TECHNICAL NOTES.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

No. 75

EFFECTS OF VARYING THE RELATIVE VERTICAL POSITION OF WING AND FUSELAGE.

By

L. Prandtl.

Extract from
First Report of the Göttingen Aerodynamic Laboratory,
Chap. IV, Sec. 7.

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EFFECTS OF VARYING THE RELATIVE VERTICAL POSITION OF WING AND FUSELAGE.*

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The object of this series of experiments was to determine the influence of the relative vertical position of wing and fuselage on the efficiency of the wing. Since the longitudinal position of the wing can be varied but slightly with reference to the center of gravity in a normal airplane, it was kept constant in the experiments to be described and only the vertical position of the wing with reference to the fuselage was varied. Fig. 1 shows the different wing positions, A to E, as likewise the shapes of the wing and fuselage and the distances between the wing chord and the axis of the fuselage. The rectangular wing has a span of 900 mm. and a chord of 180 mm. Wing model No. 436 was used, with an angle of attack of 3°.

The results are shown in Figs. 2-6, and tables 1-6. With the polar curves for the individual cases, the polar curve of the wing alone is always indicated by a dash line. The given angles of attack always refer to the wing chord.

Fig. 7 gives the differences $C_{D'}$ between the wing and fuselage together, and the wing alone, on an enlarged scale, for the several cases.

* Extract from the First Report of the Göttingen Aerodynamic Laboratory, Chap. IV, Sec. 7, pp. 118-120.

Attaching the fuselage to the wing caused, in case D, a practically parallel displacement of the polar curve in the direction of the abscissas, corresponding to the fuselage drag. In case A, there was a noticeable increase in drag, especially at small angles of attack; with increased lift, the difference was less referred to the wing alone. The same was true for case B, only in a somewhat smaller degree. Case C showed, in a striking manner, at a larger angle of attack (about 12°), a noticeable increase in drag. This phenomenon, which has not yet been explained, was confirmed by a second test. Case E was evidently the most unfavorable, since the drag was considerably greater in comparison with the other cases.

It may be accordingly stated that the differences between cases A to D are only slight, but that case E, in which the wing is a little below the fuselage, shows an aerodynamic change for the worse, in comparison with the other cases.

Translated by the National Advisory Committee for Aeronautics.

TABLE I.

Wing alone.

Angle of attack	C_L	C_D	C_M
- 8.9°	-.241	.0605	-.007
- 6.0	-.051	.0153	.055
- 4.5	.049	.0136	.078
- 3.0	.151	.0136	.101
- 1.6	.250	.0155	.126
- 0.1	.349	.0186	.147
1.4	.455	.0238	.174
2.8	.560	.0308	.204
4.3	.662	.0405	.227
5.8	.756	.0510	.252
8.7	.960	.0737	.307
11.7	1.123	.1060	.348
14.6	1.187	.1540	.373

TABLE II.

Case A.

Angle of attack	C_L	C_D	C_M
- 8.9°	-.250	.0592	-.005
- 6.0	-.053	.0213	.053
- 4.5	.047	.0190	.076
- 3.0	.142	.0186	.100
- 1.6	.246	.0201	.125
- 0.1	.344	.0235	.149
1.4	.454	.0277	.176
2.8	.563	.0354	.206
4.3	.665	.0443	.230
5.8	.766	.0546	.255
8.7	.967	.0800	.312
11.7	1.140	.1110	.351
14.6	1.228	.1480	.378

TABLE III.

Case B.

Angle of attack	C_L	C_D	C_M
- 8.9°	-.293	.0700	-.028
- 6.0	-.086	.0187	.051
- 4.5	.011	.0167	.071
- 3.0	.118	.0163	.096
- 1.6	.218	.0179	.122
- 0.1	.319	.0203	.144
1.4	.429	.0250	.171
2.8	.540	.0314	.202
4.3	.640	.0408	.226
5.8	.745	.0513	.250
8.7	.942	.0765	.306
11.7	1.113	.1070	.342
14.6	1.214	.1550	.387

TABLE IV.

Case C.

Angle of attack	C_L	C_D	C_M
- 8.9°	-.283	.0726	-.032
- 6.0	-.082	.0190	.056
- 4.5	.016	.0168	.078
- 3.0	.120	.0163	.100
- 1.6	.224	.0179	.125
- 0.1	.325	.0213	.147
1.4	.428	.0248	.170
2.8	.537	.0327	.200
4.3	.640	.0411	.223
5.8	.741	.0513	.248
8.7	.942	.0778	.304
11.7	1.076	.1100	.344
14.6	1.180	.1620	.375
17.7	1.079	.243	.388

TABLE V.

Case D.

Angle of attack	C_L	C_D	C_M
– 8.9	–.271	.0724	–.011
– 6.0	–.068	.0197	.063
– 4.5	.032	.0175	.084
– 3.0	.134	.0173	.108
– 1.6	.234	.0185	.130
– 0.1	.336	.0222	.154
1.4	.437	.0261	.175
2.8	.548	.0335	.207
4.3	.650	.0420	.230
5.8	.750	.0535	.254
8.7	.950	.0796	.310
11.7	1.125	.1110	.351
14.7	1.169	.1540	.363

TABLE VI.

Case E.

Angle of attack	C_L	C_D	C_M
– 8.9	–.234	.0747	–.003
– 6.0	–.043	.0232	.066
– 4.5	.058	.0310	.090
– 3.0	.158	.0214	.112
– 1.6	.258	.0330	.136
– 0.1	.354	.0268	.156
1.4	.453	.0315	.181
2.8	.557	.0388	.211
4.3	.657	.0474	.232
5.8	.754	.0575	.256
8.7	.943	.0842	.312
11.7	1.108	.1160	.347
14.7	1.179	.1520	.360

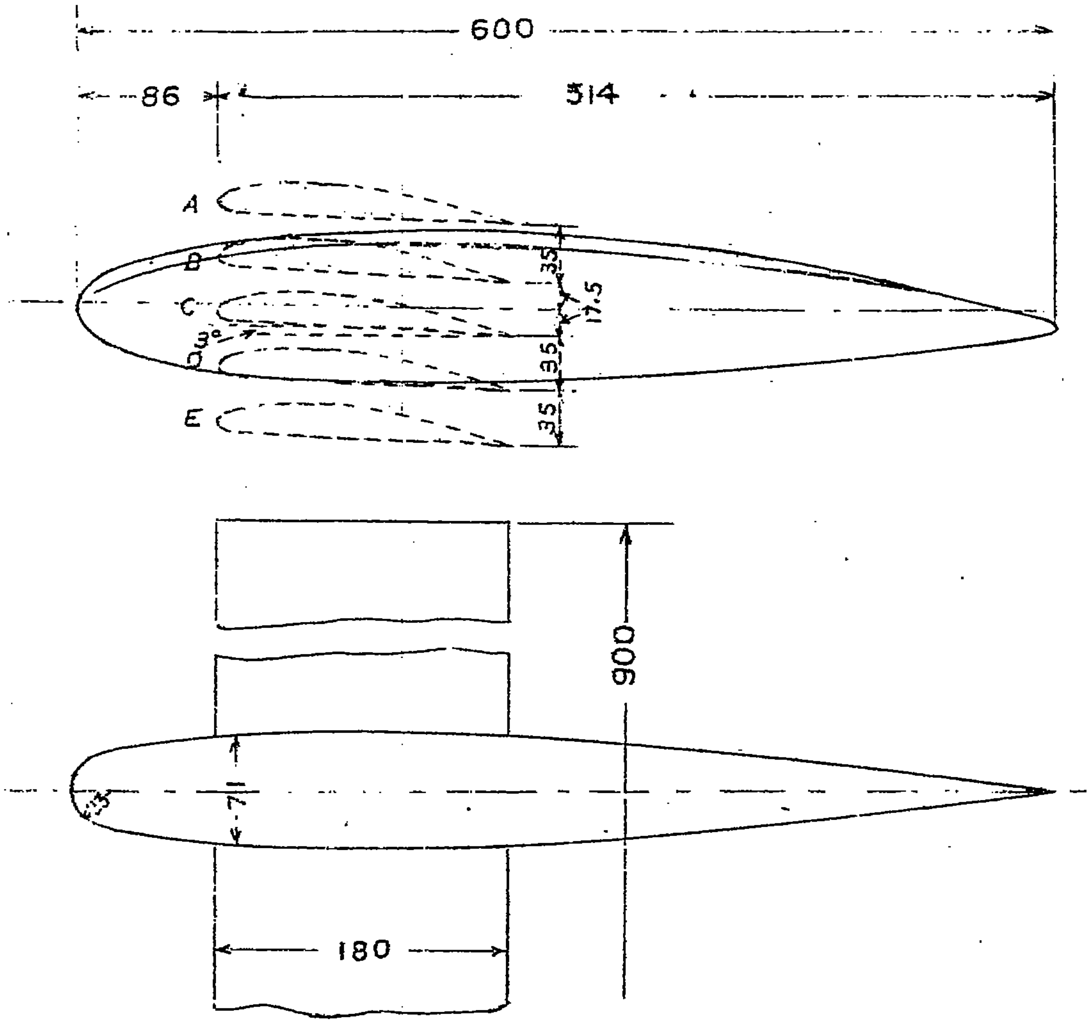
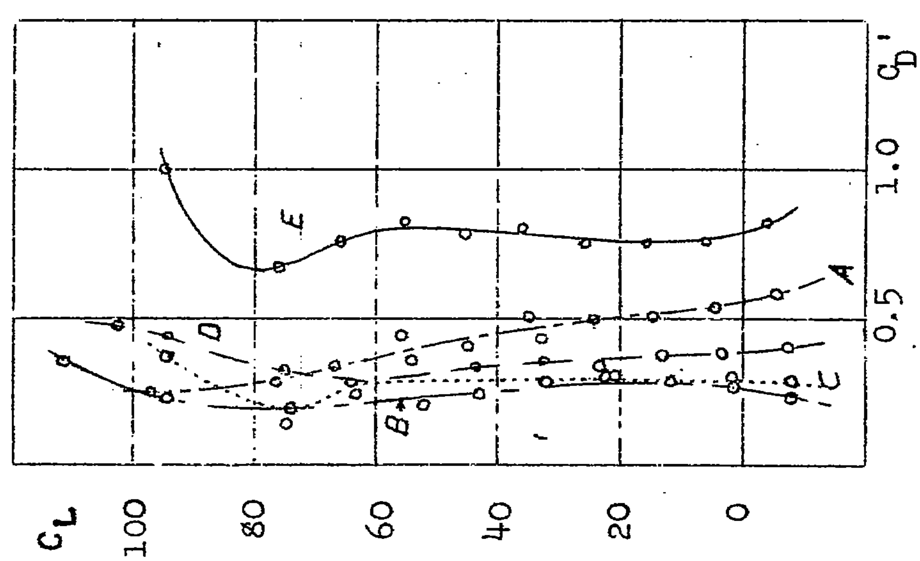

600
86
514
A
B
C
E
35
17.5
35
35
3°
900
71
13
180

Fig. 1.


C_L
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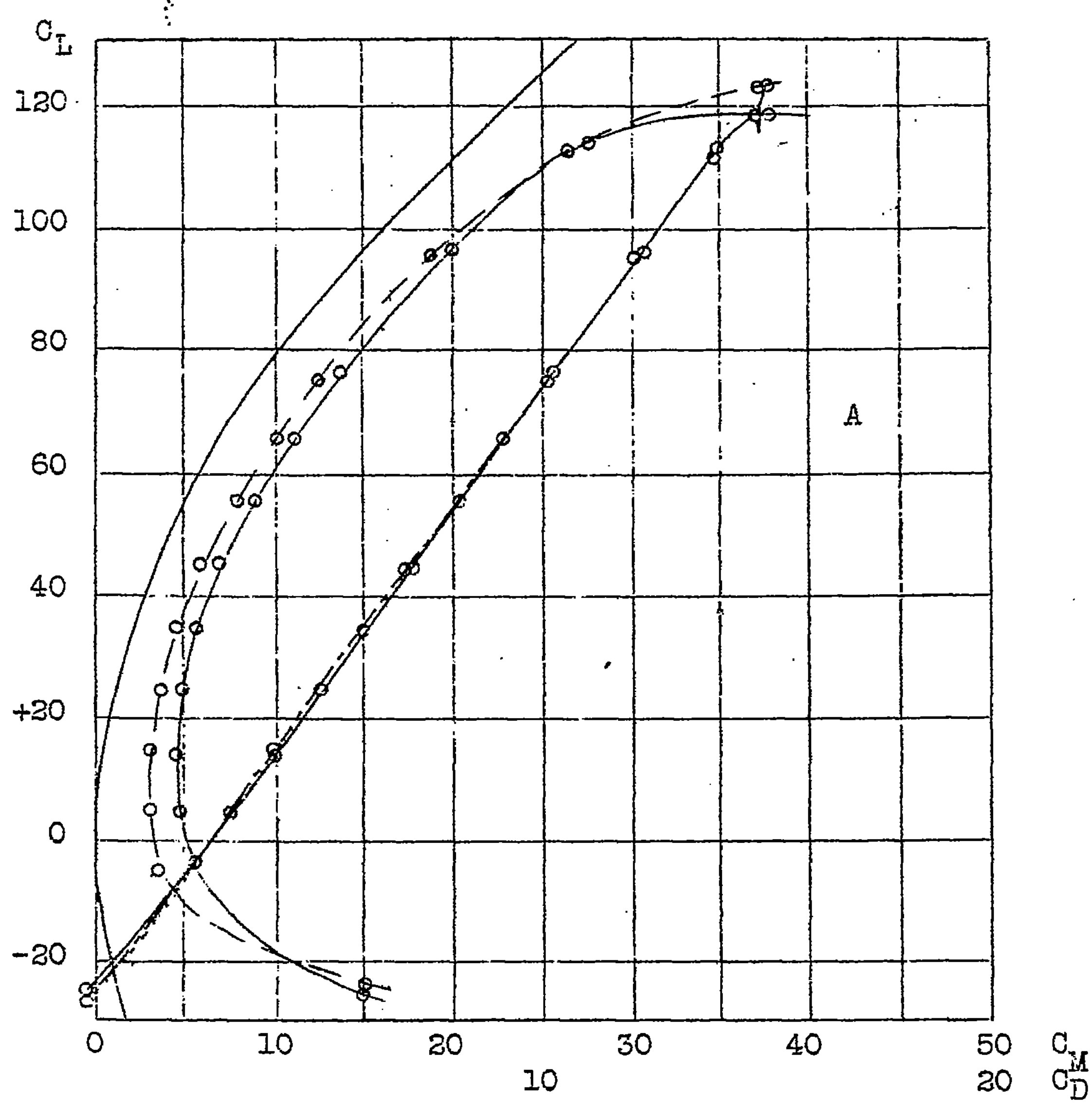
80
60
40
20
0
C_D'
1.0
0.5
A
B
C
D
E

Fig. 7



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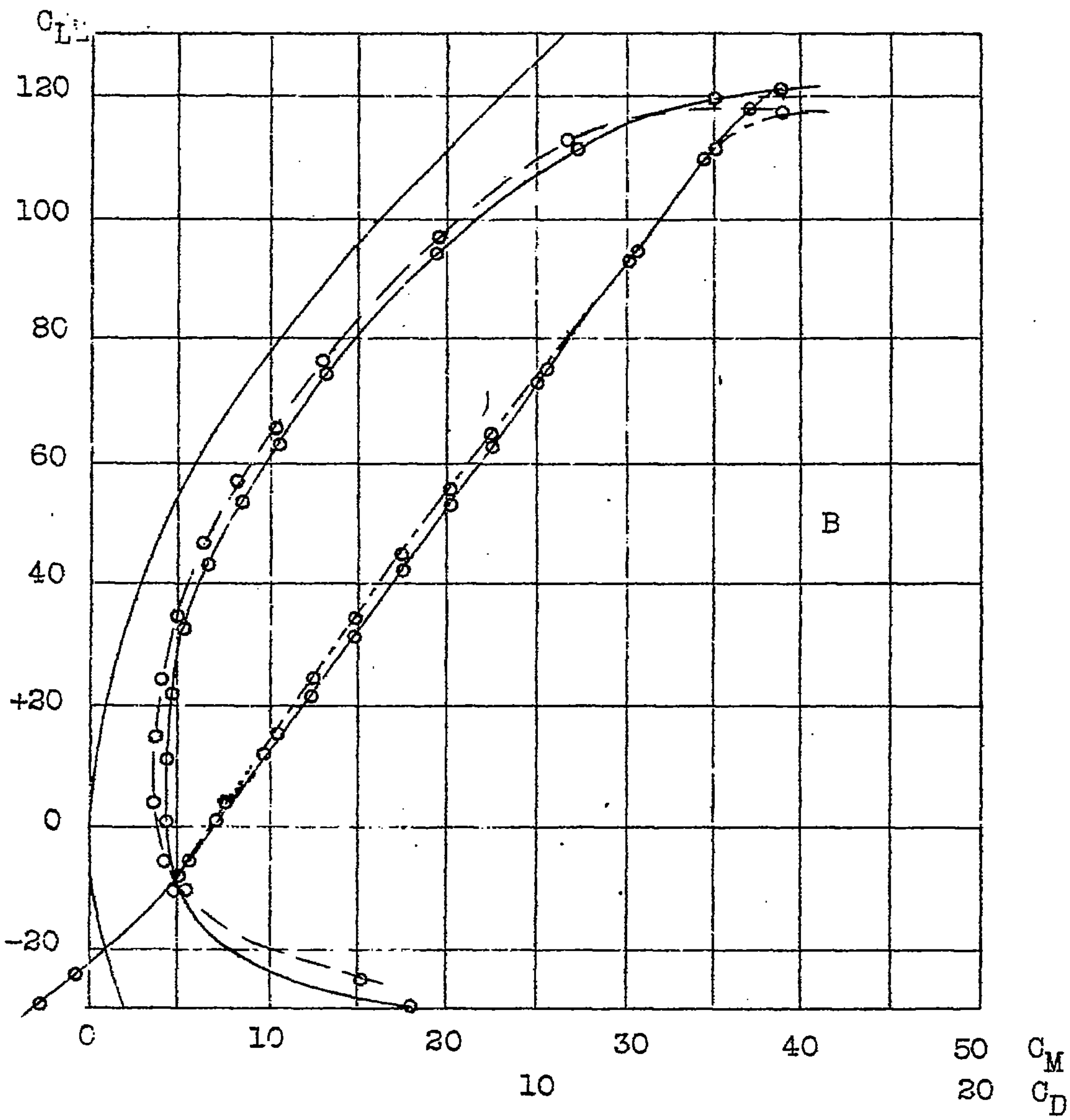

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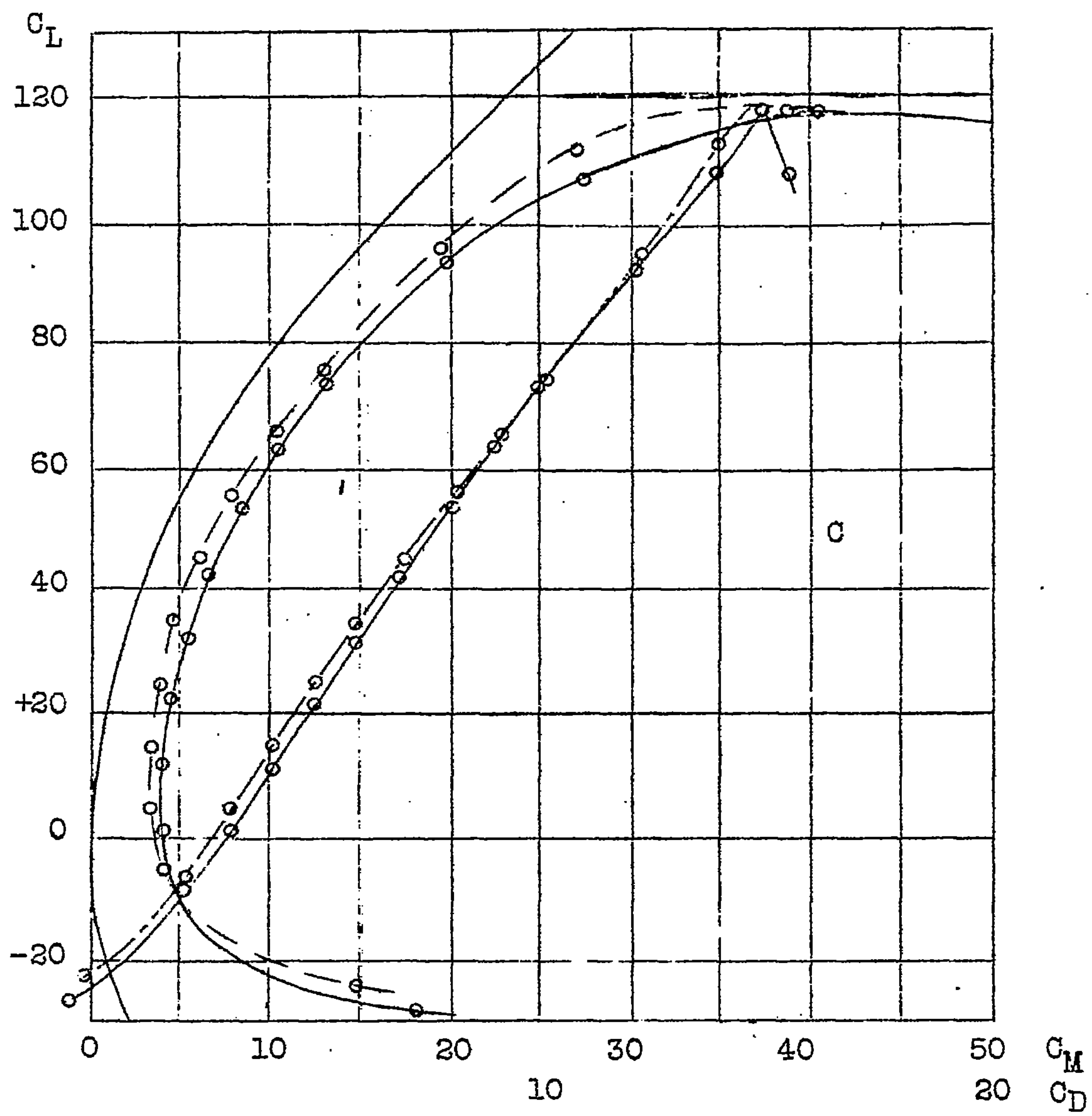

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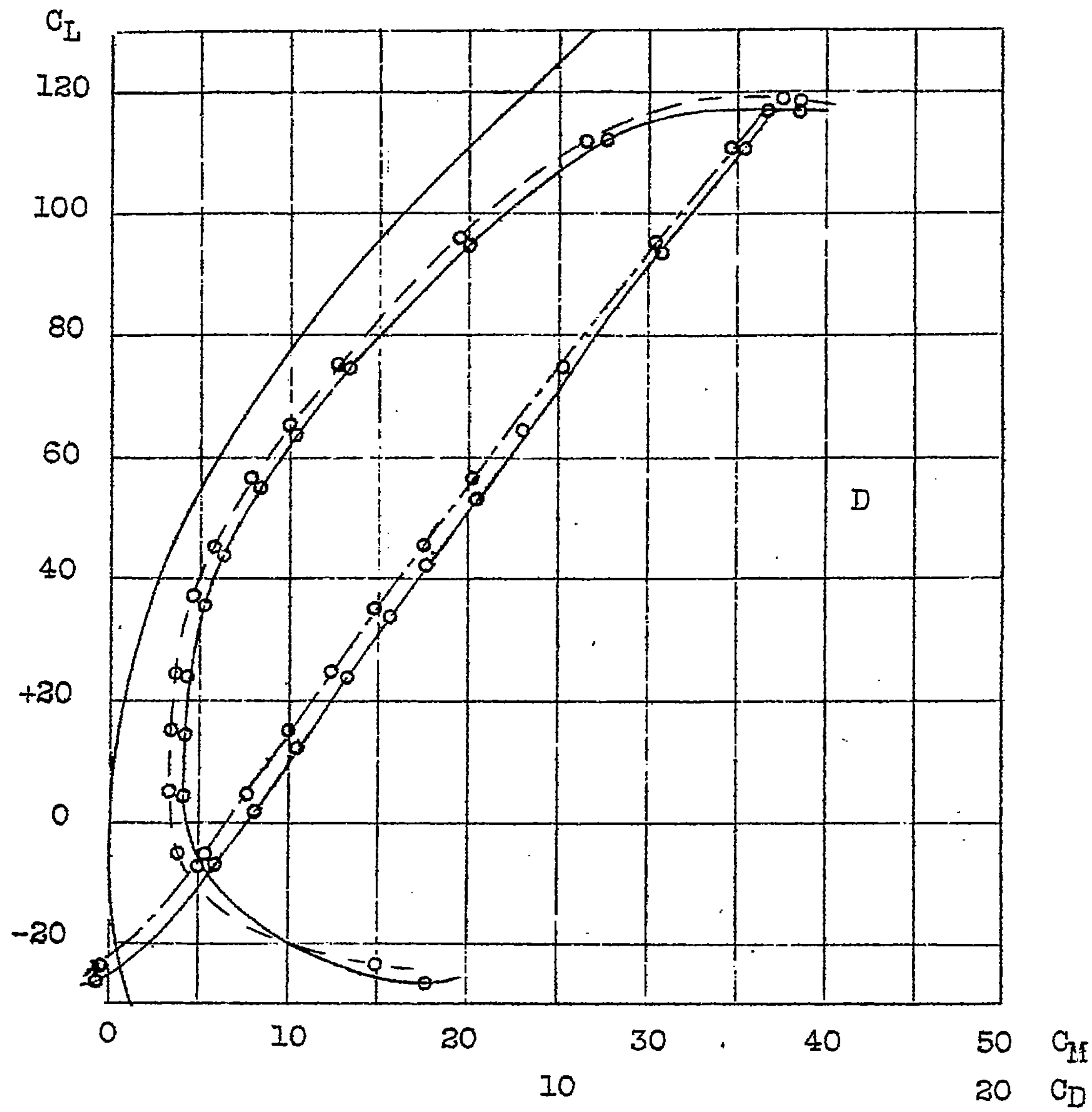

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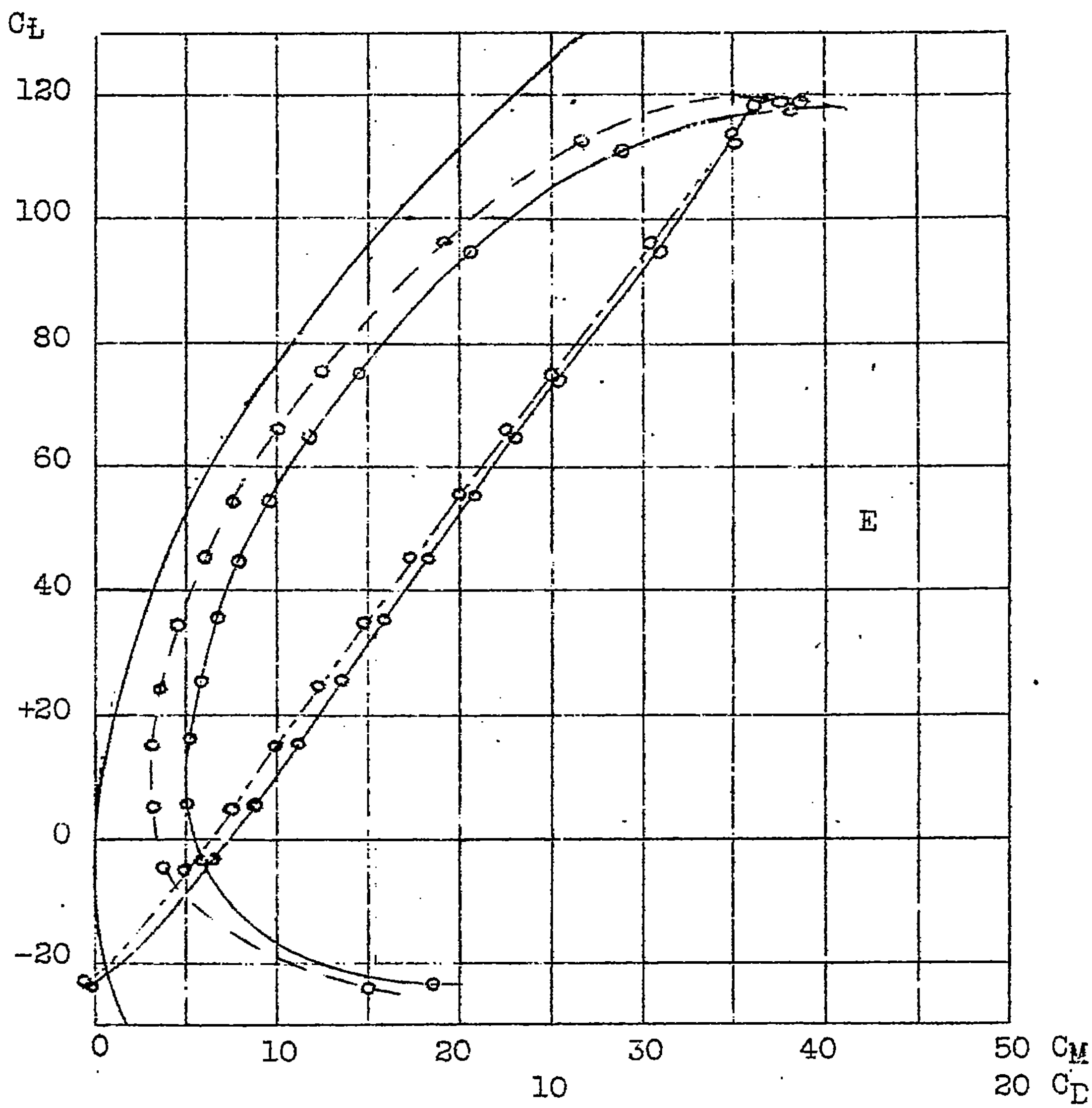

Fig. 6.