Hummin'bird

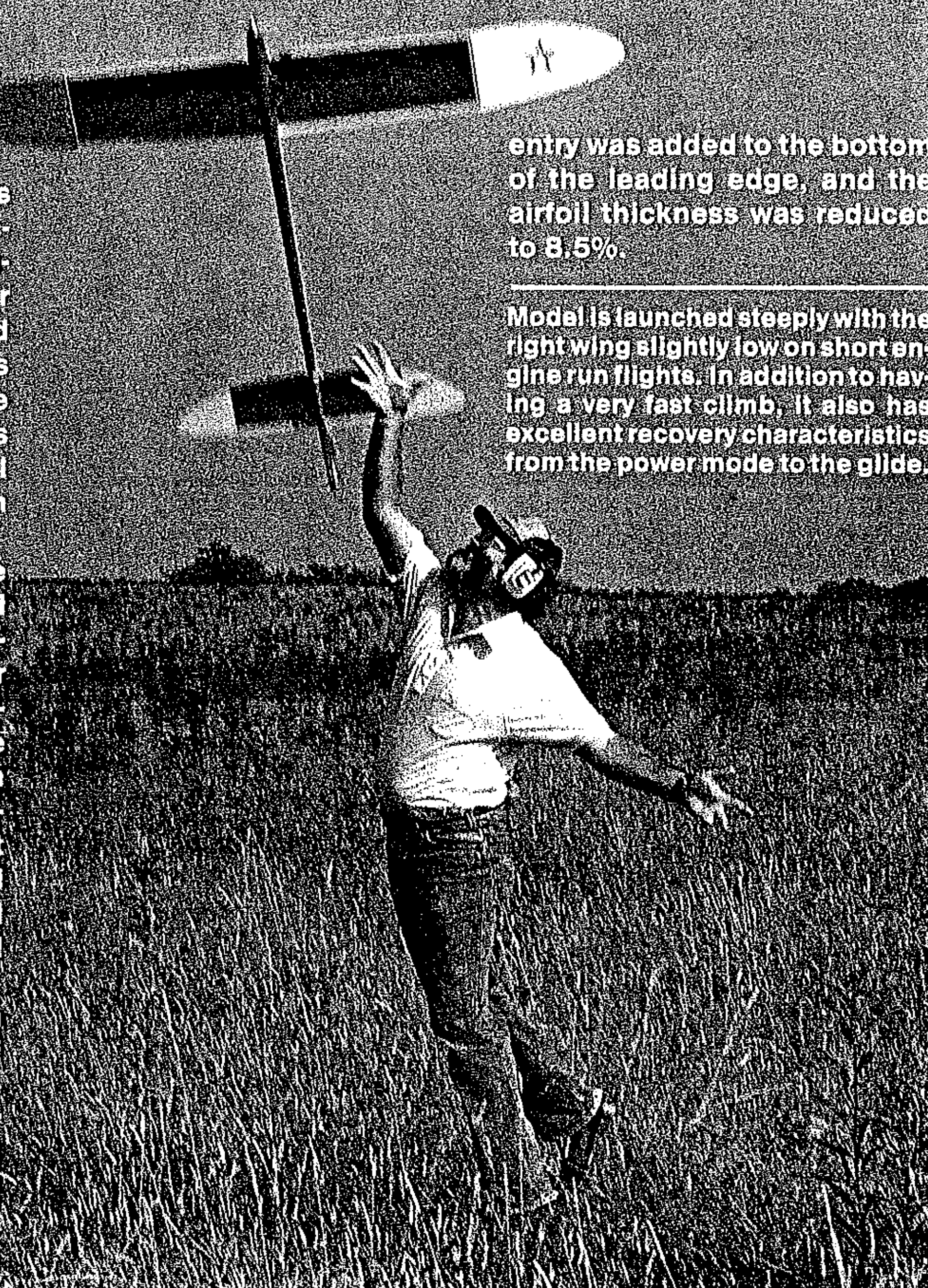
This distinctive green, white, and deep orange model ran away with the Free Flight Class B Power competition at last year's National Contest. Its high climb and floating glide made even the 4-sec.-run maxes look easy. ■Charles Caton

"WHO SAYS green airplanes don't fly?" That was the reaction of an enthusiastic youngster from the Midwest after watching the green-winged Hummin'bird retire after its 13th max at the 1985 Nats. The model is mostly green, but its swept-back, partly-elliptical wing tips and stab make it even easier to pick out in the sky.

This latest version of the Hummin'bird has developed into an exceptional competition plane that is even better than its record-holding predecessor of two years ago. The original design evolved from talks with Alabama Free Flighter Buckets Johnson about wing/stab relationships and those airfoil elements that will produce a fast climb and still permit a good glide.

The first design turned into a good airplane, but I wanted better stall recovery and a little more power for the climb. After this first version was lost in a Pensacola contest, I got a chance to make changes on a new ship. The center of gravity was moved from 75% of the wing chord to 68%, the dihedral was reduced, and the moment arm was shortened. The result was a tight, one-turn recovery from the nasty transition stalls that can sometimes threaten a competitor. The CG and dihedral changes improved the glide considerably, and the plane began to float and respond better to marginal lift. The climb was improved by a slightly smaller stablizer and a hotter engine. I also converted to a rolled tube fuselage, which I think is prettier and a lot stronger than a rectangular one of the same weight.

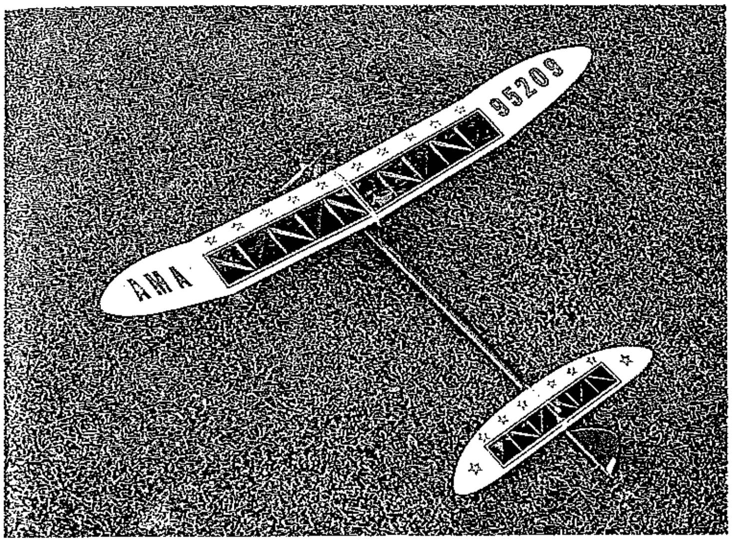
The airfoil on the Hummin'bird is an original section, but it borrows a bit from Clarence Haught's Sea Power (1985 Nats winner in C Gas), which has an excellent glide, with modifications for a faster climb. The high point was moved back, the front crest was lowered, entry was added to the bottom of the leading edge, and the airfoil thickness was reduced to 8.5%.

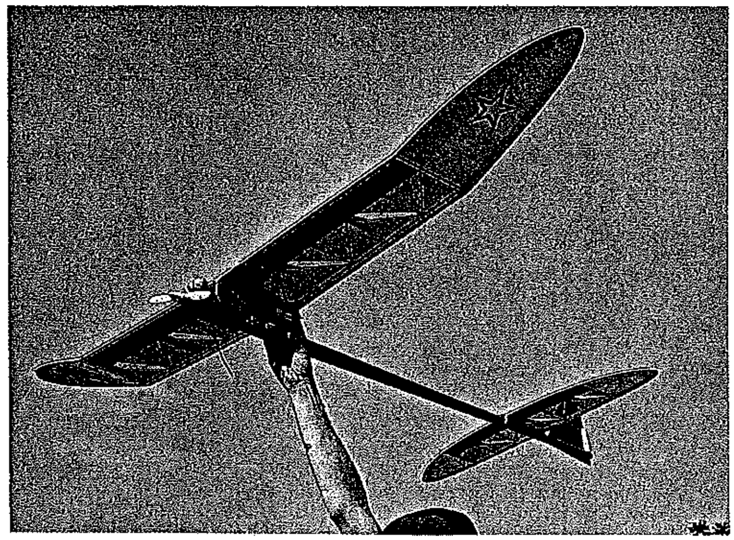


Model is launched steeply with the right wing slightly low on short engine run flights. In addition to having a very fast climb, it also has excellent recovery characteristics from the power mode to the glide.

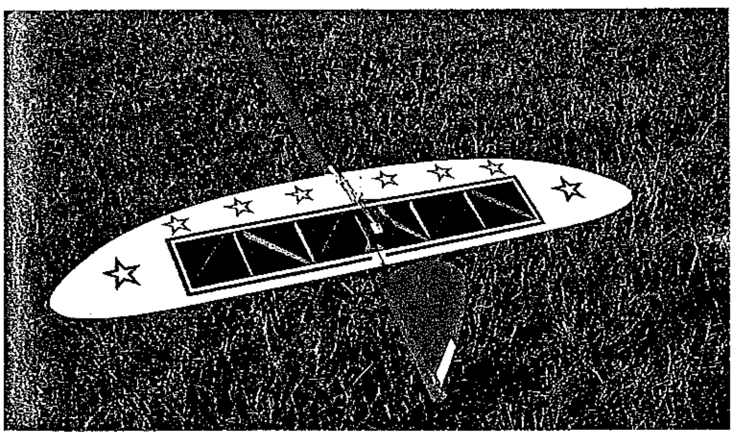
This plane is designed for a variable-incidence stab and an auto-rudder; it requires a large amount of negative stab incidence in the glide. This stab setting, which is permitted by the CG placement, is responsible for the model's good recovery characteristics—in conjunction with rudder turn. Stab tilt won't do the job on this plane, and a version of the Hummin'bird without VIT/AR should not be expected to fly without significant changes.

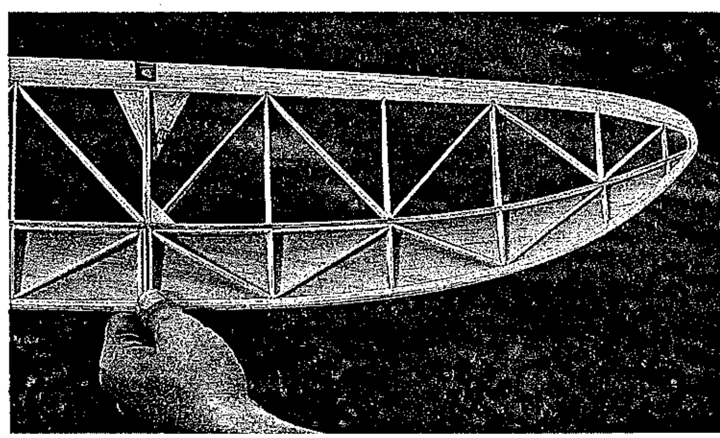
The 3.5 engine is set up on a flat backplate mount at 0°—no side thrust or downthrust. Under power, the angular difference betwen the wing and stab is set at about 1½°, and a slight amount of left rudder is necessary. The right main panel of the wing has 3⁄16 in. of washin, with all other panels being flat. The washin adds a left rolling action and helps keep the plane's nose up when it turns right under power.



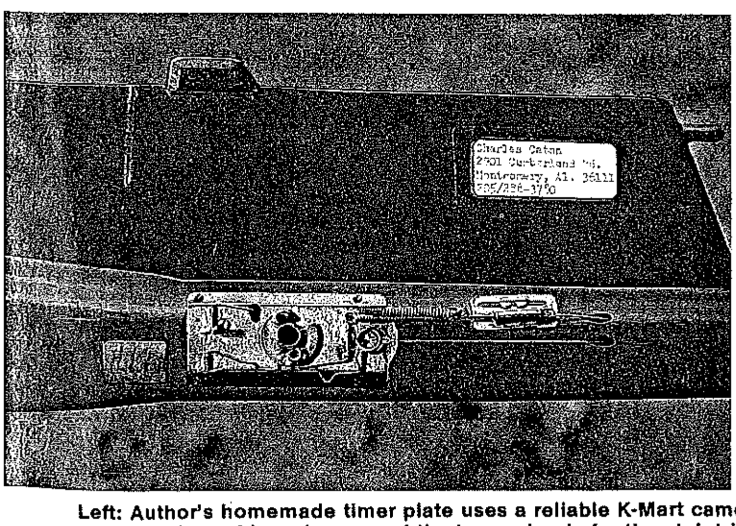


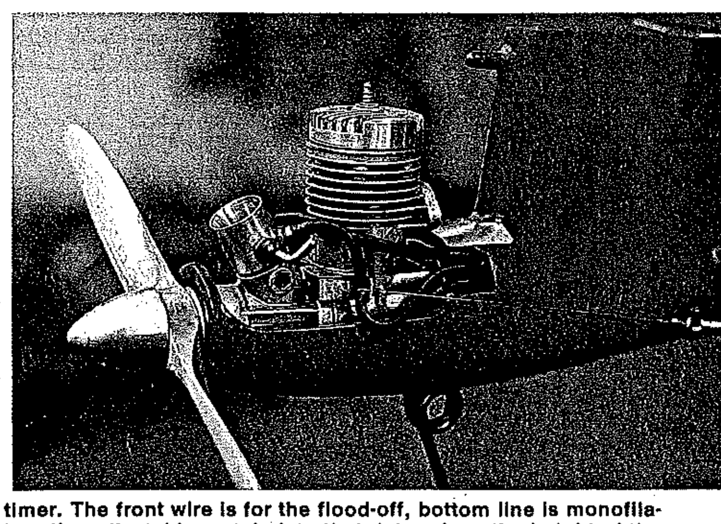
Left: This view shows the clean lines of the model and its small tubular fuselage made of rolled balsa with carbon fiber stiffeners running lengthwise between the balsa laminations. Right: Though hand-held here, this is about what you'll see while the model is in flight, distinguished by the swept-back elliptical lines. Green panels show up well against the sky, and white wing tips are easy to see in grass.



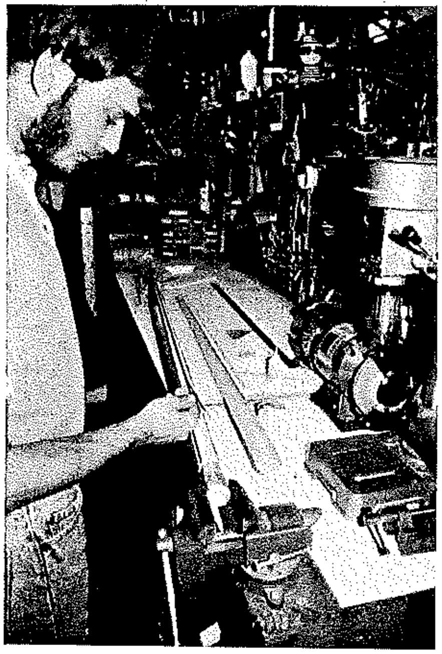


Left: The colorful stabilizer houses the dethermalizer fuse snuffer tube. The stab VIT line is released from this end for dethermalizing, with the stabilizer sliding up the line. Right: Stab construction must be beefy with the thin airfoil. The curved trailing edge is made by slitting the balsa, bending it around pins, and gluing. This is a stab for the lighter Class A version. Before covering, it weighed 19 grams.

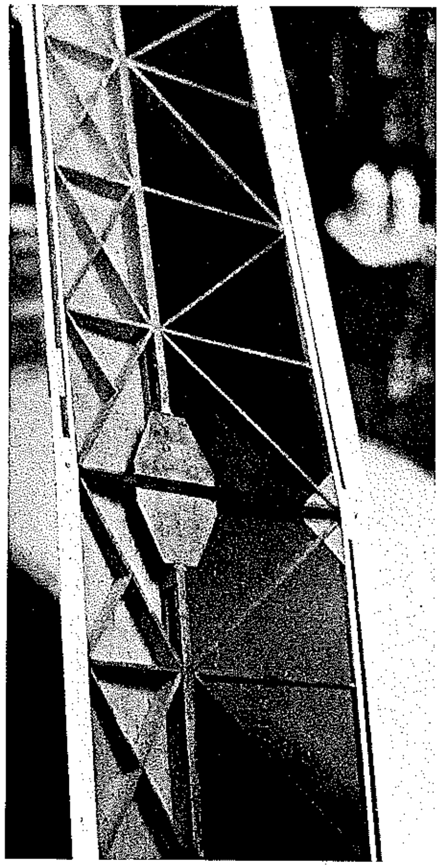




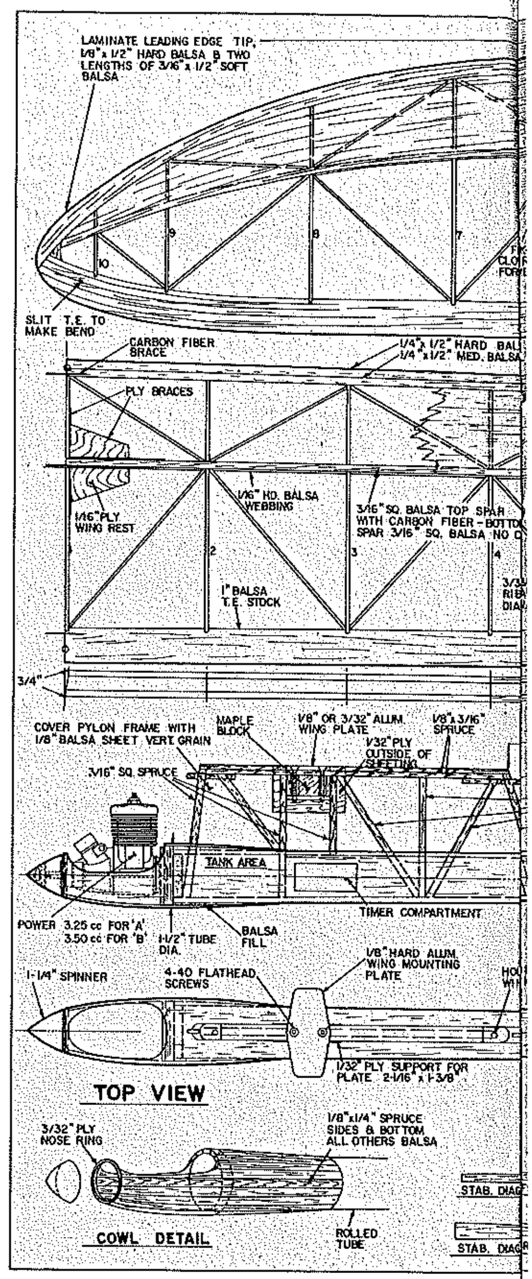
Left: Author's homemade timer plate uses a reliable K-Mart camera timer. The front wire is for the flood-off, bottom line is monofilament for the rudder release, and the top spring is for the stab trip. Note the adjustable metal plate that determines the height of the stab trip. Right: Hummin'bird's half-cowl produces a neat front end that helps in streamlining. Note the restraint line for the flood-off attached to the engine. Oversized intake maximizes power benefits of a pressure fuel supply. Landing skid fits behind the backplate mount.



Rolled-tube fuselage under construction. Carbon fiber strips are being applied to the 1/16 sheet balsa. Second lamination already has been shaped for sliding over first layer.



The wing framework as seen from the underside. Extra front diagonal brace usually is not needed, but it was added in this instance because the balsa was lighter than usual. The top spar is laminated with carbon fiber.



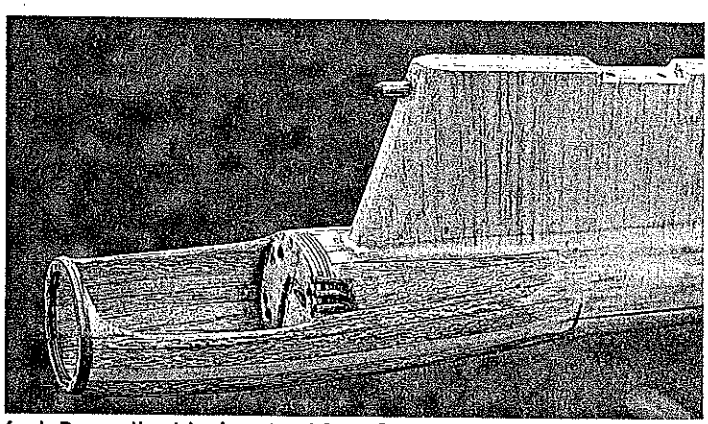
The glide circle is medium-large to the right. The Hummin'bird was designed for Cat. III flying where a fast climb is essential, but it has the kind of power pattern that will hold for longer engine runs—and the kind of glide that will give many other designs a hard time in the other categories.

Fuselage. The rolled tube is strong, crush proof, light, and will not warp. I make the tube 48 in. long from two sheets of 1/16 x 4 x 48-in. A-grain balsa. The final weight of the tube will be slightly more than the weight of the two sheets you started with. I use sheets weighing 24 to 28 grams, and the completed tube comes out at 55 to 60 grams. Following is the procedure for making the rolled tube fuselage.

Coat a pool cue stick with neutral color shoe polish wax; clamp the big end in a vise so that the stick can be used as a mandrel. Spray one side of one of the balsa sheets with water (one of your wife's spray bottles is handy for this). Let it soak for a few minutes, then spray again. When the balsa is pliable, mold the sheet around the stick; use light pressure so it won't crack. Restrain the wrapped balsa with several 6-in. strips of masking tape (the tape will stick to itself but not to the wet balsa), and then wrap the balsa with an elastic ankle bandage (I remove the masking tape as I wrap). The wood will dry in about three hours. You will need two of these molded tubes, which we will call A and B.

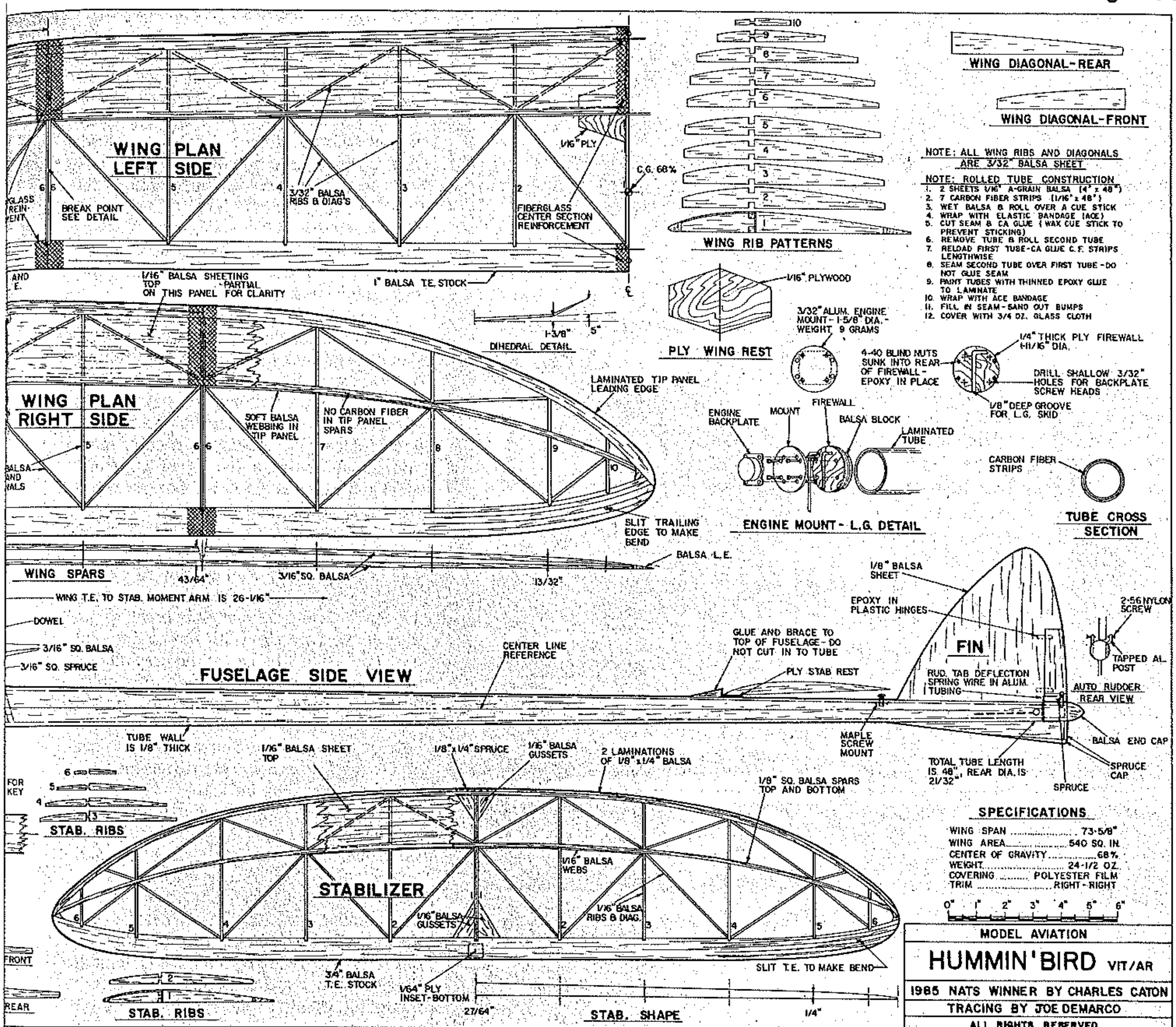
Remove the bandage. Lay a metal straightedge along Tube A where the balsa overlaps, and cut through both layers. Remove the excess wood, and slide the tube slightly up the mandrel (pool cue) to get the best fit of the seam. In this position, fasten the edges together with cyanoacrylate glue (CyA). Remove the tube from the mandrel by gently twisting back and forth (it probably won't be straight).

Feed the tube back onto the mandrel; sand the seam, and fill in any gaps with soft



Left: Author fills the homemade metal tank with 1¼ oz. of high-nitro fuel. Decorative trim is cut out from Super MonoKote. The main MonoKote covering must adhere well to all balsa surfaces (using moderate pressure from a hot iron) to prevent warping. Modified geodetic wing construction provides the needed torsional rigidity. Right: Under construction, you can see the half-cowl details. Strip wood is bent around the firewall and attached to a ply nose piece that was temporarily glued to the back of the engine spinner for alignment.

Full-Size Plans Available . . . See Page 164



balsa. Then cut seven strips of pre-cured carbon fiber 3/32 in. wide by 48 in. long. CyA-glue the strips at evenly-spaced intervals to run the length of the tube in straight lines. Sand the strips with a 220-grit block.

Slide Tube B (dry but uncut) over Tube A. Pull it together tightly with masking tape, and cut a seam where it overlaps, limiting the cut to ⅛ in. deep. Remove Tube B, and paint the inside of it with slow-curing epoxy thinned (with denatured alcohol) to the consistency of thick dope; paint the outside of Tube A with two coats. Slide Tube B back over Tube A, and wrap with the elastic bandage. The seam will not meet perfectly everywhere, but ignore this and let the lamination cure at least overnight.

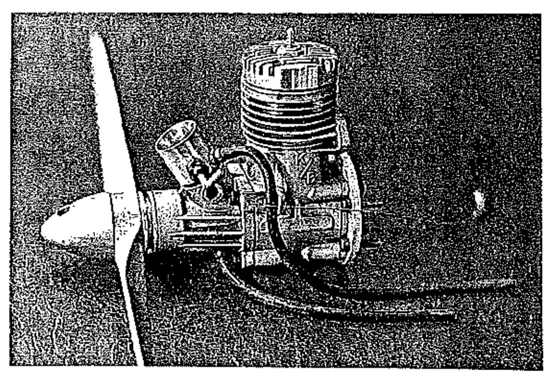
Remove the bandage the next day, and fit soft balsa into the seam gaps. Sand it, leaving the seam full of balsa dust; apply CyA glue. You will notice some little longitudinal humps caused by the imbedded carbon fiber strips. Hold 180-grit sandpaper in one hand, and twist the tube with the other hand to sand around the circumference (be careful not to let the sandpaper edges gouge the wood).

To finish the tube, first coat it with two coats of dope. Mist-spray a sheet of ¾-oz. fiberglass cloth with dope so that it will cut easily with scissors. Stick the cloth to the tube with thinner. After this dries thoroughly, apply one or two coats of clear epoxy paint to fill the grain in the cloth. The entire tube-building procedure can be done in two to three hours of working time, but you will have to find other things to do between the different steps.

In setting up this round fuselage, draw a centerline down the left side of the tube. You will need this reference for mounting the firewall straight and setting the correct incidence in the pylon.

Engine and mount installation. The power plant needs to be installed first. Cut a 1 11/16-in. dia round firewall from ¼-in. plywood. Cut a backplate mount of 1⅝ in. diameter from 3/32-in. aluminum plate. Remove your engine's backplate, center it over the aluminum mount, mark the four backplate holes, and drill them to size. Attach the backplate and the newly-drilled mount to the engine for checking the fit.

Locate four points near the edge of the mount where you can drill holes to attach the mount to the firewall—far enough from



Close-up of the K&B 3.5 engine shows the radial backplate mount and shaved lugs. Bottom tubing is attached to a pressure tap that lines up with the crankshaft opening.

the engine so the heads of the hex screws will clear the side of the engine (this puts the screw heads almost to the edge of the mount). Remove the mount from the engine, and drill the four marked holes for 4-40 hex bolts. Then align the aluminum mount over the firewall. Drill through the firewall (using the mount as a guide), and put 4-40 blind keeper nuts behind the firewall. It's a good idea to put some Vaseline in the nut threads. At some point you will have to drill shallow holes in the firewall to make room for the heads of the engine backplate bolts.

Provisions for the fuel tank should be made before going any further. I built a round metal tank to hold 1¼ oz. of fuel. It has a pressure line at the front top and two lines going to the bottom rear—one for fuel feed and the other for the engine flood-off. If you prefer a pen bladder or pacifier tank, you should build a fuel-proof compartment in the tube at this point. Seal the wood with epoxy glue, and cover the well with clear epoxy paint, as the glue will not stand up to raw high-nitro fuel.

To install the firewall system, first cut a ½-in.-thick hard balsa block to fit snugly inside the tube, and epoxy the block to the rear of the firewall. With the engine and mounting plate attached to the firewall and a straightedge mounted in place of a prop, align the engine with the centerline on the tube and epoxy-glue the firewall with the engine still attached. You will have to cut off the engine lugs if you plan to use the half-cowl and backplate mount.

If you don't like the backplate mount, a conventional aluminum beam mount will work fine. It will even give you a front end that is not so crowded, but it will also be about 20 grams heavier. If you convert to a beam mount, note that you will need to shift the pylon forward about 5/16 in. and shift the tail surfaces forward by the same amount to maintain the same moments. With either mounting system, I bend a skid with an L on top and sink it into the firewall; it is held in place by the mount and will not twist.

Pylon. Build it over the plans, noting that the four main supports are made of spruce and go all the way to the bottom of the tube. The aluminum wing plate, which I bevel on the underside edges, improves the streamlining over the traditional full-length wood mount. It is held to the pylon by two 4-40 flat-head screws countersunk into the aluminum and anchored into blind nuts (or a small threaded aluminum bar) inside the pylon.

The pylon skeleton is sheeted with ⅛-in. medium balsa, and two small 1/32 ply doublers are added outside the sheeting underneath the aluminum wing plate for support. The top of the pylon has small plywood insets at the front and back to accept holes for the blind wing keys. The pylon is longer than the wing chord to allow the wing to find its natural resting place when tied down with rubberbands; it should be keyed in this position.

Continued on page 152

and painted black.

When all the finishing touches have been put on, it's time to attach the engines. Make sure you put the offset washers under both engines (as per the plans) to assure proper line tension. If you have any doubts about your engines, put the stronger one on the inboard side. After mounting the engines, check to be sure the model balances at the CG point shown on the plans. Balancing in front of this point (nose-heaviness) is okay, but add nose weight if it balances aft of it (tail-heaviness).

Flying. Use 35-ft. steel lines. Start the inboard engine first, then the outboard one. It doesn't hurt to run the outboard engine a tad on the rich side. With both engines running, top off the fuel on the inboard engine only (this helps to ensure that the outboard engine will run out of fuel first).

With both engines running, the model will jump into the air after a short takeoff run. It flies fairly fast and is reasonably maneuverable. The model has no problem flying on one engine, although maneuvers should not be attempted with one of them stopped.

This model is designed to use two .049 Cox Babe Bee engines, though other varieties of Cox .049 engines could be substituted. In fact, the pictures show different engines. On the first day of test flying, one of the Babe Bees developed a fuel leak, and I replaced the Babe Bees with two other Cox .049s, a Black Widow and a Dragonfly. The replacements provided some extra power and longer running times, though no doubt the plane would fly almost as well with the Babe Bees.

This model has met all of my expectations. I enjoy the sound of the two engines in synch and the ability of this model to make fast laps on the ground by holding down-elevator before taking off. Twins are a lot of fun, and this model is an easy way to try a twin with minimum investment.

FF Indoor/Tenny

Continued from page 74

us can get a completely true-running prop on a single bearing!) Shaft/spar misalignment can be spotted easily from the side as the prop is driven by a few turns in a short motor. Be sure this problem is not caused by the shaft/spar joint having been broken loose. Correct any other problems you find by "tweaking" wherever necessary!

Automatic-centering hooks can be made many ways, but my favorite is shown in Figure 2. The side view shows a traditional round hook with the shaft centerline passing through the center of the hook. The end view shows how to form the back edge of the hook in an "S" curve. This bend tends to force the rubber toward the center of the hook rather than riding up into a crooked knot. The hook is most easily formed using round nose pliers to make the round hook. Dashed lines in the side view show where to grip the hook with conventional needle-nose or duck-bill pliers to form the "S" curve. Align the tips of the round-nose pliers with the shaft centerline and twist clockwise to make the "S" curve. It may take two or more tries to get just the right curve, since music wire tends to spring back. After getting the "S" curve just right, inspect the hook closely to be sure the alignment has not changed.

Use a prop-pitch gauge to measure pitch in both blades and be sure both blades are at the same angle. If the gauge is adjustable, check pitch angles at two or three places on each blade to be sure blade twist is equal in both blades. One of the photos shows an adjustable prop-pitch gauge being used to check setting on a torque-variable-pitch prop. If you care to make your own gauge, note the following features:

1) The prop shaft is provided with a fixed reference point to insure exact measurements.

2) Provision is made to measure blade angle at one-inch intervals. Both blades must be checked at the same radius, and the angles must match closely.

3) The blade-angle protractor should have increments of one degree and be constructed solidly enough to insure repeatable measurements.

Repairs made to damaged prop blades must be carefully made to avoid changes in stiffness of the structure. In particular, application of a skin of glue at a fracture in a prop spar can affect the flaring characteristics of the prop. Cyanoacrylate glue can also stiffen a structure unless used sparingly. Finally, damaged all-balsa blades must be very carefully repaired to restore the exact blade shape. Two other photos show two extremes which illustrate the concepts involved. One is of a Bostonian prop with very deep camber and curvature. Any damage which changes the camber will obviously affect how well the prop runs, as will incautious application of a glue which shrinks, thereby pulling in additional camber. The photo of one of Stan Chilton's Easy Bs gives a clear view of full-length prop spars. Stan uses very soft and light wood, sanded very thin, for prop blades. The full-length spar is necessary to control the blades under power and to allow the model to ceiling-scrub without damaging the prop blades. Repair of this type of prop is very delicate and must be done on the block used to build the prop initially.

Next time! The prop wobble issue will be carried to construction techniques which minimize prop wobble and other inefficiencies.

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Hummin'bird/Caton

Continued from page 80

I use a straightedge to find and mark a top centerline on the tube. Then I lay a straight piece of wood that is almost the thickness of the pylon along the top centerline to sight down toward the tail to aid in checking alignment. When satisfied, I mark on each side of the straightedge and cut through the tube so the pylon will fit in the hole. Note that part of the tube above the tank compartment should not be cut; the walls of the pylon will have to be fitted to the top of the tube in this area, with the two spruce supports straddling the tank compartment.

A very important step is in setting the proper incidence in the pylon. Measure from the top rear of the pylon to the centerline on the side of the tube. This rear distance should be 3 1/16 in. Then measure from the top front of the pylon to the centerline. The front should be 3⅛ in. The most important thing is the relationship of these measurements. The front of the pylon should be 1/16 to 5/64 in. higher than the rear. Get a good pylon fit, making sure the main supports touch the bottom of the tube. Don't glue it in place yet.

Half-cowl. Building it is straightforward and not hard to do. I select an aluminum spinner backplate of the size I want the front of the cowl to be. Make a round plywood nose piece from 3/32 ply sheet, cutting it just slightly larger than the spinner backplate; cut a large hole for the engine shaft to pass through. Tack-glue a 1/32-in. spacer to the spinner backplate. Glue the plywood nose piece to the spacer, and mount the engine, complete with prop. This nose piece will become the front end of the cowl, and it is already in its final position with the proper spinner clearance.

Note that the firewall is larger than the tube. Wrap the tube with a layer of 1/16 balsa to fill in this area, the fill extending about 2 in. back and beveled at the rear.

To construct the cowl stringers, first cut three strips of ⅛ x 3/16 spruce 6¼ in. long. Run the first strip from the nose piece down the centerline on the left side of the tube. CyA-glue it in spots for holding in place, and apply slow-curing epoxy around the firewall and stress points. Repeat this on the right side of the tube and on the bottom. This produces an outline of the cowl that can be filled in with medium balsa. After all the stringers are in, press soft balsa into the gaps, and hold with CyA glue. I usually apply some thin slow-curing epoxy at this point to make sure of the bond, then close in any remaining cracks with a strong filler. Sand the cowl to its final shape with a coarse sandpaper block, bringing the front end down to the size of the spinner and fairing the rear of the stringers into the tube.

Do note that you will have to be able to get an angled Allen wrench between the side of the cowl and engine for reaching the mounting bolts. Plan for this when you bend the spruce stringers around the engine (which now has no lugs). Place a temporary spacer between the side of the engine and the spruce to maintain an access space.

Wing. It is a beefy modified geodetic structure with front sheeting to take the load of a hot climb. The top spar at the wing's high point is medium-hard 3/16 sq. balsa with pre-cured carbon fiber CyA-glued to the top and bottom to make it rigid to resist impacts from dethermalizing.

The ribs are cut from 4- to 6-lb. 3/32 sheet balsa. If you feel your wood is a little heavy, you can step down to 1/16 sheet for the wing tip ribs. The 1/16 top sheeting from the leading edge to over the high point spar should weigh about 11 to 13 grams per 3 x 36-in. sheet.

This is the construction sequence I use. Notch the trailing edge, and pin it over the plans. Laminate the leading edge, and pin it down. Pin the bottom spar in place. Use a piece of 3/16 sq. wood to make sure the notches in the ribs are deep enough, then set the ribs in over the bottom spar. If the ribs are too long or too short, make the adjustments at the leading and trailing edge. CyA-glue the ribs in place, and add the top spar. The end ribs on each wing panel can be slanted to match the angle at the dihedral breaks. If you cut some templates to this angle, you can establish the correct dihedral as you build and eliminate the awful chore of trying to sand it in later.

Add the webbing, but leave it off the center to make room for a plywood brace that will be added later when the wing halves are joined. Fit and glue in the rear diagonals, leaving off the front diagonals for the time being. Mark and cut the 1/16 leading edge sheeting. Tack-glue the sheet at the front and back of each rib, then remove the wing from the plans so you can make sure that the sheeting is straight along the leading edge before the gluing is completed; this will help avoid a washboard effect. Continue attaching the sheeting to the ribs with CyA glue. With the wing upside down, the front diagonals can be cut and trimmed to conform to the contour of the sheeting.

The wing tip construction is the same as the main panel except for making the curved leading and trailing edges. Stick about a dozen pins behind the leading edge plan line, and bend the strip wood around the pins. Add the next lamination, and tack-glue it in place as you bend it around the curve. If you leave the strips with extra length, it can be bent around the curve more easily.

To form the trailing edge, use a straightedge to cut about four slits in the outermost eight inches, and bend these strips, one at a time, around pins. Again, it helps to have extra wood length. Both leading and trailing edges should then be removed and sanded flat before proceeding with the same construction sequence as used on the main panel.

The fitting of the curved top sheeting is easy if you turn the tip upside down over the sheet and use a fine-tip pen to mark the sheet along the curve of the leading edge, then along the curve on the aft side of the high point spar. Cut this out along the outside of your marks, and fit it in place.

After all the panels are built and before they are joined together, roughly trim the leading edge with a knife, leaving enough so you can form the final shape with a coarse sandpaper block. The accuracy of the front of the airfoil is a freehand proposition, and it is easy to become tired of it. If that happens, I put the work aside until later when I'm fresh enough to give it the attention it deserves.

The trailing edge will need some coarse sanding to bring it down to size. The overall sanding and shaping of the wing can be done with a large sanding block about 4 x 9 in. so that the high spots along the diagonals and sheeting can be brought in line with the ribs (which are your only airfoil references at this point). Sandpaper of 220-grit works well for this; final smoothing can be done with 400-grit paper.

Join the tips to the main panels with 5-min. epoxy, then check again for the correct amount of dihedral. If you've made a mistake, you can heat the epoxy with a covering iron until it begins to gas off; then it will release. These outer joints have no brace; just cover the front joint back to the spar with ¾-oz. glass cloth and clear epoxy paint. Do the same on the top and bottom of the trailing edge. I put two coats of dope on the spot to be covered and stick down the glass with thinner. After this dries, use the clear epoxy paint. I double the cloth weight at the wing center section, after inserting a carbon fiber brace in the leading and trailing edges.

Once the wing is joined at the center, cut out the plywood wing support and countersink it 1/16 in. into the bottom of the wing structure. Next, add the main ply dihedral brace, which also serves as the foundation for the wing support. Add the 1/32 plywood braces around the center rib and spars, making sure they extend past the end of the wing support and run almost the full height of the rib. Use epoxy on this assembly, because it takes most of the wing load on dethermalized landings.

Stabilizer. Construction is identical to the wing, but a word about weight might be helpful. I try to use 9- to 11-gram sheet wood for the ribs and top sheeting. It is desirable to have the finished weight of the uncovered stab structure to be under 1 oz. This makes the CG much easier to control. If the stab comes out heavier than you want, cover it with a lighter polyester film; you can reduce the tail weight by as much as 10 grams by choosing the lightest covering.

Setting up the final assembly. After covering the wing and stab, I temporarily mount everything (rudder, stab mount, engine, prop, pylon, wing, and stab) and hold it all together with rubberbands. Place a piece of masking tape over the center of the wing, mark it at 68% of the chord, and hang the model by the rubberbands. Shift the pylon slightly to fine-tune the proper CG, and remember to slide the stab with the pylon to keep the same moment relationship. I set the CG 2% to 3% ahead of 68%, because the paint and final finishing usually move it about that amount.

It's time to glue on the pylon (with epoxy), the stab mount, and the vertical fin. I cover the fin, pylon, and half-cowl with ¾-oz. glass cloth because it is easier to put a good finish on the cloth than it is to cover up wood grain. After sticking the cloth with dope and thinner, I put on one or two coats of clear epoxy paint. After that dries, I mix dope and talcum powder into a fairly thick (but not grainy) consistency and paint on two or three coats. This dries in an hour or less. Sand off the filler with 220-grit paper and repeat the filler application/sanding until it looks smooth, ending up with 320 or 400-grit paper. The fuselage is then sprayed with epoxy color paint to withstand high-nitro fuels.

There are a number of VIT arrangements that will work well. The one shown in the photos is dependable if you pull the rubberbands tight at the stab end—and if you have enough tension on the spring at the timer to hold the stab down under power without stretching the rubberbands that hold the stab trip line and DT release.

No matter which system someone new to VIT chooses, please understand that they all require careful attention to the engineer-in and testing aspects. If it is possible for something to hang up or pull loose, you can count on it happening. Anything that is suspect needs to be changed, and anything that is changed needs to be tested 10 times today and 10 times tomorrow. If you want a faster plane with independent power and glide trim, VIT/AR is the way to go.

Test flying. Make sure the engine is running reliably, and test the flood-off system and VIT again before trying to fly. Check the 3/16-in. washin in the right main panel. Test glide for a slight left turn in the power settings and enough negative stab incidence to keep the plane from diving in the hand glide. Use an instant DT set for a 2-sec. delay, set a 2½- to 3-sec. engine run, and launch high with the right wing slightly low. I trim with the prop I plan to compete with and run the engine at peak rpm, because trimming with slow props and a rich engine means you will have to do it all over again when you start going fast.

When you get ready to let the plane glide, remember that it requires quite a bit of additional negative stab incidence. Mine uses about ¼ in. The rudder should trip to the right for the glide.

I built my first high-performance model from an article like this, and I've loved fast Free Flight ever since. If you decide to build a Hummin'bird, put some green on it somewhere, and help me prove that green airplanes do fly.