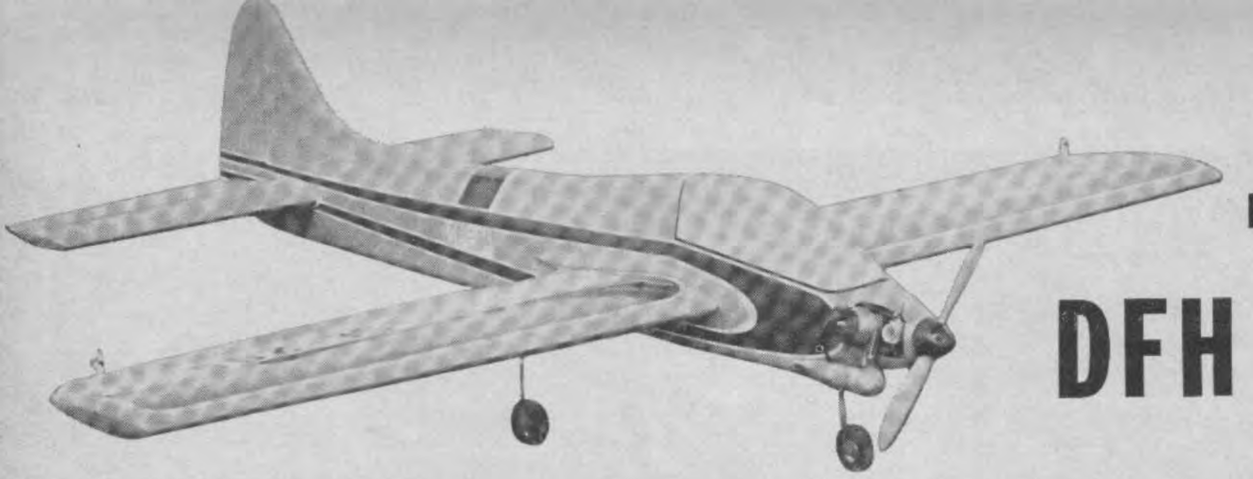


By Bengt Lund

DFH 15

A SCANDINAVIAN APPROACH TO THE F.A.I. AEROBATI FORMULA, FEATURING NOVEL AILERON SYSTEM

THIS design is the latest in a long series of models in which only the name bears a resemblance to the original. This name is almost impossible to translate into English so let us just call this one the DFH 15. However, there has been one common feature throughout the series, namely the mid-wing layout.

Descriptions of famous model designs often carry lengthy discussions about different airfoils and how important 1% more or less thickness in the tip is and what can be done with a minor difference in the airfoil curves and so on. I have seldom found the airfoil choice so important and the one chosen is there just because it greatly simplifies the building and is of the symmetrical type.

My own nutty idea concerning the aileron layout is the result of the poor aileron performance I have found on those famous designs already mentioned. To improve the aileron response, I therefore among other things, am using the warping ailerons where the 'angle' increases towards the tip like a propeller only in reverse. Don't expect the warping ailerons to make any major improvement on your flying, but with the new F3A flight programme there is more emphasis to rolling manoeuvres. You will benefit a little if you have trouble for example with the 'Top Hat' and all the fast rolls as in the 'Rolling Eight'. The servos must be of the larger more powerful types and not the minis because plenty of power is required to warp the ailerons. However, there is a bonus effect in that the warped ailerons help the servo to return faster to neutral, which produces a real 'instant' recovery from the roll to straight and level flight.

Construction of the warping ailerons originally presented some problems. First I just glued the inner edge to the fuselage. This did not create a linear angle increase as the ailerons were too rigid at the root and I had to cut away material there to make them weaker. Then I put in a torque rod at the root which works fine but you must choose the right diameter depending upon if you use hard or soft balsa for the ailerons. The inner parts of the ailerons are now also free to be used as spoiler flaps shown on the plan together with installation details for conventional strip ailerons if you prefer these. The best solution is the one used by my friend Kenneth Gustavsson who installed a second 90° aileron bellcrank halfway along each wing panel which moves the inner part of the aileron. Thus you reduce the servo strain a little and it also permits some adjustment.

I favour large lateral areas on the fuselage which will enable you to really use the rudder to control the model in the knife edge position rather than just a case of full rudder holding the model in an ugly high angle of incidence. This high angle also makes it difficult to hold the heading when the model recovers to the horizontal position or at the 45° positions in the Eight Point Roll.

When a model is flying straight and level, you need some up elevator to make it hold its altitude in the upright position. When this model is put into a knife edge position, the weight of the model 'disappears' and now works along the wing pointing downwards but the 'up elevator trim' is still there. Therefore, the plane ought to 'turn towards the fin' in knife edge a little but it has always surprised me how different models react. Most low wing models have a tendency to 'turn towards the landing gear' in knife edge but some with high wing and low stab positions tend to 'turn towards the fin'.

This mid-wing model with 0° incidence on all flying surfaces and on the engine has a dihedral of 7-8 mm. on the wing centre line which might seem odd. The answer is that the fin is far above the centre line and centre of gravity, a condition which creates a roll tendency towards inverted when in a knife edge position. This is counteracted by the dihedral. However, if you intend to use fixed undercarriage, the lower centre of gravity caused by the heavy legs and wheels will try to roll the model to upright and therefore there is likely to be a no-roll tendency in knife edge flight. In this case, delete the dihedral and build the wing straight.

Always watch the weight when you build. Fully laden, with full tank, this model should not weight more than 9¾ lbs. This is so not because the model will behave badly, but due to F.A.I. rules, limiting the surface loading to 75 gramme/dm². To me this is a ridiculous rule, particularly when the much touchier scale models which are often seen in stalled conditions, may go to 100 gram/dm². However, the lighter you build it, the better it flies.

The photographs show construction stages for DFH 13, 14, and 15 variants and there are minor differences between each model and the drawing.

The Wing

Because a large part of the camber of the airfoil at the rear falls in a straight line to the trailing edge, it is possible to use this feature to aid the construction sequence and you will find it easy to create a straight and non-warped wing. It is so flat that with the recommended 7-8 mm. dihedral you are able to pin the whole rear part of the top surface of the wing to your building board and achieve the correct dihedral. Make the rib packs first. Because of the steep taper it would be best to double up on the number of rib blanks and pick out every second one after shaping. Draw a line on the plan to correspond with the point behind the leading edge where the straight taper to the T.E. begins. Pin the flat section of the upper wing skin on the board and add the ribs. Position the front wing spars and glue all retract bay parts including the spacers. Complete the skinning of the underside and fit the rear spar with the wing pinned down flat. Then lift the assembly from the building board, fit the aileron push rods and cranks and join the two wing panels with the correct dihedral. Replace the wing on the building board, pin one panel to the board and complete the skinning of the upperside on that panel. Then pin down the other half to the board and repeat the operation. At this stage, you ought to have a straight wing with no warps. Cut out the retract wheel wells and add the glassfibre to top and bottom wing surfaces.

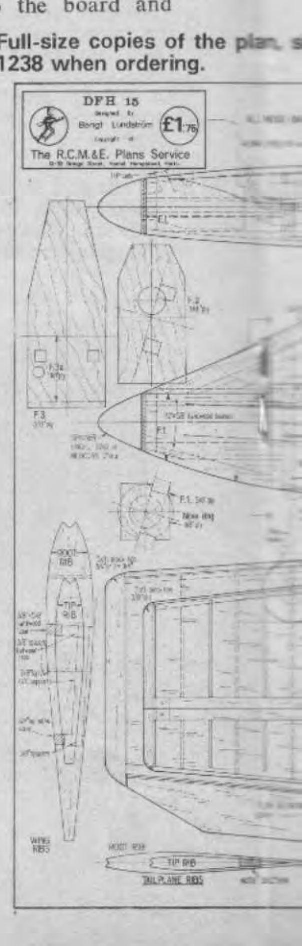
The horizontal stabiliser, including the elevators, is built in a manner similar to the wing and the elevator cut out on completion. Glue the spars to the stab and the two elevator halves and add glassfibre and epoxy. Note that, like the wing, the stab will have a slight dihedral, not for flight improvement but to get a straight line for the elevator hinges.

The fuselage

Carefully match the balsa of the two fuselage sides for hardness. Make up a sub-assembly of the bulkheads 1 and 2, together with the engine bearers.

Now comes the critical part. Fit the glued bulkheads above to the fuselage sides and add the vertical fin spar. Ensure that the two fuselage sides have equal curvature when drawn together at the rear and that the fin spar is vertical. If not, take the assembly apart and try again as you can never correct this later on. If satisfied, mount all other bulkheads 3-10 and again check for symmetry. Glue on the stab carefully and check again as this is your last chance. Then fit all remaining internal details and check the holes for the servo push rods.

Full-size copies of the plan, s 1238 when ordering.



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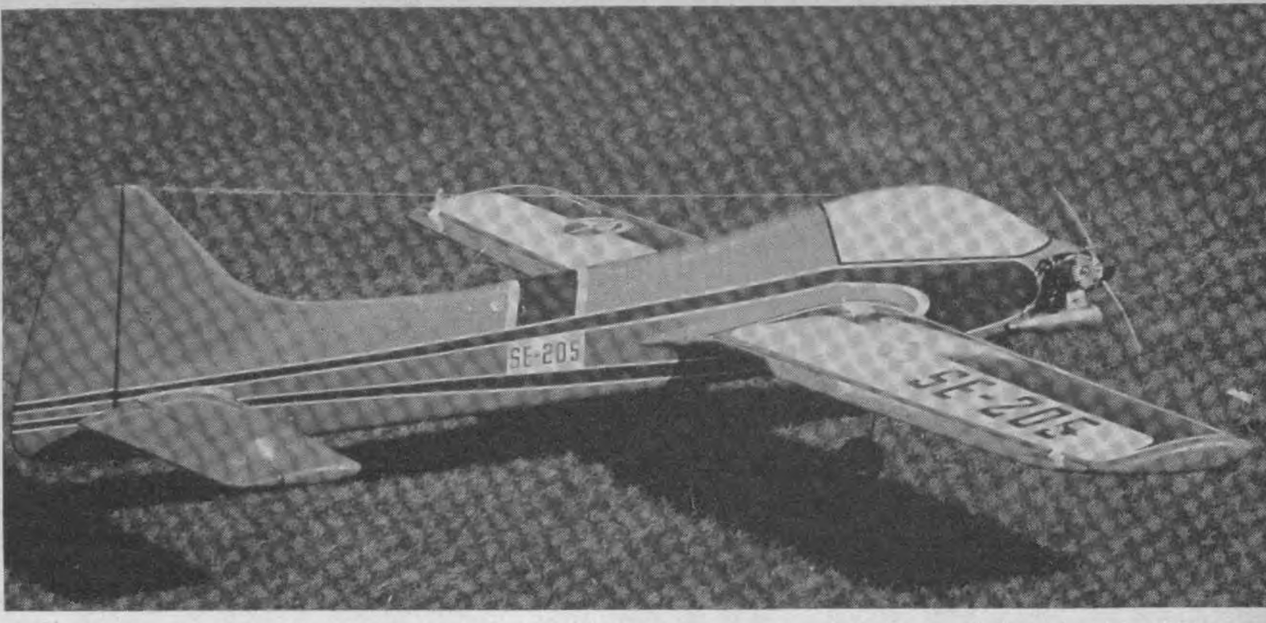


Add the fuselage floor sheeting from the tail forward and put in the wheel bay and engine room reinforcements. Follow this operation by adding the upper sides and the top with the fin. Glue on the nose section, made from scrap parts and shape the fuselage. Cut out the belly pan and epoxy glue the wing seat reinforcement. Complete all installation details, glassfibre the front end and test fit the tank.

Now glue the belly pan to the wing (10) and complete all details. Before you commence the finishing stage you should test the retract function.

Now give the whole model its final shape by careful sanding and painting. Watch the weight. Install rudder, ailerons and elevators and carefully seal all hinge lines which improves the handling in low speed. If you use a Webra Speed 61, be sure to compliment this with a 400 cc. tank.

Note that the rudder has two push rods because of its very large throw which produces a lot of neutral play. By tensioning each rod a little, this play disappears. Check the C.G. position and insert lead at tail or nose if necessary. Don't try to move the servos and the power pack as it won't help much.

Flight trim

There are, surprisingly, many different views on how to get a good flight trim. This is my method.

Check the control surfaces throws as on the plan. Then balance the wings by putting weight in one wing tip as required. As the engine is mounted to the right you usually have to add 10-20 grammes to the left wing tip.

When you have calmed down after the first take-off retract the wheels. Note that the main wheels have a slight toe-in angle which helps not only to avoid some ground loops caused when the wheels turn outwards but also to get the main wheels folded. The reason is that the legs are tilted 'downwards' due to the airfoil and when almost retracted the wheels have a negative incidence to the airflow which might be too much for the servo to counteract in full speed.

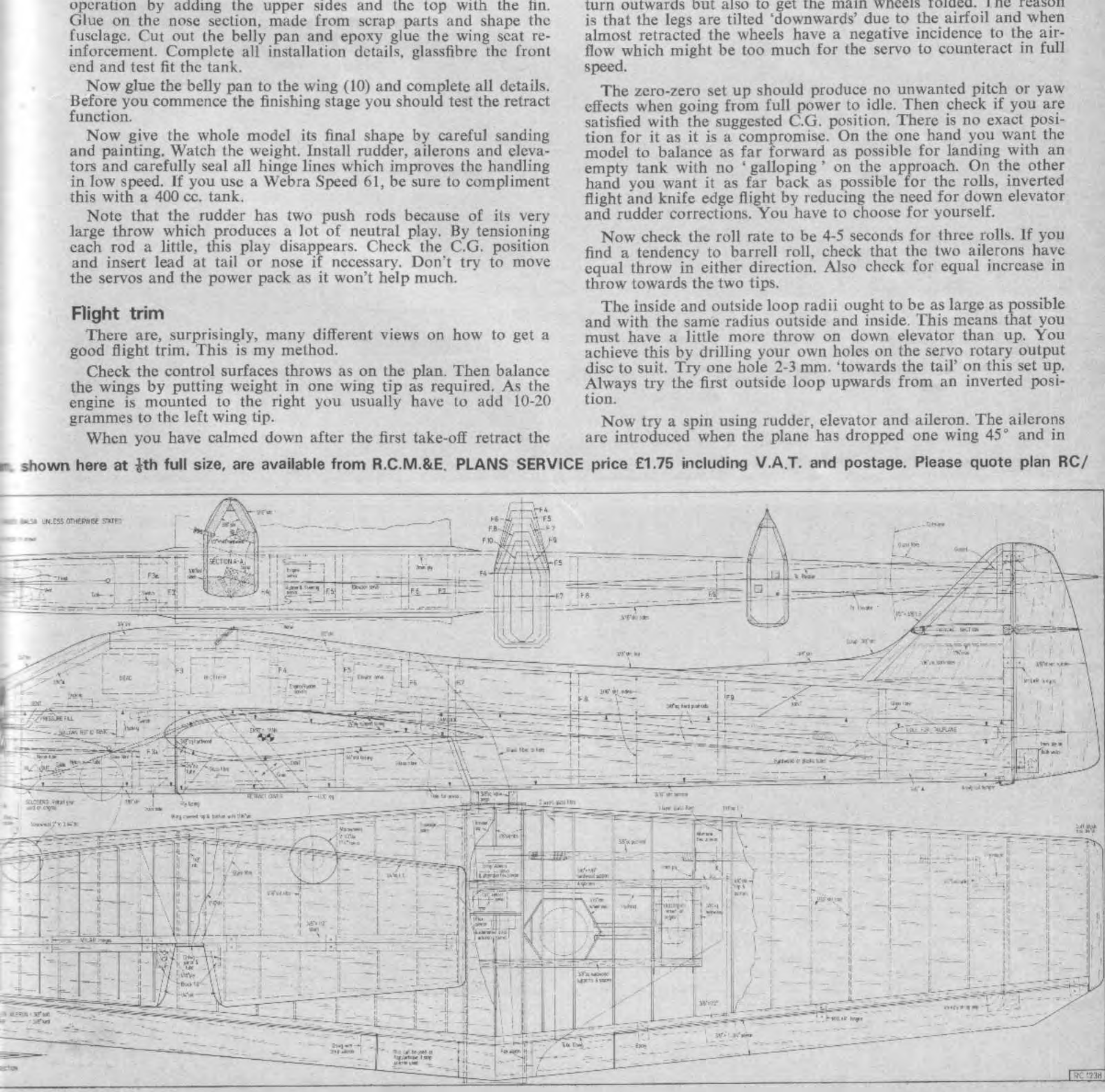
The zero-zero set up should produce no unwanted pitch or yaw effects when going from full power to idle. Then check if you are satisfied with the suggested C.G. position. There is no exact position for it as it is a compromise. On the one hand you want the model to balance as far forward as possible for landing with an empty tank with no 'galloping' on the approach. On the other hand you want it as far back as possible for the rolls, inverted flight and knife edge flight by reducing the need for down elevator and rudder corrections. You have to choose for yourself.

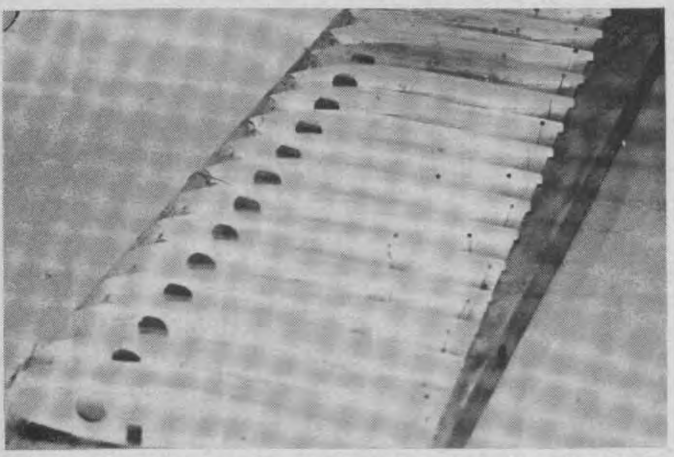
Now check the roll rate to be 4-5 seconds for three rolls. If you find a tendency to barrell roll, check that the two ailerons have equal throw in either direction. Also check for equal increase in throw towards the two tips.

The inside and outside loop radii ought to be as large as possible and with the same radius outside and inside. This means that you must have a little more throw on down elevator than up. You achieve this by drilling your own holes on the servo rotary output disc to suit. Try one hole 2-3 mm. 'towards the tail' on this set up. Always try the first outside loop upwards from an inverted position.

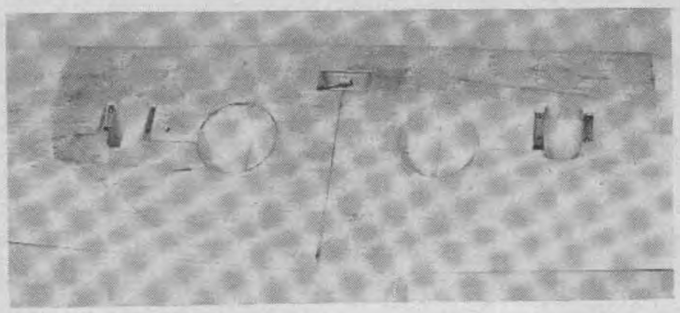
Now try a spin using rudder, elevator and aileron. The ailerons are introduced when the plane has dropped one wing 45° and in

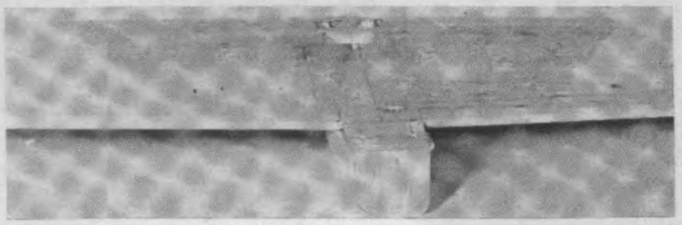
...n, shown here at 1/8th full size, are available from R.C.M.&E. PLANS SERVICE price £1.75 including V.A.T. and postage. Please quote plan RC/

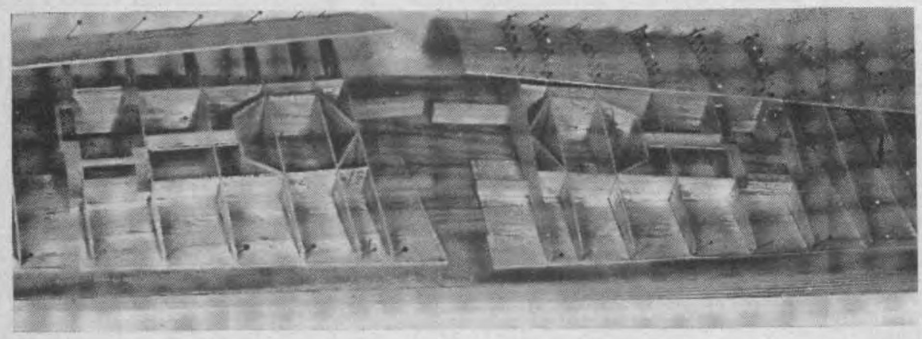




Above: first step in wing construction is to lay down wing ribs over the top surface skin, taking advantage of the straight fall of the wing section to the trailing edge. Below: one stage further on with more skin in position and undercarriage bays built-in

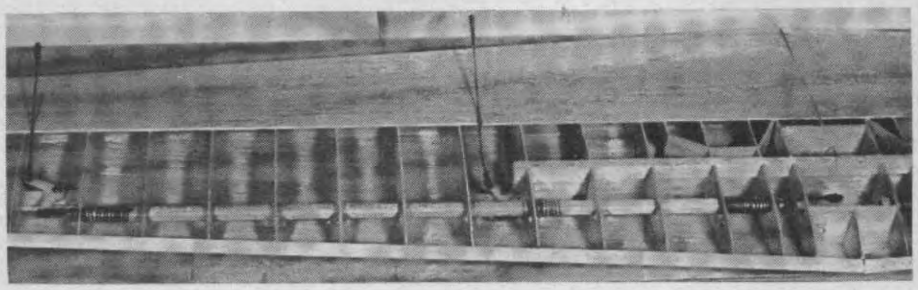


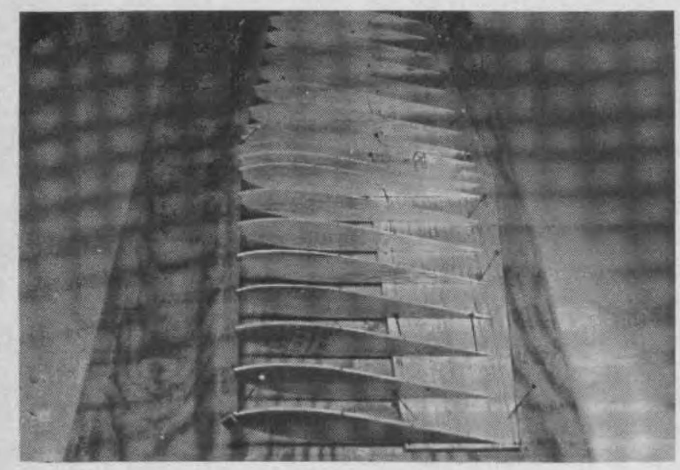




Above: two views of the completed wing showing undercarriage bays and glass fibre reinforcement.

Right: detail of the warping aileron linkage showing hefty push rod and two bellcranks.

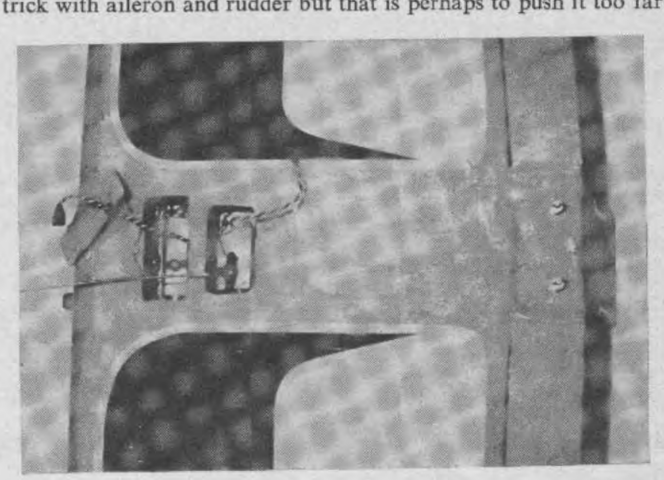


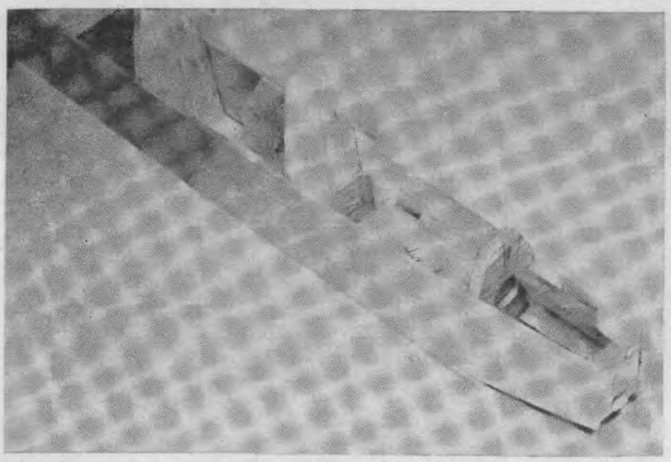


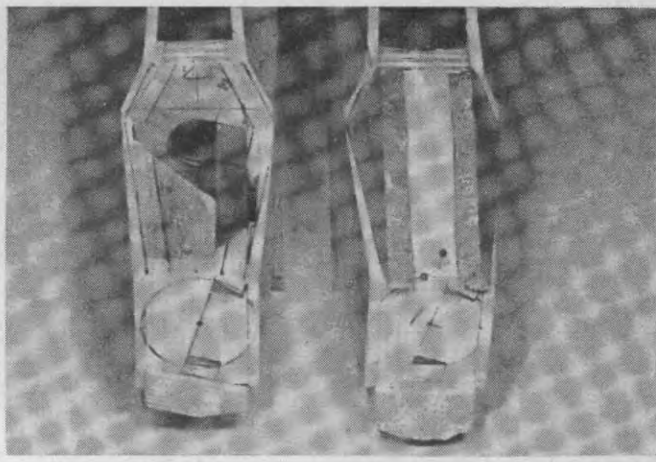
Above: tailplane under construction using same method as for wing.

the same direction as the rudder. If it won't spin, try to reduce the idle speed of the motor and if still in trouble, increase the rudder throw. However, if you don't like that much rudder for your knife edge flight, you can try an alternative trick, although it makes you a little busy. Fly the model normally with the transmitter elevator trim in the full down position. Then when slowing down for the spin, introduce more and more up elevator trim and after that full up elevator. Now you have more up elevator than you normally fly with and this might produce the desired spin, but you have to watch the recovery. As you have ten fingers you could do the same trick with aileron and rudder but that is perhaps to push it too far!

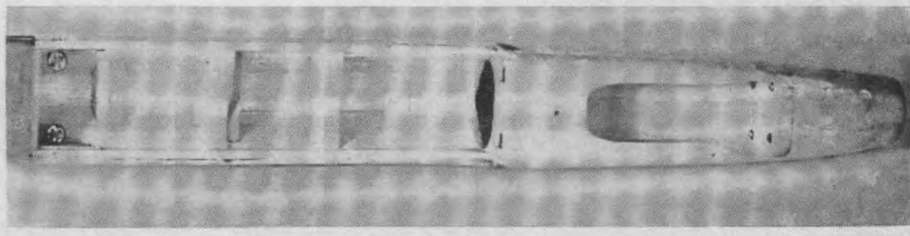
Right: wing centre section showing servo bays for aileron and retract servos.



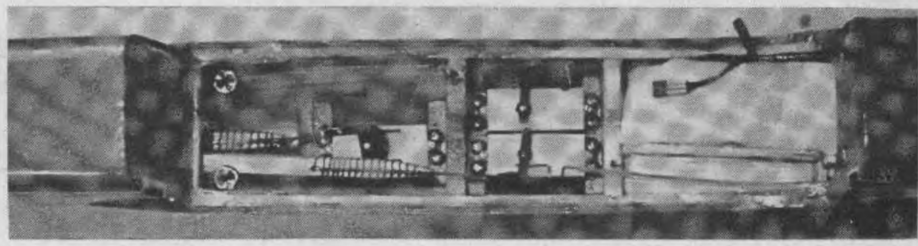




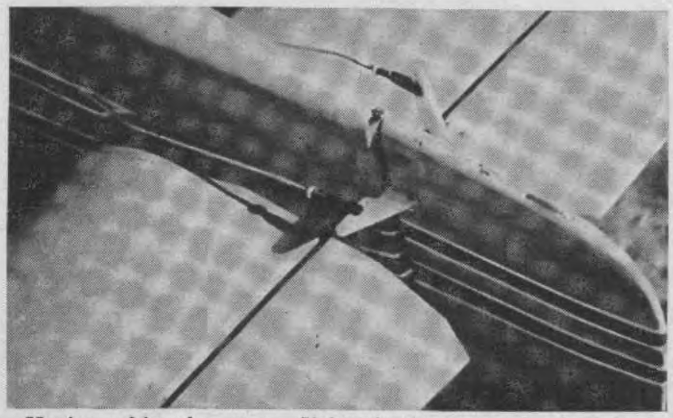
Basic fuselage construction is seen above, while detail of the engine bay is shown top right: Underside view at right illustrates the well for the retracting noseleg undercarriage assembly.



Right: completed fuselage side view. Note the ply reinforcement at the wing sect. Below right: the radio installation in the fuselage.



Below: tailcone, showing rudder and elevator control linkages. Rudder features push rod to control horn on one side, plus thread link to control horn on opposite side to minimise slip in linkage.



Having achieved a course flight trim, we now take the exercise further. For the fine flight trim you will appreciate the advantages of a midwing design with no sweep which gives far less secondary effects when correcting for something. For example if you introduce a rudder command or change engine sidethrust, you will usually have more yaw and roll side effects in the case of a low wing design with a lower C.G. position and greater dihedral angle. In most instances the same applies to a swept wing design where always the 'outside' wing in a yaw will produce more drag and roll moment due to its larger relative span compared to the 'inner' wing. The higher drag of the lower wing also necessitates more rudder correction in knife edge flight than if you have a straight wing.

To achieve fine flight trim you need a calm day. Trim the plane exactly straight and level upright, then make an outside loop. If it rolls and turns over slowly to the right, you can of course, correct this by introducing a little right aileron trim, but that would also affect your straight and level flight, so a better method of correction is to apply 2-4 gr. weight to the left-wing tip which is too light and moves inwards due to centrifugal forces.

If the model drifts sideways in a loop with the wings horizontal, something is wrong with the engine thrustline. Again, you can correct this in flight, by introducing opposite rudder trim, but of course it should really be corrected by altering the engine thrustline in the opposite direction to the drift.

Next, check the straight and level flight upright and inverted, which now ought to be good. If you have trouble, remember that if there is a tendency to roll in one direction when upright and in the other direction when inverted, the wing moving downwards is too heavy. If it rolls the same way from both upright and inverted positions, you are simply flying with a little aileron trim bias which is corrected at the trim lever.

The steps above must be done over and over again. If you are confused and don't know how to solve it, just add 3-5 gr. to one wing tip and observe the result. Better or worse? Sometimes you will find conflicts, as one solution makes something else worse, but usually even a quite 'warpy' model can be made to fly cleanly so don't give up, whatever the wise guys say!

When, after all, you have ended up with an acceptable trim, you happen to re-check the balance of the wing tips you will probably find that the model tilts one way. The reason is that it is not enough to have each wing of the same length, you also must have exactly the same chord and lift properties. Two grams out of balance is easily registered as out of trim during flight and that is not much compared to a total weight of 4,000 gr.

Full-size copies of the plan, shown here at $\frac{1}{8}$th full size, are available from R.C.M.&E. PLANS SERVICE price £1.75 including V.A.T. and postage. Please quote plan RC/1238 when ordering.