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ELECTRIC SATELLITE 450

Take one of the leading FF Power designs, add today's electric motors and batteries, have a noted flier in the field stir it all together, and the result is the high-performance FF Electric model presented here.

■ Don Hughes

THERE'S no doubt about it. Electric power is making serious inroads in the model airplane hobby. Judging from the number of ads for Electric products, there is a relatively large segment of the modeling fraternity sold on the idea. Clean and quiet electric power is a natural for Sailplanes, since it fits in with the idea of silent flight and eliminates the need for launching devices. RC sport fliers appreciate the freedom from engine-induced headaches such as vibration, fuel-soaked structures, and noise complaints.

And then there is Electric Free Flight. I often wonder if there is any future for Free Flight as a whole, much less an obscure and seemingly impossible thing like Electric Free Flight. Electric power is at odds with everything Free Flighters hold as absolutes: weight is the enemy, and power is the name of the game. Since most Free Flighters are competitors, the search is for faster engines, better rubber, exotic materials, and incremental design improvement.

Why would anyone be interested in a concept where the battery and motor weigh more than an entire Gas model?

Furthermore, the performance is touted to be about as exciting as watching paint dry. The guy who put the first electric

Our author, Don Hughes, with the completed Electric Satellite 450. Easiest way is to buy a kit and use his modifications.

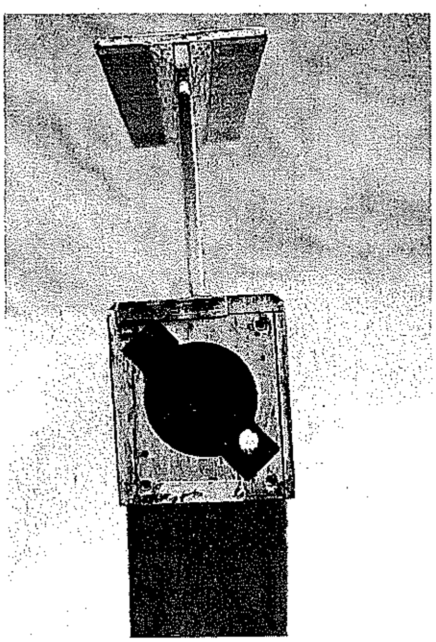
motor into a model certainly didn't do it as a challenge to F1C fliers! I've never understood, even, how enough interest was generated to get Electric FF accepted as an official AMA competition event. What was the motivation? I can only relate my personal experience.

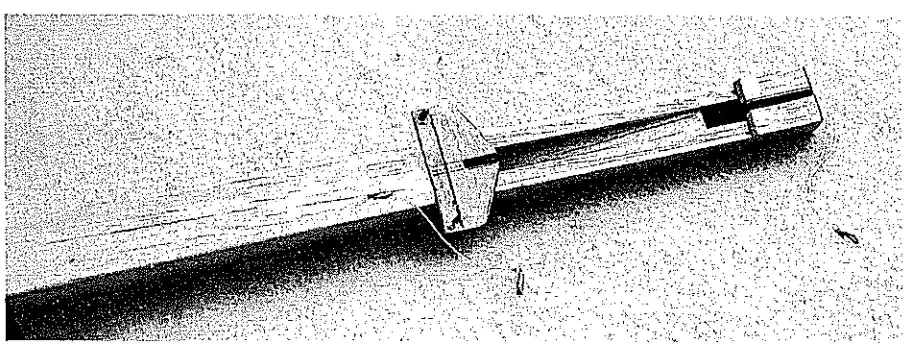
For several years before 1984, I was an avid Wakefield flier. The only thing I disliked about Wakefield is what I call the time-preparing vs. time-flying ratio. The constant making and testing of rubber motors really detracted from my enjoyment of flying. The Astro Flight ads caught my attention, and I rigged an old Wakefield for the 035 ferrite motor driven by six Sanyo N-250 Ni-Cds. It flew well enough to take second at the 1984 Reno Nats. I was hooked.

As they say, "That was then, and this is now." What can you expect from FF Electrics today? The best models will climb about like a Nostalgia Gas model; the limiting factor is the available power and weight. The surprise is how well these models glide. The typical 9-10 oz.-per-sq.-ft. wing loading doesn't seem to materially detract from the glide performance. In fact, the extra weight makes them good windy-weather fliers. With the extra motor run allowed Electrics, they often out-climb Gassies and thermal just like any other model.

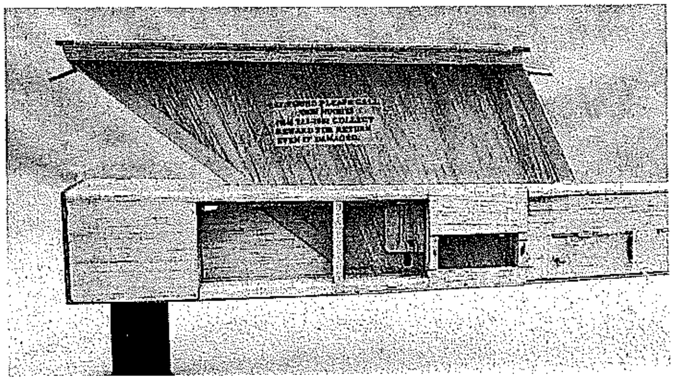
What can we expect in the future? I wish I knew. One thing is certain: better motors and batteries will become available if the RC car phenomenon is a reliable indicator. Looking back on the past six years, Electrics have improved from being a curiosity to real performers.

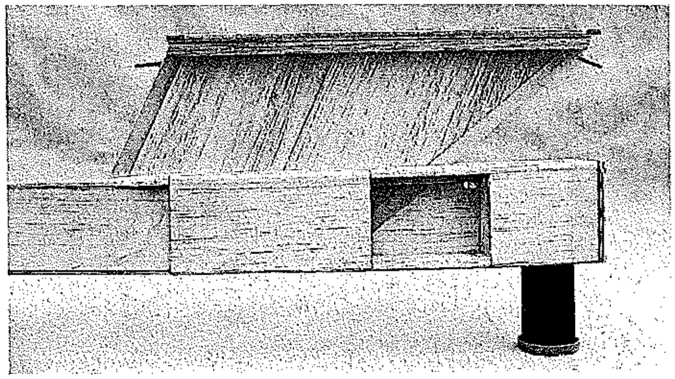
Why aren't more Free Flighters into Electrics? In my opinion, Gas fliers just aren't interested in something that "flies almost as good as a Gas model." Quiet flight isn't much of a factor in Free Flight anyway. Perhaps the entire Free Flight concept is outdated and will one day be confined to tiny reservations only allowing silent or highly muffled limited-performance models. Small Electrics will fit right in. Until that sad day, progress in FF Electrics will continue to be pushed by people who enjoy doing something different and challenging. If you are that kind of person or someone doing Electrics now but are looking for something better, the model presented here will get you on the right track.



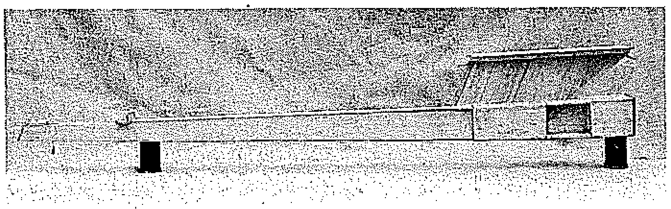


Left: Note the canted motor position in this view of the fuselage front bulkhead. Hole at lower right is for positive (+) lead to the motor. Not visible is a similar hole at upper left. Above: Stabilizer mount and fence for the pop-up-stab dethermalizer. Small cord emerging forward of the DT fence is for the auto-rudder. Doubled cord at the rear is the DT line.





Left: Close-up of the fuselage left front. You can see the battery, switch, and timer cavities. Note the holes for wires to pass left-to-right. Right: The right side, showing the cavity for a six-cell battery. If using seven cells for Class B, opening must be enlarged rearward.



Two views of the completed bare fuselage. You could build the model with the plans from this article, but the author suggests that it's easier to work with the Satellite 450 kit and just make the revisions he details. Sources are in text for all the things you'll need.

The Satellite design by Bill and Bob Hunter is about 16 years old. It has been one of the most successful and popular competition Free Flight Power models ever. I've been using the 450 version converted to electric motor power for the past five years, and it continues to be one of my favorites. Sure, there are more advanced designs with more performance potential, but the Satellite 450 has a lot going for it.

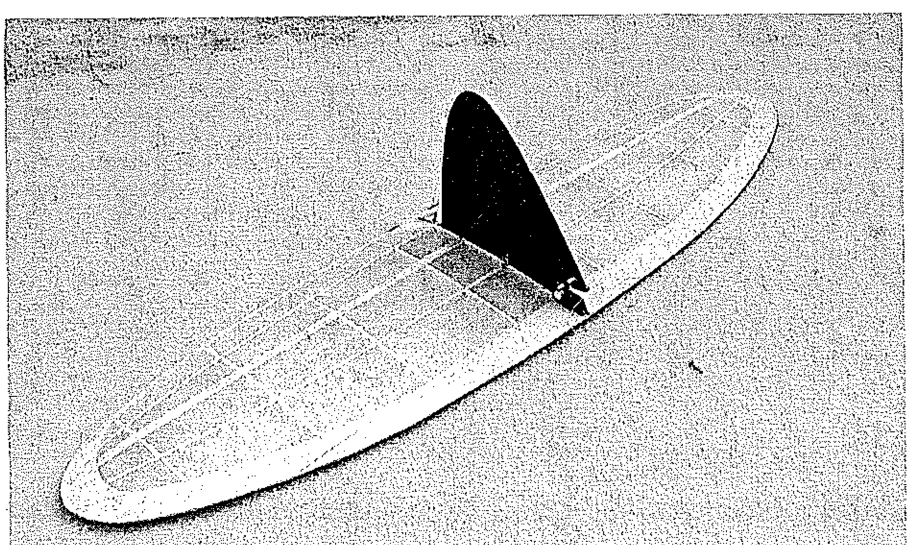
First of all, the Satellite 450 is available in kit form from Jack's Models, 7178 Aumsville Hwy., S.E., Salem, OR 97301. It is easy to build and flight-adjust, and it is consistent. Best of all, it is tough and doesn't require a lot of special reinforcement for Electric use. I've often said that Electrics can stand anything but a dethermalized (DT) landing. The extra weight really stresses the fuselage and especially the wing. High aspect-ratio designs require a lot of high-tech techniques using exotic materials to prevent fractures from the downloading upon ground impact.

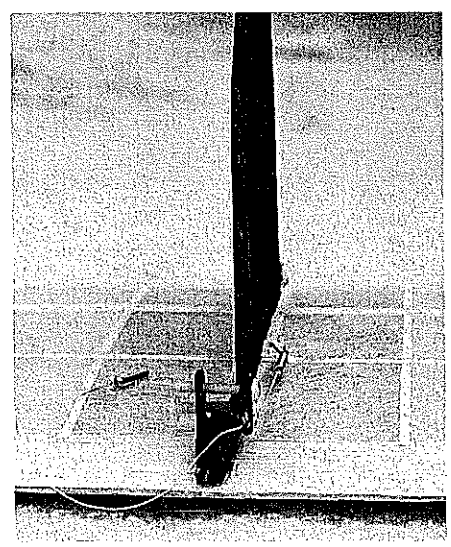
The Satellite wing can be built essentially stock and covered with one of the plastic films. The fuselage requires some redesigning to accommodate the electric motor hardware, but the basic model and layout remains unchanged. If you are an experienced Gas flier, I suggest you build the Satellite, anyway, just to get the feel of Electrics. Then go ahead and adapt the Electric concept to more sophisticated designs. If you are new to FF Power, this is an ideal starter model that really performs way above most people's expectations.

Build the six-cell, Class A version first to gain experience. Then build another one for seven-cell, Class B and be really surprised.

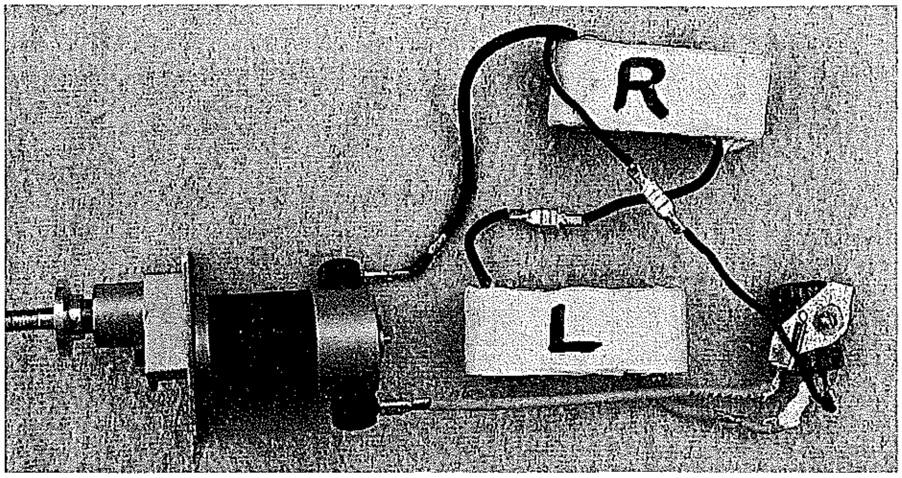
For those just now entering the world of FF Electrics, you couldn't have picked a better time. Until now, there hasn't been a really good motor for Class A, six-cell competition. Sure, I could make the Satellite 450 perform well with a variety of motors, but it took at least 10 cells to do a proper job. This many cells creates the illusion of complexity and discourages entry into FF Electrics. In addition, most reasonably priced battery chargers will only handle six to seven cells.

Astro Flight now makes a special Free Flight version of its geared 035 cobalt motor that really hums on six or seven cells, and I don't recommend anything else. Bob Boucher has given it Catalog Number 6604G, and the price is $119.95; delivery should be in a couple of days

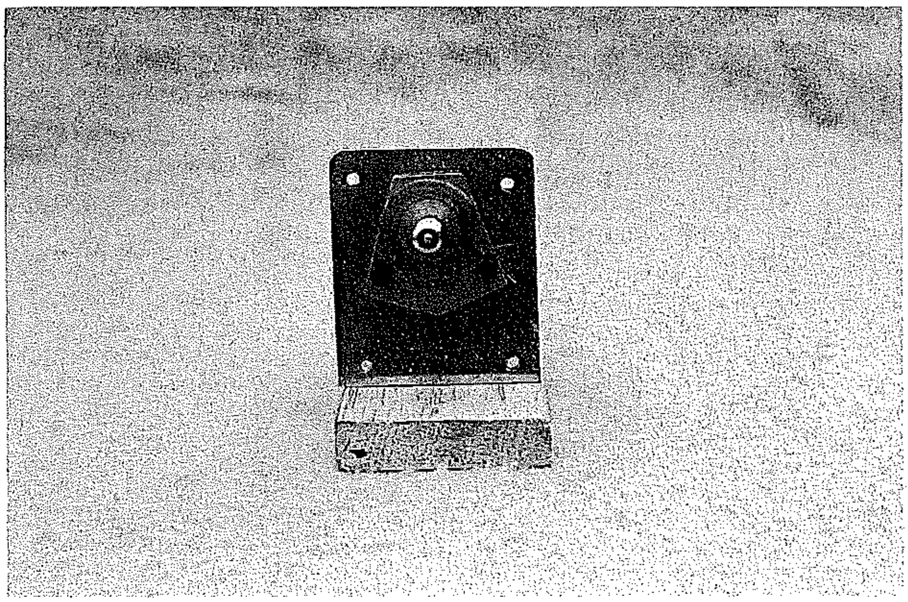




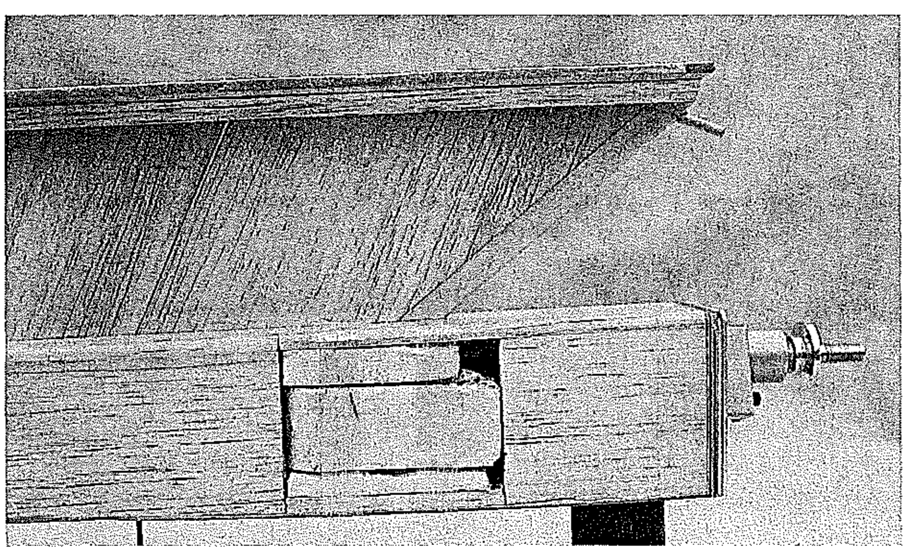
Left: The stabilizer and rudder. It's important to keep the tail end light, though the motor can be moved forward slightly to achieve the correct balance position. Right: The auto-rudder details show here. Note the spring pulling the tab against the glide-adjust screw.



The complete wiring harness is seen in this picture. If you exercise a little care, you can test-run the motor without its being mounted in the model. All photos are by the author.



Motor mounted on the sheet aluminum plate. The pinion must be 1⁄16 in. farther out on the shaft to accommodate the plate.



Right side of the completely assembled fuselage. The motor battery is held in place with filament tape and foam blocks. Motor is the Astro Flight geared 035 cobalt #6604G.

from receipt of your order. This is the only gear-drive, commercially available motor that will withstand the typical Free Flight monster crash.

As long as I'm on the subject of hardware, here's what you will need, in addition to the Astro Flight motor, for support equipment:

• A six- to seven-cell battery charger. There's lots of choices. As a minimum, get one with a current meter and current-adjust control.

• A tachometer/voltmeter by Nor-Cal. The only way you can tell how well your Electric system is working is with a tachometer. You will need the digital voltmeter to peak-charge the battery. Nor-Cal has combined the two instruments into one.

• Get the kit from Jack's Models and save yourself a lot of time.

• Order an 11 x 6.6 Aeronaut Freudenthaler propeller assembly from Hobby Lobby. This is the only source I know. The Freudenthaler is the best commercial prop I've ever used.

• Contact Doug Galbreath, 2810 Chiles Rd., Suite B, Davis, CA 95616 and order a Seelig ½A Mini-Combo timer.

• Order six or seven Sanyo N-600SCR Ni-Cd cells. They are available from a number of sources, Hobby Lobby for one. Buy individual cells, as you will be making up the battery pack yourself.

• Get lengths of red and black highly flexible #16 wire from your favorite RC car store. Trinity puts it up in little packages.

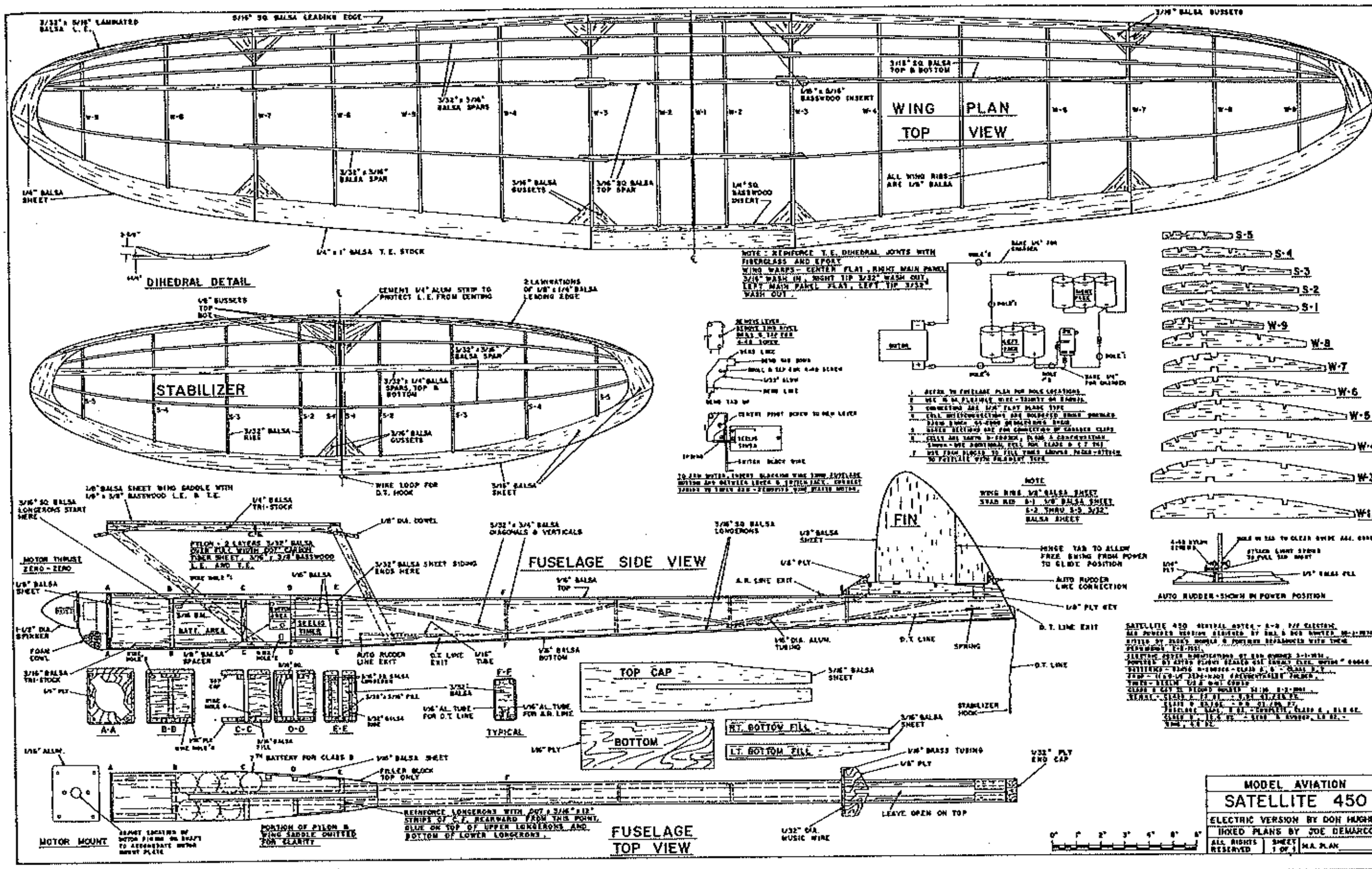
• Study the microswitch shown on the plan, and get one like it from your local electronics parts house. (Radio Shack does not stock one large enough to do the job.) Be sure it will accept push-on connectors. While you are there, get a package of male and female 3⁄16-in. flat-blade wire connectors. Also, get a coil of desoldering braid to use for the battery interconnections; doubled Radio Shack #64-2090 works very well.

• The model uses a bit of carbon-fiber in the fuselage, so you will need a sheet of the .007 material.

Start with the fuselage. Study the plan carefully, noting the differences between the Gas and Electric versions if you bought the kit. Cut the tail boom sheet balsa sides, which end at station E-E. The 3⁄16-sq. longerons end at station B-B. Glue the longerons to the sheet balsa sides using thin cyanoacrylate glue (CyA). Cut and notch the 3⁄32 x ¾-in. verticals, and glue them in place on the right side. Add the diagonals. It should be possible to mate the two sides together, but don't glue them together just yet.

The kit version of the pylon wing mount uses ⅜-in. balsa, but I prefer the thinner type which is shown. Be sure to use the carbon-fiber core and the basswood leading and trailing edges. Add the triangular section that runs between the lower leading edge and section B-B. The pylon must exactly reproduce the shape and angles shown on the plan. Do not add the wing saddle yet.

Full Size Plans Available-See Page 178



Mark a horizontal line on both sides of the pylon to show the path of the upper longerons. Glue the 3⁄32 x 3⁄16-in. filler strips to the inside of each longeron from the location of the pylon trailing edge forward to the end of the longerons.

Assemble the fuselage sides together, and try the fit of the pylon. Disassemble the fuselage sides and pylon. Position the pylon on the right fuselage side with the top longeron aligned along the pylon line. Glue the top longeron *only* to the pylon. Pin the fuselage side to the plan. Bend the longerons to align everything with the plan, and glue the bottom longeron to the pylon. Add the left fuselage side, making sure the longerons are properly aligned on the pylon. Add the 3⁄16-sq. filler between the longerons, forward of the pylon.

Cut out the bulkheads, top cap, filler strips, and 1⁄16 plywood bottom. Glue the top cap in place on top of the top longerons. Glue section B-B, D-D, and E-E bulkheads in place. Add the top and bottom 3⁄16 filler strips and the 1⁄16 plywood bottom. Add the 1⁄8-in. nose and 1⁄16 side sheeting. Add the wing saddle, and complete the rest of the structure except for the tail boom bottom sheeting.

The control lines for the DT and auto-rudder run internally just under the bottom sheeting as shown in section F-F. I use .015 piano wire for the main section of the DT line forward of the tension spring. Just bend a small loop in the wire end to attach it to the timer release arm. Use very strong Dacron line for the portion of the DT line between the tension spring and the stab hook. Use the same Dacron line for the auto-rudder line. You will need a light spring in this line, as well as a means of connecting it to the rudder tab.

Electric Satellite 450

Type: FF/Class A or Class B Electric Satellite 450

Wingspan: 56 1/2 in.

Recommended motor size and type: Astro Flight geared 035 electric motor, Sanyo N-605CR battery packs (Class A, 6; Class B, 7)

Number of RC channels recommended: N/A

Expected flying weight: Class A, 27oz.; Class B, 28.1oz.

Type of construction: Built-up balsa/basswood

Type of covering finish recommended: Clear Micafilm

The system I use can be seen in the photos showing the auto-rudder detail and the stab mount. A short length of Dacron line with a small screw tied to one end can be seen fastened to the rudder tab. This screw threads part-way into a small spring at the end of the auto-rudder line seen emerging from the top of the fuselage ahead of the stab fence. This provides both a connection and line tension.

Complete the fuselage by adding the 1⁄16 balsa sheeting from the bottom. It is a good idea to wrap the nose at the plywood bulkhead with fiberglass or 3⁄4-in. nylon reinforcing ribbon. Finish the fuselage any way you like; a few coats of dope will work. There's no fuel-soak problem with Electrics. Note that there's no landing skid. I've found that the model survives DT landings better if the impact is spread over the fuselage length. The plywood bottom prevents serious damage.

If you look carefully at the left side photo, you will see a wire and spring just behind the timer cavity. This is the timer auto-start device. A section of .015 wire is guided through a piece of 1⁄16 tubing so it blocks the timer fan. A piece of tubing is threaded over the wire and mashed to provide a place for your thumb. The end of the wire is connected to a light spring. To arm the release, hold your thumb on the mashed tubing, and connect the spring to a hook on the fuselage side. Launching the model and releasing your thumb causes the spring to withdraw the wire from the fan, and the timer starts. I prefer this to manually starting the timer.

A little motor work: When you order the motor from Astro Flight, be sure to tell them that you intend to use a 1⁄16 aluminum plate between the motor front face and the gear drive assembly for the motor mount. This means the motor pinion must be located 1/16 in. further out on the motor shaft. (The pinion is pressed onto the motor shaft, and it is easier

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Satellite 450/ Hughes

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to have it located correctly the first time).

Inspect the motor brushes to see if they are fully arced. Partially arced brushes will not safely handle the current and will require further break-in. I use my battery charger as a voltage source. Set it for about 4 V. Be sure the motor rotates clockwise, opposite to the prop rotation. Loosen the motor through-bolts, and rotate the brush end-bell while the motor is running. Observe the current meter, and position the end-bell for minimum current. Tighten the motor screws. Now just run the motor until the brushes are fully arced. The motor will get hot, so provide some means of cooling. I just put mine in the freezer with leads coming outside to the voltage source. It may take several hours to fully arc the brushes.

The motor is now ready to be timed. Optimum timing is the position of the brushes relative to the magnets that gives the highest rpm at the lowest current. Timing should be done with the prop and battery pack with which you intend to fly. There are factory timing marks on the motor, but they may not be best for the voltage and load used in this application. You really should check it out. There's more on this subject following the section on wiring and batteries.

Wiring the model is really simple. If you can wire an ignition engine, you can wire an Electric. Just study the wiring diagram on the plan and the assembly shown in the photograph. Note that disconnects allow disassembly of the components from the airframe without unsoldering.

First, make up the two packs of three cells using doubled desoldering braid soldered directly to the individual cells, even though Ni-Cd manufacturers caution against soldering directly to the cells (they cite potential damage). The reason for soldering to the cells rather than using the small welded tabs is that there is much less contact resistance with the soldered connection. Less resistance means more output voltage, and more output voltage equals more rpm. It is common practice to solder to the cells; I haven't had a problem. Just be sure to do the soldering quickly to minimize heating. Use masking tape to bind the cells together. Complete the wiring, keeping the leads as short as you can.

A word about battery charging: Even though these cells are the quick-charge variety, the initial charge should be at a slower rate. About one amp should be OK. How can you tell when they are fully charged? You monitor the charge voltage with the digital voltmeter and will see that the voltage slowly increases as the battery takes the charge. When the voltage peaks and then drops off about .02 volts, the charge is complete. Subsequent charges can be done at four amps. Ni-Cds have to be charged and discharged several times before they reach their full potential. It's just their nature.

Now that we have the voltage source and a wiring harness, let's go back to motor timing. Wrap the front portion of the motor with masking tape to bind the front end-bell to the center section. Remove the motor through-bolts. This will allow free rotation

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Satellite 450/Hughes

Continued from page 137

of the end-bell. Install the prop and the wiring harness. While holding the motor together with both hands, have an assistant operate the microswitch to start the motor. Rotate the end-bell, and note the position that gives maximum rpm. It will be fairly easy to bracket the location. The most efficient location will be that giving maximum rpm with the least advance (clockwise) rotation.

Recharge the battery, and repeat the test a few times to validate results. Done carefully, you will achieve the highest starting rpm and the least rpm decrease during the motor run. Now you know why the tachometer is important. Mark the end-bell and the center section so you can repeat the setting. Reinstall the motor through-bolts. It is possible that the threaded holes in the end-bell will not align with the gap between the magnets, making it impossible to reinstall the through-bolts with the end-bell in the new position. Not to worry. All that is needed is to drill and tap new 2-56 holes in the end-bell. It will be worth the effort.

Fit the motor to the mounting plate, and install the motor in the model. Cut the plate somewhat oversize. Drill the motor shaft and gear-drive mounting holes in the plate, and attach the plate to the motor. The motor brush axis will be canted, the exact angle depending upon the individual motor timing. Slip the motor into the nose cavity, pressing the plate against the bulkhead.

Using the nose bulkhead for a pattern, trace the outline on the back of the motor plate. Remove the plate, and finish it. The plate is fastened to the model with 2-56 screws and T-nuts. The prop shaft may not be exactly centered in the nose, but small variations are of no consequence. The main purpose of the foam cowl is to keep dirt out of the gears. It is fastened to the fuselage with filament tape. When you've assembled all the components, you've completed the fuselage.

The wing and stab have conventional construction, so I won't go into much detail. It is very important that the stab/rudder be kept light. I have three of them, and they all weigh within four grams of each other and the target weight of 1.2 oz. If the stab is too heavy, the center of gravity (CG) will be off. You can compensate by placing a ¼-in. shim (or more) behind the motor mounting plate, but a much better solution is to make the stab light in the first place.

The wing ribs can be either ⅛-in. or 3/32 balsa. Note the basswood inserts in the leading and trailing edges of the center section. The original wing tended to fracture just outboard of the wing saddle. Adding the basswood cured the problem.

The rest of the construction is like the original. Pay attention to the called-out wing warps. It is easy to kill the model without the washed-in right main panel. The flying surfaces can be covered with film and will not flutter under power, due to the thick wing. I use clear Micafilm, because it is light and tough. The new lightweight Solarfilm might also be a good choice for covering.

We are just about ready to go flying. First, make sure the CG is correct—or at least close to that shown on the plan. Initially, there shouldn't be any stab tilt. Check the wing warps one more time. Reset them with an iron if needed. The model flies in a right turn both under power and in the glide. Transition is accomplished by applying the glide rudder about two seconds before the end of the motor run. This drops the nose and starts the model on a flat turn. Set the timer function so that this sequence occurs. Lock the rudder tab at zero deflection using both adjusting screws.

Hand-glide the model. It should go straight ahead in a flat glide without a trace of stall. Adjust the rudder tab and stab incidence until this is achieved. Before attempting a powered flight, check to see that the rear stabilizer location key slides smoothly out of the fuselage groove. Any side pressure may cause the stab to hang up and only partially tilt. This will result in a spiral-dive DT—effective but hard to live with. Shim the leading edge of the stab where it contacts the fence until the key aligns perfectly with the fuselage slot.

The first powered flights are made without autorudder and with DT set to activate immediately after the end of the motor run. Set the timer for about a 4-sec. motor run. Charge the battery fully, and discharge it by running the motor for 30 seconds. Recharge, repeat the discharge, and recharge again. It is important that the battery be fully activated before making adjustments.

Launch the model nearly vertical, slightly to the right of the wind, and with the right wing down to induce the turn. Gradually lengthen the motor run, making incidence and rudder corrections as needed. Always fully recharge the battery between flights, and DT immediately upon termination of the motor run. No auto-rudder use during this phase!

Once you get a nice, steep, spiral climb, you can start working on the glide. Set the glide rudder for three turns differential from the power setting. Let the motor run for 15 or 20 seconds to get the model high enough to avoid disaster if the setting is way off. DT about 10 seconds into the glide. A nose-down or stalling glide can be corrected by shifting the CG. It takes about three turns differential between power and glide tab settings to get a good transition. If you find that this results in a too-tight glide circle, just counter with a little opposite stab tilt. That was easy, wasn't it? (The seven-cell, Class B version flies quite a bit faster than the six-cell, Class A and will take more caution when making power rudder adjustments.)

Now you need a place to show off. Since most Gas fliers don't believe Electrics can fly, much less fly well, you should be able to get them to allow you into the Gas competition at club contests. Fly the six-cell version against Class A Gassies and the seven-cell version against Class B. If they start reducing your motor run, you have their attention—and their respect. You're also ready for USFFC and Nats competitions. Go for it!

Some words about safety: Notice that I have not included a fuse or on-off switch in the wiring. If this makes you uneasy, just add them. The absence of either one has not been a problem for me. My reason for not using them is that each connection represents a voltage loss and wiring complication.

Use silicone rubber to insulate the microswitch connections from possible shorting by the spring.

The propeller will fold forward unless you make a small modification to prevent it. (You can't believe the shaking when the motor starts with the propeller folded forward.) Make a $\frac{1}{2}$ x $1\frac{7}{8}$-in. aluminum strip, and drill the center to go over the prop shaft. Place it on the shaft under the prop hub. You'll have to bend the tips of the strip rearward so the prop will be in the proper position while preventing the prop from folding forward.

You may have an instance when the motor starts with one of the blades rearward and it catches on the pylon and stops the motor. The temptation is to release the blade and launch the model. *Don't do it!* The locked rotor current is very high, and the microswitch may be damaged. When the motor gets stopped, the switch contacts may either lose their snap or weld themselves together. In either case, it's bad news: The motor does not shut off, the glide rudder kicks in, and the model powers into the ground in a death-spiral. Always test the switch after a motor stoppage.

Good luck! An SASE to me will get a prompt reply to your questions. Don Hughes, 8383 Zancanaro Ct., Citrus Heights, CA 95610; telephone (916) 723-1882.

Flying for Fun/Mathews

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twin SuperTigre 3000-powered P-38 veer off wildly to the right on takeoff, with the recovery over the pits. On the next flight the model veered even more and crashed into a parked van. Now I know for sure the problem didn't lie in the design, as I've seen several others from this kit source fly extremely well.

I've been corresponding with John Deden of Missouri City, Texas, about a true flat-bottomed-airfoil 1940s free flight design he recalls. (Can anyone help remember its name?) He had also mentioned having flown B-25s and P-38s, and he is indeed building a model P-38. When I related the fly-in mishap he responded with the following:

"We were drilled and drilled during flight training at critical or low speeds, such as takeoff or landing, to never try picking up the low wing with aileron. Use hard-over rudder first and foremost. As a matter of precise fact, it is preferred that you use only rudder.

"Seems that on the 38s with their dihedral, rudder induces a recovering roll whereas ailerons just make things worse. The full-sized P-38 rudder deflections were 30° each way!

"I can vouch for the results: One morning in Italy as I took off, I had an engine quit just about 50 to 100 ft. off the runway. I was carrying two 165-gal. drop tanks. . .My training led me to immediately jam in hard rudder and push the yoke away from me. As the wing came up I then fed in some correcting aileron. . .

"The super-scary part of all this is that just as the low wing got nearly level, the darned Allison came back on full bore! So off we went in the other direction. This was repeated several times until I could get both engines calmed down a bit. I'm convinced had I not followed those procedures drilled into my head and had I used the ailerons, I'd not have survived. . .I then proceeded to do a 'normal' emergency landing."

Since larger models fly so much like their full-scale prototypes, I'd think John's input could be useful to those who are building P-38 models—or B-25s, for that matter. That is: Stay off the ailerons if an engine gasps on takeoff or landing—use the rudders!

Neat stuff: One of the basic laws of modeling seems to be, "The more difficult two parts are to hold in position, the more likely the CyA bottle is to be clogged." Agree?

Well, by golly, at long last there is a better