WARREN-YOUNG ANTI-STALL WING

by G. Woolls England

It was way back in 1933 that Mr. Nórman Hall Warren, an Aerodynamicist friend of mine dreamed up the high lift, stall and spin proof, wing configuration featured on this model. A successful flying model was built at that time, and, in partnership with Mr. Rex Young, patents were granted in 1937 for a passenger carrying aircraft employing the Warren-Young wing.

The outbreak of war in 1939 prevented the construction of the prototype airplane.

Since the war no backing has been forthcoming to finance the full scale example but several small jetex powered models were made and proved very successful.

Although the projected Warren-Young "Skycar" has its pusher prop at the extreme rear, where it does have certain aerodynamic advantages, I preferred to build my version with the propeller between the wing as shown on the drawing, thus combining airscrew protection, minimum undercarriage, and—I think—nice lines.

From the very beginning of test flying the airplane made it plain that it was going to fly and fly well, and after a little experimenting with propeller pitches and gear box ratios fine stable flights soon became regular.

When badly over elevated the resulting stall is quite harmless, being merely an oscillation about a point on the rear wing, and no tendency to drop a wing and spin has ever been noticed.

Warren has written many articles on his wing design and the following extract from the one published in "Flight" of August 10th, 1950 is given in order to give those who have an enquiring nature some idea of the theory behind the layout.

"The gradual stall coupled with maintenance of control will allow the Warren-Young to make landing approaches at maximum lift and therefore at the lowest possible speed in level flight. Moreover, glides and also power-on descents beyond the angle of maximum lift may be a safe flying technique, when the forward speed will be exceptionally low and the aircraft will descend in an almost vertical path.

The relatively high value of C.L. max. derives from the delayed stall, which depends upon the properties of swept wings. A swept-back wing burbles prematurely in the region of the tips, whilst a swept-forward wing has a more delayed stall, which eventually begins near the root. The cause of these effects is as follows. With a swept-back wing the chordwise pressure-pattern is progressively staggered rearward as the tip is approached, which means that, in a spanwise direction, the negative pressure on the upper surface for adjacent chords is greater for the outer chord (except very near to the leading edge) and, therefore, there arises a spanwise pressure-gradient with pressure decreasing towards the tip. This results in an outward drift of the boundary layer which will carry away any stale fluid tending to collect in the inner region of the wing. At the tip, however, there is an inflow due to exchange of pressure from the lower to upper wing surface, and this neutralizes the outward flow, causing fluid to accumulate and resulting in burbling. In addition, sweep-back increases the tip upwash and thus the local angle of attack is increased, aggravating the tendency for an early tip-stall. With a swept-forward wing, on the other hand, by similar reasoning there will be a pressure drop towards the root, resulting in a boundary-layer flow in this direction. But in this case the tip inflow is not opposed to the sweep induced flow; it will increase its energy and thus delay burbling, which will eventually start in, and spread from, the root region. The result is that for the swept-back and swept-forward wing burbling spreads slowly, producing a smooth flat-top lift curve for both wings, but with a higher C.L. Max. for the forward-swept aerofoil.

In the Warren-Young wing, the front swept-back planes are joined via tip surfaces to the rear swept-forward planes and this arrangement will prevent the early tip stall by influencing the boundary flow as follows. The energetic inward flow along the upper surfaces of the rear panes will scour the tip regions and remove stale fluid, which would otherwise give rise to burbling. Also the large relative chord of the tips will cause dilution of the tip upwash and will, therefore, reduce the local C.L. increase induced by the sweep-back. The elimination of the causes of early stalling will result in a linear increase of C.L. being extended to higher angles of attack and thus the attainment of a higher C.L. max., but since not all parts of the wing will be operating at the same effective incidence or will have the same form of chordwise pressure distribution, burbling will not begin simultaneously. Moreover, due to the sweep-induced boundary layer control, the chord-wise spread of the stall will be slow."