K A H U N A

By JOHN TOOMER

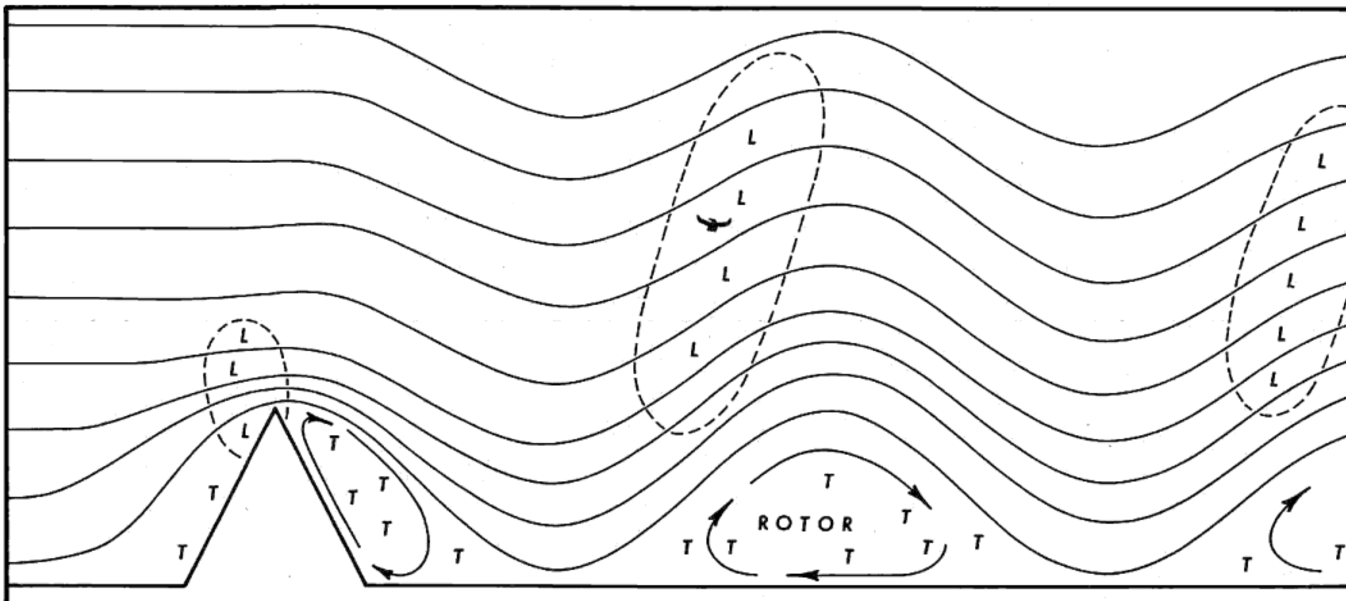

DIAGRAM 1

TIRED of the hassle you have to go through to do a little flying? Long waits for a few minutes of flight? Interference? High fuel bills? Crowds of wing stompers and fabric pokers? Like a change? No time limits in the air, fly when you like. Fly where you like. No noise to bother people. No fuel bills. No gooey mess to clean off your plane. No oil in servos. No vibration to cause trouble. No crowds to get in your way. Unbolt your motor and try soaring flight. Use your old equipment if you wish. Relays work fine in gliders. Use your old superregen set if you wish. Sit down to fly. Better yet, lay down like I do. Relax Mac, this flying game is fun if you do it right. . . .

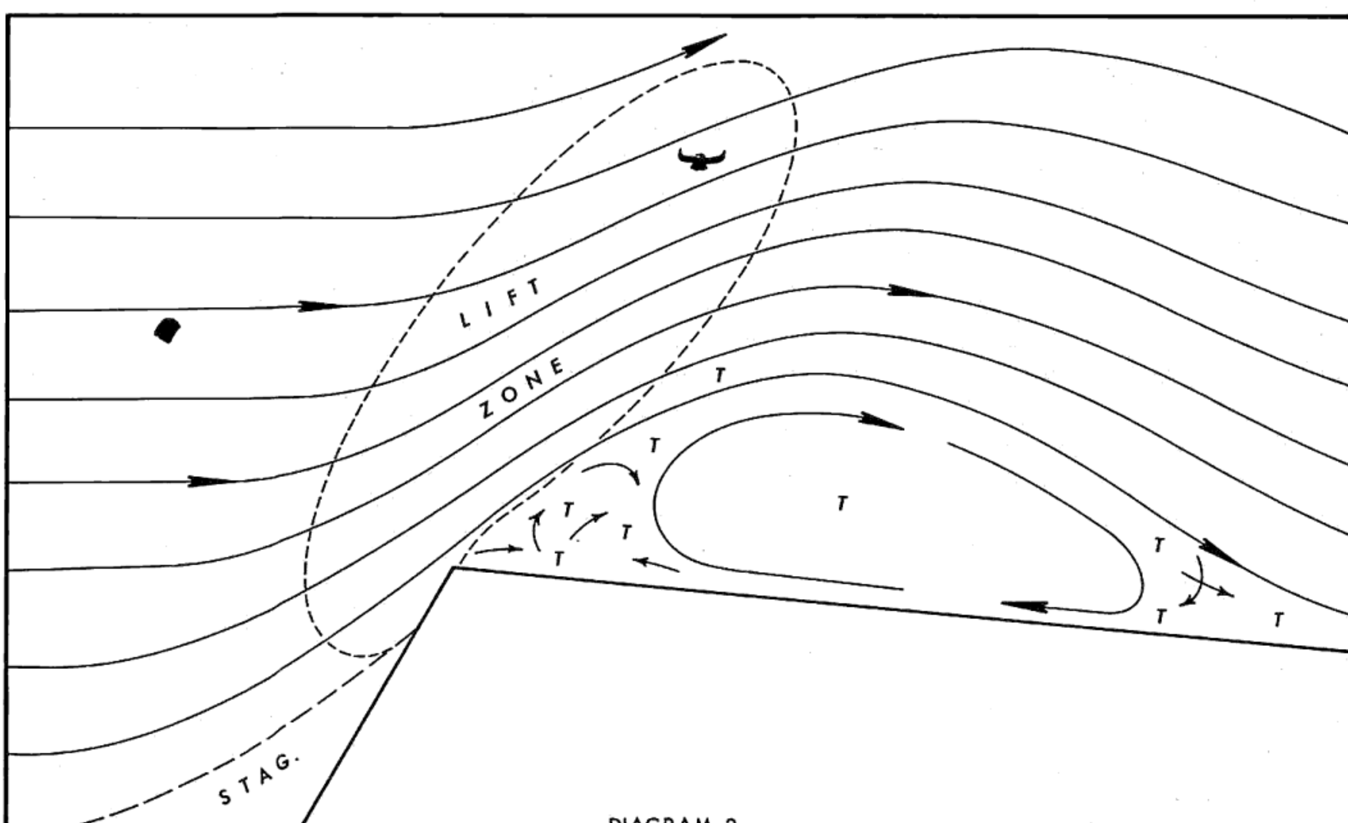

DIAGRAM 2

SOUNDS like sailplanes are the answer to just about everything doesn't it? Well, not quite but they **CAN** provide all I've said. With an engine you are limited to areas where you are allowed to make noise. Without an engine you can fly anywhere you can get your bird airborne.

This two-part article will show you how to build a general purpose sailplane for medium wind conditions. This version of the Big K has been picked because it has no vices or hidden defects to cause you trouble. If you build it according to the plans it will fly on the very first attempt. Several versions of the Kahuna have been flying since 1957. Most of them have been rudder-elevator machines but some have been converted to full multi.

Before we get into the construction of the Kahuna some general notes on gliding will help you gain a feeling for the sport. There are two basic types of soaring flight. The most commonly used is slope soaring or wave riding. This consists of utilizing the up draft of air flowing over a natural obstacle such as a cliff, ridge, hill, or mountain. This ground wave can be of sufficient size for model sailplane use over relatively minor surface features provided they are long enough to block an end run by the wind. Associated with wind barriers such as large cliffs, or mountain ranges are a series of standing waves (see diagram #1) beginning at the obstacle with what we might term the ground wave and extending backwards or downwind of the obstacle in a series of Lee or Sky waves which reach into the stratosphere on occasion. Briefly, these waves are caused by the air bouncing up and down after being forced to pass over the obstacle. The sky waves need not concern us for they are well above our flying range.

Getting back to our mountain we find light, turbulent air near the foot and up the windward slope until we almost reach the top. As we approach the critical edge (which may not be the top of the hill) the wind becomes steady and strong. On the ground it will feel as if the wind is following the contour of the ground as it sweeps over the ridge, but this isn't true. Only a few feet above your head and slightly to windward is a powerful river of air rushing upward. The wind you feel on the ground is simply a turbulent boundary layer.

To the lee of mountains is a zone of violently turbulent air descending the slopes. There is a general rotary motion to this mass of air but it is composed of numerous smaller rotors and whirlwinds oriented in every conceivable direction. If you want a real thrill try flying in lee air conditions. Expect to loose your plane, though!

Diagram #2 depicts a typical hill or cliff and some wind features you may find. First let me say that this drawing cannot attempt to show all the possible variations of conditions you might meet. Even several drawings would not be sufficient. We see an area with little or no wind at the foot of the hill. Above the ridge is an area roughly elliptical in shape and leaning leeward (Loo'ard to you swabbies!) which will support a sailplane. The lift area can be large or small. It can be tall or short. It is ALWAYS a few feet up and a few feet to windward of the ridge but it may not be anywhere else over the area or it may be everywhere. It depends on how hard the surface winds are blowing and how hard and which way winds far above are blowing. You might even notice a cyclic rise and fall in lifting force on rather calm days. This is caused by the passage of thermal areas a mile or so above you.

The strongest lift will run right through the center of the lift zone and tend to be in the bottom quarter. The smoothest ride is to be had at the front of the zone and the roughest along the back. Ravines or "holes" in the hills or cliff edge will cause a dent in the lift zone, and poor lift together with high horizontal components, which will tend to blow you away. Turbulence can be encountered in such areas.

The area along the top of the hill or cliff and to leeward for a short distance is composed of rather indifferent air — light, various winds together with occasional strong currents. What you run into here is determined in large measure by the shape of your obstruction and wind speed.

The second type of soaring is hard to do in model form because of the altitude required and specialized type of sailplane needed. Thermal soaring consists of flying in rising bubbles of hot air. Thermals start out near the ground as a general rising of a blanket of heated air. Fifty or sixty feet off the ground it has begun to divide up into small bubbles of hot air. These keep rising and begin to rejoin into larger bubbles maybe one or two hundred feet across. At half a mile altitude, where the real thermals begin, the lift zone may be as much as a thousand feet across and going up like an express train. Obviously you can't fly half a mile above you where the real lift begins so you are restricted to the smaller thermal activity lower down and may spend much time simply looking for a thermal. As far as I know there are only a half dozen people who even attempt this type of flying.

For these two types of soaring there are three types of glider. First, there is the average general purpose sailplane. It can fly in light wind conditions over a hill or ridge and in heavy thermal conditions. It is an in between machine — too light for a real blow over a ridge and much too heavy for decent thermal soaring. All of the kits on the market today are of this type. Kahuna is no exception but is at the heavy end of the scale. The Big K can take a fair blow, especially the seven foot version with fiberglassed fuselage. You can purchase kits all the way from 24" span on up to ten foot lumber yards. The smaller glider is ideal for rudder only and will perform wonders on a slope. The larger rudder only machines are better flown in the light average conditions you will usually encounter. If you build a real Cape Horner you will be limited in the number of days you can utilize unless you have a hill with a built in hurricane!

The more serious sloper builds at least one glider that exactly fits wind conditions on his favorite flying ground. The specialized sloper is a short wing high weight machine with full multi control. It takes a fair breeze to keep one up. Extreme types are called "Penetrators" because of their ability to be trimmed down to speeds which allow them to make headway against winds which would blow a lighter or slower machine away. Take a Falcon, Orion, Taurus or other powered stunt plane, remove the motor and wheels, add a pound or so of weight and you would have a pretty fair penetrator. In fact come to think of it that is a good way to make one although I don't know that anyone ever has. I'd like to suggest trying out soaring with your present plane by flying from a hill, throttling down and then trying to keep your iron mine in the air. The first few times you will probably pick days without enough lift. It takes a little time to become accustomed to flying in high winds.

Any sailplane with more than rudder and elevator control can perform most of the AMA stunt pattern and good pentrators can do it almost as well as a powered plane. Next time you're having trouble making a good pattern remember there are people who don't even use motors that can do better than you! (I'd better state here that I'm not one of 'em!)

The last and least common are the thermal soarers — huge machines with and acre or two of wing area, spans of ten and twelve feet and weights of four and five pounds. They are capable of flying only in light to medium weather. The thermal sailer cannot be stunted very safely due to its design and structure so you are confined to plain soaring which can be quite a game in itself.

Under normal trim conditions the average sailplane flies slowly enough and reacts slowly enough that almost any control system is adequate. Even compounded escapements for multi control work out very well. We'll go

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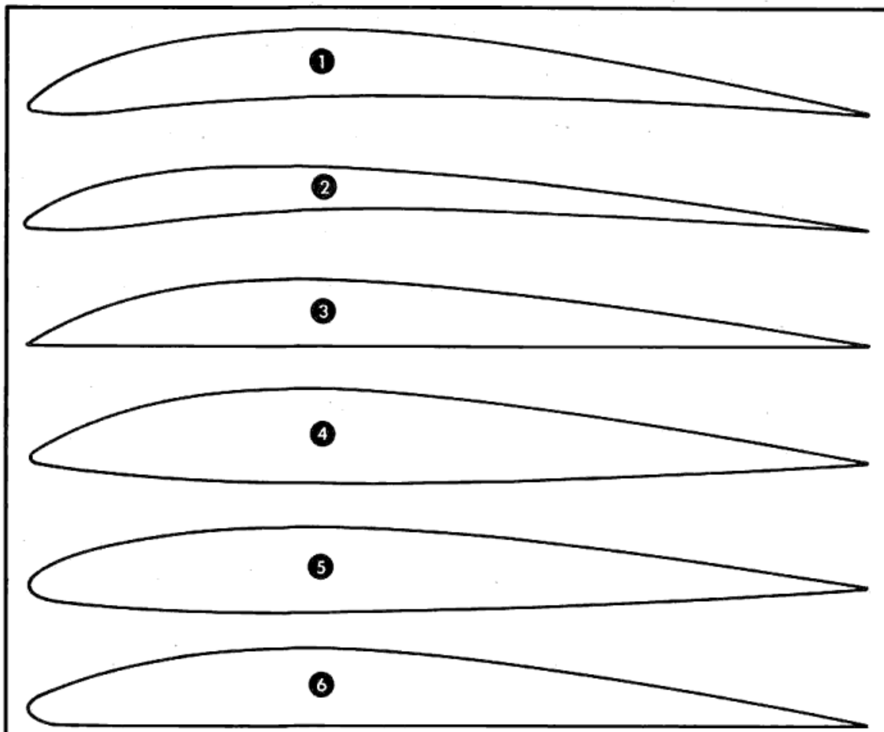

DIAGRAM 3

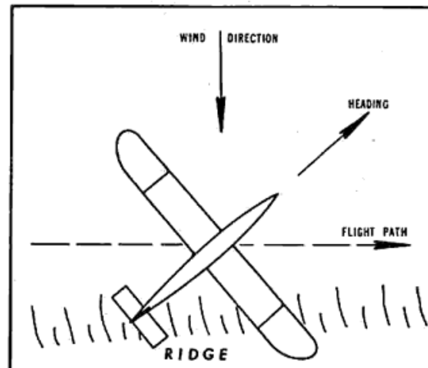

DIAGRAM 4

Kahuna

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through a few dozen ways of controlling things so you can see what a wide variety of methods you may employ. With no vibration to worry about you can use equipment and wiring techniques that would spell disaster in a powered model. Wires can be connected by using contact pins from old radio connectors. As previously mentioned relays are ideal for sailplanes and there are a lot of old relay sets around. If you get out into the country to fly you can use superregenerative equipment.

The simplest form of control is rudder only using a plain two or four pawl sequence escapement. The four pawl variety allows you to leave the plane in a turn without sending a signal. Self neutralizing escapements relieve you of the problem of remembering which position you will go to next. Single channel servos relieve you of the tedium of winding rubber motors. They are also handy if you have a large rudder only plane. Air loads build up rapidly on a control surface to overcome escapement power and there is nothing more heartrending than to see your pet buzzard wheel it in with a hung control. An answer to this problem is air balanced surfaces but none of us use them for some odd reason.

Elevator control added to rudder opens up an entire new dimension in flying. I think this is more true of a sailplane than of a powered model. Elevator control is the throttle of a sailplane. With the ability to trim the elevator setting comes the ability to adjust to varying weather conditions, change speed, and of course stunt in a workmanlike manner. You can gain quite a bit of this ability by using escapement control of elevator via compounding or by using the famous Galloping Ghost. The latter is a trifle more evident in a sailplane than it is on powered models – reminding one of a threshing machine drunk with power and bent on world conquest!

Four Channels allow full control of both rudder and elevator by use of servos. There are two interesting modifications which are used on four channel planes. Both are more applicable to the sport flyer or thermal machine than they are to stunt or penetrator. The elevator servo is the recipient of one of these gimmicks and the rudder servo the other. By masking off a section of the return circuitry on the P.C. board which most servos now sport we can convert the elevator unit into a semi trim device. Small sections of the automatic return circuit are covered with a good quality electrical tape or Scotch Magic tape. A quick blip up sends the elevator servo up but when it tries to return to neutral the slider rides up on the tape and the servo stops a small fraction away from true neutral. The same effect is made to occur on the down side by another small sliver of tape. The elevator can be positioned in this dead area by quick blips in the required direction for the masking does not impair your direct control over the unit. The limit of up trim position is picked so the plane is flying at a nice slow float. The down position is picked for maximum speed without having the plane pour "Over the edge" into a dive In between these two extremes you can trim your sailplane to fly as you wish. Some people use fully trimmable elevator but this can be quite hairy to sort out in a pinch.

The rudder modification is similar but done about half way out on each of the rudder return lands. The result is that the rudder will stop at an intermediate position when returning from full throw. This allows the plane to be left in a permanent turn for circling. To recover neutral you simply blip opposite rudder to move it over the tape and it will then neutralize in the normal manner.

If you have six or more channels at your command you can next add Ailerons, Trim elevator, and with ten or more channels, Air Brakes which gives you full house on sailplane. Trim elevator and Ailerons allow you to stunt and do the full AMA pattern taking into consideration the lack of a motor for some of the weirder maneuvers. They are also of great aid in soaring as such and are used almost as much as rudder for keeping a heading once their use is understood. (I'm speaking about Ailerons in that last sentence.)

Our last item of control is Air Brakes. Aircraft that fly in updrafts at times develop the nasty habit of not wanting to go home when you do. A dethermalizer corrects this tendency in most cases. Air brakes can be termed a dethermalizing device. Ridge runners of the penetrator class never need worry about such things, but as wing area goes up and wing loading goes down it becomes more and more of a problem. There are several aids used to bring a wayward buzzard down but none are foolproof. What you usually think of as dethermalizers are not usable because they destroy control in most cases. Pop-up tails, parachutes, etc., are not used on radio controlled aircraft.

Trailing edge flaps are used and opened out to somewhere between 60 and 80 degrees. Flaps of this type almost have to be used with trim elevator for they cause a considerable nose-up tendency as they are deployed and con-

(Continued on Page 50)

Kahuna

(Continued from Page 48)

trol becomes rather sensitive after the plane is re-trimmed. The flaps in effect change the decalage angle and cause an apparent tail heavy effect. Slotting the flaps (making a space between the flap and the under surface of the wing when the flap is open) helps out with the trim problem and also increases the braking effect. Split flaps which open both up and down should be even more effective but I have never seen such a scheme used. True air brakes look like flaps but are farther forward on the wing. A typical hinge point being 50% of chord for an under wing installation and 40% below and 60% above for dual flaps opening on both surfaces. Twenty-five to thirty percent of span is usually adequate brake size and all brakes are slotted for maximum effect.

Spoilers (I'll bet you were wondering when I'd get to them) are infrequently used in models for two reasons. Firstly they are deadly things to control and secondly they don't really do what we want. (I'll get back to the second reason a little later.) Spoilers are fences which open on the top surface of a wing to throw the airflow off and destroy lift. Spoilers can be situated anywhere from about 20% of chord to 75% of chord depending on the degree of action wished. Spoilers are usually from 10% to 20% of span and stand up from the surface about 5% to 10% of chord. A very small spoiler will go an awful long way! The effect of spoiler action will be a decided nose-down tendency so if you decide to try, be ready!

While diddling around with spoilers we discovered that even closed spoilers have an adverse effect on the performance of a wing. On model aircraft the airflow is so slow and the camber of the wing so little that almost no energy transfer is involved, and as a result, once the airstream becomes detached, it can't regain the wing surface. The airflow energy is so low that almost any irregularity will cause separation. The end of the wing leading edge planking being a very good example. Kahuna has such an irregularity but you will never know the difference for it is only of importance on high performance contest sailplanes or thermal soarers.

Air brakes are not dethermalizers as such. They are speed control devices and are used in conjunction with other controls to bring the buzzard back to the ranch. There are three basic methods of achieving a squat on the old homestead. Method number one is: Fly out of the lift and wait. That sounds pretty easy and nine times out of ten is all that is required. Which way is out though. Well, if you have explored the lift you are in (which all good pilots do) then you have a pretty fair idea of which way is the closest exit. A couple of additional rules will help you. If you are low to the ground (you are low if you can distinguish control surface parting lines and other details), turn down wind. If you are high, turn up wind. The danger of turning down wind when up high is that by the time you get out of the lift you may have been swept so far down wind that the plane will become lost on landing.

Method number two is: Spiral down. This must be done with care. Sailplanes have a greater tendency to spin or spiral because of their design and trim and some designs will not recover if the airspeed gets too high. Beware of machines with vast rudders. All that acreage wasn't put there for nothing. Keep your glider in a wide spiral and don't drive it too hard. Try to maintain as much of a bank as you can for a wing on its end can't do much lifting. If you have ailerons you will find this no problem. Your planes will come down unless you are in real trouble.

Method number three is for real trouble: DIVE! Sounds even simpler than method one doesn't it? Just push the stick forward and come down in a nice smooth dive. Why waste time with all those kooky other ways? Well matey, sailplanes have one nasty little feature I haven't mentioned. They can just about break the sound barrier in a dive and they DO break the wing barrier. I don't know what the terminal velocity is with the wings on. I suspect it is close to 100 M.P.H. I DO know what it is with the wings OFF. MUCH too fast for survival of any radio gear. You don't even need to bury the remains. That is completely automatic! The wings begin to show signs of distress at about forty miles an hour and rarely last beyond sixty. I'm speaking here of sailplanes as opposed to ridge runners or other no-float varieties. Sailplane wings are long and with very little thickness. It doesn't take much to start them flapping. First comes a faint shuddering which can sometimes be heard on the ground. Silkspan covered wings can buzz at certain speed. Then as speed goes up an obvious fluttering can be observed. This may be in several modes at once. By this time the noise is rather pronounced. Shortly thereafter one or both wings will resign. The answer to the airspeed problem is some sort of air brake to make a dive more controllable and regulate the maximum speed at which the glider can fly. Flaps or air brakes do this job. Spoilers do not (and here is reason number two why spoilers are used infrequently) have any braking effect. Used in conjunction with flaps, spoilers are ideal, for they counteract the trim disturbance caused by flaps.

(To be Continued)

KAHUNA

PART II
BY JOHN TOOMER

To dive you open the brakes first. It takes horsepower to dump a brake at speed and you might find you can't do it if you wait until you need them. Then begin applying down elevator and assorted other controls to bring the plane down.

One last word. All dethermalizers work in still air. You do not fly in still air. Make sure ou have enough control for unusual conditions.

I don't want to frighten you off with all this talk about not being able to land again. As I've said earlier the average ridge runner will never need to worry about this problem. It is usually too heavy to get into trouble and will be flown so close to the ground that it can't get into the trouble area which is several hundred feet up. I mention the matter for those few of you who like WINGS and may get into trouble before you realize what you have created.

Now on to construction! The basic design of the big K was laid out in 1955 or 56 as closely as I can remember and the first three were begun in 1957 I think. The design followed the then nordic philosophy. The underslung fin has definitely proved to be more effective than the more conventional position. The order of merit being something like 20%. Other designs achieve a similar effect by placing the tailplane atop the fin as a large portion of the interference problem seems to be generated by the upper surface of the tailplane. Wing chord was increased because of the higher wing loading of a controlled aircraft and the greater airspeed will extract more lift over a longer chordline. Airfoil section has been varied and only two or three Kahunas have had the same airfoil. The original section (#1 in Dia. 3) was the "Thing to use" back in 57. Sections #2 and #3 are used on current thermal machines and sections #4 and #5 on penetrators and stunt gliders. Section #6 is the one used on this version of Kahuna and was chosen because it dosen't have any unusual changes of lift or drag over a wide range of operating conditions. It is simple to build and cover and will give you all of the performance you can probably extract from it. Exotic airfoils are only of noticeable superiority in the hands of experts and on specialized machines.

Kahuna's wing is polyhedral for rudder only flying and can be used for multi as well although there is very little reason to use polyhedral on a plane with ailerons. My own K is rudder-elevator only with eight foot polyhedrals for a special purpose connected with that mysterious "weather vane" atop the fin. Ridge runners fly a 'beat or track back and forth along the lift zone of the hill or cliff edge. If the wind is high or the hill low there will be a considerable horizontal component present in the wind and the flyer will be called upon to make continuous corrections of the flight path by blipping "weather" rudder to keep the plane headed enough into the wind so it won't blow away. While trimming Nordics I had noticed a condition of trim which would be of use under these conditions. It certainly was not of any use on Nordics and we had a few things to say about it at the time. This system works best on gentle slopes and in steady wind conditions. The steering vane provides enough additional fin area that the plane tends to turn into the wind. The polyhedral tips (or considerable dihedral also works) tend to bank the plane away from the wind if the plane is flying across the wind. These forces tend to balance out at an angle of somewhere between 40 and 60 degrees if the vane is carefully trimmed in size. The glider will then hold this fixed heading and crab along the ridge (diag. 4). Wind speed and angle of upward flow modify the effect so that at time rudder control will still be needed to keep the plane on course. With the steering vane in place you will have three stable conditions. Dead into the wind, and right or left at whatever angle your plane trims out to. Flying a beat then consists of simply turning the plane into the wind at the end of the beat and letting up on control as it swings by the trimmed angle. It will then yaw back into the wind and begin the next pass. Heavy gliders don't respond too well to this system. The plane is rather stiff on control with the vane so removing it for normal flying is advised.

My original Kahuna is still flying. It took me two years to build mine and in that time two others were built and washed out by the builders. They have since made more exotic versions. The normal building time isn't two years. I just happen to be rather slow. I'm beginning to wish I could prang the thing, for I'd like to build several other things I've designed but the K and the present Enterprise crowd me as it is. The moral is evidently "Build weakly, so you can build again!"

Read the article to the end. Look over the plans carefully. Read the article again. Make sure you understand. Decide exactly what you want your model to be like and then cross off any parts or modifications you don't need so you don't end up with two left wings. I'd suggest you stick to straight wings unless you are building a rudder only version. If you are going to use servos, build the eight footer. If you don't have a work area long enough to lay out the fuselage or wings all at one time, do what I did, build half at a time and let the rest hang over the edge. I built mine on a two by three foot drawing board and I drew these plans on a board only two feet each way.

Begin construction by splicing everything that isn't long enough. If you lay things out correctly you can get both fuselage sides out of two three foot long boards by laying the sides out tail to tail. Cut out all the plywood parts. Make the wing tongue out of good hard dural or steel. Make two tongues just in case. Try to stay away from dural if you can for it has a habit of binding in the wing tunnels and there is nothing more annoying than an eight foot sailplane with non detachable wings fifty miles from home by VW. Graphite or silicone grease might help. My tunnels are brass and my tongue is dural. Perhaps tin tunnels wouldn't have this problem. The wing tunnels are bent from tin or brass. Solder the seam if you are able to.

The method of attaching the wings may dismay you. They are not knock off. But then again they are not "fold up" which is the main intent. I've seen both plywood and dural wing tongues of the more common type collapse on pull-outs. So far this system hasn't. The tongue should fit fairly tightly in the tunnels, but don't worry if it doesn't. My own buzzard has been flying, yea, these many years with no restraint on the wings at all and the most I've ever experienced is a quarter of an inch separation from the fuselage from time to time. There are hooks in the wing roots over which you can slip a rubber band or "O" ring if you wish to hold the wings on more definitely. The tongue and locating pin are made totally removable so they will not be a hazard when transporting the machine or working on it. The wing hooks are a hazard.

Lash the fuselage tunnel to F3 and epoxy; make sure you have a good brand. Use only that made by a known reputable manufacturer. There are several worthless brands on the market which do not set up properly. Anything that sets up faster than ten or fifteen minutes or is sticky or greasy feeling after twenty four hours is a defective formula and should be discarded. Fast set-up does not allow long chains of molecules to form from which epoxies get their superior strength. Sticky or greasy materials indicate improper chain formation also, usually because of contaminated formulas. If in doubt stick to cement.

At the same time, epoxy or glue the brass or steel locating pin tube to F4 after lashing it in place. By the way it doesn't matter if the wing tongue and locating pin tube aren't long enough to reach to the outer surface of the fuselage sides when they are assembled, for the wings rest against the ply wing roots. If your wing tongue tunnel and locating pin tube turn out too long they are filed off flush with the wing roots.

Next get a hunk of wood about three by four by five inches and saw out the nose block. Use balsa if you have to, but pine, teak or mahogany is more to the point. Sand the side contours to finished shape, but you can leave the top and bottom until later if you wish.

Meanwhile back at the construction board you are gluing the hardwood and balsa longerons and cross braces in place on the sides. I used hardwood for the top longerons to make the hatch opening less prone to damage. When everything seems reasonably dry begin assembly of the fuselage by attaching the nose block and F1 to the sides. Lay the fuselage up side down on some reasonably flat surface for the assembly operation. Use a clamp on the nose block and sides. Protect the sides by cardboard or some wooden wedges so the clamp is gripping parallel surfaces. I know you won't let this part dry as thoroughly as you should, so go ahead and add all the other formers. Lashing, clamping, twisting and wedging the thing so it doesn't fly apart. All I ask is that you somehow keep the top edges reasonably flat on your workbench. Add the additional cross bracing and the fin superstructure. Make sure you get this latter in straight! If you build in a warp you will have to remove it all and start again. Add the bottom planking. This can be two thin sheets glued one on top of the other or one thicker sheet. The two thin sheets place less strain on the fuselage. See my comment on radio installation *before* planking the bottom.

With the main structure of the fuselage complete you can now finish the nose block. If you wish you can fiberglass the nose section. As built your Kahuna will be tail heavy so you need not fear adding weight ahead of C.G.

Build the stabilizer next. If you plan to use the steering vane cut the slot for it after you have planked the center section. The steel locating pin shown on the stabilizer is to be added if you wish to bolt the stabilizer in place. A single bolt through the trim angle adjusting block will suffice. The locations for dowels are shown in case you wish to hold the tailplane on with rubber bands.

Build the structure on the fuselage for mounting the tailplane but don't plank the top of the fuselage yet. Add the wing fillets and the ply facings. Plank the fin and install the rudder.

Fit your servo decks or escapement panels to the fuselage. Install your radio gear. You might feel better doing this before you plank the bottom. It does help to be able to get at two sides while adding the innards.

If you use Bonner servos you will have a little trouble installing them as they just make the grade. Annco, Kraft, and the European servos all fit quite well. My own units are all home made so I can't say much about installing commercial units for I've only seen the results and haven't experienced the actual pains required.

If you plan any wing controls you are probably wondering how it is done. One installation was as follows: Plywood plates were fitted to the walls of the tail group servo compartment and brass bearing plates an inch or so square were epoxied onto them. The wing retaining hooks were replaced with 6-32 screws epoxied into blocks of hardwood in the wing roots. Wing nuts (what else?) then held the wings to the fuselage. The control rods pass through holes just forward of the wing tongue and attach to a bell crank for a Bonner or a more normal harness for one of the smaller servos that can be mounted crosswise. The installation I'm detailing hooked the rods into a sector plate attached to the operating arm of the servo. Adjustment for aileron positioning was by bicycle spoke turnbuckles.

Because we have several cross members blocking easy removal of the radio gear it is best to use cable connectors for all wiring unless you plan to permanently install your radio gear. Any type of connector will do, for you don't need to worry about vibration. (My own equipment is removable for I have only the one set which must be moved from plane to plane.) Install the largest batteries you can fit. As I've said, the plane will be tail heavy and a set of "C" (four) size cells or 500 ma DEAKS will just about ballast it correctly. The plane was deliberately made tail heavy to simplify C.G. trimming. The switches are mounted in the wing group compartment if you don't fit wing controls, and at the front of the receiver compartment if you do. Use a plywood plate glued across the fuselage under the upper longerons.

Install the push rods and assorted other mechanical items. Rudder movement should be about ten degrees either way but with assorted holes in the horn that will allow throws of five to seventeen degrees. Elevator movement is also plus or minus ten degrees with three to fifteen as additional ranges. If you fit elevator trim three to six degrees in either direction is adequate. Aileron throw is more difficult to state for it changes with the type of wing you make. In general about a two to one differential seems best with not much more than seven degrees of down unless you make a true mahogany log. Faster Buzzards can take more and will respond well to more nearly even differential. Kahuna doesn't respond rapidly to aileron except in a dive so don't expect snap rolls. Too much aileron will cause a decreasing effect and a nose down tendency.

Plank the top of the fuselage and anything else that looks like it could use it.

The canopy is next constructed. Pin the longerons to the fuselage and erect the various formers. Plank the canopy. This is a little tricky for you have to remove the pins as you add the side planks and then repin both the planking and longeron to the fuselage again. Plank the top of the canopy last. The canopy can be bolted to the fuselage or it can be clipped on using dress snaps. The hardwood blocks at front and rear and the bolt-on provision is for a second canopy that mounts a small cruising motor.

The wings are designed for a complex covering: heavy silkspan overlaid with light silk. This unusual method was employed to get rigidity without the weight of fully planked wings. The silk gives fracture strength to the covering. If you use only fabric covering you will do well to cap strip the ribs with ⅜" wide balsa. The wing can also be planked with 1/32" sheet and silkspan. The actual construction is conventional. Make sure the wing tongue tunnels are well epoxied or glued in their mounts and the entire root area should be especially well built. Use good tough balsa for the main spar webbing with the grain running vertically as this is where the wing gets half its strength. Also use good tough wood for the trailing edges.

I don't show supporting structure for ailerons or brakes as I expect very few machines will be made with these features and I want to keep the plans reasonably easy to follow.

Fit the diagonal bracing *tightly*. It must be incompression to do its job. It is anti-warp insurance. It is the next best thing to geodetic construction that I know of. When the structure is complete install the panels on the fuselage and check to see that dihedral angle and angle of attack are the same for both panels. Be very methodical about this check. Your plane will fly with either of these off a little but it will pull some mighty strange maneuvers if it is ever driven at high speeds. Plank and cover the wings.

Dope the entire plane and structure with a very dilute solution of clear dope. Sand and repeat the dilute doping. Cover the entire plane with silkspan or a fabric. Dope with sanding sealer and sand off as many times as is required or until you give up on this never ending job. Paint the wings lightly. Spray them if at all possible and above all don't put too much paint on them. Too much paint will end up in warps. Maybe not this year but sooner or later.

Very light colors are best for visibility. Most Kahunas have been a basic white with small areas of two tone trim. Take care about applying wild assorted striping, especially on the wing under sur-

(*Continued on Page 69*)

Kahuna

(Continued from Page 33)

faces and fuselage sides. At a distance such artwork can become confusing after an hour or so in the air.

Assemble and load the plane for flight. The balance point should fall between three and a half and four inches back from the leading edge of the wing. Ballast if you need to and then take the plane out to a grass covered field such as a school athletic field or park. Test glide and note whether the fuselage center line falls along the flight path. Aim at a spot about eighty feet in front of you. The first time or two you do this you might do well to fly over high weeds. Kahuna is about as big and as fast as you can hand launch with safety and it may take a couple of throws to get used to the power required and the smoothness necessary. The slightest deviation from a throw along the center line of the fuselage will cause the plane to either stall or dive. The trouble is that a stall looks just like a dive at this speed so before you start moving weights make very sure you are actually experiencing what you think you are. Trim the plane so the fuselage centerline points along the flight path.

Now that the plane is flying we can discuss some basic facts about center of gravity location and decalage angle. The decalage angle determines how fast the aircraft will recover from a displacement in pitch attitude and how badly the aircraft will oscillate about the stable attitude. With a rudder only machine we want pretty good recovery but the plane must damp out after a few zooms. In rudder-elevator or full multi we have control over pitch and can get

(Continued on Page 70)

Kahuna

(Continued from Page 69)

along with almost zero stability. For a given decalage angle, 3 degrees as specified on our plans, the plane will fly over a wide range of Center of Gravity locations. It will fly BEST at one location only and it is your job to find that location. As you move CG backward the glider will become more sensitive to control functions, especially elevator. When you reach the maximum rearward CG the plane will fly at only one speed and any control activation will cause loss of stability. Don't try this, for the plane (any plane) becomes spirally unstable when in this condition and sailplanes are almost impossible to control. Rearward CG locations are used for very light wind conditions. Most Nordics tend to this trim.

As the CG is moved forward the opposite series of conditions occur. Control becomes sluggish and heavy. Up and down become markedly different in speed of response. The plane flies with a more purposeful attitude and seems much steadier in the air. It can be trimmed to fly at a number of speeds. At maximum forward CG the plane has lost all pitch stability. Up elevator simply raises the nose slightly. We don't mention down in this condition. Our old friend spiral instability is back with us but for a different set of reasons.

At a point between these two extreme conditions is a spot at which the plane has a maximum range of speeds it can be trimmed to and a fair degree of controllability. This CG location also happens to be where maximum stability occurs. It is slightly forward of the midpoint between too far back and too far forward. With that sage comment I leave you to sort out your weight distribution.

We can make one more test before going out for a real try at it. You will need a little more height for this one. A low hill, bleachers at an athletic field or a building roof. Somewhere that you can glide for several hundred feet and make some control applications. Switch on your system and heave your buzzard off. Give quick blips to your rudder and see what happens. You aren't trying to turn so much as to see how the plane responds to rudder. Try it in both directions. Does the plane do exactly the same thing in each direction? Does the nose stay down or does it bob? Does the plane roll and if so how much? It should not begin a roll until a definite turn has begun. Pitch-up and roll indicate rearward CG. A sort of shudder without much turn indicates too much control surface movement. A plane this size requires some slight time before it begins to react to a control so don't confuse this normal reaction with lack of control.

You can do the same with any other controls fitter. Take care with elevator though. This close to the ground you haven't room for or speed enough to do much. If you have fitted a speed control device this is the time to test it. Aim for a soft spot before you do though. They work pretty violently in still air. Practicing on your local cricket patch, athletic field or low hill side is a good way to become proficient at spot landing. (Also gives you lots of needed exercise. If you do this you can drop the RCAF plan.) It is a point of honor among glider pilots to specify the exact landing spot for every flight. (After all we can't taxi all over creation so we have to do SOMETHING to impress each other.)

After making sure that the plane is reasonably capable of flight you will want to give it a real try but are probably staring at the thing and wondering "How do I get *this* beast up *there*?" The simplest method is the one you have used to see if it will fly at all. Heave it off a cliff. How many times in the past have you wished you could do that to some model? Here's your chance man! Find a high hill or cliff with reasonably smooth ground or water for about a half a mile to windward and long enough so that the wind has to go over it rather than around it. Make sure there is a good recovery area to windward for the first few times you may run out of air before you get back to the ranch. Pick a day with medium steady wind. You may experience gusts on the ground but many times these are local turbulence and the wind fifty feet up is steady. For the first few flights, launch directly into the wind and ride it out for a hundred feet or so before beginning control.

Don't be surprised if your glider bounces around quite a bit. This is normal. In smooth air there will be no bouncing. In rough air or near the ground let the plane take care of itself. Your reaction time plus the reaction time of the plane is normally too slow to do much about it anyway.

A second method of launching is tow line. If you think you might want to try this system build a hook in the K. Lash it to former #2 in such a manner that the line will attach to a point about a half inch in front of F2. Other designs will normally specify this location. If, for some reason, they do not, pick a spot 40 deg. forward from the vertical CG position (if the plane is rudder only) and about 20 deg. of angle forward if it utilizes elevators.

Tow launching an R/C sailplane is both harder and easier than launching a Nordic. The R/C is harder to start up but is controllable on the line and

(Continued on Page 72)

Kahuna

(Continued from Page 71)

this makes hook placement less critical. Tows are mostly used for gently rolling hills where strong ground currents may be lacking and for thermal flying. Lines of one to four hundred feet are common and if you are looking for thermals you take all you can carry.

I might mention one other method of tow which is both hair raising and spectacular. Bungey launch is the use of an elastic catapult. It can be either the short type like a large sling-shot with stakes about fifty feet apart and a start position about a hundred feet behind or it can be a single line several hundred feet long with an elastic section. There must be enough elastic to maintain flying speed yet not so much that it overpowers the plane. The sling-shot or true Bungey launch is used in hilly country as it is very hard to gain much altitude using it. Long line requires a year's production of wakefield rubber to set up and can be used anywhere. Make sure the stakes are well anchored. There are few things more disheartening than to have trudged a quarter of a mile to the glider with the launching ring and then look over your shoulder and see a two foot iron stake come whirring gracefully over the horizon. At such times one is tempted to say things but usually forebears in favor of more direct action.