Author demonstrates perfect test glide hand launch; model held high overhead with wing level and transmitter to control direction.

PHOTOS BY AUTHOR AND TOM WALCZYK

PART ONE

The AR-13 R C Glider

BY EDWARD KOLASSA . . . an interesting article covering the complete details of the development of a soaring glider that combines stunt or aerobatic capabilities along with thermaling.

• Right from the beginning it was decided—an attempt would be made to add the roll maneuver to soaring. The key word is *soaring,* and here it implies the ability to stay aloft in weak lift. Slope lift usually is not weak lift; therefore the objective was to add the roll maneuver to a glider with a decent sink rate.

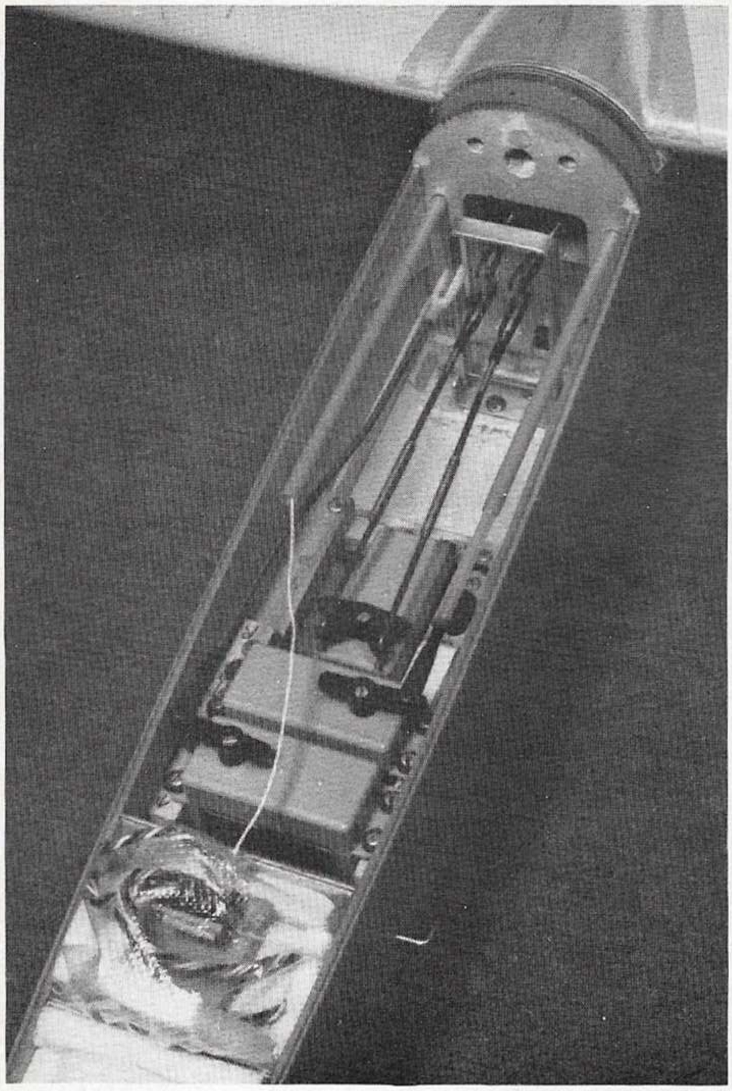
AR-13 has a decent sink rate—not super, but decent. Not quite as good as the good, old Cirrus, but fairly close to it. And the comment heard most often at the flying field, practically said word-for-word by everyone, is: "Wow, what a flat turn."

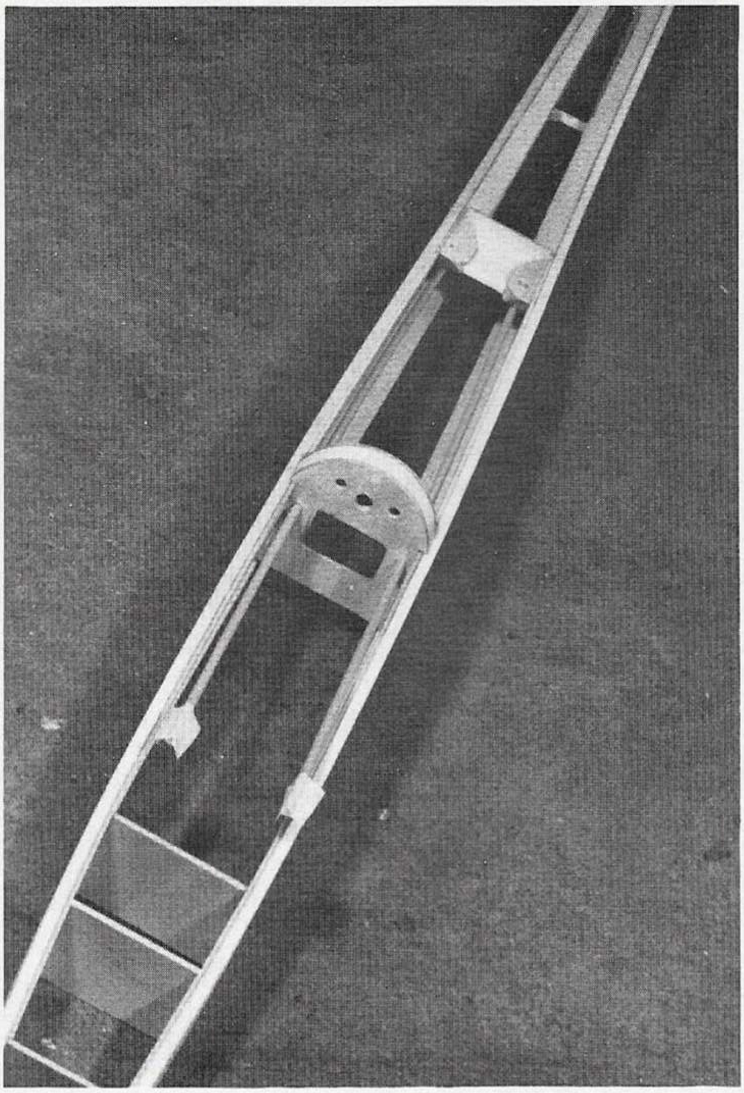
And it will do a good roll.

This project began many moons ago and included the construction of several airplanes. The initial attempt was the first glider I had seen in the flesh, so it can be said that the starting point was zero. My lack of glider experience (though mucho power experience) delayed the project somewhat. But it was time well spent, and that is what the hobby is all about, isn't it? Doing your thing and, in this case, at a leisurely pace.

The first plane, Power Off, exhibited a definite power model influence as well as a lack of glider design background. I thought that an 18% semi-symmetrical airfoil used in an 80" wing with generous dihedral would be enough to generate a roll if ample rudder was used, but the roll and the sink rate were poor. The poor sink rate was expected, but the inability to generate a fair roll was disappointing. After diving the model to generate sufficient speed, full-rudder deflection produced the first half of the roll, but the model was reluctant to go farther. Previous experience with rolling rudder/elevator power models led me to expect more, so I tried to figure out the cause of this model's poor performance, and it was—drag, which could be directly attributed to the wing's semi-symmetrical airfoil whose thickness ratio is a big, fat 18%.

While there are some benefits to using an airfoil this thick on some power models, there are few reasons for using anything over 13% on model gliders. (In fact, it is difficult to think of *one.*) Also contributing to the total drag picture, aside from the obvious boxy appearance, is the stationary





Photos above show fuselage at right during construction and, on left, complete with receiver, servos, battery pack and push rods in place.

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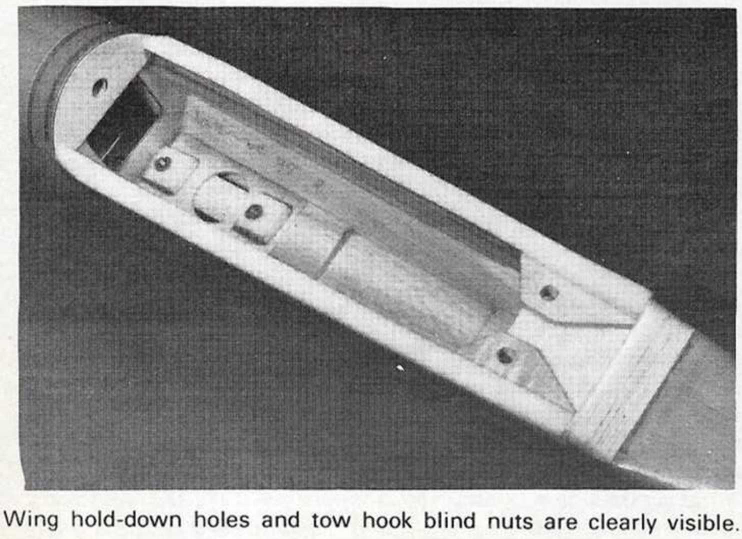
propeller. The smallest diameter and highest pitch were chosen to minimize this effect, but unless the prop is folded or the prop engine combination retracted into the model, there is no getting away from this energy-absorbing device.

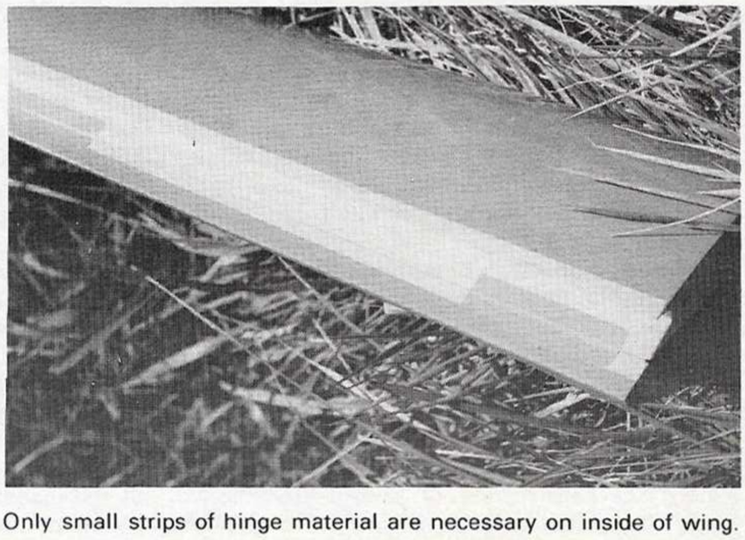
Something else to consider is the relatively low (for gliders) aspect ratio (10 to 1) of the wing. The thinking around here is that for a given aspect ratio there is a higher induced drag penalty for a rudder roll as compared to an aileron roll because the up-moving panel in a rudder roll operates at a higher angle of attack (hence higher induced drag) than the up-moving panel in an aileron roll. Put the other shoe on, and the relatively low AR of 10 becomes a relatively high AR of 10 when damping in roll due to span is considered. AR-13 established that the aspect ratio chosen for Power Off was not excessive, and damping in roll, due to span, was less of a factor than the excess drag picture.

At the time, I thought about cleaning up the design and proceeding in the same direction—that is the rudder roll—and looking back, it probably would have worked. Instead, I decided to investigate the properties of an aileron roll in a glider, and subsequent events indicated that this was the way to go.

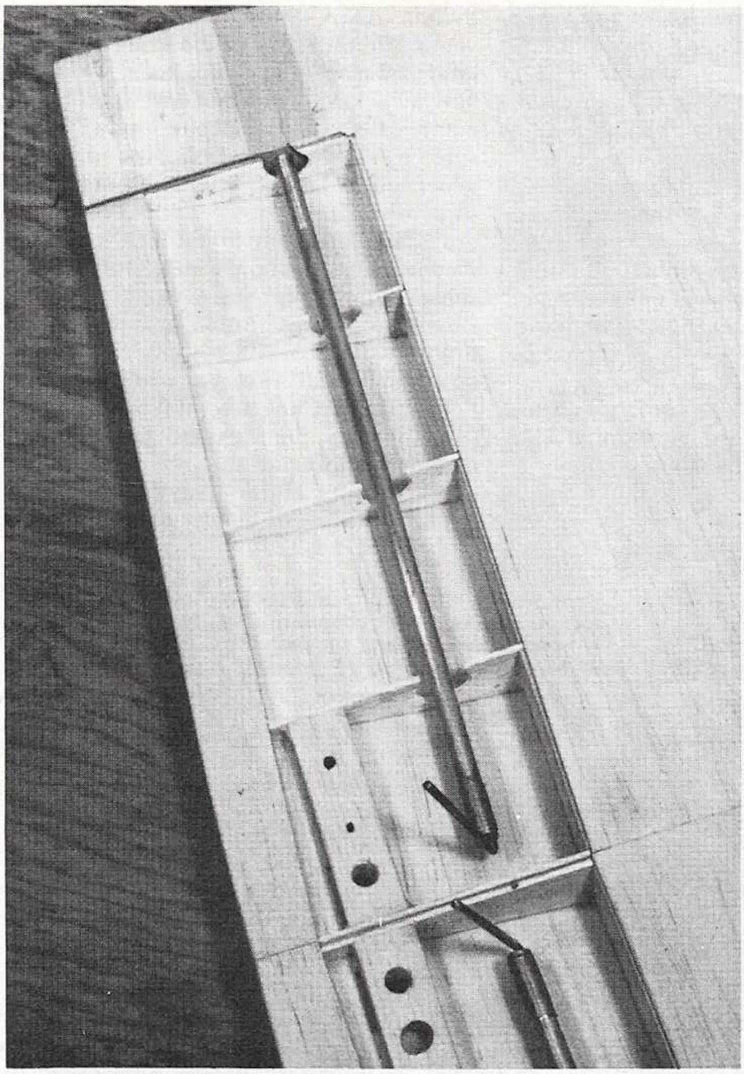
Not convinced yet that the semi-symmetrical wing section was a poor choice,



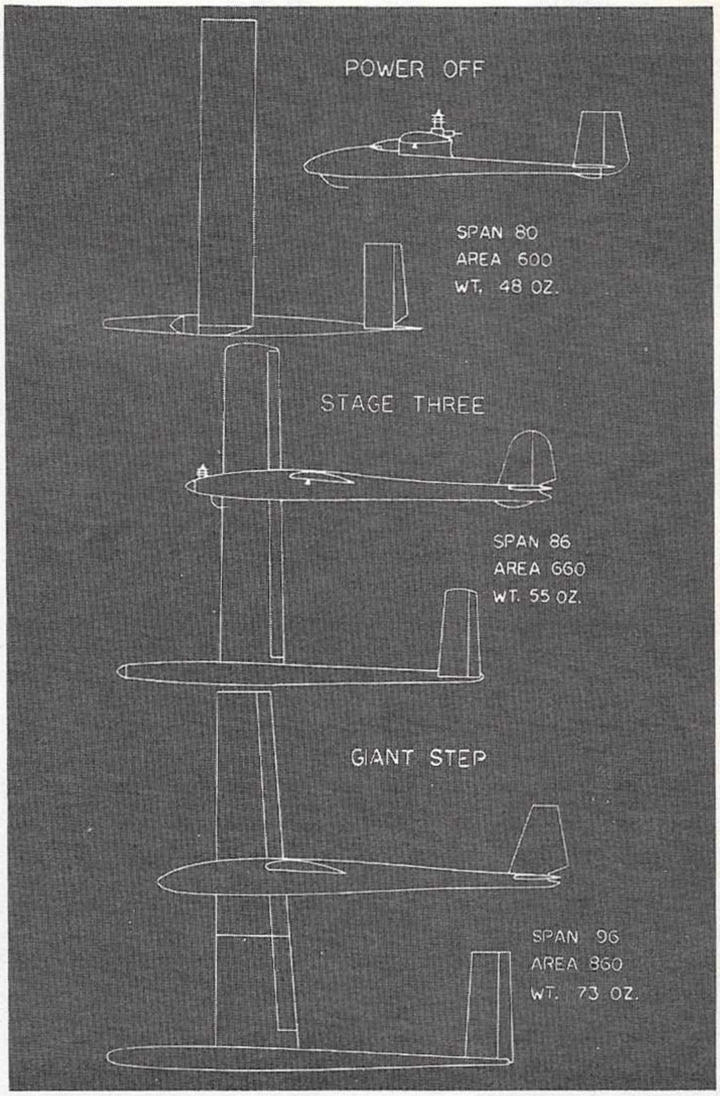
Wing hold-down holes and tow hook blind nuts are clearly visible.



Only small strips of hinge material are necessary on inside of wing.



Floating torque rod must not touch any part of the structure. Later a bearing will be placed near output arm, away from the torque rod.

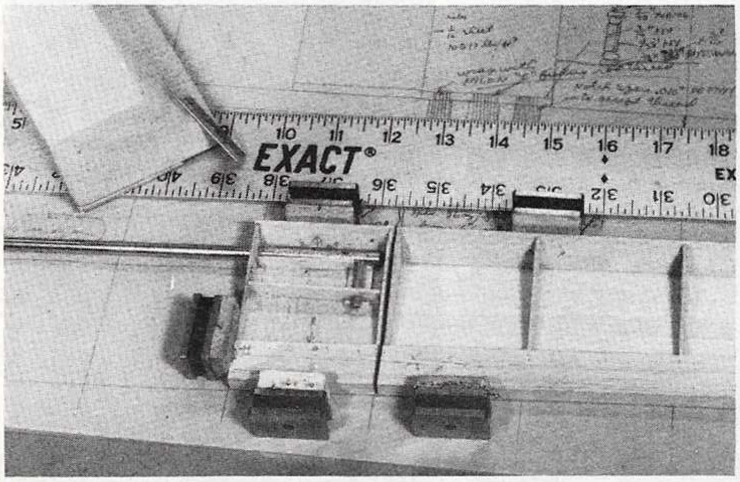


one of the new Wortman 15% laminar flow airfoils was tried on a second model, called Stage Two. While Stage Two was much cleaner, in order to make launching from a small field possible and to insure adequate stunt height on every launch, I kept the same drag-generating prop/engine combination. Ailerons and rudder were not coupled, so each could be studied for its contribution. Elevator was the third and final control included.

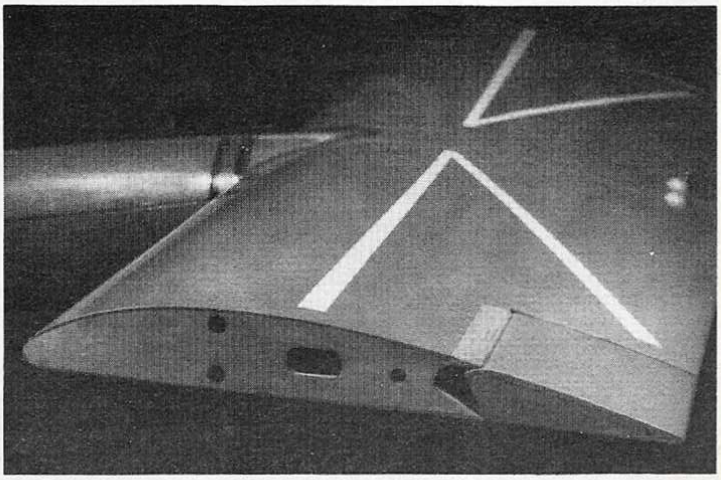
I was apprehensive during this model's first few flights because a coordinated effort of aileron and rudder was necessary to effect a turn. The small dihedral prevented the rudder from being effective by itself, and the almost nonexistent aileron differential made aileron turns look like a banked, straight line. All the control functions, aileron, elevator and rudder, were needed simultaneously to make any turn, so a fair amount of flying skill was required. The pilot furnished by the engineering department was inexperienced and had difficulty coping with the situation.

To offset the flying problem, 45° output arms were used on the servo, so now the ratio of "up" aileron to "down" became roughly 2 to 1. The change was enough to counteract the reverse yaw due to the ailerons and add a little yaw in the direction of the turn. It had the same effect as putting in some rudder control with only the ailerons being used. The engineering department and its pilot could breathe easier now.

This model did do a low quality roll demonstrating the feasibility of the roll maneuver in gliding flight. Quality



Straightedge-straight aileron. Note securing torque rod mounting.



Close-up of wing root rib. Note neat inset aileron installation!

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notwithstanding, it was nice to see *any* kind of roll. The maneuver was slow and weak and could have been improved by increasing the aileron area and/or deflection, but there was no need to do so. There was enough of a roll for experimenting, and subsequently the rudder was found to be no help at all and, in fact, impeded the roll when applied simultaneously with the ailerons. It didn't matter whether the rudder was applied in the same direction as the ailerons or opposite to the roll; the results were always the same. The model was reluctant to complete the second half of the roll. There was never any problem when the ailerons were used alone.

Very interesting. Future models could dispense with the rudder (not the fin), saving weight by eliminating the linkage, hinges and the servo. Drag is also reduced since there is no rudder air gap and no deflected rudder working against the airstream. The drag due to the deflected rudder is quite a factor, during the roll, and unless there is enough effective dihedral (large dihedral angle, low CG, high wing position, high fin, etc.) for a strong rolling moment, it's better not to use the rudder during an aileron roll.

Ideally, the rudder should be electronically coupled to the ailerons for turns and uncoupled for rolls. Hardly any aileron differential would be needed, and there would be more punch available for the roll; however for simplicity and to save weight, I went the rudderless way.

This model was deficient in sink rate and had tip-stalling problems. The tip stalling needed immediate attention. The outer-third length of the ailerons was cut away from the inner two-thirds and reglued so the outer part was up slightly when the inner portion was at neutral. A fence, just like the end plate on a wing tip, was glued between the two, different, angled sections to facilitate gluing and to control the airflow between the two. Tip stalling, while not cured, was relieved.

No geometric washout was built into this or any of the models because tip stalling could be averted by using the proper wing planform and choosing a very thick airfoil, (which usually is associated with smooth stalling) or by the use of aerodynamic washout (the tip airfoil is different from the root airfoil). More on this later. All the wings were fully sheeted to avoid flutter and for

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maximum strength because that is the nature of these beasts: to perform violent maneuvers as well as to go soaring.

The roll was there. Now, to improve the sink rate and the stall, a new wing was built and added to the existing fuse and tail, and the whole thing was called Stage Three.

A 12½% flat bottom airfoil was chosen as the root section for Stage Three. A 10% flat bottom, derived from the upper curvature of the root section, would be at the tip. In between the two, the airfoil would change progressively from root to tip.

Changing the airfoil from root to tip has certain distinct advantages. A thick airfoil can be used at the root to obtain maximum beam strength and a higher lift coefficient. A thinner airfoil at the tip is advantageous in controlling tip stalling (where one wing tip stalls before the rest of the wing) and for keeping the drag coefficient low. It is no panacea, but it is a useful tool for the designer. I decided against twisting the wing or washout for fear of wing flutter when the model was flown at high speed prior to performing stunts.

Stage Three was an improvement over Stage Two. The climb and glide were better. But the better climb caused another problem.

This model was powered by a Cox Tee-Dee .09, and as many modelers know, the cylinder head is the screw-on type. Very often, during the climb-out, the engine lost power because the head became loose. Many remedies were tried including over-tightening the head and under-tightening, and the use of Loc-Tite on the threads as suggested by the engine manufacturer. The problem persisted. It was maddening, but eventually a solution was found, which might be of interest to other glider buffs, as this problem is not uncommon.

The engine was overheating because the needle valve was not set rich enough. While the needle was set slightly rich, the high-climb angle plus the load of trying to lug a heavy aircraft meant the engine demanded a much richer mixture. Once this was determined, the head never became loose again.

As this model had a tendency to tighten up the turns, in an effort to obtain better circular flight for thermalling, the vertical tail area was reduced. Why the fin? In level flight, Stage Three would weathervane into the wind indicating strong directional stability. Also in an aileron turn, the model would be slipping rather skidding, and while in slip, the airstream would work against the vertical tail area turning the nose more into the turn. The reduction was made in small increments and resulted in some improvement. The final reduction was not tested; in fact the complete potential of this model was never fully explored because it was destroyed by enemy gunfire.

Thus Giant Step was born. Giant Step was larger, heavier and had a tow hook. No more engine to lift the model. Bring on the Hi-Start.

Going up the tow for the first time was thrilling and exciting for one who had never done it before. An untested airplane added to the suspense. The Hi-Start was a Ray Smith model and his written instructions and a magazine article on Hi-Starts were all the information available. After concluding from this information that the best bet would be to go easy, down trim was used on the first flight.

Also a modeler with some Hi-Start experience was asked to act as an adviser and plane-holder. Tow hook was in front of the Ray Smith recommended position. Adding to the anxiety—would only 2° of dihedral provide enough lateral stability going up the tow? Would the ailerons alone be able to control the model on the tow? There was no rudder. Time to launch . . . last check before launch . . . all controls are working. Okay, let it go.

What a sight! The first, quick burst was explosive and electric and remains so to this day. Stability, good. Aileron control, positive. No sweat at all. Near the top of a not-very-high launch, "How do you get off the tow?" "Just keep flying straight ahead," the adviser replied with much wisdom. It was a wise decision to be conservative on the first-tow launch.

The wing airfoil of Giant Step was the same as its predecessor, but the horizontal tail airfoil was changed. Whether the new stab airfoil was a factor is not known, but pitch stability was not enough. The CG was moved forward some, but the biggest gain was due to the elevator gap being covered. Plastic covering material was used to make a series of hinges from one end of the elevator to the other, leaving no gap at all. The change in pitch stability was quite noticeable after this was done. Hmm, closing the elevator gap made a difference.

Giant Step's aileron area was increased as was the throw, over Stage Three. The fuse was cleaner, and there was no stationary propeller to slow the model down during the roll. As expected, the roll was improved. In fact, it was quite acceptable. Hot ziggety! Sink rate and stability needed more work, though.

Sink rate, not yet acceptable, was getting there. A wing loading of 12.3 oz./sq. ft. resulted from over-building, so a reduction in weight would not be difficult. It was only necessary to contemplate, momentarily, the model in a dive and in went more wood and glue. The wing aspect ratio was kept low at 10.7 to help the roll. Now it was time to help the sink rate. A new model was designed as the final chapter, regardless of the outcome, with an aspect ratio of 13 and was appropriately called AR-13. Luck was with me, and the model turned out satisfactorily in every way.

A major improvement made by redesigning the wing, and a simpler fuselage saved weight and reduced drag.

The tip airfoil on Giant Step had the maximum camber (maximum thickness on a flat bottom) at 40% of the chord, and I felt that this position, as well as the shape of the airfoil, was a major contributor to instability. Therefore, another flat bottom airfoil of 10% thickness was chosen for the tip section, whose maximum thickness was 31%. The root airfoil was not changed because it was a proven airfoil with a good L/D and a reasonably high lift coefficient even though it was influential in causing the nose-up tendency of the model. I hoped that the new tip section would help tame the root section's pitch up tendency. And it did. And it also improved the stall.

Making every effort to decrease the sink rate, and not lose sight of the roll, the root airfoil was carried out to the wing break. The taper began at the root, but the airfoil did not begin to change until farther out on the span. By having the high-lift airfoil throughout the center section, a more optimum lift distribution might be gotten, the total lift would be greater, and would still allow the thinner section to be toward the tip, where with a given aileron deflection it would yield more rolling moment.

A reduction in wing weight began with redesigning the spar system. With more experience now, there was more feel for how much strength was needed to resist tow loads and high "G" maneuvering. Tapering the spar, as well as using less spruce, saved some ounces. Lighter skin balsa and using wood of smaller dimension in other places saved more. Using just enough glue to do the job, and no more produced more savings. Even though the new wing was longer and had more area, it turned out lighter. Way to go!

The aileron chord was increased slightly to compensate for expected greater resistance to roll due to the larger wing aspect ratio. Aileron area was removed nearer the center span, where it is almost ineffective, and added nearer the tips. The net result was an increase in aileron area because the span was longer. I then wondered whether the servos had enough torque to move the ailerons which were quite large now.

A Kraft, vintage 1970, driving KPS-10 servos, encountered no difficulty, but I lost some sleep until after several flying sessions. What probably helped the situation and helps to avoid aileron flutter also is that the ailerons are light and stiff because of the built-up, sheet-covered construction. The almost nonexistence of an aileron gap is quite an anti-flutter device as is the tight, nonslop linkage. Nevertheless, use caution when selecting servos to move this much aileron area, for some servos may not have enough torque to do the job.

The aileron linkage, practically without slop, is a direct result of the floating torque rod system. Torque rod sounds like a misnomer because ¼" brass tubing is used, but floating is descriptively accurate of its action.

In the orthodox torque rod system, like that used with strip ailerons, the center line of the torque rod passes through the center line of the hinge, allowing a bearing to be placed around the torque rod, keeping the system taut and nonbinding. It is a good system, but it does have one drawback. When the hinge line is at the bottom skin (or top), half of the rod would protrude into the airstream if the center line of the rod coincided with the hinge line, as it should for nonbinding.

The floating torque rod overcomes this deficiency by having the torque rod *above* the hinge line and *inside* the wing cavity. The torque rod is in partial orbit around the hinge line, and any bearing placed on the torque rod would restrict its circular movement. Instead the bearings are placed on another rod, attached to, and parallel to, and at the end of the torque rod, and in line with the hinge line. The bearings protrude through the wing skin, but are inside the fuselage.

Having the wing panels separated by a distance from the center span has a few benefits: Bending loads diminish sharply just a short distance from the center span making it possible to build a stronger, stiffer and less flexing wing, a must for aileronees; the wing can be built in one piece, with connecting pin tubing uncut, and separated later (this results in a very accurately-aligned wing); wing parts are smaller, less cumbersome to handle; and the vertical wing connectors are easier to install.

The vertical wing connectors contribute much to the strength and stiffness of the wing. There is hardly any wing flexing even when the ¼″ bungee Hi-Start is stretched to an 18-lb. to 20-lb. pull on a windy day. The model only weighs 4 lb., so it explodes out of your hand at launch, and the wings show no sign of strain—a fine testimonial to the vertical wing connectors.

Its strength and stiffness come from being able to use the full thickness of the airfoil. Separating the connecting pins to their maximum yields the highest beam strength, thus allowing smaller-diameter pins to be used. Two 5/32″ steel pins, epoxied inside 3/16″ o.d. aluminum tubing, supply all the resistance necessary. The aluminum tubing contributes little in strength; its function is to prevent the steel from rusting and to allow a smooth and precise mating of parts.

Good aileron design begins with the ability to reproduce the aft part of the airfoil in the aileron. Probably, the best way is to use built-up construction utilizing the rear section of the ribs. Foam is good, too, but it may turn out a little heavier, and lightness in an aileron is quite important to resist aileron flutter. Skinning the aileron with 1/16″ sheet seems to strike a happy medium between stiffness and lightness.

The aileron was hung on the knife edge of triangular, cross-sectional stock glued to the bottom of the rear spar. One long, continuous hinge of MonoKote connected the flat bottom of the airfoil (of the triangular stock) and the aileron. Short strips of MonoKote were placed at intervals, on the front of the aileron and the traingular stock. The plastic covering material also made contact with the long MonoKote strip, making a neat, if not uncommon, hinge. A strip of balsa was glued above the hinge gap and contoured to the shape of the airfoil reducing the gap to minimal size. It took several wings and a few magazine articles to decide on the best way to cover this gap.

It was found best to completely finish the aileron including covering. The bottom of the wing was fine-sanded, but not the leading edge and the top skin, where rough-sanding would do for now. After the aileron was hinged to the wing, the aileron gap cover strip was epoxied to the top of the rear spar, and at the same time the cover strip was placed in contact with the top of the aileron. It is the width of this aileron gap cover strip that is very important.

The exact width can be measured from the plans. If the strip is made wider, the top of the rib, just in front of the aileron, will have a reflex curve, deflecting the air away from the aileron, aiding and abetting separation of the air stream from the aileron. The width of the strip must not be wider than the measured width. It can be less, but never wider. In fact, making the strip slightly narrower almost compels the builder to sand more off the rear top skin, giving the airfoil, at that point, a more downward curvature. Now the airstream has a downward velocity component, as it strikes the aileron, gluing the air stream to the aileron. The extra sanding also thins the airfoil slightly, just in front of the aileron. Wind tunnel tests have shown that doing this reduces drag and improves aileron flutter resistance.

All the fuselages were heavy per length due to over-building and the use of strip planking, but mostly due to excess cross-sectional and wetted areas. Utilizing the tremendous strength of 1/32″ plywood as doubler material, the rear end of the fuse of AR-13 was reduced in cross section until it was almost boom-like, saving weight and reducing the need for nose ballast. A little 1/32″ ply goes a long way in adding strength, and it takes up less space, a factor in further reducing cross section. The ply doubler was used only on the side of the fuse, with 3/16″ sheet used on the side, top and bottom, and the triangular longerons adding enough additional strength to make a light, strong boom.

Another weight-saver was to replace the strip planking with simpler, lighter sheet, top and sides. Because the cross section was small now it was not difficult to get a nice, round cross section, where needed, by adding triangular longerons, and the time saved in building was most welcome.

Some cross-sectional and wetted areas were removed from the front of the fuse, but not the optimum because I wanted some elbow room for R/C equipment, etc. without being cramped. All this reduction did indeed save weight, but, more importantly it reduced drag.

Fin design is probably at the optimum, in that a very thin airfoil shape is sanded into the sheet balsa, and it is one piece (there being no rudder). The horizontal tail is another story.

The ubiquitous elevator attached to the stab is used rather than the more promising, all-moving stabilizer because it was thought to be more rugged for landings and high "G" maneuvering. Gain some on the fin, lose some on the stab. Not too bad. ■

PART TWO

PHOTOS BY AUTHOR AND TOM WALCZYK

Author, one second after hand-launch, attempting to determine if it should be a right, or left, or maybe "up" signal to get the AR-13 on way!

The AR-13 RC Glider

• Having shared with you the evolution of my design philosophy in the first part of this article (M.A.N. August '76 issue), we shall now get into seeing it realized. I won't go into the usual building instructions though; instead I'll only touch on certain high points, with the emphasis on how it is done in this particular factory.

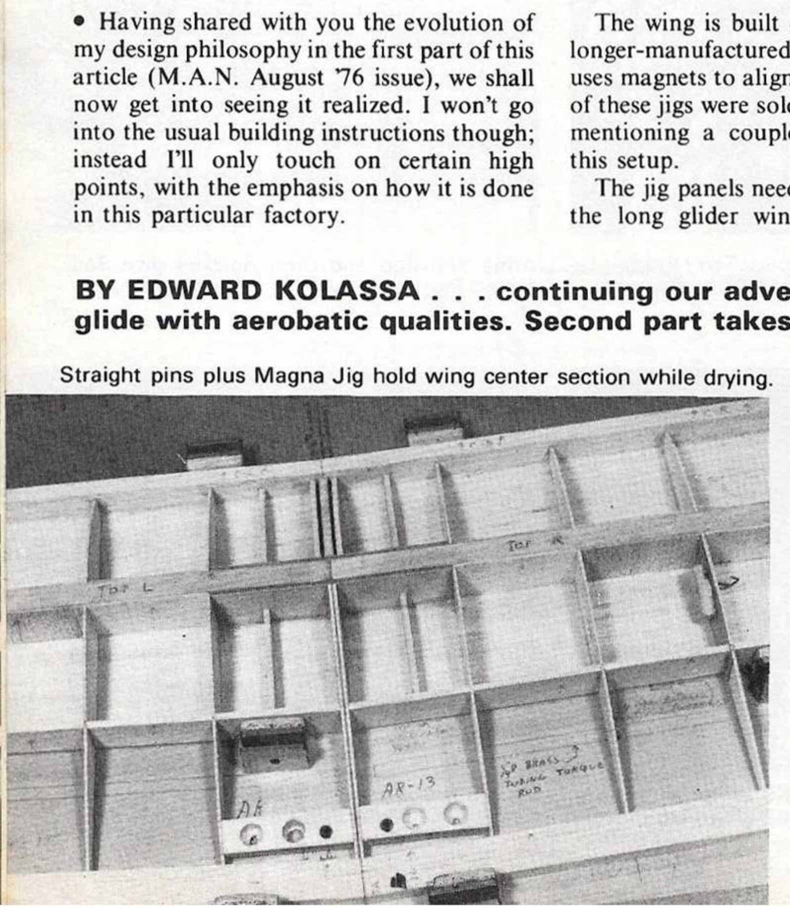
The wing is built on a Magna Jig, a no-longer-manufactured, steel-surface jig that uses magnets to align the work. Quite a few of these jigs were sold, so it should be worth mentioning a couple of improvements to this setup.

The jig panels need an extension to build the long glider wings. Strips of 1"-angle aluminum stock, or flat stock thick enough to resist bending, are bolted to the top surface of the jig, near the edge, and to one side of 1/16" steel sheet, which is the extension. Using the top surface insures excellent alignment.

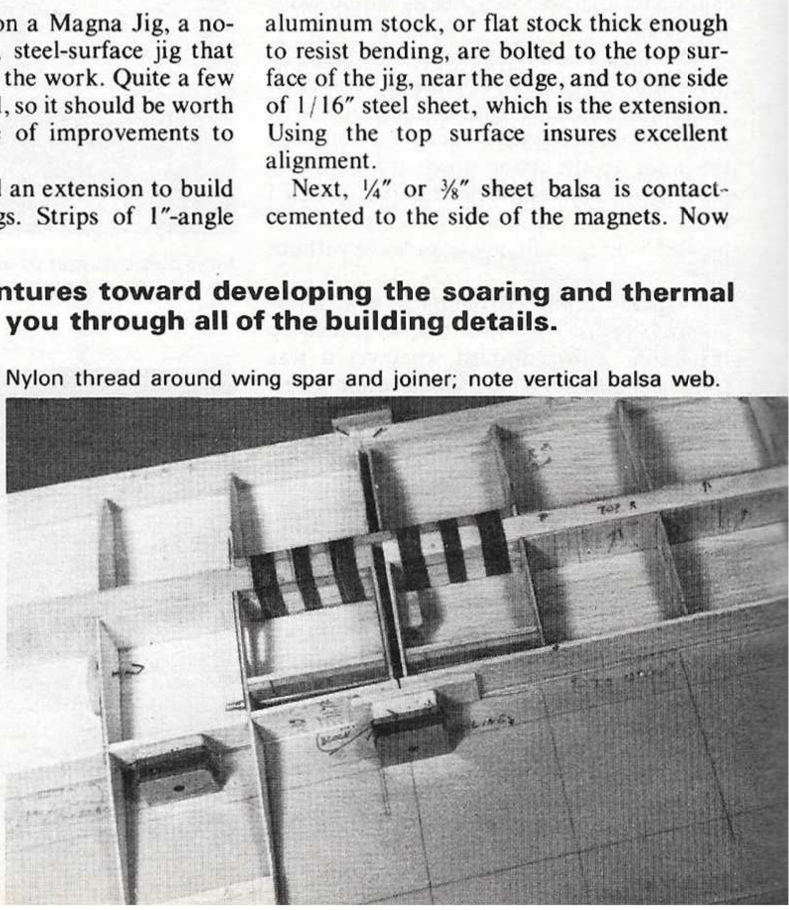
Next, 1/4" or 3/8" sheet balsa is contact-cemented to the side of the magnets. Now

BY EDWARD KOLASSA . . . continuing our adventures toward developing the soaring and thermal glide with aerobatic qualities. Second part takes you through all of the building details.

Straight pins plus Magna Jig hold wing center section while drying.

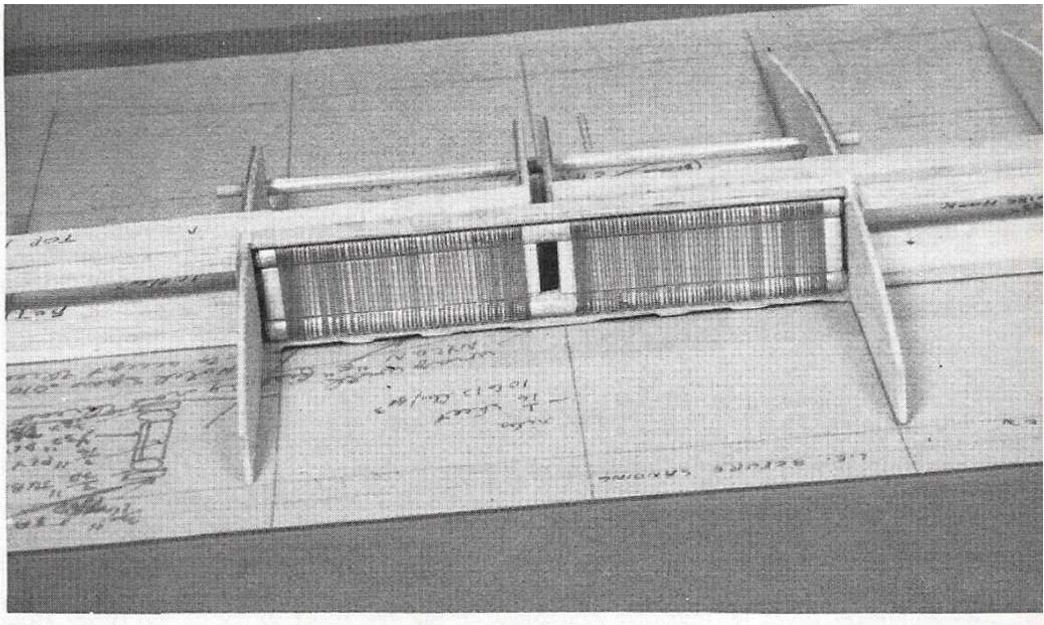


Nylon thread around wing spar and joiner; note vertical balsa web.



straight pins can be used to hold the work and anything pinned to the side of the magnets, like a rib or a former, is perpendicular to the jig surface. The beautiful part of the Magna Jig is that the work can be nearly assembled quite accurately, before gluing, and if more work needs to be done on any part, such as drilling or sanding, the part can be easily removed. It really is a good jig, and some manufacturer could do modelers a service by bringing this product out again.

The Magna Jig, or any jig, is best aligned by using a carpenter's level; the table below can then be ignored. Just be sure that the level is parallel to its previous position, and by twisting, bending and using wedges you will be able to achieve any degree of alignment, including washout, to a precise amount. Screws and copper wire tie the jig down and hold the alignment.


Slight clearance was sanded into the spar to permit the nylon thread wrapping of joint.

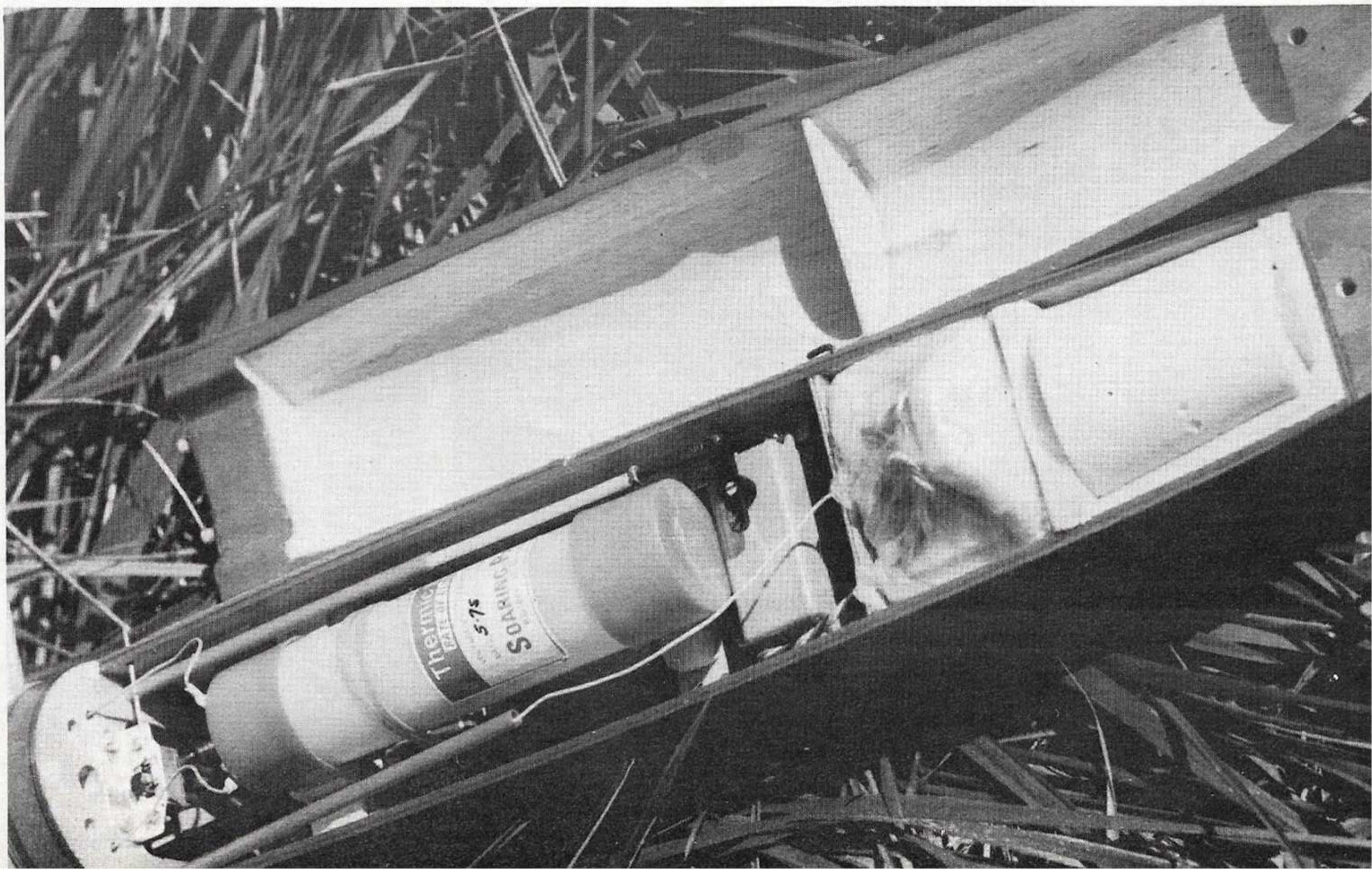
Making the ribs for the inner panel requires a template of rib #1 and rib #6. Five pieces of medium-hard (10-lb. to 12-lb./cu. ft.) sheet balsa are placed between the templates and bolted together. Five blanks are used, rather than six; the correct number to use is always one less than the required amount (July, 1974, *American Aircraft Modeler).* A few dabs of spot glue between each blank helps to prevent any shifting while sanding.

The final sanding is done so that the sanding block touches each template at the same airfoil station. In other words the block is tangent to each template, simultaneously, at the one-quarter point, one-half point, etc., and the same stations in between as well. These are airfoil stations, including the leading and trailing edge, and not rib stations. Only then will the ribs, between the templates, be comparable to the templates.

After sanding, make light razor cuts across the bottom of the stack locating the spar, the end of the rib in front of the aileron and the aileron hinge position. Any mark or cuts made on the top tend to be lost when the bevel is removed by sanding.

Upon dismantling and after sanding off the bevel from the rib edges, notice that the smallest rib exactly matches the smallest template. Mark this rib #6. On the other hand, the largest rib is slightly smaller than the largest template. It should be, as it is rib #2. Make a balsa duplicate of the largest template and designate it rib #1. Now all the ribs are made for one panel. The ribs for the other panel are made by duplicating each rib separately. This is to make sure, in case of any inaccuracy, that the panels balance each other aerodynamically.

A neat modification makes use of a spacer between each rib. Then use ten blanks, and when the stack is disassembled, mark in the order from the largest rib to the smallest: 1A, 2, 2A, 3, 3A, etc. Rib #1 is always made separately by duplicating the large template. Do not remove the bevel from the A ribs, but do so to the others. The


The Thermic Sniffler contributed considerably to flight performance of the AR-13. Ability to sniff out thermals makes it a lot easier.

AR 13 RC Glider

high side of the A ribs becomes an exact duplicate of its numerical equal. For example, the high side of rib 2A becomes the equal of rib #2, bevel removed. The A ribs can be used later to make duplicate ribs for repair work if needed.

The ribs for the outer panel are made between templates of ribs #6 and #23. Use 17 blanks (18 required ribs—count them: 6,7,8, ..., 22, 23 equals 18), and the largest rib will be rib #7, after the bevel is removed. Make a balsa duplicate of the largest template (now template of rib #6 is the large template), and all the ribs are made for the outer panel.

Slice off the rear end of each rib to make an aileron rib. Line up the aileron rib template tool with the razor-cut mark on the bottom of the rib, with the bottom of the tool and the rib even, and cut off the aileron rib. Since the razor-cut mark traverses the rib at other than 90°, use the mark closer to what was formerly the low side of the rib before the bevel was removed. If the razor cuts are not clear, use the plans to locate this aileron hinge point; the back of the leading edge (front of the rib) is the datum line.

The aileron top spar notch is made using the same tool; only now the leading edges of the tool and the aileron rib are made flush. Also even out both, the top of the tool and the aileron rib.

Building a straight and true airplane begins with a straight line. The straight line on the plans may not be straight because of the effects of moisture on the paper or poorly drawn lines, or the plans may have been unintentionally manipulated to curve the line, etc. Then, a tool like a 48″ metal straightedge can be quite useful, but first you should make sure the straightedge is straight!

You can easily check the trueness of a straightedge right at the store when you're buying it. Place two straightedges edge-to-edge and check for clearance. Since each straightedge has two edges, there are four combinations that should be checked. Not two, but all four combinations must meet perfectly and show no clearance in between in order to be sure of a truly straight edge

Another method is to draw a line with the edge facing up, and then reversing the same edge so that it faces down, place the edge against the line. Any deviation will be twice the error.

Check a right triangle or a carpenter's square for a 90° angle by drawing a perpendicular line to a known straight line with the perpendicular side facing right. Using the same base, flop the triangle so that the perpendicular faces left. The second perpendicular should coincide with the first. Again, any deviation is twice the error. It should not have to be said how important the right angle is in drawing plans, making formers and bulkheads, and squaring up in general.

The carpenter's square is used to locate the upper spar on the ribs, after squaring to the flat bottom and lining up to the lower-spar razor cut. It is also very helpful in making a 90° cut of the ribs in front of the ailerons.

The straightedge is used to line up the trailing edge in front of the aileron and to keep the front of the aileron straight so that they both match. The leading edge can waiver, but these two should be built straight.

Each half-span of the rib spar frame, including the glued wing connectors, is made directly over the plans minus the bottom sheeting. The frame is removed from the plans, and nylon thread is wrapped around the connectors. After placing the bottom sheeting in position on the plans, epoxy the spar rib frame to the sheeting using a slow-hardening epoxy to allow ample time to use the straightedge on the trailing edge.

After the top sheeting is glued to the wing structure and the wing removed from the jig, use a coping saw with a very fine blade to cut the brass tubing of the wing connectors, separating the panels. Cutting on the back stroke eliminates the tendency for the teeth to grab. It is slow, but it does the job.

In sanding the wing, give the greatest priority to maintaining the airfoil curvature. Strive for a smooth and continuous airfoil shape, rather than the smoothest finish.

With a felt pen draw chordwise lines, 6″ apart, on the wing skin. The lines are used as boundaries and as an indicator of the depth of the sanding. The sand paper is made to oscillate spanwise between two lines while traveling from leading edge to trailing edge to and around the leading edge. Just a light cut is made before proceeding to the next section and so on. The second run is made with the same magnitude or width of spanwise oscillations, only now the sanding is centered on a line.

It is of utmost importance to keep the sand paper traveling chordwise, never sanding too long on any one part of the chord to preserve the continuous airfoil curvature and to remove an equal amount of balsa from each segment of the skin. Also keep the total amount of wood, removed, small because deviation from the intended airfoil shape increases with the removal of balsa . . . and more light sandings are better than a few heavy ones.

The triangular stock, attached to the rear spar and to which the ailerons are hung, is glued with an eye on keeping one edge flat with the bottom even at the expense of an imperfect glue joint. Since the ailerons will be hinged to this balsa piece, the knife edge of the triangular stock needs strengthening by rubbing a light coat of epoxy into the grain of the wood. Use a small balloon over your finger to prevent direct contact with the epoxy.

Because of the unique twin-bevel edges of the vertical sheet strip at the front of the ailerons take special care when cutting it. If you use a single-edge razor blade, held against the beveled block, with a straightedge as a guide, you should come out with an accurately tapered strip with bevel edges. Lead weights, strategically placed on the straightedge, help to prevent it from moving if one hand also helps to hold it down.

Sanding the ailerons is the same as sanding the wing; keep in mind the ailerons' front top curvature. This curvature is the arc of a circle whose radius keeps getting smaller as one progresses toward the tip of the wing. Templates are made from 1/64″ ply; keep constant check while sanding. Final-sand this curvature after the aileron is attached to the wing so the aileron gap cover strip, which almost touches the aileron, can be used to indicate the exact curvature desired. When the aileron is deflected, the gap varies as the curvature is out-of-round.

Before the ailerons are hinged to the wing, rub epoxy into the grain of the wood under the MonoKote hinge material. The epoxy is allowed to harden before ironing on the MonoKote. MonoKote is used for the hinges because a low-stretch hinge is desirable, whereas Solarfilm is used to cover the rest of the plane because it is easier to apply on fully-sheeted surfaces and it is lighter in weight.

After the ailerons are hinged to the wing, the gap cover strip is glued to the vertical trailing edge while resting on the aileron. If the aileron top front curvature is not reasonably circular, it would be difficult to deflect the aileron without cracking this strip. It will give a little though.

Final-sand the aileron top and then apply Solarfilm to the aileron while it is attached to the wing. Take care while sanding a feather edge into the gap cover strip not to get too fine an edge as there is a tendency to go beyond this fine edge making the width of the strip less. Strengthen the feather edge by rubbing in several light coats of epoxy, again using your balloon-covered finger. Don't allow any covering material to come too close to the feather edge because, in shrinking, the covering material might warp the edge away from the aileron adding to the drag and reducing the effectivness of the ailerons.

The fuselage is constructed conventionally except for the method of contact-cementing the ply doubler to the side. Place brown wrapping paper between the contacting surfaces exposing a very small part of the surfaces, where light contact is made. Gradually, the wrapping paper is pulled back allowing a precise registration of the two parts.

Use the leading edge and trailing edge as a jig for building the stab. A center line, drawn on the oversize leading edge and trailing edge, is lined up with the center line drawn on the rib; the rib does not touch the board. Drawing the lines made the whole job easier even though a straightedge placed on top of the ribs was used to double-check their position.

This is not a very difficult model to build, but you should make a strong effort to work to close tolerances, especially on the wing. Smoothness in curvature, on the whole model, is probably more important than a smooth finish. Never sand too long in one spot; otherwise the curvature tends to be flattened. Working in good light does not necessarily mean strong light. Placing the light, properly, so that it skims across the work surface, will show far more detail—that is more imperfection—than high, flat lighting. Skim lighting is having the light strike the surface at a low angle. If the light cannot be moved, move the chair and sand farther away from the light source.

Why ailerons on a glider? It began as an exercise, something to do, and it ended by adding immensely to the pleasure of gliding flight. Around here, a 5-or 6-minute flight in sparse lift, where it is a struggle to stay up, is far more enjoyable than hitting the old boomer, where, sometimes, it is a struggle not to stay up. This is where the ailerons come in. They add another dimension to gliding flight: the roll. When much altitude is available, trade off some height for some fun.

What about competition? With the advent of multiple tasks, there should always be room for one more task; otherwise progress ends. Can a new task be defined for which points would be given for some controlled flight maneuvers to be added to the duration time? A better glider might evolve, capable of providing more pleasure and enjoyment. AR-13 just scratches the surface; it is one approach by one person. Imagine the results if many others added their ideas.

Presently, the roll on the AR-13 is very strong which leaves room to improve the duration once again. Consequently, during the next building session, the wing span will be increased by 7″ including Hoerner tips. The AR and the wing area will go up as will the anticipated duration capability. It will be a simple addition to build, and it is shown on the plans.

This model was flown with a mixer which rendered the ailerons capable of flap action. Various, in-flight, flap positions were tried, and the best position seemed to be when the bottom of the flaps were even with the bottom of the wing, that is, zero flaps. Since the flaps did not seem to add much to flying, the extra servo and the mixer were replaced with a Thermal Sniffer which did.

The mixer is shown on the plans, with the output from the mixer on the same side as the input. This makes the flap control very insensitive for small, precise flap changes, but it does limit the total flap movement. For large flap deflections, have the mixer output 180° to the input. ■