UNITED STATES

EXPERIMENTAL MODEL BASIN

NAVY YARD, WASHINGTON, D.C.

COMPARATIVE TESTS OF CONDENSER SCOOPS
FOR
DESTROYERS 364-379

FROM TESTS ON MODEL NO. 3293

EXPERIMENTAL MODEL BASIN
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INTRODUCTION

A series of tests was run on Model No. 3293 representing Destroyers Nos. 364-379 to determine the relative merits of two different designs of condenser scoops prepared by Gibbs and Cox, Inc.[1] and the Westinghouse Electric and Mfg. Co.[2] respectively. The Gibbs and Cox design was of the standard type of the Bureau of Engineering with an intake scoop having a lip projecting beyond the shell of the ship to increase the pressure at the intake. The Westinghouse design dispensed with this lip, having an intake flush with the ship's skin, and relied instead on a lip on the discharge scoop to provide an increased suction at the outlet.

METHODS AND APPARATUS

The model was fitted in turn with scoops of each design carefully made to scale. The intake and discharge on one side were connected by a copper elbow, 1-21/32" inside diameter, in which was fitted a special current meter[3] built at the Experimental Model Basin, while the scoops on the other side were blanked off. Orifice discs of varying sizes were mounted in the elbow close to the discharge scoop. behind the current meter in the line of flow, to provide different back pressures, simulating the effect of a condenser in the line of flow. Fig. 1 shows the assembly of the current meter in the elbow and three of the four orifice discs used with the dimensions of these discs, and the parts disassembled are shown in Fig. 2. In Fig. 3 may be seen the assembly as mounted in the model, ready for test.

The procedure consisted of making a group of runs at regular increments of model speed, taking measurements of the current meter r.p.m., the model resistance, and of the drop in static pressure between scoop inlet and outlet by means of water manometers. The pressure connections were made to small copper tubes run in at right angles to the walls of the scoops, which can be seen in Fig. 3.

After the tests were completed, the current meter was calibrated by the arrangement diagrammatically shown in Fig. 4. The copper elbow was removed from the model and mounted on the storage tank with the current meter in place, in the same position as on the model. Various heads of water were set in the storage tank, and the rate of discharge for each head was determined by weighing the water over an interval of time. The current meter operating an electric contact at intervals of ten revolutions, was connected to a pen on a chronograph, so that the

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1 For details, see U.D.D.Dwg. No. 3645-S-46-1-1, Gibbs and Cox, Inc.

2 For details, see Dwg. No. 305727-B-4, Westinghouse Elec. and Mfg. Co.

3 For details of current meter, see Exp. Model Basin Plans A-1132 and A-1133.

revolutions could be counted for this interval of time, and the r.p.m. computed. Fig. 5 shows the curve obtained by plotting the discharge in gallons per minute against r.p.m.

By this method of calibration the distribution of velocities in the section of the elbow at the current meter was kept sensibly the same as in the model, so that the rate of flow through the scoop for a given r.p.m. of the meter can be taken directly off the calibration curve.

DISCUSSION OF RESULTS

In Fig. 6 the curves of flow, converted to ship scale, are plotted against ship speed. The conversion factor used for the flow is $\lambda^{5/2}$ where λ= linear ratio of ship to model, which relation may be readily derived as follows:

$$\frac{\text{ship flow}}{\text{model flow}} = \frac{AV}{av}$$

where A = cross-sect. area of ship scoop
a = cross-sect. area of model scoop
V = average velocity through ship scoop
v = " " " model scoop

But $A = \lambda^2 a$

and assuming that the same conditions of similarity hold for the flow through the scoops as for the flow about the ship,

$$V = \lambda^{1/2} v$$

Therefore ship flow = $\lambda^2 \times \lambda^{1/2}$ x model flow = $\lambda^{5/2}$ x model flow

As $\lambda = 167$, $\lambda^{5/2} = 1139$

The assumption as to the conditions of similarity for the flow is probably fairly close to the truth, but needs checking against full-scale tests. As no such data are as yet available, the quantitative results presented here must be treated with caution. However, the curves of Fig. 6 probably provide a reliable relative comparison of the two scoops, especially as they are quite consistent in indicating a somewhat higher flow through the Gibbs and Cox scoop than through the Westinghouse design under similar conditions.

Fig. 7 is a plot of the pressures measured at intake and discharge with the scoops blanked off;[4] that is, under a condition of zero flow. The Westinghouse scoop shows an increase in suction at the discharge in accordance with expectations, but the loss in pressure at the intake is considerably larger than this gain in suction. As a result the total difference in pressures, which may be taken as a rough measure of the total head available to force water through the scoop, shows a decided advantage for the Gibbs and Cox design. This is right in

4 The pressure heads on the ship were obtained by multiplying the measured heads on the model by $\lambda^{(=16.7)}$ as the heads of water are directly proportional to the scale ratio.

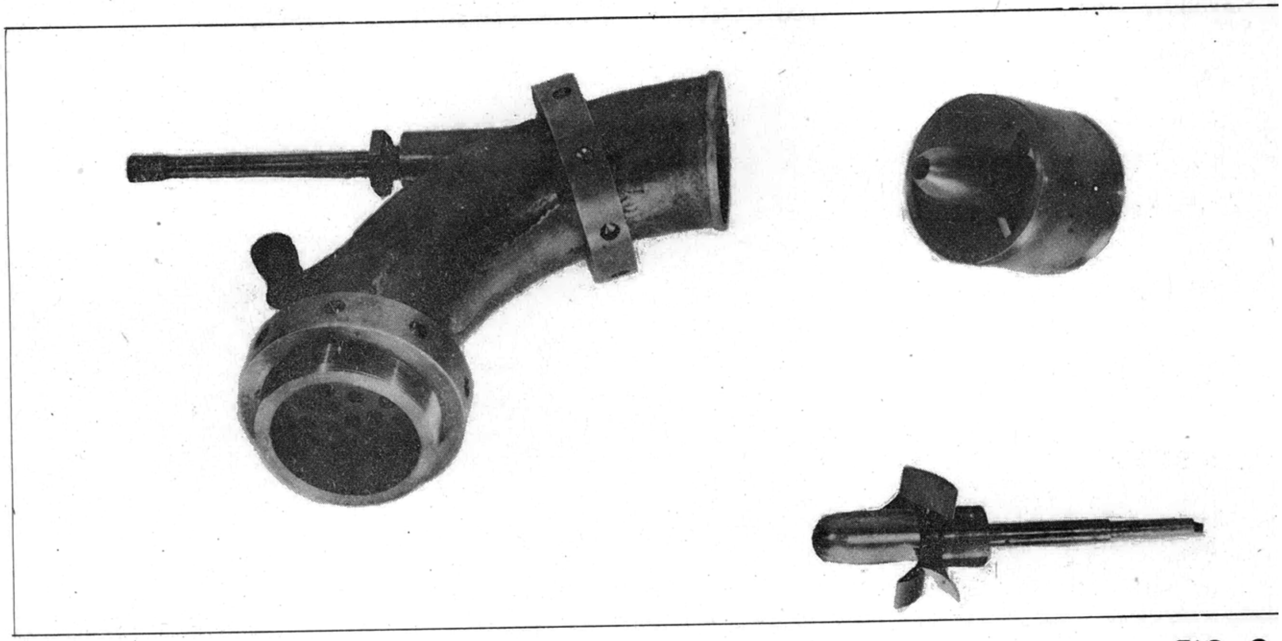
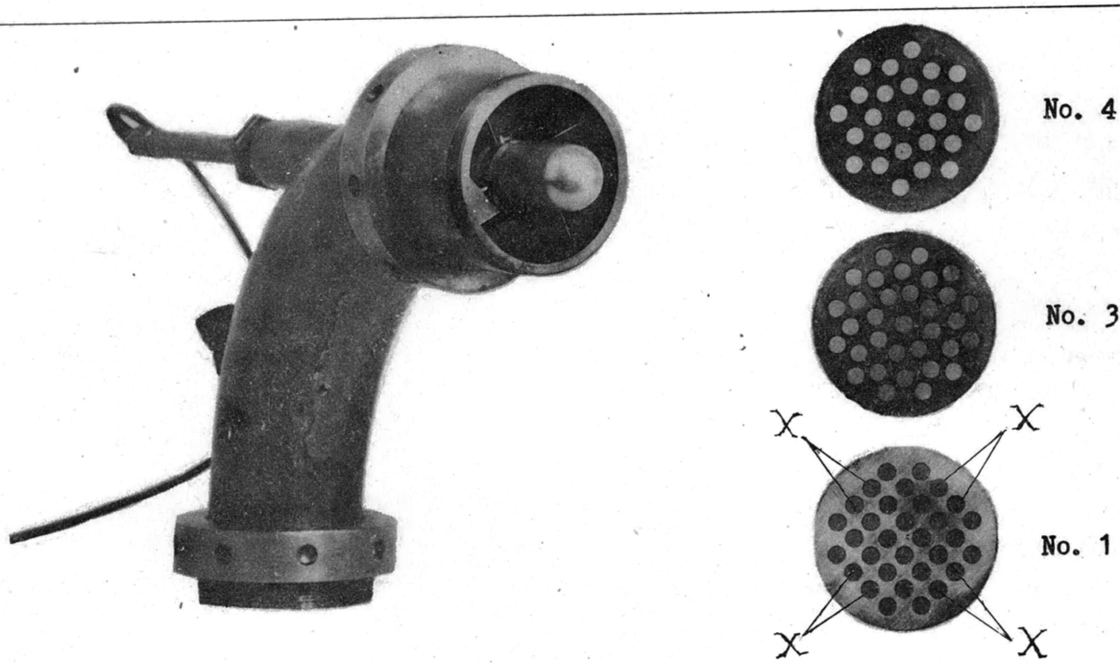


FIG. 2



ORIFICE DISCS

No. 1–32 Holes – Rectangular Spacing
2–24 " – (Same as No. 1 with Holes Marked X Plugged)
3–33 " – Radial Spacing
4–25 " – " "

All Holes 3/16" Dia.

All Discs 1 15/16" Dia. by 3/64" Thick

FIG. 1

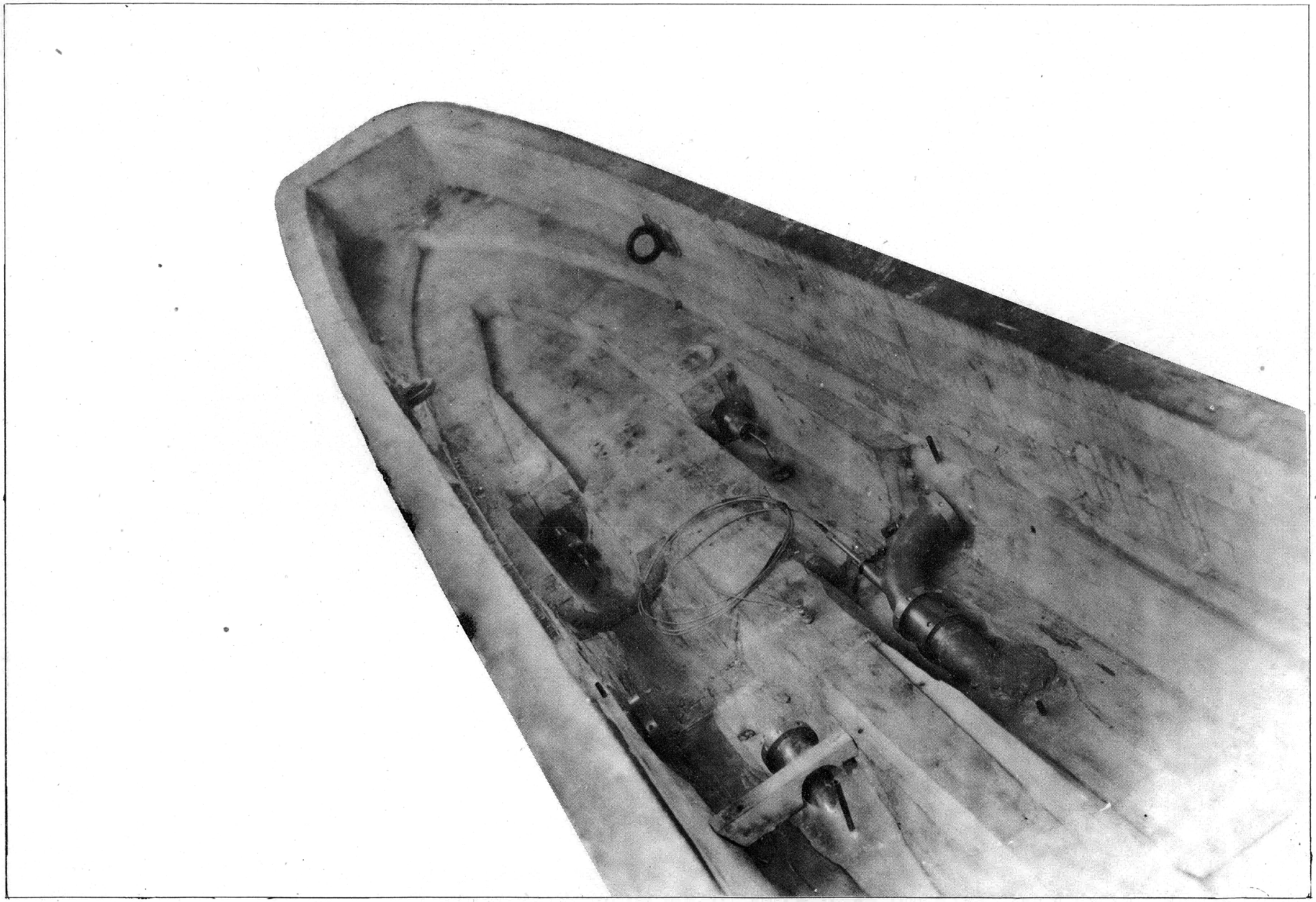


FIG. 3

line with the results on the flow measurements discussed previously.

In Fig. 8 the total pressure differences measured at the same time the flow measurements were being taken are plotted. These curves are not as consistent as those of flow, due chiefly to the difficulty of securing accurate manometer readings, but in general they agree with the previous results, showing a higher pressure drop for the Gibbs and Cox design under similar conditions.

Lastly, the effective horsepower curves as computed from the resistance measurements are plotted in Fig. 9. No appreciable difference could be detected between the two scoops and both show a rise of about 5% in the E.H.P. over the model without scoops, within the range of the experiments.

Both designs of scoops have projecting lips, and in order to determine the effect of these on the resistance a further series of resistance tests were run with the model fitted with scoops having both intake and discharge flush with the ship's skin. The following table summarizes all the scattered tests.

	% Increase in Model Resistance	
	Scoops blanked off	Water Flowing through Scoops
Flush type–intake normal to ship's skin	0	0
Flush type–intake inclined to ship's skin	0–½	4–5
Inlet or Outlet lipped	2–4	6–8

(Outlet normal to ship's skin in all cases)

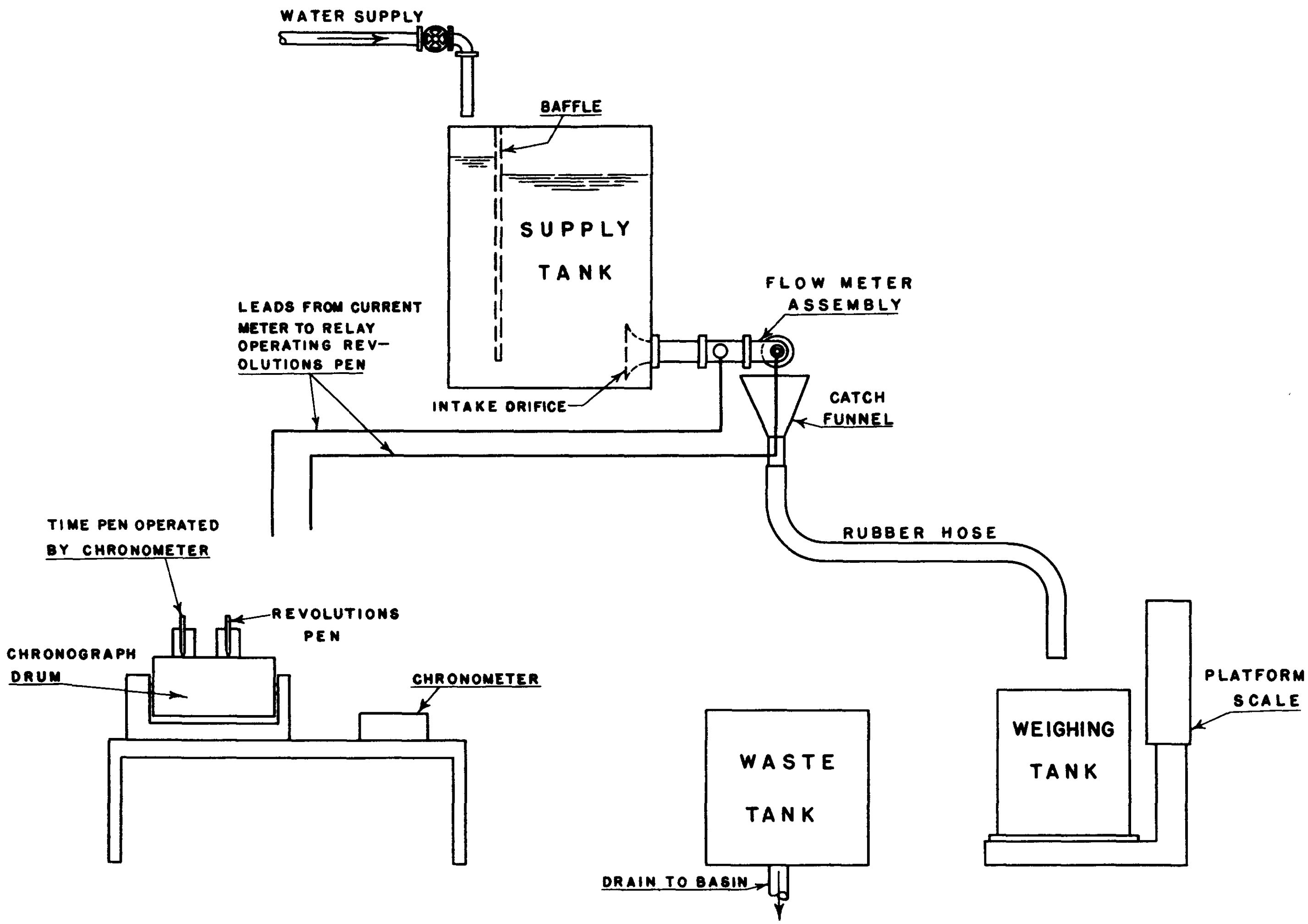


FIG.4 — DIAGRAM OF APPARATUS FOR CALIBRATION OF FLOW METER

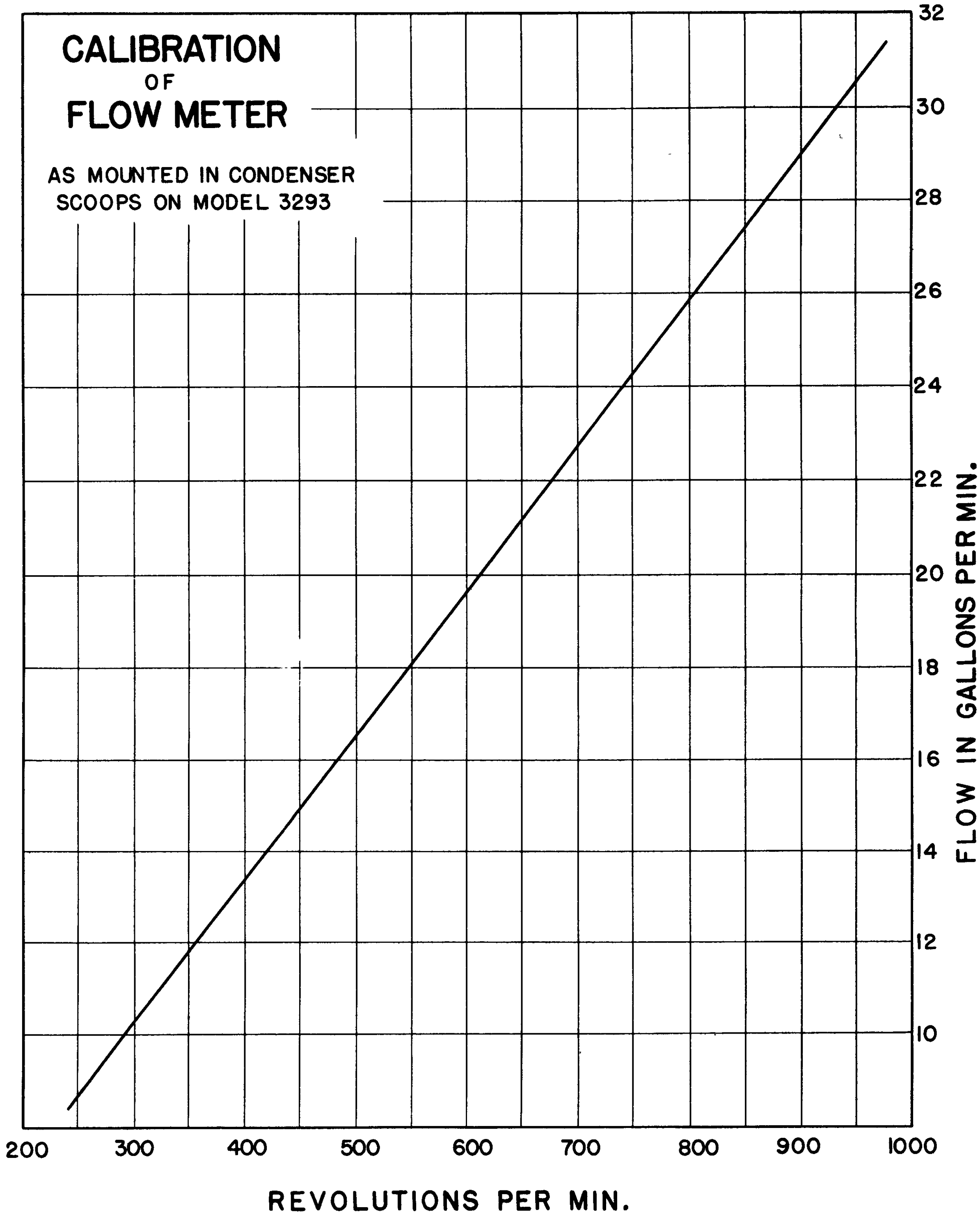

CALIBRATION
OF
FLOW METER
AS MOUNTED IN CONDENSER
SCOOPS ON MODEL 3293
32
30
28
26
24
22
20
18
16
14
12
10
FLOW IN GALLONS PER MIN.
200
300
400
500
600
700
800
900
1000
REVOLUTIONS PER MIN.

FIG. 5

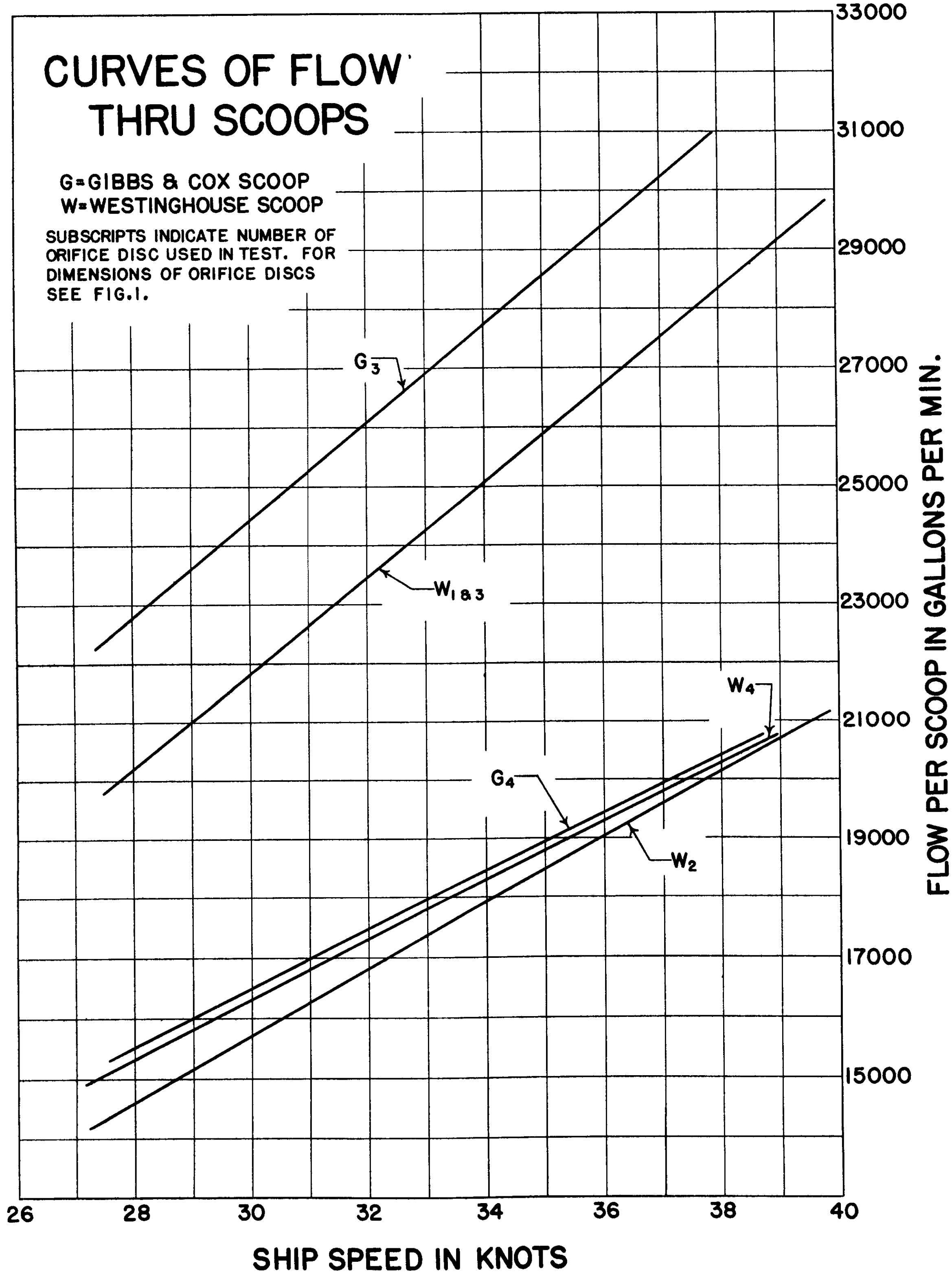

CURVES OF FLOW THRU SCOOPS
G=GIBBS & COX SCOOP
W=WESTINGHOUSE SCOOP
SUBSCRIPTS INDICATE NUMBER OF ORIFICE DISC USED IN TEST. FOR DIMENSIONS OF ORIFICE DISCS SEE FIG.1.
G3
W1 & 3
W4
G4
W2
33000
31000
29000
27000
25000
23000
21000
19000
17000
15000
FLOW PER SCOOP IN GALLONS PER MIN.
26
28
30
32
34
36
38
40
SHIP SPEED IN KNOTS

FIG. 6

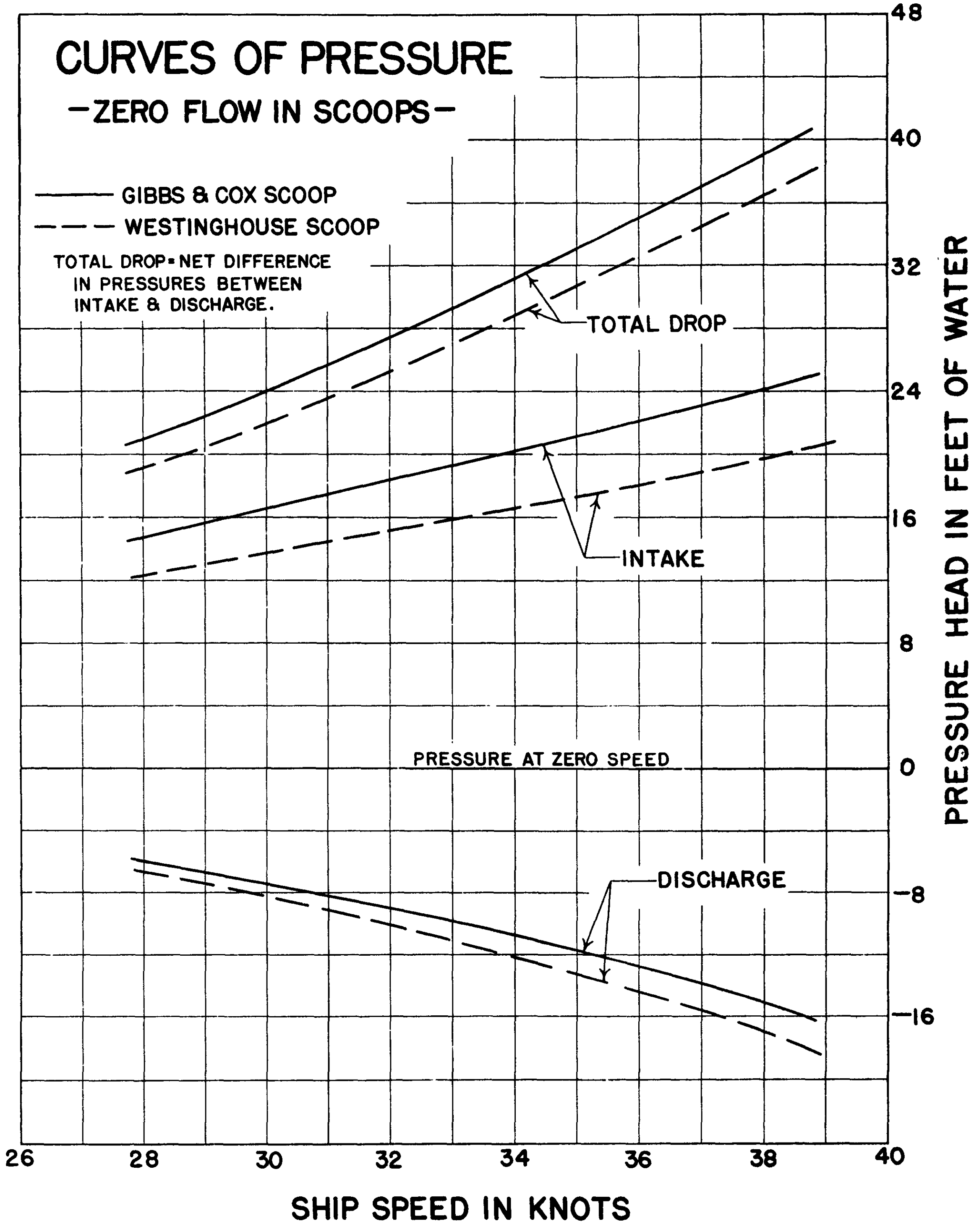

CURVES OF PRESSURE
-ZERO FLOW IN SCOOPS-
GIBBS & COX SCOOP
WESTINGHOUSE SCOOP
TOTAL DROP=NET DIFFERENCE IN PRESSURES BETWEEN INTAKE & DISCHARGE.
TOTAL DROP
INTAKE
PRESSURE AT ZERO SPEED
DISCHARGE
48
40
32
24
16
8
0
-8
-16
PRESSURE HEAD IN FEET OF WATER
26
28
30
32
34
36
38
40
SHIP SPEED IN KNOTS

FIG. 7

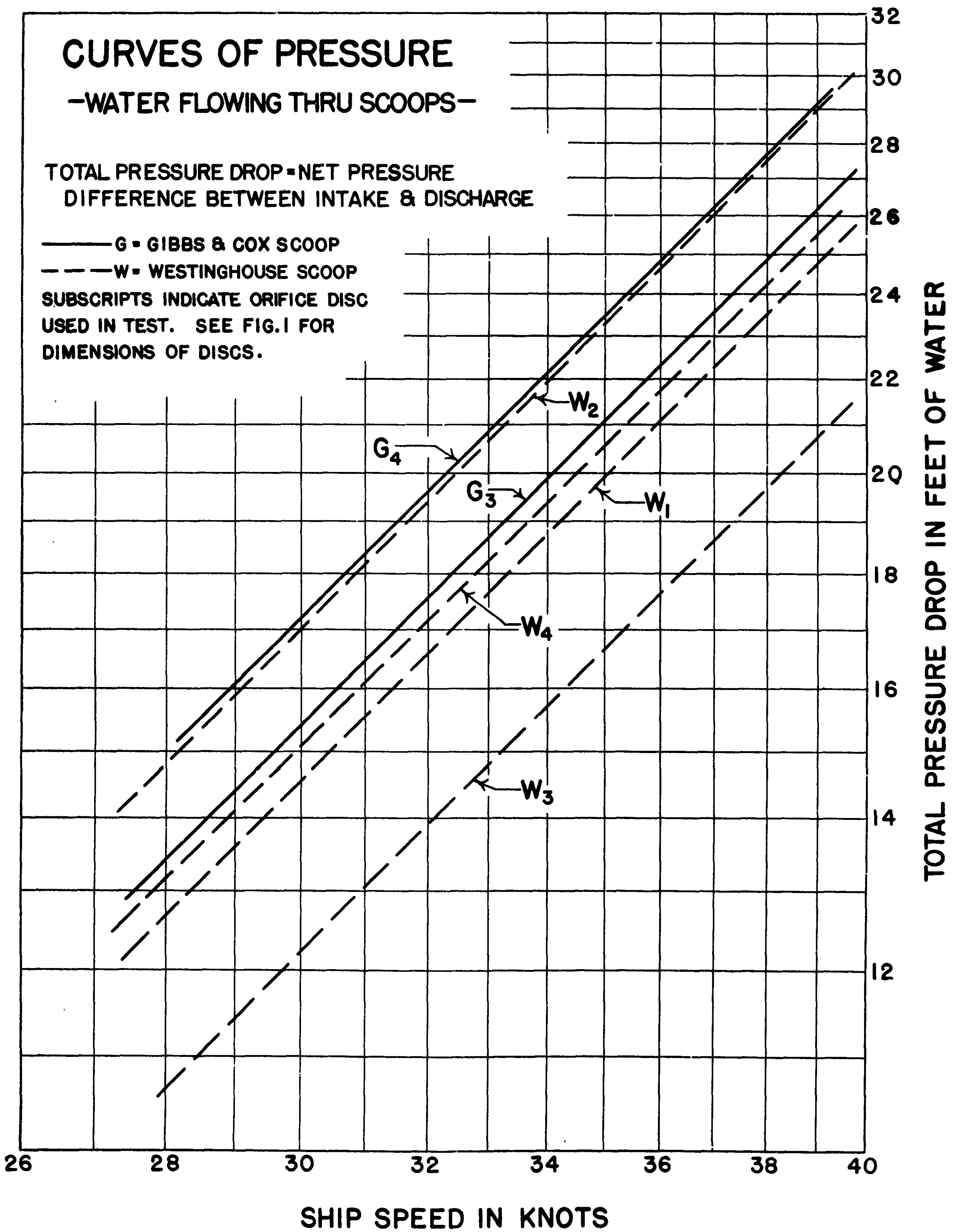

CURVES OF PRESSURE
-WATER FLOWING THRU SCOOPS-
TOTAL PRESSURE DROP = NET PRESSURE DIFFERENCE BETWEEN INTAKE & DISCHARGE
G = GIBBS & COX SCOOP
W = WESTINGHOUSE SCOOP
SUBSCRIPTS INDICATE ORIFICE DISC USED IN TEST. SEE FIG. I FOR DIMENSIONS OF DISCS.
W2
G4
G3
W1
W4
W3
32
30
28
26
24
22
20
18
16
14
12
TOTAL PRESSURE DROP IN FEET OF WATER
26
28
30
32
34
36
38
40
SHIP SPEED IN KNOTS

FIG. 8

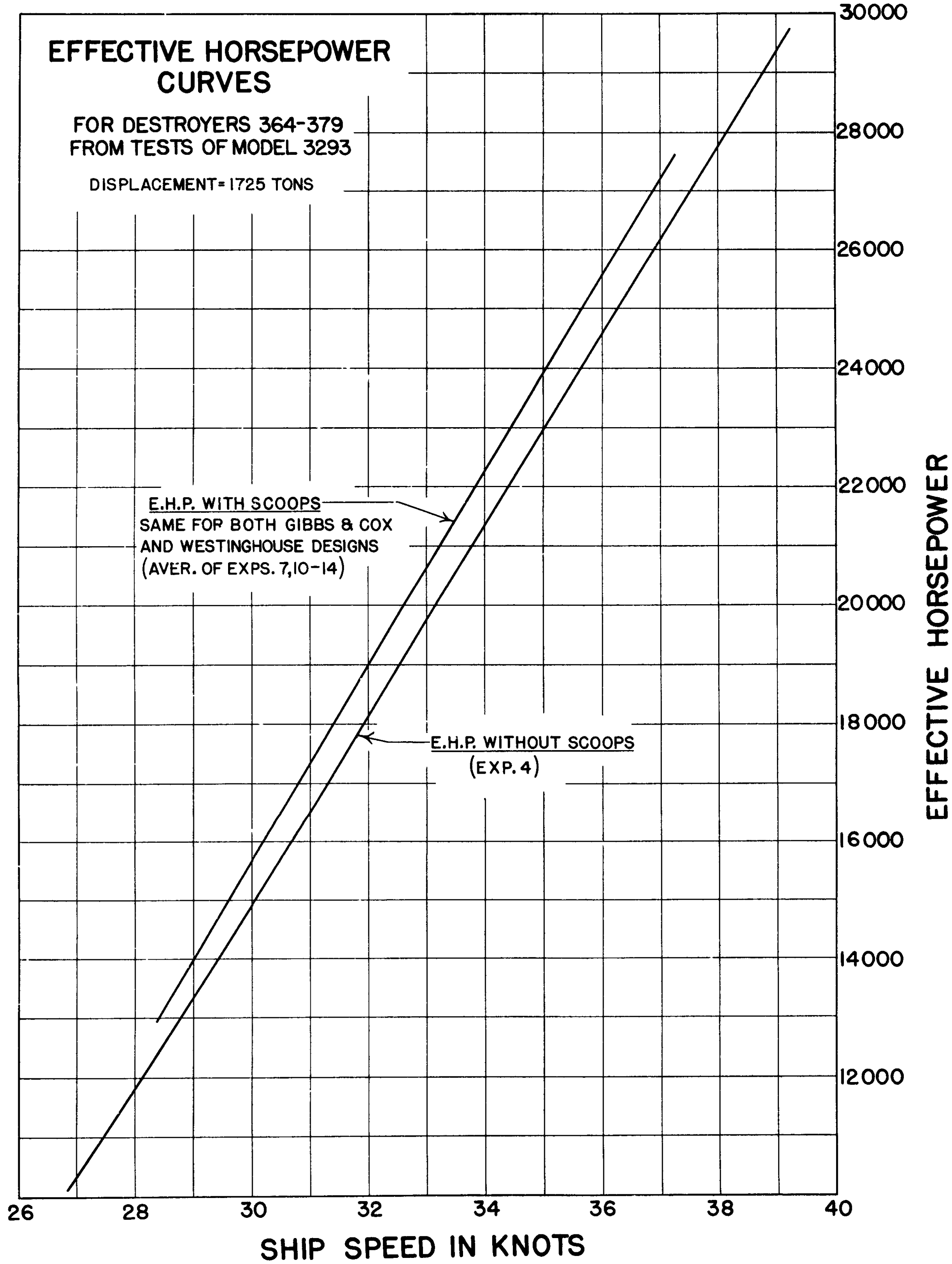

EFFECTIVE HORSEPOWER CURVES
FOR DESTROYERS 364-379
FROM TESTS OF MODEL 3293
DISPLACEMENT=1725 TONS
E.H.P. WITH SCOOPS
SAME FOR BOTH GIBBS & COX
AND WESTINGHOUSE DESIGNS
(AVER. OF EXPS. 7,10-14)
E.H.P. WITHOUT SCOOPS
(EXP. 4)
30000
28000
26000
24000
22000
20000
18000
16000
14000
12000
EFFECTIVE HORSEPOWER
26
28
30
32
34
36
38
40
SHIP SPEED IN KNOTS

FIG. 9