THE PERL PENETRATOR

by HARRY N. PERL

The author looking pleased with his new ship.

The preliminary design of the "Penetrator" was begun in the latter part of 1950 and actual construction was started in October of 1951. The author wishes to take this means to express his sincere appreciation and thanks to Ted Nelson who gave generously of his time, shop facilities and abilities in the construction of this sailplane.

The Penetrator is a Class I high performance single-place powered sailplane. However, the ship is now being flown without the power plant. The original design called for a Crosley "Cobra" 25 H.P. liquid cooled automotive engine, but unfortunately this engine is no longer in production and all of the used engines investigated were for the most part unrepairable due to rust and deterioration. Today the possibility of incorporating some type of jet engine is becoming more favorable every day with several new small units appearing on the market. The author is at present evaluating the various design problems associated with these engines and hopes to be able to make a selection soon.

The ship is of all wood construction, using Sitka spruce and mahogany plywood. The original design contemplated all metal construction, but due to the Korean War and subsequent U.S. Air Force expansion program, metal became in very tight supply. Aircraft grade spruce was found to be almost as difficult to obtain as was aluminum.

The major design feature of this sailplane is the super-finished wing which is free from "oil cans" when under load. Sailplane designers have long realized the importance of maintaining smooth and fair airfoil contours but in order to do so have had to accept large penalties in weight and/or difficult construction problems in order to obtain the required structural stiffness. Today, however, in this age of plastics, the picture has changed considerably. There is now available a new lightweight core material that can be cemented or glued to a number of different materials. It is the Dow Chemical Company's expanded polystyrene called "STYROFOAM" and can be obtained in densities ranging from 1½ to 3 pounds per cubic foot with mechanical properties varying as the density.

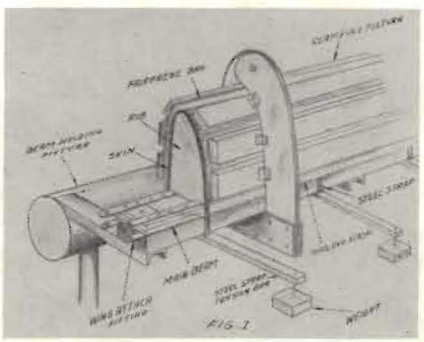

FIG. 1. The main beam on its holding fixture.

A number of adhesives for many combinations of materials are also available. Many aircraft companies have been investigating and experimenting with this material and also with the so-called "foamed in position" plastics. Most of these applications have pertained to control surfaces and such for vibration damping and in an effort to prevent flutter. It is believed that the Penetrator is the first aircraft to incorporate Styrofoam as a structural material in a major structural component. By filling the entire leading edge portion of the wing with this material and bonding the various structural elements together by gluing, the plywood covering is thus stabilized and prevented from buckling in compression. The whole leading edge structure assumes the same elastic curve as the beam when under load. A small test section was fabricated and subjected to very low pressure (2×10^{-6} mm. Hg.) and temperatures (— 10° C.) in a vacuum chamber. No adverse effects were noted. Another full scale static section of the wing root area was constructed and tested for the critical loading conditions. From the results of these tests it was concluded that a majority of the leading edge ribs could be eliminated by using Styrofoam. This would have required a more comprehensive testing program and was beyond the scope of the project at this time. It is hoped that such a program can be accomplished in the not too distant future.

The wing structural design consists of a single main beam for carrying primary bending and shear loads. The aileron attach spar is continued in to the root of the wing; the wing is plywood covered back to this spar and conventional truss type ribs are used throughout. The aft section and aileron are fabric covered. The main beam consists of one inch thick laminations oriented vertically. Taper in plan form is obtained by dropping out laminated members span-wise toward the tip. A slight weight penalty is involved but the simplified structure resulting more than justifies the new additional pounds of weight. The wing attach fittings are X4130 heat treated steel and are attached to the main beam with aluminum alloy bolts. A self-aligning feature is included for easy attachment to the fuselage. The leading edge or "D" section of the wing consists of conventional cut-out ribs spaced on twelve-inch centers with Styrofoam fitted between ribs