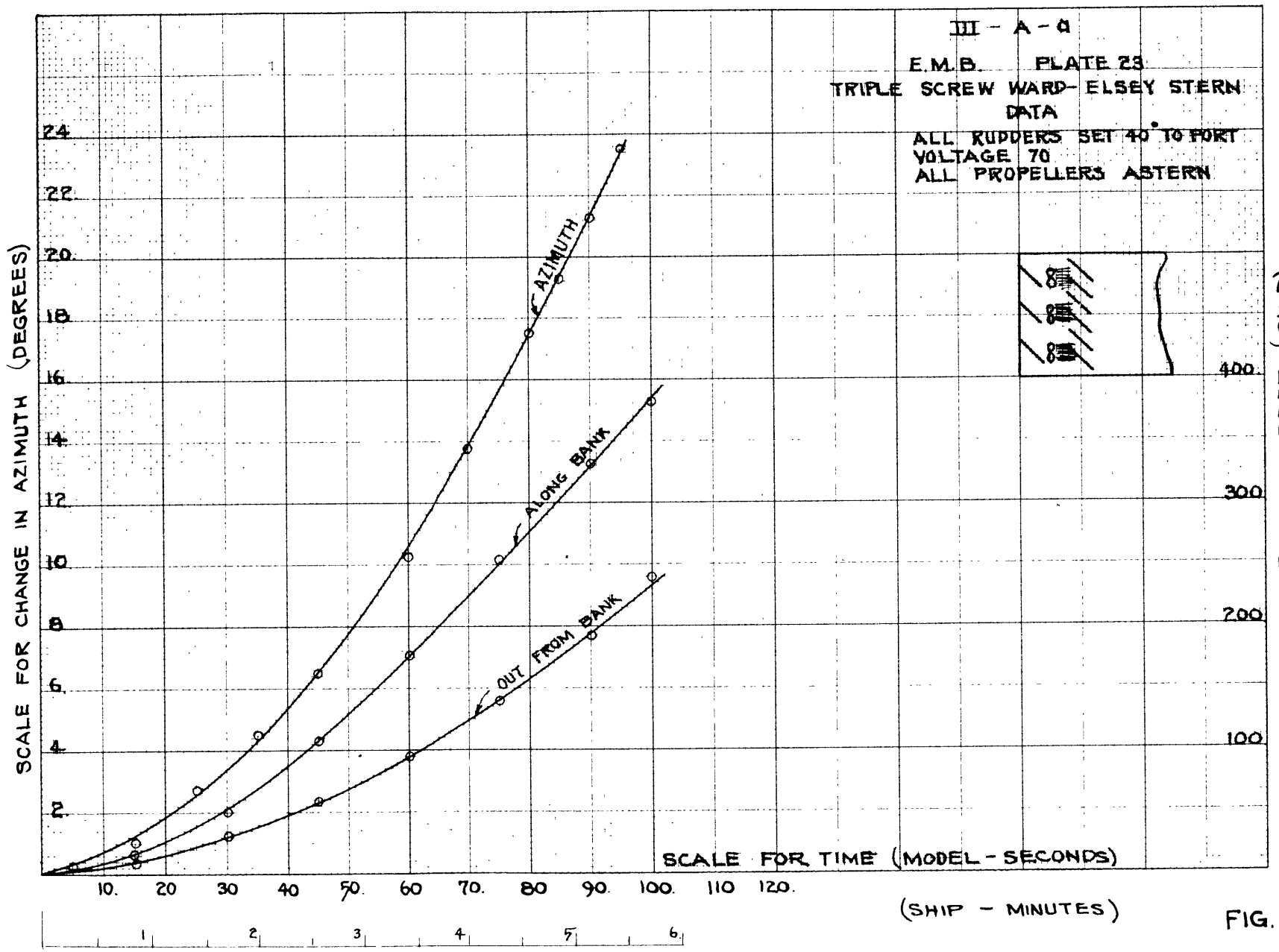

III - A - a
E.M.B. PLATE 23
TRIPLE SCREW WARD-ELSEY STERN
DATA
ALL RUDDERS SET 40° TO PORT
VOLTAGE 70
ALL PROPELLERS ASTERN
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
24
22
20
18
16
14
12
10
8
6
4
2
400
300
200
100
10.
20
30
40
50.
60
70.
80
90.
100.
110
120.
1
2
3
4
5
6

FIG. 83

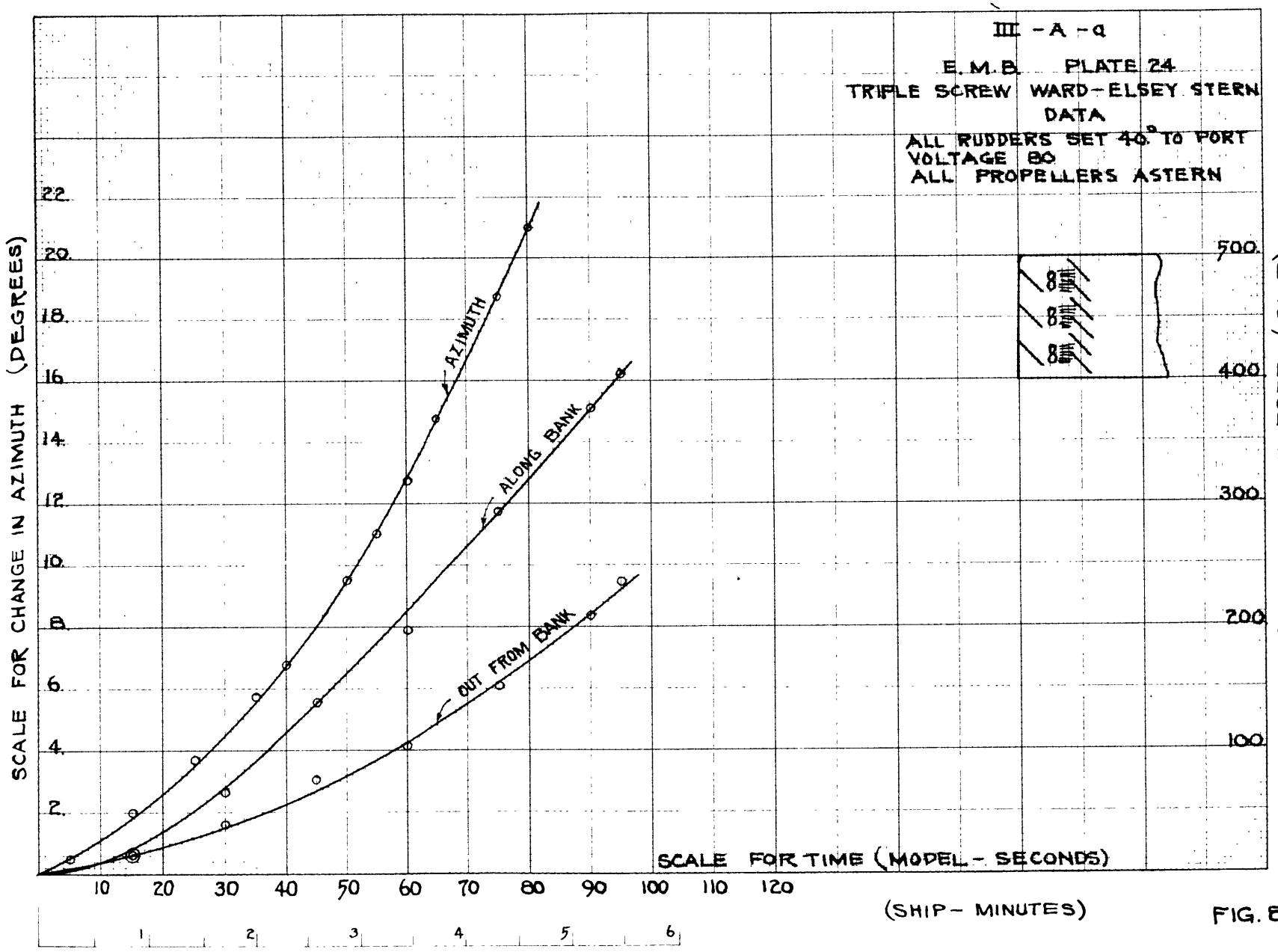

III - A - a
E. M. B. PLATE 24
TRIPLE SCREW WARD-ELSEY STERN
DATA
ALL RUDDERS SET 40° TO PORT
VOLTAGE 80
ALL PROPELLERS ASTERN
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
2
4
6
8
10
12
14
16
18
20
22
100
200
300
400
500
10
20
30
40
50
60
70
80
90
100
110
120
1
2
3
4
5
6

FIG. 84

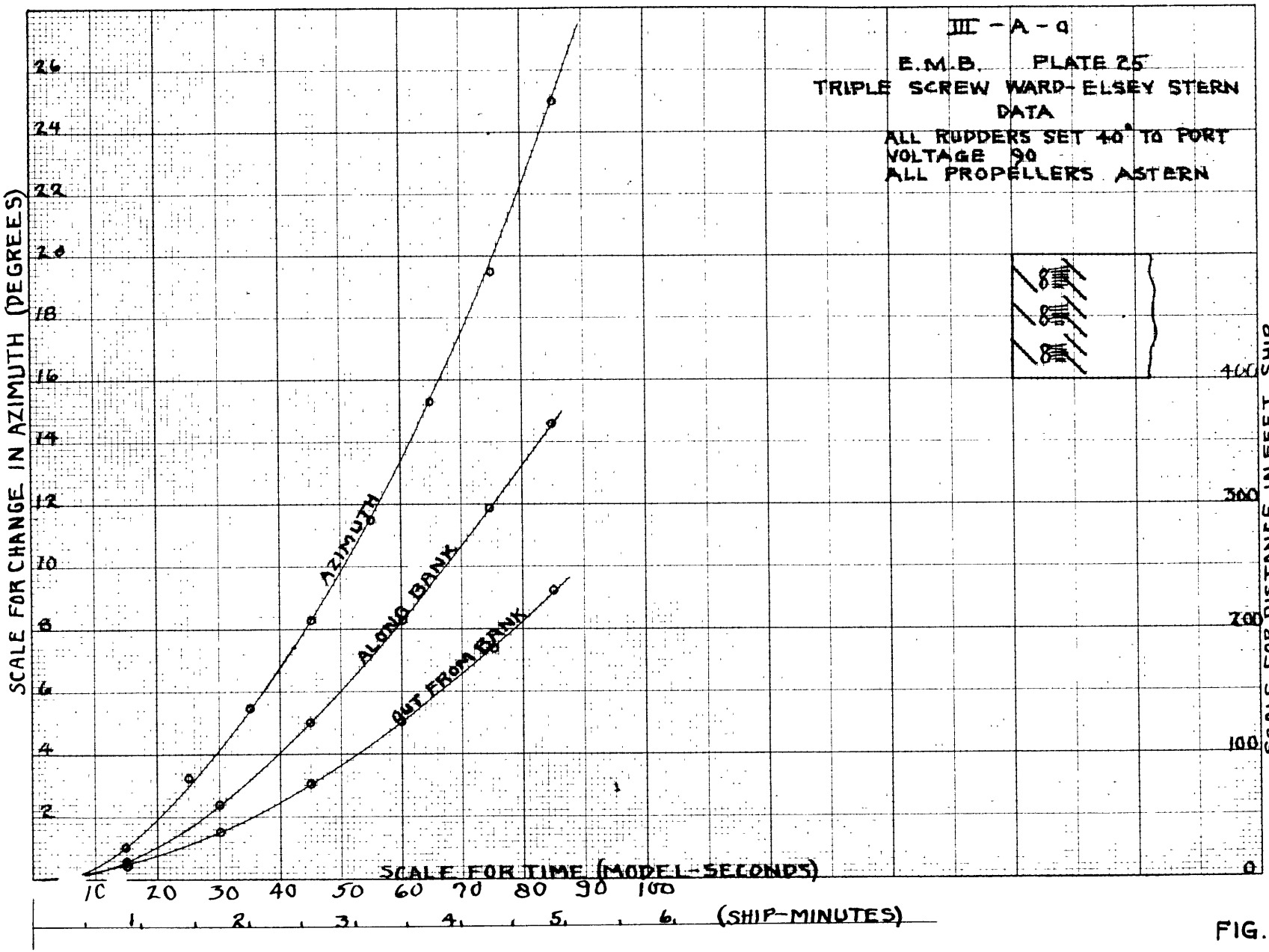

III - A - 9
E.M.B. PLATE 25
TRIPLE SCREW WARD-ELSEY STERN
DATA
ALL RUDDERS SET 40° TO PORT
VOLTAGE 90
ALL PROPELLERS ASTERN
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
26
24
22
20
18
16
14
12
10
8
6
4
2
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR TIME (MODEL-SECONDS)
10 20 30 40 50 60 70 80 90 100
1 2 3 4 5 6 (SHIP-MINUTES)
SCALE FOR DISTANCE IN FEET SHIP
400
300
200
100
0

FIG. 85

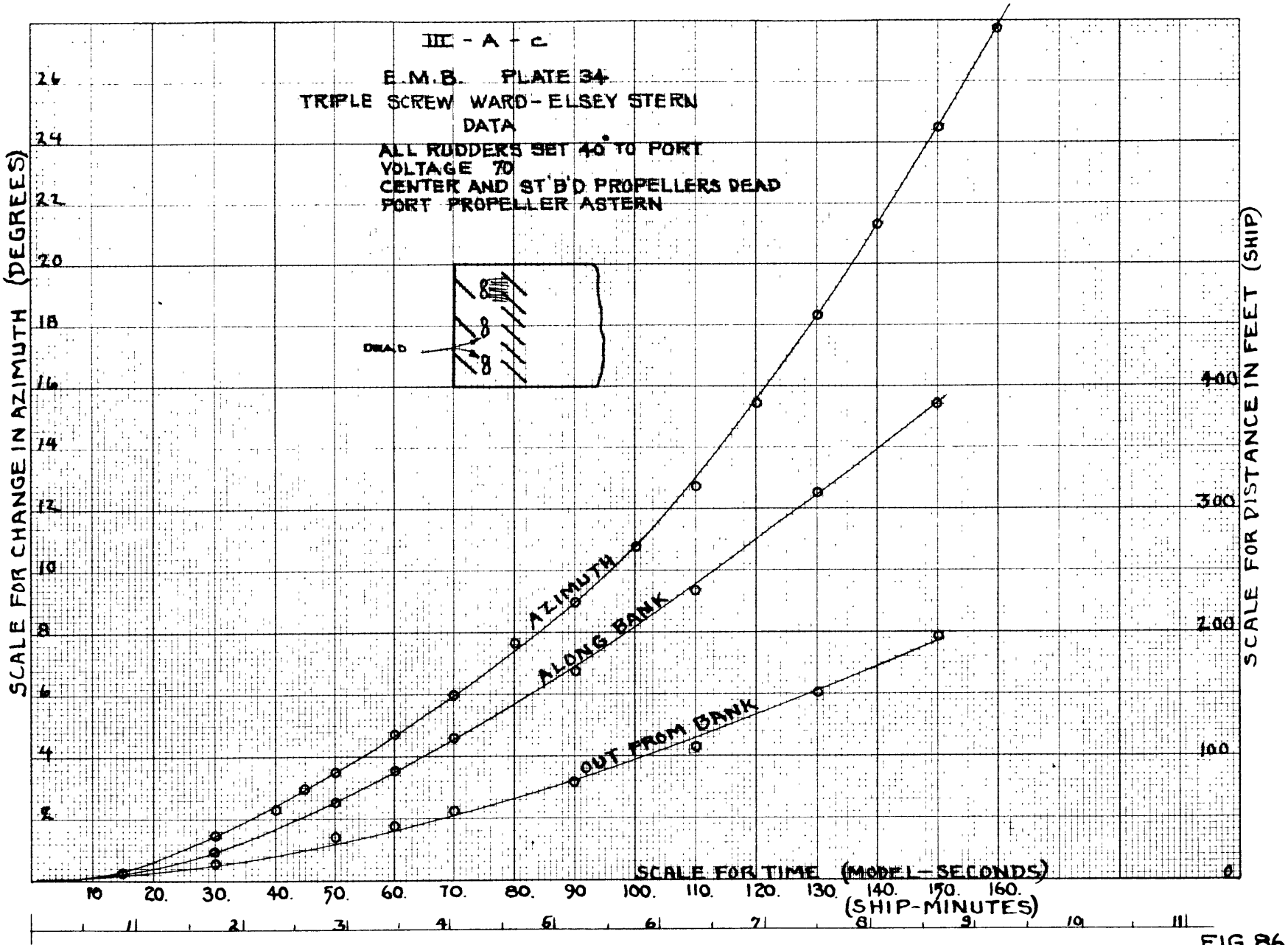

III - A - c
E.M.B. PLATE 34
TRIPLE SCREW WARD-ELSEY STERN
DATA
ALL RUDDERS SET 40° TO PORT
VOLTAGE 70
CENTER AND ST'B'D PROPELLERS DEAD
PORT PROPELLER ASTERN
DEAD
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL-SECONDS)
(SHIP-MINUTES)

FIG 86

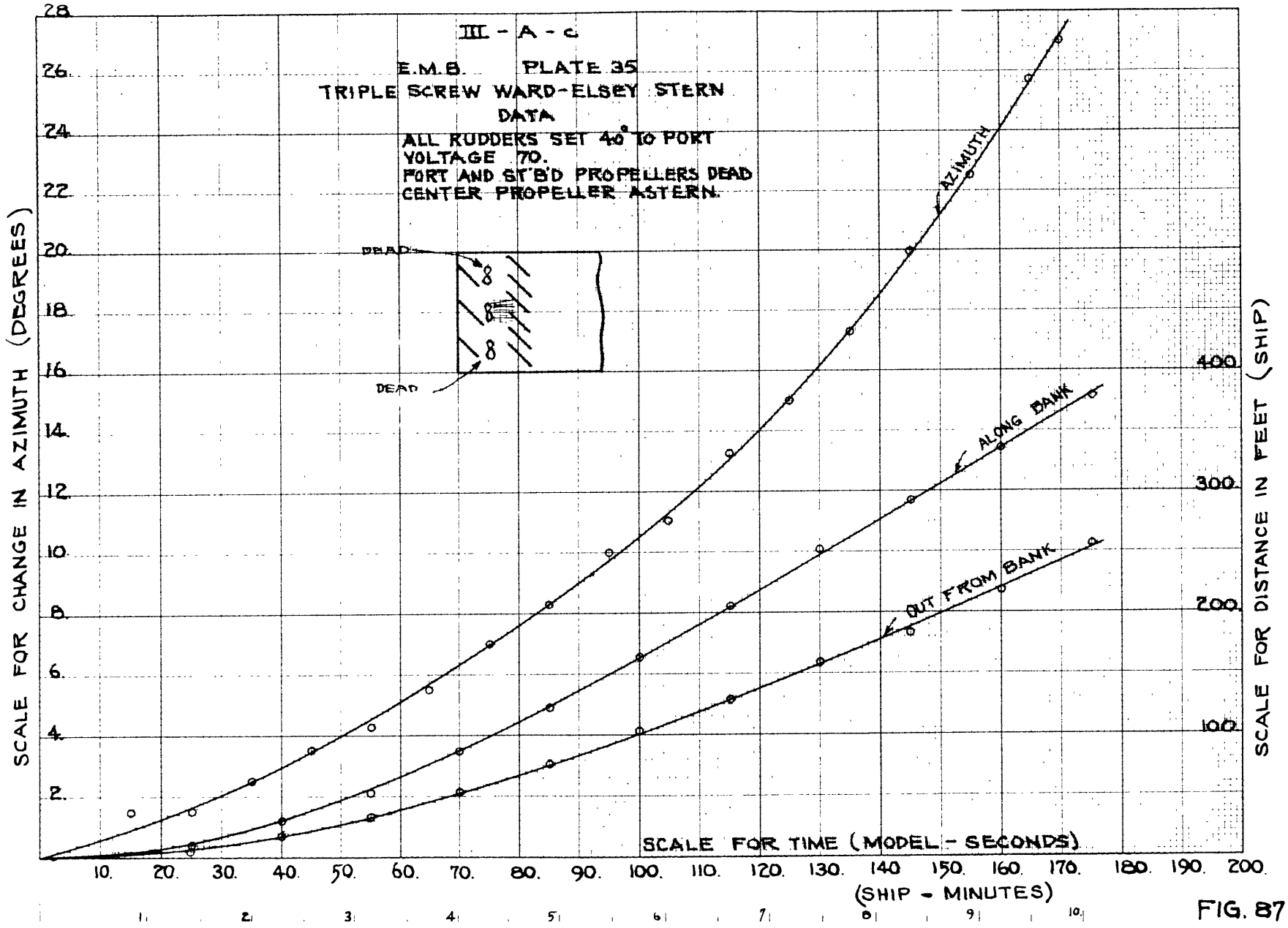

III - A - c
E.M.B. PLATE 35
TRIPLE SCREW WARD-ELSEY STERN
DATA
ALL RUDDERS SET 40° TO PORT
VOLTAGE 70.
PORT AND ST'B'D PROPELLERS DEAD
CENTER PROPELLER ASTERN.
DEAD
DEAD
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
28
26
24
22
20
18
16
14
12
10
8
6
4
2
400
300
200
100
10. 20. 30. 40. 50. 60. 70. 80. 90. 100. 110. 120. 130. 140 150. 160. 170. 180. 190. 200.
1 2 3 4 5 6 7 8 9 10

FIG. 87

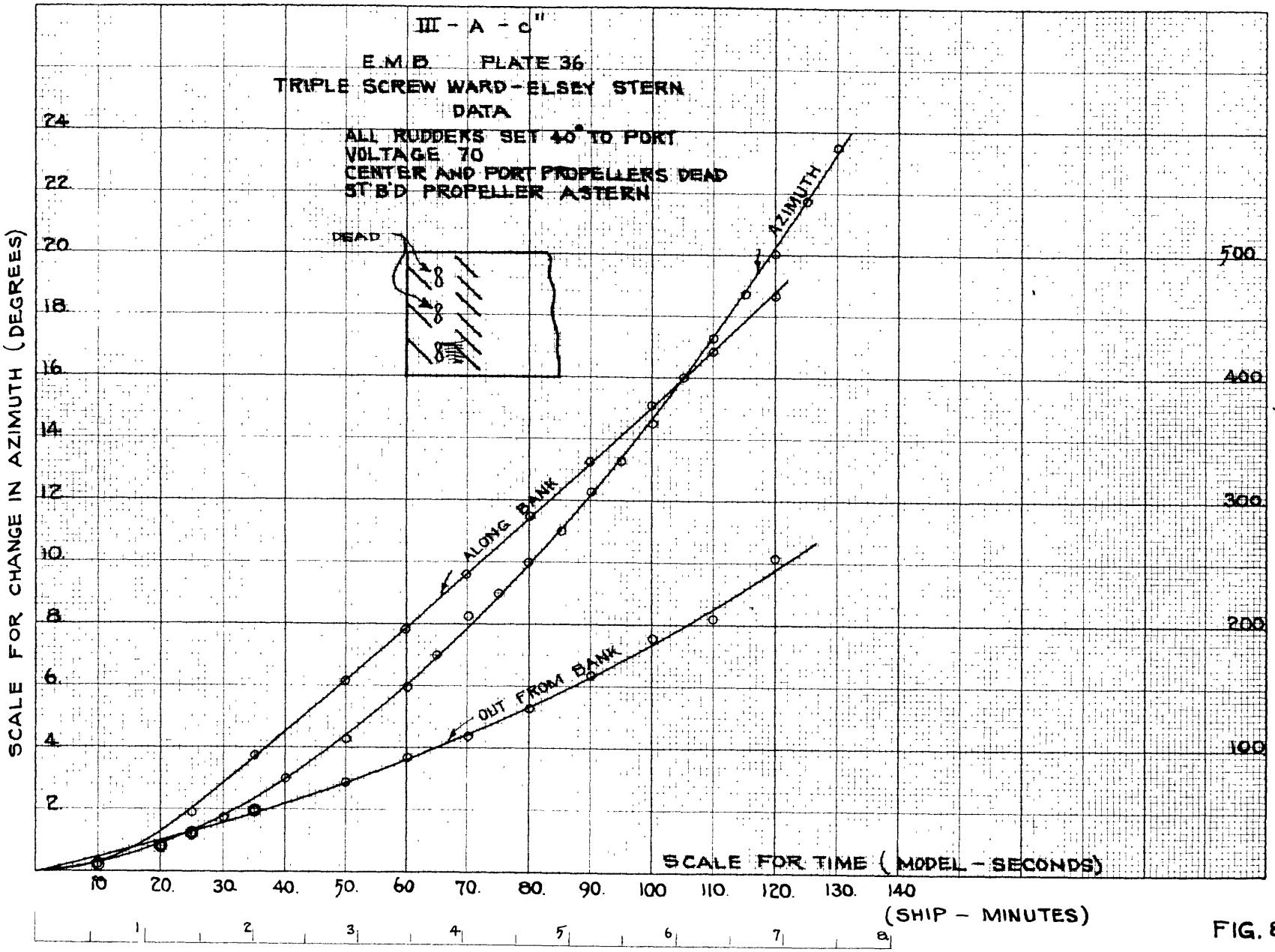

III - A - c"
E.M.B. PLATE 36
TRIPLE SCREW WARD-ELSEY STERN
DATA
ALL RUDDERS SET 40° TO PORT
VOLTAGE 70
CENTER AND PORT PROPELLERS DEAD
ST'B'D PROPELLER ASTERN
DEAD
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
24
22
20
18
16
14
12
10
8
6
4
2
500
400
300
200
100
10
20
30
40
50
60
70
80
90
100
110
120
130
140
1
2
3
4
5
6
7
8

FIG. 88

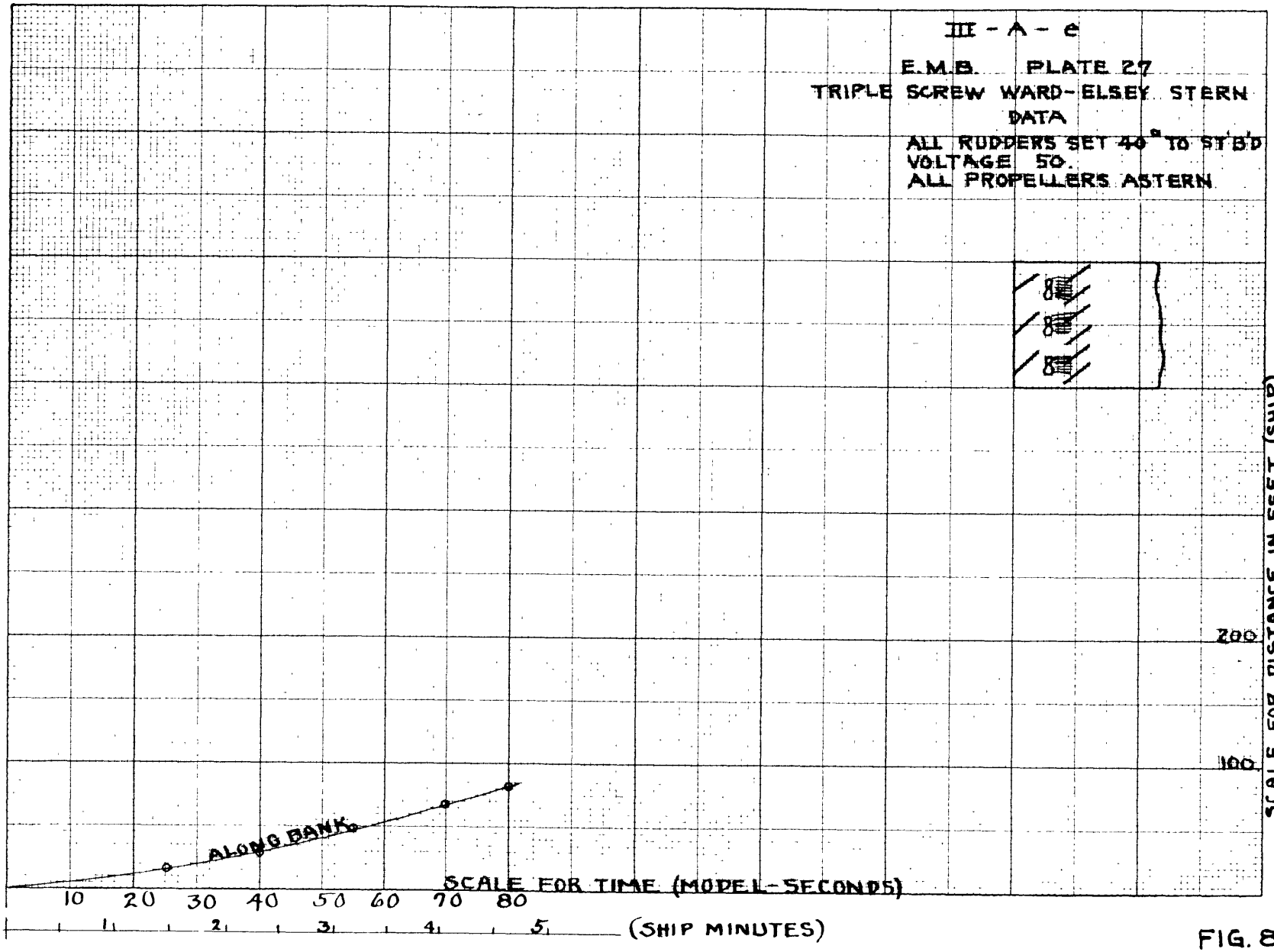

III - A - e
E.M.B. PLATE 27
TRIPLE SCREW WARD-ELSEY STERN DATA
ALL RUDDERS SET 40° TO ST'B'D
VOLTAGE 50.
ALL PROPELLERS ASTERN
ALONG BANK
SCALE FOR TIME (MODEL-SECONDS)
10 20 30 40 50 60 70 80
1 2 3 4 5 (SHIP MINUTES)
SCALE FOR DISTANCE IN FEET (SHIP)
200
100

FIG. 89

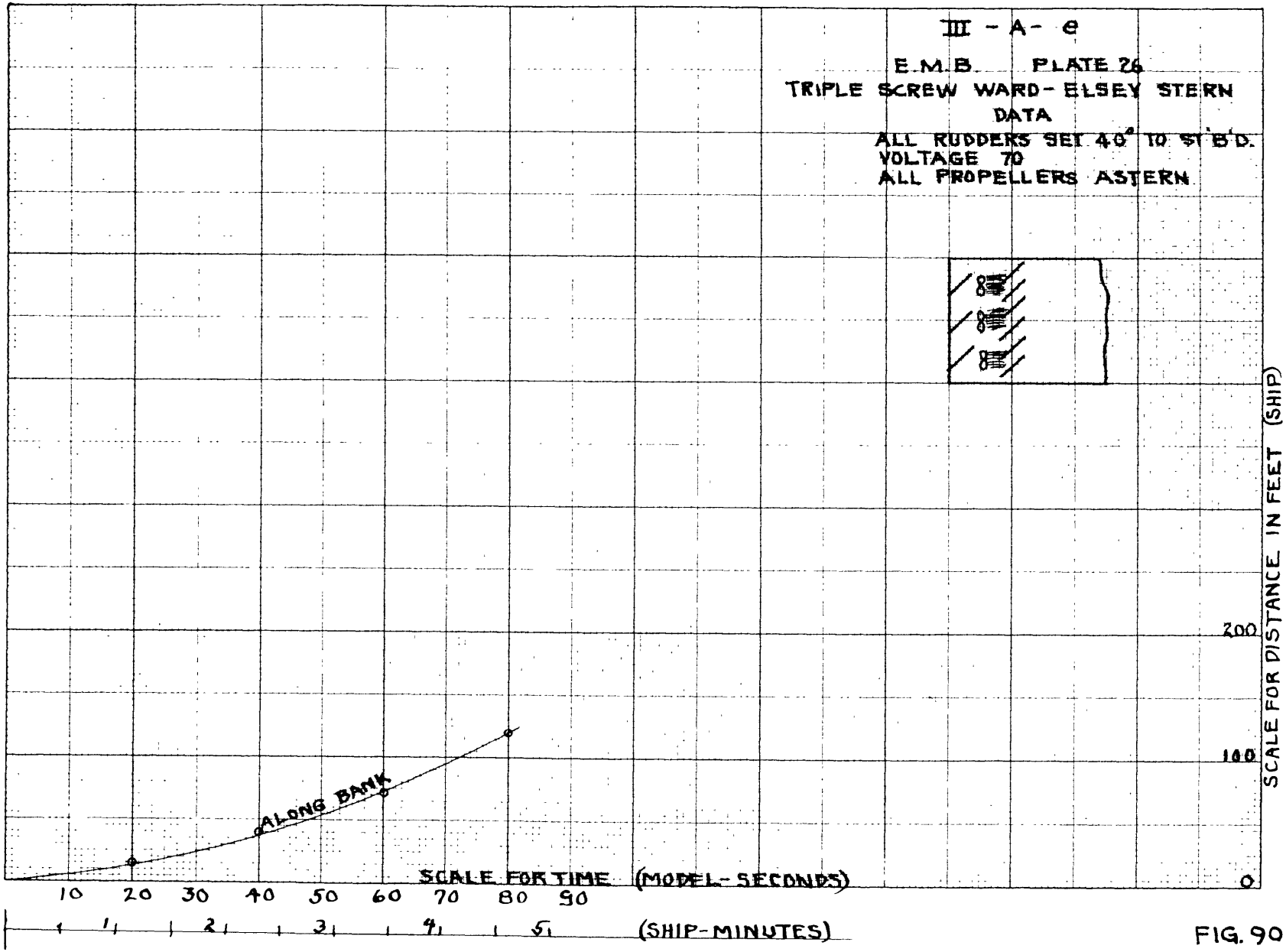

III - A - e
E.M.B. PLATE 26
TRIPLE SCREW WARD - ELSEY STERN
DATA
ALL RUDDERS SET 40° TO ST'B'D.
VOLTAGE 70
ALL PROPELLERS ASTERN
ALONG BANK
SCALE FOR TIME (MODEL - SECONDS)
10 20 30 40 50 60 70 80 90
1 2 3 4 5 (SHIP - MINUTES)
SCALE FOR DISTANCE IN FEET (SHIP)
200
100
0

FIG. 90

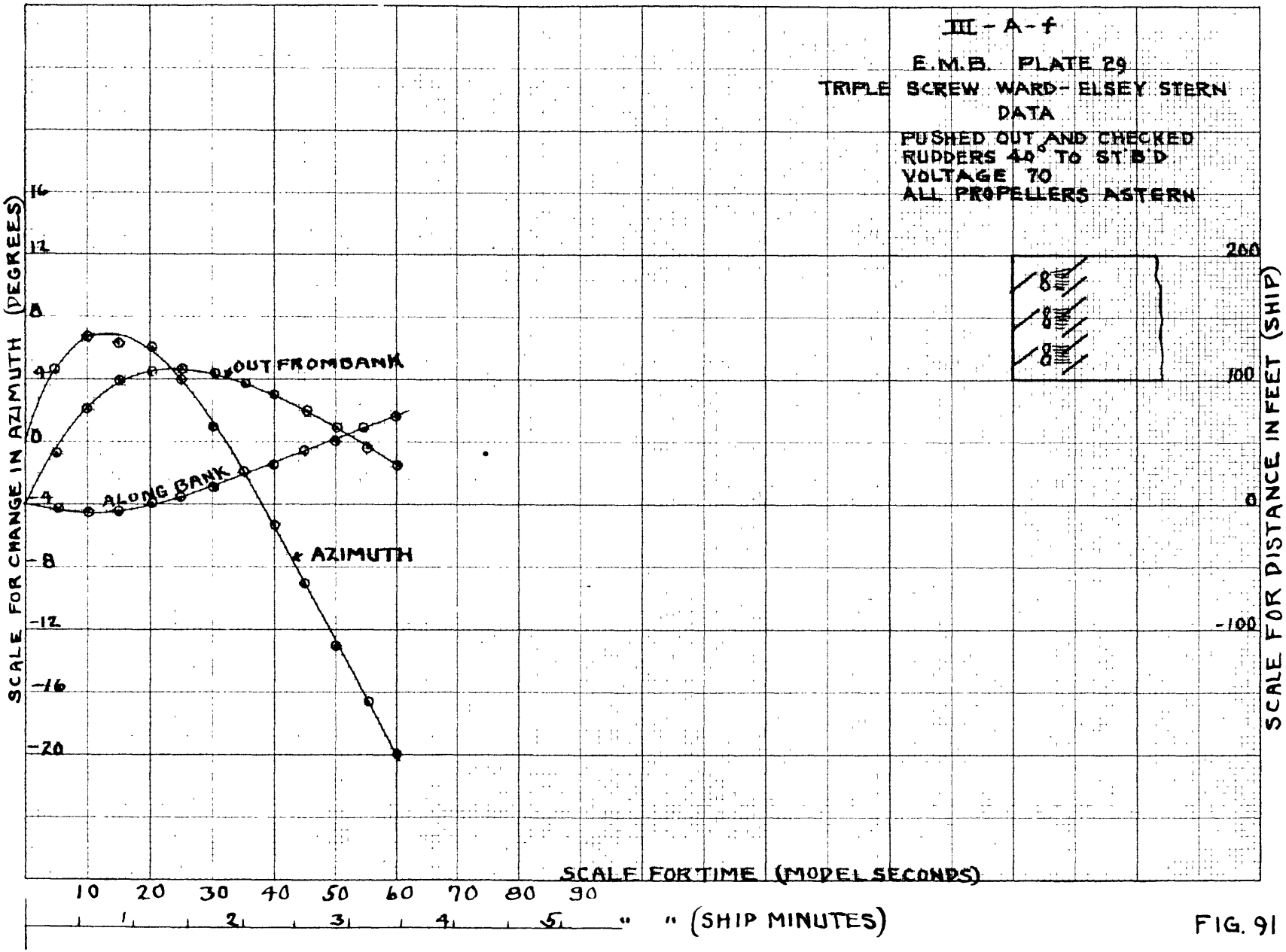

III - A - f
E.M.B. PLATE 29
TRIPLE SCREW WARD - ELSEY STERN
DATA
PUSHED OUT AND CHECKED
RUDDERS 40° TO ST'B'D
VOLTAGE 70
ALL PROPELLERS ASTERN
OUT FROM BANK
ALONG BANK
AZIMUTH
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
16
12
8
4
0
-4
-8
-12
-16
-20
200
100
0
-100
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL SECONDS)
10 20 30 40 50 60 70 80 90
1 2 3 4 5 " " (SHIP MINUTES)

FIG. 91

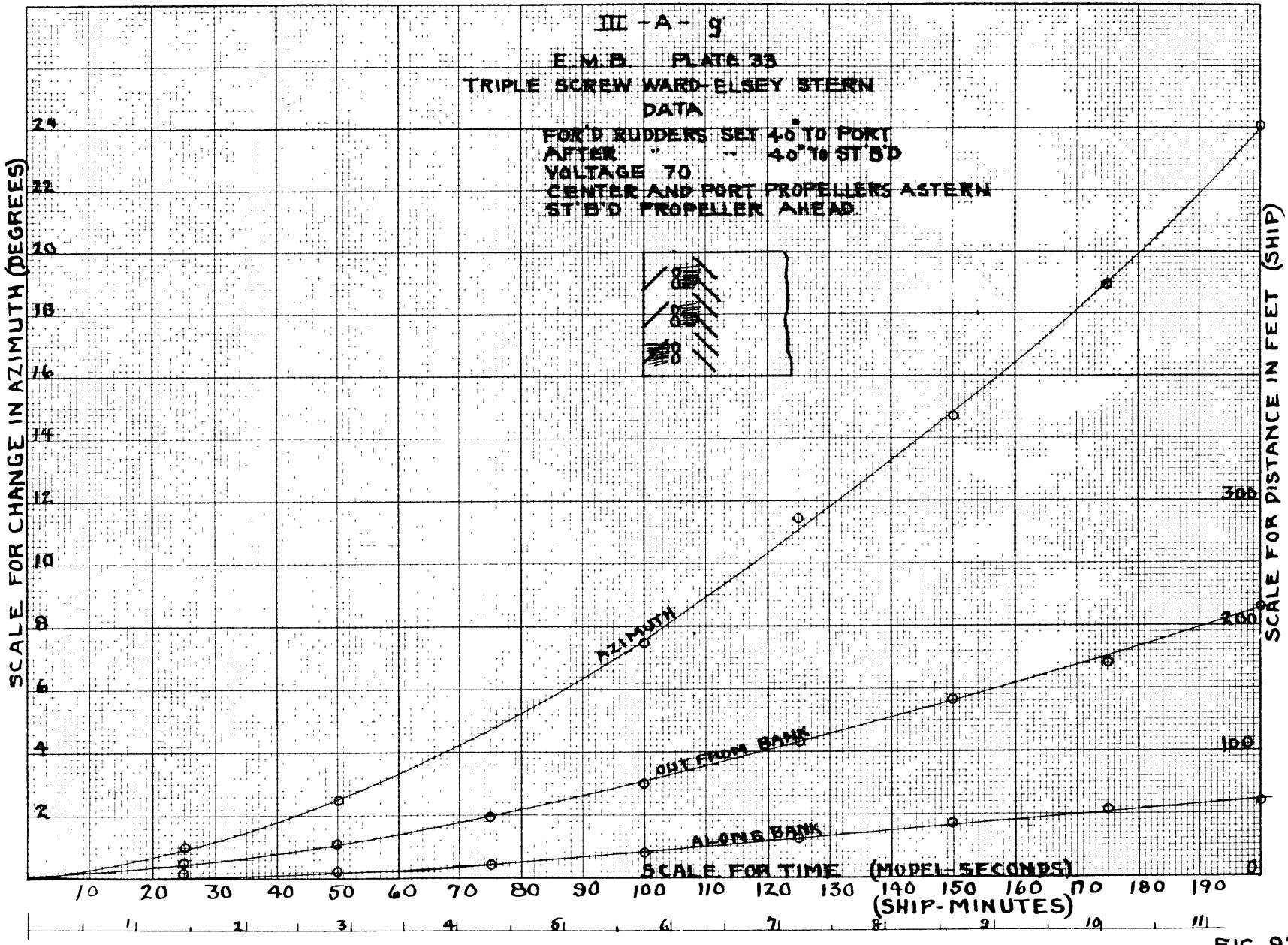

III - A - 9
E.M.B. PLATE 33
TRIPLE SCREW WARD-ELSEY STERN
DATA
FOR'D RUDDERS SET 40° TO PORT
AFTER " " 40° TO ST'B'D
VOLTAGE 70
CENTER AND PORT PROPELLERS ASTERN
ST'B'D PROPELLER AHEAD
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
24
22
20
18
16
14
12
10
8
6
4
2
AZIMUTH
OUT FROM BANK
ALONG BANK
300
200
100
0
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL-SECONDS)
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190
(SHIP-MINUTES)
1 2 3 4 5 6 7 8 9 10 11

FIG. 92

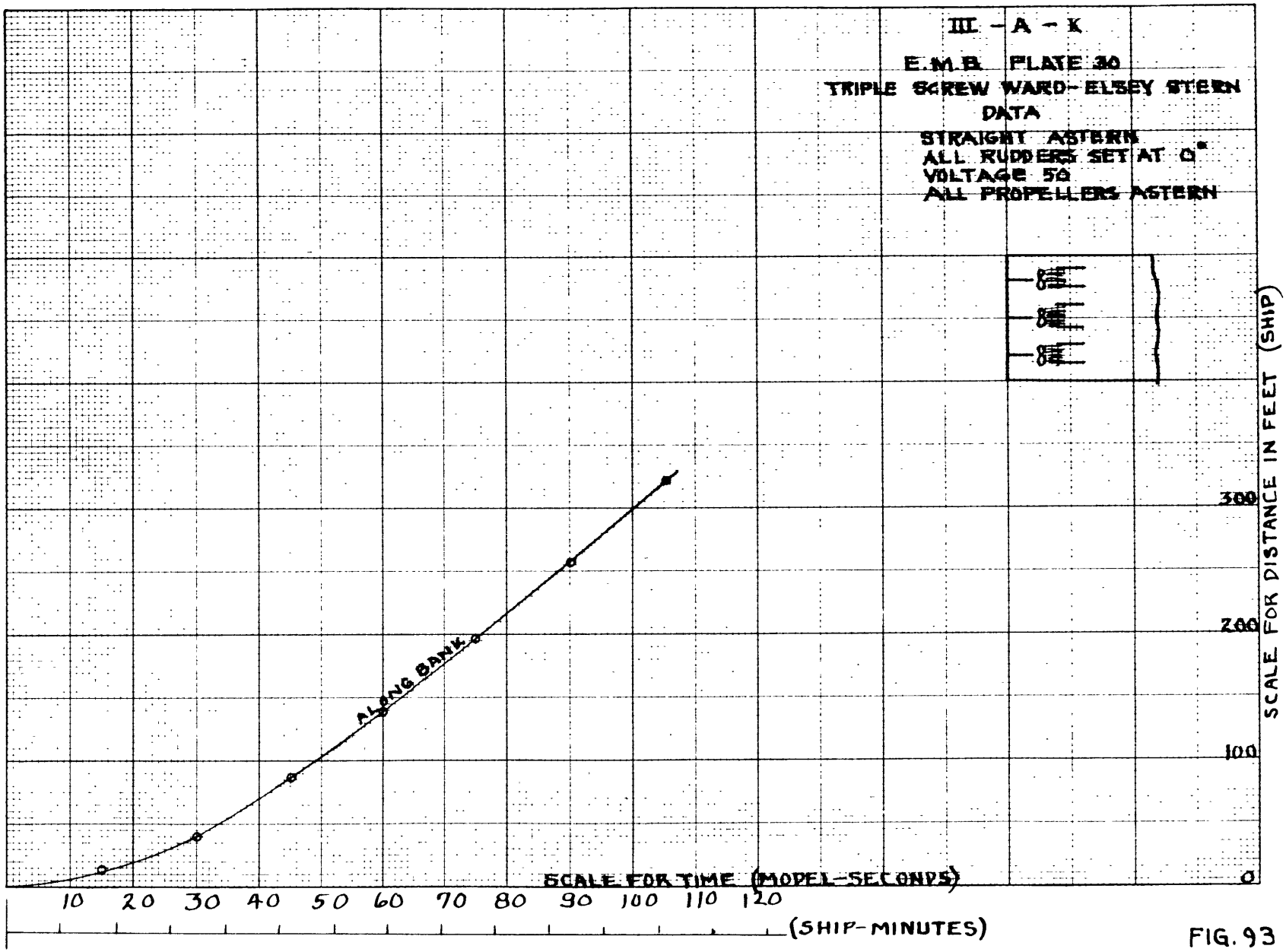

III - A - K
E.M.B. PLATE 30
TRIPLE SCREW WARD-ELSEY STERN
DATA
STRAIGHT ASTERN
ALL RUDDERS SET AT 0°
VOLTAGE 50
ALL PROPELLERS ASTERN
ALONG BANK
SCALE FOR TIME (MODEL-SECONDS)
10 20 30 40 50 60 70 80 90 100 110 120
(SHIP-MINUTES)
SCALE FOR DISTANCE IN FEET (SHIP)
300
200
100
0

FIG. 93

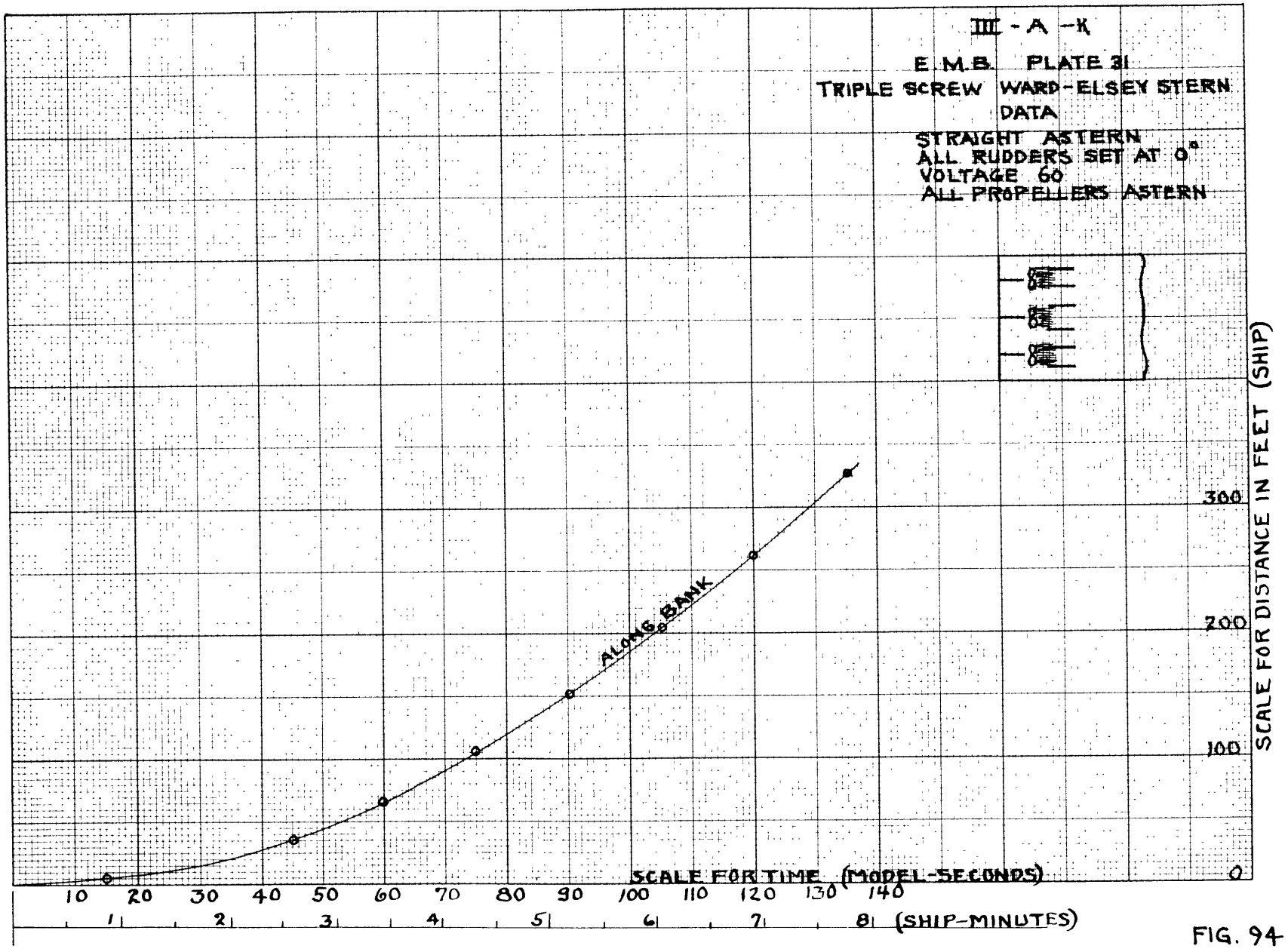

III - A - K
E.M.B. PLATE 31
TRIPLE SCREW WARD-ELSEY STERN DATA
STRAIGHT ASTERN
ALL RUDDERS SET AT 0°
VOLTAGE 60
ALL PROPELLERS ASTERN
ALONG BANK
SCALE FOR DISTANCE IN FEET (SHIP)
0
100
200
300
SCALE FOR TIME (MODEL-SECONDS)
10 20 30 40 50 60 70 80 90 100 110 120 130 140
1 2 3 4 5 6 7 8 (SHIP-MINUTES)

FIG. 94

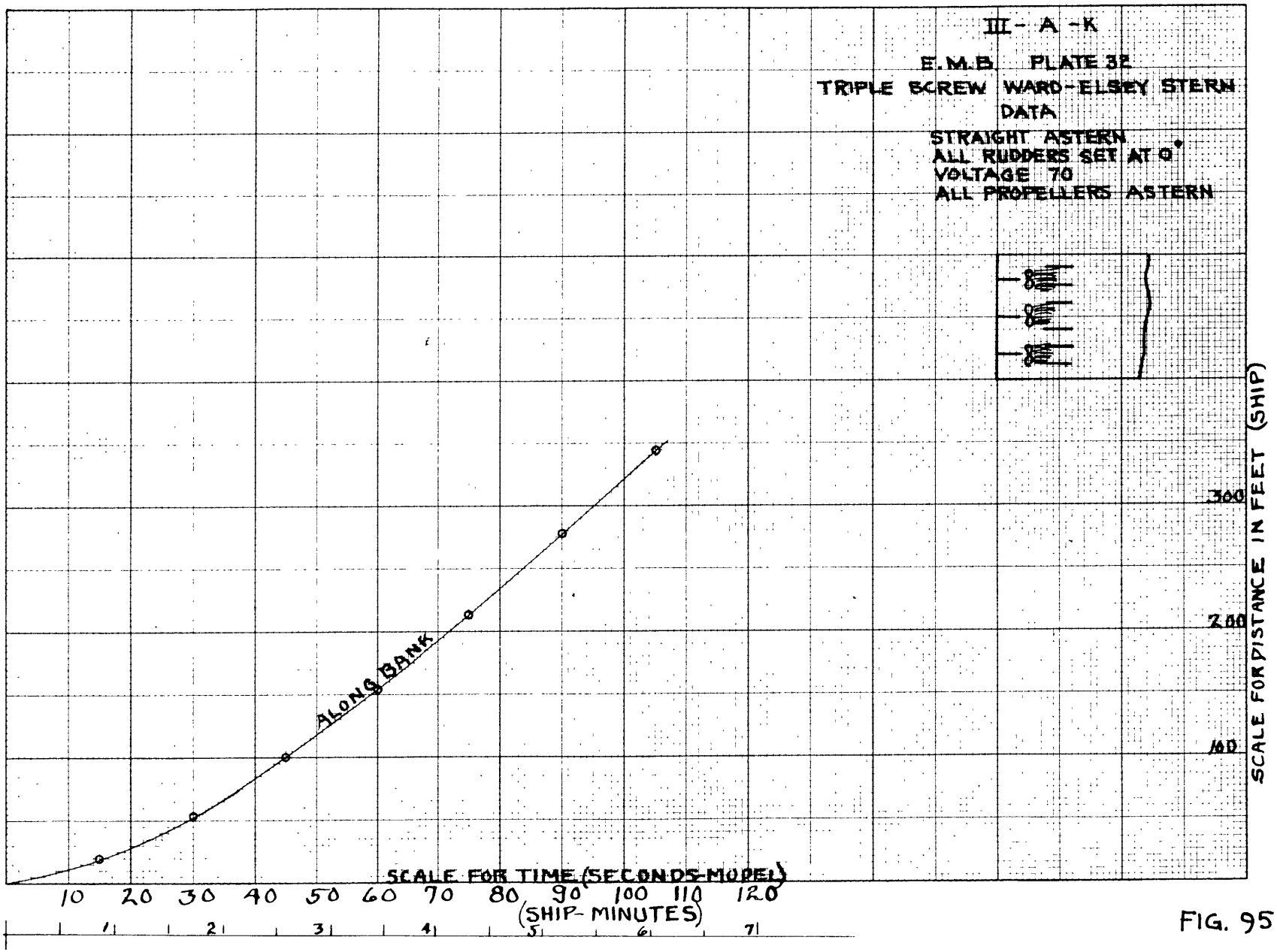

III - A - K
E.M.B. PLATE 32
TRIPLE SCREW WARD-ELSEY STERN
DATA
STRAIGHT ASTERN
ALL RUDDERS SET AT 0°
VOLTAGE 70
ALL PROPELLERS ASTERN
ALONG BANK
SCALE FOR TIME (SECONDS-MODEL)
10 20 30 40 50 60 70 80 90 100 110 120
(SHIP-MINUTES)
1 2 3 4 5 6 7
SCALE FOR DISTANCE IN FEET (SHIP)
300
200
100

FIG. 95

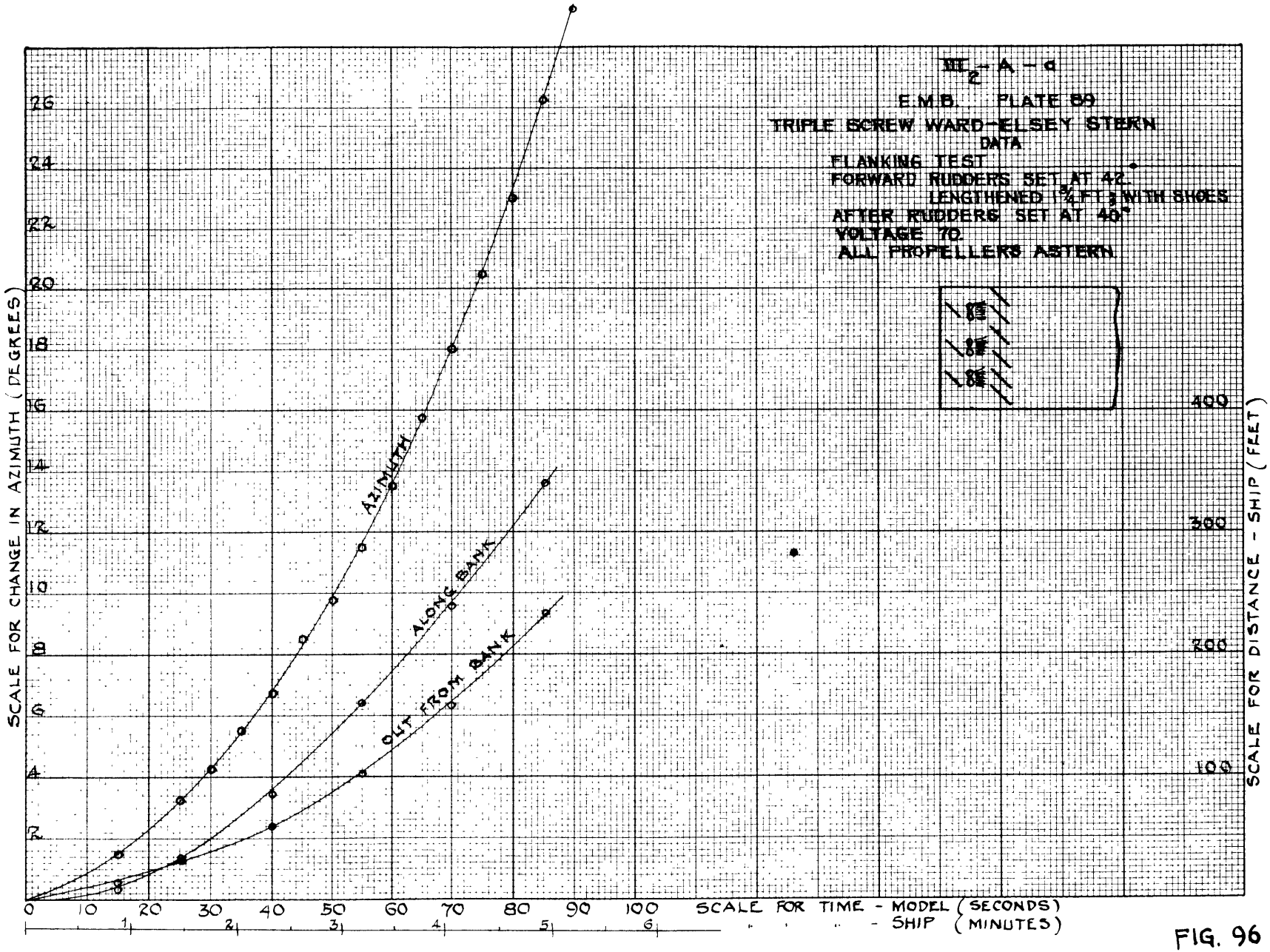

SERIES A - a
E.M.B. PLATE 89
TRIPLE SCREW WARD-ELSEY STERN
DATA
FLANKING TEST
FORWARD RUDDERS SET AT 42°
LENGTHENED 1¾ FT. WITH SHOES
AFTER RUDDERS SET AT 40°
VOLTAGE 70
ALL PROPELLERS ASTERN
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE - SHIP (FEET)
SCALE FOR TIME - MODEL (SECONDS)
- SHIP (MINUTES)

FIG. 96

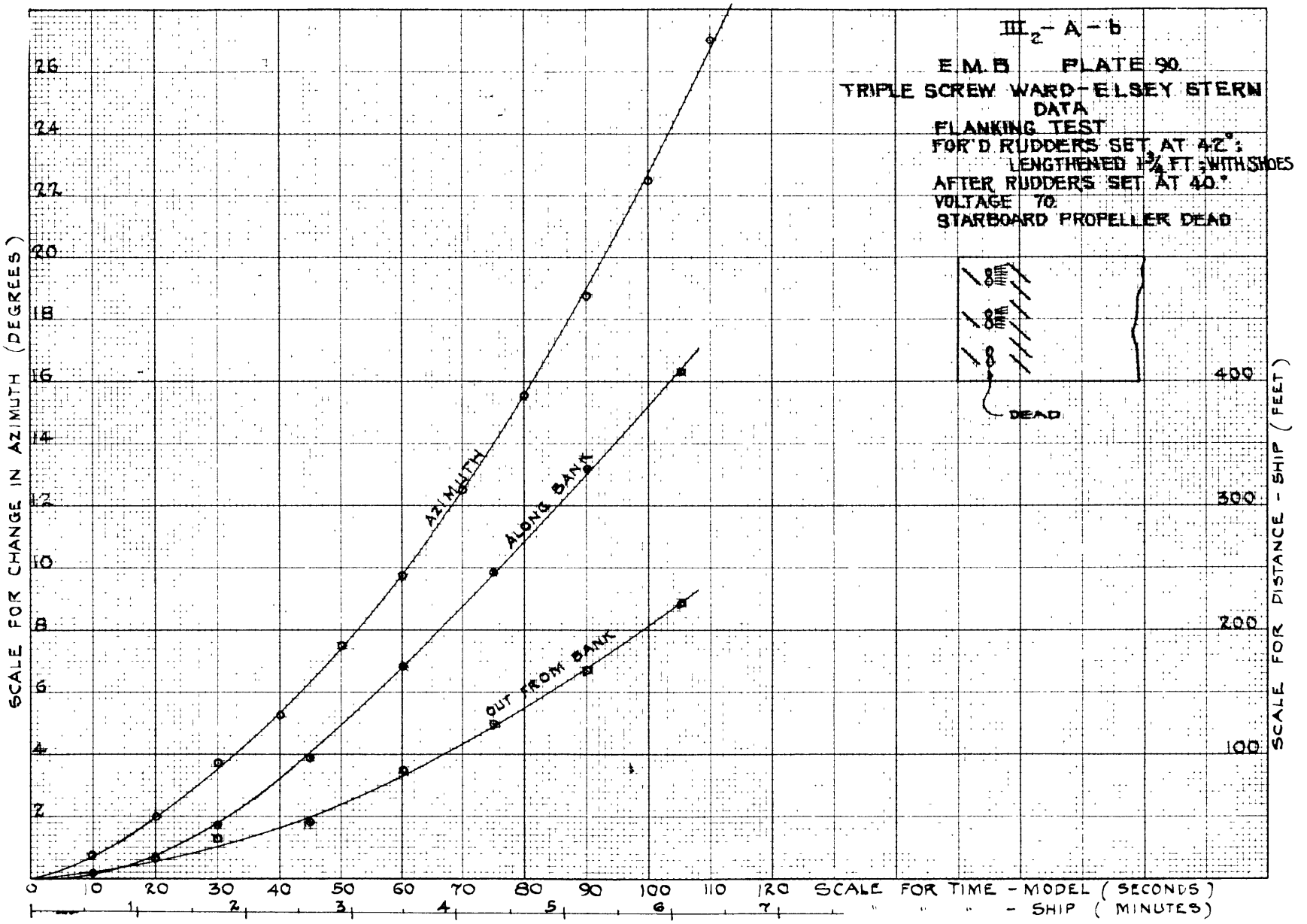

III₂ - A - b
E.M.B PLATE 90
TRIPLE SCREW WARD-ELSEY STERN
DATA
FLANKING TEST
FOR'D RUDDERS SET AT 42°;
LENGTHENED 1¾ FT; WITHSHOES
AFTER RUDDERS SET AT 40°
VOLTAGE 70
STARBOARD PROPELLER DEAD
DEAD
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE - SHIP (FEET)
SCALE FOR TIME - MODEL (SECONDS)
" " " - SHIP (MINUTES)

FIG. 97

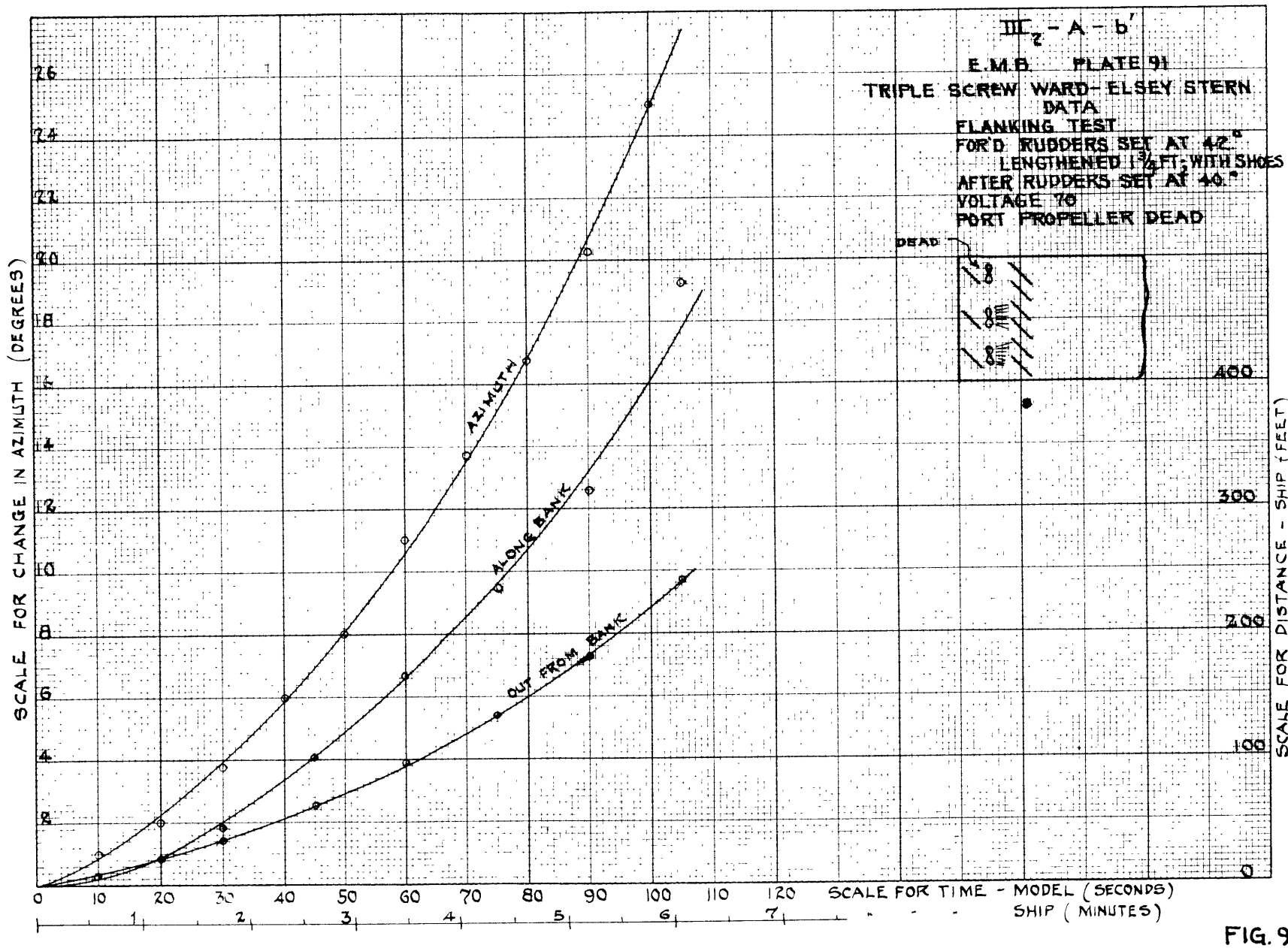

III z - A - b'
E.M.B. PLATE 91
TRIPLE SCREW WARD-ELSEY STERN
DATA
FLANKING TEST
FOR'D RUDDERS SET AT 42°
LENGTHENED 1¾ FT. WITH SHOES
AFTER RUDDERS SET AT 40°
VOLTAGE TO
PORT PROPELLER DEAD
DEAD
400
300
200
100
0
SCALE FOR DISTANCE - SHIP (FEET)
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
26
24
22
20
18
16
14
12
10
8
6
4
2
0 10 20 30 40 50 60 70 80 90 100 110 120
SCALE FOR TIME - MODEL (SECONDS)
1 2 3 4 5 6 7
SHIP (MINUTES)

FIG. 98

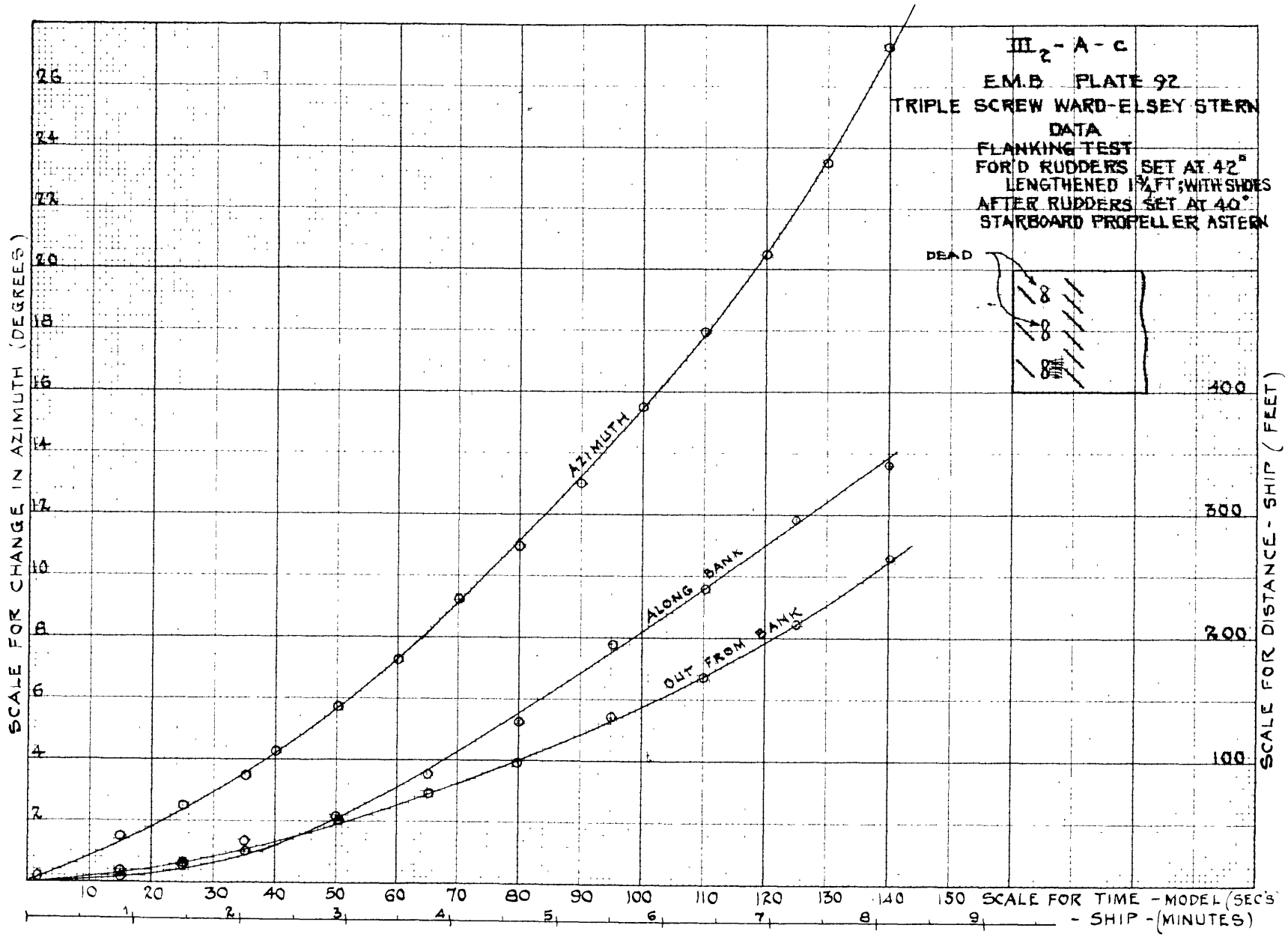

III₂ - A - C
E.M.B PLATE 92
TRIPLE SCREW WARD-ELSEY STERN
DATA
FLANKING TEST
FOR'D RUDDERS SET AT 42°
LENGTHENED 1¾FT; WITH SHOES
AFTER RUDDERS SET AT 40°
STARBOARD PROPELLER ASTERN
DEAD
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE - SHIP (FEET)
SCALE FOR TIME - MODEL (SEC'S
- SHIP - (MINUTES)

FIG. 99

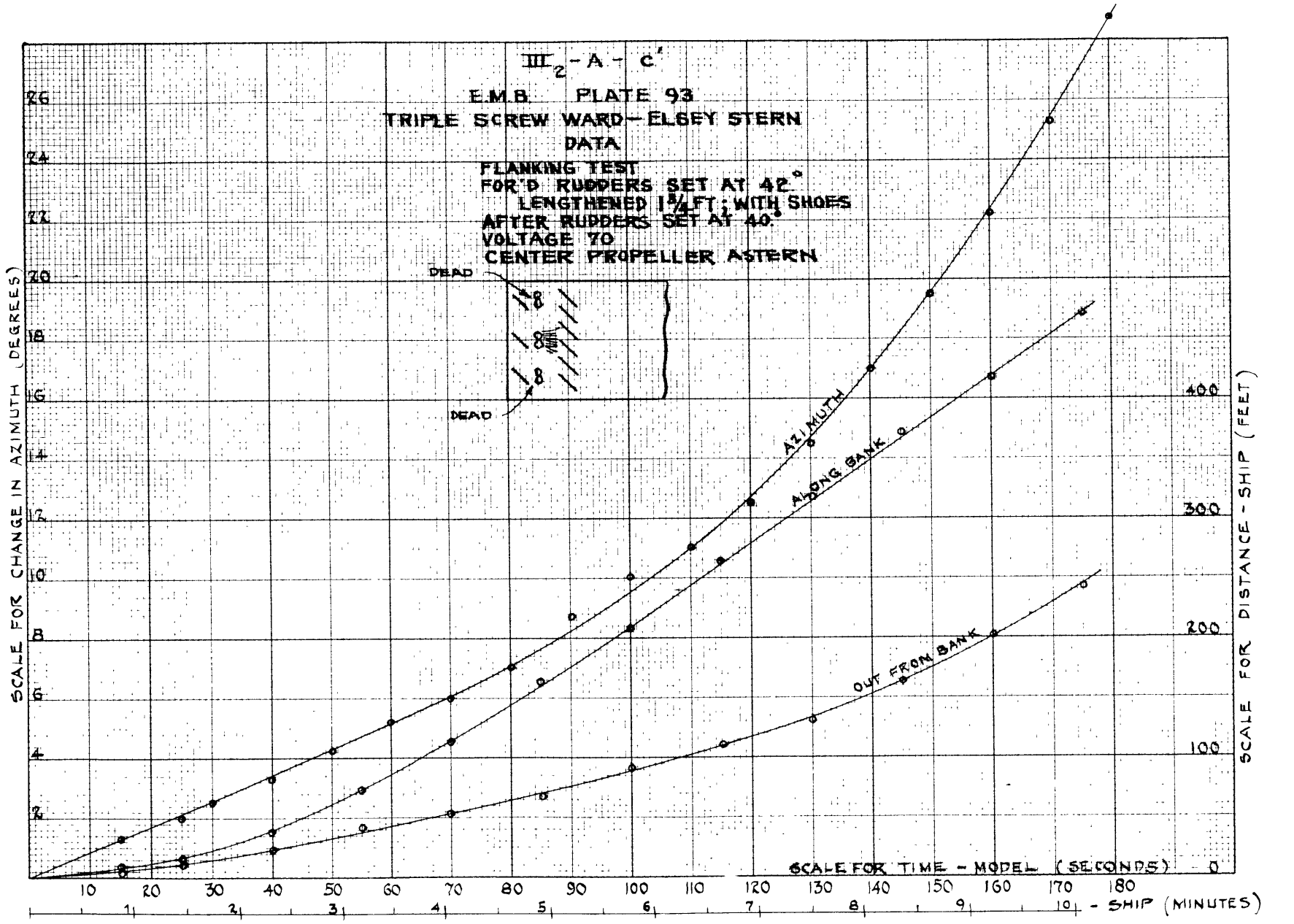

III 2 - A - C'
E.M.B. PLATE 93
TRIPLE SCREW WARD-ELSEY STERN
DATA
FLANKING TEST
FOR'D RUDDERS SET AT 42°
LENGTHENED 1¾ FT; WITH SHOES
AFTER RUDDERS SET AT 40°
VOLTAGE 70
CENTER PROPELLER ASTERN
DEAD
DEAD
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE - SHIP (FEET)
SCALE FOR TIME - MODEL (SECONDS)
- SHIP (MINUTES)

FIG. 100

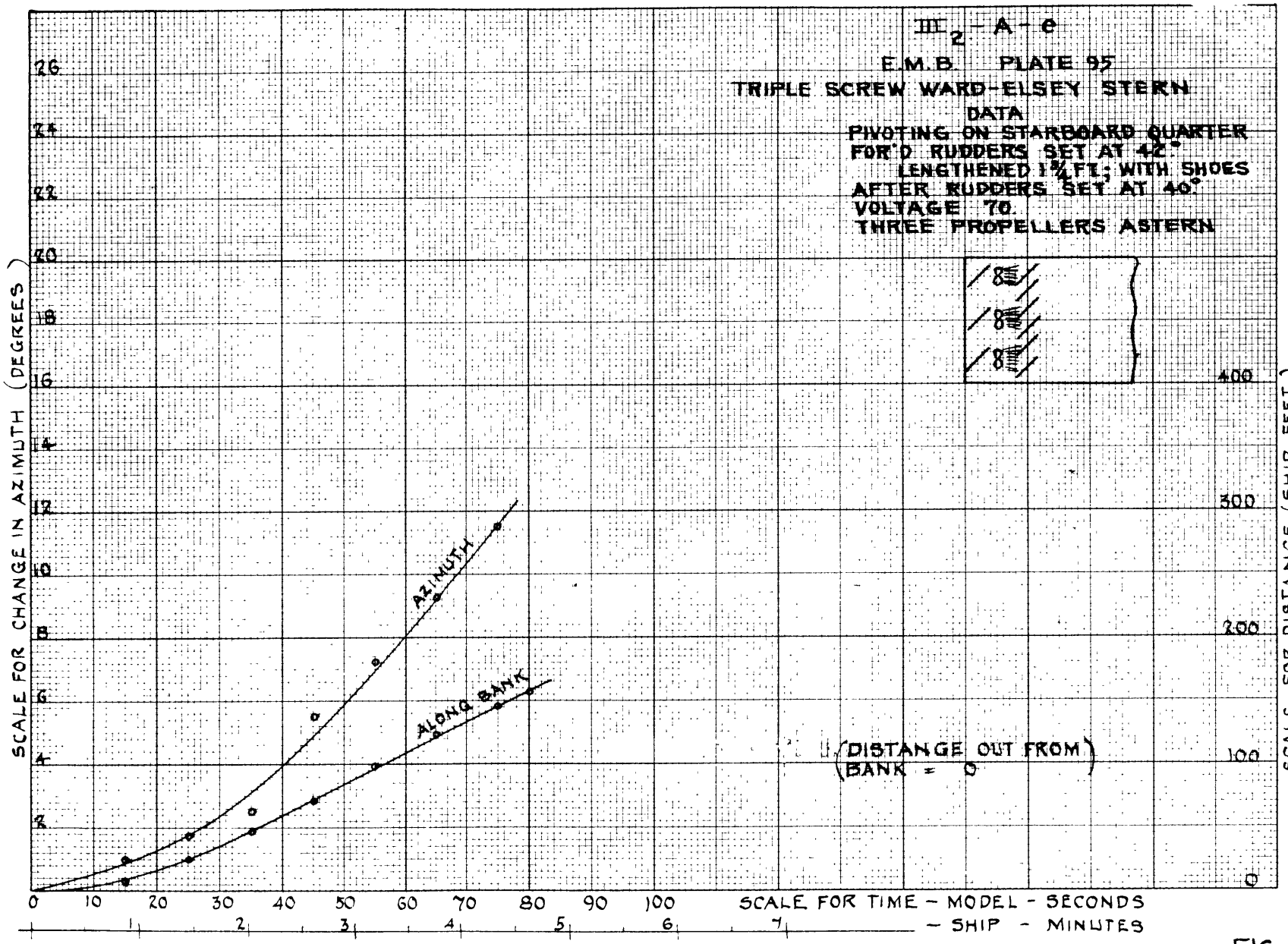

III 2 - A - e
E.M.B. PLATE 95
TRIPLE SCREW WARD-ELSEY STERN
DATA
PIVOTING ON STARBOARD QUARTER
FOR'D RUDDERS SET AT 42°
LENGTHENED 1¾ FT; WITH SHOES
AFTER RUDDERS SET AT 40°
VOLTAGE 70
THREE PROPELLERS ASTERN
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
26
24
22
20
18
16
14
12
10
8
6
4
2
AZIMUTH
ALONG BANK
(DISTANCE OUT FROM BANK = 0)
SCALE FOR DISTANCE (SHIP-FEET)
400
300
200
100
0
0 10 20 30 40 50 60 70 80 90 100
SCALE FOR TIME - MODEL - SECONDS
1 2 3 4 5 6 7
- SHIP - MINUTES

FIG. 101

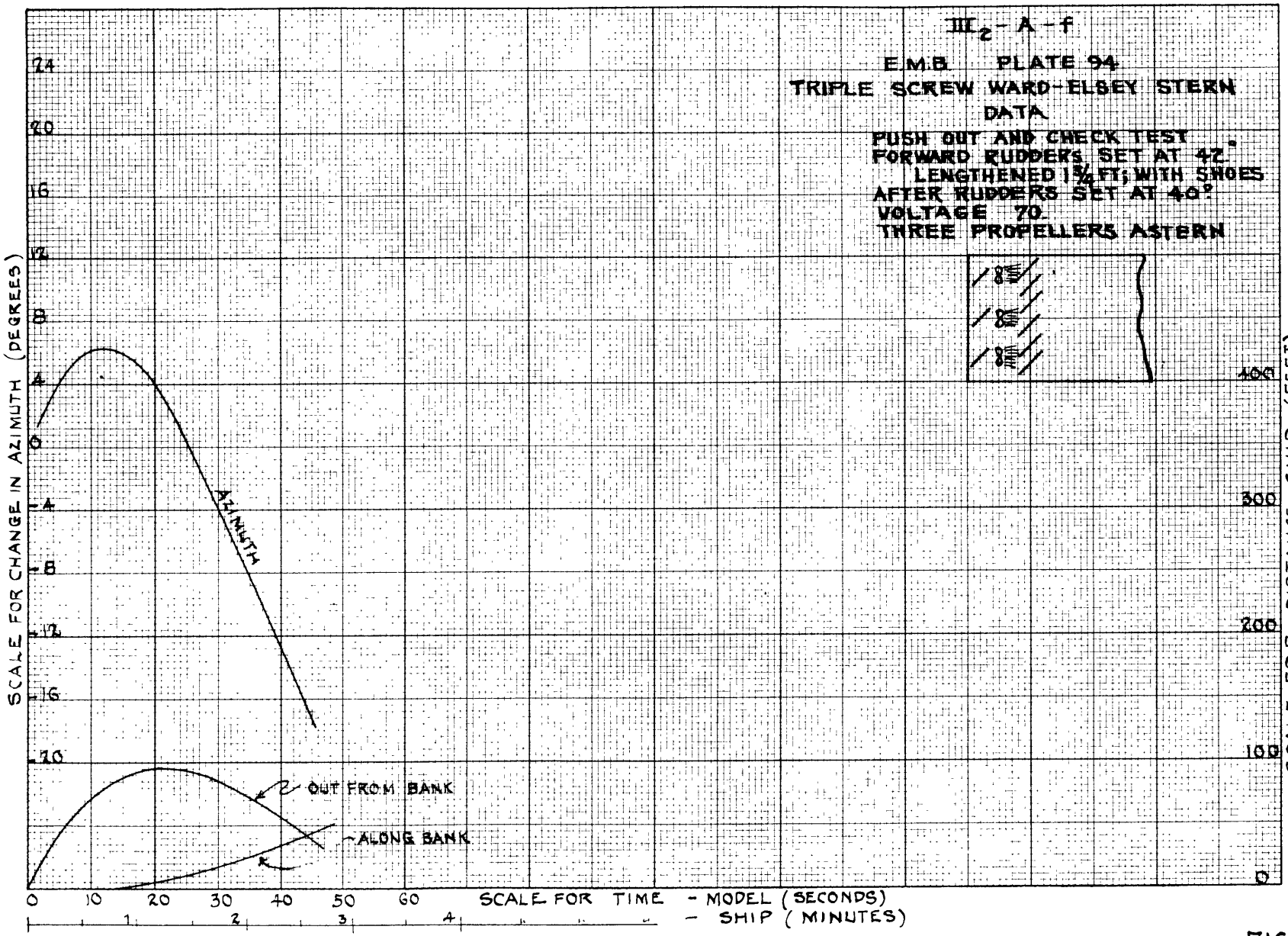

III2 - A - f
E.M.B. PLATE 94
TRIPLE SCREW WARD-ELSEY STERN
DATA
PUSH OUT AND CHECK TEST
FORWARD RUDDERS SET AT 42°
LENGTHENED 1¾ FT; WITH SHOES
AFTER RUDDERS SET AT 40°
VOLTAGE 70
THREE PROPELLERS ASTERN
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
24
20
16
12
8
4
0
-4
-8
-12
-16
-20
AZIMUTH
OUT FROM BANK
ALONG BANK
SCALE FOR DISTANCE - SHIP (FEET)
400
300
200
100
0
0 10 20 30 40 50 60
SCALE FOR TIME - MODEL (SECONDS)
1 2 3 4
- SHIP (MINUTES)

FIG. 102

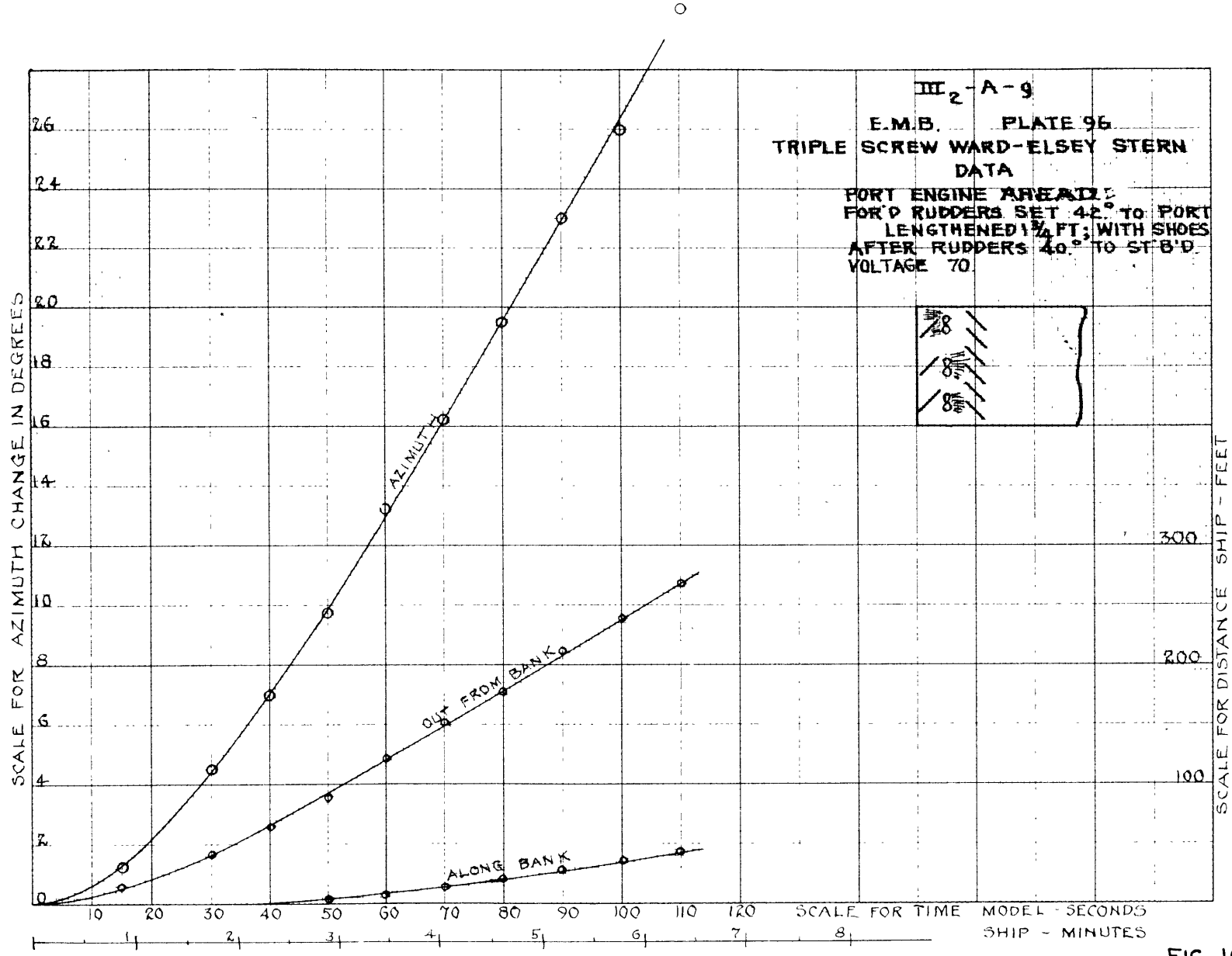

III 2 - A - 9
E.M.B. PLATE 96
TRIPLE SCREW WARD-ELSEY STERN
DATA
PORT ENGINE AHEAD
FOR'D RUDDERS SET 42° TO PORT
LENGTHENED 1¾ FT; WITH SHOES
AFTER RUDDERS 40° TO ST'B'D
VOLTAGE 70
AZIMUTH
OUT FROM BANK
ALONG BANK
SCALE FOR AZIMUTH CHANGE IN DEGREES
SCALE FOR DISTANCE SHIP - FEET
SCALE FOR TIME MODEL - SECONDS
SHIP - MINUTES

FIG. 103

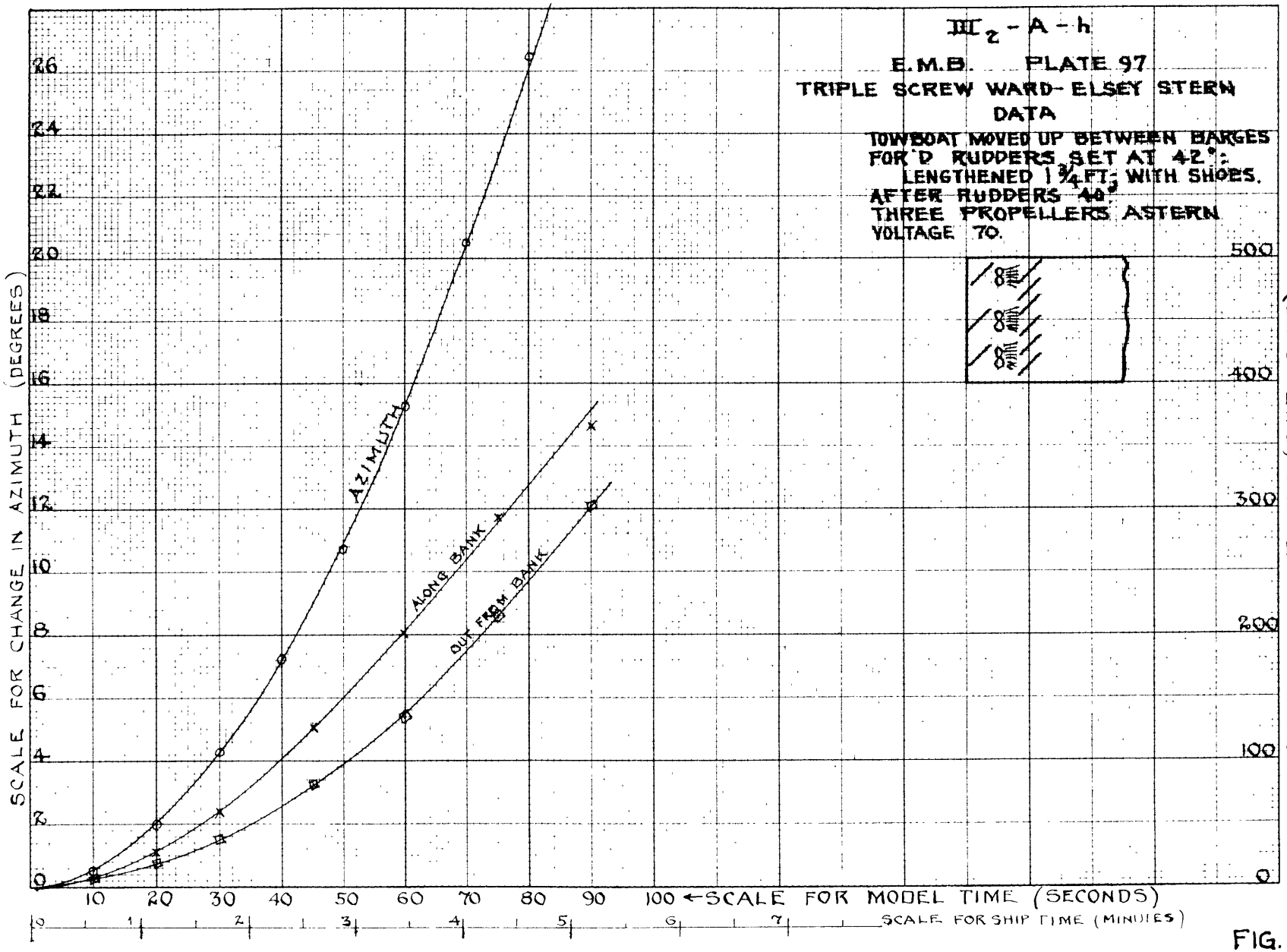

III 2 - A - h
E.M.B. PLATE 97
TRIPLE SCREW WARD-ELSEY STERN
DATA
TOWBOAT MOVED UP BETWEEN BARGES
FOR D RUDDERS SET AT 42°:
LENGTHENED 1 3/4 FT; WITH SHOES.
AFTER RUDDERS 40°.
THREE PROPELLERS ASTERN.
VOLTAGE 70.
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE (SHIP, FEET)
SCALE FOR MODEL TIME (SECONDS)
SCALE FOR SHIP TIME (MINUTES)

FIG. 104

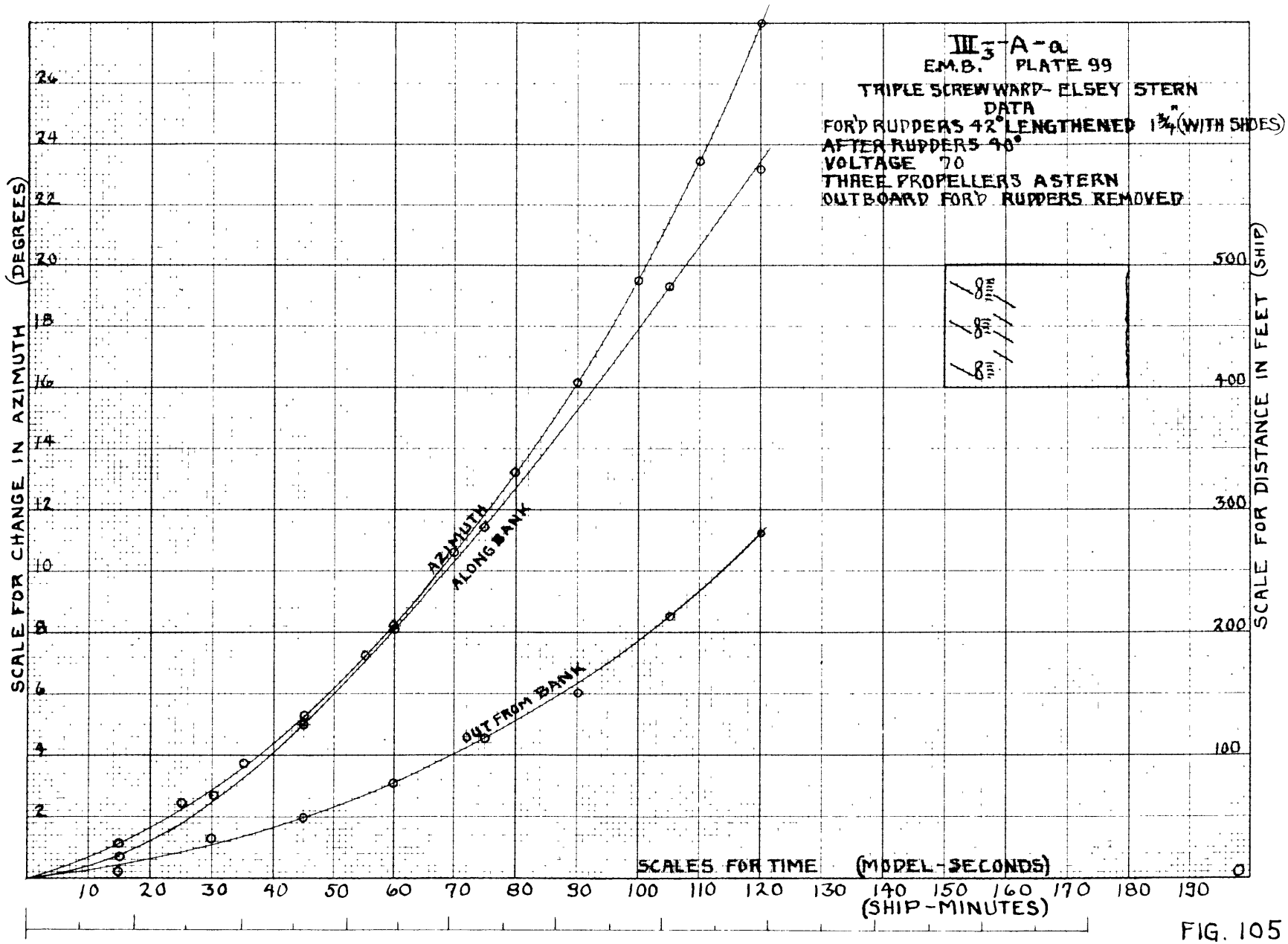

III 3-A-a
E.M.B. PLATE 99
TRIPLE SCREW WARD-ELSEY STERN
DATA
FOR'D RUDDERS 42° LENGTHENED 1¾" (WITH SIDES)
AFTER RUDDERS 90°
VOLTAGE 70
THREE PROPELLERS ASTERN
OUTBOARD FOR'D RUDDERS REMOVED
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALES FOR TIME (MODEL-SECONDS)
(SHIP-MINUTES)

FIG. 105

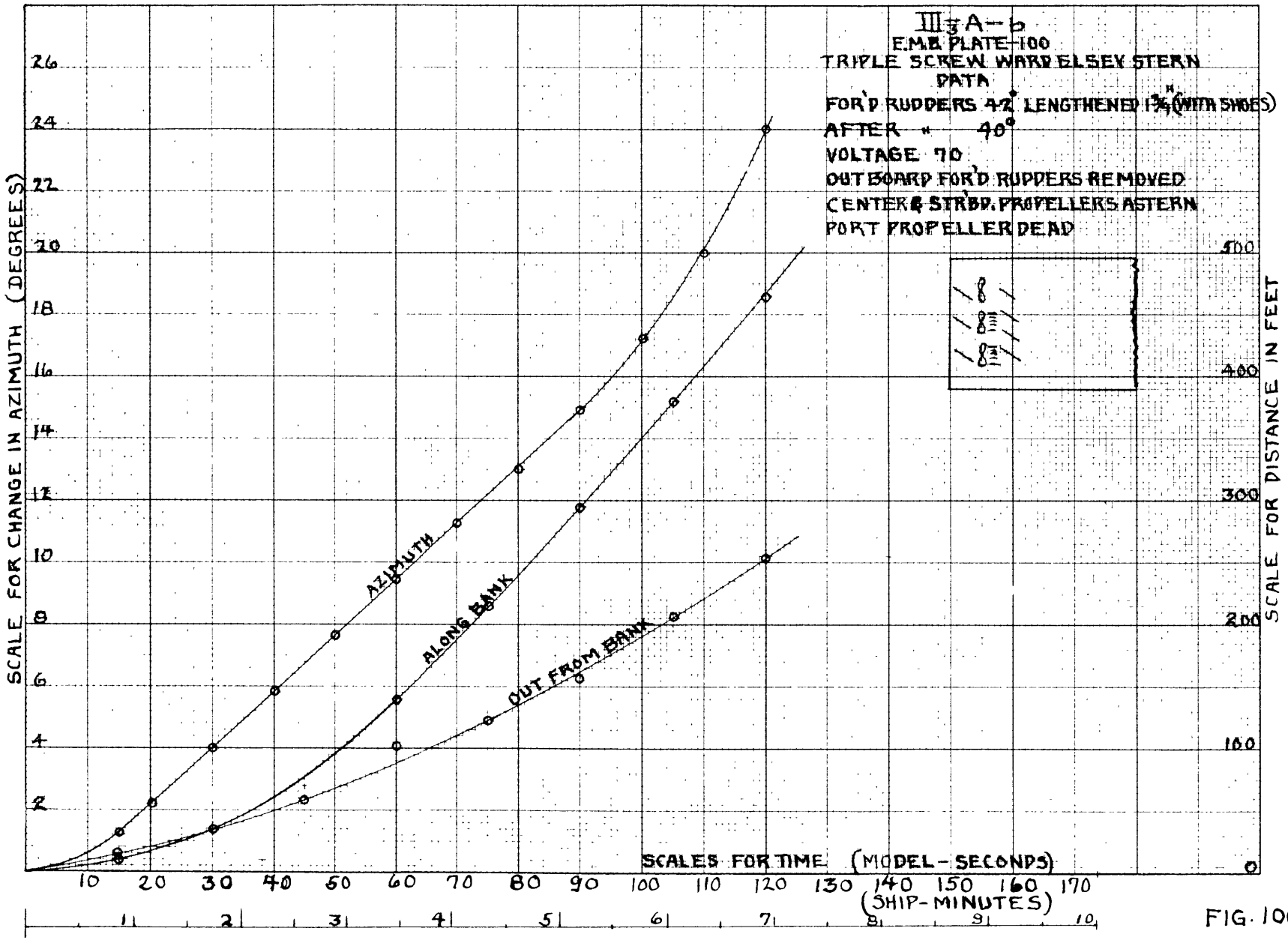

III-A-b
E.M.B. PLATE-100
TRIPLE SCREW WARD ELSEY STERN
DATA
FOR'D RUDDERS 42° LENGTHENED 1¾" (WITH SHOES)
AFTER " 40°
VOLTAGE 70
OUTBOARD FOR'D RUDDERS REMOVED
CENTER & STR'BD. PROPELLERS ASTERN
PORT PROPELLER DEAD
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET
SCALES FOR TIME (MODEL-SECONDS)
(SHIP-MINUTES)

FIG. 106

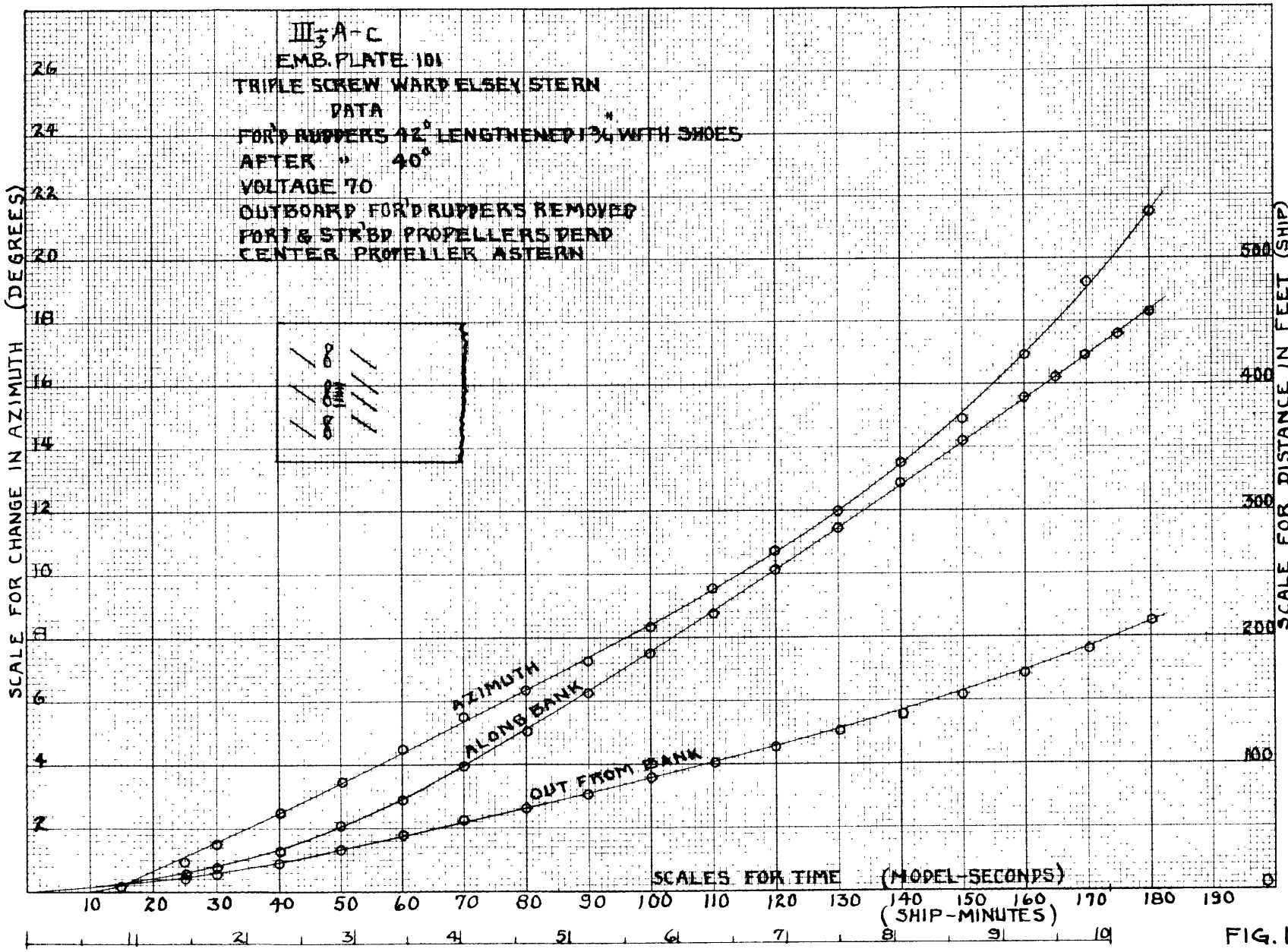

III-3 A-C
EMB. PLATE 101
TRIPLE SCREW WARP ELSEY STERN
DATA
FOR'D RUDDERS 42° LENGTHENED 1¾" WITH SHOES
AFTER " 40°
VOLTAGE 70
OUTBOARD FOR'D RUDDERS REMOVED
PORT & STR'BD PROPELLERS DEAD
CENTER PROPELLER ASTERN
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALES FOR TIME (MODEL-SECONDS)
(SHIP-MINUTES)

FIG. 107

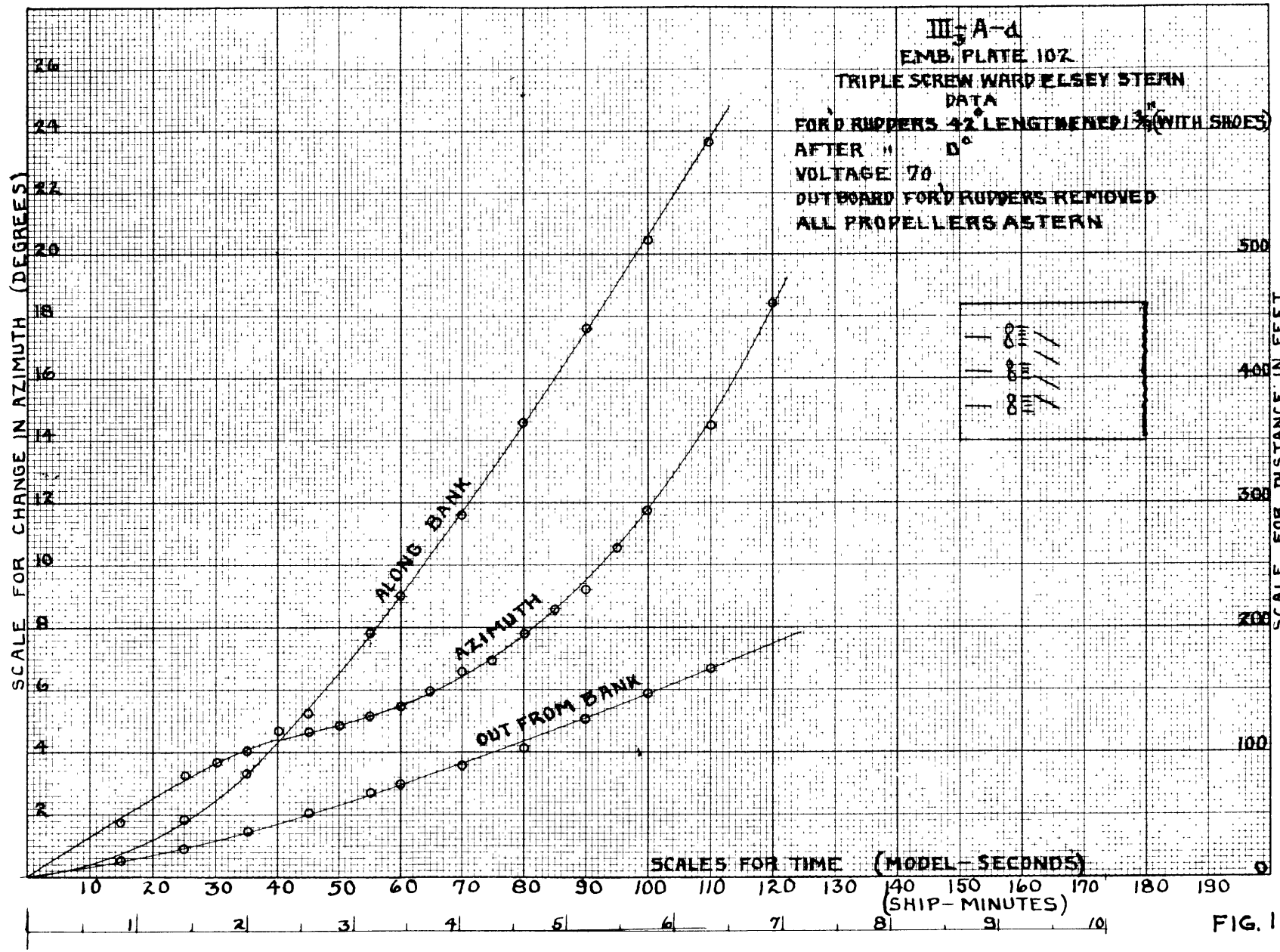

III-A-d
EMB. PLATE 107
TRIPLE SCREW WARD ELSEY STERN
DATA
FORD RUDDERS 42° LENGTHENED 3" (WITH SHOES)
AFTER " D°
VOLTAGE 70
OUTBOARD FORD RUDDERS REMOVED
ALL PROPELLERS ASTERN
ALONG BANK
AZIMUTH
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET
SCALES FOR TIME (MODEL-SECONDS)
(SHIP-MINUTES)

FIG. 108

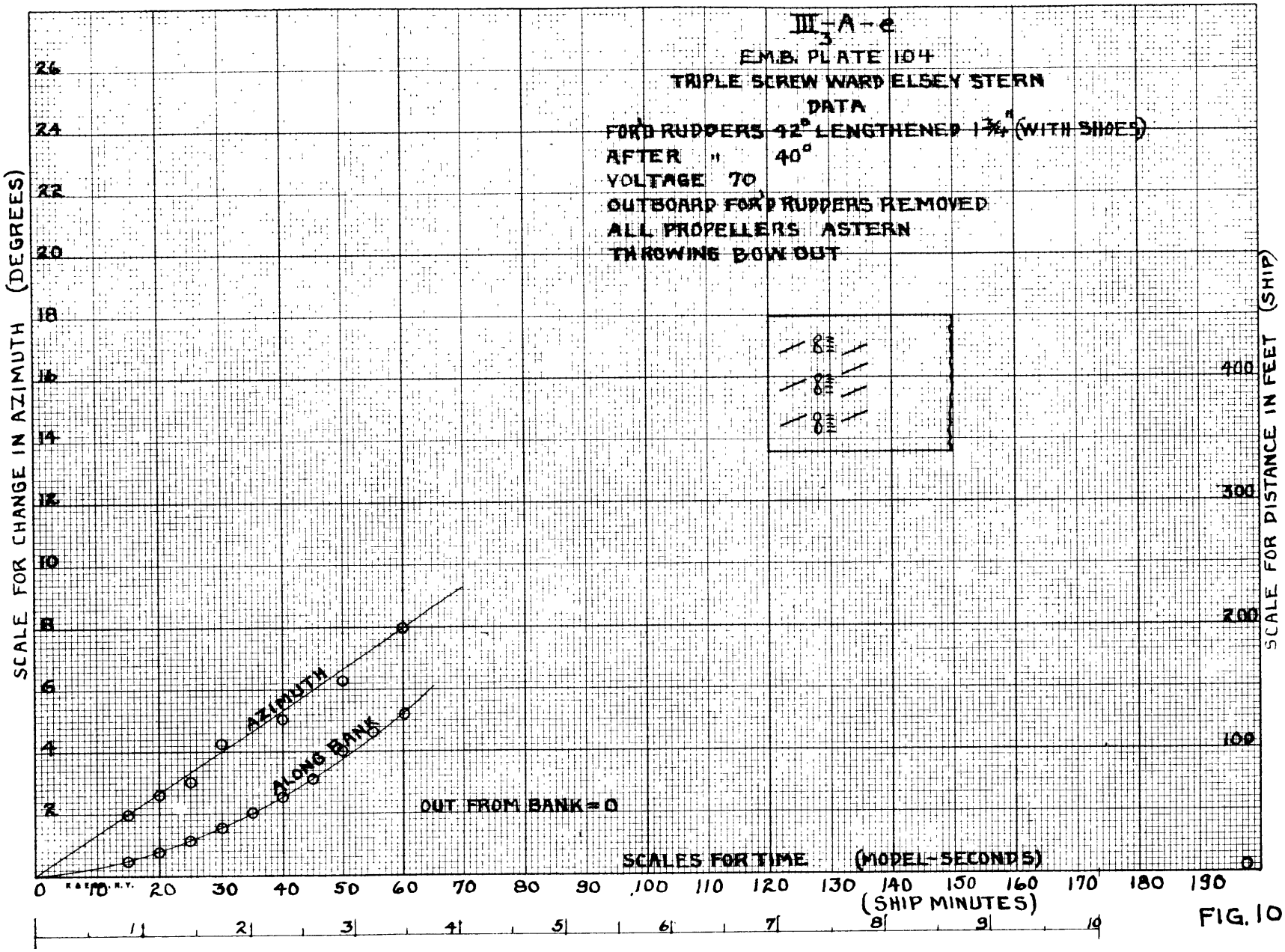

III-A-e
E.M.B. PLATE 104
TRIPLE SCREW WARD ELSEY STERN
DATA
FORD RUDDERS 42° LENGTHENED 1¾" (WITH SHOES)
AFTER " 40°
VOLTAGE 70
OUTBOARD FORD RUDDERS REMOVED
ALL PROPELLERS ASTERN
THROWING BOW OUT
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
AZIMUTH
ALONG BANK
OUT FROM BANK = 0
SCALES FOR TIME (MODEL-SECONDS)
(SHIP MINUTES)

FIG. 109

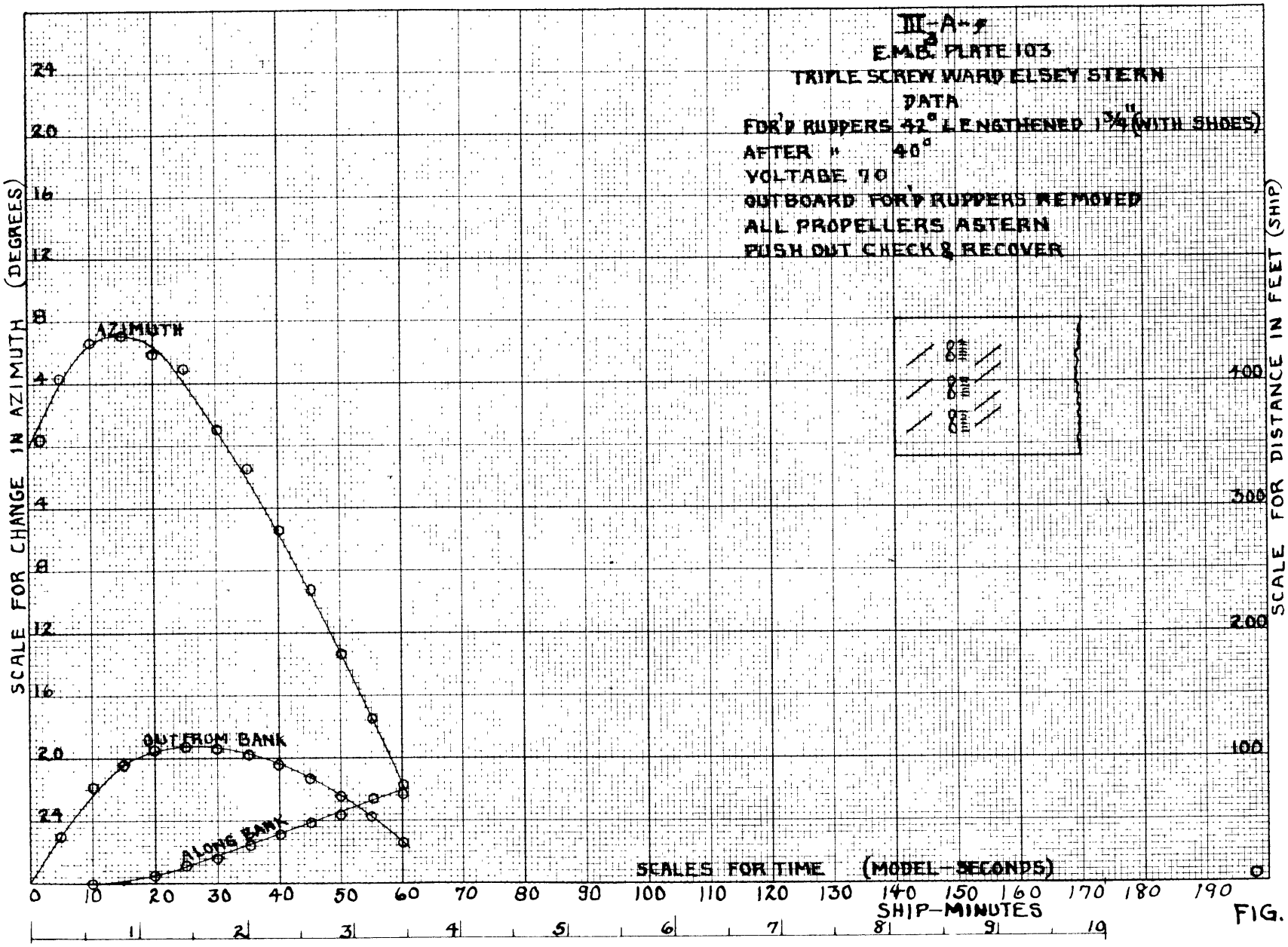

III-A-5
E.M.B. PLATE 103
TRIPLE SCREW WARD ELSEY STERN
DATA
FOR'D RUDDERS 42" LENGTHENED 1¾" (WITH SHOES)
AFTER " 40"
VOLTAGE 70
OUTBOARD FOR'D RUDDERS REMOVED
ALL PROPELLERS ASTERN
PUSH OUT CHECK & RECOVER
AZIMUTH
OUT FROM BANK
ALONG BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALES FOR TIME (MODEL-SECONDS)
SHIP-MINUTES

FIG. 110

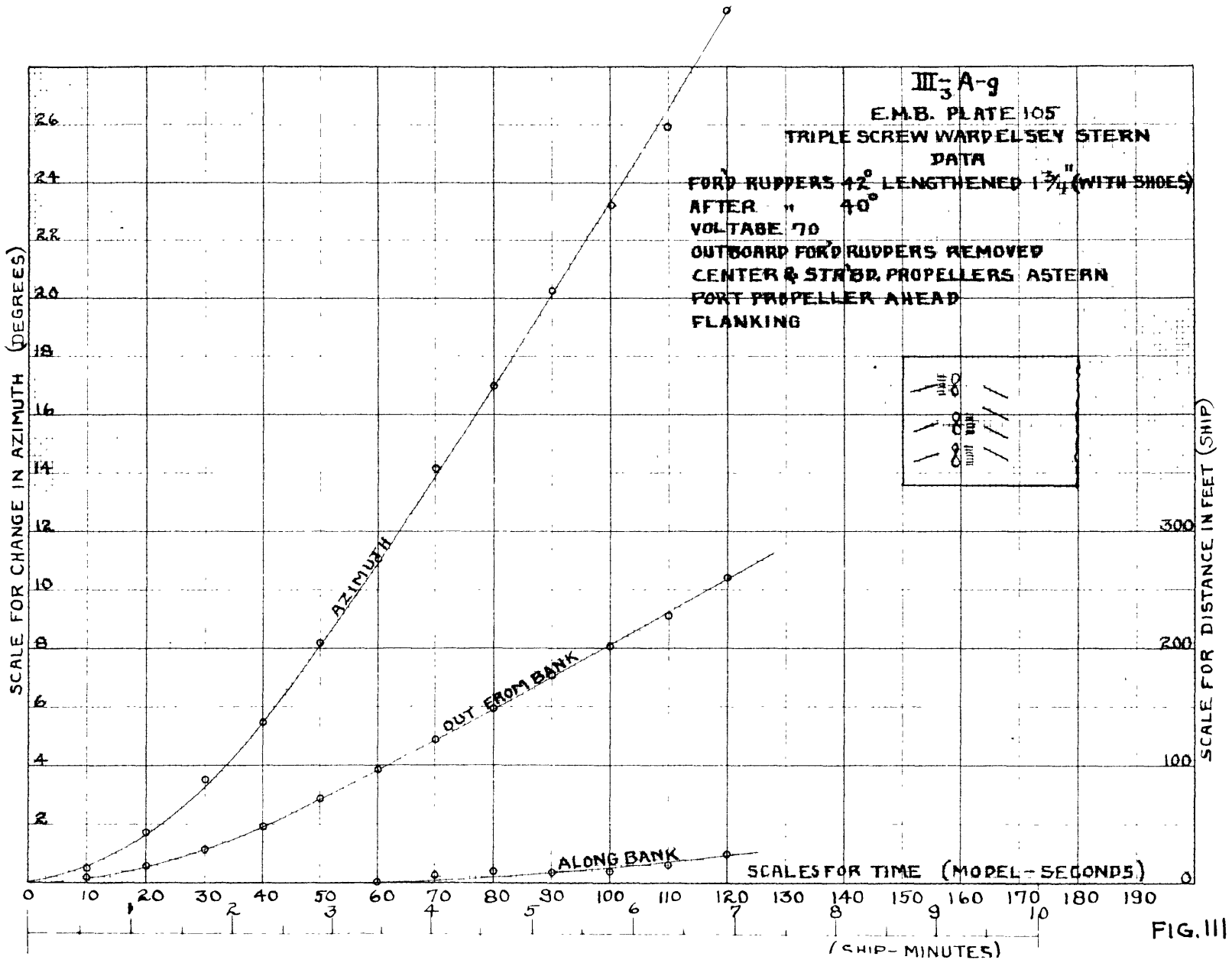

III-3 A-9
E.M.B. PLATE 105
TRIPLE SCREW WARD ELSEY STERN
DATA
FORD RUDDERS 42° LENGTHENED 1 3/4" (WITH SHOES)
AFTER " 40°
VOLTAGE 70
OUTBOARD FORD RUDDERS REMOVED
CENTER & STBD. PROPELLERS ASTERN
PORT PROPELLER AHEAD
FLANKING
AZIMUTH
OUT FROM BANK
ALONG BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALES FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190
1 2 3 4 5 6 7 8 9 10
26 24 22 20 18 16 14 12 10 8 6 4 2
300 200 100 0

FIG. III

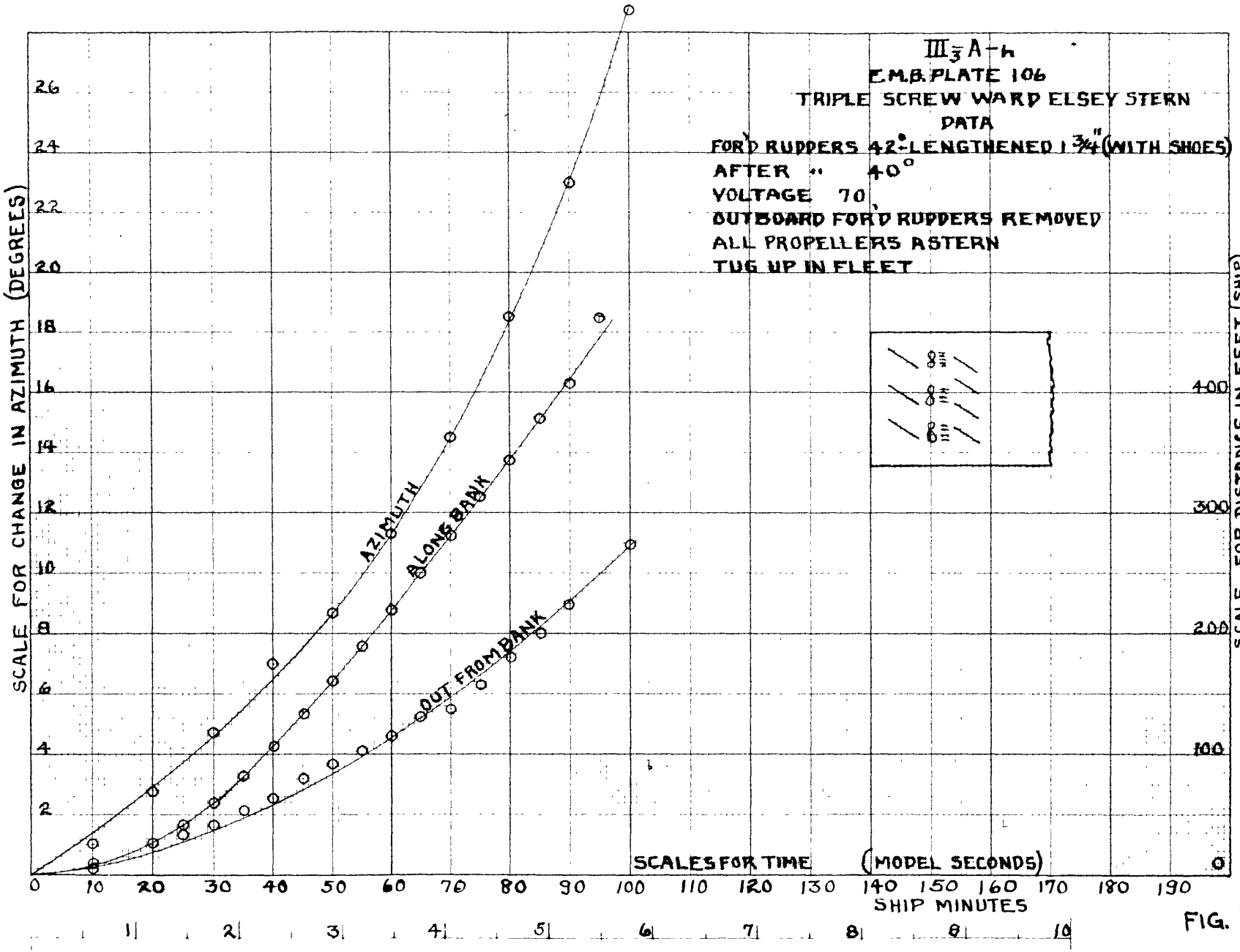

III 3 A-h
E.M.B. PLATE 106
TRIPLE SCREW WARD ELSEY STERN
DATA
FORD RUDDERS 42° LENGTHENED 1 3/4" (WITH SHOES)
AFTER " 40°
VOLTAGE 70
OUTBOARD FORD RUDDERS REMOVED
ALL PROPELLERS ASTERN
TUG UP IN FLEET
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALES FOR TIME (MODEL SECONDS)
SHIP MINUTES

FIG. 112

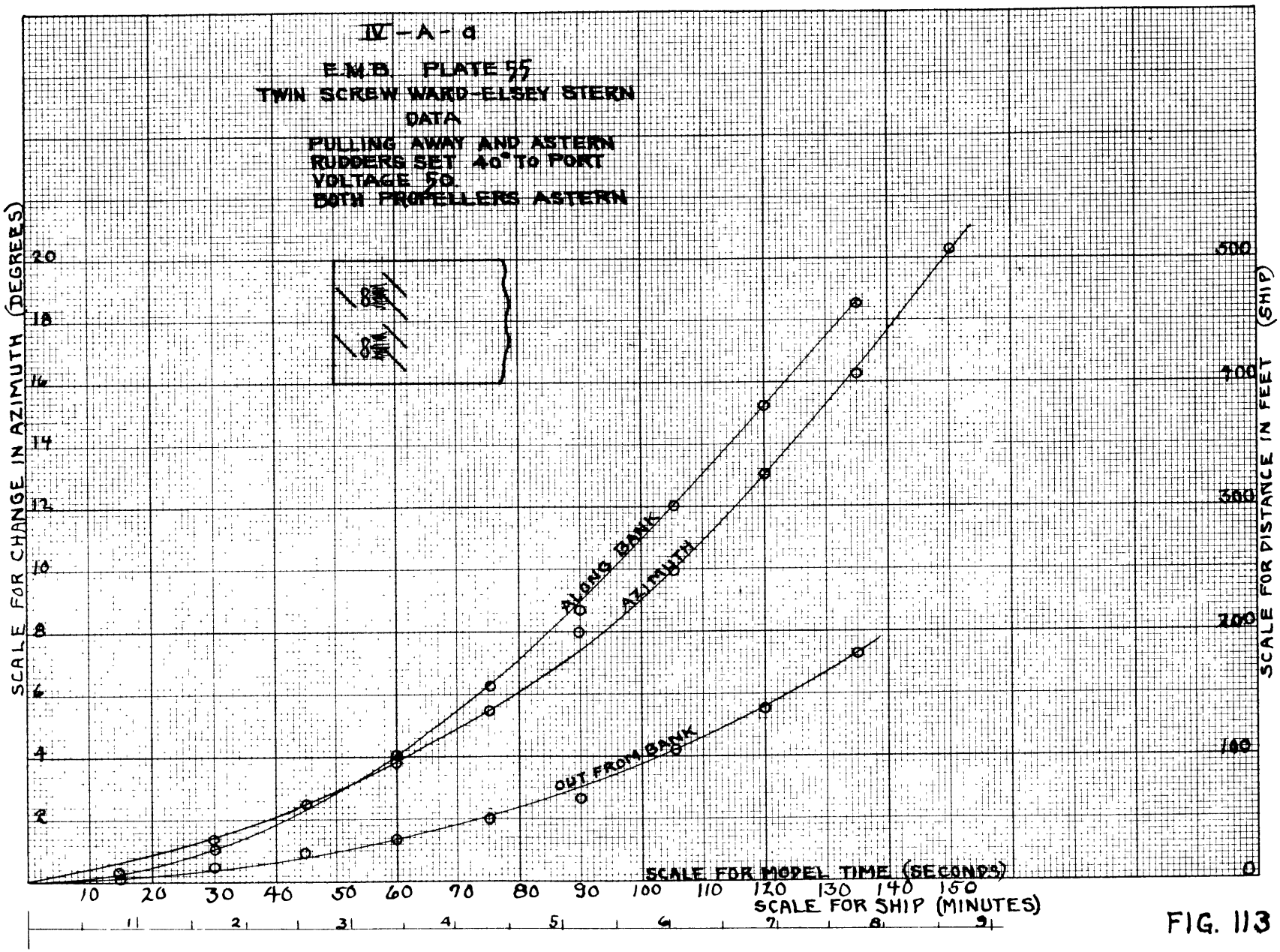

IV-A-a
E.M.B. PLATE 55
TWIN SCREW WARD-ELSEY STERN
DATA
PULLING AWAY AND ASTERN
RUDDERS SET 40° TO PORT
VOLTAGE 50
BOTH PROPELLERS ASTERN
ALONG BANK
AZIMUTH
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR MODEL TIME (SECONDS)
SCALE FOR SHIP (MINUTES)

FIG. 113

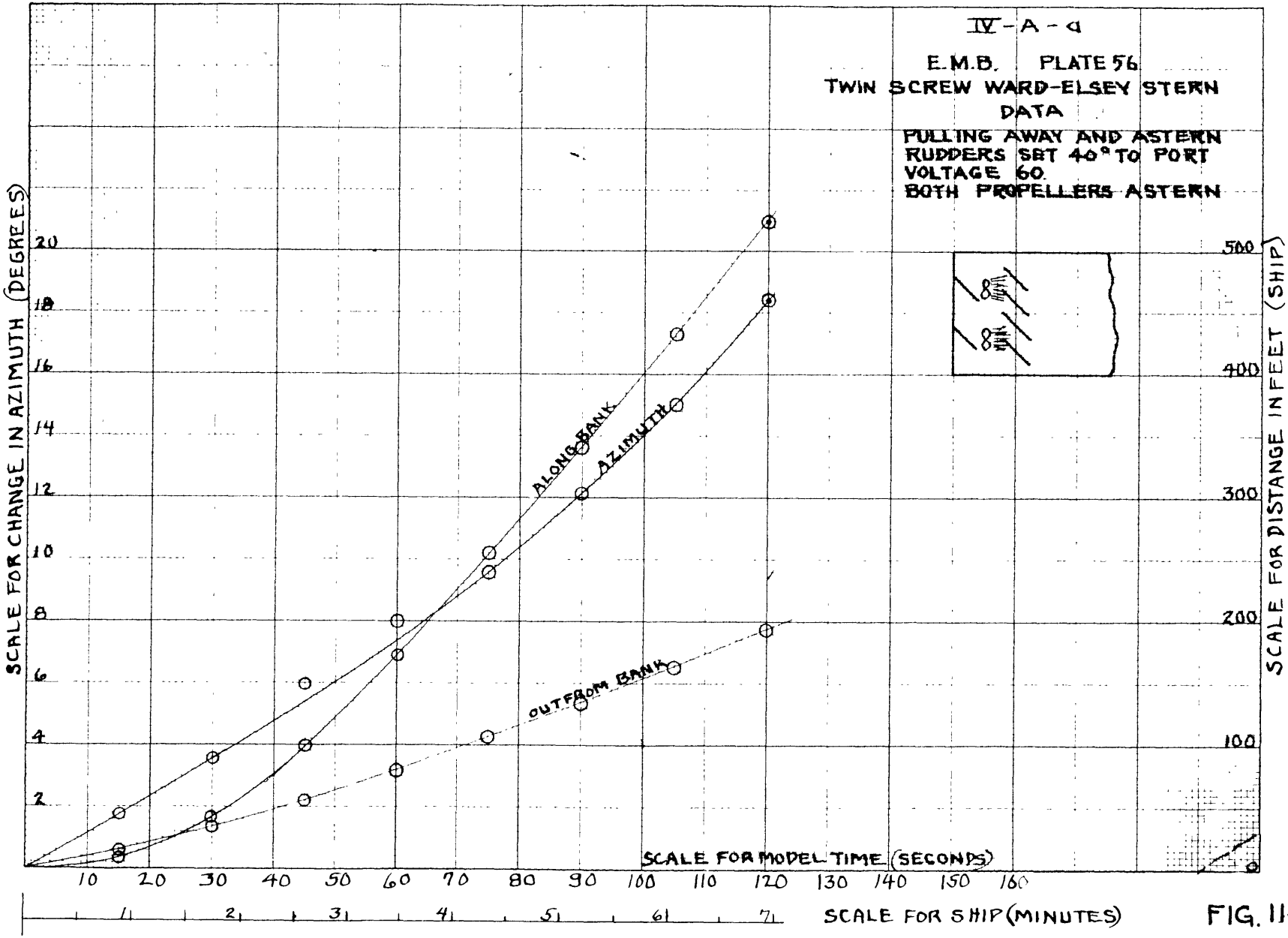

IV-A-a
E.M.B. PLATE 56
TWIN SCREW WARD-ELSEY STERN
DATA
PULLING AWAY AND ASTERN
RUDDERS SET 40° TO PORT
VOLTAGE 60.
BOTH PROPELLERS ASTERN
ALONG BANK
AZIMUTH
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANGE IN FEET (SHIP)
SCALE FOR MODEL TIME (SECONDS)
SCALE FOR SHIP (MINUTES)
20
18
16
14
12
10
8
6
4
2
500
400
300
200
100
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160
1 2 3 4 5 6 7

FIG. 114

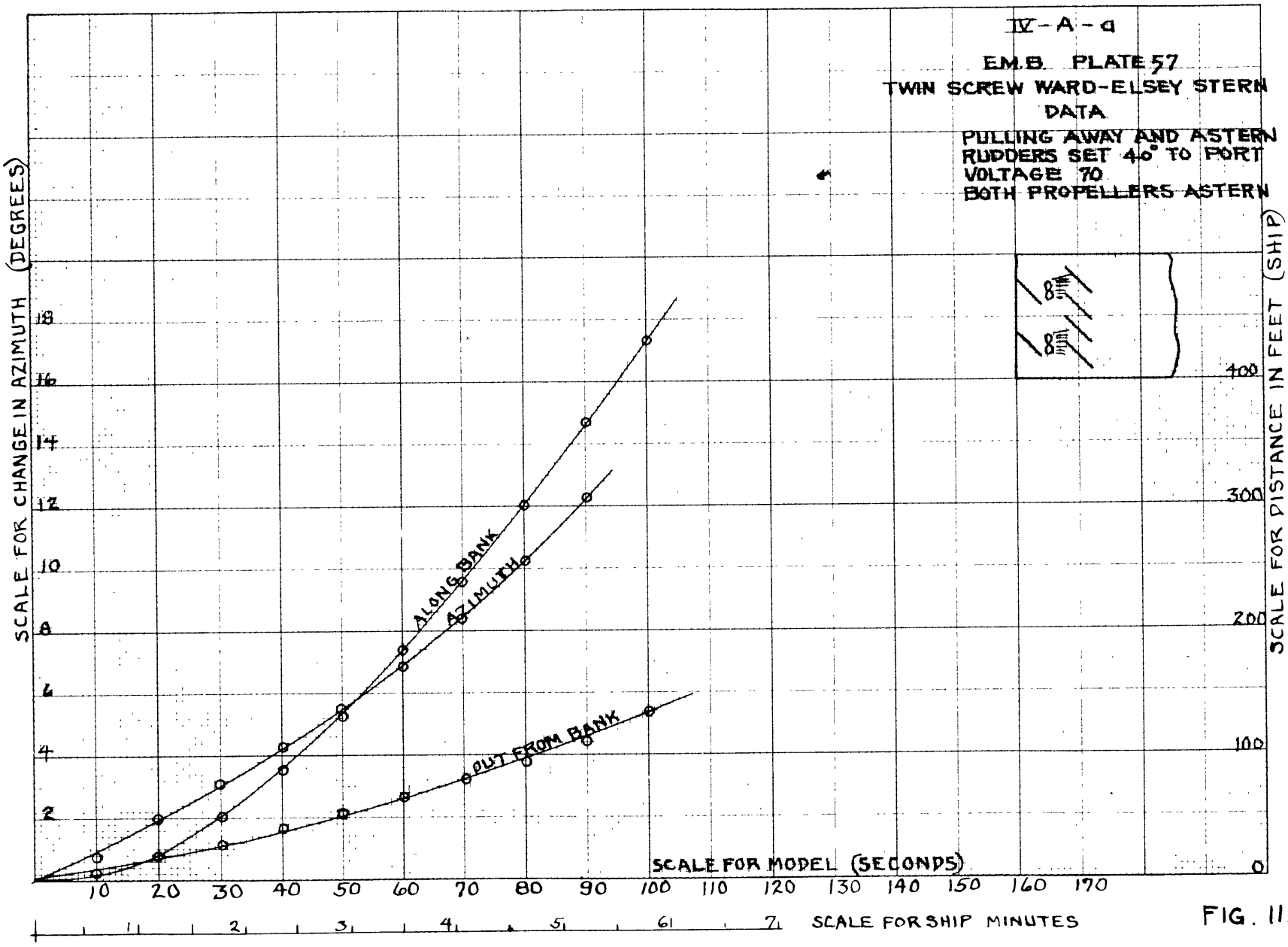

IV-A-a
E.M.B. PLATE 57
TWIN SCREW WARD-ELSEY STERN
DATA
PULLING AWAY AND ASTERN
RUDDERS SET 40° TO PORT
VOLTAGE 70
BOTH PROPELLERS ASTERN
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
ALONG BANK
AZIMUTH
OUT FROM BANK
SCALE FOR MODEL (SECONDS)
SCALE FOR SHIP MINUTES

FIG. 115

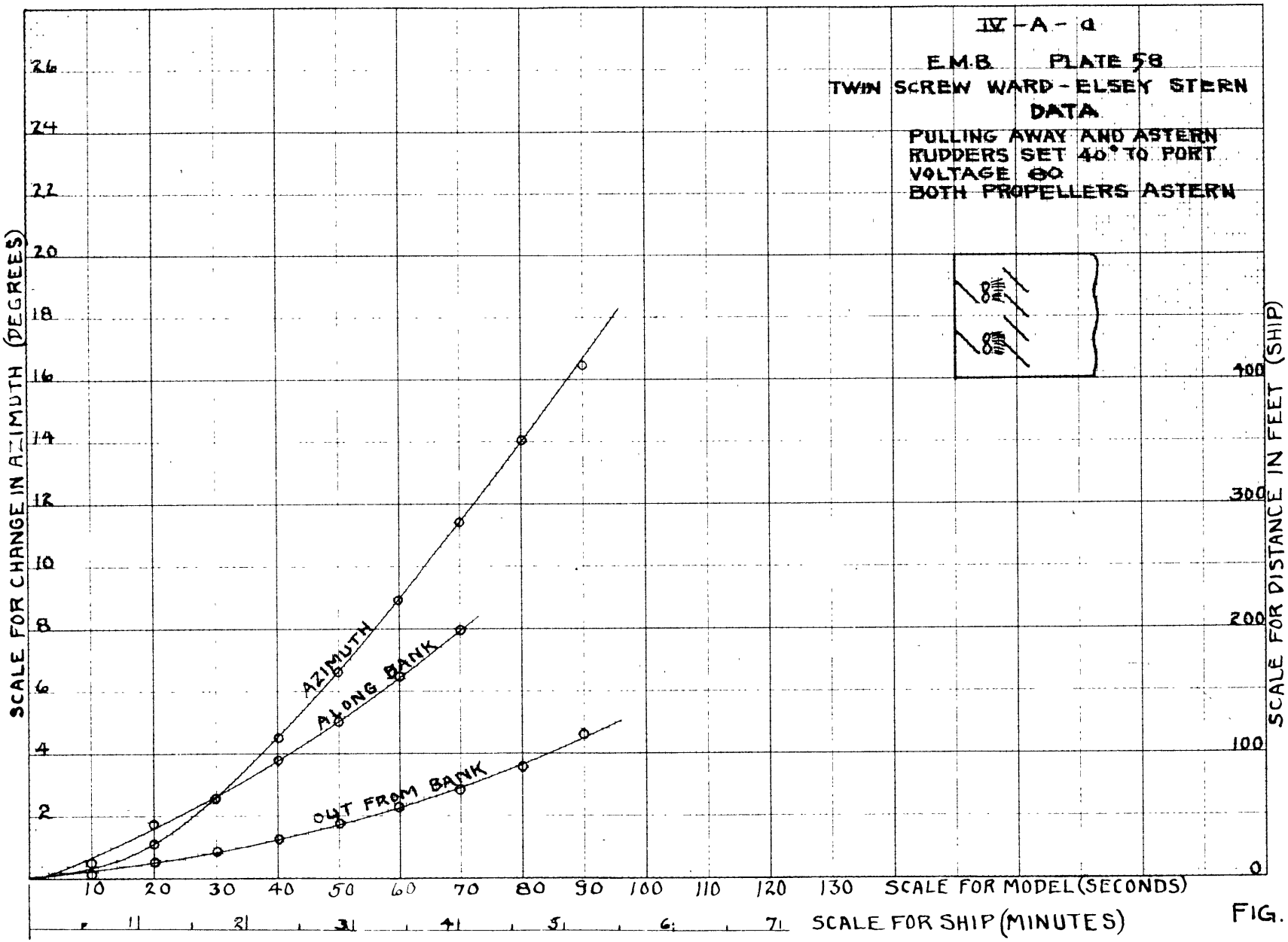

IV-A-a
E.M.B. PLATE 58
TWIN SCREW WARD-ELSEY STERN
DATA
PULLING AWAY AND ASTERN
RUDDERS SET 40° TO PORT
VOLTAGE 80
BOTH PROPELLERS ASTERN
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR MODEL (SECONDS)
SCALE FOR SHIP (MINUTES)

FIG. 116

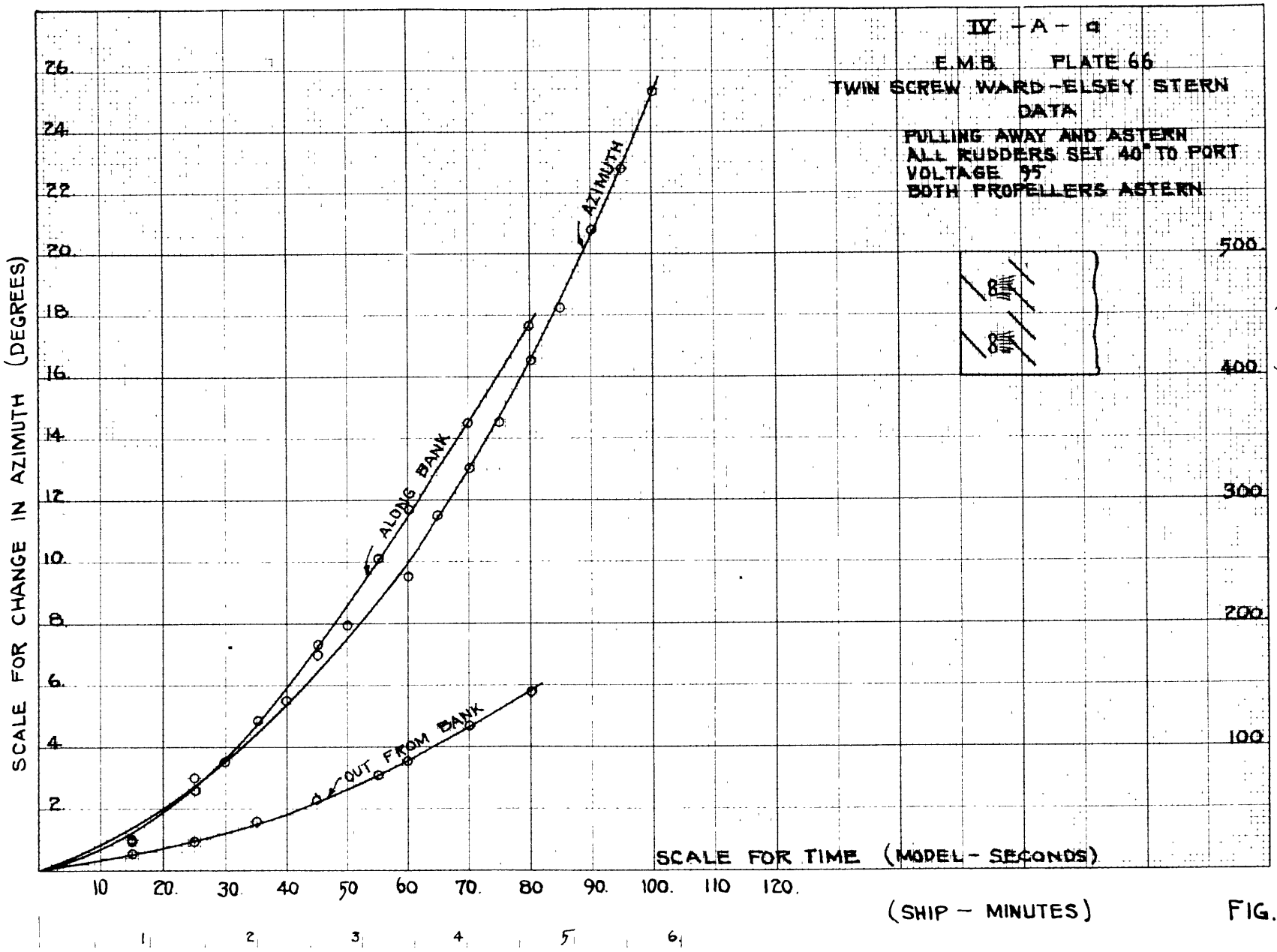

IV - A - a
E.M.B. PLATE 66
TWIN SCREW WARD-ELSEY STERN
DATA
PULLING AWAY AND ASTERN
ALL RUDDERS SET 40° TO PORT
VOLTAGE 95
BOTH PROPELLERS ASTERN
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
26.
24.
22.
20.
18.
16.
14.
12.
10.
8.
6.
4.
2.
500.
400.
300.
200.
100.
10
20.
30.
40
50
60
70.
80
90.
100.
110
120.
1
2
3
4
5
6

FIG. 117

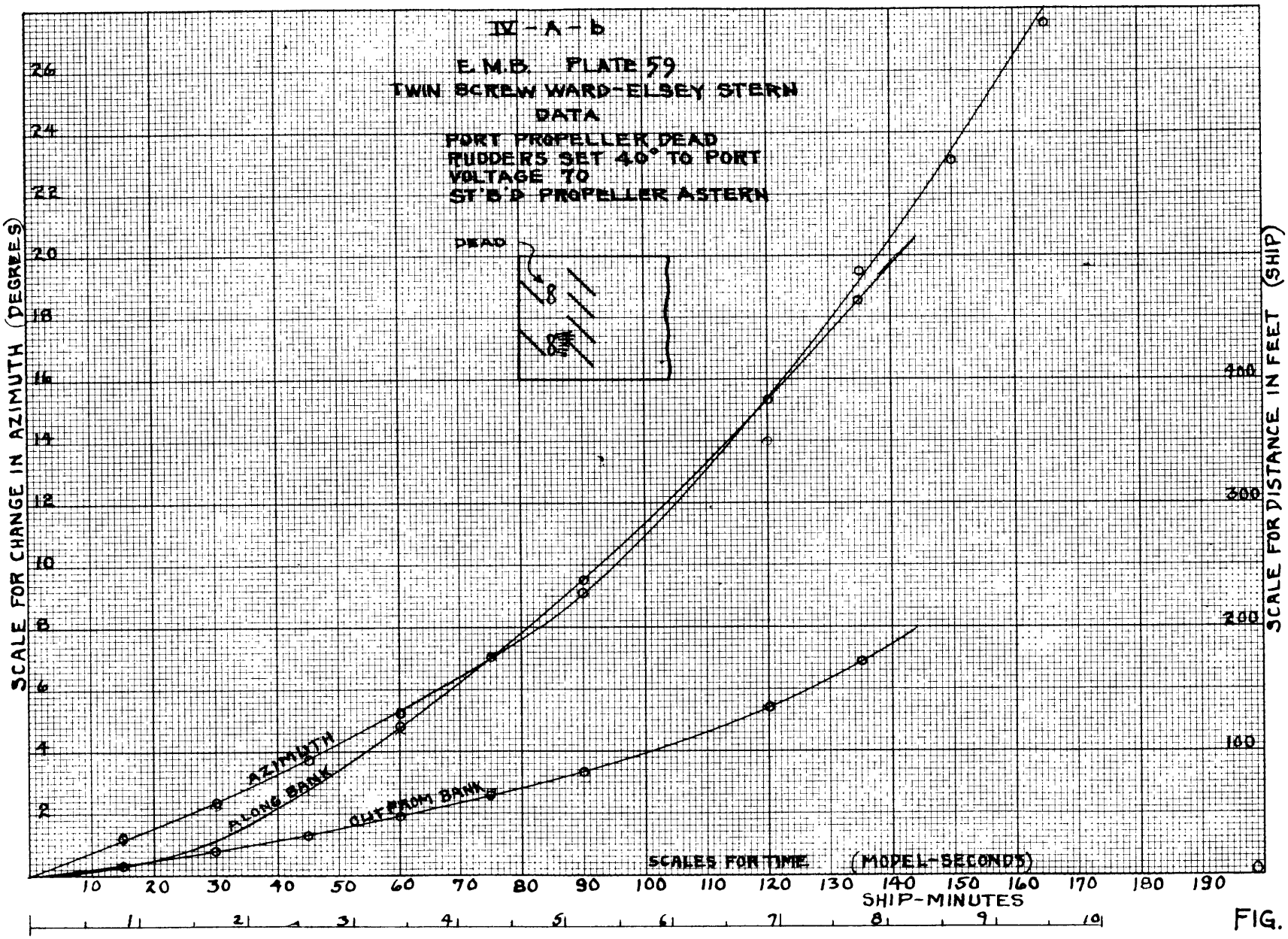

IV-A-b
E.M.B. PLATE 59
TWIN SCREW WARD-ELSEY STERN
DATA
PORT PROPELLER DEAD
RUDDERS SET 40° TO PORT
VOLTAGE TO
ST'B'D PROPELLER ASTERN
DEAD
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALES FOR TIME (MODEL-SECONDS)
SHIP-MINUTES

FIG. 118

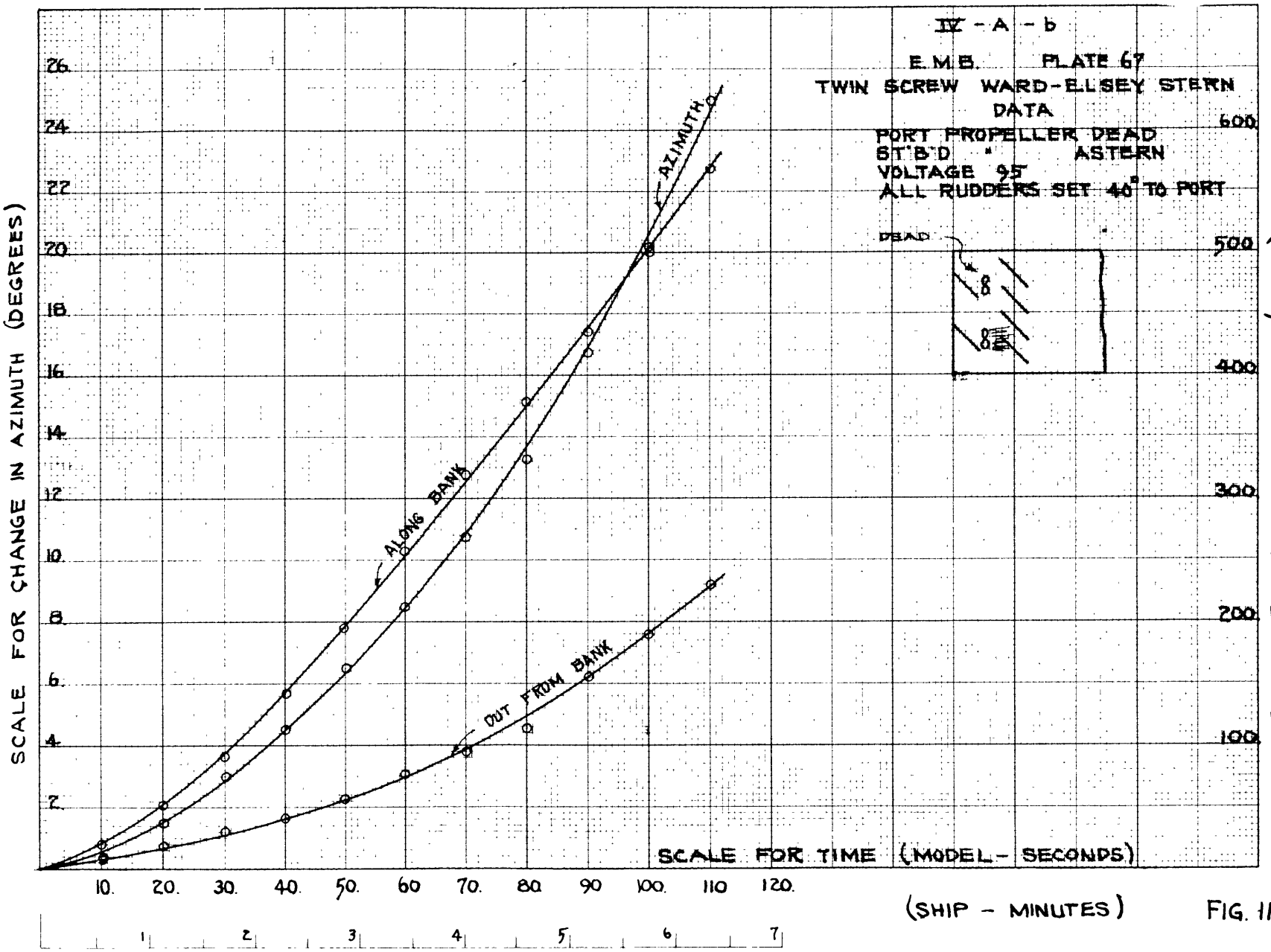

IV - A - b
E.M.B. PLATE 67
TWIN SCREW WARD-ELISEY STERN
DATA
PORT PROPELLER DEAD
ST'B'D " ASTERN
VOLTAGE 95
ALL RUDDERS SET 40° TO PORT
DEAD
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
26
24
22
20
18
16
14
12
10
8
6
4
2
600
500
400
300
200
100
10. 20. 30. 40. 50. 60 70. 80 90 100. 110 120.
1 2 3 4 5 6 7

FIG. 119

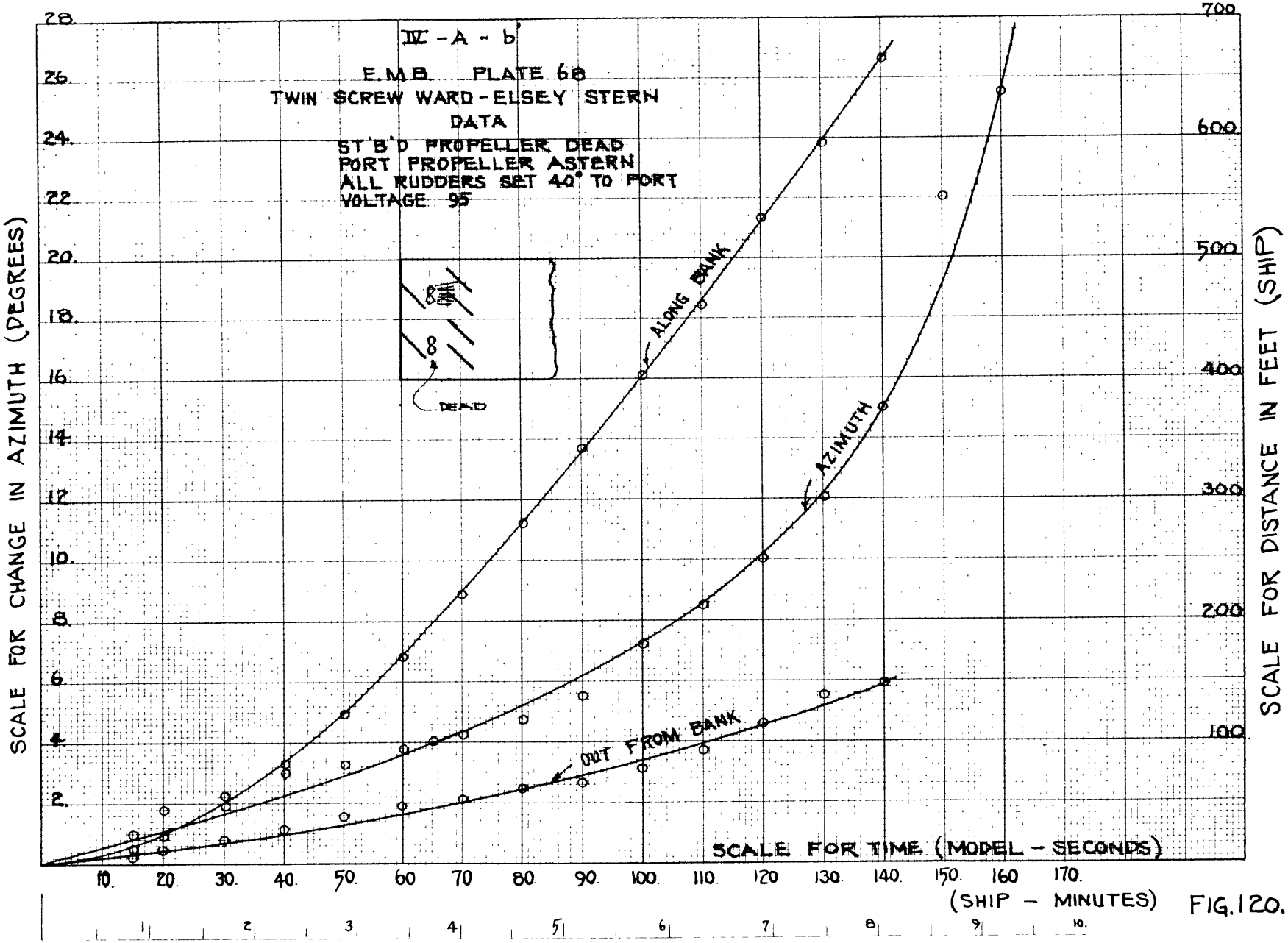

IV-A-b'
E.M.B. PLATE 68
TWIN SCREW WARD-ELSEY STERN
DATA
ST'B'D PROPELLER DEAD
PORT PROPELLER ASTERN
ALL RUDDERS SET 40° TO PORT
VOLTAGE 95
DEAD
ALONG BANK
AZIMUTH
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
28
26
24
22
20
18
16
14
12
10
8
6
4
2
700
600
500
400
300
200
100
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
1
2
3
4
5
6
7
8
9
10

FIG. 120.

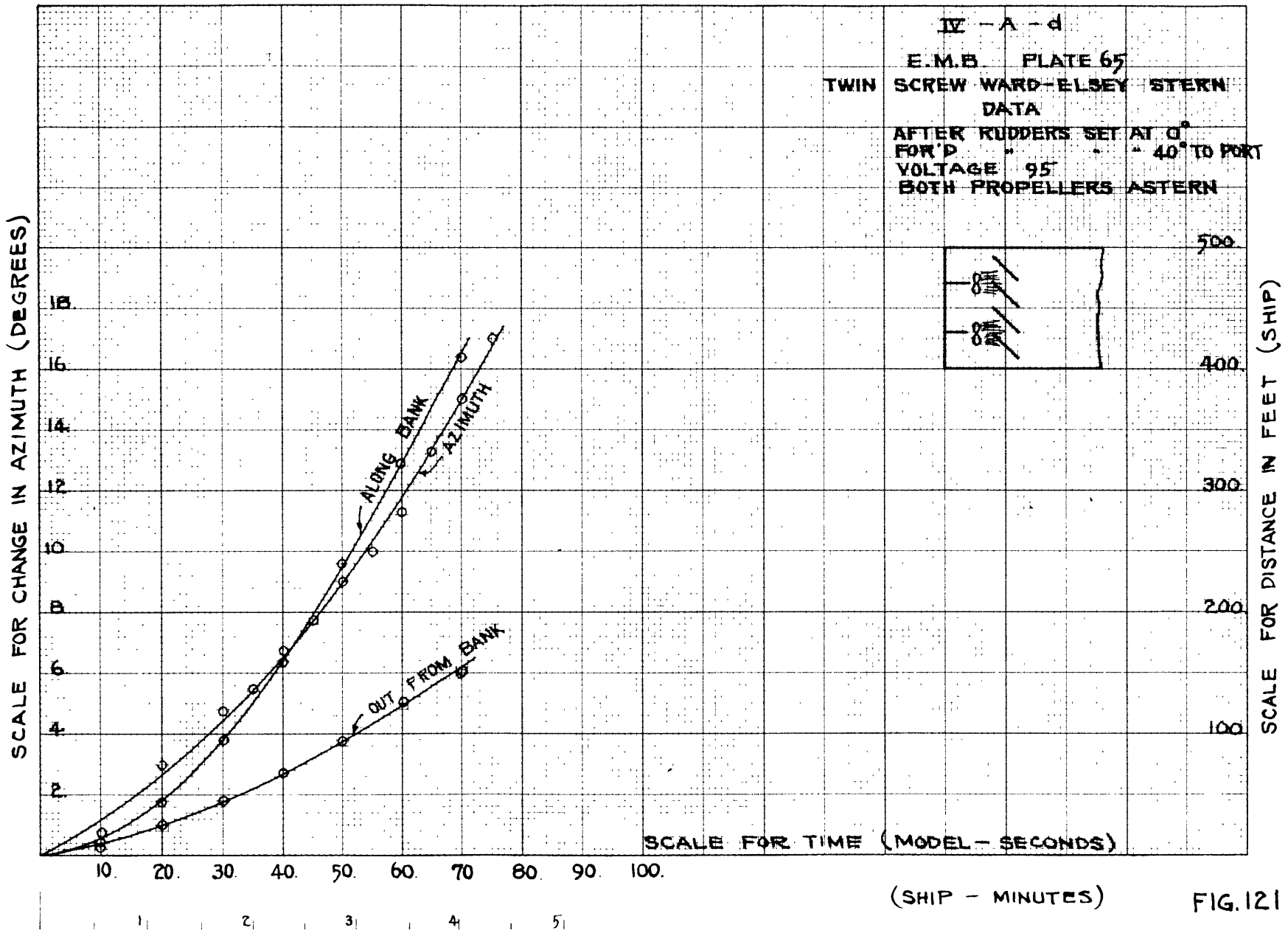

IV - A - d
E.M.B. PLATE 65
TWIN SCREW WARD-ELSEY STERN
DATA
AFTER RUDDERS SET AT 0°
FOR'D " " " 40° TO PORT
VOLTAGE 95
BOTH PROPELLERS ASTERN
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
ALONG BANK
AZIMUTH
OUT FROM BANK
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)

FIG. 121

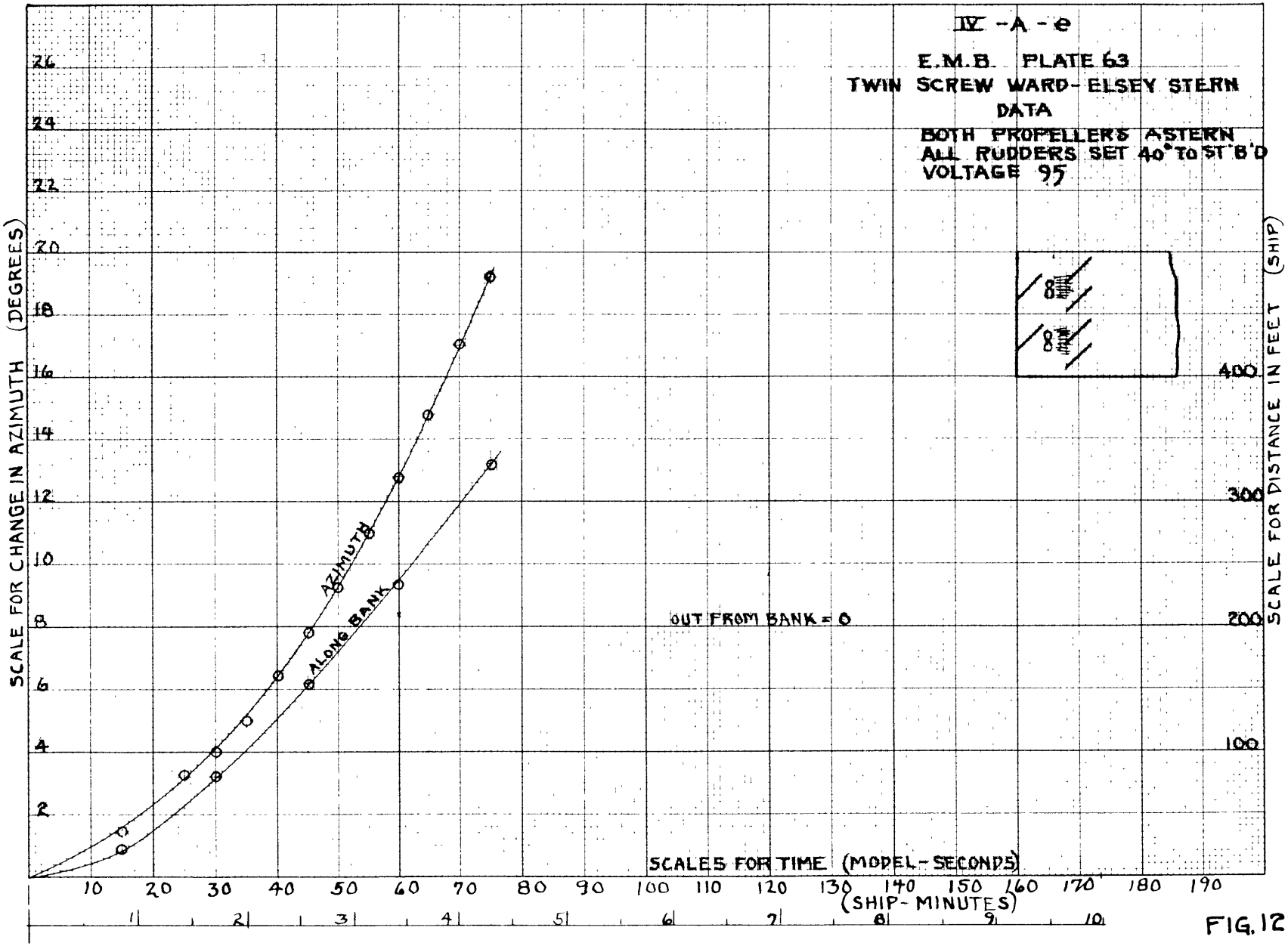

IV-A-e
E.M.B. PLATE 63
TWIN SCREW WARD-ELSEY STERN
DATA
BOTH PROPELLERS ASTERN
ALL RUDDERS SET 40° TO ST'B'D
VOLTAGE 95
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
AZIMUTH
ALONG BANK
OUT FROM BANK = 0
SCALES FOR TIME (MODEL-SECONDS)
(SHIP-MINUTES)

FIG. 122

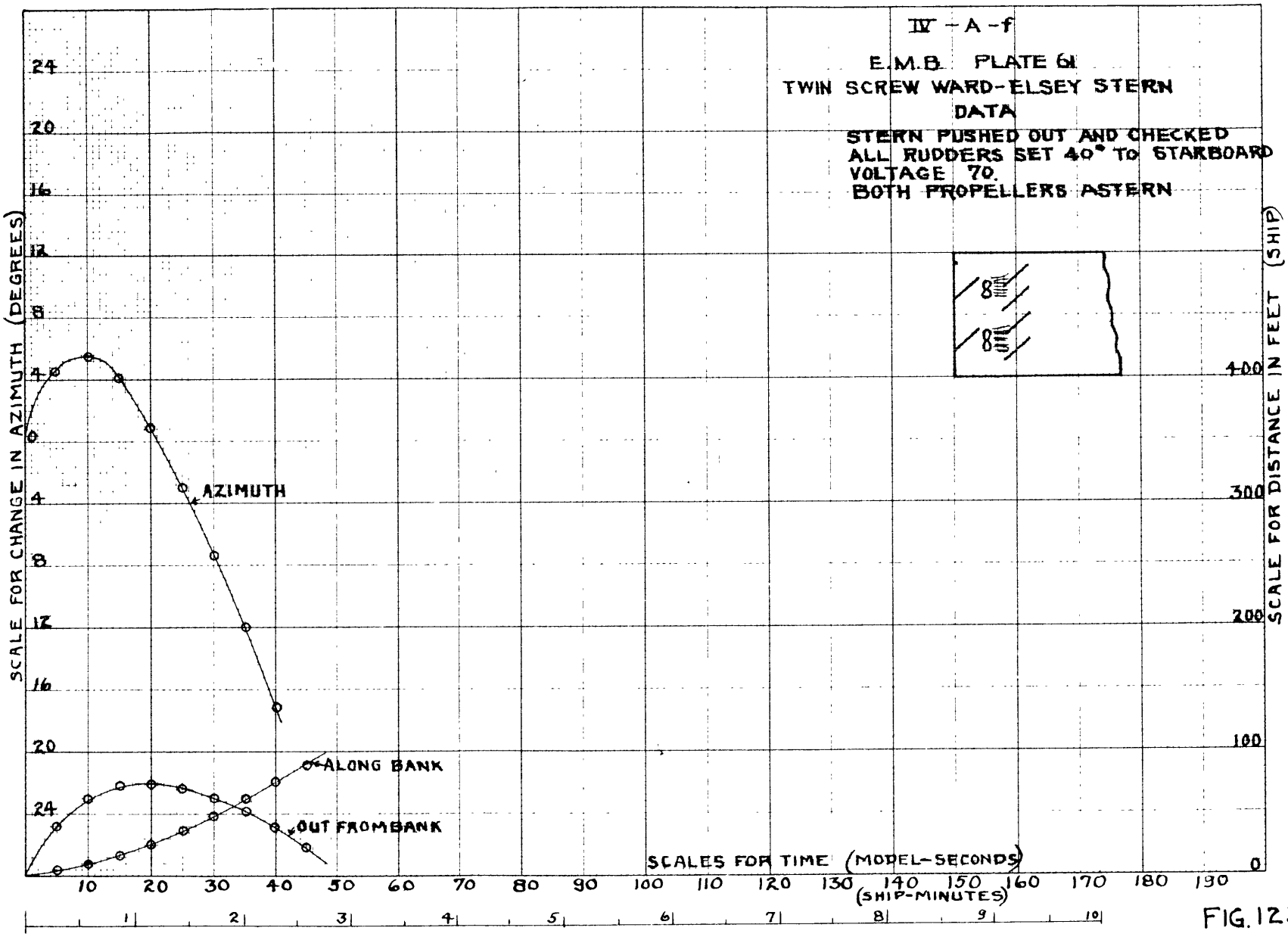

IV - A - f
E.M.B. PLATE 61
TWIN SCREW WARD-ELSEY STERN
DATA
STERN PUSHED OUT AND CHECKED
ALL RUDDERS SET 40° TO STARBOARD
VOLTAGE 70.
BOTH PROPELLERS ASTERN
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALES FOR TIME (MODEL-SECONDS)
(SHIP-MINUTES)

FIG. 123

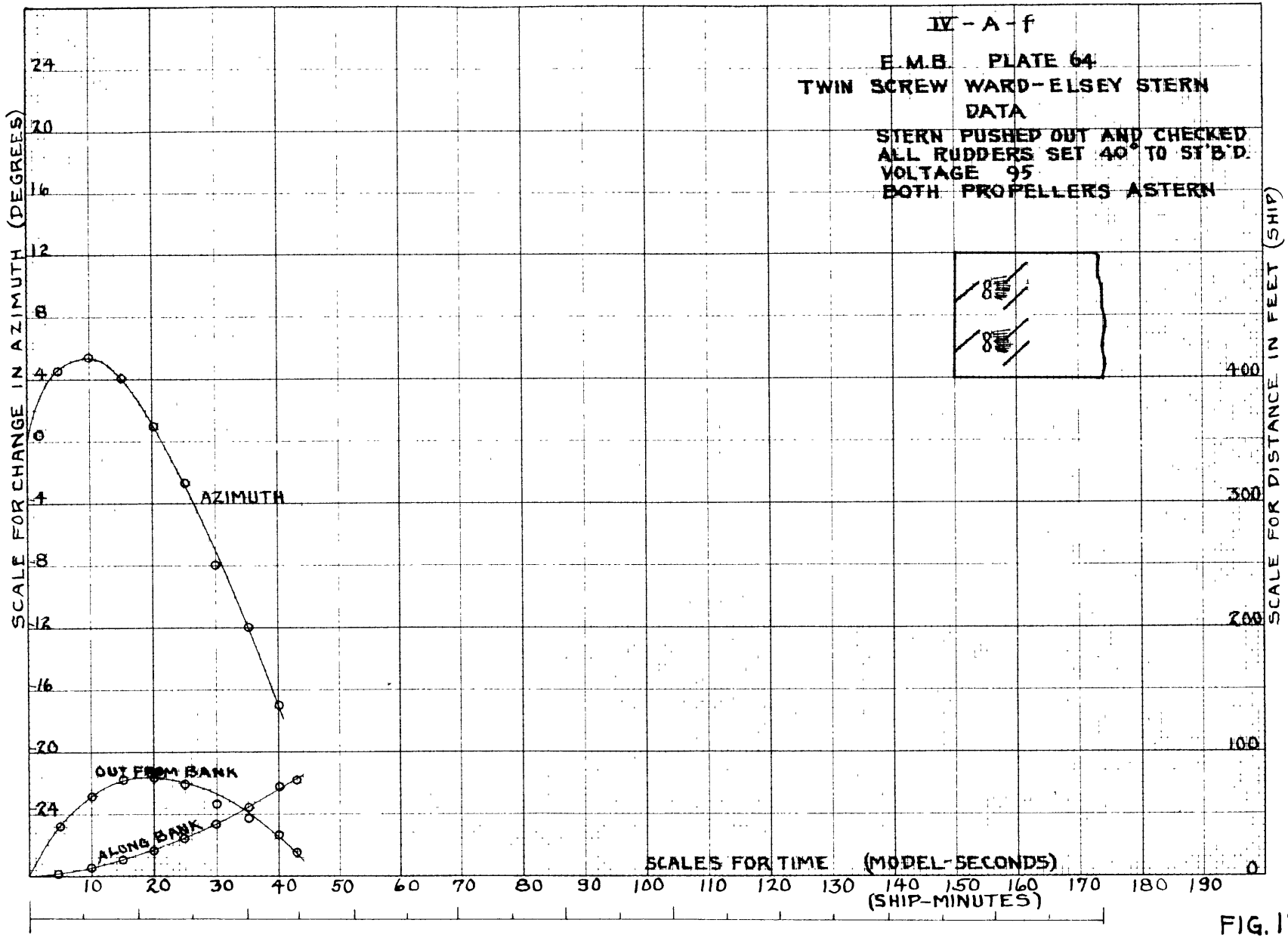

IV - A - f
E.M.B. PLATE 64
TWIN SCREW WARD-ELSEY STERN
DATA
STERN PUSHED OUT AND CHECKED
ALL RUDDERS SET 40° TO ST'B'D.
VOLTAGE 95
BOTH PROPELLERS ASTERN
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
AZIMUTH
OUT FROM BANK
ALONG BANK
SCALES FOR TIME (MODEL-SECONDS)
(SHIP-MINUTES)

FIG. 124

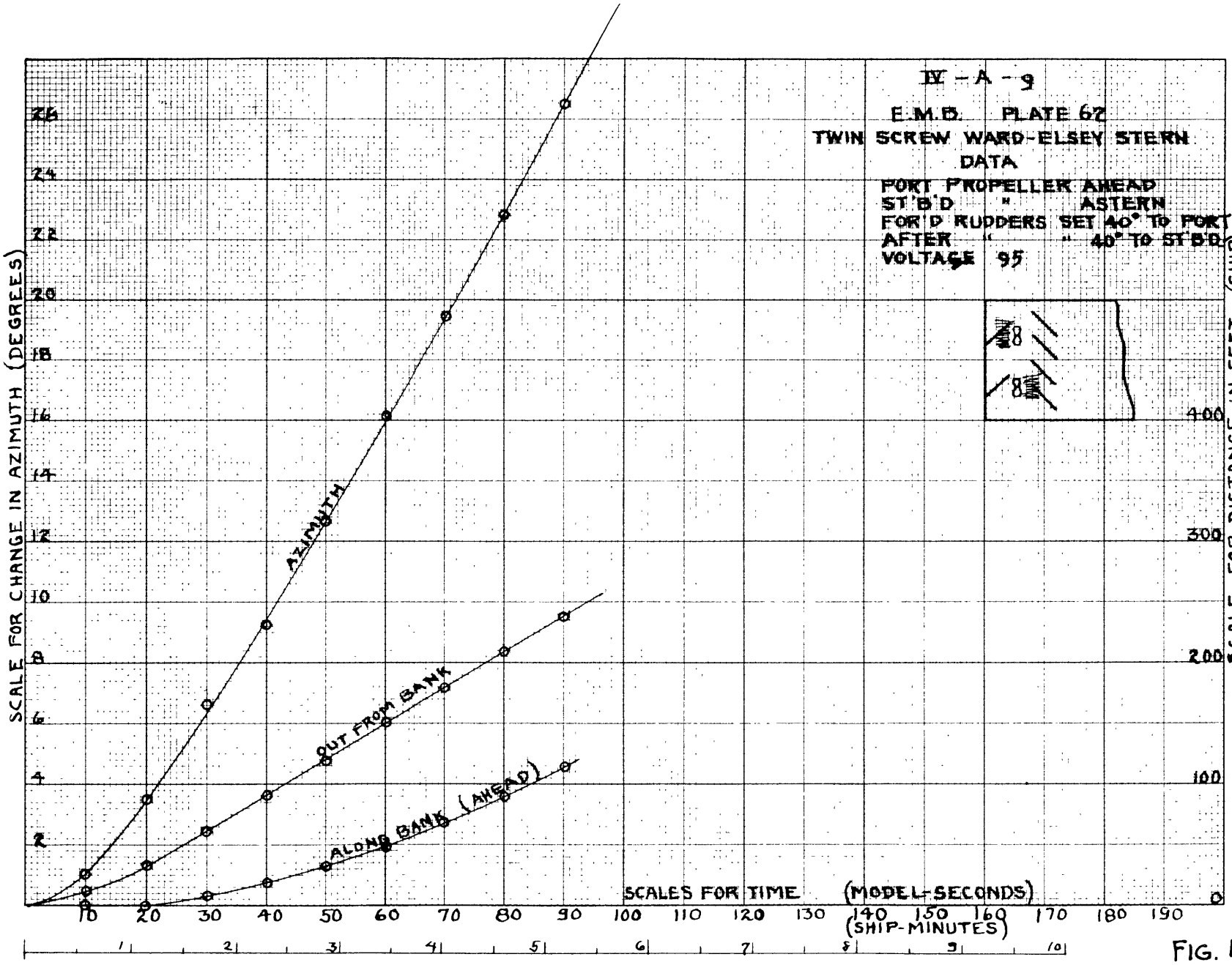

IV - A - 9
E.M.B. PLATE 62
TWIN SCREW WARD-ELSEY STERN
DATA
PORT PROPELLER AHEAD
ST'B'D " ASTERN
FOR'D RUDDERS SET 40° TO PORT
AFTER " " 40° TO ST'B'D.
VOLTAGE 95
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
AZIMUTH
OUT FROM BANK
ALONG BANK (AHEAD)
SCALES FOR TIME (MODEL-SECONDS)
(SHIP-MINUTES)

FIG. 125

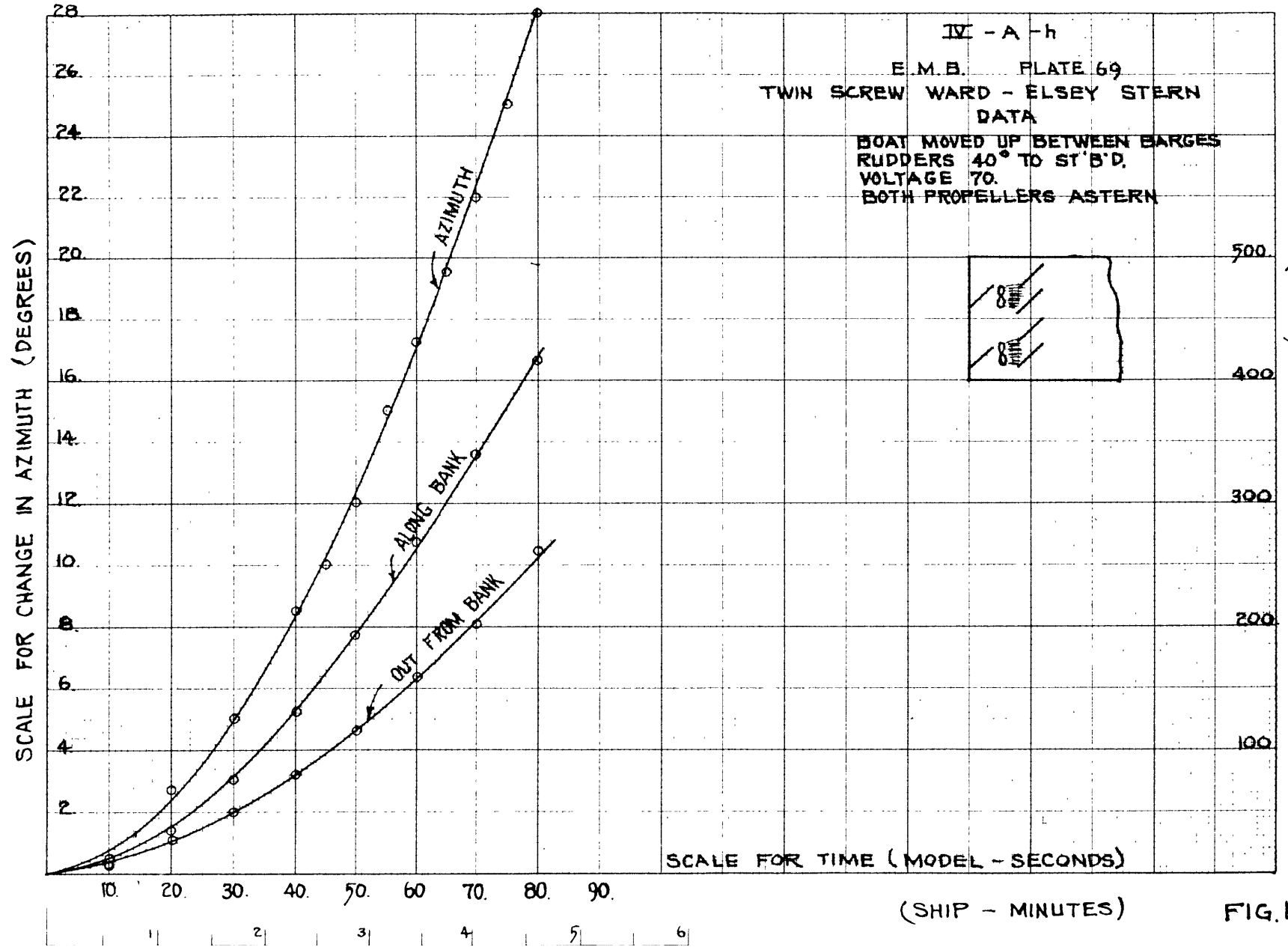

IV - A - h
E.M.B. PLATE 69
TWIN SCREW WARD - ELSEY STERN
DATA
BOAT MOVED UP BETWEEN BARGES
RUDDERS 40° TO ST'B'D.
VOLTAGE 70.
BOTH PROPELLERS ASTERN
AZIMUTH
ALONG BANK
OUT FROM BANK
SCALE FOR CHANGE IN AZIMUTH (DEGREES)
SCALE FOR DISTANCE IN FEET (SHIP)
SCALE FOR TIME (MODEL - SECONDS)
(SHIP - MINUTES)
28
26
24
22
20
18
16
14
12
10
8
6
4
2
500
400
300
200
100
10
20
30
40
50
60
70
80
90
1
2
3
4
5
6

FIG. 126

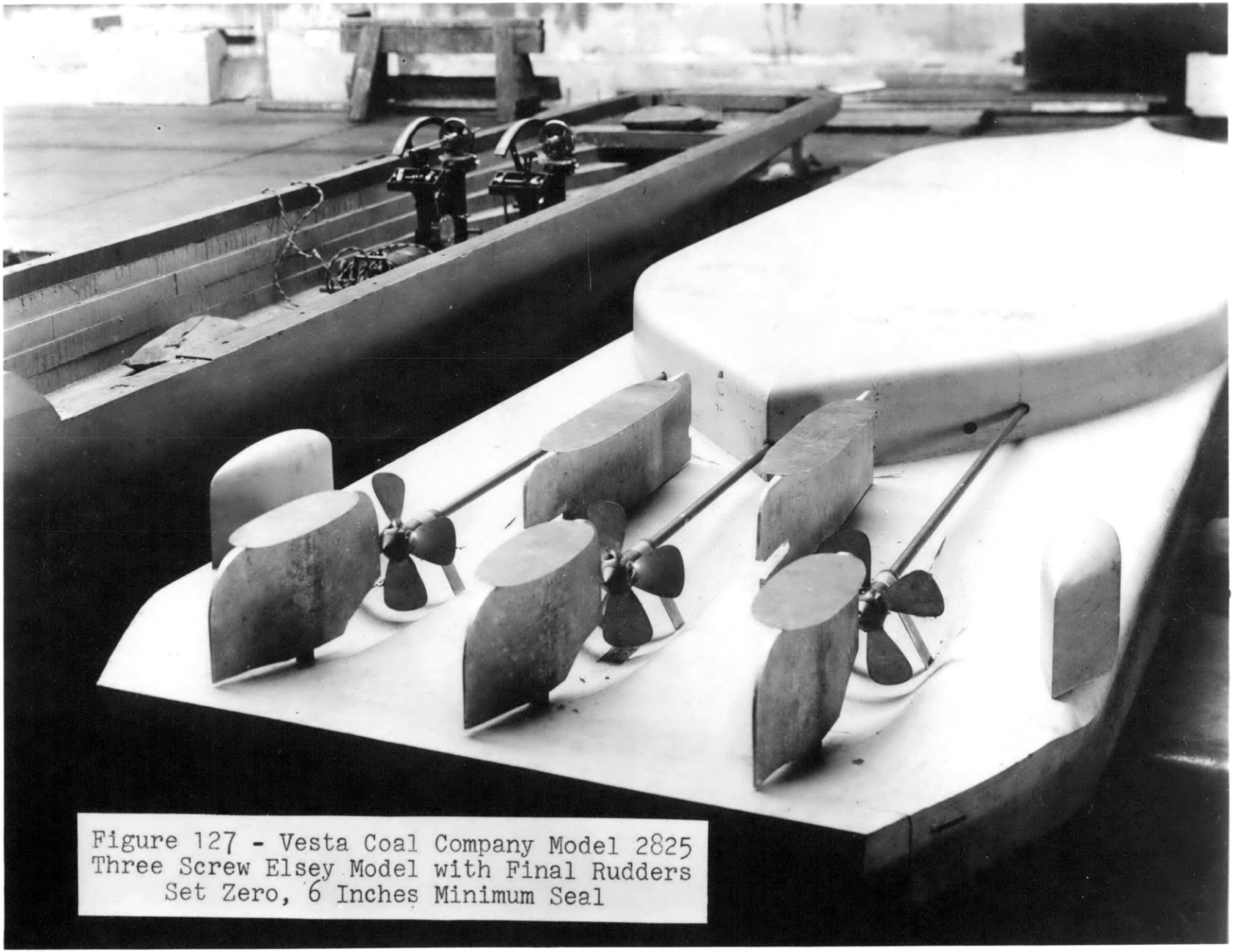


Figure 127 - Vesta Coal Company Model 2825
Three Screw Elsey Model with Final Rudders
Set Zero, 6 Inches Minimum Seal

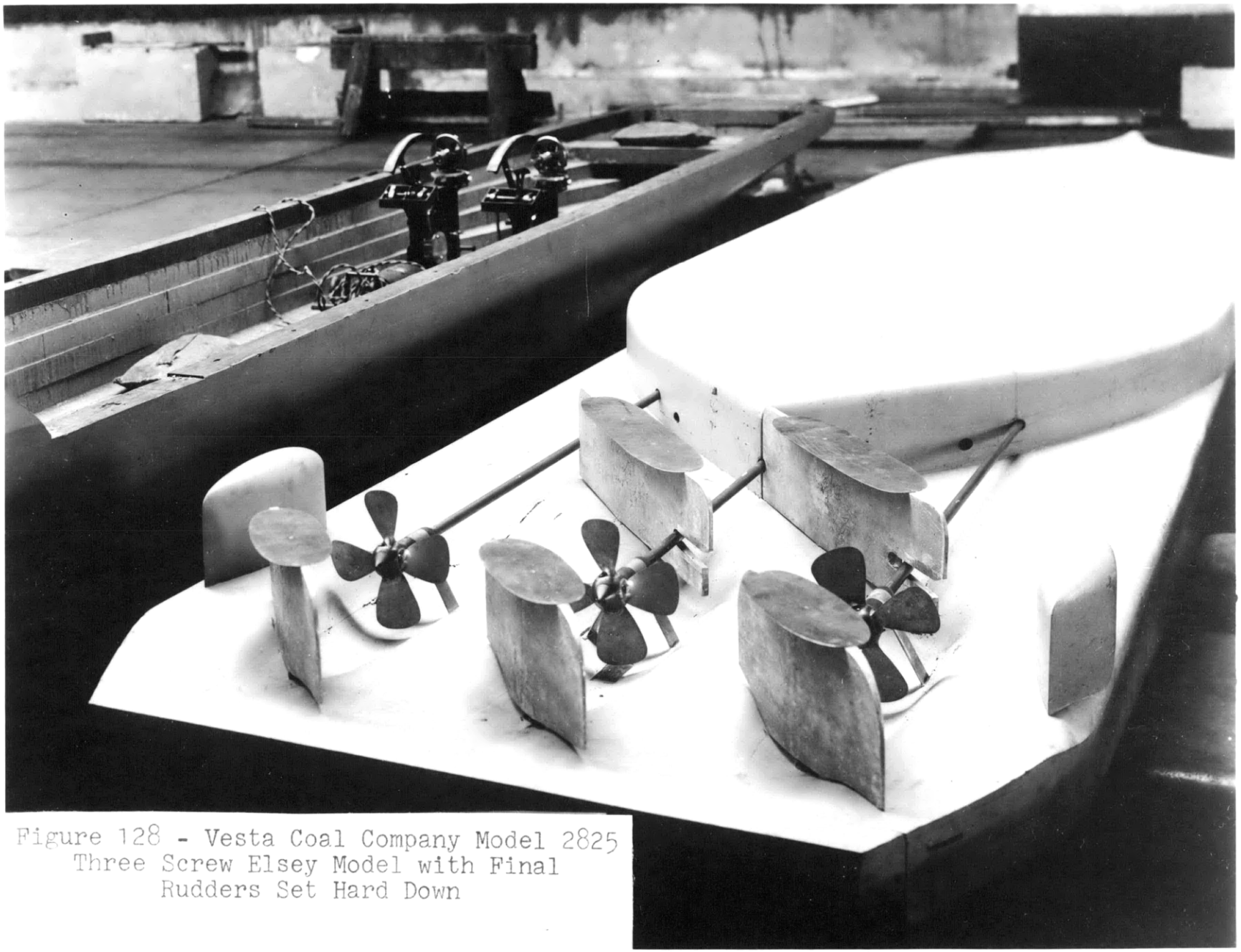


Figure 128 - Vesta Coal Company Model 2825
Three Screw Elsey Model with Final
Rudders Set Hard Down

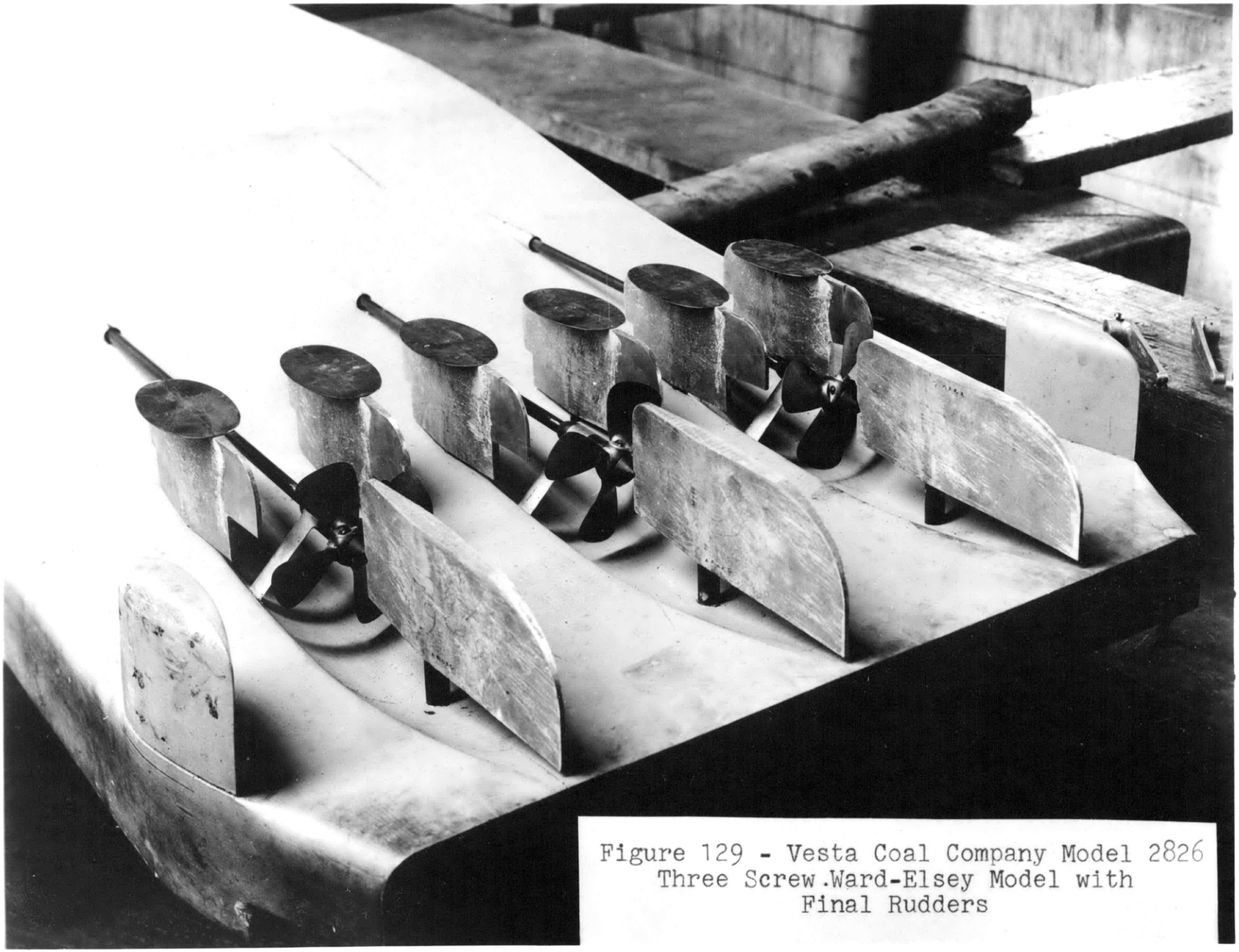


Figure 129 - Vesta Coal Company Model 2826
Three Screw.Ward-Elsey Model with
Final Rudders

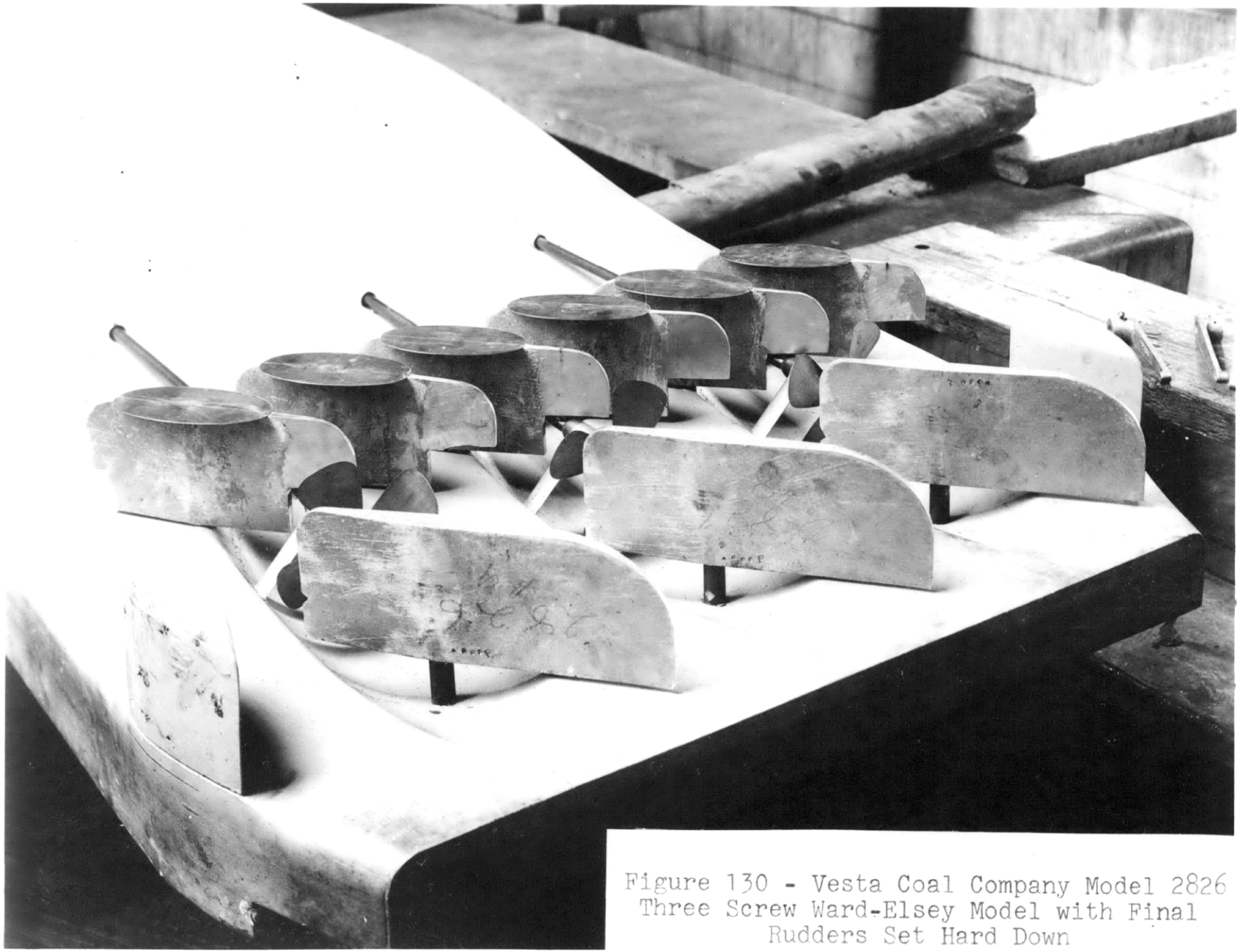


Figure 130 - Vesta Coal Company Model 2826
Three Screw Ward-Elsey Model with Final
Rudders Set Hard Down

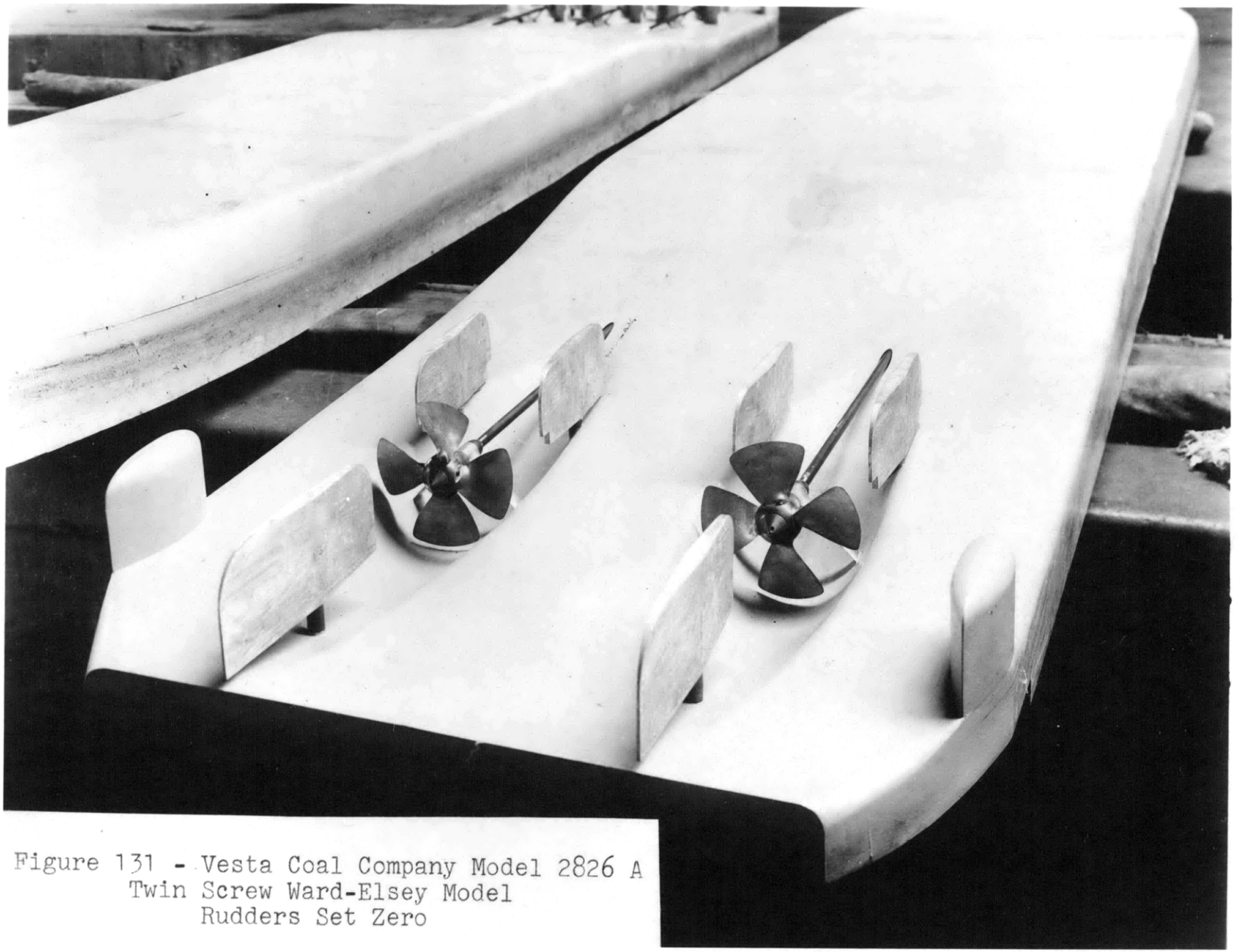


Figure 131 - Vesta Coal Company Model 2826 A
Twin Screw Ward-Elsey Model
Rudders Set Zero

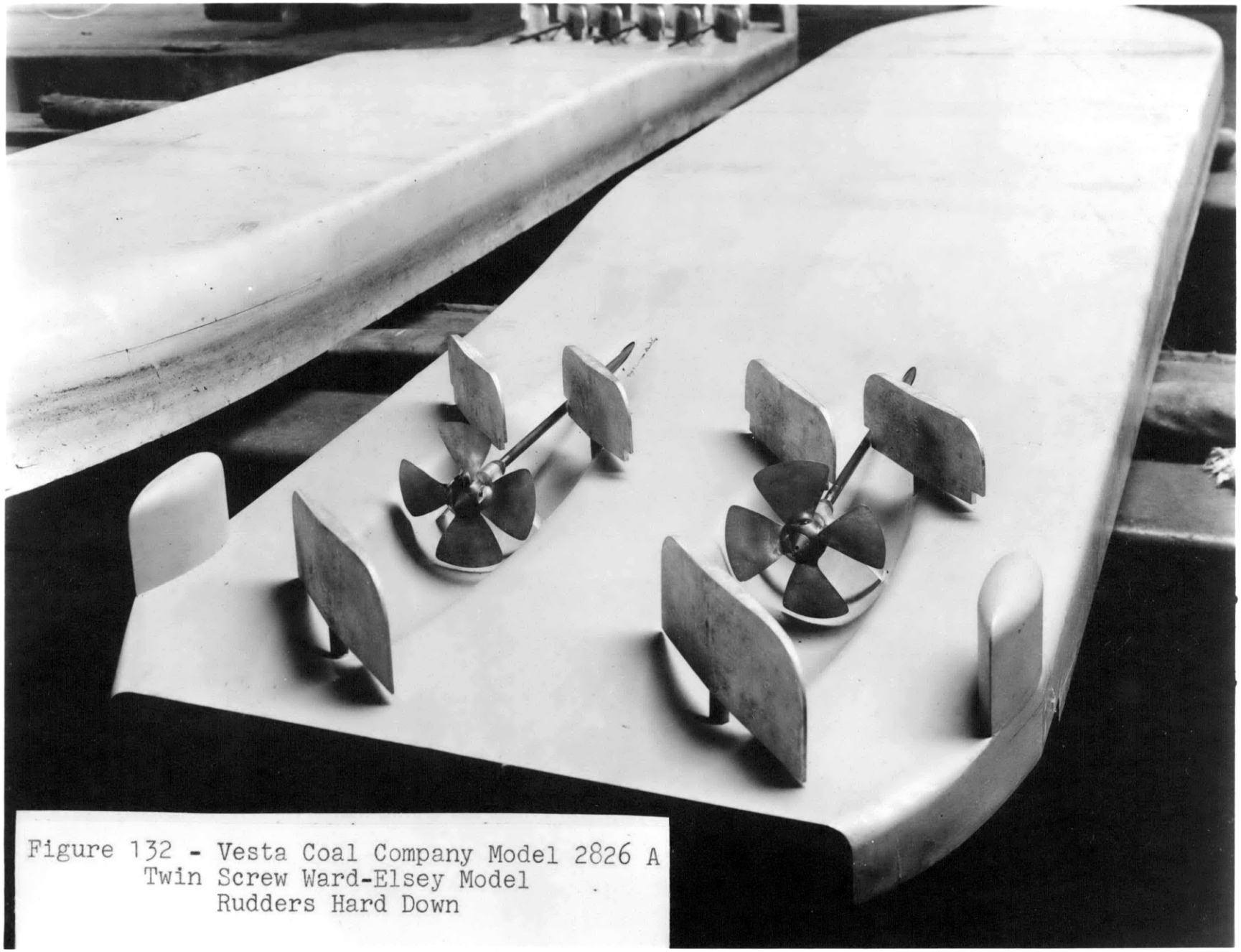


Figure 132 - Vesta Coal Company Model 2826 A
Twin Screw Ward-Elsey Model
Rudders Hard Down

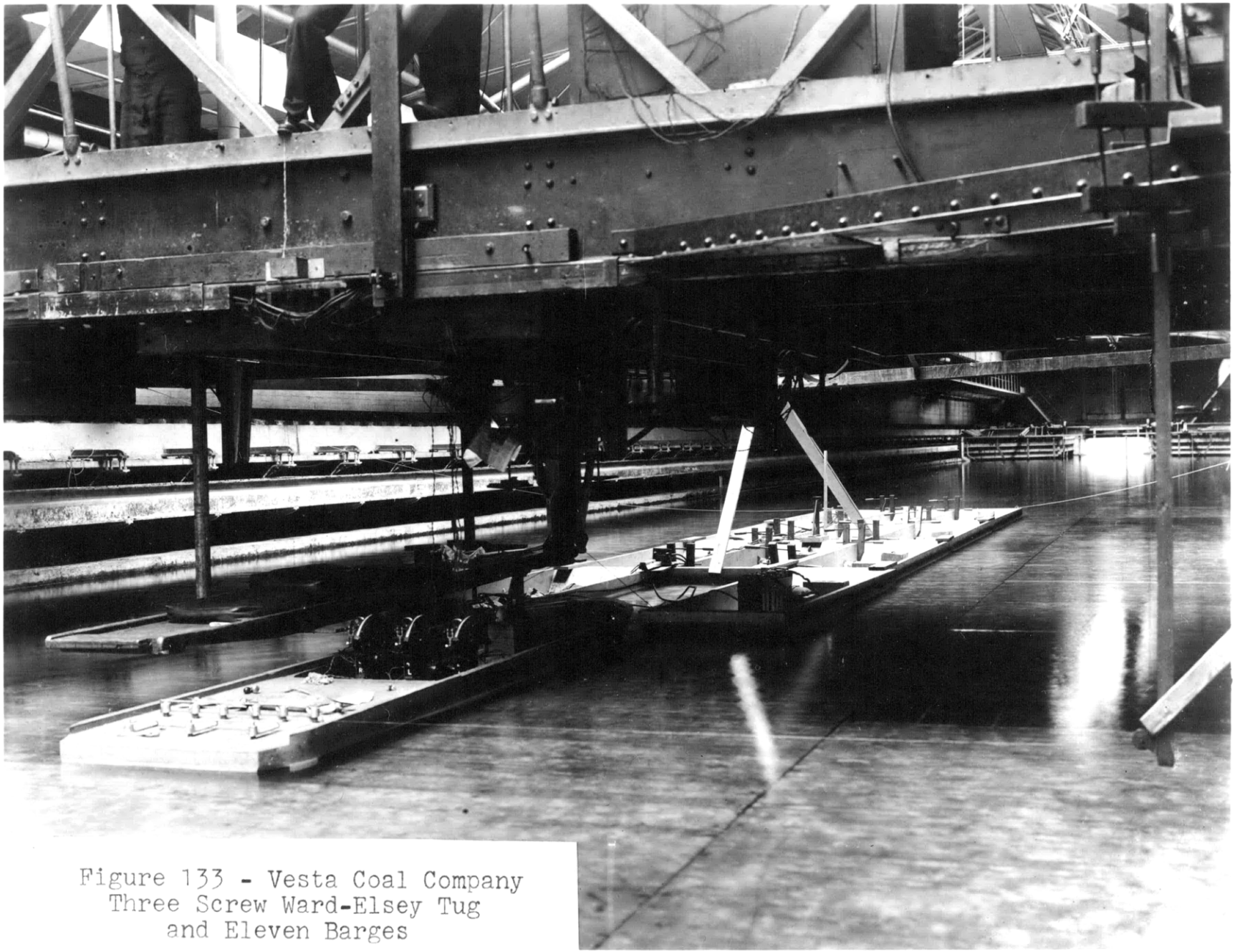


Figure 133 - Vesta Coal Company
Three Screw Ward-Elsey Tug
and Eleven Barges

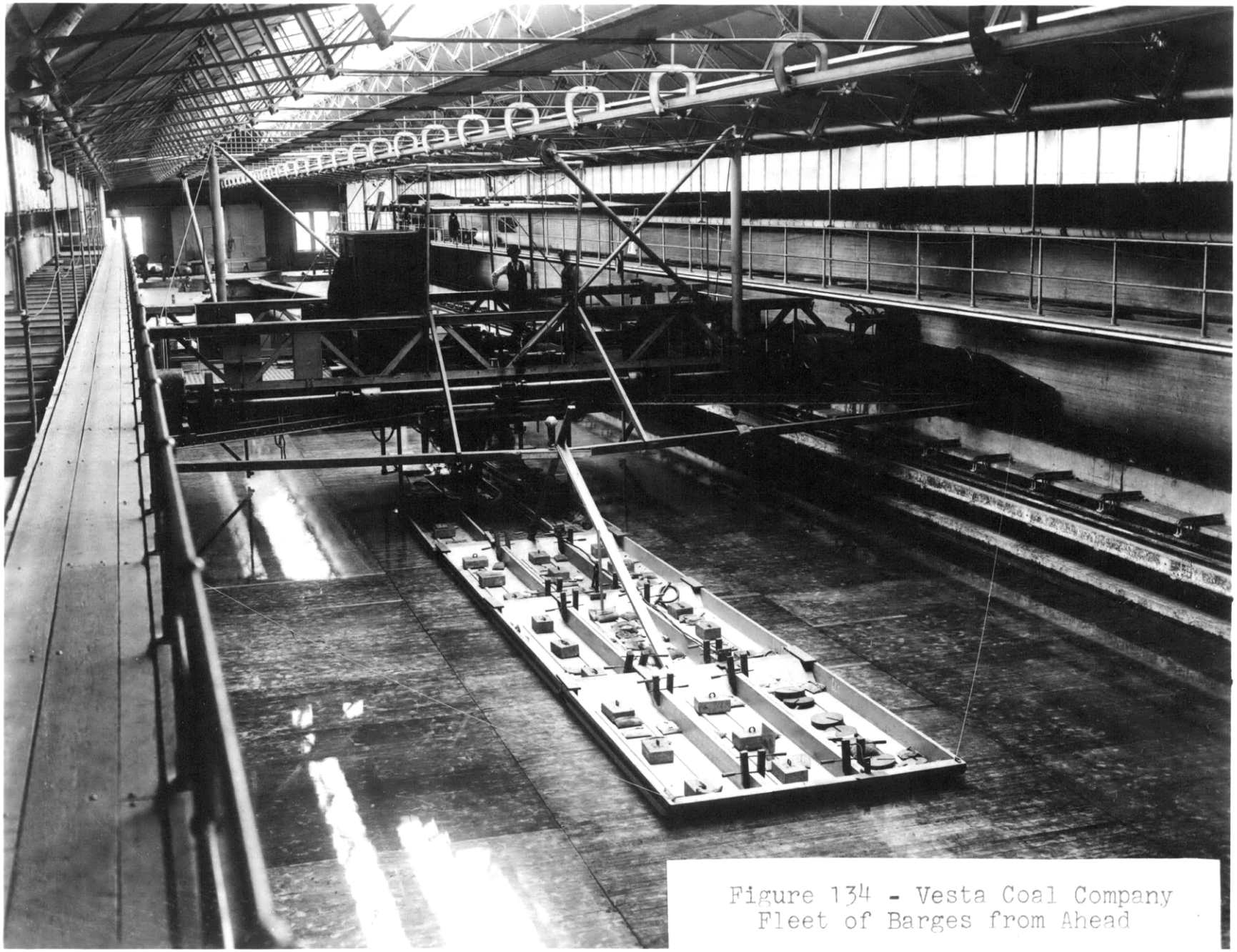


Figure 134 - Vesta Coal Company
Fleet of Barges from Ahead

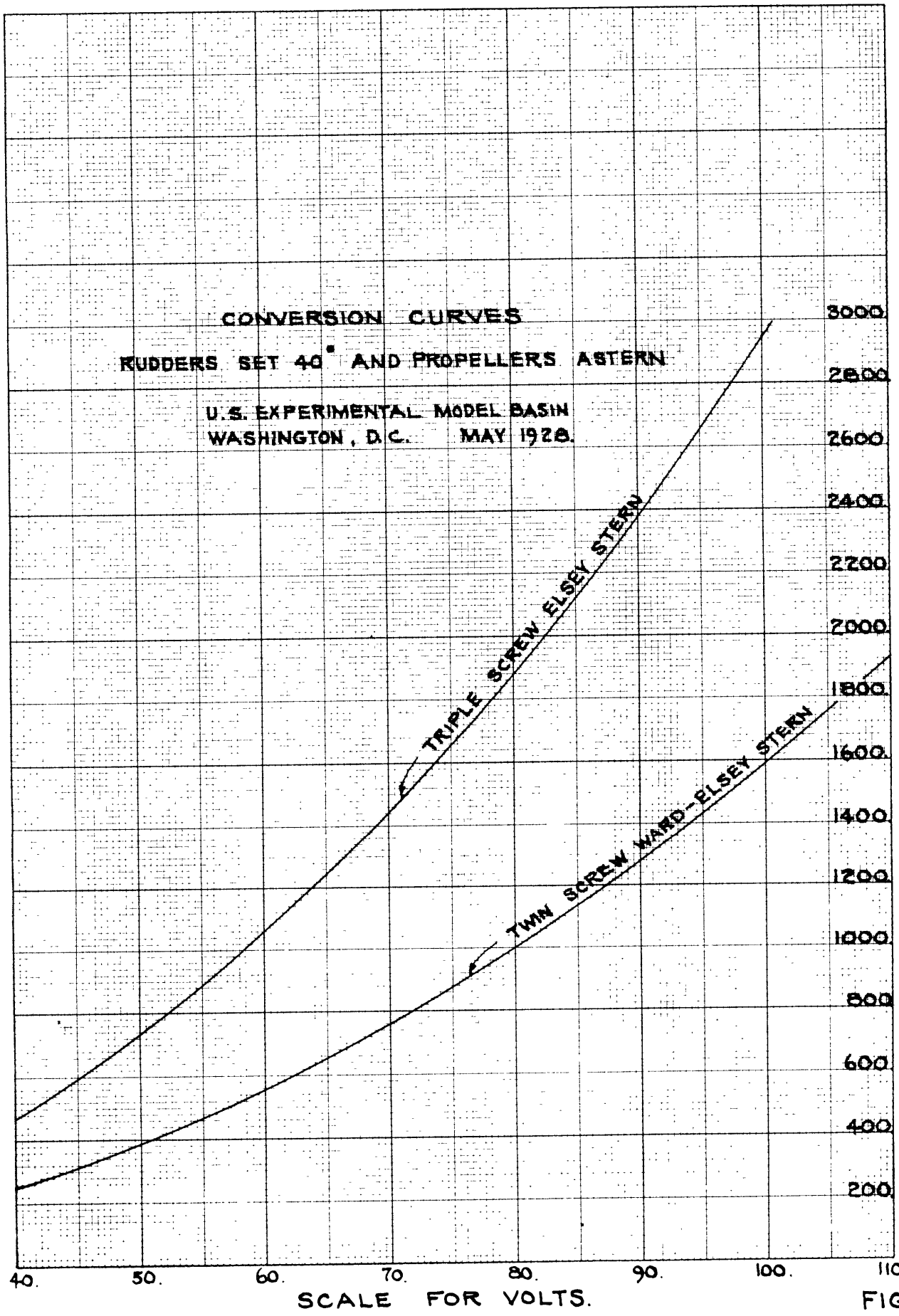

CONVERSION CURVES
RUDDERS SET 40° AND PROPELLERS ASTERN
U.S. EXPERIMENTAL MODEL BASIN
WASHINGTON, D.C. MAY 1928.
TRIPLE SCREW ELSEY STERN
TWIN SCREW WARD-ELSEY STERN
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
SCALE FOR SHAFT HORSE POWER
40.
50.
60.
70.
80.
90.
100.
110.
SCALE FOR VOLTS.

FIG 1