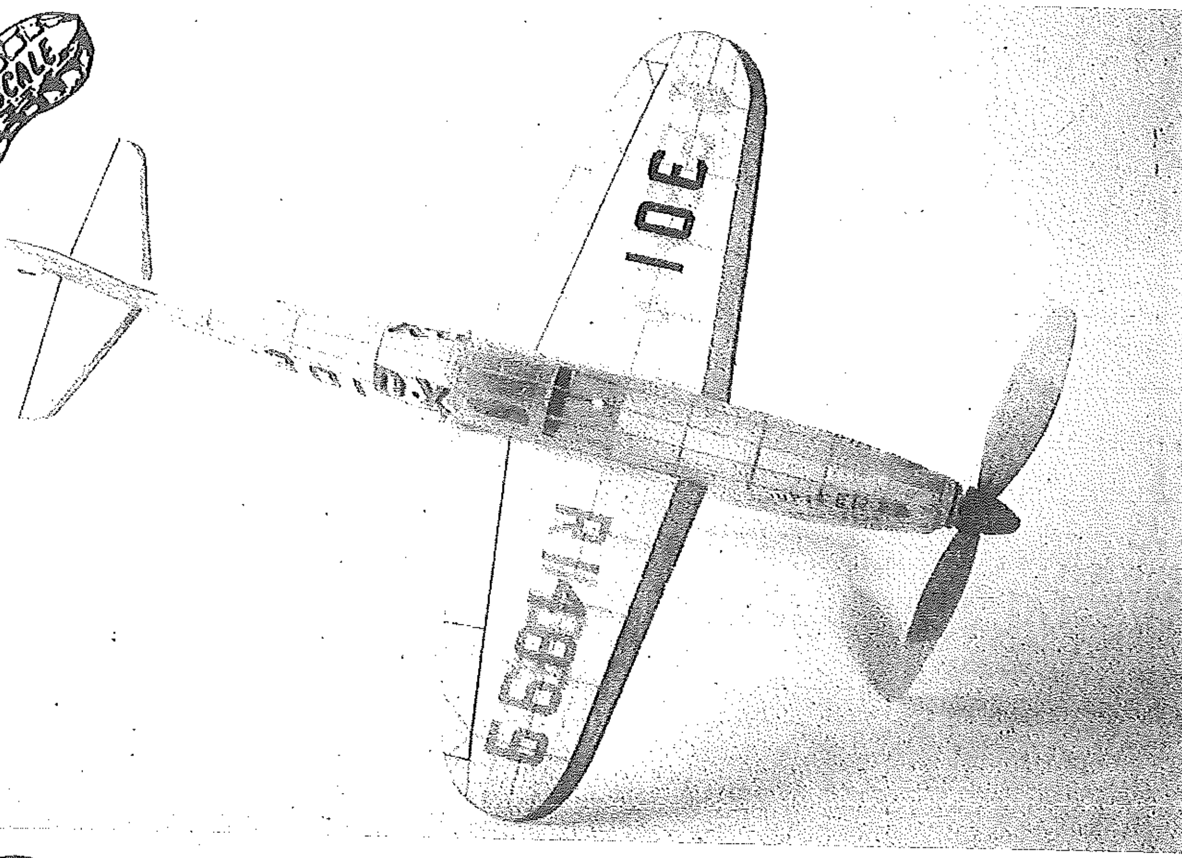
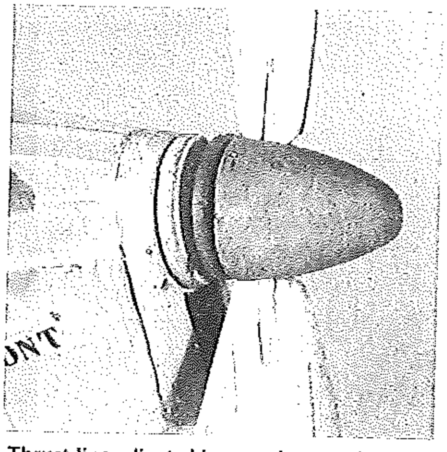


FOLKERTS SK-3

By KURT ENKENHUS . . . Overall winner of MODEL BUILDER's 1977 Parcel Post Proxy Peanut contest, this has to be one of the best Peanut Scale models ever designed. Plans show "heavy" and "light" versions.

• Cleveland, Ohio, 1937 . . . the Thompson Trophy. With rumors of war already casting shadows over the Golden Age of aviation, they gathered here for a showdown to see who was the fastest in the world. While they all worshipped speed, a glance at the bulging cowls confirmed that most of them put their faith in brute force . . . eight hundred horsepower or more of radial engine. One man, Clayton Folkerts, an aeronautical genius, preferred to court the Goddess of Flight. His SK-3 Speed King, the "Pride of Lemont", boasted only a 400 horsepower Menasco Super Buccaneer, but the slim, in-line 6 was so smoothly housed that it was the sleekest racer there.



Thrust line adjusted by rotating nose button in block. Marks help locate best setting.

The start . . . and the SK-3 trails next to last! Then the Goddess smiled, and Rudy Kling, passing one after another of the eight aircraft ahead of him, flashed to a photo-finish victory at an average speed of 256.91 mph.

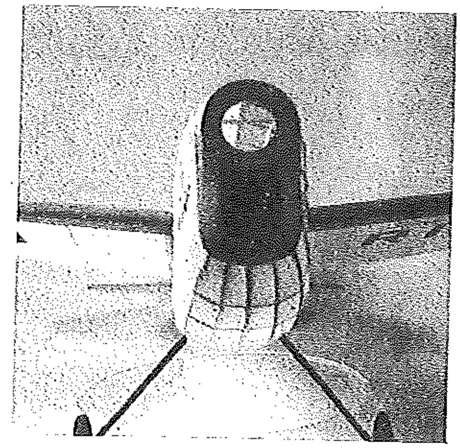
What made this plane so remarkable? Details of the fascinating development of the SK-3, as well as Bjorn Karlstrom's three-views on which my plans were based, may be found in the February, 1973 issue of American Aircraft Modeller.

The aerodynamic features which enshrined the SK-3 in air racing history also give it superlative performance potential as a 13 inch wingspan Peanut scale model. The low aspect ratio wings of generous area, long fuselage, and clean lines result in a model of light wing loading, low drag, and excellent flight stability which packs plenty of rubber winds. My enthusiasm grew when preliminary calculations suggested that two minute flights should be obtainable if the total weight could be kept to 2 pennies.

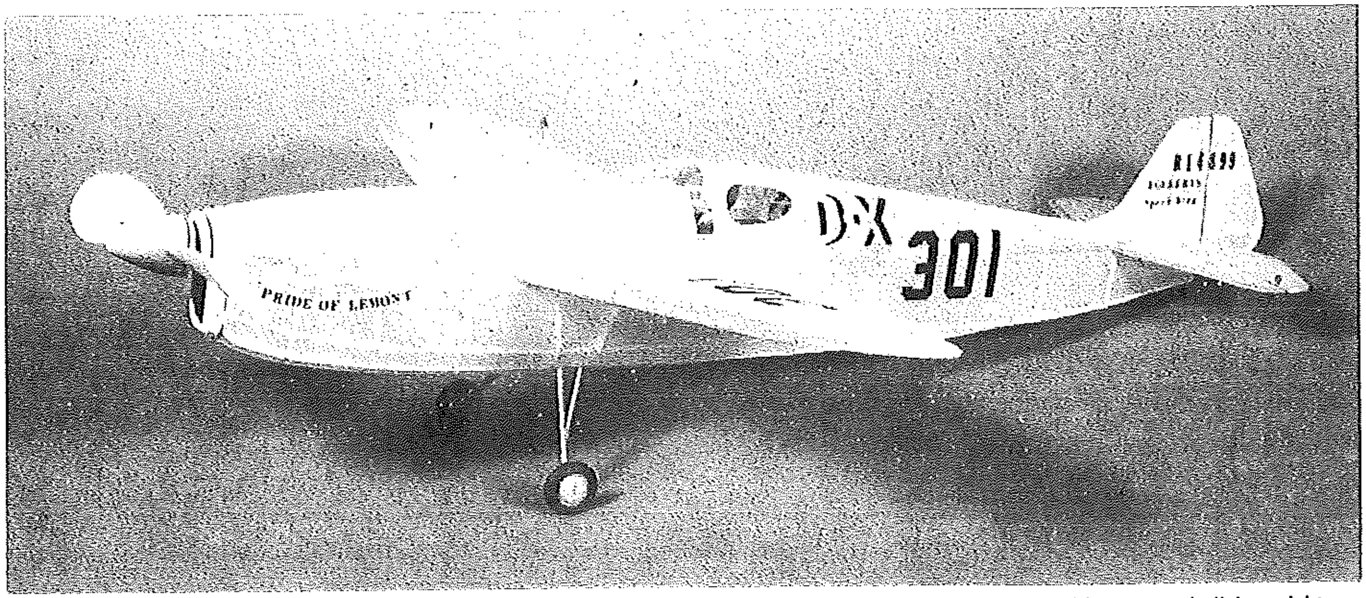
Before discussing the construction methods which permitted this weight goal to be attained, let's spend a little time analyzing the performance of an indoor rubber-powered model airplane.

MODEL PERFORMANCE ANALYSIS...
DESIGNING FOR PERFORMANCE

It's clear that the rubber motor



Super-light version has no bulkheads. Please don't squeeza da fuselage! Plans show both.



Biggest surprise to all the proxy fliers at the contest flyoff was the exceptionally slow flight speed of the Folkerts. The extremely light weight and slow RPM of the large, high pitched prop were obvious clues to its performance capability.

must supply the energy consumed in indoor cruising flight. The propulsive energy supplied is equal to the specific energy of the motor, e_r, in foot-pounds per pound of rubber, times the weight in pounds of rubber used, W_r, times the propeller efficiency, P_{eff}. The rate at which a model of drag D pounds flying at a speed V feet per second consumes energy, is DV foot pounds per second. The time it will fly before using up the available energy is therefore

$$t = \frac{e_r W_r p_{eff}}{DV} \text{ seconds.}$$

This formula is correct even when the model climbs and descends again, because the additional energy consumed in climbing against the force of gravity is regained during the descent. It tells us that to obtain long flights, we need lots of energetic rubber and a high propeller efficiency, coupled with low drag and flight speed. As we shall see, the drag is directly proportional to the weight of the model, and the flight speed increases as the square root of the weight, so building a light model is an essential prerequisite to high performance. Let's proceed with the SK-3 design calculations!

The drag is equal to the total weight of the model, W, divided by the lift-to-drag ratio, L/D:

$$D = \frac{W}{(L/D)}$$

By gliding the model (This test was done with the outdoor model, which was built first. L/D does not depend on model weight, but only on the configuration.) when balanced but without the propeller, the lift-to-drag ratio was found to be L/D = 3.5. In such a test, L/D is equal to the ratio of the horizontal distance flown to the vertical descent. From some calculations and past experience, I believed I could keep the total weight to 2 pennies, or, since there are about 143 pennies in a pound, to W = .014 pounds. The drag is therefore

$$D = .014/3.5 = .004 \text{ pounds.}$$

The flight speed is given by the aerodynamic formula

$$V = \sqrt{\frac{2W}{.0023A \cdot C_L}}$$

in which A is the wing area = 0.25 square feet for the SK-3, and C_L is the airplane lift coefficient. I estimated that, for the particular value of wing aspect ratio of the SK-3, C_L = 0.6 when trimmed near stall. We can now find the flight speed:

$$V = \sqrt{\frac{2x.014}{.0023x.25x.6}} = 9.0 \text{ feet per}$$

second, or 6.1 mph . . . a fast walk.

The propeller efficiency can be calculated from the following formula, which is based on data from full scale tests:

$$p_{eff} = 0.85 \text{ divided by } 1 + \frac{C_L A}{2\,(L/D) A_{prop}}$$

where A_{prop} is the area of a circle with the diameter of the propeller. Since the formula, in fact, indicates that propeller efficiency goes up with increasing propeller size, I picked a 6.5 inch (0.54 foot) propeller for the SK-3, for which A_{prop} = 0.23 square feet. We now find the propeller efficiency to be

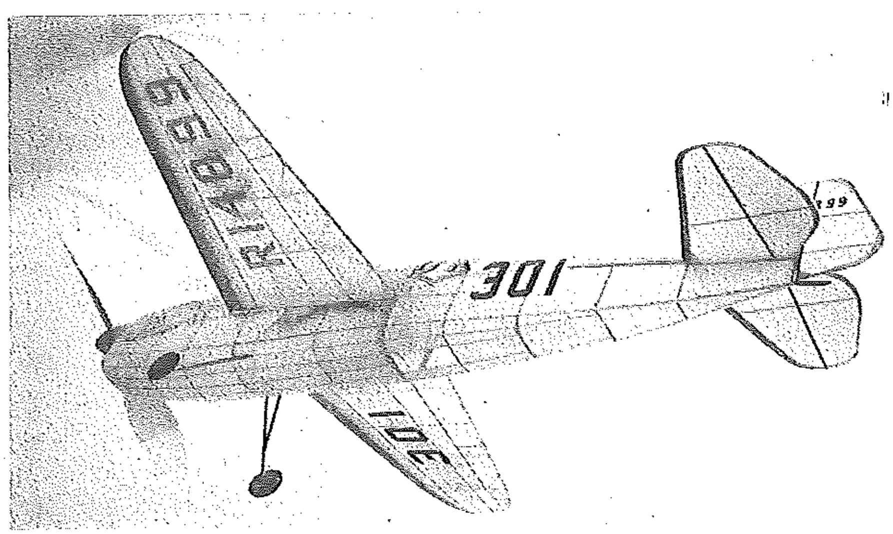
$$p_{eff} = \frac{.85}{1 + \frac{6x.25}{2x3.5x.23}} = 0.78.$$

Next, I determined the specific energy, e_r, of the rubber I had in mind through experiments using a homemade torque meter. The average of three tests gave

e_r = 2160 foot-pounds per pound.

A reason for doing several tests in succession is that the rubber tends to fatigue, and a single test gives too optimistic a value.

The final design problem was to



Underside photo reveals access opening for hooking up rubber, which is attached to dowel just aft of wing's trailing edge. Running motor to rear of fuselage would have caused balance prob.

determine the size, number of strands, and length of the rubber motor required. A key question is how thick the motor must be to provide enough torque to produce climb early in the flight, without exceeding that needed for cruising flight later. The required torque, T, in foot-pounds, is

$$T = \frac{PD}{2\pi}$$

where P is the propeller pitch in feet and D is the drag in pounds. For a 6-1/2 inch diameter propeller, the largest reasonable pitch, and the value I selected, was 13 inches (1.08 feet). The required torque is then

$$T = \frac{1.08 \times .004}{2 \times 3.14} = .00069 \text{ foot-pounds}$$

Using my torque meter to wind some sample motors, I found that 4 strands of .050 rubber gave an average torque of .0011 foot-pounds, nearly twice too much. Four strands of the next smaller size (.040) gave .0006 as an average value, but twice as much when nearly fully wound, which was just what I was looking for . . . I hoped! Flight trials are the final verdict. The most rubber I felt could be used was a 15 inch long motor weighing 0.35 pennies, or W_r = .00245 pounds, with the motor peg located just behind the wing trailing edge in order not to have to add any weight to the nose to maintain balance. When added to the structural weight of 1.60 pennies, this brought the flying weight to 1.95 pennies, or W = .0136 pounds. This is slightly less than the 2 pennies weight assumed previously in calculating drag and flight velocity; the corrected values are D = .0039 pounds and V = 8.9 feet per second.

The predicted endurance from the first formula is now found to be

$$t = \frac{2160 \times .00245 \times .78}{.0039 \times 8.9} = 119 \text{ seconds}$$

or 1 minute 59 seconds. A best flight of 2 minutes, 3 seconds was obtained by my proxy flyer, Walt Mooney, in the contest.

To complete the analysis, a calculation has to be made to see if the motor can provide the required number of propeller revolutions. The distance flown is:

$$s = Vt = 8.9 \times 119 = 1059 \text{ feet,}$$

or 5 laps of a 67 foot diameter circle. The number of motor turns required is therefore

$$N = s/P = 1059/1.08 = 981,$$

or 62 winds with the usual 16:1 ratio winder. The motor used could take more than this, leaving a little more torque left near the end of the flight, which was desirable.

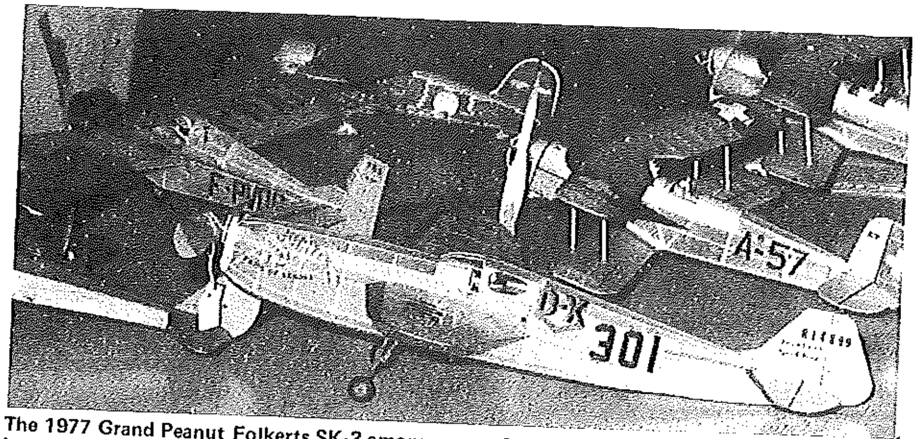
Let me emphasize that the present model does not represent an optimum design. It can be shown from the formula for endurance that maximum flight time is obtained when the rubber weight is twice that of the structure. However, 92% of the maximum is obtained when the two are equal. For the SK-3 model, the "motor efficiency", as I call it, is only 42%. By using a gearbox to match the high torque of the rubber to the relatively low torque needed for cruising flight, much longer flight times are possible. However, such a model is heavier, flies faster (but, due to the large increase in W_r, longer) and, unless exceptionally stable, is likely to hit the wall long before the "race" is over, just like some Indianapolis machinery we have read about.

CONSTRUCTION

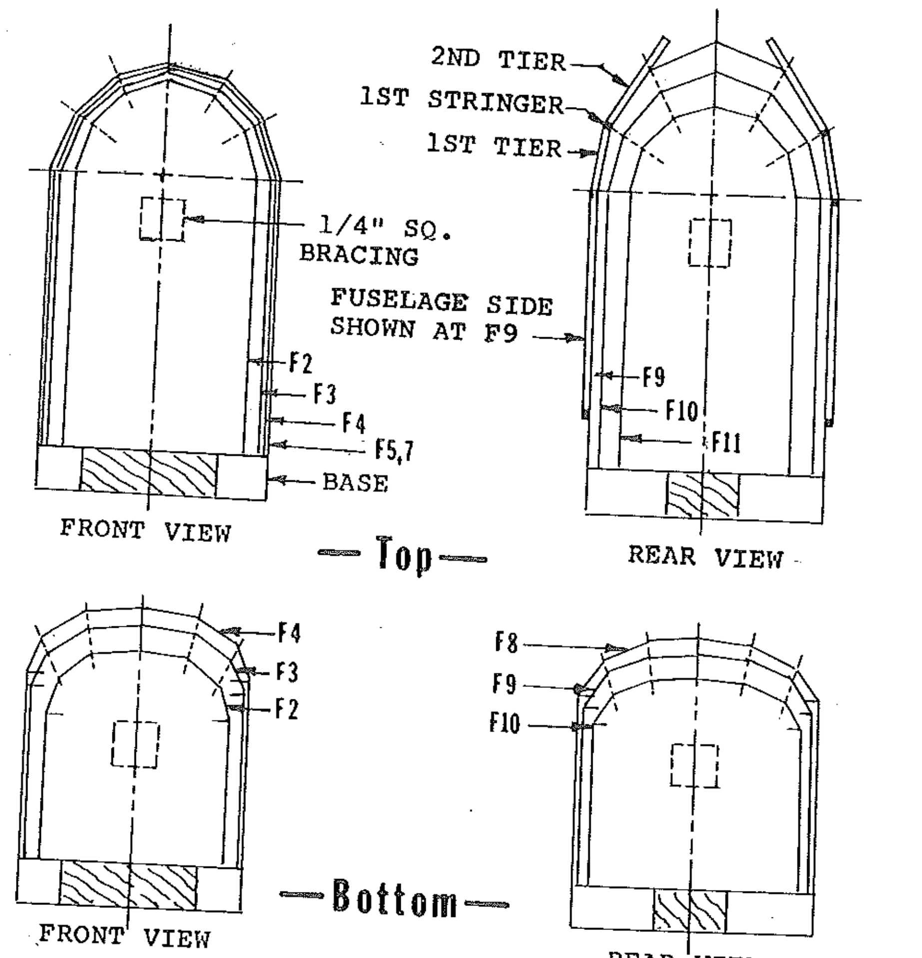
We have seen that there are many factors which promote high model airplane performance, but certainly one of the most important is keeping weight down.

How light is light? The ultimate is the indoor microfilm model, which can fly up to nearly an hour. In Peanut Scale, we can borrow the

Continued on page 92



The 1977 Grand Peanut Folkerts SK-3 among some of its competitors during static judging. It rated third in scale behind the two Jungmanns of Krekovich and Strange, Mooney plans.



These dummy formers are used in construction of the super-light "eggshell" fuselage, as described in the text. A full size reproduction of these is included with the full size plans package.

Folkerts ...... *Continued from page 51*

jargon of race car buffs and think in terms of Stage 1, Stage 2, and Stage 3 "tuning".

A "Stage 1" Peanut can be recognized by its 1/16 or thicker framework, generously doped Japanese tissue covering, plastic prop and wheels. It's usually too heavy to fly long.

A "Stage 2" model might be built from the same plans, but using selected light stripwood with balsa propeller and wheels. Flights of a minute are common.

A "Stage 3" Peanut uses 1/32 or .040 indoor stripwood and condenser paper covering. A few kits are available, such as those sold by Micro-X Products, but they are often scratch-built. Such models can provide the ultimate thrill-flights of two minutes or more. Nor need appearance be sacrificed, because, as I will explain, they can be spray painted with an airbrush to provide just as colorful a finish as their Japanese tissue rivals.

'Nough said . . . Let's build the SK-3!

If you haven't already done so, I strongly advise you to buy and read Fred Hall's book, "Indoor Scale Model Flying", for an expert's advice on construction.

And, since Peanuts use so little building materials, why not invest in the best quality? The .040 stripwood, .040, .020 and .012 sheet, condenser paper, and Micro Coat called for in the plans are all available from Gerald Skrjanc of Micro-X Products, P.O. Box 1063, Lorain, Ohio 44055. (His catalog is 75¢.) I would recommend his Ultra Cement for gluing balsa, but used thinned white glue for laminating the wing tips and attaching foam parts. The plastic model paints required for the foam wheels, spinner, and pilot, and the Floquil paints and Dio-Sol thinner used to spray paint the tissue, are available at hobby shops.

Let's warm up by building the tail surfaces. They're of conventional construction, but the result is about 2.4 times lighter than what you'd end up with using 1/16 strips and sheetwood.

Optimizing structural design is just as important as using lightweight materials, and the wings, which we turn to next, incorporate many features which maximize strength and stiffness with minimum weight. These features include built-up ribs, laminated tips, and a thin sheet leading edge which is much stiffer than a spar of equal weight. Build and assemble these parts, then cement in the wing spars in segments between ribs. Finally, add the diagonal trailing edge bracing which greatly inhibits warping, and cement the wing plug-ins to the root ribs.

Now for the fuselage. Two construction options are shown on the plans. In the "outdoor" version, the body sides built over the black outline are assembled and completed using the conventional former and stringer method.

The body of the "indoor" version, which was flown in the contest, was essentially "formerless". After gluing the sides together at the tailpost and adding formers F6 and F1B, the structure was mounted on a special form and the top deck completed with a purely stick construction as illustrated in the auxiliary drawing.

It is essential that you first run strips of 1/4 inch wide Saran Wrap over each dummy former and tack them to the bottom of the base, or you'll never be able to remove the beautifully light and true creation you've built! Hold the form over heat to shrink the Saran Wrap strips so they won't slip off during building. And cut the strips at the base to facilitate removal of the partially completed fuselage, pulling out any strips that stick afterwards. Now cement in the internal and bottom fuselage crosspieces.

Build the bottom deck on a separate form, remove, and cement in place. Almost finished . . . and not much more difficult than conventional construction, except that the whole darned thing is pretty delicate before it's completed!

If you wish to include the pilot, don't forget to build, paint, and install him before cementing the stringers and sheeting over the cockpit area between F8 and F9. Cigarette wrap is about right for the side windows, which are attached with thin dope. Hold over the stove to get them tight. If you don't have a vacuum-former to make the canopy, you can heat shrink the mylar over a balsa form . . . as I did.

"Turn" the wheels and spinner by holding sandpaper against the rough-cut foam as it rotates while cemented on a dowel shaft in your Moto-Tool. Hollow out the spinner with the Moto-Tool and slot it so it will be removable to expose the propeller winding hook. Use Hot Stuff to cement the prop shaft to the hub after binding with thread, and also to cement the landing gear in place (but not until the fuselage has been covered and spray painted). Cut out, soak, and bake the propeller blades on the prop form, then sand to a very thin airfoil shape, less than 1/32 in thickness. Mount the blades on the propeller hub at the proper angle, using triangular templates temporarily cemented near the tips as a guide.

Now that the framework is all done, plug the wings into the wing mount slots and check that both have exactly the right angle of attack as indicated by the construction note on the plans. If not, fix up the wing plug-ins until they do.

Sand the structure very gently where needed, and brush on two coats of thinned dope where the tissue will be attached. I employ thinned dope to fasten the condenser paper, then use a perfume atomizer filled with water to spray tighten. Condenser paper will not warp the structure the way Japanese tissue does, so don't be afraid to get it fairly moist. However, to cover the tail surfaces, first shrink condenser paper onto a balsa frame, then lay the freshly doped framework on the paper and let dry thoroughly before trimming. If you plan to fly outdoors, brush the covering with Micro Coat to prevent sagging tissue on humid days.

Now for some suggestions on finishing, or "Why a condenser paper covered model needn't look like a ghost ship." Buy a good airbrush. I am using a Paasche with the H-3 tip. Go to your local supplier of bottled gas, wave the airbrush hose, and tell him you want a 20 lb. refillable cylinder of CO_2, a regulator with a 0-60 psi gauge, and an adaptor to fit your hose. He'll probably tell you he wants about $80, but its worth it. Mix yellow Floquil with up to 50% Dio-Sol thinner, and with 30 psi set on the regulator, spray as fine a mist as you can get on the condenser paper. If the mist is as fine as it should be, you will have to apply several coats, but stop as soon as a translucent yellow-cream color is obtained. To paint wood or foam yellow-cream, mix some white paint with the yellow, using Floquil on wood, plastic model paints on foam. The red wing and stabilizer leading edges are most easily brushed on after marking the boundary, with a red felt-tipped pen.

Use a black felt pen for the control-surface outlines and panel separations. Consult the three-views for the location of the latter if you wish to include them.

The lettering and decals were made as follows. Spray pre-shrunk sheets of condenser paper red and black for the larger lettering; trace the outlines on bond paper and sandwich the condenser paper between this and another sheet of bond, and cut out with a sharp blade. I used black rub-on letters for the smaller printing, since I couldn't obtain red letters. Use a very fine brush to paint the comet, planets, etc., on prepared yellow condenser paper, with the pattern underneath to guide you. Now attach everything to the model with thinned dope. The plans explain how to make the louvres and pitot-static tube, if you wish to add these touches.

FLYING

With a doll-like idiot who hasn't even soloed, in the cockpit, I wouldn't put too much reliance on the test pilot. Balance the model where indicated, wind just a few turns in the motor, rotate the thrust button about 45° for right and down thrust, and check the vertical tail for 2° right turn setting. Try a few "glides" with the prop just ticking over and add clay to the nose or tail until it's correct. Maiden flights are best made outdoors on a dry, windless dawn or sunset . . . grass is a lot more forgiving than the gym wall. With more power, adjust the thrust button by rotating it until you get right circles of 60 foot diameter; mark this setting. If your model is heavier than mine, you'll need thicker rubber. (Micro-X has a wide increment of sizes.) Your 1937 Thompson Trophy winner is now ready to take on today's competition! ●

Hannan . . . . . *Continued from page 54*

Obi-Wan Kenobi, played by Alec Guinness, bears a remarkable resemblance to Richard Miller, of hang-glider fame, and delivers the most polished performance. We were glad to see that Carrie Fisher (daughter of Debbie Reynolds and Eddie Fisher) had washed her previous role out of her hair, in her portrayal of Princess Leia. She seems to have inherited her mother's voice and her father's features. Luke Skywalker (Mark Hamill) is properly "All-American Boy" throughout, in the best comic book tradition. But it is C3PO (See-Threepio) and R2D2 (Artoo-Detoo) that keeps things moving in the good humor department, with their Mutt and Jeff antics.

Model builders will be intrigued with the various space vehicles, which resemble old Nash Ramblers, more than the ultra-jazzy machines usually found in sci-fi movies. The weapons are equally unlikely, presenting the paradoxical combination of ancient and modern. How about a sword which emits a limited-length laser beam? Or spaceship guns with World War Two style Pom-Pom action? On paper, it sounds very corny . . . but it isn't on the screen! Rather, it is so outrageously incongruous as to seem perfectly logical.

In summary, we suggest you attend and prepare to be entertained. To paraphrase a line from the film, "Let the FARCE be with you"!

NEW MODEL MAG

New model publications appear about as regularly as lower prices. Thus, we were delighted when Georges Chaulet sent us a copy of a new aviation magazine from Spain. Although our linguistic capabilities are limited, we greatly enjoyed the many photos and illustrations. From what we can deduce, the magazine will deal with several facets of aircraft, including models, hang-gliders, and man-carrying sailplanes. The quality of the paper is first-rate, and the abundance of advertisements suggest a strong financial base. Engine collectors might well be turned-on by adverts for the Spanish LLAM powerplants; ball-bearing units available in both diesel and glo variations. In fact, all this fine new publication would appear to lack is a Spanish Peanut! Further information