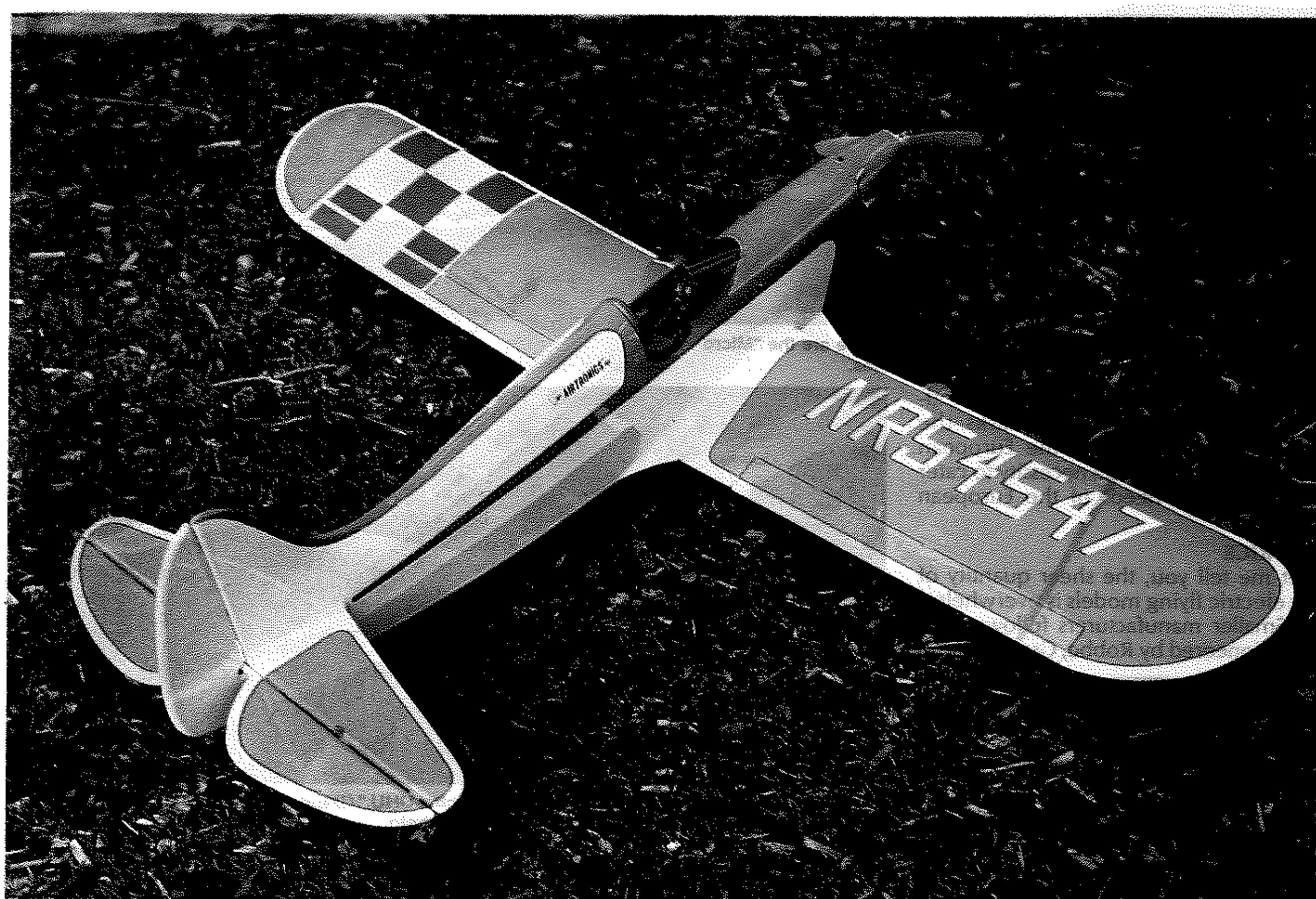

TIGERCAT Mk. II

By BOB BENJAMIN . . . "Could-be scale" at its very best! Our author has blended the most pleasing characteristics of some of his favorite airplanes into a very appealing design. For .60 to .65 size four-strokes and experienced builder/pilots.

• The Tigercat Mark 2 is another in my series of "could-be-scale" sport aerobatic designs. I interpret this term to mean that the airplane might well be a scale model of some full-size aircraft that never quite came to be, or that it might fancifully be scaled up to full-size. The Tigercat came about as an attempt to blend some of the most appealing characteristics of the limited-displacement closed course racers of the 1930s into an appealing model. There is a strong flavor of Keith-Rider, Brown and Benny Howard in this design!

Those of you who recall my Bobcat Mark 2 (*Model Builder*, Feb. '88) may notice a similarity; in fact, this latest iteration of the Tigercat is a Bobcat in terms of moments, airfoil, and incidents. The lines have been changed to increase the appeal. The overall size has of course been reduced. The Bobcat flies well on a Saito .80; the Tigercat you see here uses a Saito .65. It also happens to fit into most cars more readily than its larger ancestor.

The Tigercat, like the bigger Bobcat, is not tricky to fly, but demands your full attention all the time. It is by no stretch of the imagination a trainer. There is a small margin of positive stability in both pitch and roll built into the design, but for practical purposes the airplane will go where it is pointed. Though by no means a real racing airplane the Tigercat is quite fast and will cover a lot of real estate in a hurry, the point being that it is not a small field airplane. On the other hand, I have tested the prototype extensively in slow flight at safe altitude and determined that it will respond safely at low speed and retains aileron control right up to the point at which the wing gives up completely and stalls out. In short, it is an exciting airplane to fly for a pilot who has some solid low-wing experience under his belt.

While laying out the structural design of this airplane I gave a great deal of thought to the demands the Tigercat will make on the modelers who build it. I've explained that it's not for novice fliers, now I'll go one better and state that it's not for novice builders, either. The whole purpose in laying out the design the way I did was to provide an airplane that would be esthetically exciting both in appearance and in flight performance. To compromise visual appeal for the sake of simplified construction seemed out of keeping with what I wanted to do in the first place. Besides, there are already plenty of easy-to-build sport planes around. My final decision was to develop this airplane as a showpiece for those of you who have learned to build well. I make no excuses for having made demands on the builder. If you like the looks of the Tigercat, but don't feel your skills are up to it, don't give up. All of us "old timers" started out just like you. Keep on practicing your flying with the models you are used to and fine-tune your building skills with a couple of good rubber powered scale kits. The excellent kits by Flyline come to mind as good examples. Believe me, the results will be worth the work. I've been flying this airplane for a year at the time of this writing and I still get turned on just looking at it hanging on the wall of my shop. It has never failed to elicit all sorts of positive comments from fliers who see it for the first time.

As has been the case with other designs I have presented in *Model Builder*, I make use of a lot of spruce and basswood in this model. While these woods exact a small

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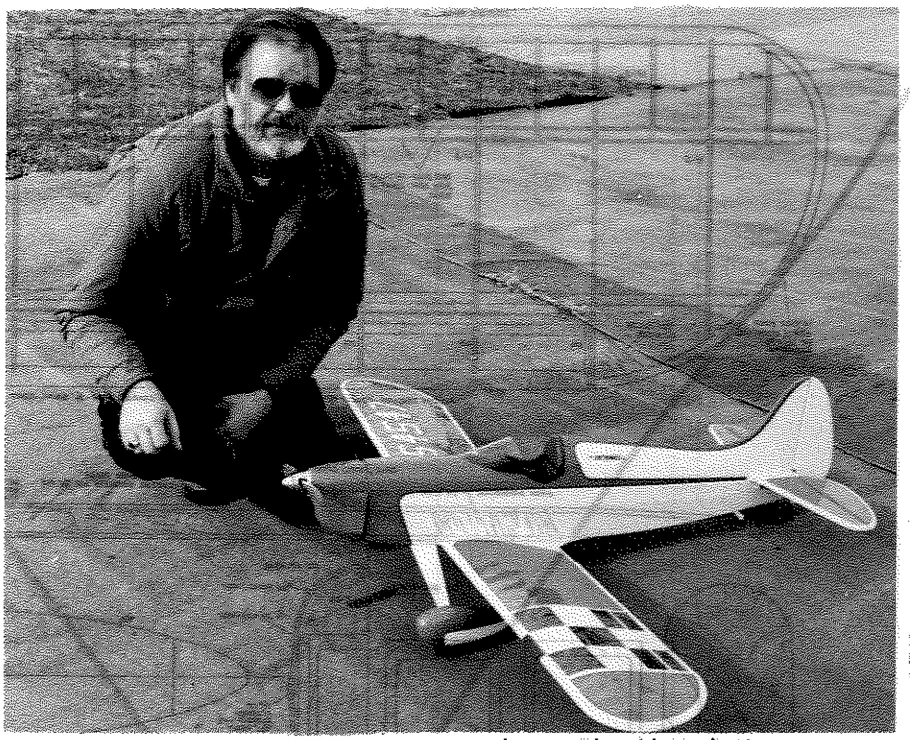

penalty in weight, they return the favor amply in terms of greatly increased strength, resistance to bowing under the tension of a properly applied covering, and in dent resistance. While there is no point in trying to make a crash-proof airplane, building one to withstand all the little knocks and dings that come along makes a lot of sense. Try it, you'll like it!

Let's build this airplane!

TAIL SURFACES

Both the horizontal and vertical tails are based on laminated basswood outlines, and it is with these components that you'll need to start work. I have been using this approach to building attractive, strong, scale-like flying surfaces for some years and have long since stopped making involved forming fixtures. Cut an ample supply of small blocks of firm wood that you can readily pin to your building board. Having covered the work surface with plastic, firmly pin a block on the inside edge of the horizontal tail laminate outline wherever you feel you will need a support. (Every two or three inches should do it; experiment until you find what works well for you.) Note that the laminated edge starts at the outer end of the straight leading edge and continues all the way around to the inside corner of the elevator. This entire length is made in one piece and later cut to separate the fixed stabilizer from the elevator. Lightly wet the bass strips and wipe them dry. Leaving enough material to run several inches beyond the ends of the finished piece, securely pin one end of the inner strip to the board and pull it tightly into position against the blocks. Move any blocks that don't hold the strip in the position you want. Pin the strip as necessary to keep it located. Now attach the end inch or so of the next strip to the "starting" end of the laminate. I find it easiest to stagger the ends of the successive strips by a half inch or so in order to pin each securely without having to remove any pins. Using "Special T" and Kick-It accelerator, secure the starting end and then glue the entire strip a few inches at a time, keeping it under light tension and pinning as necessary as you work around the outline. Repeat the operation for each strip, center can be lighter. Don't forget to leave a 3/8-inch opening there for R-1 to fit through later. The dowel elevator joiner is inset into the leading edges of the elevator halves. Make the trailing edge gusset on one side of the elevator full depth to provide an attachment point for the elevator horn. Block sand the entire assembly true and round all edges to a 3/16-inch radius. These tail surfaces are intended to simulate a welded steel tube and fabric structure, and are not tapered or airfoiled.

Build up the vertical tail and rudder in the same way. Notice that R-1 extends down to the lower surface of the horizontal tail. Orient the grain on R-1 as shown. Leave the finish sanding of the forward portion of the leading edge until after the removing and replacing any pins on the outside of the laminate. Repeat the sequence for the other side of the horizontal tail. You'll find that the entire surface outline can be laminated in a surprisingly short time. Leave the assembly on the board until it has had a chance to dry thoroughly, then pull it up and true up the top and bottom surfaces with a sanding block, then trim the ends to exact length. I'd suggest that while you're in the laminating business you go ahead and make up the vertical tail outlines and wingtip bows as well. Kind of neat stuff to play with, isn't it?

With the laminating complete, lay out the entire horizontal tail assembly. Use hard balsa for the leading edge and the hinge line edges. The 3/8 sheet fillers at the vertical tail has been assembled onto the fuselage, so that you can fair it properly into the dorsal stringer.

Test fit the control horns and hinges for the tail surfaces and set the assemblies aside.

WING

The main wing spar on this airplane is a little different from what you may be used to. Treat it as a separate construction project in its own right and take pride in doing a good job. *Don't* be tempted to substitute a chunk of hard sheet for the built-up spar. It might work, but I wouldn't want to guarantee it. The entire wing was conceived as an exercise in being different for the sake of enjoying good craftsmanship. It's in keeping with the rationale behind the entire airplane. If you're still with me at this point, we're in tune and I need say no more.

Start building the spar by cutting out the sheet balsa center core. "Split the difference" with the grain direction so the grain is at a 2 degree angle to each wing panel. Use uniform, hard wood and *do* make the cutouts at the ends of the core; the idea is to avoid any abrupt changes in the bending modulus of the spar which might provide stress foci and convenient locations for failure.

Assemble the 1/4x1/8 spruce spar caps on the core over the plan; follow this by adding the 1/16 balsa sheet spar skin to the "top" face of the spar while the assembly is accurately pinned to the plan. Note that this sheet is oriented with the grain running 30 degrees off the vertical. With the skin in place, turn the spar over and skin the other side, taking care to orient the grain 30 degrees off the vertical in the direction opposite to that of the first side. The 1/16 sheet extends from tip to tip. Now make up and attach the 1/16 ply center doublers, noting that these also should have their primary grain running spanwise and "split" referent to the dihedral angle. Make up the rear spar of hard balsa and the 1/16 ply doubler. True up the edges of the spar assemblies and you're ready to get on with the wing assembly.

With a one-piece spar you will have either to build the wing on a jig or build one panel flat on the board and then rock the wing over to build the opposite panel. I used the latter method. As long as you keep the outer surface of the main spar square to the building surface you will have no alignment problems. Cut out all the ribs and the requisite stock for the leading and trailing edges for both the wing and the ailerons, lay the edges out on the plan, and mark and slot them to accept the ribs.

Slip all the full ribs over the front and rear spars (if you are using a jig, do both panels; otherwise, you'll have to do one panel at a time). Line everything up in position over the plan. Add a 3/32-inch shim under the W-1 ribs at the center and shim the trailing edges of all the ribs until the rear surface of the main spar is exactly perpendicular to the work surface. Now you can slip the half ribs in place, followed by the leading and trailing edges. Shim as necessary to insure that these are aligned correctly and glue up the structure. You can build the ailerons flat on the board, being careful to insure that their rib spacing matches that of the wing. Trim the spar

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ends as necessary and fit the wingtip bows, centering on the leading edge and the rear end of W-4. The leading edge will taper to match the tip bow and the bow will taper to fair into W-4. Now add the 3/32 gussets at the tips and at the inner end of the aileron wells. If you are building one panel at a time, now is the time to rock the assembly over and repeat what you just did on the first half. When both panels are framed up, remove the wing from the board and add the lower 3/32 sheet center section skin. This is an "in your lap" job, so be careful to maintain alignment. With the lower sheet in place, replace the wing on the board, add the hard balsa filler at the trailing edge where the wing bolts will go through, build up and install the aileron horn assemblies from music wire and brass tube, add the wing attach dowels at the leading edge, then go ahead and close up the center section by adding the top 3/32 sheet. Don't forget the little 1/4-circle gussets at the outside corners; these will make your wing look much more finished after the covering is on.

Get out the sanding block and cut everything down to final shape. The leading edge will have to be brought down to the correct airfoil contour and blended into the tip bows, which in turn need to be sanded to a radius and faired into the W-4s. Make sure that the rear edges of the nose ribs are rounded off to prevent unnecessary bumps in the covering, and be compulsive about block sanding the entire outer wing surface to insure that all the outer edges of the various structural components are in line. A single rib protruding above its fellows will ruin the appearance of the entire wing.

Make the cutout in the center section for the aileron servo and install hardwood servo mounting blocks. Sand the ailerons to a final fit, test fit the aileron hinges, and check the entire aileron assembly for freedom of movement.

FUSELAGE

The fuselage construction is easily what we might call traditional. The two side frames, which include FD-1 and WS, are built up of hard balsa or spruce. Block sand the side frames true after assembly, then add the 1/16 ply doublers ahead of F-2, being certain to make both a left and a right side. The sides can now be joined over the top plan view, placing them on the plan upside down to allow them to rest securely on the board. Join first at F-2 and F-3, then draw the sides together at the tail, joining at the tail post and at the F-4 through F-7 locations with 1/4-inch sq. crossmembers only on the bottom. Now remove the assembly from the board and join the sides at F-1. Add formers F-2A through F-7, followed by the 1/4-inch sq. top stringers at both the nose and tail. Make and install the 1/8 ply tailwheel mounting plate, then LG-M and WM. Don't forget the triangular gusset blocks above WM.

Now comes the fun part. Cut the wing root fillet bases from 1/32 ply, taking care that the primary grain on these runs spanwise to allow easy bending around the wing saddle. Note that these bases extend to the inside edge of the WS pieces. Lightly glue the bases in place only at the very front end of the wing saddle, so that you will be free to make incidence adjustments at the trailing edge if necessary. Line up the wing as accurately as possible, measuring in from the tips to establish an accurate centerline, and make guide lines to align the wing with the inside edges of the WS pieces. Mark and drill the 1/4-inch holes in F-2 to accept the mounting dowels, then install the wing in the fuselage, pinning it in place temporarily. Trammel from the top center of F-7 to an appropriate point at each tip; insure that you have proper alignment and mark the wing accordingly. Now block the fuselage on the bench with the top longerons at 0 degrees incidence and use an incidence meter to establish the wing incidence at 2-1/2 degrees positive, measured using the chord line shown on the plan; this is where the "V" guides of a Robart or similar incidence meter will center themselves on the airfoil. Cut away or build up the WS saddles at the trailing edge as necessary, then align the plywood fillet bases and Hot Stuff the entire wing saddle assembly in position. Recheck incidence and alignment, then drill through the trailing edge into WM for the wing mounting bolts. I opened up the holes in WM to accept DuBro 10-32 threaded inserts and used 10-32 nylon bolts through the wing.

When you are satisfied with the wing installation, fix the airplane back in place over the top plan view and use a line drawn at right angles to the fuselage centerline to establish a square mounting for the horizontal stabilizer. Measure the tip distance off the plan to insure lateral alignment and satisfy yourself that the stab rests securely on the top longeron; horizontal tail incidence relative to the longeron should be 0 degrees. When the stab is securely in place, follow it with the vertical tail, aligned square with no offsets. Trim the vertical tail leading edge laminate as necessary to allow it to fair smoothly into the top stringer. At this point it starts to look kind of exciting, doesn't it?

Line up your engine mount on F-1 and drill the necessary mounting holes. Install blind nuts on the back of F-1. No downthrust is used on this airplane, but you should make provision for one degree of right thrust. Mount the landing gear, setting blind nuts into WM for the mains and into the tailwheel mounting plate for the tailwheel assembly.

Remove the wing and set it out of the way while you finish closing up the fuselage. Install the 1/8 ply battery compartment floor. Add the turtledeck stringers, followed by the 1/4-inch sheet filler blocks at F-3A. Rough cut these on your jigsaw and make a couple of round sanding blocks from various size dowels to finish sand the inside curves. Add the 1/4x1/8 fabric attach strip along the top surface of the horizontal tail on each side of the vertical fin; these will be essential to complete the covering job. Add the side stringers, noting that these are relieved where the 3/32 nose sheet covering lies over them. Follow these with the 1/8 sheet balsa fillers under the horizontal tail. Add the belly stringer and fair it into the bottom of F-3 with scrap balsa. Sheet the top of the nose with 3/32 balsa. The top sheets extend to the lower edge of the upper longeron, and will have to be cut at the low point of the cockpit opening to allow you to align the rear edge flush with F-3A and wrap the forward portion around F-2B. Light wetting on the outside and a little patience should get these in place for you. Edge-join narrow sheets if necessary to get wide enough pieces of 3/32 sheet to cover the entire forward fuselage sides from the top longeron to the bottom of LG-M. Mark and cut the outlines of the wing saddle and the rounded cutout at F-2B, noting that you will have to add filler blocks of 1/4x1/8 balsa on the outside edges of F-2 and taper them into the upper and lower longerons to give the side sheet a secure base for attachment. The side sheets are installed flush with the top cowl sheet and with the bottom edge of the lower longeron and LG-M. Don't forget the tapered extension of the side sheet behind F-3 which allows you to blend the sheet area smoothly into the lower longeron. Finish closing the nose by adding the 3/32 sheet under the nose; install this cross-grain and terminate it where the front edge of the landing gear will rest on LG-M. Now trim the cockpit opening to final shape and go over the entire fuselage with your sanding block and blend all the edges, keeping in mind the lines the covering will follow. On my airplane the wing root fillets were added after the nose was fiberglassed, a detail I'll explain shortly.

Since those of you building this airplane are not beginners, I'm not going to hold your hands on the cowl and wheel pants. There are no plastic or fiberglass units available for this design, although if someone out there likes it well enough to want to make them available, I'd like to hear from you. The pants are built up of several laminations of light 3/8 balsa sheet with 1/4-inch sheet outer faces. Add copious amounts of carving, sanding and fiberglassing and the results will be beautiful wheel pants. I inset 4-40 fiberlock nuts in the inner edge of each pant, liberally reinforcing the entire area with Hot Stuff. The nuts are matched to a 1/16-inch aluminum plate slipped over the axle and held in place on the gear by the same nut that locks the axle in place. Check the photos for a good look at this.

The cowl is carved and hollowed. If you want to make a mold and do it in fiberglass, have at it! I mounted my engine, removed the exhaust and needle valve, wrapped the engine securely in masking tape and with the spinner mounted, built up the cowl around it. Starting with a block about one inch thick and opened up to fit over the front of the engine, I roughly built up enough wood around the engine and spinner to give me material to carve and sand. When everything was smoothly shaped and blended I removed the cowl and cut the air intake, exhaust, and other openings and gave the outside surface a coat of 2-ounce fiberglass cloth attached with resin. When this had cured I opened up the inside of the cowl with a rotary file, several sanding blocks and a lot of patience, then added another coat of resin inside and out, followed as you might guess by a lot of sanding. The wheel pants got the same treatment, using 3/4-ounce cloth. While working with the resin, I covered the entire fuselage back to the stringer fillets behind F-3A, as well as the entire wing center section, with 3/4-ounce cloth. The trick to doing good, light fiberglass work is to control the amount of resin that stays on the airplane by using an appropriately light grade of cloth, and by removing any resin that lies above the cloth weave. A good alternative is the attachment of the fiberglass using Hot Stuff; this is quicker, lighter and just as strong. I used resin on this job to get a little more material buildup on which to sand out a really slick base finish.

If you want to try a different system on the cowl and pants, have at it! What I have described has worked well for me on a whole succession of airplanes, and at the expense of being a bit labor-intensive, produces beautiful, durable accessories that fit perfectly.

As I mentioned earlier, the wing root fairings were added after the entire nose was fiberglassed. In the case of my airplane this was done because I used Sig's Epoxolite to form the fillets, and the polyester resin used with the glass cloth won't cure in the presence of most epoxies. Different materials may allow you to avoid this problem, but the sequence didn't cause me any trouble. Having the area around the fillets glassed allowed me to work the Epoxolite into a nearly finished shape with copious amounts of water and the end of my finger. The cured material could subsequently be wet sanded to a final finish without having to worry about unprotected balsa getting wet.

Now is the time to do a temporary installation of your tank and route all fuel system plumbing. Do a preliminary installation of your radio system and make sure everything fits now, so you won't have to cut up a finished covering later to get it to work. I permanently installed two plywood rails at appropriate locations on the inside of the radio compartment, then screwed a plywood servo tray to them. My switch and charging plug are mounted on a bracket in the cockpit. Put the entire airplane together to insure that the spinner doesn't bind on the cowl, that the landing gear tracks properly, and to eliminate any other nasty little gremlins that will be tougher to fix later. When you have everything the way you want it, it's time to cover and finish.

There are so many methods available to model builders these days for covering and finishing airplanes, many of which work very well, that I won't attempt to specify a "best" method for this airplane. I will mention one important reservation: this wing structure was designed to be a little more flexible than some of the wings you may be familiar with. As there is no leading edge "D" tube to absorb vertical flexing loads, the wing becomes dependent on the covering for some of its strength. My prototype has been well tested with a covering of dacron polyester (Sig Koverall) applied with a heat-activated adhesive and tightened with two coats of nitrate clear dope before being primed and color finished. Any of the synthetic fabric coverings (Coverite, Worldtex, etc.) will work as well if given a coat or two of nitrate clear dope before final finishing; this will prevent the sagging long after application that sometimes affects these coverings. I specify nitrate dope because it bonds far better to dacron than does butyrate dope, and also because all the enamel or epoxy type finishes I'm aware of bond better to it than to butyrate. I cannot guarantee that the airplane will have sufficient structural strength if you insist on using an iron-on plastic film covering. In spite of various manufacturer's claims, many years of experience have left me convinced that these materials add little or no structural strength to an airplane.

A final note to you real "old time" builders out there; clear doped, dyed silk would work very well on this airplane; in fact, I nearly went that route myself instead of doing the multicolored paint job you see in the photos. I'd like to see photos of a clear doped, silked Tigercat if you build one.

There is one aspect of the covering job that I must explain in detail. This airplane demands that you make what is referred to as a faired fabric fillet between the top rear of the fuselage (the turtledeck) and the vertical fin. This is nearly universal practice on fabric covered full-scale airplanes and adds tremendously to the appearance of models where it is used. Regardless of the covering you choose, the method of doing a faired fabric fillet is the same. Cover the fuselage bottom and sides separately. Cut two pieces of covering material large enough to cover each side of the top rear fuselage and vertical fin, with enough extra to give you something to hang on to and to allow for some adjustments. The pieces you will work with will be attached along the upper longeron and to the fabric attach strip that runs along the top of the horizontal stab center section (now you know why I put those there!), to the edge of F-3A and to the dorsal stringer, and to the leading and trailing edges of the vertical tail. Start by attaching the fabric to the upper longeron and the fabric attach strip, then to the trailing edge of the fin. Keep it stretched out pretty tight. Now start working around the fin leading edge and into the curve between the fin and the dorsal stringer. Take your time, think about what is going on, and be ready to *pull* and *stretch* the fabric. The heat-activated fabric adhesives work well here, as you don't have to wait for anything to dry. You may have to heat your fabric "in the air" as you pull it to get a smooth job over the center of the fin-dorsal junction. Finish up by completing attachment along the dorsal stringer and F-3A. Wrap a little extra covering around and over the edge of the leading edge and dorsal stringer to get a good bond. Don't shrink the covering until you have both sides covered! Small wrinkles will pull out, but you can't tolerate any deep puckers or creases along the edges. When you do the second side, you will have to pre-trim the overlapping edge to prevent your trim job from cutting through the lower layer of fabric and allowing everything to slip loose. When it's all in place, go at it with the heat and shrink it up tight. Beautiful, isn't it? The trick to this thing is to take your time. It really does work; look at the photos of my airplane for proof. The system works just fine with plastic, too. If you are using silk and dope, be aware that the first coat of dope used to seal the silk will probably loosen the dorsal-leading edge seam badly and spoil the job. The fix is to make a series of closely spaced pinholes along the seam and lock it down with a shot of Hot Stuff before that first coat of dope goes on. Heat-activated adhesives won't give you this problem.

For final setup and preflight of the airplane you might want to use my specifications as a guide. The balance location shown on the plan gives me sharp maneuvers and a clean spin entry, yet allows some "drawing" of the airplane for a slow final approach. The control throws shown are sufficient for very fast angular accelerations. If you have a dual-rate equipped radio you might want to make the first flights on low rate; otherwise it might be a good idea to make the first few flights with the throws set at about half of what is shown.

My engine, as I have mentioned, is one of my well-loved Saito .65s. I run it, as I do all my four-strokes, on 10% nitro Red Max four-stroke fuel which I order mixed on a castor oil base. This engine flies the airplane with vast power to spare on a Rev-Up 13x6 wood prop. The airplane will doubtless go faster than the way I have it set up; if you want to experiment, you might start with a 12x8. The one degree right thrust I have specified appears quite sufficient to handle any tendency to yaw in flight when power is added, but as with any high-powered taildragger, you'd better be ready to add lots of right rudder on takeoff.

The radio is one of my Airtronics Championship 7 FM systems, with which I have had nothing but good experiences. You don't need big servos in this airplane, but I would caution against using "minis" to save a few ounces unless they are designed to stand a workout; although this isn't a heavy airplane, it is going to move along pretty fast and will impose considerable control loads.

A thought on engines: my airplane has a three-color-plus "show finish" and weighs in at well over six pounds. A serious attempt at building a light Tigercat should yield a five-pound machine, perhaps lighter. The new Saito .50, which I have flown, would be more than enough power if your airplane comes in at the lower end of the weight range. There are several other four-strokes in the same size range that should, of course, work well.

Take your time setting this airplane up, don't turn her loose until you are sure everything is ready to go, stay sharp while you have her in the air, and you will be rewarded with a satisfying, esthetically different airplane that will attract attention wherever you fly. •