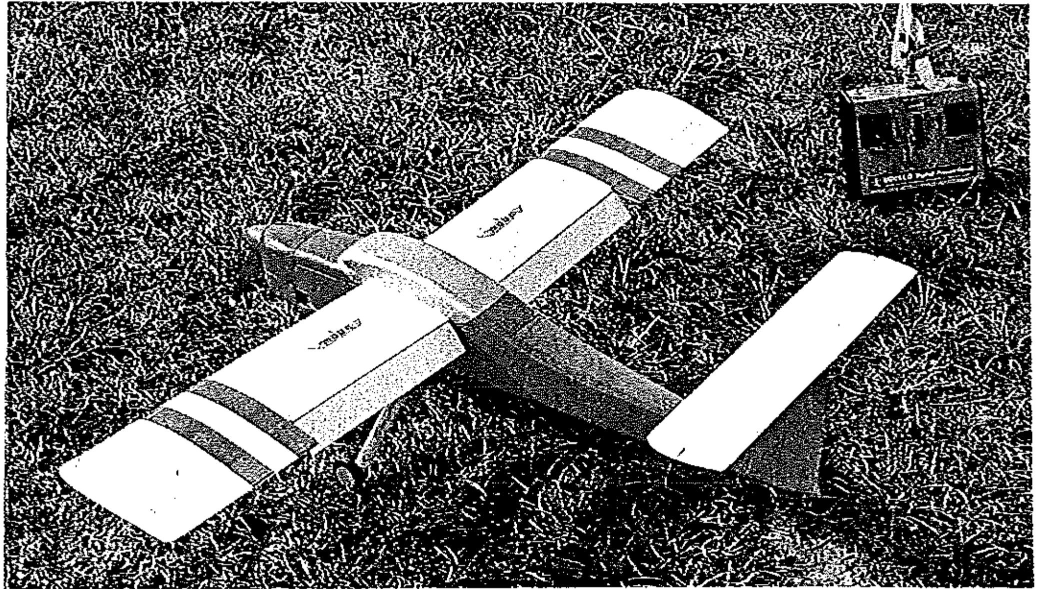
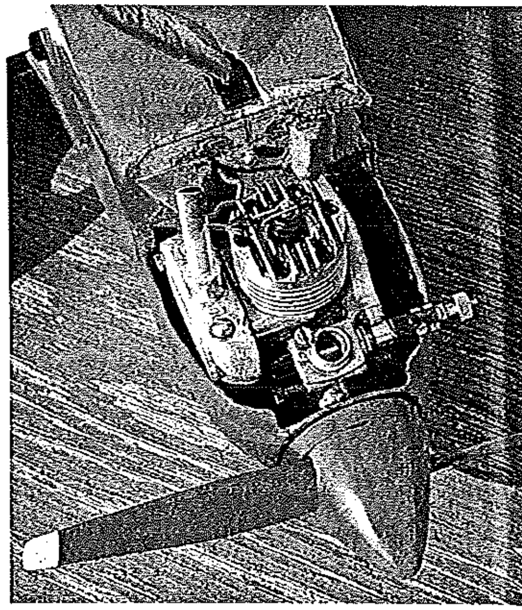
NASA-designed "dropped" leading edge on the wing is just one of the many features of this unique model.

It may be a small package, but it's loaded with innovations that make it as much fun as it is different from the other RC planes on the flight line at your field. ■A.G. Lennon

SPARROWHAWK



The same factors that make this model streamlined also make for landings that can be just a little too hot. Deploying the slotted flaps brings the landing speed to under 20 mph.



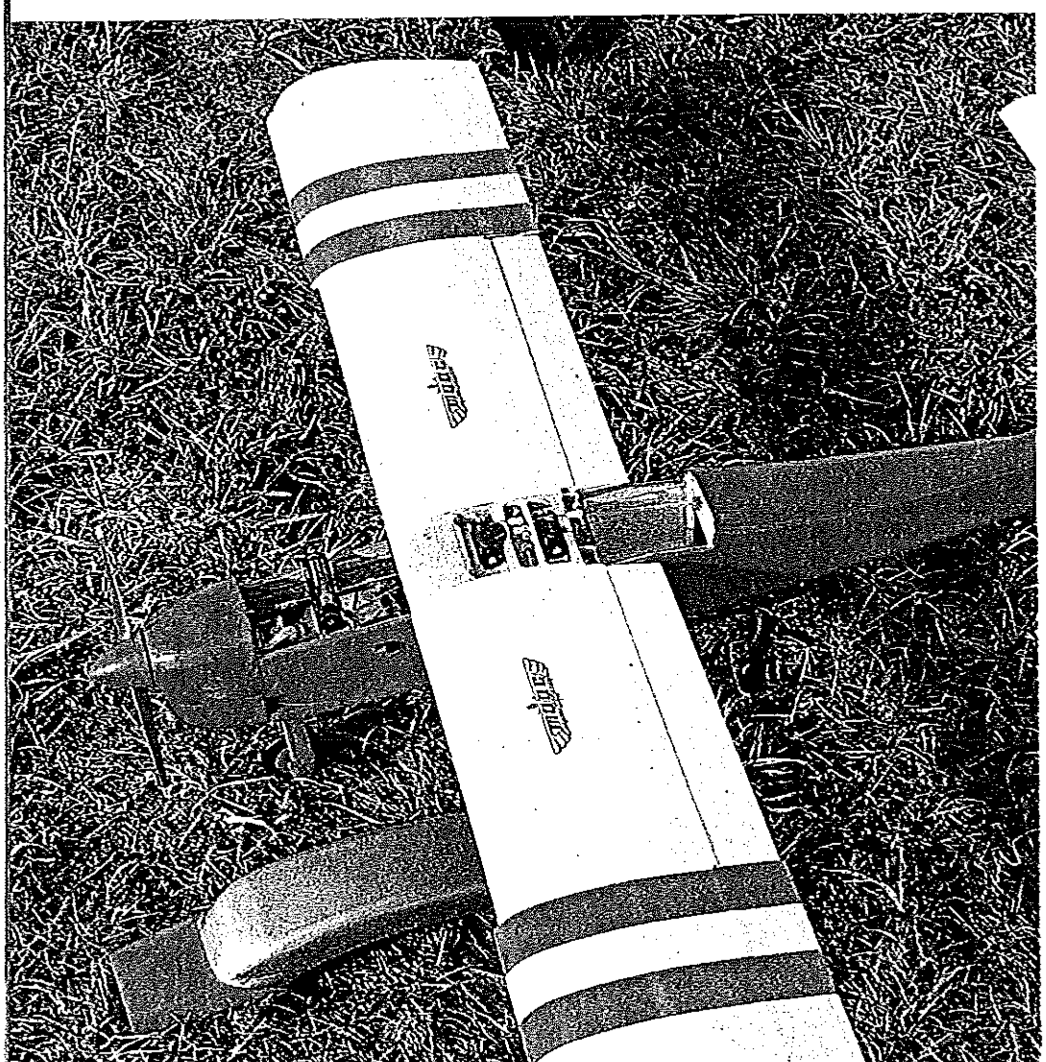
The inverted O.S. .15 and Tatone exhaust manifold fit snugly inside the nose cowling. Note attached clip for the glow plug driver.

THIS IS A FUN MODEL. It is sturdy, small, very agile in flight, easily transported, and readily hand launched. It provides surprising performance on a .15-size engine, and it has a number of unusual features.

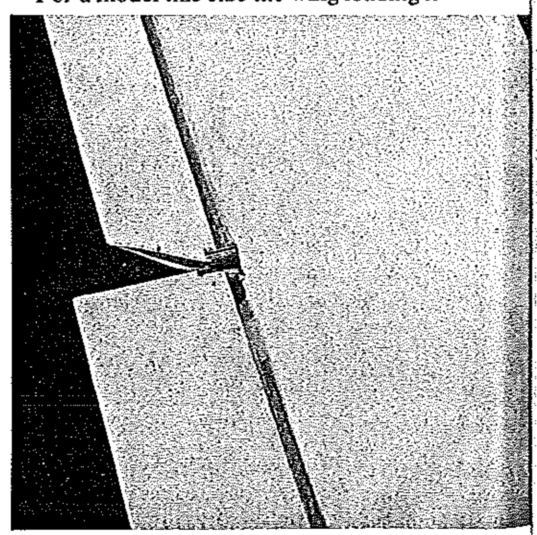
NASA developed drooped outboard leading edges. These delay the stall of the outboard wing panels by an additional 10° with full aileron control, so the model can be flown nose-high, flaps down, and at low engine rpm under full control at very low speed. In a strong wind, it will hover just like its namesake. The Sparrowhawk will spin, but only from a snap roll in a fast vertical climb. The spin lasts two or three turns and then converts to a fast spiral dive which stops promptly on control centering.

Much thought was given to reducing drag. The wing section is the Eppler 193 favored by the glider fraternity. It has low drag at the small Reynolds numbers at which this model operates. The engine is cowled, landing gear legs are faired, and there are no external control horns. The only protrusions are the needle valve and the exhaust stack. Wheels are streamlined.

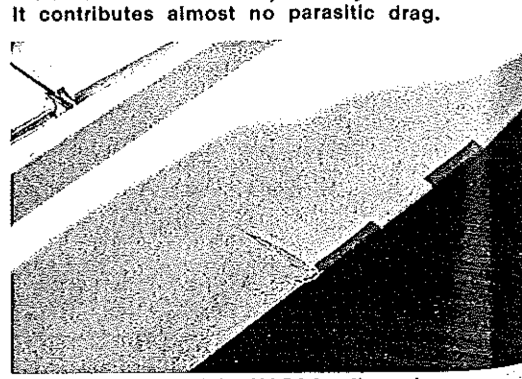
For a model this size the wing loading is



The canopy removes easily for access to the control system and on-board glow plug driver.



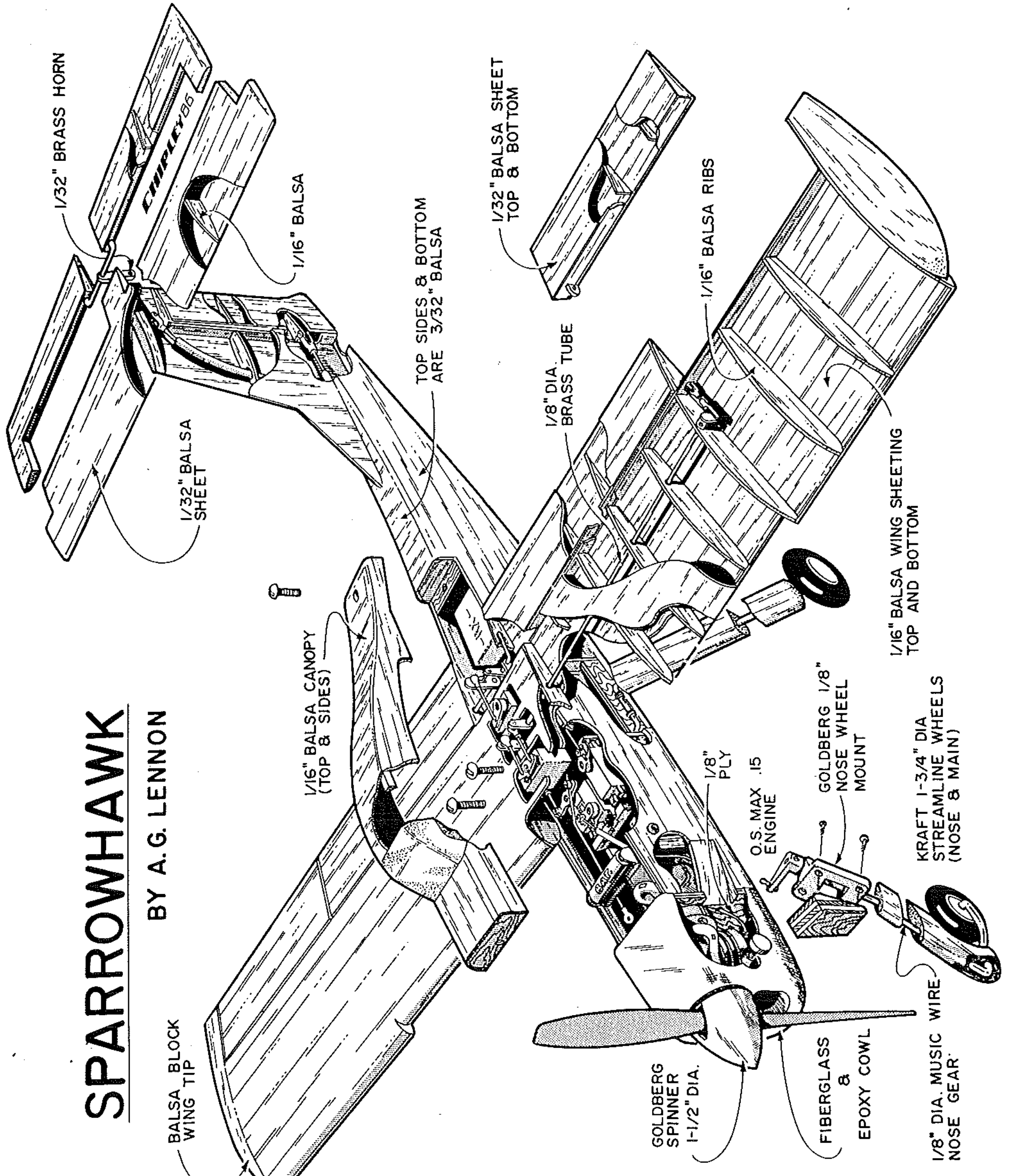
The control horn for this flap, as well as for the other control surfaces, is barely visible. It contributes almost no parasitic drag.



The inboard end of the NASA leading edge wing droop is seen in this view from below.

fairly high, resulting in a fast, flat glide that makes landings difficult to judge. The slotted flaps, when deployed, add drag and increase lift. The aircraft can be brought down at a 45° angle with very little increase in speed and landed slowly in a nose-high posture with full aileron control. Surprisingly few models have flaps, yet they add a new dimension to the fun of flying.

The main landing gear incorporates torsion bars in the fuselage that flex and absorb heavy shock without damage. The nose gear has an internal compression spring that acts similarly. The nose strut shown in the drawings differs from that in



the photos. It has less drag and is easier to fair.

The model features onboard glow plug heating. I favor inverted engines but must admit that, in this position, a good, consistent idle is not easy to come by. Some years ago, after several in-flight engine quits at low rpm, I evolved an onboard glow plug heating system that utilizes an AA-size Ni-Cd cell.

The current to the glow plug is controlled by a roller lever switch which is contact-cemented to the engine servo. At low rpm the switch is depressed by the servo arm, and current flows to the plug. The switch is positioned so that no current flows at high rpm. It is also off when both transmitter engine lever and trim lever are at the lowest position (engine cutoff). A separate on/off switch is not required.

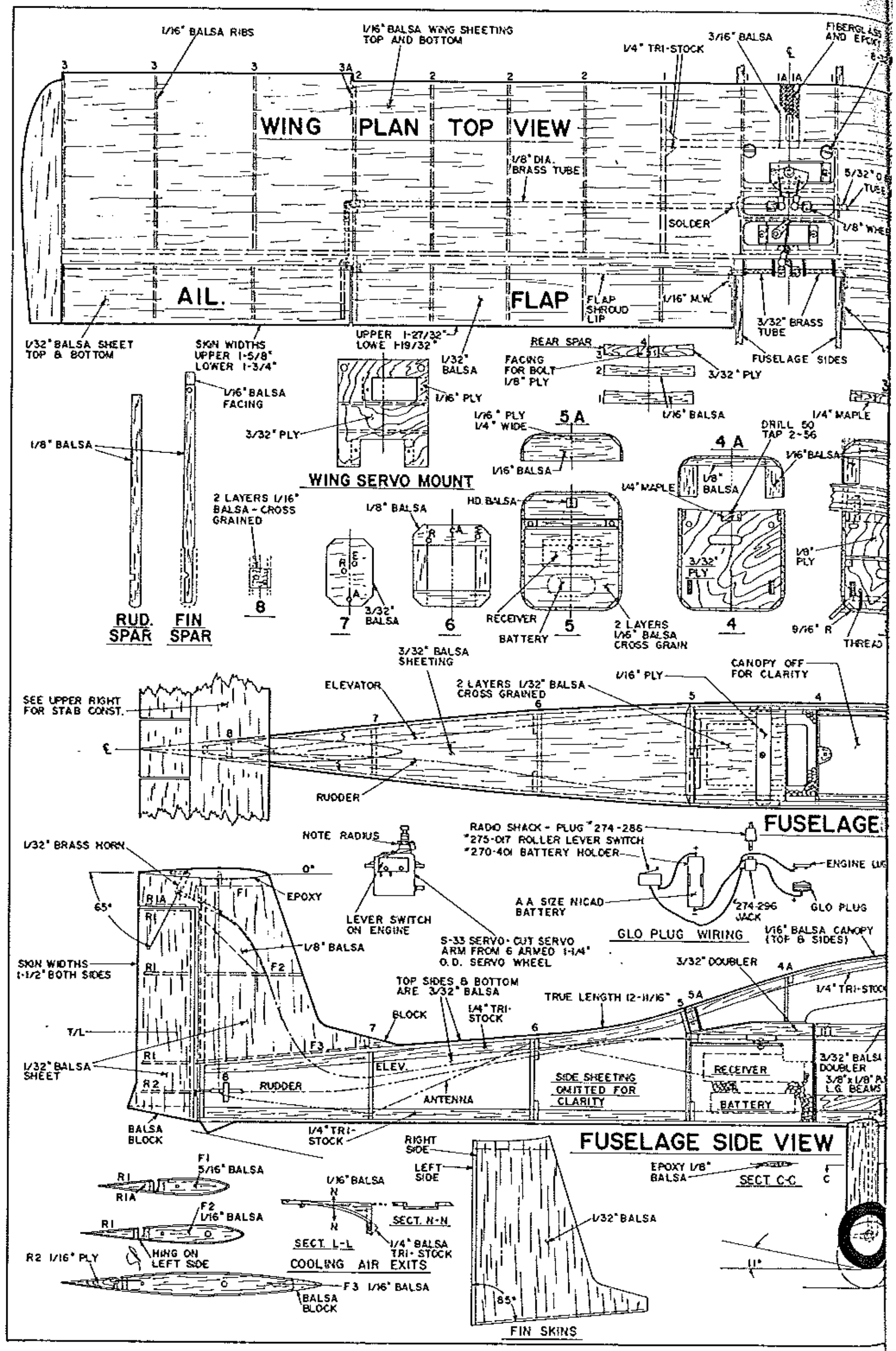
External power to the glow plug for starting is provided by a jack and plug. When the plug is in the jack, the onboard circuit is interrupted, and the engine controls can be used for starting with no drain on the onboard cell.

When the model is inverted on the field box for engine starting, the engine will be in an upright position. This results in the fuel level being above the pressure fitting in the Tatone manifold and increases the probability that the fuel will flow into the manifold. To prevent this, a ball-check valve is installed in the pressure tubing. The valve consists of an ordinary two-piece fuel line filter with a ⅛-in.-dia. ball bearing inside. It is arranged so that the ball rests on the filtering screen when the model is upright and falls into the unscreened end to effectively seal it off when the model is inverted. When the engine starts, manifold pressure and carburetor suction combine to lift the ball so that air can enter the tank.

A word of warning. If you use an electric fuel pump, remove the canopy and watch the tank fill. Be prepared to shut off the pump when full. Otherwise pressure will build up in the tank and lines, and a joint in the line will give way—most likely at the point where the pump fuel line is connected to the fuel tubing that has been detached from the carburetor for refueling.

The horizontal tail plane is mounted on top of the vertical tail surfaces out of the prop slipstream and in reduced downwash from the wing. The result is that, once the initial zoom resulting from the added lift has passed, no elevator trim change is needed when the flaps are deployed. Lowering the flaps slowly, or in the turn from the base to the final leg, will eliminate the zoom.

Ailerons, elevators, and rudder are hinged on one side with double MonoKote hinging (illustrated on the right-hand edge of the drawings). This hinging effectively seals the gap, improving control effectiveness, and is easy to install.



Construction. It's an engineering fact of life that positioning material as far from the neutral axis as possible makes for added strength and reduced weight. All-metal or composite construction of full-scale aircraft utilizes this principle. So does the Sparrowhawk.

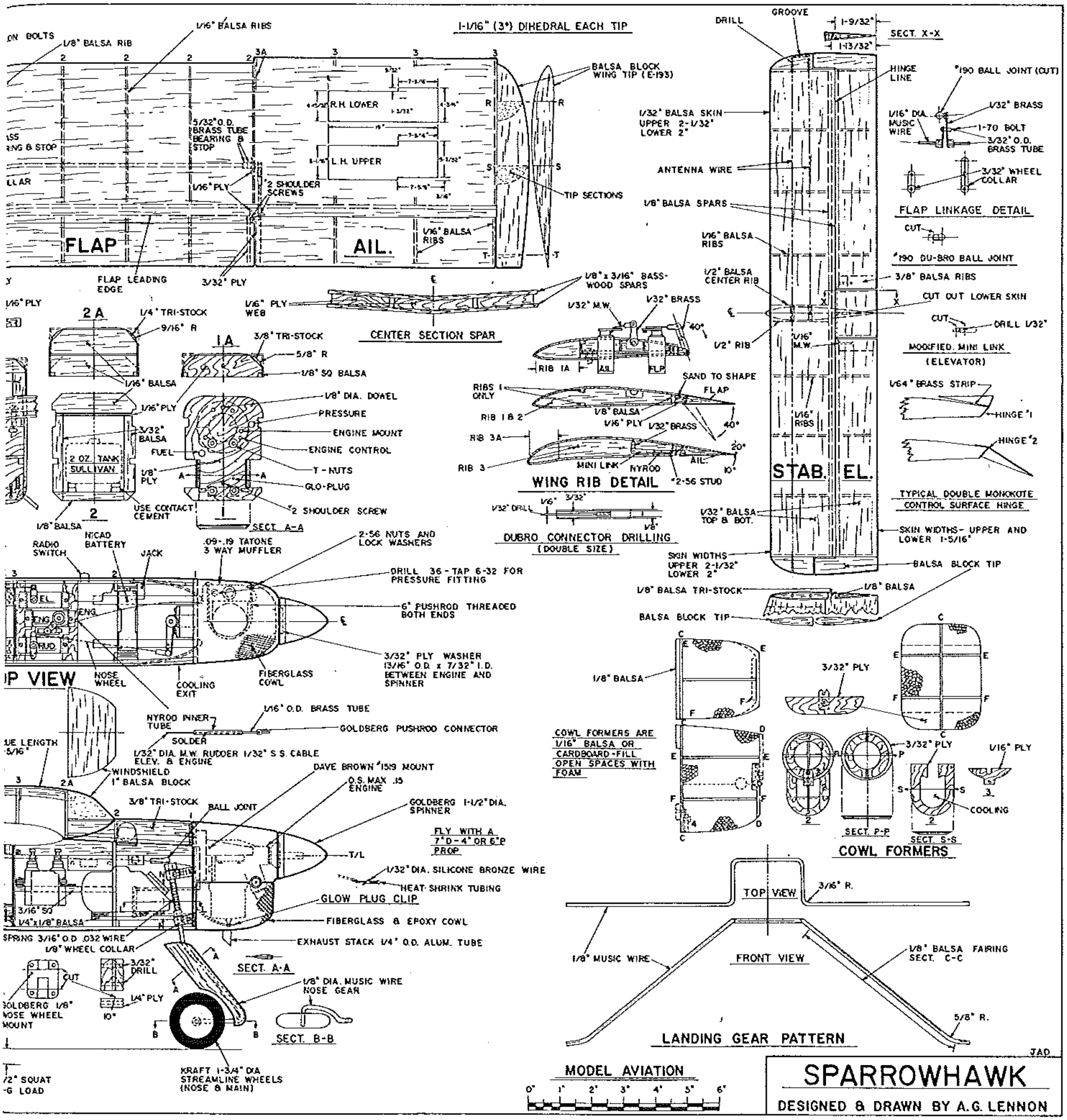
All surfaces are balsa sheet. The wing is virtually sparless as are stabilizer and fin. The result is a rugged model with smooth, low-drag MonoKoted surfaces that contribute to this small model's surprising performance.

The Sparrowhawk is controlled by five servos (Futaba S33 Micro). The battery is a Futaba NR-4G Ni-Cd 225 mAh, and the transmitter should have six channels (five channels if the fifth is controlled by a slide switch for flap operation).

Making the parts. Most components are easily made, but the model's small size will require miniaturization of some of the control components. The Du-Bro ball joints on the wing servos, for example, were shortened ⅛ in., and ¼ in. of the threaded portion of the brass connectors was drilled lengthwise 1/32 in. and soldered to the 1/32 music wire pushrods on the aileron and flap servos. The shortened plastic was then threaded on. Drilling the 1/32-in. hole is easily accomplished using the drill guide illustrated on the drawing.

Similarly, the mini link on the elevator horn was cut down as detailed. An ordinary pin was used as the pivot, the long end cut

Full-Size Plans Available . . . See Page 180



off and secured with a drop of cyanoacrylate (CyA) on the pinhead. No. 2 shoulder screws are supplied with Goldberg flat hold-downs to retain the detachable lower portion of the engine cowl.

The aileron torque tubes (⅛-in. brass tube) require a short (3/16) length of 3/32-in. music wire soldered onto the inboard ends to prevent buckling of the brass tube as the wheel collar setscrews are tightened. Similarly, the flap torque rods (1/16 music wire) should have a 3/16 length of 3/32 brass tube soldered onto their ends to provide a surface on which the wheel collar setscrew can bite.

It is a great convenience to be able to loosen aileron and flap horn setscrews to adjust for trim. The rudder pushrod is 1/32-in. music wire, and the elevator pushrod is 1/32 stranded stainless steel cable. Both have a 2-in. length of 1/16-in. brass tubing soldered onto the servo end to join to the Goldberg pushrod connectors. Both pushrods slide in Nyrod inner tubing.

The cowling is not difficult to make. It requires a mandrel or similar form. Cut and assemble the cowl formers as shown in the drawing. Assemble the spinner ring and ply components for the cold air entry and lightly glue in position on the formers. Fill in the open spaces with close-celled foam, and cut and sand to the contours of the formers. Note that the top portion of the cowl overlaps bulkhead No. 1. Two successive coats of medium-weight fiberglass and Hobbypoxy No. 2 allowed to set and followed by a another lighter coat will provide the 1/32 in. of cowl thickness.

Trim the fiberglass to the front surfaces of the spinner ring cold air entry and to the *rear* edge of the rear formers. Either gasoline or acetone will dissolve the form; both are flammable, so the work must be done outdoors. Install the rear plywood assembly (part No. 4 on the drawing) and epoxy with Hobbypoxy No.1, which can also be used to reinforce the forward ply/fiberglass joint inside the cowl.

Drill the needle valve and exhaust stack holes to 3/8 in. dia., and cut the cowl along the parting line shown. Dremel makes a small circular saw (No. 406) with a blade .005 thick that is ideal for this purpose. Avoid cutting the plywood of the spinner ring cooling assembly.

The 3/32 ply washer between the engine drive washer and spinner backplate is used to provide space between the skirt of the spinner backplate and the engine carburetor for the cowl attachment assembly.

A K&S wire bender will make short work of bending the 1/8-in. music wire landing gear legs. The 1/8-in. balsa fairings have semicircular grooved edges to fit the music wire legs. Strips of 1/32 brass clamped to the balsa sides serve to guide a 3/32 X-Acto gouge to do this job easily and quickly. Silicon bronze wire for the glow plug clip is available from a pump store that stocks replacement parts. Ask for a domestic piston pump-valve spring.

Fuselage. Epoxy the balsa fairings to all three landing gear legs, and sand to a streamline cross section. Epoxy 1/4-in. ply for the landing gear to bulkhead No. 1. Use the pre-drilled holes in the ply as guides for drilling the bulkhead. Counter bore the front so that the T-nuts are flush. Attach the nose wheel bearings and engine mount with 4-40 bolts. Install the nose wheel leg, spring, wheel collar, and steering arm. Ensure that the leg turns and slides freely in the bearings.

Assemble bulkheads 3 and 3A and the undrilled maple blocks. Assemble the landing beams with bulkhead No. 4, and epoxy liberally. Install the main landing gear legs using strong thread as shown. Assemble the balsa fuselage bulkheads No. 2, 5, 6, 7, and 8, and the canopy bulkheads 3, 4A, and 5A over the drawings. To the fuselage sides add cold air exit vents, 1/4-in. triangular balsa, 3/16 sq. balsa servo mounts, and doublers. Notch the bottom 1/4-in. triangular strips for landing gear leg clearance.

Assemble the fuselage side subassemblies and landing gear bulkhead subassemblies, and align the sides. Add bulkhead No. 1 subassembly and the remaining balsa bulkheads. Use X-Acto clamps to hold the assembly in alignment.

Install the fin spar at 90° to the fuselage bottom. Add the aft fuselage top sheeting, but leave the bottom open. Assemble the fin on the fuselage top. During assembly, install the elevator Nyrod and the antenna. This requires that the receiver be temporarily installed between bulkheads 4 and 5. (I installed a coupling close to the receiver so that the receiver could be easily removed for use in another plane while leaving the antenna installed.) Make sure that the fin is aligned with the fuselage centerline.

Install the inner rudder Nyrod, and join it and the elevator Nyrod to the fuselage bulkheads with CyA. Install the fuselage bottom sheet.

The canopy is assembled on the fuselage

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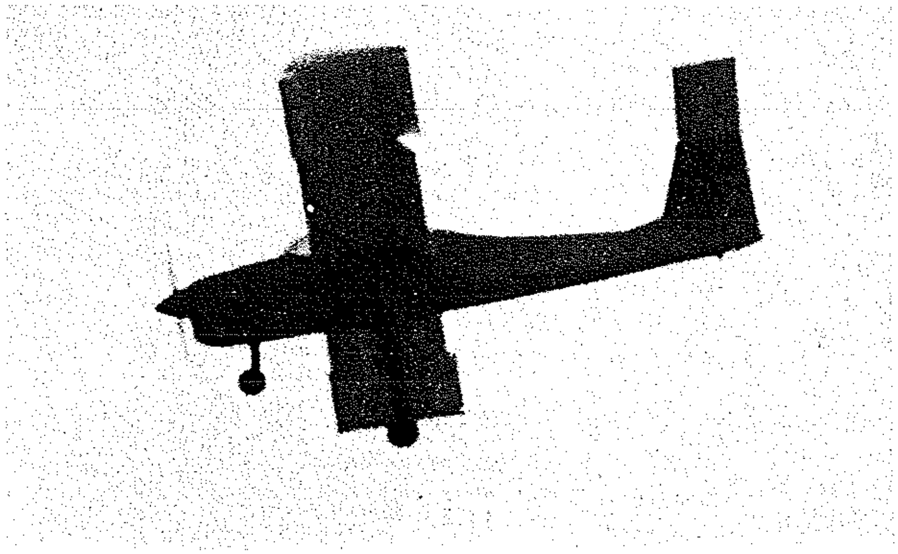
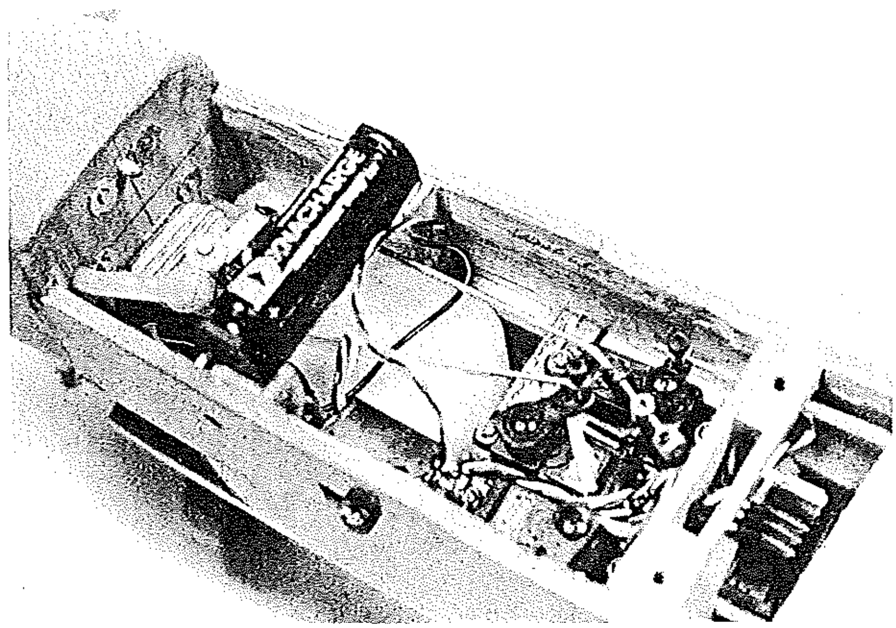
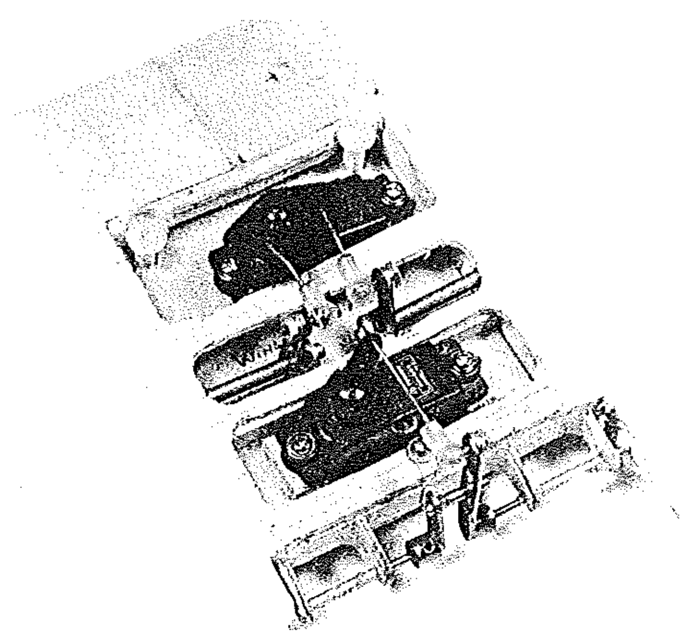


The Sparrowhawk practically loitering at 20 mph with the flaps deployed. T-tail configuration helps to compensate for the trim changes that usually occur when the flaps are dumped.



A single AA-size Ni-Cd heats the glow plug when the throttle is at idle. (The roller switch at the servo turns it on.) The white object running diagonally across the servo is a piece of toothpick used to keep the switch arm from jamming the servo when the model is inverted.



Aileron and flap servos. Ailerons are set up to operate differentially (more up than down).

Letters to the Editor

Continued from page 14

and dissemination of information to RCers.

This year we are beginning a three-evening symposium in conjunction with the Tangerine. There will be *three different programs* held each of the three evenings. We've assembled a "Who's Who" panel of speakers to staff each program.

Admission will be $7.50 per night, or $15.00 for all three nights.

Complete information about the entire Tangerine Week in Florida (including the symposium) can be obtained by sending a stamped, pre-addressed envelope to: RCACF, P.O. Box 8213, Maitland, FL 32751 (or by telephoning 305/695-2836 and leaving a full mailing address).

Dave Tyson, RCACF Pres.
Stu Richmond, RCACF Sec.
Maitland, FL

Safety/Preston

Continued from page 20

stated: "Here's a safety thing—it could have been quite bad." I agree. It could have resulted in injury or even loss of life. The following account of the incident, as related to Bill by Henry, has been slightly changed to preserve the anonymity of the involved modeler. It could have happened to any one of us!

"Yesterday, my friends and I drove 200 miles to attend a ¼-Scale Fly-In. It was just great with the best flying I've seen this year. A P-47 (winner at a similar contest last year) was lost during a landing when it ran into the crowd and scared the heck out of everyone. It had been flown very well, but while landing it was coming in a little hot, and its pilot decided to gun it and go around again.

"The big Sachs engine roared to full throttle, and the torque it produced twisted the airplane to the left, off the runway, and right towards the microphone. The pilot cut the throttle, but the model continued in its flight and tore into chairs, etc. about 10 feet away from me. It broke up and stopped at the side of a wheelchair, but the occupant wasn't touched. Another fellow, to the right of the path of it, fell backward to get out of the way but wasn't touched, either. In fact, nobody was struck by the model, which was blind luck. The pilot came running up, ashen and really shaken up. He gathered up the debris, packed his things, and left. It was purely pilot error."

The majority of model engines rotate counterclockwise when viewed from in front of the model. Because of the phenomenon, as stated by Sir Isaac Newton in his third law, when we "pour the coal" to the engine, torque produced by the engine attempts to rotate our model (when viewed from behind), to the left.

While most of us are alert to the effect of engine/prop torque on the path of our models (especially tail-draggers) during takeoff, we may forget this effect when adding power during a go-around. Generous corrections of aileron and/or rudder may be required to prevent over-flying a spectator area. You, the pilot, are responsible for the flight safety of your model. Don't forget Sir Isaac and his third law!

Have a safe month.

John Preston, c/o Model Aviation, 1810 Samuel Morse Dr., Reston, Virginia 22090.

Sparrowhawk/Lennon

Continued from page 30

to ensure a good fit. Install the engine negative wiring to the glow plug. Add the Tatone manifold. Use a 6-in. pushrod threaded on both ends and bent as shown. Notice the flat filed to the manifold for the nut seat. Install pressure tubing (manifold to tank). Add the upper cowl, and align it with the spinner backplate; then add the lower cowl. Radius the windshield block to fit the fuselage.

Wing. Take two pieces of ⅜-in. plywood 3⅜ in. wide and 20 in. long. Align the inner ends and prop up the outer ends to 3° dihedral—1¹⁄₁₆ in. at 19 in. from centerline. Pin the lower left and right-hand skins to the boards. Align the trailing edge of the skins with the side of the boards. Add the lower center section bass spar and four central short ribs. Install ply webs, upper bass spar, and ¼-in. triangles. Add the central short leading edge rib. Install the trailing edge spar and then the remaining ribs.

Wrap the lower skin around the ribs overhanging the board, and hold in place with CyA. Add the aileron torque tube assembly, and epoxy the plywood supports to the ribs. The rear spar is cut for the

Continued on page 130

Sparrowhawk/Lennon

Continued from page 127

outboard aileron pushrod exit.

Install the trailing edge plywood facing No. 3 on the rear spar. Epoxy the plywood servo mount into position, and add balsa spars No. 1 and 2. Cement the top skin to the trailing edge spar and ribs. Bend the forward portion around the ribs, and join the leading edges of the top and bottom skins with CyA. Notice that the upper skin overlaps the lower at the leading edge. Let the leading edge droop square and with sharp corners. Add the trailing edge $1/4 \times 3/16$ triangular stock, and sand to shape in front of the flaps. Add block tips.

Stabilizer. Use one of the 20 x $3\frac{3}{8}$-in. plywood planks as a base. Add a $3/32$ sq. strip at the leading edge under the lower skin. Install the ribs at the trailing edge and run strong thread as shown for the antenna. It will be used to pull the antenna into the stab during final assembly. Add the top skin and $1/8$-in. triangular stock.

Assemble ailerons, elevators, and rudder on flat plywood, lower skin first, then spars, ribs, and finally the top skin. Sand trailing edges to $1/32$ thickness.

Flaps. Epoxy $1/16$ wire torque arms to the inboard flap ribs. Make sure the joint is solid. Assemble the bottom skin and ribs on flat plywood which has been overlaid with waxed paper. Cement the leading edge of the upper skin to both lower skin and rib leading edges, holding it vertically with the lower edge resting on the plywood. When the cement sets, wrap and cement the upper skin around the ribs and to the trailing edge of the lower skin. Liquid ammonia on the upper surface of the upper skin will permit easy bending. Sand the leading edge radius and trailing edges to $1/32$ thickness.

The center section of the elevator and rudder top is a T-shaped assembly composed of four pieces of $1/32$ sheet, two stab ribs, and one rudder rib 1A. This completes the elevator and rudder top and encloses the elevator horn and linkage. It is added after installation of the horizontal tail plane on the fin.

I painted the cowl and landing gear fairings, but otherwise used MonoKote throughout. Use bright colors for easy visibility since the model is small.

Double MonoKote hinges provide gap seal for efficient control action, and they are very strong. The drawing illustrates their application. Cover the lower surface of the aileron, elevator, and right-hand side of the rudder. Install hinge No. 1. Hinge No. 2 covers the second surface and overlaps on the parent surface (fin, wing, or stab). The upper covering on the parent surface laps over hinge No. 2 to the hinge line. Where hinges 1 and 2 meet at the hinge line, they must adhere to one another for strong yet flexible hinging.

Final Assembly. Install the receiver, battery, and foam packing. Mount the radio switch and jack on plywood, then epoxy onto the inner fuselage wall as shown. Install the tank with contact cement. Set the ball check valve in the pressure line, connect the carburetor and tank with the fuel line, and install the battery mount and holder. Contact cement the roller-lever switch to the engine servo as shown.

Install the fuselage servo ply mounts and servos. Slide in the rudder $1/32$-in. music wire pushrod from the rear (midway in the fuselage rear end), and engage the L-bend in the hole in the plywood rudder rib. Slide in the elevator cable from the front, and solder the threaded connector to the cable. Add the modified mini-link. Use an ordinary pin as a pivot, and CyA the pinhead to the mini-link.

Install the No. 2 shoulder screws holding the outboard aileron pushrods to the inboard aileron rib. Assemble the outboard ply flap supports to the flap end ribs with No. 2 shoulder screws. Assemble the inboard ply flap supports and $3/32$ brass tubing on the flap torque rods. Epoxy the flap supports to the rear spar, then check the alignment of the flap with the wing flap shroud shown in the drawing of wing ribs 1 and 2. Add the flap horns.

Install the aileron and flap servos in the wing, and link them to the aileron and flap horns as shown. Mount the wing on the fuselage, and carefully align and level at

Continued on page 132

90° to the fuselage centerline. Using the bolt holes in the ply servo mount as templates, drill the fuselage maple blocks with a No. 29 drill. Remove the wing, and tap the drilled holes (8-32) for nylon wing bolts. Follow a similar procedure for the rear wing bolt using a No. 50 drill and 2-56 tap. Rear bolting for the canopy follows the same procedure.

At this point, the covering is complete. Leave the underside of the stab bare for a width of 1 in. on the centerline to provide a good epoxy joint. Set up two wood blocks 3½ in. deep, and position the model inverted so that the wing rests on the blocks on both sides of the fuselage with the top of the fin just touching the table top.

Attach the thread in the stab to the antenna. Pulling the wire to stretch the insulation just beyond the end of the wire provides a socket into which the end of the thread will be epoxied. Lightly test for strength. Gently pull the antenna out of one end of the stab and then back in again parallel to itself. Connect the modified mini-link to the elevator horn. Position the stab under the fin, and align carefully. Apply epoxy liberally to both the stab underside and the top of the fin, and make an epoxy fillet in the corners for strength. Add the T-assembly to complete the tail surfaces, and cover it and the bare portion of the stab underside.

Flying. This model will take off from grass, but I prefer a hand launch. Holding the transmitter in the left hand, throw the model upward at a 45° angle, flaps half down and engine at maximum rpm. The model will continue the 45° climb. Paved runways present no problem.

The Sparrowhawk flew right off the drawing board and needed only left aileron trim adjustment. Wheel collars on the aileron/flap torque rods make the adjustment easy. Adjust the control surface throws at the servos. I used the center hole in the servo arms of the rudder, elevator, and aileron, and the outer holes on the engine and flap servo arms. With a 7-in.-dia., 6-in.-pitch prop, the speed is 70 mph. May you enjoy this model as much as I have.

Saw/Beron-Rawdon

Continued from page 33

runner in order to minimize flex as the clamp is tightened.

Precision fence. This tool is similar in concept to the precision stop mentioned above. It allows adjustment of the fence to within a few thousandths of an inch.

The principle is simple. Two equally-tapered pieces of pine form the basis of the tool. The outboard piece is fixed to the saw table with clamps. The inboard piece is slid fore and aft to make fine adjustments in the width of the cut. I have used a 1:20 taper (0.5 in. over 10 in.) so that a 0.100-in. adjustment fore/aft changes the width 0.005.

The pine pieces are cut from a clear and straight piece of 1 x 2 (¾ x 1½) pine. First, rough-cut a piece to the taper desired. Make sure that it provides the slope you want. Then tape a second piece of 1 x 2 to it so that the first piece runs along the fence and the second is cut at an angle (much as the scarf cutter above would do). Untape it, flip it around, and clean up the first rough cut. This gives you the basic pieces. The rest should be clear from the picture.

Tapered spar template. The tapered spar template allows long, straight, tapered pieces to be made quickly and with repeatable quality. This tool is most useful for making spar caps which taper in depth and/or width, allowing more freedom in creating your structural design. Also, precision-tapered spars can allow such fancy details as a tapered wing with constant-depth webs in which the spar cap depth decreases to accommodate the decreased wing thickness.

Construction of the tapered spar template works on the same principle as that of the precision fence above. First rough-out the tapered piece that you want. I use a combination of razor plane and sandpaper to do this. Be as accurate as possible, as this piece will be the template. Temporarily attach the template with double-sided tape to the stock material to be cut. This com-