Part I • Roy Clough's
1954 "Anti-Grav" Martian Spaceship
Redesigned for Radio Control

BY SKIP RUFF

Mr. & Mrs. Martian Space Ship (he's wearing the pants). Earlier (heavier) model on right was covered with chrome MonoKote. Newest (lighter) model covered with silver Micafilm.

Designer Skip, with dad, Gordon (right), portray actual size of model. The two white "Cubs" are styrofoam test models. One is mounted on "Piggy Back" rig on Sig Kadet, used for higher altitude "glide" tests.

Photo #1.

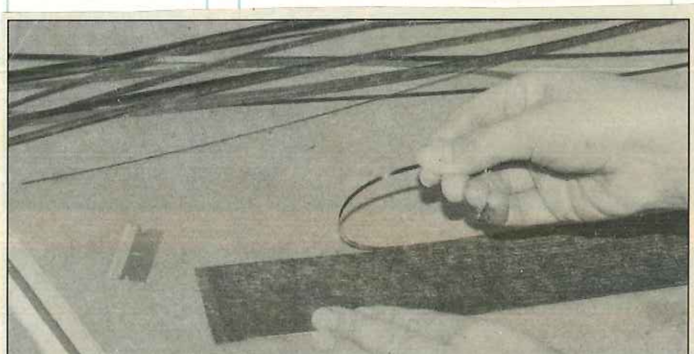
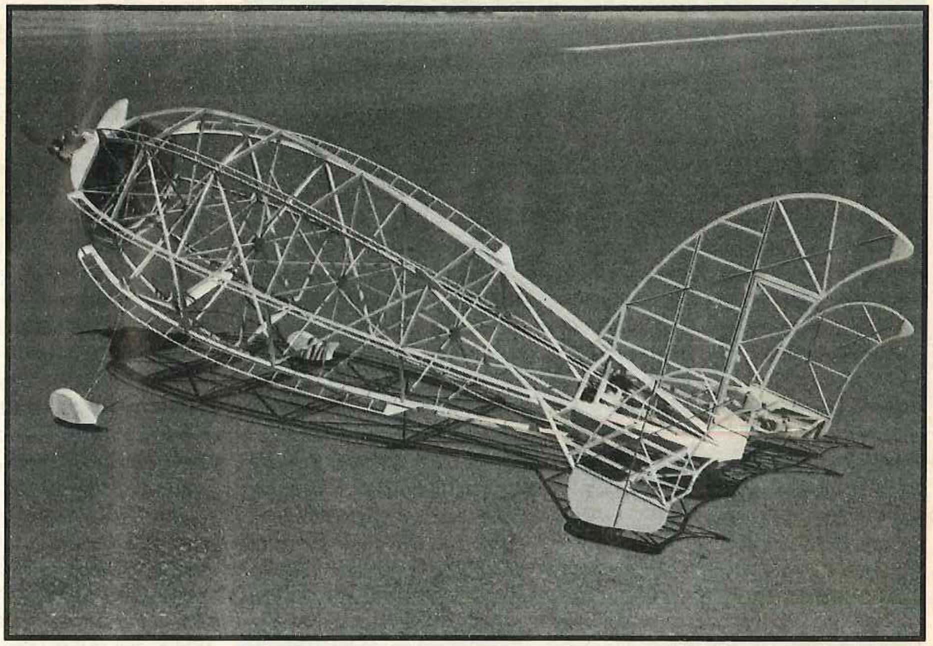
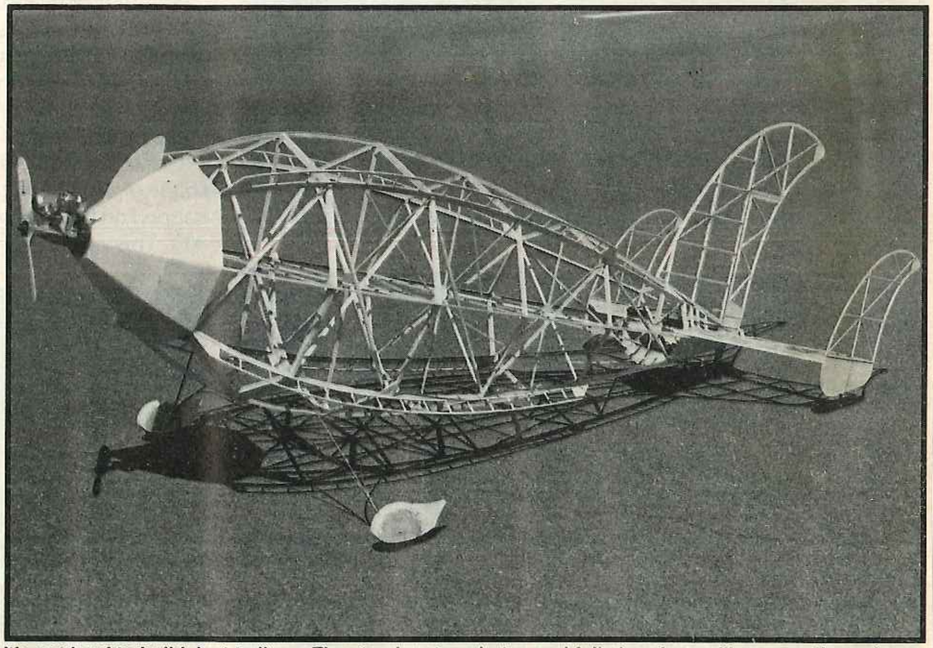


Photo #2.

Those of you who have been involved in the sport of model aviation for 20 or more years may remember the name of Roy L. Clough Jr. Between the years 1945-1968, Roy published no fewer than 70 articles on various types of models, including, but not limited to, helicopters, autogyros, flying saucers, lifting bodies, hovercraft, ducted fans, pressure jets, jetex turboprops, flying wings, slat wings, ring wings, radial wings, custer wings, tandem wings, and just about anything else you can imagine. His articles appeared in magazines such as *Model Airplane News, Flying Models, Air Trails, American Modeler, Popular Science, Popular Mechanics, Science & Mechanics, and Astounding Science Fiction.* A true genius, his designs were both innovative and highly unique, and to this day, you can still see the results of his pioneering work in the field of ducted fans and F/F helicopters, such as those marketed by Cox.





It's not hard to build, just tedious. The step-by-step photos and full size plans will see you through. No helium required!

Since childhood, I've admired and been fascinated by the wild and wacky models he has designed, especially the rotary-winged stuff and the ones with a science-fiction theme such as the "Venusian Scout," "Moon Scout," "Saturnian Space Skimmer," and the subject of this article, the "Martian Spaceship," which was originally published in the April 1954 issue of *Air Trails*magazine as a 30-inch long, 1/2A powered free flight. As is sometimes the case with an unorthodox design such as this, Roy did not initially set out to build a "Flash Gordon" type spaceship, but was actually trying to perfect a flying blimp that used no helium. After the many modifications necessary to get the thing to fly, it resembled a 1930's type spacecraft more than a blimp and Roy went ahead and published it as such.

I'm quite certain I'm not the first person to attempt an RC version of this er, uh, "aircraft" and, if memory serves me right, I remember seeing, in a later issue of *Air Trails*, a 1-1/2 size version with a single-channel escapement radio for control. It was a static photo and flight test results were not available. I also have it on very good authority, if you can believe this, that someone actually built a man-carrying version powered by a 65 hp. Continental. Again, test results are unavailable, although I have a pretty good idea of what happened if someone actually strapped himself in and tried to fly it!

Not to change the subject, but you might be interested to know that another of Roy's designs was very successfully adapted to RC by Fran McElwee and was featured in a construction article entitled "Super Saucer #5" in the April 1973 issue of *Model Airplane News*.

Anyway, in regard to my version of the Spaceship, I was finally motivated into action (after having it for years in the back of my mind as a future project) by a sketch of it as the "Mystery Model" in the April 1988 "Free Flight" column of this magazine, and by the statement a certain Editor/Publisher (who shall remain anonymous to spare him further embarrassment!) that this model could NOT be adapted to RC! *(Whoopee! The trick worked!-"A certain Editor/Publisher")*

Being somewhat skeptical of the lifting ability of such a configuration, I decided that to fly properly as an RC ship, the model would have to be larger, built light and use a lightweight radio system. I constructed a double-size version following the original shape as closely as possible and made modifications only to allow the use of a landing gear (the 1/2A original had none) and the control system utilizing throttle, rudder and elevator.

To say the first flight was exciting is an understatement! As soon as the wheels left the ground the ship rolled violently to the left. For a split second I thought torque was the culprit and that my brand new creation was going to roll inverted and auger in! After reaching about 90 degrees of left bank, the roll suddenly reversed to the right until the model was at 90 degrees on its right side, then went to the left again and so forth, left, right, left, etc., swinging rapidly through a 180-degree arc while gradually climbing. I was able to make (I still can't quite remember exactly how!) a slow circuit of the field and get the thing pointed into the light breeze at about 100 feet of altitude. A reduction in power produced a gentle, near vertical, descent with the oscillation continuing until touchdown, whew!!

Obviously something was not quite right! Although much more rapidly, the model appeared to be doing a classic dutch-roll. After some experiments with a couple of small foam spaceship gliders, vertical stabilizer area was added in the form of tip fins glued onto the ends of the horizontal stabilizer. The next flight was much better, with only a slight oscillation. Next, the forward fin on the nose (which gave dihedral effect on the F/F) was cut down to a stub and this further improved the stability to the point where the model would only rock slightly in turbulence or by quick movement of the rudder. Evidently, the lowering of the center of gravity by the addition of a landing gear, made these modifications necessary. The small forward fin now serves only as a handle for use during starting procedures.

What makes it fly? Well, if you look at it from the side, you'll see that the fuselage is actually a symmetrically shaped wing with a very short span. With the addition of a tail for control and stability and strakes for efficiency (they reduce "spanwise" airflow) the model flies as either a flying wing with a tail, or as a lifting-body, depending on how you view things. Within certain limitations, the model is easy to fly and is definitely a show-stopper at the field.

CONSTRUCTION

Although not difficult to build, I would be less than honest if I didn't say that construction is somewhat tedious. Very light wood must be used to avoid excess weight and some of the structure is rather fragile, especially before covering, making care necessary when handling parts, such as the strakes. For maximum strength with minimum weight, carbon fiber is used in certain areas. Although this material could probably be eliminated by increasing some of the wood sizes or the addition of more structural members, such as bulkheads, you're on your own if you decide to do so. If you do decide to deviate from the instructions, make sure you keep it light and follow the basic outline.

You will notice that the plans (as is the model) are a bit different in detail and perspective than the norm. Because of the unique shape of the design and the construction method, I chose to provide a basic set of drawings from which to build, and tried to cover the details that would be hard to draw on paper with many photos and these instructions.

Construction begins with the making of a jig, cut to the curved shape of a main longeron, out of 1/8-inch corrugated cardboard and capped on the edge with 1/16x1/8-inch balsa for smoothness **(photo #1)**. This is covered with Saran Wrap, or equivalent, to keep the longerons from sticking to it during lamination.

The carbon fiber I used came in a sheet of .007-inch thickness, 4x72-inch, which provides more than enough for one model. It can be purchased from Aerospace Composites (P.O. Box 16621, Irvine, CA 92741; telephone (714) 250-1107). The needed strips can be ripped from the sheet by notching one end with a razor blade to the width needed (1/8-inch for the longerons) and pulling back along its length **(photo #2)**. Be careful of slivers when handling this stuff. If you wind up with a strip slightly undersize, that's fine. Lay the first carbon fiber strip over the jig and secure it with masking tape at its ends. Using slow CA (cyanoacrylate)+ accelerator, glue a 1/8-inch square balsa strip over the carbon fiber (a butt joint is okay on the 36-inch long balsa) followed by another 1/8-inch square piece (butt joined at a different location) over the first and then a top cap of carbon fiber. A 1/16x1/8-inch balsa cap strip will eventually be glued on the outer portion of each longeron, for the covering to adhere to, during a later stage of construction. Make eight longerons, noting that three of them, which go on the top of the fuselage, are shorter than the other five **(note photo #3)**. Make each longeron a little longer than needed to insure adequate length. They can be trimmed later. Now is a good time to mark the position of each bulkhead on the longerons with a pen or pencil, to aid later assembly.

The bulkheads F-2 through F-8 are constructed in two halves, a top and bottom. The differences between the halves are noted on the plans and should be apparent in **photo #3**. Where appropriate, the bulkheads' outer crosspieces are slightly oversize so that they can be beveled down later to conform to the curve of the fuselage. There is only one half to F-9, the bottom.

Assembly of the fuselage, which is constructed in the "half shell" method, starts with the bottom half. Begin by pinning down two of the long longerons to the plans on a flat building surface **(photo #4)**. Next, the bottom halves of bulkheads F-2 through F-9 are glued to the longerons, taking care to insure they are perpendicular to the building surface **(photo #5)**. The 1/8-inch square balsawood diago-

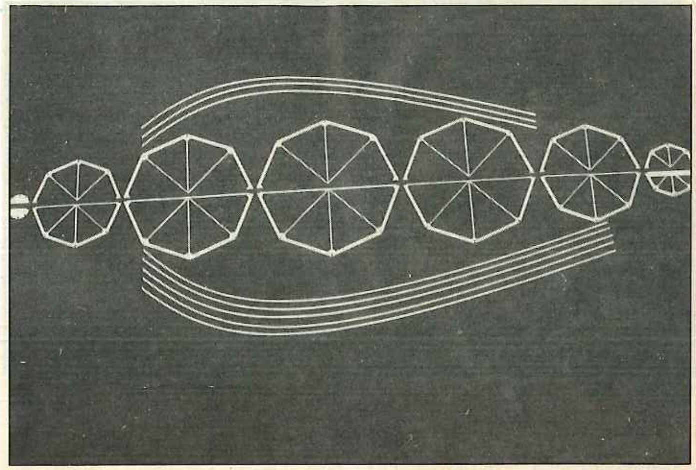
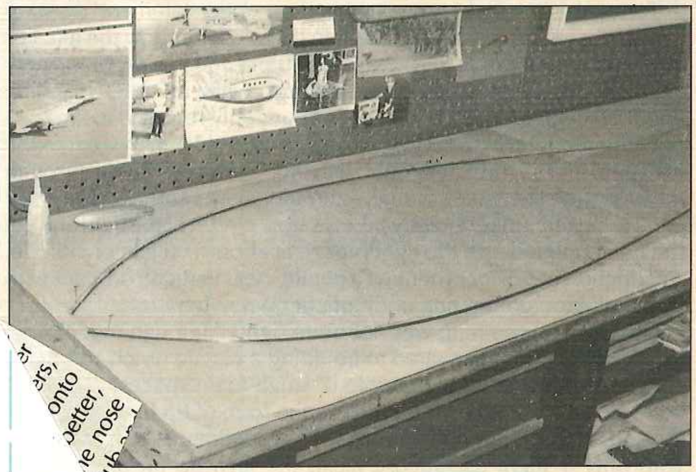


Photo #3.



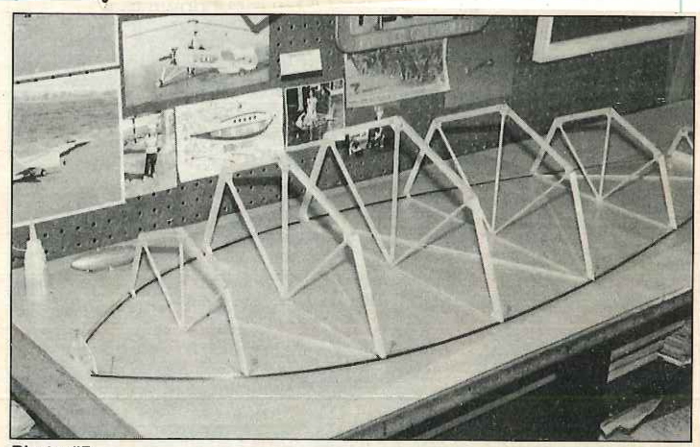


Photo #5.

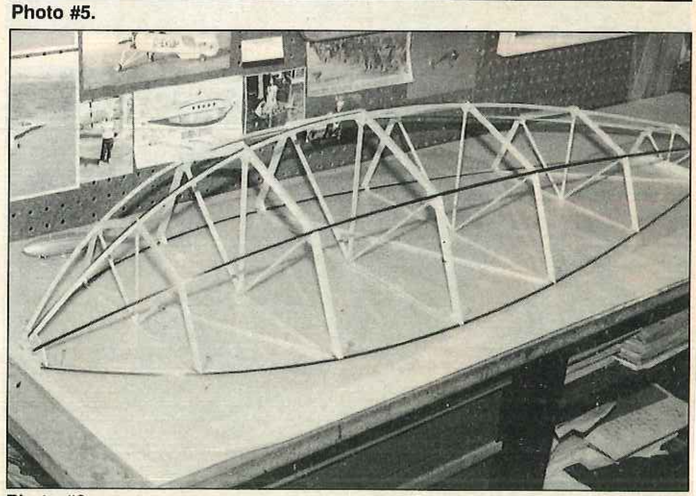


Photo #6.

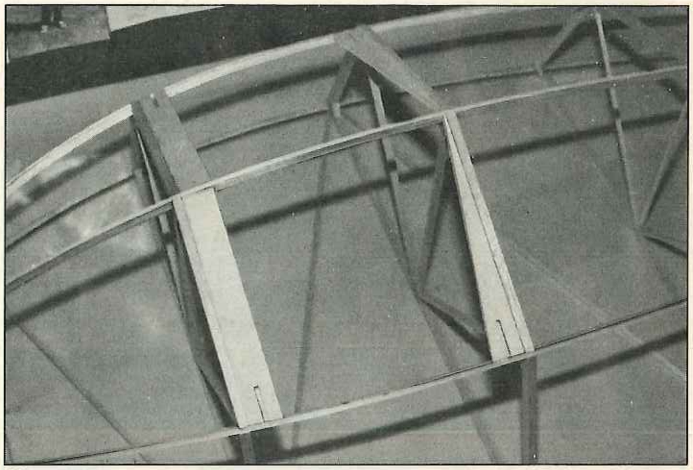


Photo #7.

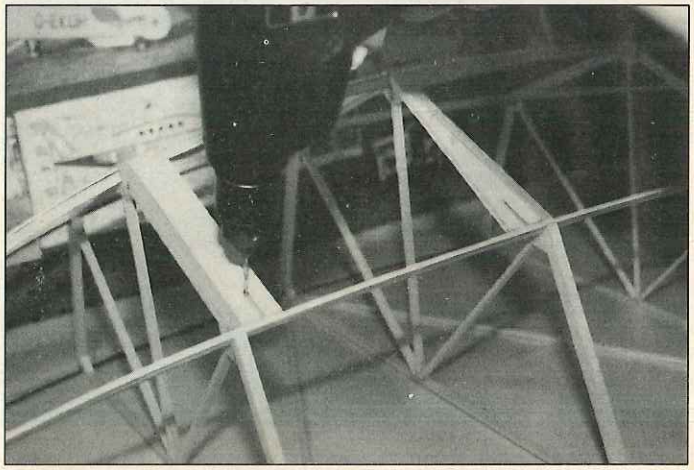


Photo #8.

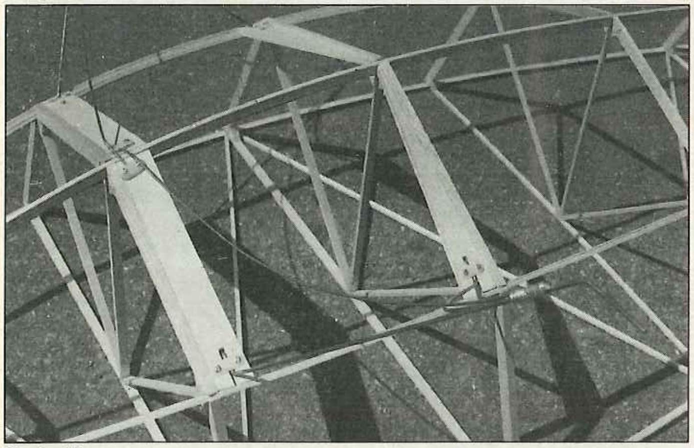


Photo #9.

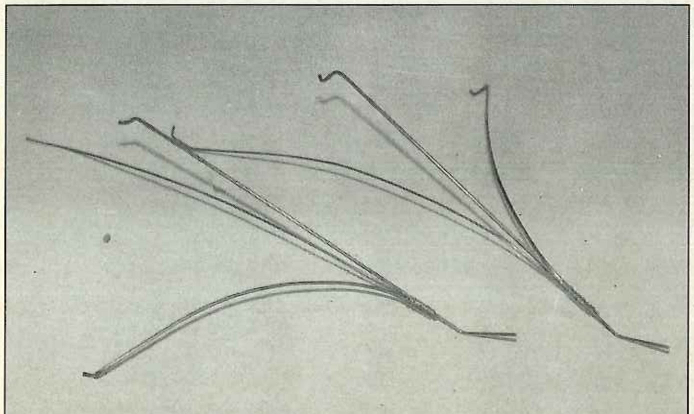


Photo #10.

nals are added next from bulkheads F-3 to F-8 **(photo #5)**, followed by the other three long longerons, which are being fitted into the slots in the bulkheads and glued in place **(photo #6)**. With everything still secured to the building board, carefully sand and bevel bulkheads F-3 and F-8, around the area of the three bottom longerons, so that they are flush with the carbon fiber outer surface of the longerons. Next, cap the three bottom longerons with 1/16x1/8-inch balsa from bulkheads F-3 to F-8. The cap strips should extend up to, but not over, F-3 and F-8, as 1/16-inch balsa sheeting will later overlap these bulkheads.

Next, the landing gear mounts are made out of 1/8-inch Lite-Ply. You will need four pieces of each one shown on the plans, two of each with slots and two without. Laminate the pieces together with CA or epoxy, a slotted piece with a solid one, which will give you four pieces (two front and two rear) 1/4-inch thick. Make sure you've made a left and right of each. Bevel the edges of these pieces as necessary until they fit into their respective places, slot side out, against bulkheads F-4 and F-5 and flush with the capstrips on the bottom longerons **(photo #7)**. Glue these in place securely and then drill a 3/32-inch hole in the inside end of each slot **(photo #8)** and a 1/16-inch hole on the two front mounts, as indicated on the plans. These holes help secure the ends of each gear wire leg.

Now is the best time to construct the landing gear. Again because of the unusual shape and many odd angles involved, I haven't shown the gear legs full size on the plans. Instead, you'll find a sketch and dimensions on the plans along with the photos and instructions to guide you. The fuselage should remain secured to a flat surface, as each leg is built "on the model" and measurements are taken from the building surface to assure correct and equal spacing of the gear legs. Each leg consists of a tripod formed from three pieces of music wire which are held to the fuselage with nylon straps and wood screws, and are wrapped with fine copper wire and soldered together at the wheel end.

The straight piece of 3/32-inch wire, which forms the axle and extends from the forward outside corner of the fuselage is ten inches long (true length) from the bend at the slot in the plywood mount to the bend at the axle. When making the bends for the plywood mount slots in the outer 3/32-inch wires, allow about 1/4-inch clearance between the wires and the longeron **(photo #11)**. This will keep the gear from flexing out far enough to strike the lower strakes on a hard landing. Note that 1/16-inch inner wires cross over at the center and that the rear 3/32-inch wire and inner 1/16-inch wires are both curved to provide a measure of shock absorbing **(photos #9 and #10)**. The amount of curve is not critical; if it looks about like what you see in the photo, that's fine. Be prepared to do a bit of twisting and re-bending to finally get things where you want them, and try to include a little toe-in and camber in the axles for good ground handling. The ends of the wires can be held together temporarily at the solder location with masking tape until everything looks good, and then wrapped and soldered. When removed from the fuselage, they should look like what you see in **photo #10**. The wheels used are Dave Brown 2-1/4 inch LECTRA-LITE units which, to the best of my knowledge, are the lightest wheels on the market.

With the gear legs off, remove the fuselage bottom half from the building surface and mount it upright on eight or more objects (cans?) of equal height and, again, on a **flat** surface **(photo #11)**. Apply weights to the side longerons, if needed, to keep them flat and level. It needs to be just high enough to allow the bottom longeron to clear the building surface. (Note **photo #11** shows the rear section of the lower fuselage already sheeted. This should NOT be done at this time. It will be covered later.) Now glue on the upper halves of the bulkheads F-2 through F-8 and the top three longerons as described earlier **(photo #12)**. You will also note that in **photo #12**, 3/16-inch balsa diagonals have been added for rigidity and this is further clarified in the side view in **photo #13**. Notice the cross diagonals between bulkheads F-4 and F-5 and the 1/4-inch balsa gussets at the lower ends of the X diagonals that reinforce the longeron/bulkhead/L.G. mount for landing stresses. Bulkheads F-3 through F-8 can be capped front and rear at their center section, or hub, with 1-inch diameter 1/64-inch ply plates, for strength.

At this point, the longeron ends can be trimmed flush with bulkheads F-2, F-8 (top) and F-9, and the firewall, F-1, can be epoxied onto the face of F-2. Sand and bevel the rest of the outer edges of F-1, F-2, F-3, F-9, and the bottom of F-8, until they're flush with the carbon fiber surface of the longerons. Apply the rest of the 1/16x1/8-inch balsa cap strips over the appropriate areas on the remaining longerons as described before, except that the top three go all the way to the rear end of the longerons, where the ends are trimmed flush with bulkhead F-8. The rest of the bulkheads can now be sanded down flush with the cap strips.

The motor mount of your choice (although a glass mount is shown, I recommend aluminum for vibration resistance and nose weight, which you'll probably need) can now be affixed to the firewall with either bolts and blind nuts or large sheet metal screws, which seem to work fine for me. This is shown in **photo #14** along with the fuel tank installation. The four-ounce Sullivan slant-style tank sits on a 1/8-inch balsa plate which is glued to the bottom of the side longerons and is surrounded by 1/4-inch foam and a 1/16-inch balsa box. The very front of the tank, around the stopper, is siliconed to the top longeron. Make sure the tank doesn't leak, as it is inaccessible once the forward 1/16-inch balsa sheeting is added later.

Install the throttle linkage at this time. As the throttle servo, along with the rest of the radio, is in the tail section, this requires a very long piece of the .032 cable size Sullivan Golden Rod that I used. The longest length available to me was 36 inches, so the difference was made up with a 3/16-inch balsa pushrod that connects the aft end of the cable to the servo **(photo #15)**. As the thin cable is very flexible, secure the nylon outer sheath to every bulkhead it crosses with silicon RTV or CA to prevent unwanted flexing and erratic throttle control. **Photo #15** also shows the curved piece of nyrod in which the receiver antenna is housed.

Sheet the front of the fuselage from F-3 forward with 1/16-inch balsa, the grain running vertically. Depending on the engine you use, you may have to provide a recess in the sheeting for muffler clearance. As far as engines go, I found the O.S. .25 FP to give excellent results. It is light (non-ball bearing) and with 25% nitro fuel and a 9x4 wooden prop, provides near vertical performance, albeit at a slow rate of speed! I would guess that the new K&B .28 Sportster would also be an excellent choice. A good .20 would fly it fine, with limited performance for climb and loops, but I do not recommend anything over a .28 or a 4-stroke. The lightweight airframe (especially the tail section) may not take the vibration or extra speed in a dive.

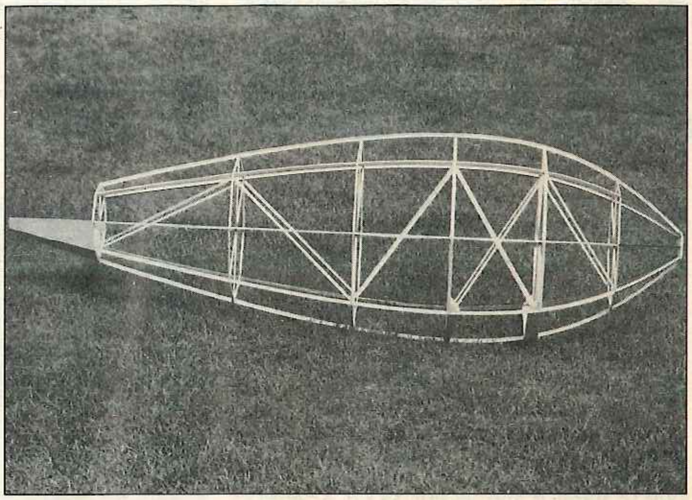


Photo #13.

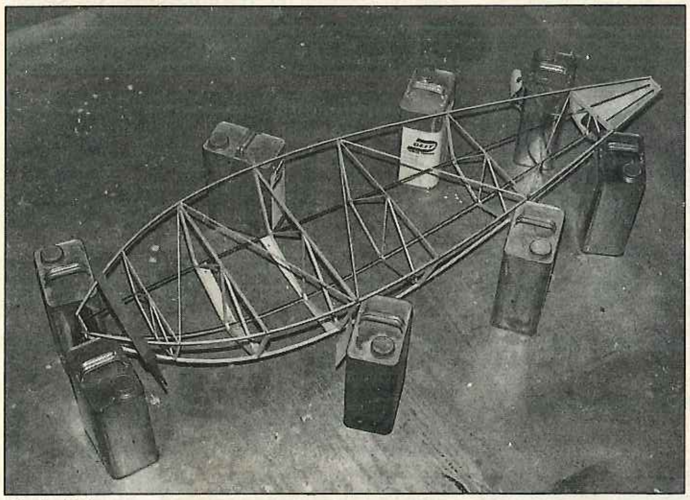


Photo #11.

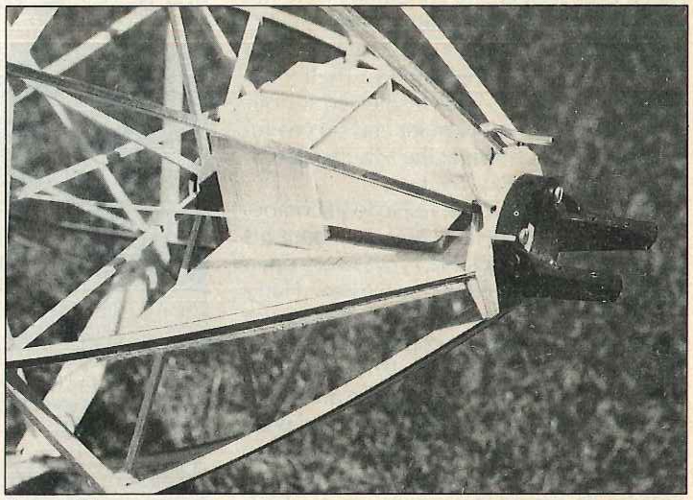


Photo #14.

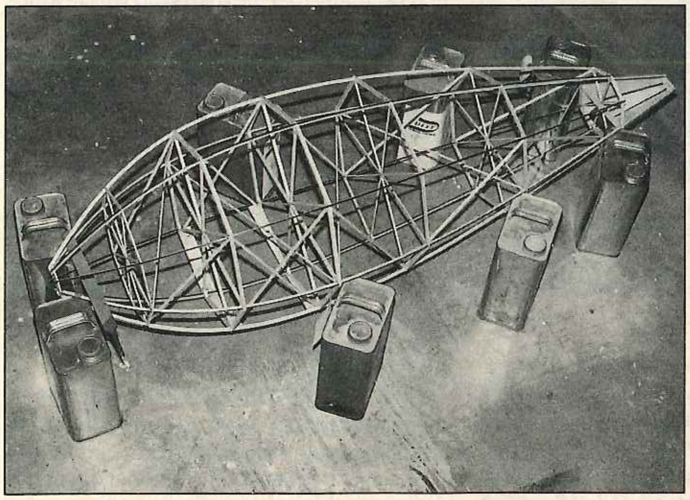


Photo #12.

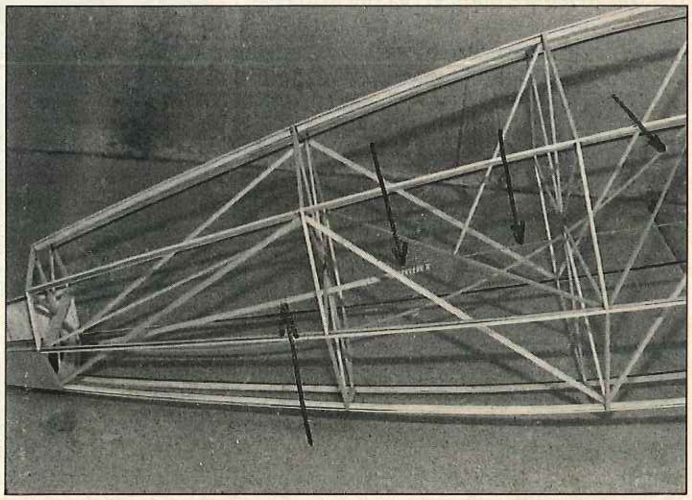


Photo #15.

Part II • Roy Clough's 1954 "Anti-Grav" Martian Spaceship Redesigned for Radio Control

BY SKIP RUFF

This is a continuation of the Martian Spaceship construction; Part I appeared in the August 1991 issue of Model Builder.

We can start on the tail surfaces next, and these are of fairly conventional (for a spaceship!) construction **(photos #16 and #17)**. The connecting wire for the two elevator halves is 3/32-inch with an outer sheath of aluminum or brass tubing. Notice how the rear spar for the vertical stab is notched for clearance over it. The 1/16-inch tailwheel wire also has an outer sheath of brass tubing that extends down about 1/4-inch below the bottom of R-1. A washer is soldered onto the bottom end of the tubing to prevent rubber bands, which hook over it to secure the tail section to the fuselage, from slipping off. A washer should be soldered on the tailwheel wire as shown on the plans to transmit the landing loads to the brass tubing and not to the rudder assembly. After the tail surfaces are removed from the plans, they can be sanded with the leading edges rounded and the trailing edges of the control surfaces and rear tip of the vertical stab sanded down to 1/8-inch thickness. Then, 1/16-inch wide C.F. strips are CA'd on both sides of the surfaces as shown in the plans and **photos #16 and #17.**

The previously mentioned brass and aluminum tubing can now be glued to the horizontal and vertical stabs as shown on the plans. Next, glue the vertical stab to the horizontal stab **(photo #19)** using a right angle to insure a 90-degree joint. Cut grooves in the forward edges of R-1, E-1 and E-2 to provide clearance for the tubing, and CA these in place **(photo #19)**, being careful not to get any glue on the music wire itself or allow it to wick between the wire and tubing. Fit the tail assembly on the rear of the fuselage (which should still not yet be sheeted). With the forward vertical and horizontal stab spars lined up with and firmly against bulkhead F-8, and the rear vertical stab spar in line with, but not touching the bottom longerons, tack glue the tail assembly to the fuselage. There should be just enough clearance to slide bulkhead F-10 in place between F-9 and the rear stab spar. If not, shim or trim the spar until it fits. Glue F-10 to the rear vertical and horizontal stab spars and then cap both sides of the rear vertical stab spar and R-1 joint with 3/4-inch squares of 1/64-inch plywood. Next, drill two 1/8-inch holes, next to and on both sides of R-1, through F-10 and F-9. Slide two one-inch long pieces of 1/8-inch dowel, that are slightly pointed on the forward end, into these holes about halfway, and CA them securely to F-10 and the 1/64-inch plywood **(photo #20)**.

For the forward attachment points, CA one-inch long pieces of 1/8-inch dowel, again slightly pointed on the front end, onto 1/2-inch square hard balsa pieces end cut to 1/4-inch thickness, or 1/4-inch lite-ply squares. Reaching through the bottom of the radio compartment (now you know why I said not to sheet it yet!), slide the dowel ends forward through the 1/8-inch holes in the bulkhead F-8 and glue the 1/2-inch square end cuts or lite-ply onto the forward stab spar and 1/4-inch sheeting. You should now be able to cut through the tail section/fuselage tack glue joints and pull the tail assembly back and off the fuselage. Using plenty of CA and some light glass cloth, finish gluing the forward dowel assemblies to the horizontal stab **(photo #21)**.

You can now sheet the rear section of the fuselage (at last!) with light 1/16-inch balsa, with the grain, again, running vertically. If necessary, sand and bevel the top half of the bulkhead F-8 down to the level of the cap strips on the top longerons and the bottom sheeting.

Slide the tail section back on the fuselage and add the rest of the tail section superstructure **(photos #22, 23, and 24)**, extending the

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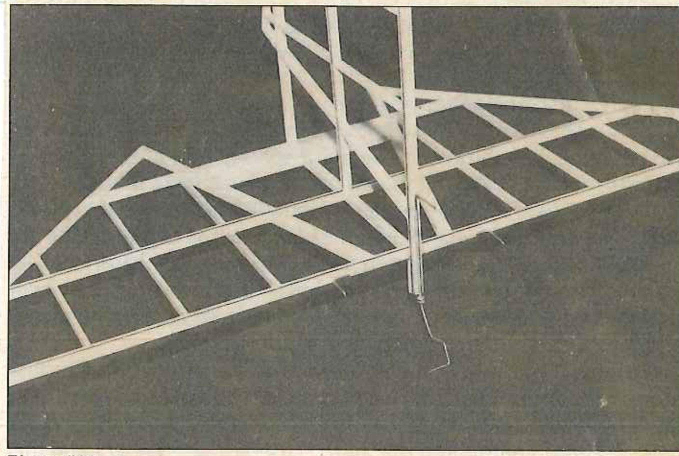


Photo #18

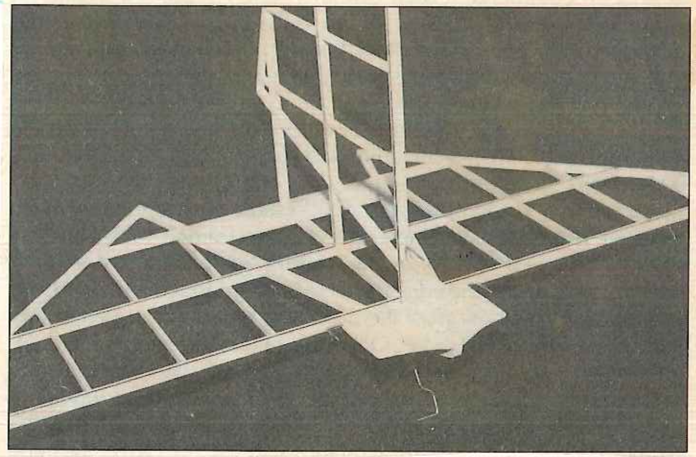


Photo #19

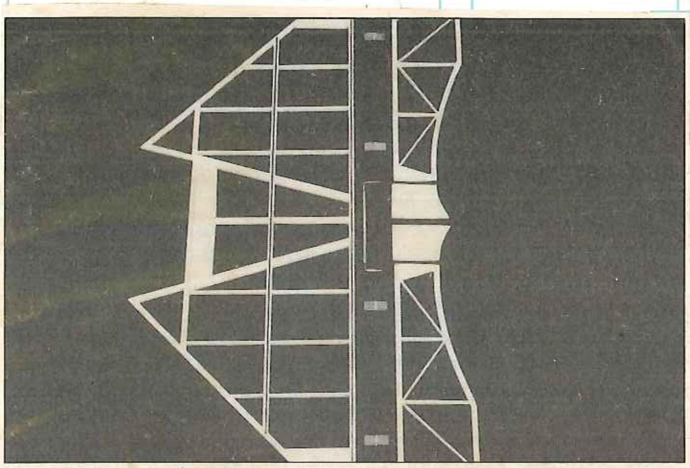
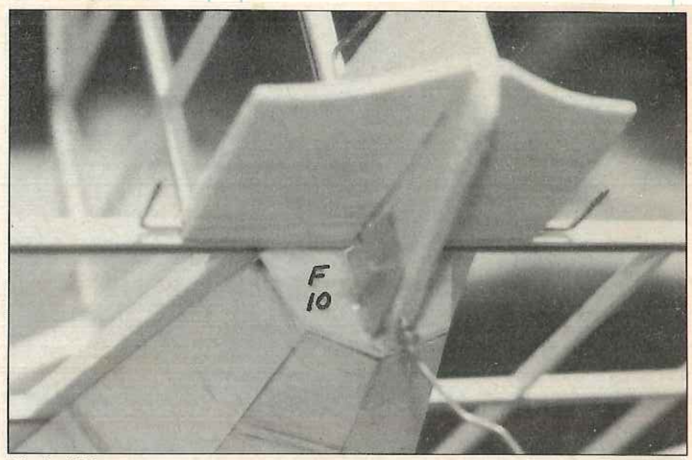


Photo #16



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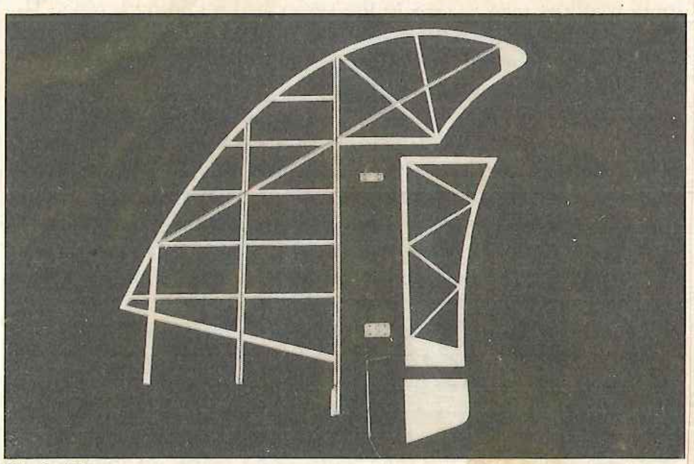


Photo #17

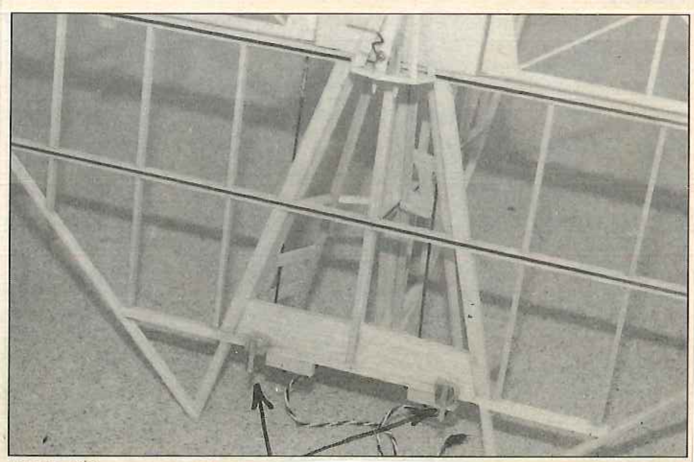
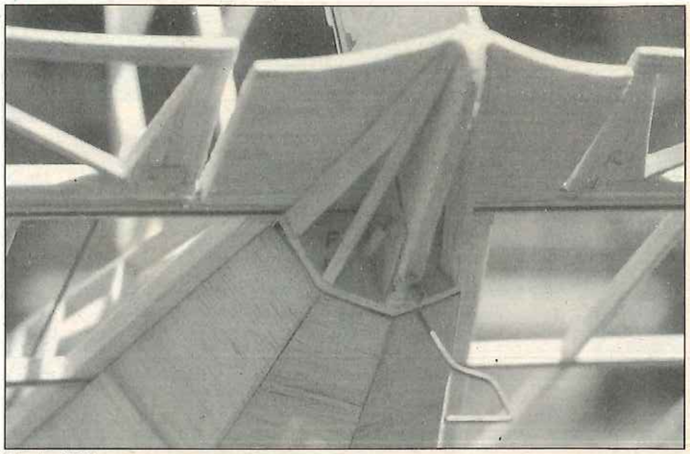


Photo #21



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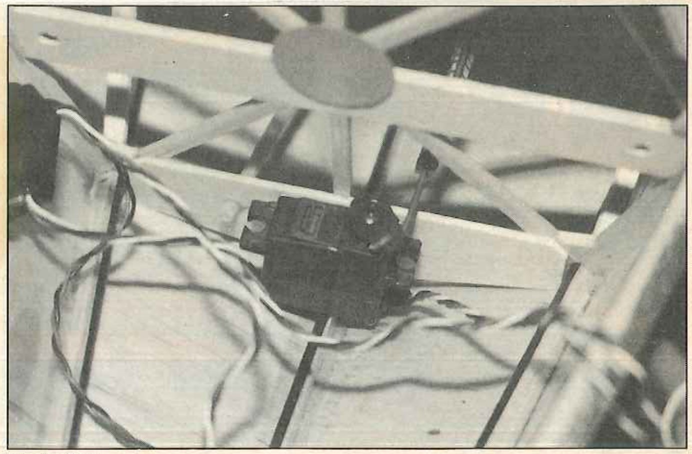

Photo #26

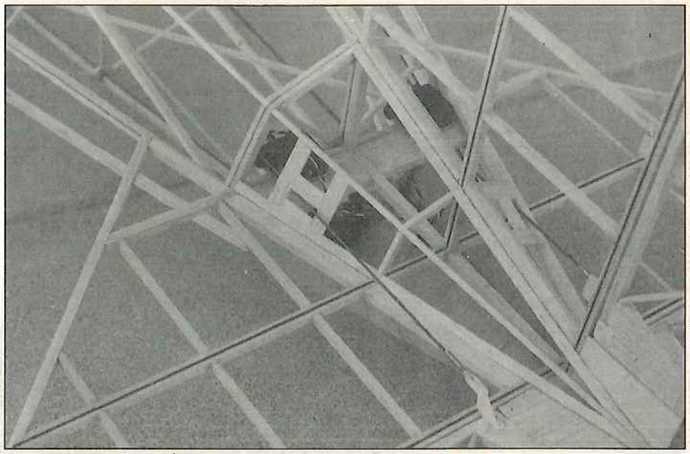

Photo #23

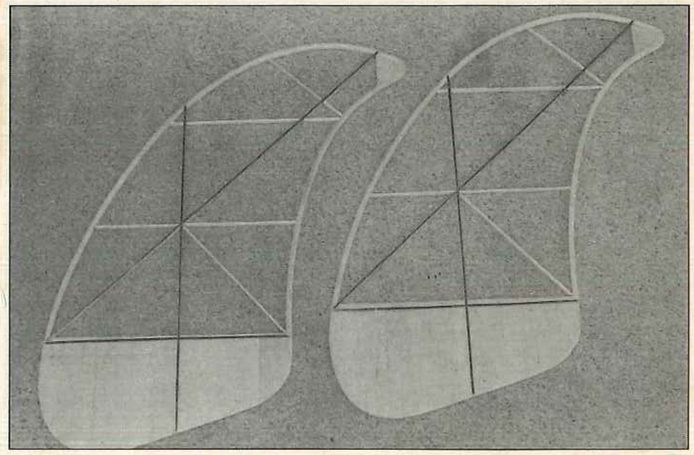

Photo #27

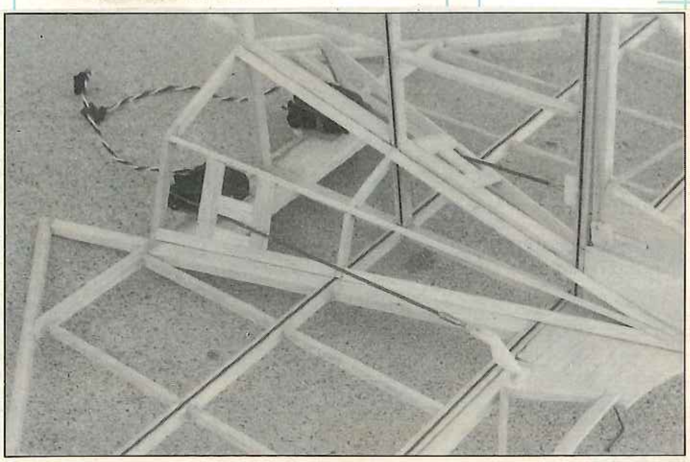

Photo #24

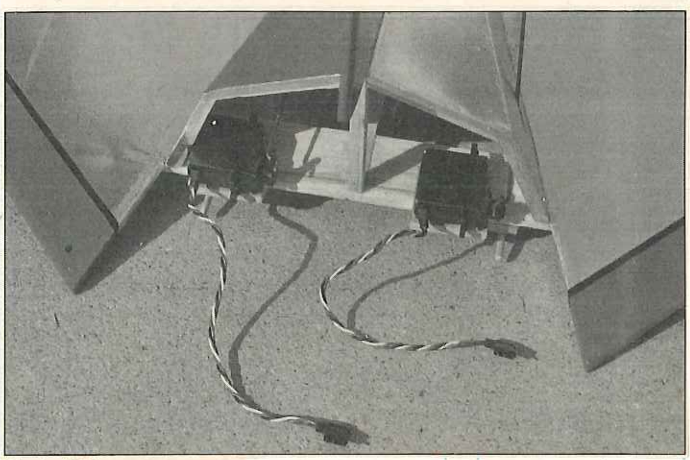

Photo #25

profile of the fuselage down to the tip of the tail. The superstructure is made out of 1/8x1/4-inch balsa, except for the covering attachment strips which are 1/16x1/4-inch. You'll probably have to sand F-10 down to match the rear of the fuselage.

The rudder and elevator servos can be installed as also shown in **photos #23, 24, and 25** (which illustrate their position with the tail section already covered). Before covering, you'll need to make up your pushrods (with the control surfaces temporarily attached) and add the 1/16x1/4-inch balsa pieces for the pushrod exit holes. The elevator pushrod length should give about 1/2-inch of up elevator (measured at the outer tip of the surface) with the servo in the neutral position. Throw for the control surfaces is two inches (1-inch left and right) for the rudder, measured at the top, and 1-1/2 inches (3/4-inch up and down) for the elevator, again measured at the outer tip. Regarding the servos themselves, they are held in place with double-stick servo tape to 1/64-inch ply plates which are glued to the horizontal stabilizer. Note how they project slightly forward, about 3/8-inch, to allow easy access to the servo arm retaining screws. The throttle servo **(photo #26)** is also held in place by tape onto a 1/64-inch ply plate that is glued onto a piece of 1/8-inch balsa that, in turn, is glued to the bottom half of F-8.

While on the subject of radios, try to utilize the lightest system available. The total weight of the airborne pack you see in the photos is four ounces, and consists of three micro-servos, a small four-channel receiver, and a battery pack made from a nine-volt rechargeable transistor radio battery. (Steps on how to make such a flight battery appear in the August 1990 issue of *Model Airplane News*, page 19). It is important to try to keep the tail as light as possible, as your model, in spite of your best efforts, will probably come out slightly tailheavy, like mine, and you'll have to add nose weight. If you don't have a lightweight system available, I suggest mounting your receiver battery in a compartment under the fuel tank, with a long ex- tension cord going from it to the rest of the radio in the tail. This is the setup I used in the first prototype and it worked well. Just make sure the long wires don't cause an interference problem with your particular radio system, and you'll have to decide whether or not to do this before covering.

The tip fins can be built next. Note the 1/16-inch wide C.F. strips on both sides as shown on the plans and in **photo #27**. The photo shows leading and trailing edges made out of four laminations of 1/32x1/8-inch balsa, but these buckled in and caused wrinkles when the covering was shrunk, so the plans specify six laminations.

Construct the strakes as shown on the plans. Note that there are four short ones and two long ones for the sides of the fuselage **(photo #28)**. The 1/8-inch square inner and outer edges of the strakes are laminated out of 1/16x1/8-inch balsa over the same cardboard jig used for the longerons. When removed from the jig, they will straighten out somewhat, but once the entire strake is constructed and removed from the plans, it will retain its shape.

If you've come this far, you're ready to do some covering. Chrome Monokote was used on the first prototype with red for the trim, and this worked out fine except that it's heavy covering. On the second one, Coverite's aluminum Micafilm is used to save weight and this is what I recommend. If used carefully, one 15-foot roll should be enough for the base color as shown in the photos, with just a little over one six-foot roll of red Black Baron Film being required for the trim and strakes. A lot of red is wasted here because of all the curves.

Covering the fuselage one section at time **(photo #29)**, is the easiest method and wastes the least amount of material. This was the first time I've ever used Micafilm and suggest following Coverite's instructions closely with the following exceptions. Although they recommend a 1/2-inch overlap of all seams, that tended to cause wrinkles on my model and I found that 1/8-inch to 1/4-inch is sufficient if you do the following: **Lightly** and carefully sand, with 400-grit sandpaper, the edge that is to be overlapped and coat **both** that area and the bottom of the piece that's doing the overlapping with two coats of Balsarite. Once the entire fuselage is covered, before shrinking, the excess Balsarite around the seams can be removed with Ironex. When shrinking, a setting of around 375 degrees (on my iron, nearly wide open) was required to get all of the wrinkles out. You might want to make a test piece first to get the hang of it. Be very careful not to touch the seams when shrinking, keep the iron moving constantly and shrink each section only partially before moving on to the next and doing the same. This will prevent the longerons from being warped laterally, which would occur if you shrank each section fully before doing the others. You might have to make three or four passes over the entire fuselage before all the wrinkles are out so have patience! The extra attention that was given to the seams will keep them from loosening when the engine is running, as certain engine RPM's tend to make the covering vibrate like a drum skin.

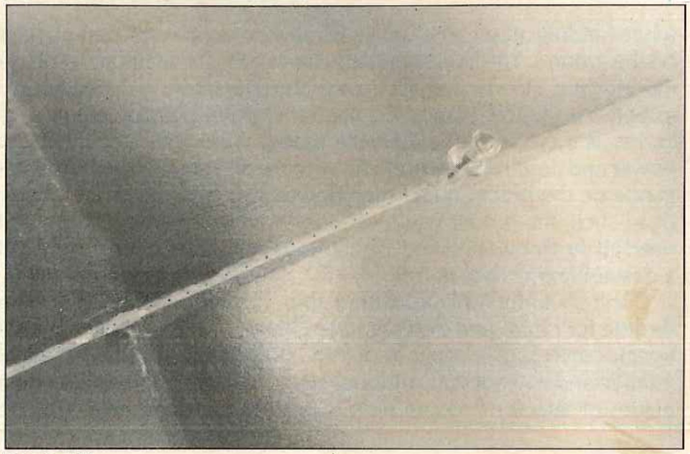
Photo #30

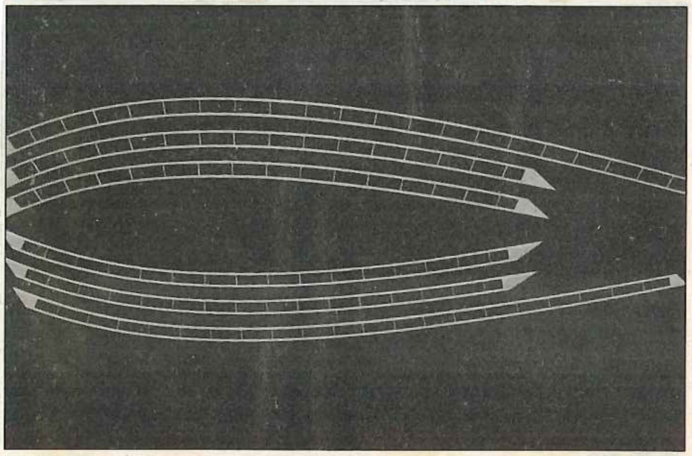
Photo #28

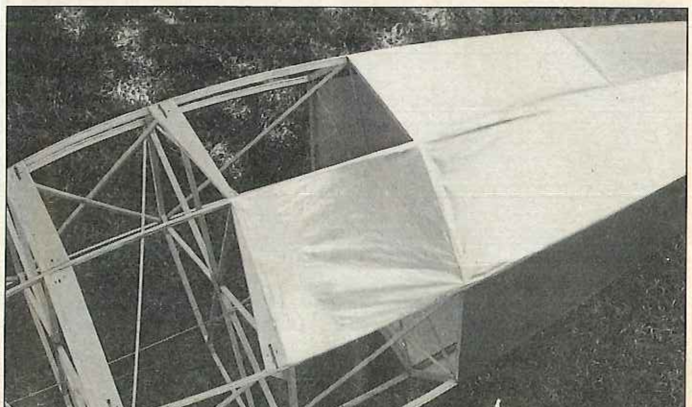
Photo #29

Covering the tail surfaces is not much of a problem, except that they tend to warp somewhat and you may not be able to get every wrinkle out (I couldn't!), especially on the fragile tip fins. Most of the warping and twisting can be taken out by twisting the surface in the opposite direction and reapplying heat to the covering.

Cover the strakes but do **not** shrink them at this time. This will be done after they have been attached to the fuselage. Also, the inside edge should not have the covering lapped over, as glue will be applied here.

The strakes are epoxied to the fuselage, one at a time, in the position shown on the plans and photos. First lightly sand the covering over the longerons where the strakes will be located and then stick pin holes through the covering into the balsa cap strips at about 1/8-inch spacing **(photo #30)**. Using pins, stuck into each bulkhead just at the sides of the longerons, as guides **(photo #31)**, coat the inside edge of the strake with slow epoxy and place it in position on the fuselage. Likely, there will be gaps at various locations between the strakes and longerons. Using masking tape, pull the strakes down until the gaps are closed **(photo #32)**. The tape is also used to make sure the strakes are perpendicular and don't snake around too much. The strakes are very fragile at this point so use care when applying pressure with the tape. It really takes two people to do this operation, one to hold the fuselage and the other to apply the tape.

Once the epoxy has set and the tape and pins are removed, shrink the covering on the strakes with an iron, starting at one end and working both sides of each one a little at a time. They will, no doubt, tend to twist around a bit along their length as the covering is shrunk, but this can be mostly eliminated by gently bending them the other way and applying the iron to the covering. They don't have to be perfect. Once the covering is shrunk, you'll find the strakes to be much more rigid, but still be careful not to bump them around.

Once covered, glue the forward fin on after first removing the covering under it on the fuselage. This has to be secure for its use as a handle.

The wheel pants shown in the photos are optional and therefore I've only enclosed an outline of them on the plans. If you decide to use them, use your favorite building method, keeping in mind they should be as light as possible. Mine were laminated from very light balsa, with 1/64-inch plywood for the sides. A wheel collar soldered to a thin piece of brass shim-stock, which is in turn glassed to the inside of the pant, secures them to the axle. You may have to grind a flat spot on the axle for the wheel collar set-screw, to keep the pant from rotating. The flat spot, along with the wheel collar in the pant, should be on the outer end of the axle.

Glue the tip fins securely to the ends of the horizontal stab, using a triangular piece of balsa on the bottom for reinforcement. Install the control surfaces with your favorite hinges. A small wire hook should be glued to the bottom longeron about 1-1/2 inches ahead of F-9 and extend out of the bottom of the fuselage enough to wrap a few small rubber bands around. Rubber bands from this to the brass tubing on the tailwheel wire secures the tail section to the fuselage **(photo #33)**.

With the model completely assembled, check the balance, according to the location on the plans, by placing a finger under the inside edge of each side strake and adding either tail, or more likely, nose weight until the model hangs level (fuel tank empty!). Mine needed about 2 ozs. of nose weight and came out at 2 lbs., 11 ozs. ready to fly (minus fuel).

FLYING

With the engine thoroughly broken-in, pick a nice calm morning or evening for the first flight. Midday turbulence tends to make the ship rock around. Head directly into any breeze and give power while holding about 50% up on the elevator to keep the tail planted on the ground. The ship should track straight. Upon liftoff, let off on the elevator slowly and retard the throttle slightly, if needed, to establish a shallow climb. The neutral elevator position mentioned earlier is a cruise setting and the model will climb steeply at full power and descend slowly at idle with the elevator at that setting. Be gentle on the rudder under high power as it is sensitive. At idle, or dead-stick, the rudder will lose most of its sensitivity and you will need all the throw specified. Be cautious with down elevator as it has a destabilizing effect in roll.

Don't try to fly it like a pattern ship, it responds much better to throttle for climb and descent. Use elevator for pitch and angle of attack control. It is capable of very slow flight in a near vertical attitude and will not stall, although it will tend to rock slightly at high angles of attack. If you've built it light enough and have enough power, it is capable of looping if your entry is correct. Full power and a shallow dive for speed is needed to get it over the top cleanly, as once you ease back on the stick and start to pull some "G's," speed bleeds off rapidly. If your model is banked slightly in either direction on entry, it will tend to roll out on top of the loop, performing a neat Immelman.

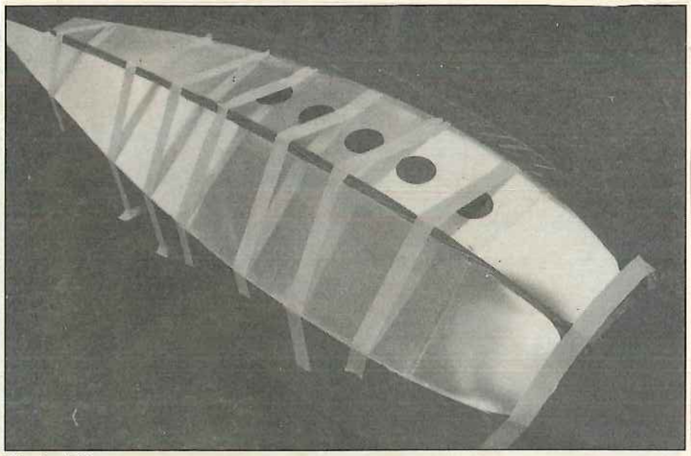
Photo #32

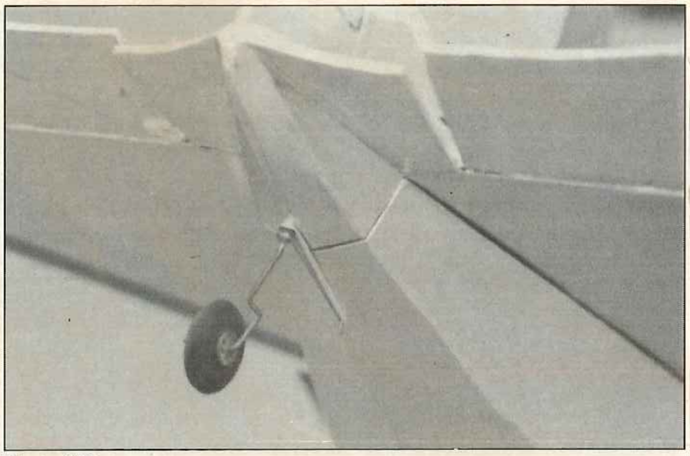
Photo #33

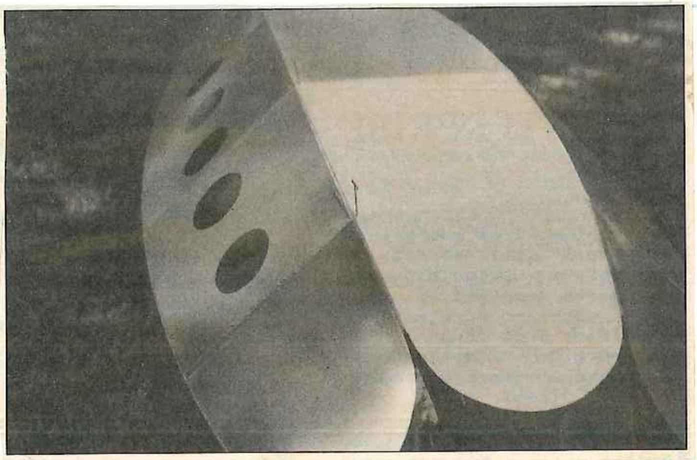
Photo #31

The destabilizing effect of down elevator allows you to perform some very rapid rolls. Again, full power and a shallow dive to gather speed. Then pull the nose up to about a 30-degree angle and immediately apply full down and full left or right. The model will begin a series of fast rolls and will continue until the controls are neutralized. Have plenty of altitude when you first try this!

As might be imagined, the spaceship's gliding abilities are nothing to write home about. In fact, it makes the Space Shuttle look like a sailplane! Unless you have a dead reliable (?) engine, it is wise to limit your flying to directly over your field, especially when low. The glide ratio is about 3-to-1, at best, and less when downwind and trying to get back to the field! On a power-off landing, you'll need to enter a shallow dive, at about fifty feet of altitude, if you want any speed left for a flare at touchdown and you'll have to time it just right to grease it on. This thing will definitely **not** float down the runway in ground-effect!

With the light framework and large unsupported areas of covering, you'll find that the model resonates like crazy at certain engine speeds. In fact, it sounds rather like the buzzing noise made by the spaceships in the old Flash Gordon/Buck Rogers serials. One fellow commented that all it needed was smoke and sparks coming out of the tail and "Ming the Merciless" waving out of a porthole to complete the effect!

Probably only having scratched the surface with my experiments with this design, I'm sure it can be developed further to improve its flight capabilities, with maybe elevons on a modified tail for roll control, changes to the strakes or tail surfaces for better handling in turbulence, and many other things. Wouldn't retracts look neat, too?

With that in mind, photos, comments and letters regarding this project can be sent to me at 128 Lexington Ave,Taft, CA 93268. Please include an SASE if you wish a reply.

You may be wondering whatever became of the original designer Roy Clough. The abrupt cessation of his articles in the late 1960's seemed to indicate to me,and others I've talked to,that he might have passed away. Well, I'm happy to report that Roy is alive and well, and after a nearly 20-year hiatus from the hobby, he's now back into it and is currently working on a number of new flying projects, many of which are electric powered. He may also be producing a line of electric powered F/F kits soon, so watch this magazine for further developments.

In closing, I wish to thank Roy Clough, George Ardwin, J.T. Herrod, and Russ Hiatt for their help with this project.

For carbon fiber supplies contact: Aerospace Composite Products, P.O. Box 16621, Dept. A, Irvine, CA 92741; telephone (714) 250-1107. The cost is $24.00 plus $3.00 shipping and handling for the 4x72-inch, .007 carbon fiber sheet. **MB**