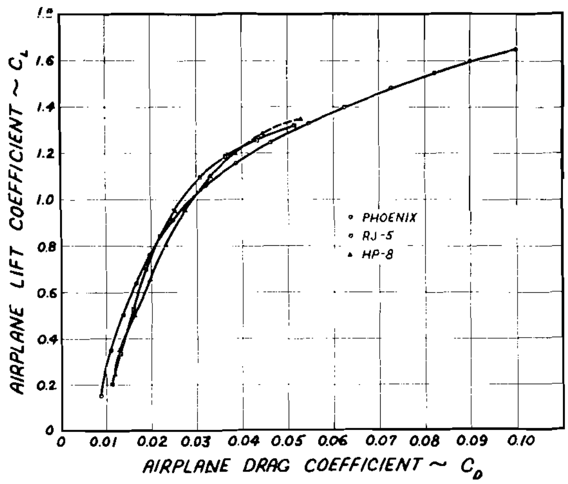

Fig. 3. Drag polar of Phoenix, RJ-5 and HP-8.

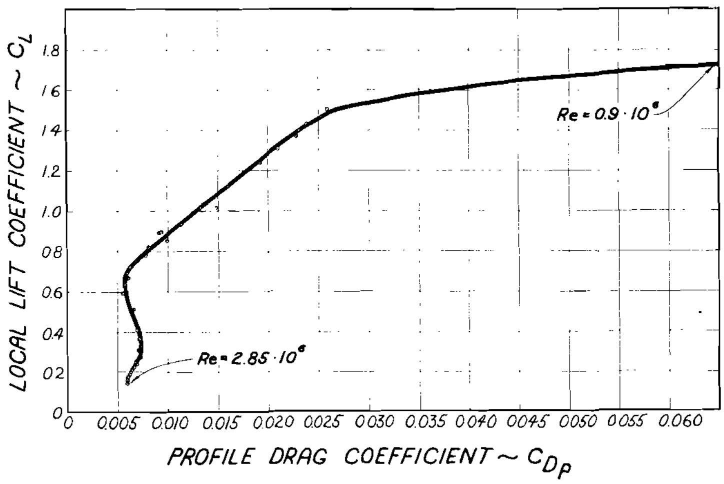

Fig. 4. Phoenix Profile drag polar, Eppler airfoil.

tion when it left Mississippi State University in April. However, that aspect will be discussed by Marshall Claybourn (ref. 5).

In order to separate the effects of wing loading one can look at the sailplane polars plotted in fig. 3. It can be seen that actual data was taken at $C_L = 1.65$ on the Phoenix. This is within the incremental $C_L = 0.1$ of the maximum lift coefficient measured. The remarkable handling characteristics mentioned (ref. 3) before can be appreciated from this ability to make measurements made so close to the stall.

In general it is quite evident that over a large portion of the flight regime Phoenix stands out ahead of RJ-5 and HP-8. While the difference does not appear large, the effect in cruising performance, nonetheless, is quite striking. This feature will be elaborated in succeeding discussion.

Properties of Eppler Airfoils on Phoenix

The basic concept under which Dr. Eppler developed his airfoils is based on pure boundary layer theory. His aim was to design the airfoils in such a way that for a given Reynolds number the behavior of the airfoils could be exactly predicted from prescribed separation and transition criteria.

In windtunnel tests made at Gottingen (ref. 6) the double bucket feature was not found. However, in fig. 4 it is quite clear that Eppler's analytic airfoil design technique is valid for two distinct, though not sharply defined, minima in drag are apparent.

The local lift coefficient is seen to reach a peak vaule, 1.72. This value agrees quite closely with the maximum airplane lift coefficient of 1.75.

Interestingly the profile drag rises rather slowly to $C_L = 1.5$ and then due to turbulent separation a steep drag rise occurs. Perhaps with a very small amount of suction behind 80% chord this separation could be delayed thus yielding a high lift at relatively low drag. The minimum sinking speed, especially in circling flight, would be correspondingly reduced.

The boundary layer development on the Eppler airfoil is illustrated graphically in fig 5. A careful study of this development reveals the essential features of Eppler's concept for airfoil design.

For the very low speeds at $C_L = 1.66$ the top surface flow is turbulent from 4% to 80% chord where the flow separates. The bottom surface is laminar to 68% where transition takes place. The separated area on the upper surface might easily be controlled with very little boundary layer suction.

At minimum sink an average of 62% of the airfoil is laminar with no separation evident. But at best glide ratio the extent of laminar flow reaches a value of 72% of the wetted area.

Oddly at $C_L = 0.48$ there appears a region of laminar separation at 78% chord which persists to $C_L = 0.16$. In addition a region of turbulent separation becomes evident at $C_L = 0.16$ in the undercambered rear bottom surface.

From these data on the boundary

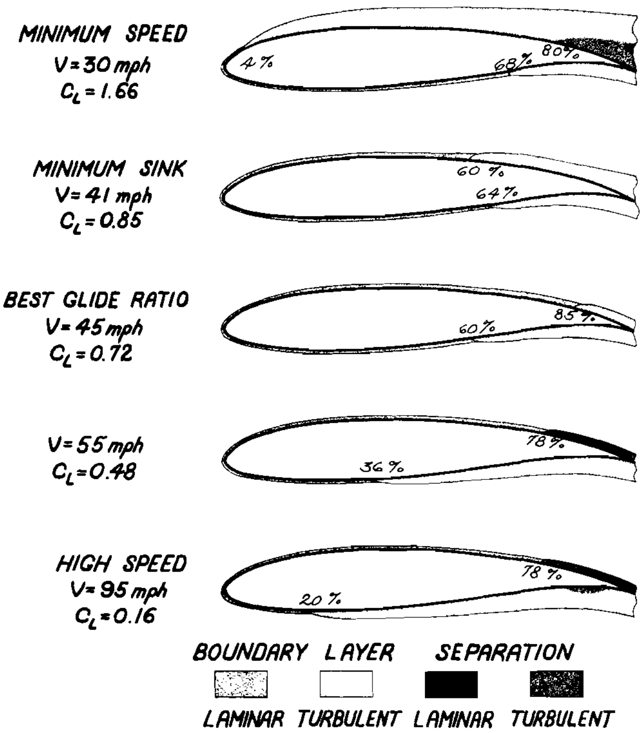

Fig. 5. Boundary layer development on Eppler airfoil.