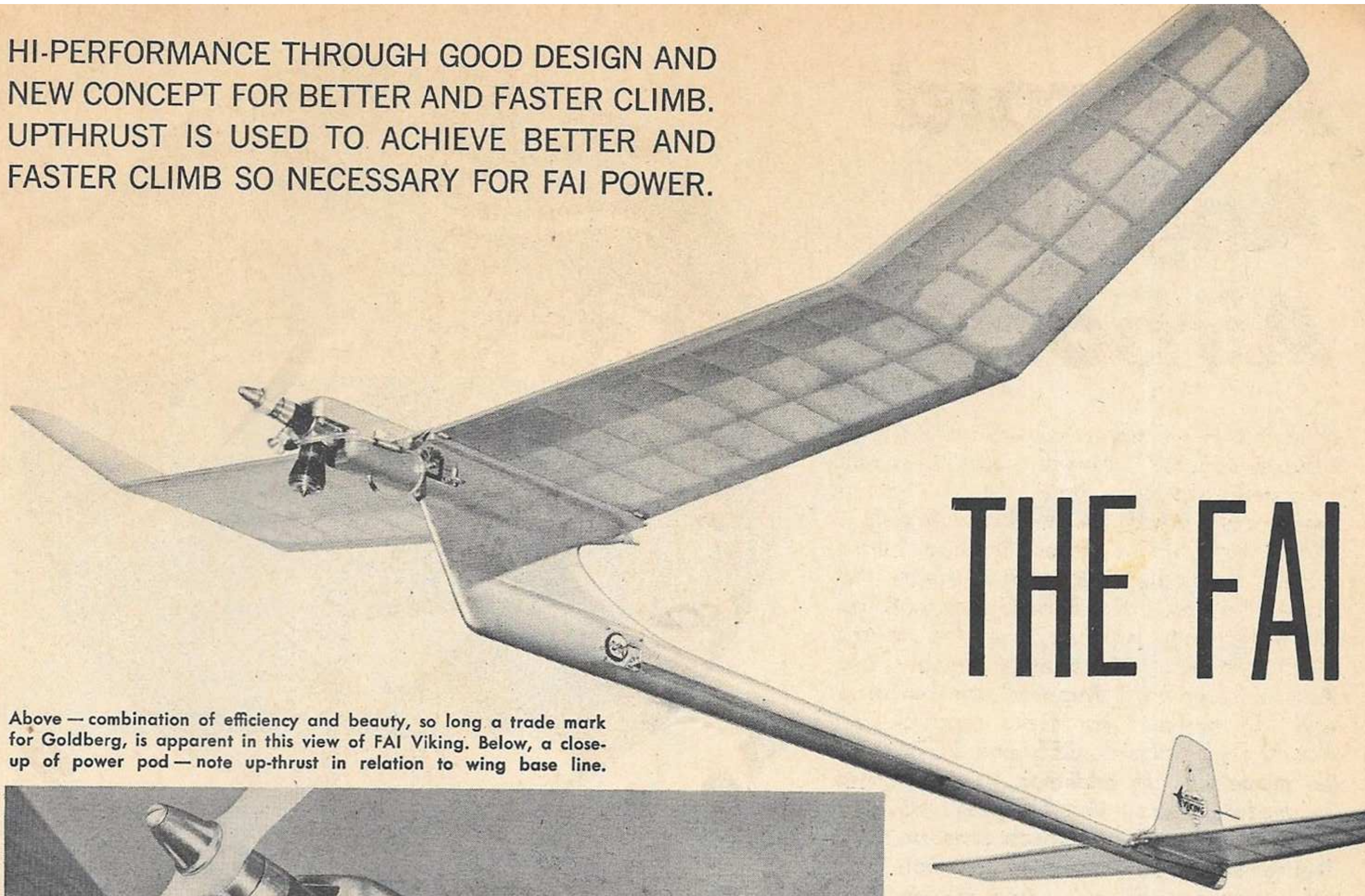
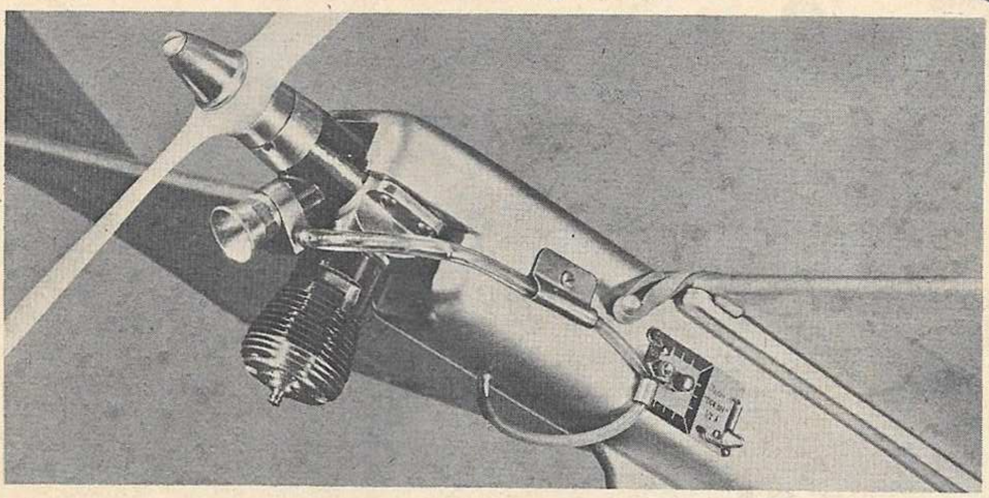
HI-PERFORMANCE THROUGH GOOD DESIGN AND NEW CONCEPT FOR BETTER AND FASTER CLIMB. UPTHRUST IS USED TO ACHIEVE BETTER AND FASTER CLIMB SO NECESSARY FOR FAI POWER.



THE FAI VIKING

by CARL GOLDBERG

Above — combination of efficiency and beauty, so long a trade mark for Goldberg, is apparent in this view of FAI Viking. Below, a close-up of power pod — note up-thrust in relation to wing base line.



► The story of FAI Viking is somewhat like looking for the pot of gold at the end of the rainbow—only this time it was really there.

It's the story of an idea that seemed both right and wrong—right because it could decrease drag during the climb—and wrong because it would definitely go against general free-flight modeling practice. Most modelers have had to use downthrust all through the years in order to kill the looping tendency. Yet what I wanted to use was *upthrust*—and that should cause uncontrollable looping!

The idea seemed so ridiculous that shortly before this article was written, a world-famous modeler stated positively that our model would loop all over the sky. He said he had been all through the FAI Viking type of layout, and the force arrangement simply could not work.

What he didn't know, was, that we had finally recognized something that has been right under our noses all along. But let's get back to the beginning.

The reason I've always used a small angle of incidence in the wing, (as well as small decalage) is that it would allow faster climb through lower drag. It seemed common sense that the propeller and the wing should not be "pointing" in different directions. However, about seven or eight years ago, I realized that this line of thought led directly to the idea of upthrust.

Briefly, the greatest source of drag in the ordinary model is the wing. When we use downthrust, we are trying to pull the wing through the air at a large positive angle, which means higher drag. To get the least possible drag, the wing must be pulled through the air at a slight *negative* angle. The reason for this is seen in airfoil performance charts derived from wind tunnel tests. Airfoils, such as are used in free flight, generally show lowest drag at a negative angle—perhaps two to four degrees negative.

This meant that upthrust would have to be used to make the wing negative to the thrustline—exactly opposite to tradition. Since most, practical modelers have often found it beneficial and even necessary to use downthrust simply to control the model, this seemed like an impossible problem. Attempts to solve it on paper were not encouraging, and, with my limited time for model-building, a serious effort to find the answer was not practical. However, I did discuss it with modelers at every opportunity.

In the fall of 1961, I met Jess Krieser, and old-time modeler who wanted to get back into free-flight. He built the ½A Viking, and in testing, I noticed the angle of climb was shallower than it should be. Also, after the engine cut out, the nose would rise sharply—just as though the engine had been holding it down. Examination showed no downthrust—but the downthrust *effect* was there. I suggested upthrust, which definitely corrected the trouble, as I hadn't noticed it in other Vikings, it

View from beneath clearly defines sleek lines of fuselage and standard Goldberg tapered wing which is thinner than section normally used.

THE FAI VIKING continued

was assumed to be just a peculiarity.

About that time, Jess asked for my rough plans of the FAI Viking, which he proceeded to draw up in finished form, plus changing the fuselage from rectangular to oval cross-section. He then built the model, and when decent weather for testing finally arrived in mid-May '62, the ship, on a 4-second engine run, made the most impressive first flight I'd ever seen. Climb and glide were excellent. However, on longer engine runs, after 5 seconds the great power of the Cox Tee Dee 15 would begin pulling the ship to the left. This was due to an undetected left turn in the rudder, and many test flights were wasted before the trouble was located. (Right thrust could have corrected it, but we were looking for a balanced design.)

After straightening out the rudder, the next few flights were flown just before dark, and showed the ship ready for more extended tests. A premature DT, however, resulted in separation and loss of the tail assembly.

A new tail was built, but I missed the flights with it. From description, the ship needed upthrust or more decalage, or both. When launched for a very steep climb, after seven or eight seconds the ship would flatten out, flying horizontally at high speed. Finally, it went so fast as to shear off the right wing, (this has since been strengthened).

By this time, the contest season was at hand, so Jess laid the Viking aside and began flying his new ½A "Ephemeris." This model is basically similar to the ½A Viking in general layout, except for higher thrustline and longer tail moment arm, and uses wing and stabilizer adapted from the Sailplane. Thrustline originally was zero, wing at slight positive. First flights were in high wind and looked excellent. However, in light wind the model proceeded to flatten out just as the FAI Viking had done. After various experiments, Jess, prompted this time by our good friend Stan Peterson, began putting in upthrust. The next day, Jess called to tell about it. "Carl," he said, "we've done it. The ½A Ephemeris needs *8 degrees* of upthrust relative to the wing."

This was too much for good efficiency, of course, but that was just the point. At last, a model had been flown with so much upthrust that wasn't just caused by a minor quirk or warp.

Meanwhile, Stan had been flying his Cox Special 15-powered combination Ephemeris-Viking (FAI-size Ephemeris wing and tail, FAI Viking fuselage). Stan also had a similar ½A combination. The performance of both ships was outstanding, stability and reliability absolutely tops.

Finally, at the DeKalb Cloudbusters contest in August, flown at Bong Air Force Base, both these jobs and Jess's ½A Ephemeris plus his newly completed FAI Ephemeris were flown. All did well. But the unique experience for me was watching the two ½As. Here were two almost similar ships, which looked and acted so much the same in flight—but Stan's ship had Viking medium thrustline set at zero, and Jess's job had high thrustline and longer tail moment arm, and *needed* its wild-looking upthrust.

It was clear that between these two little models the problem was bracketed. On the way home, we analyzed the factors involved, realizing that there were three prime means of controlling the thrustline in models of this type. In brief, these are: 1. Tail moment arm. 2. Stabilizer area. 3. Vertical location of thrustline. The idea is that in order to employ upthrust, one must have a built-in downthrust *elsewhere* in the design. This comes from having the tail situated well below the thrust line. The tail drag and lift then try to nose the ship down.

The lower the tail is, of course, and the farther back and larger it is, the stronger the effect. Now there is nothing new in this—except understanding how to use these factors to create the need for upthrust.

Let's assume we have a model—perhaps a "pylon" model—and it tries to loop with neutral thrust. If the tail is lowered, its drag will tend to nose the ship down under power, counteracting the looping tendency. A larger tail would also create more nose-down effect, but adds drag, too. Moving the tail farther back is better. If the engine is below the wing, it helps to raise it to the same level.

On conventional high-thrust low-tail ships, by moving the tail down enough, or far enough back, or making it larger, one can get enough nose-down effect so that upthrust is required. How does one know when it is required? Well, if the ship has normal decalage, and climbs fast but not steep, and noses up after the

The FAI Viking

engine cuts, it probably needs upthrust!

How much upthrust is good? It depends on the airfoil, but in general it seems that two to three degrees relative to the wing is the best compromise considering minimum drag for both wing and stabilizer. The FAI Viking needs about this amount (depending on the individual model), with zero wing incidence, and about two degrees negative in the stabilizer.

Getting back to the summer's flying, Jess and Stan continued to fly the FAI Ephemeris and Ephemeris-Vikings and did exteremely well in contests. Without a doubt these were the most stable and effective models I had seen in contests in many years. They made "hot" free-flight actually look easy! If they had any fault at all, it seemed to me that they would go up faster with a thinner wing and smaller tail like the FAI Viking.

After the contest season, Jess built a new FAI Viking with Cox Special 15, and with slight changes we decided on, such as strengthening the wing. Mainly, the thrustline was moved higher and other modifications made so we could use just the right amount of upthrust. From the start, general characteristics were highly favorable. All test flights have been very stable and nonsensitive. The climb is exceptionally fast, and the glide so flat it takes advantage of every little "help" in the air. In short, I feel that performance is just what every free-flight fan is looking for.

Upthrust is definitely necessary; without it, the ship flattens out and flies horizontally at high speed—very scary.

No right or left thrust is needed. The engine has been inverted to prevent the wing hitting it in case of a crash. Starting is not difficult, and can be made easy by just turning the ship on its side. Spruce spars and longerons are used for ruggedness. The medium-high-aspect wing, plus the small tail combined with long tail moment arm, give the high gliding efficiency especially needed in FAI competition. Wing airfoil is 8½% thick with slight undercamber. This section is somewhat higher lift than the ½A Viking, but is still a relatively low-drag section.

Construction of the model is quite conventional, and will be no problem to the modeler of average experience. The most important factor is to recognize the requirements of high speed and D/T landings in FAI ships. All joints must be good ones. Because of the speed, the model must be true, all warps being removed by heat lamp, steam, tea kettle or thinner. For dependability, the model must "cure" for several weeks in the "true" condition. The rudder and pylon must be dead straight in line with one another.

Wood in the model should be as specified to maintain strength. Silk covering over the entire structure is used for durability. Colored silk, of course, needs only clear dope.

The only construction that may require explanation is the fuselage. The sides are first cut to shape, and the four 3/16 sq. spruce longerons are glued in place, pre-

FAI Viking

ferably with a good white glue. While they are drying, a straight center line is drawn on the bottom sheet, and a line is also drawn vertically down the center of each former. Next, the sides are joined with the formers, beveling the rear to make a nice joint. Then the lower longerons are glued to the bottom sheet so that center lines on the formers line up with the center line on the bottom. This assembly operation plus the later addition of pylon and fuse top can be performed without lifting from the building board until dry.

The side blocks and bottom of the nacelle are shaped in the top view, while the flat assemblies of the pylon and wing platform are drying. Recesses are then cut with knife and small chisel to take the bearers and engine timer. The engine is mounted on the bearers, using blind nuts. Then, upside down, the pylon, side blocks, bearers, firewall, and nacelle bottom are all glued together. Later, the tank is enclosed with side pieces and top. When dry, carve and sand nacelle to shape, and cement pylon to fuselage. Also add fuse top, front fairing blocks and wing platform.

When dry, remove fuselage from board, and install D/T timer. Carve and sand fuselage to oval cross-section, except for timer area. For strength and maximum fuel protection, apply a coat of fiberglass resin to the entire nacelle and the lower front of the fuselage. Wet sand smooth and apply a layer of fiberglass cloth along with a second coat of resin. Wet sand again when dry, then apply resin once more, followed later by final sanding.

Be sure to use wing and tail keys, carefully fitted to maintain alignment accurately. Center of gravity should be very close to indicated position. Use ballast if necessary. Wing and tail incidence angles should be checked for accuracy; the flat bottom of the fuselage makes this easy. Use one washer (.020″-.025″ thick) under rear of each engine lug for upthrust.

Adjust glide in normal manner; do not alter tail incidence appreciably to get gliding trim. Then, with engine throttled back somewhat, launch at a very steep angle using four-second engine run. The customary adjusting techniques should be employed. However, if the ship shows any tendency to nose up after the engine cuts, add upthrust. Left or right turn under power should never look dangerous—apply opposite engine offset to correct. Glide may also be to left or right.

When the ship looks perfectly safe on short runs and full power, gradually lengthen duration of timer. With true alignment, full power and 15-20 second runs may be reached in a short number of flights. I would like to hear all reports on this airplane, and will answer all correspondence on it. Best of luck!