WT 21-115

TEST OF A NASA BLUNT BODY WITH FLARES IN THE JPL 20-INCH SUPERSONIC AND 21-INCH HYPERSONIC WIND TUNNELS

Robert W. Weaver

Robert E. Covey

Robert E. Covey, *Chief*
Aerodynamic Facilities Section

JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
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TABLES

FIGURES

PLOTS

Plot No.	Run No.	Mach No.	Re/in. x 10^{-6}	Max. Flare Diam. (in.)	Flare Angle (deg)	Flare Position	Test No.
1	2	6.00	0.261	no flare	-	-	21-115
↓	10	↓	0.096	↓	↓	↓	↓
↓	12	↓	0.013	↓	↓	↓	↓
↓	2	4.54	0.347	↓	↓	↓	20-512
2	2	6.00	0.261	↓	↓	aft	21-115
↓	3	↓	0.261	4.534	30	↓	↓
↓	4	↓	0.087	4.534	30	↓	↓
↓	5	↓	0.347	4.540	45	↓	↓
↓	6	↓	0.029	↓	45	↓	↓
↓	7	↓	0.117	↓	30	fwd	↓
↓	8	↓	0.261	4.544	45	fwd	↓
↓	9	↓	↓	5.076	45	aft	↓
↓	13	↓	↓	5.105	30	aft	↓
3	14	↓	0.096	no flare	-	-	↓
↓	15	↓	↓	4.534	30	aft	↓
↓	16	↓	↓	4.540	45	aft	↓
↓	17	↓	↓	4.540	30	fwd	↓
↓	18	↓	↓	4.544	45	fwd	↓
↓	19	↓	↓	5.076	45	aft	↓
↓	20	↓	↓	5.105	30	aft	↓
4	2	4.54	0.347	no flare	-	-	

PLOTS (Cont'd)

Plot No.	Run No.	Mach No.	Re/in. x 10^{-6}	Max. Flare Diam. (in.)	Flare Angle (deg)	Flare Position	Test No.
4	3	4.54	0.347	4.534	30	aft	20-512
↓	4	↓	0.042	4.534	30	↓	↓
	5		0.347	4.540	45		
	6		0.042	↓	45		
	7		0.347		30	fwd	
	8		0.042		30	↓	
	9		0.347	4.544	45		
	18		↓	5.076	45	aft	
	19			5.105	30	↓	
↓	20		0.084	4.534	30		
5	11		0.347	no flare	-	-	
↓	12		0.347	4.534	30	aft	
	13		0.042	4.534	30	↓	
	15		0.347	4.540	45		
	16		↓	4.540	30	fwd	
	17			4.544	45	fwd	
↓	26	↓	0.242	5.105	45	aft	↓

PLOTS (Cont'd)

Plot No.	Run No.	Mach No.	Re/in. x 10^{-6}	Max. Flare Diam. (in.)	Flare Angle (deg)	Flare Position	Test No.
6	21	2.81	0.2 6	4.534	30	aft	20-512
↓	22	↓	↓	4.540	45	aft	↓
↓	23	↓	↓	4.540	30	fwd	↓
↓	24	↓	↓	4.544	45	fwd	↓
↓	25	↓	↓	5.105	30	aft	↓

I. INTRODUCTION

Wind-tunnel Tests 21-115 and 20-512 were tests of JPL models of a NASA blunt body. The purpose of the tests was to investigate the aerodynamic effects of flares mounted on a blunt body. The approximate aerodynamic parameters for the tests were Mach No. 2.81, 4.54, and 6.00, and Reynolds No./in. from 0.013×10^6 to 0.347×10^6. The test* variables-and-ranges were angle of attack from 0 to 30 deg and 180 to 210 deg, flare angles of 30 and 45 deg, flare diameters of approximately 4.5 and 5.0 in., and two flare locations.

The model configuration consisted of a blunted 10-deg cone with a conical afterbody having a 100-deg apex angle and one of six possible flare configurations. Forces and moments were obtained for the complete model.

The test was conducted at the Jet Propulsion Laboratory (JPL) during the period from June 6 to 7, 1962 and from July 1 to 2, 1962.

II. MODEL DESCRIPTION

The model is shown in Fig. 1 and 2. A more detailed description of the model is shown in Fig. 3.

*The notations used in this Report are defined in the Nomenclature.

III. WIND TUNNEL AND INSTRUMENTATION

Reference 1 describes the construction and operating conditions of the 20-in. supersonic wind tunnel and the 21-in. hypersonic wind tunnel. The wind tunnels have a nominal test-section size of 20 in. square and 21 in. square, respectively, a Mach range from 1.3 to 5.0 and 5.0 to 10, respectively, flexible plate nozzles, and operate with continuous flow. Table 1 presents representative values of the test-section flow parameters for the Mach numbers at which this test was conducted.

A six-component, internal, strain-gage balance was used to measure force-and-moment data.

IV. TEST PROCEDURE

Prior to actual test operations, measurements were made to determine the position of the model, the deflection constants, and the balance tares. During the test, data points were obtained at successive values of angle of attack. These data points were plotted vs angle of attack, and any data which appeared questionable were checked before the conclusion of the run. At least one data point was checked even if all data appeared correct.

V. DATA REDUCTION

The force-and-moment data were reduced to dimensionless coefficients in the model center-of-gravity coordinate system. The coefficients were obtained as follows:

$$\text{force coefficient} = \frac{\text{force}}{q\,A}$$

$$\text{moment coefficient} = \frac{\text{moment}}{q\,Ad}$$

where

q = free-stream dynamic pressure (psi)

A = reference area = 12.57 ($in.^2$)

d = reference length = 4.00 (in.)

and the point about which the moments were measured was 1.[illegible] in. aft from the model nose, on the model centerline.

The coefficients were obtained on a digital computer by a standardized series of formulae as indicated in Ref. 2. The repeatability of the coefficient data is indicated in Table 2.

The coefficients are defined in the Nomenclature, and the coefficient sign conventions are shown in Figure 4.

VI. RESULTS

The results of this test have been reduced to dimensionless coefficients and are presented in Plot Series 1a through 6b. No attempt was made in this Report to interpret the results.

NOMENCLATURE

General

A	reference area (12.57 in.^{2})
d	reference length (4.00 in.)
M	free-stream nominal Mach number
P_t	tunnel supply-section stagnation pressure (cm Hg)
Re/in.	Reynolds number per inch
T_t	tunnel supply-section stagnation temperature (°F)
α	model angle of attack

Model*

$I_{(\ )}$	basic configuration, model to sting; angle equals 0 deg
$V_{(\ )}$	basic configuration, model to sting; angle equals 180 deg

Model Subscript Data			
Subscript No.	Max. Flare Diam (in.)	Flare Angle (deg)	Flare Position**
1	5.105	30	aft
2	4.534	30	↓
3	4.540	45	↓
4	5.076	45	↓
5	4.540	30	fwd
6	4.544	45	fwd

**For flare position, see Fig. 3.

*Model subscript data are shown in above Nomenclature Table.

REFERENCES

1. Jet Propulsion Laboratory, California Institute of Technology. Wind-Tunnel Facilities at the Jet Propulsion Laboratory, Wind-Tunnel Staff. Pasadena, California, JPL, April 18, 1961. (Technical Release No. 34-257), UNCLASSIFIED.

2. Jet Propulsion Laboratory, California Institute of Technology. Equations for Wind-Tunnel-Force Data Reduction, Wind-Tunnell Staff. Pasadena, California, JPL, April 19, 1957. (Internal Memorandum SWT G-T3), UNCLASSIFIED.

Table 1. Average aerodynamic parameters

Parameter	Mach Number		
	2.81	4.54	6.00
Static pressure (psia)	0.559	0.025 to 0.209	0.012 to 0.110
Stagnation pressure (psia)	15.41	7.70 to 63.56	19.26 to 173.34
Dynamic pressure (psia)	3.09	0.73 to 3.01	0.30 to 2.77
Reynolds number (per in. x 10^{-6})	0.206	0.042 to 0.347	0.013 to 0.347

Table 2. Coefficient repeatability

Mach No.	Coefficient*	
	C_C	$C_{m_{cg}}$
2.81	0.0014	0.0014
4.54	0.0056	0.0008
6.00	0.0081	0.0063

*Based upon the following reference area and length: A=12.57 in.^{2} and d = 4.00 in.

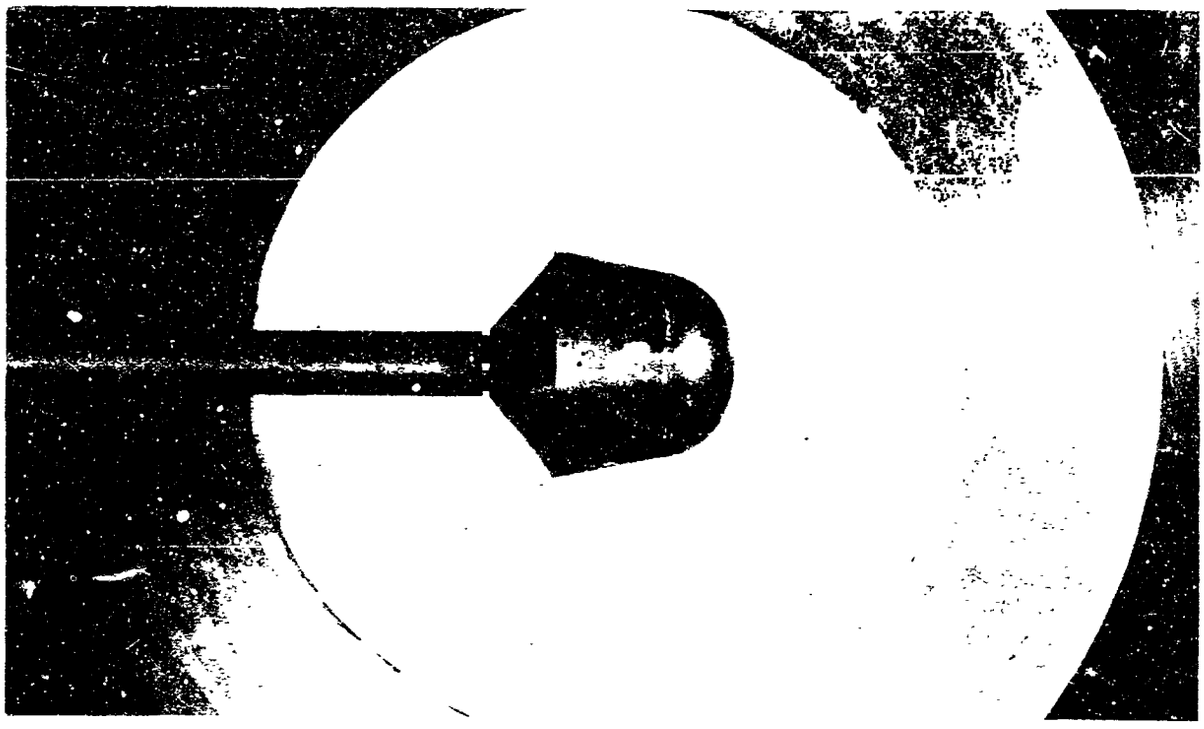

Fig. 1. Installation of model configurations I

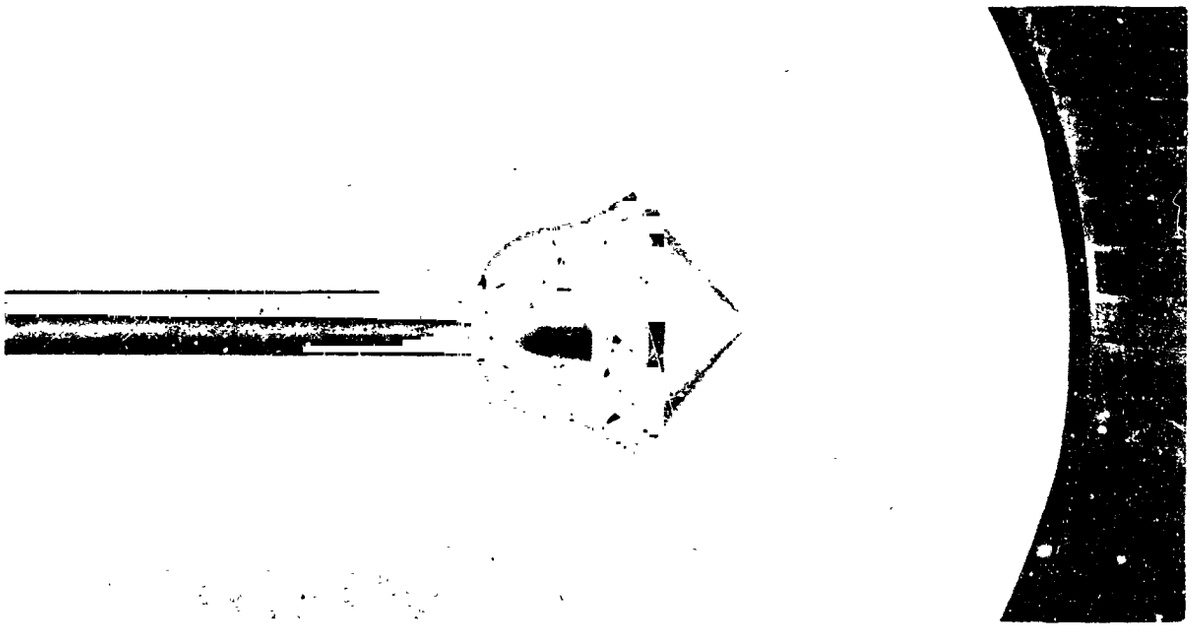

Fig. 2. Installation of model configurations V_5

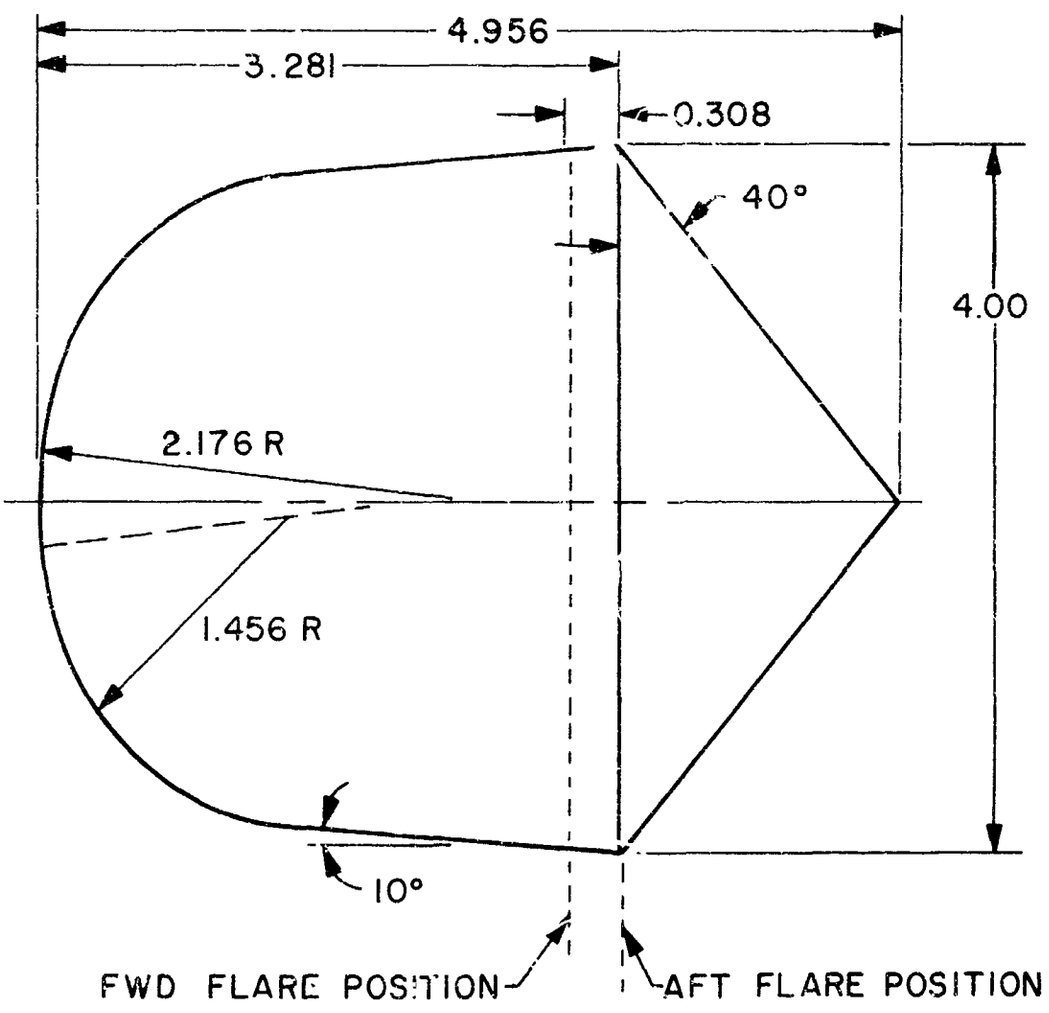

Fig. 3. Model dimensions

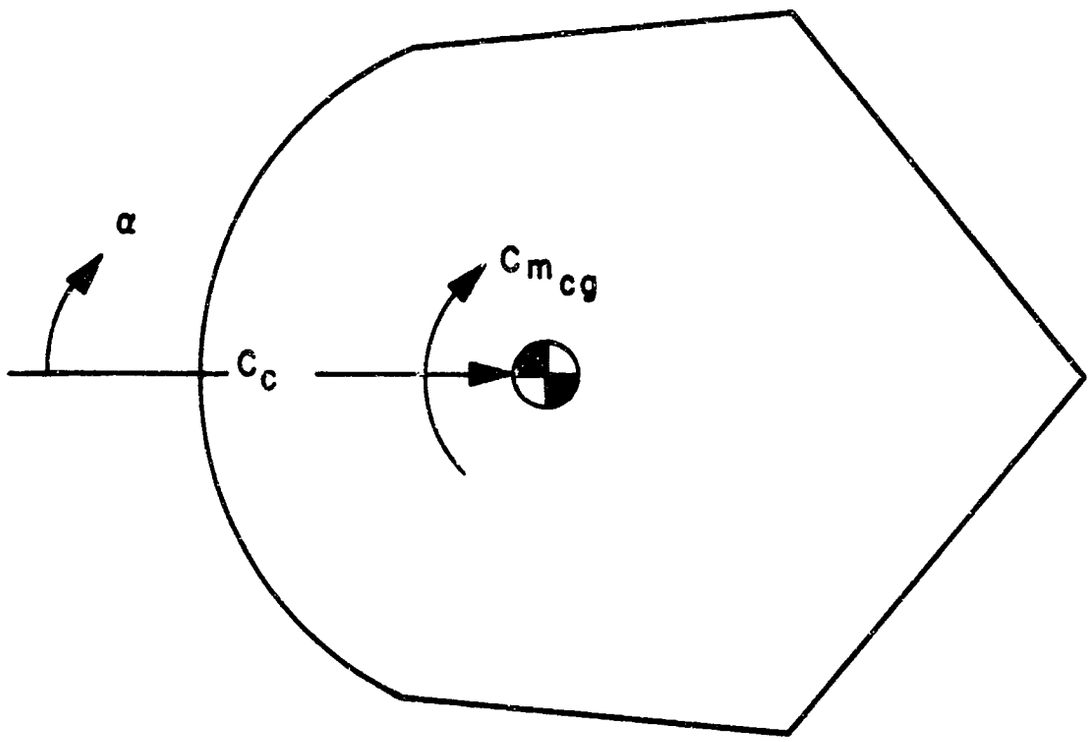

Fig. 4. Sign conventions

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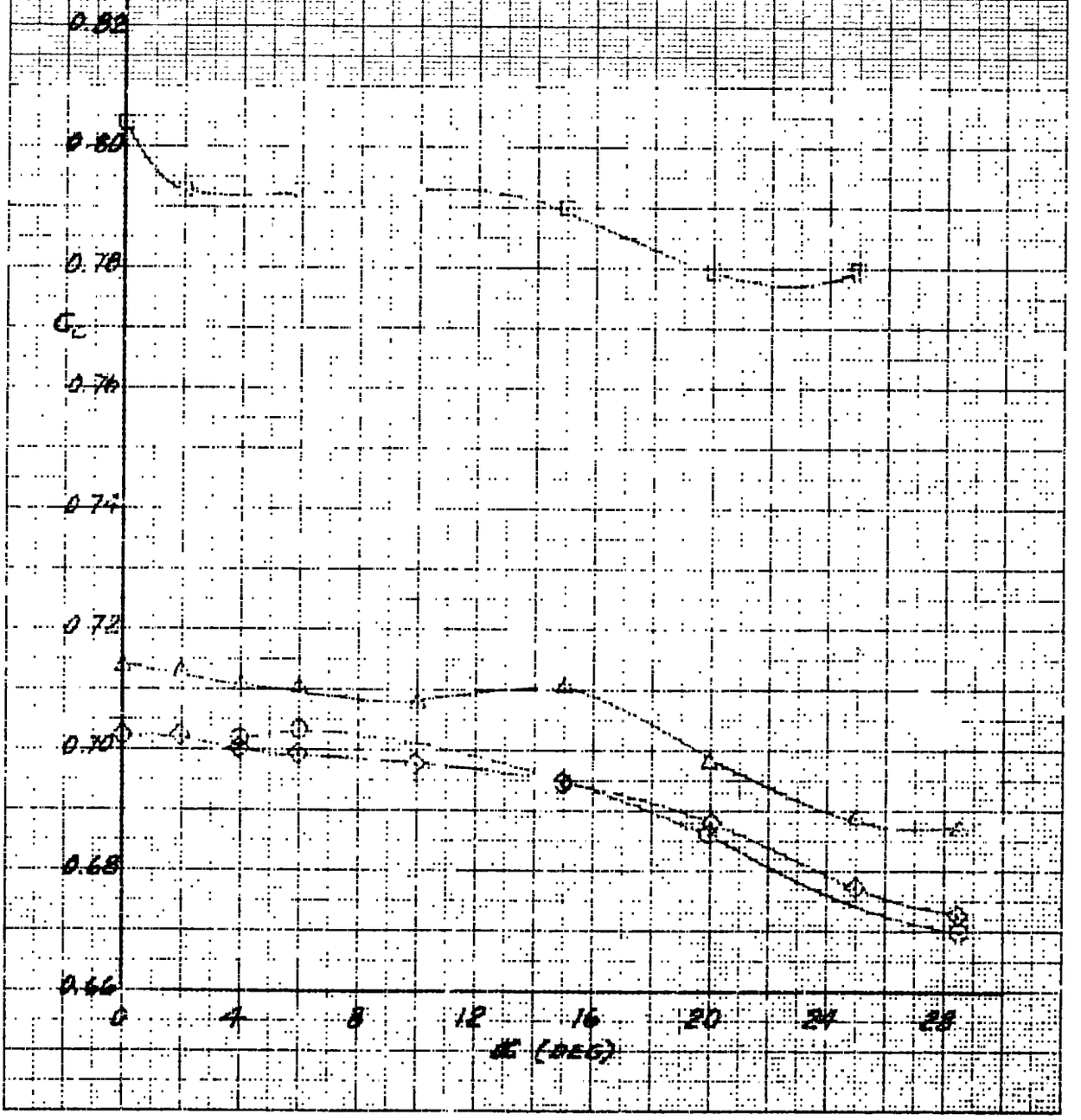
TEST	RUN	MACH	P_t (Kn/m²)	T_t °F	$Re/m \times 10^{-6}$	MAX FLARE DIA.	FLARE ANGLE	FLARE POSITION
21-115	○ 2	6.00	900	400	0.261	NO FLARE	—	—
↓	△ 10	↓	400	400	0.096	↓	↓	↓
↓	□ 12	↓	100	1000	0.013	↓	↓	↓
20-512	◇ 2	4.54	330	100	0.347	↓	↓	↓

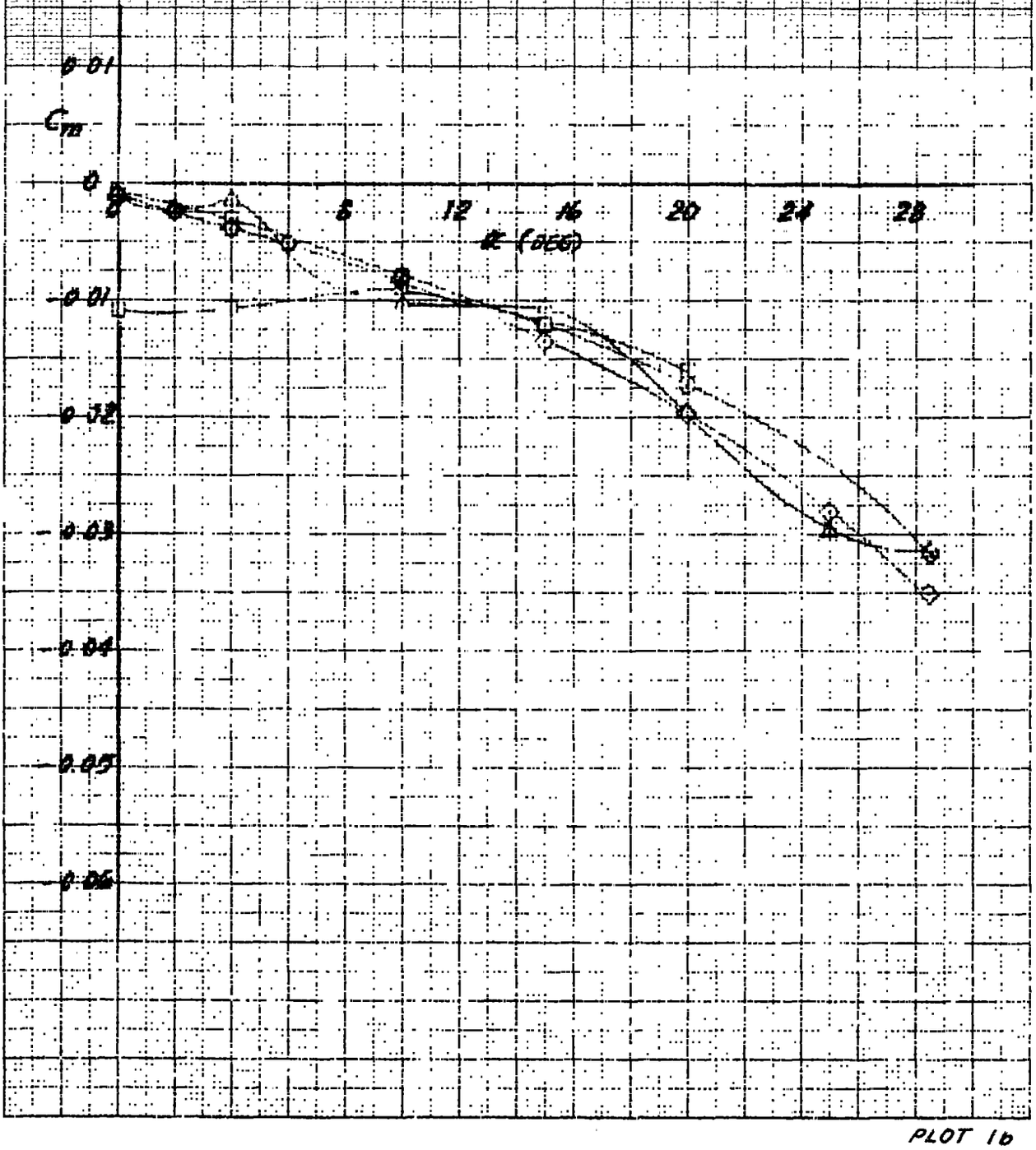


PLOT 1a

K-E

JPL WT 21-115

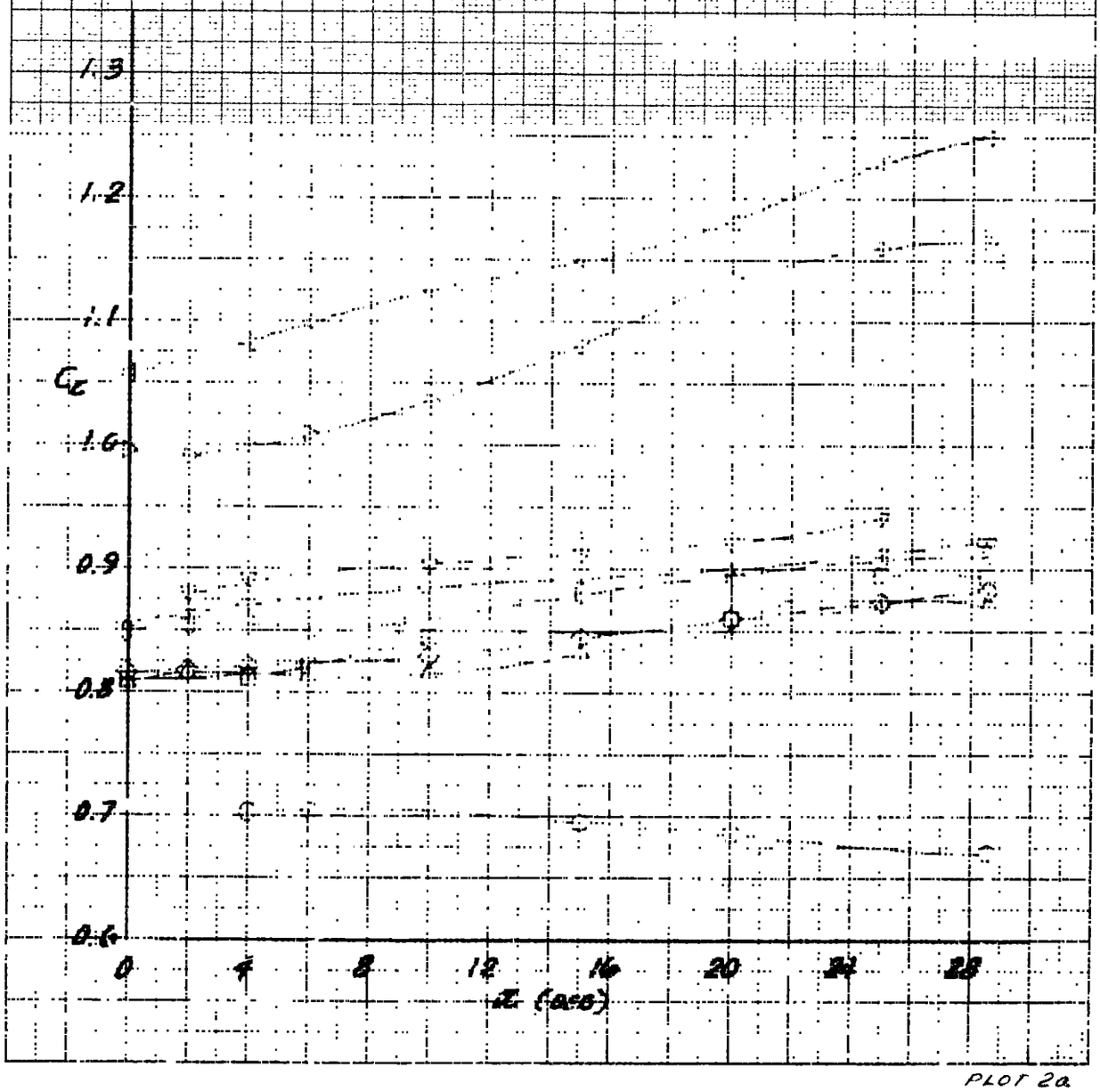
TEST	RUN	MACH	P_t (cm Hg)	T_t °F	$R_{e/inch} \times 10^{-6}$	MAX FLARE DIA	FLARE ANGLE	FLARE POSITION
21-115	○ 2	6.00	900	400	0.261	No FLARE	—	—
	△ 10		400	400	0.094			
	□ 12		100	1000	≈.013			
20-512	◇ 2	4.54	3.20	100	0.347			



PLOT 16

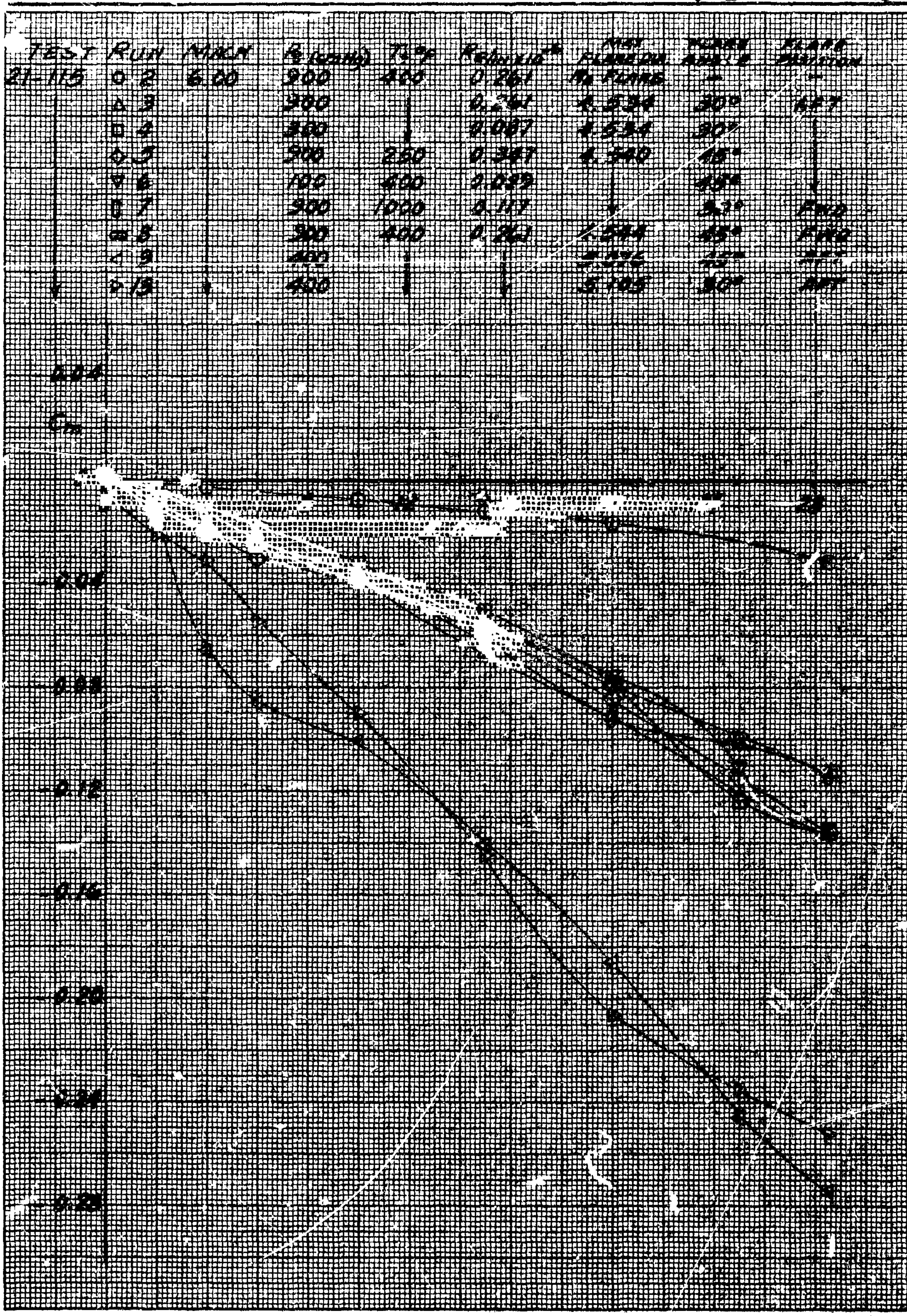
JPL WT 21-115

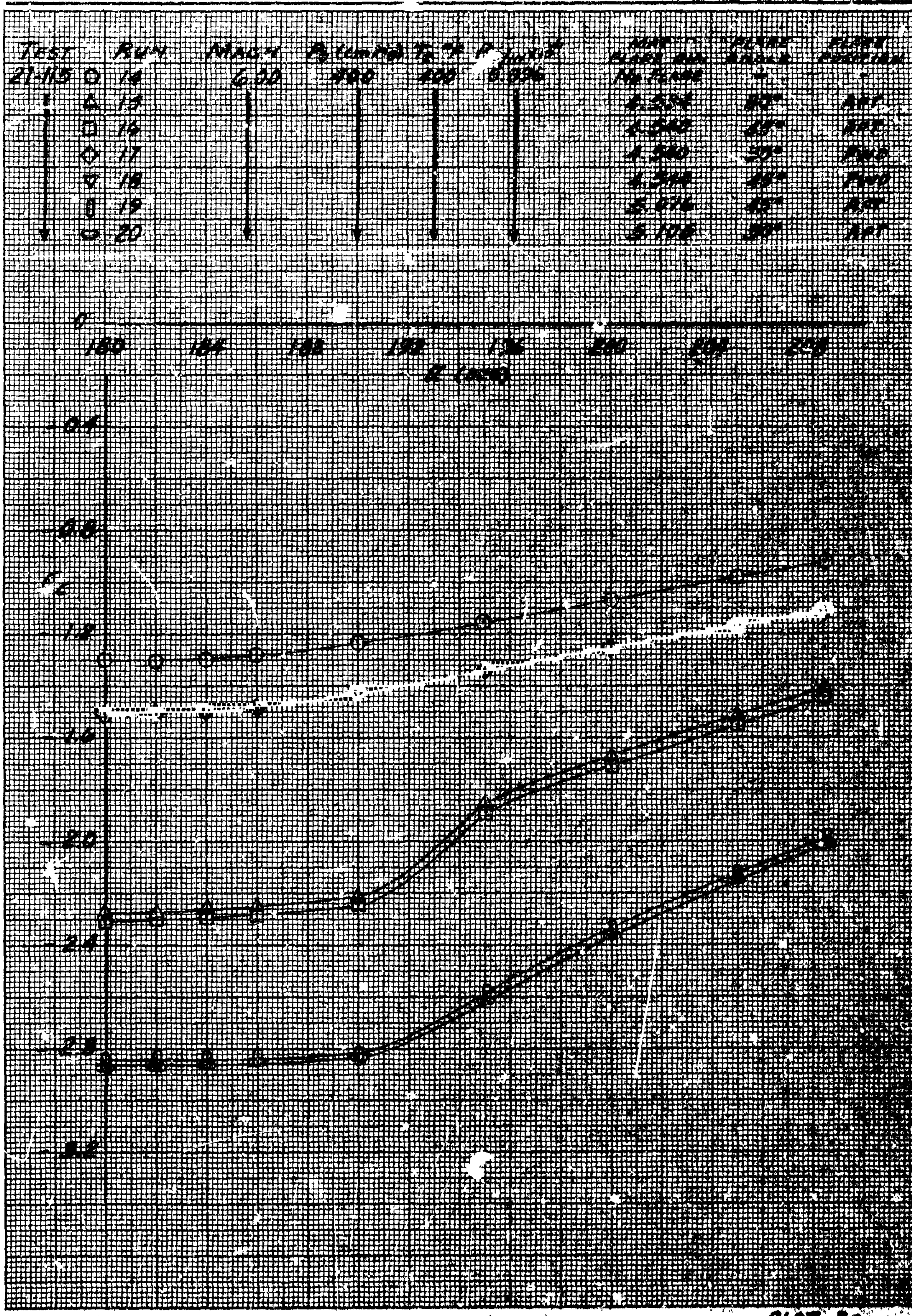
TEST	RUN	MACH	P_t (cm Hg)	T_t °F	$R_e/in \times 10^{-6}$	MAX FLARE DIA.	FLARE ANGLE	FLARE POSITION
21-115	○ 2	6.00	900	400	0.261	No Flare	—	—
	△ 3		900		0.261	4.534	30°	AFT
	□ 4		300		0.087	4.534	30°	
	◇ 5		900	250	0.347	4.540	45°	
	▽ 6		100	400	0.029		45°	
	⬡ 7		900	1000	0.117		30°	FWD
	⬭ 8		900	400	0.261	4.544	45°	FWD
	▽ 9		400			5.010	45°	AFT
	▷ 13		400			5.105	30°	AFT



PLOT 2a

K+E


TEST RUN MACH
21-115 ○ 2 6.00 900 400 0.261
△ 3 900 4.534 30° AFT
□ 4 300 0.087 4.534 30°
◇ 5 900 250 0.347 4.540 45°
▽ 6 100 400 45°
7 900 1000 0.117 FWD
8 900 400 0.261 45° FWD
9 400
13 400 5.105 90° AFT
0.04
Cm
-0.04
-0.08
-0.12
-0.16
-0.20
-0.24
-0.28


TEST
RUN
MACH
21-115
14
15
16
17
18
19
20
6.20
NO FLARE
APT
FWD
180
184
188
200
208
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-2.4
-2.8
-3.2

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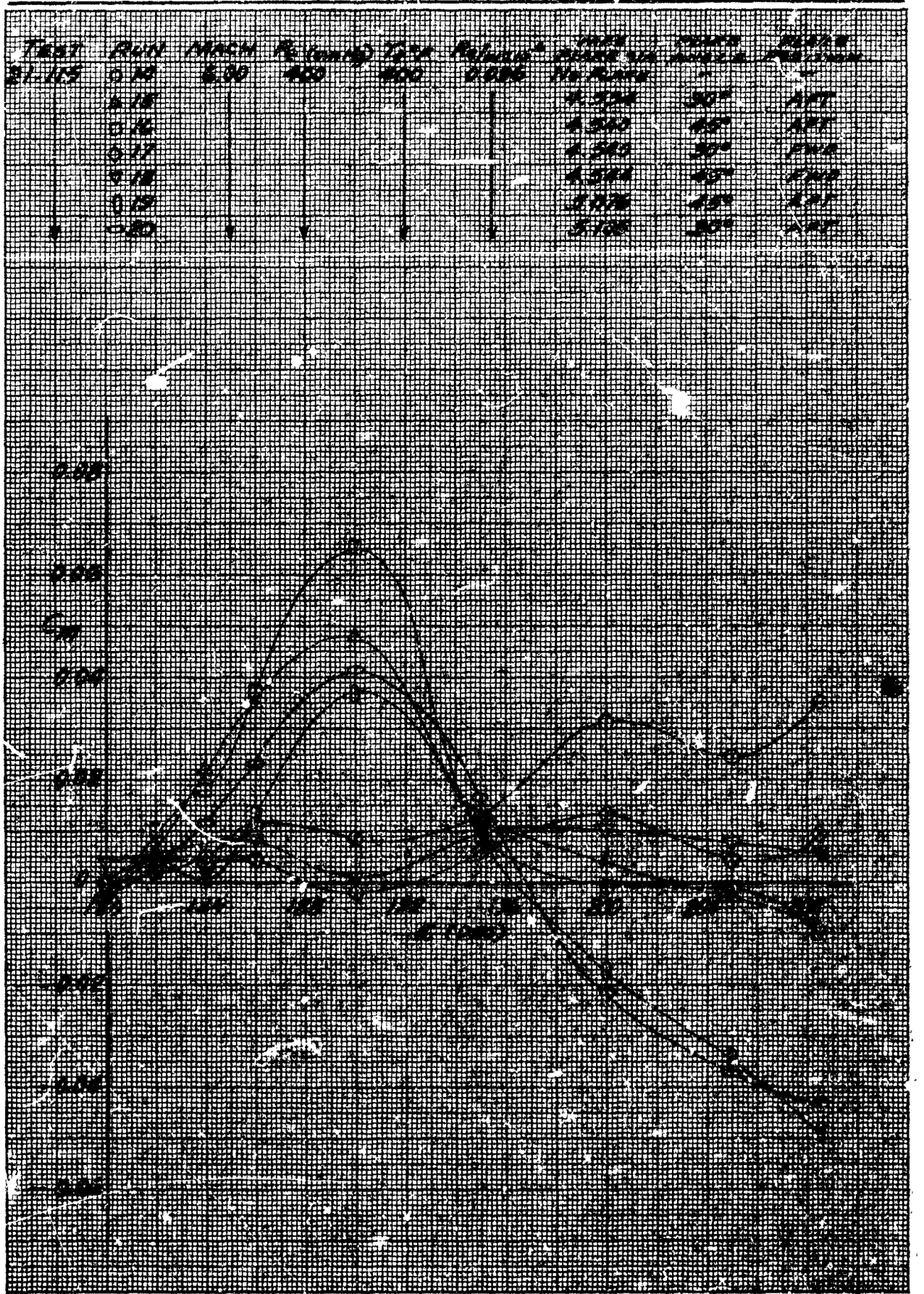
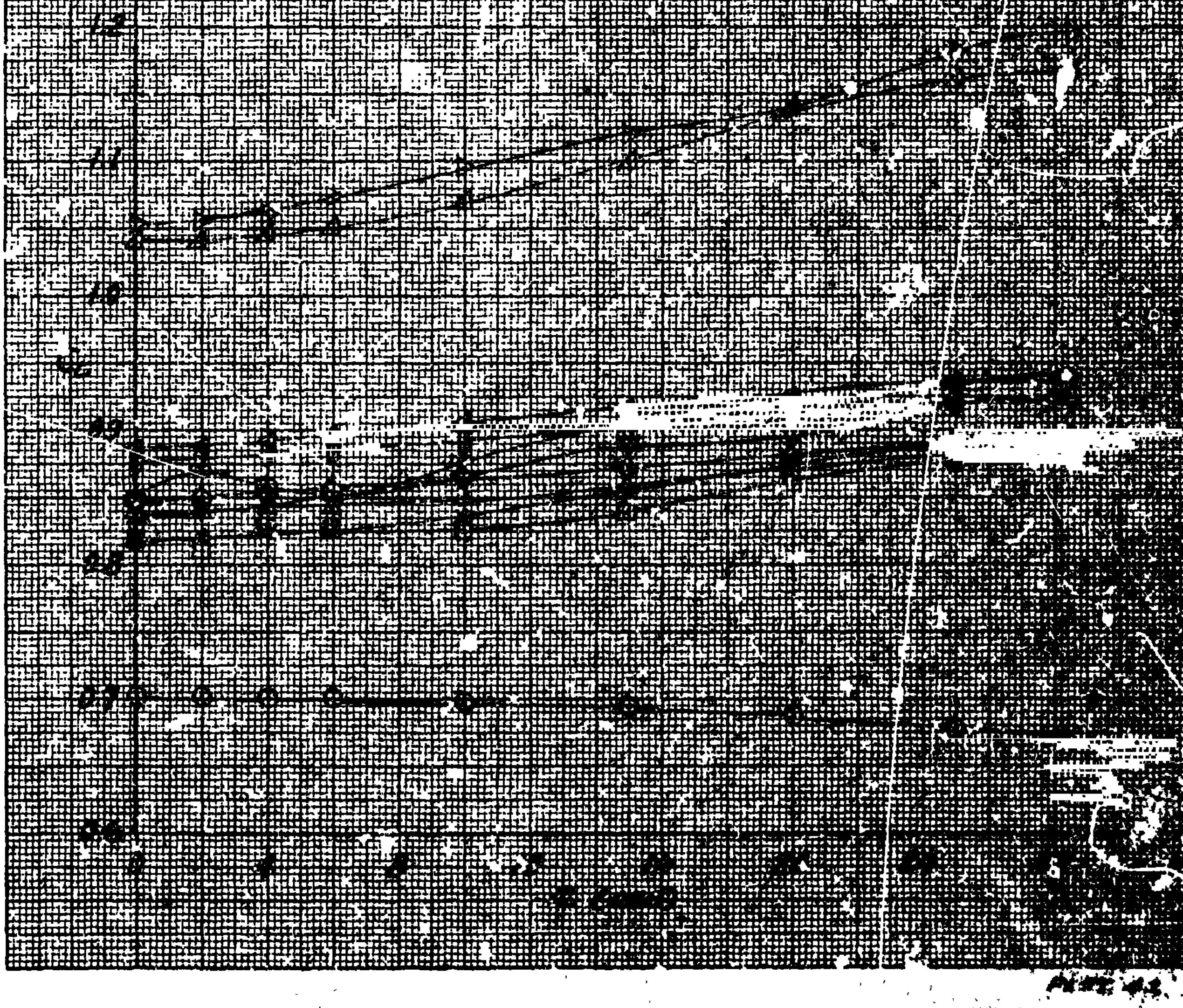


PLOT 36

TEST	RUN	MACH						
20-512	○ 2	4.54	330	100	0.347	[illegible]		
	△ 3		330		0.347	[illegible]	90°	[illegible]
	□ 4		40		0.042	[illegible]	90°	
	◇ 5		330		0.347	[illegible]	45°	
	▽ 6		40		0.042		45°	
	7		330		0.347		90°	[illegible]
	8		40		0.042		90°	
	9		330		0.347	[illegible]	45°	
	▷ 10					[illegible]	45°	[illegible]
	11					[illegible]	90°	
	× 20		[illegible]		0.024	[illegible]	90°	



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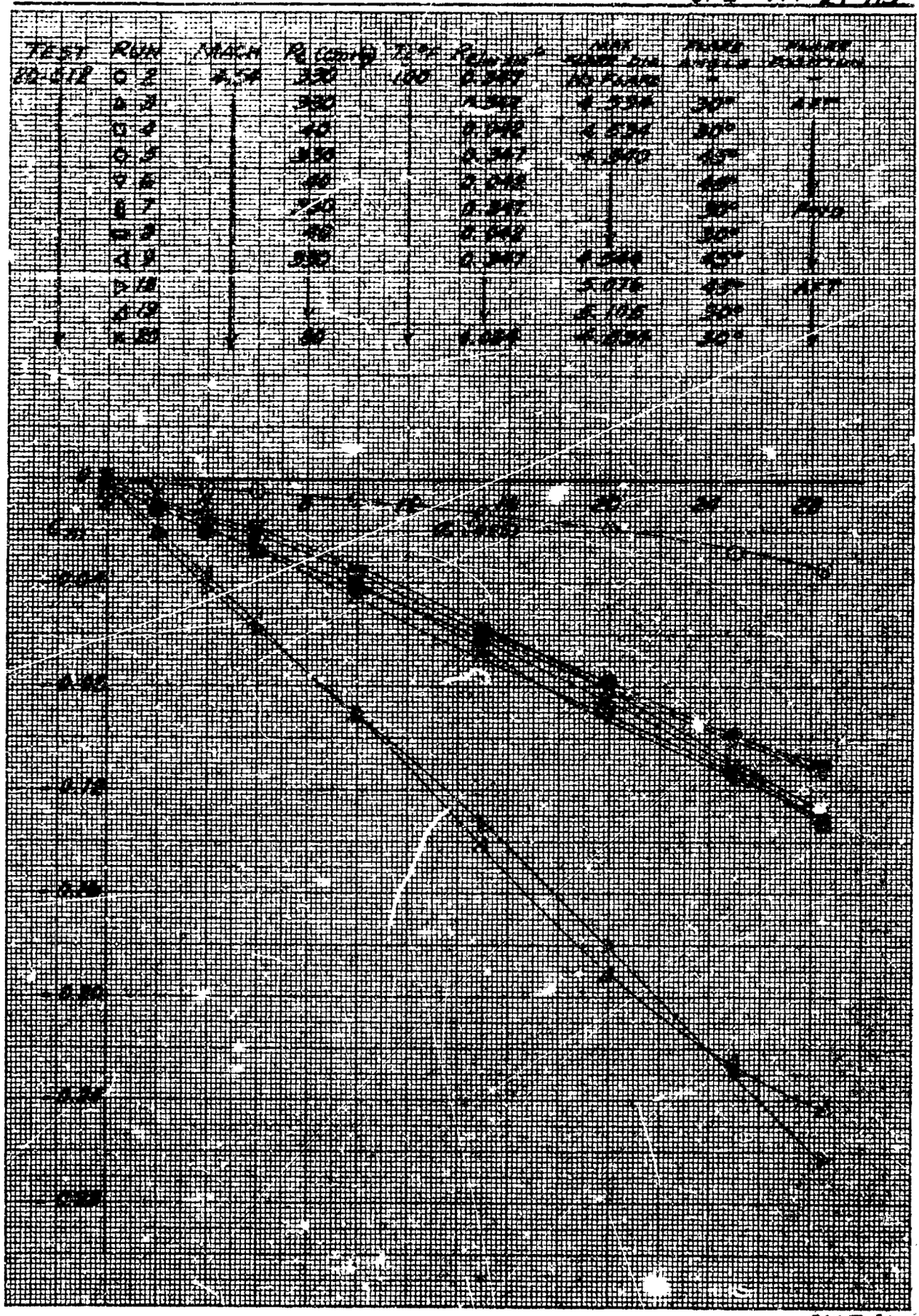
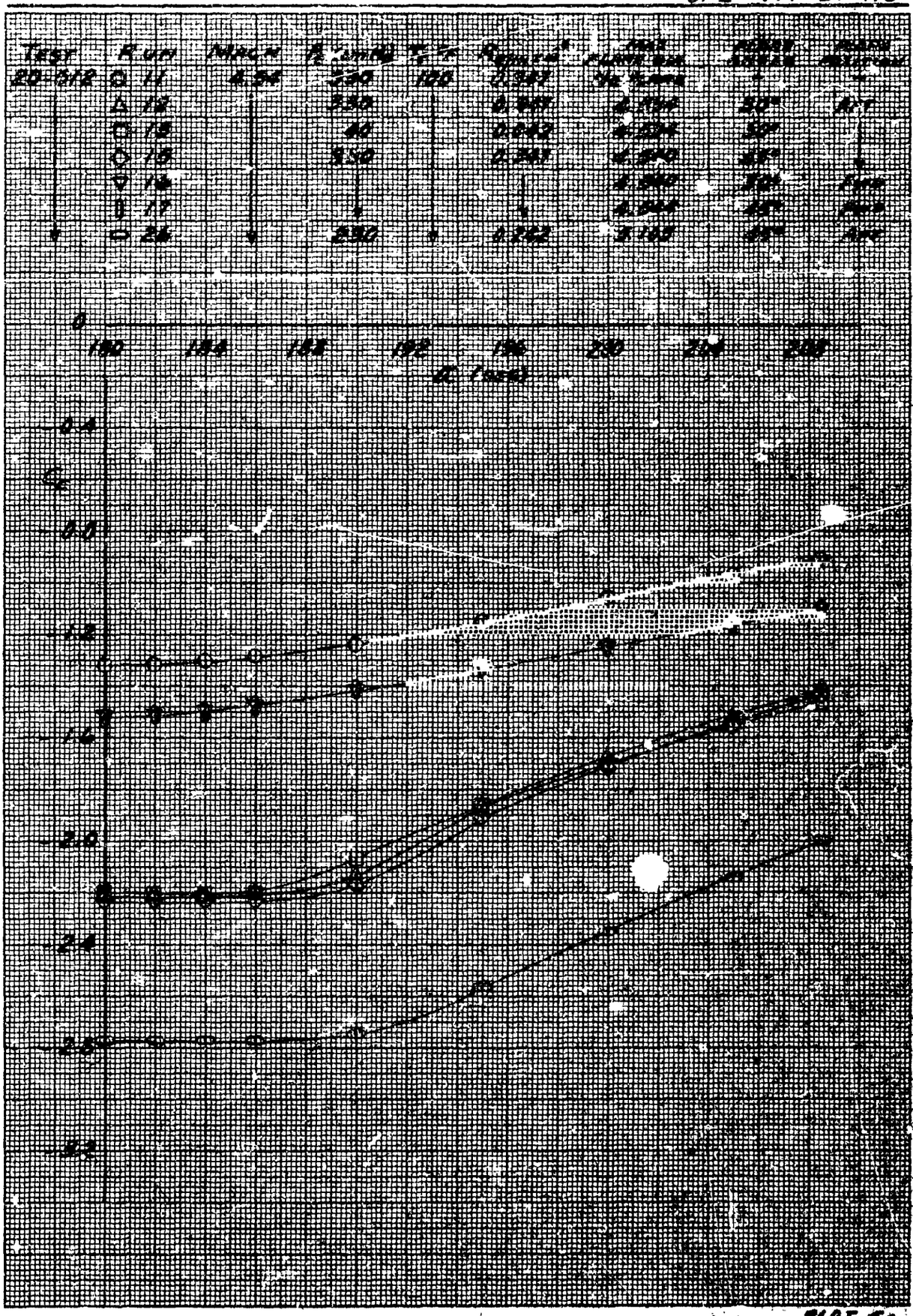


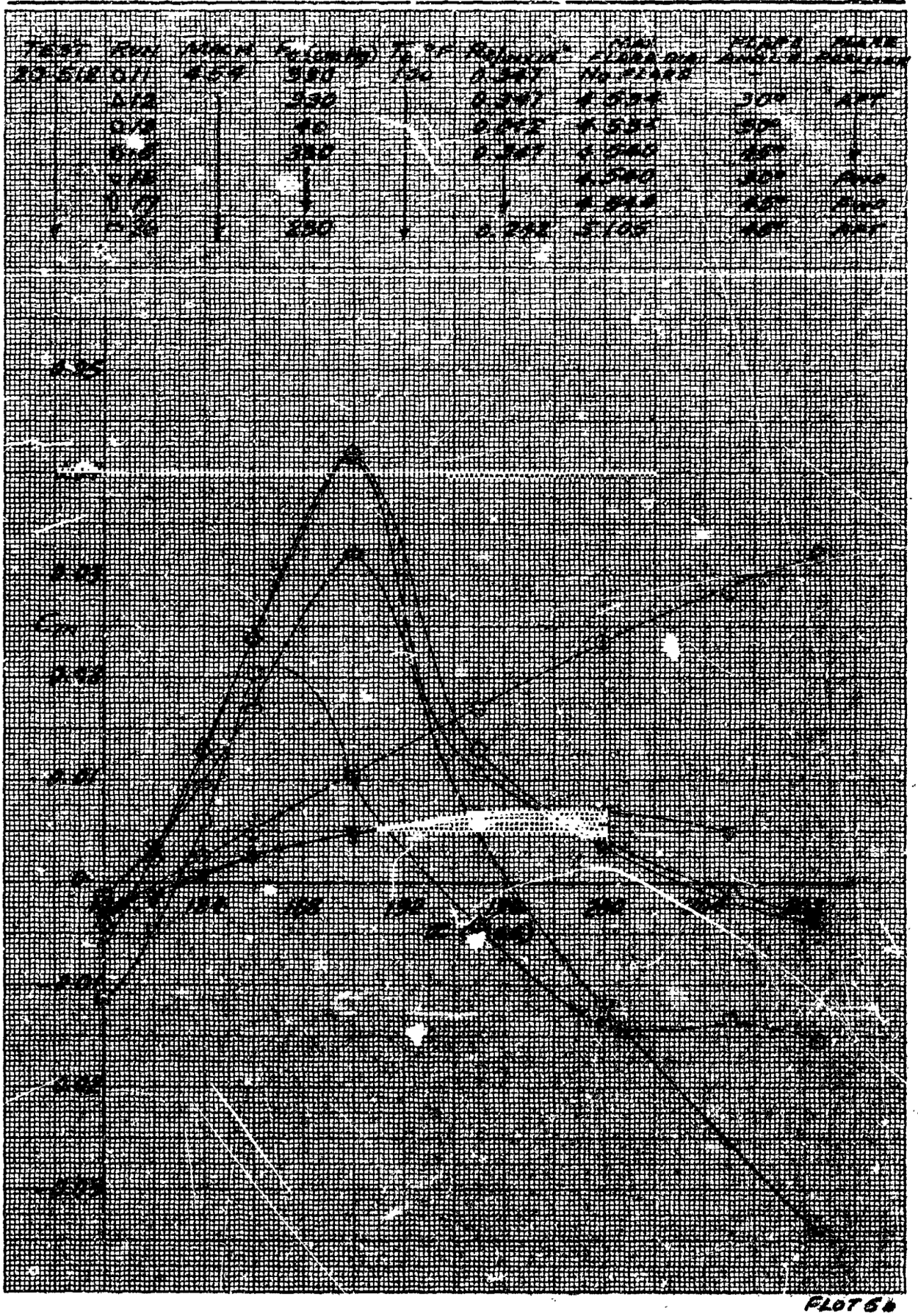
PLOT 46

JPL WT 21-115



PLOT 5a

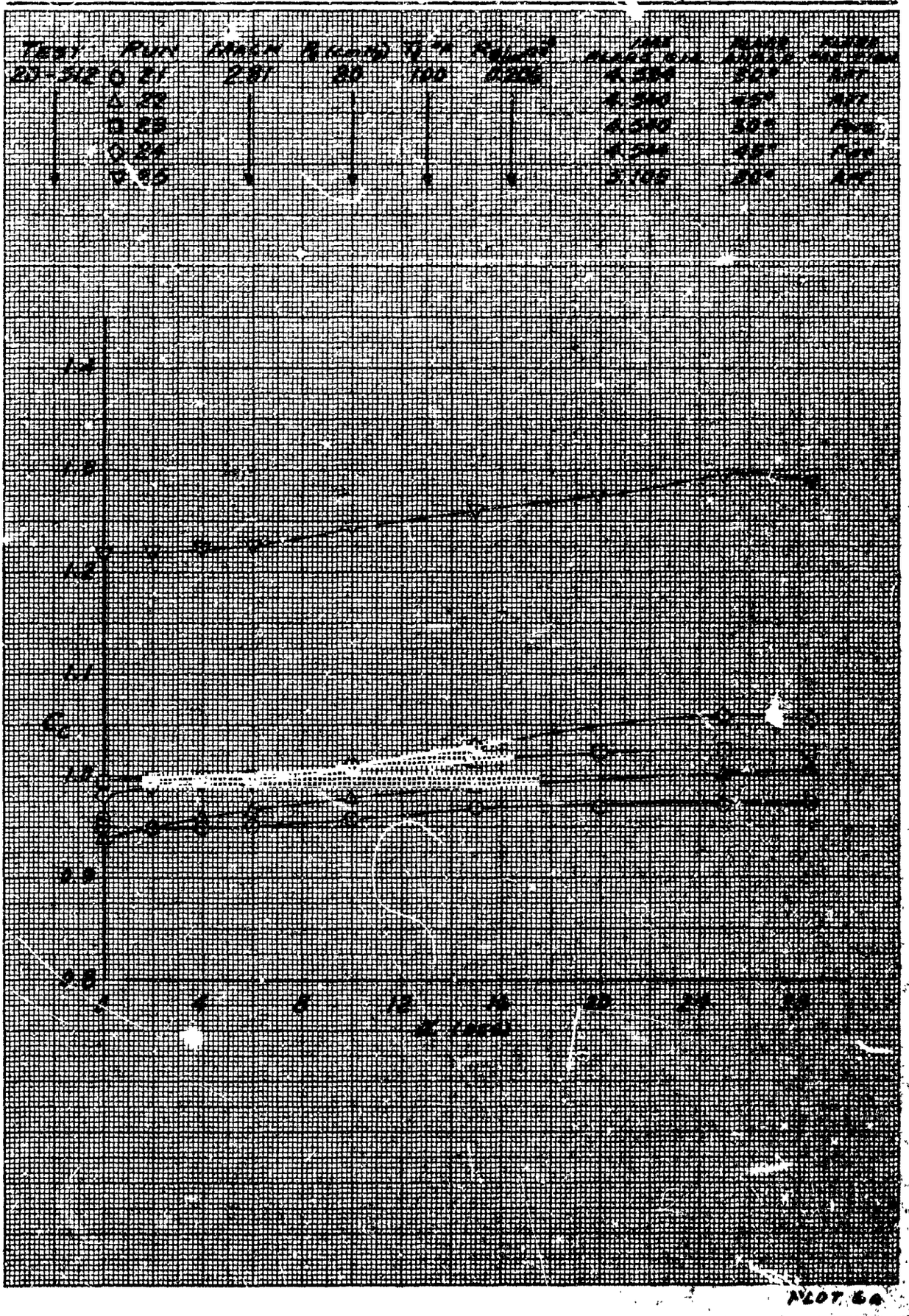
JPL WT 21-115



PLOT 6

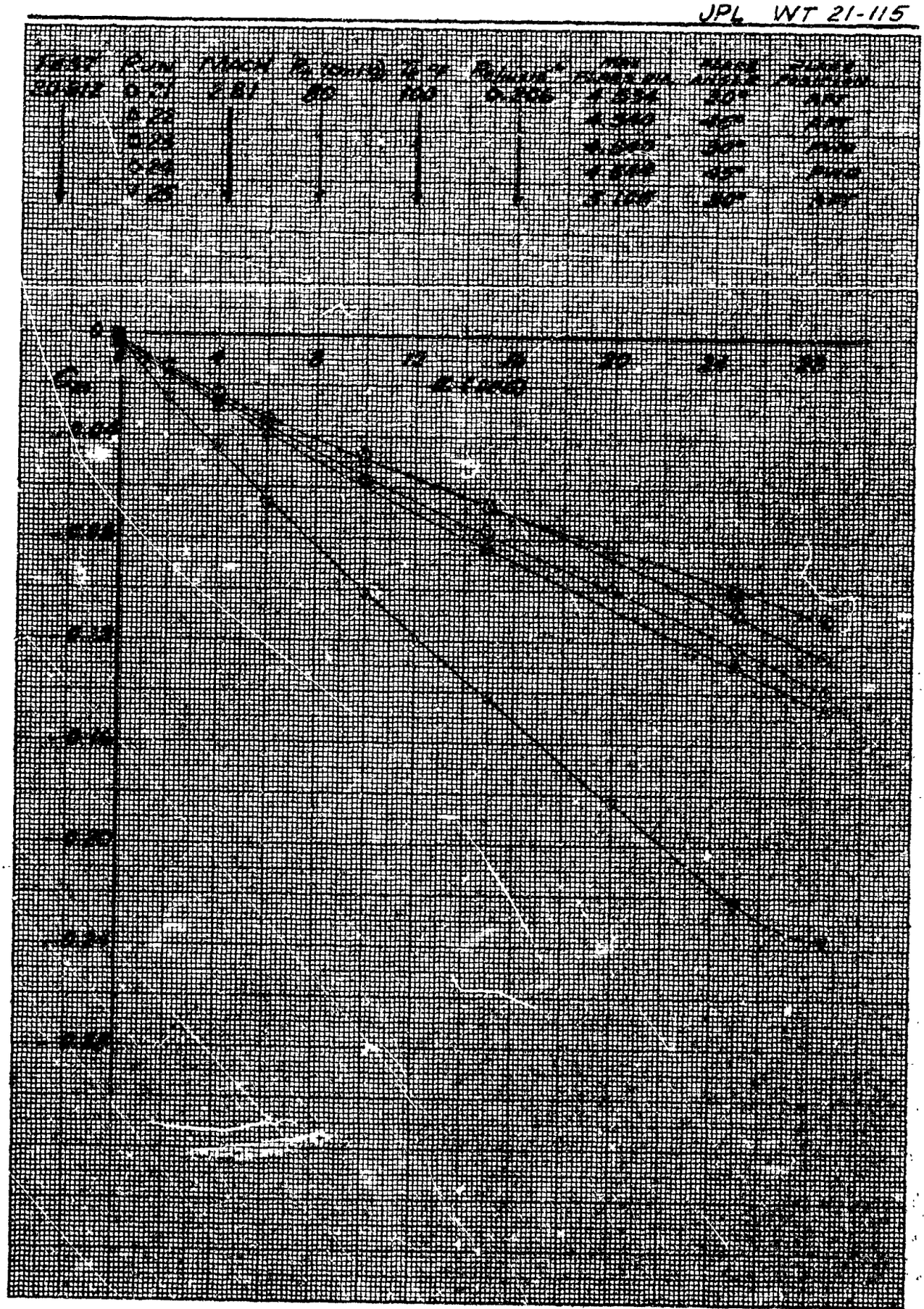
K-E

JPL WT 21-115



K&E

JPL WT 21-115



PLOT 66