



# BKB-1

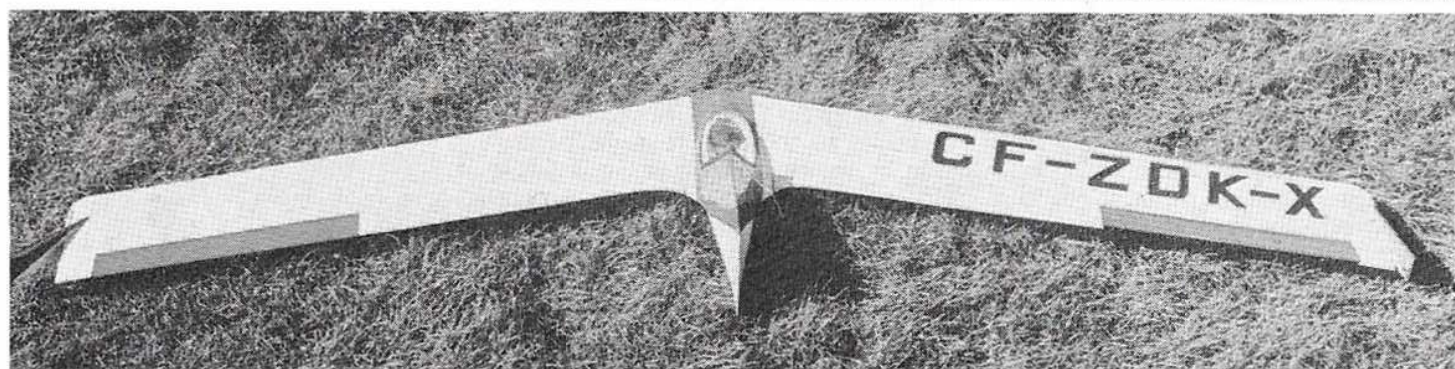
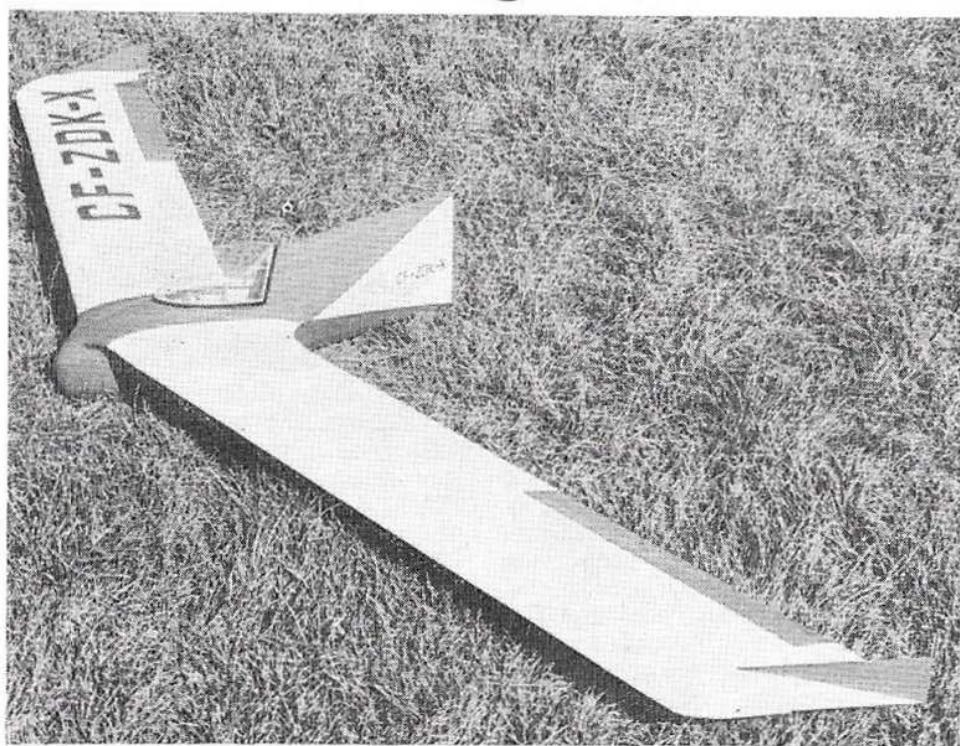


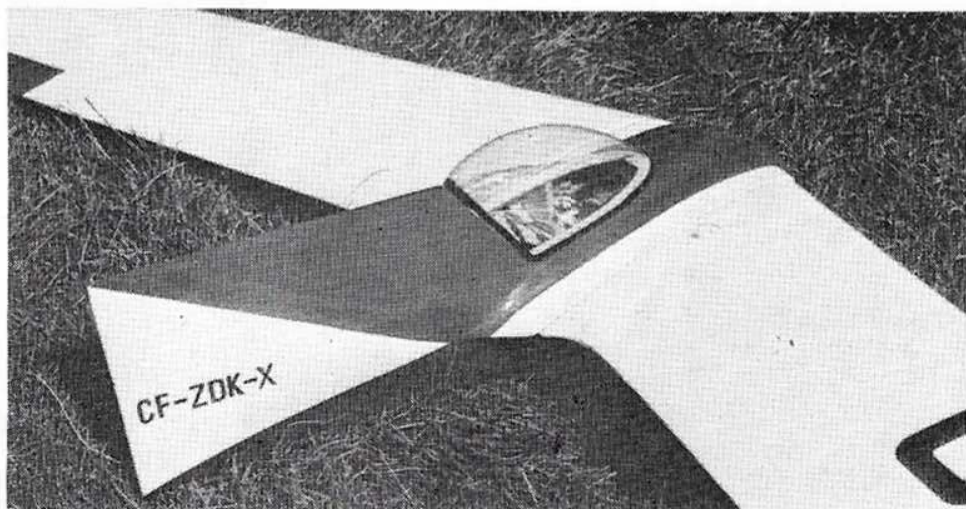
by NICK COOK

A GLANCE over the scale models entered in any scale slope-soarer competition is enough to recognise two distinct groups. The first comprises immaculate and detailed models of string-and-sealing-wax antiques, produced by great care and perseverance. The second comprises at-least-50%-prefabricated plastic stick-insects, 'produced' by capitalising on the hard work of a few individuals. (Whatever became of the pilot/builder rule?) If you haven't the skill or patience for the first group and you don't like to cheat, the only solution is to try something completely different. . . the *BKB-1*.

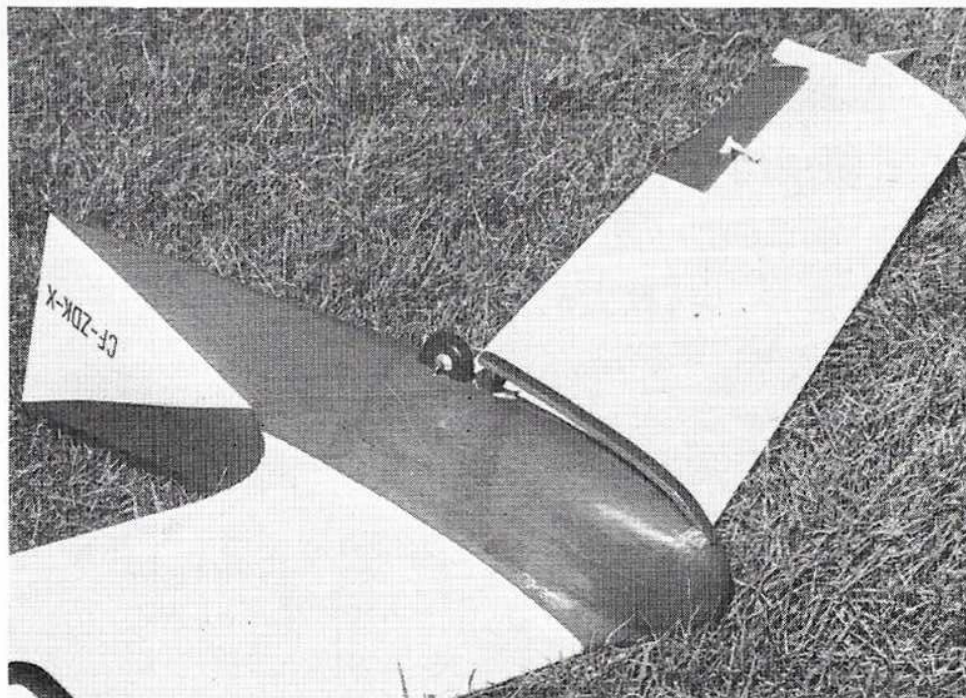
The *BKB-1* is an experimental tailless sailplane, designed and built in Canada, which first flew in 1959. The wings are swept back at 13deg. to improve directional stability, enabling a linear twist of 5deg. wash-out to be used instead of reflex camber to obtain flying trim. This combination of sweep and twist is a good candidate for flutter problems unless the wing is stiff in both torsion and bending. The final form of the model incorporates several lessons in this respect, learnt the hard

**Something different for the slope – a 96in. span scale tailless glider!**





A couple of different angles on the BKB-1. In shot below the model is inverted to show the skid, wheel and elevon horn.



way with the first prototype. In particular, the method of wing-fixing was made to be rigid under flight loads. Even if the use of a 9mm thick ply plate to anchor the wing-joiner may seem a little extreme. . . it works, and I recommend that no reductions in the indicated material sizes should be made. Follow the plan and the result will be a lightly-loaded model with a good speed range and positive control response which looks... *different.*

## CONSTRUCTION

### Fuselage

The fuselage is shaped quite like an egg, but flattened at the 'tail' end to give the effect of a fin. The shape means that conventional sheet construction must be confined to the 'tail', while the double curvature of the nose and wing roots requires planking like a boat hull.

Construction proceeds in this order. . . . Laminate all top fuselage formers to  $\frac{3}{16}$  in. thick, using  $3 \times \frac{1}{16}$  or

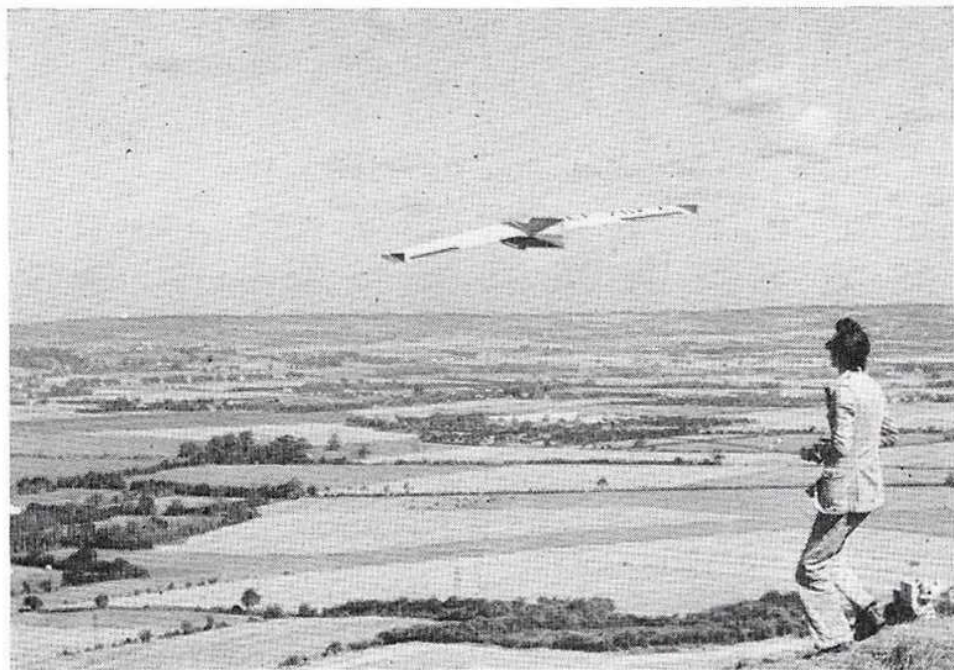
$2 \times \frac{3}{16}$  in. sheet pieces from your scrap box. Leave the bottom formers as something to do while the top fuselage assembly is setting. Formers F2, 3, 4 and 5 are reinforced with ply, as are the cockpit edgings, and F2 and F5 have doublers on one side to support the front skin. Fret out the ply wing roots and the wing-joiner plate, cutting the groove in the latter with a stiff-backed saw. A trial assembly of the top frame should be made. At this stage, the Graupner wing-joiner can be epoxied into its groove using the wing root slots to maintain the correct alignment, but don't get epoxy on any other joint yet. The formers should be chamfered carefully to the correct angle for the skin by removing each one individually and replacing it afterwards. A narrow strip of  $\frac{1}{16}$  in. balsa pressed gently against the frames give a good indication of the amount of chamfer required. Disassemble the frame, drill the ply plate at 4 or 5 places each side of the wing-joiner and bind securely

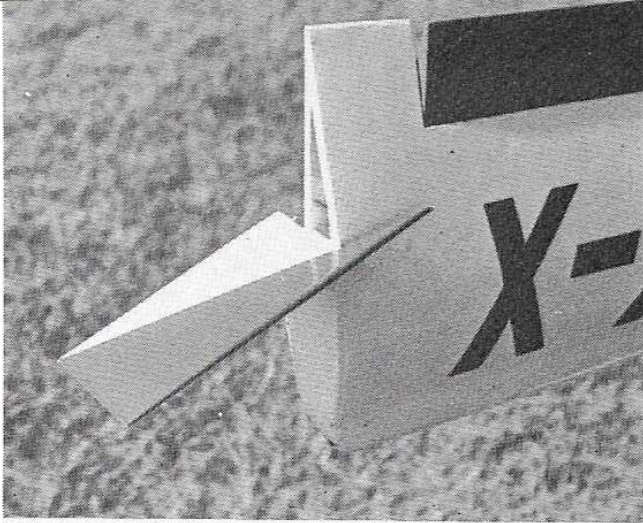
with button thread. Re-assemble and glue the frame and allow to set.

The completed top fuselage frame is very flimsy, especially at the tail, so the first skin must be applied very carefully from the bottom and working upwards. As the skinning proceeds, the structure becomes very rigid. The 'tail' end behind F5 can be skinned with 3in. wide sheet as the curvature is quite small, using enough pins to keep it against the formers. Forward of F5, the nose and wing fairings require planking with between  $\frac{1}{2}$  in. and  $\frac{3}{4}$  in. wide strips. Each successive strip should be offered to the assembly and the edge which butts against the previous strip 'adjusted' to fit with a razor plane.

When the top fuselage is quite dry, it may be lifted, inverted and replaced on the bench, sitting on the cockpit frame with the 'tail' sticking

out. The longerons for the bottom frame should be pinned—but not glued—in place on the inverted top fuselage and the bottom frame built onto them, chamfering each former as before. When dry, the bottom frame is removed, re-pinned to the bench and skinned separately. A double thickness of skin is used forward of F5, the first applied with the strips longitudinally and the second with the strips at 45deg. This produces a very strong shell. The bottom half should be  $\frac{3}{8}$  in. too big all round at the joint to allow for small misalignment when finally joined, and this excess is sanded off afterwards. The nose block, top and bottom  $\frac{1}{2}$  in. sheet spines and  $\frac{1}{8}$  in. trailing edge are added last. Correct curvature for the skid can be obtained by taping it against the underside of the fuselage while it dries. The very large bubble canopy is





available from Radio Modeller but why not make a plug and mould your own? No attachment method is shown on the plan since this is a matter of personal preference and depends on the degree of scale detail you want.

### Wings

The first job here is to make up the simple jig from two lengths of straight lin. sq. batten and some hardboard. This jig is essential to build the correct amount of twist into each wing. It is flexible enough to be twisted each way but, when clamped to the bench with packing at one end to maintain the twist, is sufficiently rigid to build upon. As

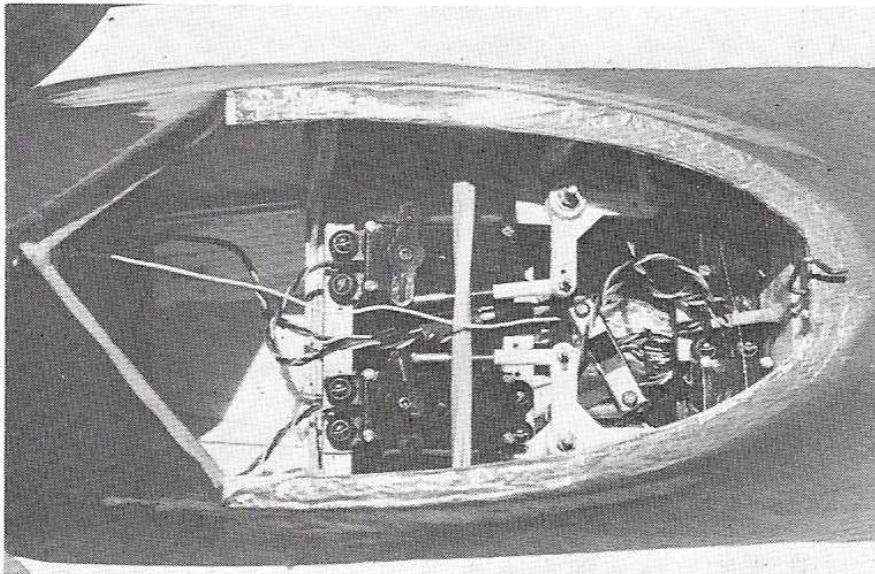
The unusual rudder/brakes are described in the constructional article. Right: into the blue.

the wings are fully sheeted, the second job is to prejoin 4 sheets to 10½ in. x 48 in. overall from individual 3 in. or 4 in. sheets. Use PVA glue, butt-joints to get the width and zig-zag scarf joints near the tips to get the extra length. Take the opportunity to pre-sand the skins flat on the bench.

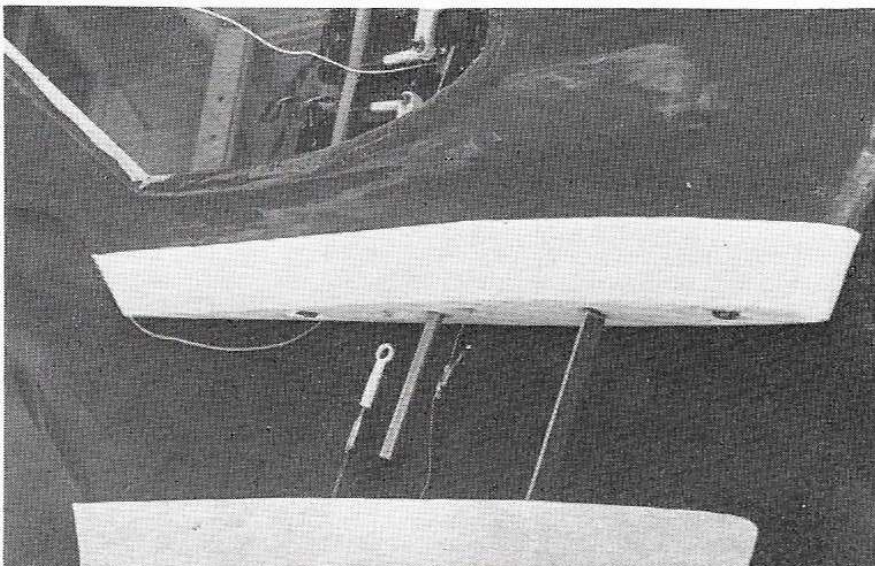
Before starting on each wing, make quite sure the jig is twisted in the correct sense for that wing—washout (i.e. the trailing edge of the tip is raised). Assembly is conventional, starting with the bottom skin and building upwards. Don't forget that

all the mechanical 'works' must be inside before the top skin is applied, when about 2-years' worth of RM's are ideal for holding it down while it dries!

Draw the elevons on the top surface of each wing with a felt-tip pen. Locate the inside corners onto the bottom skin by pushing through a long pin held vertically, then draw in the elevons on the bottom surface too. Cut out each elevon carefully with a razor saw, then trim back the edges by the thickness of the facing sheets ( $\frac{3}{32}$  in.), before facing the cut edges. Note that the 13deg. rake of the hinge-line requires that the *out-board* side of both gaps are chamfered on the underside to prevent binding, in addition to the chamfer along the hinge-line to allow the elevon to move downwards. The root fillet and the tip can now be built on, then the simple sheet tip-fins and drag-rudders added.



No doubt the scale purist will wish to at least put a pilot and instrument panel in his model. Below: detail of the wing fixing and control linkages—note ball-and-socket elevon rod joiner.



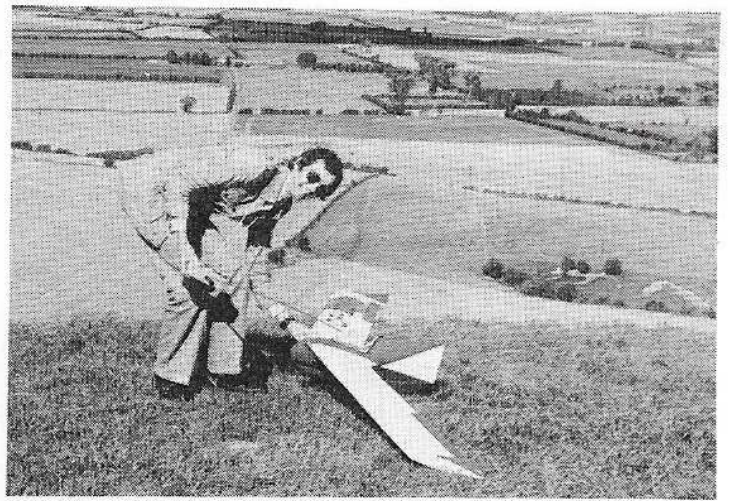
### Controls

Control is by elevons and combined rudder/airbrakes, requiring four transmitter/receiver functions and two control mixers. This can be reduced to 3 functions and one mixer by omitting the airbrakes, but no further, since independent rudder and aileron actions are advised. Elevon movement on the prototype is  $\frac{1}{4}$  in. each way as elevator and the same again as aileron since an equal-mix electronic mixer is used, but this makes the model a little over-responsive to elevator and under-responsive to aileron; so a 2:1 aileron/elevator mix is suggested. Elevon action must be slop-free for positive control, so use an electronic mixer in preference to a mechanical one.

The prototype requires  $\frac{3}{16}$  in. 'up' for neutral trim with 5deg. twist (as per the full-size) and the c.g. as indicated on the plan. The c.g. position shown gives the degree of stability I prefer—just stable and no 'zooming'—so an increased twist of 6deg. is recommended on the plan to remove the elevon offset. The tip/rudder/airbrakes are rather unconventional; they move *outwards only*, singly for rudder action and



"It'll never fly..." When Nick prepared to launch *BKB-1* for the first time, this quite spontaneous gathering of fellow modellers took place. Perhaps they were disappointed—it flew!



together as airbrakes. This one-way action is achieved by the use of thin control-line wire which pulls out a sprung-return arm for rudder control in one direction, but merely goes slack when opposite control is given.

The rudders themselves are not sprung-return like the control arm, but are free to return (or not) by the pressure of the airflow. There is a good reason for this. . . I think. The "fin" action of the fuselage is weak due to the small moment arm. Similarly, the side force from the tip-rudders also has a small moment arm. It is the drag force from the rudders acting on the long moment arm of the wing span that produces an effective yawing moment. When the *BKB-1* slips sideways the upwind rudder is pressed shut against the wingtip and produces a drag couple to yaw the model in the correct sense. The downwind rudder is free to open, producing no drag and hence no opposing couple. Independent rudder and airbrake action requires a second mixer. Running two control wires from each rudder one to a rudder servo and the other to a brake servo, will give both controls without a mixer *but* the brake will override the rudder action. The wing-retention rubber bands must be strong enough to re-seat the wing root against the fuselage if it gets displaced, otherwise the model's trim will change.

### Covering

Since this is a scale model of a "one-off" design you have no real choice of colour scheme. The scheme is very attractive so you've not much to grumble about! (*See centre colour spread—Ed.*) It is marked out on the plan, together with the registration letters CF-ZDK-X. (CF=Canada, -ZDK=individual registration of a/c and X=temporary-experimental-certificate-of-air-worthiness-pending test-results!!!) As the model is fully sheeted an overall tissue-dope-paint job is possible, and the lazy way (my) is to use plastic film. . .but watch out for wrinkles on the double-curvature of the front fuselage.

### Flying

After all the time and trouble in making the model, it would be daft to just lob it off a hill without first trimming it out. . .even if you are sure there is lift. As the model is quite light and floaty, it is possible to trim it without it ever leaving your hand. Pick a day with enough breeze to send you scurrying to the hill, but find a flat field instead. (*Sacrilege!—Ed.*) Hold up the model with one hand under the fuselage and with a finger crooked between fuselage and skid. Trot gently into the wind and, when the trim is right, you will be able to relax your grip and feel the model 'flying' captive on your finger. Now you can throw it.

You will find the *BKB-1* has a large speed range—from 'floaty' to very 'fast'—because the model is light and there is also very little parasitic drag. The aileron action is crisp when the model is flown fast, but becomes progressively less effective as the model is slowed down. For flying slowly in light slope/thermal lift, coordinated rudder and aileron are required, as the rudders remain effective throughout the speed range. The *BKB-1* will pull very small loops if you want them, but I prefer the large round one it does beautifully. The effective tip-rudders ensure consistent stall turns, but application as airbrakes makes little difference at low speed, since they are pure drag devices and do not dump any lift. Their usefulness is apparent in limiting the speed in a moderate dive to get out of strong lift as the *BKB-1* is unspinnable. With 'full everything' to initiate a spin it will only manage a half turn before pulling out into a large spiral. If all control except full elevator is released, it does a series of alternate  $\frac{1}{2}$ -turn spins. . . something like a falling leaf.

While you are building your *BKB-1* I must get back to working on my next scale effort. This one is going to have a tail. . .on the front.

