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TECHNICAL NOTE

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WIND-TUNNEL INVESTIGATION OF THE STATIC AND DYNAMIC STABILITY CHARACTERISTICS OF A 10° SEMIVERTEX ANGLE BLUNTED CONE

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SUMMARY

The static and dynamic stability characteristics of a blunted 10° semivertex angle cone were studied. The cone which had a modified spherical segment nose was tested with a flat base and with a truncated conical base.

All tests were performed in air at Mach numbers from 0.65 to 2.20 with the angle-of-attack range from -4° to +18°. Presented are measurements of the normal force, axial force, base pressure, and pitching moment from the static tests, and the damping-in-pitch moment from the dynamic tests.

Both models had satisfactory stability characteristics throughout the test Mach number range but the addition of the conical afterbody had a large destabilizing effect.

INTRODUCTION

A current study in support of the space research program concerns the investigation of the nature of the atmospheres of planets other than earth. One means of direct measurement of the atmosphere characteristics is by use of a probe vehicle that would be launched into these atmospheres. The configuration of the present study was chosen for possible application to such a mission. The purpose of this investigation was to obtain basic aerodynamic data for general design considerations and for studies of the flight characteristics of the vehicle during the terminal phase of the entry.

The basic configuration was a 10° semivertex angle cone with a modified spherical segment nose. Two models were tested, one with a flat base and one with a truncated conical afterbody. Both static and dynamic data were obtained. All tests were performed in air over a Mach number range from 0.65 to 2.20.

SYMBOLS

C_A	total axial-force coefficient, $\frac{\text{axial force}}{(1/2)\rho V^2 S}$
C_D	total drag coefficient, $\frac{\text{drag force}}{(1/2)\rho V^2 S}$
C_{D_o}	total drag coefficient at zero angle of attack
C_L	lift coefficient, $\frac{\text{lift force}}{(1/2)\rho V^2 S}$
C_{L_α}	lift curve slope at zero angle of attack, $\frac{\partial C_L}{\partial \alpha}$, per radian
C_m	pitching-moment coefficient, $\frac{\text{pitching moment}}{(1/2)\rho V^2 S d}$
$C_{m_q} + C_{m_{\dot{\alpha}}}$	damping-in-pitch coefficient, $\frac{\partial C_m}{\partial (qd/V)} + \frac{\partial C_m}{\partial (\dot{\alpha} d/V)}$, per radian
C_{m_α}	variation of pitching-moment coefficient with angle of attack at zero angle of attack, $\frac{\partial C_m}{\partial \alpha}$, per radian
C_N	normal-force coefficient, $\frac{\text{normal force}}{(1/2)\rho V^2 S}$
C_{N_α}	variation of normal-force coefficient with angle of attack at zero angle of attack, $\frac{\partial C_N}{\partial \alpha}$, per radian
C_{p_b}	base pressure coefficient, $\frac{p_b - p_s}{(1/2)\rho V^2}$
d	body maximum diameter
K	reduced frequency, $\frac{\omega d}{V}$
M	Mach number
p_b	static pressure at model base
p_s	free-stream static pressure
q	pitching velocity
R	Reynolds number based on d

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S	base area, $\frac{\pi d^2}{4}$
t	time
V	free-stream velocity
α	angle of attack, deg
$\dot{\alpha}$	variation of angle of attack with time, $\frac{d\alpha}{dt}$, radians/sec
ρ	air density
σ	radius of gyration
ω	circular frequency of oscillation, radians/sec

APPARATUS

Wind Tunnel and Balances

The tests were performed in the Ames 6- by 6-Foot Supersonic Wind Tunnel. This wind tunnel is a closed-circuit variable-density type with the floor and ceiling perforated to permit testing at transonic Mach numbers. The tests were performed in air at Mach numbers from 0.65 to 2.20.

The static forces and moments were measured by means of a conventional six-component strain-gage balance. The model and balance were mounted on a 2-inch-diameter sting. A photograph of a typical installation is shown in figure 1.

In the damping-in-pitch tests a single-degree-of-freedom forced oscillation system was used which permits a small amplitude of oscillation. A similar system is described in reference 1. The balance is essentially a set of crossed flexures which act as a mechanical spring and also fix the oscillation axis of the model. The model is driven by an electromagnetic shaker and oscillates at some predetermined amplitude and at the natural frequency of the system. As in the static tests, the models were mounted on a 2-inch-diameter sting.

Models

The forebody of the model for this investigation was a blunted 10° semivertex angle cone with the nose a modified spherical segment. This basic configuration was tested with a flat base (designated A-1) and with

a conical afterbody (designated A-2). Sketches of the models are shown in figure 2. In order to sting mount the latter model it was necessary to cut off the tip as shown. The maximum diameter for the models was 6.00 inches resulting in a ratio of model maximum area to wind-tunnel cross-sectional area of 0.00545.

TESTS AND PROCEDURES

The Mach number range for both the static and the dynamic tests was 0.65 to 2.20. The angle-of-attack range was -4° to a maximum of $+18^{\circ}$. The maximum angle of attack for the dynamic tests was sometimes limited to less than 18° because of physical interference between the model and the sting. The variation of Reynolds number with Mach number is shown in figure 3. No attempt was made to fix transition on this model.

The quantities determined from the static tests were the normal force, axial force, base pressure, and pitching moment. The axial-force coefficient presented herein represents the total axial force as measured.

The base pressure was measured with a tube mounted on the side of the sting to sense the pressure. The opening of the tube was about 1/16 inch behind the base of the model or afterbody. This single reading may not be representative of the average base pressure over the entire model base at all angles of attack so the pressure coefficients presented may not give an accurate indication of the base axial force.

The quantities determined from the damping-in-pitch tests were the damping moment from which $(C_{m_q} + C_{m_{\dot{\alpha}}})$ was evaluated, and the oscillation frequency. Since the balance construction permitted only small amplitudes of oscillation, the damping moments were measured with the model set at some nominal angle of attack and oscillated about this point. The amplitude of oscillation chosen for these tests was $\pm 1\text{-}1/2^{\circ}$.

The reference moment center used for the reduction of the data was 0.482 d aft of the nose of the model (see fig. 2). In the case of the dynamic tests, the model was oscillated in pitch about an axis through this point.

ACCURACY

An estimate of the accuracy of the data is given as follows:

Static data				Dynamic data	
C_A	±0.010	C_N	±0.004	$C_{m_q} + C_{m_{\dot{\alpha}}}$	±0.02
C_m	±0.001	C_{p_b}	±0.003	K	±0.0001

RESULTS AND DISCUSSION

Typical experimental results are presented in figures 4 through 6. Figures 4 and 5 are plots showing the variation of force and moment coefficients with angle of attack for representative supersonic, transonic, and subsonic Mach numbers. The summary plot, figure 6, shows the variations of the stability characteristics with Mach number. A complete tabulation of all data is presented in tables I and II. Table I presents the static data and table II the damping-in-pitch data.

The summary plots of the static data shown in figure 6(a) and the upper curve of figure 6(b) show that the addition of the conical afterbody had almost no effect on the static stability derivatives. Both models were statically stable about the center of gravity chosen except at $M = 0.65$ where the models were neutrally stable. Both configurations had a positive value of C_{L_α} for all test conditions.

The variation of the damping-in-pitch coefficient $(C_{m_q} + C_{m_{\dot{\alpha}}})$ with Mach number is shown by the lower curves of figure 6(b). In this case the addition of the conical base caused a rather large destabilizing effect. The model with the conical base (A-2) was either neutrally stable or unstable throughout the entire Mach number range. The flat-based model (A-1) had only a small unstable region near $M = 1.00$.

Whether or not the damping in pitch shown in figure 6(b) could cause flight stability difficulties depends upon the mass characteristics of the actual vehicle. In reference 2 it is shown that the pitching motion may become divergent if the term $[C_D - C_{L_\alpha} + (C_{m_q} + C_{m_{\dot{\alpha}}})(d/\sigma)^2]$ is positive. Both test configurations had positive or stable values of C_{L_α} greater than corresponding values of C_D so that divergent motion could occur only if the product of the mass term (d/σ) times the damping in pitch were large. The model with the conical afterbody (A-2) has fairly large regions of destabilizing damping so that it might be dynamically unstable in flight.

CONCLUSIONS

The static and dynamic tests led to the following conclusions:

1. For the moment center and Mach number range investigated, the models were statically stable except at $M = 0.65$ where the vehicles became neutrally stable. Both models had a positive lift-curve slope.

2. The damping-in-pitch measurements showed that the model with the flat base was stable throughout the Mach number range investigated except for a small region near $M = 1.00$. The model with the conical base was unstable or neutrally stable throughout the entire Mach number range. Depending upon the mass characteristics of the actual flight vehicle, this destabilizing damping in pitch could lead to flight stability difficulties.

Ames Research Center
National Aeronautics and Space Administration
Moffett Field, Calif., Oct. 27, 1961

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REFERENCES

1. Beam, Benjamin H.: A Wind-Tunnel Test Technique for Measuring the Dynamic Rotary Stability Derivatives at Subsonic and Supersonic Speeds. NACA Rep. 1258, 1956.

2. Allen, H. Julian: Motion of a Ballistic Missile Angularly Misaligned With the Flight Path Upon Entering the Atmosphere and Its Effect Upon Aerodynamic Heating, Aerodynamic Loads, and Miss Distance. NACA TN 4048, 1957.

TABLE I.- STATIC STABILITY DATA

(a) Configuration with flat base, A-1; center of moments at 0.482 d

α	C_m	C_N	C_A	C_{p_b}
M = 0.65				
-03.0	-.0008	-0.084	0.300	.363
-02.0	.0004	-0.058	0.301	.357
-01.0	-.0009	-0.030	0.302	.358
-00.0	-.0003	0.005	0.300	.355
00.9	.0009	0.030	0.301	.353
01.9	-.0005	0.056	0.303	.357
02.9	.0004	0.084	0.300	.357
05.9	-.0021	0.170	0.297	.363
08.9	-.0026	0.255	0.294	.371
11.9	-.0036	0.342	0.292	.397
14.9	-.0071	0.428	0.293	.424
17.4	-.0104	0.501	0.294	.450
M = 0.90				
-02.8	.0042	-0.120	0.362	.346
-01.8	.0021	-0.076	0.359	.353
-00.8	.0017	-0.035	0.361	.345
00.1	-.0008	0.017	0.360	.351
01.1	-.0029	0.059	0.358	.350
02.1	-.0034	0.100	0.361	.353
03.1	-.0058	0.148	0.362	.356
06.1	-.0109	0.274	0.374	.387
09.1	-.0211	0.405	0.399	.415
12.1	-.0293	0.522	0.411	.447
15.1	-.0389	0.630	0.420	.471
17.7	-.0425	0.581	0.441	.473
M = 1.00				
-02.7	.0126	-0.117	0.586	.542
-01.7	.0092	-0.075	0.582	.540
-00.7	.0041	-0.027	0.592	.533
00.2	-.0040	0.025	0.592	.525
01.3	-.0091	0.071	0.584	.533
02.3	-.0141	0.116	0.595	.537
03.2	-.0190	0.157	0.596	.542
06.2	-.0283	0.283	0.626	.579
09.2	-.0330	0.395	0.653	.616
12.2	-.0376	0.498	0.673	.631
15.2	-.0434	0.594	0.693	.660
17.8	-.0501	0.678	0.711	.704
M = 1.10				
-02.7	.0123	-0.122	0.593	.384
-01.7	.0091	-0.081	0.595	.392
-00.6	.0029	-0.033	0.594	.393
00.2	-.0033	0.015	0.592	.392
01.3	-.0081	0.059	0.594	.393
02.3	-.0126	0.097	0.594	.380
03.3	-.0160	0.139	0.600	.395
06.3	-.0259	0.255	0.620	.407
09.2	-.0304	0.360	0.645	.449
12.2	-.0346	0.456	0.664	.480
15.2	-.0401	0.547	0.679	.505
17.8	-.0461	0.623	0.692	.533

α	C_m	C_N	C_A	C_{p_b}
M = 1.20				
-02.8	.0096	-0.097	0.631	.394
-01.8	.0067	-0.062	0.631	.395
-00.7	.0025	-0.027	0.627	.393
00.2	-.0004	0.008	0.630	.389
01.3	-.0047	0.046	0.629	.391
02.2	-.0088	0.079	0.631	.393
03.3	-.0119	0.114	0.630	.397
06.2	-.0234	0.216	0.643	.411
09.2	-.0327	0.321	0.665	.432
12.1	-.0411	0.426	0.687	.461
15.2	-.0468	0.521	0.711	.494
17.9	-.0504	0.599	0.733	.530
M = 1.30				
-02.8	.0072	-0.087	0.689	.362
-01.8	.0039	-0.055	0.688	.362
-00.8	.0005	-0.023	0.688	.361
00.2	-.0025	0.014	0.687	.360
01.2	-.0051	0.043	0.687	.358
02.2	-.0085	0.076	0.685	.358
03.2	-.0120	0.108	0.685	.361
06.1	-.0215	0.198	0.698	.372
09.1	-.0309	0.293	0.712	.390
12.0	-.0408	0.394	0.730	.409
15.1	-.0481	0.487	0.753	.438
15.1	-.0474	0.487	0.749	.444
18.0	-.0517	0.566	0.768	.465
M = 1.70				
-03.0	.0059	-0.072	0.712	.277
-02.0	.0036	-0.048	0.713	.277
-01.0	.0011	-0.023	0.715	.276
-00.0	-.0013	0.001	0.714	.275
01.0	-.0034	0.030	0.714	.277
01.9	-.0057	0.053	0.715	.276
02.9	-.0083	0.078	0.713	.281
05.9	-.0153	0.151	0.711	.285
08.9	-.0219	0.224	0.704	.287
11.9	-.0290	0.303	0.705	.288
14.9	-.0361	0.378	0.714	.297
17.8	-.0434	0.452	0.723	.309
M = 2.30				
-02.3	.0029	-0.045	0.676	.186
-01.3	.0021	-0.028	0.675	.183
-00.2	.0004	-0.008	0.679	.185
00.7	-.0017	0.017	0.677	.185
01.8	-.0036	0.039	0.674	.186
02.8	-.0045	0.058	0.671	.186
03.8	-.0064	0.078	0.664	.183
06.7	-.0112	0.136	0.655	.183
09.8	-.0167	0.198	0.648	.179
12.6	-.0223	0.260	0.647	.180
15.7	-.0283	0.325	0.650	.185
18.5	-.0343	0.385	0.651	.188

TABLE I.- STATIC STABILITY DATA - Concluded

(b) Configuration with conical base, A-2; center of moments at 0.482 d

α	C_m	C_N	C_A	C_{p_b}
M = 0.65				
-03.0	.0043	-0.092	0.312	.374
-02.1	.0030	-0.064	0.311	.371
-01.0	.0017	-0.036	0.311	.375
-00.1	.0054	-0.014	0.310	.372
00.9	.0028	0.039	0.312	.373
01.9	.0048	0.045	0.311	.373
02.9	.0033	0.073	0.311	.380
05.8	.0034	0.155	0.308	.379
08.8	.0027	0.245	0.313	.396
11.9	-.0007	0.333	0.315	.422
14.9	-.0019	0.413	0.314	.450
17.4	-.0047	0.481	0.307	.474
M = 0.90				
-02.9	.0077	-0.129	0.371	.364
-01.9	.0073	-0.088	0.368	.355
-00.9	.0051	-0.042	0.364	.354
00.0	-.0006	0.012	0.366	.354
01.1	-.0029	0.058	0.365	.360
02.1	-.0036	0.103	0.365	.363
03.2	-.0059	0.149	0.367	.374
06.1	-.0077	0.272	0.384	.397
09.1	-.0176	0.396	0.389	.419
12.1	-.0259	0.514	0.418	.440
15.0	-.0353	0.619	0.422	.475
17.6	-.0443	0.586	0.444	.477
M = 1.00				
-02.8	.0158	-0.126	0.605	.543
-01.8	.0109	-0.081	0.603	.531
-00.6	.0042	-0.030	0.600	.529
00.2	-.0024	0.021	0.593	.540
01.3	-.0090	0.071	0.595	.521
02.2	-.0127	0.114	0.596	.547
03.2	-.0178	0.160	0.606	.549
06.2	-.0284	0.284	0.635	.584
09.3	-.0331	0.395	0.669	.609
12.2	-.0375	0.496	0.689	.621
15.2	-.0432	0.591	0.695	.678
17.8	-.0482	0.669	0.704	.693
M = 1.10				
-02.7	.0152	-0.127	0.612	.406
-01.7	.0106	-0.084	0.608	.408
-00.7	.0045	-0.039	0.602	.388
00.3	-.0021	0.015	0.602	.383
01.2	-.0082	0.061	0.604	.402
02.3	-.0129	0.103	0.609	.408
03.3	-.0163	0.145	0.613	.397
06.2	-.0259	0.254	0.634	.433
09.2	-.0303	0.359	0.659	.453
12.2	-.0345	0.455	0.674	.481
15.2	-.0399	0.543	0.679	.490
17.8	-.0445	0.617	0.692	.521
M = 1.20				
-02.7	.0092	-0.090	0.649	.407
-01.7	.0064	-0.057	0.645	.405
-00.7	.0035	-0.022	0.643	.404
00.3	-.0023	0.021	0.643	.404
01.3	-.0064	0.055	0.643	.403
02.3	-.0093	0.088	0.645	.404
03.3	-.0121	0.119	0.649	.407
06.2	-.0222	0.218	0.667	.431
09.1	-.0328	0.322	0.680	.443
12.2	-.0412	0.427	0.694	.465
15.2	-.0467	0.520	0.715	.492
17.8	-.0503	0.596	0.737	.520
M = 1.30				
-02.8	.0090	-0.088	0.684	.391
-01.9	.0064	-0.060	0.680	.389
-00.9	.0038	-0.028	0.681	.386
00.2	-.0019	0.014	0.680	.387
01.2	-.0046	0.044	0.679	.386
02.2	-.0072	0.073	0.678	.385
03.2	-.0112	0.103	0.683	.390
06.1	-.0196	0.194	0.688	.399
09.1	-.0297	0.292	0.692	.404
12.0	-.0388	0.390	0.698	.412
15.1	-.0469	0.486	0.727	.442
17.6	-.0516	0.563	0.740	.460
M = 1.70				
-03.0	.0070	-0.070	0.691	.297
-02.0	.0047	-0.045	0.697	.301
-00.9	.0023	-0.022	0.702	.305
00.0	.0009	0.007	0.704	.307
01.0	-.0014	0.029	0.703	.309
02.0	-.0038	0.052	0.700	.308
03.0	-.0063	0.076	0.694	.306
05.9	-.0139	0.148	0.686	.299
08.8	-.0206	0.222	0.677	.290
11.9	-.0277	0.301	0.681	.291
14.9	-.0363	0.379	0.687	.299
17.6	-.0433	0.450	0.694	.308
M = 2.20				
-02.3	.0021	-0.046	0.633	.189
-01.2	.0012	-0.025	0.630	.187
-00.1	.0003	-0.006	0.636	.188
00.7	-.0009	0.019	0.639	.188
01.7	-.0034	0.037	0.633	.187
02.8	-.0044	0.055	0.632	.186
03.6	-.0053	0.073	0.629	.187
06.6	-.0102	0.131	0.621	.184
09.7	-.0157	0.194	0.614	.179
12.6	-.0231	0.259	0.612	.183
15.8	-.0278	0.325	0.614	.182
18.0	-.0328	0.373	0.613	.185

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TABLE II.- DAMPING-IN-PITCH DATA

(a) Configuration with flat base, A-1; center of moments at 0.482 d

α	$C_{m_q}+C_{m_{\dot{\alpha}}}$	K
M = 0.75		
00.3	-00.32	.0605
-00.7	-00.28	.0604
-01.7	-00.31	.0603
-02.7	-00.31	.0604
01.3	-00.34	.0603
02.3	-00.36	.0605
03.3	-00.42	.0604
06.2	-00.52	.0606
09.2	-00.30	.0610
12.3	-00.10	.0611
15.3	-00.04	.0613
17.8	-00.03	.0614
00.2	-00.35	.0606
M = 0.90		
00.1	-00.60	.0447
-00.9	-00.52	.0447
01.1	-00.67	.0446
02.1	-00.61	.0448
03.1	-00.52	.0448
06.0	00.12	.0457
08.6	00.51	.0463
11.4	00.28	.0468
14.3	00.07	.0464
16.8	-00.42	.0457
00.1	-00.58	.0448
M = 1.00		
-00.1	00.06	.0434
-01.0	00.01	.0434
00.7	-00.06	.0433
01.5	-00.19	.0432
02.4	-00.20	.0431
05.1	00.07	.0429
07.9	-00.37	.0422
10.9	-00.17	.0422
11.8	-00.18	.0422
-00.2	00.05	.0433
M = 1.10		
-00.1	-00.02	.0405
-00.9	-00.05	.0403
00.7	-00.13	.0404
01.6	-00.29	.0401
02.5	-00.19	.0399
05.2	00.05	.0399
08.0	-00.36	.0390
10.9	-00.22	.0390
11.6	-00.16	.0393
-00.0	-00.04	.0403
M = 1.20		
-00.0	-00.26	.0367
-00.9	-00.27	.0367
00.8	-00.35	.0367
01.8	-00.40	.0367
02.7	-00.45	.0368
05.3	-00.12	.0371
08.0	00.04	.0370
08.8	00.01	.0369
00.0	-00.24	.0368
M = 1.30		
-00.0	-00.25	.0340
-00.8	-00.31	.0342
00.7	-00.28	.0342
01.7	-00.52	.0342
02.7	-00.57	.0342
05.4	-00.20	.0344
08.0	-00.02	.0346
-00.0	-00.25	.0343
M = 1.70		
00.3	-00.15	.0280
-00.6	-00.13	.0280
01.3	-00.15	.0280
02.3	-00.11	.0280
03.1	-00.15	.0280
05.8	-00.26	.0280
08.7	-00.17	.0280
11.5	-00.15	.0281
14.3	-00.05	.0282
00.3	-00.11	.0280
M = 2.20		
-00.4	-00.08	.0238
-01.4	-00.02	.0238
-02.4	-00.05	.0238
-03.3	-00.11	.0239
00.4	-00.08	.0239
01.4	-00.02	.0239
02.5	-00.02	.0239
05.0	00.00	.0238
08.1	-00.02	.0239
11.0	-00.08	.0239
13.9	-00.08	.0239
16.4	-00.05	.0239
-00.6	-00.08	.0238

TABLE II.- DAMPING-IN-PITCH DATA - Concluded

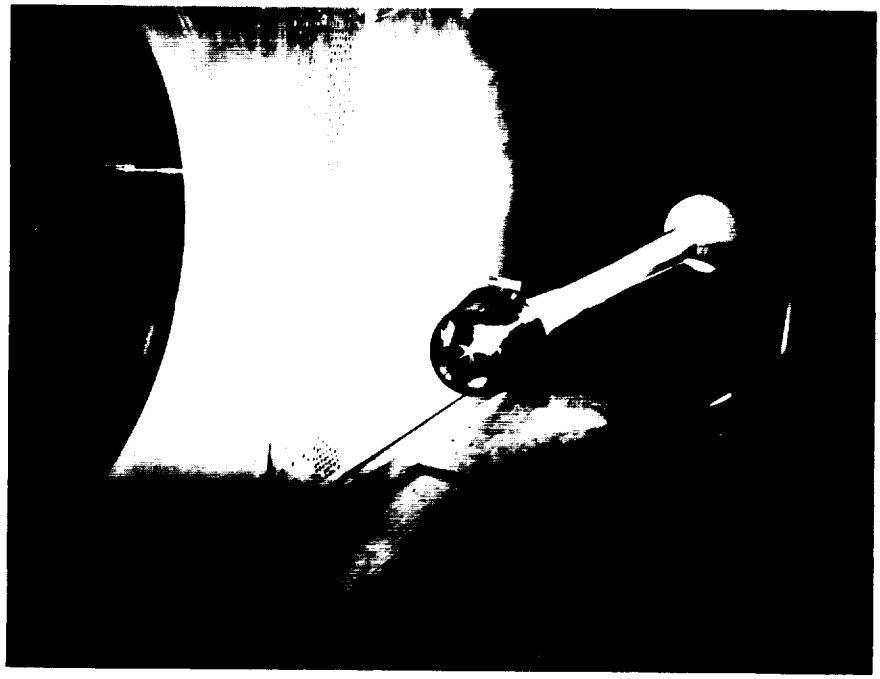
(b) Configuration with conical base, A-2; center of moments at 0.482 d

α	$C_{m_q}+C_{m_{\dot{\alpha}}}$	K
M = 0.65		
00.2	00.22	.0601
-00.7	00.20	.0601
-01.7	00.22	.0600
-02.8	00.31	.0599
01.2	00.22	.0599
02.2	00.24	.0599
03.2	00.32	.0599
06.1	00.24	.0599
09.2	00.12	.0598
12.2	00.00	.0598
15.2	-00.06	.0600
17.7	-00.04	.0601
00.3	00.20	.0606
M = 0.90		
00.1	00.00	.0446
-00.8	00.00	.0446
-01.8	00.07	.0446
01.0	00.03	.0447
02.0	00.06	.0446
03.0	00.15	.0447
05.7	00.53	.0449
08.5	00.52	.0453
11.3	00.21	.0451
14.2	00.12	.0451
16.7	-00.19	.0447
00.1	-00.04	.0447
M = 1.00		
-00.1	00.32	.0430
-01.1	00.33	.0428
00.6	00.32	.0429
01.4	00.29	.0426
02.4	00.16	.0426
05.0	00.16	.0420
07.8	-00.28	.0409
10.7	-00.18	.0412
11.7	-00.10	.0412
-00.2	00.38	.0430

α	$C_{m_q}+C_{m_{\dot{\alpha}}}$	K
M = 1.10		
-00.1	00.32	.0397
-01.0	00.35	.0397
00.7	00.25	.0396
01.5	00.15	.0393
02.5	00.16	.0392
05.1	00.05	.0383
07.9	-00.37	.0377
10.8	-00.22	.0380
11.6	-00.19	.0380
-00.1	00.35	.0398
M = 1.20		
-00.0	00.02	.0363
-00.8	-00.00	.0364
00.8	-00.00	.0364
01.7	-00.02	.0364
02.6	-00.01	.0364
05.2	00.12	.0365
07.9	00.21	.0363
08.3	00.12	.0363
-00.0	00.01	.0364
M = 1.30		
00.0	00.00	.0339
-00.4	-00.05	.0339
00.8	-00.10	.0339
01.8	-00.20	.0340
02.8	-00.27	.0340
05.3	-00.02	.0340
08.0	00.08	.0340
09.7	00.11	.0340
-00.0	-00.00	.0340

α	$C_{m_q}+C_{m_{\dot{\alpha}}}$	K
M = 1.70		
00.2	00.06	.0277
-00.5	00.02	.0277
-01.5	-00.07	.0277
01.3	00.02	.0277
02.2	00.00	.0277
03.1	-00.03	.0277
05.8	-00.05	.0277
08.6	-00.02	.0277
11.4	-00.09	.0277
13.9	00.02	.0277
00.3	-00.03	.0276
M = 2.20		
-00.5	00.03	.0236
-01.5	-00.02	.0236
-02.4	00.03	.0236
-03.3	00.09	.0236
00.3	00.12	.0235
01.4	00.03	.0236
02.3	00.07	.0236
05.2	00.03	.0235
08.1	-00.02	.0235
11.0	00.03	.0235
13.8	-00.02	.0235
16.5	00.09	.0235
-00.6	-00.04	.0234

A591



A-28199

Figure 1.- Photograph of model.

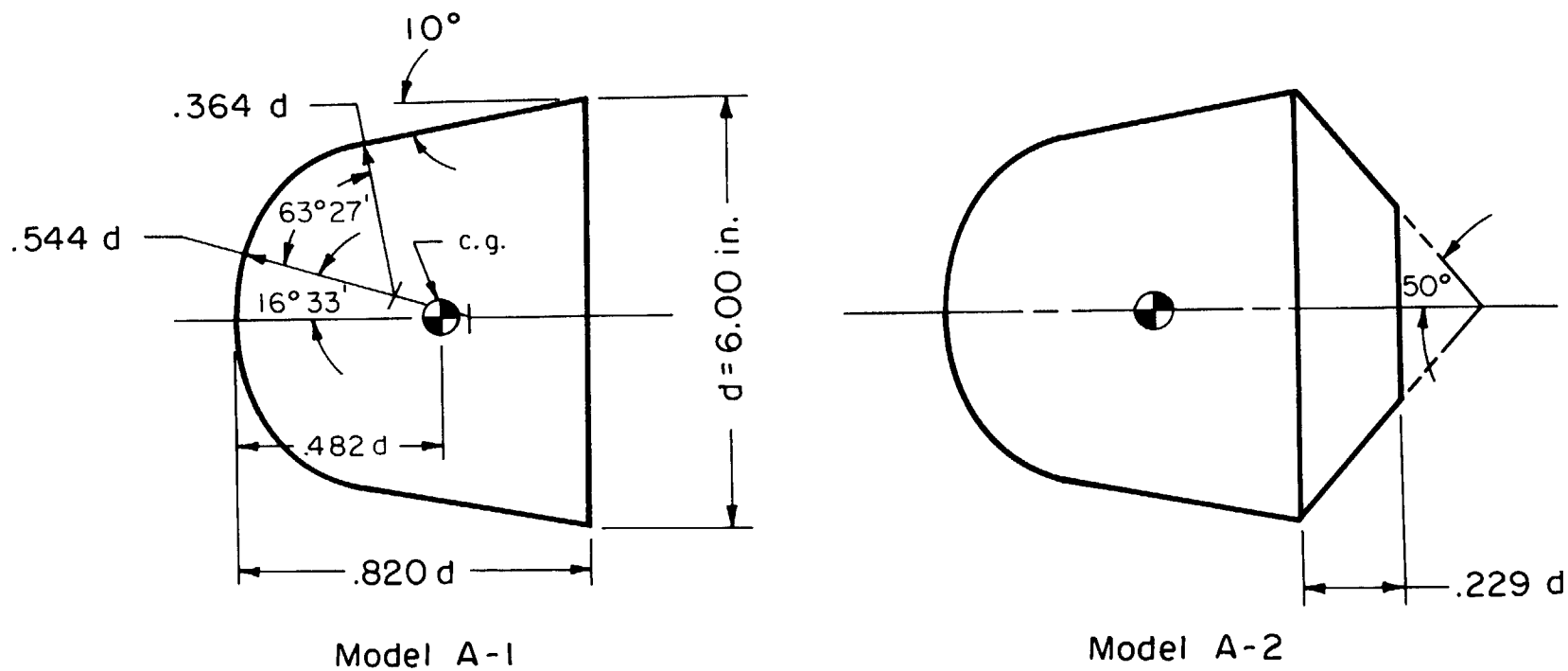


Figure 2.- Geometry of the models.

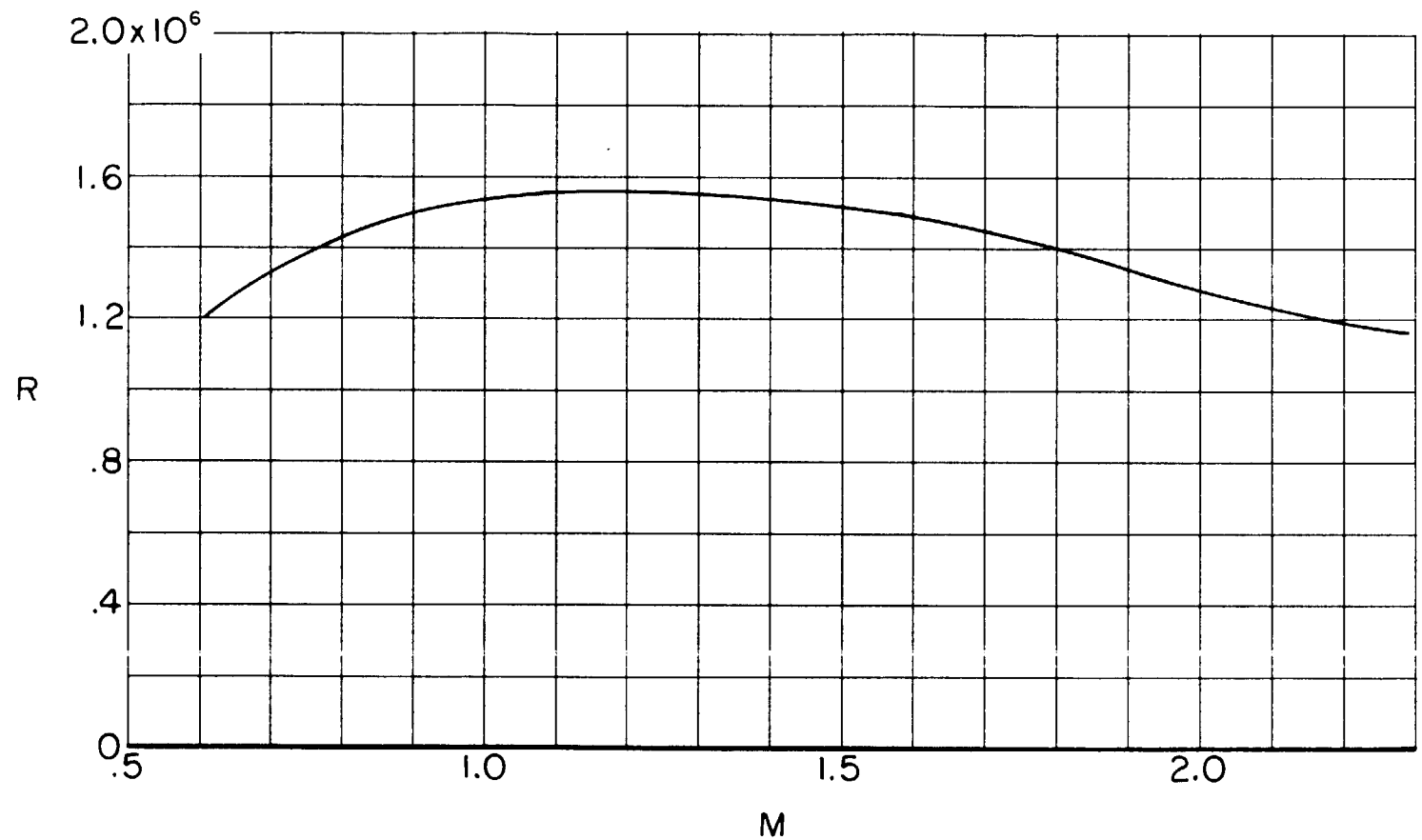
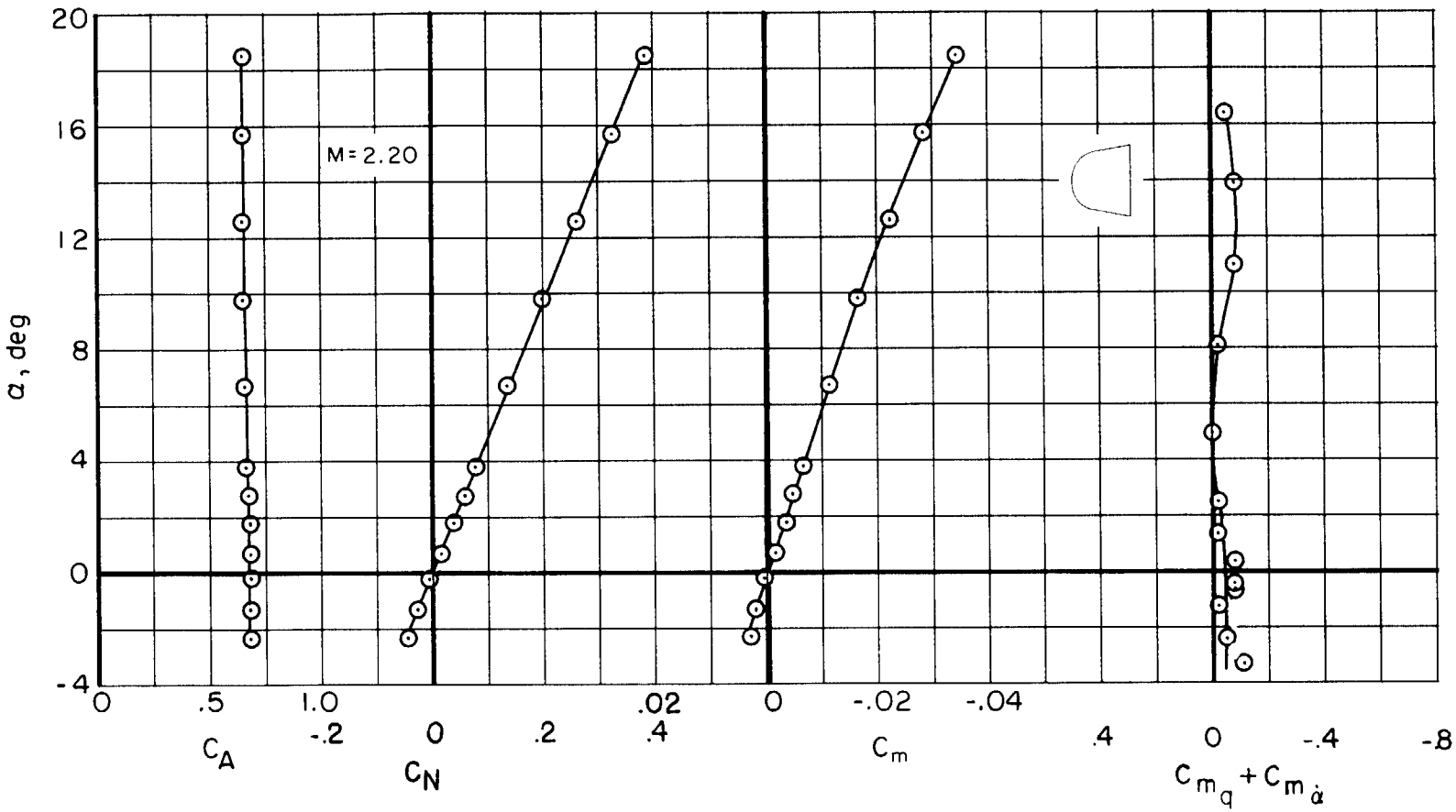
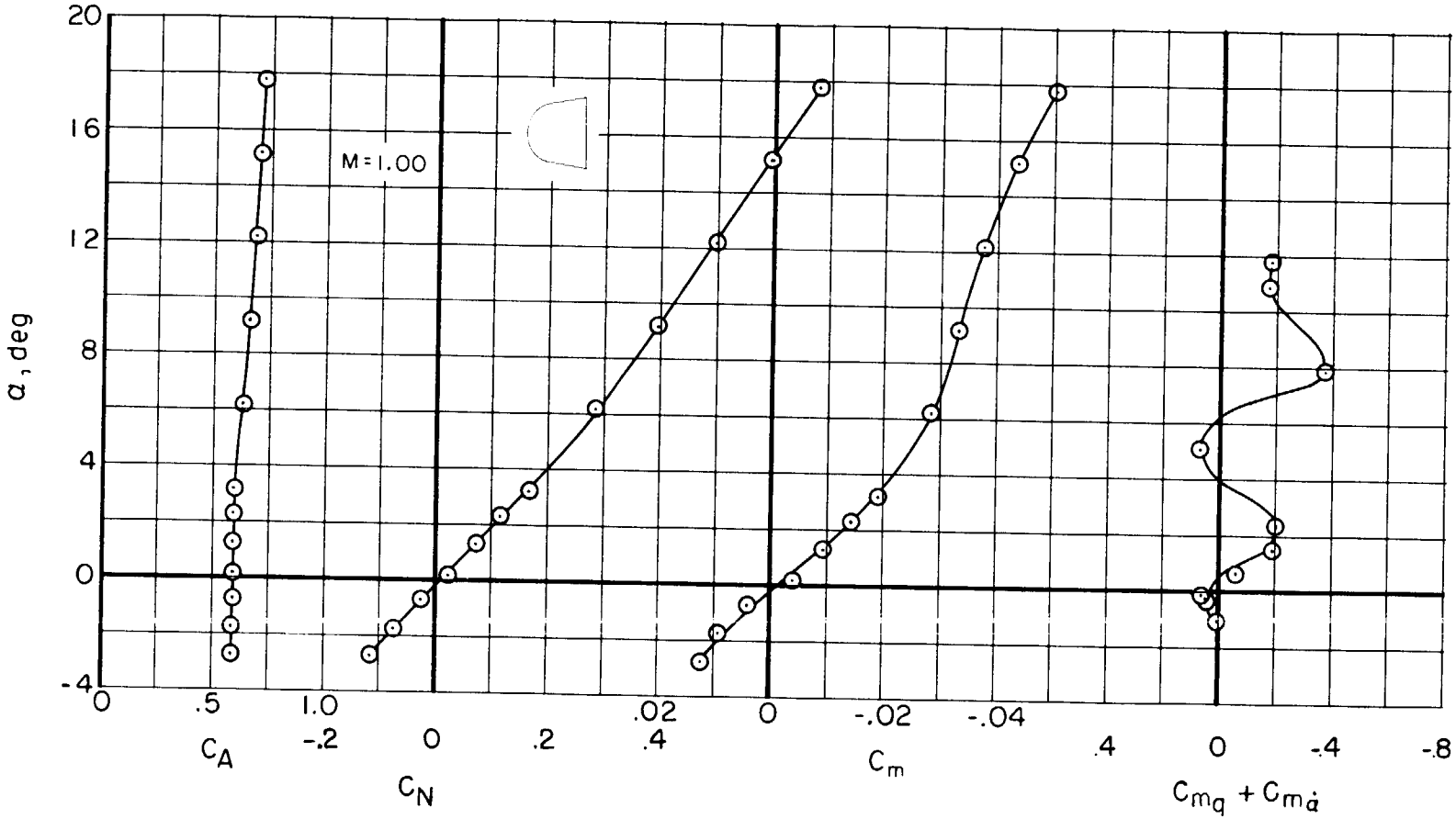


Figure 3.- Variation of test Reynolds number with Mach number.



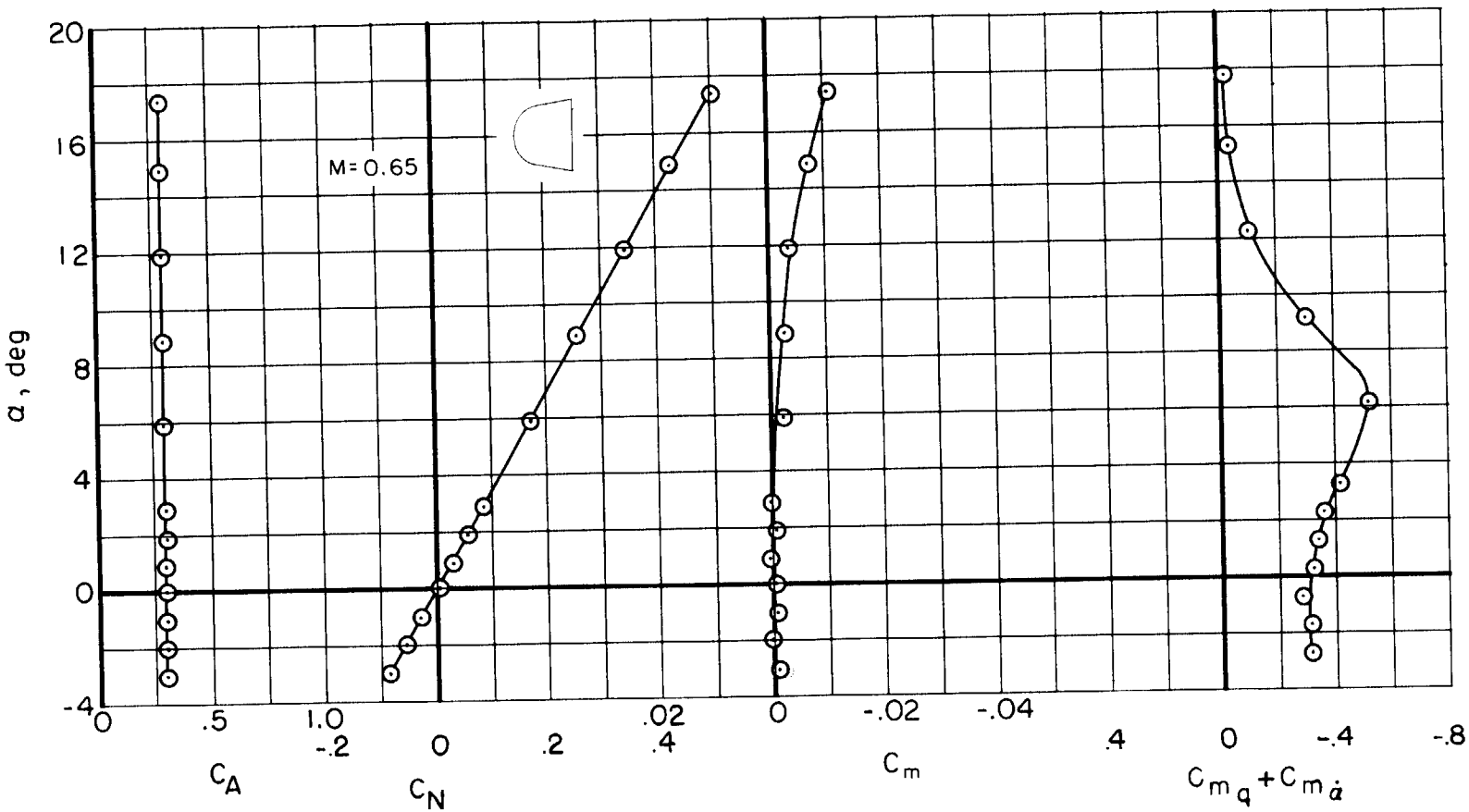
(a) M = 2.20

Figure 4.- Variation of the static and dynamic characteristics with angle of attack for model A-1.



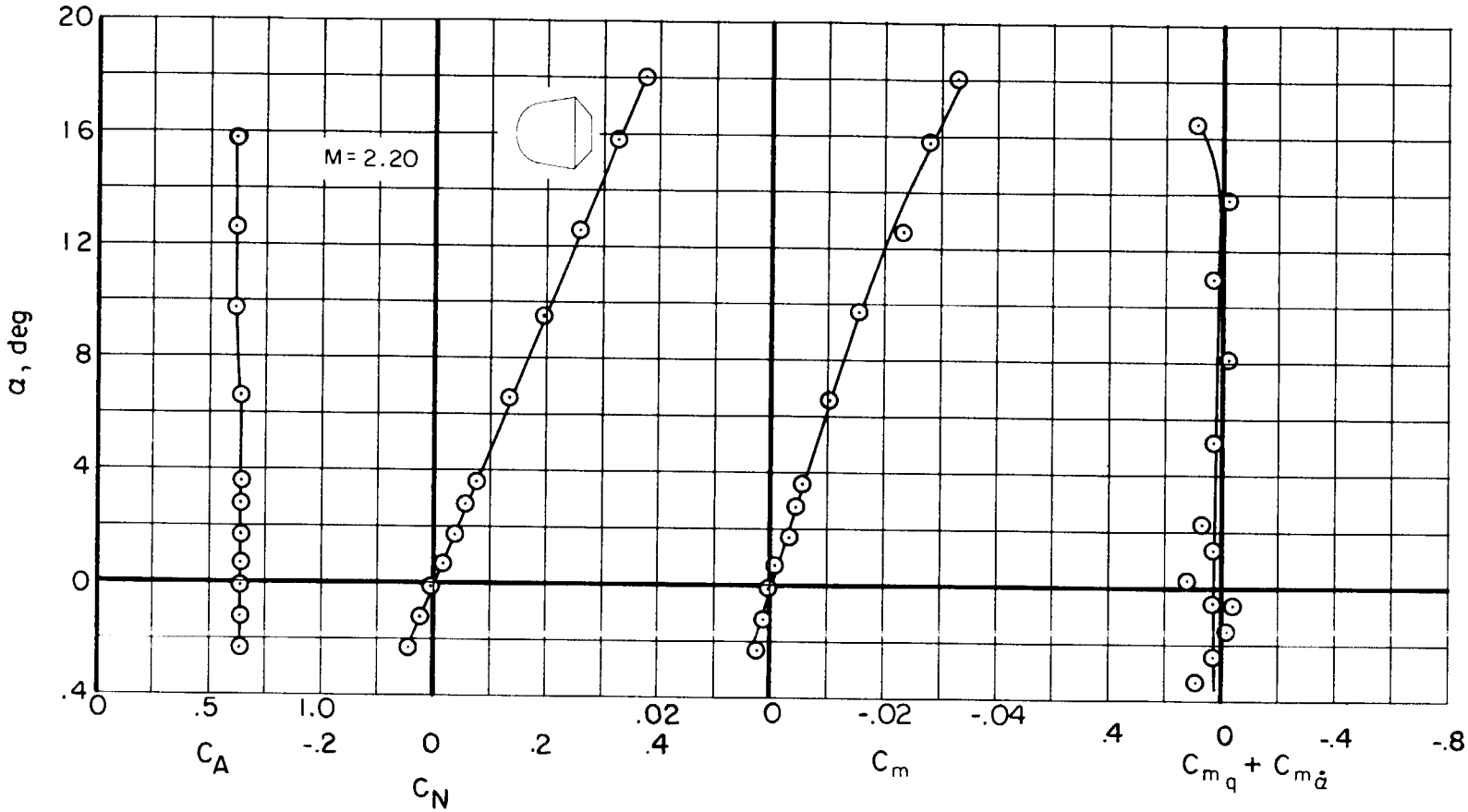
(b) M = 1.00

Figure 4.- Continued.



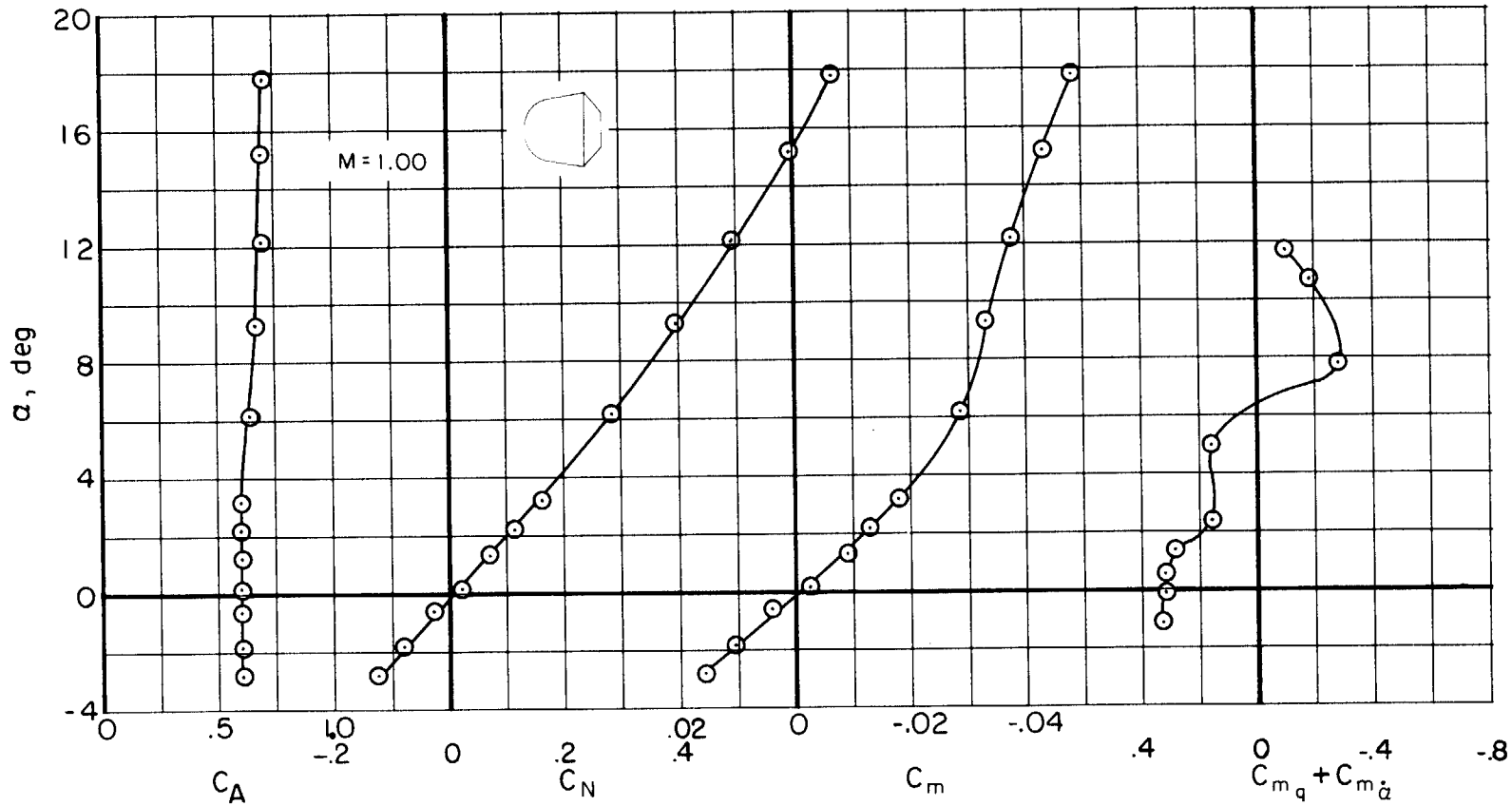
(c) M = 0.65

Figure 4.- Concluded.



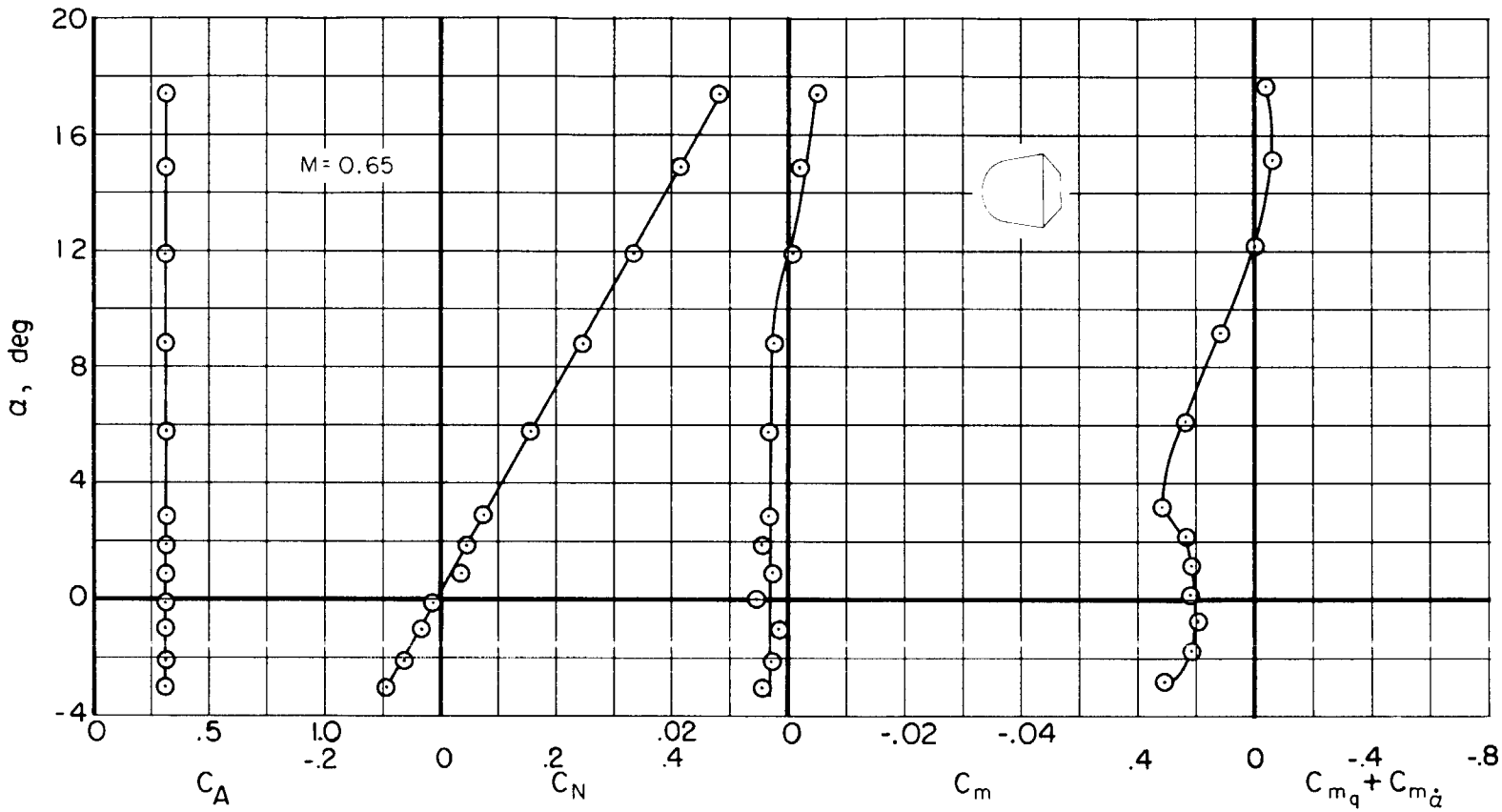
(a) M = 2.20

Figure 5.- Variation of the static and dynamic characteristics with angle of attack for model A-2.



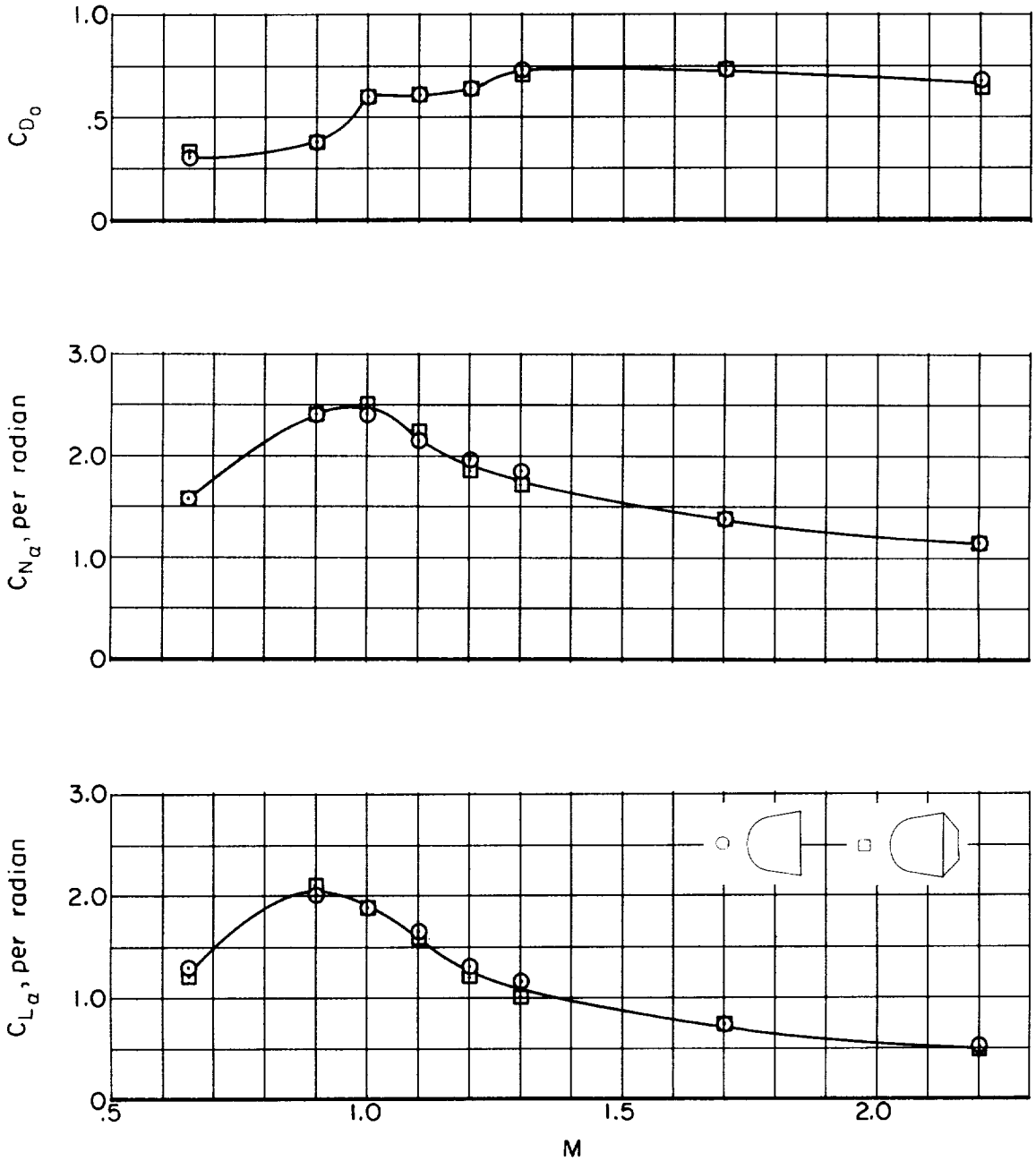
(b) M = 1.00

Figure 5.- Continued.



(c) M = 0.65

Figure 5.- Concluded.



A
5
9
1

(a) Variation of C_{D_0}, C_{N_α}, and C_{L_α} with Mach number.

Figure 6.- Zero angle of attack stability derivatives and axial-force coefficients.