

# 1931 WACO ENF



By Pete Fusco

## A BEAUTIFUL SPORT SCALE MODEL OF A ONE-OF-A-KIND WACO FOR .60-.90 2-STROKE/.90-1.20 4-STROKE ENGINES

**T**he local skeptics started telling me that the Waco Aircraft Company never built a biplane with an in-line engine even before I cut the first piece of wood for my ENF. An old guy at the Prop Nuts big bird meet in Crosby, Texas, last summer actually told me, "Nice lookin' ship, too bad Waco never built anything like it." No less of a scale guru

than Bob Banka of Scale Model Research told RCM Editor Dick Kidd, that to his knowledge Waco did not build such an airplane.

I had hoped to be the first person to do an article on a Waco that did not subject the reader to a dose of the dreaded Waco alphabet soup torture, but the doubters have forced this upon you.

The "F" in the designation meant a

three-place open cockpit biplane. Waco buffs will be quick to point out that the UPF-7, the WWII training plane, was only a two-place ship, but Waco was not above making exceptions to its own rules. The "N" in the code identified the style of wing and airfoil. The fun starts with the first letter of the designation, which identified the type of engine installed.

Most of these early "F" model Wacos were powered by the 5-cylinder radial Kinner engine and were known as either the KNF or INF, depending on which Kinner was used. There was also an RNF, powered by the 7-cylinder Warner radial. Waco produced four MNFs, powered by the inverted 4-cylinder in-line Menasco engine. All of the above were type-certificated aircraft. The four MNFs were sold to China in the early 1930s which explains why so few people have ever heard of them. The ENF was a one-of-a-kind ship built in 1931 as a testbed for the 4-cylinder Chevrolet Martin 333 inverted in-line engine. Waco simply took a standard Menasco-powered MNF and installed the Martin 333. The two aircraft were identical in appearance.

I once owned the original ENF which I partially restored before selling it in the late 1960s. When I got it, it had been converted to a Kinner power plant, the Martin 333



Color Photos By: Jim Bliss



**1931 WACO ENF**  
**1/6 Scale**

**Designed By:**  
Pete Fusco

**TYPE AIRCRAFT**  
Sport Scale Biplane

**WINGSPAN**  
Upper: 64 Inches  
Lower: 60 Inches  
**WING CHORD**  
11 Inches

**TOTAL WING AREA**  
1280 Sq. In. (Approx.)

**WING LOCATION**  
Biplane  
**AIRFOIL**

Semi-Symmetrical  
**WING PLANFORM**

Constant Chord

**DIHEDRAL, EACH TIP**  
3/8 Inches

**OVERALL FUSELAGE LENGTH**  
48 Inches

**RADIO COMPARTMENT SIZE**  
Ample

**STABILIZER SPAN**  
23 3/4 Inches

**STABILIZER CHORD (incl. elev.)**  
9 1/4 Inches (Avg.)

**STABILIZER AREA**  
200 Inches (Approx.)

**STAB AIRFOIL SECTION**  
Flat

**STABILIZER LOCATION**  
Center of Fuselage

**VERTICAL FIN HEIGHT**  
7 Inches

**VERTICAL FIN WIDTH (incl. rad.)**  
8 1/2 Inches (Avg.)

**REC. ENGINE SIZE**

.60-.90 2-stroke/.90-1.20 4-stroke

**FUEL TANK SIZE**  
16 Ozs.

**LANDING GEAR**  
Conventional

**REC. NO. OF CHANNELS**  
4

**CONTROL FUNCTIONS**

Rud., Elev., Throt., All.

**BASIC MATERIALS USED IN CONSTRUCTION**

Fuselage .....	Balsa & Ply
Wing .....	Balsa & Ply
Empennage .....	Balsa
<b>Wt. Ready To Fly</b> ..	152 Ozs. (9 Lbs. 8 Ozs.)
<b>Wing Loading</b> .....	17.3 Oz./Sq. Ft.

having long before been swept into the dustbin of aviation history. I have heard that the person who purchased the airplane from me found a Menasco and created an MNF. I do not remember his name or know his whereabouts, but if some reader knows about this airplane, perhaps he could send a picture to RCM as a follow-up to this article.

Sentimental attachments aside, there are many features of the ENF/MNF that make it an irresistible model subject. The long



in-line engine nose moment, the wonderfully graceful, if somewhat complicated, "outrigger" landing gear, identical upper and lower wing panels and, last but not least, the sexy tapered ailerons. The plans also show placement of the fire wall for the radial-engined versions. These were sold with and without a "speed ring" type cowling. The plane would be a little easier to build as a radial engine job. Simply hang a engine and some dummy jugs up front or mortgage your home and buy one of the new working radials.

There are a few deviations from scale. A bit of length was added to the fuselage which is also slightly narrower than scale to facilitate bending the two sides together. The gear was widened for better ground handling and the tail outlines were enlarged a little. I also omitted the middle strut in the cabanes for simplicity, although it is shown in the plans as dotted lines. The objective was a simple to build, light, and easy to fly giant scale biplane that would be a little different than everything else at the big bird meets.

**CONSTRUCTION**

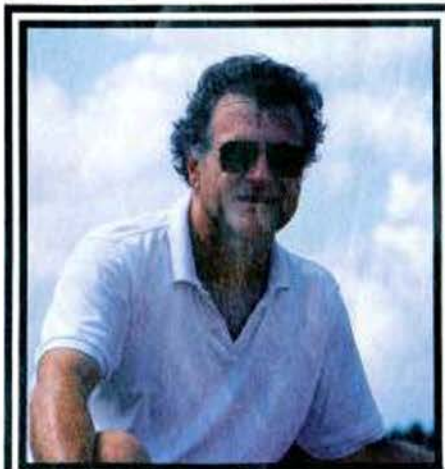
**Wings:**

We'll jump into construction with the wings, which are easy. Make 45 ribs from 1/16" medium "C" grain balsa and 11 from 1/8" hard balsa. For the top wing, place the ribs on the bottom front spar, keeping the centerline of the ribs parallel with the table top. Glue in place the top front spar. Next shim the back of the ribs and install the top rear spar. I built the top wing all in one piece and then cut through the spars between the center section and the outer panels. Bevel the ribs and spars for the proper dihedral and install the top 1/4" ply dihedral brace. Pick up the wing and install the bottom rear spar and bottom dihedral brace. Install trailing and leading edge pieces and the T1 tip piece. Sheet all but the bottom front of the wing. You will finish sheeting the wing after the "N" strut fittings are installed.

The lower wing is built much the same way but you will omit the top front of the

sheeting until after the strut attachments are fit. On both wings, top and bottom TE sheeting will bend and get glued to T1. The bottom LE sheet will also bend to T1 but on the top of the LE tip you will have to carve a small block to achieve a smooth, rounded curve.

I felt challenged by the lovely tapered ailerons and felt it wouldn't do justice to the



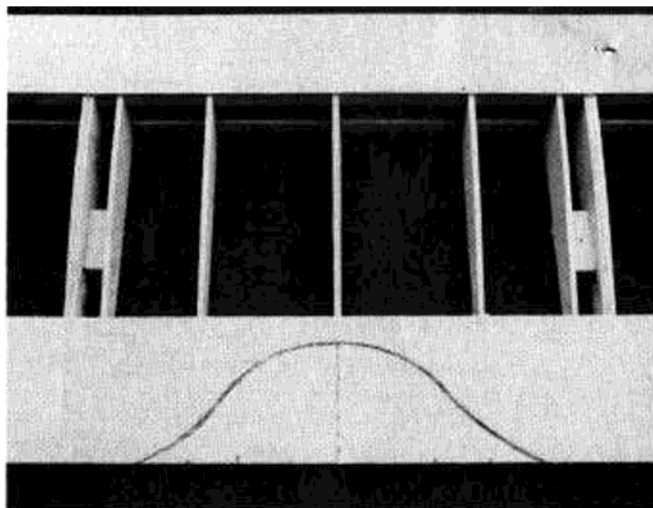
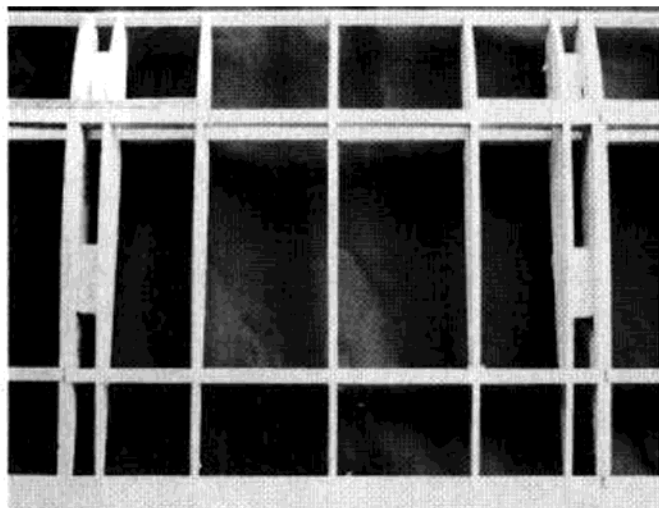
**About The Author**

For 20 years Pete was safely out of model building, blissfully unaware of all the fun that he was missing when his job as first officer on the Boeing 727 for Continental Airlines brought him into contact with Captain Jim Coleman about four years ago.

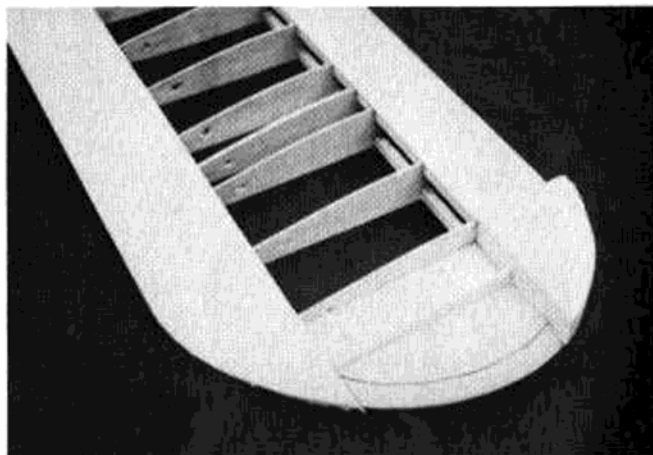
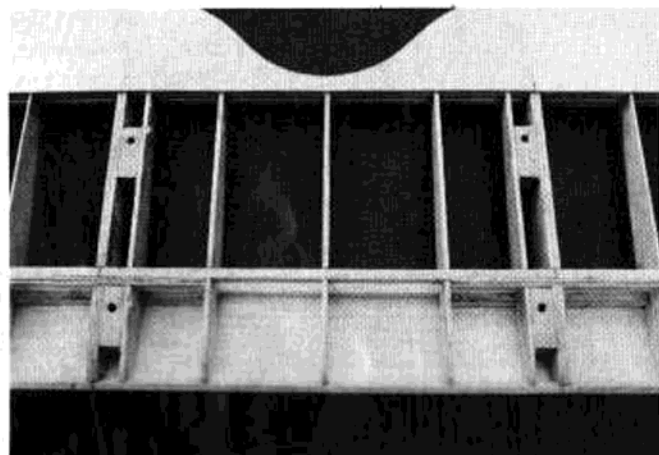
During the course of their trip, Jim mentioned that he flew R/C and had bought a kit, the Balsa USA "Enforcer," the complexity of which brought tears to his eyes every time he looked into the box. Pete told Jim that as an old free flyer, he felt obligated to hate R/C but there was certainly no kit that he couldn't build in a few weeks. After all, he had spent his entire youth hanging around hobby shops in Cleveland, Ohio, and had been a member of the famed American Airlines Gas Model Club.

Jim brought Pete the kit on the next trip. He was committed. After six long, hard months and with a few tears of his own shed, the Enforcer was finished and he was hooked. Jim taught Pete to fly on his .60 size Ugly Stik and in no time there was a permanent layer of balsa dust on everything in his garage.

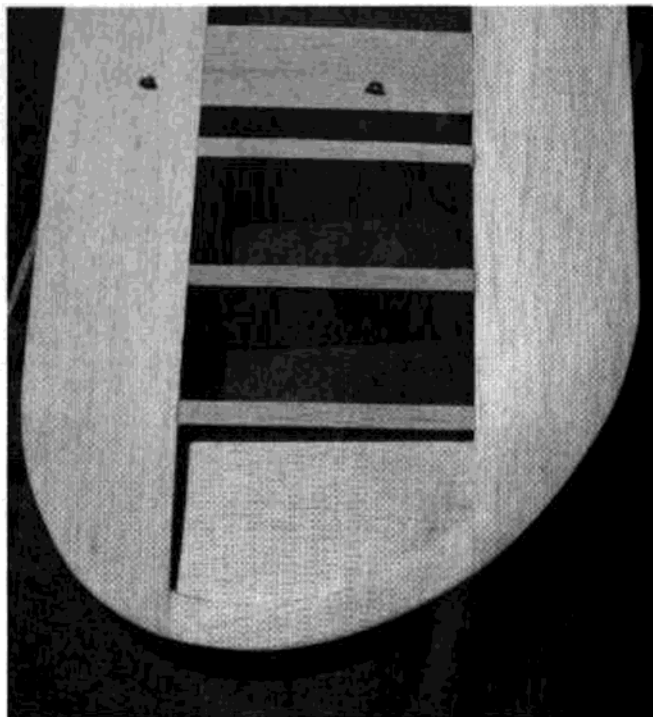
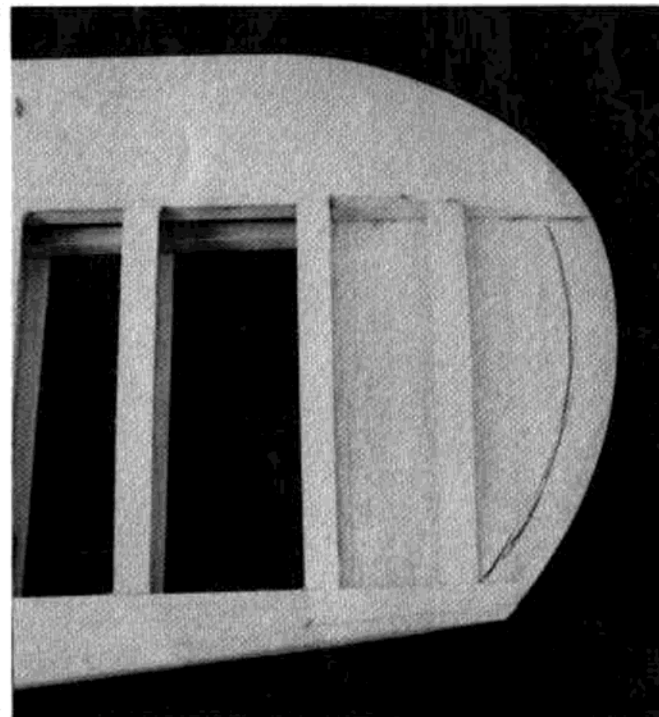
Pete spent a lot of time reading through old magazines published during his respite from modeling. He is both impressed with how many scale plans have been generated over the years and disappointed with how many great airplanes have been overlooked. The Waco ENF is the second scale plan he has published.



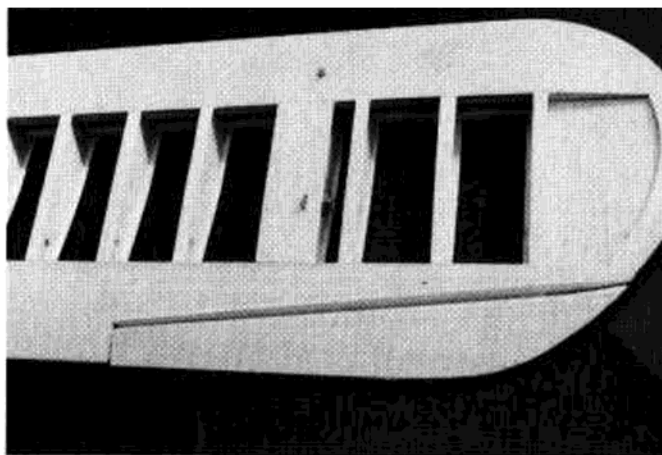
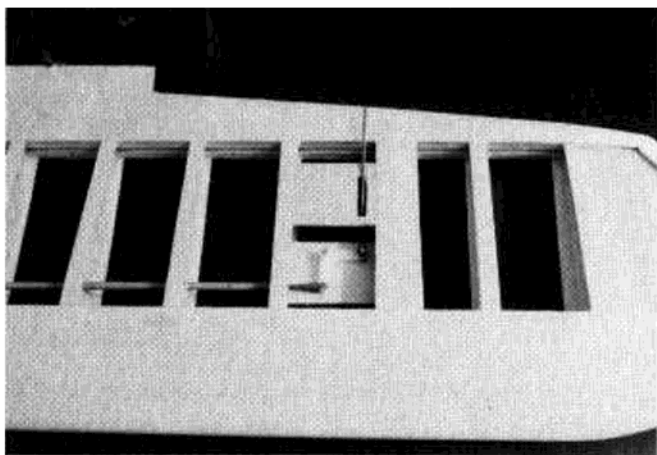
**LEFT:** Top wing center section. The plywood dihedral braces forward of the front spars and hardwood cabane mount blocks are shown in place. **RIGHT:** Trailing edge of top wing has been sheeted and marked prior to cutting out rear of center section. The gap that is created will be filled with scrap.



**LEFT:** Underside of top wing. Hardwood cabane mount blocks have been drilled and tapped for 1/4-20 nylon bolts. **RIGHT:** Typical top side of wingtip. The balsa block needed on leading edge has yet to be carved and sanded to shape.



**LEFT:** Finished top wingtip. Note half-rib and capstrip between last rib and T2. **RIGHT:** Bottom of upper wingtip differs from the top in that both LE and TE sheets get bent and glued to T1. No half rib is used.



**LEFT:** Bottom of lower wing showing bellcrank detail. **RIGHT:** Bottom of upper wing showing finished aileron fitted to wing. Note that 1/8" rib which has "N" strut fitting is "boxed" to its neighbor for strength.

original design to make them rectangular. Cut the ailerons out of the wing with a band saw or coping saw and use 1/4" medium balsa to fill the holes left in the back of the wing. The ailerons will now have to be beveled and this is where it gets interesting. As you bevel the underside of the aileron, the contour of the outer five inches of the tip begins to change and will require a lot of trial and error gluing and shaping to fit to the wing. Many hours later and with my scrap box almost emptied, it occurred to me that making the ailerons rectangular wouldn't have been so much of a crime after all. An alternate aileron outline is shown on the plans if you decide to weenie-out on the tapered ones.

#### Fuselage:

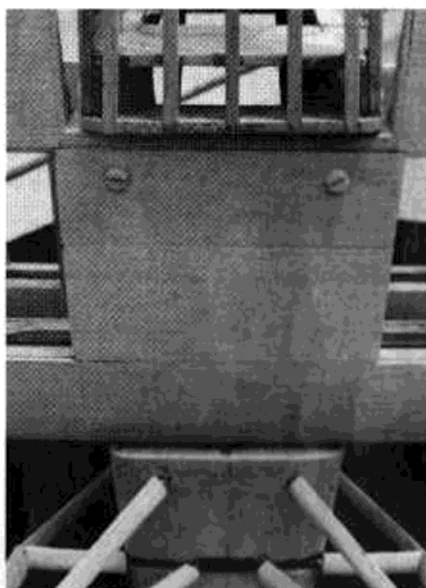
Build two fuselage "ladder" sides complete with the plywood insets. Epoxy in the fire wall and drill and fit the engine mount. Attach all the formers now, working forward to aft. For the sake of clarity, the plans do not show all the triangular stock braces. These are the lightest and easiest way to stiffen up an airframe, so epoxy them everywhere the first six formers touch the fuselage sides. Don't forget to add them also to the lower wing attach piece and gear crossbar attach piece that fit between the bottom longerons.

Bolt the cabanes to the plywood inserts you built into the fuselage sides using nylon landing gear straps. Use bronze electrical terminal ends slid over the cabane wires and bent backwards to attach the top wing. Fit the top wing for proper incidence using an incidence meter. Mark the position of the terminal ends, remove the wing and solder the terminal ends to the cabanes with StaBrite silver solder. Yes, you can solder these with the cabanes bolted to the fuselage by wrapping the area of the fuse near the cabanes with slightly damp rags and being careful with the propane torch. Yes, I did manage to singe the fuselage by not being careful. The top wing is held on with four 1/4"-20 nylon bolts which screw into the tapped hardwood blocks epoxied into the wing center section.

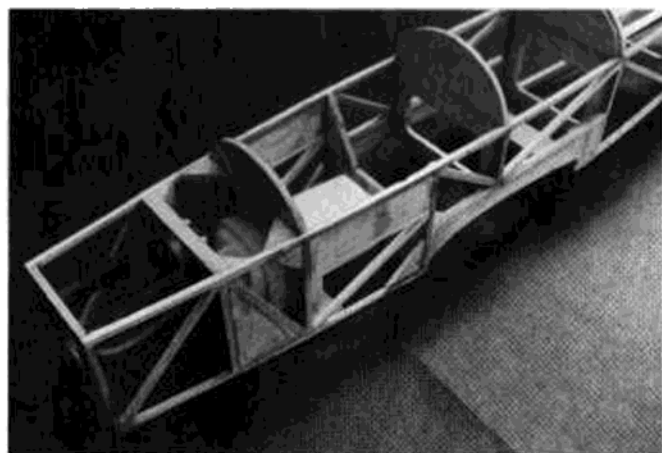
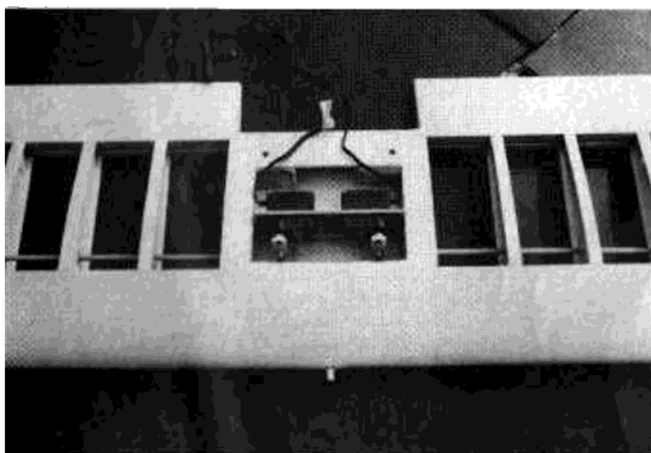
#### Landing Gear:

Don't even think about bending the gear without a K&S Mighty Wire Bender. Bend the main gear leg from one piece of 3/16" music wire and place it so that it rests on top of the top longerons in front of F3. Make two "U" shaped hold-downs from brass and attach the main gear leg with these to the front of F3. Bend the 3/16" wire crossbar and attach temporarily with more "U" shaped brackets to a piece of 1/4" plywood glued between the bottom longerons. Bend

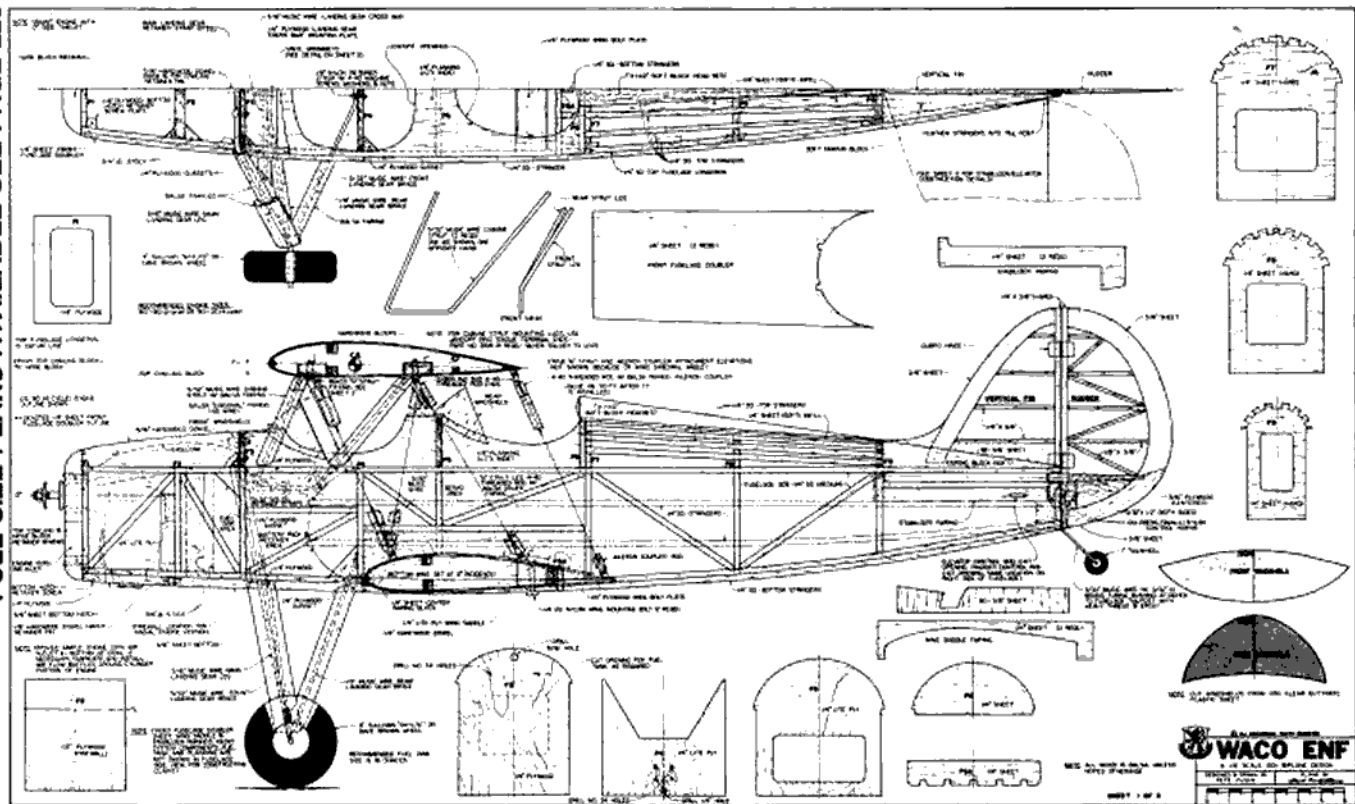
the 5/32" forward gear and connect it to the 3/16" wire crossbar using five small nylon grommets available from hardware stores. The two pieces of wire should fit very snug inside the grommets. Attach the 1/8" wire



**Lower wing fit to fuselage. A fairing has yet to be glued to the wing to fill the gap between F4 and F5A.**



**LEFT:** Any number of servo/bellcrank set-ups can be used. Author used two servos mounted in center with rods and bellcranks. **RIGHT:** Fuselage "ladders" which are built with 1/4" ply pieces installed before joining with formers. Tank and motor mount have been installed.



rear gear piece to F4 with nylon landing gear hold-downs. If everything was done right, you will have three pieces of wire coming together at the axle. Voila! An outrigger landing gear with bounce to it, thanks to the nylon grommets. And very cheap, too. After trial fitting the gear to the fuselage and wrapping the components where appropriate, it can be removed for soldering. Be sure to protect the nylon grommets with damp rags while soldering on the gear to prevent ruining them.

Glue on the front cowl sides, which will require a little bending, the lower wing mount fairing and tail fairing. All are made from 1/4" balsa sheet.

Plank the top of the fuselage. Glue the nose block to the top cowling block. After fitting the cowling block to the front of the airframe, sand it and the planking at the

same time. Add the stringers, tail block, headrest, and bottom cowl pieces. Remember to scallop between the stringers on the turtledeck so that the formers do not show through the covering.

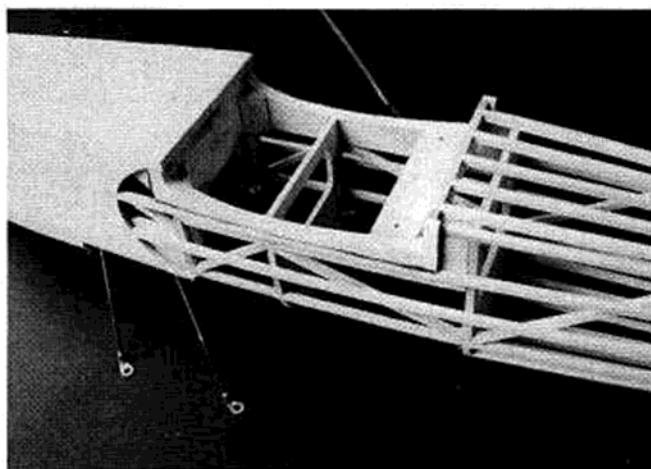
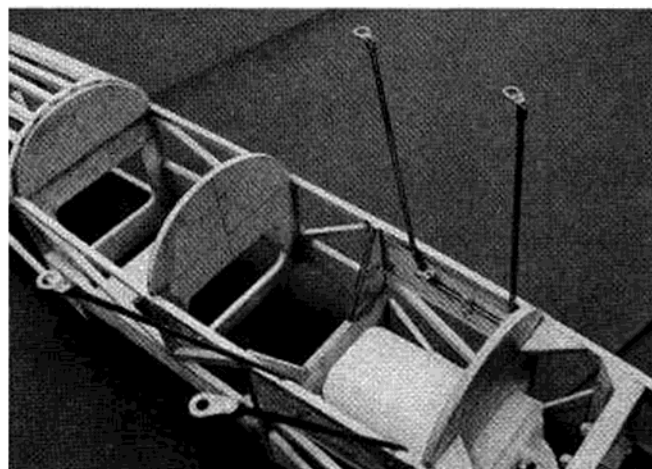
#### Tail Surfaces:

The tail feathers shouldn't require any explanation, other than to use a medium to hard balsa stock. The prototype balanced perfectly using a 90 O.S. 4-stroke with no added nose weight. But I have to admit that I went a little overboard on sanding the tail. All my modeling buddies offered their usual encouragement by predicting the tail would tear off the airplane at the first stressful maneuver. The model flew quite well without tail braces but I later added them before selling the airplane to Richard "The Demon" Denman just to be on the safe side.

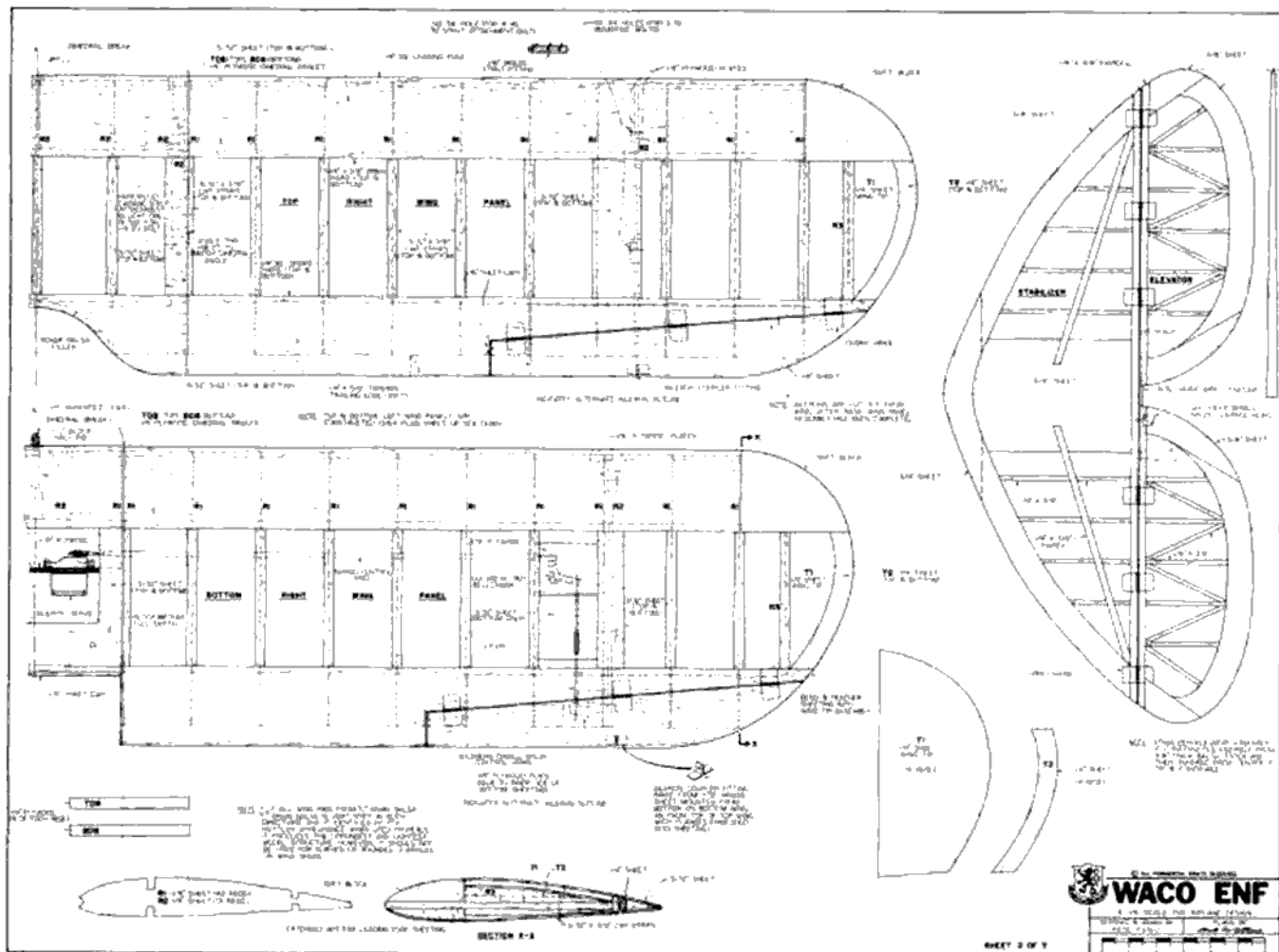
Use threaded 4-40 rod with adjustable

Du-Bro terminal ends to make the front and back pieces of the "N" struts. Mount the top and bottom wings to the fuselage, fit the rods to the brass fittings in the wings and, when the incidence is the same for the entire span of the wings, bend a piece of coat hanger to make the middle of the "N" piece. I wrapped and "glued" the coat hanger wire to the 4-40 rod with JB Weld while the ship was assembled. When you take the wings off, the "N" struts are finished and fit perfectly. The aileron struts were also made with 4-40 threaded rod.

To fair the struts on the airplane, including the gear struts, try the time-honored balsa sandwich trick. Use a glue such as Ambroid that can be carved and sanded easily. Sandwich the wire strut with balsa and plenty of glue, clamp and let dry overnight. Then, simply carve and sand



LEFT: 5/32" cabane wires are held to 1/4" ply inserts with nylon landing gear straps. This arrangement is strong and allows a little adjustment when fitting top wing. RIGHT: View of bottom stringers attached to F5A. Also the wing saddle fairing piece which is glued to the side stringer.



away everything that doesn't look like an airfoil shaped strut. It's a lot easier than it sounds.

The real aircraft had hubcaps. Cut the bottoms from aluminum soft drink cans, paint them and glue to the 4" Sullivan Skylite wheels with RC-56. You will have to grind the outer collars a bit for the caps to fit.

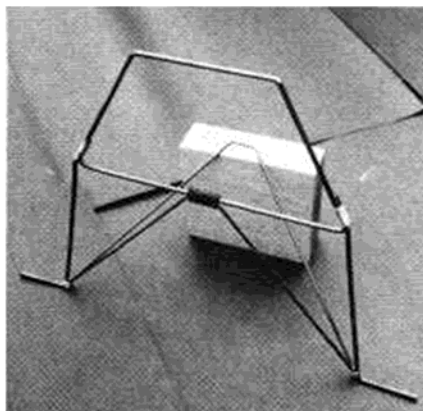
**Covering:**

I covered the ENF with Coverite's new 21st Century dark red fabric. It looks like a fine silk and dope finish, but silk and dope was never like this! The top wing, for

instance, was covered in 30 minutes using two full-span pieces which went around the curved tips with nary a wrinkle. Jeff Troy of Coverite says that Balsarite is optional, but I used it and even after many hours sitting in the boiling Houston summer sun, there were no sags on the open surfaces and no bubbles on the solid areas. Buy a pocket thermometer and follow the simple low-heat directions to the letter. One caution: The weave of the fabric has a "grain" to it which runs lengthwise on the roll. Like any fabric, it is important to run the grain spanwise on the wing and tail, and

lengthwise on the fuselage to avoid scalloping. I run a length of 1/4" masking tape along any seam lines and cut along the masking tape to ensure a neat seam. When everything is covered, wipe the ship with Ironex to clean the surfaces and enhance the shine. The matching paint was used on the hubcaps.

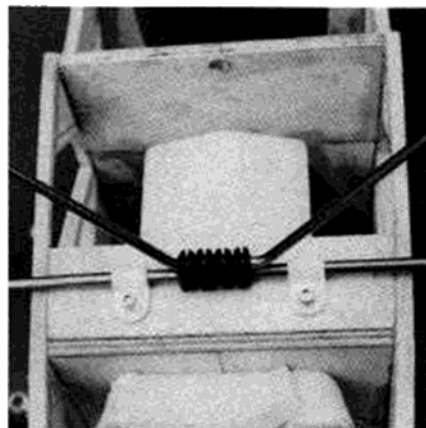
Just for the record, the original "F" Wacos were available with red, blue, or green fuselages and fin, while the wings and horizontal tail were silver. Struts were black and a black stripe down the fuselage side outlined in gold were standard. Waco



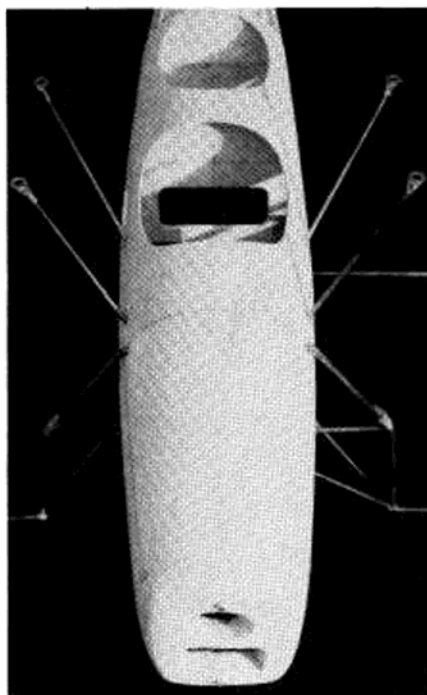
**Finished gear prior to installation. All fairing is done after gear is on aircraft. Note nylon grommets which allow a little bounce. Poor man's shock strut!**



**To keep the balsa fairings from turning on the round music wire, wrap and solder small pieces of music wire to struts. Middle piece of balsa "sandwich" is held in place nicely with these.**



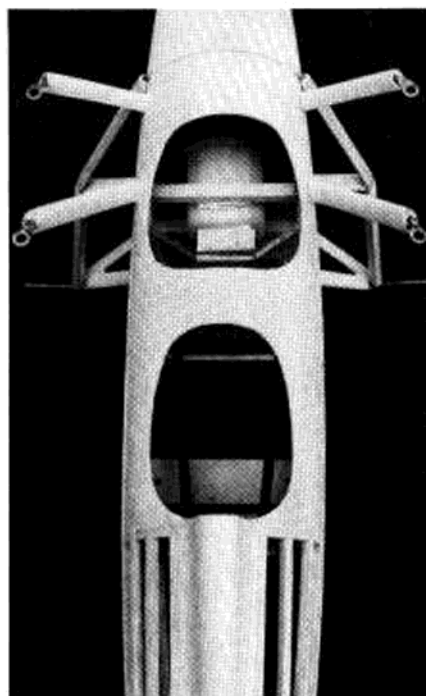
**Bottom view of gear on fuselage. Again, conduit type holders are used, but "U" shaped hold-downs would also work.**



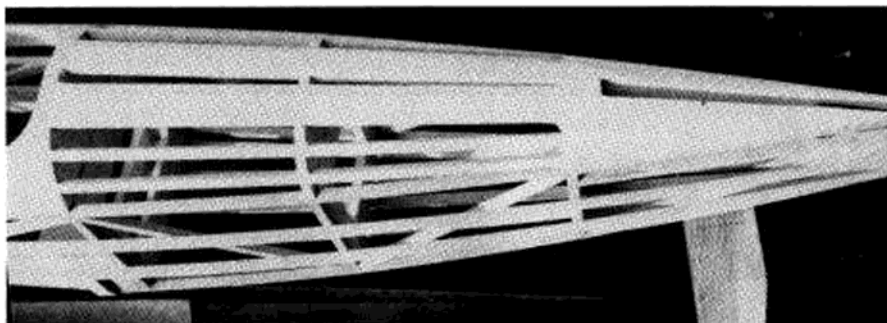
Everything sanded smooth, and cockpit cut-outs completed. The ENF had a two-place side by side front cockpit. Very cozy. A small door on left side allowed access.



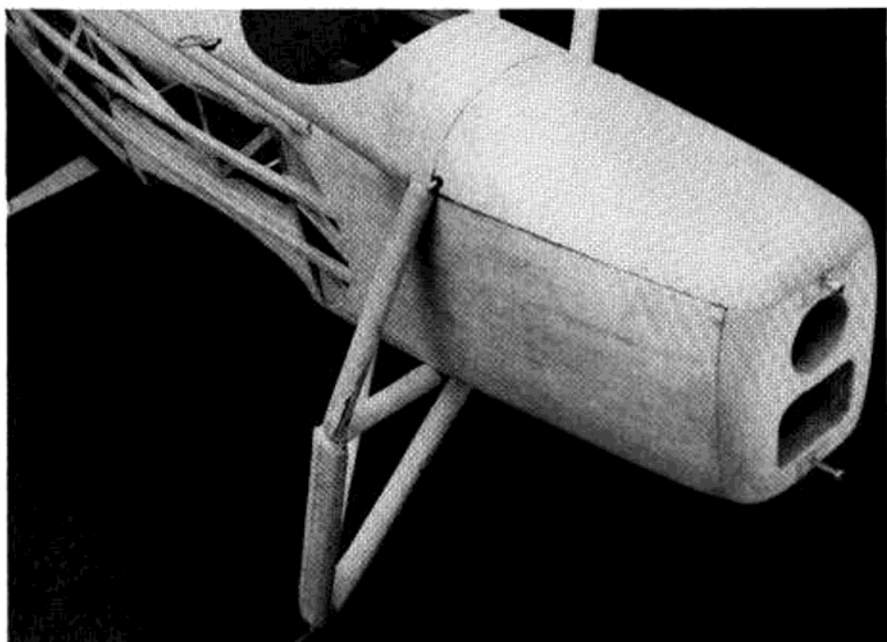
Finished top cowling block and attached nose piece. Two screws hold it to F1, doweled in rear.



Top and side view of fuselage showing headrest installed, and all struts faired with balsa.



Turtledeck completed awaiting headrest. Note fill balsa between stringers for easier covering. The soft balsa tail block was notched on a band saw to accept vertical fin prior to being glued on top of the longerons.



Good view of 1/4" balsa sheet front cowling sides and nose piece.

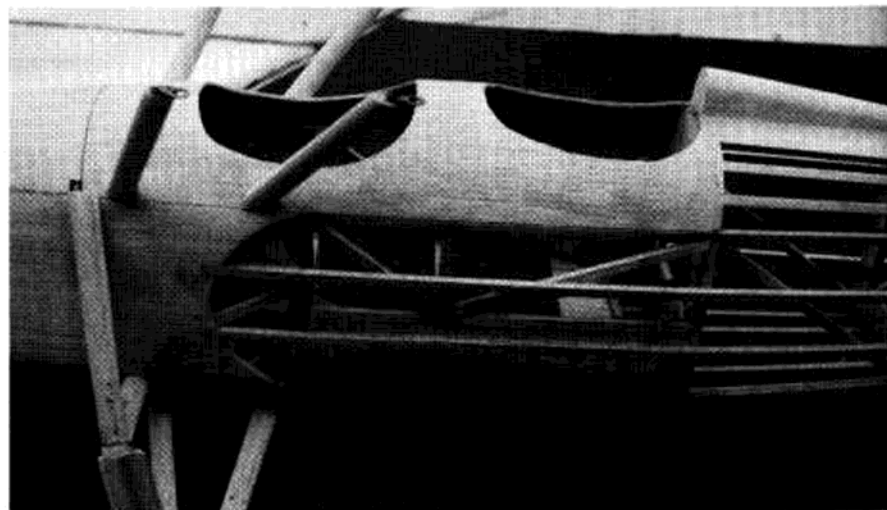
would, however, paint an airplane any way a customer wanted.

The "F" Wacos used wrap around windshields on the front and rear cockpits. The front, two-place cockpit windshield had a slight bubble to it but a flat piece as shown would do just fine.

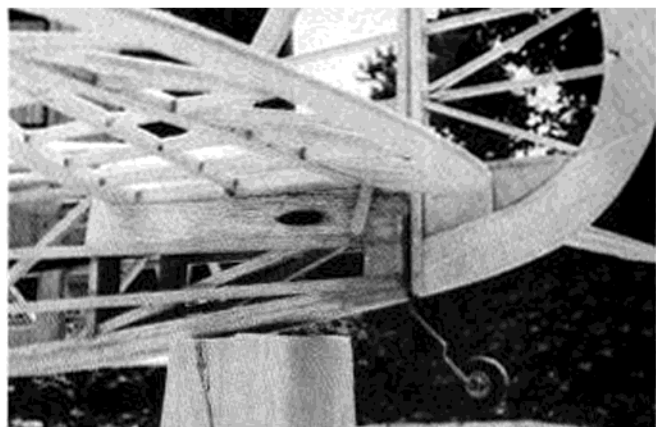
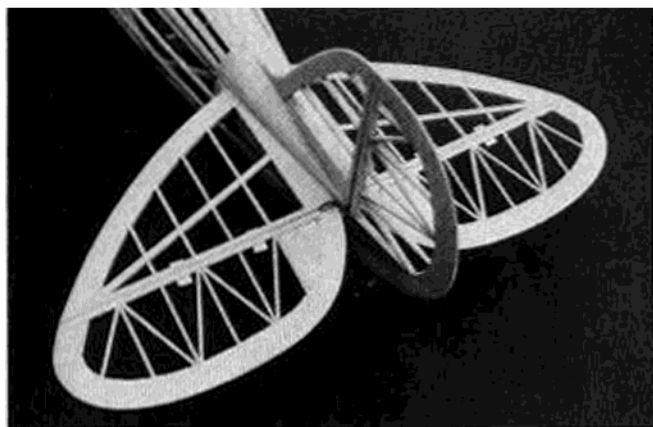
#### Flying:

Once more I entrusted a new design of

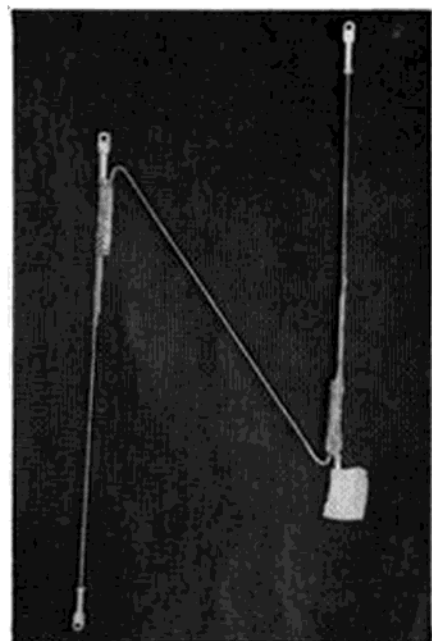
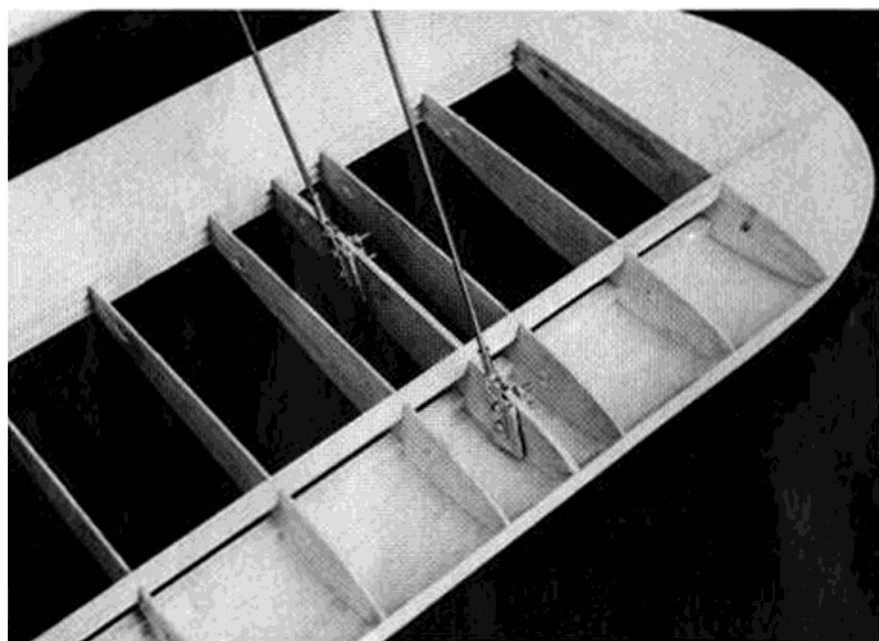
mine to fellow Barnstormer club member Ray Brickhouse. The Houston area is blessed with a remarkable number of expert R/C fliers (and an even more remarkable number of guys who just think they're experts). I like Ray because he is a fighter who will stay with a new ship no matter what. Ray would be the kind of full-scale pilot who would still be trying to recover







**LEFT:** Tail group. The use of 3/8" sheet might seem heavy handed, but it will be mostly sanded away as you sand in an airfoil shape, and taper from the center outward on the stab and elevator, and from the bottom up on the fin and rudder. A long sanding block armed with 60 grit paper makes this easy. **RIGHT:** Bottom of tail showing the tail fairing, control rod exit, and tail wheel wire which is attached to rear of fuselage in a brass tube using nylon reinforcing tape and epoxy. It is bent to insert into hole in rudder.



**Typical "N" strut attachment.** A brass strip has been bolted to a plywood sandwich on the rib. A Du-Bro #302 terminal end has been screwed onto a 4/40 threaded rod and bolted to the brass strip (see text).

**"N" strut construction (see text for details).**

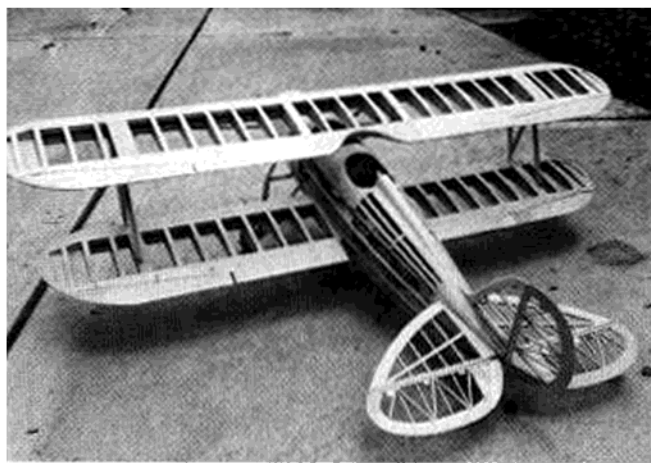
have to admit briefly losing faith in my hero and thinking, "Hell, Ray, I coulda' done that." But the 13 x 6 prop bit into the thin,

hot Texas summer air and just kept going. There can never be enough said for keeping them light. Ray was making passes for Will

and Jim to shoot pictures when a nagging doubt overcame me. Had I remembered to put the nuts on the aileron struts? As casually as I could, I asked Ray to land the Waco.



**LEFT:** "N" struts after being faired with balsa, and shaped. **RIGHT:** Finished "N" struts bolted to wing attachments. There are numerous ways to accomplish this task; author says feel free to use your favorite method.



*Finished Waco ENF ready for cover. Whew!*

After checking the nuts, which were on, Ray flew again and tried some stalls. With the throttle closed and the stick all the way back, the ship just kept floating around and didn't do anything nasty. Just when I was feeling very proud, the engine quit. Now here was the ultimate test of a scale ship. How would it glide? I am happy to report that we almost had to shoot it down. Ray's comments said it all, "Flies and lands just like a trainer."

A few weeks later Barney Mellvaine flew the ENF at a big bird meet and put it through its paces. It rolls just like an old biplane should, with a little nose up and plenty of aileron. Loops were quick and clean. Barney's comments about the control movements were, in a word, "crisp."

So finally, after a 25 year wait, I got my Waco ENF in the air. Admittedly, it's only one-sixth the size of a real one, but a whole lot cheaper to operate. □



*A Foto Paak of this Waco INF red w/silver surfaces (NC864V) available from Scale Model Research, 3114 Yukon Ave., Costa Mesa, California 92626. Paak No. 3567/16, \$16.00.*



*The Waco "MNF" pictured here in 1930's was outwardly the same as the "ENF," only the engines were different. Wheel pants and fabric covered lower gear "A" frames were factory options.*

**From  
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Aug. 1993**