The aerodynamic merging of wings, fuselage and cockpit

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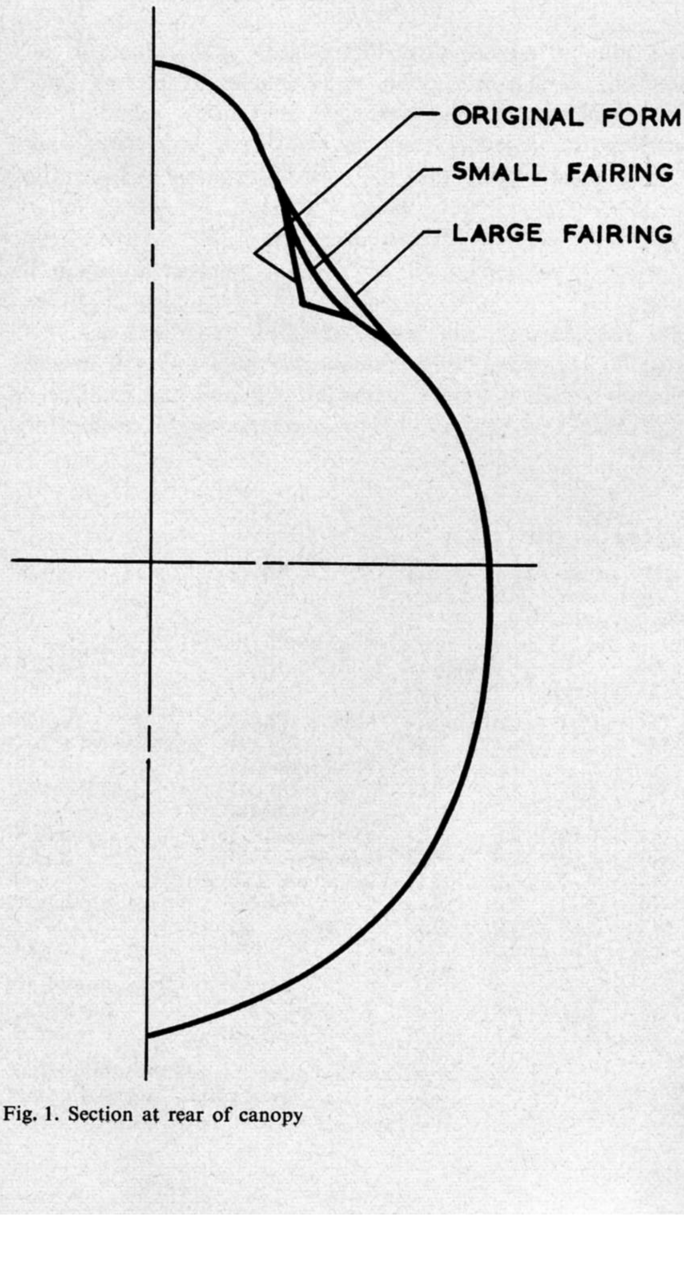

Fig. 1. Section at rear of canopy

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Introduction

It is not possible to decide whether a sailplane really has the optimum shape until, based on flight measurements, a number of improvements have been made. A. Raspet (1) and his collaborators have given many such examples of measurements followed by improvements on a series of sailplanes. This method resulted in performance improvements by purely aerodynamic means. There was practically no serious structural alteration but rather there was careful detailed work directed towards small deficiencies which resulted in the discovery of sources of considerable drag and its elimination. This diagnostic technique which Raspet has developed on the basis of systematic flight measurements is a research technique which, if continued, will in the future bring further useful results. In the thirties, experimental model tests were made, particularly by Muttray (2) in Göttingen, on the optimum shape of wing-fuselage junction, including the pilot's canopy. At that time Muttray said that the wing-fuselage junction cannot be considered without the canopy which should be completely merged into this junction. This was the first real attempt to consider such aerodynamic problems simultaneously.

Even nowadays with totally enclosed cockpits, cases arise from time to time where the optimum aerodynamic merging of fuselage and wing requires further study. These developments originated with Madelung's «Vampyr» and Lippisch's «Fafnir» in which for the first time the pilot was totally enclosed without excrescences on the fuselage. As a result of Muttray's wind tunnel work and measurements, Lippisch in his «Sao Paulo» (Fafnir II) produced a smooth, continuous fuselage-wing junction. He moved away from the shoulder wing to the mid-wing lay-out. However, in

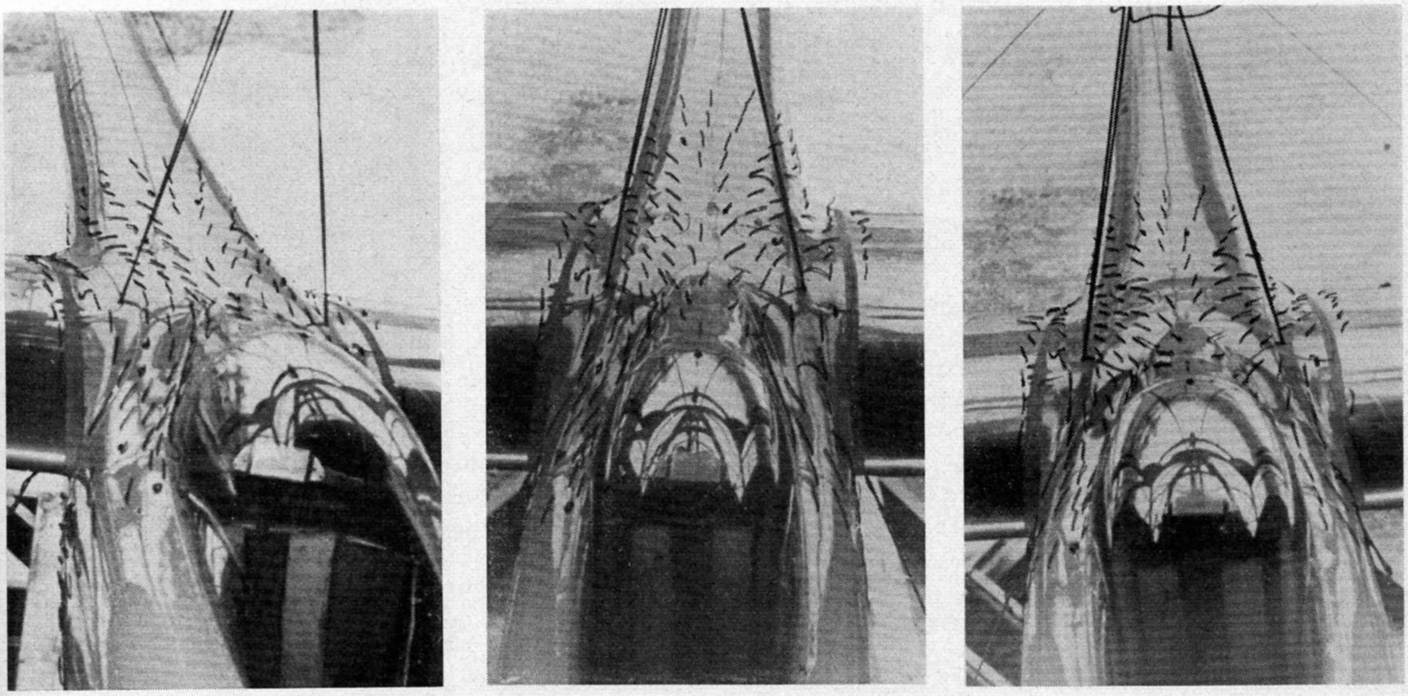


Fig. 2. Original form of prototype
a) $a = 0^\circ$ b) $a = 5^\circ$ c) $a = 10^\circ$

later sailplane development, very few types have been tested in the wind tunnel before construction as done by Muttray.

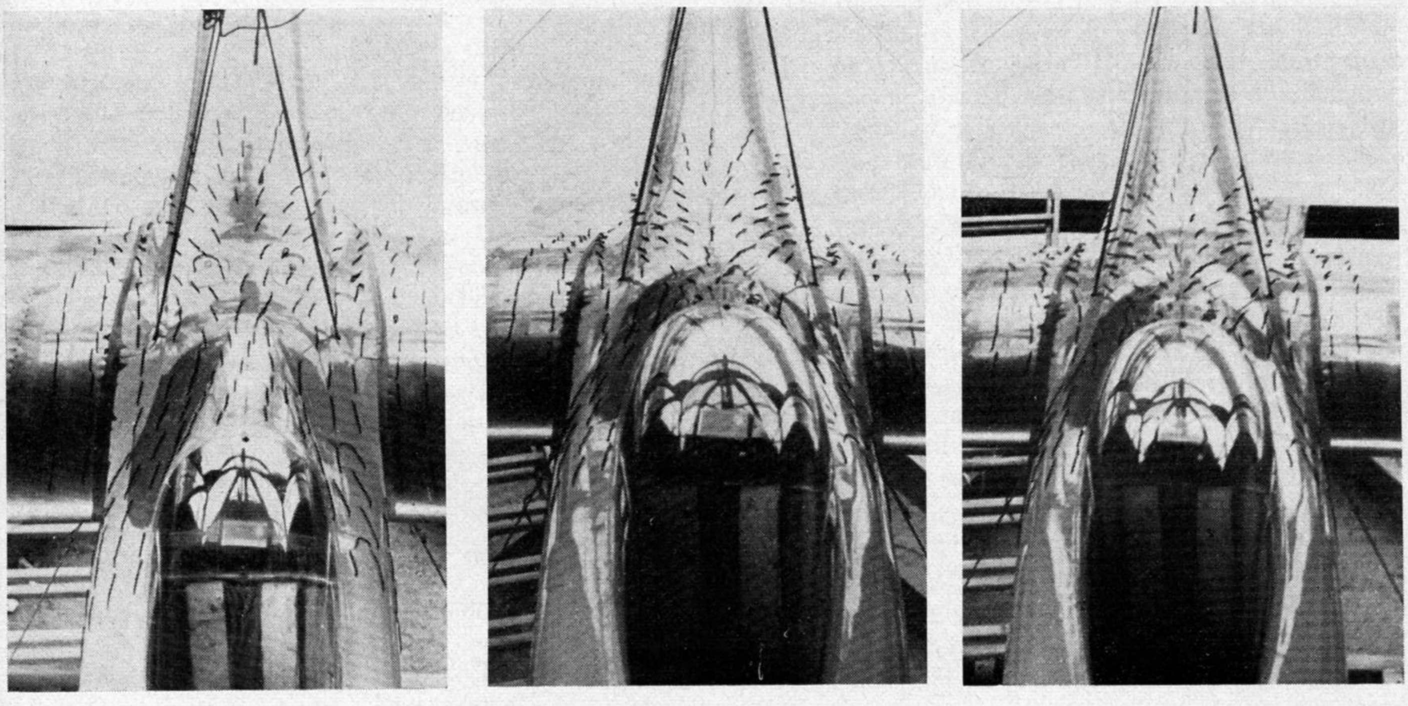
The second method is the full scale analysis of flight tests using wood tufts. Such studies usually bring useful results for a range of speeds if the tufts are properly observed and photographed and the appropriate modifications are then made to the sailplane.

In this report on tests in an open jet wind tunnel the full scale «Meteor» sailplane was wool tufted in the region of the centre-section and canopy. As a result of observations and close-up photographs, it was possible to identify the disturbances and suitably re-shape the areas of irregular flow. Such work is actually very easy to do.

Tests in open wind tunnel

The flow over the fuselage-cockpit assembly was studied by means of wool tufts at various incidences and airspeeds in

Fig. 3. First development—small fairing
a) $a = 0^\circ$ b) $a = 5^\circ$ c) $a = 10^\circ$



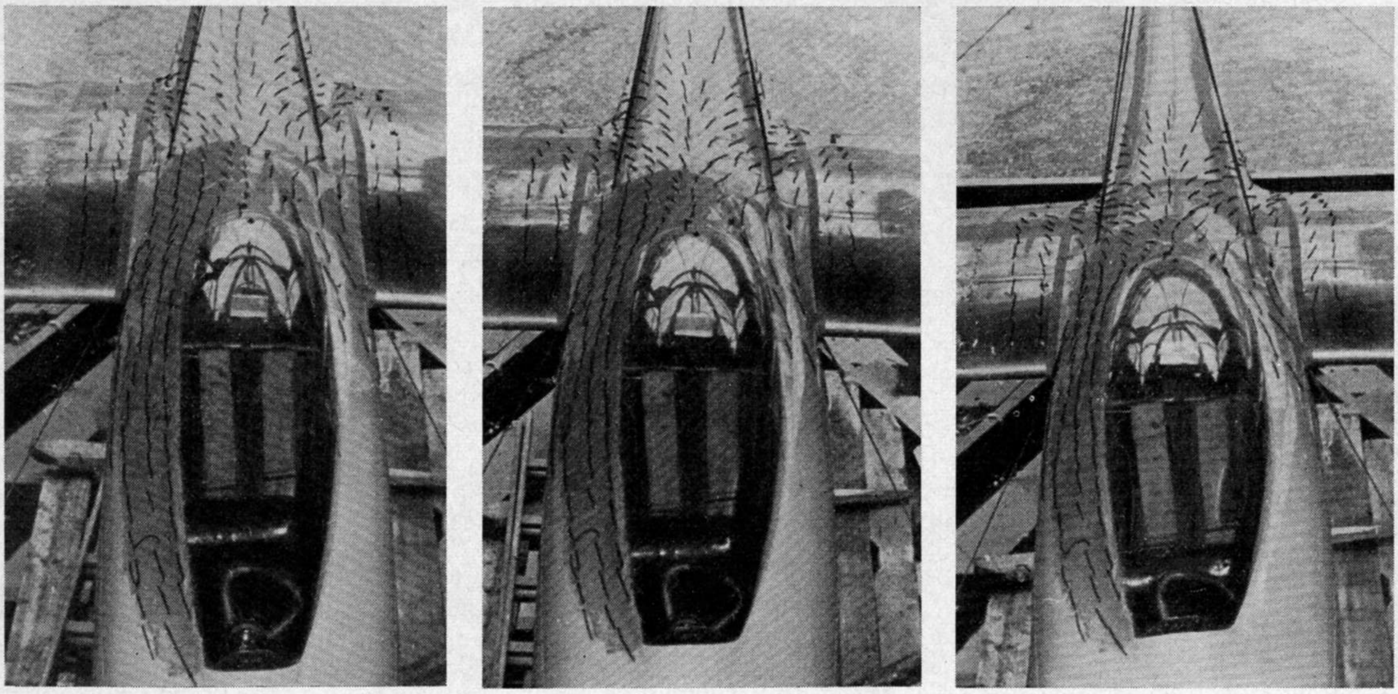


Fig. 4. Second development—large fairing
a) $a = 0°$ b) $a = 5°$ c) $a = 10°$

the open jet tunnel of 2.5 m diameter. The fan is driven by a 600 KW motor. The sailplane, with stub wings with large end plates, was supported so that the incidence could be continuously varied during the tests. The incidence was varied between 0° and +10° and the speed of airflow between 20 and 30 m/sec.

The tests were made on the original form of the prototype and on two developments in which the canopy was faired into the fuselage. These are illustrated in fig. 1, which shows cross-sections for the three shapes at the rear of the canopy. Typical results are shown in fig. 2 to 4. As a consequence of these tests, the decision was taken to make a radical change of canopy shape.

References

(1) *A. Raspet:* Control of the Boundary Layer on Sailplanes—Paper presented at the Fourth Congress of OSTIV, 1952.

(2) *H. Muttray:* Die aerodynamische Zusammenfügung von Tragflügel und Rumpf—L. F. F. Bd. 11, Nr. 5, 1934, München.