CLOUD BOUND 4

A RADIO CONTROLLED DURATION SAILPLANE OF TWELVE FOOT WING SPAN FEATURING A VARIABLE CAMBER WING WITH COUPLED DRAG BRAKES AND SPOILERS

BY DON DRURY

Thirty five years of modeling, mostly in free-flight categories, had led to a wealth of knowledge and instinct into what makes a winning competition airplane. All the theory and claims about design, airfoil, glide ratio, etc., is important, and a logical approach to modeling, but does not necessarily create winners. If it did, all models would be identical. If we look over the designs of the top ten models at any large contest, we find that wing spans will vary from 7' to 13', wing loadings of 6.5 oz. to 12 oz., high or low aspect ratios, with or without spoilers, fiberglass or built-up construction, V-tail or conventional, etc.

So what makes a winning model? First, of course, a good clean design free of problems like warped wings, loose couplings, a ship with good responses, positive reactions and consistency. In other words, a carefully constructed airplane. Second, and probably the most important, is the pilot. Luck can be a dominant factor in competition flying, however, the experienced flyer who knows his ship like the back of his hand is the one who's at the top of the heap consistently.

Last season my competition flying was disastrous, yet the three models I flew are all capable of winning contests and my flying ability is adequate. We could say the year was one of bad luck. Even though I feel luck is a big factor in competition, I can't accept bad luck for a bad showing.

I spent some time thinking of all the factors that contributed to last year's flying and made a problem and possible solution list to see what I could come up with in the way of a sailplane with greater potential. Here is a summary of that thinking:

(1) Problem: Sloppy flying.
Solution: Practice, practice, practice. Know your ships' capability. Test fly in all conditions.

(2) Problem: Not enough altitude off tow.
Solution: Tow hook position is critical. Test fly under all conditions and move the hook accordingly. An electric winch will take a large ship higher than a small ship.

(3) Problem: Cross wind launch.
Solution: Again, a larger ship will work better in a cross wind than a small ship.

(4) Problem: Light to no wind.
Solution: Light loading, a large ship, tow hook position, high lift wing (undercambered).

(5) Problem: Windy day.
Solution: Faster ship on the tow. One that will penetrate to the top of the tow into the wind. Add ballast. Sharp leading edge for penetration, strong wing, clean ship, flat bottom wing, added ballast for penetration in the glide. Spoilers and/or flaps needed for landing.

The author with his magnificent Cloud Bound 4, a highly competitive Open Class sailplane.

If you want an Open Class machine that is the ultimate in sophistication, versatility and performance, the Cloud Bound 4 is for you.

(6) Problem: Variable winds or gusty winds.

Solution: Spoilers and possible drag brakes are necessary for spot landing. Variable camber wing to penetrate at maximum wind condition. Added ballast also needed for penetration.

(7) Problem: Rolling terrain.

Solution: Spoilers for landing, low level ground thermals of a rolling terrain can be used for lift if penetration speed balances the wind velocity closely. This can be achieved with variable camber.

(8) Problem: Tight, clean turns in a thermal and on landing approach.

Solution: Polyhedral wing. If a large ship, the approach turn must be made with enough altitude.

(9) Problem: Airplane velocity in relation to thermal.

Solution: Bubble thermal: Should fly tight and slow circles. Wave type or stationary thermal: Fly a bit faster than wind speed and drift back and forth across the face of the lift. The Solution is ballast and/or variable camber to maintain proper speed relative to wind velocity.

(10) Problem: Getting back to spot landing after downwind thermal ride.

Solution: Ballast, variable camber, clean design, sharp leading edge.

(11) Problem: Getting to a thermal in a hurry. Sometimes you come off the hook in lift, but usually it is on the other side of the field.

Solution: Fast ship, variable camber wing so that you can pick up velocity so you can get there in a hurry.

(12) Problem: Structure.

Solution: Strong but light; give

TYPE AIRCRAFT
Competition & Sport Sailplane
WINGSPAN
144 Inches
WING CHORD
11¼" (Root) 6⅝" (Tip)
TOTAL WING AREA
1278 Square Inches
WING LOCATION
Shoulder Wing
AIRFOIL
Variable Camber
WING PLANFORM
Double Taper
DIHEDRAL, EACH TIP
2½°
POLYHEDRAL, EACH TIP
3½°

O.A. FUSELAGE LENGTH
51 Inches
RADIO COMPARTMENT AREA
(L) 15" X (W) 2⅜" X (H) 2¼"
STABILIZER SPAN
36 Inches
STABILIZER CHORD (incl. elevons)
5-7/16" (Avg.)
STABILIZER AREA
193 Square Inches
STAB AIRFOIL SECTION
Flat
STABILIZER LOCATION
V-Tail, Top of Fuselage
VERTICAL FIN HEIGHT
NA
VERTICAL FIN WIDTH (incl. rudder)
NA

REC. ENGINE SIZE
NA
FUEL TANK SIZE
NA
LANDING GEAR
NA
REC. NO. OF CHANNELS
3 (Using 4 servos)
CONTROL FUNCTIONS
Elevons, Flaps
Brake Flaps & Spoilers
BASIC MATERIALS USED IN CONSTRUCTION
Fuselage .... Balsa, Spruce & Ply
Wing .... Balsa, Spruce & Ply
Empennage .... Balsa, Spruce & Ply
Wt. Ready-To-Fly .... 80 Oz.
Wing Loading .... 9 Oz/Sq. Ft.

special thought to wing spar construction, fiberglass fuselage, etc.

(13) Problem: Variable wing camber.

Solution: Slight increase in drag at hinges, possible over-control.

(14) Problem: Ballast.

Solution: Can't change ballast during flight. If ballast is used — locate ballast in wing, not in fuselage.

The conclusion I have arrived at in going over this list is the "Cloud Bound 4". A 12' span sailplane with a 9 ounce wing loading should be the best answer to calm conditions and bubble thermals. I have also opted for variable camber wings to increase or decrease the speed of the plane as wind conditions vary and I also use some ballast additions where I feel it will help. As long as I'm using a variable camber design, drag brakes coupled to fence spoilers become logical.

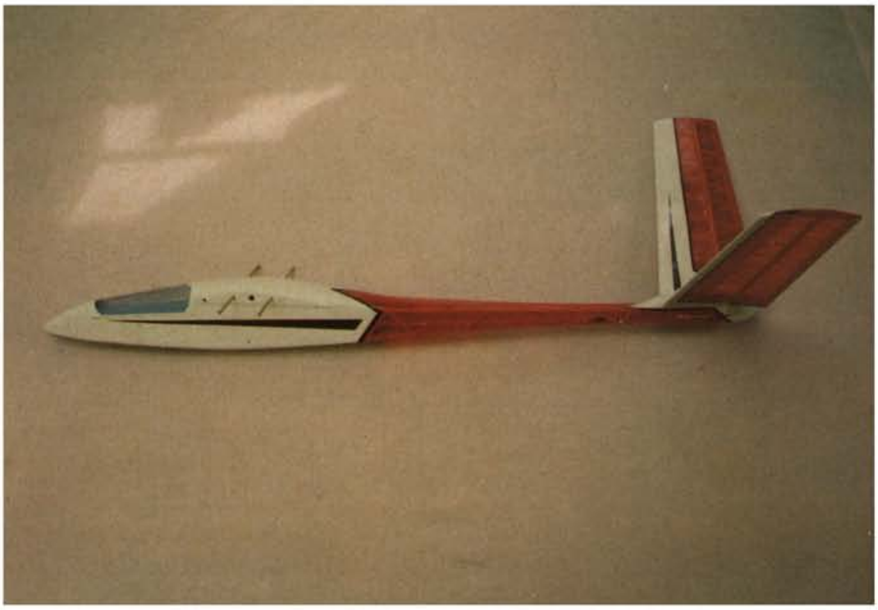
The wing structure is based on Lee Renaud's Grand Esprit. I feel the spar structure he used is the strongest possible considering the weight factor. The front section of the fuselage is fiberglassed for strength and the after structure is of spar construction for lightness. A V-tail is lighter than a conventional stabilizer and rudder. Only 4 ounces of nose weight was needed to balance at the Center of Gravity. This is my answer to the variable conditions that plague contest flying and if you agree, let's start building.

CONSTRUCTION

Fuselage: The fuselage sides are 1/4" spruce longerons with 1/4" square hard balsa cross members and 1/4" soft balsa sheet inserted from the nose to the rear of the wing. Build two sides, one over the other. Add the top and bottom cross braces and add 1/4" triangular stock inside the cabin area as a base for the 1/2" sheet top. The bottom of the fuselage is 3/8" sheet balsa. The tail section of the fuselage is shown in the exploded drawing including a simple method of changing the incidence.

The tongues for the elevons are 1/16" aluminum sheet. Add scrap blocks where needed at the tail mounts and add the nose block. 1/8" square spruce stringers are used to flow the top and bottom sheet balsa into the rear section of the fuselage. Install a plate of 1/8" plywood to receive the Airtronics tow hook. Install the wing rods in the fuselage and temporarily fasten in place with 5-minute epoxy.

Use the lightest fiberglass cloth you can find and glass the inside of the fuselage in the cabin area. Use a liberal amount of resin around the wing rods. Fiberglass the entire balsa area of the fuselage with light weight glass cloth. Two coats of resin should be enough.



The Cloud Bound 4 fuselage, minus wings. Note Vee-tail.

Before fiberglassing, be sure to carve and sandpaper the ship to the proper cross section.

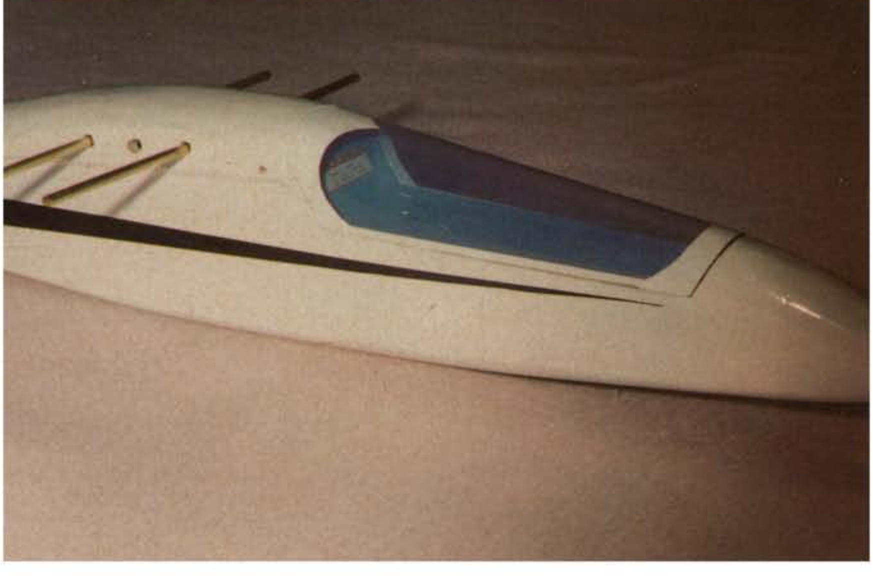
Now that the fuselage is constructed, build the canopy to fit. A commercial canopy may be used although an acetate sheet does a good job. Install the NyRods in the fuselage and cover the open area with Solarfilm. Hobbypoxy or K & B Superpoxy should be used over the tail mount and glassed part of the fuselage.

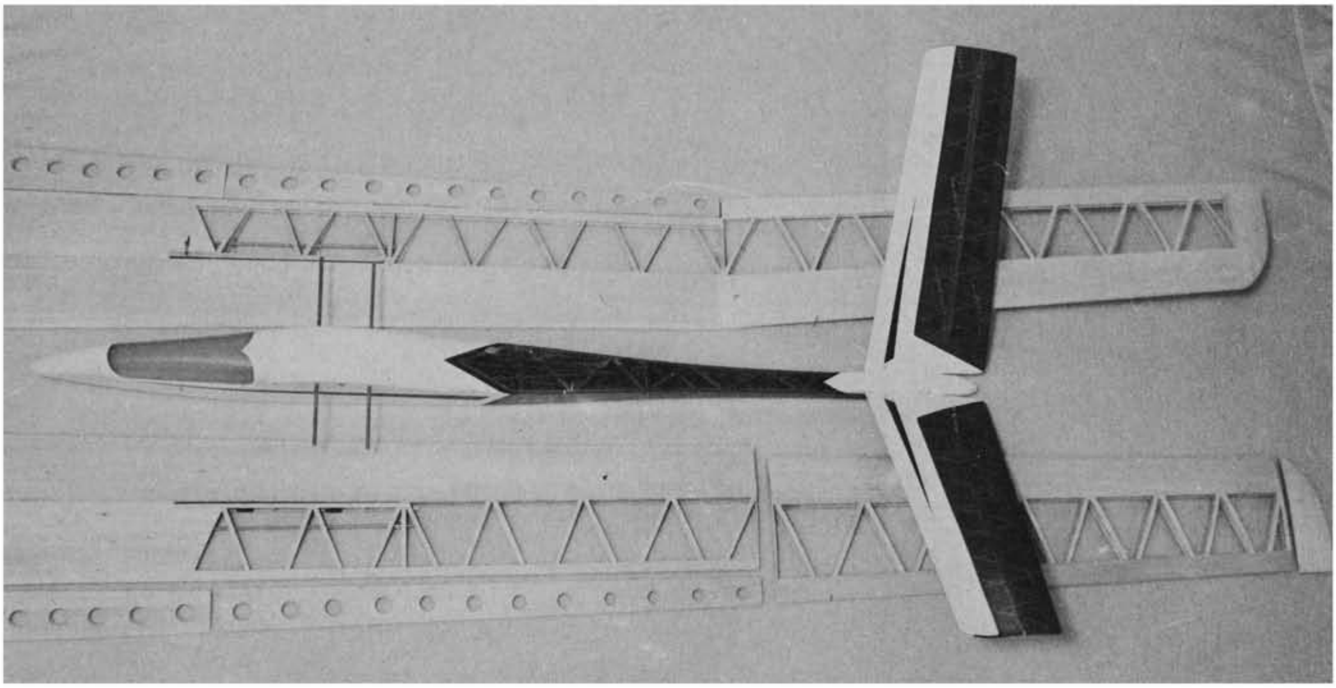
Elevons: The hinge area spars and leading edge are a sandwich type construction with 1/4" x 1/16" spruce strips between two 3/16" x 1/16" balsa strips. The ribs are 1/8" x 1/16" balsa over and under the 1/16" x 1/4" spruce spar. The trailing edge is 1/8" x 3/4" T.E. stock. The top and bottom of the root section is 1/16" ply filled with 1/16" scrap to receive the aluminum tongue. The root rib is added last and shaped to fit the tail mount. Sand to airfoil shape and bevel at the hinge area. Cover with Solarfilm and make a Solarfilm hinge. When the finished elevons are mounted in place, drill 1/16" holes through the plywood and aluminum tongue and lock in place with a toothpick or hard wood dowel.

Radio Installation: Your radio can now be installed with the batteries placed as far forward as possible. I used a Kraft four channel system with Kraft mixer for elevon control. I also used two KPS-12 servos in the wings connected to a "Y"-yoke and plugged into the motor control system of the receiver.

Wing: Construct the center section spars from four 1/4" x 1/8" spruce longerons stacked on top of each other with the top spar tapered from 3/16" to

Close-up view of the cockpit area and wing rods.





The Cloud Bound 4 with a new set of wings under construction.

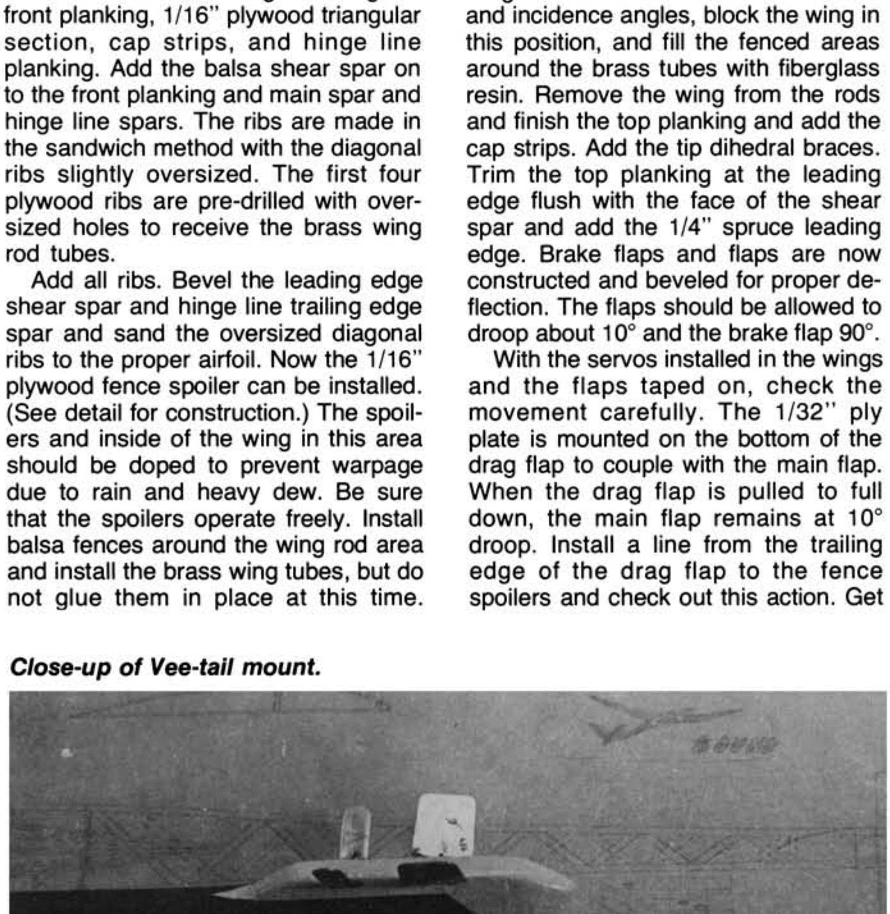
0". Add the 1/4" x 1/8" spruce spar to the face of the stacked spars. Build the entire bottom of the wing including the front planking, 1/16" plywood triangular section, cap strips, and hinge line planking. Add the balsa shear spar on to the front planking and main spar and hinge line spars. The ribs are made in the sandwich method with the diagonal ribs slightly oversized. The first four plywood ribs are pre-drilled with oversized holes to receive the brass wing rod tubes.

Add all ribs. Bevel the leading edge shear spar and hinge line trailing edge spar and sand the oversized diagonal ribs to the proper airfoil. Now the 1/16" plywood fence spoiler can be installed. (See detail for construction.) The spoilers and inside of the wing in this area should be doped to prevent warpage due to rain and heavy dew. Be sure that the spoilers operate freely. Install balsa fences around the wing rod area and install the brass wing tubes, but do not glue them in place at this time.

When both center wing panels are completed this far, mount them on the wing rods and check out the dihedral and incidence angles, block the wing in this position, and fill the fenced areas around the brass tubes with fiberglass resin. Remove the wing from the rods and finish the top planking and add the cap strips. Add the tip dihedral braces. Trim the top planking at the leading edge flush with the face of the shear spar and add the 1/4" spruce leading edge. Brake flaps and flaps are now constructed and beveled for proper deflection. The flaps should be allowed to droop about 10° and the brake flap 90°.

With the servos installed in the wings and the flaps taped on, check the movement carefully. The 1/32" ply plate is mounted on the bottom of the drag flap to couple with the main flap. When the drag flap is pulled to full down, the main flap remains at 10° droop. Install a line from the trailing edge of the drag flap to the fence spoilers and check out this action. Get all this engineering worked out perfectly, then finish sanding and prepare for covering.

Close-up of Vee-tail mount.



The tip sections are made the same way, except that only two 1/4" x 1/8" spruce spars are used. Taper from 3/4" to 1/2" at the tip. Use a few webs to space this taper. The front main spar is 1/4" balsa instead of spruce. Connect to the center panel, being careful to maintain the proper incidence angle and dihedral. Sand to finish shape and cover with Solarfilm. No wash-out is needed in the wing tips. The flaps in the droop position give a wash effect to the wing tips and are prevelant at faster speeds.

Now we are ready to fly the big bird. Check the C.G., incidence angles, and radio action. The flap action should give a flat bottom wing when the trim tab on the motor stick is in neutral and the throttle stick all the way up. This provides about 5° up with up trim and 7° down in slow trim. When the stick is pulled all the way down, the drag flaps are at 90° and the spoiler is fully extended. Make the first dozen flights with the trim in neutral and stay away from the spoilers until you really know how the ship reacts. Work in the drag flaps and spoilers when you are high enough, so you are not too surprised with the change of flight attitude. The nose will drop quite severely and the elevator action is less sensitive, causing the plane to slow down quite a bit.

Again, learn these characteristics before you start working on spot landings. Now start experimenting with flap changes. Your flying speed will increase about 10 mph from droop position to up position. Slight trim changes

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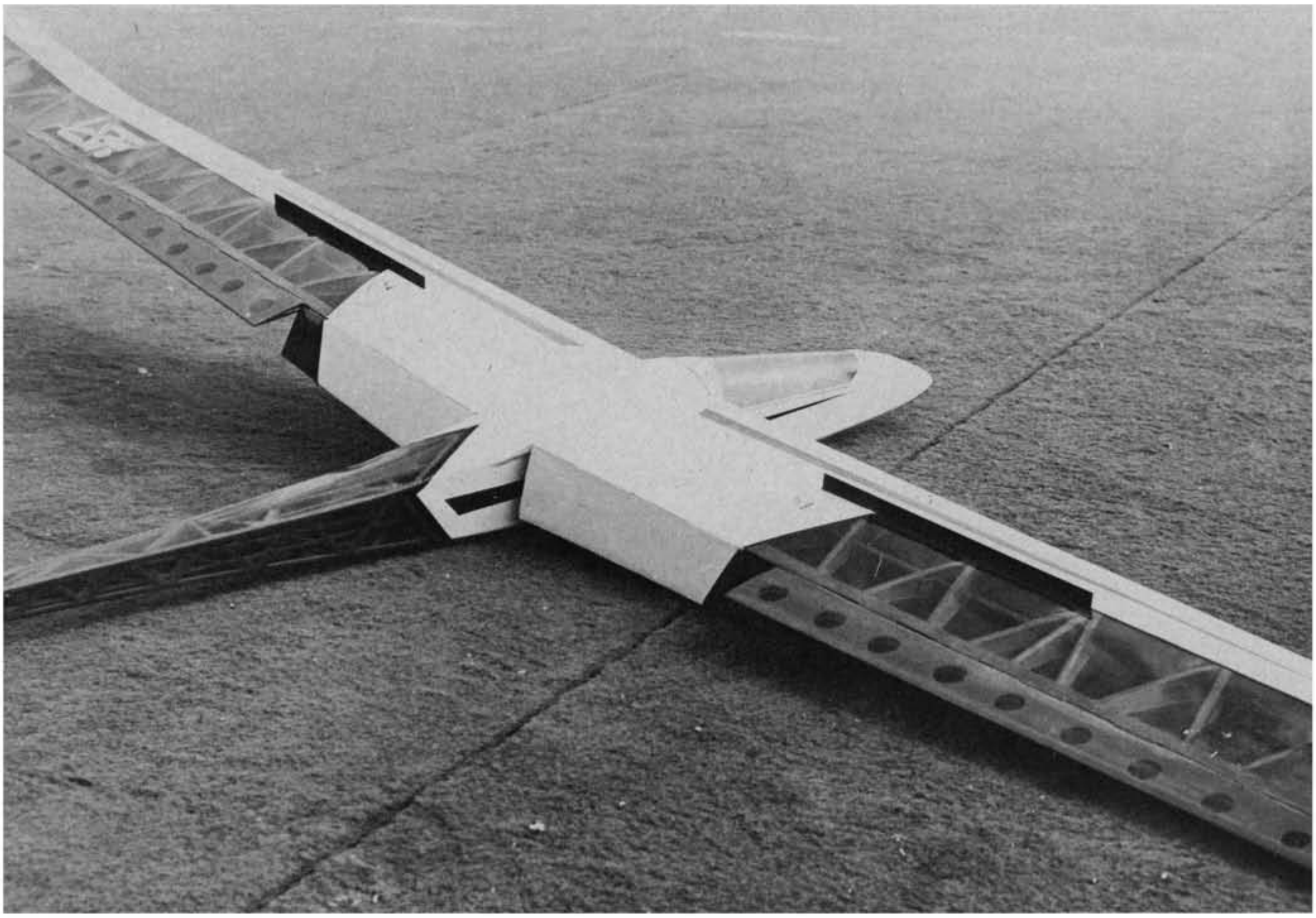
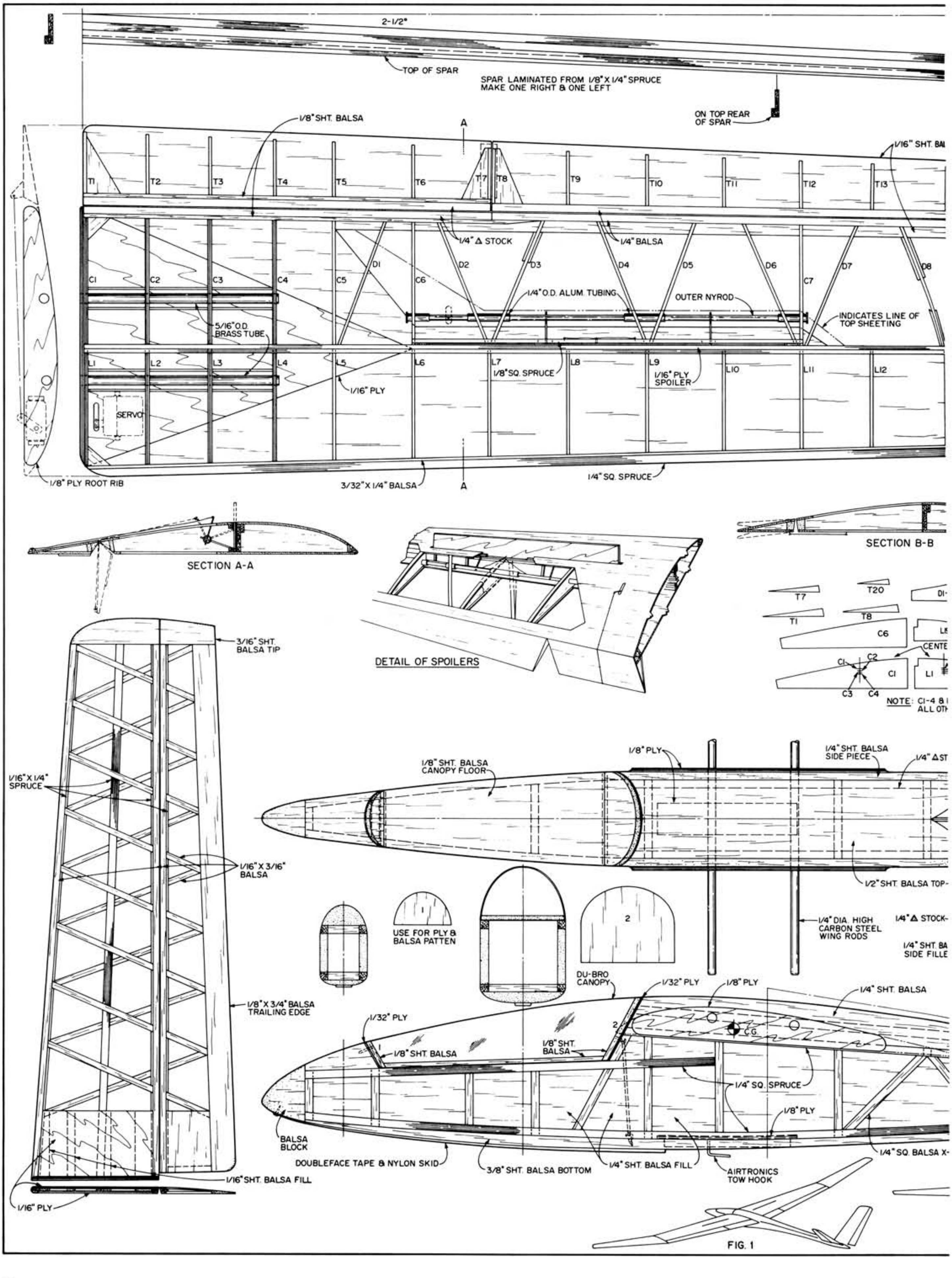
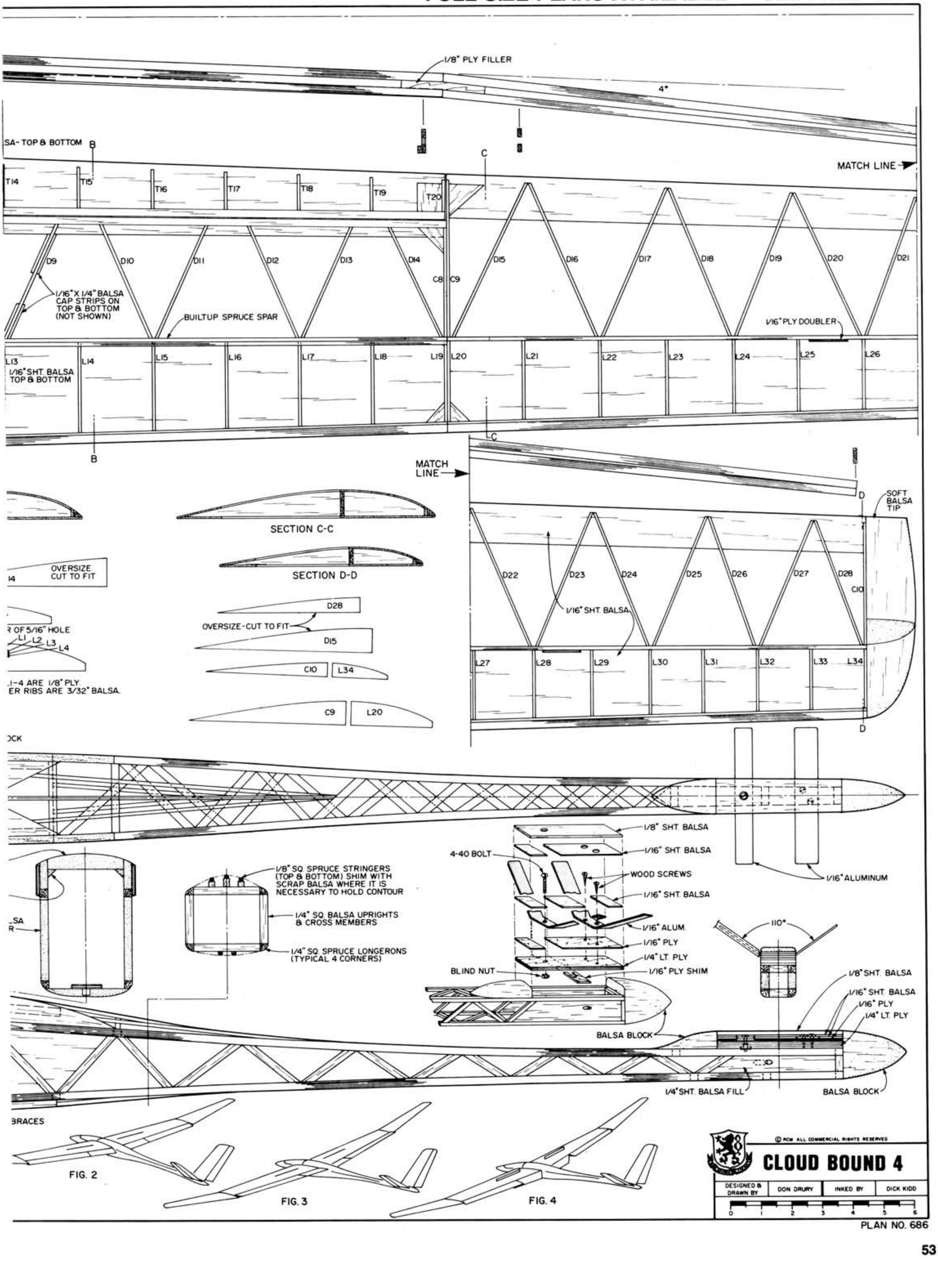


ABOVE: The coupled drag brakes and spoilers. BELOW: The Cloud Bound 4 ready to take on all comers.


2-1/2"
TOP OF SPAR
SPAR LAMINATED FROM 1/8" X 1/4" SPRUCE
MAKE ONE RIGHT & ONE LEFT
ON TOP REAR OF SPAR
1/8" SHT. BALSA
A
1/16" SHT. BAL
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
T13
1/4" Δ STOCK
1/4" BALSA
D1
D2
D3
D4
D5
D6
D7
D8
C1
C2
C3
C4
C5
C6
C7
1/4" O.D. ALUM. TUBING
OUTER NYROD
INDICATES LINE OF TOP SHEETING
5/16" O.D. BRASS TUBE
L1
L2
L3
L4
L5
L6
L7
L8
L9
L10
L11
L12
1/8" SQ. SPRUCE
1/16" PLY SPOILER
1/16" PLY
SERVO
1/8" PLY ROOT RIB
3/32" X 1/4" BALSA
1/4" SQ. SPRUCE
SECTION A-A
SECTION B-B
DETAIL OF SPOILERS
T20
D1
T1
C6
C1
C2
C3
C4
L1
CENTE
NOTE: C1-4 & L
ALL OTH
3/16" SHT. BALSA TIP
1/16" X 1/4" SPRUCE
1/16" X 3/16" BALSA
1/8" X 3/4" BALSA TRAILING EDGE
1/16" SHT. BALSA FILL
1/16" PLY
1/8" SHT. BALSA CANOPY FLOOR
1/8" PLY
1/4" SHT. BALSA SIDE PIECE
1/4" ΔST
1/2" SHT. BALSA TOP
USE FOR PLY & BALSA PATTEN
2
1/4" DIA. HIGH CARBON STEEL WING RODS
1/4" Δ STOCK
1/4" SHT. BA SIDE FILLE
DU-BRO CANOPY
1/32" PLY
1/8" PLY
1/4" SHT. BALSA
1/32" PLY
1
1/8" SHT. BALSA
1/8" SHT. BALSA
C.G.
1/4" SQ. SPRUCE
1/8" PLY
BALSA BLOCK
DOUBLEFACE TAPE & NYLON SKID
3/8" SHT. BALSA BOTTOM
1/4" SHT. BALSA FILL
AIRTRONICS TOW HOOK
1/4" SQ. BALSA X
FIG. 1

FULL SIZE PLANS AVAILABLE — SEE PAGE 190



CLOUD BOUND 4

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may be needed to maintain level flight. Remember that in the droop position you are usually circling, or in a thermal, so trim changes should not be made at this time. Now that you are completely confident of yourself and the ship, go up on the tow with flaps in the droop position for extra lift. Release and change to the flat bottom mode and go after a thermal. When you're in the greatest lift, droop the flaps and ride the thermal and, at about 8 minutes time, reduce to the flat bottom mode again and head for the spot. If you're too far out, lift the flaps and drop the nose slightly and *move*. Make your approach from down wind toward the spot at about 9½ minutes. When you're 100 feet down wind, the 50' spot is coming up fast. Pop your spoilers and brakes about 20' out and 10' up and fly into the spot. Practice over and over again, and you'll find the Cloud Bound 4 has everything you want in a high performance sailplane - - - for competition or just plain soaring fun.□