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SATAN MK.III

By BOB BEECROFT

The Satan series began during the last days of the short-lived 178 ounce rules. The first two national records were set with a heavy (9 1/2 oz.), 320 square inch version of the design. These were the 1/2 A and A Junior records. Both records were set after the rules changed to unlimited weight.

With the then-current long motor runs, a large 425 square inch version was built for 1/2 A - A competition, weighing 8 1/2 ounces. This airplane took full advantage of the long runs and had a supurb transition and glide, with surprising penetration due to the sharp leading edges used. This airplane picked up the Senior 1/2 A and A records.

The large, light model even handled the wind well, as was proven one very windy year at the Phoenix Southwest Regionals. Many airplanes stacked due to the wind, but the 425 just went up and up, flipped out into the glide, and maxed every flight. This Mark II version was built in a variety of sizes from 320 to 1000 square inches . .

The Mark III Satan, of which the 520 is the latest in the series, has been built in sizes from 240 to 1300 square inches. The Mark III comes after a lapse of several years in building activities due to service, marriage, college, and so on.

The current series configuration was developed after some study of the state of the art, and is a compromise between the very smallest and hottest climbers, and the larger Mk II Satans. The 520 inch wing and large stab give a beautiful glide, very fast climb, and smooth transition.

My own Satan 520 uses a Super Tigre G - 15 .19. Initial choice for power was the Rossi .15, but due to lack of availability here in San Diego, I finally settled on the Tigre. Any of the hot .15's can be used with success, or for a milder ship, a Cox or other good .09 could be used.

CONSTRUCTION

The flying surfaces are pretty conventional. so not much detail is necessary . . . A couple of notes though. Don't skimp by using balsa for the top spars. Spruce really adds a great amount of strength, and very little weight. Pick medium grade balsa wood for the center section leading edge, trailing edge, hard for the bottom spars, and lighter grade for the main panels. The wood in the tips should all be very light stock. All the ribs are light quarter-grain 1/16 sheet, except for the ribs at the tip polyhedral breaks which are 3/32.

There's a reason for the strange plan layout. Try building the tips in one piece, and the same for the main panels. This way, a very closely balanced wing can be built. In addition, you prefabricate all the spars, ribs, leading and trailing edges, it is super-fast. *Leave out* the rear bottom spar until the truss ribs are all cut and fit into place.

The truss ribs are all put in as rectangles (slice a 1/16 X 3 X 36 sheet into three 1 X 36 inch strips), and leave them square on top for the time being. When fitting in the truss ribs, block up the leading edge of the right main panel 5/16 of an inch at the far right corner, to build in the wash-in. Same goes for the *trailing* edge of the wing tips; block them up 1/8 inch for wash-out.

Now let your Titebond (thinned 1/3 water to 2/3 resin) dry overnight . . . You can go on to the stab while this dries.

After the wing is dry, pull it up, and flip it over. It will sit steadily on the flat tops of the untrimmed ribs. The notches for the rear main spar can now be cut at the precise angle to which the spar passes through the truss ribs. Cement a SHARP razor blade to a piece of scrap, so that the blade protrudes a depth. Place the bottom spar over the notches already in the straight ribs, and drop the blade down into the truss ribs, using the spar as a guide, the blade flush against it. Pull up the spar, knock out all the pieces, and check the fit. Should be perfect. Double glue, and push the spar in place.

Now pin the wing back down, right-side up, wash-in and wash-out blocks in place. Be sure to double-glue all parts with Titebond; brush a coat on both surfaces, let the glue set a few minutes, then re-coat, and assemble the parts. Later, another coat is brushed around every side of every joint. Don't try for a fillet, just let it soak in. If the joints all fit well, a super-strong structure will result.

Although not shown on the plans, I use 1/16 ply dihedral braces at the L.E., T.E., and on both sides of the bottom spars at the center panel breaks, plus nylon tape over the L.E. and T.E. joints. To keep the tips light, use 1/16 ply at the L.E. joint, and only on the front side of both bottom spars. The T.E. joint is just glued and taped, and if fit well, will be more than strong enough.

Before putting the dihedral in the wing, trim all the truss ribs to shape, and with a large sanding block, carefully sand them all down flush with the top of the straight ribs. Carve and shape the leading edges to the shape shown, and do the finish sanding on all the wing panels. Now, after the dihedral is in, all that remains to sand is the joints. I usually leave the 3/32 sheet tips 'till last, but they could probably be put in and sanded to shape more easily before the tip panels are on the wing.

The stab is very simple. Keep it light, and *flat.* If you use the D.T. system shown on the plans, you'll have to build in the 1/8-inch ply D.T. stop-key/rubber hold down, and be sure it is very securely cemented in place. I like this system because no limit string of any sort is needed, and hence, there is nothing to hang up, which could result in no more Satan! Trim the key to give about 40 degrees of pop-up, and make sure it is long enough so as not to allow the stab to come off. I've never lost a stab, but for the weak at heart, put on a limit wire if you must.

The fuselage is probably the most time consuming part of the airplane, and I always built it last. I like to have the wing and tail covered and doped by the time the fuselage is nearly done, so that they can be strapped to the body, and the center of gravity checked prior to the pylon being permanently affixed. I build as much of the body as possible, including sheeting, fin, sub-fin, and so on, bolt on the motor and gear, and put

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on the wing and tail. You have to give an educated guess as to how much weight the finish will add to the tail of the fuselage, but if anything, you want a slightly nose-heavy model. It takes very little ballast to move the C.G. *back*, and a *bundle* to move it forward! Slide the pylon back as necessary, but not more than half an inch. Still going to be tail heavy? Better check that stab weight, and build another one if necessary.

I recommend building the fuselage upside-down on a good centerline. Center mark every former when you cut them out (ACCURATLY!) Cut the pylon formers to 5/8-inch depth to accept the pylon, but leave the pieces in place, and center mark all of them too. Cut out the fuselage sides, and be sure there is no bow up or down in them.

Frequently, when you cut a long sheet of balsa diagonally, it will bow somewhat, so I cut them a bit on the large side, and then trim with a straight edge down to the proper size.

Tack the tail together, pin it down to the center line, then proceed with the formers. The nose, back to the second former, has a 1/16 ply, inside doubler on each side, and a 3/16 balsa doubler on the inside of that. See detail sketch on the plans. The 1/16 ply has 2-56 blind mounting nuts epoxied in place for Allen-head screws to mount the timer, and the proper size hole cut into the doublers to fit the timer. Also, don't forget the 4-40 blind mounting nuts in the firewall to fit the motor mount.

The doublers in the nose section take some time to fit up properly, so that the 1/8 square spruce longerons will fit all the way up the body to the firewall. The effort is worthwhile, as a very strong front end is achieved in this manner.

Still, after all the sheeting is in place on the top and bottom, epoxy and light fiberglass or nylon tape is placed over the firewall and front end back to the second former.

Leave the fuselage pinned down to the center line after the formers and doublers are in place, cut the 1/8 notches in them, if not already done, and fit in the spruce longerons. They should be tapered and fit all the way to the tail end. After drying, sand down any rough edges, and place the 1/16 diagonal sheeting all the way to the tail end.

Wait for all of this to dry well overnight and then pull it up. The result is a very straight body that will stay straight while you do the work from the top side. Knock out the pieces in the pylon formers, and see that a piece of quarter inch stock will fit properly into the all.

Next, locate the position for the ply stab platform, and lay a straightedge across. Trim down the side of the fuselage slightly, until stab tilt is as shown on the plans. Your Satan may require more or less stab tilt to achieve the proper left glide circle, depending on several factors, including how tight a glide circle you like. If a large circle is used, it will hunt out thermals and tighten up into them when it finds one. Windier conditions and small field sizes dictate tighter glide circles.

Now cut the notches in the top of the formers for the spruce longerons, and glue them in. Pass the spruce just under the cut for the stab tilt, and later, when the cement is dry, block sand the top so that it is flush with the spruce. The fuselage then has a very slight dip on one side that no one will notice . . . unless you tell 'em . . . so don't! Go ahead and put on the top sheeting, with the grain diagonally opposite to that on the bottom, stopping at a point just behind the pylon, and just ahead of the stab platform location. Glue the platform on now, and put the 1/8-inch cross-grain sheeting from the aft side of the platform back to the tail end. After this is all dry, trim all overhanging sheeting down flush to the sides.

Cut out the fin and sub fin, including the spruce on the sub fin. These must fit very well, as they are butt glued to the body. I leave mine unfinished until they are glued in place on the fuselage. This way you can actually align the fin with the pylon, and be sure it is straight. I use a piece of thread pulled taught and laid from the inside edge of the forward pylon notch and laid against the fin. Check the other side and when the exact center is found, mark the fin and fuselage with a very sharp pencil. Glue securely. With Titebond, the butt joint is plenty strong . . . I've never broken one loose.

If you prefer to cut out grooves for the fins, be sure to extend the fins by the depth you drop them in . . . the fin area on this airplane is very near the critical point, and any off-handed whacking off of fin area will result in a nifty zero-stability barrel roll just before your new Satan self-destructs! The fin is intentionally at the near critical point so that the airplane will turn into lift easily in the glide. A too large amount of fin area can result in an aircraft that will actually turn *away* from lift when it gets near it! Walt Mooney had an airplane that did just that at one time. It flew fine, but never thermalled. Then one time when it and another model were up at the same time, and very close, he saw the one turn into a boomer, and his own turn the other way. Too big a rudder was the conclusion, and after some surgery, the problem was solved . . . So much for fin areas.

When the fin and sub fin are in place and dry, sand to a streamlined shape. A line drawn down the center of the trailing edge of the fin is a great help when sanding, to ensure that you don't sand the fin to one side, rendering useless all your efforts to make sure it was straight to begin with.

If you have not built the pylon by now, do so. Before cementing into place, check the C.G. as discussed previously, then go ahead and finish the sheeting around the pylon, and finish the fuselage up. On smaller models such as this one, I like to tissue the entire body, and then finish it up with either clear or color epoxy. If you use the pacifier fuel system, it is most advisable to pour some Super-Poxy into the cavity for it, and slosh it all around to thoroughly fuel proof the inside in case of pacifier breakage. I hope your formers fit well inside, or you'll have epoxy running all over the place!

You can build the landing gear in behind the firewall, but I think the type shown has several advantages. For one, if it breaks, it is very easily replaced. For another, and more important, it makes conversion to floats for ROW a snap.

A note in passing on finishes. We are in an age where miracle finishes are available from several sources, such as Monokote and Solarfilm. They are great from several points of view; super fast covering and finishing time, and very puncture proof, bright, non-fading colors, water and fuel proof. These covering materials *do* have some disadvantages that should be considered before use though. In hot, dry weather they loosen up (Top Flite says the structure shrinks . . . and it does, but the net result is the same . . . the covering is a bit loose). On a very light structure such as a competition free flight, this can be disasterous, as flutter will set in and the wing will literally explode, or wash out one or more of the panels at high velocities, ending in a crashed airplane. A super-duty structure helps, but any slight, covering-induced warps will be lost or at least change when the covering goes loose (even just a little that

you cannot detect) and will cause serious trim changes from one flight to the next. I have a Ram Rod 600 with a film finish, powered by a very hot Super Tigre .29, and if the motor is run on anything much hotter than peanut oil, the wing does a kind of Irish jig on the way up . . . and then down. I've retired it until it can be re-covered. My own recommendation for covering is good ol' Japanese tissue. Double-cover if your normal flying site is hard on airplanes. Use TCP in your dope to stabilize the shrinking, and let your flying surfaces cure, checking them carefully before each flying session for at least several weeks.

FLYING

Key the wing and stab now. To check squareness I use a piece of thread tied around a pin, stuck in the very end of the fuselage, pulled taught and touched from tip to tip, to see that it is keyed properly. If not, trim out the key slot in the wing saddle until alignment is true and then fill in the side of the slot with card stock or whatever needed to fit the key in place so the wing will not shift. Do the same with stab.

Now you're ready to see if it glides.. Run down to the nearest field with tall grass (Hmmm), and hand glide. If the model hits you on the foot, it may be nose heavy. If it does a gigantic stall and crashes into that tall grass, it may be tail heavy. In either case, check that the C.G. is in the right place (3/8-inch forward of the very trailing *edge*). If the C.G. is right, the fuselage may be bowed up or down. If so, shim accordingly until some semblance of a glide is obtained. You can't tell much from handgliding, so if it shows no radical tendencies, start power testing.

If the *C.G.* is right, *incidence* is right, the *fin* is *on straight*, with the right *stab tilt* and *wash-in* and *wash-out, down thrust* as shown, and *side-thrust* as shown (DON'T forget the sidethrust!), it'll fly. How well is up to you from this point. Use about a 4 second motor run, at nearly full power (just crack it over to a two-cycle, but don't lean it down). No, don't put the prop on backwards . . . that's only asking for trouble. With the short, near-full power run, the model should get the nose up good, and be starting into its right climb, accelerating rapidly. If the glide is O.K., go to full power, short run, and fly it again. Make adjustments as necessary, one at a time, and in small increments. Use very short fuses, to eliminate chasing as much as possible.

Some notes on trimming are in order, especially if you're new at competition free-flights. Remember that for the glide, stab tilt shimming under one side of the stab platform for more or less glide turn will tend to decrease the climb angle somewhat. If the climb is too steep, and more or less glide turn is desired, this can be used to advantage. Also, tightening the glide turn will take out slight stalling tendencies, and opening the turn may induce a slight stalling tendency.

In any event, make small changes *one at a time*. I use match book covers or card stock for small shims a lot of the time. C.G. changes will have no effect on the power if they are not accompanied by incidence changes, and can be used if necessary to trim the glide.

Changes in thrust will have no effect on the glide at all. Remember that for the most part, thrust adjustments have their greatest effect initially, before the airplane builds up speed. I use 8 degrees down and 4 degrees left thrust. The left thrust takes effect right away, and keeps the airplane going nearly straight, until other forces take effect and pull it into the right climb.

The wash-in in the right panel keeps the wing up under power. If your Satan has *any* hard-right tendencies prior to getting the nose up, it needs a bit more left thrust. This is essential, and must be delt with as a first priority!

Then get the right power pattern with power tab. Make power tabs with pieces of 1/16 or 1/32 sheet, 1/4 wide, and as long as needed to do the job. Cut them diagonally, like T.E. stock. Glue them on as needed to make adjustments. DON'T cut a tab in the fin thinking you'll just move it and pin it in place, or glue it. There is no way to tell precisely how much you change the tab from one flight to another.

Any *really* hot pylon ship is very sensitive to adjustments. To give you an idea of this so you'll have a starting point, mine went from a straight up, slightly left (dangerous!) pattern at full power, to a bit too hard to the right with a tab 1/16 x 1/4 x 5/8-inch glued on the right side of the fin, 3/4 of the way up to the top of it. Cutting the tab down to about 1/2-inch produced the perfect pattern. Remember too, that power tabs will effect not only the turn under power, but the climb angle as well. If you put on more tab to get more turn, the climb angle will lessen, and if you open up the power turn, the climb angle will be steeper. When the power pattern is *very* close, use card stock glued to the fin on top of the tab. High powered airplanes respond quickly to very slight adjustments, so take it a little at a time.

Hot pylon ships can be a challenge at times, even in experienced hands. One change at a time is a good general rule . . . that sometimes needs to be broken. Only experience can tell you when it should be broken. Watch every flight carefully, and keep your thinking cap on. If the ship does something squirrely, think it through, right when it happens, to be sure of what it did, so that thought-out adjustments can be made.

I get a very steep rolling climb of about 3 turns at full run, with the airplane flipping out on the top with no loss in altitude. If the pacifier system is new to you, *do* give it a try. It really works well, and is much simpler than the conventional pressure systems. I use a simple Tatone pinch-off timer. A flood-off can be rigged with a T fitting, but I have found it unnecessary. With the pacifier, the needle is so close to shut off already (mine runs full bore at about 1/2 turn open) that when the timer hits the tubing, the motor stops very quickly.

The pacifier requires some practice to use without problems. A syringe is needed to fill it. Know how much fuel your engine requires for your normal settings, to give a full run without running out. Then mark the syringe, and after every flight, empty the pacifier, and refill to the proper amount. Remember, it is inside the fuselage, so you need to refill it to know how much is in it. Pinch the tubing off with your finger when holding the model to start it. Prime the motor, connect the leads, and crank it up. Release the tube the instant the motor fires. After a short while you'll get the hang of it, and it becomes almost automatic.

The more you fly and practice with the systems (like the motor/pacifier, D.T.), and so on, the more your chances of success. Form good habits and practice as if every flight was the one you need to get the record. Don't do something one way one time, and another way another time. You'll forget something once, and there won't be a next time until you build another airplane!

I hope these comments are of value to those of you who are new to pylon style competition free flights. Any comments or suggestions would be appreciated, and can be sent directly to me, Bob Beecroft, 4475 Utah St., San Diego, California 92116. ●

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