AF 451

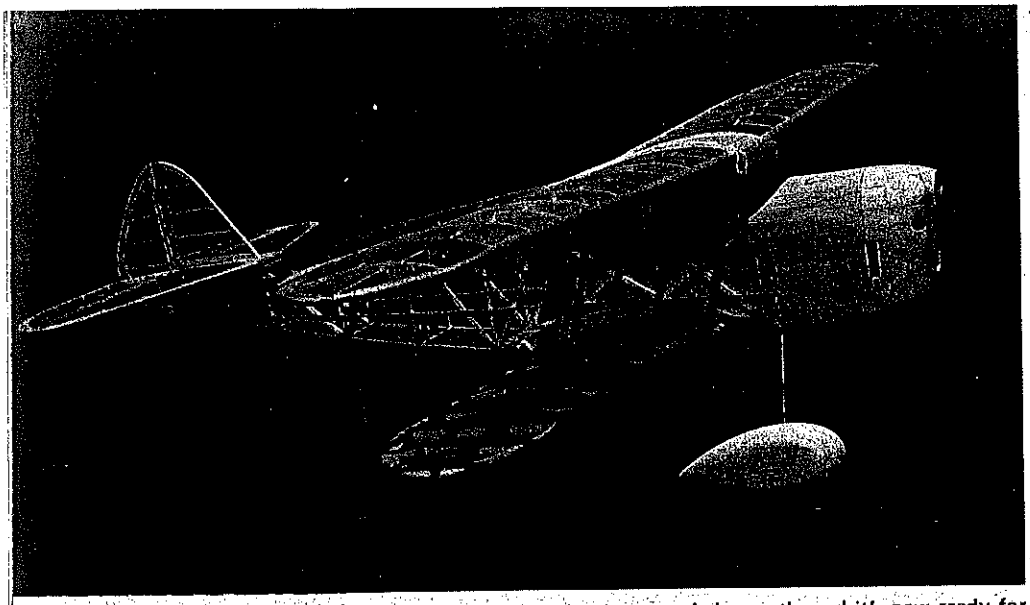
Elf Biplane

ONE DAY in the fall of 1976, I decided to browse through John Pond's Old-Timer Plans Catalog in search of a prospective winter project. Among the Bombshells and the Buccaneers, one listing caught my eye. It was an Elf Biplane by a fellow named Frank Ehling, a name which most of you will probably recognize and associate with many famous designs. Since I have an affinity for both Old-Timers and biplanes, I thought I would gamble on Mr. Pond's price of $1.50 for this rare combination to find out

The high-speed needle has been set, and all controls have been checked for proper functioning. The Elf waits, O.S. .30 idling, for a clear runway.

The Senior

Few designers have earned more respect in model flying than Frank Ehling, creator of the original Elf Biplane and countless other models—and AMA Technical Director for many years. Our presentation is for an enlarged and modernized RC version using three or four channels and .29-.35 engines. ■ **Gary E. Brown**



All of the pieces have been built, everything has been sanded smooth, and it's now ready for covering. When the structure is this beautiful, you'll certainly want a translucent covering.

what an Elf really looks like. Just to be on the safe side, though, I ordered a couple more sets of plans for Old-Timers that I was already familiar with.

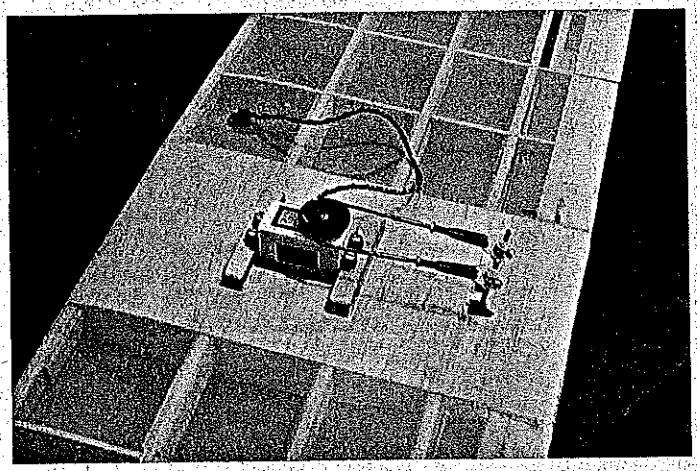
When the envelope arrived several weeks later, I was pleasantly surprised. The Elf was a pretty cabin biplane with a 39-in. upper wing and a shorter lower wing a la the Waco. Its tail feathers were regular Old-Timer fare, and its nose was like a Rearwin. I promptly forgot about the old standby plans I had ordered.

I began to rework the plans for RC and a modern glow engine. At 39 in. it was just about right for an .049 engine and some Ace rudder-only pulse equipment that was sitting on the shelf. The Elf turned out to be a great single-channel flier. With a Cox Golden Bee .049 and a 7-3 prop, it would run for about 3½ min. and attain several hundred feet of altitude on a good flight. After the engine quit, the Elf was a real floater, even for a biplane. An occasional thermal would noticeably slow its descent.

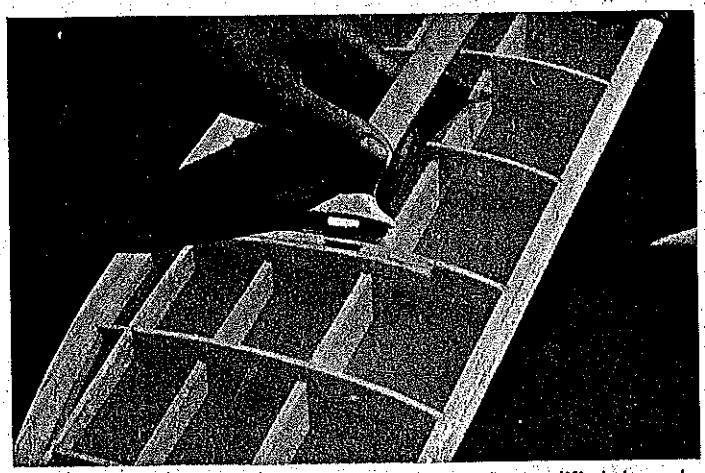
A couple of years later, I installed a Cox .09 and some small Ace digital-proportional equipment for two-channel (rudder and elevator) control. That turned the Elf into a hot little bomb that would loop and roll—but it could no longer float around in big, lazy circles due to the weight of the additional equipment.

At this point it was clear that the Elf had to be bigger to fly well with multi-channel radio equipment. I set out for a larger version, completely redrawing the plans.

I settled on a 60-in. span for the upper wing and then began to compute all of the important dimensions. Throughout the re-design process, a continuous effort was made to keep the structure light so that an engine in the .29 to .35 range could be used and still retain those easy Old-Timer flight characteristics. I installed an O.S. .30 in mine, and it has been entirely adequate for this



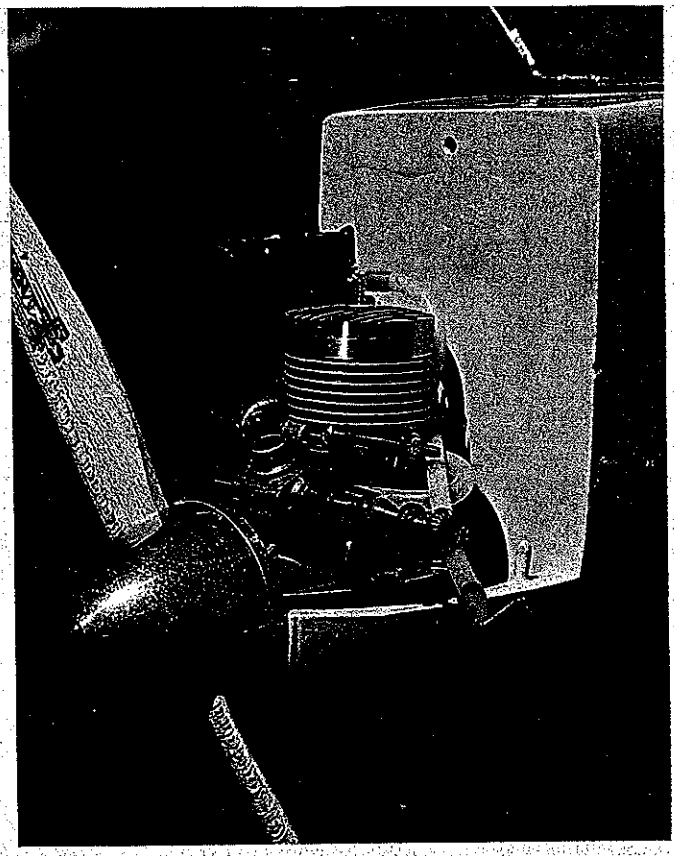
Left: The radio area as seen from the top of the fuselage. The servos are mounted to the extreme rear to help with balancing. The battery pack sits on a 3/32 ply floor in front of the servos, and the receiver is rubberbanded to another ply plate beneath the servos. The rear end of the fuel tank can be seen at left. Right: On the aileron servo, note that the wheel has been drilled for differential action—more up than down movement.

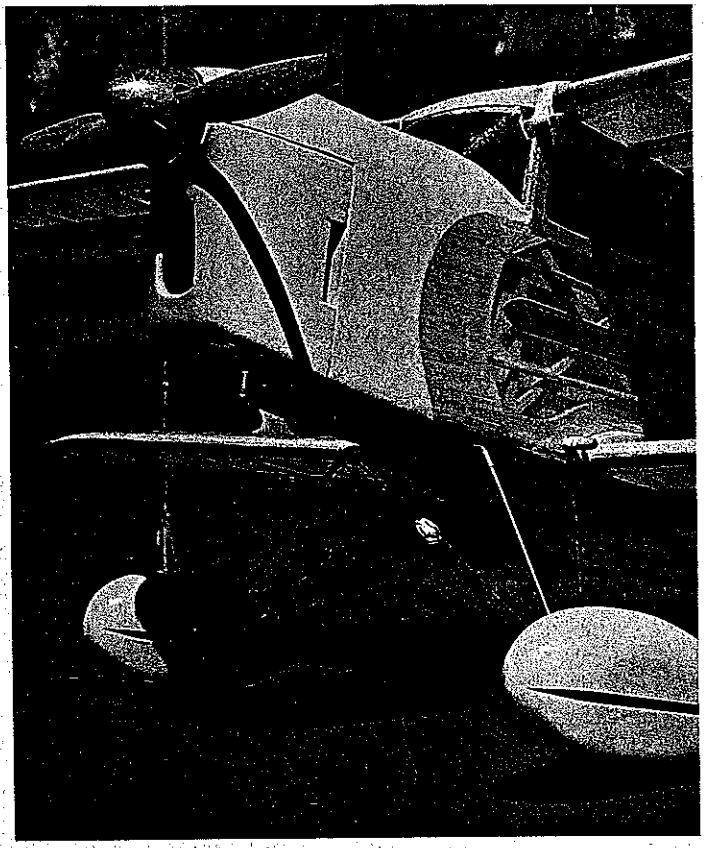


Left: This shows the strut mount before it was modified. It worked okay for a number of flights, but one strut eventually fell out during a rather tight maneuver. After that, 1/16-in. pins were added to hold them as shown on the plans. Right: The landing gear is attached with 4-40 bolts. Brass tabs are wrapped around the 1/8-in. music wire landing gear and soldered. The crossover wires act as shock absorbers.


CHUCK WOOD by Hank Clark
'SON IN THE FUN'
HANK CLARK WHEELEY SAYS YOU'RE LATE THIS STRIP! BOY- WHEN I GO OFF, YOU GOOF OFF! WHAT'S THE POOR EXCUSE THIS TRIP- AS IF I COULDN'T GUESS!
PLAY NOW- FLY LATER
U.S. MARINES
BAHAMASAIR 737 DIRECT NASSAU- 3 DAZE! MUCH WINDSURFING- SAILING - REEF DIVING- CALYPSO BANDS- DANCIN' --YOU WANT MORE--?
OH YEAH!
Bahamas Air
NOPE! IT'S ONE ROUTE I KNOW WELL- -YOU'RE OFF THE HOOK!
RIGHT NOW, WE HAVE TROUBLES! MY LITTLE PILOT FLEW THE COOP- MAD AT ME - WANTS THREE GIRLS! I'M BUSY- YOU'RE BUSY- MUCHO ART- NO TIME FOR CESSNAS - THE FALCON MODEL SITS!
A.M.A. WANTS Y.O.U.
TOUGH - BUT I HAFTA' DO A HAFFKE -GEE BEE Z!

3/16" SQ. SPRUCE THRU STAB. INTO BLOCK
3/16" SHEET FRAMING
3/16" SQ. BALSA RIBS
1/16" X 3/8" RIBS
3/16" X 3/8" POST AND RUDDER L.E.
3/8" SQ. SPARS
1/8" SQ. HARD (2)
1/8" DOWEL STAB. MOUNTS (3)
1/16" PLYWOOD CABIN OUT WINDOWS
1/16" SHEET C/S COVER
3/4" TAIL WHEEL ON 1/16" M WIRE THRU BRASS BRACKET INTO RUDDER
3/16" SQ. SPRUCE LONGERONS AND FRAMES
1/8" SQ. STRINGERS SIDES TOP BOTTOM
AIL. CONTROL INTO SERVO IN WING C/S
3/16" X 1/2" AILERON SPARS
1/4" X 1" BALSA T.E.
3/8" BALSA COWL
1/16" PLY.
29 - 35 ENGINE
1/8" SHEET LAMINATES WITH 3/32" PLYWOOD AND WIRE PEGS
1/16" SHEET INSIDE PANEL
1/4" SHEET ALL TIPS
3/32" SHEET ALL RIBS WITH VENT HOLES
1/2" BLOCK BUILD UP
1/4" PLY FIREWALL
1/8" SHEET FROM F1
1/8" PLUS 3/16" WING SADDLE TO T.E. WING
3/16" PLYWOOD L.G. MOUNT
1/16" PLYWOOD REINF. ALL MAIN SPARS TOP AND BOTTOM WING
1/8" MUSIC WIRE GEAR
3/8" X 1/2" BALSA L. EDGES
4-40 BOLT IN BLIND NUT
PLYWOOD INSET GEAR ATTACH
1/2" SHEET
1/8" SHEET
2 3/4" DU BRO WHEELS





Left: Note the 1/8-in. wood dowel which helps to retain the cowl. The muffler is easy to make from K&S brass stock, and it performs well. Enclosure of the muffler in the cowl preserves the clean lines of the fuselage. Right: The spinner is a 2-in. one made by Fox. A 10-4 Zinger prop pulls the Elf Senior around nicely. Notice the area just ahead of the red stripe where the epoxy overlaps the MonoKote covering.

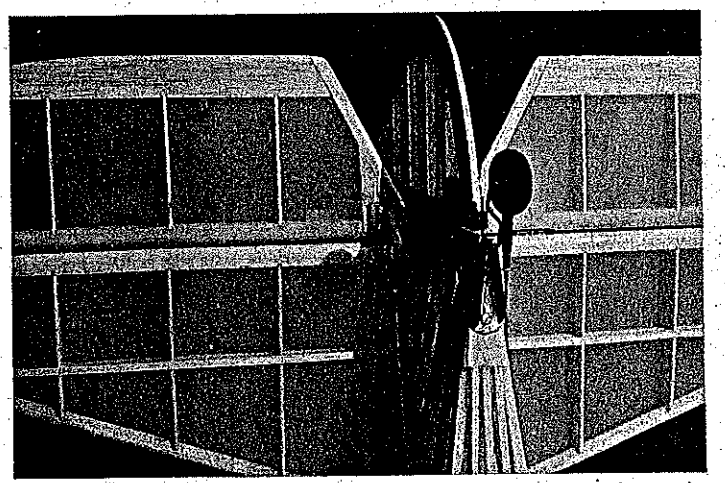
5-lb. model. Probably a good Schnuerle-type .25 would also do the job. Do stay away from anything larger than a .40; the Elf doesn't need a lot of power to fly well.

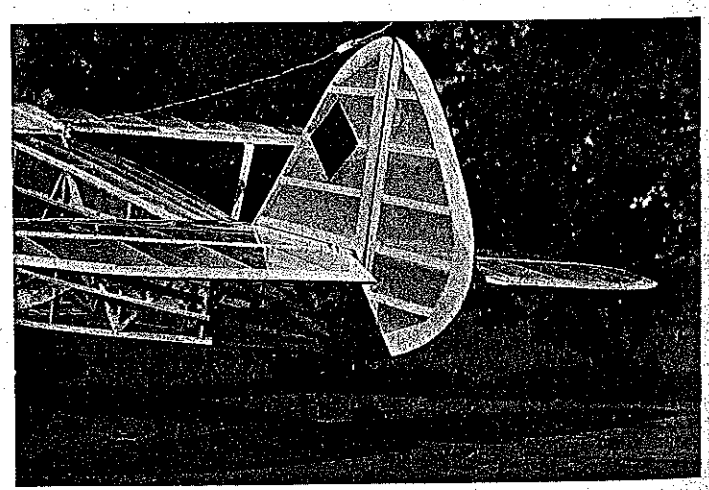
You've probably noticed already that this Old-Timer has ailerons. Because of its semi-scale appearance, I felt that ailerons would not detract from the plane's good looks, and they certainly improve its handling as opposed to the typical wallowing-about in three-channel style. For the conservative Old-Timer enthusiasts, this model could be flown three channel by increasing the rudder and fin sizes and the amount of dihedral in the wings. I have suggested some three channel dihedral figures on the plans.

Construction. Before beginning, study the plans to thoroughly acquaint yourself with each subassembly. Construction techniques are typical of Old-Timers. However, beware of two important points. First, don't omit the 3/32 plywood front top wing dowel mount; it extends from the top of the cabin right down to the plywood landing gear mount. Second, note the 1/8 sheet balsa wedge between the fuselage and the stabilizer to give positive incidence to the stab. Also note how the stab is secured with the three dowels.

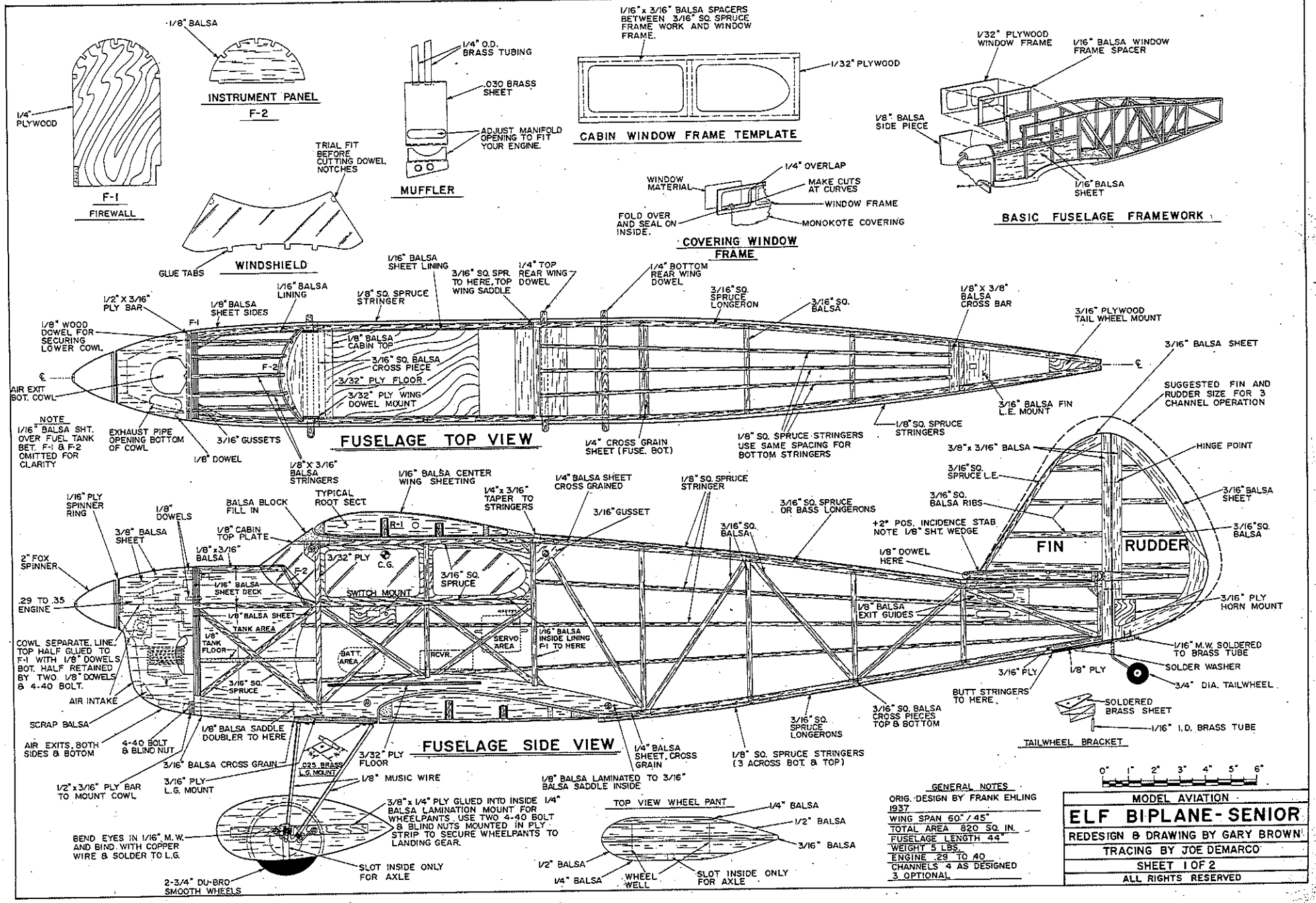
Wings. Begin by cutting out all of the parts you will need to complete their construction. The No. 2 rib is the most common, so make two 1/16 plywood templates of it, sandwich all No. 2 ribs between them, and gang-sand the balsa ones to the finished dimensions. While the No. 2 ribs are still assembled in a stack, cut out the notches for the spars, and cut off the tails at the aileron spar. Even if you are going to build this model without ailerons, I suggest you include the aileron spar if you think you may want to add them in the future. Cut out Rib Nos. 1, 3 and 4 and the wing tip parts.

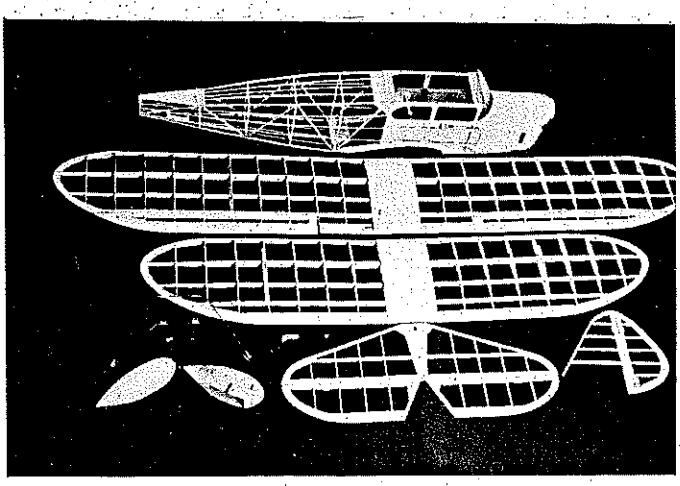
Assemble the spars. The aileron spar should be a firm to hard ½ x 3/16 balsa. Their tips are tapered after assembly of the wing panels. The front spars were sawn from a ¾-in. plank of knotless,

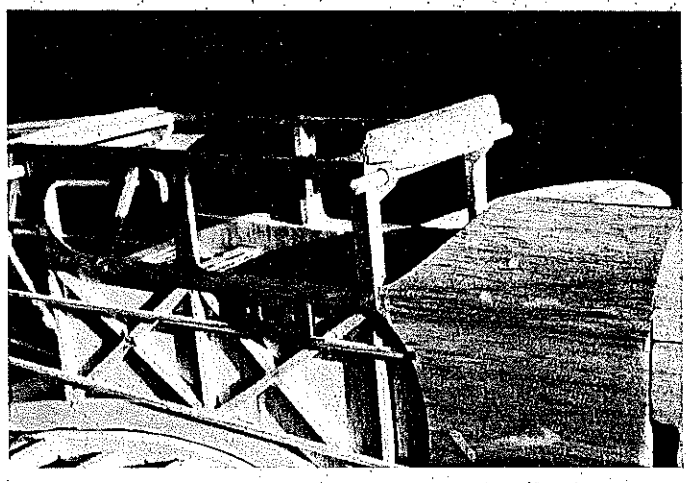




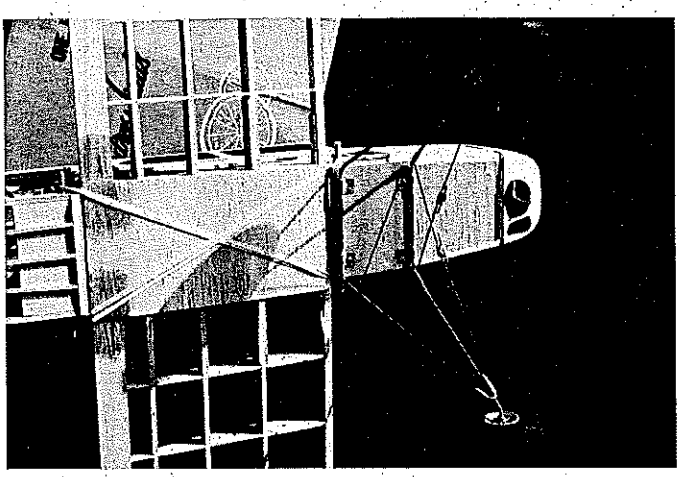
Left: The tail wheel mount is soldered brass stock that is fastened to plywood with screws. The control horns are also mounted on plywood. Right: Three 1/8-in. dowels help to secure the stabilizer to the fuselage. The leading edge of the vertical fin is spruce, making a strong attachment point to a 3/16 balsa piece on the fuselage. Elf logo on the fin was done with Pactra Formula-U on two squares of MonoKote trim.

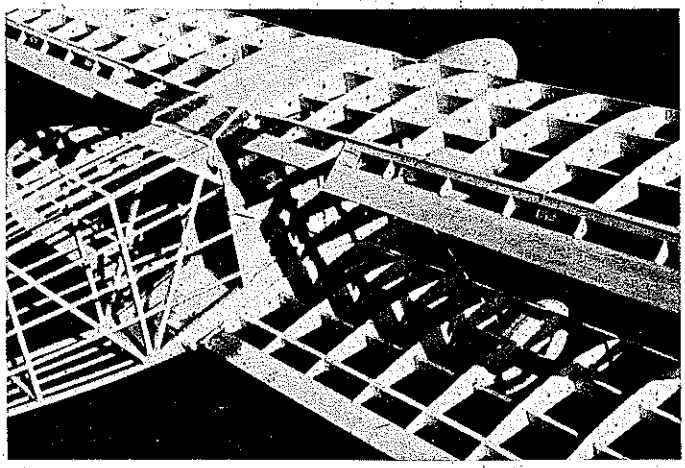




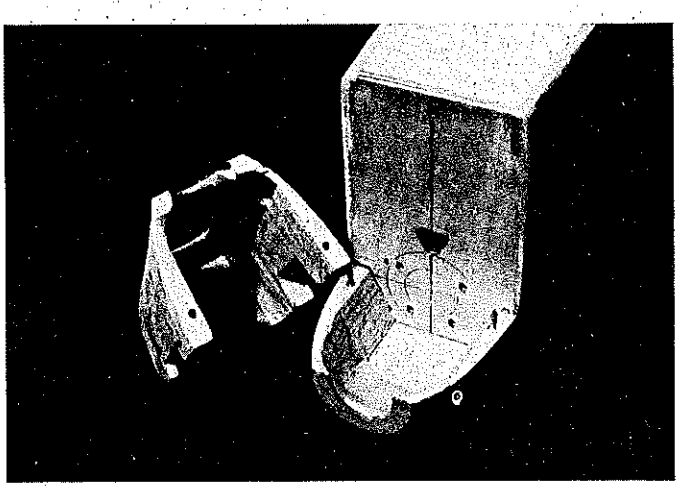


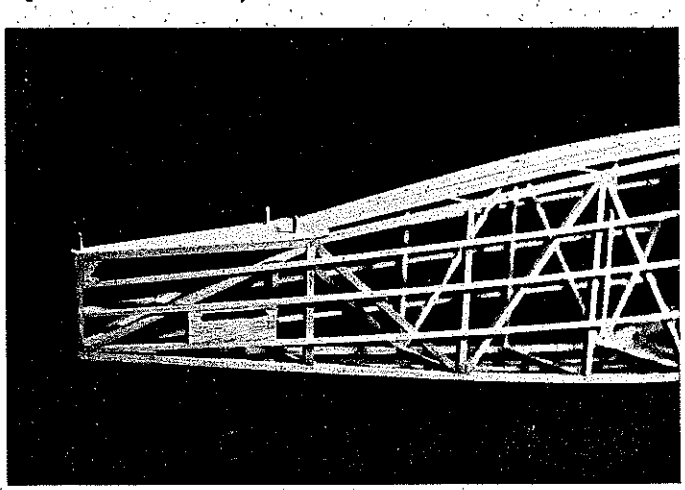
Left: All the pieces are ready for covering. At this point, everything should be carefully and smoothly sanded. Right: Note the 3/32 ply mount for the front of the top wing. Vertical-grain sheeting on the inside of the cabin provides strength for firmly mounting the radio equipment.





Left: The landing gear is fastened to 3/16 plywood with 4-40 bolts through brass mounting tabs. This method allows convenient removal of the gear if repairs are needed. Right: Ailerons are activated with torque rods (not installed when the picture was taken). Main spar is 3/16 pine. Holes in the ribs help to equalize pressure on the inside and outside of the wing and within the rib bays.





Left: Cowl is held on by two wood dowels and a 4-40 bolt through the bottom into the firewall. Cut generous-sized cooling holes in the cowl. Right: You can see the stab-mounting dowels sticking up. Also note taper of the 1/8 sheet platform that gives the stab 2 deg. positive incidence.

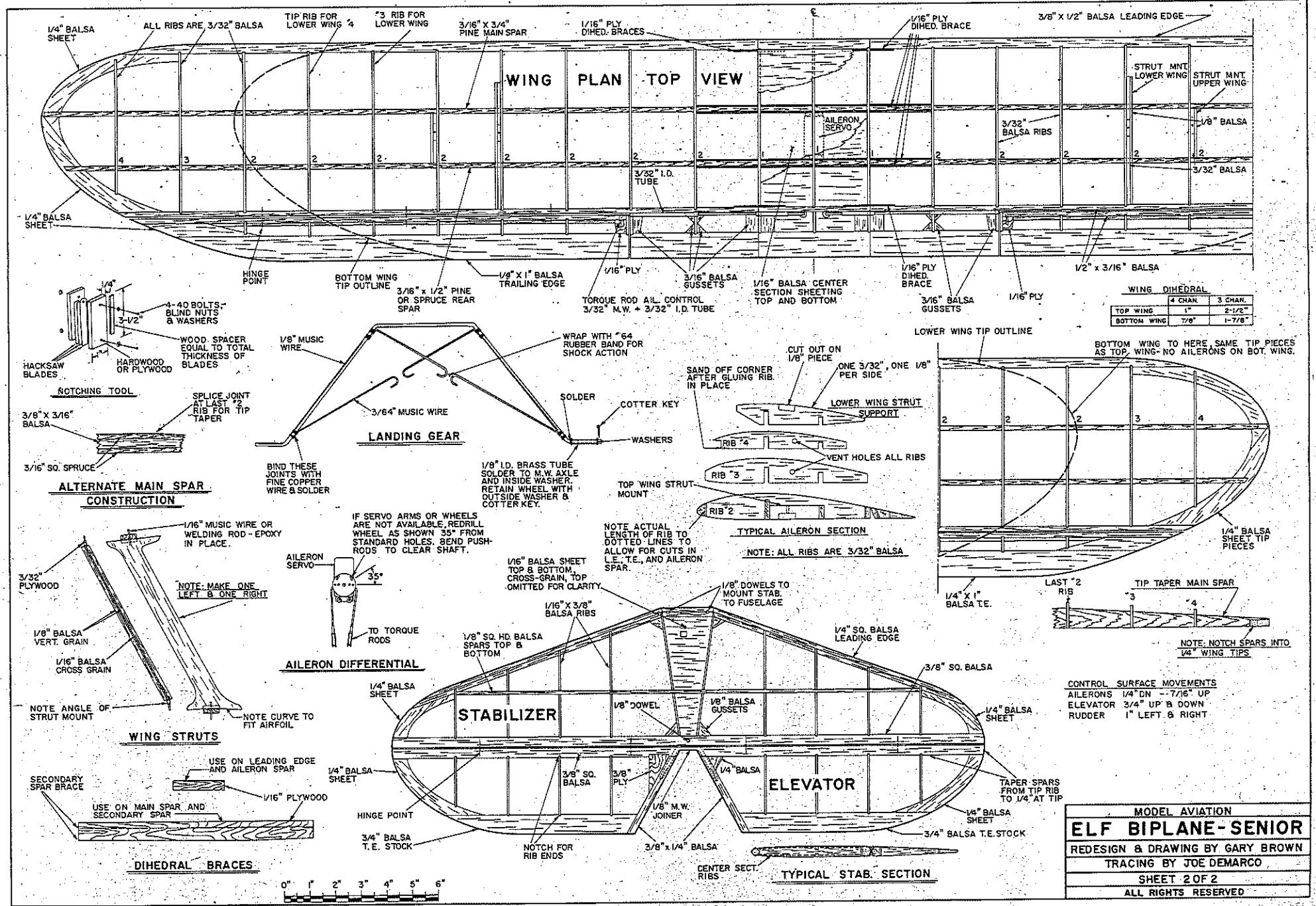
straight-grained pine to a thickness of 3/16 in. The rear spar is 3/16 x ½ pine or spruce as is commonly available at hobby shops. Please note that the tips of the spars need to be tapered from the last No. 2 rib to the tip before wing assembly begins.

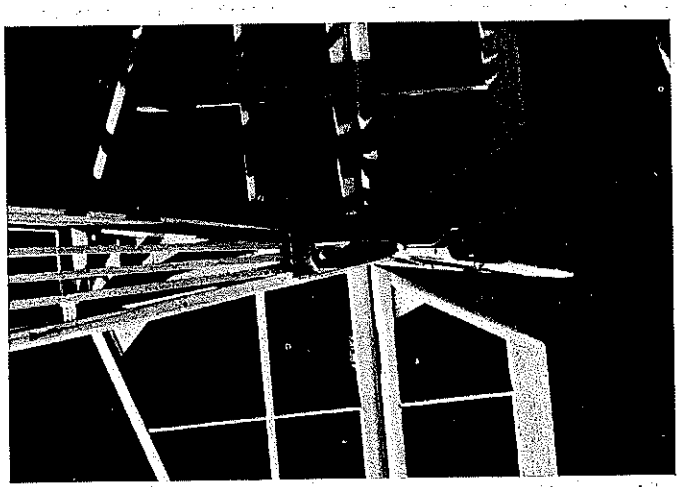
The right and left wing panels can now be assembled exclusive of the ailerons and trailing edge, which will be added later. Finish the wing assembly by joining the panels with 1/16 plywood dihedral braces; add the remaining center section No. 1 ribs and the trailing edge. The last step in the wing construction is to sheet the center sections of both wings with 1/16 balsa.

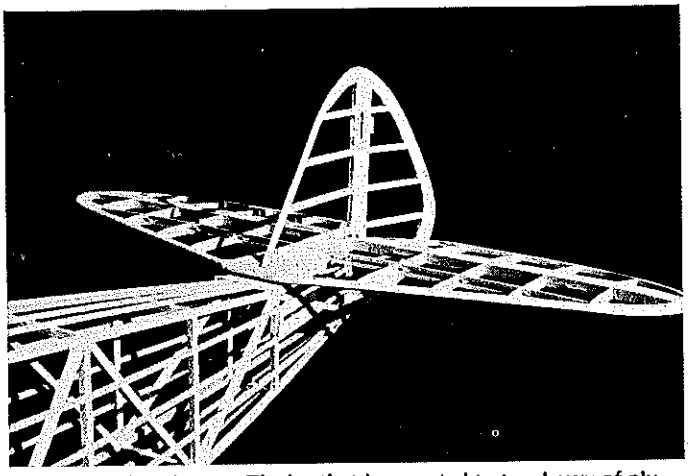
After the wings are completed, it wouldn't hurt to twist in about ¼ or 3/8 in. of washout in the tips. If you have covered them with MonoKote or some other iron-on, this will be simple. Just reheat the material near the tips, and twist the tips in the correct direction (raise the trailing edge). Make sure that you get equal amounts of washout in opposite tips; otherwise, you'll be correcting with aileron trim.

The ailerons are assembled independent of the wing over the plans. They are actuated via torque rods.

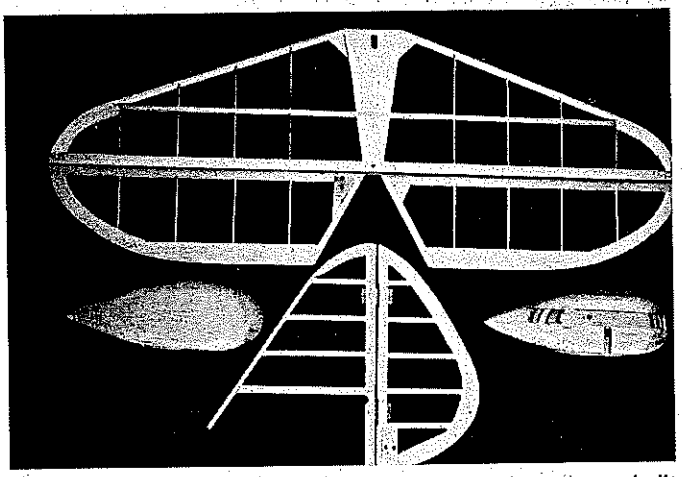
If you don't have the appropriate power tools to cut the 3/16 x ¾ pine main spar, an alternate can be easily made. Laminate a 3/8 x 3/16 balsa strip between two 3/16 sq. spruce pieces. A

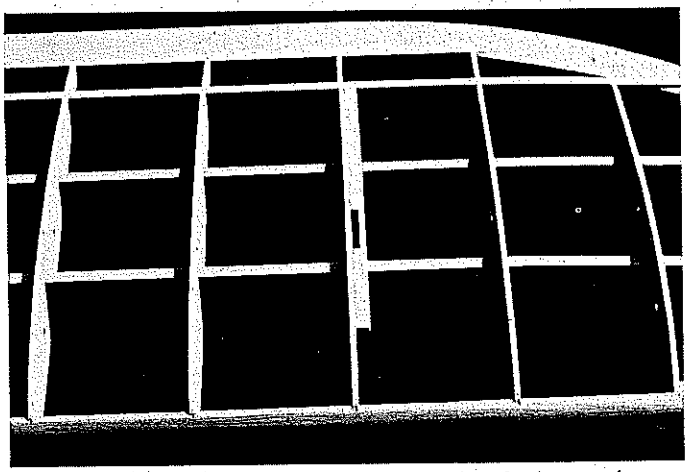






Left: This is another view of the tail wheel mounting that was shown in one of the color pictures. The bracket is mounted to two layers of plywood—one a 3/16 piece between the two fuselage longerons, the other a 1/8 piece on top of the longerons (which also meets the 1/8 spruce stringers). Right: The leading edge of the stab is 3/16 sq. spruce firmly cemented to a 3/16 balsa piece mounted between the top two longerons.





Left: The stab, elevator, fin, and rudder are simple structures built directly over the plan. The ply mounting strip on the wheel pants shows clearly on the one on the right (inner side). Right: The strut mounts are simply doubled-up balsa pieces with a slot cut in the middle piece.

splice joint will need to be cut in the top spruce piece were the spar begins to taper at the last No. 2 rib.

The notches for the ribs in the leading edge and aileron spar are cut with the tool as sketched on the plans. It is quite simply two pieces of wood that sandwich two or three hacksaw blades together. The width and depth of the notch is adjusted by adding or subtracting the blades and varying the depth. Use a spacer behind the blades to keep the two pieces of wood parallel.

Before covering the wings, I like to wrap the trailing edge dihedral joints at the center section with a patch of fiberglass cloth and a couple coats of epoxy cement. This will strengthen the joint and protect the thin wood against the rubberbands.

Fuselage. The two side frames are built up of 3/16 sq. spruce and balsa and then joined together. Cut out the bottom wing saddles from 3/16 sheet, and pin them over the plans. Next, assemble the 3/16 sq. framework for one side, noting that the longerons are 3/16 sq. spruce. After the first side cement is dry, leave it on the plans and assemble the second side directly on top of the first. When this is done, laminate the 1/8 balsa wing saddle doublers to the *inside* of each fuselage side. Note how the 1/8 in. doubler extends only to the front of the landing gear mount.

Join the fuselage sides at the wing trailing edges, top and bottom, with the ¼ balsa plates. Be sure that the sides are parallel forward of these two points. After they are thoroughly dry, cement in the 3/16 plywood landing gear mount. Glue the 3/32 plywood front wing dowel supports in place. Note how they extend the full height of the cabin. Pay careful attention to the gluing technique here, as they carry quite a load and simultaneously lend a lot of strength to the cabin area. Add the 3/16 sq. cross member at the top front of the cabin and the 1/8-in. cabin top plate.

At this point, the tail end of the fuselage may be clamped together temporarily and all of the 3/16 sq. balsa cross members added from the wing trailing edge rearward. When this step is completed, glue the tail end of the fuselage sides together, and then proceed to the nose to finish the fuselage framing.

First, glue on the ¼ plywood firewall, and line the fuselage inside with vertical-grain 1/16 balsa from the firewall back to the trailing edge of the top wing. Mount your engine, determine the tank position, and glue in the fuel tank floor. Finish the fuselage sheeting by adding 1/8 balsa sheets to the sides just aft of the firewall and 1/16 balsa sheets on top of the nose section. The fuselage framing is completed by adding 1/8 sq. spruce stringers to the top, sides and bottom—and the plywood window frames and pushrod exits. The wing dowels are added after the fuselage is covered. Their exposed ends can be fuelproofed with polyester resin or epoxy.

The cowling is constructed of 3/8 sheet balsa, which is lightly glued to the firewall over the mounted engine. Cement on the 1/16 plywood spinner ring, and quickly mount the spinner to the engine to properly align the ring to the rear of the spinner. Now, carve and roughly shape the cowling. When this step is done, carefully break the cowling off the firewall, and carve out the inside as much as possible to lighten it; generously cut cooling and needle valve holes.

Once the cowling is fine-sanded to its finished shape inside and out, cut the upper part from the lower part, and permanently glue the upper section to the firewall; use three 1/8-in. wood dowels for added holding power. Use

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glass cloth and polyester resin on the inside of the cowling for strength. If you have a favorite method of attaching cowls, use it. The method using one bolt and two wood dowels as shown on the plans is simple, and it has worked without problems for me.

Wing struts. These are purely optional, as they do not support any load. Build the struts last, after the model is completely finished. Slight variations in dimensions and wing saddle cushion thickness may require your struts to be slightly longer or shorter than shown on the plans. Measure your finished wing gap carefully or make a cardboard template from the plans to figure the exact length your struts should be. Also, make sure they fit snuggly between the wings, as a loose fit will practically guarantee vibration. Notice the cross-graining of the balsa strut laminations before cutting out the pieces, an important factor contributing to their strength.

Once the struts are finish-sanded to the proper length, rubberband the wings to the fuselage, and align them perfectly to each other. Next, determine the exact location on the strut for the 3/32 plywood mounting block, and pin and epoxy them securely to each end of the strut. The struts were finished in yellow epoxy paint to match the cowl and wheel pants.

Tail section. The stabilizer and elevator are constructed over the plans. Sand the taper into the leading edge of the ribs as you shape the ¼ sq. leading edge. Note that the center section of the stab is covered with 1/16 sheet.

The fin and rudder are also built over the plans. Note the spruce leading edge of the fin. Since this model could also be flown on three channels (rudder, elevator and engine), I have drawn a slightly enlarged fin and rudder to ensure good control. Also note the increased wing dihedral angles for three-channel use.

The wheel pants are, of course, optional, but they don't take long to build, and they add a lot of that "golden age" flavor to this model. They consist of laminations of balsa with a strip of ¼ plywood for mounting purposes. Cut out the center laminations to allow about 1/8 in. around the circumference of the wheel. The middle 3/16-in. lamination can be varied to allow for the thickness of different wheels. Du-Bro wheels fit the pants as designed. Before carving and sanding, add the ¼ plywood mounting bar to the inside of each pant as shown. A 4-40 screw and blind nut on either side of the axle mounts the wheel pant to the landing gear. When mounted, be careful that the pants don't bind on the wheels.

The landing gear is made from 1/8-in. music wire with 3/64-in. music wire crossover shock absorbers. Cut four small brass tabs, solder them to the landing gear as shown, and use 4-40 bolts and blind nuts for mounting to the fuselage. For the wheels, I like to solder brass tubing to the axle and retain the wheel with a washer and cotter key. Be sure to bend a little toe-in into each axle for better ground handling.

For a good solder joint, clean the parts to be soldered with emery cloth or fine sandpaper until they are shiny. Put on a drop of acid-type flux, and heat the parts with a gun or iron until the solder will melt when touched to them. Allow the solder to flow into the base metal. Remember, never use acid-type flux or acid-core solder on electrical wires due to its corrosive effects.

Covering. Since this model is rather lightly loaded and uses very strong wing spars, you may use just about any covering method or material you desire (except no burlap or house paint!). My model uses a combination of transparent MonoKote and epoxy paint. You will notice in the photos that the wheel pants, struts, nose area, and cowling are

all opaque yellow. These parts were all finished in epoxy paint. For the wheel pants and cowling, I filled the balsa with two coats of polyester resin, sanding after each coat. Then I applied three coats of K&B Superpoxy yellow per instructions, and that gave a terrific finish.

For the nose area and firewall, where there is so much fuel and oil, I also used Superpoxy to keep the MonoKote sealed. First, treat the bare wood inside and outside the nose area with two coats of polyester resin for fuel proofing; do the same with areas that don't need paint, such as the tank floor and back side of the firewall. Sand all the area where polyester resin was applied that will be finished with either paint or MonoKote. Next, cover the fuselage with MonoKote to within an inch or so of the firewall, except for the top and bottom. Carefully sand (with No. 60-grit paper) all of the MonoKote that you will overlap with paint. With the MonoKote surface dull and rough, epoxy will stick quite well, leaving the nose area nicely fuel-proofed.

When MonoKoting the fuselage, cover right over the side window frames, then cut the MonoKote out of the windows, leaving about a ¼-in. margin. This margin will be folded over and sealed down on the inside of the plywood window frame. Cut the ¼-in. margin of MonoKote diagonally at the curves of the frames in order to get a neat fold-over. Once the MonoKote has been sealed down on the inside of the frame, glue the windows in place on the inside of each frame.

Radio installation. Assuming that you build according to the plans and use an engine of average weight, the model will probably be nose-heavy. Start your radio installation by mounting the servos as far to the rear of the cabin as possible (but not so far as to make access difficult). Install the engine, fuel tank, wheels, etc., and move the battery and receiver to properly locate the balance point. I installed 3/32 plywood floors as shown to attach the receiver and battery with rubberbands. Simply placing the radio equipment under the fuel tank will probably result in a nose-heavy condition. Set up control surface throws as shown on the plans.

Note that I have used differential throw in the ailerons. If you can find a servo arm or wheel made for differential action, you're all set. If not, just redrill a servo wheel as shown on the plans. You will also need to bend the pushrods so they clear the servo shaft.

Muffler. On my Elf it is a homemade affair from K&S brass stock. Its total enclosure within the cowl preserves the clean lines of the nose and keeps most of the oil underneath the model. With the correct tools and materials, custom mufflers for any model are not difficult to make. Just remember not to make them too restrictive.

To assemble the muffler, once you have cut and trial-fitted all of the parts, use a 30% silver solder and a Bernz-O-Matic type propane torch to solder the parts together. As with any type of metal joining, clean the two pieces to be joined, and use the correct type of flux. After cleaning the joint area with fine sandpaper until it shines, apply a thin coat of silver solder flux, and begin to heat it with the torch. Sheet metal heats

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Elf/Brown

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quickly, so apply the solder, and it should melt into a flat puddle around the joint. If the solder forms a little ball on the base metal, the material is either 1) not hot enough, 2) not clean enough, or 3) not fluxed. Practice on a piece of scrap brass first, and you will pick up the knack of it quickly. After the solder job is complete, chip away any encrusted flux, and rinse thoroughly with water. A Du-Bro muffler strap works well for attaching the muffler to the engine.

If I haven't convinced you to try building your own muffler, a Du-Bro Muff-l-Aire II should work well with a little modification to the cowling.

Flying. First of all, here are a few words about upside down engines. Inverted engines are not any harder to start than upright ones, providing that you flip the model belly-up to start. The easiest way to do this is with a cradle. Robart makes a nice one of Styrofoam, or you can build one with a few pine boards in a short time. If you're careful with priming, you can even get an inverted engine to start regularly without turning the model upside down. Just be careful, when using an electric starter, that the engine does not get a hydraulic lock from too much fuel prime, resulting in a bent rod.

While on the topic of running inverted engines, in my experience, I have never found inboard batteries necessary or desirable to keep the glow plug lit at idle. Provided your carburetor is adjusted correctly and your fuel tank is placed properly, an engine will idle just as well inverted as upright. On the minus side, the onboard plug lighter just adds weight and the potential for a fire hazard should something chort-circuit.

After you've adjusted the engine idle and made sure the surface throws are set correctly, it's time for that first flight. On takeoff, be prepared to correct the heading with a little right rudder. Give it full throttle, and in a short distance it will lift off with a little up-elevator. Once in the air, climb to a safe altitude, and acquaint yourself with its handling characteristics. Since there's a lot of wing area to move about, you'll notice that it reacts very gently to aileron control. Coordination of rudder (while not necessary because of the aileron differential) will snap things up quite a bit.

On landing, don't be afraid to slow down the Elf. Be ready again to use a little rudder, and pull the tail down with a touch of up-elevator once it begins to slow on the ground.

If you enjoy Old-Timers and cabin biplanes, try an Elf. It may never sweep the SAM Championships, but like all Old-Timers, it's loads of fun to fly.

Radio Technique/Myers

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when you're not using it! It doesn't make a sound unless there is a transmitter operating in the vicinity. You could put an LED (light-emitting diode) on it as a pilot light, but that would use more battery current than the wand does.

OK, gang, make one up and use it! Let John Lange know how much you appreciate his generosity by writing him at 1700 N. 37th Ave., Stone Park, IL 60165.

While at Toledo this year, I met and talked with John (Blue Thunder) Simone and photo'd his Eagle Helicopter, soon to be in production. The wings are there to enhance maneuverability, and John expects to be able to perform a whole new series of aerobatics with it. I can't wait to see the time when a Helicopter wins a Pattern event. Who'll be first?

Several elaborate, expensive new RC systems were shown at Toledo by Altech (Simprop, represented by Hanno Prettner), Miniature Aircraft Supply Co. (Multiplex, being imported by Walt Schoonard) and Futaba's PCM (the digital pulse-code modulation system). So far, the only one I've handled (and done any testing on) is the Futaba PCM, which showed outstanding performance. In spite of the fact that the receiver is a single-