The Development of the Ross-Johnson 5 Sailplane

By RICHARD H. JOHNSON

It was in May of 1948 that Harland Ross and I decided the American skies needed a new sailplane. There never had been one in North America which could report a 30-1 glide ratio excepting perhaps the then new French Air-100.

At the onset the design was almost entirely that of Ross. We agreed on the general layout and I commissioned him to do the construction. I might mention that the new laminar airfoil was brought to our attention by Dick Lyon, a Hughes Aircraft engineer, and we are eternally indebted to him for the fine choice. Also Stan Hall and some of his associates at Northrup undertook the tedious stress analysis and spanwise lift distribution calculations.

Work was under way soon at Bishop, California and in the meantime I decided to join Dr. Raspet at Mississippi State College and assist him with the sailplane project of the Engineering Research Station while attending the Engineering School there .At his suggestion I brought my ailing sailplane "Tiny Mite" to flight test. It was from these tests that we gained a great deal of information that was going to help us with RJ-5 and also gave me a deep appreciation for accurate flight testing and analysis for which Dr. Raspet is well known.

Harland worked hard but found the construction of the metal wings was more difficult than he had expected. By the winter of '49-50 he had the spars and leading edges completed, a start on the flaps and ailerons, and the monocoque fuselage shell well along. He had spent 2200 hours on the construction. It was then that we agreed that I should undertake to complete the craft at Mississippi State College. This made us happy at Mississippi State as it gave us a chance to modify the design to agree with what we had found to be good practice.

First of all the wing location was raised from its intended midwing position to a high wing. We had found this to be very essential to obtain high wing efficiency and low drag, especially at high lift coefficients. If an appreciable amount of fuselage extends above the wing then the boundary layer attached to this part of the fuselage will cause a discouraging amount of airstream separation which means drag and poor spanwise lift distribution.

Next the wing angle of incidence was reduced so that the axis of the fuselage would be the same as that of the airstream at 80 M.P.H. This meant poorer takeoff and landing characteristics, though not objectionable, and perhaps some loss in L/D max. It does give better glide ratios at high speeds which we felt was essential for the type of machine I wanted. The incidence of the wing with the fuselage axis is + 2.5 measured from the zero lift chord. After flying the ship in the summer competition, I feel that we did the right thing as my most efficient cruising speed (calculated) was rarely under 90 M.P.H. Hence the operation almost never included the speeds between thermal flying, 45-50 M.P.H., and that of cruise.

A landing wheel has a fine place on a trainer but most certainly not on a performance job. Therefore a landing skid was used and a dolly made to facilitate ground handling. Bruce Carmichael, aerodynamicist at Goodyear Aircraft, calculated that the drag of a wheel was about equal to a flat plate of twice the area of the wheel projection. This is said to be due to the effects of the airflow in and around the wheel well.

Probably the biggest control problem of sailplanes is that of adverse yaw and we set about to see if we could make some progress here. Small conventional ailerons with only 6 square feet of area apiece were designed and spoilers just inboard of them were made to start opening when the aileron was deflected up 12°. The aileron differential is two to one, giving a maximum up travel of 30° and 15° down. Thus the spoilerons would be full open when the aileron was deflected up 30° and of course closed on the other wing.

This system worked well in flight and the machine had a surprisingly decent rate of roll. During the summer competition I found that I could fly all day and almost never deflect the ailerons far enough to open the spoilers (12°).

In the following fall accurate flight tests were made to find what needed improving. Even after we changed the canopy design, the ship still had a poor efficiency factor of 62%. Looking for the trouble we tried larger fuselage-to-wing fillets but obtained no success there. Next the spoilerons were removed as they provided a small amount of airflow between the bottom and top of the wing even when retracted. The results were most gratifying, the efficiency factor rose to 70%, the L/D max increased 1.2 points and the minimum sink decreased .1 ft/sec. On top of all this the lateral control was still as good.

On flight evaluation tests we measured the time in seconds to roll a machine from a bank of 45° to an opposite 45° bank, using full control and an airspeed of 20% above the stalling speed in level flight. With spoilerons the RJ15 rolled in 6:2 seconds and without the spoilerons in 6.2 seconds also. This fine result with such abnormally small ailerons touched off a series of other tests on the T.G.-3 and Pratt-Read. It was found that both these machines would roll faster with only the outboard half of the aileron operating than with the whole aileron. Also the control forces and adverse yaw were reduced about 50%. In all cases the aileron controls were deflected to the stops, the control systems have a negligible amount of elasticity, and the wings are quite stiff torsionally. More research in this matter is being undertaken here to determine the reason why this occurs.

I had originally planned to use the highly effective D.F.S. type dive brake for glide and speed control but after giving some more thought to the problem, I decided differently. A spoiler on the top surface of a wing is undesirable for several reasons. First of all, unless it is a smoother installation than any I have seen, the roughness has its share of drag but most of all this roughness will trigger separation of the airflow at high lift coefficients. Also any air leakage from the inside of the wing past these spoilers add a rather fair amount of drag. The biggest objection is that these spoilers, while causing the desired high drag, (when open) they actually decrease the maximum lift available from the wing and hence induce a higher stalling speed. Most aircraft designers realized years ago that on a landing approach both high drag and high lift is desirable. Sailplanes should be no exception, therefore a simple split flap was installed on the bottom surface and hinged at the .50 chord

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