AIRFOILS

By R. D. HISCOCKS

It is a pleasure to present another of Dick Hiscocks' papers. His thorough treatment of Glider Towing in the November-December, 1947, SOARING will be recalled. In the present paper, the history of sailplane airfoils is treated in a similarly thorough manner. A series of papers on sailplane airfoils taking up the aerodynamic features has been promised.

It is unfortunate that early wind tunnel results were taken in turbulent flow, so that these results are useless in selecting an airfoil. Perhaps this history will become all the more interesting when the reliable low turbulence results are obtained.—Tech. Ed.

IN the design of a high performance sailplane no liberties with the requirements of good aerodynamics are permissible. Careful judgment is accordingly necessary in the choice of a suitable wing section. Much can be learned from theory, but in the final analysis we must rely largely on experience. It is useful therefore, to examine some of the profiles which have been used in the past with varying degrees of success.

Early experimenters, such as Lilienthal who pioneered with the hang glider, were not handicapped by an overwhelming quantity of scientific information. For their aerodynamic data they were forced to rely mainly on the only acknowledged authorities of their day,—the birds. As a result in the contraptions which were the undoing of many a pilot prior to 1920 the wing section most commonly used closely resembled that of the Goose (Fig. 1).

At the high lift coefficients essential to low speed flight the Goose section displays a commendably low drag and it accordingly has much to recommend it for aircraft flying at leisurely speeds. It is also docile at high angles of attack approaching the stall. The main shortcomings are structural; there is no depth of section to provide room for wing spars, and the high camber produces large pitching moment forces which tend to twist the wing and also load the tailplane. For any practical structure a biplane arrangement seems to be essential. The bird presumably is blissfully ignorant of current strength regulations.

A thicker section than that of the Goose is required for wings with the large spans necessary for a good soaring performance. Nature has again provided a suggestion in the profile of the Albatross (Fig. 2), whose soaring abilities are legendary. This section has been widely imitated, a typical example is the Go 482 (Fig 3).

The product of a highly profound mathematical operation, the Go 482 was probably adopted by Madelung, mainly because of its resemblance to the Albatross, for the classic "Vampire" sailplane. It was this machine which demonstrated to a skeptical world in 1921 that soaring was possible.

During the active period which followed, "mathematical" sections were adopted generally in Europe, notably the "Go" series which was developed by elegant mathematical operations which yielded the shape of the streamlines and the pressure pattern about a section on the assumption that air friction effects could be ignored. This simplified theory is of restricted use because many of the most interesting properties of a section such as profile drag, maximum lift and scale effect generally depend directly upon friction forces.

These sections are thus no better than those selected on the basis of practical experience or aesthetic taste but they were preferred because the mathematics insured a harmony of form, convenience of classification and the possibility of tests with shapes which could be varied in a systematic way.

Successor to the Go 482 was the highly successful Go 535 (Fig. 4) which was first used on the "Consul" in 1923 and subsequently adopted for such outstanding machines as the "Darmstadt I." "Sperber, Jr.," "Windspiel" and "Kranich." During this period performances improved from the "Vampire" gliding angle of 1:16 and sinking speed of 2.7 f.p.s. to a gliding angle of 1:28 and a 1.8 f.p.s. sinking speed for the Fafnir II of 1934. Another popular section of this period was the Go 652 (Fig. 5) which one would judge from the shape of the trailing edge found more favor with the aerodynamicist than the builder.

The foregoing marked the end of an era of highly cambered profiles designed to provide a low sinking speed only at low forward speeds. The discovery that the sailplane is not restricted to slope soaring led to the adoption of sections with a low drag at the reasonably high cruising speeds required for cross country flying.

This was achieved mainly by a reduction in camber. An example is the Go 681 (Fig. 6) which was