Model Glider Design

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To the

Black Panthers

of the
760th Bomb. Squadron
460th Bomb. Group, 15th Air Force

FOREWORD

The information given in this book should prove timely to many of us who had to switch to gliders for flying fun. As you will find, the text is rather general and you may not comprehend all of it at the first reading. This is natural as you may not have had any previous experience with gliders. In time you should be able to connect your troubles with the information given.

When we started to write we had no idea of how many pages we would fill, and were rather surprised to end with as many as we did. It seems that as we went along we somehow managed to find more information in our accumulated files and personal experience than we suspected of having. Perhaps the fact that at one time we flew full size gliders, and made several tow-line gliders just before starting on this book had something to do with the case. At any rate we tried to anticipate all possible questions which you may have.

As you will note, the book will be most useful to beginners and to those who do not have time to go deeper into the theoretical phase. We feel that in this case any builder who advances to the Expert Class will be able to understand regular text books on aerodynamics and so satisfy his need.

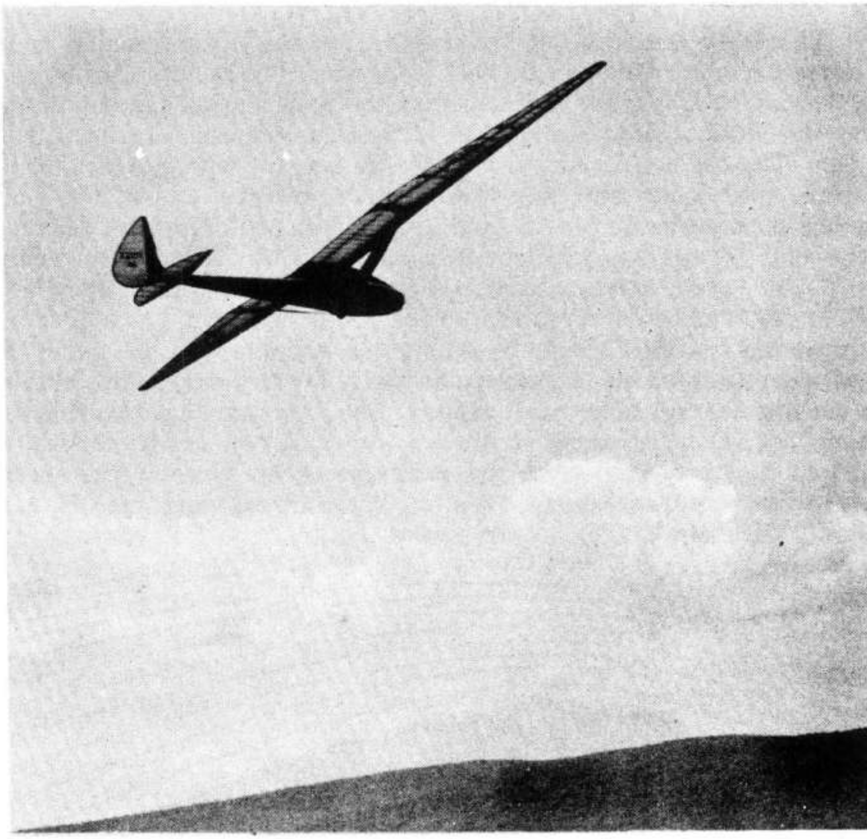
We started this book last March (1943), on the eve of our induction into the army. By strange coincidence we finished it on the eve of our departure for overseas. Some might wonder how we managed to do any extra work in the army. Well, there are lunch hours, and hours between Recall at 1700 and 0500 Reveille.

So, if you find mistakes, remember the conditions. We hope you will find this book helpful in making glider building and flying more interesting and exciting.

Winter 1944
Somewhere in U. S. A.

FRANK ZAIC
U. S. A. Air Corps.

ELMIRA, N. Y. ME 1933



Fred Loomis

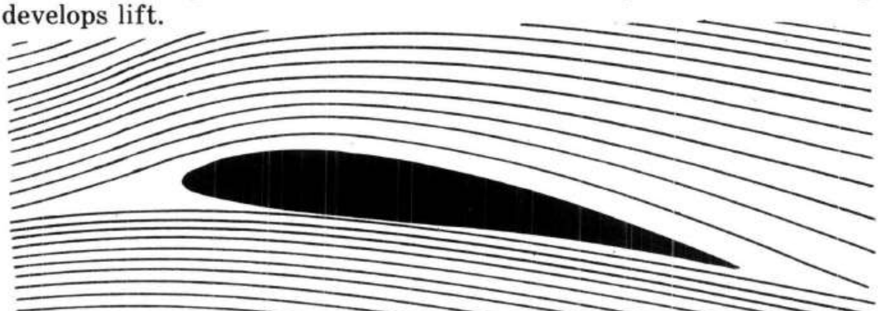
MODEL GLIDERS

The events of the time point to the glider as the logical model to build during the war days. The fun of flying our own creation can still be had without using materials which are vital to our victory. A glider can be constructed from almost any kind of material on hand in about half of the time required for other types of models. It will also last much longer since its impact with the ground during an unhappy landing will not be as powerful as it is when power is used.

The only difference between a glider and a power plane is that the glider utilizes the force of gravity to obtain forward motion while the power plane has the motor and the propeller. However, this difference tends to confuse many folks into believing that gliders are dangerous. Perhaps they still think that once the motor stops a plane drops like a rock. Since some of us may be just at the threshold of this hobby it might be a good idea to review the theory of flight with specific emphasis on gliding.

THE ACTION OF THE WING

The wing develops lift by reacting on the air molecules as it moves forward. This can be best understood by assuming that the molecules are standing still and that the wing moves against them. As the wing comes into contact with a molecule a reaction takes place. The molecule naturally wants to remain where it is and is stubborn about it. But the wing is more powerful and it keeps on going. The molecule has to give ground but not before he delivers his most powerful haymaker. Because of its tiny size the molecule may not have a strong reaction, but if we consider that there are 7,000,000,000,000,000,000,000,000 air molecules in a cubic foot of air we can see that almost anything can happen. The net result of the wing reaction on the molecules on its lower portion is to obtain a certain amount of upward motion. The exact amount depends on how fast the wing reacts on the air and just how much downward the air had to move before the wing passed by. Greater the speed and longer the downward movement of the air so much greater will be the resulting lift. This then is how the lower portion of the wing develops lift.



The action of the upper portion of the airfoil is a bit more difficult to understand without having a certain amount of aerodynamical background. However, the point is to reduce the air pressure over the top so that the higher pressure under the wing will have an easier job to push the wing upward. The shape of the airfoil and placing of the wing at anangledoes this job for us. By combining the two actions we end up with lift.

The wing develops lift all over its area, above and below, but it is not uniform all over. Some portions lift more than others. Also the lift varies in its position when the wing is set at a different angle or when the air changes its direction as it does in a gust. The net result of this action is that we cannot pin the center of lift at one particular spot for all possible situation. However, we do know that this center of lift moves forward when the angle is increased and backward when it is decreased. By using a stabilizer we can also make the wing fly at one particular angle. But more about this later on.

FACTS ABOUT GRAVITY

Because the earth is such a tremendous mass of matter it has the power to attract or hold objects to itself. This power or force is known as the force of gravity. While walking on earth we take it for granted as nothing special happens. But if we were to walk off a cliff we would soon know what it is. Or would we? The next step is to find out the effect of gravity on objects which move through air.

Discounting the effect of air resistance, the speed at which an object moves downward through the air can be found by multiplying 32 ft. by number of seconds the object has been falling. If the object has been falling for 2 seconds, the speed at the end of 2 seconds will be 64 ft. per second. If we want to know how far it has fallen we use the following formula: $\text{Distance} = \frac{1}{2} \times 32 \times (\text{seconds})^2$ In our example we would have: $\text{Distance} = \frac{1}{2} \times 32 \times (2)^2$ or 64 feet. In actual practice the air resistance produces entirely different figures. A feather is light in comparison to its area or size and it will just drift downward. But if we were to take this feather and powder it and compress it into its smallest possible size, we would find it coming down pretty fast. — If rain were not held back by air resistance, ordinary umbrella would only be good as a sun shade.

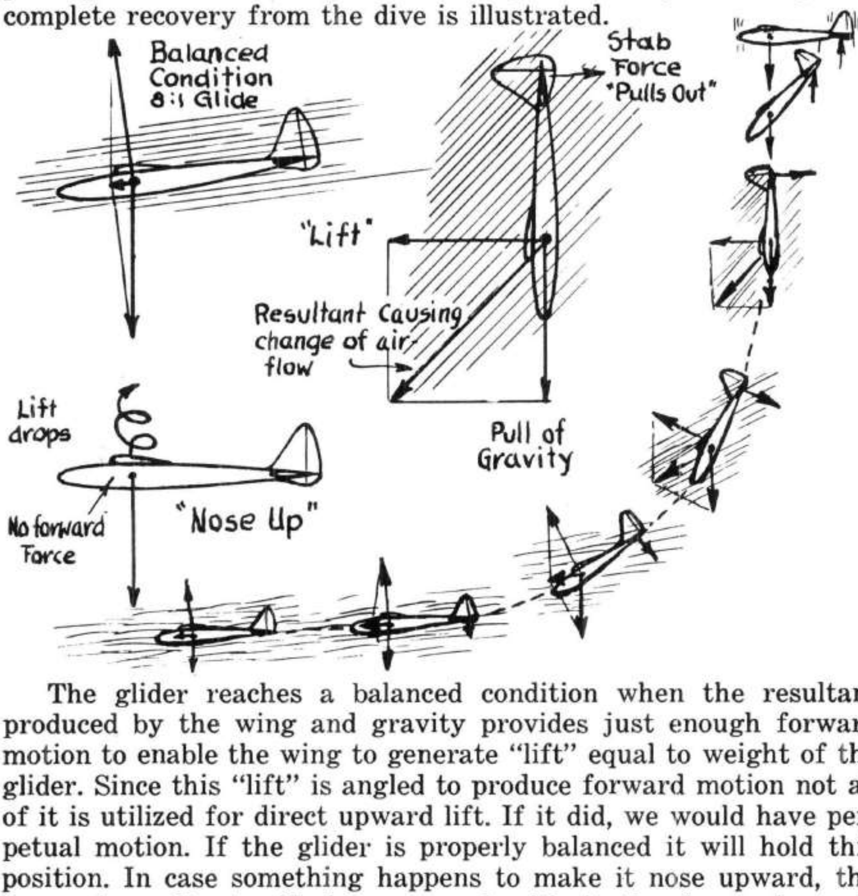
Now that we have a vague idea of how the wing develops lift and that the force of gravity tries to pull all matter to its center we can start on how the glide develops.

THE DEVELOPMENT OF THE GLIDE

Let us assume that the glider has been taken up by a balloon and that it has just been dropped. At first it drops down on an even keel. But as soon as it speeds up under the effect of gravity the air molecules begin to react on it. Since the tail surfaces offer the most resistance they are held back. This allows the front of the glider to nose downward. As this happens the overall resistance of the glider is decreased considerably so that it can drop down at much greater speed. Before we know, the wing and tail begin to react to the airflow just as though they were moving horizontally. As a matter of fact if we were to place the various forces now in action such as lift and pull of gravity in their place, and then turn the sketch 90° we would have normal flight conditions. And as a matter of fact we do have flight conditions present during the dive.

The next step is to bring the glider out of the dive and into its normal glide. Note the two basic forces now existing in the diving glider. The force of gravity pulls downwards, and the effect of the moving wing on the air is to develop side force which is normally known as lift. It is evident that the glider cannot dive straight down if there is a side force. A compromise is reached in which the glider tends to move sidewise. But as soon as it moves into this new direction the angle at which the glider meets the air is changed as shown.

Although this may result in lowering of wing's force, the important thing is that the stabilizer is now also affected as shown. The result of this is that the stabilizer will tend to pull the tail to one side and force the nose to point away from the vertical line. This particular action of the stabilizer will continue as long as there is a surplus of speed due to diving, and which causes the resulting direction. Surplus speed means more power or lift generated by the wing. The complete recovery from the dive is illustrated.

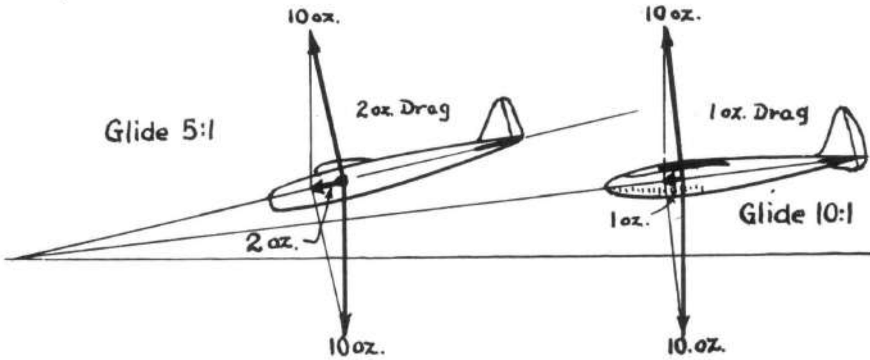


The glider reaches a balanced condition when the resultant produced by the wing and gravity provides just enough forward motion to enable the wing to generate "lift" equal to weight of the glider. Since this "lift" is angled to produce forward motion not all of it is utilized for direct upward lift. If it did, we would have perpetual motion. If the glider is properly balanced it will hold this position. In case something happens to make it nose upward, the forward resultant will decrease and with it the forward speed. When this happens, the glider will have less lift and the gravity will start to pull it down. This will change the airflow so that it will strike the lower position of the stabilizer which in turn will move the glider downward so that it can pick up its regular speed. However if the glider is not balanced and is tail heavy, the nose keep on going upward until all forward speed is lost, and the glider becomes like any other object, and the cycle just described will be repeated. If on other hand the glider is upset so that it dives, the increase in speed will bring about the resultant which will tend to make the airflow strike the upper surface of the stabilizer which will pull the nose upward as described.

KEYS TO THE GLIDE

The forces developed by the wing and the pull of gravity are the keys to the gliding. It is evident that if the lift were straight up we would reach a static position with no forward motion resulting from the set-up. This might be alright for a balloon but not for a glider which must move to enable its wing to produce lift. Yet the acme of efficiency is the vertical line. The closer we can get to it and still have forward motion so much better will our glider be. This is where the drag comes in.

(The only power possessed by the glider is its weight and height. Weight determines the pull of gravity which in turn determines the speed of the glider. The height determines the distance in which this weight operates. Therefore we should be economical with these two.)



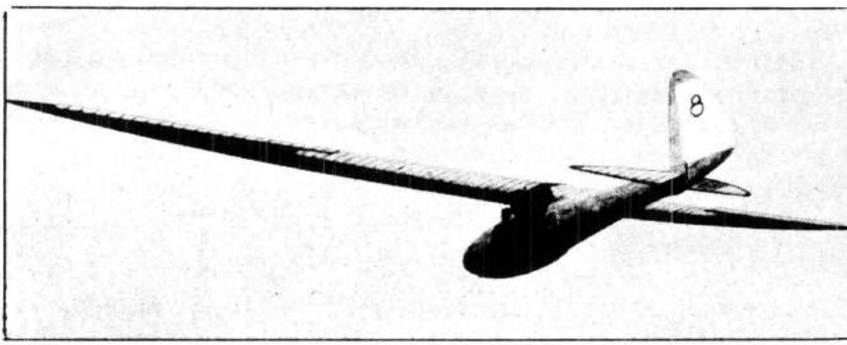
The force which tries to hold the glider from moving forward is the reaction of air molecules against the moving glider. The value of this force will depend on the "face" the glider presents to the airflow. Streamlined job will naturally present a better "face" than box type. Just how we penalize ourselves by designing a lot of built-in resistance can be best illustrated by the following example:

We have two gliders whose wing areas and weight, say 10 ozs., are similar. One has 1 oz. drag and the other 2 ozs. Since areas and weights are same, both gliders will glide at same speed and angle of attacks regardless of their drag. However, the high drag job will require a more powerful resultant to produce the needed forward speed. This can be seen on the scale diagrams. The diagram shows rather small differences in the angle between high and low drag situations. Yet the angle of the high drag is twice that of the streamliner. This means that the streamlined job will stay up twice as long as the box.

The actual gliding angle or ratio can be determined if we know the drag. Or rather if we know the L/D of the model. That is if at a particularspeedthe lift is 10 oz. and the drag is 1 oz. the L/D is 10. The gliding ratio would be 10 to 1. Note how this is proven in the force diagram.

DESIGNING THE GLIDER

Too many of us simply take any old wing and tail and fuselage that happens to be around and call the collection a glider. In some cases the combination may work after a fashion. But to get full measure of pleasure we should build the glider from the beginning as a glider. Since at the moment there is not much of a selection in the kit market we had best try our own.



Since all other parts of the glider depend on the wing area for their size and shape it is the proper thing to decide on the wing area before doing anything else. The Academy has several classes for record purposes. Whichever one you are going to pick, use all the wing area allowed. The efficiency of the wing and airfoil increases with size. Those who had experience in building large gas models can start with 500 sq. in. But for a beginner a 200 sq. in. is about the best. It gives good results and it is still economical. Gliders having areas less than 200 sq. in. do not seem to be so good. They loose the glider effect. They are more or less at the mercy of the breeze. Still they should not be forgotten. Especially if they are to be used in small fields.

Once the wing area is decided upon the design outline can be approximated by using the following graph and tables:

Fuselage Length $= \sqrt{\text{Wing Area} \times 4}$

Ex: $\sqrt{200 \text{ sq. in} \times 4} = \sqrt{800} = 28$ in.

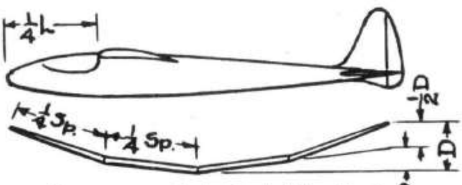
No need of ever making the fuselage longer than that given by the formula. In fact, if the Aspect Ratio is 12:1 or over the fuselage need not be longer than 50% of span.

Position of Wing on Fuselage: Leading Edge should be at about 25% of fuselage length from front. See sketch. We use this relationship on our own gliders and have found it good. It allows a good moment arm for balancing. (If weight is needed for contest it should be added at C. G.) It also makes smoother or streamlined outlines possible by having longer noses. Tail moment arm will be found sufficient.

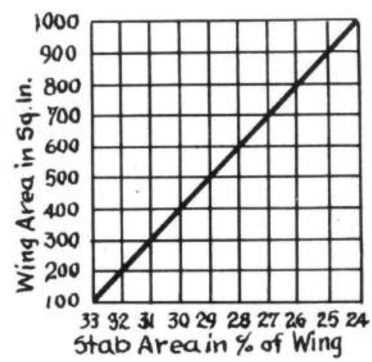
Rudder Area should be about 10% of wing area. In most cases this will be found workable. The correct area can only be determined during flight tests. Later on we will describe symptoms which will show whether or not the area is correct.

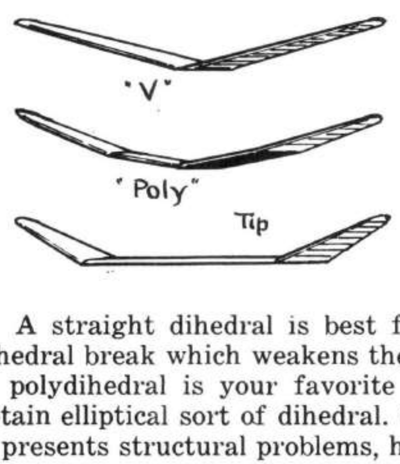
Stabilizer Area for a particular wing area can be found by consulting the graph. Do not use stabilizers greater than indicated. Large stabilizers delay or need a lot of altitude for recovery from stalls or dives. More about this later.

Dihedral: Personally we use 1½″ under each tip for every foot of span. Ex.: 6 ft. span would have 9″ dihedral. 1¼″ is about minimum for thermal hunters. Stay within these limits. Greater dihedral than 1½″ is not needed.



Recommended Polydihedral





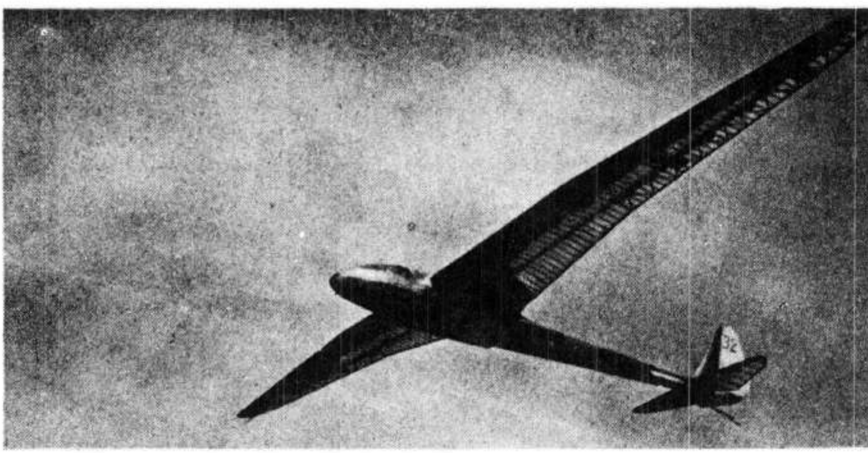
Dihedrals in Side Skid

A straight dihedral is best for gliders. It eliminates the poly dihedral break which weakens the structure and adds a bit of drag. If polydihedral is your favorite break up the wing as shown to obtain elliptical sort of dihedral. Gull dihedral is not recommended. It presents structural problems, harder to check up, and it has poor spiral characteristics. A much more powerful rudder must be used to obtain same turn possible on ordinary dihedral with small rudder. See sketch and note how only center section, with its short moment arm presents dihedral effect when in a side slip. Gull dihedrals are disappearing from modern soarers as the designers are becoming more and more familiar with spiral stability. More about the function of the dihedral later on.

The information given should enable you to find the basic dimensions of the glider you have in mind. The next step is to clothe this outline and to make each part as perfectly as you know how, and also place it so that it will be at its best aerodynamical position and shape. To that end the following information is given.

WING SHAPE

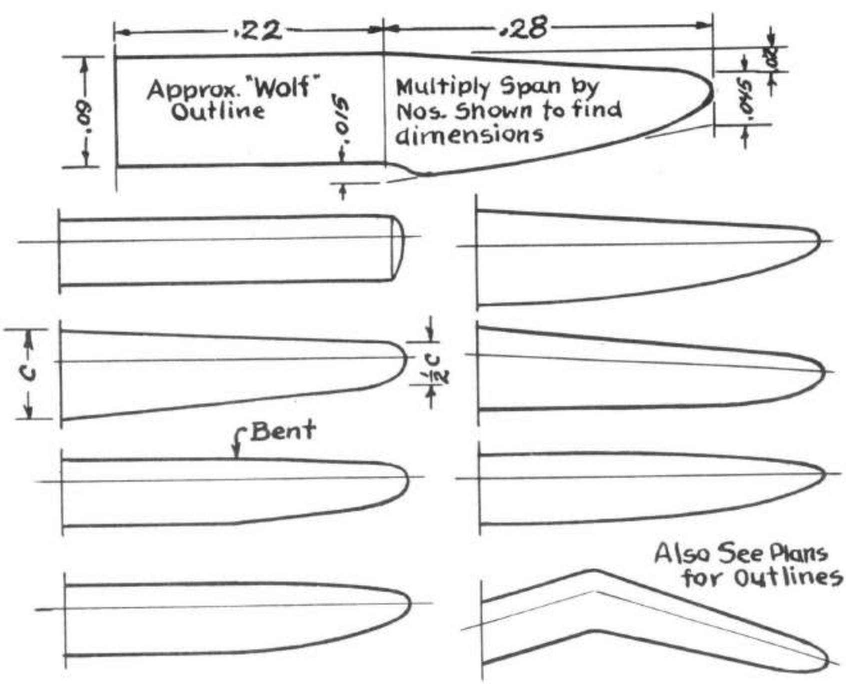
Although the super-soarers have long and narrow wings, or of high Aspect Ratio, the model gliders should not follow them to the letter. While a soarer may have span of 50 feet and an average chord of 2½ feet, a model glider of similar Aspect Ratio, 20 to 1, would not do so well. We have to consider the effectiveness of narrow airfoils and the strength of long spars. From our experience we found that there is no need of having Aspect Ratio higher than 14 to 1. — The decrease of induced drag after this value is not worth the structural troubles that always come in. — According to tests, changing from A. R. of 4 to 6 would be more beneficial than changing from 6 to 12. — As a matter of fact, many of the utility soarers have A. R. in this neighborhood, 12 to 1.



Specifically, gliders under 150 sq. in. should not have greater A. R. than 8. The 200 sq. in. jobs should get along nicely on 10 to 1. Larger designs may use the 14 limit. But whatever may be the Aspect Ratio on which you eventually decided always make sure that the tip rib is never less than 3½" wide. If the tip is rounded, carry out the straight line taper and note the size. — Airfoils having chords of less than 3½" seem to loose more in lift than you gain by having large Aspect Ratio. Always remember that any part of the wing which is not lifting is just so much drag. If you can make the part lift, the increase of drag will be slight, especially since the model may move slower.

OUTLINE AND TAPER

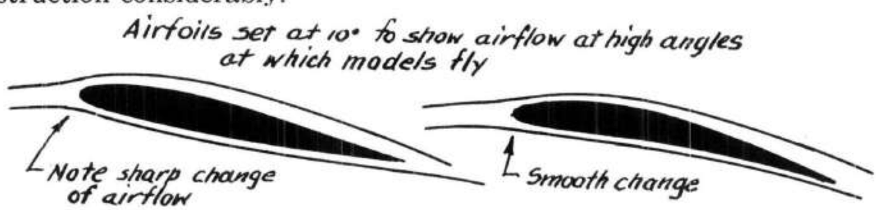
The logical outline is to have straight edges up to ¼ span and then taper so that tip rib is about ½ of the center rib providing it is not less than 3½". It is a good idea to use the leading edge spar without a break at the ¼ span spot but bent it to shape. The bend should be gradual. Just use a piece of square stock to obtain the natural curve as shown. The trailing edge may have a straight taper. But with a little more trouble a very effective shape can be had. See sketch. This shape has been adopted for the Thermic Series of Jasco gliders. It was originated by Wolf Hirth who designed the "Mimeo." Proportions are given so that it may be enlarged to any size. — The only trouble with curved edges is that the ribs have to be individually plotted. However, this is fairly easy if the method shown later on is used. If you have balsa available you can produce a whole variety of shapes. See suggestions. As far as aerodynamical characteristics are concerned all of them are of about equal value. If you are in a hurry, don't hesitate to make just a straight wing. Any kind of a wing is better than none.

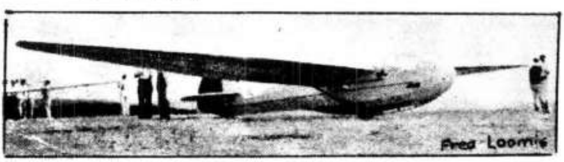


The tips should naturally be well shaped. Both for sake of appearance and efficiency. However, if the wing has tapered tips, the tip outline is not as important as it is when it is a straight job. Although some of the present day pursuit jobs may have square tips, it is no reason why we should do likewise. They use almost streamlined airfoils and at low angles of attack. While models fly at high angles and many of the airfoils are undercambered. As a matter of fact, the main purpose of having large Aspect Ratio is to reduce the tip losses by having them smaller. Another reason is that square tips develop considerable drag when they are in a side slip and they tend to work against the rudder. If square tips were good we can be sure that birds would use them.

AIRFOIL

The large soarers use a fairly deep airfoil with generous amount of undercamber. However, this does not mean that they are the best. The fact that the span is so large makes it necessary to have deep spars to carry the load. For model purposes the NACA 6409 and 6412 are as good as anything you can find. One of the most popular American soarers uses NACA 4412 which is similar to 6412 but it has a leading edge more suited for metal work. As in other model work, the under cambered airfoils require finer workmanship, and if you have trouble in building, or are just beginning, use Clark Y NACA 6409 with flat lower camber. This simplifies the construction considerably.



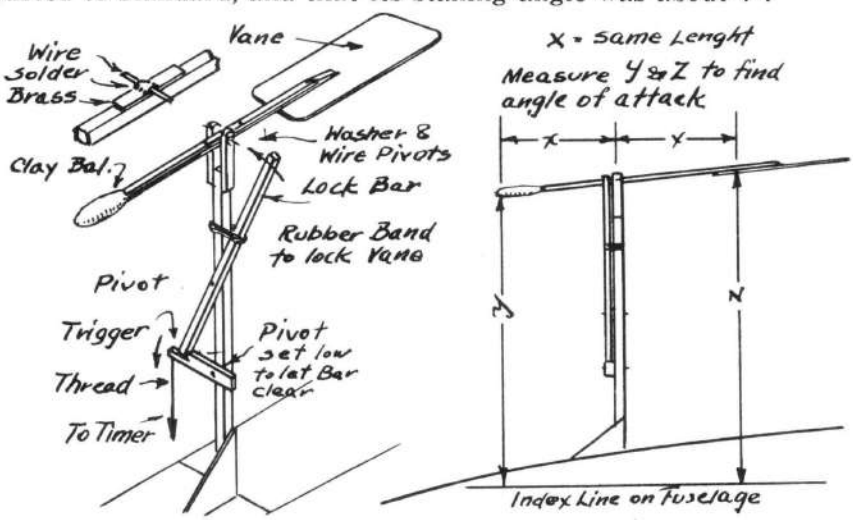


SCHWEIZER SGS 2-8
Uses NACA 4412
Note Incidence Angle

The main reason that we suggest the above airfoils is that they show very good results at model speeds. Especially at high angles of attack. Since models fly at surprisingly high angles of attack the use of the above airfoils is necessary. For example, the angle of attack may be around 8°. Now place anyone of the above airfoils in this situation and compare it with some other so called soaring section. Note how smoothly the above series flows into the airflow. While others separate the air and then force it down rather fast. However, we are showing several other airfoils which might strike your fancy. But always keep in mind that it is more important to have a stable and manageable ship than have the best airfoil on an unstable ship. — If the airfoil will cause construction troubles and tend to make the wing weak or warpish, forget the airfoil. Flying or towing gliders is not as simple as one may think. Gliders can be more exasperating than anything else you may have flown. It is sometimes just impossible to launch the glider to even see how well it glides. So start with flat camber to assure strong and true construction. Then try a similar wing but with undercamber and see what happens. — When in doubt about airfoils, just place them at high angle of attack and see how the airflow is affected. A streamline section will be automatically out. The above airfoils also lend themselves to smooth leading edge covering, unlike some thick sections.

ANGLE OF ATTACK RECORDER

To find out more about the angle of attack, the writer made a device which records the airflow during the flight. See drawings for details. Note how the vane is locked during flight to retain the angle. Time was short and this recorder was only tested on the "FLOATER" which is shown elsewhere. The angle of attacks recorded was between 5° and 6°. Any attempt to make the glider glide slower by removing weight from front would cause a stall. Addition of weight to make it glide faster reduced duration as expected. It may therefore safely be said that the model was adjusted to standard, and that its stalling angle was about 7°.



The airfoil used was N.A.C.A. 6409 with flat bottom. However, we should not blame the airfoil for this low stalling. The model had light wing loading, 2 oz. per 100 sq. in. It was also large enough to make the airfoil efficient. All these factors caused the glider to fly slow, and it is a known fact that speed has a great deal to do with stalling. A stall will occur much sooner at low speeds than at high. At 100 M.P.H. the stall might happen at 15°, but under 15 M.P.H. the stall might be less than 10°.

The wing loading is a fair indicator of the stalling angle, not forgetting the size or scale effect. Wings having a loading of 2 oz. per 100 sq. in. might stall between 7° and 8°: 3 oz. per 100 sq. in. at about 9° to 10°. While heavier loading might increase the angle to 12°. It should be understood that these figures are just guestimations, and that they are based on the fact that an increase in wing loading will speed up the model, and thereby increase the angular range.

This subject, low speed aerodynamics, it still at its beginning. Recorders such as shown should prove of great value. If any one of you tries it, the writer would appreciate reports.

LAYOUT OF WING'S OUTLINE

When designing a new model most of us usually decide on the span first and then by trial and error method determine other dimensions. Or we may start with area and eventually reach the desired outline. This work can be greatly simplified by using the following formulas. These formulas are especially useful if we only have the wing area and Aspect Ratio figures.

$$\text{Aspect Ratio} = \frac{\text{Span}}{\text{Average Chord}} \qquad \text{Span} = \text{Average Chord} \times \text{Aspect Ratio}$$

$$\text{Average Chord} = \frac{\text{Span}}{\text{Aspect Ratio}} \qquad \text{Span}^2 = \text{Area} \times \text{Aspect Ratio}$$

$$\text{Average Chord} = \frac{\text{Area}}{\text{Span}} \qquad \text{Aspect Ratio} = \frac{\text{Span}^2}{\text{Area}}$$

$$\text{Span} = \sqrt{\text{Area} \times \text{Aspect Ratio}} \qquad \text{Area} = \frac{\text{Span}^2}{\text{Aspect Ratio}}$$

$$\text{Area} = \text{Span} \times \text{Average Chord}$$

Examples: Wing Area 200 sq. in. Aspect Ratio 10:-. Find Span

$$\text{Span} = \sqrt{\text{Area} \times \text{A.R}} = \sqrt{200 \text{ sq.in} \times 10} = \sqrt{2000} = \text{Approx. } 45 \text{ in.}$$

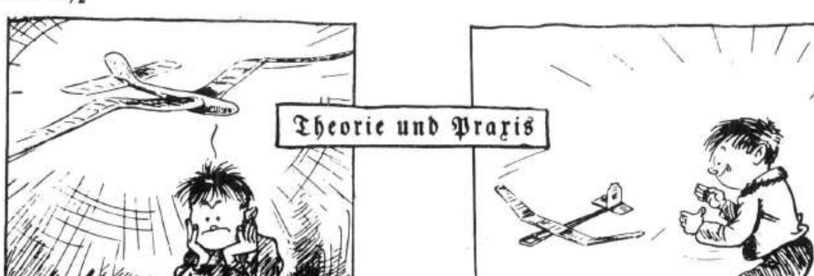
To find Average Chord: Span = 45" Area = 200 sq.in. A.R. = 10

$$\text{Av. Ch} = \frac{\text{Area}}{\text{Span}} = \frac{200}{45} = 4.5'' \quad \text{or} \quad \text{Av. Ch.} = \frac{\text{Span}}{\text{A.R}} = \frac{45}{10} = 4.5'' \text{ A.C}$$

If the wing has no taper and has square tips, the chord will be 4½" from center to tips. If it is tapered, the average chord will be equal to the sum from center and tip divided by 2.

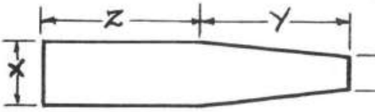
$$\text{Average Chord} = \frac{\text{CENTER RIB} + \text{TIP RIB}}{2}$$

Since in our example the average Chord is 4½" the total of center and tip rib will be 9". This 9" can be divided in anyway desired. You can have 8" center and 1" tip and still have same Average Chord, area, span and Aspect Ratio. However, since it is not aerodynamically advisable to use such small tips we should use about 3½" tips. The center rib will then be about 5½"



Outlines that have straight center sections and tapered tips can be found just as easily. Although the process is a bit more involved, it can be solved by using the example shown as a start. The length of the tapers will have to be decided before solving the problem. The tip rib can be expressed in inches or in percentage of the center rib. If the wing is large and we do not have to worry about the size of the tip rib we can use the percentage factor. If the wing is small and we do not wish to have tips less than 3″ we can use 3″, or whatever size we decide on, as the tip value in the problem. The answer will give the center chord. Note that we are working only with one half of the wing and therefore use only half of the area.

½ Area=100 sq. in. ½ Span=22.5″. Z=11.25″. Y=11.25″. X=Center Chord.



% of X = Ex = 50% or .5X

$$\tfrac{1}{2}\text{AREA} = (Z \times X) + Y\left(\frac{X + \%X}{2}\right) \quad \#1$$

$$100 = 11.25X + 11.25\left(\frac{X + .5X}{2}\right) \quad \#2$$

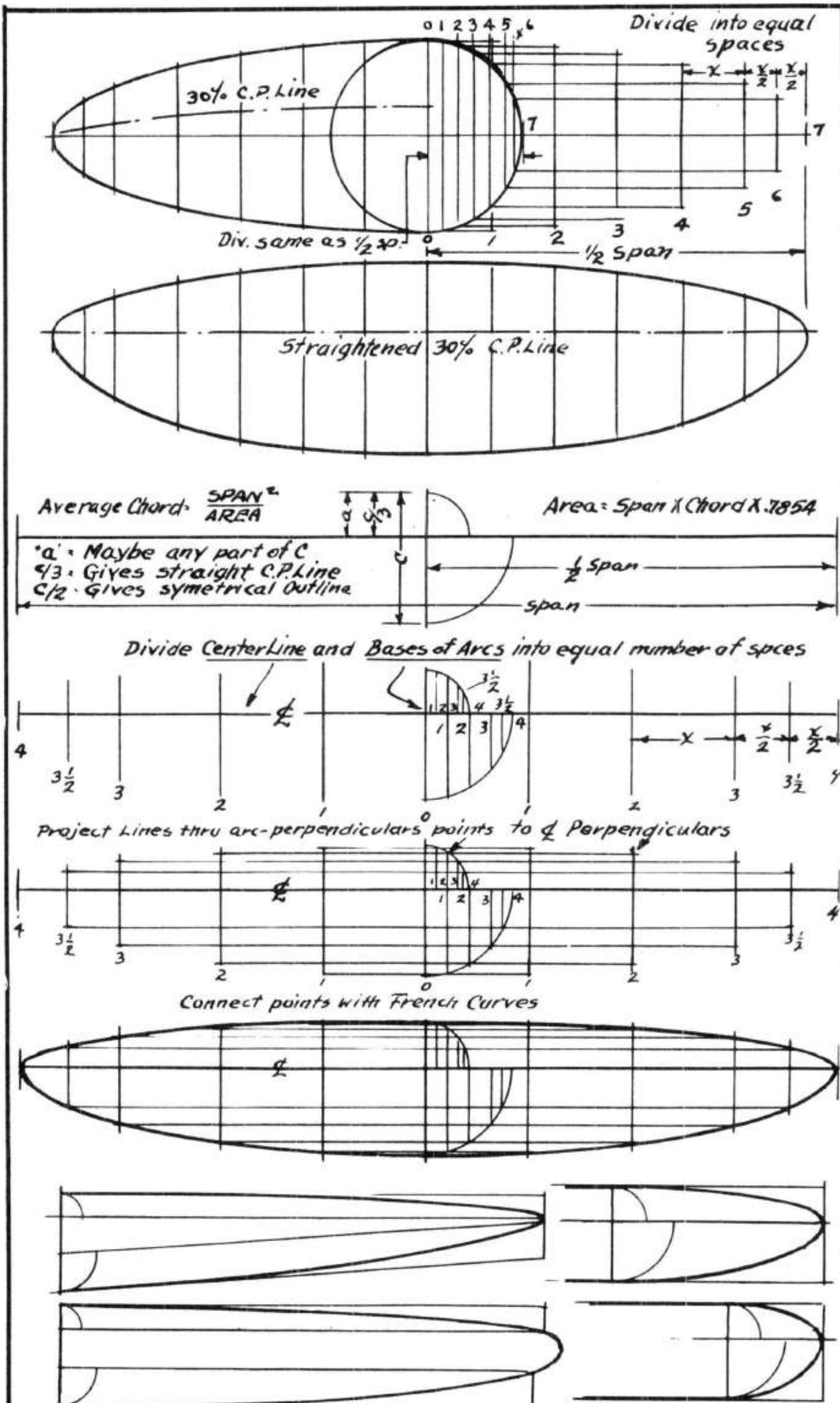
$$100 = 11.25X + 11.25\left(\frac{1.5X}{2}\right) \quad \#3 \qquad 100 = 11.25X + 11.25\,(.75X) \quad \#4$$

$$100 = 11.25X + 8.44X \; [\#5] \quad 100 = 19.69X \; (\#6) \quad X = \frac{100}{19.69} = 5'' \text{ Center Chord}$$

In this example the tip turned out to be 2½″, a bit on the small side. If we had used 60% the center chord would be 4.9″ while the tip would be very close to 3″, more like what we need.

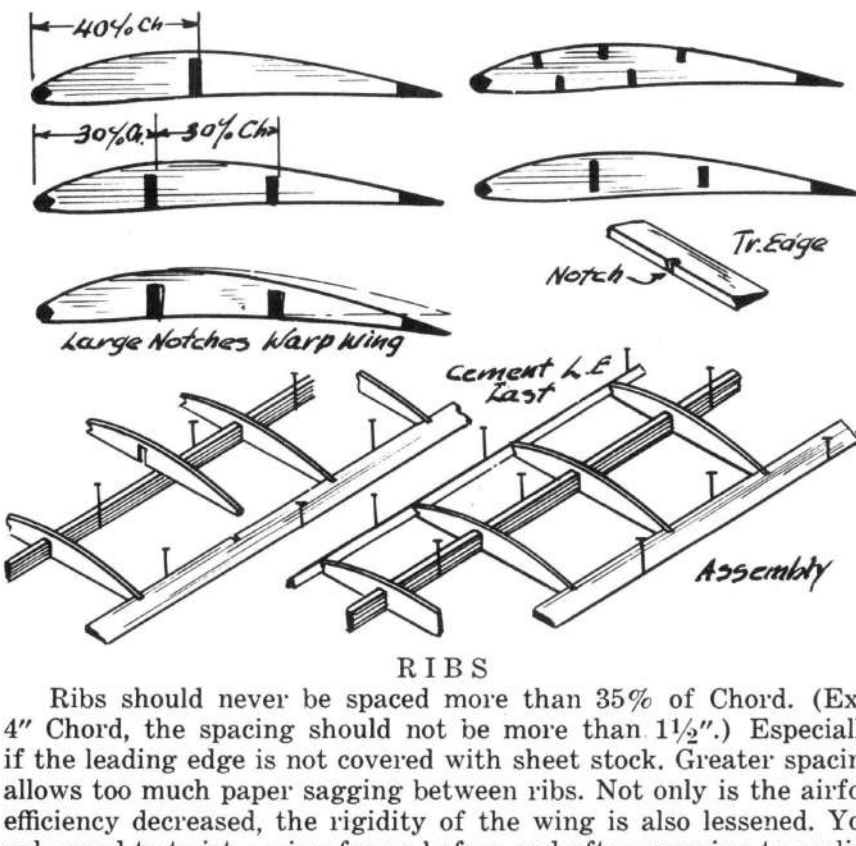
By using this system to determine the dimensional phase of wing design almost any outline can be quickly worked out to fit most conditions. If your design calls for curved leading and trailing edges, draw straight lines through them so that you will have triangles and rectangles which can easily be "area'd." The areas excluded can be made up by including blank areas inclosed in the outline.

If curves are your specialty, your best bet is to make use of the ellipse. The ellipse can be varied in so many ways that there is no end to its combinations. A standard ellipse has equal outlines on each side of its center line. Since the Center of Lift or Pressure is found at about 30% spot behind the leading edge, such a line will make the C.P. curve as shown. If this C. P. line is straightened by changing the ellipse we obtain a much more graceful shape. This outline can be obtained by plotting a normal ellipse and then changing or shifting the outline to suit the 30% line. However, it is much easier to use the method shown for developing such ellipses. By using this particular method, building up ellipses with equal span but different center chords or spacings, we can obtain the combinations mentioned. This particular method can also be applied to the development of graceful tips and other outlines. A rather "chic" wing outline can be developed by adding elliptical outlines to trapezoidial or triangular bases as shown. The formulas which will be found helpful in finding Areas and Average Chord of elliptical outlines are shown. The beauty of the elliptical development is that the outlines are automatically determined without depending on our supply of French curves.


Divide into equal spaces
30% C.P. Line
Div. same as 1/2 sp.
1/2 Span
Straightened 30% C.P. Line
Average Chord = SPAN² / AREA
Area = Span X Chord X .7854
'a' = Maybe any part of C
C/3 = Gives straight C.P. Line
C/2 = Gives symetrical Outline
1/2 Span
Span
Divide CenterLine and Bases of Arcs into equal number of spces
Project Lines thru arc-perpendiculars points to ℄ Perpendiculars
Connect points with French Curves

SPAR SPACING

The spacing of spars should be approximately as shown. Note how the height of rib is used to obtain deep spars, and the positioning of multi-spars to cover high spots. Notch trailing edge to take end of ribs to facilitate assembly and increase rigidity. (An idea the writer presented a long time ago.) Try to have spar notches on ribs to fit spars snugly. If they are too large, cement will pull on ribs and develop camber which might cause warps. If you are able, center the spars. See illustrations for assembly procedure.



RIBS

Ribs should never be spaced more than 35% of Chord. (Ex.: 4" Chord, the spacing should not be more than $1\frac{1}{2}$".) Especially if the leading edge is not covered with sheet stock. Greater spacing allows too much paper sagging between ribs. Not only is the airfoil efficiency decreased, the rigidity of the wing is also lessened. You only need to twist a wing frame before and after covering to realize just how much we depend on covering to give us the strong wings. Just consider sagging as so much slack which must be taken up before the wing reaches its rigid conditions.

No matter what material you use for ribs do not cut-out lightening holes or slot. This weakens the ribs too much. You would be surprised how hard the paper tries to bend them. The weight saved is very small when compared with the total weight, and saving weight on gliders which are usually under weight in such manner is rather silly.

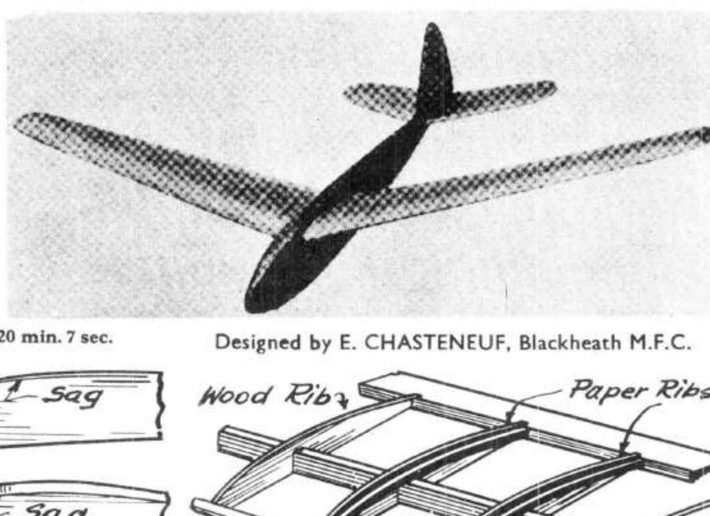
The thickness of the ribs depends on the chord. Up to about 6″ 1/20 Balsa or 1/32 bass or pine will be found strong enough if the recommended spacing is used. Beyond 6″ and up to about 10″ chord use 1/16 balsa or 1/20 hardwood will do. Do not use plywood for ribs; too hard to handle and edges are ragged. Cardboard or composition ribs are only good for holding airfoil shape and should never be used when strength is needed. A good shock will bend them beyond their elasticity point and a crease is made. It is possible that they can be used in combination with regular wood ribs. Try 2 paper ribs between wooden ones. A strip cemented to side of paper rib might remove its major fault.

If you have time, false or leading ribs will add smoothness and better looking edges. They are easy to make and cemented in place.

During assembly the ribs may be merely tacked in place with cement. But after the assembly, go over all joints twice and coat with cement every side of the connection.

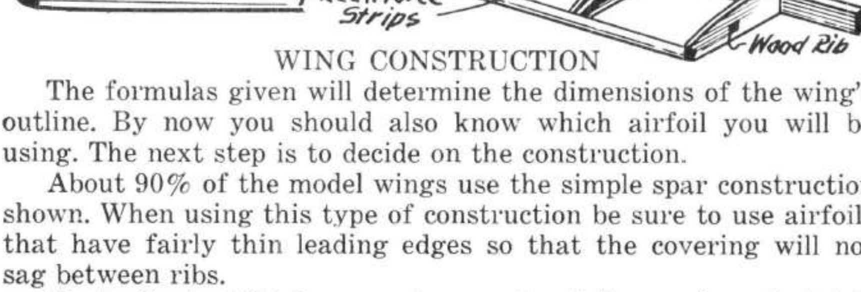
Span 52½″

Length 28½″



Holder of
British Record 20 min. 7 sec.

Designed by E. CHASTENEUF, Blackheath M.F.C.



WING CONSTRUCTION

The formulas given will determine the dimensions of the wing's outline. By now you should also know which airfoil you will be using. The next step is to decide on the construction.

About 90% of the model wings use the simple spar construction shown. When using this type of construction be sure to use airfoils that have fairly thin leading edges so that the covering will not sag between ribs.

N. A. C. A. 6409 is a good example of the preferred airfoil. When the chord is 4″ or under only one spar may be used. But for wider chords two spars should be used to keep the wing from warping and ribs from weaving.

Although there is no special formulae for finding the size of the spars a fairly good rule to follow is to use the following proportions:

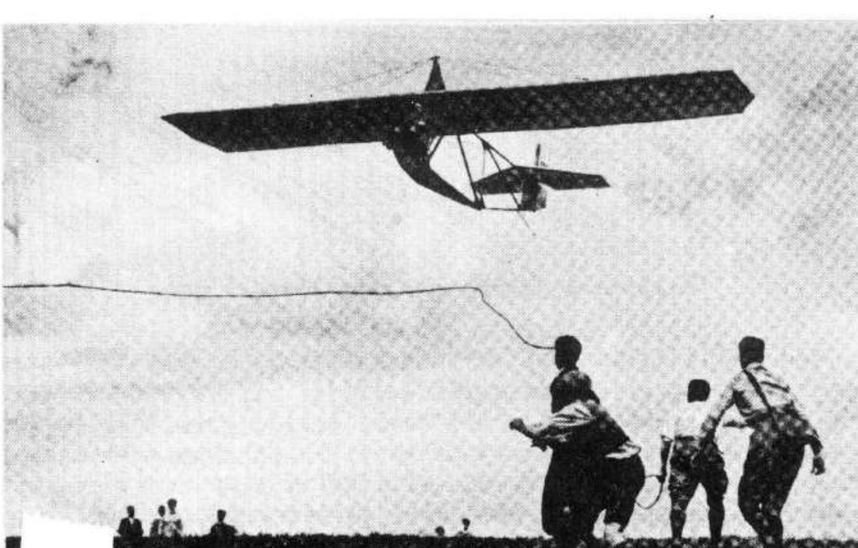
Leading Edge: Square; Allow 1/32 for every 1" of center chord. Ex: 4" chord would have 1/8" sq. Leading Edge.

Main Spar: Height; 3/32" for every 1" of center chord. Ex: 4" chord would need 3/8" high or wide span. Thickness: 1/32" for every 1" of center chord. Ex: 4" chord would need 1/8" thick spar.

Trailing Edge: Width; 3/32" for every 1" of center chord. Ex: 4" Chord would have 3/8" wide trailing edge.

When chord is such that the proportions will produce sizes that are not standard, use the next largest size. Also, if only one spar is used, it is advisable to have wider Trailing Edges, say 1/8" for every 1" of center chord.

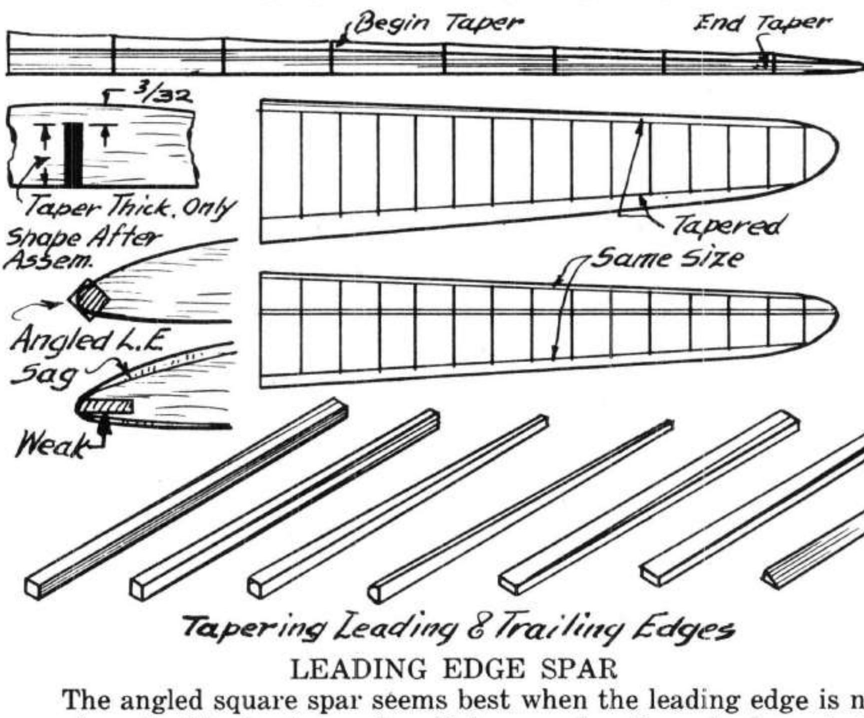
The proportions hold true even if we use more than one center spar. Just subdivide the value found into the number of spars you would like to use. Incidentally, when deciding on spars, make sure that they are deep. The height should be at least three times greater than the thickness. Example: 1/8" thick spar should be at 3/8" high. If you like multi spar construction you can take the 1/8"x3/8" and subdivide it into 6 per of 1/16"x1/8" which would be just right for 4" chord. If we wish to use two spars, a subdivision into 3/32"x3/8" front spar and 1/16"x3/16" rear spar would do. As you can see, the proportions are generous and sufficient strength will be obtained, providing that hard, 15 lb. balsa is used. If hardwood is used, you may reduce the sizes by 30%. Simply multiply the answer given for balsa center spar by .07 and the correct size for hardwood will result. Leave the sizes as given for balsa leading and trailing edges when Chords are below 5". On wider chords the .7 factor may be applied when converting to hardwood.



TAPERING SPARS

When the wing tapers from center to tip, the spars need not start tapering until their top is about 3/32" below top of the particular rib. Then taper the spar to fit end rib and the rib where the taper begins. Taper in depth only. Not only is thickness hard to taper but it also complicates rib development.

Personally we let the leading and trailing edges be of same size throughout the span. In some cases, such as Copland's wing, the edges have to be tapered both ways. This is done by tapering the stock to rectangular dimensions first and then cutting to shape. Be methodical and mark spot to which a particular curve extends before cutting, a small plane is the ideal tool. A template will be very helpful. The trailing edge is simply tapered to angle after basic tapering. Many builders are careless with trailing edges and make no effort to obtain the required taper but just round corners. You would be surprised how quickly an experienced builder can spot a careless one by the workmanship on the trailing edge. Make an effort to obtain the proper bevel or buy the pre-tapered stock.



Tapering Leading & Trailing Edges

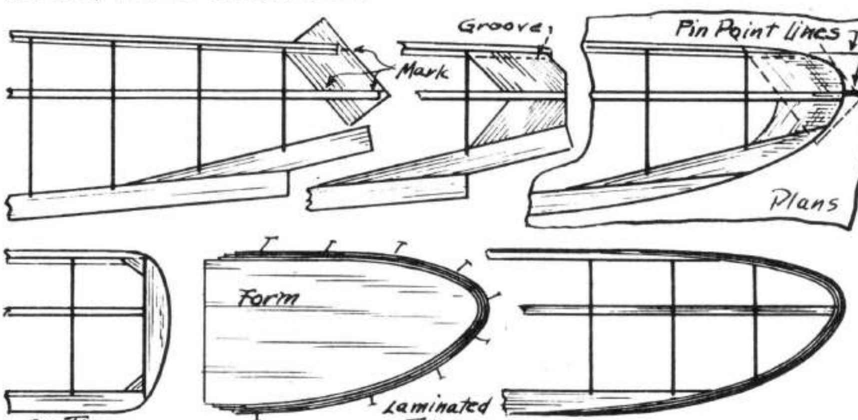
LEADING EDGE SPAR

The angled square spar seems best when the leading edge is not reenforced with sheet covering. It has good anti-crush characteristics, and the angular cut on ribs keeps them in place. The shaping should be done after assembly to obtain smooth lines. Never use a spar set into a slot or cut-out. Although it may have seemingly good shock properties, it may crack on upward load, and it also provides poor covering base. Some other types are shown elsewhere.

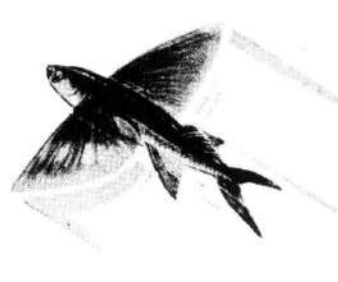
TIPS

The tip should be almost solid balsa and made up of fewest parts possible. Do not use reed, bamboo or wire for outlines. A glider has no long landing gear and consequently the tips come in for rough treatment. Be sure not to have the tip stock grain parallel with the span as it is liable to crack. Use fairly thick stock, about the thickness of trailing edge. Extend all spars as far as possible so that they may provide good cementing anchorage for tip stock. It is best to cement the various segments in place before shaping. The segments are determined by placing the stock under the projecting spars and using them as guide while penciling the angles. If a drawing is used, place the stock under the tip and pin-point the angles. Note that a groove is provided for angled leading edge. The segments should have squared edges to obtain good cementing contact. Shape to outline after cement has set well. Use template guide. Then finish by continuing the flow of the particular edge so that it will end in a rounded tip end. Use sandpaper towards end as knife cuts will be shown through paper.

When using plain square tips cement a strip on the end as shown. This will prevent the paper from pulling the end rib "in" and causing sags and wrinkles. It also greatly improves the appearance, especially if the entire design is kept in that vein. Be extra generous with cement after finishing. In fact, coat the entire tip, top and bottom, with a cement skin.



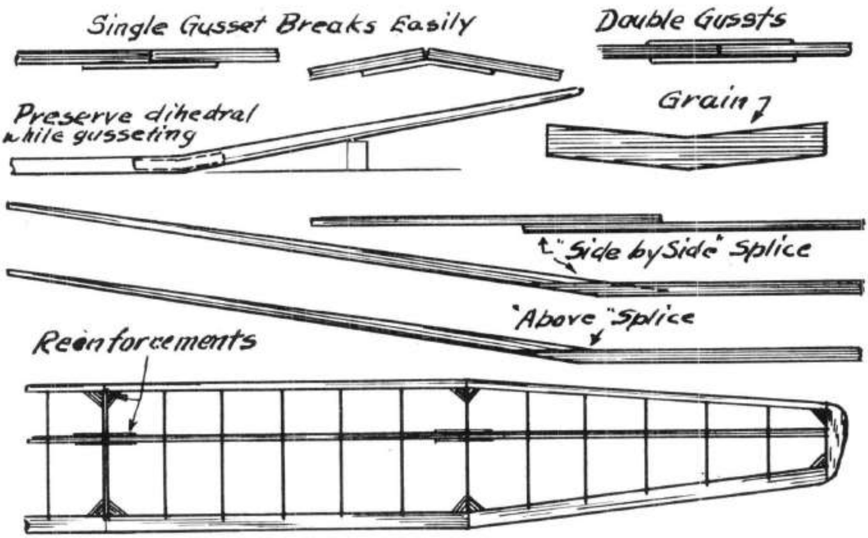
a Dutch sailplane, 6 feet.



CENTER SECTION & SPLICING

Center section splice, as well as all other splices, should be re-enforced with gussets on both sides. We must not depend on regular model cement too much. If only one gusset is used and the cement cracks between spars, the entire load is placed on the gusset. Use hardwood or plywood for gussets. Hardwood, bass or pine is preferable as plywood has two grains and we must be sure that its outer grain runs spanwise. Reasons for using hardwood are that such gussets will flex under load instead of cracking as balsa is liable to do, and that the thinness of hardwood makes a better looking job.

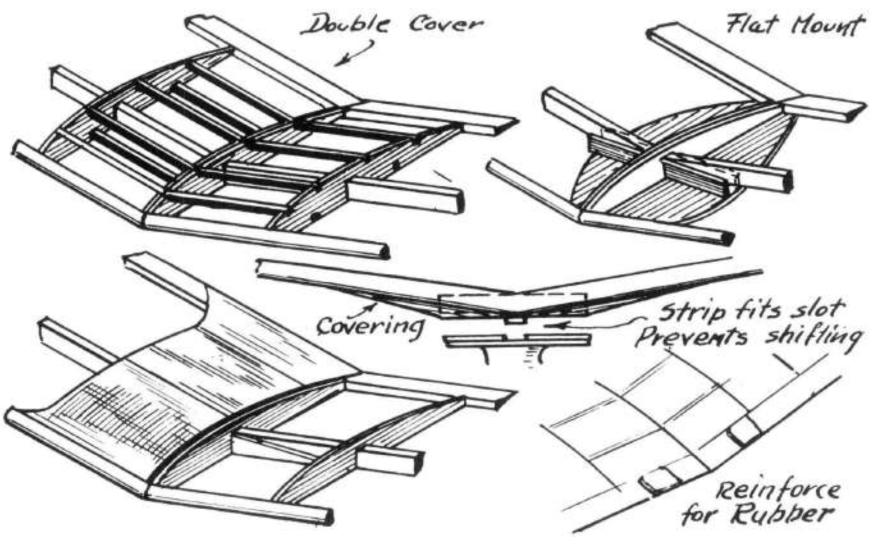
Use 1/32 or 1/20 stock for gussets for wings up to about 5 ft. span. 1/20 to 1/16 stock for larger wings. Use plenty of cement and form tube-like layer around the splice. Keep the wing in the dihedral "jig" while the cement is setting. Although the cement may be perfectly dry on the butt joints, the new cement used for gusseting will dissolve it and the two halves might come apart if care is not taken. It is a good idea to gusset one spar at a time and let the other spars keep the shape.



In some cases the spars may be spliced by overlapping as shown. Note two types. When using "one above other" splice, it is advisable to assemble the two portions in a jig so that both halves will be similar. Note that "side by side" splice will require change of spar slots on the ribs.

Cement fairly large corner blocks at leading and trailing edge connections, and on the corners of square tips. You will find that edge connections will spring open after only a few hard landings unless they are strongly reenforced with corner blocks and cement. Butt joints are never strong.

You will find that paper on center will soon be torn and shredded by rubber unless it is reenforced by covering the center section with sheet stock or cementing several strips at high spots and critical points as shown. Sheet covering is easy. Use 1/20 balsa or 1/32 bass or pine stock. Start at leading edge. Make sure cement is set before bending sheet over carved ribs. Butt joint the next sheet to the first. Overlap trailing edge. Trim sides or ends to center and to second rib with scallops at edges. Fit the other side to obtain snug butt joint. Use same procedure on bottom. Sandpaper all over to remove irregularities and apply a coat of cement over all joints. Note that center four ribs are cut a bit smaller to allow for sheet thickness. If strips are used the size will depend on the size of the wing as it determines the amount of rubber necessary to hold it in place. Use 3/32 sq. Balsa or 1/16 sq. pine for wings up to about 300 sq. in., and 1/8 Balsa or 3/32 pine for wings over that area. When using strips double cover the center area for more protection. Also reenforce trailing edge to prevent rubber bands from cutting into it.

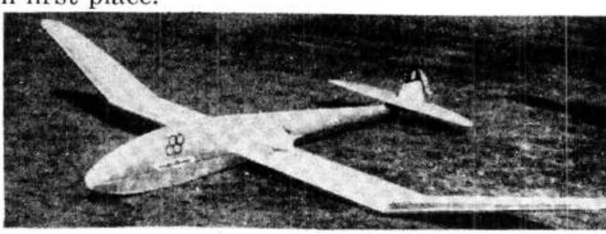


It is sometimes necessary to have flat lower center section on "V" dihedral wing for mounting. When the mounting area on the fuselage consists of a small flat cross brace, the wing portion can be made as shown. This should be built-in rather than made after covering. The covering will streamline the edges. When covering, attach paper to 3rd rib so that the paper will be able to adjust itself to the circumstances. Although a more rigid mounting can be obtained by making the lower center portion as shown. The first method works well when rubber holding bands run over the center, but when two sets of bands are used it might tend to rock and swing.

TWO PIECE WING

If at all possible make the wing in one piece as a two piece wing presents quite a problem. However, if you must make it in two pieces, try the following system. If convenient make the center section flat as it will simplify the job. Also design the glider with the wing held on with rubber so that it may "fly off" in case of hard landing and prevent the load of sudden stop from breaking the connection stubs.

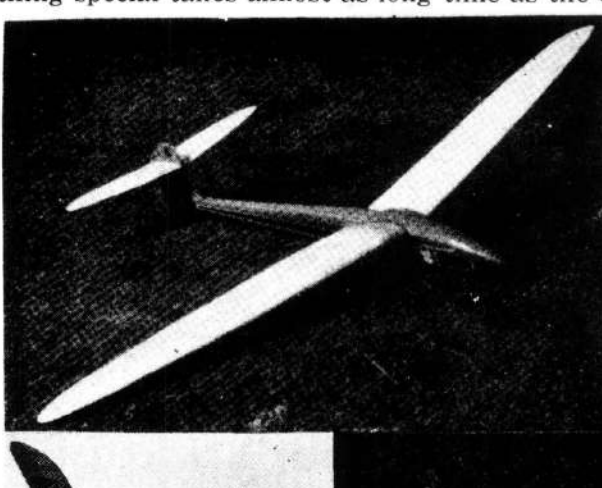
The problems involved in two piece wing is to make the connection rigid, unbreakable and easily worked. Nothing can be so exasperating as having the glider with broken connections before getting a chance to find out how it performs. Practically every builder thinks of tubes and dowels. In most cases they proved to be disappointing and this combination is not recommended. The dowels break too easy, and during the breaking process they usually bend the tube so that it makes replacement a major operation. If the rod does not break a good shock is sure to bend the tube and so locking the connection. Round metal tubes also present fixing problems and they have a habit of becoming loose. Therefore, do not use tube and dowel combination except on small wings which could be made in one piece in first place.



The connection which we used successfully on a 100" Span wing is shown. The stubs were made from 1/16" dural, and the boxes from 1/16" plywood. After making the stubs and boxes, cement one set first and let the cement set. (Be sure to have the wing lined up for trueness). Attach the second set, but instead of tying with thread use rubber bands. Before the cement has a chance to set move the halves in and out so that the second set will adjust itself to the front one. If you are satisfied and the wing is true, let cement set. Complete by wrapping second set with thread and be generous with cement all over. Hardwood, oak, maple or ash may be substituted for dural stubs providing it is thick enough, almost the thickness of the spar. If the dihedral starts at center make wood stubs as shown to avoid sharp corner weakness.

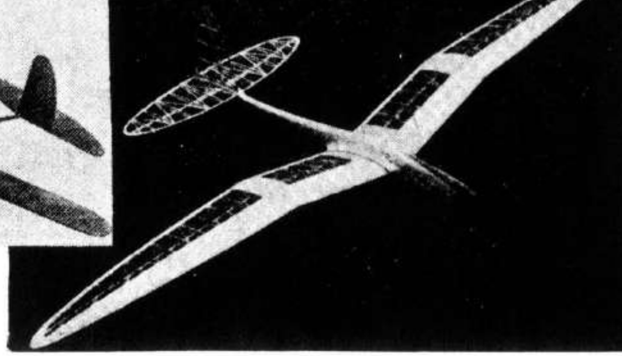
If you are handy with metal work you may try the connection shown. The reason for bringing them above and below the surface is to obtain better rigidity as well as making it easier to fix together. The upper portion may be covered with a streamlined cap. Care should also be taken to prevent the lower portion from ripping parts of fuselage during shocks. Good brothers successfully used this system on the 8 ft. radio controlled gas model wing. However, the landing gear helped in absorbing the landing shock and also kept the wing above the ground. It is advisable to use hardwood spars and plywood reenforcement at point of attachment.

When the wing is fixed to the fuselage we have a nicer problem on hand. In the above the wing could swing and fly off on landing, but in this case when the wing hits an obstacle it will swing the entire model around, and if the fuselage is held back something will crack unless provision is made to have the wing separate itself from the fuselage. Shown are several methods. Since we have not tried them personally we cannot tell you how they work. As you can see the idea is to provide rigid foundation yet allow easy separation when the wing hits. Note: When designing such wing forfuselage connections be sure to allow swinging clearance for stubs. Use rear stub for a pivot, and see if the front stub clears its hole. Also try to have as much space between stubs as possible to obtain better rigidity. All stubs should be made of hardwood and should fit snugly the hardwood lined boxes or slots. We now leave you to your problems, as we believe that you are an experienced builder, otherwise you would not be trying this. Very often we find that making something special takes almost as long time as the entire model.

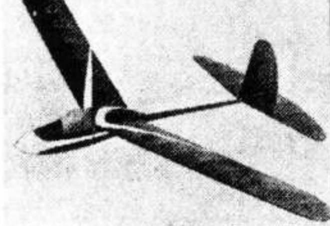


A seven foot sailplane with no balsa in its structure, by L. Temple

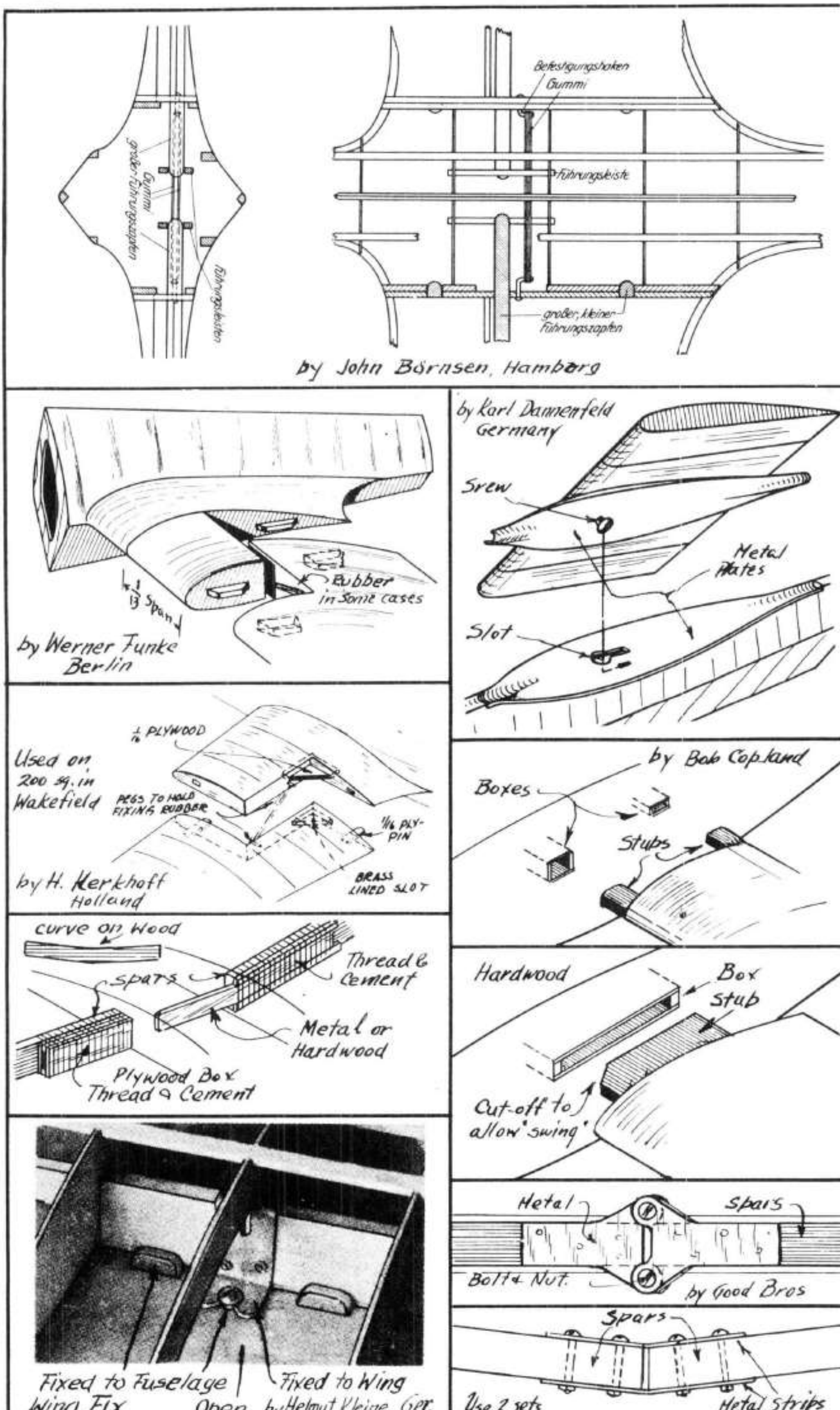
in England



A six-foot wing span by Mr. R. Bowyer

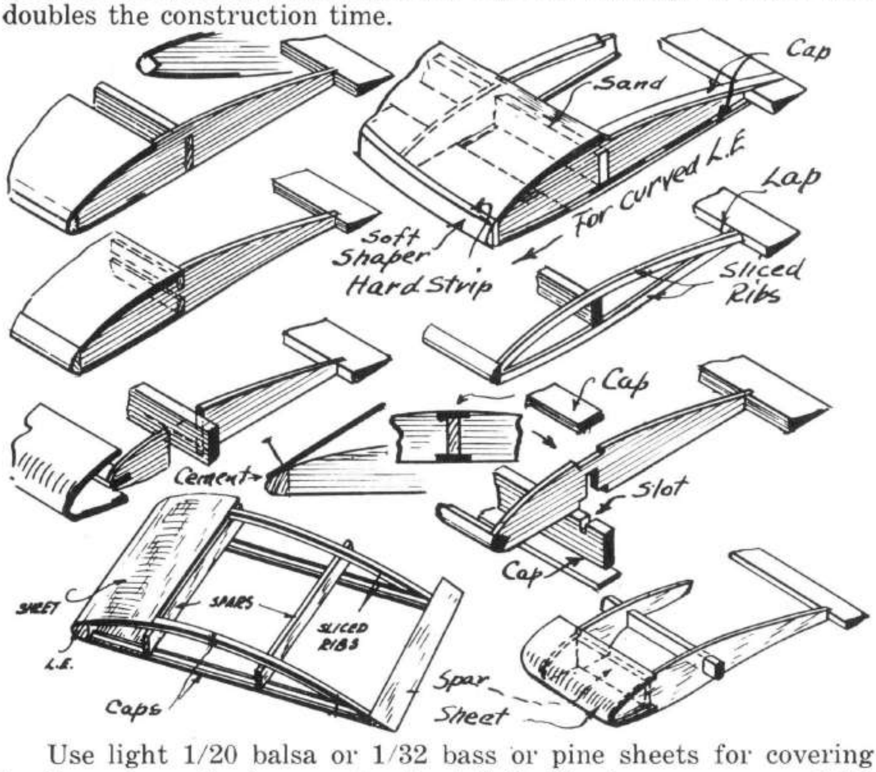


"ALBATROSS"
42 In. wing span
by THE MODEL SHOP
New Castle-on-Tyne


Befestigungshaken
Gummi
Führungsleiste
großer, kleiner Führungszapfen
Gummi
großer Führungszapfen
Führungsleisten
by John Börnsen, Hamburg
Rubber in some cases
1/3 Span
by Werner Funke Berlin
by Karl Dannenfeld Germany
Srew
Metal Plates
Slot
1/16 PLYWOOD
Used on 200 sq. in Wakefield
PEGS TO HOLD FIXING RUBBER
1/16 PLY-PIN
BRASS LINED SLOT
by H. Kerkhoff Holland
by Bob Copland
Boxes
Stubs
curve on Wood
spars
Thread & Cement
Metal or Hardwood
Plywood Box Thread & Cement
Hardwood
Box
Stub
Cut-off to allow 'swing'
Metal
Spars
Bolt & Nut.
by Good Bros
Spars
Use 2 sets
Metal Strips
Fixed to Fuselage
Wing Fix
Open
Fixed to Wing
by Helmut Kleine, Ger.

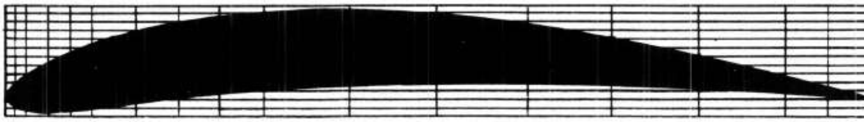
SPECIAL WING CONSTRUCTION

Shown are several types of wing constructions which are used by more advanced builders. Note that the main emphasis is placed on the leading edge which must be strong to take shocks and form smooth surface for aerody nomical reasons. Sheet covering and capping add considerable strength and rigidity although it more than doubles the construction time.



Use light 1/20 balsa or 1/32 bass or pine sheets for covering leading edges of wings up to about 8 ft. For large spans use 1/16 balsa or 1/20 hardwood. Start by cementing the sheet to the lead.edg. Make sure that every portion is well cemented before bending to the ribs. Use pins to hold sheet in place. Sand sheet edge to conform to rib's curve. It is best to overlap the rib and leading edge junction. If sheet is brought to the edge there is a good chance that the sheet will break away. Personally we prefer to cap ribs to take care of the sheet edge over the ribs. If ribs are cut to take care of the sheet, start work on ribs. We also sand sheet between ribs to obtain a smooth continuous surface after covering. Without sanding the sheet edge presents a corner.

Do not cover wings with sheets. You will be disappointed. It is practically impossible to obtain smooth surface unless you plank with at least 3/22 strips. And every change in weather will warp the wing. Same applies to solid balsa wings unless a good finish, about 4 coats of dope, is applied.



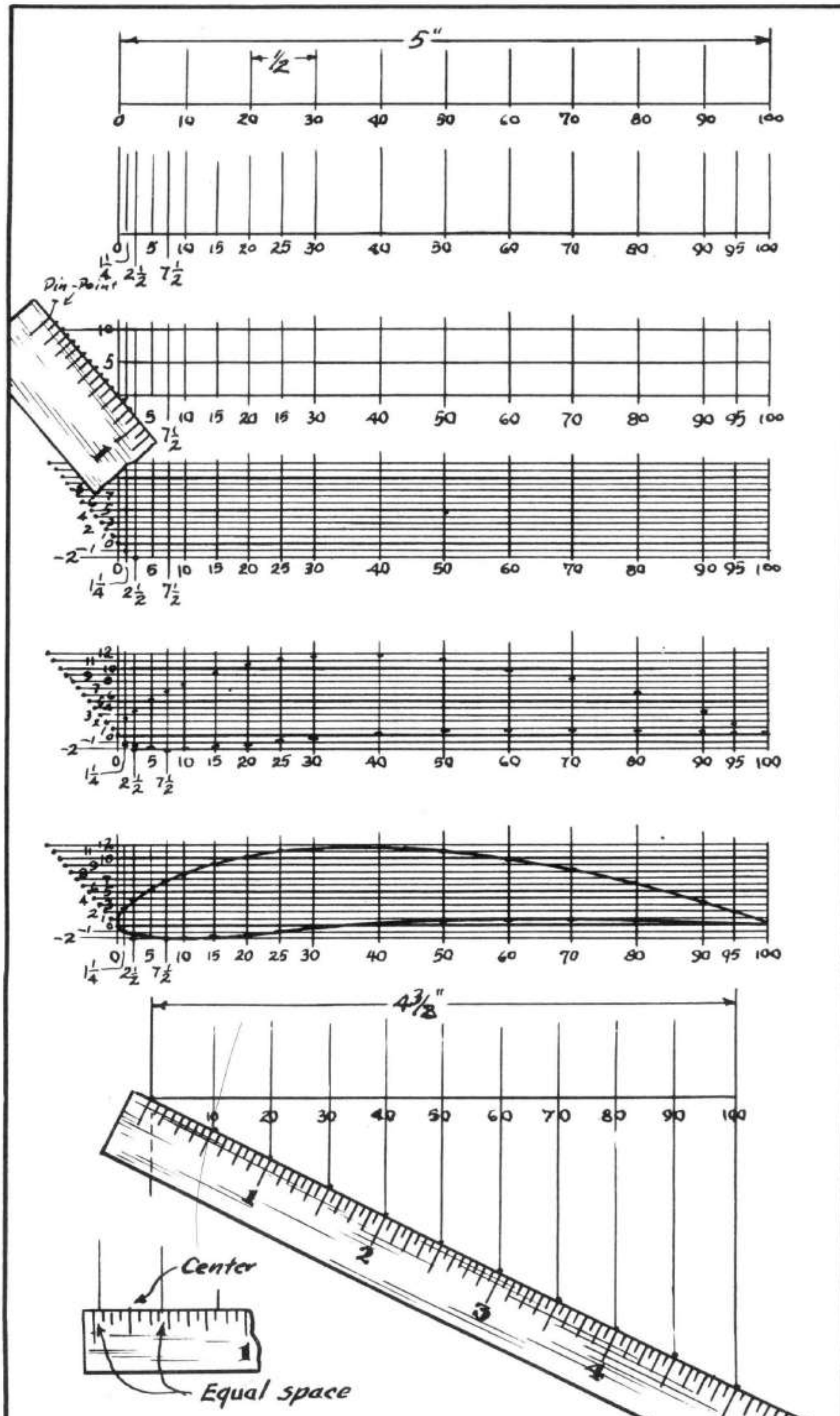
PLOTTING AIRFOILS

Airfoil plotting is simple once you have taken the trouble to work out an example. Since airfoils for models are rather small in comparison to full size we have to be very accurate when drawing the graph as the lines come rather close. You will need a drawing board, T square, ruler, triangle, 3H pencil and a French curve with flowing lines. You may use any kind of paper for practice or if you intend to use a metal template. But for fast work plot on 2 or 3 ply Bristol Board or similar style of paper. Your art dealer knows what you want. A good notebook cover will do. You will be using this paper for template. So use your judgment.

The first step is the construction of the graph. Let us assume a nice convenient chord like 5″. Draw two vertical lines 5″ apart and then a base line as shown. We must divide this 5″ space into a certain number of spaces as indicated by the left, or "% Chord Station" column on the coordinate's table. In case of N.A.C.A. 6412 we have 18 spaces. But if you will notice we have 10 basic 10% Chord spaces.

Since 5″ is 100% Chord in this case, 10% is ½″. So we subdivide 5″ into ten ½″ spaces and number them from 0 to 100 as shown. Find this number in the left column and note which numbers are still missing. Most of them will be found between 0 and 10 because it is between these two points that the airfoil makes a sharp downward and upward bend and consequently finer plotting is needed. However, before adding these lines subdivide into halves the following spaces: 0 to 10, 10 to 20, 20 to 30, and 90 to 100. Then, subdivide 0 to 5 and 5 to 10, and finally 0 to 2½. Number them. Note that you have now all stations.

The next two columns provide us with the positions of the upper and lower cambers. For example at the 30% C station the upper curve is 11.65% C above the base line, while the lower curve is .38% below it (or —.38). We could multiply the chord, 5″, by these percentages and get .58 in. for the upper curve and .19 in. for the lower and then measure off these distances. However, to do same for all stations is a long job. A simpler way is to draw horizontal lines spaced 1% Chord apart. Start by drawing a horizontal line 10% Chord (or ½″) above the base line. Divide this space into halves and number the two lines 5 and 10. It is now necessary to divide the space between 0 and 10 into ten 1%C spaces. Do this by angling the ruler until you have ten 1/16th between the lines. Pin point at the 1/16th point and add two extra points above 10 and below 0 to take care of all requirements. Draw horizontal lines through points and number them as shown. This completes the graph for plotting a 5″ Chord airfoil. Try one!


5"
1/2
Pin-Point
4 3/8"
Center
Equal space

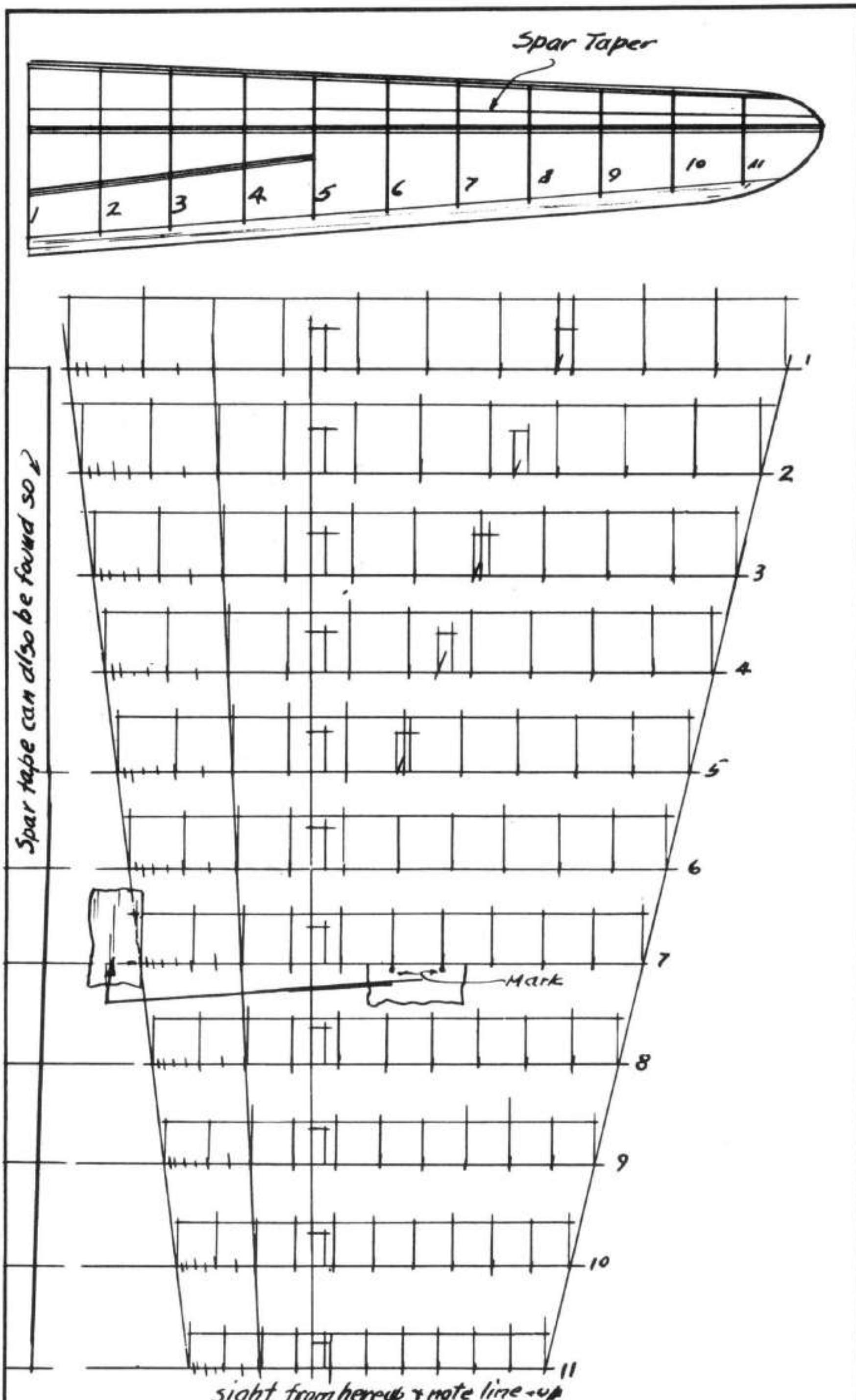
AIRFOIL FOR TAPERED WING

The best way to obtain true airfoils on a tapered wing is to plot each one individually. The job is not too long if a method is used. The idea is to make all coordinate graphs first and then plot. The graph can be made fast for a straight tapered wing by drawing as many base lines as there are ribs and also have them evenly spaced. Be sure that the large ribs do no interfere with each other. Measure out the center or largest rib. Next measure out the tip rib, but before placing it on its base line note the spar positions. If the spars run straight, even if its only one, draw a line to represent an edge. Now you have a definite place for the tip rib. If the spars angle or bend the position of the tip rib depends on its position behind the front line. Divide the tip into ten spaces. While at it you might as well make the finer subdivisions on both center and tip rib. The size and spacings of the in-between ribs is found by connecting similar spots on the end ribs and making small cross marks on all the base lines where the ruler or T square edge crosses them. Using these cross marks draw short vertical lines. Next mark the 10% C spacing on edge of paper and mark the 10% thickness line position. From now on it is same as described. You may use the ruler or cone idea for finding the 1% spacings. When graphs are finished, plot the curves.

After plotting locate the spar positions. This can be done by referring to the plan view. Dividers are best for this work. Draw a small vertical line on each rib. Then add the thickness line. The height of the spar will depend on the thickness of the ribs. As we mentioned before, the spar should be never less than 3/32″ below top camber. So determine at which rib this happens while spar is at its full depth. Then find the allowable depth at tip rib. Make a side view drawing of the taper over the plan view. This will provide the depth of the spar for each rib. Simply transfer the dimension to the rib drawing. Also drawn on the individual ribs the leading and trailing edges. This will determine the exact template outliner. Note: Be Sure to add 1/20 to trailing edge to allow for notching, and if center or leading edge is covered allow for the sheet thickness. The ribs are now ready to be cut out and used for templates.

When the plan form is irregular, curved or elliptical the airfoils will have to be individually graphed and plotted. Use plan view for chord dimensions as well as for all others. In this case the cone idea will come handy in subdividing different chords.

Elmira Soaring Contest

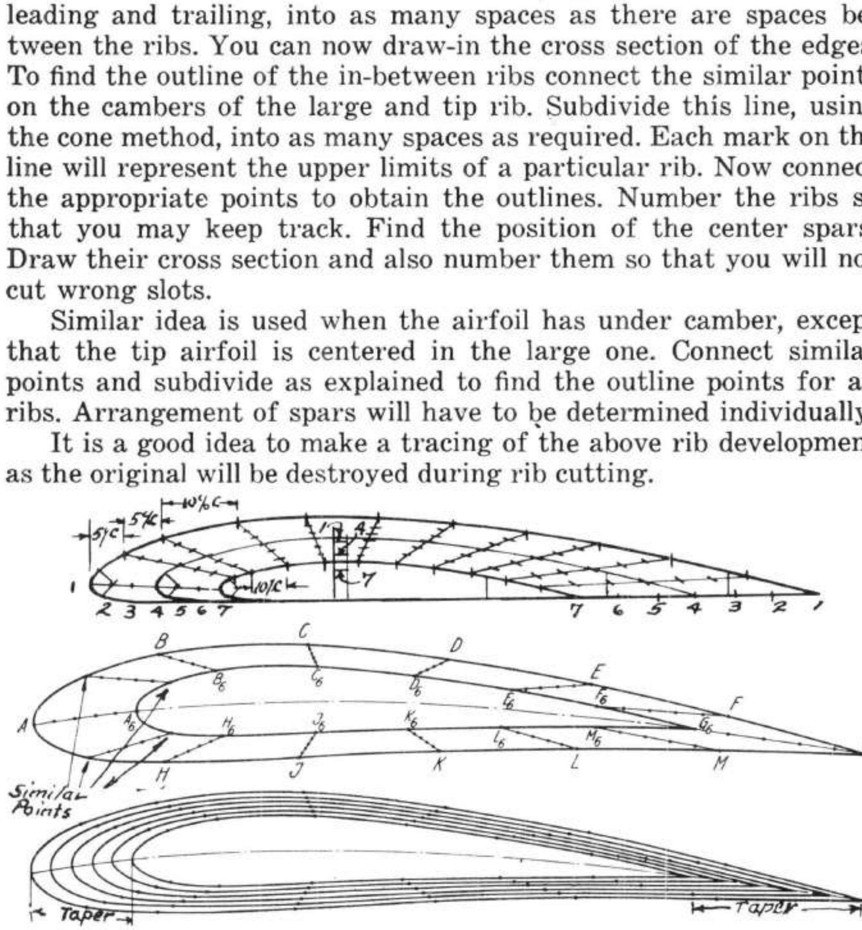

Spar Taper
1
2
3
4
5
6
7
8
9
10
11
Spar tape can also be found so
Mark
sight from here up & note line-up

SIMPLIFIED TAPERING

One method which we use on straight tapers and when lower camber is flat is to plot the large airfoil first and then the tip within the large one. We position the tip rib to correspond to its position on plan view. The next step is to divide the space between the edges, leading and trailing, into as many spaces as there are spaces between the ribs. You can now draw-in the cross section of the edges. To find the outline of the in-between ribs connect the similar points on the cambers of the large and tip rib. Subdivide this line, using the cone method, into as many spaces as required. Each mark on the line will represent the upper limits of a particular rib. Now connect the appropriate points to obtain the outlines. Number the ribs so that you may keep track. Find the position of the center spars. Draw their cross section and also number them so that you will not cut wrong slots.

Similar idea is used when the airfoil has under camber, except that the tip airfoil is centered in the large one. Connect similar points and subdivide as explained to find the outline points for all ribs. Arrangement of spars will have to be determined individually.

It is a good idea to make a tracing of the above rib development as the original will be destroyed during rib cutting.

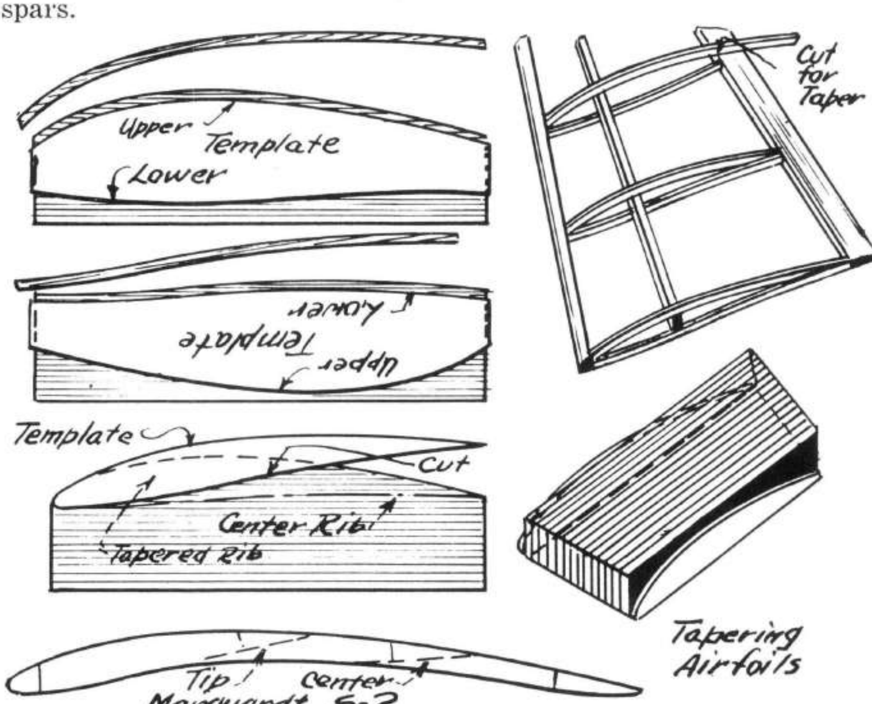


The method in cutting ribs from such plottings is as follows: Trim with scissors the large rib. Cut out the leading edge "V" if angled spar is used. Cut off trailing edge portion, allowing for notching. Do not cut out center spar slots. Lay the template over the rib stock. Pin point the top corners and two sides near the base of the rib slot. This will locate the slot which is cut out after the rib is cut out. Carefully guide the razor blade around the template so that the paper will not be cut. All this while press firmly on template to prevent shifting. Cut as many ribs of this size as required. After this is done cut to the next outline and carry on as described not too far into the night.

OTHER TAPER METHODS

One method, developed by Roger Hammer, consists of slicing upper and lower camber outlines in form of strips. Then by cutting off excess at trailing edge fairly good job can be obtained. We have never used it so we cannot give exact details but we imagine that if center and tip ribs are made first the taper of the spars can be found. Note the overlap at the trailing edge.

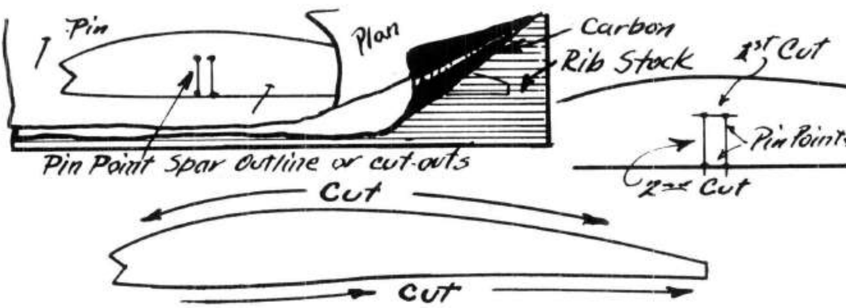
Another method which he used made use of full size template. First cut the upper curve. Then mark off the chord of the smaller rib. Find the inner point of the trailing edge and mark off the thickness of the trailing edge. Superimpose the leading edge of the template over the partially cut rib and using the leading edges as a pivot swing the template upward until the trailing edge mark is reached. Cut along the lower camber to face the rib. As you can see every rib will have to be individually fitted. It seems to lend itself well to the design which only has leading and trailing edges for spars.



Roy Marquardt designed a special airfoil for thin wings and which only needs to be cut at the trailing edge for tapering. See sketch. Then we have a method which is illustrated at least once a year in every magazine. In this case the large and small ribs are plotted. Then the required number of strips is rigidly held between them. Cut off surplus while using the end ribs as guide. Make two sets, one for each half.

TRACING RIBS FROM PLANS

The best method is to have a piece of new carbon paper between the outline and the rib stock. Use a fine point, but not needle sharp as it will tear the paper. Use pins to hold the three parts together. Make sure that the grain of the rib stock runs parallel with the rib outline. As before, spar outlines should be pin pointed to get good results.



RIB STOCK & CUTTING

The recommendations for rib stock still stand, but we failed to mention what grade of wood to use. We also mentioned, while discouraging lightening of ribs by using cut-outs, that the ribs have to withstand considerable compression under the proper tension. Therefore try to use stock which is cut along the quarter-grain line, the line radiating from center outward. You can recognize such stock by its speckled surface and its stiffness against tubular bending. This also applies to pine or basswood. When balsa is used the stock should be of medium weight, 8 to 9 lbs. per cut. ft. Heavier stock makes rib cutting more difficult.

While cutting ribs, or any irregular outlines, consider the grain. Always cut away from the center of the high point to prevent tearing off parts. While cutting upper camber, cut in direction shown. Follow same procedure if the lower surface is cambered. See cut directions. This is especially important when wood is hard and grainy. You can do almost anything with soft balsa. A sharp cutting edge will also make the work easier. You should have no trouble in cutting bass ribs up to 1/20th with razor.

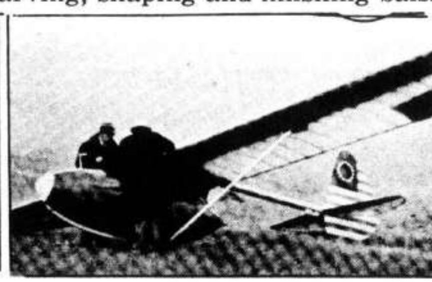
If you are cutting ribs from printed sheets, just follow the above instructions. But if you are using a template you will have to be more careful. First be sure that template does not shift after cutting has started. Use pins if convenient. Pin point the spar slots as advised. We usually cut the leading edge "V" and then the upper camber. If we slip, we can always move down and try again. The lower portion, being straight or almost so will naturally be easier. In cutting spar slots, cut the horizontal cuts first. This will provide a stop as well as prevent the rib from cracking and bending into a "V" when razor is pressed. Use blade at angle to cut.

THE FUSELAGE

When laying out a fuselage remember that the ideal glider would be a flying wing and that anything added to it is just so much drag which will decrease its performance.

The International rules, as ours did up to 1942, call for (Length $/200)^2$ cross section. This is about right as it makes it possible to design strong structures and still retain full size resemblance. It is hoped that our present $(\text{Length}/100)^2$ will be changed as soon as possible. Seems rather strange to take off all restrictions on gas models with so much surplus power and pile it on gliders which are handicapped right from the start.

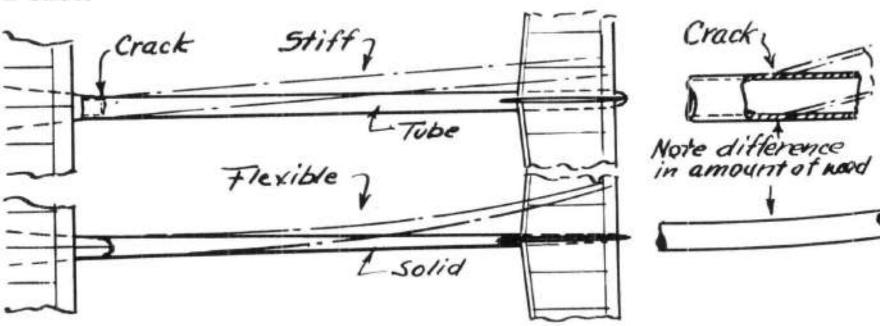
As you can see from the plans shown elsewhere in the book, there is a large variety of fuselage designs. Beginners should naturally start with simple framework. Although pod and boom looks easy enough to make, if it is not recommended for beginners because of experience required in carving, shaping and finishing balsa.



The pod and boom (especially for (L/200) rule) is the logical choice from aerodynamical viewpoint. It supplies all the essentials with minimum of drag, especially skin friction. No matter at what angle the fuselage may be angled to the airflow, the drag will still be less in comparison with conventionals. However, one should be careful how to use this combination. While going through the "Thermix X" series and also several boom gas jobs we found several important facts about this combination.

The boom should always be solid; made from very hard balsa or even bass or pine. A tubular boom, although lighter will break or crack very easily, and paradoxily enough, because of its stiffness. This can be explained by the fact that when a glider hits head-on the weight of the tail tends to crush the tube. If the force is a direct compression all may be well, but this seldom happens and the impact inertia usually whips the boom to one side. If the tube is equadiametrical throughout the break will occur near the pod as this is the place where the inertia of the tail has the longest moment arm. This means that the force is concentrated on a very small spot. As you can see only a small portion of the tube is brought under full stress and it's no wonder that the tubular boom snaps. Tapering the tube helps only in reducing weight where it is not needed but the weakness of having too little material where the stress is applied, and stiffness, the real danger, is still there. Of course when the size of the tapered boom is increased so that it begins to look like a regular fuselage, the circumstances are different. But, then, the job is no longer in the pod and boom class.

In contrast a solid boom is flexible. This means that when the tail whips the boom, the flexure will absorb the inertia over the entire length of the boom. By the time the load comes close to the pod its full force is expanded. If there is still some left the solid cone of the boom will distribute the load to more material than possible in a tube.



When using boom and pad you can use the dimensions given for the "Thermic X" designs. They proved strong in most cases. Small pods can be carved from single blocks. Make them extend more than on "Thermics" so that less balance will be used. Large pods can be built as shown. Do not use stringer and bulkhead pods. They crack and crush too easy. Planked pods will do. Note the basic design of the "Thermic" and how every need is taken care of. It took a lot of jiggling. The aerodynamical points will be taken up later.

PLOTTING THE FUSELAGE

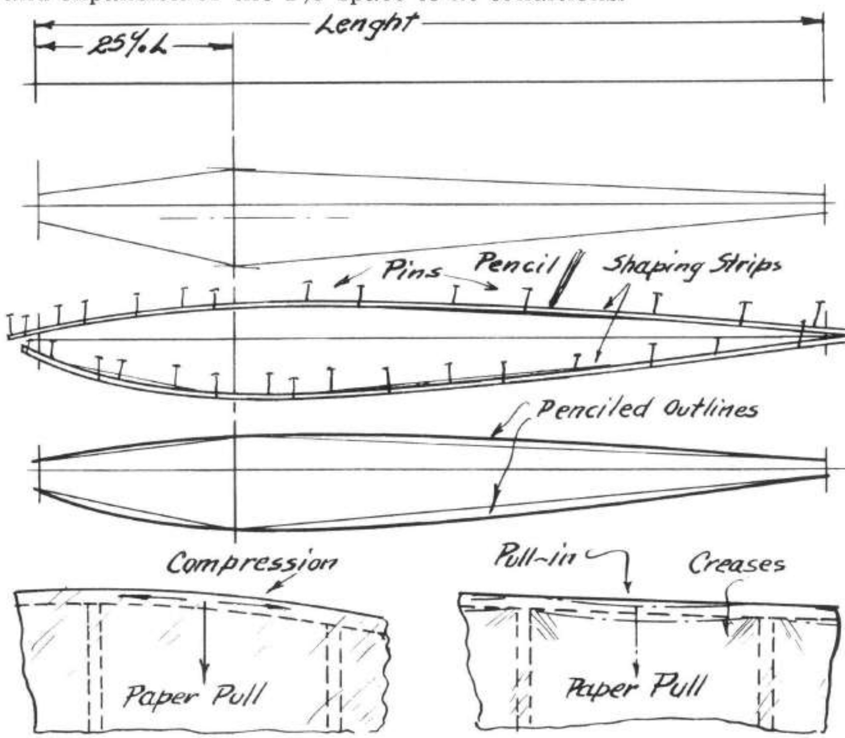
The plans offer a large variety of fuselage designs from which to choose. Still it's a good idea to know how to develop a fuselage.

Most of us have an idea what we want, but we still have to draw it up, and find out if it can be made. But no matter what ideas we may have we still have to stick to the basic layout of surfaces. Let's start on a simple job.

From our table of proportions we determine the length of the fuselage. Once this is known we can easily find out the required cross section area and also the position of the wing. So draw the base line, measure the length and draw a vertical line at 1/4 length to indicate the position of the leading edge.

The next step is to draw a full size pattern of the cross section. If it is rectangular a ratio of 2:1 will do. That is, the height to be twice of width. You can of course change this ratio to suit your design. (We will treat other shapes later on). So far we have enough dimensions to box the fuselage.

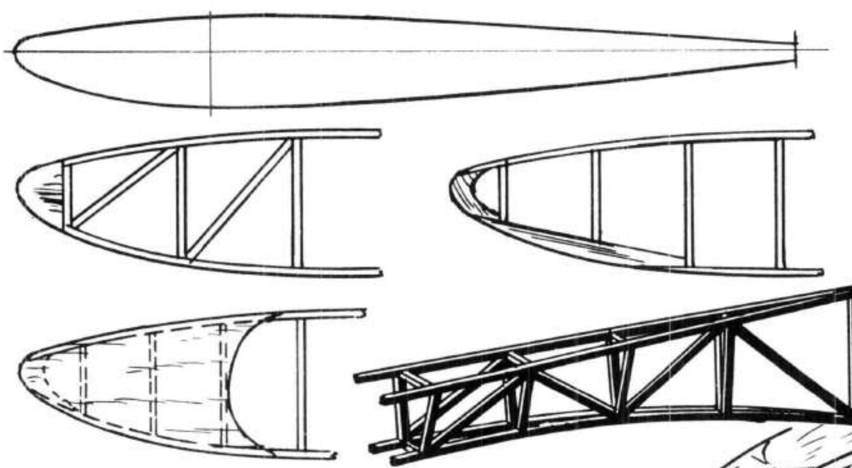
From aerodynamical viewpoint the ideal outline would naturally be streamlined. However it somehow does not seem to fit the picture which we usually associate with gliders and we tend to modify. Of course, if you would like to see how it would look, plot one from ordinates given elsewhere. Remember we said about compression and expansion of the 1% space to fit conditions.



We usually assume that the high point should be at the ¼ line. Also, we raise the center line slightly to obtain a more pronounced bottom curve. Now draw straight lines from ¼ spot to ends to get an idea of the outline. If you are satisfied, take a square strip and try to obtain good, natural curves by bending and holding it in place with pins while penciling the curve.

While laying out the fuselage avoid straight lines and try to have outward curves. This will make the frame rigid and also assure tight covering. As you may know, wood has very good compression characteristics so that when the shrinkage of the paper pulls the longerons inward it places them under compression and nothing happens, and the paper will become tighter because it cannot bunch. Since paper acts as bracing a tight paper means rigidity. If the longeron is straight the paper is liable to pull it out of line enough to spoil the covering and lessen the cross bracing characteristics. Also when a fuselage is loaded or bent, the outward curved longerons will be kept from cracking by the paper, while an inward curve will crack.

The front is usually shaped with French curve. At this point it is a good idea to decide on the type of nose to use, balsa block or rounded with stiff paper. Also check the curve and see if you can follow it with the longeron. If you cannot, you may have to use sheet stock. When using sheet "shapers" remember that they cannot be bent in plan view. The rear portions need not come together as we need strength and rigidity for carrying the tail surfaces. In some cases the longerons may be bent into a sub rudder, and when joining the two sides, glue the lower longerons together. However, when the longerons are heavy they are liable to pull the rear out of shape, and so be prepared to use diagonals.



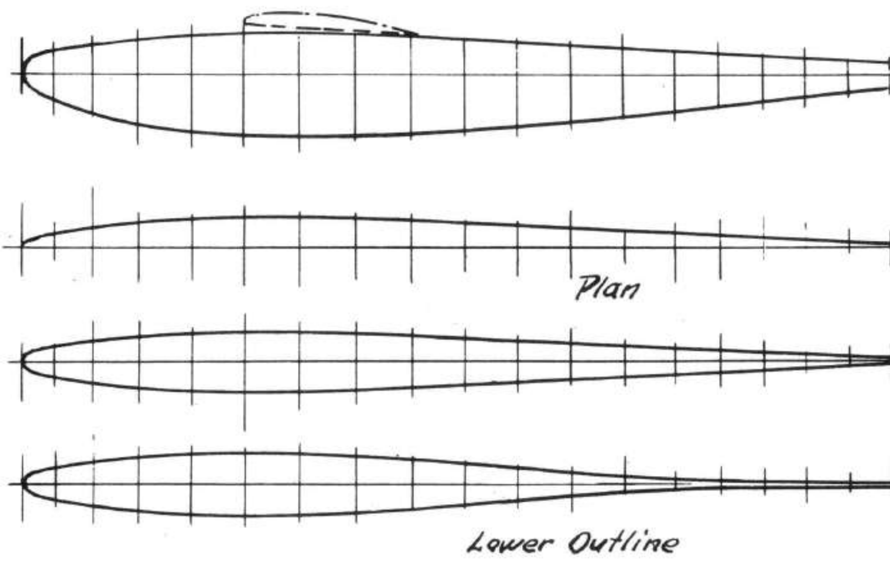
by Gus Briegleb

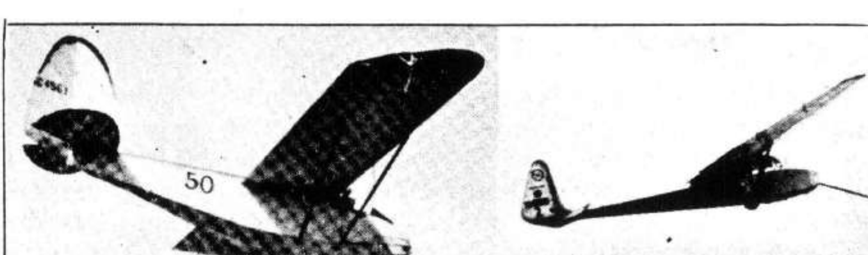
After the side is outlined, determine the position of the uprights. Their spacing will depend on the size and strength of the wood and local conditions. They have to be spaced closer to take care of extra load or where longerons come close. If the longerons have no outward curve the space may be about 10 x size of longeron (10 x $\frac{1}{8}=1\frac{1}{4}$"). If the wood is hard balsa or bass the spacing may be a bit greater. On curved portions you may space as high as 16 x size. Where the curve is sharp you will naturally need closer spacing and also diagonals.

The actual spacing should be started with an upright at the 1/4 spot over which the leading edge rests, and another at the trailing edge. This will take care of rubber band stresses. Divide the in-between space as per recommendations. Use close spacing at the very nose. Have even spaces behind the trailing edge until you get near the tail where the longerons come close.

The plan view is drawn next. Work one side first. When it looks good, make the other side like it with help of dividers or marked paper edge. Extend the upright lines from side view to make cross braces. Also plot lower plan, if difficult.

At this time you should also determine the construction of the tail surfaces and how they will be fixed to the fuselage so that extra strips may be shown on the drawing.





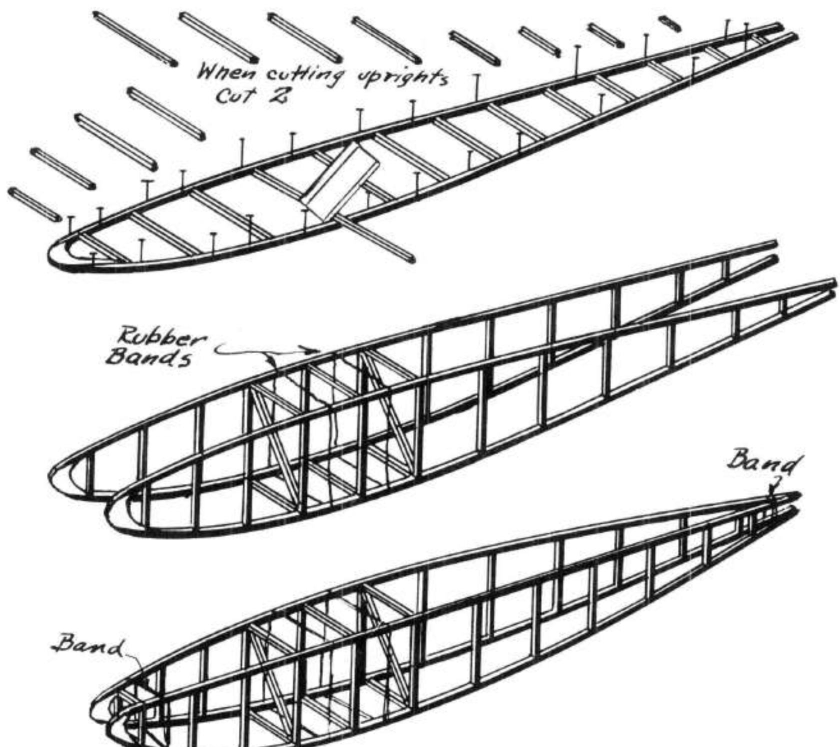
FRANKLIN PS - 2 HALLER HAWK Sr.

LONGERON DIMENSIONS

If hard balsa is used, use 1/16 sq. up to 10″ lengths, 3/32 sq. up to 20″, 1/8 sq. up to 30″, 5/32 sq. up to 40″ and 3/16 sq. up to 50″. If bass or pine is used take off 1/32 from the particular balsa size. Use same size for uprights, diagonals, cross braces and other needs.

ASSEMBLY

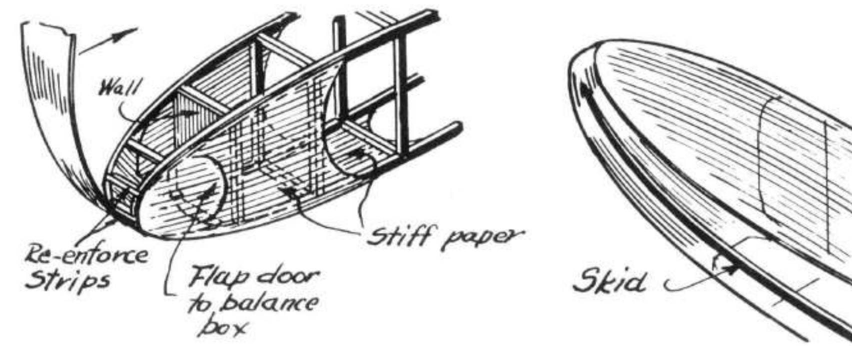
To prevent cement sticking to plans, rub Ivory soap or parafin over the joint portions before beginning the assembly. To assemble; lay longerons over plan, and hold in place and to curve with pins. Measure up-rights and cut two to snug fit. If the fit is forced, the longerons will bulge after the pins are removed. Cement all sheet shapes in place. Let cement set well, and remember that the cement next to the plans is not dry. So be careful when removing from pin-jig. Make the other side.



Cut all cross braces before assembling two sides. Measure the space between longeron edges and then subtract two longeron thicknesses to obtain correct size. To assemble sides start with widest cross braces which will be found around $\frac{1}{4}$ spot. Cement top and bottom. Let the cement set and make sure that sides are perpendicular to the board. It is a good idea to add temporary diagonals to hold fuselage "square". Then slip several rubber bands over center to prevent "springing". Bring ends together and cement the nose pieces. Hold in place with rubber bands. By doing this you will have less trouble in keeping the fuselage straight. Now start cementing the remaining braces in place. You will have to use more bands to keep longerons pressing on braces.

RE-ENFORCING SIDES

The nose of the glider has to take terrific punishment, and if the nose is not made extra strong it is liable to let go and let the longerons spring apart. One method of re-enforcing is shown on "Floater". Here 2-ply Bristol Board paper is cemented to sides and



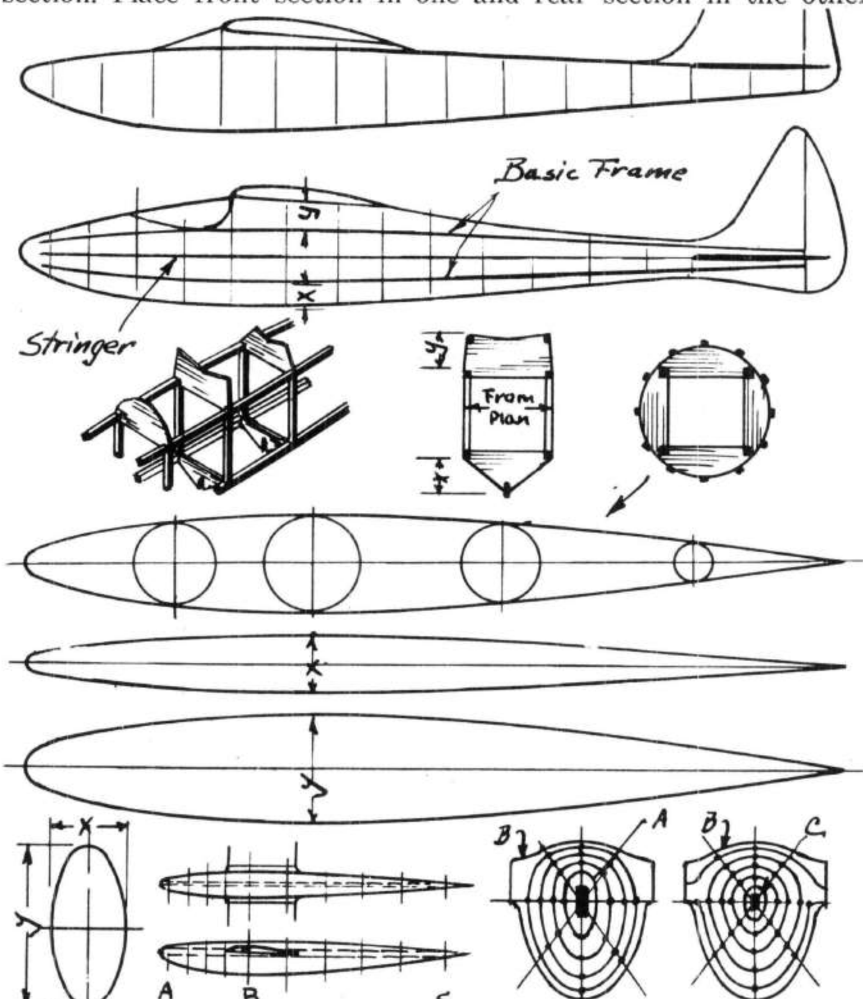
used to give smooth nose curve. Before cementing them in place, make a balance box as shown. This will also contribute to the general strength. If a solid balsa block is used have the paper board overlap it to obtain better grip. The bottom, and wherever you may grip the fuselage, should be covered twice. Run a center skid after covering.

MORE FUSELAGE PLOTTING

There is no end to the variety of fuselages we can design. Just by adding a cabin effect to the above plain fuselage we have a different design. The basic fact to remember in designing is to keep the longerons unbroken as far back as possible. Think twice before cracking one to obtain a window effect. Always "add" superstructure to the basic frame. "Thermic 50" is a good example of this rule. The framework is symetrical on all sides, except plan behind wing, yet by addition of triangular bulkheads and side stringers we get a good shape.

In designing new outlines follow the procedure given. After finding the main cross section, draw the basic framework. Then outline the actual shape, and the plan view. Make the two sides of the basic frame. The triangular bulkheads are plotted by taking the height from side view and the width from plan view: all the dimensions needed for constructing a triangle. Allow for longerons and stringers when making the bulkhead. On "50" the front top is rounded, and the wing rest is also specially shaped. In most cases it is best to shape to fit. It could be plotted by method shown later. Very often we let the celluloid decide the shape. It's best to follow celluloid's natural curve than to cut it into strips to fit. After all bulkheads are plotted, assemble the fuselage as described.

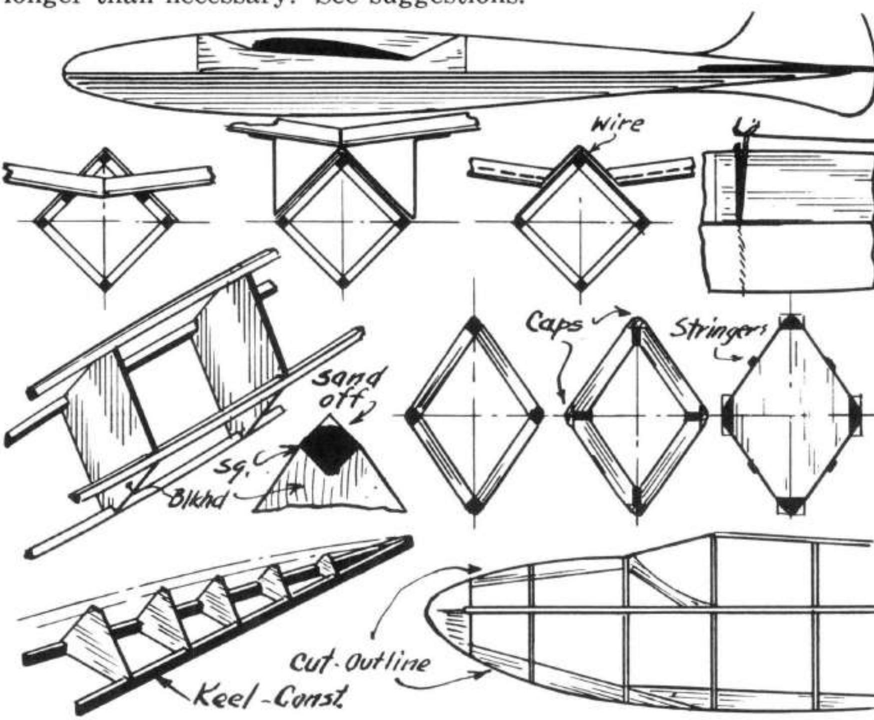
When the fuselage is round we only need side view to obtain the various diameters. If it is elliptical we can use a set system which will give us similar ellipses. Position of stringers can be found by triangles. In case the fuselage does not have similar cross section throughout we have to plot individual bulkheads. This is done by drawing couple side and plan views. Then draw two sets of center section. Place front section in one and rear section in the other.



Remember to use center lines. From the drawing find the height and width of each bulkhead. Divide the outlines of the center and end bulkheads and connect them with lines. Divide these lines into spaces equal to spaces between the two bulkheads. If there is a peculiar curve the spacing will have to conform to it so that it will be "flowed" smoothly. If you plan to use center keel, mark its slots on each bulkhead so that the bulkhead will be in same position. Also draw radial lines to mark position of stringers if used.

DIAMOND FUSELAGE

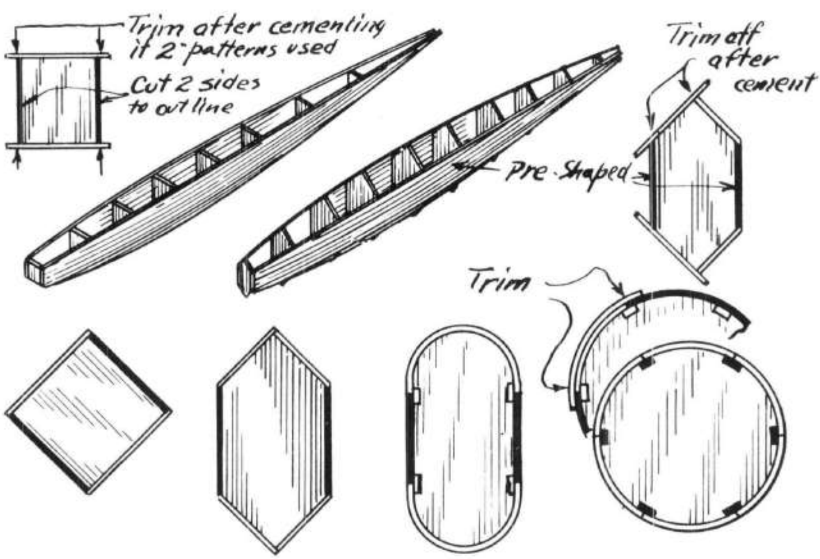
There seems to be no end to the variations possible with diamond fuselage. A square job when set on edge looks good, especially if wire wing mounts are used. Do not raise the wing higher than necessary to clear the fuselage. You can also cut out a wing's rest as shown providing you have enough cross section left. You may also try making heavy wire saddles with which to connect the two halves as shown. But this is actually harder to achieve than one can imagine. When using wire saddles be sure to cover sides with sheets to prevent tearing. If wing mounts are used do not make the bars longer than necessary. See suggestions.



In making true diamond sections use bulkheads to simplify the work. If cross braces are used you will have to fit each one individually to fit conditions. A refined method of this construction is to use capping strips as shown. Bulkheads are easily plotted from side and plan-view. Use rectangular longerons, to allow rounding of corners. Bulkheads can be made in one or two pieces. Two piece kind will allow jig-board assembly. When curves are sharp, make use of diagonal braces or cut the curve from sheets. Here again you can complicate the design by rounding sides and using stringers. Just plot the bulkheads as shown. As on all fuselage designs, also be sure to have sturdy nose and keel. Also do not raise the wing higher than necessary. Pylons have no place on gliders!

MONOCOUQUE FUSELAGES

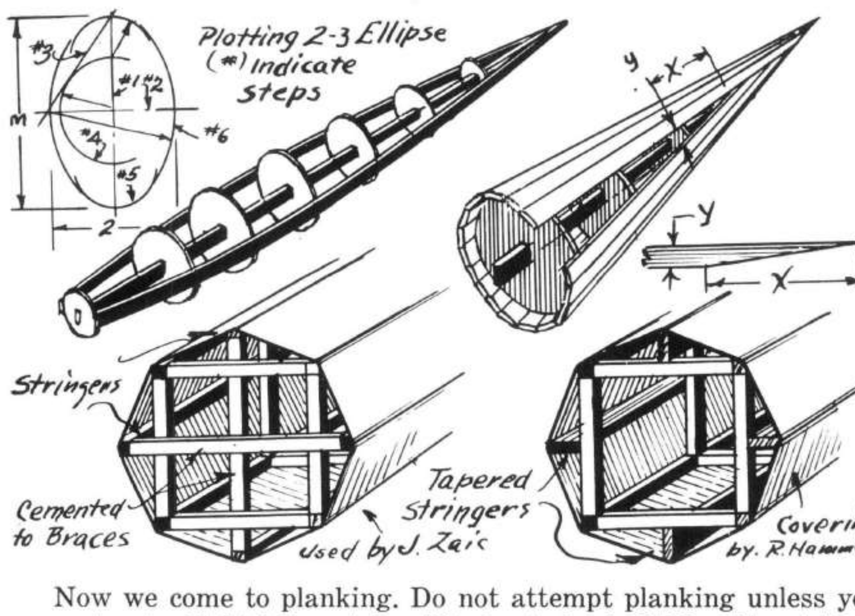
Monococque fuselages are undoubtedly the strongest of the lot. Although the advanced types require exceptional workmanship and quality material almost every one can assemble flat sided designs. Let's take a square or diamond job with symmetrical sides. Plot one side and cut four patterns from medium 1/20th balso or 1/32 bass. Cut as many bulkheads as needed. We usually space them 2". Be sure to make the bulkheads with one side a bit smaller (1/10" to be exact) so that sides will overlap. Assemble two sides, starting from center and working toward ends. Then cement top and bottom patterns. Use rubber bands to hold them in place. If patterns are well made the fuselage will be perfectly straight. Sandpaper check for uncemented cracks, dope and cover with paper.



The next step is to build "shaped" fuselages, such as shown, which have four or more sides. Plot the bulkheads by using side and plan views. Assemble with "easiest" sides first. You may have to use stringers or longerons to obtain extra cementing area.

Covering rounded sections is a bit harder. No trouble should be experienced if the center line is straight so that the compound curve is slight. But as soon as the center is curved we have compound curves which require more care. Start by cementing flat sides and trim their edges so that they overlap halfway over the longerons. If the sheet is wide enough you can cover the entire curve at one time. Start by cementing it at the center. When dry, press sides down and hold in place with rubber band while trimming the edges to fit. Remove bands, coat area with cement and again press side down and hold in place with bands and pins. When set cement and trim the remainder portion. Note how the cross section is designed so that all joints will be over "flat" area and thereby avoid sharp corners. If the wood is light you should have no trouble in covering compound curves if you do it gradually. Balsa will adjust itself to gradual curves; just keep it under constant pressure with rubber bands.

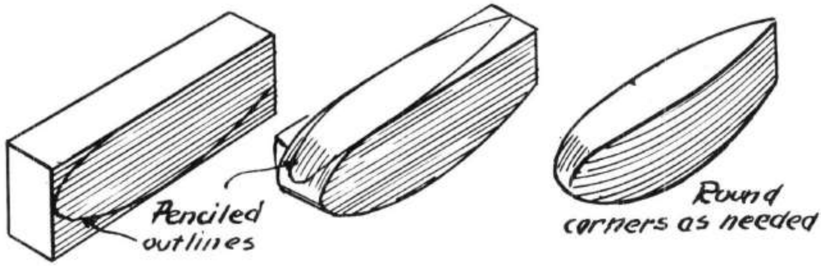
When covering round or elliptical fuselages you will need at least six splicing longerons. (Once we covered an elliptical job with four 3" wide sheets. The wood was perfect and it took us twelve hours to complete just the covering). Start by cementing two opposite sides. (It is understood that bulkheads are held in position by central keel which may be removed when job is done). Use pins and rubber bands to hold sheets in place while cement is setting. Trim edges to half way mark on longerons. Other sheets are first fitted to edges at center. With center fix, work towards ends, trimming to fit by feel and gradual cutting. Do not worry about small cracks. They can be filled with balsa dust and cement mixture. Sand lightly, dope and cover with paper.



Now we come to planking. Do not attempt planking unless you can get extra light balsa strips. The best size is 3/32 x ⅜ cut from 5 lb. stock. Plot bulkheads and hold them together with center keel. Cement side strips first, then top and bottom. Use pins to hold them in place. Now you can cement other strips as you see fit. If the front has a decided curve, pre-taper the tip of the strip. At the tail end the strips are tapered to fit by drawing a straight line as shown and then cutting off the surplus. Complete the job with medium and fine sandpaper and the job looks as though it was carved. Fill crack with dust and cement. Dope and cover with paper.

CARVED FUSELAGES

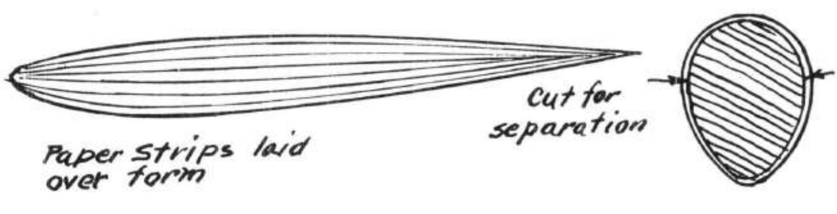
Carved fuselages are seldom used on gliders except in pod form. When carving pods or any other parts use step by step procedure. Outline side and plan before rounding corners. When pod is extra large cement several blocks together. Finish with medium and fine sandpaper, dope, woodfiller and gloss.



MOLDED FUSELAGES

Molded fuselage is something we still talk about but never get around to actually making one. It does require considerable amount of preparation and at the same time we are not sure of the results. Evidently, the future of molded fuselages and other shapes depends on the commercial people.

We could repeat instructions given by some magazine writers, but as we have not personally tried the idea we are reluctant to repeat. So far we made a plastic banded balso prop blade and had good results.



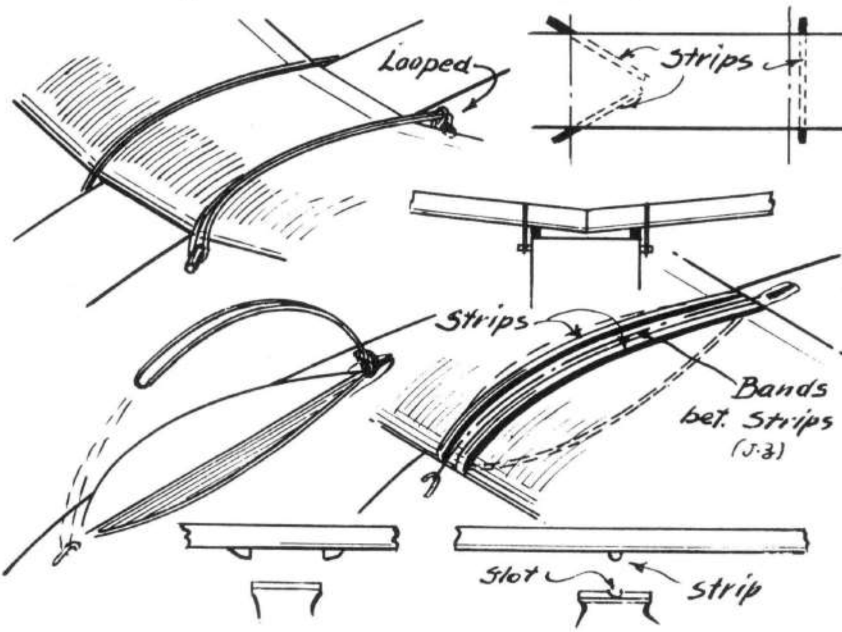
The base of molded fuselage is plastic cement such as "Weldwood" and "Cascamite". Such cement only need addition of water to be ready for use. They harden in a few hours, but it can be accelerated by holding the work near a radiator. The material used is ordinary drawing paper which is cut into strips. The form should be carved from bass or pine, well coated with parafin or wax to prevent sticking. Soak paper strips in the cement mixture and lay over form. After enough layers have been applied set the work aside. Note when the cement is almost hard. Slit top and bottom to remove form. Recement and cover slit with a strip.

Finish with several layers of colored dope which should be used to fill up the paper edges. If you are really interested in knowing more about it, try it!

WING MOUNTS

The importance of having the wing anchored cannot be overemphasized. During the towing period the wing is under severe strain and poor anchorage may allow the wing to shift enough to ruin the flight.

To obtain good anchorage we need good wing rests or mounts and tight rubber. On flat fuselages the problem is simple as we have a large flat surface for wings with flat center section, and widely separated rests for "V" dihedral. It also simplifies rubber holding. Note how this is done. In the rear the rubber bands are looped to prevent loss, and in front the projections are set at angle so that the wing will release itself on hand landing.



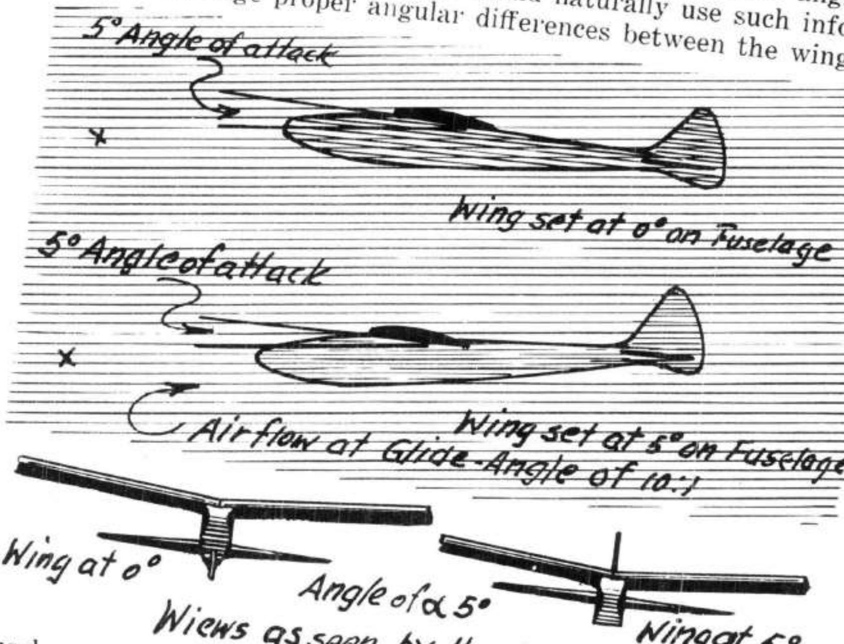
When the wing mount is streamlined we can use only one fastening to preserve clean lines. When we use a single fastening we must make sure that the wing rest is wide at center and that it cooperates with solid parts on the wing, such as spars or ribs.

A flat center wing tends to wander if not held tight. In such case we must either provide a stop or alignment combination between the wing and fuselage, or between wing and rubber. In first case; a groove on the fuselage cooperating with a rod on the wing will do the trick. In second case; confine rubber between stops, so that the rubber will swing the wing back into position. The first case is more positive.

Although wing mounts have been mentioned before, it is aired again so that you will realize their importance. Therefore, when designing a fuselage make sure that the wing will have a good base.

WING'S INCIDENCE

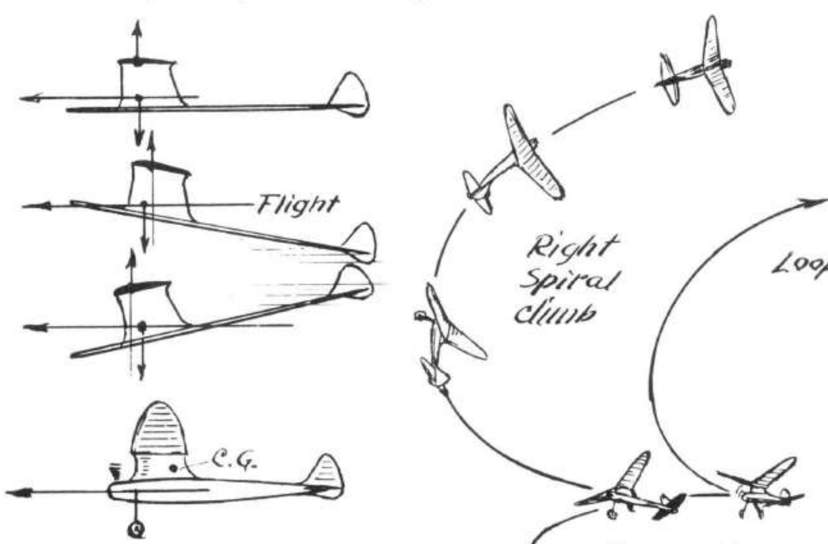
We have proved with the Angle of Attack Recorder that models, including gliders, fly at high angle of attacks, at angles on verge of stall. Because of low speed, the high angle may mean only 5° to 6° with stalls at 7° to 8°. This means that the wing will be inclined 5° to 6° to the airflow. Now, if the wing is set at 0° in relation to the fuselage we have a situation as illustrated. It is evident that the fuselage will offer tremendous drag unless it is of pod and boom type. To get rid of this drag we merely mount the wing at higher incidence, at an angle which almost equals the angle of attack. Of course if we knew the exact angle of attack, and at what angle the fuselage has its lowest drag we would naturally use such information and arrange proper angular differences between the wing and



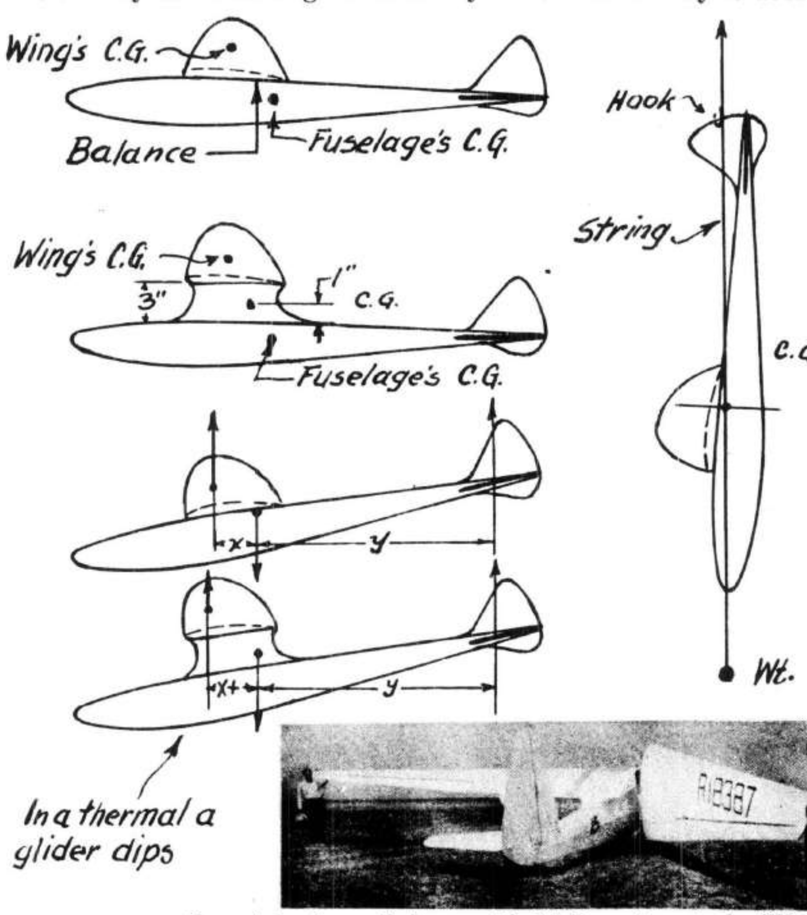
fuselage. As the matter stands now you can safely use 5° incidence, and under no circumstances make it less. If the glider happens to have stalling tendency you should correct it by additional nose ballast, changing the stabilizer setting or moving the wing back (a procedure which is not recommended). If you decrease its incidence you will be bringing the fuselage into higher drag position. After all, the wing may have been trying to move at too high angles brought about by poor balancing. So, when designing wing rests or mounts do not forget to incorporate about 5° incidence. It may take a while before this fact that models fly at high angles is known to all. Those who know the facts are already making use of them. Also remember that models have always flown at high angle, but we did not know it.

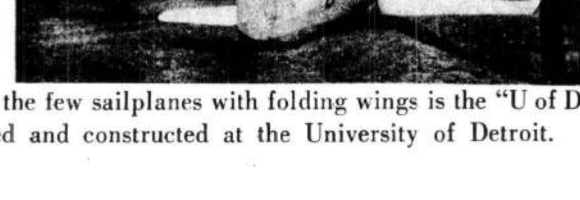
HIGH WING

We are passing through the super high wing area. It seems that many boys think that by just sticking the wing up a few more inches all their troubles will be solved. But as many of you may have found out, it proved to be a rosy dream. The super high wing is especially evident on gas models. It was found that by raising the wing, high power could be controlled on small models. We could go into details and show that it was the re-arrangements of various parts, brought about by the high wing, that actually did the trick. For example, high wings make it possible to move it over the motor so that the C.G. could be closer to the trailing edges and so bring about lifting tail conditions. Also the large dihedral used and the fin-like pylon in combination with slim fuselage and small rudder brought about right spin conditions under power. But the high wing also had looping tendencies, C.G. back, low thrust —— line and high drag point doing the work. So, by combining right spin with a loop we have a climbing right spiral. A familiar sight, no doubt. And another familiar sight was a right spin without the benefit of the loop, or loop without the benefit of the right spin. Something did not click. We only have to look at the outstanding rubber designs to see that super high wings are not essential. Remember Copland and Cahill? And most of others had wing on fuselage. Also, most of the full size gliders have mid wings. There must be a reason.



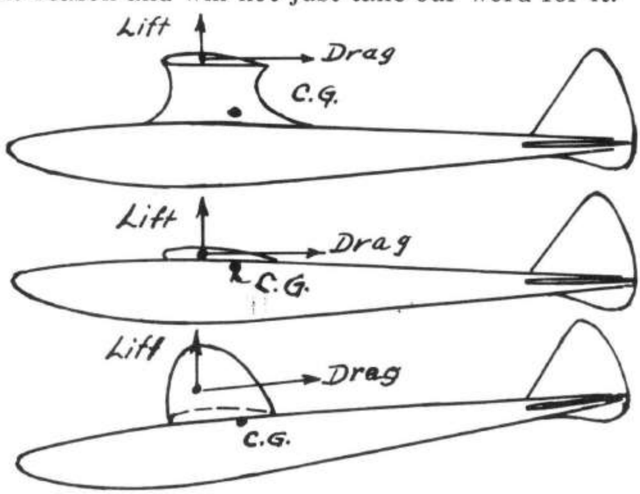
The main argument for using super high wings is that pendulum stability is obtained. We do not claim that this is not so. However, the actual value of this stability is so small that it is not worth creating more drag to get it. Let us find the C.G. position. Find vertical position of C.G. by holding under wing. Hook tail with a plumb line as shown. Where the string crosses the vertical line, you will find the exact C.G. spot. In most gliders this will be found under the wing. This is logical if we break up the C.G. into wings and fuselages. See diagram. In many cases the wing weighs ⅓ of the total. This means that if you raise the wing 3" you will raise the combined C.G. 1". Then if you consider that the model will have to get out of trim to obtain the pendulum stability you will find that the active stabilizer will be on the job so that the model will not get out of trim. As a matter of fact, if we were to analyze the situation that occurs during a thermal flight you will find that pendulum stability is bad business. During thermal activity the glider naturally noses down. See what effect high wing has. It tends to bring the model up and thereby increasing the load on stabilizer which may be close to stall. If you have a high wing model that begins to gallop while on way down through thermals you now know why it does it.

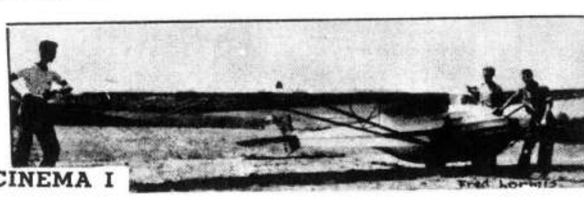




One of the few sailplanes with folding wings is the "U of D" designed and constructed at the University of Detroit.

Note what happens when the wing is lifted higher. Although the drag value may be same, its moment arm is longer, which means that more powerful counter forces will have to be applied. Take concrete facts for an example. A wing that lifts 10 oz. has L/D of 10. This means that drag is 1 oz. Now place this 1 oz. in the diagram and work out the moment arms and you will find out what a high wing can do to decrease efficiency. Then place a no-dihedral wing over the C.G. spot and note the difference. So, stick to wing on fuselage. But be sure to reason it out for yourself so that you will know the reason and will not just take our word for it.



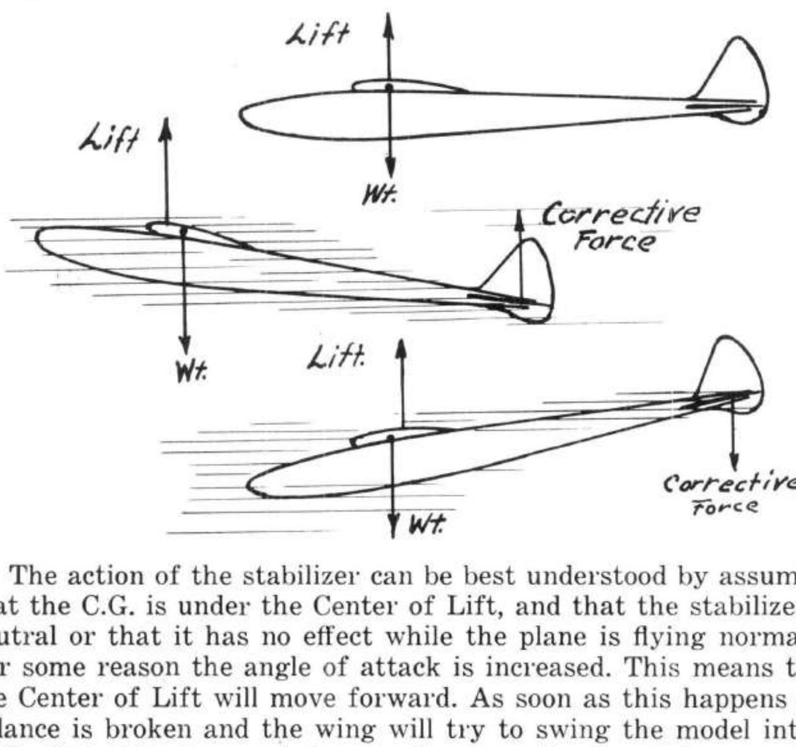


CINEMA I

You may wonder why we may seem to be so anti-super high wing. Actually, every model that has fair dihedral and is set on fuselage is a high wing job. The center of lift and drag will naturally be found somewhere between the tip and center, near the wing's C.G. spot. If the dihedral is 6″ and the wing has no taper, the center of lift and drag is 3″ above the center section, definitely a high wing condition. Now, let's draw the forces active during the glide. Note particularly the wing's drag. Note that it is above the C.G., and that its tendency is to nose the model upward. This tendency has to be brought under control. This can be done by moving the wing back so that part of its lift will be used, or we may add weight on nose, adding weight means more lift must be made, or we can increase the tail's incidence to develop more lift. In generating lift we get drag. So, to balance the high drag point of the wing we generate more drag.

THE STABILIZER

The purpose of the stabilizer is to prevent the wing from "unstabling" the model. As you know, when the angle of attack is increased, the Center of Lift moves forward and the lift is also increased, and thereby the wing obtains a longer moment arm about the C.G. with which to nose the model upward into a stall. If the angle of attack is decreased, the Center of Lift moves backward which shorten the moment arm and thereby promoting a nose dive. To prevent the wing from doing such foolish things we use the stabilizer.

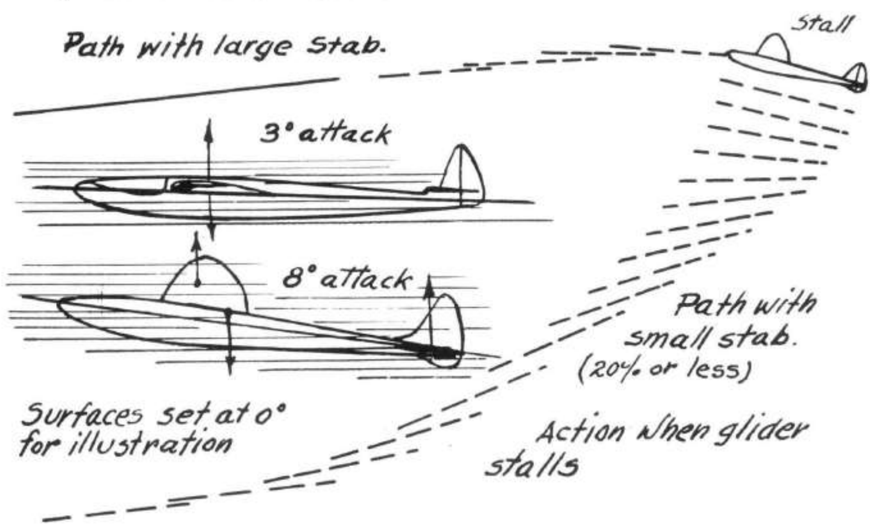


The action of the stabilizer can be best understood by assuming that the C.G. is under the Center of Lift, and that the stabilizer is neutral or that it has no effect while the plane is flying normally. For some reason the angle of attack is increased. This means that the Center of Lift will move forward. As soon as this happens the balance is broken and the wing will try to swing the model into a stall. But this does not happen because the heretofore neutral stabilizer now has a force. The new airflow, besides acting on the wing also acts on the stabilizer so that it develops an upward force which counters the effect of the wing. Under most circumstances the small force produced by the stabilizer multiplied by the long moment arm is stronger than the effect of the wing about the C.G. so that the wing or the plane is brought back to its original position. If the model hits an up-current, as in a thermal, the model will nose downward under the force of the stabilizer which acts as a vane.

If on other hand the angle of attack is decreased, the Center of Lift moves behind the C.G. tending to dive the model. The new airflow also produces a downward force on the stabilizer which will try to nose the model upward and out of the dive.

This set-up of having Center of Lift over or near the C.G. is present on full size planes, and the small stabilizer, when compared with models, will have no trouble in preserving the balance. Since the balance is delicate, a slight change in the stabilizer, made by the elevator, will change the direction of the plane very easily.

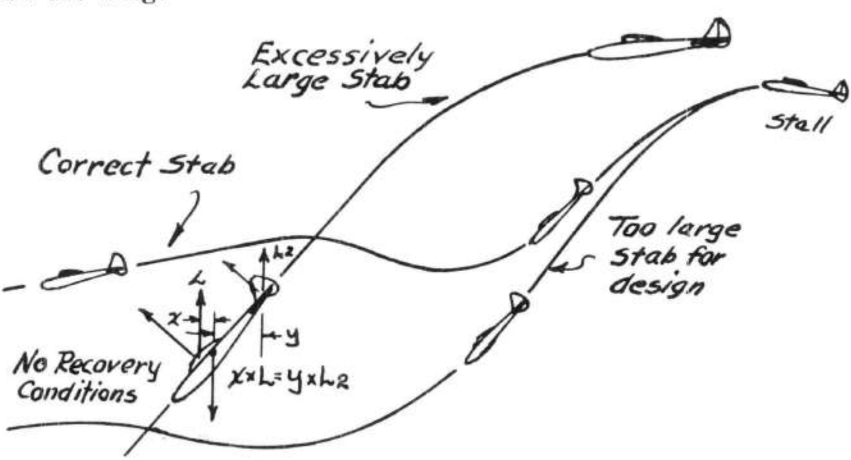
On models we have a different situation. The center of Lift is quite a bit ahead of the C.G. This means that the stabilizer is always carrying some part of the total load. It can do so by being rather large in comparison with full size; 40% of the wing area being commonly used on rubber models.



However the real difference lies in the fact that full size planes fly at about 2° or 3° angle of attack. This means that the wing is far from stalling and the stabilizer will have ample time to bring it to normal, and only 1° more or less may be needed to develop enough corrective force. But in models the wing borders near stall and only 1° may separate it from the stall. Therefore a small stabilizer may not be able to correct the situation in time. Also during the recovery from the subsequent dive the model will gather inertia as it is being nosed upward so that when the aerodynamical balance is reached, the inertia may again carry the wing into a stall. This is evident by the galloping action which can only be cured by decreasing the incidence of the wing, without making any other changes, which will decrease the angle of attack. This will increase speed, but decrease duration. A large stabilizer will naturally react sooner and more powerfully and thus keep the wing under control. This then is the reason why models use larger stabilizer than regular planes, and why flying scale models give us so much trouble. But we should not be surprised, they were made to fly at low angle, while models must fly at high angles.

It might be mentioned that there is nothing wrong in flying at high angles. As a matter of fact, easily proven by figures, the duration is much better at high angles than at low. Of course, if you want speed, that is another matter. The trouble is found within ourselves by treating models as though they were flying at low angles when they are actually flying at high.

Our proportion chart for stabilizer area calls for decrease of area (on wing percentage) as the area of the wing is increased. The reason for doing this is to make the glider more maneuverable. We found if a large stabilizer was used on a large glider there was a tendency to have the stabilizer carry considerable load by having it set almost at the same incidence as the wing. This means that there is little left for stabilizing effect, and the glider may stall without being stopped. During the recovery dive the wing and stabilizer might reach a balanced condition so that there is no recovery from the dive. Sometimes it also happens that without any seemingly reason the model will nose over into a dive without zooming out of it. All this happened to us. The cure was a smaller stabilizer, one which compared with the table, and setting it at lower incidence than the wing.

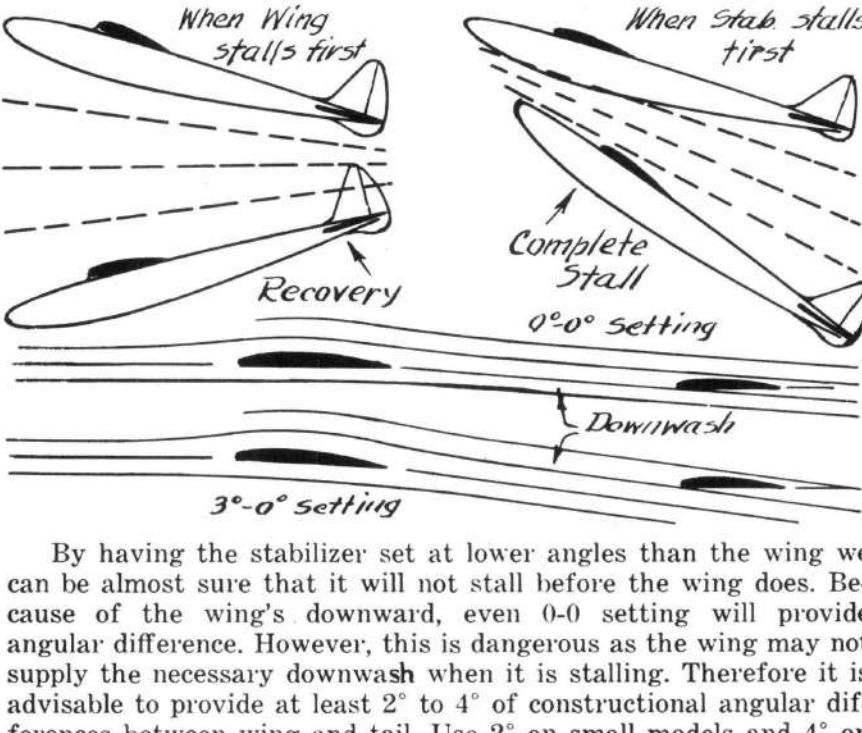


The reason that large stabilizer area works on smaller models is that it is less aerody nomically efficient. Also a smaller glider weighs less so that it does not build up large inertia which would carry the glider beyond the balancing point. Also, because of its size, the recovery dives will be much smaller.

We found these facts by experience, and although the explanations might not be clear to both of us, follow the graph and design your stabilizers accordingly. Just remember, that a small stabilizer will bring about faster and shallower recovery, but it will call for finer and more critical adjustments. Also note at the beginning how the stabilizer works during the dive and how it brings about the glide.

ANGULAR DIFFERENCES BETWEEN WING & STABILIZER

One of the basic design principles is: Never allow the stabilizer to stall. If the wing stalls and looses lift, only the front portion of the model will drop and proceed to assume normal angle again. But, if the stabilizer also stalls, the tail also drops and the the plane loses forward speed and its airplane characteristics. If a lifting stabilizer is overloaded and is bordering at the stall, a slight upset might cause it to stall, with the result that the wing will also stall. This being one reason why regular planes are not allowed to be designed with lifting tails.



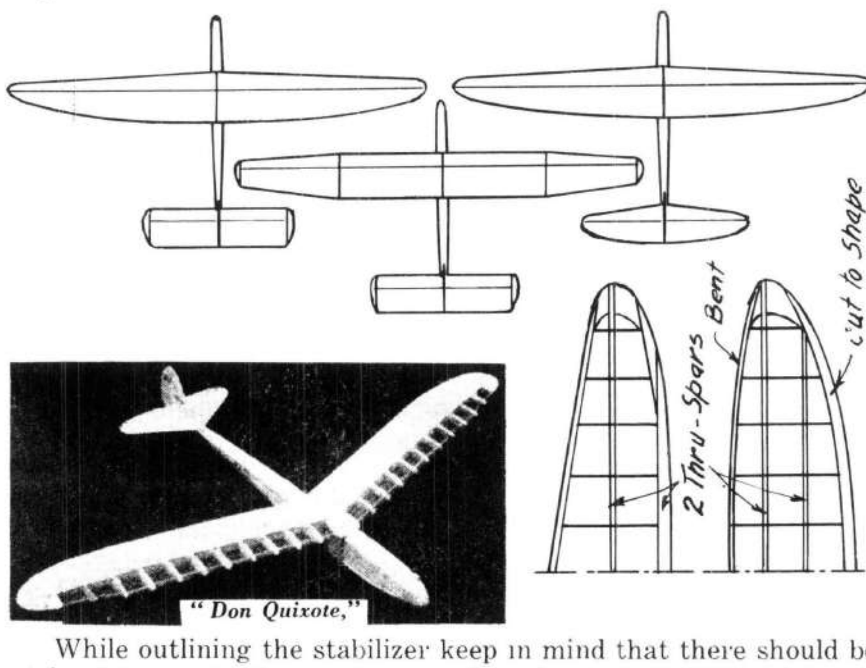
By having the stabilizer set at lower angles than the wing we can be almost sure that it will not stall before the wing does. Because of the wing's downward, even 0-0 setting will provide angular difference. However, this is dangerous as the wing may not supply the necessary downwash when it is stalling. Therefore it is advisable to provide at least 2° to 4° of constructional angular differences between wing and tail. Use 2° on small models and 4° on large ones. Although the final setting will be found during test flights.

Ross-Stephens sailplane

SHAPE AND CONSTRUCTION OF STABILIZER

Read the chapter on wing and consider that practically everything recommended for the wind also applies to the stabilizer. However, in most cases it is not practical to have high aspect ratio stabs. Ratios of 4:1 to 6:1 are the rule. Use the smaller ratio for small models, below 200 sq. in., so that you may observe the 3″ minimum chord rule. 6:1 should satisfy most of the larger designs.

The wing outline should decide the stab's outline so that they may complement each other. You can see how a combination of a tapered wing and straight stabilizer looks. So, if the wing is tapered, the stab should follow suit. If the wing tips are round or square, stab's should be likewise. Also the leading edge on a tapered design should sweep back more than the trailing edge. Sweep back gives the impression of forward motion. You will find that most pleasing lines are those which "lean" forward and just radiate with "speed lines."



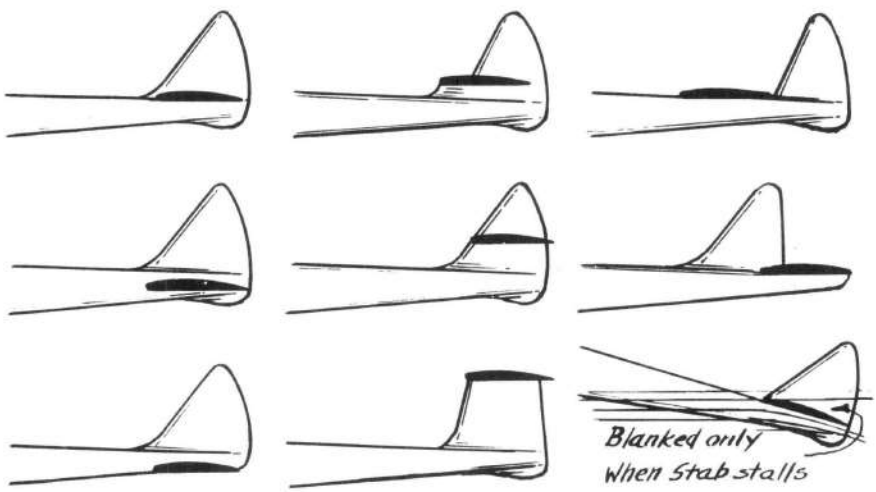
"Don Quixote,"

While outlining the stabilizer keep in mind that there should be at least two unbroken spars extending from tip to tip to prevent warping. Personally we keep the trailing edge and one center spar unbroken, and let the leading edge sweep back for taper. See outline suggestions. Use methods described for wing in obtaining elliptical outline or tips.

The size of the spars may be lighter than that recommended for the wing. But do not stint on the leading and trailing edges and tips. Cover center section with sheet stock or cement cross strips to prevent tearing of paper when using rubber for fixing.

AIRFOIL FOR STABILIZER

Like on other types of models, use regular airfoils of Clark Y or flat bottomed N.A.C.A. 6406 or 6409 variety. Streamlined sections may be used if the glider is designed for speed, scale or starting, and should be used in combination with C.G. close to Center of Lift. You can try under camber to obtain more lift, but better try the standard first and see what the change will do. Under camber is hard to keep without warping. Flat sections should only be used on small gliders as we need at least one vertically set spar to prevent curling.



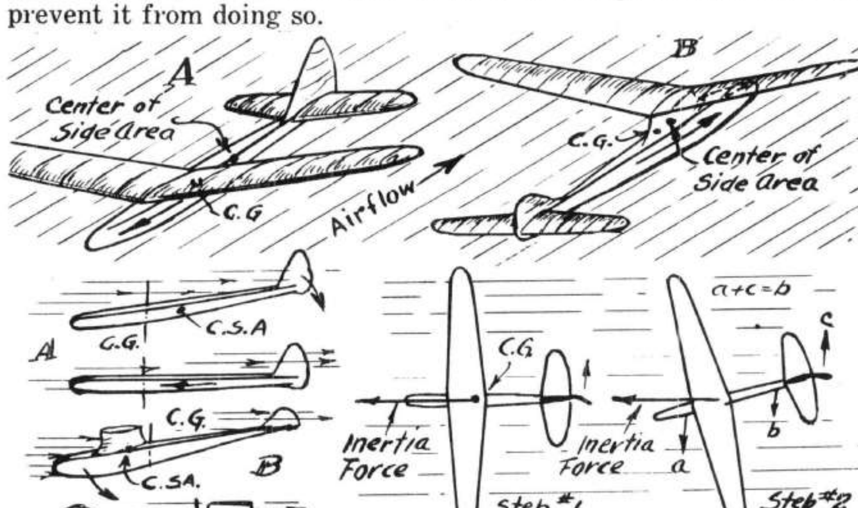
POSITION OF THE STABILIZER

The first consideration in positioning the stabilizer is to have rigidity. This means that it should be attached to the top of the fuselage, in a slot or on the bottom. Some might want to place it midway or on top of the rudder. Reason being to have smoother airflow. Structurally this is a bad spot. Also if we consider that the fuselage is pretty slim, when compared with full size planes from which the information was taken, it should be evident that the stabilizer gets plenty of undisturbed air. To avoid blanketing of the rudder, only the top position will not do that. Also consider, especially if the rudder is cemented to the stabilizer, that after testing, it is best to cement the stabilizer solid to preserve adjustments. By having the stabilizer in a slot or on the bottom we can make the rudder integral with the fuselage and still have a removable stabilizer which can be used as a dethermalizer. The fore and aft position is determined by the fuselage. Try to have it back as far as possible but still retain good mounting. Read "wing mount" paragraph to find out how to obtain steadiness.

RUDDER AND SPIRAL STABILITY

The rudder can make or break a model. Since we do not know how to determine its exact area we must learn to recognize the symptoms or instabilities which are brought about by wrong proportions.

The purpose of the rudder is to make the model have a definite objective, which may be a straight line or a circle. We can easily achieve a straight flight, with or against the wind, by increasing or decreasing the area. By having extra large area the model will face the wind because as soon as it tries to turn aside the large area behind the C.G. will swing it right back as shown. To fly with the wind we use a small rudder to make sure that the frontal area is more powerful. Although we may launch such a model into the wind, the large frontal area will swing it around so that it glides with the wind. If it attempts to turn, the large frontal area will prevent it from doing so.



As soon as we decide to make the model turn we get into a different problem. Here the dihedral of the wing, and rudder work together. This combined action is rather complex and we will start by assuming that the wing is flat and that it has no dihedral effect. We set the rudder to turn. This will cause the fuselage to pivot about the C.G. but not change its direction as we have not introduced a side pulling force. The rudder will rotate the fuselage until it reaches a balanced condition in which the frontal and rear areas balance each other. Note the position of the rudder. Of course, if the rudder is turned sharply it will tend to spin the model and thereby losing flying speed. Here, then, we have the rudder adjusted for a turn but all we get is a sort of a skidding forward motion. Now let's bring the dihedral into the picture.

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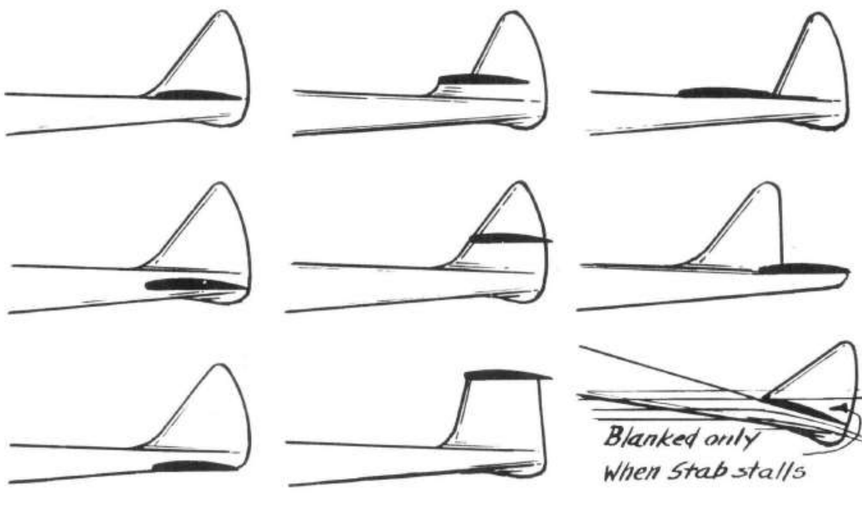

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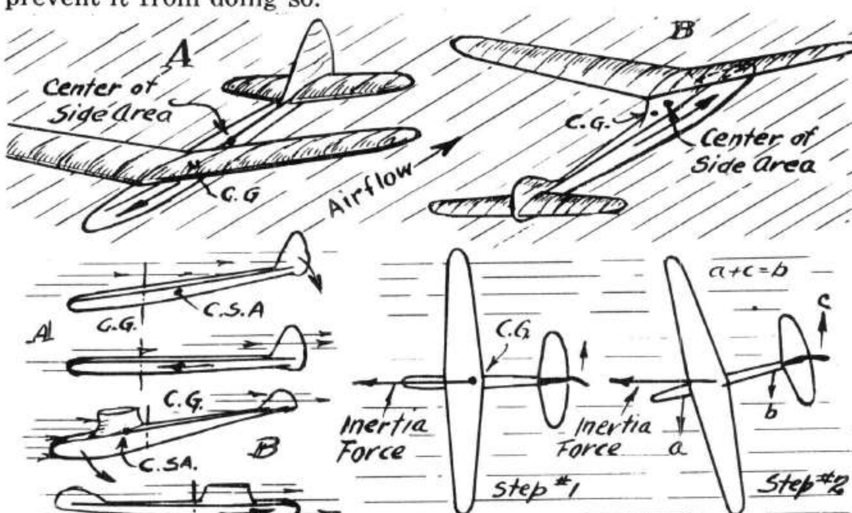

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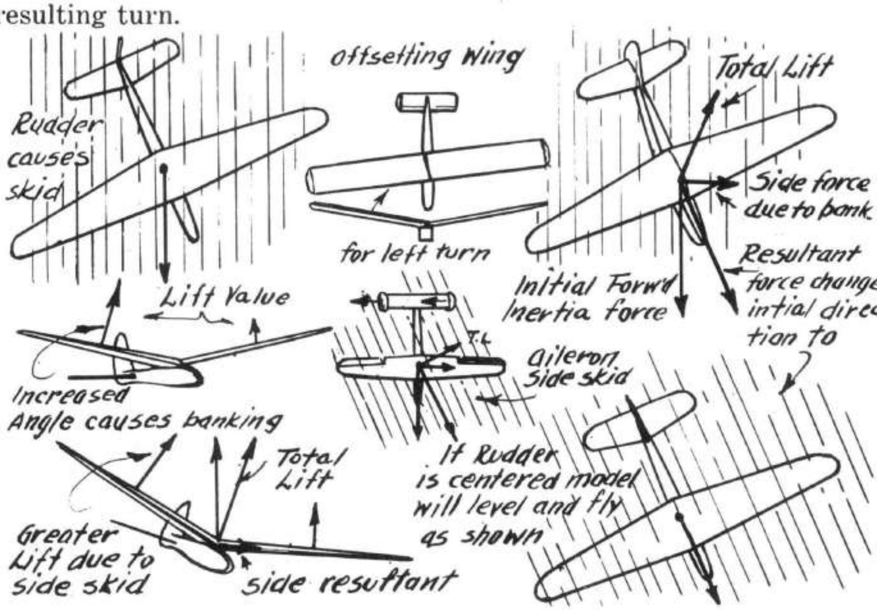
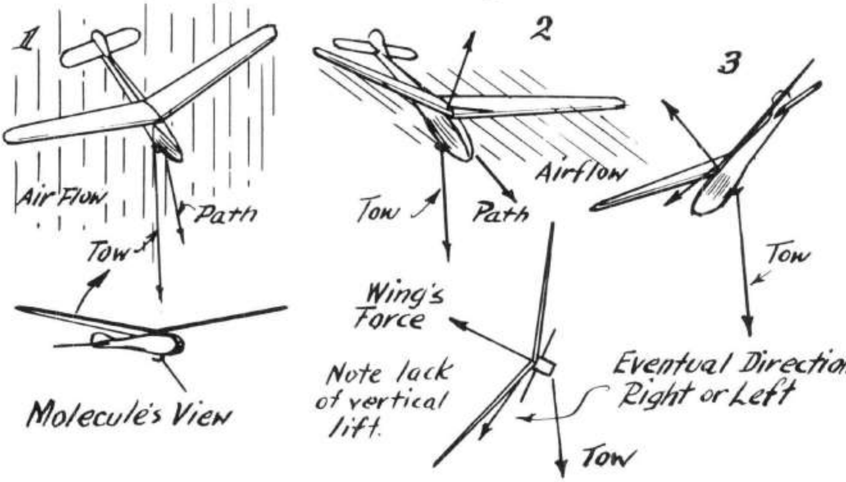
As long as the model faces the airflow the dihedral has no effect. But as soon as the rudder swings the model as described, the dihedral becomes active. As the model swings into the skid the wing is exposed as shown. Note how much greater is the angle of attack on the right wing. As soon as this happens the right wing will begin to rise and rotate the model. When this is done the lift is no longer vertical but at an angle. Solving this angular lift by parallelogram we find that we have a force which tries to pull the model to side. Placing this force in the plan diagram we see a difference. Without the dihedral effect the rudder just rotates the model about the C.G. but with the generations of side force by the dihedral effect we also have a force which changes its direction. So, when all is said and done, the rudder does not do the actual turning, but it does bring about conditions which bring the dihedral into the play and with the resulting turn.



You may recall a light plane design which had fixed twin rudders and turns were made by operating only the ailerons. In this case they banked the wing and so producing a side skid. As soon as the skid started the airflow changed so that the fixed rudders tried to face the plane into the new airflow which was in direction desired. This kept on as long as the ailerons were operated.

All this means that both rudder and dihedral (which automatically produces banks) are needed to obtain a turn. Also that it may be done by operating either one of them; rudder with dihedral, and ailerons with fixed rudders. Regular planes use both to obtain smooth turns without skidding which is present in other cases. On models we can get turns by adjusting rudder, warping one wing or offsetting the wing as shown.

The trouble comes when the rudder is too small or too large when used with a particular dihedral. (When we mention small or large rudders we actually mean the area behind the C.G. in relation to the frontal area). When a rudder, or area behind C.G., is too small we have trouble right from the start of the tow. As we tow the glider we suddenly find it swinging from side to side until it eventually swings over into a dive. What happens is that when the model is being towed the glider's direction changes constantly so that the airflow hits it on the side and skid conditions are present. Let's "face" the problem. See drawing.

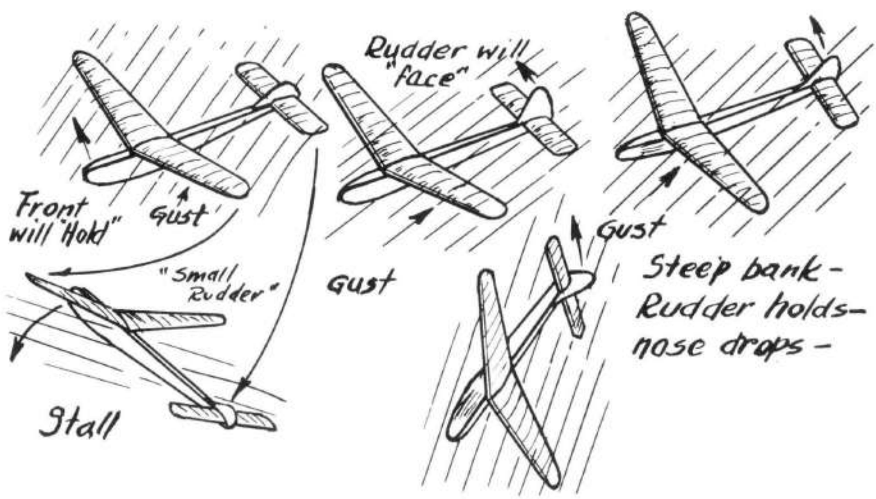


Evidently the right wing will try to rotate the model and the more powerful frontal area will try to bring the glider into greater skid. The result is that the model will hang. As it begins to slide downward the airflow changes so the left wing now has greater angle and it swings the model back again. This may repeat several times with banks getting steeper until the model is completely out of control. If we did not have the tow line pulling such side to side swinging would kill speed and eventually end up in a stall. But by having a pull on the tow line the model eventually dives. This happens when the bank is almost vertical as shown and the pull of the tow pulls the nose downward. With very little vertical lift left the glider has no choice but dive, the wing's force providing the zooming effect. Actually the action may be more complicated, but we do know that it happened because the area behind the C.G. was too small. When you see this in your model, release the tow and add more rudder area as soon as possible.

When the rudder is too large we do not have towing problems. The large rudder simple "faces" the glider into every new airflow so that the dihedral of the wing is never given a chance to act with power, and we have no trouble in getting all of the altitude we can. You may have trouble on first test flights. See towing paragraphs.

STABILITY IN TURNS

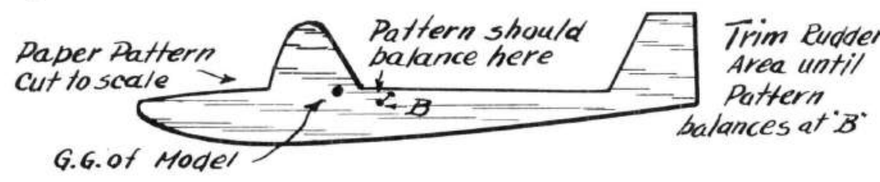
We have shown how the rudder and dihedral cooperate in producing a turn. Very often the turn develops into a spin or stall instead of a circle as it was intended. The cause, again, can be found in incorrect rudder area. After the glider is released from the tow the turn adjustments will begin to function. With fine adjustments it may be possible to get stable flights with a small or large rudder providing the air is calm. But if it is turbulent, which it usually is during the better part of the day, the glider will naturally be thrown about.

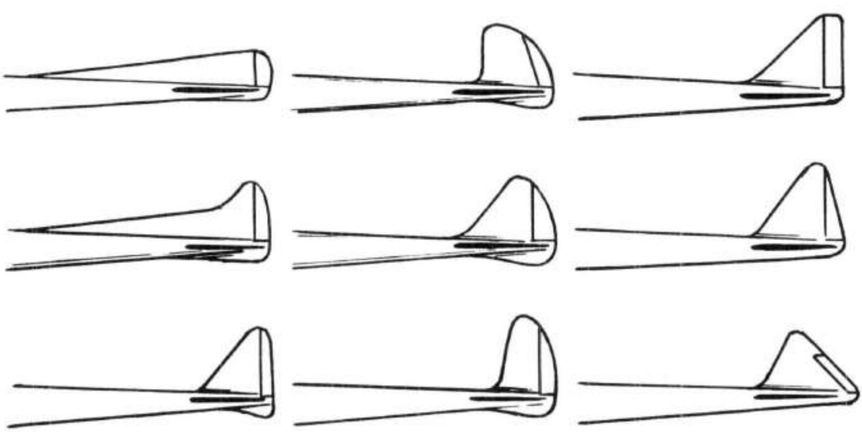


If during the tussle the model should happen to get into a skid or side airflow, the subsequent action will depend on the area of the rudder. If the area is too small the model will swing away from the airflow and the inside wing will raise and most likely start the swinging which is characteristic of small rudders. If the rudder is large the model will face the airflow and proceed to make its turn. However, if the model is thrown into a steep bank the results will be as follows: Small rudder will most likely cause a stall. The nose will rise and the tail will drop. The wing will make an effort to raise itself but lack of forward speed will end the effort. In case of large and rear area, the tendency will be to swing the model into the new airflow, regardless of the position of the model at that time. Without side airflow the wing will not have a chance to bring the model to a level position. The model, because it lacks good vertical force will continue to slip or skid and producing more side airflow for the rudder to bring the model into, the first result is a spiral dive. Now that you know how much trouble an incorrect rudder can cause, you will realize the importance of having it correct. Also that a model which may behave well in calm weather will become hard to handle under normal conditions.

RUDDER AREA

We wish that we could give you a definite formula for finding the rudder area, but all we can suggest is to start with 10% of wing area, and then watch out for signs which will tell you whether or not you need more or less area. You may try side pattern idea. Make a side view of the model, including dihedral, on a stiff paper. Locate on it the C.G. position. Cut out the pattern and with a pin find the "C.G. of the pattern." If the balancing point is few inches behind the regular C.G. point, the rudder area is considered good. If the balancing is further back cut off some area from the rudder. In case the point is close to the C.G. add area to the rudder. However, you will still have to depend on test to find out if you were right.





RUDDER OUTLINE

The effect of Aspect Ratio is similar as on other surfaces. But in consideration of the side-flow effects and stalling possibilities, it seems best to make the rudder of law A. R. It is quite possible that low A. R. will allow greater plus–minus leeway in rudder area. If a dorsal fin is used, the rudder should not be considered as end to it as shown, but it should have a definite outline of its own. An A. R. of 1½ or less is a good start. As a rule, personal opinion or "artistic instinct" will usually dictate the outline. We try to have the leading edge angled, although a distinctive shape can be had with straight edge. Look up some full size planes and pick out the outlines you like.

POSITION OF THE RUDDER

The logical place for the rudder is on the top of the fuselage; not only for structural but also for stability reasons. In looking at the side view of a skidding model we can see that everything which is below C.G. will tend to act against the dihedral effect. A low rudder definitely acts against the dihedral. Those of us who have tried low rudders have nothing encouraging to report. Besides, low rudders rip off too easily.

SUB RUDDER

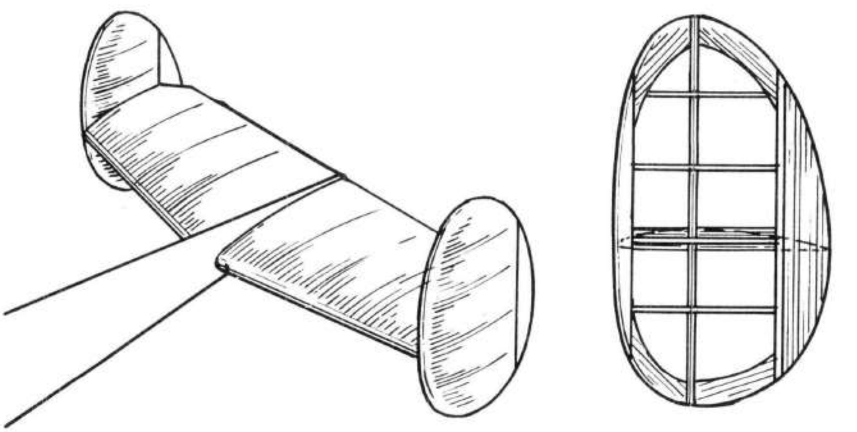
Sub rudders are now incorporated on almost every design. They act as tail skids and also allow smooth outlining. It is evident that the sub-rudder acts more like a dorsal fin than a regular rudder because of its low Aspect Ratio layout. A sub rudder is a good thing to have. Might mention that the writer started the trend when he copied the Bowlus Albatross's rudder way back in 1934.

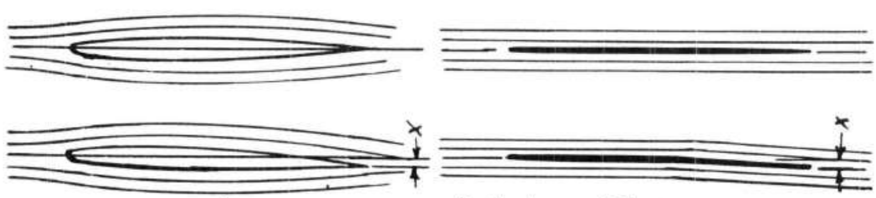
TWIN RUDDERS

Twin rudders lend a certain air of distinction to a model, but that is about all. They may increase the efficiency of the stabilizer by acting as end plates. But since we already use large stabilizers, this advantage is not great enough to make up for certain disadvantages. (Speaking for models only).

Personally, we wish that we could use twin rudders as they simplify tail construction. But we had enough experience with them to come back to single type. It was found that twin rudders need about ⅓ more total area than a single type. This seems logical when we consider that smaller rudders have lower Reynolds Number, or scale efficiency, and all around tip losses. Ordinary rudder has only one tip for tip losses, while twins are usually made to have four tips. Although twin tip rudders do help the stabilizer, a slight increase in its angle makes that up. Perhaps the greatest objection to twin rudders is that it is difficult to keep them adjusted, or know just how they stand in relation to the rest of the ship. A single rudder can be easily checked by sighting along the fuselage, but twins complicate this procdure. A slightest touch on the stabilizer will mean that both rudders move and thereby increasing the possibility of having excess control. It is hard to keep from using balsa sheets for twin rudders. We have already pointed out the disadvantages of using thin sections for rudder. Then we also have to consider how well would the twins behave at high angles of side drift; their stalling is a good possibility.

If you are minded to use twins, remember that their total area must be ⅓ greater than that of a single type: Use regular streamlined airfoil and built-up construction: Be prepared to cement the stabilizer permanentnly in place: Have control tabs: Remember the flight and glide characteristics which show up rudder conditions.





Streamlined Rudder Airfoils. Flat

RUDDER'S AIRFOIL

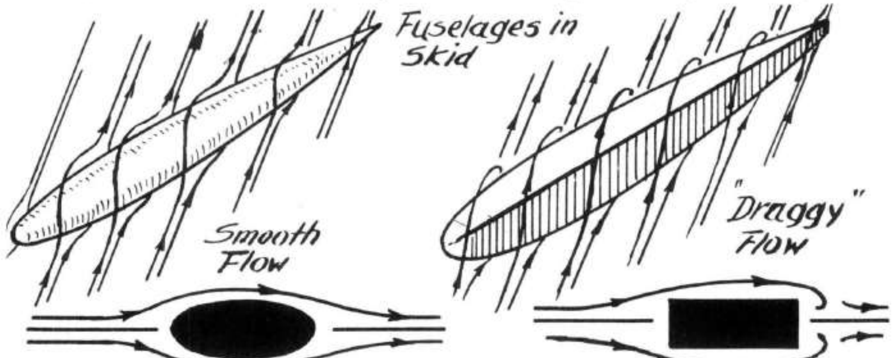
Since the rudder plays a vital part in flight, its every detail should be carefully considered. Although balsa sheet rudders might be easy to build, they should be avoided, and a regular streamlined and built up section used; and not too thin at that. This fact can be best illustrated by noting a flat and a streamlined section in an airflow. When the airflow is direct, the streamlines may be as shown. Note that they follow very closely along the surface of the flat surface but tend to separate near the trailing edge of the thicker or streamlined section. With the airflow following its surface so closely along the chord, a slightest change or warp on flat section will mean some sort of a reaction. While on the streamlined section a slight change or warp will have very little effect. Since it is desirable not to have very positive rudder action while the model shifts from straight flight into a side drift for torque or stability control, the streamlined section is the one to use. Or we may say that the streamlined rudder allows the model few degrees of right or left leeway without being too sudden in forcing the model into the airflow. Since it is necessary to have fairly large rudders on models, this leeway is desirable. It is also evident that rudder adjustments will be less critical on streamlined type than on flat surface.

Aside from having better aerodynamical conditions, a streamlined airfoil allows sturdy and rigid construction which keeps its line-up. In contrast we have flat balsa rudders which may warp between home and the field, or whenever the temperature changes, or it might develop small warps which are difficult to find. An 8% C thick streamlined airfoil should fill the need.

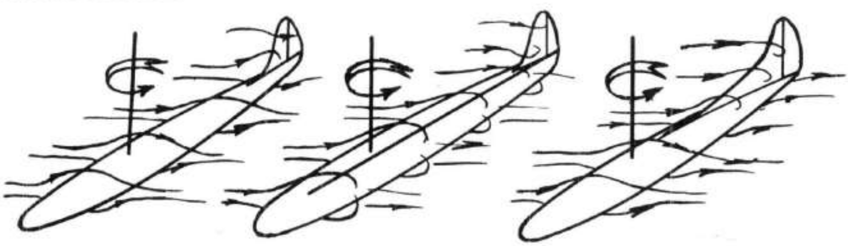
DORSAL FIN

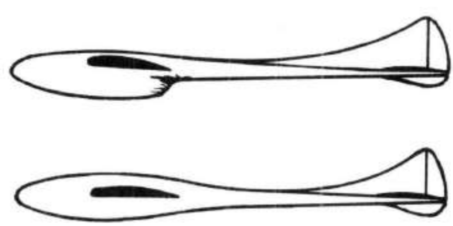
As we watch the big planes develop we note how the top of the fuselage is changed by the introduction of fins which are similar to dorsal fins found on fishes. The idea behind these fins is to compensate for poor fin quality of streamlined fuselages. In noting the lift and drag characteristics of streamlined bodies whose cross sections differ, we see that a round fuselage develops very little lift as it presents a 'fair' section. But a square fuselage shows a certain amount of lift with definite Center of Pressure. Since this Center of Pressure of Lift is near the 35% spot, or behind the normal C. G., we may consider it as a force which is aiding the rudder. Also, such 'low aspect ratio' bodies do not have their stalling points at normal angles of 15°. In fact, they never seem to stall so that we may depend on them having some force at all times.

The reason that dorsal fins are used on streamlined fuselages is as follows: When a plane is swung violently so that it gets into large skidding angles, the rudder may stall and thereby lose the only antiskid force. We can just picture such an incident. As long as the rudder had normal aerodynamical reaction it tried to bring the plane into the prevailing airflow and out of skid. But as soon as it stalled, its force was suddenly cut down to practically nothing and



there was nothing left to prevent the plane from continuing its initial sweep. All this is possible where weight is large and the initial upsetting force great enough to overcome the weight and so start a momentum which may be too great to be stopped with ordinary rudder. If the fuselage is square we can see that it will still exert some anti-skid force even though the rudder may have stalled. By using a dorsal fin, we are, in a sense, using a low aspect ratio surface and with it the prolonged "under" stall. By noting how the fin merges into the rudder we can see that only a small portion of the rudder may reach the actual stall so that the plane will be kept safe in acute side-skid angles. It should be evident that in a straight flight, the dorsal fin has very small additional drag with exception of skin-friction.



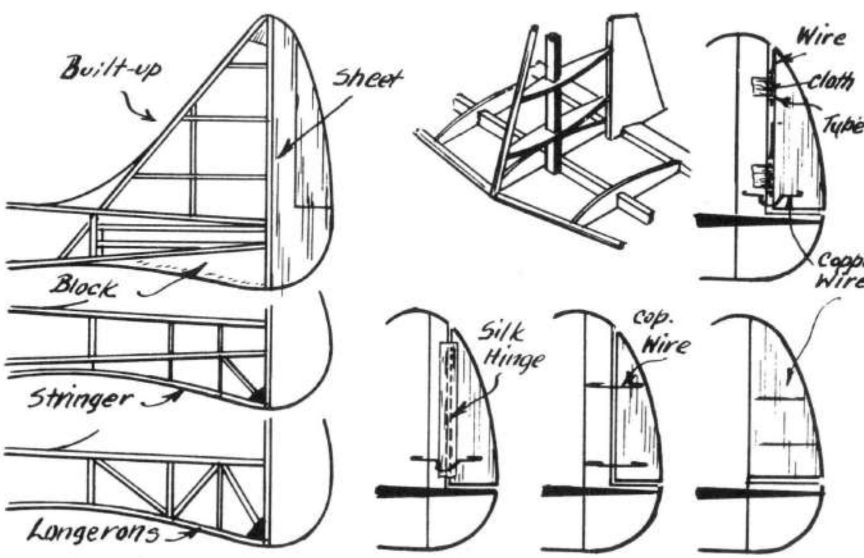


The use of dorsal fin on multi-motored planes can be best appreciated by noting what happens when one of the motors cuts. The more powerful side would naturally tend to swing the plane around. If the action happens suddenly, the pilot may not have time to press the rudder bar, or for that matter, the rudder and fin area might stall. By using dorsal fin, the rotating action is automatically slowed down and the plane may never reach the danger zone.

In applying the dorsal fin to models we have to consider the design. A square or diamond fuselage has no need for it as its body has inherent dorsal fin characteristics, boom jobs have a definite need for it. This applies both to stick models and current gas jobs with very slim fuselages. In fact, any model which lacks the essential side areas for skid control, may need the dorsal fin. The writer has not as yet fully investigated dorsal fins in practice, but logical reasoning presented above should make all of us give more thought to dorsal fins.

RUDDER CONSTRUCTION

While designing the last few gliders we evolved the rudder structure shown. It is easy to make, yet it has good appearance. The triangular base provides the needed rigidity, and the extension of leading edge and rear spar through and along the rear of the fuselage to provide excellent anchorage. If the model is small, the rudder may need only the leading and rear spar. For larger job it is advisable to use a short spar at the base, especially if a slot is made for the stabilizer. If the rudder is attached to stabilizer be sure that it has good anchorage. Overlap spars and avoid butt joints. Use corner blocks where needed. We usually assemble various parts before cutting to outline. Sub rudders are usually shaped from soft balsa or outlined with strips as shown. Gradual shaping is preferable to abrupt type. Note different methods of hinging and holding tab in place. If at all possible fix the rudder to fuselage. It will save you lots of trouble, and you can also do a good job of fairing it while covering.



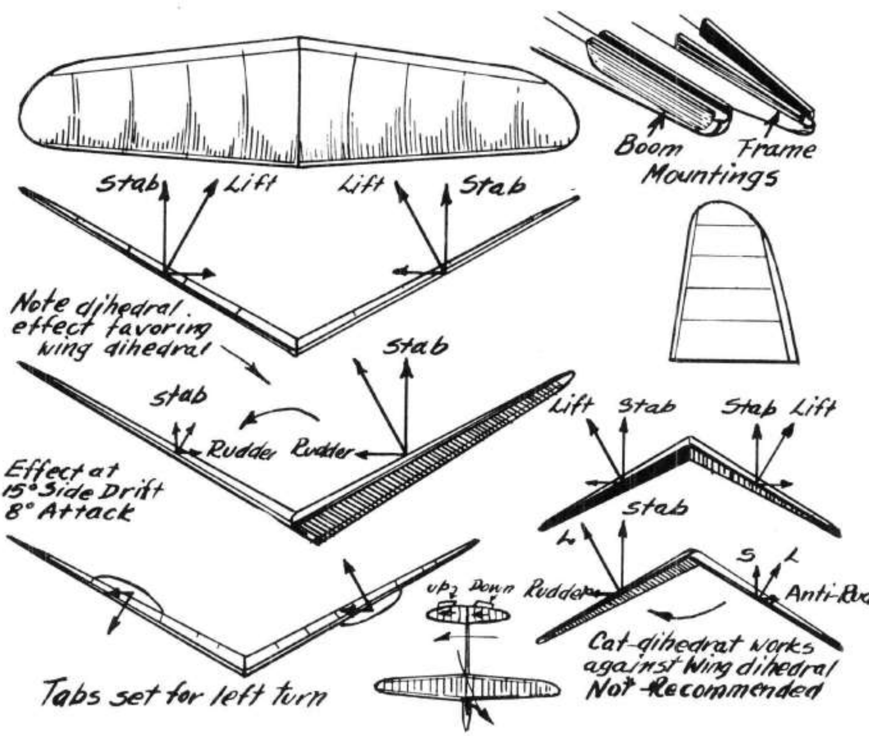
LANDING GEAR

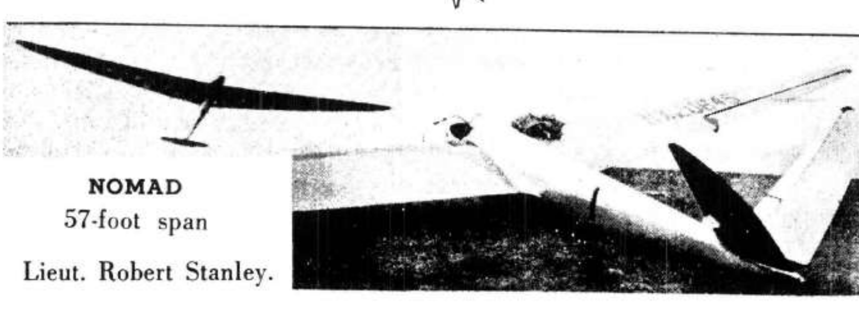
Very few gliders use landing gear. If they do, it is usually in form of single wheel. The best type of wheel to use is the air wheel because of its good shock absorbing qualities. If wood or solid rubber is used make sure that the attacking wire acts as a spring. The wheel should naturally be placed ahead of the C.G. Just a bit behind the leading edge of wing seems to be a good spot. Be sure to reenforce structure around the wheel.

By all means use a skid, even though a wheel is used. Cement it after covering. It will strengthen and save the lower surface of the fuselage.

"V" TAIL

We tried "V" tails and found these workable. See "50x", although we did not do enough experimenting to find out which is better. In laying out a "V" tail consider it from plan and side views. Plan view should be about the same if ordinary flat stab was used. And side view should be equivalent to rudder area. If you want to see how it works look at it from side flow. See drawing. The dihedral effect will be present. The tabs work as shown. Inverted "V" is out. It may give the side force to take care of the rudder needs, but its dihedral effect is counter to wings. Note mounting. Cement in place if possible. To find out if the dihedral is too large or small follow the instructions given for regular rudder. Low dihedral will produce small rudder symptoms and etc.

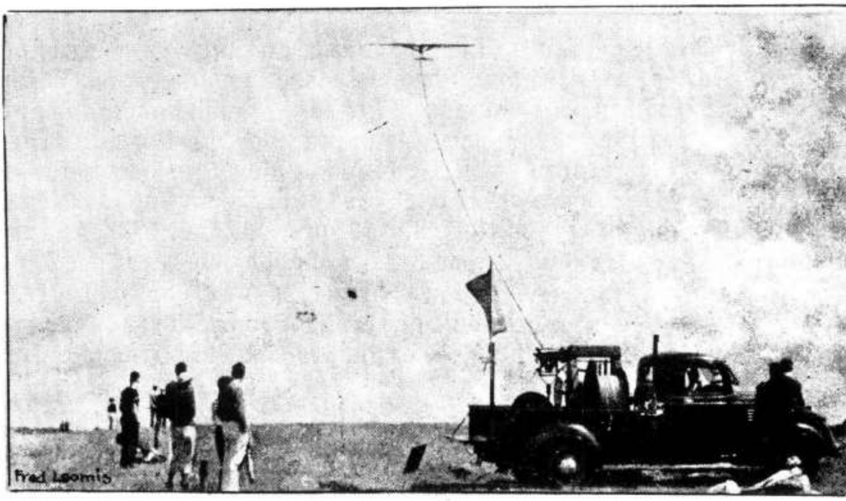




NOMAD

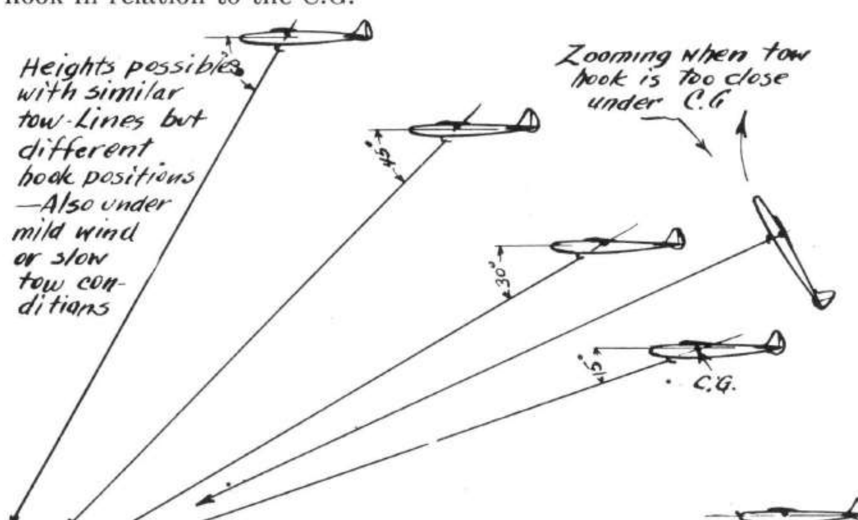
57-foot span

Lieut. Robert Stanley.

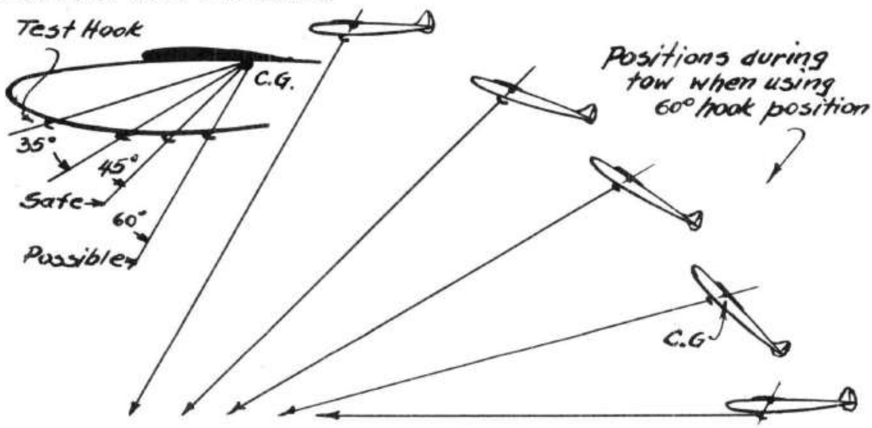


TOW HOOK, FLYING AND TOWING

The most critical period of glider flying is the towing. This is so because the glider must be adjusted to make fairly small circles, yet it must be towed straight into the wind to achieve maximum altitude. Then, also, the duration in many cases will depend on the height to which we can tow it. The problem therefore, is to counteract the circling tendency and at the same time attain maximum height. The answer to both problems lies in the position of the tow hook in relation to the C.G.

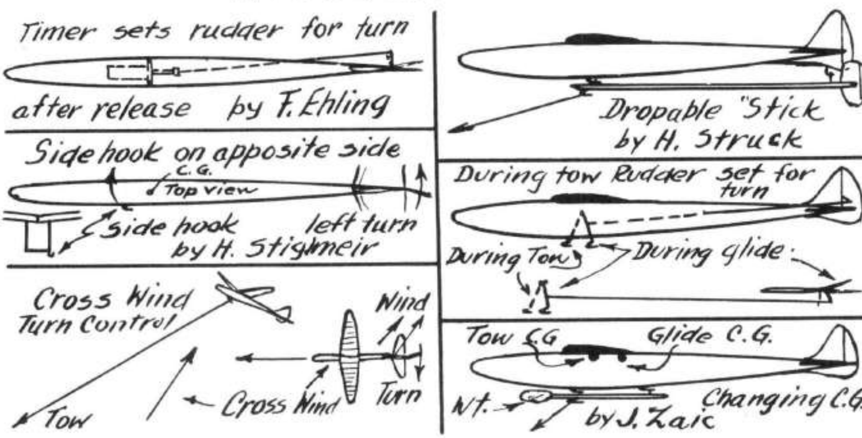


To obtain maximum altitude the hook should be as far back as circumstances permit. The idea is to set the entire glider at very high angle of attack and practically kite it upward. If the hook is too far forward, the towing line will soon pass through the C.G., about which the wing and tail are balanced, and only by increasing the towing speed can more height be achieved. See diagrams. While if the hook is too far back the pull of the tow would soon be behind the C.G. and the glider will try to loop and slip the tow line. Evidently the correct position will be found somewhere between the two extremes. We made several trials and found that for most conditions positioning the hook on the 45° line to the C.G. will do. Winkler, a German glider expert, recommends 60° position. This works in calm weather, but not in a breeze. 45° will work in a fair breeze, but windy or gusty conditions call for more distant spacing at about 35°. To solve the change of wind problem, the obvious thing to do is to have two hooks.



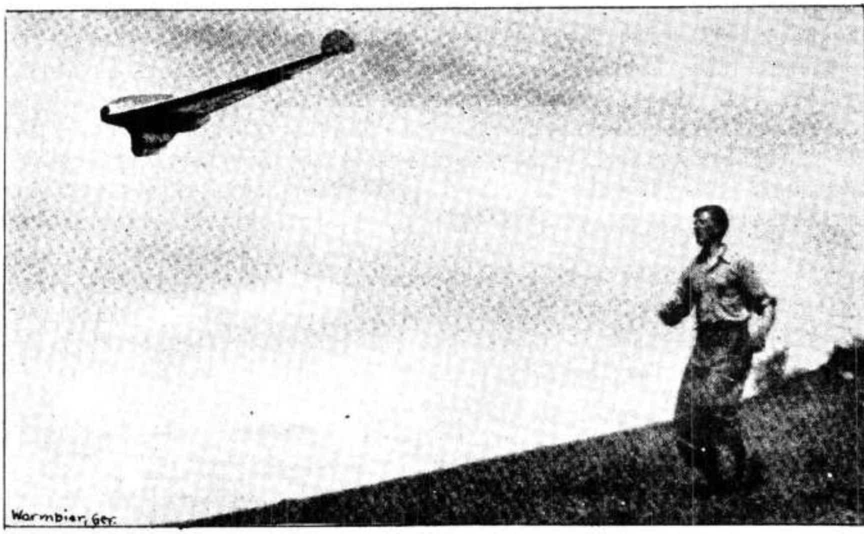
Having the hooks at about 45° position we were able to get the gliders practically overhead. All this was accomplished with very little running effort. After the initial takeoff the gliders would climb by merely walking the tow. In some cases the pull was so tight or strong that we had to walk towards the glider, or back to the takeoff spot to ease the pull. Perhaps the design, generous dihedral and 10% rudder had something to do with getting 100 ft. heights on 100 ft. tow. If you have trouble getting altitude, try changing the tow hook and place it further back. There is absolutely no reason for high speed running all over the field.

To take care of the turn or circling adjustments we have to counteract them during the towing period. There are four main methods by which this can be done. One is to use a timer as suggested by Frank Ehling to actuate the rudder for turning after the towing has been done. This naturally calls for close timing. Another method (a French idea) is to have the tow hook pivoted so that it will pull the rudder tab for a straight flight while under tow pull. As soon as the tow is eased or dropped, the rudder returns to its circling position. This method requires a certain amount of mechanical work which every builder is not able to do, and there is always a chance that the system will break down somewhere. By placing the hook off center, the pull of the tow counteracts the rudder adjustment. This idea was suggested, after use, by Henry Stiglmeir in 1938 Year Book. As you can see by the diagram the side hook is placed on the side same as the turn. That is, if the turn is to the left, the hook must be on the left. We use this particular set-up and have found it very satisfactory. Without much effort you can try the effectiveness of side hook by having center hooks in line with side hooks. Henry Struck invented the "golf stick" or temporary rudder area device which drops off with the tow line. See sketches. Counter turn adjustments may be used if area is not effective. It seems to be one of the best methods of controlling the rudder turn during the tow, four



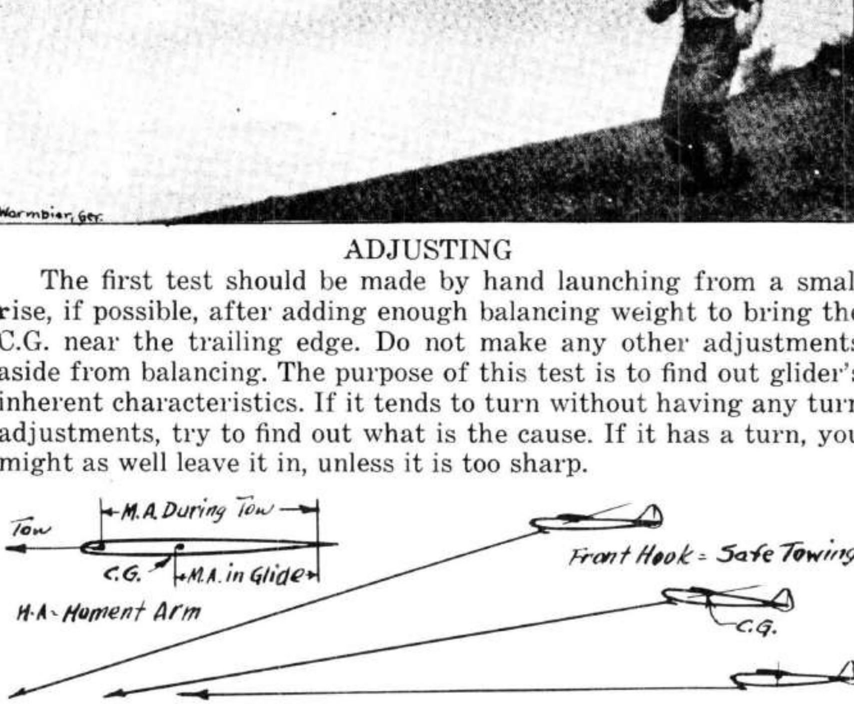
The turn adjustment can also be controlled after a fashion by a technic in towing. If the glider is set for a right turn set the tow so that the prevailing breeze will strike the glider at an angle from the left side. The towing will have to be done cross wind at start. As you can see, the side breeze will tend to turn the glider into the wind, and thereby counteract the right turn rudder. When using this method, not recommended over the systems described, you will have to act fast as the model will soon face the wind and the rudder will take over. If the air is still you can "manufacture" side wind by running in a circle while towing.

While towing do not let the glider have the upper hand. In time you will know exactly what to do no matter how the model may behave. If the glider tends to swing to one side and does not come back to normal, run into opposite direction to provide counter force. In most cases, the glider will recover and start to climb again. It may be a good idea to tie the towline to the hook and just "play" with the glider like a kite to find out what you can do. Of course, if the glider is still out of control when coming closer to the ground release the line and let it recover by itself. We are, of course, assuming that the glider is in good flying condition. An unstable model will do things despite whatever efforts we may make.



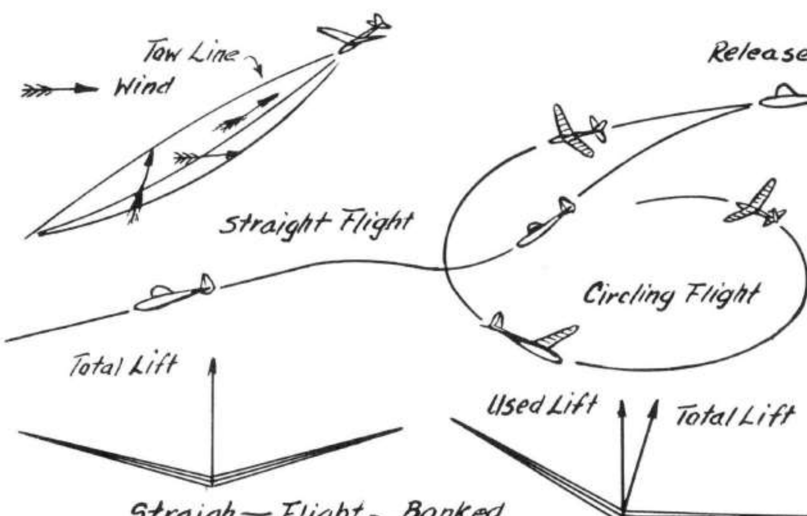
ADJUSTING

The first test should be made by hand launching from a small rise, if possible, after adding enough balancing weight to bring the C.G. near the trailing edge. Do not make any other adjustments aside from balancing. The purpose of this test is to find out glider's inherent characteristics. If it tends to turn without having any turn adjustments, try to find out what is the cause. If it has a turn, you might as well leave it in, unless it is too sharp.



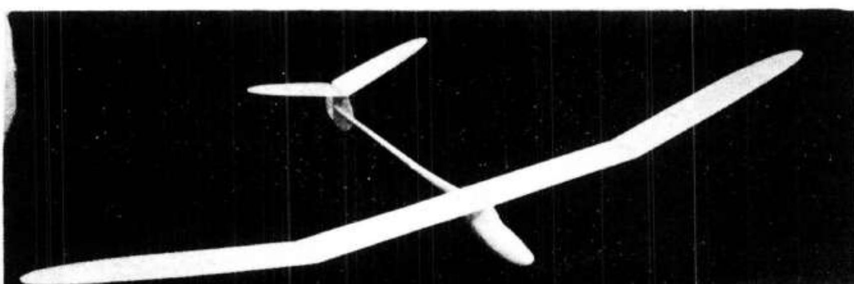
As with other models we adjust until the glider is slow, and just a slight change would cause it to stall. (A logical proof that models fly at high angles, bordering on stall). You are now ready to try towing. For this initial tow we use a special testing hook which is almost on the nose of the fuselage. The reason for using a hook so far forward is to avoid the steep climb which regular hooks provide. As you may have learned, the first tow flight is very critical as almost anything may happen because we have very little control during the steep climb, but all this is changed when nose hook is used. Not only will the glider tow be almost horizontal but the model will also stay level as the tow moment arm will be helping rudder keep the model straight ahead and so counteract whatever turning tendency there may be. It will also take care of slight rudder turn adjustments when we reach that stage.

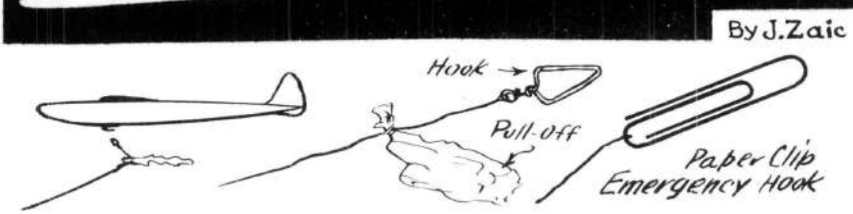
Have someone hold the model level and about shoulder high, and rather loosely so that it will slip out of the grasp when it is pulled. Check for wind direction by noting the sag of the towline. Correct until the sag is straight down. Slowly take up the slack and start to move. Your helper should move with you until he feels the model lifting out of his hand. Look over shoulder and see what is happening and act accordingly. If you use nose hook you will only be able to tow up about 30 feet which is about all you need. The glider should dip down slightly after release and assume a steady glide. If it does not, note the particulars and make corrections. In case it has a natural turn, leave it alone if it is mild. The next test is to make the glider circle. Adjust rudder for left turn, if side hooks are on left side, and tow by nose hook. The circle should be fairly sharp before trying rear books. (In case the natural turn is right & it can be tightened with rudder without trouble, move side hooks to right side). When you are satisfied, try rear hooks.



It is best to use 35° side hook for start. This will be easier to control than 45° hook, and side hook will take care of rudder turn adjustments. Tow the glider up about 50 ft. or just under the point where it may give trouble. In case you have failed to make turn adjustments you will find that the glider will dip and zoom after rear hook tow. A turn adjustment will eliminate the dip as the wing will bank into a turn as soon as it is released. You will find that the speed and glide will be faster in turns. This is caused by the bank as all of the lift is not upward. Remove some clay until satisfactory glide is achieved. Increase the altitude, and then try the 45° hook. If the glider is properly proportioned, the behaviour will be just about like described. If you have trouble reread the stabilizer and rudder paragraphs to find out what is the cause.

The stabilizer is used for adjustments when the glider behaves queerly and ordinary balancing does not seem to work: For example, the glider may release from the tow and into a normal glide. Suddenly it whips into a stall and then into a dive, or it may dive without stalling. If we correct it by adding weight we find that it becomes faster and definitely out of balance, and if we remove ballast we get an actual stall. The correction should be made by giving the stab more negative angle. Although this will cause a stall, it will be such that it can be corrected by adding weight to nose. The trouble may have been caused by too delicate balance between wing and tail. By giving tail more negative the balance is no longer delicate as the stab is functioning as a stabilizing unit. When the model dives in a sort of inverted loop, the stabilizer is too large and it has too much power about the C.G. under certain conditions. By increasing its negative angle the trouble may be overcome. Here again we advise you to read up paragraphs on stabilizer.





TOW LINE AND PULL-OFF

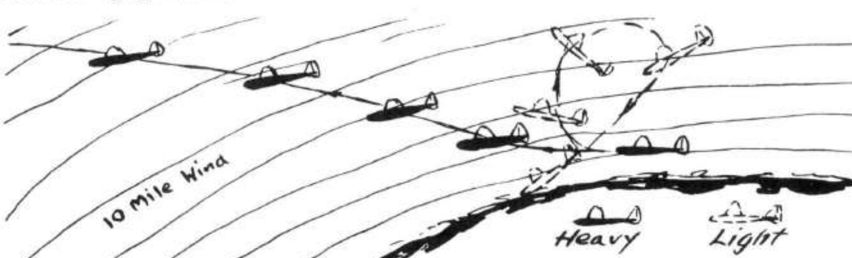
The strength requirements of the tow line depend on the glider. Up to about 150 sq. in. wings #8 thread is strong enough. Use kite string for towing gliders having spans up to 6 ft. For larger jobs use fish line which you know is stronger than kite string. Our record rules allow maximum length of 100 ft. International rule allows 100 meters or about 315 ft. For your own enjoyment, sky is the limit.

Tow loop is bent from piano wire, about .025, to shape shown. This guarantees quick and positive drop-off. To assure fast and complete disengagement of loop from hook, tie a bit of tissue paper or a ribbon of cloth about 6" ahead of the loop. As soon as the line slackens, the drag of the tissue will pull-off the loop. Thank John Zaic for this idea. At the handling end of the line attach a short dowel for sure gripping and to act as a base for winding up after use.

OTHER LAUNCHINGS

Hill Launching: Most of the German gliders were designed for hill launching. The aim being distance and duration. The launch procedure is simple; just launch into wind over the valley. Unless a glider is designed for such flying the results are disappointing. Most of our gliders are much too light and are too stable for hill work. They would be thrown back into the hill, or would circle until they are back on or over the hill.

For hill launching the glider should have fairly high wing loading so that it may have enough speed to make headway against the breeze. Once it is far enough from the hill almost anything may happen. Many designs try to glide into the wind to get over the valley. We should have no trouble making such glider. The real trouble comes in finding a hill which is bare of trees so that a glider may be recovered undamaged. The hills used by Germans are ideal for such flying which may account for development of special hill launching gliders.



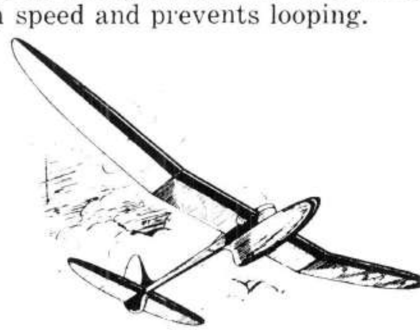
Hi-Start Launch was imported from Germany. It is a combination of catapault and towline launching. By using light rubber, the tow is fairly slow and glider has no trouble in reaching altitudes equal to length of string. After you had some experience you can add more rubber and get higher altitudes due to extra speed.

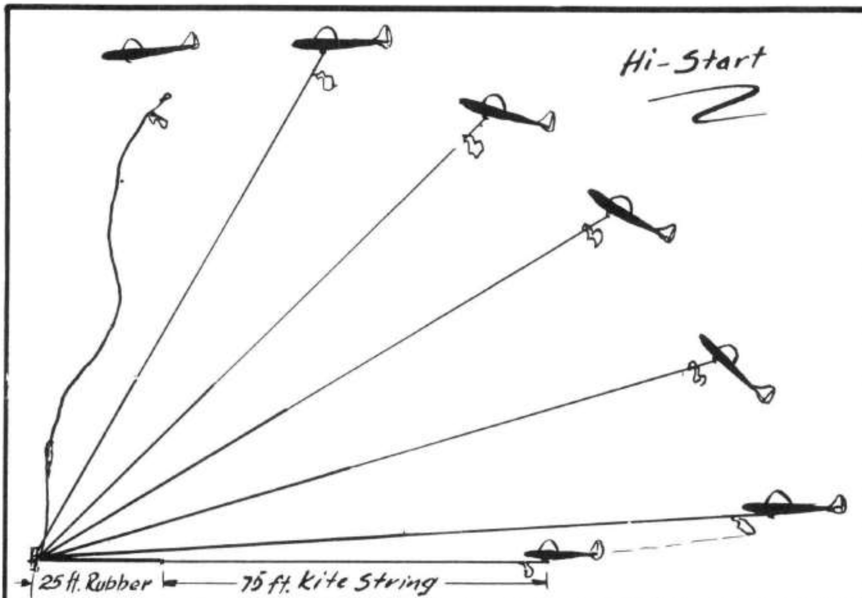
Some of you may have tried this idea and have been disappointed. This was probably caused because the rubber was too powerful. Use smallest amount of rubber possible; just enough for the glider to struggle up. We use about 25 ft. of rubber with 75 ft. of towline. Use single strand of the following sizes of rubber for particular job: 1/16 flat for up to 150 sq. in., 1/8 flat up to 350 sq. in., 3/16 up to 500 sq. in., and 1/4 for larger jobs. By using such light rubber you cannot harm the glider. Yet there is enough power to apply a steady pull on the string which is all that is needed. After you have proved to yourself that Hi-Start is practical you can slowly add more power. See sketch for general set-up. Use side hook and other adjustments as already described.

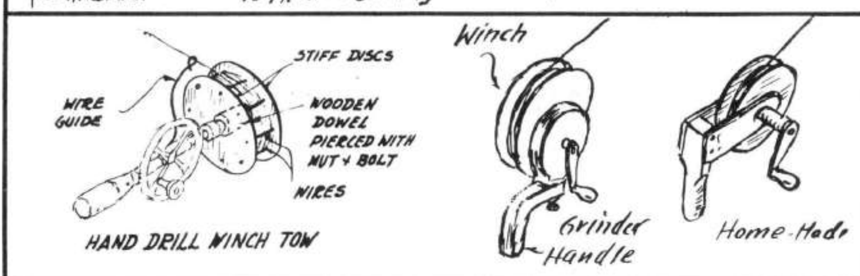
Hi-Start is especially fun in calm weather. By progressive adjustments you can make the glider circle back to you at the starting line. It is thrilling to watch your ship climb up and automatically take care of itself, especially if you are reluctant to run.

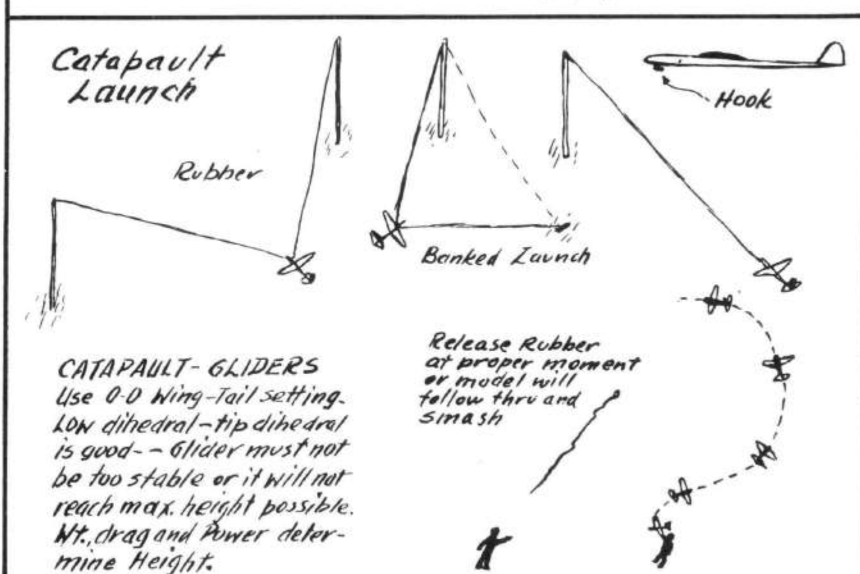
Winch Towing: Some of you might like to try winch towing. The idea is to wind or reel the line to obtain forward speed. It does complicate a rather simple or clear cut towing job. Europeans go for it in a strong way. Some of them have winches fixed in front of them so that they have some control. But of course, you just can not drop the line when the ship gets out of control. See several methods of making winches.

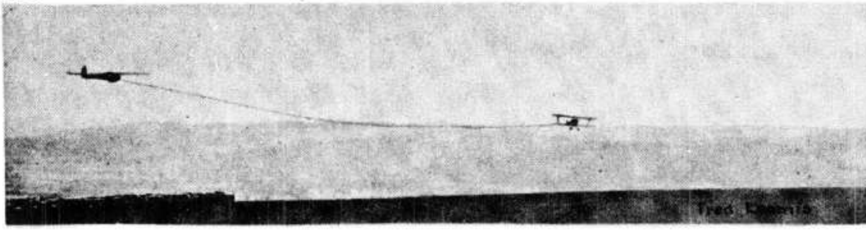
Catapault Launch: This type of launching is too severe for built-up gliders. The initial speed is just too high. It can be used for all-balsa gliders designed for such flying. There are several methods of making or holding the catapault. See sketches. Because of high speed and sharp point of the fuselage, this launching should be treated carefully and done in cleared area. Personally we are not crazy about it as it is one of those brute power propositions which is hard to keep under control. You can try launching regular hand launched gliders by using low power. Note the position of the hook. This gives high speed and prevents looping.




Hi-Start
25 ft. Rubber
75 ft. Kite String


WIRE GUIDE
STIFF DISCS
WOODEN DOWEL PIERCED WITH NUT + BOLT
WIRES
HAND DRILL WINCH TOW
Winch
Grinder Handle
Home-Made

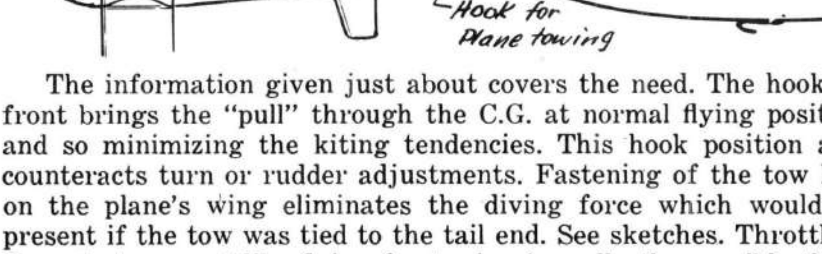

Catapault Launch
Rubber
Banked Launch
Hook
Release Rubber at proper moment or model will follow thru and smash
CATAPAULT-GLIDERS
Use 0-0 Wing-Tail setting. LOW dihedral-tip dihedral is good--Glider must not be too stable or it will not reach max. height possible. Wt., drag and Power determine Height.



PLANE TOWING

To those of you who may want to try plane towing the following information sent to us by Richard Cooper of Mason, Mich., may be just the thing to start you off. He states:

Use about 40 ft. of tow line. Fasten it on to the plane at the center of its wing. (It will not work anywhere else). The hook has to be placed at the tip of the glider's nose and shaped as shown. The launching technique is as follows: Throttle the motor to about a half, correct plane and glider with tow line. The fellow with the gas job and the glider holder should start running at the same time. This must be done or the tow ring will fall off the hook due to its design. The glider should be held lightly. The gas job is released first, and the plane should pull the glider out of holder's hands. This usually happens as the plane begins to climb. The glider will almost always fly above the plane, but the tow hook position will prevent too high a position. Use about 30 to 40 sec. motor run. When the motor cuts the plane will nose down while the glider will fly at its flat gliding position as the ring falls off the hook. It was found that if more than 2/3 throttle is used with 40 ft. tow line the glider swings from side to side slowing up the climb. (Buzzard Bombshell powered with Ahlsson 60 special and Thermix 50X used when the above facts were found. On 30-40 sec. power run the glider stayed up $3\frac{1}{2}$ min. after release).

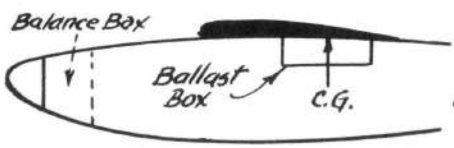


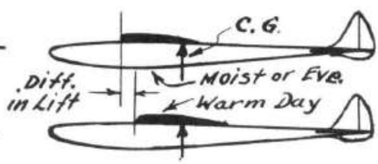
The information given just about covers the need. The hook-up front brings the "pull" through the C.G. at normal flying position and so minimizing the kiting tendencies. This hook position also counteracts turn or rudder adjustments. Fastening of the tow line on the plane's wing eliminates the diving force which would be present if the tow was tied to the tail end. See sketches. Throttling down to transport like flying for towing is really the sensible thing to do. If you wish, you can use timer release, on plane or glider.

BALANCING AND BALLAST WEIGHT

Modelling clay is the best material to use for balancing. It can be used for finest adjustments as it can be easily broken up. However, in many cases, especially on jobs over 300 sq. in., the balance box is too small to accommodate all of the clay needed. In such cases use metal. Lead is preferred since it can be easily cut, or nails, nuts and bolts. Use just enough clay to hold metal pieces from shifting or rattling. For fine adjustments use clay.

Since most of the gliders, even after addition of balance weight, are still too light for record or contest flying, provision must be made for adding ballast weight. The best place for this weight is on the C.G. spot so that there will be no changes in any of the balances. Make a strong ballast box as shown. Use clay and metal mixture to bring the weight of the glider to the requirements.





TESTING IN THE EVENING

Most of us like to test the models towards the end of the day when the air has calmed down. But as you have undoubtedly found out, the evening adjustments do not seem to work during the warmer and livelier part of the day. This is caused by the following: The calm evening air makes it possible to adjust the model very close to the stall without getting into trouble. When this setting is used during the livelier part of the day, the model will usually stall and adjustments have to be made all over again. Also, towards the evening the air becomes moist. This moisture in the air causes the paper covering to loose its tautness, and the covering becomes wrinkled and sagged. This decreases the lift considerably, and we have to move the wing forward, take off balancing weight or make other adjustment to prevent steep glide. When this setting is used during the latter part of the day, the wing develops more lift than it did in the evening and it will naturally tend to stall the plane, and we have to start making new tests during the best flying part of the day, mid-morning.

Under such circumstances we should not depend on evening tests which are made for evening conditions. To test in the evening for regular flying we should adjust so that the model has more speed which means that it is not close to a stall under moist air conditions but will be during latter periods of the day. As it is, the main reason for testing in the evening is to test for spiral stability. If the model is spirally unstable it will show up whenever we fly. These, then, are the reasons why many models which behave well in the evening prove to be a disappointment the very next day.

HAND LAUNCHED GLIDER

The present design is a far cry from the 1930 job with its narrow and flimsy wing. If the 1930 glider were to be launched in a modern manner it would just disintegrate. It is quite possible that the modern glider had its start when John Zaic developed the side throw which permitted full use of arm's strength without causing a loop or breakage. Prior to that we usually launched them straight ahead and hoped that the loop would be small. To keep the glider together during the side launch, described later, the wing gradually assumed the present comparatively low aspect ratio form. In fact, the entire structure was thoroughly strengthened.

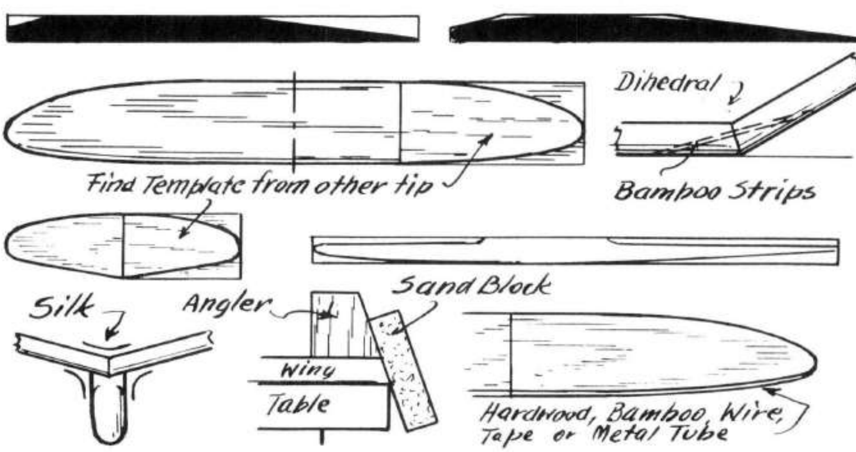
The basic design is illustrated by the numerous plans shown elsewhere. The smallest of Joe Hervat's designs is probably the best to follow if you are just starting advance glider work. (New-comers should definitely start with smaller and simpler designs, which will assure fair flying no matter how the glider is made. Its like comparing a training plane with super-pursuit job). It seems to perform well under severe "human" handicaps and its spiral stability is exceptional. The basic design has been pretty well standardized. Aspect Ratio is low, between 4 and 6 but the wing is usually elliptically outlined to obtain all possible aero-dynamical efficiency. Greater Aspect Ratio might result in wing breakage. The stabilizer is around 33% of wing area and is also well shaped as you can observe from plans. Here again the rudder area is an unknown factor, but 7% seems to be an average. You will have to check the flight to see where you stand. The fuselage is about equal to the span, and the leading edge of the wing is set from 1/4 to 1/2 of length from front. The shape of the fuselage may be more important than we may think. We should experiment more with fairly large frontal area as practiced by Joe Hervat. By having large frontal areas, the area of the rudder will not have to be so critical, and side slipping or skidding action will be dampened or slowed down. Use about 1½" dihedral under each tip for every 10" of span.

MATERIAL

Having proper material to work with just about cuts the building time in half and also assures good flying. The wing should be made from semi-quarter grained, 5 to 6 lbs. balsa. Full quarter-grained stock is too brittle and cracks easy under adjustments or landing shocks. While annular ring type tends to work too easily. In-between grain is just about right. Stock lighter than 5 lbs. is too weak, except for indoor gliders, and it very often cracks near center joint. Tail surfaces should have similar grain and be slightly heavier, 7 lbs. Its grain should be even and should have no warps. For fuselage, use the hardest stock you can find, 15 lbs. is good, or you can use hardwood.

CONSTRUCTION

The wing is the main element and you should be prepared to spend considerable time on it. Practically every glider uses airfoil with flat lower surface. The section developed by Jr. Aero Supp. is as shown, and only corners need to be rounded to obtain airfoil shape. However, as the chord decreases towards the tips you will have to plane to shape. If only ordinary sheet stock is available, make every effort to obtain airfoil sections. Plane the sheet to section similar to JASCO'S before rounding corners. Using cardboard template outline the wing tips. Plane tips to airfoil shape. Sand smooth with medium, 6-10 and 10-0 sandpaper. It is best to cut now the wing in half, and after making certain that both halves are similar, angle the dihedral edges and cement them together to the desired dihedral. When angling for dihedral use the suggestion shown to assume perfect fit. The tail surfaces are cut to outline before sanding. While sanding, thin the trailing edges to obtain fair streamlined



section. The fuselage is also first cut to outline and then the corners are rounded or shaped to obtain tear drop section. Cut a "V" groove on the fuselage where the wing rests. Coat all cement areas with cement so that it will have a chance to sink into balsa. You may start assembling by cementing the stabilizer first so that you can use it to line-up the wings when their turn comes. Add more cement to form fillets and spread it about an inch from the points to strengthen the wood at the critical spot. While adding cement, be sure that the original cement does not loosen up. Silk strips over wing joint help considerably in preventing cracks. Finishing is done as described elsewhere. In a nutshell; use plasticised dope, such as Glider Polish, on thin surfaces. On fuselages and fairly strong wings you can safely start filling pores with plasticised wood filler such as JASCO type, and finish with Glider Polish. Note leading edge reenforcements.

REPAIRING

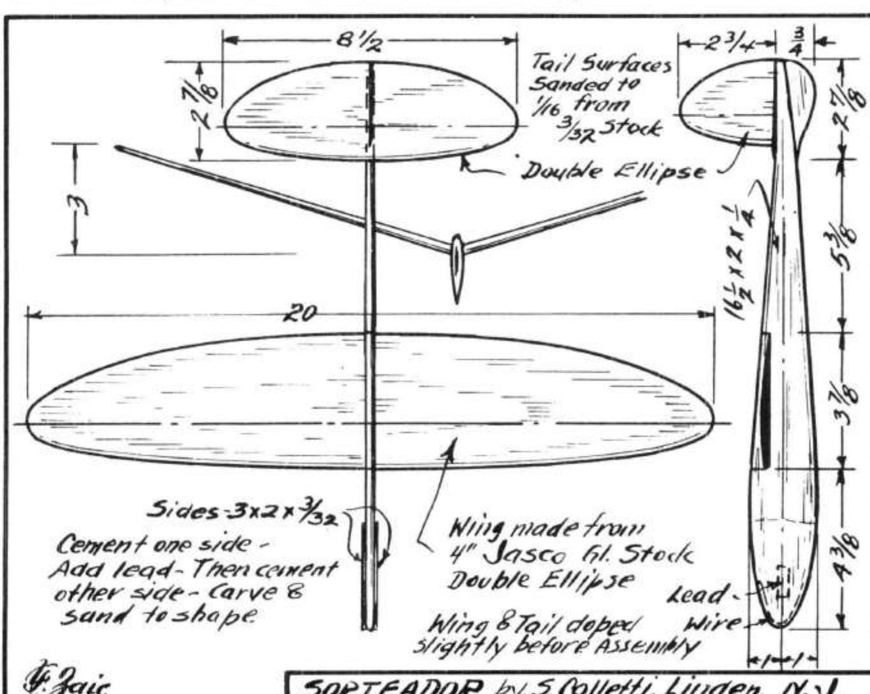
When repairing use cement sparingly so that it may dry well throughout. Do not be tempted to try if it is ready too soon. Use bamboo strips and silk to hold parts together.

ANGULAR SETTING

The advanced gliders use 0-0 setting. This makes it possible to launch the glider to great heights as the glider has arrow-like characteristics. However, the setting calls for critical and expert adjustments, and conditions for longitudinal or up and down stability are poor. Such settings require time and long distances to recover, and spiral dives are a familiar sight during hand launched glider flying. The beginner should keep away from this setting, and set the stabilizer slightly negative, about 1/32″ for each inch of stabilizer's chord. This will make the adjustments less critical and the glider will have that swinging motion which can be easily controlled by addition of clay.

BALANCING WEIGHTS

Modeling clay is best. If too much clay is needed to balance a particular job, use metal which should be imbedded in the fuselage and cemented in place. Leave the glider slightly underbalanced so that final adjustments can be made with clay.

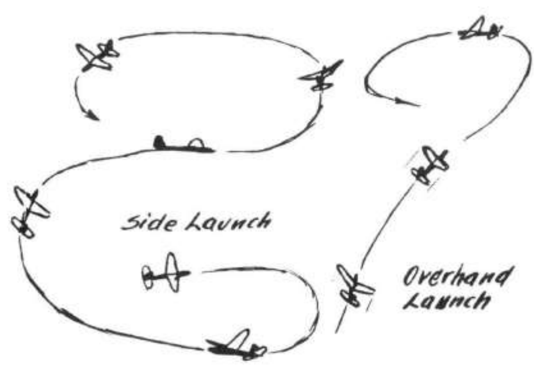


LAUNCHING

Making the glider is only half of the job. The other half is to get it up high with no other means but your arm. As you will find out, hand launching a glider is an art which requires practice. It comes to some naturally. To others a bit harder. And to some never.

We find it rather difficult to explain the launching method. The entire motion is complex and you simply have to find out your style by yourself. For the amount of effort exerted the best launching angle is 45° straight ahead. However, this is impractical as we must have circling adjustments on the glider, and they would cause a dive to side soon after launch. Still, the idea is to come as close to this criterion as possible and still retain control.

The adjustments depend on your hand dexterity. If you are right handed, adjust for left circle, using rudder and wing warpage. Apply adjustments gradually. Launch into a right turn. The result will be a right spiral climb and a left glide. The beginner, using negative stab angular set-up should start by launching with underhand throw. Hold the glider naturally and crook the hand at the elbow just enough to bring the wing a bit off the vertical line. The fuselage should point up a bit when released. The releasing moment is critical. It should occur when the arm just about reaches its maximum forward point. After that the arm slows down and begins to swing inward. The exact point will have to be determined by yourself.

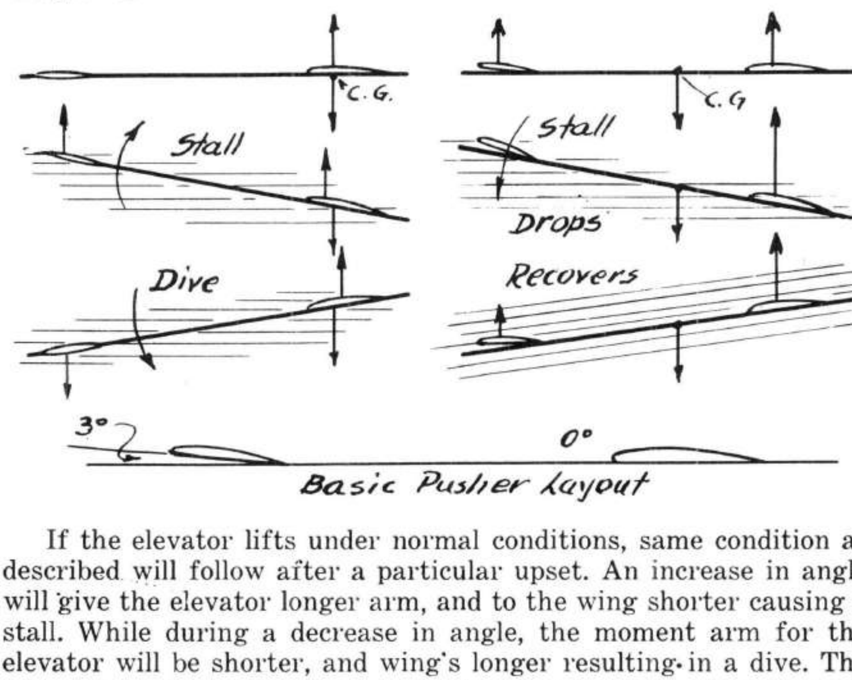


As your launching improves and you know how to adjust, point the fuselage upward at higher angle. You will also automatically reach the overhand, or baseball, launch. When launching at high angles be sure to hold the glider in a bank to take care of the turn adjustments. Dick Everett cuts a round notch in the wing in which to rest the index finger to obtain extra power, sort of sling-shot effect. Through the entire hand launch glider career be prepared for complete wash-outs, and also for out-of-sight flights that you will cherish for years and years.

PUSHER DESIGN

Frankly, we have very little of proven data on pushers as very little technical work has been done on them. However, we can use logic and whatever we may know about model aerodynamics to work out some general rules.

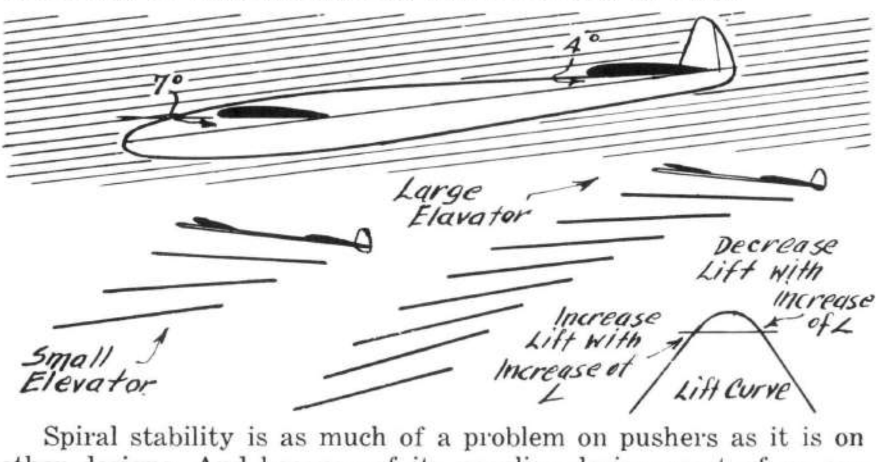
In contrast to normal design, the elevator on a pusher must always carry a load to maintain stability, and the elevator must stall to bring about a balance after an upset. If a pusher design had C.G. under center of wing's lift and a neutral elevator a change of airflow would work as follows: If the angle of attack is increased the Center of Lift would move forward and tend to swing the nose up. While the elevator will do likewise with its newly made lift. If the angle of attack is decreased the C. L. moves back, tending to dive the model, and the elevator will be helping it by its negative force. See diagrams.



Basic Pusher Layout

If the elevator lifts under normal conditions, same condition as described will follow after a particular upset. An increase in angle will give the elevator longer arm, and to the wing shorter causing a stall. While during a decrease in angle, the moment arm for the elevator will be shorter, and wing's longer resulting in a dive. The cure for such condition is to have the elevator set so that it stalls before the wing does. In fact, the elevator should be working on the other side of the lift curve at which an increase of angle would decrease lift, and a decrease in angle will increase lift. We know that we are working in close quarters but that is the way the pusher seems to work when it is flown without operating controls and must have inherent stability. When the elevator works normally in such a stalling condition, the wing should still be a few degrees from its stall. Therefore we may say that the elevator should be set at an angle 2° or 3° greater than the wing. Since the elevator will be working under stalling condition it should be set on fuselage to have the airflow parallel. A 7° incidence is a good compromise. Setting the wing 3° less we would find its angle of incidence to be 4°. A set-up which probably none of us have ever used, but one which logic and knowledge of model aerdynamics proves.

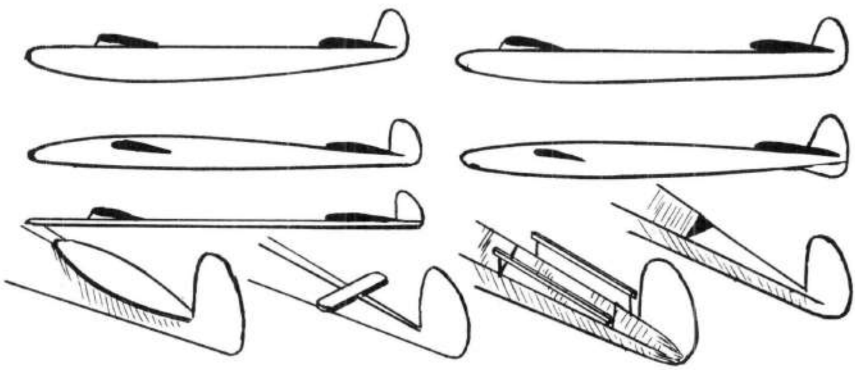
It is hard to say just how large we should make the elevator. Since rules penalize us according to the wing area we should try to use elevators as large as possible. However, the larger elevators will cause us more trouble than smaller. For example, a large elevator carries quite a load, and when it stalls completely, the sudden release of the load will cause a sharp dive. And during the recovery from the dive the large elevator may swing the model into another stall. A smaller elevator will have a light load so that a sudden stall will not be too upsetting and the elevator may have a chance to recover with small loss in altitude. Also, a smaller elevator will have lower aerodynamic efficiency and the stall may not be sharp so that it will be able to work on the change of lift sign as shown. Now that you have an idea what may happen, suppose we start with about 30% of wing elevator and then be guided by tests.

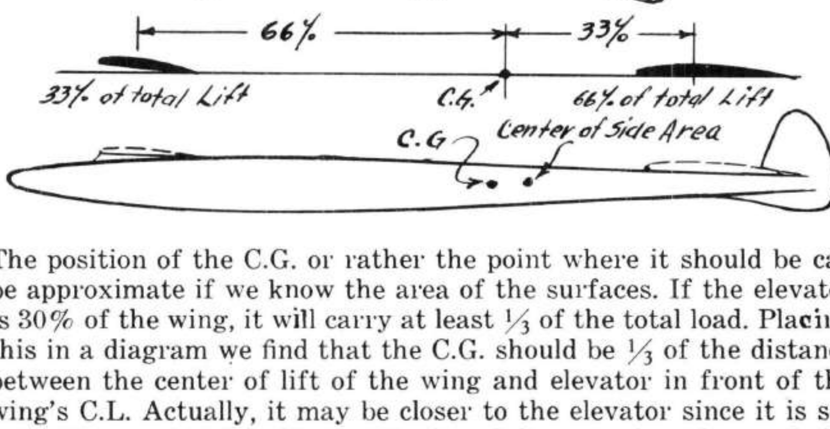


Spiral stability is as much of a problem on pushers as it is on other designs. And because of its peculiar design most of us are rather helpless in analyzing its action during tests. So that in most cases either we hit on a lucky design or on a "lemon" as we seldom know what is wrong when we have spiral troubles.

We can find out if we made a proper distribution of side area when we test the glider. If it persists in facing the wing with slight rudder adjustment; the area in the rear is too strong. And if it travels with the wind the frontal area is too large. This follows the weather vane rule. The correction, naturally, is to add more side area on the weaker side. (It is much easier to add than to remove) until small rudder adjustments will be effective. The next question is how large should the rudder be, and where should we place it, in front or behind the C.G. Before we answer this question, let us make a rough layout of the design.

Wing design should follow the recommendations given under wing design including the amount of dihedral. The fuselage length may follow the formula given for the standard design, but ½ of wing span seems good for almost all cases. The outline and shape will depend on your ability and time available. The main problem will be the elevator and wing mounts as they are at the extreme ends where the fuselage tapers to points. So keep them in mind when designing the fuselage. Shown are several suggested designs.

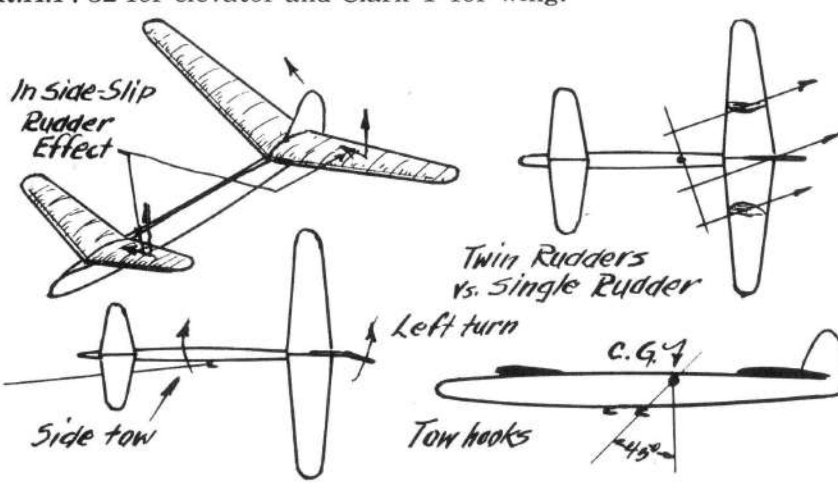




The position of the C.G. or rather the point where it should be can be approximate if we know the area of the surfaces. If the elevator is 30% of the wing, it will carry at least ⅓ of the total load. Placing this in a diagram we find that the C.G. should be ⅓ of the distance between the center of lift of the wing and elevator in front of the wing's C.L. Actually, it may be closer to the elevator since it is set at higher angle of incidence. Having C.G. near the wing and the large portion of the fuselage in front of it, we will need extra side area in the rear which can be included in form of a rudder as shown. However, the rudder should not be large as the wing has rudder-like correction when in a side slip. Although the elevator has similar effect in opposite direction, the wing may be more powerful, hence the caution. So start with about 5% of wing area. This should have some turn effect when used to test during early trials. Do not fix rudder to wing, twin or single, as you have no way of checking the line-up of twins, and every time the wing moves the rudder adjustment is lost. Also, twin rudders, no matter where they are along the wing, have same effect as if they were placed on center. See sketches. As you may realize, when working in an unknown field it is best to have as fewer problems as possible.

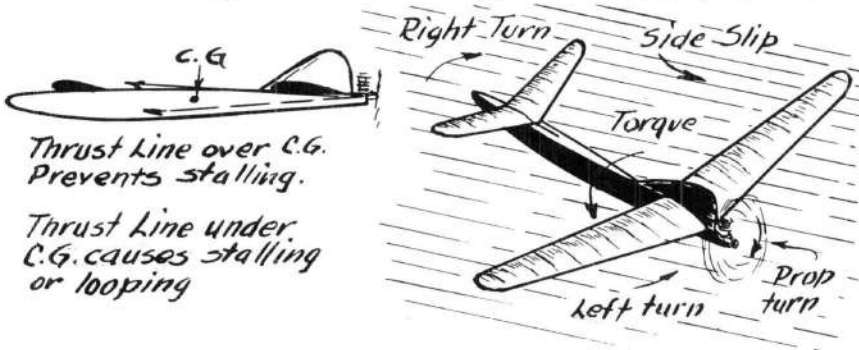
Mount the wing and elevator without allowance for balancing by sliding them back and forth. The longitudinal balance should be achieved by adding weight where needed, or, as a second choice, by changing incidences. The model will usually be underweight, so do not worry about the balancing weight. The built-in incidence should be about 4° for wing, and 6° for elevator. By having wing and elevator in a fixed position, tracking down trouble will be so much easier.

The elevator may have an area of about 30% of wing as a start. Dihedral angle may be same as on the wing. No need of having more as the wing has enough dihedral effect. It is also better to use fins for side area than to increase the dihedral. As you can see from the diagram, part of the dihedral action works as rudder in side slip. So, if the model tends to fly with the wind, hard to control circling during windy period, or tends to skid and nose up into stall, decrease the elevator's dihedral. Use Aspect Ratio of about 6:1. Airfoils on the pushers should follow the following rule: Use early stallers on elevator and high angle stallers on wing. It seems that under cambered airfoils stall at lower angles than those having flat or convexed lower surface. Therefore, use undercambered for elevator. You might try N.A.C.A. 6409 as is for the elevator, and for the wing modify it by having flat under surface. Or you can use R.A.F. 32 for elevator and Clark Y for wing.

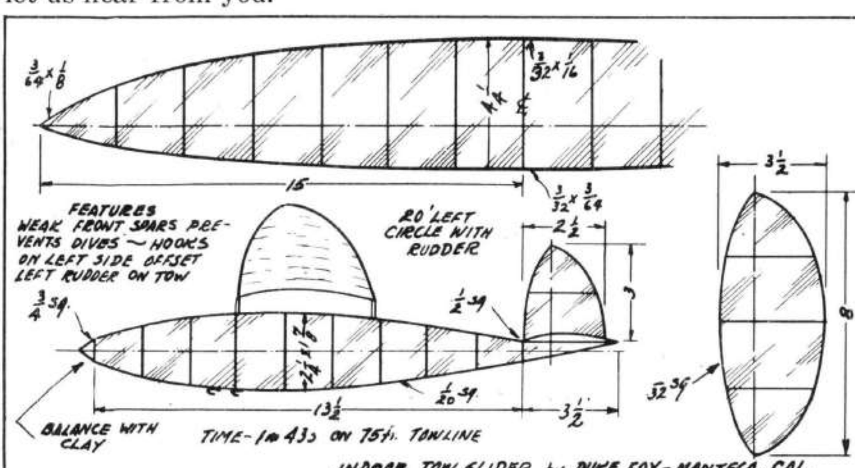


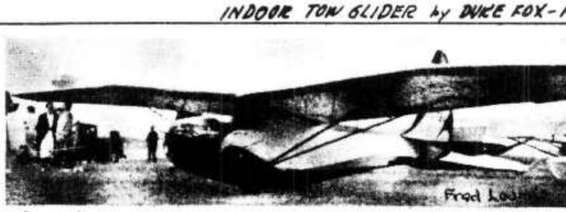
Use side hook towing procedure. The tow hook should be on the 45° line as shown. Since we cannot predetermine the C.G. until after hand glide tests use some sort of a movable hook. After C.G. is found, cement two hooks, one at 45° and the other slightly ahead. As you know, you will have to use opposite rudder to counteract side tow. We believe that we have covered most of the points by which you will be able to tell what is causing the trouble. Above all do not be afraid to experiment.

In case some of you wish to add power, just make sure that thrust line passes slightly over the C.G. spot. Also assume that the model will be in a constant side slip as shown during the power-on period. Too much frontal area will cause it to spin to right And too much rear area will cause a left spin. Although therightspin may be converted into a climbing spiral by having the thrust line pass under the C.G. Opposite action will happen when left prop is used.

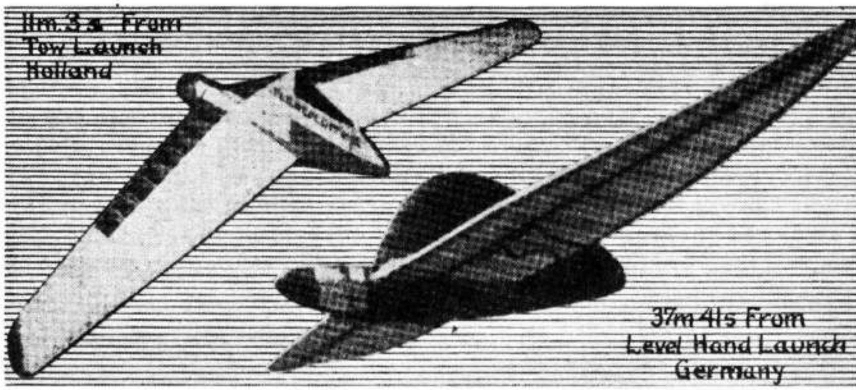


We wish that we could make a pusher to test all of the statements made, but at the moment of writing Uncle Sam wants most of our time for more important business. If you try a pusher job, let us hear from you.





The Sun Spot, built by Robert Auburn of Buffalo, is basically of Franklin design and has many refinements which place it in the class of a semi-sailplane. 46 foot gull wing

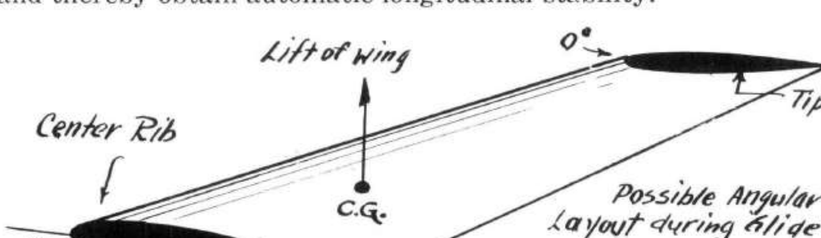


FLYING WING

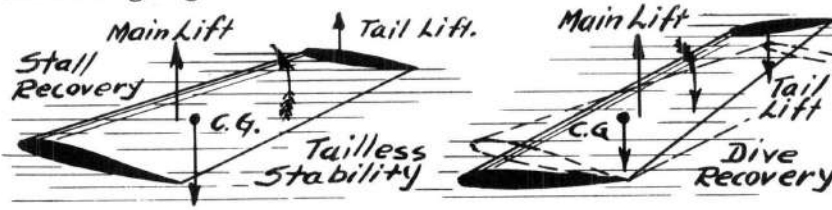
We are now entering the field which is visioned as being the last word in efficiency, but which is still far from perfection, namely, the "Flying Wing." Although many successful men carrying "wings" have been made, they were all of experimental nature and with one or two exceptions none went beyond that into regular production. In time, when sufficient capital is present to cover the initial high cost of experimenting and production we may see the "Flying Wing" come into its own.

As you may know the main problem with "wing" is its stability. To appreciate the value of standard tail surfaces, remove them and see what happens. Then you will know what we are up against when we try to incorporate all the functions of the tail in the wing itself.

Longitudinal stability is obtained by having the wing swept-back, and setting tips at lower angles than the center portion so that the angular relationship between center and tip will be as shown. This layout is similar to our standard arrangement except for closer coupling. By balancing and adjusting so that the tip will be neutral during flight we can keep the Center of Lift travel under control and thereby obtain automatic longitudinal stability.

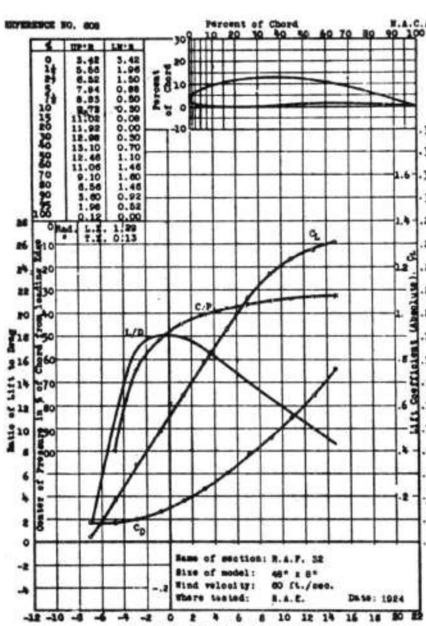


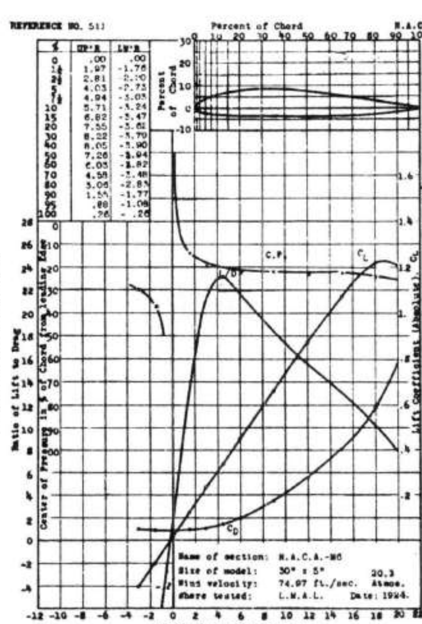
We do not know the exact angular difference between center and tip on full size wing and we hesitate to guess. If we did know, it probably would not help us much as model wing will be flying at much higher angles because of our adjustments to get lowest possible sinking speed. Assuming that the stalling angle will be around 8° we should figure that the flying angle will be 6°. So that we may get good control, the angular difference between tip and center should be 6°. This will assure prompt correction on part of the tips if wing wanders away from 6° position as the tips will be normally neutral and any change in airflow will make the operate. It might be mentioned now that flying wings should be adjusted to fly a bit faster than regular models to keep from being too close to the stalling angle.



Since so much depends on the position of the Center of Lift we must use airfoils on which the C. of L. tends to remain in same spot.

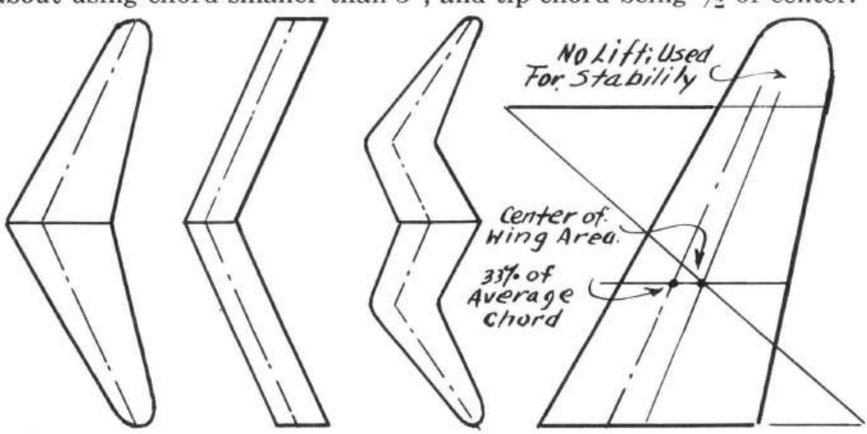
Airfoils such as M-6 have the desired characteristics. See M-6 graph and note the C. P. (Center of Pressure, same as Center of Lift) curve and how it tends to be at the same spot through a large angular travel and actually reverse its traveling in comparison to undercambered airfoil. While talking about M-6 type of airfoils note that C. P. (or C. L.) is closer to the leading edge than on other airfoils we use. This means more balancing weight to bring the C. G. under the C. L.

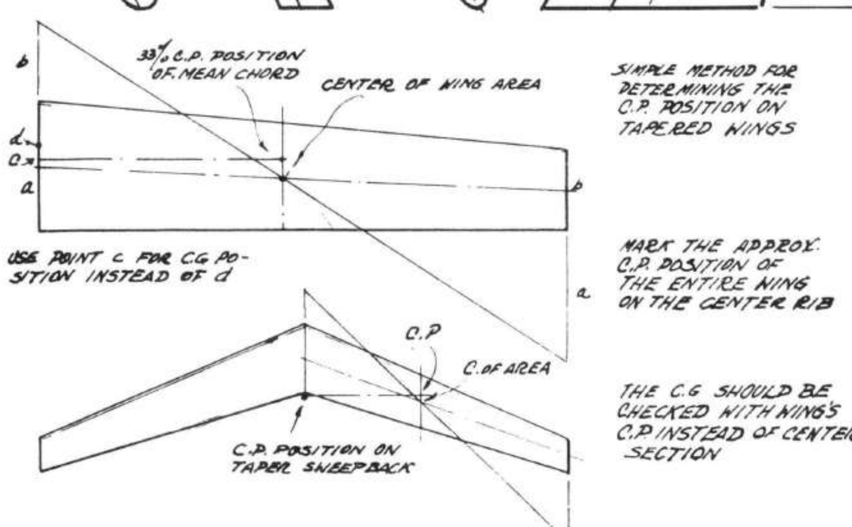




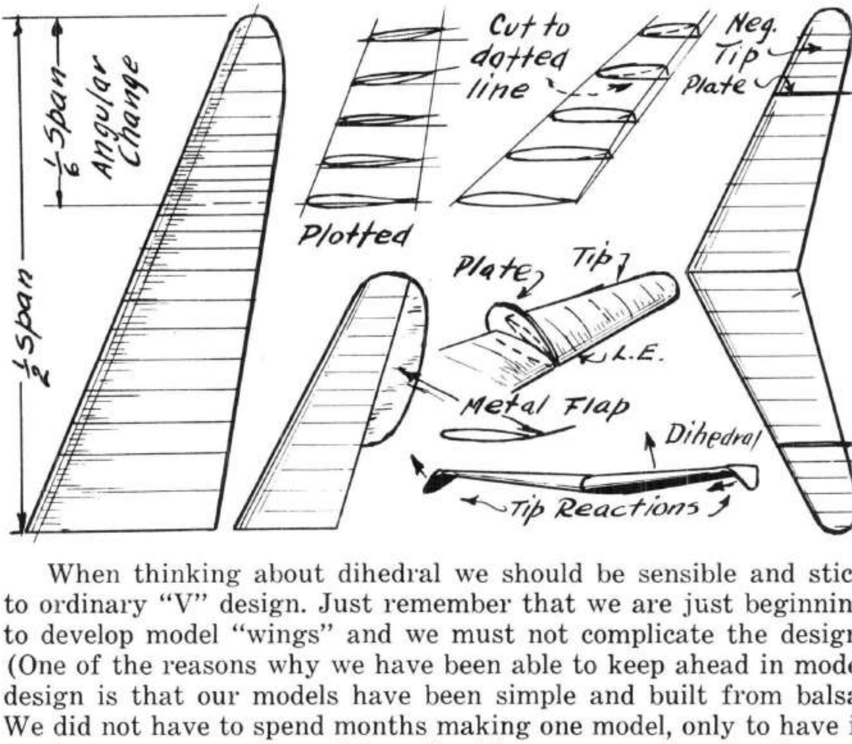
Sweep back is ncessary to obtain stabilizing effect of the tip. The "sweep" may vary from 15° to 30°, depending on the expected C. of L. travel. If we use wide center chord, we should expect greater C. of L. travel so that the "sweep" angle should be greater. While if constant chord is used then the sweep back may be around 15° as the C. of L. movement is small. You can make a fair estimate of the C. L. position by finding the center of the lifting area and then locating the spot according to the C. P. graph. See drawings. Note how only that part of the wing which contributes lift is used.

For a start we suggest a constant chord outline. This will simplify work, but still give you experience. After that you can make whatever shape you wish. If you plan to follow a bird wing shape, be sure to follow the angular setting as shown. This compares, after a fashion, with the actual angular arrangement as found on bird's wing. When using tapered wings remember what we said about using chord smaller than 3″, and tip chord being ½ of center.





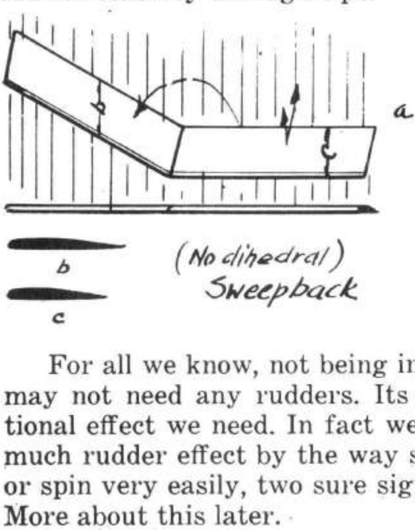
The angular change of the tip should start at about 1/6 of span from tip. Bring about complete change as soon as possible while still retaining smooth lines as the angle changes. This is done by gradually changing the airfoil shapes from that used at center to streamlined tip section. This change may be done by plotting every rib, or shaping the ribs between regular and tip after assembly. Use closely spaced ribs to make covering easier. The simplest method is to make the wing in three sections. Center to have regular airfoil, while tip sections will be streamlined. Connect them with a flat plate between them to take care of the trailing edge gap. If you like, you can use rod and tube pivot to make adjustments during tests.

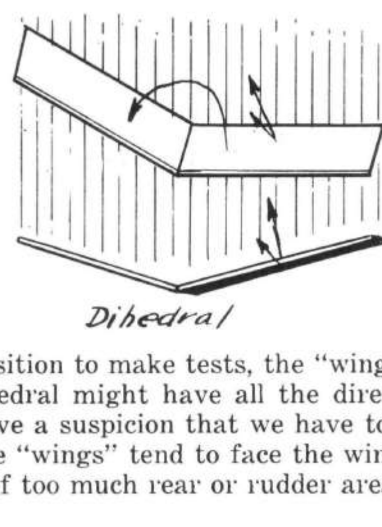


When thinking about dihedral we should be sensible and stick to ordinary "V" design. Just remember that we are just beginning to develop model "wings" and we must not complicate the design. (One of the reasons why we have been able to keep ahead in model design is that our models have been simple and built from balsa. We did not have to spend months making one model, only to have it crack up, as many boys did on the European continent). Rumors have it that Northrop "wing" wing tips are going up. Place this design in a side airflow and you will see that downward angled tips tended to neutralize the dihedral effect. Whenever in doubt, just place the model in a side airflow position and take a look along airflow, and see how the model will behave with your particular dihedral. We do not see any need for using more dihedral than we do on ordinary models. So, use 1¼″ to 1½″ for every foot of span under each tip. This amount of dihedral should be enough. If you have spiral stability troubles look for the source elsewhere than insufficient dihedral.

Somehow Spiral Stability determines the outcome of practically every flying machine. It is one stability which cannot be bottled and poured out as needed. The "wing" is no exception to the rule, and it usually gives us more trouble than other designs.

In analyzing the "wing" for directional stability we find that it has a certain amount of it due to the sweep back. See sketch. The left wing (a) will develop slightly more lift and drag than the right. This is due to the fact that the air flowing over left side will act on smaller chord than on the right side although their thickness is same. As far as the air is concerned both wings have similar areas but right has lower Aspect Ratio and thinner airfoil in proportion, two facts tending to lower lift. The result will be that the left wing will tend to lag due to greater drag and rotate the "wing" as shown. So, although the "wing" may have no dihedral or rudders it will try to swing into the airflow due to sweep-back. The action is similar to that developed by the dihedral as you can see, except that it has lower force value. 1° of dihedral will be as effective as 10° of sweep-back, and the only reason we are using sweep-back is to get longitudinal stability through tips.

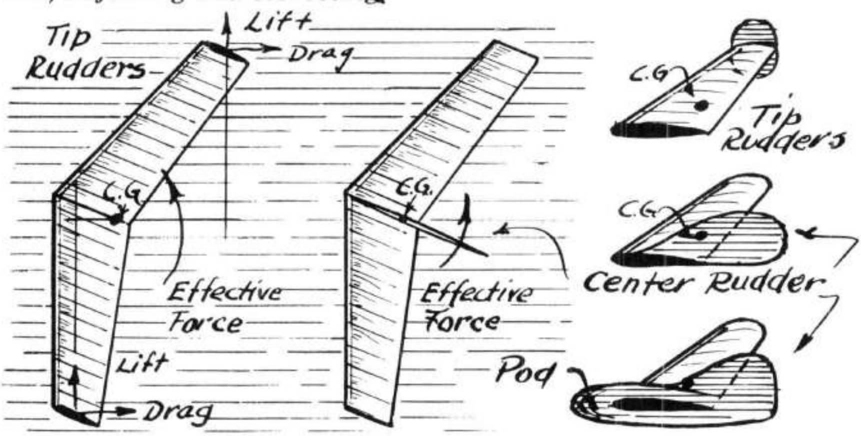


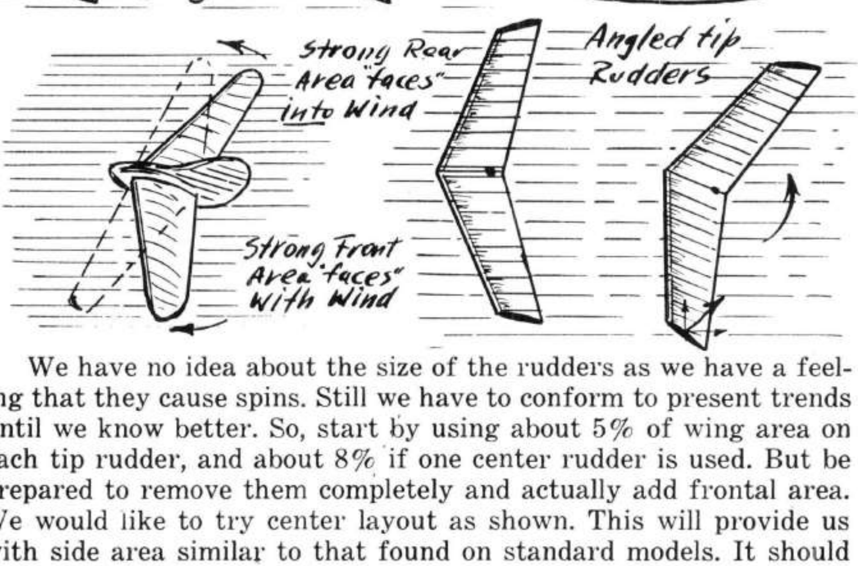


For all we know, not being in position to make tests, the "wing" may not need any rudders. Its dihedral might have all the directional effect we need. In fact we have a suspicion that we have too much rudder effect by the way some "wings" tend to face the wind or spin very easily, two sure signs of too much rear or rudder area. More about this later.

When we use tip rudders we have additional elements tending to bring or keep the model out of side slip or skid. Although the rudders may be way out on the tips, they actually have small moment arms. Since the drag value of each cancel each other we only have "lift" effect left. When this is diagramed we get results as shown. A rudder placed a bit behind the center would have the same power. In some cases the rudders are set to converge as shown. When the wing side skids the inside rudder has greater angle with which to develop corrective forces. As you can see, the rudders tend to bring the "wing" into airflow without rolling it as the dihedral or sweep-back does.

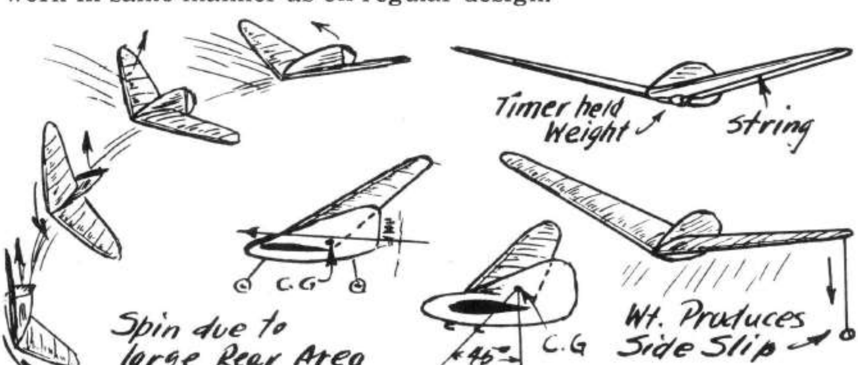
As you have been shown, we may replace the tip rudders with one center rudder without losing anything by way of longer moment arm. So, as far as we are concerned, we believe that if rudder is needed, we might as well have it at center. It will simplify construction, adjusting and correcting.





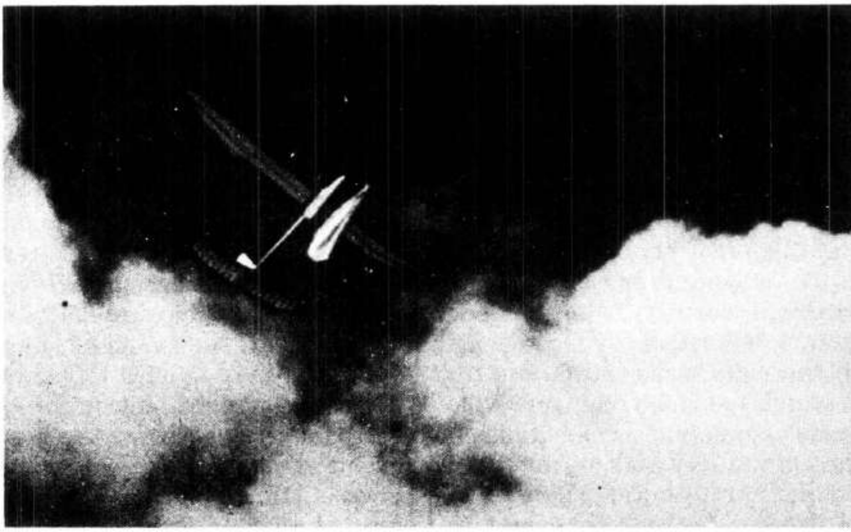
We have no idea about the size of the rudders as we have a feeling that they cause spins. Still we have to conform to present trends until we know better. So, start by using about 5% of wing area on each tip rudder, and about 8% if one center rudder is used. But be prepared to remove them completely and actually add frontal area. We would like to try center layout as shown. This will provide us with side area similar to that found on standard models. It should slow down spiral action, and also make exact rudder area less critical. It will simplify finding correct distribution of side area while testing as it will be easy to add or subtract area. It will also provide fuselage effect, and base for skid and two hooks.

Testing: Hand launch and add balancing weight until a smooth glide is obtained. Try tow by using front test hook which will prevent steep climbing and side dives. After release note the behaviour. If it stalls, add more weight. If it is fast but flat, leave it alone. "Wings" should be flown few degrees from the stalling angle which means that they will be faster than normal gliders. If there is a breeze, check for directional side areas; straight into the breeze glide means that rear area is larger than frontal; while a turn so that it flies with the wind means that frontal is larger. Correct on spot for too much frontal area, and make further check flights for rear area. On the next test try slight turn adjustment. If it takes it nicely, all is well, and you increase the turn adjustment until you have fairly small circles. If it does not take slight turn adjustment and the glider persists in facing the breeze, you know that rear area is too large and part of it will have to be removed, because if you force the turn with large rudder adjustment you may cause it to spin. A left rudder will cause a skid to the right. As the right wing on the ship backs into a left turn, the model may start a left skid in which too large rear area will cause a spin. It might be mentioned at this point that as the glider makes tighter circles part of the vertical lift is lost and we may have to remove some of the balancing weight to retain the original glide. However, this will depend on the position of C. G. with respect to Center of Lift. If G.L. is behind C.G., weight will be removed; C. G. under C. L. no change; C.L. in front of C.G. add weight. After trial tests and corrections have been made, try tow hooks closer to C. G. Remember that side hook will work in same manner as on regular design.



So, as far as we know this is about all that can be said about "tailless" gliders. Remember to fly them at higher speeds so that you will keep them from stalling. And that spins can be controlled by proper distribution of side area, and that it is our opinion that most of the present designs have too much rear rudder area.

We did not try to go into the construction angle as this is well covered elsewhere. In time, after more of us have tried "flying wings" we should have more concrete information to pass on to newcomers. If you are planning a powered job, our advice is to make it first as a glider. To test for torgue control, have a timer release a weight which is attached to left wing by a string. This will produce same reaction as if the motor was running. The thrust line should go through C. G. or slightly above it. We sure would appreciate hearing from you if you are experimenting with "wings."



"CLIMBING" by F. Zaic

THERMALS

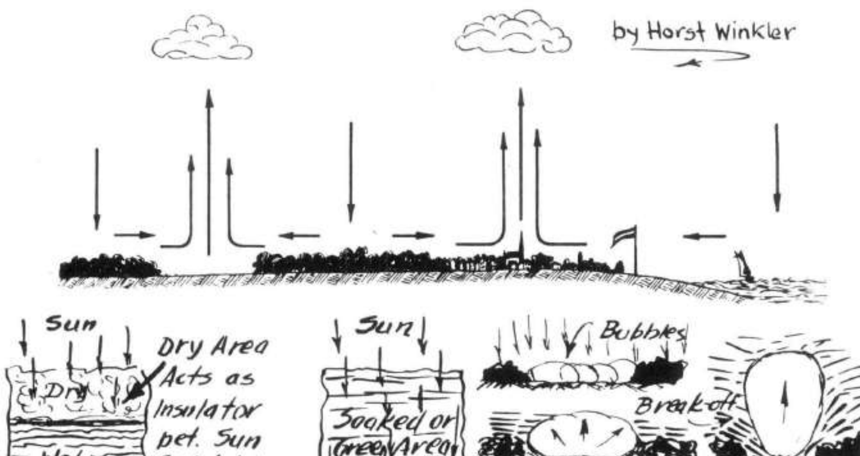
Sun is the cause of thermals, and thermals are the cause of experts. Of the two facts, we are primarily interested in the first one, how the sun manufactures thermals. The second may become evident to you soon enough if you practice what we preach. Now to thermals.

The story begins early in the morning, while the sun is still resting behind the horizon. The ground is covered with dew, and water vapor in the air has almost reached the saturation point, and in valleys and gullies the mist is thick. Soon the rosy tinted sky over the eastern horizon heralds the rising sun. Then comes the sun itself and soon its warm rays are dispersing the damp coolness of the night. Higher and higher climbs the sun, and warmer and warmer becomes the day as the rays of the sun are more direct. And before we know it the blue skies are filled with peaceful looking white billowy clouds. Little do we realize the enormous power used used during the intricate process of their manufacture as we watch them drift slowly away.

It is during the cloud forming process that the thermals are made. But before we go on we have to understand three forms of heat transfer, or how the heat is taken from spot and brought to another. In the Physics text books you will find them listed as conductivity, convection and radiation. Heat transfer by conductivity is self explanatory. If we were to heat one end of a metal rod, the heat will spread towards the other end. By convection the heat is transferred by air. For example, the air above a stove is warmed which causes it to expand and become lighter than the cooler surrounding air, so that it rises upward and carries the heat with it.

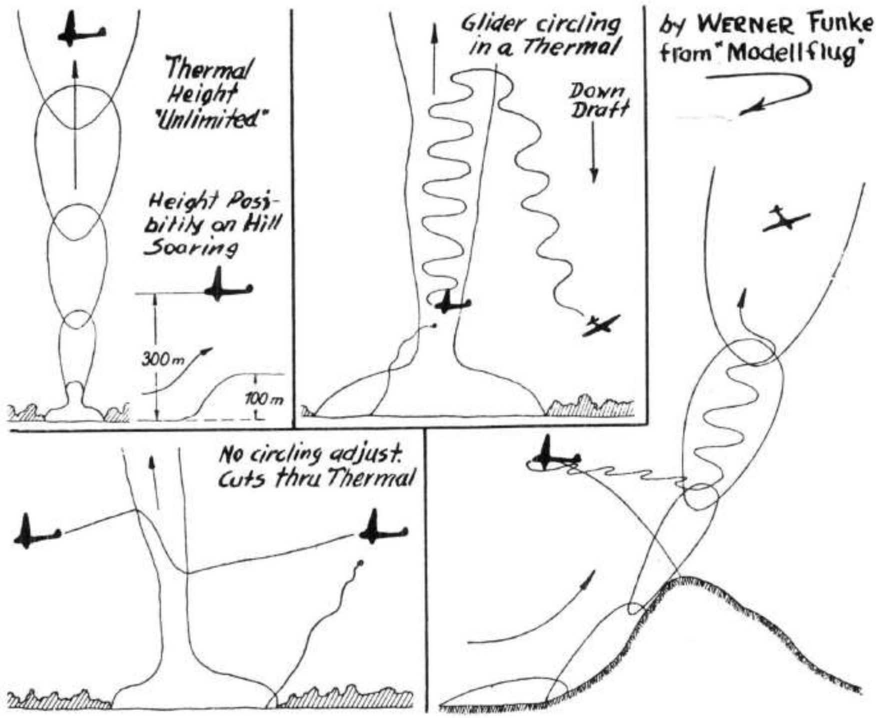
Transfer by radiation is a bit harder to understand as it is in the same class as electricity and light. The rays from the sun come to us at the speed of 186,000 miles per second, and pass through the outer empty space, and then through our own atmosphere, and eventually striking the ground and stirring up its molecules into electronic dance. The air itself does not seem to have enough substance to absorb the sun rays, but the ground does.

Although the sun sprays its radiation equally over the ground, the time required to warm it up depends on the condition of the terrain. Water, marshes and tree covered earth will absorb a tremendous amount of heat with very slight increase in their temperature as the heat is transferred throughout the medium. The presence of water in green vegetation likewise requires more heat to raise the temperature than if it were dry. While plowed and ripened fields, flat sand or similar areas, buildings and many other dry terrain need much less heat to increase or raise their temperature. The heat remains on the upper surface and is only slightly transferred further downward. So here we have conditions which prelude thermal activities, a difference in temperature close together.



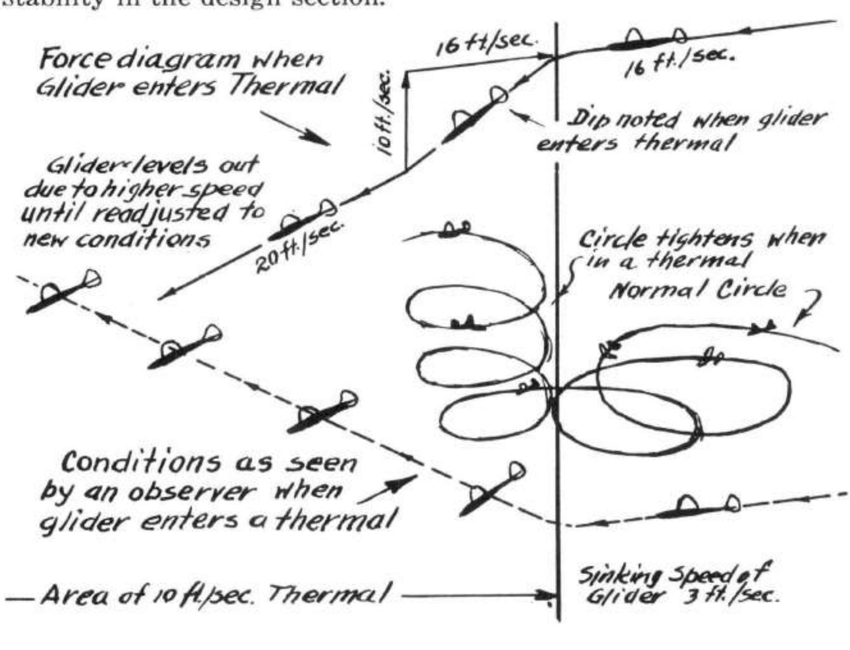
As the air above a good "heat reflector" is being warmed up it begins to expand. At first the expansion takes place very close to the ground; like bubbles on bottom of a kettle before water begins to boil. Then one bubble joins another and so on until the bubble reaches considerable size, but it is still held earthbound by the cooler air around it. However, the bubble finally has enough balloon like buoyancy to break through. As it leaves the ground, the cooler air which is over poor "heat reflector," blows in to take the place of the escaping bubble. The process continues and the bubbles are sometimes released in a definite time period. As they float upward they may contact the preceding one so that there may be a continuous upward movement.

While the ground was warming up the air above it, the dew and the mist evaporated. That is, the increase in temperature raised the saturation point so that the water vapor took its invisible gaseous form. As the warm air bubbled upward it naturally took along this water vapor. But as the warm air kept rising it was slowly being robbed of its heat by the surrounding cool air. With no means to keep it warm, the rising air eventually becomes as cold as the air around it. When this happens the water vapor again reaches its saturation point and mist is formed. More vapor is brought up by the warm air so that eventually there is enough mist or fog to be evident to us on the ground as a cloud. The size of the cloud depends on the thermal activity over a particular area, and general weather conditions. Wind will naturally tend to scatter or mix hot and cold air so that chances of forming a large cloud are slimmer. The part of the cloud building process which we use is the upward moving column of warm air.

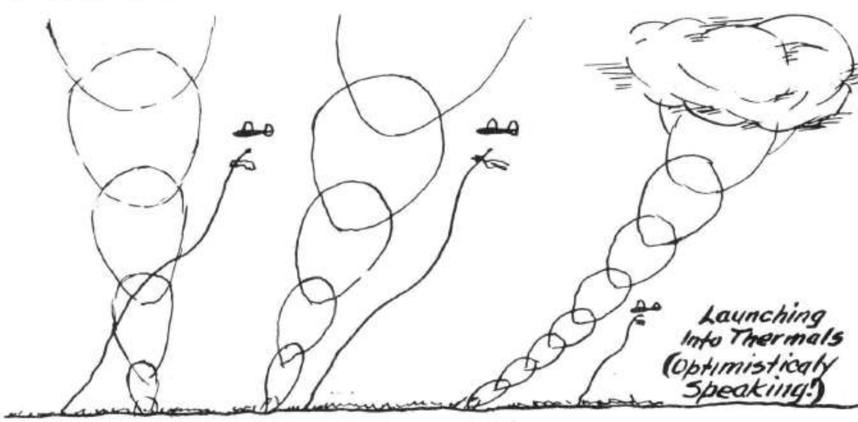


If it takes a glider 1 minute to glide down from 100 ft. its sinking speed is $1\frac{1}{2}$ ft. per second. So that if such a glider blunders into a thermal which is rising $1\frac{1}{2}$ ft. per second we can see that the glider will remain at the altitude at which it hit the thermal. If the vertical speed of the thermal is more than $1\frac{1}{2}$ ft. per second the glider will rise, and if it is less the glider will sink. This fact, the rise and fall of the glider due to thermals, should be evident to all.

When a model gets into a mild thermal the situation passes unnoticed until we begin to realize that minutes are piling up and the model is still gliding. But when the thermal is powerful we can see the action as it occurs. The model suddenly noses down and the circle tightens so that it looks like spin, and before we know it, the job is gone out of sight straight up. At one time when this happened we used to say, "Look how powerful is the thermal. The model is diving yet it keeps on going up!" However, a bit of thinking shows that this is a normal reaction. Let us say that the speed of the glider is 10 m.p.h. or 16 ft. per sec. And the rise of the thermal is 10 ft. per sec., rather on the powerful side. Placing these figures in a diagram we have a new airflow direction as shown. Rather steep. However, this condition may never be reached because as soon as the glider noses downward under the influence of the thermal the forward speed is increased so that instead of being 16 ft. per sec. it may be 20 ft. per sec. Placing this figure into the diagrams we can see the difference. With increase of speed, which varies with strength of the thermal, the turn adjustments we may have made for normal flying will be that much more powerful so that the circle will be of much smaller diameter, and chances of actual spinning are good if the model has delicate spiral stability balance. From the information given so far we can say that when the thermal is mild the reaction is almost unnoticed. But when it is powerful the glider will nose down, speed up, and tighten its turn. Since the thermals have limited dimensions the value of tight circling is self evident. Hence the reason for our stressing the spiral stability in the design section.



How to find thermals? Now, that is a question! As we have seen the thermals build-up over quick heating areas. Also that they are sort of squeezed away from the ground by the incoming cooler air. If the conditions are calm the ship should be launched so that it will be released over the point where it will have a chance to circle inside of thermal. In case there is a slight breeze the thermal will rise up at an angle as shown. The release should be made slightly downwind of the area. Since the clouds are the result or a finale of the thermals, we should find thermal action under it, providing the cloud is not old and is not passing out. Figuring on wind and height of the cloud the launch should be made to intercept the thermal as shown on diagram. But who will tell us the air speed and the height of the cloud? So we still have to hunt. Naturally the best time would be a bit after the cloud has passed the overhead spot. Powered models have a much better chance to catch thermals because of their ability to achieve altitude higher than 100 ft. maximum possible with 100 ft. of tow line. The higher the model so much better are its chances. The diameter of the thermal is greater, and the model has so many more circles during which to make contacts as it glides down.



So, as you can see the best bet is to keep on launching all over the field and observe where the thermals are best, and then concentrate on that spot. The facts we have told you may be true but thermals are invisible and we simply have to grope around for them. If we were flying a regular soarer we would feel them, and by fast action get into the thermal and start spinning to stay in it.

TIME FOR THERMALS

From experience and observation we found that the best time to go thermal hunting is between ten and one. This seems logical. It takes a few hours to heat up the air so that it may expand and bubble up. After One many of the poor "heat reflectors" are warm enough to heat the air. Without temperature differential the thermal's action stops. Of course, the action continues on into the afternoon, but the thermals are comparatively rare when compared with mid-morning when they are bubbling all over the field. They also seem to be much higher in the afternoon so that low flying models can't catch them. Just check your own experience. Also, after lunch the wind has a habit of picking up speed and scattering the thermals all over the landscape. So, if you want action, be ready to fly by ten. The chances of getting thermals after twelve are slimmer and slimmer. In the morning they are more numerous and also lower. So, if you are anxious to become an expert, come prepared to fly before ten.

When the sky is overcast so that no shadows are found, thermal conditions are just about nill. The thick blanket of clouds seem to absorb most of the sun's radiation so that not much is left over for ground to do its work of producing differences in temperature. Also, on some days when the sky is clear and sun seems extra hot the thermal conditions are not as good as one would expect. On such days you will find that the barometric pressure is low and consequently the humidity is high. The thermals that are formed do not rise very high and the models that catch them soon come down after passing the edge of the field. It seems that the high humidity, or water vapor concentration, absorb part of sun's radiation and so raising the temperature of air without depending on the ground. Of course, the ground still does its part, but it is less effective and is unable to start powerful thermals as described before. You may recall such days. They are hot and uncomfortable. You get sunburnt before you know it. You would expect big doing on such a hot day, but flights are not exceptional.

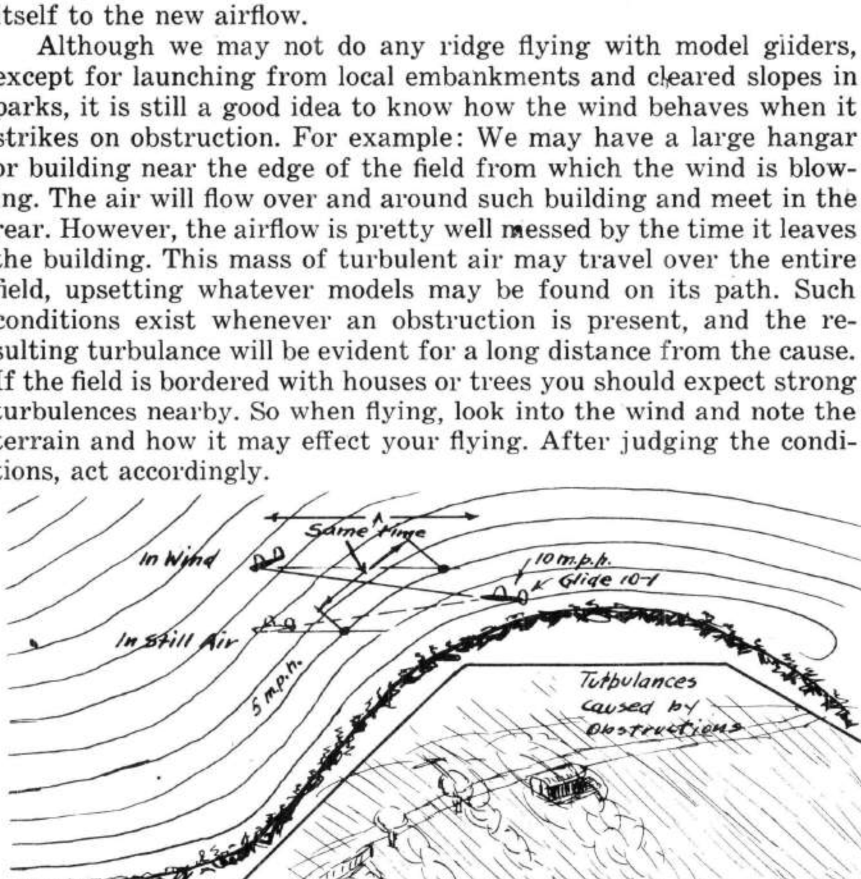
Although most of us may associate summer time as the only time that thermals are with us, the fact is that they exist all year round whenever the sun has a chance to heat the ground, and the air is calm so that whatever thermals are formed will not be scattered by the wind. So do not be surprised to find them during cold winter days. Just remember that they depend on the difference of temperature of ground area. It makes very little difference what the actual temperature may be. However, it is evident that during late autumn, winter and early spring the ground is pretty well soaked, and good "heat reflectors" are few and far between.

We could go on talking about thermals, but we believe that you now have enough information to get an idea of the trouble mother nature has to go through to make someone an expert overnight.

DEFLECTED WIND

The early man carrying gliders depended entirely on ridge deflected wind to stay up longer than the natural glide period. The action is simple; the hill causes the air to flow along its contour. By placing force diagrams in different spots we can see that the "rise" will depend on the angle and velocity of the defected wind. If the sinking speed of the glider is equal to the "rise" it will remain level. If it strikes or glides over other spots the results will depend on the particular condition. Note how the "risers" change strength at different points from the hill. Also how the glider noses down to adopt itself to the new airflow.

Although we may not do any ridge flying with model gliders, except for launching from local embankments and cleared slopes in parks, it is still a good idea to know how the wind behaves when it strikes on obstruction. For example: We may have a large hangar or building near the edge of the field from which the wind is blowing. The air will flow over and around such building and meet in the rear. However, the airflow is pretty well messed by the time it leaves the building. This mass of turbulent air may travel over the entire field, upsetting whatever models may be found on its path. Such conditions exist whenever an obstruction is present, and the resulting turbulance will be evident for a long distance from the cause. If the field is bordered with houses or trees you should expect strong turbulences nearby. So when flying, look into the wind and note the terrain and how it may effect your flying. After judging the conditions, act accordingly.

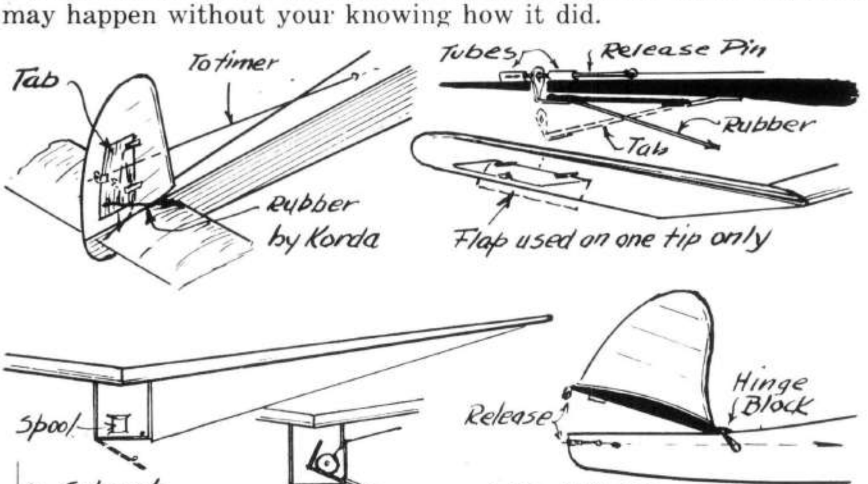


Now that you know how "uncalm" really is the air you can see why we stressed stability as much as we did. And why we place the stability factor above all others. No matter how streamlined a model may be, if it lacks stability, it is useless. Also, we can now see why heavier or faster models seem smoother. They simply pass through minor disturbances which would cause trouble to light floaters. By careful observations you should be able to learn more about the movement of air caused by thermals and obstructions.

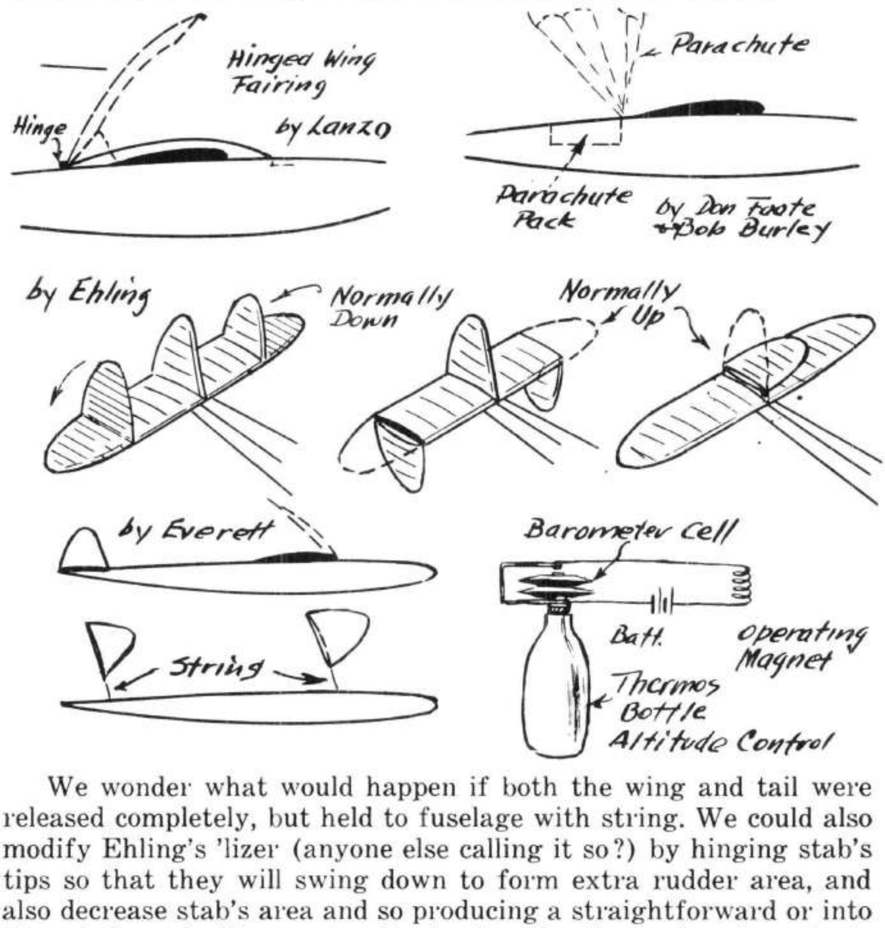
DETHERMALIZING

Who would have thought way back that some day we would be racking our brains how to bring the model "down", rather than how to bring it "up". Since the thermals are just about the same as they used to be for thousands of years, it must be the improvement in the model that is causing us so much trouble when a good model meets a friendly thermal. Since the dethermalizing era just began to blossom on eve of the second World War, we have a rather limited number of methods, and we still have to find the perfect method which would be simple but positive in operation. Shown are several methods now used and which were collected or edited by Carl Goldberg in Model Airplane News. A model may be dethermalized by having it go into a steep spiral, stall, do a falling leaf or by parachuting.

Steep spiraling is produced by forcing the wing into a steep bank in which a great deal of vertical lift is lost. This can be done by rudder or wing tip tab which would bring the dihedral of the wing into play as described under rudder section. If Schwab method is used the weight on tip will cause side slip conditions similar to those found while the model is under power so that you will have to think where to place the weight. If it helps the rudder turn adjustment you may expect prompt descent, but if it is opposite to turn adjustment you may expect much slower action. So if rudder is set for right turn, cement the thread to right wing for fast action. In any case the model is liable to come down in a nasty spiral dive if the rudder is too large, (one way to find out how it would behave under power). But the fact that the weight, spool, hangs down about 150 ft. gives the model time to recover after the spool touches the ground. When using spiral methods be prepared for unhappy landings as you are treading in the spiral stability field where anything may happen without your knowing how it did.



Carl's dethermalizer is about the best in the stalling "class". It is fairly simple and it has been thoroughly tested. You can determine your own final "upsetting" angle. Flaps do not seem to be effective enough, both on wing and on fuselage sides. Writer's tests agree with Carl's on this. Chester Lanzo's hinged wing fairing is probably the best bet in the flap field as it has both stalling and retarding tendencies. It is also easy to make and operate. It is quite possible that if the rudder were flattened against the stabilizer we might get good "falling leaf" descents. Dick Everett suggested releasing one of the wing's edges to produce a dive or a stall.

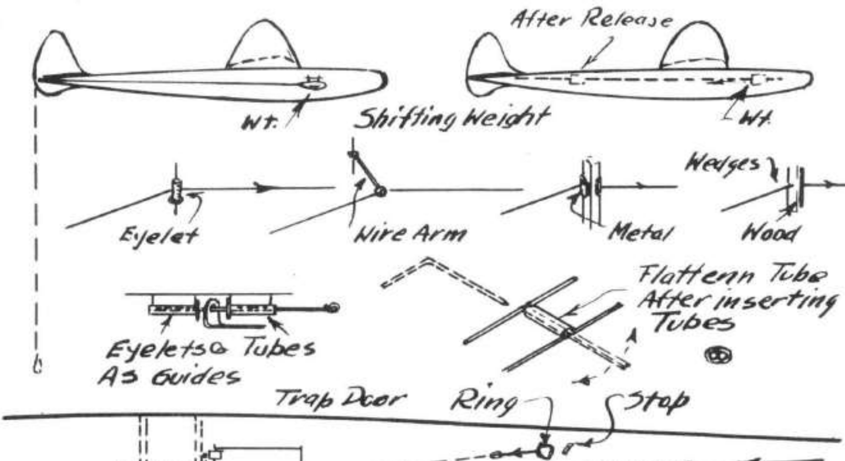


We wonder what would happen if both the wing and tail were released completely, but held to fuselage with string. We could also modify Ehling's 'lizer (anyone else calling it so?) by hinging stab's tips so that they will swing down to form extra rudder area, and also decrease stab's area and so producing a straightforward or into the wind mush. The reason for having the tips swing down is to simplify hinging due to flat lower surface an dto make sure the tips do not swing upward in case something goes wrong. The stall or mush can also be caused by shifting weight to tail. This can be easily done by tying the weight to a string and string it up front. It may be in form of a streamlined bomb, if you like, or boxed inside. We haven't tried it, but you can very easily. It sounds good, especially for gliders where balancing weight is used. In fact this shifting of weight may be the thing as it simplifies the construction of mechanism. All you need is a release on the trap door, or rack. If it is used for spiral control, tie string to tip as on Schwab's. It might be helpful to have a bit of rubber tension when using trap door to assure operation.

Parachute has its points, but as Carl pointed out, the chute may not have enough sinking speed to take care of more powerful thermals. Of course, one should never overlook its stunt value.

OPERATING MECHANISM

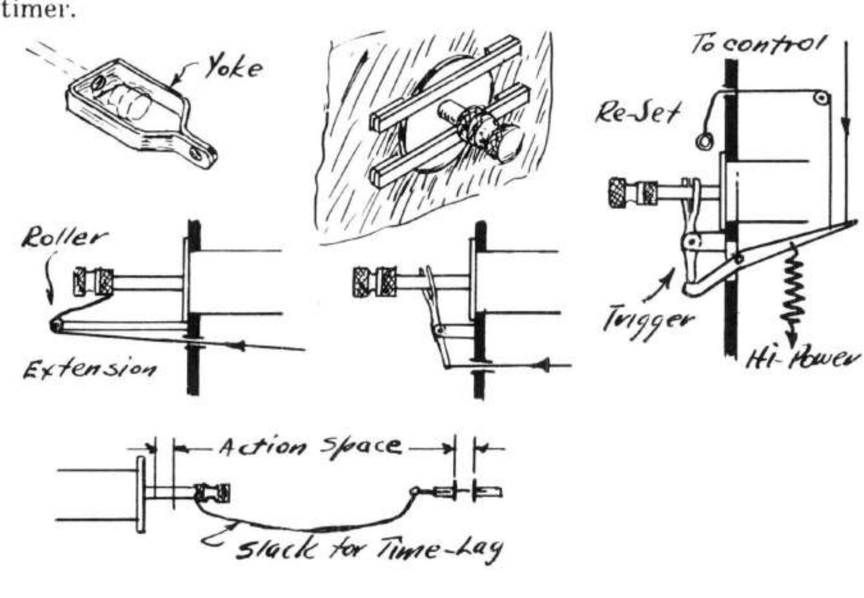
The dethermalizer will be as good as the mechanism which operates it. Therefore, every effort should be made to have positive control from the timer to the 'lizer. The timer itself has enough power to operate almost any design, but very often considerable amount of power is lost by the timer and 'lizer connection. If thread is used and has to be "bent" use eyelet rollers, bell cranks or at least metal bearing surfaces as the thread is liable to cut into the wood and wedge itself. Wire connection should also be bent with a bell crank. Trigger releases or wherever wire control is supported should be guided by eyelets or tubes to assure smooth and positive control. When a strong hinge is needed make one as shown from tubing and wire. Cloth may be used for light hinges.

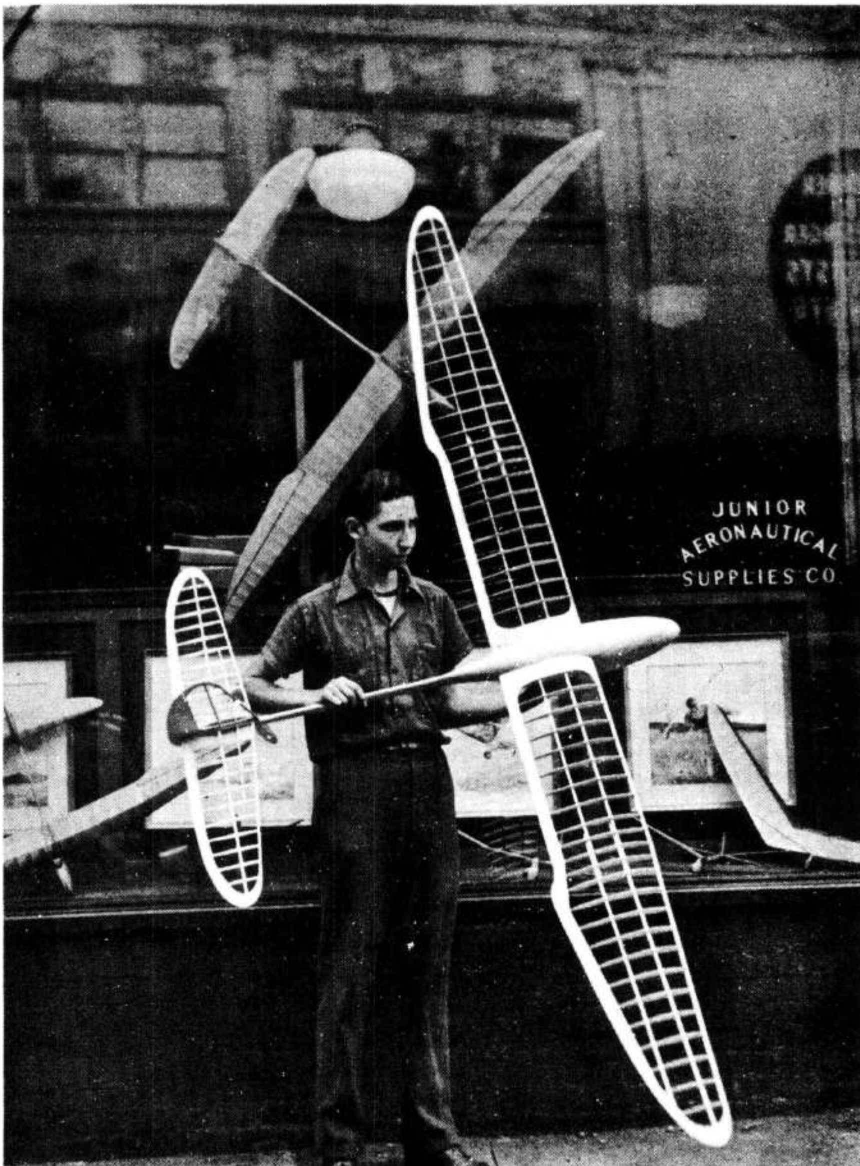


The timer should be fixed where it can be readily controlled and repaired, be in most direct line to the 'lizer, and operate by pulling the connection line if possible. (The problem here differs from the original purpose of the timer, to cut off current). When the fuselage design permits, the timer may be fixed inside, close to one side, and serviced via a trap-door. The timer can be set by remote control as shown with aid of "U" yoke to which control line is also fixed. In fixing the timer remember that it will be rough work so use two bulkheads for rigidity. Ordinary cement will suffice providing anti-pull strips are cemented over the face as shown. If obtainable, small nuts and bolts will be ideal for the job. Do not forget to have a small ring at the free end of remote control string which you can slip over a stop to keep the timer "set" without attention. It is so much easier and quicker to slip off the ring instead of a thread loop. If at all possible mount the timer internally as it will simplify the work beyond belief.

When the timer is mounted in manner similar to ignition control we complicate the mechanism as the power "stroke" is outside of the fuselage. To bring the power to the 'lizer we can mount an extension as shown, use levers or have the timer set off a trigger which would release some other power for action. See illustrations. Since timers differ in design of "power stroke" you will have to use your judgment which control is best. In some cases the control stroke may be short, while in others long. If short movement is needed on full stroke, provide for lag with slack. Whenever possible use wire for control line as thread has "give" which complicates fine adjustments as you may well know.

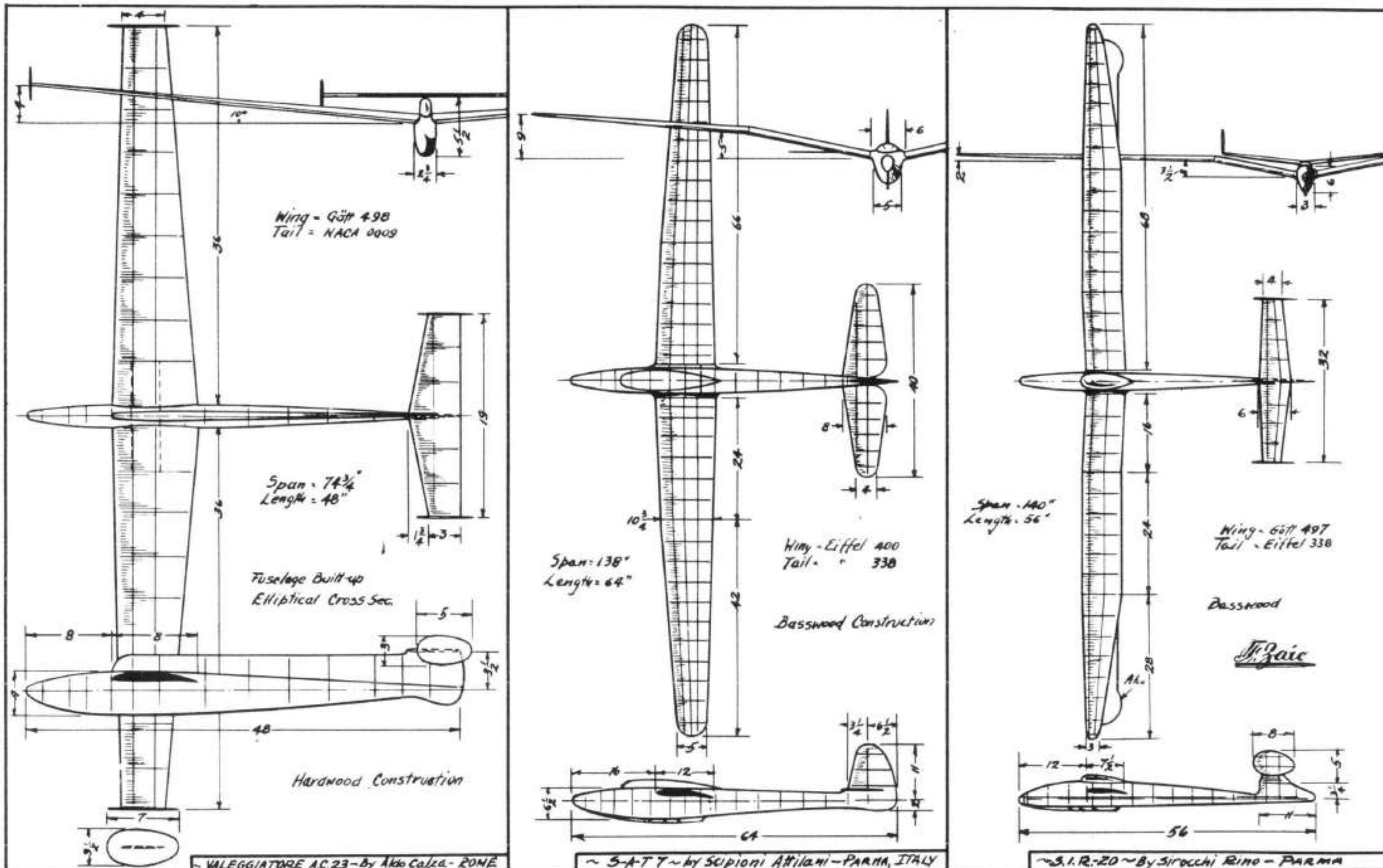
The timer should be mounted on the unit on which the 'lizer is fixed. If the 'lizer is on fuselage, mount timer on it. If on wing have timer on it. In some cases it might pay to mount the timer in a streamlined blister. Also, try to operate with trigger control to avoid fine adjustment with the control line. It is much easier to make accurate and exact mechanism at the timer then by the 'lizer. Besides a trigger may release more sudden power than possible by the timer.

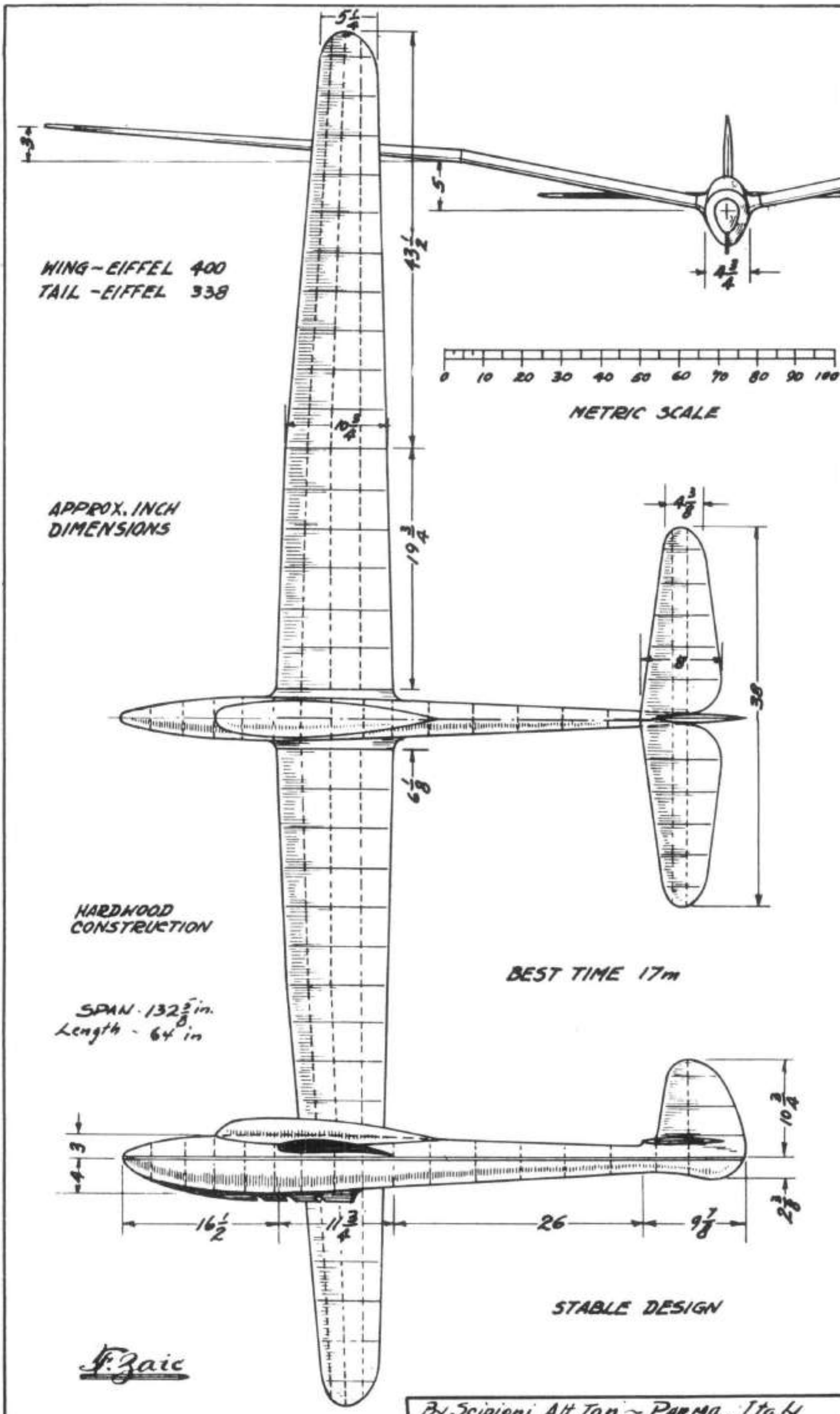


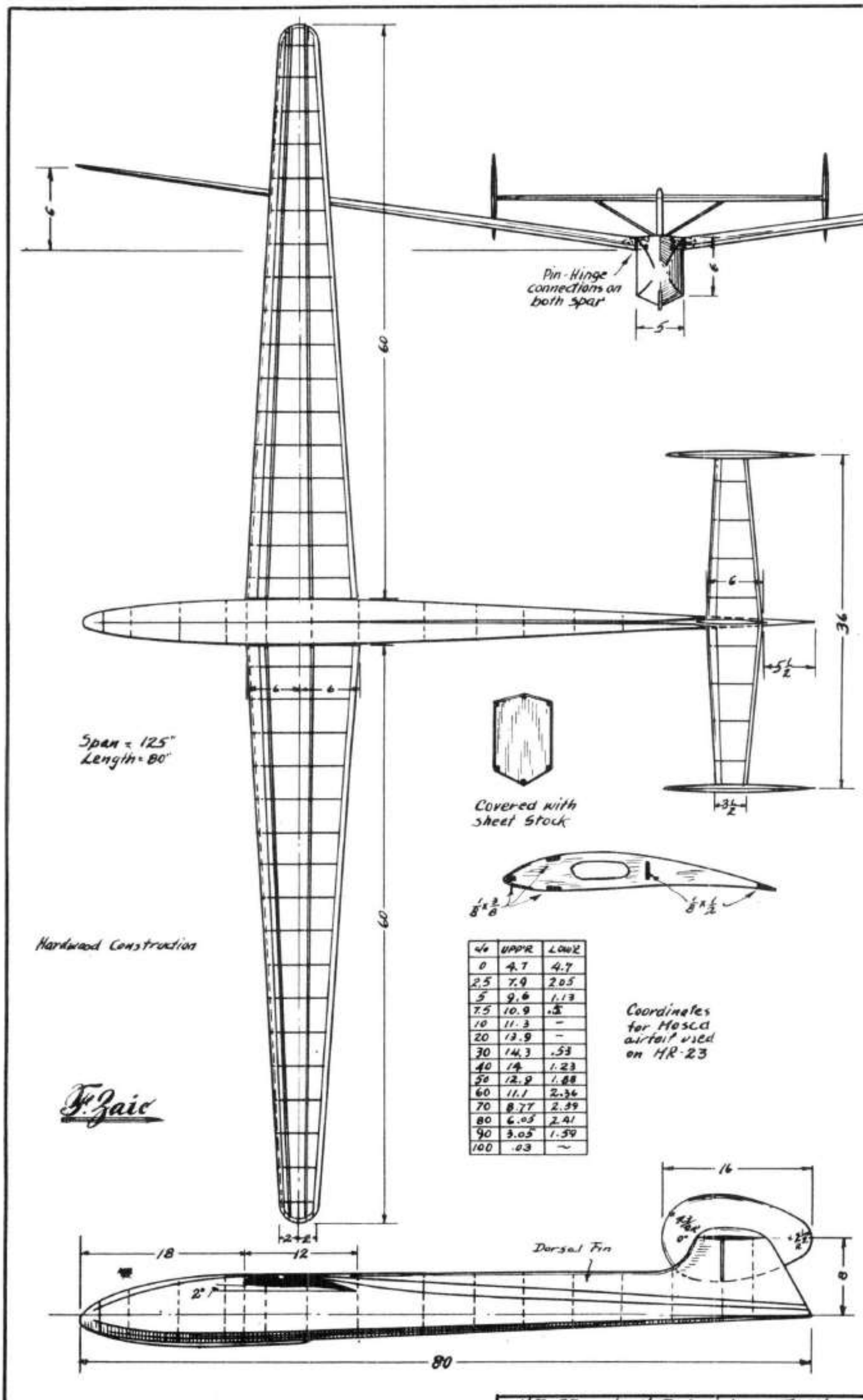


THERMIC "100" *built by* **B. SCHOENFELD**

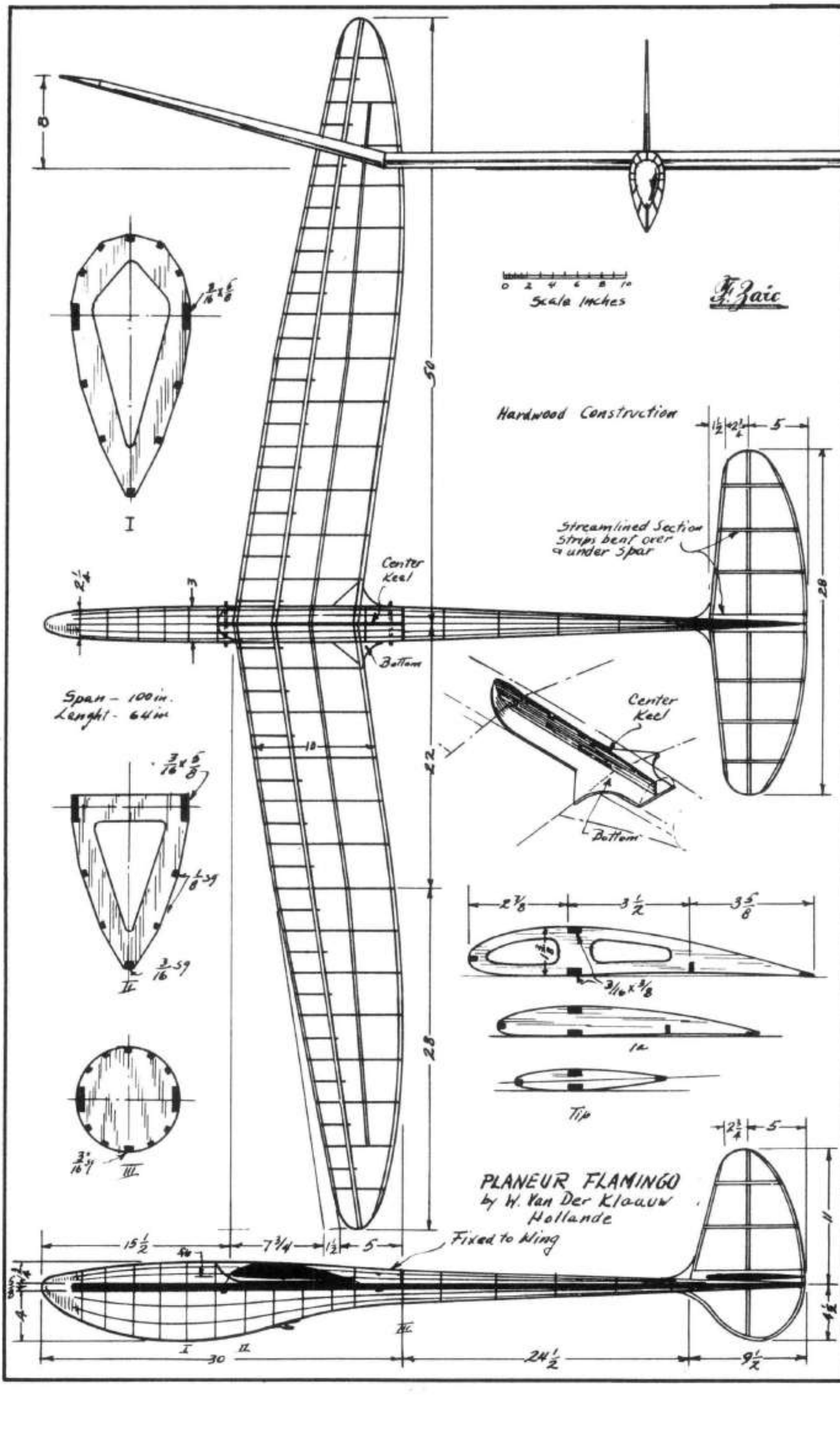
PLANS

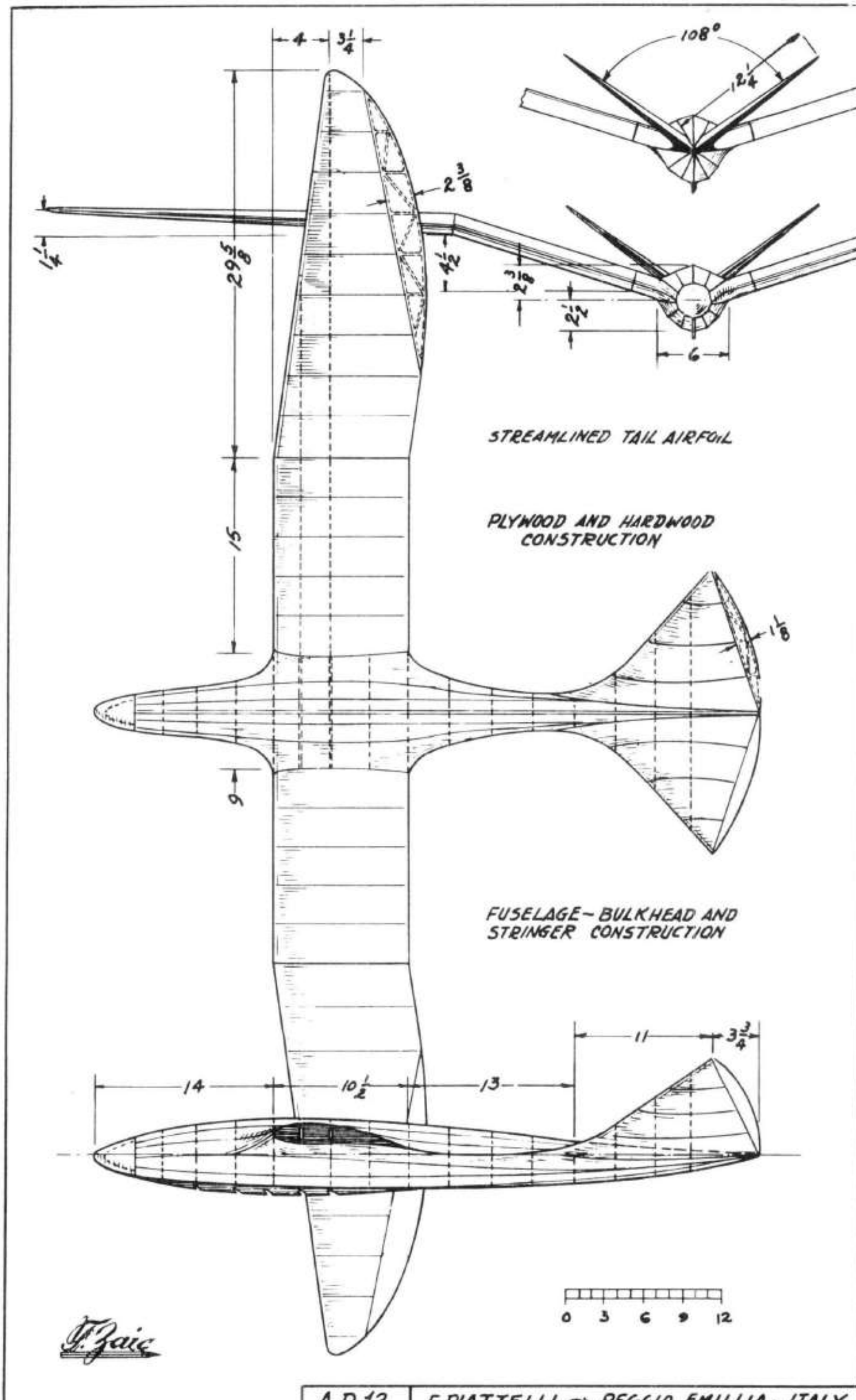

Wing - Gött 498
Tail = NACA 0009
Span - 74¾"
Length - 48"
Fuselage Built-up
Elliptical Cross Sec.
Hardwood Construction
~ VALEGGIATORE A.C.23 ~ By Aldo Calza - ROME
Span: 138"
Length: 64"
Wing - Eiffel 400
Tail - " 338
Basswood Construction
~ S-A-T-T ~ by Scipioni Attilani - PARMA, ITALY
Span - 140"
Length - 56"
Wing - Gött 497
Tail - Eiffel 338
Basswood
F. Zaic
~ S.I.R.-20 ~ By Sirocchi Rino - PARMA


WING - EIFFEL 400
TAIL - EIFFEL 338
APPROX. INCH DIMENSIONS
HARDWOOD CONSTRUCTION
SPAN · 132 5/8 in.
Length - 64 in
METRIC SCALE
0 10 20 30 40 50 60 70 80 90 100
BEST TIME 17m
STABLE DESIGN
5 1/4
43 1/2
19 3/4
10 3/4
6 1/8
4 3/4
4 3/8
38
16 1/2
11 3/4
26
9 7/8
10 3/4
2 3/8
F. Zaic
By Scipioni Alt Tan ~ Parma, Italy.

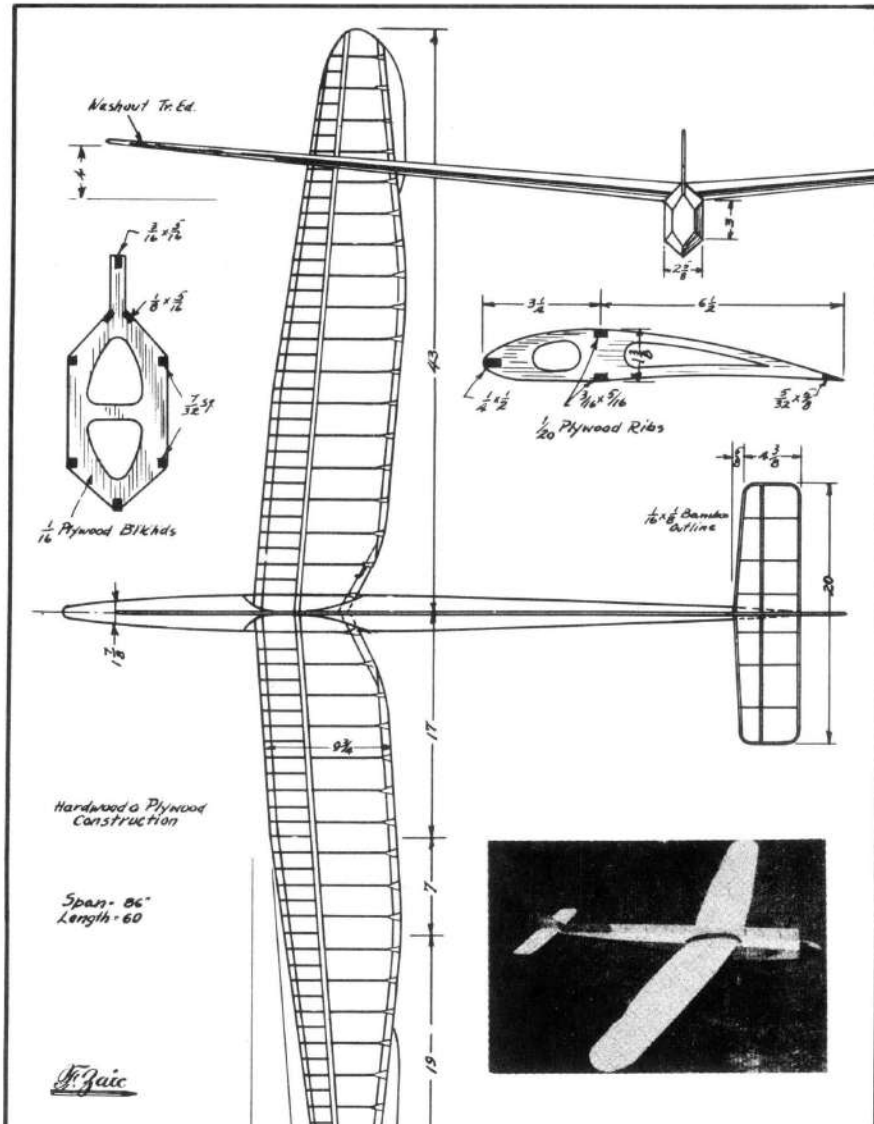


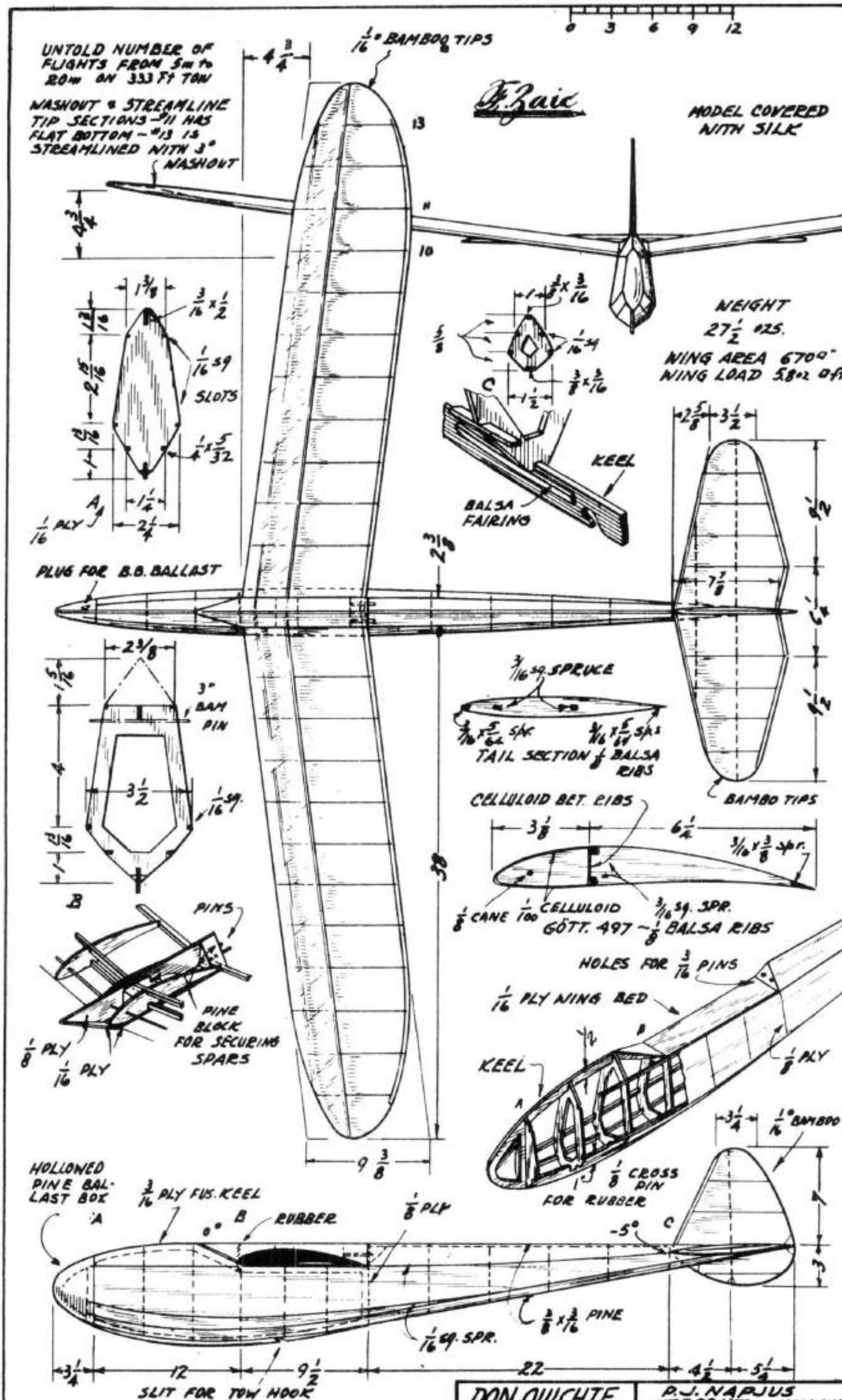
%	UPP'R	LOW'R
0	4.7	4.7
2.5	7.9	2.05
5	9.6	1.13
7.5	10.9	.5
10	11.3	–
20	13.9	–
30	14.3	.53
40	14	1.23
50	12.9	1.88
60	11.1	2.36
70	8.77	2.39
80	6.05	2.41
90	3.05	1.59
100	.03	~

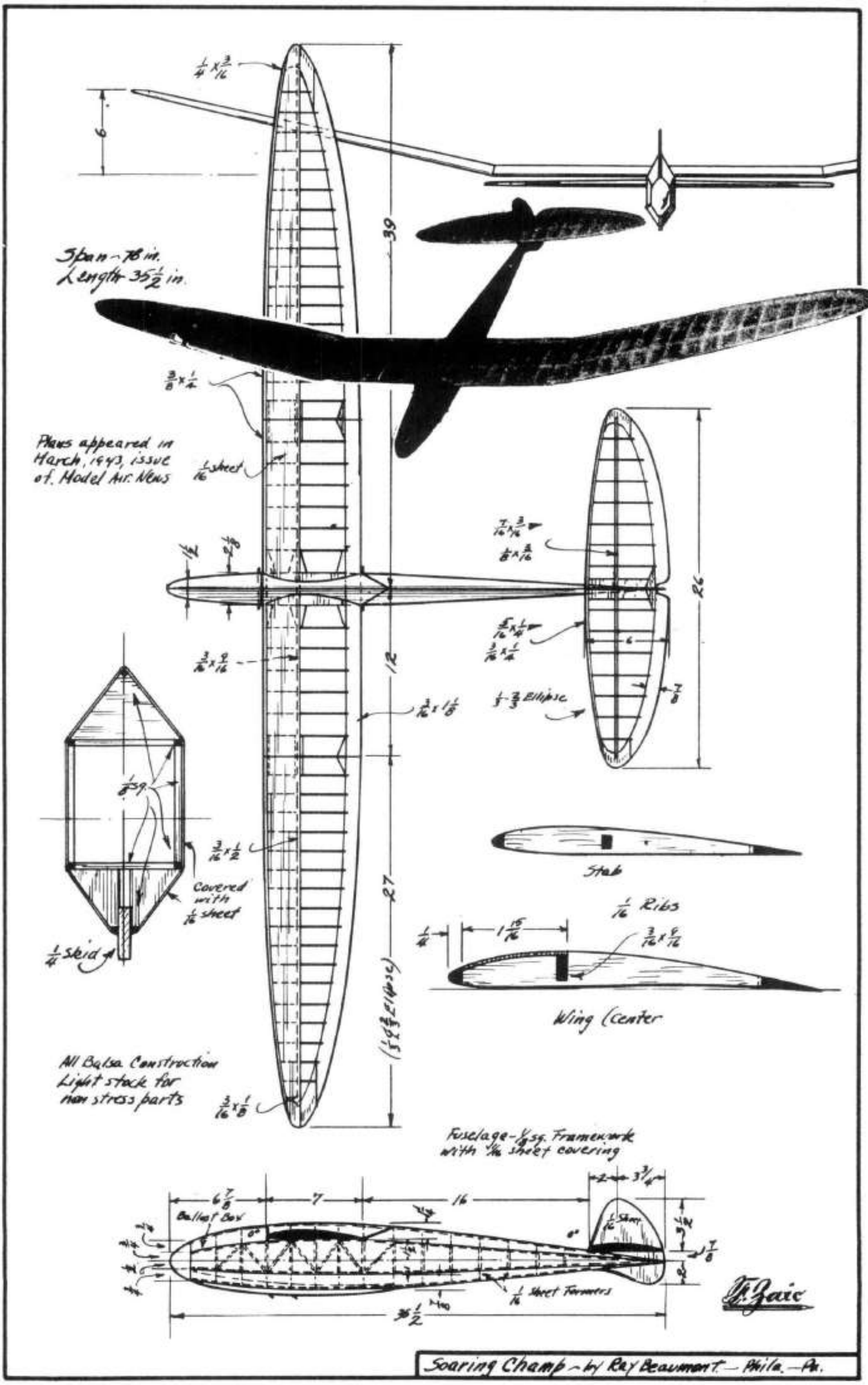

Scale Inches
F. Zaic
Hardwood Construction
Streamlined Section Strips bent over & under Spar
Center Keel
Bottom
Span - 100 in.
Lenght - 64 in
Tip
PLANEUR FLAMINGO
by W. Van Der Klaauw
Hollande
Fixed to Wing

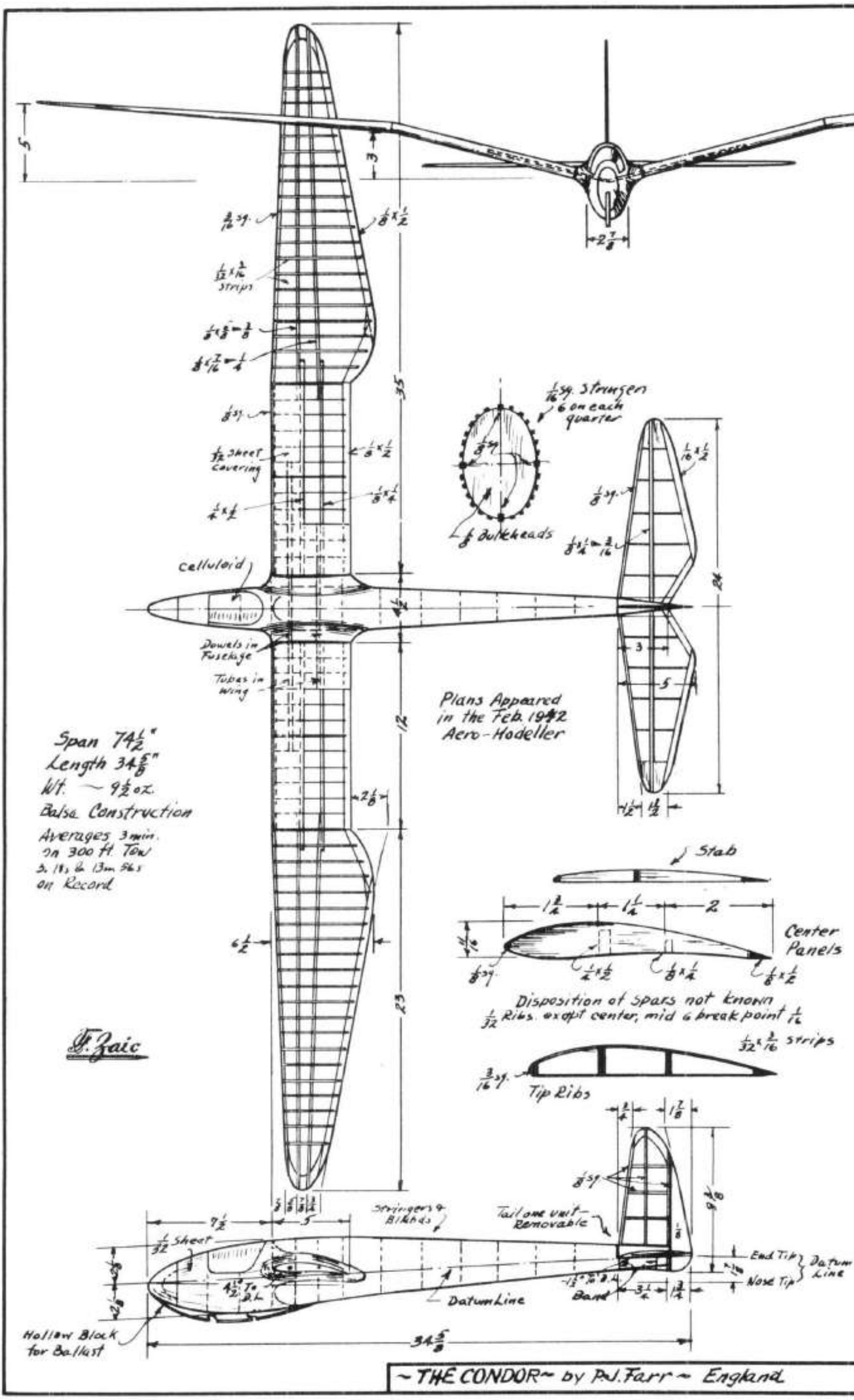


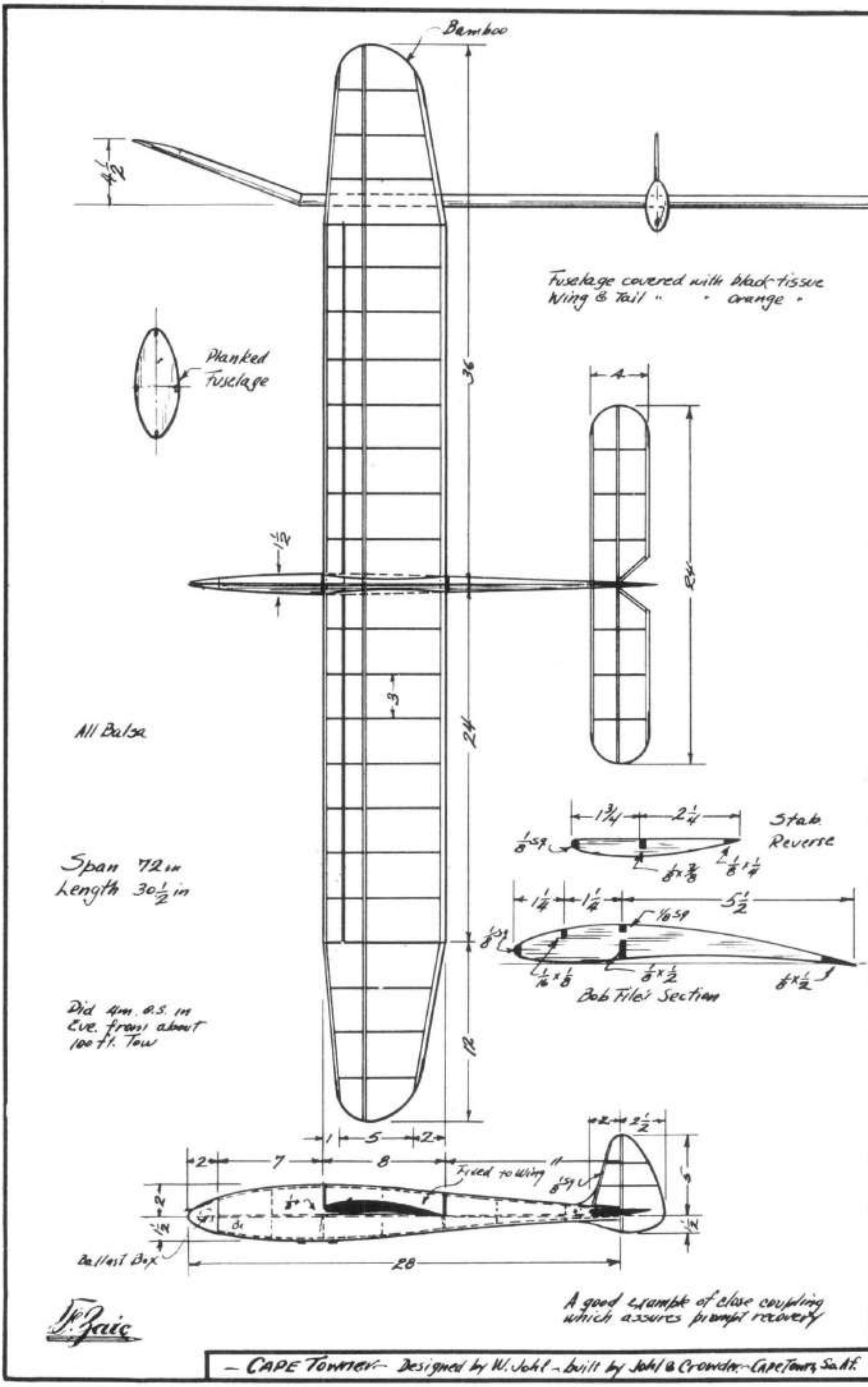
108°
12 1/4
2 3/8
4
3 1/4
1 1/4
29 5/8
4 1/2
2 3/8
2 1/2
6
STREAMLINED TAIL AIRFOIL
PLYWOOD AND HARDWOOD CONSTRUCTION
15
1 1/8
9
FUSELAGE - BULKHEAD AND STRINGER CONSTRUCTION
11
3 3/4
14
10 1/2
13
0 3 6 9 12
F. Zaic
A.P. 13
F. PIATTELLI → REGGIO EMILLIA - ITALY


Washout Tr. Ed.
1/16 Plywood Blkhds
1/20 Plywood Ribs
1/16 x 1/8 Bamboo Outline
Hardwood & Plywood Construction
Span- 86"
Length- 60
F. Zaic
-1931 RHON WINNER- by Oskar Gentsch-Germany

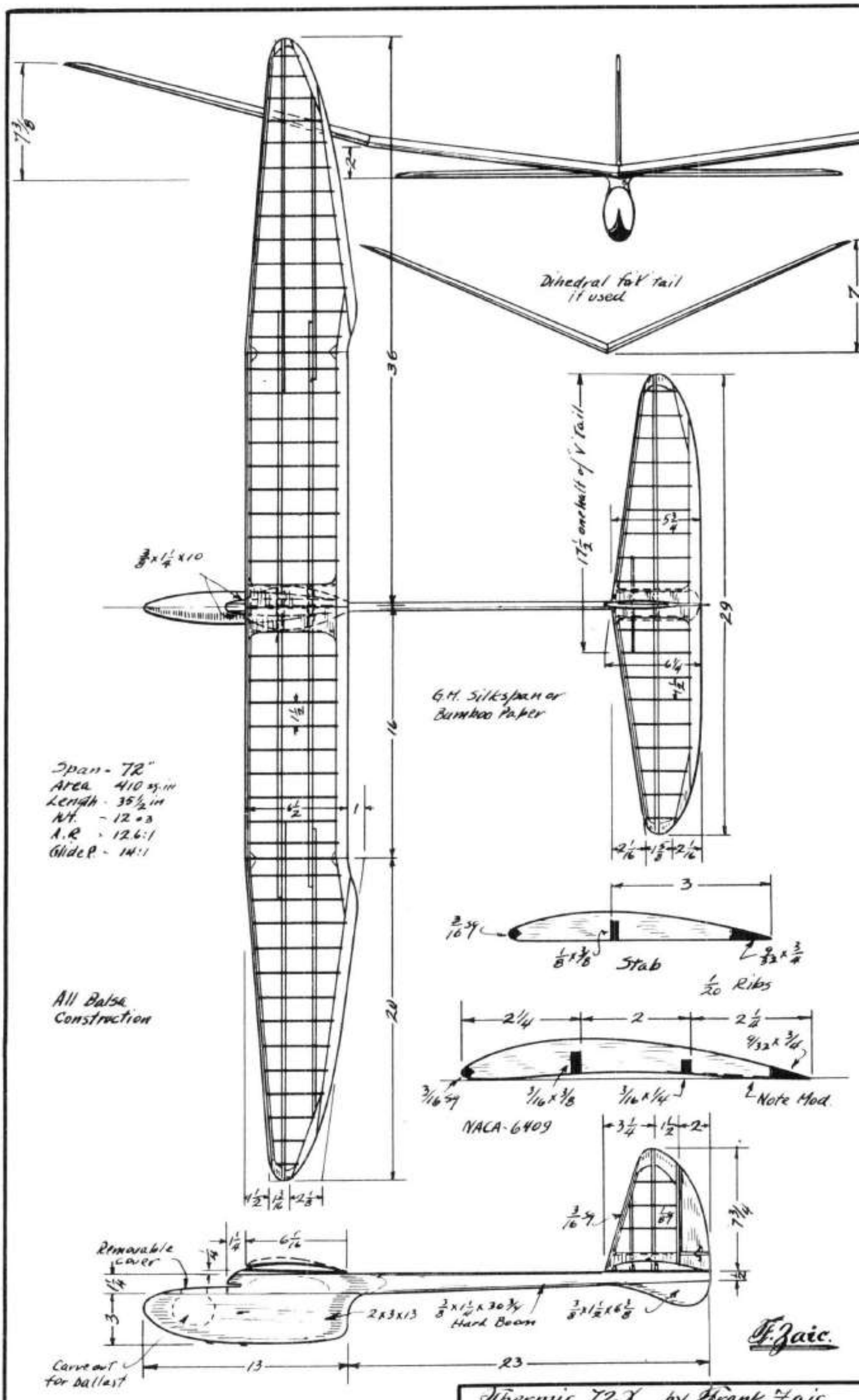

UNTOLD NUMBER OF FLIGHTS FROM 5m to 20m ON 333 Ft TOW
WASHOUT & STREAMLINE TIP SECTIONS — #11 HAS FLAT BOTTOM — #13 IS STREAMLINED WITH 3° WASHOUT
1/16" BAMBOO TIPS
MODEL COVERED WITH SILK
WEIGHT 27 1/2 OZS.
WING AREA 670□"
WING LOAD 5.8oz □ft.
SLOTS
1/16 PLY
PLUG FOR B.B. BALLAST
KEEL
BALSA FAIRING
3/16 SQ. SPRUCE
TAIL SECTION 1/8 BALSA RIBS
BAMBO TIPS
CELLULOID BET. RIBS
1/8 CANE
1/100 CELLULOID
3/16 SQ. SPR.
GÖTT. 497 ~ 1/8 BALSA RIBS
3" BAM PIN
PINS
PINE BLOCK FOR SECURING SPARS
1/8 PLY
1/16 PLY
HOLES FOR 3/16 PINS
1/16 PLY WING BED
1/8 CROSS PIN FOR RUBBER
1" 1/16 BAMBOO
HOLLOWED PINE BALLAST BOX
3/16 PLY FUS. KEEL
RUBBER
1/8 PLY
3/8 x 3/16 PINE
1/16 SQ. SPR.
SLIT FOR TOW HOOK
DON QUICHTE
P.J. NARJUS
UTRECHT HOLLAND

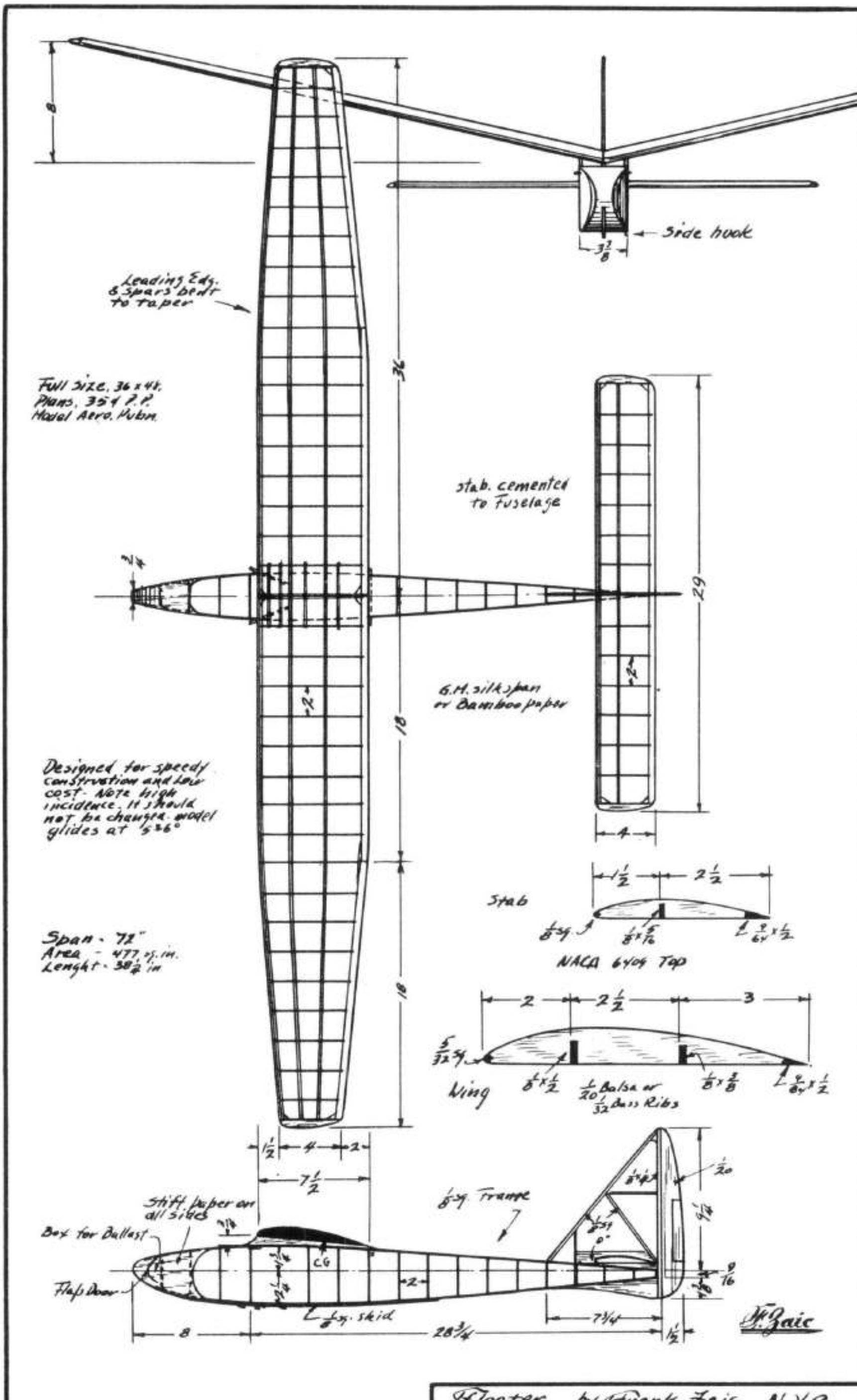

Span - 78 in.
Length - 35 1/2 in.
Plans appeared in March, 1943, issue of Model Air News
All Balsa Construction
Light stock for non stress parts
Covered with 1/16 sheet
1/4 skid
Stab
1/16 Ribs
Wing Center
Fuselage - 1/8 sq. Framework with 1/16 sheet covering
Ballast Box
1/16 Sheet Formers
Soaring Champ - by Ray Beaumont - Phila. - Pa.

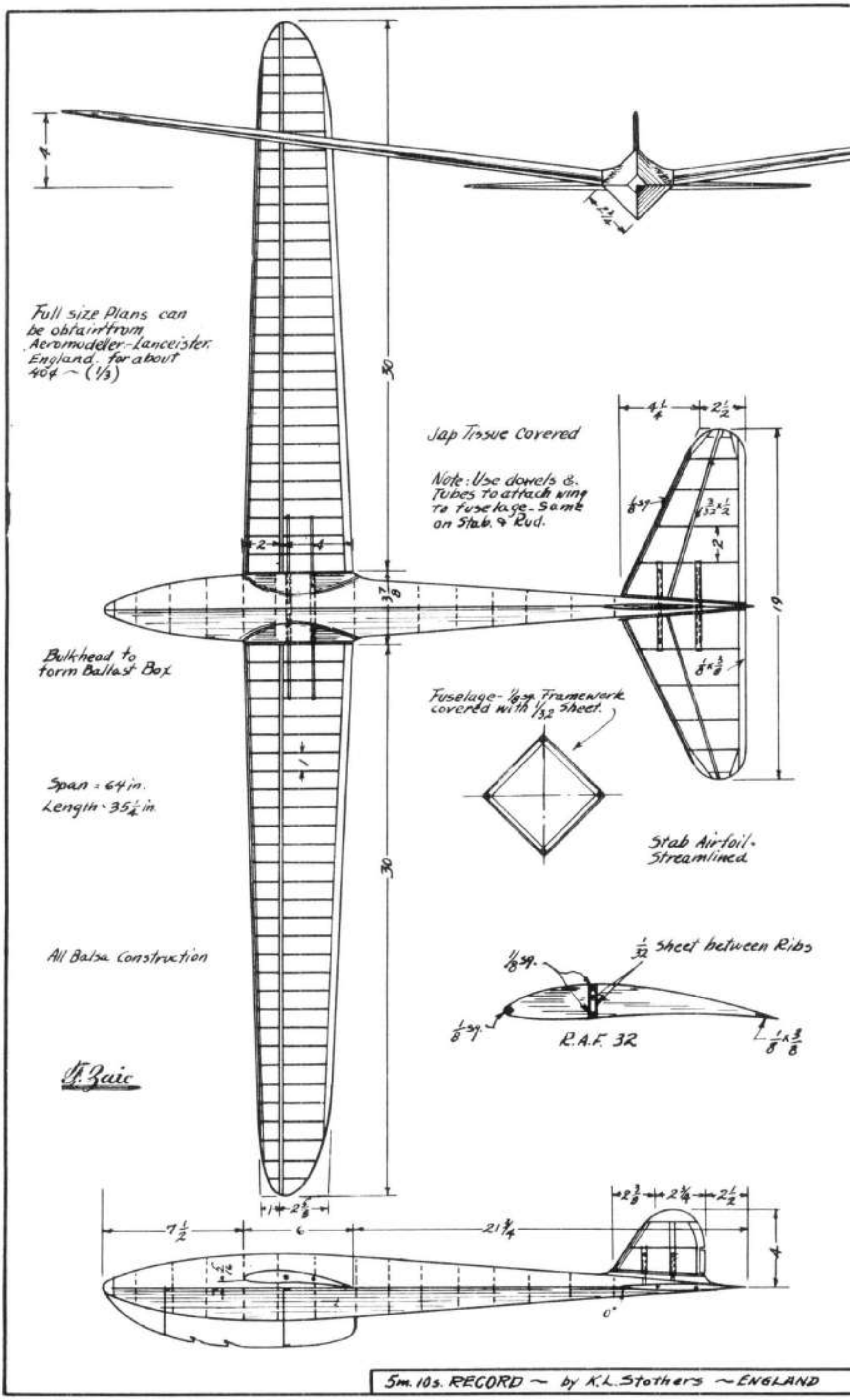

Span 74½"
Length 34⅝"
Wt. ~ 9½ oz.
Balsa Construction
Averages 3 min. On 300 ft. Tow
On Record
Plans Appeared in the Feb. 1942 Aero-Modeller
Celluloid
Dowels in Fuselage
Tubes in Wing
Bulkheads
Stab
Center Panels
Disposition of spars not known
Tip Ribs
Tail one unit — Removable
Stringers & Blkhds
Datum Line
End Tip
Nose Tip
Band
Hollow Block for Ballast
F. Zaic
~ THE CONDOR ~ by P.J. Farr ~ England

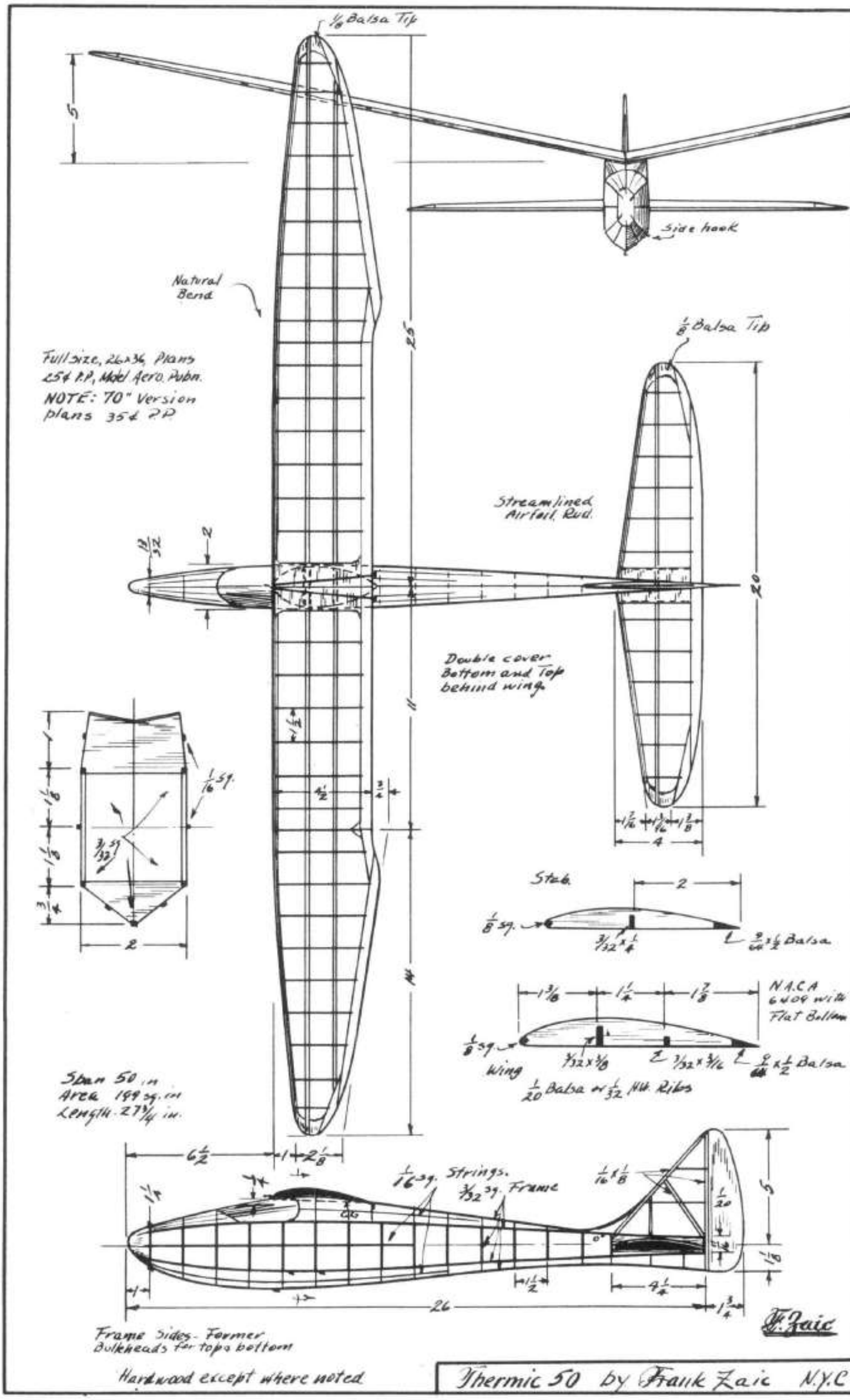


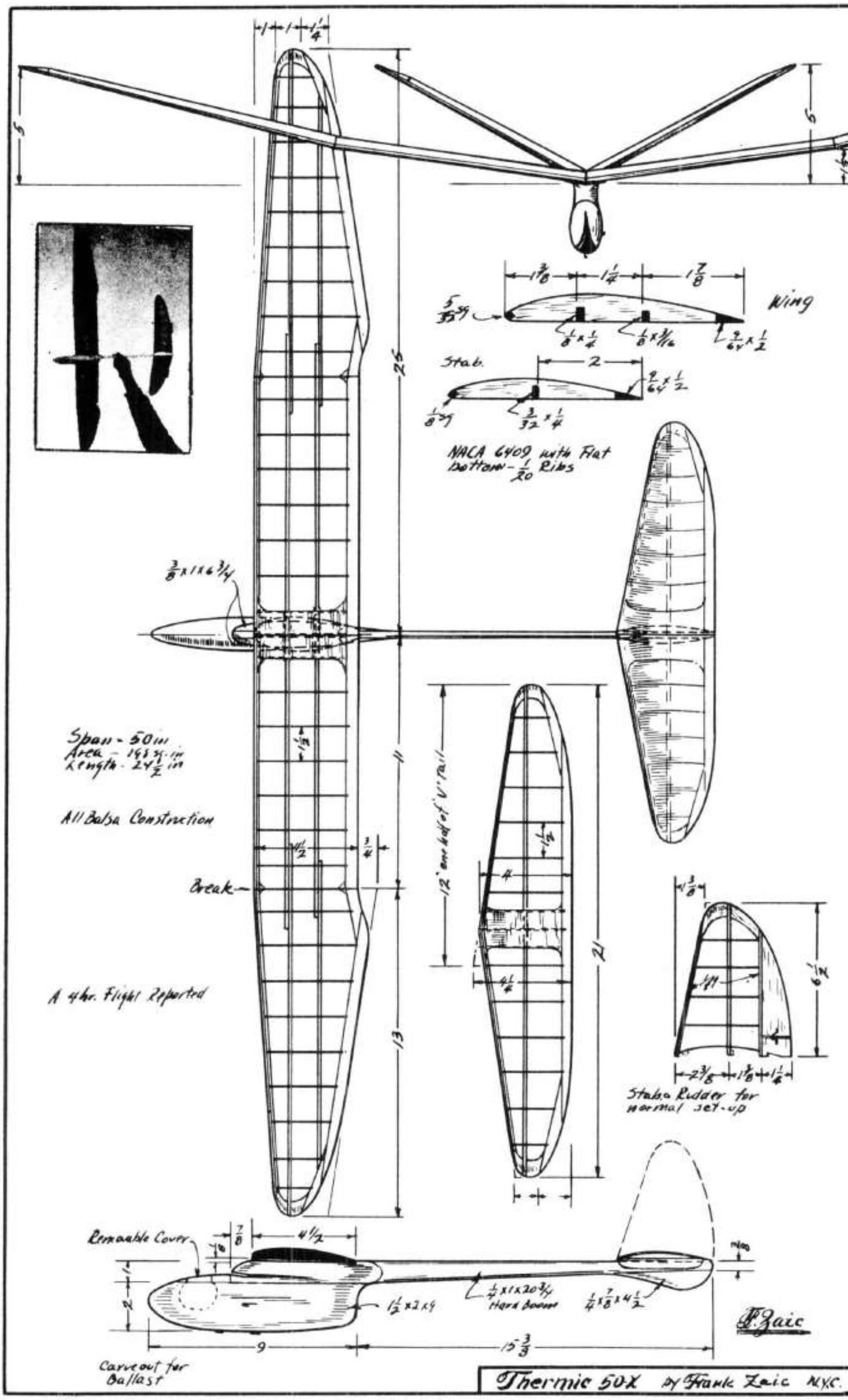
Bamboo
Fuselage covered with black tissue
Wing & Tail " " orange "
Planked Fuselage
All Balsa
Span 72 in
Length 30½ in
Did 4m. O.S. in Eve. from about 100 ft. Tow
Stab. Reverse
Bob File's Section
Fixed to Wing
Ballast Box
A good example of close coupling which assures prompt recovery
— CAPE TOWNER — Designed by W. Johl — built by Johl & Crowder — Cape Town, So. Af.

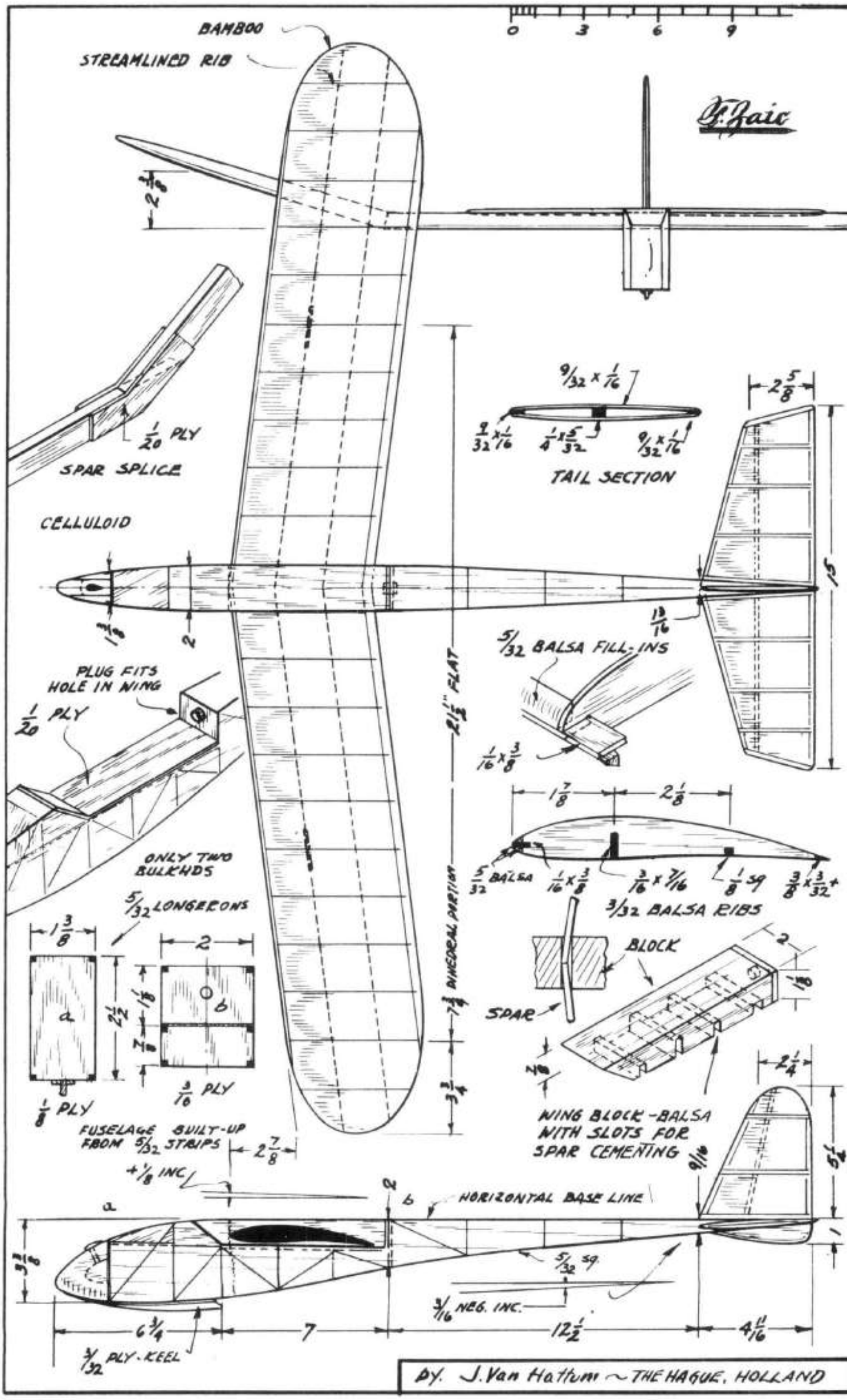

Dihedral for tail if used
7
7 3/8
2
36
16
20
17 1/2 on half of V tail
5 3/4
29
6 1/4
4 1/2
2 1/16 1 5/8 2 1/16
3/8 x 1 1/4 x 10
G.M. Silkspan or Bamboo Paper
Span - 72"
Area 410 sq. in
Length - 35 1/2 in
Wt. - 12 oz
A.R - 12.6:1
Glide R - 14:1
6 1/2
1
1 1/2
3
3/16 sq
1/8 x 3/8
Stab
9/32 x 3/4
1/20 Ribs
All Balsa Construction
2 1/4
2
2 1/4
9/32 x 3/4
3/16 sq
3/16 x 3/8
3/16 x 1/4
Note Mod.
NACA-6409
1 1/2 1 3/16 2 1/8
3 3/4 1 1/2 2
3/16 sq
1/64
7 3/4
Removable cover
1 1/4
6 5/16
3
2 x 3 x 13
3/8 x 1 1/4 x 30 3/4 Hard Beam
3/8 x 1 1/2 x 6 1/8
Carve out for ballast
13
23
F. Zaic.
Thermic 72-X by Frank Zaic

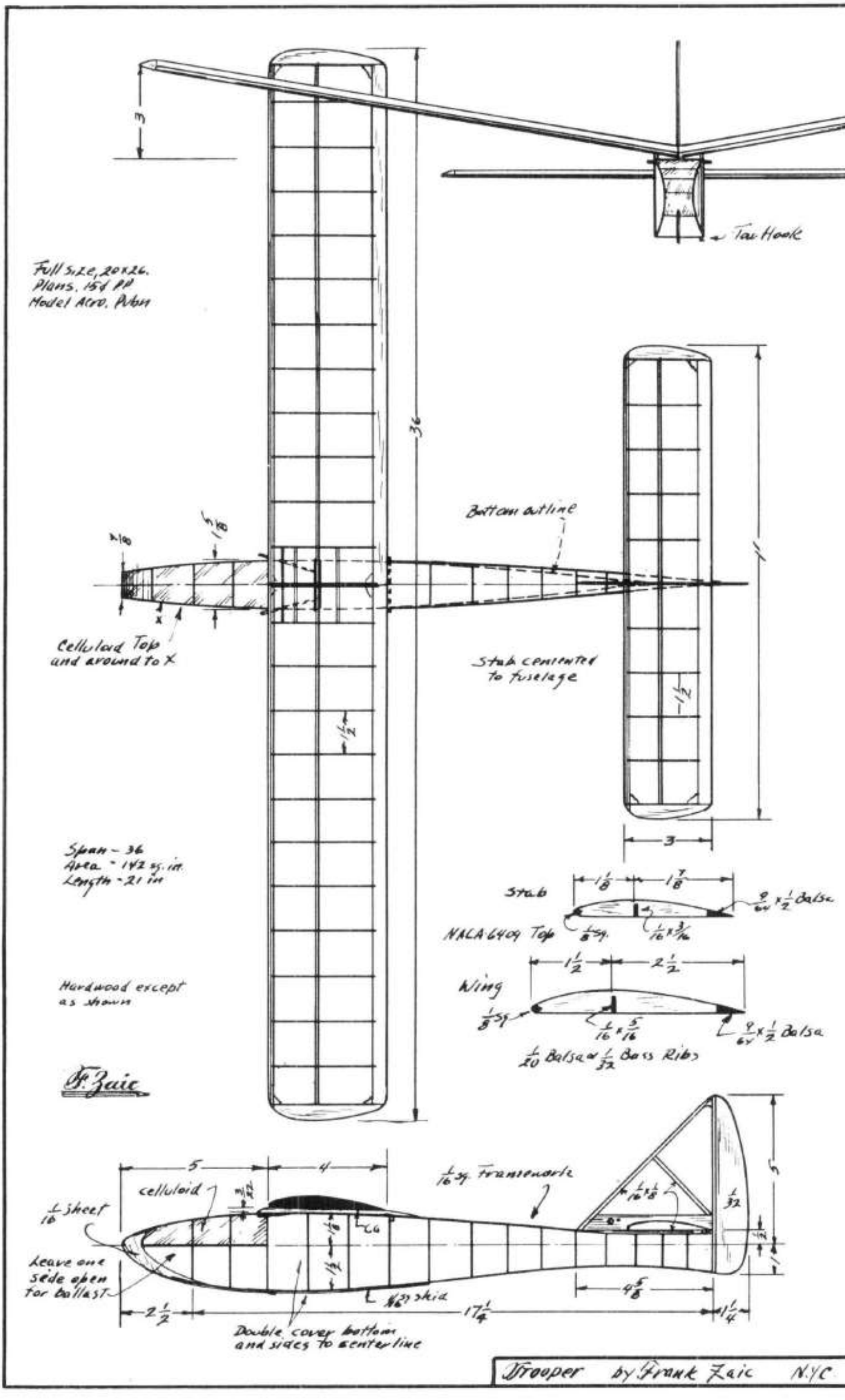

Side hook
Leading Edg. & Spars bent to taper
Full size. 36 x 48. Plans. 35¢ P.P. Model Aero. Pubn.
stab. cemented to Fuselage
G.M. silkspan or Bamboo paper
Designed for speedy construction and low cost. Note high incidence. It should not be changed. model glides at 5 to 6°
Span - 72"
Area - 477 sq. in.
Lenght - 38 1/2 in
Stab
NACA 6409 Top
Wing
1/20 Balsa or 1/32 Bass Ribs
Stiff paper on all sides
Box for Ballast
Flap Door
CG
1/8 sq. skid
1/8 sq. Frame
F. Zaic
Floater by Frank Zaic N.Y.C.

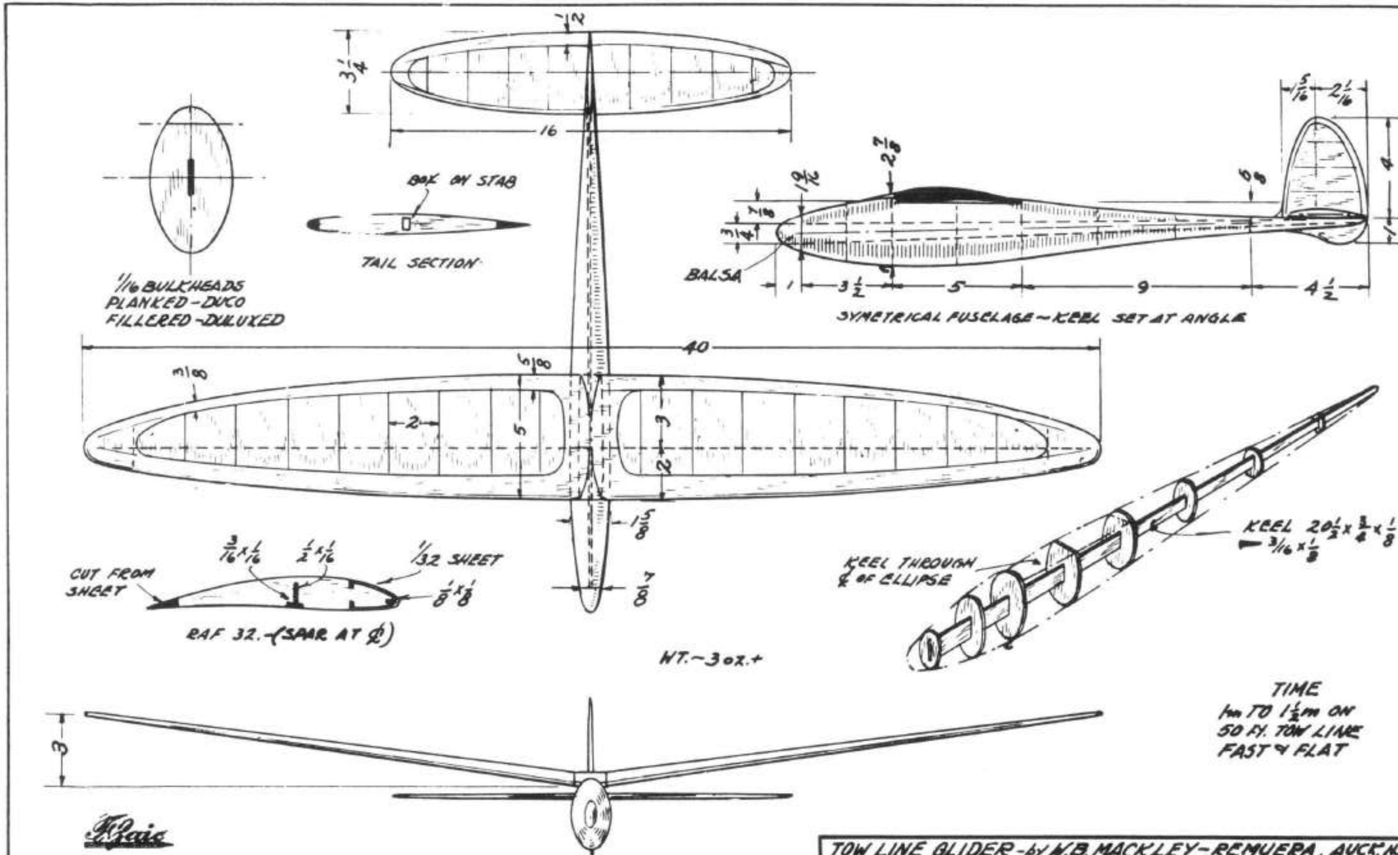

Full size Plans can be obtain from Aeromodeller - Lanceister. England. for about 40¢ ~ (1/3)
Jap Tissue Covered
Note: Use dowels & Tubes to attach wing to fuselage - Same on Stab. & Rud.
Bulkhead to form Ballast Box
Fuselage - 1/8 sq. Framework covered with 1/32 Sheet.
Span = 64 in.
Length - 35 1/4 in.
Stab Airfoil - Streamlined
All Balsa Construction
1/32 Sheet between Ribs
R.A.F. 32
5m. 10s. RECORD ~ by K.L. Stothers ~ ENGLAND

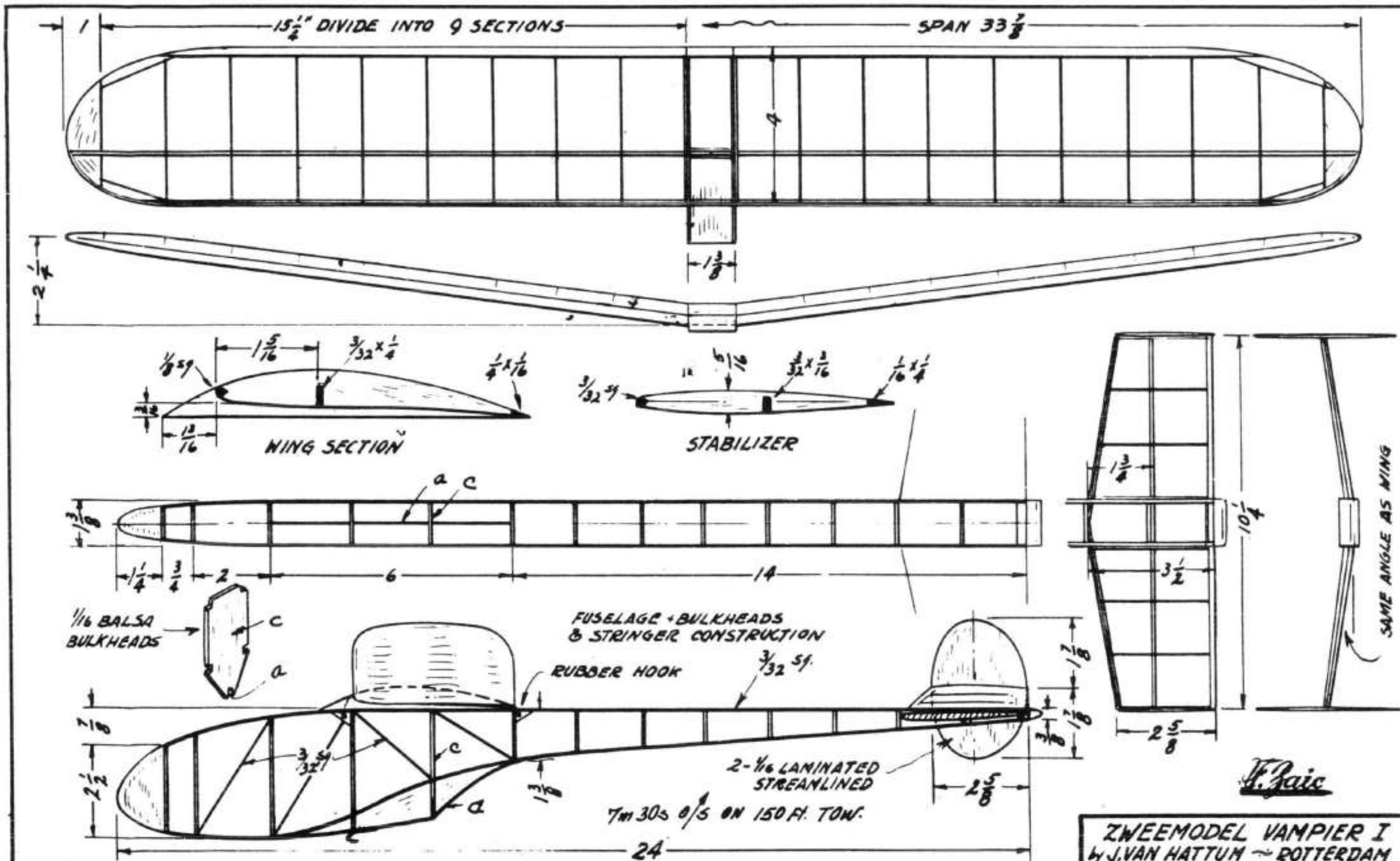

1/8 Balsa Tip
Side hook
Natural Bend
Full size, 26x36, Plans 25¢ P.P. Model Aero. Pubn.
NOTE: 70" Version plans 35¢ P.P.
1/8 Balsa Tip
Streamlined Airfoil Rud.
Double cover Bottom and Top behind wing.
Steb.
1/8 sq.
3/32 x 1/4
9/64 x 1/2 Balsa
N.A.C.A 6409 with Flat Bottom
1/8 sq.
Wing
3/32 x 3/8
3/32 x 3/16
9/64 x 1/2 Balsa
1/20 Balsa or 1/32 Hd. Ribs
Span 50 in
Area 199 sq. in
Length 27 3/4 in.
1/16 sq. Strings.
3/32 sq. Frame
1/16 x 1/8
CG
Frame Sides - Former Bulkheads for tops bottom
Hardwood except where noted
F. Zaic
Thermic 50 by Frank Zaic N.Y.C

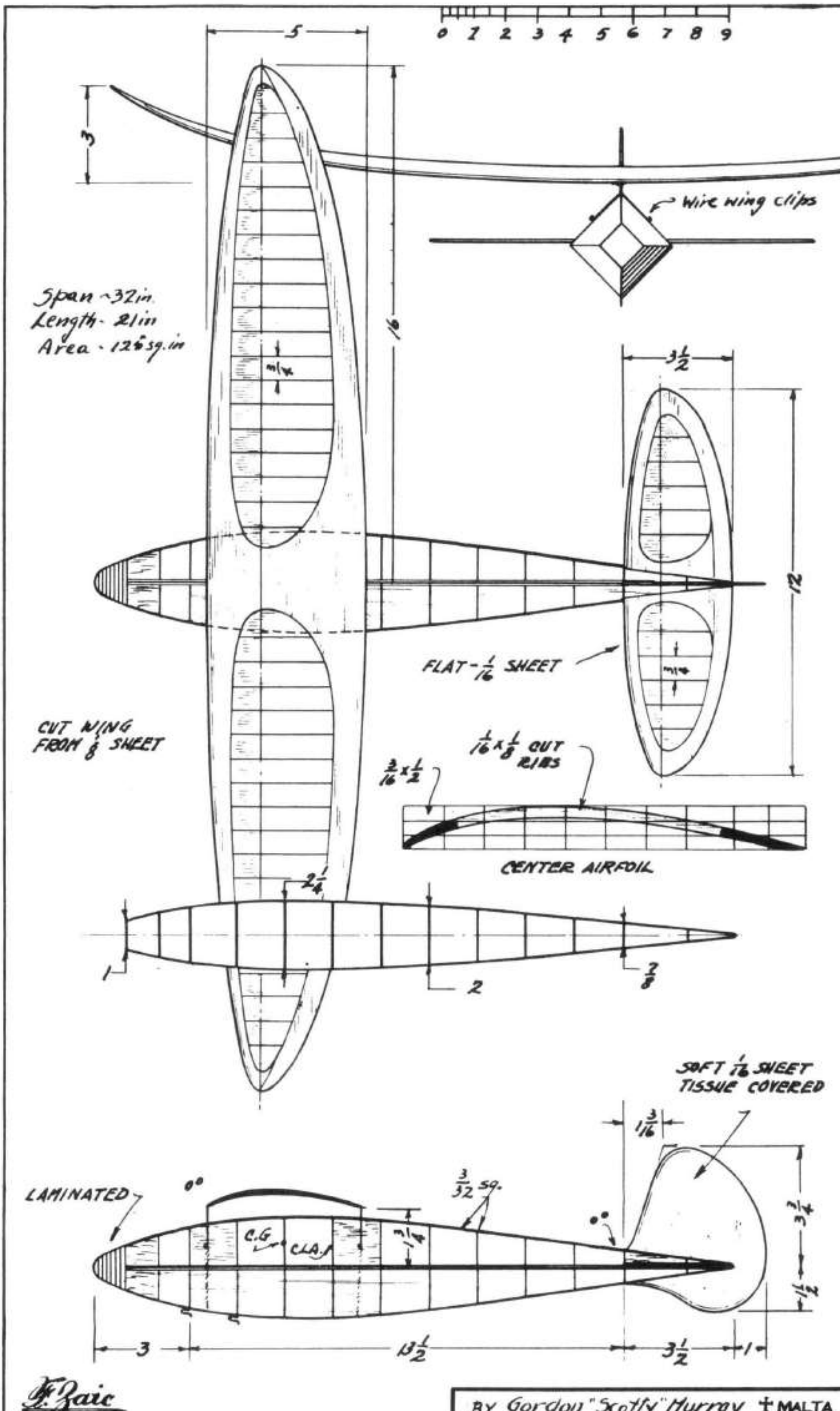

Wing
Stab.
NACA 6409 with Flat Bottom - 1/20 Ribs
Span - 50 in
Area - 183 sq. in
Length - 24 1/2 in
All Balsa Construction
Break
A 4 hr. Flight Reported
12" are half of 'V' Tail
Stabe Rudder for normal set-up
Removable Cover
1/4 x 1 x 20 3/4 Hard Boom
Carve out for Ballast
F. Zaic
Thermic 50X by Frank Zaic N.Y.C.

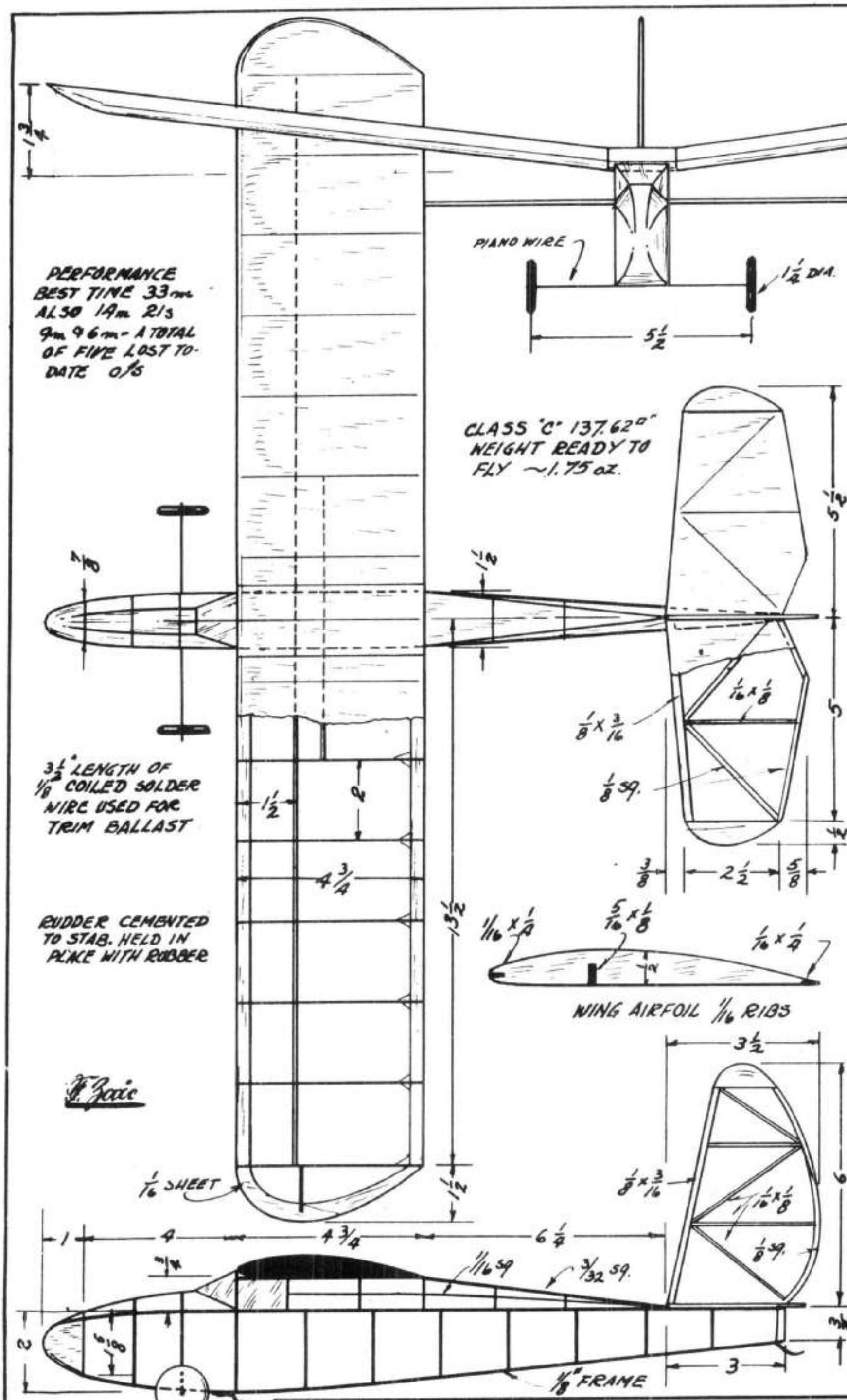

BAMBOO
STREAMLINED RIB
0 3 6 9
SPAR SPLICE
1/20 PLY
CELLULOID
TAIL SECTION
9/32 x 1/16
1/4 x 5/32
5/32 BALSA FILL-INS
1/16 x 3/8
PLUG FITS HOLE IN WING
1/20 PLY
ONLY TWO BULKHDS
5/32 LONGERONS
21 1/2" FLAT
7 1/4 DIHEDRAL PORTION
3 3/4
5/32 BALSA
3/16 x 7/16
1/8 SQ
3/32 BALSA RIBS
BLOCK
SPAR
WING BLOCK - BALSA WITH SLOTS FOR SPAR CEMENTING
1/8 PLY
3/16 PLY
FUSELAGE BUILT-UP FROM 5/32 STRIPS
+1/8 INC
HORIZONTAL BASE LINE
5/32 SQ.
3/16 NEG. INC.
3/32 PLY-KEEL
6 3/4
7
12 1/2
4 11/16
BY. J. Van Hattum ~ THE HAGUE, HOLLAND

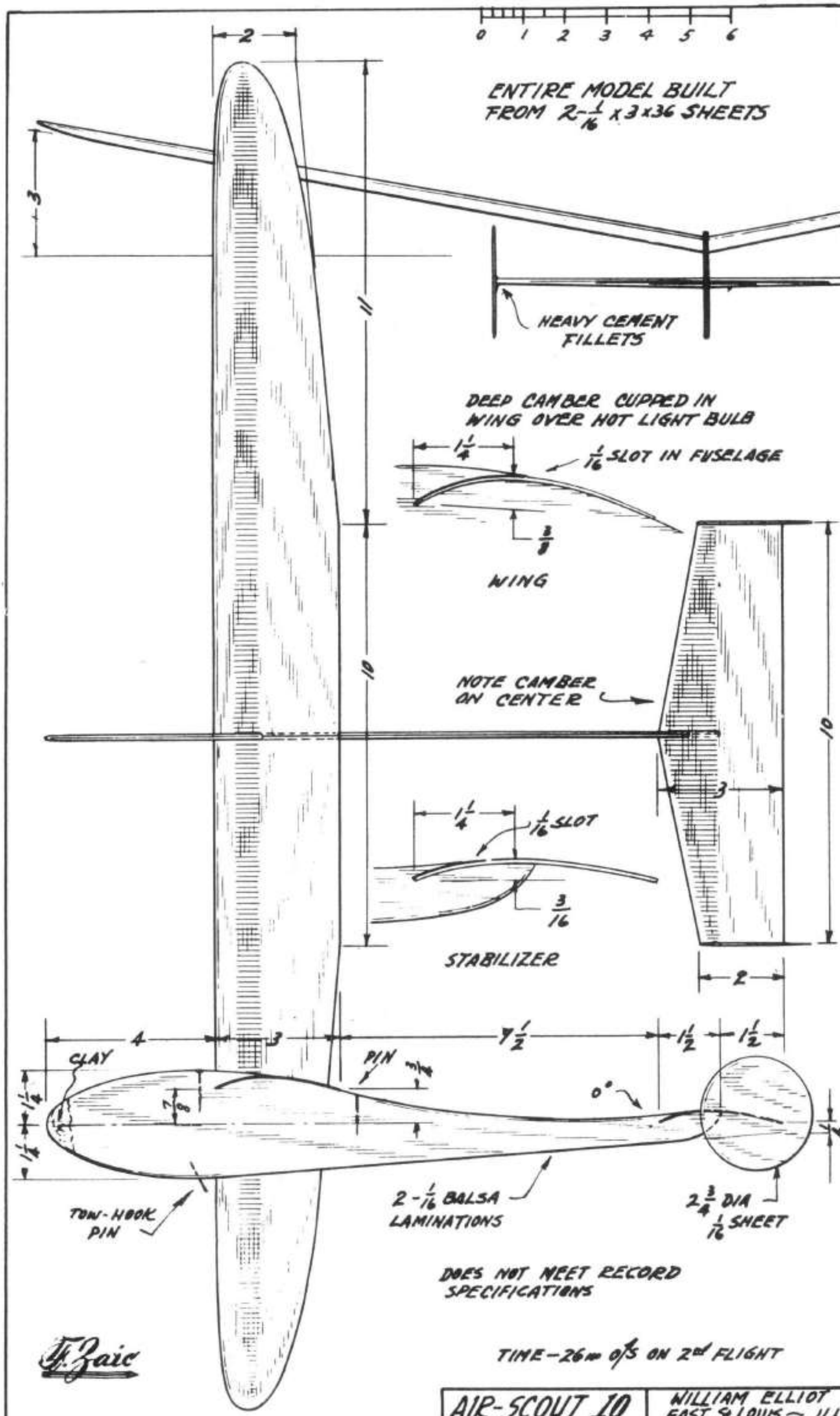

Tow Hook
Full size, 20x26. Plans. 15¢ PP Model Aero. Pubs
36
3
Bottom outline
Celluloid Top and around to X
Stab cemented to fuselage
11
3
Span – 36
Area – 142 sq. in.
Length – 21 in
Stab
NACA 6409 Top
9/64 x 1/2 Balsa
Wing
1/20 Balsa or 1/32 Bass Ribs
Hardwood except as shown
F. Zaic
celluloid
1/16 sheet
Leave one side open for ballast
1/16 sq. Framework
CG
Double cover bottom and sides to center line
Trooper by Frank Zaic N.Y.C.

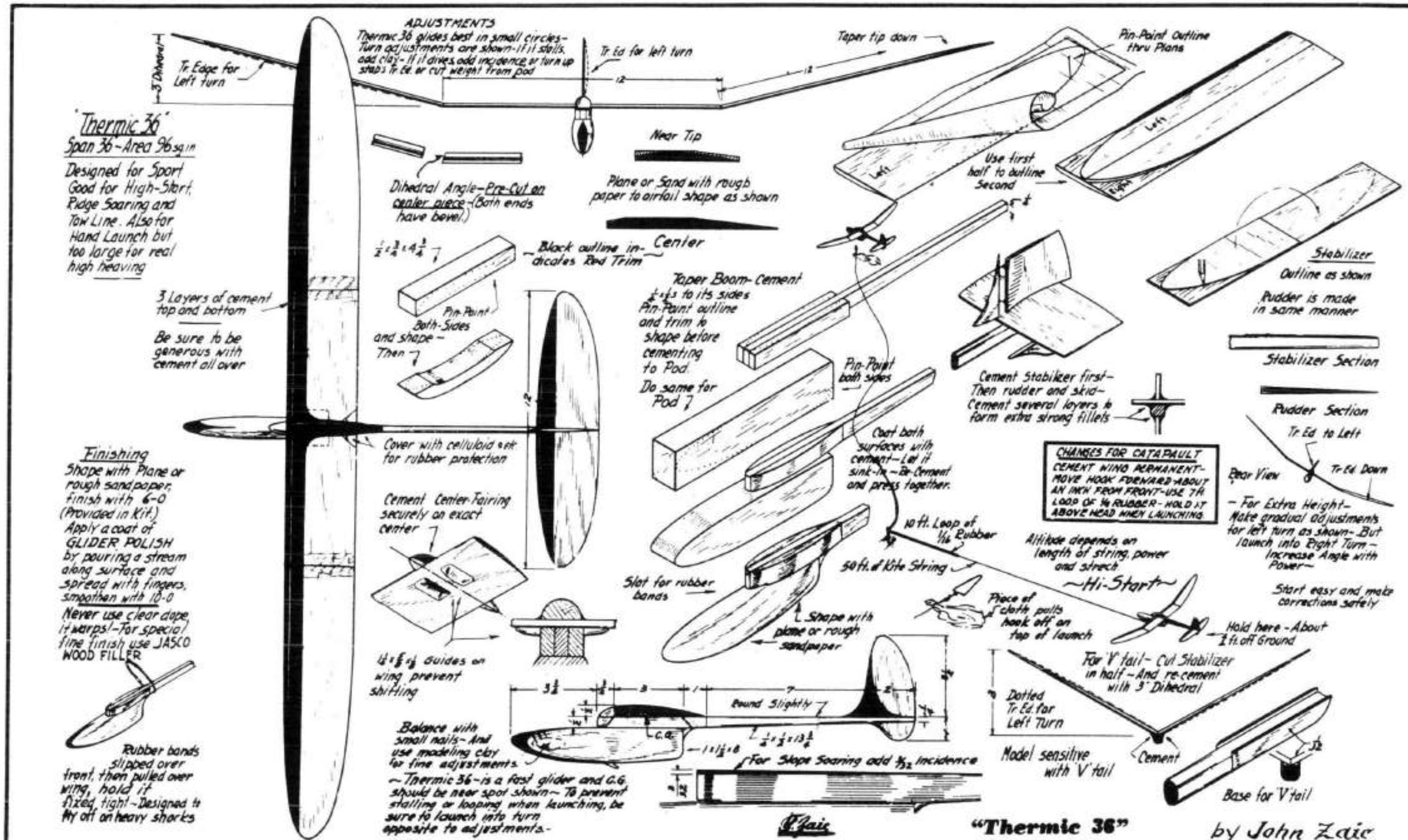

1/16 BULKHEADS
PLANKED-DUCO
FILLERED-DULUXED
BOX ON STAB
TAIL SECTION
BALSA
SYMETRICAL FUSELAGE~KEEL SET AT ANGLE
40
16
CUT FROM SHEET
1/32 SHEET
RAF 32.-(SPAR AT ℄)
KEEL THROUGH ℄ OF ELLIPSE
KEEL 20½ x ¾ x ⅛
3/16 x ⅛
WT.~3 OZ.+
TIME
1m TO 1½m ON
50 FT. TOW LINE
FAST & FLAT
TOW LINE GLIDER-by W.B. MACKLEY-REMUERA, AUCK. NZ


15 1/4" DIVIDE INTO 9 SECTIONS
SPAN 33 7/8
WING SECTION
STABILIZER
1/16 BALSA BULKHEADS
FUSELAGE + BULKHEADS & STRINGER CONSTRUCTION
RUBBER HOOK
2-1/16 LAMINATED STREAMLINED
7m 30s O/S ON 150 Ft. TOW.
SAME ANGLE AS WING
ZWEEMODEL VAMPIER I
by J. VAN HATTUM — ROTTERDAM

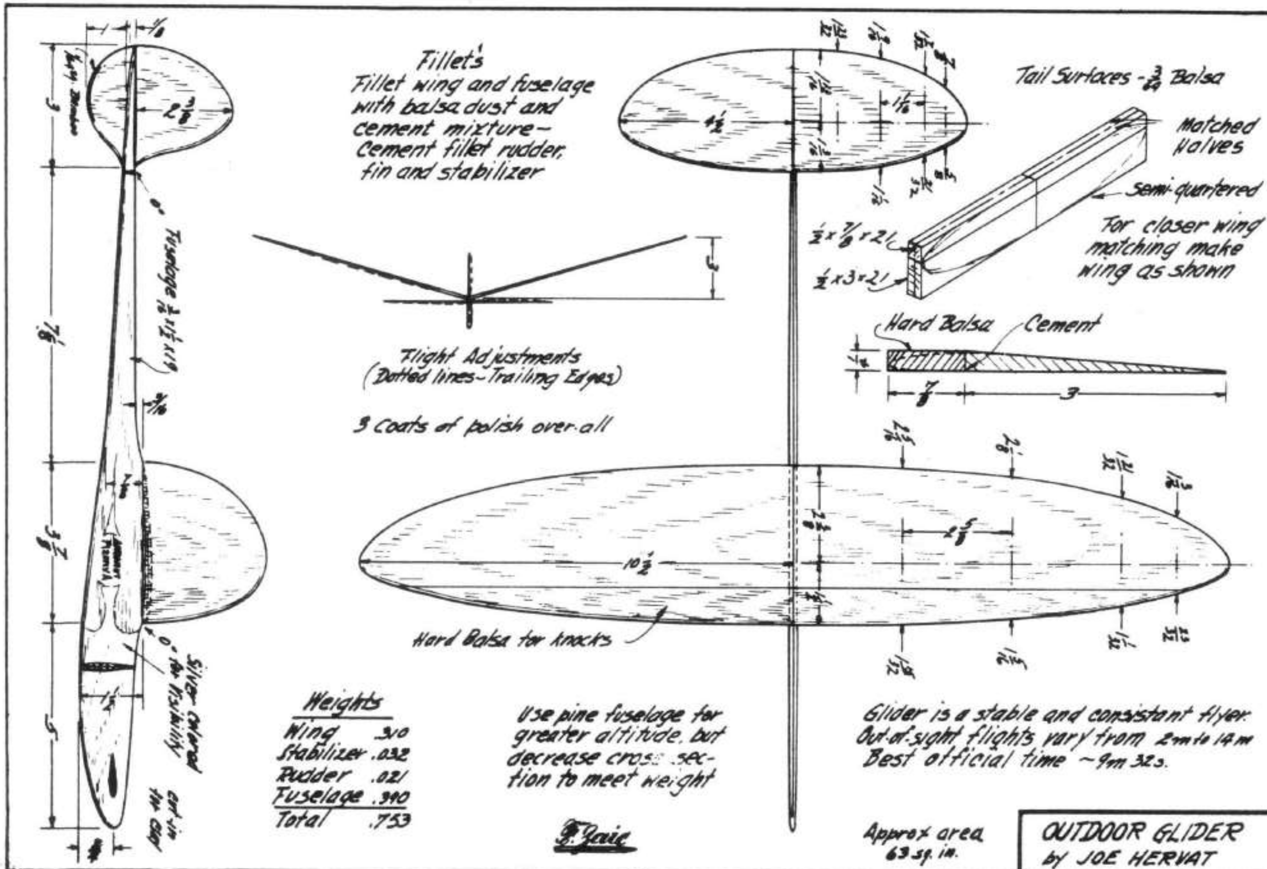

0 1 2 3 4 5 6 7 8 9
5
3
16
Wire wing clips
Span - 32in.
Length - 21in
Area - 125 sq.in
3 1/2
12
FLAT - 1/16 SHEET
CUT WING FROM 1/8 SHEET
1/16 x 1/8 CUT RIBS
3/16 x 1/2
CENTER AIRFOIL
2 1/4
1
2
7/8
SOFT 1/16 SHEET TISSUE COVERED
1 3/16
LAMINATED
0°
3/32 SQ.
C.G.
C.L.A.
1 1/4
3 3/4
1 1/2
3
13 1/2
3 1/2
1
F. Zaic
By Gordon "Scotty" Murray MALTA

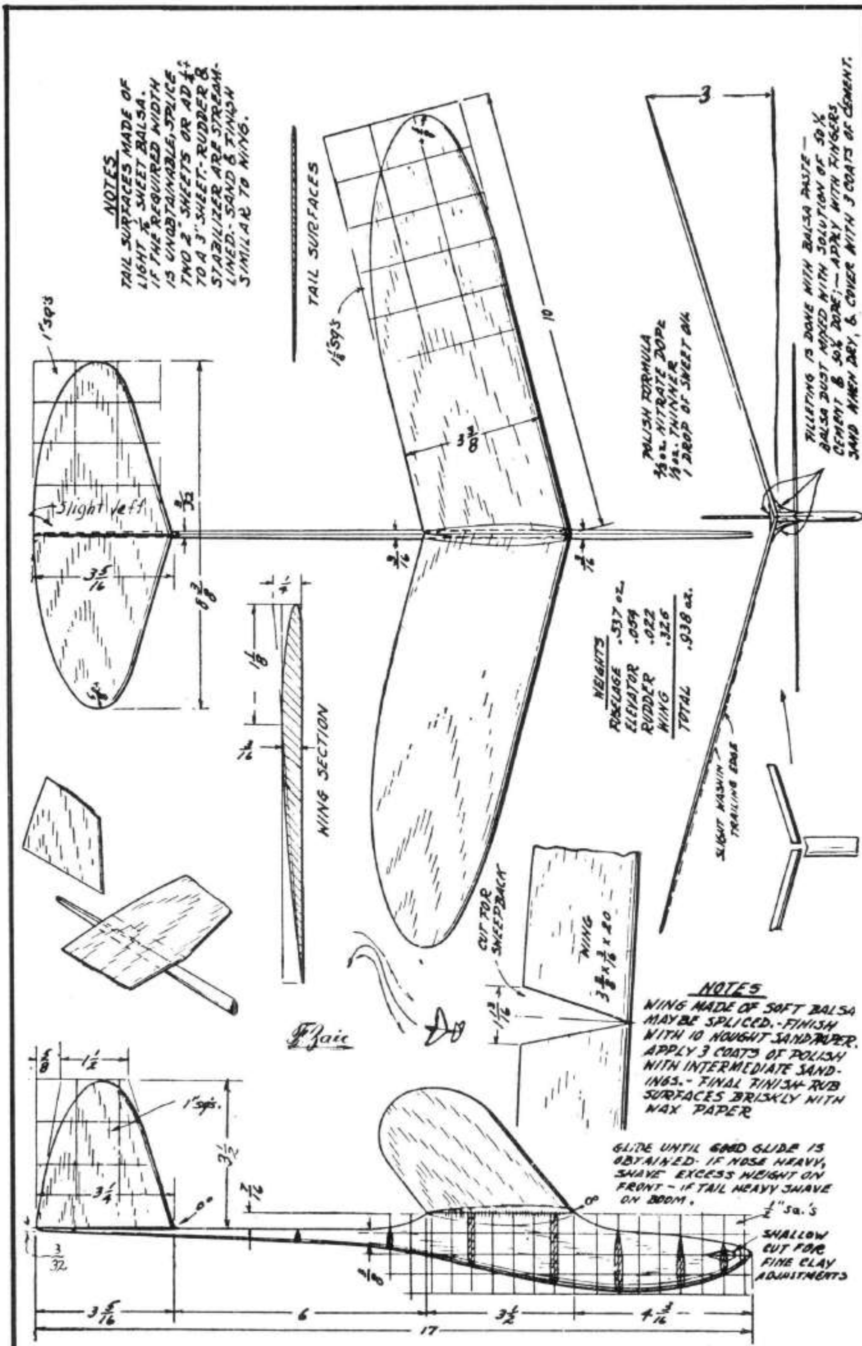

PERFORMANCE
BEST TIME 33m
ALSO 14m 21s
9m & 6m - A TOTAL
OF FIVE LOST TO-
DATE O/S
PIANO WIRE
1 1/4 DIA.
5 1/2
CLASS "C" 137.62□"
WEIGHT READY TO
FLY ~1.75 oz.
1/8 x 3/16
1/16 x 1/8
1/8 SQ.
3 1/2" LENGTH OF
1/8 COILED SOLDER
WIRE USED FOR
TRIM BALLAST
RUDDER CEMENTED
TO STAB. HELD IN
PLACE WITH RUBBER
1/16 x 1/4
5/16 x 1/8
1/16 x 1/4
WING AIRFOIL 1/16 RIBS
1/16 SHEET
1/16 SQ
3/32 SQ.
1/8" FRAME
TOW LAUNCHED GLIDER BY ELBERT J. WEATHERS - SAN DIEGO. CAL.

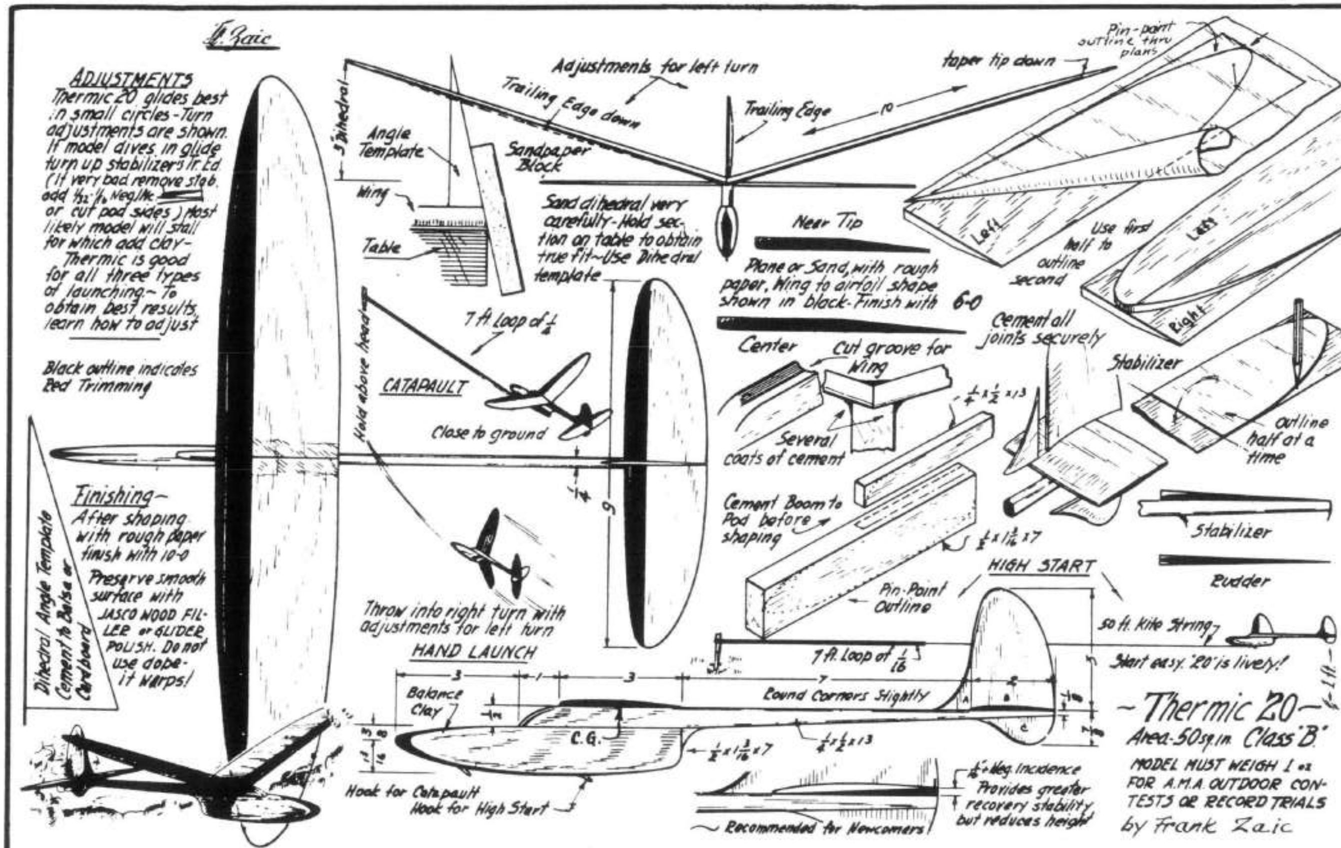

0 1 2 3 4 5 6
ENTIRE MODEL BUILT FROM 2-1/16 x 3 x 36 SHEETS
HEAVY CEMENT FILLETS
DEEP CAMBER CUPPED IN WING OVER HOT LIGHT BULB
1/16 SLOT IN FUSELAGE
WING
NOTE CAMBER ON CENTER
1/16 SLOT
STABILIZER
CLAY
PIN
0°
TOW-HOOK PIN
2-1/16 BALSA LAMINATIONS
2 3/4 DIA 1/16 SHEET
DOES NOT MEET RECORD SPECIFICATIONS
TIME—26 m O/S ON 2nd FLIGHT
F. Zaic
AIR-SCOUT 10
WILLIAM ELLIOT EAST St. LOUIS — ILL.

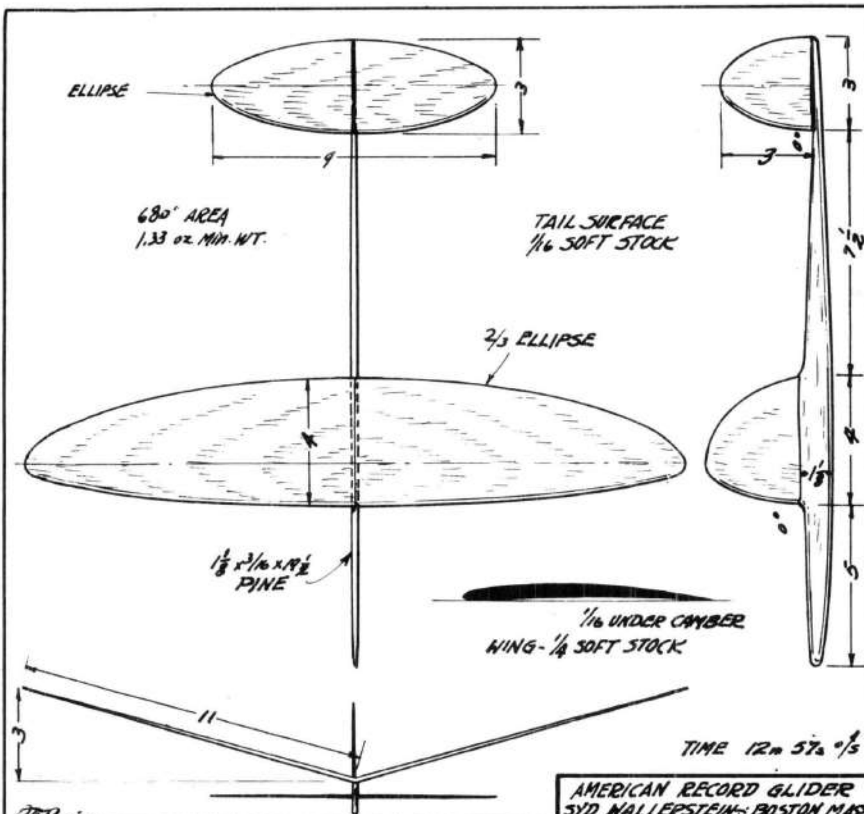


ADJUSTMENTS
Thermic 36 glides best in small circles- Turn adjustments are shown-If it stalls, add clay- If it dives, add incidence or turn up stab's Tr. Ed. or cut weight from pod
Tr. Ed for left turn
Taper tip down
Pin-Point Outline thru Plans
Tr. Edge for Left turn
3" Dihedral
"Thermic 36"
Span 36-Area 96 sq.in
Designed for Sport Good for High-Start, Ridge Soaring and Tow Line. Also for Hand Launch but too large for real high heaving
Near Tip
Dihedral Angle-Pre-Cut on center piece-(Both ends have bevel)
Plane or Sand with rough paper to airfoil shape as shown
Center
Use first half to outline Second
Black outline indicates Red Trim
Stabilizer
Outline as shown
Rudder is made in same manner
Stabilizer Section
Rudder Section
Taper Boom-Cement to its sides Pin-Point outline and trim to shape before cementing to Pod.
Do same for Pod
3 Layers of cement top and bottom
Be sure to be generous with cement all over
Pin-Point Both-Sides and shape-Then
Pin-Point both sides
Cement Stabilizer first-Then rudder and skid-Cement several layers to form extra strong fillets
Tr. Ed. to Left
Rear View
Tr. Ed. Down
Finishing
Shape with Plane or rough sandpaper, finish with 6-0 (Provided in Kit.) Apply a coat of GLIDER POLISH by pouring a stream along surface and spread with fingers, smoothen with 10-0
Never use clear dope it warps!-For special fine finish use JASCO WOOD FILLER
Cover with celluloid at for rubber protection
Coat both surfaces with cement-Let it sink-in-Re-Cement and press together.
CHANGES FOR CATAPAULT
CEMENT WING PERMANENT-MOVE HOOK FORWARD ABOUT AN INCH FROM FRONT-USE 7 ft LOOP OF 1/4 RUBBER-HOLD IT ABOVE HEAD WHEN LAUNCHING
- For Extra Height-Make gradual adjustments for left turn as shown-But launch into Right Turn-Increase Angle with Power-
Cement Center-Fairing securely on exact center
10 ft. Loop of 1/16 Rubber
Altitude depends on length of string, power and strech
50 ft. of Kite String
~Hi-Start~
Start easy and make corrections safely
Slot for rubber bands
Piece of cloth pulls hook off on top of launch
Hold here-About 1 ft. off Ground
Shape with plane or rough sandpaper
For 'V' tail- Cut Stabilizer in half-And re-cement with 3" Dihedral
Guides on wing prevent shifting
Round Slightly
Dotted Tr. Ed. for Left Turn
C.G.
Balance with small nails-And use modeling clay for fine adjustments.
~Thermic 36-is a fast glider and C.G. should be near spot shown~ To prevent stalling or looping when launching, be sure to launch into turn opposite to adjustments.
For Slope Soaring add 1/32 incidence
Model sensitive with 'V' tail
Cement
Base for 'V' tail
Rubber bands slipped over front, then pulled over wing, hold it fixed tight-Designed to fly off on heavy shocks
Zaic
"Thermic 36"
by John Zaic

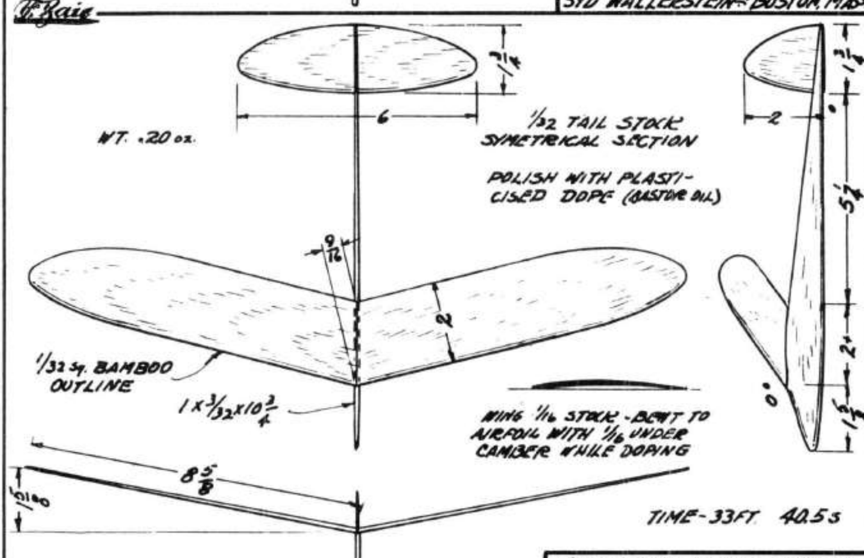

Fillets
Fillet wing and fuselage with balsa dust and cement mixture— Cement fillet rudder, fin and stabilizer
Tail Surfaces - 3/64 Balsa
Matched Halves
Semi-quartered
For closer wing matching make wing as shown
Hard Balsa
Cement
Fuselage 3/16 x 1 1/2 x 19
Flight Adjustments (Dotted lines—Trailing Edges)
3 Coats of polish over-all
Hard Balsa for knocks
Silver colored for Visibility
cut-in for Clay
Weights
Wing .310
Stabilizer .032
Rudder .021
Fuselage .390
Total .753
Use pine fuselage for greater altitude, but decrease cross section to meet weight
Glider is a stable and consistant flyer. Out-of-sight flights vary from 2m to 14m
Best official time ~9m 32s.
Approx area 63 sq. in.
OUTDOOR GLIDER
by JOE HERVAT


NOTES
TAIL SURFACES MADE OF LIGHT 1/16 SHEET BALSA. IF THE REQUIRED WIDTH IS UNOBTAINABLE, SPLICE TWO 2" SHEETS OR AD 1/4" TO A 3" SHEET. - RUDDER & STABILIZER ARE STREAMLINED. - SAND & FINISH SIMILAR TO WING.
TAIL SURFACES
1" sq's
1 1/8 sq's
Slight left
WING SECTION
POLISH FORMULA
1/2 oz. NITRATE DOPE
1/2 oz. THINNER
1 DROP OF SWEET OIL
WEIGHTS
FUSELAGE .537 oz.
ELEVATOR .054
RUDDER .022
WING .325
TOTAL .938 oz.
FILLETING IS DONE WITH BALSA PASTE — BALSA DUST MIXED WITH SOLUTION OF 50% CEMENT & 50% DOPE; — APPLY WITH FINGERS, SAND WHEN DRY, & COVER WITH 3 COATS OF CEMENT.
SLIGHT WASHIN TRAILING EDGE
CUT FOR SWEEPBACK
WING 3 3/8 x 3/16 x 20
NOTES
WING MADE OF SOFT BALSA MAYBE SPLICED. - FINISH WITH 10 NOUGHT SANDPAPER. APPLY 3 COATS OF POLISH WITH INTERMEDIATE SANDINGS. - FINAL FINISH RUB SURFACES BRISKLY WITH WAX PAPER
GLIDE UNTIL GOOD GLIDE IS OBTAINED. IF NOSE HEAVY, SHAVE EXCESS WEIGHT ON FRONT — IF TAIL HEAVY SHAVE ON BOOM.
1/2" sq.'s
SHALLOW CUT FOR FINE CLAY ADJUSTMENTS
FUSELAGE — 2×3/16×17 PINE
NOTICE THE TEAR DROP CROSS-SECTIONS
Best time ~ 39m 30s O.S.
OUTDOOR GLIDER ~ by Joe Hervat - Kenosha - Wis.

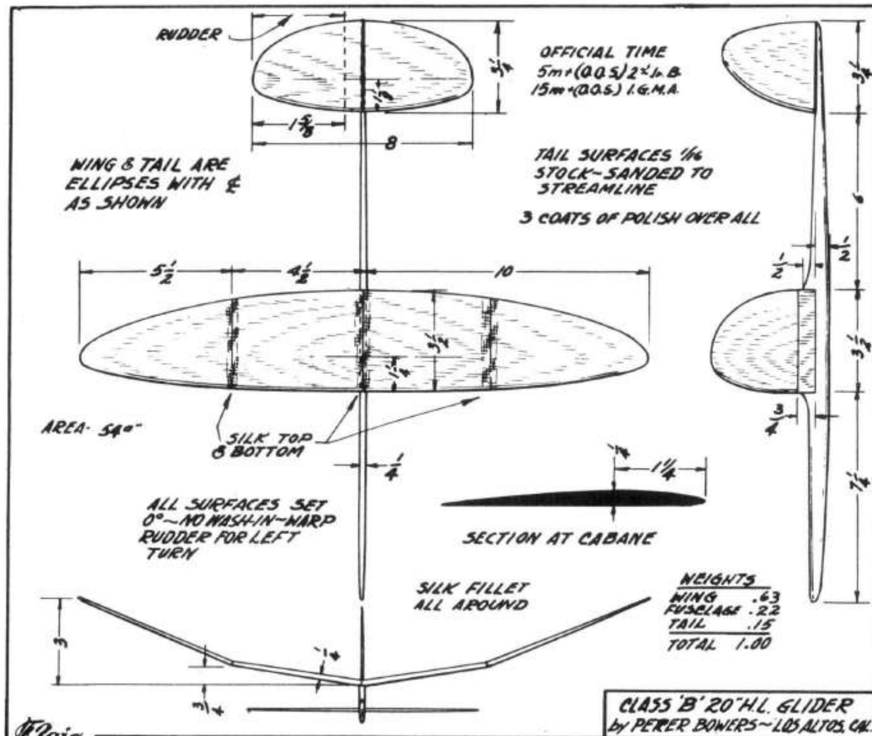

F. Zaic
ADJUSTMENTS
Thermic 20 glides best in small circles - Turn adjustments are shown. If model dives in glide turn up stabilizer's tr. Ed. (If very bad remove stab. add 1/32-1/16 neg. inc. or cut pod sides) Most likely model will stall for which add clay - Thermic is good for all three types of launching - To obtain best results learn how to adjust
Black outline indicates Bad Trimming
Finishing -
After shaping with rough paper finish with 10-0
Preserve smooth surface with JASCO WOOD FILLER or GLIDER POLISH. Do not use dope - it warps!
Dihedral Angle Template Cement to Balsa or Cardboard
5" Dihedral
Angle Template
Wing
Table
Sandpaper Block
Adjustments for left turn
Trailing Edge down
Trailing Edge
10
taper tip down
Pin-point outline thru plans
Sand dihedral very carefully - Hold section on table to obtain true fit - Use Dihedral template
Near Tip
Plane or Sand, with rough paper, Wing to airfoil shape shown in black - Finish with 6-0
Center
Left
Use first half to outline second
Right
Cement all joints securely
Cut groove for Wing
Several coats of cement
Stabilizer
outline half at a time
Cement Boom to Pod before shaping
Stabilizer
Rudder
Hold above head
7 ft. Loop of 1/4
CATAPAULT
Close to ground
6
Throw into right turn with adjustments for left turn
HAND LAUNCH
HIGH START
Pin-Point Outline
7 ft. Loop of 1/16
50 ft. Kite String
Start easy. '20' is lively!
Balance Clay
C.G.
Round Corners Slightly
Hook for Catapault
Hook for High Start
Recommended for Newcomers
1/16" Neg. Incidence Provides greater recovery stability but reduces height
~ Thermic 20 ~
Area - 50 sq. in. Class 'B'
MODEL MUST WEIGH 1 oz FOR A.M.A. OUTDOOR CONTESTS OR RECORD TRIALS
by Frank Zaic

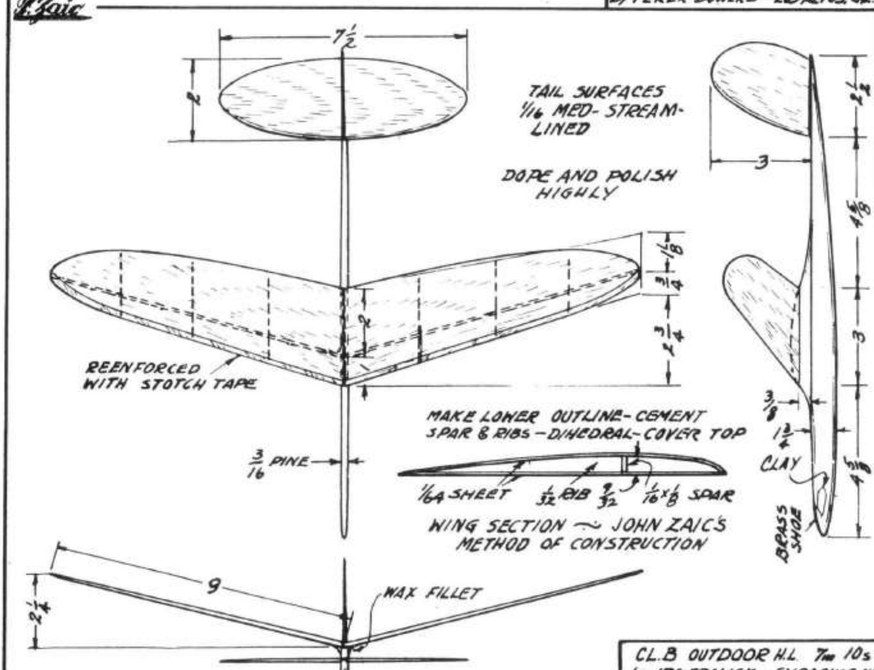


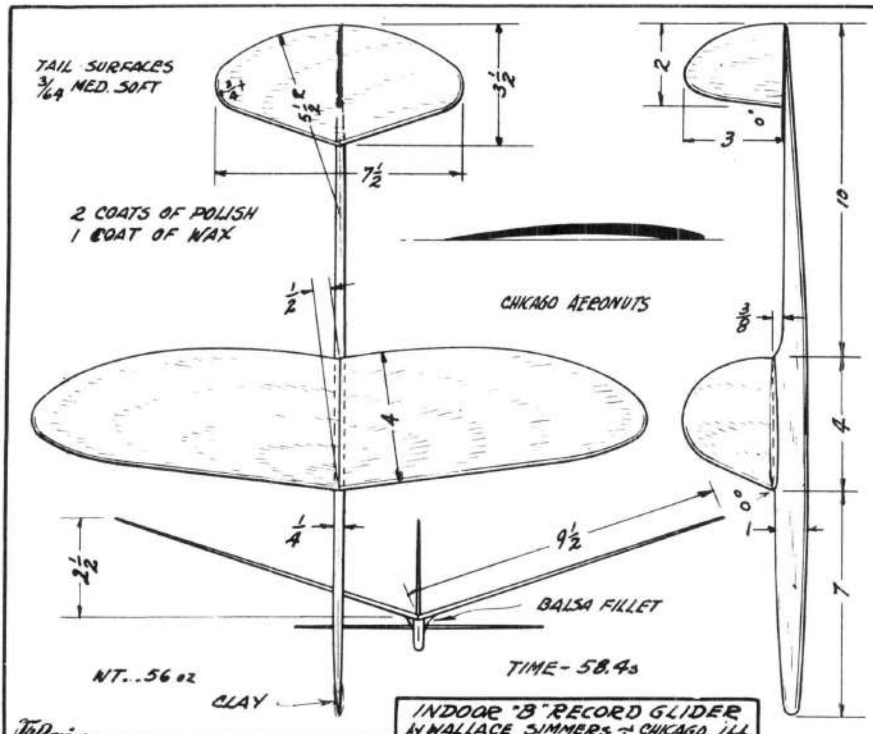
AMERICAN RECORD GLIDER
SYD WALLERSTEIN - BOSTON, MASS.

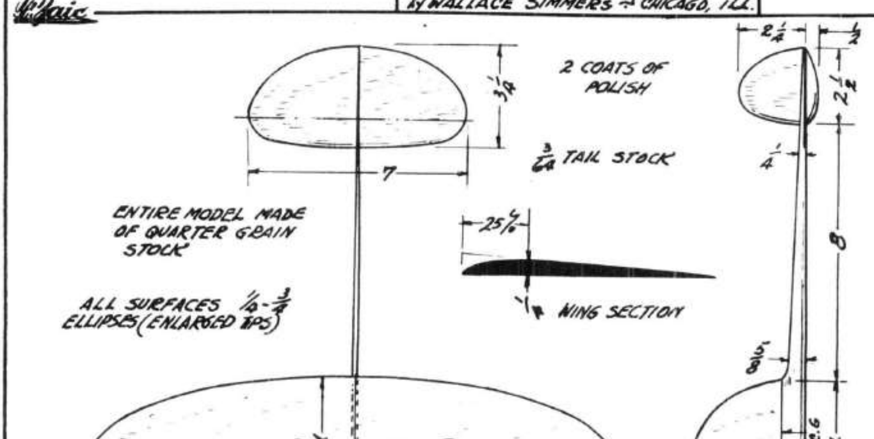


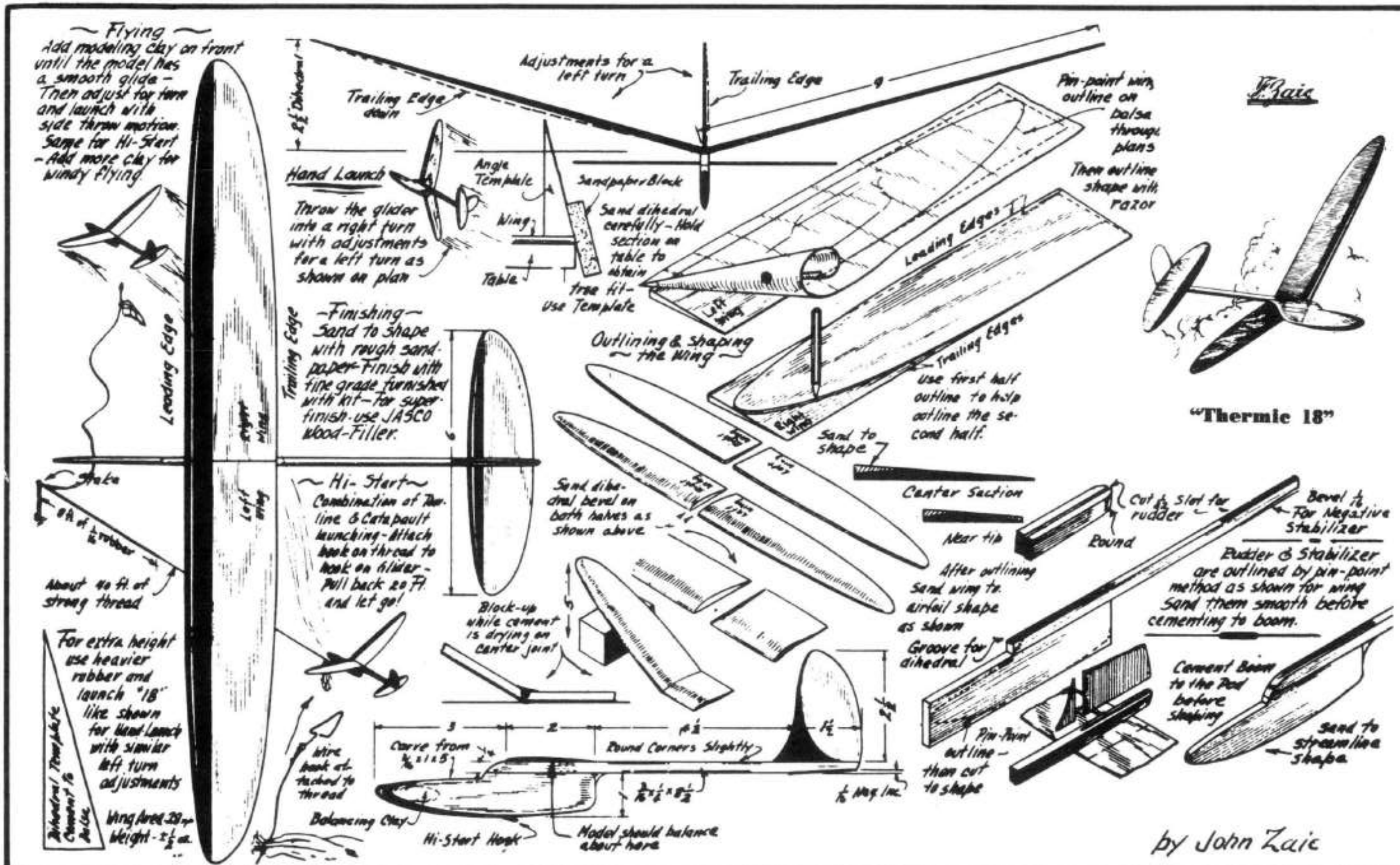
LOW CEILING INDOOR GLIDER
BY GORDON CAIN - BOSTON, MASS.

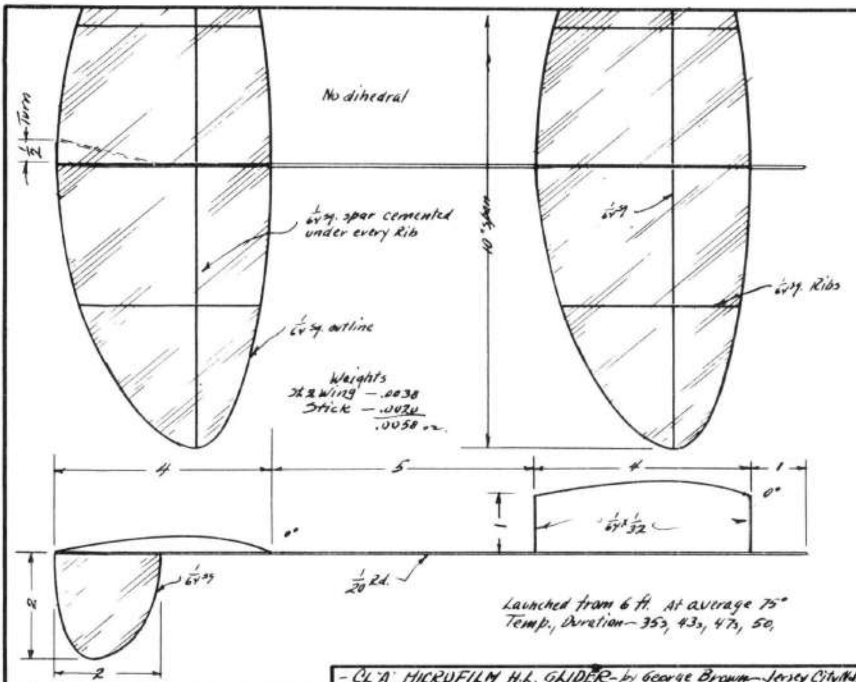

RUDDER
OFFICIAL TIME
5m+(O.O.S) 2nd I.B.
15m+(O.O.S) I.G.M.A.
WING & TAIL ARE ELLIPSES WITH ℄ AS SHOWN
TAIL SURFACES 1/16 STOCK-SANDED TO STREAMLINE
3 COATS OF POLISH OVER ALL
AREA- 54□"
SILK TOP & BOTTOM
ALL SURFACES SET 0°~NO WASH-IN~WARP RUDDER FOR LEFT TURN
SECTION AT CABANE
SILK FILLET ALL AROUND
WEIGHTS
WING .63
FUSELAGE .22
TAIL .15
TOTAL 1.00
CLASS 'B' 20" H.L. GLIDER
by PETER BOWERS ~ LOS ALTOS, CAL.
F. Zaic

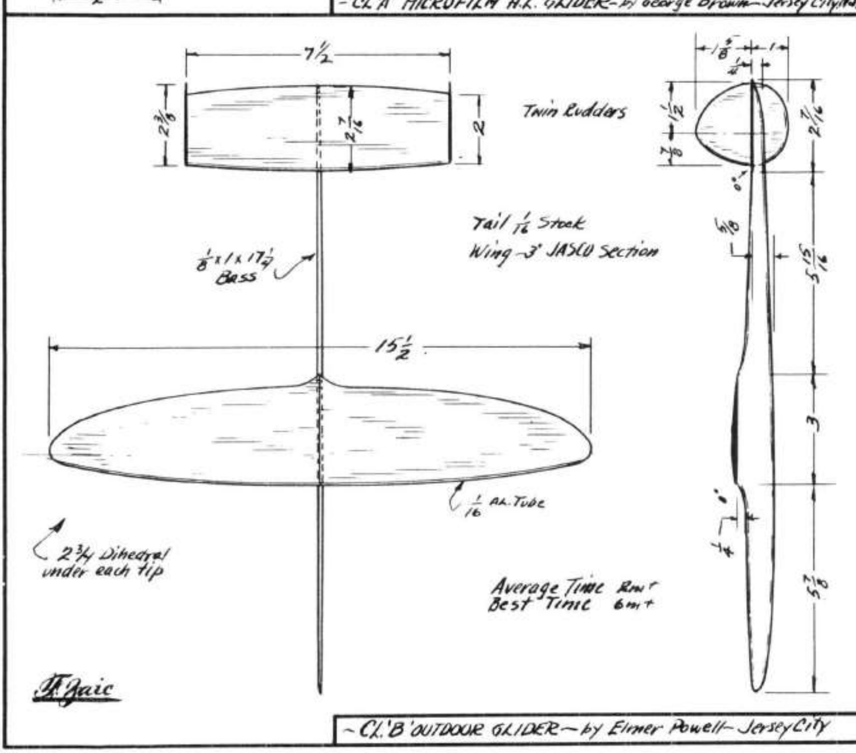

TAIL SURFACES 1/16 MED- STREAMLINED
DOPE AND POLISH HIGHLY
REENFORCED WITH STOTCH TAPE
MAKE LOWER OUTLINE- CEMENT SPAR & RIBS - DIHEDRAL- COVER TOP
3/16 PINE
1/64 SHEET
1/32 RIB
9/32
1/16 x 1/8 SPAR
WING SECTION ~ JOHN ZAIC'S METHOD OF CONSTRUCTION
CLAY
BRASS SHOE
WAX FILLET
CL.B OUTDOOR H.L. 7m 10s
by IRA FRALICK - SYRACUSE N.Y.

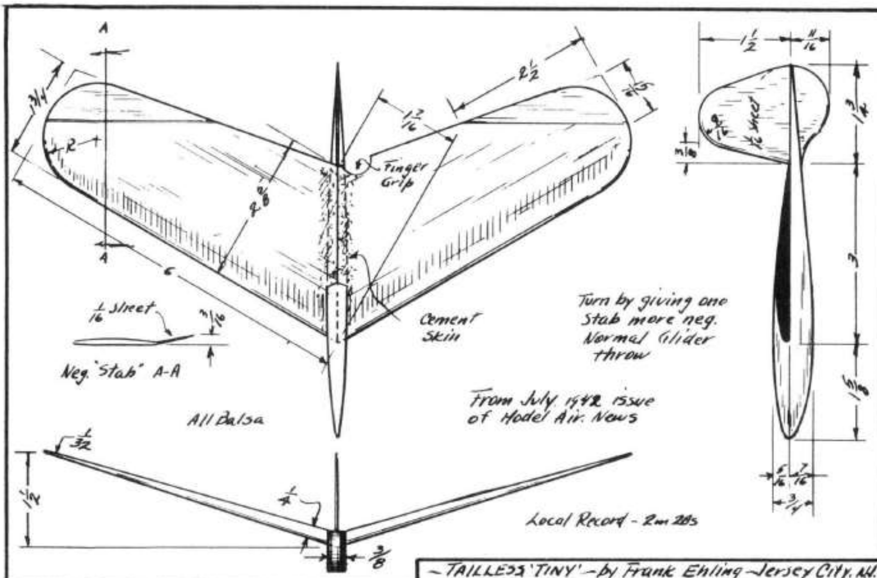

TAIL SURFACES
3/64 MED. SOFT
2 COATS OF POLISH
1 COAT OF WAX
CHICAGO AERONUTS
BALSA FILLET
WT. .56 oz
TIME - 58.4s
CLAY
INDOOR "B" RECORD GLIDER
by WALLACE SIMMERS - CHICAGO, ILL.

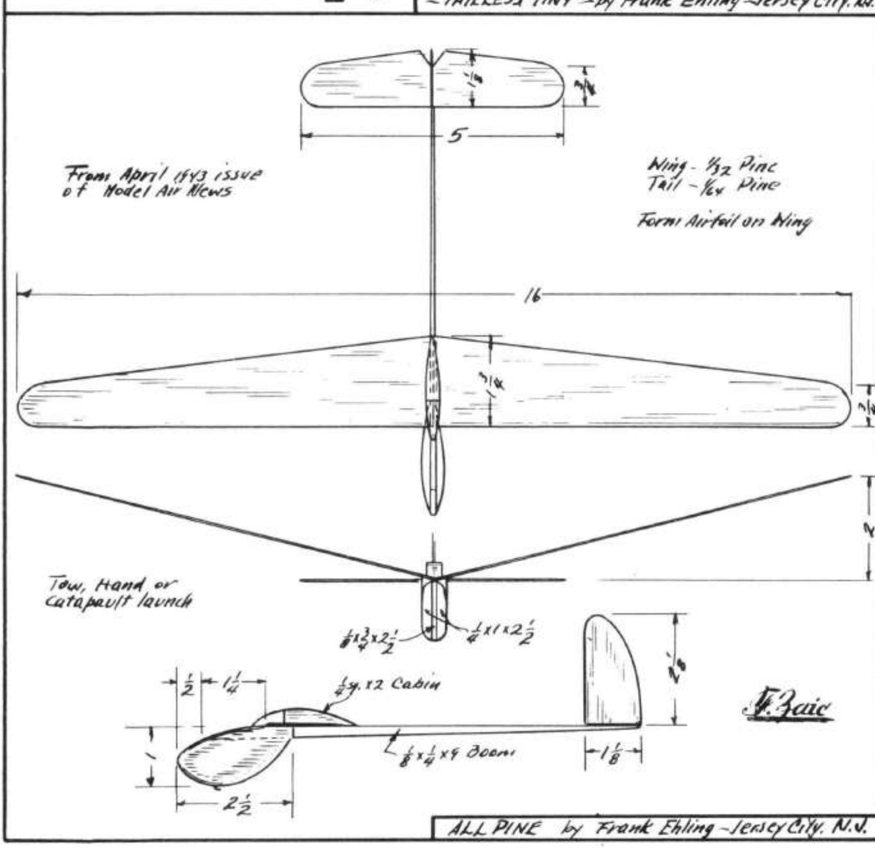

2 COATS OF
POLISH
3/64 TAIL STOCK
ENTIRE MODEL MADE
OF QUARTER GRAIN
STOCK
ALL SURFACES 1/4 - 3/4
ELLIPSES (ENLARGED TIPS)
WING SECTION
WT. .6 oz
CHICAGO AERONUTS
TIME - 1m 1.2s
INDOOR "B" GLIDER by M. HUGUELET

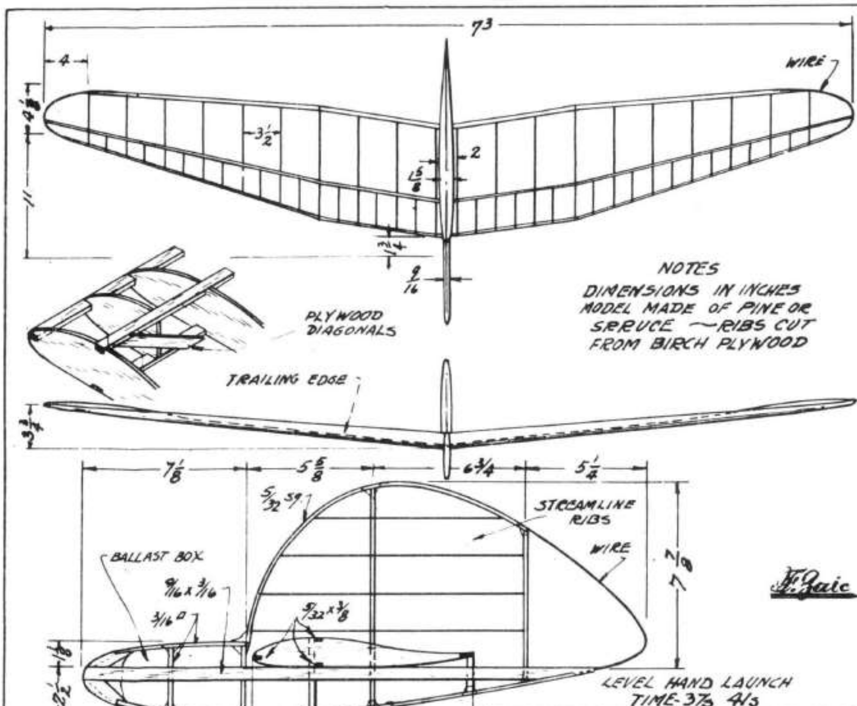

~ Flying ~
Add modeling clay on front until the model has a smooth glide - Then adjust for turn and launch with side throw motion. Same for Hi-Start - Add more clay for windy flying.
Leading Edge
Trailing Edge
Right wing
Left wing
Stake
8 ft. of 1/16 rubber
About 40 ft. of strong thread
For extra height use heavier rubber and launch "18" like shown for Hand Launch with similar left turn adjustments
Wing Area 39 sq.
Weight - 1 1/2 oz.
Dihedral Template Cement to Balsa
2 1/2 Dihedral
Trailing Edge down
Adjustments for a left turn
Trailing Edge
Hand Launch
Throw the glider into a right turn with adjustments for a left turn as shown on plan
Angle Template
Wing
Table
Sandpaper Block
Sand dihedral carefully - Hold section on table to obtain true fit - Use Template
-Finishing-
Sand to shape with rough sandpaper - Finish with fine grade furnished with kit - For super finish use JASCO Wood-Filler.
~ Hi-Start ~
Combination of Tow-line & Catapult launching - Attach hook on thread to hook on glider - Pull back 20 ft. and let go!
Pin-point wing outline on balsa through plans
Then outline shape with razor
Leading Edges
Trailing Edges
Left wing
Right wing
Outlining & Shaping the Wing
Use first half outline to help outline the second half.
Sand to shape
Center Section
Near tip
Sand dihedral bevel on both halves as shown above
Block-up while cement is drying on center joint
After outlining Sand wing to airfoil shape as shown
Groove for dihedral
Cut 1/16 Slot for rudder
Round
Bevel 1/16 For Negative Stabilizer
Rudder & Stabilizer are outlined by pin-point method as shown for wing. Sand them smooth before cementing to boom.
Pin-Point outline - then cut to shape
Cement Boom to the Pod before Shaping
Sand to streamline shape
Wire hook attached to thread
Balancing Clay
Hi-Start Hook
Model should balance about here
Carve from 1/2 x 1 x 5
Round Corners Slightly
1/16 Mag. Inc.
"Thermic 18"
by John Zaic


No dihedral
Turn
1/64 sq. spar cemented under every Rib
1/64 sq. outline
1/64 sq. Ribs
10" Span
Weights
Stick — .0020
.0058 oz.
1/20 Rd.
Launched from 6 ft. At average 75° Temp., Duration—35s, 43s, 47s, 50,
-CL.'A' MICROFILM H.L. GLIDER—by George Brown—Jersey City, N.J.

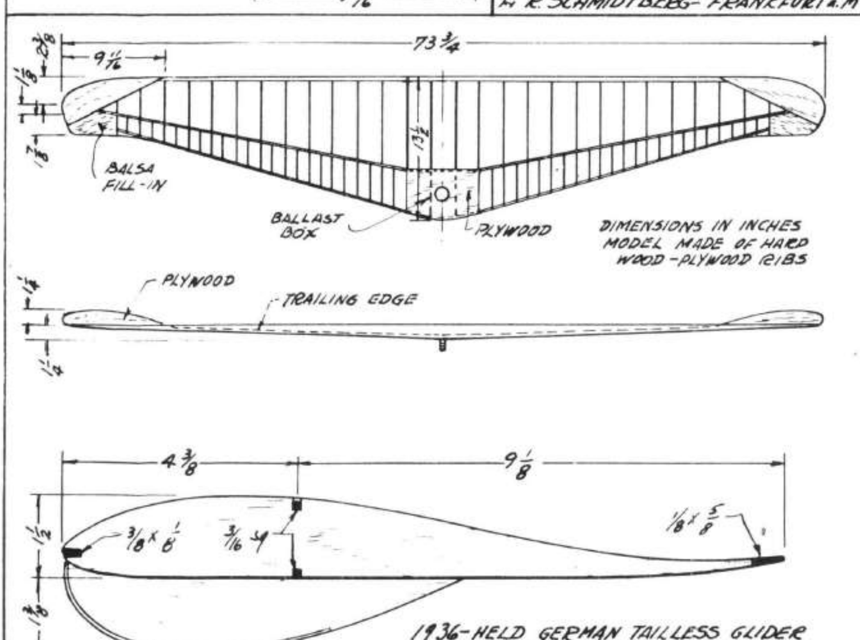

7 1/2
Twin Rudders
Tail 1/16 Stock
Wing—3" JASCO Section
Bass
15 1/2
1/16 AL. Tube
2 3/4 Dihedral under each tip
Average Time
Best Time
-CL.'B' OUTDOOR GLIDER—by Elmer Powell—Jersey City


A
A
3/4
R
2 1/2
1 3/16
5/16
2 5/8
Finger Grip
6
1/16 sheet
3/16
Cement Skin
Neg. "Stab" A-A
All Balsa
From July 1942 issue of Model Air News
Turn by giving one Stab more neg. Normal Glider throw
1 1/2
11/16
3/16
1/16 sheet
3/4
3
1 5/16
5/16
7/16
3/4
1/32
1 1/2
1/4
3/8
Local Record - 2m 28s
TAILLESS 'TINY' - by Frank Ehling - Jersey City, N.J.

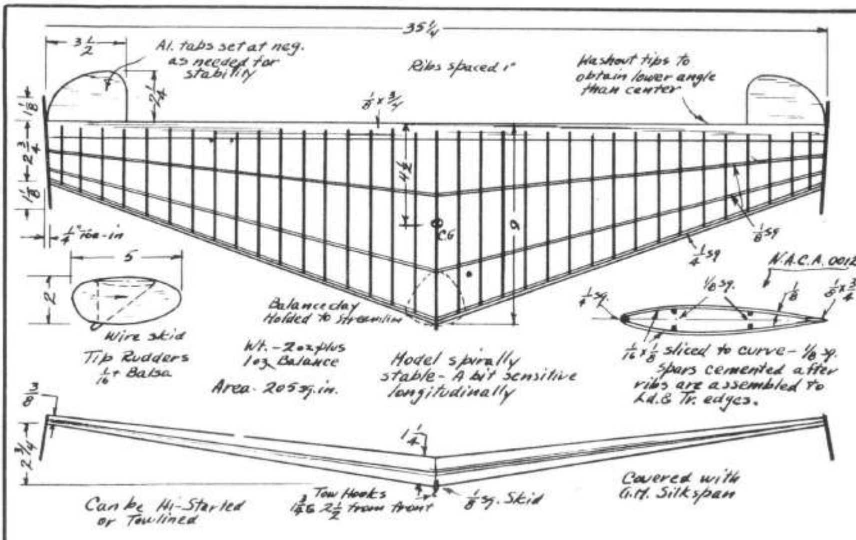

5
From April 1943 issue of Model Air News
Wing - 1/32 Pine
Tail - 1/64 Pine
Form Airfoil on Wing
16
2
Tow, Hand or Catapault launch
1/8 x 3/4 x 2 1/2
1/4 x 1 x 2 1/2
1/2
1 1/4
1/8 sq. x 2 Cabin
1/8 x 1/4 x 9 Boom
1
2 1/2
1 1/8
F. Zaic
ALL PINE by Frank Ehling - Jersey City, N.J.



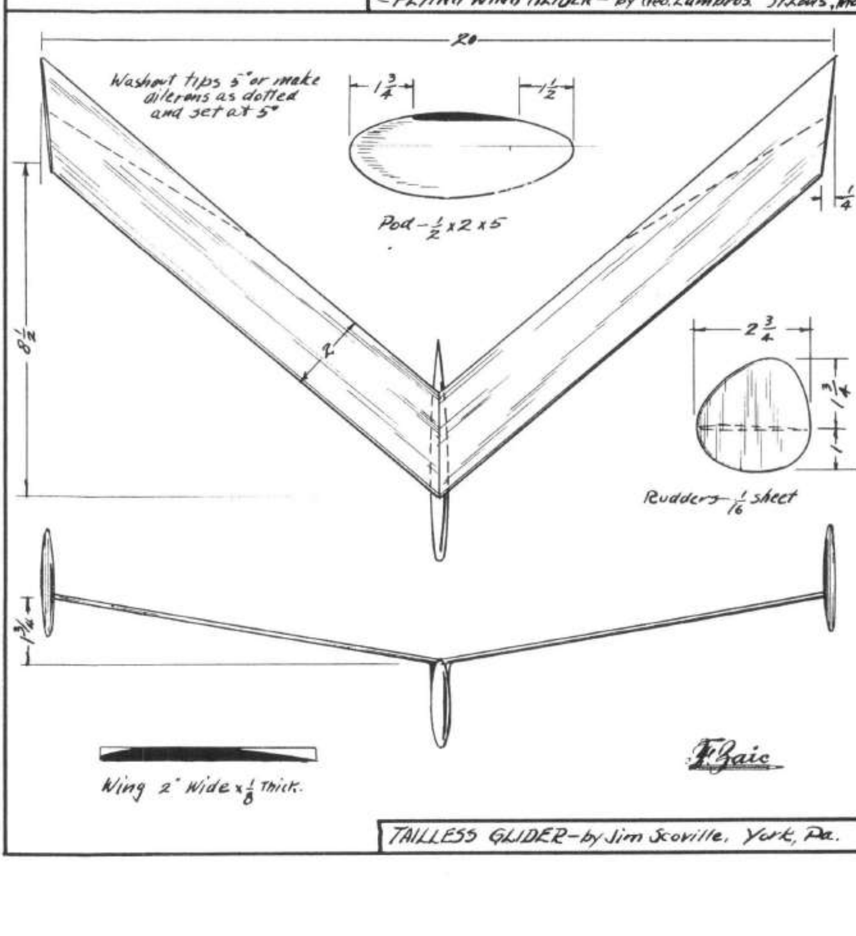
GERMAN RECORD TAILLESS GLIDER by R. SCHMIDTBERG- FRANKFURT a. M



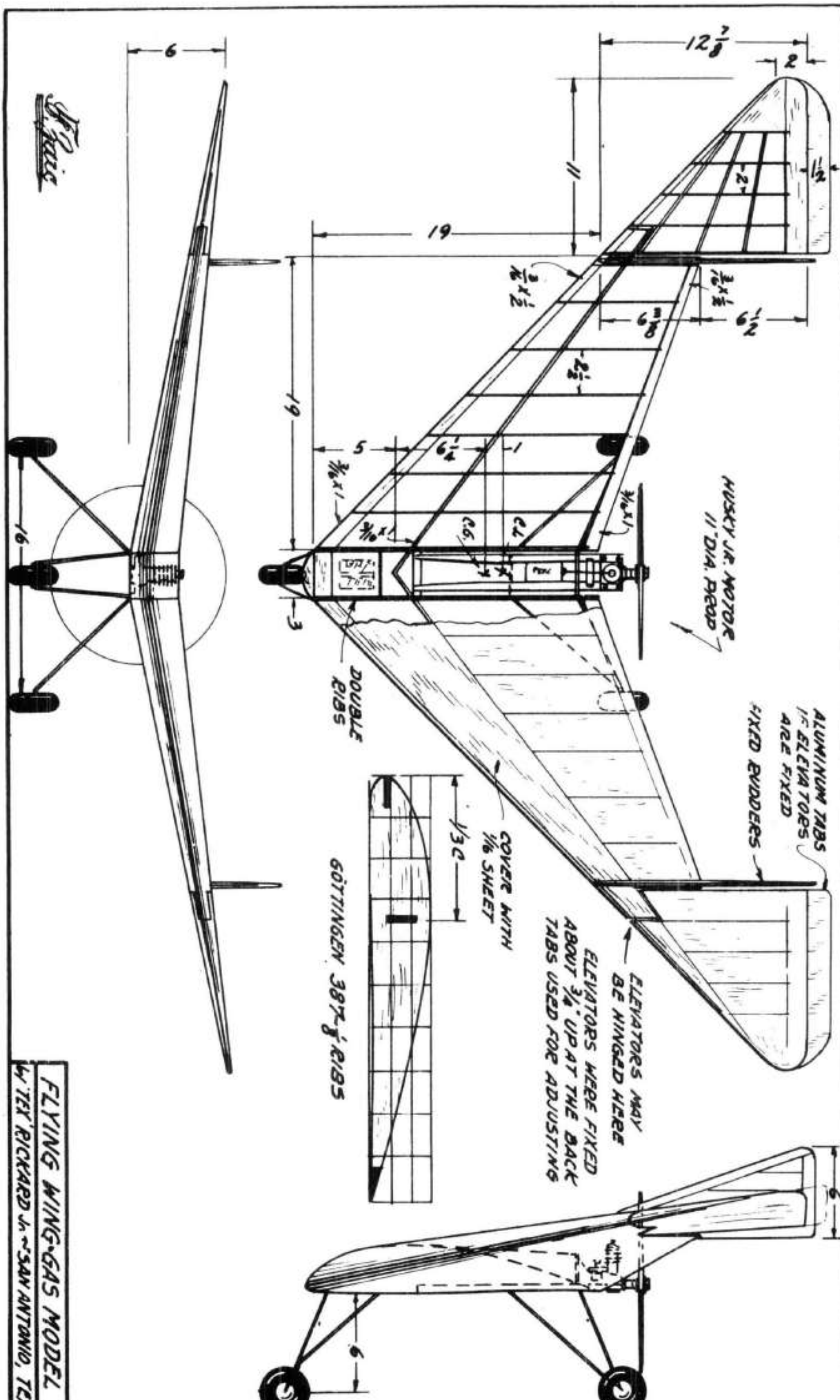
TAILLESS GLIDER- by E. KLOSE - DRESDEN. GER.

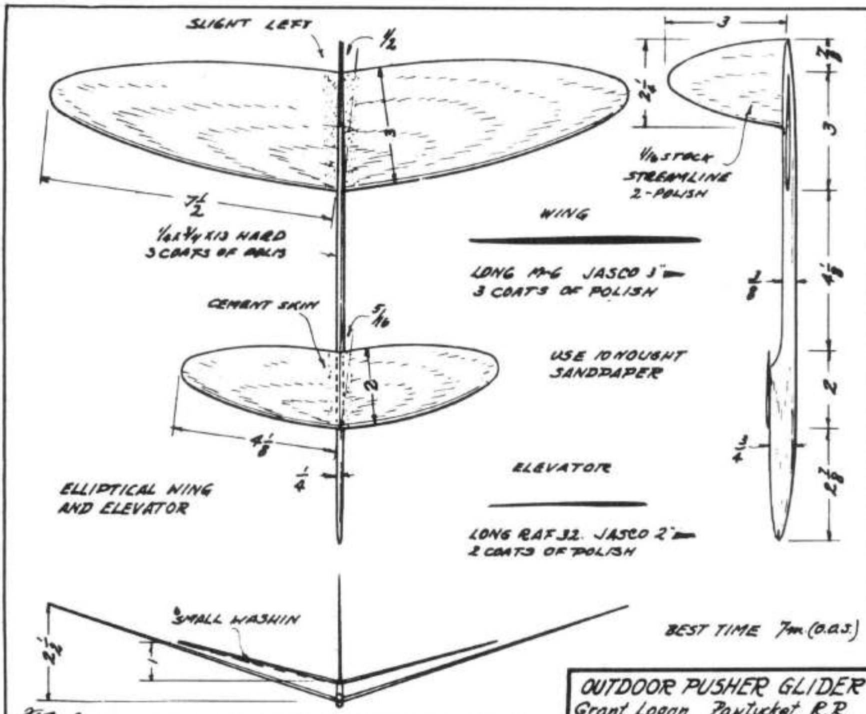


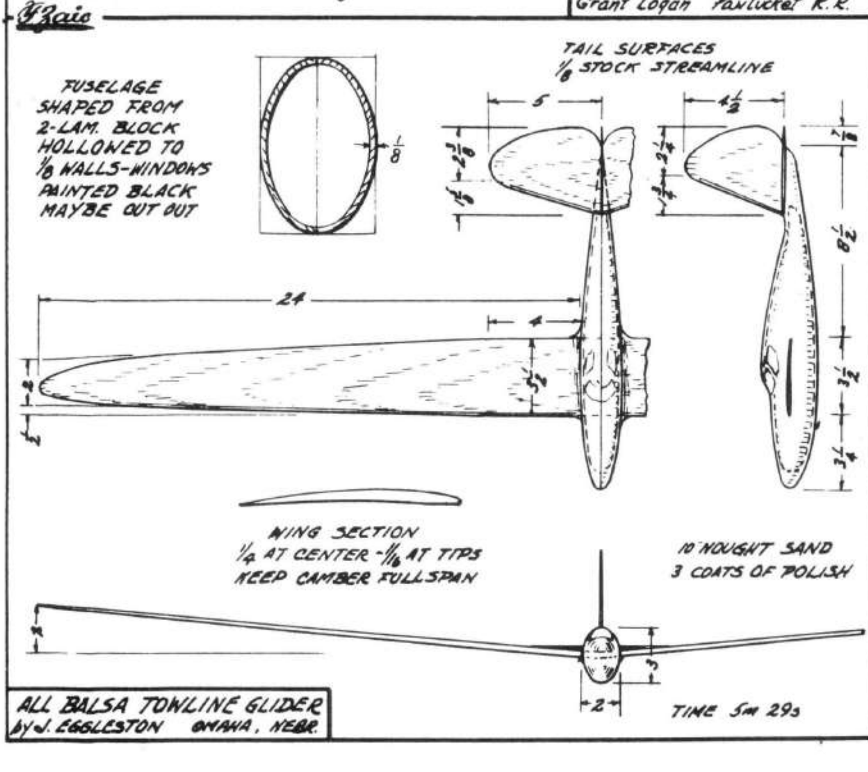
-FLYING WING GLIDER- by Geo. Lambros. St. Louis, Mo.

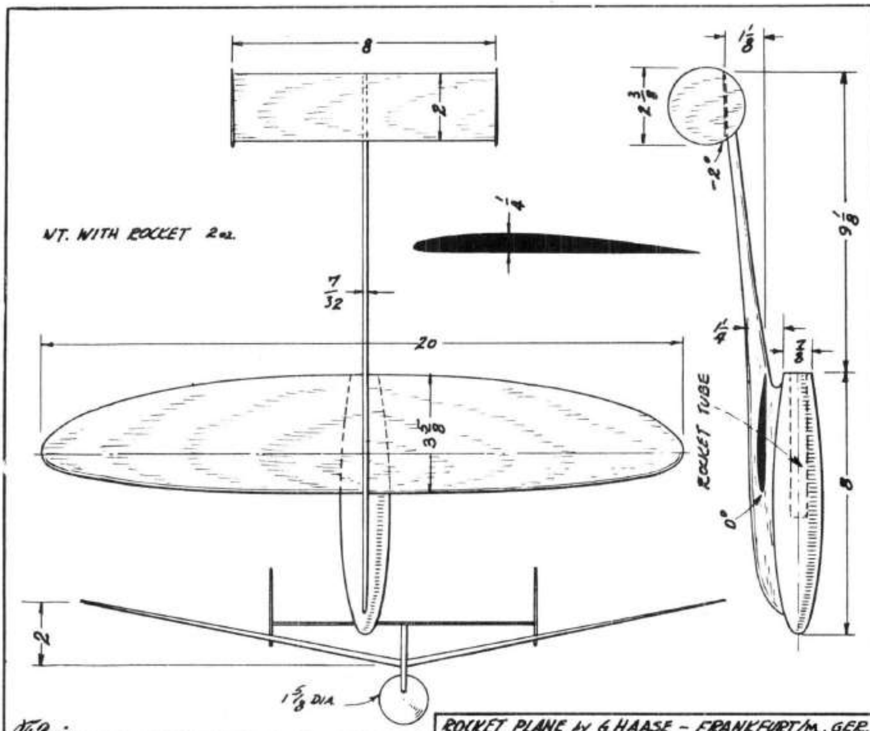


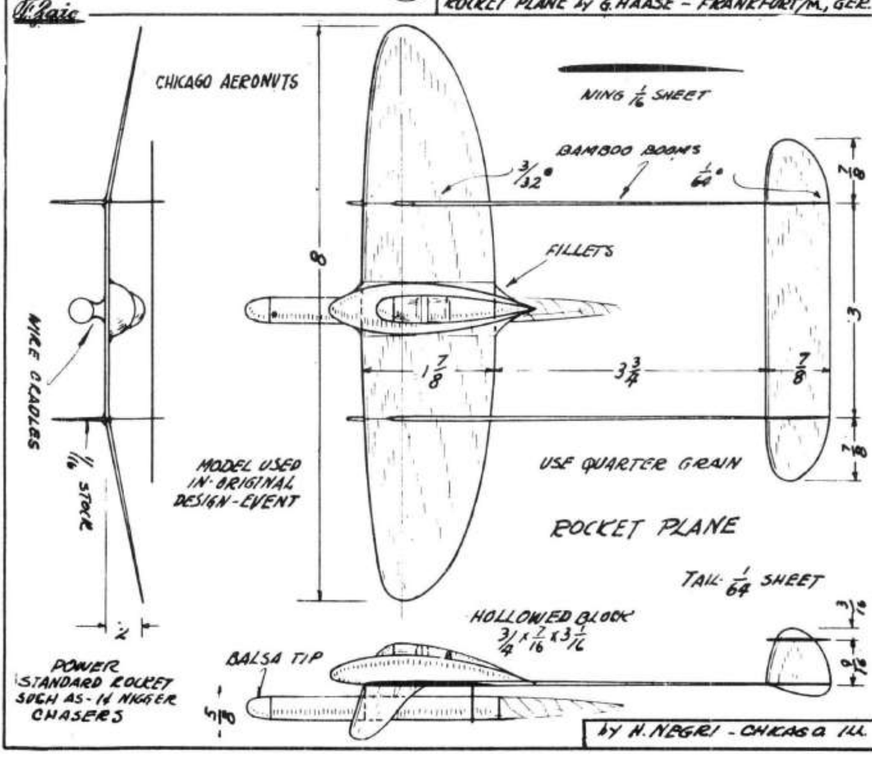
TAILLESS GLIDER - by Jim Scoville, York, Pa.

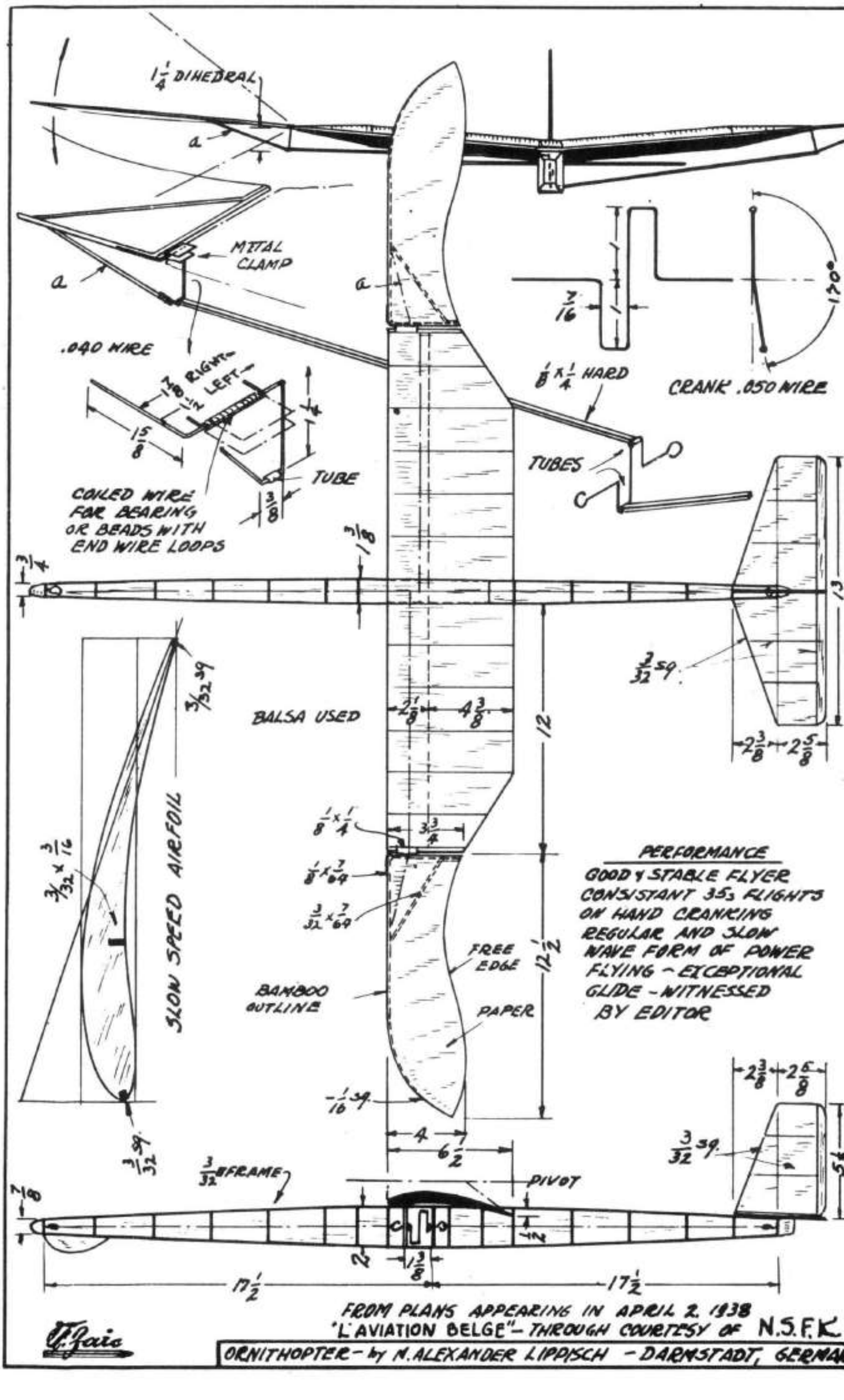

FLYING WING-GAS MODEL
by 'TEX' RICKARD Jr. — SAN ANTONIO, TEX
HUSKY JR. MOTOR
11" DIA. PROP
ALUMINUM TABS IF ELEVATORS ARE FIXED
FIXED RUDDERS
ELEVATORS MAY BE HINGED HERE
ELEVATORS WERE FIXED ABOUT 3/4" UP AT THE BACK
TABS USED FOR ADJUSTING
COVER WITH 1/16 SHEET
DOUBLE RIBS
GÖTTINGEN 387 - 1/8" RIBS
1/3C
C.G.
C.L.


SLIGHT LEFT
1/2
7 1/2
1/16 x 1/4 x 13 HARD
3 COATS OF POLIS
CEMENT SKIN
5/16
4 1/8
1/4
ELLIPTICAL WING
AND ELEVATOR
4/16 STOCK
STREAMLINE
2-POLISH
WING
LONG M-6 JASCO 3"
3 COATS OF POLISH
USE 10 NOUGHT
SANDPAPER
ELEVATOR
LONG RAF 32. JASCO 2"
2 COATS OF POLISH
SMALL WASHIN
BEST TIME 7m (O.O.S.)
OUTDOOR PUSHER GLIDER
Grant Logan Pawtucket R.R.

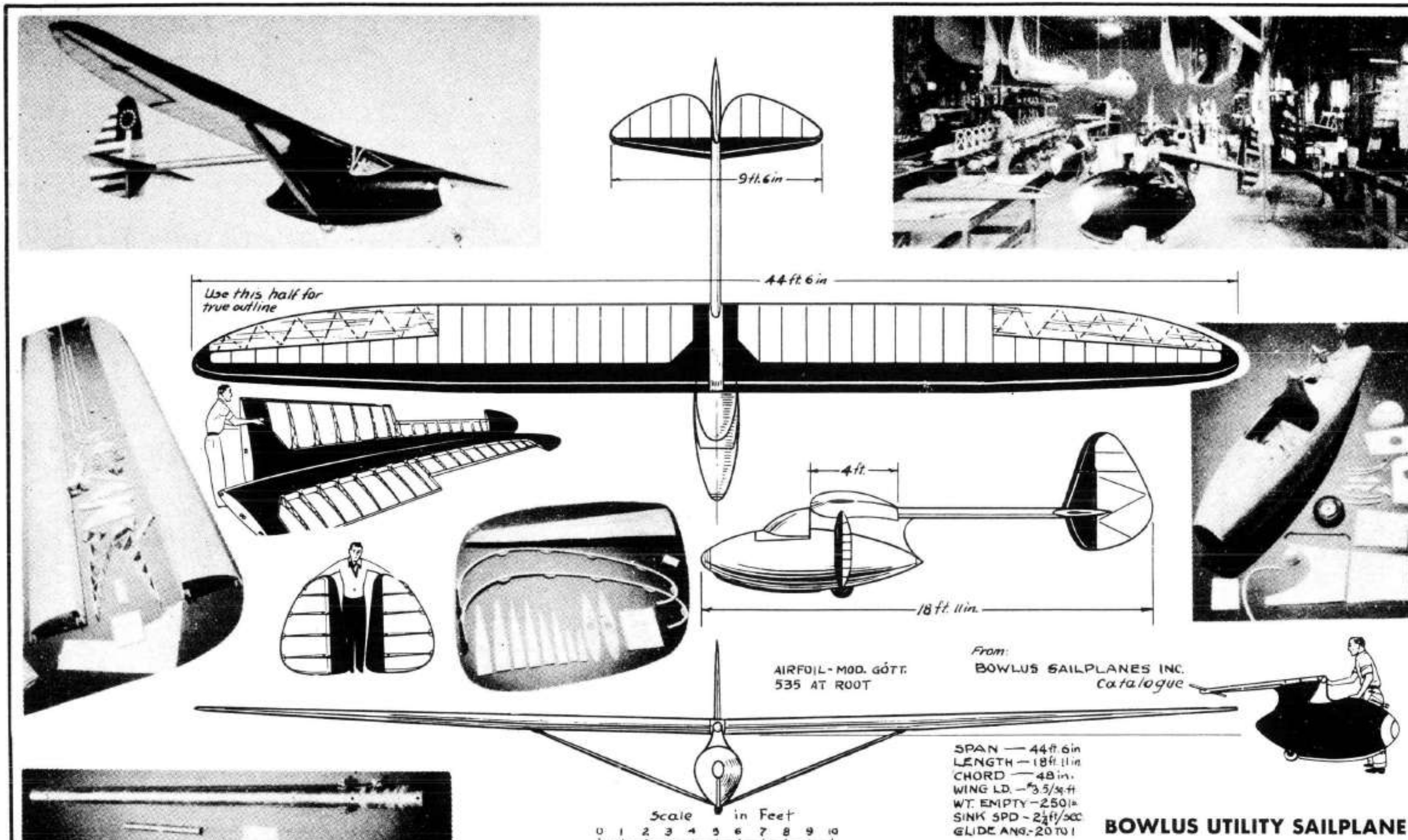

FUSELAGE
SHAPED FROM
2-LAM. BLOCK
HOLLOWED TO
1/8 WALLS-WINDOWS
PAINTED BLACK
MAYBE CUT OUT
1/8
TAIL SURFACES
1/8 STOCK STREAMLINE
5
4 1/2
24
4
WING SECTION
1/4 AT CENTER - 1/16 AT TIPS
KEEP CAMBER FULLSPAN
10 NOUGHT SAND
3 COATS OF POLISH
TIME 5m 29s
ALL BALSA TOWLINE GLIDER
by J. EGGLESTON OMAHA, NEBR.

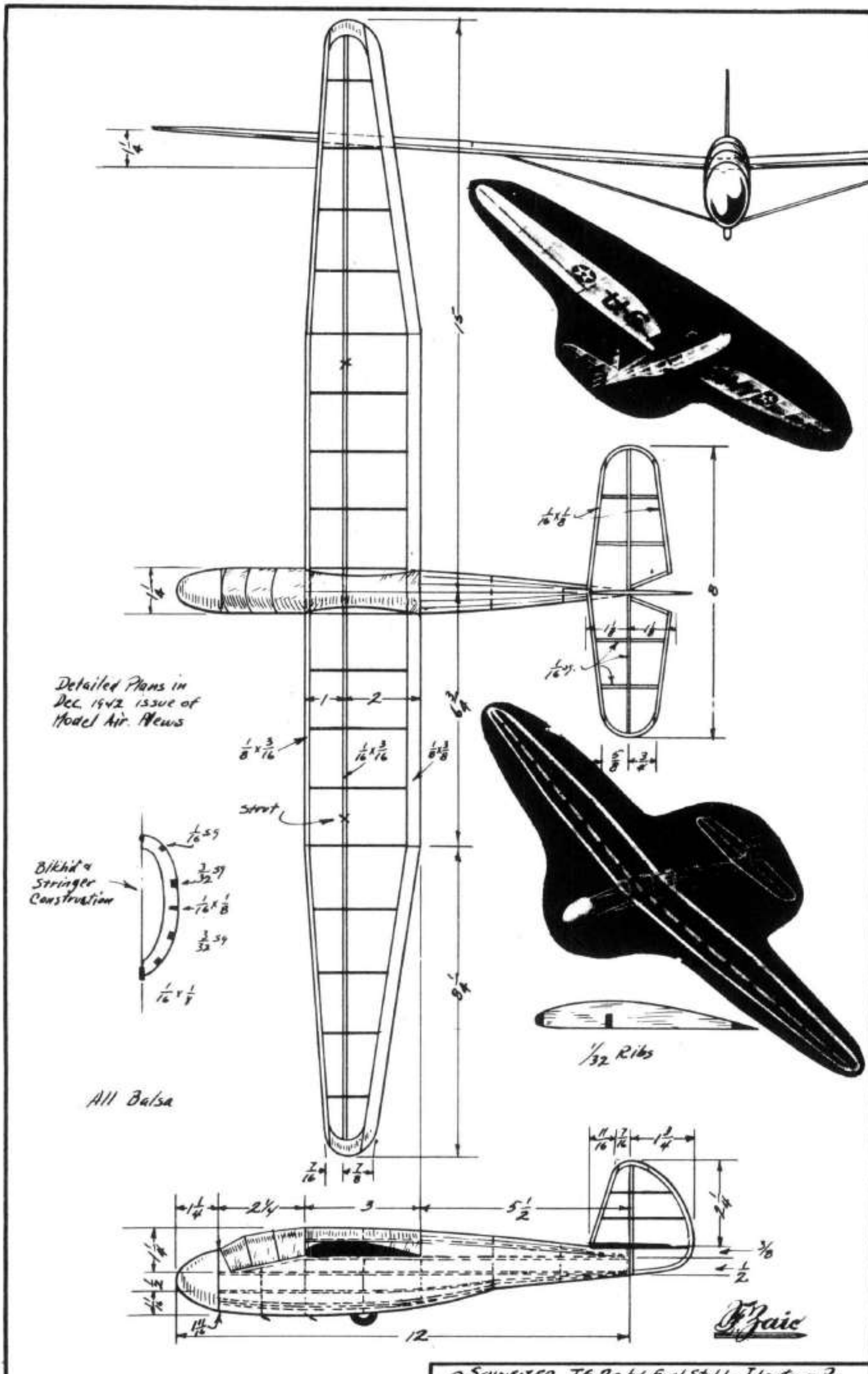

8
2
WT. WITH ROCKET 2 oz.
1/4
7/32
20
3 5/8
2
1 5/8 DIA.
1 1/8
2 3/8
-2°
9 1/8
1/4
3/4
ROCKET TUBE
0°
8
ROCKET PLANE by G. HAASE - FRANKFURT/M, GER.

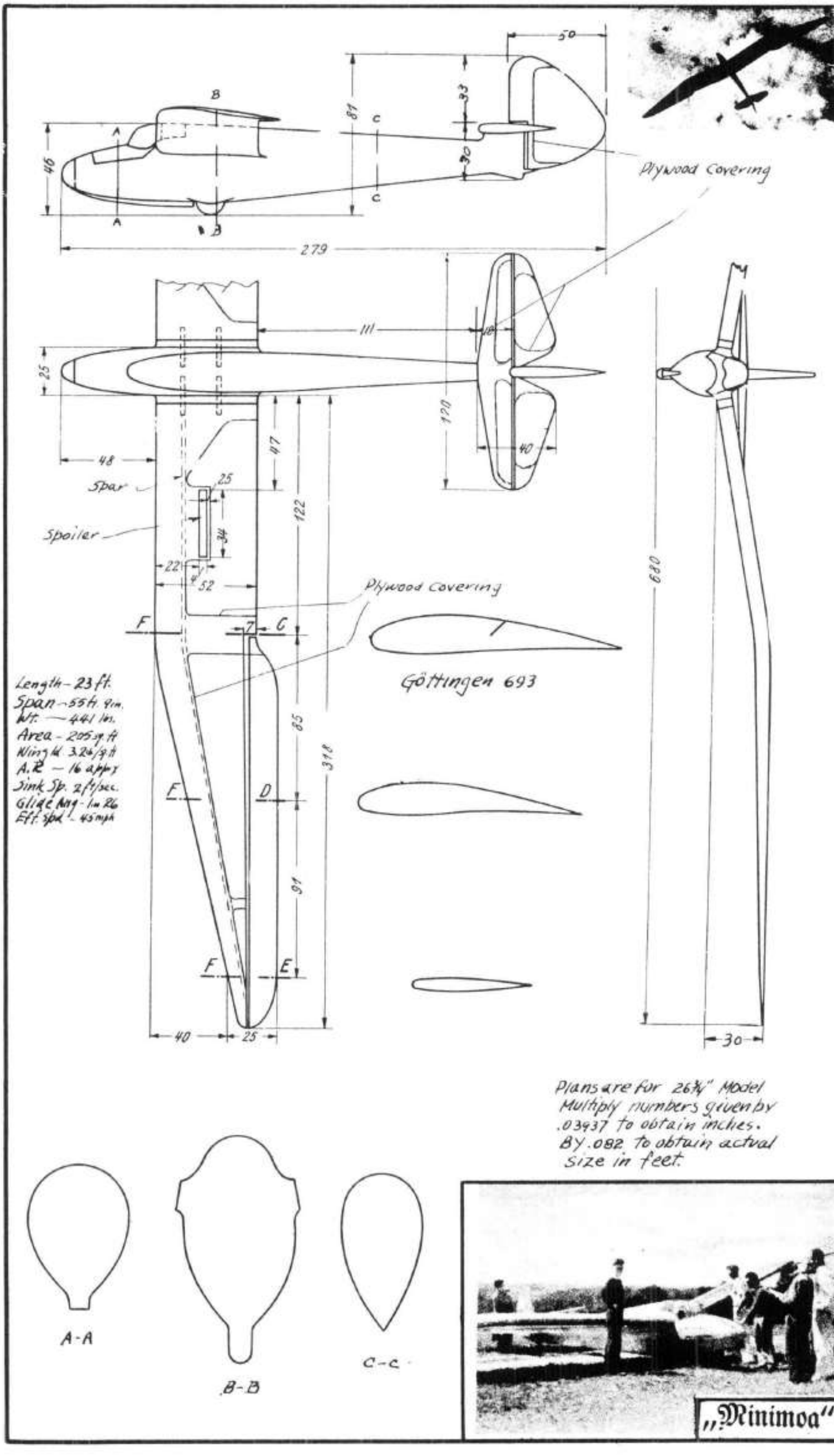

CHICAGO AERONUTS
WING 1/16 SHEET
BAMBOO BOOMS
3/32°
1/64°
8
FILLETS
WIRE CRADLES
1 7/8
3 3/4
7/8
3
7/8
7/8
1/16 STOCK
MODEL USED IN ORIGINAL DESIGN-EVENT
USE QUARTER GRAIN
ROCKET PLANE
TAIL 1/64 SHEET
HOLLOWED BLOCK 3/4 x 7/16 x 3 1/16
3/16
9/16
BALSA TIP
POWER STANDARD ROCKET SUCH AS 1¼ NIGGER CHASERS
5/16
by H. NEGRI - CHICAGO ILL.



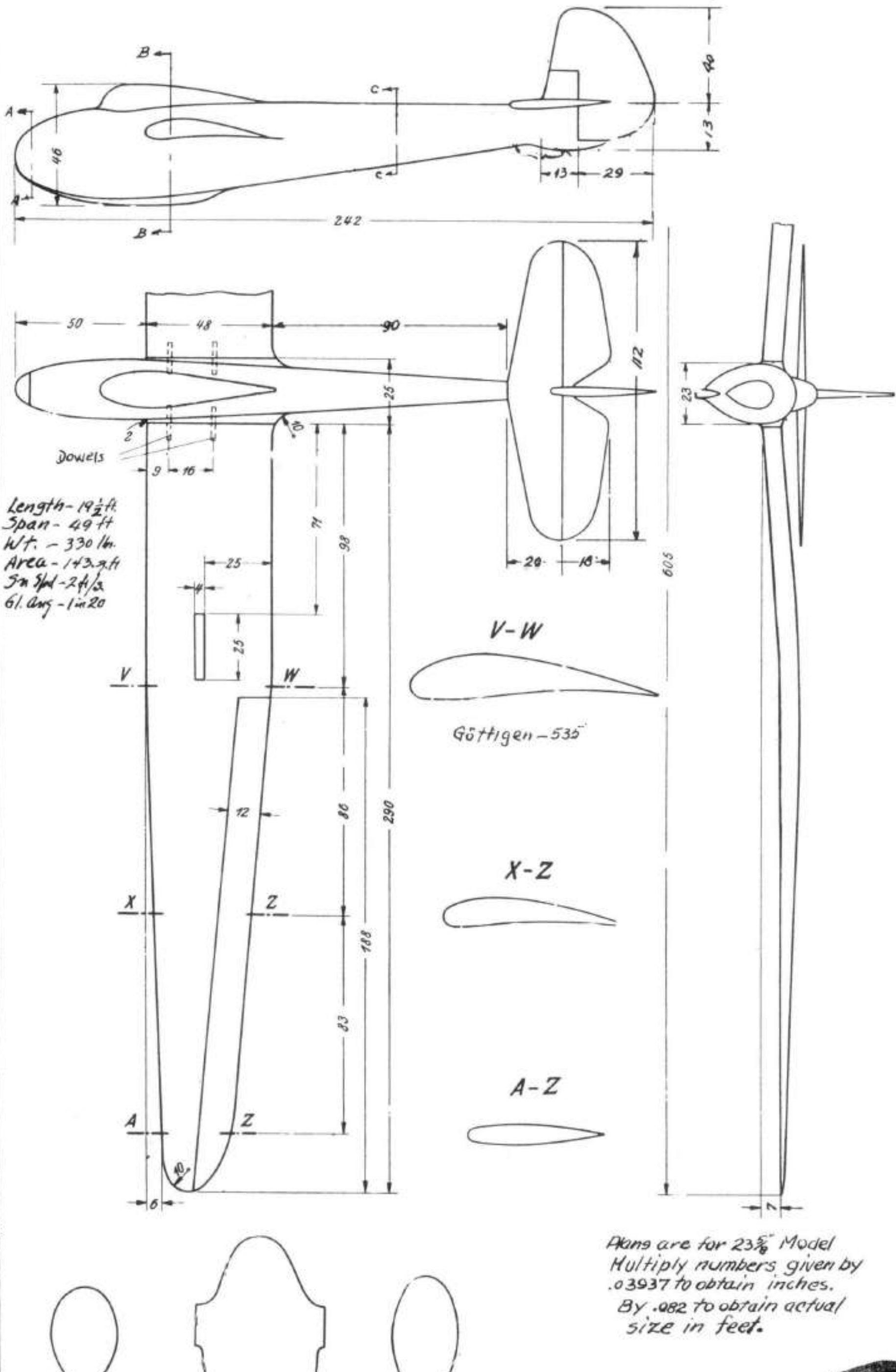
1 1/4 DIHEDRAL
a
METAL CLAMP
.040 WIRE
1 3/8 RIGHT
1 1/2 LEFT
1 5/8
1 1/4
TUBE
3/8
COILED WIRE FOR BEARING OR BEADS WITH END WIRE LOOPS
7/16
1
1
CRANK .050 WIRE
170°
1/8 x 1/4 HARD
TUBES
3/4
3/16
13
3/32 sq.
2 3/8
2 5/8
3/32 sq
SLOW SPEED AIRFOIL
3/32 x 3/16
3/32 sq
BALSA USED
2 1/8
4 3/8
12
1/8 x 1/4
3 3/4
1/8 x 7/64
3/32 x 7/64
FREE EDGE
BAMBOO OUTLINE
PAPER
12 1/2
1/16 sq
4
6 1/2
PERFORMANCE
GOOD & STABLE FLYER
CONSISTANT 35s FLIGHTS
ON HAND CRANKING
REGULAR AND SLOW
WAVE FORM OF POWER
FLYING - EXCEPTIONAL
GLIDE - WITNESSED
BY EDITOR
2 3/8
2 5/8
3/32 sq
5 1/4
3/32 FRAME
PIVOT
7/8
2
1 1/2
1 3/8
17 1/2
17 1/2
FROM PLANS APPEARING IN APRIL 2, 1938
"L'AVIATION BELGE" - THROUGH COURTESY OF N.S.F.K.
ORNITHOPTER - by M. ALEXANDER LIPPISCH - DARMSTADT, GERMANY

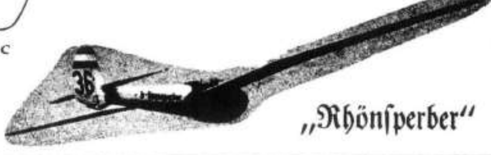

9 ft. 6 in
44 ft. 6 in
Use this half for true outline
4 ft.
18 ft. 11 in.
AIRFOIL - MOD. GÖTT. 535 AT ROOT
From:
BOWLUS SAILPLANES INC.
Catalogue
SPAN — 44 ft. 6 in
LENGTH — 18 ft. 11 in
CHORD — 48 in.
WING LD. — #3.5/sq.ft
WT. EMPTY — 250 lb
SINK SPD — 2¼ ft/sec
GLIDE ANG. — 20 TO 1
Scale in Feet
0 1 2 3 4 5 6 7 8 9 10
BOWLUS UTILITY SAILPLANE


Detailed Plans in Dec. 1942 issue of Model Air News
Blkhd & Stringer Construction
All Balsa
1/32 Ribs
strut
SCHWEIZER TG-2 by Earl Stahl - Johnstown, Pa.
Zaic


Plywood Covering
Plywood Covering
Spar
Spoiler
Göttingen 693
Length - 23 ft.
Span - 55 ft. 9 in.
Wt. - 441 lbs.
Area - 205 sq. ft
Wing ld. 3.26/sq ft
A.R - 16 appx
Sink Sp. 2 ft/sec.
Glide Ang - 1 in 26
Eff. spd - 45 mph
Plans are for 26¾" Model
Multiply numbers given by
.03937 to obtain inches.
BY .082 to obtain actual
size in feet.
A-A
B-B
C-C

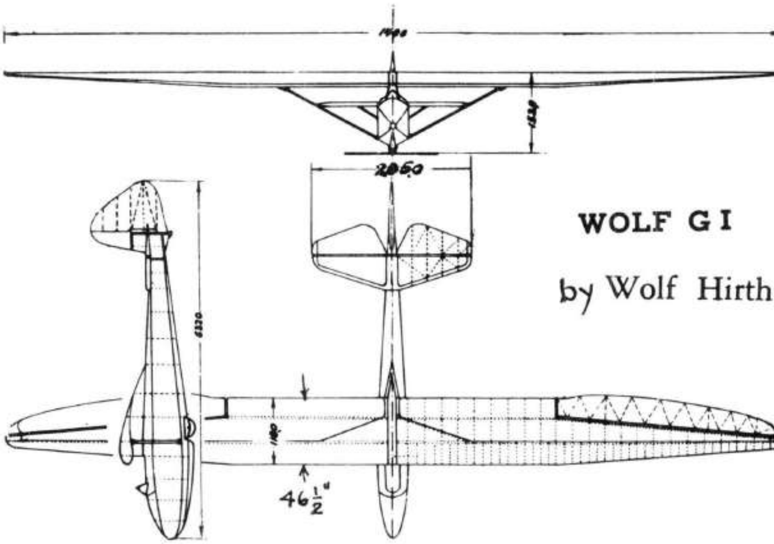
„Minimoa"





Modellflug

„Rhönsperber"

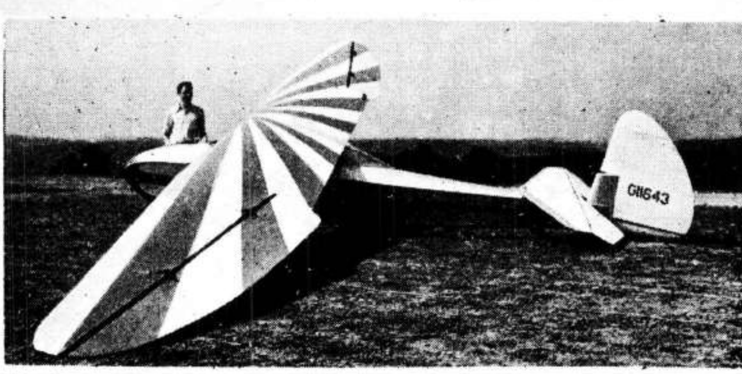


WOLF G I

by Wolf Hirth

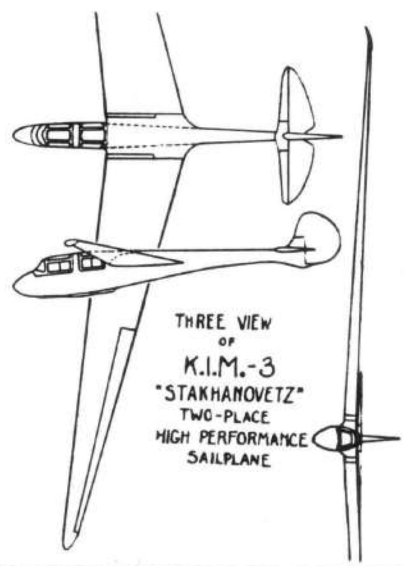
SPECIFICATIONS

Wing span—45 ft.
Length—20 ft.
Wing area—162 sq. ft.
Aspect ratio—1:14
Empty weight—290 lbs.
Useful load—200 lbs.
Total weight—450 lbs.
Gliding angle—17:1
Sinking velocity—3 ft. per sec.

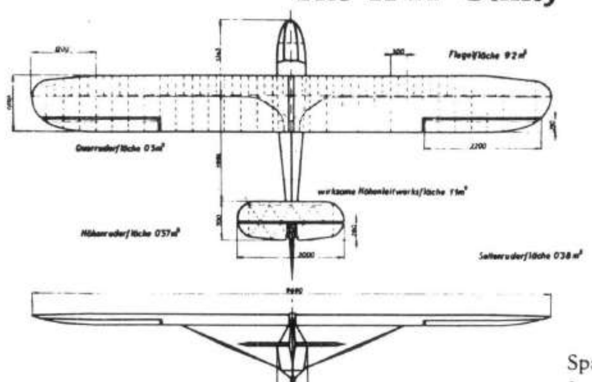


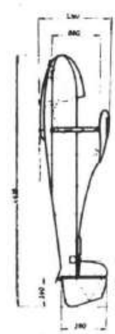
The K.I.M.-3 is better known as the two-seater "Stakhanovetz", with which the present world distance record for multi-place gliders was made by Pilot Kartasheff and his passenger, who soared 400 miles from Moscow to Tcheinigoff on July 22nd. The most notable feature of this high performance sailplane is the pronounced sweep forward of its wings, which allows perfect visibility for both cockpits, something that cannot be claimed for any other two-seater. Straight dihedral is used with the wing tip deflected downward to prevent tip and aileron damage. Although further details of the construction of this unusual design are lacking, the specifications and performance figures are as follows:

Span: 66.6 ft.
Length: 26.7 ft.
Wing area: 235 sq. ft.
Weight empty: 616 lbs.
Gross weight: 968 lbs.
Aileron area (1): 14.8 sq. ft.
Elevator area: 22.5 sq. ft.
Rudder and fin area: 11.2 sq. ft.
Cruising speed: 47 mph
Stalling speed: 32 mph
Gliding ratio: 1:25.5
Sinking speed: 2.1 ft./ sec.



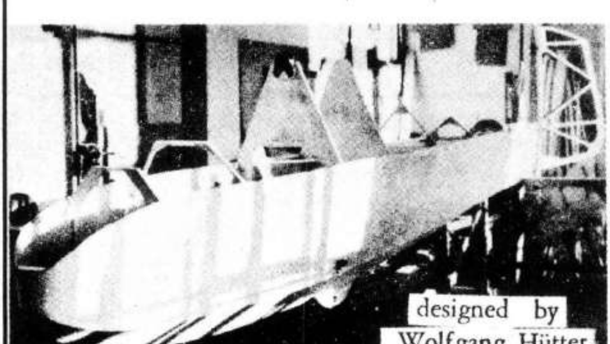
The H-17 Utility



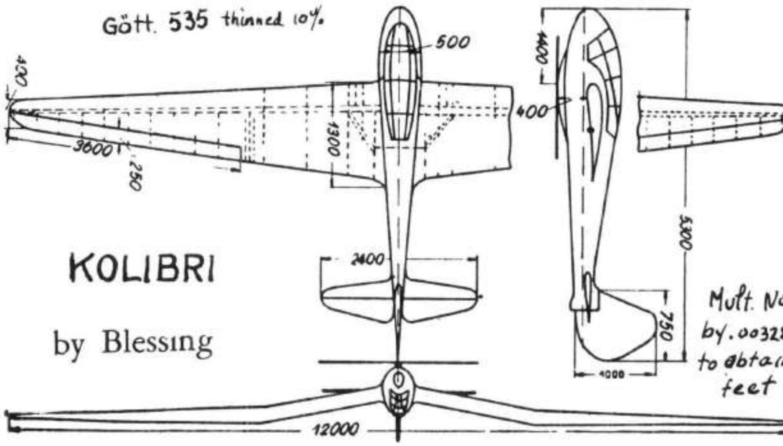


SPECIFICATIONS

Span—32 ft.
Length—15 ft.
Wing area—100 sq. ft.
Wing loading — 3.5 lbs. per sq. ft.
Cord—3 ft. 1 in.
Aspect ratio—11
Wing section—G-535
Empty weight—145 lbs.
Normal gliding speed—35 m.p.h.
Gross weight—345 lbs.
Useful load—200 lbs.
Gliding ratio—1:16
Sinking speed—3 ft. per sec.

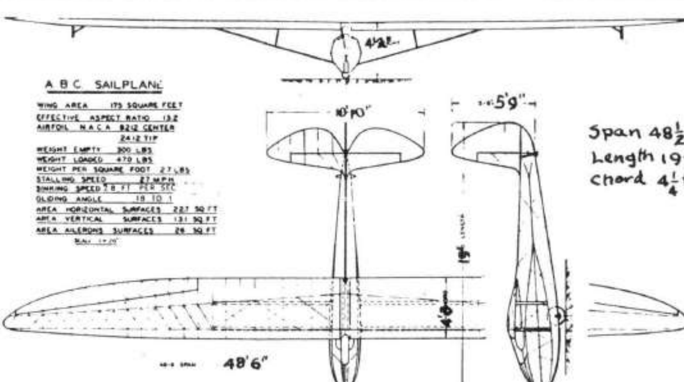


designed by Wolfgang Hütter



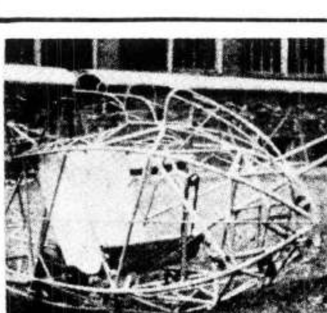
SPECIFICATIONS

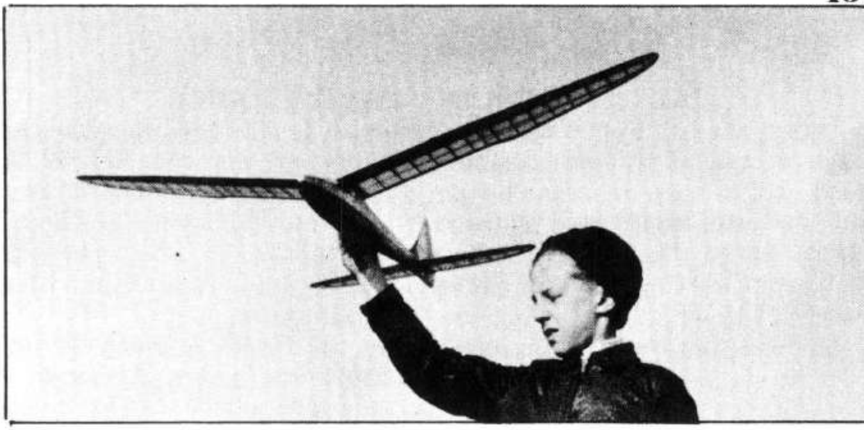
Span ..... 39 ft. 4 in	12 m.	Loading ...... 18 kg/m.²	4 lbs/sq. ft.
Length .. 16 ft. 5 in	5 m.	Weight empty... 106 kg.	233 lbs
Height .. 2 ft. 9 in	.9 m.	Gliding ratio...... 23:1	
Area .. 107.6 sq. ft.	10 m.²	Sinking speed .75 m./sec.	— 2½ ft/sec



The A.B.C. Sailplane

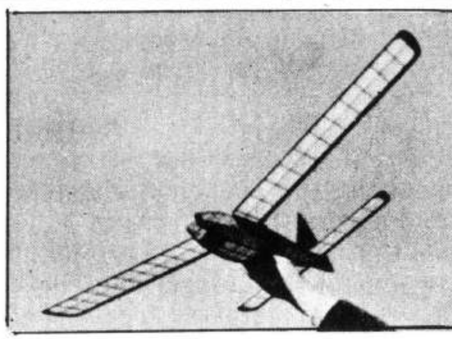
by Arthur Schultz



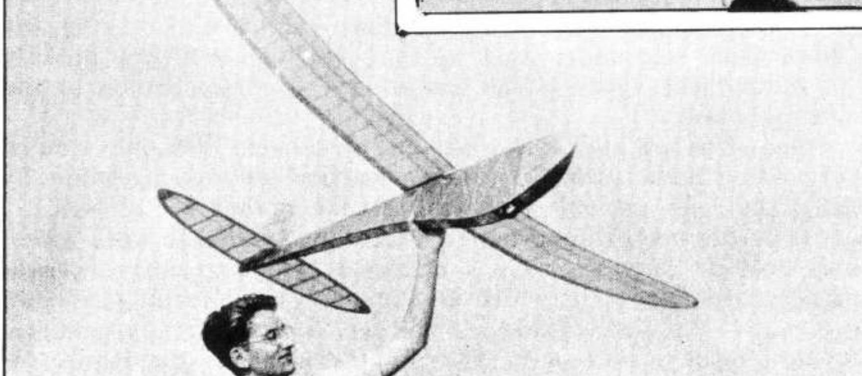


THERMIC "50"

TROOPER



RECORD GLIDER *by* GERES



EXTRAS

HOW TO KEEP THE FAMILY HAPPY

Since one has to live with his family, it is advisable to cause the least amount of trouble possible by being neat and considerate. A good way to keep everyone happy is to work on a large board. Not only does this board hold plans on which to work, but it can also be placed out of the way when the working hours are over. There is no need of wasting valuable time getting the table re-set every time you want to build. Just bring the old board down.

In selecting the working board keep the future in mind. If you plan to make large models, obtain a large size board. Although a drawing board is the ideal, any clear and level plank will do. Since one has to push pins into it to hold the work in place, be sure that it is made from soft wood. Keep away from composition or plywood boards.

WORKROOM

For those of us who are not blessed with special workroom or a basement, the kitchen is about the best place for working. Aside from having the refrigerator handy, this room is usually so organized that all utensils are behind glass or closet doors. All surfaces are of paint, tile or linoleum. This means that balsa dust or shavings can be easily gathered together after the work is done in the wee hours of the morn. When doing an unusual amount of carving, use a large paper bag under work so that shavings will drop directly into it. A large waste paper basket is a good companion to the working board.

Some of us are able to work in our own room. The only trouble that we may have is that we are liable to develop slovenly habits by letting the room get out of control so that mother will always bypass it during her cleaning tours. Therefore, try not to work where balsa dust or shavings have a chance to lodge in curtains, bedspreads, carpets or spots which need stooping for sweeping. We are sure that if you are considerate you will have no family troubles. If you happen to be one of those folks who blame the family for being unable to build, look at yourself for the basic source of trouble. As a rule, every family is proud of extra work done by its members.

LIQUIDS

Quality liquids have fair odors, and the family soon grows accustomed to them. Therefore check your liquid supply and use only those which have inoffensive odors. To prevent spilling or overturning, use containers with wide bases, such as cans. All containers should be kept closed to prevent evaporation and air-contamination. The accumulation of solidified liquid on container's opening can be cut off with a sharp razor. The critical period is the doping time.

Try to do this when the family is out. Perhaps if you mention the fact that you plan to dope your model on a particular day, they might take the hint and go to the movies. When using the thinner, work near window or some other well ventilated spot. Of all liquids used for model work, the thinner is the most serious nose-offender.

CLOTHING

So far we have failed to find anyone wearing an apron or smock while working on models. Since hands do get cluttered up with cement, dope and such, it is a very comfortable feeling to be able to clean the fingers by wiping them on trousers. Therefore wear clothing which can take it. White ducks are fine. If by chance some liquid drops on your best, thinner will usually remove the spot. Be sure to do so before sending the suit to the cleaner as some of them are not prepared to handle nitrated spots and they are liable to rub the spot too much.

SCALING PLANS

When working from full size drawings one should have no trouble in keeping to the exact dimensions. But when working from small plans it is necessary to draw full size outlines. When making full size outlines it is not necessary to draw all details. A wing, for example, only needs single lines for spars and ribs. In case of fuselage, draw the inside outline so that you can use it as a guide for cutting the uprights and for placement of outline pins. Incidentally, when cutting the uprights, make two of each so that identical sides may be had and time saved. When it comes to tip outlines and such, lay out the shape on stiff paper which can be used as a template. It is too difficult to make two identical shapes without the aid of template. Also make full size drawings of all wire items. Never try to fit celluloid over curved portion without first making paper templates which can be cut to shape without fear of ruining valuable celluloid. Once the cement touches celluloid, it cuts into it and ruins its transparency.

TOOLS

As in every field, it is the man behind the tool that counts. A model may be built almost completely with a single edge razor or razor knife. However, work will be found easier if the following are found on the table: Sharp knife which can be used for prop carving, small block plane needs only to be tried to make it indispensable, several grades of sandpaper, good round nose pliars ($1.00 up), soap or wax, steel edge ruler, "T" Square, triangles, French Curve, compass, drawing paper and thumbtacks, soldering iron, small vise, good soft brushes, hack saw, hand drill, files and many other items which one picks up during the building period. Sharp razor or knife or block plane is most essential because balsa wood is too soft for dull edges.

THE BEGINNING

Be sure to check over the supplies for their quality and usefulness. To prevent the work from sticking to the plans due to the dripping of the cement, coat all cement-point areas with Ivory soap, polish, candle or parrafin. This arrangement, however, will prevent the cement which is next to the surface from setting. So be extra careful when removing the work from the pin-jig and do not give it the famous static test.

When anyone mentions the long time required to build the model we wonder if the drying of the cement was used as an excuse to catch up on magazine reading. You will be surprised how fast a model can be built if the drying interval is used to work on some other part.

Specific construction highlights will be found under their particular headings. However, we would like to mention that you should not hesitate to change any construction which does not seem right. Some kits have very wide rib spacing. Use more ribs. Others have stringers lie flush with the bulkhead which makes an awkward appearance when it is covered. Sand smooth all knife or razor cuts which will be covered as the paper has a way of revealing the tiniest crack. Also be generous with the cement at vital parts. As you will find out, model cement is not an ideal adhesive for model work. Its only advantage is fast drying. Now that you have the proper atmosphere and advice, we will leave you to your trials and tribulations.

THE MATERIALS

After a builder has built several models he begins to get curious about the supplies he uses. At least that is the way we used to feel. When one begins to research into the supplies' background he finds that the whole world contributes material to the model airplane builders. Balsa wood comes from Ecuador, from a spot right on the equator and due south of New York City. Rubber is gathered in the jungles of Brazil. Cotton, which contributes cement and dope, comes from our own sunny South. Prior to 1939 the music wire was imported from Germany where it was converted from Scandinavian ore. We now have domestic wire. At one time Japan supplied the entire lot of covering tissue and silk. Now, luckily, we have domestic tissue which is superior in many way to the Japanese. Domestic silk has also taken place of Japanese silk. Aluminum comes from all over the globe. So, the next time you are looking at your wonderful model, consider the number of men, ships and trouble involved in the manufacture and production of the material from which the model was made. It is hoped that you will not bring their efforts to a mediocre end by poor workmanship and designing. So that we may be able to make better models more easily, the basic materials used for model work are hereby described in complete detail.

BALSA WOOD

Balsa is particularly adapted for model work because of its lightness and structure. It is made up of countless number of air cells. Like a bunch of tiny reeds cemented together. It is a natural monocoque construction. Such structure produces exceptional rigidity with low weight. It also allows the cement to flow into the cells and secure good anchorage. The trapped air helps in setting of the cement.

BALSA GRAIN

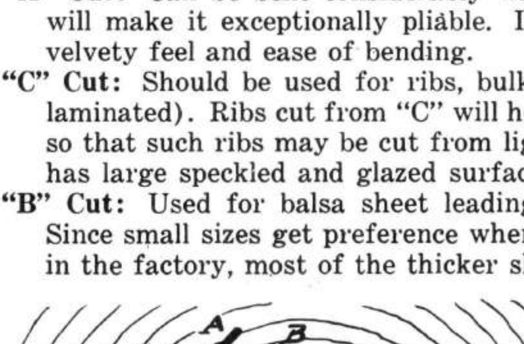
When a balsa log is cut in half it discloses a cross section pattern similar to regular trees. The only difference lies in the rate of growth. In common with ordinary trees, balsa possesses the well-known cut characteristics. For example, if a tree is sliced so that it produces a continuous plank or veneer, such a plank can be very easily bent into very small diameters. It seems that by bending along a year's growth, the difference in texture is null. But if a plank is cut right across the log, such a plank will be exceptionally rigid and it will tend to crack before it will bend. In lumber circles such a cut is known as quarter-cut (because if a log is spit into four quarters the grain will be as shown) and it is used for table tops and other items which must not warp. In the model world JASCO has tried to simplify the various cuts by referring to them as "A," "B" and "C" cuts or grains.

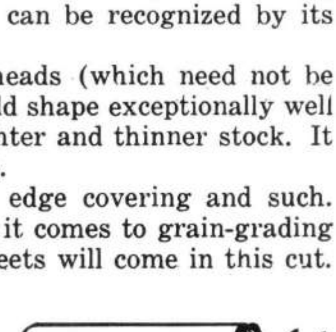
Balsa sheets cut along the A-A line follow a year's growth and their composition is more or less uniform so that it is especially suitable for tubular work. C-C cut provides laminar-like structure which is very stiff and rigid. B-B has the in-between characteristics. The specific uses for grain cuts are as follows:

"A" Cut: Can be bent considerably without wetting. Moistening will make it exceptionally pliable. It can be recognized by its velvety feel and ease of bending.

"C" Cut: Should be used for ribs, bulkheads (which need not be laminated). Ribs cut from "C" will hold shape exceptionally well so that such ribs may be cut from lighter and thinner stock. It has large speckled and glazed surface.

"B" Cut: Used for balsa sheet leading edge covering and such. Since small sizes get preference when it comes to grain-grading in the factory, most of the thicker sheets will come in this cut.





WEIGHT-GRADING

Although balsa is known as the lightest wood, it varies in weight from 3.5 lbs. to 20 lbs. per cu. ft. It was found that its weight is a good indicator of its strength. Two spars cut to identical dimensions will vary in strength according to their weight. That is: Spar cut from 12 lb. stock will be twice as strong as one which is cut from 6 lb. balsa. If we compare two spars which have same weight and similar type of section, we will find that their strength is the same, regardless of their actual dimensions. Ex: 1/8 x 1/2 spar cut from 12 lb. stock will be just as strong as a spar cut to 11/64 x 11/16 from 6 lb. stock.

HARD AND SOFT BALSA

There is, however, a distinction in the type of strength offered by hard and soft balsa. Spars cut from hard balsa will bend almost twice as much as same strength spars cut from lighter stock when similar loads are applied. This follows the regular beam formula. The lesson for us in this case is to use small and hard balsa spars when a great deal of energy has to be consumed. That is, when a wing tip hits the ground, a spar made from light balsa might snap at a comparatively small bending moment. While a harder and springier but smaller spar will absorb the shock by its ability to flex a longer distance. This follows the Energy Law which states that Energy=Load x Distance. By using this criterion we can classify balsa as to its specific use according to its weight. The Color-Code indicated below was adopted by the Jr. Aero. Supp. Co. Many other companies are now using the idea and the colors are pretty well standardized.

BALSA COLOR-CODE

LIGHT NATURAL: 3.5 to 5.5 lbs. Used almost exclusively for indoor work if stock is clear and without cracks. Perfect grade rare; about 10 bd. ft. in 1,000. Secondary light grade used for monocoque planks.

YELLOW 6 lbs.: Glider wings, planking, cowlings, fillets, fairing and wherever low weight bulk balsa is needed.

ORANGE 7-8 lbs.: Light stringers, leading edge covering, strong tubes, ribs, "Ritz wing," bulkheads, all balsa constructions folder prop blocks, outlines and where normal strength is needed. Better to use thick Orange ribs than thin Green.

RED 9-10: Large spars, outline trailing edges, strong ribs and bulkheads, husky prop blocks. A good all around grade.

GREEN 11-12 lbs.: Longerons, spars, strong bulkheads and nose plugs. Good all around stock for strips.

BLUE 13-14 lbs. Small size strips and spars which have to take punishment. All small strips (1/16 sq. and such) should be hard.

BLACK AND HARD NATURAL: 15 lbs. and over. Used for gas model work, glider fuselages and tail booms.

SECRET OF FINE WORKMANSHIP

One secret of fine workmanship is to use light and generously sized balsa wherever work is exposed to view, such as wing tips, cowlings, and balsa covering, and also where accurate shapes are needed. It was found that when balsa has to be cut by a template guided razor, hard grade will tend to divert the blade into the grain line away or into the template, and thereby making the job more difficult. No such trouble will be found when cutting light balsa. Since we have so many ribs in a wing, we can be sure of this chordwise strength without making the ribs from hard stock. Be sure to use "C" cut. When using balsa sheets for covering, use at least 1/20 stock. Thinner sizes which are difficult to obtain true, will tend to sag between supports and provide very little leeway for sanding rough surface. By using thick but light balsa, the work can be sanded evenly and smoothly so that the job will look fine.

STRENGTH NOTES

Balsa is strongest when under direct compression. Just think of how much strain a rubber model fuselage has to sustain. As long as balsa is under direct compression it will be very strong, but as soon as it bends out of line, its strength drops off rapidly. Balsa will crush instead of cracking if the distance between supports is not greater than 8 x its smallest dimension. Ex: 1/8 sq. should be fixed every 1" to obtain maximum load possibilities. Beams must be used when there are long distances between supports. Multi-spar wings call for close rib spacing to preserve the small spars. In fuselage construction we get around the above limits by prebending the longerons, and prevent them from bending out under load with the covering. It is evident that they will not come towards center.

SURFACE FINISH

To obtain maximum strength all balsa material should have smooth and polished surface. This follows the general aviation rule which states that all corners must be rounded to prevent tiny cracks from developing into larger cracks, and surfaces polished for the same reason. So that you may judge this point for yourself, take a smooth sheet of balsa, run a tiny pin scratch across it, bend the sheet until it breaks. Nine times out of ten, the break will happen at the scratch. Now, it is difficult to obtain perfect surface on balsa. (JASCO, however, has developed a special saw blade which does produce fine surface. Although we are not permitted to describe the basic design of this saw, the idea behind it is to produce powder-like saw dust which does not lodge in the saw teeth and thereby not scoring the balsa as it is forced through the cut.) Therefore, if the wood is used on important spots, be sure to sand it smooth. A warning about sanding. Rough sandpaper cuts rather deep and breaks up the surface into countless scratches. #2-0 is a fair grade for rough work. Use 6-0 10-0 for finishing.

SELECTING BALSA

The balsa business is highly competitive so that some of the stock is not exactly as we would like to have it. Therefore, it is to your advantage to find a model shop which specializes in special contest balsa service. The next step is to find out when your local shop receives a new shipment. Stock up as much as your purse allows. Note how you can determine the Grain-cut by the surface appearance. If you make a fairly large purchase, the dealer will not be apt to put you into the "fussy" class, a classification everyone should try to avoid. A good mark of an expert builder is his ability to "see" good balsa when he sees it, and the eagerness with which he stocks everytime he runs over a good selection. It might be mentioned that you should try to obtain your sheet wood in 2" width. 3" is difficult to cut to true dimension throughout the length. The saw that cuts 3" has to be almost twice as thick as the one that cuts 2". Also, the grain and strength of a 3" sheet may vary a great deal on the same piece. Since so much balsa is wasted into sawdust, practically no manufacturer is foolish enough to discard uneven cuts and poor quality. If perfection is desired, be prepared to pay about 500% more, something no model builder is prepared to do. You should expect good quality and workmanship on 2" since it is much easier to handle.

LIQUIDS

The basic ingredients of model airplane liquids are nitrated cotton and solvents. Now, cotton is made of cellulose (an amorphous white carbohydrate (C6H1005) isometric with starch, insoluble in ordinary solvents, and forming the fundamental material of the structure of plants) which is insoluble in ordinary solvents such as acetone or lacquer thinners until it is treated with nitric and sulfuric acids. After the cotton is treated it still retains its physical appearance but it becomes a powerful chemical "stuff," and it can now be dissolved in acetone or other solvents. When the nitrated cotton is dissolved it just "disappears" but it produces a solution which when exposed to air will result in a clear and hard skin of celluloid-like substance.

The difference between the various liquids used by the model builders depends on the amount of nitrated cotton (and its "number") used in relation to the solvents, and also on the addition of other ingredients for special requirements.

CLEAR DOPE

Ordinary dope is a simple solution of nitrated cotton, solvents and plasticizers which provide flexibility.

CEMENT

Cement is similar to clear dope except that more cotton is used per a given total. It may be mentioned here that model cement needs air to set. We can see this if we note that the solvent has to evaporate before the cotton will solidify. Therefore, when making laminations, do not work on them until the next day. In fact, model cement is poor for lamination work. Better use one of the new plastic power types such as "Weldwood."

BANANA OIL

About same as dope except that it is thinner and contains a combination of solvents for specific reasons. It will leave a thin hard and flexible skin.

COLORED DOPES

Mixture of clear dope, colored pigments and gums which produce gloss. Colored pigments are made from clay which has been color treated and all that goes with it.

GLOSS SOLUTIONS AND LACQUERS

Basic solution of clear dope, gums for gloss, and plasticizers to prevent cracks when the surface is exposed to air and sun.

MICROFILM SOLUTION

A special mixture similar to lacquer. However, its plasticizer quantity and quality is carefully balanced to produce flexible film without tackiness.

HOW DOPE TIGHTENS

The clear dope tightens the covering by "wetting" the fibres so that they can work as explained under water doping. Besides that, the dope tries to maintain an unbroken surface while the solvents are evaporating and it follows the law that the shortest distance between two points is a straight line. When the dope is dry, the covering is more or less saturated with a celluloid-like structure.

Pigments and gums act like plasticizers by contributing bulk to the solution. When the solvents evaporate, these additions stay with the cotton. By being intermixed with them, the cotton looses its contracting properties by loosing connections with itself, so to speak. This is why color dope is more liable to loosen the covering than tightening it. Also, such solutions are considerably weaker than straight dope. Just remember the behavior of the cement when you tried to cement a joint which was covered with colored dope. There is not enough cotton to affect a good junction.

WHY DOPE AND CEMENT BLUSH

Whenever a rapid evaporation takes place considerable amount of heat is being used up. Therefore, when the solvents evaporate from the dope or cement, the temperature of the dope and the air above it is lowered. All ends well if the air is dry. But if the air is not dry but has an overabundance of water vapor in it (humidity), the result of cooling the air will be to make the water vapor condense into liquid water on the surface of the cement or dope. Since moisture on the surface of the wet dope or lacquer precipitates the nitrocellulose out of the solution, thus giving the white appearance known as "blush".

The quality of the dope or cement determines the conditions under which blushing will occur. Good cement and dope will not blush under normal conditions. While poorer grade will do so almost every time. Temperature and the humidity of the air are the deciding factors. If temperature is low and humidity high, except blushing galore. If temperature is high and humidity is low, dope all you can. Offhand we would say that good conditions exist when the temperature is around 75° and the humidity is 40%. Next time you have trouble with blushing, check the humidity and temperature charts in your local paper. Rainy days are bad for doping and cementing unless you work in a heated room. Try not to use gas oı electric heaters to keep the humidity low. Always remember that model liquids are high inflammable. If you have any sense of responsibility, always keep a pail of sand handy, especially if you are working on gas models.

Gums and plasticizers retard blushing by obstructing or slowing down the escapment of the solvents so that they have to take more time to evaporate out of the solution.

HOW THINNER REMOVES BLUSHES

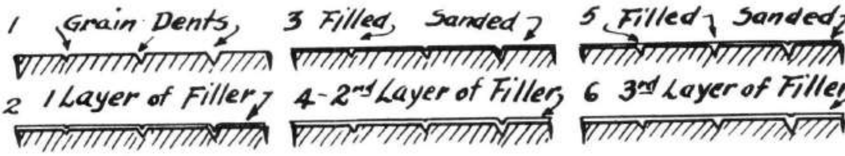
When we apply thinner over a blush we can see that its action is to dissolve the dope or cement, and as the dope redries under more favorable conditions, the blush disappears. Removing blush from colored dope is more trying as the thinner tends to spoil the surface. It might be mentioned that blushed dope or cement is much weaker than normal. So try to use the better grades which tend to blush only under abnormal conditions.

BALSA FILLERS

The purpose of the filler is to even up the surface of the balsa by filling up the grain dents. There are many commercial preparations which can be used on hardwood and metal, and even on balsa if weight is not important. But if weight is important, use a filler especially designed for balsa, such as JASCO Wood Filler. This particular filler is composed of plasticized clear dope so that it will not warp thin balsa, and the "filler" portion is made up of white powder which "takes" to dope. It might be mentioned that this particular filler was developed by Roger Hammer.

HOW FILLER WORKS

The first layer lays an even skin over all. This must be sanded until the wood is exposed. Shallow grain holes are now filled. See sketch. Keep on adding more coats with intermediate sandings until all holes are completely filled. Be sure to sand well or you will find yourself with lumps here and there and everywhere. Remember that the purpose of the filler is to fill the pores, and that it needs work as no filler will do the job by itself. It is best to sand after every coat.



PREPARATION FOR FILLING

Before applying filler, coat the surface with one or two coats of clear dope. This will saturate the balsa with dope and prevent the filler from going deeper than necessary. (If surface is thin and liable to warps do not use dope.) The first two or three layers of filler should be sanded with dry paper. After that, if you are sure that the surface is water-proof, use wet sandpaper. This will make it possible for the paper to bite deeper without becoming clogged. Warning: If the water seeps through the upper coat, put the work away to dry because the filler will peel off the wet or moist balsa. You are now ready to apply colored dope.

COLOR DOPING

Colored dopes are basically made up of clear dope and pigments which are made from colored clay. As a rule, colored dopes are too thick to be used directly on the model. Thin them about 50%. About two coats will suffice for paper trimming or coloring. Be sure to apply one or two primary coats of clear dope before using colored dope. (Use colored paper whenever possible to save weight.) When trimming, be sure to use masking tape which should be firmly patted against the surface to prevent under creeping.

In Color Doping balsa, prepare it by applying one or two coats of clear dope, several layers of wood filler, and then the colored dope. Use a good, soft sable brush. Apply two coats. Let them set well. Sand down with W/D carborundum paper such as 360A. When all is smooth and worked down, apply two more coats. Always be sure to let every coat dry well before adding more. Otherwise you will be working on gelatin-like matter. Four coats will do for ordinary work. After slight sanding with 360A, finish with 400A. Although colored dope has a gloss if it is not sanded, it is of flashy type which does not look good. Therefore, after sanding with 400A, apply two coats of Banana oil, gloss solution or clear lacquer. Rub off the "flashy" look with some rubbing compound. Bring out that hand rubbed lustre with a polishing wax. Note: Use wet sandpaper to prevent rising of "heat" blisters.

STRIPING

It is easy to make pin-stripes and scallops by using Scotch Masking tape. When using tape be sure to tamp or press it well against the surface so that the dope will not leak under it. Use fairly thin coats. If a dark shade is applied on a light background about two coats will do. Remove the tape while the dope is still a bit sticky, after allowing about ten minutes for setting, so that the dope will ease down at the edges and eliminate the ridge. However, if the tape is removed too soon, the dope is liable to flow off the line. The nature of the tape allows formation of severe curves. Just try it and be surprised. It can be obtained in model shops in 5 cent sizes. For economy, buy it in a paint store in larger rolls.

DOPING THIN BALSA

Ordinary dope warps thin balsa. But since some protection has to be applied, and the surface fuzz laid low, we can use dope which has been plasticized. Castor Oil and Trycresyl Phosphate make good plasticizers. Commercially, such items are known as Glider Polishes, a trade name originated by Jr. Aero. Supp. Co., which also developed the first solution suitable for glider work. Glider Polish may be spread over the surface with fingers. In fact, light balsa may be treated by pouring a narrow stream of Polish along the span, and then spreading it over the entire area with fingers, and keep on rubbing the area until the polish has dried. This will produce a fairly good finish. Slight touch with 10-0, sanded side first, and then the paper side, will finish the job. Sandpaper suitable for rubbing down are graded from 6-0 to 10-0 in the dry type, and 360A to 400A in W/D. Coarser papers will not do.

POWDER CEMENTS

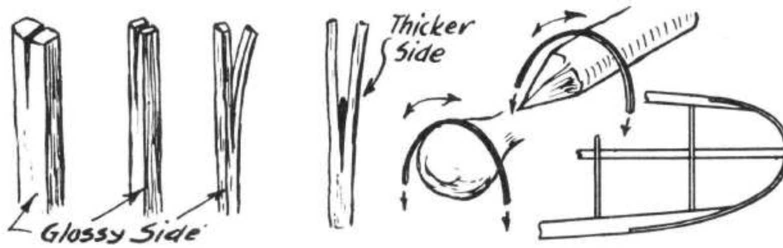
Recently, several new types of powder glues have been placed on the market. They should not be confused with casein type. The new type is of plastic rosin nature. They are especially suitable for model work because they require very little water to bring them into proper consistancy. Ordinary casein glue requires too much water for balsa. Water tends to flow into the wood and make the joint uncertain. Another advantage of the new plastic glue is that it sets surprisingly fast, especially if the work is held over heat. Commercially these new glues are known as "WELDWOOD" and "CASCOMITE."

We have used this type of glue for lamination work and consider it superior to ordinary model cement. It has a good future, especially if we have trouble in getting regular cement. Try it.

BAMBOO

Bamboo used to be a vital item in model building. Its specific use was for wing tips, landing gears and bent ribs. Balsa now displaces it almost entirely, except for landing gear where wire is used, and for holding the rubber motor in the rear. When you have an occasion to use bamboo be sure to use that portion which is next to the glossy side. This portion is the strongest and it can also be bent a great deal. Although it may be purchased in several strip forms, the best size is 1/16 x 1/4 because it may be stripped by yourself. There is a definite technique in stripping even strips. Start by stripping the piece in halves. Then keep on reducing each half into halves until the desired size is obtained. The inner white portion can be removed by bending it away as the knife is moved down. In fact, one can control the stripping procedure by bending away the side which is getting too wide.

Although it is possible to bend bamboo without heating it, the best results will be obtained by shaping it while it is warm. Bends made without the aid of heat have to be fixed at several spots to prevent warping. Soldering iron or electric bulbs will be found very handy. By gliding the strip over the hot iron it is possible to obtain all sorts of bends. It may also be heated by holding near open flame such as candle. Be careful not to char the bamboo as it will loose its strength. Pre-bent strips will offer very little trouble when cementing. Be sure that all bamboo ends merge evenly into the balsa portion.



COVERING MATERIALS

Paper is the most popular covering material, and it is always a source of surprise to us that paper can take as much abuse as it does. Regular model paper, both domestic and foreign has good strength characteristics, can be easily applied and cost is low. Of course, we should watch out and not use colored tissues which are used for wrapping presents. Silk is also used by those who can afford it and know how to apply it; although by using the technic developed by Paul Plecan the covering end is easy.

At one time we had to depend entirely on Japan for model tissue, and it was a mystery to us why no domestic manufacturer produced model paper as the market was large enough. Luckily for us few years ago a couple of companies did take trouble to develop domestic model paper. Perhaps the best known brand is the "SILKSPAN" which is manufactured by the Aldine Paper Co. of New York City. In answer to our request for technical information on paper, Mr. Walter T. Cusack, Manager of the Aldine's Industrial & Technical Department, sent us the following reply:

Until recently, covering paper was supplied exclusively by Japan. The paper situation has now changed, and the story connected with it is very interesting. Without covering material, obviously a plane cannot fly. With rubber powered models, fabric is of course out of the question for the weight would prevent the plane from staying in the air. Since the very beginning of model aeronautics, Japanese tissue paper has been the only material which had all of the essential properties for a good covering. Naturally one wonders why American paper was not good enough. The answer to this is that a very light weight tissue is necessary. Furthermore it must be extremely strong. This property is essential to prevent ripping by strong air currents when in flight, and a complete wreck of the plane on landing. No ordinary American paper possesses these qualities.

Japan makes paper from native fibres usually of the Mulberry family. These fibres are very long and thin. Consequently when made into a sheet of paper, the give it great strength. Furthermore they spread evenly into a fine mesh to form the finished sheet. In the United States on the other hand, the fibres of Spruce, Fir and more recently Pine are most commonly used in paper making, but their thickness and shortness prevents them from providing the strength found in Japanese paper. Even pulp produced from cotton or linen rags cannot be made into a sheet of satisfactory characteristics.

On the face of it, one would think that the continuation of model aeronautics would be bound to a foreign country for paper. The leading kit manufacturers conceded this, for they sent out hundreds of letters to American paper mills and tried in many ways to get a domestic source of supply. The only success they had was in getting some papers that could be used on gas model planes where their excessive weight could be carried without serious difficulty.

Finally American ingenuity succeeded in accomplishing what seemed impossible. Experienced model builders gave advice, support and encouragement to the Aldine Paper Company when we set out to produce a paper that would meet their specifications. After the groundwork was laid, these modelers tested and passed advice on samples given them until such a paper was gradually evolved. It required special vegetable fibres, equipment and processing to get the desired results. However, they have been obtained. What is more, the product in its present form has improved on the imported paper because it is more uniform, stronger and absolutely insoluble in water, having been treated to withstand most solvents. The builder can soak it in water and apply it like silk.

The development has been well named, "Silkspan," and application for registration of this name has been filed with the U. S. Patent Office. The process by which it is made has already been patented. This new American paper is made in two weights and four colors in addition to white.

Paper manufacturing is a detailed procedure but roughly, the pulp or base fibre is mixed with large quantities of water so that the relationship of water to fibre is less than one part of fibre to one hundred parts of water. This flows on to a rotating or traveling wire screen of very fine mesh. The water drains through the screen and the fibres remain on its surface. These wet fibres are lifted from the wire and carried through a series of felts and driers to ultimately emerge as a finished sheet of paper. In ordinary paper making, this process is carried out at high rates of speed. However, in the manufacture of "Silkspan" where the fibres lay upon the wire form such a delicate and thin web, the process is much slower and difficult to manipulate. What is more, a high speed operation could not possibly produce uniformity, essential to a satisfactory model airplane covering paper such as "Silkspan." A slow moving, closely controlled operation on patented equipment with special fibres not employed in ordinary paper making produce "Silkspan."

As every model airplane builder knows, it is possible to put the covering on in a relatively loose state and then shrink the paper to tightness through the application of water. This phenomenon is brought about by the characteristics of the fibres. Water will cause them to swell. Their expansion in breadth is made up by a shrinkage in length. Upon drying, they do not regain their original dimensions. All paper making fibres will do this. The chemistry and physics of this are still more or less theoretical. However, this is what happens

"Silkspan" is insoluble in water. The reason for this can only be partially explained. Ordinary papers are held together by sizing compound or binders or different varieties. If these are left out, as with blotting paper, the structure is very much weakened. What is more, when water is placed on ordinary papers, the sizing is dissolved and the fibre so lubricated that they slide away from each other very readily and the paper breaks down. "Silkspan" is so manufactured that water has no lubrication action upon the fibres to permit them to slide apart. The method of imparting this remarkable characteristic to the paper cannot be divulged and we must ask you to excuse us from giving any further details.

Perhaps your publication might be more in tune with the times if some mention were made of the effect that the war is having on our paper. In the first place, shortages of raw materials made it very difficult for us to maintain uniformity of quality. This makes it impossible to give you any table of physical characteristics, weight, strength, etc. What is more, the equipment on which this paper is manufactured is also engaged in manufacturing papers which are very essential to certain war uses. In addition to this, new specialty papers which we can produce are finding their way into the war program. Consequently, we must do everything we can to get the maximum amount of production from our machines. To do this, we have eliminated all colors in "Silkspan" for the duration of the war.

COVERING PROCEDURE

Covering is an art which can be easily acquired after few trials to find out how paper can be worked, and by following a definite procedure. Before attempting to cover, coat the framework with dope. This will keep the adhesive dope on the surface and also prevent water soaking if the covering material is used wet.

As a rule, the top of the wings is covered first. Cut the paper so that it will overlap edges about 1". Be sure that the grain runs spanwise. Paper shrinks most along the grain line. If the grain is chordwise, the shrinking effect will try to pull the paper into shortest possible distance between the leading and trailing edges with consequent deep sagging when the job is completed. Use regular dope as adhesive for light tissue, and half-half mixture of dope and cement for gas model grade and silk.

Start by tacking the paper to the middle of the center rib. When this is thoroughly dry, coat the end rib over its complete chord. Fix paper to it so that it will form a smooth triangle between center and top rib as shown. You may have to hold paper in place with hands while blowing on the adhesive dope so that it will set faster. Once this is done, lift up the triangular flaps and coat the edges with adhesive and pull the paper tight from tip rib towards the center. If the wing is longer than the paper, repeat in similar manner. Trim overlap with a sharp razor so that they will overlap only about 1/8". Brush-dope such overlaps to the spars. Note that there is no need of fixing the paper to every rib. When doping, the dope will flow through the paper and cement it to the ribs.

The tips always present problems as the paper must cover compound curves. If "Silkspan" is used, moisten the area and carefully pull the overlap so that the wrinkles disappear. If regular Japanese tissue is used, cut several segments. Then cement the segments from the trailing edge to the front. See sketch.

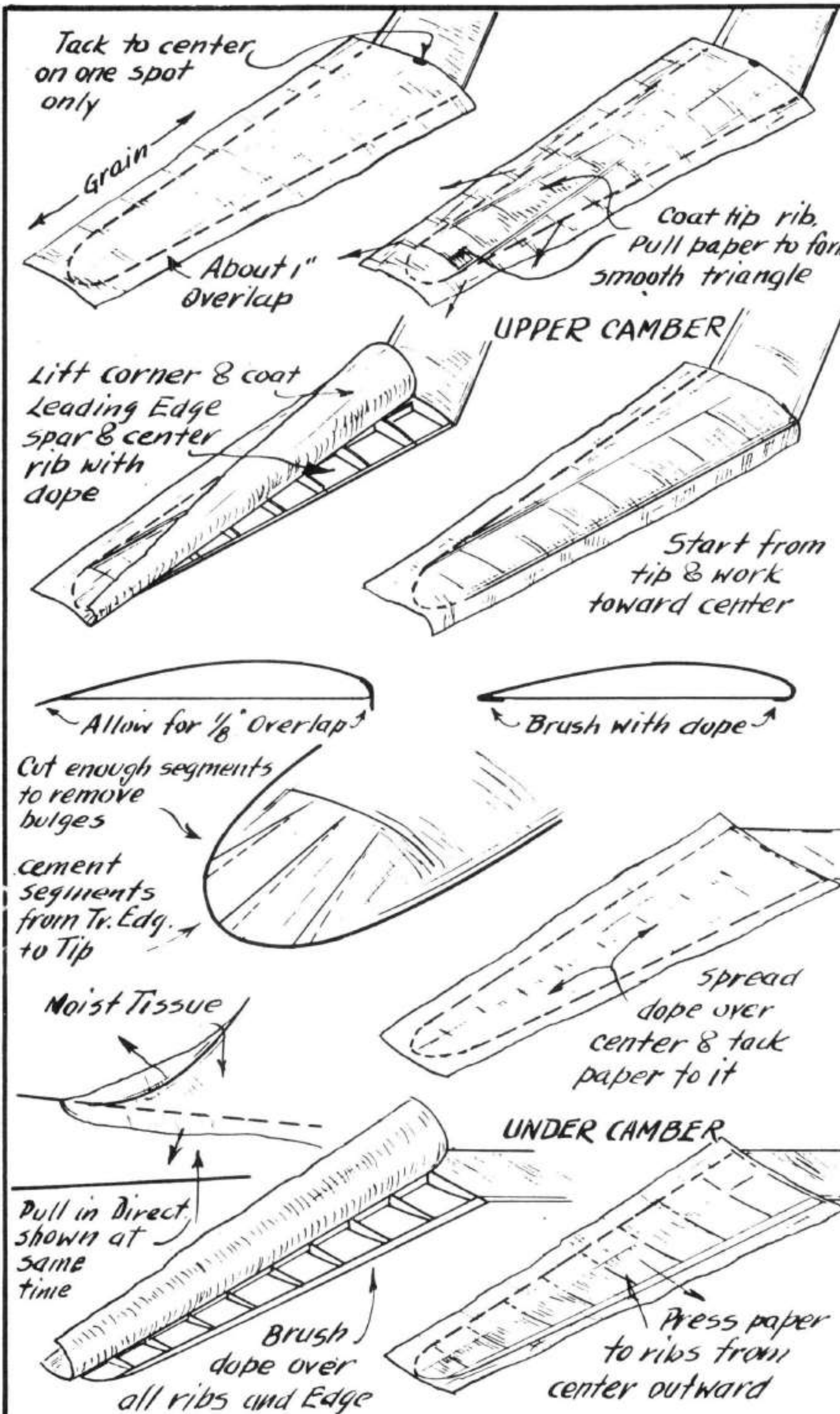
Flat surfaces should be treated in similar manner. Although most any method will do.

On under-cambered portion of the wing, the paper must be cemented to every rib before water doping. This can be best done by cementing the tissue along the center of the wing. See drawing. After this has set, each half may be treated individually. If curve is deep, the going may be gradual to accommodate the paper to the curve. By dividing the camber, the job is so much easier.

Double tissue covering is exceptionally strong, pleasing, light and smooth. The first layer is applied as described. Finish it completely with water and clear dope. Apply the second layer in identical manner, but have the grain run chordwise. Spray with water and finish with dope.

COVERING WITH WET PAPER

For best results cover with dry paper. When paper is used wet, it tends to sag much more between ribs after it has been doped than normally. However, there are many jobs which cannot be done any


Tack to center on one spot only
Grain
About 1" Overlap
Coat tip rib, Pull paper to form smooth triangle
UPPER CAMBER
Lift corner & coat Leading Edge spar & center rib with dope
Start from tip & work toward center
Allow for 1/8" Overlap
Brush with dope
Cut enough segments to remove bulges
cement segments from Tr. Edg. to Tip
Spread dope over center & tack paper to it
Moist Tissue
UNDER CAMBER
Pull in Direct. shown at same time
Brush dope over all ribs and Edge
Press paper to ribs from center outward

other way. This is especially true for round fuselages, fillets or sharp tapers. Use "Silkspan." Soak it in water and squeeze off the excess water. Use cement-dope mixture for adhesive. Such cement has slower drying quality which allows it to penetrate deep into the wet paper. When using wet paper, it is possible to work in small sections. Do not worry if the cement blushes and turns white. Whiteness can be removed with thinner when the paper is dry.

COVERING WITH SILK

Covering with silk used to be quite a job before Paul Plecan found out that by using wet silk the most severe curves could be covered with ease. Use the same covering procedure as given for tissue. You might have to wet the silk several times before you are finished. Be sure to tap over the cement area so that the cement will ooze through. Wings and other flat areas are easy. You might have trouble with pylon and round fuselages, which we can cover with one piece of silk. Use plenty of pins to hold the silk in place while you pull out the wrinkles. The reason that the wet silk can be worked so well is that when silk is wet its threads can slide over each other without friction. Dry silk threads present considerable amount of internal friction and a pull to eliminate a wrinkle may effect a large area when only a small portion has to be corrected.

DOPING

Water doping is essential after the covering is completed. Water tends to loosen up the internal stresses incurred during the covering and allows the fibres to set themselves according to the new loads. As you have already been shown, water also makes the paper fibres swell and so causing shrinkage upon drying. Use a good insect sprayer to do the spraying job. As a last resort, a piece of absorbent cotton may be used to make the paper wet. Since most of our fingers will have cement edges, it is dangerous to touch wet paper with them.

In a good many cases only one coat of dope is necessary to preserve the tightness and close up the pores. But as a rule, two coats are used. It is not advisable to use more. The paper might become too brittle and tear when the model makes a hard landing. Silk can stand about three coats. This warning can be more clearly understood if we realize that dope is nothing else but celluloid in liquid form. When it dries, it grips the paper fibres in a solid sheet. So that when a tear starts, it is very easy for it to continue as only one fibre at a time is attacked. The action is of shearing type against which the fibres may not have strong resistance. As you probably know, after several months the wing covering becomes brittle because the plasticizer has evaporated. So do not be too anxious to put on many coats. Just try tearing an undoped silk and compare its resistance against silk which has been doped. Usually Bamboo paper, and silk sometimes, has to be sanded with fine sandpaper to remove fibre ends which stick up after doping.

COLOR VISIBILITY FOR MODELS

Red may be the best color for auto signals, and orange yellow or vermillion orange for aircraft visibility. But this should not lead us to think that they will also be best for models. It is true that as long as we can see the actual color, the visibility of the mentioned colors may be best. But models are small and they soon pass beyond the point where the color can be recognized. Beyond that point the colors merge into shades of black and white. For example: Dark red may become dark grey. While yellow may become light gray. Therefore, it seems that we should be more concerned about getting the contrast of shades on our models rather than high color visibility. Bob Copeland uses black fuselage and rudder, and white wing and stab. Such a contrast shows up black against the white cloud, and white against blue sky and green ground. Dark blue fuselage and rudder, and yellow wing and stab serve some end. Dark red will tend to give dark shades. The Placement of colors can be reversed of desired.

In checking over the colors available in model tissue it seems that only black, white, red, yellow and blue can be used for shade contrast. Orange is much too pale, and like green, neutral.

Visibility depends on the size of the object. We should therefore use the full span of the wing or length of the fuselage as the shade carrier. If we were to break up the wing into two color halves, we may be only able to follow one half of it which would cut down the distance. It is all right to run a trim line or a sheet covered leading edge along the front of the wing, providing it is not too wide. We only have to notice camoflaged planes and ships to see how visibility may be lessened by breaking up the colors.

We have a slightly different problem when we use colored dopes because they have solid matter which may give the surface a light color yet present a dark shade when held against the light or sun. For example: A wing doped with white dope may have enough opaqueness to cause a dark shadow underneath. Evidently, the shade value will be no longer light, but dark. We must remember that when the model is flying it is almost always between the light source and the observer, rather than being seen with the light behind the observer. Therefore, if you expect to use the color as a light shade visibility aid, use just enough color dope to color the surface without making it lose its transparency.

SUN FLASH VISIBILITY

The visibility of sun flash dazzle was impressed on us while we were still youngsters. A bright shine way out in the fields would turn out to be a tiny piece of glass, rather than a diamond as we had childishly expected. The basic reason why a sun flash is so visible is that it consists of sun rays which are reflected by the glass or polished surface. Our eyes are normally adjusted to subdued light so that a pure sun ray has a very powerful impression on our vision, and we have no trouble in seeing a weak flash a mile away caused by an object which we cannot see across the street.

Some of us have tried to utilize this sun flash to aid model visibility. But there are many conditions which must be met to make it a dependable means. The sun, reflecting surface and the observer must be in exact coordination. If the model is between the sun and observer no helpful reflections are possible. A curved reflection surface provides better flash possibilities.

To be successful in obtaining sun flashes we must use good reflection surfaces. Ordinary silver dope will not do as it is made up of aluminum powder which break up the surface. Metal foils are best. Apply them with rubber cement which is best for this purpose. A good place to put them is on the curves such as the leading edges of the wing and tail, so that the chances of catching sun are increased. A metal foil streak line along the fuselage will help. A star or other insignias placed on wing and fuselage will also increase the chances.

COLORS AND COLOR MIXING

Red, yellow and blue are the primary colors. The secondary colors, orange, green and violet are produced by mixing the primary. That is, red and yellow give orange; yellow and blue give green; blue and red give violet. The tertiary colors, citron, olive and russet, are produced from four parts of orange and one part of green for citron; four parts of orange and one part of olive for russet; four parts of green and one of violet to make olive. The above colors, with white, black, gray, silver and gold are all that are necessary to make the modern industrial colors ordinarily used. Varying the proportions in mixing the colors will throw the resulting color to the shade desired. That is, if a light orange is desired, use a larger proportion of yellow than of red. For a dark orange, use a greater proportion of red, and so on.

Mixtures of colors to get certain results may be tabulated as follows:

Black and Red make Brown	White and Black make Gray
Blue, Red, White make Lavender	White and Yellow make Straw Color
Green and Yellow make Pea Green	Blue and Red make Purple

Blue, Red, and Yellow make Olive Drab

In mixing colors, add the darker shades to the light, as it takes a great deal more of the light shade to lighten a dark color than it does of a dark color to darken a light hue. A little experience in mixing and tinting with the shades of color that the painter may have available will enable him to match most colors quite successfully.

SELECTION OF COLOR AND COLOR COMBINATIONS

The selection of colors and color combinations for aircraft should be guided by (1) durability of some colors as compared with others, (2) visibility of the colors in the air and on the ground, and (3) pleasing color harmonies.

Greens, oranges, yellows, dark grays, aluminum and certain shades of non-fading reds (like Stearman Vermillion and Fokker Red) give better hiding and protection in strong sunlight.

White, light cream and light grays "chalk" more readily and hide poorly.

Dark blues, particularly, tend to brittleness, and should be used only over black undercoatings. Light blues tend to change shade on exposure. Some light reds and maroons, especially, as well as purple, are subject to fading.

All of these colors are used with satisfaction, but as explained, some are far superior in lending lengthy life to the finish.

NOTE: In the event that reds or light maroons are used as the final color, it is recommended that an under coat or ground coat of orange be used to assist the reds or maroons in hiding or producing a more uniform depth of color. If dark maroons are used as a finished color, it is recommended that a little black pigmented dope be added to the first coat of this color. If dark blues are used, apply a ground or under coat of black pigmented dope before applying the blue.

It is, of course, understood that light colors should never be applied over dark colors as it will be almost impossible to eliminate the darker shade no matter how many coats of lighter shades are used. Therefore, two-tone jobs should have their lighter color applied first and then the darker shade.

VISIBILITY TABLE

The following visibility table, as published by the Physical Society of London, showing the effective range of auto signals:

Color	Range in miles	Color	Range in miles
Red	3-3.5	Yellow	1-1.5
Green	2.5-3	Blue	.5-.75
White	2-2.5	Violet	.5-.75

Orange yellow to vermillion orange colors have been commonly accepted after many tests in actual aircraft operation as the most visible colors contrasting with land, sky, verdure and water. These colors are also durable and resistant to fading. It is small wonder then that they are so popular, combining as they do the safety factor of extra visibility and longer life.

Another interesting table by Le Courrier, taken from the "Scientific American," may prove valuable to those using planes for advertising purposes. It gives legibility of various color combinations:

Legibility Order	Decoration	Background	Legibility Order	Decoration	Background	Legibility Order	Decoration	Background
1	Black	Yellow	4	Blue	White	9	White	Green
2	Green	White	5	White	Blue	10	White	Black
3	Red	White	6	Black	White	11	Red	Yellow
			7	Yellow	Black	12	Green	Red
			8	White	Red	13	Red	Green

A listing of color combinations selected by a leading color expert specializing in color schemes for aircraft:

WINGS & STAB	FUSELAGE & RUDDER	STRIPING & TRIM
RED	RED	BLUE
RED	YELLOW	BLUE
RED	GRAY	YELLOW
RED	BLUE	ORANGE
YELLOW	BLUE & BLK	YELLOW
YELLOW	RED	GOLD

WINGS & STAB	FUSELAGE & RUDDER	STRIPING & TRIM
RED	WHITE	BLUE
GREEN	BLACK	GOLD
GREEN	GRAY	GREEN
SILVER	BLUE	ORANGE
WHITE	BLUE	BLUE
ORANGE	BLUE	ORANGE

SOARING IN A *Thundercloud*

Henry Stiglmeier

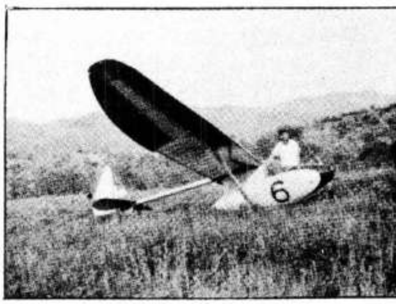
Friday, April 25, 1941, at the Fourth Annual Soaring Meet at Arvin, California, I got off on a winch tow at 12:17 p.m., in my Baby Albatross sailplane, and skirted the foothills for five miles in search of a thermal. Three hundred feet above the ground I found a weak upcurrent, and worked up to 1,200 feet altitude. Since my goal was Arvin, ten miles distant, and return, and I could not get higher, I set out toward Arvin. I worked two thermals to the last ounce of lift, and started back from Arvin with about 3,000 feet altitude. Thermals were scarce on the return trip and I flew in almost a straight line at a speed of about fifty-five miles per hour to a small cloud forming over the takeoff area. I found a thermal there and I decided to earn some points on duration rather than to land, since I could not see any other sailplanes in the air.

Clouds were forming rapidly everywhere in the vicinity. In a short time I was under the cloud base at 6,500 feet altitude. Rain was falling from some of the clouds over the mountains to the East. I flew in and out of the cloud base a few times to 7,000 feet altitude and then flew west to some smaller clouds. It was difficult to locate the upcurrents under the clouds, but I finally got up to the base of one again. If I could only get a couple of thousand feet higher, I thought. The same day I had had my first glimpse of the thirty-inch gold trophy offered for the best altitude of the contest. The memory was still fresh in my mind. The best height to date was about 9,000 feet.

I rose into the cloud and flew straight until I came out of its side. The altimeter read about 7,800 feet above take-off. I flew along the edge hesitatingly and then turned into the cloud again. I came out into the end of a cloud valley with about 9,500 feet. Only large white clouds were visible banked around me. About 1,000 feet more, I thought, and turned back into the cloud. 10,000 feet came with satisfaction. At 12,000 feet, the wings were dripping wet. It was like flying through a fog. At 13,000 feet, ice began forming on the wings. I tried to fly straight west to get out of the cloud, but the air was so gusty I could not hold the course. At 14,000 feet hail peckered the windshield like popcorn in a tin skillet. Then the ship started in a series of dives and stalls which I could not stop. I gave up the idea of trying to get out of the cloud and started circling. I thought I was turning left but the turn indicator showed right. I relied on my instrument and flying was smoother. I held open the wing spoilers, and searched for a downdraft in which to spiral. I had visions of meeting hailstones as large as plums and air as rough as a bucking horse if I got much higher. With joy I found a downdraft but it didn't last long. The sailplane and I were going up higher.

I released the spoiler control, but it didn't move. Ice had frozen the spoilers in the open position. The windshield was covered with ice. I could see only through the sides. The hail came in surges, and sprayed through small cracks onto my lap. My short-sleeved sport shirt was not very warm.

At 15,000 feet the hand of the altimeter completed one revolution. Both pellet-type rate-of-climb indicators had ceased functioning. Two bolts of lightning flashed by, giving me light shocks from the control wheel. Then the whistle of the wind ceased and the ship hovered. Here was a chance to put the plane into a spin. I pulled the control wheel back all the way. Then the ship seemed to fall, but the airspeed increased slowly. Soon I noticed that the airspeed showed zero. It had iced up too. The ship did not feel like it was spinning, but rather just circling. I held it in a right turn, and centered the ball bank indicator. The altimeter hand was well on its second revolution. I wasn't interested in it any more. Enough is enough!



Author and Ship after Flight.

I took a few deep breaths of air. It seemed fresh and cold. Doubtless the thin air at this high altitude was affecting me. I moved my fingers to keep up the circulation. My arms felt heavy. The hand on the altimeter had remained at 18,200 feet for some time. I waited and hoped for the end, whatever it would be. I had not moved the controls for some time and it occurred to me that they might be frozen fast. Carefully I tried the rudder. It was stiff! In a few moments I worked it loose. I did likewise with the elevators and ailerons. Thereafter I kept moving all the controls slightly and the ship responded sluggishly.

Since I had been flying blind for some time (about three quarters of an hour) I could easily have drifted over the mountains. I did not relish the thought of hitting a mountain peak which stuck up into a cloud. I watched carefully out of the side of the windshield where there was no ice. After a while I saw spots—actually white spots in the gray fog of the cloud. I blinked my eyes, and then the spots disappeared. While puzzling over this, I suddenly came out of the base of the cloud. Then I realized I was over a snow-dotted mountain top and not very far from it. As the ship turned I saw more mountains and then a patch of green in a valley. Immediately I headed for it and nosed the sailplane down for more speed to get away from the mountain. I tried to open the cockpit hood but there was so much ice around it that I could not swing it open. I managed to get a two-inch crack to peer through, and while maneuvering the ship so I could see better, a cluster of ice, which had begun melting, swept through the crack into my face. My glasses were fogged and I had to remove them.

Soon I was over the valley and began to fly in circles. Loud cracks could be heard about every five seconds from the ice melting off the nose of the glider. The plane responded to the controls better as the ice melted. It seemed as though the ship was coming back to life and I was tempted to try to stay up and fly back to the takeoff. However, with the instruments out of order, mountains all around, and my goose pimples, it was easy to forget it.

I surveyed the ranch below for ditches and fence posts while I descended. The landing was made on high ground in deep grass. I certainly felt good to walk on the ground again.

ELMIRA *to* LEWISBURG

by Richard Johnson

July 13, of the National Contest looked like a good soaring day. The cumuli were building up nicely. My ground crew and I rolled the "Baby Albatross" out of the hangar to the starting line and we installed the barograph as we waited our turn. As the ship ahead of me took off, I put on my parachute and climbed in. Just before the take-off, the barograph was turned on and the crew put the hood on. It was only about 10:30 A. M., but I wanted to get off early so that I could get my 5 hours duration for a Silver "C" license.

There was no slope wind, but there was a good cloud about a mile and a half to the northwest of the take-off field. I got a good tow to about 500 feet and then headed for this cumulus. The air began to get rough and the variometer showed a 10-foot per second rise, but I lost this without gaining altitude. I was then about 400 feet above the valley and I found only down currents under the cloud so I landed in the emergency landing field. My crew was down in 15 minutes with the trailer and we quickly disassembled the "Baby" and returned to the hill. In the meantime several ships got away.

As I took off the second time, there was a slight breeze. At 150 feet on this tow, the winch was pulling me 65 MPH which was 10 MPH faster than I had ever flown the ship and the air was rough so I quickly released and glided to the edge of the hill. With the light wind I was able to hold my own. About 5 minutes later a Schweizer 2-place took off and made a turn over the ridge then landed. I was beginning to lose altitude and when I got below the top of the hill, the air became violent. The Walters variometer went from 10 foot per second up to 10 foot per second down. There was not much chance of getting back to the top of the hill so I followed the ridge east in the direction of the airport in the valley.

About a half mile down the ridge I was able to rise to about 200 feet above the hill on the slope wind, which was smooth and pleasant to fly in. I hit a 10 foot per second lift once, but I thought it was only the slope wind until I saw a "Wolf" circling above me. I quickly found the lift again and circled it to 2700 feet where it weakened. In the meantime, the "Wolf" went north in the direction of the ridge. I had told my brother who was my crew chief that I would go south if possible, so I headed for the best cloud in that direction. I found that there were down currents between the thermals for the rest of the flight which made me stay with the thermals until they were dead.

I kept on going like this and while I was trying to get lift over some mountains about 10 miles north of Williamsport, I saw a "Minimoa" come from the direction of Elmira. I tried to follow it, but he soon was out of sight. By this time I was at 1800 feet and I needed altitude badly. I soon found a weak thermal and circled it for half an hour before I reached the cloud base at 5200 feet. I then headed for Williamsport and flew in some light lift for another half hour over the city at 4500 feet. It was the nicest part of the flight. As I cruised around, I could see sailboats on the river far below.

Loomis

Richard Johnson (right) with crew at Elmira

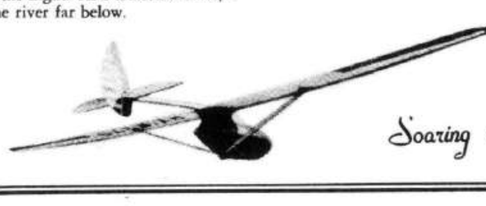
I then headed for some clouds to the south and found the lift weak. I wanted to be sure of staying up my five hours and the sky beyond was clear so I stayed with these clouds for the next hour and a half without getting to their base. All the cumuli during this flight were nearly flat and the lift was never strong.

After I passed the five hour mark, I flew south to get as much distance as possible. When I got down to 2000 feet, I did not find the regular down currents between the thermals as I had on the previous part of the flight. Instead, I flew at zero sink for long periods at a time. At 500 feet I picked out a clear field. I was very careful to approach it right. I went over the fence at five feet and at the same time the left wing tip touched the outer leaves of a tree beside the fence, but no damage was done.

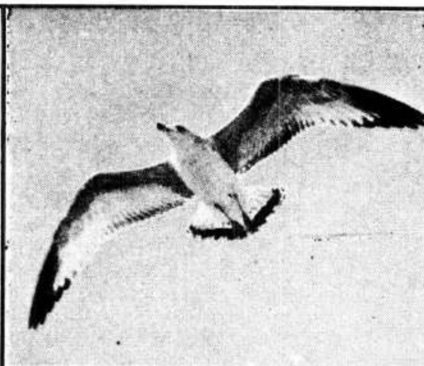
Within a few minutes, the owner of the field was out and drove me to his house to telephone Harris Hill of my location. My crew started out shortly after I had taken off and they went south, calling back to Harris Hill by telephone every hour. When they made their last call, they were within five miles of my landing place, Lewisburg, Pa.

(Ed. Note—The flight described above won for Richard Johnson his Silver "C" soaring certificate. He arrived at the Eleventh Annual National Soaring Contest with a glider, plenty of enthusiasm, but no licenses. He successfully passed his CAA private glider pilot's test, won his "C" early in the meet, and he finished third in the contest.)

Late Tuesday afternoon, Richard Johnson of Los Altos, California, the youngest pilot entered in the contest, age 17, earned his "C" license. This flight marked the beginning of a sensational performance by this pilot.

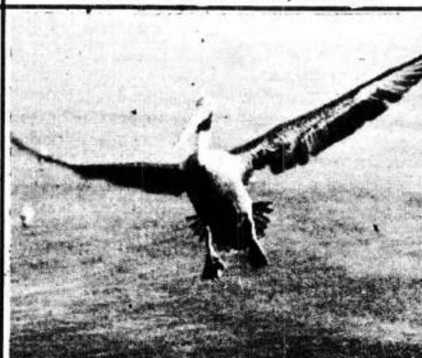


And this is how a pelican slows its flight on a sweeping turn.



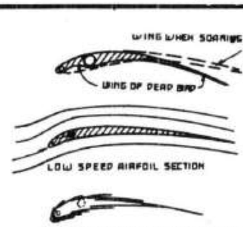
A sea gull slowing its speed with back-swept wings and heavy dihedral.

A frightened pelican puts on the brakes and stalls before the camera.



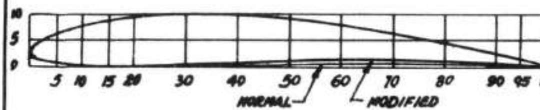
This pelican is in a tully stalled position with zero forward speed.

BIRD	WEIGHT (POUNDS)	AREA (SQUARE FEET)	SPAN (FEET)	LOADING (POUNDS PER SQ.FT)	ASPECT RATIO
STORK	4 7	5.6	6.85	1.4	7.1
TURKEY VULTURE	4.25	4 5	5 4	1.06	6.5
GULL	.94	1.5	4.1	1.03	11.1
HERON	3 5	4.26	5.45	82	7
PELICAN	14.6	10 7	9.2	1.36	8.1
PETREL	1.1	1.3	3 74	.74	9.3
ALBATROSS	25.38	8 12	12.3	3.12	18.5



And here we have a pelican gliding to a landing with negative diiiedral and flexed wing tips. The wings are compressing air against the water.

by RAOUL J. HOFFMAN



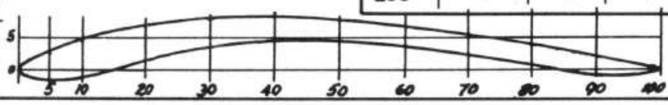
Göttingen 602

%	Upper	Lower Nor.	Lower Mod.
0	2.50	2.50	2.50
1.25	4.00	1.48	1.48
2.5	4.85	1.15	1.15
5	6.20	.75	.75
7.5	7.05	.50	.50
10	7.75	.40	.40
15	8.80	.20	.20
20	9.45	-	-
30	10.00	.05	.40
40	9.80	.15	.65
50	9.10	.25	1.00
60	8.00	.35	1.25
70	6.55	.45	1.15
80	4.75	.40	1.00
90	2.55	.30	.60
95	1.35	.20	.30
100	-	-	-

This section is used extensively on rubber and glider models, large or small.Very good results on small slow ships because of small drag increase owing to scale-efect.Concave recommended for small light models.With flat undercamber for lift stabilizers.-----Van Hattum

Marquardt S-2

%	Upper	Lower
0	0.0	0.0
5	2.35	-1.50
10	4.40	-1.00
20	6.70	1.50
30	7.80	3.50
40	8.30	4.50
50	7.90	4.50
60	6.90	3.90
70	5.60	2.60
80	3.90	.90
90	2.00	-1.00
100	0.00	0.00



Decimal Equivalents

	.015625	1/64
1/32	.03125	
	.046875	3/64
1/16	.0625	
	.078125	5/64
3/32	.09375	
	.109375	7/64
1/8	.125	
	.140625	9/64
5/32	.15625	
	.171875	11/64
3/16	.1875	
	.203125	13/64
7/32	.21875	
	.234375	15/64
1/4	.25	
	.265625	17/64
9/32	.28125	
	.296875	19/64
5/16	.3125	
	.328125	21/64
11/32	.34375	
	.359375	23/64
3/8	.375	
	.390625	25/64
13/32	.40625	
	.421875	27/64
7/16	.4375	
	.453125	29/64
15/32	.46875	
	.484375	31/64
1/2	.5	
	.515625	33/64
17/32	.53125	
	.546875	35/64
9/16	.5625	
	.578125	37/64
19/32	.59375	
	.609375	39/64
5/8	.625	
	.640625	41/64
21/32	.65625	
	.671875	43/64
11/16	.6875	
	.703125	45/64
23/32	.71875	
	.734375	47/64
3/4	.75	
	.765625	49/64
25/32	.78125	
	.796875	51/64
13/16	.8125	
	.828125	53/64
27/32	.84375	
	.859375	55/64
7/8	.875	
	.890625	57/64
29/32	.90625	
	.921875	59/64
15/16	.9375	
	.953125	61/64
31/32	.96875	
	.984375	63/64
1	1.	

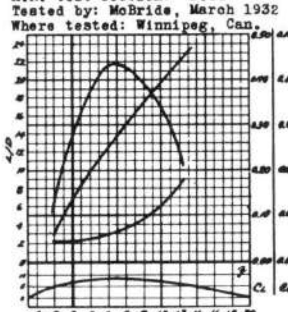
Number of Gage	British Imperial Standard Wire Gage	Music Wire Gage American Steel & Wire Co.
7/0	.5000	
6/0	.4640	.004
5/0	.4320	.005
4/0	.4000	.006
3/0	.3720	.007
2/0	.3480	.008
0	.3240	.009
1	.3000	.010
2	.2760	.011
3	.2520	.012
4	.2320	.013
5	.2120	.014
6	.1920	.016
7	.1760	.018
8	.1600	.020
9	.1440	.022
10	.1280	.024
11	.1160	.026
12	.1040	.029
13	.0920	.031
14	.0800	.033
15	.0720	.035
16	.0640	.037
17	.0560	.039
18	.0480	.041
19	.0400	.043
20	.0360	.045
21	.0320	.047
22	.0280	.049
23	.0240	.051
24	.0220	.055
25	.0200	.059
26	.0180	.063
27	.0164	.067
28	.0148	.071
29	.0136	.075
30	.0124	.080
31	.0116	.085
32	.0108	.090
33	.0100	.095
34	.0092	.100
35	.0084	.106
36	.0076	.112
37	.0068	.118
38	.0060	.124
39	.0052	.130
40	.0048	.138

CONVERSION TABLE

Inches to Centimeters--2.54
Centimeters to Inches---.3937
Sq.In. to Sq. Cm.--------.155
Sq.Cm. to Sq. In.------6.452
Ounces to Grams-------28.35
Grams to Ounces---------.0353
Ex:-8 oz. x 28.35 = 206.80 g.

1 meter-------39.37 in.
1 centimeter----.3937 in.
1 millimeter----.03937in.(1/25)
1 kilometer-----.62137 mile
1 foot----------.3048 meter
1 inch --------2.54 centimeter

Name of section: McBride B-7
Wind velocity: 7 f.p.s.
A.R. test section: 3.44
Tested by: McBride, March 1932
Where tested: Winnipeg, Can.

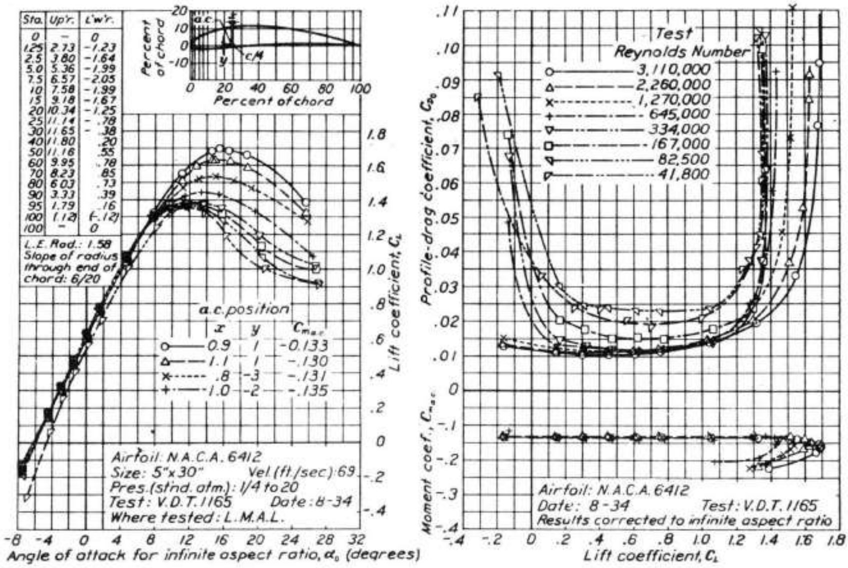


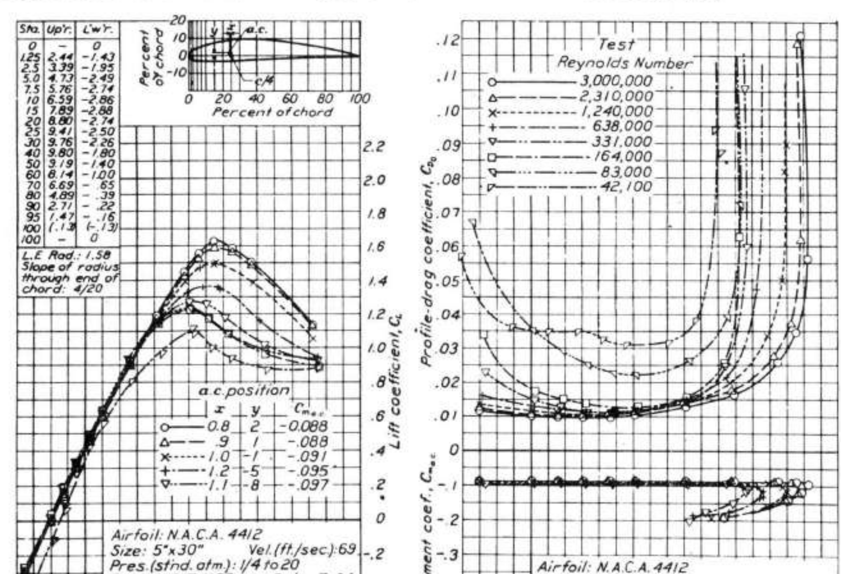
Angle of Attack in Degrees

R.A.F-32 & M-6 On Page 94

ORDINATES IN % CHORD

0%	5.%	10.	20.	30.	40.
0.0	2.35	4.40	6.70	7.80	8.30
50%	60.	70.	80.	90.	100.
7.90	6.90	5.90	3.90	2.00	0.0





AIRFOIL FORMULAS

The Lift and Drag formulas to be used with the airfoil charts shown are as follows:

Lift (In lbs.)—C_L x P/2 x S x V²

Drag (In lbs.)—C_D x P/2 x S x V²

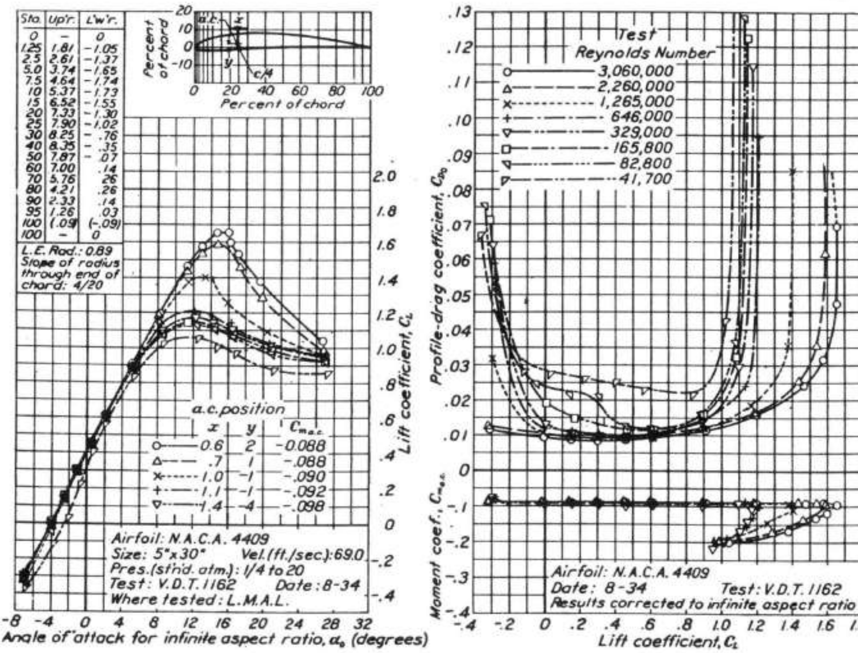
C_L—Lift Coefficient

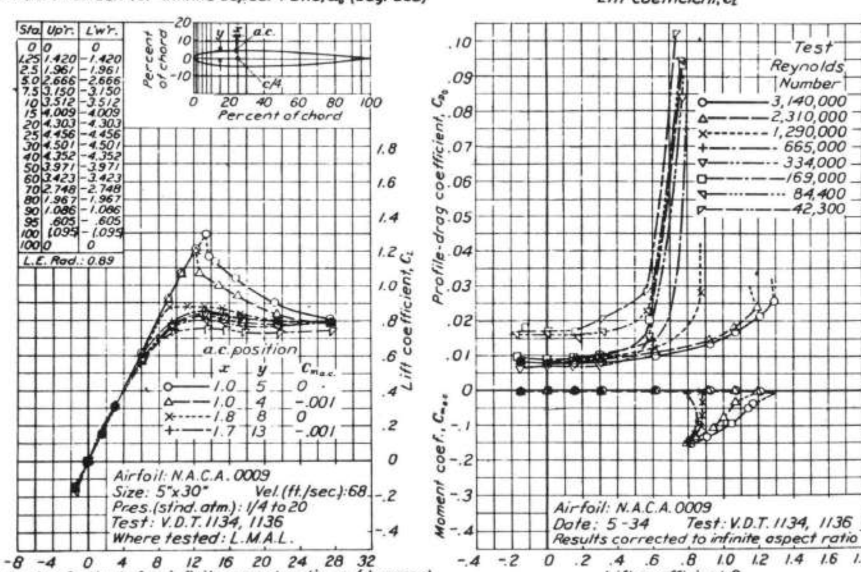
C_D—Drag Coefficient

P —Density of Air (.00238 st 15° C. & 760 m.m.)

S —Area of Surface in Square Feet

V —Air Speed in Feet per Second





Example:

S —Area, 288 sq. in. or 2 sq. ft.

V —Speed, 10 M.P.H. or 14.67 Ft. per sec.

P —.00238 (P/2=.00119)

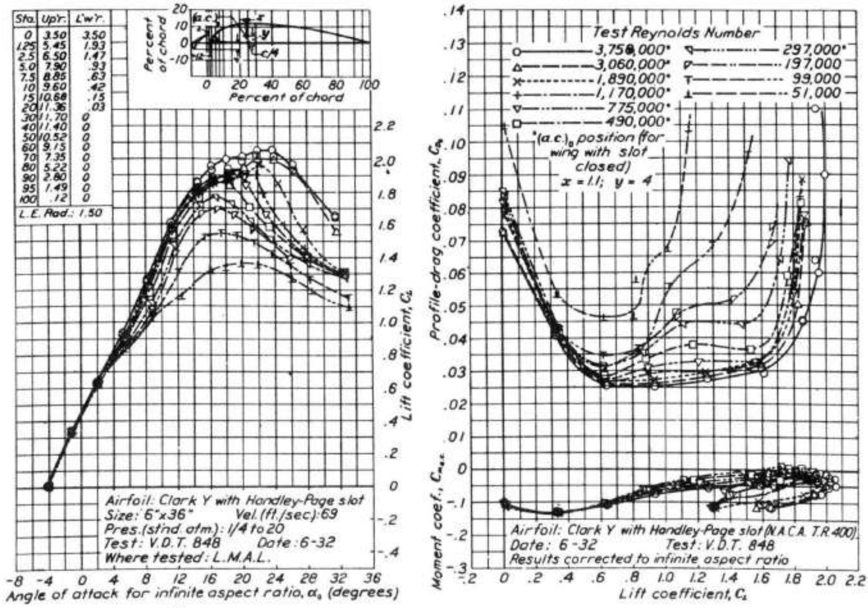
C_L—Lift Coef. at 8° , Gott. 497, — 1.1

C_D—Drag Coef. at 8° , Gott. 497, — .10

Solving:

Lift —1.1 (Coef.) x .00119 (P) x 2 (sq.ft.) x 215.1 (V^2)—.56 lb. or 9 oz.

Drag—.10 (Coef.) x .00119 (P) x 2 (sq.ft.) x 215.1 (V^2)—.05 lb. or .82 oz.



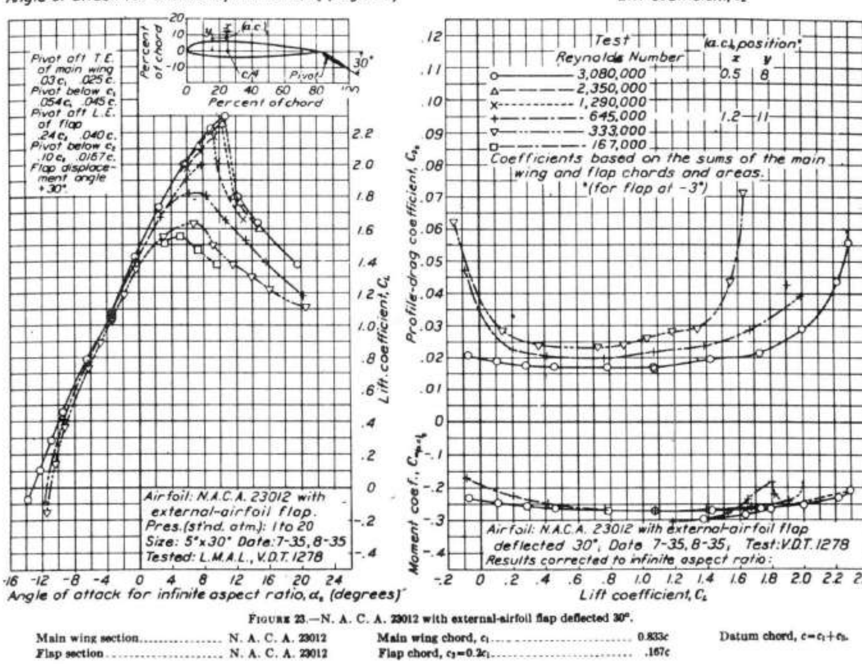
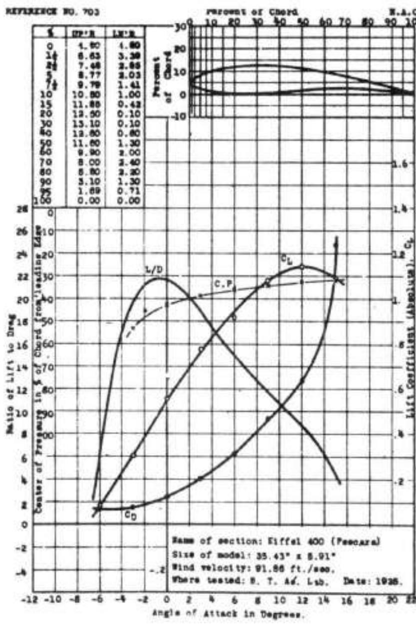


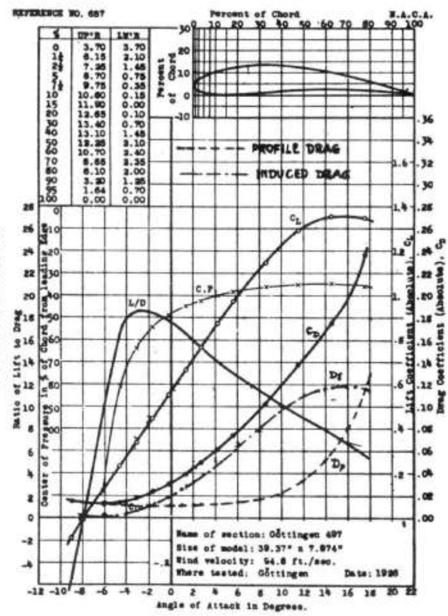
FIGURE 23.—N. A. C. A. 23012 with external-airfoil flap deflected 30°.

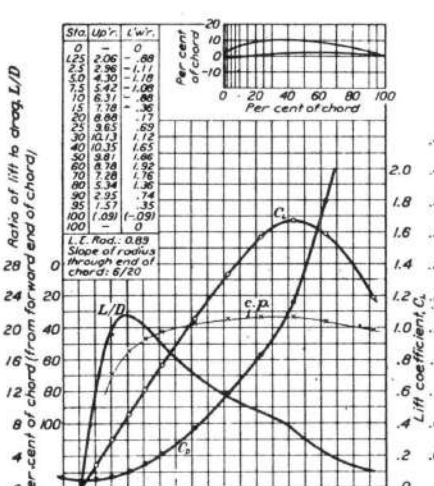
Main wing section	N. A. C. A. 23012	Main wing chord, c_1	0.833c	Datum chord, $c=c_1+c_2$.
Flap section	N. A. C. A. 23012	Flap chord, $c_2=0.2c_1$	.167c	

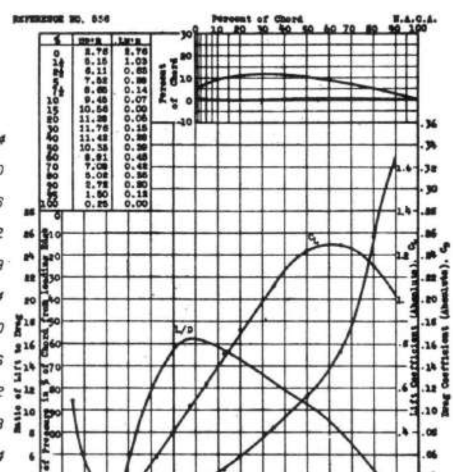
CONVERSIONS FORMULAS

Multiply No. of Ft. per sec. by 0.6818 to find M.P.H.
Multiply No. of M.P.H. by 1.467 to find Ft. per Sec.
Multiply No. of Min. by 1.136 to find M.P.H.
Multiply No. of M.P.H. by 88 to find Ft. per Min.



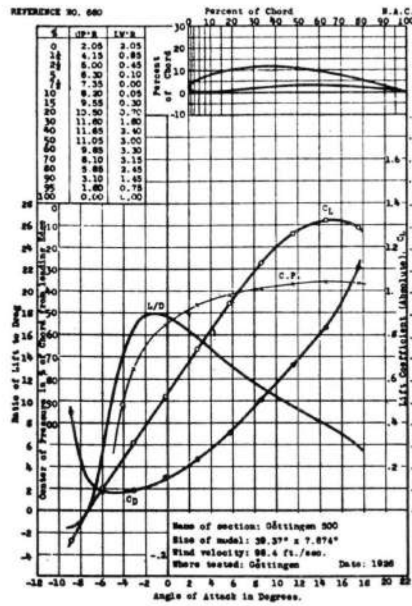


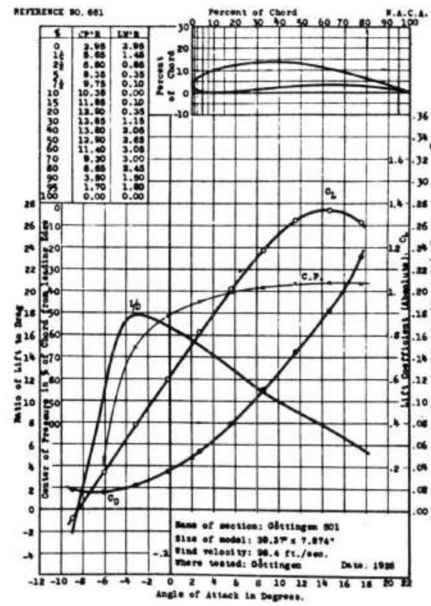


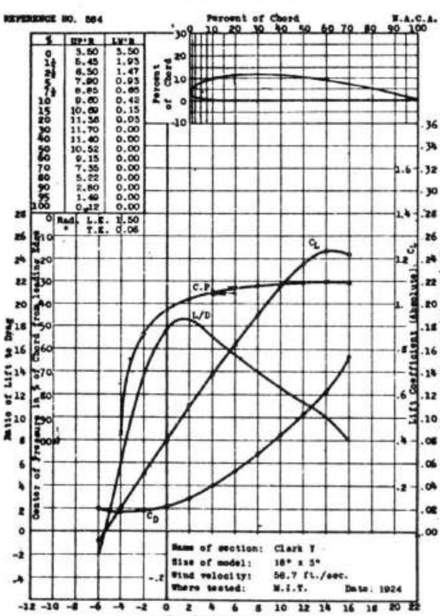


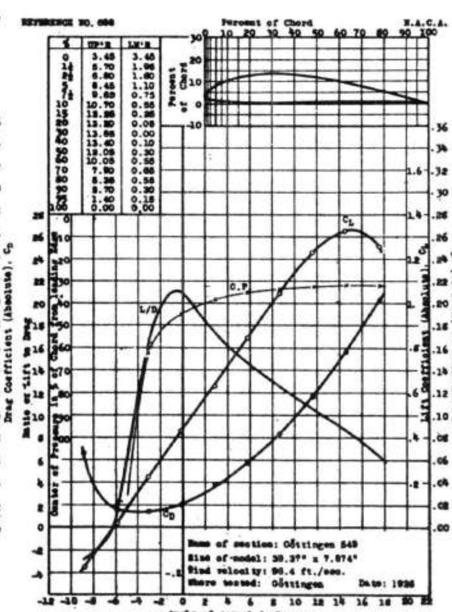
These Lift and Drag formulas can be used as shown for the airfoil charts which have L/D, C_L and C_D curves on same graph; and when Aspect Ratio similar to test is used (On Gott. 497 A. R. is 5:1). When we change the A. R. we have to subdivide C_D into its two components, Induced (C_Di) and Profile (C_Do) drag coefficients. Most of the N.A.C.A. single graph charts show only C_Do (Profile). To find C_Di (Induced) we use the following formula:

$$C_Di = \frac{C_L^2}{3.1416 \times \text{Aspect Ratio}}$$





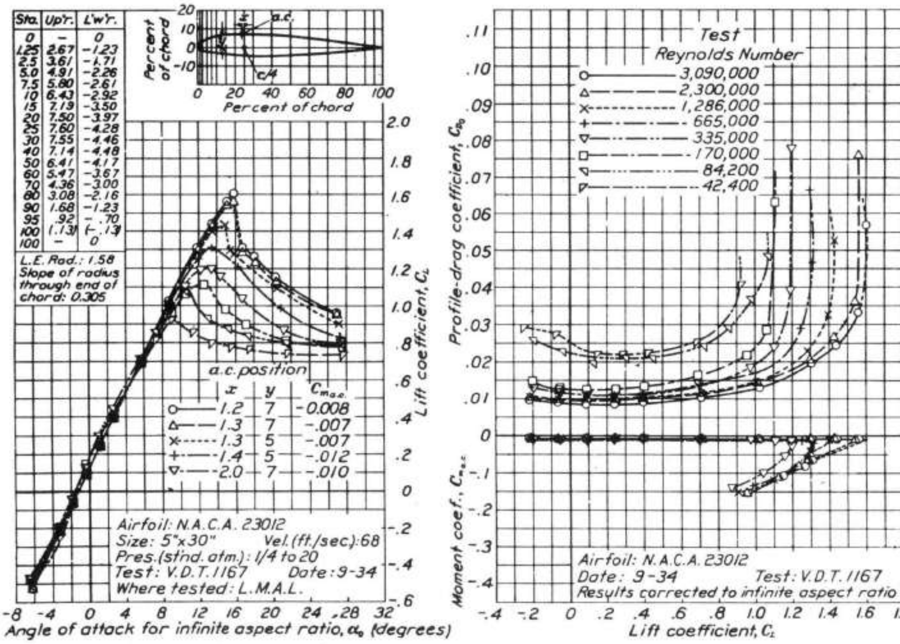


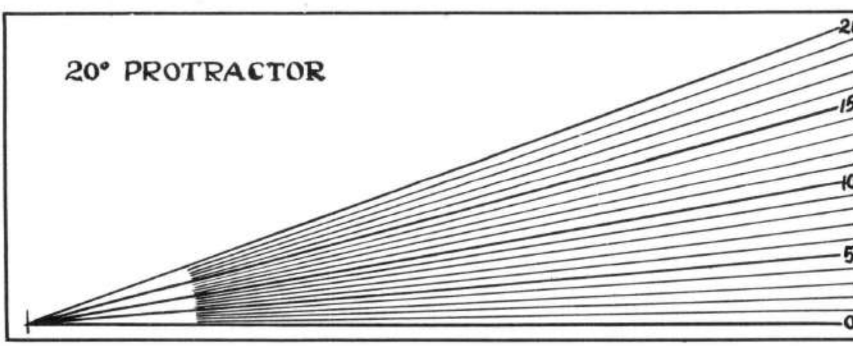


Use the Aspect Ratio of your wing and not the test wing's. By adding the resulting C_Di to the C_Do as given on the graph you will have the C_D for the particular Aspect Ratio.

To correct for Aspect Ratio when using three graph charts (such as Gott. 497) we have to first separate C_Di from C_D to find C_Do of Profile Drag Coef. This is done by using the C_Di=

$$\frac{C_L{}^2}{3.1416 \times A.\ R.}$$





of test wing formula. When C_D is found, subtract it from C_D. The result will be C_Do. Make a list of C_Do values found at different values. Next, find C_Di for the Aspect Ratio you are using. Use the C_L as given on graph. Add the resulting C_Di to the C_Do to obtain total C_D.

If you actually work out several problems, using different Aspect Ratios, you will find the efficiency value of high A.R. The Induced Drag decreases with increase og A.R. Consequently, if there is less drag we need less power. In a glide, this means flatter glide. On a power plane we can fly further with same amount of fuel.

REYNOLDS NUMBER

Here are two facts which place limit on Aspect Ratio, structure and scale effect. Structure is obvious. Scale Effect is a bit harder to understand without some aerodynamical background. It has to do with the number of air molecules being "pushed" or "affected" in a given time. The number of molecules acted upon in a given time is controlled by the chord of the wing and speed at which it moves. By using the following formula you can determine the Reynolds Number of your wing:

Reynolds Number—6,300 x Speed (Ft. per Sec.) x Chord (in Feet). If you are using one of the N.A.C.A. airfoils, which has several curves at different R.N., pick the one which meets your needs. Naturally, the R.N. will vary from center to tip if the wing is tapered. In some cases the tip may be so small that the R.N. will be very low.

The recommendations given in this book for Aspect Ratio are practical from structural and aerodynamical viewpoint. If the area is low, we obtain higher R.N. by using wider chord or lower Aspect Ratio. If the area is large we do not have to worry about the R.N. as we have fair chord at higher A.R., but we do make sure that the wing will be strong enough to keep its shape. When using small area it is best to worry about R.N. rather than A.P. The 3" or 3½" minimum chord recommendations was made by the writer many years ago. It was a sort of a guess which later tests seem to have proven as a fact.

DAVIS AIRFOILS

Some of you might wonder why we did not include a few Davis sections. The main reason is that those we would include would be similar to the N.A.C.A.'s shown without having characteristics charts. Those Davis sections shown or described in some magazines have never been tested in wind tunnels. Rather the Davis formula was used so it produced the particular section. So if a Davis section looks like one of the N.A.C.A.'s you might as well use the one you know something about.

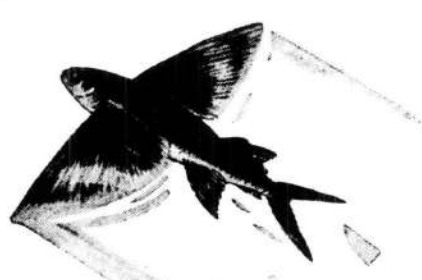
Truthfully, we are not very familiar with the Davis airfoils which are made from a formula which will provide an airfoil for a particular or special condition. We believe, we have an idea of the principle involved in its design. It seems that the main idea is to have the leading edge enter the airflow at most favorable positions when the plane is flying at its cruising speed so that it will have the lowest possible drag for the amount of lift generated.

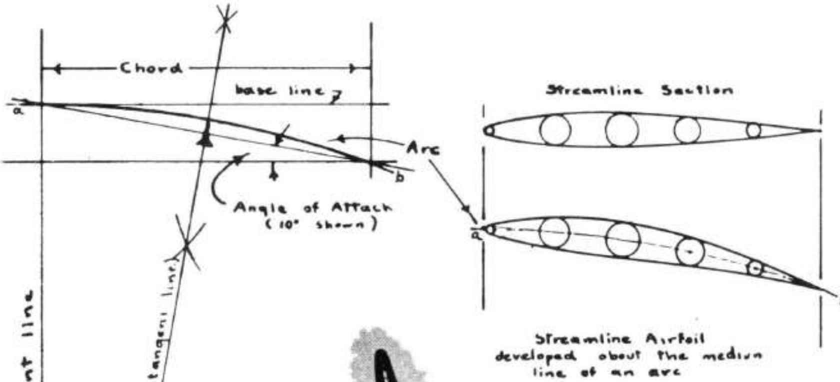
The airfoil is then so designed, that the median line is an arc which is tangent at the leading edge, and whose radius depends on the conditions. The thickness about this median arc is also determined by the formula. The aerodynamical characteristics are found by standard airfoil formulas which can predict the characteristics pretty close to actual without making wind tunnel tests. Naturally, after a particular Davis section has been developed from the requirements it is tested in a wind tunnel. In a way we may say that the Davis airfoil Formula can be used by a designer to develop a specific section.

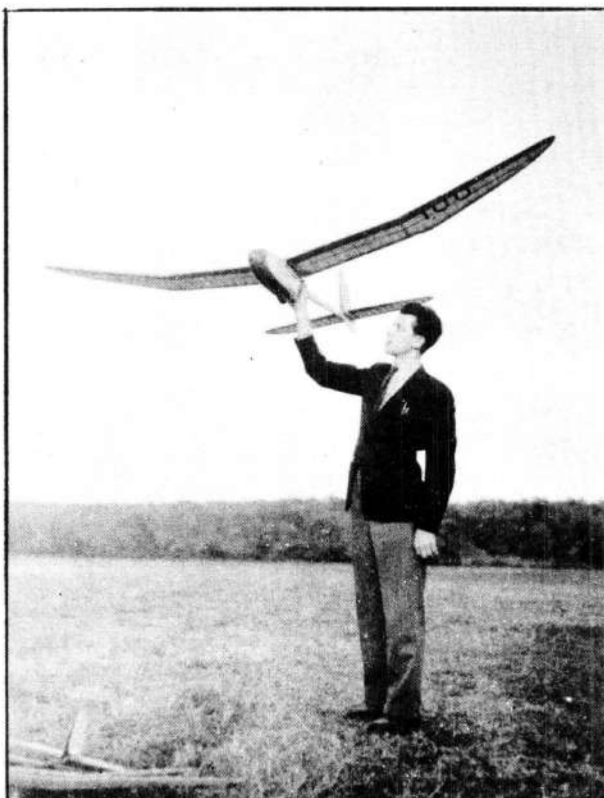
If you would like to design a "Davis" wing, or airfoil use the following procedure: Decide on the chord and angle of attack and make the layout shown. Draw an arc so that it will pass through "a" and "b", and be tangent to base line, and whose radius will "radiate" from somewhere along the tangent line. Now take a streamlined airfoil and plot it around the arc. You can thicken or thin it for structural purposes as shown elsewhere. The result will be an airfoil, which will be most efficient at that particular angle of attack.

The airfoil plotting shown is more or less our idea of how we can design an efficient airfoil, and for all we know, it may follow the Davis principle, which we would like to study more thoroughly and hear from someone who knows more about it.

The information just given on airfoils is rather limited, but if we know model builders and their disdain of theoretical facts, it is about all that is needed in this book.




Chord
base line
a
b
Arc
Angle of Attack
(10° shown)
Tangent line
Radii (extended to tangent line)
Streamline Section
a
b
Streamline Airfoil
developed about the median
line of an arc



GENERAL INDEX

'Lonse' Dresden A-24

OUR SINCERE THANKS

To the boys who made it possible to present such a large assortment of plans and information.

To the Publishers of "Model Airplane News," "Aeromodeller" and "Modellflug" for their cooperation.

And to all of you who helped in this work.

CORRESPONDENCE

Although we would be more than glad to correspond with anyone interested in gliders, we cannot make promises of prompt reply under the circumstances.

Send mail to:

Model Aeronautic Publications
203 East 15th Street
New York 3, New York

It will be forwarded to us wherever we may be at that time. Would especially like hearing how some of our suggestions worked out and about new ideas which you may have developed.

So until next meeting, "May the thermals be at your beck and call!"

FRANK ZAIC.

By KEGEL & LAUTENHAHN *from* "MODELLFLUG"

THE END

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