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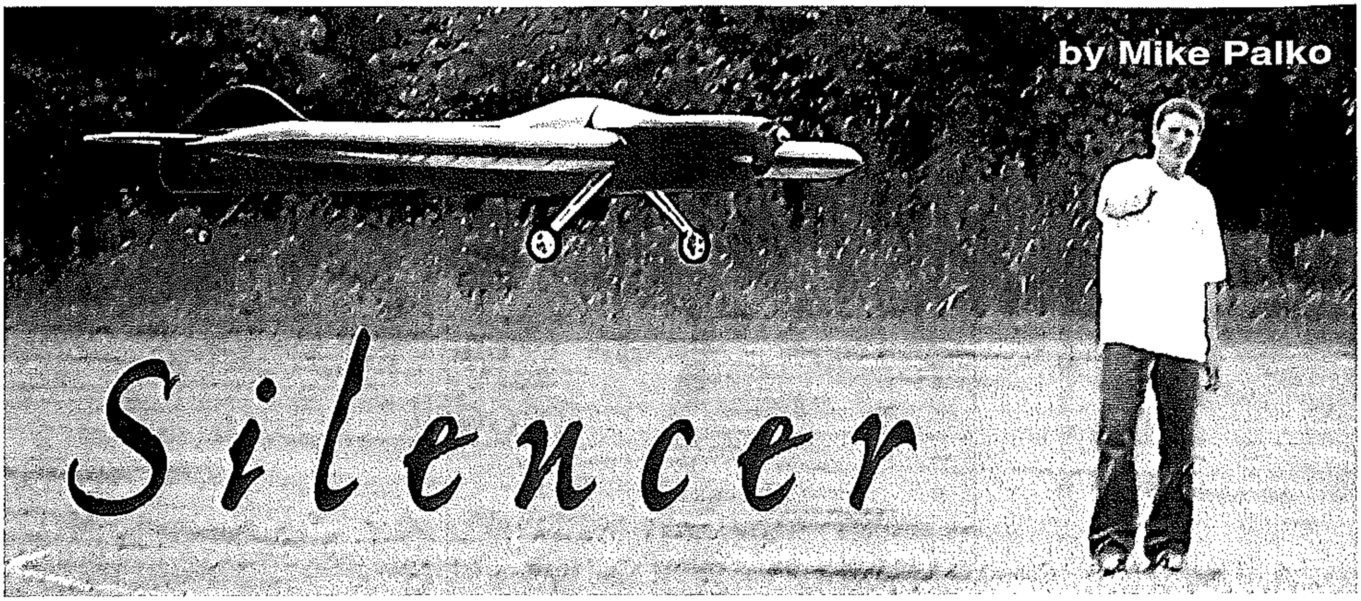


An electric revolution in action. This is the most successful electric-powered CL Stunt model to date. John Glatthorn photo.

Competitive electric-powered CL Precision Aerobatics becomes a reality

I HAD MY first experience with electric flight when I was 10 years old. I broke my plastic CL RTF model after just a few flights, and after that my dad and I decided to build an electric-powered RC trainer together. I thought it was the coolest thing ever, because, as with my RC cars, I just had to charge the batteries and turn the model on to fly. But its flight performance wasn't too successful, and I quickly lost interest in it.

Shortly after that I was introduced to a club called the Philly Fliers. I became interested in CL flying and haven't looked back. It wasn't until 1997, at the age of 17, that I became interested in electric flight again, and I built my first electric-powered Precision Aerobatics (Stunt) model.

I had seen several electric CL models fly, but none of them performed with enough authority or duration to be competitive. I'm not sure what it was, but I was drawn to electric power and thought it would be fun and challenging to see how well I could get an electric Stunt model to perform.

I had no idea where to start, so I built a Sig Twister and used an 05 can motor with a seven-cell battery pack to get a base point. As I worked on the project, I realized that I was not only developing a power system that was new to CL, but one that showed some real advantages in competition.

Some of the most important benefits were consistent motor runs, no CG shift during flight as the fuel burned off, and never having another over-run or an engine that wouldn't start. In addition, motors produce little vibration and leave no residue to soak into the balsa and eventually ruin an otherwise good Stunt model.

There are also drawbacks to electric power, such as power-to-weight ratio, cost, and safety. But as technology advances, electric power will continue to approach the performance of internal-combustion engines, and the safety issues will be addressed.

I worked with the Twister on and off until 2003, when I reached a point where I felt I was close to having a competitive Stunt model. At that point I needed to take the next step and design a new airplane from the ground up. The Twister flew great for an electric-powered CL airplane—better than most people had ever seen such a model fly—but it was still far from what I really wanted.

It was a profile, and it didn't have the drive to get through high winds. It was extremely close on run time, so if I missed the wind and had to take an extra lap or two or got blown out of a maneuver, it didn't have the battery capacity to get through to the end of the flight. The Twister was built so light that it was to the point of being weak. I needed a new approach.

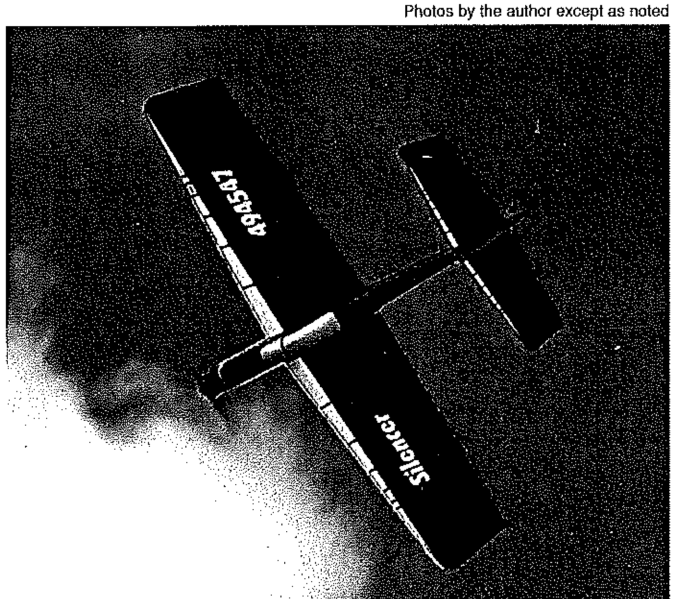
Power System: I felt that the Silencer would be the answer to the problems I mentioned. Its design would incorporate a stronger, more aerodynamic airframe and a new power system.

The biggest performance gain would be in the battery pack. I switched from a Sanyo 10-cell 2600 mAh NiMH pack to a Thunder Power (Gen2) 4S2P 4200 mAh Li-Poly pack. This is really two 2S2P packs wired in series because a 4S2P is not available off the shelf.

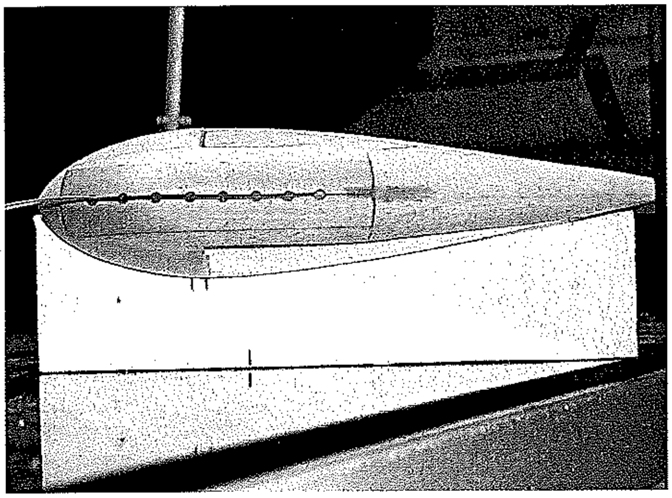
This change alone would increase the battery capacity by roughly two-thirds, increase the voltage by 2.8 volts, and drop the weight by approximately 8 ounces! It would allow me to run a higher voltage with a lower amp draw and maintain the same, if not increase the setup's, output in watts. It's safer and more efficient to run lower current with higher voltage because there is less heat buildup, which also increases the life of the motor and the battery.

I also switched to a motor that was capable of turning a lower-pitch propeller at a higher rpm. I replaced the AXI 2820/10 that I had been using with a Plettenberg Orbit 15-18, which can handle more voltage and higher current levels. I have found it to be more

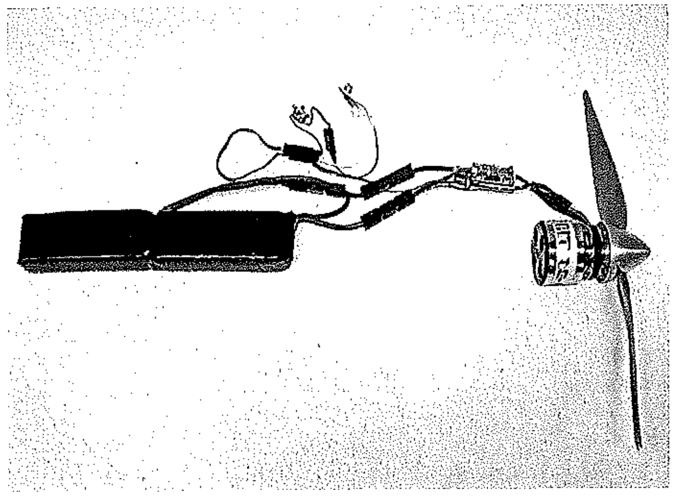
Photos by the author except as noted



It's hard to tell that the model is electric—until you realize that there is no smoke trail from burnt fuel! Will Hubin photo.



Mike's model has all of the normal flight-trim features, such as this adjustable leadout guide. Neat workmanship!



Power is the Plettenberg Orbit 15-18 motor, two Thunder Power 2S2P Li-Poly battery packs wired in series, a Castle Creations Phoenix-45 ESC, and a Sergio Zigras timer.

efficient than the AXI by 8-10%. This would give me more usable capacity from the battery, thus extending my flight times.

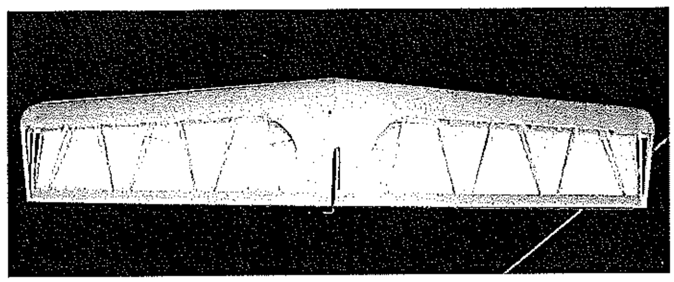
The AXI and the Orbit are brushless outrunners, or rotating can motors. This means that the entire motor case spins, creating a power plant that cools itself slightly and is capable of turning a large propeller without using a gearbox because of its higher torque output.

This was important to me because a gearbox adds weight, creates noise, reduces the strength of the power train—because it may strip or wear out—and adds cost and complexity to the setup. This does not mean that direct drive is the only way to go, but there were more negatives than positives in using a gearbox for my application.

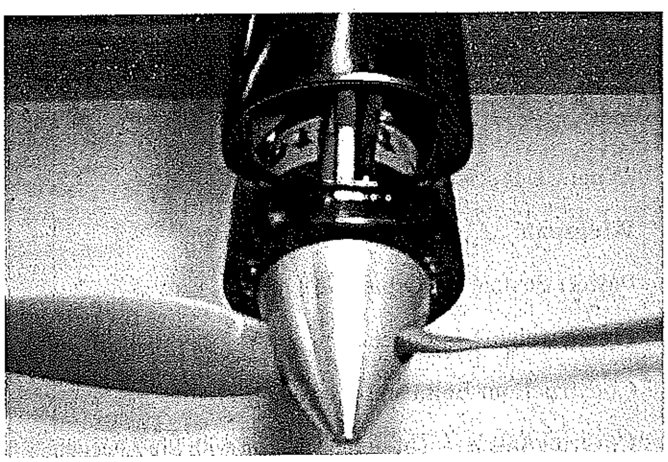
I had been using a Castle Creations Phoenix-35 ESC, which is capable of handling 35 amps continuously. I knew I would be pulling close to 35 amps, so I changed to a Phoenix-45 to increase the safety margin. The Orbit runs at full throttle the entire flight, so the ESC has to be able to handle the current and heat buildup for five to seven minutes at a time.

However, an ESC does more than control the motor's speed. The Castle Creations ESC controls eight parameters of the motor, including cutoff voltage and throttle type. These two factors are particularly important because they will benefit the CL flier the most.

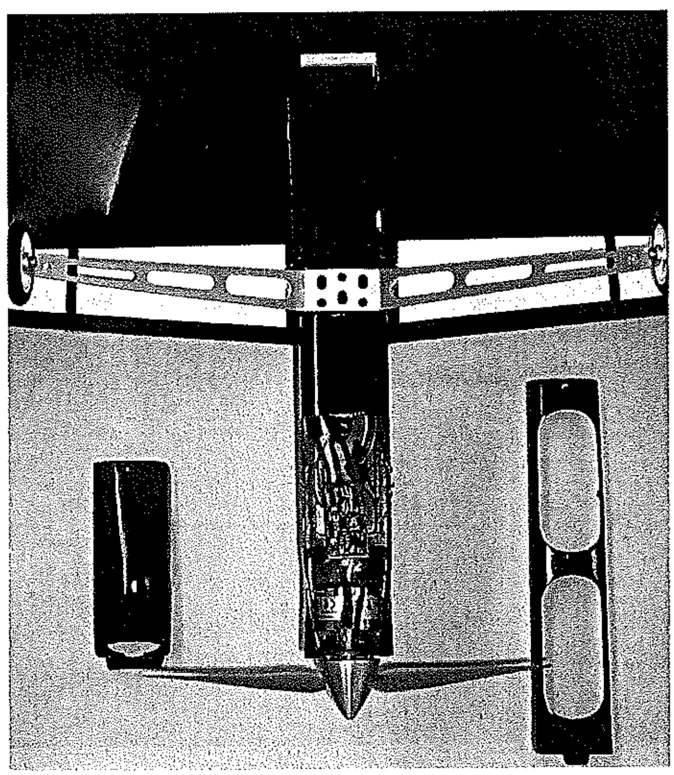
The cutoff-voltage feature is a must with Li-Poly batteries. With a 4S battery pack, you need to set the cutoff voltage to 12. Li-Poly cells should never be discharged to less than 3 volts per cell under load; otherwise, permanent damage or fire could result. If the timer would ever fail, the ESC would turn off the motor when the battery pack reached 12 volts, saving the pack and airplane from possible damage.



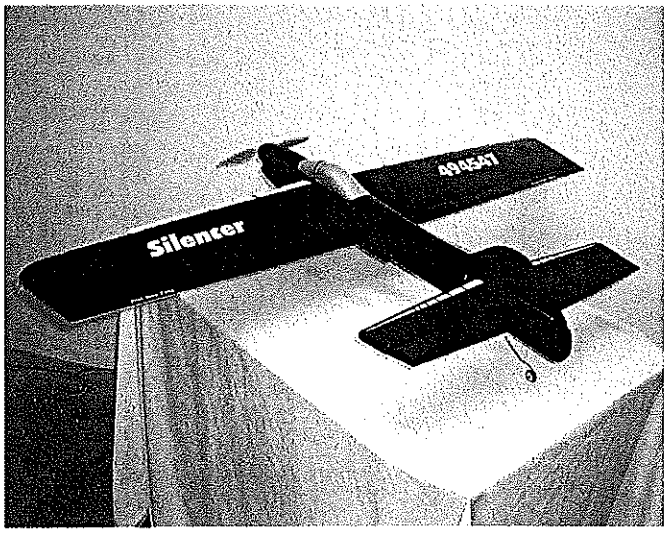
The structure had to be light and strong. Mike used the Lost Foam wing-building system to construct the rigid Warren truss-type wing.



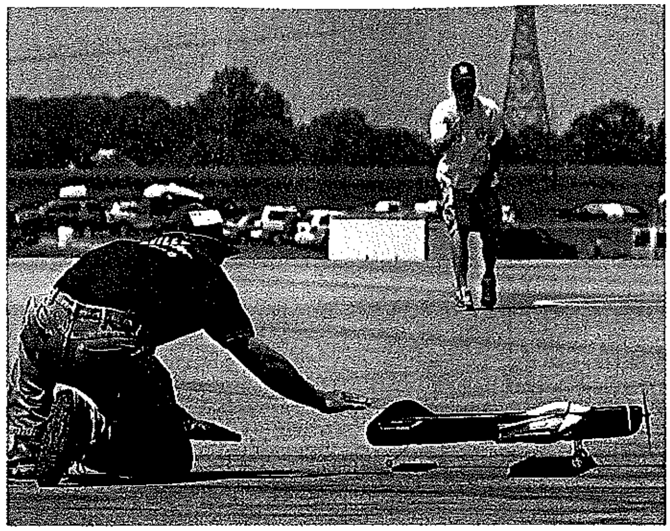
With the cowling on, the model's nose looks like a normal "engined" Stunter. Note the cooling holes in the nose ring.



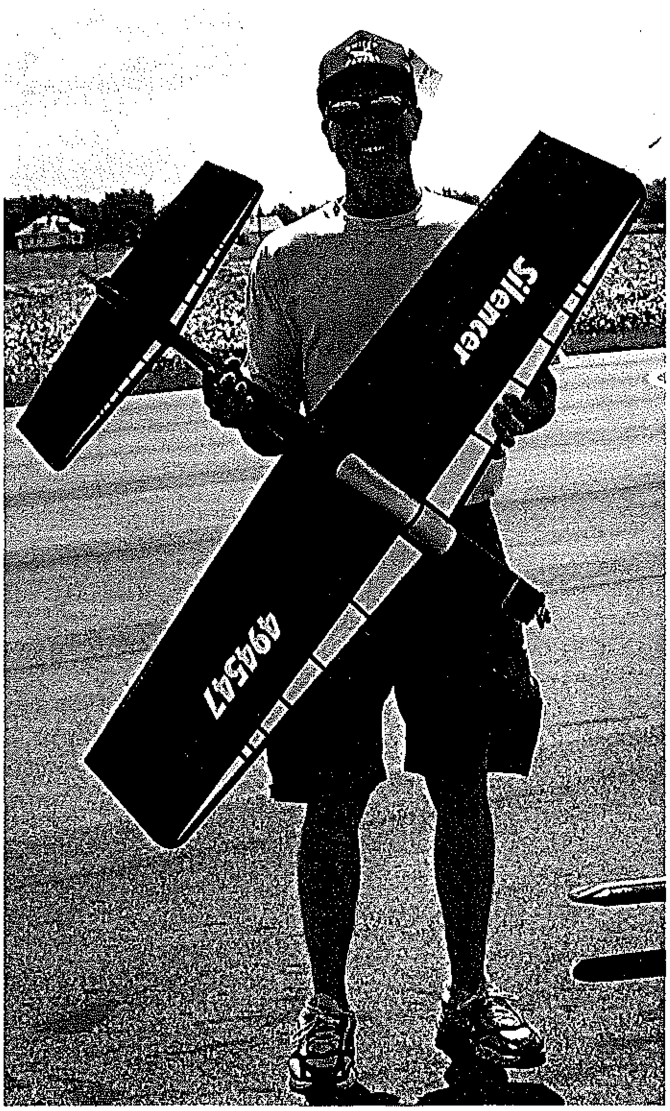
With cowl and battery cover removed, it's easy to see the system components' placement. Good airflow through this area is a must!



The sleek, clean model gives up nothing in aesthetics—or performance—to glow-powered models of the same size and type.



Dan Banjock launches Mike's Silencer during 2004 Nats Advanced competition. Mike finished a credible sixth. Hubin photo.



Does Mike look proud? He should! He has elevated the performance of electric-powered models to a competitive level in CL Stunt. Look for more from him! Hubin photo.

The throttle type can be chosen from four settings. I have learned that the high-rpm governor mode works best for our purposes. This helps hold the motor at a constant rpm, preventing whip-up and keeping a uniform speed throughout a maneuver, much like a tuned-pipe setup.

However, the ESC will not work without something telling it what to do. To control the ESC, I am using a timer that Sergio Zigras designed and built. The run time is adjustable from five to seven minutes by turning a small speed potentiometer. The timer plugs into the ESC and, when turned on, gives it a signal to arm and then slowly ramps to full power. No external power is needed to run the timer. It uses power from the Li-Poly pack.

As for the power system's weight, the motor weighs 6.21 ounces, the ESC weighs 1.06 ounces, the timer is negligible at .07 ounce, and the battery weighs 14.18 ounces. This is a total of 21.52 ounces including all connectors.

It seems heavy, but with attention to detail and the lack of plywood doublers, engine beams, and crutch, the bare airframe's weight can be lowered dramatically to compensate.

CONSTRUCTION

Keep the overall construction as light as possible. I weighed each part as I built the Silencer, looking for areas where I could save

Silencer

Type: CL Precision Aerobatics

Wingspan: 52 inches

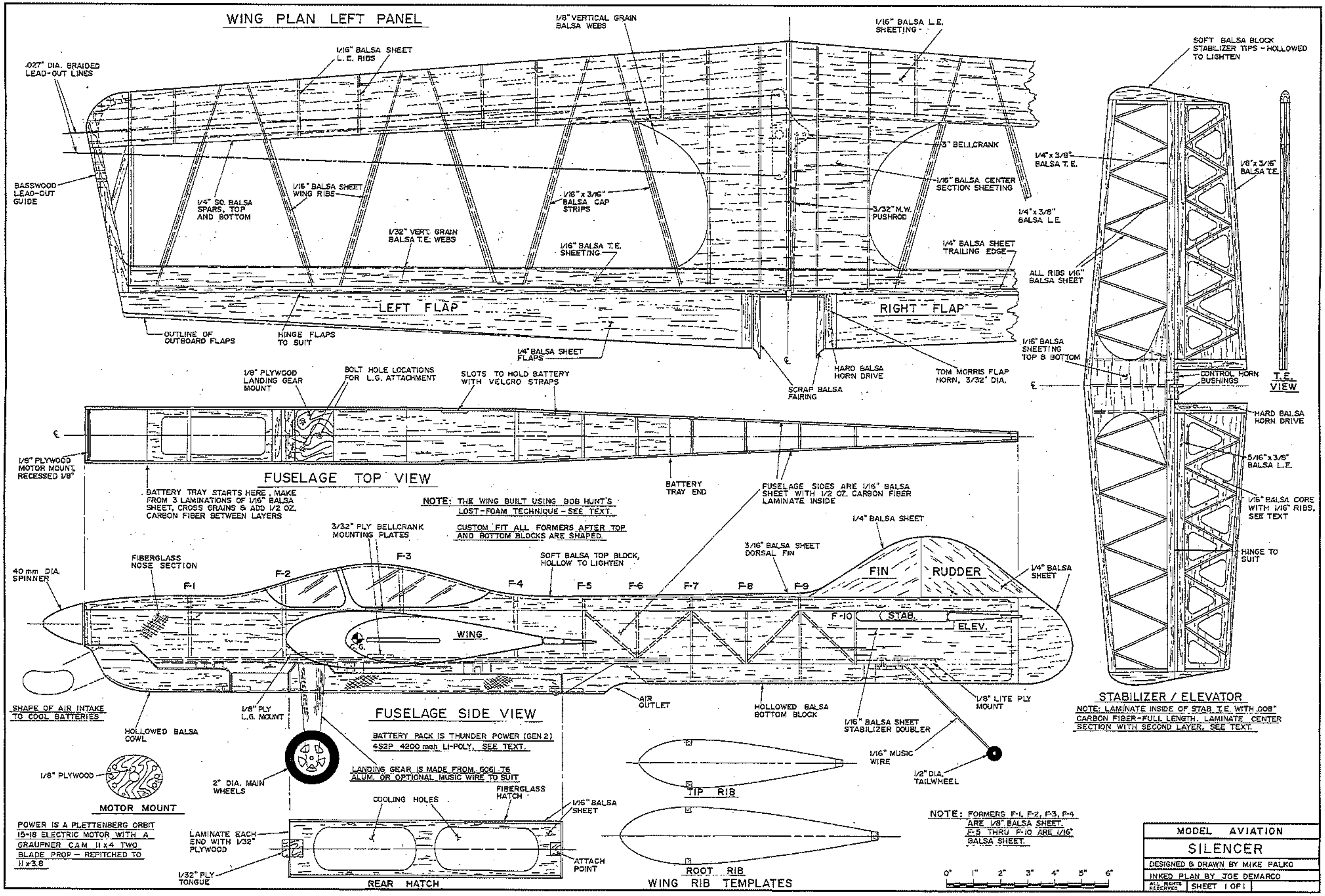
Power: Plettenberg Orbit 15-18 motor

Flying weight: 44 ounces

Construction: Balsa and plywood

Covering/finish: Light-grade silkspan with Sig Litecoat and Brodak modeling dopes

Full-Size Plans Available—see page 191



weight. Weight is the biggest concern with electric power because you are "behind" from the start; however, with the right wood selection and a light finish, you can keep the weight to a minimum.

Wing: The wing is built up and utilizes a Warren truss-type ribbing scheme. The main ribs are angled, and there are half ribs between the opposing sets of ribs at the LE to support the sheeting. The model has a 52-inch wingspan and 510 square inches of wing area, including the flaps. The wing panels are of equal length.

I built the wing using Bob Hunt's Lost Foam wing-building system because it is one of, if not the most, accurate ways to construct a wing. It allows you to build the structure extremely light and maintain its integrity, and it provides the easiest and most accurate way to produce the Warren-truss rib sets.

Using the Lost Foam method, you mark the desired rib locations on the front and rear of a foam blank that is cut to the planform of the wing. Cut and sand the core, and mark the rib locations chordwise on it using a ballpoint pen. Also mark the spar location on the core on the top and the bottom.

The rib locations are then accurately scribed into the lower cradle half from which the core was cut. This cradle is as accurate a negative shape as the core is a positive shape, and it can be used as a building fixture. The core is sliced vertically at each rib station, yielding perfectly accurate rib templates from which balsa ribs can be generated.

Bob has produced a two-video set about the Lost Foam wing-building system, and it includes all of the information about how to cut and prepare your own fixture sets. His company—Robin's View Productions—sells the videos and offers a cutting service. He can supply complete Lost Foam fixture sets for this model and hundreds of others.

To help keep weight to a minimum, I used 4- to 6-pound, contest-grade wood throughout. The flaps are made from 1/4-inch straight C-grain balsa, with the grain following the TE to help reduce the chance of warps. The outboard flap is 1/8-inch wider at the tip than the inboard flap is, to help the inboard and outboard wing panels lift equally in a turn.

The fuselage blankets the outboard wing because the model is flying in a circle and is angled somewhat tangent to the path of flight. Therefore, the outboard wing and flap have less effective area. The outboard flap's larger area helps the wing turn flat and without a rolling tendency, even though there is less airflow over it.

Tailplane: The stabilizer is 3/8-inch thick and is built using a Warren truss-style construction. The LE and TE are made from 1/4 x 3/8 balsa. I laminated the forward face of the stabilizer TE with .008-inch carbon fiber over the full span, and I used a double layer in the center-section for added stiffness. The tips are soft balsa, carved to shape and hollowed.

The elevators are 5/16-inch thick, and I built them using a sheet of 1/16 balsa that was shimmed 1/8 inch off the building board. The LE and TE were glued to the 1/16 sheet, as were the ribs. Then I flipped the elevator over and glued the bottom ribs in place.

I capped the inside root edges of the elevators with hard balsa to support the elevator horn, and I capped the tips with soft balsa and carved them to shape. The elevators were then sanded and tapered to 1/8 inch at the TE. Once they were completed, I went back and removed the wood between each rib to reduce the weight even further.

Fuselage: The fuselage is built with 1/16 C-grain sides. On the inside I doped on .5-ounce carbon-fiber mat as a replacement for the doublers. The motor mount is 1/8 aircraft plywood with three holes drilled and lightly countersunk in each side to allow for motor cooling.

The motor mount sits roughly 1/8 inch behind the front edge of the fuselage. The overhanging fuselage sides act as a small scoop to help guide air into the cooling holes. I put a fillet of Aeropoxy Lite on the inside and outside of the motor mount glue joint for added strength and to help smooth the airflow.

I covered the nose section with .75-ounce fiberglass, making sure to wrap around the front of the nose to reinforce the motor-mount joint. I also reinforced the inside motor-mount joint with .75-ounce fiberglass.

Final Assembly: Install the battery tray after the wing is joined to the fuselage. Once the wing is in place, its lower center-section needs to be removed for battery clearance. During wing construction, the lower bellcrank mount must be sunk into the wing $\frac{5}{8}$ inch so you don't sacrifice strength. Otherwise, this section of the bellcrank mount would be removed to provide clearance for the battery tray.

I made the battery tray from three layers of $\frac{1}{16}$ balsa with alternating grain, to make balsa plywood. I laminated each layer together with epoxy and .5-ounce carbon-fiber mat. I epoxied this tray directly to the landing-gear mount, the wing, and the lower bellcrank mount, tying everything together. I used Aeropoxy Lite to make fillets inside the battery compartment and around the wing to help blend and reinforce the joints.

I removed the lower wing center-section to position the battery pack as close to the airplane's centerline as possible, in an effort to keep the vertical CG in the proper location. If the 14-ounce battery was placed too far from the intended vertical CG, you could end up with an airplane that would rock and roll as speed changes were made during flight or cause the outboard wing to fly high or low in level flight, resulting in poor performance.

The battery pack tucked high into the fuselage also allowed me to have a fuselage with minimal side area. I wanted a model that would fly well in light or heavy winds. Airplanes with large fuselages or vertical surfaces are usually affected more by the wind or tend to "weather vane" during flight.

So far this design has proven to work extremely well. Its first real test was at the 2004 Nats, where I flew it in winds exceeding 20 mph, gusting at times to more than 30 mph. This was an extreme case, and in winds that high it's difficult to get any airplane to perform well. The Silencer made it through the wind slowly at times, but I was able to complete the pattern and land it safely.

Flying: The ready-to-fly weight came in at 44 ounces. This gives the Silencer a wing loading of 11.59 ounces per square foot of wing area, which is close to that of glow-powered Stunt models. Performance so far has been better than expected. As of this writing I have put only 25 flights on the Silencer, so I need to do more trim work to get it dialed in, but the potential is surely there.

The propeller is turning out to be one of the most important areas of trimming. First flights yielded lap times in the mid- to low-four-second range with a 10 x 5 APC-E propeller. The model is being flown on 19-strand, .015 x 60-foot, eyelet-to-eyelet control lines.

So far the best propeller for this model has been a Graupner CAM 11 x 4 two-blade, repitched to 11 x 3.8. On the same 60-foot lines, I am now turning 5.1- to 5.2-second lap times.

At launch the motor is pulling 32-34 amps and spinning the 11 x 3.8 propeller roughly 11,800 rpm. This equates to approximately 450 watts in, or .6 horsepower, and roughly 382 watts out to the propeller, or .51 shaft horsepower.

After the first flights, the battery temperature was 100° and the motor temperature was 140°, measured at the windings. The motor temperature has to be measured at the windings because the motor case spins and cools more than the windings, giving you a false reading. The Li-Poly batteries should never exceed 140° during discharge, and I have been told that brushless motors can handle as much as roughly 200° safely.

History: September 7, 2003, I competed in the Bergen County CL contest and finished with 497.5 points. This put me in eighth place out of 17 entrants in Expert with my electric Twister.

The following summer at the 2004 AMA Nats, I flew the Silencer to sixth place out of 37 entrants. I also received the James A. Hunt Technical Innovation Award for my accomplishment.

Thanks: This project has turned out to be more fun and rewarding than I ever imagined it would be. I thank Castle Creations and Thunder Power batteries for their fantastic customer service, along with everyone who has helped or supported me throughout this project. Without them, it wouldn't be where it is today.