

AR-1

By Jack Caldwell

Photo By Steve Calderon

INTRODUCTION

For years, the thrill of slope soaring has been an obsession with me. At first I haunted the nearby hills of Livermore, California, where I flew a variety of floaters. Sometime later, my brother-in-law introduced me to coastal soaring at a site near Santa Cruz, California. We stood on a cliff overlooking a stretch of sea whose beauty and sound were a treat in themselves. I'd never seen so many types of gliders in one place. I was surprised to see the speeds attained and the aerobatics performed. I could

**If you like speed,
you've got to have a
ship that will penetrate
— this is it!**

hardly wait to start building and flying the type of gliders needed to meet the challenge of the coastal conditions.

Recently, the spiraling cost of gasoline for the 150 mile round trip to Santa Cruz has forced me to do my

flying closer to home again.

My SR-7 and leadsleds won't fly well without that great coastal wind. I've had to find a plane with the same capability as the fast slope ships, that will fly in the lighter lift of the Livermore hills.

It has taken some time and experimenting, but I've finally designed one that makes inland soaring as exciting as the coastal variety.

Some of the special features of the Ar-1 are: a sharp entry on the leading edge; landing flaps and a T-tail design. The Ar-1 flies inverted, has a respectable roll rate and does inside

and outside loops close enough in size to make vertical Figure 8's a snap. It has a very gentle stall and the recovery is quite smooth.

If you like speed you've got to have a ship that will penetrate the wind. For a slope ship to do this, one must increase the wing loading. Want to go faster? Add more weight. But heavy airplanes don't fly in light air, so we trade weight for streamlining, hence the sharp leading edge. (Don't be tempted to deviate from the design if you want top performance.) The AR-1

MATERIAL LIST

Balsa:

- (4) sheets 1/16" x 4" x 36".
- (3) sheets 1/16" x 3" x 36".
- (3) sheets 3/16" x 3" x 36".
- (1) sheet 1/4" x 3" x 36".
- (2) 3/16" x 5/16" x 36".
- (2) 1/4" x 3/8" x 36".
- (1) 3/16" x 1/2" x 36" — wing shim.
- (2) 1/4" x 5/16" x 36" — trailing edge stock balsa.

- (1) 1" x 1 1/2" x 12".
- (1) 2" x 2" x 24".
- (4) 3/8" x 36" — triangular stock balsa.
- (1) 1/2" x 3/8" x 36".
- (1) 3/8" x 1 1/2" x 6".

- (1) 1/2" x 3/8" x 36".
- (1) 3/8" x 1 1/2" x 6".

Spruce:

- (4) 1/8" x 1/4" x 36".
- (2) 1/4" x 1/4" x 36".
- (1) 3/8" x 3/8" x 2" (can use pine).
- (1) 1/4" x 3/8" x 6".
- (1) 2" x 2" x 4" (pine or redwood nose block).

Birch Plywood:

- (1) 1/16" x 6" x 48" (rib template and fuselage doublers).
- (1) 1/8" x 6" x 12".

Miscellaneous:

- (1) 1/16" x 12" brass tubing.
- (1) 1/8" x 12" brass tubing.
- (1) 1/16" x 36" aluminum tubing.
- (1) 1/8" x 36" aluminum tubing.
- (1) 3/32" x 36" steel wire.
- (1) 1/16" x 36" steel wire.
- (1) set flex tubing and cable (available from Hobby Lobby International #HLH 805).
- (1) antenna tube.
- (1) brass threaded coupler.
- (6) metal clevises
- (1) Kit of Sig 25X foam.

Servo mounting tape, Titebond glue, Hot Stuff, 6 minute epoxy, 30 minute epoxy, MonoKote, 1 1/2" fiberglass tape.

is not recommended as a first airplane, but if you are tired of flying rudder-elevator, and have experience with quick response, high performance floaters, the AR-1 will be a nice change. When you can't fly with seagulls, the AR-1 will keep you up there with the buzzards.

CONSTRUCTION

The construction sequences may seem strange to you, but as you build, the reasons for my method will become clear.

Vertical Fin:

Select the lightest material for the inner core parts.

Cut core parts from soft 1/4" balsa. Cut outer skins from medium-hard 1/16" balsa. The grain of the core pieces should be parallel to the tailpost. The grain of the outer skins will be parallel with the leading edge of the fin. Cut a piece of drive tubing 28" long. Cut a 1/8" x 1/16" shim to center the drive tube in its slot.

Pin a skin over the plans, glue the front core piece in place and add the 1/8" x 1/16" shim. Glue in the aft core piece, drive tube and tail post. Glue on the top skin and the leading edge. After the glue has set, remove from plans and sand to shape. Do not install the trailing edge stock, tail skid or vertical fin cap at this time.

Fuselage: (Part 1)

Cut the sides, bottom and tail-boom top sheeting from 3/16" balsa. Cut out the doublers from 1/16" birch plywood. Glue the doublers to the sides, making sure you end up with a left and right side.

Lay the sides, bottom to bottom, inside up.

Mark the location of formers F-1, F-2 and F-3. Lay the bottom inside up and mark the centerline from the nose to the tail. Cut out formers F-1, F-2 and F-3 and the tongue at F-3 from 1/8" birch plywood and mark the centerline.

Glue the triangular stock to the inside of the sides. Trim the tail section of the triangular stock to clear the elevator tube, antenna tube and tail post.

At the tail post location, temporarily clamp 1/4" scrap spreader between the fuselage sides. Don't glue.

Install F-3 but don't glue. Wrap rubberbands or masking tape around the fuselage at F-3 to hold the sides in place. Epoxy F-2 in place and rubberband it to hold it in place. Set the fuselage assembly over the plans and align the center marks on formers F-2, F-3 and tail. Epoxy F-1 in place and clamp the nose section together. When set, remove the rubberbands and the clamp. (Do not remove the clamp at the tail post.)

Align F-1, F-2, F-3 and tail with the centerline of the bottom sheeting and glue in place. Cut the spreader pieces and install where needed between the sides of the fuselage to match the curve of the bottom. Do not glue the spreaders, as they will be removed. Rubberband or pin the sides and the bottom together.

After the glue has dried, remove the spreaders. Glue the tail-boom top sheeting in place. When set, remove the tail post spreader and sand the fuselage to shape from F-3 to tail. Lay the fuselage on a flat surface and

weight it down. Insert the elevator drive tube, antenna tube and tail-fin. Epoxy the fin in place and make sure it's straight.

Remove former F-3, spot glue the antenna tube and elevator tube in place to align with the notches in F-3.

Mix 3/4 ounce Sig 25X foam

AR-1

Designed By: Jack Caldwell

TYPE AIRCRAFT

Sport Aerobatic
Slope Glider

WINGSPAN

74 Inches

WING CHORD

9" (Avg.)

TOTAL WING AREA

665 Sq. In.

WING LOCATION

Shoulder Wing

AIRFOIL

Semi-Symmetrical
WING PLANFORM

Swept L.E.

DIHEDRAL EACH TIP

1/2" Under W14

O.A. FUSELAGE LENGTH

40 1/4 Inches

RADIO COMPARTMENT SIZE

(L) 7 3/4" x (W) 1 1/2" x (H) 1 1/4"

STABILATOR SPAN

19 1/4 Inches

STABILATOR CHORD

3 1/2" (Avg.)

STABILATOR AREA

67.4 Sq. In.

STABILATOR AIRFOIL

Symmetrical

STABILATOR LOCATION

T-Tail

VERTICAL FIN HEIGHT

5 Inches

VERTICAL FIN WIDTH

7 1/2" (Avg.)

REC. ENGINE SIZE

NA

FUEL TANK SIZE

NA

LANDING GEAR

NA

REC. NO. OF CHANNELS

3

CONTROL FUNCTIONS

Stabilator, Ail., Dive Brakes

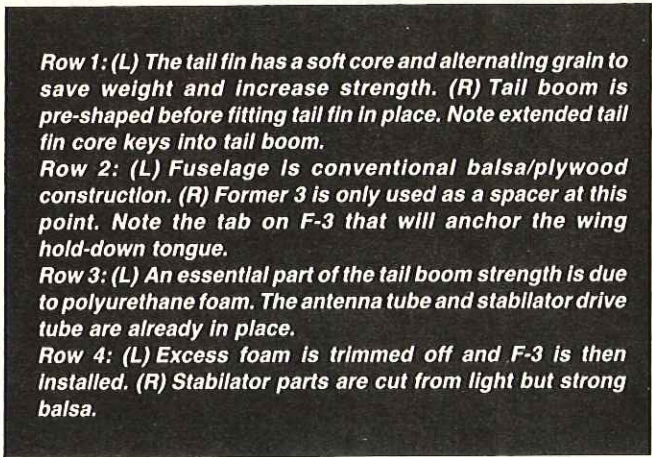
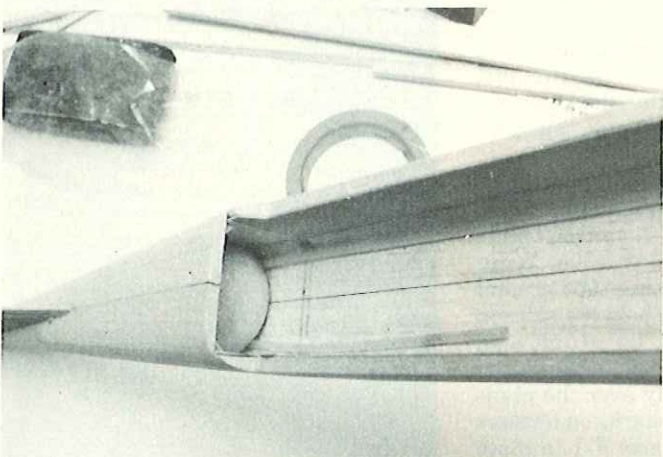
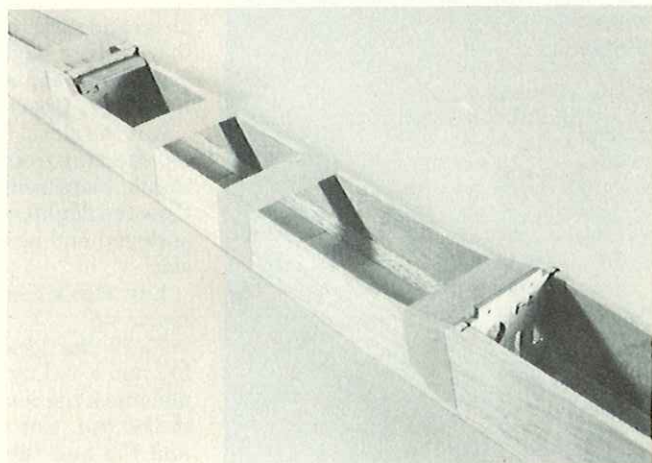
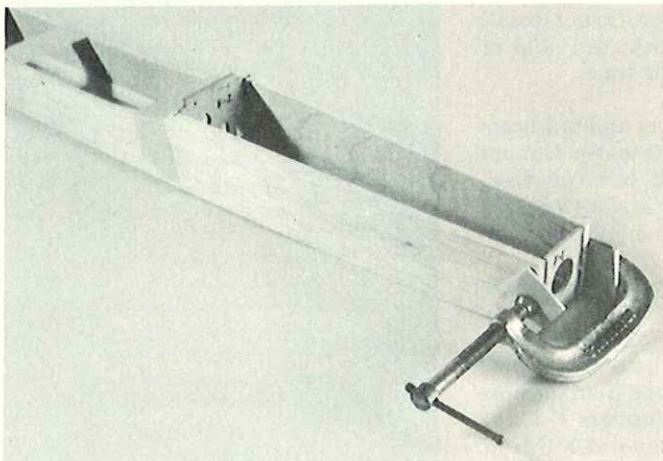
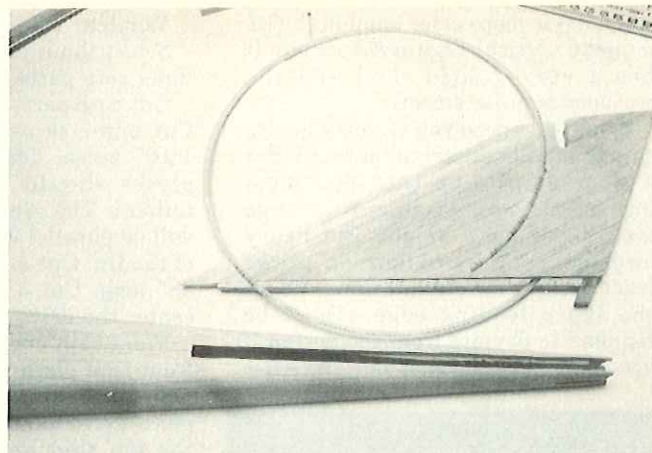
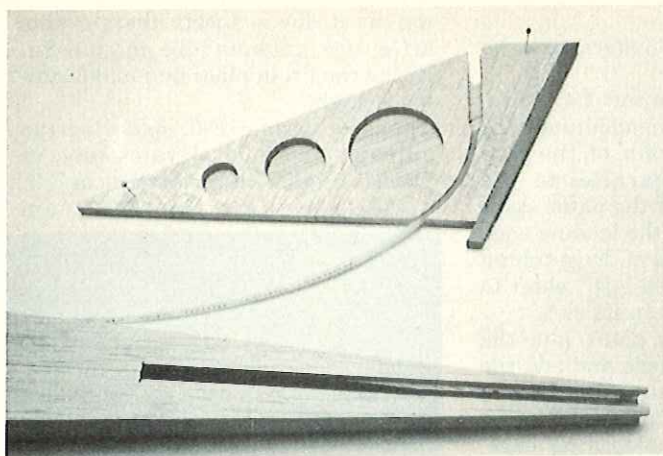
BASIC MATERIALS USED IN CONSTRUCTION

Fuselage Balsa, Ply & Spruce
Wing Balsa, Ply & Spruce
Empennage Balsa & Spruce
Wt. Ready To Fly 39 Oz.
Wing Loading 8.5 Oz./Sq. Ft.

according to the instructions on the can, and pour into tail-boom. When the foam has set, cut excess away to the aft side of former F-3.

Assemble and epoxy former F-3. When set, epoxy this assembly in place.

Glue the trailing edge stock to the text to page 33

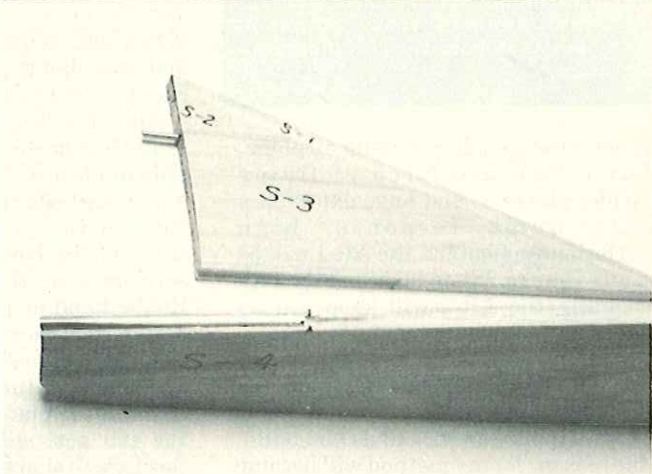
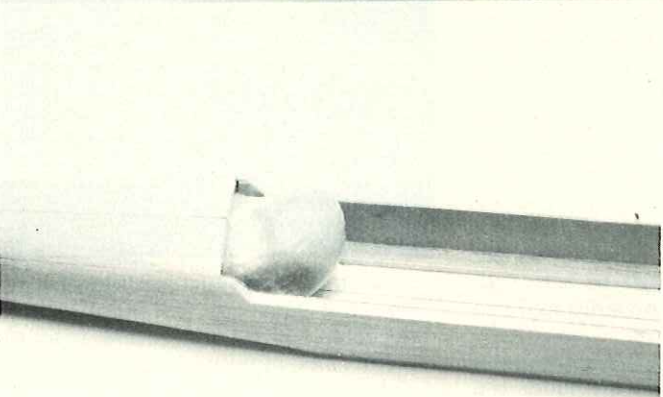


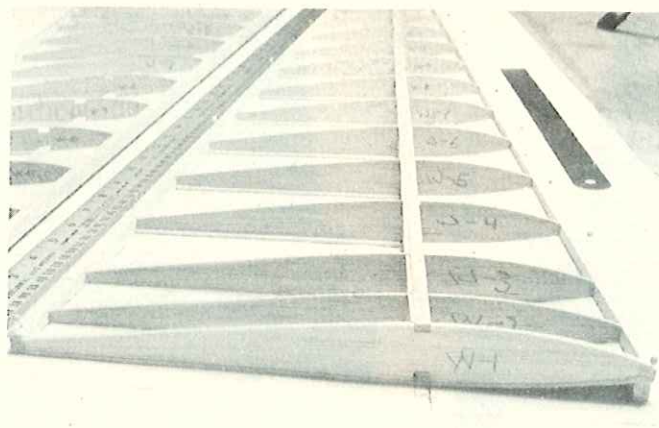
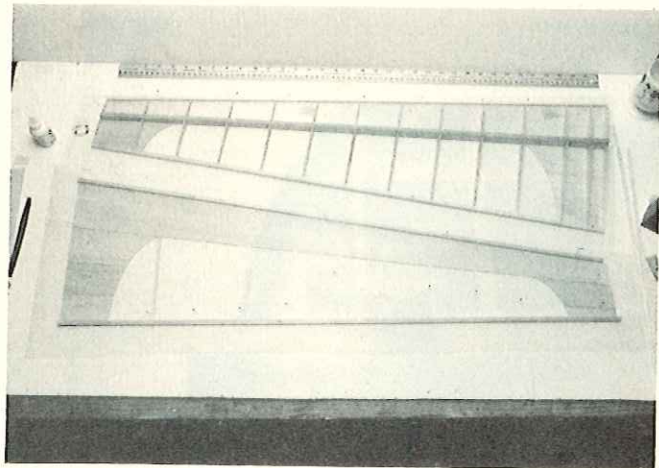
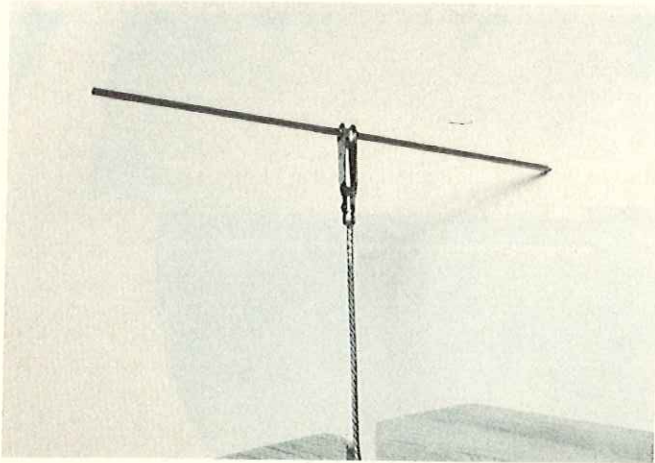
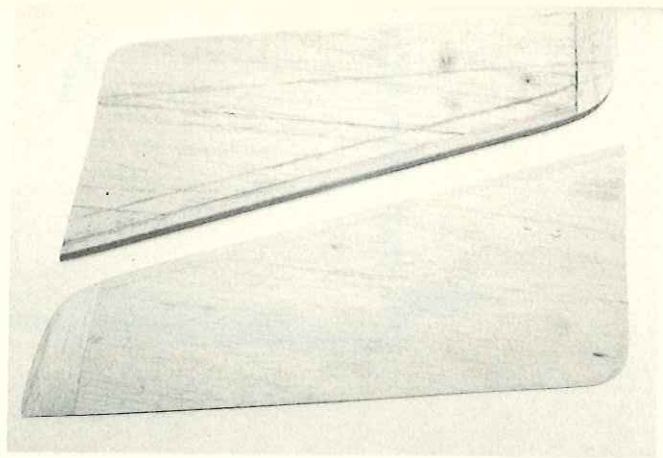
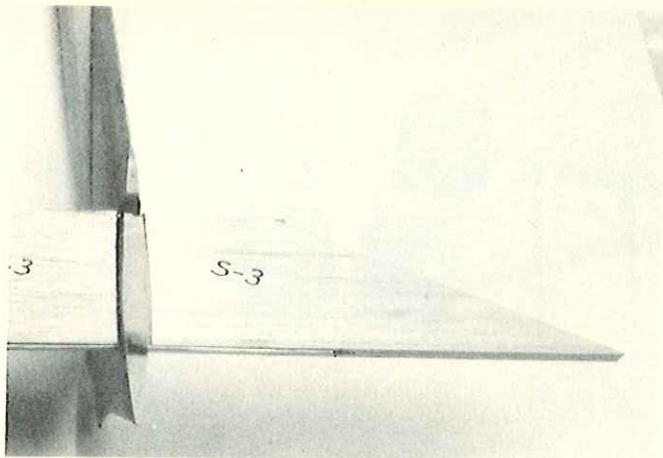
Row 1: (L) The tail fin has a soft core and alternating grain to save weight and increase strength. (R) Tail boom is pre-shaped before fitting tail fin in place. Note extended tail fin core keys into tail boom.

Row 2: (L) Fuselage is conventional balsa/plywood construction. (R) Former 3 is only used as a spacer at this point. Note the tab on F-3 that will anchor the wing hold-down tongue.

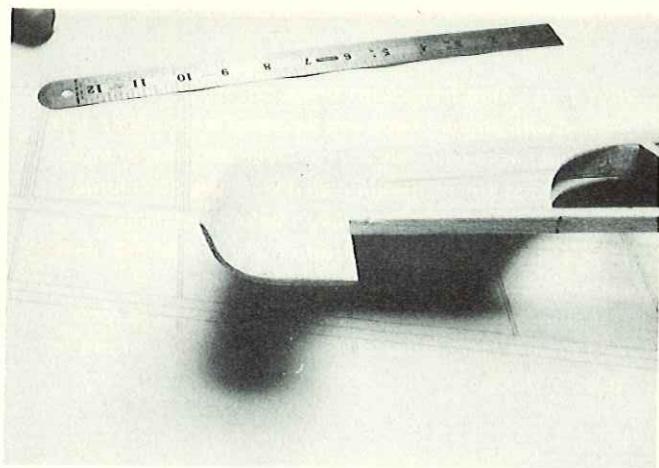
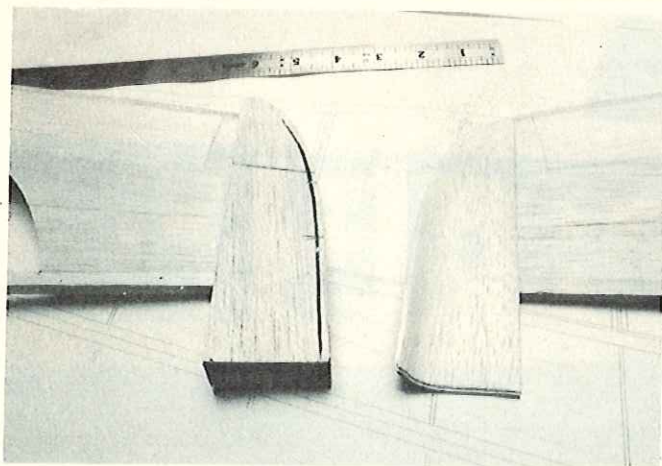
Row 3: (L) An essential part of the tail boom strength is due to polyurethane foam. The antenna tube and stabilator drive tube are already in place.

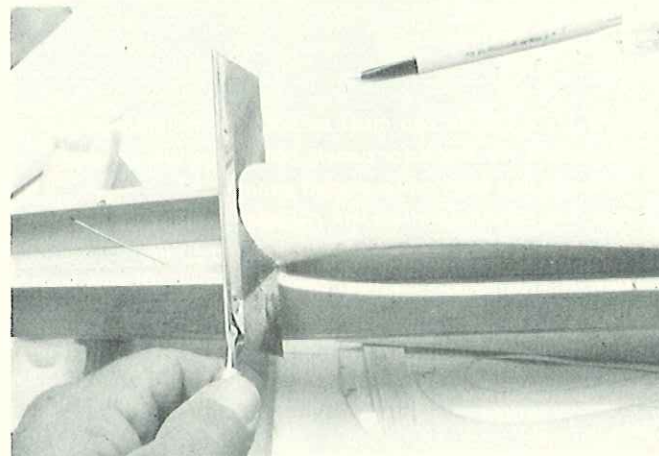
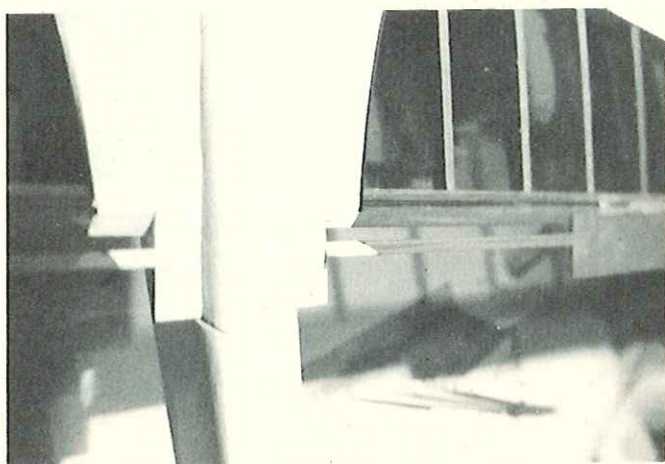
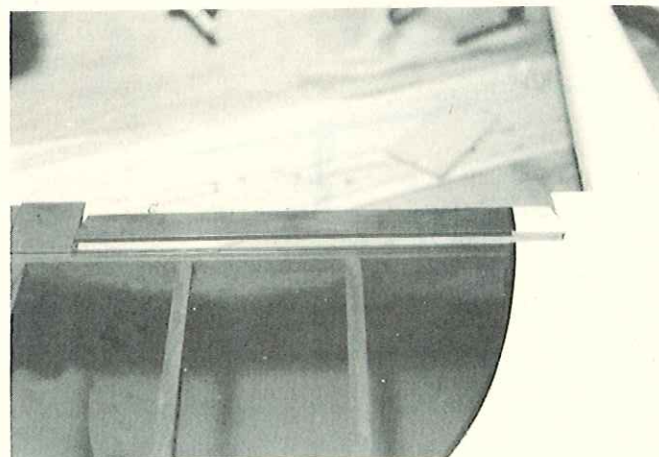
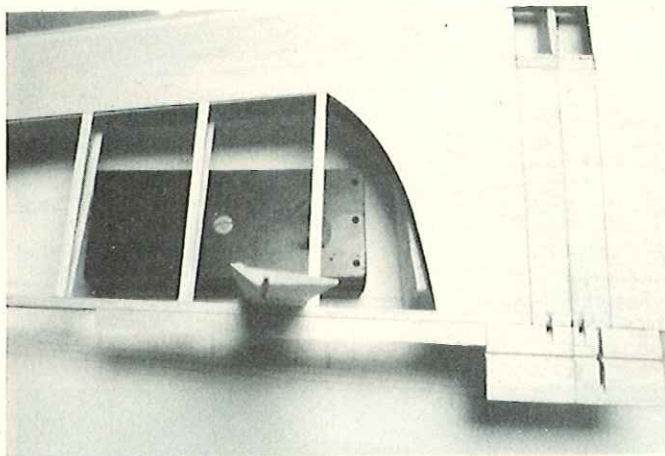
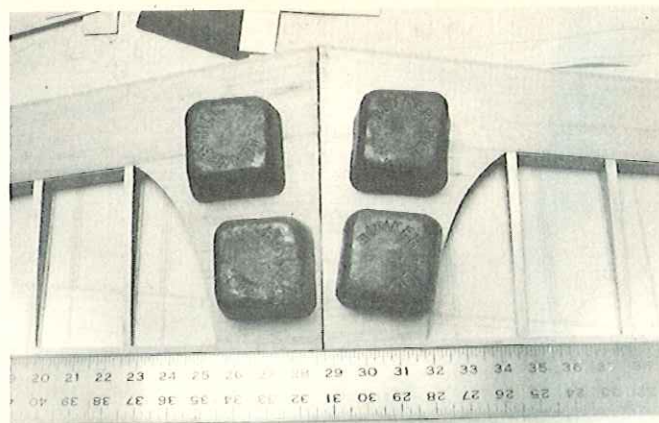
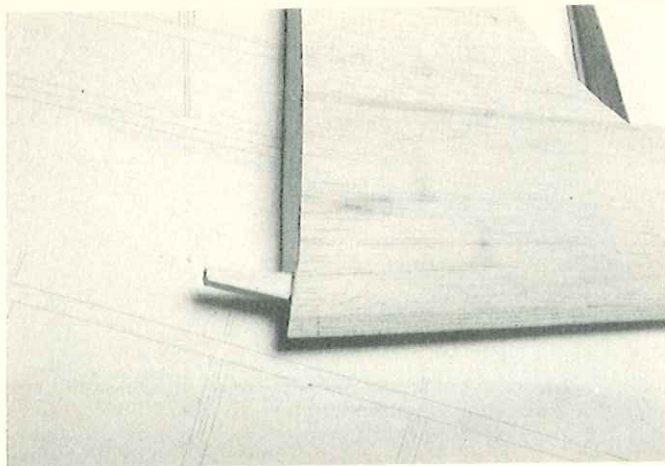
Row 4: (L) Excess foam is trimmed off and F-3 is then installed. (R) Stabilator parts are cut from light but strong balsa.



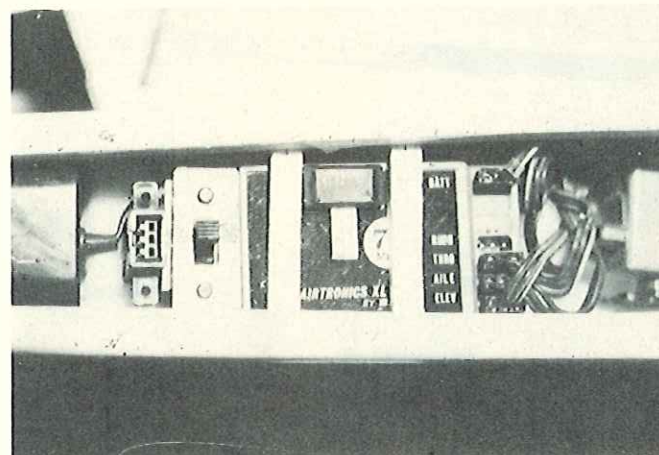


Row 1: (L) Tail fin cap must be left off until stabilator is completed. (R) Stabilator panels before and after shaping. Note sanding lines on unshaped panel.
 Row 2: (L) Stabilator drive link. (R) Wing panels being built.
 Row 3: (R) Leading edges must be shimmed up.
 Row 4: (L) Wing tips are best carved in pairs. (R) Finished wing tip. Note tip sheeting.





Row 1: (L) Wing hold-down block. (R) Wing trailing edge aligned with straight edge and weighted while epoxy sets.
 Row 2: (L) Note end view of dive-brake and filler at trailing edge of wing. (R) Trim setting on dive-brake, don't forget to MonoKote dive-brake and alleron before installing.
 Row 3: (L) Dive-brake full open. (R) Turtledeck being constructed.
 Row 4: (R) Switch and charging plug attached to receiver with double tape. Balsa strips on top of receiver are not glued in place.



aft part of the tail post. Finish sanding the fin to shape. Glue in the 1/2" triangular balsa filler at F-3.

Glue in the 1/8" x 3/16" cockpit side rails. Using epoxy, install the preshaped redwood noseblock. Sand the remainder of the fuselage to shape, except for the canopy fairing section.

Fit and glue the tail skid in place. Cut the wing turtledeck from a 2" x 2" x 13" balsa block. Cut the canopy and canopy fairing assembly from a 2" x 2" x 11" balsa block. Do not cut the canopy fairing away from the canopy. Tack glue the turtledeck and canopy assembly to the fuselage. Sand to shape. Set the full size W-2 rib template in the wing saddle and scribe both sides of the turtledeck. Set this assembly aside.

Wing:

Cut out all the rib patterns W-1 through W-14 and the full size airfoil of W-2. (If you do not wish to cut up the plans you may want to trace these onto another sheet of paper.) Glue these to 1/16" plywood with draftsman's rubber cement, available at stationery stores. Accurately cut and sand to final shape. Don't skip this step, as you will be making two sets of ribs from these templates. If you should damage a wing section, you can go back to your rib patterns for perfect replacement parts.

Get out your favorite flat building board. (I prefer celetex for ease of pinning.) Pin on your plans and cover with waxpaper or plastic wrap to protect them.

Cut the tapered leading edge shims from 3/8" x 1/2" x 36" balsa, tapering from 3/8" to 1/8". If you're careful you can get two shims from this one piece. Using the guide marks to the outside of W-1 and W-14 at the spar line, cut your lower sheeting to fit from these guide marks to the aft side of the sub-leading edge. Use medium hard 1/16" x 4" x 36" balsa.

If you have a table saw you may wish to preshape the balsa sub-leading edge and the spruce leading edge pieces before assembling.

Tape the lower leading edge sheeting to the sub-leading edge, fold open a gap and run in a bead of Titebond. Close this back, wipe off excess glue and pin down until dry.

While this dries, cut the 1/4" wide capstrips from 1/16" scrap. Pin the shim to the plans so that the aft part of the shim extends slightly behind the sub-leading edge sheeting joint. Pull the tape off the sub-leading edge assembly. Pin the assembly on the top of the shim. Bow the assembly to the approximate shape of the ribs. Line up the trailing edge of the sheeting with the trailing edge of the spar line.

Take two pieces of 1/4" x 3/8" x 36" sub-trailing edge material and cut a

3/32" x 1/8" x 14" long notch for the aileron torque link, extending from the W-1 rib out on each piece. Pin the trailing edge in place with previously notched areas top aft. Cut and fit the center section sheeting, tip sheeting and lower capstrips. Pin in place and Hot Stuff all joints.

Now check the ribs, making sure they are 1/16" below the top of the sub-trailing edge, to accommodate the top capstrip and sheeting. Install and glue the lower spar. Install and glue ribs W-1 through W-14. W-1 should be angled 1/32" on both wing panels.

Cut the top spar 1/32" shorter than the lower spar. Install the top spar and vertical shear webbing. When installing the shear webbing, the lower part will sit on top of the lower capstrip. Glue in place with Titebond.

Cut out the upper sheeting. The upper sheeting will extend from the aft part of the top spar to the front of the sub-leading edge. After the shear webbing has thoroughly dried, block sand it flush with the top spar. Shape the top of the sub-leading edge, using a long sanding block to keep it straight.

Install the top leading edge sheeting. This should be glued with Titebond. Align the back edge of the sheeting with the trailing edge of the top spar. Lay a long piece of wood along the spar to hold the sheeting in place and weight it down. Shape the sheeting tight to the ribs as you are pinning it in place to the sub-leading edge. Do not wet the sheeting, as this will tend to warp the wing.

Install the center sheeting, tip sheeting and top capstrips. When this is dry, lift the wing from the plans and sand the front of the sub-leading edge straight to receive the spruce leading edge. This should be installed with epoxy. If you work fast you can use GMP 6-minute epoxy. If you need more time, use Devcon 30-minute epoxy. Line up the top of the spruce leading edge with the top of the wing. Use short strips of masking tape to hold this assembly until set. Wipe off the excess epoxy.

Install the tip blocks, carve and sand to shape. Lightly sand the sub-trailing edge to the shape of the airfoil. Now shape the leading edge.

Check the fit of the wings at the root section using a 1/2" shim under each wing tip at W-14. If the two W-1 ribs do not fit snugly, adjust by sanding until they do.

Cut out the forward wing mounting block. Cut away the front of the center ribs to accommodate the wing mounting block. Fit and epoxy in place to one wing.

Lay your wings on a flat surface with waxpaper under the wing center section and epoxy together with 1/2" shims in place to keep the top of the

wing flat. Be sure the trailing edge of both wings are straight. Weight this assembly down until epoxy has set.

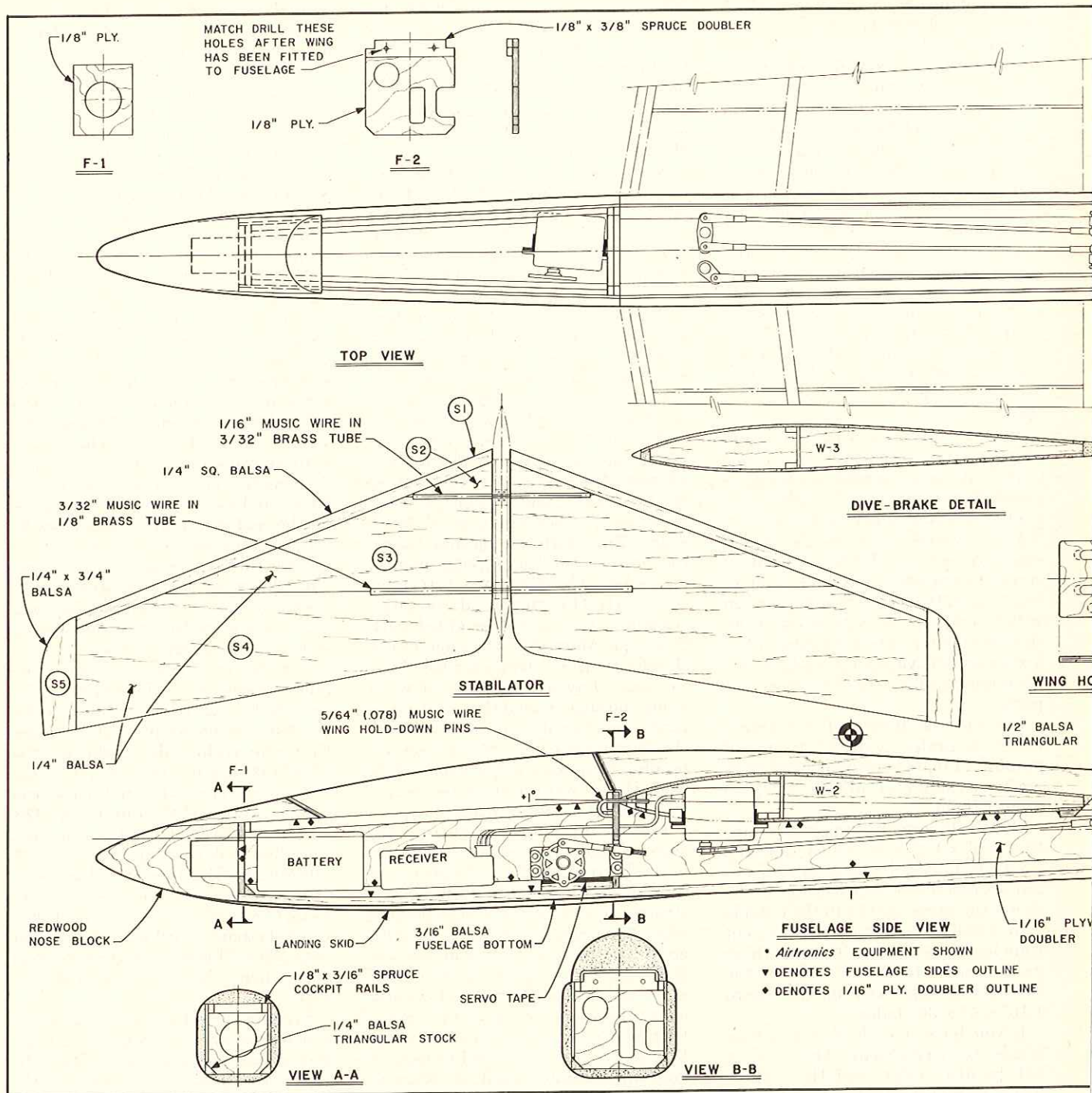
Remove the wings from the building board and cut out the lower sheeting forward of the wing spar to accommodate the aileron and dive-brake servos. Install the servo mounting rails. Take the 1 3/4" x 5/16" x 36" trailing edge pieces and lay them in place on the plans. Mark them W-1 left and W-1 right. Measure out 14" on each side from W-1. Cut a 1/8" x 1/16" groove for the aileron torque rods on the top leading edge.

From the tip end of each, cut off 23 3/4" to be used for the ailerons. Taper the leading edge of the ailerons ten degrees and set aside. With the remainder of the material, cut a 1/8" x 1/8" groove on the bottom side, 1" from the trailing edge. Out of this material we want two 9" pieces for the dive-brakes, two 1 1/4" outboard filler pieces and two 2" center filler pieces for the center section. Glue the two 2" center pieces together. Cut a recess to receive the dive-brake control horn. Glue this piece to the trailing edge of the wing. Make sure that the bottom of the wing and the bottom of the trailing edge center section are flat.

Cut the two holes to receive the aileron torque rods. Make up the right and left torque rod assemblies. **Note:** the left aileron torque rod is longer than the right side. Make up the dive-brake torque rod assembly and set aside. The aileron torque rod tubing is 1/8" O.D. aluminum. The torque rods are 3/32" O.D. steel wire. The dive-brake tubing is 3/32" O.D. aluminum. The torque rod is 1/16" O.D. steel wire. The dive-brake bellcrank was made from 1/16" printed circuit board material, copper both sides. This solders nicely to steel wire when you use a good soldering flux.

Prepare the ailerons by cutting out a notch on top to receive the aileron torque rod, keeping it flush with the top of the aileron. Fit and install the hinges, but do not glue at this time.

Split the two dive-brakes per the plans. Glue the front section from the dive-brake to the trailing edge of the wing. Glue in the 1/4" filler pieces, keeping them flat with the bottom of the wing. Lay your aileron torque rod assembly in the locations provided at the trailing edge of the wing. Make sure the tubing is flush with the top of the wing. Hot Stuff the tubing in place. Do not apply Hot Stuff within 2" of the ends of the tubing. This will prevent gluing the aileron wires to the tubing. Apply a piece of masking tape over the wires where they pass through the wing. This tape should be sealed tight to the wood so it just barely covers the aileron tubing. Sand



the leading edge center section of the wing to fit the fuselage saddle, leaving 1/16" clearance at F-2.

Apply fiberglass tape from the trailing edge, wrap around the leading edge, back to the servo opening in the bottom of the wing. I suggest Devcon 30-minute epoxy for this. You can cut the epoxy with lacquer thinner to make brushing easier. Turn the wing over and apply another strip of tape from the servo holes to the front edge of the aileron torque rods. Be careful not to get epoxy on the aileron linkage.

Make the aft wing mounting tongue, cut holes to receive the aileron

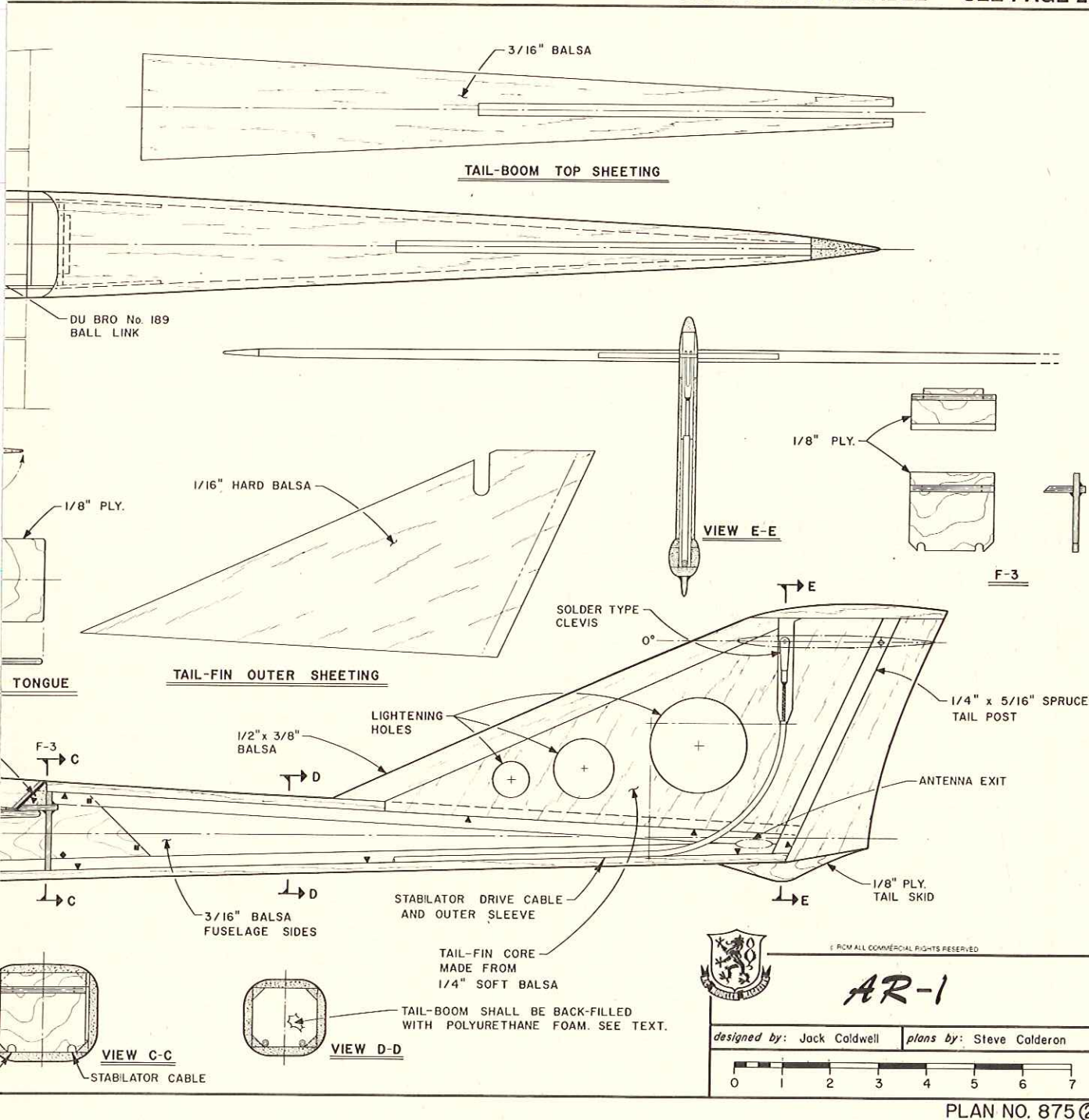
linkage, recess for dive-brake pushrod and epoxy in place.

Remove the turtledeck and cut away the airfoil section from the lower part and fit to the top of the wing so the turtledeck aligns with the canopy and fuselage. Cut the canopy away from the canopy fairing. Cut the front and back turtledeck formers from 1/16" plywood and glue in place. Cut the rear canopy former from 1/16" plywood and glue in place. Set the wing in the fuselage and measure from the back of the tail skid to each wing tip. The distances should be equal. Drill two holes through F-2 into

the leading edge of the wing for 1/16" mounting wires. Pin the canopy in place. Protect the canopy and aft part of the fuselage with plastic wrap so you don't glue the whole thing together.

Epoxy the turtledeck onto the wing. Be sure to align it with the aft part of the fuselage and canopy. Align and epoxy the canopy fairing in place. Finish sanding the front of the fuselage.

Temporarily drop in the dive-brakes and the wire assembly. Fit the dive-brakes to the trailing edge of wing, leaving adequate space for



MonoKote: When you are satisfied with the fit, Hot Stuff the aluminum tubing into the dive-brake slots. Drill two 1/16" holes 2" on either side of the center of the aluminum tubing. MonoKote the wing and dive-brakes, except for the bottom of the filler pieces and the bottom of the center section.

Set the dive-brake assembly in place. Install the dive-brake servo. make up one end of the 1/16" linkage wire with a clevis and solder. This clevis will be used at the dive-brake control horn. Hook up the dive-brake servo to the throttle on the receiver.

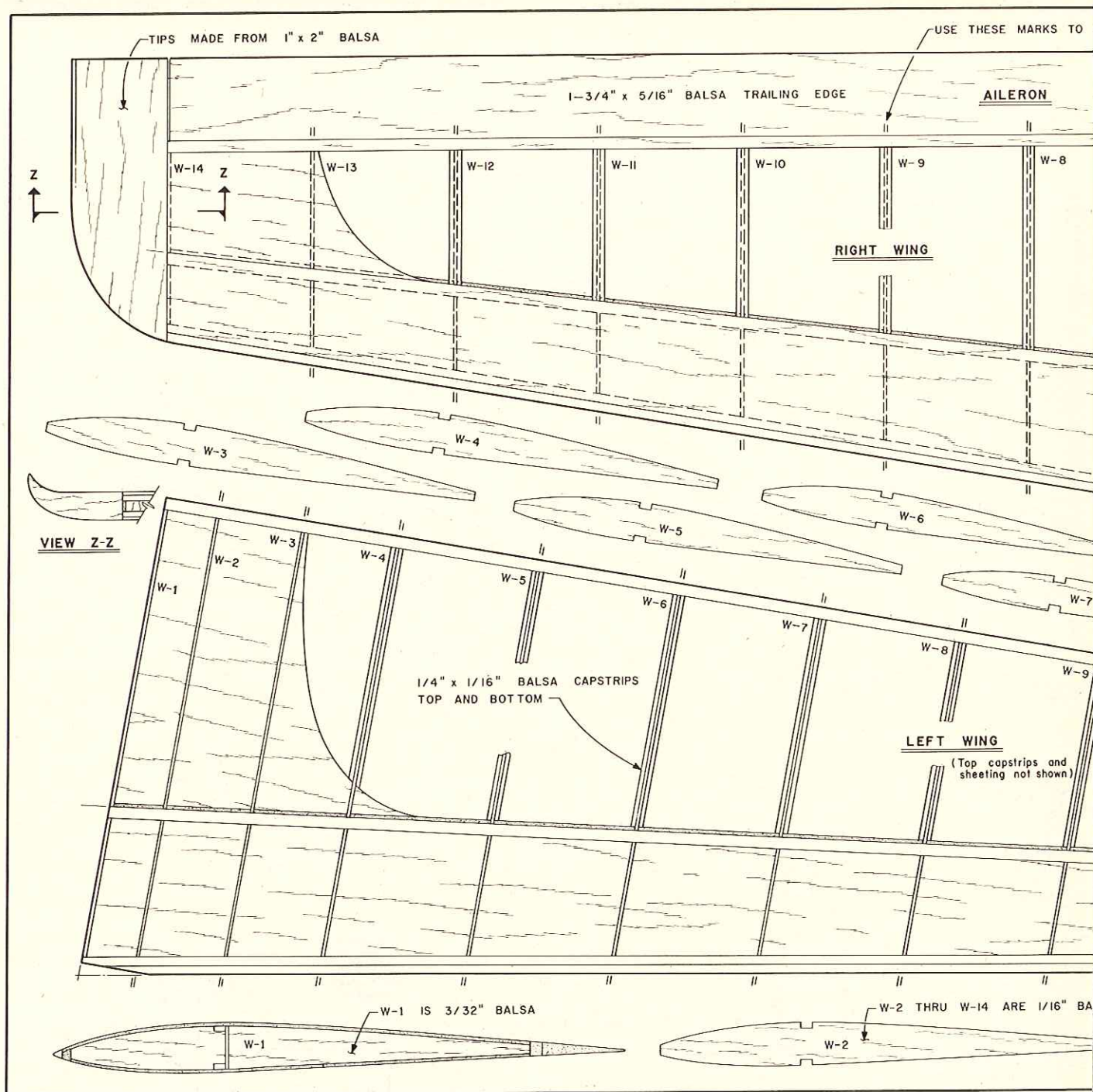
Turn on the radio and set the throttle and trim to the top of the receiver. Turn off the radio. Make sure the dive-brakes are fully closed and the control horn is in the rear position. Install the threaded coupling and clevis to the servo. Cut the 1/16" linkage wire to the proper length and solder. Turn on the radio and cycle the dive-brakes to make sure everything works right. Full down trim and throttle should set the dive-brakes at a 90 degree angle to the trailing edge. Hot Stuff the tubing to the filler pieces and the center section. Be careful not to glue everything together. Close the

dive-brakes and apply Hot Stuff through the 1/16" holes previously drilled in the dive-brakes. Install the ailerons and Hot Stuff the hinges and aileron torque rods. Install the aileron servo and adjust the linkage. Set the ailerons for 3/16" up and 3/16" down for the first flight.

Fuselage: (Part 2)

Drill a 3/32" hole in the fin for the stabilator pivot wire.

Install the stabilator servo platform. Install the stabilator servo using servo mounting tape at the angle shown in the top view on the plans.



Make the stabilator actuator assembly from 1/16" steel wire and a clevis. Remove the pin from the clevis by grinding off the head of the pin and punching the pin out. Center the steel wire through the clevis and solder. Cut an adequate length of steel cable and solder to the actuator assembly. Slide through the tubing and align with pivot wire. Center the stabilator servo and the actuator assembly. Install the clevis and brass coupling to the servo. Cut the elevator control tubing 5/8" from the coupling. Align and glue the tubing to the side of the fuselage. Cut the cable to the proper

length and solder to the coupling.

Stabilator:

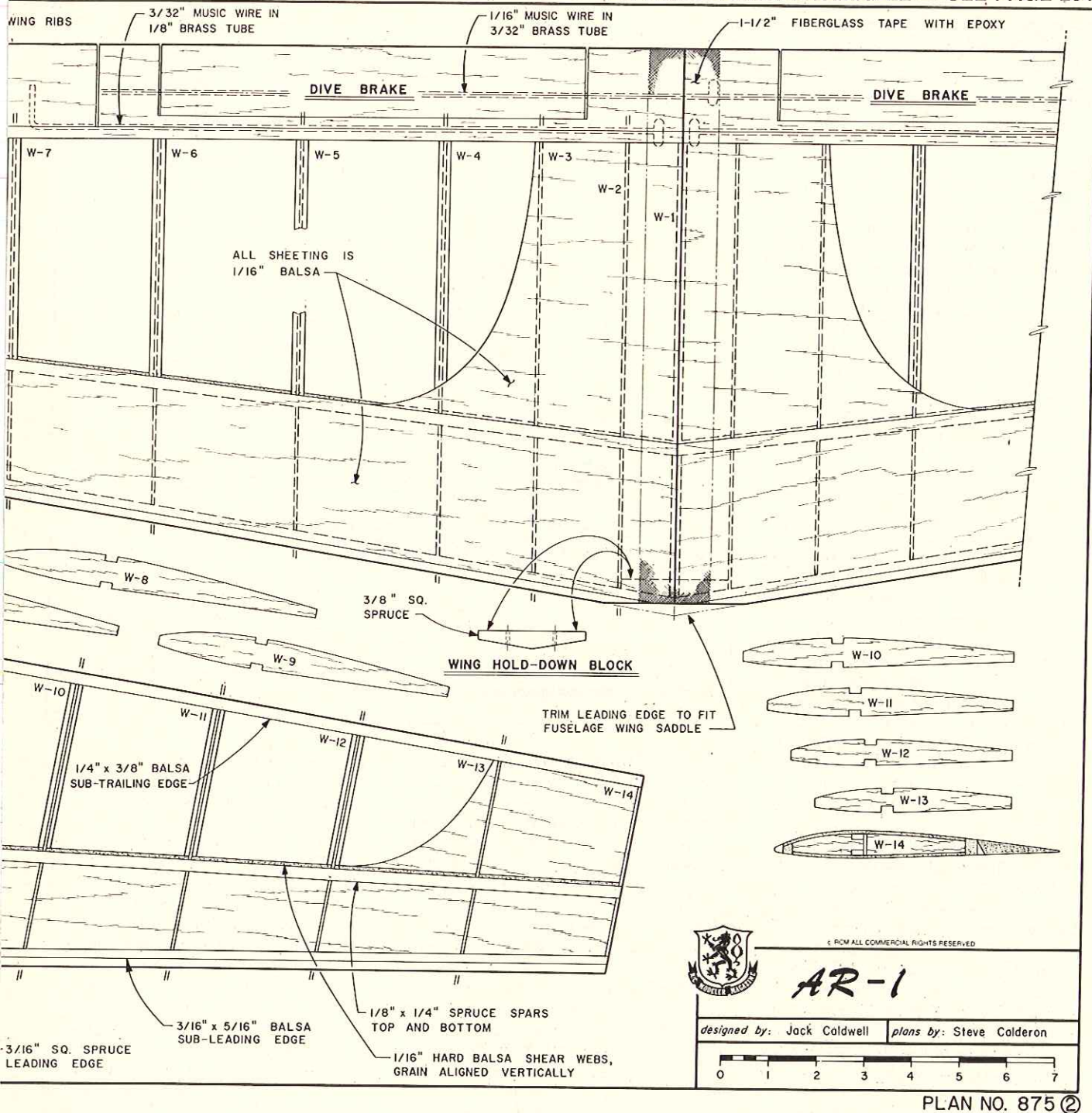
Cut parts S-2, S-3 and S-4 from the lightest balsa. Cut parts S-1 and S-5 from medium hard balsa. Groove S-2, S-3 and S-4 per the plans. Make sure the grooves are a little on the loose side, to allow for adjustment when fitting to the stabilator wires. Cut two pieces of 1/16" brass tubing and two pieces of 1/8" brass tubing and slide the tubing onto the elevator pivot and the actuator wires. Rubberband both S-3 pieces in place and block both sides of S-3 to level. Hot Stuff tubing to S-3, being careful not to glue the tubing to

the wires. Add a drop of Hot Stuff to the pivot wire at the tail post. Be careful not to glue the stabilators to the pivot wire. Remove and lay both S-3's on a flat surface over a piece of plastic. Hot Stuff S-1 and S-5 in place. Sand to shape and MonoKote.

Hot Stuff 1/4" x 3/8" balsa block to the top of the fin and finish sanding. MonoKote your AR-1.

Install the canopy latch. Slip the radio antenna through the antenna tube. If you have any excess antenna, route it up the back of the fin and tape it in place.

Install your radio and balance your



new bird.

Balancing the AR-1:

The balance point for the initial set-up should be at 6 7/8" from the trailing edge of the wing. Balanced at this point, my bird weighed 39 ounces. This gave me a wing loading of 8 1/2 ounces per square foot.

First Flight:

Now off to your favorite hill. Try to select a day when the wind is 10-12 mph. Range check your radio. Set the trim on the stabilator and ailerons at center with dive-brakes fully closed. If you have never flown an aileron ship of this type, before you toss your AR-1

off, I should give you a few pointers on how it flies. Due to the flat wing style, the AR-1 must be flown into and out of the turns. Whatever attitude you put the AR-1 into, it tends to stay in until you give it opposite control to return to level flight. It is not like a plane with dihedral, which will tend to return to level flight.

Now is the moment of truth. Give the AR-1 a brisk toss straight out, directly into the wind and be ready to apply a little down, if needed. Go for a bit of altitude and set your trim for level flight. As you make your turn, the nose will drop a bit, but as you

level off again, she will pick up a bit of speed and the nose should come back up.

If you are not used to flying this type of glider, remember you must keep the speed up for it to perform well.

To land the AR-1, drop the trim on the dive-brakes. Start your downwind leg, make your final turn, set up into the wind and apply full dive-brakes. Apply a little down elevator and set her down. After a little practice at setting your elevator trim, the AR-1 will just about land itself. I hope you will enjoy flying the AR-1 as much as I do.