THE POWERED SAILPLANE

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(Continued from May-June Issue)

Wing

The planform of the wing is divided into three panels consisting of a rectangular center-section and straight-tapered outer panels with elliptical tips. The thirty percent chord element line is normal to the plane of symmetry. The taper ratio of $C_t/C_r = .333$. The leading edge sweepback is 2°16′ and the trailing edge sweepforward is 3°18′. The airfoil sections used are the Gottingen 549 at the root fairing to Gottingen 676 at the tip. There is no geometric washout. The selection of these airfoils was considered prudent in that low Reynolds number characteristics were well known and the stall behavior was satisfactory. Reference 5 gives an interesting comparison of this section with other airfoils used in sailplane design. This particular airfoil combination has been used on many successful European designs. The new low-drag sections developed by the NACA presented interesting performance possibilities, but lack of substantial low Reynolds number data left many design problems in doubt. Reference 6 states also that drag characteristics curves of these sections apply "if, and only if, the wing surfaces are fair and smooth." The narrow dimensional deviations permitted in using these sections necessitates extremely careful construction.

The basic structure of the wing consists of a single main beam which carries the primary bending and shear loads. The beam is termed a "C" beam and is composed of upper and lower flanges which are made from unequal angle 7075T-6 extrusion. These extrustions are continuous and are tapered in planform, elevation and thickness. The flanges aft and are riveted to a shear web. The leading edge "D" section carries the torsion loads and is composed of metal ribs and preformed metal skin. In addition, the entire volume of the leading edge is filled with an expanded polystrene plastic called "Styrofoam." This material performs two functions. First, it provides a smooth airfoil contour from the leading edge aft to the point of maximum thickness. No "oil-cans" or other malformations are present under wing deflections up to and including the design limit wing load. The entire leading edge assumes the same elastic curve as the main beam. Second, the leading edge skin is also reinforced permitting higher allowable buckling stresses to be employed.

Harry Perl and Ted Nelson in the roomy cockpit of the Nelson Hummingbird.

This can be evaluated in terms of fewer ribs and lighter gauge skin. (A paper is being prepared on this subject at the present time.) Reference 1 gives data on this interesting material. There are also a number of comparable materials now available. Foamed-in-place plastics were also investigated and were found to be unsatisfactory for this specific application and desired density. Extensive tooling was required to hold the part while the foaming reaction took place due to a slight pressure which develops during this period. The lack of a non-destructive inspection method for checking the cavity condition after foaming warranted eliminating this method completely. The precise control required in using this process, such as temperature of the mix and the cavity, the rate of mixing the ingredients, etc., requires the development of a fine technique. Under production conditions with good control and using higher densities this material is undoubtedly satisfactory.

The present method of fabrication using "Styrofoam" in the "HUMMINGBIRD" consists of cutting the material to rough size and then final contouring these pieces when in position on the leading edge. An epoxy resin called "Styrobond" is used to bond the plastic to the leading edge metal skin and beam shear web. The entire leading edge assembly is then placed in a Vinylite plastic vacuum envelope for applying pressure during the curing period. This type of construction offers interesting possibilities in using some of the new low drag sections and in the formulation of simpler types of wing construction. The wing tips are fabricated from formed magnesium sheet and are filled with "Styrofoam." A small wing tip skid is provided for ground functions.

The aft section of the wing from the main beam to the rear spar is covered with light gauge magnesium skin except at the root drag bay section. This section uses 7075T-6 sheet. Torsion and drag loads are transmitted through this area to the fuselage by a fitting attached to the rear spar. The main wing attach fittings are X-4130 heat-treated steel and are provided with self-aligning brackets for easy and rapid assembly of the wing and fuselage.

Ailerons are conventional and are hinged at the juncture of the upper surface. The hinge gap is completely sealed to prevent leakage losses. The control system is cable actuated and includes quick-disconnect fittings at the wing root. The surfaces are full static-balanced and are fabric covered, as is the portion of the wing aft of the rear spar.

Slotted spoiler-dive brakes are provided for glide path control and are of the parallelogram type. The controls are automatically engaged at assembly. Provision is also made for the installation of oxygen containers in the wing root.

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