NASA TN D-949

TECHNICAL NOTE

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STATIC LONGITUDINAL CHARACTERISTICS AT HIGH SUBSONIC SPEEDS OF A COMPLETE AIRPLANE MODEL WITH A HIGHLY TAPERED WING HAVING THE 0.80 CHORD LINE UNSWEPT AND WITH SEVERAL TAIL CONFIGURATIONS

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WASHINGTON August 1961

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SUMMARY

An investigation was made at high subsonic speeds of a complete model having a highly tapered wing and several tail configurations. The basic aspect-ratio-4.00 wing had zero taper and an unswept 0.80 chord line. Several aspect-ratio modifications to the basic wing were made by clipping off portions of the wing tips. The complete model was tested with a chord-plane tail, a T-tail, and a biplane tail (combined T-tail and chord-plane tail). The model was tested in the Langley high-speed 7- by 10-foot tunnel at Mach numbers from 0.60 to 0.92.

The data show that, when reduced to the same static margin, all the tail configurations tested on the model provided fairly good stability characteristics, the biplane tail giving the best overall characteristics as regards pitching-moment linearity. Changes in static margin at zero lift coefficient with Mach number were small for the model with these tails over the Mach number range investigated.

INTRODUCTION

Many research and production-type high-speed airplanes experience abrupt changes in longitudinal stability at moderate and high lift coefficients, particularly when flying at high subsonic and transonic speeds. Investigations of thin-wing models having various sweep angles, aspect ratios, and taper ratios (refs. 1 to 4) have shown that the tail-off (wing or wing-fuselage) contribution to the pitching-moment nonlinearity can be minimized by proper selection of wing plan form. One such investigation (ref. 1) on small-scale, thin, highly tapered wings indicated

[1]Supersedes recently declassified NACA Research Memorandum L56J03, by Kenneth W. Goodson.

that minimum nonlinearity of the variation of pitching moment with lift at subsonic and transonic speeds was obtained when the line of zero sweep is a constant-percent chord line lying between the 0.75 chord line and the trailing edge. An additional attractive feature of highly tapered wing plan forms is that they are known to offer certain structural advantages over wings of less taper.

The present investigation was undertaken to determine whether the results obtained from the small-scale wing-alone tests could be applied to a model at higher Reynolds numbers and to obtain complete-model data. An aspect-ratio-4.00 wing with a taper ratio of zero and an unswept 0.80 chord line was selected as having the desired overall characteristics. The wing had an NACA 65A004 airfoil section parallel to the plane of symmetry. Longitudinal aerodynamic characteristics for the model were obtained with the wing clipped to form aspect ratios varying from 4.0 to 3.0. The aspect-ratio-3.50 clipped wing was tested in conjunction with several tail configurations, and some limited tail-on tests were made with the wing clipped to an aspect ratio of 3.00.

SYMBOLS

The data are presented about the system of axes shown in figure 1. The pitching-moment coefficients are referred to a center-of-gravity position which is located at the quarter-chord point of the aspect-ratio-3.50 clipped wing.

C_L lift coefficient, $\frac{\text{Lift}}{qS}$

C_D drag coefficient, $\frac{\text{Drag}}{qS}$

ΔC_D change in drag due to lift

C_N normal-force coefficient, $\frac{\text{Normal force}}{qS}$

C_A axial-force coefficient, $\frac{\text{Axial force}}{qS}$

C_m pitching-moment coefficient, $\frac{\text{Pitching moment}}{qS\bar{c}}$

q dynamic pressure, $\frac{\rho V^2}{2}$, lb/sq ft

ρ mass density of air, slugs/cu ft

V free-stream velocity, ft/sec

M Mach number

S wing area, sq ft

c local chord parallel to plane of symmetry, ft

c_r root chord, ft

c_t tip chord, ft

$\bar{c}$ wing mean aerodynamic chord, $\frac{2}{S}\int_0^{b/2} c^2 dy$, ft

$\bar{c}_h$ horizontal-tail mean aerodynamic chord, ft

$\bar{c}_v$ vertical-tail mean aerodynamic chord, ft

l_h, l_v tail length, measured from quarter chord of $\bar{c}$ to quarter chord of $\bar{c}_h$ and $\bar{c}_v$, respectively

b wing span, ft

y spanwise distance from plane of symmetry, ft

Δx change in mean aerodynamic quarter-chord location due to clipping of wing, in.

α angle of attack, deg

i_t stabilizer deflection, positive when trailing edge is down, deg

A aspect ratio

λ taper ratio

$\Lambda_{0.8c}$ sweep of 0.80 chord line, deg

$\Lambda_{c/4}$ sweep of wing quarter-chord line, deg

MODEL AND APPARATUS

A three-view drawing of the complete model is shown in figure 2(a). The model with the basic pointed wing (taper ratio of zero) had an aspect ratio of 4.00 with an unswept 80-percent chord line. The basic wing was also modified to form wings with aspect ratios of 3.50, 3.25, and 3.00 by clipping the wing tips (fig. 2(b)).

The model was fitted with an unswept-trailing-edge vertical tail ($\Lambda_{c/4} = 28.0^\circ$) and with a delta horizontal tail which could be mounted in two positions. (See figs. 2(a) and 2(c).) The horizontal tail could be mounted on the rear end of the fuselage in the wing chord plane extended and also on the tip of the vertical tail in a T-tail arrangement. The apex of the horizontal tail (basic T-tail arrangement) overhung the leading edge of the vertical-tail tip by 1.93 inches. The various tail configurations of the basic model are shown in figure 2(c).

In addition to the tail configurations of the basic model, the model was modified to give zero overhang of the horizontal tail (T-tail) and also to keep the original tail length for this configuration (fig. 2(d)). In order to keep the same horizontal-tail length, a reduced-sweep vertical tail was constructed for the zero overhang configuration (tail configuration 7).

The incidence of the horizontal tail of the T-tail configuration could be varied by use of several mounting brackets. The incidence of the chord-plane horizontal tail was fixed at 0°. Dimensions of the fuselage with a fineness ratio of 10.94 are presented in table I. A photograph of the model mounted on the sting support of the Langley high-speed 7- by 10-foot tunnel is shown in figure 2(e).

TESTS

The sting-supported model was tested in the Langley high-speed 7- by 10-foot tunnel through a Mach number range of 0.60 to 0.92 and through an angle-of-attack range that varied with loading conditions (the maximum range being about -3° to 24°). The Reynolds number based on the mean aerodynamic chord varied with Mach number from about 2.6×10^6 to 3.4×10^6.

Longitudinal stability tests were made for the model with the basic wing with an aspect ratio of 4.00 and with the basic wing clipped to give aspect ratios of 3.50, 3.25, and 3.00. The aspect-ratio-3.50 wing was selected for more detailed investigation of a complete model with various tail configurations. Some stabilizer effectiveness tests (for values of i_t of 0° to approximately 6°), were made with this wing. A few tail-on tests also were made with the aspect-ratio-3.00 wing.

CORRECTIONS

Blockage corrections were applied to the results by the method of reference 5. Jet-boundary corrections to the angle of attack and drag were applied in accordance with reference 6. Corrections for effects of the longitudinal pressure gradient in the wind-tunnel test section have been applied to the data.

Model support tares have not been applied, except for a fuselage base-pressure correction to the drag. The corrected drag data represent a condition of free-stream static pressure at the fuselage base. From past experience, it is expected that the influence of the sting support on the model characteristics is negligible with regard to the lift and pitching moment.

The angle of attack has been corrected for deflection of the balance and sting support. No attempt has been made to correct the data for aeroelastic distortion of the steel wing model.

PRESENTATION OF RESULTS

The results are presented in figures 3 to 15 as follows:

	Figure
Effect of aspect ratio on the longitudinal aerodynamic characteristics, tail-off	3
Effect of various tail configurations on the longitudinal aerodynamic characteristics of the aspect-ratio-3.50 model .	4 and 5
Effect of aspect ratio on the longitudinal aerodynamic characteristics of the tail-on model	6
Effect of stabilizer deflection on the aerodynamic characteristics of the complete model (aspect-ratio-3.50 wing) with various tail configurations	7 to 10
Summary of aerodynamic characteristics	11 to 15

Tabulated results of normal-force and axial-force coefficient are presented in tables II to IX. The results are presented about a center of gravity located at the quarter-chord point of the aspect-ratio-3.50 wing.

DISCUSSION

Pitching-Moment Characteristics

The effect on pitching-moment characteristics of reducing aspect ratio by clipping the tips of the basic aspect-ratio-4.00 pointed wing is shown in figure 3. The results show that clipping small portions off the wing tips (that is, reducing the aspect ratio) generally reduces the longitudinal stability in the low lift-coefficient range, the effects becoming more significant as the aspect ratio becomes relatively smaller. (See figs. 3(a), 3(b), and 11.) These data also show that small localized nonlinearities occurring at moderate and high lift coefficients at high subsonic (above critical) Mach numbers are minimized by small reductions in aspect ratio. These data in general show results similar to those of the small-scale models of reference 1. After clipping the aspect-ratio-4.00 wing to an aspect ratio of 3.50, the aspect-ratio-3.50 wing was selected for the complete-model tests of the present program. Consequently, before the wing tips were cut off to form the aspect-ratio-3.25 and aspect-ratio-3.00 wings, the aspect-ratio-3.50 wing was tested rather extensively on a complete-model configuration with several different tail arrangements, inasmuch as the wing tips could not be accurately replaced. The complete-model characteristics with this wing are discussed in the following paragraphs.

Results of tests of the aspect-ratio-3.50 wing on a complete model with a vertical-tail and several horizontal-tail locations are shown in figure 4. These results show that the local nonlinearities previously mentioned for the wing-fuselage configurations are still evident with the complete model but that the horizontal tail generally tends to reduce their magnitudes. Note that the T-tail arrangement provides considerably more stability up to moderate lift coefficients than does the chord-plane horizontal tail (figs. 4(a) and 12) probably because of smaller changes in downwash with angle of attack (ref. 7) at the high tail (T-tail) and the greater exposed area of the high tail. It should also be noted that a combination of the T-tail and the chord-plane tail (biplane tail, configuration 5) has almost linear pitching-moment characteristics up to stall except for some local nonlinearities at $M = 0.92$.

In order to give a more direct comparison of the effects of the various horizontal tails on the longitudinal stability of the complete model, the T-tail, the chord-plane tail, and the biplane tail data have been reduced to a static margin of $-0.10\bar{c}$ at $M = 0.60$ (fig. 13) and adjusted to give $C_m = 0$ at $C_L = 0$. These results show that the biplane tail model has the best overall stability characteristics of any of the tail configurations tested in regard to pitching-moment linearity over the Mach number range investigated. This configuration shows increased stability at the stall. Similarly, no pitch-up is noted for the low-tail (chord-plane) configuration although the increase in stability at the higher lift coefficients (fig. 13) is somewhat greater than might be desired. The T-tail arrangement, on the other hand, shows a mild reduction in stability at moderate lift coefficients along with a strong pitch-up tendency above $C_{L_{max}}$. This configuration, however, may provide a warning of the impending pitch-up in the form of a momentary increase in stability at stall and perhaps buffeting associated with the wing stall.

It is believed that any of the present tail arrangements would prove acceptable when used in conjunction with the wing of this investigation. Note that changes in static margin with Mach number are very small for any of the tail-on configurations for the Mach number range investigated. (See figs. 12 and 13.)

For the T-tail configuration with horizontal-tail apex overhang (tail configuration 4 of the present paper), reference 8 shows a considerable reduction in directional stability at high subsonic Mach numbers; whereas, essentially no reduction is indicated when the horizontal tail has zero overhang. For this reason it is desirable to have the horizontal tail located in the rear position (tail configuration 6). With these results in mind, tests were made with the horizontal tail in the rear position to determine whether there were any large or adverse effects on the longitudinal-stability characteristics. Also, another configuration having a reduced-sweep vertical tail (tail configuration 7) made it possible to maintain the original horizontal-tail length and at the same time avoid the unfavorable directional interference. The effects of these tail modifications on longitudinal stability were small. (See fig. 5.)

The basic wing was modified to an aspect ratio of 3.00 by clipping the tips to form a more practical tip chord. This modification was also expected to provide somewhat greater stability for the T-tail arrangement just prior to stall. The results of figure 6, however, show this modification to be rather ineffective for the T-tail arrangement.

Lift and Drag Characteristics

Small reductions in aspect ratio produced by clipping off the tips of the basic pointed wing did not appreciably affect the lift characteristics of the wing-fuselage configuration. (See fig. 3(c).) Because of unexplained scatter in the minimum drag, the present data are not considered suitable for analysis of lift-drag ratios. Drag due to lift results obtained from these data, however, should be indicative of aspect-ratio effects through the lift-coefficient range. Such results (fig. 14) show that clipping the wing tips increases slightly the drag due to lift at the higher Mach numbers. These data (fig. 3(d)) also indicate that the drag rise is not reached in the Mach number range of the present investigation.

The effect of small changes in horizontal-tail leading-edge overhang and tail length (fig. 5) had no appreciable effect on the lift characteristics, although small increases in drag due to lift were noted at the higher Mach numbers. Also, changes in aspect ratio for the tail-on configuration had small or negligible effect on the lift and drag characteristics. (See figs. 6(b) and 6(c).)

Stabilizer Characteristics

The usual variation of the aerodynamic characteristics with stabilizer deflection was obtained for the complete model with the various tail configurations. (See figs. 7 to 10.) These data show that pitching-moment linearity and pitch-up characteristics were not appreciably affected by stabilizer deflection. The stabilizer effectiveness for the various tail configurations is shown in figure 15.

CONCLUDING REMARKS

An investigation of longitudinal stability at high subsonic speeds (Mach numbers of 0.6 to 0.92) of a highly tapered model having several tail configurations indicates the following results:

In general, the data indicate that reasonably good longitudinal stability characteristics can be obtained with a highly tapered wing having zero sweep of the 80-percent chord line when used in conjunction with a low tail, a high tail, or a biplane tail. The data show that the model with a biplane horizontal tail (T-tail plus chord-plane tail) gave the best overall longitudinal stability characteristics in regard to pitching-moment linearity against lift for the Mach number range investigated. Changes in static margin at zero lift coefficient with Mach number for these tails are small for the Mach number range investigated.

Langley Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., September 14, 1956.

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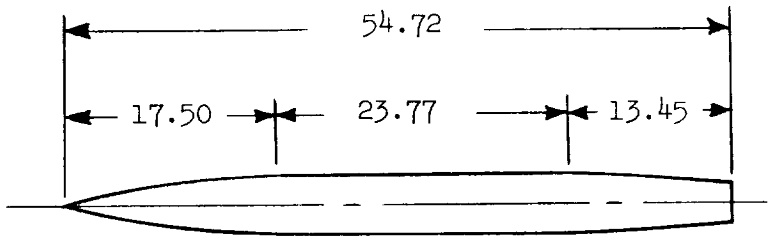
TABLE I.- FUSELAGE ORDINATES



Station, in.	Radius, in.
0	0
2.00	.53
4.00	1.00
6.00	1.44
8.00	1.80
10.00	2.07
12.00	2.30
14.00	2.42
16.00	2.47
17.50	2.50
41.27	2.50
43.27	2.42
45.27	2.35
47.27	2.25
48.30	2.14
54.72	1.65

TABLE II.- NORMAL- AND AXIAL-FORCE COEFFICIENTS (TAIL-OFF MODEL)

Aspect ratio	i_t, deg	M = .60			M = .80			M = .85			M = .90			M = .92		
		α°	C_N	C_A	α°	C_N	C_A	α°	C_N	C_A	α°	C_N	C_A	α°	C_N	C_A
4.00	—	-3.15	-.1843	.0056	-3.23	-.2103	.0059	-3.28	-.2314	.0063	-3.31	.0073	-.2579	-3.32	-.2834	.0092
		-2.09	-.1134	.0076	-2.15	-.1340	.0074	-2.18	-.1390	.0083	-2.20	.0096	-.1609	-2.21	-.1831	.0103
		-1.04	-.0456	.0079	-1.07	-.0595	.0085	-1.08	-.0662	.0093	-1.09	.0106	-.0739	-1.06	-.0730	.0104
		.01	.0139	.0078	.01	.0113	.0085	.01	.0157	.0092	.00	.0103	.0131	.01	.0099	.0107
		1.07	.0764	.0077	1.10	.0858	.0082	1.10	.0905	.0090	1.12	.0101	.1035	1.13	.1104	.0102
		2.12	.1444	.0066	2.19	.1754	.0063	2.19	.1740	.0074	2.24	.0086	.2085	2.24	.2107	.0096
		3.17	.2124	.0049	3.27	.2574	.0050	3.30	.2629	.0050	3.33	.0065	.2921	3.36	.3239	.0070
		4.23	.2832	.0036	4.37	.3300	.0041	4.39	.3430	.0033	4.45	.0049	.3842	4.49	.4275	.0055
														5.59	.5260	.0046
		6.34	.4111	.0015	6.51	.4678	.0030	6.57	.4889	.0025	6.65	.0042	.5676	6.70	.6339	.0046
														7.78	.6961	.0039
		8.43	.5190	.0010	8.63	.5731	.0038	8.69	.6009	.0037	8.80	.0042	.7255			
														9.95	.8500	.0028
		10.52	.6295	.0013	10.73	.6681	.0044	10.82	.7318	.0045	10.90	.0052	.8077	11.01	.9223	.0026
											11.97	.0053	.8677			
		12.59	.7311	.0026	12.83	.7668	.0061	12.89	.8044	.0063						
		14.62	.7925	.0055	14.87	.8291	.0082	14.92	.8517	.0090						
		16.64	.8150	.0089	16.81	.7722	.0142	16.91	.8464	.0121						
		18.62	.7786	.0118	18.89	.8450	.0155	18.97	.8878	.0164						
		20.69	.8609	.0121	20.97	.9253	.0155									
		22.74	0.9540	.0124	23.07	1.0301	.0156									
		23.77	1.0046	.0127	24.12	1.0773	.0152									
3.50	—	-3.15	-.1865	.0072	-3.24	-.2135	.0073	-3.27	-.2261	.0074	-3.31	.0081	-.2531	-3.32	-.2690	.0092
		-2.10	-.1177	.0091	-2.15	-.1320	.0091	-2.17	-.1413	.0097	-2.20	.0102	-.1529	-2.20	-.1614	.0108
		-1.04	-.0459	.0102	-1.06	-.0564	.0102	-1.07	-.0616	.0110	-1.07	.0116	-.0629	-1.09	-.0667	.0119
		.01	.0144	.0109	.01	.0135	.0107	.01	.0145	.0117	.02	.0125	.0171	.02	.0166	.0126
		1.07	.0776	.0108	1.10	.0891	.0107	1.11	.0961	.0115	1.13	.0125	.1039	1.15	.1116	.0128
		2.12	.1464	.0095	2.20	.1764	.0089	2.22	.1883	.0100	2.26	.0103	.2023	2.27	.2193	.0113
		3.19	.2295	.0084	3.30	.2636	.0079	3.33	.2750	.0084	3.37	.0093	.3124	3.39	.3256	.0098
		4.26	.2898	.0072	4.39	.3373	.0068	4.43	.3583	.0074	4.49	.0081	.3941	4.53	.4478	.0098
											5.59	.0079	.4874	5.64	.5409	.0090
		6.37	.4250	.0056	6.56	.4830	.0065	6.62	.5120	.0069	6.69	.0065	.5687	6.73	.6140	.0090
											7.76	.0081	.6315	7.83	.7209	.0095
		8.47	.5315	.0051	8.69	.5917	.0072	8.76	.6242	.0086	8.83	.0093	.6990	8.91	.7875	.0099
											9.91	.0108	.7634	9.98	.8454	.0099
		10.56	.6375	.0051	10.80	.7039	.0084	10.85	.7233	.0103	10.97	.0114	.8193	11.05	.9199	.0108
											12.01	.0119	.8567			
		12.64	.7520	.0070	12.88	.7849	.0101	12.93	.8062	.0118	13.05	.0132	.8924			
											14.10	.0145	.9415			
		14.69	.8171	.0095	14.94	.8578	.0126	14.99	.8707	.0143						
		16.66	.8024	.0137	16.89	.8131	.0176	16.98	.8667	.0202						
		18.67	.8056	.0141	18.95	.8734	.0183	19.04	.9208	.0215						
		20.73	.8803	.0133	21.06	.9681	.0182									
		22.81	0.9777	.0119	23.16	1.0567	.0180									
3.25	—	-3.16	-.1986	.0069	-3.25	-.2128	.0074	-3.26	-.2185	.0076	-3.31	.0078	-.2429	-3.33	-.2620	.0093
		-2.11	-.1191	.0090	-2.16	-.1348	.0089	-2.17	-.1404	.0096	-2.19	.0098	-.1507	-2.21	-.1588	.0107
		-1.06	-.0583	.0101	-1.06	-.0606	.0101	-1.08	-.0638	.0108	-1.09	.0110	-.0668	-1.09	-.0670	.0116
		.00	.0027	.0106	.00	.0038	.0104	.01	.0091	.0114	.01	.0119	.0102	.01	.0133	.0129
		1.06	.0664	.0105	1.09	.0780	.0103	1.10	.0856	.0112	1.12	.0119	.0942	1.13	.1003	.0125
		2.11	.1330	.0092	2.18	.1580	.0089	2.20	.1694	.0097	2.23	.0101	.1866	2.25	.2004	.0115
		3.17	.2054	.0077	3.28	.2437	.0075	3.31	.2603	.0081	3.36	.0084	.2922	3.38	.3168	.0103
		4.24	.2806	.0064	4.37	.3218	.0064	4.41	.3366	.0070	4.49	.0076	.3961	4.50	.4165	.0095
											5.59	.0070	.4749	5.61	.5193	.0094
		6.36	.4112	.0049	6.53	.4584	.0059	6.58	.4751	.0074	6.67	.0076	.5479	6.70	.5912	.0092
											7.74	.0087	.6177	7.81	.6810	.0099
		8.46	.5215	.0044	8.65	.5658	.0063	8.73	.6057	.0079	8.82	.0094	.6907	8.90	.7900	.0103
											9.87	.0104	.7333	9.95	.8318	.0110
		10.54	.6228	.0046	10.77	.6805	.0071	10.84	.7126	.0098	10.93	.0111	.7930	11.04	.8902	.0115
											12.01	.0116	.8527			
		12.62	.7266	.0060	12.86	.7677	.0096	12.94	.8033	.0112	13.05	.0126	.8951			
											14.10	.0139	.9380			
		14.67	.8095	.0090	14.92	.8468	.0119	15.00	.8661	.0135						
		16.65	.7860	.0130	16.86	.7904	.0163	16.96	.8459	.0186						
		18.65	.7891	.0137	18.94	.8566	.0169	19.03	.9095	.0198						
		20.73	.8846	.0124	21.02	.9345	.0164									
		22.79	0.9599	.0106	23.14	1.0411	.0239									
3.0	—	-3.15	-.1677	.0072	-3.23	-.1960	.0076	-3.25	-.2029	.0085	-3.28	.0091	-.2201	-3.29	-.2318	.0097
		-2.09	-.1031	.0092	-2.15	-.1248	.0095	-2.16	-.1273	.0105	-2.18	.0114	-.1352	-2.18	-.1424	.0118
		-1.04	-.0443	.0103	-1.06	-.0535	.0107	-1.06	-.0554	.0120	-1.07	.0127	-.0574	-1.08	-.0629	.0129
		.01	.0146	.0111	.01	.0099	.0112	.01	.0111	.0127	.01	.0135	.0122	.01	.0119	.0138
		1.06	.0734	.0108	1.09	.0792	.0113	1.11	.0868	.0124	1.12	.0134	.0903	1.12	.0933	.0139
		2.11	.1379	.0096	2.19	.1544	.0099	2.21	.1624	.0110	2.23	.0119	.1786	2.25	.1946	.0126
		3.19	.2084	.0083	3.28	.2374	.0085	3.31	.2489	.0095	3.34	.0100	.2685	3.37	.2957	.0114
		4.25	.2789	.0068	4.36	.3126	.0074	4.40	.3280	.0080	4.46	.0084	.3669	4.48	.3950	.0100
											5.57	.0070	.4532	5.58	.4763	.0093
		6.36	.4111	.0054	6.53	.4551	.0071	6.57	.4735	.0085	6.65	.0021	.5309	6.68	.5454	.0100
											7.73	.0101	.5912	7.76	.6261	.0109
		8.45	.5228	.0049	8.66	.5697	.0077	8.73	.6058	.0095	8.79	.0113	.6614	8.85	.7164	.0122
											9.87	.0128	.7235	9.91	.7836	.0133
		10.55	.6312	.0055	10.77	.6779	.0091	10.83	.7048	.0123	10.93	.0134	.7735	11.00	.8511	.0137
											11.98	.0142	.8168	12.08	.9348	.0147
		12.62	.7394	.0071	12.86	.7645	.0111	12.92	.7963	.0138	13.03	.0152	.8734			
											14.09	.0169	.9234			
		14.67	.8089	.0102	14.91	.8289	.0134	14.98	.8636	.0169						
		16.66	.8056	.0143	16.87	.7953	.0182	16.96	.8470	.0229						
		18.66	.7999	.0152	18.94	.8527	.0191	19.03	.8966	.0246						
		20.72	.8880	.0139	21.02	.9336	.0195									
		22.80	0.9759	.0131	23.13	1.0358	.0186									

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TABLE III.- NORMAL- AND AXIAL-FORCE COEFFICIENTS WITH TAIL

CONFIGURATIONS 1 TO 5 (A = 3.50)

Tail Configuration	i_t, deg	M = .60			M = .80			M = .85			M = .90			M = .92		
		$a°$	C_N	C_A	$a°$	C_N	C_A	$a°$	C_N	C_A	$a°$	C_N	C_A	$a°$	C_N	C_A
1	—	-3.16	-.2013	.0084	-3.26	-.2292	.0081	-3.29	-.2472	.0081	-3.32	.0084	-.2673	-3.34	-.2850	.0099
		-2.13	-.1391	.0097	-2.16	-.1471	.0087	-2.18	-.1566	.0100	-2.20	.0101	-.1639	-2.22	-.1907	.0111
		-1.06	-.0711	.0108	-1.10	-.0804	.0106	-1.10	-.0802	.0111	-1.11	.0117	-.0837	-1.12	-.0964	.0127
		.00	-.0059	.0111	.00	-.0021	.0097	.00	-.0001	.0110	.00	.0118	-.0033	.00	-.0033	.0122
		1.04	.0566	.0110	1.08	.0724	.0096	1.10	.0782	.0112	1.10	.0116	.0787	1.12	.0993	.0126
		2.11	.1273	.0098	2.16	.1430	.0082	2.19	.1601	.0094	2.22	.0101	.1836	2.23	.2031	.0119
		3.16	.1897	.0077	3.26	.2288	.0072	3.28	.2345	.0074	3.33	.0080	.2833	3.35	.3122	.0104
		4.21	.2604	.0060	4.33	.2977	.0058	4.37	.3182	.0056	4.43	.0065	.3716	4.45	.3905	.0075
		6.33	.3939	.0044	6.49	.4373	.0035	5.47	.4000	.0046	5.53	.0048	.4472	5.56	.4880	.0063
		8.42	.4990	.0029	8.61	.5442	.0044	6.53	.4533	.0040	6.60	.0042	.5042	6.63	.5614	.0054
		10.50	.6094	.0024	10.73	.6677	.0052	7.62	.5299	.0041	7.68	.0047	.5757	7.75	.6745	.0050
		12.57	.6943	.0035	12.81	.7514	.0063	8.68	.5866	.0039	8.77	.0051	.6667	8.79	.6995	.0044
		14.62	.7810	.0052	14.87	.8155	.0074	9.75	.6451	.0046	9.82	.0055	.7050	8.69	-.1355	-.0002
		16.63	.8061	.0082	16.79	.7582	.0130	10.79	.6840	.0025	10.87	.0056	.7582			
		18.60	.7637	.0111	17.61	-.3340	.0104	11.84	.7371	.0053	11.96	.0052	.8570			
		19.31	-.8500	.0081	19.69	-.2525	.0091	12.87	.7689	.0063	12.99	.0055	.8664			
		21.37	-.7634	.0071	21.81	-.1352	.0071	13.92	.8305	.0068	12.81	.0026	-.0780			
		22.42	-.7018	.0060	22.84	-.0800	.0058	14.93	.8426	.0082						
								15.90	.8247	.0113						
								15.64	-.2503	.0103						
								16.68	-.2289	.0103						
								17.72	-.1882	.0107						
								18.76	-.1529	.0105						
2	—	-3.18	-.2120	.0081	-3.27	-.2392	.0091	-3.30	-.2515	.0112	-3.32	.0100	-.2678	-3.35	-.3002	.0111
		-2.12	-.1412	.0095	-2.18	-.1615	.0112	-2.19	-.1612	.0111	-2.20	.0118	-.1747	-2.22	-.1868	.0125
		-1.06	-.0737	.0126	-1.10	-.0856	.0122	-1.10	-.0815	.0118	-1.11	.0132	-.0898	-1.11	-.0975	.0136
		-.01	-.0142	.0118	-.01	-.0113	.0127	-.01	-.0087	.0127	-.01	.0132	-.0098	-.01	-.0080	.0137
		1.04	.0481	.0125	1.06	.0552	.0124	1.08	.0606	.0126	1.11	.0131	.0753	1.11	.0817	.0134
		2.09	.1158	.0100	2.15	.1331	.0111	2.19	.1509	.0112	2.21	.0117	.1750	2.22	.1791	.0124
		3.15	.1835	.0084	3.24	.2242	.0096	3.28	.2376	.0092	3.34	.0102	.2909	3.34	.2921	.0111
		4.22	.2599	.0070	4.35	.3134	.0083	4.39	.3280	.0076	4.46	.0088	.3823	4.48	.4136	.0105
		6.33	.3900	.0067	6.50	.4373	.0075	6.56	.4770	.0069	5.55	.0079	.4655	5.55	.4711	.0086
		8.43	.5006	.0055	8.62	.5531	.0073	7.64	.5442	.0064	6.62	.0074	.5242	6.68	.5919	.0088
		10.51	.6078	.0061	10.74	.6667	.0084	8.71	.6027	.0070	7.71	.0082	.6067	7.78	.6733	.0089
		12.59	.7203	.0079	12.83	.7594	.0099	9.76	.6469	.0083	8.78	.0089	.6651	8.86	.7695	.0097
		14.64	.7987	.0104	14.89	.8308	.0122	10.83	.7138	.0090	9.87	.0098	.7394	9.96	.8667	.0096
		16.66	.8291	.0126	16.84	.7869	.0163	11.86	.7493	.0097	10.92	.0121	.7973			
		18.63	.7758	.0154	17.64	-.2925	.0131	12.90	.7967	.0111	11.95	.0108	.8306			
		20.68	.8491	.0147	19.74	-.2095	.0117	13.93	.8282	.0119	13.02	.0115	.8888			
		21.37	-.7714	.0113	21.85	-.0971	.0113	14.94	.8543	.0136						
		22.42	-.6903	.0104	22.89	-.0503	.0109	15.93	.8399	.0158						
								16.92	.8313	.0168						
								16.72	-.1961	.0140						
								17.76	-.1608	.0134						
3	0	-3.16	-.2020	.0095	-3.26	-.2270	.0090	-3.28	-.2380	.0091	-3.31	.0092	-.2586	-3.32	-.2749	.0107
		-2.11	-.1263	.0111	-2.16	-.1421	.0107	-2.18	-.1571	.0106	-2.20	.0113	-.1660	-2.24	-.1864	.0120
		-1.05	-.0592	.0122	-1.09	-.0744	.0122	-1.11	-.0781	.0124	-1.12	.0126	-.0817	-1.13	-.0976	.0136
		.00	-.0003	.0121	-.01	.0014	.0122	-.01	.0013	.0126	.00	.0130	.0061	-.01	-.0006	.0133
		1.05	.0699	.0124	1.08	.0753	.0122	1.09	.0790	.0124	1.10	.0127	.0824	1.09	.0886	.0133
		2.11	.1399	.0117	2.16	.1507	.0114	2.18	.1616	.0114	2.21	.0115	.1865	2.21	.1919	.0121
		3.15	.2014	.0098	3.23	.2243	.0094	3.27	.2407	.0092	3.29	.0091	.2609	3.32	.2899	.0112
		4.23	.2881	.0077	4.32	.3111	.0077	4.36	.3234	.0072	4.41	.0070	.3551	4.44	.3946	.0087
		6.31	.4114	.0057	6.47	.4489	.0054	5.44	.3956	.0053	5.51	.0054	.4394	5.53	.4756	.0072
		8.42	.5315	.0036	8.59	.5656	.0043	6.52	.4745	.0046	6.59	.0049	.5170	6.65	.5800	.0061
		10.50	.6406	.0027	10.68	.6744	.0051	7.60	.5464	.0041	7.68	.0048	.5992	7.72	.6365	.0054
		12.56	.7491	.0036	12.77	.7813	.0050	8.65	.6024	.0044	8.75	.0053	.6763	8.77	.7083	.0050
		14.61	.8374	.0053	14.83	.8664	.0058	9.72	.6671	.0043	9.79	.0050	.7175	9.85	.8039	.0039
		16.62	.8861	.0072	16.76	.8583	.0096	10.76	.7108	.0048	10.89	.0049	.8238	10.92	.8762	.0030
		18.56	.8614	.0090	17.55	-.2084	.0034	11.82	.7702	.0051	11.93	.0048	.8649			
		19.26	-.7296	.0026	19.62	-.1104	.0001	12.86	.8240	.0050	12.97	.0042	.9026			
		21.34	-.6167	-.0003	21.71	-.0050	-.0030	13.86	.8497	.0055	14.02	.0043	.9629			
		22.36	-.5728	-.0014	22.76	0.0691	-.0049	14.89	.8980	.0059						
								15.86	.9002	.0078						
								15.59	-.1585	.0048						
								16.63	-.1070	.0035						
								17.63	-.0899	.0029						

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TABLE III. — CONCLUDED

Tail Configuration	i_t, deg	M = .60			M = .80			M = .85			M = .90			M = .92		
		$\alpha°$	C_N	C_A	$\alpha°$	C_N	C_A	$\alpha°$	C_N	C_A	$\alpha°$	C_N	C_A	$\alpha°$	C_N	C_A
4	-0.7	-3.15	-.2351	.0091	-3.22	-.2569	.0098	-3.25	-.2728	.0098	-3.27	.0118	-.3052	-3.30	-.3323	.0133
		-2.09	-.1537	.0119	-2.14	-.1717	.0116	-2.16	-.1759	.0115	-2.17	.0139	-.2009	-2.18	-.2093	.0159
		-1.05	-.0836	.0126	-1.07	-.0865	.0130	-1.08	-.0895	.0133	-1.07	.0144	-.1065	-1.10	-.1165	.0173
		.00	-.0134	.0133	.00	-.0089	.0129	.00	-.0101	.0131	.01	.0142	-.0152	.01	-.0105	.0153
		1.05	.0624	.0138	1.08	.0726	.0129	1.08	.0764	.0131	1.09	.0139	.0726	1.12	.0821	.0145
		2.11	.1411	.0125	2.15	.1518	.0112	2.16	.1680	.0114	2.19	.0120	.1752	2.21	.1874	.0130
		3.15	.2114	.0097	3.22	.2371	.0094	3.25	.2543	.0090	3.31	.0100	.2778	3.31	.2921	.0112
		4.21	.2957	.0081	4.30	.3149	.0080	4.35	.3445	.0069	4.40	.0078	.3790	4.42	.4022	.0090
		6.30	.4281	.0059	6.44	.4648	.0054	5.41	.4154	.0054	5.48	.0062	.4616	5.51	.5182	.0080
		8.40	.5494	.0032	8.56	.5882	.0045	6.49	.4913	.0046	6.56	.0048	.5448	6.62	.6311	.0069
		10.47	.6590	.0028	10.66	.7037	.0044	7.56	.5654	.0039	7.65	.0055	.6389	7.69	.6962	.0058
		12.54	.7713	.0034	12.75	.8058	.0052	8.64	.6448	.0043	8.69	.0054	.6885	8.76	.7775	.0049
		14.57	.8411	.0055	14.79	.8774	.0060	9.69	.6950	.0042	9.75	.0054	.7545			
		16.60	.8883	.0074	16.74	.8478	.0105	10.73	.7418	.0046	10.82	.0054	.8373			
		18.56	.8426	.0098	17.54	-.2560	.0053	11.76	.7911	.0051	11.87	.0052	.8790			
		20.63	.9174	.0098	19.65	-.1791	.0040	12.81	.8389	.0052	12.92	.0051	.9291			
		21.35	-.7123	.0051	21.77	-.1013	.0033	13.85	.8828	.0055						
		22.38	-.6971	.0050	22.85	-.0527	.0032	14.88	.9266	.0060						
								15.81	.9072	.0085						
								16.82	.8990	.0102						
								16.59	-.1601	.0056						
								17.66	-.1069	.0051						
								18.68	-.0890	.0042						

Tail Configuration	i_t, deg	M = .60			M = .80			M = .85			M = .90			M = .92		
		$\alpha°$	C_N	C_A	$\alpha°$	C_N	C_A	$\alpha°$	C_N	C_A	$\alpha°$	C_N	C_A	$\alpha°$	C_N	C_A
5	{-0.7, 0}	-3.15	-.2280	.0093	-3.22	-.2506	.0100	-3.23	-.2628	.0105	-3.26	.0131	-.2861	-3.28	-.3069	.0141
		-2.10	-.1501	.0113	-2.14	-.1589	.0117	-2.15	-.1704	.0118	-2.17	.0148	-.1911	-2.18	-.1950	.0168
		-1.04	-.0723	.0129	-1.08	-.0823	.0130	-1.08	-.0868	.0136	-1.07	.0154	-.0909	-1.08	-.0958	.0172
		.00	-.0055	.0128	.00	.0039	.0133	.01	.0006	.0137	.01	.0154	-.0073	.02	-.0010	.0162
		1.04	.0697	.0131	1.09	.0827	.0135	1.09	.0792	.0137	1.11	.0149	.0830	1.10	.0989	.0160
		2.10	.1390	.0120	2.15	.1669	.0121	2.17	.1751	.0123	2.20	.0133	.1947	2.20	.1923	.0142
		3.14	.2225	.0101	3.22	.2435	.0100	3.25	.2571	.0355	3.30	.0107	.2877	3.31	.3046	.0120
		4.20	.3058	.0079	4.31	.3337	.0081	4.33	.3408	.0077	4.39	.0083	.3860	4.40	.4010	.0104
		5.24	.3754	.0064	6.43	.4779	.0060	5.42	.4280	.0061	5.47	.0067	.4649	5.51	.5021	.0082
		6.30	.4506	.0052	8.54	.5975	.0045	6.49	.5065	.0053	6.55	.0053	.5500	6.60	.6090	.0071
		8.37	.5702	.0026	10.65	.7392	.0038	7.57	.5936	.0044	7.60	.0047	.5991	7.68	.6972	.0066
		10.46	.6923	.0016	12.72	.8383	.0039	8.61	.6544	.0041	8.70	.0050	.7185	8.75	.7771	.0052
		12.52	.7951	.0016	14.77	.9345	.0046	9.68	.7328	.0041	9.74	.0054	.7627	9.83	.8727	.0045
		14.56	.9001	.0030	16.69	.9215	.0074	10.72	.7730	.0042	10.80	.0054	.8363	10.91	.9527	.0036
		16.57	.9347	.0045	17.46	-.1493	.0005	11.75	.8249	.0041	11.88	.0049	.9261			
		18.52	.9261	.0068	19.54	-.0744	-.0021	12.79	.8715	.0041	12.91	.0043	.9586			
		20.58	1.0099	.0050				13.82	.9147	.0049	13.92	.0040	.9829			
		21.30	-.5801	-.0016				14.82	.9489	.0049						
		22.33	-0.5435	-.0022				15.79	.9556	.0065						
								15.52	-.0948	.0016						
								16.53	-.0609	.0013						
								17.55	-0.0264	-.0003						

TABLE IV.- NORMAL- AND AXIAL-FORCE COEFFICIENTS WITH TAIL CONFIGURATIONS 4, 6, AND 7 (A = 3.50)

Tail Configuration	i_t, deg	M = .60			M = .80			M = .85			M = .90			M = .92		
		α°	C_N	C_A	α°	C_N	C_A	α°	C_N	C_A	α°	C_N	C_A	α°	C_N	C_A
4	-0.7	-3.15	-.2351	.0091	-3.22	-.2569	.0098	-3.25	-.2728	.0098	-3.27	.0118	-.3052	-3.30	-.3323	.0133
		-2.09	-.1537	.0119	-2.14	-.1717	.0116	-2.16	-.1759	.0115	-2.17	.0139	-.2009	-2.18	-.2093	.0159
		-1.05	-.0836	.0126	-1.07	-.0865	.0130	-1.08	-.0895	.0133	-1.07	.0144	-.1065	-1.10	-.1165	.0173
		.00	-.0134	.0133	.00	-.0089	.0129	.00	-.0101	.0131	.01	.0142	-.0152	.01	-.0105	.0153
		1.05	.0624	.0138	1.08	.0726	.0129	1.08	.0764	.0131	1.09	.0139	.0726	1.12	.0821	.0145
		2.11	.1411	.0125	2.15	.1518	.0112	2.16	.1680	.0114	2.19	.0120	.1752	2.21	.1874	.0130
		3.15	.2114	.0097	3.22	.2371	.0094	3.25	.2543	.0090	3.31	.0100	.2778	3.31	.2921	.0112
		4.21	.2957	.0081	4.30	.3149	.0080	4.35	.3445	.0069	4.40	.0078	.3790	4.42	.4022	.0090
		6.30	.4281	.0059	6.44	.4648	.0054	5.41	.4154	.0054	5.48	.0062	.4616	5.51	.5182	.0080
		8.40	.5494	.0032	8.56	.5882	.0045	6.49	.4913	.0046	6.56	.0048	.5448	6.62	.6311	.0069
		10.47	.6590	.0028	10.66	.7037	.0044	7.56	.5654	.0039	7.65	.0055	.6389	7.69	.6962	.0058
		12.54	.7713	.0034	12.75	.8058	.0052	8.64	.6448	.0043	8.69	.0054	.6885	8.76	.7775	.0049
		14.57	.8411	.0055	14.79	.8774	.0060	9.69	.6960	.0042	9.75	.0054	.7545			
		16.60	.8883	.0074	16.74	.8478	.0105	10.73	.7418	.0046	10.82	.0054	.8373			
		18.56	.8426	.0098	17.54	-.2560	.0053	11.76	.7911	.0051	11.87	.0052	.8790			
		20.63	.9174	.0088	19.65	-.1791	.0040	12.81	.8389	.0052	12.92	.0051	.9291			
		21.35	-.7123	.0051	21.77	-.1013	.0033	13.85	.8828	.0055						
		22.38	-.6971	.0050	22.85	-.0527	.0032	14.88	.9266	.0060						
								15.81	.9072	.0085						
								16.82	.8990	.0102						
								16.59	-.1601	.0056						
								17.66	-.1069	.0051						
								18.68	-.0890	.0042						
6	-0.7	-3.15	-.2504	.0095	-3.22	-.2787	.0106	-3.24	-.2912	.0104	-3.28	.0116	-.3311	-3.28	-.3359	.0131
		-2.11	-.1780	.0114	-2.16	-.1925	.0120	-2.16	-.2003	.0122	-2.18	.0129	-.2209	-2.19	-.2315	.0145
		-1.05	-.0994	.0132	-1.08	-.1062	.0134	-1.08	-.1093	.0138	-1.08	.0146	-.1141	-1.08	-.1209	.0152
		-.02	-.0272	.0129	-.01	-.0273	.0135	-.01	-.0288	.0139	.01	.0147	-.0236	.00	-.0246	.0152
		1.04	.0481	.0124	1.07	.0517	.0129	1.11	.0587	.0134	1.08	.0143	.0622	1.10	.0737	.0145
		2.08	.1178	.0117	2.14	.1323	.0123	2.16	.1413	.0126	2.17	.0133	.1560	2.21	.1846	.0140
		3.14	.1903	.0100	3.21	.2208	.0104	3.25	.2341	.0105	3.27	.0115	.2614	3.31	.2907	.0126
		4.18	.2686	.0083	4.29	.3053	.0088	4.34	.3290	.0084	4.38	.0100	.3685	4.41	.4066	.0114
		6.28	.4142	.0061	6.44	.4747	.0061	5.42	.4168	.0068	5.48	.0086	.4593	5.51	.5204	.0108
		8.39	.5458	.0042	8.56	.5970	.0059	6.50	.5029	.0059	6.56	.0080	.5464	6.60	.6122	.0101
		10.46	.6495	.0040	10.65	.7061	.0073	7.60	.5679	.0060	7.62	.0081	.6124	7.69	.6930	.0091
		12.53	.7501	.0052	12.74	.7982	.0082	8.62	.6327	.0067	8.78	.0091	.7634	8.73	.7804	.0092
		14.58	.8393	.0080	14.79	.8784	.0100	9.68	.6975	.0071	9.74	.0094	.7424			
		16.59	.8751	.0110	16.73	.8397	.0147	10.72	.7414	.0076	10.80	.0100	.8132			
		18.59	.8406	.0137	18.80	.8936	.0147	11.78	.7941	.0080	11.84	.0103	.8593			
		20.63	.9020	.0138	20.91	.9561	.0154	12.79	.8254	.0091	12.90	.0104	.9238			
		22.72	.9722	.0146				13.83	.8780	.0102						
		23.75	.9986	.0152				14.84	.9041	.0115						
								15.81	.8824	.0137						
								16.81	.8907	.0157						
								17.84	.9227	.0161						
								18.88	.9357	.0161						
7	-0.7										-3.24	.0120	-.3028	-2.64	.1448	.0171
											-2.16	.0139	-.1994	-2.15	-.2075	.0152
		.00	-.0133	.0133	.00	-.0179	.0136	.02	-.0111	.0147	.03	.0156	-.0118	.03	-.0177	.0170
		2.10	.1347	.0119	2.16	.1572	.0118	2.18	.1678	.0126	2.20	.0136	.1744	2.23	.2026	.0155
		4.21	.2940	.0089	4.32	.3324	.0088	4.37	.3556	.0089	4.40	.0097	.3758	4.45	.4279	.0117
		6.31	.4286	.0069	6.47	.4815	.0076	6.52	.5102	.0080	6.58	.0087	.5456	6.61	.5972	.0111
		8.40	.5462	.0051	8.56	.5982	.0072	8.63	.6296	.0089	8.71	.0105	.6983	8.73	.7260	.0119
		10.46	.6582	.0047	10.67	.7262	.0077	10.73	.7466	.0095	10.82	.0118	.8171	11.01	.9691	.0119
		12.53	.7586	.0065	12.75	.8108	.0090	12.82	.8517	.0108	12.88	.0125	.8995			
		14.58	.8533	.0089	14.80	.8911	.0107	14.88	.9266	.0128	14.97	.0146	.9899			
		16.59	.8748	.0116	16.74	.8524	.0149	16.83	.9116	.0169						
		18.56	.8519	.0146	18.81	.9137	.0152	18.91	.9826	.0179						
		20.63	.9070	.0134	20.91	0.9813	.0153	21.02	1.0421	.0186						
		22.72	0.9908	.0130	23.04	1.0406	.0161									

TABLE V.- NORMAL- AND AXIAL-FORCE COEFFICIENTS WITH TAIL CONFIGURATION 6

M = .60

Aspect ratio	i_t, deg	α°	C_N	C_A
3.50	-0.7	-3.15	-.2504	.0095
		-2.11	-.1780	.0114
		-1.05	-.0994	.0132
		-.02	-.0272	.0129
		1.04	.0481	.0124
		2.08	.1178	.0117
		3.14	.1903	.0100
		4.18	.2686	.0083
		6.28	.4142	.0061
		8.39	.5458	.0042
		10.46	.6495	.0040
		12.53	.7501	.0052
		14.58	.8393	.0080
		16.59	.8751	.0110
		18.59	.8406	.0137
		20.63	.9020	.0138
		22.72	.9722	.0146
		23.75	.9986	.0152
3.00	-0.7	-3.12	-.2071	.0094
		-2.07	-.1376	.0120
		-1.03	-.0653	.0131
		.02	.0015	.0142
		1.07	.0682	.0142
		2.12	.1435	.0131
		3.17	.2220	.0113
		4.23	.3004	.0100
		6.34	.4428	.0076
		8.43	.5649	.0062
		10.52	.6956	.0061
		12.58	.7857	.0077
		14.63	.8723	.0113
		16.60	.8626	.0154
		18.63	.8934	.0170
		20.68	.9264	.0167
		22.78	1.0023	.0176

M = .80

Aspect ratio	i_t, deg	α°	C_N	C_A
3.50	-0.7	-3.22	-.2787	.0106
		-2.16	-.1925	.0120
		-1.08	-.1062	.0134
		-.01	-.0273	.0135
		1.07	.0517	.0129
		2.14	.1323	.0123
		3.21	.2208	.0104
		4.29	.3053	.0088
		6.44	.4747	.0061
		8.56	.5970	.0059
		10.65	.7061	.0073
		12.74	.7982	.0082
		14.79	.8784	.0100
		16.73	.8397	.0147
		18.80	.8936	.0147
		20.91	.9561	.0154
3.00	-0.7	-3.17	-.2326	.0100
		-2.09	-.1466	.0122
		-1.03	-.0706	.0131
		.04	.0018	.0140
		1.11	.0759	.0139
		2.18	.1581	.0124
		3.26	.2480	.0109
		4.35	.3321	.0093
		6.48	.4849	.0083
		8.61	.6141	.0085
		10.71	.7315	.0094
		12.90	.8271	.0113
		14.84	.8971	.0136
		16.79	.8609	.0176
		18.85	.9131	.0183
		20.97	0.9822	.0195
		23.13	1.0544	.0199

M = .85

Aspect ratio	i_t, deg	α°	C_N	C_A
3.50	-0.7	-3.24	-.2912	.0104
		-2.16	-.2003	.0122
		-1.08	-.1093	.0138
		-.01	-.0288	.0139
		1.11	.0587	.0134
		2.16	.1413	.0126
		3.25	.2341	.0105
		4.34	.3290	.0084
		5.42	.4168	.0068
		6.50	.5029	.0059
		7.60	.5679	.0060
		8.62	.6327	.0067
		9.68	.6975	.0071
		10.72	.7414	.0076
		11.78	.7941	.0080
		12.79	.8254	.0091
		13.83	.8780	.0102
		14.84	.9041	.0115
		15.81	.8824	.0137
		16.81	.8907	.0157
		17.84	.9227	.0161
		18.88	.9357	.0161
3.00	-0.7	-3.20	-.2405	.0100
		-2.11	-.1497	.0125
		-1.04	-.0715	.0135
		.03	.0014	.0143
		1.11	.0833	.0145
		2.19	.1654	.0125
		3.29	.2602	.0103
		4.37	.3423	.0089
		6.53	.5063	.0073
		8.66	.6340	.0088
		10.75	.7466	.0107
		12.84	.8450	.0119
		14.97	.9213	.0143
		16.87	.9078	.0196
		18.95	.9619	.0202

M = .90

Aspect ratio	i_t, deg	α°	C_N	C_A
3.50	-0.7	-3.28	.0116	-.3311
		-2.18	.0129	-.2209
		-1.08	.0146	-.1141
		.01	.0147	-.0236
		1.08	.0143	.0622
		2.17	.0133	.1560
		3.27	.0115	.2614
		4.38	.0100	.3685
		5.48	.0086	.4593
		6.56	.0080	.5464
		7.62	.0081	.6124
		8.78	.0091	.7634
		9.74	.0094	.7424
		10.80	.0100	.8132
		11.84	.0103	.8593
		12.90	.0104	.9238
3.00	-0.7	-3.22	.0119	-.2530
		-2.12	.0132	-.1597
		-1.05	.0144	-.0751
		.04	.0154	.0064
		1.12	.0149	.0862
		2.21	.0131	.1748
		3.31	.0113	.2700
		4.43	.0097	.3837
		5.52	.0095	.4770
		6.60	.0096	.5535
		7.68	.0106	.6330
		8.71	.0118	.6963
		9.80	.0128	.7702
		10.85	.0134	.8211
		11.92	.0143	0.8926
		12.98	.0151	.9436
		14.01	.0160	.9863

M = .92

Aspect ratio	i_t, deg	α°	C_N	C_A
3.50	-0.7	-3.23	-.3359	.0131
		-2.19	-.2315	.0145
		-1.08	-.1209	.0152
		.00	-.0246	.0152
		1.10	.0737	.0145
		2.21	.1846	.0140
		3.31	.2907	.0126
		4.41	.4066	.0114
		5.51	.5204	.0108
		6.60	.6122	.0101
		7.69	.6930	.0091
		8.73	.7804	.0092
3.00	-0.7	-3.22	-.2719	.0128
		-2.12	-.1640	.0146
		-1.05	-.0813	.0154
		.04	.0015	.0163
		1.13	.0928	.0145
		2.24	.1927	.0156
		3.34	.2840	.0125
		4.45	.3999	.0119
		5.56	.5126	.0122
		6.64	.5905	.0117
		7.72	.6976	.0130
		8.84	.7972	.0136
		9.88	.8634	.0140
		10.96	.9463	.0150
		12.02	1.0046	.0158

TABLE VI.- NORMAL- AND AXIAL-FORCE COEFFICIENTS WITH TAIL CONFIGURATION 4 (A = 3.50)

Tail Configuration	i_t, deg	M = .60			M = .80			M = .85			M = .90			M = .92		
		α°	C_N	C_A	α°	C_N	C_A	α°	C_N	C_A	α°	C_N	C_A	α°	C_N	C_A
4	-0.7	-3.15	-.2351	.0091	-3.22	-.2569	.0098	-3.25	-.2728	.0098	-3.27	.0118	-.3052	-3.30	-.3323	.0133
		-2.09	-.1537	.0119	-2.14	-.1717	.0116	-2.16	-.1759	.0115	-2.17	.0139	-.2009	-2.18	-.2093	.0159
		-1.05	-.0836	.0126	-1.07	-.0865	.0130	-1.08	-.0895	.0133	-1.07	.0144	-.1065	-1.10	-.1165	.0173
		.00	-.0134	.0133	.00	-.0089	.0129	.00	-.0101	.0131	.01	.0142	-.0152	.01	-.0105	.0153
		1.05	.0624	.0138	1.08	.0726	.0129	1.08	.0764	.0131	1.09	.0139	.0726	1.12	.0821	.0145
		2.11	.1411	.0125	2.15	.1518	.0112	2.16	.1680	.0114	2.19	.0120	.1752	2.21	.1874	.0130
		3.15	.2114	.0097	3.22	.2371	.0094	3.25	.2543	.0090	3.31	.0100	.2778	3.31	.2921	.0112
		4.21	.2957	.0081	4.30	.3149	.0080	4.35	.3445	.0069	4.40	.0078	.3790	4.42	.4022	.0090
		6.30	.4281	.0059	6.44	.4648	.0054	5.41	.4154	.0054	5.48	.0062	.4616	5.51	.5182	.0080
		8.40	.5494	.0032	8.56	.5882	.0045	6.49	.4913	.0046	6.56	.0048	.5448	6.62	.6311	.0069
		10.47	.6590	.0028	10.66	.7037	.0044	7.56	.5654	.0039	7.65	.0055	.6389	7.69	.6962	.0058
		12.54	.7713	.0034	12.75	.8058	.0052	8.64	.6448	.0043	8.69	.0054	.6885	8.76	.7775	.0049
		14.57	.8411	.0055	14.79	.8774	.0060	9.69	.6960	.0042	9.75	.0054	.7545			
		16.60	.8883	.0074	16.74	.8478	.0105	10.73	.7418	.0046	10.82	.0054	.8373			
		18.56	.8426	.0098	17.54	-.2560	.0053	11.76	.7911	.0051	11.87	.0052	.8790			
		20.63	.9174	.0098	19.65	-.1791	.0040	12.81	.8389	.0052	12.92	.0051	.9291			
		21.35	-.7123	.0051	21.77	-.1013	.0033	13.85	.8828	.0055						
		22.38	-.6971	.0050	22.85	-.0527	.0032	14.88	.9266	.0060						
								15.81	.9072	.0085						
								16.82	.8990	.0102						
								16.59	-.1601	.0056						
								17.66	-.1069	.0051						
								18.68	-.0890	.0042						
4	-4.0	-3.09	-.2313	.0129	-3.13	-.2607	.0137	-3.15	-.2705	.0138	-3.18	.0160	-.2820	-3.19	-.3074	.0187
		-2.04	-.1619	.0145	-2.06	-.1765	.0149	-2.05	-.1778	.0147	-2.07	.0177	-.1835	-2.08	-.1891	.0186
		-1.00	-.0925	.0150	-.98	-.1014	.0151	-.98	-.1028	.0147	-.98	.0177	-.1028	-.98	-.0990	.0184
		.06	-.0231	.0146	.09	-.0229	.0152	.10	-.0208	.0148	.12	.0174	-.0110	.12	-.0059	.0178
		1.10	.0518	.0141	1.16	.0576	.0140	1.19	.0663	.0143	1.22	.0163	.0762	1.23	.0936	.0171
		2.16	.1296	.0125	2.24	.1455	.0121	2.28	.1588	.0123	2.32	.0133	.1826	2.33	.1941	.0156
		3.20	.1990	.0109	3.32	.2296	.0106	3.36	.2460	.0100	3.41	.0114	.2759	3.43	.2983	.0133
		4.26	.2797	.0096	4.39	.3103	.0093	4.44	.3279	.0075	4.50	.0095	.3662	4.52	.3892	.0112
		6.35	.4075	.0067	6.52	.4508	.0061	5.52	.4065	.0061	5.59	.0081	.4561	5.62	.4933	.0095
		8.44	.5300	.0045	8.63	.5670	.0052	6.59	.4797	.0053	6.67	.0062	.5380	6.70	.5966	.0087
		10.52	.6413	.0027	10.74	.6885	.0048	7.66	.5460	.0048	7.73	.0058	.6034	7.78	.6842	.0070
		12.60	.7552	.0032	12.82	.7818	.0049	8.72	.6156	.0045	8.77	.0060	.6526	8.86	.7645	.0057
		14.63	.8212	.0048	14.86	.8543	.0047	9.76	.6680	.0045	9.84	.0063	.7338	9.95	.8679	.0043
		16.62	.8479	.0057	16.80	.8172	.0083	10.82	.7289	.0045	10.87	.0061	.7780	9.82	-.0220	-.0013
		18.61	.8309	.0078	17.61	-.2531	.0035	11.85	.7723	.0045	11.93	.0049	.8320			
		19.31	-.7829	.0044	19.73	-.1734	.0033	12.88	.8069	.0046	13.01	.0045	.9057			
		21.40	-.7118	.0040	21.85	-.0836	.0028	13.90	.8467	.0049	14.04	.0044	.9469			
		22.44	-.6720	.0039	22.92	-.0436	.0031	14.93	.8846	.0057						
								15.90	.8750	.0075						
								15.64	-.1894	.0041						
								16.69	-.1527	.0037						
								17.73	-.1192	.0034						
4	-6.0	-3.10	-.2910	.0154	-3.14	-.3209	.0189	-3.16	-.3304	.0202	-3.20	.0226	-.3550	-3.21	-.3723	.0250
		-2.04	-.2185	.0178	-2.07	-.2363	.0197	-2.06	-.2339	.0216	-2.09	.0231	-.2479	-2.09	-.2502	.0251
		-1.00	-.1461	.0185	-.98	-.1518	.0201	-.98	-.1498	.0212	-.99	.0239	-.1492	-.99	-.1539	.0253
		.04	-.0760	.0180	.09	-.0748	.0198	.11	-.0708	.0204	.11	.0231	-.0700	.11	-.0620	.0242
		1.10	-.0065	.0170	1.16	.0022	.0189	1.19	.0064	.0196	1.20	.0224	.0161	1.21	.0237	.0230
		2.15	.0633	.0162	2.25	.0829	.0169	2.27	.0957	.0179	2.30	.0201	.1150	2.33	.1363	.0216
		3.21	.1441	.0133	3.33	.1768	.0147	3.38	.1922	.0149	3.43	.0174	.2301	3.44	.2643	.0196
		4.25	.2165	.0120	4.41	.2611	.0131	4.47	.2815	.0128	4.51	.0154	.3206	4.55	.3690	.0174
		6.36	.3699	.0095	6.55	.4134	.0112	6.63	.4461	.0101	5.63	.0140	.4276	5.66	.4657	.0155
		8.45	.4846	.0070	8.68	.5429	.0099	7.69	.5213	.0098	6.71	.0133	.5098	6.73	.5459	.0151
		10.53	.5988	.0062	10.77	.6551	.0101	8.76	.5861	.0106	7.78	.0134	.5836	7.83	.6655	.0157
		12.60	.7187	.0080	12.84	.7487	.0111	9.82	.6560	.0110	8.84	.0138	.6410	8.90	.7225	.0147
		14.64	.7960	.0098	14.89	.8228	.0124	10.86	.6978	.0112	9.89	.0137	.6985	9.95	.7862	.0142
		16.66	.8425	.0109	16.83	.7931	.0151	11.89	.7432	.0120	10.95	.0148	.7804	11.03	.8583	.0138
		18.62	.8082	.0126	17.65	-.2753	.0118	12.92	.7867	.0125	12.01	.0147	.8461			
		20.69	.8737	.0124	19.76	-.1897	.0119	13.98	.8396	.0132	13.07	.0147	.9038			
		21.40	-.7397	.0104	21.90	-.1037	.0130	14.96	.8471	.0142						
		22.46	-.6858	.0106	22.95	-.0655	.0136	15.92	.8284	.0163						
								16.93	.8457	.0159						
								16.72	-.1868	.0134						
								17.75	-.1603	.0133						

TABLE VII.- NORMAL- AND AXIAL-FORCE COEFFICIENTS WITH TAIL

CONFIGURATION 6 (A = 3.50)

Tail Configuration	i_t deg	M = .60			M = .80			M = .85			M = .90			M = .92		
		$\alpha°$	C_N	C_A	$\alpha°$	C_N	C_A	$\alpha°$	C_N	C_A	$\alpha°$	C_N	C_A	$\alpha°$	C_N	C_A
6	-0.7	-3.15	-.2504	.0095	-3.22	-.2787	.0106	-3.24	-.2912	.0104	-3.28	.0116	-.3311	-3.28	-.3359	.0131
		-2.11	-.1780	.0114	-2.16	-.1925	.0120	-2.16	-.2003	.0122	-2.18	.0129	-.2209	-2.19	-.2315	.0145
		-1.05	-.0994	.0132	-1.08	-.1062	.0134	-1.08	-.1093	.0138	-1.08	.0146	-.1141	-1.08	-.1209	.0152
		-.02	-.0272	.0129	-.01	-.0273	.0135	-.01	-.0288	.0139	.01	.0147	-.0236	.00	-.0246	.0152
		1.04	.0481	.0124	1.07	.0517	.0129	1.11	.0587	.0134	1.08	.0143	.0622	1.10	.0737	.0145
		2.08	.1178	.0117	2.14	.1323	.0123	2.16	.1413	.0126	2.17	.0133	.1560	2.21	.1846	.0140
		3.14	.1903	.0100	3.21	.2208	.0104	3.25	.2341	.0105	3.27	.0115	.2614	3.31	.2907	.0126
		4.18	.2686	.0083	4.29	.3053	.0088	4.34	.3290	.0084	4.38	.0100	.3685	4.41	.4066	.0114
								5.42	.4168	.0068	5.48	.0086	.4593	5.51	.5204	.0108
		6.28	.4142	.0061	6.44	.4747	.0061	6.50	.5029	.0059	6.56	.0080	.5464	6.60	.6122	.0101
								7.60	.5679	.0060	7.62	.0081	.6124	7.69	.6930	.0091
		8.39	.5458	.0042	8.56	.5970	.0059	8.62	.6327	.0067	8.78	.0091	.7634	8.73	.7804	.0092
								9.68	.6975	.0071	9.74	.0094	.7424			
		10.46	.6495	.0040	10.65	.7061	.0073	10.72	.7414	.0076	10.80	.0100	.8132			
								11.78	.7941	.0080	11.84	.0103	.8593			
		12.53	.7501	.0052	12.74	.7982	.0082	12.79	.8254	.0091	12.90	.0104	.9238			
								13.83	.8780	.0102						
		14.58	.8393	.0080	14.79	.8784	.0100	14.84	.9041	.0115						
								15.81	.8824	.0137						
		16.59	.8751	.0110	16.73	.8397	.0147	16.81	.8907	.0157						
								17.84	.9227	.0161						
		18.59	.8406	.0137	18.80	.8936	.0147	18.88	.9357	.0161						
		20.63	.9020	.0138	20.91	.9561	.0154									
		22.72	.9722	.0146												
		23.75	.9986	.0152												
6	- 3.8	-2.07	-.2044	.0142	-2.07	-.2103	.0156	-2.07	-.2164	.0166	-2.08	.0182	-.2327	-2.08	-.2351	.0195
		-1.02	-.1260	.0153	-1.00	-.1352	.0162	-1.00	-.1376	.0171	-.99	.0188	-.1420	-.99	-.1465	.0202
		.03	-.0592	.0149	.07	-.0507	.0161	.08	-.0554	.0169	.10	.0181	-.0546	.10	-.0531	.0192
		1.08	.0161	.0143	1.13	.0244	.0152	1.16	.0321	.0160	1.19	.0172	.0393	1.19	.0418	.0180
		2.13	.0885	.0133	2.21	.1144	.0139	2.25	.1317	.0143	2.28	.0148	.1427	2.27	.1577	.0162
		3.17	.1639	.0116	3.29	.1989	.0119	3.35	.2384	.0118	3.38	.0127	.2497	3.42	.2826	.0144
		4.23	.2505	.0099	4.37	.2873	.0104	4.42	.3120	.0097	4.49	.0108	.3518	4.51	.3886	.0137
								5.49	.3908	.0085	5.58	.0100	.4473	5.61	.4852	.0119
		6.34	.3961	.0077	6.51	.4434	.0088	6.59	.4785	-.0061	6.65	.0094	.5249	6.68	.5690	.0113
								7.64	.5398	.0074	7.71	.0097	.5907	7.77	.6812	.0114
		8.42	.5137	.0060	8.62	.5602	.0080	8.71	.6186	.0079	8.78	.0105	.6729	8.87	.7696	.0108
								9.76	.6710	.0085	9.86	.0109	.7468			
		10.50	.6340	.0060	10.72	.6761	.0072	10.80	.7148	.0087	10.88	.0113	.7880			
								11.82	.7496	.0095	11.95	.0115	.8539			
		12.58	.7459	.0067	12.80	.7761	.0094	12.89	.8162	.0103						
								13.90	.8440	.0108						
		14.62	.8151	.0093	14.86	.8508	.0111	14.92	.8802	.0121						
								15.89	.8619	.0144						
		16.63	.8565	.0114	16.79	.8207	.0143	16.87	.8613	.0158						
								17.92	.8968	.0158						
		18.58	.8193	.0135	18.87	.8783	.0149	18.95	.9149	.0165						
		20.66	.8856	.0139	20.98	.9463	.0158									
		22.76	0.9582	.0144	23.11	1.0150	.0174									
		23.78	.9820	.0160												
6	-5.4	-3.10	-.2910	.0172	-3.12	-.3152	.0198	-3.13	-.3246	.0205	-3.15	.0228	-.3571	-3.16	-.3647	.0241
		-2.04	-.2156	.0182	-2.05	-.2327	.0203	-2.05	-.2439	.0213	-2.06	.0237	-.2549	-2.06	-.2728	.0257
		-1.00	-.1460	.0190	-.97	-.1481	.0205	-.97	-.1582	.0214	-.96	.0238	-.1643	-.96	-.1686	.0246
		.04	-.0763	.0185	.10	-.0728	.0200	.12	-.0706	.0204	.12	.0224	-.0772	.12	-.0800	.0240
		1.10	-.0066	.0176	1.16	.0042	.0189	1.18	.0046	.0195	1.21	.0210	.0084	1.21	.0086	.0221
		2.14	.0687	.0161	2.25	.0887	.0169	2.27	.0956	.0172	2.30	.0185	.1037	2.32	.1226	.0202
		3.20	.1466	.0137	3.32	.1732	.0146	3.36	.1989	.0146	3.41	.0160	.2222	3.43	.2269	.0168
		4.25	.2218	.0120	4.40	.2633	.0127	4.45	.2812	.0121	4.51	.0140	.3225	4.55	.3536	.0164
								5.53	.3670	.0105	5.60	.0129	.4163	5.64	.4580	.0147
		6.34	.3643	.0095	6.54	.4196	.0102	6.61	.4476	.0096	6.66	.0117	.4771	6.73	.5621	.0141
								7.67	.5193	.0100	7.73	.0118	.5608	7.81	.6502	.0137
		8.44	.4874	.0079	8.67	.5549	.0096	8.71	.5768	.0101	8.79	.0123	.6246	8.86	.6986	.0126
								9.78	.6470	.0106	9.84	.0129	.6871	9.95	.8103	.0126
		10.52	.6018	.0074	10.76	.6639	.0107	10.83	.6977	.0110	10.87	.0127	.7069			
								11.86	.7311	.0118	11.93	.0136	.7891			
		12.59	.7135	.0086	12.83	.7465	.0114	12.88	.7691	.0125	13.02	.0136	.8713			
								13.93	.8218	.0133	14.03	.0145	.8797			
		14.62	.7884	.0113	14.88	.8251	.0136	14.94	.8529	.0146						
								15.91	.8380	.0165						
		16.65	.8295	.0132	16.81	.7950	.0165	16.91	.8463	.0180						
								17.93	.8589	.0179						
		18.62	.8062	.0154	18.88	.8447	.0171	18.98	.8857	.0185						
		20.68	.8667	.0155	21.00	.9295	.0176									
		22.76	0.9415	.0168	23.13	1.0072	.0193									
					24.19	1.0363	.0200									

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TABLE VIII.- NORMAL- AND AXIAL-FORCE COEFFICIENTS WITH TAIL CONFIGURATION 7 (A = 3.50)

M = .60

Tail Configuration	i_t, deg	α°	C_N	C_A
7	-0.7	.00	-.0133	.0133
		2.10	.1347	.0119
		4.21	.2940	.0089
		6.31	.4286	.0069
		8.40	.5462	.0051
		10.46	.6532	.0047
		12.53	.7586	.0065
		14.58	.8533	.0089
		16.59	.8748	.0116
		18.56	.8519	.0146
		20.63	.9070	.0134
		22.72	0.9908	.0130
7	-4.8	-3.10	-.2734	.0162
		-2.05	-.2010	.0176
		.04	-.0584	.0184
		2.15	.0922	.0157
		4.26	.2543	.0125
		6.35	.3971	.0109
		8.43	.5092	.0087
		10.50	.6267	.0083
		12.58	.7412	.0102
		14.63	.8161	.0113
		16.63	.8513	.0131
		18.59	.8197	.0145
		20.65	.8772	.0143
		22.76	.9747	.0150

M = .80

Tail Configuration	i_t, deg	α°	C_N	C_A
7	-0.7	.00	-.0179	.0136
		2.16	.1572	.0118
		4.32	.3324	.0088
		6.47	.4815	.0076
		8.56	.5982	.0072
		10.67	.7262	.0077
		12.75	.8108	.0090
		14.80	.8911	.0107
		16.74	.8524	.0149
		18.81	.9137	.0152
		20.91	0.9813	.0153
		23.04	1.0406	.0161
7	-4.8	-3.14	-.3008	.0175
		-2.06	-.2197	.0191
		.08	-.0595	.0191
		2.23	.1117	.0161
		4.40	.2890	.0130
		6.54	.4359	.0114
		8.64	.5621	.0110
		10.74	.6807	.0112
		12.81	.7743	.0123
		14.87	.8530	.0132
		16.79	.8135	.0160
		18.88	.8803	.0157
		20.99	.9627	.0168
		23.06	.9970	.0173

M = .85

Tail Configuration	i_t, deg	α°	C_N	C_A
7	-0.7	.02	-.0111	.0147
		2.18	.1678	.0126
		4.37	.3556	.0089
		6.52	.5102	.0080
		8.63	.6296	.0089
		10.73	.7466	.0095
		12.82	.8517	.0108
		14.88	.9266	.0128
		16.83	.9116	.0169
		18.91	.9826	.0179
		21.02	1.0421	.0186
7	-4.8	-3.15	-.3127	.0187
		-2.08	-.2301	.0204
		.10	-.0615	.0205
		2.27	.1261	.0169
		4.45	.3175	.0129
		6.60	.4719	.0113
		8.69	.5770	.0122
		10.81	.7083	.0131
		12.90	.8098	.0139
		14.95	.8916	.0150
		16.90	.8726	.0180
		18.99	.9397	.0189

M = .90

Tail Configuration	i_t, deg	α°	C_N	C_A
7	-0.7	-3.24	.0120	-.3028
		-2.16	.0139	-.1994
		.03	.0156	-.0118
		2.20	.0136	.1744
		4.40	.0097	.3758
		6.58	.0087	.5456
		8.71	.0105	.6983
		10.82	.0118	.8171
		12.88	.0125	.8995
		14.97	.0146	.9899
7	-4.8	-3.19	.0214	-.3463
		-2.07	.0234	-.2402
		.12	.0229	-.0618
		2.32	.0190	.1476
		4.53	.0149	.3700
		6.70	.0133	.5348
		8.77	.0137	.6300
		10.95	.0154	.8141
		13.04	.0159	.9133

M = .92

Tail Configuration	i_t, deg	α°	C_N	C_A
7	-0.7	-2.64	.1448	.0171
		-2.15	-.2075	.0152
		.03	-.0177	.0170
		2.23	.2026	.0155
		4.45	.4279	.0117
		6.61	.5972	.0111
		8.73	.7260	.0119
		11.01	.9691	.0119
7	-4.8	-3.19	-.3700	.0239
		-2.07	-.2502	.0253
		.13	-.0553	.0249
		2.35	.1687	.0212
		4.50	.4098	.0169
		6.74	.5787	.0156
		8.87	.7233	.0154
		11.07	.9478	.0158

TABLE IX.- NORMAL- AND AXIAL-FORCE COEFFICIENTS WITH TAIL CONFIGURATION 5 (A = 3.50)

M = .60

Tail Configuration	i_t, deg	α°	C_N	C_A
5	-0.7, 0	-3.15	-.2280	.0093
		-2.10	-.1501	.0113
		-1.04	-.0723	.0129
		.00	-.0055	.0128
		1.04	.0697	.0131
		2.10	.1390	.0120
		3.14	.2225	.0101
		4.20	.3058	.0079
		5.24	.3754	.0064
		6.30	.4506	.0052
		8.37	.5702	.0026
		10.46	.6923	.0016
		12.52	.7951	.0016
		14.56	.9001	.0030
		16.57	.9347	.0045
		18.52	.9261	.0068
		20.58	1.0099	.0050
		21.30	-.5801	-.0016
		22.33	-.5435	-.0022
5	-4.0, 0	-3.11	-.2655	.0137
		-2.07	-.1962	.0143
		-1.01	-.1209	.0167
		.03	-.0514	.0165
		1.09	.0265	.0170
		2.12	.1013	.0157
		3.18	.1793	.0136
		4.23	.2655	.0119
		6.32	.3988	.0087
		8.39	.5182	.0060
		10.48	.6432	.0048
		12.55	.7570	.0047
		14.58	.8508	.0059
		16.59	.8935	.0072
		18.53	.8819	.0082
		19.24	-.7139	.0025
		21.32	-.6075	.0009
		22.37	-.5628	.0009

M = .80

Tail Configuration	i_t, deg	α°	C_N	C_A
5	-0.7, 0	-3.22	-.2506	.0100
		-2.14	-.1589	.0117
		-1.08	-.0823	.0130
		.00	.0039	.0133
		1.09	.0827	.0135
		2.15	.1669	.0121
		3.22	.2435	.0100
		4.31	.3337	.0081
		6.43	.4779	.0060
		8.54	.5975	.0045
		10.65	.7392	.0038
		12.72	.8383	.0039
		14.77	.9345	.0046
		16.69	.9215	.0074
		17.46	-.1493	.0005
		19.54	-.0744	-.0021
5	-4.0, 0	-3.17	-.2860	.0157
		-2.09	-.2073	.0166
		-1.03	-.1266	.0177
		.06	-.0459	.0172
		1.13	.0327	.0169
		2.20	.1226	.0152
		3.28	.2069	.0129
		4.35	.2892	.0114
		6.48	.4408	.0087
		8.57	.5617	.0073
		10.69	.6891	.0064
		12.77	.7988	.0065
		14.80	.8726	.0062
		16.73	.8768	.0086
		17.50	-.1979	.0019
		19.60	-.0899	-.0003
		21.71	-.0051	-.0020
		22.78	0.0666	-.0019

M = .85

Tail Configuration	i_t, deg	α°	C_N	C_A
5	-0.7, 0	-3.23	-.2628	.0105
		-2.15	-.1704	.0118
		-1.08	-.0868	.0136
		.01	.0006	.0137
		1.09	.0792	.0137
		2.17	.1751	.0123
		3.25	.2571	.0355
		4.33	.3408	.0077
		5.42	.4280	.0060
		6.49	.5065	.0053
		7.57	.5936	.0044
		8.61	.6544	.0041
		9.68	.7328	.0040
		10.72	.7730	.0042
		11.75	.8249	.0041
		12.79	.8715	.0041
		13.82	.9147	.0049
		14.82	.9489	.0049
		15.79	.9556	.0065
		15.52	-.0948	.0016
		16.53	-.0609	.0013
		17.55	-0.0264	-.0003
5	-4.0, 0	-3.18	-.2962	.0166
		-2.09	-.2088	.0180
		-1.01	-.1246	.0160
		.06	-.0425	.0180
		1.15	.0400	.0176
		2.24	.1358	.0159
		3.31	.2145	.0137
		4.39	.3071	.0110
		5.48	.3858	.0090
		6.55	.4645	.0092
		7.61	.5376	.0076
		8.67	.6072	.0075
		9.71	.6594	.0073
		10.76	.7291	.0071
		11.83	.8110	.0066
		12.84	.8330	.0072
		13.85	.8674	.0067
		14.86	.9016	.0069
		15.85	.9178	.0078
		15.55	-.1437	.0040
		16.59	-.0956	.0027
		17.62	-.0576	.0021

M = .90

Tail Configuration	i_t, deg	α°	C_N	C_A
5	-0.7, 0	-3.26	.0131	-.2861
		-2.17	.0142	-.1911
		-1.07	.0154	-.0909
		.01	.0154	-.0073
		1.11	.0148	.0830
		2.20	.0133	.1847
		3.30	.0107	.2877
		4.39	.0083	.3860
		5.47	.0067	.4649
		6.55	.0053	.5500
		7.60	.0047	.5991
		8.70	.0050	.7185
		9.74	.0054	.7627
		10.80	.0054	.8363
		11.88	.0049	.9261
		12.91	.0043	.9586
		13.92	.0040	.9829
5	-4.0, 0	-3.21	.0207	-.3177
		-2.12	.0213	-.2179
		-1.02	.0214	-.1222
		.08	.0210	-.0316
		1.16	.0192	.0461
		2.27	.0173	.1497
		3.36	.0153	.2515
		4.47	.0131	.3500
		5.55	.0107	.4323
		6.62	.0094	.5062
		7.67	.0089	.5796
		8.75	.0099	.6614
		9.81	.0085	.7352
		10.85	.0084	.7840
		11.91	.0079	.8494
		12.97	.0072	.9231

M = .92

Tail Configuration	i_t, deg	α°	C_N	C_A
5	-0.7, 0	-3.28	-.3069	.0141
		-2.18	-.1950	.0168
		-1.08	-.0958	.0172
		.02	-.0010	.0162
		1.10	.0888	.0160
		2.20	.1923	.0142
		3.31	.3046	.0120
		4.40	.4010	.0104
		5.51	.5021	.0082
		6.60	.6090	.0071
		7.68	.6972	.0066
		8.75	.7771	.0052
		9.83	.8727	.0045
		10.91	.9527	.0036
5	-4.0, 0	-3.24	-.3270	.0206
		-2.14	-.2273	.0224
		-1.04	-.1279	.0233
		.06	-.0329	.0220
		1.16	.0685	.0216
		2.28	.1886	.0207
		3.39	.2788	.0179
		4.49	.3865	.0149
		5.58	.4782	.0130
		6.65	.5459	.0110
		7.75	.6546	.0101
		8.80	.7342	.0093
		9.89	.8253	.0082

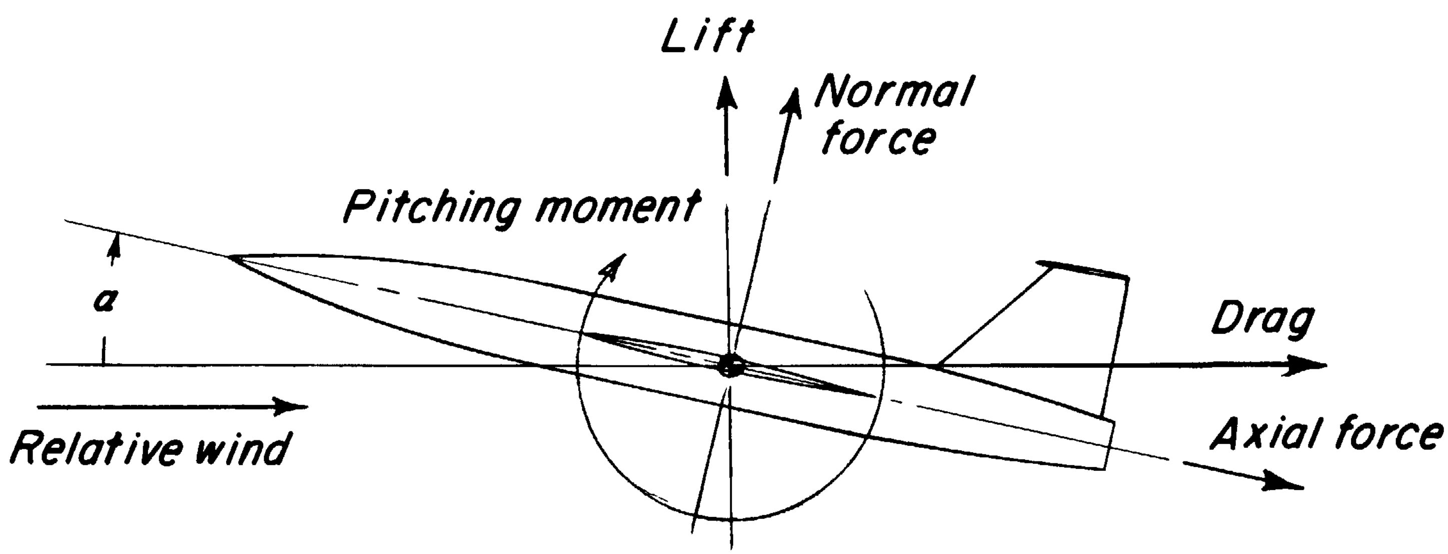
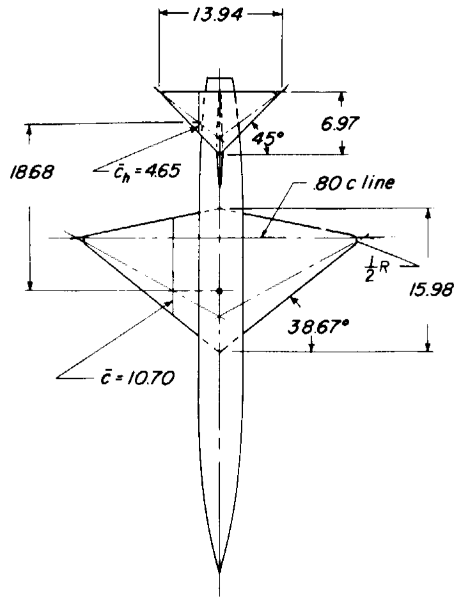
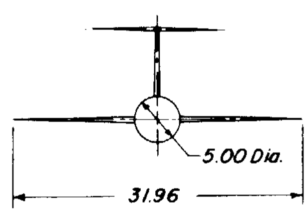
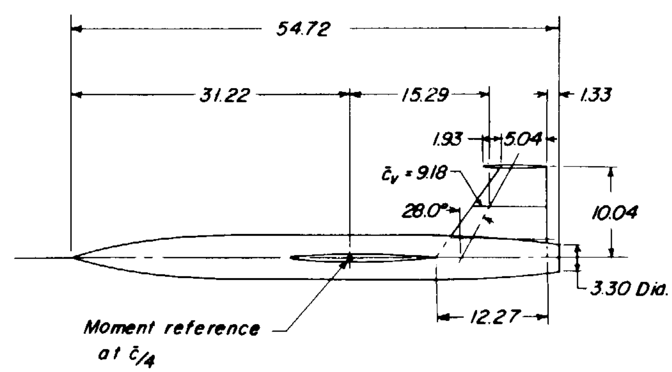


Figure 1.- System of axes. Positive values of forces, moments, and angles are indicated by arrows.



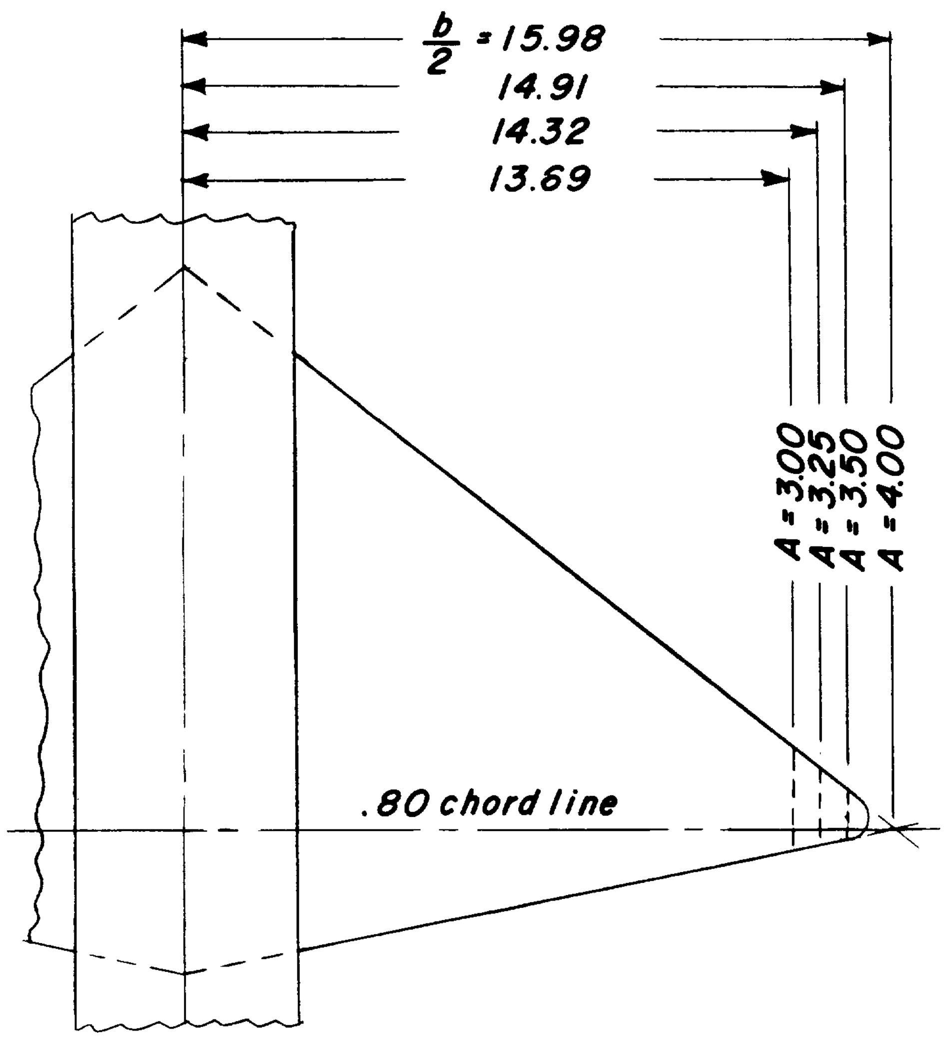
Geometric Characteristics Of Model	Wing	Horiz. tail	Vert. tail
Area, ft²	1.773	.337	.603
Aspect ratio	4.00	4.00	1.16
Taper ratio	0	0	.411
$\Lambda_{c/4}$, deg	28.82	36.85	28.00
NACA airfoil section parallel to airstream	65A004	65A006	65A006





(a) Three-view drawing of basic model. Wing aspect ratio 4.00. All dimensions are in inches.

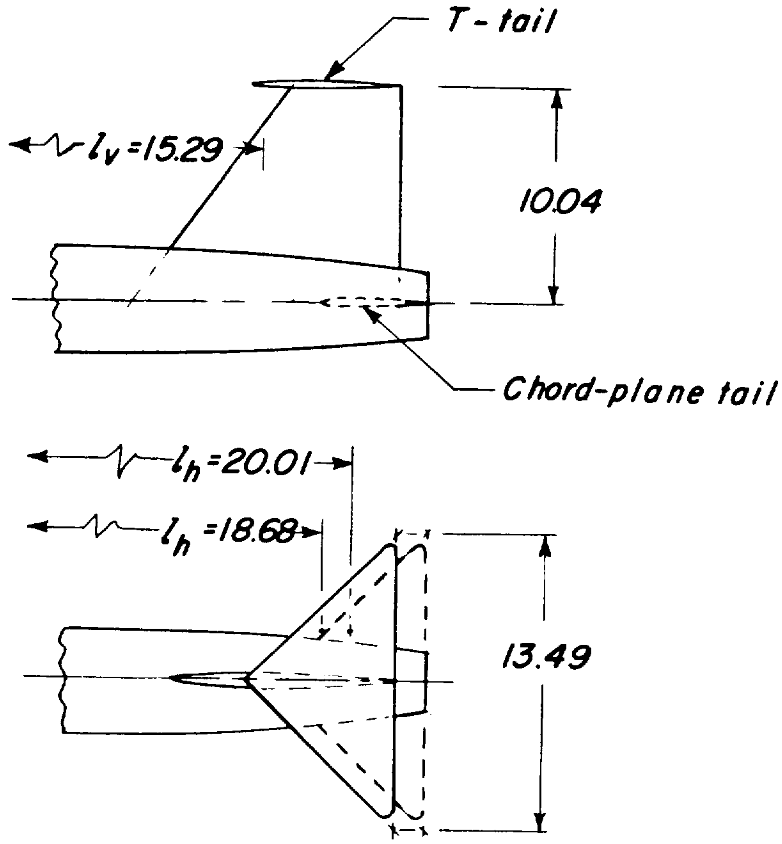
Figure 2.- Geometric characteristics of model.



A	λ	$\Lambda_{.8c}$	c_r	c_t	$\bar{c}$	S	Δx
4.00	0	0°	15.98	0	10.65	1.77	0
3.50	.067	↓	↓	1.07	10.70	1.77	-.017
3.25	.104			1.66	10.76	1.76	-.062
3.00	.143			2.28	10.83	1.74	-.095

(b) Wing-tip modifications of basic aspect-ratio-4.00 wing. All dimensions are in inches.

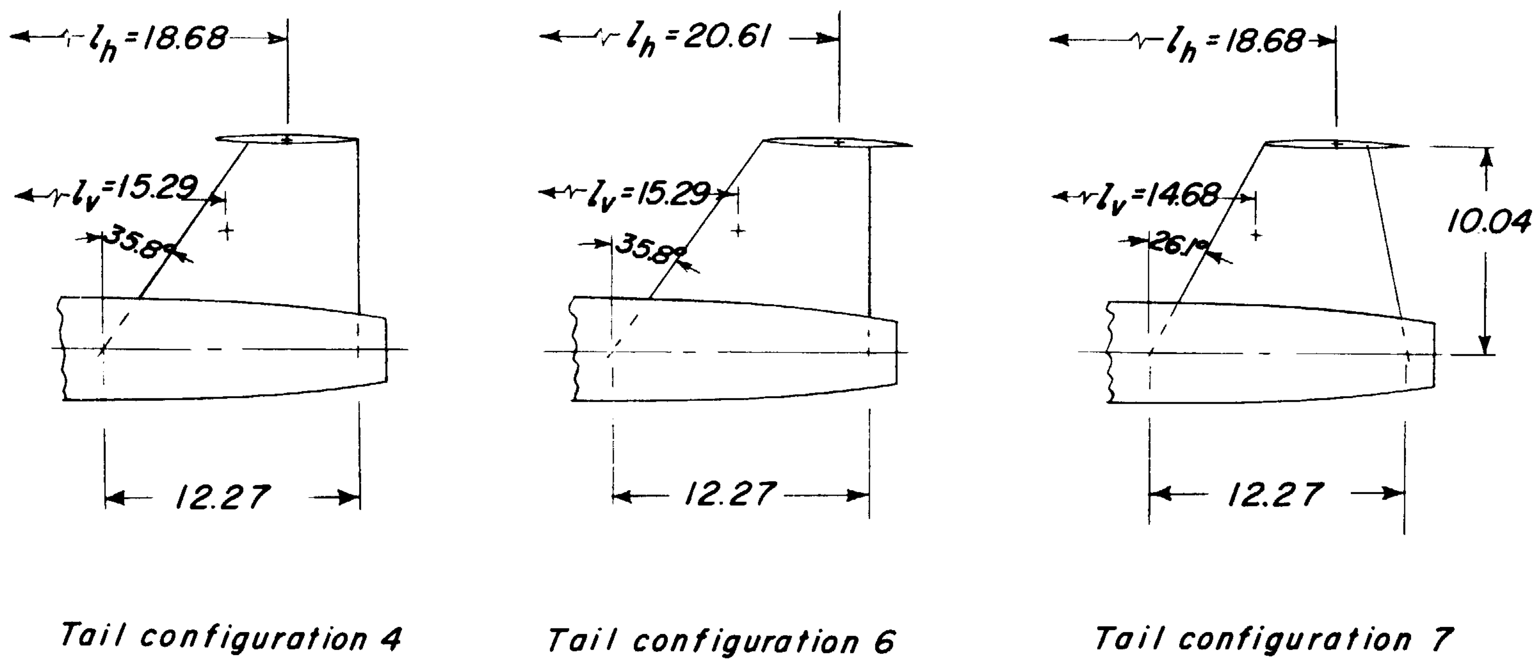
Figure 2.- Continued.



Tail Configuration	Horizontal tail	Vertical tail (Unswept trailing edge)
1	Off	Off
2	Off	On
3	Chord-plane tail	On
4	T- tail	On
5	Biplane tail	On

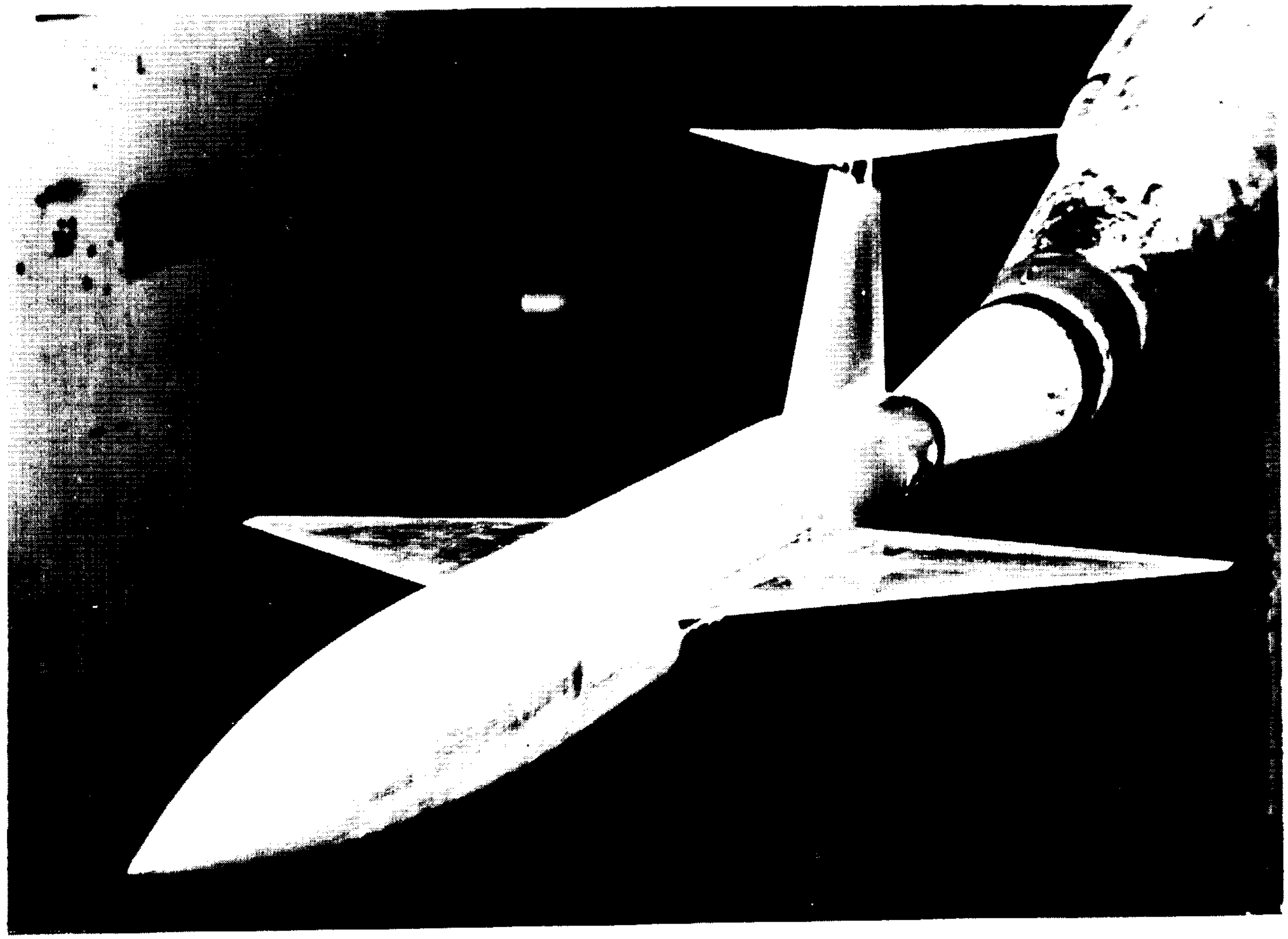
(c) Model tail configurations with unswept trailing-edge vertical tail.

Figure 2.- Continued.



(d) Horizontal-tail overhang and tail length.

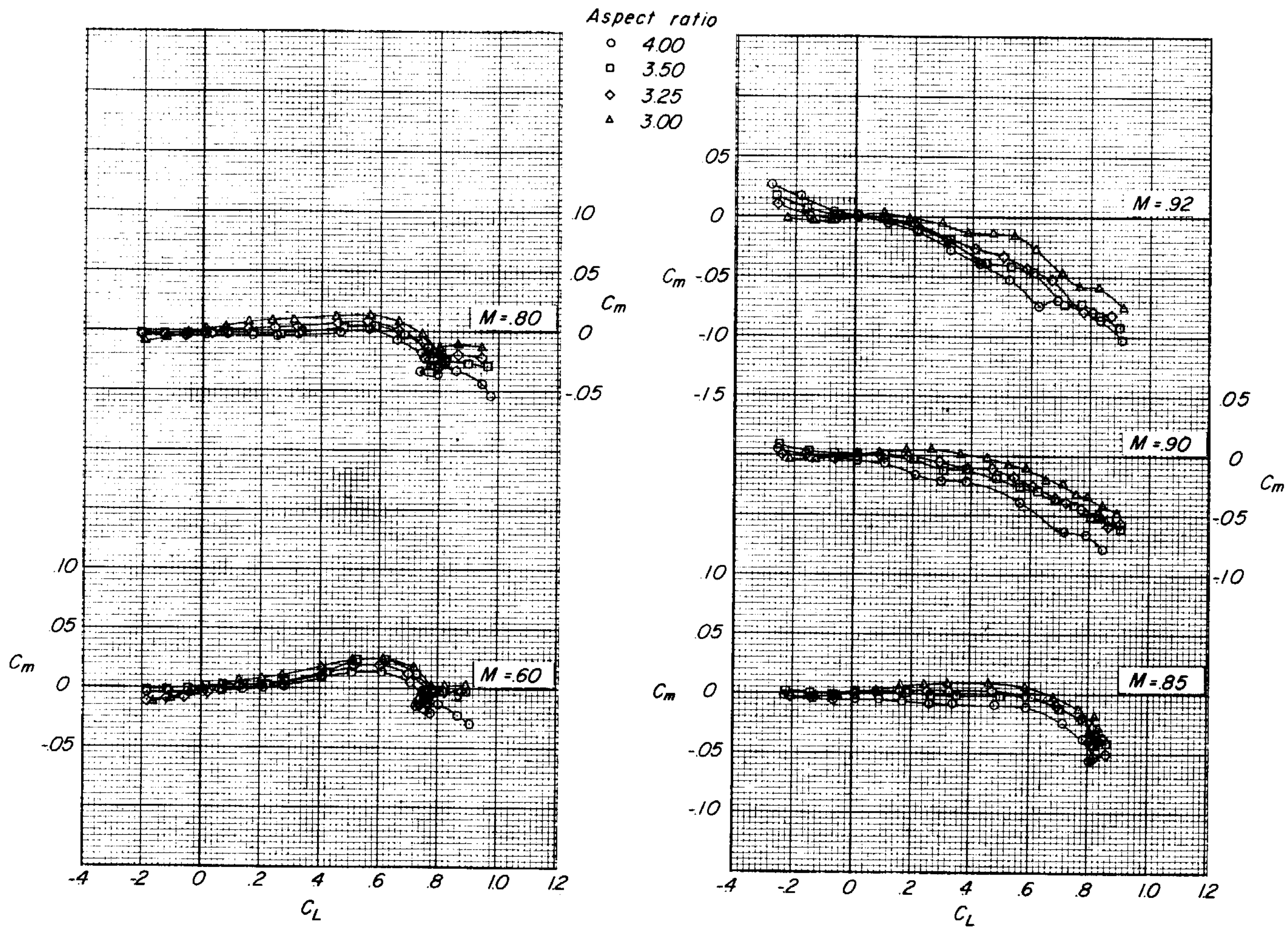
Figure 2.- Continued.



L-89250

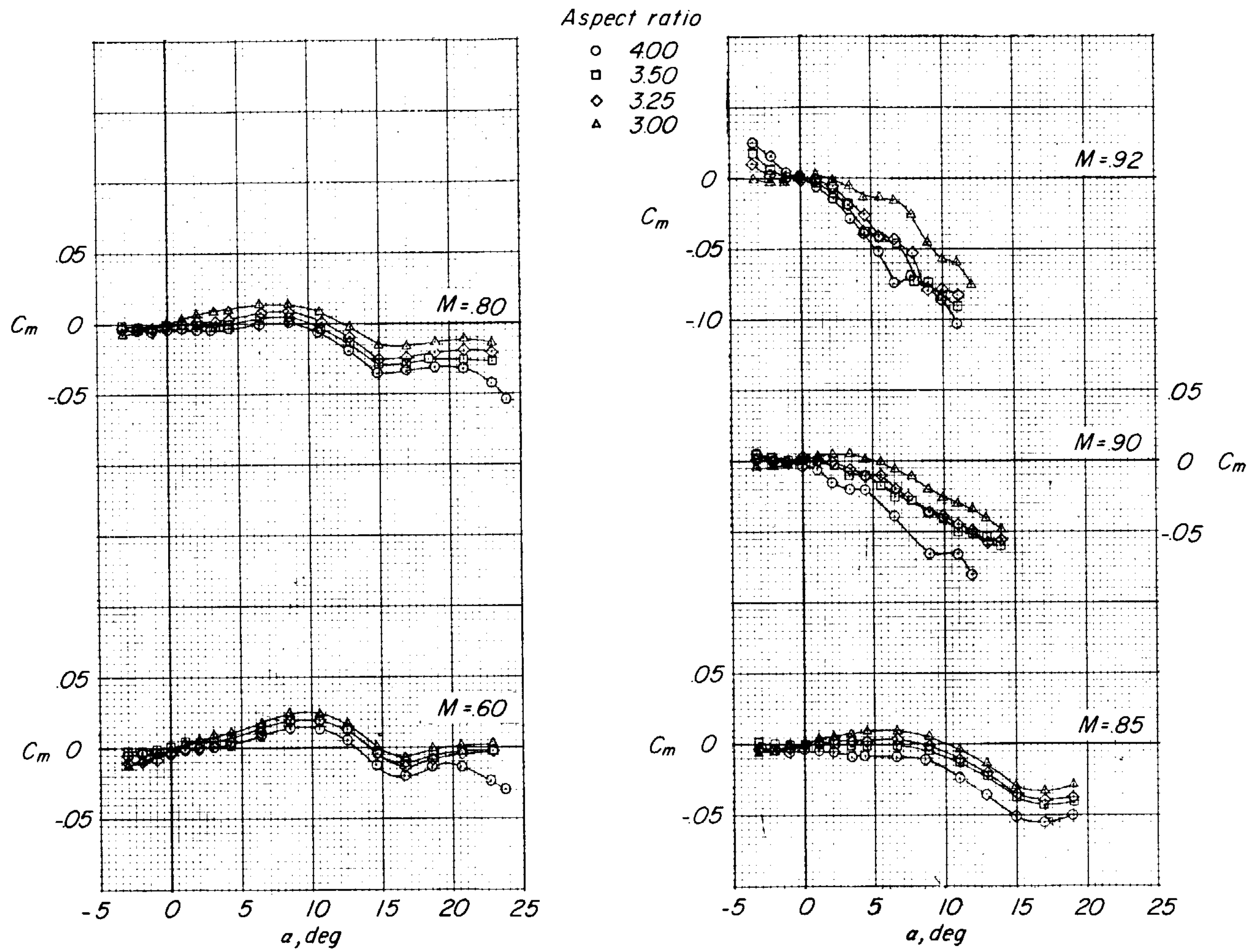
(e) Photograph of model mounted in tunnel.

Figure 2.- Concluded.



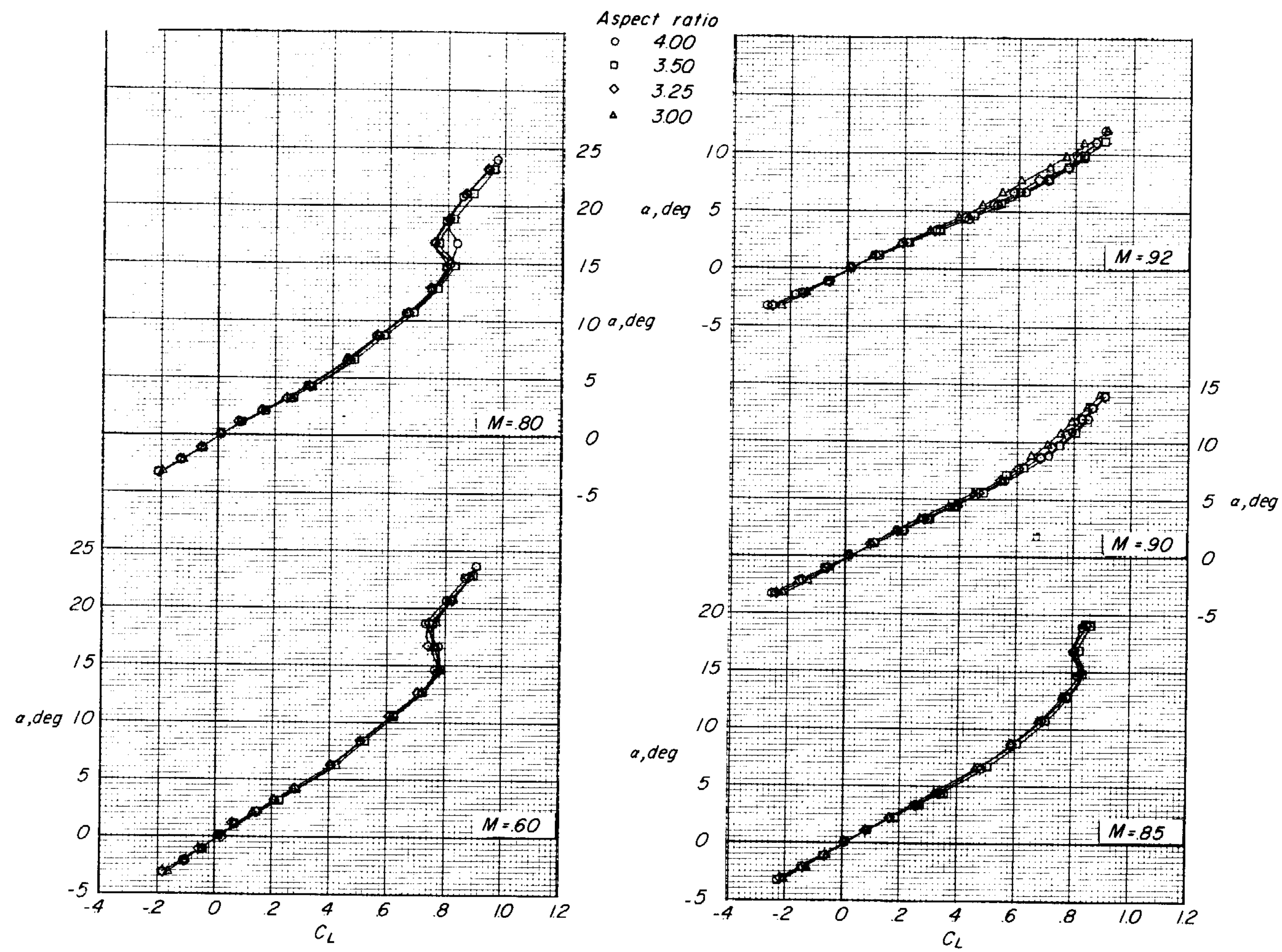
(a) C_m against C_L.

Figure 3.- Effect of aspect ratio on the longitudinal aerodynamic characteristics of the model. Tail off.



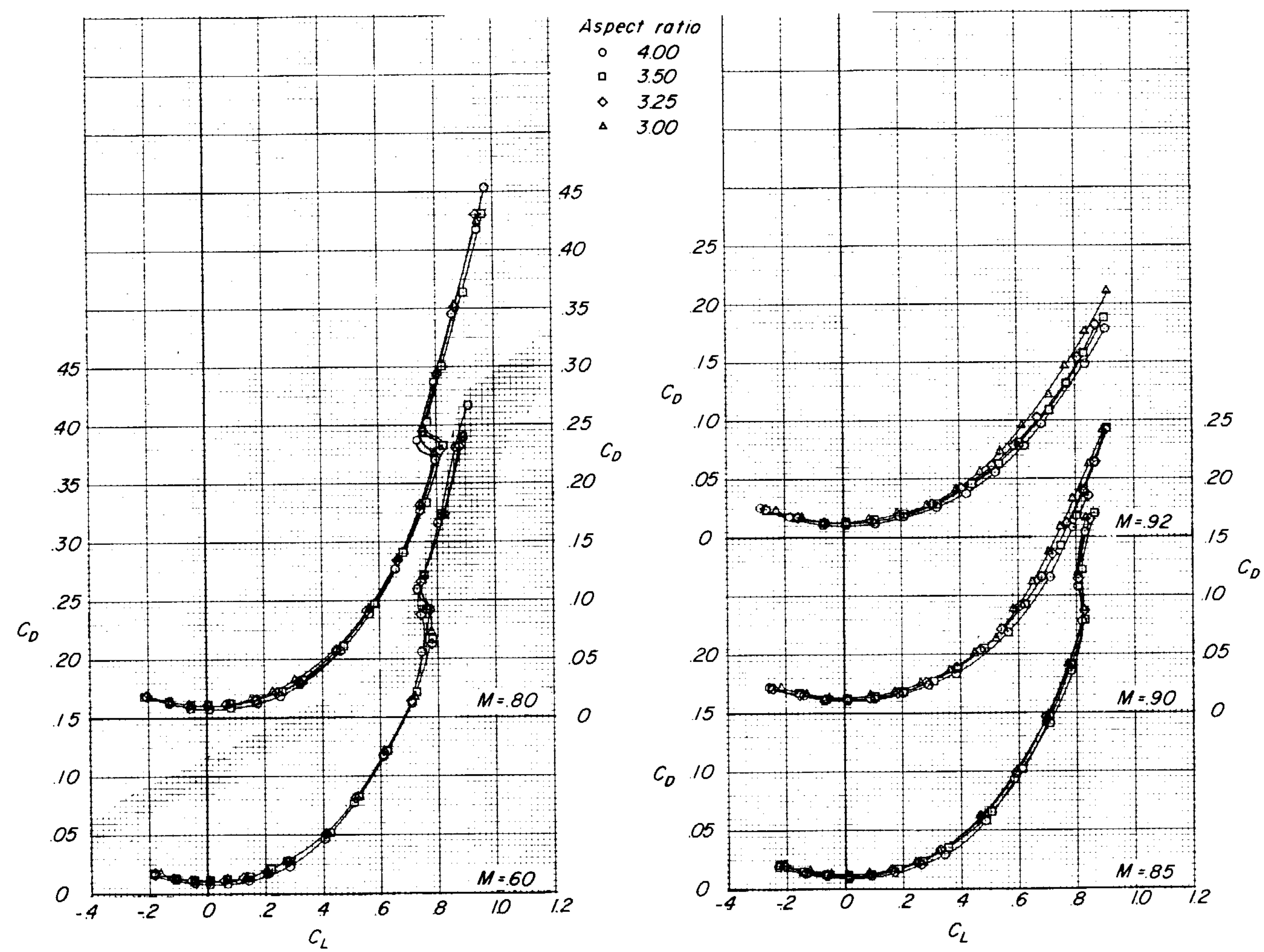
(b) C_m against α.

Figure 3.- Continued.



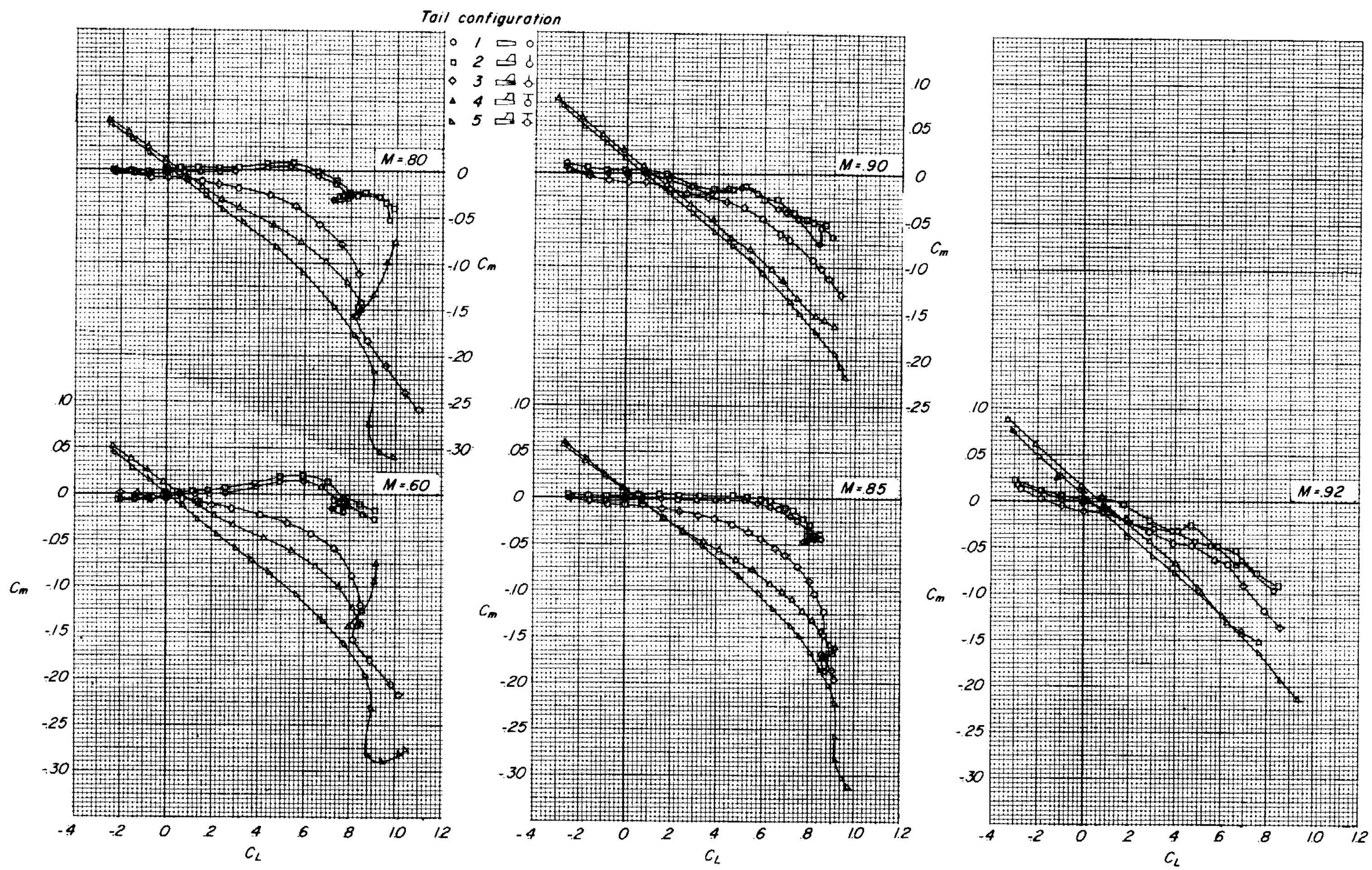
(c) α against C_L.

Figure 3.- Continued.



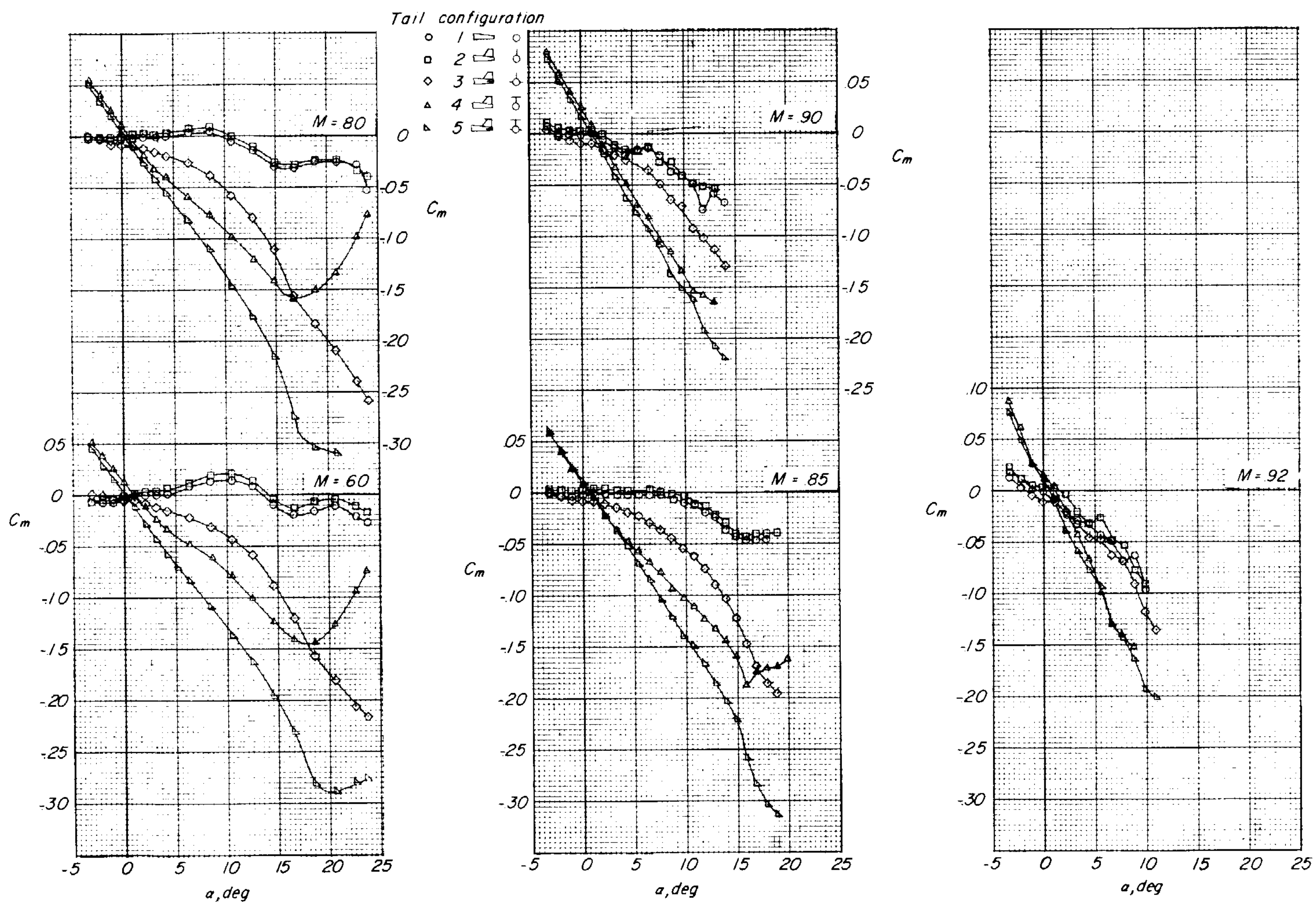
(d) C_D against C_L.

Figure 3.- Concluded.



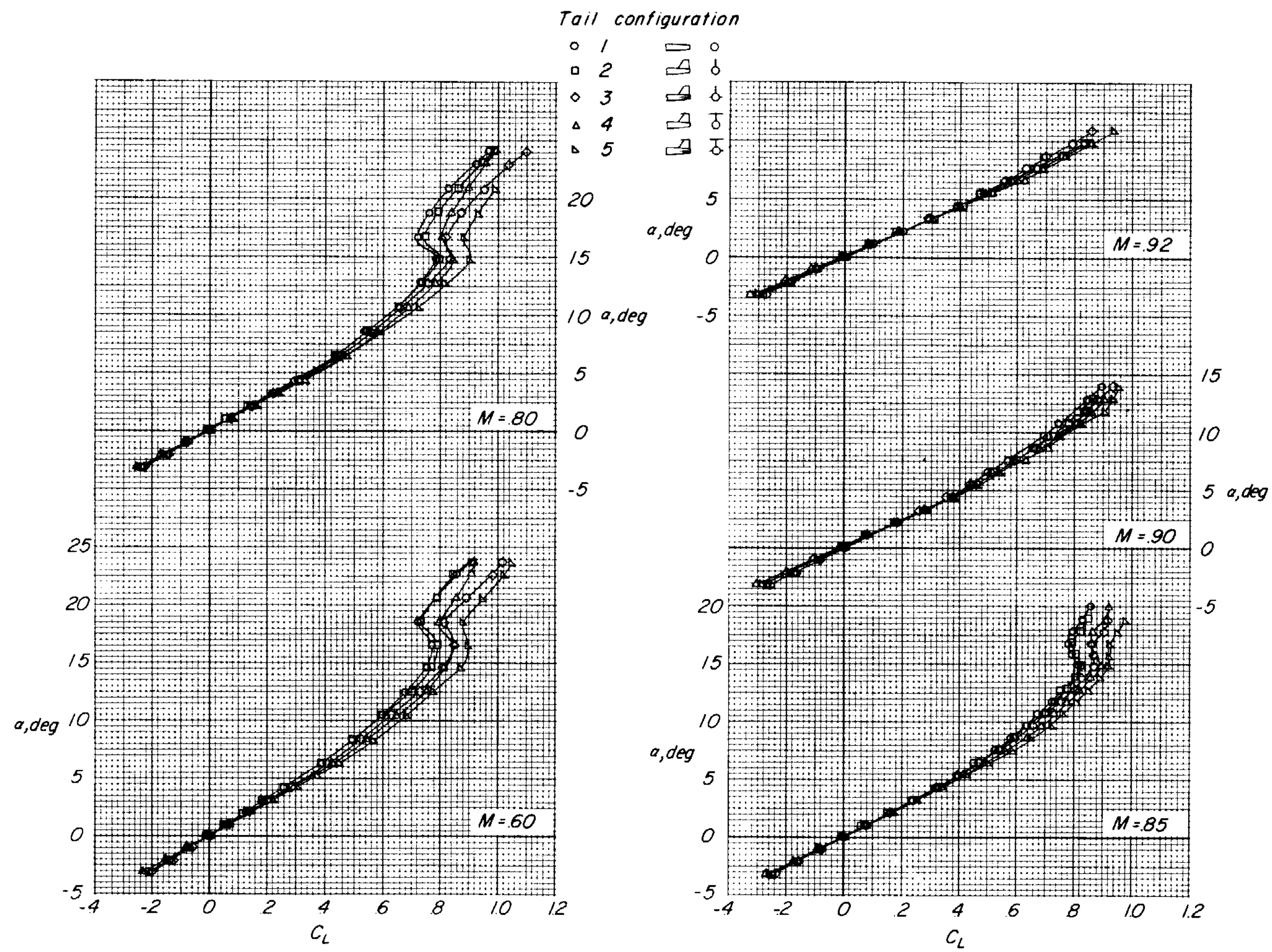
(a) C_m against C_L.

Figure 4.- Longitudinal aerodynamic characteristics of the model for several tail configurations. Wing aspect ratio, 3.50.



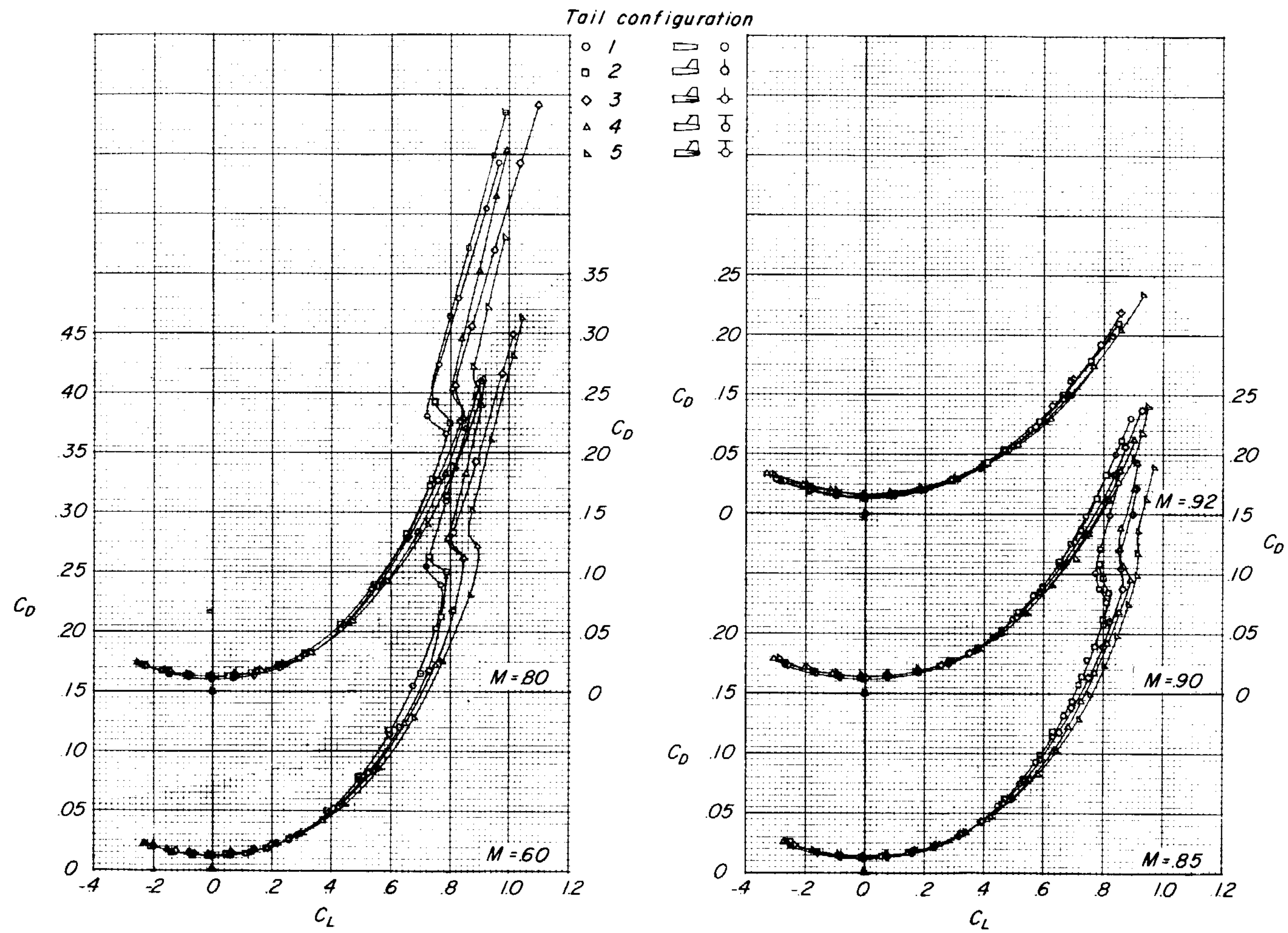
(b) C_m against α.

Figure 4.- Continued.



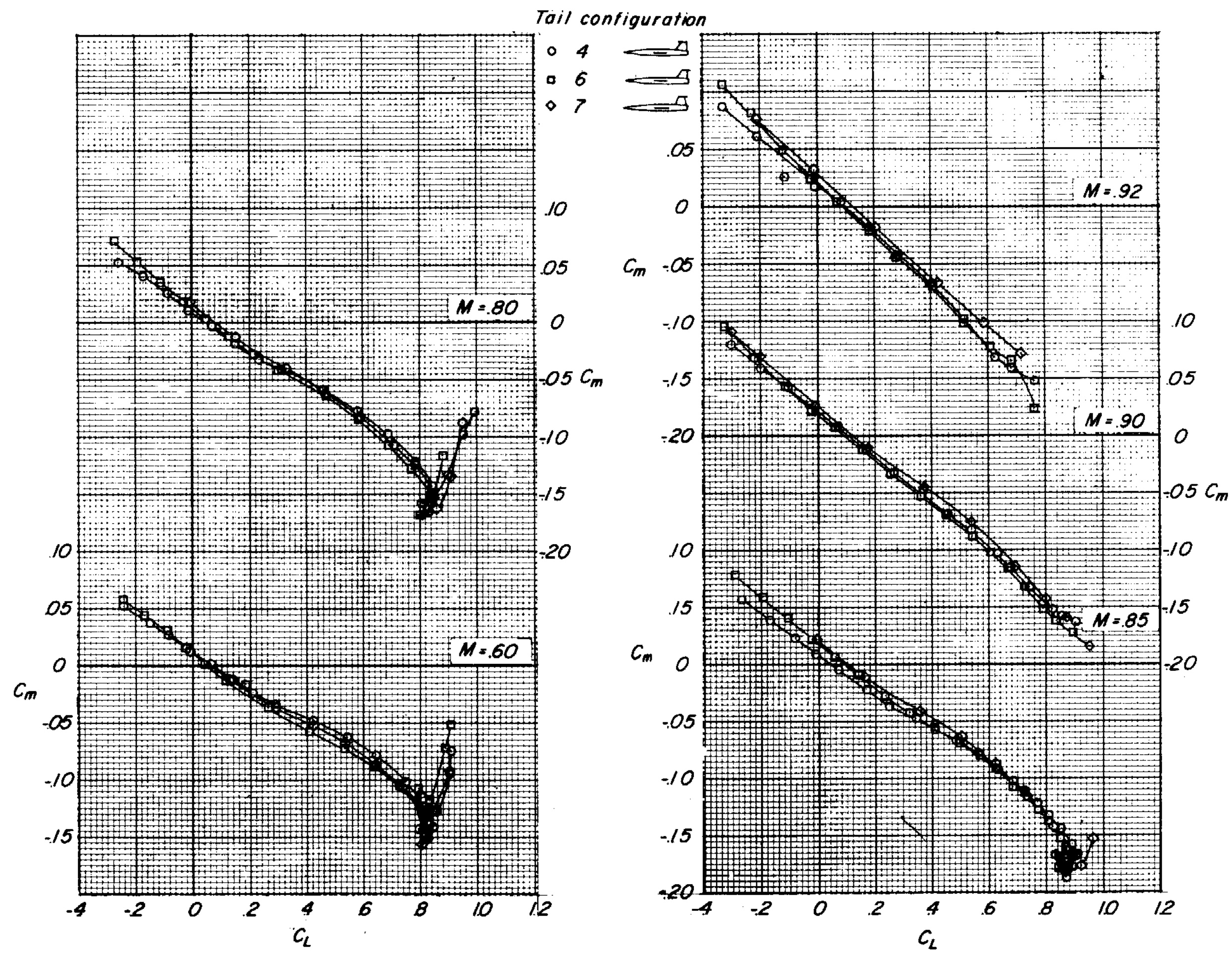
(c) α against C_L.

Figure 4.- Continued.



(d) C_D against C_L.

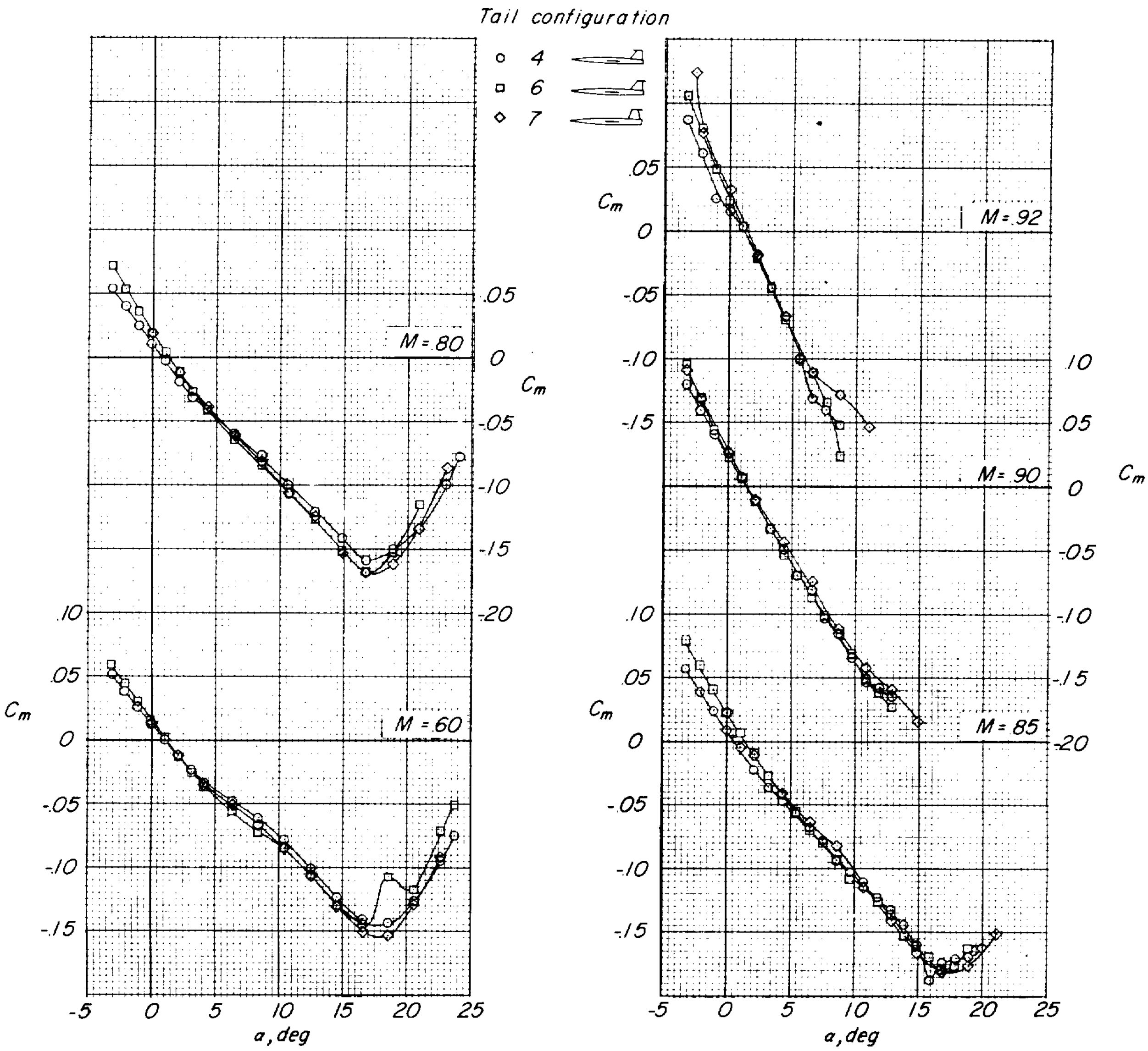
Figure 4.- Concluded.



(a) C_m against C_L.

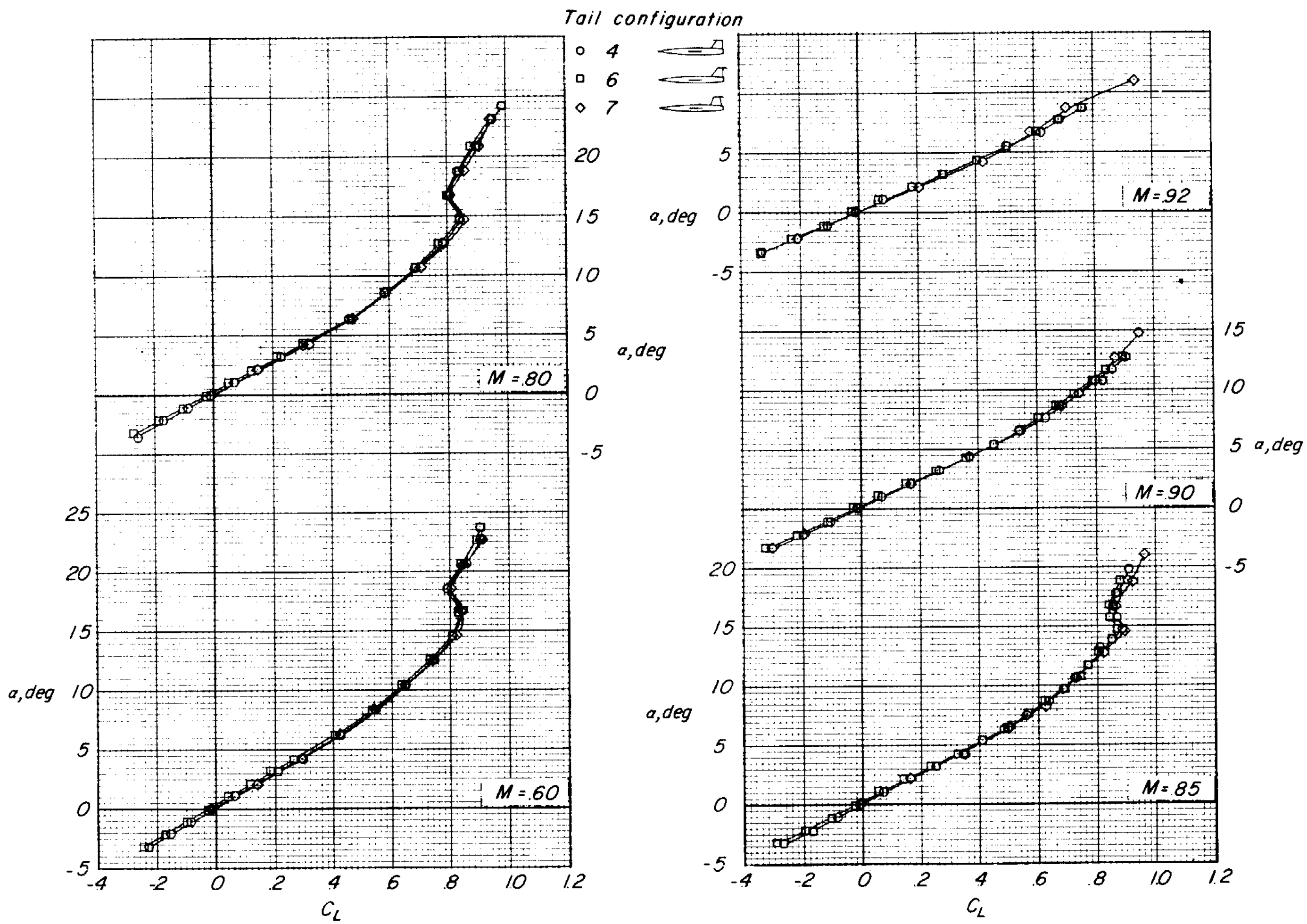
Figure 5.- Effect on the longitudinal aerodynamic characteristics of several variations of the T-tail arrangement. Wing aspect ratio, 3.50.

L-1699



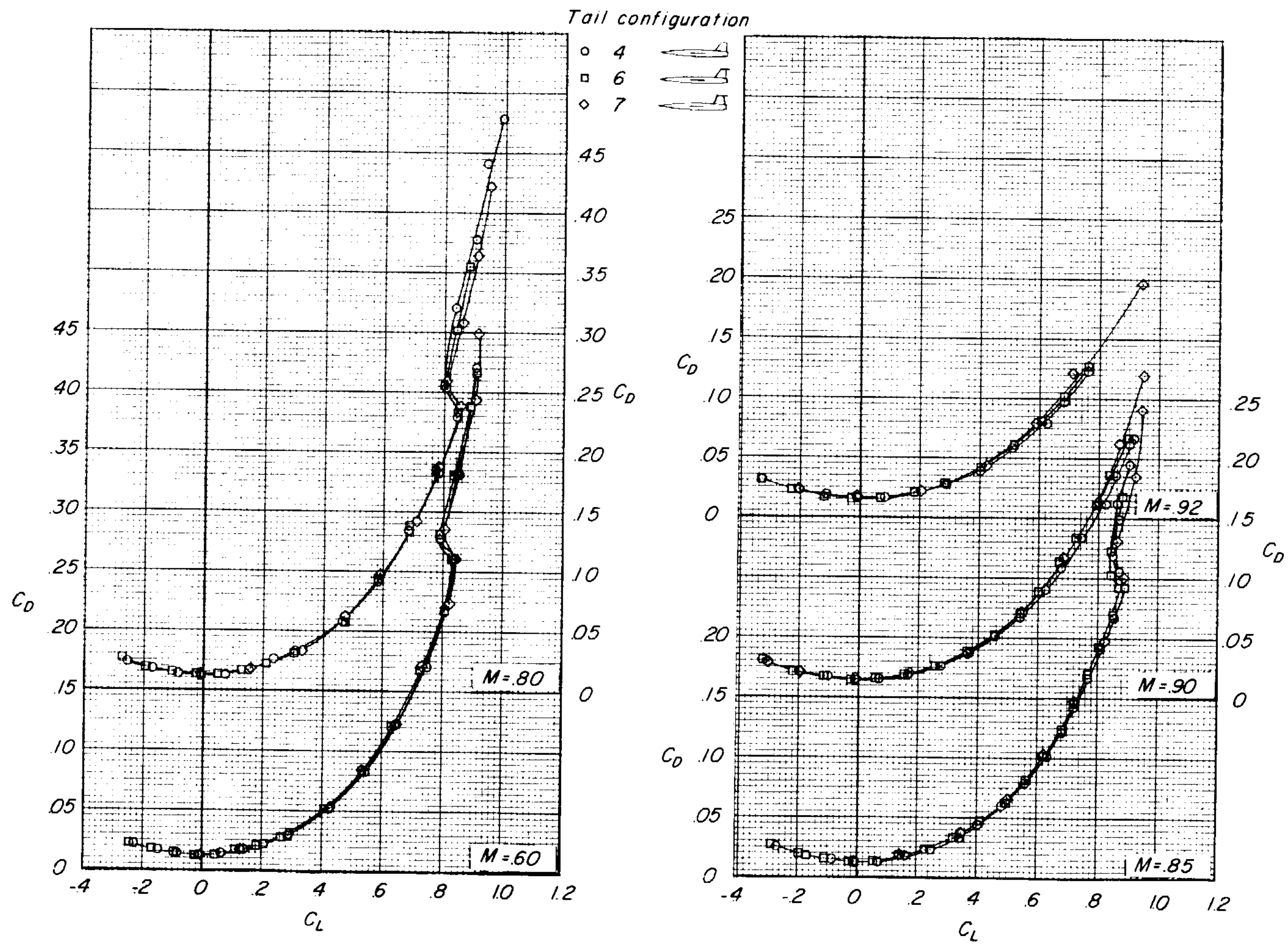
(b) C_m against α.

Figure 5.- Continued.



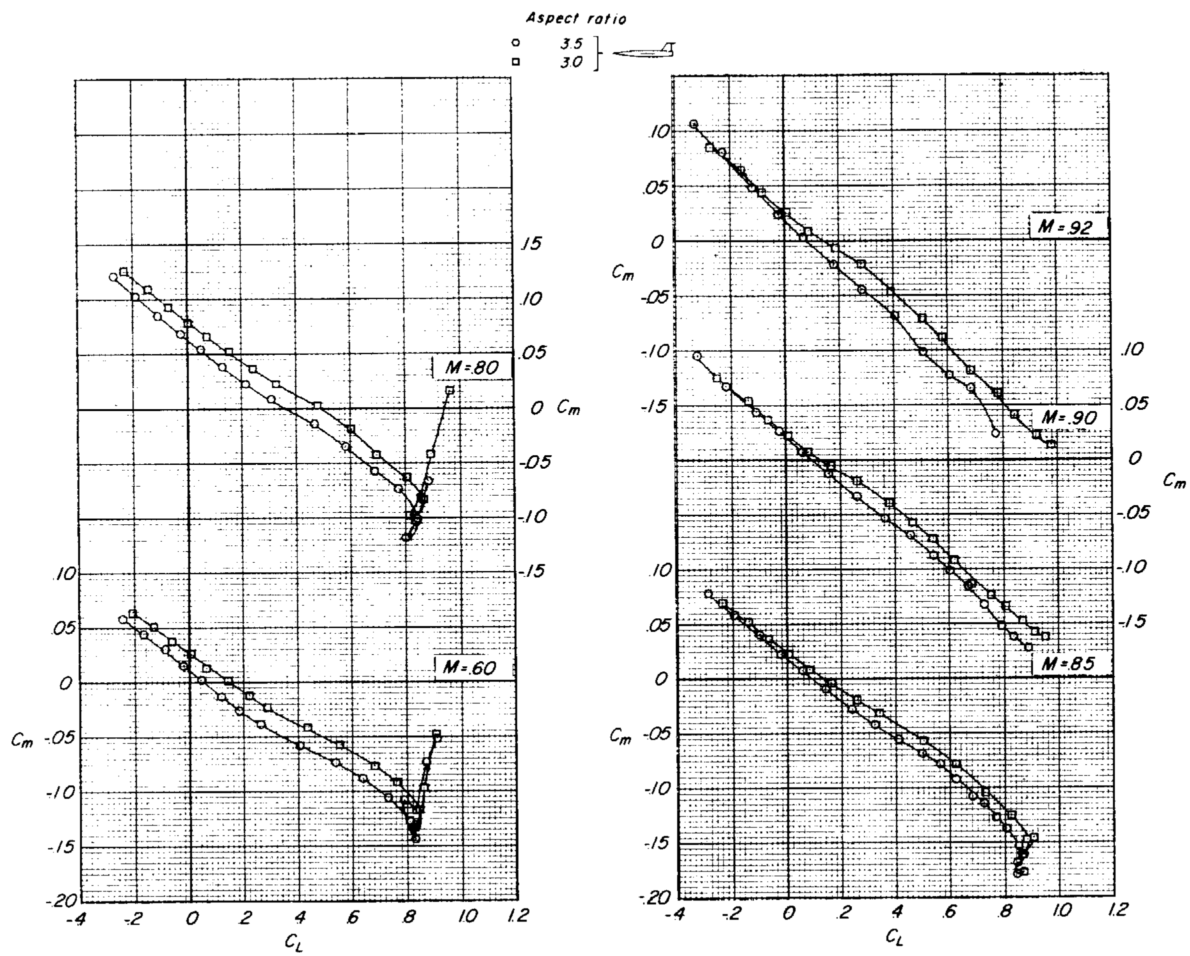
(c) α against C_L.

Figure 5.- Continued.



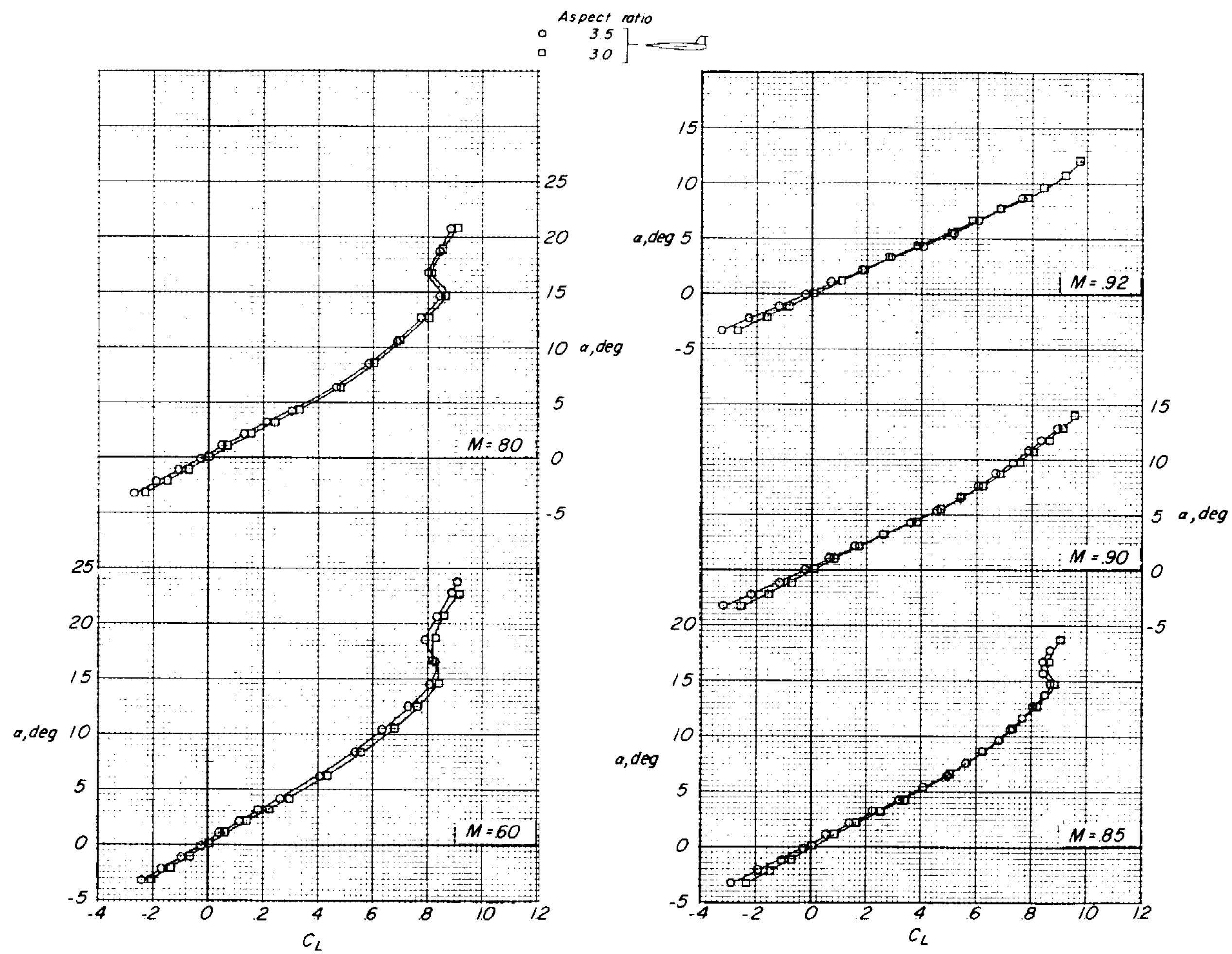
(d) C_D against C_L.

Figure 5.- Concluded.



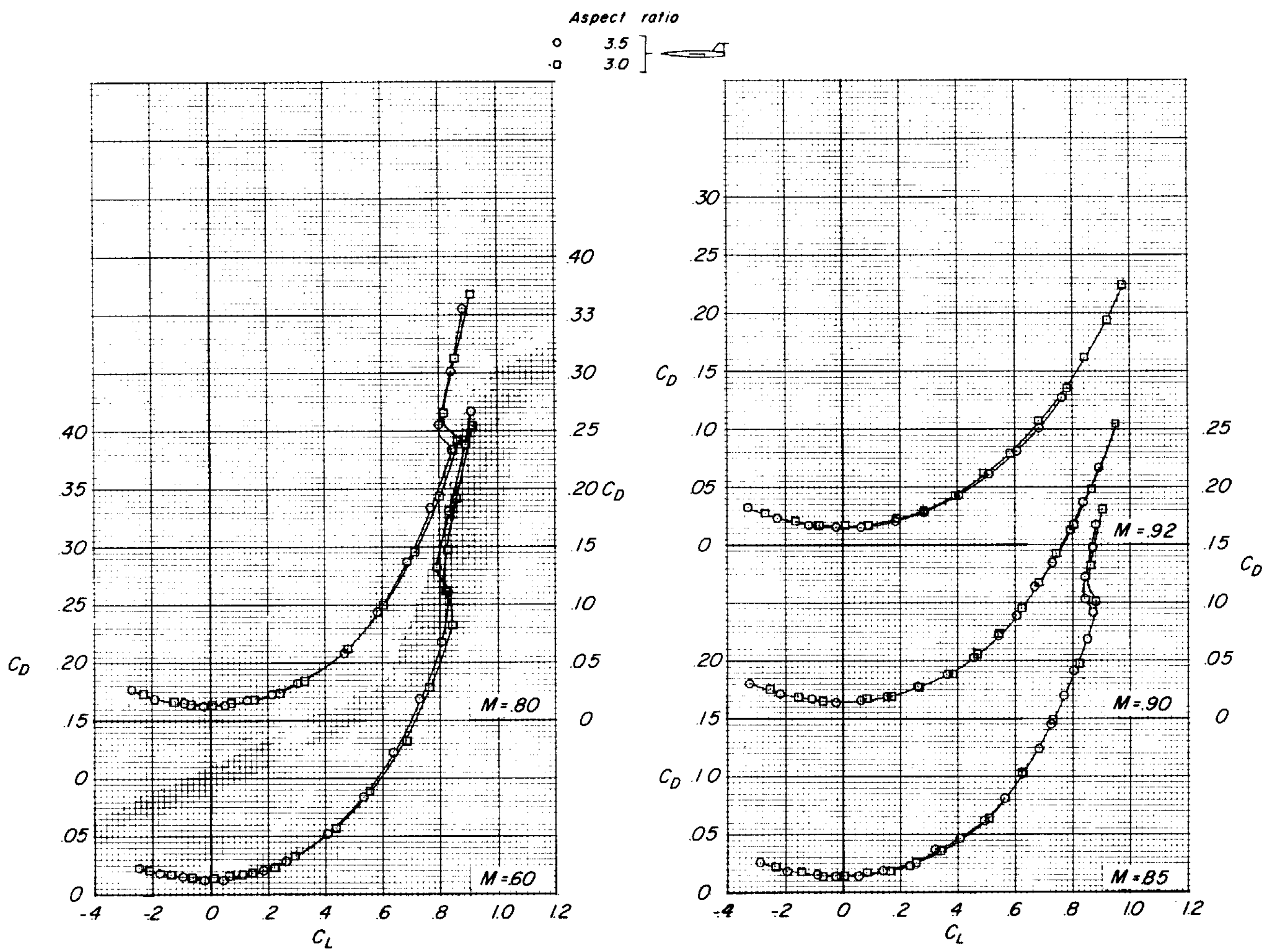
(a) C_m against C_L.

Figure 6.- Effect of wing aspect ratio on the longitudinal characteristics of the T-tail model. Tail configuration 6.



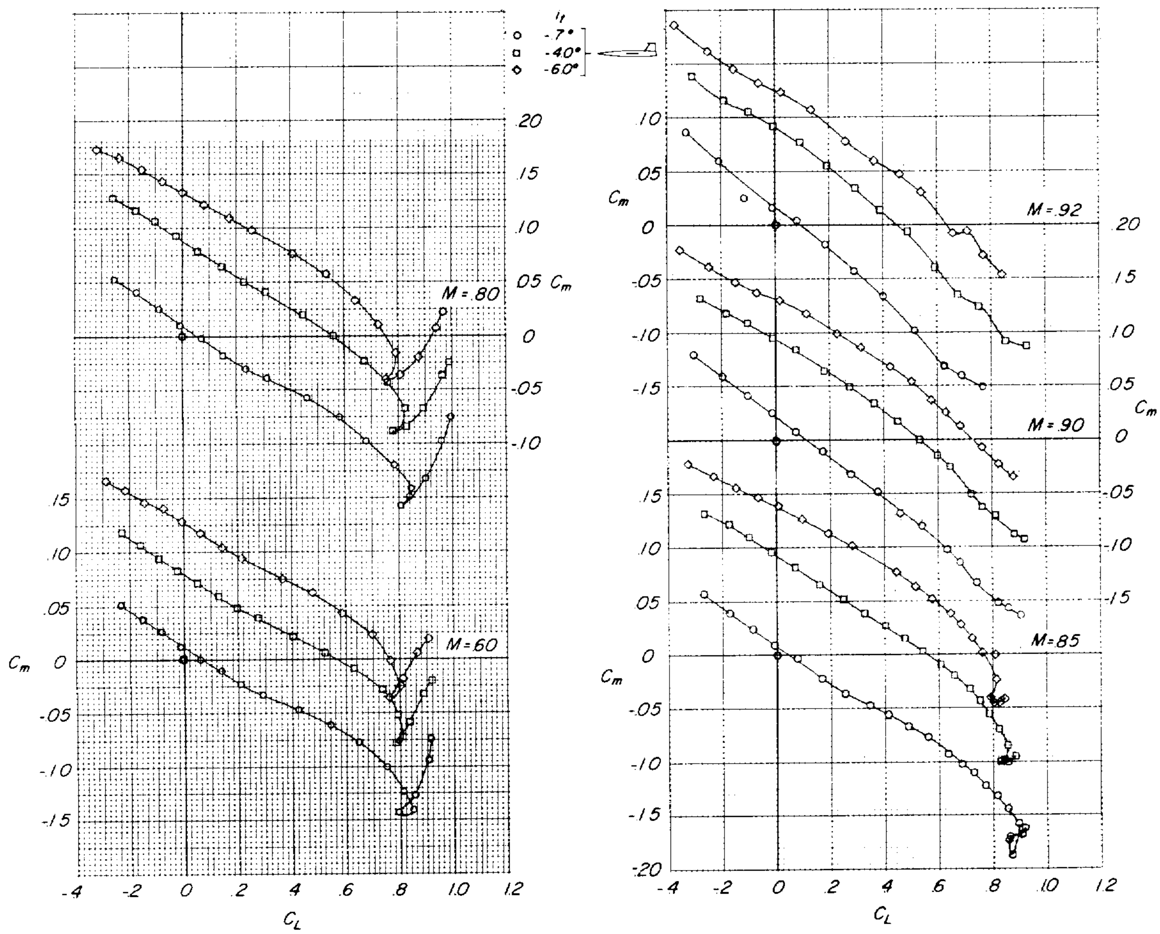
(b) α against C_L.

Figure 6.- Continued.



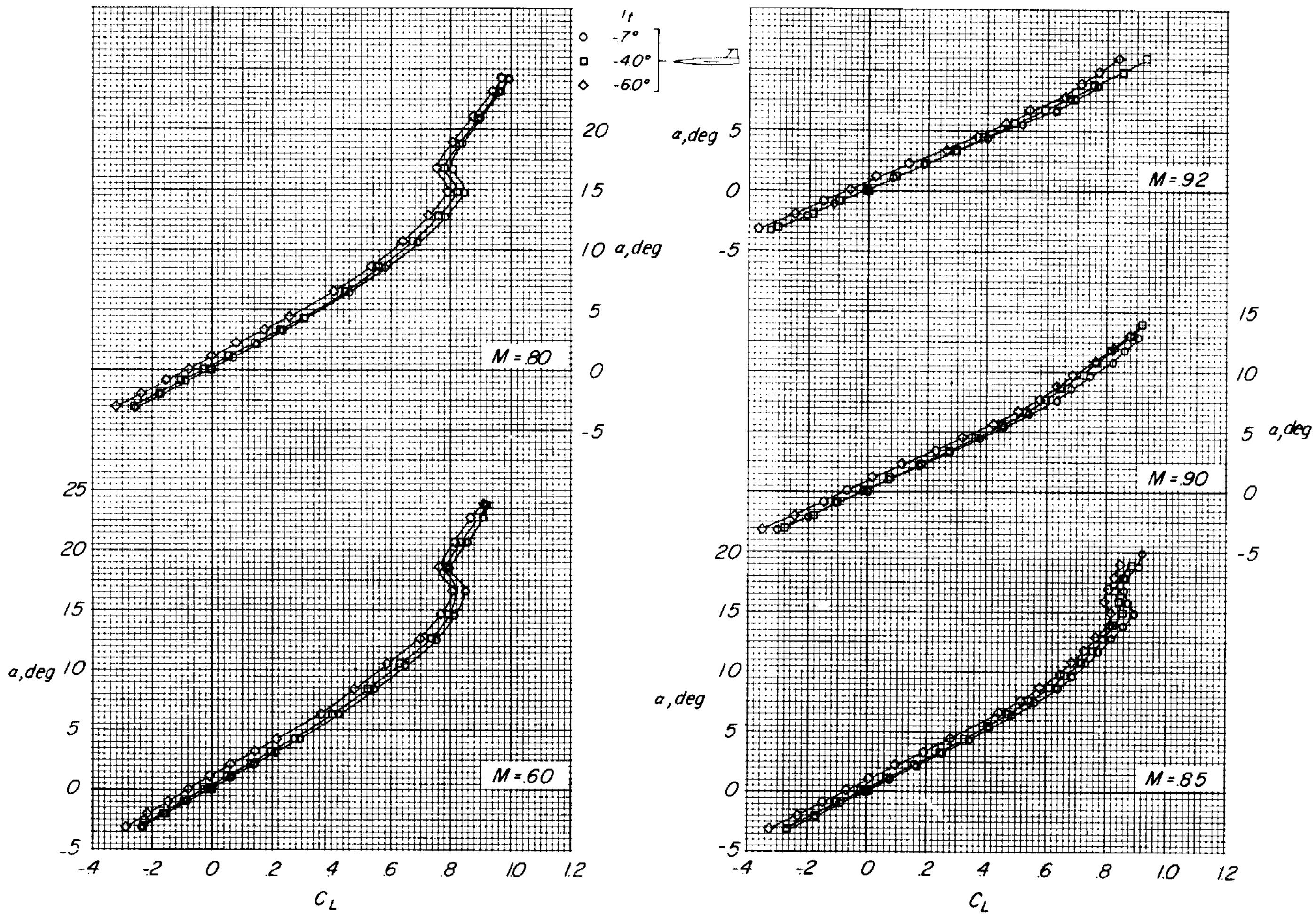
(c) C_D against C_L.

Figure 6.- Concluded.



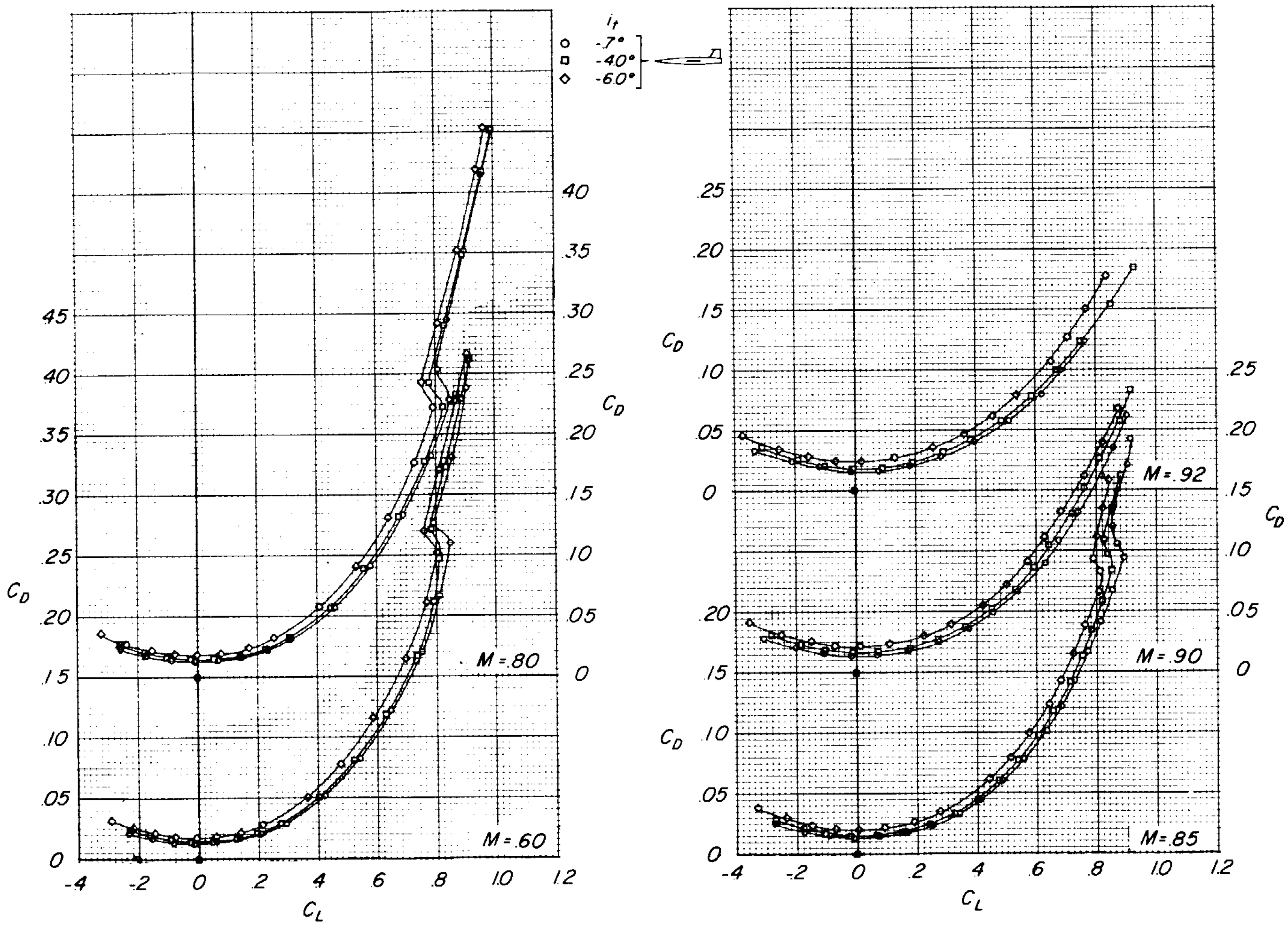
(a) C_m against C_L.

Figure 7.- Effect of stabilizer deflection on the aerodynamic characteristics of the T-tail with leading-edge overhang. Tail configuration 4; wing aspect ratio, 3.50.



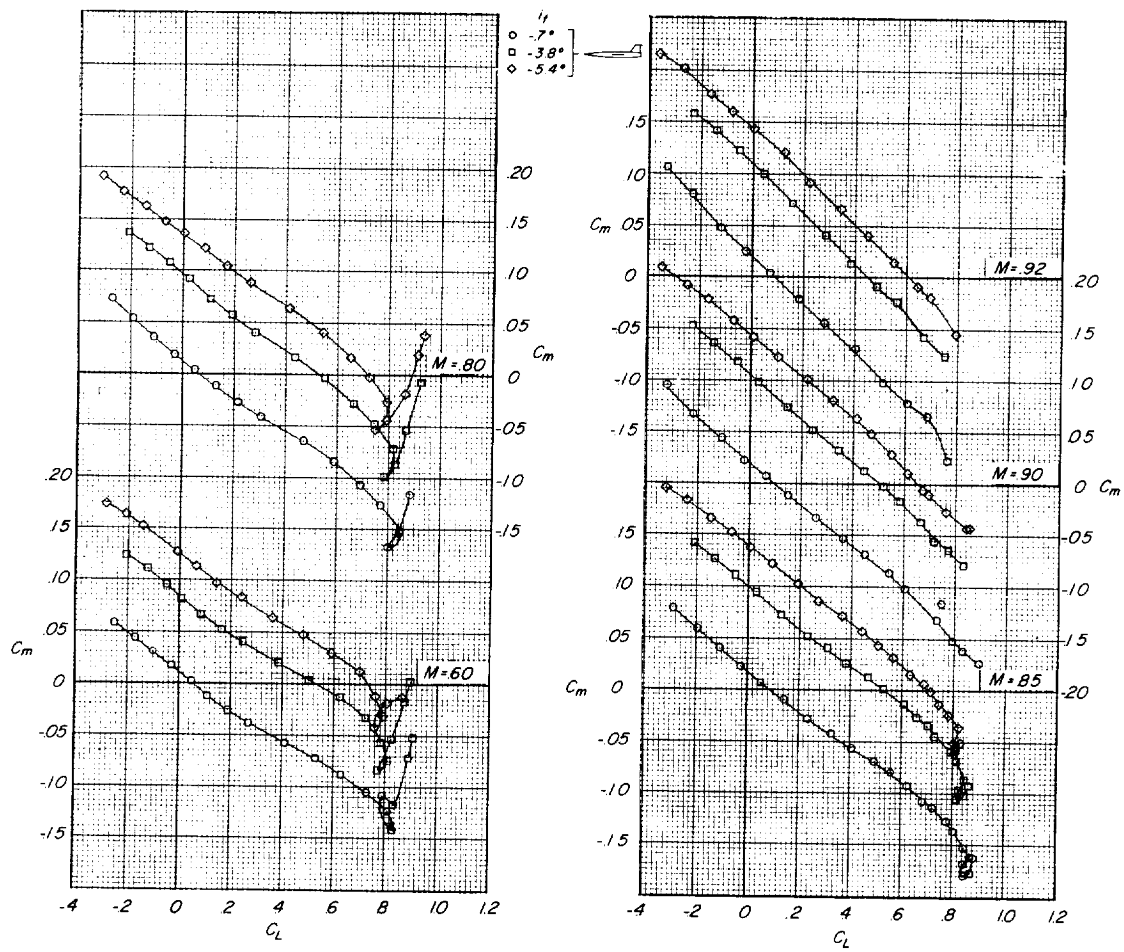
(b) α against C_L.

Figure 7.- Continued.



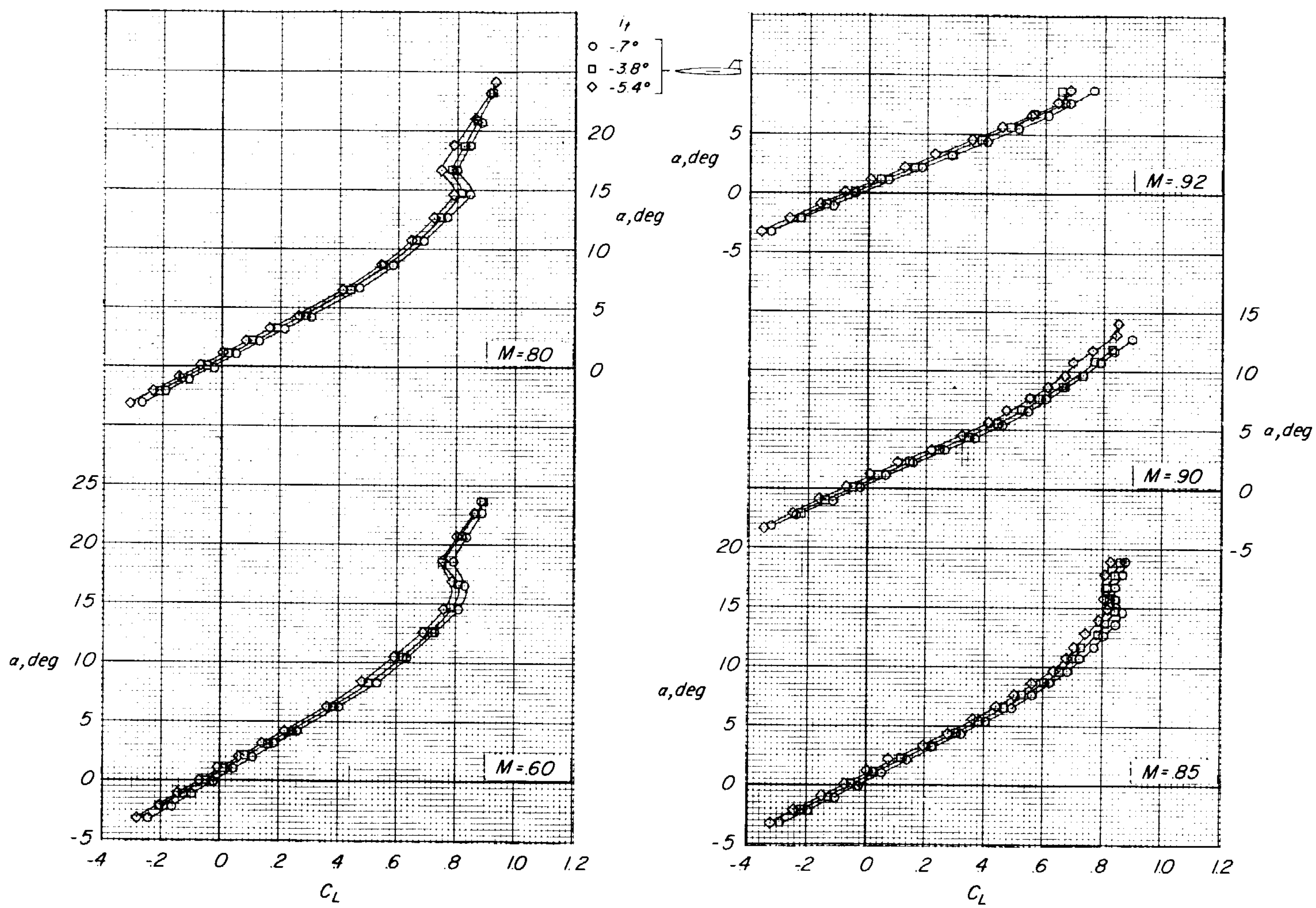
(c) C_D against C_L.

Figure 7.- Concluded.



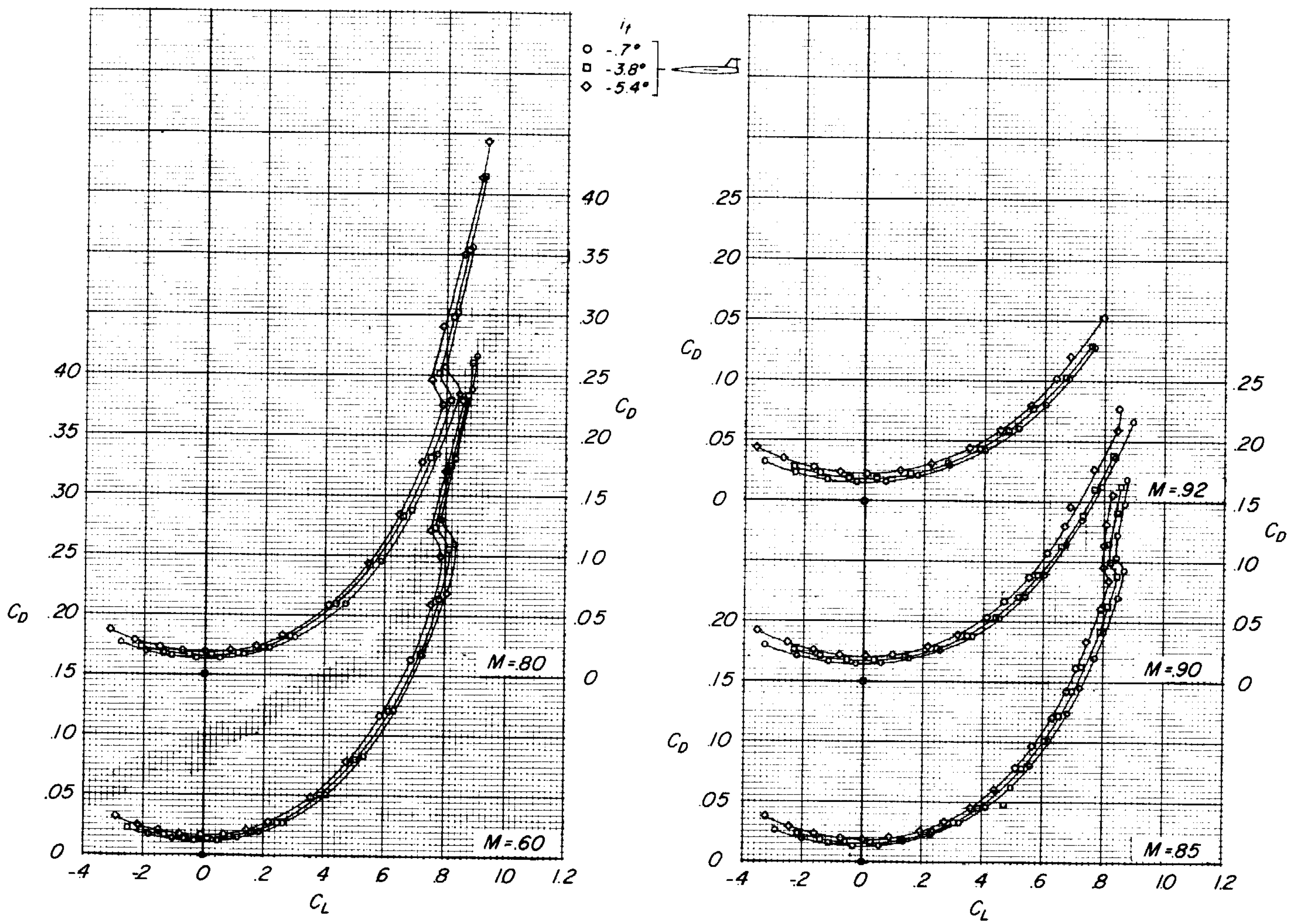
(a) C_m against C_L.

Figure 8.- Effect of stabilizer deflection on the aerodynamic characteristics of the T-tail configuration without leading-edge overhang of the horizontal tail. Tail configuration 6; wing aspect ratio, 3.50.



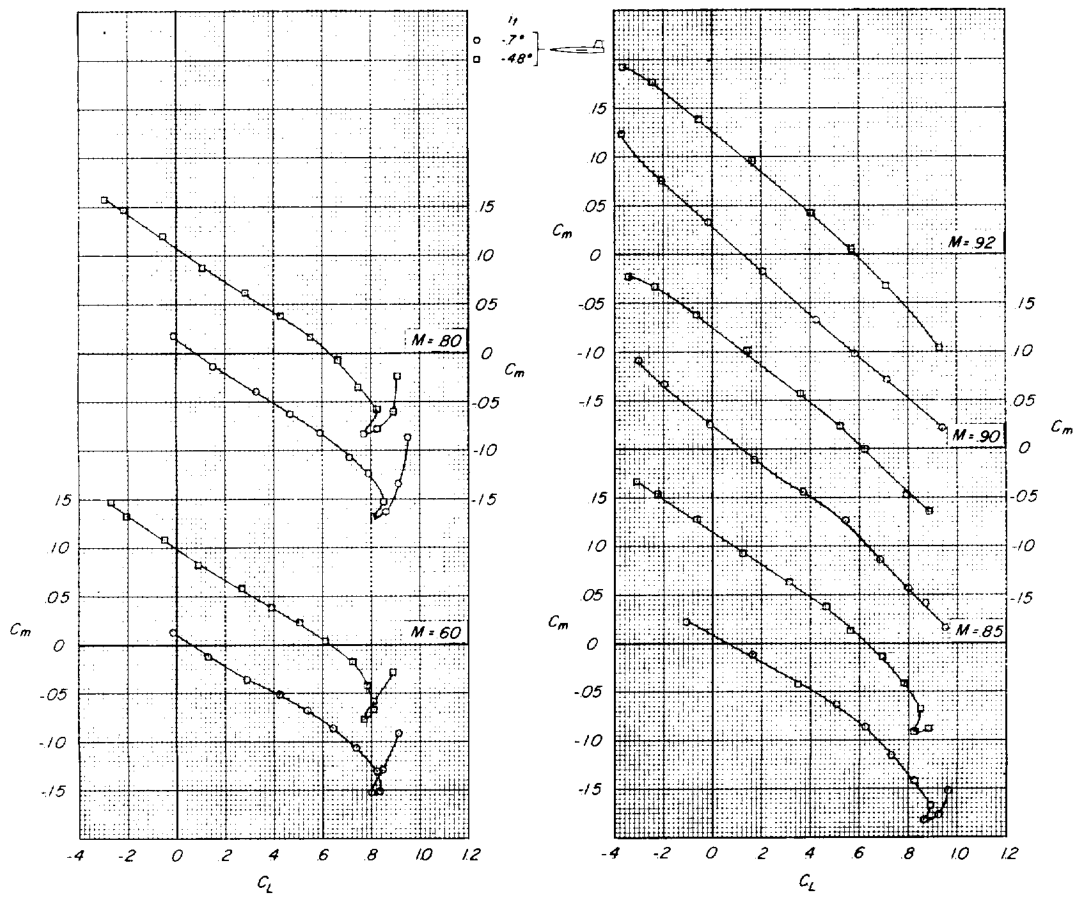
(b) α against C_L.

Figure 8.- Continued.



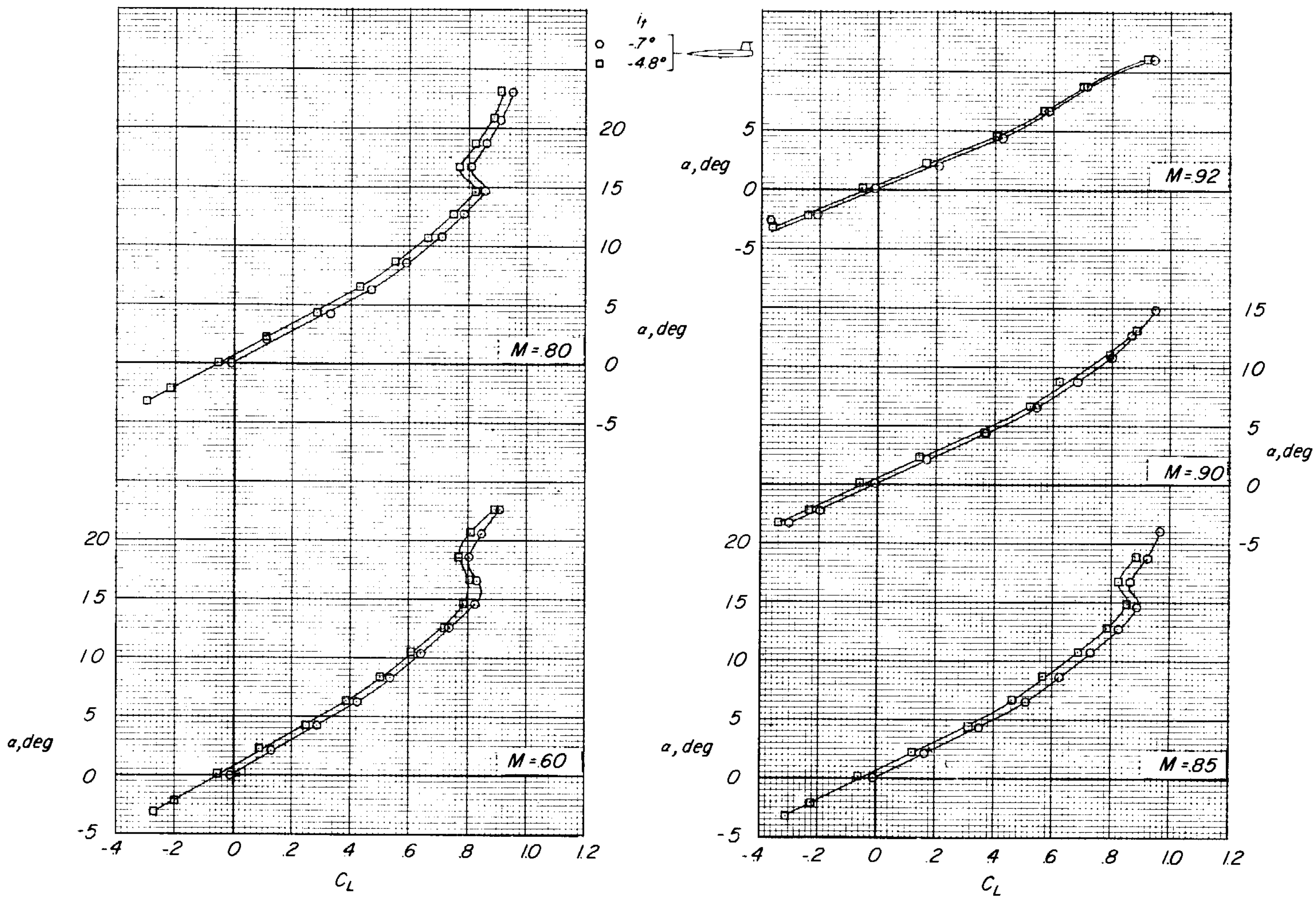
(c) C_D against C_L.

Figure 8.- Concluded.



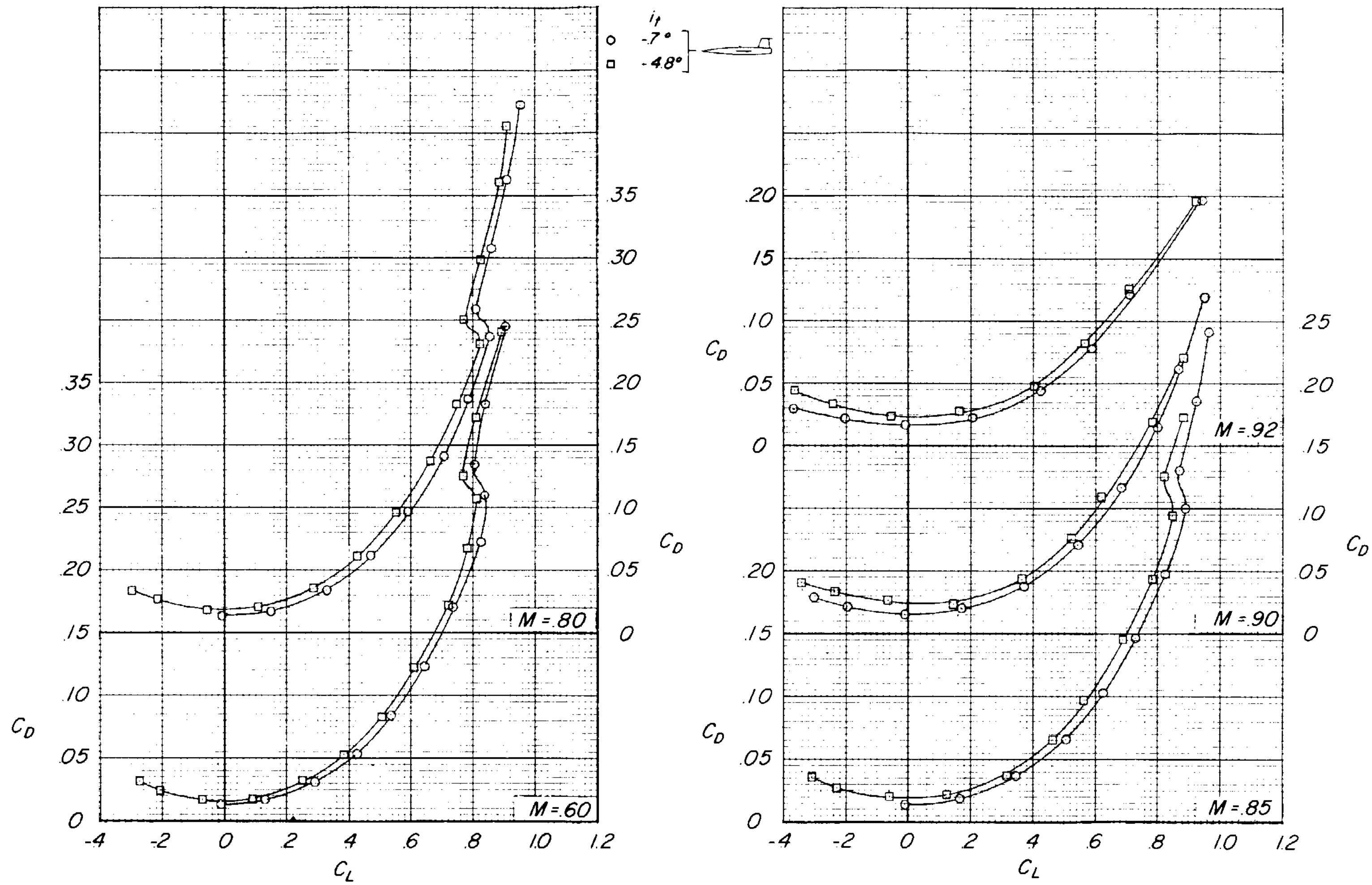
(a) C_m against C_L.

Figure 9.- Effect of stabilizer deflection on the aerodynamic characteristics of the T-tail without leading-edge overhang and mounted on a reduced sweep vertical tail. Tail configuration 7; wing aspect ratio, 3.50.



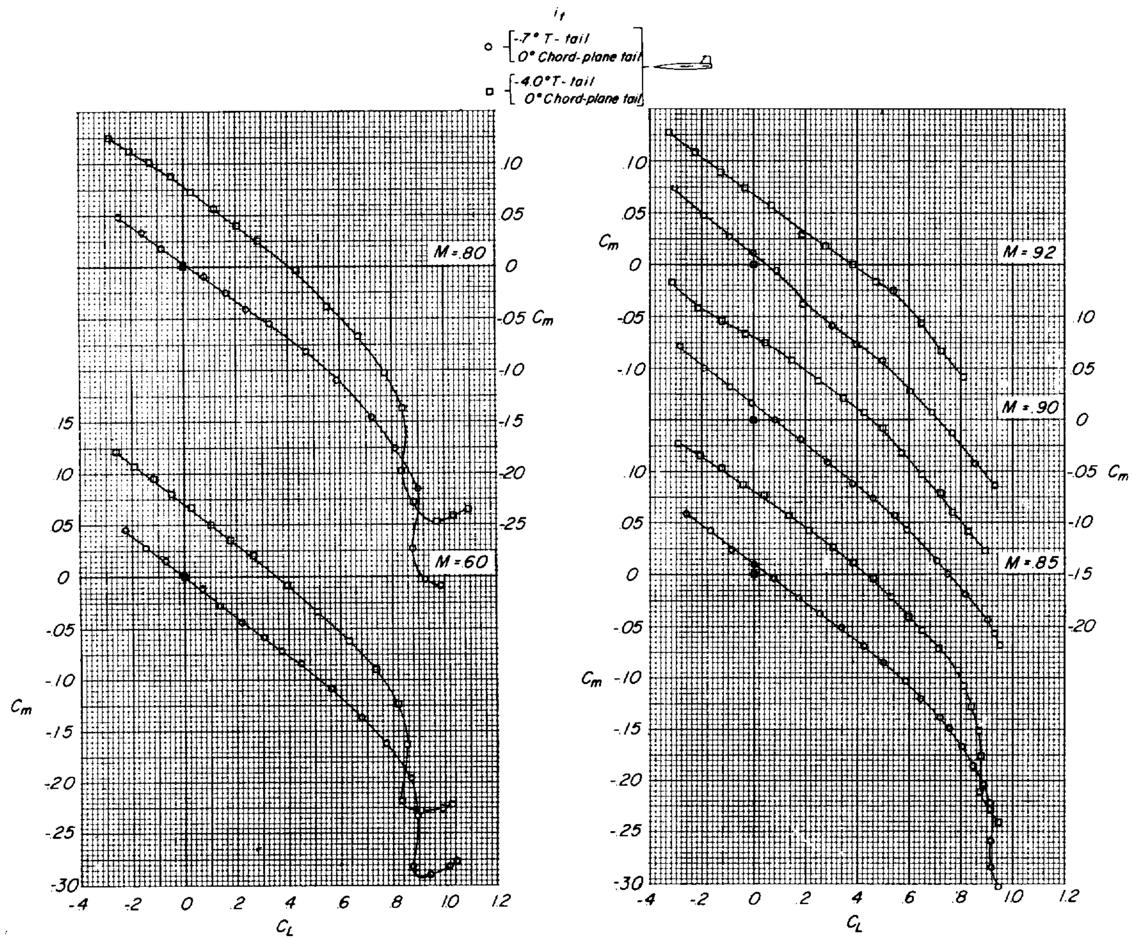
(b) α against C_L.

Figure 9.- Continued.



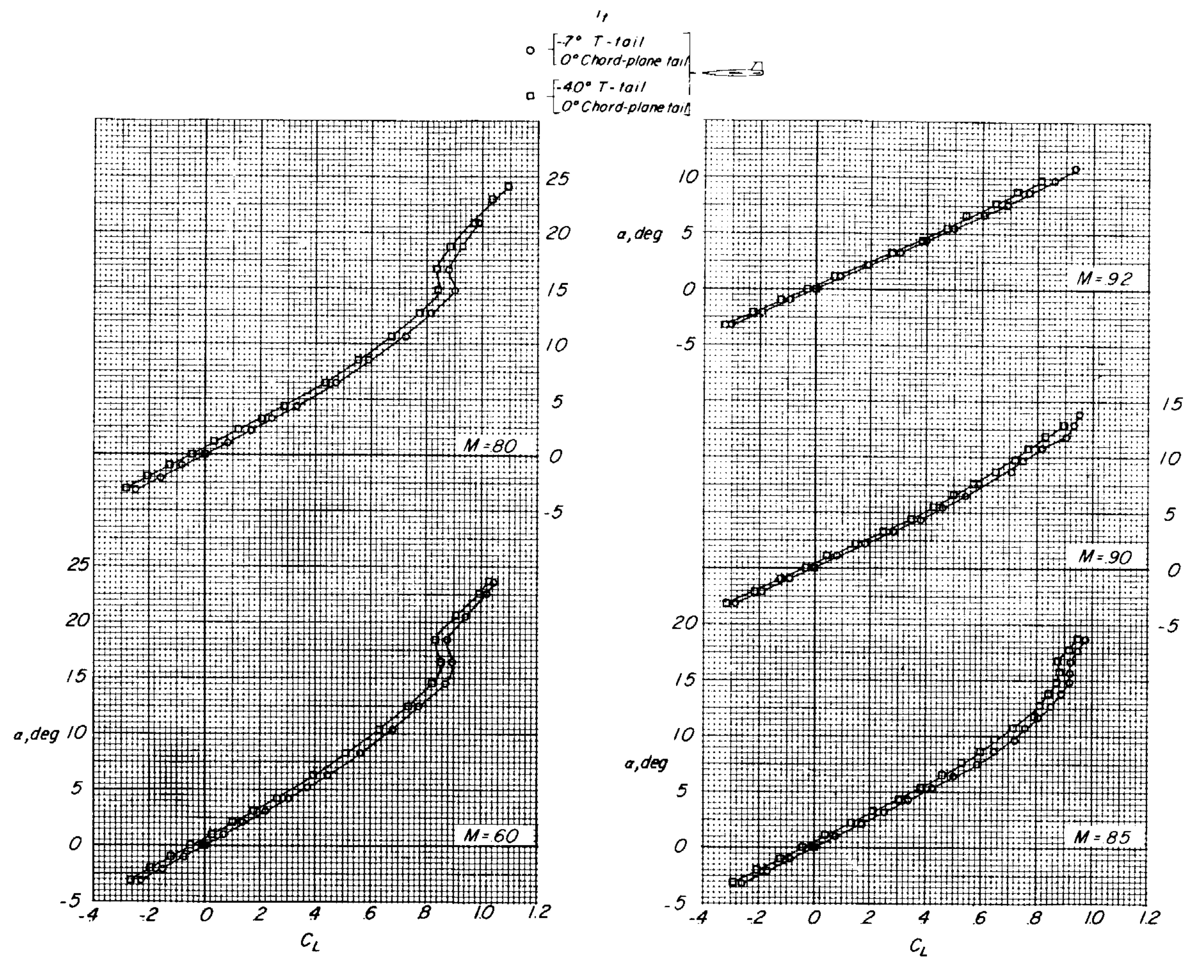
(c) C_D against C_L.

Figure 9.- Concluded.



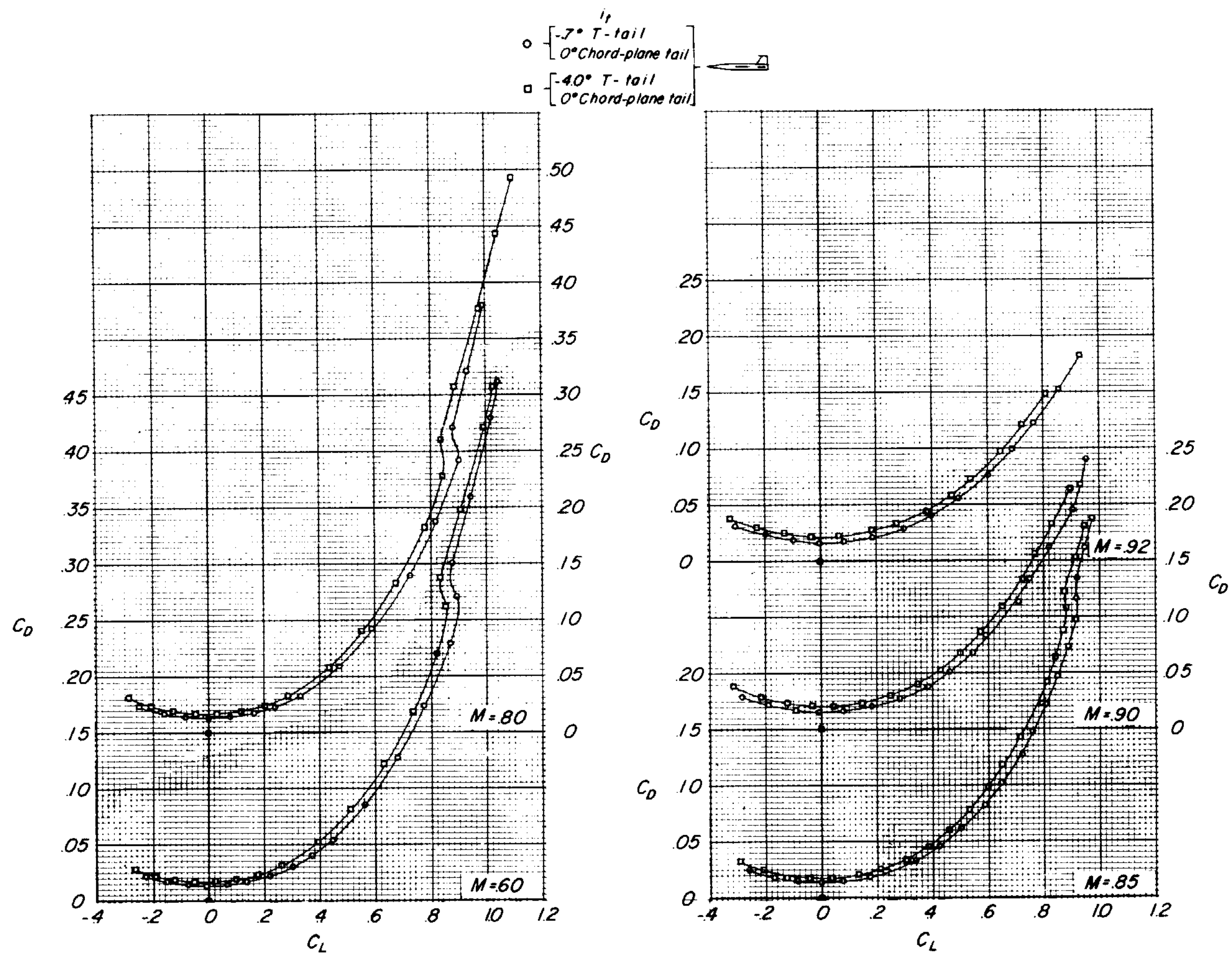
(a) C_m against C_L.

Figure 10.- Effect of stabilizer deflection on the aerodynamic characteristics of the biplane-tail configuration. Tail configuration 5; wing aspect ratio, 3.50.



(b) α against C_L.

Figure 10.- Continued.



(c) C_D against C_L.

Figure 10.- Concluded.

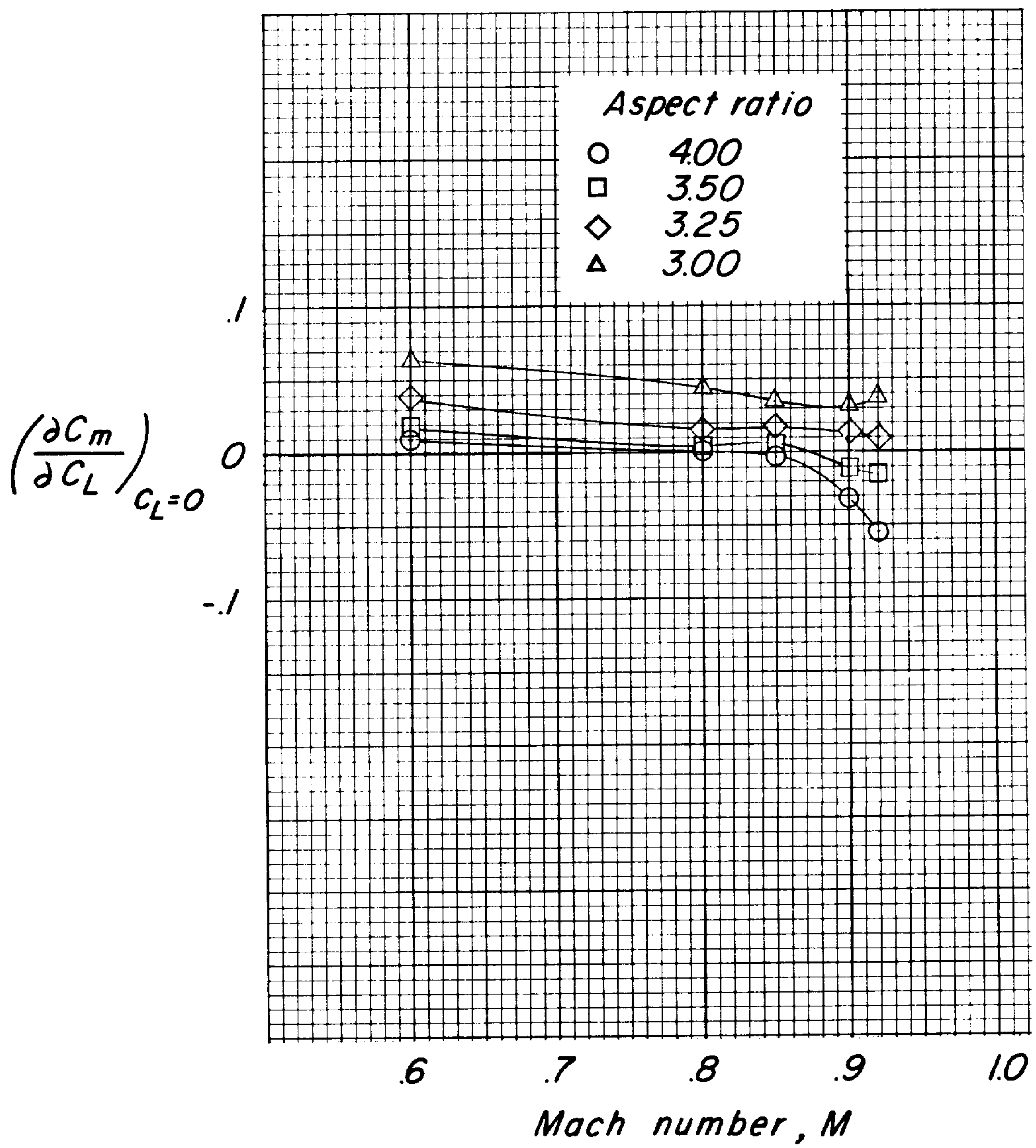


Figure 11.- Variation of $\left(\frac{\partial C_m}{\partial C_L}\right)_{C_L=0}$ with Mach number for the wing-fuselage model for various wing aspect ratios.

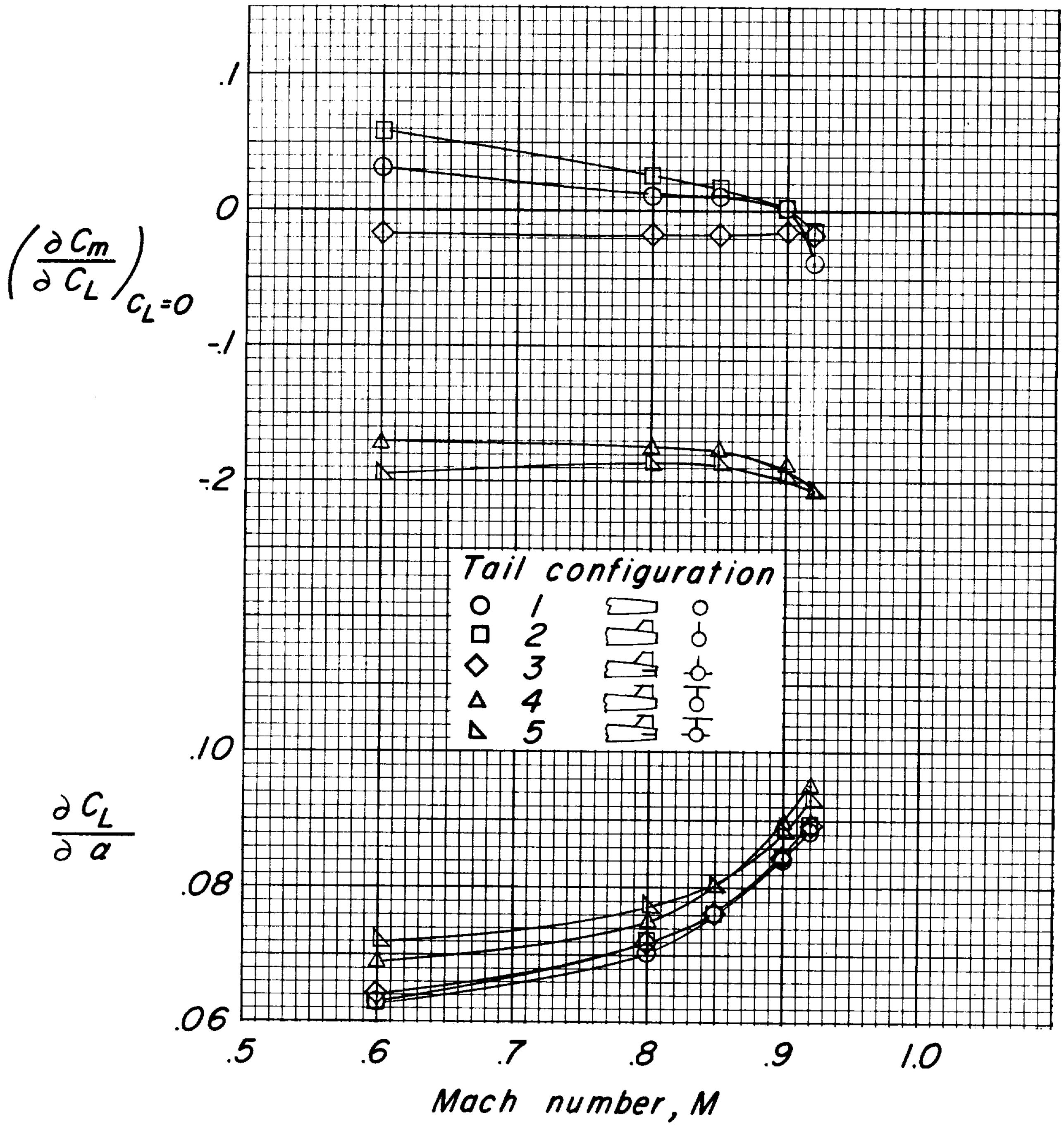


Figure 12.- Variation of $\left(\frac{\partial C_m}{\partial C_L}\right)_{C_L=0}$ and lift-curve slope with Mach number for the model with the aspect-ratio-3.50 wing and various tail configurations.

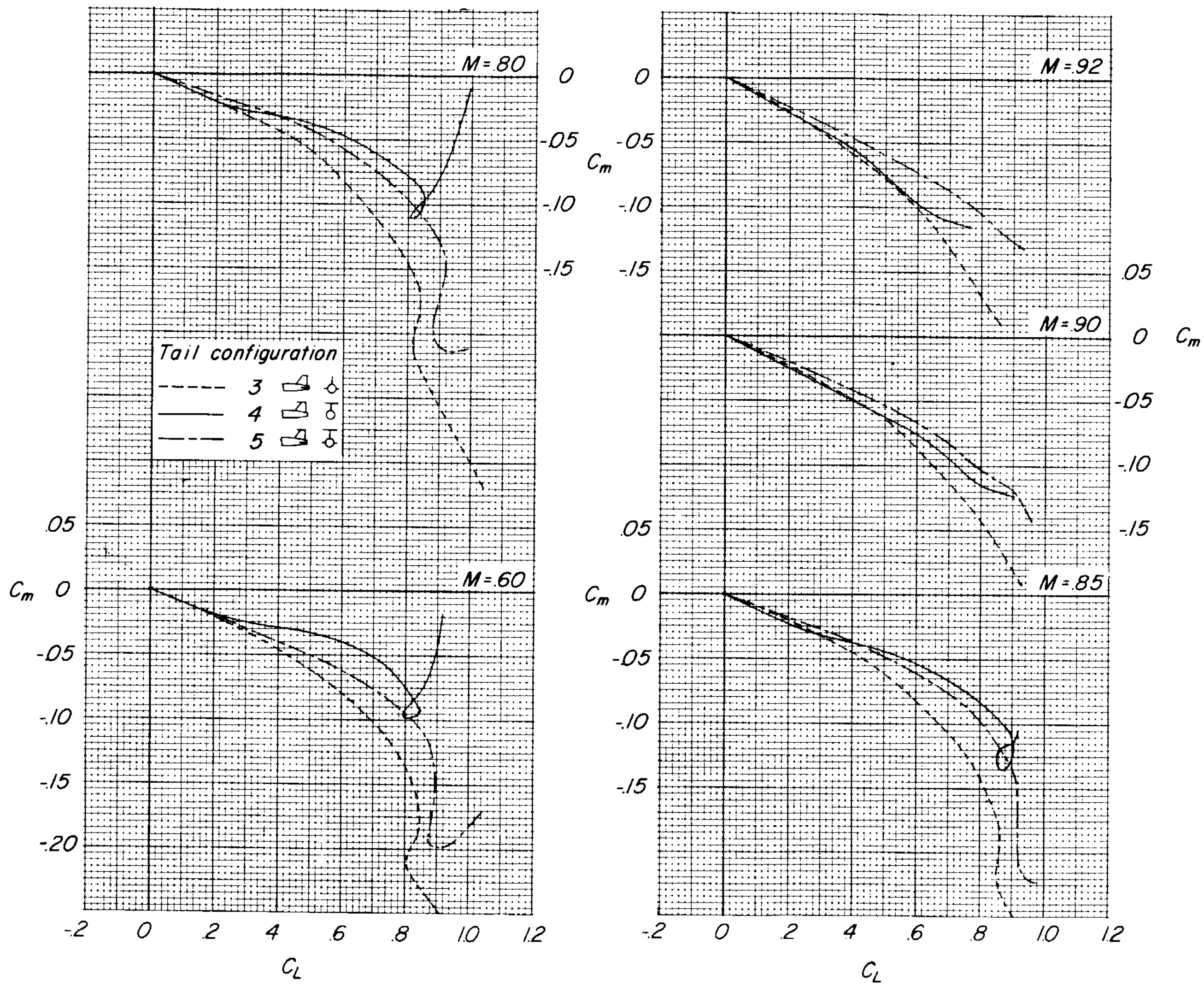


Figure 13.- Longitudinal stability characteristics of the aspect-ratio-3.50 model with several tail configurations adjusted to give a -0.10$\bar{c}$ static margin at M = 0.60.

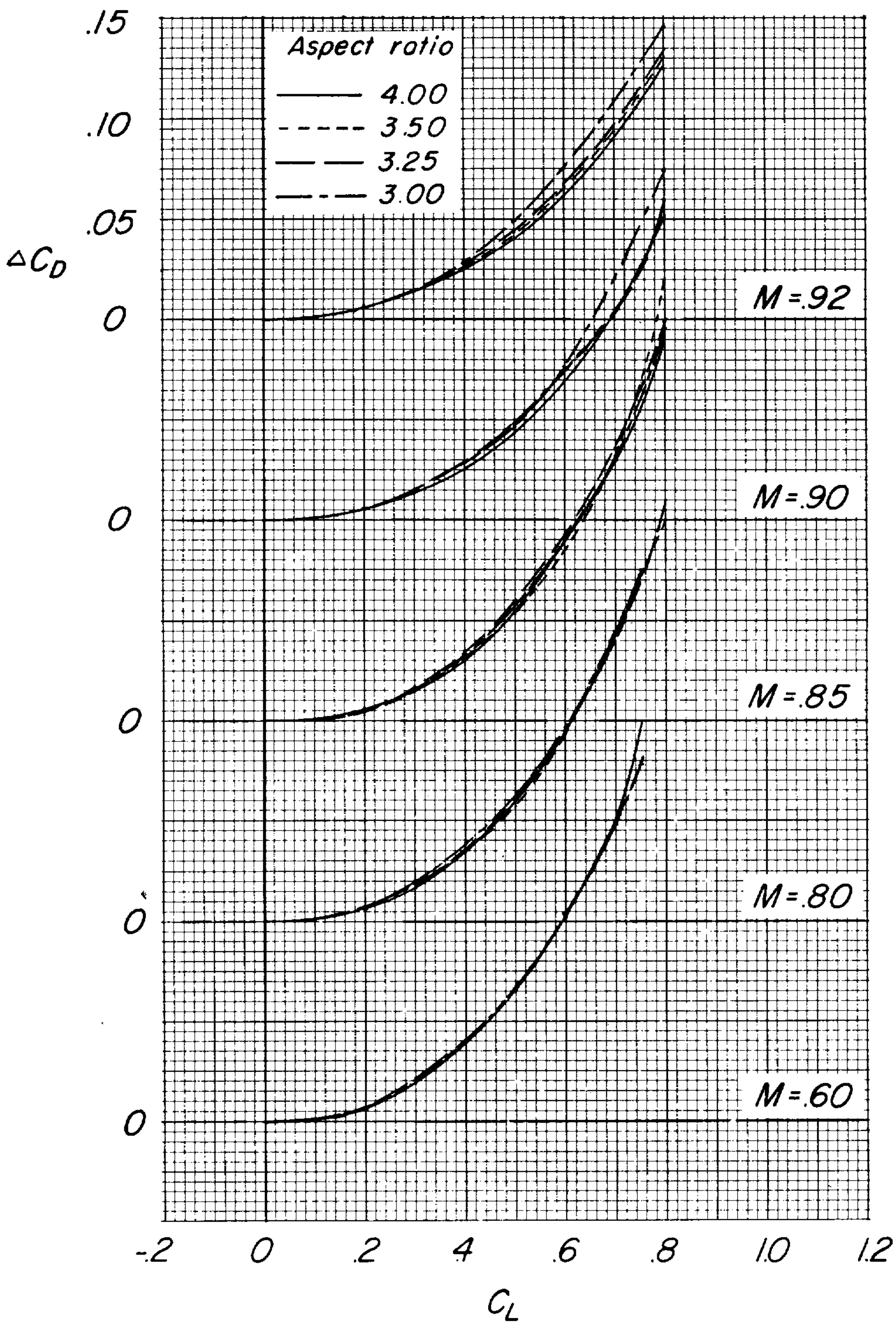


Figure 14.- Effect of aspect ratio on drag due to lift. Tail off.

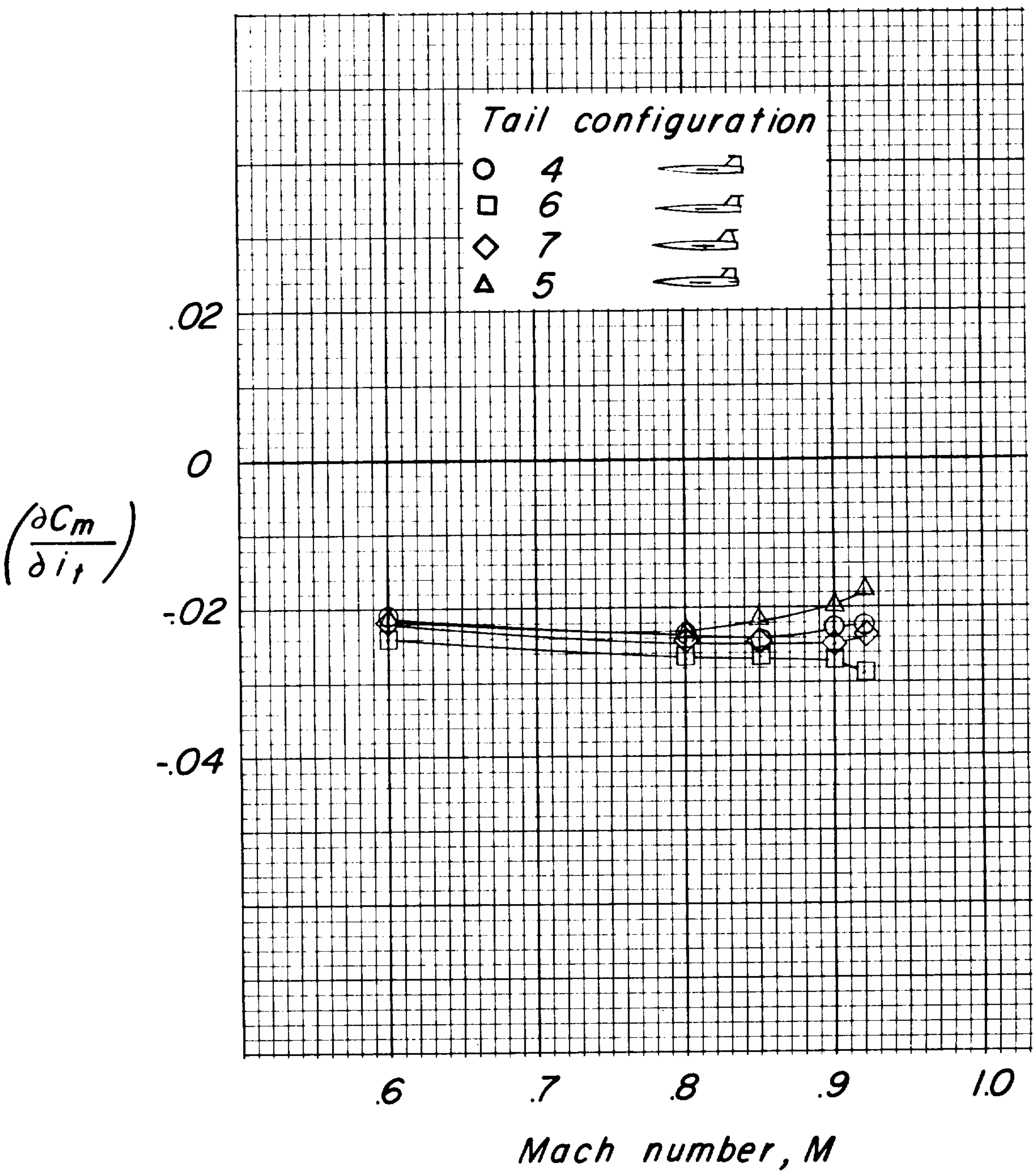


Figure 15.- Variation of stabilizer effectiveness with Mach number for the model with the aspect-ratio-3.50 wing and various tail configurations.

NASA-Langley, 1961 L-1699

NASA TN D-949
National Aeronautics and Space Administration.
STATIC LONGITUDINAL CHARACTERISTICS AT HIGH SUBSONIC SPEEDS OF A COMPLETE AIRPLANE MODEL WITH A HIGHLY TAPERED WING HAVING THE 0.80 CHORD LINE UNSWEPT AND WITH SEVERAL TAIL CONFIGURATIONS. Kenneth W. Goodson. August 1961. 57p. OTS price, $1.50. (NASA TECHNICAL NOTE D-949. Supersedes NACA RM L56J03)

A pointed wing model of aspect ratio 4 was modified by clipping small portions off the wing tips to form wings with aspect ratios of 3.50, 3.25, and 3.00. The aspect-ratio-3.50 wing was extensively tested as a complete model with various horizontal- and vertical-tail combinations. The tail configurations consisted of a chord-plane horizontal tail, a high or T-tail configuration, and a combined T-tail and chord-plane tail (biplane tail) configuration.

Copies obtainable from NASA, Washington

I. Goodson, Kenneth W.
II. NASA TN D-949
III. NACA RM L56J03

(Initial NASA distribution: 1, Aerodynamics, aircraft; 3, Aircraft; 50, Stability and control.)

NASA

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