ELECTRO

BY R.G. SCHMITT, JR.

The issuance of Federal Airworthiness Regulation FAR 103 in 1982 rekindled the design, development and fabrication of homebuilt aircraft, which had been so effectively suppressed by the requirements and enforcement of FAR 23 and succeeding regulations, dating back to the mid '20s. One of the interesting designs which began life as an ultralight, as authorized by FAR 103, was Mr. James E. Feris' JN-1, a pert single-seater, to be powered by a Kawasaki 440cc motorcycle engine. Unfortunately, or perhaps fortunately, the design proved to be over the weight limitations for an ultralight aircraft. However, because of the soundness of the design and construction, Mr. Feris was able to register the aircraft in the Experimental category, and this airplane is flying today under the registration 85JN—1985 being the year of fabrication, and "JN" being the initials of the first names of Mr. and Mrs. Feris.

As a footnote to the above, the JN-1 is actually Mr. Feris' eighth design, and is being followed by both a true ultralight version (presently under construction) and a somewhat larger two-seater (side-by-side). Also, according to Mr. Feris, there are presently five or six other JN-1s flying, built from plans sold by him.

Our one-tenth scale model is based upon a small three-view and specifications furnished by Mr. Feris. Deviations from scale are minor—a larger horizontal stabilizer, and an additional two degrees of dihedral added to the two degrees of the full-scale.

As with all electric-powered models, the flight performance is very closely related to overall model weight. Therefore, the builder must be careful in the selection of the wood, covering material, and finishing techniques. The author's model weighed in at just over 13 oz., which was 1 oz. over the design objective. Even so, performance was sprightly, with flights in the 3-1/2 to 4 minute range, and an estimated flight altitude of 250-300 feet, with a flight pack of three 500 mAH cells. Tom Schmitt (of HiLine Ltd., distributors of the IMP-30 motor used in the model) recommends using a 700-800 mAH pack for longer flights with a weight increase of only a little over one ounce.

CONSTRUCTION

Every modeler has his own starting point. The author usually begins construction with the wing, so let's go from there.

Because of the relatively high wing loading of this model, it is most highly recommended that only spruce be used for the main wing spars. The rear spar can be hard balsa, if desired. The ribs and nose ribs should be cut from medium quarter-grained 1/16 or 1/8 sheet as specified, and the tip former from 3/32 medium sheet. To minimize damage from weeds, etc., upon landing, the leading edge should be made from firm to hard balsa, and the trailing edge at least firm grade wood. The anti-warp diagonals need only be of medium stock, however.

Assembly of the spars as shown on the plans is the first step, after which they may be pinned down on the plan (one side at a time) and the ribs (except for the root ribs) positioned in place, and glued. It will be necessary to trim those ribs to fit where the 1/32 plywood doublers prevent them from just slipping over the spars. After the ribs are in place, the leading edge can be fitted, and then the nose ribs. The trailing edge is glued in place, followed by the anti-warp diagonals. Vertical grain shear webs of 1/32 balsa are then glued to the rear side of the main spar from the spar doublers out to the strut attach pad. The wing tip former is next added, and then the trailing edge gussets. After all glue has set, the structure may be lifted from the building board, and the above steps repeated to form the other wing panel.

After completion of both panels, the structure is then positioned on and glued to the 1/32 sheet panel which forms the undersurface of the center section, and the root ribs installed. Accurately locate the wing positioning spar but do not drill it for the dowel, as this is best drilled upon assembly from the hole in F-1. Be sure to install the pre-drilled wing hold-down bolt pads in the center section before installing the upper sheeting. Mark (with a pinhole) the location of the center of the holes in the bolt pads in the lower surface, so that you can drill back up through the center section and accurately locate the bolt holes in the upper surface. The upper surface of the center section may then be added. To complete the wing structure, chamfer the top edge of the wing tips to conform with the airfoil contour, after which the leading edge should be shaped and the wing structure sanded all over. Add the underside trailing edge gussets, and both the upper and lower surface card stock corner gussets. (These not only contribute to the strength of the structure, but also prevent unsightly wrinkles from forming in the corners of the covering when shrunk.) Spray or brush on a coat of dope, and sand lightly all over.

The dorsal, fin, and rudder are cut from firm 3/32 sheet. Note that the fin has a cross-grained leading edge, and that the rudder has both upper and lower stiffeners to minimize warpage. Sand all over, and round all edges except the rudder trailing edge, which is left square. After sanding, install the 1/16 ply rudder doubler, which is slotted to accept the control horn and provide a firm support, which the balsa alone could not do. Give all pieces a coat of low-shrink dope, sand lightly, and set aside. Do not install the control horn until after covering.

The horizontal stabilizer and elevator are built flat on the plan. Both spars should be cut from very firm 1/8 sheet. Taper as indicated on the plan. The leading edge and tips should also be of firm balsa. The trailing edge and ribs may be cut from medium stock. Roughly taper the ribs to shape before gluing in place. Final shaping is accomplished by block-sanding the structure while it is still flat on the plan. Add the center section fill-in, and the upper surface card stock corner gussets, similar to the wing, after which the frames can be removed from the building board. The leading edge, tips, and mating spar sides are rounded, and the lower surface sanded. Again, leave the trailing edges flat. Install the lower gussets, dope both structures, let dry, sand lightly all over, and set aside. Before doping, it is advisable to strengthen the center of the elevator spar with CA.

Begin fuselage construction by first cutting out the two nose sides and nose doublers from firm 1/8 sheet. To insure that they are identical, it is recommended that they be cut at the same time, from two sheets tack-glued together. At this time also, cut out F-1 and F-3 from 1/8 lite-ply, and, F-2 from 1/8 firm balsa. Note that the longerons intersect the bulkheads at an angle, so leave sufficient material in the bulkhead notches so that they may be trimmed to a snug fit on the longerons at the correct angle. Use hard 1/8 sq. balsa for the longerons, and medium for the uprights, crosspieces, and diagonals.

Build the first fuselage side directly on the plan, omitting the bulkheads, but otherwise complete. When dry, remove it from the plan, and build the other side, and glue the bulkheads to it in their correct position, square (90°) to the building surface. Let dry, then install the first side in the correct position on top of the bulkheads. Let dry again, then remove the assembly from the building board and draw the two rear uprights together. Glue, making certain that there is no twist in the fuselage structure. When this is dry, add the crosspieces and the upper and lower diagonals.

Cut the nose block from firm 3/8 sheet. Before gluing it in place, cut the indicated openings—these are scale, but are also necessary for motor and battery cooling. The landing gear mounting tubes are made from 1/16 I.D. aluminum tubing, which has been fully wound with thread to insure a good bond, and are installed in the corners made by F-1 and the fuselage nose pieces. Note that the right tube is spaced 3/32 of an inch forward of the bulkhead by means of a 3/32x1/8 spacer—this is necessary to allow the landing gears to lay parallel. The landing gear support gussets may then be glued in place, both fore and aft of the bulkhead, after which the nose doublers should be carefully fitted between the noseblock and the landing gear gussets. Notice that the lower edge of the doubler is installed 1/16 inch above the lower contour to allow for the 1/16 balsa lower sheeting, which is cut, carefully fitted, and glued in at this point.

The upper side of the nose section is framed with 1/8 square, inset 1/16 inch, to provide support for the nose hatch. The hatch consists of a 1/16 sheet panel, framed on the underside with 1/8 square, sized so that it fits snugly inside the nose framing.

At this time the windshield framing may be completed. Notice in particular that the small 1/8 sheet balsa pieces, which are mounted on the upper cabin member, match the contour of the root ribs, and fair the windshield frame to F-1.

Add the gussets between the upper cabin member and F-1, and the 1/8 ply cross member at the back of the cabin, into which are mounted the blind nuts for the wing mounting boles. But do not install those nuts just as per the drawing—instead, accurately position the wing on the fuselage, drill the hole for the wing positioning dowel from the hole in F1, install the dowel, and then drill down through the wing hold-down bolt pads to accurately locate the holes for the blind nuts.

I found it very convenient to also have equipment access through the bottom of the fuselage—therefore the opening on the lower surface between F-1 and F-2 was framed with 1/8 sheet doublers which were made to match the contour of the fuselage, but inset 1/16 inch to accommodate the hatch. The hatch itself is made like the nose hatch, of 1/16 sheet and 1/8 square balsa, sized to fit snugly inside the fuselage framing.

The fuselage structure is completed by shaping the nose. Before rounding all edges, shape the nose block as shown on the plan in both the top and side views. Fair the nose block smoothly into the fuselage sides and bottom, and then sand the entire frame, removing all rough edges and protrusions. Give it a coat of dope, and when dry, lightly sand it again all over.

The landing gear is formed from two pieces of 1/16 music wire, bent as shown on the plans. After assembling them to each other (through the short tubes), make the final vertical bend in each strut, making sure that the bends are exactly 90 degrees, and that both sides are parallel, otherwise they won't go into the landing gear tubes. The lower portion of the struts may either be faired with a piece of folded card stock, or with a tapered piece of 1/16 balsa, tacked to the strut with CA, the trailing edge rounded, wrapped with silk, and well doped.

Believe it or not, the wheels presented quite a problem. None that were available either looked right or were light enough. After making several sets (which didn't look right either), my friend, Byron Lechler, suggested cutting a Dave Brown foam-tired wheel in half. This can easily be done by mounting the 1-1/2 inch wheel on a 1/8-inch spindle or a 5-40 machine screw, chucking it in an electric drill, and slicing the tire in half, using a razor knife. The hub may then be snapped apart and the female side drilled out, so that the male side may protrude through. The 1/2 tire is then mounted back on the reassembled (but thinner) hub, which is tacked together with CA, and the protrusion cut off. The wheel is then mounted back on the spindle or screw, chucked back into the drill, and the tire shaped to a realistic contour with a sandpaper block or an emery board. (Warning: this is a very dirty operation—fine black dust going everywhere—so it is best done outdoors, or at least in the garage.) The wheel is then bushed with 1/16 I.D. tubing, and the hub painted if desired. The wheels are retained on the gear by a soldered or epoxied washer. The landing gear is prevented from dropping from the airplane in flight by means of a small rubber band, stretched between the struts, under the fuselage.

The wing struts are strictly nonfunctional, designed for show, not for go. They are fastened to the wing with a 1/4-inch long No. 2 wood screw, while the lower end is retained to the fuselage by means of a short piece of 1/16 O.D. wire insulation (stripped from the wire) which is inserted into a small grommet set in the side of the fuselage. In case of impact, the insulation will bend and slip out of the grommet, thus saving the strut. Be sure and leave about 1/8 inch between the strut end and the fuselage.

Before covering, it is advisable to make the necessary provisions for installing the propulsion and R/C systems, as this is a small model and one cannot get one's hands inside to do practically anything. So *plan ahead*—carefully! Also, consideration must be given to the distribution of weight so the model will balance properly. Since every modeler may have different equipment, no details are shown on the plan, other than the mounting provisions for the IMP-30 motor, with which the prototype was powered. My JN-1 is controlled with a mini 4-channel receiver, two S-33 servos, and a High Sky off-on controller. The positioning which resulted in the correct balance point location is as follows (but yours may be different!):

Flight battery pack—on the bottom of the motor compartment, just forward of F-1, held in place with velcro.

Rudder and elevator servos—on either side of the fuselage, just aft of F-1, mounted on 1/32 ply pads (shown on the plans) with servo tape.

Motor control—mounted on the aft side of F-1, above the servo arms, held in place with servo tape.

Receiver battery (four 50 mAH)—mounted on the lower hatch, held in place with velcro.

Receiver—mounted on the front side of F-2, at the bottom, held in place with velcro.

After locating the components within the fuselage, it is a good idea to temporarily mount the servos and tail surfaces (hinged with Scotch tape, for the moment), and build and trial-fit the pushrods. On a model this size, a pushrod of 1/32 piano wire and 1/8 square balsa is more than adequate. An idea which worked for me was to fit the pushrods, accurately locate and bend the "Z" bends in each end, then cut the wire near the control surface horn. Then, on final assembly, and after covering, the pushrod can be rejoined with a 1/2-inch length of 1/32 I.D. brass tubing and a drop of solder—outside the covering.

Selection of a covering material for this small model also poses a bit of a problem—the plastic films are all too heavy, Japanese tissue is not strong enough, and the optimum material, silk, is also too heavy unless one can control the amount of dope applied, and not allow the dope to penetrate the pores of the silk. I am aware of two techniques that have been developed to control the penetration; the first—spraying the silk first with a Knox gelatin/water mixture, the second (developed by my old flying buddy Ed Lidgard)—using strips of tissue which have been spread with dope and then pulled across the surface to be doped. I have not tried either yet, but plan to do so soon, as I feel silk is the ideal covering material for small electrics. Another material which comes highly recommended for light weight applications is Coverites's Micafilm—which I have not tried yet either—but will in the near future.

So the prototype was covered with the remaining alternative, silkspan, shrunk with a water/alcohol mixture, and sprayed with three coats of 3:1 thinner/Litecoat dope. A fourth thin coat was brushed on to hold the colored tissue, used to duplicate the color scheme of the original. This technique was devised by the late Walt Mooney, and is described in detail in his article on the JN-1, in the February 1989 issue of Model Builder.

The windshield, side, and rear windows are made of the thinnest semirigid plastic you can find (it is very heavy stuff). I was forced to settle for a .005 thick vinyl "report" cover, obtainable at most office supply stores.

After the tail surfaces are covered, doped, and decorated, the rudder and elevator can be hinged. On a model this small, the use of polypropylene plastic strips is the easiest and lightest method. I used "Radio South" brand material cut into 1/8-inch wide strips 1/2-inch long. To use, make a cut about 1/4 inch deep in the surfaces to be joined, insert the strip into each surface, and put a drop of CA into the joint. The paper covering on the polypropylene draws the CA into the hinged surfaces by capillary action, and there they stay. It is best to flex the hinge back and forth a number of times before installing on the airplane.

FLYING

With the equipment installed as described above, the prototype balanced about halfway between the CG limits shown on the plan. That this was the correct location was proven on examination of the control surfaces after gliding in after the first flight—the surfaces were exactly neutral! The model, as built, had one unpleasant flight characteristic: it was excessively responsive to rudder inputs. For this reason, the author recommends that only the lower 1/2 or 2/3 of the scale rudder be used. Also, depending upon the motor used, the 3.5 degree downthrust may not be necessary. With the IMP-30, the original model showed no stall characteristics at "burst" power at 2 degrees. Fortunately, this is easy to change—just install the motor mount with a 1/32 inch thicker motor plate support at the top than at the bottom. This method of motor mounting was selected for several reasons. First, it will break away and prevent damage to the motor shaft; second, it will allow the installation of different motors; and third, it does provide a means of thrust line adjustment.

Fly electric! ***MB***