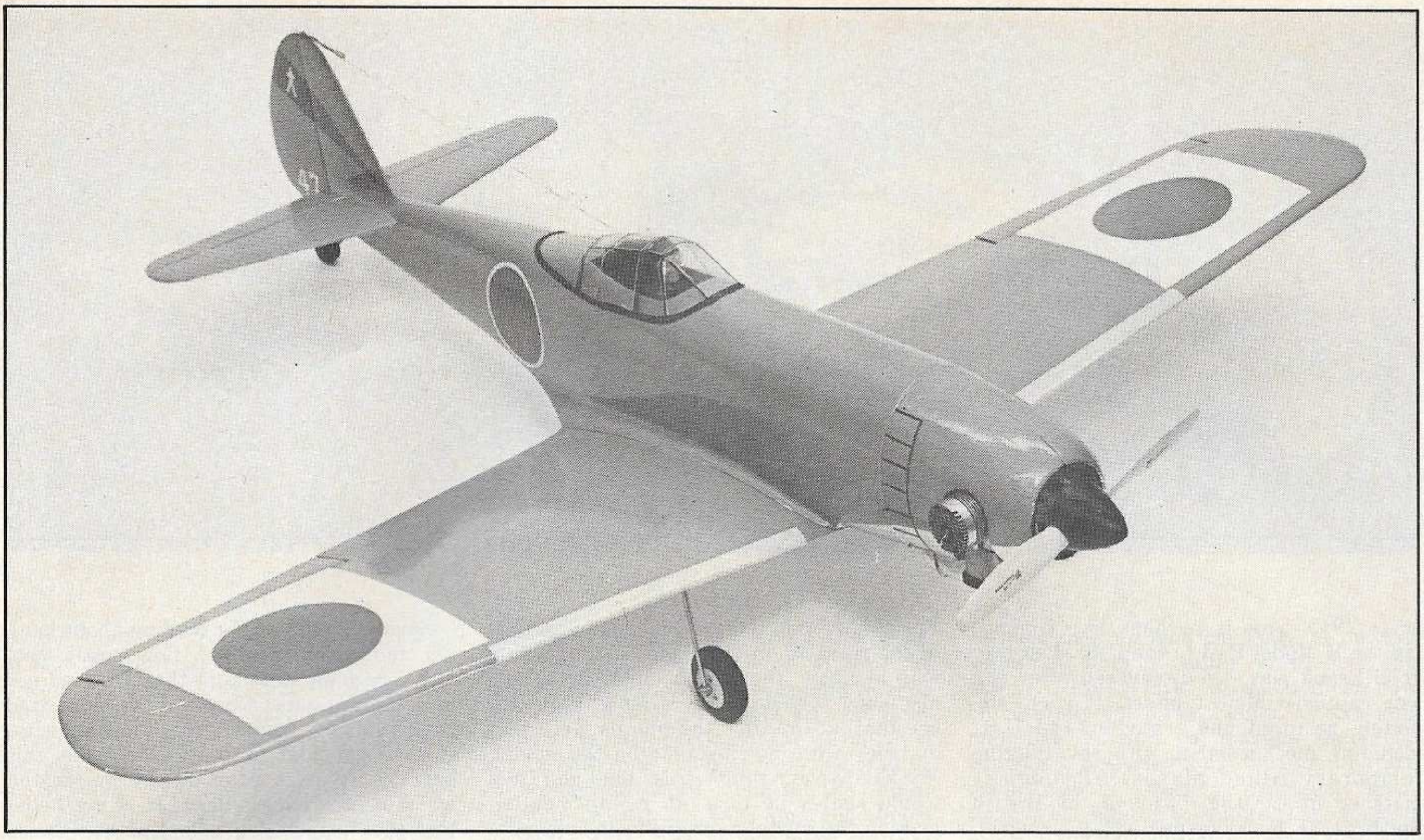


PHOTOGRAPHY: BRYCE PETERSEN

The Pacific Hurricane: Goldberg's Retracts, World Expert system and a Fox Eagle .60 motivate this Stand-Off Scale.

Nakajima KI-84-1a Hayate

by C. S. Hines

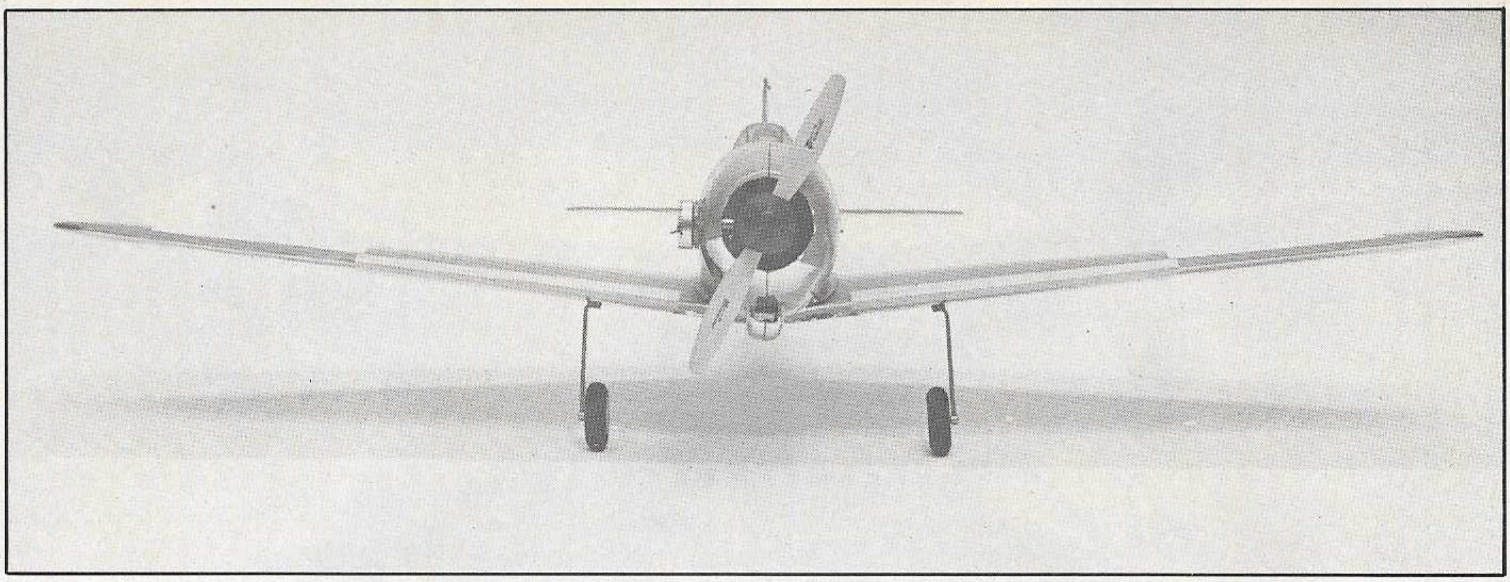
Violent action names seem to have been appropriate for World War II fighter aircraft. Names like "Thunderbolt," "Lightning," "Typhoon," and "Hurricane" all were famous names given to excellent aircraft as we all know. What you may not realize is that these names were assigned to aircraft on both sides. For instance, the successor to the famous Japanese Navy Air Force Zero was the Mitsubishi J2M3 Raiden (Thunderbolt); the Macchi-Castoldi 202 Folgore (Lightning) was an Italian fighter interceptor; and the Japanese Army Air Force B-29 interceptor was the Nakajima KI-84-1a Hayate (Hurricane). These are just a few examples of the same names being applied by both the Allies and the Axis Forces to their fighter planes.

As in any period of accelerated development, such as wartime, no one side retains superiority in any category of weapon for very long. This was particularly true of fighter planes which evolved from biplanes to jets during World War II, in a period of scarcely more than six years. Having lived through that particular period of our history, I would not, at that time, have admitted what later research appears to confirm regarding comparison of Japanese and U.S. aircraft. I think we must admit now that in the Pacific Theatre, the overall performance of the best Japanese fighter aircraft were never equaled by their contemporary Allied planes although ours could take more punishment and, in the beginning at least, offered more protection for their pilots. A further analysis also shows that the full potential of Japanese fighter aircraft was seldom demonstrated in the latter part of the war due to the poor training given pilots prior to combat. They were further plagued with engine manufacturing problems created by our bombing of their facilities. For instance, neither the K1-61 Tony nor the J2M3 Jack reached either their production or performance potential due to engine development and other manufacturing problems, although both are now admitted to have been excellent aircraft.

It appears to have been more common for Japanese aircraft manufacturers to build both the engine and airframe in contrast to the U.S. practice of largely independent engine and airframe development and manufacturing facilities. However, like the USAF and the U.S. Navy, the Japanese Army Air Force and the Japanese Navy Air Force each had their own favorite manufacturers. Due to the predominantly Naval war in the Pacific, we became more familiar with JNAF planes like the Zero and tend to forget that the JAAF existed as a parallel but separate military organization. Notice I did not say "equal" for the Navy was able to get more than its share of the budget for its far-flung operations while the Army was limited to a few large offshore bases and the defense of the homeland.

While the air war in the Pacific was ultimately won by our overwhelming superiority of numbers, it may also have been affected by a difference in the cultural philosophy of the major combatants. Stated in the most simple terms, the Japanese soldier and airmen were taught that to die in battle was glorious but the GI was taught that to survive and fight again was the name of the game. This meant that the Japanese pilots stayed in a combat unit until he was killed or unable to fly. Undoubtedly, some of their most skilled fliers were shot down as a result of fatigue by less experienced, but fresh Allied pilots. Our policy was to rotate experienced men from combat to training status so that our replacement pilots were far better prepared than their Japanese counterparts.

The Pacific Hurricane, Nakajima KI-84 Hayate was given the Allied code name of "Frank," It is a Japanese Army Air Force plane and, like the A2M6 Zero of the Navy, it was one of the success stories of the Japanese consolidated manufacturing approach. While it never reached the production numbers or the reputation of the Zero, it was a far superior airplane. Keep in mind, however, that it was developed in 1943 and first reached combat units in 1944, whereas the Navy Zero was developed pri-



or to 1940. This is perhaps like comparing the H Model P-51 to the P-40. Just how good Frank was, we discovered after one was captured almost intact. It was completely restored and tested in the U.S., including mock combat with several contemporary Allied planes. Although it matched in size the P-51 and the British Spitfire (37 ft. wingspan, 32 ft. length), it outclimbed and outmaneuvered both as it also did when matched against the Thunderbolt. Frank was not a flying coffin as we referred to the Zero, since it had self-sealing fuel tanks and armor plate behind the pilot comparable to U.S. standards for the time.

For the statistical buff, it weighed approximately 2½ tons and was powered by an Ha-45 Homare engine, also built by Nakajima, which was capable of producing nearly 2,000 horsepower. In this respect, it equaled the Pratt and Whitney R-2800 engine used in the Corsair and many other U.S. planes. This engine was very tightly cowled behind a large spinner and was attached to a slim fuselage. Its sleek lines caught my eye and the more I read about it and examined the statistics for the Frank, the more determined I became to build a model to see if I could simulate the performance of the original.

I'm pleased to say that even my most optimistic hopes were met, if not exceeded. One thing that will strike you in looking at the plans or the photos is the relatively small stab and elevators and the seemingly too small ailerons. (Note: For appearance only, the plans show the stab ten percent larger than the actual model as built.) While on the subject of appearance, you will see a very large dihedral is used which duplicates the original in this respect. This makes for a very stable plane but one that is, nevertheless, also very maneuverable. On the other hand, the rudder area is quite large enabling one to duplicate most pattern maneuvers, if you so desire.

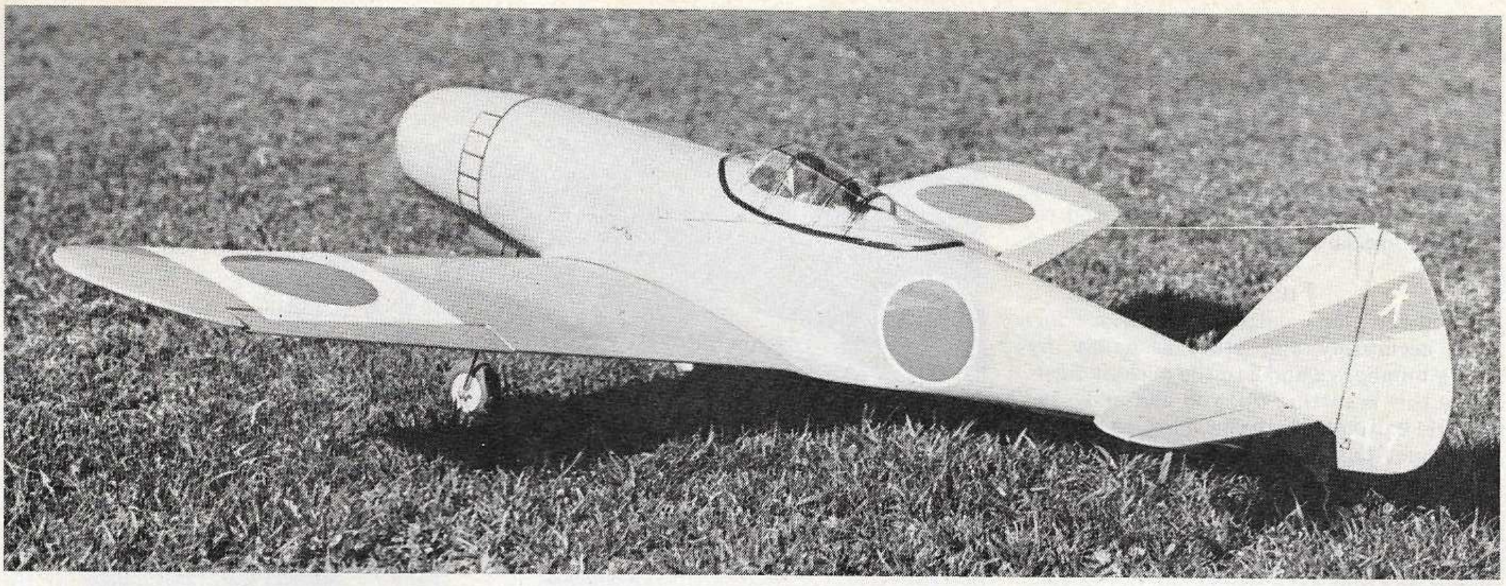
My preference for scale is approximately one and one-half inches to the foot so that commercial decals and pilot are available as are instruments and a canopy. A Royal Oscar, Jr. canopy will do just fine as the K1-43 Oscar was a predecessor of the Frank. The retract gear used is Goldberg although any other will do very well. For this reason, I have not shown details of the retracts on the plans but, for a fine ship like this, they are a must. The plans also show wheel covers although you will see that, at the time the photos were taken, they were not installed on the model. We have a very rough grass field and they would simply be torn off, not to mention making the model more difficult to handle on the ground. It is controlled with a World seven channel Expert series radio and power is provided by a Fox Eagle .60 swinging an 11x7½ propeller which gives it spectacular performance. For me, a Sport Scale plane is supposed to fly and this one certainly does.

I believe that a model of a fighter plane should have lots of power. The finished model weighs 6 pounds and, with the .60 up front, gives it a power to weight ratio of about 5 pounds per horsepower, compared to 3 pounds per horsepower for the full-size plane. Since the plane has adequate dihedral and an airfoil designed for stability, no washout is used or needed in the wing tips, making for simpler construction. This dihedral also allows the wings to provide some support during rolls since very little rudder or elevator correction seems to be required. You will also see from the plans that the wing airfoil is quite thin with the leading edge and forward portion relatively sharp at the fuselage, but becoming more rounded toward the tips. This gives great penetration and speed for very realistic fighter-like performance, without sacrificing quite docile landing speed, which is made possible due to a wing loading of only 22 ounces per square foot.

One of the things that perhaps prompts me to design my own planes more than anything else is the opportunity to test some newly developed theory or some new building technique. For those who have read earlier articles of mine, there are several pleasant surprises in this aircraft. The first and best is that it is a relatively simple and positively rugged construction for a design that has a lot of compound curves. A second is the use of the "fat" control surfaces giving smooth and highly efficient control with minimum movement. The "fat" (or laminar flow, as I call them) control surfaces are employed for ailerons, elevator, and rudder.

Somewhere in all my reading about laminar and turbulent flow, flow separation, etc., I recall a statement that air does not like to jump gaps. Once air has separated from a surface, particularly at low velocity, it does not like to reattach. When this happens, there is a turbulent area created which causes excess drag. It is my belief that this happens on model aircraft more so than on full-sized aircraft. When it does, any control surfaces lying in this disturbed air are ineffective until considerable deflection has occurred. To overcome this effect, some designers use tape or other devices to cover the control surface gap. This results in dramatic control improvement in most cases. The benefit comes from retaining attached flow over the control surfaces rather than from blocking any theoretical "leakage" through the gap. What I believe actually happens without such covers is that the air leaving the wing separates at the (aileron) gap and the control surfaces are left in turbulent air. When moved far enough to intercept smooth air, controls then become effective from the "push" on one side but get no "lift," due to the turbulent air, on the other side. A better solution than tape which can be used on one side only is to construct the control surfaces so that they are thicker than the wing (stab or fin) is at the hinge line. Using the ailerons as an example, the wing is about 3/8" thick at this point, so ½" aileron stock is about right. The control surface stock should be approximately 50 percent thicker than the airfoil is at the hinge line. When this is carved into a symmetrical shape, the control surfaces will constantly intercept the air crossing the gap on both top and bottom. This will cause the air flow to reattach and eliminate the turbulent air zone with its attendant drag. Movement of the controls is most effective since there now is both "push" and "lift" generated when they are moved.

One caution should be noted here. If you do not use this type of control, you may be very disappointed in the performance of this plane, since the sizing of all the controls is based on the efficiency of this theory. You may feel that these control surfaces would appear unattractive. However, in the finished model, they are not noticeable unless someone points it out.



On the ailerons, taper at each end slightly so that they appear to flow into the airfoil without an unsightly offset. Please be assured that this theory is no pipe dream, but is based on experience with several planes, including a pattern plane, which is super smooth and very fast. I believe that this is in part due to the fact that the profile drag of the "fat" controls is less than the induced drag of the conventional control surfaces where the previously mentioned turbulence and cavitation appears to take place.

As in the case with most articles like this the Hayate is not intended for the beginner and I will not go into a step-by-step how-to-built-it text. There are some hints that may make construction more enjoyable but any competent builder could work from the plans and photos without any significant trouble.

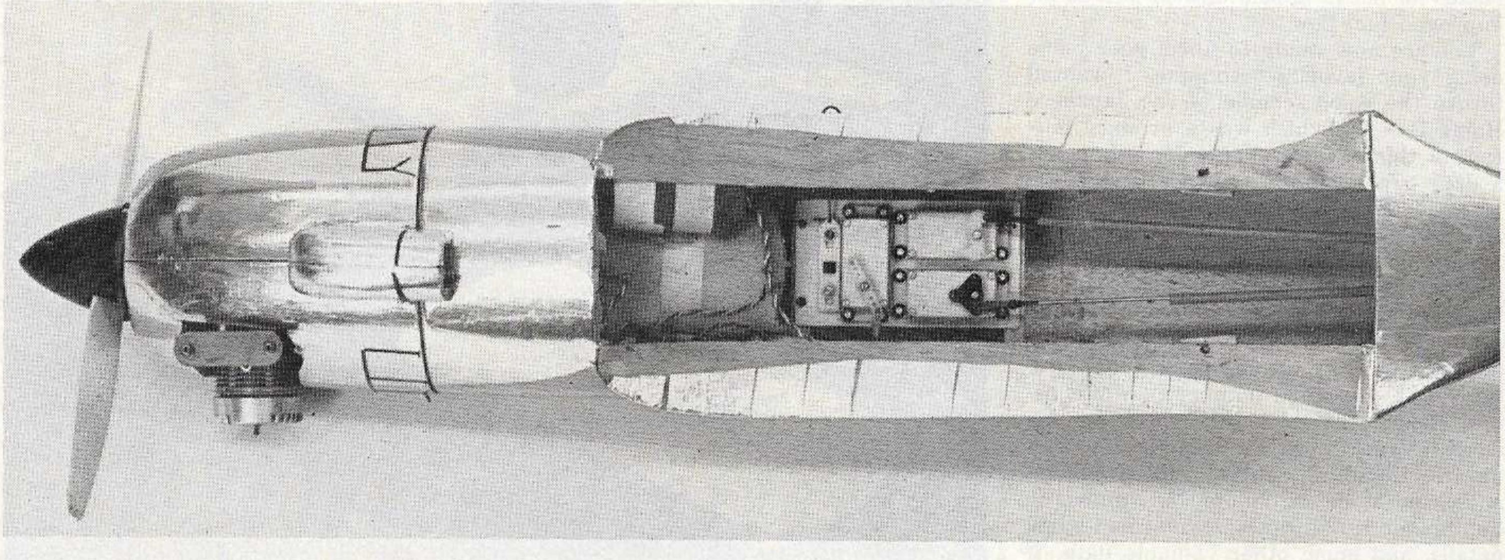
Wing Construction

Foam wings are so easy to build and sturdy that they were used. I find that using female templates are easier for me when hot wire cutting foam. They extend well beyond the desired wing core and allow one a decent start and finish platform for the wire. I have found that by starting my cut at the leading edge of the wings, while the wire is hotter, it will follow the greater curve of the leading edge without the center dragging, which would tend to spoil the airfoil. As the wire cools, go a bit slower over the back portion of the airfoil. Just before both ends emerge from the trailing edge, slow down a lot and let the center catch up so that the wire emerges almost straight. This may sound more difficult than it really is, but if you practice a little to get the right wire heat and speed of cut, you will be making nice foam cores in no time. While on the subject of foam cutting, I prepare a miter jig and also hot wire cut the root of these cores to the correct angle for dihedral. This is not only faster than sanding but is much more accurate.

The wing is covered with 1/16" balsa sheet after the landing gear is installed and the center dihedral braces are installed in one half and the sockets are made in the other. I prefer to cover the core on both sides first then sand the leading and trailing edges to get good straight lines. The leading and trailing edge stock is then glued to the wing and rough shaped. The wing tips are simply extensions of the sheet covering and are left hollow with a 1/8" spacer being fitted between the top and bottom sheets. The two wing panels can now be joined and you now have a completed wing except without ailerons. Now carefully lay out the aileron cut-outs by adding 1/4" on each end and 3/8" to the width, this portion can now be carefully cut away (which always kills me). The 1/4" and 3/8" framing should be added to the wing and the ailerons are made from 1/2" stock as previously mentioned. The aileron torque rods are formed of 1/8" dia. music wire in a plastic tube and are laid in a trough cut through the top of the wing skin and into the foam. If done carefully, the skin can be replaced over the imbedded torque tube. Shape and sand everything until smooth and pleasing to the eye and then you are ready to install your "fat" ailerons.

Retract Gear

If you have decided to install retracts, and I hope you have, you may wish to try this technique. In order to obtain the advantage of the gear being well forward when extended for greater ground stability, and yet retract into the wing behind the leading edge, the retract gear must be set at an angle. The main body of the Goldberg retracts may be set to about 15° toe-in and the same amount of nose-up. This combination throws the leg forward when the gear goes down. The wheels are set true in this position so that the model



From front to back: A sturdy spinner for electric starts, 11-7½ prop on a Fox Eagle .60, lots of power for the 6 lb. bird. Tank, battery pack and receiver, split cowl and oil coolers, servos, pushrods. Chrome MonoKote on bottom, slice to negotiate filleting. **Above**: Warm up for take-off.

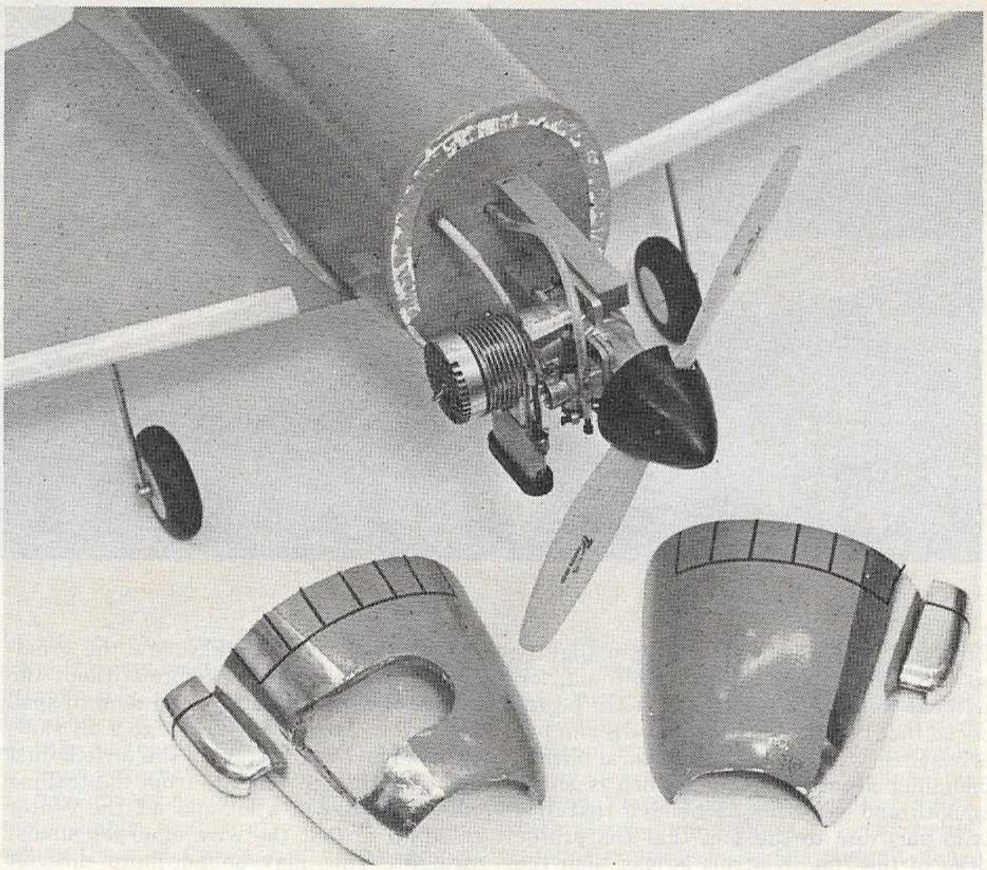
tracks easily. In the retracted position, the wheels lie slightly tipped up toward the front allowing them to conform very closely to the bottom surface of the wing which, at this point, is also curving upward toward the leading edge. The small angle does not affect the operation of the retracts making them very smooth and realistic in appearance.

Fuselage

From the plans, cut out the various formers accurately and start assembly by fitting numbers 2 and 3 to the cockpit floor. While this is setting up, you can add 3/4" triangle balsa pieces to the sides, as shown. All former positions should be marked as accurately as possible on the inside of each piece because this will determine how straight the fuselage will be. Dampen the 3/16" sides on the outside only with a wet sponge and glue each accurately to the subassembly made previously. From here on, work forward to the firewall, which has been precut and predrilled, then the tail can be pulled together, at which time a check for straightness should be made. There are only one or two more hints in the construction of this basic plant fuselage. First, add all the planking top, bottom, and shoulders, except for the bottom plank and the rear, which is left open until the pushrods have all been installed. Note that the lower front plank is glued to the *front* of former 1-A, not to the outside edge, as in all the other cases. This is so the wing dowels are well seated in this former. Epoxy the 1/32" ply wing fillet seat in place and then add the rear bottom plank. Do not carve the bottom edges round until after the wing fillets are completely roughed in. Otherwise you will have much more filling to do than is necessary.

At this point, fit the wing to the fuselage and block up the assembly for about 1/8" positive angle of attack, then check and mark the centerline for the stab. Make the cut-outs for the stab and install it so that, when viewed from the rear, it is parallel to the wing. Add the vertical stab, then carve and sand everything to final shape. Build the cowling and oil cooler in two halves, split vertically, but doweled together and screwed to the firewall prior to final shaping. The side mounted engine makes for better appearance as well as for improved fuel flow.

You are now ready to finish your plane using your favorite technique. I wanted to use the color scheme of the Japanese Home Defense which was a primary mission of this aircraft. The color scheme is a dark green on top with natural metal (chrome MonoKote) underneath. The yellow leading edge bar indicates Home Defense, and the red meatballs (Hinomaru) are set on which squares on the wing and have a white border on the fuselage. The green lightning strike on the fin and rudder was used by an unknown Senti with the JAAF unit code number in white below. References used in research on this aircraft were Aero Publishers, Inc. Volume 3, Revell, Inc., 1/72" Plastic Model, and Scale Modeler, Volume 7, Number 9, September 1972 for colors, rivet and panel details, and much other valuable data. If you are just going to use the plane for fun flying, those details don't count. But, if you want to get extra static points in competition sport scale, you will no doubt wish to add the dummy exhaust stacks, wheel covers, and other details shown on the drawings and in reliable references.



Side mounted engine on hardwood mounts. Fuel line, cowl halves and cut-out for engine is visible. **Beneath:** Stan chose yellow home defense markings, camouflaged top, Kraft wheels, Du Bro muffler.

While a .60 engine was used on the prototype, power could be anything from a very good .40 up to a .60 because at 6 pounds this is a very clean ship which is both fast when going flat out and docile when slowed down for a landing. Like any well-powered tail-dragger, you will find it will require some right rudder as you open the throttle for take-off. The balance and moments are very good, however, and it has no bad ground handling tendencies.

As stated earlier, I have designed a number of airplanes, each of which has explored some new interest. I believe, however, that this design combines the best in ease of construction with realistic appearance and superb performance. When you build this project, I hope you will find it as pleasing and rewarding as I have.