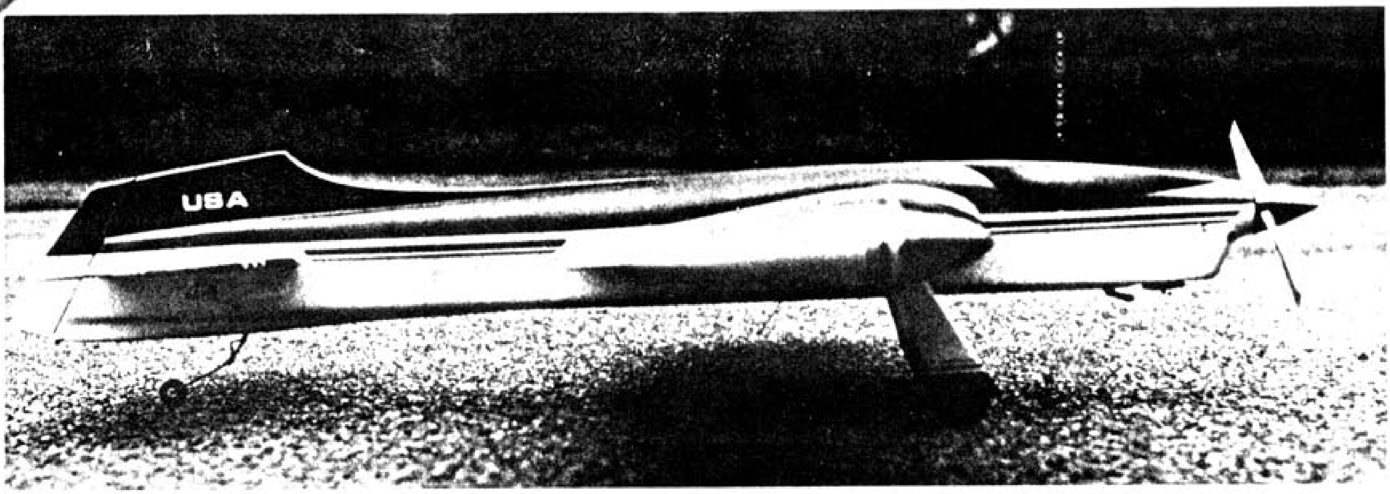
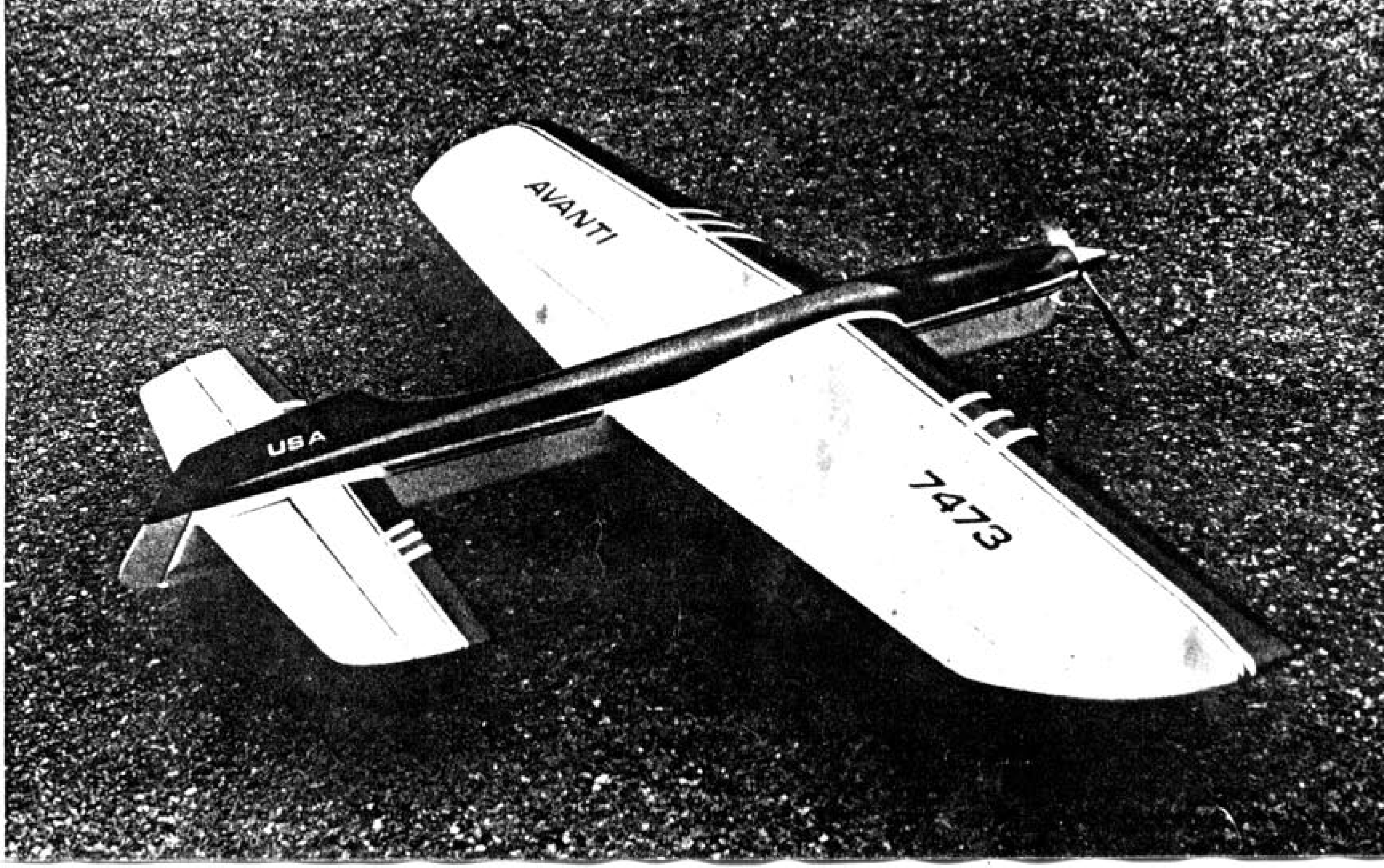
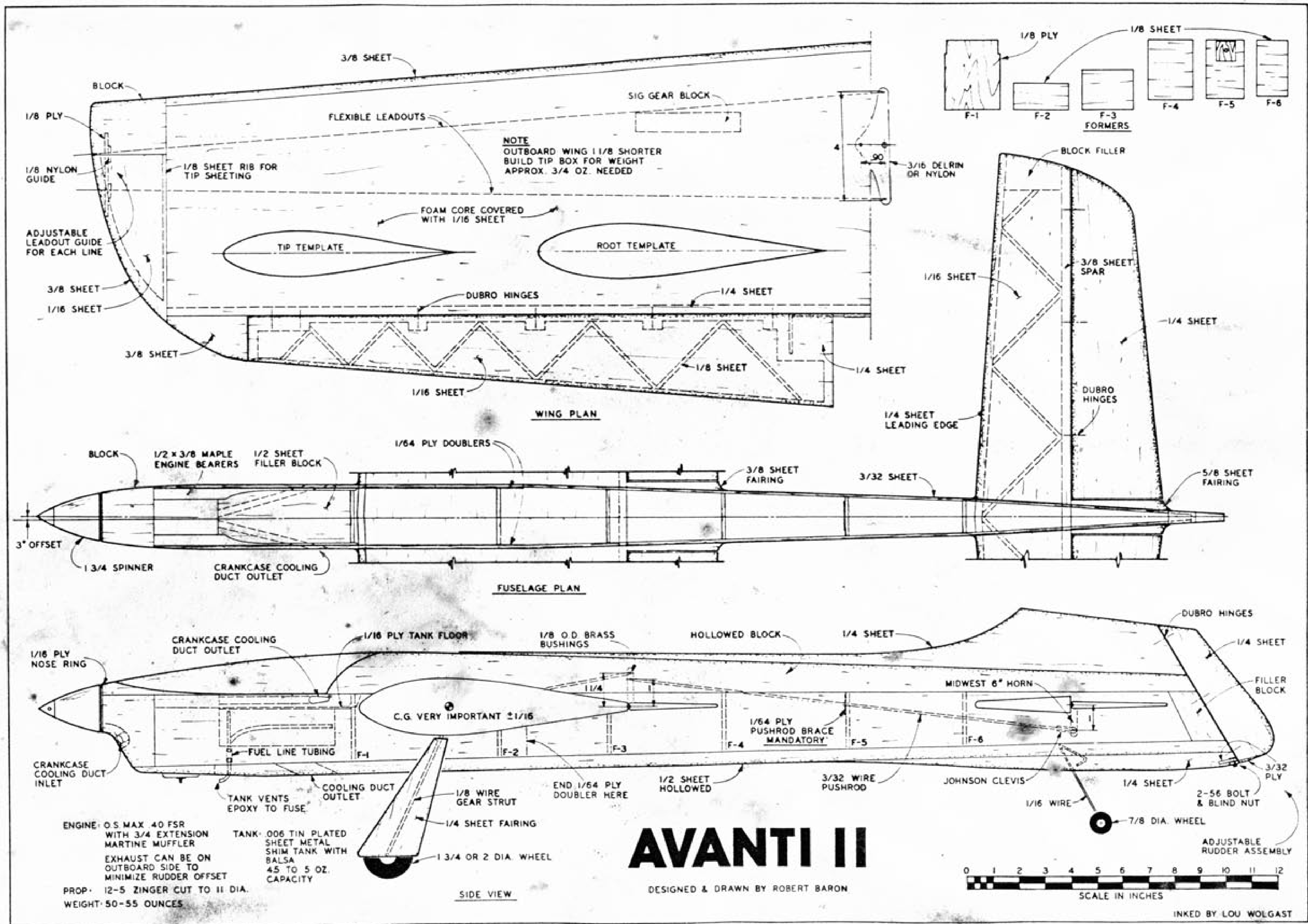


Avanti II

This thoroughly engineered contest design is capable of competing at the highest levels/**Bob Baron** 60 in span

When you stop and think about it, the ideal control-line stunter must be a mechanical marvel. Besides leaping over tall buildings with ease, it should fly slowly for piloting accuracy, maintain good line tension over a wide range of weather conditions, have high stability for smoothness, yet turn quickly for good corners. It must be aesthetically pleasing to a wide cross section of people, and still obey the laws of aerodynamics. It must be light enough to routinely pull ten G's negatively and positively thousands of times without fatiguing or changing its flying qualities over a useful competitive life of 500 flights. It should be mechanically sound and predictable in its handling qualities. Getting down to the "nitty gritty" of precision flying, it should have a good measure of reserve for correcting late pull-outs and take correction for finessing corners. Low physical effort is important to minimize fatigue when practicing hard. Landing and take-offs should be predictable over a wide range of surfaces, wind directions and velocities.





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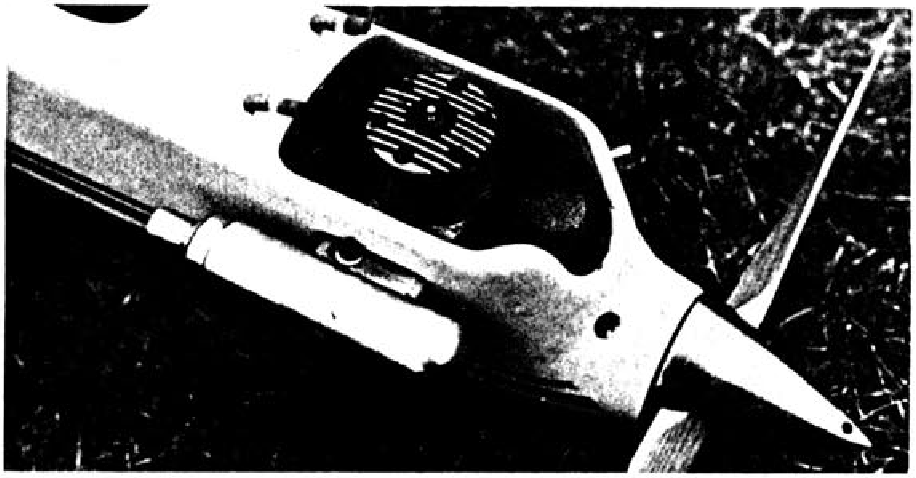
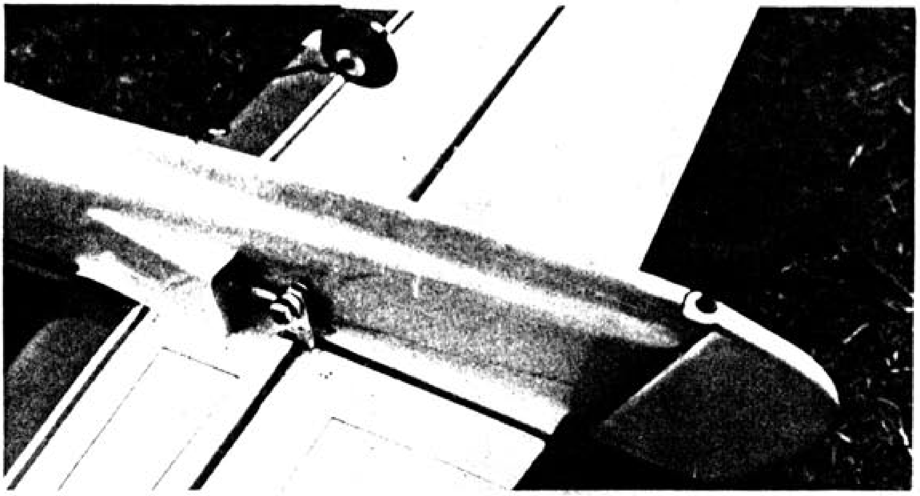


PHOTOGRAPHY: BOB BARON



The controls are adjustable (**above**). This external linkage allows ratio changes between the flaps and elevators. The OS .40 FSR receives adequate cooling in this ship (**top**). Note the tank vents. Bob doesn't believe in removeable cowlings. The engine drops in through large opening. The Avanti II is an original.

Turning rates in both directions should feel the same. Given all these criteria, many of which are in contradiction with one another, it is small wonder that looking for the ideal stunter resembles the search for the Holy Grail.

If you've gotten this far you are no doubt expecting to hear that I have found it. If I did, then I forgot where I put it. Those witnessing the 1980 Nats saw the Avanti II finish a fraction of a percentage point behind the 1980 FAI team. Unfortunately my pit crew was unable to clip the leadouts of the finalists and I ended up fourth. Lucky for me, Ted Fancher continued to use Quik-Links on his ship and Murphy's Law took it from there.

The Avanti II is the result of a concerted effort to keep the smooth and predictable flight qualities of the original Avanti and correct several shortcomings. First the turning ability needed to be improved, as the original was capable of flying only an average corner relative to the competition. Secondly, as with most ships, the original Avanti turned more quickly on the outside loops than the inside loops. The last improvement sought was a greater mechanical advantage in the control system to both decrease physical effort at the handle and insure adequate power to move the controls in low tension maneuvers such as the overhead eight and the top two corners of the hourglass. Solutions to these problems were found by Bill Netzeband using the results of his detailed analysis of control-line aerodynamics that were confirmed flying a series of ½A planes during the last year.

The solution to maximizing the turning ability of a given plane turns out to be simple, but only after wading through many equations that either bewildered or bore most of the stunt flying fraternity. Bill's solution consists of positioning the plane's center of gravity such that the control system and stabilizer movements allow the flaps to travel to a full 30 degrees in a square corner. By doing so we get the maximum lift coefficient out of the wing before getting so much drag that the engine can no longer keep up adequate flight speed. As a comparison, most ships use only 15 degrees of flap movement to execute a corner. The second problem, that of getting equal turning in both directions, is solved very simply by putting the thrust line through the center of the wing and tail. While the gear drag is below the center of gravity, the tremendous induced drag (drag due to lift) is so high compared to the parasite drag, that we can safely assume that the center of the wing is the center of drag. The only problem introduced by lining up everything in one line is that inverted flight requires a little more down control than we are used to on conventional planes. The last problem, that of reducing pushrod loads and control handle effort is solved again by Bill with his trusty T-59 calculator. Basically this consists of using a four inch belcrank and control horns that are at least one inch long. In a maneuver such as the overhead eight, only about two G's are available to actuate the controls. With a system with pushrod loads that are too high, the airplane is simply incapable of generating the necessary forces to move the control surfaces sufficiently regardless of what the pilot does. This is why many ships have difficulty doing a tight overhead eight or a good hourglass.

A light wing loading is essential to good performance. In the Avanti II, the flaps, wingtips, and stabilizer are built up and covered with 1/16" sheet. The fuselage is 3/32" sheet with a 1/64" ply doubler and the canopy is painted on the top block. With the weight savings of the built-up surfaces and the light weight finish (6 ounces from bare wood), the dry weight is in the low 50 ounce range.

I am a firm believer in sophisticated simplicity. By that, I mean that the finished result of a system be as simple as possible without sacrificing the performance possible with more involved solutions. My engine/fuel system incorporates only those features known to work reliably and still provide substantial power. The tank is a metal Uni-flo type with *no pressure*. Only a Uni-flo or full crankcase pressure system will give the same run from beginning to end. The one open vent of the Uni-flo tank is capped with a plug having an opening the size of a pin to minimize the chance of dirt getting into the fuel system. The engine is a stock O.S. Max .40 FSR with a .275 venturi with a one inch long throat and a five degree taper on the intake. A stock Super Tigre .46 needle valve assembly is used. By running a 12-5 Zinger cut down to 11 inches, the engine r.p.m. is up where the engine can develop useful power and a good fuel draw. Fuel economy is excellent with 4½ ounces enough for a safe pattern. Crankcase cooling ducts cut through the engine bearers, allow the case temperature to remain stable which is the key to consistent runs. Using this system the engine will sound too fast on the ground (it is actually overheating). Once released, the engine will settle down in two or three laps as the case temperature comes down and will then lock in for the rest of the flight. Fuel is a standard 10 percent nitro, 22½ percent castor oil, and the remainder alcohol.

The Avanti II uses independently adjustable leadouts. By having the up line in front, the difference in tether point for up and down is used to control precession. Gyroscopic precession, rediscovered only recently by Al Rabe, is very real and must be accounted for if we are to have good line tension both ways. In practice, I tune the ship for insides using just the up line adjustment, and then tune the outsides with the down line. In this particular ship the leadouts ended up about 1¼ inches apart.

Construction Notes

It is difficult to beat the weight of air when building a light stunt ship. Minimizing the amount of lumber surrounding this air is the key to lightness. If we could train termites to eat away the inside of a completed ship, as Bill Werwage has suggested, we would still have a stiff structure as it is the outer shell of wood and paint that gives strength to the plane. Building light has proved to be easier than instructing termites so we will pass on a few of our thoughts.

There is a natural tendency to build

stronger than necessary which inevitably leads to excess weight. I have found that a plane constructed almost entirely with five minute epoxy and Hot Stuff will last far beyond its useful life as a competition model. Hot Stuff is very light and fast for assembling the built-up structures. I use it to frame the flaps, stabilizer, wingtips and fuselage. Hot Stuff is excellent for gluing the flap horns in place by drilling 1/16" holes in the bottom of the flap over the horn. The Hot Stuff will stiffen the wood around the horn as well as bond the horn. Hinges can be glued the same way provided they are lubricated to prevent binding. Five minute epoxy is used to glue fuselage doublers, engine bearers, and plywood formers. The only place I use a slower drying epoxy such as Hobbypoxy Formula I is attaching the stabilizer/elevator to the fuselage where I need time to align everything carefully. The first four inches of the nose is covered with K & B resin and ¾ ounce cloth to prevent stress cracking. Coat the inside of the engine and tank compartment with one coat of resin or Hobbypoxy Formula II glue for fuel-proofing.

The alignment of the stabilizer with the wing is very critical. To do this properly, cut the edge of a ⅛" x 3" sheet of balsa with a metal straight edge. Then cut clearance for half the wing at the root. Once the wing is mounted in the fuselage and *after* the bottom block is glued securely, (to minimize bending and twisting) pin this tempate to the fuselage side. Align the template so that the straight cut edge goes through the leading and trailing edge of the wing. Pencil or ink the center line of the stabilizer and flaps using the template as the guide. Use this line as a guide when mounting the stabilizer and aligning the flaps and elevator at neutral.

In making the nose, dremel away the nose ring and balsa until the wall thickness of the fuselage is uniformly 3/16 inch. This will serve as an optimum place to secure nose weight if needed. When the plane is completed, balance the ship as per the plans using a piece of soft ¼ inch balsa rounded on edge so as not to damage the finish on the bottom of the fuselage. If necessary, use Prather weights flattened to a bendable thickness and epoxy to the inside of the nose ring being careful to allow clearance for the engine. Do not load the engine by putting excessive weight on the crankshaft as this can cause overheating.

Flying Tips

Flying the Avanti II is a little different from most ships. Using the engine/prop set-up described, the lap times are a little fast at 5.2 seconds on 64 feet of line. However, the plane does not increase speed in maneuvers nearly as much as other ships. As a result the impression to the flyer is a rather relaxed pace once you have adjusted to the handling qualities. Level flight requires a little extra attention to get real smoothness. This is a trait of my planes for many years, and I have come to accept it as the price for really quick response through the intersection of eights. My handle spacing is 3⅞ inches.

So much for the Avanti II. Aerodynamics by Bill Netzeband, styling and paint scheme by Lou Dudka and Les Demmit, mechanics and execution by Bob Baron. What are you waiting for?