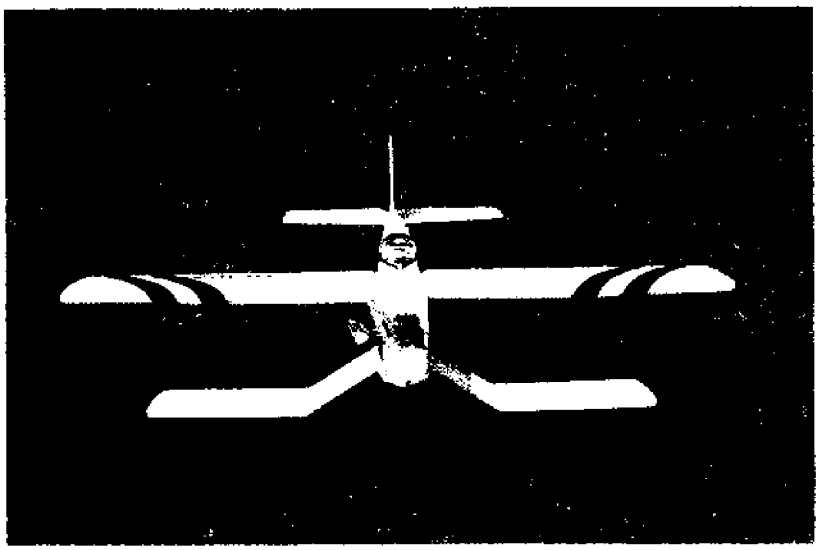
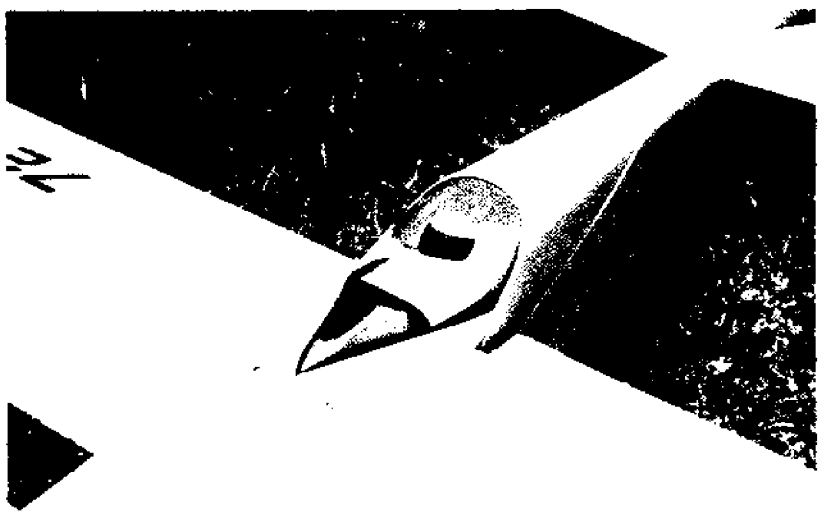
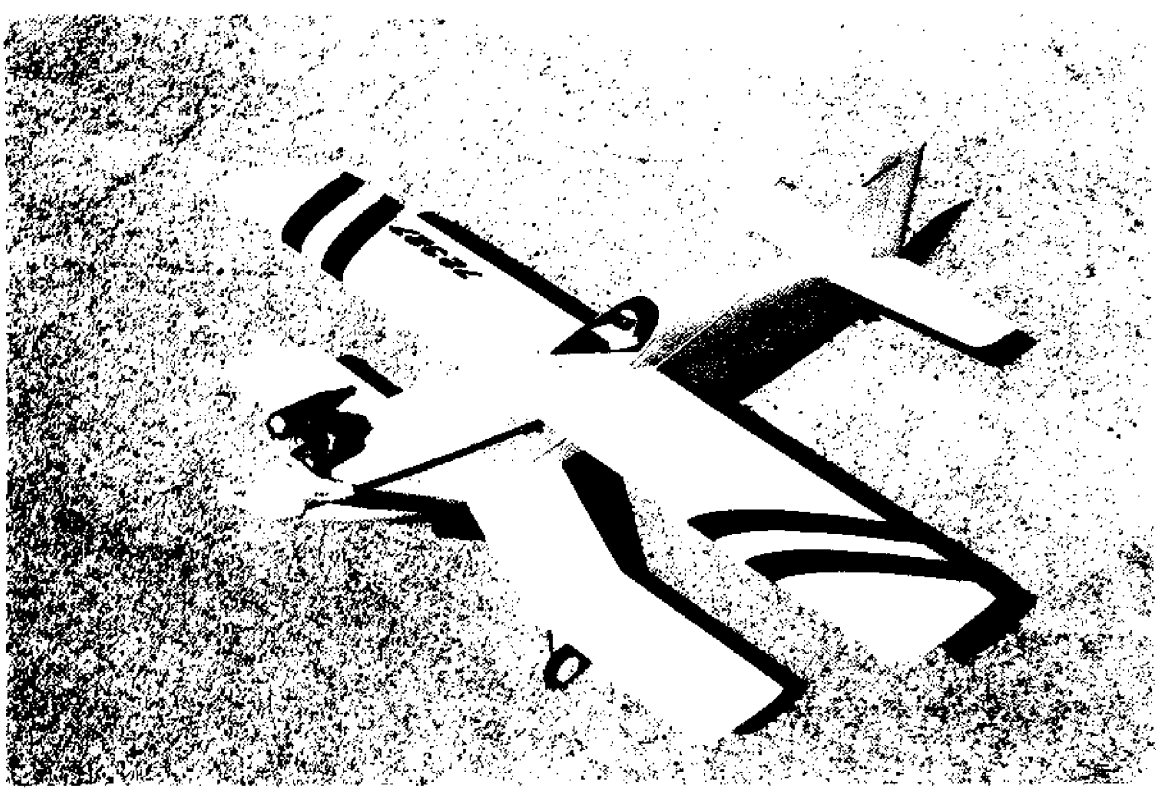
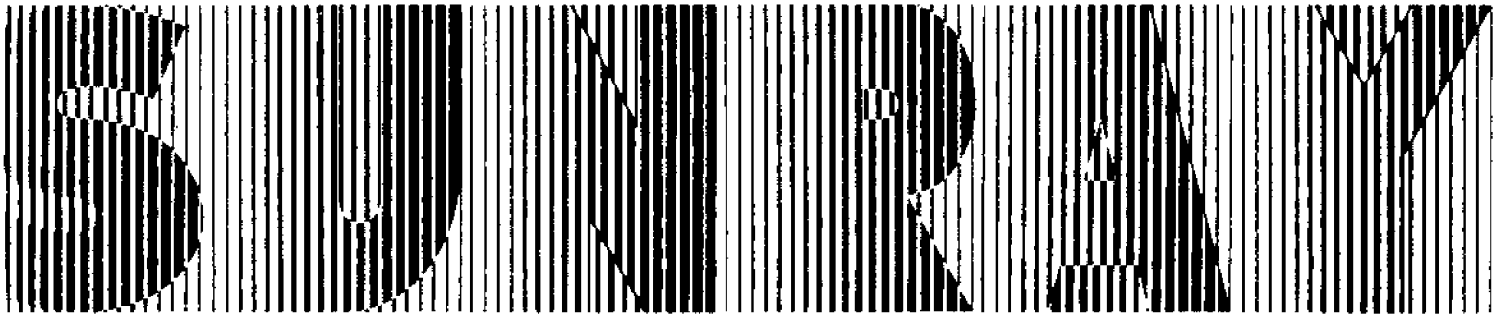
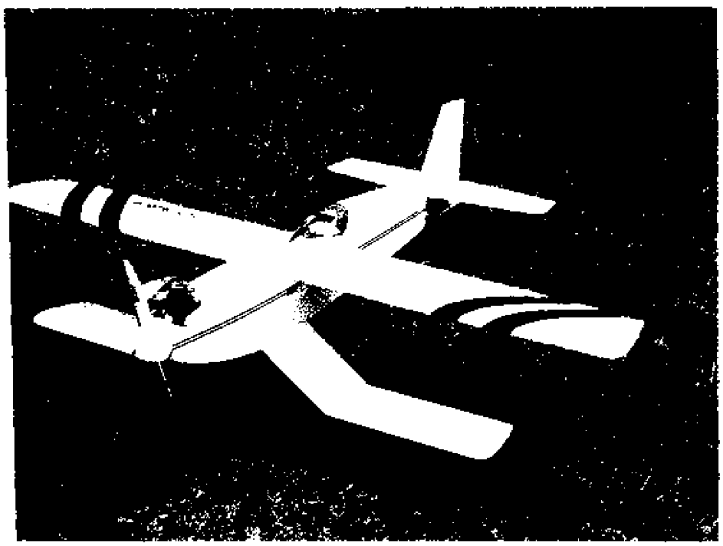


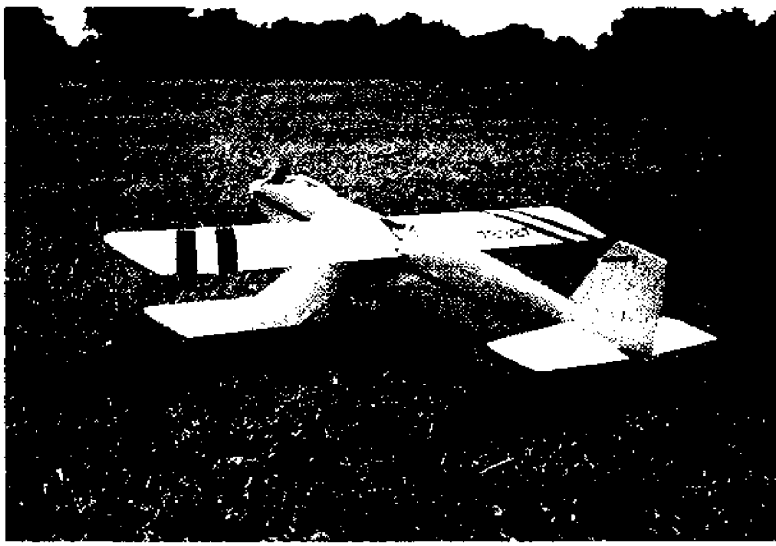
Build this high performance biplane for a rewarding new experience in sport and pattern flying.

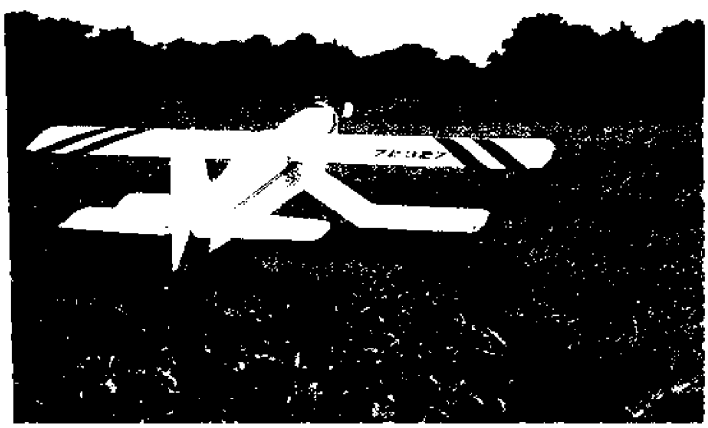












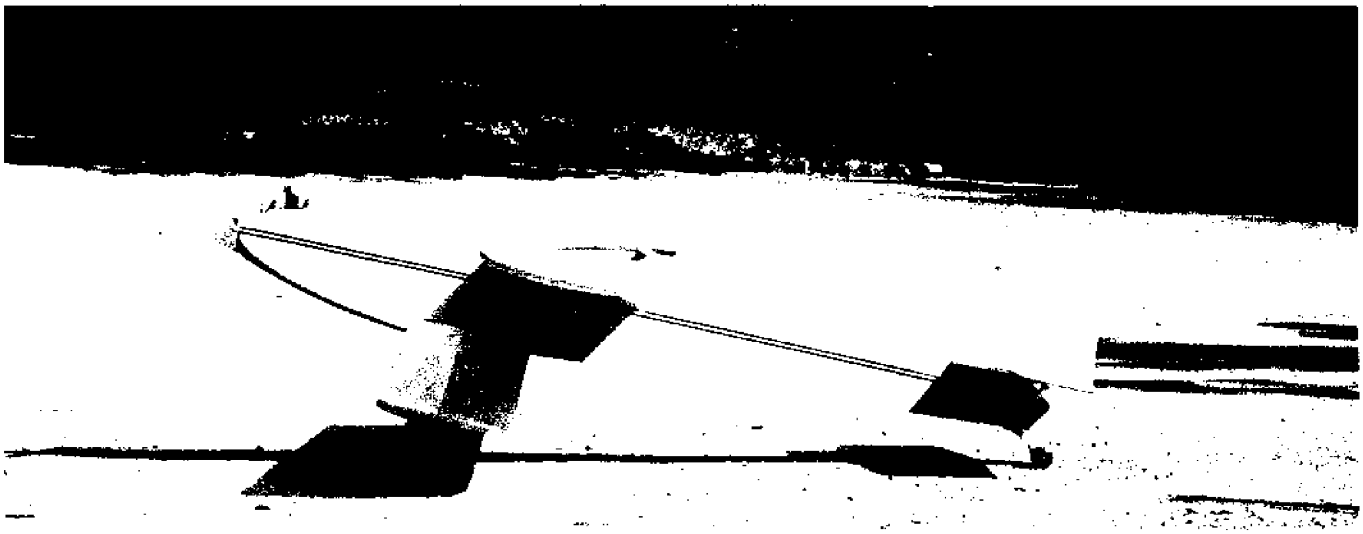
BY JACK SCARBROUGH

Designed as a new type of biplane for R/C models, this .60 powered plane has the sleek high speed appearance of the latest of the small full-size racing "sport biplanes." But in contrast to the pure racing type, the Sun Ray incorporates superior stalling, stability and control characteristics, comparable to the best design practice in R/C pattern planes. At the same time, the low drag inherent in the wing to fuselage and cockpit configuration is retained.

This is a fast biplane, highly maneuverable and performs **all** AMA and FAI patterns, is good for open pylon, and makes a great all around sport plane for the Sunday flyer. She's extremely steady and stable in high winds, with easy stall characteristics and slow landing speed. The wide stance landing gear sets up good control in ground maneuvers, landings, and take-offs. One of the most remarkable features of this airplane is its ability to do sustained knife edge flight, and starting from straight level flight, will climb out and complete a 270° knife edge loop! The plane is completely predictable in all flight maneuvers.

Major Construction Features

Both wings are removable, using standard leading edge locating dowels and aft nylon wing hold-down bolts. The cockpit enclosure and platform over the wing are one unit, removable to allow access to the upper wing hold-down bolts. The radio is reached from above, with upper wing removed. No hatches exist, access to the fuel tank and battery pack compartment being through the upper wing space and forward through a generously cut-out bulkhead. 1/16" plywood doublers inside the balsa fuselage sides run 24" back from the firewall past the wings. These doublers are necessary, especially with 2 wing saddle cut-outs. Landing gear wire has a minimum of exposed length, utilizing part of the "inverted gull" section of the lower wing, both for strength and air drag reduction. The lower wing is built on a full depth 1/4" thick plywood continuous spar, to assure maximum strength through the angled joints and center section. Most basic building features are normal, with easy construction throughout.



Wing Construction — Ribs

Begin by making all parts first before assembly. Make the ribs from 3/32" balsa. Neither wing is tapered, so for each wing, all ribs are the same. A fast and accurate way to cut duplicate ribs is to make two identical rib templates from hard 1/16" or 1/8" plywood — then sandwich 12 to 18 rectangular rough cut balsa rib stock between the templates. Drill two 1/8" or 3/16" holes along the rib centerline for bolting the assembly together. Cut the balsa on a power saw, or carve, then sand the balsa down to the templates. On the lower wing, each rib is made with an overhead tab joining the front and rear parts, because the full depth spar separates the rib into two parts. The tab allows us to easily install the rib accurately as if it were a one piece rib. After gluing, the tabs are cut off. These ribs can be easily made, using lower wing rib templates. 4 ribs only for the angle joints are made from 1/4" balsa. Use the lower wing templates, but finish sand slightly oversize as stated on plans. 6 lower wing ribs may now be cut out to accept the landing gear blocks.

Upper Wing

Notch all spars and leading and trailing edge pieces as shown on plans. Pin the 3/8" x 1/2" lower spar for one wing panel to a flat building board, and slide the nine ribs onto the spar, then pin the ribs to the notched trailing and leading edges. To insure a straight wing, make sure the spar is flat on the table, and leading and trailing edges are parallel to table. As an aid, the trailing edge may be blocked up 1/2" along the whole length of the panel. Then add the upper spar. Glue all joints and let dry. Add plywood dowel support. Drill the leading edge 1/4" and add dowel. The centerline of the dowel and support is 1" from the center of the wing. Add two 1/4" false ribs on to the dowel, above and below.

Add the leading and trailing edge sheeting to the top of the wing. Let dry. Then add the sheeting to the bottom of the wing, and finally the center sheeting. Add 3/32" capstrips and shaped wing tip blocks. Make these blocks by drawing the side and top views of the tip shape on balsa blocks,

SUN RAY

The Super Bipe

Designed By: Jack Scarbrough

TYPE AIRCRAFT
Sport and Competition Bi-Plane
WINGSPAN
Upper 51" — Lower 38"
WING CHORD
Upper 9" — Lower 6¾"
TOTAL WING AREA
700 Square Inches
WING LOCATION
Upper — Top of Fuselage
Low. — Bottom of Fuse. w/inverter gull
AIRFOIL
Symmetrical
WING PLANFORM
Constant Chord
DIHEDRAL, EACH TIP
No Dihedral
O.A. FUSELAGE LENGTH
50½ Inches
RADIO COMPARTMENT AREA
(L) 11" X (W) 3"(avg) X (H) 3½"
STABILIZER SPAN
21 Inches
STABILIZER CHORD (incl. elev.)
6 Inches (average)
STABILIZER AREA
126 Square Inches
STAB AIRFOIL SECTION
Flat
STABILIZER LOCATION
Mid-Fuselage
VERTICAL FIN HEIGHT
7½ Inches
VERTICAL FIN WIDTH (incl. rudder)
7 Inches (average)
REC. ENGINE SIZE
.61 Cubic Inch
FUEL TANK SIZE
12 Ounce
LANDING GEAR
Conventional
REC. NO. OF CHANNELS
4
CONTROL FUNCTIONS
Rudder, Elevator, Ailerons, Throttle
BASIC MATERIALS USED IN CONSTRUCTION

Fuselage	Balsa and Ply
Wing	Balsa and Ply
Empennage	Balsa
Weight Ready-To-Fly	120 Ounces
Wing Loading	24.6 Oz./Sq. Ft.

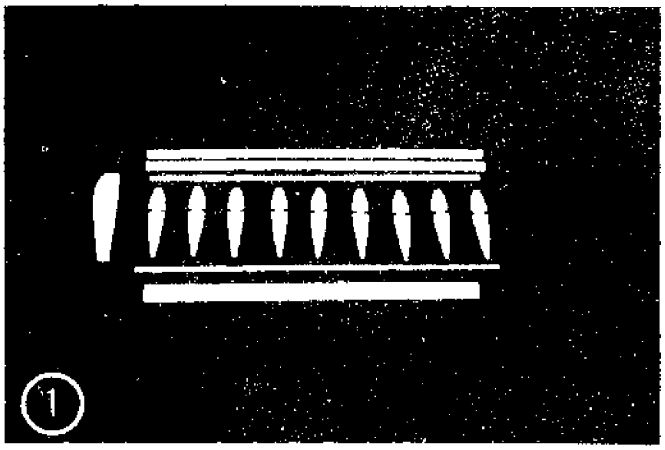
cut out one view on a jig or band saw, tape the block back together, and cut out the other view, then finish carve and sand to a rounded contour.

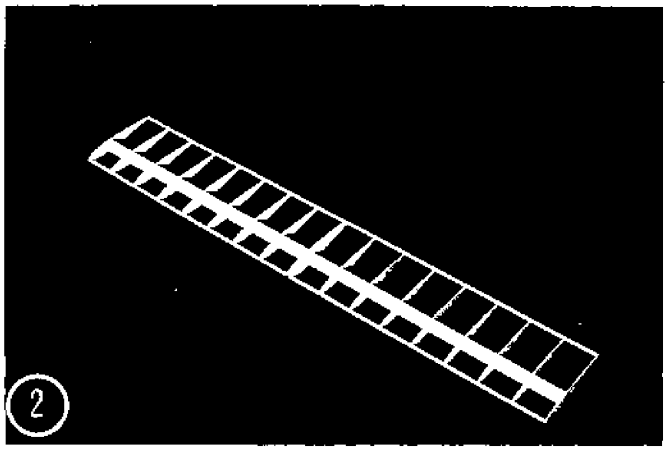
Repeat for the other wing panel. Place both panels on a flat surface and butt glue together - there is no dihedral. Sand the entire wing and reinforce the wing center section with 6" wide fiberglass cloth and epoxy.

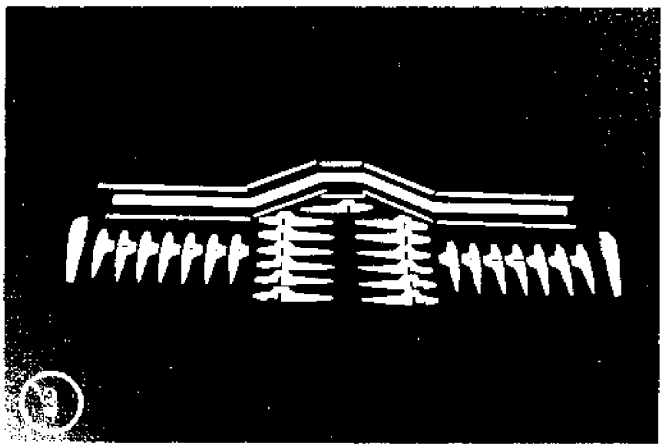
Lower Wing

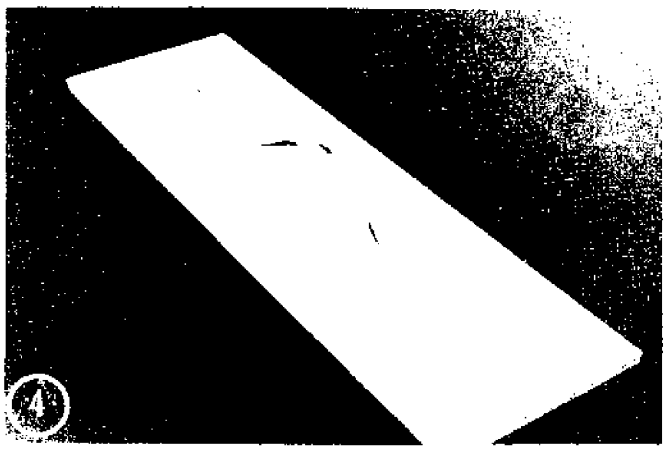
Make the 1/4" continuous plywood spar from a 36" long piece of high grade aircraft plywood. If that length is not available, use 2 pieces (about 19⅛" long each), with a 2¼" overlap joint epoxied at the center section. That was done in the actual construction. Make the spar to the finish length spanwise of 36". To make a smooth overlap joint, 2¼" of each end forming the joint must be cut and rasped down to one half the thickness (1/8"). Then lay the spar flat on the table, with the lower edge of the outer panel sections pushed up against a straight edge laid on the table. This will set up the required zero dihedral on outer panels. Epoxy the overlap joint. Drill 1/4" holes for dowels in the center section, 1" from each side of the centerline.

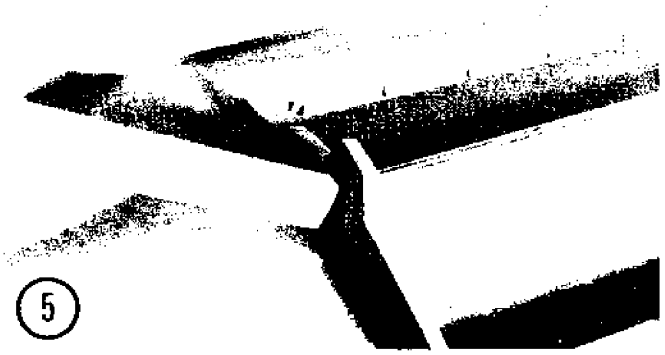
Cut the leading and trailing edge pieces slightly overlength in 5 pieces each, 1 center section, 2 gull sections, and 2 outer panel sections. Notch for standard ribs as on plan except at the joints. Where all these pieces join at the gull section to form a 33° angle, easier assembly will result if they are pre-cut exactly to length at those joints. Lay each piece on the front view of the lower wing plan over the centerline shown, with notches lined up, and cut off each piece at each joint exactly to length and at the angle shown (16½° each spar). No measurements or protractors are necessary with this method. Use the front view for both the leading and trailing edge pieces, but be sure the notches are facing in the correct direction (aft for leading edge; forward for trailing edge) before cutting off to length, and cut the angles for either the **right** or **left** wing panels. Now notch each piece at the joint to accept 1/2 of the 1/4" thick canted rib. The shoulder of the notch is cut at the



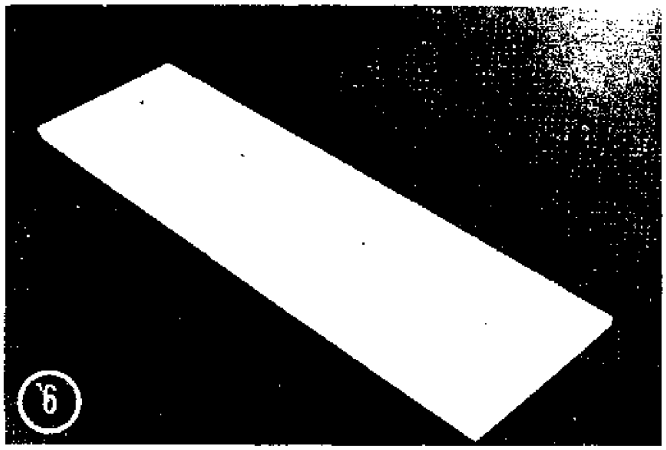


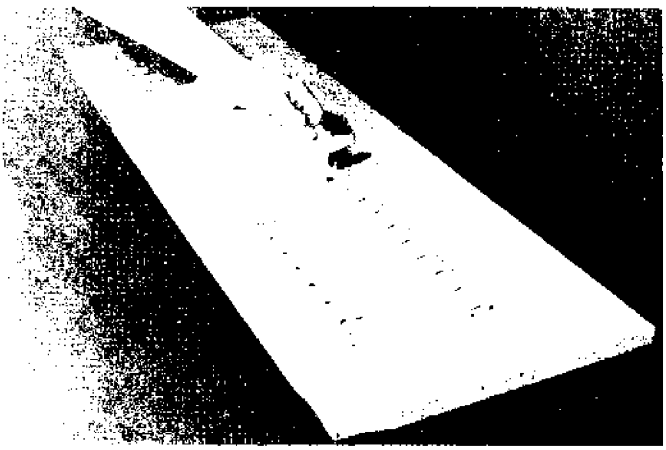


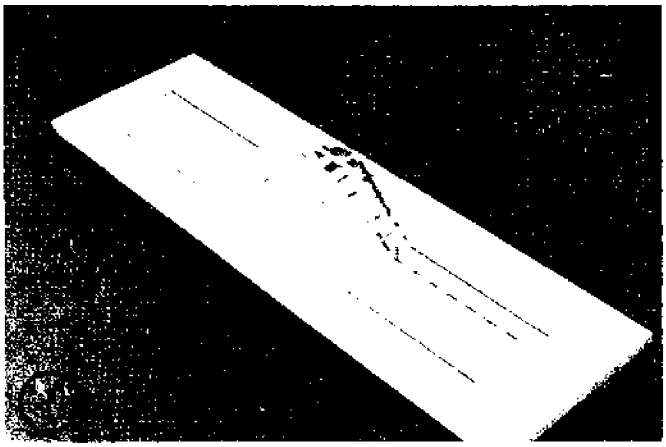


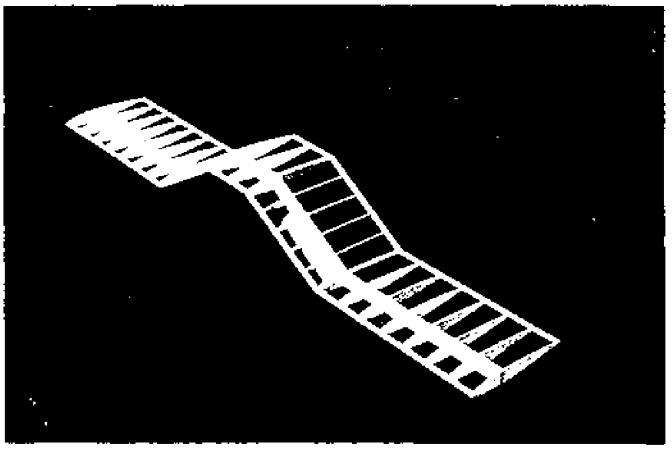


(1) Parts for one panel of upper wing. (2) Both panels of upper wing structure completed. (3) Parts for complete lower wing. (4) Initial set-up for building lower wing. Spar is set upright with tip ribs and outer panel trailing edge pieces in place. (5) Lower wing outer panel leading edge notched and cut to length. (6) Lower wing outer panel structure completed. (7) Installing a lower wing rib.

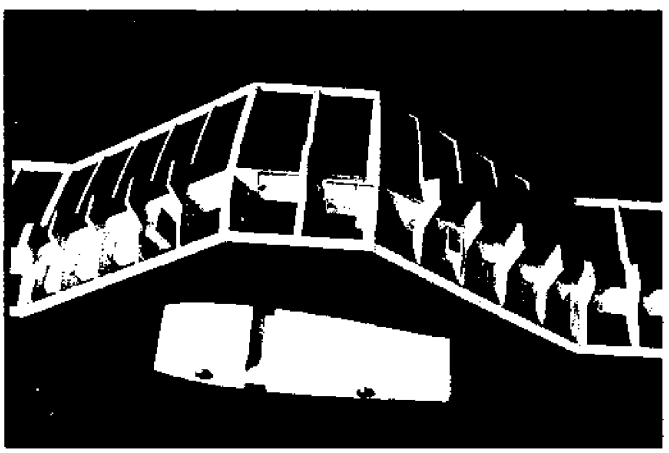


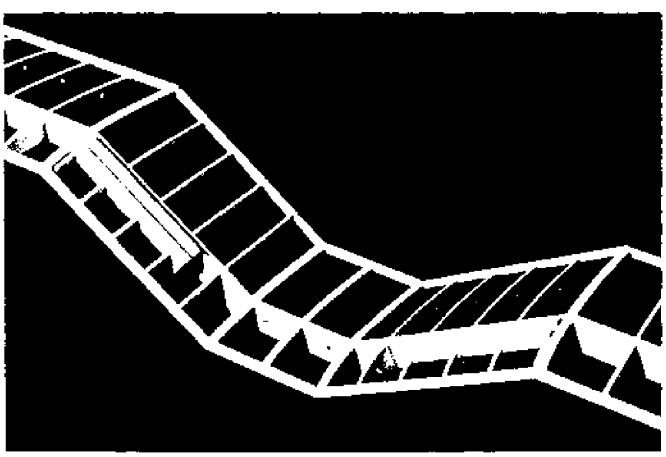


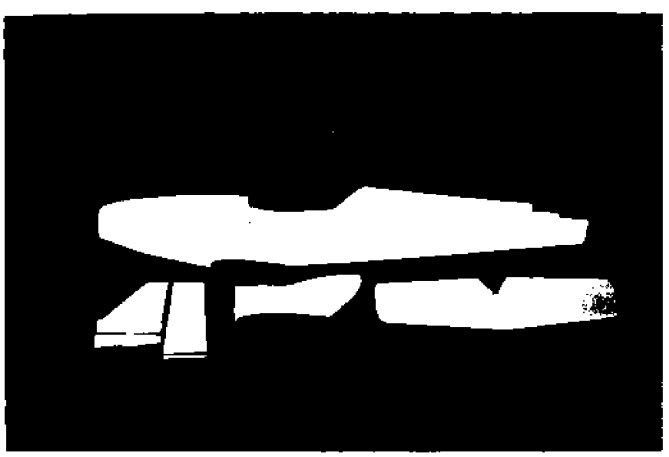


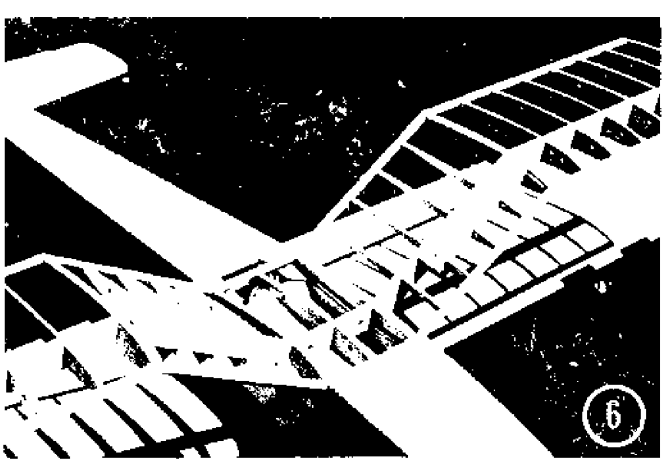


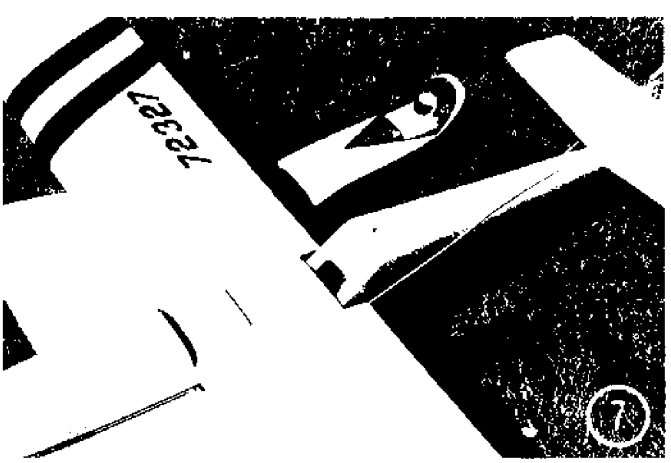
(1) Lower wing basic structure complete before cutting off rib tabs. (2) Lower wing structure after cutting off tabs. Landing gear blocks installed. (3) Lower wing main spar center section lap join it, showing use of angle gauge on canted rib. Landing gear block installation shown from top. (4) Landing gear block installation from the bottom of the lower wing structure. (5) Basic fuselage and empennage parts. (6) Lower wing in position on fuselage. (7) Canopy removed showing upper wing hold-down.











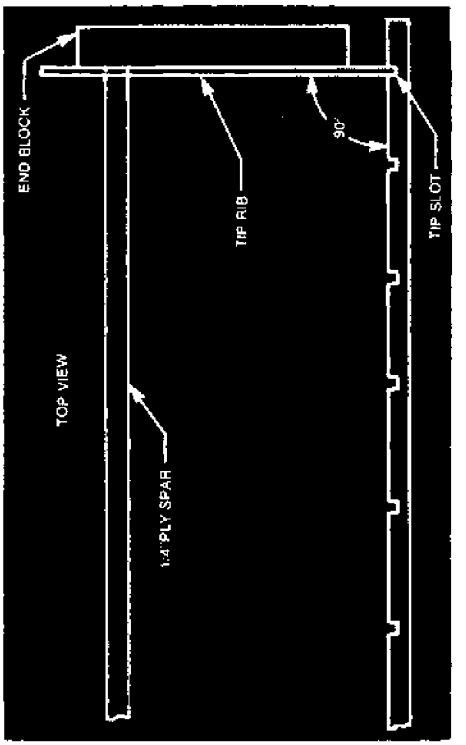
same angle as the cut-off angle, estimating by eye.

Assembly for this wing will go quickly by first setting the main spar upright on a flat table. The outer panel wing trailing edge must be blocked up with a 3/8" high balsa **straight** strip running the full length of each outer panel. Glue or tack the strip to the table and pin the trailing edges to the strip. Slip a rib over the spar on the outer wing panel near the tip, and set up the spar. Now tack a 4 or 5 inch long end block on the table at exactly a right angle (90°) to the trailing edge strip and against each end of the spar as shown in the sketch and photo. The end blocks will position the outer rib, so that the outside of the rib will be flush with the end of the spar. The ribs should be an easy slip fit (no tighter) over the plywood main spar.

Start the rib assembly on an outer panel. The idea is that the trailing edge pieces and the leading edge pieces are used to align the ribs for the whole assembly. The ribs are glued to the main spar **after** assembly. Slip the outer panel ribs down over the main spar, glue into the trailing edge slots and immediately glue in the leading edge. See that the bottoms of the ribs are flush with the table and the bottom of the main spar. Then place the two lower 1/4" canted ribs into position and tack glue on to the spar and leading and trailing edges. Use of a small 1/16" ply "angle gauge," as shown, is helpful. Continue assembling and gluing the ribs and leading and trailing edges up the gull section. Don't forget to set the ribs with landing gear block cut-outs in their correct location.

Next set the upper 1/4" canted ribs (with tabs **down**), and finally the double center section rib, and glue in the center section leading and trailing edges. Check alignment and glue all ribs to the main spar, and let dry. Set in the hardwood landing gear blocks, epoxying them tight to the main spar and to the ribs, then the plywood block support plates. Epoxy small (up-turned) landing gear slotted blocks on the inner end of each block. Finally, trim off all rib tabs, sanding the upper contour of the ribs flush with the plywood spar.

Sheet the gull section first, covered



completely. All sheets project back 3/4 of an inch aft of the trailing edge spar, the top overlapping the bottom sheet, to obtain a sharp trailing edge (see drawing). At the **inside** joints, bevel the sheeting as shown on the front view to obtain a tighter joint when rolling the sheeting back from the leading edge. Complete all sheeting **except** for the **upper** side of the center section. Drill the leading edge for the 1/4" dowels and glue into place through the holes pre-drilled in the spar, then add false ribs. Sheet the upper center section. Glue the 3/8" capstrips into place. Glue the tips into place. Glue the 1/16" ply aft wing plate onto the **bottom** of the lower wing. Cover the center section with 6" wide glass cloth and epoxy, extending the covering over the joint and down about 1" onto the gull section.

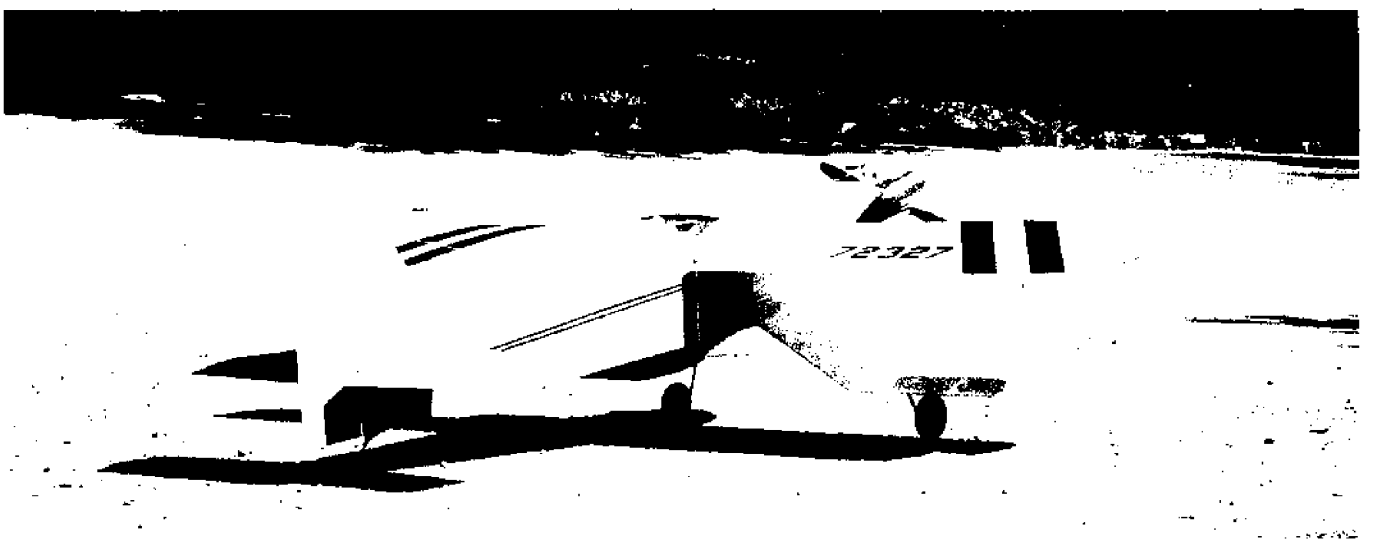
Fuselage and Tail Surfaces

Cut out the fuselage sides from 3/16" x 48" balsa. Edge join two pieces to obtain the approximate 5⅜" necessary width, if sufficiently wide stock is not available. Fuselage sides should have 1/16" plywood inside liners cemented at this time with contact cement. Cut out the 1/4" plywood bulkheads and 1/2" balsa nose block.

Drill the firewall for your engine mount, and also for the throttle cable, fuel and vent lines. Draw the centerlines on each bulkhead and the nose block. On the inside of the fuselage sides, draw the bulkhead positions with straight lines. Draw a centerline on a flat table. Assemble the fuselage upside down with the top of the sides resting on the table. See that the centerlines of the bulkheads coincide with the table centerline. Use epoxy on the plywood bulkheads. Clamp or block the sides tight to the bulkheads. Join the fuselage rear, and add the 1/4" square balsa bracing (aft of bulkhead #3). Let dry. Before releasing the clamps, add the 1/4" triangular stock around the firewall, the bottom 3/4" stock in the tank compartment, and the 1/4" bottom balsa blocks. Then plank the aft fuselage bottom with 1/16" balsa cross grain. Let all glue dry, then release the clamps. Carve and sand the forward fuselage contours approximately to shape — sanding the nose later to the final 2¾" spinner diameter.

Cut out and glue the 1/4" aft stab plate onto the top of the fuselage sides. Note the forward portion is notched 1/16" to fit inside the turtle deck sheeting. Begin the turtle deck by gluing 1/8" square balsa along the top inner edge of the fuselage sides, to form a rabbet for the 1/16" sheeting to fit into. See section drawing. Cut bulkhead #3A from 1/4" balsa and formers F1 to F4 from 1/8" balsa. Glue these into position before notching for the stringers. After the glue is dry, pin each stringer into position, mark, notch and glue in place. Cover the deck with 1/16" balsa sheet in two pieces, to meet at the top center. Lay the edge of one sheet along the top center, and roll down and over the framework, marking it to fit flush with the top of the fuselage sides and into the rabbet. Use ammonia on the outside of the sheet to

to page 94



help bend it around. Pin and glue into place. Repeat for the other side. Let dry. Trim off excess sheet flush at bulkhead #3A and Former F4.

Cut out the tail surfaces — vertical fin and rudder from 1/4" balsa, and stab and elevators from 3/8". Sand the leading and trailing edges to contour.

Epoxy the four hardwood wing blocks into place; exact position is not critical. Drill two 1/4" holes in the 1/4" plywood plate to accept the upper wing dowels. Pin foam tape in the saddle and fit the upper wing to the saddle and the dowel plate. Epoxy the dowel plate into fuselage. Fit the lower wing to the saddle (with tape in). Mark and drill bulkhead #2 for the lower wing dowels, checking that the lower wing outer panels are parallel with the upper wing.

With both wings in place and aligned, drill and tap the hardwood wing blocks for 1/4" — 20 nylon bolts. Glue the stab on with the wings in place and align with the upper wing. Let the glue dry. Then glue the vertical fin. Let dry. Add the fairings behind the turtle deck, glued to the fin. Notch the fuselage for the plywood tail wheel support and glue into place.

Cut out the fuselage at the engine compartment to fit your engine. After completing all cut-outs, give the engine and tank compartment a liberal coating of slow drying epoxy. Bolt in the engine mount and the engine. I used a Kraft glass filled nylon engine mount. Glue the 1/16" plywood nose ring to fit the 2¾" spinner, and final sand the fuselage contours to match.

With the upper wing in place, make the upper wing canopy platform from 1/4" balsa and fit into place. Drill two holes through it into the wing top sheeting. Line up the blind nuts in the small 3/16" x 3/8" balsa cross block shown on the plan and glue this to the wing. Make the enclosure from a solid balsa block, or if clear plastic, cut out the rear portion of a Sig WW II #11 or #13 canopy. Fit and glue the enclosure to the platform, sanding all parts to match the fuselage front and turtle deck. Mark and glue in the rear canopy 1/4" locating dowel to fit a matching hole in bulkhead #3A. The remaining things need to be scheduled with your finish method. Install the tail wheel assembly. Cap the rudder bottom with the plywood plate and plastic tubing for the tail wheel wire. Sand the entire airplane and hinge all surfaces.

Finish

A beautiful, reasonably fast and lightweight finish used on the Sun Ray was to MonoKote the wings, then spray paint the fuselage and tail surfaces with K & B Superpoxy of matching color. The fuselage was prepared by smoothing out most nicks and hollows with Hobbypoxy "Stuff" and block sanding, then covering the whole thing with silkspan and one coat of Aerogloss dope. Wait 48 hours, sand lightly and apply about 8 coats of Superpoxy Primer, block sanding and filling (if necessary) after 3 coats and the last coat. Finally, spray with K & B Superpoxy.

Flight Characteristics

See that the plane balances as shown on the plan. This is important since balance is rather critical for outside maneuvers. Start the take-off run full throttle with up elevator to keep the tail wheel on the ground. After gaining a little speed, immediately go to neutral elevator, to let the tail come up and level the airplane. Allow plenty of time to gain flying speed, then ease her off with slight up elevator.

You'll find the Sun Ray an exceptionally easy airplane to fly, very steady and stable, but with plenty of control effectiveness for any maneuver in the book, and "then some."

If the plane is rolled to the right and a little left rudder is given, easy knife edge flight is obtained. A little more rudder will cause the airplane to climb out in a knife edge position. Keep feeding rudder, and she will complete the 270° knife edge loop.

You'll be pleasantly surprised at the relatively high flying speed for a biplane. Axial rolls are true, with only a little elevator trim required, and can be made at a very high rate if desired.

Try a long slow roll to run the length of the field. She will track beautifully, and easily maintain altitude with just a small amount of rudder and elevator trim applied successively as she rolls.

Now coming in to land, chop the throttle, approach and she will slow down nicely. Set her down on two wheels with the tail still just off the ground, which seems to be the most satisfactory. Taxi her in, and you'll realize what a really great flight you've just had. ❑