

FIRESTREAK



A look-alike of the full size Lear Fan Supership, this model is a real performer. Powered by a .15, when airborne, hold onto your hat.

by Joseph M. Mergen

The writer has been intrigued by the configuration of this design since the Douglas XB42 "Mixmaster" Bomber prototype days, circa 1946. The advent of the new Lear Fan 2100 brought it all together again and the temptation to build it as an R/C model would not go away.

This type of airplane actually predates the Douglas. Paulhan-Tatin built and flew a similar configuration with a 50 hp Gnome engine in 1911. The only data which can be found is that it "outperformed all others" in its power class doing 80 mph.

The writer had actual experience with the "Mixmaster" having designed and built the propellers while Chief Design Engineer at the old Curtiss Wright Propeller Division.

The Douglas outflow everything around also and was abandoned only because of gear box troubles and the advent of the jet engine. The lack of public and government interest in anything military in the demobilization days of 1946 may have had something to do with its demise also.

Anyway, here it is again in the Lear Fan 2100. Somebody re-invents this airplane every 35 years. Some valid claims can be made for this type airplane and are as follows:

- Symmetrical thrust during single engine operation.
- Drag reduction due to lack of slipstream over the fuselage, empennage and some of the wing and fuselage boundary layer clean up.
- Improved stability due to propeller normal force behind the C.G.
- Clean fuselage and surface shapes with minimum interference drag points.

- Low cabin noise and vibration.
- Lack of structure through cabin such as the wing spar, etc.
- Good visibility.
- Good appearance.
- Efficient structure.

FIRESTREAK

Designed By: J.M. Mergen

TYPE AIRCRAFT

Aerobatic Sport

WINGSPAN

40 Inches

WING CHORD

8" (Avg.)

TOTAL WING AREA

320 Sq. In.

WING LOCATION

Low Wing

AIRFOIL

Symmetrical (NACA 63012)

WING PLANFORM

Double Taper

DIHEDRAL EACH TIP

1 1/4 Inches

O.A. FUSELAGE LENGTH

34 Inches

RADIO COMPARTMENT SIZE

(L)11" x (W)2 1/2" x (H)2 1/2"

STABILIZER SPAN

17" (Proj. V-Tail)

STABILIZER CHORD (inc. elev.)

4 1/2" (Avg.)

STABILIZER AREA

76 1/2 Sq. In.

STAB. AIRFOIL SECTION

Flat

STABILIZER LOCATION

Top of Fuselage

VERTICAL FIN HEIGHT

3 1/2 Inches

VERTICAL FIN WIDTH

3" (Avg.)

REC. ENGINE SIZE

.15 Cu. In.

FUEL TANK SIZE

4 Oz.

LANDING GEAR

Tricycle

REC. NO. OF CHANNELS

4

CONTROL FUNCTIONS

Ruddervator, Ailerons, Throttle

(V-Tail w/Mixer) Opt. Flaps

BASIC MATERIALS USED IN CONSTRUCTION

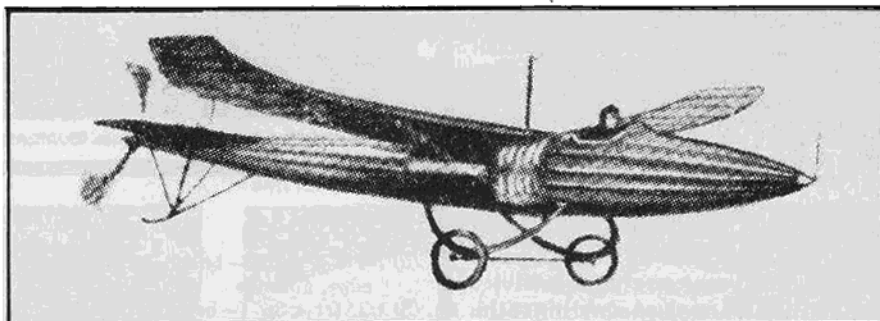
Fuselage Balsa, Spruce & Ply

Wing Balsa, Spruce & Ply

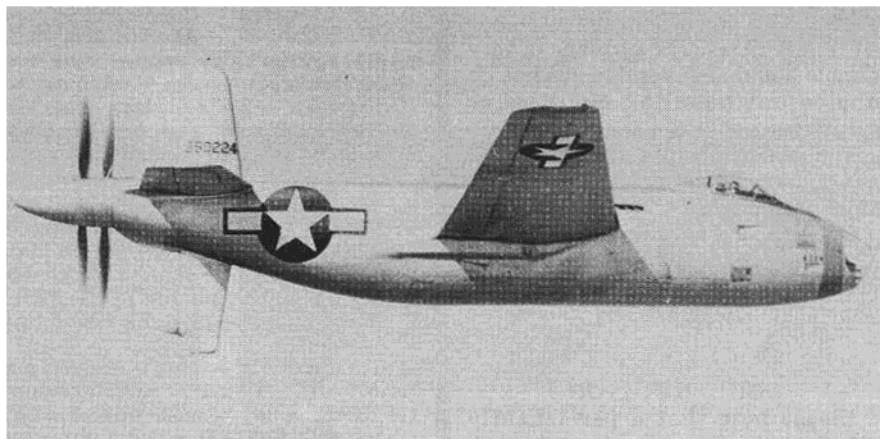
Empennage Balsa & Spruce

Wt. Ready To Fly 45 Oz.

Wing Loading 20.25 Oz./Sq. Ft.



First known aft fan by Paulhan-Tatin in 1911. 50 horsepower, 80 mph.



1946 aft fan bomber by Douglas. Military designation XB42. Two engines geared to two counter rotating propellers.



1981 aft fan by Lear — Lear Fan 2100. Two turbo-prop engines geared to a single propeller.

So much for the big one. The model has almost everything going for it that the big one has except people in the cabin to enjoy the quiet and Reynolds number. Even the Reynolds number

isn't too bad being 430,000 at 70 mph.

"Firestreak" is not a scale model of the Lear, but is close enough to suggest it is the same airplane. Making it to scale was abandoned when it was discovered that a scale wing would be so small that the wing loading would be undesirably high for a 40" wingspan model. A larger model with a .40 or .60 CID or even larger engine might be built to Stand-Off Scale with great success. Maybe some day — but back to the present.

Flight testing the model proved to be a delight. Prior to flying, the writer was concerned as to the directional stability due to the long nose ahead of the wing and undesirable sensitivity in pitch due to the close coupling of the tail. Neither problem arose and, with the surface travels shown, the handling is excellent. Stability is outstanding. It has been flown "hands off" many times. The airplane is very nimble and maneuverable but has no unpleasant handling qualities or surprises.

The speed with this small engine is impressive. "Firestreak" is the proper name. It has been clocked at 82 mph.

Oh, by the way, the only clean-up job after flying is to wipe the oil off the prop, spinner and left ruddervator. Won't that be new to us glo-engine users?

CONSTRUCTION

Please note that a permanently attached wing is used on this model. A removable wing was considered, however, a more rugged model is obtained with the wing cemented in place. Also the airplane is small and easily transported in one piece.

Construction of the semi-oval fuselage may seem complicated but really is no harder than a flat one except for lots of sanding.

Attention must be paid to keeping the radio components in the location shown to balance the engine weight. Their location also provides very good accessibility.

Care should be taken to use reasonably light balsa for fuselage planking and empennage parts for good balance.

The above will also help the total weight which should be kept at 45 oz. or less with a full fuel tank.

The prototype was built with a fixed wing and using standard Futaba 4 channel radio gear balanced right at the 30% location shown without ballast. Flight testing has shown this to be a very satisfactory C.G. location.

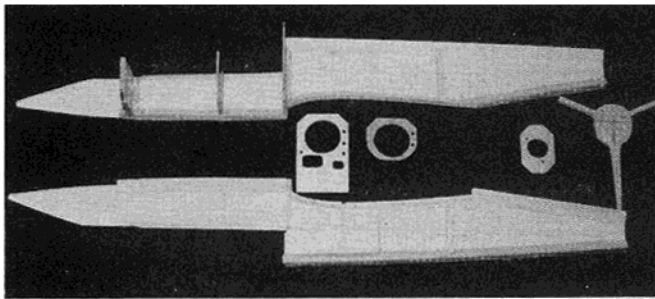
Since this is a pusher airplane using a right hand rotation engine (you can't get a reverse rotation engine in this size), it requires a left hand propeller. Fortunately "Zinger" has just gone into production of an 8/4 pusher or left



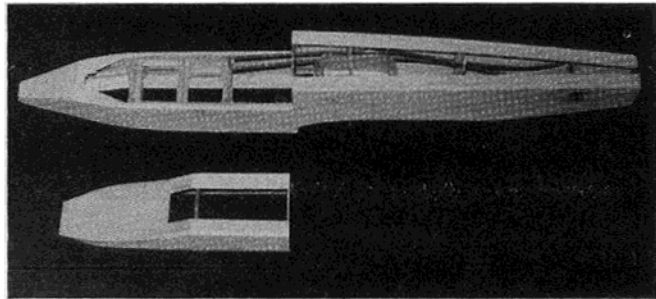
Firestreak on final approach. Note partial flaps.

BILL OF MATERIALS

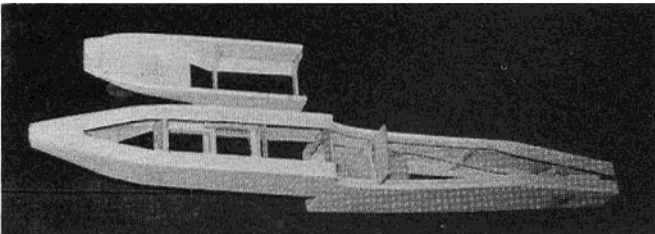
- (5) 1/4" x 3" x 36" — balsa — fuselage sides, top, W1, stabilizer, ruddervators, wing trailing edge, ailerons
 - (3) 1/2" tri. x 36" — balsa — fuselage longerons
 - (1) 1/8" x 3" x 36" — balsa — fuselage bottom, F8, fuselage doublers, inner leading edge
 - (2) 3/32" x 3" x 36" — balsa — ribs, W2, W3, W4, W5, W6, W7
 - (1) 1/4" tri. x 36" — balsa — wing saddle, etc.
 - (1) 3/8" x 1/2" x 48" — balsa — wing leading edge
 - (3) 1/16" x 3" x 36" — balsa — planking, spar webs
 - (1) 3/4" x 7/8" x 12" — balsa — wing tips
 - (1) 3/8" x 3" x 8" — balsa — cabin top, windshield
 - (1) 1/2" x 1/2" x 2 1/4" — balsa — nose block
 - (1) 1/16" x 1/4" x 16" — spruce — cabin tracks
 - (2) 3/32" x 3/16" x 48" — spruce — wing spar caps
or (3) 3/32" x 3/16" x 36" — spruce — (spliced)
 - (2) 1/4" x 1/4" x 24" — spruce — stab spars, servo rails
 - (1) 1/4" dia. x 3/4" — hardwood dowel — wing dowel pin
 - (1) 3/16" x 6" x 10" — ply — F4, F9, F9A, stab spar doublers, wing center web
 - (1) 3/32" x 6" x 12" — ply — F4A, F5, F6, F6A, F6B
 - (1) 1/8" x 6" x 5" — ply — F7, F10, F9A, hatch block
 - (1) 1/16" x 6" x 12" — ply — F9, F9B, F7A, wing spar doubler, wing center web, hatch, hatch tongue
 - (1) 3/8" x 5/8" x 9" — pine — landing gear blocks
 - (1) .010-.015" x 6" x 5" — soft aluminum — cowling, exhaust def.
 - (1) 1/8" dia. x 36" — music wire — main landing gear
 - (1) 1/8" O.D. 3/32" I.D. x 1 1/2" — brass tube — fuel line
 - (1) 1/8" dia. Goldberg SN 180 — nose gear assem.
 - (4) 1/8" dia. — WC 180 — wheel collars
 - (1) 3/16" dia. x 36" — Nyrod Assem. — ruddervators
 - (1) 1/8" dia.-1/16" dia. — cable assem. — throttle
 - (3) #2 thd. brass cable ends — throttle
 - (6) #2 thd. steel threaded rods — throttle, ailerons, etc.
 - (3) Steel clevises — throttle, ailerons
 - (2) #4 ball joints — ailerons
 - (1) 3/32" dia. x 8" — music wire — aileron horns
 - (2) Small nylon horns — ruddervator
 - (1) Du-Bro mixer — ruddervator
 - (3) Small nylon clevises — ruddervator, throttle
 - (4) #1 x 3/8" — screws — hatch, cowl
 - (4) #4 — "T" nuts — engine mount
 - (4) #4 — bolts & lockwashers — engine mount
 - (10) #2 x 1/4" — screws — landing gear & hatch
 - (4) .032" x 3/4" x 1/4" — alum. sheet — landing gear clips
 - (2) #2 x 1/4" — screws — exhaust deflector
 - (1) Sullivan round fuel tank — 4 oz.
 - (1) 3/16" dia. x 24" — fuel line
 - (1) 1/16" dia. x 7" — music wire — nose wheel, steering
 - (1) Robart Super Pumper
 - (1) 2" dia. — std. wheel
 - (2) 2 1/4" dia. — std. wheel
 - (1) KM15 — engine mount
 - (1) 1 1/2" dia. — Goldberg spinner
 - (1) 8" dia. x 4" pitch pusher prop — Zinger
 - (1) O.S. .15 engine
 - (1) 4 channel radio
 - (1) 1/16" x 1/8" x 2.5" soft rubber — cowl vib. isolator
 - (1) Roll MonoKote or equivalent, epoxy, cyanoacrylate, aliphatic cements, solder, foam wrap, as required
- Optional flaperons
- (1) Du-Bro Mixer — flaperons
 - (1) 1/16" ball joint — flap-throttle arm
 - (2) #2 x 12" threaded rods — flaperon pushrods



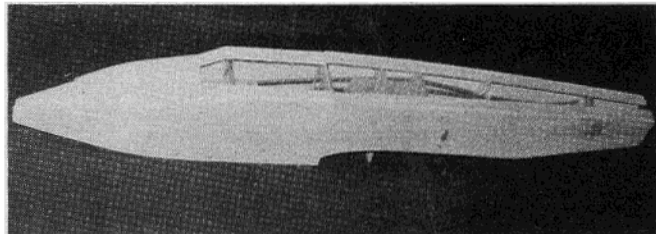
Fuselage side assemblies ready to join. Note marked frame locations and saw cuts in longerons.



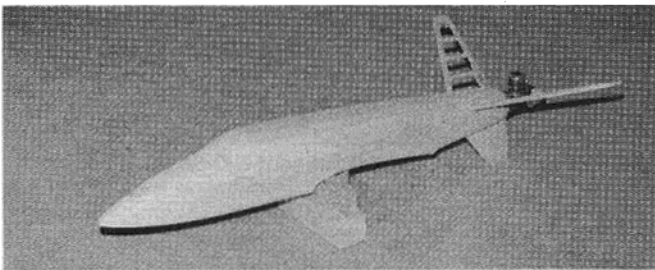
Fuselage and cabin with all frames in place except F8. Assemble F8 when rough sanding is completed. Nyrod tubes, servo rails, and fuel tank in place.



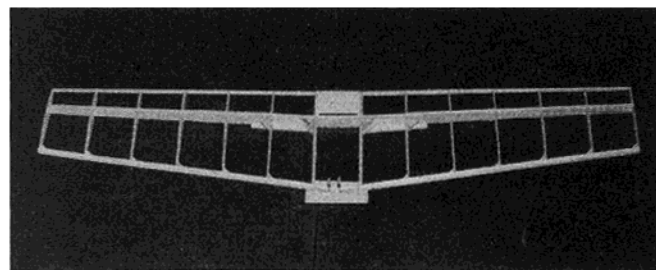
Bottom view of fuselage and cabin showing throttle cable tube.



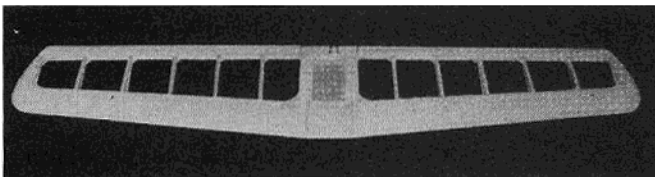
Fuselage with cabin in place. Don't worry, it will look better with top planking and sanding.



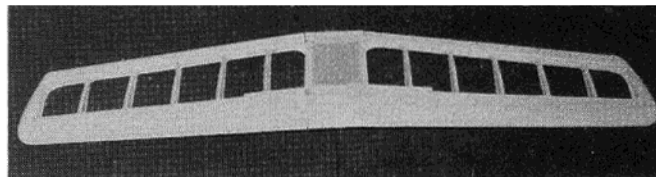
Finish sanded fuselage. Stabs are fully installed. Note partial wing fairing at trailing edge (see text).



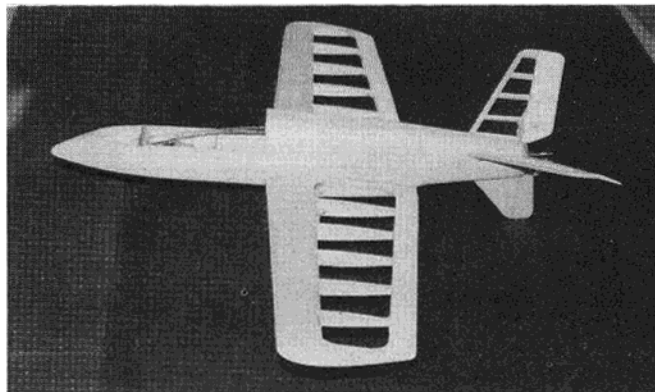
Wing frame less tips and planking. Aileron horns are installed at this time.



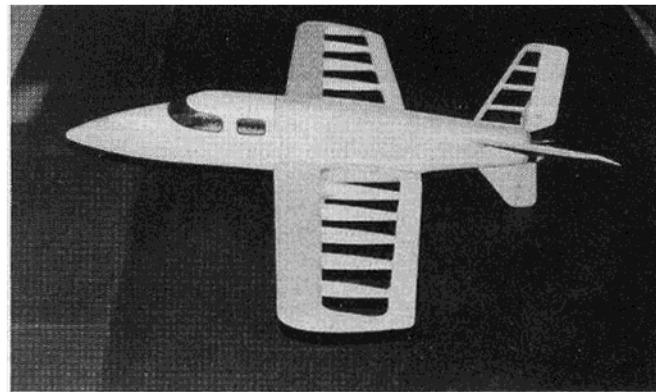
Top view of finished wing with ailerons and hatch in place.



Bottom view of finished wing.



Since a permanently attached wing was chosen, the whole airframe was assembled at this point. Ailerons and ruddervators are hinged with MonoKote.



Assembled airframe with finished and covered cabin in place.

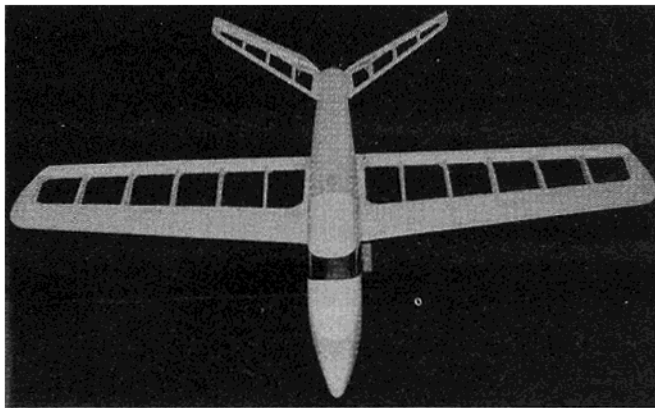
hand propeller. This seems to be just right for this airplane. The photos show a "Grish" 8/6 cut down to a 7/4" dia. The airplane flies reasonably well on this prop, but loses some thrust

compared with the 8/4.

Fuselage:

Start the fuselage by cutting out all frames including the partial frames for the canopy and the nose block. It

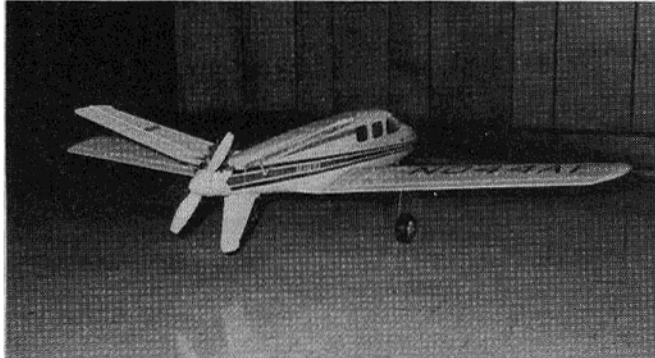
will be convenient to cut out and cement F8, F8A and the stab spar reinforcement to each other. Also drill and assemble the "T" nuts for the nose gear and engine mount.



Front view of airframe. Windshield and windows are chrome MonoKote.



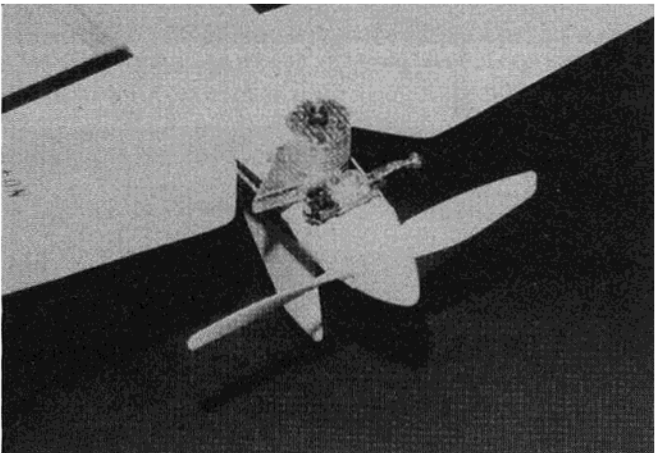
Firestreak finished and ready to fly. Graphics are MonoKote on MonoKote. Lettering and numbers are Rub-On transfers covered with clear MonoKote.



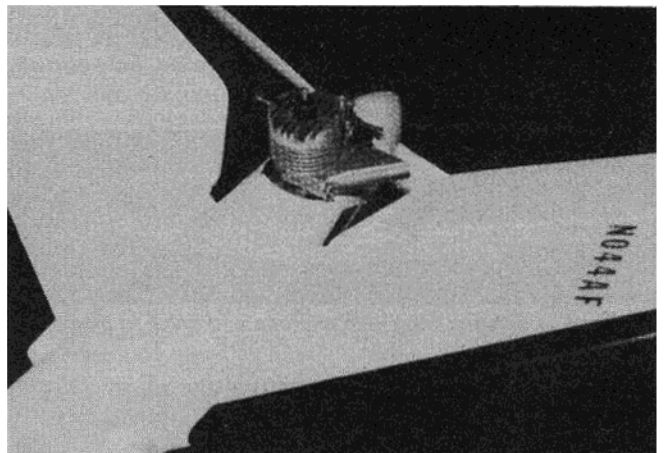
Rear three quarter view of Firestreak. Note trailing edge fairing.



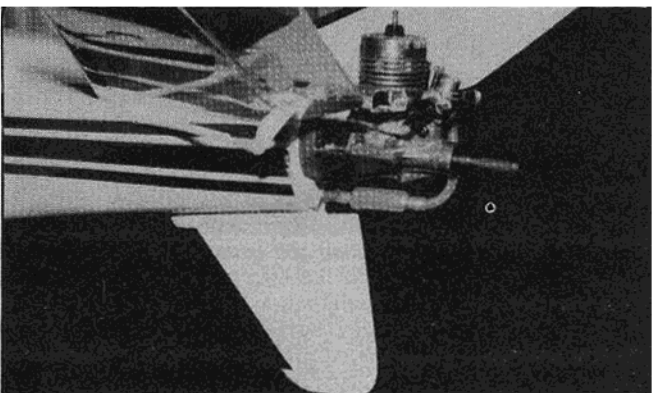
First place in "Unique Class," Concord R/C Show.



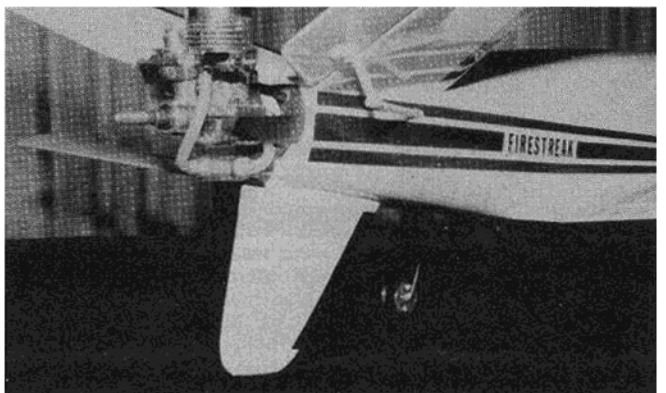
Detail of power plant from the rear. Note details of home built exhaust deflector.



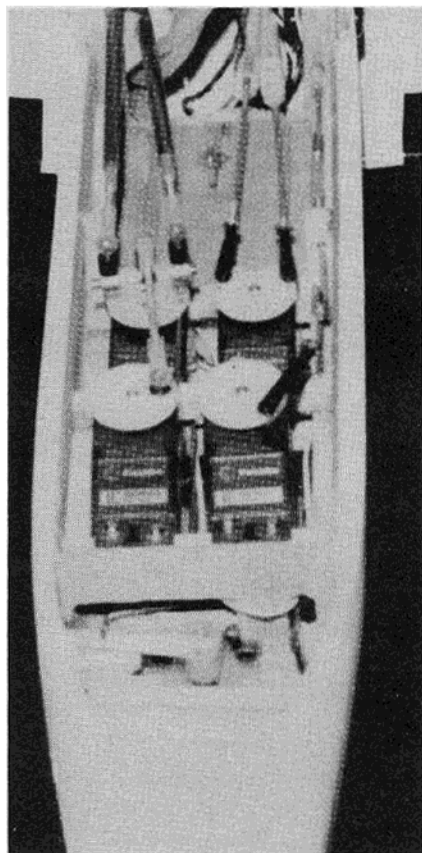
Detail of aft end of fuselage from front showing power plant and ruddervators.



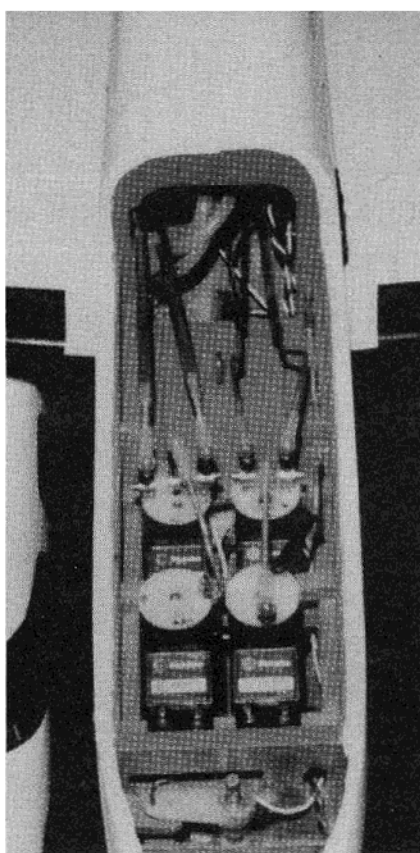
Left side of engine installation showing throttle linkage and pumper installation. Hardwood cowling block is shown.



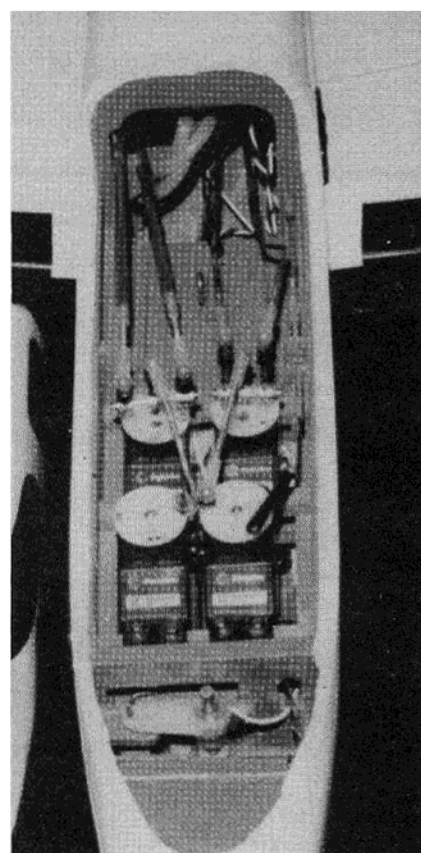
Right side of engine installation. Note side pumper line connects to center of rear crankcase plate which must be drilled, tapped, and have fitting installed. Pumper lies on cowling.



Cabin removed to show control system. This is aileron only hook-up (top right hand servo).



Optional flaperon arrangement. Mixer added to aileron servo and controlled by throttle servo. Shown in full throttle-flaps up condition.



Optional flaperon arrangement. Mixer added to aileron servo and controlled by throttle servo. Shown in idle throttle-flaps down condition.

Next, butt join the 1/4" x 3" fuselage side material along a horizontal line (the W/L is convenient) and cut out fuselage sides. Note that the canopy separates at the forward side of F4 and at the waterline. Also note the splice at F1. The 1/4" thick fuselage sides stop here. Now assemble the triangular longerons, triangular wing saddles, and canopy rails. Don't be afraid to use razor saw cuts to make bending easier. Cut out the nose sides from 1/8" sheet and splice at F1 as shown. Do not assemble doublers or triangular longerons ahead of F1 at this time.

The fuselage sides are joined by cementing to F1, F3, and F4. Make sure these frames are square with the centerline. Next add F5, F6, and F7. Check alignment of sides with sides of F8 but do not install F8.

The fuselage nose ahead of F1 is made of 1/8" sheet to facilitate bending. Soak the 1/8" sheet, bend, and cement to nose block. Next, add the triangular longerons and 1/8" doublers to this forward section. Razor saw cuts will facilitate bending the longerons and doublers.

Build up the cabin in the same way. The top, windshield block, and nose top can be assembled on the canopy.

After installing the ruddervator nyrods, throttle cable, fuel tank, and

line, the fuselage top and bottom planking can be cemented in place. This is as good a time as any to put in the servo rails.

For sanding the fuselage to shape, templates can be made for each station, etc., however, the writer did not take all these pains with the contour but sanded the fuselage to shape as follows:

Square off the aft end at F8 and, using the F8 assembly as a template, mark the end of the fuselage. Lay out the shape of the top of F4 on the aft end of the cabin and sand the top to shape. After taping the cabin on, the contours can be eyeballed between the windshield and F8 using the cut-away portion of the longerons as a guide to thickness. This sounds a little "barbaric" but seems to work. At the wing trailing edge, let the fuselage sides come almost straight down. Then aft of the trailing edge, blend in the oval contour again. The result will be a very nice looking partial wing fairing.

When the rough sanding is completed, recess the fuselage end to receive the stab spar reinforcements and F8A and cement the F8 assembly in place being sure to square up with the wing saddles.

Empennage:

Using light 1/4" sheet balsa you

may strip the parts needed for the stabilizers and ruddervators. All parts are balsa except the spruce spars and the wedges between F8 and the spars. Leave the root rib out until the stabilizers are attached to the fuselage.

Assemble the stabilizers to the fuselage as follows:

Lightly scribe the "waterline" on the fuselage with a soft pencil. Draw a zero incidence line using the "waterline" as a reference and measuring from it to the bottom of the spar extension on F8.

Trim the leading edge so that it butts against the fuselage when the spar and spar extension on F8 fit. Cement in place. Then carefully fit the root rib and cement in place.

Using 1/2" or laminating two 1/4" sheets, shape the two pieces of the ventral fin and cement in place. Sand flush with F8A.

This completes the empennage and fuselage which are now ready for final sanding and covering.

Wing:

The wing section used on "Firestreak" is a high speed NACA 63012 symmetrical section. This section has very little center of pressure travel and practically zero moment about the aerodynamic

center. The result is a very stable but highly maneuverable airplane.

There is nothing unusual about the construction. Begin by cutting out the ribs. Leave a little stock at the trailing edge (1/32") to allow for fitting to the trailing edge spar.

If you do not use a jig, build the wing upside down on your flat table. Pin the upper spar cap down on the plan which has been covered with waxpaper. Add the ribs and bottom spar cap. Block up the trailing ends of the ribs for trailing edge alignment and cement the trailing edge in place from W1 to W7. Leave out the center section. Align the 1/2" inner leading edge and cement between W1 and W7. Leave out the center section.

Now cut the bottom spar cap at the centerline. Turn the wing right side up and form the dihedral by pinning down the center and blocking up the tips.

Add the 1/4" center web. Add all 1/16" vertical shear webs and complete the trailing and leading edge center sections.

Add landing gear blocks and the 1/16" plywood bottom doubler. Fit the hatch and hatch block. Install aileron cranks, rib caps and planking. The leading edge outer pieces, tips, and fuselage fill block come next. The wing can now be sanded.

Engine Cowling:

Cut out F9, F9A, and F9B. These pieces are circular but F9 and F9A are shaped to give clearance around the carburetor. The center hole in F9 should be made a tight fit on the engine nose section to help fit the cowling and opened up later to accept the rubber vibration damper. Add two 1/4" x 1/4" x 1/2" hardwood blocks at 4 and 8 o'clock on F8 to take cowling screws. Install the engine and after laminating, install F9, F9A and F9B.

Using the pattern on the drawing, cut out a paper pattern and fit on the balsa upper cowling piece, the hardwood blocks on F9, F9A and F9B. When satisfied with the fit, use the paper pattern to cut out the aluminum cowling. Shape and fasten with (5) #0 x 1/4" flat head screws at the spinner end and one screw at 4 and 8 o'clock at the blocks mounted on F8. Open up the hole in F9 and cement in a strip of soft rubber "O" ring as shown.

Assembling and Finishing:

Finish sanding the fuselage, stab, fin, ruddervators and wing. Cement the wing in place now. With a little fitting the juncture of the wing and fuselage can be very smoothly covered, leaving no line or gap.

The fuel tank is mounted as usual with the "clunk" to the rear.

The writer used two fill and vent lines, bending both to go to the top of

the tank. Two 1/8" O.D. x 1" brass tubes were cemented in just aft of F4 on the bottom right. These extended 1/2" below the fuselage and were scarfed 45° toward the front to prevent any reduced pressure in flight. The tubes were connected to the tank by two short lengths of fuel line.

Don't try to get away without the pumper. The system will almost work but not quite. The tank is just too far away, and will cause flooding in a climb and running too lean in a descent, particularly at idle power.

The drawing should be self-explanatory regarding the controls. You will probably have to reduce the width of the mixer nylon block to get the right amount of rudder sensitivity. This is convenient since it provides clearance for the end of the nose wheel steering bar.

The writer strung the RX antenna from the RX forward to F4 and then back down the other side of the fuselage to the tail bringing it out just ahead of F8 and making a small knot. Range testing and over twenty flights to date have shown everything to be okay even though some of the flights were nearly out of sight.

The main landing gear is simply two pieces of 1/8" diameter music wire bent as shown with a short vertical bend extending through holes in the block at W1. The struts are secured by .015" x 1/4" x 3/4" aluminum tabs screwed to the block at W1 and W2 with #1 x 3/8" screws.

A pair of 1/16" diameter M.W. hooks cemented to F2A and F3 and a #64 rubberband are used to hold the cabin in place.

While a standard 500 mAh battery pack will fit, a more convenient, lighter and less expensive pack can be made by soldering four nicad AA's together in the configuration shown on the drawing.

Flying:

"Firestreak" flies just like any other plane in its class but probably a little faster. Take-offs are conventional tricycle gear operations. In spite of the absence of slip stream over the tail, rudder and elevator effectiveness at low speeds do not seem at all impaired.

In high speed flight the airplane seems to be very adroit and at the same time grooves very well. Inverted flight is stable and smooth. Since the airplane is so clean the tendency is to land fast. In spite of the relatively high wing loading for this size model it will float and must be slowed down until it wants to "pay off" just as the wheels touch.

As stated earlier, the airplane does not have any bad habits in spite of its unusual configuration and I'm sure you will really enjoy flying it.

Addendum:

After 20 test flights to optimize the airplane it was decided that the high landing speed could be substantially improved by adding flaperons. Since there was not much room for a fifth servo, it was decided to actuate the flaps with the throttle servo. In other words full throttle — flaps up, idle — flaps down. By using another mixer on the aileron servo and controlling it with an over center arm on the throttle servo, the flaps stay substantially up at throttle settings from full to one-half and then are deployed rapidly on the way to idle.

This worked out very well and provides a very flexible power schedule with flaps up, and then a great reduction in speed and glide slope for approach and landing.

So, a very fast, highly maneuverable airplane is made to approach slowly with a good glide angle and have a very positive touchdown with the addition of the optional flaperons.

The maximum flaps down angle is 30°. The aileron throws with flaps up remain the same. You will note that the aileron action increases slightly by the selected geometry when the flaps are down. This seems to work out just right.

Unlike conventional aircraft, with flaps, which pitch up, this high V-tail configuration produces a slight pitch down when flaps are deployed. □

**From
RCModeler
Dec. 1982**