UNORTHODOX MODELS - 2

TAILLESS TYPES

BY S · R · CROW

A pre-war photo of the author with the first Schmidtberg tailless model built in this country to the designer's original drawings.

INTEREST in the development of successful Flying Wing types in this country has been accelerated by such contests as the Handley Page Trophy and the prospects of more events for Tailless Model Aircraft. On the Continent there has been for many years a nucleus of enthusiasts conducting research in this branch of model aeronautics, who in their turn have been unaware of British work in this sphere. Nevertheless in spite of awakening enthusiasm there has as yet been little literature published on the subject, and certainly no attempt to publish any concise description of the sundry variants that have been developed.

Perhaps a note of warning is necessary at the outset. The experimenter may be tempted to devote his research to small all-balsa solid gliders, which in their way are interesting and instructive, but one must not be misled by the behaviour of such models, which in the main have what approximates to a flat plate airfoil and very narrow chords, not that this last is, in itself, neccessarily a bad thing. Equally, experiments with models of too large a size are apt to be costly and limit the amount of research carried out in a given time. Probably a span of three to four feet is the best compromise, it was on a model of this size that the writer gained much valuable data; this machine, the "Crowfly," is reproduced in plan form and illustrated in this publication.

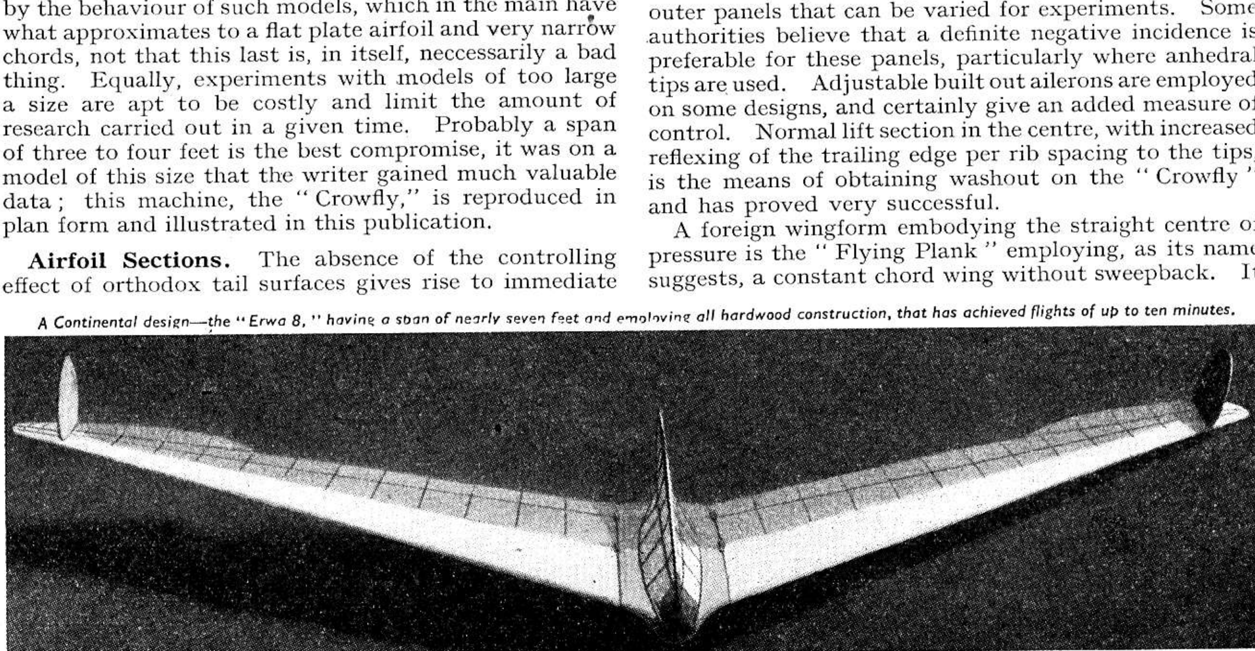
Airfoil Sections. The absence of the controlling effect of orthodox tail surfaces gives rise to immediate problems of stability, and this may be met, in the first instance, by a wise choice of airfoil section. There are a number of proven sections which have a high degree of stability, among which are those with reflex trailing edges such as R.A.F.30, R.A.F.33 and CLARK Y H. which are available as Airfoil Section Sheets. Using these as a basis the keen experimenter may like to develop his own section. Given the requisite apparatus, there is a lot of satisfaction in so doing, otherwise it is better to rely on a proven section; in any event many of the so-called "original" sections can be recognised as very near relations to existing types.

Wing Form. There is a surprisingly wide range of wing forms that may be adopted, and protagonists claim successes with many varied shapes. However, stability needs force the conclusion that a measure of sweepback or sweepforward is essential. The sweptback wing form has proven the most popular basis for experiments to date. Degree of sweepback may be varied within certain limits of, say, 15° and 30°, or may be stated as a total sweepback equal to one chord width, or one mean chord width in the case of tapered wings, as the effective minimum. The sweepback can be accentuated by 5°–10° at the tips for approximately 10 per cent. of the span which adds considerably to the stabilizing effect of the tips. With these types there seems no logical reason to increase the normal dihedral of from one to one and a half inches per foot of semi-span. The dihedral may vary as in orthodox model aircraft, by underslung weight or parasol wing combination being included in the design, giving pendulum stability.

To aid stability it is desirable that the outboard sections should be washed out, for an average airfoil there will be a difference of 5° to 6° between the angle of incidence of the inboard and outboard panels. This can be achieved by building it in or by having adjustable outer panels that can be varied for experiments. Some authorities believe that a definite negative incidence is preferable for these panels, particularly where anhedral tips are used. Adjustable built out ailerons are employed on some designs, and certainly give an added measure of control. Normal lift section in the centre, with increased reflexing of the trailing edge per rib spacing to the tips, is the means of obtaining washout on the "Crowfly" and has proved very successful.

A foreign wingform embodying the straight centre of pressure is the "Flying Plank" employing, as its name suggests, a constant chord wing without sweepback. It

A Continental design—the "Erwa 8," having a span of nearly seven feet and employing all hardwood construction, that has achieved flights of up to ten minutes.



cannot be recommended, however, as little is known in this country of its actual performance,

At this point let us refer to the diagram of Wing Plan Forms. Some of these are only suggestions, and comments on each shape may prove useful. Reflex and washout are shown in shaded lines.

FIG. 1. Here is the orthodox and most popular tailless design, with well sweptback wing and washout at the tips. This wing form has been tried and found most efficient and reliable, especially for the newcomer to tailless models.

FIG. 2. A near semi-circle in shape, with scope for the more advanced designer to develop. Theoretically it is fairly efficient, the writer has tried this form cut from cartridge paper and trimmed it to give quite good glides, the results of a larger job may not be gratifying but is worth trying.

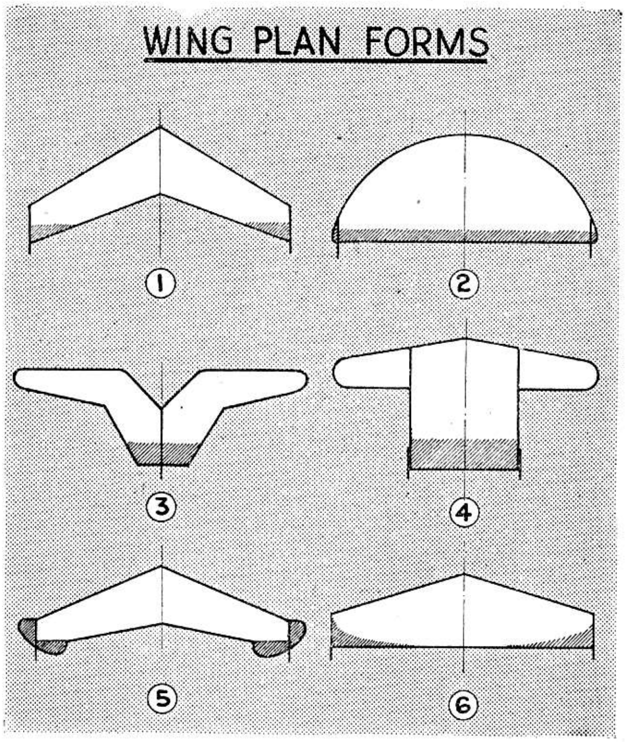
FIG. 3. Here the wing is swept forward from the roots for part of the span, with the stabilizing reflex in the trailing edge of the centre section ; the fin is situated centrally. A similar layout has been tried in America, but little " gen " has been gleaned as to performance, etc. This is definitely not the job to tackle as a " first timer."

FIG. 4. Perhaps this should come under the classification of a " Flying Fuselage." The centre bay is of reflex airfoil section, with normal lifting surfaces in the form of stub wings set at a dihedral. The experimenter with this form should be content with short duration flights rather than a high efficiency performance. The design has something in common with the Burnelli Flying Wing, an American full-size craft about which much has been written.

FIG. 5. Confidence has been placed in this plan form by the writer, who is employing it in the construction of a powerful craft with a wing span of 8 ft. The machine is near completion and tests will take place shortly. As can be seen, the tip surfaces are set at a negative angle of incidence to the main surfaces, the fins being located at the change over. The tips are also set at anhedral. Many modellers will want to develop Flying Wings from this plan form which is aerodynamically efficient and looks very graceful when completed.

FIG. 6. This is ideal both aerodynamically and constructionally. The washout of the wing, scribing a curve (on plan) from a normal high lift section such as Clark Y. in the centre, and changing throughout the half span, when at the tips the section is symmetrical with reflex trailing edge. Rib planning is important here, to make an efficient transformation from centre to tip section. The A.V.10 reproduced in this issue is similar in plan, the difference being that the " Borgé 3 " airfoil is used throughout the wing taper.

Fins. Once more there are various schools of thought, the fin, or fins, can be placed centrally, above or below, or above and below the wing, at the wingtips or a position between these extremes. It is even omitted altogether at times, though with doubtfully beneficial results! Further modifications include toed-in tip fins, which can toe in laterally or longitudinally. Full size practice, which is equally in an experimental stage, lends support to all these variations, but should be followed with a degree of reservation on models.

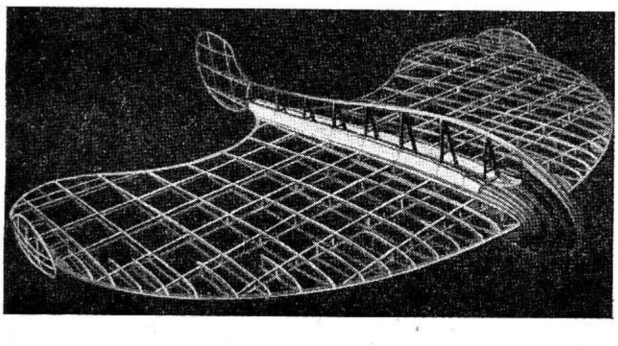


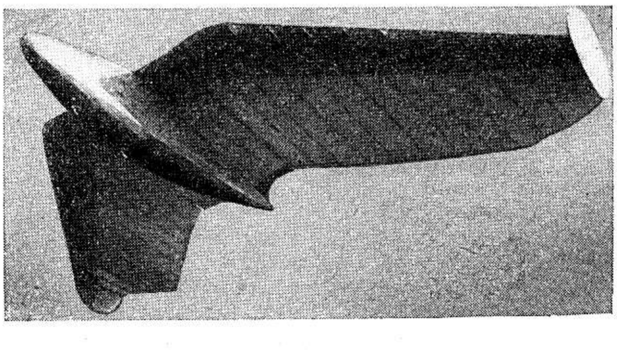
The writer whilst experimenting found the centre fin, when situated above the wing, to be efficient in the glide after a tow launch, but has come to the conclusion that the wing tends to blanket the fin whilst the model is making its launching climb, causing a form of oscillation or wallowing which often led to a " hook flight " crash. The remedy found was the addition of wing tip fins which gives rise to the question, is a centre fin necessary or if used, as efficient, area for area, as wing tip fins. It is likely that should the modeller wish to incorporate the centre fin on a glider, the best place is below the wing where it operates in a freer airflow. The A.V.10 follows these lines.

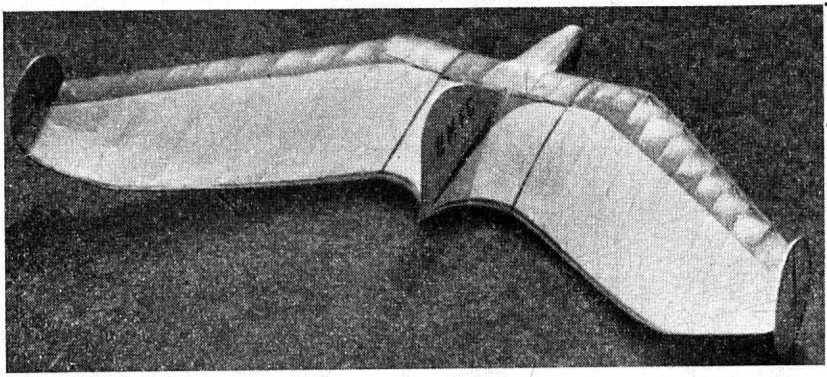
Towline Fault Finding. Anyone with experience of tailless types realises how difficult it is to judge their probable behaviour on a tow launch, from short hand-launch flights. To avoid unnecessary breakages during tests, a few suggestions are offered.

A long towline of at least two hundred feet is recom-

Left : Uncovered view of a German design by A. Armes, using a modification of the plan form in Fig. 2. Right : An excellent shot of " Crowfly " in flight that shows its graceful lines to advantage.







Another picture of "Crowfly." The increasing reflex of the outboard ribs can be clearly seen.

mended, added to which a short length of 1/32 in. sq. rubber to act as a shock absorber. Models up to four feet span should not be first flown in winds exceeding 10 F.P.S. Larger models up to 15 F.P.S. and not at all in gusty weather. If the model passes its preliminary hand-launch tests, it may then be attached to the towline at the most forward hook, that is, in advance of the normal hook attachment. Perhaps at this point a few words about the position of the hooks would be timely. On orthodox type gliders (that is mainplane *and* tailplane craft) the most efficient position for the tow hook is usually below the leading edge of the mainplane; this does not apply with the increased sweepback of a tailless glider. A hook *can* be fitted at this point, but it will be well forward of the best launching position. A series of three to four hooks, spaced at pitches of 3/4 in. to 1 in., commencing at a point approximately 1 in. in front of the C.G. of the machine, should give sufficient range to cover tow launches under all conditions.

The C.G. should be brought forward temporarily by the addition of plasticine to the nose, this helps to prevent a model that is heavy aft, from going into a loop. It is unwise to trust too much in any apparent appearance of stability from a hand launch. It is better to have these first tests with a nose heavy machine than have "tow loops" and "hook flights" that generally end in disaster.

The towline should be kept as taut as possible to give the operator the utmost control, this is because lateral stability is still an unknown factor. If it is good no harm will be done. But if it is excessive or deficient, control is essential so that the model can be judiciously released. Superstability where the model oscillates from side to side like a falling leaf is a common fault in tailless types, and this often leads to a wing tip landing; similarly a quick release can often save the model from the consequences of a sudden spin in. Superstability is usually due to a large moment of inertia about the longitudinal axis, or in other words, the lack of a normal body leads to the distribution of weight more evenly across the whole wingspan.

Lack of lateral stability may be due to congenital instability in the design or a fault in the construction. Note on each flight whether the model breaks away alternately, to left and right, or only to one or other side. In the first case the design is at fault, in the latter it is incorrectly built; this will mean finding the building fault and putting it right. Probable building faults can be unequal incidence on wings or incorrectly set fins.

If all is well so far, a cautious attempt may be made to improve the gliding angle by lightening the nose slightly of the additional weight added for testing. Do this little by little, noting the behaviour of the model at each stage. Finally the model can be tried by a full launch from the hook position found to be best on test flights.

Conclusions. To-day little is known of the tailless type, especially in the model sphere, thus there are ample possibilities for experiment. Maybe we shall soon see "Flying Wings" competing on equal footing, as regards performance, with the normal wing fuselage and tailplane model aircraft.

One great advantage of the model flying wing is its suitability for transport. The basic design lends itself admirably to the split wing and dowel method and as there is no tailplane and little or no fuselage, the room required in the modeller's box is very small.

Apart from the very generous rewards awaiting the successful tailless designer, this type is acclaimed as potentially the last word in efficiency. Added to which it requires a minimum of building time and materials.

No attempt has been made to discuss powered tailless flight, but petrol and diesel engined flying wings, not forgetting Howard Boys' rocket-propelled designs, open up immense possibilities for further investigation.

Full-size Plans. As usual, full-size drawings of the two plans appearing in this article are available through Aeromodeller Plans Service, Allen House, Newarke St., Leicester, at 2/6 each post free. The writer can recommend his own design "Crowfly," with every confidence; in the hands of novice or expert alike it has performed well. The "A.V.10" by Guy Borgé has been extensively tested by the Aeromodeller Research Staff, who are loud in its praises.

The simple lines of "A.V.10," a splendid "first-timer," are here depicted. This is a Mark II model with modified fins; other variants flown by "Aeromodeller" Research Staff include a Mark III with adjustable tip ailerons.