Build Your Own FLYING SAUCER

By ROY L. CLOUGH, JR

She flies through the air with the greatest of ease, transition from powered flight to glide is smooth, the glide itself is slow and the letdown gentle. It is spin proof and one of the most stall-resistant models ever built, yet when forced into a stall it recovers cleanly without the violent oscillations usually associated with "tail-less" types.

It has been observed many times to climb steadily at a 45 deg. angle into a stiff breeze, yet it may be trimmed for straightaway speed dashes at a surprising clip with the little Infant power plant.

We can hear the free flight fans: "How can that thing possibly fly? It has nothing suggestive of dihedral- what keeps it from rolling over?" Or, "We've tried these generally-delta type models before-fine as long as a gust doesn't upset them, but everybody is familiar with the stall and endless dive characteristics produced by longitudinally disposed lifting surfaces. And how can you rig a thing like that to climb under power, yet still glide nicely-with a symmetrical section, yet!"

This model has the answers. Behind it lie a dozen experimental saucer-deltas, both free flight and control line, several bent crankshafts and at least one broken crankcase.

Worries about surface warpage are a thing of the past; the model is one unit, you build it, you cover it, and there she is, all ready to go. Nothing to twist out of shape, nothing that must be assembled "just so" every time it is to be flown. In addition to this the model is extremely difficult to smash up, and lastly, if it lands in a tree it will usually slip down through the branches to the ground without hanging up. That's not a strictly aeronautical consideration, to be sure, but a rather endearing characteristic to those who must do their flying near wooded areas.

Some background: A number of experiments with gliders, prior to powered flight attempts, fixed the ideal aspect ratio at the three quarter mark. That aspect ratio of .75* seemed about right. At higher figures longitudinal stability began to suffer, and as the length, or chord was increased producing an AR of less than .75, lift began to drop very rapidly, plus introducing an oscillating stall from side to side in a nose-up condition at low speeds.

***Non-rectangular aspect ratio determined by formula.**
Span^3 4 Total lift area =AR

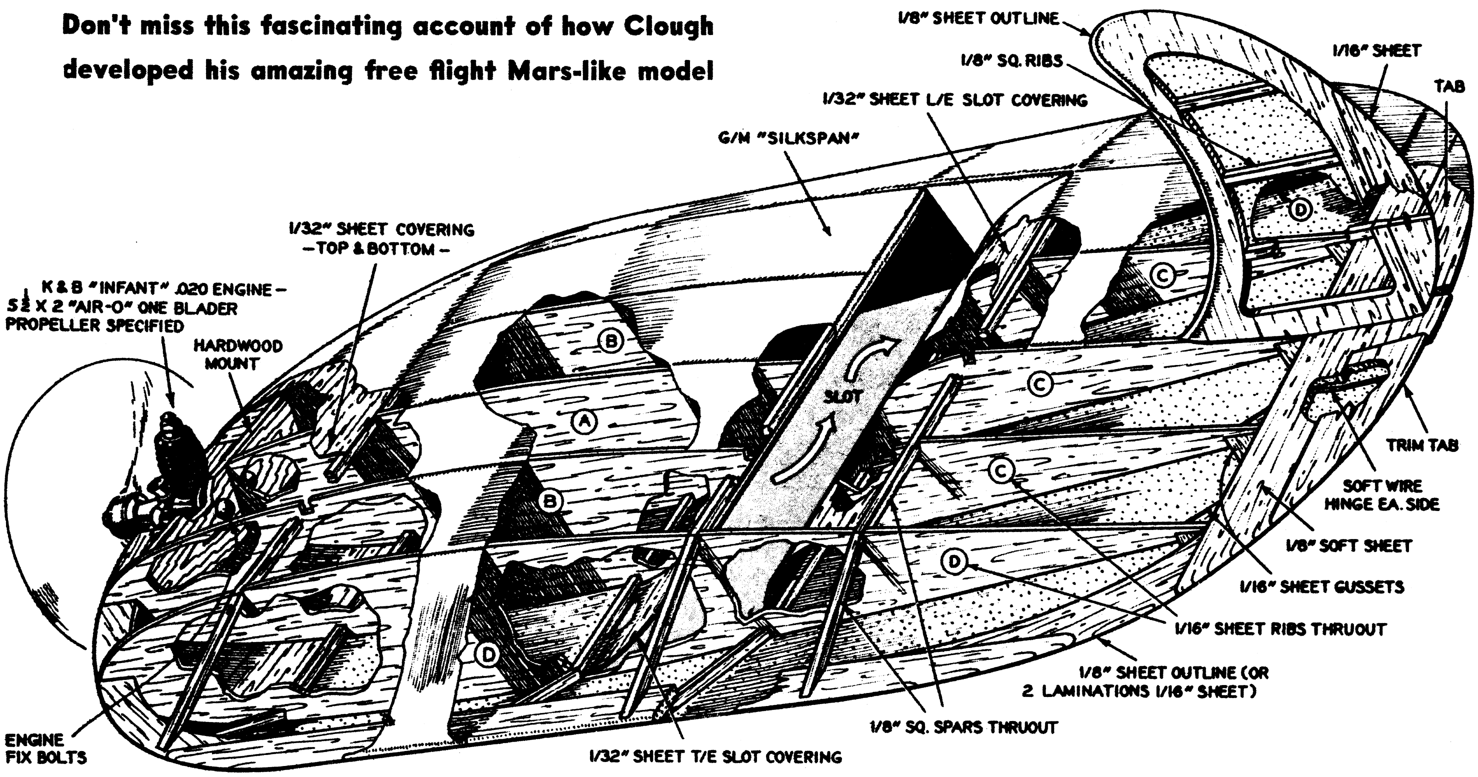
It was found that the airfoil section had to be practically symmetrical if optimum performance and efficiency were desired. The reason for this is that strongly re-flexed sections produced as much drag, in a practical sense, as the tail they were supposed to eliminate. In the .75 configuration another factor- short span-prevented any effective root-tip incidence variation, and it was felt that it would also introduce lateral instability, particularly since the machine would have no dihedral angle in the usual sense.

By experience with symmetrical sections on other, conventional free flight models, it had been found that the lift of such a section is quite adequate, possibly because of a lower drag factor, quite as high as some of the highly touted under-camber wings, provided they are operated at the proper angle of attack.

This may surprise some model designers who feel that a symmetrical, or full streamline section is a "no lift" section. That this isn't true becomes, evident when one considers they are operated at a high angle of attack. We have the empirical evidence of control-line stunt models using such sections which invariably out-glide and out-perform even right-side-up maneuvers by top cambered wing types.

In addition to this I had been flying a sport free flighter of 40" span and full symmetrical foil for six months with excellent results (I predict there will be a swing toward symmetrical sections on free flight when their- many advantages-particularly their insensitivity to power fluctuations-

Don't miss this fascinating account of how Clough developed his amazing free flight Mars-like model



become better known). Thus the symmetrical section was decided upon. It had the lift, it had very low drag, it would permit high speeds or high climbs, and it greatly simplified construction problems and made for good geometric design balance and straightforward building.

This was fine. But it also had a zero pitching moment, which, while assuring fine neutral stability, unfortunately assured as well a near-zero ability to recover from a longitudinal displacement. We struggled with this one through several early designs. They flew well, steadily and fast, with no tendency to stall by their own devices-yet sooner or later a gust would account for them, force them up into a stall, and that particular model would end its career in a screaming dive to the ground.

Attempts to provide a recovery couple seemed always to clutter up the design with auxiliary stabilizing surfaces (similar to the "safety" stab used on some of the British delta-wing jets) or pointed back toward reflex surfaces. During this time it was established also that there had to be a considerable amount of area up forward. This was necessary to prevent side wise, tumbling (I believe this is a sort of rapid span-wise rather than chord-wise stall) and this pointed directly to the "Flying Platter" configuration. Here the sweepback was more gentle, yet still enough to take over the functions usually performed by dihedral angle.

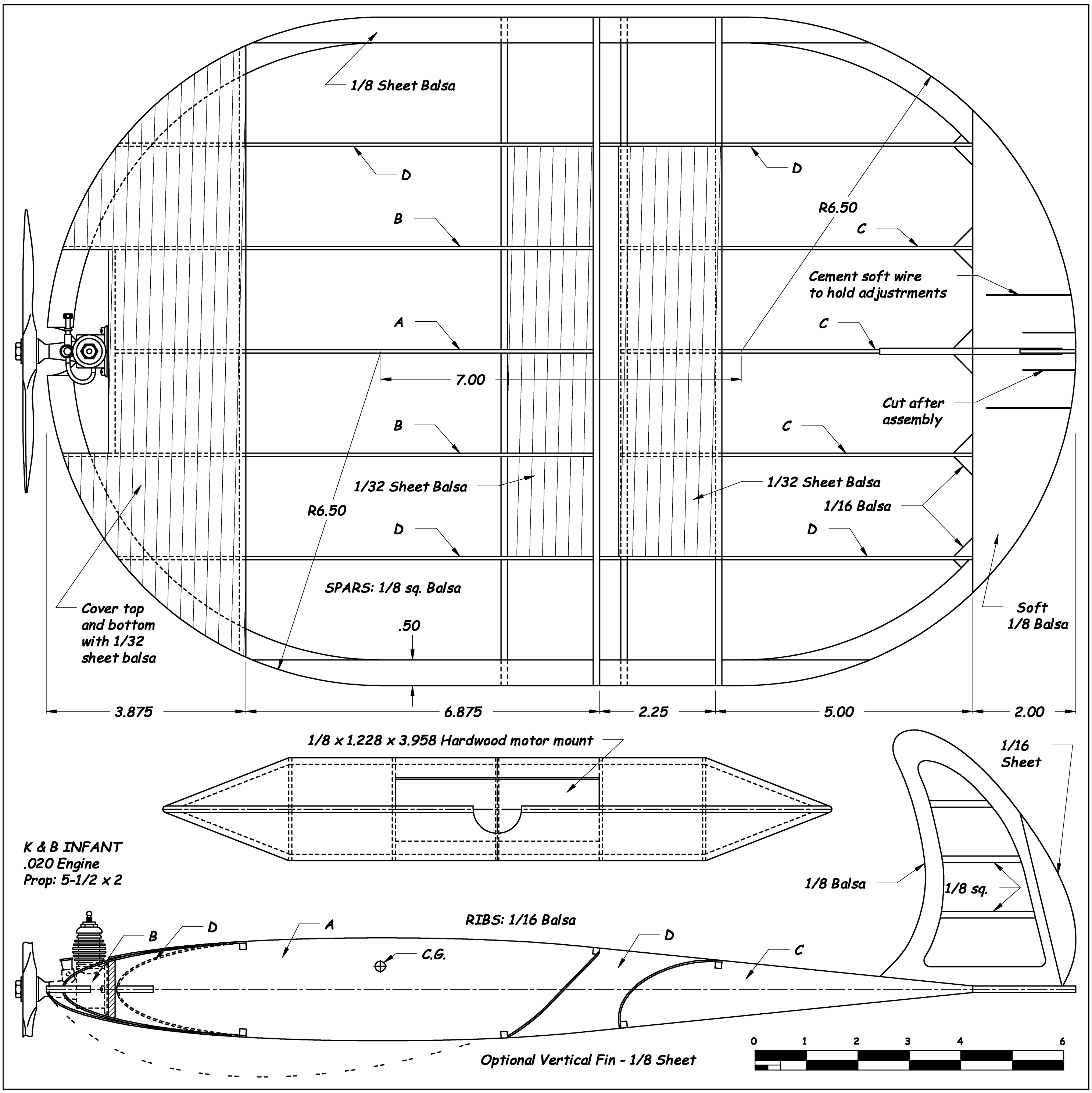
At this point the use of slots was tried. It was found that slots would not prevent a stall, but would increase the angle before it broke. A few more experiments established that careful placing of the slot would result in a slight recovery couple from a dive, since the topside of the wing, favored by the slot, would generate more lift in a sudden acceleration. However, the recovery took far too long and secondary stalls frequently developed.

The leading-edge slot was not the answer, or, if it was, it had to be movable proportionately to the dynamic pressure. Frankly, I could not see this for models. The engine vibration factor is much too high, the scale effects are much too rugged; it would be a practical impossibility to design a floating slot, which could withstand vibration, yet be light enough to operate without absorbing the advantages of its use in added weight and complication. This led to paper cutout gliders weighted with pins and slotted in some rather improbable places; at the center, around the rim, and finally at a point about one-third forward from the trailing edge. This looked good and as a result more gliders were cut out and the location of the slot nailed down, its present position being fixed empirically. And it works.

The recovery from a forced stall is clean. Yet the model will not stall of itself. What has been done, in effect, is to build in a tail surface, but with a difference; this one operates to raise the tail when the 'model is flown at a high angle of attack, yet it will also raise the nose when flown (in the glide, usually) at negative angles. At flat angles it does not bring on a loop or dive.

Construction is very simple. Make up the 1/8" balsa outline, or, if you prefer, laminate it from 1/16" sheet. The ribs offer no difficulty; 1/8" sq. spars maintain the alignment. The motor mount is simply a piece of pine or plywood. The slot section and the leading edge of the Saucer are covered with 1/32" sheet, although you may wish to use 1/16" on the bottom front section for additional ruggedness since the Saucer has no landing gear. The rudder must be put on square and true and the trim flaps are cut into the trailing edge of the model after it is finished. Cover and finish with fuel-proof dope.

The C.G. location should be within a half-inch or so of the



location shown on the plan; not very critical, since the tabs can be used for minor corrections. Make sure the motor is mounted accurately with no up- thrust; a faint down thrust is permissible but not needed, generally speaking.

Test-glide over tall grass with a loop of solder replacing the prop. (Use a one-blader set to stop blade up, for flying.) If the model is true and balances correctly a level shove should take it out in a smooth flat glide. If it dives a bit use a touch of tab to bring the nose up. If it stalls-by this I mean if it oscillates from side to side as it goes forward-then it is tail heavy enough to require a bit of ballast up forward. No real zoom and plunge stall can develop in test gliding unless you shove it nose-high with practically no speed at all.

Now for powered flight adjustments: Several are possible. It depends upon what you want. Note that in the photos no central fin is shown, although there is one on the plan.

You will not need this fin for straightaway flights; in fact, lowering the CLA by the use of this fin is not at all desirable if high directional stability is desired. On the other hand, if you want tight circles, the fin should be used.

The original model would fly straight out, or in 150-foot left-hand circles without the fin and without spiraling in on rudder tab alone. However, tightening up the circle, either right or left will result in a descending spiral unless the ventral fin is used, or, alternatively, the model trimmed excessively tail-heavy. Offsetting the thrust line to the left with the rudder set right produces safe tight circles and a good flight pattern.

For speed dashes use just enough right rudder to counteract torque roll and shim in a little down thrust to prevent the model from climbing, and of course, don't use the fin. All flights are H/L.

AIR TRAILS

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