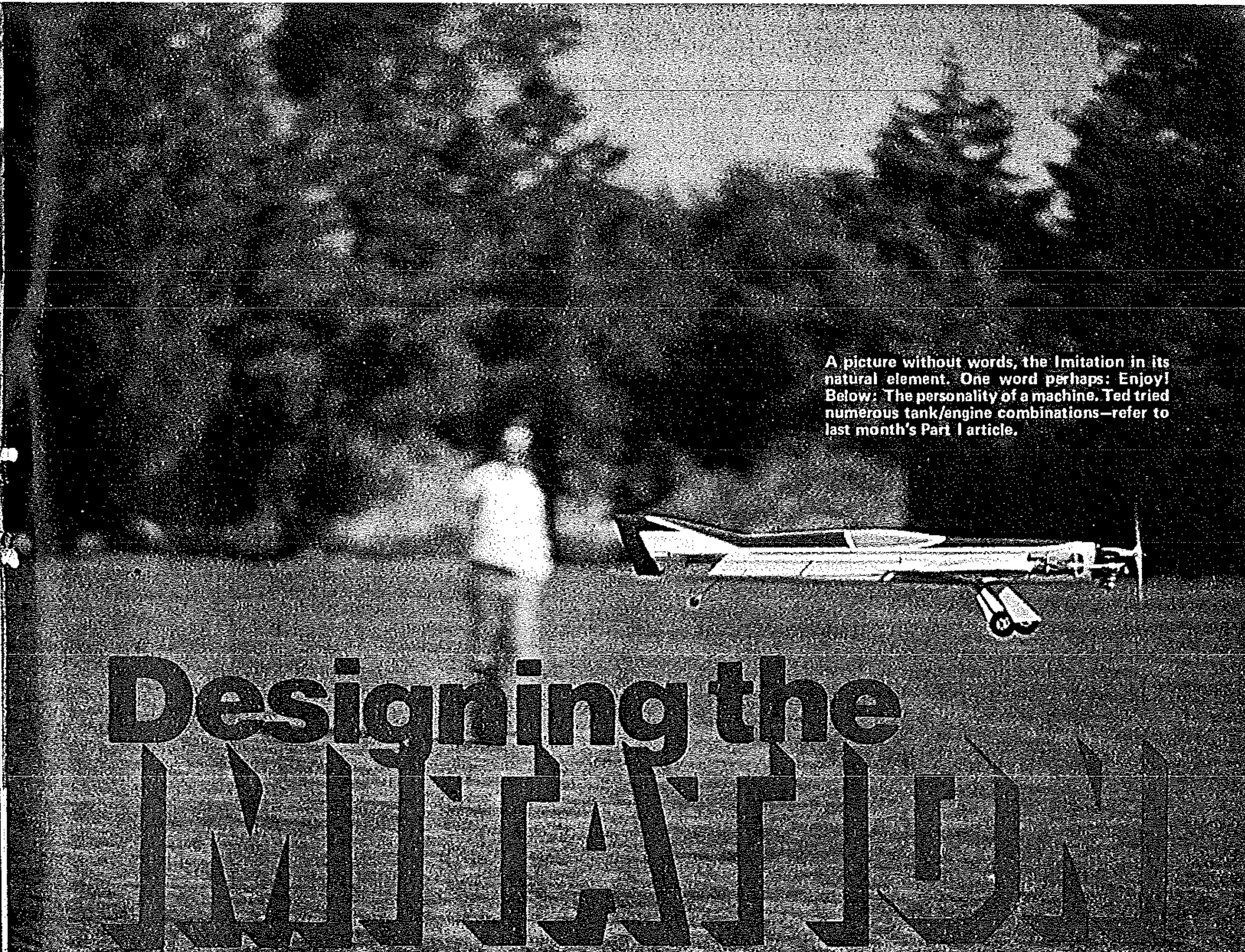
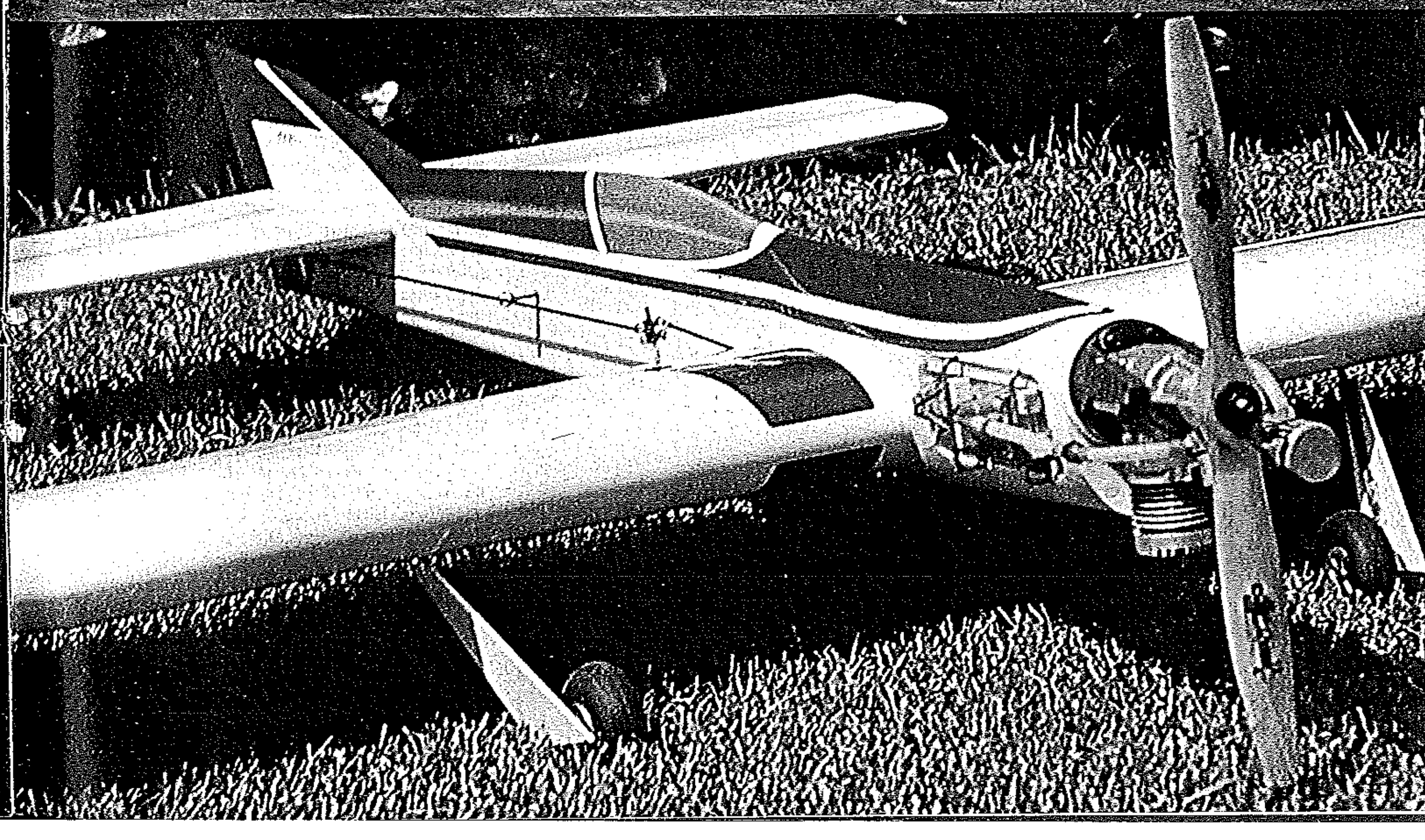
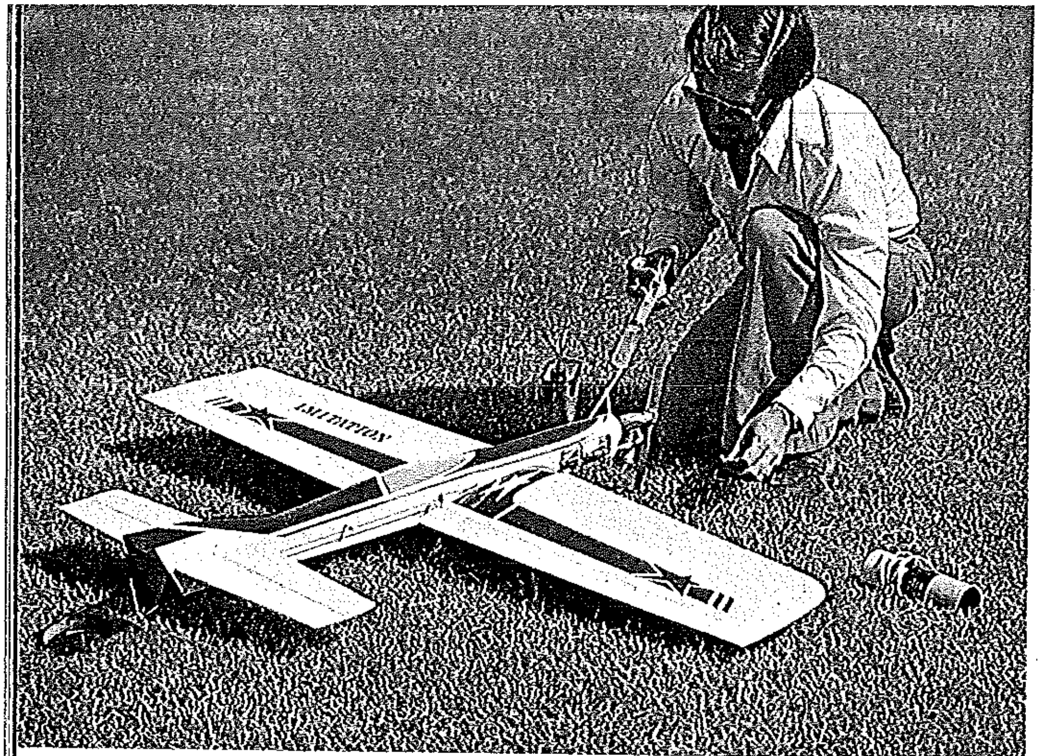


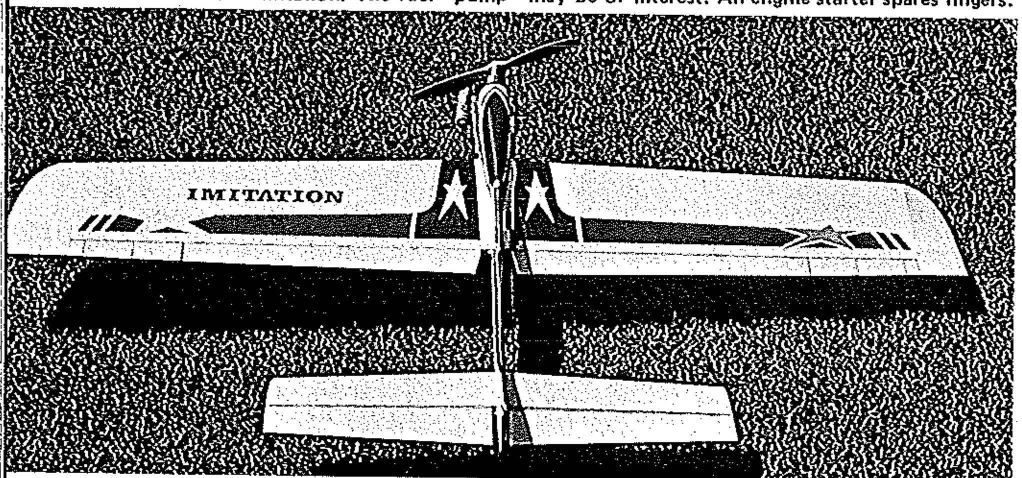
A picture without words, the Imitation in its natural element. One word perhaps: Enjoy! Below: The personality of a machine. Ted tried numerous tank/engine combinations—refer to last month's Part I article.

Designing the IMITATION

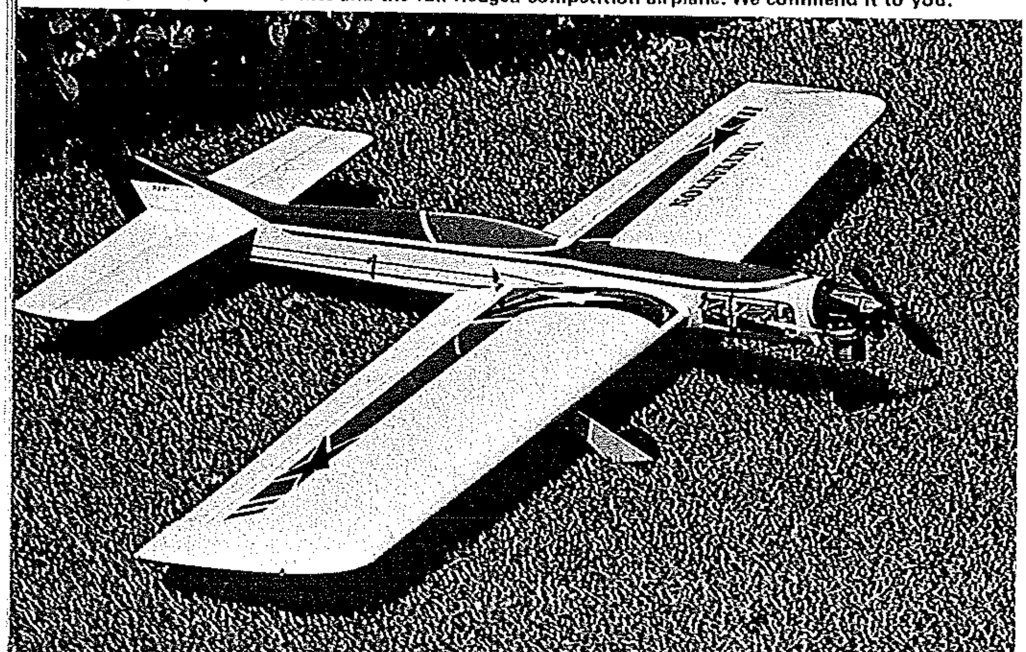




Ted fuels the Imitation. The fuel "pump" may be of interest. An engine starter spares fingers.



This rear view stresses the rakish clean lines. This machine narrows the gap between traditional profile/sport machines and the full-fledged competition airplane. We commend it to you.



Virtually all of the features described in the two-part article may be seen in this photo. The tank compartment in the widened nose of the profile by now will be appreciated for versatility.

Following last month's in-depth study—Designing the Imitation—*MA* is pleased to present a superior project for one of the best-ever stunt machines. ■ Ted Fancher

Editor's Note: Due to the overwhelming amount of material accompanying this project, many detailed pictures of the airplane were presented in last month's installment—and are not repeated here. The reader is referred to the September issue.

NOW that you've read last month's saga of designing the Imitation, I assume you are all waiting with bated breath and Hot Stuff in hand eager to begin construction of your own. So let's discuss building one.

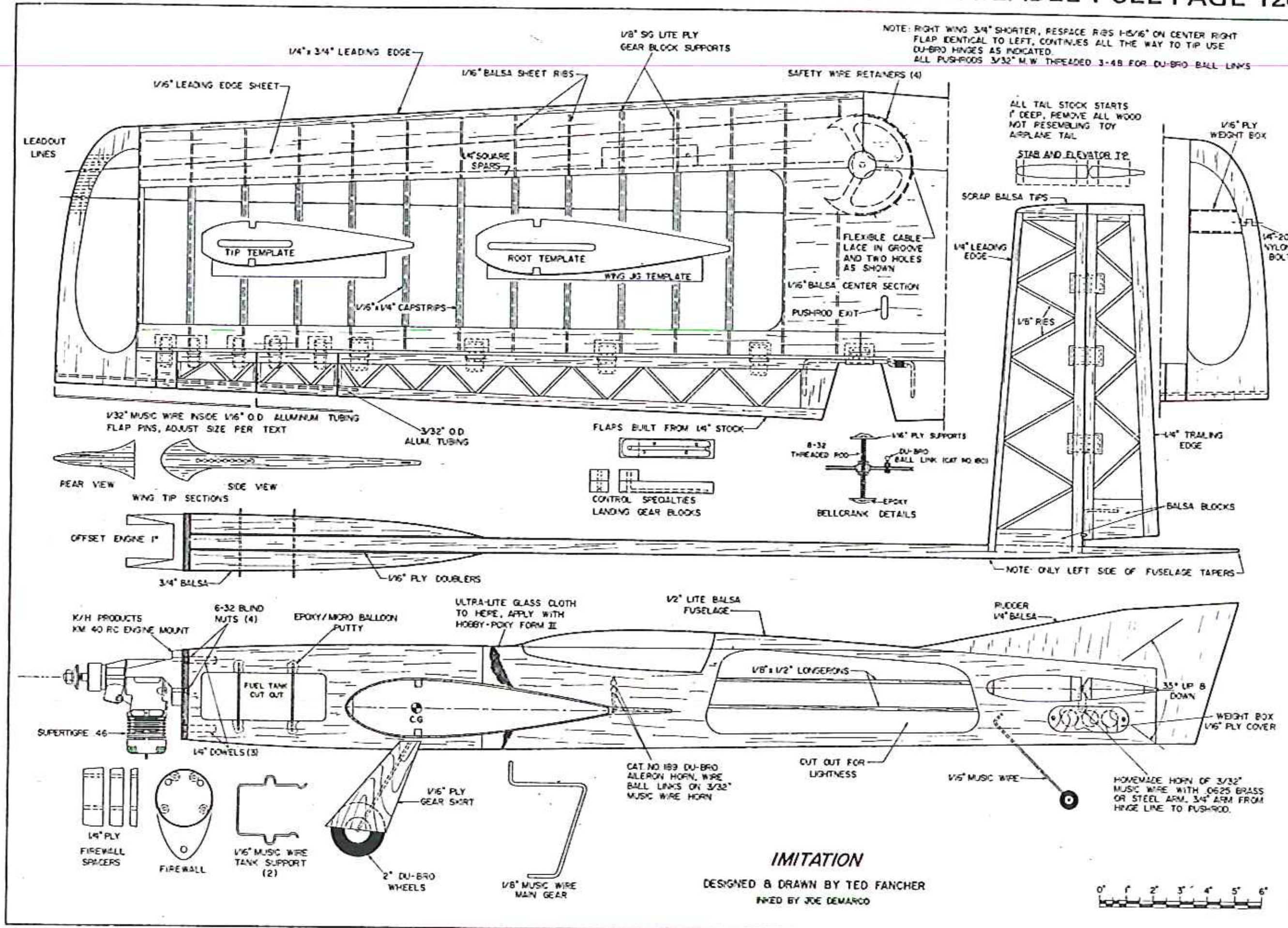
The Imitation's appeal to the builder will most likely be based on one of two factors. Most probable would be the average flier's desire for an easily built, and reasonably good looking, stunt ship which is also capable of contest-level flight performance. He will likely have several kit profiles under his belt and be fairly well versed in basic flight trim. To be of value to him this article will cover some of the construction features which are either unique to the Imitation or, if not unique, might not have been encountered in simpler projects. In addition, some more advanced bits of flight trimming will be included.

More advanced fliers will be attracted by the unusually broad range and number of adjustable features which allow an unprecedented amount of experimentation with flight trim. Some fliers with access to a machine shop may be interested in building and trying the 3½-in. circular bellcrank detailed on the plans. These fliers will need to know in a little more detail exactly how these devices are intended to be used.

Let's start with the easy stuff and build the fuselage. The Imitation fuse is only slightly more complicated than the average profile and should pose no special problems. First select a light but firm piece of ½X4X36" balsa. If this piece weighs more than about 5½ ounces, you should consider cutting out the lightening hole aft of the wing to avoid the possibility of a tail-heavy plane.

Since alignment is the single most important factor in the construction of a successful stunt ship, you should now very carefully lay out the fuselage. Use a medium tip ball-point pen and draw directly on the sheet balsa. First, be absolutely certain that the end of the sheet, which will be the nose of the airplane, is exactly 90 degrees to the lengthwise dimension. This is particularly important as it will align your thrustline to zero degrees of incidence. Next, draw in the thrustline (T/L). Extend this line all the way to the tail and you will note that the thrustline and the centerline of the stab and elevator coincide. The thrustline should fall 1 5/16" below the top of the uncut balsa sheet. Now drop down one inch from the thrustline and draw in the centerline of the wing cut-out. The leading edge of the wing cut-out should be 5 7/8" aft of the nose. Accurately trace the wing root section off the plans and transfer it to the fuselage again, being extremely careful to maintain alignment. Do the same with the stabilizer cut-out, being sure to locate it 29 5/8" aft of the nose at the leading edge of the stab. Also, while you are marking cut-outs, lay out the tank compartment and, if necessary, the

FULL SIZE PLANS AVAILABLE . SEE PAGE 128



lightening cut-out in the aft fuselage. Not that the locations of all the major components are drawn on the uncut fuselage blank, you can add lines outlining the profile shape of the body itself. Once you are positive that everything is where it should be, and is straight, proceed to cut away all the scrap areas. Scrap from below the aft belly can be used for the cockpit and turtle deck.

With the shaped fuselage as a template you may now cut out the 1/16 plywood doublers and the 3/4" balsa block nose pieces. Cut the 1/4 plywood firewall to shape and locate the mounting holes for four 6-32 mounting bolts to hold a Kraft-Hayes KM-40 engine mount. Install blind mounting nuts on the back of the firewall to accept the bolts. You may now proceed to glue the entire front end together, using Hobbypoxy Formula II Epoxy glue. When this has hardened (overnight), drill 1/4" holes as shown through the firewall and install the three hardwood dowels with Formula II.

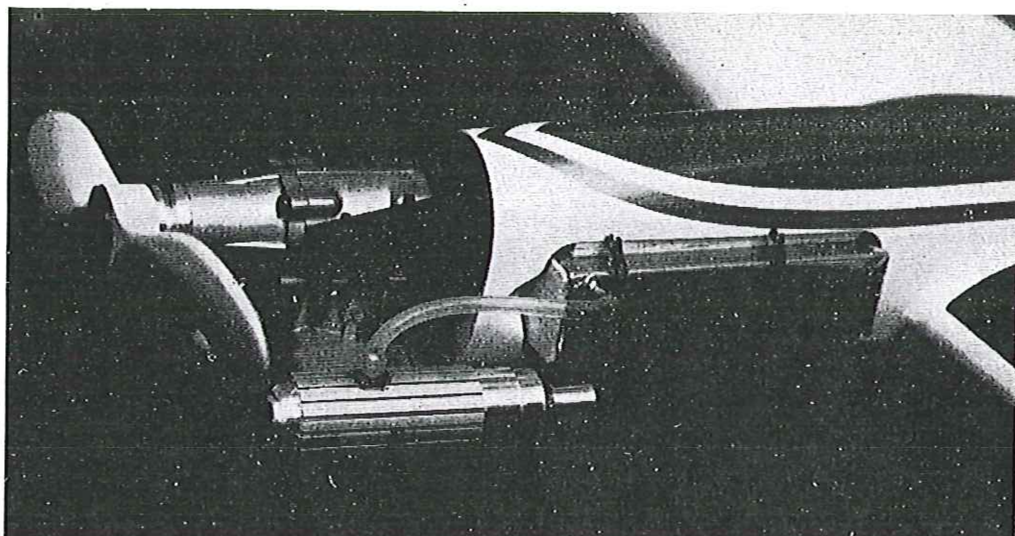
After this has hardened you may shape the entire body to a pleasing, streamlined shape. Bend the 1/16 music wire tank support wires and install with five-minute epoxy and micro-balloons in cavities hollowed out to accept them.

Set the fuselage aside for now and start on the wing. As with most current designs, a foam-core wing made for the Imitation is available commercially. The original uses a "Master" foam wing made to my specifications by J and K Custom Foam Wings, 10261 Janice Lynn, Cypress, Calif. 90630. John Poynter is in charge at J and K and is doing an outstanding job of taking up the slack left when Bobby Hunt left the wing business. Their wings are accurately made with good craftsmanship and, best of all, rapid service. I heartily recommend their products.

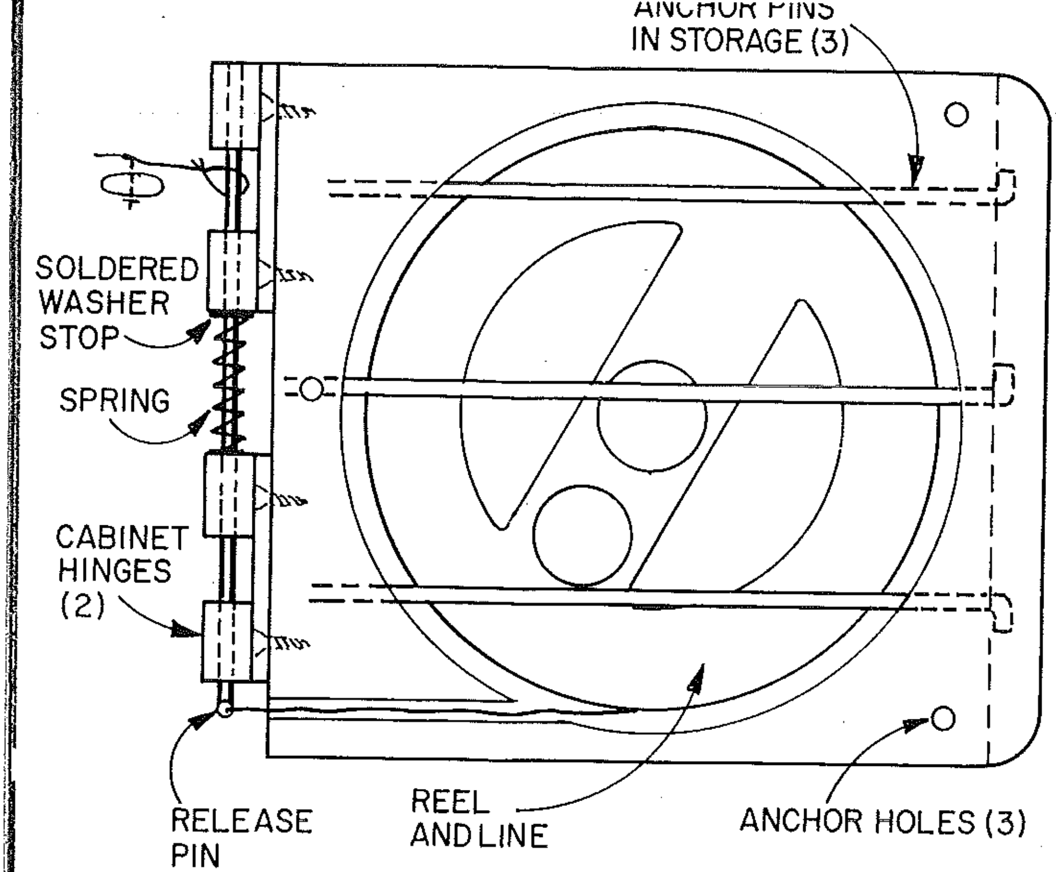
For those who prefer to build their own wings, a conventional "C-tube" type of construction is shown on the plans. If you are new to scratch building, here is a brief rundown on the techniques involved, and also a suggested method of jig building the wing to maintain a warp-free structure. First, cut 26 rectangular rib blanks from 1/16 light balsa. These should be cut to accurate length for each rib location. Now, cut out the root and tip templates from either 1/16 plywood or thin aluminum and sandwich 13 of the rib blanks in order between the templates, being careful to maintain common centerlines. This sandwich can either be bolted together or temporarily tack glued using Hot Stuff, while you shape the balsa rib blanks into a nicely tapered set of ribs using a razor plane and sandpaper. Repeat the process with the remaining 13 blanks for the other wing and you should end up with two sets of perfectly shaped ribs.

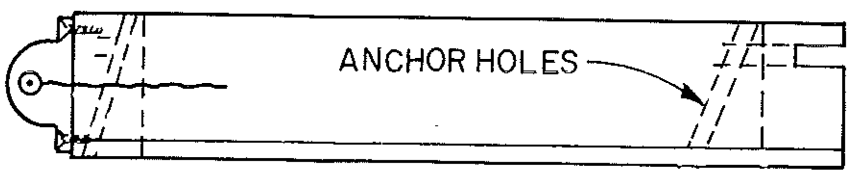
Probably the most difficult task for the beginner and intermediate-level builder is the construction of an unwarped, tapered wing. It can't be built with the trailing edge pinned to the work board, as can a constant-chord wing, and as a result most wings are built "in the air," attempting to pin and glue while keeping your fingers crossed. Usually this method is a failure. In the final analysis, there is no substitute for a wing jig when it comes to building a tapered wing straight.

I personally use and enjoy the Ajusto-Jig.



One of the typical—and one of a great many—tank installations that were tested during the development of the Imitation. Muffler pressure line shows here—feed line is on other side of ship.





"FANCHER'S" STOOGE

However, not having access to a commercial jig should not discourage a builder, as there are a number of methods available to jig build a wing using ordinary materials. It might not be as convenient as some of the fancy ones but, if the wing comes out straight, it has done its job. On the plan, you will notice directly below the tip and root templates, two items labeled jig templates. These can be used in the same manner as the rib templates by sandwiching balsa blanks between the plywood or aluminum templates and stack shaping jig supports for each rib. I should emphasize that the supports should be made separate from the ribs, even though it looks tempting to do the whole mess at once. Also, it isn't necessary to jig each rib. Every other one is adequate and will save some of that expensive balsa.

Once you've made the ribs and the jig supports, lightly tack glue the supports in place on their respective ribs. Don't permanently attach them as they must pop off relatively easily after the construction is nearly complete. Now slide the 13 ribs into place on the lower 1/4 sq. spar on which you have previously marked the rib locations from the plans. Do not glue yet. Now, (I assume you have a large, flat building surface—if not, this whole exercise is a waste of time), layout on your building board the proper spacing and location of the ribs along a common reference line at the aft end of the jig supports. Using a square block of wood to insure that the ribs are vertical, permanently glue the jig supports (with their tack-glued ribs) directly to the building board using Hot Stuff. Install the top 1/4" spar, and when you are sure everything is straight, tack glue both spars in place at each rib. Carefully mark the rib locations on the 1/16X1 trailing edge sheets and permanently attach the lower piece in place. Follow that with the top sheet and ⅛" trailing edge cap. Install the ¼X¾" leading edge and glue it and the spars in place solidly, using Tite-bond type glue. Using a razor plane and a long sanding block, shape the top of the leading edge to shape to accept the 1/16 leading edge sheet. Splice the spars and leading edge in the center section with scrap material.

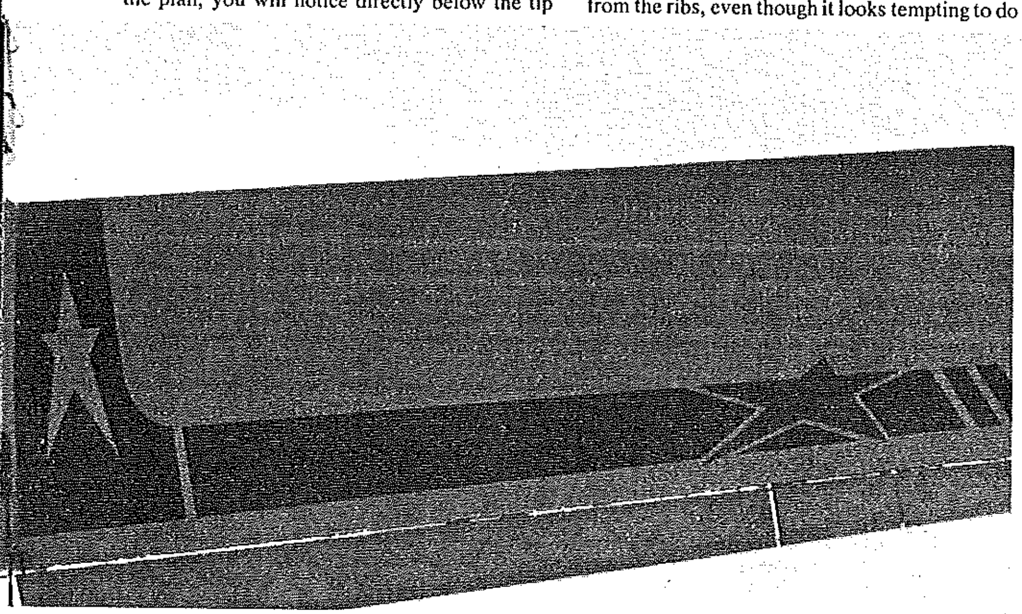
Now is the time to install the bellcrank and lead-outs. If you prefer to use the more conventional platform-mounted bellcrank, you will have to build up support rails to hold the platform. No big deal, just be sure that it is strong. If you prefer, as I do, the popular foam-wing style of installation, using 8-32 threaded rod clear through the wing, with a floating bellcrank in the middle, locate the bellcrank assembly as shown and glue in place through the spar with epoxy. This will hold the unit in place until wing construction is complete, when the 1/16 plywood caps will be epoxied in place to permanently anchor the unit.

Once the controls are installed you may sheet the leading edge and center section and add the 1/16X¼" cap strips. One hint. When applying the leading edge sheeting, soak the wood for ten minutes or so in the bathtub in a solution of hot water and ammonia. Not only does this make the wood easier to bend around the curve of the airfoil, but the ammonia softens the lignin in the pores of the wood. Lignin is the element which causes the wood to hold its shape. Once it is softened, the wood can be bent to the desired new shape (within reason), and when it dries, the lignin rehardens and the wood assumes the new shape permanently. As a result, sheeting applied in this manner will not attempt to return to its natural shape and will thus not attempt to twist the structure to which it is attached.

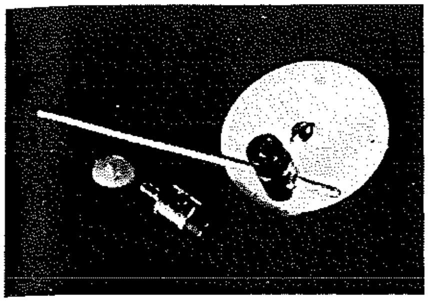
Once the top side of the wing is thoroughly dry, very carefully pop the ribs loose from the jig supports and turn the wing over. The ribs will not align exactly with the jig supports when inverted; however, the width of the cap strips will allow some support, and the leading edge sheeting will match close enough for it to be pinned in place. Secure the wing on the jig supports as rigidly as possible and proceed to sheet the leading edge and plank the center section, as you did the top. What you should have now is one perfectly straight wing. If not, I'm afraid you must return to go and start all over again. Crooked wings are not much better than no wings at all.

The flaps may either be carved from light but rigid 1/4 balsa or built up in Warren-truss fashion, as shown on the plans. If you desire to try the variable flaps, a glance at the pictures and

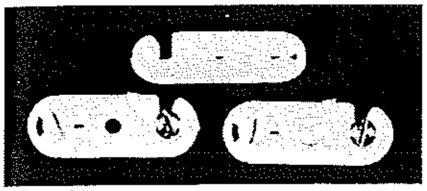
Continued on page 125



The segmented flap for experimental purposes was fully discussed last month—its four sections show clearly in this photo. Note that tank (as used in this case) is shown projecting slightly through the thick, forward section of the profile fuselage. A big attraction of this profile to the average flier, is an easily built, good looking stunt ship with contest level performance.



The Carl Goldberg pushrod connectors, a very convenient method. Pushrod attachment is just nothing at all to do and adjustments are made simple. The "better mouse trap" so to speak.



We've always suspected Carl is one of those guys who looks at everything and ponders how it could be done better, simpler. These are his flat hold-downs—just think how many Rube Goldberg—no relative if you don't go back that far—gadgets you've tried for the same task.

And the band plays on. These are angle hold-downs supplied in the kit and used for fuel access hatch, can be used for cowlings and other removable sections.

running rich, only lean enough to maintain a good idle, especially on the ground. This engine has more than enough power for the Falcon Mark II with good lubricating type fuels to do pattern flying, within the limits of the airplane's design. We found, like most engines, it required some experimenting. But once familiarity was gained, two or three flips and it was taxied out for the takeoff. The Duke has produced what is needed. Who could ask for anything more?

This adventure with products from "The Duke," Carl "The Man," and Paul the "Pillar," has not only been educating to us, but given a fair chance, should be rewarding to all who care to try this combination of plane, engine and radio.

Author's Note: In all fairness, this author wants you to know that we at the We-Fly Lab are flattered that some assume we are experts. It isn't a role we try to play. Many of the new products are just as new to us as to you, but past experience helps and we, too, must experiment—like others, we are not always successful. We just simply do not have the space or time to answer all requests or evaluate all new products. Your comments good and bad, needs for help, or suggestions for future adventures you would like to see, are all appreciated, we will cover as much as we can. Thanks for your support in our endeavors.

Imitation/Fancher

continued from page 70

the plans will illustrate the method of pinning the pieces better than a couple of thousand words. One note of caution: Do not depend on friction to hold the flap pins in place! Vibration will cause them to work their way out and they could cause the controls to jam and destroy the airplane. Always wrap a piece of Scotch tape over the exposed bent end of the pins to prevent this. This is a more serious problem on the outboard wing, where centrifugal force and vibration work together.

When installing the 3/32 O.D. aluminum tubes which receive the flap pins, install the whole length in one piece before cutting the short sections of flap from the major piece. Now the whole works can be cut with a razor saw for perfect alignment. For those of you who prefer to omit the variable-length flaps, I would recommend that you use a flap length of 24 in. on both wings. I am an advocate of equal size flaps on both wings in conjuction with a relatively small amount of wing asymmetry. This allows the use of a little more tip weight before the plane starts to hinge in hard corners, and results in improved line tension.

The wing tips are made from ½ sheet balsa with the addition of a small amount of scrap balsa at the leading edge. This will moderate the covering problem by flaring the break from the tip airfoil to the much thinner tip.

If you decide to use a foam wing from J and K, follow the directions for construction as provided. Especially important is the need for a strong joint at the root because of the lack of support from the narrow fuselage at the trailing edge. Do *not* omit the fiberglass tape over the joint—I prefer Hobbypoxy Formula II for this purpose.

SAFE FLYING
IS NO ACCIDENT

On the foam wing, the tips could be carved from solid balsa and achieve a one piece overall appearance if the open bow construction doesn't appeal to you. Although I feel they are adequate, I have had people tell me they look out of place on an otherwise sheeted wing.

Whichever wing you choose to install, I recommend the use of the Control Specialties, Co. landing gear blocks as shown on the plans. As you can see in the pictures, these are a very professional looking item with recessed tin plates held in place by countersunk screws. (These are also available from J and K Wings.) Installation instructions are provided with the foam wing. If you are building up the wing, make up rib doublers from ⅛ Sig-lite ply for the ribs shown supporting the gear blocks. Then, merely notch the ribs to match the gear mounts and epoxy the mount to the two ribs and the spar. This type of mount is very strong and I recommend it highly.

The multiple hole adjustable lead-out guide was copied exactly from some guy's red Nobler that keeps showing up at the Nats year after year. It's very simple and lighter than fixed lead-outs by maybe two grams. However, if you don't have the tools to drill the holes accurately and cleanly, you would be well advised to use one of the mechanical bolt and sliding block arrangements seen on many stunt ships. Sloppy holes in this system could cost an airplane!

The adjustable tip-weight box is one of my pet ideas. It is a simple plywood box with a No. 7 hole drilled and tapped through the balsa tip with a ¼-20 thread to accept a nylon wing hold down bolt. The head is cut off the bolt so that it will thread into the tip unobtrusively, and weight is added or subtracted in the form of lead shotgun pellets. Works great!

The tail on the original Imitation was built as shown on the plans and is a full one-inch thick at the root, and tapers to ½ in. at the tips. It was built up on a flat building board using full one-inch-depth stock for all components, leading edge, trailing edge, hinge-line spars and ribs. All the components were Hot Stuffed directly to the building board and the top was then shaped with a razor plane and a long sanding block. After the top was shaped, one-inch squares of scrap ¼ balsa were Hot Stuffed temporarily to a dozen or so spots around the perimeter of the surface. The tail was then popped loose from the building board and remounted upside down, supported by the one-inch squares of scrap, again Hot Stuffing in place on the building board. The bottom of the tail was then shaped to match the top, resulting in a perfectly straight tapered tail section which is very rigid and weighs less than one ounce for the whole 140-sq. in. tail. The tail could be made from a ¼ very light balsa sheet, with very little deterioration in overall performance and considerably less work.

The control system on the original Imitation was built up almost entirely from scratch. The heart of the system is the 3 1/2-in. circular bellcrank, which is coupled to the homemade 3/32 music wire horns by a 3/32 pushrod. The pushrods are attached to the horns with Du-Bro Ball Links. These are very strong and nearly trouble-free. The only problem I have had with them is the 2-56 threaded rod pulling out of the nylon link. To prevent this, I merely thread the pushrod with a 3-48 die and thread the ball-link directly to the rod. To avoid destroying your 3-48 die on the music wire, be sure to soften the area to be threaded by heating in a torch until it is cherry red and then allowing it to air dry. It will be very hard but soft enough to thread. The flap horn is made by bending 3/32 music wire as shown and silver soldering the two pieces together, after binding with copper wire. The elevator horn is the more conventional type with a flat steel arm, silver-soldered to the music wire. This was used to allow for the possibility of needing slop in the elevator for level flight stability. However, the Imitation has always been rock solid and has never required any slop to be used.

As with the thick tail, the home-made controls are a fine tuning refinement and could be replaced with conventional store-bought items with only minor deterioration in performance. If you are a serious stunt flier, however, I recommend you give this type of system a try, as it results in much lighter control forces. With the ball-links to make alignment less critical, controls can be totally free from binds with almost no effort. The larger than normal arms on the horns and bellcrank plus the circular shape which retains the full 1¾ in. lever arm on the lead-outs for the full range o control movement, gives a feeling similar t(power steering. They are not sensitive but requir(very little effort to achieve any amount of contro desired.

Once all your components are built, put them all together in the conventional manner—wings in front and the tail in back. If you make your cut-outs accurately, this is the only way they'll fit. Be absolutely sure that the wing and stab are squarely aligned with no decalage, i.e. incidence in either.

Once assembled, start the finishing procedure by fine sanding everything in sight until the wood structure is flawless. Minor dents can be filled with Dap Vinyl Spackling Compound. Any major flaws should be filled with balsa for weight saving. When satisfied with the condition of the surface MonoKote the wing and tail. Gary McClellan had a very good rundown on the proper method of applying the heat shrink coverings some months back in Wynn Paul's column on stunt.

Begin finish of the fuselage by applying lightweight fiberglass cloth to the nose section with

Hobbypoxy Formula II. When cured, sand the glass smooth and apply two coats of unthinned clear dope to the entire fuselage. Cover the fuse with light-weight Silkspan, using very thin dope as an adhesive. This is followed with one or two coats of full-strength clear.

Now apply the fillets using Sig Epoxolite. Be sure that your fillets overlap the edges of the MonoKote on all surfaces, as this will help make the covering bullet-proof as far as lifting is concerned.

If you haven't already done so, mask off all the MonoKote areas as the rest of the finish should be sprayed on. First, mix one tablespoon of talcum powder into a pint of clear dope. Thin this to spraying consistency and apply one coat to the fuselage and rudder. Sand very carefully and you shouldn't have to use a second coat. Once you are satisfied with the condition of the surface, mix up some Super Poxy color and spray on a very light tack coat. Allow this to set for about five minutes and proceed to spray on one wet coat. This should be all the color required. Remove the masking tape immediately before the paint sets up and it will leave almost no discernible edge. The original was trimmed with Trim-Kote on the wing and Super Poxy colors on the fuselage. The gold stripe is D.J.'s striping tape.

Now, bolt on the motor, install the Pylon Brand SO-6 slant oval tank shimmed with balsa to align with the spray bar, bolt on the wheels, and let's go flying!

The center of gravity shown on the plans was taken directly from the original after it had been well trimmed. It may be a good idea to start out with it slightly further forward on your first flights. The first flights should be confined to determining if the wing is straight, the tip weight approximately correct, and the tank located properly for both upright and inverted flight, and to get a feel for the way the plane reacts. Have your helper watch the wings carefully, both in level flight and on end during maneuvers. If the wings do anything besides line up perfectly with the flying lines at all times, an adjustment is necessary in either tip weight or by straightening a warped wing. A general statement can be made regarding which of the foregoing is the culprit in a given case. If the outboard wing is high upright and low inverted it's a sure bet that you have a warp problem. If, on the other hand, the outboard is low (or high) both upright and inverted you should be looking at the tip weight when you get it back on the ground. If it's low both ways, remove weight a quarter ounce at a time until they level out, and vice versa if the wing is high both ways.

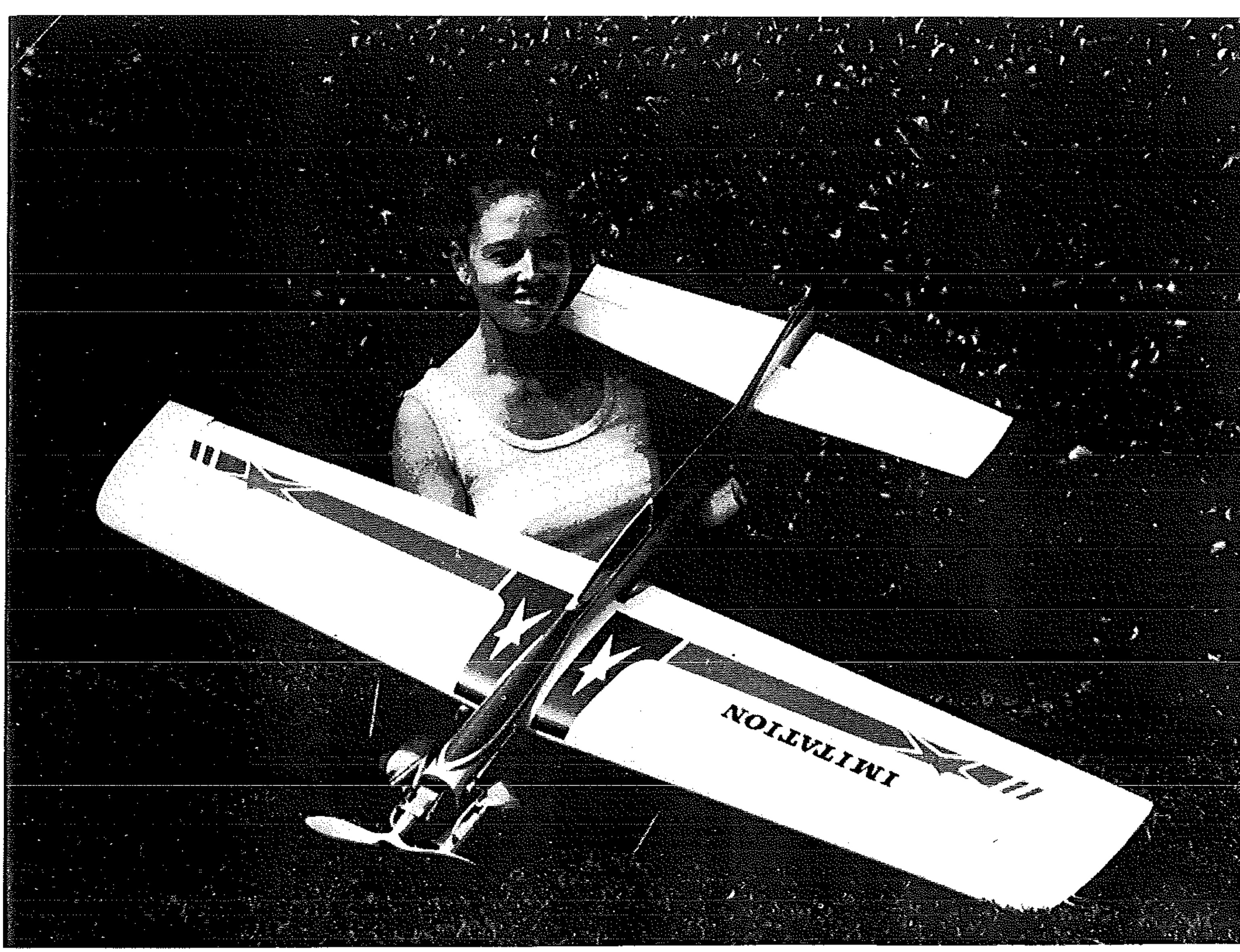
Adjustable lead-outs are often a mystery to novices. Here are some symptoms of incorrect lead-out location to watch for. If the plane pulls hard in level flight but is loose at the top—the first loop of the clover for instance—it indicates that they are too far aft. If the airplane hinges in hard corners but flies with the wings level you may have to move them forward. If the lead-outs get too far forward, the airplane would become too light on the lines and tend to nose in at you slightly each time you gave a sharp control input. Contrary to popular thinking, more lead-out problems come from being too far aft than too far forward. Remember that a straight airplane wants to fly at a tangent to the circle and doesn't require large amounts of engine, line, or rudder offset to maintain adequate line tension. Keep in mind that less is generally best when dealing with trim adjustments.

The most efficient set-up will have the airplane flying as cleanly as possible, as opposed to crabbing sideways which creates unnecessary drag and robs thrust. A good clue to how cleanly your plane is flying is to examine the oil pattern on the bottom of the wing after a flight. The oil should have only a slight tendency to creep out the outboard wing and should continue the length of the fuselage. The lead-outs as shown on the plan should be within a fraction of an inch of correct for your plane.

The Imitation is not sensitive to trim changes, so feel free to experiment with a variety of trim adjustments. Try different flap/elevator ratios; different leadout locations; move the C.G. around. It's amazing how much you can learn about trim if you take the time to experiment.

You have probably noticed that I have studiously avoided referring to my experiment with the 40-size engines, which was one of the prime reasons for developing the Imitation in the first place. If the editor chooses to use one, a picture will show some of the variety of motors (Editor: Shown in last month's installment) with which I have flown the Imitation. While all of those shown are powerful and show promise, I'm afraid the only one to which I am prepared to give total endorsement is the good old S.T. .46. I quickly found that none of these engines, just straight out of the box, was going to give the kind of consistency and predictability necessary for top-level stunt competition. But, that's another story for another day.

Just one advertisement. If you like to fly stunt and you don't belong to PAMPA, the Stunt Pilot Fraternity, you're missing half the fun. Drop a line to Wynn Paul, our secretary/treasurer, at 1640 Maywick Drive, Lexington, KY 40504. If you want to discuss the Imitation, or stunt in general, drop me a line at 158 Flying Cloud Isle, Foster City, CA 94404.



If pretty Shareen is Ted's "better half," we don't know what that makes the Imitation, a thing of beauty in its own right. The 59-inch ship is a profile variation, the true profile beginning just forward of the cockpit.

Designing the IMITATION

For the discriminating stunt pilot, an in-depth exploration of aerodynamic philosophies being evolved through the author's Citation series of aircraft. Article and plans for the Imitation appear next month. Ted Fancher

Editor's Note: In order to reenforce the reader's impressions of the author's discussion of design development, we "borrowed" many of the photos that were intended for next month's construction feature and plans. They will not be repeated—so be sure to keep this issue for reference. Both installments include a vast amount of priceless information relating to all these photos and our necessarily generalized captions do not, in this instance, do justice to the author, or to the knowledgable stunt flier.

THE Imitation was designed as a flying testbed to explore the soundness of a number of aerodynamic philosophies with which I had been experimenting through my "Citation" series of competition stunt aircraft. In addition, it was intended to be used to test the suitability for stunt purposes of a variety of the currently available very powerful Schnuerle-ported 40 engines.

The Citation, although it has had an enviable contest record, including a third and a second at the last two National Championships, does have a couple of significant shortcomings which I felt had to be corrected before investing time and effort into a new competition airplane. First and foremost, it is too much of a thoroughbred, that is, although it is capable of outstanding performance, it is entirely too critical to trim adjustments and weather conditions. It is necessary to spend considerable time before a contest trimming and adjusting to the peculiarities of the contest site. For instance, before qualifying at the '78 Lake Charles Nats I had to tear

AIRCRAFT: Imitation **DESIGNER:** Fancher **SOURCE:** Original

WING

Span . . . . 59"

Asymmetry: Inboard Span in ins: 29.875; Outboard span in ins: 29.125; I/B 102.5%

Root Chord: 12.2"; Tip Chord: 9.2" Mean Chord: 10.7"; Taper Ratio 75.4%

MGC: (See *Fundamentals of A/C Flight*, pg. 35) Location on Halfspan —" Lgth. . . 10.8"

Area: (Span x Mean Chord): 631 sq. " (4.384 sq. '); Volume (MGC x Area) . . 6814.8 sq. "

Aspect Ratio: (Span^2/Area) . . . . 5.5 to 1

Center of Lift: (MGC/3) inches from leading edge at MGC . . . . 3.6"

Airfoil High Point from leading edge: Root 2.7"–22%; Tip 2.02"–22%

Airfoil Thickness: Root 18.3%–2.23"; Tip 18.4%–1.7"

Center of Gravity in % of MGC: 16%–1.73" from leading edge

Center of Gravity to Center of Lift (+ if CG forward, - if CG aft) . . . . +1.875"

Center of Gravity to Leadout Midpoint (+ if CG forward, - if CG aft) . . . . +1.25"

FLAPS

Span	36"	42"	48"	49.5"
Area: (Root Chord + Tip Chord) (Span) / 2	69.75	81.375	93.0	96.0
Flap Moment: C/L to Hinge Line	5.25	5.25	5.25	5.25
Flap Volume: (Flap Area/Wing Area)	11%	13%	14.7%	15.2%
Flap/Tail Ratio	49.8%	58.1%	66.4%	68.6%
Flap Effectiveness Ratio: (Area) X (Moment) / Wing Volume	.056	.066	.075	.077

TAIL

Span . . . . 25"

Area: Root Chord (6.4") + Tip Chord (4.8") x Span / 2 . . . . 140 sq. "

Area of Elevator: 63 sq. "; Area of Stabilizer: 77 sq. "

Tail Volume: Tail Area /Wing Area 22.2%

Tail Aspect Ratio . . . . 4.5 to 1

Tail Moment: C/L Wing to C/L Tail . . . . 22.0"

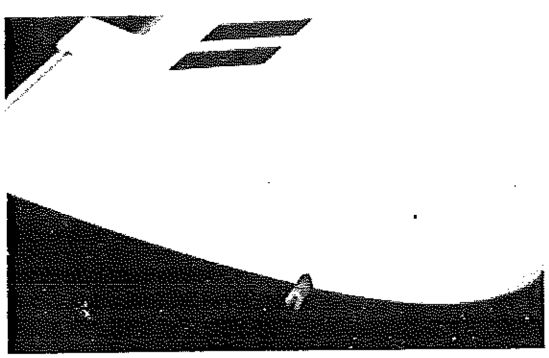
Tail Effectiveness Ratio (Tail Moment x Tail Area) / Wing Volume 452

Total Control Effectiveness Ratio: (Tail Moment x Tail Area)-(Flap Moment x Area) / Wing Volume see below

Stability: (Tail Area x Tail Moment) / Wing Volume 452

→ 36" = .398 42" = .389 48" = .380 49.5" = .378

out almost a full ounce of nose weight in order to regain the same degree of crispness in corners that I had had in the cool, heavy air of Northern California. In addition, it was necessary to explore a whole series of props to find one which would allow crisp maneuvers and not result in excessive air speeds. The single most perplexing problem, however, is the Citation's inability to come out of a corner hard and flat every time. It is altogether too sensitive to handle adjustment and center of gravity location,

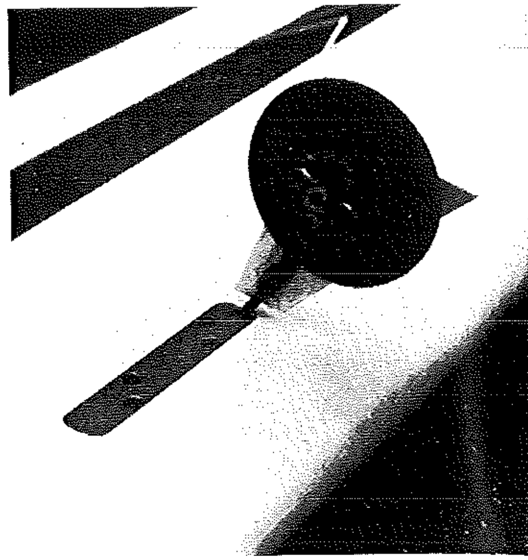


The right wing tip showing the nylon bolt into the variable weight box; and the flap pin. Multiple segment flaps allowed experimentation with four different lengths of high-lift device, and evaluation of merits, or demerits. Ted's findings are given in the text.

and has to be literally nursed around corners if an occasional bobble is to be avoided.

Because of the need to resolve these problems I decided to design an easily built test ship which would allow me to investigate possible solutions. To be meaningful, such a design would have to combine ease of construction with a truly competitive planform which would, as nearly as possible, display the characteristics of a state of the art competition stunt plane. Such a combination would have to include: An inverted engine with an appropriately located fuel system, i.e. directly behind the engine and adjustable in the vertical to allow trimming for consistent engine runs. In addition, it should be possible to easily interchange engines to explore potential replacements for the venerable ST 46. The planform, i.e. wing span, wing area, moment arms, horizontal stab and elevator area, aspect ratios, etc., would have to be identical to a competition plane of the same size. And, although it would be an easy matter to build a simple profile significantly lighter than a competition ship, this temptation had to be avoided as a lighter wing loading would make the results of any tests meaningless in the translation to a heavier ship.

In compliance with these basic para-

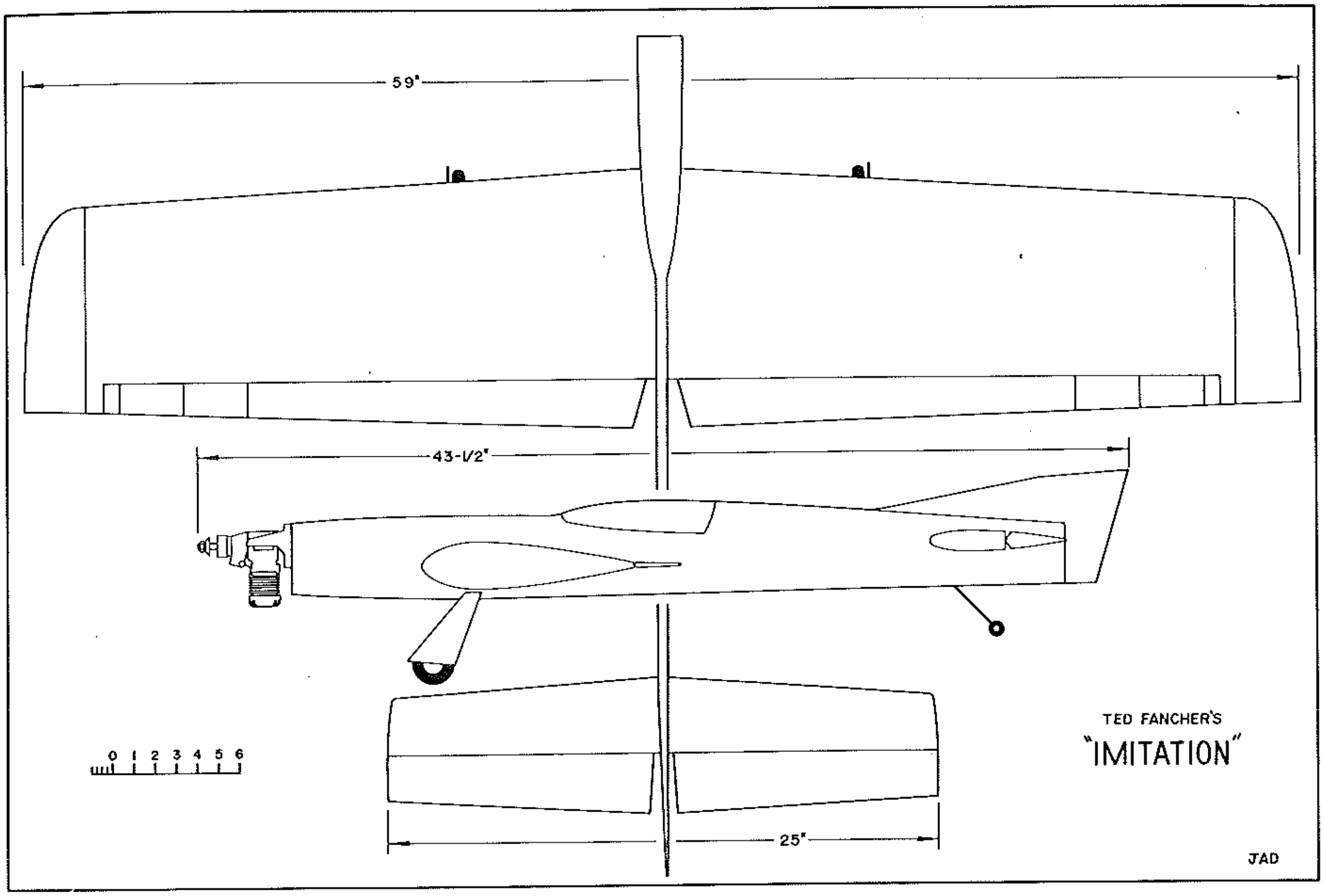


A nice touch is the metal plate which attaches with 4 flathead screws over the landing gear wire which mounts in normal fashion on simple block assembly—Control Specialties item.

meters the Imitation came off the building board sporting a semi full fuselage on the front end, supporting a Kraft-Hayes KM-40 engine mount which is easily removable to accommodate a variety of engines. A cutout was incorporated in the nose to allow the fuel tank to be properly located, and allowance was made for space to shim the tank either up or down.

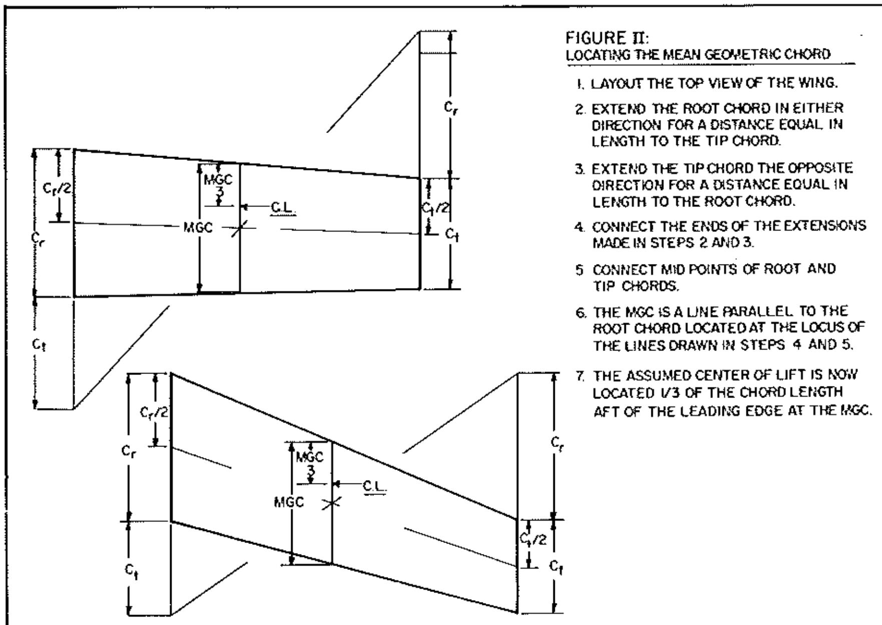
Aerodynamically, the Imitation features a 59-in. wing span of 631 sq. in. of area. This results in an aspect ratio of 5.5 to 1. (For those unfamiliar with the term, an aspect ratio is mathematically defined as the length of the wing span squared, divided by the area, or for constant chord or straight tapered wings, the wing area divided by the average chord.) A comparatively long tail was employed along with a large horizontal stab and elevator, 140 sq. in., or 22.2% of the wing area. No attempt was made to keep weight down and, as a result, the Imitation came out weighing 50 to 53 ounces, de-

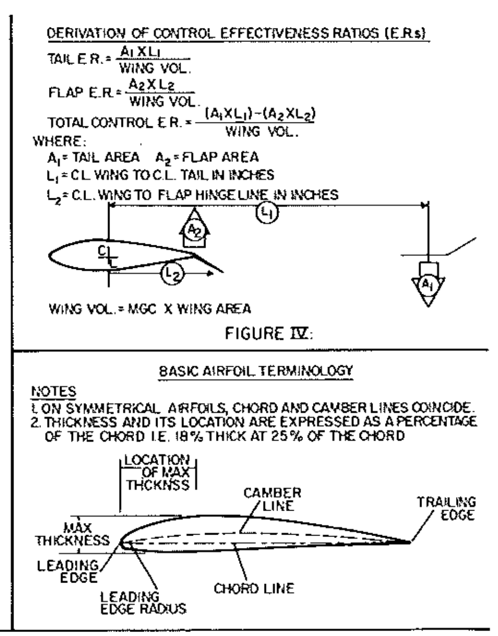
Ted's handle is adjustable on both lines as the picture makes clear. The manufacturer's reminder not to fly near overhead power lines is an excellent safety reminder—some require it!

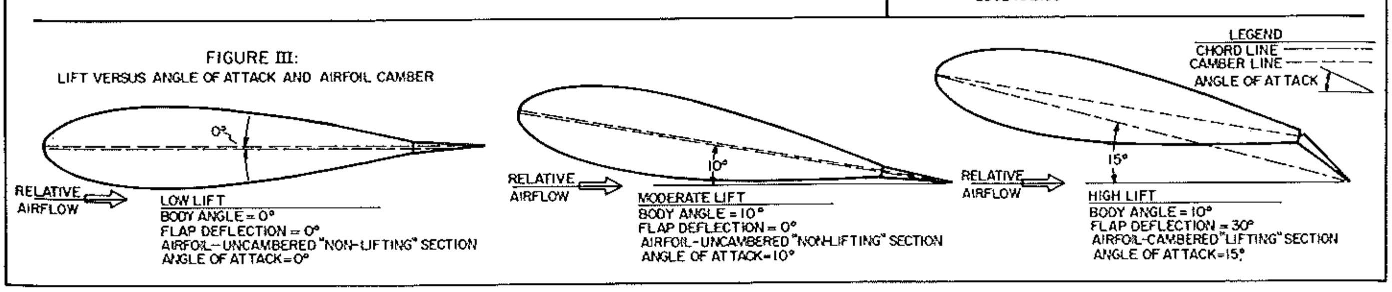


pending on the weight of the engine. This translates to a wing loading of 11.4 to 12.1 oz./sq.ft.—actually slightly in the heavy competitive range. The Citation, for instance, has a wing loading of 11.0 oz./sq.ft.

In addition to these basic requirements, all of the now mandatory adjustable features would have to be included in order to achieve optimum flight trim. My personal approach to such things as adjustable line guides, tip weight, tail weight, control ratios, and so forth, are detailed on the plans and in



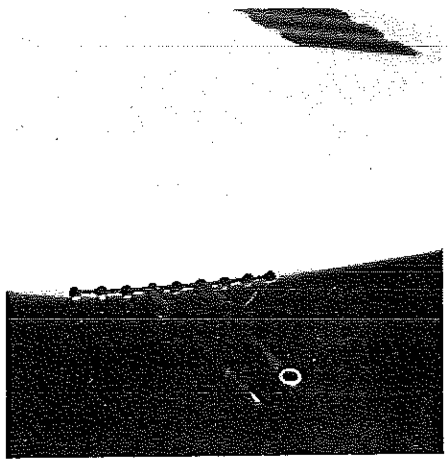




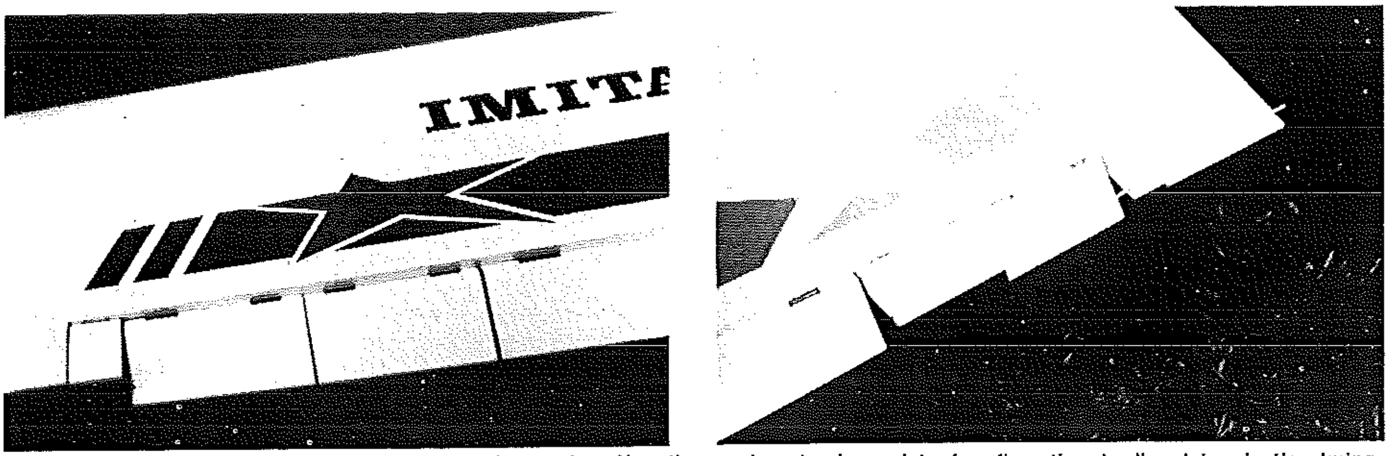
the pictures accompanying this article and the construction article which follows next month. They are generally straightforward and any unusual items will be addressed more completely at a more appropriate point.

There are a couple of innovations which are quite unusual and which were occasioned by my desire to evaluate their effects on the flight characteristics of the ship. The most obvious is the multiple segment flaps which allow experimenting with four different lengths of high-lift device and the evaluation of the merits and demerits of each. This was very interesting, and I will expand on my findings a bit.

The second unusual adjustment is the firewall spacers which allow me to move engines forward and aft, thus varying the "nose moment arm." It has been my opinion for some time that the length of the nose moment was not significant in terms of flight trim. Rather than spend time on it, let me just state that nothing I have learned as a result of the ability to move the nose moment by as much as ¾ of an inch has given me any reason to change my opinion in this regard. I could tell no difference in flight characteristics as a result of a longer or shorter nose, provided that the center of gravity remained in the same location. Suffice it to say, I am happy with whatever nose length results in the least need for additional weight to bring the airplane to proper flight trim. Try the spacers if you like, just remember to adjust the CG so that it remains constant throughout your experiments.



Adjustable leadouts may mystify novices, but they allow corrections for a wide variety of trim problems to fine tune the airplane to fly correctly. This is Ted's neat arrangement.



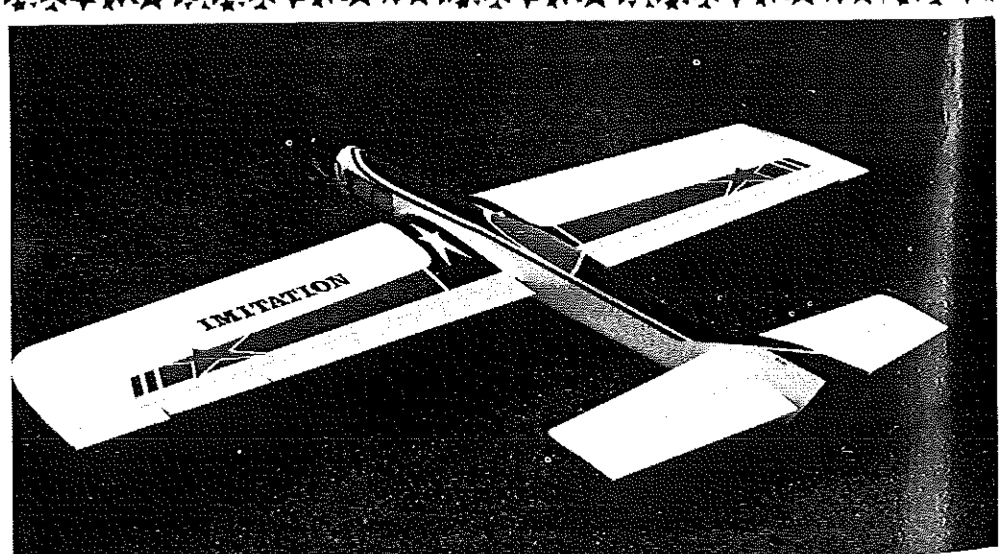
These two views of multiple segment flaps afford an impression of how they can be set up in a variety of configurations to allow determination during test flying of condition preferred by the pilot to give him precisely the characteristics, during various maneuvers, which he seeks.

Other less obvious innovations include the use of a very thick horizontal stab and elevator employing Warren Truss construction for rigidity, Du-Bro Ball Links for control linkages, and a homemade, circular 3½" bellcrank which I have detailed on the plans. If you have access to a machinist it is a nice feature, but a standard Sig or Top Flite nylon bellcrank would do yeoman service with only slightly increased control forces at the handle.

Once the design goals were established, the next step was to translate them to paper. The usual approach to "designing" an original stunt ship is to lay out a profile on paper which appeals to the designer, and then try to find a place to locate the more mundane essentials such as a wing, tail, engine and tank, wheels, etc. I decided to use at least a 10% more scientific approach by deciding what aerodynamic layouts would hopefully provide the flight characteristics I desired, and only after laying out the essentials, would I wrap the results in the gossamer of my personal vision.

The table shown in Fig. 1 was developed by Bill Fitzgerald and myself over the past five years. Its purpose is to display, mathematically, approximately 40 parameters which we felt were significant in affecting the manner in which a stunt ship flies. Initially, we used the table to collect comparative data from several proven designs with which we were familiar. Our primary emphasis was on factors which establish rapid pitch change (rate of turn) and stability. This compilation, along with a certain amount of basic aerodynamics with which we were familiar, eventually allowed us to develop a mathematical concept of what a potentially outstanding stunt ship should look like—"by the numbers."

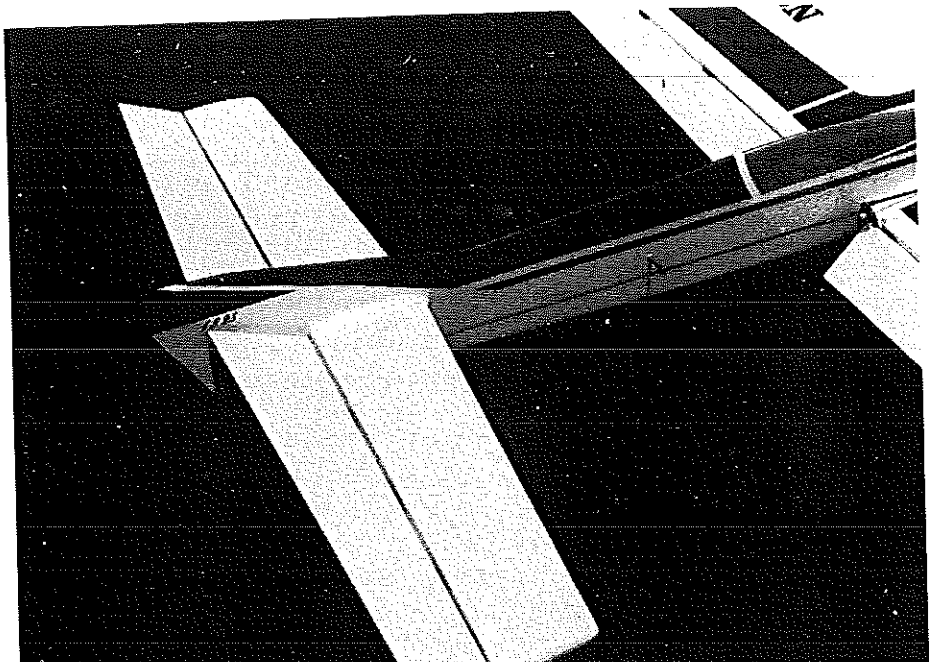
While most of the items on the table are self explanatory, a few of the parameters may be unfamiliar. Taper ratio is the ratio of the tip chord to the root chord, i.e. a wing with a 7.5-in. tip chord and a 10-in. root



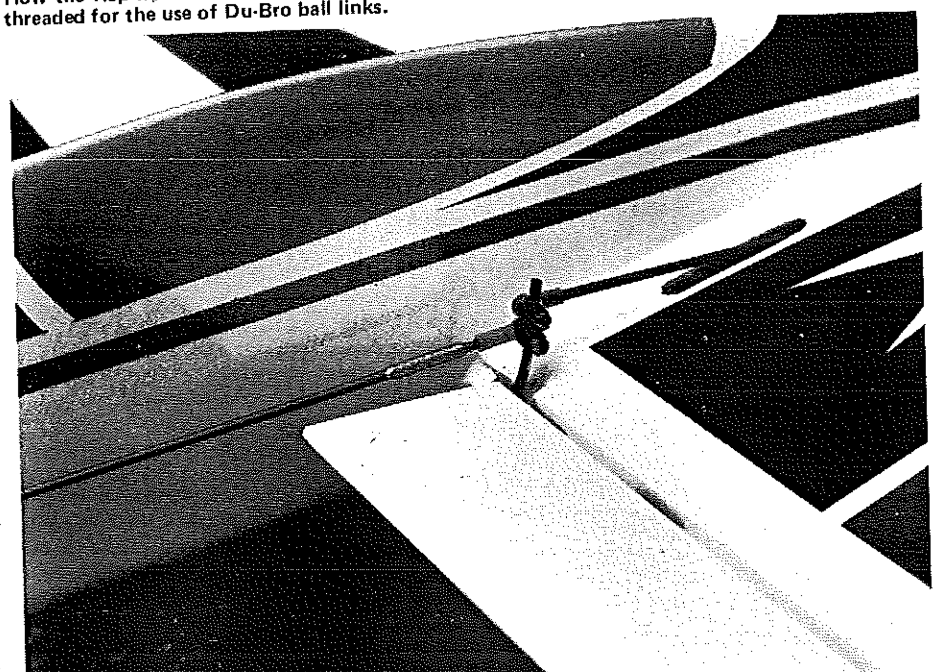
chord would have a taper ratio of 75%. The M.G.C., or Mean Geometric Chord, is a graphically derived station along the span which closely approximates the Mean Aerodynamic Chord. (See Fig. II.) This is the point at which the results of all the aerodynamic forces may be assumed to be concentrated. For all practical purposes, with simple tapered wing planforms the Mean Aerodynamic Chord and the M.G.C. may be considered identical.

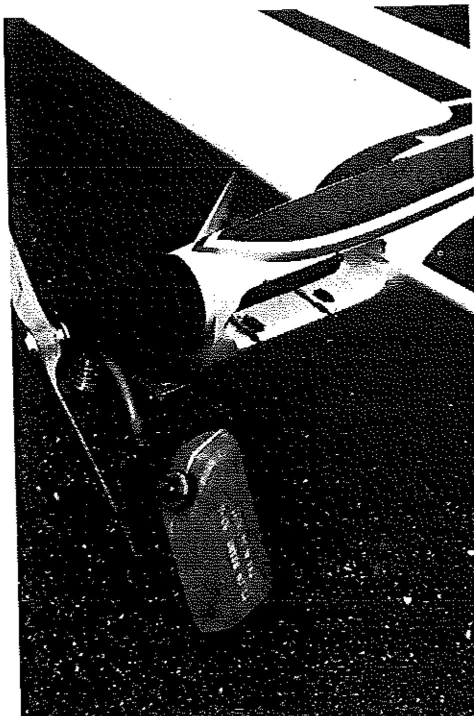
For design purposes I have arbitrarily designated a point 33% aft of the leading edge at the M.G.C. as the Center of Lift. This arbitrary point is used as a datum or reference point for many of the design parameters to follow—primarily those dealing with moment arms. I may as well say it now. Even though it may be considered heresy by many, the classic measure of moment arms, i.e. back of prop to wing leading edge, and crack to crack on the flaps and elevators, is of practically no value. Because this takes no cognizance of different planforms (top view of wing, tail shape and relationships) and aspect ratios, it can be seen that, for instance, a 15-in. tail moment on a 600 sq. in. airplane of 54-in. span bears little resemblance to a 15-in. tail moment on a 600 sq. in. airplane with a 65-in. wing which is swept back 20°. To be of any merit, such comparisons must be based on a common reference. For design and discussion purposes, then, an arbitrary reference should be established. I have chosen to use the point titled Center of Lift in the table.

Harkening back to my comments regarding the adjustable nose length, note that I have as a result of this test, not bothered with a measurement of the "nose moment." I just don't think it's significant. Argue with me. I love it!



Above: We won't comment on the coupling of flaps and elevators illustrated in this photo because the author goes deeply into this, and all other matters, in both this article and next month's construction feature. A point of interest is the fairlead to eliminate pushrod deflection. Below: How the flap horn is set up to allow throw adjustment of short/long pushrods. All pushrods are threaded for the use of Du-Bro ball links.





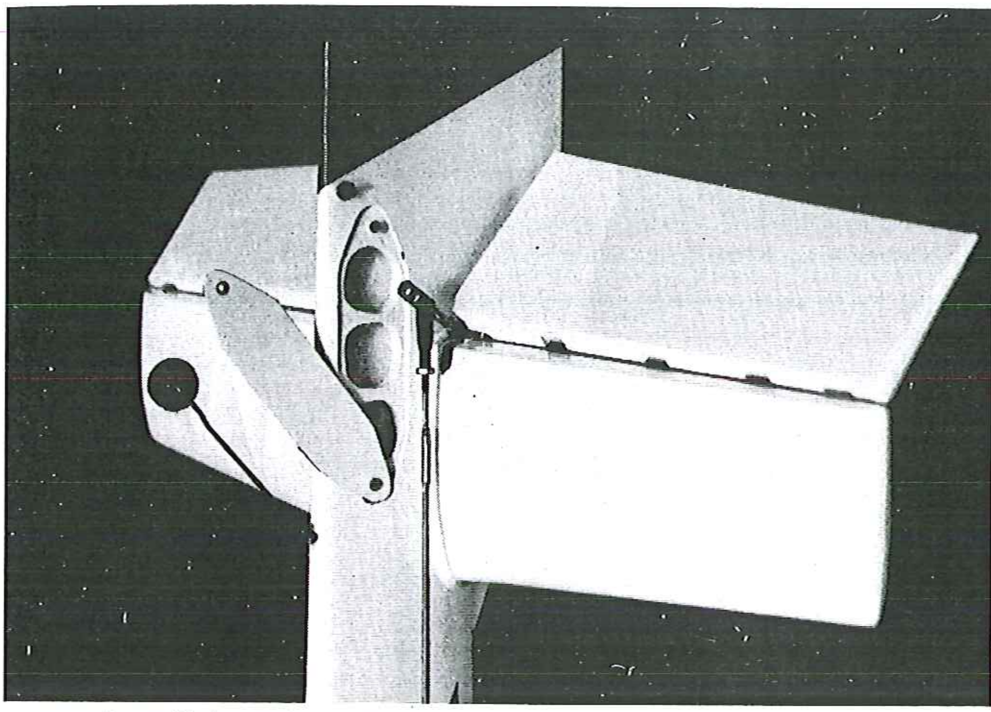
The 6-oz. Sullivan nylon oval slant tank taken out to show contours of cutout for mounting. Arrangement used on plans to be published.

Volume (of the wing) is the mathematical product of the wing area multiplied by the Mean Geometric Chord, and is used in later calculation regarding stability and control effectiveness. By using wing volume in the force calculations rather than just wing area, we get a measure of the effectiveness of aspect ratio in determining control response. As aspect ratios decrease, i.e. M.G.C. becomes larger, the wing volume becomes larger and the effectiveness of the tail surfaces for both control and stability decreases. More on that later.

You will notice in the area covering flaps that it becomes somewhat cluttered due to the use of four different flap sizes. Rather than try to totally digest the numbers, I suggest you read my conclusions from this experiment later in the article.

In both the flap and tail sections of the table I have an entry for flap/tail volume. These might more appropriately be called flap/tail percentages as they reflect the comparative size of the flaps and the tail in comparison to the wing.

The three Effectiveness Ratios (Flap, Tail, and Total Control) are developments of our work and are solely for the comparison of one plane to another. (See figure IV.) They have no mathematical basis or validity for any other purpose. What we attempted to do was to illustrate the potential of forces developed by the tail and flaps to affect the flight path of the wing. The tail, by virtue of the lift it develops multiplied by its



One could almost write a book about many things here evident to the discerning stunt pilot's eye: hinging, jam nut at clevis, easily accessible compartment for flexibility in use of weights.

distance from the datum, is capable of applying "X" amount of force to achieve a change in angle of attack. The flaps, by virtue of the same two factors, are able to apply "Y" amount of leverage to affect the angle of attack, in, however, the opposite direction. Both of these forces are acting on the wing which has a certain amount of reluctance to change direction, based primarily on its size and shape. Therefore, by subtracting the restraining force of the flaps from the force of the tail and relating the result to the wing volume we are able to derive a number which roughly approximates the ability of a given airplane to change directions. As this number gets larger the ability of the airplane to corner briskly increases. As you will note in the later discussion regarding the variable length flap experiments, the validity of this approach—if not the mathematical soundness of the formula—is totally supported.

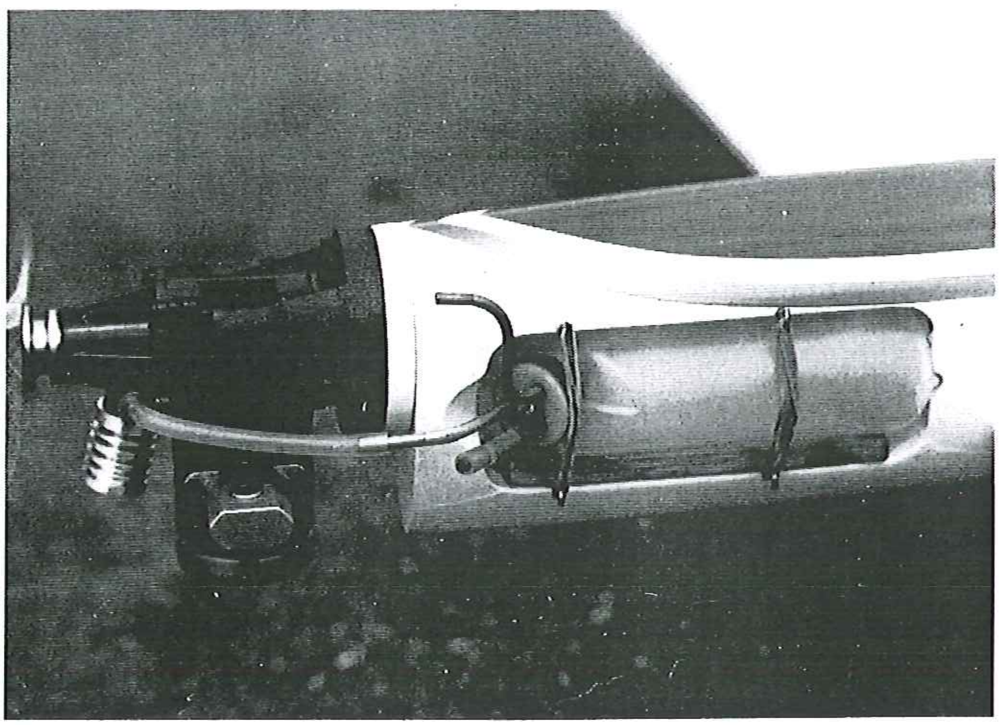
I dislike, as I'm sure you do, the designer who tells you he did something a certain way for a very good reason but doesn't want to bore you with the technicalities. Not very fair of him to pass the cloak of ignorance to his readers. Therefore, I'm going to run down my conception of what a stunter should look like in general, and at least a cursory explanation of why I feel a particular characteristic employed on the Imitation is important. If you disagree with me, that's great. It's about time the stunt world had some controversy over something besides judging!

First of all, I feel we should be using higher aspect ratios on stunt ships. Higher aspect ratios result in significantly lower induced drag in high lift-drag situations, such as a square corner. Rapid drag build up causes speed decay and demands greater horsepower from the engine. Reduce the drag build-up in corners, and the need for an automatic four cycle/two cycle engine run becomes less demanding. Since induced drag comes from a combination of tip vortices (miniature horizontal tornadoes formed at the tips by the high-pressure air on the bottom of the wing being drawn around the tip to the low-pressure area on the top), and wing down-wash (the tendency of the high velocity air particles on the upper surface of the wing to continue downward beyond the trailing edge), it can be reduced by moving the tips further apart (a good argument for raked style wing tips versus flat plate types), and by reducing the length of the chord for a wing of given area, i.e. higher aspect ratios.

There are some negative results from higher aspect ratios. Maintaining the structural integrity of the longer wing is difficult, and more care must be taken to avoid warps as their effects are more pronounced. In terms of performance, the lowered induced drag results in an aircraft which has an increased sensitivity to power and prop changes. I have found it necessary to use large diameter, lower-than-normal pitch props to maintain proper lap times and control an increased tendency to accelerate in consecutive maneuvers. Zinger 12×5s and 12×4s seem to be ideal, resulting in lap times of 5.5 to 5.7 seconds per lap and nicely controlled airspeed in maneuvers on 62-foot lines. I have also been doing some testing with one of Bobby (No. 1) Hunt's three-bladed Rev-Ups that shows some promise.

Secondly, tails should be significantly longer, for both stability and turn performance. The effect on stability is relatively easy to perceive and I don't believe is open to serious debate. There is, on the other hand, a large school of thought who argue the merits of shorter tails because you get more "kick" closer to the CG to throw the plane around the corner. To understand why this concept is in error, it is necessary to understand the concept of a moment arm and the effect that it has on pitch change, angle of attack, lift produced, and resultant body angle.

Assume we are entering the first corner of an inside square loop. What the judges are looking for is, in the simplest terms, a 90-degree change of flight path. The concept that this change in body angle is the result of air pushing against the deflected elevator,



Deep cheek blocks that contour the basic profile afford an opportunity to neatly submerge exposed tank. The mount is a carbon/glass Kraft-Hayes item, familiar to RC people. Firewall spacers allow up to 3/4 inch movement but Fancher regards it essential that C.G. remain as specified.

and causing the aircraft to rotate about the center of gravity, is simply not true. In chronological order, what in fact takes place, is the following.

It must be understood that the tail functions not by deflecting air, but rather by producing lift in the same way as any lifting surface, i.e. through the difference in pressure between the top and bottom of the airfoil. The lift thus produced is multiplied by its distance from the aircraft's center of gravity. The product of the lift force applied, multiplied by the force's distance from the center of gravity is the moment arm. Increase either and the resultant force increases. The force thus applied causes the aircraft to pitch up, resulting in an increased angle of attack which, in turn, results in increased lift from the wing. Assuming sufficient thrust to overcome the induced drag which comes with the increased lift, it can be seen that the aircraft will continue to increase angle of attack as long as the force continues to be applied by the tail, and at a rate proportional to the degree of force being applied, until such time as the force is removed and the plane continues along the newly achieved flight path. Since the aircraft has an inherent desire to remain in motion along a given path until displaced by an outside force, it is obvious that the greater the force applied, the more rapid will be the resulting change in flight path. Therefore, longer tail moments will result in tighter turns with less lift and drag than shorter tails.

Thirdly, as aircraft size increases we find control inputs necessary to deflect larger control surfaces against the slipstream are becoming greater as well. For a comparatively small man such as myself, these increased requirements for muscle in the center of the circle become substantial, especially in light of the need for hundreds of practice flights a year. This problem can be attacked both aerodynamically and mechanically.

Aerodynamically, forces can be reduced by both reducing the proportion of the surface which is deflected, i.e. smaller elevators and flaps, and by keeping the chord of the deflected surfaces as short as reasonable. To easily demonstrate the latter phenomenon, try deflecting any rectangular object, such as a piece of wood approximately four times as long as it is wide (a 4 to 1 aspect ratio!), both lengthwise and widthwise against the slipstream outside your car window at 55 mph. You will notice considerably more resistance when you attempt to deflect the surface lengthwise. This demonstrates the significantly reduced control leverage required of high aspect ratio control surfaces. Because of this, and the fact that such a long, narrow lift device is more efficient and creates less drag than short and fat ones, I feel that flaps should be limited to between 15 and 20% of the wing chord at a given station on the wing. On the Imitation this results in flaps which are 17% of the chord at all stations.

The proponents of large elevators are probably questioning my sanity when I suggest smaller ones. Again, it is important to remember that the force which causes pitch change comes from the lift produced by the entire tail, not solely by the amount of surface we are deflecting into the slipstream. Therefore, what we are looking for is an efficient lift-producing surface. Probably the most efficient tail would have an elevator which comprised approximately 25% of the total tail surface—something like the Flite Streak, which everyone knows will outmaneuver the more conventional-tailed Ringmaster hands down.

There is, however, some compromise necessary in terms of drag and stability which makes larger than optimum elevators result in an aircraft which is more stable while maneuvering. Since moving the center of drag aft is stabilizing in its effect, and since a certain amount of drag comes hand in hand with the lift the tail produces to maneuver, it is apparent that at the sacrifice of a little more drag we can build an airplane which is more controllable while maneuvering, and which has less tendency to overshoot headings. For this same reason, the thicker tail was employed along with a lower aspect ratio. Such a tail won't be the most efficient in terms of maximum rate of turn, but will come close, and the net effect will enhance the overall flyability of the airplane. As a result of these compromises, the Imitation has a tail which totals 140 sq. in., of which 55% is stabilizer and 45% elevator. The aspect ratio of the tail is 4.5 to 1.

Mechanically, control forces can be reduced by achieving increased mechanical advantage over aerodynamic resistance to

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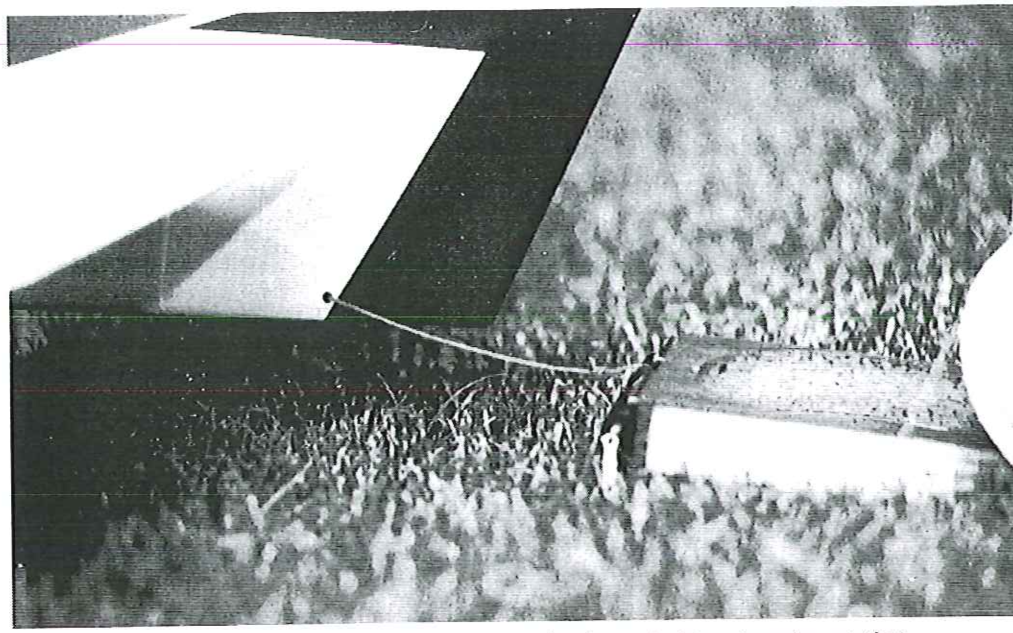
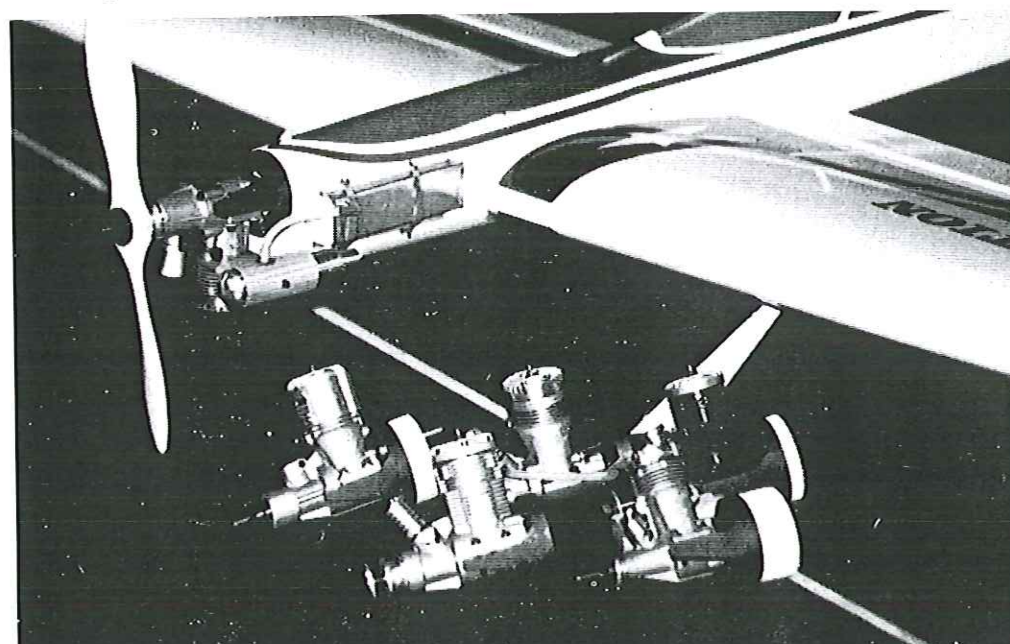


While Ted makes no comment on his stooge, so many readers have asked how to make one, that we include this explanatory picture. Stooge anchored to ground, string pulls release pin. Voila!



Some of the variety of 40-size engines used during the experimentation—note different firewall spacers required. Metal tank appears in this picture, as does the muffler pressure arrangement.

several hours. Texas was covered with a monstrous high pressure system that day, but surely *some* drift was to be expected. At this point, we turned on the T.V. and discovered we were looking at a weather balloon released that morning at Palastine, TX by the National Science Foundation. This jumbo was 450 feet in diameter, containing 40 million cu. ft. of helium, and was floating 23 miles overhead!

I am still amazed at the unaided visual identification of an object at 120,000 feet. Apparently so were many others, as the switchboards in Dallas went wild after sundown when the reflected sunlight produced a pinkish cast on the side of the polyethylene balloon leading to thousands of U.F.O. reports.

Dee B. Mathews, 506 S. Walnut, Greensburg, KS 67054.

Imitation/Fancher

continued from page 45

deflection. Simply stated, this means longer control horns and a bigger bellcrank. The Imitation uses a homemade 3½" circular bellcrank which maintains its full 1¾" fulcrum for the entire range of control movement. The pushrod exits the bellcrank 0.9" from the bellcrank axis, and is attached to a DuBro Ball Link on the flap horn one inch from the flap hinge line. The flap to elevator pushrod is located 0.75 inches from the respective hinge lines for a classic one-to-one flap elevator ratio. A conventional horn was employed on the elevator to allow the use of elevator slop, if necessary. It now appears that ball links could have been used throughout, as the long tail moment and large surface area of the tail have proven to provide all the stability one could hope for. The handle which provides the finishing touch to the control system is a modified Custom Master Flight Handle, as designed by Bob Baron, and produced by Gene Martine, at Custom Master Products, 5424 Oliver Street S., Jacksonville, FL 32211.

Before leaving the subject of control surfaces, let's talk a bit about those variable span flaps and their effect on the flight characteristics of the Imitation. First of all, let's once and for all rid ourselves of the desire to think of flaps as separate and distinct from the wing. Wing flaps are simply a part of a wing which happen to be attached in such a way that they may be moved up or down about a hinge line, and, by so doing, make substantial changes to the characteristics of the airfoil. Reference Figure III. These changes significantly affect the amount of lift which a wing of given area is capable of producing. The classic symmetrical stunt airfoil is often referred to as a non-lifting section, inasmuch as its top and bottom surfaces are mirror images and, as a result, the camber line (a line drawn equidistant from the top and bottom surface) is a straight line. Theoretically, such a section at zero angle of attack would produce no lift due to there being no differential in velocity—and therefore, of pressure above and below the wing.

Now, if we were to hinge the aft 15 or 20% of that wing surface and deflect it downward, we will have altered a number of things. First of all, we have instantly changed the uncambered "non-lifting" airfoil into a cambered "lifting" one. Also, since the measure of an airfoil's angle of attack is defined as the angle between the relative wind and a line between the leading edge and the trailing edge (the chord line), we have concurrently increased the angle of attack. These two items acting in concert have made a quantum increase in the amount of lift produced by the same airfoil in its natural symmetrical state. From this, it is apparent that the amount of flap area is not the most important factor in determining the amount of additional lift produced. Rather, it is the percentage of the total wing span which is equipped with the high lift device which is significant. In other words, a wing which has 15% of its total area as flap along its full span will produce significantly more lift than the same wing with 15% of its total area as flap, but concentrated in only, say, ½ or ⅔ of its span.

So far, all is well and good. We've seen how we can apparently get something for nothing almost instantaneously just by bending the back of the wing. There is, however, a small fly in the ointment. It buzzes around the fact that the center of lift is, almost without exception, located somewhat aft of the center of gravity. Additionally, the center of lift will move further aft with the deflection of flaps and the concurrent increases in lift and angle of attack. As a result of the divergent location of the centers of lift and gravity, a moment is produced between the two whenever either is increased. In the case of the classic stunt configuration with the center of lift aft, the force manifests itself as a negative pitching moment. It wants to pitch the nose in the direction opposite to your desired change. This pitching moment adversely affects your ability to make rapid changes in attitude, and it is therefore in our best interests to minimize its effects if we are seriously in search of the elusive rule-book corner.

Since this pitching moment is again the product of the lift times its distance from the center of gravity, any minimizing of its effect must come through reduction of one or the other. Any reduction of lift would have to come through a decrease in flap size, and since we are in need of all the lift we can generate, its reduction is not a viable solution to the pitching moment dilemma. A decrease in arm is achievable in a variety of ways. Higher aspect ratios inherently have less distance between CL and CG. Smaller chord flaps also result in less rearward movement of CL with deflection. A third possible method of shortening the arm is to move the CL forward. In an attempt to accomplish this, the high point of the airfoil on the Imitation was placed at 22% of the chord for the full span, a full 8% further forward than the Citation's 30%. Finally, the classic method of merely moving the CG aft is always available through the addition of tail weight.

A design, such as the Imitation with its high stability coefficient, i.e. a large tail on a long arm, is much more amenable to such a solution as it can withstand a much furth aft C.G. without becoming unstable. In addition, the large tail and long moment arm provide the leverage necessary to overcome the adverse pitching moment and, therefore, retain adequate turn potential even with full span flaps. It is my opinion that these last two items—moving the C/L forward and the ability to move the C.G. aft and still retain adequate stability—are primarily responsible for the improvement in the Imitation's ability to come out of corners hard and flat when compared to the Citation.

There is a silver lining to the pitching moment cloud, however. A negative—or, for our purposes, opposing-pitching moment—is stabilizing in its effect. Imagine briskly rotating a bicycle wheel with no resistance and trying to stop it precisely at a predetermined point. Now, mentally repeat the same exercise with light to moderate brake pressure resisting your efforts and imagine how much easier it would be to stop precisely. The pitching moment of the wing acts in the same manner to resist and stabilize your efforts to change its attitude against its wishes.

Flight tests on the Imitation with varying flap sizes seem to back up the foregoing theories. It was initially flown with only the innermost sections of flap operable. The flights in this configuration were spectacular when it came to corners. With only 60% of the span flapped and with a total of only 11% of total wing area movable, pitching moment was minimal. With the huge leverage of the tail the plane could literally leap through corners. Unfortunately, round maneuvers suffered a nearly uncontrollable tendency to wander. Minor control inputs would cause noticeable pitch changes manifested as visible flat spots in the rounds. As increasing amounts of flap were made operable, the extremes of explosive corner and marginal tracking began to moderate. Now the corners, although still impressively tight, became much more controllable and precise exits easier. As the pitching moment from the additional flap increased, the plane became much easier to fly through round maneuvers and tracking improved remarkably.

The experiment with the flaps made it tempting to build a competition airplane with the same feature. In windy weather, when "G" forces build up in consecutive maneuvers, it would be tempting to be able to fix some of the flap to reduce adverse pitching moment in hard corners, and thus reduce, or eliminate, the loss of corner normally associated with flying in the wind. I think, though, that this temptation should be avoided because of its adverse effect on the round maneuvers and the fact that you would never really come to know your plane intimately. Although I learned a great deal from the experiment, I still don't feel confident that I could say how much flap is ideal. I will only cautiously generalize that a little too much is probably better than too little.

These are the highpoints of the design philosophy which resulted in the Imitation. To say that the plane was a success would be an unfair understatement of the facts. It is in most respects the best flying plane I have flown and in terms of tight and precise corners it has few, if any, peers. All of the experimental features which were tested on the Imitation were so successful that the results are now being incorporated in my new competition ship, the Excitation.

Because of the relative ease of construction, the Imitation should be a reasonable project for any builder with a few profiles under his belt. Due to its outstanding flying capabilities it is a perfect selection as a contest machine for beginners and even advanced fliers. Any builder who desires a far better than average plane for practice or for impressive Sunday barnstorming ought to take a close look.

(To be Continued)

Suggested Reading

Fundamentals of Aircraft Flight—Frederick K. Teichmann, Hayden Book Co., Inc., Rochelle Park, NJ.

Aerodynamics for Naval Aviators—Issued by the Office of the Chief of Naval Operations Aviation Training Division (Primarily Chapter I Pages 1 through 95).

FLY SAFELY!

CL Speed/Hempel

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eral Speed supplies and Rossi engine parts. John Newton, 2154 Los Padres Drive, Rowland Heights, CA 91748 — airplane parts for Chuck Schuette-design asymmetric sidewinder.

Questions concerning this article, or FAI Speed in general, may be addressed to Charles Lieber, 725 Signal Light Rd, Moorestown, NJ 08057.

Gene Hempel, 301 North Yale Dr., Garland, TX 77459.

CL Scale/Gretz

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authentically contoured spinners are available. All of these parts are cast of gray epoxy resin and are ready-to-paint, with no priming or extensive sanding required. The samples that I saw appeared to be very accurately researched and duplicated, and displayed excellent workmanship.

Also available from this firm are hand-carved laminated wood scale props suitable for most of the WW1 vintage kits on the market. They also come ready-to-finish and include metal hub plates.

For you scratch-builders, Keeler will make custom props, either cast resin or wood, providing that you can furnish adequate scale documentation. This should include the diameter of the full-size prop and as many photos and drawings as possible. All of your materials will be returned upon completion of your prop.

"Ring Around the. . .Cockpit!" One of the oldest tricks in the scale modeling book is using fuel line tubing to simulate the padded edging which is normally found around the rim of the open cockpits of many vintage full-scale aircraft. This is commonly referred to as the cockpit "coaming." While building my CL Sport Scale PT-19, I became reacquainted with this familiar technique and jotted down a few notes which may be of interest.

The coaming around the cockpits of the actual full-size PT-19 that I was duplicating was made of padded black leather. While this type is typical of most older open cockpit aircraft, you may find that some of the homebuilt types of today will have a foam or rubber edging. In any case, you need to find a brand of tubing that has the right diameter and wall thickness to give the correct degree of size and roundness. I found some ⅛" I.D. × ¼" O.D. black neoprene rubber tubing (formerly marketed by VECO) which looked just right from 10 feet away on the 1/6th scale model. After the finish was complete, I used a sharp #11 X-acto knife to cut the cockpit openings to their final shape.Then the flat black anti-glare panel was painted on.

When dry, cut a piece of tubing for each cockpit slightly longer than you figure is actually needed. Use a sharp blade again to cut through the tubing lengthwise along one side so that it can be opened up and slipped over the cockpit edge. Then trial fit the tubing to the model for the first time without glue. Start at one end and very carefully go all the way around making certain that the tubing is *firmly* pushed up against the balsa edge before cutting it to final length. When you're completely satisfied that it will fit as desired, take it off and mix up a batch of slow drying (overnight) epoxy glue.

Use a piece of wire to work the epoxy inside of the tubing. Slip the tubing back in place on the model and use plenty of pins to secure it to the balsa cockpit until the glue dries. With the tubing I was using, it was necessary to push the pins in firmly and then withdraw them just slightly while holding the tubing back with the fingers to avoid leaving a permanent dimple in the tubing after the epoxy