REPORT 1284
AERO REPORT 952

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NAVY DEPARTMENT

THE DAVID W. TAYLOR MODEL BASIN

AERODYNAMICS LABORATORY

WASHINGTON 7, D.C.

WIND-TUNNEL TESTS OF TWO-DIMENSIONAL CABLE FAIRINGS

by

Norman G. Ziegler

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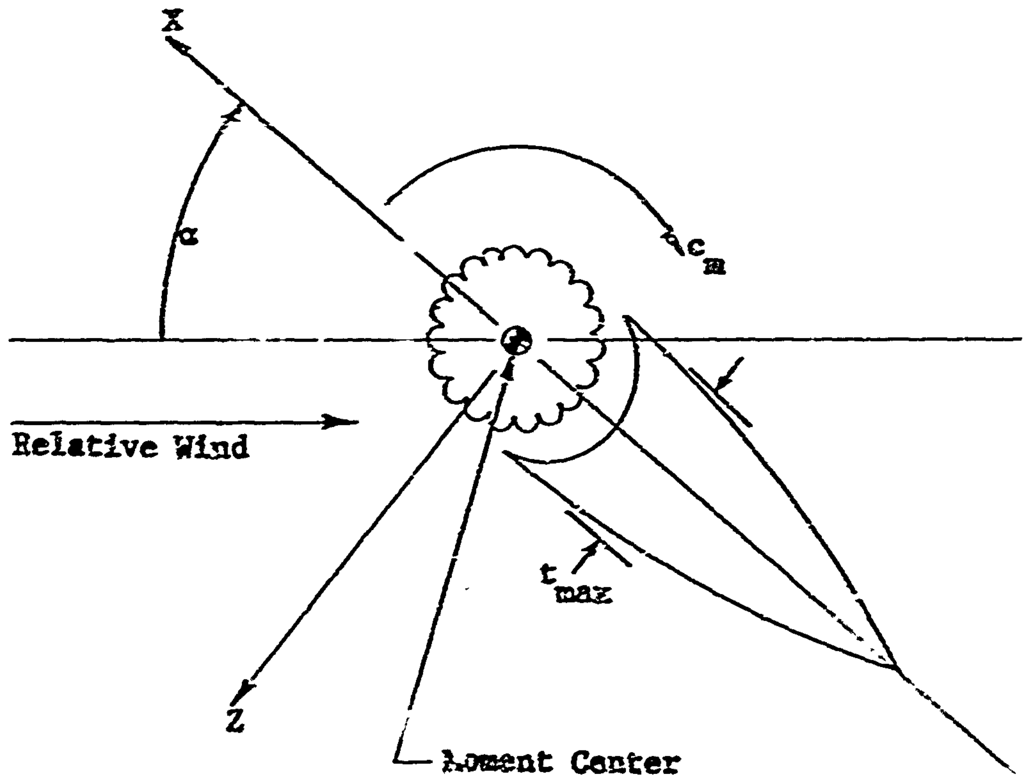
NOTATION

Positive directions are shown by arrows.

Side View



Axis	Moment in pound-inches	Moment Coefficient
Y	m_Y	$c_m = m_Y/qSc$

Symbols

T	ratio of maximum fairing thickness to cable diameter = t_{max}/d
t_{max}	maximum thickness of the fairing
F	fineness ratio of cable and fairing combination (c/d)
d	cable diameter
S	frontal area of cable (b·d)
b	span of cable
c	chord of cable and fairing combination
q	dynamic pressure ($\rho V^2/2$)
V	free-stream velocity
R	Reynolds number ($\rho Vd/\mu$)
ρ	mass density of air
μ	absolute viscosity of air
a	speed of sound
M	Mach number (V/a)

Angular Setting

α	angle of attack in degrees (angle between the chord plane of the cable and fairing combination and the relative wind vector)

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UNITED STATES NAVY
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SUMMARY

Nine two-dimensional cable fairings of various thicknesses and fineness ratios were tested at various Reynolds numbers in the 18-inch Supersonic Wind Tunnel of the Aerodynamics Laboratory. Pitching-moment coefficients were obtained for an angle-of-attack range of approximately -6° to 12° for each model.

INTRODUCTION

Wind-tunnel tests of two-dimensional cable fairings were conducted at the request of the Hydromechanics Laboratory of the Taylor Model Basin (Reference 1). Related tests on faired cables had been performed previously at low Reynolds numbers in the 8- by 10-foot Subsonic Wind Tunnels of the Aerodynamics Laboratory (References 2 and 3). The tests discussed herein were conducted in the 18-inch by 18-inch Supersonic Wind Tunnel of the Aerodynamics Laboratory to determine the pitching-moment coefficients of cable fairings of various thicknesses and fineness ratios at several Reynolds numbers.

The nine different fairing shapes were tested during August 1958. Pitching-moment coefficients were obtained for an angle-of-attack range of about -6° to 12°. This report presents the data in graphical form without discussion and completes the project.

MODELS AND EQUIPMENT

The photograph in Figure 1 shows the nine fairing models and the simulated cable behind which the fairings were tested. Three thicknesses of fairing (T = 0.6, 0.8, 1.0) were tested. Fairings of each thickness were fabricated in three chord lengths so that the cable and fairing combinations had fineness ratios, F, of 3, 4, and 5. All of the fairings were made of aluminum. The 1-inch-diameter cable was simulated by wrapping copper tubing around an aluminum bar and then soldering it in place. The fairings and the cable had a span of 8.46 inches and were fabricated in the Model Basin shops.

Since the test section is 16 inches wide and the models were to be approximately half this span, an auxiliary wall was fabricated from 1-inch aluminum plate and installed down the center line of the test section. The test section width after this alteration was 8.5 inches. The subsonic nozzle blocks were installed and since they are an inch thicker than supersonic nozzles, the resulting usable test-section size was 8.5 inches by 16 inches.

The models were tested in a horizontal position. The cable and fairing, being only 8.46 inches in span, cleared the opposite wall by 0.02 inch. Since data were desired on the fairing only and not the cable, the fairing was mounted on the faceplate of a 1-inch-thick, external flexure wall balance mounted flush in the door of the test-section wall, while the cable was mounted in the proper position ahead of the fairing but was fastened to the auxiliary wall. All of the fairings had a 0.625-inch radius concave leading edge. A curved gap of 0.125 inch width was maintained between cable and fairing at all times. Figure 2 shows a fairing mounted on the balance faceplate on the open door and the cable mounted on the auxiliary wall.

A device was installed on the auxiliary wall to indicate by flashing a light if a fairing happened to touch the wall during a run.

The balance could be rotated and locked at any attitude between runs, thus enabling rotation of the fairing about the cable to any desired angle of attack.

The balance leads were brought out to Leeds and Northrop Speedomax strain-gage indicators, from which the data were recorded. The airspeed was regulated by the extent to which the tunnel operating valve was opened.

DESCRIPTION OF TESTS

Each of the nine configurations was tested at four free-stream airspeeds in order to cover the desired Reynolds number range. At each airspeed a pitching-moment series was run covering a nominal angle-of-attack range of -6° to 12° in 2° increments.

Several sets of tare runs were made to determine the contribution of the balance faceplate to the gross pitching-moment data. The tare runs consisted of angle-of-attack sweeps with both cable and fairing attached to the auxiliary wall, while the wind forces acting on the balance faceplate were noted.

The Reynolds numbers for the test are based on the cable diameter (d), and are noted on each of the plots.

RESULTS

The data were corrected for tares and reduced to nondimensional coefficients. Wind-tunnel boundary corrections were then applied to the coefficients. Corrections for tunnel air-stream angularity were also made before plotting the data in final form.

The four airspeeds at which the tests were conducted correspond to Mach numbers of 0.1, 0.2, 0.3, and 0.4. From wind-tunnel tests on airfoils at these Mach numbers, it is known that compressibility effects were negligible at all except the highest test airspeed ($R \approx 2.2 \times 10^5$) at angles of attack greater than 8°. For such extreme conditions the correction for compressibility effect would not exceed 10 percent of the coefficient value. No compressibility corrections were applied to the data presented.

Figures 3, 4, and 5 show the variation of cable-fairing pitching moment with angle of attack for four Reynolds numbers. Figure 3 shows the pitching moment of the 0.6-thick fairings for the three fineness ratios. Figures 4 and 5 show the pitching moment of the 0.8-thick and 1.0-thick fairings, respectively, for the three fineness ratios.

In general, the data taken at the lowest Reynolds numbers ($R \approx 0.6 \times 10^5$) are not too reliable because of the light load encountered (relative to the balance design loads). These data are therefore left unfaired. The data are believed to be accurate within the limits shown in the table below.

$R \times 10^{-5}$	Accuracy of c_m
0.6	±0.07
1.2	±0.02
1.7	±0.01
2.2	±0.006

Aerodynamics Laboratory
David Taylor Model Basin
Washington, D.C.
November 1958

REFERENCES

1. HL memo S81/1 (544:TG:mjl) of 17 Dec 1957.

2. Matthews, John T. Wind-Tunnel TEsts of Two-Dimensional Faired and Unfaired Sections (Title Unclassified). Wash., May 1956. 16 l. incl. illus. (David Taylor Model Basin. Rpt. C-756. Aero Data Rpt. 34) CONFIDENTIAL

3. Matthews, John T. Wind-Tunnel Tests of Two-Dimensional Faired Cables. Part I - Four Cables at Low Reynolds Numbers (Title Unclassified). Wash., Jul 1957. 15 l. incl. illus. (David Taylor Model Basin. Rpt. C-855. Aero Rpt. 921 Pt. 1)

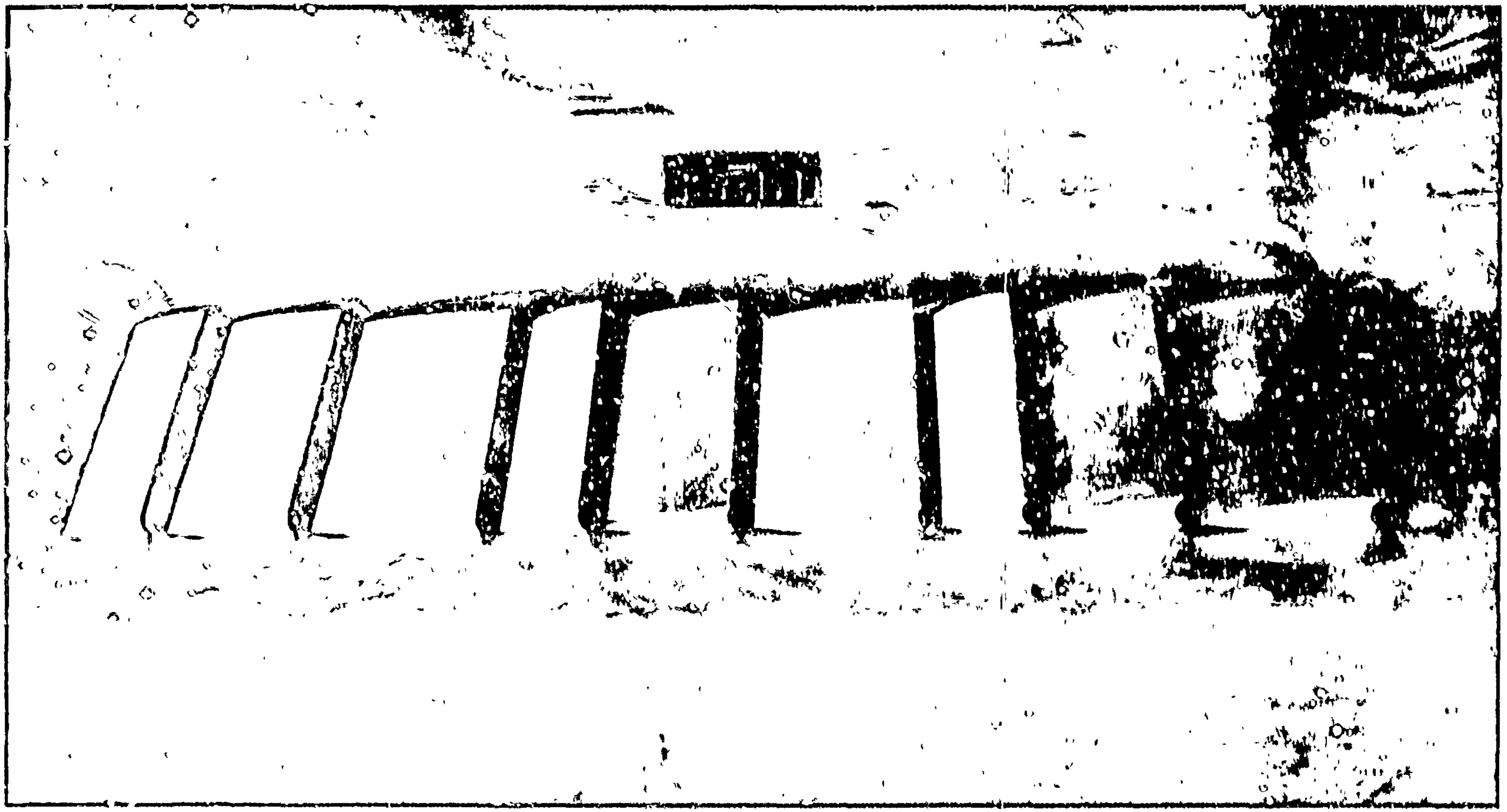

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Figure 1 - Cable Fairing Models and Simulated Cable

(Fairing configurations shown in the order of presentation of data.)

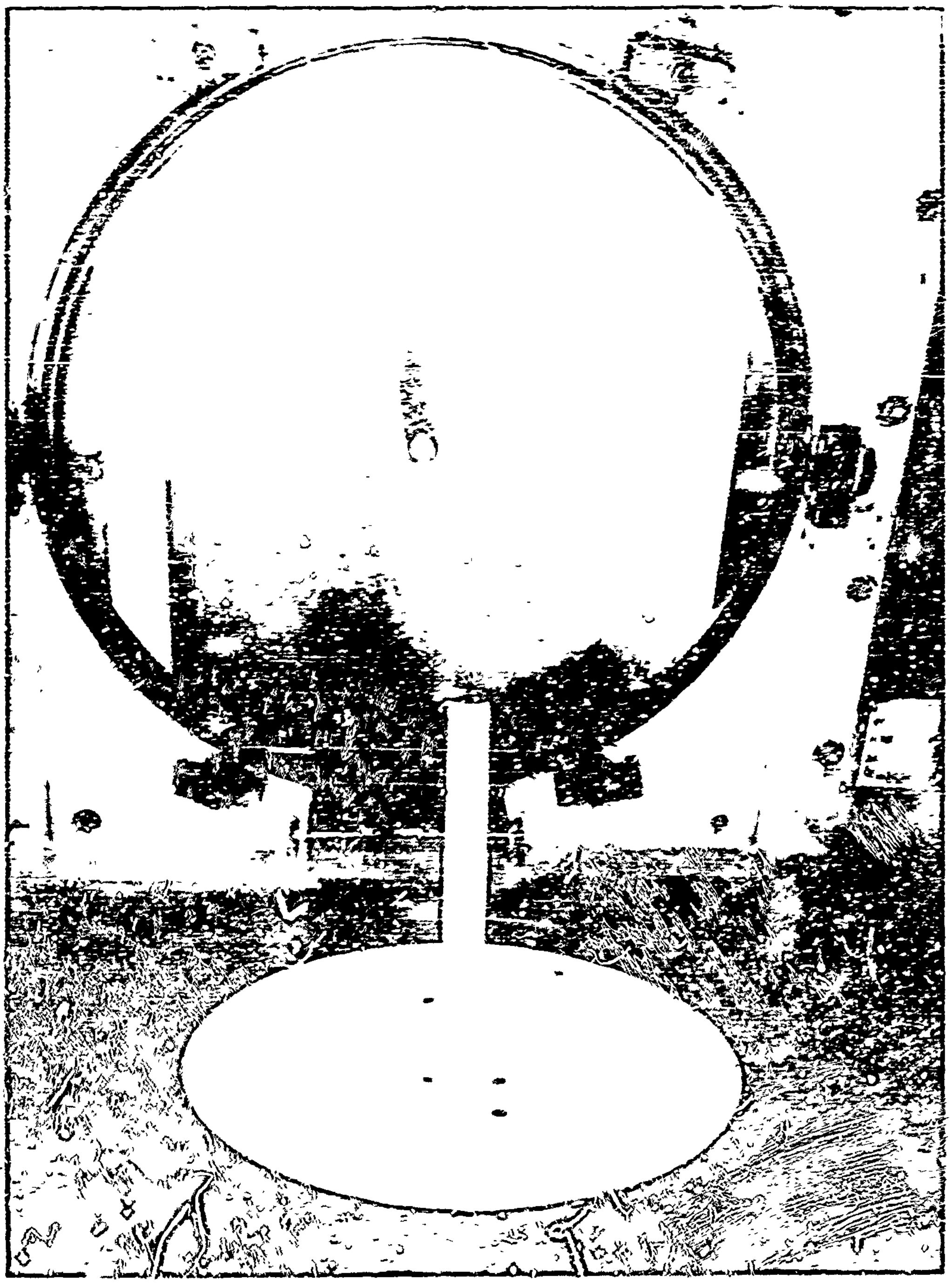

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Figure 2 - Test Section With Door Open

(Fairing model is installed on wall balance in the door and cable is mounted on auxiliary wall.)

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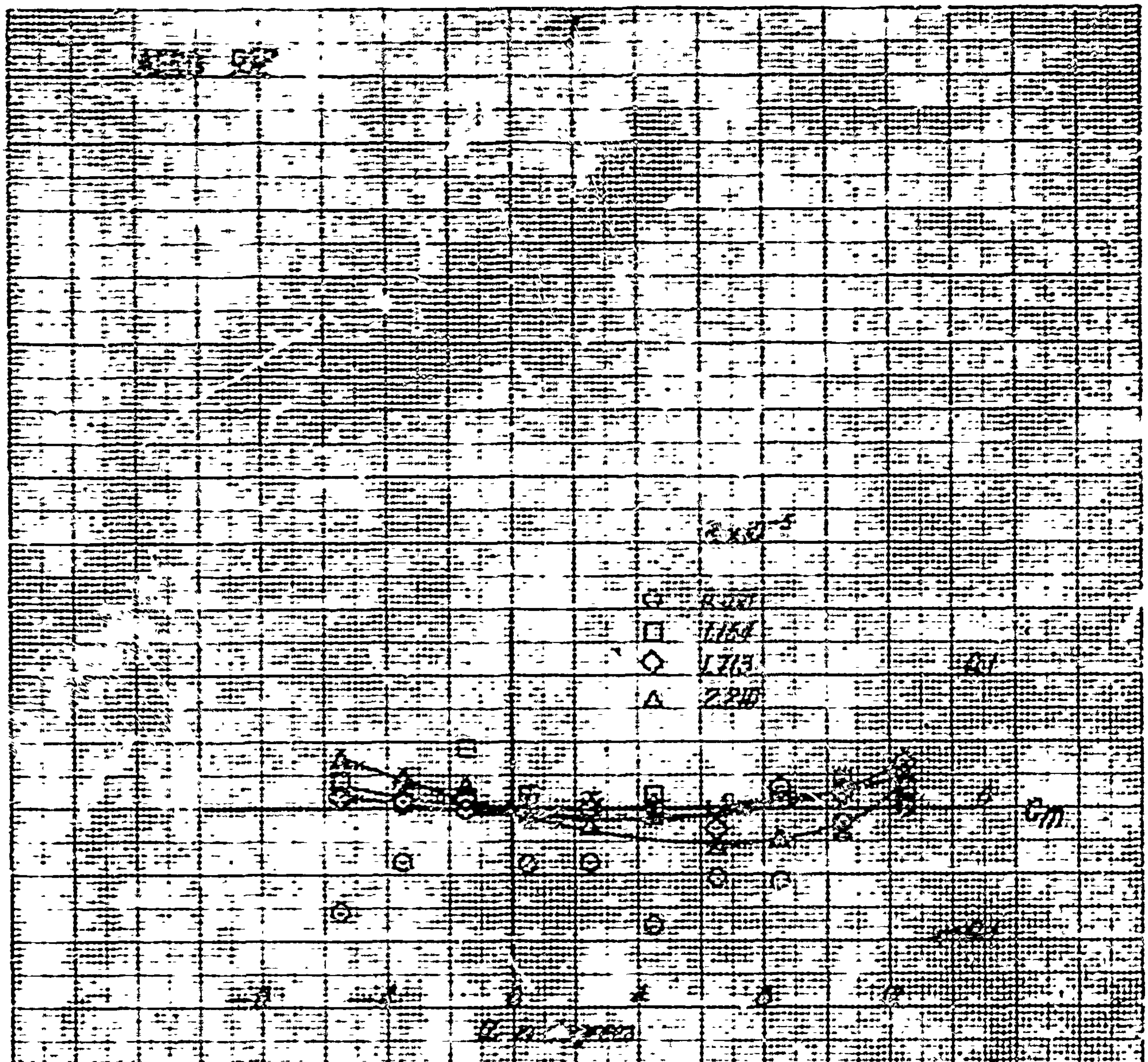

Figure 3 - Pitching-Moment Coefficient Variation with Angle of Attack for T-4A Fuselage

(a) F=5

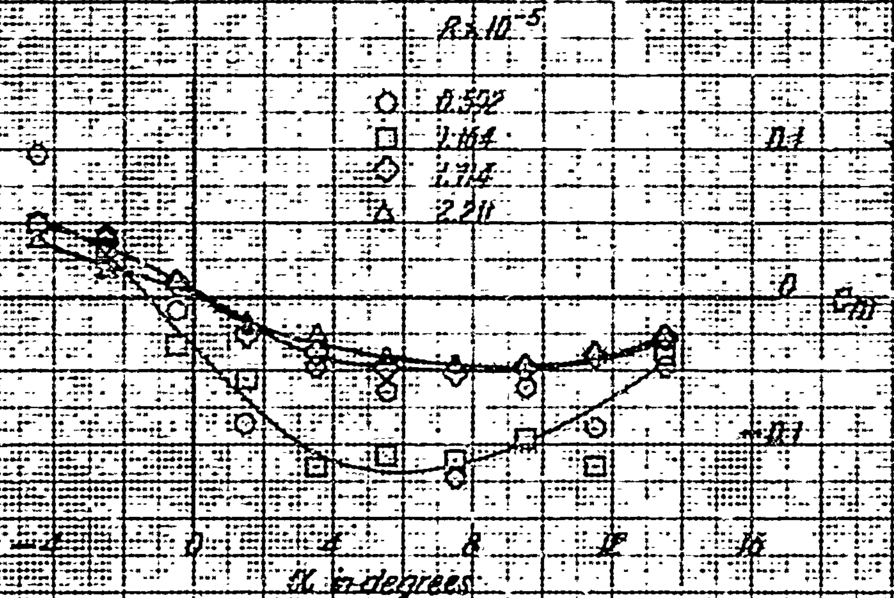

Figure 3 (Continued)

(b) F = 8

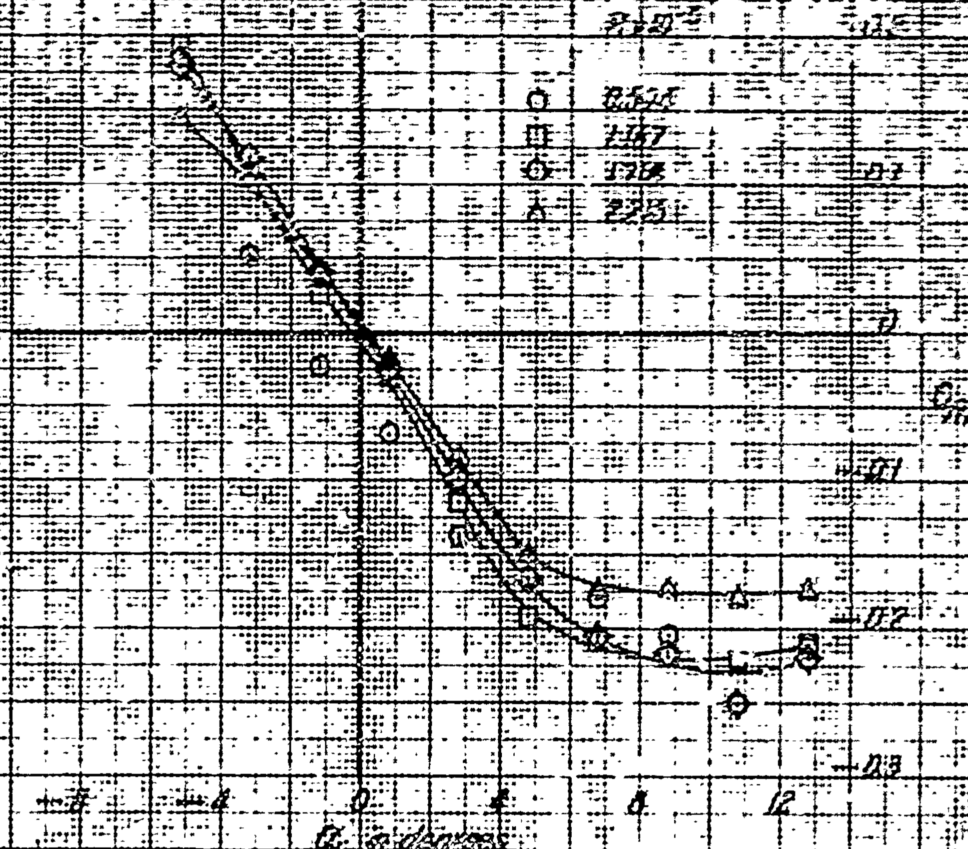

Figure 5 (Continued)

(d) C_m

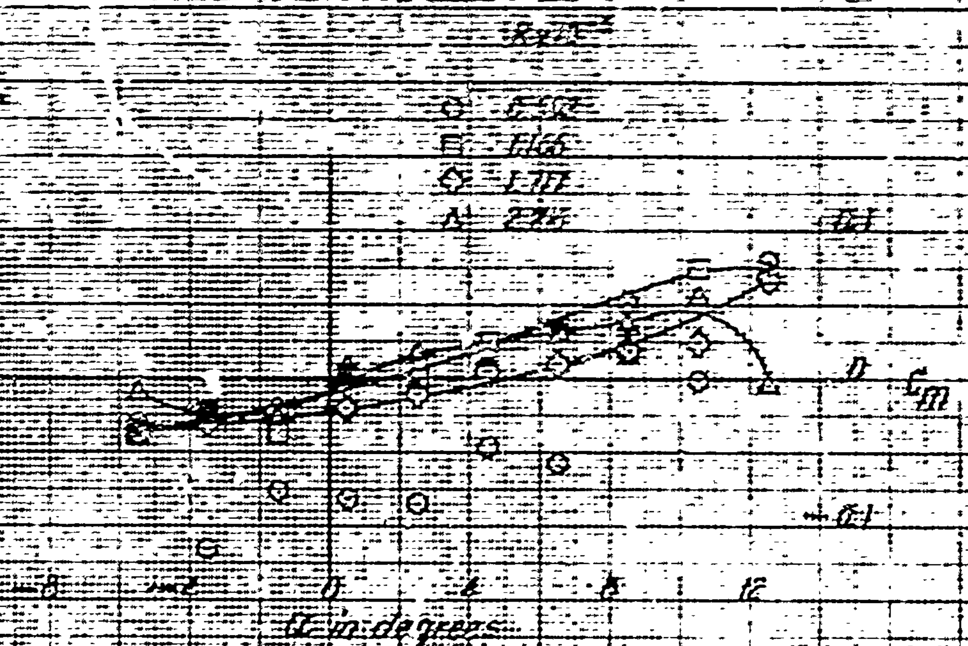

Figure 4 - Pitching-Moment Coefficient Variation
With Angle of Attack for T = 0.8 Fairings
(a) l = 3

FIGURE 4a

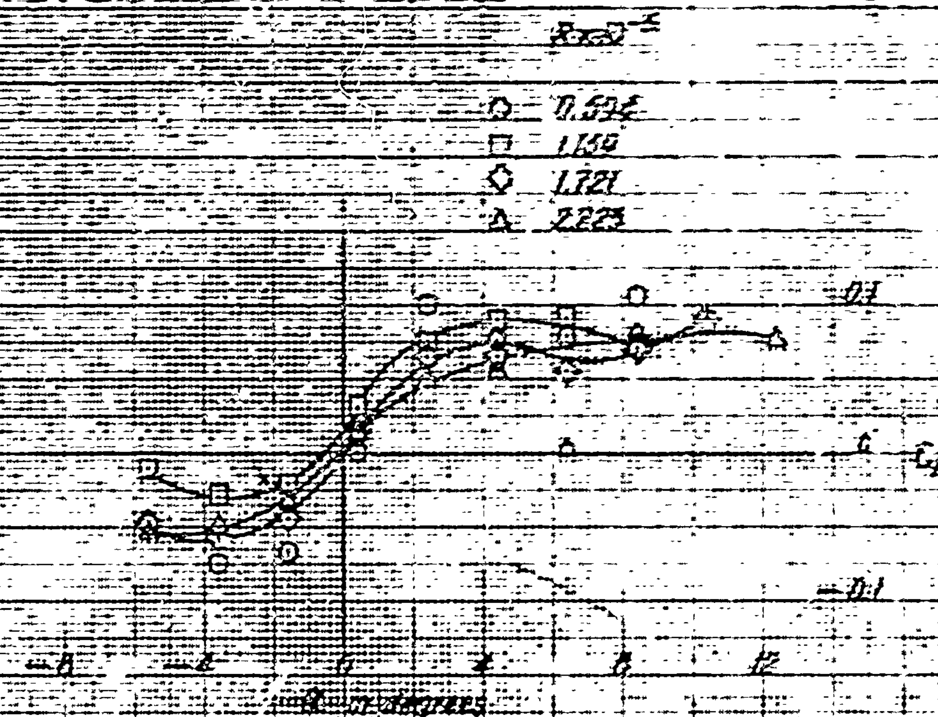

Figure 4 (Continued)

(b) F = 4

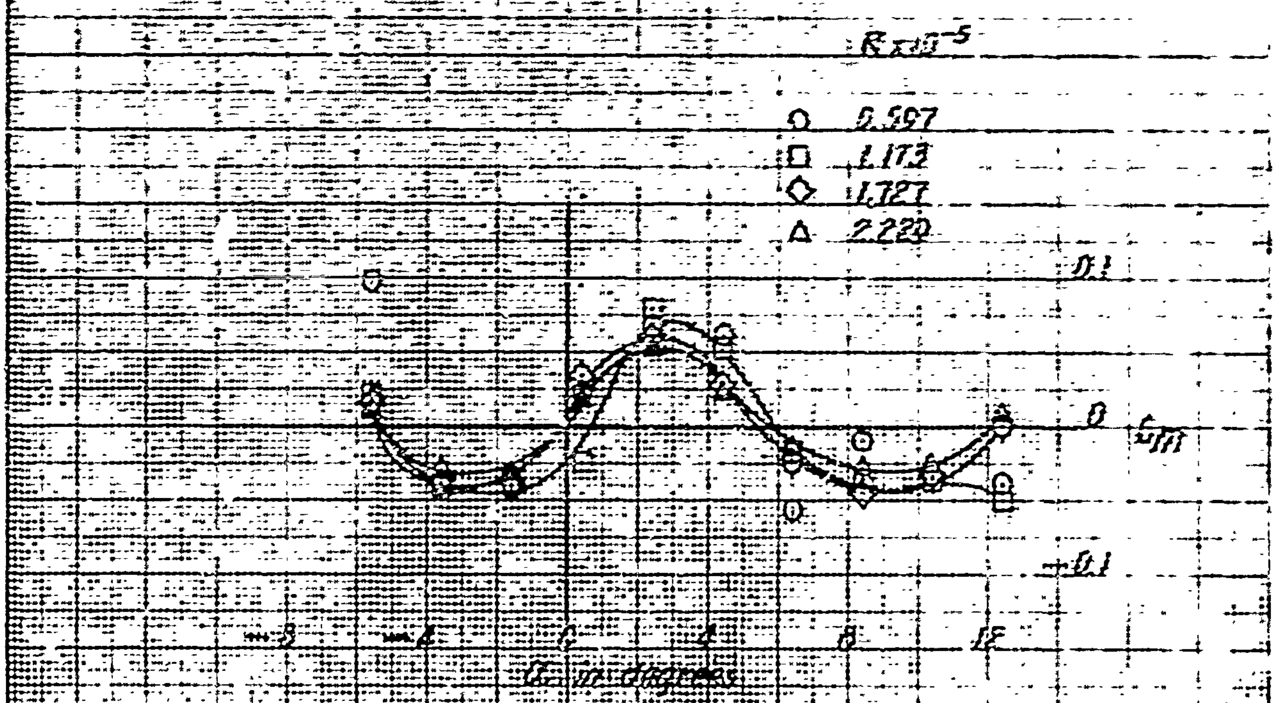

Figure 4 (Concluded)

(c) F=5

FIGURE 4c

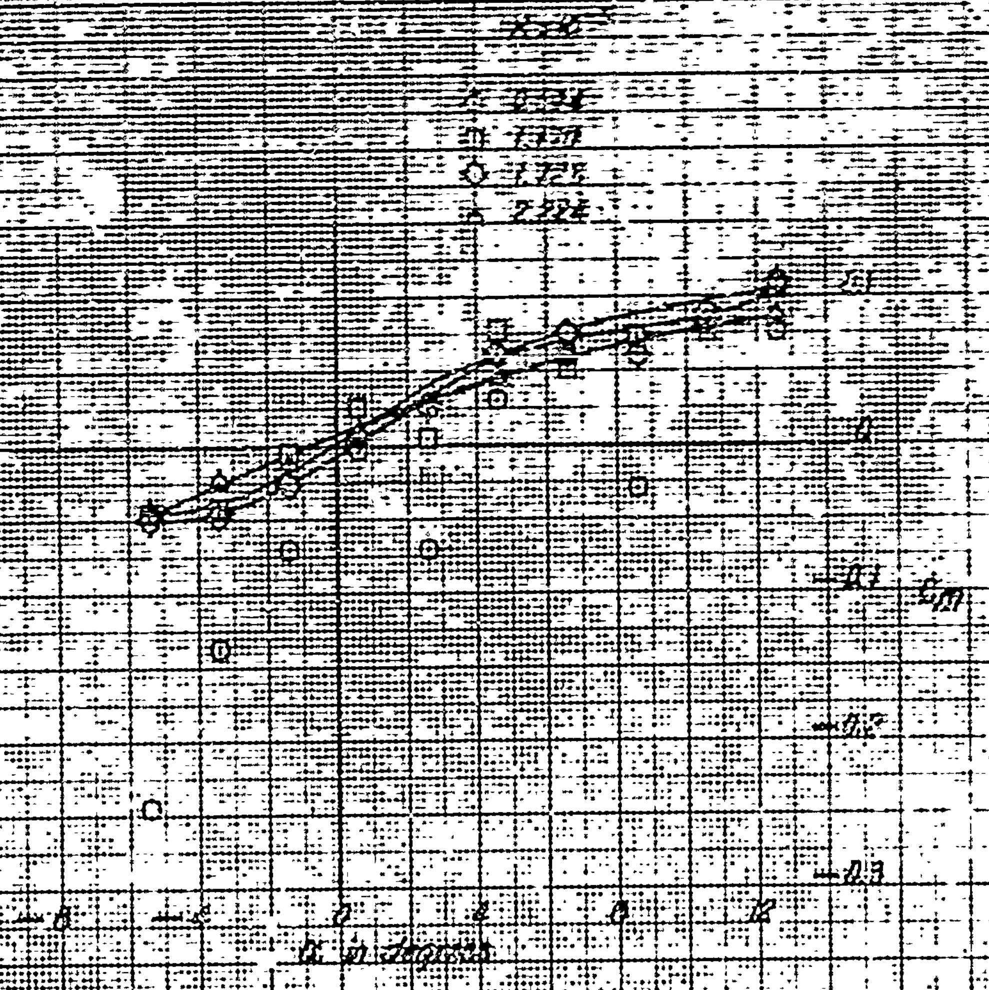

Figure 5 – Pitching-Moment Coefficient Variation

With Angle of Attack for T-1.0 Fairings

(a) J ± [illegible]

FIGURE 5a

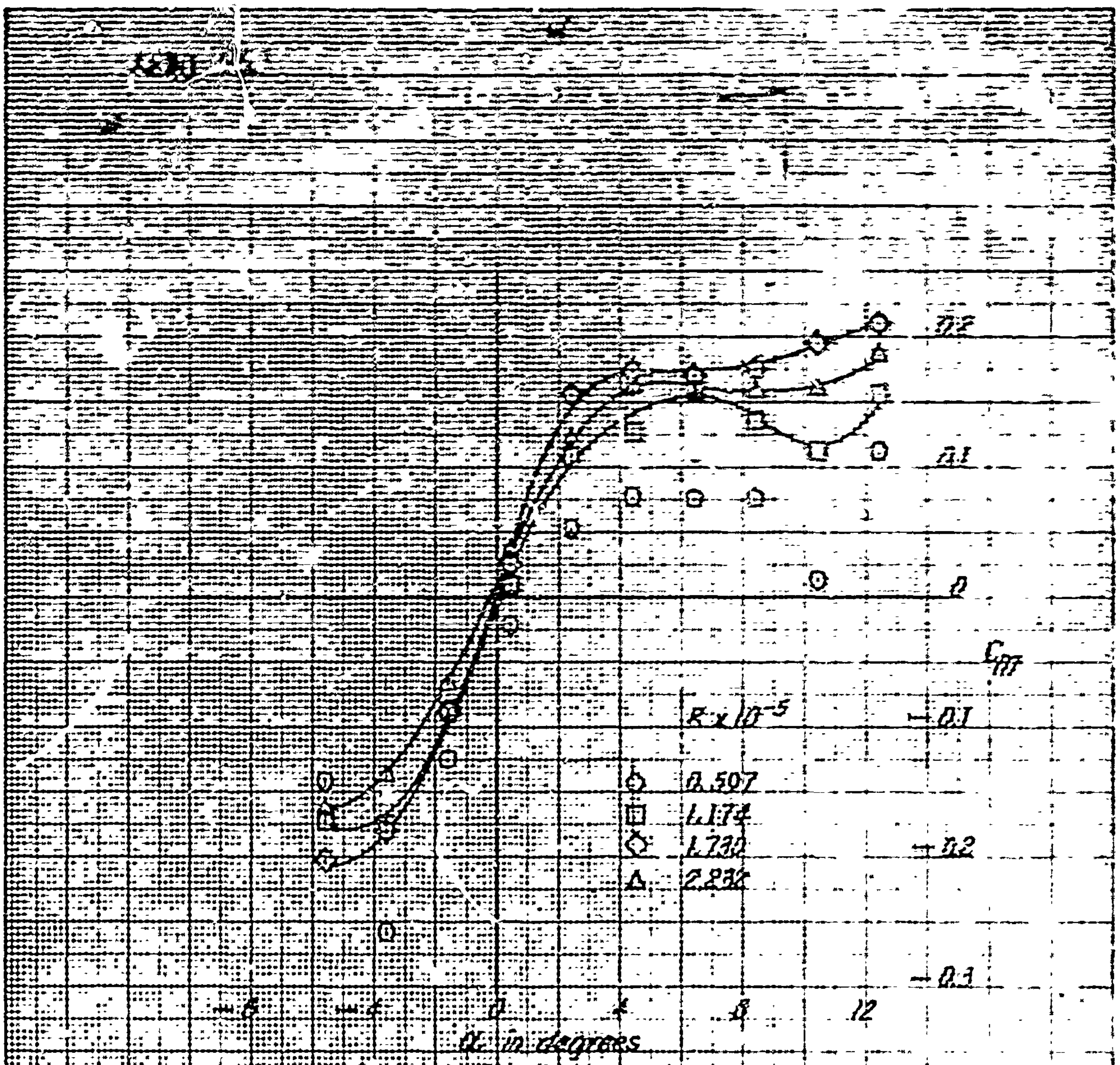

Figure 5 (Continued)

(b) F = 4

FIGURE 5b

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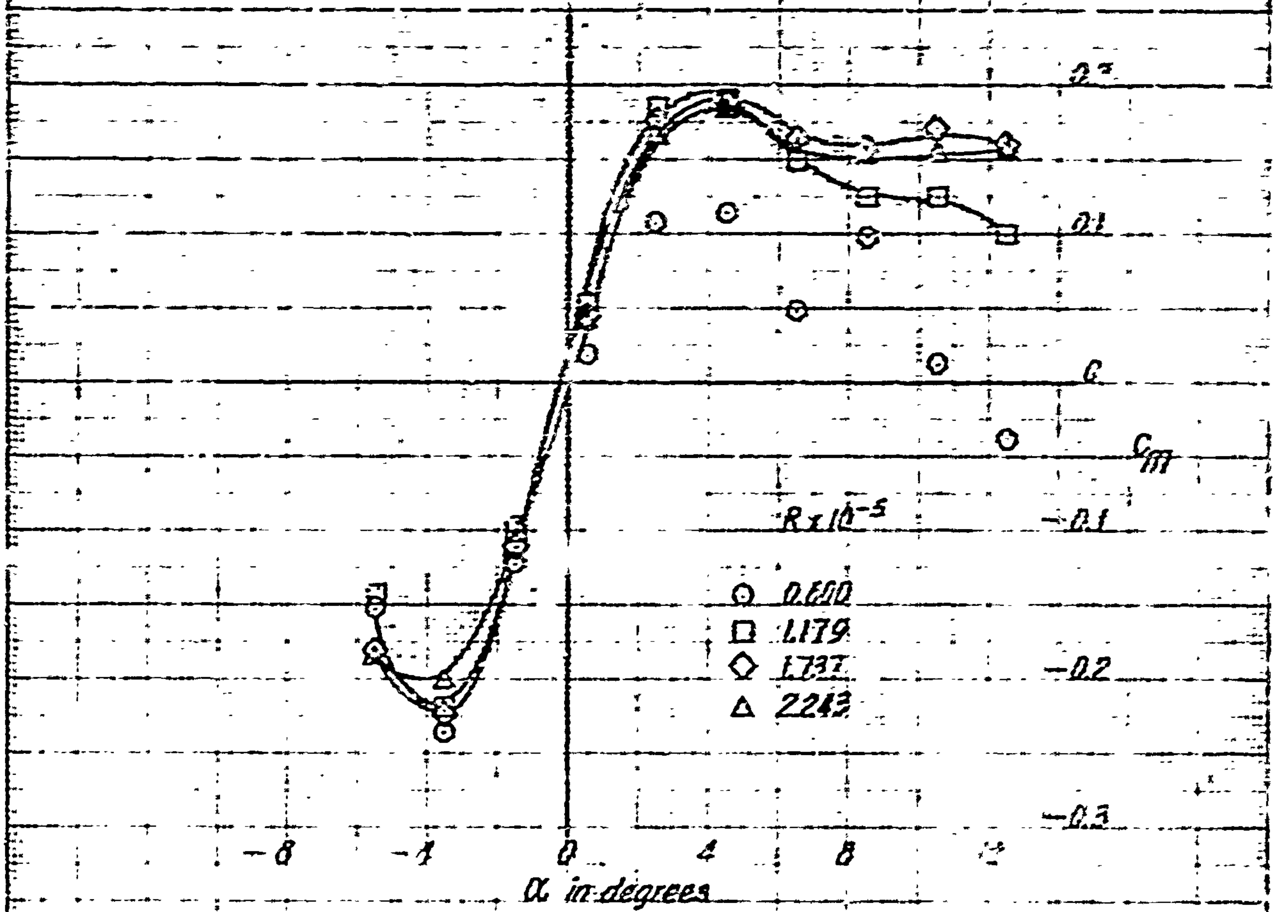

Figure 5 (Concluded)

(c) F=5

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FIGURE 5c