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ADDITIONAL POWER-ON WIND-TUNNEL TESTS OF THE 1/8-SCALE MODEL OF THE BREWSTER F2A AIRPLANE WITH FULL-SPAN SLOTTED FLAPS

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MEMORANDUM REPORT

for the

Bureau of Aeronautics, Navy Department

ADDITIONAL POWER-ON WIND-TUNNEL TESTS OF THE 1/8-SCALE MODEL OF THE BREWSTER F2A AIRPLANE WITH FULL-SPAN SLOTTED FLAPS

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INTRODUCTION

Additional tests as recommended in reference 1 were made in the 7- by 10-foot wind tunnel of the 1/8-scale model of the Brewster F2A airplane to determine the angle of attack of horizontal tail and the elevator angles required for trim with flaps down.

MODEL

The 1/8-scale model of the Brewster F2A airplane with the modified wing and full-span slotted flaps is the same as was used for the tests reported in reference 1. Three-view drawings for the complete model and the modified wing with full-span flaps may be found in references 1 or 2. All the surfaces were set in the manner described in references 1 and 2.

The same electric motor was used as in the previous tests. The propeller used in the subject tests, however, had two blades instead of three or six, and had a 13 percent larger diameter than in the preceding tests. Since the propellers used in the previous tests were 6 percent larger in diameter than the scale size for the prototype, the two-blade propeller was 20-percent oversize in diameter. These larger blades were used since the blades used in the previous tests were no longer available at the 7- by 10-foot wind tunnel.

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TESTS AND RESULTS

The test conditions in this series of tests were the same as described in reference 2.

Coefficients.- The results are given in standard coefficients as described in reference 1. The propeller advance diameter ratio V/nD is based on the two-blade propeller diameter D of 1.54 feet. The same corrections were applied to the test results as were applied in the previous investigation.

Test procedure.- As in the previous tests, propeller calibrations were first made. The two-blade propeller characteristics are presented in figure 1 for $\beta = 20^\circ$. The same procedure was used as described in reference 1 to obtain the operating charts for the model. Figure 3(a) of reference 1 was again used to obtain the prototype thrust coefficients.

For convenience in locating results, a résumé of the tests is given in the following table:

Test No.	Power condition	No. prop. blades	β	δ_f	δ_e	δ_r	i_T	ψ	Type of test	Model condition	Figure
27	-----------	2	20	0	0	0	-0.9	0	Thrust calib.	Complete model	1
28	$\frac{1}{2}$ Rated	2	20	40	0	0	-.9	0	Pitch	-----do-------	2,3,5,6
29	----do-----	2	20	40	0	0	-2.1	0	--do--	-----do-------	5
30	----do-----	2	20	40	-5	0	-.9	0	--do--	-----do-------	3
31	----do-----	2	20	40	-10	0	-.9	0	--do--	-----do-------	3
32	----do-----	2	20	40	0	0	.7	0	--do--	-----do-------	5
33	----do-----	2	20	40	---	--	----	0	--do--	Complete model minus horizontal tail	6
34	Windmilling	2	20	40	0	0	-2.1	0	--do--	Complete model	7
35	----do- ---	2	20	40	0	0	.7	0	--do--	------do-------	7
36	----do-----	2	20	40	---	--	----	0	--do--	Complete model minus horizontal tail	7

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DISCUSSION

Type of propeller.- The effect of changing from the three-blade propeller $(D = 1.36 \text{ ft})$ used in reference 1 with $\beta = 30^\circ$ to the two-blade propeller $(D = 1.54 \text{ ft})$ used in the subject tests with $\beta = 20^\circ$ is shown in figure 2. Changing from the three-blade to the two-blade propeller increased the slope of the pitching-moment-coefficient curve a small amount. The change in the slope of the pitching-moment-coefficient curve is probably caused by a change in the downwash and q distribution at the wing and tail, associated with the change in propellers. The increase in lift may be largely due to a small variation in flap setting and angle of attack. The variation in resultant drag is probably caused by a slight variation in propeller rpm.

Elevator deflection.- The effect of elevator deflections is shown in figure 3 for the model with 1/2 rated power, the flaps deflected, and the landing gear extended. The decrease in longitudinal stability dC_m/dC_L with up-elevator deflection has been found in previous power-on tests made at the 7- by 10-foot wind tunnel. The decrease in dC_m/dC_L with up-elevator deflection is probably the result of the change in the direction of the load on the tail along with the ratio of the change in downwash and dynamic pressure at the tail with increasing angle of attack.

The elevator angles for trim are given in figure 4 for the model with 1/2 rated power, the flaps deflected, and the landing gear extended. These elevator angles were interpolated from the data in figure 3. In reference 1, it was pointed out that it was not good practice to extrapolate to obtain elevator trim angles. The angles for trim in figure 4 are $1\frac{1}{2}^\circ$ to 2° more positive than the values given in reference 1.

Angle of attack of tail surface.- The effect of small stabilizer deflections is given in figure 5 for the model with 1/2 rated power and flaps deflected. Figure 6 gives the effect of horizontal tail on the aerodynamic characteristics of the model with 1/2 rated power and flaps deflected. The effect of small stabilizer angles and horizontal tail is shown in figure 7 for the model with propeller windmilling and with flaps deflected.

The stabilizer tests (figs. 5 and 7) show that the change in pitching-moment coefficients with stabilizer angle dC_m/di_T increases with the application of power. The value of dC_m/di_T for propeller windmilling 0.0205 agrees with the value used in correction of pitching moments for tunnel effect.

The angle of attack of the horizontal tail is shown in figure 8 for the model with flaps deflected and landing gear extended for both 1/2 rated power and windmilling propeller. The values α_T were obtained by dividing the ΔC_m caused by horizontal tail by the value dC_m/di_T for the individual conditions. Since a tail surface stalls at angles of attack of approximately 15°, these data show no indication of tail stall.

An analysis of the subject data indicates that a larger horizontal tail is desirable for the airplane with full-span slotted flaps.

Langley Memorial Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., October 27, 1941.

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REFERENCES

1. Lowry, John G.: Power-On Wind-Tunnel Tests of the 1/8-Scale Model of the Brewster F2A Airplane with Full-Span Slotted Flaps. NACA MR, Aug. 21, 1941.

2. Lowry, John G.: Power-Off Wind-Tunnel Tests of the 1/8-Scale Model of the Brewster F2A Airplane. NACA MR, June 21, 1941.

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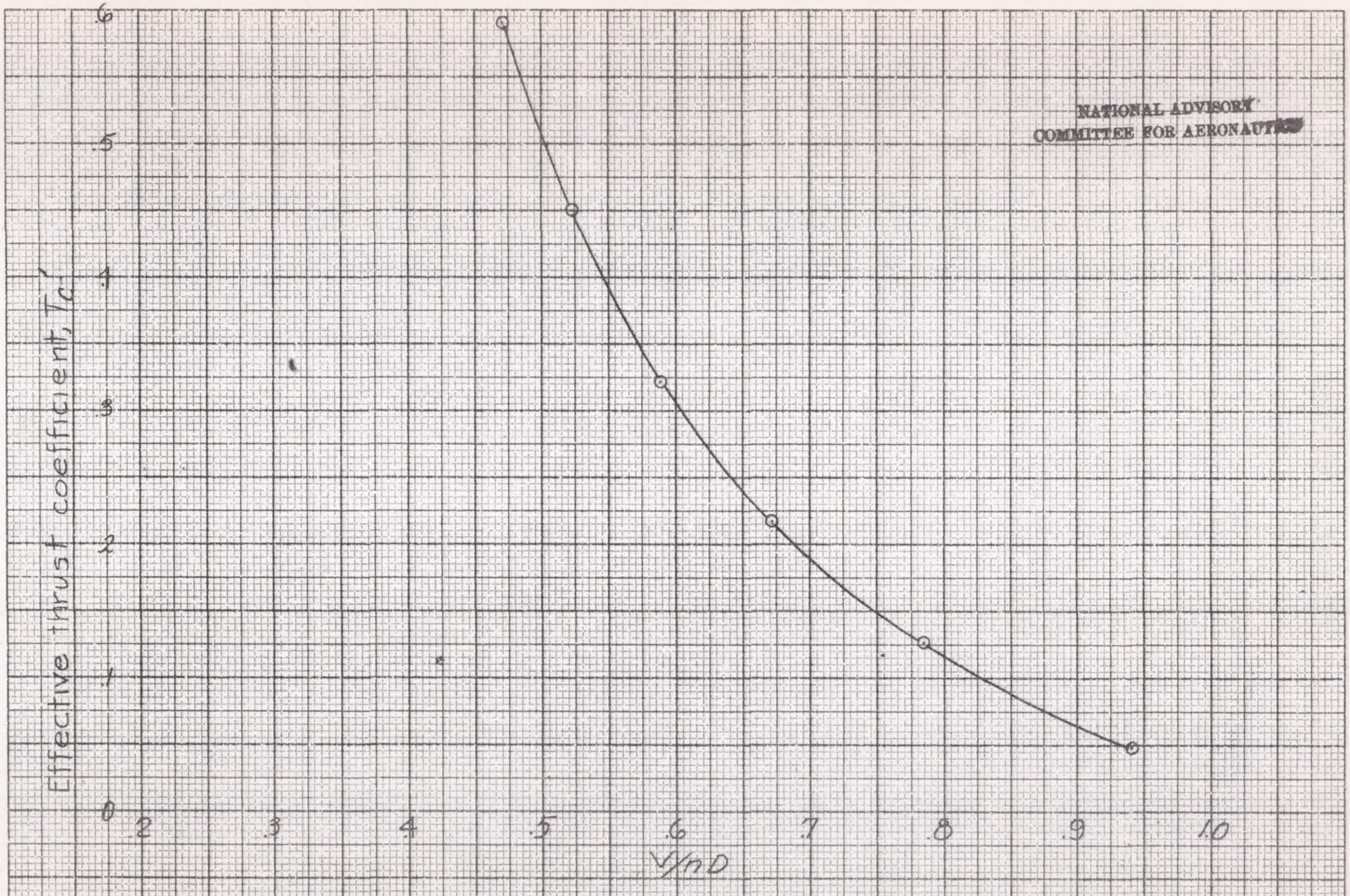

FIGURE 1.- Effective thrust coefficient calibration of the $\frac{1}{8}$ scale model of the Brewster F2A airplane. $\alpha = \Psi = \delta_f = \delta_e = \delta_r = \delta_a = 0$, $i_t = -0.9°$; L.G. retracted. 2-blade propeller, Diam. = 1.54 ft, $\beta = 20°$

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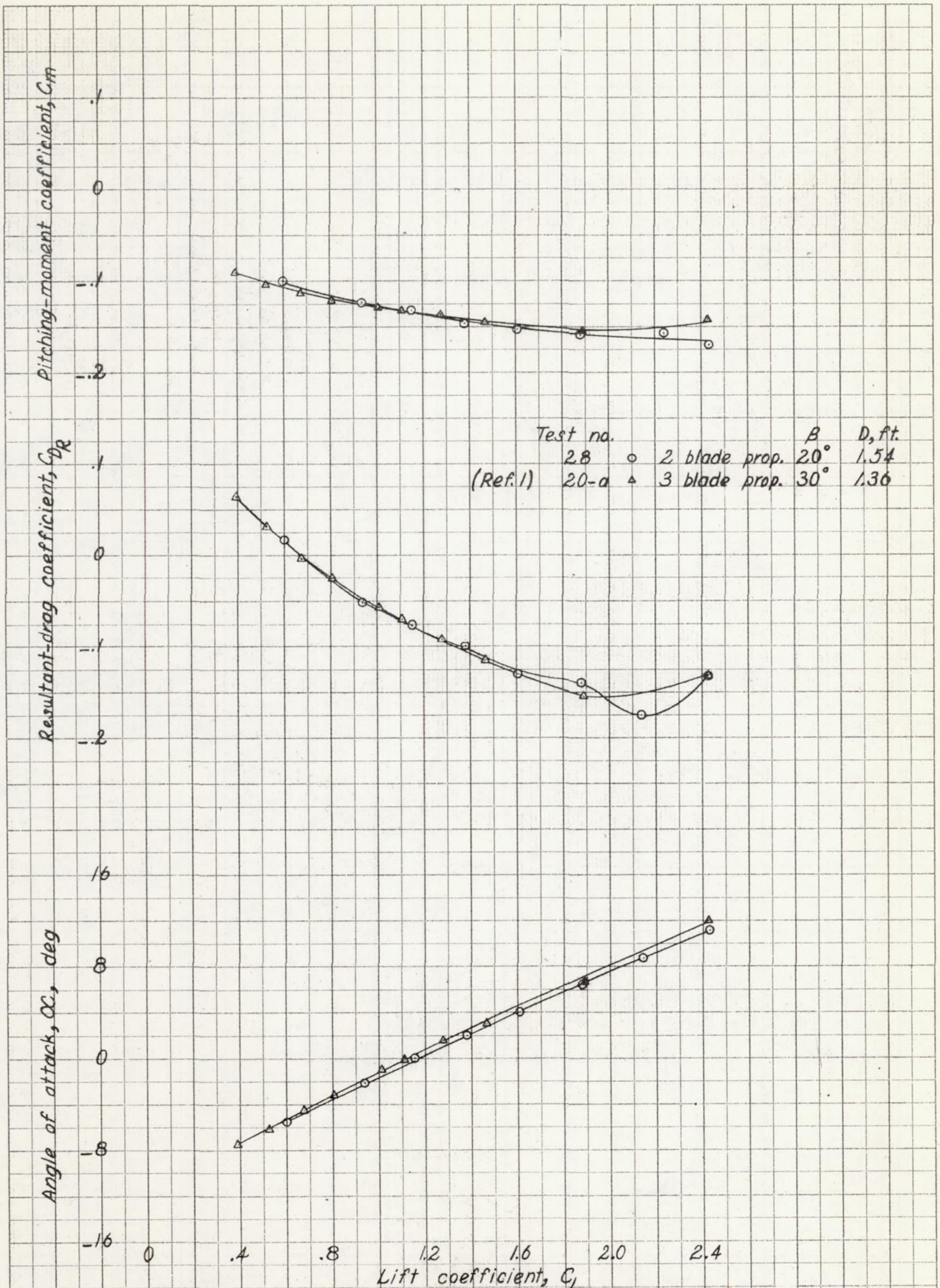

Figure 2.- Comparison of aerodynamic characteristics of the $\frac{1}{8}$-scale model of the Brewster F2A airplane with two propellers. Approximately $\frac{1}{2}$ rated power, $\psi = \delta_e = \delta_r = \delta_a = 0$, $\delta_f = 40^\circ$, $i_t = -.9^\circ$, $q = 16.37$ lbs/ft², L. G. extended.

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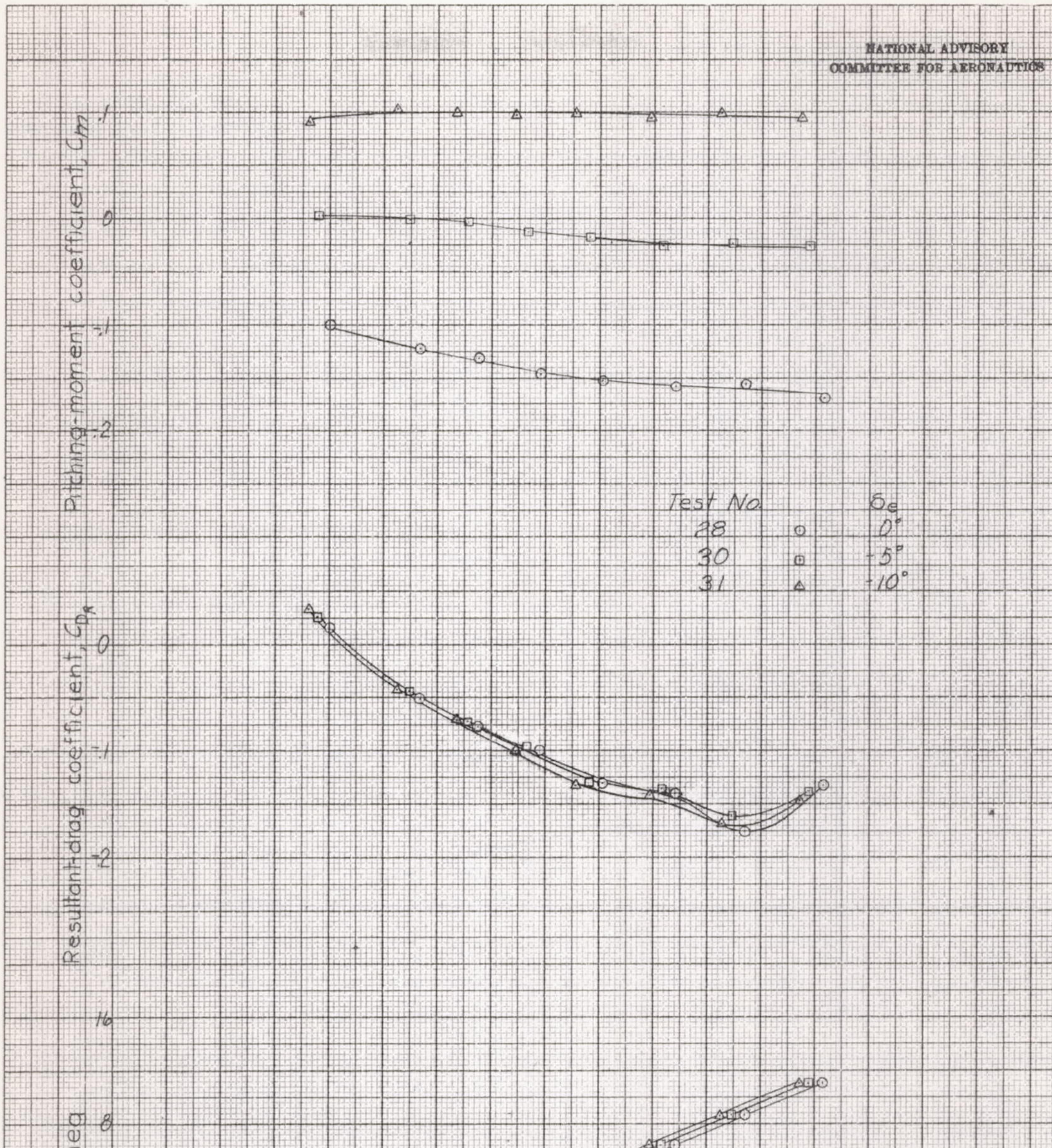

FIGURE 3.- Effect of elevator deflection on the aerodynamic characteristics of the ⅛-scale model of the Brewster F2A airplane. Approximatly ½ rated power, 2 blade propeller, $\beta = 20°$, $\psi = \delta_a = \delta_r = 0°$, $i_T = -.9°$ $\delta_f = 40°$, $q = 16.37$ lbs/ft², L.G. extended.

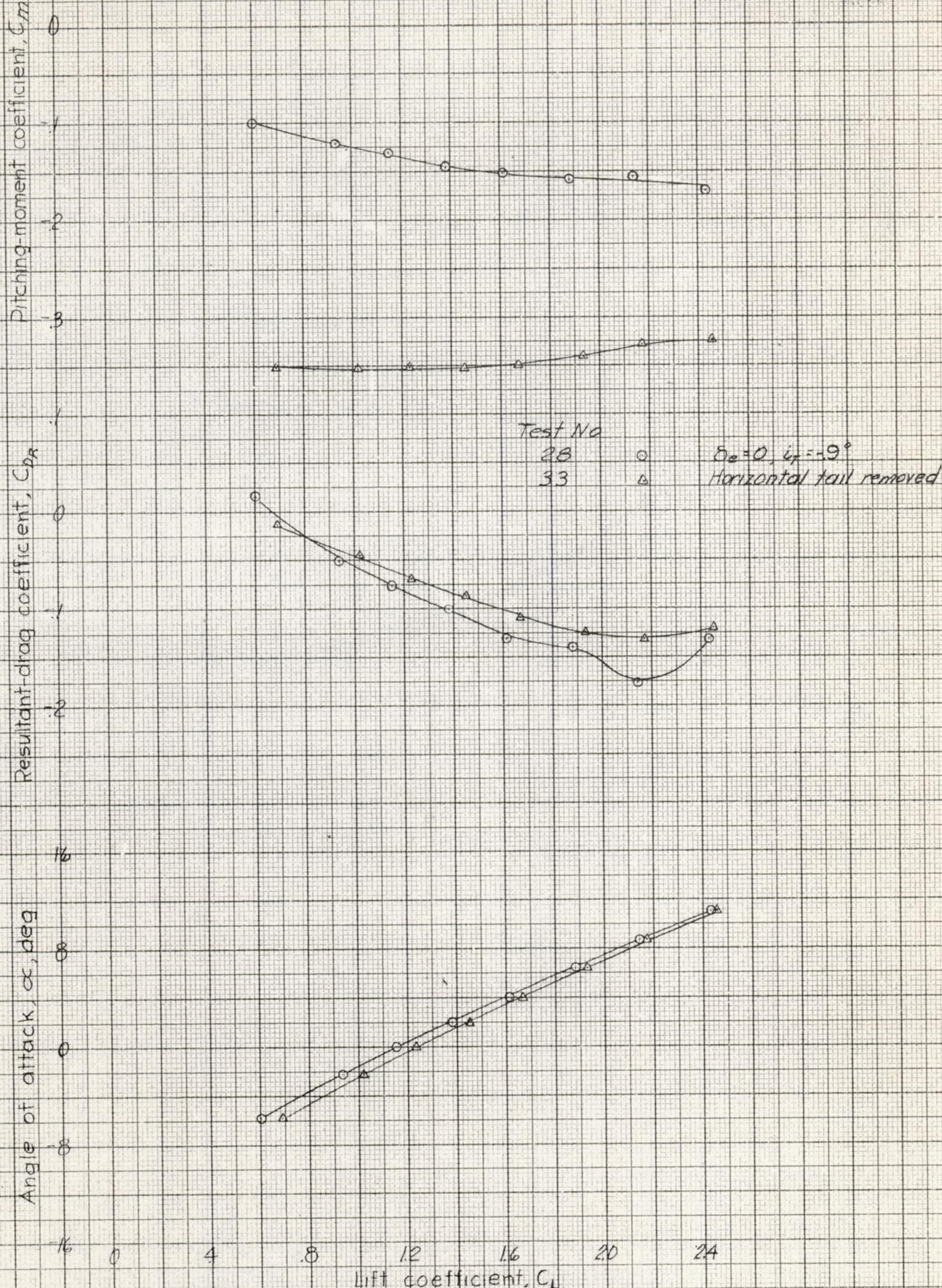

FIGURE 6.- Effect of horizontal tail on aerodynamic characteristics of $\frac{1}{8}$ scale model of Brewster F2A airplane. Approximately $\frac{1}{2}$ rated power, 2 blade propeller, $\beta = 20°$, $\psi = \delta_a = \delta_r = 0$, $\delta_f = 40°$, $q = 16.37$ lbs / ft², L.G. extended.

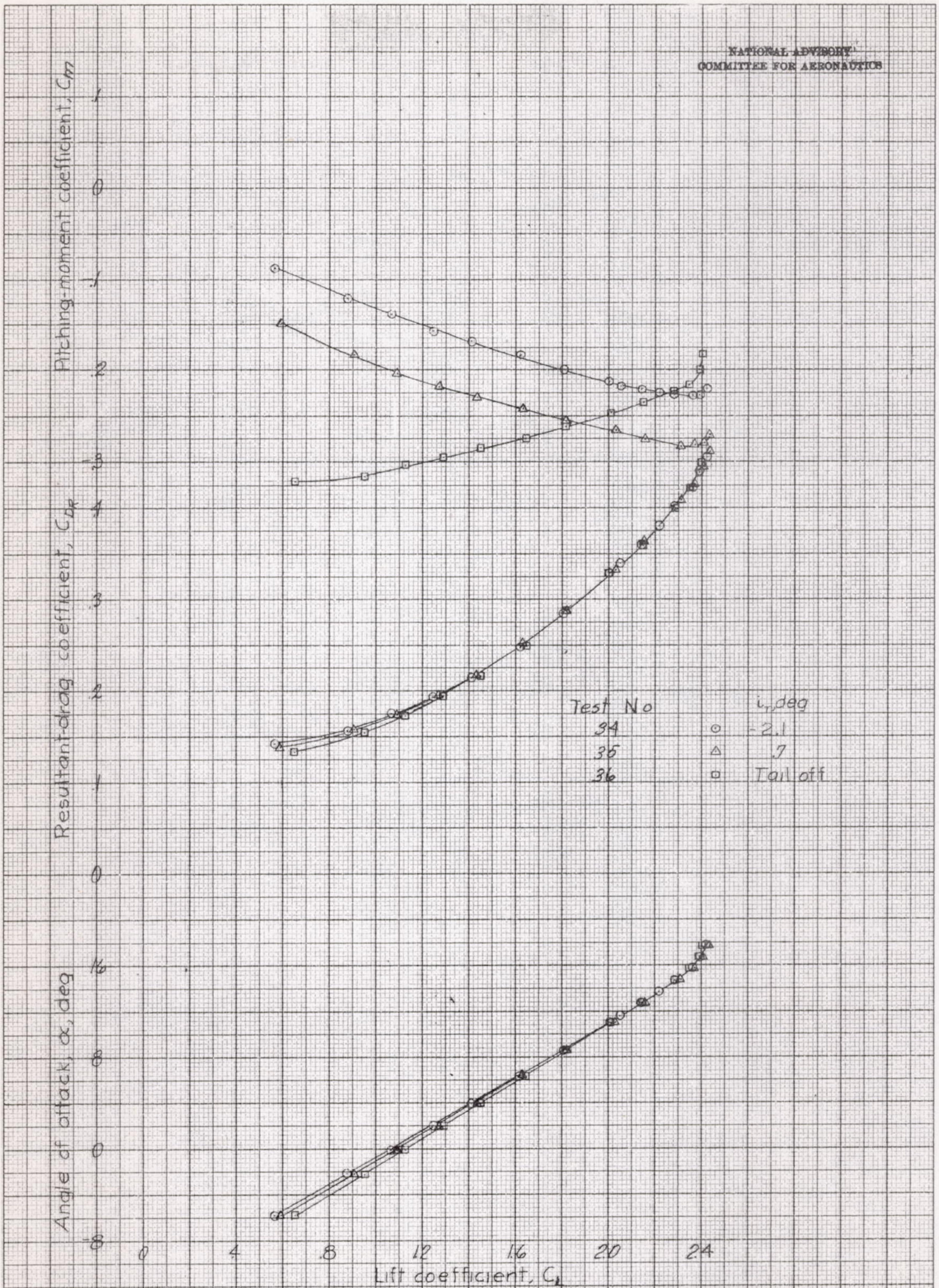

FIGURE 7.- Effect of stabilizer angle and horizontal tail on the aerodynamic characteristics of the $\frac{1}{8}$ scale model of the Brewster F2A airplane. Windmilling propeller, 2 blade propeller, $\beta = 20°$, $\psi = \delta_r = \delta_a = \delta_e = 0°$, $\delta_f = 40°$, $q = 16.37$ lbs/ft², L.G. extended.

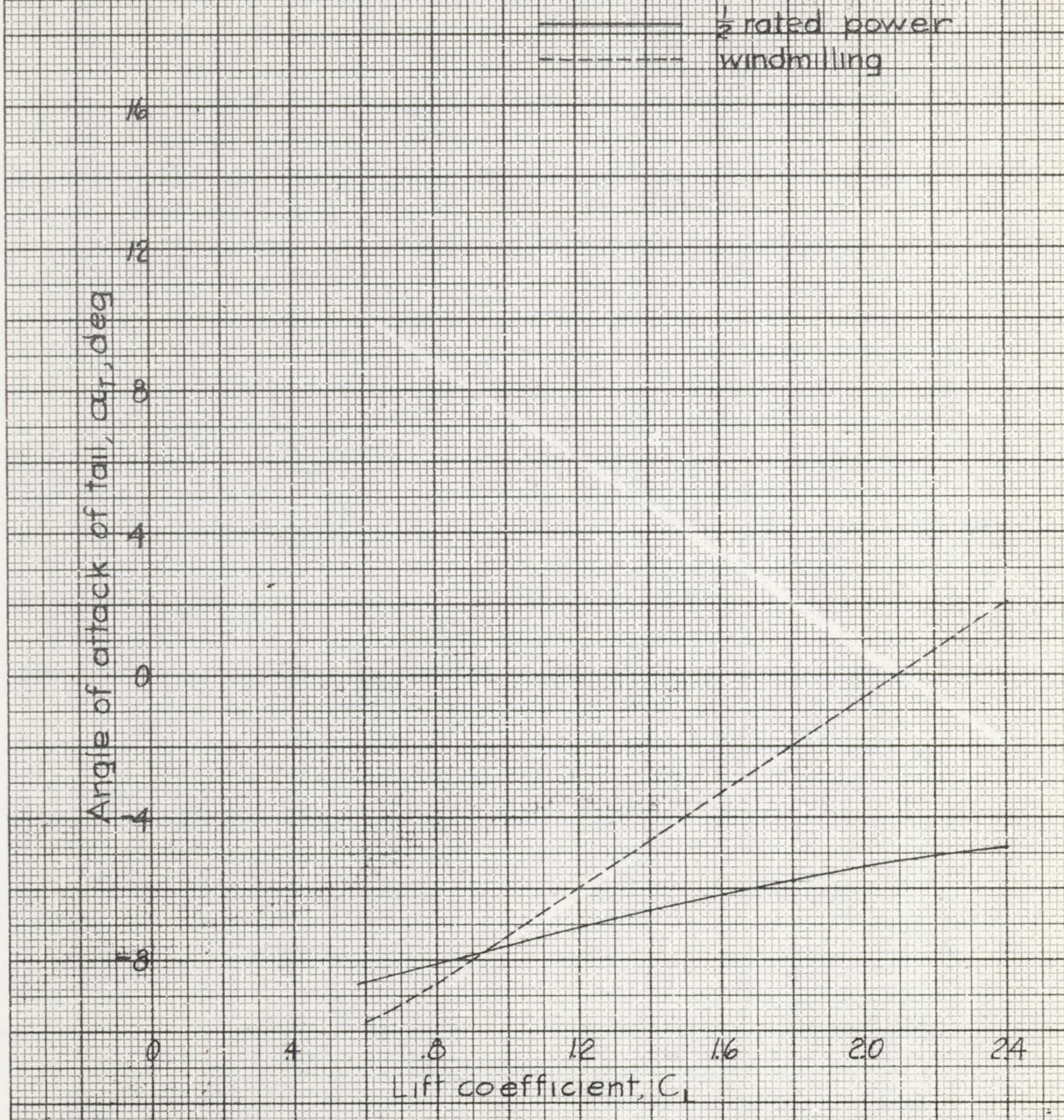

FIGURE 8.- Angle of attack of tail on the $\frac{1}{8}$ scale model of the Brewster F2A airplane. 2 blade prop., $\beta = 20°$, $\psi = \delta_a = \delta_e = \delta_r = 0°$, $i_t = -2°$, $q = 16.37$ lbs/ft², L.G. extended, $\delta_f = 40°$.