Snapper ready for flight.
This one has lights for night flying.

Snapper

L-BENT FOR TRAVEL

By Frank Kelly

All these parts assemble at the field
without tools and latch into place securely.

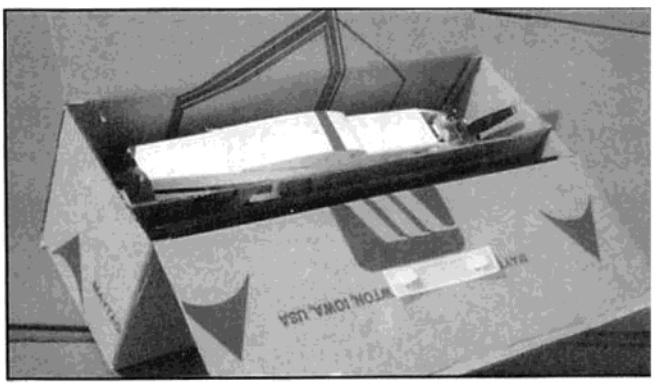
Snapper Specs

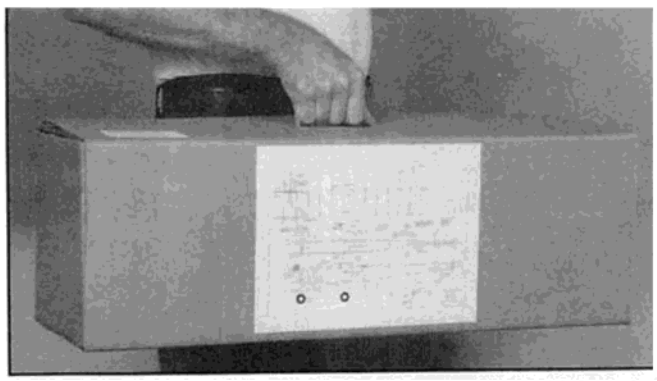
DESIGNED BY
Frank Kelly
TYPE AIRCRAFT
Sport
WINGSPAN
50-1/2 inches
WING CHORD
9 inches
TOTAL WING AREA
450 Sq. Inches
WING LOCATION
Shoulder Wing
AIRFOIL
NACA 1415
1% camber at 40%, 15% thick
WING PLANFORM
Constant Chord
DIHEDRAL, EACH TIP
3/4 Inch
OVERALL FUSELAGE LENGTH
39-1/2 Inches
RADIO COMPARTMENT SIZE
8-1/2"L x 2-1/2"W x 2-3/8"H

STABILIZER SPAN
19 Inches
STABILIZER CHORD (inc. elev.)
5 Inches (Avg.)
STABILIZER AREA
92 Sq. Inches (Approx.)
STAB AIRFOIL SECTION
Flat
STABILIZER LOCATION
Top of Fuselage
VERTICAL FIN HEIGHT
5.0 Inches
VERTICAL FIN WIDTH (inc. rud.)
5 Inches (Avg.)
REC. ENGINE SIZE
O.S. .25 FSR or .19-.35
FUEL TANK SIZE
4 Oz.
LANDING GEAR
Conventional
REC. NO. OF CHANNELS
4

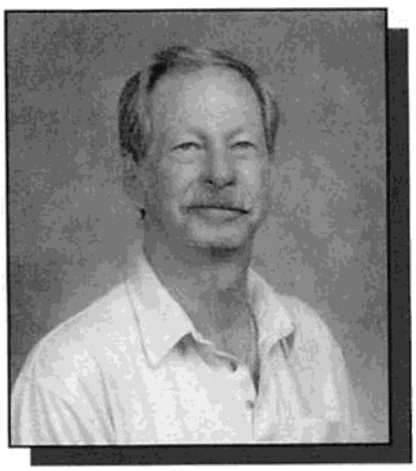
CONTROL FUNCTIONS
Rud., Elev., Throt., Ail.
C.G. (from L.E.)
5/16 Inch
ELEVATOR THROWS
1/2" Up — 1/2" Down
AILERON THROWS
3/8 Inch
RUDDER THROWS
1/2" Left — 1/2" Right
SIDETHRUST
1° Rt
DOWNTHRUST/UPTHRUST
5° Downthrust
BASIC MATERIALS USED IN CONSTRUCTION

Fuselage	Balsa & Ply
Wing	Balsa & Ply
Empennage	Solid Balsa
Wt. Ready To Fly	56 Oz. (3 Lbs., 8 Oz.)
Wing Loading	17.9 Oz./Sq. Ft.





(L): All the parts fit into a cardboard box for travel with room to spare for some support equipment. The box is assembled with hot glue and secures with Velcro patches. (R): The Snapper, all boxed up and ready to travel!

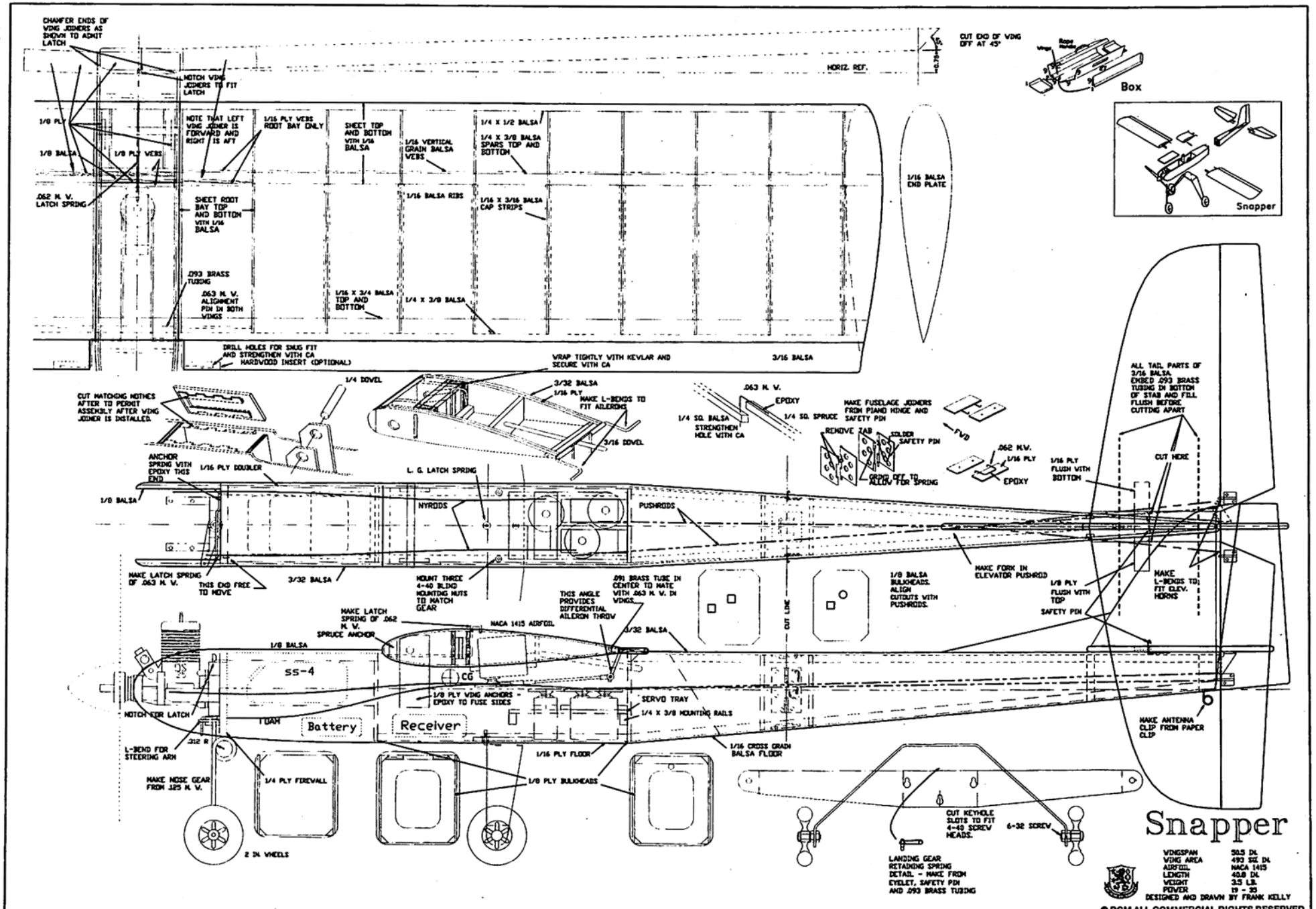


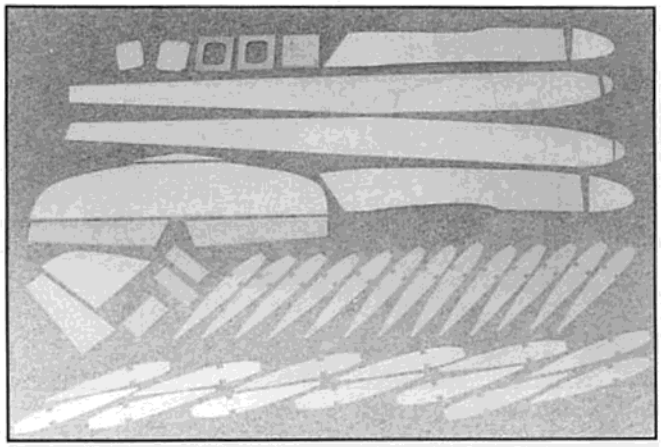
About The Author

Frank Kelly has been a modeler since 1938. He enlisted as a Naval Aviation Cadet on his 17th birthday and had his first solo on V-J day. After graduating from the University of Michigan, he moved to California and spent most of his career designing spacecraft and spacecraft systems. He developed a computer program for plotting NACA airfoils for his own use nearly 30 years ago and later adapted it for general use on home computers. It is now in use all over the world and a new 32-bit version for Windows is presently available. He has published numerous articles in model magazines and technical journals. He is now retired and lives in Arizona.

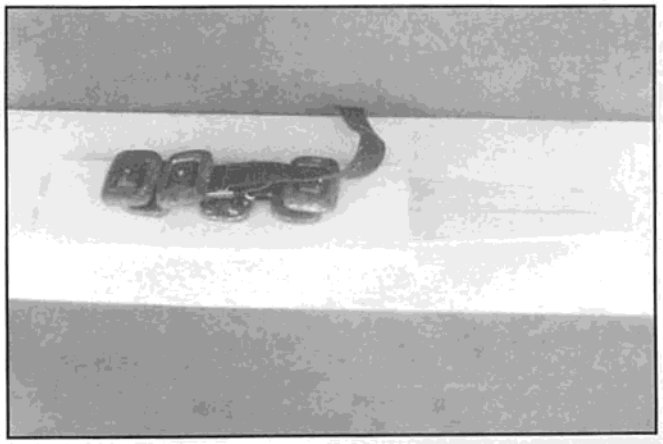
It would be nice to take an airplane along when going somewhere on a trip, but models are inherently fragile and cumbersome. They just don't fit in the trunk along with luggage and things, and something is bound to poke a hole in the covering. Snapper is designed with that in mind. It comes apart and can be assembled **without tools** in a minute or two, ready to fly. It fits in a 9" x 9" x 27" cardboard box for protection, with room to spare for a few odds and ends. A 25-size plane performs well and is small enough to be considered for travel. Snapper is an easy-to-fly plain vanilla generic airplane, but is capable of satisfying performance. Everything snaps in place and latches, hence the name; beyond that, it is unremarkable. None of the latches are load-bearing members; they simply prevent random motion caused by vibration. It has a box fuselage whose size was determined by available 3" x 36" balsa sheets. The wing is of conventional construction except for the joiner, and the tail is 3/16" solid sheet balsa. All the controls are engaged using L-bends in the linkages. The container would have to be a clumsy 40" long if the fuselage didn't come apart, but a system derived from piano hinges permits the fuselage to be separated for storage while retaining adequate structural integrity for flying. The wings and horizontal tail members push on and latch with ailerons and elevators engaged. The tricycle landing gear with steerable nose wheel is also easily removable, but structurally sound. The center section of the wing normally stays in place as a part of the fuselage with the aileron servo connected, but it, too, can be removed without tools for access to the radio compartment. The sliding hatch cover has no visible latch, but can be removed to expose the fuel tank and battery compartment when the wing center section is off. The wing has a semi-symmetrical NACA 1415 airfoil with minimal dihedral for quick take-offs

FULL-SIZE PLANS AVAILABLE ON PAGE 189

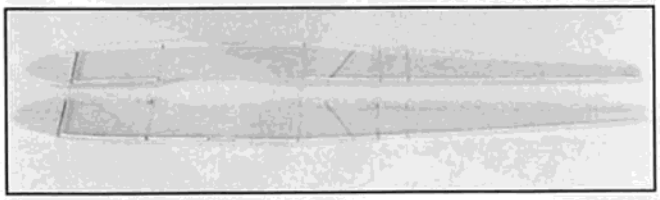




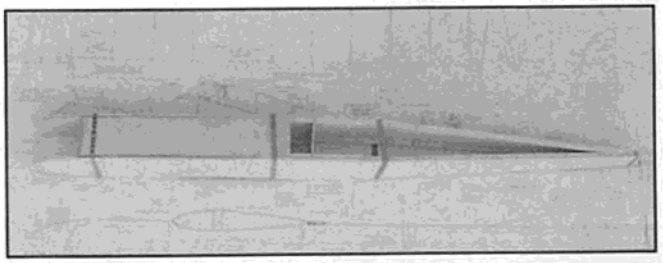
Cut-out parts, ready to start assembly.



Laminating fuselage doublers.



Fuselage sides with triangle stock.



Assembling fuselage over plans.

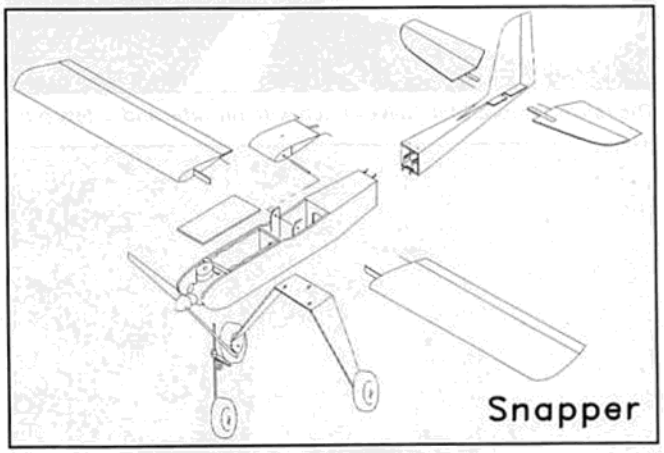


FIGURE 1

Cutting groove in stab with sharpened brass tubing.

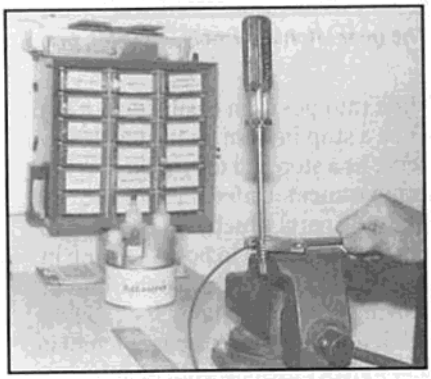
and good inverted performance, while retaining forgiving characteristics. Some of the unusual features require some patience for the necessary alignment and close fit, but, otherwise, the construction is straightforward. No machining is required for construction except with simple hand tools (Figure 1).

Fuselage

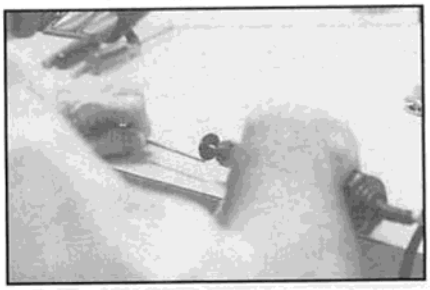
Build the whole fuselage first without the joiner. After it is finished, you will take a deep breath and saw it in two. Laminate the 1/16" plywood doublers to the 3/32" balsa sides, making a right and a left side. Glue the triangle stock along the edges, but spaced back to allow for the mating skins. Note that they are not all the same thickness and that provision must be made for the 1/8" ply landing gear mount. Place the sides vertically over the plan and CA the two plywood bulkheads in place with the 1/16" plywood floor in position. Epoxy the aft ends of the fuselage sides together to assure perfect alignment, then carefully epoxy the firewall to the sides. When thoroughly cured, finish installing the floor forward of the aft bulkhead and mount the 3/32" balsa fuselage top aft of the wing. Glue the thick balsa dummy cowling on forward of the firewall and provide support with more triangle stock. Do not install the bottom aft covering until after the pushrods are in place.

Hatch

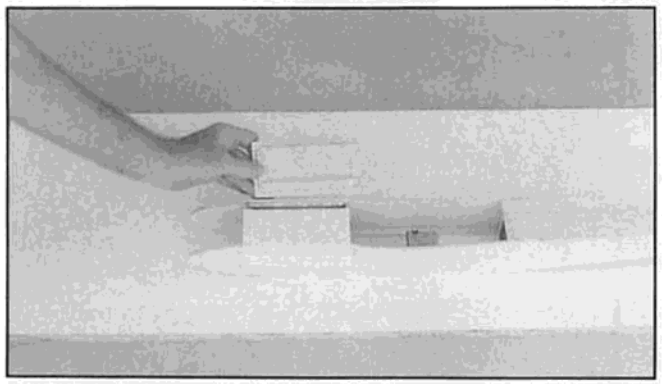
Build the hatch cover and glue in 1/16" x 1/4" balsa strips on both sides that just clear the triangle stock on the top front of the fuselage. Next, glue in 1/16" x 3/8" balsa strips over the first ones so they are wider than the hatch opening. Sand these at an angle so the assembly slides over the triangle stock when inserted from the rear. When done correctly, it will



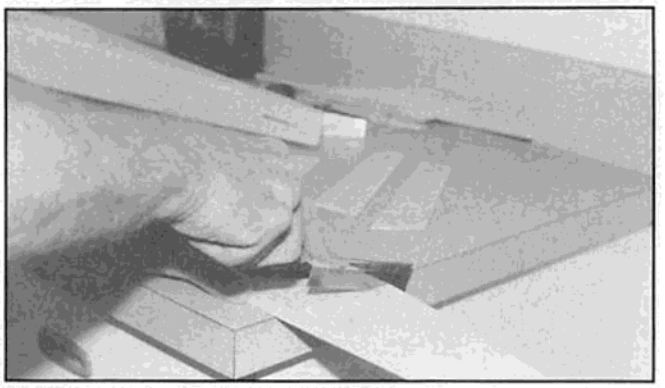
Bending nose gear spring.



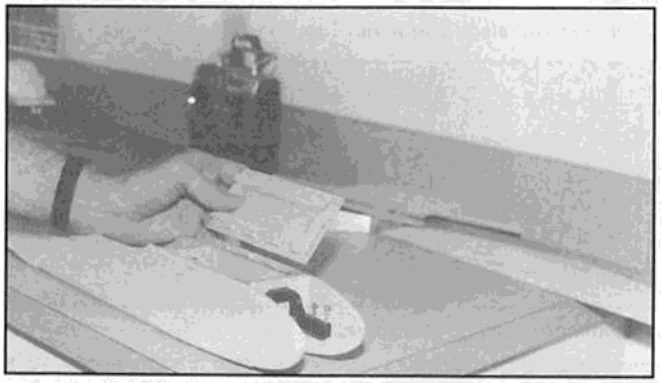
Grinding notch in nose gear.



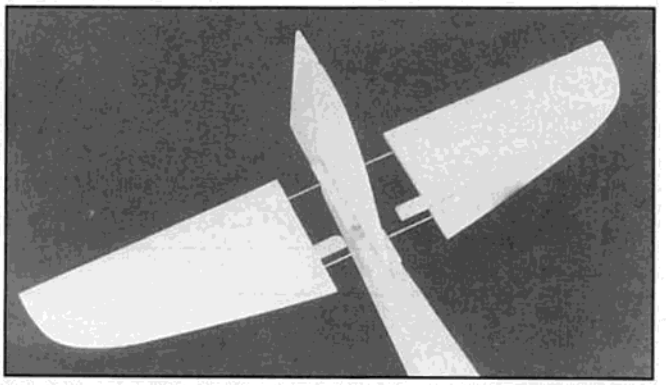
Paper template used for hatch notch locations.



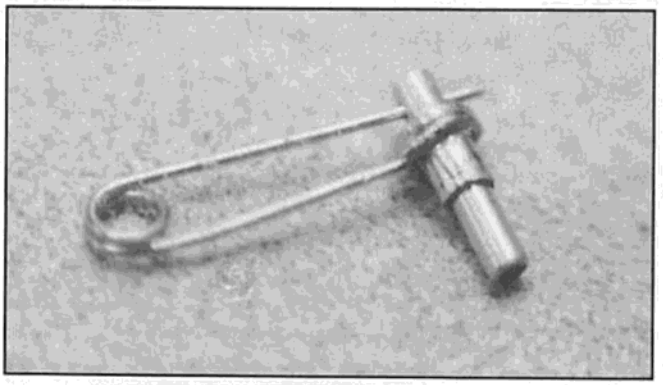
Cutting stab with embedded brass tubing.



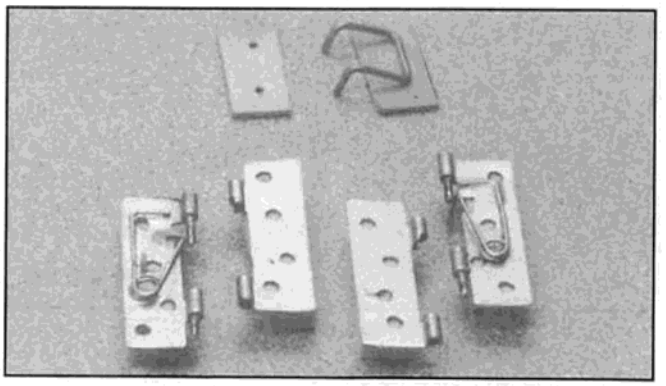
The completed hatch cover.



The tail assembly. Stab halves latch with ply tabs and safety pin.



The gear latch assembly — eyelet, brass tubing, and safety pin.



The fuselage joiners are made from hinges and safety pins.

slide into position easily but not rattle. Glue a strip in front on the inside to serve as a stop and to seal the compartment. Unfortunately, the plywood parts which will be glued to the fuselage sides to hold the wing in place, will prevent the hatch from moving more than about 3/4", so now mark four cutouts on a paper template and transfer them to both members on both sides. When the cutouts are in place, the hatch can be placed 3/4" behind its intended position (just forward of the ply parts), then slid forward to seat correctly (Figure 2).

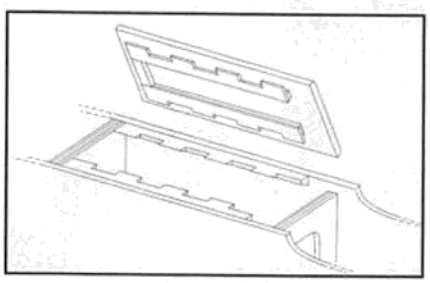


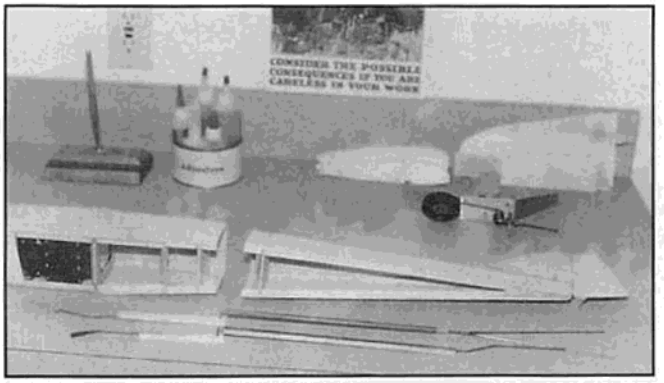
FIGURE 2

The sharp edges of the fuselage can be rounded at this point, except for the still uncovered bottom aft part. Leave a sharp corner just behind the wing and leave a flat area for the stab. A router makes the task so simple that it seems trivial, but it's also easy with simple hand tools.

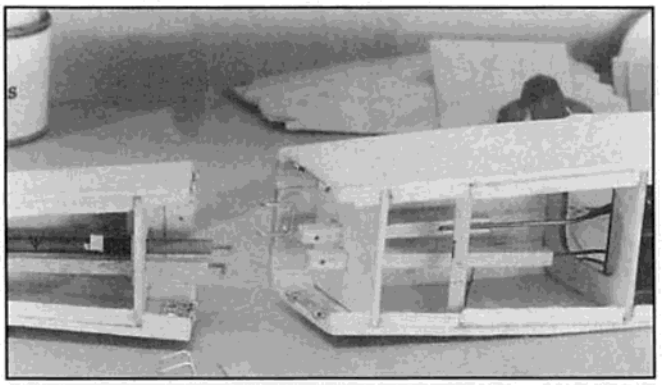
Tail

The horizontal stabilizer and vertical fin both require butt joints because they exceed the 3" width of a standard balsa sheet. Make the whole stab in one piece and cut it apart later. Cut grooves in the bottom surface for the 3/32" brass joiner tubing and embed them in place with epoxy, slightly below the surface. Fill in the groove with wood filler and sand flush. When finished, cut them apart at the indicated location with a fine saw. Round the ends of two pieces of 1/16" music wire, cut to the proper length, and reassemble. This method assures perfect alignment of the three pieces of the stab. Cut a 1/2" wide notch 1/16" deep in the bottom of the right stab to accommodate the plywood tab, and a similar notch 1/8" deep in the top of the left stab for the other tab. Cut out the center section to clear the two tabs. Remove the end of No. 3 safety pin (they pull off) and bend to the necessary shape to form a latch and mount it temporarily to check the fit. Cut a small chamfer on the corners of the tabs to allow them to pass the safety pin. Make very small notches in both plywood tabs to mate with the safety pin. Take the time here to make it all fit

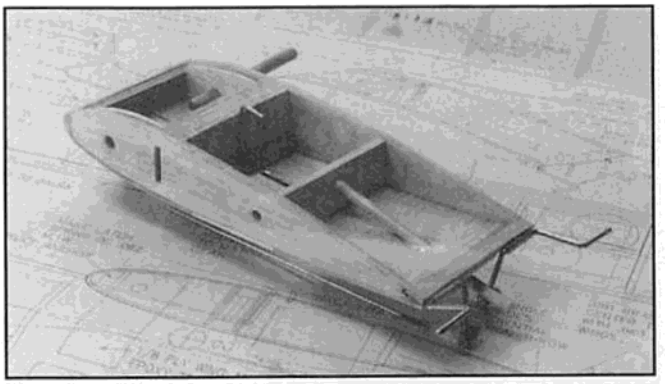
The moment of truth — sawing the fuselage and pushrods.



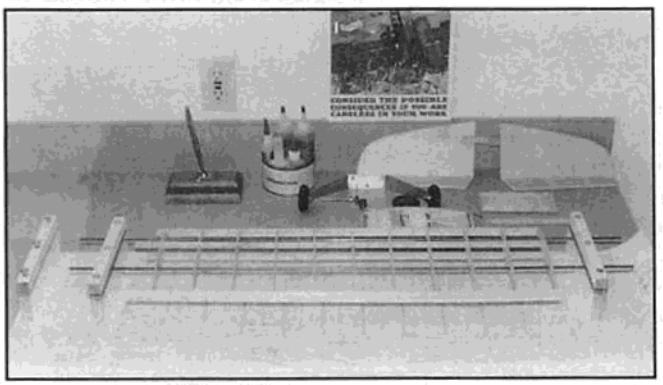
The fuselage and pushrods parted.



Fuselage and pushrod joint details.



The wing center section.



A simple wing jig is useful but not required.

A table saw cuts off the wingtips neatly at 45°. Note shim under TE.

perfectly, then install the safety pin permanently on the fuselage, and securely epoxy the stab center section, and safety pin to the fuselage with generous fillets. Check alignment with the full stab assembled while the epoxy cures and be sure the safety pin is free to move as required.

Similarly, mount the fin onto the stab with big fillets and verify alignment. Mount the rudder and elevator and install control horns. It is convenient to secure one joiner wire to the left stab and the other to the right one with a drop of CA. Use short horns or cut off large ones to provide the necessary clearance between the rudder horn and the adjacent elevator horn.

Landing Gear

The main gear has three keyhole slots to accommodate three 4-40 screw heads. This can be done with drills and jewelers' files, but they must be located carefully so the three screw heads will all fit through the holes and also allow the assembly to slide over the screw shanks. Take care to align the holes with the holes in the fuselage with blindnuts.

The axles are made from 6-32 stainless steel screws and nuts. Tighten the nuts securely against each other with just enough clearance for the wheel hubs. A drop of CA is also good insurance if you can do it without gluing the wheels to the shaft. Make the latch from an eyelet, some 3/32" dia. brass tubing, and another safety pin. Drill a No. 60 (.040") hole through the brass tubing. Solder the safety pin to the shank of the eyelet, make sure that nothing binds, then slide the tubing onto the safety pin and force the tubing into the eyelet, then bend as required until it moves freely. Drill a hole in the fuselage floor to accommodate the latch and epoxy the eyelet assembly to the floor, taking care to assure that the action is not impaired (Figure 3).

Commercially available nose gear assemblies do not have long enough shanks for the necessary latch, so the nose gear is bent from a piece of 1/8" dia. music wire. The coil spring can be bent in a vise but it takes a bit of muscle. Bend it around a 5/16" rod

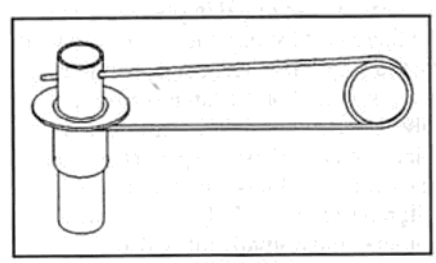
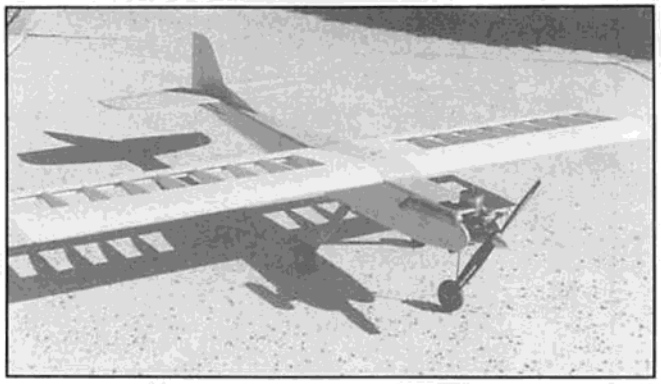
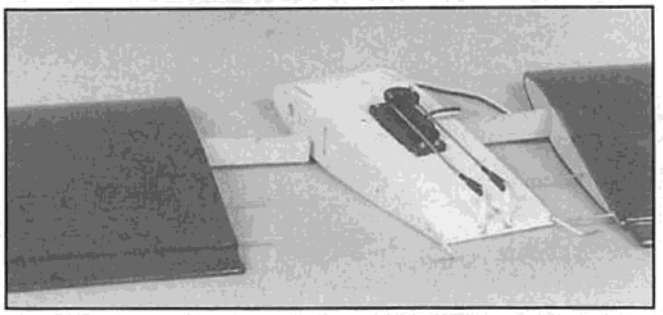


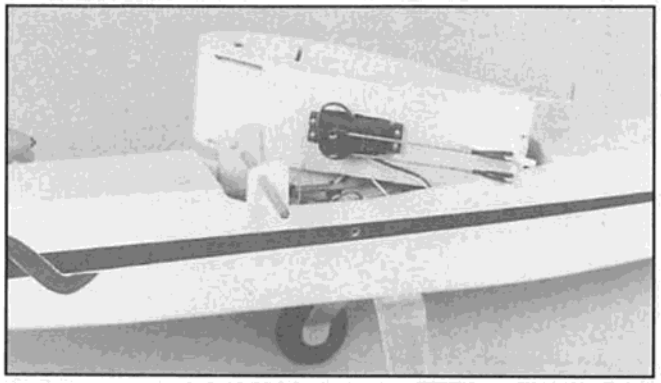
FIGURE 3



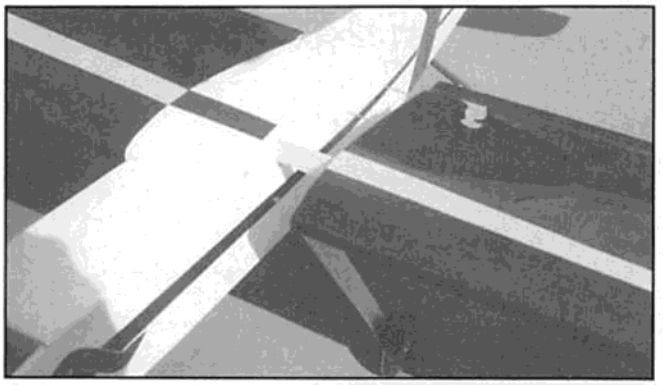
The bare bones ready for covering. This one has no dihedral.



The wings plug into the center section. The ailerons have holes in the trailing edges to accept the servo linkage. Note the notches in the spars which latch them in position. Dual alignment pins double as electrical connectors for navigation lights.



The wing center section with aileron servo normally remains in place for storage but can be removed by withdrawing the dowel.



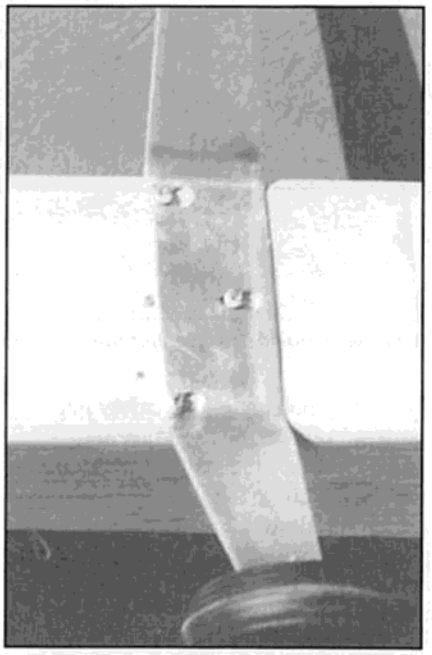
The wings and ailerons simply plug in and latch. The aileron servo stays with the fuselage.

(an X-Acto handle is good) and be sure to realign it into a flat object after the first U bend. If you start out with a tight spring, the rest will follow. Bevel the top end to accept the retaining spring and cut a slot at the right place to match its diameter. An abrasive wheel on a Moto-Tool works well for this, but always use eye protection because they can disintegrate violently. If your motor mount has a 5/64" dia. hole for a nose gear, install a length of brass tubing as a bushing. You will need to relieve the bottom of the firewall a little to accommodate the coil. Make the retaining spring from 1/16" dia. music wire. Assure perfect alignment and epoxy in position.

Wing

Build the center section first. The ply rib goes on the **inside** with the 3/32" balsa rib on the **outside**, the two laminated together to make a right and left assembly, just like the fuselage. The spars are of spruce because the wing joiners are not glued in place as usual so there is substantial leverage and load in the slots. Another spruce member serves to anchor the latch spring. 1/8" ply vertical webs will be epoxied in place and a 1/8" balsa spacer placed in the center. A slot is cut in all three to align perfectly with slots in the wing joiners, and a small slot is also necessary in the lower spar to allow the latch spring to move. Partial ribs are installed in front to aid in alignment of the dowel which attaches the wing to the fuselage. The left wing joiner goes on the forward edge of the spar and the right joiner on the aft edge with the balsa spacer between. Make a temporary wing joiner for fit checks. Cut the slots in the ribs and test the fit. Bend the latch spring to shape and assemble the parts for alignment. Make adjustments as necessary until the wing joiners slide in and latch with no binding and no play. When satisfied, use epoxy liberally and wipe off any that might inhibit proper action. Wrap the spars and webs with strands of Kevlar fiber or heavy Dacron thread and secure with CA. The wing loads will be substantial but this technique will provide adequate strength to survive violent maneuvers. The loads will all be in the vertical direction since the wing is restrained from sideways movement by the latch and aft pin. Install the rails for the aileron servo mount and embed a 3/32" dia. brass tube at the top rear of the assembly for the alignment pin. Sheet the bottom with a suitable cutout for the servo but leave the top uncovered for now (Figure 4).

Make the 1/8" ply parts that attach the wing to the fuselage. Install the 3/16" dia. dowel temporarily and align



Keyhole slots in the landing gear engage screw heads in the fuselage. A spring loaded pin retains the assembly.

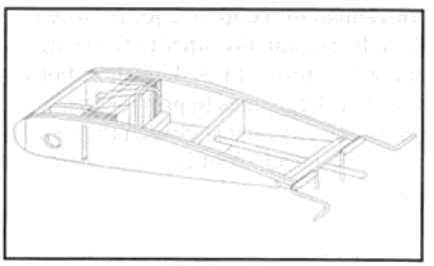
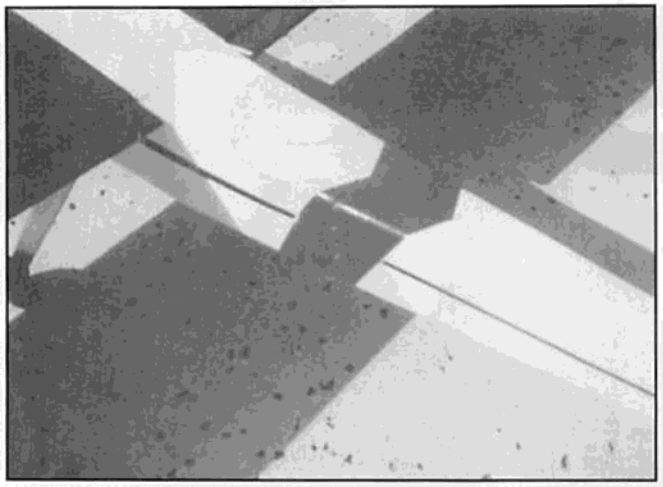
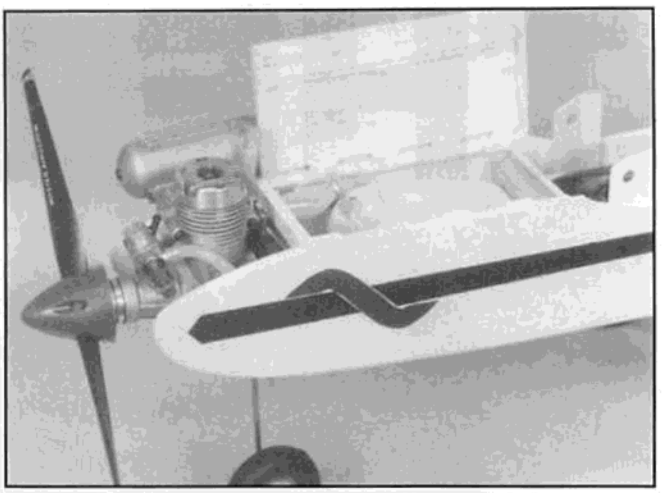


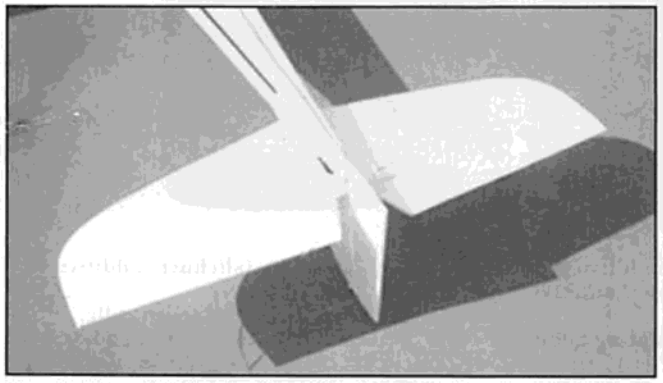
FIGURE 4



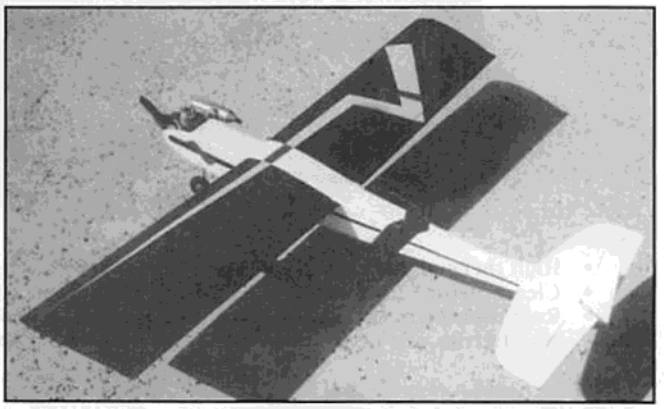
The fuselage joint is largely invisible when assembled.



The hatch slides into place and is secured by the wing center section.



The stabilizer latches in place like the wing; the elevator linkage has an internal Y connection and L-bends engage the elevator horns. The receiver antenna is retained by a clip.



Snapper appears to be an ordinary trainer but has some very unusual features with no compromises in performance.

with a hole in the aft bulkhead. Drill the 1/4" dia. holes in all the parts and align, then securely epoxy them to the inside of the fuselage in the exact position with the wing center section in place. Epoxy the 3/16" dia. dowel in place at the same time. When the epoxy is nearly cured, verify that the hatch does not interfere and that the wing section was not stuck in the process. Build two wings and be sure to make a right and left wing. The root rib should be angled slightly to match the center section. After verifying that the ply wing joiners fit the center section and latch properly, epoxy them to the ply webs in the root bay and fill the space between with scrap balsa. The wingtips are simply angled at 45° and sheeted. A table saw may be overkill but it makes this task easy. Use whatever you have available but note that the aft trailing edge is not adjacent to the tip rib. Sheet the root bay and the top and bottom forward of the spars. Add the cap strips and fit the ailerons.

Install the aileron servo and the linkage in the center section. The brass tubing or hinge pin in the linkage should align with the aileron hinge line. Mate the L-bends with holes in the ailerons. It should be a snug fit without being tight so it slides on without binding or play. Use CA to strengthen the hole.

Radio

There is room for a three-servo tray under the wing and an aileron servo in the center section, but little space to spare. Check placement carefully so there is no interference. A block of packing foam makes a good bed for the receiver and battery, and serves like a crash helmet to protect things better than rubbery foam. Just secure everything to prevent it from moving. I like to install a length of NyRod inner housing to feed my antenna through. Since the fuselage comes apart, it exits just forward of the joint on the bottom. Make a clip from a paper clip to hold the end at the tail and epoxy in position.

Make a Y connection pushrod for the elevators, and feed the ends through slots in the fuselage before making the L-bends. I used a fiberglass arrow shaft for the pushrod and embedded a short length of NyRod inner housing at the aft end to mate with a 2-56 bicycle spoke which formed the middle part of the Y. That allows some adjustment for trim without taking the whole assembly apart. There is enough stress on the rudder pushrod during assembly that it can break if not handled gently so I used spruce for the aft segment. When the two pushrods are in and not interfering, saw the fuselage in half with pushrods still in place. Round but do not point the wires for the pushrod joiners. Make 1/2" L-bends on one end and 1/8" on the other, then embed the wires on the aft members, and make matching holes through the mating parts. Chamfer the holes slightly to form little funnels to facilitate insertion, and strengthen with CA. Remove the pushrods and epoxy the bulkheads in place (Figure 5).

The Fuselage Joint

The fuselage joiners are made from lightweight piano hinges that have 1/4"

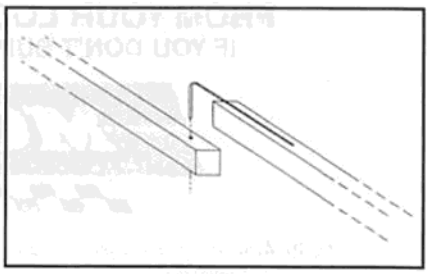


FIGURE 5

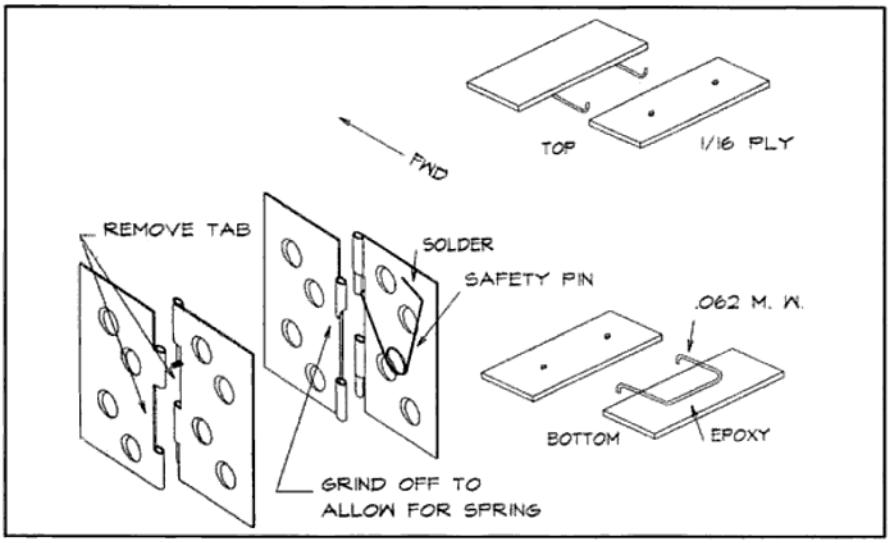


FIGURE 6

tabs. It is important to make a left and right part which are mirror images of each other. Cut the hinge into segments containing six tabs (three on each side) and cut off the center tab. Round the ends of four 1/2" lengths of hinge pin wire and solder in place with 1/4" protruding. Bend a No. 3 safety pin as shown, then grind off just a little of one tab down to the pin and bevel the other end of that tab. The safety pin should push against the hinge pin. Hold the pin in place with pliers and test the action. Adjust as necessary and solder in place. This latch is absolutely critical because it prevents the tail from falling off in flight; but, when properly done, it is more than adequate, and it's redundant for extra safety. The wires and plywood doublers on the top and bottom provide additional strength. When assembling, the long L-bends on the pushrods allow that joining, independent of the short tabs on the hinges, top and bottom (Figure 6).

Remove the pushrods and invert the fuselage on a flat surface. A small slot is required on each side to accommodate the latch actuator tabs. Epoxy the four hinge parts to the fuselage sides with the hinge line exactly aligned with the parting line. Balsa scraps can be used to hold the parts in place while the epoxy cures. Mount the ply plates on the top only; leave the bottom open until the pushrods are finished.

The square holes in the aft bulkheads should align with the pushrods, but they probably won't fit perfectly, so trim the holes as necessary to allow them to function. Scrap balsa can be used to reform the square holes, which help to keep the pushrods aligned during assembly as well as in normal operation. With the linkages operating properly, the bottom of the fuselage can be covered to complete the construction.

Assembly

The most convenient sequence for assembly is as follows: Leave one wire in one stab and the other wire in the other. Push on the right stab partway, align the L-bend with the appropriate hole in the control horn, then all the way in to latch. Repeat with the other one. Before sliding the fuselage halves together, carefully align the L-bends in the pushrods with the matching holes and slide them partway on, then align all the piano hinges and push home and verify the double latch. It is helpful to move the elevator down and the rudder right to extend the L-bends during assembly. Push the antenna wire into the clip at the tail. Slide the main gear over the three screw heads and past the latch. Push the nose gear into the motor mount while aligning the L-bend with the steering arm and verify a latch. Set the fuselage down on its gear and push on one wing, aligning the L-bend with the hole in the aileron. Repeat with the other wing and verify a solid latch. Turn it on, verify operation, fill the tank, and go fly.

The Box

While building a custom cardboard box is not a normal modeling activity, it's kind of fun. I went to the nearest major appliance dealer and he was pleased to give me the shipping box for a dishwasher. It's a simple matter to cut off one side and lay out the pattern with a yardstick, then cut it out with a utility knife. I folded all the creases over the sharp edge of my workbench with a board holding the cardboard flat. Fold the creases double and flatten it out with a board. Use a hot glue gun for the assembly. It is faster than white glue and permits a little realignment. The separator protects the wings from punctures. If you make a mess of the first one, just use another piece and start over. I made a smaller 2" x 3" x 24" box to put inside and space the fuselage up to allow for the propeller. It can hold a few tools and a glow plug battery. There's even enough room left over for a quart can of fuel if you plan carefully. I recycled a plastic handle from another box but you can use a piece of rope with knots on the inside, and Velcro squares hold it closed (Figure 7).

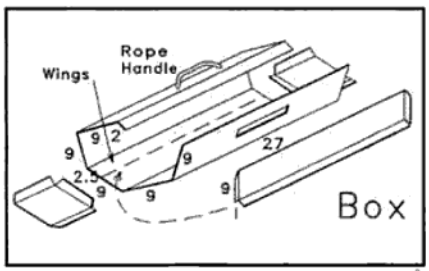


FIGURE 7

Flying

The Center of Gravity must be in the range shown on the plans and it should fall into place without any added weight with the equipment placed as shown. A washer under the left side of the engine mount provides a little right thrust to minimize torque roll on take-off. The thrust line is almost aligned with the wing and tail, but another washer under the top of the engine mount was found worthwhile to avoid pitch up with throttle. Snapper is easy for a beginner to fly on low rates and at moderate speed, but is capable of performing impressive maneuvers with higher rates.

Editors note: *For those interested in the author's NACA Airfoils computer program it is available for $20 postpaid from the author at: 2200 Jamaica Blvd. South, Lake Havasu City, AZ 86406. His e-mail address is* **KelComp@ctaz.com**

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