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CR-134132

(NASA-CR-134132) AN EXPERIMENTAL PROGRAM USING A 9.7 DEG HALF-ANGLE CONE MODEL AT FREE STREAM MACH NUMBER EQUALS 4.88 AND ALPHA PRIME S OF 10 DEG AND 29.5 DEG (Texas Univ.) 16 p HC $3.00 CSCL 01A

N74-11811

Unclas

G3/01 23098

"AN EXPERIMENTAL PROGRAM USING A 9.7^{o} HALF-ANGLE CONE MODEL AT M_{∞} = 4.88 AND α'S OF 10^{o} AND 29.5^{o}"

by H. Tom Faria

Aerospace Engineering Report 73004

NAS 9-10976

Department of Aerospace Engineering and
Engineering Mechanics

The University of Texas at Austin
September 1973

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INTRODUCTION

The following report presents data on the flow field of a blunted cone model, which were obtained at the request of NASA Johnson Space Center. The experimental work was performed in the Universtiy of Texas Supersonic Wind Tunnel. The data obtained consist of surface pressure measurements, surface oil flow photographs, and schlieren photographs. Because of other commitments, time is not available to analyze these data at present. Thus, the objective of the report is to make these data available for others who may wish to use them.

Contract NAS 9-10976

EXPERIMENTAL PROGRAM

Facility

The tests were conducted in the University of Texas Supersonic Wind Tunnel. The facility is a two-dimensional, blow down type wind tunnel, using air as a test gas. The test section cross-section dimensions are width 6.0 in. (15.3 cm.) by height 7.0 in (17.8 cm.). The test section diverges slightly along its length to accommodate boundary layer growth.

At a free-stream Mach number of 5 the free-stream Reynolds number range is 15×10^6 to 26×10^6 per ft. (49×10^6 to 85×10^6 per m.). The data taking period for the high Reynolds number is approximately 40 seconds in duration.

A photograph of a typical test setup is presented in figure 1.

A mercury filled manometer board was used to measure model surface pressure data. Once the mercury levels reached steady-state during the run, the pressure leads were sealed with a knife switch and the pressures read. The maximum visual error in reading the manometer board was on the order of ± 0.02 in. (± 0.05 cm). This corresponds to a pressure error of ± 0.01 psi. (± 7x10 N/m^2).

Model

The model was a 9.7^o half-angle cone with a 0.25 in. (0.63 cm.) radius spherical nose cap. The total model length was 2.99 in (7.60 cm.). The model was fabricated from acrylic plastic and instrumented with 19 pressure taps. The locations of the taps are presented in table 1. The zero reference for the axial position is the nose apex and the zero reference for the angular position is the most windward ray of the cone.

Table 1: Pressure Tap Locations

Tap no.	Axial Position (in.)	(cm.)	Angular Position (degrees)
1	.44	1.12	6
2	.44	1.12	40
3	.48	1.22	94
4	.46	1.17	118
5	.43	1.09	146
6	.44	1.12	178
7	.94	2.39	7
8	.94	2.39	45
9	.95	2.41	68
10	.96	2.44	95
11	.94	2.39	119
12	.94	2.39	147
13	.92	2.34	188
14	1.89	4.80	0
15	1.91	4.85	46
16	1.90	4.82	75
17	1.94	4.93	119
18	1.89	4.80	150
19	1.89	4.80	183

Test Program

The test program consisted of seven runs for each angle of attack. The run sequence was:

1) surface pressure measurement,

2) free-stream Mach number establishment by use of a pitot probe,

3) side view oil flow photograph,

4) top view oil flow photograph,

5) bottom view oil flow photograph,

6) side view schlieren photograph, and

7) top view schlieren photograph.

The angles of attack tested were $\alpha = 10^\circ$ and $\alpha = 29.5^\circ$.

Nominal test conditions were:

stagnation pressure - 250 psig. (1.75×10^6 N/m^2)

stagnation temperature - 535°R (297°K)

free-stream Mach number - 4.88

free-stream Reynolds number - 17.4×10^6 per ft. (57×10^6 per m)

RESULTS

No analysis of the data is presented in this report.

The surface pressure distributions are presented as computer output in tabular form. Tables 2 and 3 present the surface pressures for angles of attack of 10^{o} and 29.5^{o} respectively. The output format consists of the heading, which identifies the run and pertinent parameters, and the surface pressures in tabulated form. Definitions of the parameter names follow:

MODEL - model identification

ALPHA - angle of attack (degrees)

IRUN - run number

IMO - month

IDAY - day of month

UREINF - free-stream unit Reynolds number per ft.

FSMACH - free-stream Mach number

PINF - free-stream static pressure as computed from the free-stream Mach number (psia.)

PT1 - stagnation pressure in the tunnel stilling chamber (psia.)

PINFM* - pressure measured using an orifice in the tunnel wall

PT2 - stagnation pressure behind a normal shock in the test section

*The wall pressure does not represent the free-stream static pressure and; therefore, is not normally used for the data analysis performed at the University of Texas. Therefore, the wall pressure was not measured.

I - pressure tap number

CIRC - angular position of pressure tap (CIRC = 0. is the most windward ray - degrees)

AXIAL - axial position of pressure tap (AXIAL = 0. is the model apex - in.)

P(I) - pressure measurement (psia.)

PRAT(I) - P(I)/PINF

PEXP(I) - P(I)/PT2

The data photographs are presented in the following order:

Figure No.	Photograph topic
2	side view surface oil flow $\alpha = 10^{\circ}$
3	oblique view surface oil flow $\alpha = 10^{\circ}$
4	top view surface oil flow $\alpha = 10^{\circ}$
5	bottom view surface oil flow $\alpha = 10^{\circ}$
6	side view schlieren $\alpha = 10^{\circ}$
7	top view schlieren $\alpha = 10^{\circ}$
8	side view surface oil flow $\alpha = 30^{\circ}$
9	top view surface oil flow $\alpha = 30^{\circ}$
10	bottom view surface oil flow $\alpha = 30^{\circ}$
11	side view schlieren $\alpha = 30^{\circ}$
12	top view schlieren $\alpha = 30^{\circ}$.

Table 2: Surface pressure distribution for $\alpha = 10^{\circ}$

MODEL	ALPHA	IRUN	IMO	IDAY	UREINF
CONE	10	3	9	7	1.74103E+07

FSMACH	PINF	PT1	PINFM	PT2
4.88	5.73175E-01	2.63345E+02	~~1.30787E+01~~	1.78413E+01

I	CIRC	AXIAL	P(I)	PRAT(I)	PEXP(I)
1	6.00	.440	2.49361E+00	4.35053E+00	1.39766E-01
2	40.00	.440	2.30206E+00	4.01634E+00	1.29030E-01
3	94.00	.480	1.71758E+00	2.99661E+00	9.62700E-02
4	118.00	.460	1.35413E+00	2.36250E+00	7.58983E-02
5	146.00	.430	9.61198E-01	1.67697E+00	5.38749E-02
6	178.00	.440	9.07171E-01	1.58271E+00	5.08467E-02
7	7.00	.940	2.47397E+00	4.31626E+00	1.38665E-01
8	45.00	.940	2.23330E+00	3.89637E+00	1.25176E-01
9	68.00	.950	1.56041E+00	2.72240E+00	8.74600E-02
10	95.00	.960	1.21660E+00	2.12257E+00	6.81901E-02
11	119.00	.940	8.97348E-01	1.56557E+00	5.02961E-02
12	147.00	.940	7.30354E-01	1.27423E+00	4.09361E-02
13	188.00	.920	8.04028E-01	1.40276E+00	4.50655E-02
14	0.00	1.890	2.87181E+00	5.01035E+00	1.60964E-01
15	46.00	1.910	2.53291E+00	4.41908E+00	1.41969E-01
16	75.00	1.900	1.75196E+00	3.05660E+00	9.81971E-02
17	119.00	1.940	8.62967E-01	1.50559E+00	4.83690E-02
18	150.00	1.890	7.94204E-01	1.38562E+00	4.45149E-02
19	183.00	1.890	9.51375E-01	1.65983E+00	5.33243E-02

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Table 3: Surface pressure distribution for $\alpha = 29.5^{\circ}$

MODEL	ALPHA	IRUN	IMC	IDAY	UREINF
CONE	29.5	1	9	7	1.74776E+07

FSMACH	PINF	PT1	PINFM	PT2
4.88	5.75391E-01	2.64363E+02	~~1.41523E+01~~	1.79103E+01

I	CIRC	AXIAL	P(I)	PRAT(I)	PEXP(I)
1	6.00	.440	8.22397E+00	1.42928E+01	4.59176E-01
2	40.00	.440	6.61788E+00	1.15015E+01	3.69501E-01
3	94.00	.480	1.70629E+00	2.96544E+00	9.52685E-02
4	118.00	.460	1.60314E+00	2.78618E+00	8.95096E-02
5	146.00	.430	5.81532E-01	1.01067E+00	3.24692E-02
6	178.00	.440	6.25737E-01	1.08750E+00	3.49373E-02
7	7.00	.940	8.51866E+00	1.48050E+01	4.75630E-01
8	45.00	.940	6.94695E+00	1.20735E+01	3.87875E-01
9	68.00	.950	3.40079E+00	5.91039E+00	1.89879E-01
10	95.00	.960	1.62770E+00	2.82886E+00	9.08808E-02
11	119.00	.940	7.04322E-01	1.22408E+00	3.93250E-02
12	147.00	.940	4.98035E-01	8.65560E-01	2.78072E-02
13	188.00	.920	6.55206E-01	1.13872E+00	3.65827E-02
14	0.00	1.890	8.49411E+00	1.47623E+01	4.74258E-01
15	46.00	1.910	7.11395E+00	1.23637E+01	3.97199E-01
16	75.00	1.900	3.56778E+00	6.20062E+00	1.99203E-01
17	119.00	1.940	8.41847E-01	1.46309E+00	4.70035E-02
18	150.00	1.890	6.65029E-01	1.15579E+00	3.71311E-02
19	183.00	1.890	8.17289E-01	1.42041E+00	4.56324E-02

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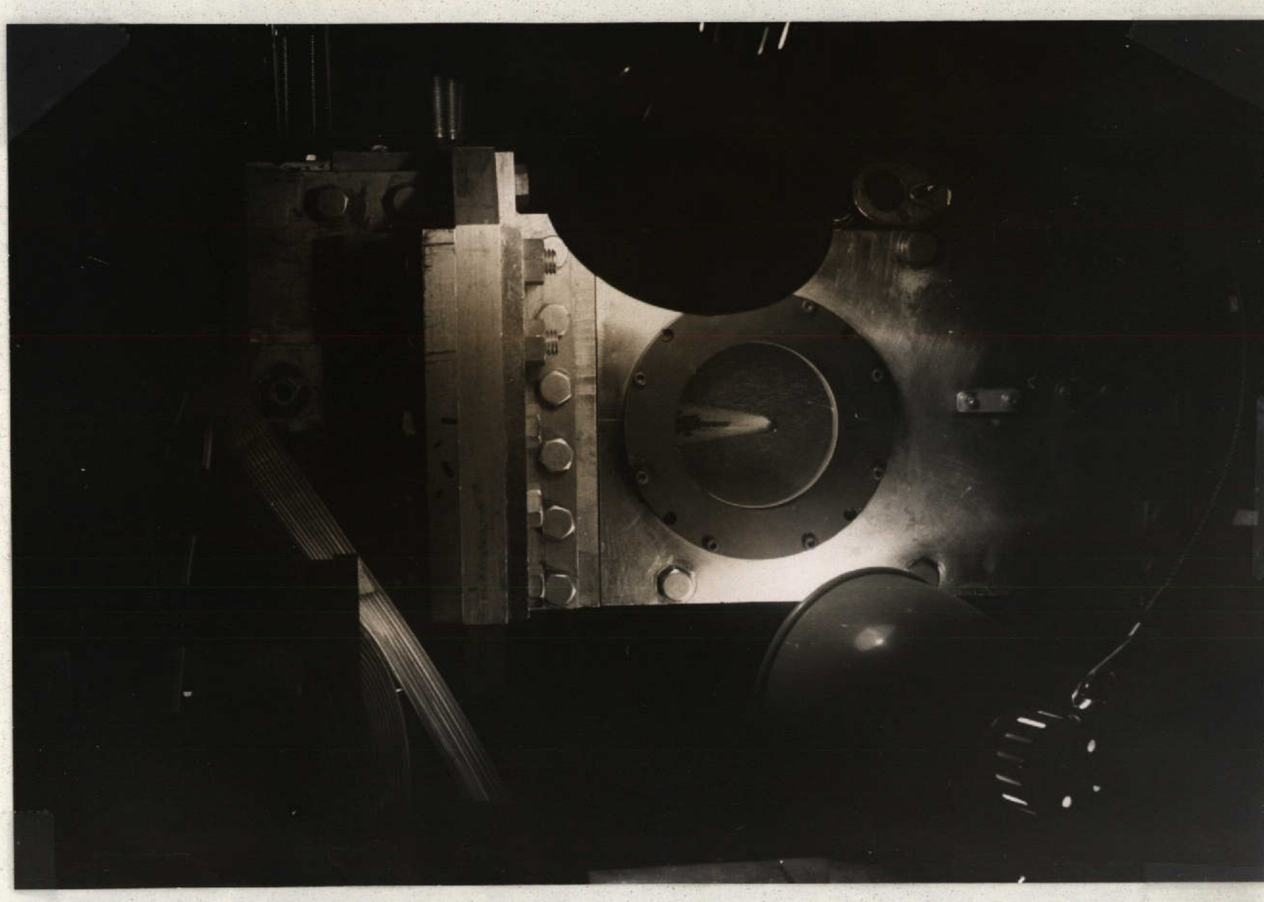

Figure 1: Typical test setup

Figure 2: Side view surface oil flow $\alpha = 10^{o}$

Figure 3: Oblique view surface oil flow $\alpha = 10^{\circ}$

Figure 4: Top view surface oil flow $\alpha = 10^{\circ}$

Figure 5: Bottom view surface oil flow $\alpha = 10^{\circ}$

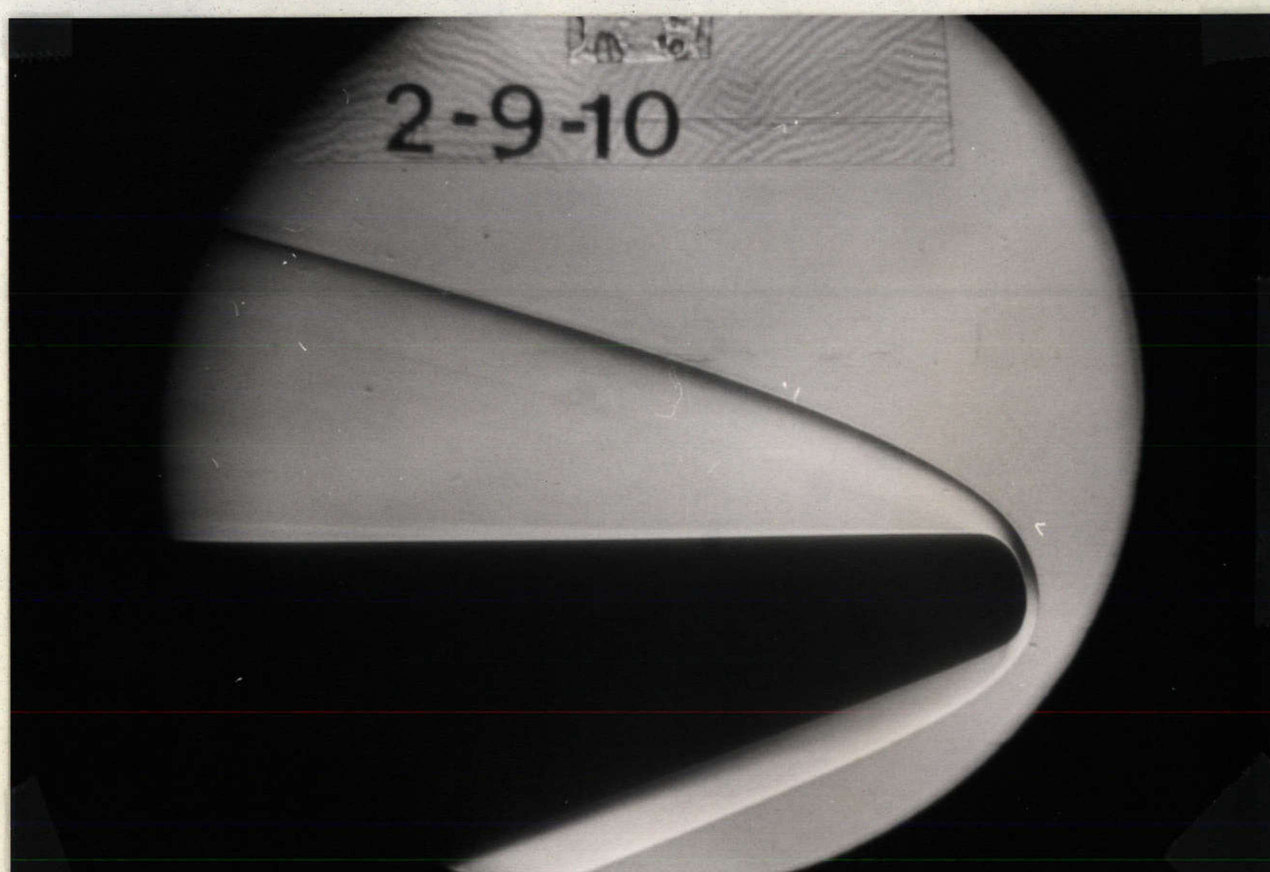

Figure 6: Side view schlieren $\alpha = 10^{\circ}$

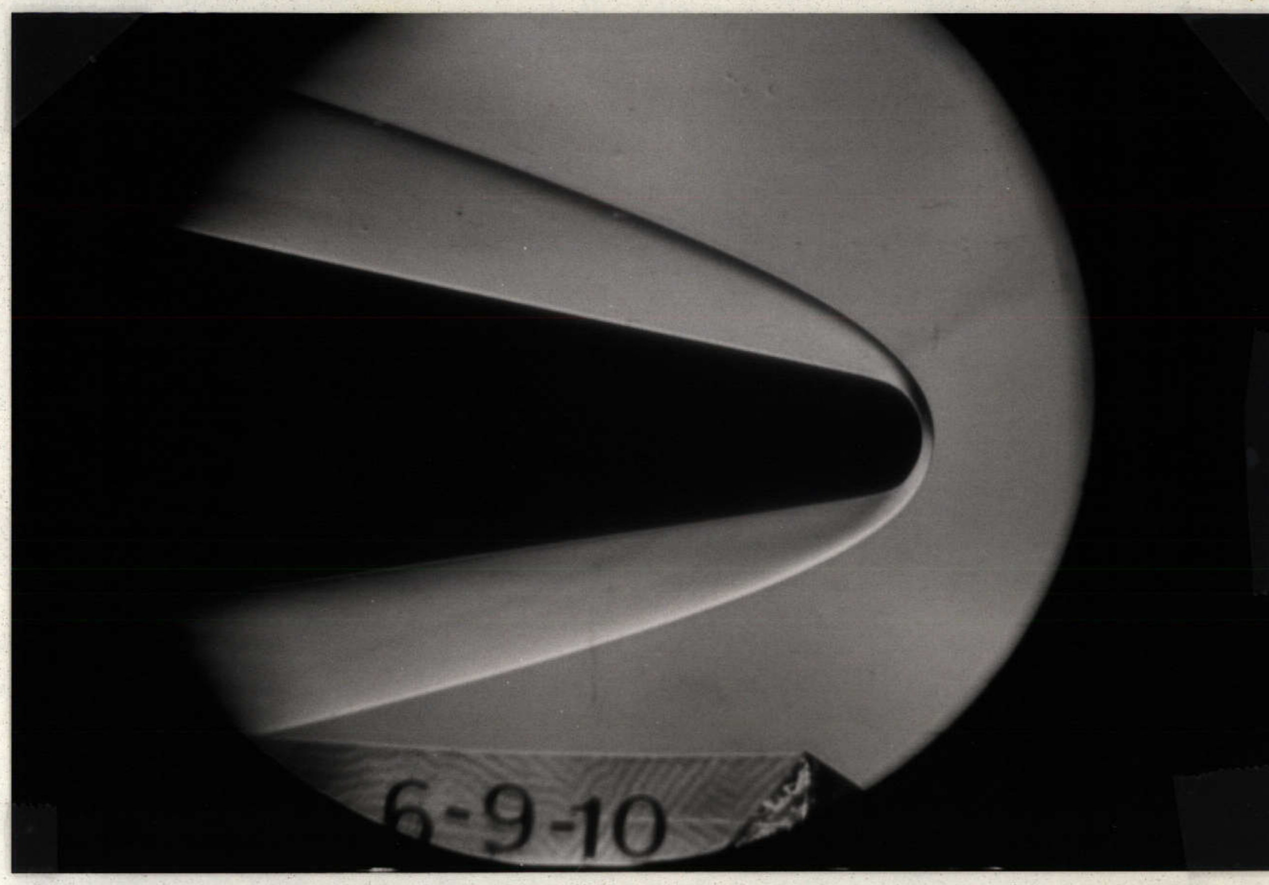

Figure 7: Top view schlieren $\alpha = 10^{o}$

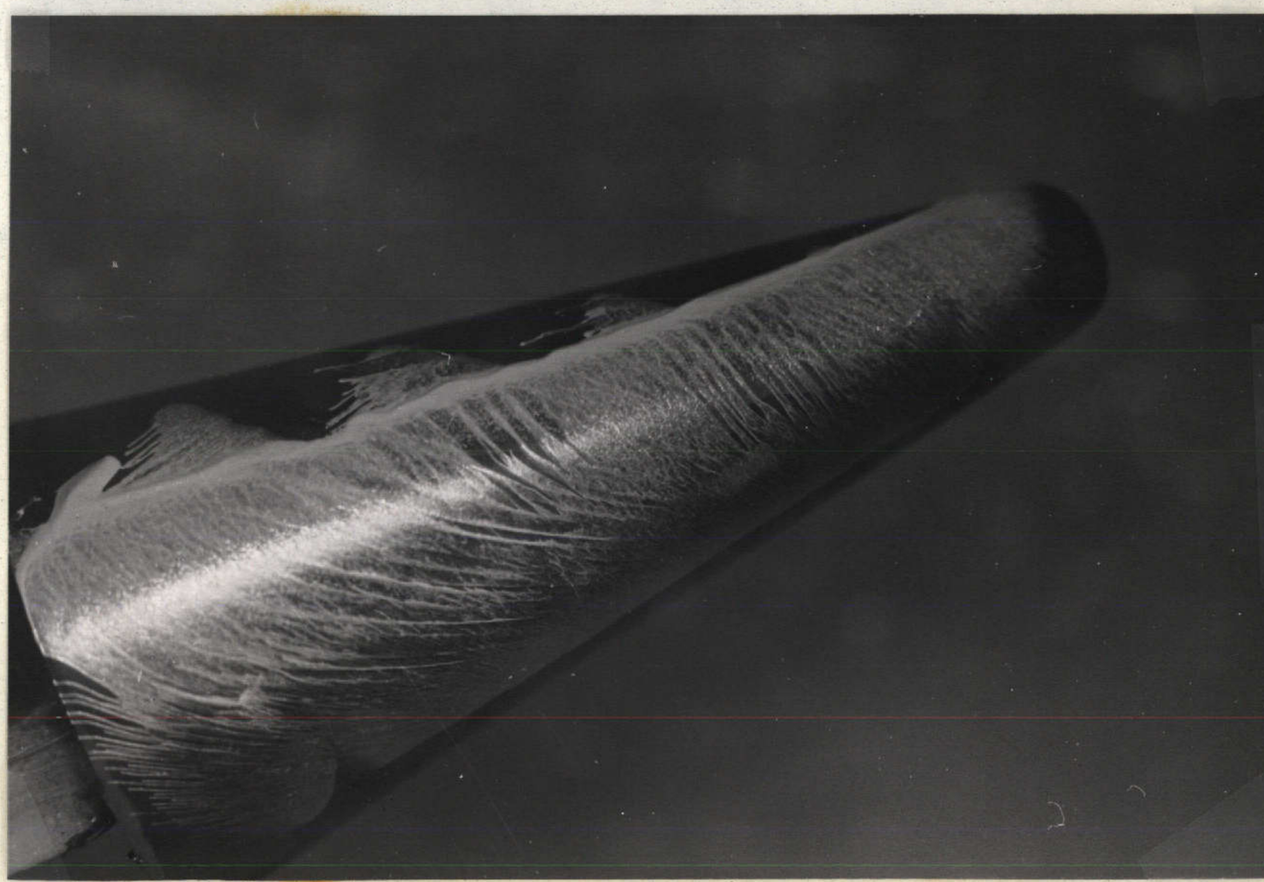

Figure 8: Side view surface oil flow $\alpha = 30^{o}$

Figure 9: Top view surface oil flow $\alpha = 30^{\circ}$

Figure 10: Bottom view surface oil flow $\alpha = 30^{\circ}$

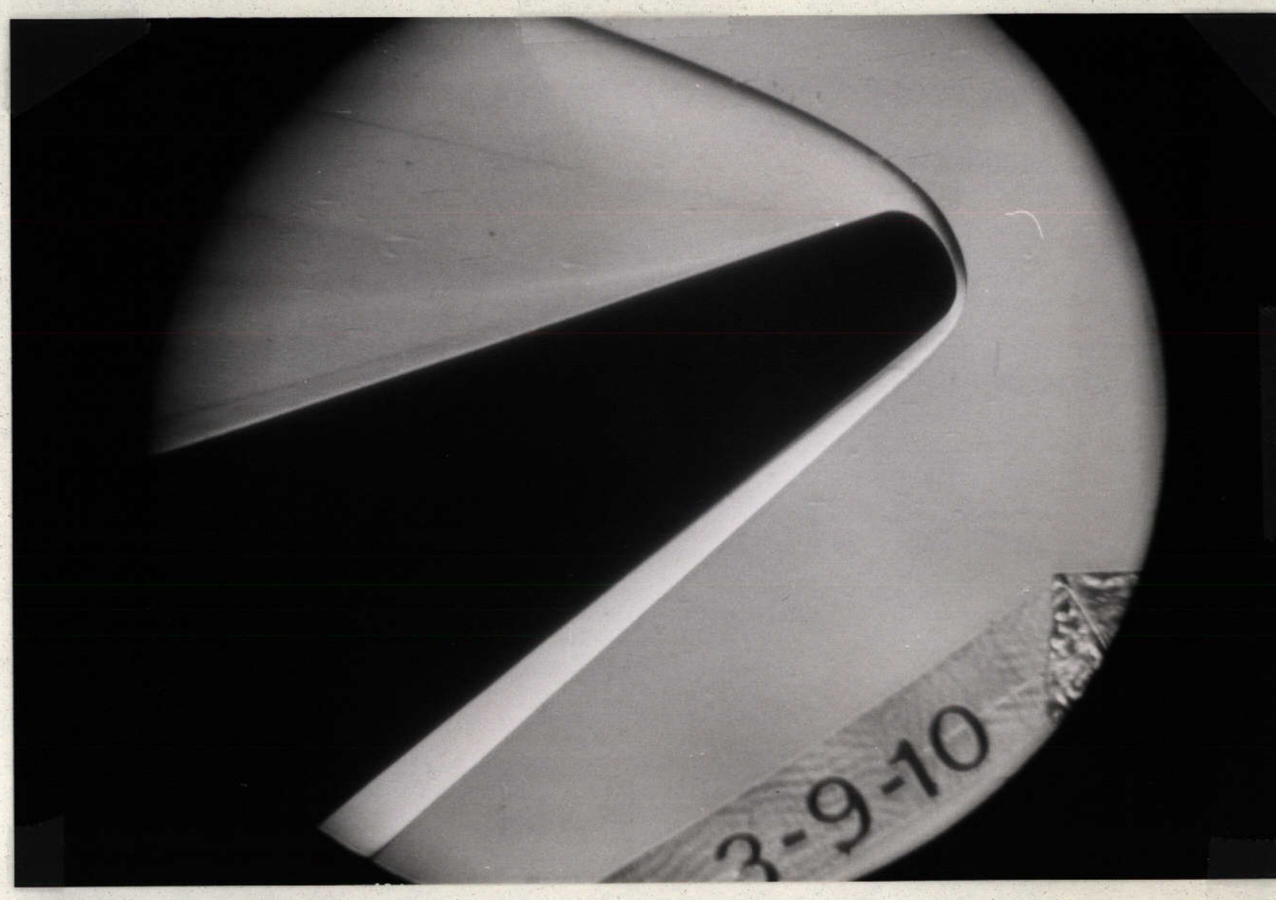

Figure 11: Side view schlieren $\alpha = 30^{o}$

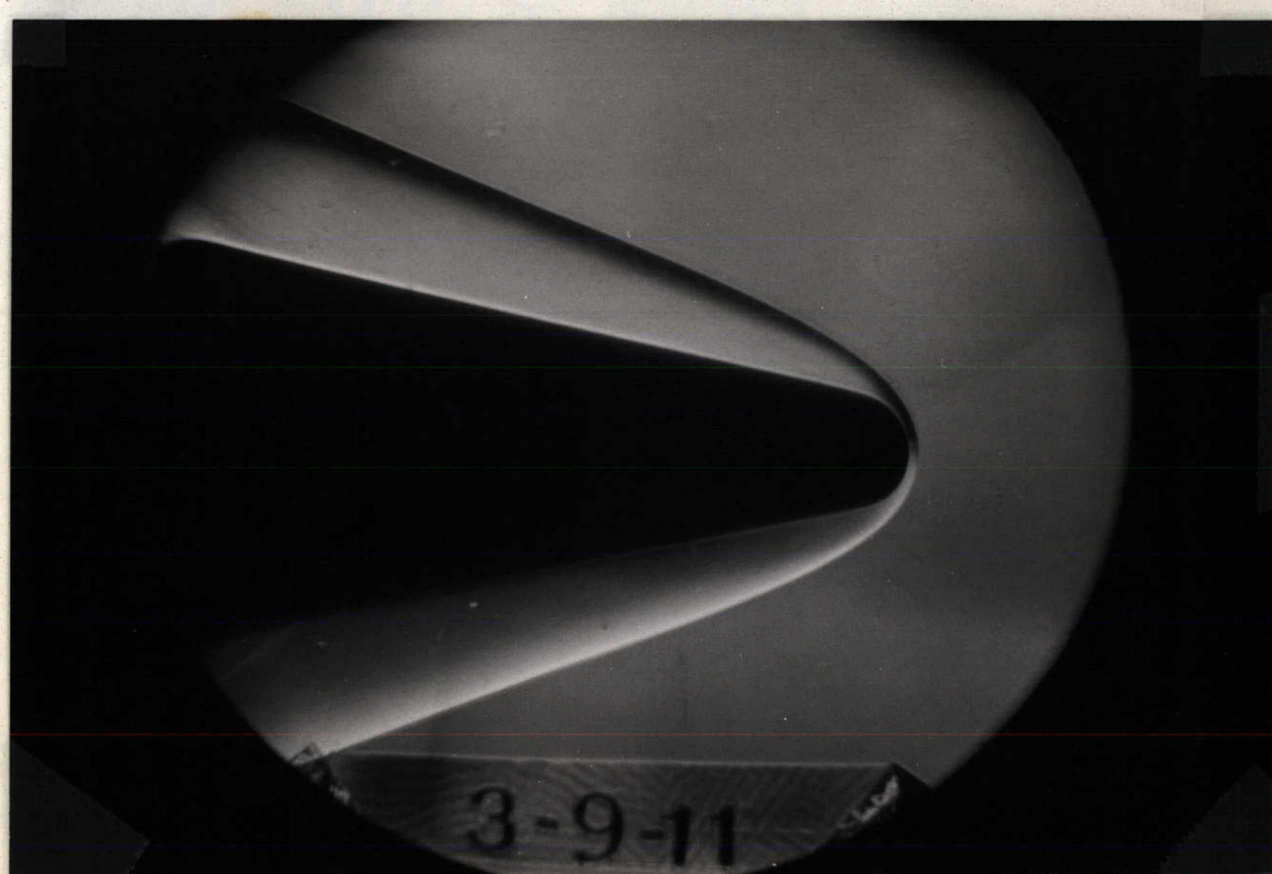

Figure 12: Top view schlieren $\alpha = 30^{o}$