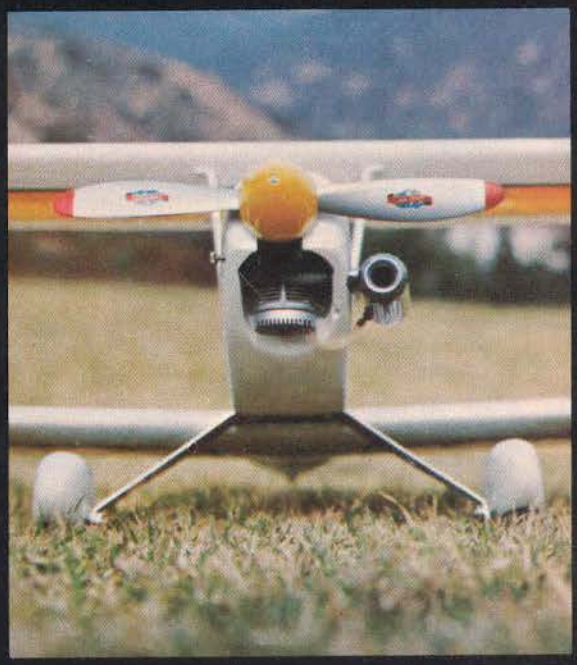
THE ACRO-STAR

By Don Dewey and Lee Renaud



ACRO-STAR CONTEST

1ST PLACE

One Kraft 5-channel proportional system.
One set of plans for the full size Experimental Aviation Association Acro-Sport biplane.
One one-year membership in the E.A.A.
One two-year subscription to R/C Modeler Magazine.

2ND PLACE

Fifty dollar cash award.
One one-year membership in the E.A.A.
One Airtronics Acro-Star kit.
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3RD PLACE

One one-year membership in the E.A.A.
One one-year subscription to R/C Modeler Magazine.
One Airtronics Acro-Star kit.

For biplane addicts, the ultimate R/C bipe is a someday project . . . the irresistible two-winger that captures all of the beauty of the carefully crafted homebuilt. The authors have put it all together in appearance and performance with the

ACRO-STAR

TEXT BY LEE RENAUD

PHOTOS BY DON DEWEY

The Acro-Star was born one night during a hangar session between the authors. We were discussing the differences in construction techniques and materials used in R/C sailplanes and R/C power planes, and how the sailplane approach might provide some advantages if applied to a power model. One thing led to another and the idea of a sport-scale biplane featuring advanced construction techniques began to look like an intriguing project.

The tremendous interest in Stand-Off scale models, and the added appeal of a model that looks like a real airplane made a scale appearance a must. We have long admired the beautiful pictures of homebuilt aircraft in Sport Aviation Magazine. This is published monthly by the Experimental Aircraft Association, Incorporated, P.O. Box 229, Hales Corner, Wisconsin. 53130, and is the "RCM" for homebuilders. This magazine is filled with information and photos, and we suggest that the serious scale modeler subscribe to it. We particularly liked the lines of the EAA biplane, and used this aircraft as the basis for laying out the Acro-Star. We tried to capture the essential appearance of the EAA bipe, using moment arms and proportions that have provided good flying characteristics on other biplane designs we have flown. This design is not scale but most of our friends who have seen it thought it was. By changing the headrest outline and interplane struts you can create a Smith Miniplane, or several other similar homebuilt aircraft. One of the nice things about homebuilt aircraft is that they are as individualistic as modelers, and modifications of the basic design are many and varied.

This model packs 820 square inches of lifting surface into a compact sized ship that, when fully assembled, easily fits into the back of a Pinto Station Wagon. Prototypes have been flown with engines from .40 to .60 size, and weighs between 5½ and 7 pounds. The prototype shown in the photos is powered by a Veco .61 with muffler and weighs 6.5 pounds with an Orbit 4 channel radio system and PS-6 servos. With 5.7 square feet of area this works out to a wing loading of 18 ounces/square foot.

Powered with a good .40, such as the OS Max or K & B FR .40, the Acro-Star is a great sport ship for the Sunday flier. With a .60 up front it will fly the pattern and execute the vertical maneuvers with ease.

Our prototype is dressed up with optional features such as the interplane "N" struts, wheel pants, cabane fairings, pilot, etc. These add to the looks but the simpler basic version shown on the plans flies just as well. The widespread use of electric starters ensure easy starting with the inverted engine shown. If you prefer an upright engine, just turn it over and cut a hole in the top cowl block and raise the tank slightly higher.

Structural design is conventional, with a few innovations to help make the job easier. Wing construction is almost the same for both wings, and both are easily built on a flat surface without special jigs. The lower wing has a slight amount of dihedral to prevent a "drooped tip" appearance, and the ailerons are cut out and hinged after the assembly is completed for easy alignment. The spruce spars and full span shear webs provide quick building and a very strong warp-resistant structure. Medium weight 3/32" sheeting ensures smooth covering and provides a little extra material for sanding, with only a slight increase in weight. The solid tail surfaces are easy to assemble and finish, and angling the grain as shown provides warp resistance.

Fuselage sides are 1/8" poplar plywood (Sig Lite-ply or equivalent) which offers tremendous strength with a gain in weight of only two ounces over balsa. Combined with the spruce top longerons, nose doublers, and balsa triangle stock on the bottom corners, this is a rugged structure that will survive rough treatment. Internal ties are used to locate the formers and to strengthen the cabane supports. The forward doublers are spaced apart to provide support for the servo rails. Balsa fill-in fore and aft lock the rails securely in place.

Cabane structures scare many modelers away from biplane or parasol designs. We have tried many different approaches to this problem on past designs, but have never been completely satisfied. We think the approach used on the Acro-Star is a real breakthrough and plan to use it in our future designs. The plug-in feature makes it easy to assemble the struts and align the top wing, and makes sanding and finishing the fuselage a cinch. After finishing is complete the right and left cabane strut assemblies are epoxied into the sockets and you're ready to fly.

The struts are formed from 1/8" diameter welding rod instead of music wire. This material is easy to bend and solders beautifully because of the copper plating. Welding rod is readily available at most auto body shops or part stores. It is very tough and provides plenty of strength. All four uprights are the same part which makes bending easier. An added feature of this design is that, in a severe crash, the struts will bend, absorbing the force instead of tearing the wing up. If too badly bent to straighten, they can be removed by unsoldering the cross piece and heating the strut to break the epoxy bond. You can then twist and remove the bent parts and replace with a new set.

You have several options in building the Acro-Star; 1) Order the full-size plans from RCM and start build-

ing, making all parts yourself; 2) Order the plans from RCM and from Airtronics, P.O. Box 132, Sierra Madre, Calif. 91024, order a special scratch-builders kit including pre-formed cabane struts, dural gear, aileron hinge material, and all airframe hardware – for $9.95 postpaid or; 3) Wait for the complete Airtronics kit for the Acro-Star which will be available in May.

CONSTRUCTION

TOP WING:

Start by building the wings first as they will be needed to complete the fuselage assembly. Make two rib templates of 1/8" ply spot glued together, rubber cementing the outline from the plans to the ply. Cut a stack of 16 3/32" sheet rectangles and pin between the templates. Carve and sand the balsa to match the templates. Cut spar notches and check fit before unpinning the stack. Use a felt marking pen to draw a line on the bottom surface to help identify the ribs during assembly. Repeat for the second wing, but don't unstack as yet. Cut a sheet of 3/32" hard balsa to a width of 2-29/32". Insert two short lengths of 1/4" square spruce into the spar notches in the wing rib stack and use as a gauge for the height of the shear webs. Cut 30 of these from the pre-cut sheet, with the grain running vertically.

Trim 1/8" from the leading edge of the rib templates and make one 1/4" thick center rib for the top wing. Next, notch the ply rib templates for the cabane strut pads per W-2 outline. Cut the spar ties, cabane pads, strut pads, tips, etc., now for both wings.

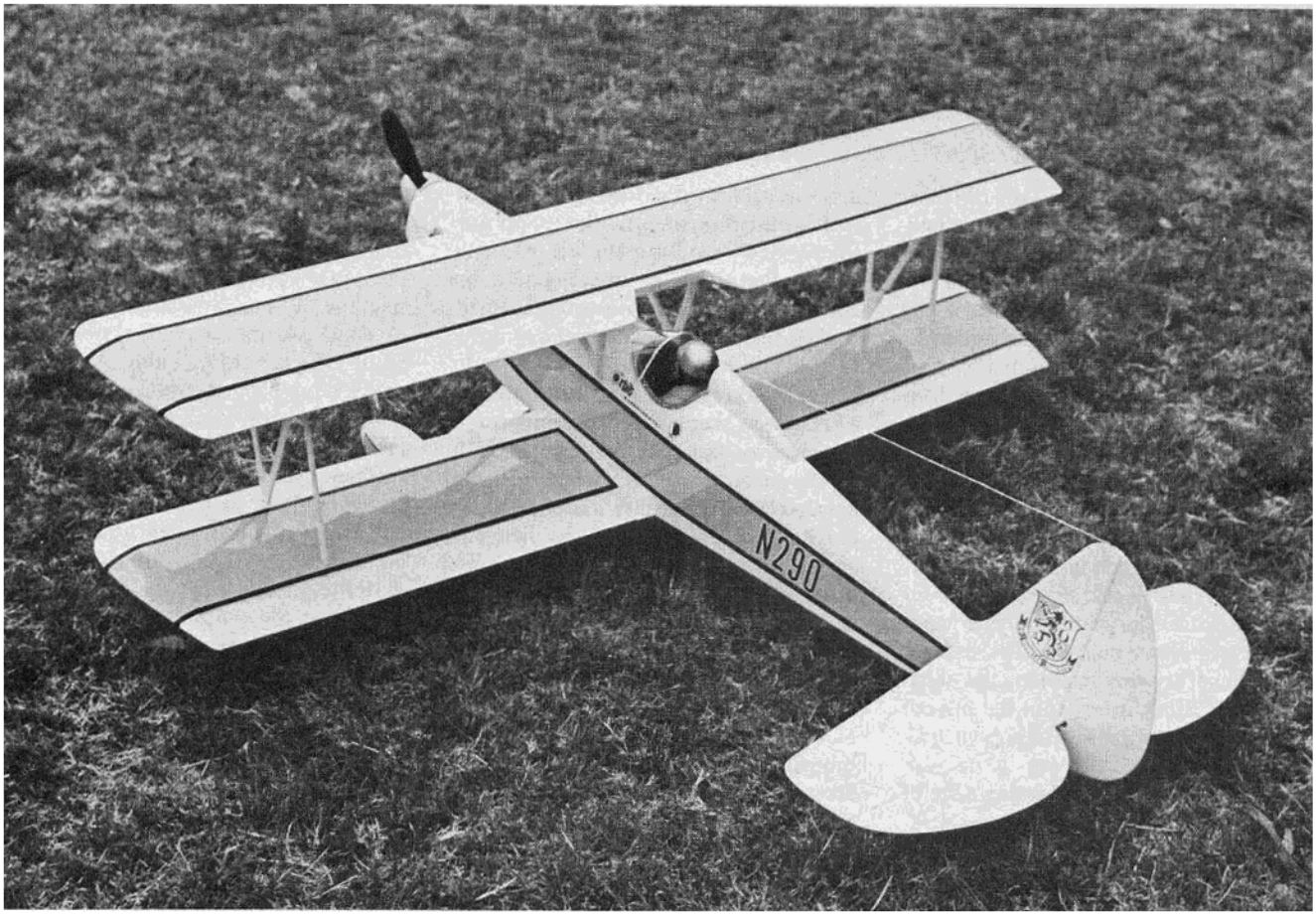
Begin assembly with the top wing. You may use a flat work surface at least 9" wide x 48" long or an RCM Wing Jig or Adjusto-jig, as you prefer. If working on a flat surface, tape the plan down and cover with Handi-Wrap. Pre-assemble the trailing edge sheet and rear spruce spars before starting the wing. Be careful to get the sheet and spars flush on the outside surface. Sand the outside smooth before starting construction. Now, taper the lower T.E. sheet with a razor plane and sandpaper, and pin down on the plan. Pin the 1/4" square balsa spar supports in place and lay the lower 1/4" square spruce main spar on the supports. Epoxy 1/4" stock to the ply ribs and epoxy these ribs in place lining up carefully. Use pins to locate the spar. Epoxy the 1/16" ply spar ties and the 1/4" x 1/2" balsa cut-out frame in place. Working outward from the ply ribs, glue a shear web to the spar and rib surface, then glue the first balsa rib to the shear web and T.E. sheet, using another web as a spacer to keep the rib parallel. Continue assembling the webs and ribs working out to the tip ribs, using the web to space the ribs and to keep them square. Use pins to hold the aft end of the rib tight against the T.E. sheet. Adjust the spacing at the tip ribs if the span is too long or too short.

Run a bead of Titebond on top of the shear webs and rib notches and drop the top main spar in place, pressing down firmly against the webs. Bevel the 1/4" x 3/8" balsa L.E. to shape with a razor plane or saw from 1/4" sheet. Epoxy the spruce leading edge doubler to the leading edge. Install the L.E. using rubber bands and masking tape to hold in place. Check the alignment carefully and adjust the ribs, if required.

Remove the pins from the trailing edge sheet and use a sanding block to feather the ribs into the lower T.E. sheet. For a straight trailing edge use Hobbypoxy Formula I epoxy to join the aft seam, pinning the sheet tightly against the lower sheet. Don't use Titebond or similar glues to join the sheets as the joint will tend to curl. Be sure the rear spar is down tight against the ribs. Use masking tape or pins to hold the sheet down. We've been using contact cement recently to install leading edge sheeting and suggest you try this method. Mark the rib positions on the inner surface of the sheet with a fine line felt pen, and use a small brush to paint a stripe of contact cement at each rib location. Paint the sheet spanwise where it touches the main spar and leading edge. Paint the rib faces, leading edge and main spar surfaces that touch the sheet.

Stick a pin into the spar near the center and tip to provide an alignment point when installing the sheet. Note that the leading edge sheet aft edge is located at the center of the main spar to provide a ledge to support the cap strips. After the contact cement is thoroughly dry, hold the sheet slightly above the wing using the pins to help in positioning. Slowly lower the rear of the sheet until it contacts the spar and press firmly down. Use your hands to press the sheet in place against the ribs working toward the leading edge. Finally press the leading edge in place.


BARDAHL
N290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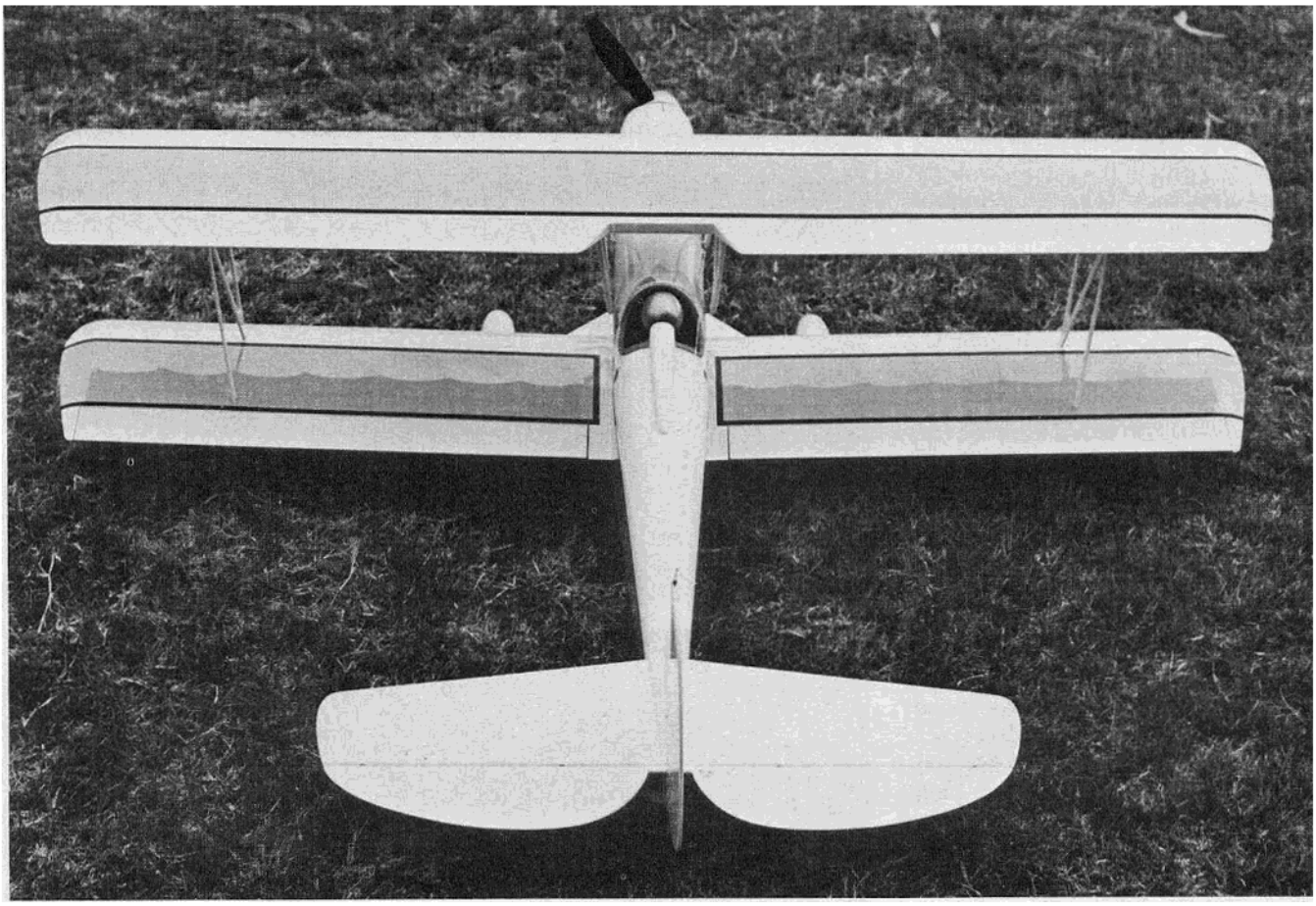
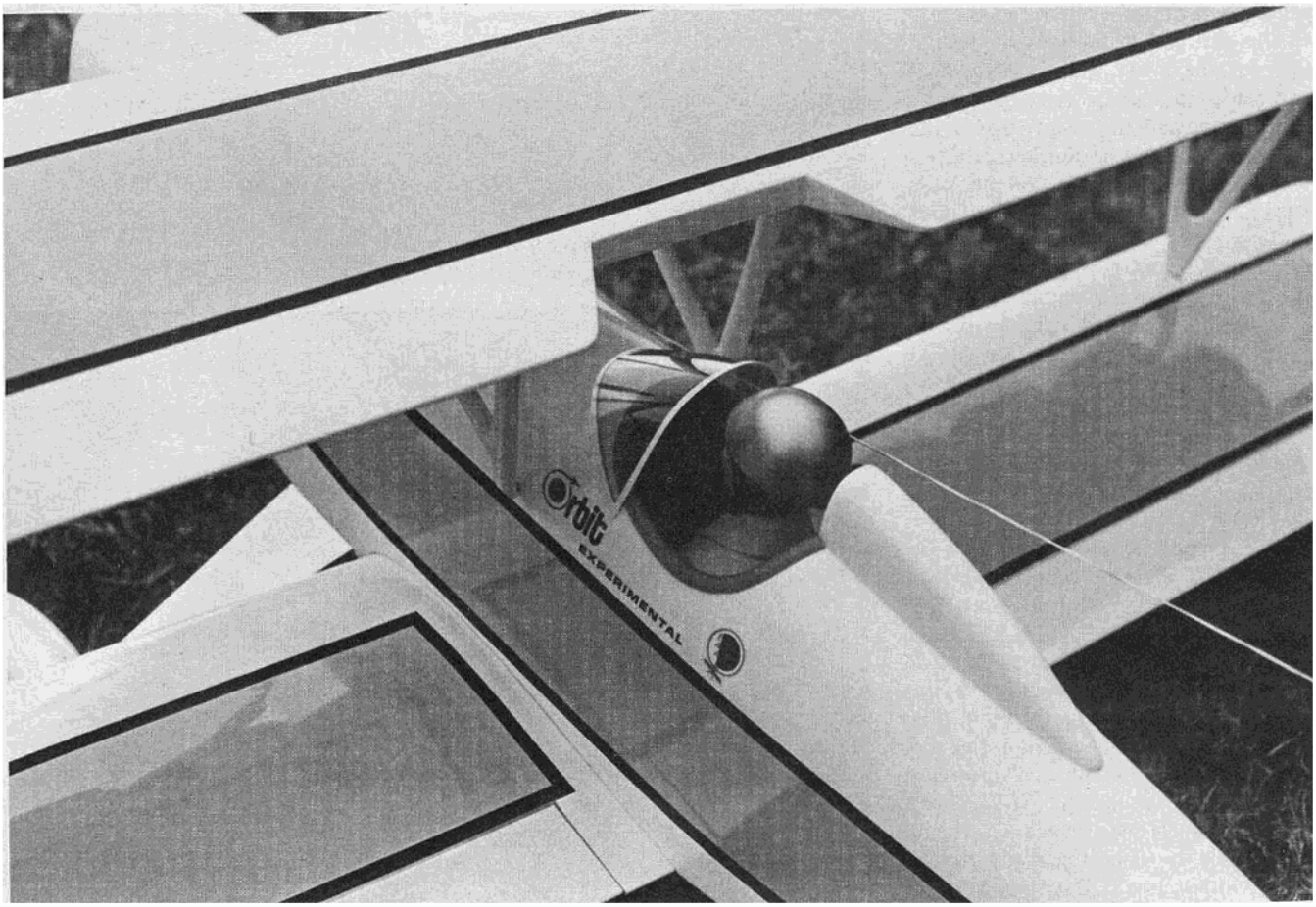



Orbit
EXPERIMENTAL

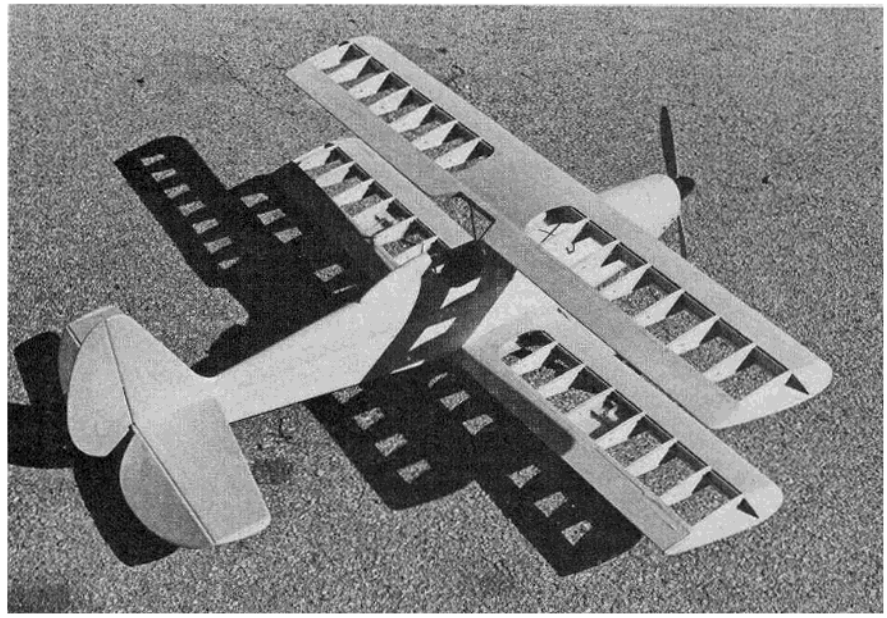
The beauty of this method is that no drying time is needed and the wing can be removed from the work surface immediately. A bonus is that you don't have any pin holes in the sheet which makes finishing easier. Just be careful to position the sheet accurately as you can't move it once the cement makes contact.

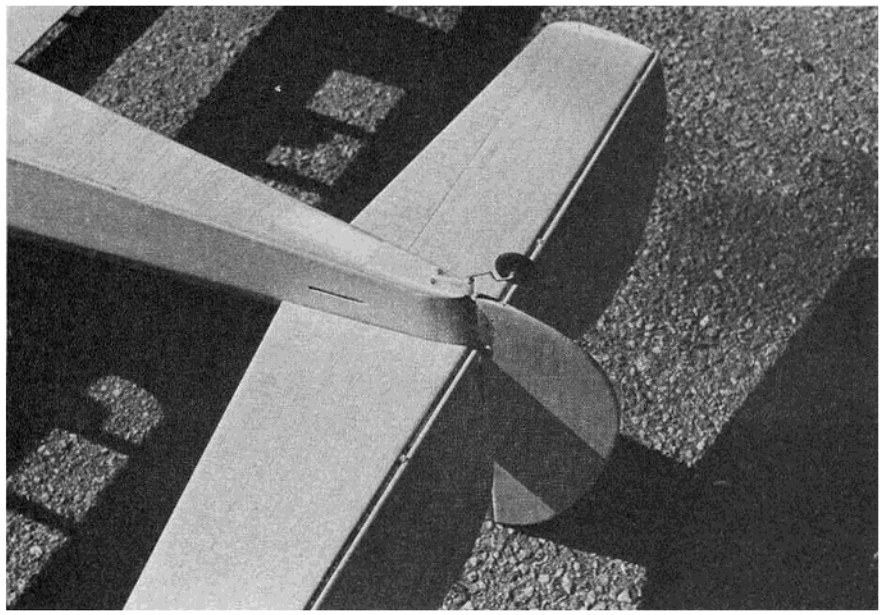
We prefer to add the cap strips and center sheet to the top surface before removing the wing from the board. For easier cap strip installation, try cutting the strips 1/32" too long and cut the edge that butts against the leading edge sheet at a slight angle like a blunt chisel so that the bottom surface of the cap strip is longer than the top. This end is pushed slightly into the sheet and the cap strip is bowed slightly and snapped into position. If properly cut this technique will eliminate the need for pins to hold the cap strips in place.

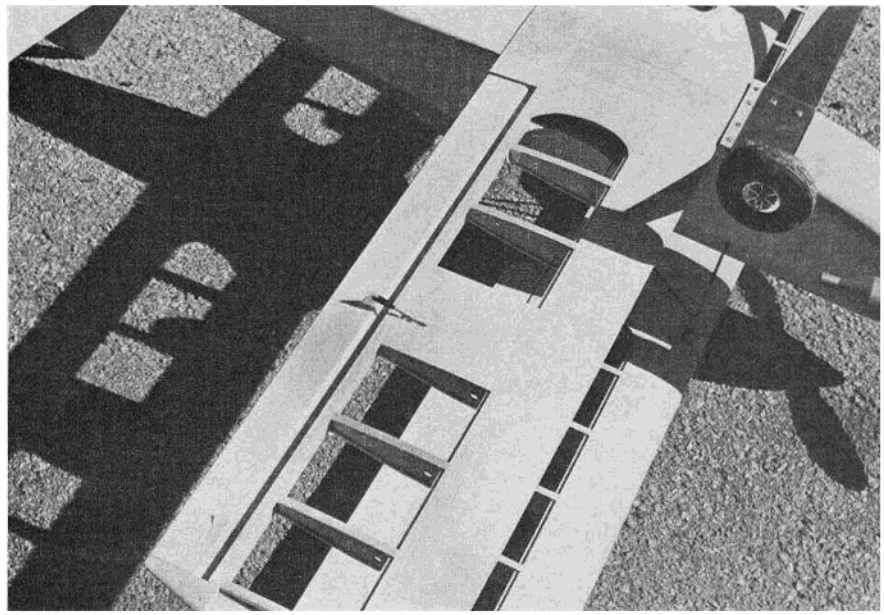
Remove the wing from the board and flip over. Press the #6-32 blind nuts into the cabane strut pads. Fit the pads into the notches in the ply ribs and check to be sure the pads are flush with the outer surface of the sheet. Spot glue the pads with Hobbypoxy 4 to hold in position, then mix up a batch of Sears Filled Epoxy and use this to secure pads. Build up a generous epoxy fillet between the top of the pad and both sides of the rib. Cut out the lower leading edge sheet and center sheeting to clear the cabane pads and install the sheet. Install the 3/32" balsa strut mounting pads on the lower surface. Note that the pads are lined up with the inboard edge of the cap strips. Add the lower surface cap strips. Trim the spars and sheet flush with the tip ribs and use Formula 4 to epoxy the 1/4" sheet tips in place. Add the tip blocks or use 3/32" sheet triangles placed sunburst style if you prefer. Trim the trailing edge sheet for the center section cut-out. The top wing is now ready for final sanding and covering.

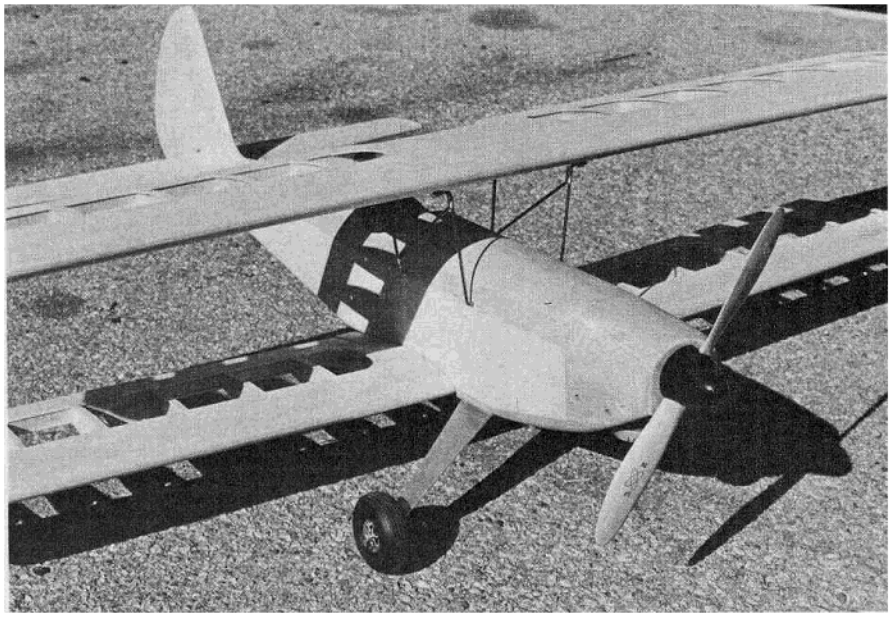
BOTTOM WING:

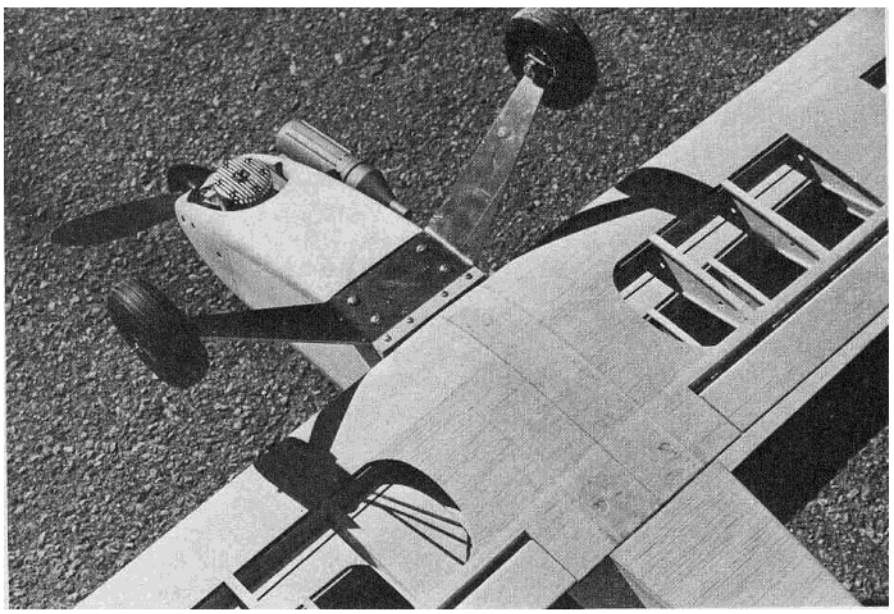
The bottom wing construction is identical to the top wing except for the center section and ailerons. We built our wing flat and added the dihedral after construction was complete but you can use a hinged board or use the Adjusto-jig to build the dihedral into the wing. If built flat the center ribs must be angled slightly for the dihedral, using the 1/4" sheet dowel supports as a gauge. Trim the center ribs to clear the trailing edge filler blocks. Space the false ribs to

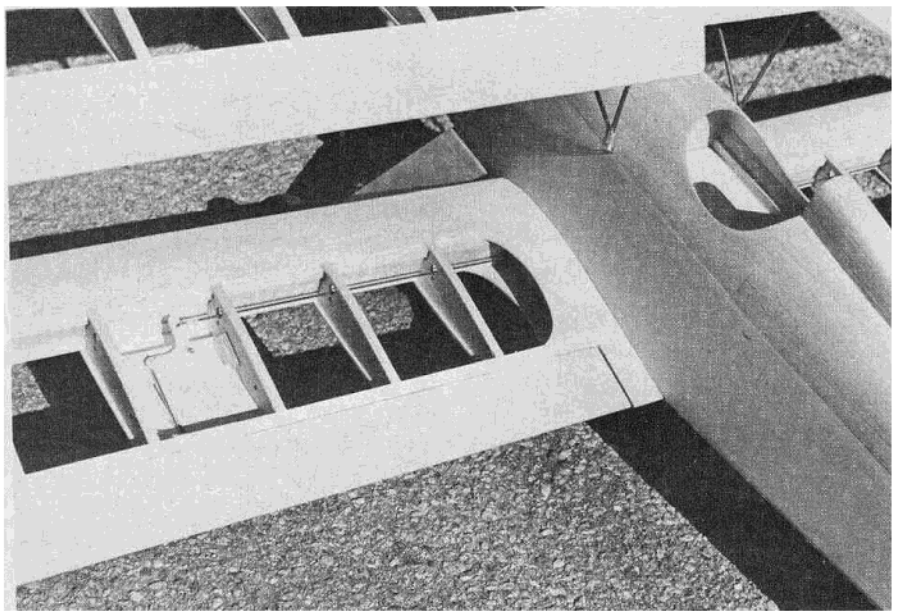










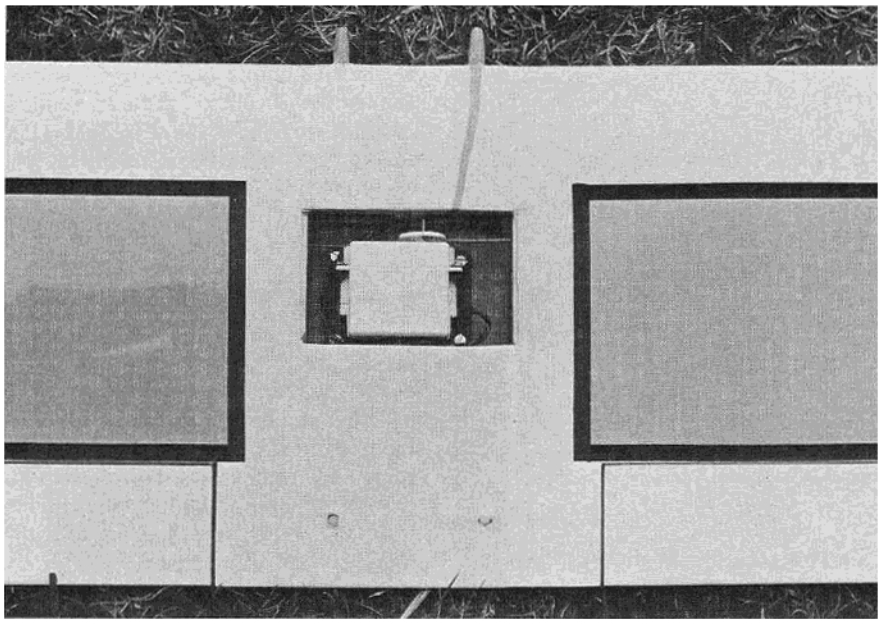


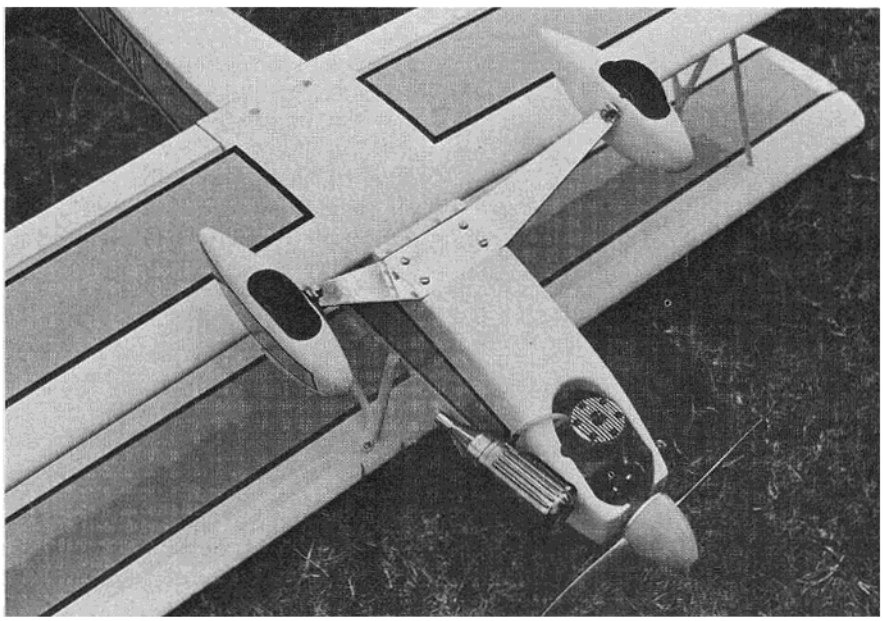
suit your aileron servo. Epoxy the bellcrank mount supports to the sides of the ribs before installing these ribs. Remember to epoxy the aileron horn mounts to the lower trailing edge sheet. Complete the assembly as per the top wing instructions except that the strut pads are in the upper surface and line up with the outboard edge of the cap strip. This gives a slight angle to the struts for more realistic appearance. Note that the tips and rear tip blocks are not epoxied to the tip rib aft of the rear spars as the ailerons will be cut out later. We applied masking tape to the face of the rib aft of the spars and trimmed the tape flush with the sheet before adding the tip to prevent epoxy from creeping into the joint.

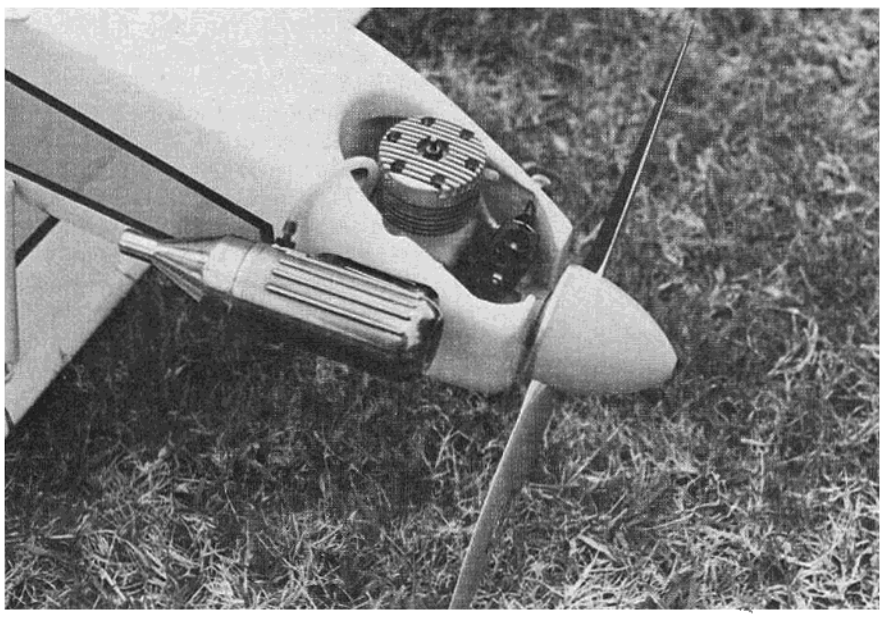
Join the panels when completely assembled, blocking up each tip rib 3/4". Sand the center ribs hand launch glider fashion for a tight joint and epoxy the panels together. Make the cut-out for the aileron servo removing the portion of the center ribs in the cut-out. Install a 1/8" ply floor on which to mount the servo. Now wrap the center joint with 3" fiberglass tape and epoxy or resin. Sand the wing all over.

Lay out the inboard end of the ailerons and draw a line on the upper and lower trailing edge sheet. Cut through the seam between the rear spar and trailing edge sheet on the upper and lower surface, between the tip rib and your line. On the upper surface make a parallel cut 7/32" aft and on the lower surface cut 17/32" aft of the rear spar. Remove the sheet between the cuts. Use an X-Acto No. 13 saw, or remove the backing from a razor saw, and cut through the ribs flush with the rear spars and remove the ailerons. Trim the forward end of the ribs in the ailerons in line with the sheet. Block sand the wing and aileron faces and cap with 3/32" x 3/4" sheet using Formula I epoxy. Cut a 3/32" sheet filler for the inboard end of the ailerons and epoxy in place. Trim the face sheet flush and sand smooth, completing the basic wing assembly. Be sure to add the aileron bellcranks and linkage before covering the wing.

Our prototypes used full-span surface hinges for the ailerons. This provides an aerodynamic seal at the hinge line and results in a slop-free installation. If you prefer to use conventional hinges install 1/4" x 1/2" balsa blocks in the wing and aileron before capping the faces. Use at least three hinges on each aileron. We are enthusiastic about







the surface hinges and suggest that you use them for the easiest and tightest aileron linkage you've seen. Use temporary masking tape hinges to hold the ailerons in place while you install the bellcrank and mount. Cut the lower sheet away so that the aileron horns seat on the ply horn mounts and install the horns with #2 x 5/16" long sheet metal screws. Slot the aileron bay sheet to clear the horn pushrod and install the pushrod. Insert the 1/16" diameter music wire pushrod through the holes from the tip, bend the bellcrank end, and install. Mount the aileron servo, make up the center pushrod attachment, and check the aileron operation. Enlarge the holes in the false ribs to eliminate any binding if you use a rotary output servo. Set both wings aside until needed to complete fuselage construction.

TAIL SURFACES:

Cut out the surfaces from medium weight 1/4" balsa. Drill a 5/64" diameter hole in the 1/4" ply rudder insert for the tail wheel wire and epoxy the insert into the rudder. Epoxy the stabilizer and fin together, pinning down to a flat surface until dry.

Align the elevators with the stabilizer trailing edge and epoxy the 1/4" square spruce tie. Install the hinges but do not cement in place as yet. We used Robart hinges on our prototype. Round the edges and sand the surfaces smooth, tapering the elevator and rudder to the cross sections shown on the plans.

FUSELAGE:

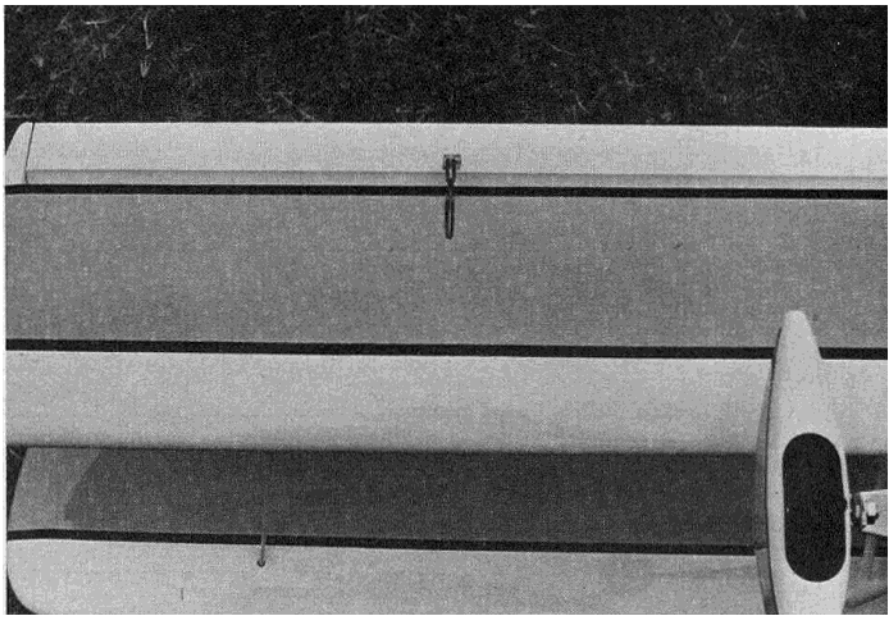
Cut out the sides, ties, nose doublers and formers. Mark former locations on the sides and pin to board. Glue the 1/4" square spruce top longeron to the top edge of the sides. Apply contact cement to the sides and doublers where they join. Install the ply doubler first, spacing 1/4" from the forward edge of the side. Check the gap between the doublers with the spruce ties, and trim the balsa doubler, if necessary, then install balsa doubler. Be sure to make a right and left side! Epoxy the cabane strut blocks, F-4 to former F-3 and F-5. If you don't have access to a saw to groove the 1/4" ply then epoxy three pieces of 1/8" ply together to form F-4. Use F-3 as a spacer to locate the cabane ties and epoxy in place. Add the forward and aft triangular stock and the 1/4" x 1/2" tailpost to each side.

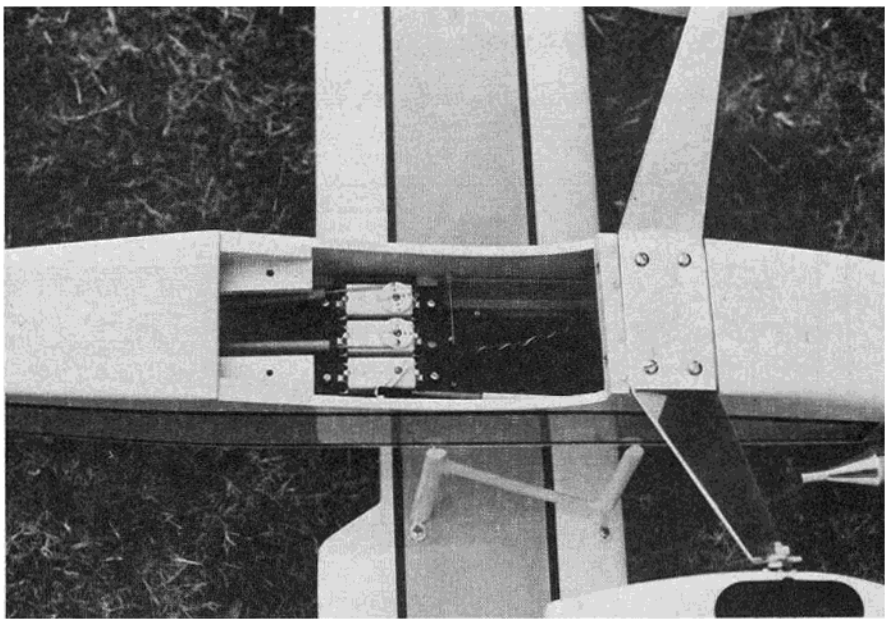
Locate the holes in the firewall to suit your engine and tank, and press

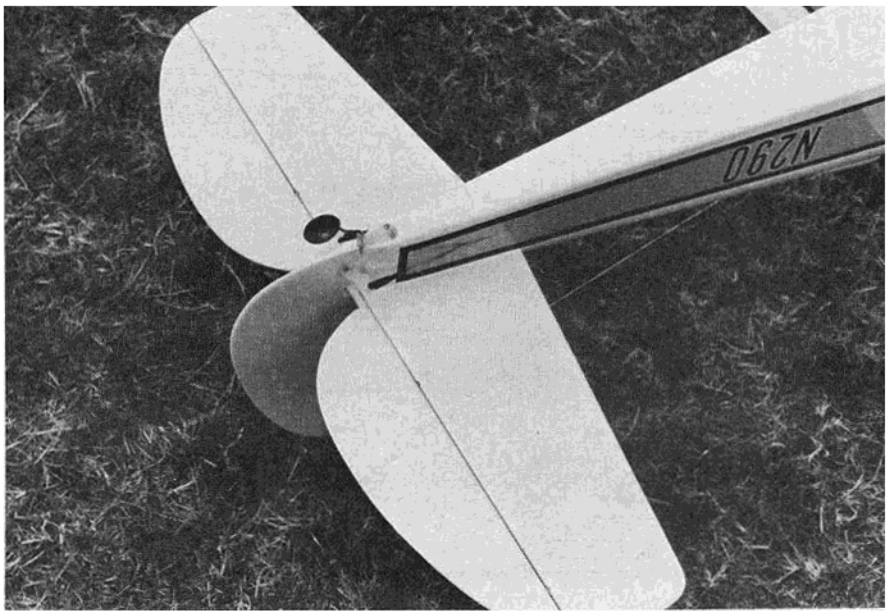
the blind nuts into the firewall. Glue the 1/4" x 1/2" sheet supports to F-5 and carve to the former outline. Remove one side assembly from the board, but leave the other pinned in place. Use Formula 4 to epoxy formers F-2, 4, and 5, and Sears Filled Epoxy to join the firewall, F-1, to this side using a square or triangle to check alignment. When dry, epoxy the edges of these formers and install the second side. Use a square to ensure that the sides line up properly at the tailpost. Remove pins aft of F-5 from the side pinned to the board and pull the sides together at the rear. Taper the 1/4" x 1/2" tailposts for a tight joint and epoxy the sides together. Check that the joint is 1-15/32" above the work surface. Slide the sides back and forth slightly to adjust this dimension and tape tightly together. When this joint is thoroughly dry remove the fuselage from the board.

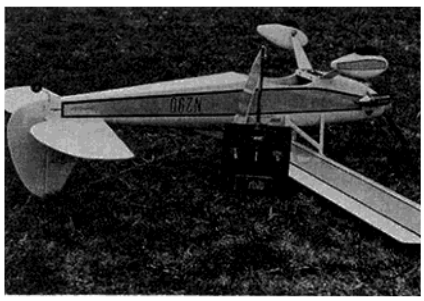
Trim the 3/4" triangle stock flush with the sides and epoxy the landing gear mount, F-8, in place using a square to align. Install the balsa formers F-6 and F-7 using rubber bands to pull the sides together so that they fit tightly against the formers. Install the 1/4" square spruce top stringer, 1/8" x 1/2" T.E. stock forward turtledeck supports, and 3/32" x 1/4" spruce turtledeck stringers now. Notch the supports to clear the cabane struts before assembly. Use a long sanding block to bevel the former edges slightly for a smooth turtledeck. Add the bottom wing hold-down supports and epoxy the 1/4" ply hold-downs to the sides and supports. Install 1/4" triangle stock reinforcements to this area and to F-2. Drive three small brads through the sides into the firewall on each side and fillet the rear of the firewall to the sides with Sears Filled Epoxy. It's a good idea to also fillet the landing gear support to the bottom edges of F-2 for added strength.

Use rubber bands around the fuselage to hold the bottom wing in position. Check for squareness with the fuselage center line by pushing a pin into the tailpost joint and use heavy thread to measure the distance from the pin to each tip at the outboard aileron tip. Adjust the wing until both tips are equidistant. Pin the stabilizer in place and check that the lower wing is aligned by sighting from the nose using the stab as a reference. Correct any misalignment by trimming the fuselage sides. When the wing is









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ACRO-STAR

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properly aligned use a short length of 1/4" O.D. sharpened brass tubing placed in the slots in F-8 to locate the leading edge hold-down dowels. Press the tubing against the wing leading edge with a screwdriver in the slot. Remove the wing and drill 3/16" diameter through the leading edge and 1/4" sheet dowel support in the wing. Use a rat-tail file to enlarge the holes for a snug fit on the dowels. Insert the dowels and check the fit in the slots, also use F-8A to be sure the dowels are flush with the outer surface of F-8. When properly aligned, remove the

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