and not one of the gliders suffered damage to such an extent that it became a complete loss." A pilot possesses a definite advantage over a contrary aircraft if that aircraft's kinetic energy is low (low speed and small weight) and if the natural periods of unstable oscillations are long. Under these conditions he can outwit the aircraft.

One cannot over-emphasize the advantages of a low weight, low speed motorless prototype over a powered prototype. The low speed results in low energy content on landing as well as a long period for any oscillation since most aerodynamic oscillations are a linear function of airspeed. These long oscillations are easily controlled by the pilot. In addition the motorless craft has no interference from the gyroscopic effect of the engine or from the slipstream. When it is desired to explore a large family of configurations, the economy of building simple gliders of wood should be an important consideration for a researcher wishing nearly full-scale effects. At the same time the various configurations may be used as structural prototypes to learn the relative loadings of the various structures and their ability to carry these loadings.

Interference Studies.

The interference of the flow around a fueslage with that of a lifting wing attached to the fueslage is a fundamental problem of fine aerodynamics. When the configuration is a mid-wing or low-wing all of the elegant computations for the airfoil shape are useless unless one can include the decelerating effect on the airflow of the sides of the fuselage. Such a computation was made on an outstanding German sailplane design in 1934 by Dr. A. M. Lippisch, one of the fathers of the world soaring movement. In

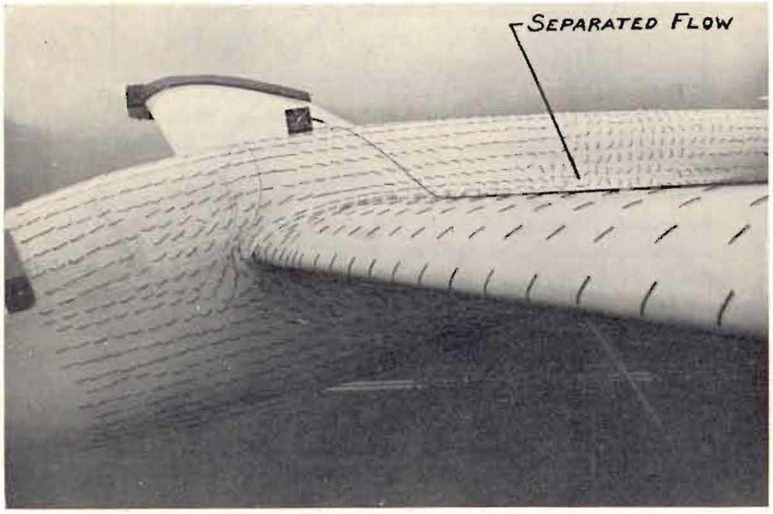

Fig. 2

Figure 2 is shown a tuft study of the flow in the wing root of another German high performance sailplane taken in flight. This examination shows the flow separating toward the trailing edge of the wing. Suitable modifications to the root could have been made with cardboard and scotch tape and the test repeated. However, recently as a result of careful flight tests in the U.S.A. with existing mid-wing designs a general approach to this problem has been developed. This approach is based on a concept of volume expansion of the airflow in the wing-root. By suitable filleting, or by modifying the after portion of the fuselage this volume expansion may be minimized.

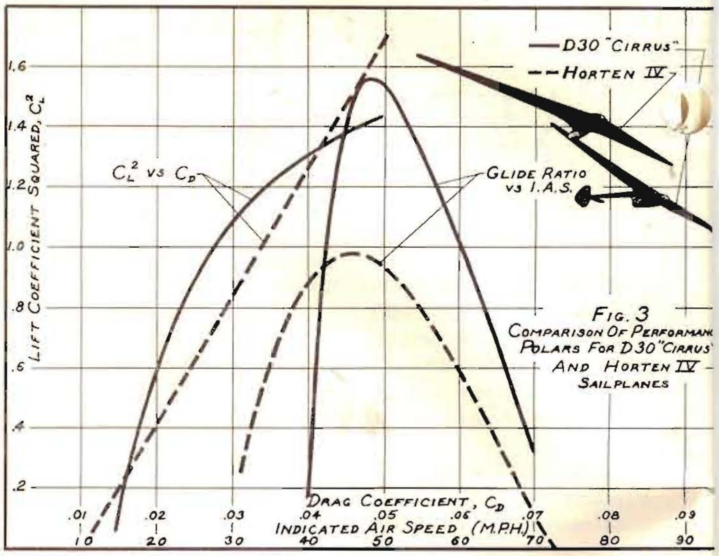

FIG. 3 COMPARISON OF PERFORMANCE POLARS FOR D30 "CIRRUS" AND HORTEN IV SAILPLANES

In fact, some designs have been modified in such a way as to pressurize the wing root thereby achieving pressure gradient favorable to resisting separation of the airflow.

A sailplane also lends itself quite well to the study of span-wise lift distribution and how it is affected by interference, plan form, twist and sweep. In Fig. 3 are shown two drag polars obtained from a comparison flight of two revolutionary German designs, the Cirrus D-30 of Darmstadt Institute of Technology and the Horten IV tailless prone piloted sailplane. The D-30 on which the comparison was based had an aspect ratio of 33.6 and had a measured glide ratio of 37.6. The Horten IV on the other hand had a minimum drag coefficient of 0.01, the lowest ever measured for any sailplane. (The ME 163 rocket interceptor airplane of Lippisch also had as low a drag.)

Wing Tip Research

In the early days of aviation, experimenters placed considerable emphasis on wing tip design. Perhaps they realized the influence of a performance and stability the three dimensional flow around a tip but certainly they were not able to measure the effects in full scale flight. Attempts to study space flows around tips in small turbulent tunnels were made later but no recent studies in low turbulence tunnels are known. Some work in Germany during the war showed an improvement of as much as 11% of a specially designed tip over a conventional rounded one. It should be realized that tunnel wall interference is difficult to remove from the measured results when there are changes taking place in the tip flow. For this reason full scale flight tests offer the most reliable results. In Figure 4 is shown the influence of slotted wing tip and pointed wing tip taken from comparison measurements made by tracking the bird with a calibrated sailplane.

Boundary Layer Research.

The recent great strides made in the understanding of the viscous flow in the boundary layer is to a large measure due to the experimental confirmation of the stability theory in low turbulence tunnels. Laminar airfoils could not have been developed without this valuable tool. Since transition from laminar to turbulent flow is initiated by turbulence in the free stream the importance of reducing the degree of turbulence in the testing environment is evident. How-