

Electric Challenge

By Charles D. Evans



The author's granddaughter, Elizabeth Anne Laur, with the finished model.

The Twin

Thoughts of a twin electric plane had been running around in my head for quite some time; then one day while reading Bob Kopski's column, I came across a reference to Dr. Keith Shaw's article published in another magazine regarding the twin theme. This was just the stimulus needed to get the grey matter cooking and start the design process, the development of Electric Challenge — The Twin was under way.

My first thoughts were about the motor power. I have a good selection of Astro Flight cobalts ranging from 15's to 60's, so this was not really a problem and the 15 geared cobalts were finally settled upon. A lot of thought

was given as whether to have the props contra rotate or not. Keith Shaw states in his article that there was "very little change in performance" between the two options. I decided to go with the contra option. I do have memories of the old WWII warbirds using the contra principle, so I guess that's where it comes from.

Now that the power was decided, a design had to be created based on the guidelines utilizing Keith's formulas and two that have been around for long time. T-L-A-R, That Looks About Right, and K-I-L-S, Keep It Light Stupid. The effort was expended, and the model presented here is the result.

Next question, what batteries to use? I chose the Sanyo 1250 mAh SCR's because of their size, weight, and ability to deliver the punch necessary to get the craft airborne.

Many sketches were made in an attempt to catch an attractive and simple presentation. The lines of my previous design, the Electric Challenge (25) seems to have won. Most of the construction follows this design.

CONSTRUCTION

When starting to build a scratch design, I always make a kit of the parts necessary to build the complete plane. Templates are made of all formers,



fuselage sides, doublers, wing ribs, etc. Now all parts are cut from the indicated wood types and sizes. Selection and grading of the balsa used can help reduce the weight without weakening the surface or structure.

The templates for cutting the wing ribs are made from lite ply and the edges treated and hardened using thin

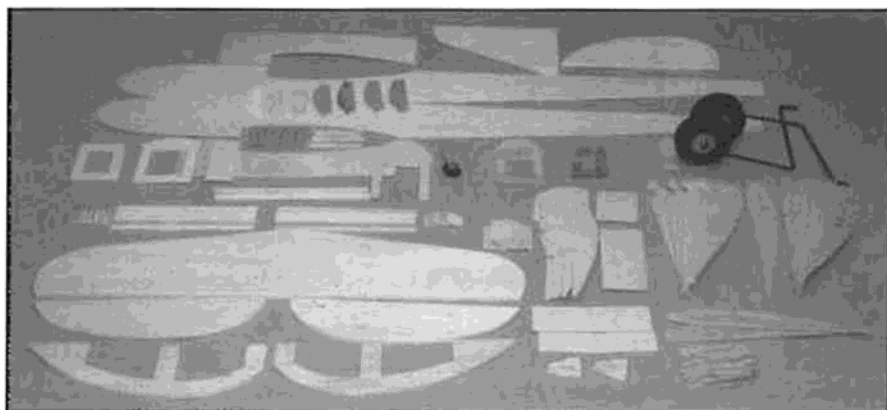
CA. This makes the edges resistant to your X-Acto knife blade. To make the leading dowel cutout, I use a 1/4" o.d. brass tube sharpened from inside to outside with a cone stone from my Dremel tool set. With the wing rib templates formed and the leading edge dowel cutout fashioned, it's a simple matter to press the tubing through the balsa when cutting the ribs. The 1/32"

wing doublers can be scored with your cutting tool and the final cutout made with a 1/4" diameter file. Construct all sub-assemblies, i.e., wing ribs with ply doublers, landing gear blocks, motor mounts and fuselage sides with doublers. Don't forget, you must make a left-hand and a right-hand side.

Sport Twin For 2 Geared 15 Cobalt Electric Motor

Set components and sub-assemblies aside until they are needed. A good place to start building our Twin is the wing. This requires the most patience and is best to complete first.

Wing: The wing assembly is straightforward with nothing too difficult or complicated, with the possible exception of the nacelles.



First step, cut out all the parts to make a kit.

ELECTRIC CHALLENGE THE TWIN

Designed by:

Charles D. Evans

TYPE AIRCRAFT

Twin Motor — Sport Electric

WINGSPAN

62 Inches

WING CHORD

10-1/2 Inches

TOTAL WING AREA

632 Sq. In.

WING LOCATION

Low Wing

AIRFOIL

Semi-Symmetrical

WING PLANFORM

Constant Chord

DIHEDRAL, EACH TIP

1 Inch

OVERALL FUSELAGE LENGTH

38 Inches

RADIO COMPARTMENT SIZE

11" (L) x 2-11/16" (W) x 2" (H) (Avg.)

STABILIZER SPAN

22 Inches

STABILIZER CHORD (inc. elev.)

6-1/2 Inches (Avg.)

STABILIZER AREA

122 Sq. In.

STAB AIRFOIL SECTION

Flat

STABILIZER LOCATION

Mid-Fuselage

VERTICAL FIN HEIGHT

8-3/4 Inches

VERTICAL FIN WIDTH (inc. rud.)

6-1/2 Inches (Avg.)

REC. MOTOR SIZE

Astro Flight Geared Cobalt "15"

BATTERY SIZE

1250 mAh SCR (24-27 Cells)

LANDING GEAR

Conventional

REC. NO. OF CHANNELS

4

CONTROL FUNCTIONS

Rud., Elev., Throt., Ail.

C.G. (from L.E.)

3-3/8 Inches

ELEVATOR THROWS

1/2" to 3/4" Up — 1/2" to 3/4" Down

AILERON THROWS

1/2" to 3/4" Up — 1/2" to 3/4" Down

RUDDER THROWS

1" Left — 1" Right

SIDETHRUST

—

DOWNTHRUST/UPTHRUST

—

BASIC MATERIALS USED IN CONSTRUCTION

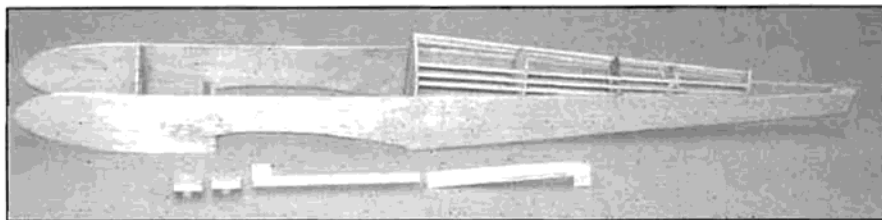
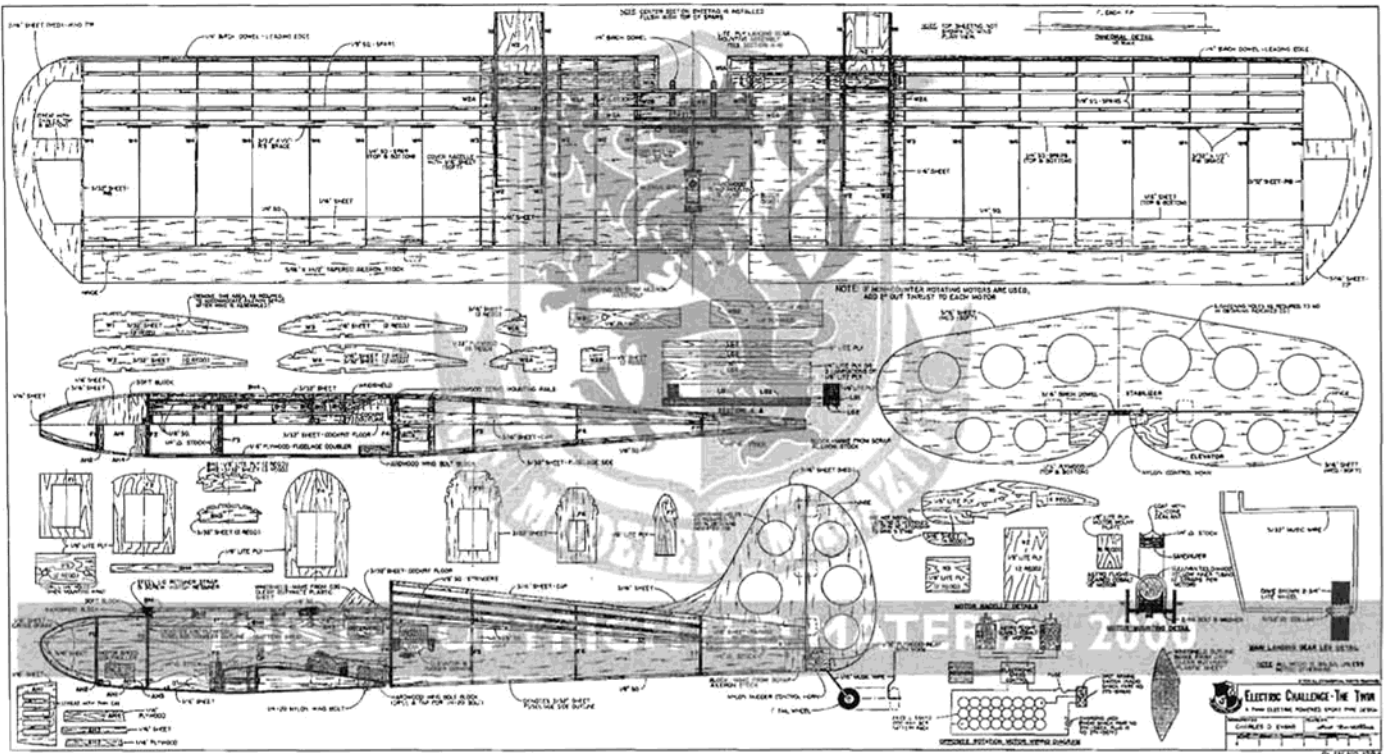
Fuselage Balsa, Ply, & Hardwood

Wing Balsa, Ply, & Hardwood

Empennage Balsa, Ply, & Hardwood

Wt. Ready To Fly . . 108 Oz. (6 Lbs. 12 Oz.)

Wing Loading 24.6 Oz./Sq. Ft.



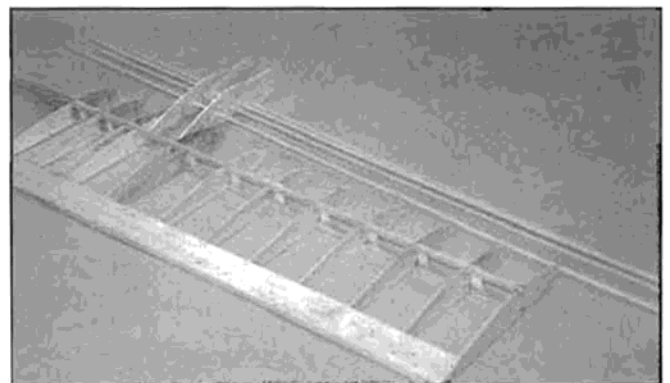
The fuselage with some of the sub-assemblies.

These may require some hand-fitting and alignment. You will notice the 1/8" sq. turbulator stringers and the 1/4" dia. leading edge dowel pass through the 1/8" lite ply nacelle sides. This imparts great strength to the assembly and at the same time keeps it light. Notice that the bracing between the wing spars does not go from rib to rib. The strength comes from the joint of the brace and the rib plus the bond of the brace and the spars. I have been using this method

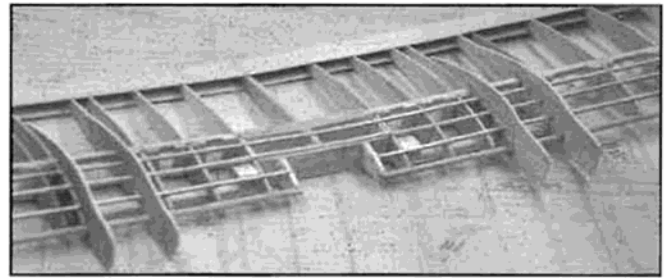
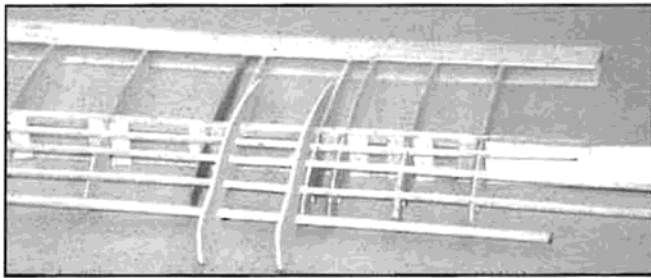
of bracing for years and have not had a failure to date. Anything you can do without compromising the structural integrity will help to make a better plane. Build it to fly — not to crash. The wingtips are where weight adjustments are made when balancing. Just remove balsa from the heavy side. Use thin CA to firm up the center web of the wingtip. Apply to the top and bottom. The landing gear blocks are made from 1/8" and 1/4" lite plywood.

They are very light and strong. Use medium CA. Be sure to allow sufficient spacing between the strips to accommodate the landing gear. A good idea is to use a leftover piece of landing gear wire as a spacer. The stack of lite plywood on the inboard section of the landing gear block must be shaped and fitted to the airfoil of the wing rib it will be glued to. After shaping and sanding the stack, drill the hole for the torsion leg of the landing gear. Sand everything square and install.

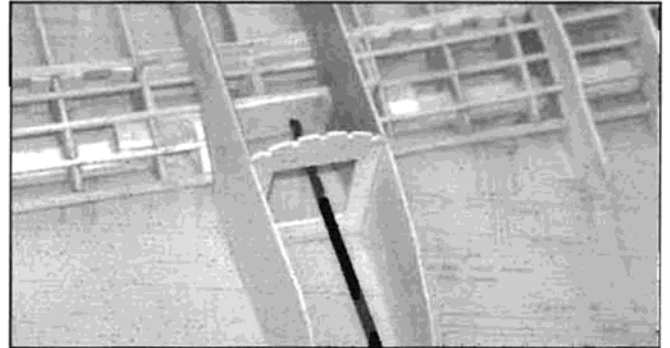
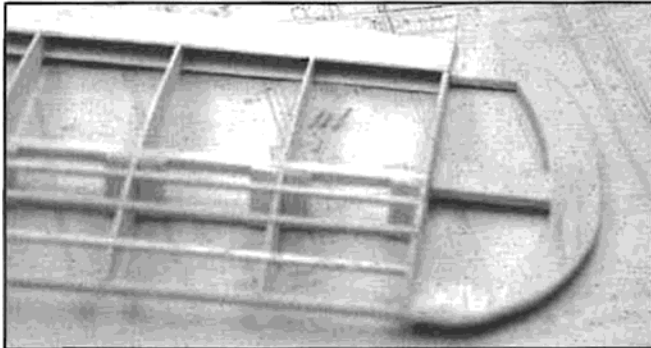
Don't forget to install the 1/4" square balsa in the aft end of the center section of the wing. It's mandatory to anchor the aileron horn wire bearings when filling the center section with epoxy as per plans. The purpose of the epoxy is to strengthen the center and to eliminate the crush when you tighten the 1/4-20



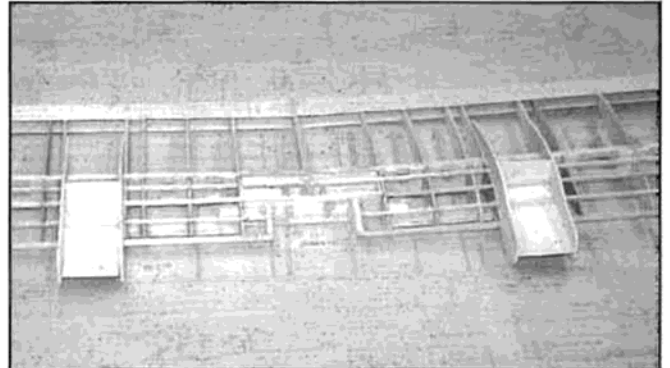
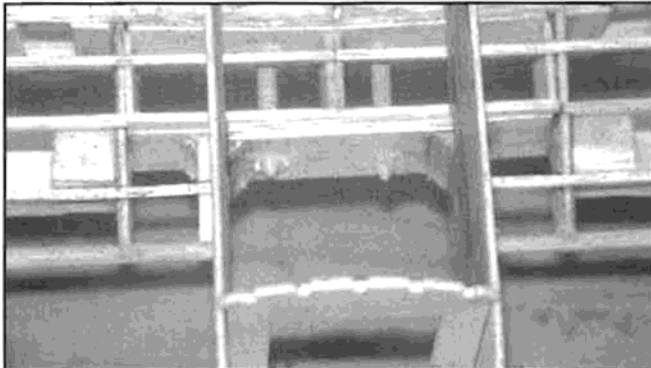
LEFT: Wing assembly under construction. Note the 1/32" plywood doublers attached to ribs for landing gear mounts and spar braces/shear webs glued in place. RIGHT: Assembling the nacelles to the wing. Thread the L.E. dowel and 1/8" sq. turbulator spars through the N1 nacelle sides.



LEFT: Insert the L.E. dowel into radius on tip rib, then drop N1's onto the 1/4" sq. spars and insert the 1/8" sq. pieces into their notches. **RIGHT:** Wing halves joined together with dihedral braces. All turbulator spars and the L.E. have been glued in place.



LEFT: Add the 3/16" balsa wingtip. **RIGHT:** Drill the 1/4" dia. holes in the fuselage for the L.E. dowels using a long bit.



LEFT: Wing dowels installed in wing and test-fit in fuselage. **RIGHT:** The motor mount N2 and firewall N3 are trial-fit in place.

nylon screws. Also take notice of the 1/4" square back up for the hinges.

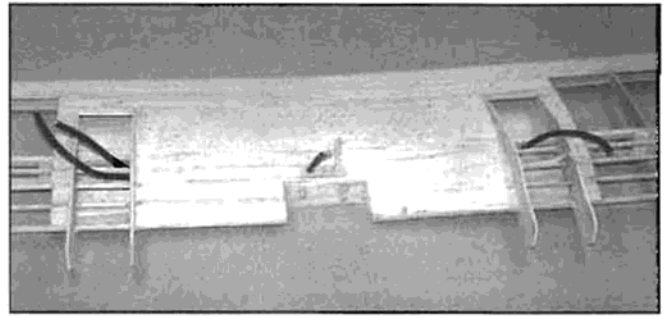
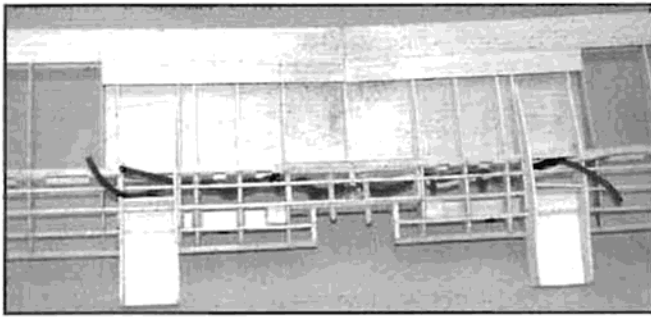
Before installing any of the sheeting, the wiring for the motors must be installed. The two Astro Flight 15 geared cobalt motors are wired in series. This eliminates one motor-out problems. A simple pictorial schematic can be found on the plans. The wire, 15 to 12 gauge hiflex, is buried in the wing

with only the positive and negative leads protruding from the center section and terminating with the appropriate color Sermos connector. Be sure to twist the wires together when doing your installation to help in the elimination of EMI problems. Another helpful method of EMI elimination was presented by Bob Kopski regarding the installation of three .001 mfd capacitors on the motor.

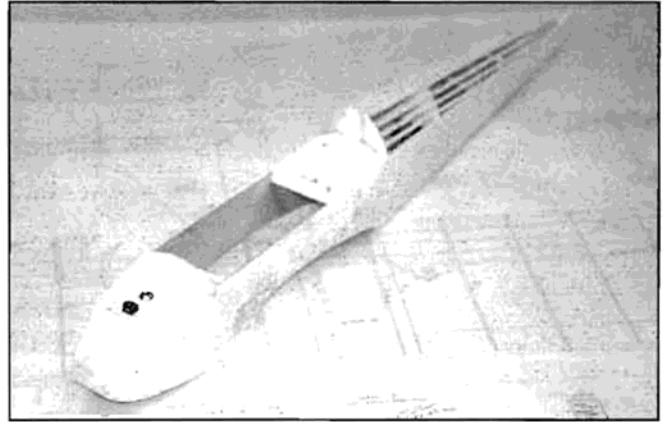
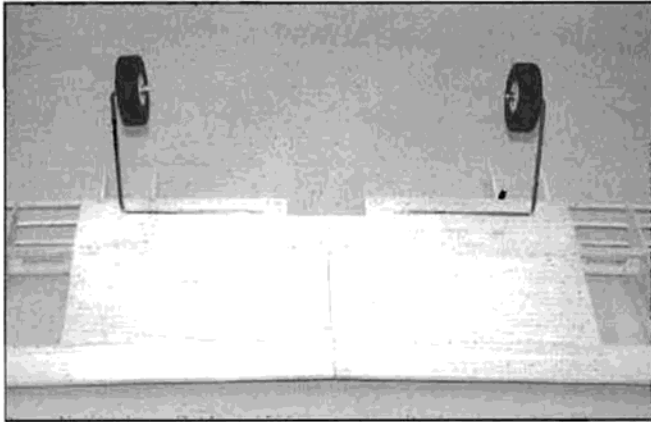
One is installed from brush to brush. The other two are installed from each brush to ground. Wired as shown will result in contra rotating props. APC 11 x 7 tractor and pusher props were used accordingly.

Stab, Elevator, Fin, Rudder:

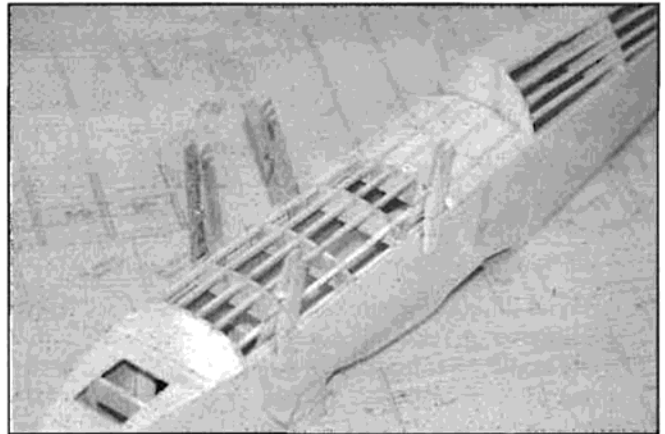
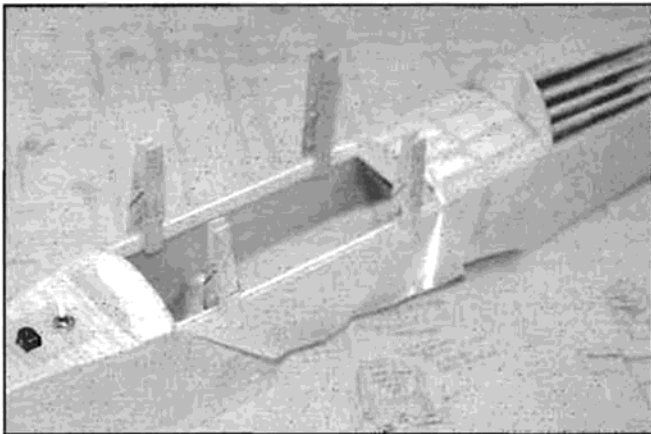
Choose the balsa carefully. Lite to medium, straight grained should work just fine. No big surprises in this area. Be



LEFT: Twist the motor wires together during installation to help prevent electrical noise. **RIGHT:** Wing sheeting completed. N2 and N3 have been removed for installation later.



LEFT: Landing gear is trial-fit into place and aligned to provide 2-3 degrees of toe-in. **RIGHT:** Fuselage assembly. Note the charging jack and motor arm switch mounted on 1/16" plywood.



LEFT: When assembling the battery hatch, use waxed paper to prevent gluing parts to fuselage side. **RIGHT:** Assemble BH1, 2, and 3 to side rails, then add the 1/8" sq. stringers.

sure to install the 1/32" plywood horn mounts in the elevator and rudder on both sides. This takes some time, but it's worth the trouble and prevents the horns from pulling through the surface they are attached to. Use medium CA to provide a good bond.

Fuselage:

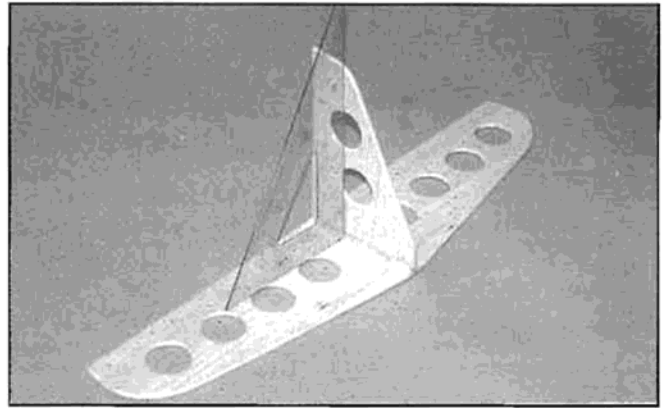
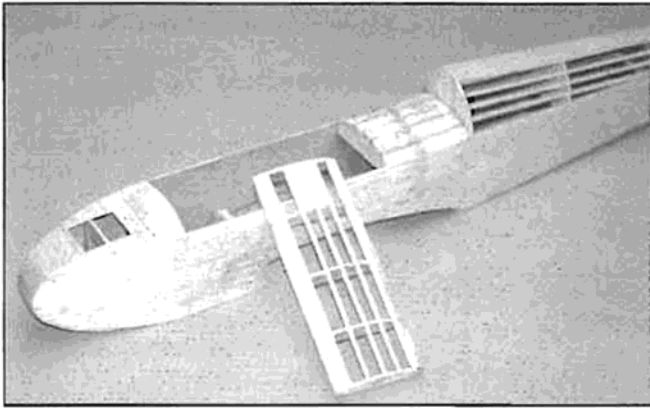
Begin by marking the former positions on both the right and left fuselage sides. Assemble the two F3's together using gap-filling CA. After the CA has cured, sand the assembly square. Next, assemble F2, F3, and F4 to one side using a 90° triangle to square the formers to the side. The assembly of the two sides together comes next. Check for proper alignment and squareness at each glue step. After the CA has cured, add the

wedge at the tail and draw the two sides together and glue. Be sure to check for squareness and twisting. Add formers F5, F6, and F7. Now would be the opportune time to seat the wing to the fuselage and to drill the two leading edge dowel holes. The use of a 12" long 1/4" dia. drill bit will enable you to penetrate the F3, WB1, and the first WB2. The dowels are to be installed after the covering is completed. Add the two remaining formers F1 and F2. To ease assembly, wet the outside of the fuselage sides with rubbing alcohol or water. The 3/16" balsa sheet doublers in the nose are there to supply a good gluing edge for the 1/16" balsa sheeting. Add a soft block to the top of F2 and sand to a pleasing shape. Drill a 1/8" dia. hole through a BH1 battery hatch former and

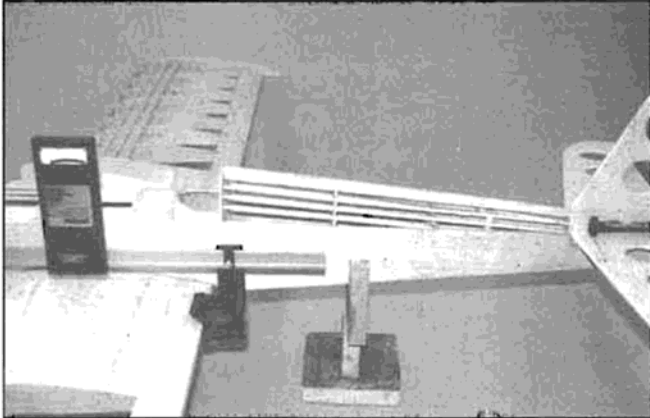
F2 for the 1/8" dowel front battery hatch hold-down.

The air hatch allows a flow of cooling air through the plane to cool motor controller as well as the batteries. What goes in must come out, so be sure to remove the covering between one of the pairs of formers in the aft end of the fuselage. No need to balsa-sheet the bottom.

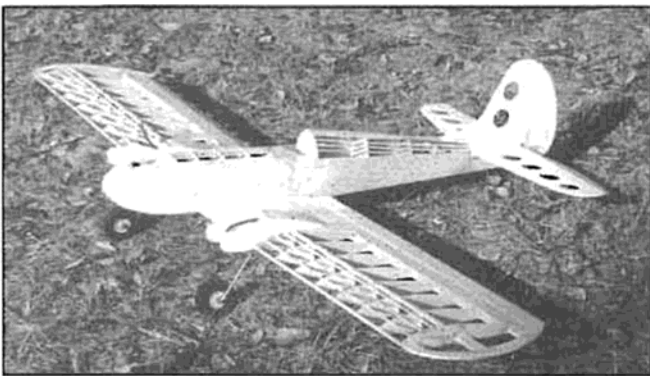
The battery hatch was designed for those of us who like to change battery packs at the field to get in as many flights as possible. The battery hatch is constructed using the fuselage as an assembly tool. First, line the fuselage hatch opening with plastic wrap or waxed paper to keep the assembly from sticking. Clamp BH4 to each side. Glue BH1,



LEFT: Completed hatch with 1/16" balsa sheeting on sides and rear center. **RIGHT:** Assemble the horizontal stabilizer and vertical fin. Be sure to keep these parts square during assembly.



LEFT: This is my set-up for checking/setting the incidence. Begin by setting the wing at 0°, then set the stab at 0°. **RIGHT:** After the wing and stabilizer are set at 0°, set both motor mounts at 0/0° also.



LEFT: Ready for covering. **RIGHT:** The finished model.

BH2, and BH3 formers in position. The BH1 with the 1/8" hole is next to F2. Add a small stack of lite plywood squares, about 3/8" x 3/8" in the center of the first BH3 to hold the screw for the rear hatch hold-down. This hold-down is made from a steel landing gear strap belt 90° about 1/8" from the end. Add all the 1/8" square stringers to the fuselage and battery hatch. Cut out a cockpit and add a 1/16" balsa floor. If you wish to add a pilot figure, use plywood for the floor.

Any motor mounting system you may choose will more than likely do a good job. The one I have been using for several years was developed by Bob Kopski. I have accepted it as a valid, simple, and reliable method of mounting electric motors. I like to keep the motor in the

open air to keep it as cool as possible. Refer to detail B on the plans.

Covering:

Electric Challenge — The Twin can handle any of the Mylar films. The lighter the better. Mine is covered with MonoKote and trimmed in self-stick color.

Conclusion:

I wish I could say Electric Challenge — The Twin flew straight off the drawing board, but in all honesty I can't. The first model had a few gremlins in it, like trim and balance. So, you guessed it, whamo! A six foot underground landing. After dissecting the remains, a few other items surfaced. The original motor control that was used caused a surging/glitching

problem. Since switching to the new system, the problems have disappeared.

The other problem is a bit embarrassing, the contra rotating prop was on backwards. One must install the pusher with the lettering facing the motor. Once the gremlins were put to bed, all was well. The plans presented here have overcome all the problems and are the plans the plane shown herein were built from.

Flying:

Be sure the timing is set so that each motor is drawing the same current. Manufacturer's instructions should be followed to the letter. I believe the contra rotating scheme is the way to go. Not only is it different, but the torque cancels itself.

My model is set up 0-0-0. That means both motors 0°-0° and that the wing and stab are 0°-0°. I have tried the wing at +1° or +2°, but personally prefer 0-0-0. As we know, each person is different, so, if you see a need to change the set-up, please do your thing.

Electric Challenge — The Twin will perform as many aerobatics as this old boy can do! I would imagine in the hands of a more proficient or professional pilot it would do more. I'm perfectly happy with its ability to follow my commands. Enjoy!

Bill of Materials

Wing:

- 2 — 1/4" x 36" birch leading edge dowels
- 6 — 1/8" x 1/8" x 36" balsa
- 2 — 5/16" x 1-1/2" x 36" aileron stock
- 2 — 3/16" x 1/4" x 36" balsa
- 4 — 1/4" x 1/4" x 36" hard balsa
- 1 — 12" x 24" x 1/8" lite ply
- 1 — 3/16" x 4" x 48" balsa
- 4 — 1/16" x 1-1/2" x 36" balsa
- 4 — 1/16" x 4" x 48" balsa
- 1 — 1/32" x 12" x 24" ply
- 2 — 3/32" x 4" x 48" balsa
- 2 — 1/4" x 1/4" x 36" lite balsa

Stab, Elevator, Fin, Rudder

- 3 — 3/16" x 4" x 48" medium balsa
- Scrap — 1/32" ply
- 1 — 3/16" dowel

Fuselage:

- 2 — 3/32" x 4" x 48" medium balsa
- 1 — 1/8" x 12" x 24" lite ply
- 8 — 1/8" x 1/8" x 36" balsa
- Scrap — 3/16" sheet balsa
- 1 — 3/32" x 3" x 36" balsa
- 1 — 1/32" x 12" x 24" ply
- 2 — 1/16" x 3" x 36" balsa

Miscellaneous:

- CA — thin
- CA — gap filling
- 15 — Sonic-Tronic Nifty Hinges
- 1 — Du-Bro 1" tail wheel
- 1 — pkg. each 1/16" and 5/32" wheel collars, Du-Bro
- 1 — pkg. Du-Bro steel landing gear straps
- 1 — 1/16" music wire
- 1 — 5/32" music wire
- 1 — pair Du-Bro strip aileron horn wires with bearings
- 1 — pair Du-Bro strip aileron horn set
- 1 — Sullivan Products Gold-N-Pushrods
- 4 — Du-Bro clevises
- 1 — electronic speed control/throttle
- 4 — pair red and black Sermos connectors
- 2 — Du-Bro control horns
- 1 — 4-channel radio (minimum)
- 1 — APC 11 x 7 tractor prop
- 1 — APC 11 x 7 pusher prop

