CHAPTER 19

GERMAN "HANGWIND" SECONDARY GLIDER

SECONDARY gliders of the "Hangwind" type are extensively used throughout Germany for instruction purposes in their many schools. After students have mastered primary gliders, they graduate to this type, which prepares them for the greatest of all gliders, the soaring sailplanes.

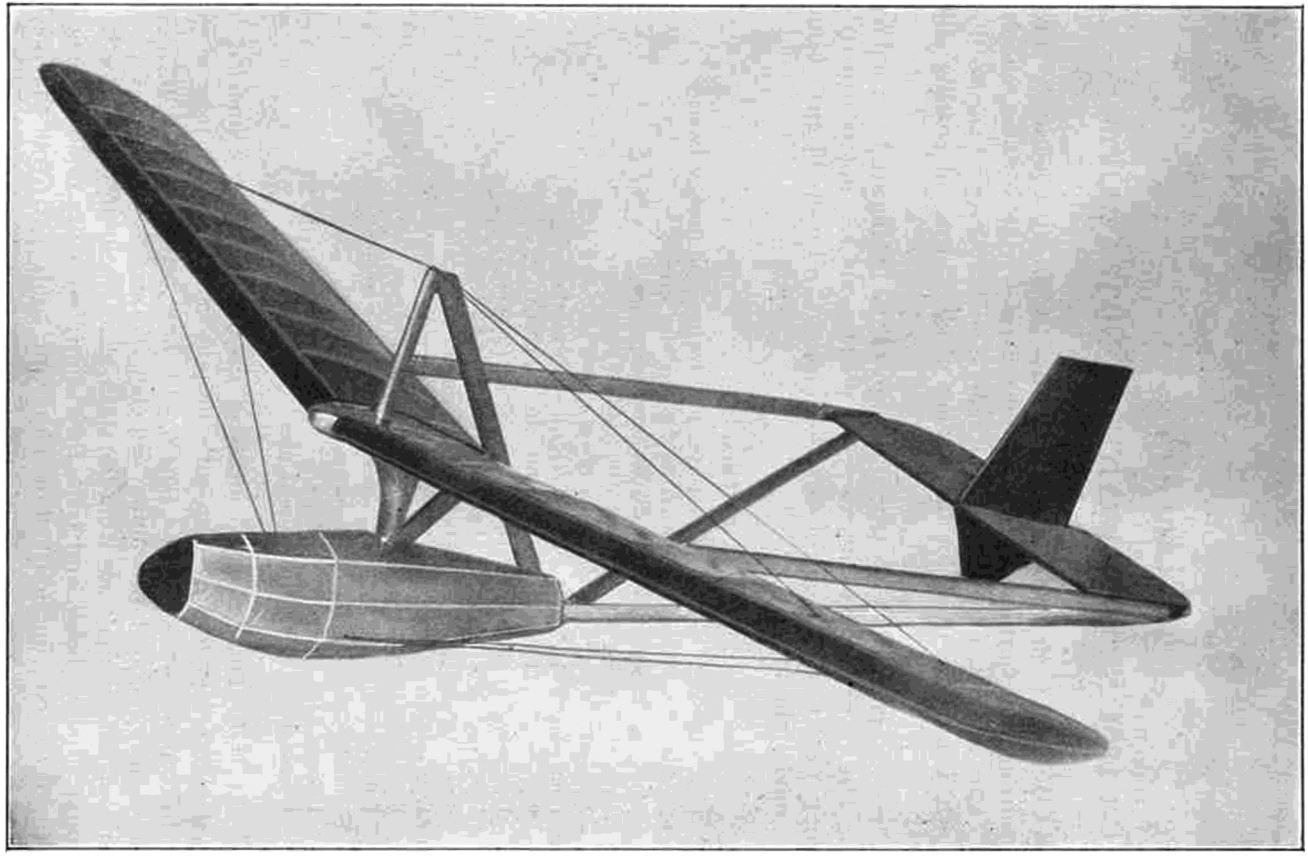
The model given here is a true scale copy of the "Hangwind" secondary glider. The cutting of its dimensions to model scale has not lessened its gliding powers. Careful study of its action in flight will prove of great value to any model builder.

MATERIAL LIST

1 pc.	$\frac{1}{16}$" x	3"	x 28"	—Sheet balsa for wing ribs and fuselage formers
2 pcs.	$\frac{1}{4}$" x	$\frac{5}{16}$" x	9$\frac{5}{8}$"	—Balsa for leading edge spars
2 pcs.	$\frac{1}{8}$" x	$\frac{1}{8}$" x	9"	—Balsa for inner wing spars
2 pcs.	$\frac{1}{8}$" x	$\frac{3}{32}$" x	8$\frac{1}{8}$"	—Balsa for trailing edge spars
2 pcs.	$\frac{5}{16}$" x	$\frac{5}{8}$" x	1$\frac{5}{8}$"	—Balsa for wing tips
1 pc.	$\frac{1}{16}$" x	$\frac{1}{16}$" x 24"		—Balsa for wing bracing
1 pc.	$\frac{1}{2}$" x	1$\frac{1}{4}$" x	1$\frac{3}{8}$"	—Balsa for wing support
1 pc.	$\frac{1}{16}$" x	$\frac{1}{16}$" x 28"		—Balsa for fuselage stringers
1 pc.	$\frac{1}{2}$" x	$\frac{5}{8}$" x	$\frac{7}{8}$"	—Balsa for fuselage nose block
1 pc.	$\frac{1}{8}$" x	$\frac{1}{4}$" x 36"		—Balsa for outriggers and struts
1 pc.	$\frac{1}{16}$" x	$\frac{1}{16}$" x 24"		—Balsa for elevator and rudder
1 pc.	$\frac{1}{32}$" x	$\frac{1}{32}$" x	8"	—Split bamboo for elevator
1 sheet				—Japanese tissue for covering
1 bottle				—Colorless cement
1 bottle				—Dope
1 package				—Model pins

FUSELAGE. The fuselage consists of six balsa formers connected by balsa stringers, four outriggers, a wing support, a mast, and a nose block. Rule $\frac{1}{8}$" squares on a sheet of paper, and draw a full-size working plan of the six formers, as shown under "Fuselage Formers."

Cut each of the drawings from the sheet, place them on the $\frac{1}{16}$" x 3" x 28" piece of sheet balsa, and trace their outlines on the wood in pencil. These are cut out and finished smooth with sandpaper. Note that each



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of these formers has small notches cut in them to fit the 1/16" square stringers. When cut and sandpapered, mark each with its proper number, as shown in the plan. This is done to aid the builder in locating their position in the fuselage framework. The side view of the model, shown at the top of the plan page, shows each of these formers by number.

When building any fuselage of formers and stringers, all stringers running in a straight line should be attached first, so that those requiring bending can be easily given the necessary curve by following the notches cut for them in the formers, after the formers have been given their position through the location of straight stringers.

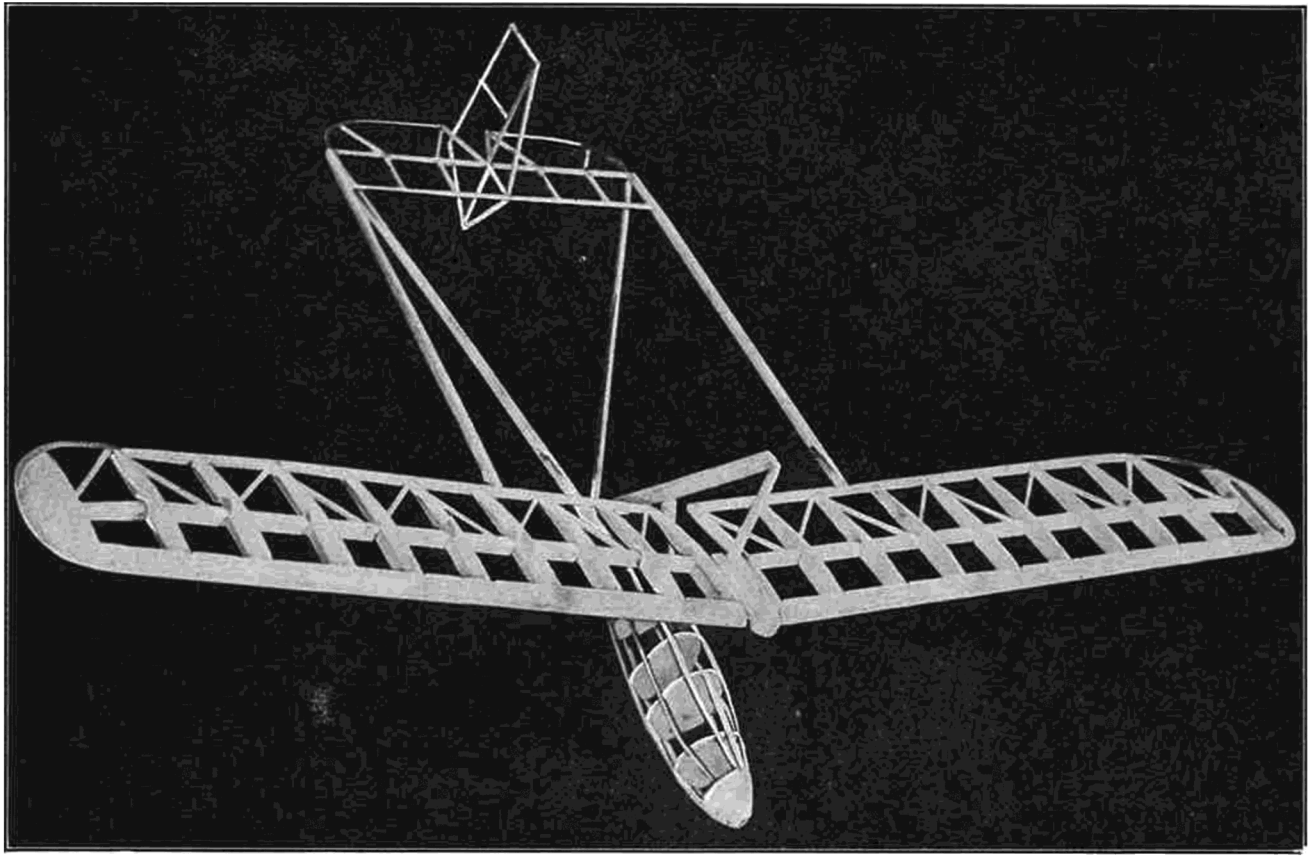
On this fuselage, only two stringers extend in a straight line. These are shown in the plan by the letter K. On the top and side view, these have been clearly marked, while the notches they fit into on the first two formers are designated on the graph plan of the fuselage formers. To start these stringers, cement the ends of two lengths of the 1/16" x 1/16" balsa into the side notches of former No. 1 shown by letter K. They are then cemented into the corresponding notches of former No. 2, which is placed 1/2" behind former No. 1. Continue cementing each of these stringers into the same notches on the remaining formers, making sure to space the formers, as shown in the side view of the fuselage.

From the balsa block measuring 1/2" x 5/8" x 7/8", shape the nose piece of the fuselage, as shown in the side and top view of the plan. This is cemented to former No. 1. The wing support is shaped and attached to the fuselage. This is cut from the 1/2" x 1 1/4" x 1 3/8" balsa block. Note its front, side, and top shape, as shown under "Wing Support." Cut out this shape, and finish smooth with sandpaper.

The top center stringer is cut just behind former No. 4 to allow the end of this support to be sunk into the fuselage 1/4". It is cemented to former No. 4 and the end of the center stringer just cut to accommodate it. The straight back of this support should be parallel to the formers of the fuselage. The mast L is 1/8" x 3/16" x 1 1/2" long and is made of balsa wood. It should be streamlined, being 1/8" at the front and tapering to an edge at the rear. This is cemented to the top of the wing support, as shown in the side view. It should form a right angle with the top of the wing support.

The brace J extends from the top, rear end of the fuselage to the top of the upright mast piece L. It is 1/8" x 1/4" x 4" long, and should be streamlined in the same manner as piece L. Cement this brace in position, as shown in the side view of the fuselage.

The brace J is further strengthened by a shorter brace running from the top center stringer, just in front of former No. 5, to a point 1 1/2" from



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the lower end of brace J. This is 1/8" x 1/4" x 15/16" long, and should also be streamlined. Cement this piece in place, after cutting its ends at an angle to fit.

Four outriggers are cut from the 1/8" x 1/4" x 36" long piece of balsa. The two D pieces, as shown in the plan, are cut 7" long and then sandpapered to a streamline, while the outriggers E are cut 6 5/8" long and finished in the same manner. These are not assembled at this time.

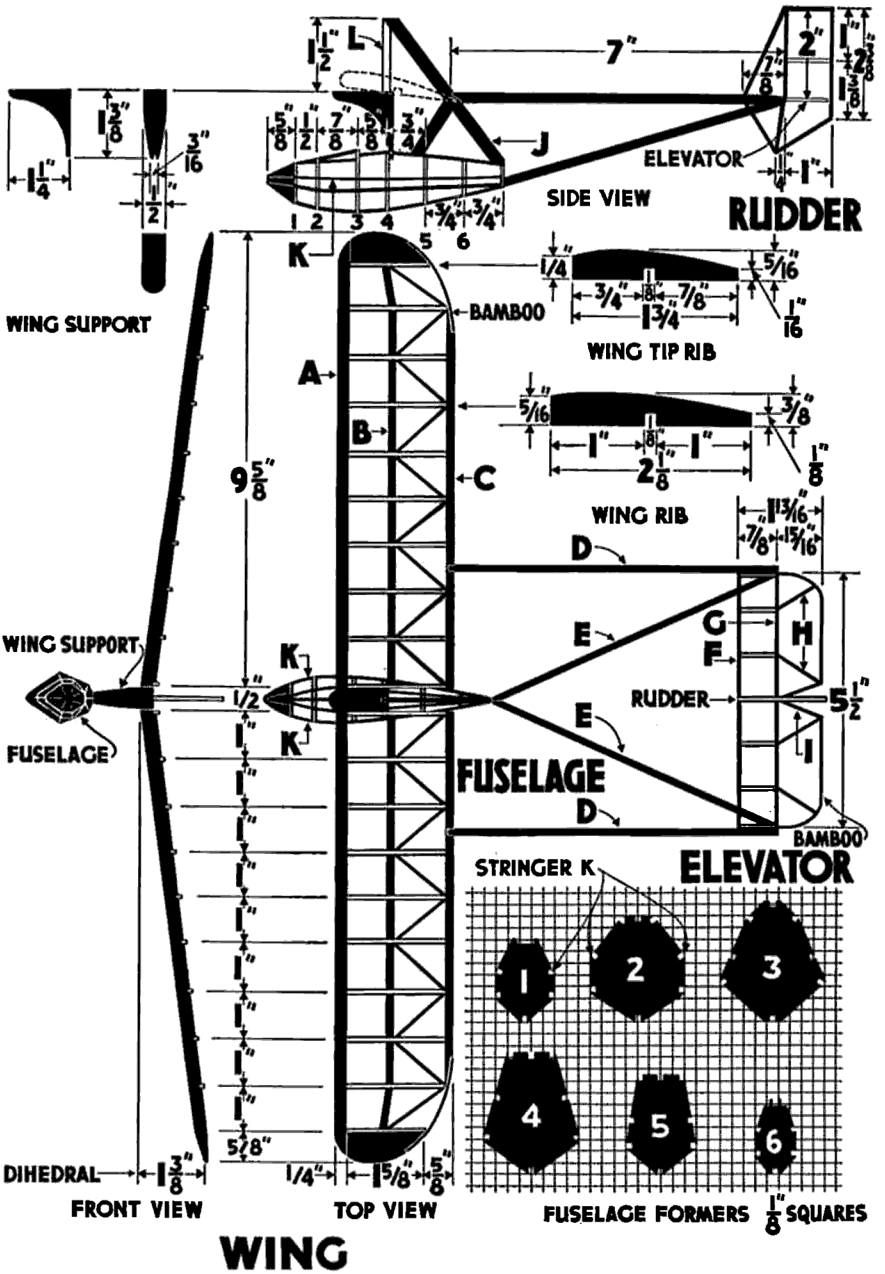
ELEVATOR. The elevator consists of a leading edge spar F cut 1/16" x 1/16" x 5 1/2" long. An inner elevator spar of the same dimensions is cut, as shown by G. These two spars are joined together by 1/16" x 1/16" x 3/4" long balsa ribs. Cut seven of these ribs and cement them in place between the leading edge spar and the inner spar G. The rear portion of the elevator is constructed of 1/16" x 1/16" x 1 1/8" balsa braces, each of which should be cemented in place and then cut to exact length. These braces are shown by letters H and I. The trailing edge of the elevator is formed from bent 1/32" split bamboo. (See Chapter 3, "Bamboo.") The elevator is covered on its upper side only with Japanese tissue. (See Chapter 7, "Wing Covering.") Give the surface a spraying with water and finish with a coat of banana oil or dope.

RUDDER. The rudder is also made of 1/16" x 1/16" balsa lengths. The trailing edge piece is 2 3/8" long, while the inner spar upright is 2" long above the elevator and 1 1/8" below it. When all pieces have been cut to proper length, assemble the rudder on the elevator with cement. This is done before covering because the rudder fits over the elevator and extends up and down from it. Cover the rudder on both sides with Japanese tissue, water-spray, and coat with banana oil or dope.

WING. The wing is made in two halves, but all parts for both should be cut and shaped before assembling takes place. Cut a pattern of the wing rib, as shown in the plan, out of tin or paper. On the 1/16" x 3" x 28" sheet of balsa wood, trace the outlines of eighteen of these ribs. These are cut out and notched to accommodate the inner wing spar B, as shown under "Wing Rib." Finish each with sandpaper. Both leading edges are now shaped from the two 1/4" x 5/16" x 9 5/8" balsa pieces. These should be made half round to carry out the curvature of the wing ribs at their front. Do this work with sandpaper.

The inner wing spar is 1/8" x 1/8" x 9" long for each half of the wing. These require no shaping. The trailing edge spars are shaped from 1/8" x 3/32" x 8 1/8" long balsa pieces. They are shaped half round to conform with the ribs at their trailing ends.

Two wing tip ribs are required, which should be cut from the 1/16" sheet



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balsa to the size and shape shown in the plan under "Wing Tip Ribs." To complete the preparation of the wing material, two sheet balsa wing tips should be cut from the two 5/16" x 5/8" x 1 5/8" balsa blocks. These are cut to the shape shown in the top view of the wing. Their inner edge, which rests against the wing tip rib, is left 5/16" thick, but from this point they taper off to an edge at the extreme end of the wing.

Each half of the wing is now assembled, and as both are done in the same manner, these instructions cover one half only. The ribs are spaced 1" apart along the inner wing spar B, which is cemented into the notches cut in the ribs for this purpose. The leading edge spar A is cemented in place along the leading end of the ribs, and this is followed by the cementing of the trailing edge spar C to the trailing ends of the ribs. At the point where the outer wing rib contacts the inner wing spar, this spar is cracked to give it the necessary bend to fit into the notch of the wing tip rib, which is cemented to the leading edge spar at its end. The inner spar is cemented into the notch cut for it in the wing tip rib at the same time.

The solid balsa wing tip is cemented to the outer side of the wing tip rib. To complete the trailing edge of the wing, a short length of 1/32" split bamboo is bent to shape and cemented to the trailing edge of the tip and to the trailing edge spar, both of which are grooved to accommodate this bamboo piece.

To strengthen the wing structure, bracing is cut from 1/16" x 1/16" balsa wood. Nine 1½" long pieces of this bracing are required for each wing half. Cut these and cement them in place to the trailing edge spar and the inner wing spar, as shown in the top view of the wing.

The second half of the wing is assembled in the same manner. Both halves are covered on both sides with Japanese tissue. (See Chapter 7, "Wing Covering.") Water-spray the wing and finish it with a single coat of dope.

ASSEMBLY. Both halves of the wing are attached to the sides of the wing support. Study the front view of the wing. Note that each half is located on the side of the wing support so that the upper surface of the wing is just above the top of the support. It should also be noted that the wing has a 1 3/8" dihedral and a 1/8" angle of incidence. This latter measurement means that the leading edge of the wing must be 1/8" higher than the trailing edge. Do not confuse this wing location with the wing outline shown in the side view of the plan. The part of the wing shown in that view is connected to the outriggers, and as the wing has a dihedral angle, it necessarily is higher than the part which connects with the wing support.

Attach the wing halves to the support with model pins until the proper

angles of incidence and dihedral have been obtained, and then apply cement between the inner end of the wing and the side of the support. Allow one hour for drying.

The outriggers are now attached to the wing. Note the location of D outriggers. These extend from the trailing edge spar of the wing straight out and parallel to the top of the wing support. The inside measurement between these two outriggers is 5½". Measure 2½" from the inner end of the wing halves toward both wing tips, mark, and cement the ends of the outriggers at these points. The tail assembly, which includes the rudder and elevator, is cemented between the other ends of these outriggers, as shown in the top view of the plans. The elevator must be parallel to the outriggers when this connection is made. The two outriggers E are cemented between the end of the fuselage and the trailing ends of outriggers D. This completes construction with the exception of the landing and flying wires, which can be added to the model by studying the photograph. These are of white cotton thread cemented at points of contact. Small model pins should be used to hold the outriggers in place until the cement has dried, when the pins can be removed.

A small cockpit can be cut into the top of the fuselage by removing the top stringer between formers No. 3 and No. 4, as shown in the side view of the plans. This will aid in attaching the necessary weight to the nose of the model. (See Chapter 17.) After the weight has been determined, the lead, or other metal, should be cemented inside the fuselage. The model can be painted any desired colors.

As this type of model closely resembles soaring flight when in the air, choose a hilly locality with a fair wind blowing, and launch the model into the wind. These dimensions may be doubled if the builder wishes a large glider model.

CHAPTER 20

BOWLUS SAILPLANE

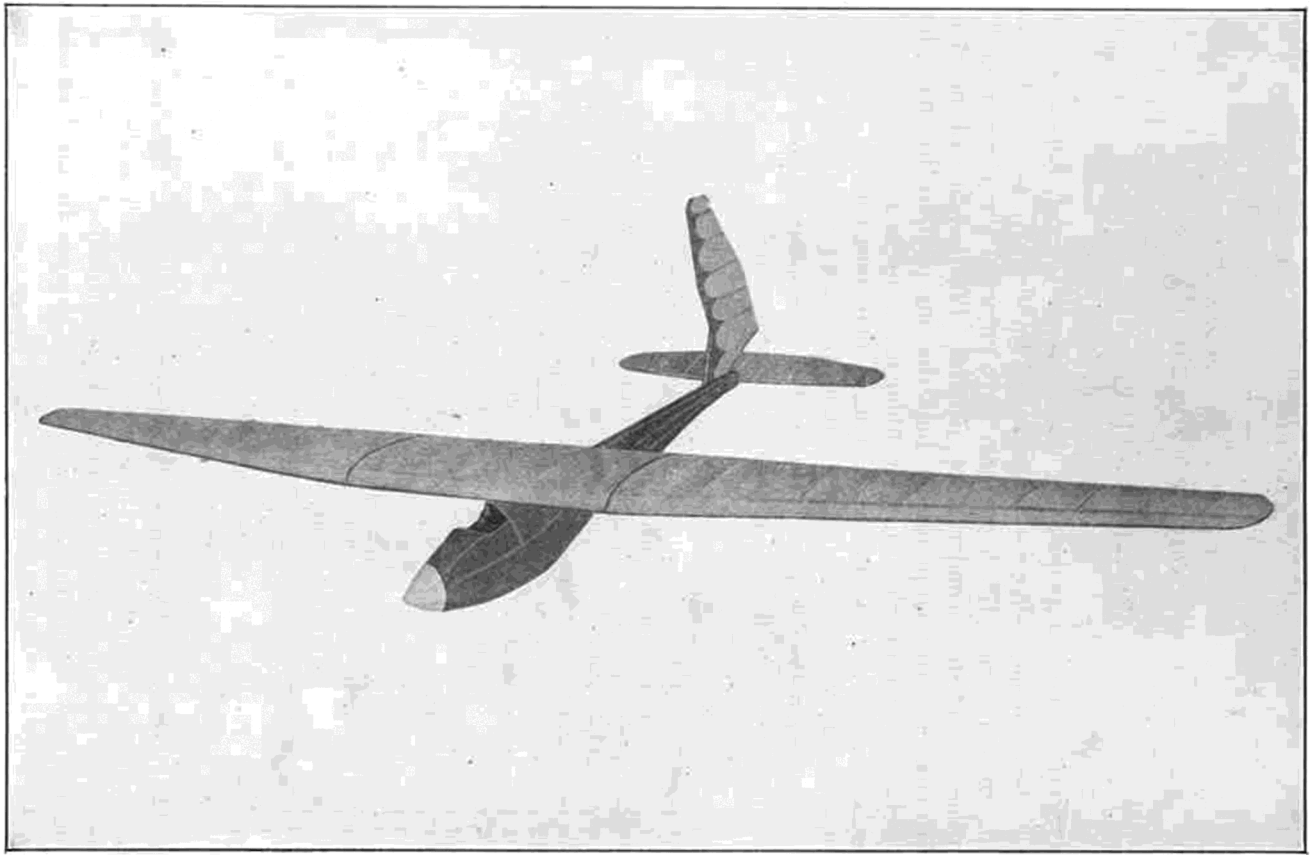
THE Bowlus sailplane is of the advanced type of soaring glider, being named after its designer and builder, W. Hawley Bowlus of San Diego. When students have mastered the primary glider (Chapter 18) and the secondary type (Chapter 19), they are advanced to this last type of soaring sailplane. On these, they are prepared for their final tests through which they obtain their glider pilot's licenses.

It was on one of these Bowlus sailplanes that both Charles and Anne Lindbergh took their tests and received their first-class glider pilot's licenses. The model given here is a true replica of this famous sailplane, and has proved a most efficient flyer, as well as a beautiful model.

MATERIAL LIST

1 pc. —1/4" x 3/8" x 36"	—Balsa for leading edge spars
1 pc. —1/8" x 1/4" x 36"	—Balsa for inner wing spars
2 pcs.—1/16" x 1/16" x 15"	—Bamboo for trailing edge spars
1 pc. —1/16" x 1/16" x 7"	—Bamboo for trailing edge spar of center section
1 pc. —1/16" x 2" x 40"	—Sheet balsa for wing, elevator, and rudder ribs
2 pcs.—1/16" x 1/16" x 15"	—Bamboo for elevator and rudder
1 pc. —1/16" x 1/16" x 12"	—Balsa for elevator and rudder inner spars
2 pcs.—1/8" x 3/8" x 3/4"	—Balsa for elevator tips
1 pc. —1/32" x 1" x 27/16"	—Sheet balsa for center section of wing
1 pc. —1/16" x 2" x 12"	—Sheet balsa for fuselage formers
3 pcs.—1/16" x 1/16" x 36"	—Balsa for fuselage stringers
1 pc. —5/8" x 3/4" x 1"	—Balsa for nose block
1 pc. —7/16" x 7/16" x 3/8"	—Balsa for tail block
1 pc. —5/16" x 7/16" x 2 1/2"	—Balsa for wing mount
4 pcs.—1/8" diam., 2 1/2" long	—Aluminum tubing for wing
1 oz.	—Cement
1 sheet	—Japanese tissue for covering
1 oz.	—Dope

FUSELAGE. Study the plan of the fuselage in Plan 1. Nine 1/16" sheet balsa formers are required for this model. These are designated by the letters A, B, C, C, D, E, F, G, and H in the graph plan of each, as well as on the top view of the fuselage, where their location in the framework of the fuselage is shown.



BOWLUS SAILPLANE

Rule 1/8" squares on paper, and draw a full-size working plan of each of these formers. They should then be traced on the sheet balsa, cut out, and the necessary notches made in each.

Each of the stringers is shown in the plan by number. Note that all duplicate stringers are shown by the same number. For example, stringer No. 1 is shown as No. 1 on both sides of the top view of the fuselage. This is done because these are exact duplicates and are located in the same positions on both sides of the fuselage. It will also be seen in the side view of the fuselage on the right of the plan. It appears only once here, because its duplicate is hidden behind it. All these stringers are 1/16" x 1/16" balsa wood cut to proper lengths.

The nose block is of solid balsa measuring 5/8" x 3/4" x 1", being cut to the shape shown on both views of the fuselage. Its inner face should be shaped to conform to the outline of former A, as it is cemented to this former, and should carry out the general streamline of the fuselage.

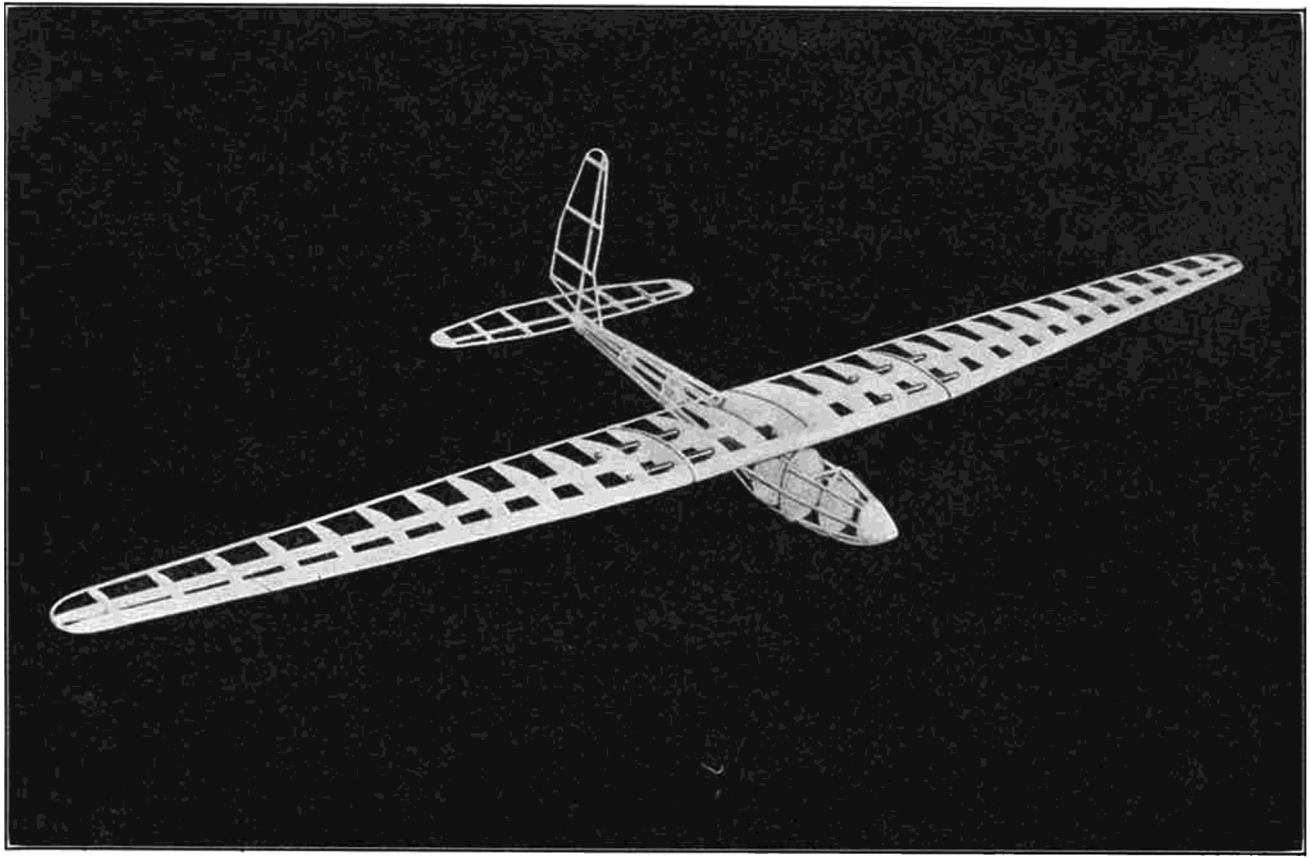
The tail block is also solid balsa. It should be given the form of fuselage former H, as it is cemented against the outside face of this piece. It is 7/16" x 7/16" x 3/8"

When these pieces have all been cut to proper shape and size, they should be carefully sandpapered smooth and then assembled. Cement stringers No. 6 into the notches cut for them in formers C, C, D, E, F, G, and H. Each of the other stringers is then attached in the same manner, making sure that each of the formers is properly spaced, as shown in the side view of the plan.

The formers B and A are added, and the nose and tail blocks cemented to formers A and H respectively. The main wing support block is shaped from a balsa block measuring 5/16" x 7/16" x 2 1/2" long. This wing mount is shown in the top and side views of the fuselage in solid black. Cut it to shape, and cement it to the tops of stringers No. 6, locating it at the front on former C. The fuselage is covered with Japanese tissue, as explained for round fuselages in Chapter 8. Water-spray the tissue and finish it with a single coat of dope.

RUDDER. The rudder is made of five balsa ribs, a balsa inner spar, and a bamboo outline piece. Study the rudder plan in Plan 2. From the 1/16" sheet balsa, cut the five ribs M, N, O, P, and Q, making them 1/8" wide at their widest point, tapering to 1/16" at each end.

The inner spar R is 1/16" x 1/16" x 3 7/8" long balsa wood. Thrust this spar through the holes cut for it in each rib, space the ribs on it, as shown, and cement each in position, making sure that they are on a line with each other. The edge of the rudder is made of 1/16" square split bamboo. Heat



BOWLUS SAILPLANE SKELETON

the length (see Chapter 3, "Bamboo"), and bend it to shape. Cement it in place to the ends of the ribs and the two ends of the inner spar.

Cover the rudder on both sides with Japanese tissue. (See Chapter 7, "Wing Covering.") Water-spray the tissue, and when dry, give it a coat of dope. It is now mounted on the fuselage. This connection is made with rib M. Coat the rib with cement and attach it to the fuselage on the top-center of the tail block. The end of the inner spar of the rudder should come at the very end of the tail block, while the front of rib M extends forward between formers H and G, as well as between stringers No. 6.

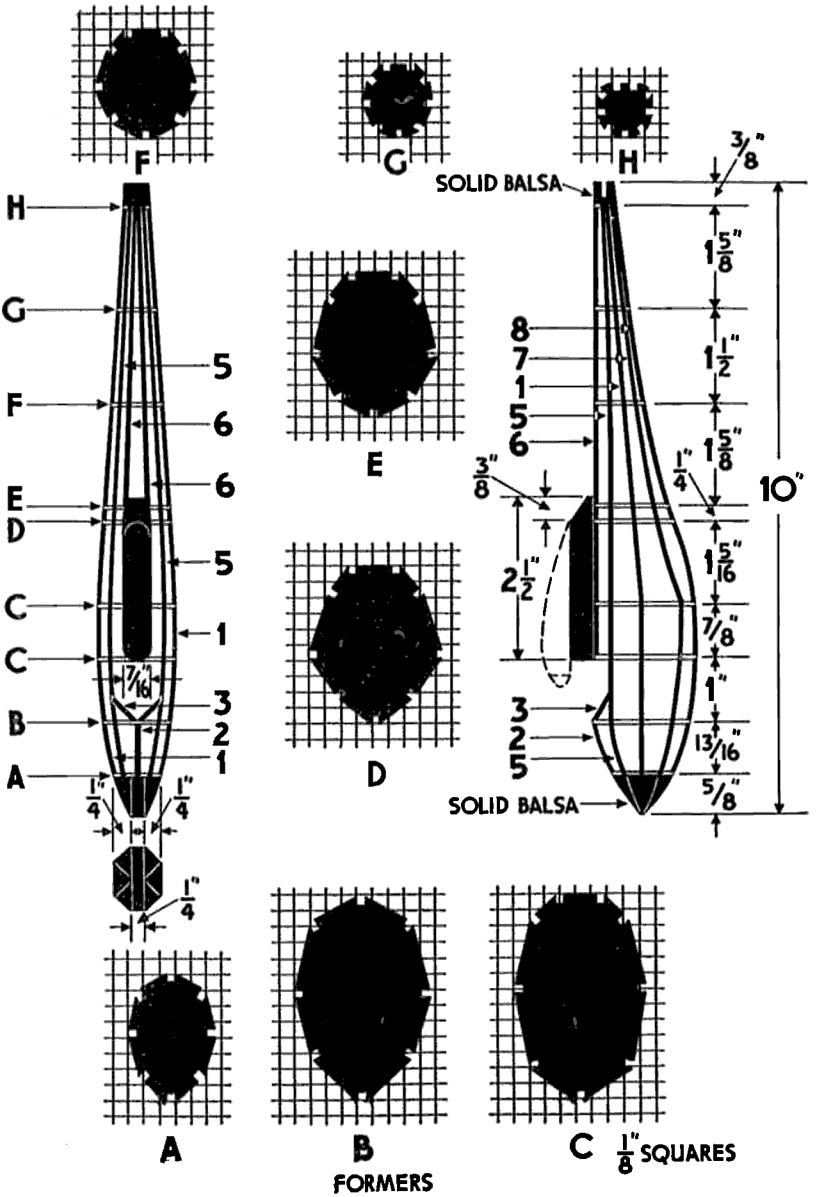
ELEVATOR. The elevator requires seven 1/16" sheet balsa ribs. These are shown in Plan 2 under "Elevator" as S, T, and U. Follow the same method used in cutting the ribs of the rudder, when cutting these ribs, making two S, two T, and three U ribs. These are also 1/8" at their widest part, tapering to 1/16" at both ends.

The inner elevator spar 2 is 1/16" square balsa. Make it 7" long. Solid balsa tips are used on this elevator, being cut to shape from 1/8" x 3/8" x 3/4" blocks. These are tapered to match the taper of ribs S and narrow toward their ends to match the 1/16" square bamboo outline.

Space the seven ribs on the inner spar, and cement each in place, making sure it forms right angles with the spar. Small 1/8" deep holes are cut in the solid wing tips to accommodate the ends of this spar. Cement the tips in place against the ribs S. The leading and trailing edge spars are made from 1/16" square split bamboo. The leading edge spar 1 should be heated, bent to conform to the ends of the ribs, and then cemented in place. The trailing edge spar 3 is attached in the same manner. As this elevator has no dihedral, it should be covered on both sides with Japanese tissue. Water-spray and give one coat of dope to stretch the covering.

In Plan 1 will be seen a notch in the tail block. (Note side view of the fuselage.) This is cut to accommodate the elevator, which is cemented into it. Make it 1/4" deep and 1/16" thick. The leading edge is thrust into this notch and cemented in place. The center rib U is the one placed into this slot. When doing this, care should be taken to see that it is centered perfectly, and forms right angles with the rudder.

WING. The wing is made in three sections, which for instruction purposes will be called the left, right, and center sections. As the left and right sections of the wing are exact duplicates, building instructions will cover only one of these. Twelve ribs of 1/16" sheet balsa are required for the left or right sections. The usual 1/8" squares should be ruled on paper, and full-size working plans of each rib made, as shown under "Wing Ribs" in Plan 2. For the entire wing, two of each of these ribs are necessary, except



FUSELAGE

BOWLUS SAILPLANE PLAN 1

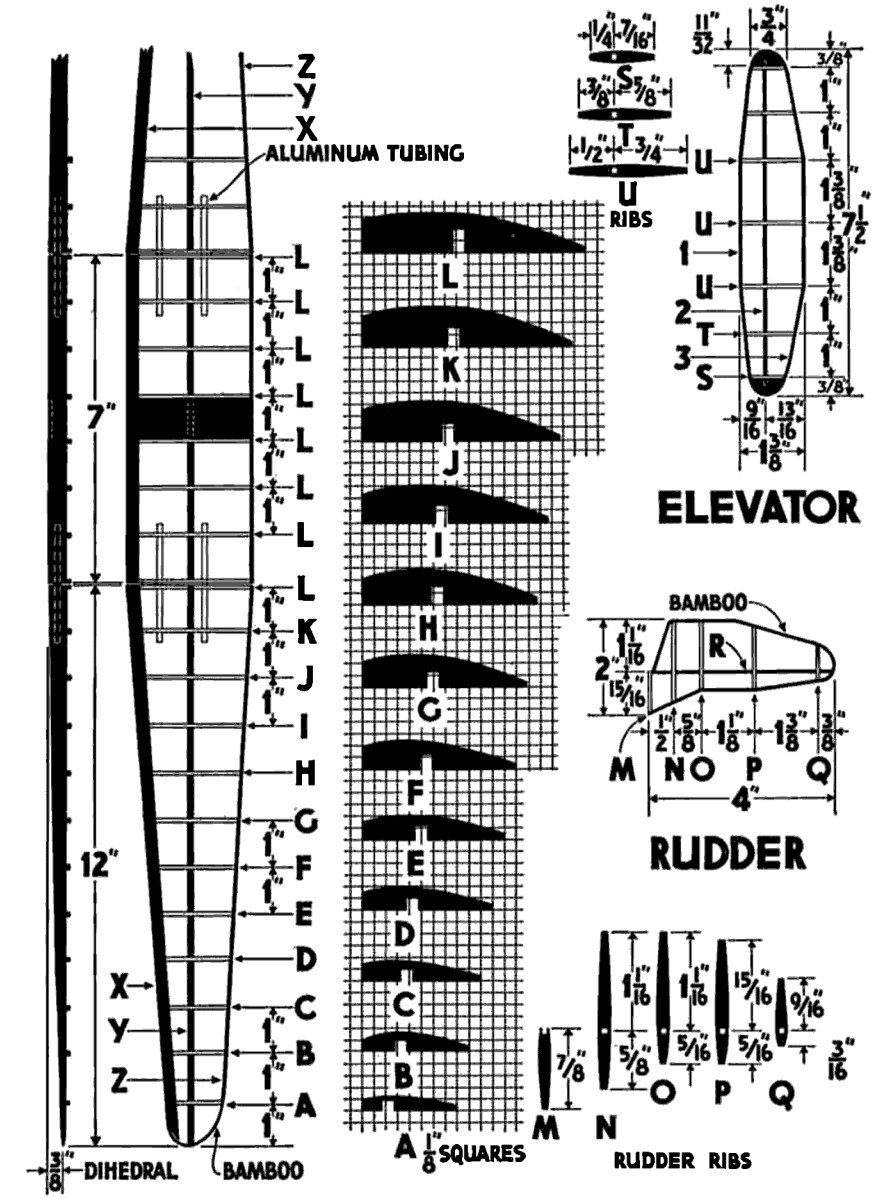
rib L, which is used on the inner end of each side section and for the entire center section, making ten necessary in all. Trace the rib outline on the 1/16" sheet balsa, and then cut them out. Make the necessary inner spar notch in each, as shown.

The leading edge spar X of one side section is 1/4" x 3/8" x 12" long. The inner wing spar Y for the same section is 1/8" x 1/4" x 12" long, while the trailing edge spar Z is 1/16" square bamboo. The leading edge spar is tapered from 3/8" thick at rib L to 1/16" at the wing tip. The inner wing spar is tapered from 1/4" at rib L to 1/16" at the wing tip, while the trailing edge remains the same along the entire length of the wing. Space the ribs along the inner wing spar Y, as shown in the top view of the wing in Plan 2, and then cement them in place, each at right angles to the spar. The leading edge spar is cemented to the ends of the ribs, after it has been sandpapered to a half-round form to fit the contour of the ribs. When completed, the bamboo trailing edge spar should be bent to form the wing tip at one end, and then cemented in place. A piece about 13" long will be needed for this spar.

The three sections of the wing are held together by four 2 1/2" lengths of 1/8" diameter aluminum tubing, which can be purchased at any model airplane supply house. In each side section, two lengths of this tubing extend through holes cut in ribs L and K. These holes should now be made. Note their position in Plan 2, showing the top view of the wing. One is located halfway between the leading edge spar and the inner wing spar, while the second one is 1/4" behind the inner wing spar. Two 1/8" diameter holes must be made in each of these two ribs to accommodate this tubing.

The section is covered on both sides with Japanese tissue. (See Chapter 7, "Wing Covering.") Water-spray the wing, and when dry, give it a coat of dope to shrink the tissue. The other side section of the wing is made and assembled in the same manner.

The center section of the wing is made with eight L ribs, which are cut from the 1/16" balsa sheeting. A 1/8" x 1/4" notch is cut in each of these to take the inner wing spar. The leading edge spar is 1/4" x 3/8" along the entire length, while the inner wing spar is 1/8" x 1/4". Both of these spars are balsa. The leading edge spar should be given a half-round form to match the other leading edge spars, but the inner wing spar is left without any forming. The trailing edge spar is 1/16" split bamboo. Each of these three spars is 7" long. Assemble this section in the same manner as the side sections. The section between the fourth ribs from each end has a solid 1/32" sheet balsa piece, fitted between the ribs and the leading and trailing edge spars. It is cemented to the under side of the inner wing spar, and to the sides of the



BOWLUS SAILPLANE PLAN 2

adjoining ribs, as well as the leading and trailing edge spars. Being fitted on the under surface of the wing, it forms a wing base.

The necessary holes for the aluminum tubing are made in the two outer ribs on each end of this center section. Care must be taken when doing this, as the wing dihedral is obtained through the position of these holes. Place the center section flat on a table. Insert two of the tubes into the holes of one side section. Line this section up with the center section so that the ends of the tubes just touch the sides of the end rib of the center section. Lift the tip of the side section 3/8" off the table. Mark the exact spots where the tubes rest against the outer side of the center section end rib. Cut 1/8" diameter holes at these points. With the wing tip still off the table 3/8" insert the ends of the tubes into these holes. Continue pushing them through until they rest against the second end rib of the center section. Again check the side section and center section to see that they have their inner spars forming a straight line, and that the tip of the side section is off the table 3/8". When in this position, mark the points where the ends of the tubes rest against the rib. Cut 1/8" diameter holes at these two points. The tubes are now removed from the side sections, placed in position in the center section and firmly cemented. This allows the tubes to be slipped into the holes of each side section, or removed from them, without being moved from the center section, where they are permanently attached. The tubes are attached to the other end of the center section in the same manner after like tests.

The center section is covered on both sides with Japanese tissue, water-sprayed, and doped. The wing is mounted on the fuselage. Note its position in Plan 1 showing the side view of the fuselage.

Coat the balsa wing base with cement and press it in position on the wing mount of the fuselage. Note that the trailing edge of the wing crosses the mount at a point 3/8" from its trailing end, and that the forward portion of the wing extends beyond the mount. Care must be taken to see that the wing forms right angles with a center line drawn through the center of the fuselage from nose to tail. Another test for this is to see that the edge of the wing is parallel with all fuselage formers.

A cockpit, into which weights may be inserted, is cut in the top of the fuselage. It extends from stringer 5 on one side to the same stringer on the other, and from former C at the back to stringers 3 at the front, which give it a V-shape at the front. For flying instructions, proper determining of weights and launching, see Chapter 17.