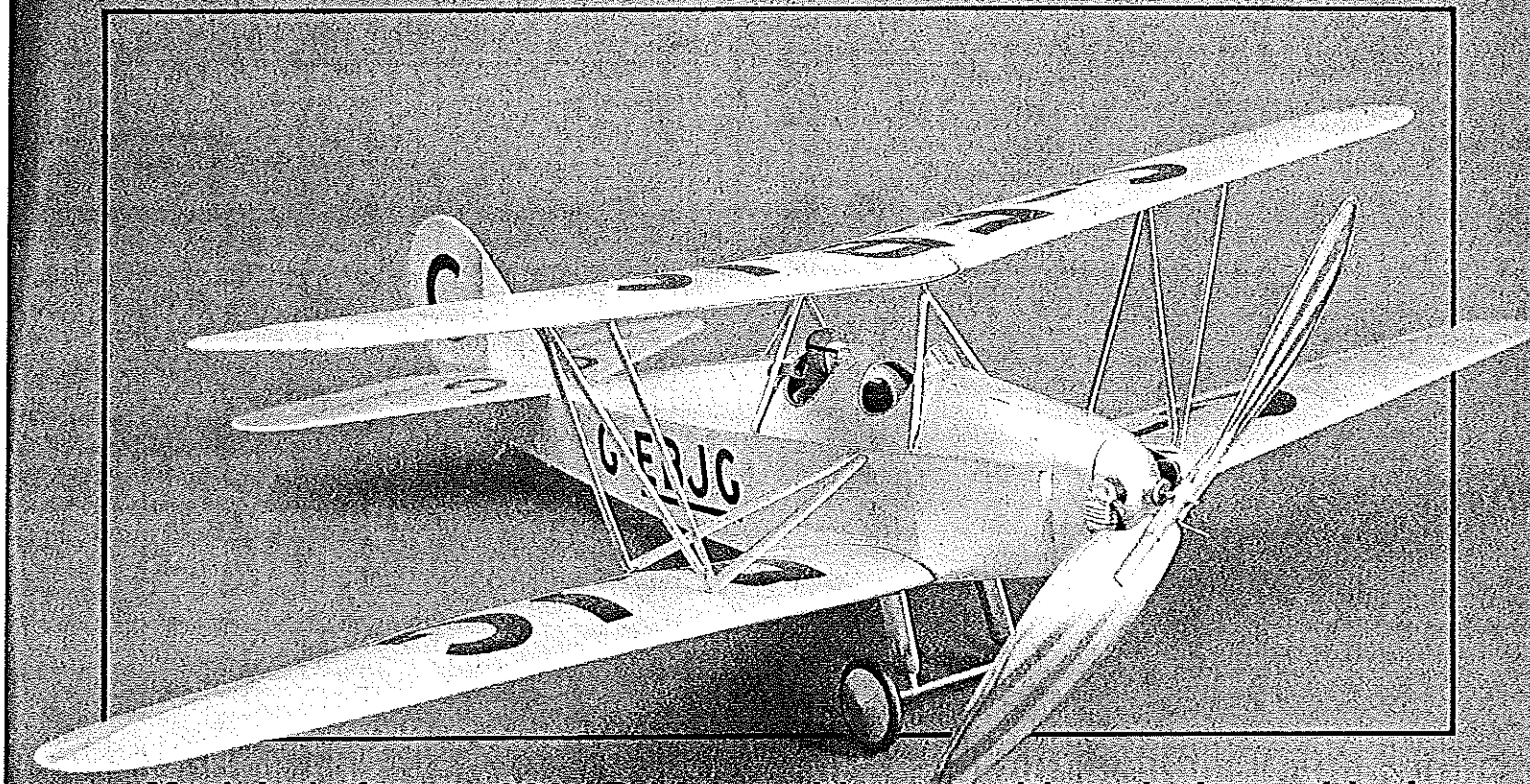


Modeled after a 1920s British multi-competition airplane, this Jumbo Scale rubber-powered model flies (just like the original) as either a monoplane or biplane. ■Bill Noonan.

PARNALL PIXIE

IN 1923 the British newspaper *Daily Mail* offered a prize of 1,000 pounds for an efficient "motor glider" aircraft design, with emphasis on economy. As the governing body for the competition, the Royal Aero Club established the classes and set stringent rules covering minimum engine size, engine displacement, and other specifications. The classes were Speed, Altitude, and Duration, while engine displacement was not to exceed 750cc.

The competition, popularly referred to as the Lympne (pronounced "Limm") Trials after the locale, ran from October 8th through 13th, 1923. With most of the British manufacturers participating, 21 motor gliders were entered in all—a pretty amazing total.

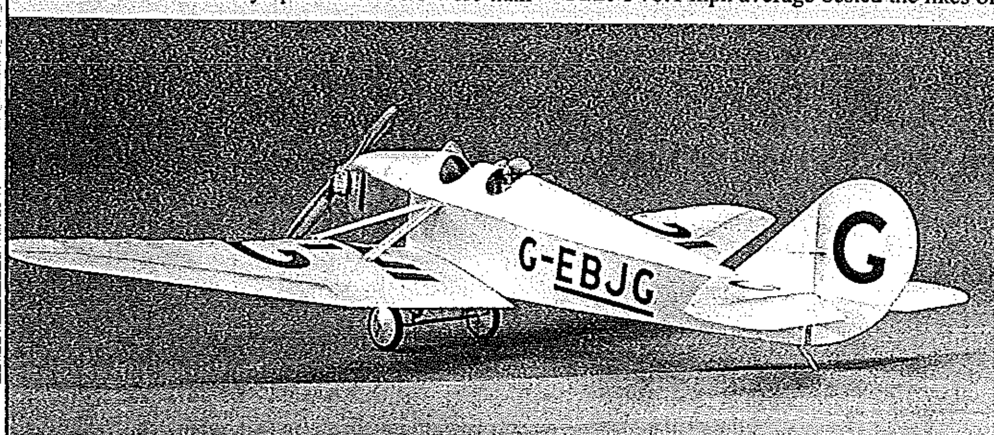
One of the more interesting and unusual designs to emerge from this contest was the Parnall Pixie, the product of Parnall design chief Harold Bolas' conviction that an aircraft with changeable wings and power plants stood the greatest chance of success. The Pixie featured three different wing/engine configurations, each adapted to a specific, Lympne-designated class or event. For the Speed class, Bolas paired the most powerful engine with the smallest wings; for Duration, the most economical wing/engine arrangement was used; while a third option was employed for the Altitude class.

We know for certain that the basic wing/engine configurations were limited to these three, but with the Pixie the quest for variety apparently extended to the airframe

Top: With a top wing noticeably shorter in span than the bottom wing, the Pixie is an interesting looking biplane. Flight characteristics are not appreciably changed with the upper wing in place, but duration suffers from the additional weight and drag. Above: With its silver color, scale propeller, and generous markings in black, the Pixie makes a very handsome subject.

The Pixie in biplane configuration completely changes the character of the design, giving it particular distinction. Top wing duplicates the registration markings found on the lower wing.

The upper wing relies on the cabane strut unit as the primary method of affixing the wing to the fuselage. The interplane "N" struts have wire pegs which engage tubing in the wings.



While not as easy to adjust and trim as a parasol or cabin model, the Pixie's generous rudder and fin do help out. More dihedral would make adjusting easier but would spoil scale looks.

as well. Documentation as to the exact number of different airframes that were produced, however, remains unclear; it's hard to pinpoint what constituted a specific variant among the assorted mutations that came along.

All of the Lympne contenders were hampered by a lack of reliable power plants—a frequent complaint in the 1920s—and the Pixie was no exception. In fact, its problems with clogged fuel lines and recalcitrant magnetos limited the diminutive craft to a single victory. In the Speed event, the Pixie's 76.1 mph average bested the likes of de Havilland, Avro, Hawker, and Handley Page.

After the 1923 Lympne competition, the Pixie was flown as a sport aircraft, registered G-EBJG, and finally assigned to the Aeroplane and Armament Experimental Establishment to be evaluated by service pilots as a trainer. The pilots' unanimous verdict was that although it was generally well suited as a trainer, the airplane afforded inadequate downward vision over the wing.

For its last fling in competition the Pixie returned to its old stomping grounds, Lympne, where the famed Frank Courtney flew it to fourth place in the September 1926 Air Ministry Trials.

The G-EBJG version did survive World War II, and was presented to the Midland Aircraft Preservation Society by its fifth owner. Whether it exists today is not known.

Construction. Before starting construction, it is suggested that you take time to look over the plans, familiarizing yourself with various details such as wood sizes and how individual components fit together.

Fuselage. Covering the plans with wax paper or Saran Wrap before construction will protect them from surplus glue. Note that longerons are laminated from $\frac{1}{16}$-sq. and $\frac{1}{8}$ x $\frac{1}{32}$ balsa. Refer to a typical cross-section detail on the plans. Although this is a bit more trouble than conventional square timber, it results in a much neater covering since the tissue does not adhere to the upright structure except at each end of the fuselage.

After laying the longerons in place, fit in all upright $\frac{1}{16}$-sq. parts. The rubber anchor provision at the rear is faced with $\frac{1}{64}$ plywood for extra strength. The fact that the longeron configuration allows for a $\frac{1}{32}$ detent permits you to set the $\frac{1}{32}$ sheet balsa into the nose sides. This also applies to the plate which the wing root abuts.

Make a right side and a left side, then cement them together at the tail post, making sure that the $\frac{1}{32}$-edge longeron component faces out. Cement in the cross braces at their appropriate stations, starting in the cockpit area. It will be necessary to pinch in the nose last; consult the top view for width.

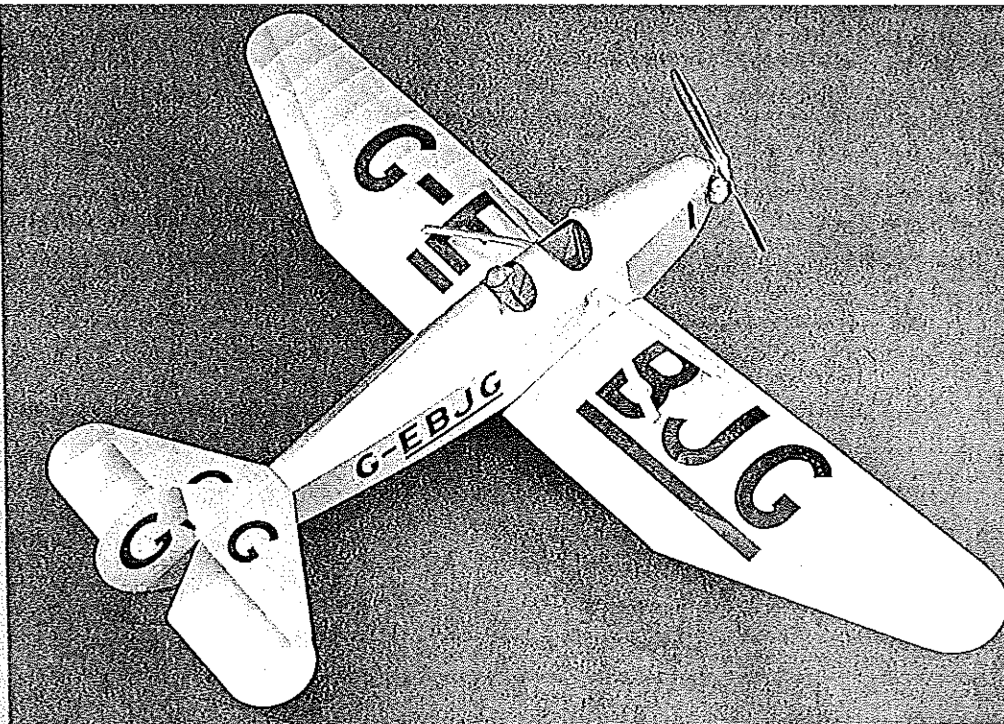
Cut former B from $\frac{1}{20}$ medium balsa sheet and cement in place. Follow the same procedure with the rest of the formers, confirming their width by taking measurements of the fuselage as it tapers toward the tail post. Mark off and file stringer notches aft from former D. A folded piece of 200-grit sandpaper or a small jeweler's file will facilitate this. (If you can't find a small jeweler, it's OK to get a file from a big one!) The forward formers have only one stringer running along the center. These are covered with straight-grained $\frac{1}{32}$ sheet balsa.

Rough-cut the nose block from medium balsa, and tack it in place temporarily with a dab of cement. Finish contouring it to fair in with the fuselage frame lines. When you are satisfied that the nose block is the right shape, remove it and cut it at station A, which separates the thrust button and dummy engine portion from the "skirt" immediately behind.

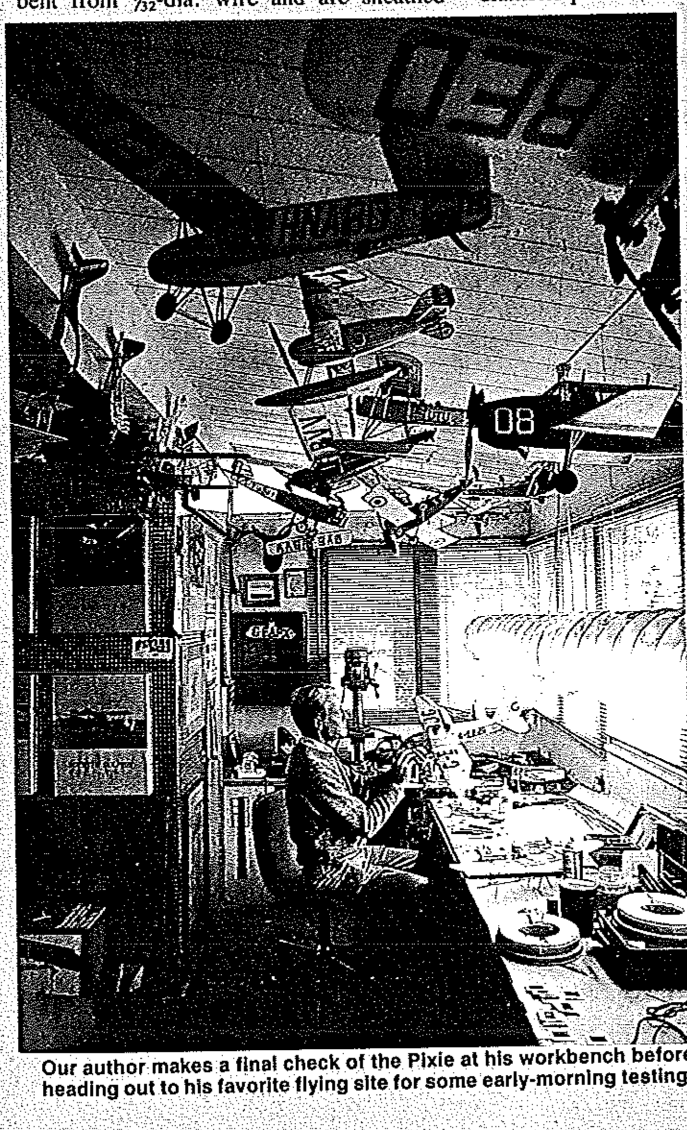
Cement this hollowed-out portion in place on the front of the fuselage frame. Cut former A (this has a rectangular cutout which will eventually receive the 3/16-in. indexing plug) from 1/64 sheet plywood, and cement it in place on the "skirt."

If you want your Pixie to have removable wings, for convenience in storage and transit as well as resistance to breakage if the model should strike a fixed object (like the earth), you'll be incorporating the optional "tongue-and-box" feature, an assembly which is very strong yet doesn't exact a heavy weight penalty. Build the tongue following the pattern on the plans. Make a right and a left tongue by cutting two pieces of laminated material fashioned by cementing 1/64 plywood to 1/20 sheet balsa. Cut slots in the appropriate places to allow passage of the tongues past the uprights on the fuselage sides. Do not cement the tongues in place until you have completed the wings. It will be necessary to slide the tongues into the wing boxes to confirm proper incidence and dihedral before cementing them in place.

The unusual landing gear is easy to install. The parallel single support struts are bent from 1/32-dia. wire and are sheathed with simulated oleo fairings made from light balsa. The spreader is soldered to the bottom of these and utilizes a small-diameter plastic straw to bring it up to scale appearance and also hide the solder joints.



The plan view of the Pixie shows its handsome proportions and moment arm arrangement. The relatively long nose makes it easier to balance the model at the correct center of gravity.


Our author makes a final check of the Pixie at his workbench before heading out to his favorite flying site for some early-morning testing.

If you intend to fly your Pixie from the ground, you can see that the scale landing gear length causes considerable propeller-diameter restriction. On our model we solved this by incorporating 1/32-I.D. aluminum tubes, which were epoxied to the 1/64 ply landing gear bulkhead (LG) inside the fuselage. These allow the parallel legs to be partially withdrawn (about 3/4 in.) for prop clearance. A slight bend in the wire, giving it a friction fit inside the tubing, will provide enough resistance to support the weight of the model.

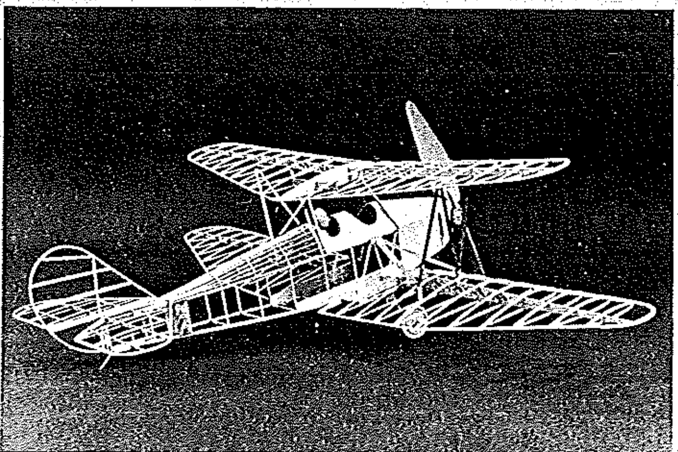
Note a semicircular reinforcing collar of 1/64 plywood at the apex of the landing gear upright pieces on the side view. This surrounds a 1/32-I.D. aluminum tube running across the fuselage which forms a "plug-in" for the lower wing struts. Similar tubes are provided for easy installation of the cabane strut unit. This allows the model to be flown, like the original aircraft, as either a monoplane or a biplane. The centered "trailing" strut functions as a plug-in for a balsa piece in the turtleback.

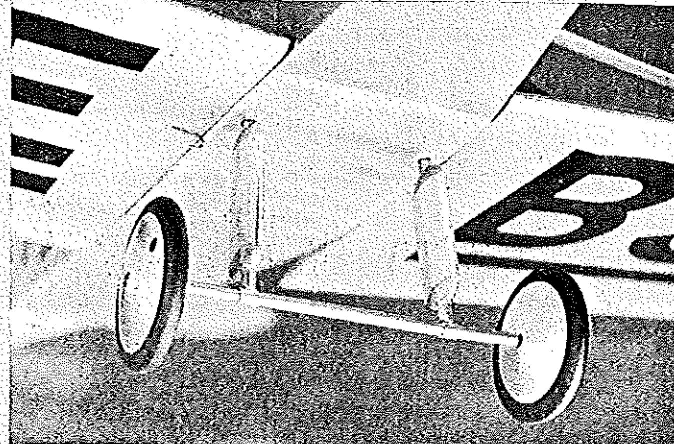
The dummy engine may be made from balsa or basswood. Details like fins and spark plugs can be fashioned from plastic sheet and small-diameter tubing. Finish off the nose block with plastic or wood thrust button. The prop hook should be bent from 1/16-dia. music wire. Our model incorporated a spring-disengaging freewheeler.

The prop consists of two laminated plywood blades, each made by cementing two pieces of 1/64 plywood cut to the appropriate shape and bound tightly to a pine or balsa pitch block. You can substitute a 6-in.-dia. coffee can for the pitch block, binding the newly cemented blades with a discarded rubber motor at an angle of about 15° off the centerline. A 1/4-in.-dia. birch dowel one inch long is slotted at one end and cemented to each finished blade. The dowel is inserted in the 1/4-in.-I.D. brass hub and eyeballed to the correct pitch, about 45° at the center of each blade. Drill the hub with small-diameter holes and force pins into the dowels to prevent the pitch from changing. This type of prop construction, while not particularly handsome, does allow for experimentation with optimum pitch, and for easy replacement of blades as well.

Wing. Cut both wing spars from hard 1/16 sheet balsa. If you're going to build in the optional tongue-and-box removable wing feature, cut a notch at the lower wing root to accommodate the box portion later on. Mark each spar with a pencil at each rib station.

The Pixie wing design is very light and





Left: The framework displays balsa engineering to good advantage. It's a compromise between ultra-light construction, which would sacrifice strength, and an over-stressed structure, which would have to pay a penalty for excessive weight. Right: Landing gear may be removed by sliding the wire legs out of tubing glued in the fuselage. Oleo fairings are hollow paper sheaths with balsa ends. Axle is wire inside a small straw.

strong. There are two options for fabricating the ribs: slicing or laminating. We chose the laminating method for its greater strength. Even though the wing is tapered, it is possible to use a simplex airfoil. This provides a master form of male and female pieces which hold the two $\frac{1}{20}$-sq. pieces together during the drying period of lamination.

This simplex airfoil form utilizes the shape of the airfoil at the broadest chord (about 5½ in. on the lower wing), and merely chops off surplus rib length at the leading and trailing edges to effect a harmonious contour all along the panel. Our rib form was cut for $\frac{1}{16}$ cardboard, the edges of which were waxed to prevent surplus cement from adhering the part to the form.

Construction procedure is similar for both upper and lower wings, except that the lower one utilizes the tongue-and-box assembly, while the upper relies on $\frac{3}{32}$-dia. aluminum tubes for support and panel alignment. These 1½-in.-long "pins" slip inside $\frac{3}{32}$-I.D. tubing cemented in the wing roots. (See detail on the plans.) Both the upper and lower wings are held in place by rubberbands which are stretched between hooks to hold the wing panels in compression.

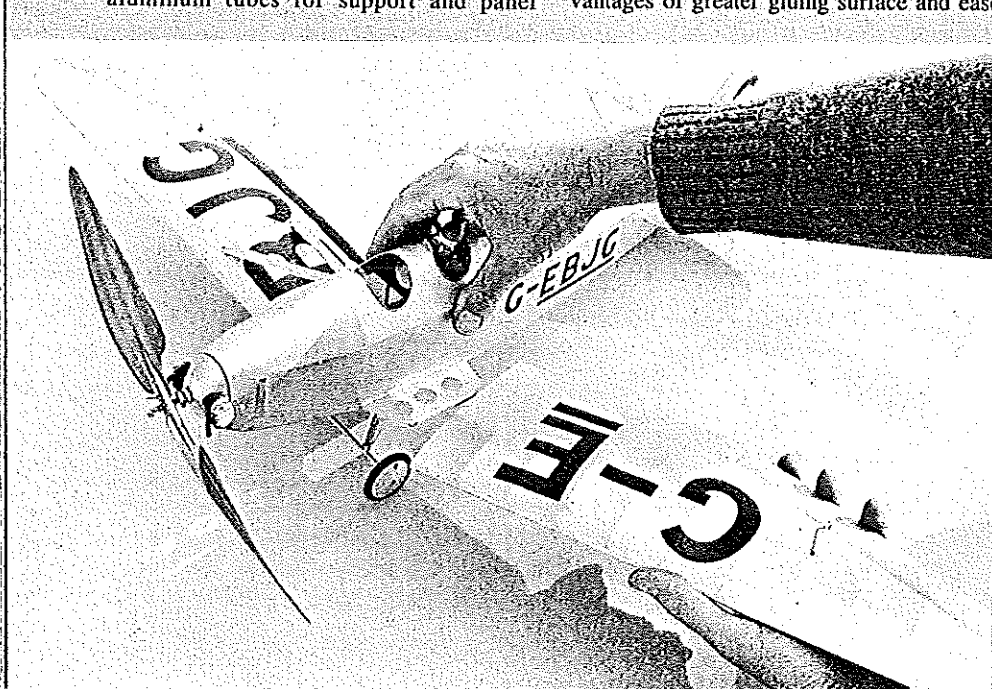
Begin wing construction by laying the respective rib bottoms in place over the plans, trimming them to conform to chord. Secure the ribs in place with pins, but don't pierce the wood. Cement the leading and trailing edges into place. Since the airfoil is essentially symmetrical, it will be necessary to elevate both the leading edge (LE) and trailing edge (TE) above the plans on the upper wing. Next, cement the spars in place. Hot Stuff facilitates this operation.

Notice that the upper rib components are offset when they are positioned. Borrowing from nautical terminology, these could be called "sister ribs." The feature has the advantages of greater gluing surface and ease of fitting.

Tips on all surfaces are soaked and bent from two or three pieces of $\frac{1}{8}$ x $\frac{1}{32}$ balsa strip. Use a waxed cardboard form cut to tip contours as a tool in this operation. Apply white glue between the laminations and allow to dry overnight on the form. Trim the tips and cement them in place, sanding all parts to achieve a smooth contour transition from leading to trailing edge.

Use $\frac{1}{64}$ plywood ribs to make the doublers on the root ribs. This is good insurance against damage in case of a landing mishap. It is important to align the tongue slots carefully so as to assure symmetry of incidence between the right and left lower wing panels. Construct the tongue boxes from $\frac{1}{20}$ sheet balsa. Before cementing each box in place, confirm the box opening by sliding the tongue through the slot in the plywood rib. It should be a friction fit. After attaching the boxes, position the tongues in the fuselage bottom, slip on the right and left wing panels, and eyeball the proper dihedral. Hot Stuff the tongues in place, and remove the wings.

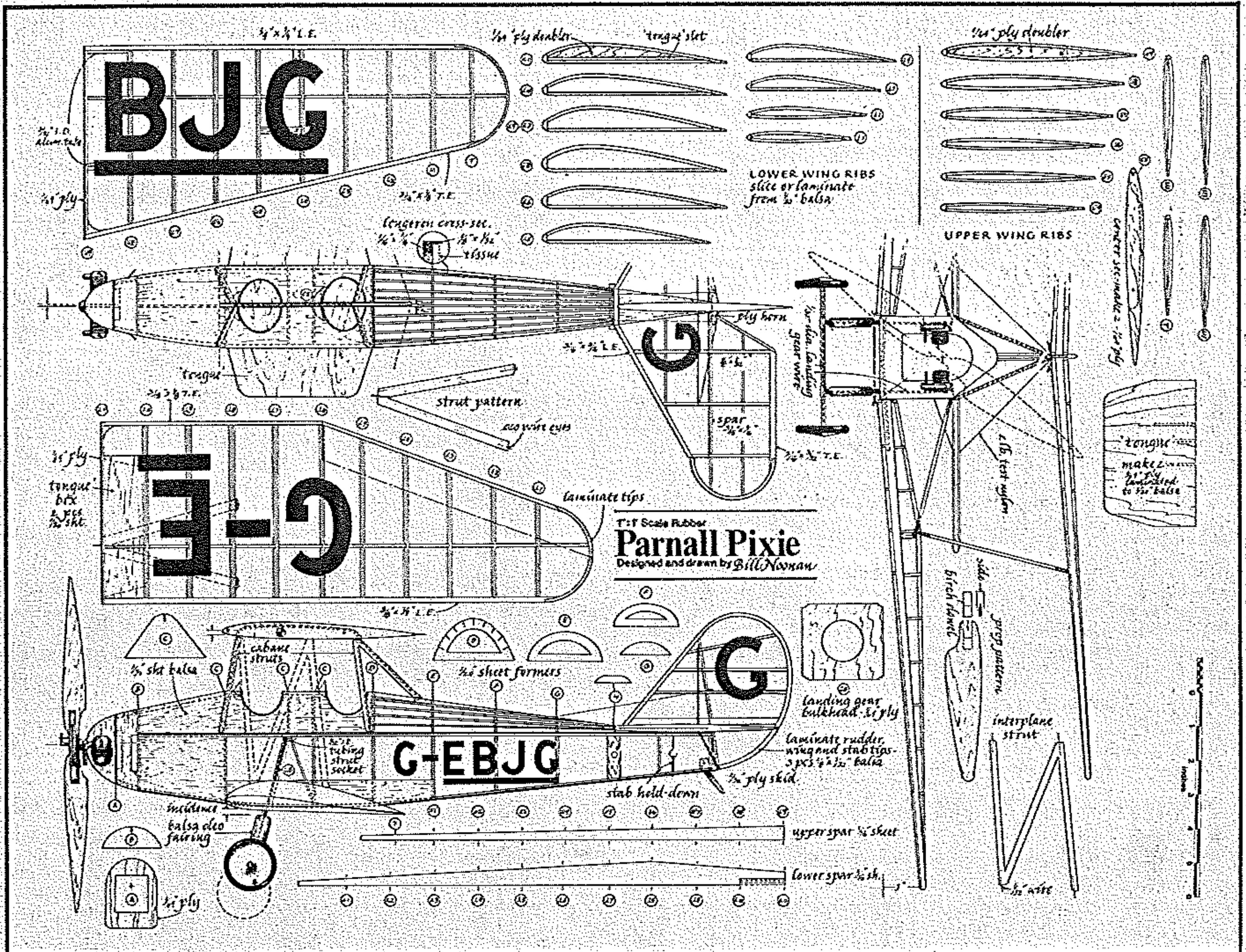
The cabane struts are made from $\frac{1}{32}$-dia. wire bent to shape and soldered. Fairings may be made from either balsa or soda straws. The ribs which form the center section (CS) are really an envelope which slips over the wire and is attached with epoxy. (See the sketch.) As described earlier, the unit plugs into tubing and is removable. When the model is flown as a biplane, the unit is held in place by spring tension. The interplane N struts are fitted with short pins at the top and bottom. These fit into the $\frac{1}{32}$-I.D. tubing cemented into scrap balsa blocks in the wing.



Removable surfaces make the Pixie easy to transport or store, but the main advantage is minimizing damage in case of impact with an obstruction or the ground. The wing panels easily slide onto the "tongues" protruding from the fuselage. Prop is made from laminated $\frac{1}{64}$ ply.

Tail Surfaces. Both the vertical and horizontal tail surfaces are built with the "sprung-rib" method, which we have found to have two advantages: optimum strength-to-weight ratio and resistance to warping.

Position the leading and trailing edges over the plans and secure with pins, but don't pierce the wood. Cement the tips in place. Cut and position the $\frac{1}{8}$ x $\frac{1}{32}$ lower rib components between the LE and TE, with



the ⅛-in. edge lying flat on the plans. Cement into place.

The stabilizer center section should be a triangle of $\frac{1}{32}$ sheet that conforms to the fuselage top view. Add the two trailing half-ribs which run from the center section to the right and left elevator trailing edge.

Cut the spar from hard $\frac{1}{16}$ sheet so that it tapers from $\frac{3}{16}$ in. at the center section to about ⅛ in. at the tips. Cement it in place on the bottom rib parts. The secondary (front) spar is made from $\frac{1}{16}$ x ⅛-in. material. Glue it in place also.

Add the top rib parts, which duplicate the bottom ones. Cement them at the leading edge, allow to dry, then force them down over the spars until they fair in with the trailing edge. Their tension will cause the lower ribs to bend slightly upward, giving a symmetrical section. Glue them in place. When they're dry, remove them from the plans and carefully shape the leading and trailing

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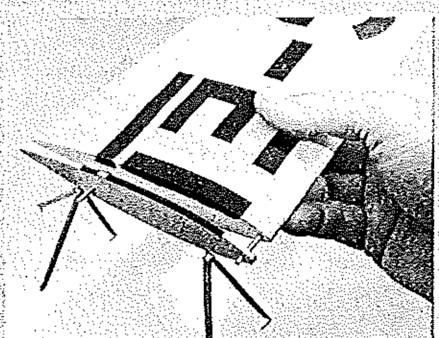

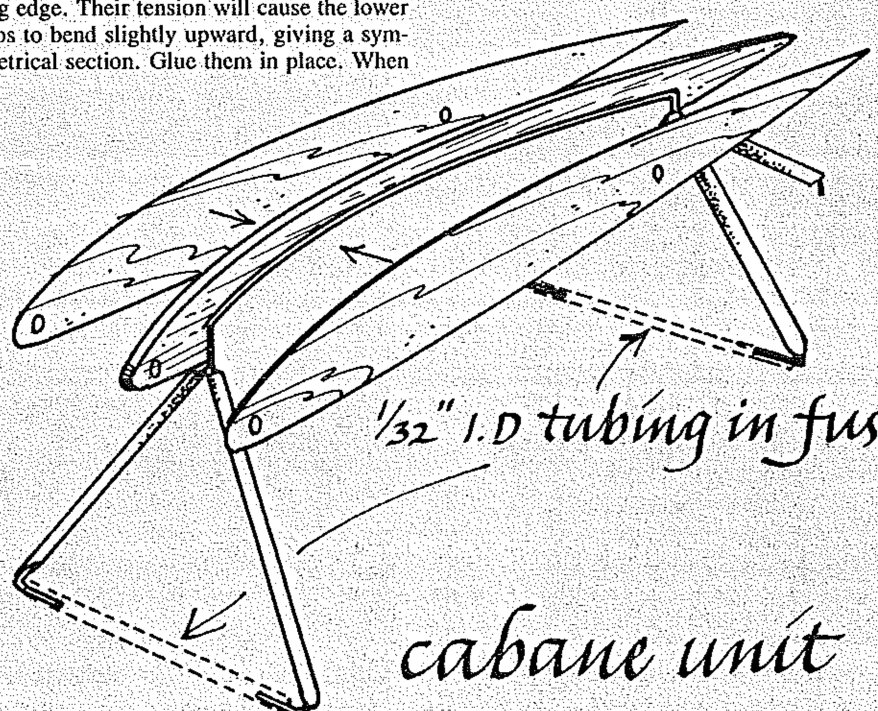

The photo shows the finished product, and the sketch depicts its construction. The cabane "spider" engages tubing in the fuselage sides. The upper wing panels mate against the airfoil rib of the cabane unit and are aligned by the tubing. Rubberbands hold the wing panels together.

$$1.5 \times 14 \times DF \times 1.46$$

$$446.5 - 94DF = 30.66DF$$
$$DF = 3.58$$

The third method for locating the balance point for a canard is to use the classic formulas which were developed by Dr. Joseph Foa for the University of Minnesota in a paper titled *Proportioning a Canard Airplane for Longitudinal Stability and Safety Against Stall* (on file at the AMA Renaud Research Library in Reston). Unfortunately, these formulas require information which is difficult for the modeler to obtain (low Reynolds Number airfoil data); but if they are worked with approximations, they show clearly that the CG range for a full-sized canard is proportionately much larger than that for a model—and this discrepancy illustrates the problem that the modeler is faced with.

Additional clues to successful canard design in Dr. Foa's paper include the utilization of a more efficient airfoil for the foreplane than for the mainplane (a philosophy used by Rutan), and the requirement for a higher decalage angle in a canard (up to 5°).

It is our hope that the information provided by Luther Hux's experiments, supplemented by Dr. Foa's suggestions, will help you to be successful in making your own canard design fly.

Parnall Pixie/Noonan

Continued from page 85

edges to conform to the airfoil.

We added a third piece of $\frac{1}{16}$-sq. balsa by slipping it between the open ribs. While not a true spar, this helps keep the ribs from collapsing and contributes to a better symmetry of section between the spar and the trailing edge.

After covering and finishing, the vertical stabilizer is cemented on the stab centerline. Two .020 wire hooks are cemented in place on the bottom of the stab. The tail unit will be secured on top of the longerons by stretching orthodontist's small rubberbands through apertures in the fuselage bottom and attaching these to wire hooks. Short lengths of bamboo prevent the rubberbands from pulling back into the fuselage. This arrangement not only allows for easy removal of the tail for transit and storage, but also facilitates incidence change, which is important during the adjustment period when flying.

Odds and ends. We covered our model with white Japanese tissue from Bob Peck, shrinking it with a light spray application of rubbing alcohol. When this was dry, and the covering job was free of any unsightly wrinkles, we hit the corners and edges with a light sanding using 400-grit wet-or-dry paper.

Finishing was done with three coats of clear nitrate dope reduced 50% with thinner to a spraying consistency. For the last coat, silver powder was added, in the ratio of about as much as you could get in a common pencil ferrule (the brass collar that holds the eraser) to an ounce of dope.

We used a rather elaborate photographic transfer to make the registration letters; but they may just as effectively be cut from black tissue and carefully cemented in place. Adhesive spray, available at most artist's supply houses, facilitates this application.

The aileron, elevator, and rudder separation may be made either with carefully inked lines or with $\frac{1}{32}$ black Chartpack tape. We airbrushed these by masking with tape and giving the illusion of contouring to the typical leading portions of the respective surfaces.

Our pilot was carved from light balsa, sanded, and given a wood-filler bath. Acrylic colors were used to simulate skin and leather. Goggles were bent from small-diameter wire and carefully dipped in clear dope. Capillary action in the dope closed the elliptical openings, forming the "lenses." It's a lot easier than trying to fit little chunks of acetate.

The "flying wires" which form a diago-

Continued on page 166

nal brace between the fin and stab were made of one continuous piece of 2-lb.-test nylon fishing leader, stitched through the tissue with a fine needle. The control wires which exit the fuselage turtleback at former G are fine elastic thread which has been cemented in place. Loops are provided at the trailing end which engage notches in the 1/64 plywood control horn in the rudder, allowing for unfettered removal of the tail.

We tested our model over tall grass on a windless Sunday morning. You don't need to copy the Sunday morning part, but it's prudent to have the other two elements if you can. We started our tests with the model in the biplane configuration, but soon decided to try out the low-wing option first. It proved a bit touchy about inexact center-of-gravity—if it's too far back you may have problems. Ours required a careful stab incidence change, in small (1/64) increments to the leading edge. If you go too far, the model tends to fly into the terra firma. It should circle to the left when properly adjusted. The symmetrical-section top wing does not alter the adjustments, if it is warp-free.

Our power came from 12 strands (six loops) of 1/8-in. Sig rubber, about twice the length of the distance from the rear peg to the prop hook. You should be able to pack in 1,000 turns. In any event, we recommend using a winding tube when pushing the stretchy stuff to the max.

The Parnall Pixie is unquestionably unique looking in its biplane mode, and might be called handsome as a low-wing. Either way, it makes an interesting and rewarding project.

Scale Masters/Root

Continued from page 94

During a lunch break, Ron Gilman demonstrated two Bob Violett Models fan jets. The performance of these beautiful high-tech models was absolutely breathtaking, with high-speed passes of better than 160 mph. In fact, Ron set an unofficial speed record of 169.7 mph with this aircraft.