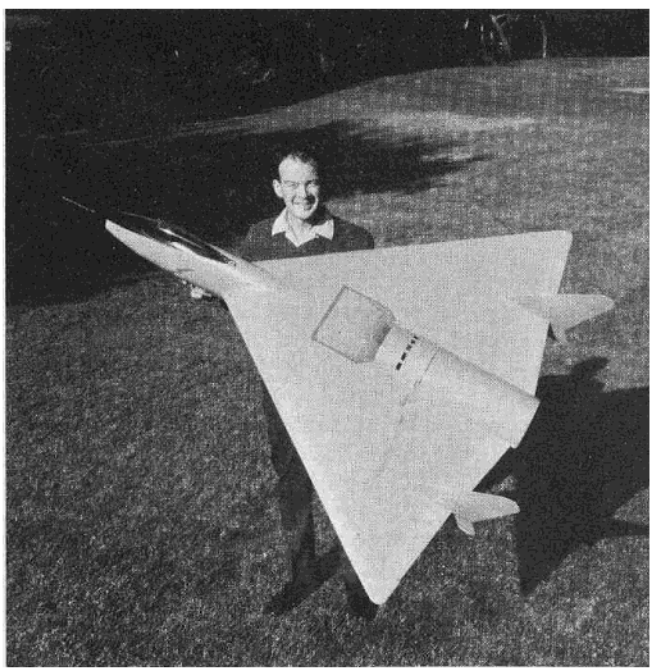
The Fan Piper is a magnificent .60 powered ducted fan delta that is a real show-stopper, on the ground or in the air. Don't be deceived by its jet-like appearance — It's inherent stability makes it relatively easy to fly.

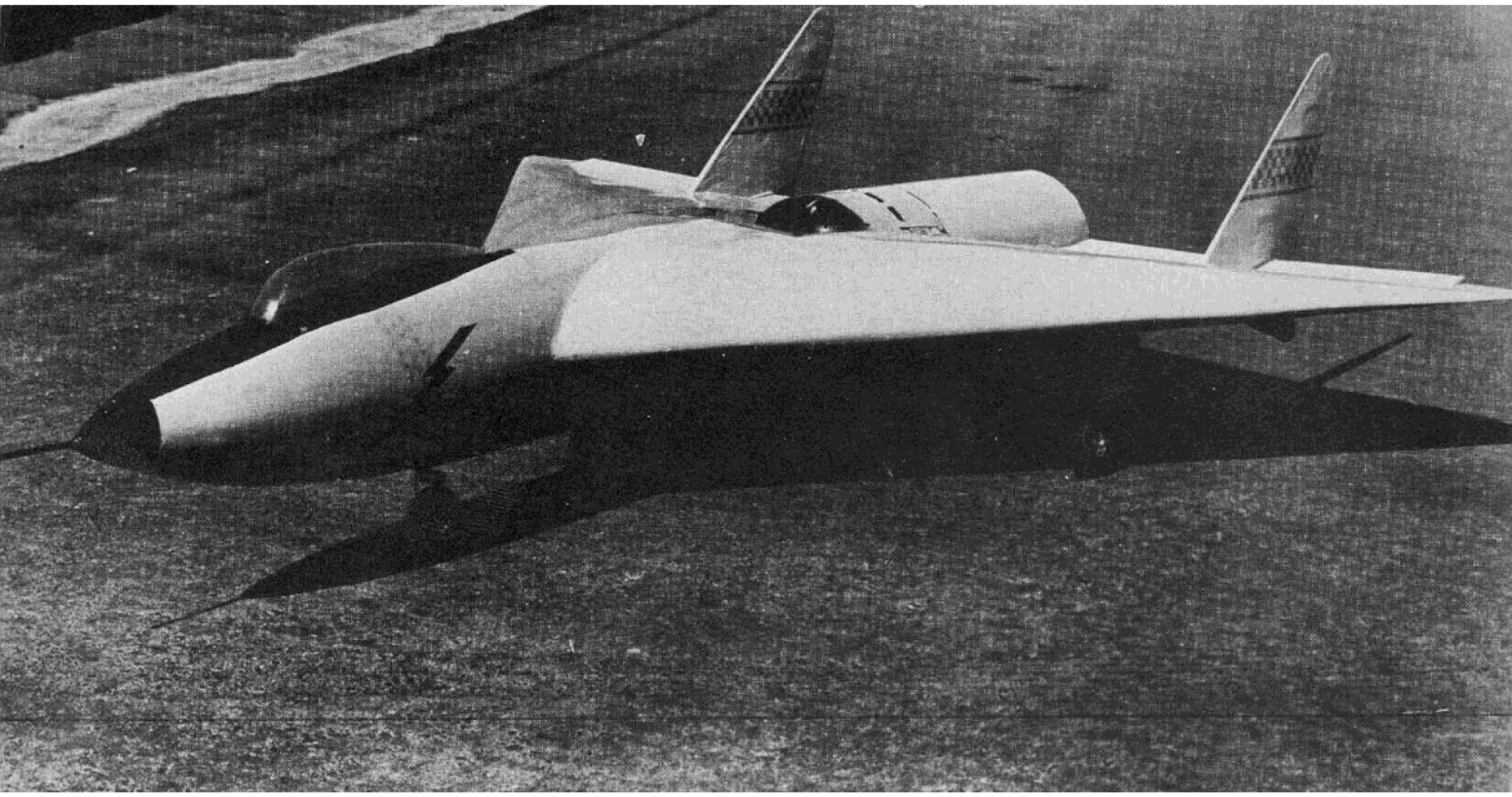
THE FAN PIPER



By E. D. BRIDGES

This design was inspired by an article in RCM (April, 1968) entitled "Banshee" by Capt. C.W. Peake. The photos and plans started up old fires which, after almost 30 years of inactive modeling, broke out in quite a blaze, cooling and flaring occasionally, as I progressed from plans through construction and taxi tests. Public reaction varied from "poor fellow" to "let me know (evil grin) when you try to fly it." I naturally thought positive, it had to fly; e.g., Bumble Bee Theory, and as miracles go, it flew right off the drawing board. It is very stable and trims hands off with no dutch roll or oscillations.

The guidance system is Heathkit with ailerons, elevator, and throttle control. Elevons were not used and proved unnecessary. The fins are fixed, no moveable rudder. The nosewheel is steerable from the ailerons and a nosewheel brake operating from the forward elevator. These two features were used to great advantage on the trial ground runs prior to first lift off. If your flying field is limited, in length,



a brake is extremely handy. This bird can really move on the ground after a long landing. Just to be on the safe side, an arresting gear has always been set up and ready. It saved the plane twice when the engine quit at an inopportune time.

The dimensions are 66" span, 81" length, 10¾ lbs. weight, and a wing area of 10 sq. ft. Power at present is an Enya 60-II TV.

The construction should be kept as light as possible consistent with good building practice since the thrust output is slightly limited (about 4 lbs), compared with the average prop driven model. Even with the present thrust, the climb out angle can be somewhat spectacular to say the least!

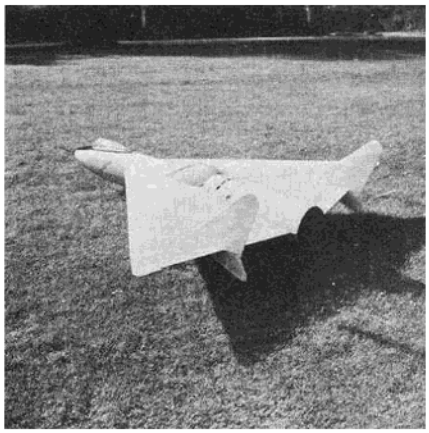
The plane is built around a crutch using "the old fashioned" spar, rib, balsa sheet covered wing and planked monocoque fuselage. Styrofoam might be a good way to go, but I haven't tried it yet. The original duct was made with 1/8" balsa planked on a form, but the duct shrunk when the weather warmed up and the prop had to be trimmed down several times to maintain tip clearance. I suggest the duct be made from 1/32" ply rolled with the grain lengthwise. The guide vanes, made from 1/8" balsa sheet, are rounded on the leading edge and tapered to a streamlined trailing edge. The guide vane center support is made with 1/16" sheet balsa strips planked on round 1/8" balsa bulkheads. Pin ½ bulkheads on plan, plank and when dry remove, add other ½ bulkheads and plank remaining ½. Make nose piece from a block or scrap balsa. Glue the guide vanes to the center support, 6 on the front and 6 on the rear, spaced 60 degrees apart and in line with each other fore and aft. Dope on the silkspan plus two coats of clear and two coats of a dark color. Dope the inside of the duct with three coats of clear and two of color. Use fuel proof dope as the inside of the duct gets quite saturated with exhaust oil. When dry, fit and glue the guide vane assembly in the duct with a pair of guide vanes, vertical in front and rear. To keep a perfect circle in the prop area, when fitting the guide vane assembly, I cut a circle of 1/8" ply just large enough to fit around the duct and slightly forward of the prop line. The disc that comes out of the circle can be used later on the engine, when installing the duct in the airframe.

The general construction layout is similar to Capt. Peake's Banshee. The crutch is cut from 1/8" Mahogany plywood. To keep weight down to a minimum I cut lightening holes in the crutch, all ribs, except R5, and in all fuselage bulkheads. The rib templates are layed out on light cardboard using the table of ordinates. Measure the chord on the inboard side of the rib from the wing leading edge to the trailing edge of the rear spar. After the ribs are cut to shape then cut off aft ends 3/8 inch. This is a modified M-6 section and is very stable on this plane. Cut the templates to shape, then trace them on 1/8" balsa sheet. I had to edge glue several sheets together to fit R1 and 2. Draw the Θ base line on all ribs. Some ribs will be cut with reference to this line during assembly and the line will also be used to keep ribs aligned and true until the spars are glued in place. The main wing spars are cut from ¼" hard balsa. If your balsa is not long enough, use a long taper splice at the wing tip end of the spar.

The first stage assembly comes next. Lay the plan on a surface of soft wood large enough to span the sings and extend from the aft end of the crutch forward to F1. If you have a loft with a wood floor you are fortunate. The living room or the kitchen floor is probably out of the question, and the cement floor in the garage makes it very difficult to pin things in place, so a layer of soft wood is about the best answer.

Place the crutch on the plan and tack with light nails so it will stay put. Cut 40 or 50 three inch right triangles from cardboard. These are used to hold ribs and bulkheads square and aligned during assembly. Set ribs next. Cut the No. 1 ribs on the Θ line and glue on crutch. Cut bottom pieces 1/8 inch below Θ line and set aside. The reason for these cuts is that the bottom face of the crutch is the Θ

reference line for construction and also the center line of thrust. Cut ribs No. 2, 3/8 inch below 0 line. Cut ribs No. 3, 5/8 inch below 0 line and save the rib bottoms. Set all ribs on the plan using blocks under R4 and 5 and triangles to hold them true and steady. Next set the top main spars on the ribs and mark and cut in the slots for the spars. Be careful to make your cuts parallel to the spar and true vertical. If the spar slots are cut properly, the top of the spars will just lay flush with the



ribs all the way to the tip rib. The spars butt to the tip ribs. The same holds true on the bottom spars. Center mating ends of spars are beveled for a good butt fit. Cut the nose of the ribs so that the bottom face of the leading edge is on the 0 line of all ribs and then install. Install the top false ribs and later the bottoms; these can be eyeballed to fit. Bevel all ribs on top, and later, on the bottom edges, from the leading edge to the main spar so that the wing skin will lay flat on the rib edges. Glue on the rear spar.

Cut out all fuselage bulkheads from 1/8" sheet medium balsa. Cut F 6,7 and 8, 1/8 inch above 0 line and glue the top halves to the crutch. Put the bottom halves on 0 line and set aside. Pin the top halves of F 1,2,3,4, and 5, to the plan using triangles. Plank two ¼" x 1/8" balsa strips, one on each side, from F1 back to the wing leading edge, laying the edges of the strips flat on the plan. Plank the second row ½" x 1/8" all the way back to the main spar. After the glue is dry remove all the nails, pins, etc. Now you can put the frame on a large table or bench if you don't have a permanent set in your back by this time. Plank the rest of the fuselage top. Turn the frame over and install the stiffener web, glue on the rib and bulkhead bottoms, if you can find them in the mess, cut and glue in the bottom spars and the false ribs. Install the engine mount including stiffener blocks and solid 1/16" ply nose wheel doubler bulkhead. Dope the complete engine, fuel tank, and servo areas with at least four coats of fuel proof dope. Install the steerable nose gear and NyRod and nosewheel brake cable or wire, if used, also the fuel tank and vent. I used a 500 cc plastic hip pocket whiskey flask with a clunk type feed. Pad between tank and engine mount with sponge rubber.

Complete the bottom fuselage planking and cut the crutch away so that the engine fits flat on the engine bearers. Install an aluminum stiffener under the engine mount and bolt as shown on the plans. Align the engine in the mount, drill holes, and install the engine using Allen head bolts. With the duct installed, removal of the engine is much easier with an Allen wrench than a screwdriver. I highly recommend an extension to the outside on the needle valve. This makes final peaking of the engine quit easy and extremely safe.

Trim the 1/8" ply disc to fit tight at the prop line and install on the prop shaft. Slide the duct over the disc into position and glue well to all edges touching the crutch. Make sure the duct is centered vertically and horizontally with the thrust line. Cut in and glue sub spars and stringers. Make the top and bottom vertical fins and install. Fill between the top and bottom main spar with ¼" hard sheet balsa web as shown on the plan. I cut lightening holes in the filler web leaving an X-brace design. Glue on 1/16" ply doublers for the main gear as shown on the plan. Bend and install the main gear. Install 1/8" medium balsa wing tips. Turn or carve the nose cone from soft balsa and glue on F1.

Make control surfaces, sand to streamlined shape, and temporarily install it in place. Install the bellcranks and push-pull rods using clevis connectors and plastic control horns. Now remove the control surfaces.

Cover the top of the wing and, later, the bottom with 1/16" medium soft sheet balsa with the grain parallel to the leading edge. Center the bellcranks in neutral and mark on the servo rods where they come through into the servo compartment and cover the bottom of the wing. Trim and sand the wing tip and install the control surfaces with Super MonoKote or plastic hinges.

Make the servo hatch frame and plank with 1/8" soft balsa. Extend the fairing aft of the servo hatch right down to the rear crankcase of the engine and across the crutch. I used three dowels across the front of the servo hatch frame and a wood screw into a pine block glued under the aft center to hold down the hatch.

Mark and cut out the prop hatch with a razor saw. Now unscrew the prop nut and cut through the ply disc and remove. I used 3/8" x 1/32" ply strips glued to the inside edge of the duct as a ledge for the closed prop hatch. Be sure to dope and paint after installing the strips. Make two 1/16" piano wire hooks and glue on the aft corner of the hatch and just below on the duct. When the hatch is closed after starting the engine, a rubber band is wrapped around the two hooks on the outside to hold the hatch down for flight. I used Super MonoKote for a hatch hinge but it did not hold well so I later installed plastic control hinges which work much better.

I covered the entire model with Super MonoKote. It makes a beautiful finish and is very strong and lightweight, about 5 oz. total.

The canopy is a Sig 13 incher. Cut to fit and glue on the fuselage, then cut the fuselage ¼ inch below the canopy all the way around with a razor saw. Glue two pegs, or balsa strips, sticking out forward under the front of the canopy hatch. They slide in under the cowl and hold down the front of the hatch. Glue a 1/16" ply plate under the rear of the canopy opening, drill through the rear of the canopy and plate. Use a 3/4 inch long machine screw and blind nut to lock down the rear of canopy.

Mount the receiver behind the V of the main spar. I mounted the on-off switch behind the rear of the canopy and the battery in the cockpit for proper balance. The antenna is run forward inside the top of the fuselage and along the edge of the canopy and out through the nose. I used a piece of semi-rigid plastic tubing for the probe to hide the antenna.

Install servos. I highly recommend the servos be mounted on servo mounting tape. Mine were mounted on rails with the rubber grommets that came with the servos. This proved unsatisfactory due to engine vibration, at different engine speeds, raising heck with the servo feedback condensors and causing servo oscillations. The tape cured this problem and holds very well.

Rig the aileron and elevator push-pull rods by aligning the marks previously made. This centers the bellcranks for equal travel. Center the servo actuators and fasten the rods to the servos. Lay a straight edge up under the last upsweep of the wing bottom and rig the ailerons ¼ inch up (reflex) at aileron trailing edge, and the elevator flat on a straight edge. This was the magic setting on mine and, if the CG is right on, will fly the bird very nicely. The throttle is linked to the servo with NyRods.

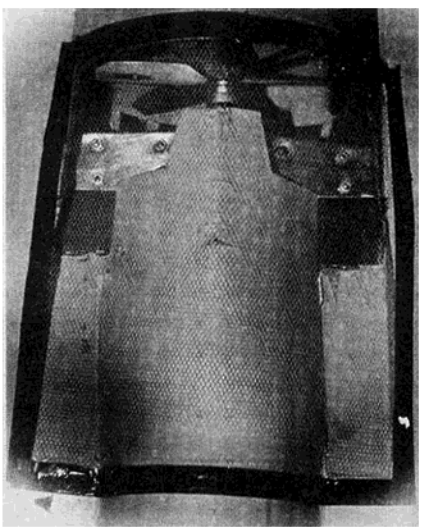
I hand prop the engine with no difficulty. Tighten the prop with the blade at 1:30 o'clock on compression. Flip the prop smartly with a motion from 1:30 left and up to 11:00 o'clock using a good follow through. For the more "chicken" a small jar lid bolted behind the prop and a pull cord wrapped around the lid will also work satisfactorily.

Speaking of props, I mortised two 9/7 pushers together to make a four blade prop. Before gluing together, fit the props carefully and lay on a flat surface to check that all tips track perfectly. If the duct is round and the engine set right, just a touch of sanding on the tips will give 1/16" tip clearance. This should give about an 8-¾ to 8-7/8 diameter prop. A six blade 9/7 puts out about 4 lbs. of thrust as well but lugs the Enya down too much. With a powerhouse .60 to .80 engine the six blade should give performance plus. If wood pusher props are hard to find, the Enya and the Rossi rotation can be reversed. On the Enya, separate the front crankcase plate and rotate the plate ¼ turn with normal engine rotation and reassemble. On the Rossi, rotate the back plate ¼ turn with normal rotation. This will allow tractor props to be used in a pusher installation with a much wider selection of props.

Don't leave out the guide vane assembly. It is very necessary for strength and proper airflow. I cut rectangular holes in the leading edge of the prop access hatch to let in more air. The aft edge of the holes should be about 1/8 inch forward of the prop line. The duct is tapered but the volume of air through it is constant. Be sure that the inside of the duct is as smooth as possible.

A 1/8" mesh nylon screen is used on the bottom intake. I used Super MonoKote around the edges to hold the screen in place. Glue a 1/32" ply, ¼" wide doubler strip on the inside top of the duct leading edge and the same on the outside bottom leading edge, then dope and paint.

As a result of some unusual events, I subsequently met Capt. Peake. We had several long talks about models and D/F's in particular and since his "Banshee" article inspired this "flying stove pipe", as some have called it, and since he had considerable flying experience with his D/F Delta, I asked him if he would flight test the Fan Piper. He agreed, with great enthusiasm, and we set the date. With nerves on edge, (mine at least) we tried some acceleration runs. On the second run some loose rock was ingested thru the bottom intake demolishing the prop and part of the duct. This caused an on-the-spot modification to the bottom front of the duct to sort of even-up the jagged remains and actually resulted in a better intake opening.



View of bottom intake showing the aluminum stiffener plates, wood stiffener blocks, fairing, 1/32" ply tank area cover, and screen.

Later the screen was added to prevent further disasters.

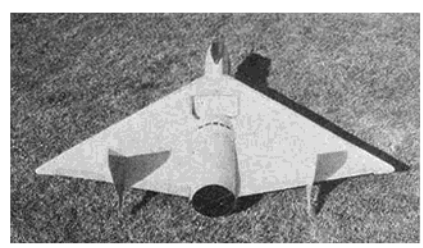
On the first flights the bird took ¾ to full back-elevator to rotate. This was due to the main gear being about 9 inches aft of the C.G. The gear was bent forward and extended to the position shown on the plan. This makes rotation and lift off more to scale and much less nerve shattering.

One thing is very important. Be sure the wheels spin free and track true. Any wheel or ground drag will delay acceleration and greatly increase the ground run. On a calm day it takes about 250 feet to accelerate. At this point ½ to ¾ back elevator is applied and, as lift off takes place, slowly ease the elevator forward toward neutral to establish a nice 10 or 15 degree climb angle. The plane will not stall and pitch forward from level flight. This is a characteristic of delta wings. It hangs in a nose high attitude with a high sink rate. This is called the back side of the power curve and should be avoided close to the ground on take offs and approaches. In this attitude though, aileron control is excellent.

For loops, a shallow dive to pick up speed is required, then up and over easy. Slow rolls are no problem. For an Immelman, start your roll as the top of the loop is entered, and it looks beautiful. For approaches on a calm day give it plenty of room. With power off or idle, the glide is very smooth with a nice angle. Caution: this plane does not have prop wash over the wing and control surfaces so do not rely on application of power to get out of trouble on a slow approach. This is just like a full grown swept wing jet, so keep a bit of power on the approach until you get used to the flight characteristics. Incidentally, the plane has been flown in a 15 M.P.H. plus wind and the stability in the gusts is excellent.

The Fan Piper, in the air, is a very rewarding sight and quite a show stopper proving that large D/F models are not as impossible as many people have thought. This field is wide open for the adventurous designer and builder. There are questions to be proven such as, multi blade propeller versus multi blade impeller. Blade number, shape pitch, and diameter for a particular engine size. Compressed volume versus constant volume, although I favor constant volume at this time.

Several things have been established so far. The spiral airflow from the prop must be straightened by guide vanes and the volume air flow must not expand in the duct. The duct must be as smooth as possible inside and straight through with no bends or curves. A propeller or impeller in the duct entrance gives the most thrust. The further back the prop is in the duct, the less thrust is developed. At this stage of the art, a tractor or pusher installation seems to have equal thrust capability.



One last note: 3-¾ lbs static is minimum thrust for this plane. Be sure the engine is peaked at max R.P.M. before takeoff.

So, go to it. Build the Fan Piper or design your own. Join the poor mans' jet set. Good luck and good flying. ●

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