the relative state of the development of the various sailplanes. HP-8 was not included in any of these comparisons because the performance data was not that of the final configuration.

It can be seen that the Phoenix possesses a skin friction drag coefficient below that of a turbulent flat plate flow. While Tiny Mite is almost as good in this respect it must be remembered that the airfoil on Tiny Mite RAF 34 was incapable of developing high lift coefficients such as those of Phoenix. In other words, the speed range of Phoenix far surpassed Tiny Mite, which is evident from these curves.

Soaring Characteristics

Most of the previous discussion was concerned with the performance measured in straight gliding flight. However, the aspect of soaring which is most important is that of gaining energy from the atmosphere. This involves circling in thermals for a large percentage of the flight time. Special cases of wave soaring for distance flying or ridge soaring are not the normal food for soaring pilots.

For making the transformation from straight flight performance to circling performance one has two means:

1. The nomographic method Hakinnen (ref. 7).
2. The analytic approach (ref. 8).

For this paper Eppler's analytic approach was used. The optimum circling polars at the bottom of fig. 10a were computed for the three sailplanes. Phoenix is outstanding over the entire circling domain.

When the sinking speed in the circling mode is added algebraically to

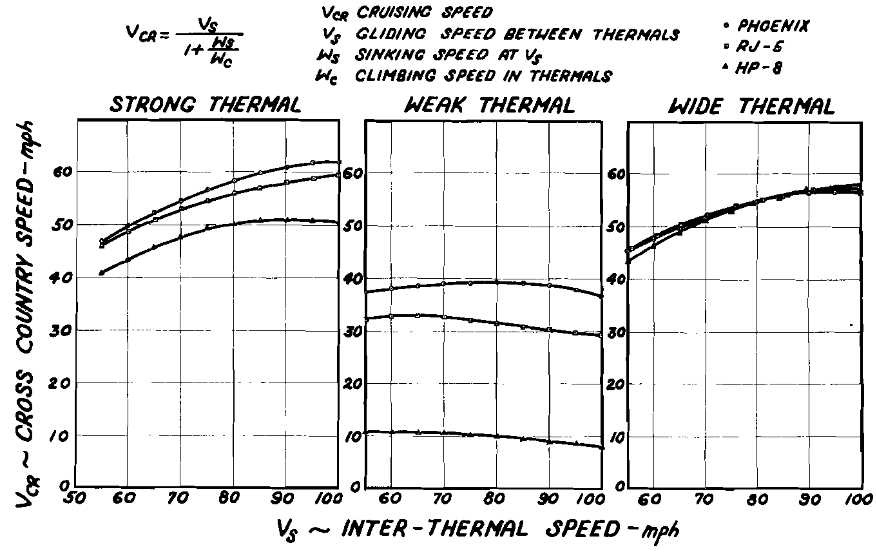

Fig. 11. Comparison of cruising characteristics of Phoenix, RJ-5 and HP-8.

the strength of the three principal thermal models as defined by Carmichael (ref. 9) we obtain the climbing velocities shown in the upper portion of Figures 10a, 10b and 10c. Only in the wide thermals do the heavier sailplanes, RJ-5 and HP-8, approach the climbing ability of Phoenix.

But the climbing ability represents only one phase of cross-country soaring, viz., the energy extraction. The other phase, cruising between thermals, is equally important in either contest flying or record distance flying. By combining the circling phase with the cruising we can obtain the cross-country speed for the three representative thermals, fig. 11. Phoenix is seen to excell in strong thermals and particularly in weak thermals. However, in wide thermals the three sailplanes are about equal in cross-country performance; with RJ-5 slightly ahead at very high inter-thermal speeds.

Conclusions

This study illustrates quite clearly that the philosophy of drag reduction first initiated on RJ-5 still offers a powerful means for improving the cross-country sailplane soaring in thermals.

We must include in parametric studies the skin friction coefficient which we now know to be attainable. Upon completion of a design we must strive to reduce the skin friction drag coefficient so that we may profit by improving the state of the art. Furthermore the concept of very low drag with low wing loading needs to be exploited in sailplane designs for contest work where one poor flight can lose the contest.

This study clearly shows that a drag coefficient for the sailplane does not yield a true picture of the design problem for cross-country thermal soaring sailplanes. The con-

Fig. 10a (left). Thermal soaring characteristics, weak thermal.
Fig. 10b (center). Thermal soaring characteristics, wide thermal.
Fig. 10c (right). Thermal soaring characteristics, strong thermal.