TECHNICAL NOTES

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PRESSURE DISTRIBUTION ON WING RIBS OF THE VE-7 AND TS AIRPLANES IN FLIGHT

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Summary

This paper is the first of a series of notes, each of which presents the complete results of pressure distribution tests made by the National Advisory Committee for Aeronautics, on single-wing ribs of the VE-7 and TS airplanes for a particular condition of flight. The level flight results are presented here in the form of curves and show the comparison between the pressure distribution over a representative thin wing, R.A.F.-15, and a moderately thick wing, U.S.A.-27, throughout the range of angle of attack.

Introduction

This paper is the first of a series of notes, each of which presents the complete results of pressure distribution measurements on single ribs of both the VE-7 (R.A.F.-15 airfoil) and TS (U.S.A.-27 airfoil) airplanes for a particular maneuver or condition of flight. These results have been partially presented in Technical Report No. 257 (Reference 1), in which special attention was given to high and low angle of attack conditions.

Because of the amount of data involved it was not possible in Report No. 357 to include all the information obtained in the tests. Since it is believed that the complete pressure distribution for other maneuvers than those where the maximum loads were experienced are of interest and value, this series of notes is being issued. The methods of testing, the apparatus, and a discussion of the accuracy of the results are given in N.A.C.A. Technical Report No. 257.

The locations of the points at which the pressures were measured are shown in Figures 1 and 2. It should be pointed out here that too close an application of the results should be avoided since only a single rib in the span of each wing was investigated. The rib chosen in each case was located outside of the slip stream and inside of the aileron to avoid disturbances as much as possible. The pressures on the wing ribs in the slip stream are probably of a greater magnitude and a different distribution than those at the rib investigated, and those in the outer region of the wing , also, differ in magnitude and distribution because of the wing tip and aileron effects. Thus, their use for estimating the loading over a complete airplane will give only approximate results.

Discussion of Results

The results are given in curve form in Figures 3a-6.

It may be mentioned here that the peculiar pressure distri-

bution gave rise to the discovery that the wing profiles were not evenly faired at the ribs investigated on the TS airplane. The presence of a bulge on the lower surface and a slight depression on the upper surface of both upper and lower wings a few inches aft of the leading edge where the fourth pressure points were located indicate that the low pressures there encountered, while true enough for these ribs, are not likely to be encountered in the general case. At the same time, it was noticed that in wind tunnel pressure distribution data, where a large number of points were investigated over a single rib, low pressures existed at approximately the same location as found in these tests. These low pressures are very local in character, however, and are believed to be due to critical points in the air flow over the surface. In the flight tests herein described, it is probable that the critical flow and uneven surface combine to produce unusually low pressures at the points mentioned.

As a result of these low pressures near the leading edge on the TS airplane, the center of pressure travel is quite erratic, and an attempted comparison with wind tunnel results showed nothing but a number of points scattered in the vicinity of the wind tunnel curve (Figure 4). The center of pressure curve for the upper wing of the VE-7 airplane is fairly good (Figure 6), and the travel is of the same magnitude as indicated by monoplane wind tunnel tests, but for any given angle of attack the center of pressure is about 2½% farther forward on the full-

scale airfoil. This is in accordance with the results found in a wind tunnel investigation of a biplane cellule with the same airfoil section and approximately the same gap/chord ratio and stagger (Reference 2).

Conclusions

It is concluded from these results that:

(1) The pressure distribution over the wing of a full-scale airplane may vary widely from the distribution over a model airfoil in the wind tunnel because of the irregularities in the surface of the full-scale wing.

(2) The pressure curves are similar for thin wings and thick wings at high angles of attack, but at the lower angles the curves for the thick wing are characterized by a considerable down load on the leading edge.

References

1. Crowley, Jr., J. W. : Pressure Distribution Over a Wing and Tail Rib of a VE-7 and of a TS Airplane in Flight. N.A.C.A. Technical Report No. 257 (1927).

2. Munk, Max M. : The Air Forces on a Systematic Series of Biplane and Triplane Cellule Models. N.A.C.A. Technical Report No. 256.

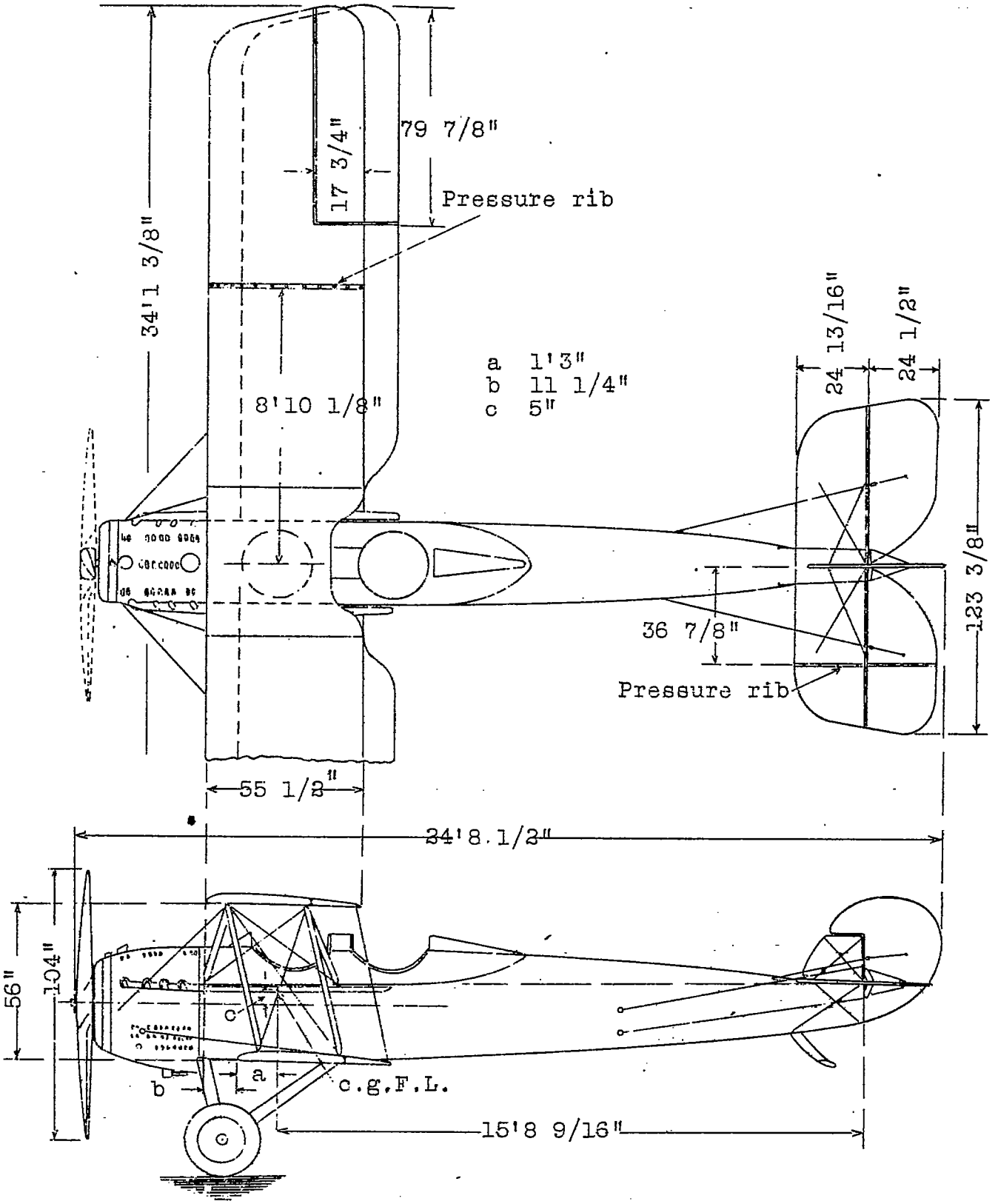


Fig.1 VE-7 airplane, showimg location of false ribs.

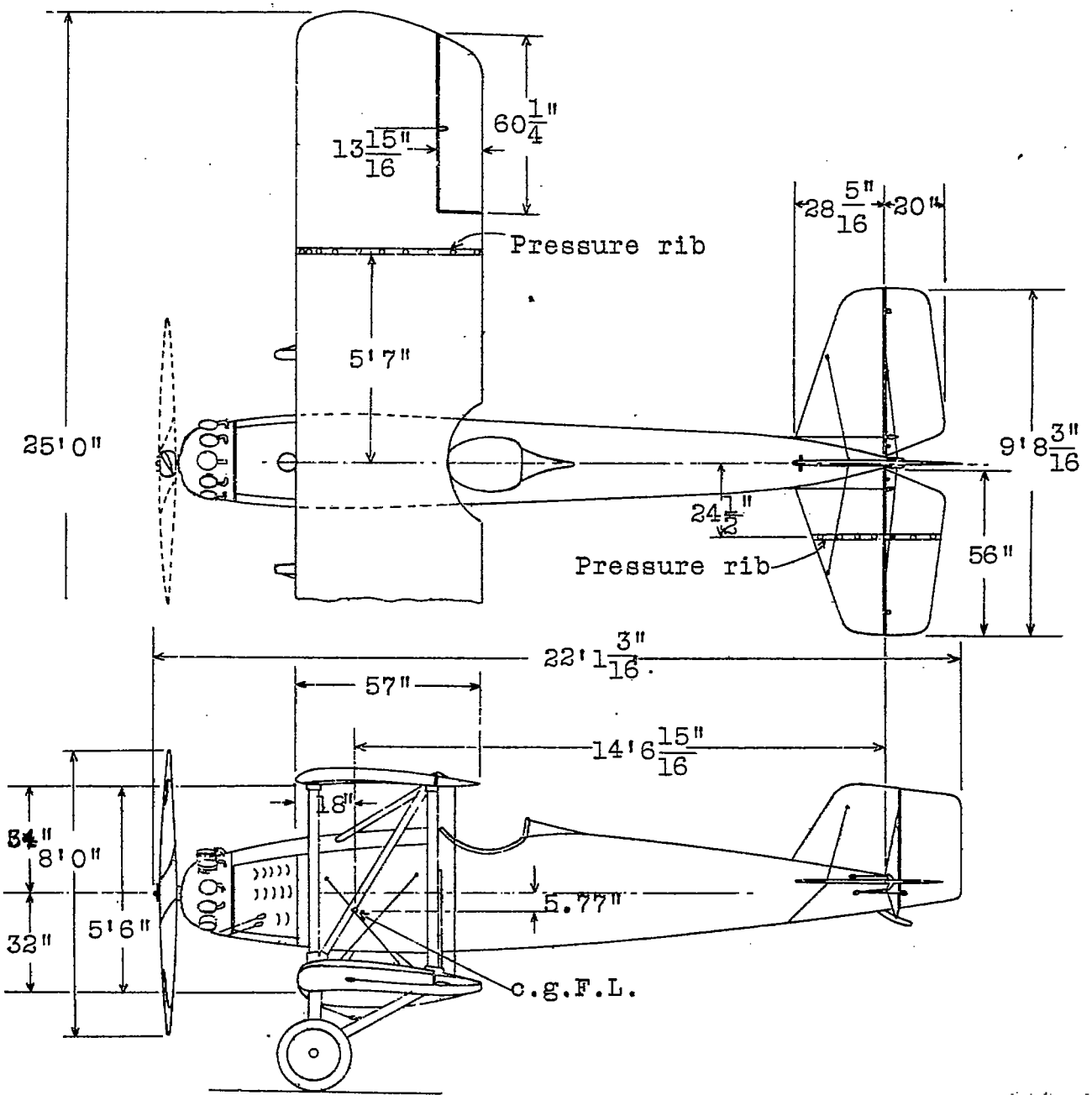
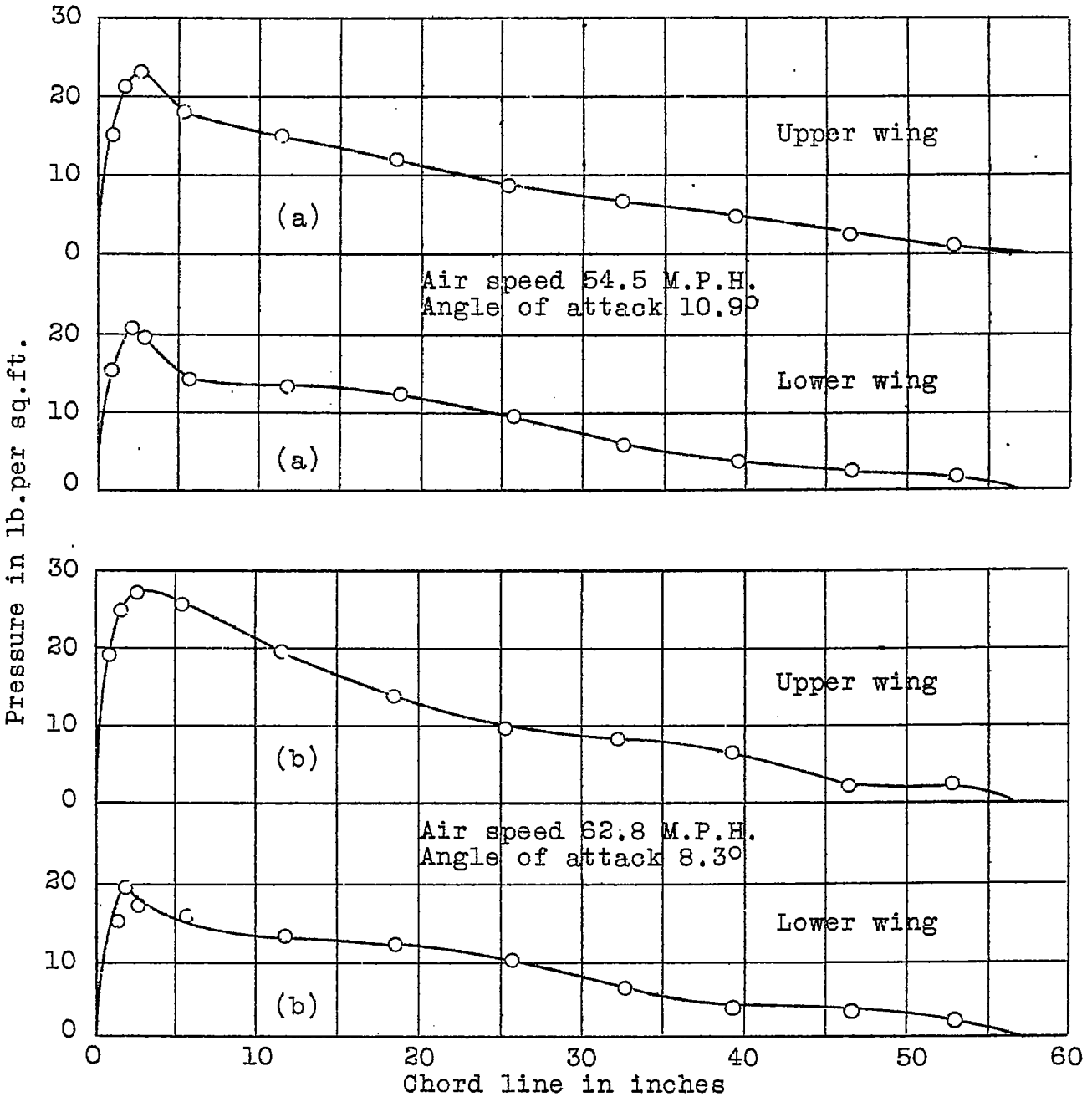
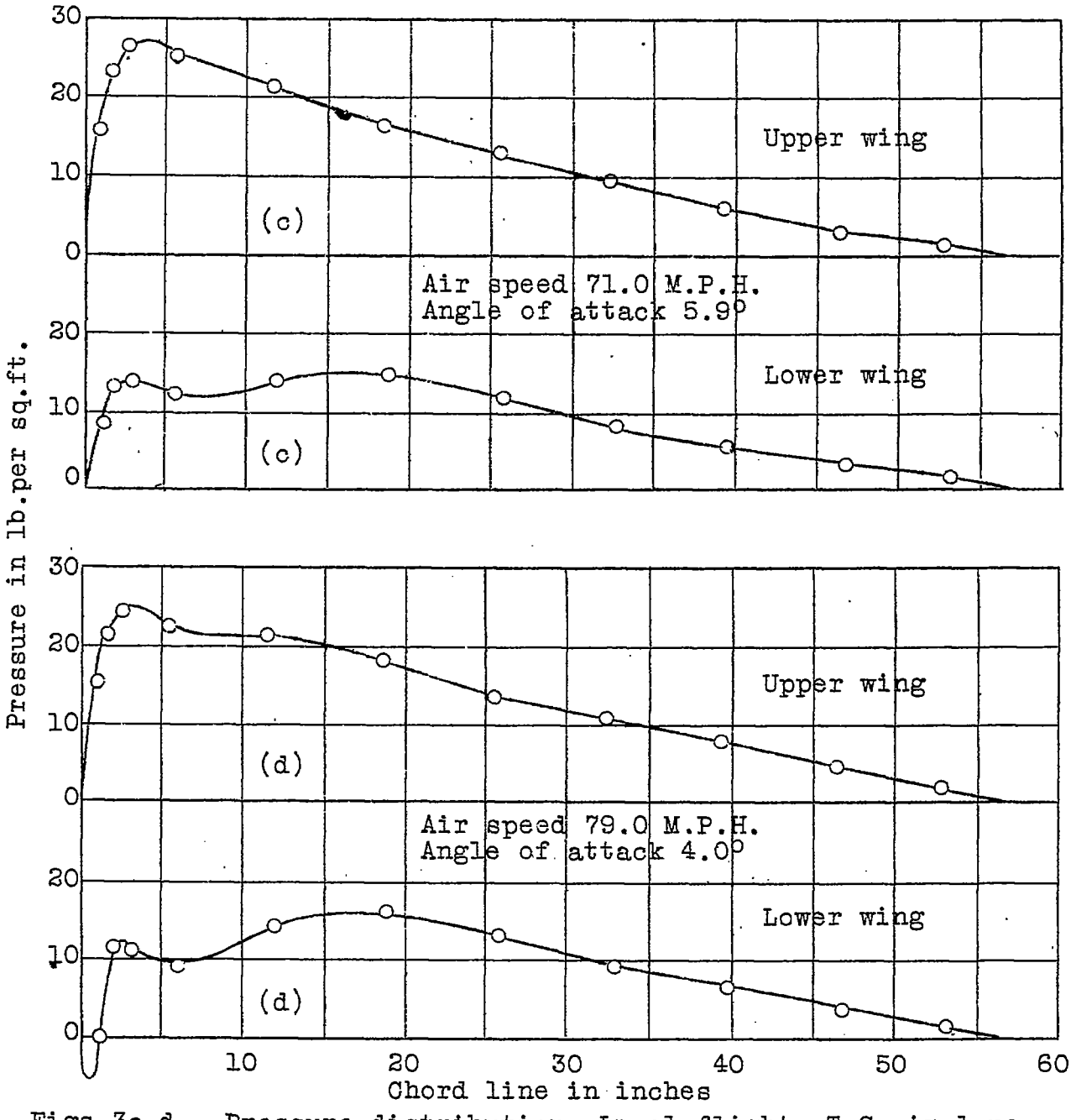


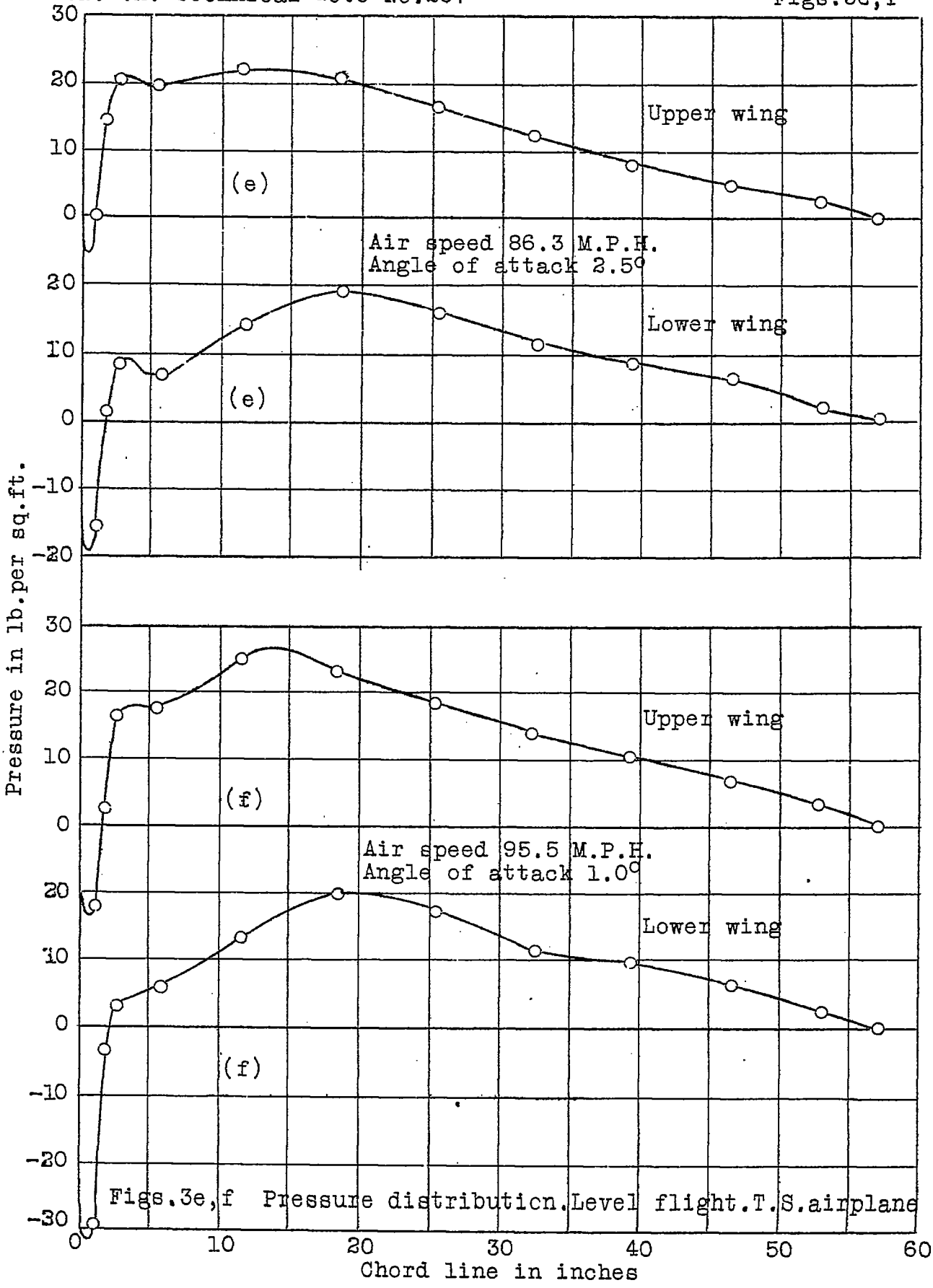
Fig.2 T.S. airplane, showing location of false ribs.



Figs.3a,b Pressure distribution. Level flight. T.S.airplane.



Figs.3c,d Pressure distribution. Level flight. T.S.airplane.



Figs.3e,f Pressure distributicn.Level flight.T.S.airplane

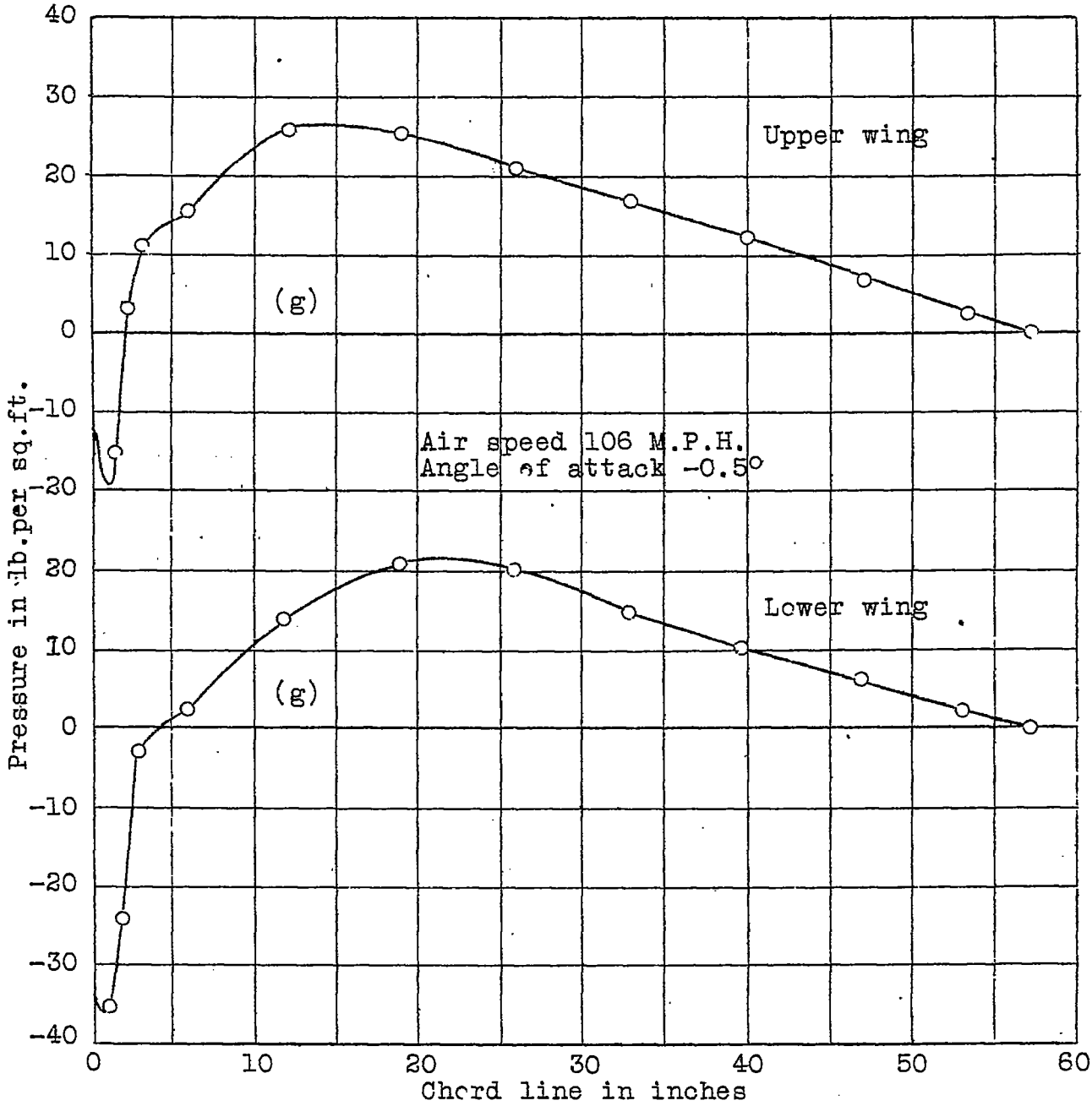


Fig.3g Pressure distribution. Level flight. T.S. airplane.

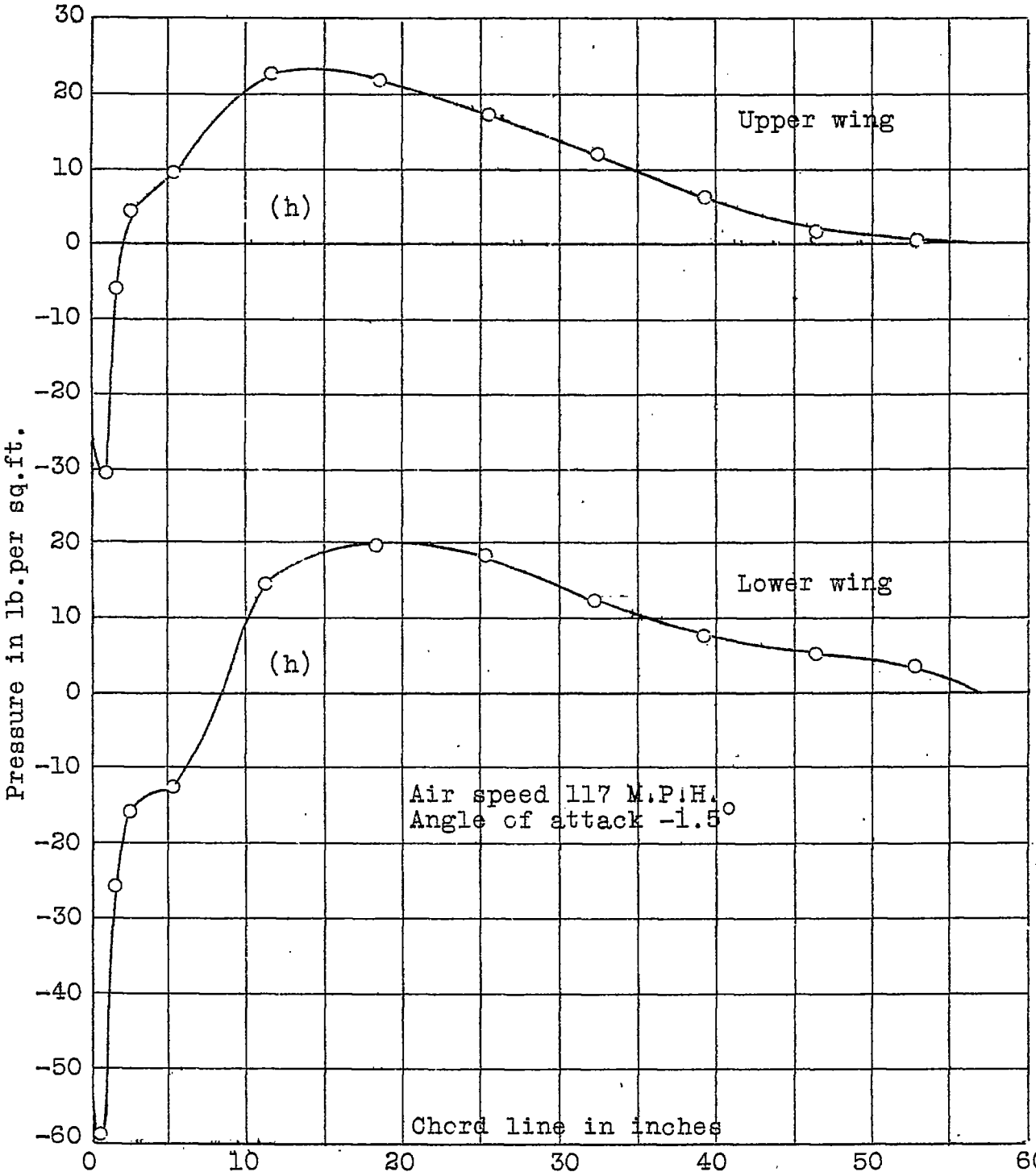


Fig.3h Pressure distribution. Level flight.T.S.airplane.

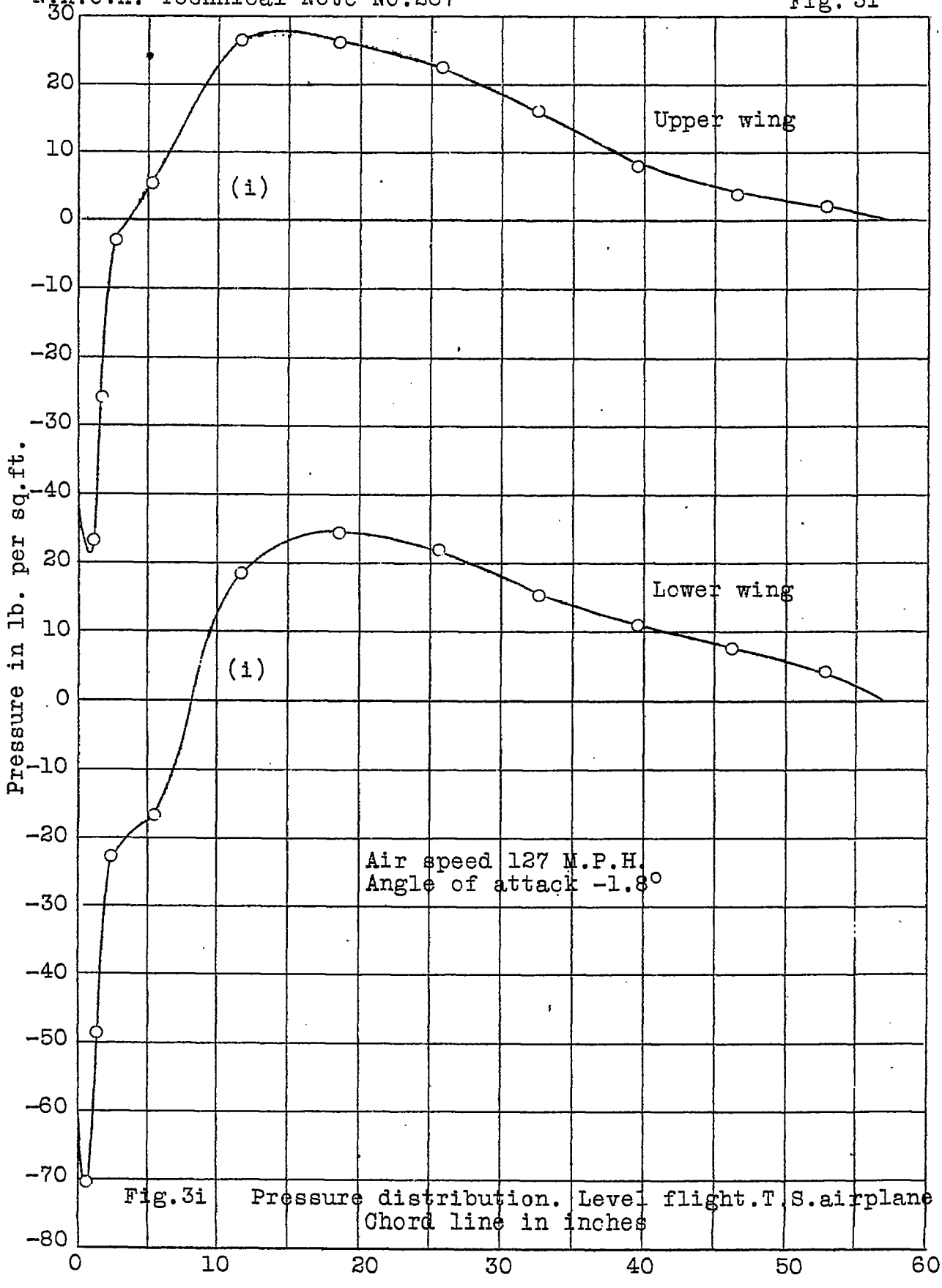


Fig.3i Pressure distribution. Level flight. T.S.airplane
Chord line in inches

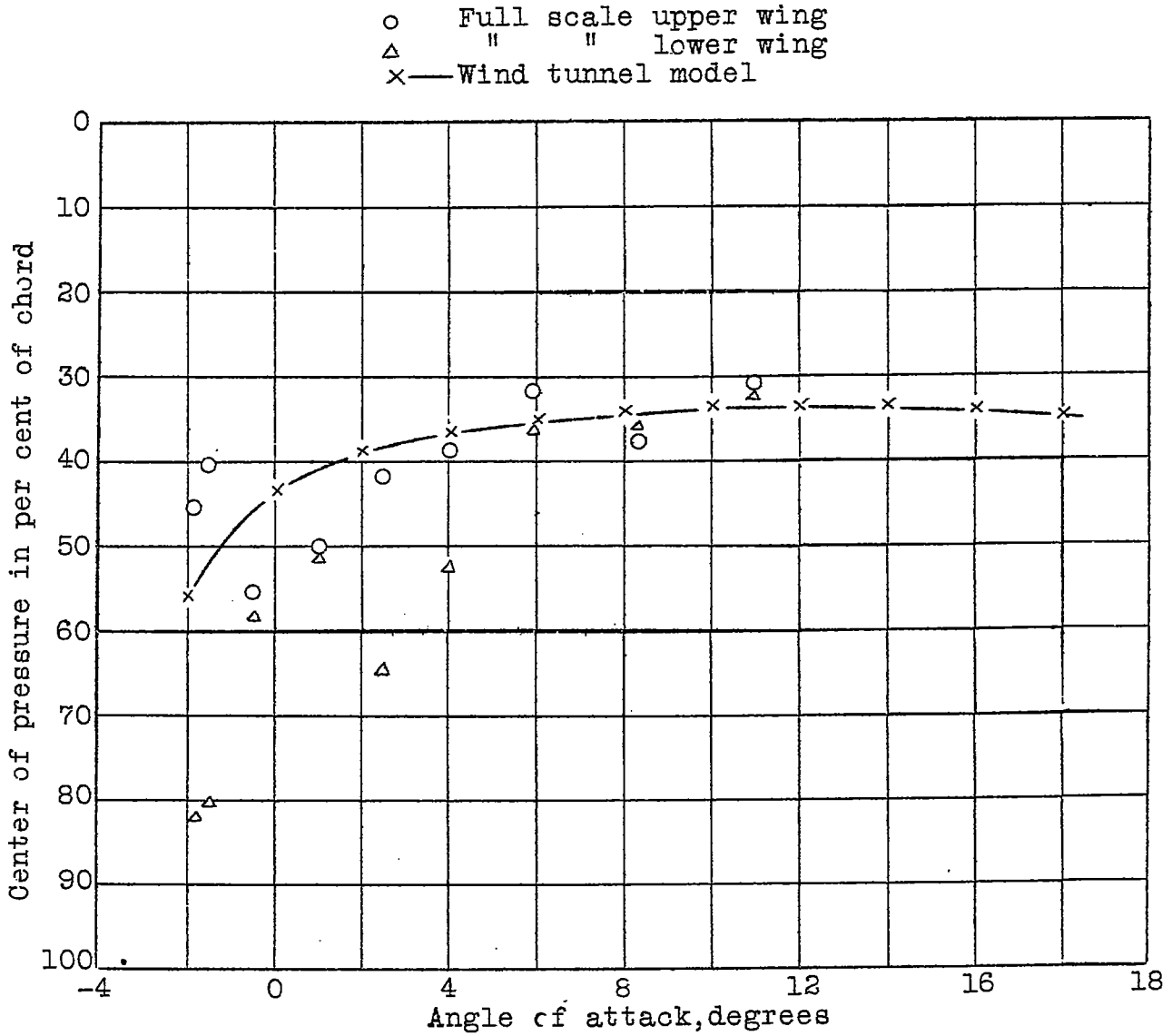
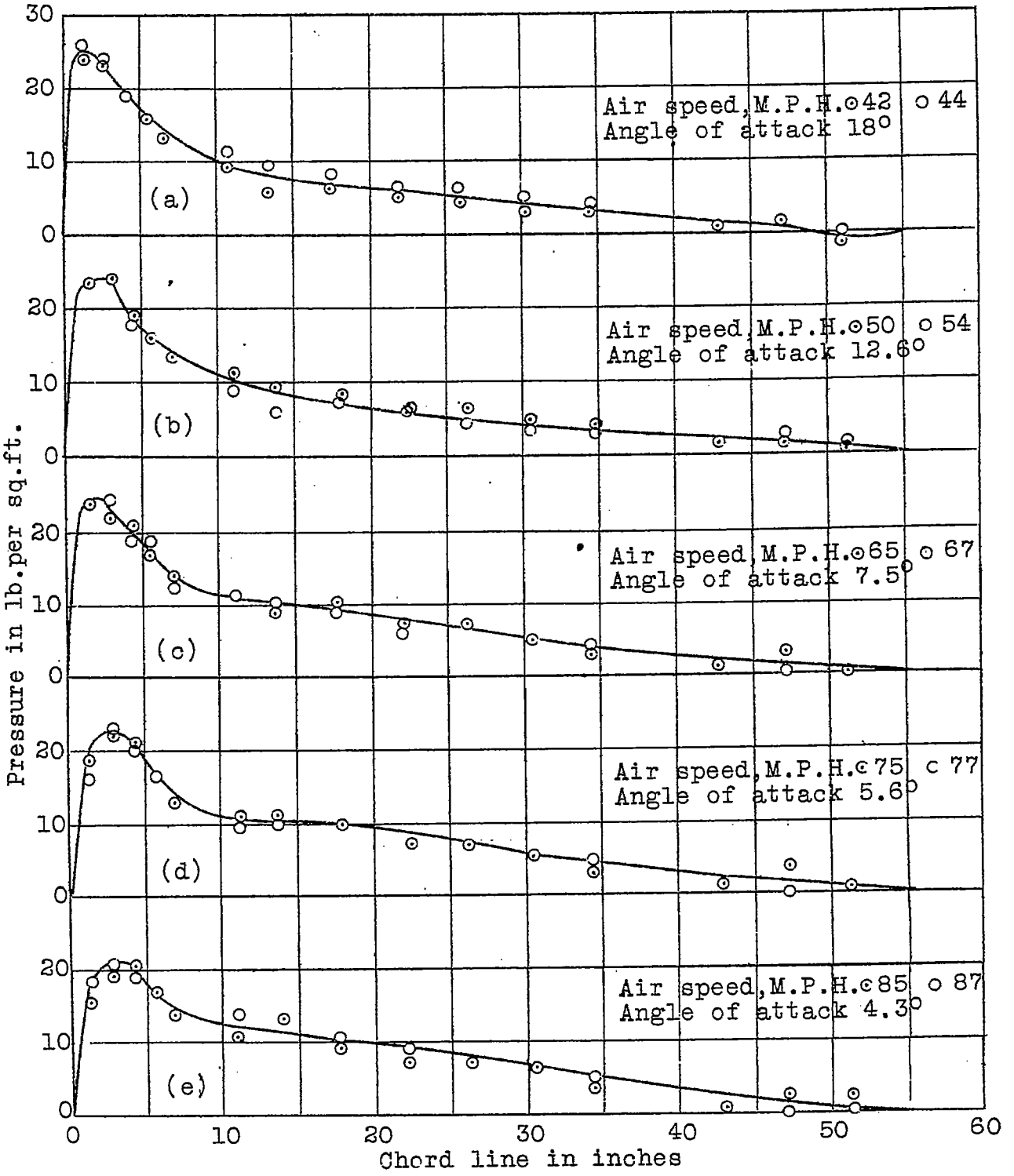
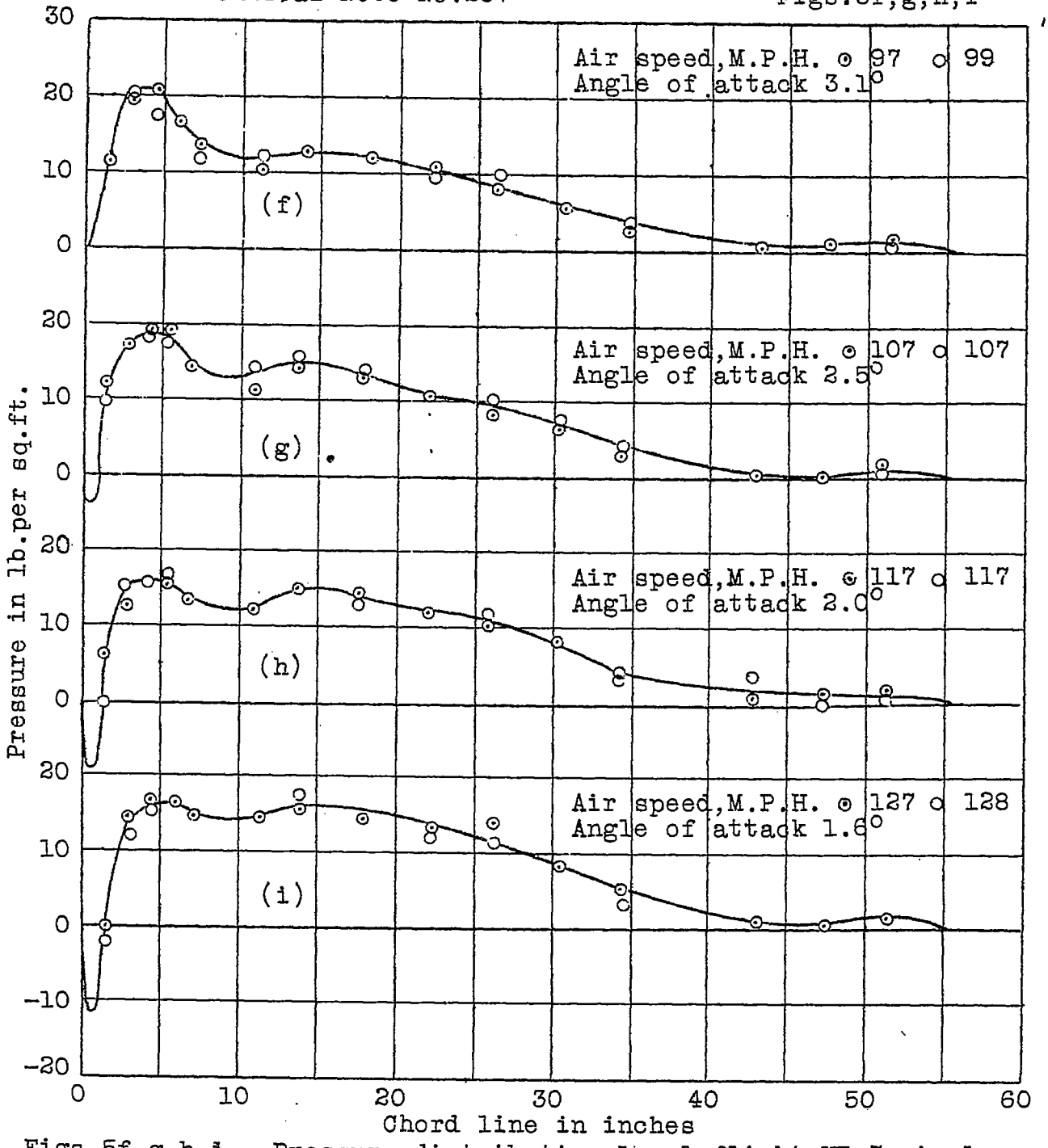


Fig.4 Comparison of C.P. travel on full scale U.S.A.-27 airfoil with C.P. travel on wind tunnel model.



Figs.5a,b,c,d,e. Pressure distribution. Level flight. VE-7 airplane.



Figs.5f,g,h,i Pressure distribution.Level flight.VE-7 airplane.

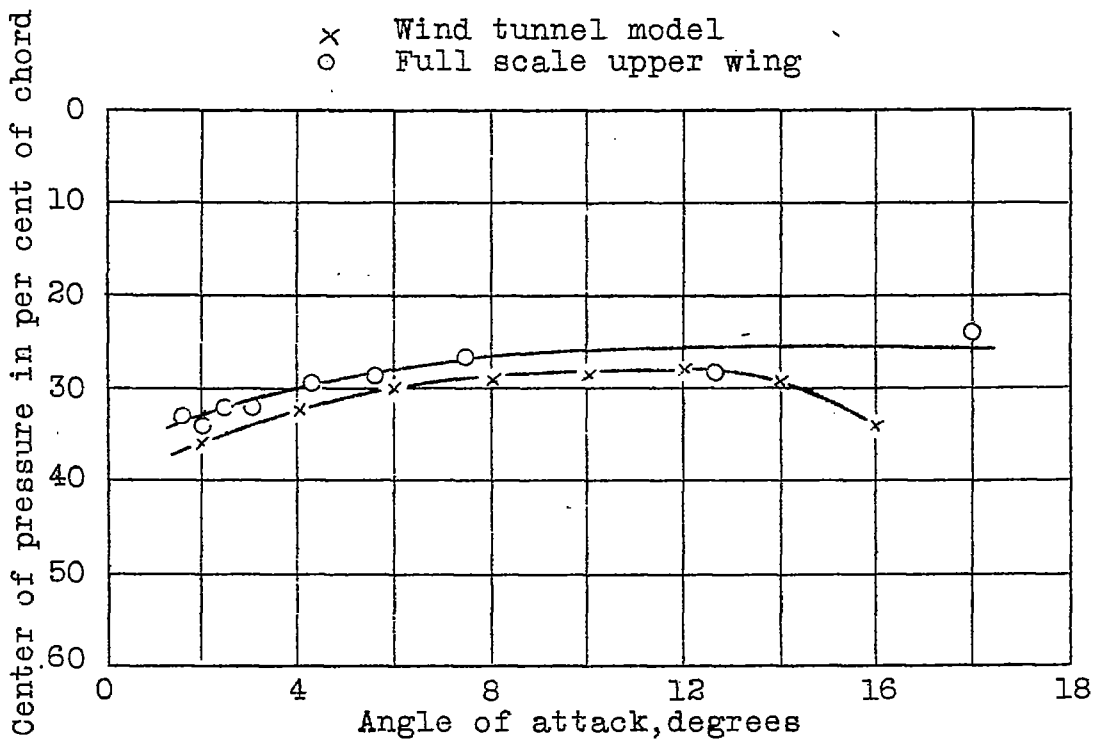


Fig.6 Comparison of C.P. travel on full scale R.A.F.15 airfoil with C.P. travel on wind tunnel model.