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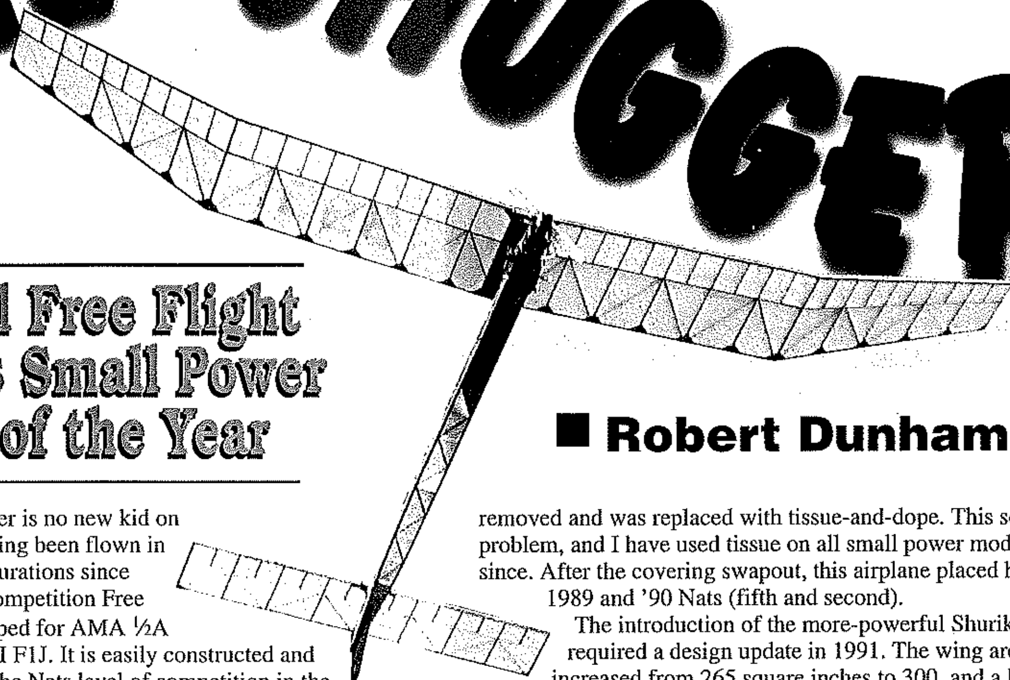
LIL' CHUGGER



National Free Flight Society's Small Power Model of the Year

Robert Dunham II

The Lil' Chugger is no new kid on the block, having been flown in several configurations since 1988. It is a competition Free Flight airplane developed for AMA ½A and A classes, and FAI F1J. It is easily constructed and is a proven winner at the Nats level of competition in the 265 and 300 sizes, with or without Variable Incidence Tailplane (VIT).

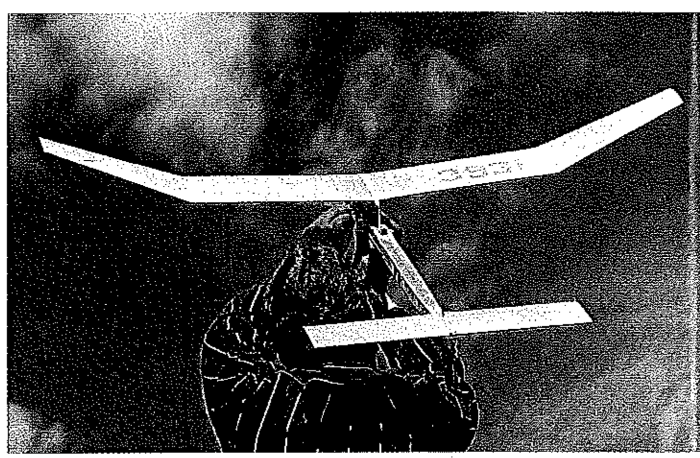
The Chugger 300 Mk II evolved from a first-generation Chugger 265, originally built in 1988 and based on Gil Morris' Matchsticks, but the construction was simplified and conventional building materials were employed.

A Cox TD .049 engine was used at that time, and all flying surfaces were Mylar™ covered, which led to inconsistencies in the power pattern—no doubt because of wing flex. The Mylar™ was removed and was replaced with tissue-and-dope. This solved the problem, and I have used tissue on all small power models ever since. After the covering swapout, this airplane placed high at the 1989 and '90 Nats (fifth and second).

The introduction of the more-powerful Shuriken engine required a design update in 1991. The wing area was increased from 265 square inches to 300, and a lengthened tail moment and smaller stab enabled it to comfortably handle the increased power; the glide was also improved. This airplane was subsequently lost at the 1993 Nats; after encountering some super lift, it was seen to dethermalize (DT) but was never found. Flights were finished with my 265 backup and I ended up in fourth place.

At the 1994 Lubbock Nats, the six-year-old plain-vanilla Chugger 265, retrofitted with a Stels .049, was again brought out of semiretirement, and posted five maxes and a downer in somewhat "iffy" weather to capture my first win in the Open ½A class.

Photos by the author Graphic Design by Carla Kunz



Above: Ready to launch. Robert is about to pull the release pin on a modified Tomy timer. Built-up tailboom no problem.

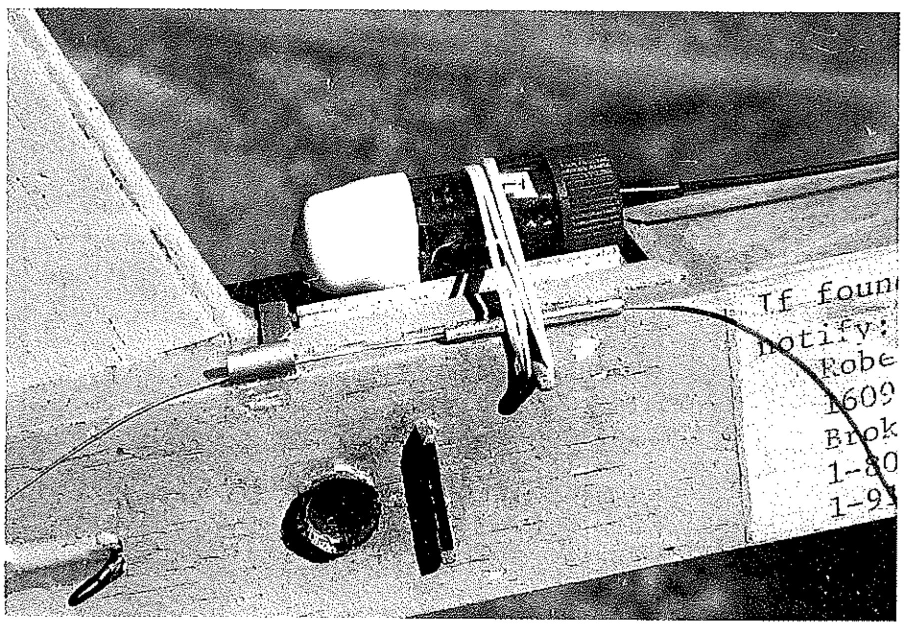
Left: The author and Chugger. Nats-winning design has been thoroughly tested and sized to optimize available power.

The current version sports an easily formed music-wire VIT (1/2 gram) operated from a customized Tomy engine cutoff timer. The improvement in climb angle and speed was impressive, with the bonus of being able to independently fine-tune the glide setting. The wing aspect ratio was increased and diagonals were added to the wing and stab to make these surfaces even more torsion-resistant.

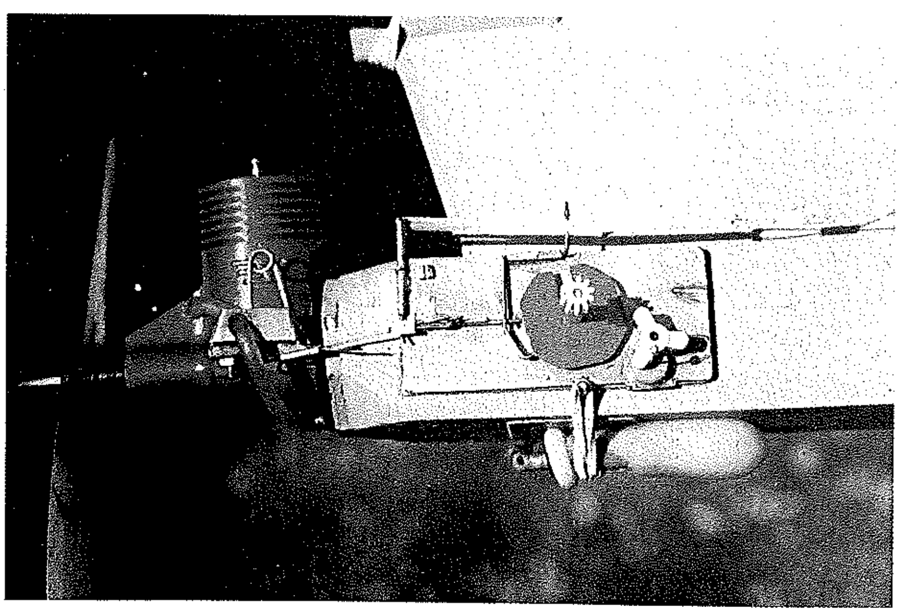
The 300 Mk II with VIT is the best of the Chuggers to date. This was confirmed by winning ½A Gas and placing second in F1J at the 1996 Nats, and reversing these positions in 1997. It is a potential winner in ½A and F1J, even against very tough competition. Many Free Flighters are not "into" composite materials or construction methods, and I hope that others will be attracted to Chugger-type models—not sophisticated, but with the proven ability to successfully compete against so-called high-tech competition.

The big plus for stick-and-tissue construction is that the *modus operandi* of the average modeler is to gather up most (if not all) of the lumber and parts required at the hobby shop in the morning, then start the chips flying that afternoon. You actually become a *builder* of the model, instead of an *assembler*.

A good, reliable, steady running .05 to .06 engine is a must. There will be no need to purchase often-expensive, long-delivery cottage-industry parts such as machined pans, carbon tailbooms, VIT/bunt hardware, elevator saddle, folding prop, formed composite leading edges, etc. Instead, you might look into investing in a good locator system, which could come in very handy if your Chugger finds some really good lift.



Tracking radio (top) of type sold by Jim Walston is light in weight and offers protection against loss. Snuffer tube (lower left) extinguishes dethermalizer fuse.



Timer weighs only eight grams, and handles engine shutoff (far left) and VIT functions. Pacifier mounted on bottom makes wire skid unnecessary, saves weight.

The all-up flying weight of the 300 Mk II, complete with VIT, should be 6.75 to 7.5 ounces. This weight range is very attainable if you build carefully and watch wood selection, covering material, and finish.

At this time I have chosen to not employ the bunt method of transition, and depend on light weight, modest-but-adequate wing aspect ratio, and forward balance point to help make the transition go smoothly. These features assist the transition, which is critical for the short engine runs allowed in the deciding late rounds. I am not antibunt, and a good bunt is pretty to watch, but an untimely misfire can bring a string of maxes to a screeching halt in a hurry.

Good air-picking is a necessity, no matter what the design features happen to be—and therein often lurks the thin line of separation between fliers.

CONSTRUCTION

Spend a couple of evenings studying the plans. You are going to scratch-build this project, and although it's not difficult, you should have some previous knowledge of working with balsa structures and should have built several similarly constructed models.

If you have a good Cox TD or AME. 049 and wish to use it, take the 300 plan to a copy shop and have them make a print using a 5% reduction factor. The cost will be minimal and the result will be a 265-square-inch (flat) wing plan, with everything else to the proper proportion. Wood sizes remain the same, and the finished weight of this combination should not exceed 6.25 ounces.

I use Duco cement as my primary glue for balsa construction because of its lightness and repairability, plus it's not brittle and sands well. Cyanoacrylate (CyA) glues and epoxies have applications in heavily fuel-wetted areas, but are used sparingly. (However, for quick-fix field repairs, CyA can be your best friend.)

Fuselage: If there are any skeptics about the merits of stick-and-tissue tailbooms, I can only say that my four Chuggers have logged several hundred flights, and none has had a boom broken for any reason. Small, lightly loaded power models descend slowly in the DT mode and land without much fuss. The fabricated wooden structure seems to be forgiving (probably less brittle) and seems to flex without breaking.

The main ⅛ square longerons should be matched as closely as possible for grain, stiffness, and hardness. This is sometimes difficult if you use prestripped stock, so I suggest that you build, borrow, or buy a balsa stripper and cut your own strips from sheet stock. Produce four good square-sided strips and tag one end so that you can keep track of how they came off the sheet. Pin to the plan with the heavy end at the nose.

The 1/16 sheet side panel should be installed and the vertical uprights positioned as shown. The diagonals are added, and you ıght find the simple cutting jig shown to be ɜlpful in producing them *en masse* with a ıinimum of time and effort.

Repeat for the companion side, which I ɔnstruct directly on top of the one just ɔmpleted. Remember, the diagonals on this de run to opposite corners, which makes e structure fully geodetic when finished.

The sides are removed from the plan and ꞉parated, then placed on a flat surface and ghtly block-sanded on front and back to move glue bumps and other irregularities.

Carefully prepare the 1⁄16 bulkheads from x-pound balsa, making sure they are cut curately, with square corners. Lay the ght-side structure flat on the building board ıd glue in the bulkheads at the appropriate ɔsitions, keeping them vertical until set. he left side is then glued to the vertical ılkheads, two positions at a time, beginning F-1 on back to F-3, watching to make sure at everything is kept aligned and true.

Lift the basic fuselage frame from the ıilding board, then drop in and glue the ırward fuselage bottom panels (grain the ng way) and top panel (cross-grain). Install l cross-members and diagonals from F-3 ırward, and let everything set for at least an ɔur.

Bring the fuselage sides together at the ar, but before gluing, cut former F-4 to idth to retain the curvature you have ıosen. When you are satisfied with the ghted symmetrical appearance, glue erything together and install the top and ɔttom braces, followed by the diagonals.

The front firewall is 1⁄8 plywood, and e engine mounting method will depend ı the power plant selected. You can obably purchase a machined radial-ount adapter ring, which replaces the ıgine backplate, greatly simplifying the oblem. Blind mounting nuts are installed ı the back side of the plywood to accept e ring, and the firewall is slow-cure-ɔoxied in place on the fuselage with rust offsets as shown on the plan.

LIL' CHUGGER

Type: FF ½A-F1J

Wingspan: 53 inches

Engine: .05-.06

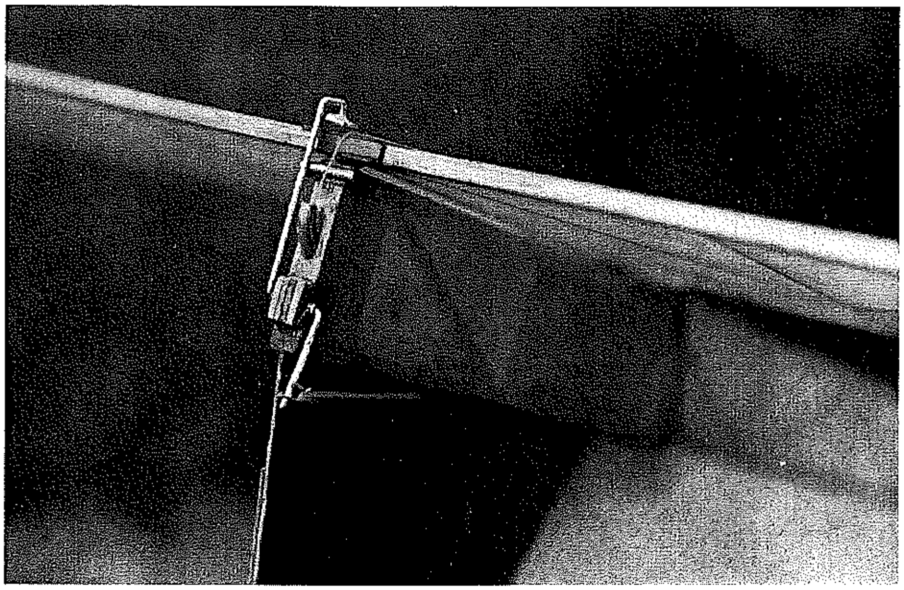
Flying weight: 6.75-7.5 ounces

Construction: Built-up

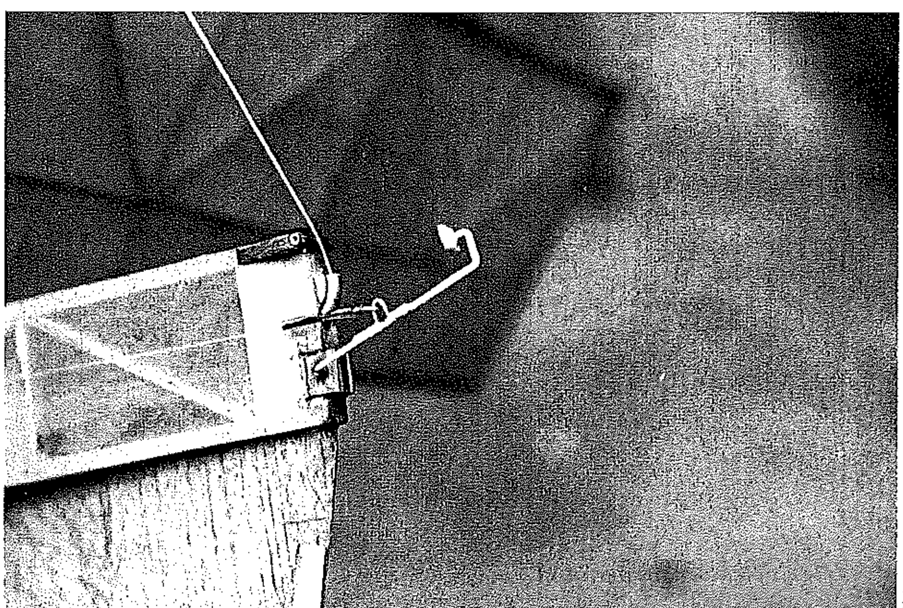
Covering/finish: Japanese tissue and dope

LIL' CHUGGER NATIONAL CONTEST RECORD

½A Gas			
1989 USOC	5th	265	Cox TD .049
1990 Nats	2nd	265	Cox TD.049
1991 Nats	2nd	300	Shuriken .05
1993 Nats	4th	300	Shuriken .05
1994 Nats	lst	265	Stels .049
1995 Nats	4th	300	Shuriken .05 (VIT)
1996 Nats	1st	300	Shuriken .05 (VIT)
1997 Nats	2nd	300	Shuriken .05 (VIT)
F1J			
1995 Nats	2nd	300	Shuriken .05 (VIT)
1996 Nats	2nd	300	Shuriken .05 (VIT)
1997 Nats	lst	300	Shuriken .05 (VIT)

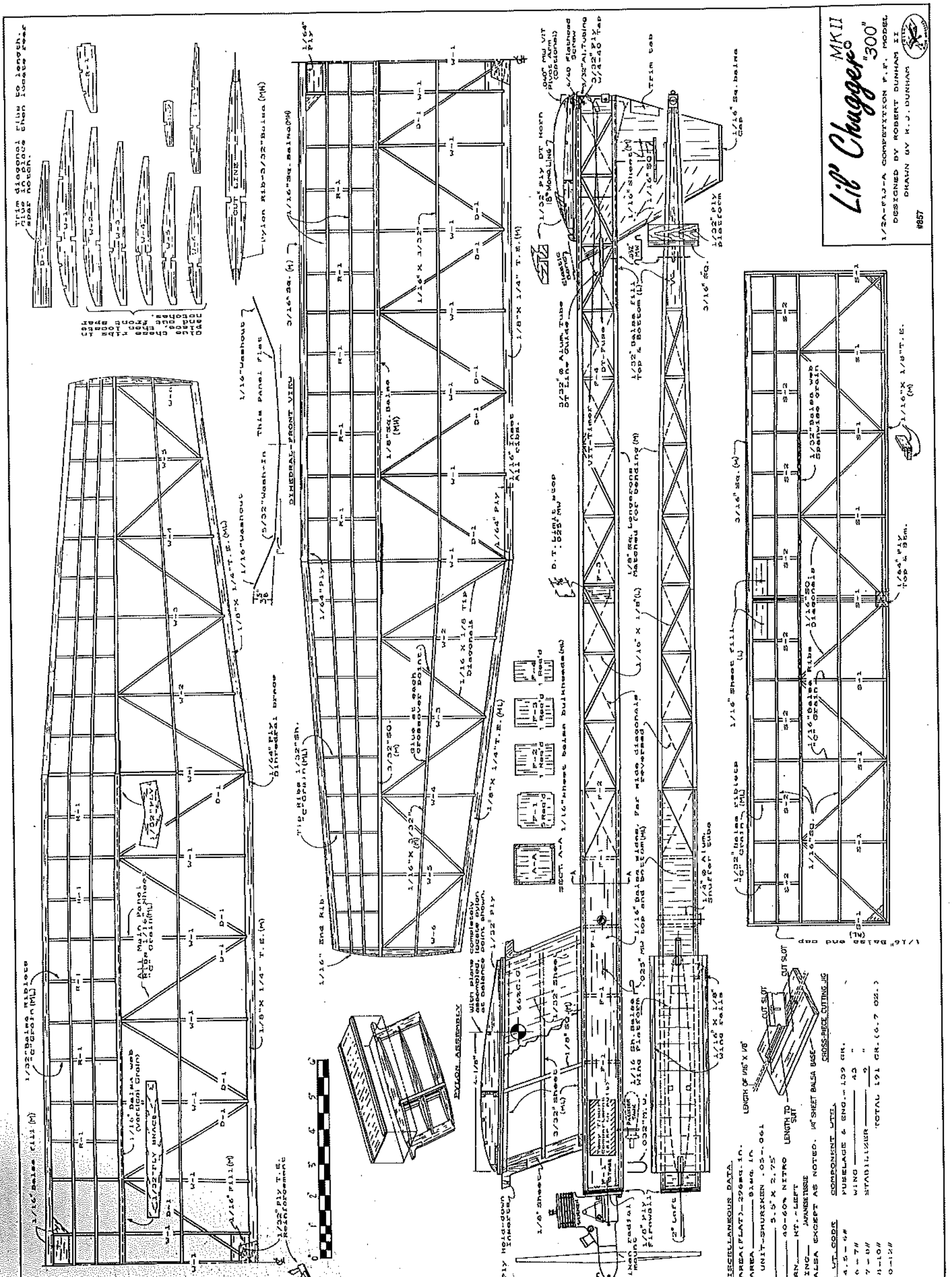


Music wire Variable Incidence Tailplane (VIT) arm allows fine-tuning of climb and glide settings for best performance. Power position shown here.



VIT arm pivots rearward to allow stab to pop up for DT. Limit line holds stab at proper angle for floating descent. A 4-40 screw is used to adjust incidence.

Full-Size Plans Available—see page 181



The lack of a landing skid is not an versight; it has been found unnecessary nd is a good place to save several grams of aluable weight.

The 1⁄16 sheet rudder should be no roblem to assemble—just keep the grain irection as shown. Sand to a symmetrical irfoil section and don't overlook the 1⁄16 quare stiffener insert. The rudder extends rough the fuselage bottom sheet until it iakes good, solid contact with the top ieet. When final-gluing, close tention should be paid to perpendicularity id neutral alignment.

imer: I have used modified Tomy timers or the engine cutoff and VIT activation on nall power models for many years. I find iem to be very reliable, they run steadily, id are minimally affected by engine ibration; they also tolerate a reasonable nount of disc loading.

(I believe that most timer malfunctions e centered around pilot error—not tivating the start button, incorrect disc ositioning, wrong line hookups, etc. They ippen to everyone.)

The manufacturer of these toys ontinually introduces new figures that have fferent articulations and shaft takeoffs to commodate the animation required. I ever know until disassembly whether the y will be suited for my application. owever, I was fortunate to stumble across Tomy motorboat with all of the attributes quired, and I purchased a dozen of them.

I am not going to elaborate on the odification procedure here; several good ticles have been published in US and ritish magazines. Attention should be ought to the Tomy's eight-gram finished eight, $2 cost, and enjoyment received om their gyrations prior to "loboTomy." he crossover wire system makes it mecessary to slow down the pawl, thereby ducing the chance of stalling the action. If is happens, the end result is a total disaster and you will need to bring in another load of balsa.

If you don't want to try your luck with a Tomy, purchase a Texas Timer 1/2A Mini or Seelig four-function 1/2A timer. Both are dependable and require no modification, but weigh 16-20 grams. Regardless, the line hookups will require some improvisation, depending if you run the lines internally or externally, or you choose VIT or locked-up. Just don't forget, the 9-12-gram weight penalty rides along on every flight.

Pylon: The wing pylon is best built in halves. Prepare the 1/8 x 1/2 leading and trailing edges with the 1/8 plywood hold-down inserts epoxied in place. Three pylon ribs are cut from 3/32 balsa sheet, and two of them are cut in half in the long direction and are match-marked.

Pin the LE and TE pieces on the plan and glue in only the bottom and middle half-ribs. Remove from the plan and attach the companion half-ribs and the full top rib. The 1/8 square vertical stiffener is fitted into place and glued. The sides of 1/32 sheet are added and edges trimmed.

The 1/16 sheet wing platform is pieced together and cut to length and width, and the 1/16 x 1/8 hard edge runners are added. The completed platform is then glued to the pylon, with attention being paid to alignment. This part is put aside until other components are completed; when the airplane is completely assembled, locate the pylon with the CG at 66% chord.

Wing: The wing is constructed in separate panels, and care should be taken to choose wood that is somewhere near the density and grain indicated; an accurate gram scale helps.

A 1/16 plywood cutting template should be made of center panel rib W-1. It is helpful to push straight pins through the template at two positions (just barely protruding) and CyA in place. The pins ensure that the template stays put while slicing the ribs from light 1/16 C-grain balsa sheet. Locate the spar notches during this operation.

The trailing edge is chosen from wrap-free medium-weight 1/8 x 1/4 strip stock, and the rib inset notches are located and cut with a Dremel scroll saw. These 1/16 deep insets greatly strengthen the rib attachment point and should be a tight fit on the rib. The TE has a very slight taper to conform with the top camber slope; a sanding block or mini razor-plane will do this job if you are careful.

(Don't let the blunt trailing edge construction turn you off. I have used this construction on power models and Mulvihills, and I can't tell any difference in performance compared to a full taper. Wind-tunnel tests show that the top surface air flow has turbulated and broken away long before reaching this point on the wing, and the blunt construction is no disadvantage. Just try one, and I think you might like it. Weight consideration and better wood selection are the other reasons for this choice.)

Pin the LE, TE, and 1/8 square bottom spar on the plan and lay in the full straight ribs. The 1/16 vertical shear webs are installed flush with the back edge of the bottom spar. The half-ribs are installed, followed with the 1/8 square top spar. Cut the diagonal ribs from C-grain sheet and install. Omit the rear spar notches; they can be located more accurately later, after the panels are joined.

The tip panels are similar in construction to the main panels, except that 1/16 x 1/8 diagonals are used between full straight ribs. At each crossover point the diagonals should be glued to the rear spar. If the crossover doesn't touch the spar, the gap must be bridged with short lengths of scrap balsa. These glued points add to the integrity of this part of the wing and provide considerable torsional stiffness, preventing high-speed flutter and twisting.

The completed panels are prepared for polyhedral by carefully trimming and sanding the LE, TE, and main spars. This is a slow and tedious job, but the abutments must be a tight fit at all touching points. Epoxy is used here and on the overlapping 1/32 plywood braces. Since the TE does not have a large gluing area, small 1/64 plywood keepers are imbedded to strengthen this critical juncture. When carving the LE to shape, introduce a small amount (1/32 inch) of Phillips entry to the bottom side.

All the other bits and pieces can now be added, including the TE wing rubber plywood reinforcement, LE balsa fill, and the slanted 3/32 tip ribs. The whole structure should be sanded smooth and prepared for covering.

Stabilizer: The construction is similar to the wing, except that the trailing edge is constructed into an L-shaped cross-section using 1/16 x 1/8 medium balsa. Light wood should be used throughout, and the target finished weight should be 9-11 grams.

Construct and install the stab mount. A slight amount of left turn tilt (3/16 inch) should be visible, which translates to the left tip being high when viewed from the rear.

Covering/Finish: Japanese tissue is the recommended covering material for the Chugger, principally because of its light weight and tautness. All structures and edges in contact with the covering should be given a coat of unthinned butyrate dope, lightly sanded with 200-grit paper to remove fuzz and raised grain. Tissue is applied with the same dope and is sprayed with water to tighten.

Two coats of thinned clear dope are applied to the flying surfaces and the boom portion of the fuselage. The bottom side of the first three inboard bays of the wing is double-covered with tissue, watershrunk, and doped. A spray coat of colored epoxy paint is applied to the front of the fuselage, starting just behind the pylon. This provides additional protection against deterioration from fuel spray and handling.

A slight amount (3/32 or less) of washout (trailing edge high, viewed from the rear) should be introduced into the tip panels by holding in position until the dope has dried. Over-tweaking is generally needed, since there will be a tendency for the structure to return to its original shape, but hopefully, 1/16 washout will be retained. The same method is used to apply 1/8 washin to the right main wing panel.

This tweaking-and-holding procedure is repeated on subsequent occasions where recovering and doping of large areas is required for normal maintenance. I have not been successful building-in these subtle wing warps with open-structured surfaces, and find they are best induced during the covering operation. Check these intentional warps periodically, especially in damp conditions and before making competition flights.

Preflight: Before proceeding to the flying field it is important to complete all of the detail work and prove-out the various flight systems to make sure everything is functioning properly. The wing is keyed with short lengths of 1/8 square balsa, resulting in a slide fit on the wing platform. The center of gravity (CG) can now be located within the range of 62-66% of the wing chord, and the fuselage ballasted with lead to make corrections. To be safe, the CG should not be rearward of the 66% point, or flight adjustments could become complicated and difficult to diagnose and correct.

It is especially important to ascertain that the VIT/engine cutoff timer disc is not overloaded to the point that it will not run steadily, but it must be able to withstand sufficient rubber band tension to keep the stab firmly seated in the power mode. Be sure that the fuel pinchoff mechanism (a Reid Simpson gadget) is located in close proximity to the engine needle valve, and that it closes shut with authority and is foolproof. This last check is done with the engine running, of course, and at the same time you can observe the rotational speed of the timer disc and mark the three-second location for the first test flights.

The maiden test hop should be preceded by test-gliding over high grass with the stab in the glide position and the prop removed. The optimum glide is a slight left bank with no tendency to stall. Correct any stall or dive by deftly adjusting the wire VIT arm using needle-nose pliers, or by adding 1/64 plywood shims to the stab top or bottom rub plates.

To establish the initial power setting, lower the stab TE about 1 1/2 turns of the 4-40 adjusting screw. Never fly without a fuse, so take care of this matter by cutting and installing a short fuse that has the end charred for easy lighting. Set the engine timer for no more than three seconds.

Start the engine and needle it to nearly full power, using mild fuel (30% nitro). Light the fuse and gently launch the Chugger straight up, keeping the wings level. It should accelerate rapidly in a nearly vertical right spiral and should be about 200 feet high when the engine cuts. Hopefully you will get a glimpse of the glide before the DT; correct any dive or stall by adjusting the wire VIT arm.

If your Chugger headed for a vertical loop under power, it is overelevated and the stab adjustment screw should be lowered ¼-½ turn, depending upon the severity of the maneuver. If the power pattern was flat (arcs over toward the ground) it is underelevated, so raise the screw ¼-½ turn.

The glide circle is adjusted with stab tilt to approximately 150 feet in diameter. The power turn is adjusted by making small changes with the rudder tab, and I can't emphasize enough how much effect these changes are magnified during the high-speed climb. If the engine thrust offsets have been built in correctly, no adjustments should be required.

On long engine runs you my observe a gentle left roll in conjunction with the right turn. This is no problem as long as it does not become excessive. The right wing washin becomes effective at high speed, causing it to lift against the right turn induced by the prop wash impinging the pylon and underslung rudder—all the while keeping the nose up during the climb.

As the climb and glide pattern are optimized, gradually increase the fuel nitro and engine run up to seven seconds, and the longer gliding flights can be observed before DT. This may take a dozen flights and more than one test session, but your Chugger should be close to being ready to hit the contest circuit.

Flyoff Tactics: It is not at all presumptuous to believe that the Chugger (and others) should be capable of consistently making AMA Cat. III seven-second engine run, two-minute-max flights. It is another matter, however, to consistently be successful with the four-second engine-run, 2½-minute max. When you reach this plateau, observations and careful attention to details are required prior to each official flight.

A ground- (and possibly air-) check of the engine run should be performed; second attempts are not allowed. Backing-off the engine timer is recommended, to allow for sound travel and timekeeper reaction delays.

Time management also comes into play, since toward the day's end there are often only two or three fliers left. Few airplanes with short engine runs are being flown this late, so you may have to rely on other means (bubbles, streamers, or thermistors) to observe and monitor the air quality.

Flyoff flights commonly take place in the waning hours of the meet, when the air is cooling and time is running out. If you are more than one flight behind and less than an hour remains, you might consider assembling a backup model so that flights can be put up in rapid succession. (Just the act of preparing a second airplane—even if it is not competitive—can sometimes create panic and cause your opposition to rush and pick bad air. Hopefully, you can take advantage of this and move ahead—desperate measures in desperate times.) Round up some chasing help so that you can remain on the flightline and get airborne again.

In F1J, the flying format is completely different, with rounds for the first five flights and progressively longer maxes for the flyoff. Under certain weather conditions, these long flights introduce the timer's eyesight into the equation, so always supply the timer with a good pair of binoculars. Ask him to acquaint himself with them, and strongly suggest that he focus in, well in advance of the airplane disappearing. In any event, ask him to spot the airplane down and to mark the line with a terrain feature.

I hope that you build the Lil' Chugger, and that our paths will cross at some future competition. If so, please introduce yourself and relate your experiences with this design. If you have questions or want to confer on a building question, please contact me.

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