

# WIND FREE

BY ROD AND MARK SMITH

## INTRODUCTION

The Windfree has been successfully flown in competition against all types of R/C sailplanes. With this sailplane the expert can win contests or the flier who has reached the intermediate level of R/C soaring ability can practice the finer points of the art.

Construction of the airframe is conventional, since all materials are standard size and readily available. Even the canopy can be replaced with materials available at your hobby shop. The attachment of the wings and stabilizer to the fuselage is solid and simple with no grommets, hooks or rubber bands to wear, shift or fail at the crucial moment.

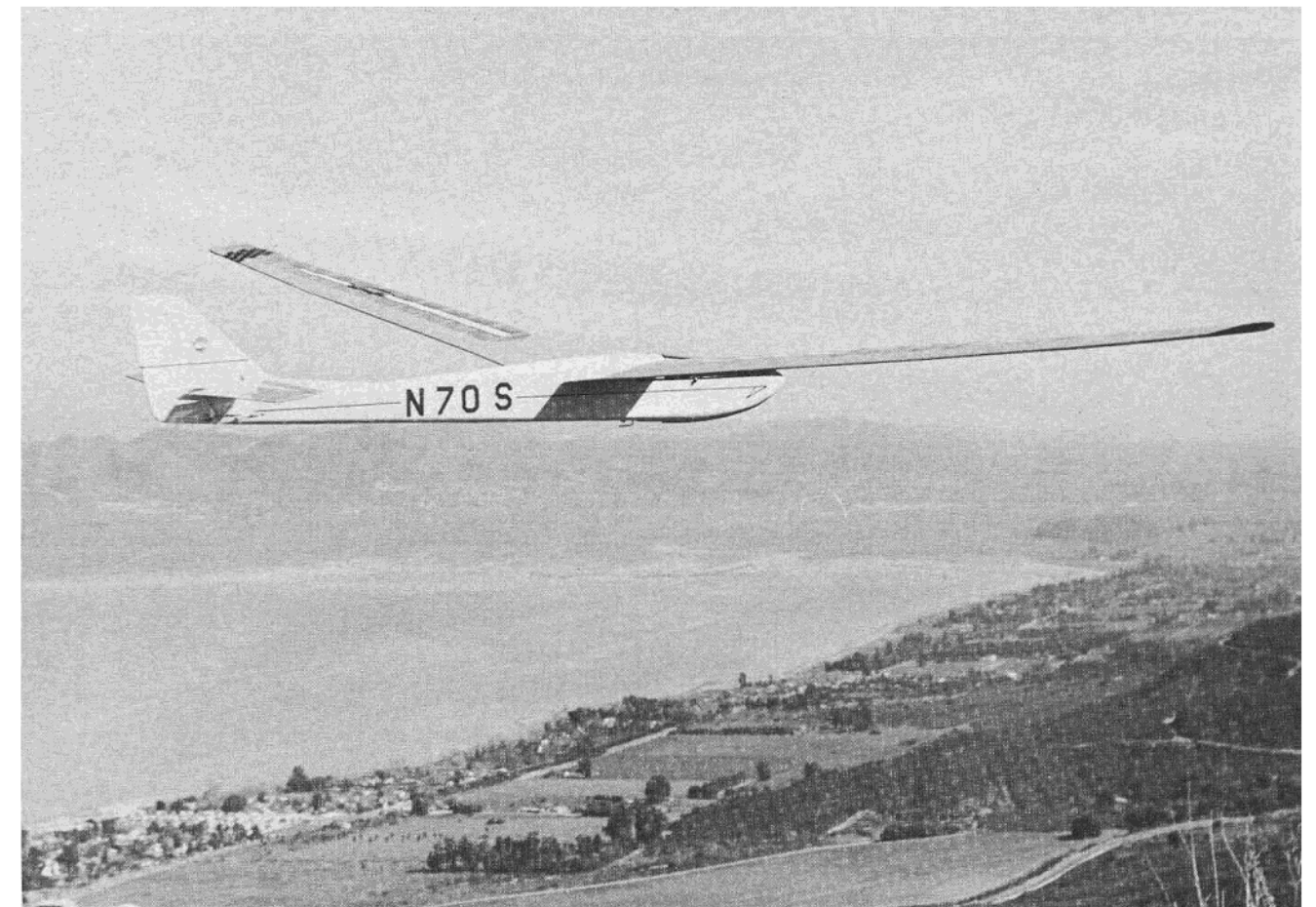
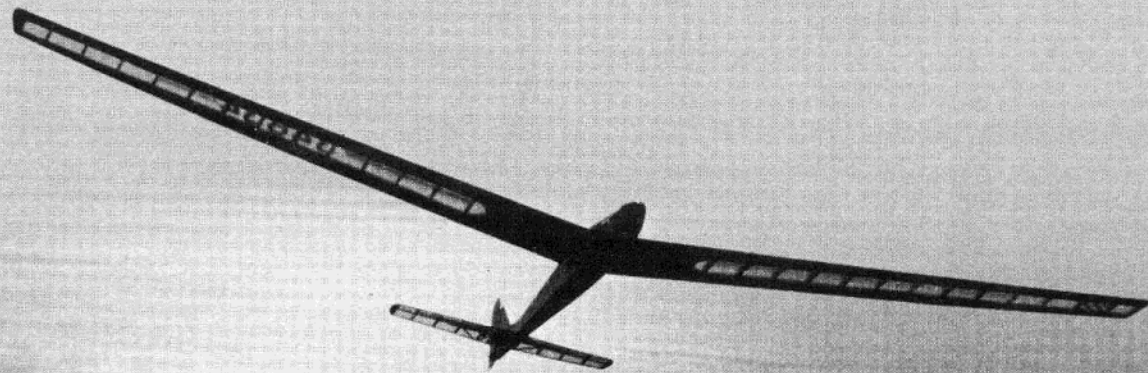
## WING CONSTRUCTION

(1) Prepare a flat work surface five feet long and at least one foot wide. Use a material that will not bend or warp and one in which pins can be inserted. The completed wing will only be as straight as the surface on which it is built. Cut the drawing of the right wing panel from the plans and tape it to the work surface. Tape a sheet of wax paper over the plans.

(2) In the following text the term cement will be used to designate Ambroid and the term glue will designate Titebond. Cement the 1/16" x 2" balsa sheets together to form the leading and trailing edges. Pin these sheets over the plan so there will not be a gap at the 45° butt joints. Cut a doubler from 1/16" sheet scrap, as shown on the plans and glue in place. Be sure the glue does not get in the area of the 1/4" x 1/4" leading edge or the 3/32" x 1/4" spar.

(3) Pin and glue the 3/32" x 1/4" bottom spruce spar in place over the 1/16" x 2" leading edge sheet. Note that the spar stops at rib # 12. Clean off any excess glue that is squeezed out of the joints. Shim the rear bottom spar 1/16" above the work surface and pin in place.

(4) Cut out, then glue and pin the ribs in place. Make sure to cut the spar slots slightly oversize to assure that the ribs will be down tight on the leading and trailing edge sheets and not perched on top of the spar. Push the ribs as far forward as they will go. Align the front of the ribs with a straight edge.



(5) Cement and pin the  $\frac{1}{4}$ " x  $\frac{1}{4}$ " leading edge in place.

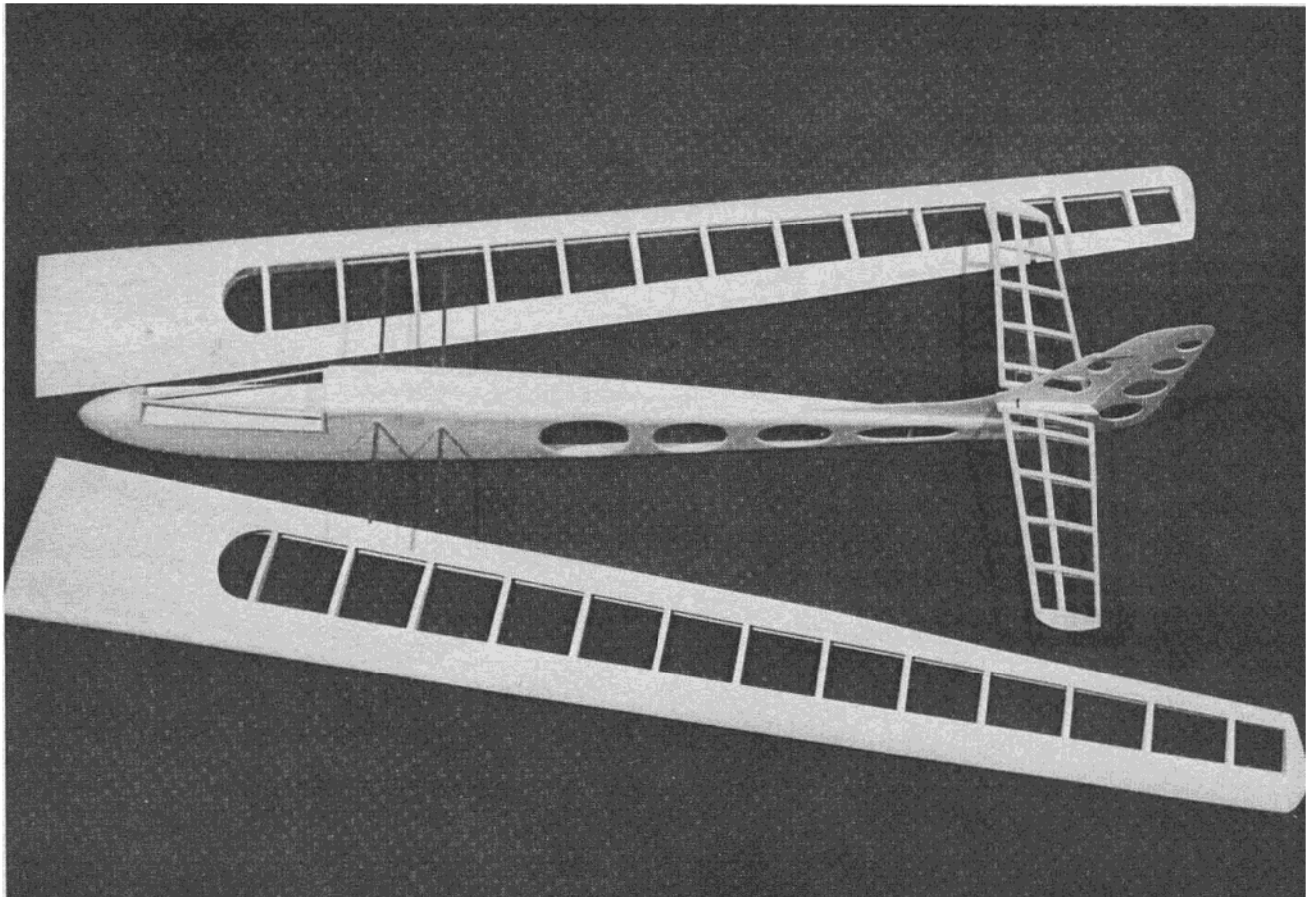
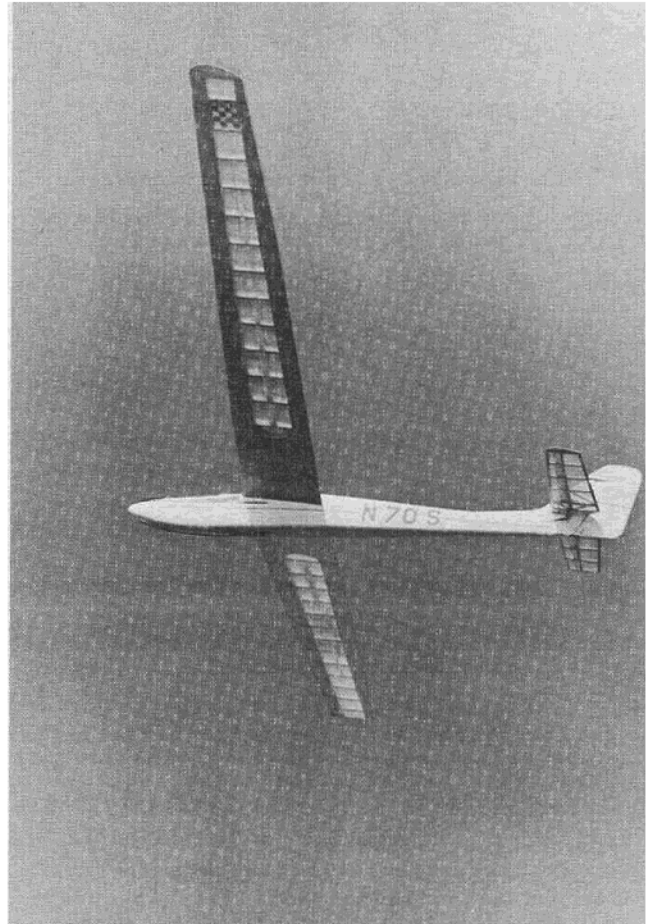
(6) Glue the top spars in place; splice the front spar as shown on the plan. Be sure to use Titebond glue. Do not use excessive glue at ribs 1, 2, or 3. These ribs are drilled out later to permit the  $\frac{3}{16}$ " diameter brass tube to be installed. Excessive glue will make this job more difficult.

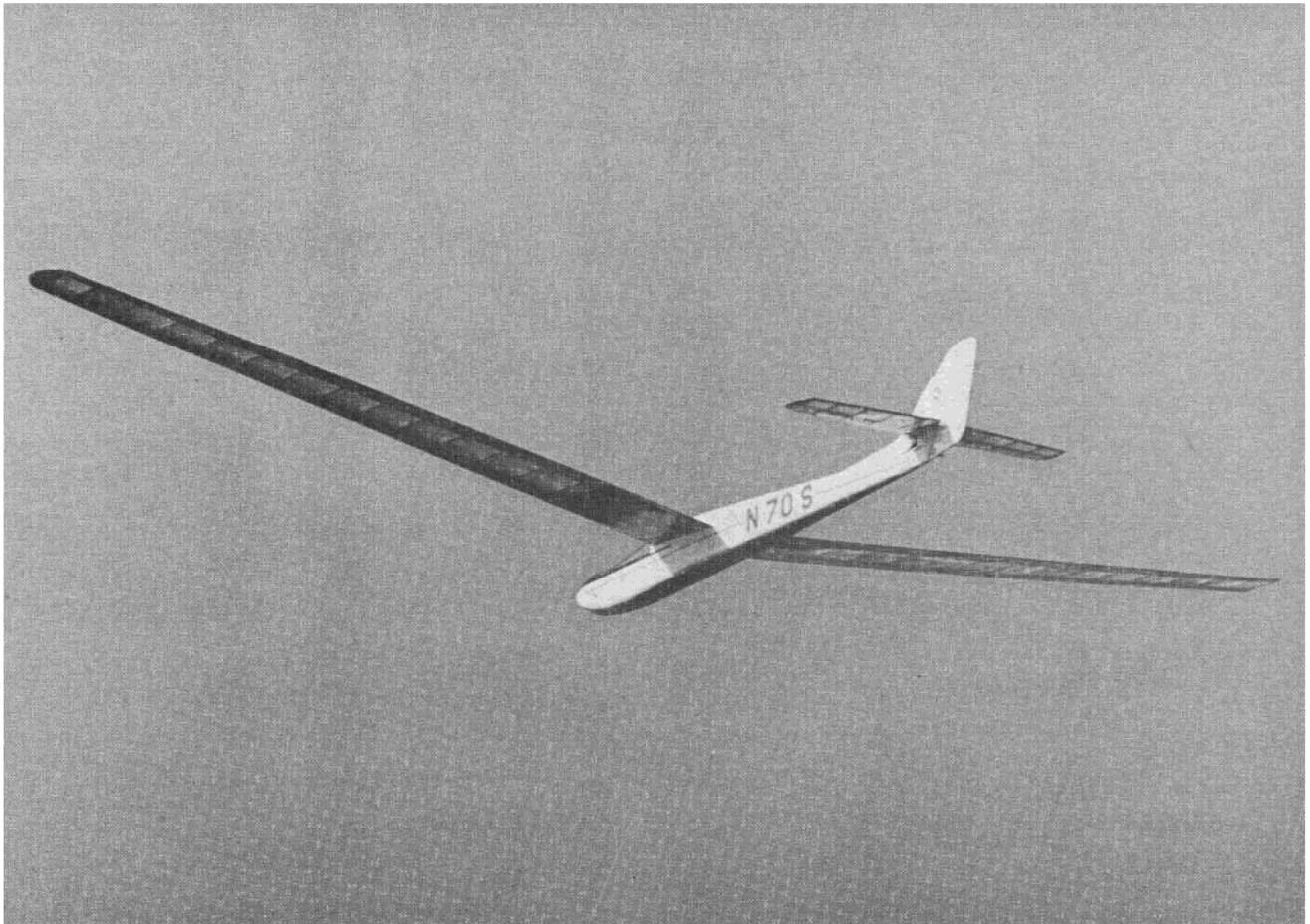
(7) Glue and pin the  $\frac{1}{16}$ " sheet front shear webs in place on both front and rear spars. Do not enclose the spar completely by installing the rear shear webs. Glue the  $\frac{1}{16}$ " sheet scrap trailing edge stiffener in place. Let the assembly dry for at least eight hours.

(8) After the assembly has dried, trim off the excess shear web material that projects above the top spar. Cut the leading and trailing edge sheets to the proper outline. The best way to mark the trim lines on the wing trailing edge, is to extend the wing outline on the plans with a pencil and straight edge. When the assembly is in place over the plan, you can then align the straight edge with the extended lines and draw the trim line on the wood. A good metal straight edge, or "yard stick", may be purchased at the hardware store for about one dollar. This tool is useful when working with large wings.

(9) Glue a  $\frac{1}{16}$ " scrap sheet splice doubler to the  $\frac{1}{16}$ " x 2" top leading and trailing edge sheets. Be sure the doubler is on the proper side of the sheet. Wipe off any excess glue. Excess, dried glue will prevent the mating sheet from forming a tight joint.

(10) Remove the wing assembly from the plan and sand





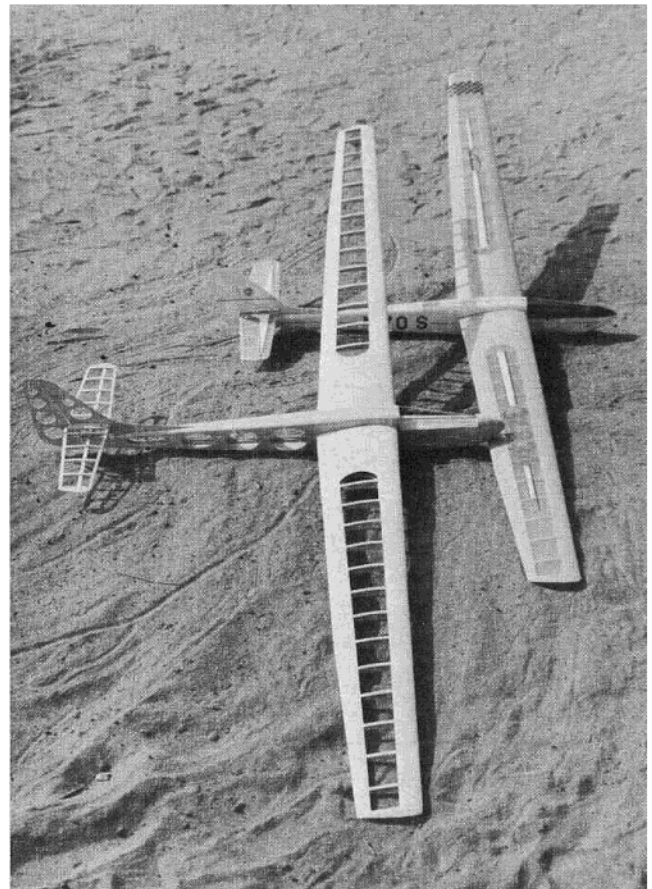
the  $\frac{1}{4}$ " x  $\frac{1}{4}$ " leading edge and the  $\frac{1}{16}$ " x 2" trailing edge so that they fair into the curve of the ribs. Don't slant the top of the leading edge so much that when you cement on the  $\frac{1}{16}$ " x 2" top leading edge sheet, the sheet will not bend over the leading edge and the ribs. Use a sanding block that is at least  $\frac{3}{4}$ " x 2" x 9".

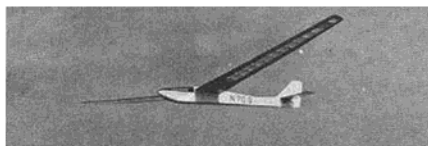
(11) Apply a fillet of glue to all of the joints except where the ribs (R2-1, R2-2) contact the top spars. Use a glue gun for this operation. Be sure to put large fillets inside the wing spar.

(12) Pin the assembly to the work surface and coat the top of the front spar, leading edge and the top of all the ribs where the  $\frac{1}{16}$ " x 2" leading edge sheet contacts them, with glue. Pin the  $\frac{1}{16}$ " x 2" leading edge sheet in place. If you wet the sheet on its upper surface it will bend easier but then the wing will have a nice spanwise elliptical warp when the sheet dries. This won't hurt the performance of the sailplane and your friends will wonder how you got the fancy elliptical dihedral. Don't tell them! Just be sure you wet the leading edge sheet when you build the left wing panel. Also, be sure to clean off any excess glue that is squeezed out of the joint between the top spar and the  $\frac{1}{16}$ " x 2" leading edge sheet.

(13) Glue and pin the  $\frac{1}{16}$ " x 2" trailing edge sheet in place.

(14) Let the wing panel dry for several hours. Don't remove the pins until the glue has really dried.





(15) Trim the spars, leading edge and trailing edge off flush with the root and the tip rib.

(16) Drill the holes in ribs R2-1 and R2-2 for the 3/16 O.D. brass tubes. File a sharp edge on a piece of 1/4" diameter brass tube and use this for a cutter. Guide the cutter with your fingers and the top spars. Keep the tube tight against the spar as you drill the holes. Don't epoxy the brass tubes in place, yet. Take some time with this step. If the holes are accurate, and the tube touches the spar, then the installation of the wing wires in the fuselage will be much easier.

(17) At this point the right wing panel should lack the 3/16" root rib (W2-0), the 1/16" sheet planking at the root from ribs 1 to rib 4, the tip block, the cap strips and the rear shear web on both spars and the brass tubes.

(18) Repeat the above steps and construct the left wing panel.

(19) When both panels are at the stage of completion as described above, the brass tubes are installed. Plug the end of each tube with 1/16" balsa using the tube itself as the plug cutter. Epoxy the plugs in place with 5 minute epoxy from the outside. Remove any tarnish from the outer surface of the tube with sandpaper and wipe the surface clean with a cloth and acetone. When the tubes are clean, slip them into the wing with the plugged ends toward the tip. Be sure there are no burrs on the inside diameter of the tubes or the ends of the 5/32" diameter wires. Press the short 5/32" diameter tooling wires through the holes in the 1/16" plywood jig. Use this jig to position the tubes in both wing panels. Pin one panel to the work surface and insert the wires of the jig into the tubes. If the jig does not slip into place easily, elongate the holes in the rib R1-1 and R1-2 until the tubes can align with the jig. Slide the other wing panel over the jig wires. The wing panels should now be butted against the 1/16" plywood sheet and flap on the work surface. All four tubes should be resting against the top spars. Clamp the tubes in place with clothespins. Be sure that the wing panels will still slip over the jig wires. When the brass tubes are aligned with the jig, put a couple of spots of 5 minute epoxy on each tube to secure it to the top spar.

(20) When the epoxy has cured, remove the wings from the work surface and set aside until the fuselage and stabilizer are built.

#### FUSELAGE

(1) Cut out and lightly sand the fuselage sides.

(2) Pin the right fuselage side over the plan and draw light pencil lines across the sides. Use the marks on the plan above the station letters (B through K) and the marks located between the top and side views of

the fuselage. These lines will locate the fuselage vertical braces. Mark the edges of the fuselage sides to show where the line is located. Mark the position of the front of the 1/8" plywood fin base (F2-8).

(3) Remove the right fuselage side and pin both sides together so that the lines you drew are between the two sides. Mark the position of the lines on to the edges of the left side.

(4) Remove the pins and draw the lines on the left side. Be sure you have a left and right fuselage side.

(5) Pin both fuselage sides to the work surface so that the lines drawn on the sides are facing up. Do not pin the sides over the drawing.

(6) Cement and pin F2-1 and both the bottom longeron and the top rear longeron in place. Saw cuts will permit the 3/16" sq. top longeron to bend in the area of fuselage station E.

(7) Glue the 1/8" square vertical brace at station G in place.

(8) Glue the 3/16" square canopy rest to the top edge of the fuselage side. Be sure it extends to the front edge of the fuselage.

(9) Glue the 1/8" square vertical brace at B in place.

(10) Glue the 3/32" x 1/4" spruce longeron in place.

(11) Glue the 1/16" plywood doubler (F2-5) in place. Be sure the holes for the wing wires are aligned with the 5/32" holes in the fuselage sides.

(12) Glue the 3/16" square vertical braces in place. Note how the braces are notched to fit over the 3/32" x 1/4" spruce longeron. A 1/16" scrap shim is placed under the 3/16" square brace at station E and F between the bottom longeron and the 3/32" x 1/4" spruce longeron. (See section E on the drawing.) Use the plywood bulkheads F2-3 and F2-4 to position the 3/16" square braces in respect to the wing wire holes.

(13) Glue the remainder of the vertical braces in place except at station K.

(14) After the glue has dried, cut the fuselage lightening holes out of the plan and use them for templates to mark the holes on the fuselage sides. Cut out the holes in the sides and sand them smooth.

(15) Glue in the vertical brace at station K.

(16) Bevel the longerons to fit the fin. See the top view of the fuselage for the angle.

(17) Pin the canopy base (C2-2) in place on the fuselage. Be sure you have cut the base slightly undersize. This is done so that when the canopy frame is covered with the clear plastic, the plastic will be flush with the fuselage sides. Allow a ledge the thickness of the plastic on both sides, when you pin the canopy base in place.

(18) Glue all of the fuselage cross braces in place. Do not install any bulkheads at this time. Cement and pin the 1/16" sheet balsa, rear top fuselage covering in place from fuselage station I to the front of the 1/8" plywood fin base (F2-8). Use a 90° triangle to check the fuselage to be sure the fuselage cross section is square.

(19) Sand the 1/8" sheet balsa fin parts so that the edges to be cemented are straight and the corners are sharp. Laminate the lower rudder hinge between two sheets of 1/16" balsa scrap and epoxy in place in the plywood fin base. Sand the balsa flush with

bulkhead (F2-2) in place.

(24) Glue the 3/8" nose fairing block in place. Use the canopy base to locate the position of the block. Allow clearance so the canopy can be removed.

(25) Slip the 1/16" plywood doubler (F2-12) over the tow hook. Cover the bottom of the fuselage. The 3/16" sheet grain runs crosswise while the 1/16" sheet grain runs lengthwise. Do not cover the top of the fuselage until the controls are installed.

(26) Sand the front of the fuselage flush and glue on the nose block.

(27) Slot the fin (F2-9) for the rudder hinge. This is as far as the construction of the fuselage can progress at this time. The canopy must be in place before the nose is shaped.

#### CANOPY

(1) Notch C2-1 and C2-3 for the 1/8" diameter dowels. Place wax paper over the fuselage in the area of F2-2 and the 3/8" nose fairing block so the canopy will not be glued to the fuselage.

(2) Glue and pin C2-1 and C2-3 to the canopy base. Pin C2-1 to the 3/8" fairing block and C2-3 to fuselage bulkhead F2-2. The wax paper will provide clearance.

(3) When the glue has dried, remove the canopy and glue the 1/8" diameter dowels in place. Check the fit of the canopy assembly with the fuselage.

(4) After the glue has dried, trim off the 1/8" dowel flush with C2-1 and C2-3.

(5) Glue the 3/16" square canopy cross brace in place.

(6) Drill a 1/16" diameter hole in each side of the fuselage. Locate the hole about 1/32" of an inch lower than the lower surface of the 3/16" square canopy cross brace. Use a piece of 3/16" square scrap to assist in locating the holes from outside the fuselage. Press short lengths of 3/32" diameter tube into the holes and epoxy in place. Cut a piece of 3/32" diameter tube to the length of the 3/16" square canopy cross brace. Slide a length of 1/16" diameter wire through the tubes in the fuselage sides. Have the 3/32" diameter tube on the wire and between the fuselage sides. Coat the bottom of the 3/16" square canopy cross brace with 5 minute epoxy and pin the canopy in place on the fuselage. When the epoxy has cured pull the 1/16" diameter wire and remove the canopy. Do not complete the canopy at this time. Set it aside and proceed with the stabilizer and rudder.

#### TAIL SURFACES

(1) Place wax paper over the stabilizer drawing.

(2) Pin the 3/16" x 1/4" leading and trailing edge pieces in place.

(3) Cut the 3/32" x 1/4" balsa strips to fit between the leading and trailing edges. Cement and pin the strips in place. We will call these strips "ribs."

(4) Glue and pin the 3/32" x 1/4" spruce spar in place over the ribs.

(5) When the cement has dried remove the pins from the leading and trailing edges and shim them above the work surface with 1/16" sheet scrap. Be sure the shim supports each rib where it contacts the leading or trailing edge.

(6) Cement and pin 3/32" x 1/4" ribs in place over the spar.

(7) When the stabilizer assembly has dried, remove it from the plan and sand the tips and root flush with the ribs.

(8) Cement the 1/16" sheet stabilizer root ribs and tips in place.

(9) When the cement has dried, sand the 1/16" sheet root ribs to the contour of the 3/32" x 1/4" ribs.

(10) Cut the 3/32" diameter brass tube to the lengths shown on the plan. Clean the tubes with sandpaper and then wipe off with a cloth and acetone.

(11) Sharpen the end of the tubes and push them through the root rib of the right half of the stabilizer.

(12) Cut two lengths of 1/16" diameter wire to the lengths shown on the plan. Clean the wires with sandpaper and acetone.

(13) Slide the wires into place in the left hand half of the stabilizer. Bring both halves of the stab together so the root ribs butt together. Pin the assembly to the work surface. Place a couple of drops of 5 minute epoxy on the wires and tubes to attach them to the stabilizer structure.

(14) When the epoxy has cured, remove the assembly from the work surface and tie the tube and wire to the spar with thread. Be neat! Everyone will be able to see your work through the MonoKote or Solarfilm. Coat the wires, tubes, and spars where they attach to each other, with epoxy.

(15) Sand the end of the forward stabilizer fairing (S2-3) until the 1/16" diameter hole is exposed. Cement the fairing in place on each half of the stabilizer. Use the 1/16" diameter tie wire to locate these fairing blocks on the stabilizer.

(16) Slide the 1/16" plywood control horn over the pivot wire of the left stabilizer half. Use the horn as a pattern to show where to cut away the 1/16" root rib. When the horn will fit flush into the root rib, glue it in place.

(17) Some builders will object to running the control rod clevis through a bare hole in the 1/16" plywood control horns. The holes in both the rudder and stabilizer control horns may be bushed with a 3/32" O.D. brass tube. Epoxy a short length of tube in the hole. When the epoxy has cured, file the brass tube flush with the surface of the control horn and remove any burrs from the inside of the tube.

(18) Sand the stabilizer tips, fairings, root ribs, leading and trailing edges until the assembly is smooth and streamlined. Put large fillets of glue inside each rib where they contact the leading and trailing edges. Refer to the plan for the cross section of the stabilizer tip and the fairing.

(19) Sand the front of the rear stabilizer fairing (F2-10) so it clears the forward fairing. Sand the fairing to the airfoil shape of the stabilizer. Be sure the 3/32" diameter brass pivot tube in the fin projects about 1/16" out from each side of the fairing. When the fairing is completed, cement in place on the fin. Use a pattern, cut from the plan, to position the fairing at the proper angle of attack with respect to the fuselage.

(20) Cement a piece of 1/8" scrap balsa in the hole in the plywood fin base (F2-8) as shown on the plan. This will provide a surface to attach the covering material to the fin.

#### RUDDER

(1) Place wax paper over the plan.

(2) Sand the 1/8" sheet parts R2-1 and R2-2 so the edges to be glued are straight and the corners are sharp.

(3) Pin the 1/8" x 3/8" strip together over the plan.

(4) When the assembly is dry, sand it to a streamline shape.

(5) Slot the rudder in the location shown on the plan, for the rudder horn.

(6) Slot the rudder for the hinges. Trim the hinges as shown on the plan so the slots do not have to be so deep. If there is difficulty making slots in the "thin" 1/8" sheet use the lamination technique as explained in the fuselage section of this article. Do not install the rudder on the airplane at this time.

(7) Cover the rudder. Cut through the covering material and epoxy the control horn in place.

#### FINISH

In this section all of the components of the airplane are brought together for final fit, sanding and covering.

(1) Fit short wood shims between the brass tubes and the lower spars.

(2) Rest the wing panels on their leading edge. Use something to support the panels in this position. Mix a volume of Hobby-poxy II, sufficient to fill the voids between the brass tubes and the spar. Pour the epoxy into the spar cavity and around the brass tube. Be sure the ends of the tubes are plugged.

(3) When the spar cavity is full of epoxy, pin the rear shear webs in place. There should be enough epoxy in the spar so that when you pin on the rear shear web, the epoxy is squeezed out of the joints. Let the wings remain resting on their leading edges until the epoxy has cured.

(4) Cap strip all ribs except W2-1, W2-2 and W2-3. Sand off the shear web that projects above or below the spars.

(5) Cover the wing root top and bottom from ribs W2-1 to W2-4 with 1/16" sheet balsa as shown on the plan.

(6) Sand the sheet covering flush with the root rib. (W2-1)

(7) Use the tube alignment jig to mark the hole positions on the mating rib blank (W2-0). This is done by sliding the wires into the wing tubes so they project out about 1/16". Align the mating rib blank and press lightly to mark the position of the holes. Remove the rods from the wing and drill two 3/16" diameter holes in W2-0. Cement the blanks onto the wing so that the holes align with the tubes.

(8) Cement the wing tips in place.

(9) After the glue has dried, the wing panels are now ready for final sanding. Sand the rear of the top trailing edge sheet until the rear edge of the trailing edge is about 1/16" thick. Sand the bottom of the leading edge to the radius shown on the plan. Sand the top leading edge sheet to complete the airfoil. Take your time with this step and check the work as it progresses. Cut out the center section planking sheet between rib R2-3 and R2-4 as shown on the plan. Sand the sheet covering to a smooth curve. Sand the tip block to the cross section shown on the plan. Sand the 3/16" root rib (W2-0) to the contour of the airfoil.

(10) Slide the wings in place and note how the root ribs do not fair into the fuselage. Remove the panels and sand the root rib at the proper angle and curve so that when the wing panels are in place the root rib lays flush on the fuselage side. This will take several trial fittings before the fit will be satisfactory.

(11) The wing panels are now complete except for covering. MonoKote or Solarfilm

are good covering materials. Transparent yellow or orange gives excellent visibility during high thermal flights.

(12) Attach the rudder to the fin, temporarily, by slipping the hinges into the slots.

(13) Install the stabilizer.

(14) Build a battery support in the nose of the airplane. Use 1/16" plywood scrap. The batteries must rest against the nose block. The receiver is located behind the battery and the servos are behind the receiver.

(15) We prefer stranded steel control cables. Pylon Brand .030" diameter is available at your hobby shop.

(16) Mount the radio control system so that the inertia loads during hard landings are not concentrated on one small area of the structure. Be sure the clevis or Kwik-Link to the rudder horn rotates easily on the threaded portion of the control cable. It must rotate or the push-pull cable will twist and cause the system to bind. The rudder horn is mounted at an angle to the hinge line so that as the rudder moves the horn will impart a twisting motion to the clevis. If the horn is located 90° to the hinge line, then this rotary motion is eliminated but a small amount of air drag will result. Use double sided tape to mount the components of the radio system. The switch can be taped to the receiver case and a push-pull wire to the switch can be extended through the fuselage side.

(17) After the control system is installed, cover the top of the fuselage with 1/16" sheet balsa.

(18) Round off the external corners of the fuselage as shown in sections B-B, E, and H. Fair the rear of the fuselage into the fin.

(19) Install the canopy frame and sand the fuselage and canopy as an assembly. Leave the fuselage slightly larger than the canopy so that when the celluloid is installed the fuselage and canopy will be flush. Sand the nose block to fair into the fuselage.

(20) Remove the canopy frame from the fuselage and paint the frame black or zinc chromate. Cement the plastic over the frame. Pin the plastic in place while the cement dries. Push the pins through a strip of scrap balsa so the balsa presses the plastic flat against the canopy structure. When the cement has dried, remove the pins and wood and trim the plastic flush with the canopy structure.

(21) Trim the canopy with 1/8" wide trim tape.

(22) Sand any bumps or rough spots on the surface of the fuselage, fin and stabilizer structure. Cover these parts with MonoKote or Solarfilm and trim.

(23) Epoxy the rudder hinges into the rudder.

#### FLYING

(1) Windfree will fly "right off of the building board." If the wings are aligned properly the airplane should not require any ballast.

(2) Warp about 1/8" to 3/16" of wash-out into each wing panel. This will cause the airplane to have a smooth stall without one wing tip or the other stalling early.

(3) If the wings slip on and off the fuselage wires too easily, bend the forward wire downward very slightly. Make the bend about 3" out from the fuselage. This "kink" will provide enough drag to retain the wing panels on the wires. □