CHAPTER 31

ALL-IN-ONE MODEL

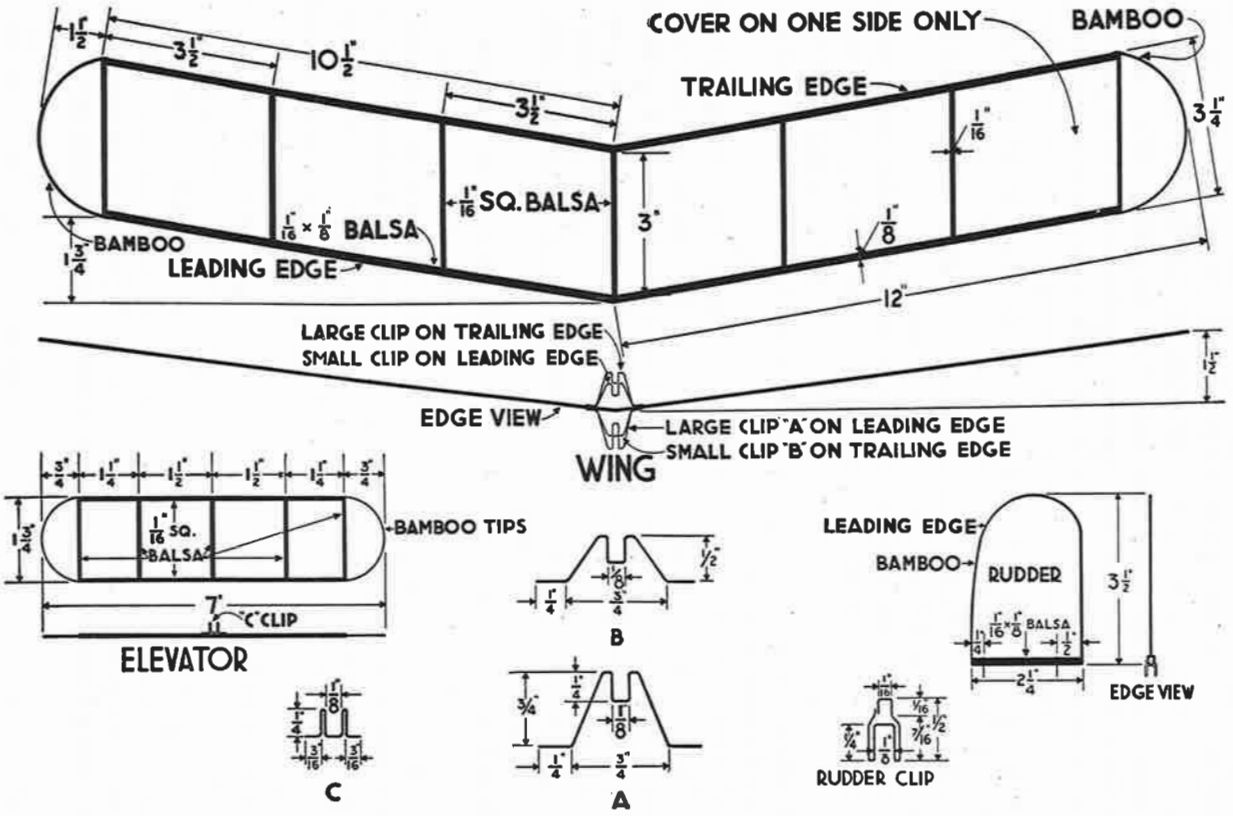
THERE are fifteen different types of model airplanes used for endurance flights. These are divided into three classes, the stick tractors, the stick pushers and the fuselage models. There are five of each of these three classes: the hand launched; the R.O.G.—rise-off-ground; the R.O.W.—rise-off-water; the R.O.S.—rise-off-snow; and the amphibian model, which can rise from either land or water. As the average model of this type requires ten parts in its construction, it would take 150 parts to build the entire fifteen, which would require weeks of work, as well as considerable expense.

For those who wish to own and fly all fifteen, here is a single model that will solve the problem. It requires only nine simple parts which can be assembled in various ways to form the entire fifteen models. It would be impossible to carry fifteen models anywhere, but these parts can be packed in a shoe box.

To build them is the work of a few hours, and the entire material costs less than a dollar. As will be seen, the wing is the dihedral, sweepback type, while the fuselage is the semi-round design so popular today. Six strands of rubber form a powerful motor.

Do not confuse this model with the average stick-and-fuselage endurance plane, as it far surpasses any of these in performance. Weighing less than half an ounce it can be counted on to give a good record of itself at any model meet. The builder should experiment with various propellers, as well as other motor strengths, so that the maximum of endurance can be had from his plane. As each model varies slightly in the building, this will be found worth the effort. Here is a model worthy of the attention of novice and expert alike, for its possibilities are numberless.

WING. Cut four 10½″ lengths of 1/16″ x 1/8″ balsa for spars. Cut seven 3″ lengths of 1/16″ square balsa for ribs. Make a full-size, top view drawing of the wing, as shown in Plan 1. Lay the spars in position on this drawing and cement all the ribs, except the center one, in place between the spars. Short lengths of 1/32″ split bamboo are bent to form the wing tips. (See Chapter 3, "Bamboo.") Cement these in place.



ALL-IN-ONE MODEL PLAN 1

The wing dihedral is now obtained and the spars of each half wing joined together. To do this, lay both halves of the wing flat on the drawing with the ends of their spars together. Holding one half of the wing flat on the drawing, lift the tip of the other half 3″ off the surface. When in this position the ends of the spars are cemented together and held in position until dry. A small block can be placed under the wing tip to help do this work. (See Chapter 7, "Wing Assembly.") By lifting one wing tip twice the height of the desired dihedral, each wing will be given the proper angle. When dry, the center rib is cemented in place.

The wing is covered with Japanese tissue on one side only. Hold the tissue with dope. (See Chapter 7, "Wing Covering.")

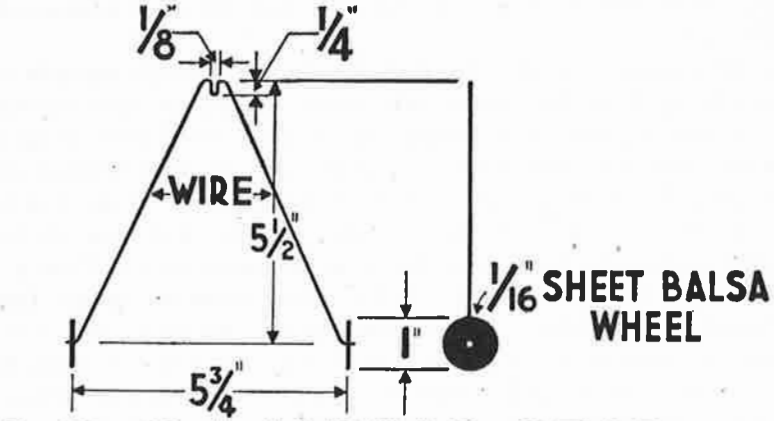
Four wing clips, two large and two small, are bent from No. 6 piano wire, as shown in Plan 1 under A and B. These are cemented to the leading and trailing edge spars of the wing directly over their joint, as shown. Two are placed on top and two under them on the under surface of the spars. (See Chapter 6, "Clips.")

ELEVATOR. Cut two 5½″ lengths of 1/16″ square balsa for spars. Cut five 1¾″ lengths of 1/16″ square balsa for ribs. Lay the spars parallel to each other and cement the ribs in place between them. Short lengths of 1/32″ split bamboo are bent to form wing tips. Cover with Japanese tissue on one side only. Two clips are bent from the same piano wire, as shown under C in Plan 1. Cement one on the leading edge and one on the trailing edge, as shown.

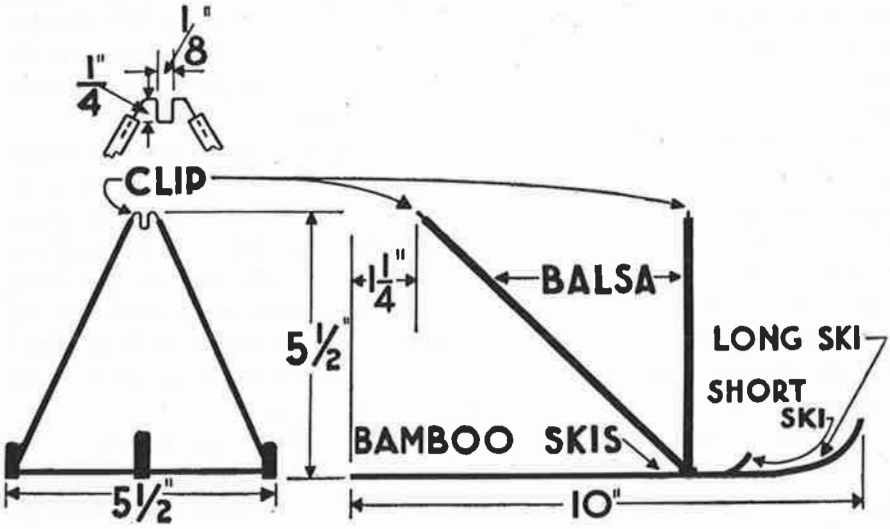
RUDDER. Cut one 2¼″ length of 1/16″ x 1/8″ balsa. Bend a length of 1/32″ split bamboo to form the outline of the rudder. Cement its ends to the ends of the balsa length. Cover with Japanese tissue on one side only. Bend two clips from No. 6 piano wire, as shown under "Rudder Clip" in Plan 1. Cement one ¼″ from the leading end of the balsa length and the other ½″ from its trailing end, so that the open ends of the clips extend down from the balsa length.

MOTOR STICK. Cut a 17¼″ length of 1/8″ x ¼″ balsa. From No. 8 piano wire, bend an end hook, as shown in Plan 4 under D. Cement this on the 1/8″ wide top of the motor stick 2½″ from one end. On the other end, cement a regulation propeller bearing, and strengthen the cement with a thread wrapping, as shown. The propeller bearing can be purchased or made. (See Chapter 6, "Propeller Bearings.") This completes the motor stick.

PROPELLER. Carve two standard propellers in the regular manner from ¾″ x 1¼″ x 10″ balsa propeller blocks. (See Chapter 9, "Carved Pro-



R.O.G. LANDING GEAR



R.O.S. LANDING GEAR

pellers.") Both are carved exactly the same, but the shaft is inserted from opposite sides.

In the pusher propeller, the shaft is inserted through the hub so that it extends out from the convex side, while the tractor shaft extends out from the concave side. (See Chapter 9, "Tractor and Pusher Propellers.")

Bend a propeller shaft from No. 8 piano wire, thrust it through the hub of the propeller, bend its end around, as shown in the plans, and hold it with cement. Two washers are threaded on the shaft and its hook is threaded through the bearing, as shown on the motor stick in Plan 4.

MOTOR. Three strands of 1/8" flat rubber form the motor. Obtain a 45" length of this rubber. Tie one end on the end hook, pass it forward through the hook of the propeller shaft, bring it back and through the end hook, and up to the propeller shaft again, where it is tied. The rubber is left longer than the distance between the end hook and the propeller shaft to allow for extra turns when wound, which in turn provide surplus endurance.

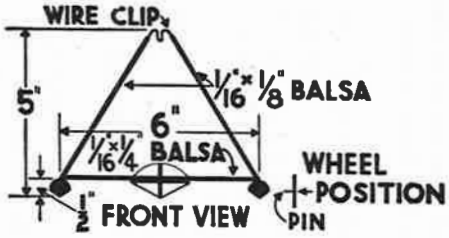
R.O.G. LANDING GEAR. This is bent from a length of No. 10 piano wire, as shown in Plan 2. The small notch at the top allows it to slip on the motor stick. Two 1" diameter wheels are cut from 1/16" sheet balsa. (See Chapter 10, "Solid Balsa Wheels.") These are fitted to the wire axles, which can then be turned up to prevent the wheels from slipping off. Another method to hold the wheels in place is to apply a small drop of cement to the ends of the axles after the wheels have been attached. When the cement becomes hard, it will hold the wheels on the axles.

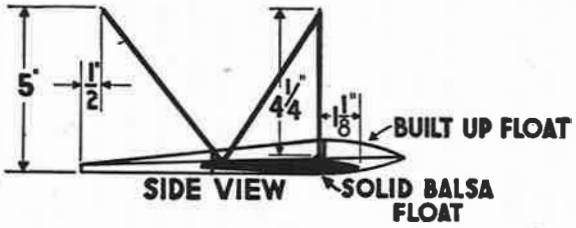
R.O.S. LANDING GEAR. Cut two 2½" lengths and one 10¼" length of 1/16" x 1/4" bamboo. Bend the end of the long piece until its tip is 1" high, and bend the short pieces until their tips are ½" high. (See Chapter 3, "Bamboo.") These form the skis of the gear. Cut a 5½" length of 1/16" x 1/4" balsa, which serves as a cross brace of the skis. In the exact center of this brace, cement the long ski. The brace must cross the top of the ski 2½" from its curved end, and form right angles with it. When dry, the short skis are cemented at the ends of the brace, parallel to the long ski.

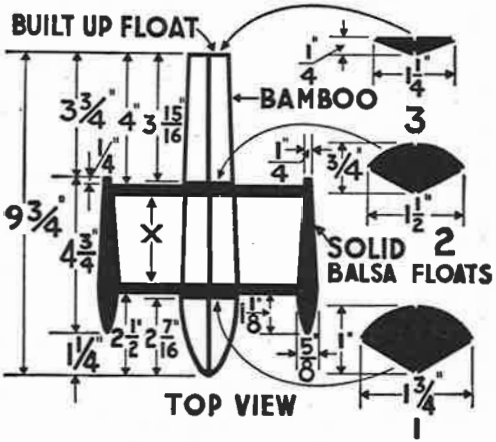
The brace crosses over the short skis half-way along their lengths.

From 1/16" x 1/8" balsa, four lengths are cut to form the uprights of the gear. The front pair must be long enough to reach from the ends of the cross brace to a point 5½" above the center of this brace, where they meet to form a triangle, as shown by the front view in Plan 2. At this point they are joined together by a small wire clip, bent from No. 8 piano wire, as shown under "Clip."

The remaining two uprights must be long enough to reach from the ends







R.O.W. AMPHIBIAN GEAR

of the brace to a point 5½" above the long ski and 1½" from its end. At this point, they are also joined together by a similar clip. Both these clips should have their ends thrust into the ends of the uprights, where they are held with cement.

R.O.W. LANDING GEAR. From ½" x ⅝" x 4¾" balsa blocks, cut two small floats to the shape shown in the top, side and front views in Plan 4. Cut two 6" lengths of 1/16" x ¼" balsa for cross braces. These are shown as X under "Top View" in Plan 3.

The large center float is built up from balsa formers and bamboo stringers. From 1/16" sheet balsa, cut the three formers, as shown under "Float Formers." These are numbered 1, 2, and 3 in Plan 3. Two lengths of 1/32" split bamboo are used to give the float its side-to-side and top-to-bottom form. The side stringer has one end cemented to the side notch cut in former 3, and is then cemented to the side notches in formers 2 and 1. It extends out from former 1 a distance of 2 7/16", where it is bent sharply around to form the nose of the float. It is then cemented in the opposite side notches of the three formers and ends at former 3.

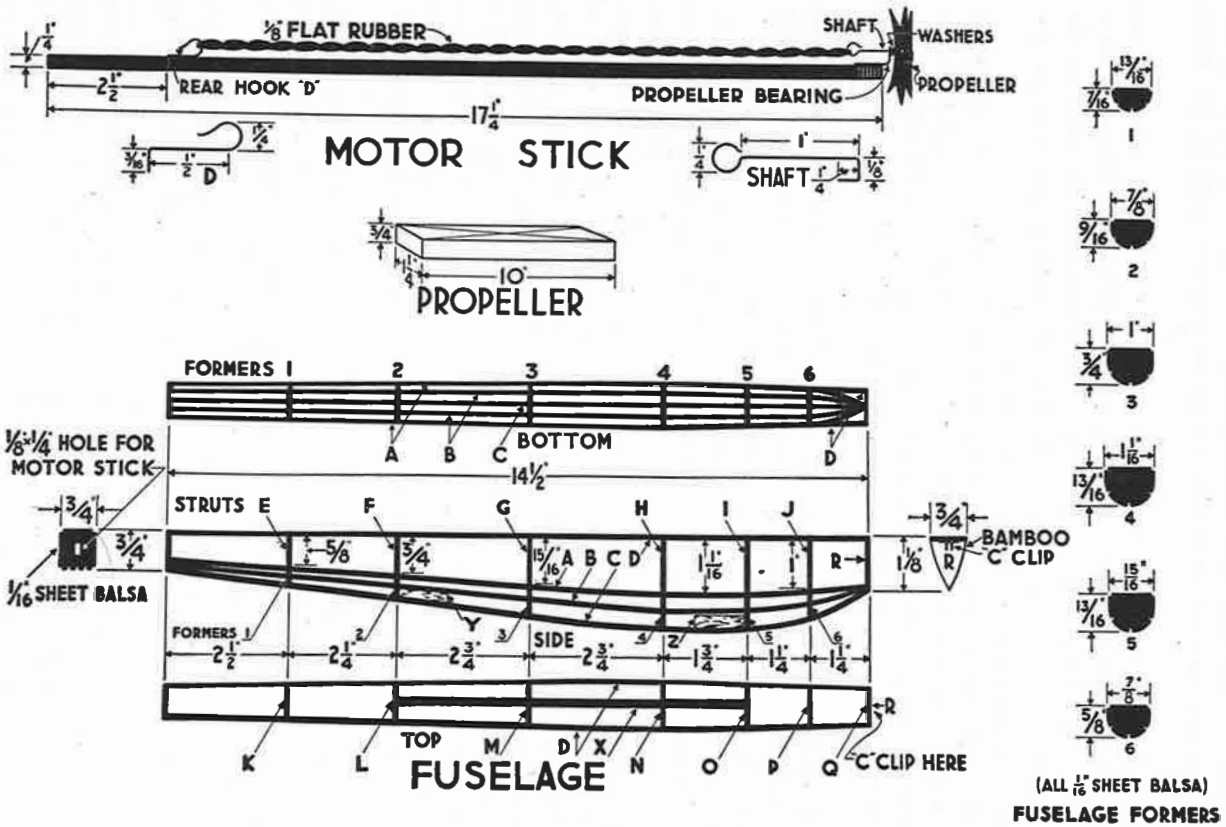
The second stringer starts from the top notch in former 3, passes through and is cemented to the top notches of formers 2 and 1, continues out to the bend of the side stringer, where it is likewise bent and cemented to the side stringer. It then passes through the bottom notches of the three formers, and is cemented to each, ending at former 3.

The two cross braces are now cemented in place to the large float. The front one fits behind former 1, and is cemented to it and the top of the side stringer, extending out on each side of this stringer an equal length. The back brace fits just in front of former 2, is cemented to it and the top of the side stringer, extending out from both sides an equal length.

The top and bottom of the large float are covered with Japanese tissue. It is sprayed with water, allowed to dry for ten minutes, and then given four coats of banana oil. When completed, the solid balsa floats are cemented under the cross braces.

Six lengths of 1/16" x ⅛" balsa form the uprights of the gear. The front ones must be long enough to reach from the ends of the front brace to a point 4¼" above the center of the large float, where they meet to form a triangle, as shown in the front view. At this point they are joined together by a wire clip similar to the one used on the R.O.S. landing gear. The center uprights must be long enough to extend from the top ends of the front uprights to the ends of the back cross brace. Cement these in place.

The rear uprights extend from the ends of the back cross brace up to a point level with the front uprights and back to within ½" of the end of



ALL-IN-ONE MODEL PLAN 4

the large float. These also form a triangle directly above the center of the large float, where they are joined by a clip such as was used on the front uprights.

AMPHIBIAN LANDING GEAR. Cut two 1″ diameter wheels from 1/16″ sheet balsa. (See Chapter 10, "Solid Balsa Wheels.") Through their centers thrust model pins for axles. These are thrust into the sides of the small solid balsa floats, which turns the R.O.W. landing gear into an amphibian. Note these under "Front View" in Plan 3.

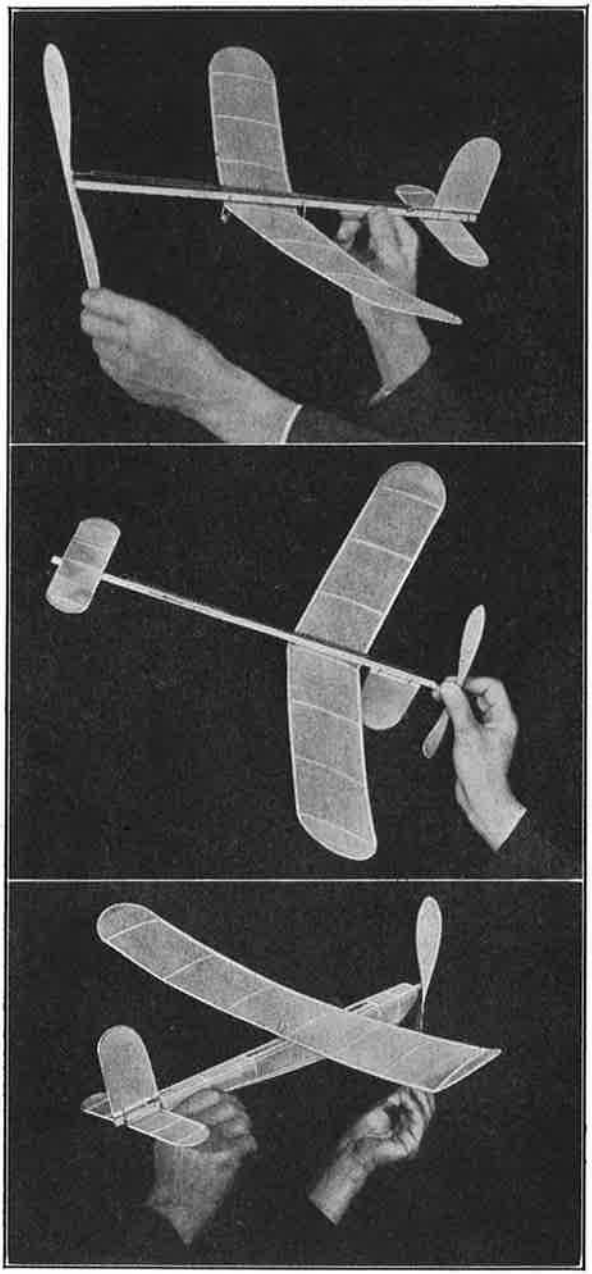
FUSELAGE. From 1/16″ sheet balsa, cut the six formers, as shown in Plan 4, under "Fuselage Formers." The fuselage is built in two sections, the half-round portion, which is obtained by the formers, and the oblong section, which is built on the half-round portion, and made of balsa stringers and struts.

Build the half-round section first. From 1/16″ sheet balsa, cut out the tail former, which is shown on the left of the side view of the fuselage. Through its center, cut a 1/8″ x 1/4″ hole into which fits the end of the motor stick.

Study the bottom view of the fuselage. Five stringers are required. The stringers A are cut from 1/16″ square balsa. The single stringer C is cut from the same stock, while the two stringers B are cut from 1/32″ split bamboo. Cut two A balsa stringers, two B bamboo stringers, and one C balsa stringer. Cement their ends into the small notches cut along the bottom edge of the tail former. Stringer C, which is the bottom one, is cemented into the bottom center notch cut in former 1, followed by stringers B which are cemented into the center notches of former 1. The five stringers are then cemented into the same notches in former 2, which is placed 2 1/2″ from former 1, followed by formers 3, 4, 5 and 6. The ends of the stringers extend 1 1/4″ out in front of former 6, where they are cemented together to form the nose of the fuselage.

Study the side view. Note blocks Y and Z. These are small balsa blocks measuring 1/4″ x 1/8″ x 1″, and are cemented to stringer C in front of former 2 and just behind former 5. They should also be cemented to these formers. This completes the half-round section.

The top of the oblong section is now made. Study the top view in Plan 2. Seven cross braces are required. They are shown as K, L, M, N, O, P and Q, and are cut from 1/16″ square balsa. They are 5/8″, 11/16″, 13/16″, 7/8″, 13/16″, 3/4″, and 3/4″ long respectively. Cut these braces, marking each with its letter. Two 1/16″ square balsa stringers shown as D are cut 14 1/2″ long. Place these parallel to each other on a flat surface and cement the braces between them. A 7 1/4″ length of 1/8″ square balsa is cemented between braces L and O, being notched to fit these braces and braces M and N over



HAND-LAUNCHED SINGLE-STICK TRACTOR

HAND-LAUNCHED SINGLE-STICK PUSHER

HAND-LAUNCHED FUSELAGE MODEL

which it extends. Locate it in the center of these braces. The nose form of the fuselage is obtained by a length of 1/32" split bamboo, which is bent to form as shown by R in the side view of the fuselage. Its ends are cemented to the ends of brace Q, which is equipped with a small clip on its under side. This is the same as the elevator clip.

The top section is cemented to the half-round section. The two stringers D are cemented to the top notches of the tail former and the ends of the half-round section stringers A, B, and C are cemented to the bend of the bamboo nose form.

Six pairs of struts are cut from 1/16" square balsa. Struts E are 5/8", struts F are 3/4", struts G are 15/16", struts H and I are 1 1/16", while struts J are 1" long. When cut, cement them in place between stringers D and stringers A. The fuselage is covered with Japanese tissue. The top section between cross braces L and O is left open. On the bottom, the sections between the formers 2 and 3 and between 4 and 5 are also left open, their width being from stringer B on one side to the same stringer on the other. This completes the making of all our model's various parts.

ASSEMBLY

SINGLE-STICK TRACTOR (HAND-LAUNCHED). Attach elevator to under side of motor stick just behind end hook. Attach rudder to top side of motor stick just above the elevator. Attach wing to under side of motor stick. Decide location by gliding plane. Adjust wing for gradual glide. (See Chapter 16, "Gliding Method of Wing Adjustment.") Attach tractor propeller to motor.

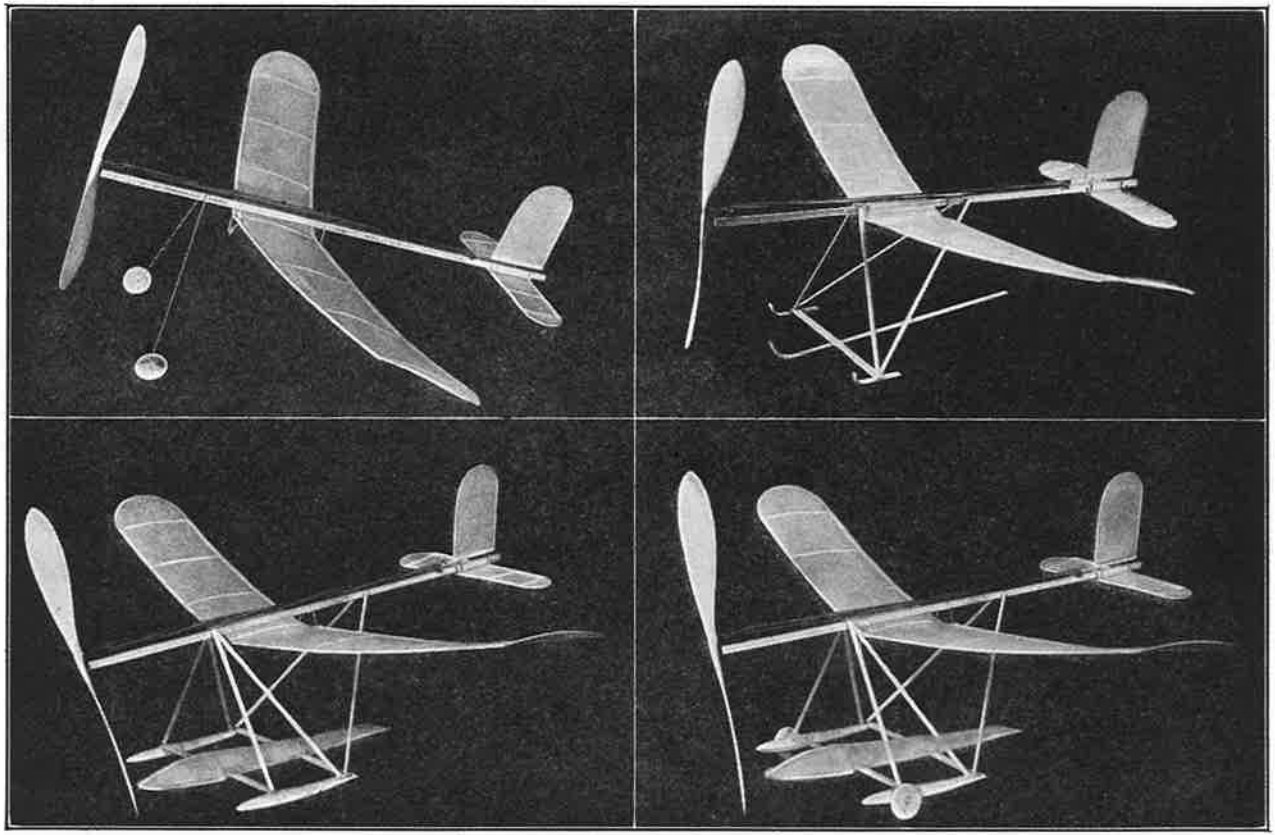
SINGLE-STICK TRACTOR (RISE-OFF-GROUND). Assemble as above. Attach R.O.G. landing gear about 2" to 3" back from front end of motor stick by forcing opening of clip on under side of stick.

SINGLE-STICK TRACTOR (RISE-OFF-SNOW). Assemble for hand-launched tractor. Attach R.O.S. landing gear on under side of motor stick with its clips in front and back of wing.

SINGLE-STICK TRACTOR (RISE-OFF-WATER). Assemble for hand-launched tractor. Attach R.O.W. landing gear to under side of motor stick with its clips in front and back of wing.

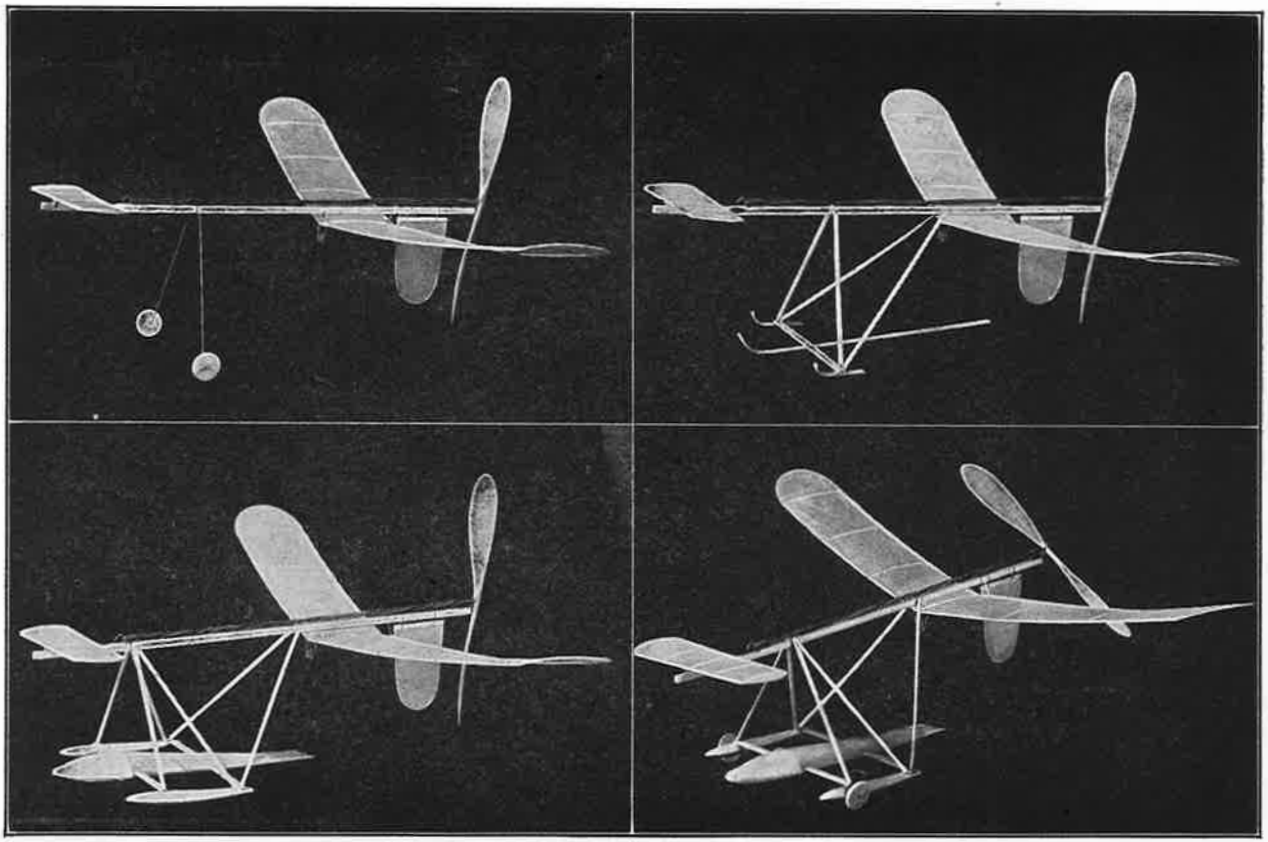
SINGLE-STICK TRACTOR (AMPHIBIAN). Same assembly as above. Add wheels to sides of small floats.

SINGLE-STICK PUSHER (HAND-LAUNCHED). Attach elevator to top side of motor stick just in front of end hook. Attach pusher propeller. Attach rudder to under side of motor stick 1" from propeller. Attach wing



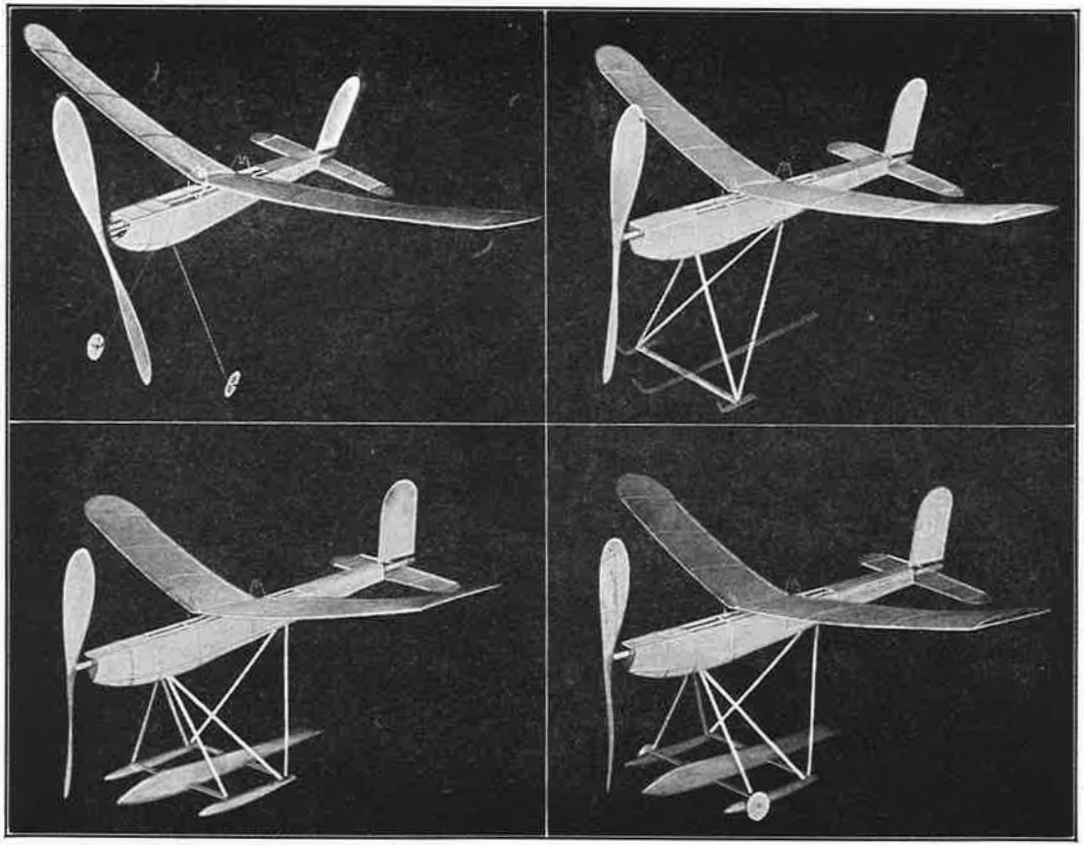
R.O.G. SINGLE-STICK TRACTOR
R.O.W. SINGLE-STICK TRACTOR

R.O.S. SINGLE-STICK TRACTOR
AMPHIBIAN SINGLE-STICK TRACTOR



R.O.G. SINGLE-STICK PUSHER
R.O.W. SINGLE-STICK PUSHER

R.O.S. SINGLE-STICK PUSHER
AMPHIBIAN SINGLE-STICK PUSHER



R.O.G. FUSELAGE MODEL
R.O.W. FUSELAGE MODEL

R.O.S. FUSELAGE MODEL
AMPHIBIAN FUSELAGE MODEL

to under side of motor stick with wing tips pointing back to propeller. Glide model for proper location.

SINGLE-STICK PUSHER (R.O.G.) Same assembly as above. Add R.O.G. gear 2″ back of elevator.

SINGLE-STICK PUSHER (R.O.S.) Same assembly. Add R.O.S. gear between elevator and wing.

SINGLE-STICK PUSHER (R.O.W.) Same assembly. Add R.O.W. gear between elevator and wing.

SINGLE-STICK PUSHER (AMPHIBIAN). Same assembly as R.O.W. Add wheels to sides of balsa floats.

FUSELAGE MODEL (HAND-LAUNCHED). Insert motor stick through hole in rear former, allowing it to extend 2″. Force stick up into front clip. Attach tractor propellor. Attach wing to top center brace. Locate by gliding.

FUSELAGE MODEL (R.O.G.). Add R.O.G. gear to block Z on longeron C with above assembly. See Plan 2.

FUSELAGE MODEL (R.O.S.). Same assembly with R.O.S. gear attached to blocks Y and Z.

FUSELAGE MODEL (R.O.W.) Same assembly with R.O.W. gear attached to blocks Y and Z.

FUSELAGE MODEL (AMPHIBIAN). Add wheels to R.O.W. gear with same assembly.

CHAPTER 32

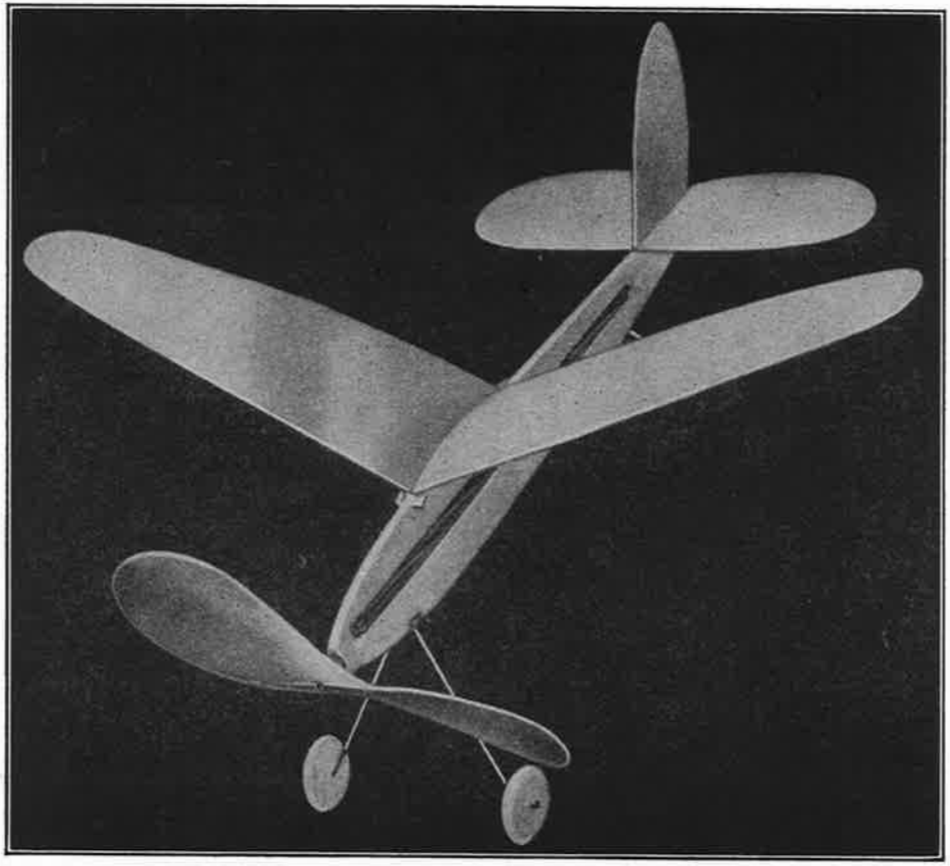
PROFILE SPEEDSTER

IN recent years a number of models have appeared with fuselage forms cut from sheet balsa. If it were possible for a model to be half-fuselage and half-stick at the same time, this type would belong to that class. It has the general outline of a fuselage model from either side and looks like a stick model when viewed from the front or rear. Some models of this type have their sides covered with tissue on which are painted doors, windows, cockpits, etc., usually found on the side of any fuselage model. The designer and builder of this particular one, Louis Garami, has done a splendid job, and it was for this reason that it was chosen for these pages. The author appreciates Mr. Garami's permission to use it.

MATERIAL LIST

1 pc.—1/8" x 1¾" x 11½"	—Sheet Balsa (Fuselage)
1 pc.—1/32" x 3" x 24"	—Sheet Balsa (Wing, Rudder, Elevator)
1 pc.—1/8" x 1" x 6"	—Sheet Balsa (Wing Ribs)
1 pc.—¾" x 1 1/16" x 6"	—Balsa Block (Propeller)
1 pc.—1/8" x 16½" long	—Flat Rubber (Motor)
1 pc.—.028 x 12" long	—Music Wire (Fittings)
1 pc.—1/8" x 1" x 2"	—Hard Balsa (Wheels)
1 pc.—1/16" O.D. x ½"	—Aluminum Tubing (Bearing)
1	—Copper Washer
1	—Eyelet Bearing
1 pc.—1/16" square x 1"	—Bamboo (Tail Skid)
Colorless Cement	
Clear Dope	

FUSELAGE. The fuselage is cut from a single sheet of balsa, as shown at the top of the plan. It is 1/8" x 1½" x 11¼" long. Square up a sheet to this size and draw in the outline of the fuselage. Before cutting it out, the inside "motor" section is outlined. Measure 7/16" in from the nose of the fuselage for its front end. Measure 8½" from this front along the fuselage and mark a second point for the rear. Draw vertical lines through these points parallel with the bottom of the sheet. Locate the center of the fuselage and measure 5/32" on each side of this center line. Rule lines paral-



PROFILE SPEEDSTER

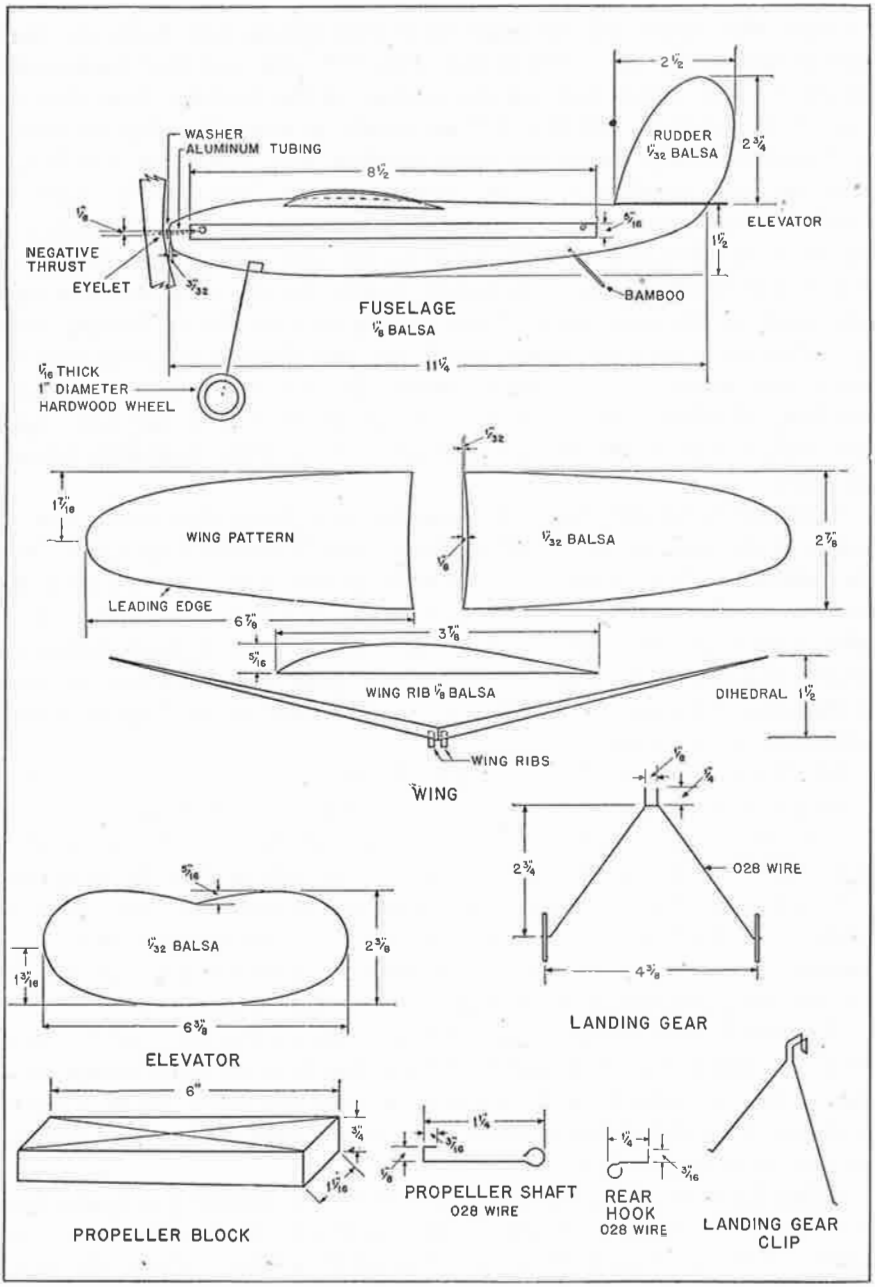
lel with the center one through these two points and from the front vertical line to the rear vertical line. This 5/8" wide and 8 1/2" long area is cut out for the motor. Cut out the outline of the fuselage. Note that the nose of the fuselage, which is 1/2" in length, is slanted so that its base is 3/32" behind its top. Finish the entire fuselage with sandpaper. Cut a 1/16" piece of split bamboo 1" long and cement it into a hole made to hold it in the bottom edge of the fuselage, as shown in the plan. Bend the rear hook of .028 music wire, thrust it up into the ceiling of the motor slot and cement firmly in place, as shown. A hole for the propeller bearing is now made in the nose with a large pin. Note that this is slanting down 1/8" to create a negative thrust. Work the pin through the nose into the motor slot, insert the 1/16" O.D. (outside diameter) aluminum tubing in this hole, and then cement a large washer in front of it on the nose. Apply two coats of dope to the fuselage and rub it down with sandpaper between the coats.

LANDING GEAR. Bend the landing gear from .028 music wire, as shown in the plan under "Landing Gear" and "Landing Gear Clip." Note the "saddle" on top of the gear which keeps the "legs" from rocking. Cut two sheet balsa wheels 1/8" thick and 1" in diameter, place them on the axles, which are then turned up to prevent the wheels from falling off. Cement the clip of the gear 1 5/8" behind the nose of the fuselage, as shown in the plan. Line up the wheels and see that they are 4 3/8" apart. Project them forward, as shown.

ELEVATOR. This is cut from a single sheet of 1/32" balsa. Note its form in the plan. Square up a piece of this sheet balsa 2 3/8" wide and 6 3/8" long. Lay out the curves, as shown in the plan, and then cut it out. Sand all edges smooth and round, and then apply two coats of dope rubbing down with sandpaper between them. The elevator is cemented to the top of the fuselage. Its leading edge should come exactly 2" in from the rear of the fuselage, so that it extends out beyond the end of the fuselage 3/8". See that it is directly centered on the fuselage and at right angles to it.

RUDDER. The rudder is shaped from a squared-up piece of 1/32" sheet balsa measuring 2 1/2" wide and 2 3/4" long. Cut it to the form shown in the plan, dope and sand it, and then cement it to the center of the elevator, as shown. Test to see that it forms right angles with the elevator and runs parallel with the fuselage.

PROPELLER. The propeller is carved from a medium-hard balsa block measuring 3/4" x 1 1/16" x 6" long. Full instructions for carving such a propeller are given on page 91 under "Carved Propellers." Bring the tips of the blades to 1/16" in thickness with sandpaper. They should be 1/8" thick



PROFILE SPEEDSTER PLAN

at the hub. Cement a large washer and a small eyelet to the hub to prevent wear. Bend the propeller shaft from .028 music wire. Cement it in the hub hole, pass two small washers over its protruding shaft, insert the shaft through the aluminum tubing bearing, and then bend its hook. Complete the assembly by a single loop of 1/8" flat rubber between the rear hook and the propeller shaft hook.

WING. The wing is made in two halves from 1/32" medium balsa, as shown in the pattern on the plan. Take great care when cutting the inner end curves where the halves are joined together. Cut two ribs from 1/8" sheet balsa. Note this rib in the plans. Sand and dope all parts and then assemble the halves, which is done in this manner: Pin one rib on each side of the fuselage, as shown in the top view of the plan. Line them up from the top and sides. Now spread cement over the tops of the ribs, but do not spill any on the fuselage. The wing halves are then pinned on to the ribs so that they join each other at the middle and so that their tips are raised the required dihedrals. The joint formed by the two halves must be cemented together also. Allow the structure to dry at least two hours. A single rubber band holds the wing in place during flights, which also allows it to be moved to any location along the fuselage. This completes the model.

CHAPTER 33

FIFTEEN-MINUTE CHAMPIONSHIP TRACTOR

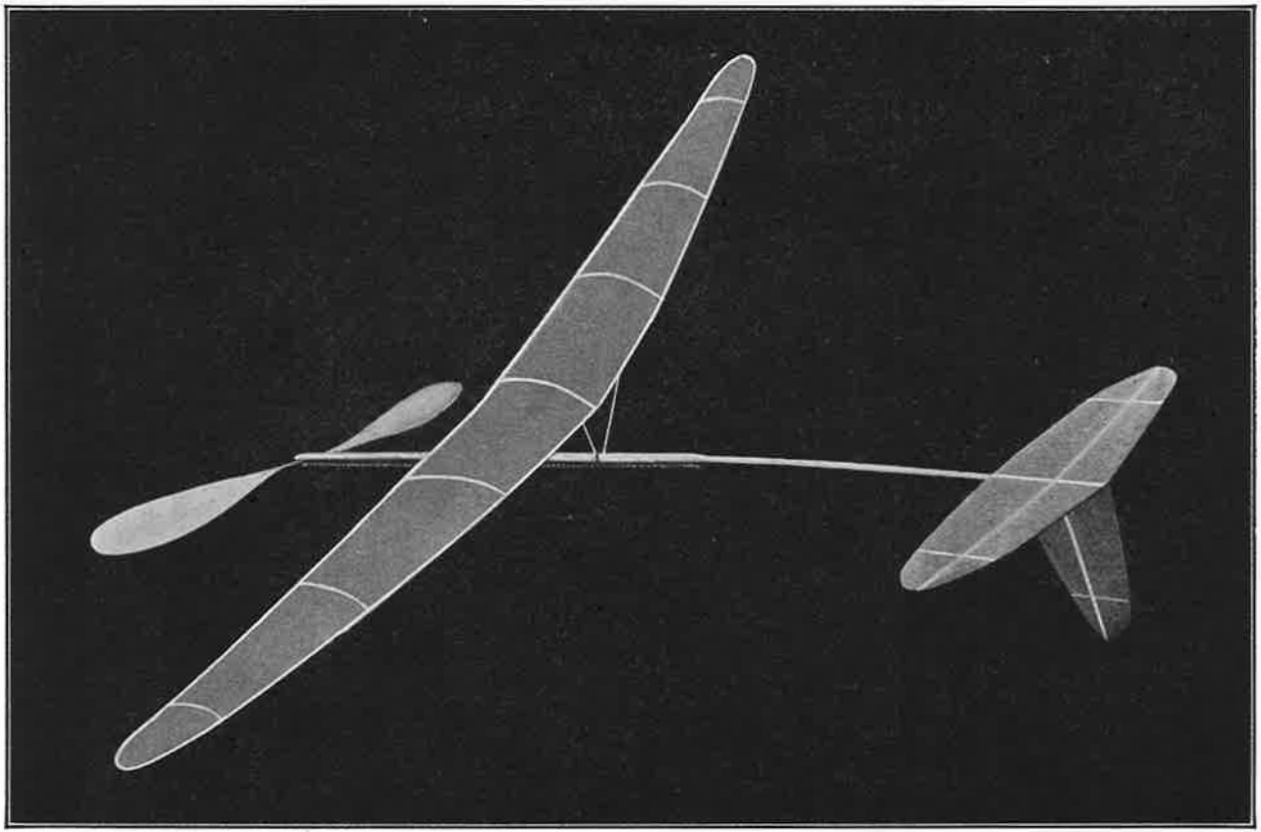
HERE is a perfectly designed and finely balanced single-stick tractor, especially built for indoor endurance competition. This superb example of model airplane construction is presented here through the kindness of its designer and builder, Edward H. Beshar, well-known model expert, who has flown it for fifteen minutes and five seconds. Of such delicate construction that its weight can only be measured in drams and grains, this flying feather opens to the model builder of experience many new fields of exploration and experimentation.

MOTOR STICK. A hollow motor stick is used on this model. Obtain a piece of 1/64" sheet balsa. If this thickness cannot be obtained at your model supply house, obtain the thinnest they have and then carefully sandpaper it down with No. 000 sandpaper to 1/64" thickness. Jeweler's sandpaper is even better if obtainable.

When the piece is of proper thickness, cut it 5/8" wide and 15" long. This is soaked in hot water for five or ten minutes. While it is soaking, obtain a 1/8" x 1/4" x 20" long stick of balsa or pine, and plane it to the shape shown in the plan under "Stick Form." When completed, it should be sandpapered on all sides so that it is 1/64" smaller all around than its original size of 1/8" x 1/4".

The soaked balsa sheet is placed around this stick and bent, using the stick as a bending form. Tie the sheet balsa in place around the stick with wide ribbon, as string, wire, or thread will quickly mar or dent the soft balsa. Make sure that both ends of the stick protrude from the ends of the balsa sheeting. Allow the balsa to dry in this position, and then remove the stick. Coat the edges of the balsa sheeting with cement and press them together. The sheeting should be tied again with the ribbon until dry.

Some builders prefer to leave the stick in position, apply cement along the crack formed by the edges of the balsa sheeting, and then slightly tighten the ribbons. When this method is used, the stick should be pulled back and forth inside the balsa to prevent any surplus cement from adhering to it.



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Two balsa plugs are shaped to fit the inside form of the motor stick. These are 1/4" long and cut to shape from balsa blocks. Coat all sides of one plug with cement and slip it into place in one end of the stick, so that the end of the stick and the end of the plug are flush with each other. This end becomes the leading, or propeller, end of the motor stick. The second plug is fitted into the trailing end of the stick in the same manner, except that it is inserted 1/4" further into the stick, as shown in the plans under "Boom Attachment." (See Chapter 12, "Motor Stick.")

A piano wire end hook and a can hook are bent from No. 5 (.014") piano wire, and attached to the under side of the motor stick, as shown in the plan. The under side of the motor stick is the wider portion, as shown in the plan under "Boom Attachment." A regulation propeller bearing is cemented to the under side of the stick at its front end. (See Chapter 6, "End Hooks," "Can Hooks," and "Propeller Bearings.") Complete the motor stick by smoothing with jeweler's sandpaper.

BOOM. This is cut from a balsa stick measuring 1/16" x 3/32" x 10" long. This stick is sandpapered down so that it tapers gradually to 1/32" x 1/32" at its trailing end, while its leading end, which connects with the motor stick, remains the original size of 1/16" x 3/32". As the elevator is built on the trailing end of the boom, it is not attached to the motor stick at this time.

ELEVATOR. This consists of a sheet of Japanese tissue, two ribs, and the end of the boom, crossed by a center spar. Iron the paper smooth, trace the outline of the elevator on it, and cut it out. The two elevator ribs are 1/64" square and 2" long, while the center spar is 5/64" square. Cement it over the boom 1 1/2" from the end of the boom and at right angles to it, making sure that the center spar extends out from the sides of the boom an equal distance. The two 1/64" square ribs are cemented to the top of the center spar 2" in from its ends, as shown. They must form right angles with the spar.

The tops of the center spar and the ribs are coated with clear dope or banana oil, and tissue is pressed in place on them. The wing, elevator, or rudder coverings are not water-sprayed or doped, but left as attached.

RUDDER. The rudder extends down from the elevator by means of a center spar, which is 5/64" square balsa and 4 1/2" long. A single 1/64" x 1/64" x 2" long balsa rib is cemented 2" from the end of the center spar, so that one end of the rib extends 3/4" out, while the other extends 1 1/4" out from the center of the spar.

Japanese tissue is ironed smooth, cut to shape, and attached over the rib and spar, after these members have been coated with clear dope or

banana oil. The spar of the rudder is cemented to the boom 1½″ in from its trailing end, which completes the rudder and its assembly. Test to see that the rudder and the elevator form right angles with each other.

The boom, rudder, and elevator are attached to the motor stick by means of the boom. The end of the boom is coated with cement and inserted into the end of the motor stick until it rests against the balsa plug. Two small balsa wedges are inserted between the stick and the boom on the top and bottom sides of the boom. These should also be coated with cement. This method of attachment is shown in the plan under "Boom Attachment."

Note that the boom does not extend out from the stick directly in line with that member, but slightly to one side. This is called the "offset" of the boom, and is shown in the plan under that name. To obtain this, see that the end of the boom is ¼″ to one side of the end of the motor stick, and then hold it on a flat surface in this position until the cement dries. This enables the model to turn in circles as it flies, which is necessary for indoor contests.

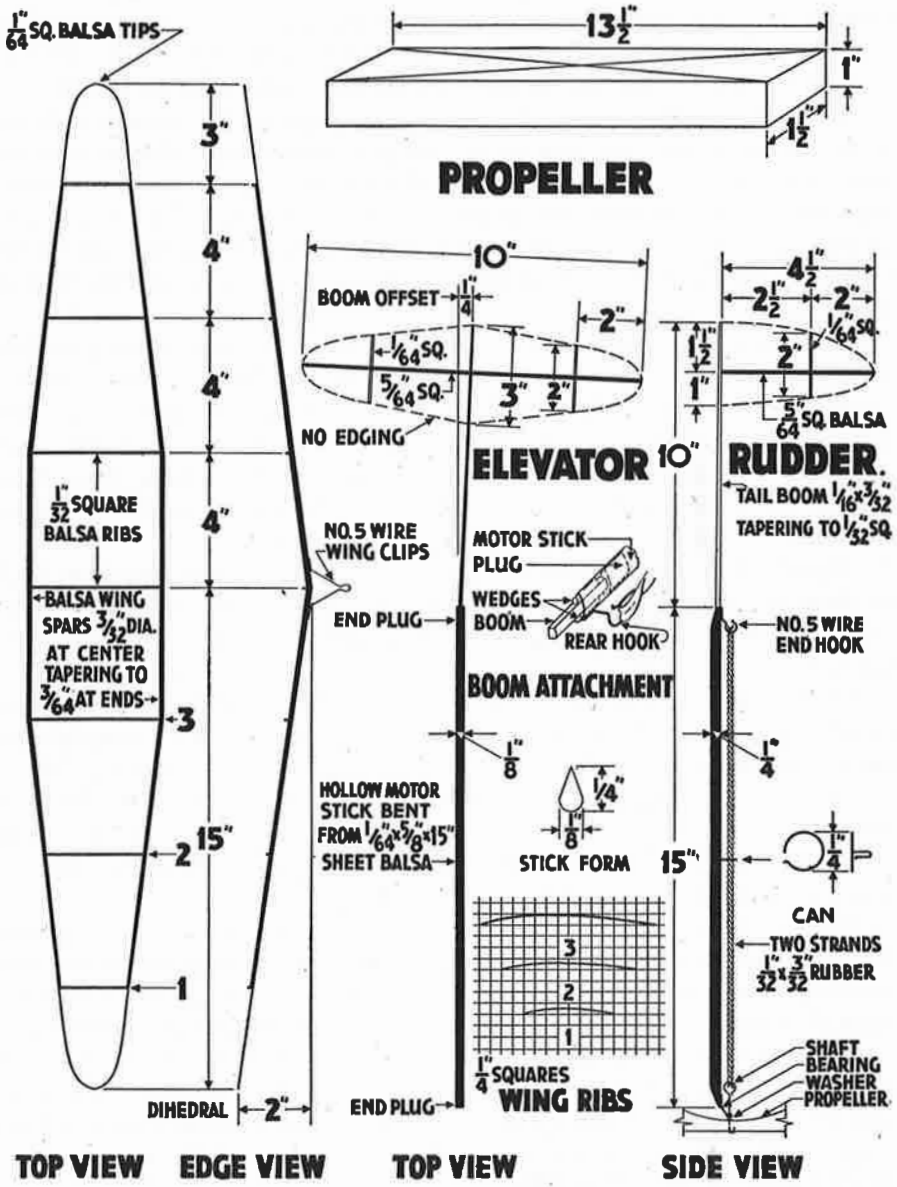
WING. The wing requires two balsa spars, 24″ long. They must be $\frac{3}{32}$″ in diameter at their center points tapering to $\frac{3}{64}$″ at their ends. This work should be done with No. 000 sandpaper, and great care should be taken to see that each spar is round with a gradual taper toward both ends.

Seven balsa wing ribs are required. These should be $\frac{1}{32}$″ square, and curved as shown in the graph plan under "Wing Ribs." Make templates of these ribs, soak them, and then bend each to shape. (See Chapter 3, "Balsa Wood.") A full-size plan of the wing is drawn. Place the spars in position on the plan. At the points of their bends, crack the spars. They are then bent to conform to the plan and cemented along the cracks. Hold the spars in position until the cement dries.

Placing the spars in position on the plan, cement each rib in its proper location between them. Wing tips of $\frac{1}{64}$″ square balsa wood are soaked and bent to shape by placing them on the plan. (See Chapter 3, "Balsa Wood.") Slightly notch the ends of the spars, and cement the balsa tips in place.

The necessary 2″ wing dihedral is now obtained. Crack the spars at their centers, place the wing on a flat surface, and then lift one of the wing tips 4″ off it. While holding the tip in this position, apply cement to the cracks in the spars. Hold the wing in this position until the cement dries. (See Chapter 7, "Wing Assembly.")

The wing is covered on its upper surface only. Use Japanese tissue. Coat the spars, ribs, and wing tips with clear dope or banana oil, and press the paper in place on the framework. The tissue should be carefully ironed to



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remove all wrinkles, before it is applied to the structure. When dry, trim all edges, but do not spray with water or coat with dope.

Two wing clips are bent from No. 5 (.014″) piano wire. The larger of these is 1¼″ high overall, while the smaller one is ⅛″ shorter. (See Chapter 6, "Clips.") Cement the large one on the under side of the trailing edge spar at its center, as shown in the plan. The small clip is attached in the same position to the leading edge spar.

PROPELLER. A medium pitch propeller is used on this model. It should be carved from a 1″ x 1½″ x 13½″ balsa propeller block. (See Chapter 9, "Carved Propellers.") The carving of this propeller should be done very carefully. Sandpaper the blades until so thin that light will easily show through them.

A propeller hook is bent from No. 5 (.014″) piano wire, and cemented through the hub. Test the propeller for proper balance.

MOTOR. The motor for this model consists of two strands of 1/32″ x 3/32″ pure Para rubber. As a 5″ slack is allowed each strand, obtain a piece of this rubber measuring 38″, and tie its ends together tightly. Before assembling the motor, slip the wing in place on the motor stick, as it cannot pass the propeller when in place on the shaft.

Two washers are then applied to the propeller shaft, which in turn is threaded through the hole of the propeller bearing. Loop one end of the rubber around the end hook, pass the rubber strands through the center can hook, and loop the other end around the propeller hook. Note the propeller assembly in the plans.

FLYING. The model is carefully tested to obtain the exact position of the wing on the motor stick. Glide the model. If it has a tendency to stall, the wing must be moved backward. If it should dive, move the wing forward. All such tests should be made before winding the motor. Test the model until a long, slow and even glide has been obtained.

On the motor stick, mark the point where the clips are located, so that when the model is again assembled for flights, it will be easy to adjust the wing. Wind the motor and launch. Prewinds of the motor will aid considerably, while a drop of oil on the propeller shaft's washers will decrease friction. For the proper method of launching, see Chapter 16, "Correct Launching of Single-Stick Tractor."

CHAPTER 34

MILE-A-MINUTE TWIN PUSHER

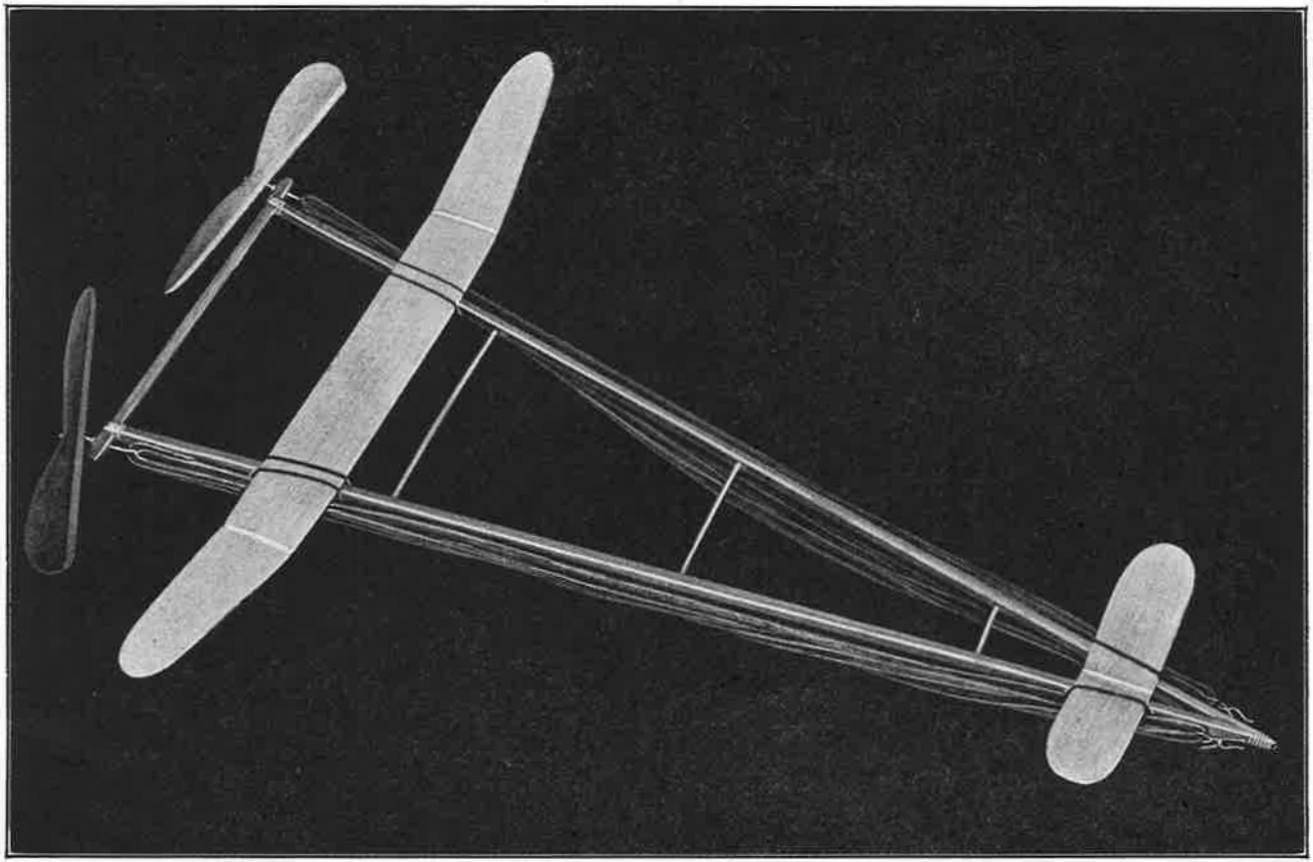
HERE is a record-breaking model for all enthusiasts who like speed. Designed and built by Edward H. Beshar, nationally known model builder, it has been officially clocked 56.2 miles per hour over a two-hundred-yard course at a recent Eastern meet.

Additional rubber can increase the speed to over a mile a minute. This model is built along simple lines that the average model builder can easily follow, and can be counted on to give excellent speed performances.

Unlike the usual stick model, this plane is not greatly affected by weight, as its action is more that of a bullet than the soaring flight of endurance models. Because of this, the A-frame is constructed of white pine to withstand the strain of its wound motors, while the wing and elevator are of solid balsa. For the same reason, the builder must not expect long flights, as the design is such that these are impossible. Average speed flights will be around three hundred and fifty yards.

FUSELAGE. On all twin pushers, the fuselage is known as the "A-frame." This is constructed of two 3/16" x 3/8" x 24" white pine lengths. Study this in the plan under "A-frame." Note that a spreader bar separates these pine lengths at one end, while they meet at the other. The spreader bar is 1/4" x 1/4" x 8 1/4" long, and is cut from white pine. This piece is left square at the ends, but is streamlined between the points of contact with the A-frame beams. Note this in the plans under "Spreader Bar," which shows an end view of the model without the propellers. The cross section of the spreader bar, as shown in this view, will give the builder an idea of how his bar should appear when finished. Your knife should be used to rough this shape out, and it should be finished smooth with sandpaper. The two beams of the A-frame should be carefully sandpapered smooth with their edges slightly rounded. Note that the 3/8" wide surfaces of these lengths become the side of the beams when assembled, while the 3/16" surfaces become the top and bottom of the beams.

The beams have 1/4" x 1/4" slots cut into them to accommodate the spreader bar, while their other ends are tapered to fit the angle formed by the bar. Assemble the spreader bar into the slots of the beams so that the thin



MILE-A-MINUTE TWIN PUSHER

edge of the bar is facing out, or toward the rear. See that the inside distance between the beams is 6⅜", as shown in the plan. When in this position, bring the other ends of the beams together so that one overlaps the other. In this position, mark the angle each piece must be cut, remove the beams from the spreader bar, and cut their ends at the indicated angle. Reassemble the three pieces and check your work. If the two forward ends fit flush against each other, while the spreader bar is in its proper location, they have been correctly cut.

Three ⅛" holes are bored through the ⅜" sides of each beam. These are for the ⅛" pine dowels. Note their location in the plans. Lay both beams end to end next to each other on a flat surface. Divide their lengths into 6", boring a hole through the beams at these points, but not until they have been assembled in position with the spreader bar. When in this position, the holes may be bored, so that each hole will extend through each beam at the proper angle, or in line with the opposite hole.

Cement the spreader bar into position in the slots of the beams, and at the same time, cement the opposite or front ends of the beams together. The spreader bar is further strengthened with silk thread binding, as shown. Obtain ⅛" dowels from your nearest model supply store, fit them through the holes bored in the beams, and cut them to proper length. These are cemented in place. On the outer side of the beams and at the points where the ends of the dowels appear through the beams, lightly sandpaper to bring the dowel ends flush with the face of each beam.

The usual nose hook is bent from 1/16" diameter brass wire and attached over the ends of the beams with cement and silk thread, as shown. (See Chapter 6, "Nose Hooks.") To add further strength to the A-frame, 1/32" sheet balsa strips are cemented to the outer sides of the beams over the ends of the dowels. Cut these ⅜" wide and 21" long, center them between the nose and the spreader bar, and cement each in place. Allow one hour for complete drying, and then give the entire A-frame a careful sandpapering.

The A-frame construction is completed by applying two propeller bearings to the ends of the spreader bar. The majority of model builders prefer to purchase bushing bearings for such models, but they can be made. This requires a soldering operation, so if your work shop is not equipped for this work, much time will be saved by purchasing them. Such a bearing consists of a ¾" length of brass tubing to which is soldered a large washer of about 7/16" diameter. As 1/16" wire is used for propeller shafts, the inside diameter of the tubing must also be 1/16" in diameter.

Halfway between the end of the spreader bar and the side of the beam, bore a hole equal in size to the outside diameter of the tubing. The tubing

is inserted into this hole with its washer on the rear side of the bar, as shown in the plan. Apply such a bearing to the other end of the spreader bar for the second propeller. These are not cemented in place, as their fit should be tight enough to hold them in place. To complete the A-frame, it should be given three coats of dope. After the first two coats, give the entire frame a light sandpapering, apply the third coat, and complete with a second sandpapering.

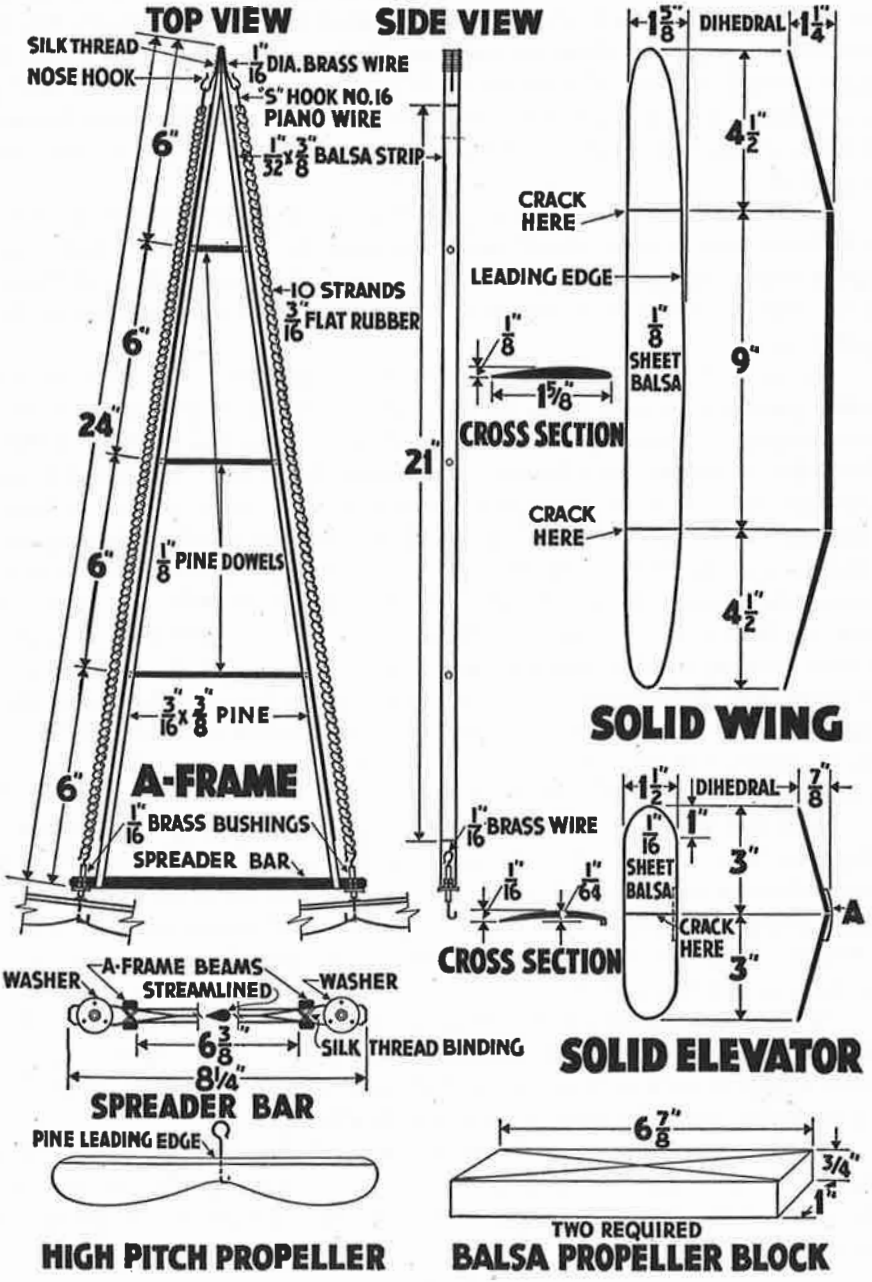
PROPELLERS. Two pusher propellers are required for this model. A left hand and a right hand propeller must be carved from balsa propeller blocks measuring ¾″ x 1″ x 6⅞″. (See Chapter 9, "Carved Propellers," "Right and Left Hand Propellers" and "Tractor and Pusher Propellers.")

To strengthen the leading edges of the propellers, a ¼″ wide strip of white pine is cemented along them, as shown. When thoroughly dry, these are sandpapered until their thickness and form follow that of the propellers. Propeller shafts are bent from 1/16″ diameter brass wire. Insert the length through the hub of the propeller, bend it around, and cement it in place, after the end of the wire has been forced into the hub wood of the propeller. The hook of the shaft cannot be bent until it has been inserted through the brass tube bearing. Do this, bend the hook of the shaft with your pliers, and you are then ready to complete the propeller. The second shaft is applied to the second propeller and assembled on the A-frame in the same manner. To complete the propellers, give each six coats of dope, sandpapering them smooth between each coat. As brass has a deteriorating effect on rubber, the hook portions of the shafts should be wrapped with thread or tape, or equipped with spectacle rubber tubing.

MOTIVE POWER. Each propeller is equipped with ten strands of 3/16″ flat pure Para rubber. The thickness of the rubber strands allows fewer turns than on endurance model motors, so slack in the rubber is not necessary, although it should have a slight slack to guard against possible tension. Obtain a length of this rubber measuring 440″ long. Cut it into two equal lengths, giving ten strands of 22″ lengths for each motor.

"S" hooks are bent from No. 16 piano wire. (See Chapter 6, " 'S' Hooks.") Equip each of the hooks on the nose hook with one "S" hook, and loop each length of rubber between the "S" hook and the propeller shaft hook on each side, tying the ends of each tightly together.

WING. The wing is made of ⅛″ sheet balsa. Obtain a piece 1⅝″ wide and 18″ long. With sandpaper, shape the leading edge, as shown in the plan. Follow this by shaping the wing tips, leaving the trailing edge straight. The wing camber is now obtained. Note this in the plans under



MILE-A-MINUTE TWIN PUSHER PLAN

"Cross Section." Round the leading edge and then taper it off to a sharp trailing edge.

At points 4½" from each wing tip, score the wing with your knife or razor blade from leading and trailing edge, making the cuts at right angles to the trailing edge. Crack the wing along these slight cuts. Placing it flat on a table, lift one end section's tip off the table 1¼". When in this position, apply a generous amount of cement along the crack on both sides, and allow to dry thoroughly. Repeat the same process with the other end section. The wing is given five coats of dope with a thorough sandpapering between each coat. Care must be taken not to overdo this sanding operation, or the camber of the wing will be quickly changed.

ELEVATOR. The elevator is made of 1/16" sheet balsa, and measures 1½" wide and 6" long. Round its tips with sandpaper, as shown, and then obtain the elevator camber. Note this under "Cross Section." Unlike the wing, the elevator has a top and bottom camber, so sanding must be done on both sides. When completed, score the center from leading to trailing edges with a knife or razor. Crack the elevator along this line and place both pieces, if they have completely broken, flat on a table. Lift one tip off the table 1¾", and while in this position, apply cement along the crack. Hold in position until perfectly dry. A small 1/16" sheet balsa elevation block is added to the leading edge of the elevator. This is shown in the plans under "Solid Elevator" as A. It should be 1/16" wide and 1½" long, grooved in the center to fit the angle of the elevator.

Complete the elevator by giving it five coats of dope and sandpaper lightly between each coat. Both the elevator and wing are assembled to the A-frame in the usual manner. Full instructions for using rubber bands to hold these parts to the A-frame will be found in Chapter 28 under "Assembly." In the same chapter under "Flying" will be found full data concerning the launching of such models. The chief difference between this speed model and endurance models is that only a double row of knots should be wound in the motors, and that when launching the model great care must be taken to see that it is held perfectly straight, otherwise your flight will fail. Mr. Beshar holds his speed model propellers with one hand, bending his fist around the spreader bar, while the other hand holds the nose. For further information on the proper method of launching, see Chapter 16, "Correct Launching of Speed Twin Pushers."

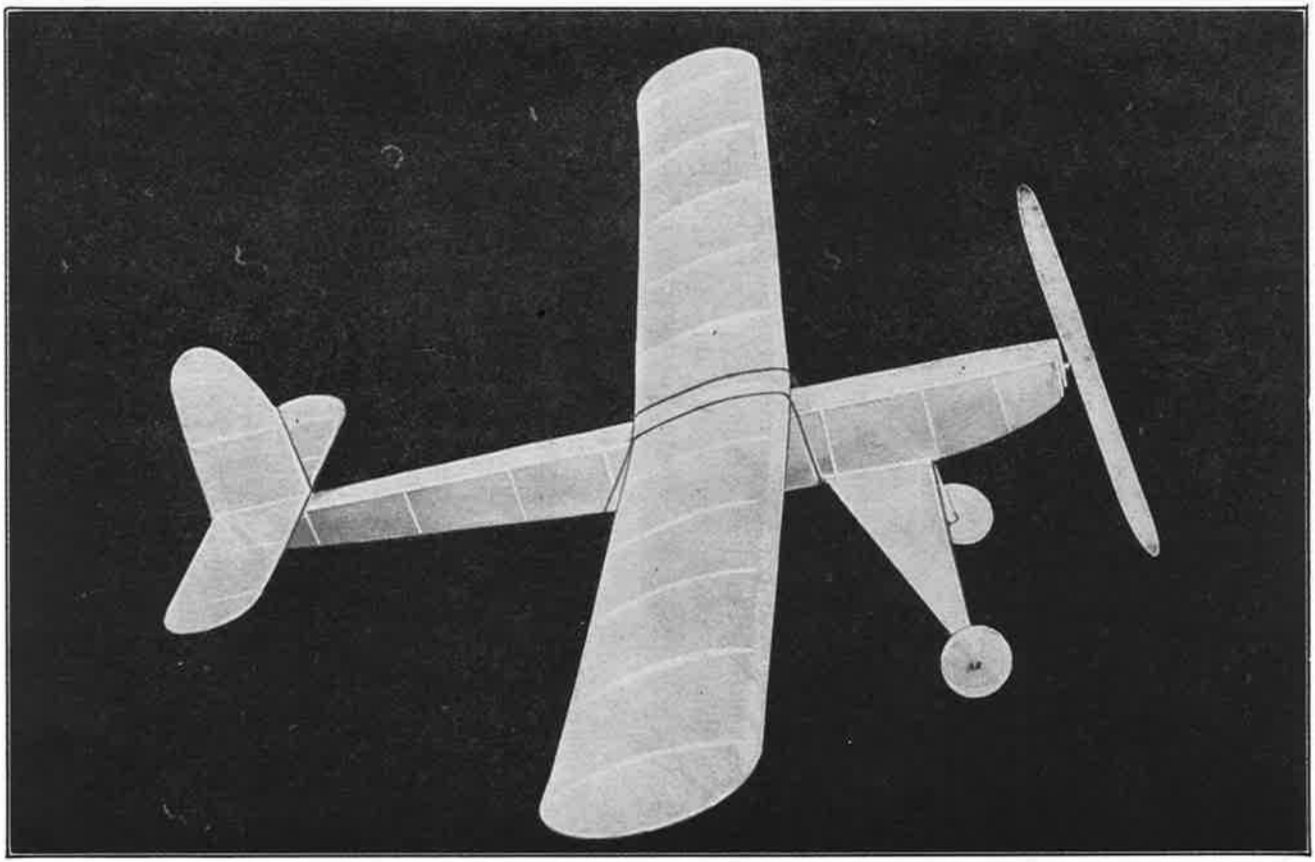
CHAPTER 35

OUTDOOR COMMERCIAL TRACTOR

MANY model builders prefer to design their own fuselage models. These are called "commercial models" and are built primarily for flight results rather than appearance. Having the general lines of a real plane, they are not, however, copies of manufactured planes.

The model given here is the popular triangular-fuselage, commercial type, which has proved a great favorite at model meets where endurance contests for fuselage models are held. It is an excellent performer with a graceful appearance. As this is the first built-up fuselage given in this book, detailed instructions in the text should be carefully followed by all beginners. After one model of this type has been successfully built and flown, the builder will have little trouble designing, building, and flying his own commercial models.

FUSELAGE. Study the plan of the fuselage. Note that all the struts of the fuselage have been lettered or numbered. Vertical struts are lettered C to L, while the horizontal struts are numbered 1 to 10. The first step of the work is to draw on paper a full-size working plan of the top of the fuselage. Study the top view, as given in the plan. On your paper, draw a straight line down its center, which will represent an imaginary line through the center of the top of the fuselage. At one end draw a short line at right angles to this long line. This short line should be marked "nose." This line gives the location of horizontal strut No. 1. As it is $\frac{3}{8}$" long, measure $\frac{3}{16}$" on each side of the center line and draw the strut on the plan. Strut No. 2 is located 1" behind strut No. 1 and is $\frac{1}{2}$" long, so must extend on each side of the center line $\frac{1}{4}$". It must be parallel to strut No. 1 and at right angles to the center line. No. 3 is 1" behind No. 2 and is $\frac{5}{8}$" long, so must extend $\frac{5}{16}$" on each side of the center line. The distances between these struts are given in the plan. Mark these off and draw each horizontal strut in position. No. 4 is $\frac{5}{8}$" long; No. 5, $\frac{5}{8}$"; No. 6, $\frac{9}{16}$"; No. 7, $\frac{7}{16}$"; No. 8, $\frac{3}{8}$"; No. 9, $\frac{1}{4}$", and No. 10 is $\frac{3}{16}$" long. When these have been drawn on the plan, join their ends with lines representing the longerons Q, as shown. This completes the drawing of the top. All pieces, including the struts and longerons, are $\frac{1}{16}$" x $\frac{1}{16}$" balsa. Cut the ten struts to their proper lengths,



OUTDOOR COMMERCIAL TRACTOR

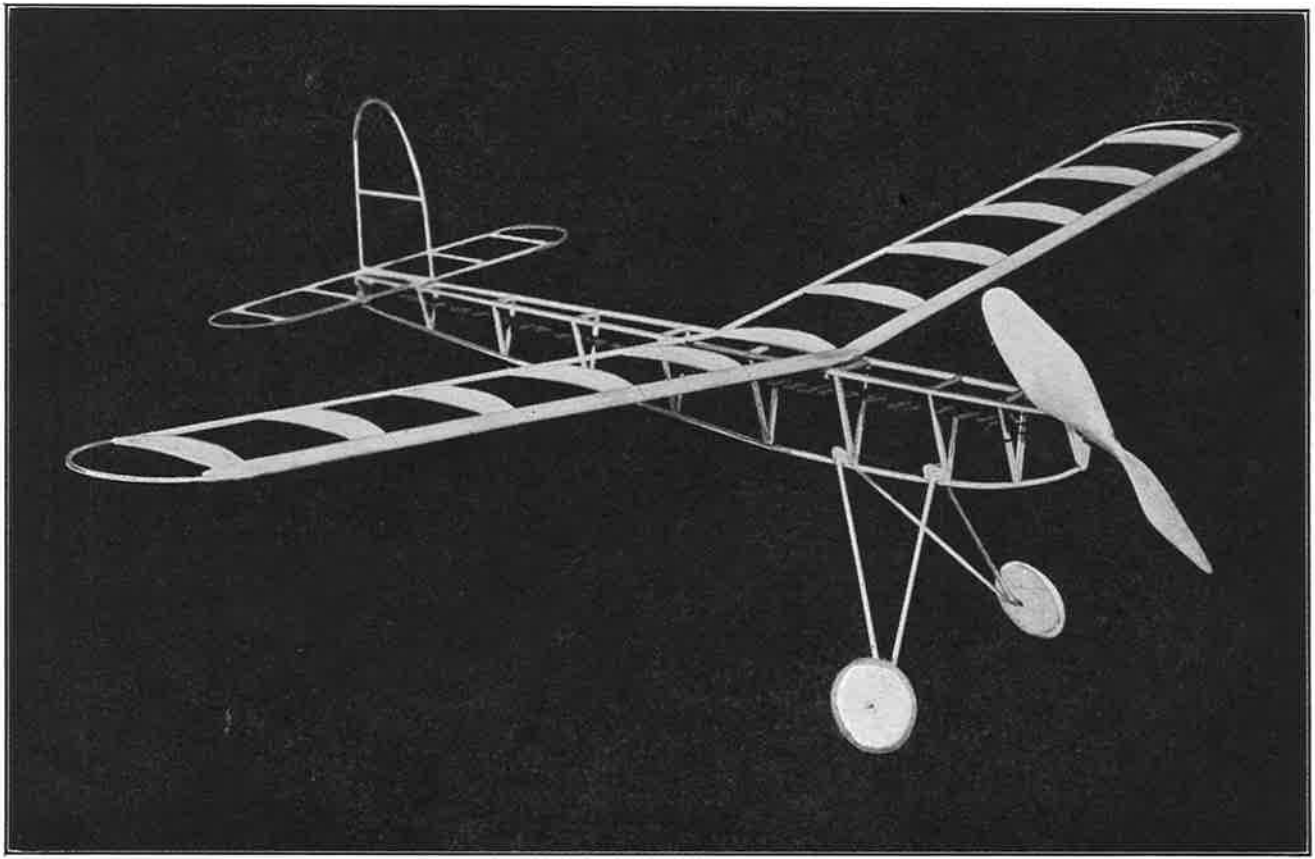
placing each in position on the plan. The two longerons are cut from the same size balsa, soaked and bent to conform with the curve given them in the plans. (See Chapter 3, "Balsa Wood.")

The top of the fuselage is now assembled. Cement the struts between the longerons, placing each piece on the full-size plan as the work progresses. Allow an hour for drying. The two sides forming the triangle of the fuselage are cut and assembled. Turn to the side view of the fuselage. The struts of the sides are lettered, and are spaced the same as those on the top section of the fuselage, being placed directly under them. They are cut to proper length from 1/16" x 1/16" balsa.

Strut C is cut 5/8" long; strut D, 1 1/16" long; strut E, 1 1/4"; strut F, 1 5/16"; strut G, 1 5/16"; strut H, 1 3/16"; strut I, 1"; strut J, 3/4"; strut K, 5/8", and strut L is cut 7/16" long. As both sides are exact duplicates, two of each of these struts must be provided. These are cemented in place to the top of the fuselage. They are cemented to the under side of longerons Q at the points where the horizontal struts contact the longerons. The ends of each pair are brought together directly under the center of the top portion of the fuselage. When all of these have been attached, a 1/16" x 1/16" balsa longeron R is soaked and bent to proper form, so that the ends of each vertical pair of struts contact it. When dry, cement this longeron in place along the fuselage.

A nose plug is cut from 1/16" sheet balsa, as shown in the plans. Another triangular piece of sheet balsa is cut 1/16" smaller all around and glued to the first piece, as shown under "Nose Plug." See that this is centered on the first triangle before cementing, and also test it to see that it fits snugly in place between the nose strut No. 1 and the two side vertical struts C. The two triangle pieces are cemented together. A small hole is made with a pin through these pieces to accommodate the propeller shaft. This piece acts as a propeller bearing. It is not cemented in place, but relies on the snug fit of the smaller triangle to hold it to the nose. This smaller plug is shown as O in the plans.

A similar plug is fitted on the other end of the fuselage, as shown under "Tail Plug" in the plans. To it is attached in the same manner another smaller triangle, as shown by P. These are cemented together, after tests to see that the small plug fits between the end horizontal strut No. 10 and the end vertical struts L. The fit should be a tight one. A double rear hook is bent from No. 12 piano wire, as shown in the plans. (See Chapter 6, "End Hooks.") This is inserted in a hole centered in the tail plug, as shown in the side view. This is not cemented in this hole, as the pull of the wound motor will bring the outside hook tightly against the plug, which will keep



OUTDOOR COMMERCIAL TRACTOR SKELETON

it from turning before launching. The fuselage is not covered until after the motor assembly.

PROPELLER. The propeller is carved in the usual manner from a 3/4" x 1" x 6 1/2" balsa propeller block. (See Chapter 9, "Carved Propellers.") The propeller hook is bent from No. 12 piano wire. Before bending the hook, the nose plug must be placed on the shaft with two washers, as shown. The propeller is attached in the usual manner. At this time the hook in the shaft is made.

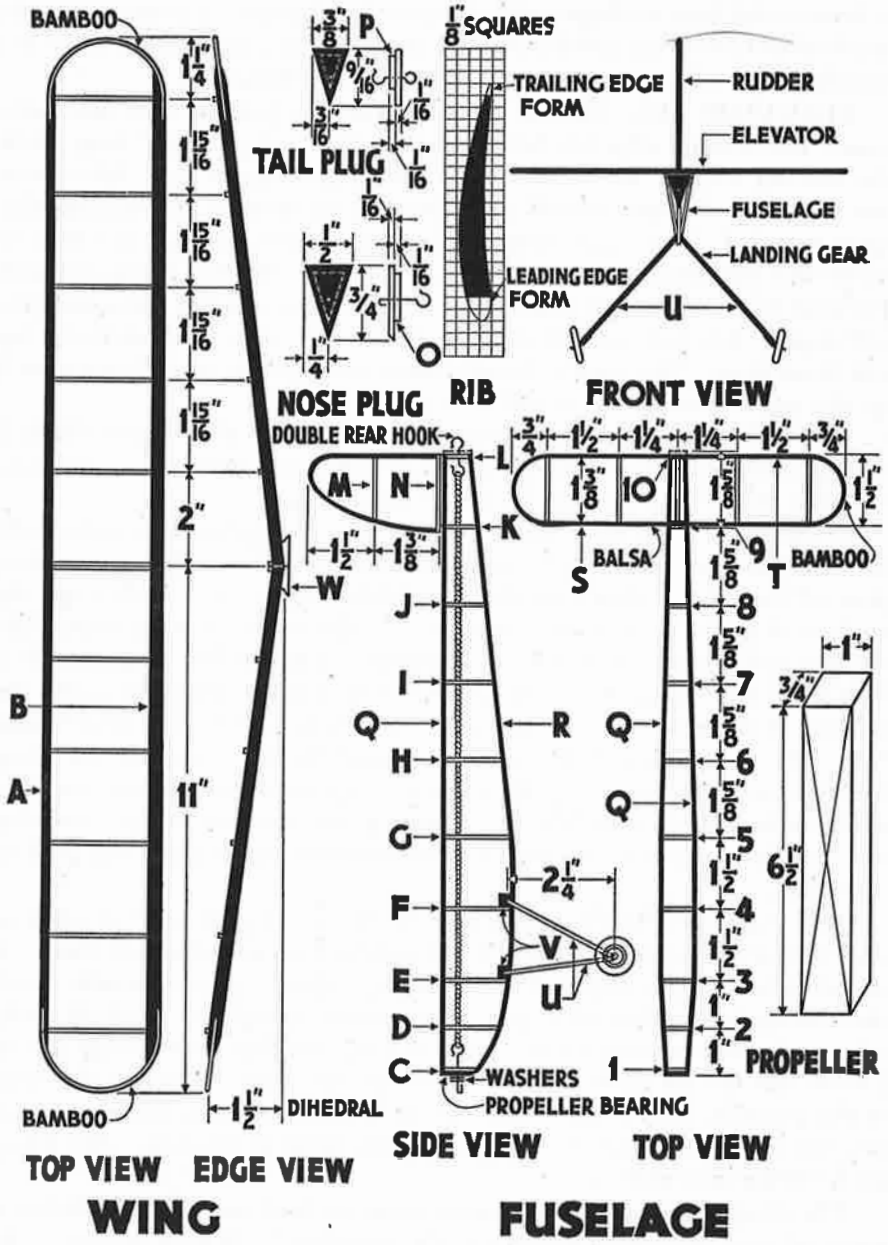
MOTOR. Three strands of 1/8" flat rubber are used for motive power. Considerable slack should be allowed in the rubber, so obtain a piece 35" long. This is attached to the rear hook, passed through the hook of the propeller shaft, looped around the rear hook, and brought to the front where it is fastened to the propeller shaft, making three strands in all. Both the nose and tail plugs are fitted into place, completing the motor assembly. When winding the motor by a winder, the hook of the winder is attached to the outside hook of the tail plug, the plug removed, and the winding done.

LANDING GEAR. Two small 1/16" sheet balsa blocks are cut, as shown in the side view by V, and cemented to longeron R. The front one fits just behind strut E, while the rear one fits behind strut F. They are 1/4" square and should be cemented to the longeron and the adjoining struts. The landing gear consists of four 1/16" square balsa struts, as shown by U. The front struts are 2 7/8" long, while the rear ones are 3 1/4" long. These are cemented to the sides of the small balsa blocks attached to the lower longeron. They extend down 2 1/4", where the lower ends of each pair are cemented together, as shown in the side view of the fuselage. They are spread 3" apart at their base, where small piano wire (of No. 8 gauge) axles are bent, one end being cemented to the sides of the struts, while the other holds the wheel.

Two 1" diameter solid balsa wheels complete the landing gear. These are cut from 1/8" sheet balsa and placed on the axles. Give the ends of the axles a drop of cement to hold them in position.

The fuselage and landing gear can now be covered. Use Japanese tissue for this work. See Chapter 8, "Fuselage Covering." The landing gear is covered in the same manner. Cut the tissue to the exact size of the triangle formed by each pair of struts, coat the struts with banana oil, or dope, and press the paper on them. Water-spray the fuselage and landing gear, and complete with one coat of dope.

RUDDER. This consists of a single outline piece of split bamboo and two ribs. The ribs are shown as M and N. Both are of 1/16" square balsa. Cut N 1 5/8" long and M 1 5/16" long. The 1/16" split bamboo outline piece



OUTDOOR COMMERCIAL TRACTOR PLAN

is heated and bent to shape. (See Chapter 3, "Bamboo.") Cement the ribs in place and cover the rudder on both sides with Japanese tissue. Give it a spraying with water and finish with a thin coat of dope.

ELEVATOR. The elevator is constructed of bamboo tips and balsa wood. The leading edge S is balsa wood cut 1/16" x 1/16" x 5 1/2" long, while the trailing edge T is the same size. Five 1/16" x 1/16" x 1 3/8" balsa wood ribs are cut, and cemented into place between the leading and trailing edge spars S and T. Two 1/16" square split bamboo elevator tips are bent to shape and cemented to the ends of S and T. The elevator is covered with Japanese tissue on its upper side only. Finish the covering by water-spraying and doping. It is now assembled on the fuselage. Note its location in the top and front views. The center elevator rib is cemented between longerons Q on the tops of struts Nos. 9 and 10.

The rudder is fastened in place over the elevator. The rudder rib N is cemented to the center elevator rib. When doing this assembly work, make sure that the elevator and rudder form right angles.

WING. The wing is of simple construction. It requires two main spars, two bamboo wing tips, and twelve sheet balsa ribs. Draw a full-size working plan of the rib, as shown in the plan under "Rib," and then trace the outlines of twelve of these on a piece of 1/16" sheet balsa. Cut the twelve ribs out and finish them smooth with sandpaper. The leading edge spar B is 3/16" x 1/4" x 21" long. It should have its leading side rounded to match the contour of the ribs. The trailing edge spar A is 1/16" x 1/8" x 20 1/4" long. Note that the plans call for two ribs placed in the center of the wing. Builders can make their own choice as to whether to use one or two. The double ribs add strength but also weight to the finished model. Assemble the wing by cementing the ribs in place between the leading and trailing edge spars.

Two 1/16" split bamboo wing tips are bent and cemented in place at the ends of the wing spars, which are notched to accommodate them. As the wing has a large dihedral angle of 1 1/2", this is now obtained. Crack the leading and trailing edge spars after making a slight cut on their under sides at the center point of the wing. Placing one half of the wing flat on a table, lift the tip of the other half 3" off the surface. Holding the wing in this position, pour cement into the cracks made in the trailing and leading edge spars, and allow it to remain in this position until dry. (See Chapter 7, "Wing Assembly.")

The wing is covered with Japanese tissue on both sides, after which it is water-sprayed and coated with dope. (See Chapter 7, "Wing Covering.") To complete the wing, a small elevation block is fastened to the leading edge

spar. This is shown in the edge view of the wing as W. It is cut from 1/8" balsa wood, being 3/16" wide and 3/4" long. One edge is shaped to fit the angle of the wing, while the opposite edge remains straight to match the top of the fuselage on which it rests when the wing is in place. Cement holds this small piece in place.

No wing clips are necessary for this wing, as it is held on with a rubber band. Break the band and pass it around the fuselage, bringing its broken ends together above the top of the fuselage. Place the wing in position on the fuselage with the elevation block resting on the two longerons Q. As this is attached to the leading edge of the wing, it must be nearest the nose of the model. When in this position, bring the two ends of the rubber band over the top of the wing and down and under the fuselage, one strand on each side, where they are tied.

FLYING. Before winding the model, it should be glided to obtain the best possible position for the wing. The rubber band will allow this to be adjusted forward or backward as required. When a long, even glide has been obtained, the motor can be wound and launched. For the proper method of launching, see Chapter 16, "Correct Launching of R.O.G. Model."

SOLID SCALE MODELS

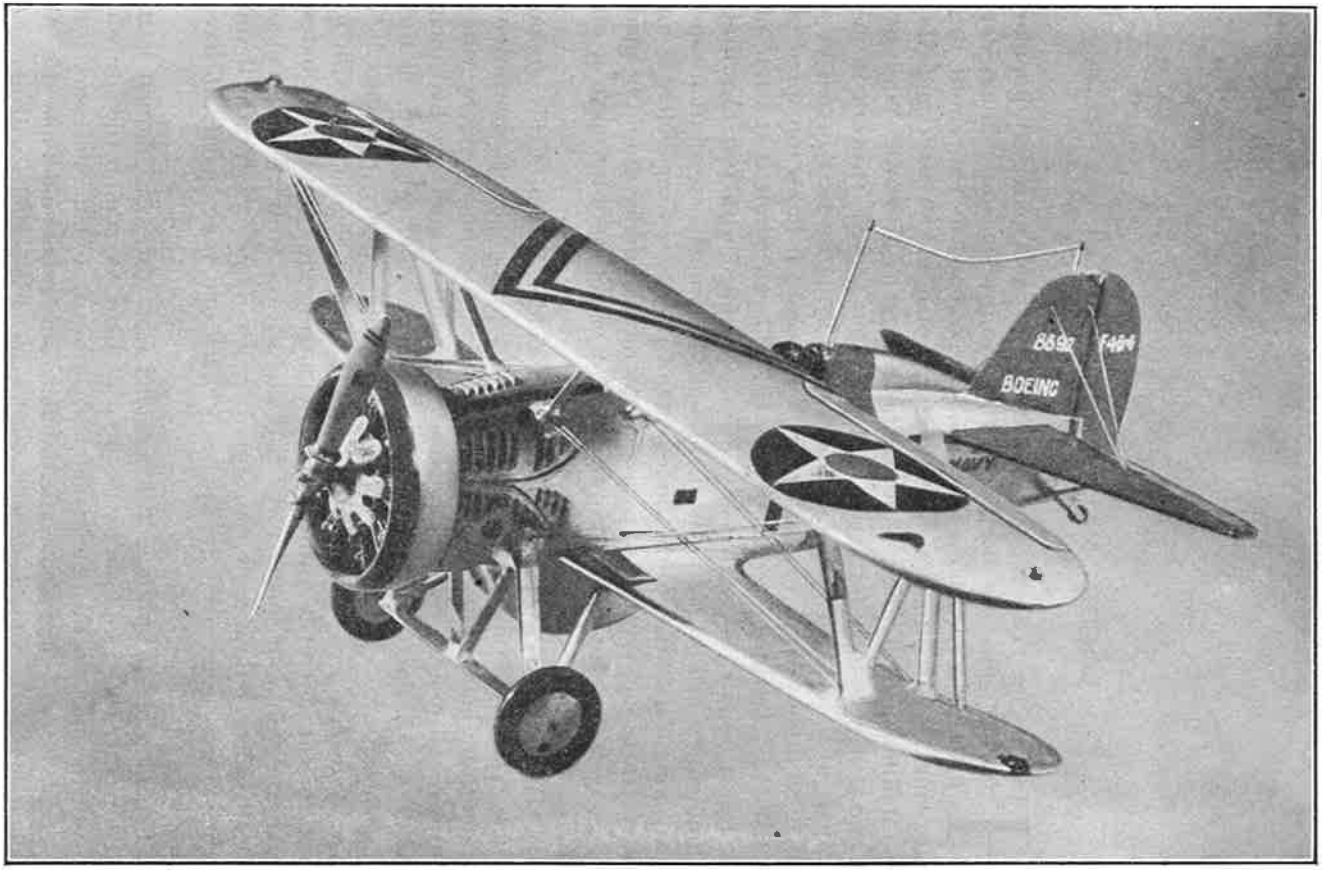
CHAPTER 36

BOEING NAVY PURSUIT F4-B4

HERE is an exact replica of that famous and extremely popular Navy Fighter, the Boeing F4-B4. A worthy antagonist in any dog fight where rugged maneuverability, speed and strength count, this of all planes is a favorite among the pursuit pilots of the Navy and Marines. Manufactured by the Boeing Aircraft Company of Seattle, Washington, and designed solely for aerial fighting, it has proved its worth in the rigid tests to which such planes are put by our flying forces. Powered by a Pratt & Whitney "Wasp" engine of 500 horsepower, it has a top speed of 186 M.P.H., a landing speed of 61 M.P.H., and can climb at the rate of 1,980 feet a minute. For active service it is equipped with two Browning machine guns synchronized to shoot through the propeller revolutions and a small bomb rack fitted to the under side of the lower wings. Here is an airplane Uncle Sam is proud to own and any model builder should be glad to add to his collection. Its sturdy lines and bright coloring make it an attractive addition.

READING PLANS. All of the solid scale models shown in this section are true replicas of the real planes. It will be noted that no dimensions appear on the plans. These are shown by the squares on which the views are drawn. All of the original models used for this section have had their plans drawn on squares representing ½" each. As the wing span of this Boeing model covers twenty-five squares and as each square represents ½", it can be readily seen that the wing is 12½" long. Should you wish to change this size it can be easily done by changing the size of the squares. Should you wish your model to be half this size, or with a wing span of 6¼", all you need do is draw your squares half as large or ¼" each. If you wish it twice as large make the squares 1" each and your model will have a wing span of 25".

The first step in building such a model from this type of plan is to make an exact full-size duplicate of the page plan. Decide on the size you wish your model, and then rule your paper in squares of the necessary size. The graph form of plan allows the builder to make his model any size. As the changing of the wing is done, so each part of the model will likewise



BOEING NAVY PURSUIT F4-B4

change, keeping each part in proper proportion. All dimensions given for other parts should be divided or multiplied in the same manner, according to the scale you are following.

When drawing your full-size duplicate plan from the page plan, care should be taken to see that the particular line you are drawing passes through each square in exactly the same location that the same line passes through the same square of the page plan. After the plan has been completed, each part can be measured by rule or the counting of squares. For example, let us assume that our squares are ½" each. The center plan represents the top view of the model. By counting the squares along its length, we see that the wing is 12½" long. As it covers four squares in width, it is therefore 2" wide. We are now speaking of the top wing. By the bottom plan, representing a front view of the model, we can see that the leading edge of the upper wing is ⅜" thick. Proof of this can be seen by turning to the top view of the model representing a side view. Here we can not only check the thickness of the wing but can also note its general shape. In this view can be seen the taper of the wing, which is also shown in the bottom view. To further aid the builder, the shapes of the wings, as well as the shapes of the fuselage, have been shown by cross-sectional views. Note the one under 1-1. The dotted line running through the wing and marked with the same numerals simply indicates that at that particular point the wing is of the shape shown in the cross-sectional view. A like view is also shown for the lower wing. As the fuselage varies in shape at different points, three cross-sectional views are shown for it. Note these under A-A, B-B, and C-C. On the top view of the model these points are indicated by dotted lines running through them.

Each part of the model should be read in this manner, which will give thickness, width, length, and the shape of the part. The builder should also study the accompanying photograph. Here are shown many of the building and finishing details not ordinarily seen on the plan.

WINGS (Lower). The lower wing is cut from a ¼" thick, 1½" wide, and 11" long piece of sheet balsa: (Note: All parts may be made of pine if the builder prefers. Balsa is recommended because of the ease with which it can be worked.) (See Chapter 7, "Solid Wing Construction.") Shape the wing as shown in the bottom, top, and cross-sectional views. Note the latter under 2-2. Finish with a light sanding. The wing is now cut along its center line into two equal halves of 5⅜" length each. The required dihedral angle is now given it. (See page 46, "Dihedral Angle.") The lower wing has a dihedral angle of ½". Obtain this dihedral and cement the two halves together.

(Upper). The upper wing is cut from a ½" thick, 2" wide, and 12½" long piece of sheet balsa. Shape the wing as shown in the bottom, top, and cross-sectional views. The latter is shown under 1-1. As this requires no dihedral angle it is now finished smooth with sandpaper. Both wings should have their tips rounded as shown in the center view. Note that both taper to a knife-edge at their tips.

FUSELAGE. This is shaped from a 1¼" thick, 1¾" wide, and 7" long balsa block. Draw the three fuselage cross-sectional views full size and make cardboard templates of each. (See Chapter 8, "Solid Fuselage Construction.") Carve the block until each template fits it perfectly at the point which is indicated on the top view in the plan. Carve out the cockpit, as shown in the center and top views. The under side of the fuselage is cut out to accommodate the lower wing. Note this in the top view. If you wish, the cockpit may be fitted with an instrument board, seat, control stick, as well as the windshield. (See Chapter 15.)

ENGINE AND COWLING. The engine has nine cylinders distributed evenly around a center core and built as described in Chapter 11. This is covered with a ring cowling, which exposes the engine from front or back. Follow the directions in Chapter 11 for making these. Cement the engine core with its cowling in place to the center of the fuselage nose.

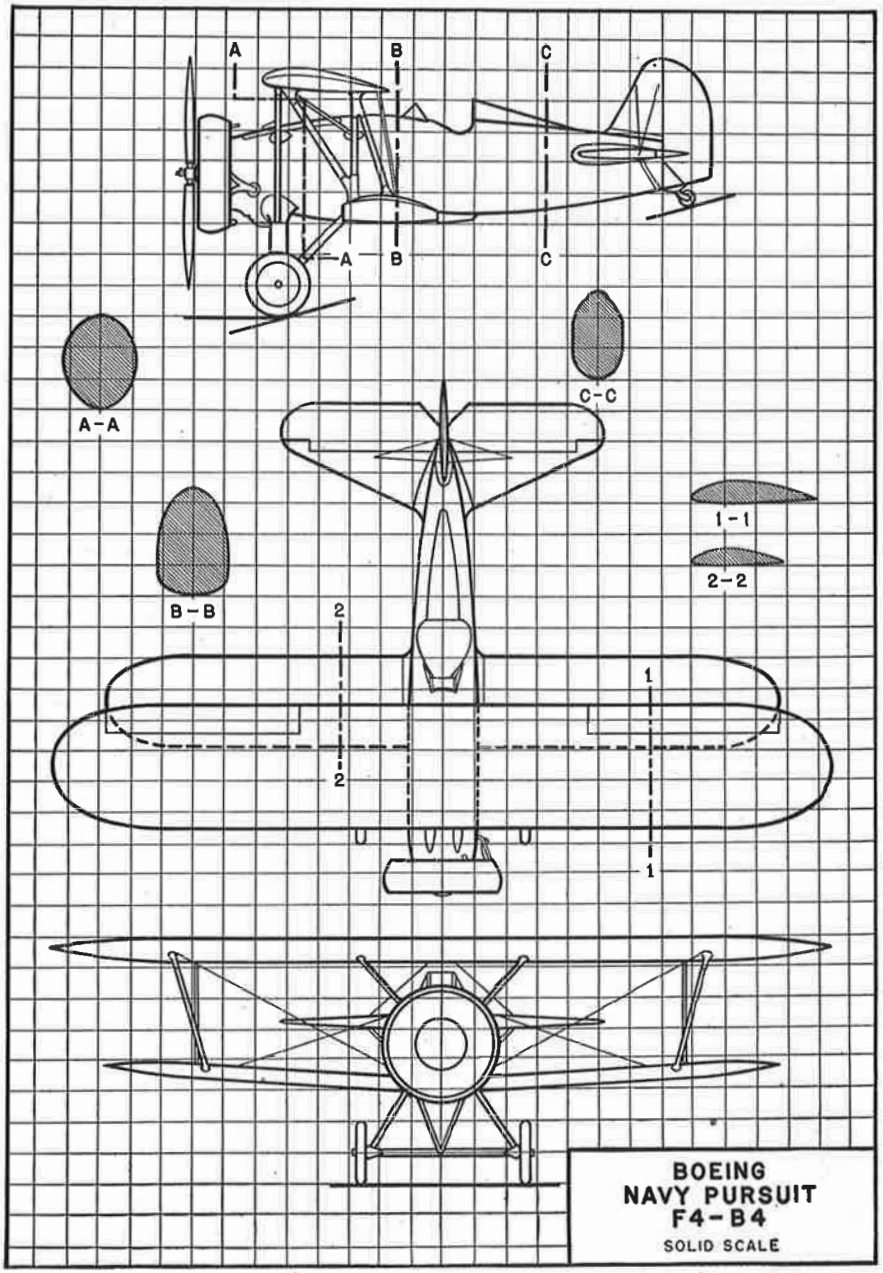
PROPELLER. The propeller for this model is cut from a ⅛" thick, ½" wide, and 3¾" long balsa block. (See Chapter 9, "Exhibition Propellers.") This is the usual two-bladed propeller and is attached to the engine core with a model pin.

ELEVATOR. The elevator is cut from a ⅛" thick, 1¾" wide, and 5¼" long balsa sheet. Note its form in the center view of the plan. It is cut from a single piece and the fuselage slotted to take it. Sand it to streamlined shape, as shown in the top view of the plan, slot the fuselage and fit it in place.

RUDDER. The rudder is cut to shape, as shown in the top view of the plan, from sheet balsa measuring 1/16" thick, 1¾" wide, and 2¼" long. Note how it fits around the end of the fuselage. Finish with sandpaper and cement in place.

LANDING GEAR. Cut the six landing gear struts to size and shape as shown in the top and bottom views of the plan. Cut the axle and make two solid, rubber-tired wheels of 1" diameter, as shown in Chapter 10, "Disk Rubber-tired Wheel."

ASSEMBLY. Assemble the two wings after cutting the eight wing struts. The landing gear struts are then assembled to the axle and the under side of the fuselage. Attach a small tail skid wheel and the model is ready for



BOEING NAVY PURSUIT PLAN

painting, which should be done at this time.

PAINTING. Paint should not be applied until the entire model has been thoroughly sanded with a fine sandpaper. Fill all cracks with any good plastic wood. The upper wing has its top side painted a dark yellow. The stars are red, white, and blue, while the chevrons are blue on this plane, although this color varies with the squadron. The under side of this wing is painted aluminum. The lower wing is aluminum on both sides. Stars are painted on its under side as they were on the top of the upper wing. The rudder and elevator are red with white lettering, as shown in the photograph.

The entire fuselage is aluminum with a red band around it. The engine cowling is aluminum with a band of blue around its leading edge. The engine and wheel tires are painted black, while the propeller is aluminum with red bands at its tips. The fuselage lettering is black.

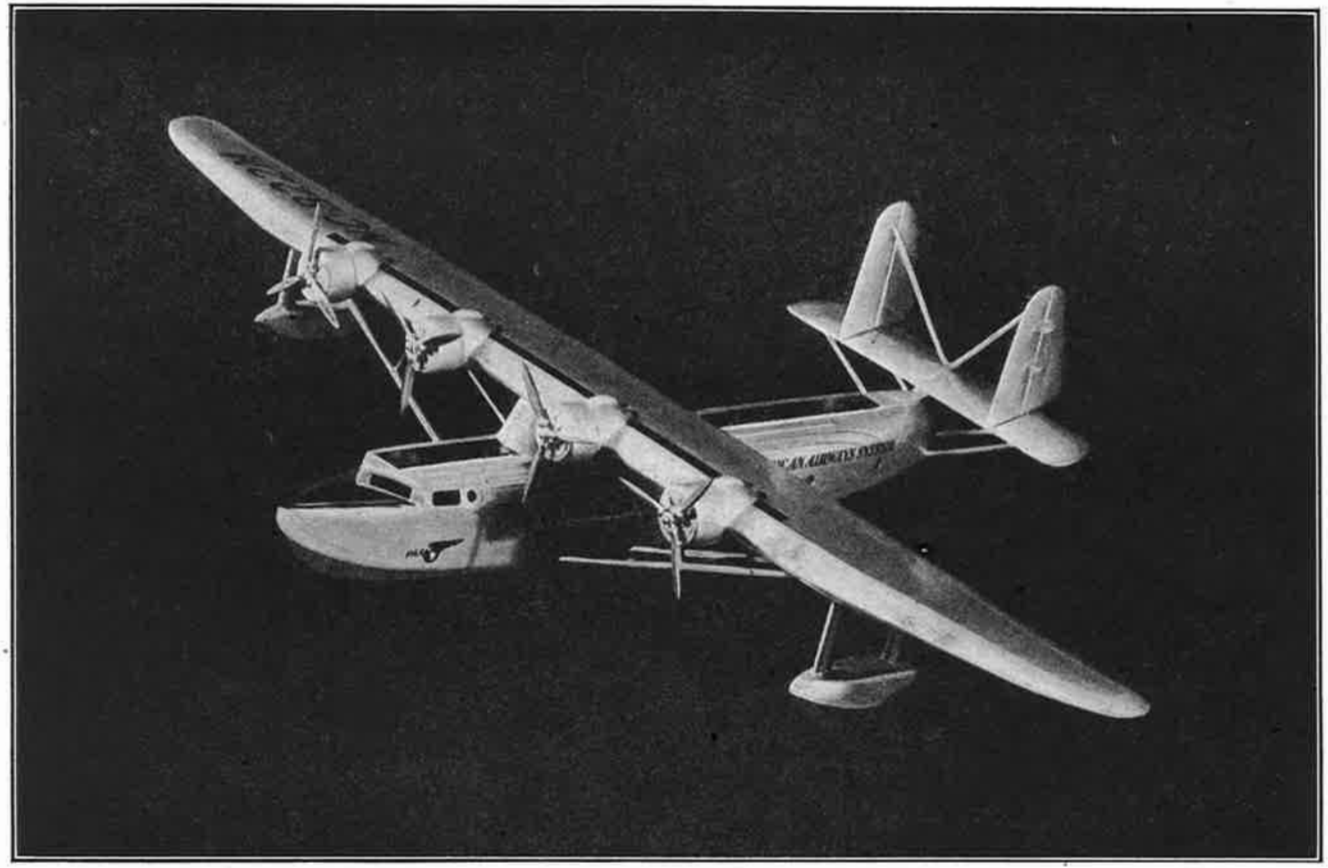
CHAPTER 37

SIKORSKY S-42-B BERMUDA CLIPPER

THESE giant airplanes have been used successfully for passenger and freight flights over both the Atlantic and Pacific air routes of the Pan American Airways. Manufactured at Bridgeport, Connecticut, by the Sikorsky Aviation Corporation, they are capable of carrying thirty-two passengers, a crew of five, and tons of freight. The passenger compartment is so designed as to be converted into a fourteen-berth sleeper. Powered with four Pratt & Whitney "Hornet" engines capable of a combined horsepower of 3,000, they reach a top speed of 188 M.P.H., a cruising speed of 163 M.P.H., and can land at the comparatively low speed of 65 M.P.H. Carrying fuel tanks large enough to hold fuel for a 1,200-mile cruising range, there are few ports here or abroad that these planes cannot reach. Their tremendous wing span of over 118 feet gives safe stability, while their length of 68 feet and height of over 21 feet supply ample room for passengers, crew and freight. Here is a model, true in every detail, that every model builder should have in his collection if he would make it an interesting and complete one. (Read "Reading Plans" on page 319.)

WING. Turn to the plan shown on page 328. The squares on which it is shown represent ½" each. Make a full-size copy of the plan on squares of this size. If you wish a larger model than the one given here, which has a wing span of 12½" long, the squares must be drawn larger. A smaller one can also be made, but is not recommended because of the fine detail work that such a model requires. The wing is carved from a piece of sheet balsa wood measuring ¼" thick, 1½" wide, and 12½" long. In the plan will be seen the cross-sectional views of the wing indicated by 1-1 and 2-2. View 1-1 shows the size and shape of the wide portion comprising most of its length, while the view 2-2 shows these features near its tips. These locations are shown in the plan by dotted lines across the wing in the center view. Carve the wing to this shape and size, round its tips as shown, and then bring it to a satin finish with fine sandpaper. (See Chapter 7, "Solid Wing Construction.")

NACELLES. Four nacelles are now carved from small balsa blocks. Each of these blocks should be rounded to a 9/16" diameter and cut ¾"



SIKORSKY BERMUDA CLIPPER

long. Note how they are given the form of cones toward their trailing ends. Finish each of these with fine sandpaper and then slot them so that they will fit over the leading edge of the wing. Cement each one in place, fill in any cracks with a plastic wood, and smooth with sandpaper.

PROPELLERS. Four three-bladed propellers of the exhibition type are now carved. Their blades should be ¾" long. Finish each with light sandpaper and attach them to the center of the nacelles with model pins. (See Chapter 9, "Three-Bladed Exhibition Propellers.")

PONTOONS. The wing carries two pontoons near its tips. Note these in the plan. They should be carved from ¼" thick, ½" wide, and 1½" long blocks of balsa wood. Finish smooth with sandpaper. Carve the two struts that hold these in place on the under side of the wing and attach with cement. This completes the wing unit.

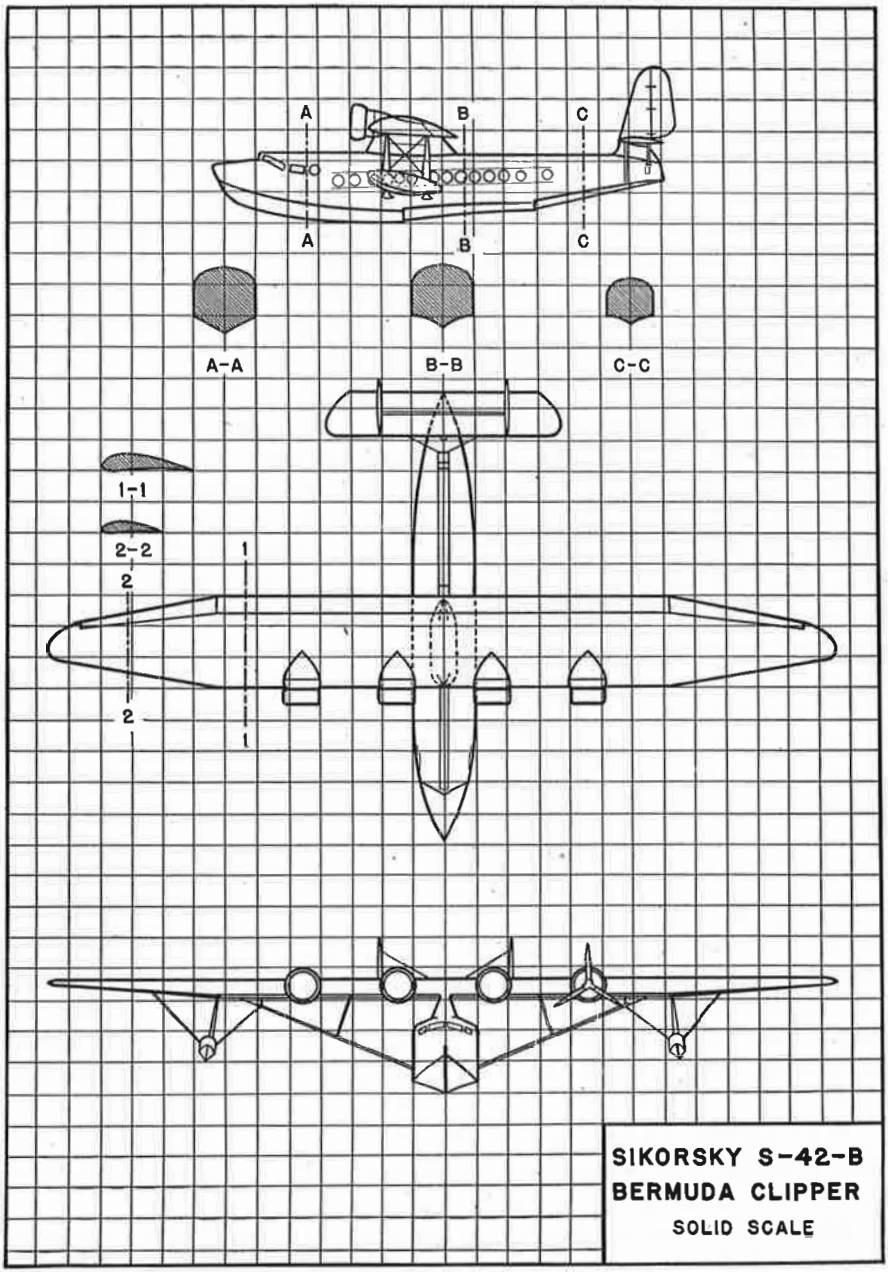
FUSELAGE. The fuselage is carved from a balsa block measuring 1" thick, 1¼" wide, and 7½" long. Such a fuselage is known as the "hull," as it is actually a boat type designed to ride on the water. Make a full-size copy of the three cross-sectional views, as shown under A-A, B-B, and C-C. From these cut out three templates of cardboard. Before actually starting to carve, study all three views shown in the plan and also the photograph. Start the carving, and as you proceed keep testing with the templates on the locations shown for them in the top view of the plan. Bring the hull to a satin finish with light sandpaper.

WING BLOCK. The small wing block shown in all three views is now carved. This serves to support the wing above the hull. It is carved from a ¾" thick, ½" wide, and 1½" long block of balsa. Note its form in dotted lines in the center view of the plans. Finish smooth with sandpaper.

WING STRUTS. The wing is attached with two large struts on each of the fuselage. These are strengthened with shorter struts running between the main struts and the under side of the wing. Cut these out, smooth with sandpaper to streamlined form, and attach the wing in place. The wing block is first cemented to the top-center of the fuselage. The wing is then cemented in place on it, and the supporting struts cemented between the wing and fuselage. Fill all cracks and finish smooth with sandpaper.

ELEVATOR. This is carved from a ⅛" thick, ¾" wide, and 3¾" long sheet of balsa. It is streamlined, as shown in the top view, and finished smooth with sandpaper.

RUDDERS. Two rudders are carved from sheet balsa pieces measuring ⅛" thick, ⅞" wide, and 1¼" long. Finish these with streamlined forms with sandpaper. The elevator is held with block and struts. The rudders



SIKORSKY BERMUDA CLIPPER PLAN

are cemented to the top of the elevator and supported by struts. Cut these and complete the assembly.

PAINTING. Go over the entire model with the finest of sandpaper. Note and fill all cracks. Draw in the side cabin windows with a compass and paint them black. The front cabin windows should be carefully ruled in and also filled with black. Do this work most carefully. Paint the entire fuselage aluminum with the exception of the two stripes on its top, which should be finished in black. Rudders and the elevator are aluminum. The top of the wing is international orange with a stripe of black near its leading edge. The license numbers on the top and bottom of the wing are in black. Paint the under side of the wing, as well as the nacelles and propellers, aluminum. The pontoons are aluminum to the water line. Both the fuselage and the pontoons are black below the water line.

The lettering "Pan American Airways System," as well as the insignia, are a marine blue. Turn to page 154, Insignia 15, for this design. For any models of this type a standard should be made on which to rest them. Those having the usual undercarriage do not require standards. (See page 144, "Solid Scale Models.")

CHAPTER 38

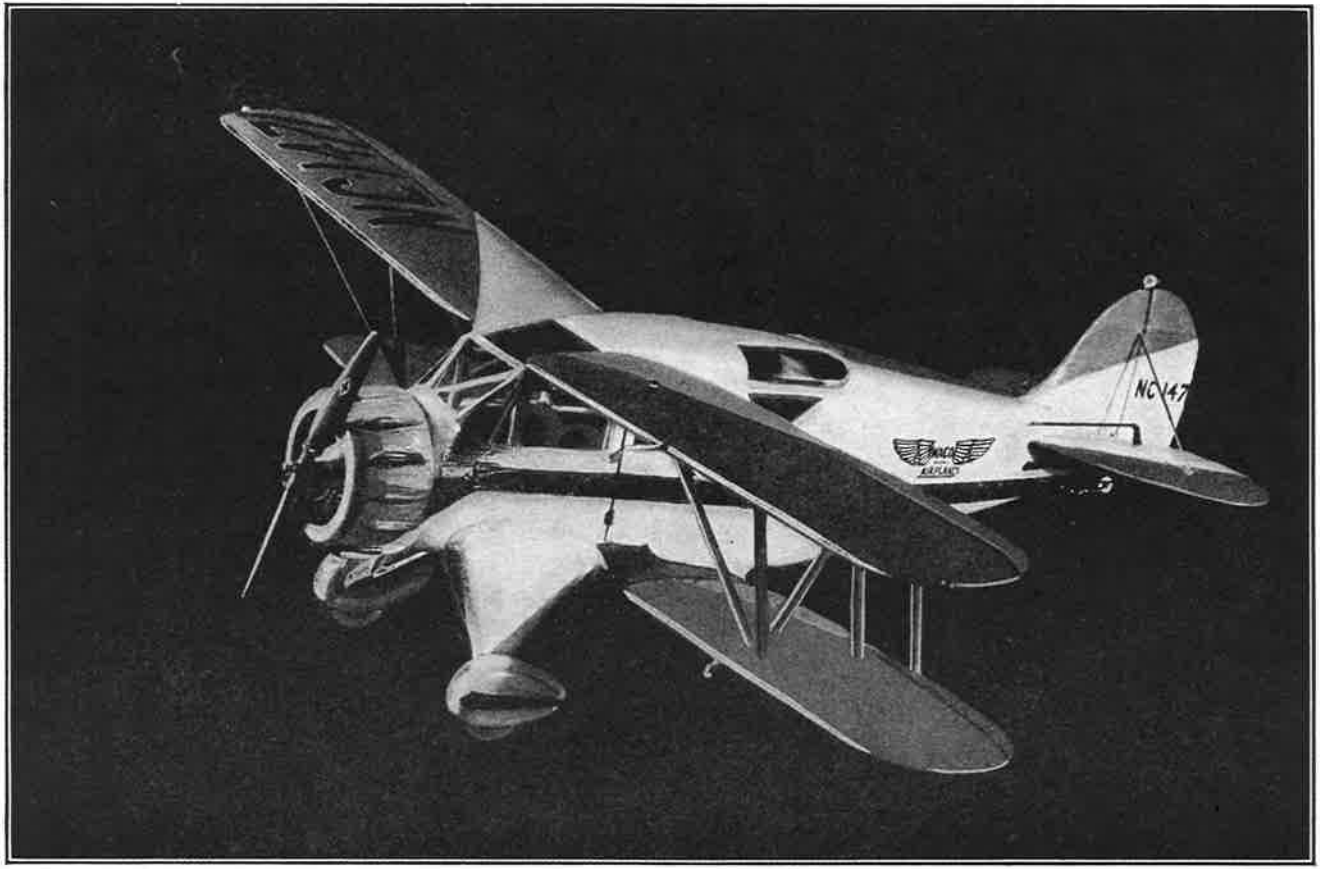
WACO CABIN

THE Waco airplane has long been a favorite among the sportsman pilots throughout the world. While used in the United States for short passenger trips and inter-city hops, they have been used in Mexico and China for military purposes. They are manufactured by the Waco Aircraft Company of Troy, Ohio, which for the past few years has been the largest producer of small commercial planes in this country. This type of biplane seats four people in its cabin and is usually powered with a 225 horsepower Jacobs engine. When so equipped it has a top speed of 148 M.P.H., a cruising speed of 130 M.P.H., and can safely land at 53 M.P.H. These planes also come equipped with either the Continental 210 horsepower engine or the Wright "Whirlwind" engine of 250 horsepower. With a total wing span of 33 feet and length of over 25 feet, it is noted for its dependability, graceful lines, and attractive appearance. The airplane modeller will find it a subject worthy of his every effort. (See page 319.)

WING (Upper). The top wing measures 11″ from tip to tip, although it actually is two halves measuring only 5⅛″ each. The fuselage between these halves makes up the difference in length. Note the size and shape of each half in the plan. This is also shown in the cross-sectional view 1-1. Carve both halves from balsa sheets measuring ¼″ thick, 1¾″ wide, and 5⅛″ long. Leave their inner ends squared until they are ready to be fitted to the fuselage. Finish smooth with sandpaper.

(Lower). The lower wing is also made in two duplicate halves. Note their shape and size in the plan. The cross-sectional view 2-2 also shows these points. Carve both halves from balsa sheets measuring ¼″ thick, 1⅝″ wide, and 3¾″ long. Their inner ends are not shaped until ready to be fitted to the fuselage. Finish smooth with sandpaper.

FUSELAGE. The fuselage is carved from a single block of balsa measuring 1½″ thick, 1¾″ wide, and 7¼″ long. Note the three cross-sectional views shown under A-A, B-B, and C-C, and their location on the model indicated by dotted lines on the top view. Make a full-size copy of these three cross-sections and from them cut out three cardboard templates. The engine cowling is part of the fuselage block and should be indicated by its



WACO CABIN

round form and an indentation made around its trailing edge. Complete the cowling by hollowing it out to a depth of around ½" and leaving its walls ⅛" thick. The engine should then be made and inserted into this cowling. (See Chapter 11, "Engines.") The cabin must be hollowed out and fully equipped. (See Chapter 15.) Fit all windows with isinglass, as shown in the photograph and plan. Complete the fuselage by giving it a satin finish with fine sandpaper.

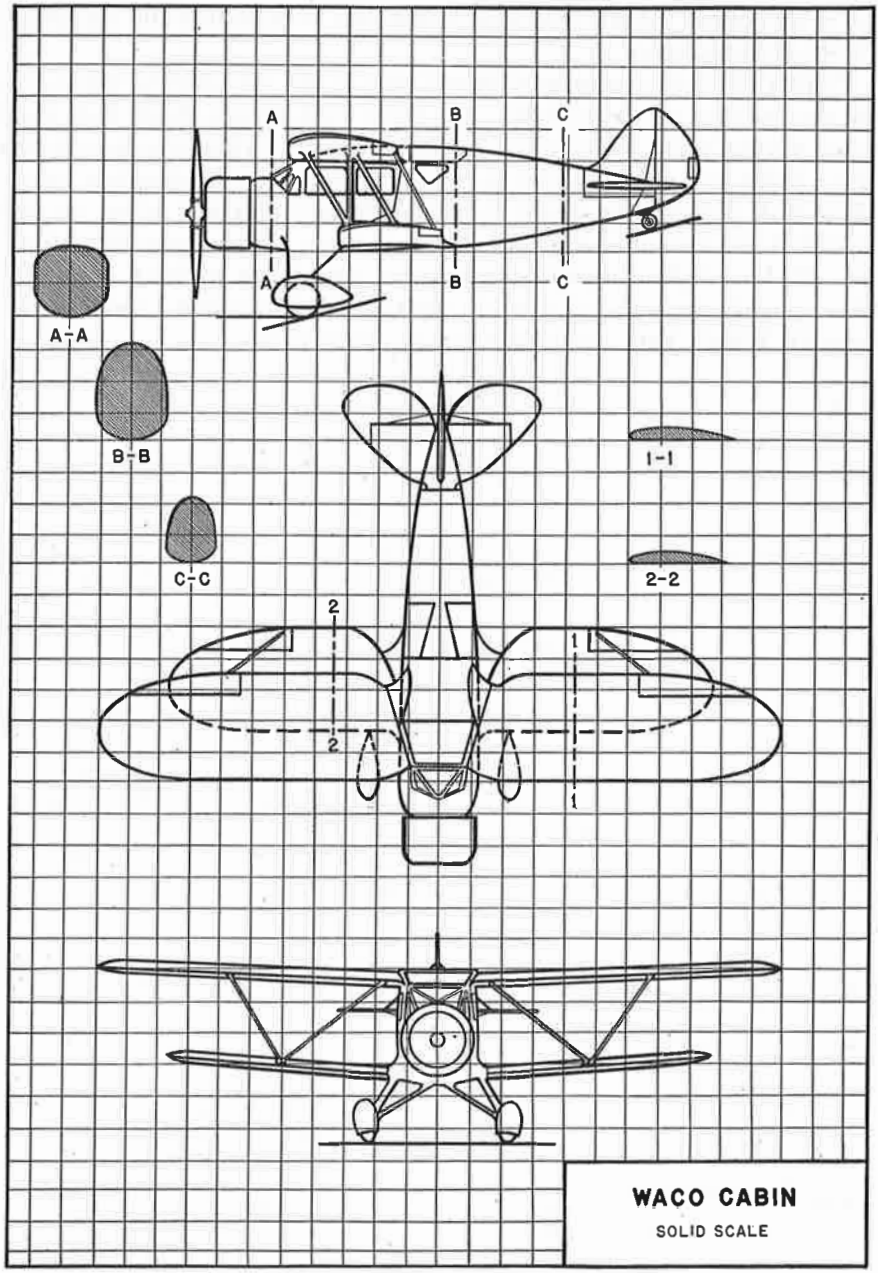
ELEVATOR. The elevator is carved from a single piece of sheet balsa wood measuring ⅛" thick, 1½" wide, and 1¾" long. Note its size, shape, and streamlined appearance in the center and top views of the plans. Give it a smooth finish with sandpaper.

RUDDER. The rudder is carved from a single piece of balsa wood measuring ⅛" thick, 1½" wide, and 2" long. It can be seen in the top view of the plan, while its streamlined form is shown in the center plan. Finish smooth with sandpaper.

LANDING GEAR. Carve two wheels ½" in diameter of ¼" sheet balsa. (See Chapter 10, "Solid Balsa Rubber-tired Wheels.") Wheel pants are cut from 3/16" thick, ½" wide, and 1½" long balsa sheets. (See Chapter 10, "Wheel Pants.") Four landing gear struts are required. Two of these extend from the side of the wheel pants to the under edge of the fuselage. They are carved from ⅛" thick, ¾" wide, and ¾" long balsa sheets. Note their shape and size in the top and bottom views of the plans. One can also be seen in the photograph. Two streamlined struts extend from the inner side of the pants to points under the center of the fuselage. Carve all these pieces, finish each with sandpaper, and cement them in place, as shown in the plans. Attach the wheels with model pins cut short to fit the width of the pants.

PROPELLER. This is two-bladed, 2¾" long, exhibition propeller. Carve it out as explained in Chapter 9, "Exhibition Propeller." Finish smooth with sandpaper.

ASSEMBLY. Cut the required struts from balsa wood and mount the wings as shown in the plans. Give each the necessary dihedral. Carve the ends of each half of the wings to fit against the side of the fuselage. Cement the struts in place and finish by filling in all contours with plastic wood. Go over all joints for cracks, fill any found, and finish smooth with sandpaper. Attach a small tail wheel to the under side of the fuselage just below the elevator. Slot the fuselage to accommodate the elevator and cement it in place. The rudder is then attached to fit over the end of the fuselage with cement. Go over all joints with plastic wood, and then finish smooth with sandpaper. Attach the propeller with a model pin thrust through the



WACO CABIN PLAN

core of the engine. Check your work to see that all is correct and the model is ready to be painted.

PAINTING. All commercial planes such as this one may be painted to suit the builder, as no set colors are given such planes. Each individual owner has his plane painted to suit his own taste. However, here is the color scheme used on the model shown here. The entire fuselage is a cream-yellow with a dark blue stripe along it. The tail unit and wings are red with black license numbers. The engine is black and its propeller aluminum. All lines indicating ailerons, fins, etc., are shown in black. Paint the Waco insignia on both sides of the fuselage, as shown in Chapter 14, Insignia 51. Wheels have white centers with black tires.

CHAPTER 39

VULTEE LADY PEACE

THE Vultee Lady Peace is manufactured in Downey, California, and is one of the fastest single-engined transport planes in the world. Powered with a Wright "Cyclone" engine of 850 horsepower, it has a top speed of 240 M.P.H., a cruising speed of 217 M.P.H., and can land at the comparatively low speed of 63 M.P.H. It has room for eight to ten passengers, a cruising range of 950 miles, and its sleek lines give it a beautiful appearance in the air. It is not a difficult airplane for the beginner in modelling to make. While a modern plane in every way, its lines are not so hard to follow that a close application to these instructions and the accompanying plans will not well reward the builder whether an expert or a beginner. (See "Reading Plans" on page 319.)

WING. The wing is made of two duplicate halves. Each of these should be carved from a sheet of balsa measuring $\frac{5}{8}$" thick, $3\frac{1}{4}$" wide, and $7\frac{1}{2}$" long. Note the three cross-sectional views shown under 1-1, 2-2, and 3-3, and their locations shown in the center view by the dotted lines. Bring both halves to their proper shape and size with sandpaper. Note that each half has a small tab located at the inner end of the half and extending out from its trailing edge. These tabs are shown in the center view of the plan by dotted lines. Complete both halves and compare them to see that both are alike.

FUSELAGE. The fuselage is carved from a single block of balsa wood measuring $1\frac{1}{2}$" thick, 2" wide, and 11" long. Note the three cross-sectional views in the plan under A-A, B-B, and C-C. Make a full-size copy of these and then cut three cardboard templates from them. Use these templates while carving the block to its proper shape and size. As the engine cowling is part of the fuselage block, it should be indicated by its round form and an indentation cut along its trailing edge. It should then be hollowed out $\frac{1}{2}$" deep and its side walls $\frac{1}{8}$" thick. Make a nine cylinder engine and cement it into the cowling. (See Chapter 11, "Engines.") Note the small tail wheel under the trailing end of the fuselage. The fuselage is notched to accommodate it. The tail wheel is cut from $\frac{1}{16}$" sheet balsa to a diameter of $\frac{1}{4}$". Two short wires extend across this notch in the fuselage and



VULTEE LADY PEACE

the wheel is attached in place with a third wire running through its hub and fastening to the first two wires. If you wish to hollow out the cabin for a more realistic appearance, it should be done at this time. Equipping the cabin is not practical because of its small size. Go over the entire fuselage with sandpaper for a satin finish.

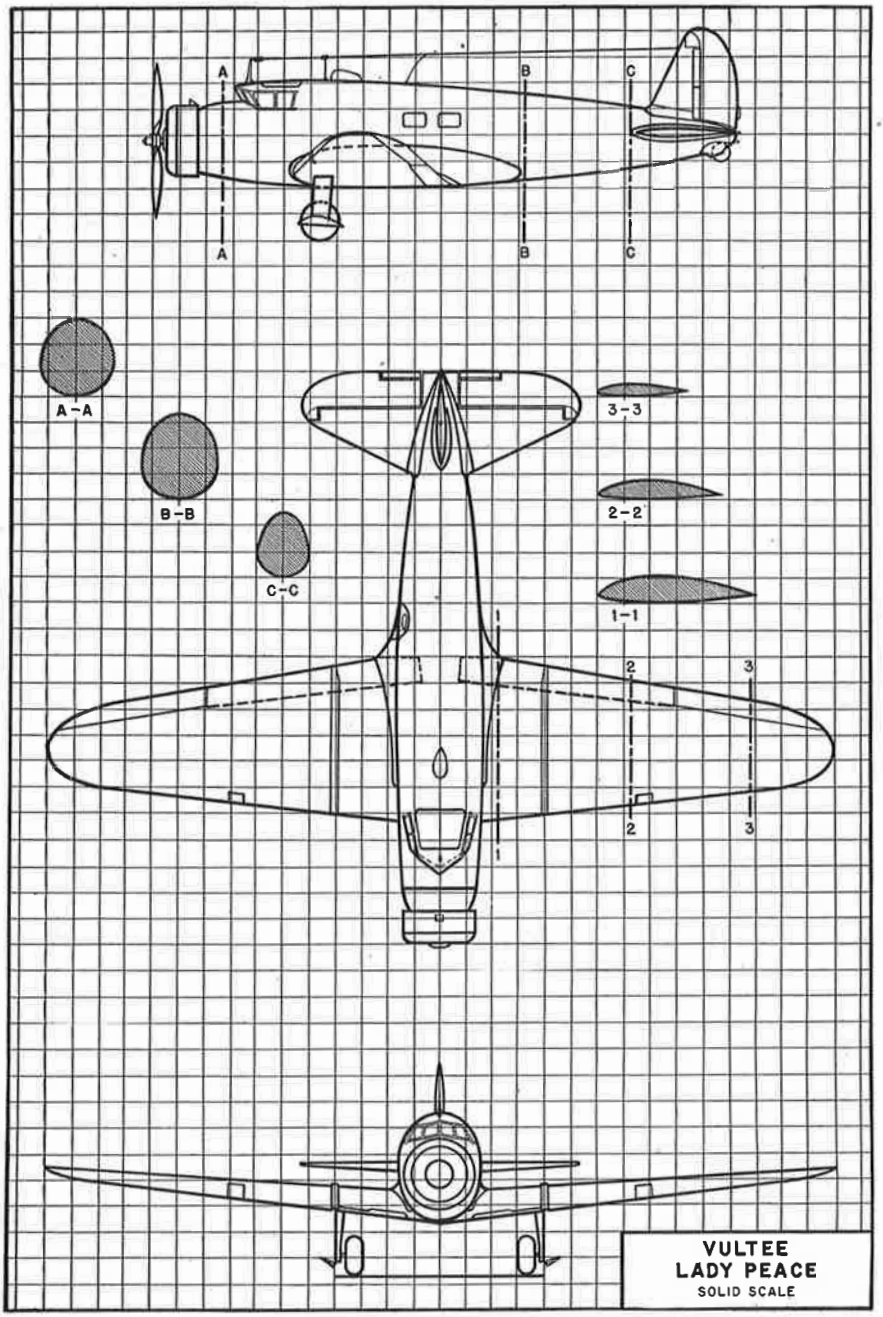
ELEVATOR. The elevator is carved from a piece of sheet balsa measuring ¼" thick, 2" wide, and 5½" long. Note its shape in the center view of the plans. Its streamlined form is shown in the top and bottom plans. Give the entire elevator a thorough sanding with a fine sandpaper.

RUDDER. The rudder is carved from a ¼" thick, 1¾" wide, and 2" long balsa sheet. Its bottom edge is shaped to fit on top of the fuselage, as shown in the top view. Note that the size and shape of the rudder is also shown in the same view. Its streamlined form is shown in the bottom and center views. Carve out the rudder and finish smooth with sandpaper.

PROPELLER. This model requires a 3" long exhibition propeller. Carve this out of balsa wood as explained in Chapter 9 under "Exhibition Propeller." Finish smooth with a fine sandpaper and then attach in place on the core of the engine with a model pin.

LANDING GEAR. The landing gear consists of two wide wheel struts, two wheels, and two small semi-formed wheel pants. The wheels are of the balloon or "doughnut" type. They should be cut from sheet balsa blocks measuring ⅝" thick, and ¾" square. This work is explained in Chapter 10 under "Balsa Doughnut Wheels." (See Fig. 70.) Finish each smooth with sandpaper. The wheel struts are cut from sheet balsa measuring 3/16" thick, ⅜" wide, and 1" long. They should be carved to size, properly streamlined, and finished smooth with sandpaper. The semi-formed wheel pants are small pieces of sheet balsa carved to the shape and form shown in the top and bottom views of the plan. Finish smooth with sandpaper. The landing gear is now assembled.

ASSEMBLY. Place each half of the wing against the side of the fuselage in its proper position and mark the location of their tabs on the side of the fuselage. Note that the wing halves join under the fuselage. The inner ends of each half must be carved out to properly fit the side of the fuselage, as shown in the plan. Note that each wing half is given a 1" dihedral. Obtain this dihedral as explained in Chapter 7 under "Dihedral Angle" on page 46. When properly fitted, cement the wing halves in place. To obtain the proper curves at the joints, as indicated in the plans and shown in the photograph, fill in all joints with a good plastic wood. When completed, polish down with fine sandpaper. The landing gear is assembled by cementing the wheel struts in place to the under side of the wing, attach-



VULTEE LADY PEACE PLAN

ing the wheels in place with short model pins, and then cementing the wheel pants in place. The location of these pants is shown in the bottom view of the plan. The elevator is cemented into a slot cut through the tail of the fuselage. Locate the proper place for this slot, as shown in the top view of the plan, and cut the slot in the fuselage. Great care must be taken not to split the fuselage block in the process. Slip the elevator in place and cement it firmly. The rudder is cemented to the top-center of the fuselage over the elevator, which completes the assembly.

PAINTING. The entire model should be painted aluminum or silver. The license numbers on the top and bottom of the wing are in black. The stripe around the fuselage is orange and blue. The wide center one is blue, while the smaller ones on each side of it are orange. Add the wiring, fin, and paint in the cabin windows in black. If the cabin was hollowed out fit the windows with isinglass. Paint the propeller aluminum.

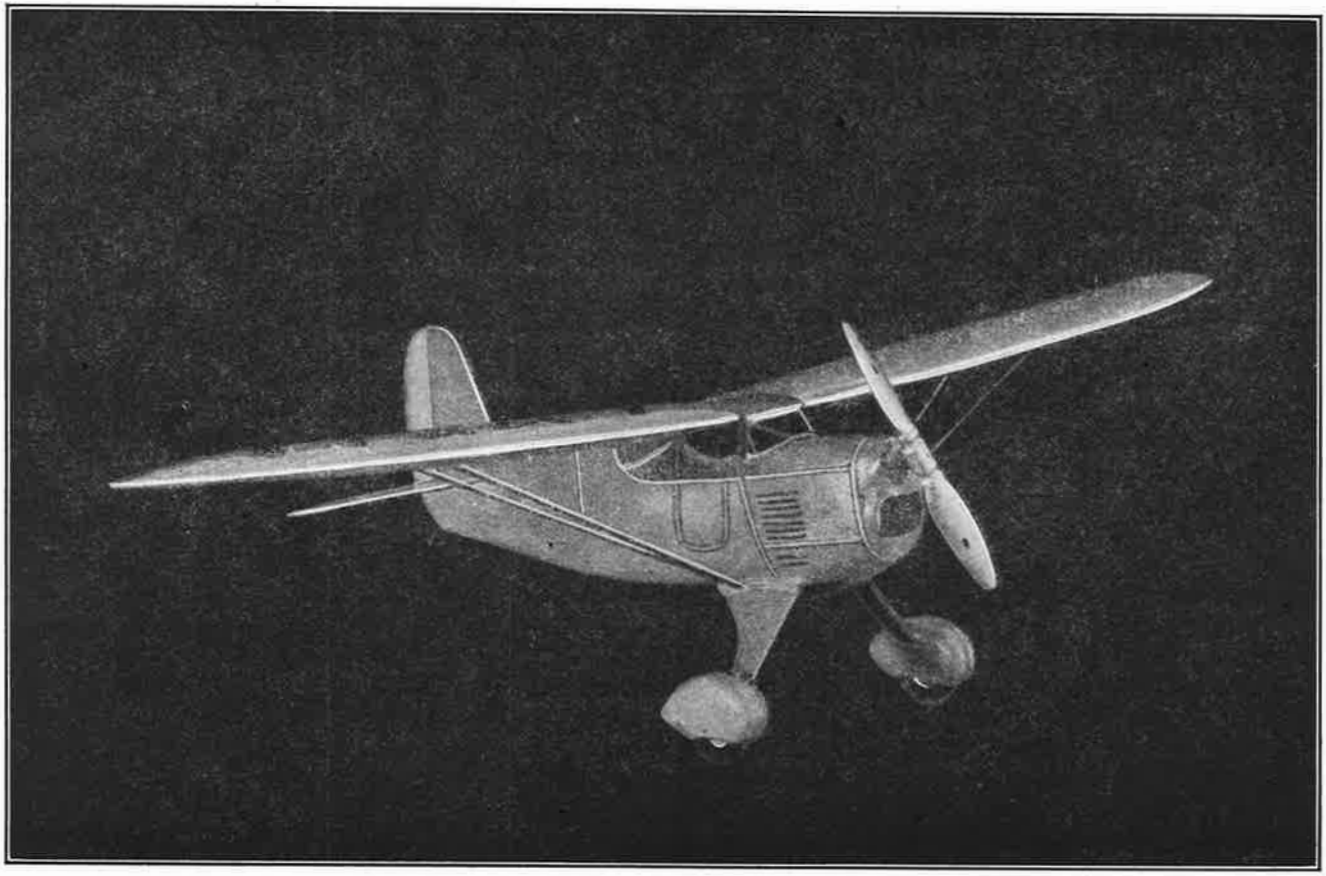
CHAPTER 40

REARWIN SPEEDSTER

THE Rearwin Speedster is a two-place, cabin, sport plane manufactured by the Rearwin Airplane Company of Kansas City, Missouri. Powered with a four cylinder Menasco "Pirate" C4-S engine developing 125 horsepower, it is capable of traveling at a top speed of 166 M.P.H., a cruising speed of 140 M.P.H., and can land at 48 M.P.H. Sufficient fuel can be carried to give it a flying range of 600 miles. A wing span of 32 feet gives it great stability and a roomy cabin is found within its 22 feet of length. The Rearwin Speedster has been a favorite among sportsmen of the air for long years. Its general lines and solid design should prove splendid material for the model builder. As it is a private plane, any number of interesting color schemes can be used for it, and the builder may use his own taste and ingenuity in developing the final finish of his model. (See "Reading Plans" on page 319.)

WING. The wing is made in two equal halves from pieces of sheet balsa measuring ¼" thick, 2" wide, and 5⅝" long. Note the cross-sectional view shown in the plan under 1-1. Give both halves this streamlined contour along their entire lengths. In the bottom view of the plan will be seen how the under side of each wing half tapers off quite sharply at its tip. Give each half this taper, round the tips as shown in the center view of the plan, and then finish smooth with sandpaper. Do not shape the inner ends of the halves at this time, as this must be done only after the fuselage has been completed.

FUSELAGE. The fuselage is carved from a balsa block measuring 1" thick, 2" wide, and 7½" long. In the plan under A-A, B-B, and C-C will be seen three cross-sectional views of it. The locations of these views are shown in the top view of the plan by dotted lines running through three points along the fuselage. Carve the block after making three templates from these cross-sectional views. Use the templates as the work proceeds to make sure that the fuselage is given its proper form. Hollow out the cabin, equip it with two seats, control stick, etc., and finish the windows with isinglass. The engine ventilators shown in the top view of the plan should be made on each side of the engine cowling. These are short corrugated



REARWIN SPEEDSTER

lines made with the knife or a comb. (See Chapter 15, "Cockpits" and "Miscellaneous.") When the carving has been completed and the entire fuselage carefully inspected, go over all parts with a fine sandpaper. Complete the inner ends of the wing halves by sanding them down to fit the contour of the fuselage at its sides where the wing halves are attached. These locations are shown in the top and bottom views of the plan.

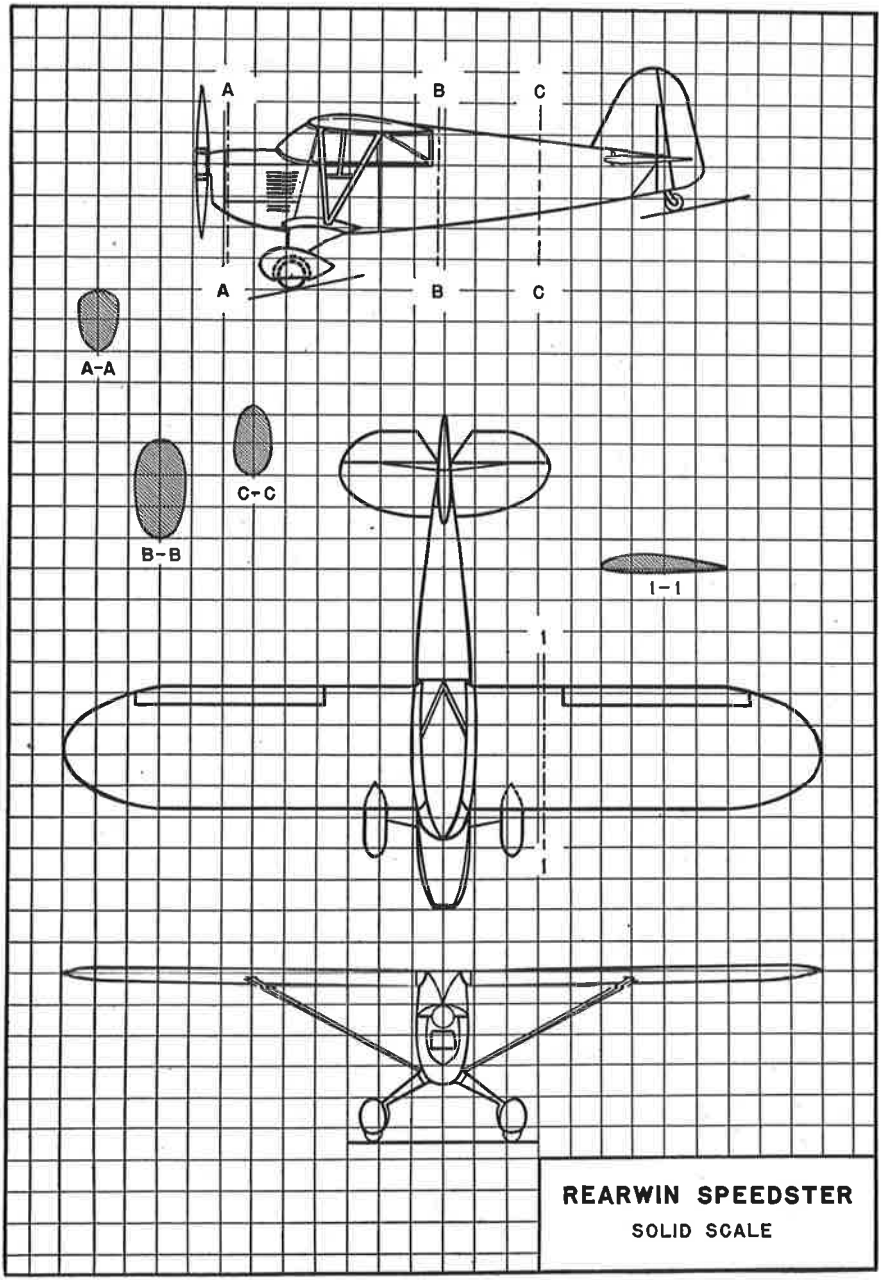
PROPELLER. A single-blade, exhibition propeller is carved from a ¼" thick, ½" wide, and 2½" long balsa block. This is fully explained in Chapter 9 under "Exhibition Propellers." When finished, give the propeller a thorough sanding with a fine sandpaper, and fasten it in place to the nose of the fuselage with a model pin.

ELEVATOR. The elevator is carved from a sheet balsa strip measuring ⅛" thick, 1½" wide, and 3⅜" long. Note its streamlined form in the top view and its general contour in the center plan. Cut the elevator to shape and size, as shown, and then finish smooth with sandpaper.

RUDDER. The rudder is a single piece fitting around the end of the fuselage. Note its general shape in the top view of the plan. It is carved from a piece of sheet balsa measuring ⅛" thick, 1¾" wide, and 2" long. After it has been carved to shape, properly streamlined, and fitted around the end of the fuselage, it should be thoroughly sanded with a fine sandpaper.

LANDING GEAR. The landing gear consists of two landing gear struts, two wheel pants, and two wheels. The struts are shown in the bottom and top views of the plan. Carve these from sheet balsa pieces measuring ¼" thick, 1¾" wide, and 1¾ long. Cut their upper ends to fit the side of the fuselage. The wheel pants are made from balsa blocks measuring ½" thick, ⅝" wide, and 1⅛" long. Follow the instructions given in Chapter 10 under "Wheel Pants." The wheels are 7/16" in diameter. Their construction is shown in Chapter 10 under "Balsa Doughnut Wheels." Complete these parts, test for size by fitting them together, and finish smooth with sandpaper.

ASSEMBLY. The elevator fits into a slot made in the fuselage to take it. Carefully cut this slot, apply cement, and fit the elevator into place. The rudder is fastened with cement around the trailing end of the fuselage over the exact center of the elevator. Cement the landing gear struts to the sides of the fuselage, as shown in the top view. Insert each wheel in a wheel pant and hold with a model pin. The pants are then cemented to the ends of the landing gear struts. Cement the wing halves in place on each side of the fuselage. Note that they are not given a dihedral. Cut the three wing struts, as shown in the top view, cement them together in units, and then



REARWIN SPEEDSTER PLAN

attach them between the under side of the wing and the sides of the fuselage. Round out all joints, such as that made by the wing and the fuselage, with plastic wood. Go over the entire model with fine sandpaper to remove all traces of cement, roughness, and sharp joints. Add tail wheel.

PAINTING. As this is a privately owned plane, any color scheme may be used. However, the original model shown here had a yellow wing and elevator. The fuselage and rudder were blue, while engine markings, tires, numbers, and tail wheel were black. These may be changed or other colors substituted as the builder sees fit.

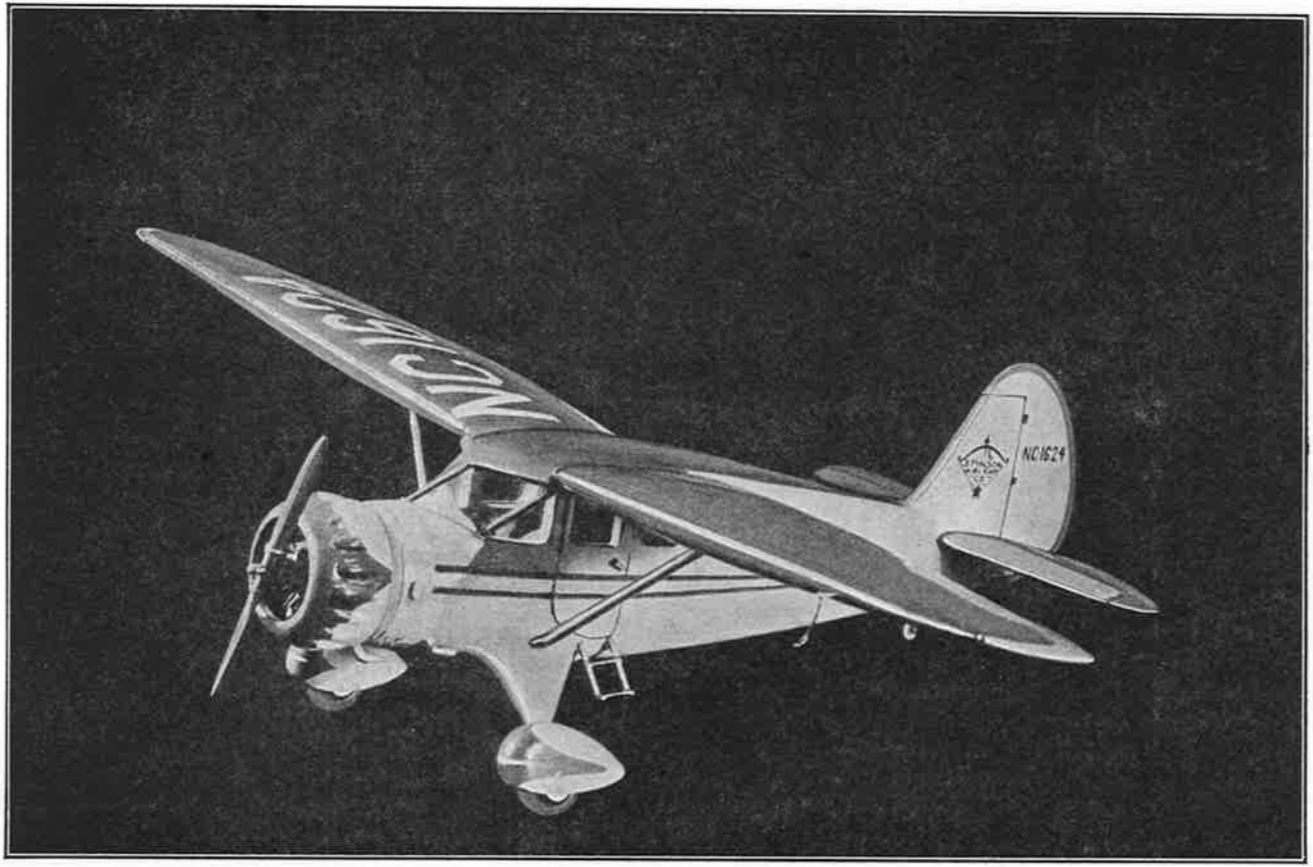
CHAPTER 41

STINSON RELIANT

STINSON airplanes have been favorites among those flying and owning their own planes for many years, but the "Reliant" has proved by far the most popular. The Stinson Aircraft Corporation of Wayne, Michigan, is the manufacturer of this rugged, economical, and dependable cabin plane. Powered with a Lycoming engine developing 225 horsepower, it is capable of attaining a top speed of 143 M.P.H., a cruising speed of 137 M.P.H., and can be landed safely at 55 M.P.H. Should increased performance be desired, the "Reliant" can be obtained with engines developing as high ratings as 320 horsepower. Here is an airplane that makes splendid material for the model builder, as it not only has sleek lines and can be painted in any combination of colors, but is also quite simple in construction and can be easily copied. Before starting to build, turn to page 319 and read the section "Reading Plans."

WING. The wing is made in two halves. In the plan under 1-1, 2-2, 3-3, and 4-4 are shown four cross-sectional views of the wing. The locations of these sections are shown in the center view by dotted lines. Each half of the wing is carved from a piece of sheet balsa measuring $\frac{3}{8}$" thick, $2\frac{1}{2}$" wide, and $5\frac{1}{2}$" long. At the location 2-2 will be seen the thickest portion of the wing. This can also be seen in the bottom view of the plan. The general form of the wing is shown in the center view. Carve both halves exactly alike, but do not forget that one must be the left wing and the other the right. Finish each half with a fine sandpaper, but do not carve their inner ends until after the fuselage has been finished.

FUSELAGE. A balsa block measuring $1\frac{3}{8}$" thick, 2" wide, and $6\frac{3}{8}$" long is used for the fuselage. Make full-sized copies of the cross-sections A-A, B-B, and C-C, and then cut out cardboard templates from them. The proper locations of these sections are shown in the top view by the dotted lines running through the fuselage. Carve the block to the required shape. Be sure to use the templates during the carving to check your work. When finished, carve out the cabin and then complete the work by giving the entire fuselage a thorough sanding both inside and out with a fine sandpaper. The hollowed-out cabin is then equipped. This is fully explained in Chap-



STINSON RELIANT

ter 15, "Cockpits." Note that the fuselage block does not include an engine cowling.

ENGINE AND COWLING. A nine-cylinder engine is made for this model. This is fully explained in Chapter 11 under "Engines." It is fitted with a ring cowling which is carved from a 5/8" thick and 1 5/8" square block of balsa wood. Such work has been fully covered in Chapter 11 under "Solid N.A.C.A. Cowling." When both the engine and its cowling have been completed, attach the engine to the center of the fuselage nose with a model pin and then cement its cowling over it, as shown in the photograph.

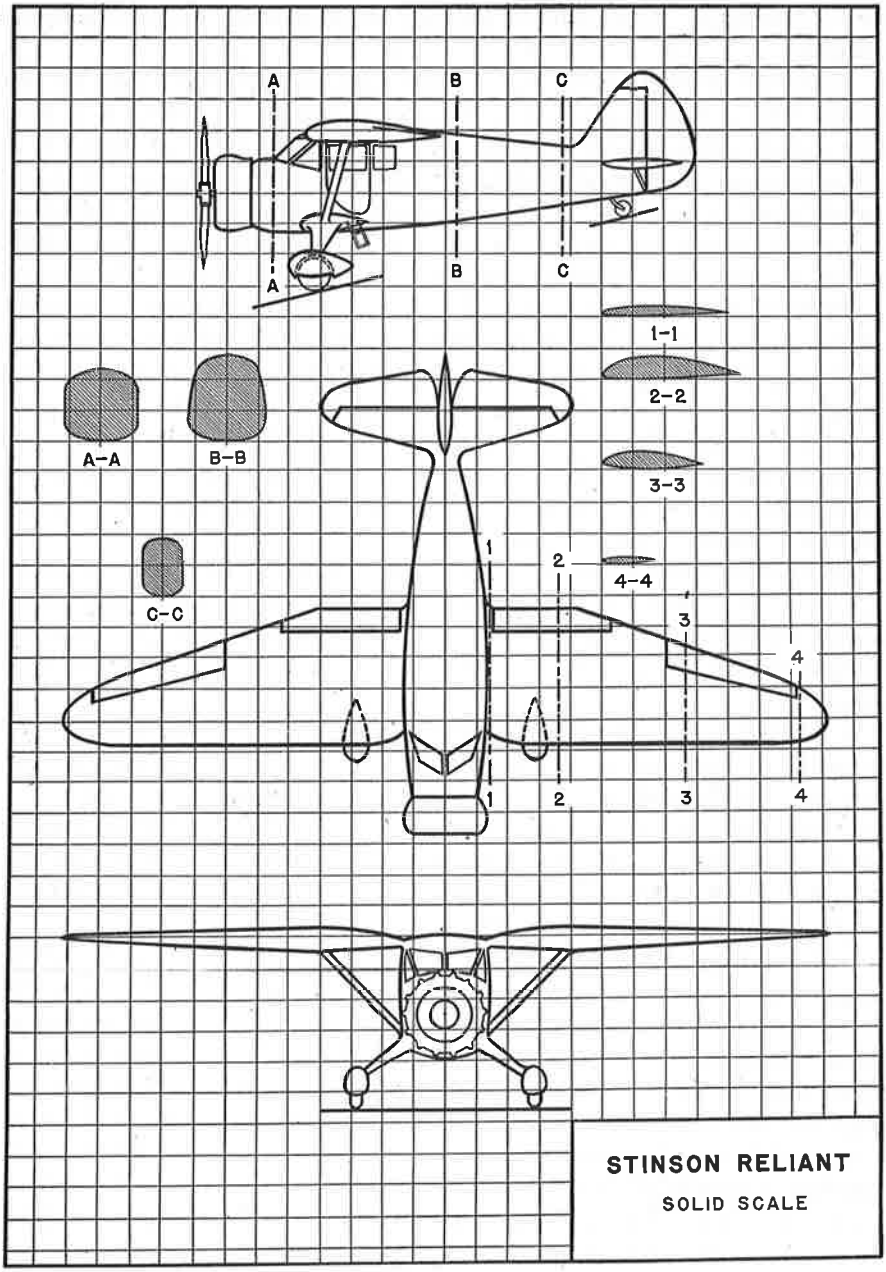
PROPELLER. This model requires a two-bladed, exhibition propeller, which can be carved from a balsa block measuring 1/8" thick, 1/4" wide, and 2 1/2" long. See Chapter 9, "Exhibition Propellers." Finish smooth with sandpaper and attach to the core of the engine with a model pin.

ELEVATOR. The elevator is made of a single piece of balsa wood sheeting measuring 1/4" thick, 1 1/4" wide, and 4" long. Note its face surface in the center view and its edge in the top view. Carve the piece to this form and finish smooth with sandpaper.

RUDDER. The rudder is carved from a piece of sheet balsa measuring 1/4" thick, 1 1/4" wide, and 2" long. It is shown in the top view. Note that it is carved to fit over and around the trailing end of the fuselage. Streamline it, as shown in the center view, and then finish smooth with a fine sandpaper.

LANDING GEAR. The landing gear consists of two landing gear struts, two wheel pants, and two wheels. The struts are shown in the bottom and top views of the plan. Each one is carved and streamlined from a balsa block measuring 1/4" thick, 1/2" wide, and 3/4" long. The wheel pants are made to take 1/2" diameter wheels. (See Chapter 10, "Wheel Pants.") Two 1/2" diameter wheels are carved from 1/4" thick sheet balsa. (See Chapter 10, "Solid Balsa Wheels.")

FINISHING AND ASSEMBLING. Complete the fuselage by adding isinglass to the windows of the cabin, a small tail wheel to the under side of the fuselage, a cabin ladder, door knobs, etc., as shown in the photograph. Sand the inner ends of the wing halves to fit the contour of the cabin roof, and attach in place with cement. Cut to size, streamline, and sand the two wing struts. These are then cemented in place between the fuselage side and the under side of the wing. Note that the wing has not a dihedral. Assemble the wheels in their pants, and then cement the pants to the landing gear struts, and the opposite ends of the struts to the sides of the fuselage. The tail of the fuselage is slit to accommodate the elevator. Slip the elevator into this slot and hold with cement. The rudder is



STINSON RELIANT PLAN

cemented around the end of the fuselage, as shown. The entire model and each of its parts are given a careful sanding with a fine sandpaper. All cracks, sharp joints, and any other blemishes must be filled with any good plastic wood and then sanded smooth. The model is now ready for painting.

PAINTING. Any airplane sold for private use is painted to suit the purchaser. It is for this reason that any model of such a ship may be treated in any way the model builder sees fit. The original of the one shown in this chapter was red and white. All parts shown in white in the photograph were white, while the darker portions were red. The engine, tires, and all numbers are painted black. The propellers of such models are usually finished in silver. On page 155, Fig. 79, Insignia No. 36, is shown the proper Stinson marking for this model. All doors, window frames, ailerons, rudder fins, tail wheel tire, and instrument board inside the cabin should be either outlined in black, if only a line, or painted entirely black. (See Chapter 13, "Solid Scale Models," for further painting instructions.)

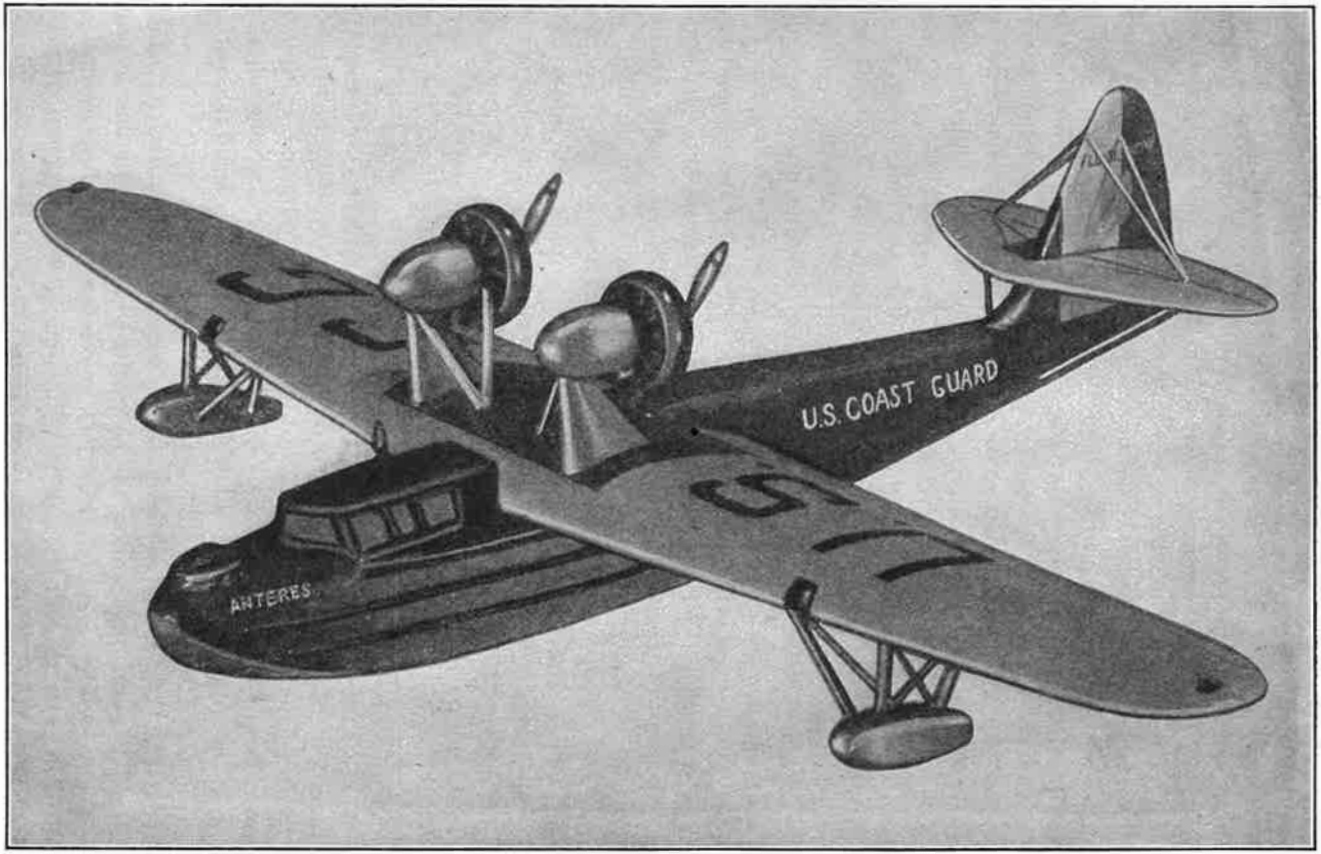
CHAPTER 42

G. A. FLYING BOAT

UNTIL recently, the General Aviation Flying Boat, known as the FLB-8 (Flying Life Boat), was manufactured by the General Aviation Corporation of Dundalk, Maryland. This firm is now known as the North American Corporation of Inglewood, California, where it is engaged solely in the manufacture of military planes. The G. A. Flying Boats have been used by the U. S. Coast Guard for a number of years. Here they not only patrol our coast against smugglers of contraband, but likewise aid in saving the lives of shipwrecked sailors. For such work the plane carries a crew of four and is equipped for ambulance necessities. Powered by twin Pratt and Whitney "Wasp" engines mounted in "pusher" arrangement and delivering 425 horsepower each, the plane is capable of a top speed of 125 M.P.H., a cruising speed of 90 M.P.H., and can be landed at 60 M.P.H. Its wing span is over 74 feet, its total length nearly 54 feet, and its fuel supply sufficient to give it a flying range of 1,000 miles. Here is a plane every model builder will be proud to build and own. Before starting actual work, turn to page 319 and read the section "Reading Plans."

FUSELAGE. The fuselage is carved from a single block of balsa wood measuring 1⅝" thick, 1¾" wide, and 10" long. Three cross-sectional views of the fuselage are shown in the plan under A-A, B-B, and C-C. Copy these full-size, and then make cardboard templates from your drawings. Use these templates as the carving proceeds to guarantee perfect shapes and sizes at the points on the fuselage where they belong. These are shown by dotted lines in the top view. Note how the wing fits over the fuselage in the bottom view. Give the entire fuselage a thorough scrubbing with fine sandpaper to complete it.

WING. The wing is carved from a single piece of sheet balsa measuring ⅝" thick, 2½" wide, and 14" long. In the plan under 1-1, 2-2, and 3-3 are shown three cross-sections of the wing with their respective positions shown by dotted lines on the center view. Follow these closely when carving the wing. Note that the wing is perfectly flat on its upper side and that it tapers off toward each wing tip on its under side. Complete the carving by giving the entire wing a thorough sanding with light sandpaper. It should be



G. A. FLYING BOAT

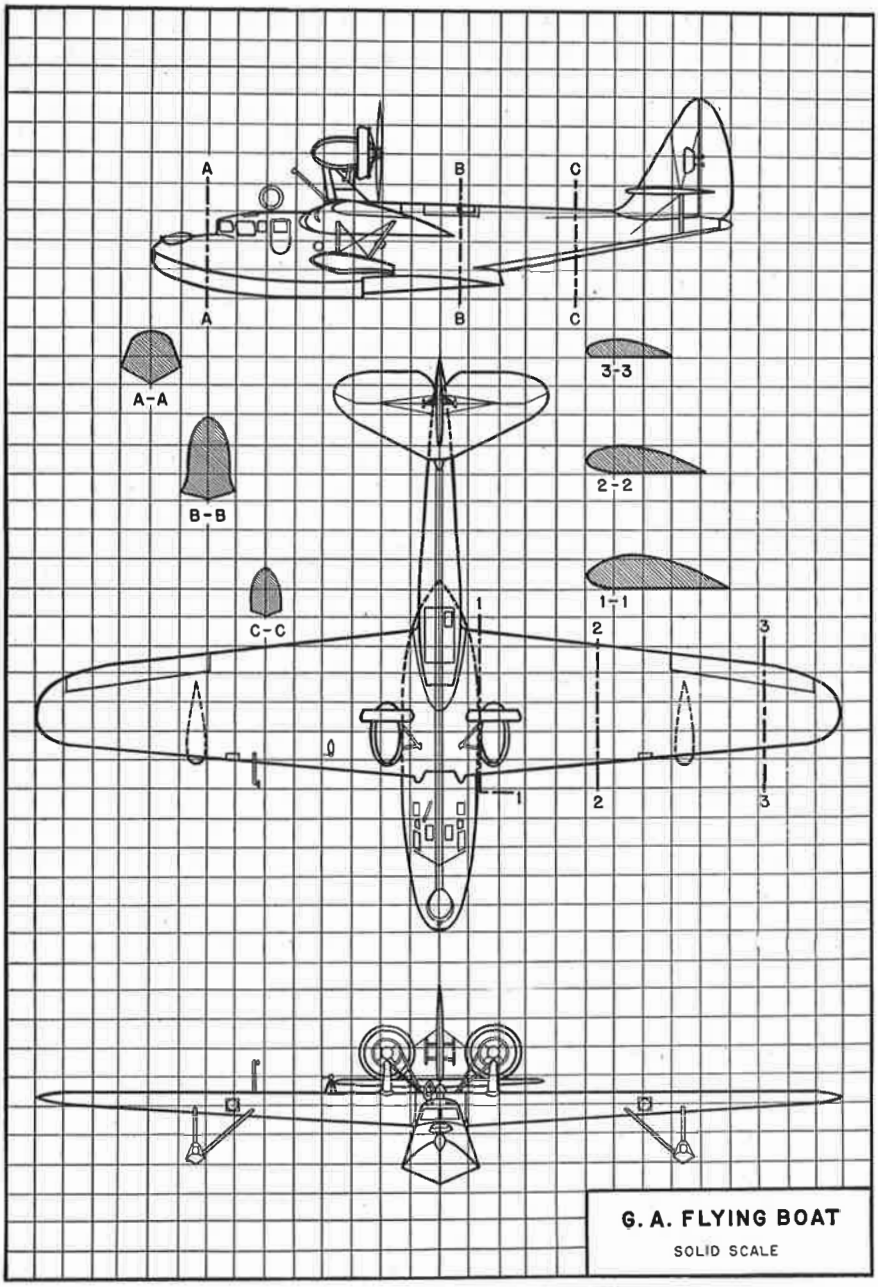
fitted to the fuselage at this time. Note that the top of the fuselage is cut so that the wing can fit into it. This cut in the fuselage must be deep enough to allow the wing to fit down flush with the top of the fuselage. It must also be so cut as to permit the fuselage to fit around both the leading and trailing edge of the wing, as shown in the photograph. When this cut has been made, cement the wing in place. If properly made, the wing must be slipped into the fuselage cut from one of its tips, as the top of the fuselage extends over both the leading and trailing edges of the wing.

PONTOONS. Two pontoons must be made to fit on the under side of the wing near its tips. These are carved from small balsa blocks measuring 3/8" square and 1½" long. Their shape and size are shown in all views in the plans. Short pontoon struts are cut, streamlined, and assembled to hold the pontoons to the under side of the wing. Each pontoon requires four such struts with cross bracing, as shown in the plan and photograph.

NACELLES. Two engine nacelles mounted on nacelle standards will be needed. The standards are carved from ¼" thick, ½" wide, and 5/8" long balsa blocks. Note their shape in the photograph and top view of the plan. The nacelles are carved from balsa blocks measuring ½" square and ¾" long. Their shape can be seen in the photograph and the top and center views of the plan. Carve these four pieces and finish smooth with sandpaper. The tops of the standards must be carved to fit the round contours of the nacelles. When this has been done, cement the nacelles in place on the standards. Two engines must now be made. These should have nine cylinders. Their construction is fully explained on page 129 under "Engines." Fit each one with a ring cowling, as explained on page 132 under "Ring Cowling." Cement the cowling around the engine and attach the unit to the center of the nacelle with cement. When both units have been completed, they should be cemented in place on the wing. Carve the lower end of each standard to fit the curve of the wing and cement it in place. Each nacelle unit is strengthened by two struts, as shown in the photograph and plan. Cut these, streamline them properly, and cement them in place.

PROPELLERS. Each engine is equipped with a two-bladed, exhibition propeller. Carve these from 1/8" thick, ¼" wide, and 1 5/8" long balsa, as explained on page 111 under "Exhibition Propeller." Attach each with a model pin to the center of the engine.

RUDDER. The rudder is carved from sheet balsa measuring 1/8" thick, 2" wide, and 2 1/8" long. This is shown in the top and center views of the plan. Its lower edge must be shaped to fit on top of the fuselage tail, as shown in the plan. Finish the rudder with sandpaper and cement in place.



G. A. FLYING BOAT PLAN

ELEVATOR. The elevator is made to fit around the leading edge of the rudder. Carve it from a single sheet of balsa measuring 1/8" thick, 1½" wide, and 3⅝" long. When completed, cut a slot from its trailing edge just large enough and long enough to permit it fitting around the rudder, as shown in the plan. Finish smooth with sandpaper and cement in place. A short elevator strut is added on the under side of the elevator on each side. This runs down to the side of the fuselage. Brace wires are then added. Two are placed on the upper side of the elevator running to the rudder on each side, and a single one on each side is run from the elevator to the fuselage, as shown.

FINISHING. Fill all joints, cracks, and other blemishes with a good plastic wood. Go over the entire model with a fine sandpaper and then mark all windows, doors, lettering, numbers, and insignia in light pencil lines. The model is now ready for painting.

PAINTING. The hull above the water is Austin blue. Below the water line is aluminum. The wing and elevator are deep yellow. The rudder is painted red, white, and blue, with the red placed at the trailing edge. On the upper-left side of the wing are the letters "U.S.," while "C.G." appear on the upper-right half. On the under side of the wing, the letters "U.S.C.G." appear. These letters on the wing are in black. The words "U.S. Coast Guard" appear on each side of the fuselage in white, as shown in the photograph. The nacelles, struts, and propellers are aluminum, while the engine cowlings are in red. The letters "FLB-51" appear on each side of the fin, while the General Aviation Corporation insignia appears on both sides of the rudder. This is shown in Chapter 14, Insignia No. 16. The Coast Guard insignia is painted on both sides of the fuselage nose, as shown in the photograph. Outline all joints in black, which completes your model.

CHAPTER 43

DOUGLAS DC-3 MAINLINER

THE Douglas DC-3 Mainliner is an enlarged version of its twin-motored predecessors, the DC-1 and the DC-2, which are now used on more airlines than any other type of airplane in the world. The DC-3, shown here, is the largest airplane manufactured by the Douglas Aircraft Company. It is built at Santa Monica, California, in the largest aircraft factory in the world. This giant of the air carries twenty-one passengers by day and sleeps fourteen by night. The sleeper is designated by the letters "DS-T," which mean "Douglas Sleeper Transport." The Fokker Company manufacture these planes under license in Europe. In the United States, Douglas planes are used by the United Airlines, Pan American Airways, Braniff Airways, Pan American Grace Airways, TWA, Eastern Air Lines, and American Airlines.

The DC-3 has a wing span of 95 feet and a total length of 65 feet. It is powered with either Pratt and Whitney Twin "Wasp" engines, or Wright G-2 "Cyclone" engines, which develop over 1,000 horsepower. With a top speed of 213 M.P.H., a cruising speed of 192 M.P.H., and a landing speed of only 64 M.P.H., it carries fuel tanks large enough to permit a cruising range of 2,150 miles. Here is a monster of the air every model builder will want in his model collection. Turn to page 319 and read carefully the instructions given under "Reading Plans." Then gather your materials and tools and get busy making a replica of this greatest of transport planes.

FUSELAGE. Turn to the plan showing the three views of this plane and study each carefully. Because of the fillets used between the rudder and the fuselage, the top line of the fuselage, shown in the top view, is not continued to the tail of the fuselage. Note that this blends into the rudder. When making your full-sized copy of the top and center view of the model, continue the top line of the fuselage, shown in the top view, through the rudder to the trailing point of the fuselage. The lines indicating the sides of the fuselage, shown in the center view, are also continued through the elevator to the same trailing point.

The fuselage is carved from a balsa block measuring 1¾" thick, 2⅛" wide, and 13¾" long. Make a full-sized copy of the three cross-sectional



DOUGLAS DC-3 MAINLINER

views of the fuselage, shown at A-A, B-B, and C-C, and from these full-sized drawings make three templates for use during the carving work. Note that the cross-sections B-B and C-C carry out the fillets of the wings on that of B-B and the rudder on that of C-C. These are shown merely to indicate position and should not be included in the templates. Because of the nature of the fuselage design, the cabin is not hollowed out completely, as such work would prove too difficult on so small a scale. Give the entire fuselage a thorough scrubbing with sandpaper after testing carefully with your templates to see that it has been carved to perfect shape.

WING. The wing is made in four parts. The two duplicate center sections, shown in the bottom view, and the two outer wings, which can be seen in both the center and bottom views, go to make up the single wing of the model. The center sections are carved from balsa sheeting measuring ½" thick, 3" wide, and 2⅝" long. The streamlining of these center sections is shown in the plan under 1-1. In the bottom view will be seen how the inner ends of these two center sections are carved to fit around and under the fuselage, where they join with each other in tapering, knife edges. Their outer edges are as shown at 1-1, where the outer wings join them. Note that these center sections have no dihedral, while the outer wings are given a 1⅛" dihedral. Complete the outer wings by carving them to the form shown in the plan at 1-1, 2-2, and 3-3, and the general shape shown in the center view. When these four parts are completed, go over each with sandpaper. Cement the outer wings in place to the center sections. In doing this, give each outer wing its proper dihedral of 1⅛". (See page 46, "Dihedral Angle.") The inner ends of the assembled wing halves are now cemented in place to the fuselage. Note the location in the top and center views of the plan.

ENGINE NACELLES. Two engine nacelles are required for this model. They are carved from 1⅛" square by 2⅝" long balsa blocks. Note how they are given the form of a cone, being perfectly rounded at the front and then tapering off to points at the rear. Because this model is built on so small a scale, it is not recommended that actual engines be built and inserted in the nacelles. However, if the builder wishes, these may be added. (See Chapter 11, "Engines.") When engines are omitted, the nacelles should be hollowed out about ⅛" deep and this area painted black to represent the engine. Slots are cut in the tapering, cone-shaped, trailing ends of the nacelles to allow them to fit over the leading edge of the wing. Complete the carving, test the slots to see that they fit over the wing perfectly, and then complete the nacelles with sandpaper. They are now cemented in place over the wing edge, as shown in the center and top view of the plan.

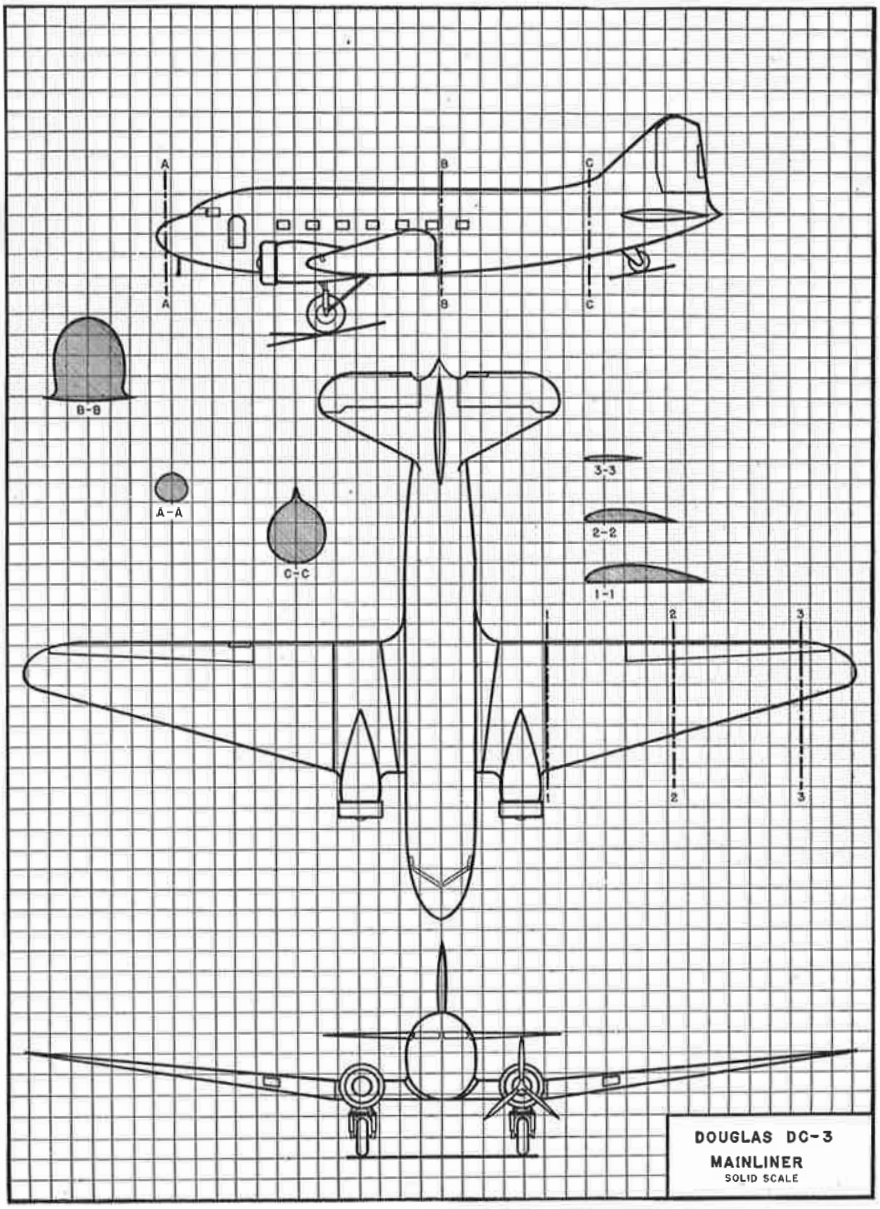
PROPELLERS. Two three-bladed exhibition propellers are required for this model. These have 1½" long blades and are carved from balsa wood. This work is fully described in Chapter 9, page 111, "Three-bladed Exhibition Propeller." Finish smooth with sandpaper and then mount each one to the center of the nacelle with a small model pin.

ELEVATOR. The elevator is made in one piece from a balsa sheet measuring ⅛" thick, 2⅜" wide, and 5¾" long. Its streamlined surface is shown in the center view, while the edge may be seen in the top view. Note that it appears to go past the sides of the fuselage in the center view and into the fuselage. This is because of the rounded form of the fuselage. When the elevator has been properly shaped, sanded smooth, and tested for size, it is ready for assembly. This work, however, is not done until the final assembly of the model.

RUDDER. The rudder of this model is carved from a single sheet of balsa measuring ⅛" thick, 2¼" wide, and 3½" long. It is streamlined, as shown in the center view, and its lower edge carved to fit the upper curve of the fuselage. Note this is the top view. Finish smooth with sandpaper.

LANDING GEAR. To decrease air resistance when in flight, the Douglas Mainliner draws its wheels up into its wing. This flight position is shown in the accompanying photograph. Landing position is shown in the plan. The builder may have his choice as to which position he wishes to have his model when completed. If the former is used, a standard to hold the model must be built. In the latter case, the model stands on its own wheels. As can be seen from the plan, the landing gear consists of two units of shock absorbers, landing gear struts, and wheels. The shock absorbers and struts are cut from balsa strips, while the wheels are carved from ¼" sheet balsa and have diameters of ⅞" each. These wheels should be of the "doughnut" type, which are fully explained on page 125 under "Balsa Doughnut Wheels." Mount each wheel between the absorbers with a short model pin cut to proper length.

FINISHING AND ASSEMBLING. A slot is cut in the trailing end of the fuselage to accommodate the elevator. This is then cemented in place and the opened end of the fuselage filled in with a plastic wood. All joints on both the top and bottom of the elevator where it connects with the fuselage should be filled with plastic wood and fillets made to curve from the elevator into the sides of the fuselage. The rudder is cemented in place on the fuselage and fillets of plastic wood used in the same manner as on the elevator. A small ½" diameter balsa tail wheel should be added to the under side of the fuselage. All joints of the wing where it joins the fuselage should be filled in with plastic wood in the form of fillets. This gives it the



DOUGLAS DC-3 MAINLINER PLAN

appearance of blending into the fuselage, as shown in the photograph. Go over all cracks, joints, and other blemishes with the plastic wood, filling each in until it disappears, and then finish to a satin smoothness the entire model. All windows, doors, lettering, insignia, and other marks to be added to the model when it is painted should now be added in light pencil marks. If a landing gear has been made, it should be cemented in place at this time.

PAINTING. Paint the entire model aluminum. All rudder, elevator, and aileron lines should be ruled in black. Windows should be filled in with a light gray. Remove both propellers from the nacelles and paint the hollowed-out face of each nacelle black. The propellers are then painted aluminum and replaced on the nacelles. Landing gear tires and the tire on the tail wheel should be painted black, while the wheel centers are painted white. All numbers and insignia should be black. The word "Mainliner," shown on the side of the fuselage in the photograph, is red. The outline of the door and all window frames should be outlined in black, which completes the model.

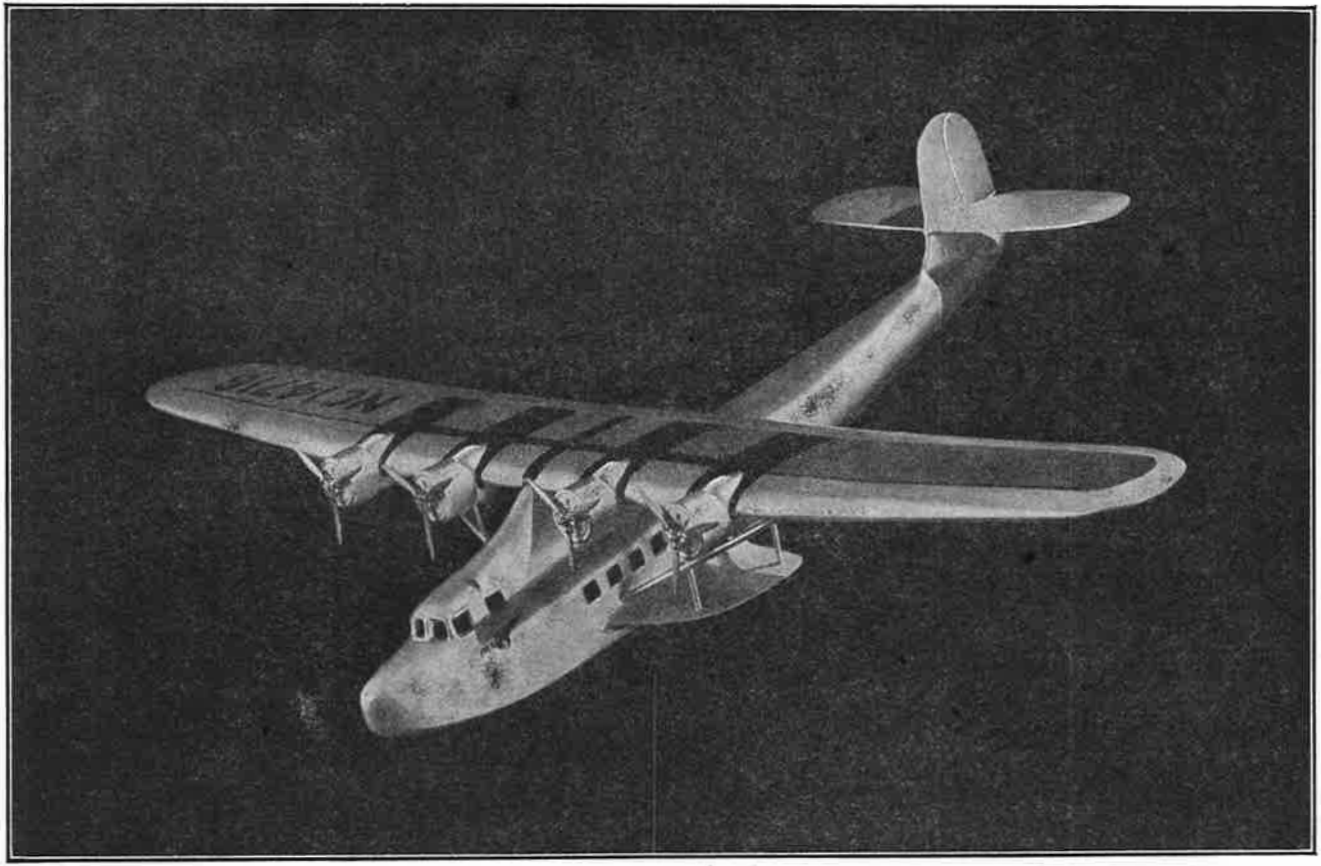
CHAPTER 44

MARTIN CHINA CLIPPER

THE Martin flying boats, better known as "clipper ships," are manufactured by the Glenn L. Martin Company in Baltimore, Maryland. This particular type is designated as "Model 130." These planes were built primarily for the Pan American Airways for the carrying of passengers and freight over their transpacific routes to the Orient. A weekly schedule is maintained at this time. They are powered with four Pratt and Whitney "Twin Wasp" engines. Each of these develops 1,000 horsepower and has fourteen cylinders in staggered units of seven cylinders each. Its maximum speed is 180 M.P.H., and with its engines running only three-quarters of their full horsepower it can cruise at 165 M.P.H. These planes land at 70 M.P.H. With a wing span of 130 feet, a length of 90 feet, and a height of over 24 feet, these giant flying boats carry 46 passengers, a crew of six, and fuel enough to cruise 3,200 miles. Turn to page 319 and reach the instructions given under "Reading Plans" before actual work is started on the model.

FUSELAGE. The fuselage, or "hull," is carved from a balsa block measuring 2″ thick, 2¼″ wide, and 14⅛″ long. Make full-size copies of the three cross-sectional views of the fuselage shown in the plan under A-A, B-B, and C-C. When completed, make a cardboard template of each one. The locations of these cross-sections are shown by dotted lines on the top view. Note that the fin appears to be a part of the fuselage in this view. Continue the top line of the fuselage through the rudder in the top view to obtain the fuselage's form. The cabin slopes up to the leading edge of the wing, as is shown in the photograph, and the fuselage is cut away to accommodate the wing and allow it to fit on top of the fuselage. Do not hollow out the cabin. When finished, complete the fuselage by sanding it with a fine sandpaper.

WING. The main wing is carved in three pieces. Two duplicate outer wing sections are carved from two balsa sheets measuring ½″ thick, 3⅛″ wide, and 6½″ long. Carve these to the shapes shown by the cross-sections 2-2, 3-3, and 4-4. The center section is carved from sheet balsa measuring ⅜″ thick, 2⅜″ wide, and 7″ long. Note its form given by the cross-section



MARTIN CHINA CLIPPER

1-1 and in the bottom view of the plan. Complete this section with sandpaper, center it in position on the fuselage, as shown by the bottom and top views, and cement in place. Both outer wing sections are then cemented to the center section at ½″ dihedral angles. (See page 46, "Dihedral Angle.") The short lower wing is carved from two sheet balsa pieces measuring ¼″ thick, 3″ wide, and 2″ long. Note their shape in the center view of the plan, and their streamlined form in the top view. Make both alike and cement them in place on each side of the fuselage. Four long wing struts and eight short ones are cut and cemented in place between the wings, as shown.

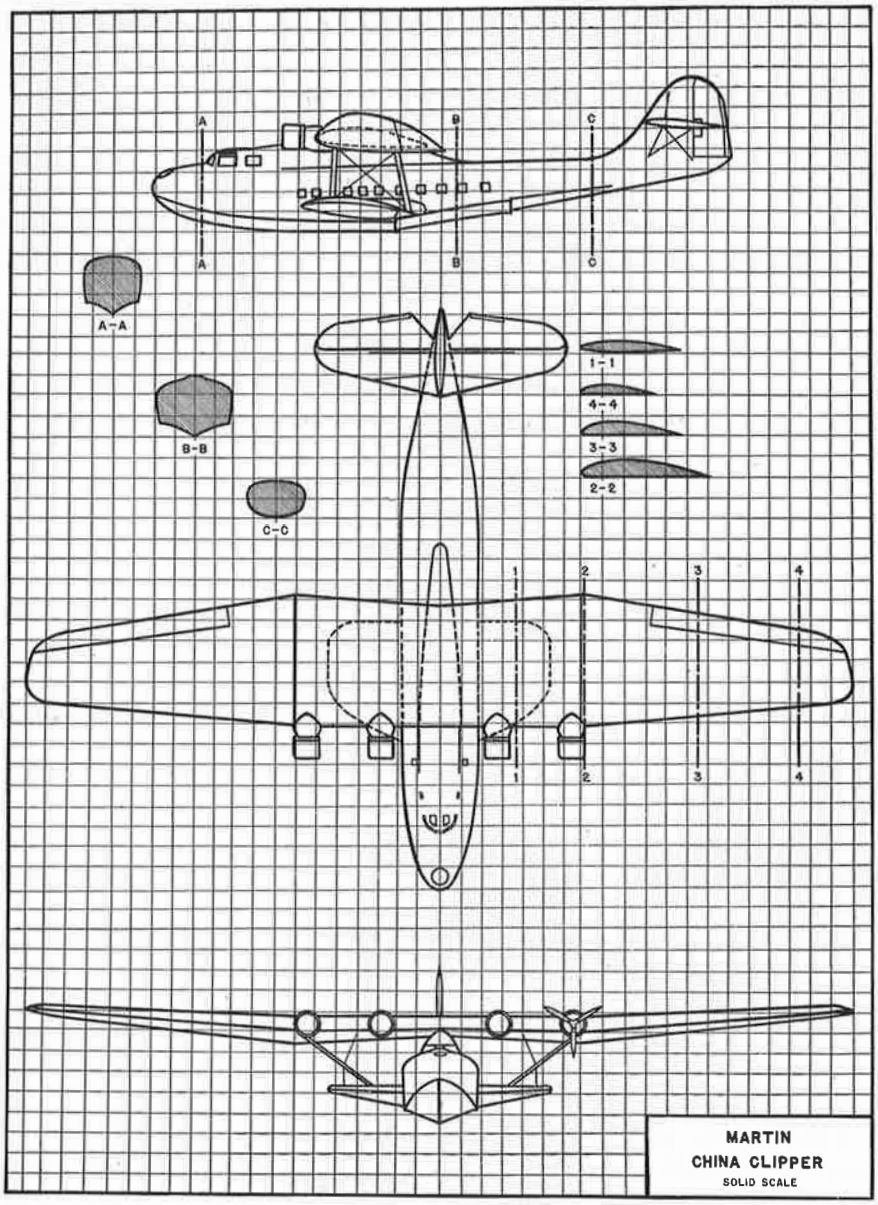
NACELLES. Four engine nacelles are carved from balsa blocks measuring ⅝″ square and 1½″ long. Do not attempt to fit these with engines because of their extremely small size. Note how these are slotted to fit over the leading edge of the main wing. Make these slots and test for fit. Cement in place.

PROPELLERS. Four three-bladed, exhibition propellers must be carved for the engines. (See page 111, "Three-bladed Exhibition Propeller.") Fit each in place to the center of the nacelle nose with a model pin.

RUDDER. The rudder and fin are cut from a single sheet balsa piece measuring ⅛″ thick, 2″ wide, and 3¼″ long. While it appears to be a part of the fuselage in the plan, it is actually a separate piece cemented in place and flared out at its base with fillets of plastic wood. Streamline it as shown in the center plan and then carve to proper shape. Note this in the top plan. The lower edge of the rudder is then shaped to fit the top of the fuselage, where it is cemented in place. Finish the work by sandpapering all joints and then filling them with plastic wood. Flare the bottom of the rudder to make it blend into the fuselage, as shown in the photograph. This is done with plastic wood. Go over the entire rudder with fine sandpaper.

ELEVATOR. The elevator is carved from sheet balsa measuring ⅛″ thick, 2″ wide, and 3″ long. As it is made in two parts, two such pieces will be needed. Note the shape of each half in the center view of the plan. Streamline each piece and carve to shape. Cut their inner edges to fit along the rudder. Finish the elevator by carefully sanding its pieces, and then cement them in place on each side of the rudder.

FINISHING AND PAINTING. Go over the entire model with fine sandpaper. Fill all joints, cracks, and other surface blemishes with a good grade of plastic wood. Mark in pencil the outlines of all windows, doors, flaps, insignia, numbers, and other decorations. The fuselage is black from its water-line down. All cabin windows and the catwalks on the wing are



MARTIN CHINA CLIPPER PLAN

also black. The license numbers, all stripes, and the hinge lines of the rudder, elevator, and ailerons are painted in black. The Pan American Airways insignia should be in marine blue. The top of the main wing is international orange with black outline stripes. All other parts, such as the hull, elevator, rudder, lower wing, and propellers are finished in aluminum. While the propellers are off the model, paint the center of each nacelle black to represent the engines. (See page 149, "Pan American Airways," Insignia No. 15.) Complete the model by painting all struts aluminum. When the first coat has been applied and allowed to dry, give the entire model a second one. A light sanding between coats will obtain the satin finish desired.

CHAPTER 45

LOCKHEED ELECTRA

THE Lockheed Electra is manufactured by the Lockheed Aircraft Corporation at Burbank, California. This company discontinued the manufacture of their "Orion," "Vega," and "Altair" models in 1936, and the "Electra" took their places. This new type proved very popular and is now supplied to many foreign countries for airline use.

This plane carries ten passengers and a crew of two. Powered by twin Pratt and Whitney "Wasp" engines of 450 horsepower each, this transport can reach a top speed of 210 M.P.H., a cruising speed of 195 M.P.H., and can be landed at 64 M.P.H. They also come equipped with Wright engines of the same horsepower. Before any work is started on the model, turn to page 319 and read the instruction given under "Reading Plans."

FUSELAGE. The fuselage is carved from a single balsa block measuring 2″ thick, 2¼″ wide, and 14″ long. Three cross-sectional views of it are shown in the plan under A-A, B-B, and C-C. Copy these full size and then make cardboard templates from the copies. As the wing fits on both sides of the fuselage and is not in one piece, the fuselage need not be shaped or cut to accommodate it. Note how the under side of the fuselage is cut away at its trailing end. This cut holds the brace of the tail wheel, as shown in the top view. Otherwise the entire fuselage has no difficult lines. Use the templates constantly while the carving is being done to insure correct form. The exact locations of these three templates are shown in the top view of the plan by dotted lines. When all carving has been completed, go over the entire fuselage for a final check as to dimensions, and then finish it with a light sanding with fine sandpaper.

WING. The wing is made in two duplicate halves. Three cross-sectional views covering each of these halves are shown in the plan under 1-1, 2-2, and 3-3. Their locations on the wing are shown in the center view by dotted lines. Note the general shape of each half in the same view. Each of these halves is carved from sheet balsa measuring ¾″ thick, 4½″ wide, and 9⅛″ long. Carve each half to proper form and streamline it as shown by the cross-sections. Complete each with a careful sanding with fine sandpaper.



LOCKHEED ELECTRA

NACELLES. Two engine nacelles are required for this model. Note their shape in the bottom view. Their general form is shown in the center and top views. Each of these is carved from balsa blocks measuring 1¼" square, or round, and 3⅜" long. They are given the rounded form of a ring cowling at their leading edges and then taper off to cone form the balance of their length. The cowling-shaped portion is hollowed out to take the engine. Each of these nacelles is slotted to fit over the leading edge of the wing, as shown in the plan. Cut these slots with great care so as to prevent possible splitting of the wood. Test each one for proper fit, but do not cement in place at this time. Finish smooth with sandpaper.

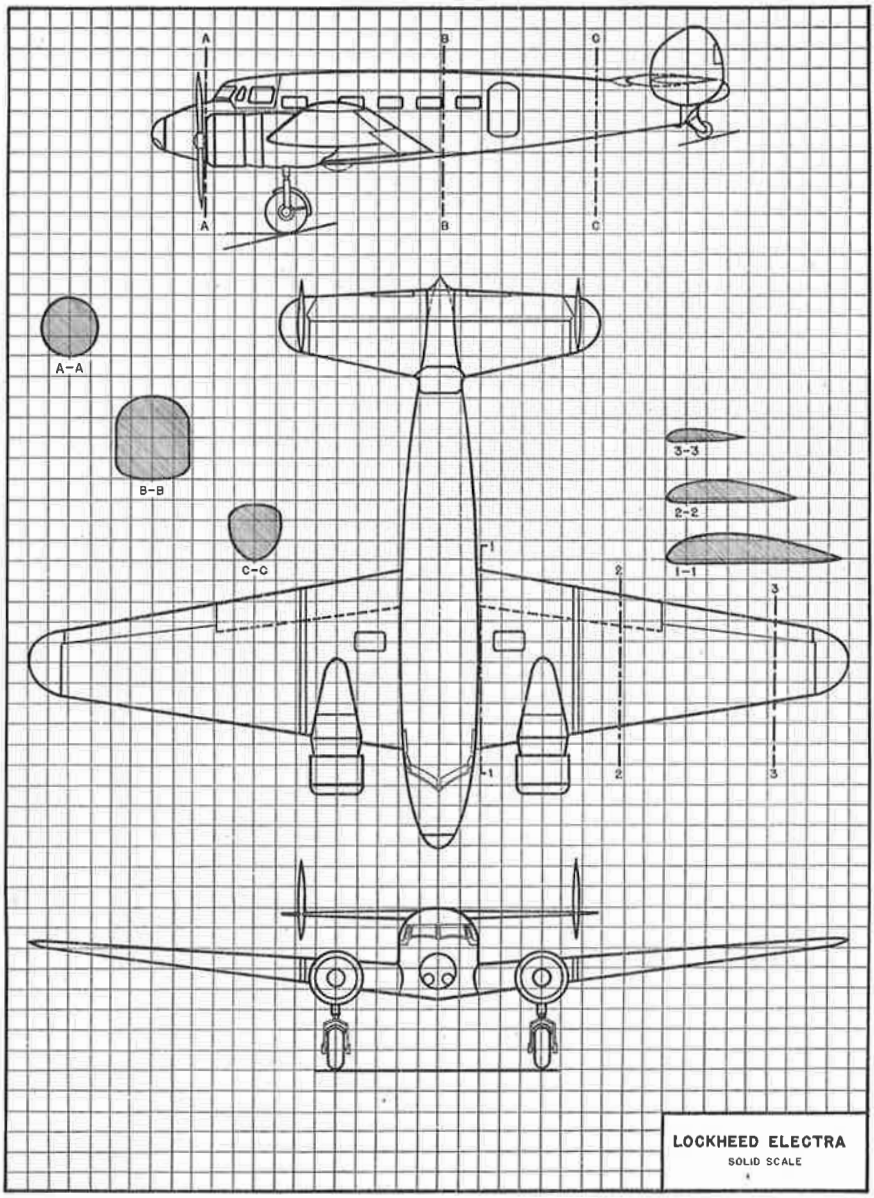
ENGINES. Two nine-cylinder radial engines are made to fit into the nacelles. Full instructions for making these will be found on page 129 under "Engines." If the builder does not wish to go to such detail, small 1" diameter blocks may be inserted into the hollowed-out nacelles and cemented in place to represent engines. Do not cement either the engines or the blocks into place at this time.

PROPELLERS. Two exhibition propellers will be needed. These should be carved from ⅛" thick, ¼" wide, and 3¼" long balsa blocks. Full instructions for this work will be found on page 111 under "Exhibition Propeller." Finish each propeller by sanding it lightly with fine sandpaper.

LANDING GEAR. The landing gear consists of two wheels and two fork brackets. The wheels are carved from balsa blocks measuring 1" square or round and ¼" thick. They are of the "doughnut" variety, which are fully explained on page 125 under "Balsa Doughnut Wheels." Carve both of these and finish with sandpaper. The forks may be carved from balsa blocks ⅛" thick, ½" wide, and 1½" long. Note their shape in the top and bottom view of the plan. The wheels are held between the prongs of the forks with model pins sheared to length. While the wheels may be attached in place at any time, the landing gear as a unit should not be attached until later.

ELEVATOR. The elevator is carved from a single sheet of balsa wood measuring ¼" thick, 2⅛" wide, and 7⅝" long. Its maximum thickness is at its center and it then tapers off toward each tip, as shown in the bottom view. The general form is shown in the center view, while its streamlined shape is shown in the top view. Note how its trailing edge is cut away from the top of the fuselage to permit its flap to work up and down properly. Carve this to proper shape and size, and then complete it with a careful sanding.

RUDDERS. This type of plane has two rudders located on the elevator near its tips. Note this location in the bottom and center views of the plan.



LOCKHEED ELECTRA PLAN

Each rudder is carved from sheet balsa measuring 1/8" thick, 1 3/4" wide, and 2" long. It is streamlined, as shown in the bottom and center views of the plans. Finish each of the rudders with sandpaper but do not mount at this time.

TAIL WHEEL. The tail wheel is 3/8" in diameter and 1/8" thick. It is mounted in a fork brace cut as shown in the top view. As this is too small for a model pin, the tail wheel should be cemented in place.

ASSEMBLY. It will be found best to paint certain parts before they are assembled together. Paint the inside of the nacelles and the propellers aluminum. Paint the engines black. When dry, cement the engines inside the nacelles and attach the propellers to the core of the engins with model pins. Cement the nacelles in their proper places over the leading edge of the wing. Bore small holes into the under sides of the nacelles and insert the landing gear forks 1/4" deep into them. Hold with cement. Note their locations in the bottom and top views of the plan. Place the wheels in their forks and hold with a model pin. Sand the inner ends of the wing halves to fit the side contour of the fuselage. Note that each wing half must be given a 1 3/8" dihedral. (See page 46, "Dihedral Angle.") Obtain this height for each tip above its center section, or inner edge, and cement the halves in place. Note their location in the center view of the plan. A slot must be cut in each rudder so that the rudder may be slipped over the leading edge of the elevator and cemented in place. Attach both rudders in this manner. The tail wheel is then cemented in place to the under side of the fuselage at its trailing end.

FINISHING AND PAINTING. Go over the entire model with plastic wood, and fill all cracks, joints, and other surface blemishes. Finish off with a light sanding. Paint the entire model aluminum. All license numbers are in black. Paint the nose, leading edges of the nacelles, and the stripe around the fuselage in marine blue. All doors, windows, aileron, elevator, and rudder lines should be in black. Fill in with black the doors and windows. Paint the wheels white with black tires. The Lockheed insignia should be painted on each side of the fuselage, or on the outer side of each rudder. This insignia is shown on page 157, No. 64. When finished, a coat of varnish will protect it. This completes the model.

BUILT-UP, NON-FLYING SCALE MODELS
AND
FLYING SCALE MODELS

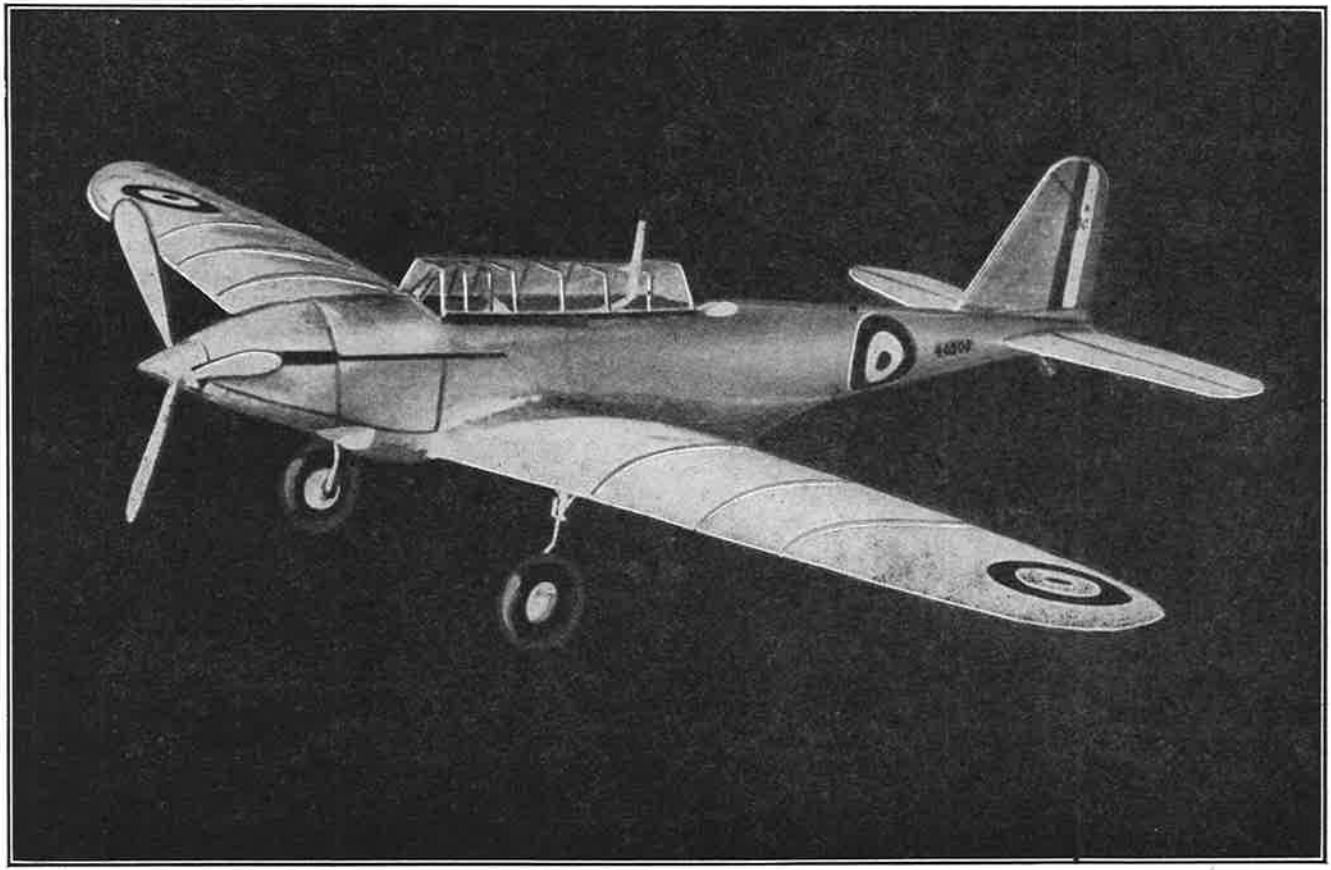
CHAPTER 46

FAIREY "BATTLE"

WITH the advent of super-bombers and ultra-fast pursuit planes, England's Royal Air Force found it necessary to develop an all-purpose fighter to keep pace with them. The Fairey "Battle" is its answer to such a challenge. Powered by a single 1,000 horsepower Rolls-Royce "Merlin" engine, this raider of the skies attains a top speed of over 260 M.P.H. Completely equipped with the very latest of instruments, guns, light bombs and radio, the "Battle" is acclaimed one of the most efficient fighters of modern times. Here is a perfect flying-scale replica of the "Battle" built by Robert V. Smith. The author appreciates his kindness in allowing its reproduction here.

MATERIAL LIST

1 pc. —1/16" x 2" x 24"	—Sheet balsa
1 pc. —1/32" x 2" x 24"	—Sheet balsa
3 pcs.—1/64" x 2" x 24"	—Sheet balsa
2 pcs.—7/8" x 1 3/4" x 17/8"	—Balsa blocks
1 pc. —3/4" x 17/8" square	—Balsa block
2 pcs.—5/8" x 7/8" x 1 1/4"	—Balsa blocks
1 pc. —1/16" x 1/4"	—Bamboo
2 —1 1/4" diameter	—Wheels
2 sheets	—Tissue
1 oz.	—Cement
1 oz.	—Wood filler
1 oz.	—Clear lacquer
2 oz.	—Banana oil
1 oz.	—Silver paint
3 cans	—Red, white and blue lacquer
8 feet	—Brown rubber
1 foot	—No. 15 music wire
6	—Washers
Cellophane	
Spaghetti tubing	
Aluminum tubing	
Sheet aluminum	



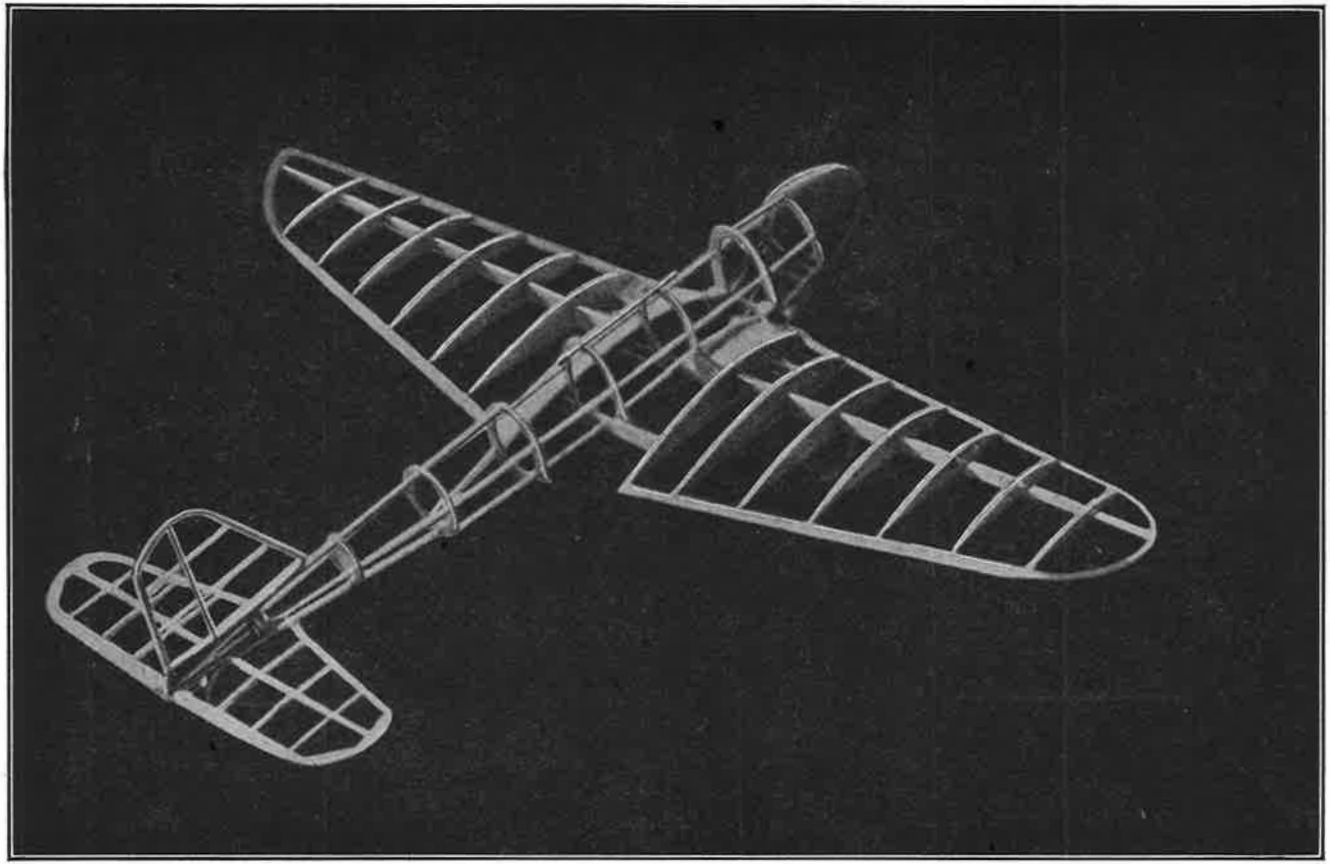
FAIREY "BATTLE"

FUSELAGE. Study Plan 1 showing a top and side view of the fuselage. Turn to Plan 2 and make full-size copies of the fuselage formers on 1/4" squares. Trace these on 1/16" sheet balsa and cut them out. The formers "D" and "E" should be laminated to make them strong enough to hold the wing, as they form the wing stubs. The main longerons are cut from 1/8" x 1/16" hard balsa. The curved side stringers, shown in the side view of Plan 1, that run from former "G" to the fillet blocks "Q," are of 1/16" square hard balsa.

Cut from two blocks of soft balsa measuring 3/8" x 9/16" x 1 3/16" the two wing fillets. These are shown in Plan 2. They are designated in Plan 1 by the letter "Q." Note their location. These blocks must be notched to accommodate the 1/16" square stringers used for filleting the wing. In Plan 1 will be seen the radiator block "R." This is located under the fuselage in its center between formers "B" and "D" directly under former "C." It is cut from a 3/4" x 1 7/8" square block of soft balsa. Note its side shape in the side view of the fuselage in Plan 1. Its bottom is shaped as shown in Plan 3 under "Front View," where it is shown by radiator lines. The top is carved to fit the contour of the underside of the fuselage. The small block shown in Plan 1 between the front end of the radiator block and former "B" is the oil radiator. An additional former is cut out to fit on the front of the radiator block. This is carved from 1/16" sheet balsa measuring 5/8" high and 1 3/4" long. It is straight across its top, straight along its sides, and the bottom is shaped to match the bottom of the radiator block, as shown in the front view of Plan 3. Its upper corners are notched to take the short stringers between formers "B" and "C." Its top edge must be notched in the center to accommodate the bottom-center fuselage stringer.

Cement the longerons and stringers in place in their respective notches in the formers. Cement the wing fillets and the radiator block in place. The radiator former is cemented to the front face of the radiator block and the oil radiator block is cemented in front of it. The nose block is now carved. To do this, cement two 7/8" x 1 3/4" x 1 7/8" balsa blocks together, and carve the outer form of the nose block. Note this in Plan 1. It should be given the same shape as former "B" in cross-sectional contour. When the outside of the block has been completed, break open the blocks and hollow them out, as shown in Plan 1 by the dotted lines. When completed, cement the two blocks together again and then cement the nose block to former "B." The entire fuselage structure should now be given a thorough sanding with light sandpaper.

The fuselage framework is covered with 1/64" sheet balsa. From 1/16" sheet balsa cut two No. 7 wing ribs. These are shown in Plan 2 on 1/4"

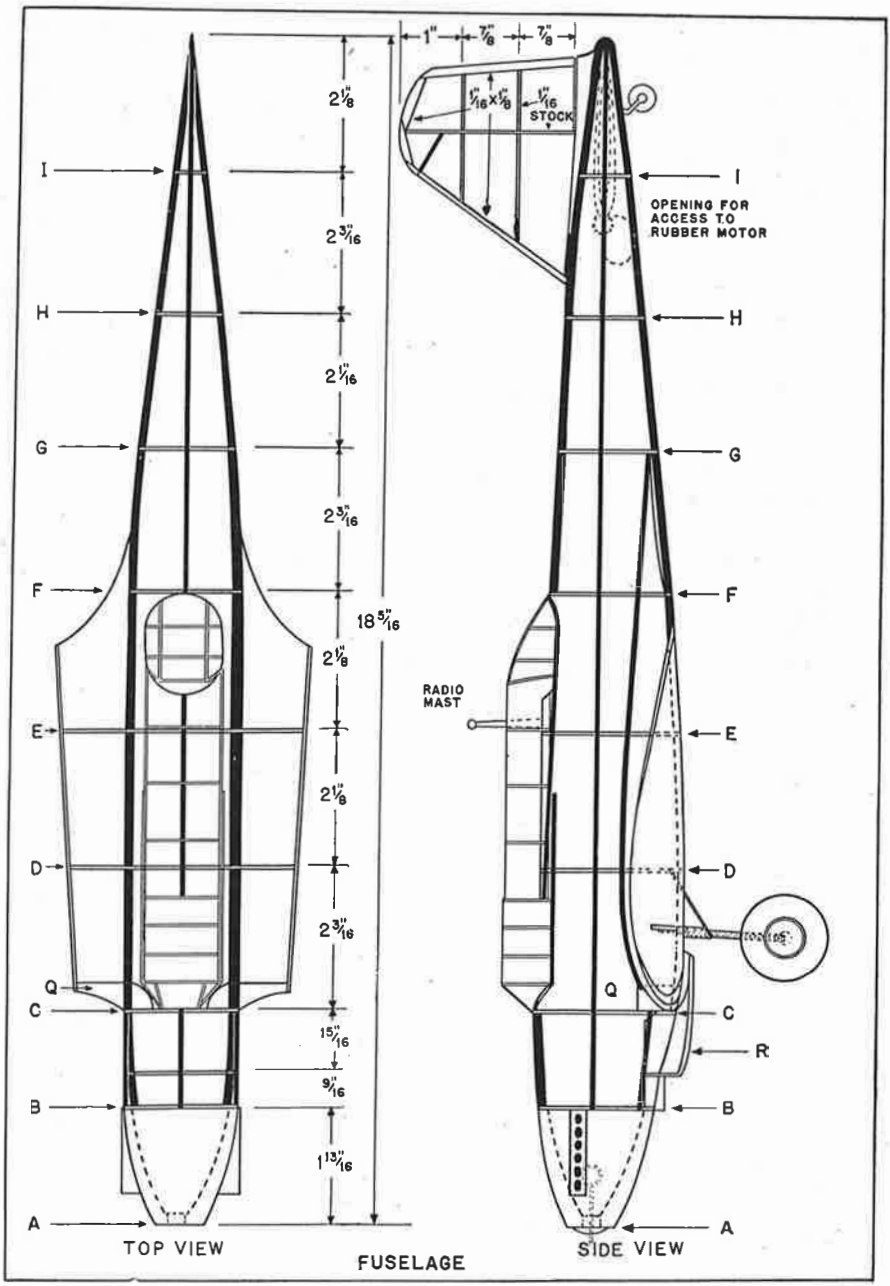


FAIREY "BATTLE" SKELETON

squares. These two ribs are now cemented in place on each side of the fuselage to block "Q" and the formers "D" and "E." Start the covering by cementing small sheets around one stub rib "7" and into the fairing stringer back of former "G." Do this on both sides of the fuselage. When these sheets are dry, trim them and cut the curve shown between the trailing end of the stub rib "7" and former "G." The upper portion of the fuselage between formers "C" and "F" can be covered with one piece and the two cockpits cut out later. Two pieces of sheet balsa will be enough to cover the sections between formers "F" and "I." Note opening left for access to motor. The remaining section can be covered with two sheets after an end hook of No. 15 music wire has been bent and cemented in place. Place one on the bottom and the other on the top. When finished, round the end of the fuselage as shown in Plan 1 under "Side View." The small fillet in section "C" and "D" can be put in easily with a mixture of cement and balsa dust.

The entire fuselage should now be doped with a wood filler solution and when thoroughly dry carefully sanded with a fine sandpaper. The two cockpits should be cut as shown in Plan 1 and the pilot's enclosure then constructed. Eight frames are built up on 1/16" square balsa sticks. These frames may be of bamboo or soft wire, and should be cemented in place on the balsa sticks. Note this structure in Plans 1 and 2. When this enclosure has been completed, it is covered with cellophane and cemented in place over the cockpits on the fuselage.

WING. Make a full-size copy of ribs "1," "2," "3," "4," "5," and "6" on 1/4" squares. Trace two of each of these on 1/32" sheet balsa and cut them out. With the tracing of rib "7" already used for wing stubs, trace two more of these ribs on 1/16" sheet balsa and cut them out. The main spar is cut from 1/16" sheet balsa and is tapered from a width of 5/8" at rib "7" to 1/8" at rib "1," where it tapers off to a point. Cut two of these spars. A 3/32" x 1/8" leading edge has one edge rounded to form its leading side. It should be tapered to fit the smaller ribs. The trailing edge is cut from 1/16" sheet balsa stock and is 3/16" wide. It must be notched to accommodate the bamboo tip, as shown in Plan 3. When two leading and two trailing edge spars have been cut and properly fitted, cement the wing halves together. Rib "7" should not be cemented in place until all others are dry. The wing structure is then placed against the side of the fuselage in proper position. Tilt rib "7" until it is flat against the stub rib on the fuselage and the wing tip has a dihedral of 1". When in this position, cement rib "7" in place on the wing structure. Repeat this process with the other wing half. The short spar running between rib "7" and rib "6" is now cut and cemented in



FAIREY "BATTLE" PLAN 1

place. This spar is used as a support for the landing gear attachment. Complete the other half of the wing in the same manner. The wing halves are now covered with colored tissue. An orange should be used so as to follow the colors used on the original model. Be sure to leave the section where the landing gear fastens on to the under side of the wing half opened and uncovered, so that the gear can be properly fastened in place. This section is between ribs "7" and "6," as shown in Plan 3.

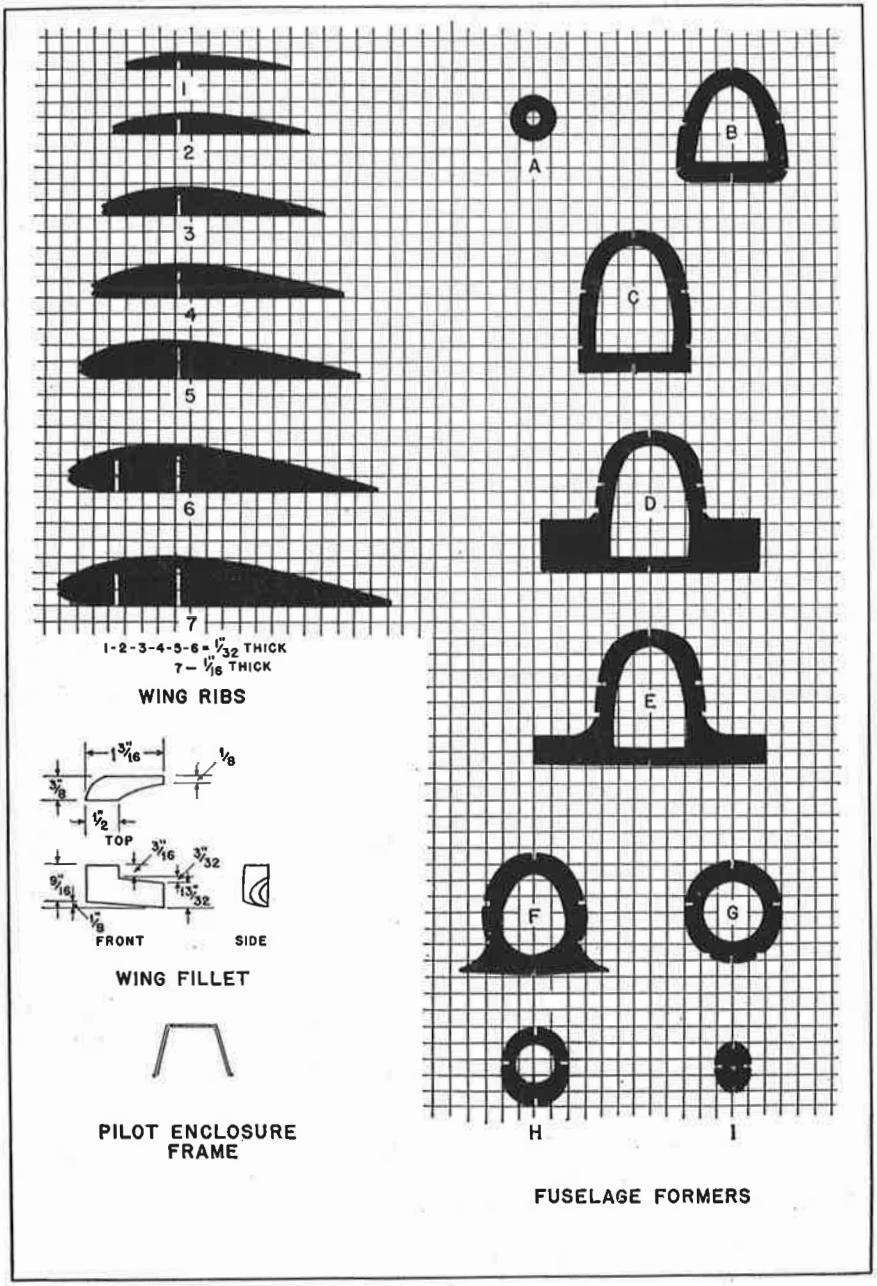
LANDING GEAR. Bend two landing gear "legs" from No. 15 music wire, as shown in Plan 3. The lower ends are bent to form axles, but the upper bends, made to attach to the short wing spar, are not bent until later. Slip either spaghetti tubing or plain rubber tubing over these wires down to the portions bent for axles. Leave a 3/4" length at their upper ends bare. Over the upper end of this tubing slip a 3/8" length of aluminum tubing to represent the large-size shock absorbers of the real plane. The upper 3/4" length of bare wire on each piece is now bent at right angles for fastening purposes. Fit a 1 1/4" diameter balsa wheel to each axle. This should be of the disc type. When each assembly of these landing gear "legs" is complete, cement and bind with silk thread each one to their respective wing spar, as shown in Plan 3 under "Front View." The covering of the under side of the wing halves is now completed. Small wire braces are bent, as shown in the plan, and attached around the tubing. Their upper ends extend to the main spar of the wing where they are forced into it.

RUDDER. The trailing edge spar of the rudder is 1/16" x 1/8" x 2 3/8" long. The leading edge spar is 1/16" x 1/8" x 3 1/16" long. The spar is cut from 1/16" sheet balsa to a length of 2 9/16" long. Cut the tip pieces from 1/16" sheet balsa to fit, as shown in Plan 1. All ribs are cut from 1/16" sheet balsa and shaped to fit. Round the leading edge spar to form a good streamlined appearance. Carve the fillet from soft wood and cement it in place to the rudder framework. Cover the rudder with tissue and set aside to dry.

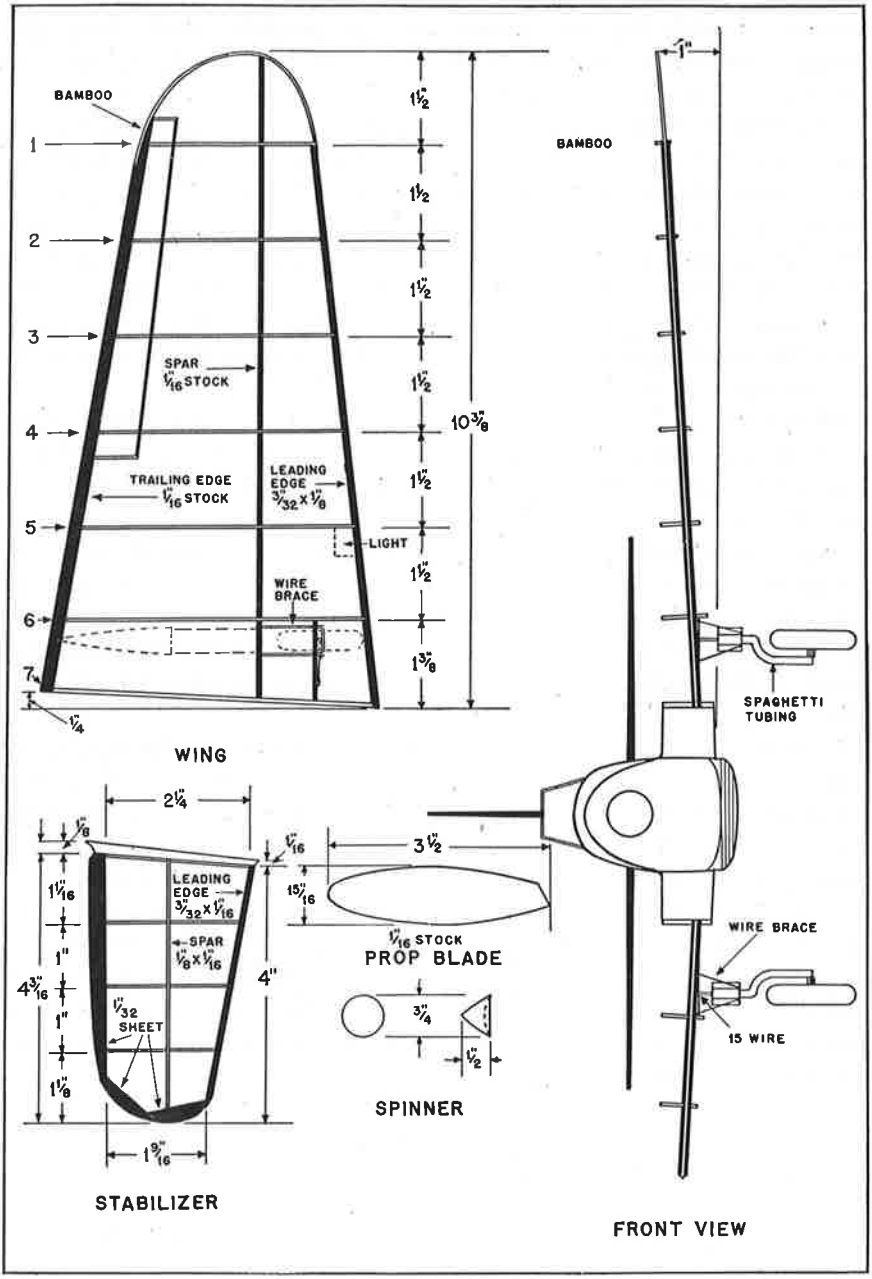
STABILIZER. This is made in two parts, as shown in Plan 3. Cut all parts to proper size. The fillets shown in the plan are carved from soft balsa and cemented in place when the structure is assembled. When completed, cover each half with tissue and set aside to dry.

PROPELLER. Carve three propeller blades and a spinner, as shown in the plan. Bend a shaft from No. 15 music wire. A hardwood nose button serves well for a bearing. Two brass washers should be used between the bearing and the spinner to minimize friction. Cement the blades in place in their spinner, attach the shaft to the spinner, pass it through the bearing, and bend the hook.

MOTOR. Four to six strands of 1/8" brown rubber will adequately



FAIREY "BATTLE" PLAN 2



FAIREY "BATTLE" PLAN 3

power this model. Slip the strands over the propeller shaft, drop them through the fuselage, and attach them over the end hook. At the same time slip the nose button in place.

ASSEMBLY. Cement the wings in place on the fuselage. Carve two wheel streamlines, such as shown by the dotted lines on the wing in Plan 3. These consist of half-cones bent from 1/64" sheet balsa 1 7/8" long. They are cemented in place on the under side of the wing directly behind the wheels with their pointed ends just touching the trailing edge spar. Cement the rudder and stabilizer in place on the fuselage. A small tail wheel is added to the under side of the fuselage. When the entire assembly has been completed, the model should be carefully inspected and all flaws corrected before painting is started.

PAINTING. Give the entire fuselage two coats of silver paint. Touch up all the enclosure framework with black paint. The fin of the rudder is silver, while equally wide stripes on the rudder are painted red, white and blue. The same colors are used on the wing tips and the sides of the fuselage. The propeller and its spinner are given several coats of silver paint to make them look like metal. Exhaust pipes should be painted black and glued in place on each side of the nose. A radio mast will enhance the appearance of the model as will identification numbers. The tail wheel should be black with aluminum discs. The wheels are treated in the same colors, while their "legs" are silver.

FLYING DETAILS. When all painting has been completed, glide the model carefully over tall grass. Should it stall, add a little weight in front. If it should glide too steeply or actually dive, bend up the elevators slightly. When a perfect glide has been obtained, try the model under power. If four strands have been used, the motor can be given 1,200 turns with a winder when stretched. If six strands have been used, it should not be given more than 960 turns with a winder after stretching. Should your model prove heavy, it may require eight strands of rubber. In this case it should be held to 825 turns. If all building instructions have been closely followed, your model should weigh around 1.4 ounces and give an average duration flight of close to sixty seconds.

CHAPTER 47

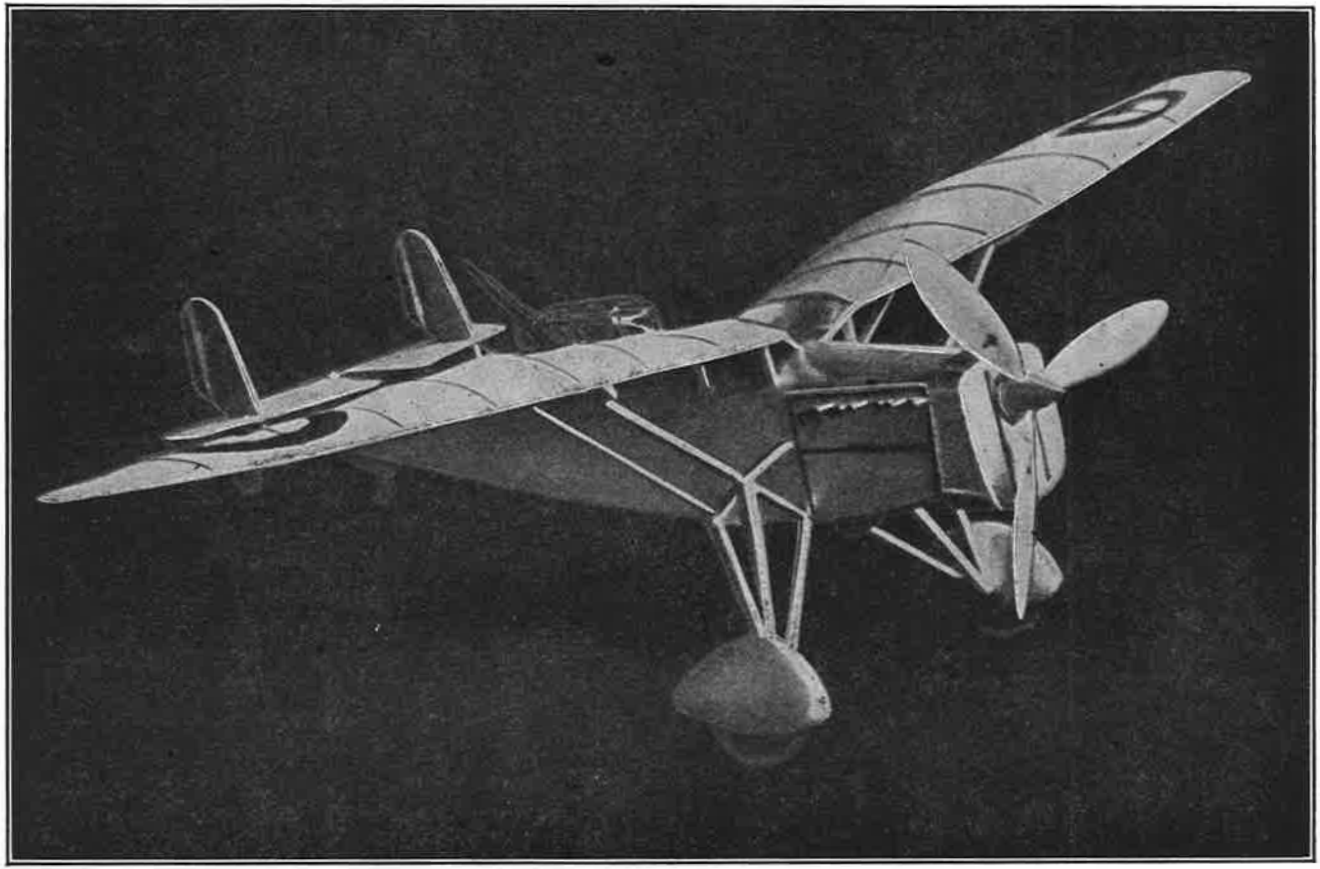
MUREAUX 180-C2 PURSUIT

IN an effort to meet the rigid requirements of the French government covering military airplanes, M. Brunet designed and had accepted the Mureaux 180-C2 pursuit plane which proved more than successful. Powered with a geared supercharged Hispano-Suiza Xcrs engine developing 690 horsepower, this modern raider of the skies can maintain a speed of 237 M.P.H. under full load at 1,600 feet altitude. Here is an example of the new and modern borrowing from the old. It will be noted that the Mureaux—efficient fighter of today—has borrowed the old frontal radiator from planes considered long ago as obsolete. An interesting comparison can be made if the reader will turn to the S.E. 5 on page 413 or the German Fokker D-7 on page 476, and compare the radiators of these World War planes with that of the modern plane shown here. However, tests have proven it superior in general efficiency.

The author expresses his appreciation to Robert V. Smith, who built the perfect replica of the Mureaux Pursuit plane that is presented here. It is exact in every detail and yet has proved to be an extraordinarily fine flying model. This is due to the fact that correct weight distribution has been maintained throughout and also to the semi-parasol type of wing construction. If the following instructions with their accompanying plans are closely followed during the building, the Mureaux model will prove a valuable addition to the builder's collection of true replicas and at the same time give him splendid flight performances.

MATERIAL LIST

1 pc.	—1/16" x 2"	x 12"	—Sheet balsa
2 pcs.	—1/32" x 2"	x 24"	—Sheet balsa
5 pcs.	—3/32" x 3/32"	x 24"	—Balsa
1 pc.	—9/16" x 2"	x 12"	—Balsa block (pants)
1 pc.	—1/8" x 2"	x 12"	—Sheet balsa (struts)
1 pc.	—9/16" x 3/4"	x 6"	—Balsa block (wing fillets)
1 pc.	—1/2" x 2"	x 2 1/4"	—Balsa block (radiator)
1 pc.	—1/4"		—Bamboo strip
1 pr.	—1 1/2"		—Balsa wheels



MUREAUX 180-C2 PURSUIT

MUREAUX 180-C2 PURSUIT

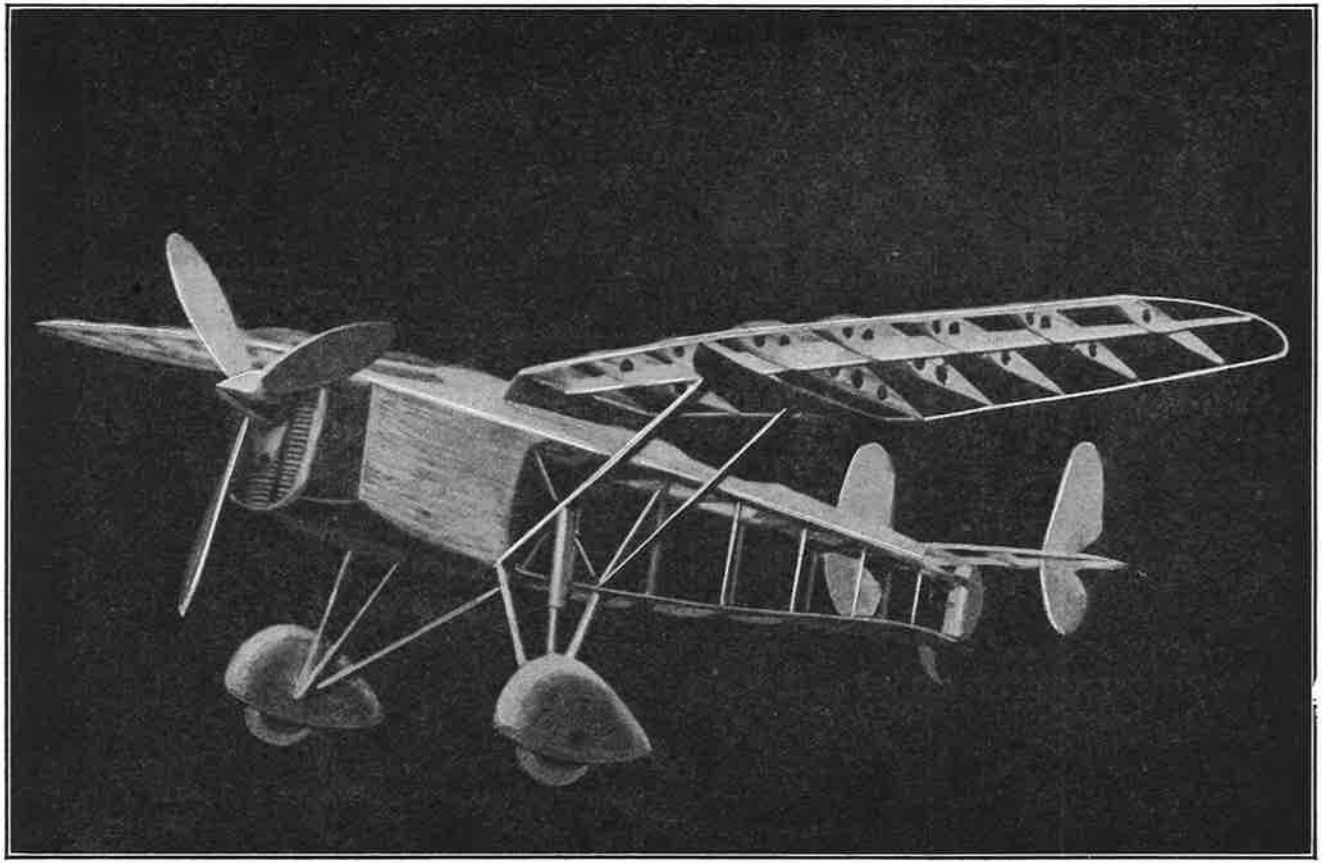
1 sheet—1″ x 7″	—Aluminum (cowling)
1 pc. —⅛″ x 7′ 0″	—Rubber
3	—Dural washers
1 pc. —12″ long	—.028 piano wire
1 pc. —⅛″ x 6″ long	—O. D. aluminum tubing

Cement, Banana Oil, Cellophane, Silver Dope, Blue, Red, and White Lacquers.

FUSELAGE. The fuselage of this model is a simple four longeron construction job. These four longerons extend the total length of the fuselage. They are designated in Plan 1 by the numbers "4" and "5." Longerons "4" are the upper ones, while the lower ones are longerons "5." All these are cut from 3/32″ square medium balsa wood. The fuselage formers, shown in Plan 2, are cut from 1/16″ sheet balsa. These formers are shown on 1/4″ squares in Plan 2 under "A," "C," "D," "F," "H" and "J." Other stations have been shown as they appear along the fuselage, such as "B," "E" and "G," which actually are not formers but braces made up of 1/16″ x 3/32″ balsa. The side portions of formers "A," "C," "D," "F," "H" and "J" are also made up of 1/16″ x 3/32″ braces. They are shown with the formers merely to give their proper lengths. Rule paper, trace these formers and their braces full-size, transfer them to 1/16″ sheet balsa, and cut them out. Remember to cut the braces 3/32″ wide, and do not forget that the formers "A," "C," "D" and "F" have bottom formers as well as top ones.

Make one side of the fuselage at a time. Place the top longeron "4" flat on the table and cement the upright braces at their various locations along its length. The bottom longeron "5" is then bent to meet the lower ends of each of the braces. Complete both sides of the fuselage in this manner and then start cementing the top formers in place, as shown in Plan 1. These are followed by the bottom formers and the side diagonal braces, as shown in the side view of Plan 1. Note that several braces extend across both the top and bottom of the fuselage to hold the framework of its sides apart and in proper location. Note that two short stringers extend from former "C" to former "D" along the top of the fuselage, where notches are cut to accommodate them. Cut and cement these in place.

The fuselage is now covered in certain areas with 1/32″ sheet balsa. Note this in the photograph of the uncovered model and in the side view of Plan 1. The rounded top of the fuselage between the upper longerons "4" is covered along its entire length. The sides of the fuselage between formers "A" and "C" is likewise covered. Cut this balsa covering to size and shape and cement it in place. The top covering is now cut to make the cockpit, as shown in Plan 1 under "Top View." The nose block is carved

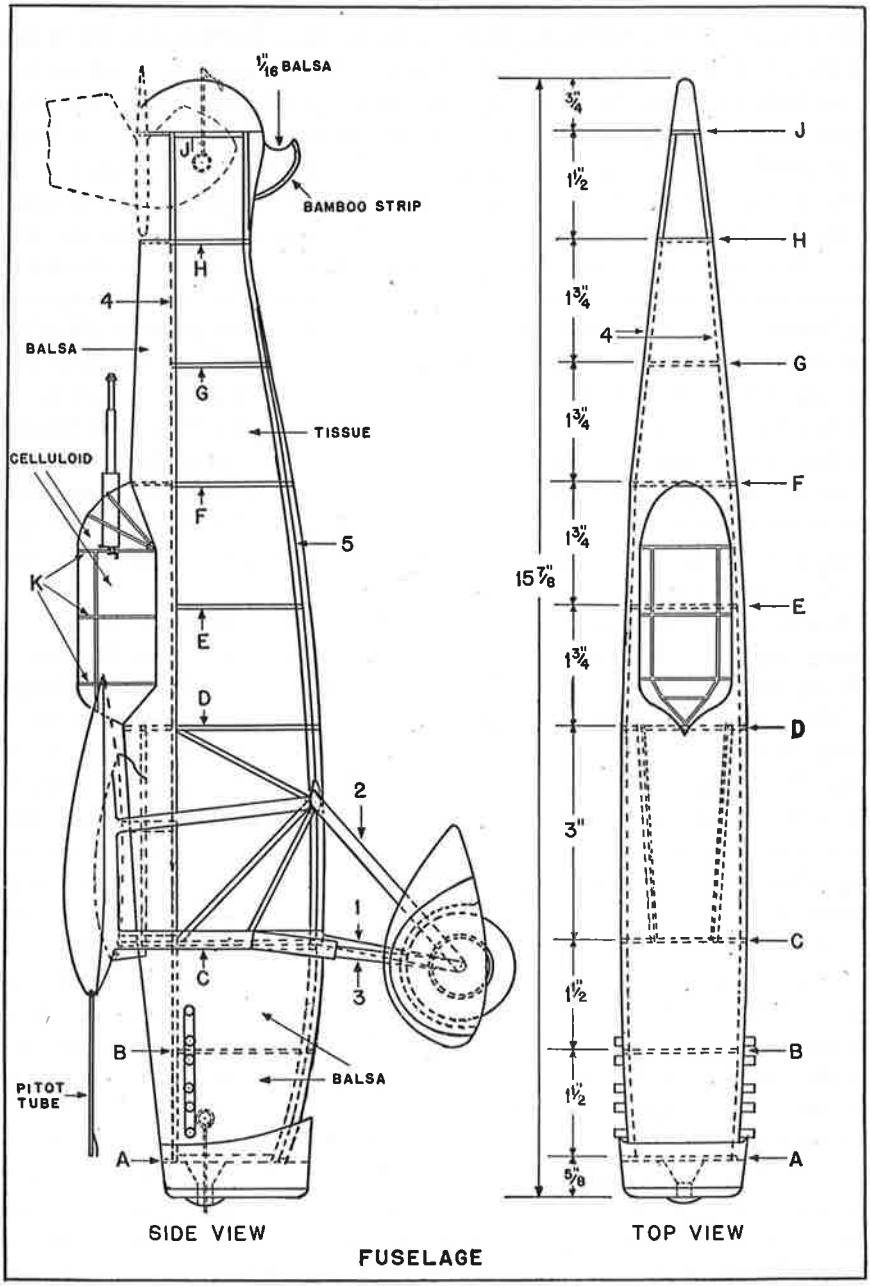


MUREAUX 180-C2 PURSUIT SKELETON

from a 9/16" x 1¾" x 2¼" balsa block. Note its shape in Plan 4 under "Landing Gear." It is its full width of 1¾" across the top and tapers off to 1½" at the bottom curve. It is cut 2⅛" in length at the front. Note how it is square with the front along its bottom, but slants up to carry out the slant of the fuselage top along its own top. This can best be seen in Plan 1 under "Side View." The radiator lines can be traced on light paper and glued to the nose block. A 3/16" hole must be drilled through it to take the nose plug. Note its location in Plan 1. A smaller hole can either be drilled or painted on the radiator paper just below the nose plug hole to represent the "cannon" the real plane carries. Note this hole in the photograph of the uncovered model. It will be found best to increase the size of the nose plug hole on the inside face of the nose block, as shown in Plan 1. Cement the finished block in place against former "A," as shown in Plan 1. A finished cowling is cut from the aluminum sheeting and fastened around the block by means of model pins which will represent rivets. This cowl should start just at the rounded front edge of the nose block, and it should be shaped along its trailing edge as shown in Plan 1. Do not fasten it in place until the block has dried.

Go over the entire fuselage with a fine sandpaper. Remove all traces of cement and fill all cracks and joints with wood filler. The fuselage is now covered with Japanese superfine tissue. Use banana oil for an adhesive. It will be found that the under part of the fuselage can best be covered by cutting the paper and covering one section at a time. The cockpit enclosure is now made. Bend three hoops of 1/32" square bamboo, as shown in Plan 2 under "K." Add the cross pieces and the other smaller hoops shown in Plan 1. Cement these together and then cement the framework over the cockpit. The whole frame is then covered with cellophane cemented to it, as shown in Plan 1. A small machine gun, such as shown on page 167, should be made and added to the rear of the cockpit. Paint the entire fuselage silver and trim the cockpit with black. Hinged portions of the hood can be made with lines drawn with India ink and the words "Levez ici," meaning "lift here" can be printed on at appropriate places along the fuselage. Finish the fuselage by adding six exhaust pipes on each side of the balsa-covered engine hood. These are cut from 1/8" O.D. aluminum tubing.

ELEVATOR. The elevator is of built-up construction. Its details are shown in Plan 3. The spar is cut from 1/32" x 5/32" hard balsa. It tapers from this width toward both tips, as shown in Plan 4 under "Landing Gear." Elevator ribs are shown on 1/4" squares in Plan 2. These are cut from 1/32" sheet balsa. Cut two of both "1" and "2" ribs and one of rib "3." Note how these are cut to fit on both sides of the spar in the plan. Cement these in



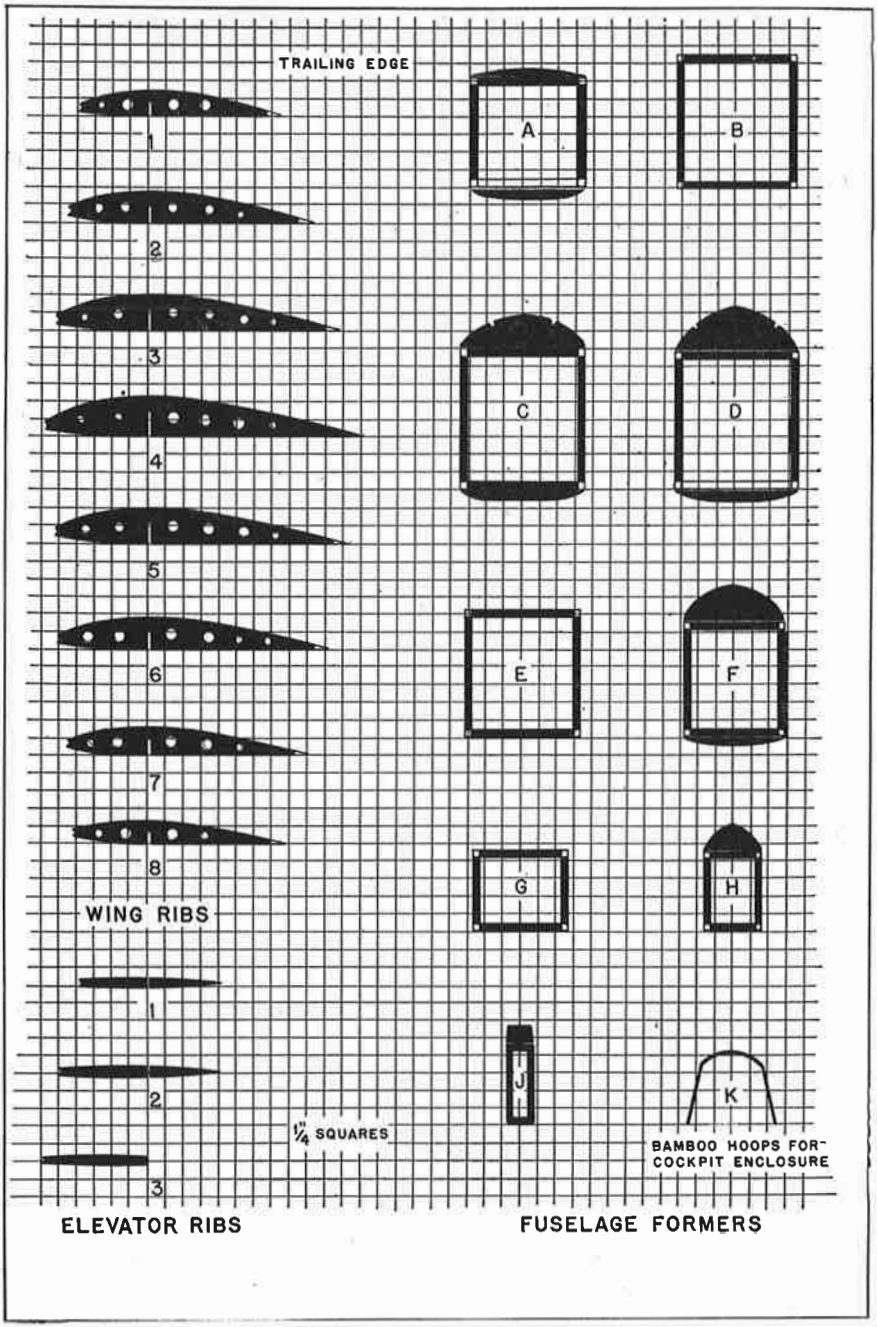
MUREAUX 180-C2 PURSUIT PLAN 1

position to the spar. The leading edge spar is made of two lengths of 1/16" square balsa. Each should be 3" long. Cement these pieces in place to the ends of the ribs. The entering edge of this spar should be rounded by sanding. The trailing edge spar is made up of four lengths of 1/16" x 5/32" balsa. The straight parts are cut 2 5/16" long and the remaining two lengths, which must be cut in proper curves from sheeting, are cut to length. Cement the straight portions to the trailing ends of ribs "1" and "2." When in place and dry, cut the curved portions to reach from the ends of the straight ones to the spar, as shown in Plan 3. Cement these in place, and then notch the ends of the trailing and leading edge spars to take semi-rounded tips of 1/16" round bamboo. The elevator is not covered until the rudders have been made and cemented in place.

RUDDERS. This model requires two rudders or "fins." They are a comparatively simple job to do, as they are of solid sheet balsa. Cut two pieces of 1/8" sheet balsa 1 7/8" wide and 3 3/4" long. The center of the slot in their trailing edge is 1 1/2" up from their bottom edge. It is cut 1 3/16" wide at its large opening on the trailing edge. The small notches on their leading edges are made directly in line with the center of the large trailing edge notch, and are used to accommodate the leading edge spar of the elevator. Note in the cross-sectional view "X-X" the general streamlining of each of these fins. Sand each one with fine sandpaper, and cement them in place on the elevator framework. This location is shown under "Elevator" in Plan 3 next to spar "1."

FINISHING TAIL SURFACES. The elevator and rudder are now ready to be finished. Each of the rudders should be painted on both sides with the colors given in Plan 3 under "Rudder." Cover the elevator on both sides with green tissue. It can best be done by using six pieces, although if slots are cut for the rudders only two will be necessary. If you use the green tissue only a light spraying of water will be necessary to properly tighten it. If the colored tissue is not available, complete the job with white tissue and finish with a light coat of colored dope. The entire assembly is now cemented on the rear of the fuselage between the last turtle deck former and on top of the tail post former, as shown in Plan 1 under "Side View" by dotted lines.

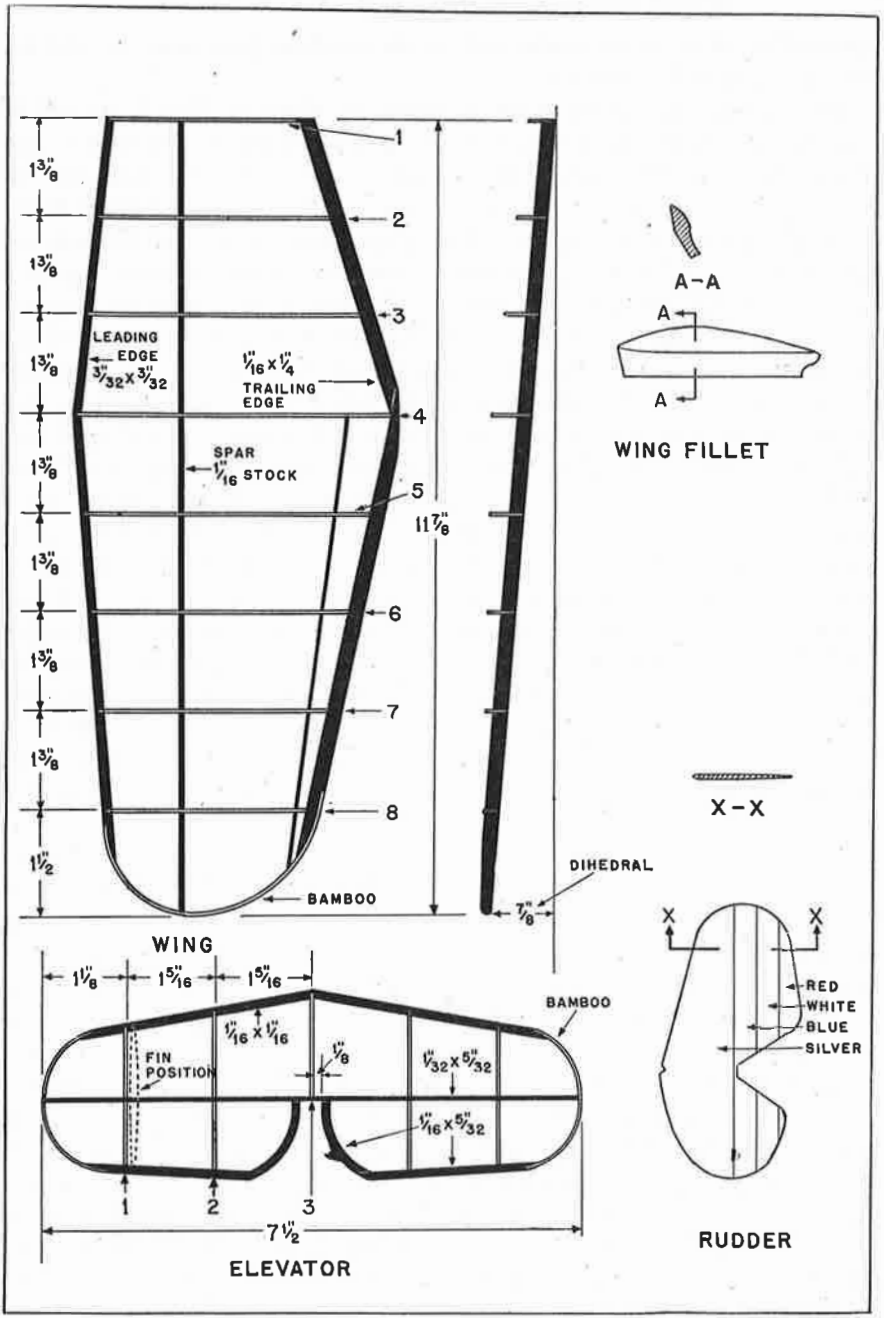
TAIL SKID. The fuselage with its tail unit is completed by adding the tail skid, which is shown in detail in Plan 4. A tail block is cut from hard balsa measuring 3/8" x 3/4" x 1 3/8". It should be carved to the shape shown in the plan, and then slit to receive the balsa skid. This piece is then cut to shape, and its lower edge covered with a bamboo strip. It is then cemented in the slot cut in the tail block. This entire assembly is then



MUREAUX 180-C2 PURSUIT PLAN 2

cemented in place to the under side of the fuselage longerons "5" and former "J," as shown in Plan 1.

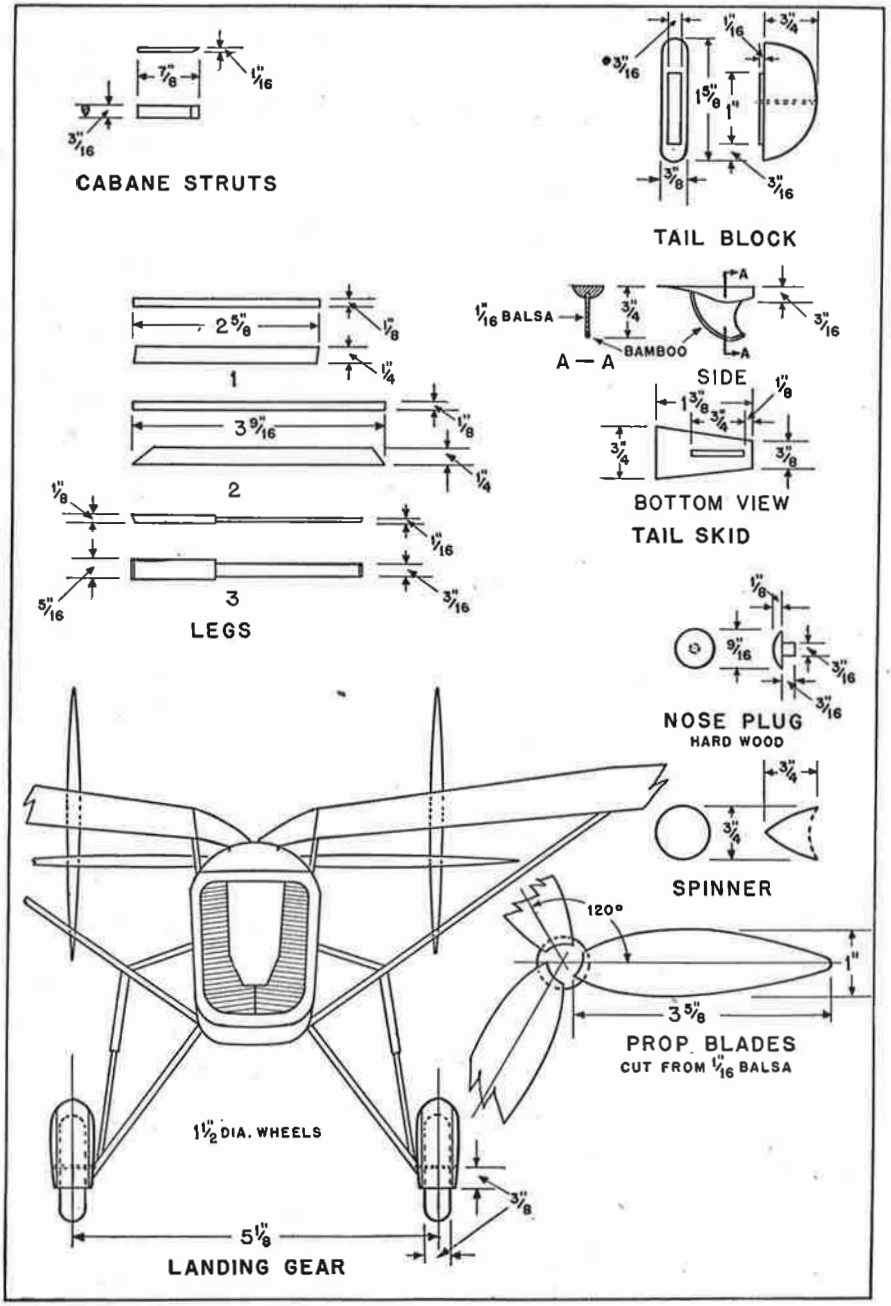
WING. One half of the wing is shown in detail in Plan 3. As will be seen, this is actually the left half when looking at the model from its tail surfaces forward. The right half is made exactly the same with the ribs reversed. The ribs for the wing are shown in Plan 2 under "Wing Ribs." These are drawn on 1/4" squares. Rule paper with squares of this size and make full-size copies of each of these eight ribs. Transfer these copies to 1/32" sheet balsa, and cut each one out. As two of these ribs are required for both wings halves, a second set should then be traced on the wood and cut out. Remove inside areas of these wing ribs to eliminate excess weight. This is explained and shown on page 50. When all sixteen ribs have been cut out and lightened, sand each one smooth. The inner spar is shaped from 1/16" sheet balsa. It is 3/8" wide at rib "4" and then tapers off toward both end ribs "1" and "8." If the slots in each rib have been properly cut to their right depth, the spar can be placed in them, the ribs correctly spaced along the spar, and the spar can then be cut to match the bottom edge of each rib, which will give the spar its correct taper. As can be seen in Plan 3 under "Wing," the actual tapering of the wing itself is gained by the height of the ribs and not through any form given the spar. It will also be seen that the varying thickness of the wing is gained on its upper side while its under side remains perfectly straight. Cut the spar, shape it properly along its 11 7/8" length, space each rib in its proper location, and cement them to the spar. Make sure that each rib is at right angles to the spar when cemented. The leading edge spar is cut 3/32" square. Cement this spar to ribs "8," "7," "6," "5" and "4." When dry, snap it carefully at rib "4" without actually breaking it, and then cement it in the notches of ribs "3," "2" and "1." The entering edge of this spar is sanded round for good appearance. The trailing edge spar is cut from 1/16" sheet balsa 1/4" wide. It is made in two lengths, as shown in the plan. The length covering ribs "1," "2," "3" and "4" is 4 1/4" long. The other length, covering ribs "4," "5," "6," "7" and "8," is 6 9/16" long. These measurements are those of the inner edges of these pieces. Note that both these spars must be sanded to a triangular form to carry out the top shape of the ribs, as shown in Plan 2 on the trailing ends of the ribs. When this has been done, cement the short length to ribs "1," "2," "3" and "4." The long piece is then cemented in place to the remaining ribs after the short piece has been tapered at its end to match it. When dry, the last piece is tapered on its trailing edge at its inner end where it joins the short spar. Note this in the plan. The ends of both the leading and trailing edge spars are notched at their tip ends to take a bent bamboo



MUREAUX 180-C2 PURSUIT PLAN 3

wing tip, as shown in Plan 3. Cement this in place and then complete the right side of the wing in the same manner. Fillet blocks must now be cut to shape and sanded smooth. These are shown in Plan 3 under "Fillet." A good front view of them can be seen in Plan 4 under "Landing Gear." These fillets are of prime importance. Their fit must be perfect as the wing halves must go on the fuselage at zero degrees incidence and be true in all respects. As their lower ends fit the fuselage and their outer ends fit against ribs "1," considerable fitting should be done before cementing them in place. When finished and carefully sanded, they should be cemented to these ribs. The wing halves are now covered. If colored paper was used on the elevator, use the same for this job. If not, cover them in plain tissue and then dope to color. The under side of each half is covered with a single sheet, but the upper side should be applied in two sheets. If colored paper has been used, spray the wing halves lightly with water. Take every care to weigh them down when this spraying is done to prevent warping. If dope is used for color, the same precautions must be taken. It may be found easier to scribe the French circles on the paper before applying it to the wing, but if this is done great care must be taken to see that they are properly located when the tissue is applied. These circles must appear on both sides of the wing near its tips, as shown in the photograph. Remember that the outer circle is red, the center one is white, and the small inner circle blue.

WING STRUTS AND ASSEMBLY. Two wing struts are used on each side of the fuselage. These are of different width so are divided into front and back wing struts for clarity. The two front struts, located on each side of the fuselage, are 1/8" x 1/4" x 4 3/4" hard balsa. They should be streamlined and sanded smooth. The two rear struts, located just behind the front ones on each side of the fuselage, are 1/8" x 3/16" x 4 3/4" hard balsa. They must be finished in the same manner as the front ones. Two strut fillets are shaped from 1/8" sheet balsa. They are 3/8" wide and 4 3/8" long. Their shape is the same as rib "4" near which they are located. However, they should be gracefully tapered from their original thickness at the top, where they fit against the under side of the wing, to 1/16" at their bottom, where the wing struts are connected. The upper end of the front strut is cemented to the lower edge of the fillet 1/2" in from its leading end. The rear strut is cemented 2" in from its trailing end. Cement both wing strut units to these fillets, but do not attach them to the wings at this time. Four short cabane struts are now cut and properly streamlined, as shown in Plan 4 under "Cabane Struts." Paint the two wing strut units and these four cabane struts silver. The wings are now ready to be mounted. Note that each wing tip



MUREAUX 180-C2 PURSUIT PLAN 4

is given a 7/8" dihedral, as shown under "Wing" in Plan 3. Sand the wing fillets already attached to the inner ends of the wings until they fare nicely into the top of the fuselage and at the same time allow the required dihedral. The wing fillets with their wings are then cemented into proper position on each side of the fuselage top, as shown in Plans 1 and 4. Note that these fillets fit almost directly over the short stringers running between formers "C" and "D," and that when in location on the fuselage they rest about an 1/8" apart. The four supporting cabane struts are then added between the under side of the wings and the fuselage. Their upper ends fit on the under side of the wings directly under the joints formed by the fillets and ribs "1." Their lower ends fit on the fuselage directly over longerons "4." The front ones are on a line with former "C," while the back ones are placed 1 7/16" behind them. Bring the lower end of the front wing strut to the side of the fuselage where former "C" houses longeron "5." When in this position, move the strut unit until its upper fillet contacts the under face of the wing. Cement the fillet to the leading, trailing, and inner spar of the wing when in this position. The lower end of the back strut is then cemented to the fuselage over longeron "5" where it falls. Complete the opposite strut unit in the same manner. Test to see that both wing halves are located exactly alike and both have equal dihedrals of 7/8" each. As shown in Plan 1, a pitot tube will improve the looks of your model. A thin balsa stick with a short bent wire on the end will make a splendid one. It should be located halfway along the wing and extend out from its leading edge, as shown. Paint it silver.

LANDING GEAR. This landing gear is of the ordinary variety, consisting of two wheels, two wheel pants, six struts and a pair of braces. The three struts used as units for each wheel are shown in Plan 4 under "Legs." Two of each of these "legs" should be cut to size and then properly shaped and streamlined. Each wheel pant is carved from soft balsa in the manner shown on page 128. It is carved to outer shape 1 7/16" wide, or high, and 3 1/8" long. If the original stock of 9/16" was used, this must then be split into two pieces of 9/32" thick. These are then carved out to take a 1 1/2" diameter wheel 3/8" thick. The blocks are then cemented together and sanded smooth. The wheels can be made, as explained on page 123 under "Solid Balsa Rubber-tired Wheels," or they can be purchased. Make the wheel hubs of thin tubing and use .028 music wire for axles. These are forced into the sides of the wheel pants. The wheels are assembled 5 1/8" apart with struts "1" extending from the hub point on the inner sides of the pants to the contacting point of the lower longerons "5" and formers "C." The struts "2" extend from the hub point on the inner side of the

pants to the ends of the wing struts on longerons "5," while the shock absorber struts "3" extend from the base of struts "1" up to the points on the wing struts where they contact them. Cement all these struts in place, test the wheels for smooth running, and then cut and add the short struts, or braces, running from the wing struts over to the sides of former "C." Paint the entire landing gear silver with black wheels and white tires.

POWER UNIT. The tail block is shown in Plan 4. Carve this from hard balsa and fit it into the opening of former "J." Make it a snug fit and when finished attach a .028 music wire rear hook through it, as shown in Plan 1. Paint the entire plug silver to match the fuselage. As a three-bladed Ratier propeller is used on the real plane, a similar type should be used on the model. The four parts of this propeller are shown in Plan 4. Make a spinner, as shown in the plan, and then sand out three blades from 1/16" sheet balsa. This type of propeller is fully explained on page 102 and in Fig. 58 will be seen its various parts. A hardwood nose plug can either be purchased for use as a hangar, or one can be made from hard balsa or pine. Bend a propeller shaft from .028 music wire and attach it to the propeller. Pass it through the nose plug and then bend its hook. Apply the three dural washers between the spinner and the plug to minimize friction, and paint silver.

Six or eight strands of 1/8" flat rubber will power the model according to its weight and the speed at which you wish it to fly.

FLYING. Test the model by gliding it over tall grass. Add weight or bed the tail according to the way it acts. By starting in with just a few turns of the motor, you can quickly and safely correct any bad tendencies it may have. Rather long duration flights are possible with this model as its detachable tail plug makes the use of a winder possible.

CHAPTER 48

CURTISS SOC-1 NAVY SCOUT

HERE is the latest combination scout and observation plane built by Curtiss for the United States Navy. Designed to meet the strenuous requirements necessary for planes operating from cruisers and battleships, it is already noted for its ruggedness of structure and unusual versatility of performance. A low landing speed, excellent handling qualities and inherent safety for its crew are among the many praiseworthy qualities of this plane. As this latest of scout fighters is not only pleasing to the eye from the standpoint of general appearance but likewise from its fine proportions, it makes an interesting model to build and fly. Because of these qualities in its design, the builder will find it an exceptional flier.

It is to William Winter that we owe our appreciation for the model that appears here. The constructional methods followed by Mr. Winter are conventional with one exception. This exception is his method of assembling the fuselage. Four master stringers, or longerons, are used as guides for the primary assembly. These are already cut to exact curve before the fuselage is assembled, which eliminates any chance of error.

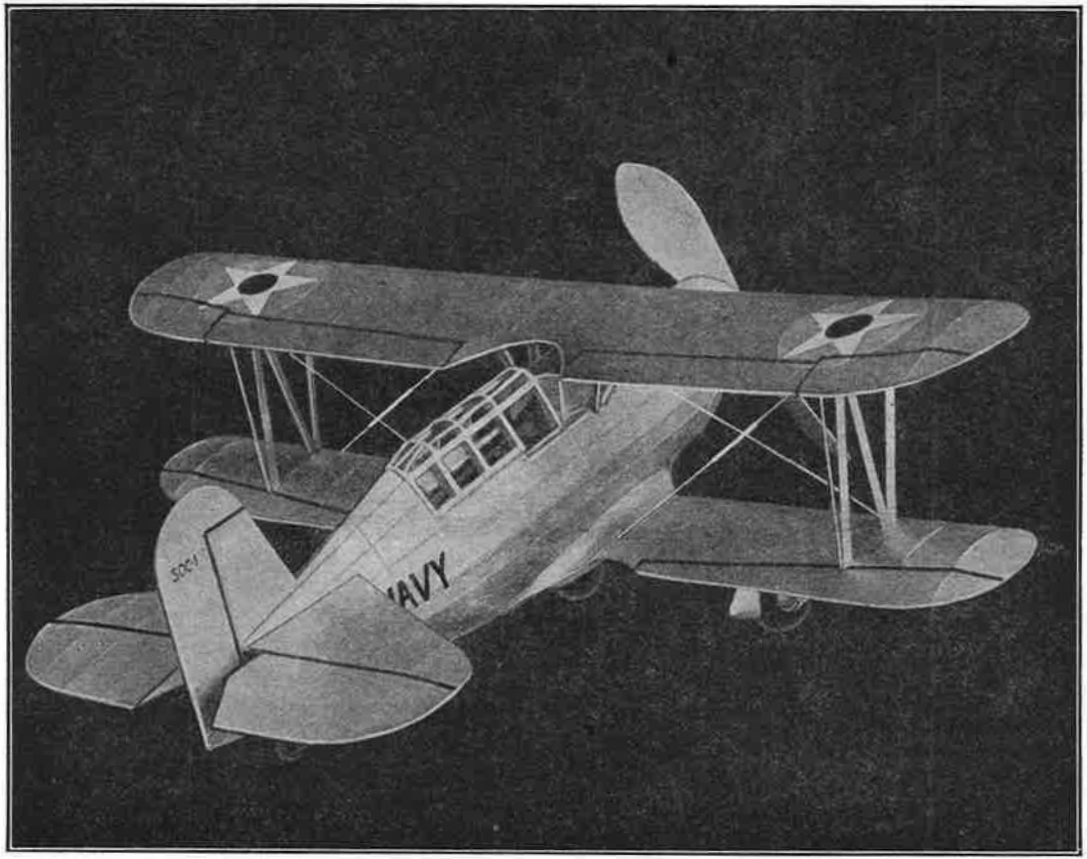
MATERIAL LIST

8 pcs.—	1/16" x 1/16" x 36"	—Strip balsa
5 pcs.—	1/16" x 3/16" x 36"	—Strip balsa
2 pcs.—	1/16" x 1/8" x 36"	—Strip balsa
2 pcs.—	3/32" x 3/16" x 24"	—Strip balsa
2 pcs.—	1/32" x 3/16" x 24"	—Sheet balsa strip
1 pc .—	1/16" x 3" x 24"	—Sheet balsa
1 pc .—	1/32" x 2" x 24"	—Sheet balsa
1 pc .—	1/4" x 3" x 18"	—Sheet balsa
1 pc .—	15/16" x 2 1/4" x 8 1/2"	—Balsa block
2 pcs.—	15/16" x 5/8" x 7/8"	—Balsa block
1 pc .—	1" x 1" x 1 15/16"	—Balsa block
2 pcs.—	5/16" x 2" x 1 5/8"	—Balsa block
2 pcs.—	1/2" x 1 1/8" x 2 5/8"	—Balsa block
2 pcs.—	5/16" x 1" x 2 1/2"	—Balsa block
1 oz.		—Cement
2 ozs.		—Clear dope

2 sheets	—White tissue
8 ft. —1/8" flat	—Rubber
1 pr. —1½" dia.	—Wheels
1 —½" dia.	—Tail wheel
1 ft. —.020	—Music wire
1 ft. —.028	—Music wire
1 ft. —.034	—Music wire
3 pcs.—1/16"	—Unsplit bamboo
4 —2½"	—Star insignias
Cellophane	
Silver dope or powder	

FUSELAGE. A top and side view are shown on Plan 1, while the fuselage formers, or bulkheads, are shown on Plan 2. The construction of the fuselage consists of cutting to proper size and shape four master stringers, which are indicated in Plan 1 by "Master Stringer Bottom" and "Master Stringer Side." The master stringer along the top is in two parts. The front one of these is lettered "A," while the rear one is lettered "B." The bottom master stringer has been given the letter "C," while the side masters are designated by letter "D." It will be noted that the left side and bottom of Plan 1 has been divided into ½" squares, indicated by short lines along the margin. This has been done to aid the builder in drawing a full-size outline of the fuselage, which must be done on paper first and then transferred to sheet balsa. Make a full-size copy of the side outline of the fuselage on paper and then transfer to 3/32" sheet balsa the two top master stringers "A" and "B" and the bottom master stringer "C." When laying these out, make each one ¼" wide and cut them out with great care. A full-size pattern of the top view is then drawn in outline and the side master stringers "D" transferred to sheet balsa. These are also cut ¼" wide. While this ¼" width tapers off toward the trailing end of the fuselage, it will be found best to cut these stringers the full width along their entire length and then when in place in the notches of the fuselage formers they may be trimmed to match the depth of these notches. It must be understood, however, that such a procedure necessitates perfect cutting of the former notches. When the master stringers have been cut out, sand them lightly with a fine sandpaper, and then mark in pencil the exact location of each former. These locations are shown in the side view of Plan 1.

The nine fuselage formers are shown in Plan 2 on squares representing ¼" each. Rule paper with squares of this size and draw a full-size copy of each former. Draw in the locations of all the notches on each one. Transfer each to 1/16" sheet balsa. Only the four notches housing the master stringers are cut out at this time. When all the formers have been cut out, go over

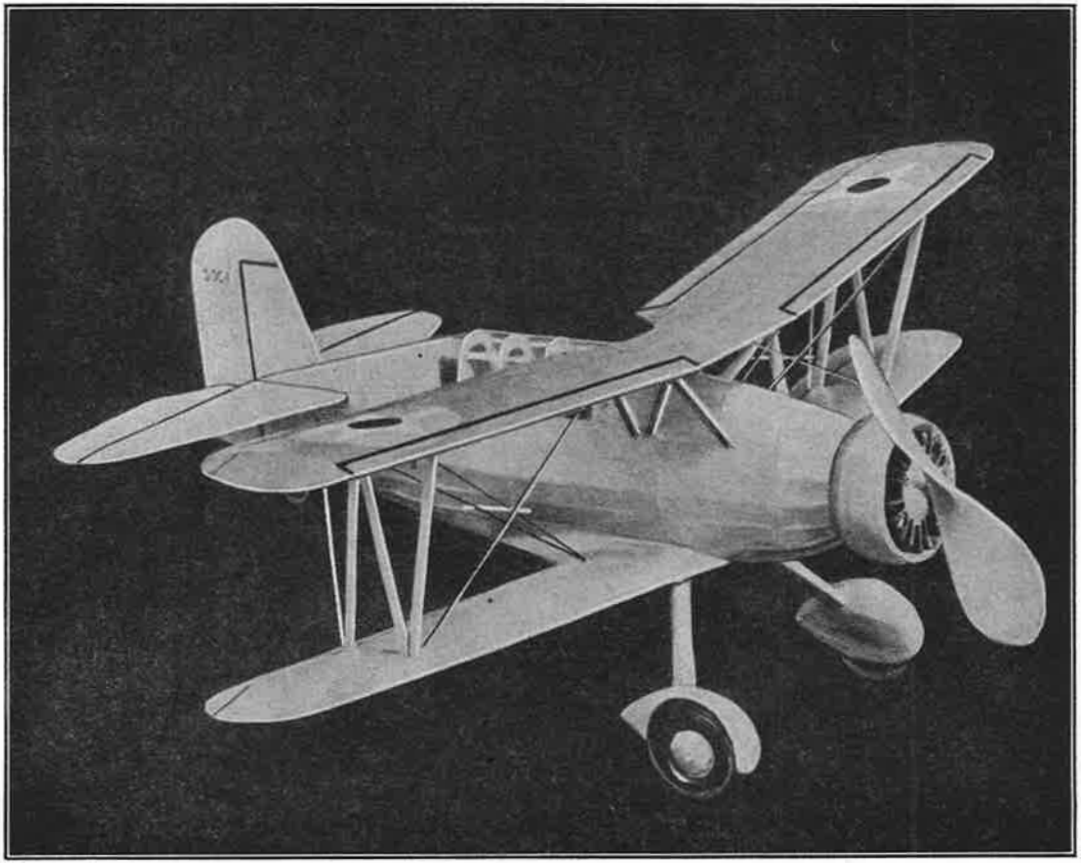


CURTISS SOC-1 NAVY SCOUT

each one lightly with a fine sandpaper. Cement formers "2" and "6" in position on the side master stringers "D." When thoroughly dry, add the remaining formers to these two stringers. The top and bottom master stringers are then cemented into their proper notches in these formers. While the structure is drying, cut 1/16" square balsa stringers to complete the framework. These auxiliary stringers are cemented in place in each former, and their notches cut while the work proceeds. If instructions have been followed, the location of each of these stringers has been marked on each former. It will be noted when placing master stringer "B" that former "7" has to be cut and bent back to accommodate it and the auxiliary stringers forming the rear top of the fuselage. This bend is shown in the side view in Plan 1. Note that it is made across the former at a point two notches above the notch housing the side master stringer "D."

Former "C" is shown on squares representing 1/4" each. A full-size drawing of this should now be made, transferred to 1/16" sheet balsa, and cut out. The master stringer "A" and the three auxiliary stringers located on each side of it must be cut to proper length to fit snugly against former "C" when it has been cemented in place against former "5" at the proper slant.

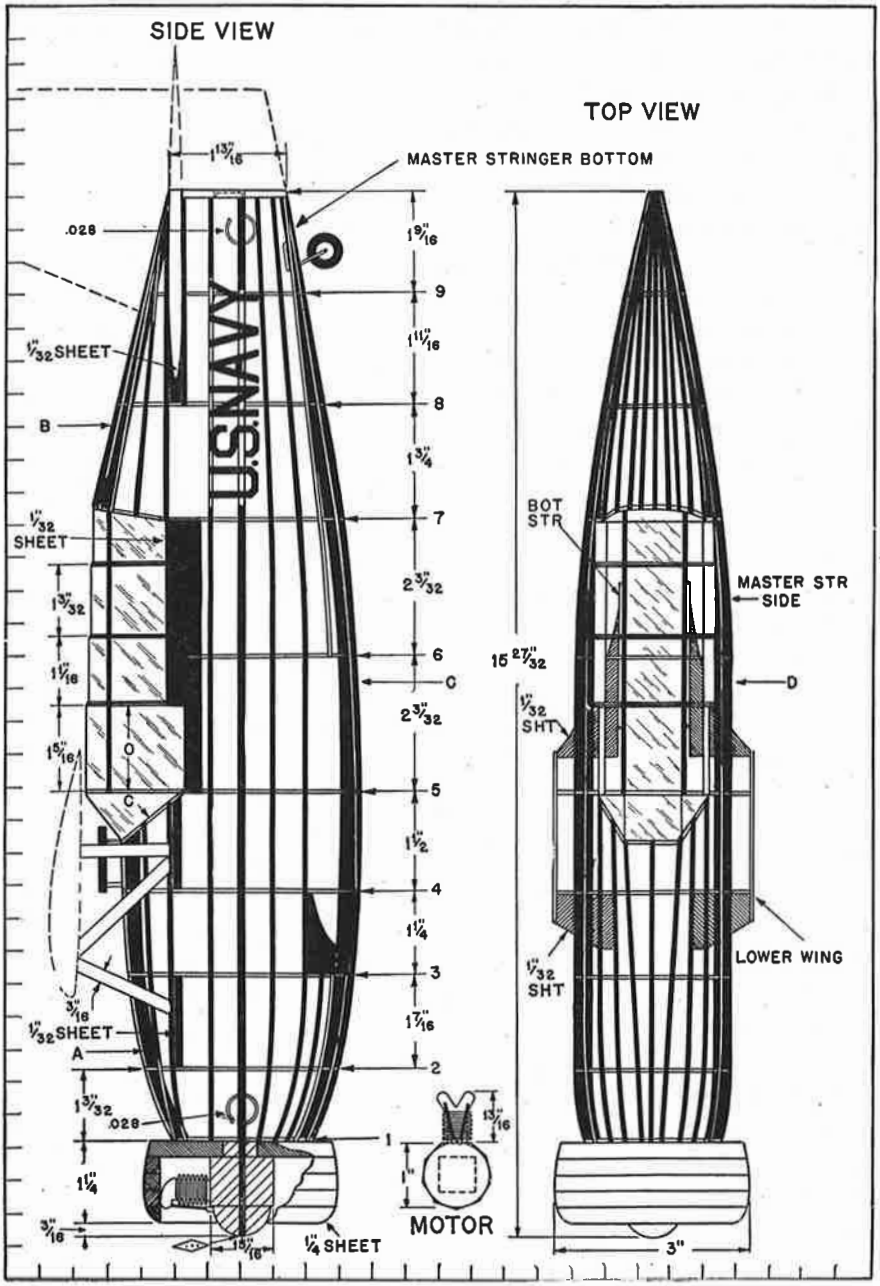
The cockpit overhang located on each side of the cockpit between formers "5" and "7" is shown in solid black in the side view of Plan 1. Both these pieces are cut from 1/32" sheet balsa. The lower portion of the fuselage between formers "3" and "4" is also covered with 1/32" sheet balsa to act as a support for the lower wing fillets. This is shown in black in Plan 1 and its trailing end has been cut away to show location of the lower wing, but the sheeting actually fills the entire space. This must be applied on both sides of the fuselage in this location. The auxiliary stringers that support the center-section wing struts are also reinforced with sheet balsa. These will be seen in the side view of Plan 1 between formers "2" and "3" and formers "4" and "5." Laminated 1/32" sheet balsa may be used, or single 1/16" sheeting will serve. A rudder post is now cut 1/8" x 1/4" x 1 13/16" long. It is equipped with a rear hook bent of .028 music wire. The stringers are brought together at the rear and cemented in place to the post, as shown in the side view of Plan 1. The cockpit formers are cut from 1/32" sheet balsa. The largest of these is designated as "0" and is shown on squares representing 1/4" each on Plan 2. The shape of this former is typical of the others, although they become smaller in size as they progress toward the rear of the cockpit. As can be seen in Plan 1, they are laminated when called for. Cut these formers and cement them in place. Two fillet ribs are cut at this time. These are duplicates of the short rib of the lower wing, shown in



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Plan 3 under "Lower Wing." These fillet ribs have no notches cut in them and their length and contour should include the leading and trailing edge spar form. They are cemented in place against the extensions on formers "4" and "5" on both sides of the fuselage. The widths at the ends of these extensions will be the same as the width of the ribs at their points of contact. When these are in place they become an integral part of the fuselage. Before the fuselage is covered the tail wheel axle should be bent and fastened in place, as shown in the side view of Plan 1. The entire fuselage is now covered with tissue. Use narrow strips of the tissue to avoid wrinkling. Leave openings under the former "4" to install the landing gear mount. When the covering is in place, spray it with water lightly to tighten the paper. It is then painted with silver dope. Use strips of cellophane of a width determined by the size of each space between the cockpit formers to cover this enclosure. Cement them in place. The shape of the front of the enclosure is easily determined from the top and side views of the fuselage on Plan 1. The sight just in front of the enclosure is a short length of 1/8" round balsa stock mounted on short strips. This should also be painted black. When the fuselage has been completely painted, the wing fillets are cut and attached. Those on both sides of the fuselage extending back from the fillet ribs are of 1/32" sheet balsa, as shown in the top view of Plan 1. They run from the trailing ends of the fillet ribs back under the fuselage to the lower stringers, as shown. Cut these and cement them in place. The remaining two fillets just in front of the fillet ribs are of built-up 1/32" sheet balsa, or may be cut solid from soft balsa blocks measuring 15/16" x 5/8" x 7/8". They are cemented against the front face of former "4" on both sides of the fuselage. Paint them both silver, which completes the fuselage construction.

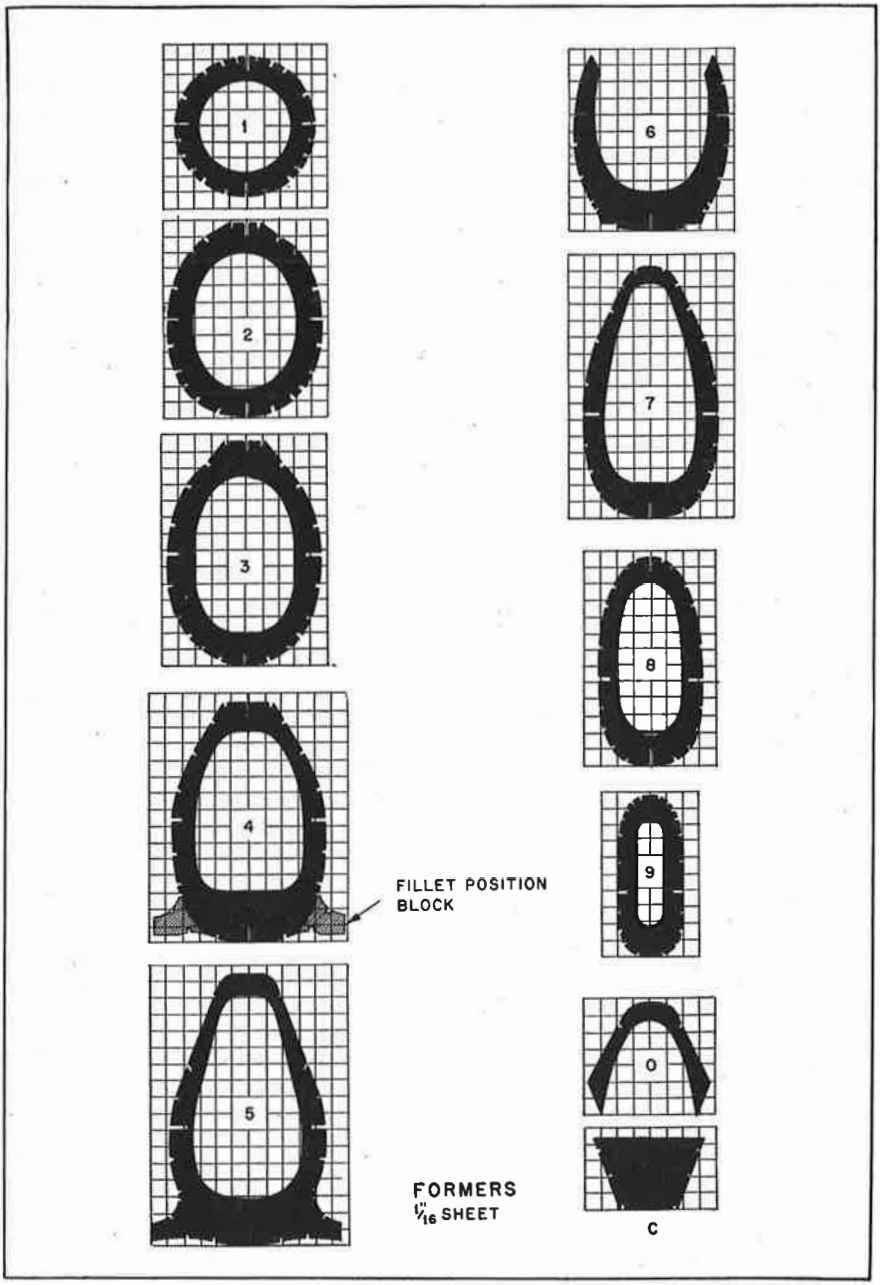
LANDING GEAR. The landing gear of this model consists of two wheels, two wheel pants and two landing gear struts. The assembly and its various parts are shown in Plan 4 under "Landing Gear." The pants are made up of two pieces each. Both these pieces are shown on squares representing 1/4" each. One is cut out to take the wheel, as shown, while the other holds the wire joint stiffener. For this reason they should not be cemented together until the inner part is joined with the strut. Cut these four pieces to size and shape, test them with a 1 1/2" wheel to see that it gives plenty of clearance, and then polish them smooth with sandpaper. Two 1 1/2" diameter wheels should be provided, or they can be easily made. They are 3/8" wide and should be of the doughnut variety. The construction of these is fully explained on page 125 under "Balsa Doughnut Wheels." Wire axles of .028 music wire should be bent, but are not applied until the pants are



CURTISS SOC-1 NAVY SCOUT PLAN 1

ready for assembly. The two landing gear struts are cut to shape from hard balsa 5/16" x 1 5/8" x 2 1/8" long. These pieces are first streamlined and flared at the top where they maintain their full width. They then taper off in a close curve to a 5/8" width along their entire length. Their thickness tapers off from their original 5/16" to 5/32" at their ends where they are joined to the wheel pants, as shown in Plan 4. Cut these to shape and size and then finish them with sandpaper. Slant their bottom ends to take the wheel pants. Mount the inner part of each pant to one strut and reinforce it with the bent wire stiffeners, as shown in the plan. The wheels are then mounted by their axles through the other parts of the pants, and the parts cemented together. Do not cement the struts to the pants at this time. The landing gear cross-brace, or mount, supports the upper joint of the struts. This is shown in heavy lines on the front view of the model in Plan 4. It is cut from 1/4" stock to the exact shape of the lower portion of former "4." A pronged washer of tin is embedded in the top surface of the strut where the .034 music wire stiffener passes through it. A second washer of the same type is embedded in the wood of the mount directly in line with the one in the strut where the stiffener passes through and into the mount, as shown. Fasten these stiffeners in the mount, as shown, and then bend them to the required angle to receive the struts. A spring of .020 music wire is bent to shape, as shown, and lashed to the mount with silk thread. Bind this spring and both stiffeners with the same binding. Coat with dope for strength. The mount is now passed through the opening left on the under side of the fuselage and securely cemented in place against the rear face of former "4." Force the struts on the protruding strut stiffening wires until they are all the way in. The tips of the spring are now bent and forced into the struts on their inner sides, as shown in the plans. Align the landing gear so that the wheels are 5 1/2" apart center-to-center of tread and perfectly in line with each other. The spring ends are then bound around each strut, as shown, and the thread doped for strength. When completed, cover the opening on the under side of the fuselage and paint it silver to match.

ELEVATOR. The elevator, or stabilizer, is shown in detail on Plan 4. It is made in one piece. The main spar running through its center from tip to tip is indicated by letter "A." This must be cut 1/16" x 3/16" x 10 7/8" long. The seventeen ribs, or cross-braces, are cut from 1/32" sheet balsa 3/16" wide. Each should be tapered from its spar end to 1/16" width at its other end, and given a proper streamlined form. The leading edge spar "B" is 1/16" x 1/4" x 2" long. Lay the spar flat on the bench and cement each rib



CURTISS SOC-1 NAVY SCOUT PLAN 2

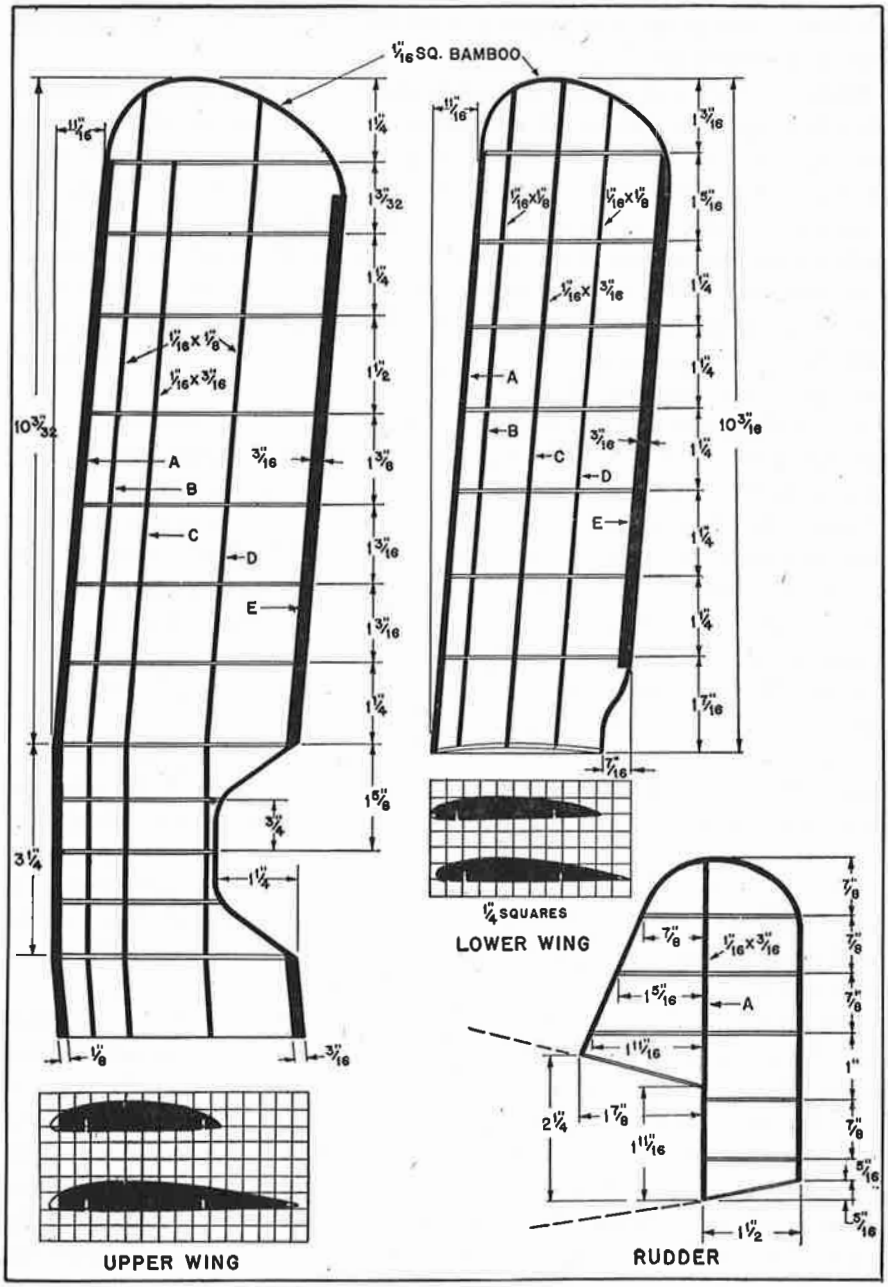
in place. Shave the ends of spar "B" to match the leading edge slant and cement it to the end of the 2 1/16" long center rib. Outline the elevator with 1/16" square bamboo and add the short braces located near the trailing edge, which run parallel to the center spar and are shown in black. Cover the elevator with the tissue. To do this best, use separate strips of tissue for each side of the frame. Dope the edges in place and draw the paper as taut as possible without wrinkles. Spray the tissue evenly and secure the surfaces to the bench while it is drying. When the elevator has dried thoroughly, apply silver dope lightly. An opening is cut through the fuselage in the location shown in the side view of Plan 1. The elevator is slipped through this opening and centered in the fuselage with its main spar "A" tightly against the rudder post brace. Cement the elevator in this position. The openings on both sides of the fuselage are supported by short stringers on which the elevator rests. Cut these and cement them in place. The spaces left by this opening and not filled by the elevator are now fitted with 1/32" sheet balsa, which is cemented in place and nicely fitted around the elevator. As it has been necessary to break the cover tissue to do this fitting, the paper should be repaired around the elevator and repainted. Two short struts are cut from 1/16" sheet balsa 1/8" wide. These must be properly streamlined and then cemented in place. They fit directly under the elevator spar halfway out toward its tip at their upper ends and are attached to the rudder post brace at the base of the fuselage on each side. These should also be painted with silver dope.

RUDDER. The rudder follows the elevator construction in practically every detail. It is shown in Plan 3 under "Rudder." The main spar extending the full height of the rudder is shown as "A." It is of sheet balsa measuring 1/16" x 3/16" x 5" long. Cut this piece and sand it smooth. The nine ribs, or cross-braces, are cut from 1/32" sheet balsa 3/16" wide. Each one must be tapered exactly as were those of the elevator. Lay the main spar flat on the bench and cement each rib in place. Test it against the rudder post brace on the fuselage to see that the rib which fits over stringer "B" is properly attached. The rudder is then outlined with 1/16" square bamboo as was the elevator. See that the bottom of the rudder has its bamboo edge carrying out the form of the fuselage. Cover the rudder on both sides with tissue. Use a piece for each side. Spray lightly while held flat on the bench, and when dry remove it and dope with silver. The rudder is now cemented in place on the fuselage. The main spar is cemented to the rudder post brace and the cross-brace cemented over master stringer "B." Rudder and elevator lines may be drawn in with India ink, or black strips of tissue pasted on these surfaces.

WINGS (Upper). The upper wing is shown on Plan 3. A front view will be found in Plan 4. The upper wing will require sixteen long ribs and three short ones. On Plan 3 these will be found drawn on squares representing 1/4" each. Make full-size copies of these two ribs and trace the necessary number on 1/32" balsa. Cut them out and notch each carefully. Note that they have two notches on their bottom edges and only one on their top edges. Wing spars "B" and "D" fit in the lower ones, while spar "C" goes into the top notch. The leading edge spar "A" is 3/16" x 1/8". It must be shaved down to match the contour of the ribs, as shown in the graph plan under "Upper Wing." It remains straight along the center-section for 3 1/4" and then both panels are given an 1 1/16" sweepback, as shown. Snap the spar to obtain this and apply cement to strengthen the break. Do not cut to length until all ribs have been evenly spaced along it and cemented to it. Inner spars "B" and "D," which fit on the bottom edge of the ribs, are 1/16" x 1/8", while inner spar "C," which fits on the top edge of the ribs, is 1/16" x 3/16". Cut these three spars, snap each at the ends of the center-section, and give them their proper sweepback. Cement all the ribs in their proper locations on the spars. Start with the center-section where the ribs are located at right angles to the spars, and then continue along the outer panels with the ribs parallel with those of the center-section. When the tip ribs are in place, trim the spars to proper length. Cut two trailing edge spars from 1/16" sheet balsa 3/16" wide. Shape both of these to the trailing end contour of the ribs. Cement them in place and cut to proper length. Wing tips are of 1/16" square bamboo bent to shape over a flame. The trailing edge of the center-section is of the same size bamboo, which should be bent over a flame, carefully fitted, and then cemented in place. The wing is now given its necessary dihedral. This is shown in Plan 4. Holding the center-section of the wing flat on the bench, snap the spars at the outer rib on each end of the center-section, and lift the tips 3/4" above the level of the bench. Drops of cement should be applied over these breaks and the wing held in this position until dry. The lower wing is made before any wing covering is done.

(Lower Wing). The lower wing is built in exactly the same manner as the upper wing. The ribs are shown on squares representing 1/4" each. Make full-size copies of these and transfer fourteen of the long ones and two of the short ones to sheet balsa. The long ones are cut from 1/32" sheeting, while the two short ribs are of 1/16" balsa sheeting. The leading edge spar is shown by "A." It is 1/8" x 3/16". Inasmuch as two lower wings must be made, two spars in each case must be cut. Trim spar "A" to match the

contour of the ribs but do not cut it to length at this time. The inner spars "B" and "D," which fit along the bottom edge of the ribs, are 1/16" x 1/8". Do not cut to length. It will be noted that a third spar is shown in the plans. If the builder wishes to add to the strength of these lower wings, it may be added and the necessary notch for it cut in each rib. Place the leading edge spar along a rule and then move its tip back 1 1/16" to obtain the required sweepback. Without moving the opposite tip, which becomes the fuselage end of the wing half, cement the ribs to it at right angles to the edge of the rule. Add the other spars at this time. Do not cement the 1/16" thick rib at this time. The frame of the wing half is now placed flat on the bench. Hold the inner end on the bench and lift the tip 3/4" above the surface. When in this position cement the inner rib in place at the ends of the spars, but see that it is fitted in a vertical position while the tip of the wing is in dihedral position above the bench. This insures it fitting flat against the rib fillet already attached to the fuselage and at the same time giving the wing its necessary dihedral. Complete both halves in this manner. Short 1/32" x 1/4" braces are cemented between the first two inner ribs. These are located between spars "B" and "C" and between spars "C" and "D." Complete both halves by sanding them carefully. Both the upper wing and the lower wing halves are now covered with tissue. One piece of tissue is used to cover the under side of the top wing. The top of the upper wing is covered with three pieces cut to take the center, the left and the right panels. The tops of the lower wing halves are covered with single pieces and so are their bottoms. In covering the wings fasten only the edges of the paper at first. Spray the tissue and fasten the frames to the bench until dry. They are then finished with dope. Both wings are silver with the exception of the top of the upper wing. This is painted yellow. The 2 1/2" diameter star insignias are then added and will be found to fit nicely. Place the wings aside to dry. Cut six center-section struts of 1/16" x 3/16" balsa. These should be streamlined carefully and then cut to their proper lengths. A side view of these is shown in Plan 1, while a front view is given in Plan 4. The leading struts are cut 1 13/16" long. The center ones are 2 3/16" long. The trailing struts are 1 19/32" long. The leading and center struts must be cut at a slant at both ends to fit against the under side of the upper wing and along the fuselage stringers at the sides. Assemble all these struts into two side units, and then cement them in place on the fuselage at the proper angles. When the cement is thoroughly dry, mount the top wing. Check carefully for perfect alignment. It will be found best to remove small squares of the covering paper wherever the struts come in contact with the frame.



CURTISS SOC-1 NAVY SCOUT PLAN 3

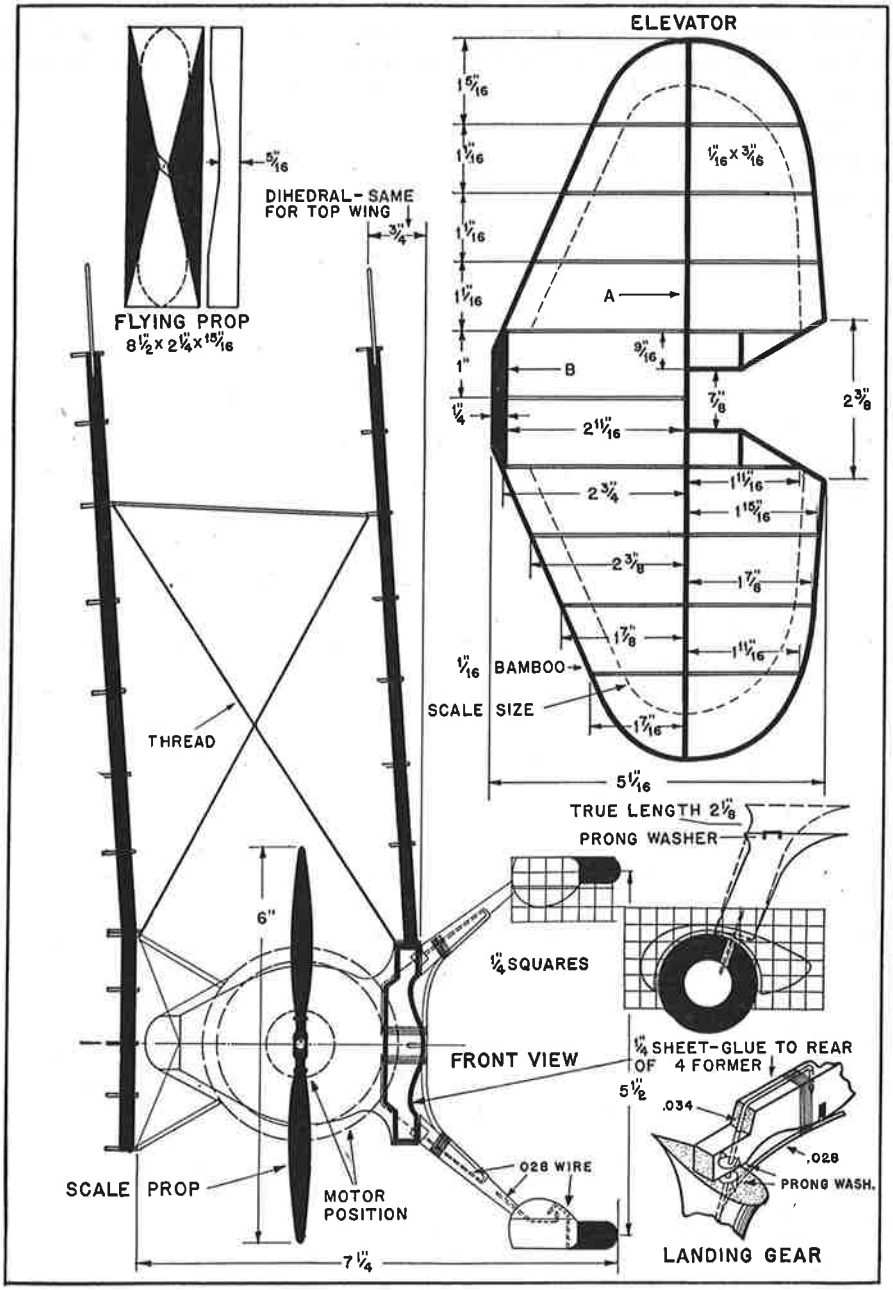
This insures fast joints. The paper around the struts can be easily replaced, sprayed, and then painted.

Cement each lower wing half against the face of its respective rib fillet on the fuselage. Carefully check the incidence of each one in relation to the other. Cut the six interplane struts from balsa. They are all 1/16" thick and 3/16" wide. The leading and trailing struts are 4 1/8" long, while the center one is only 4". These struts and their assembly are shown quite clearly in the photograph. Each one of these should be given a good streamlined form and then sanded perfectly smooth. They are then attached in place between the wings in units of three struts each. Cut squares away to reach the wood, cement each strut in place, recover with tissue the bared areas, spray, and dope to color.

ENGINE COWLING. A laminated cowling is used on this model. It is built up of five discs of 1/4" sheeting. The first four are laminated roughly and cut out 2 1/2" in diameter with a jig-saw when dry. The rear ply has a 1/2" square hole cut in it for the plug before laminating it to the first four. When the entire five pieces have been laminated and the cement is dry, the outside is shaped to a 3" diameter circular form, as shown in Plan 1. Sand smooth and cement the finished cowl in place against former "1" on the fuselage.

ENGINE. The crankcase is a block 1" square and 1 3/16" thick. It is shaped for 3/4" of its thickness into nine flat sections to take the cylinders. The remaining thickness is finished off in a rounded form much like a spinner. Dummy celluloid cylinders are spaced evenly around this core, or they may be made of balsa wood as explained on page 129 under "Engines." The square plug fitting into the hole cut in the inner face of the laminated cowling is 1/4" thick and 1/2" square. Test for snug fit. The thrust bearing is a tin washer with prongs embedded in the face of the plug. The engine cylinders should be painted black and its center crankcase silver. The cowl is also silver.

PROPELLER. This is carved in the usual manner from a propeller block of hard balsa measuring 15/16" x 2 1/4" x 8 1/2" long. It is shown in Plan 4 under "Flying Prop." The tips are rounded after the carving is finished, as shown by the dotted lines. Take care to obtain perfect balance of the finished propeller. A propeller shaft is bent from .028 music wire only at its front end where it is embedded in the front face of the propeller hub. Use a tin washer similar to the one in the plug for the rear face bearing of the propeller. Slide a friction washer and the plug on the shaft, and bend the rubber hook. The motive power is gained from eight strands of 1/8" flat



CURTISS SOC-1 NAVY SCOUT PLAN 4

brown rubber. Complete the model by adding wires to support the wings. These—being dummies—are of No. 60 black thread. Note their locations in the photograph and plans.

FLYING. Test the model over tall grass. Otherwise fly the model R.O.G. on a few turns and gradually increase the winds as proper balance is attained. A small lead weight may be used for balancing.

CHAPTER 49

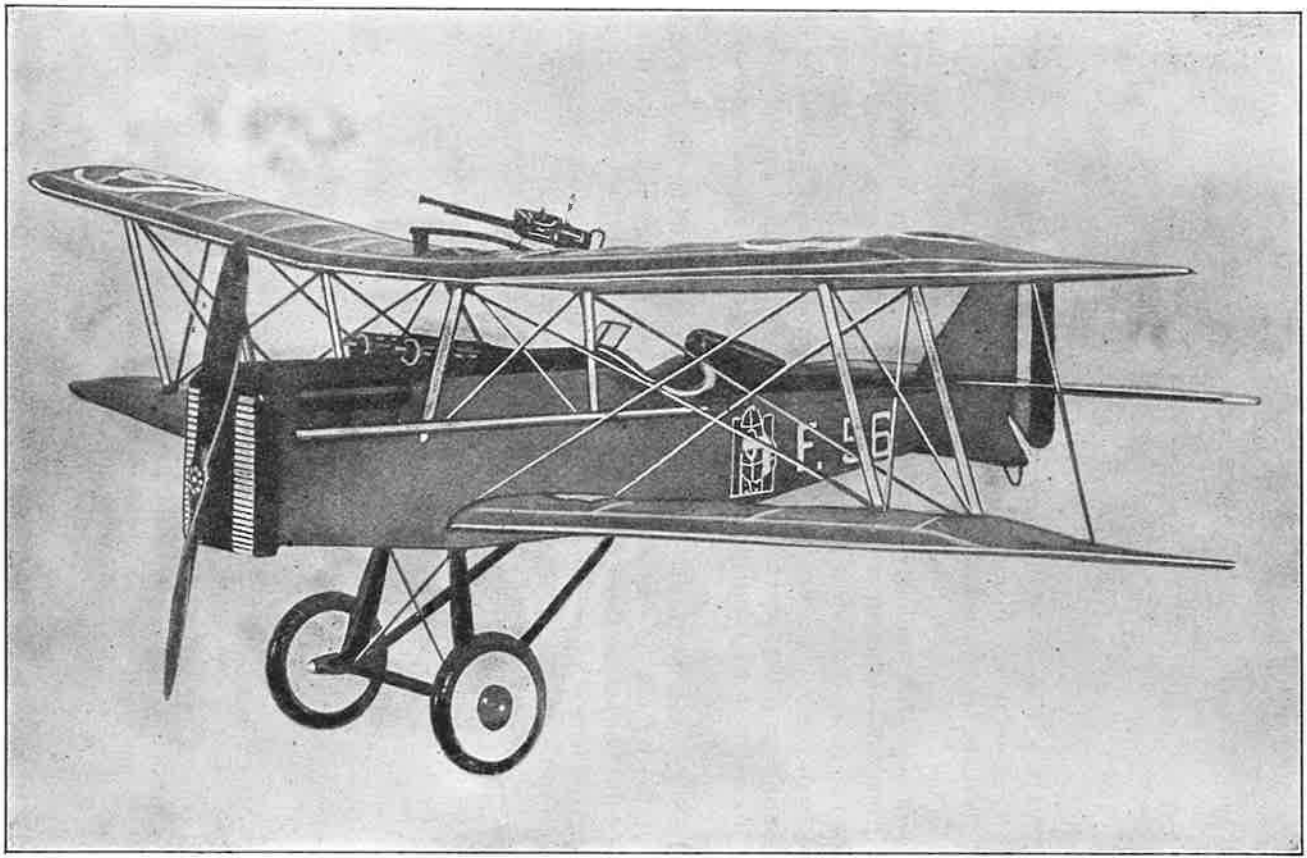
S. E. 5

THE S. E. 5 (Scouting Experimental 5) was a single-seater biplane famous in the history of the British Royal Flying Corps, which became the British Royal Air Force in 1918. This plane was conceded to be the fastest fighting pursuit plane on the Western Front. Powered with an eight-cylinder, water-cooled Hispano-Suiza engine developing around 200 horsepower, it was capable of over 100 miles an hour, which was then considered a terrific speed. Equipped with a Vickers machine gun on the front cowl, which was synchronized to shoot between the blades of the rotating propeller, and a movable Lewis machine gun on the upper wing, it presented a formidable foe to the boys carrying the German cross on their wings.

The S. E. 5 was the predecessor of the S. E. 5-A, and while it would not be considered a worthy opponent of the modern military plane, in those days it would tackle anything with wings and plenty of things without. The model given here is a true replica of the author's plane, which he flew when an officer in the British Royal Air Force.

MATERIAL LIST

6 pcs.— 1/16" x 1/16" x 36"	—Balsa for fuselage stringers, struts, etc.
1 pc. — 1/16" x 3" x 12"	—Sheet balsa for fuselage formers
1 pc. — 1/32" x 1 3/4" x 2 1/4"	—Sheet balsa for cockpit cowling
1 pc. — 1/32" x 1 3/8" x 1 3/4"	—Sheet balsa for cockpit floor board
1 pc. — 1/4" x 1 3/8" x 2"	—Balsa block for radiator
2 pcs.— 1/4" x 1/4" x 1 1/2"	—Exhaust manifolds
2 pcs.— 1/8" x 1/8" x 5 7/8"	—Exhaust pipes
1 pc. — 5/16" x 5/16" x 1 5/8"	—Balsa head rest
1 pc. —1" x 2"	—Isinglass for windshield
1 pc. — 1/4" x 1/4" x 15 1/2"	—Balsa for leading edge spar of upper wing (A)
1 pc. — 1/8" x 1/4" x 16 1/2"	—Balsa for leading inner wing spar (B)
1 pc. — 1/8" x 1/8" x 17 1/8"	—Balsa for trailing inner wing spar (C)
2 pcs.— 1/8" x 1/4" x 8"	—Balsa for trailing edge spars (D)
1 pc. — 1/8" x 1/8" x 2 1/2"	—Balsa for trailing edge spar (E)
2 pcs.— 1/8" x 1/8" x 3/8"	—Balsa for trailing edge spars (F)
1 pc. — 1/16" x 2" x 24"	—Sheet balsa for upper and lower wing ribs
2 pcs.— 1/4" x 1/4" x 7"	—Balsa for leading edge spars of lower wing (G)



S. E. 5

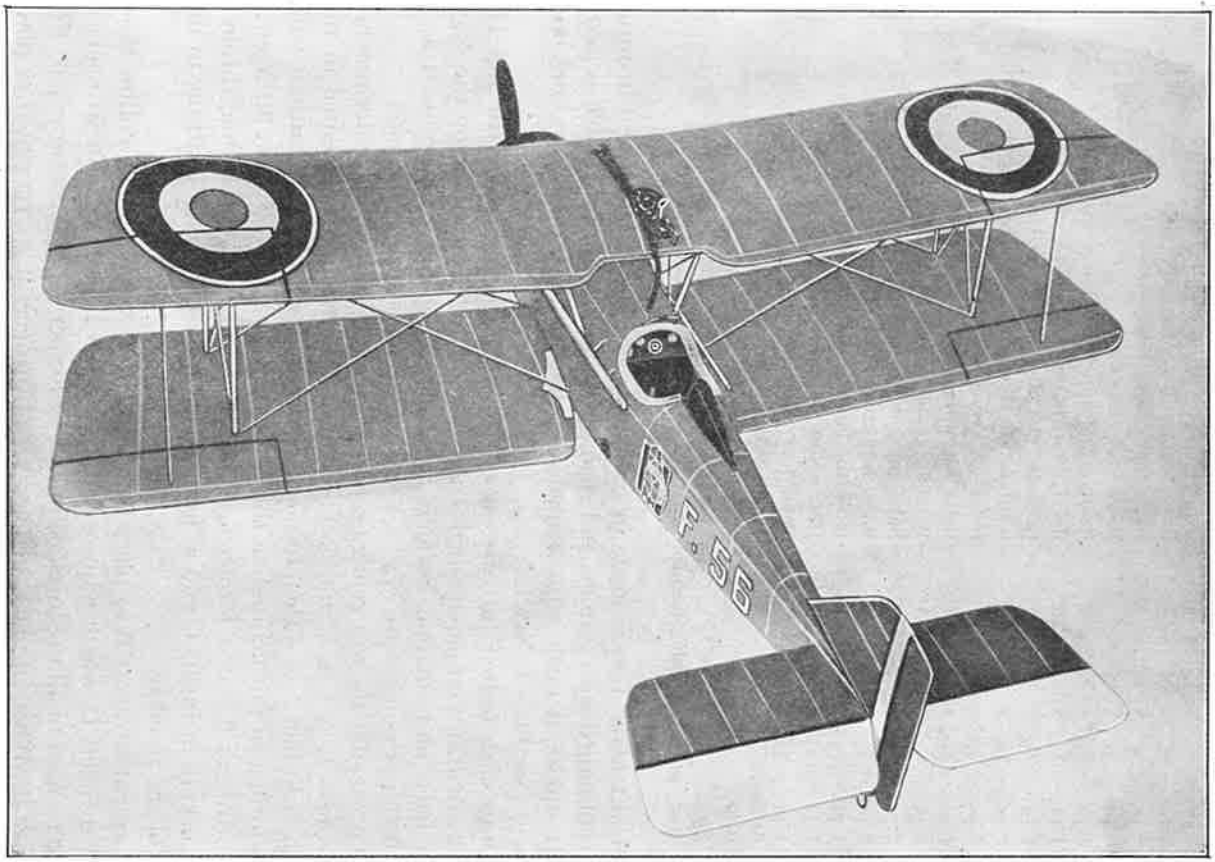
2 pcs.— 1/8" x 1/4" x 7 1/2" —Balsa for leading inner wing spars (H)
2 pcs.— 1/8" x 1/8" x 7 15/16"—Balsa for trailing inner wing spars (I)
2 pcs.— 1/8" x 1/4" x 7 3/4" —Balsa for trailing edge spars (J)
2 pcs.— 1/8" x 1/8" x 5/8" —Balsa for trailing edge spars (L)
2 pcs.— 1/8" x 1/8" x 1/2" —Balsa for spars (K)
1 pc. — 1/16" x 1/16" x 16" —Bamboo for upper and lower wing tips
1 pc. — 1/16" x 1/8" x 26" —Balsa for elevator and rudder ribs
1 pc. — 1/16" x 1/16" x 9" —Balsa for elevator and rudder spars (B and A)
2 pcs.— 1/16" x 1/16" x 15" —Bamboo for elevator and rudder outlines
4 pcs.— 1/16" x 1/8" x 1 7/8" —Balsa for center section struts
4 pcs.— 1/16" x 1/8" x 2 1/2" —Balsa for wing struts
2 pcs.— 1/8" x 3/8" x 1 1/2" —Balsa for landing gear struts (E)
2 pcs.— 1/8" x 3/16" x 2 3/4" —Balsa for landing gear struts (F)
2 pcs.— 1/4" x 1/4" x 1" —Balsa for streamlined shock absorbers (G)
1 pc. — 1/8" x 1/4" x 2 1/4" —Balsa for landing gear axle (D)
1 pr. —1 1/2" diameter —Disk wheels
1 pc. — 3/8" x 5/8" x 5 1/4" —Balsa for propeller
2 sheets —Japanese tissue for covering
2 oz. —Colorless cement
2 oz. —Colorless dope
Red, white, and blue lacquer

FUSELAGE. This is made in two parts. The top is half-round in form and is obtained with formers and stringers, while the bottom, which is practically square, is made with stringers, upright struts, cross braces, and one former. (See Plan 1, No. 12.)

Draw each former full size on 1/8" squares, except formers 10 and 11, which are drawn on paper ruled with 1/12" squares. Trace these on the 1/16" sheet balsa and cut out. Formers 1, 2, and 3 are duplicates, as well as 5 and 6. Their notches are 1/16" x 1/16". All stringers are 1/16" square.

To assemble the top, cement center stringer A into the top center notches of formers 1, 2, 3, 4, 5, and 6. The end of this stringer is cemented in the notch of former 1, and then former 2 is attached 7/8" from it. Continue with each former in this manner, as shown in Plan 1 on the top view. Stringer A and stringers B end at former 6, while stringers C and D continue through the cockpit. Stringers C end at former 10, while stringers D continue to the end of the fuselage.

Cement stringers B in place to formers 1, 2, 3, 4, 5, and 6. Follow these with stringers C, which require adding formers 7, 8, 9, and 10. Stringers D are cemented to all the formers, including former 11, and continue past this former 1". When in place, stringer A and stringers B are cemented in place to formers 7, 8, 9, 10, and 11. All these three stringers continue out beyond former 11 for 1", where they and stringers D are cemented together.



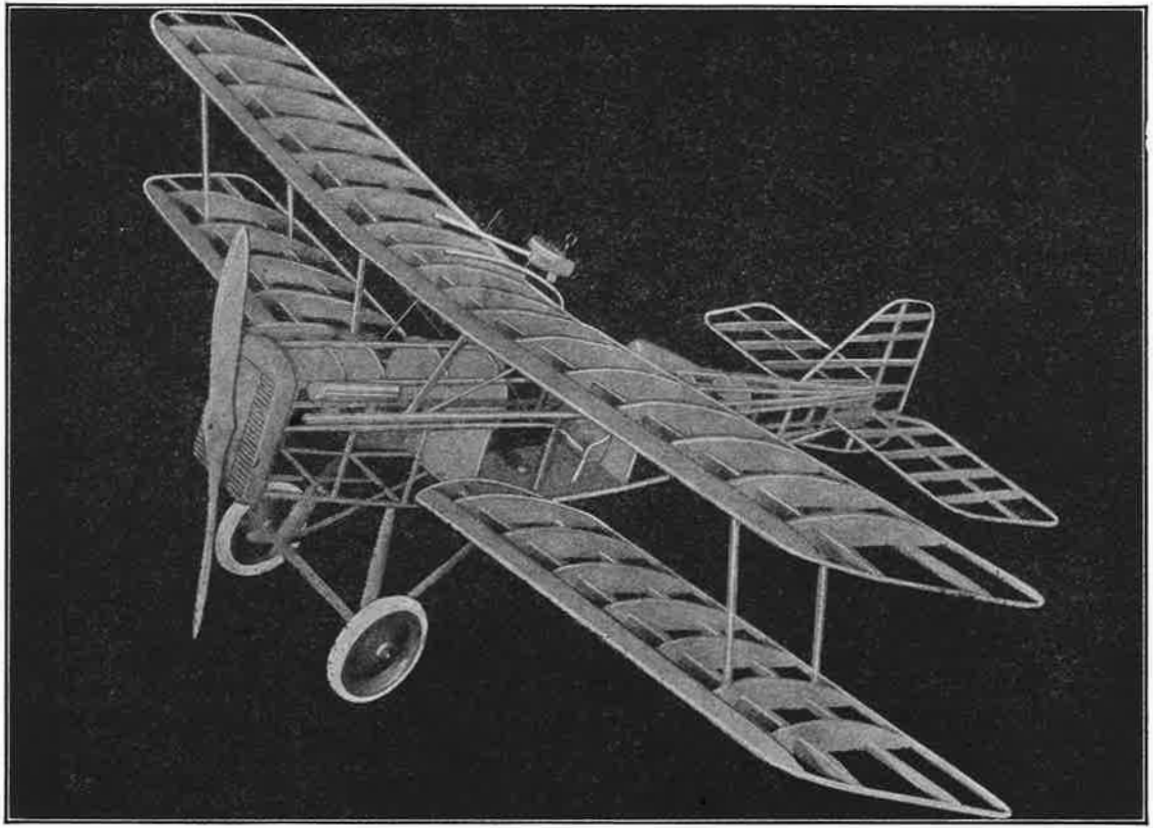
REAR VIEW SHOWING COCKPIT OF S. E. 5

Assemble the bottom portion of the fuselage. The 1/16" x 1/16" x 3/8" upright strut G is cemented at right angles to the ends of stringers D. The radiator is cut as shown in Plan 1 under "Radiator" from the 1/4" x 1 3/8" x 2" balsa block. Its width is that of former 1, while its top curve must match the curve of former 1. Cement this piece against former 1, so that its curve will match that of the former. Bottom former 12 is cemented to the bottom of the radiator, so that its straight edge will be parallel and the center of its curved edge will be flush with the bottom edge of the radiator.

Stringers E are cemented into the side notches cut in former 12. Study the side view in Plan 1. Starting from the radiator, the first upright strut behind former 12 is 1" long, while the second, third, and fourth are 1 1/16" long. Cut these 1/16" x 1/16" balsa struts and cement them in place between stringers D and E on each side of the fuselage. Note the distances these struts are apart in the plan. Stringers E are directly under stringers D along the entire length of the fuselage, when it is viewed from the top, so stringers E are separated by bottom cross braces 1 1/4" long, which are cemented between the stringers and in line with the first four upright struts. Stringers E are brought together and cemented at the end of the fuselage to strut G. All the upright struts from former 6 to the end are cemented directly under formers 6, 7, 8, 9, 10 and 11 between stringers D and E on both sides of the fuselage. They are also joined across the bottom with 1/16" square cross braces. Their lengths are the same as the straight edges of the formers under which they fit, less 1/8" which allows for the width of stringers E.

A short stringer is cut and its forward end cemented into the bottom center notch in former 12. Its other end is cemented to the second bottom cross brace, after being brought under the first bottom cross brace. The cockpit floor board is cut from the 1/32" x 1 3/8" x 1 3/4" sheet balsa. It is cemented in place between stringers E from side to side and formers 6 and 7 from fore to aft.

The cockpit is equipped with instrument board, rudder, joy stick, and seat. (See Chapter 15, "Cockpits.") The cockpit cowling is bent from the 1/32" x 1 3/4" x 2 1/4" sheet balsa. (See Chapter 3, "Balsa Wood.") This is bent to fit the curves of formers 6 and 7. It extends between stringers D on each side of the fuselage. A hole is cut in it as shown in Plan 1, and it is cemented in place. A piece of isinglass is cut to serve as a windshield, and cemented to the front edge of the cowling hole. The head rest is shaped from the 5/16" x 5/16 x 1 5/8" balsa block. Do not attach the head rest until the fuselage is covered. The exhaust pipes and manifolds are sandpapered to form, but not attached at this time.



S. E. 5 SKELETON

The fuselage is covered with Japanese tissue. (See Chapter 8, "Fuselage Covering.") Spray with water and when dry paint with dope.

The head rest is cemented in place just behind the cockpit, or former 7, on stringer A. Exhaust pipes and manifolds are not attached until after painting.

TAIL SKID. This is built up of $\frac{1}{16}$" x $\frac{1}{16}$" balsa lengths. (See side view, Plan 1.) It is located on the center bottom of the fuselage and extends from former 10 to strut G, where its extension continues for $\frac{1}{2}$" beyond. Cement the structure together, and when dry cover with Japanese tissue, water-spray, and finish with dope. A wire skid is added to this framework, as shown by the dotted lines. Bend this from piano wire and cement in place.

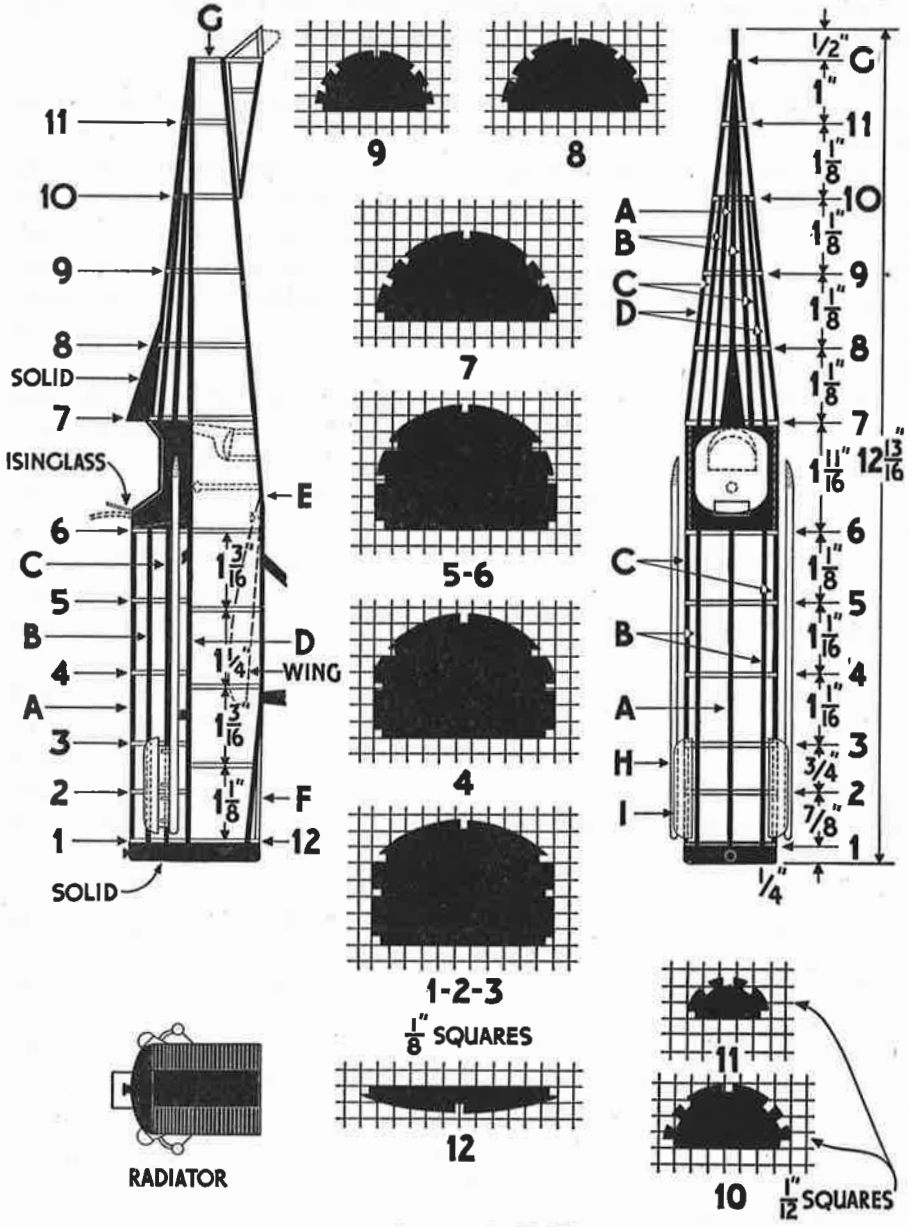
ELEVATOR. This is built of eight $\frac{1}{16}$" x $\frac{1}{8}$" x $2\frac{1}{8}$" balsa ribs, two $\frac{1}{16}$" x $\frac{1}{8}$" x $1\frac{1}{8}$" center C ribs, one $\frac{1}{16}$" x $\frac{1}{16}$" x $6\frac{1}{2}$" inner elevator spar, and a $\frac{1}{16}$" x $\frac{1}{16}$" bamboo outline edge piece, as in Plan 3.

Cut the eight straight ribs, streamline them, and cut a $\frac{1}{16}$" square hole through each, as shown. Thread spar B on these ribs, locate each in proper position, and cement them in place. See that each one is at right angles to spar B. The outline bamboo is bent to form and cemented to the ends of each rib and the outer ends of spar B. The ends of the trailing edge portion of the bamboo are cemented to the center of the spar.

The ribs C are cemented to spar B at a slant obtained from the form of the fuselage sides at its end. The leading edge of the bamboo has its ends cemented to the ends of these center ribs. Test the assembly to see that it fits around the end of the fuselage on a level with stringers D by placing ribs C against these stringers on each side and the inner spar B against strut G.

Cover on both sides with Japanese tissue, water-spray and finish with dope. Place the fuselage end into the V-shaped slot of the elevator made by ribs C, so that inner spar B rests against strut G and ribs C are against stringers D and parallel with them. Cement in this position and hold until dry.

RUDDER. This requires five $\frac{1}{16}$" x $\frac{1}{8}$" balsa ribs, one $\frac{1}{16}$" x $\frac{1}{16}$" x $2\frac{1}{16}$" balsa inner spar A, and a $\frac{1}{16}$" x $\frac{1}{16}$" split bamboo outline piece. The ribs are $\frac{3}{4}$", $2\frac{3}{4}$", $2\frac{1}{4}$", $1\frac{3}{4}$" and $1\frac{3}{8}$" long, counting from the bottom rib up. Cut these ribs, streamline each, and cut a $\frac{1}{16}$" square hole $\frac{3}{4}$" from their trailing ends, as shown. Thread the spar A on these ribs, cement each in its proper location, and see that it forms right angles with spar A. Place the rudder over the end of the fuselage with its ribs in line with stringer A, and spar A against spar B of the elevator.



FUSELAGE

S. E. 5 PLAN 1

Snap and bend the longest rudder rib to conform to the slope of stringer A, as shown. When in position, apply cement to the crack made in this rib, and allow to dry. The elevator spar B and rudder spar A are notched at their intersection, so that spar A can fit tightly against fuselage strut G. Remove the rudder and bend the bamboo outline length. Cement one end to the lower end of spar A, bring it around, cementing it to the ends of each rib. Then cement its other end to the leading end of the longest rib, as shown.

Cover on both sides with Japanese tissue, water-spray, and finish with dope. Place it on the fuselage. Apply cement to the under side of the bent rib and to the spar, fit the notches of spars B and A together, and press into position. Hold until dry. See that it forms right angles with the elevator, and is also parallel and in line with stringer A.

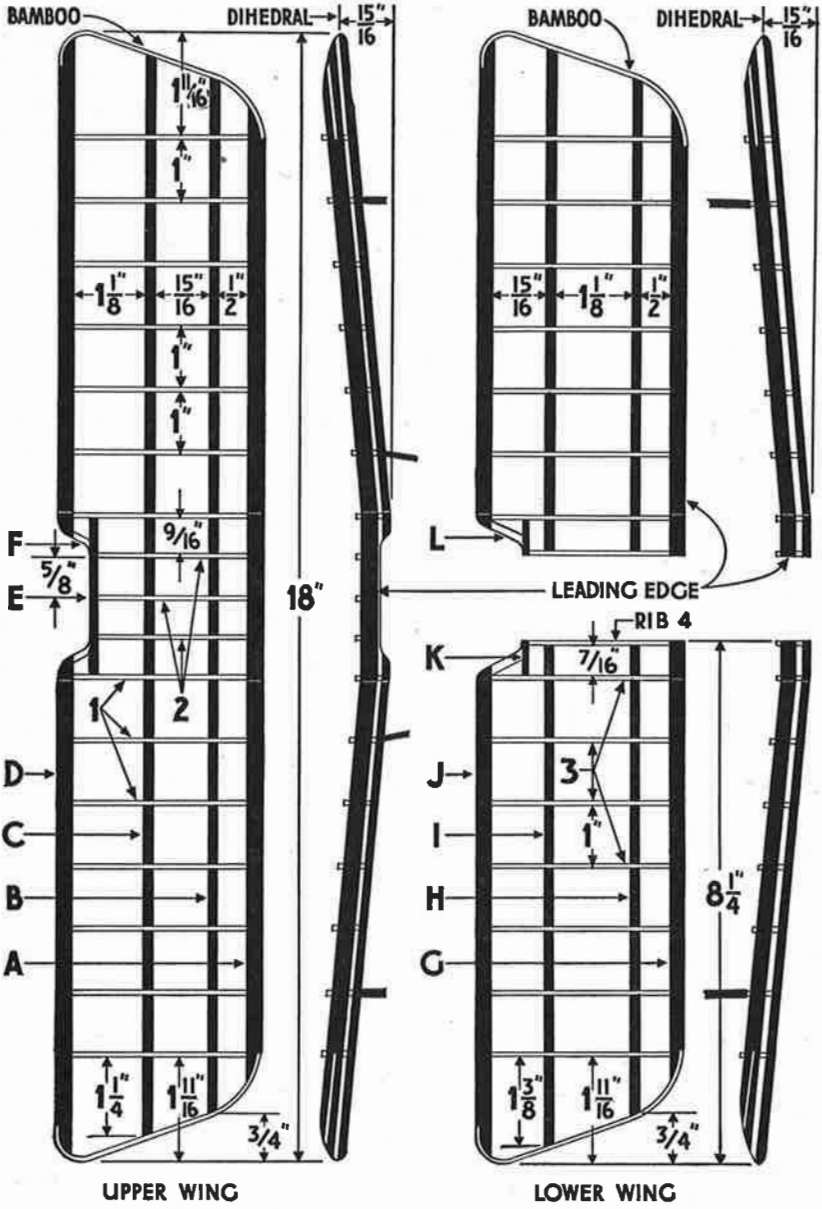
WINGS (Upper Wing). This is made in one piece. Its ribs are shown in graph in Plan 3 under "Wing Ribs." Draw full-size copies of these ribs on 1/4" squares. Fourteen No. 1 ribs and three No. 2 ribs are traced on 1/16" sheet balsa, cut out, and properly notched. The leading notch is 1/8" x 1/4", while the trailing notch is 1/8" square.

Leading edge spar A is 1/4" x 1/4" x 15 1/2" long balsa wood. It should be shaped as on rib No. 1 in Plan 3. The leading inner wing spar B is 1/8" x 1/4" x 16 1/2" long balsa wood, and the trailing inner wing spar C is 1/8" x 1/8" x 17 1/8" long balsa.

The trailing edge consists of five lengths of balsa wood. Trailing edge spars D are 1/8" x 1/4" x 8" long, and shaped as on rib No. 1 in Plan 3. Spar E is 1/8" x 1/8" x 2 1/2" long, extending across the center section of the wing. Spars F, which connect spars D and spar E are 1/8" x 1/8" x 3/8" long. These require no shaping.

Cement the ribs on the two inner spars, and when dry cement spar A to the front ends of the ribs. The ribs must be at right angles to spars B, C and A. The trailing edge spars D are cemented in place to the trailing ends of the No. 1 ribs, while spar E is cemented to the trailing ends of the No. 2 ribs. These are joined by spars F. Round the ends of spars D at the center section, as shown. Bamboo measuring 1/16" square is bent to shape the wing tips, and cemented in place. Round the ends of spars A and D to taper into the tips, as shown. The wing is given a 15/16" dihedral at each tip. The thick section on top, shown in the edge view, which keeps its thickness for the entire length, represents the leading edge spar A, while the thinner one just below it, which is broken at the center section, represents the trailing edge spars D.

The leading edge of the wing is therefore higher than the trailing edge,



WINGS

S. E. 5 PLAN 2

but this has nothing to do with its construction. The difference in the positions, or heights, of these spars is gained when the wing is assembled on the fuselage.

The center section of the wing is held flat on the table, while both of the tips are lifted 15/16" off the table by cracking each spar in two places at the ends of the center section. While in position, cement is applied to these cracks, and the wing tips held up until dry.

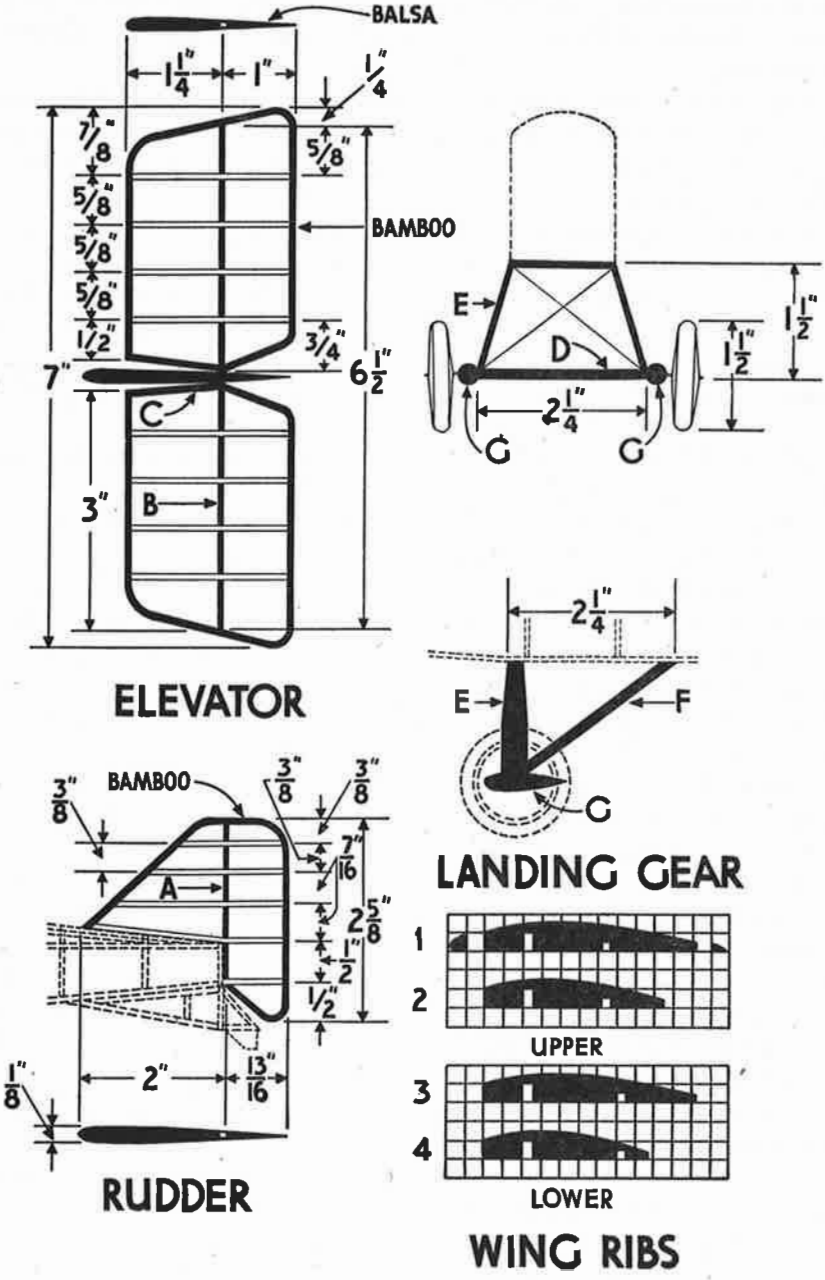
The wing is covered on both sides with Japanese tissue, water-sprayed, and finished with dope.

(Lower). This is made in two duplicate parts. (See Plan 3, "Wing Ribs.") Fourteen No. 3 and two No. 4 ribs are necessary for these wings. These are copied, traced on the 1/16" sheet balsa, cut out, and sandpapered smooth, as were those for the upper wing. The notches in these ribs are cut 1/8" x 1/4" and 1/8" x 1/8".

The leading edge spar G is 1/4" x 1/4" x 7" long for each wing. It is shaped like the corresponding spar of the upper wing. The leading inner wing spar H is 1/8" x 1/4" x 7 1/2" long, and the trailing inner wing spar I is 1/8" x 1/8" x 7 15/16" long for each half. The trailing edge spar J is 1/8" x 1/4" x 7 3/4", and is shaped like the trailing edge spar of the upper wing. The short spars K are 1/8" x 1/8" x 1/2", while the trailing edge spars L, which join K and J, are 1/8" x 1/8" x 5/8" long. Each half is assembled in the same manner as was the upper wing. Each is fitted with a 1/16" square split bamboo wing tip, bent to form and cemented to the ends of the spars. The wings are given 15/16" dihedrals. The distance between inner rib No. 4 and inner rib No. 3 remains flat, while the dihedral is gained from the latter rib to the tip. Give both halves this dihedral, as explained for the upper wing, and hold until dry. (See Chapter 7, "Wing Assembly.")

The halves are covered on both sides with Japanese tissue, water-sprayed, and finished with dope. The wings are ready to be assembled on the fuselage. Study their location in the solid scale plan. The lower wing position is also shown in the side view in Plan 1. The leading edge of the lower wing is 3/16" above its trailing edge. Apply cement to ribs No. 4 of each half, and press them in position to the sides of the fuselage. Prop up their tips so that the cement can dry in this position.

The upper wing is attached above the fuselage by means of center section struts, and outer wing struts connect it and the lower wing. The four center section struts are 1/16" x 1/8" x 1 3/4" balsa, streamlined, and finished with sandpaper. The leading pair of these struts extends from stringers D on each side of the fuselage up and out to the under sides of the No. 1 ribs located on each end of the center section. They are located 5/16" behind


BALSA
1 1/4"
1"
1/4"
7/8"
5/8"
5/8"
5/8"
5/8"
1/2"
5/8"
BAMBOO
3/4"
7"
6 1/2"
C
3"
B
ELEVATOR
E
D
1 1/2"
1 1/2"
2 1/4"
G
G
2 1/4"
E
F
G
LANDING GEAR
BAMBOO
3/8"
3/8"
3/8"
A
7/16"
2 5/8"
1"
1/2"
1/2"
1/8"
2"
13/16"
RUDDER
1
2
UPPER
3
4
LOWER
WING RIBS

S. E. 5 PLAN 3

former 3 on stringers D and extend up to points 5/16" behind the leading edge on ribs No. 1. The under side of the upper wing ribs must be parallel to the under side of the lower wing ribs.

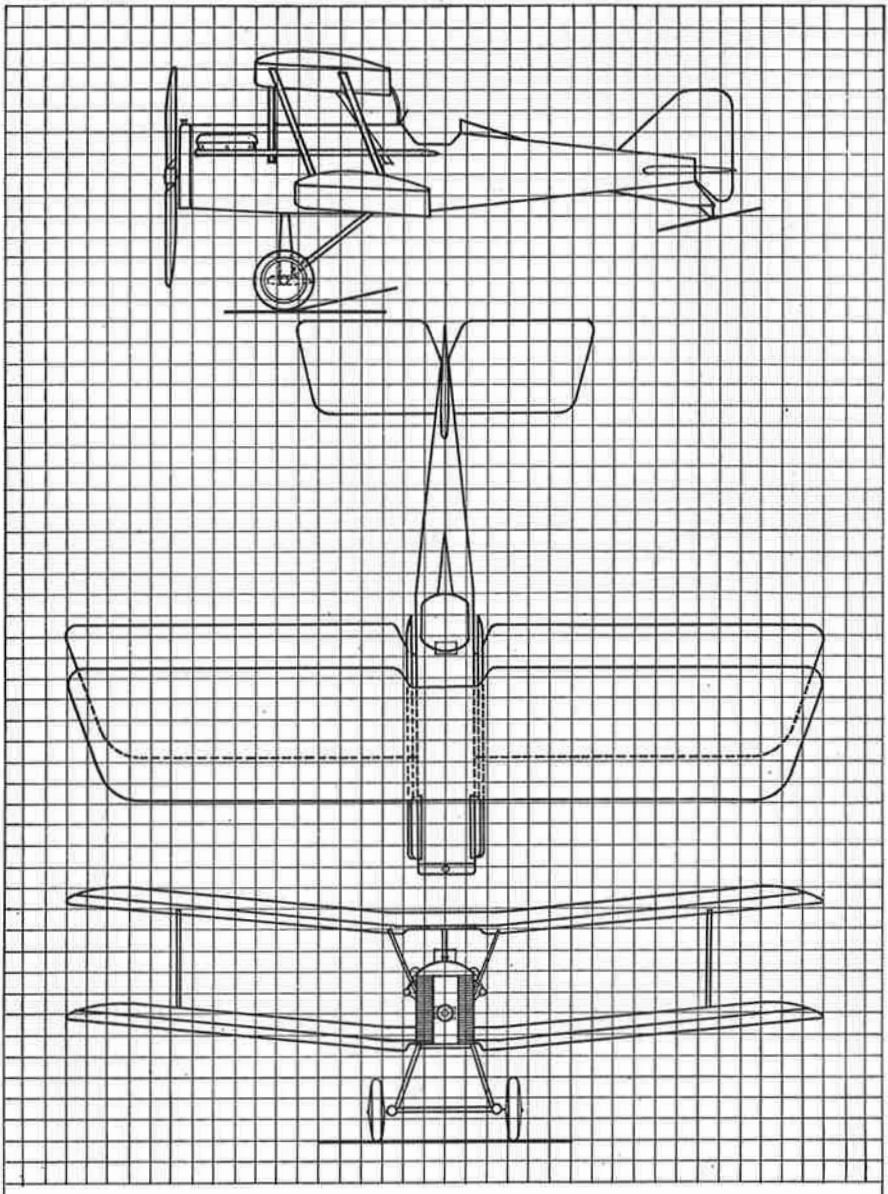
The trailing pair of these center section struts extends from stringers D on each side of the fuselage to the under sides of the No. 1 ribs on each end of the center section of the upper wing. They are located 3/8" in front of former 6 on stringers D and on spar C on the No. 1 ribs. Cement these struts in place. The outer wing struts extend from the lower wing to the upper wing. They are the same size as the center section struts, but are different in length. The leading pair is 2 5/16" long, while the trailing pair is 2 1/2" long. They are cemented between the top of the lower wing and the under side of the upper wing, with the front pair between the second end ribs of each wing and in line with spars H and B. The second and rear pair is located on the same ribs under spar C of the upper wing, and extends to a point on the same ribs of the lower wing and parallel with the leading pair of struts. Cement these in place.

Bracing wires, made of wire, 1/32" split bamboo, or thread; are crossed between each pair of the end and center section struts. These extend from the top of the leading strut to the bottom of the trailing strut, while another wire crosses this from the top of the trailing strut to the bottom of the leading strut. Attach these two wires between each pair of end wing struts and each pair of the center section struts. Flying and landing wires are added between the fuselage and the outer wing struts.

LANDING GEAR. Struts E are shaped from the 1/8" x 3/8" x 1 1/2" balsa pieces. Plan 3 shows the form of these. Struts F are 1/8" x 3/16" x 2 3/4" balsa. Streamline these struts. The streamlined shock absorbers G are shaped from 1/4" x 1/4" x 1" balsa, or can be cut from 1/4" diameter dowels. The axle D is 1/8" x 1/4" x 2 1/4" balsa and streamlined. Two rubber-tired wheels of 1 1/2" diameter are purchased or made. (See Chapter 10, "Solid Balsa Rubber-tired Wheels.")

Struts E are cemented to the ends of axle D and extend in and straight up to stringers E just in front of the second upright strut. Struts F are cemented to the ends of the axle and extend up and back to stringers E on each side of the fuselage at points 2 1/8" behind the landing gear struts E, where they are cemented. The shock absorbers are cemented to the ends of the axle D and parallel to bottom center stringer F. The wheels are mounted with model pins thrust through their hubs and into the shock absorbers. If the pins are long, they can extend on into the ends of the axle. Cross bracing wires are added, as shown, to complete the assembly.

PAINTING. This model, being a true replica of the author's War



SOLID SCALE PLAN FOR S. E. 5

S. E. 5, has been given his insignia, paint job, numbers, etc. The entire fuselage and upper and lower wings are painted a bright red. The fin is blue, while the rudder is white and red. Near the tips on top of the upper wing and under the lower wing are the British War emblems. These have a white outer circle, a blue one slightly wider, another white one of the same width as the blue circle, and a center red ball.

The landing gear is black with the centers of the wheels white. The radiator is divided into three strips with the center one in black. The two outer strips are white, and black lines are drawn through these to indicate the radiator. A small black cap is added at the top of the radiator. The stabilizer, or front portion of the elevator, is red, while the flaps are white. On both sides of the fuselage are the letters and numbers F. 56, indicating the 56th Fighting Squadron. The head rest is black. The insignia consists of a brown ham over which is placed the letter "H." The portion of the H which extends over the brown of the ham is white, while the rest of it is black. Just under the ham and between the bars of the H appears the small letters "A" and "M," spelling the word "Ham." This was the author's nickname during the War and was used on his plane. (See Chapter 14, No. 120.)

The edge of the cockpit is fitted with spectacle tubing. The head rest has an upholstery tack pushed into it. The edge of the isinglass windshield is painted black, and small steps are painted on each side of the fuselage just under the cockpit. (See Chapter 15, "Miscellaneous Accessories.") All wires are painted silver with aluminum paint. The ailerons are ruled on both sides of the upper and lower wings, and $\frac{1}{32}$" split bamboo or thread aileron control wires are cemented from the top center of the lower aileron to the bottom center of the upper aileron.

Silver exhaust pipes and black manifolds are painted and attached to the sides of the fuselage. The former are attached just above the pipes with model pins thrust through the manifolds and into the pipes, where they are cut off. The manifolds are attached with cement to each side of the fuselage over stringers B just behind the radiator. The pipes are held at the front by the manifolds, while bent model pins thrust through them and into former 6 hold their other ends.

Two machine guns are required. One of these is a Vickers gun, which is cemented under the wing between stringers A and B on the left side of the fuselage. The other is a Lewis gun, which is attached to a gun mount. The mount is bent from $\frac{1}{16}$" bamboo, and extends from just in front of the cockpit over the top wing to its leading inner spar, where it is cemented in place with the aid of a small elevation block. (See Chapter 15, "Machine

Guns.") When completed, paint the guns and mount black, and cement them in place. The Lewis gun is attached to its mount by a model pin.

PROPELLER. The model is completed by carving a war propeller of the old wood type. It is carved from a 3/8" x 5/8" x 5 1/4" long balsa block. (See Chapter 9, "Carved Propellers" or "Laminated Propellers.") It is stained the color of mahogany or oak, and small dots of silver are made around its hub to indicate propeller bolts. This is attached with a model pin thrust through its hub into the center of the radiator. A coat of Valspar varnish should be given the entire model to make it appear as bright as possible and to preserve the paint.

SOLID SCALE MODEL. See Chapter 46 under "Solid Scale Model" for general building directions for a solid scale model of this plane.

CHAPTER 50

GERMAN DARMSTADT D-22

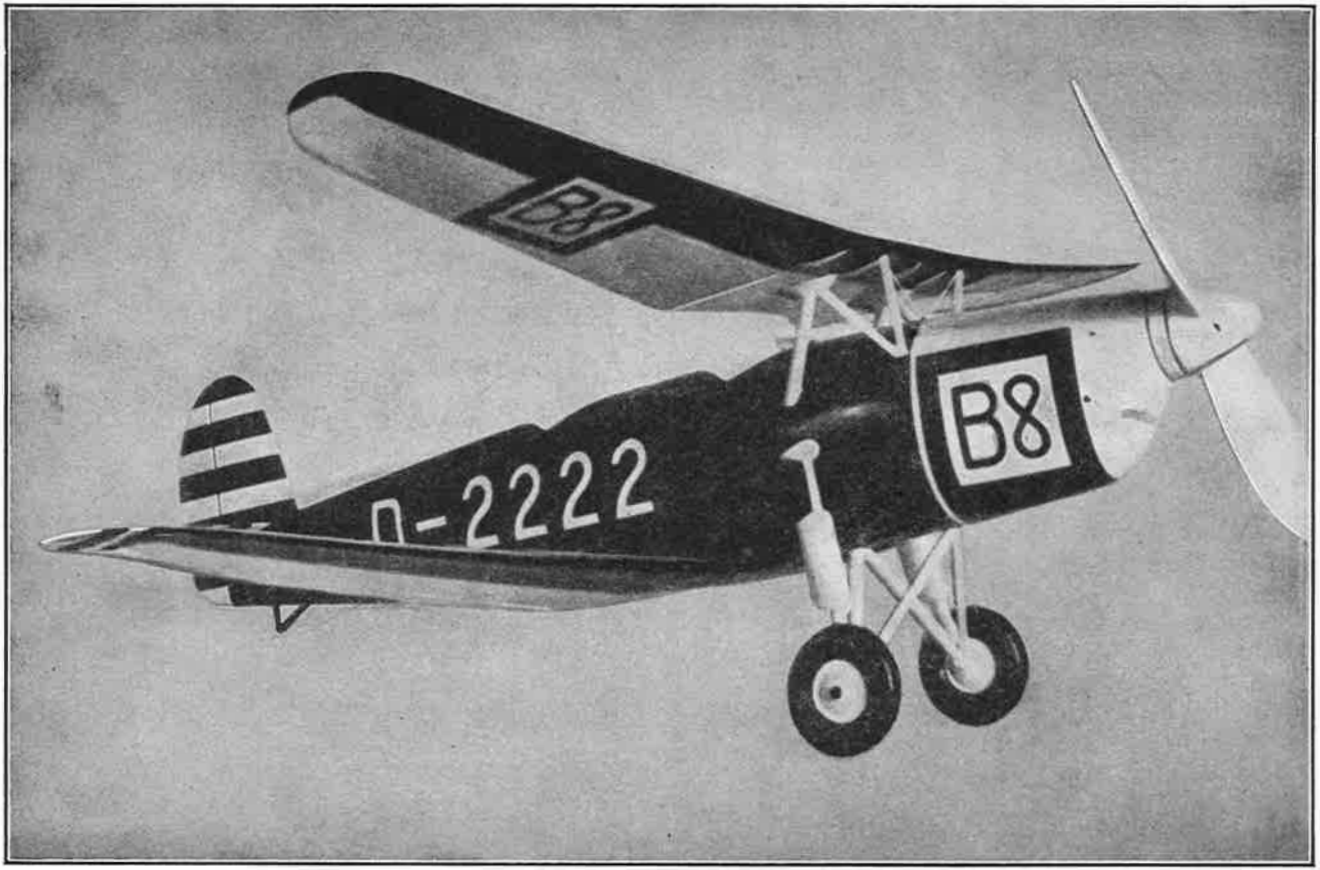
HERE is a modern German biplane the design of which follows along strikingly different lines than those usually found in planes of today. This is likewise true of several other German types of today. The Darmstadt D-22 is the product of The Darmstadt University Aviation Society (Academische Fliegruppe) of Darmstadt, Germany, which is better known for its excellent sailplane designs. The numeral and letter "B8" appearing on the model shown here likewise appeared on the real plane from which the model was copied. This signifies the entry number assigned to this particular Darmstadt on a circuit air race held in Europe in 1932.

The primary purpose of this plane is as a sport-trainer. Its top speed is 152 M.P.H., which placed it near the top for speed performance of all the commercial planes of Europe at the time of the race. The span of each wing is 23 feet and its overall length is 21 feet. It was chosen for model work because of its many novel features. These include its great amount of wing stagger, the wide gap between planes, wings of extremely high aspect ratio, the omission of all outer wing struts usually found on biplanes, the long lever arm, monocoque fuselage and the amply large tail surfaces for stability.

Elbert J. Weathers, the original builder of the model to whom the author expresses his appreciation, built the model shown here on a scale of 1″ equaling 1′ 0″. His original model weighed just two and a quarter ounces ready for flight. All claims made for its fine flying ability will be amply and easily proved if the following instructions are carefully followed and perfect alignment is obtained. All balsa used throughout its construction is the medium-hard variety unless otherwise noted.

MATERIAL LIST

2 pcs.—1¼″ x 3¼″	x 19″	—Balsa (Fuselage)
1 pc. —1/16″ x 3″	x 36″	—Balsa (Ribs, Tips, etc.)
1 pc. —1/32″ x 3″	x 36″	—Balsa (Tail surfaces, Tips, etc.)
1 pc. —1/16″ x 2″	x 36″	—Balsa (Wing spars)

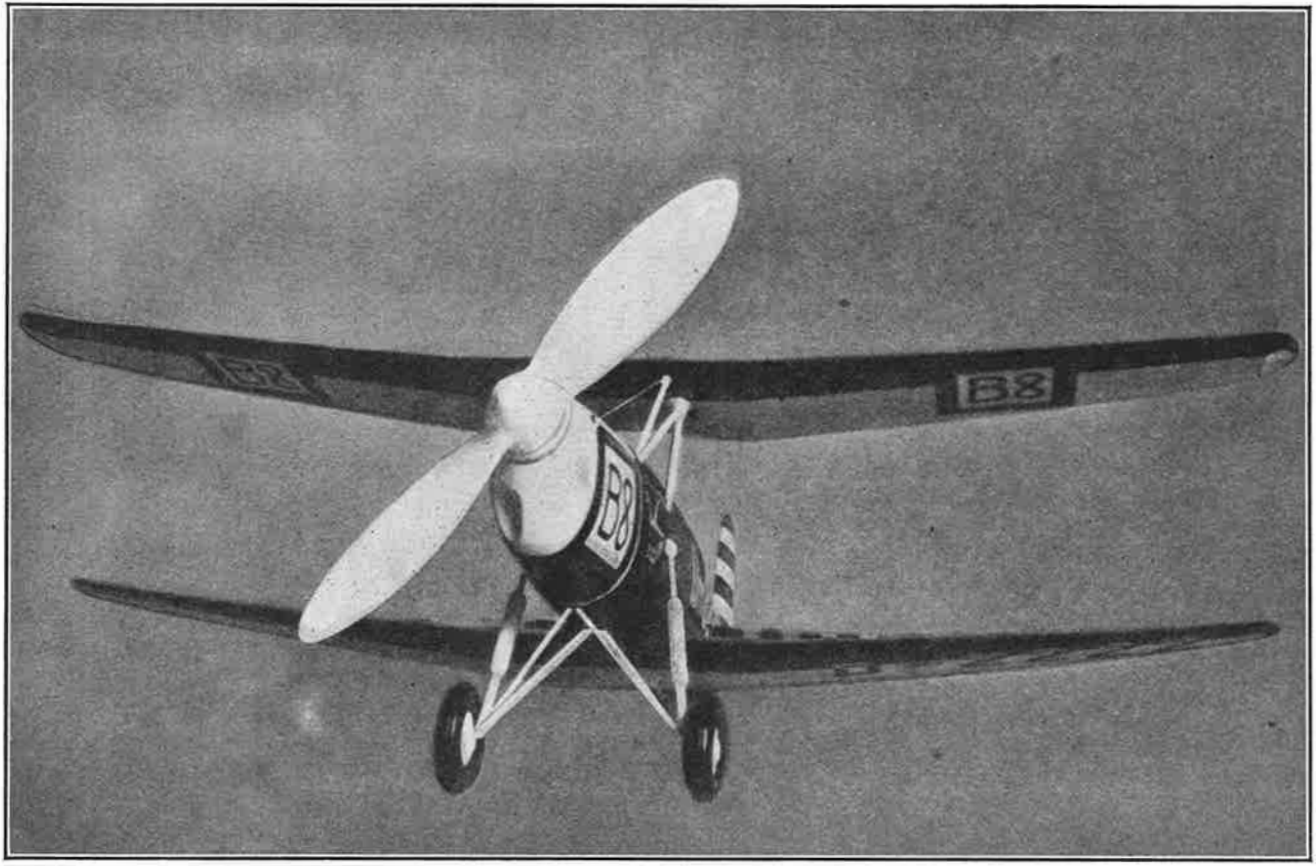


GERMAN DARMSTADT D-22

GERMAN DARMSTADT D-22

1 pc. —1/8" x 1/4" x 36"	—Balsa (Tail surface spars)
1 pc. —1/8" x 1/8" x 24"	—Balsa (Landing gear struts)
1 pc. —1/8" x 1/4" x 18"	—Balsa (Wing struts, Landing gear, etc.)
2 pcs.—1/4" x 5/8" x 1 1/2"	—Balsa (Landing gear struts)
1 pc. —1/16" x 1/8" x 12"	—Balsa (Tail unit struts, Tail skid)
1 pc. —1/64" x 3" x 12"	—Balsa (Wing covering)
1 pc. —1/2" x 1 1/4" x 9"	—Balsa (Propeller)
1 pc. —1/8" x 1 1/4" x 1 1/4"	—Pine (Nose Block)
1 pc. —3/8" diameter x 1/2"	—Pine (Nose Plug)
1 pc. —16' 10"	—1/8" flat rubber
1 pc. —12" long	—No. 18 music wire
2 sheets	—Mino tissue
1 can	—Cement
Celluloid	
Banana Oil	
Black dope or paint	
White dope or paint	
Clear dope	

FUSELAGE. The side and top views of the fuselage are shown on Plan 1, while its templates are shown on Plan 2. The fuselage of the Darmstadt is made up of two balsa blocks measuring 1 1/4" x 3 1/4" x 19" long. Obtain two such blocks and cement them together at two or three points for temporary adhesion. When these have dried, the outside of the fuselage is carved to shape. It will be found best to do this in two operations. The first of these requires a full-size copy of the side view and the top view of the fuselage outline. The proper dimensions for these drawings may be obtained from the templates on Plan 2, which have been shown on squares representing 1/4" each. The nose of the fuselage is 1 1/4" in diameter. When these views have been drawn and properly checked, the side view should be traced on the side of the block and the top view on the top of the block. The block is then cut to match these contours, which completes the first operation. The second operation consists of completing the carving of the fuselage to its exact shape and size. For this work, the templates are used. The five fuselage templates are shown on 1/4" graph on Plan 2. Rule paper with squares of this size and trace the templates on them. When completed, transfer each one to stiff cardboard and cut out. Note that these templates have been designated by letters "A-A," "B-B," "C-C," "D-D" and "E-E," and that their various locations along the fuselage are shown in Plan 1. The circular parts of the templates indicate the shape of the fuselage at the points designated in Plan 1. Proceed to carve the exterior of the fuselage to its proper shape and size. When the work has been completed and thoroughly checked, the entire surface should be brought to a satin finish with



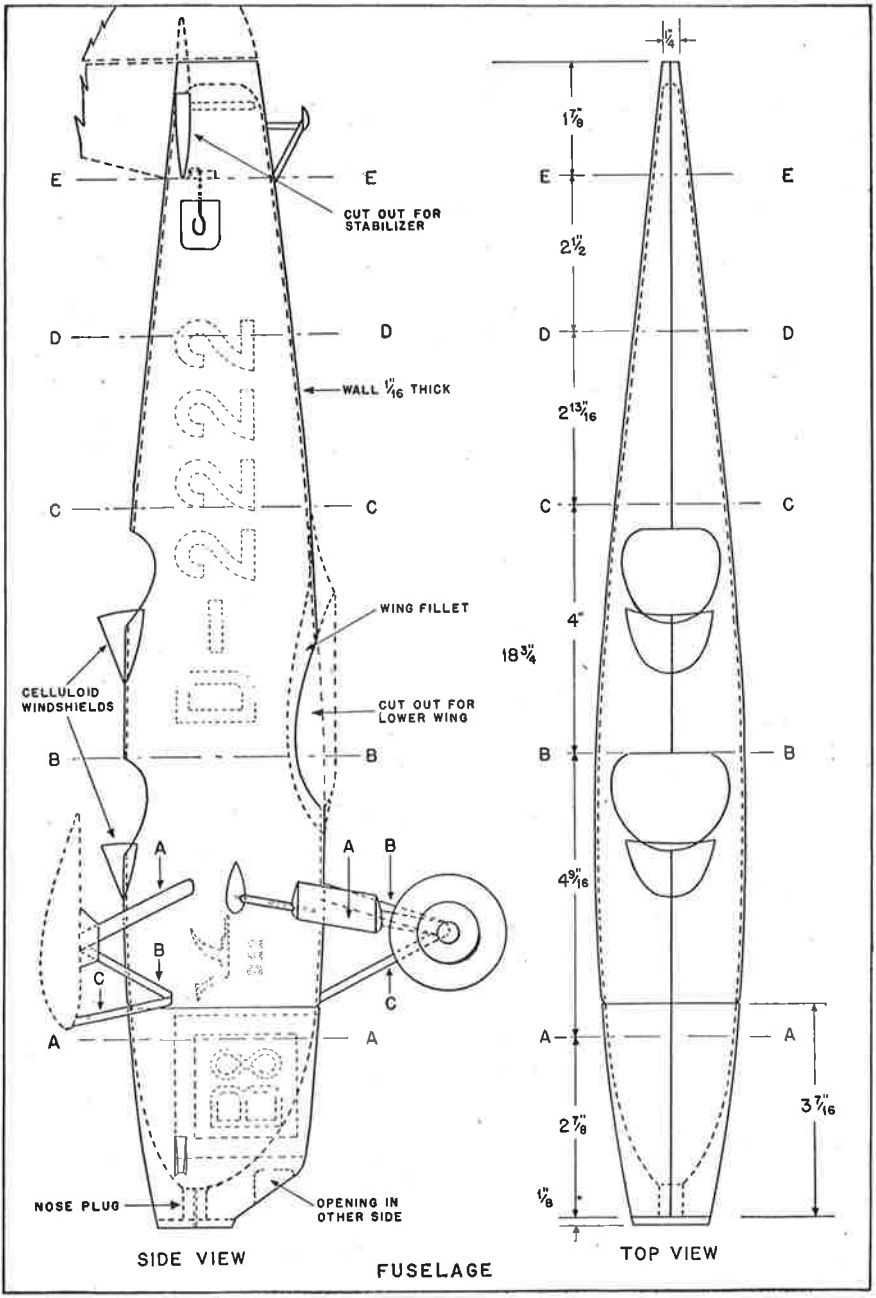
GERMAN DARMSTADT D-22

sandpaper. The two blocks now forming halves of the fuselage are broken apart when the exterior work is finished. The inside areas of these blocks are now hollowed out to form the necessary fuselage shell. In Plan 1 will be seen the inside of the fuselage wall. This is shown by dotted lines. Any suitable tool, such as a sharp knife, fine chisel, or gouge, may be used for this work. It need not be too smooth inside but care should be taken to make it of even thickness along the sides and top and bottom walls. Note that the walls become quite thick at the nose of the fuselage. When completely finished, hold each half up to a strong light and go over all its surface. In this way the thicker parts of the wall can be seen darker than the thin areas. Such a test will allow the builder to correct any great differences. While it is not necessary to finish the inside of the fuselage smooth, a coat of black dope will go a long way toward removing the "raw" appearance of a rough interior. When the interior has been completed to this point, a 3/8" diameter hole is cut through the front end of the blocks to accommodate the nose plug. Note this in Plan 1.

The blocks are now placed together and inspected closely for any flaws. They are then cemented together again to form a completed fuselage shell, which will be found strong and extremely light. In Plan 1 under "Top View" will be seen a mark across the fuselage just behind the location of "A-A" template. This is shown as 3 7/16" behind the nose of the fuselage. This same mark will be seen going down the side of the fuselage in the other view. It is merely a knife indentation around the fuselage to represent the trailing edge of the engine cowl. It should be made at this time, but care must be taken to see that it does not cut through the walls of the fuselage. The rear hook block is now installed. This consists of a 1/8" x 1/2" hard balsa block cut to proper length. Two 1/8" x 1/2" holes are cut through the walls of the fuselage at the point shown in the side view of Plan 1. The block is then inserted into this opening and trimmed flush with the outsides of the fuselage sides. When this has been done, remove the block and fit it with a rear hook bent from No. 18 music wire and cemented in its center. In the same view will be seen a 5/8" x 3/4" hole in the left side of the fuselage which shows the rear hook in place. This hole is used for motor installation and should be cut at this time. A thin slit is made with a razor blade between this hole and the hole of the rear hook block on the same side. This is done to allow the stem of the hook to pass within the fuselage shell when the block on which it is mounted is cemented in place. The rear hook block is now inserted in its holes and cemented in place. At the same time repair the slit by coating it with cement. Cut an air vent in the lower right side of the engine cowl, as shown in the plans and

photographs. Cut the two cockpits at their proper locations, as shown in Plan 1. As neither of these employ combing, round off their edges for a neat appearance. The section which is removed for the lower wing installation can now be traced with pencil and carefully cut away. Note this section in the side view of Plan 1. The top curve of this section from the side should be the same as that of lower wing rib "E" shown in Plan 2. The tail skid is made of hard balsa measuring 1/16" x 3/32" cut to fit. This should be made at this time and cemented in place, as shown in the side view of Plan 1. The nose plug is now cut to proper shape and size. It is made of pine and cut 3/8" in diameter and 1/2" long. A pine nose block is cut to match the nose of the fuselage. It is 1/8" x 1 1/4" in diameter. It should be fitted to the nose and its edges tapered to match the contour of the fuselage. The nose plug is now cemented to the nose block to make one piece. The bearing in the plug is made from a dural rivet with the top of the head filed or turned off. As all the music wire fittings on the model are of No. 18 wire, the nose plug bearing should be drilled to take this size. Go over the entire model with a fine sandpaper to remove all signs of excess cement and other surface blemishes. On Plan 4 will be found the windshields drawn on 1/4" squares. Cut two pieces of celluloid to this size and shape, and then cement them in position in front of each cockpit, as shown in Plan 1. This completes the fuselage.

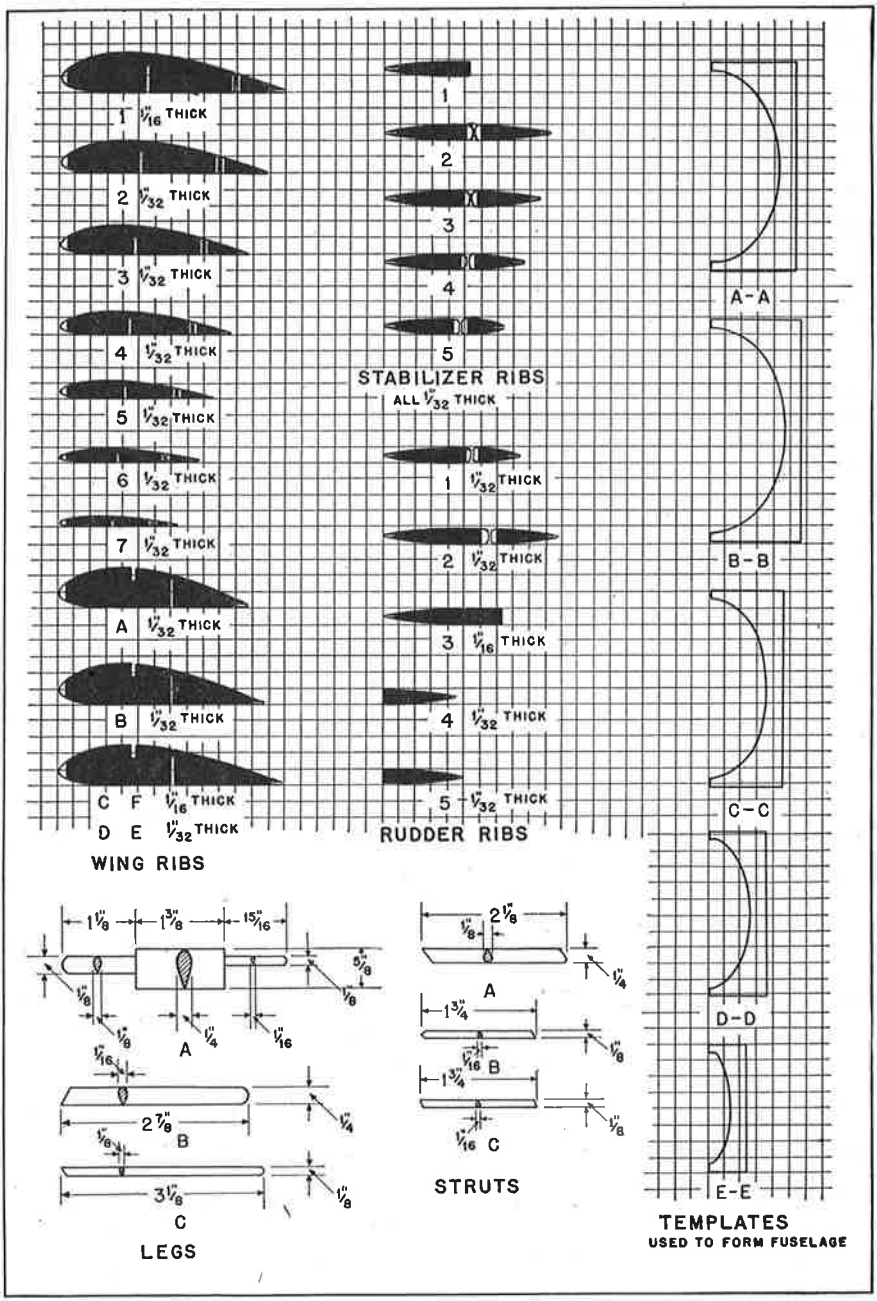
WINGS (Upper Wing). The upper wing is built in three main sections. These are the center-section, the left panel and the right panel. Both panels are duplicates. In Plan 3 the right panel is shown together with the center-section. The ribs for both wings are shown in Plan 2 under "Wing Ribs." These have been drawn on squares representing 1/4" each. Make a full-size copy of each of these ribs on paper ruled with 1/4" squares. For the wing panel we are now building, we will require one of each of the ribs from "1" to "7," but as both panels are built alike it is best to cut out two of each of these to insure duplicate ribs for each panel. Trace two "1" ribs on 1/16" sheet balsa. Trace two of each of the others on 1/32" balsa. Cut out these fourteen ribs and test to see that pairs in each case are exact duplicates. Set aside one set of seven until you are ready to build the second panel. Make sure that the single notch in each of these ribs has been cut to its exact depth. The short lines shown across each rib indicate the aileron of the lower wing and can be ignored at this time. Trace an inner wing spar on 1/16" sheet balsa and cut it 7/16" wide. Turn to Plan 3 which shows the upper wing assembled. Through an error in numbering the ribs on this plan, these appear with reverse numbers. The rib shown as "1" in this plan is in reality rib "7," etc. Do not cut the inner spar to



GERMAN DARMSTADT D-22 PLAN 1

length until the ribs have been spaced properly on it. Cement each rib in place on this spar, and then trim the width of the spar to match the lower edge of each rib. Cut the spar to exact length and cement rib "7," or "1" as it appears on Plan 3, in place on its end. The leading edge spar is cut 1/8" x 1/4" and cemented in place against the entering edge of each rib. Note its shape in the plan when against the ribs. It must be sanded down to this form when in place against the ribs. Note how it tapers toward the tip in Plan 3. The trailing edge spar is cut from 1/32" sheet balsa. It is 3/16" wide and stock should be left to cut its small curve at its tip end. Cement this spar in place and sand to match the contour of the ribs to which it is attached. Cut 1/32" sheet balsa to shape for the wing tip. Two short spars are cemented to the outer side of rib "1," as shown by the white lines, and the sheeting applied both on top and bottom of them. Note the dimensions in Plan 3 under "Lower Wing," which are the same as those applying to the upper wing. Go over the entire structure with fine sandpaper to complete it. The second wing panel is now built up in the same manner. Test to see that it is an exact duplicate of the first one.

The center-section is now built. The five ribs required for this are shown in Plan 2 under "Wing Ribs." These are designated by letters. For the upper wing center-section you will need one "A," two "B" and two "C" ribs. These are shown on Plan 3 as "8" for the "C" ribs, "9" for the "B" ribs, and "10" for the "A" rib. Make proper full-size tracings of these and transfer two "C" ribs to 1/16" sheet balsa and the remaining "A" and "B" ribs to 1/32" sheeting. Cut these five ribs out, notch each of them properly on top and bottom, and finish smooth with sandpaper. The leading inner spar, which is located along the upper edge of the ribs, is cut 1/16" x 3/16" to the length shown under "Lower Wing," which is the same. The trailing inner spar is cut 1/16" x 7/16" to the same length. When both these spars are cut to size and length, they are cemented to the ribs. Do not cement the outer ribs "8" at this time as these must be attached in place at an angle determined later. Space the three center ribs along these spars and cement in place, as shown. The leading edge spar is cut from balsa the same size and shape as were the leading edges of the panels. The trailing edge spar is cut to shape from 1/32" sheet balsa. When finished it should be 3/16" wide, as in the case of the panels. Cement these spars to the three center ribs. The 1/16" end ribs "8," or "C," are now attached. These must be applied at an angle so that when the outer wing panels are given their proper dihedral, the inner ribs of these panels will fit tightly against the outer ribs of the center-section. To do this, place the center-section flat on the bench. Place one panel in position against the center-section. Hold-



GERMAN DARMSTADT D-22 PLAN 2

ing its inner end flat on the table, lift its tip 15/16" above the bench. Move rib "8" until its face is flat against rib "7" of the tilted panel. Cement it in this position. The opposite end rib is then given its proper angle found in the same manner. When completed, cement the three sections together.

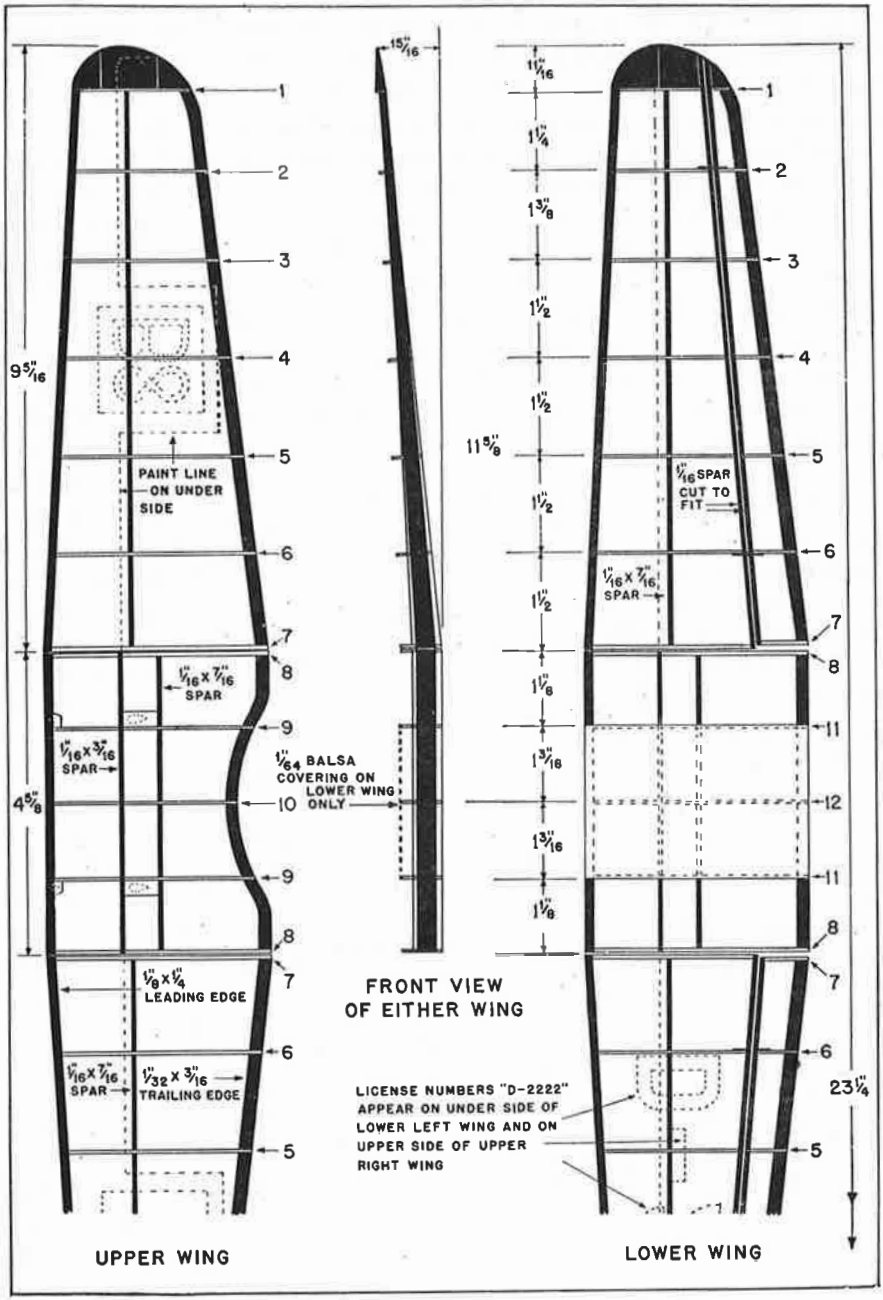
(Lower Wing). The construction of the lower wing is made in five parts: two main wing panels, one center-section and two ailerons. This is shown in Plan 3. All spars and ribs are of the same thickness and form. The outer left and right wing panels should be built up completely and fully assembled with the exception of cementing rib "7" to the structure. When all ribs, leading and trailing edge spars, and the inner wing spars are cemented together, take a razor blade and cut through each rib in the positions shown on them in Plan 2. The panel and the aileron are then finished with 1/16" spars cut to fit. Cement rib "7" in place to the wing, cut it off, and cement its trailing end portion that has been cut away to the inner end of the aileron. Note that the trailing edge spar and the leading edge spar of the aileron are slightly shorter than the spars of the wing panel. This is to permit the aileron free movement. The 1/16" spars that are used on the trailing edge of the wing panel and on the leading edge of the aileron should be left square to fit against each other, as shown in the plan under "Lower Wing." The center-section of the lower wing is constructed in the same manner as was that section for the upper wing. The dihedral angles of its outer ribs, shown in Plan 3 as "8" and in Plan 2 as "F," are obtained in the same manner as those of the upper wing. Cement the outer wing panels to this center-section with the same dihedral angles at its tips. The top of the center-section between ribs "12" and over "12" are covered with 1/64" sheet balsa, as shown. Do not apply the balsa sheeting on the bottom. The wing tips of the lower wing are made in the same manner as were those of the upper wing. In Plan 3 will be seen at ribs "2" and "6" the short copper wire hinges used to hold the aileron in place. These are embedded in the ribs, passed through the 1/16" spars of both the aileron and wing, and then fastened into the ribs of the wing panel. Fasten the ailerons in place on the wings in this manner.

STABILIZER. The stabilizer is shown in detail in Plan 4. Its ribs are shown in Plan 2. As the stabilizer and elevators are made separately, build the stabilizer first. The ten ribs it requires are shown together with the ten corresponding ribs of the elevators on squares representing 1/4" each on Plan 2. Make full-size copies of these, transfer them to 1/32" sheet balsa, and cut them out. When doing this work, cut those for the elevators at the same time. The trailing edge spar of the stabilizer consists of a single length of balsa measuring 1/4" high, 1/8" wide, and 9 5/8" long. Cut this

spar, space each rib against it in its proper location, and cement them to it. The leading edge spar is cut to size and shape from 1/32" sheet balsa. It is 3/16" wide along its entire length. As the ribs have been notched to take this spar, fit it in place and cement. Tips are made in the same manner from stock of the same size. The elevators are now made with the same size spars. When spacing the ribs on them, care should be taken to see that the ribs of the elevators are in line with those of the stabilizer, as shown in the plan. Complete both the elevators and the stabilizer by sanding them to a satin finish. The elevators are then attached in place to the trailing end of the stabilizer with copper hinges such as already used on the lower wing. Their locations are shown at ribs "5" and "2."

RUDDER. Details of the rudder are shown in Plan 4. As it is of the same construction as the stabilizer, no trouble should be experienced in making it. The seven ribs for the fin and rudder are shown in Plan 2 under "Rudder Ribs." It will be noted that ribs "1" and "2" are used for both the fin and the rudder. All spar sizes are given. Assemble the fin first. Great care must be taken when cementing rib "3" to the frame, as it must be given the same slant as that of the top of the fuselage on which it is cemented. The rudder is hinged with copper wire at ribs "3" and "1." Complete with fine sandpaper.

LANDING GEAR. A side view of the landing gear is shown in Plan 1 with each of its struts designated by letter. The details of these struts are shown on Plan 2 under "Legs," while a front view of the assembly is shown on Plan 4. All of the stock used for the landing gear should be as hard as possible to withstand the shocks it receives when the model is in use. The longest strut, which in this case carries the dummy shock absorber, is made in two pieces. This strut is designated as "A" in Plan 2. The large 5/8" wide portion and the 1/4" part at the left are cut to shape and streamlined as shown from a single block. The short 1/8" portion on the right is made separately, reinforced with a wire brace through it and the largest part, and then cemented in place. Make two of these "A" pieces in this manner and finish smooth with fine sandpaper. Part "B" consists of a single length of 1/16" x 1/4" x 2 7/8" balsa. It must be streamlined as shown in its cross section and then finished with fine sandpaper. Two of these pieces are also needed. The third and last strut "C" is a single length of 1/8" square balsa streamlined as shown in its cross section. Make two of these also. The wheels are manufactured ones of 1 7/8" diameter and are made of celluloid. These can be made of 1 3/16" balsa if you do not wish to purchase them. Do not assemble the landing gear until the fuselage has been covered, which will permit easier handling.



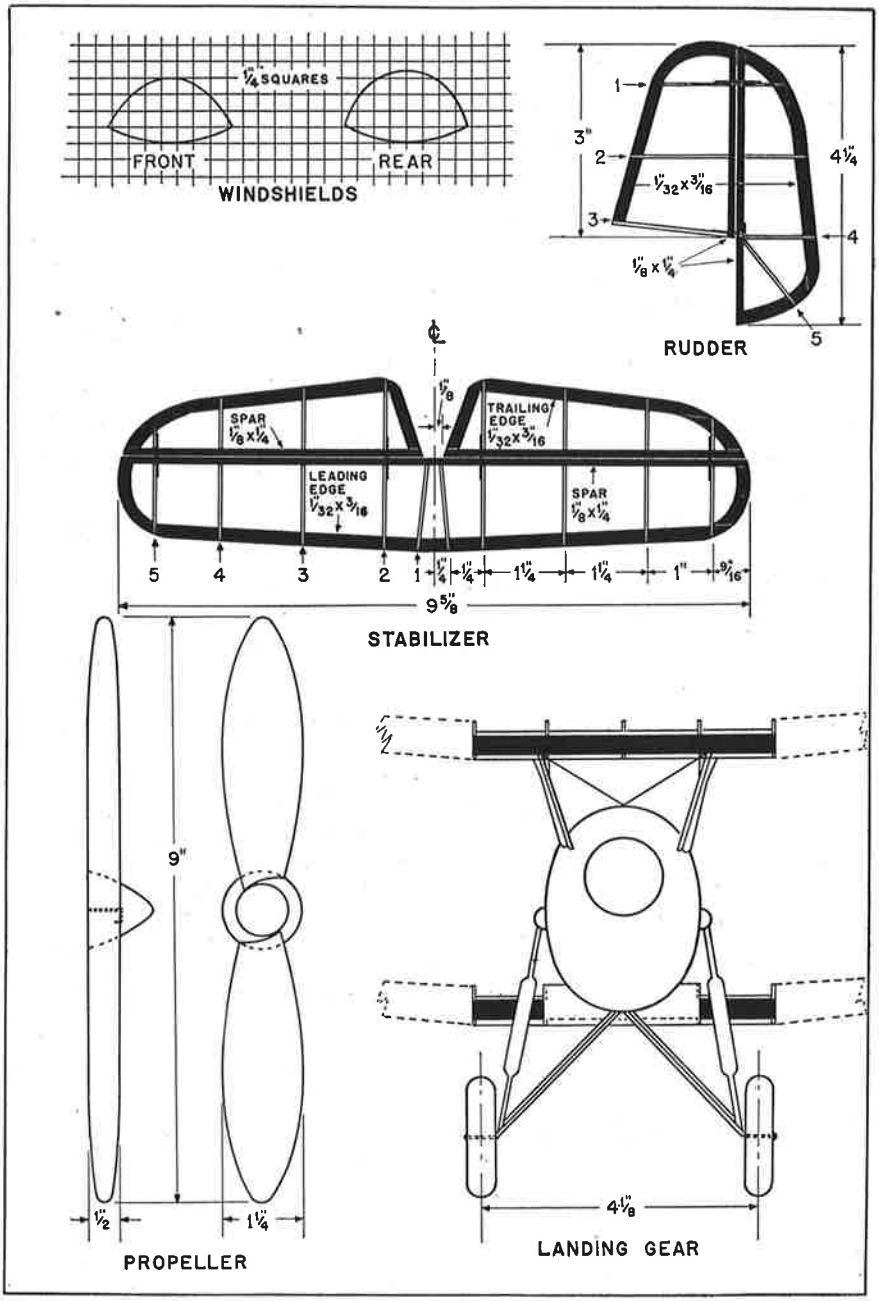
GERMAN DARMSTADT D-22 PLAN 3

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PROPELLER. The propeller for this model is carved from a medium-hard balsa block originally measuring ½" x 1¼" x 9" long. It is shown in Plan 4. Carve the block as shown in the front view and then taper its ends as shown in the side view. Note that the rear portion of the spinner, which is the largest in diameter, is carved as an integral part of the propeller itself. It actually forms the hub. A cone-shaped cap is then carved to finish out the form of a spinner. Be sure to sand the blades to an even thinness. The propeller shaft is bent from a No. 18 length of music wire. It is inserted into the propeller and cemented in place before the cap is cemented in place. When the shaft is in place and cemented in the propeller with its cap cemented over it and before its hook has been bent, pass a dural washer over the protruding end and then pass it through the nose plug bearing. Remove the nose plug when doing this. The hook of the propeller shaft is then bent and the nose plug replaced.

COVERING. The various parts of the model can now be covered. It will be found that the Mino tissue adheres perfectly when cemented with clear dope. It produces a fine, smooth finish after being painted with the color dopes. The fuselage is covered with strips of the tissue applied horizontally along it until completely covered. The shell is then finished with two coats of clear dope. All wing surfaces are now covered. Do each panel and the center-sections with great care. Spray lightly with water and when dry apply two thin coats of clear dope to them. Cover the stabilizer and rudder in the same manner, water-sprayed, and then finished with the two thin coats of clear dope. Care must be taken against the parts warping during the spraying and painting. None of these parts are assembled until after the color painting has been completed.

PAINTING. The coloring scheme used on the model is the same as that used on the real plane from which the model was copied. The whole model is finished in black and white, which produces excellent contrast and unusual beauty. The fuselage shell is painted first. To properly prepare it for this work, the letters "D-2222" should be traced in on both its sides, as shown in the photograph and Plan 1. This work is followed by painting these white. The square area of white on the engine cowl holding the identification number "B8" is also painted white. When dry, these numbers are traced in with pencil. They should appear on both sides of the cowling. Another method is to paint the area in which the "D-2222" marks appear and when dry to do the actual tracing of the letters on the white area. The indentation mark around the trailing edge of the cowling is also painted in white. The entire fuselage shell is then painted black. When approaching the lettering areas, it will be found that a fine even



GERMAN DARMSTADT D-22 PLAN 4

line can be struck around the edge of the letters and around the white squares on the cowling. This procedure will be found much easier than attempting to finish with the white lettering *over* the black. When the fuselage has been completely painted, the stabilizer and rudder are finished.

Study the accompanying photographs before attempting this work. Both these parts are finished off in the style required of German planes in commercial use. This consists of stripes of black and white. In each case these stripes run parallel with the ribs making up the part. They are 7/16" wide on both parts. The black stripe starts with the tip of the rudder, while the tips of the elevator are started in white. Rule off these stripes on both pieces. Filling an ordinary drawing pen from a drafting set with black dope, rule in these stripes. The black ones are then filled in with a brush. These are followed by the white ones. The wings are now painted. As these are the most difficult of the painted parts, full details have been shown on Plan 3. On the under side of the lower left wing appears the license number "D-2222," which is the only insignia appearing on the lower wing. Note that these numbers overlap into the black portion along the leading edge of the wing, and that as they do so they change from black to white. These same numbers appear on the upper right wing top, and they overlap and change colors in the same manner. The number "B8" also appears on the under side of the upper wing on both its outer panels. These are in black on a white surface and are framed with a black border, as shown in the plans and photographs. While this does not complete either the covering or the painting, it will be found best to start the assembly and do this covering and painting as that work progresses.

ASSEMBLY. Assemble the landing gear to the fuselage. This is shown in Plans 1 and 4. Note in Plan 4 that the wheels must be 4 1/8" apart from center-tread to center-tread of the tires. Axles are bent from No. 18 music wire, inserted through the hubs of the wheels, bent up, and then forced into struts "A." Struts "C" join the others at the axle and then join together under the center of the fuselage just behind its trailing end cowl line, as shown. Struts "B" start from the axle, where they are cemented to struts "A" and "C," and then extend back and up to a center point under the fuselage exactly in line with the joint formed by the two "C" struts. The "A" struts start at the same point at the axles and extend up on both sides of the fuselage, as shown. It will be noted that the tops of these last struts are set in small fillets. These can be easily made with a mixture of cornstarch and clear dope, which produces a quick-drying putty. All these struts are now covered with tissue. This covering permits them being painted and produces a clear high-gloss finish. They should be

painted white. Tires are black with white wheel centers. The upper wing struts are now cut to proper size and shape. These are shown in Plan 1 as "A," "B" and "C." Their dimensions are given in Plan 2 under "Struts." Two of each of these struts will be needed. In Plan 3 under "Upper Wing" will be seen the location of these struts on the outer side of the center-section ribs "9." Remove the tissue in small squares on the under side of this section of the upper wing, and insert 1/16" balsa sheeting between the spars and the ribs. The same procedure is followed with smaller pieces at the leading edge of the wing and ribs "9." These accommodate struts "C." Cut the six struts and streamline them, as shown in the plan. These are now mounted on the fuselage. They must likewise be covered with tissue and painted with white dope. The lower wing is now assembled on the fuselage in the section removed to take it. Cement it in place and then make the fillets required on each side of the fuselage. These can also be formed with the cornstarch and clear dope. After they have set, they are covered with the tissue and painted with black dope. Care must be taken to see that each wing tip has the same dihedral and is in position off the bench an equal height. It must also be checked when the stabilizer is attached. The upper wing is then cemented in place on the wing struts. Note that struts "A" and "B" are filleted at their point of contact on the under side of the wing. This fillet is shown in the photograph and is made with the same mixture of cornstarch and clear dope. Cover these fillets with tissue and paint with white dope. Be sure that all these joints are heavily cemented.

The stabilizer is now attached in place on the fuselage. In Plan 1 will be seen the section that is removed to permit the stabilizer being slipped into place. Make this cut in one piece across the top and into the sides to form an overlap. The stabilizer is then cemented in its seat and the capping section removed by the cut just made is cemented over it. When dry, the rudder is cemented in place by its fin. Note that the lower rib "3" is cemented to the top-center of the fuselage. Make sure that the fin is at right angles to the stabilizer when in place. The stabilizer brace struts are of 1/16" x 1/8" balsa cut to necessary length. They should be carefully streamlined and then cemented in place. The upper ends of these struts fit on the under side of the stabilizer at its trailing edge spar on ribs "3," while their lower ends fit against the sides of the fuselage near its bottom, as shown in Plan 1 under "Side View." Go over all joints where cement has been used and carefully scrape away any excess showing. All spots requiring touching up with the color dope should be attended to at this time. Complete the assembly by adding the wing strut braces between struts

"C." These are made with heavy white thread and should be painted when once in place. Note them in Plan 1 of the front view.

FLYING. Six or eight strands of 1/8" flat rubber are used to power the model. This strength may be varied to suit the builder in an effort to obtain a variety of flight results. The original model flew well from the first. It was found to require no nose weight, although the elevators were used with slight adjustments to give it the correct flight attitude. Before attempting power flights, test it by gliding the model over tall grass. If properly adjusted it should fly at a moderate speed with a long steady climb of steep enough angle to produce many and varied thrills.

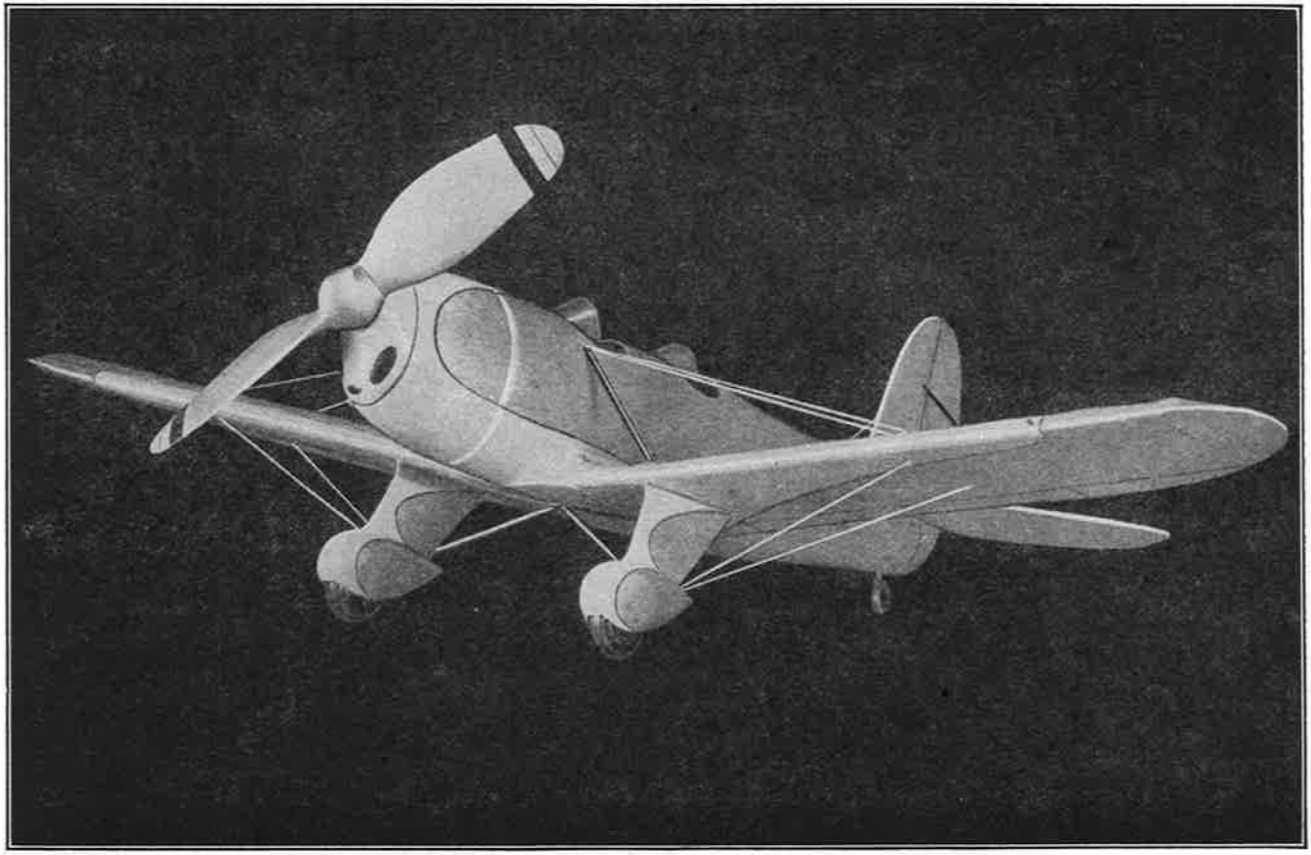
CHAPTER 51

RYAN S-T

THE Ryan S-T sport plane is manufactured by the Ryan Aeronautical Company, Lindbergh Field, San Diego, California. This is the same company that built Col. Lindbergh's famous "Spirit of St. Louis." The Ryan S-T is one of the most popular open-cockpit, low-wing sport planes in this country at the present time. It gives a high performance and its operating cost is little more than that of the average automobile. The engines with which it can be equipped range from 95 horsepower to 150 horsepower, which guarantee splendid flying qualities in all cases. The fuselage is an all-metal one of the monocoque type of construction. Wing and tail unit are of metal framework covered with fabric. When powered with a Menasco C-4-S engine of 150 horsepower, it produces a top speed of 160 M.P.H., and a rate of climb of 1,400 feet a minute. It can be safely landed at 50 M.P.H.

MATERIAL LIST

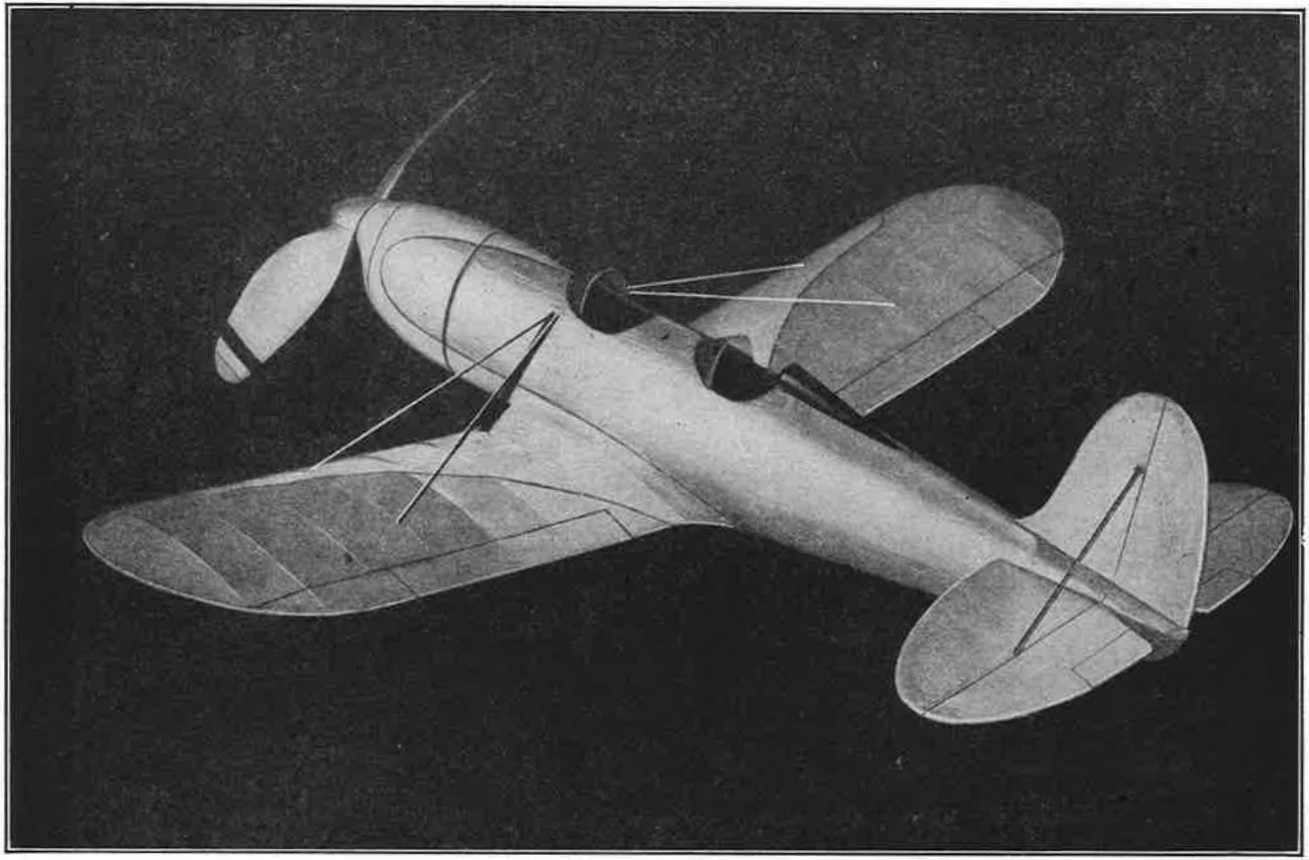
2 pcs.—	1″ x 2¾″ x 15″	—Balsa (Fuselage)
2 pcs.—	1″ x 1 1/16″ x 5″	—Balsa (Fillet Blocks)
1 pc. —	½″ x 1⅛″ x 2″	—Balsa (Nose plug)
1 pc. —	½″ x ¾″ x ⅞″	—Balsa (Tail plug)
1 pc. —	1/16″ x 3″ x 36″	—Balsa (Ribs and Outlines)
1 pc. —	1/32″ x 2″ x 36″	—Balsa (Wing edge covering)
2 pcs.—	1/16″ x 1/16″ x 12″	—Hard Balsa (Leading Spars)
2 pcs.—	1/16″ x 1/16″ x 12″	—Hard Balsa (Lower wing spar)
2 pcs.—	1/16″ x ⅛″ x 12″	—Hard Balsa (Upper wing spar)
2 pcs.—	1/16″ x 1/16″ x 12″	—Hard Balsa (Rear spar)
2 pcs.—	3/32″ x ⅜″ x 12″	—Balsa (Trailing spars)
2 pcs.—	¼″ x ¼″ x 1⅞″	—Balsa (Landing Gear Supports)
2 pcs.—	⅛″ x 3/16″ x 1⅞″	—Balsa ("K" struts)
4 pcs.—	½″ x 1¼″ x 2¾″	—Balsa (Wheel pants)
4 pcs.—	⅛″ x 1⅜″ x 2½″	—Balsa (Landing gear legs)
1 pc. —	7/16″ x ⅜″ x 3¼″	—Balsa (Headrest)
1 pc. —	1/16″ diameter x 1″	—Pine (Dowel Bushing)
1 pc. —	1/16″ x 5/16″ diameter	—Pine (Tail wheel)
1 pc. —	⅞″ square block	—Balsa (Propeller spinner)
1 pc. —	⅝″ x 1″ x 6½″	—Balsa (Propeller)



RYAN S-T

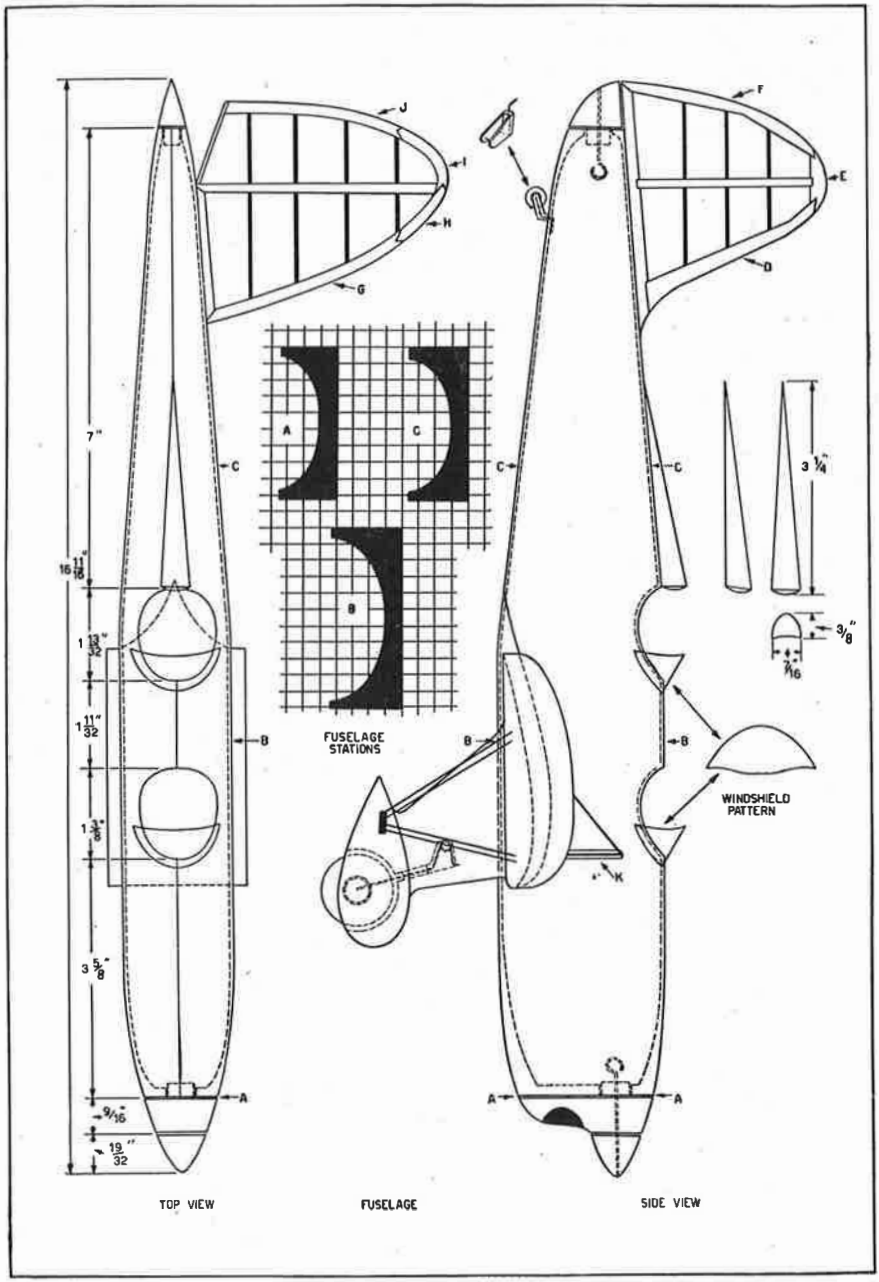
1 pc. —12" long —Music Wire No. .010 (Fittings)
1 pc. —⅛" flat x 11' 0" long—Rubber (Motor)
2 sheets —Japanese Tissue
Fine Sandpaper
Celluloid
Brass Eyelet
White Thread
Cement
Banana Oil
Silver, Yellow and Red Dope
Washers

FUSELAGE. The fuselage is shown in Plan 1. As will be seen it is of the hollowed-out variety, which was followed in its construction to simulate the metal covering of the real plane. Two blocks of soft clear-grained balsa will be required for the fuselage. These must measure 1" x 2¾" x 15", which will leave enough excess material to allow for proper shaping of the fuselage. The two blocks should be cemented together at two or three points to give temporary adhesion. When this joint has dried, the exterior of the fuselage is carved to shape. This work is best done in two separate operations. The first of these requires a full-size copy of the top and side views of the fuselage outline. The proper dimensions for these drawings should be found by measuring the height and width of the inside curve of the templates. These are shown in Plan 1 under "Fuselage Stations." The dimensions along its length will be found beside the top view in the same plan. The templates are shown on ¼" squares. When both these views have been brought up to full size, the side view should be traced on the side of the block and the top view on the top of the block. Only the actual outline of the fuselage will be necessary, and this should not include the nose and tail plugs. These two parts may, however, contribute toward properly laying out the full-size views, as they can be measured for definite dimensions. These are shown in Plan 3 on ¼" squares. When the outline of the fuselage has been traced on the block the block is carved down to these guide lines. Carve the sides first and then the top and bottom. This completes the first carving operation. The second carving operation brings the exterior fuselage to its true shape. For this work, the templates must be used. Make full-size copies of the three template forms shown as "A," "B" and "C." Rule paper with ¼" squares and copy each one on them. Trace these on stiff cardboard and cut them out. The various locations of these templates along the fuselage are shown in Plan 1. The inner circular portions of the templates designate the shape of the fuselage at these points. Proceed to carve the exterior of the fuselage to its proper shape



RYAN S-T

and size. When the work has been completed and carefully checked, the entire surface is finished with sandpaper to produce a satin finish. The two blocks are now broken apart. The inside areas of these blocks must be removed until a 1/16" wall remains. In Plan 1 will be seen the inside of the fuselage wall shown in dotted lines. Note that this thickness is maintained throughout except at the tail and nose where it widens out. Any suitable tool, such as a sharp knife, gouge, or fine 1/4" chisel, may be used for this job. It need not be too smooth inside, but should be finished as nicely as possible. As the proper thickness of the walls is approached, the cutter should be substituted for fine sandpaper. By holding the shells against a strong light, you will be able to detect any thick areas needing additional touching up. Use every care to obtain walls of uniform thickness. When this has been completed, a single coat of black dope is recommended on the inside to remove any "raw" appearances of the cutter. When finished, a 3/8" square hole is cut in the nose of the fuselage to hold the nose plug, as shown in both views of Plan 1. A 1/4" x 3/8" hole is cut in the rear of the fuselage to accommodate the tail plug. Make these cuts at this time. The blocks are now placed in position together and inspected for any flaws. Use cement generously between the blocks, wrap strong rubber bands around them, and set the fuselage shell away to dry. When the cement has set, remove the bands and sand the shell carefully. Remove all signs of excess cement in this manner. Once again check size and shape with the templates and the fuselage shell is completed. The nose plug is now made. This is shown on Plan 3 under "Nose Plug," where it appears on 1/4" graph squares. Rule paper with 1/4" squares and copy the plug on it. Transfer the front of the plug without its small extension in the back on the 1/2" x 1 1/8" x 2" balsa block. Carve this piece out, sand smooth, and then cement the plug in place on it. This small plug is 1/4" thick and 3/8" square. Test it in the hole made in the nose of the fuselage for proper fit. The tail plug is made from the 1/4" x 1/4" x 3/8" balsa block. Its backing piece is then cut to the shape shown on 1/4" squares under "Tail Plug" in Plan 3. This is carved from the 1/2" x 3/4" x 7/8" balsa block. When properly shaped, the small nose plug is cemented in place, as shown in the plan, which forms the finished tail block. This too must be made to fit into its hole in the rear of the fuselage. Both these fits should be snug without being too tight. A rear hook is bent from No. .010 music wire and cemented in place in the tail plug, as shown in the side view of Plan 1. With a sharp knife, cut out both cockpits after they have been outlined in pencil. These will be seen in the front view of Plan 1. The headrest, shown in the same plan, is shaped from 7/16" x 3/8" x 3 1/4" balsa, and is then

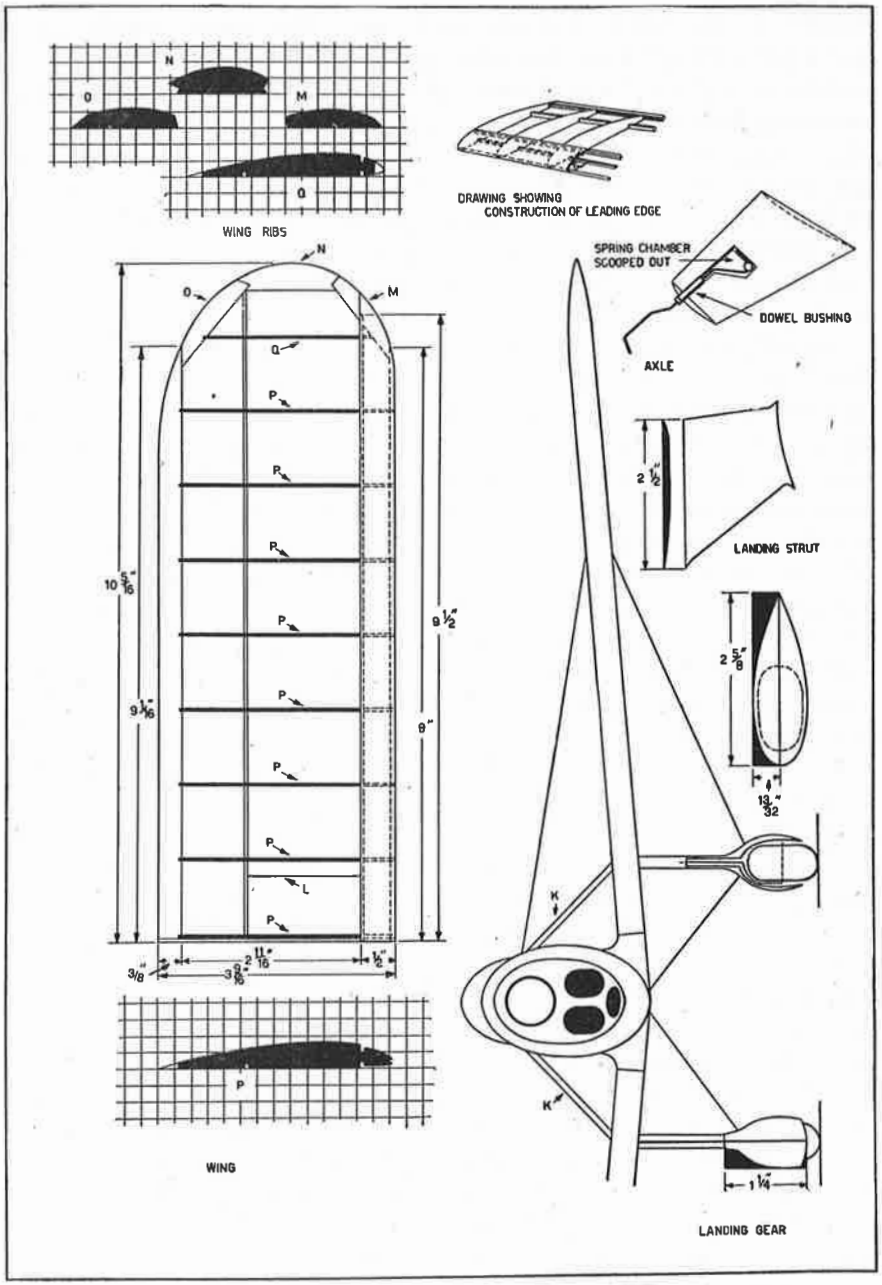


RYAN S-T PLAN 1

cemented in place at the trailing edge of the rear cockpit on the top-center of the fuselage. Sand the edges of the cockpits and at the same time remove all traces of cement around the headrest. The windshields are not put on until after the model has been painted. The tail wheel is made up of a half-rounded post to whose sides thin sheet balsa pieces are cemented, as shown in the side view of Plan 1. This has a short length of wire thrust through the post and into the fuselage, where it is cemented in place. The tail wheel is inserted between these balsa lips and held with a short pin used as an axle. In Plan 3 will be found the details of the wing fillets. As shown in Plan 1 these fit on the lower sides of the fuselage and extend under the bottom of it. While they appear to be one block, they are actually made in halves and then—when in position on the fuselage—they have the appearance of one piece. Each of these is carved from a block measuring $\frac{7}{8}$" x $1\frac{1}{16}$" x $4\frac{5}{8}$" long. They must be given a curve on their inner sides that will match the contour of the fuselage at the point to which they are cemented to it, as will be seen in the front view. When these pieces have been finished, they should be cemented in place on the sides of the fuselage. When dry, sand to remove excess cement, which should have been generously applied.

ELEVATOR. The elevator is shown in detail on Plan 1. It is constructed in two halves. The edge spar, which fits against the side of the fuselage, measures $\frac{1}{16}$" x $\frac{1}{8}$" x $2\frac{1}{16}$" long. It remains perfectly straight along its outer edge, while its inner edge is shaped to fit the slight curve of the fuselage side. The inner spar is $\frac{1}{16}$" x $\frac{1}{8}$" x $3\frac{5}{8}$" long. Cut both these pieces from $\frac{1}{16}$" sheet balsa. The ribs are all $\frac{1}{16}$" square balsa. The forward ones, which extend from the inner spar to the leading edge spar "G" are $1\frac{5}{8}$", $1\frac{1}{8}$", 1" and $\frac{5}{8}$" long reading from the inner end toward the tip. The corresponding ones extending from the inner spar back to the trailing spar "J" are $1\frac{1}{16}$", $1\frac{1}{32}$", $1\frac{5}{16}$" and $1\frac{1}{16}$" long. Cut these eight ribs and cement them on each side of the spar at right angles to it. They should be spaced evenly along its length. The edge pieces "G," "H," "I" and "J" are now cut from $\frac{1}{16}$" sheet balsa $\frac{1}{8}$" wide. These are shown on $\frac{1}{4}$" squares in Plan 3 under "Elevator." Make full-size tracings of these, transfer them to the wood, and cut them out. Cement each in its proper place. Sand the frame when the cement has set to clean it up and give leading, trailing and tip spars streamlined forms. Complete the second half in the same manner. The elevator is covered later.

RUDDER. The rudder is of the same construction. All outline edge pieces are cut from $\frac{1}{16}$" sheet balsa. These are shown in Plan 3 under "Rudder." Make full-size copies of pieces "D," "E" and "F" on $\frac{1}{4}$" squares,



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transfer to the balsa, and cut each out. The inner rudder spar is 1/16" x 1/8" x 21 1/16" long. The edge spar, which fits against the top of the fuselage, is 1/16" x 1/8" x 3 7/8" long. All ribs are 1/16" square. Their lengths, measuring from the inner spar forward to the leading edge spar "D," are 1 3/16", 15/16" and 5/8". Their corresponding ones running from the inner spar back to the trailing edge spar "F" are 1 3/16", 1" and 3/4" long. Cut all these pieces and cement them to the inner spar at right angles to it. The outline spars "D," "E" and "F" are then cemented in place, and these are followed by the edge spar, which completes the assembly of the rudder. It is covered later.

WING. The wing is made in two halves. Its details are shown on Plan 2. Ten ribs are required for each half. These are shown in the same plan by "P," which is the long rib, and "Q" the shorter tip rib. Rule paper with 1/4" squares and make a full-size tracing of both these ribs. Note that the leading nose of each of these ribs is recessed 1/64". This recess runs from the bottom front notch around the tip to the top notch. Cut out this recess on all the ribs when they are being made. Trace eight "P" ribs and one "Q" rib on 1/16" sheet balsa and cut them out. Note that each of these has three 1/16" square notches cut in it together with a fourth notch of the same size to take the leading edge spar. Trace one additional "P" rib without any notches in it on the sheet balsa and cut it out. This blank should also carry the additional length of the trailing edge spar shown in the plan in white, as it ends the wing half on its fuselage end and caps the leading, trailing, and three inner spars of the wing. It is shown in the plan on the lower end of the wing half by a double line and is located against the first "P" rib. When all these ribs have been cut out, place one on top of the other to see that all are exact duplicates in outline with the one exception of rib "Q." The leading edge spar is 1/16" x 1/16" x 9" long. The leading top and bottom inner wing spars are 1/16" x 1/16" x 9 1/2" long. The trailing edge spar is 1/16" x 3/8" x 9" long. Cut these four spars, space the ribs equally along them, and cement each in place at right angles to the spars. Cement end rib "P," which was cut without notches, against the last "P" rib on the inner end of the wing half. The wing tip is made up of three balsa outline pieces. These are shown on 1/4" squares as "M," "N" and "O." Piece "M" is traced on 3/16" sheet balsa and cut out. Pieces "N" and "O" are traced on 1/16" sheet balsa and cut out. They are then cemented together, as shown, to form the wing tip. Trim the trailing edge spar and the leading edge spar at their tip ends to conform with the contour of the tip as formed by the three pieces "M," "N" and "O." Cement this half-circle to the ends

of all spars. The trailing inner wing spar is now cut 1/16" square to length and cemented in the bottom notches of the ribs. Sand the tip to obtain the tapering contour shown in the front view of the plane in the same plan. The recessed front of the ribs is now covered with 1/64" sheet balsa. Two lengths are used. One covers the bottom and the other the top, and their edges meet along the leading edge spar. This covering runs from the leading edge spar back to the front inner spars, as shown in the same plan under "Drawing Showing Construction of Leading Edge." Cement this covering in place and then sand lightly. The sheet balsa should be held in position to the ribs and spars until thoroughly dry. The trailing edge must be sanded down to the form shown in the graph. The landing gear brace "L," which is shown in Plan 3 under "Detail L," is cemented between the front and rear inner spars and against the second "P" rib, as shown. Cut it 1/4" square and 1 13/16" long to fit snugly. When cementing this brace in place, it should be located flush with the straight lower edge of the rib. Cover the wing later.

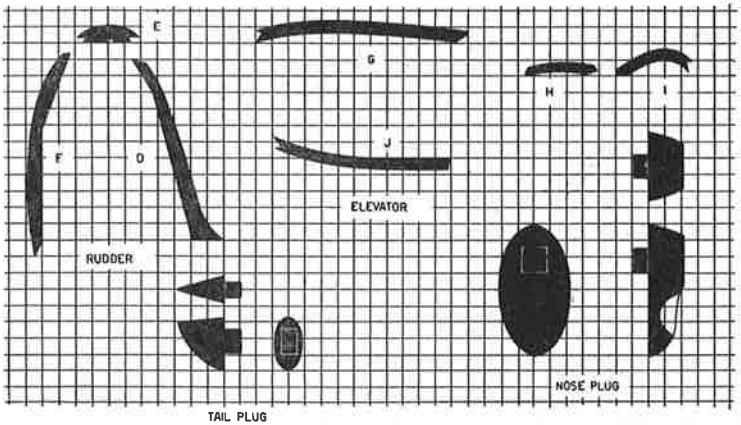
LANDING GEAR. The landing gear consists of two landing gear struts, two wheel pants and two wheels. The struts are constructed in halves. These are shown in Plan 2 under "Landing Strut." Each half is cut to shape from a 1/8" x 2 1/2" x 1 7/8" long piece of balsa. The lower end, which fits on top of the wheel pant and is shown in Plan 1, is 1 3/8" wide. It is shaped for this fit after the wheel pant has been made. A spring chamber is hollowed out of one half, as shown in the plan. An axle is shaped from music wire. This shape from the front is shown in the front view of the landing gear. It is passed through a 1/16" diameter dowel cut 1" long, which is of pine. The wire is then looped once to form a spring, and its upper end held by spring against the top of the spring chamber. The dowel is cemented into the entrance of this chamber so that it extends out 3/8" below the base of the strut half. Apply cement to both halves of the strut and clamp them tightly together. When dry, sand the piece to streamlined form on its exterior, but do not attempt to finish its bottom end. The wheel pant is also made of two halves. It requires two balsa blocks measuring 1 3/16" x 1 1/4" x 2 5/8" long. Each half must be scooped out 5/16" deep and in a 1 1/4" half-circle. When these are cut out, the exterior of each is given its proper form, as shown in the side view of Plan 1. Note in this same view that the dowel extends down into the top of the pant. The pant must be bored to take it, but its halves should not be assembled at this time. When the top curve of the pant has been cut, the bottom edge of the strut is shaped to fit it. The wheels are of the "doughnut" variety fully explained on page 125 under "Balsa Doughnut Wheels."

They are cut 1/2" thick and 1 1/16" in diameter. Complete two struts, two pants and two wheels. These units are now assembled. Thread a wheel on its axle, cement the wheel pant halves together, and at the same time cement the strut on top of the pant with its dowel in the pant. Set aside to dry. Both units should be assembled in this manner, but are not cemented to the wing until later.

PROPELLER. The propeller is carved from a block of medium hard balsa measuring 5/8" x 1" x 6 1/2" long. The design best suited to this model is shown on page 90, Fig. 49. The spinner is shaped conical from a block of balsa 7/8" square. A portion of its rear face is removed to allow the hub of the propeller to be cemented in place in it. Remove the nose plug and force a small hole all the way through it to take the music wire, propeller shaft. This is then forced into the hub of the propeller and then on into the spinner cap, where it is cemented in place. A washer or two, or a bead, should be used between the nose plug and the spinner. When thus assembled, the protruding end of the shaft is bent into a hook, as shown in the side view of Plan 1. Replace the nose plug in the fuselage.

COVERING. The entire fuselage should be covered with white tissue, sprayed with water, and then set aside to dry. Cover the elevator halves and the rudder on both sides and spray in the same manner. Care should be taken to hold these parts flat on the bench while drying to prevent warping. The wing halves are covered with two sheets. One completes the under side and top side of one half, while the other is used on the second half wing. Water spray these surfaces while held firmly to the bench. The landing gear struts and pants are likewise covered with tissue, which permits their surfaces to take the color dope properly. All of these parts should be water sprayed and then allowed plenty of time to dry naturally.

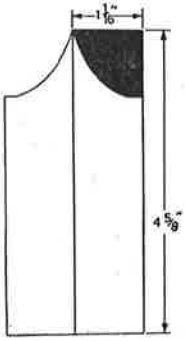
ASSEMBLY. The wing halves are cemented on each side of the fuselage to the stubs of the wing fillets. If these have been made perfectly the wing tips will have a natural 1 1/16" dihedral, but it is best to measure this height and obtain it when cementing the halves in place. The tips should be supported this height above the table while the cement is drying. Cement the rudder in place on the top-center of the fuselage, but see to it that its keel edge is not cemented to the removable tail plug. Note this in Plan 1 in the side view. The elevator halves are now cemented on each side of the fuselage shell, as shown in the top view of the same plan. Check the rudder and elevator for perfect alignment. These pieces must form right angles with each other. Cut two rudder braces 1/16" x 1/16" of balsa, streamline them, and cement them between the rudder and the elevator on both sides, as shown in the photograph. The landing gear



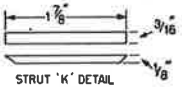
TAIL PLUG



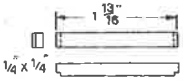
PERSPECTIVE SHOWING WING FILLET



BOTTOM VIEW



STRUT 'K' DETAIL



DETAIL 'L'



FRONT VIEW

SIDE VIEW

WING FILLET DETAIL

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struts are cemented to the under sides of the landing gear braces "L." Note that they extend down perfectly straight, as shown in the front view of Plan 2.

PAINTING. The entire model is a combination of yellow and silver. Trace in light pencil lines the border of these colors on the fuselage. The one showing darker in the photographs is the yellow. Put the border lines in with India ink and then apply one coat of silver on the lower portions of the fuselage and around the nose and a coat of yellow dope over its top. The inside of the cockpits will show black and the headrest is red. Elevator, rudder, spinner and propeller blades are silver. Note the silver and yellow outlines on the wings and landing gear. Follow these suggestions closely. The wing struts are now cut from $\frac{1}{16}$" x $\frac{1}{8}$" balsa, streamlined, and cemented in place, as shown in the side view of Plan 1 and the front view of Plan 2 by the letter "K." Note that they fit directly over the landing gear struts. The flying wires shown in the photographs and plans are now added. White thread is used in this case.

FLYING. Six to eight strands of $\frac{1}{8}$" flat rubber are used for this model. The motor is attached with the use of "S" hooks, which are bent and attached to the propeller shaft at the front and the rear hook at the back. Glide the model over tall grass for test. Weight may be added if necessary. When good glides are obtained, wind the motor about half strength and test in the air. The author expresses his appreciation to Mr. Jesse Davidson for the use of this model. Mr. Davidson, long an expert in model building, gave this model for use in this book, and from past experience the author can guarantee good results from any model designed and built by Mr. Davidson.

CHAPTER 52

BRITISH WESTLAND COÖPERATION

IT is doubtful whether the British Royal Air Force ever possessed a faster or more useful plane than the Westland Coöperation A39-34. Here is one of England's premier fighters which keeps her Air Force one of the greatest single fighting units the world has ever known. As temporarily designated, it has a span of fifty feet and a length of thirty. At the present time it is powered with a poppet-valve Bristol Mercury engine developing 600 horsepower. However, this engine is being changed in the production of the A39-34 to a new sleeve-valve Bristol Perseus 825 horsepower engine. One of its many unique features is its Handley Page slots and flaps, which enable it to get into and take off from small fields such as encountered during wartime conditions. It is also equipped with a twoway radio, photography apparatus, an automatic, controllable-pitch, three-bladed propeller, heating units for high altitudes, and is constructed of metal framing covered with fabric. It carries enough fuel to sustain flight for six hours. Tail units are covered with a light metal alloy sheeting, and the cockpits are so situated as to permit the pilot and his gunner a maximum amount of vision at all times and at the same time be in direct communication with each other. The pilot is seated exceptionally high up in front of the observer. The landing gear is of the single strut type with wheels covered by peculiarly shaped pants.

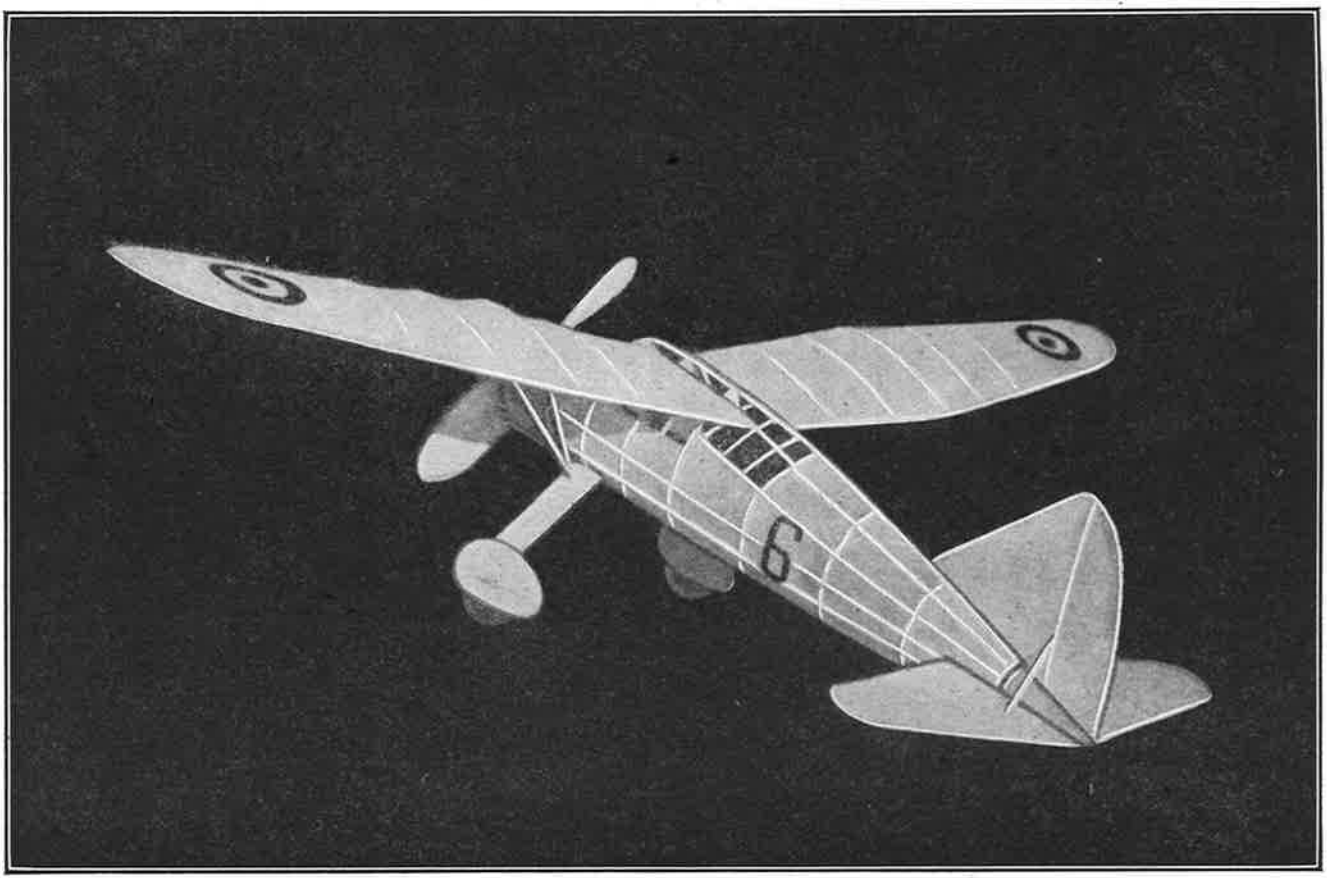
The author expresses his appreciation to the builder of the model, Robert Harrison, who co-operated in permitting it to appear in these pages. The flyability of the model is quite good due to the gull-shaped wings and the lightness of its construction. Mr. Harrison's model, as shown here, has flown for half a minute, but with all "extras" removed, which will greatly lighten it, the plane will be good for flights of over a minute and is recommended for flying scale contests.

MATERIAL LIST

1 pc. —1/16" x 2¼" x 24" —Sheet Balsa (Formers)
1 pc. —1/16" x 2" x 24" —Sheet Balsa (Ribs, Tail pieces)
1 pc. —1/8" x 2" x 12" —Balsa (Landing gear legs)

15 pcs.—1/16" x 1/16" x 18" —Strip Balsa (Longerons)
1 pc. —1/16" x 1/8" x 18" —Strip Balsa (Tail outlines)
2 pcs.—1/8" x 1/4" x 18" —Strip Balsa (Leading edge)
2 pcs.—1/16" x 1/4" x 18" —Strip Balsa (Trailing edge)
2 pcs.—1/32" x 1/32" x 12" —Strip Bamboo (Cockpit details)
3 pcs.—2 3/8" x 1/4" x 1/2" —Pine block (Scale Propeller)
1 pc. —3/4" x 1 3/8" x 6 1/2"—Medium Balsa (Flying Propeller)
1 pc. —7/8" x 7/8" x 1/2" —Pine (Nose Block)
1 pc. —1" x 1" x 1 5/8"—Medium Balsa (Tail plug)
1 oz. —Cement
2 ozs. —Banana Oil
1 oz. —Acetone
4 —British insignia (1 1/2")
2 —British insignia (7/8")
12" —Piano Wire (.028")
96" —Flat rubber (1/8")
1 sheet —Japanese tissue
1/2 sheet —Black tissue (Wing numerals)
1 sheet —Cellophane (6" x 12")
1 pair —Balsa Wheels (1 1/4")
6 —Brass Washers.
1 oz. —Silver Dope (Scale Model)

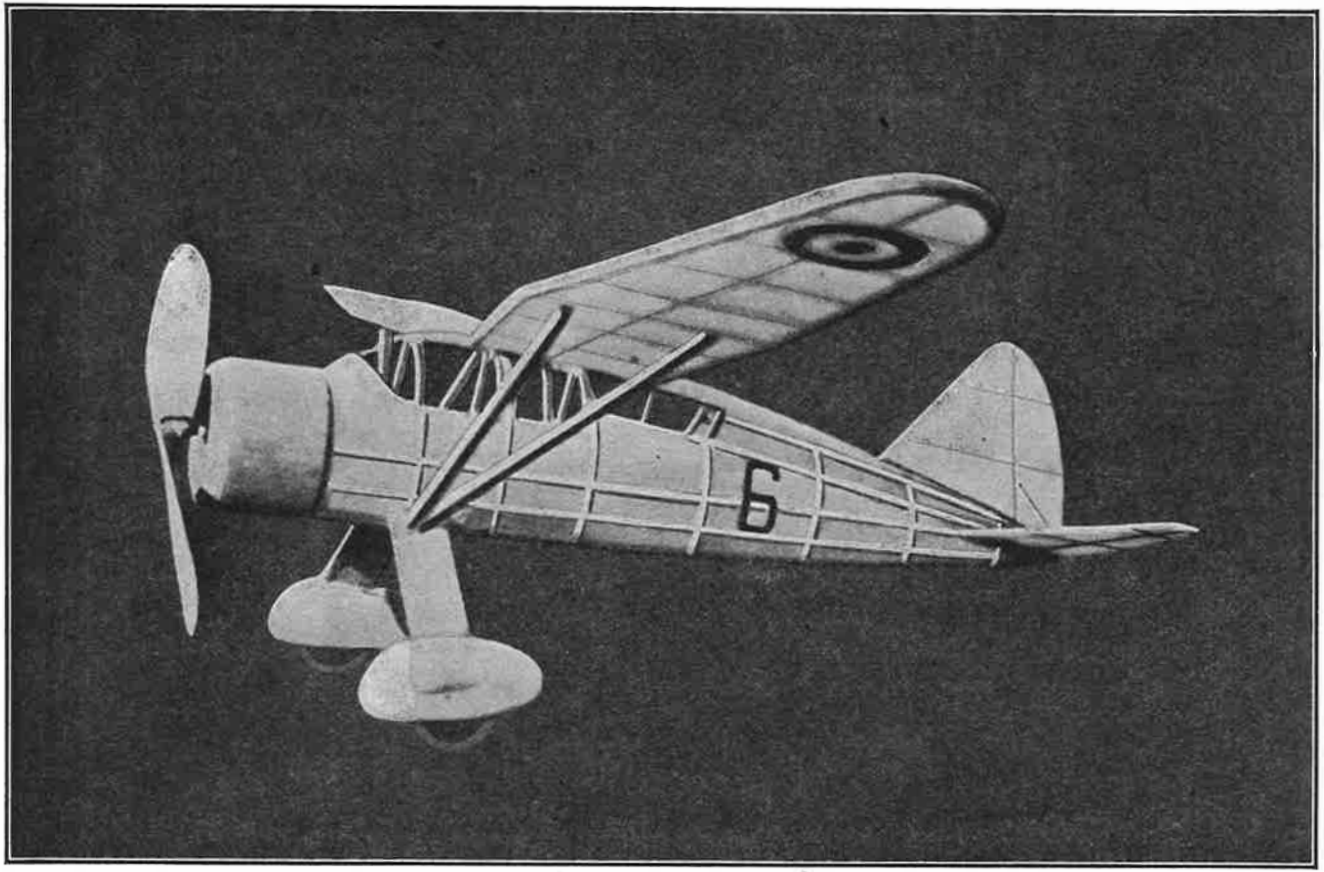
FUSELAGE. The fuselage with its formers is shown on Plan 1. The formers have been drawn on squares representing 1/4" each. Rule a sheet of paper with 1/4" squares and make full-size copies on it of each of the eight regular full formers and the half former "K." These are then traced on 1/16" sheet balsa and carefully cut out. Note that a 1/16" x 1/8" slot is cut on the bottom and sides of each of the full formers. These accommodate the master stringers. All other slots are cut 1/16" square to take the auxiliary stringers. To properly cut these three master stringers, a top view of the fuselage must be drawn full size. The curve of the bottom of the fuselage must also be drawn full size. When this has been done, lay out the bottom and side stringers on 1/16" sheet balsa. These should be cut 1/8" wide. When completed, cement these stringers in their respective slots in the formers. Be sure to space each former properly along the stringers, as shown in Plan 1 on the top view. The balance of the formers are cut 1/16" square. Cement stringer "F" in the top notch of each former. Note that this former, as well as former "E," start at former "5" and proceed to the tail former "8." They then start in again at former "4" and continue forward to former "2," where stringers "C" stop. Stringer "F" again starts in at half-former "K" and ends at former "1." The top windows between stringers "D" and extending between formers "4" and "5" are now covered with non-waterproof cellophane. Those extending from former "4" to former



BRITISH WESTLAND COÖPERATION

"K" between stringers "B" on both sides of the fuselage are likewise covered with the same cellophane. The frames for the top windows and the frame between formers "3" and "4" are made of 1/32" square split bamboo, as shown in the top and side views. The use of non-waterproof cellophane is recommended as it will shrink when the fuselage is water sprayed, which gives a neat and tight appearance to the "glass." The engine cowling is made up of two formers and 1/16" square stringers. Cut two 2 1/16" diameter formers from 1/16" sheet balsa. Remove a 1/2" diameter circle from the center of the one to be used on the leading end of the cowl. The other, which is cemented against former "1," should be cut away in the center to match that former. Notches 1/16" square must be cut in both these formers to accommodate the cowling stringers. Cement the stringers in place, but do not cement the cowl in place against former "1" at this time. The facing on the cowl consists of a 2 1/16" diameter balsa block 1/4" thick. It is given the exterior shape shown in the plan and then the center is cut out in a "1" diameter hole. This is cemented against the leading cowl former. A nose plug is cut from a pine block measuring 1/2" x 7/8" x 7/8". The plug portion must be cut to fit snugly into the hole made in the leading cowl former. The larger portion is given a 1 3/16" diameter conical form 3/8" thick, as shown. Cover the cowling with 1/32" sheet balsa. Cement it around the cowl formers and stringers, and then sand to obtain its slight curve, as shown. The cowl is now cemented to former "1" on the fuselage, which completes the front. The tail plug is likewise removable. It is shaped from a 1" x 1" x 1 5/8" balsa block. Bring it to a 1" diameter and then finish its length in a conical form, as shown in Plan 1. Turn up a 1/4" long block of pine to a 7/16" diameter, or better still, carve it to fit snugly into the hole of former "8." This is then equipped with a tail hook bent from .028 wire, as shown in Plan 2 under "Hooks." Cement the tail plug to the center of its backing piece, insert and cement the tail hook in place, and finish smooth with fine sandpaper. The tail skid is made of a balsa brace of 1/8" stock with a split bamboo runner, as shown.

ELEVATOR. The elevator is made in two halves. Both are shown in Plan 1 under "Elevator." The main spar of each half is 1/16" x 1/16" x 3 11/16" long. Cut both these spars at this time from balsa striping. The trailing edge spar is 1/16" x 1/8" x 3 15/16" long. Cut both these spars at this time. The leading edge spar is 1/16" x 1/8" x 3 11/16" long. Both these spars for both halves are now cut from balsa. Take your original, full-size drawing of the top view of the fuselage and lay out the curves of the "A" master stringers. The inner edging of the elevator halves must match these curves. They are cut 1/16" x 1/8". Do not cut these pieces to length until the as-

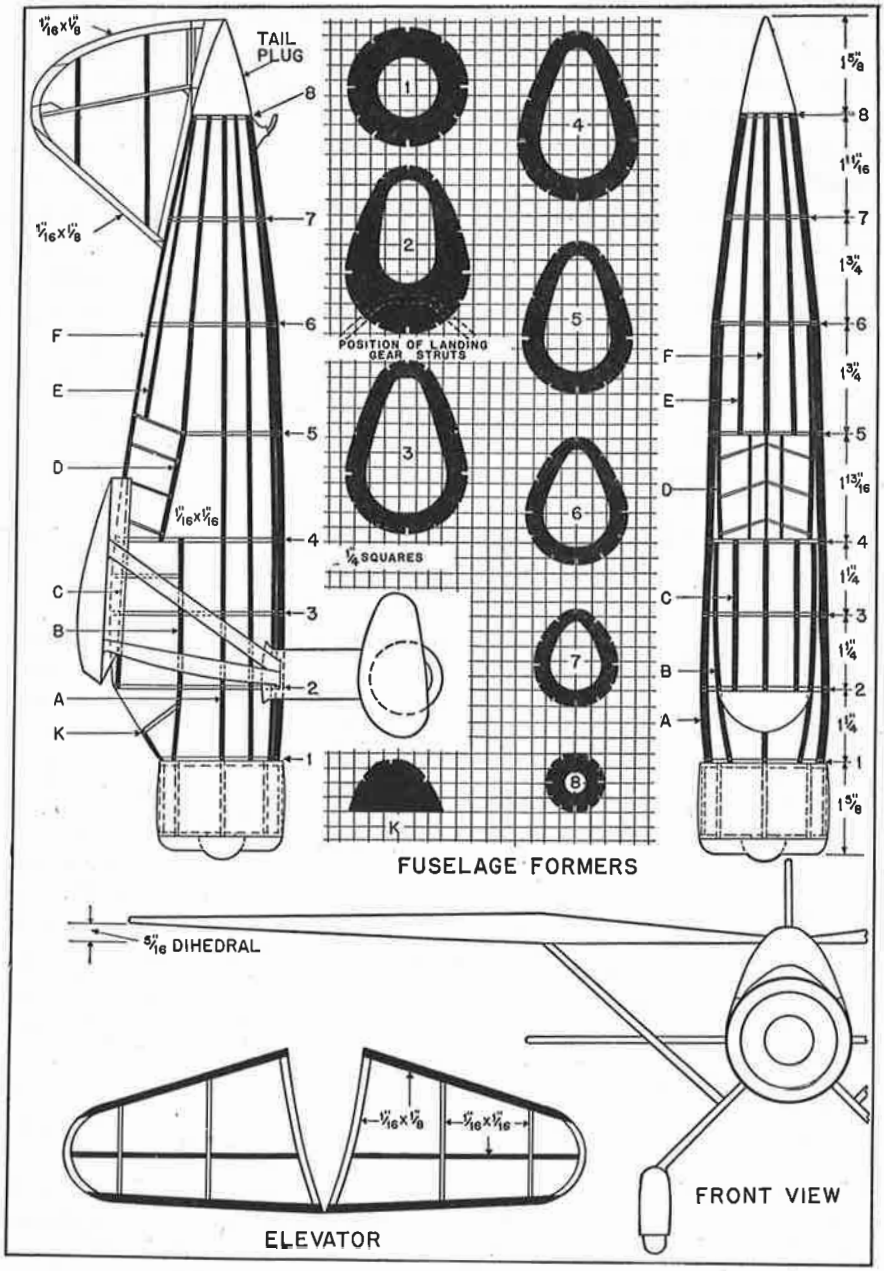


BRITISH WESTLAND COÖPERATION

sembly has been started. The tip rib is 11/16" long between the inner spar and the leading edge spar. It is only 5/8" long between the inner spar and the trailing edge. Locate these two ribs, which actually form only one, 3/4" from the outer end of the inner spar. It is cut 1/16" square and should be cemented on each side of the spar at right angles to it. The center rib, which is the same size, is located 1 3/8" in from the tip spar. It is 1 3/16" long between the inner spar and the leading edge spar. It is only 11/16" long from the inner spar to the trailing edge spar. Cement these two rib sections on each side of the spar, and then cut to length and cement the curved inside rib, or edging, in place. At this time, the leading and trailing edge spars are cemented in place. A curved tip is cut from 1/16" x 1/8" balsa and cemented to the three spars, as shown. Round the edges of the leading and trailing edge spars with sandpaper.

RUDDER. The rudder is shown in position on the fuselage in Plan 1. The keel edging of the rudder, which fits along the top-center of the fuselage, is cut to the required curve from 1/16" sheet balsa. It is perfectly straight on its upper edge with the curve made only on its bottom edge. This curve should be made by actually fitting it to the fuselage top. Cut the piece 1/8" wide at its widest point. It is then cut 3 3/4" long. The center spar is 1/16" square cut exactly 2 3/4" long. The center spar is placed at an angle, as shown, and the three ribs placed parallel with master stringer "A." The large center rib is 1/16" square cut 2 3/16" long from the inner spar to the leading edge. It is only 1" long from this spar to the trailing edge, and is located 7/8" up from the keel edging. The short bottom rib is 1/16" x 1/8" x 1 5/16" long. It is shaped to fit on the keel edge, as shown, and must be placed parallel with stringer "A" of the fuselage. Cement this rib in place and then cement the large center rib parallel with it and 7/8" from the base of the keel edging piece. Cut the leading edge spar 1/16" x 1/8" x 3" long. Cement it to the front end of the keel edging and the large rib. Complete the curve, as shown, with 1/16" x 1/8" balsa forming the upper tip and trailing edge spars. Add the top rib 5/8" down from the upper end of the main inner spar, which completes the rudder.

WING. The wing of this model is built up in two halves. The plans show only the left half, but as both are duplicated in construction the right half will not be needed. In Plan 2 the wing half together with its ribs is shown in full detail. As the ribs are shown on squares representing 1/4" each, it will be necessary to rule paper with squares of this size and make a full-size copy of each rib. Trace two of each of these ribs on 1/16" sheet balsa. Notches are 1/16" square and must be carefully located. Cut out these sixteen ribs and lay aside one set for the other half of the wing.

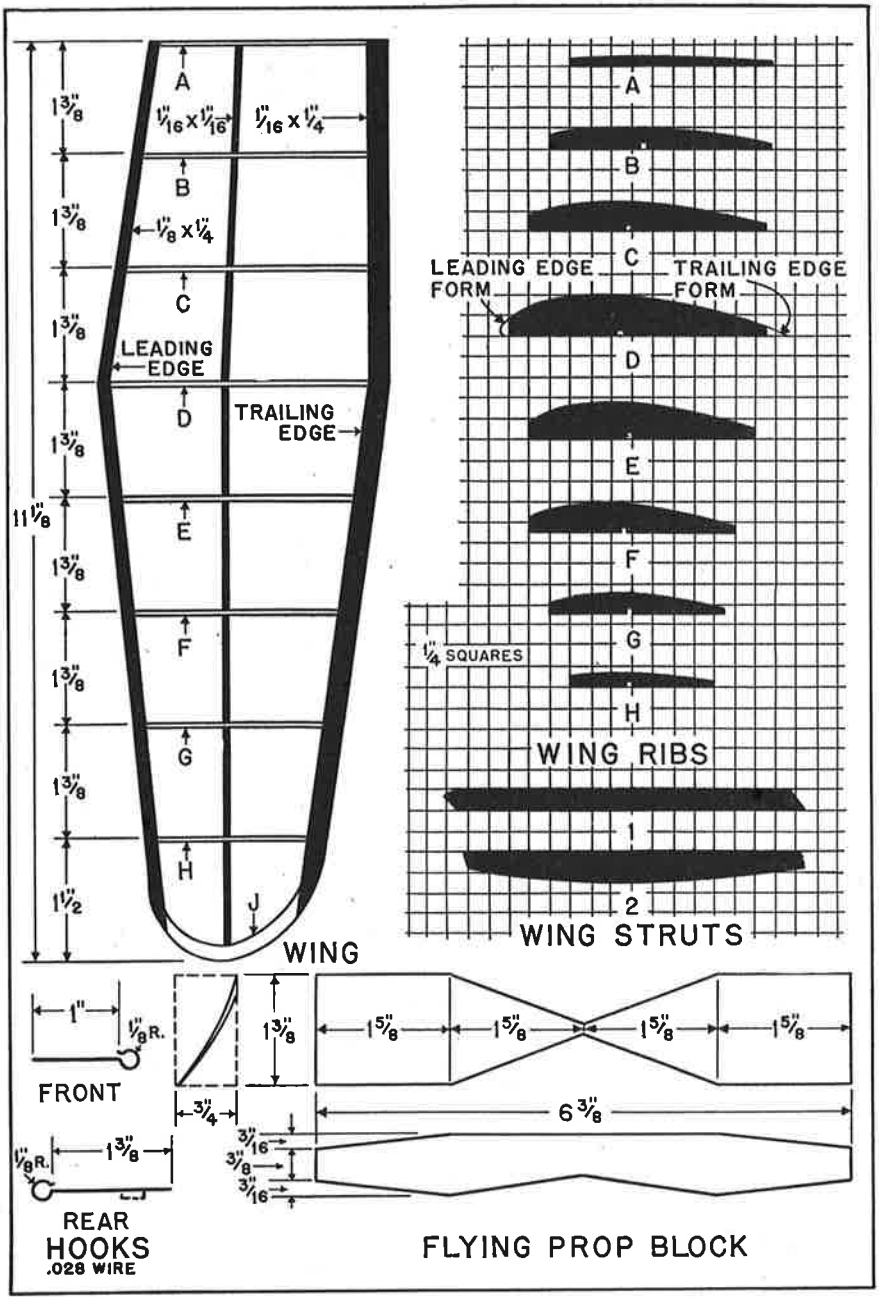


BRITISH WESTLAND COÖPERATION PLAN 1

The inner spar is 1/16" square and should be cut 11" long. Cement ribs "D," "E," "F," "G" and "H" in place on this spar, crack it slightly at rib "D," and proceed to cement ribs "C," "B" and "A" in place. Trim the spar to proper length at rib "A," but do not trim it at the other end until the tip has been made. The leading edge spar is 1/8" x 1/4" balsa. It must also be broken at "D" rib. Cement it in place to the ends of the ribs and then sand it to shape and taper, as shown under "Wing Ribs." The trailing edge spar is cut from sheet balsa 1/16" thick to a width of 1/4". It is cemented to the trailing ends of the ribs and then sanded to the shape shown. Apply cement over the breaks in the three spars to strengthen them. Outline the wing tips on paper and then cut them from 1/16" sheet balsa. They should be 1/8" wide. Cement one in place on the ends of the three spars, as shown. The right wing half is now made in the same way, which completes the wing structure except for its covering which is done later.

COVERING. Each wing half is covered with two sheets of white tissue. One of these will cover from rib "A" to rib "D" on both the top and bottom, while the second sheet will cover from rib "D" to rib "H" on both sides. This second sheet can be continued on over the tip if it can be made to cover smoothly. Start at the top of the trailing edge and bring the paper forward around the leading edge and then back to the under side of the trailing edge. If the tissue is glued only along the trailing edge, it will tighten nicely when the wing is sprayed with water. Hold the wing to the bench and spray lightly with clear water. Each elevator half is covered in the same manner and sprayed. The rudder is then covered and sprayed. Make sure that these pieces are held firmly to the bench to prevent warping. Because of the elliptical form of the fuselage's cross-section, it will be found best to cover it with several small strips of the tissue. These should cover one or two sections but no more. When speaking of sections, the space between two master stringers is meant. The cowling should also be covered with tissue, which completes the covering with the exception of water spraying. If, however, its flying ability is of secondary importance it should be painted with silver dope.

LANDING GEAR. The landing gear consists of two 1 1/4" diameter wheels of balsa. These may be made in the usual manner, as explained on page 123 under "Solid Balsa Rubber-tired Wheels," or they may be purchased. The pants are made of a balsa block and when finished should measure 1/2" x 1 1/4" x 2 3/8" long. They are made of two blocks as explained on page 128 under "Wheel Pants." The two landing gear struts are shaped from 1/8" sheet balsa cut 13/16" wide and 2 1/2" long. They are streamlined

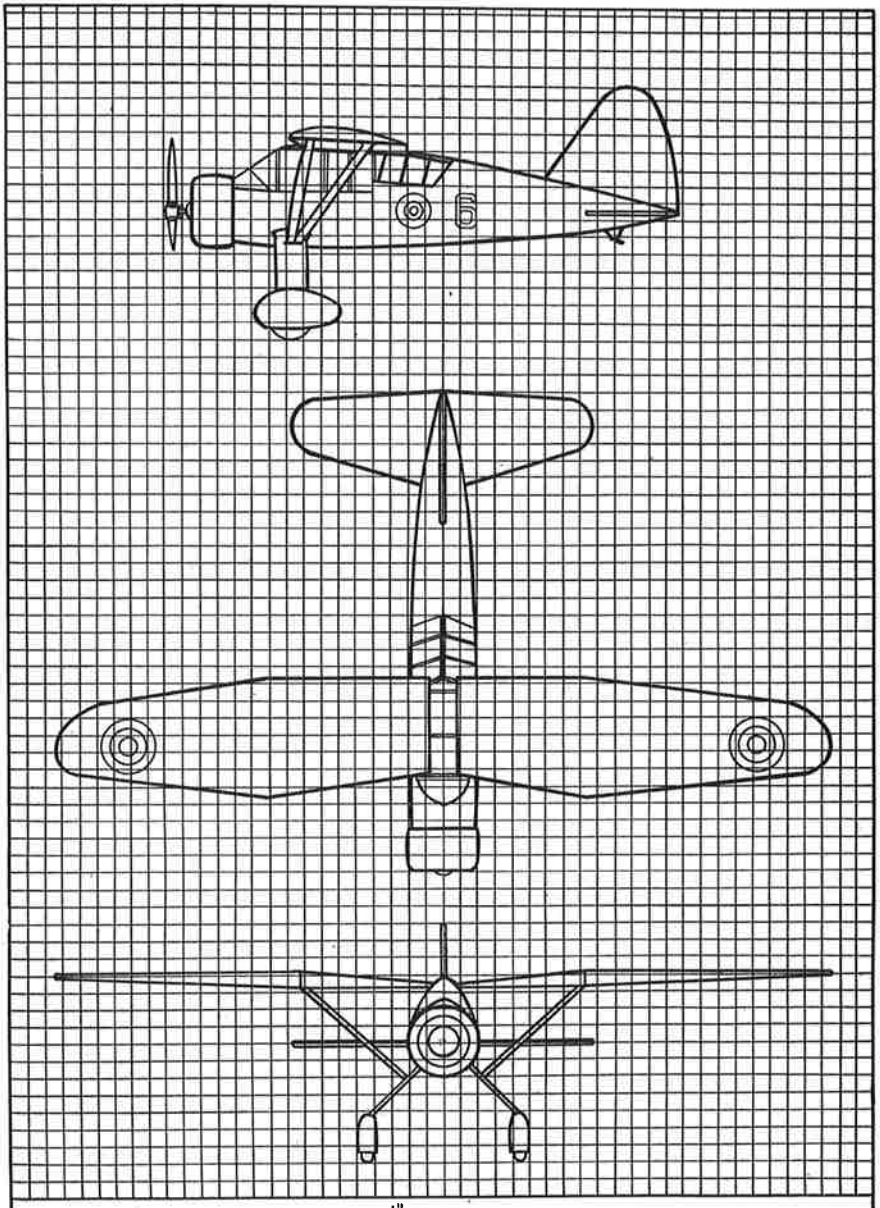


BRITISH WESTLAND COÖPERATION PLAN 2

and cemented into the slots cut in former "2" for them. The angle of these slots will determine the angle of the struts. Note that the wheel pants are then cemented to the ends of these struts at the tops of the pants. If properly constructed, the center wheel treads should be 2¼" apart. Attach the wheels in the pants with short piano wire axles cut to length. The landing gear should be painted with silver dope if the rest of the model has been so treated.

ASSEMBLY. Assemble the elevator halves by cementing them on both sides of the fuselage directly over the master stringers "A." The trailing edge of the elevator must be flush with the tip of the tail plug. Do not cement the elevator halves past the "8" former, as the tail plug must be free. When in position, the elevator is followed by the rudder. Cement its keel edge along stringer "F," but do not apply the cement past former "8." Make sure that the elevator is perfectly level from side-to-side, and that the rudder is at right angles to it. Both wing halves are now cemented into place on the fuselage. For exact location see Plan 1. Note that rib "A" on each half is cemented to the short stringer "C" extending between formers "2" and "4." In doing this particular job, great care must be taken to see that each tip is given a 5/16" dihedral, as shown in Plan 1 under "Front View." While the wing joints are drying, their tips should be held in this position by blocks. Four wing struts will be needed. These are shown on ¼" squares in Plan 2. Trace full-size copies of these on 1/16" sheet balsa and cut two of each one. They should be sanded to a good streamlined form and cut to length, as shown. It will be found best to cut these longer than shown in the plan, and then determine exact length by actual fitting. Struts "2" are located at the front of the wing strut assembly, while struts "1" fit behind. Note that their lower ends meet on the landing gear strut and their upper ends fit under and to rib "D." Assemble both wing strut units on both sides of the fuselage in this manner. If the builder finds that the water spray has not tightened his tissue as he would wish, he may further tighten the covering by applying a solution of 50 percent banana oil and 50 percent acetone with a brush. The number "6" appearing on each side of the fuselage must be carefully lettered in with a soft, sharp pencil, and the number then filled in with black dope. The wing cockades are of the British type and their size is 1½" in diameter. Small insignia may be added on each side of the fuselage, as shown on the solid scale plan. These should be ⅞" in diameter. This completes the model as far as the general structure goes.

PROPELLER. If a scale model is being made, a ¼" x ½" x 2⅜" block must be used from which to carve each blade of a three-bladed propeller.



1/8" SQUARES

SOLID SCALE PLAN FOR WESTLAND COOPERATION PLANE

Full instructions for such a propeller will be found on page 111 under "Three-bladed Exhibition Propeller." Sand them to shape and cement them into a hub 1/4" x 5/16" long. If the builder wishes to fly his model, a propeller must be carved in the usual manner from a balsa propeller block measuring 3/4" x 1 3/8" x 6 3/8" long. It will be seen in Plan 2. Lay out the block as shown in the plan and proceed to carve it as any other two-bladed, flying propeller. Sand the blades well and make a good job of it. Bend a front hook the same as any propeller shaft of .028 music wire. Drill the nose plug for this size of wire. Attach the wire in the usual way to the hub of the propeller, pass one or two brass washers over the protruding end of the wire, slip it through the nose plug when the plug is out of the fuselage, and bend its hook. Attach from three to five strands of 1/8" rubber of the best quality over the propeller hook. Shake it down and attach it over the tail hook. The plugs at both front and rear are then replaced and the model is ready for flight.

FLYING. If possible always test a new model over a field of tall grass which will break its fall should adjustment be wrong. Glide the model for a long even glide. Should it have a tendency to stall a little weight may be added in the nose. Lead shot glued into the cowling is recommended. When proper glides result give the motor a few turns and slowly increase until maximum strength is being used.

CHAPTER 53

GERMAN FOKKER D-7

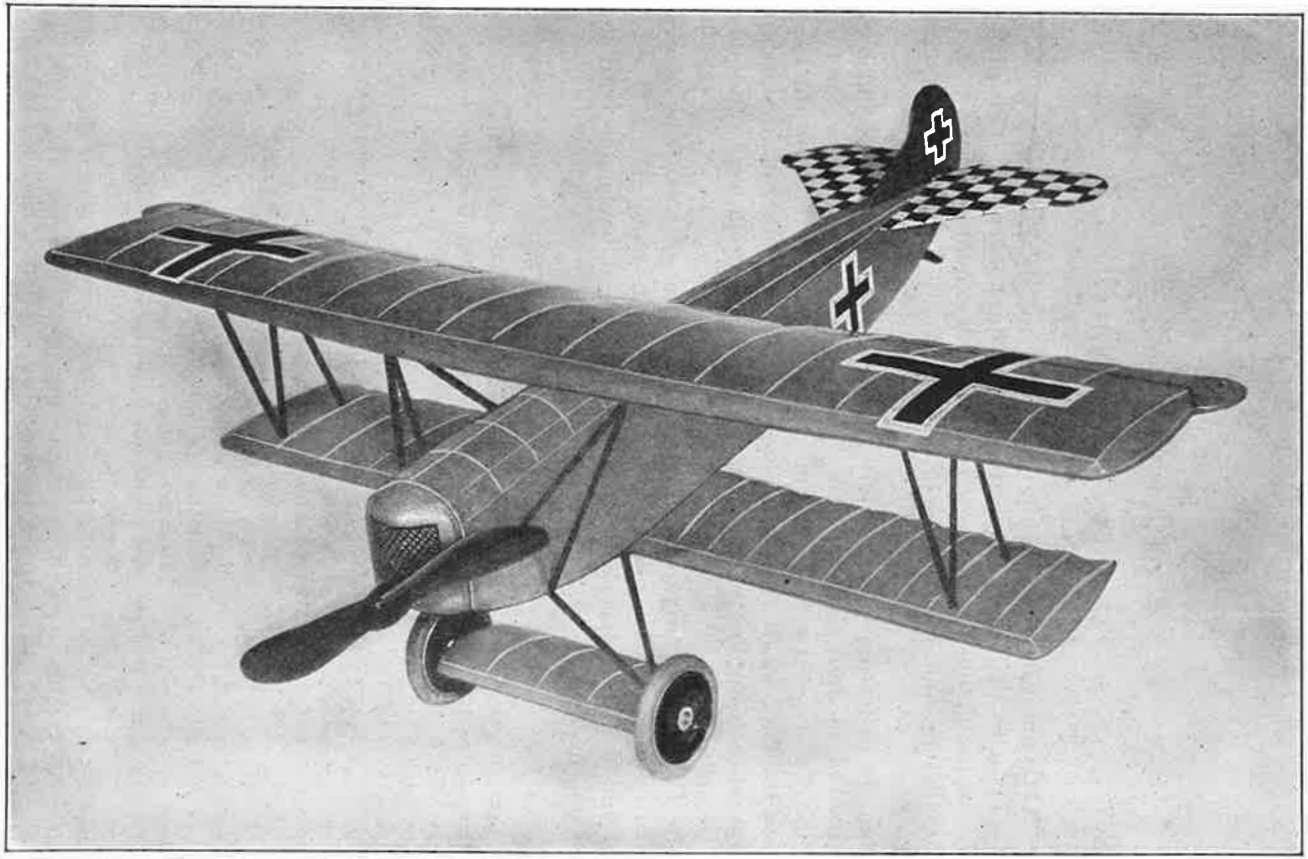
THE finest fighting machine developed and used during the World War by the German Government was the Fokker D-7. This single-seater fighter was powered by a Mercedes engine, had a top speed of 120 miles an hour, and was the pride and glory of the German Imperial Air Force.

Many of its features were entirely new to the airplane world, and have been used on modern planes of today. The welded steel tubing of the fuselage, the "N" type of wing strut, and the tapering form of wing thickness are now standard in all Fokker airplanes of today. Another of its startling innovations was the first balanced control surfaces, which were considered marvels in 1918.

The Fokker D-7 has proved a splendid flying model, enjoying a wide popularity among model builders the world over. Its simple lines, graceful flight, and realistic appearance make it an excellent model for both the novice and expert.

MATERIAL LIST

1 pc.	—1/16" x 1½" x 15"	—Sheet balsa for fuselage formers and tail ribs
5 pcs.	—1/16" x 1/16" x 36"	—Balsa for fuselage stringers, struts, and cross braces
1 pc.	—1/32" x 1⅛" x 4"	—Sheet balsa for cockpit cowling
1 pc.	—⅛" x ¼" x 12½"	—Balsa for motor stick
1 pc.	—½" x 1½" x 1¾"	—Balsa block for fuselage radiator
1 pc.	—¼" x ⅜" x 16 5/16"	—Balsa for upper leading edge spar A
1 pc.	—⅛" x ⅜" x 16⅝"	—Balsa for inner wing spar B
1 pc.	—⅛" x ¼" x 16⅝"	—Balsa for inner wing spar C
2 pcs.	—⅛" x ¼" x 7 11/16"	—Balsa for trailing edge spars D
2 pcs.	—¼" x ¼" x 6¼"	—Balsa for lower wing leading edge spars H
2 pcs.	—⅛" x ¼" x 6¼"	—Balsa for leading inner wing spars G
2 pcs.	—⅛" x ⅛" x 6⅛"	—Balsa for trailing inner wing spars F
2 pcs.	—⅛" x ¼" x 6"	—Balsa for trailing edge spars E
1 pc.	—1/16" x 3" x 36"	—Sheet balsa for wing ribs
1 pc.	—1/16" x ¼" x 15"	—Bamboo for wing tips, tail outlines, etc.
1 pc.	—¼" x ¼" x 3½"	—Balsa for leading edge spar F of landing gear wing
1 pc.	—⅛" x ¼" x 3½"	—Balsa for inner spar G of landing gear wing
1 pc.	—⅛" x ¼" x 3½"	—Balsa for trailing edge spar H of landing gear wing



GERMAN FOKKER D-7

GERMAN FOKKER D-7

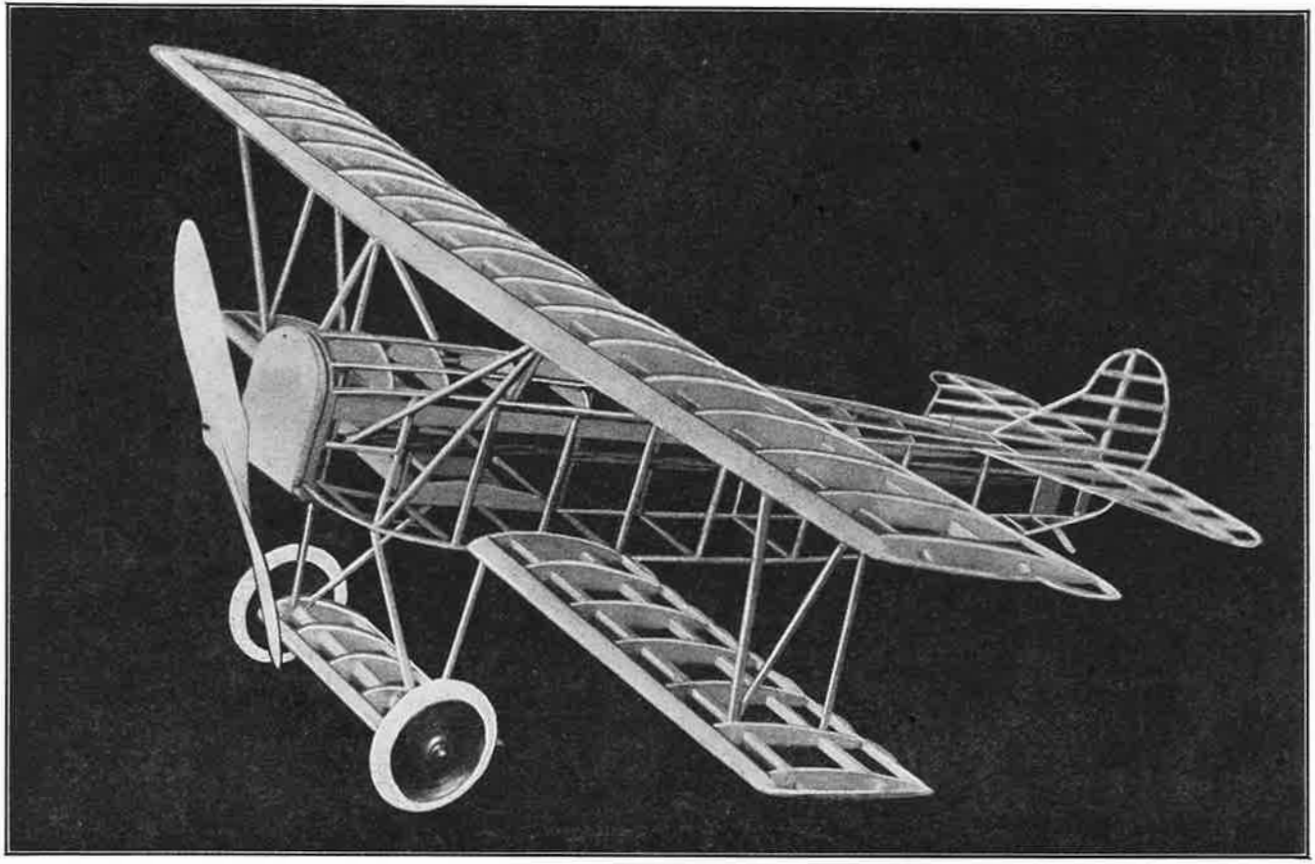
1 pc. —1/16" x 3/8" x 6"	—Sheet balsa for ribs of landing gear wing
1 pc. —1/16" x 1/16" x 6 1/2"	—Balsa for elevator spar A
1 pc. —1/16" x 1/16" x 2 3/8"	—Balsa for rudder spar C
1 pc. —1/16" x 1/8" x 42"	—Balsa for wing, center section, and landing gear struts
1 pc. —1/2" x 5/8" x 6"	—Balsa propeller block
1 pc. —4" long	—No. 9 piano wire for fittings
2 —1 5/8" diameter	—Rubber-tired wheels
2 sheets	—Japanese tissue for covering
1 pc. —42" long	—1/8" flat pure Para rubber for motive power
1 pc. —1/4" x 3/4"	—Isinglass for windshield
1	—Bushing eyelet
2 oz.	—Colorless cement
2 oz.	—Red dope

FUSELAGE. In Plan 1 side, top, and bottom views of the fuselage are shown. The top is first constructed. This requires twelve formers, five stringers, and a sheet balsa cockpit cowling. Make full-size plans of the formers on paper ruled with 1/8" squares. Formers 8 and 9 are required for the bottom of the fuselage and will not be needed at this time, but should be drawn, traced, and cut with the others.

Trace the outlines of the formers on the 1/16" sheet balsa stock. Note that five 2 formers are required. The twelfth is shown above the fuselage side view, and is used as an end brace for the motor stick, which fits into the 1/8" x 1/4" hole cut to accommodate it, as shown.

When all these formers have been cut, they should be notched as shown. Each of these notches are 1/16" square to accommodate the fuselage stringers. They are now assembled. To assemble formers and stringers, all stringers which remain straight should be attached first. This enables the builder to locate the position of each former in relation to the entire assembly. When all straight stringers are in place on the formers, all the remaining stringers must be bent to fit the positions their notches in the formers have naturally taken.

Study the side view of the fuselage in Plan 1. Note that top center stringer C remains perfectly straight, which will bring the tops of formers 1, 2, 2, 2, 2, 2 level with each other. Cement this stringer in place in the top center notch of these formers, spacing each of the formers as shown. Stringers B are now added. These are also short stringers, running from former 1 to the last 2 former. Two full length stringers must now be attached. These are stringers A. To fit them into their bottom side notches in former 1, they must be slightly bent down, as shown in the side view. They also require bending to fit into the first 2 former, but from the second 2 former on to



GERMAN FOKKER D-7 SKELETON

the end of the fuselage, they run straight. Cement these stringers into the formers 1, 2, 2, 2, 2, and 2, which are located in front of the cockpit.

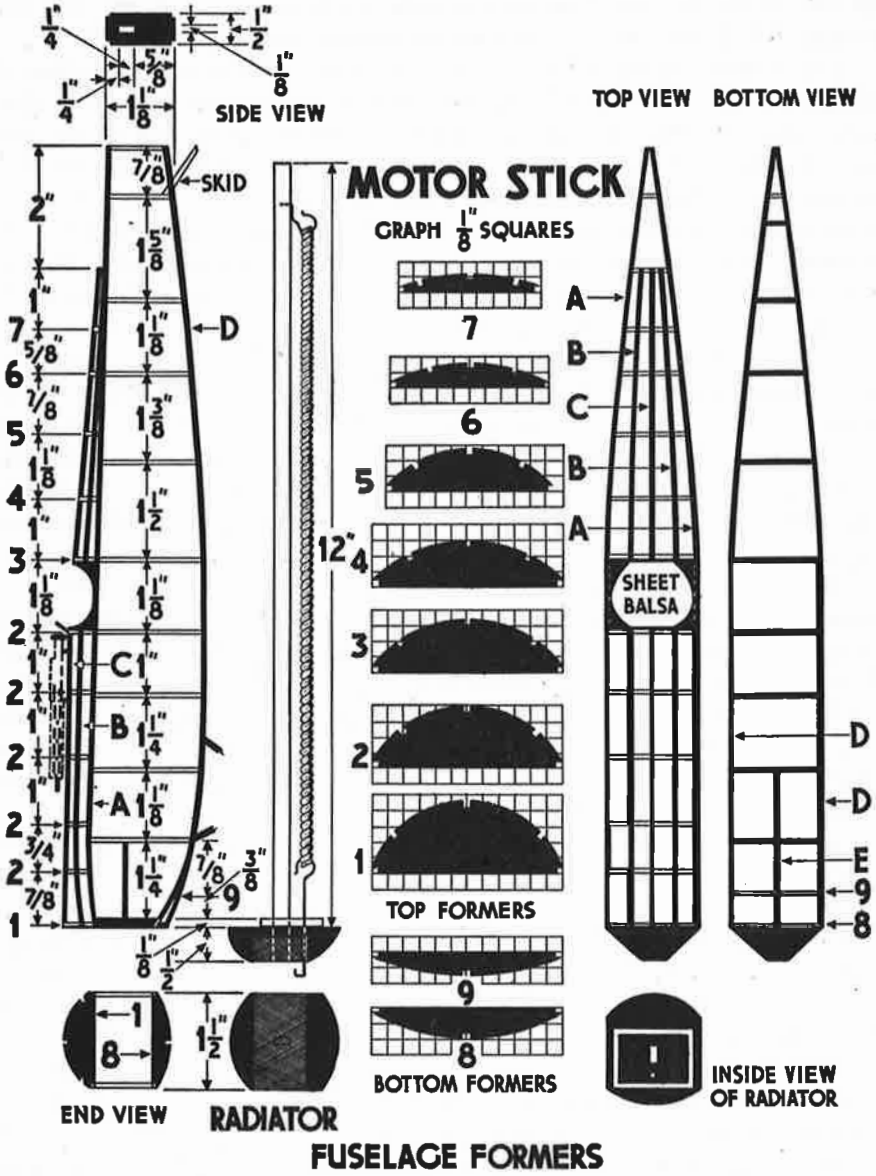
The remaining top formers 3, 4, 5, 6, and 7 are attached to these A stringers, which are cemented into their bottom side notches. Make sure that these added formers are spaced properly, as shown on the left of the side view. These formers are first attached to the main assembly by stringers A, because these stringers are straight. The rear portion of stringer C is cemented into the top center notches of these new formers. It requires no bending, but extends 1″ beyond former 7. The stringers B are added in their notches of these formers, and they also extend beyond former 7 1″. The top view of the fuselage should now be studied.

Stringers A extend 2″ beyond stringers B and C, where they meet and are cemented together. The former used to hold the motor stick and shown at the top of the side view, is cemented in place. Stringers A fit into the top corner notches of this piece, which is located 7/8″ from the ends of stringers A. A 1/16″ x 1/16″ balsa cross brace is fitted between stringers A at the point where the ends of stringers C and B come, which is 2″ from the ends of stringers A.

The ends of stringers B and C are cemented to the top of this cross brace, as shown in the top view of the fuselage. A cowling is added over the cockpit. This is cut from the 1/32″ x 1 1/8″ x 4″ long sheet balsa piece. It must be curved to fit the curves of formers 2 and 3, over which it fits. A hole is cut in its center, as shown in the top view of the fuselage, and it is then cemented between formers 2 and 3 and stringers A on each side. This completes the assembly of the top portion of the fuselage, and the structure should appear as shown in the top view of Plan 1.

Study the bottom view of the fuselage. This is built flat and given its curve, as shown in the side view, after it is assembled to the top portion just finished. Note that the bottom consists of two formers 8 and 9, three stringers D and E, and a number of bottom cross braces. Stringers D are cut 12 3/8″ long, as shown in the side view. The bottom cross braces are shown in solid black on the bottom view. Note that the only cross pieces shown by double lines are the two formers 8 and 9 and the rear former, which holds the motor stick. This last former, having already been attached to the top assembly, cannot be attached to the bottom structure until it is assembled to the top portion of the fuselage.

The bottom cross braces are 1/16″ square balsa lengths. Note the location of formers 8 and 9. The bottom cross brace just beyond former 9 is 1 3/8″ long. The next four braces are all the same length as this first one. Cut these five bottom cross braces. The ends of stringers D are cemented into the top



FUSELAGE

GERMAN FOKKER D-7 PLAN 1

side notches of former 8. Make sure former 8 forms right angles with these stringers. Former 9 is cemented to the stringers 7/16" behind former 8. The first bottom cross brace is cemented between stringers D 15/16" behind former 9. Each of the remaining 13/8" long bottom braces are cemented in place between stringers D at the distances shown in the side view. Note that these braces are all in line with the side upright struts, shown in the side view, but that the first three of the struts and bottom cross braces are not in line with the top formers, although the fourth and fifth struts and cross braces are directly in line with formers 2 and 3, which form the cockpit.

When the two bottom formers and the first five bottom cross braces have been cemented to the bottom stringers D, the ends of these stringers are brought together and cemented. The remaining four braces are added between these stringers. Cut them to required lengths and cement each between stringers D, as shown in the side view for the upright struts. Note that the seventh brace from the front is the only one of the four remaining braces that is located in line with a former, which in this case is former 6.

The stringer E is cemented into the bottom center notches of formers 8 and 9. It is then cemented to the tops of the first and second bottom cross braces, as shown, in their exact centers.

The fuselage is completed by joining the top and bottom portions together. Two 7/8" long upright side struts are cut from 1/16" square balsa. These are cemented between top former 1 and bottom former 8, as shown in Plan 1 under "End View." The bottom structure of the fuselage is bent in a curve and the stringers D brought back and fitted into the bottom corner notches of the former at the end of the fuselage, which holds the motor stick, where they are cemented. The ends of stringers A and the ends of stringers D are joined by an upright single strut 13/16" long. The first upright struts behind formers 1 and 8 are 19/16" long. They are cemented between stringers A at the top and stringers D at the bottom, being located 15/16" from the front formers, which will bring them in line with the first bottom cross brace. The second upright struts are 111/16" long, and are in line with the second bottom cross brace, or 11/8" behind the first.

The third pair of upright struts is the same length as the second pair, and is located 11/4" behind them. From this point on, all the remaining upright struts should be cut long enough to extend between the top stringers A and bottom stringers D in line with the bottom cross braces. After the first three upright struts have been cemented in place, the curve of the bottom structure will take form so that the remaining upright struts can be cut to the various lengths called for by the form it has assumed.

Two short stringers are cemented on each side of the fuselage, as shown

in the side view. These extend between the upright struts joining formers 1 and 8 and the first upright struts behind them. The fuselage is covered with Japanese tissue (see Chapter 8, "Fuselage Covering"), water-sprayed, and when dry, completed with a coat of red dope. An isinglass windshield is cemented to the top of former 2 in front of the cockpit.

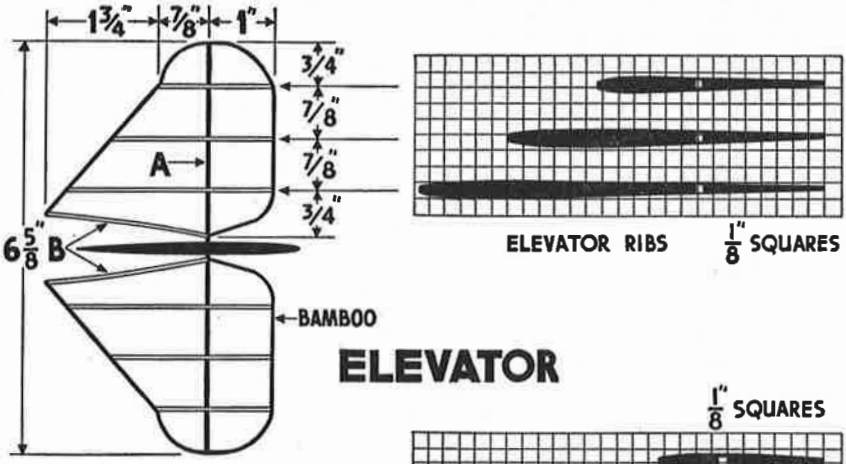
MOTOR STICK. The motor stick is 1/8" x 1/4" x 12 1/2" long. It is cemented into a fuselage nose piece, which forms the radiator. This is cut from the 1/2" x 1 1/2" x 1 3/4" solid balsa block. (See Plan 1, "Radiator.") Its flat back must be the exact size and form of the top of former 1 and the bottom of former 8, and it must be as wide as the two upright struts between these formers are apart.

Its thickness is rounded as shown at the end of the motor stick. A 1/8" x 1/4" hole is cut through the center of this radiator piece, and the end of the motor stick is cemented in it, as shown. On the inside or back face of this piece, a plug is formed of 1/16" square balsa lengths. These are cut and cemented together so that they will fit snugly inside the space formed at the front of the fuselage by formers 1 and 8 and their two upright struts, which join them. Note this formation shown in white in the plans under "Inside View of Radiator." An end hook is bent from No. 9 piano wire and cemented in place on the under side of the motor stick, so that its hook is 1" from the end of the stick. (See Chapter 6, "End Hooks.")

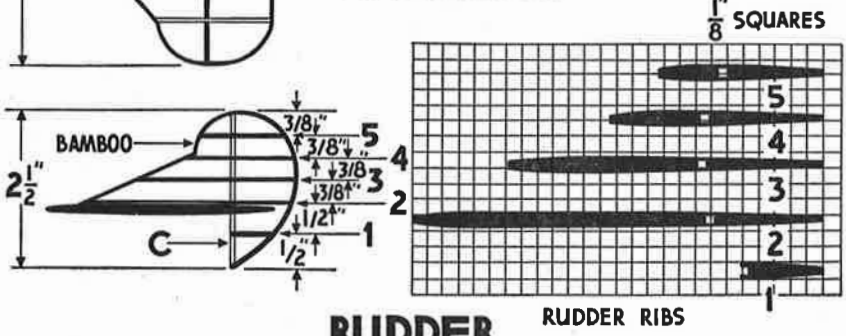
A small hole, about the diameter of the No. 9 wire, is made through the radiator directly under the end of the motor stick and in the center. It should be so placed as to allow the propeller shaft hook to be in line with the end hook, as shown. A small brass bushing eyelet is forced into this hole from the front or curved side of the radiator. This completes the motor stick and radiator, except for tests which should be made to determine that the radiator plug will fit tightly into the space formed by the front formers. Place the stick in the fuselage and force its end into the hole cut to accommodate it in the rear former. At the same time, press the radiator plug into position between the front formers 1 and 8, so that the back face of the radiator will fit tightly against the front faces of these formers. Test to see that the radiator is held snugly, but not so tight as to make removing it difficult.

The radiator is painted with red dope, and a black radiator grill is drawn on it with thin crossed lines, as shown.

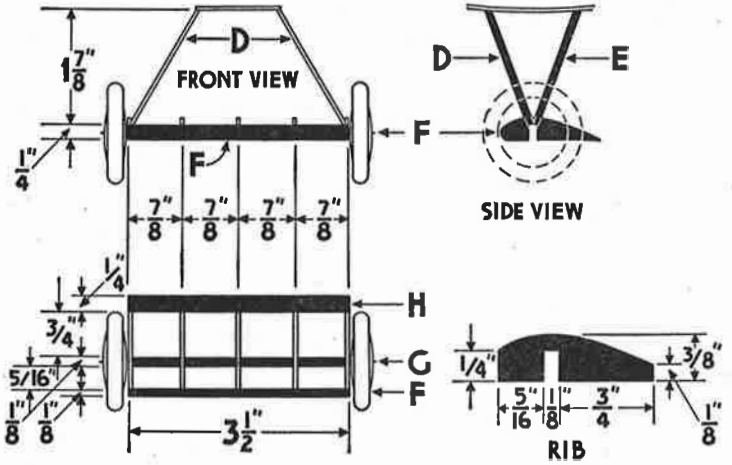
ELEVATOR. The elevator consists of a 1/16" x 1/16" x 6 5/8" long balsa inner spar A, six 1/16" sheet balsa ribs, two 1/16" square balsa fuselage brace ribs B, and two 1/16" square bamboo outline lengths. (See Plan 2, "Elevator.") Make a full-size copy of the ribs on paper ruled with 1/8" squares,



ELEVATOR



RUDDER



LANDING GEAR

GERMAN FOKKER D-7 PLAN 2

as shown under "Elevator Ribs." Trace two of each of these ribs on the 1/16" sheet balsa stock, and cut them out. Each of the six ribs has a 1/16" square hole cut in it 1" from its trailing end. Two 1/16" x 1/16" x 2 1/2" long balsa lengths are cut to serve as fuselage brace ribs. These are shown by B.

Space the ribs on the spar A and cement each in place, making sure they are all at right angles to the spar and have been spaced correctly on the spar. Cement the two ribs B to the outer sides of stringers A, so that their trailing ends are flush with the end of the fuselage. Notch the ends of stringers A and cement the spar A into this notch so that the spar extends out from these stringers an equal length on both sides. Two lengths of 1/16" square bamboo are bent to form the outlines of each half of the elevator. One end of each of these pieces is cemented to the spar A at the fuselage, while the other is cemented to the leading end of the rib B.

The elevator is covered on both sides with Japanese tissue, water-sprayed, and when dry, given one coat of clear dope. Both sides of the elevator are then ruled with 1/4" squares, and the alternating squares in each row are painted black.

RUDDER. A 1/16" x 1/16" x 2 3/8" long balsa spar C, five 1/16" sheet balsa ribs, and a 1/16" square bamboo outline piece make the rudder. Draw a full-size plan of the five ribs on paper ruled with 1/8" squares, trace each of them on the 1/16" sheet balsa stock, and cut them out. (See Plan 2, "Rudder Ribs.")

These are now properly spaced along the 1/16" x 1/16" x 2 3/8" inner spar C and cemented in place. Test to see that each rib is at right angles with the spar. The 1/16" square bamboo length is bent to form and cemented in place. The rudder is covered on both sides with Japanese tissue, water-sprayed, and finished with a coat of red dope. It is then cemented to the fuselage. The spar C is cemented against the rear upright strut of the fuselage, while rib 2 fits on top of center stringer C. Test to see that the rudder and elevator form right angles, and that the rudder is in line with center stringer C.

A tail skid of 1/16" x 1/8" balsa is cemented through the covering tissue of the fuselage to the center bottom of the rear former, as shown in Plan 1.

LANDING GEAR. The landing gear of the Fokker D-7 is formed of a short stub wing acting as an axle and supported by four landing gear struts. Study the plan in Plan 2 under "Landing Gear." Five 1/16" sheet balsa ribs are cut out, as shown under "Rib." The leading edge spar F is 1/4" x 1/4" x 3 1/2" long, and must be shaped to carry out the general form of the rib. The inner spar G is 1/8" x 1/4" x 3 1/2" long, while the trailing edge spar

H is 1/8" x 1/4" x 3 1/2" long. The trailing edge spar must also be shaped to carry out the general form of the rib at its trailing end.

The ribs are spaced 7/8" apart along the inner spar G and carefully cemented in place at right angles to this spar. The leading edge spar is then cemented to the leading ends of the ribs, and the trailing edge spar H is cemented to their trailing ends.

The structure is covered on both sides with Japanese tissue, water-sprayed, and given a coat of red dope. Two 1/16" x 1/8" streamlined struts hold this stub wing to each side of the fuselage. These are cut long enough to allow the landing gear wing to be 1 7/8" below the fuselage, as shown in the front view. The front struts D extend from stringers D at the first pair of upright side struts behind former 9 to the inner spar G at each end of the landing gear wing just inside the end ribs.

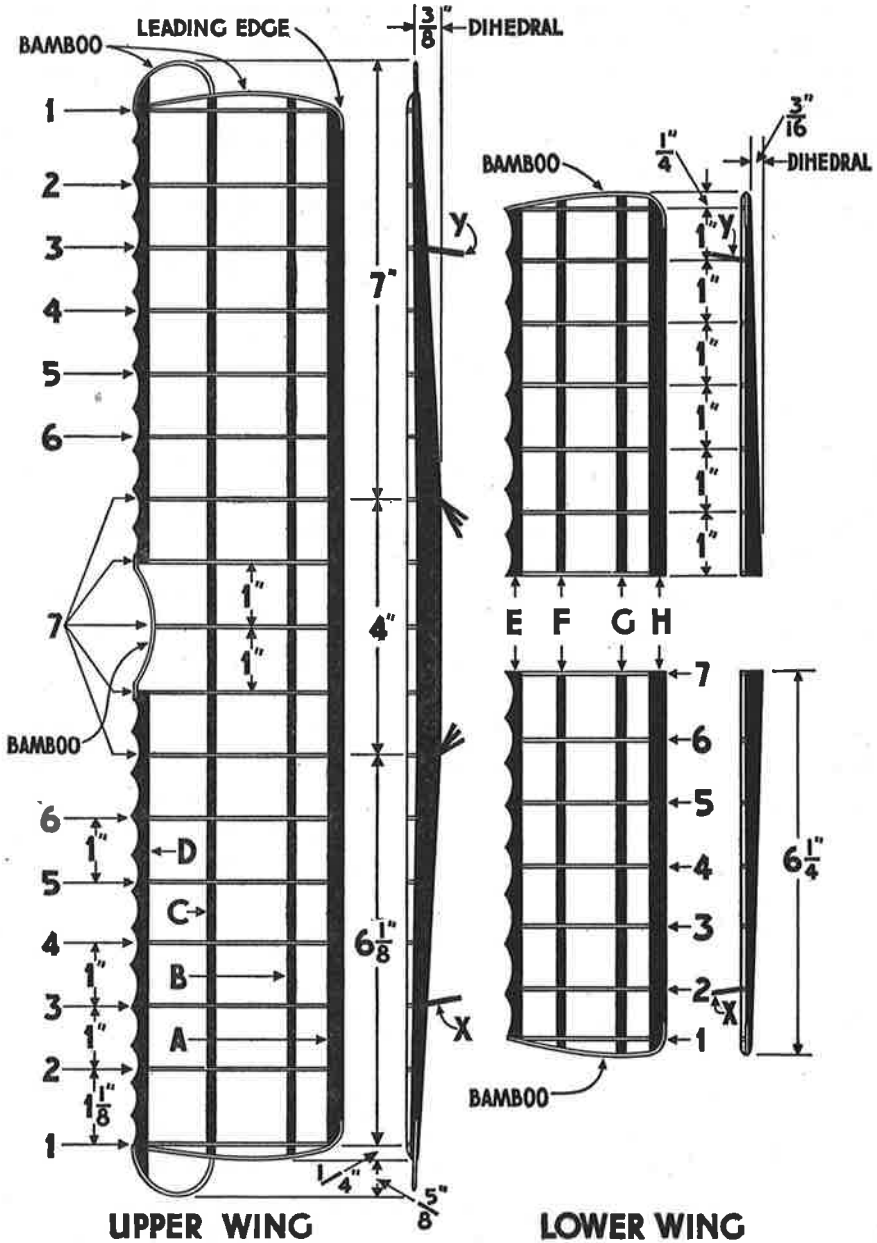
The trailing struts E extend up from the same points on the landing gear wing to stringers D on each side of the fuselage at points 1/2" behind the second upright side struts behind former 9. All four of these struts should be cut the same length so that the landing gear wing will be correctly centered under the fuselage.

Two 1 5/8" diameter rubber-tired wheels are attached to each side of the landing gear wing. (See Chapter 10, "Solid Balsa Rubber-tired Wheels.") They are attached to each end of the inner spar G by thrusting model pins through the hubs of the wheels and into the ends of the spar.

WINGS (Upper). The upper wing is made in one piece. It requires four main balsa spars, seventeen balsa ribs, and two bamboo wing tips. The leading edge spar A is 1/4" x 3/8" x 16 5/16" long. The leading inner wing spar B is 1/8" x 3/8" x 16 5/8" long, while the trailing inner wing spar C is 1/8" x 1/4" x 16 5/8" long. The trailing edge spars D consist of two lengths, each measuring 1/8" x 1/4" x 7 11/16" long.

The upper wing, Plan 3, has a 3/8" dihedral at each tip, although the top of the wing is flat. This is a constructional dihedral, since it is built into the wing and is not obtained by setting each half at an angle. To obtain this type of dihedral, all the four wing spars must be tapered on their under sides only, while their upper sides remain straight.

All these spars remain their full size along the 4" of center section, as shown in Plan 3, where only ribs 7 are used. From each end of this center section, the spars are tapered on their under sides to their ends. The leading edge spar A remains 1/4" x 3/8" along the center section and is then tapered to 1/4" x 1/8" at each end. Note that all the spars retain their original width along their entire length, while tapering in thickness only. The lead-



WINGS

GERMAN FOKKER D-7 PLAN 3

ing edge spar A must not only be tapered but also half-rounded to continue the curve of the ribs, as shown at rib 7 in Plan 4.

The leading inner wing spar B remains 1/8" x 3/8" along the center section and then is tapered toward both ends to 1/8" x 1/8", while the trailing inner wing spar C remains 1/8" x 1/4" along the center section and is then tapered toward both ends to 1/8" x 1/8". The trailing edge spars D are both 1/8" x 1/4" at their inner ends and retain this overall size along their entire lengths, although they must be shaped to carry out the general form of the trailing ends of the ribs, as shown in Plan 4 on rib 7. These spars must also be scalloped along their trailing edges, as shown in Plan 3. Mark off 1/2" points along the entire lengths of these spars. Measure 1/8" in from their edges and draw a line parallel to the edge along the entire length of each. A compass can then be used to obtain the curves within these dimensions, or a penny can be placed with its edge in each 1/2" long rectangle, and the curve drawn with a pencil. These are then cut out, and finished smooth with sandpaper.

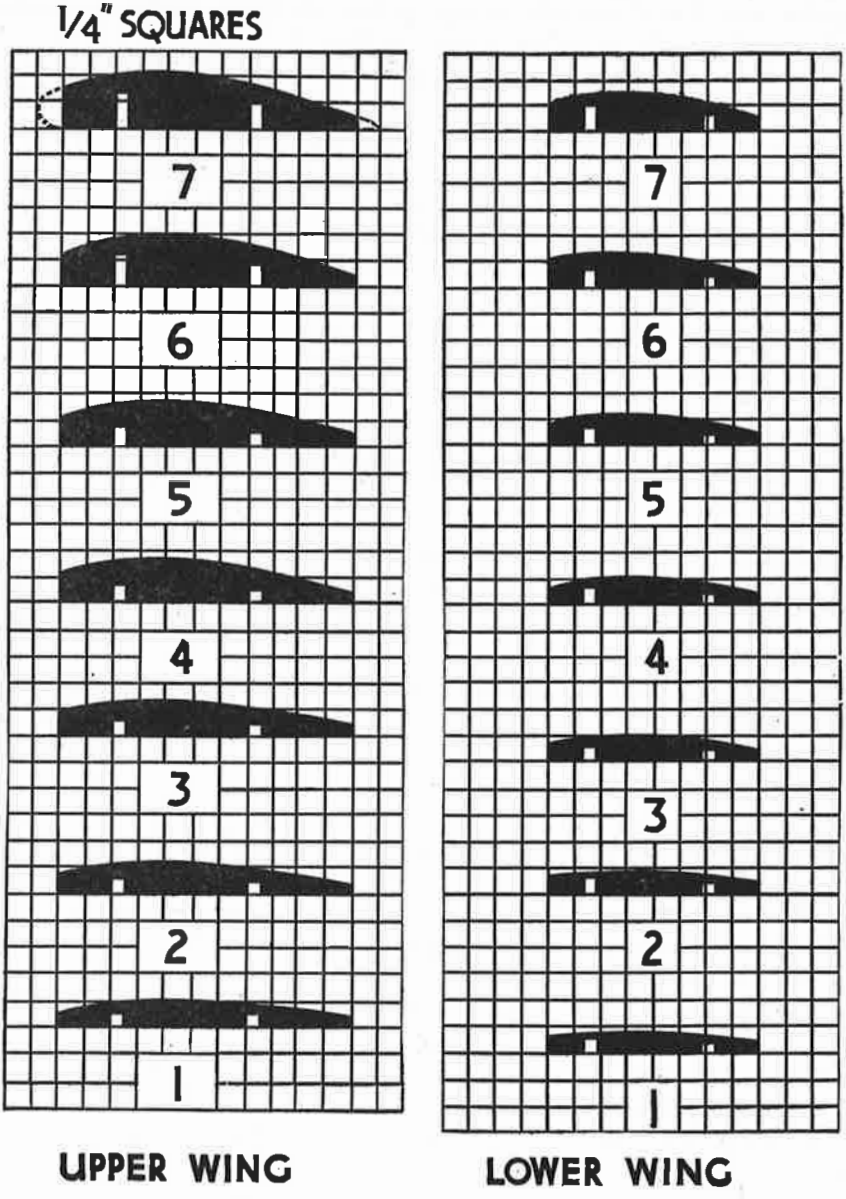
A full-size drawing of each rib is made on paper ruled with 1/4" squares, as shown in Plan 4 under "Upper Wing." These are traced on the 1/16" sheet balsa stock. Remember that two of each of the ribs 1, 2, 3, 4, 5, and 6 are required, while five of rib 7 will be needed for the center section, making seventeen ribs in all.

When these have been cut out, two notches must be cut in each. These must be tapered in size from rib 7, where they are the original width and thickness of the inner spars, down to rib 1, where both are 1/8" square. Finish each rib by a light sandpapering.

The wing is assembled by cementing the ribs along the two inner spars B and C. Locate the center of each spar and cement one of the ribs 7 in place. Test to see that it is at right angles with the spars. The remaining four of these ribs are then cemented, two on each side of the center one. These must be parallel with the center rib. The ribs 1, 2, 3, 4, 5, and 6 are cemented in place on each side of this center section, as shown. Make sure that all these ribs are 1" apart, measuring from center to center of their thickness, except the end ribs 1, which are 1 1/8" away from ribs 2.

The leading edge spar A is cemented in place against the leading ends of these ribs. The two trailing edge spars D are cemented in place against the trailing ends of the ribs, except the center rib 7, which they do not cover. A 1/16" square bamboo length is bent to form and cemented over the end of the center rib 7, where it curves out to the ends of the trailing edge spars D and is cemented in place, as shown in Plan 3.

Two lengths of this same bamboo are bent and cemented around the



WING RIBS

GERMAN FOKKER D-7 PLAN 4

ends of the leading edge spar A, the ends of both inner wing spars, and the trailing ends of ribs 1, where these contact the trailing spars D.

Circles of this bamboo are bent and cemented to the ends of trailing inner wing spar C and around the ends of the trailing edge spars D, which are tapered to match the curves of these bamboo pieces. (See Chapter 3, "Bamboo.")

The wing is covered on both sides with Japanese tissue, water-sprayed, and given one coat of red dope. (See Chapter 7, "Wing Covering.")

(Lower). The lower wing is made in two halves, as shown in Plan 3 under "Lower Wing." It requires eight balsa spars, fourteen sheet balsa ribs, and two bamboo wing tips. The two leading edge spars H are 1/4" x 1/4" x 6 1/4" long. They retain this size at ribs 7 and then taper to 1/8" x 1/4" at their ends. Note that all the spars retain their full width and taper only along their thickness. The leading inner wing spars G are 6 1/4" long, being 1/8" x 1/4" at ribs 7 and tapering to 1/8" x 1/8" at their ends, while the trailing inner wing spars F are 6 1/8" long, and taper from 1/8" square at ribs 7 to 1/16" x 1/8" at their ends.

The trailing edge spars E are 1/8" x 1/4" x 6" long and are not tapered. Both the two leading edge spars H and the two trailing edge spars E must be shaped as shown in Plan 4 on rib 7 of the upper wing. The trailing edge spars must also be scalloped, as were the upper trailing edge spars D.

Two of each of the seven ribs, shown in Plan 4 under "Lower Wing," are made. Make full-size drawings of these on paper ruled with 1/4" squares, and trace two of each of the ribs on the 1/16" sheet balsa. These are cut out, notched, and finished with sandpaper. The two halves of the wing are now assembled, as directed for the upper wing. Two 1/16" square bamboo wing tips are bent to form and cemented on the ends of the wings. Both halves are covered with Japanese tissue on both sides, water-sprayed, and finished with a coat of red dope.

Study the solid scale plan to determine the exact location of both the upper and lower wings, as well as the strut formations holding them. The center section of the upper wing is held by three struts on each side of the fuselage, which are cut from the 1/16" x 1/8" balsa stock. These six struts in units of three meet at points on the under side of the wing. These points are shown in Plan 3 on the edge view of the upper wing. Each is located on the leading inner wing spar B on the under side of rib 7, which is located at the end of the center section. From each of these points, three struts spread to points on the sides of the fuselage. The leading ones extend down to points in the center of the short side struts running between formers 1 and 8 and the upright struts just behind them.

The middle struts extend down and connect on stringers D at the same points that landing gear struts D connect with them. The trailing struts extend down to points on stringers A 2½" behind former 1. These struts must all be cut long enough to allow the upper wing to be ¾" above stringer C and 1" behind former 1 of the fuselage. The straight under edge of center rib 7 must be parallel with the top center stringer C. Cement each of these six struts in place, after streamlining them.

The lower wings are cemented against the sides of the fuselage over stringers D, so that the straight under edge of the ribs 7 will be flush with the bottom of the fuselage, as shown in the side view of the model in the solid scale plan. The leading edge of these lower wings must be exactly 2⅜" behind former 8, or 1⅜" behind the leading edge of the upper wing. The straight under surface of the upper wing must be parallel to the straight under surface of the lower wing.

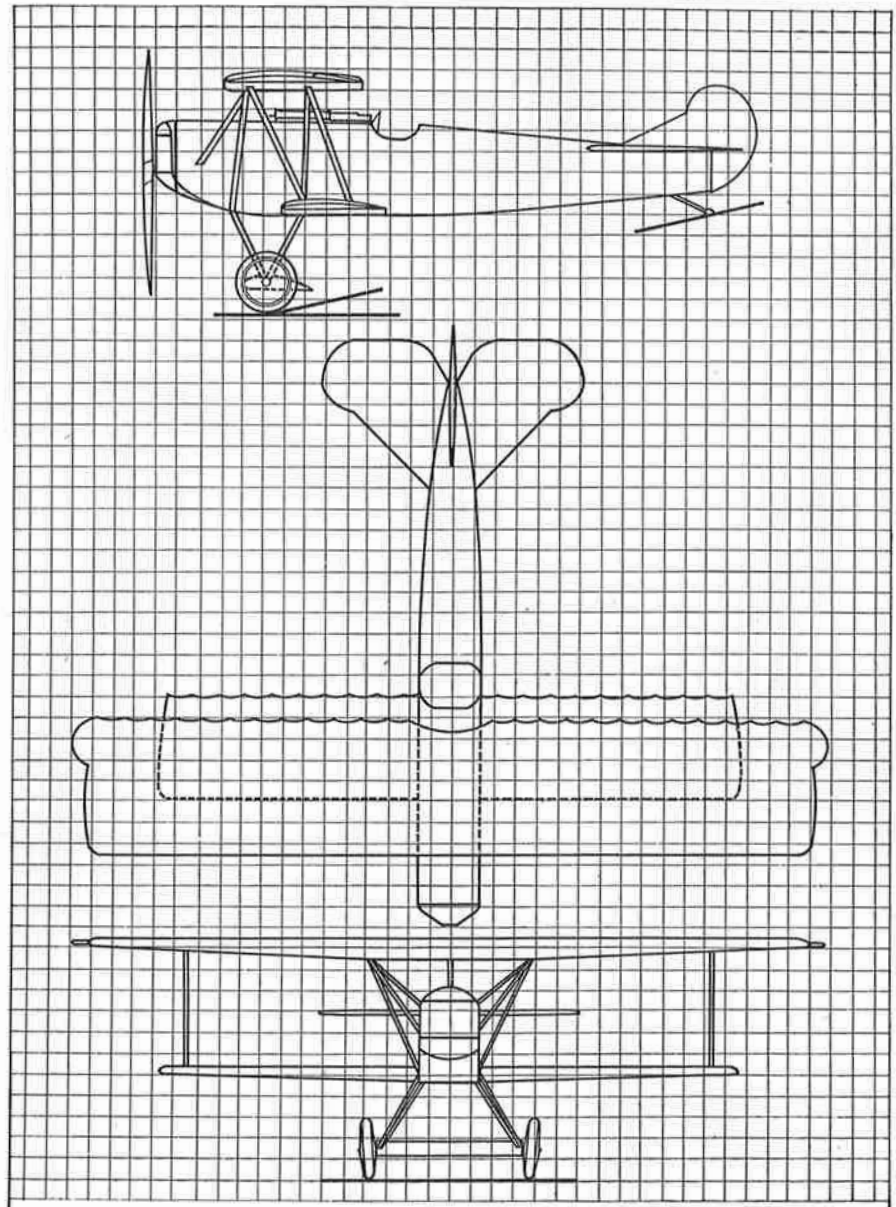
The two wings are joined together by two units of "N" struts, as shown in the side view of the solid scale plan. On the upper wing, these units are located on the under sides of ribs 3 at each end, as shown by Y and X on the edge view of Plan 3 under "Upper Wing." On the lower wing they are located on rib 2 at each end of each half wing, as shown on the edge view by Y and X of Plan 3.

The leading struts are on the leading inner wing spars of the upper wing and on the leading inner wing spars of the lower wing, where these spars contact the ribs 3 of the upper wing and the ribs 2 of the lower wing. The trailing struts are on the same ribs where these ribs contact the trailing inner wing spars of both wings. Cut these to proper size, streamline them, and cement them in place. Note that the leading and trailing struts of each unit are parallel with each other. A third strut is cut and cemented between the leading and trailing struts of each unit.

MOTIVE POWER. Four strands of ⅛" flat rubber are used for this model. Obtain a 42" length of this rubber and tie its ends together. Put it aside until the propeller has been carved and assembled.

PROPELLER. The propeller is carved from the ½" x ⅝" x 6" balsa propeller block. (See Chapter 9, "Carved Propellers.") As this is a flying propeller, it should be equipped with a propeller shaft bent from No. 9 piano wire. (See Chapter 6, "Propeller Shafts.") Remove the motor stick from the fuselage and insert the wire shaft through the radiator block before bending its hook. Bend the hook, loop the rubber motor into two loops, and attach it to the end hook and the propeller shaft.

As the propeller should represent the old wood propeller of war days,



SOLID SCALE PLAN FOR GERMAN FOKKER D-7

it should be stained and then varnished, but for good flying the surface should be left unfinished.

ACCESSORIES. Two machine guns are now made. See Chapter 15, "Machine Guns," where instructions for German machine guns are given. Make two of these, paint them black, and cement them on each side of top center stringer C just in front of the cockpit.

PAINTING. As the main portion of the model has received its color from the red dope used on its covering tissue, little finishing is required. The usual German Cross insignia is used on the top of the upper wing at its tips, on the under side of the lower wing at its tips, on both sides of the rudder, and on both sides of the fuselage behind the cockpit. (See Chapter 14, No. 88.) All struts should be black, as well as the edge of the cockpit. The tail skid should also be black. All the crosses on the model should be in black with white 1/8" wide borders around them.

FLYING. See Chapter 51, "Flying."

SOLID SCALE MODEL. See Chapter 46 under "Solid Scale Model" for general building instructions for a solid scale model of this plane.

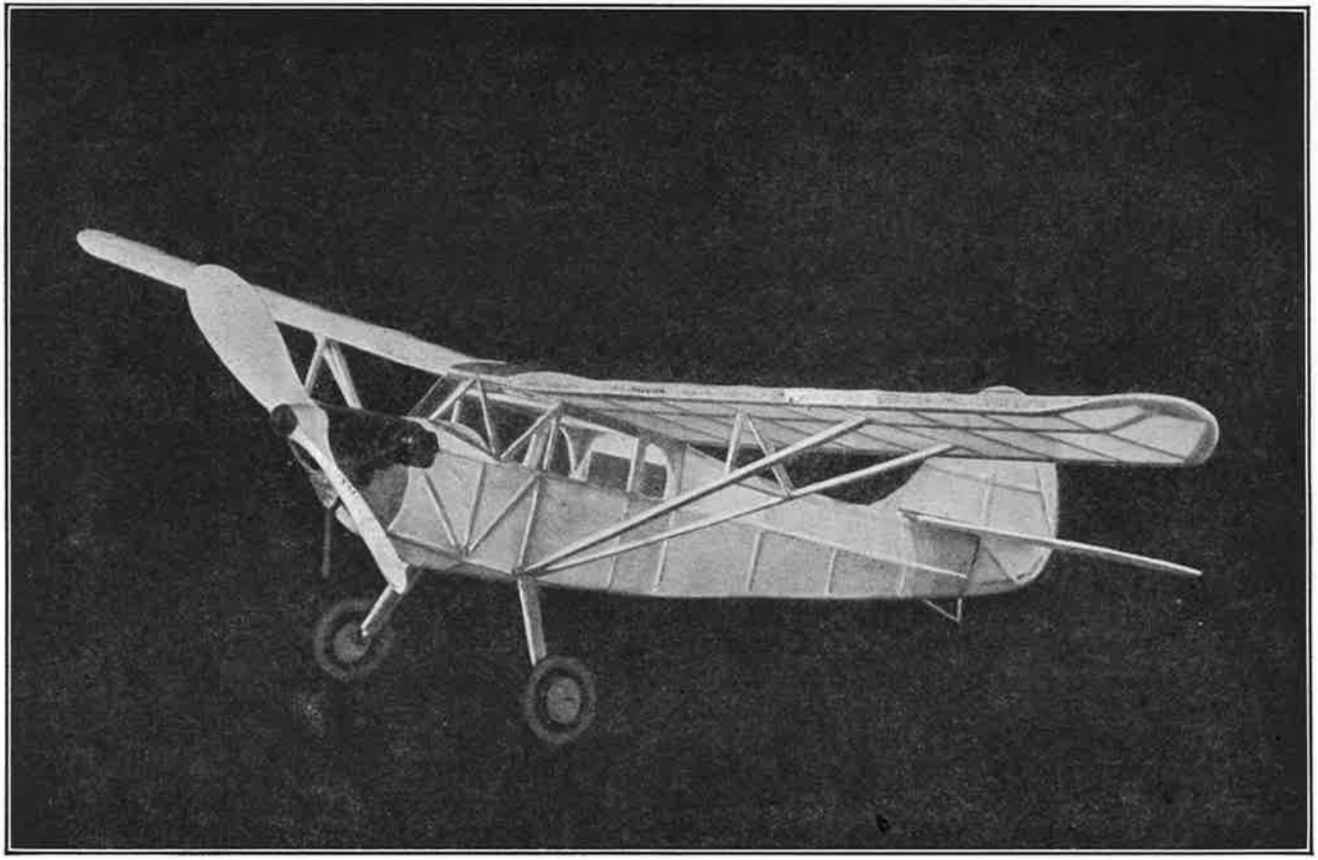
CHAPTER 54

AERONCA SPORTPLANE

THE Aeronca light sportplanes are manufactured by the Aeronautical Corporation of America at Lunken Airport in Cincinnati, Ohio. For many years their planes have led the field of compact, light sport airplanes. Their latest model is known as the "Model K," which has already reached popularity among the sport fliers both in this country and abroad. The Model K is powered with an Aeronca two-cylinder engine developing forty horsepower. Seating two passengers in side-to-side arrangement, the plane has a top speed of 93 M.P.H., a cruising speed of 85 M.P.H., and can land at 35 M.P.H. It takes off with a remarkably short run, can climb 450 feet a minute, and carries fuel enough for a 250 mile cruising range. The model shown here was designed and built by Jesse Davidson, who is a well-known figure in the model airplane world. Pontoon plans are given so that it may be changed into a seaplane if the builder prefers water to land, or skis may be attached for snow.

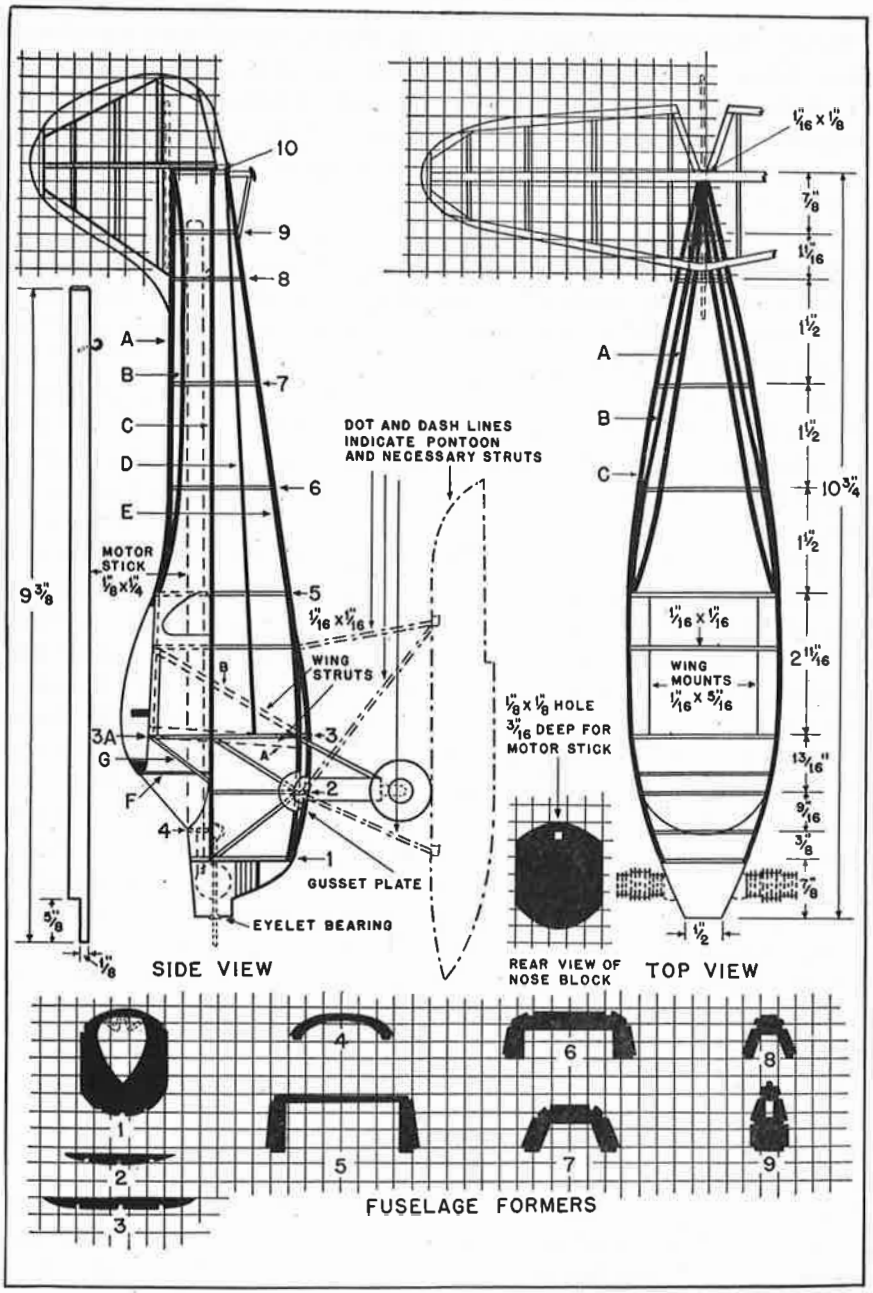
MATERIAL LIST

3 pcs.—1/16" x 1/16" x 26"	—Balsa (Longerons, braces, struts, etc.)
1 pc. —1/8" x 1/4" x 9 3/8"	—Balsa (Motor stick)
1 pc. —1" x 1 1/4" x 1 1/2"	—Balsa (Nose block)
3 pcs.—1/16" x 3" x 36"	—Sheet Balsa (Ribs, formers, etc.)
2 pcs.—1/2" x 1" x 1"	—Balsa (Cylinders)
1 pc. —1/4" x 3/16" x 24"	—Balsa (Leading spar)
1 pc. —1/8" x 1/4" x 24"	—Balsa (Inner spar)
1 pc. —3/32" x 3/16" x 24"	—Balsa (Trailing spar)
1 pc. —5/8" x 1" x 6"	—Balsa (Propeller)
1 pc. —1/8" x 3/16" x 12"	—Balsa (Wing struts)
1 pc. —1/16" x 1/8" x 12 1/2"	—Balsa (Rear wing struts)
1 pc. —3/16" x 5/16" x 6"	—Balsa (Landing gear struts)
1 pc. —1/4" x 7" long	—Bamboo (Skis)
1 pc. —12" long	—No. 18 Music Wire (Fittings)
2 sheets	—Japanese tissue
Model pins	
Cement	
Banana Oil	
Sandpaper	
Celluloid	



AERONCA SPORTPLANE

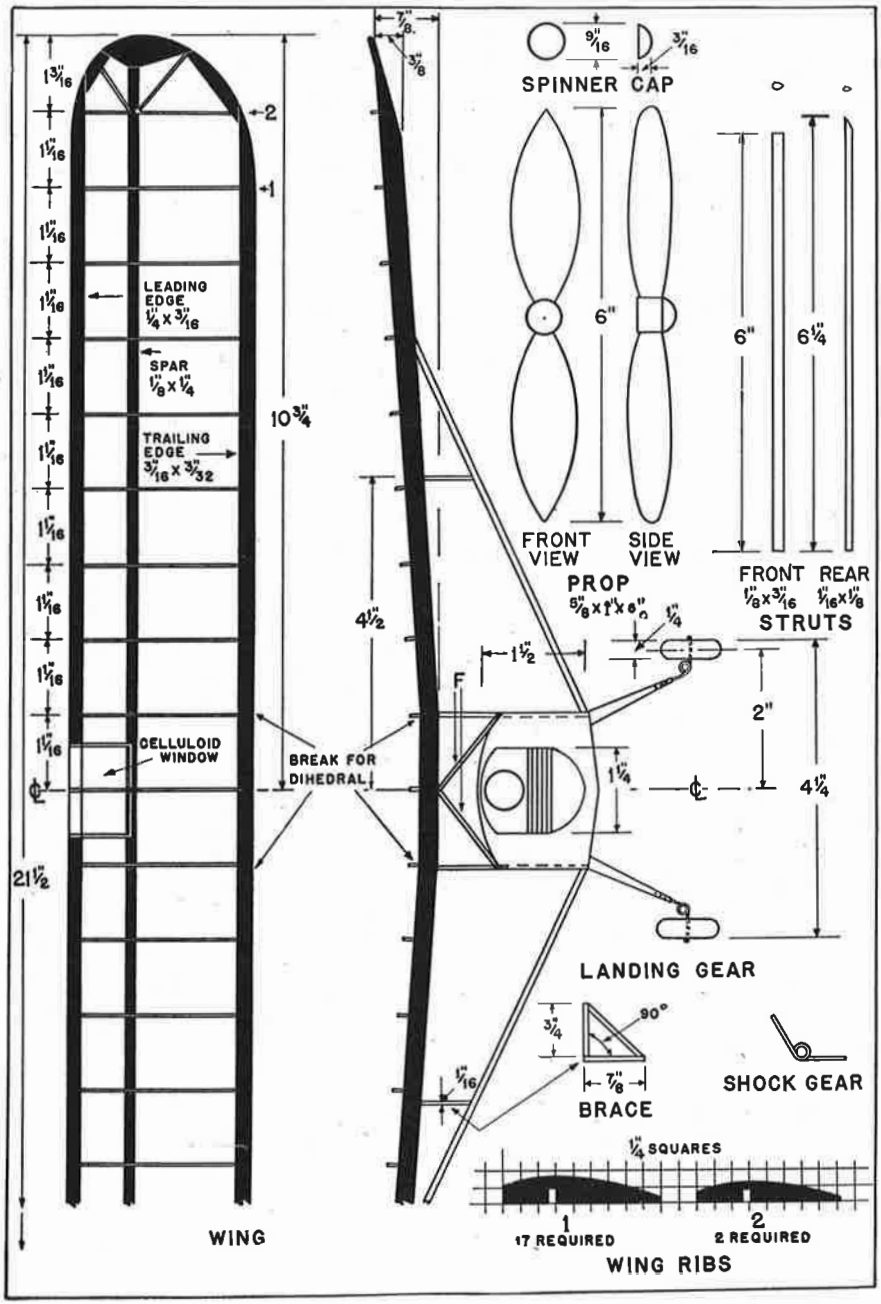
FUSELAGE. The fuselage is shown in Plan 1. All stringers are of 1/16" square balsa. The nine formers are shown on squares representing 1/4" each. Rule paper with such squares and make a full-size tracing of each former on them. These are then traced on 1/16" sheet balsa and cut out. Make sure that all their notches are properly placed. Note that the former "9" has a 1/8" x 1/4" hole cut in it to accommodate the motor stick. Sand all these formers just enough to remove roughness and mark in pencil the number of each. The two master side stringers, which appear straight in the side view and are marked "C," are first cemented in place. Cement the ends of the "C" stringer in the notches at the top-sides of former "1." See that the stringer and the former form right angles. Cement "4," "5," "6," "7" and "8" formers to the "C" stringers by placing these stringers in the bottom-side notches of these formers. Test to see that they are parallel with each other and at right angles to the "C" stringers. Space them as shown in the top view. The former "9" has the "C" stringers cemented in its side notches. Complete the top assembly of stringers by adding "A" and "B" stringers between former "5" and the end post on the fuselage. These fit into notches cut for them in these formers. Cut a 1/16" x 1/16" x 7/8" long end post and cement the ends of these stringers in place on it, as shown in the side view. Cement a 1" long upright brace of 1/16" square balsa extending down from stringer "C" directly under former "5." Cement a second brace 13/16" long under stringer "C" directly in line with former "3," which has not as yet been placed. Cement both these braces to stringer "C" at right angles to it. Bottom stringer "E" is now cemented to the bottom of the end post, through the bottom notch in former "9," and then brought in a straight line as far as the upright under former "5" to which it is firmly cemented. It is then bent in a gradual curve to the end of the second upright at former "3" location, and cemented to the end of this upright. It continues in its curve until it is cemented to former "1." Complete the stringer "E" on the other side of the fuselage, which is cemented in the same manner to the two upright braces. Complete each side of the fuselage by cutting 1/16" square uprights to required length and cementing them in place under each former between stringers "C" and "E." Cross braces of the same size are now cut and cemented in place between the "E" stringers at the location of each pair of side uprights, which form the bottom of the structure. Formers "2" and "3" are now cemented to the under cross braces located 15/16" behind former "1" and 13/4" behind the same former. Note their locations in the plans. Short stringers are then cemented in their notches and extend from former "1" to the cross brace under former "5." The three side braces, shown between formers "1" and



AERONCA SPORTPLANE PLAN 1

"3" and converging at former "2," are now cut and cemented in place. The same assembly is repeated on the other side of the fuselage. A gusset plate of 1/16" sheet balsa is cut for each side and cemented over the ends of these converging braces, as shown in the side view at former "2." Study the photographs of the finished model. Note the side and front window framings. These framings are now cut to size and shape from 3/64" sheet balsa. The side framings are covered with thin sheet celluloid on their outer sides. They are then cemented on top of stringers "C" against former "5," as shown. At their front ends braces "3A" are cut 1/16" square and cemented against them and on top of stringers "C," as shown. These "3A" braces are supported by a top cross brace cemented between them at their tops. They are further supported by "G" braces cemented at an angle between their tops and stringers "C." A second top cross brace is fitted between the framing on each side at the tops of these cut-outs, as shown in the top view. Balsa braces "F" are also 1/16" square balsa cemented in place and supported at their top joint by other 1/16" bracing. Cut the wing mounts and cement them in place between formers "5" and "3" at the top. The nose block is now shaped from a 1" x 1¼" x 1½" balsa block. Three views of this block are shown in Plan 1. Shape it properly and then cut a 3/16" deep hole 1/8" square in its back face, as shown under "Rear View of Nose Block" in Plan 1. This has been shown on 1/4" squares for dimension purposes. The black lines shown on the lower part of the block represent the cooling fins of the oil reservoir and are done in imitation by making rather deep impressions with a sharp pencil point. In the exact center of the ½" diameter front face of the nose block, an eyelet bearing is inserted, as shown in the plan. Bend a motor stick clip of No. 18 music wire and cement it to the rear face of former "1." This is shown on former "1" under "Fuselage Formers" in Plan 1. Make the opening 1/8" square and locate it at the top-center of the former. The motor stick is shaped from a piece of 1/8" x 1/4" x 9 3/8" long hard balsa. Round its rear end so that it slips into the hole cut for it in former "9." The front end has its width cut to only 1/8" for a distance of 5/8", as shown on the left of Plan 1. Slip this 1/8" square end into the hole cut for it in the nose block after spreading cement over it. Make sure that the stick protrudes from the nose block at right angles to the back face of the block, and is perfectly straight. Bend a rear hook of No. 18 wire and cement it to the under side of the stick in its center and 7/8" from its end.

The tail skid is of balsa. The front piece is 1/16" square and the upright is 1/16" x 1/8". Cement these pieces in position to the under side of the fuselage, as shown in the side view. Cover the entire fuselage with Japanese



AERONCA SPORTPLANE PLAN 2

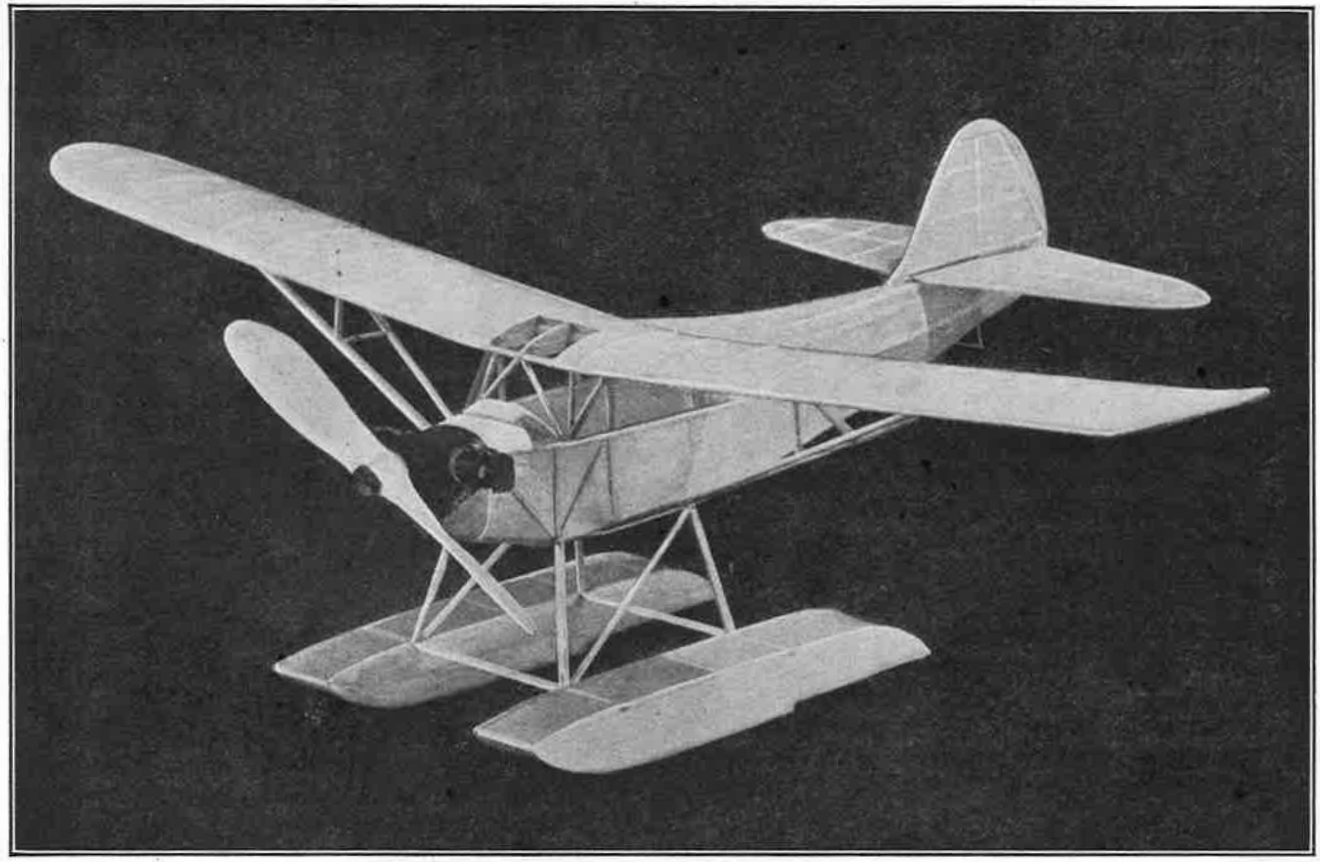
tissue using banana oil as an adhesive. Water spray the tissue when in place to shrink it, but take care not to warp the frame.

LANDING GEAR. The landing gear consists of two struts, axles, and two wheels. Both struts are shown in the side view of Plan 1 and the front view of Plan 2. They are cut to shape from 3/16" x 5/16" x 17/16" long. Taper their thickness, as shown in Plan 3, and streamline their width. Bend two axles, such as is shown in Plan 2 under "Shock Gear" from No. 18 music wire. Thrust the end well into the base of the strut and cement it in the position shown. Two 7/8" diameter 1/4" wide "doughnut" wheels are made or purchased. Full data on these is given on page 125 under "Balsa Doughnut Wheels." Thread them on the axles and bend up the ends of the wires to keep them in place. Cement the upper ends of the landing gear struts to stringers "C" on each side of the fuselage and notch to take former "2." Place them at such an angle as to allow the wheels to spread 4" center-tread to center-tread.

ELEVATOR. The elevator is shown on Plan 1 on squares representing 1/4" each. Rule paper with squares of this size and make a full-size copy of the elevator completing its other side at the same time. All parts are of 1/16" sheet balsa, and the entire elevator is made in one piece. Cut out all three spars and the three tip pieces. Fit the rubs, which are 1/16" square, in place, and cement the parts together. Cover the elevator with a single sheet of tissue on both sides. Use banana oil as an adhesive. Pin to the bench to prevent warping and then spray with water to tighten the covering. The elevator is now cemented in place on top of the fuselage, as shown in Plan 1. Note that its inner spar is directly over the fuselage end post. Inspect for perfect alignment of tips, and see that the elevator forms right angles with the sides of the fuselage.

RUDDER. The rudder is made in the way just described for the elevator. It is also made up solely of 1/16" sheet balsa. When completed, cover the rudder on both sides with tissue, pin to the bench, and then water spray. Its leading edge is cemented to the top of former "8" and its center spar to the back of the fuselage end post. Its lowest front rib is cemented to the top-center of the elevator. Make sure that it is in line with the motor stick and at right angles to the elevator.

WING. The wing is constructed in one piece. Its details are shown on Plan 2. The two rib sizes are given on 1/4" graph squares. Rule paper with squares of this size and make full-size copies of these two ribs. The frame requires seventeen "1" ribs and two "2" ribs, which are now traced on 1/16" sheet balsa and cut out. Cut the leading edge from 3/16" x 1/4" balsa, the inner spar from 1/4" x 1/8" balsa, and the trailing edge spar from 3/32" x 3/16"



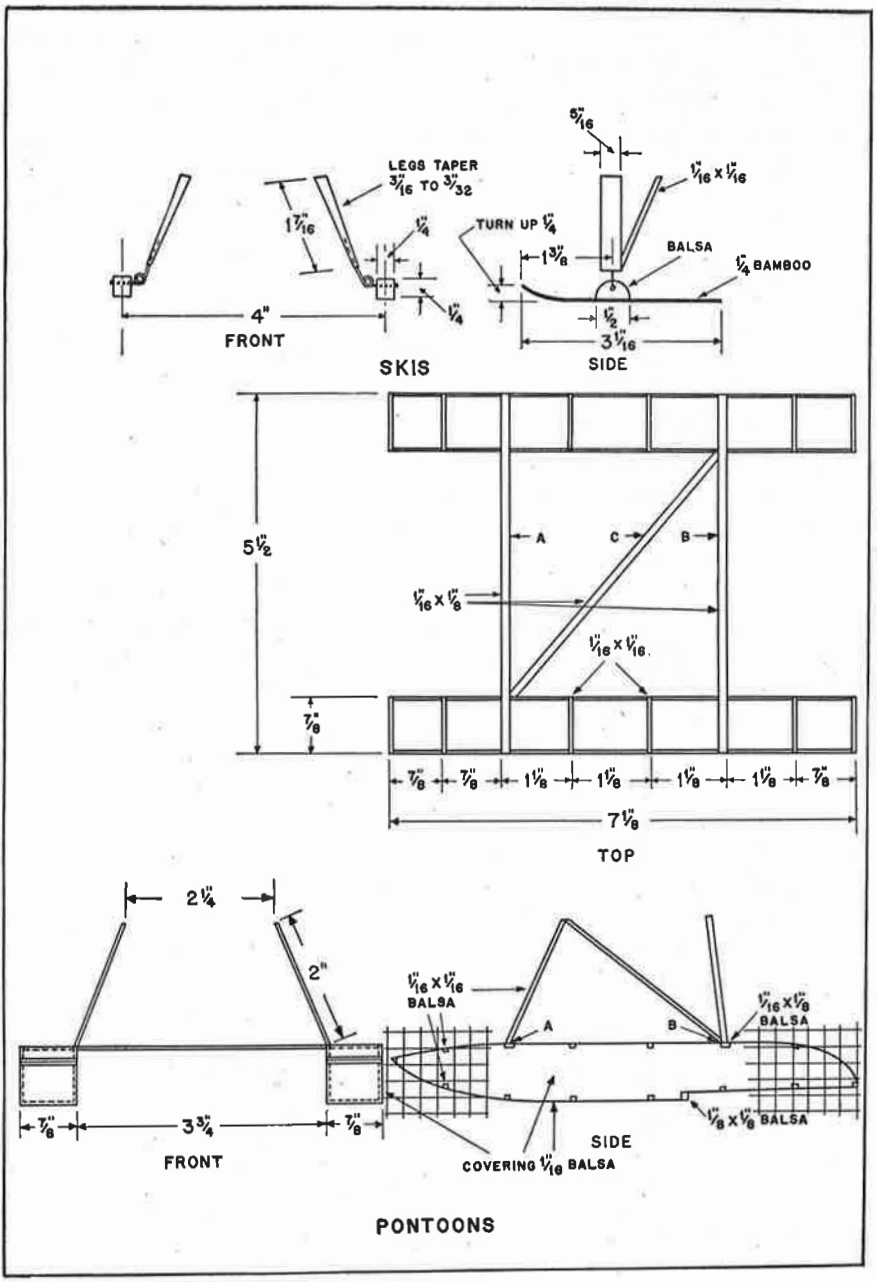
AERONCA SPORTPLANE ON PONTOONS

balsa. The inner spar keeps its original form, but the leading and trailing edge spars must be shaped to carry out the contour of the ribs. The two "2" ribs fit at the tops, as shown. Note that a center section made up of three ribs remains flat while the balance of both wing halves have dihedral angles. Break the spars at the locations of the ribs placed on each side of the center rib. Give each tip a 7/8" dihedral. Apply cement over the breaks while the tips are held in this position. Note the "wing window" over the center rib on the leading edge. This section must be covered with celluloid, as shown in the plan and photographs. The wing is now covered on both sides with Japanese tissue. It should be cut around the window so that the edge of the paper covers the edge of the celluloid to make a nice appearing job. When finished, pin the wing in position and water spray. The wing struts are shaped as shown in Plan 2. They are then streamlined. Two of each of these struts will be required. The front struts are cemented to the "C" stringers directly above the landing gear struts. Their upper ends are cemented to the under side of the fourth rib in from the tips of the wing. The rear strut is cemented to the same rib on each side at its upper end and next to the front strut on the "C" stringer at its lower end. Two strut braces are made up of 1/16" square balsa. Note its details in Plan 2 under "Brace." These are attached as shown in the plan. The best view of the wing strut assembly is shown in the photograph of the model on wheels. The center-section ribs are cemented to the framework of the cabin and the two wing mounts. Check for alignment and correct dihedral.

PROPELLER. The propeller is shown on Plan 2. It is carved in the regular way from a balsa propeller block measuring 5/8" x 1" x 6" long. Use hard balsa for this piece. Sand the blades to 1/16" thickness at their tips, and round its hub as shown. The propeller shaft is bent from the No. 18 music wire and cemented to the hub in the usual manner. The straight protruding end of the shaft is threaded with two washers, and then inserted through the eyelet bearing in the nose block. Its hook is then bent. Shape a spinner cap from 3/16" thick and 9/16" diameter balsa, as shown in Plan 2, and cement it over the outer face of the propeller hub. The motive power consists of three strands of 1/8" flat rubber. Loop these between the propeller shaft hook and the rear hook.

ENGINE. Two cylinders are shaped from balsa wood. This is fully explained on page 129 under "Engines." These cylinders are cemented to the sides of the nose block, as shown in Plan 1 under "Top View."

PONTOONS AND SKIS. This model is equally efficient on pontoons for water or skis for snow. Both have been covered in Plan 3. If the model is to be used on water all covered parts should be doped to make them



AERONCA SPORTPLANE PLAN 3

waterproof. The pontoons are simple in their design and construction. Each pontoon has a solid side cut from 1/16" sheet balsa, and shaped as shown on the graphs. These sides are held by top and bottom cross braces of 1/16" square balsa. Each pontoon is then covered with tissue, water sprayed, and thoroughly doped to make it waterproof. When both are finished, they are held together by two spacer braces, as shown in the plan. These are designated by "A" and "B." Brace "C" is cemented diagonally as shown for further support. When fitting the pontoons on the model, turn the model over on its wing and work in this position. When the two side struts with their diagonal brace have been cut to size for both sides of the fuselage, they are cemented in place, as shown in the photograph of the model on pontoons.

The skis are of bamboo with their front ends bent up over the flame of a candle. The plans clearly show how they are attached to the landing gear struts. Here is a three-way model which will give you splendid performance on land, water or snow!

CHAPTER 55

PITCAIRN AUTOGIRO PCA-3

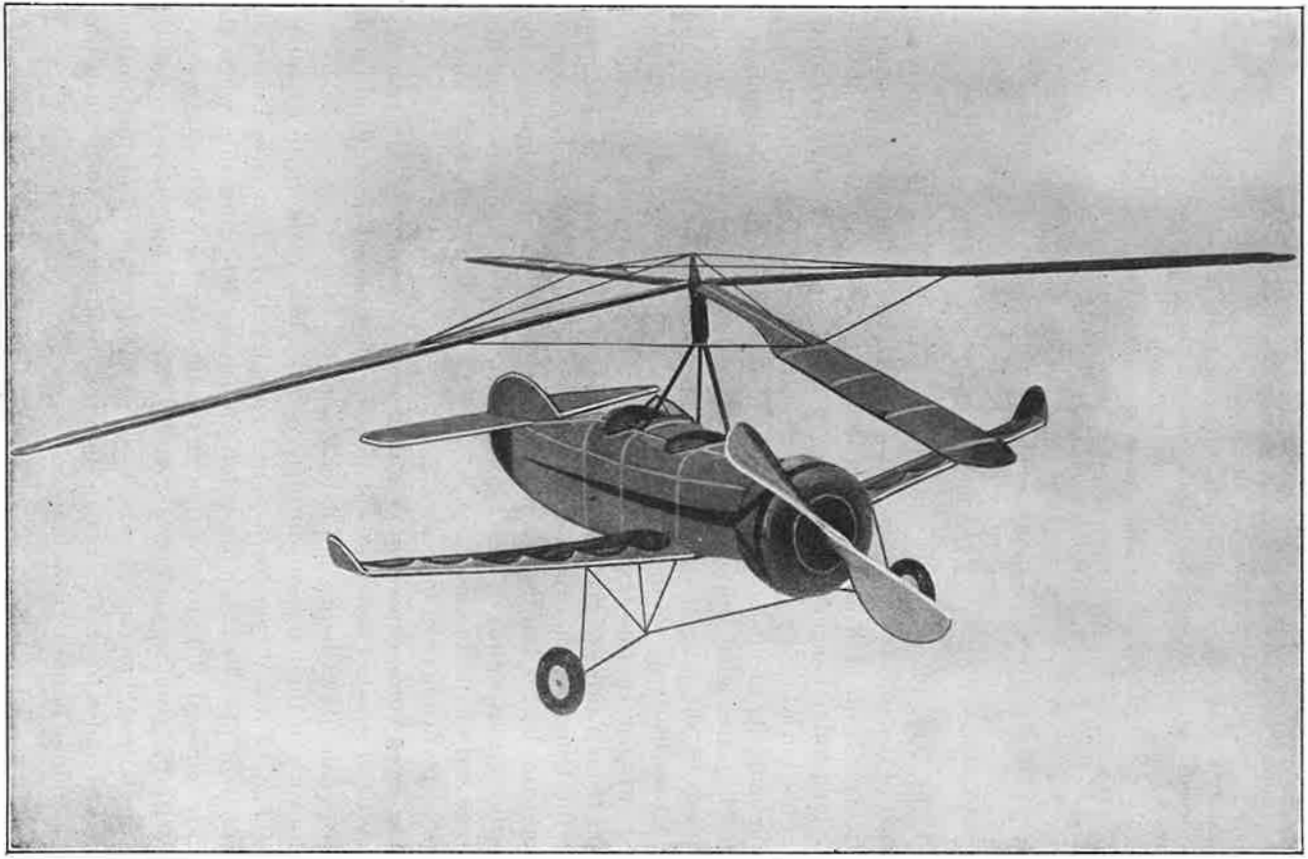
THE Pitcairn PCA-3 is a 3,000 pound autogiro produced by Pitcairn Aircraft, Inc., the first licensee of the Autogiro Company of America. It carries a pilot and two passengers and is powered with a Wright "Whirlwind" engine developing 300 horsepower.

Introduced for commercial purposes in 1931 by its inventor, Juan de la Cierva and its American sponsor, Harold F. Pitcairn, the autogiro in this country has won a wide popularity. It is manufactured at the new Willow Grove, Pennsylvania, plant of Pitcairn Aircraft, Inc.

While the plane weighs 3,000 pounds, the model weighs less than an ounce. The autogiro scale model has not proved to be an exceptional flyer, but both the open and closed types have been given in this book because of their great experimentation possibilities. They are good flyers, but cannot be compared to ordinary models. It will be found that careful adjustments are necessary to produce satisfactory flights, but if these are made, the PCA-3 and the cabin autogiro PA-19, found in the following chapter, will fly well and give the builder interesting and instructive flights.

MATERIAL LIST

6 pcs.—	1/16" x 1/16" x 12"	—Balsa for fuselage longerons, stringers, struts, and braces
1 pc. —	1/32" x 3" x 12"	—Sheet balsa for formers and cockpit cowlings
1 pc. —	1" x 2 3/8" x 2 3/8"	—Balsa block for engine cowling
1 pc. —	1" x 1" x 1"	—Balsa block for cowling plug
1 pc. —	1/8" x 1 1/4" x 1 1/4"	—Sheet balsa for plug cap
1 pc. —	1/32" x 3" x 12"	—Sheet balsa for wing ribs
8 pcs.—	1/16" x 1/16" x 6"	—Balsa for wing spars A, B, C, and D
2 pcs.—	1/32" x 3/4" x 1 1/4"	—Balsa for wing tips
1 pc. —	1/16" x 1/16" x 24"	—Balsa for spars and ribs of elevator and rudder
1 pc. —	1/16" x 1/4" x 15"	—Bamboo for elevator and rudder outlines
1 pc. —	1/32" x 1/8" x 20"	—Sheet balsa for blade ribs of rotor system
4 pcs.—	1/8" x 1/8" x 12"	—Balsa for leading edges of blades A
1 pc. —	1/16" x 1/4" x 15"	—Bamboo for trailing edges of blades B and hinges C
1 pc. —	1/16" x 1/16" x 8"	—Balsa for hub supports H and I
1 pc. —	3/16" x 3/16" x 11/16"	—Balsa for rotor blades' core
1 pc. —	3/16" x 3/16" x 7/8"	—Balsa for rotor hub
1 pc. —	1/16" x 1/4" x 15"	—Bamboo for landing gear struts



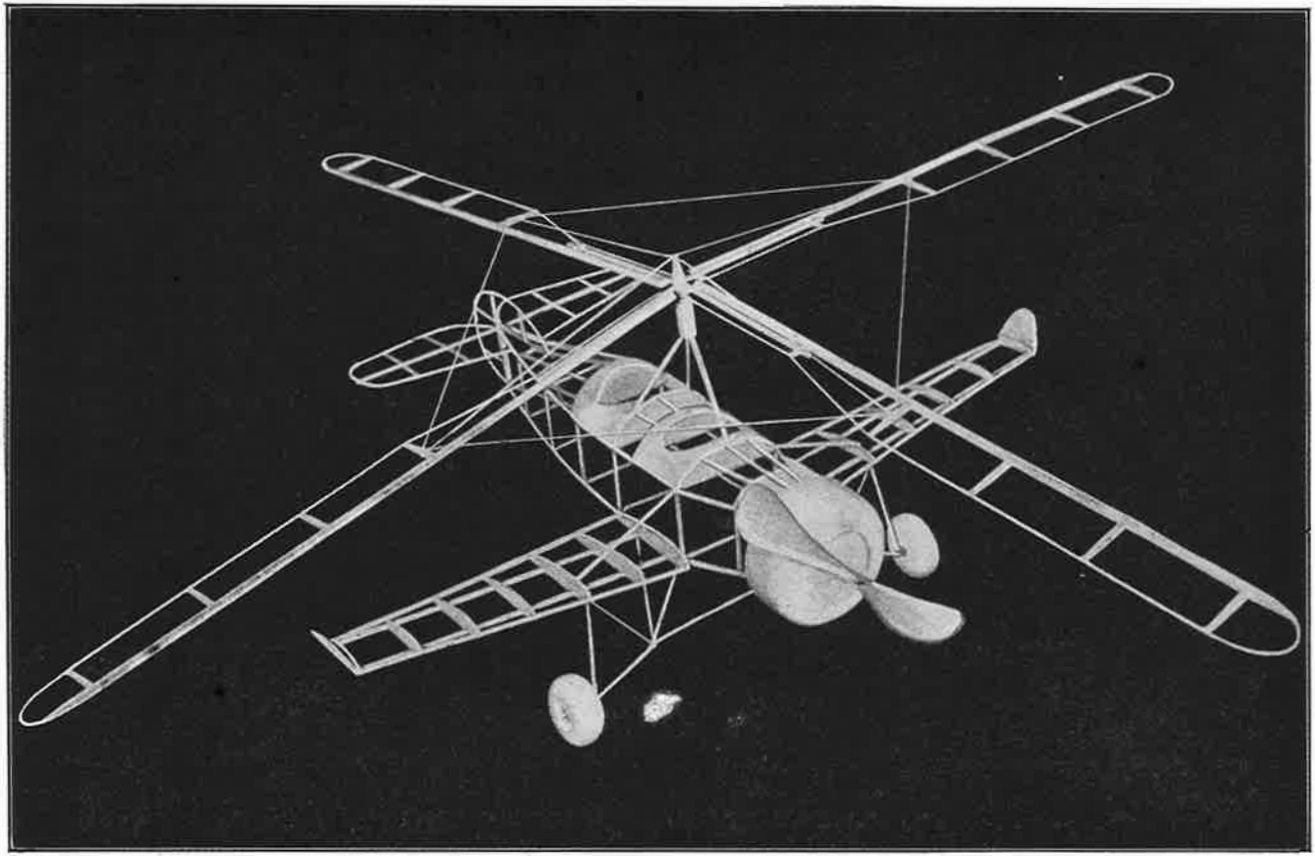
PITCAIRN AUTOGIRO PCA-3

1 pc. — 1/16" x 1/16" x 4 1/2"	—Balsa for wing struts K
2 1 1/8" diameter	—Balsa wheels
1 3/16" outside diameter	—Copper washer for rotor hub
1 long	—Pin for rotor system
1 spool	—White silk thread for blade supports
1 6" length	—No. 9 piano wire for fittings
1 36" length	—1/16" flat pure Para rubber for motive power
1	—Bushing eyelet for cowling plug
1 3/4" x 1" x 6"	—Balsa propeller block
1 sheet	—Japanese tissue
1 2" x 2"	—Sheet celluloid or isinglass for windshields
1 oz.	—Colorless cement
1 oz.	—Colorless dope
1 small package	—Model pins

FUSELAGE. Plan 1 shows three views of the fuselage. The top is constructed of a number of formers and stringers, while the under portion of the fuselage is made of longerons, struts, and cross braces. When only four main longitudinal members are used to form a fuselage, they are called longerons, but when a greater number give it form, they are called stringers. On the majority of models given in this book, all longitudinal members of the fuselage are called stringers solely as a means of preventing any possible confusion on the part of the builder. The longerons in this model, however, are so clearly shown that they will be called longerons and the stringers called stringers in this text. The longerons are shown by the letters A and E. Draw a full-size plan of the bottom view of the fuselage. The plans show the length of the fuselage, together with the distances between the bottom cross braces, but they do not show the lengths of these braces, which form the various widths of the fuselage. These lengths, when counting from the rear end of the fuselage, are: 5/8", 1 5/16", 1 7/8", 2", 2", 1 3/8", and 1". Draw in the two bottom longerons E.

The seven bottom cross braces and the two longerons are cut from 1/16" square balsa wood. These are bent to shape and placed in position on the full-size plan. (See Chapter 3, "Balsa Wood.")

Pin each of the longerons in place on the plan, as shown in Chapter 8 under Fig. 42 B and cement their rear ends together. The cross braces are cemented in place between these longerons, and left until dry, when the pins are removed. The top portion of the fuselage formed by longerons A is exactly the same as the bottom, except that these longerons extend 1/8" past the bottom longerons at the front of the fuselage, and the positions of the first and second cross braces from the front are 1/8" in front of their corresponding bottom cross braces.



PITCAIRN AUTOGIRO PCA-3 SKELETON

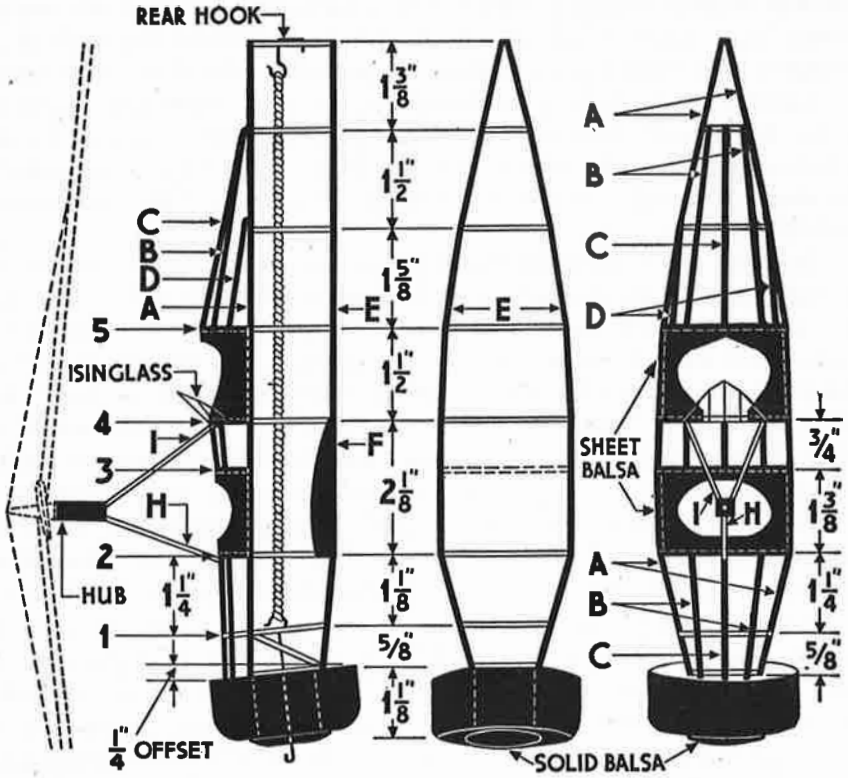
This is necessary because the autogiro flies with its tail low, so that its motor must be set at a slight angle to allow the propeller to be perpendicular. Study the side view of the solid scale plan. The fuselage is shown on a level, while the propeller is tipped. This is not its flying position. When the fuselage has its tail down in flying position, the propeller and engine will be perpendicular. Cut the top cross braces the same size and length as those of the bottom. Bend the longerons A, pin them in place on the bottom view plan, and cement their rear ends together. Cement the cross braces in place between longerons A.

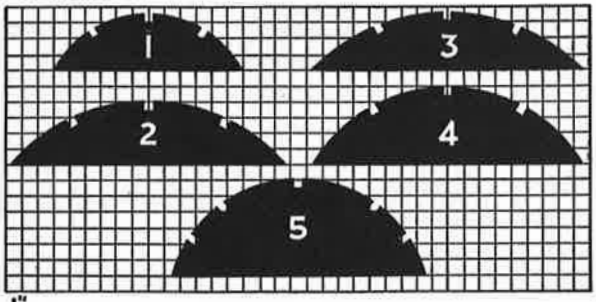
These two assemblies are joined by 1/16" x 1/16" x 1 3/16" upright struts. Cut fifteen of these struts. Cement a single strut at the end of the fuselage between longerons A and E. Longerons A and E run parallel with each other from the rear to points in line with former 2. Longerons A continue straight, while the bottom longerons E bend up toward longerons A. Cement the six pairs of upright struts between these longerons on each side of the fuselage in line with the top and bottom cross braces. Bend the longerons E up, and cement these 1" long upright struts between the four longerons at their ends. As the top longerons are longer than the bottom ones, these struts must be cemented at a slant to join the ends of the longerons together. The remaining pair are 1 1/8" long, and join the longerons together on both sides of the fuselage directly in line with the top and bottom cross braces. Two additional balsa braces are cemented between the first and second struts, as shown.

Make a full-size drawing of the five formers on 1/8" squares. Trace these on 1/32" sheet balsa, and cut them out. Their notches are 1/16" square. These formers are cemented to the top cross braces of the fuselage, as shown, except former 3 which is cemented to the tops of longerons A only. Former 1 is cemented at a slant in line with that of the second pair of struts.

Stringer C, running through the top center notches of the formers, is cemented in place. This must be severed to form the two cockpits, as shown. Stringers D and B are cut the same lengths as A and cemented in place. The front and back cockpit cowlings are cut from the 1/32" sheet balsa. The front cowling is bent to fit over formers 2 and 3, while the rear one is bent to fit over formers 4 and 5. Both these cowlings extend between longerons A on each side of the fuselage. Cockpit holes are cut in them to the shapes shown in the top view of Plan 1, and they are cemented in place.

The solid balsa engine cowling is cut from the 1" x 2 3/8" x 2 3/8" balsa block. It is rounded to a 2 3/8" diameter. A 1" diameter hole is cut through the center of this block, as shown by the white dotted lines, and the front







INSIDE VIEW OF COWLING

FUSELAGE

PITCAIRN AUTOGIRO PCA-3 PLAN 1

face has its edges rounded. Plan 1 shows a view of the back of this cowling. Three 1/16" square holes are cut in this back to hold the ends of the stringers. The front top cross brace fits just above this hole. The cowling is cemented to the ends of the longerons and their connecting braces and struts. It naturally falls into a slanting position when cemented to these members. The ends of stringers B, C, and D are cemented into the holes cut for them. An isinglass or celluloid windshield is cut to shape and cemented on top of former 4.

Bend an end hook from No. 9 piano wire and cement it to the rear upright strut of the fuselage. (See Chapter 6, "End Hooks.") Two wing mounts, shown by F on the side view of Plan 1, are cut and cemented on each side of the fuselage on longerons E. A plug is cut from the 1" x 1" x 1" balsa block to fit the hole of the cowling. Make this a snug fit. A 1/8" sheet balsa cap with a 1 1/4" diameter is cemented over the front end of this plug. A hole slightly larger than the diameter of the propeller shaft is cut through the center of the plug. The fuselage is not covered until later.

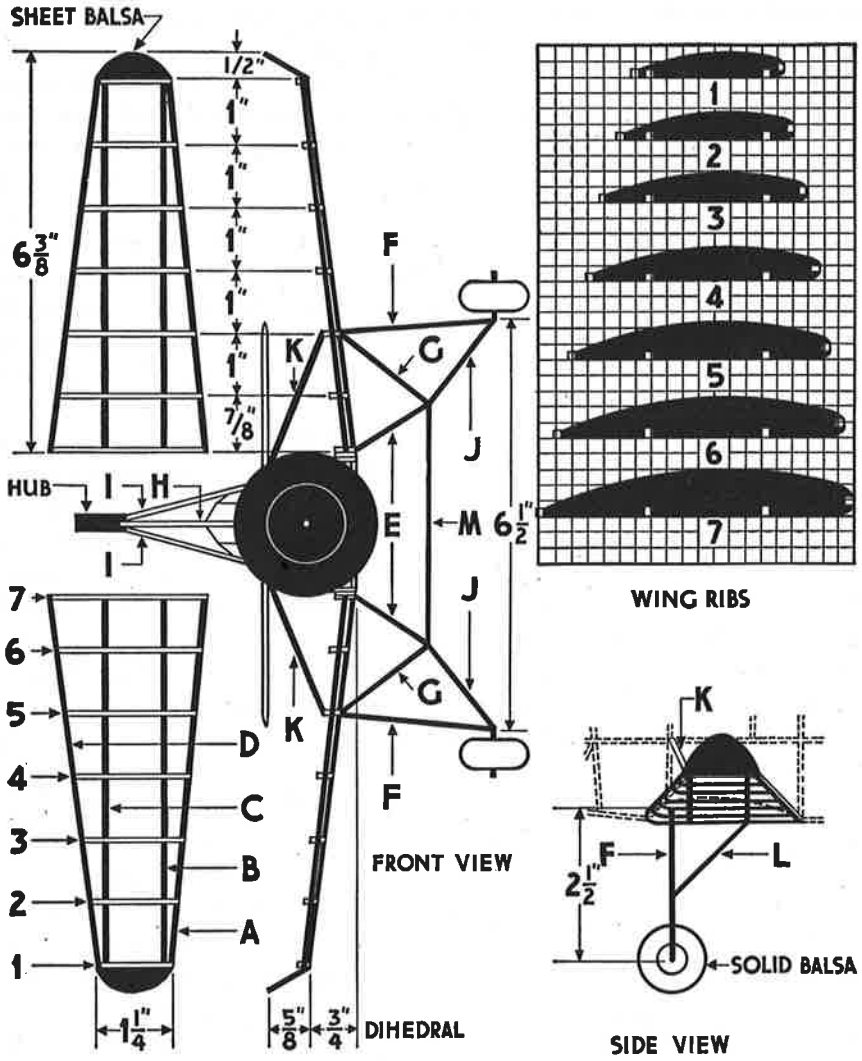
WING. The wing is made in two parts, as shown in Plan 2. Draw full-size patterns of the wing ribs on 1/8" squares, as shown under "Wing Ribs." Trace two of each of these ribs on 1/32" sheet balsa, and cut them out with 1/16" square notches in their leading ends, and under sides. Cement the two 1/16" square inner wing spars B and C in the notches of the ribs. The ribs must form right angles with these spars. The 1/16" square leading edge spar A is cemented in the front notches of the ribs, followed by the 1/16" square trailing edge spar D, which is cemented to the trailing ends of the ribs. Complete the other half of the wing.

Two solid balsa wing tips are cut to shape from the 1/32" x 3/4" x 1 1/4" sheet balsa pieces. They are cemented to ribs 1 with their outer ends 5/8" above the straight under edges of ribs 1.

The wing halves are covered on both sides with Japanese tissue, and water-sprayed but not doped. (See Chapter 7, "Wing Covering.") The wing is not attached at this time.

ELEVATOR. Cut spar F 1/16" x 1/16" x 6 3/8" as in Plan 3 under "Elevator." Two 1/16" x 1/8" x 1 3/4" long balsa ribs are cut, streamlined, and 1" from their trailing ends 1/16" square holes are cut through their sides. The two end ribs are the same size, 1 1/2" long, and have 1/16" square holes cut through them 3/4" from their trailing ends. Slip spar F through the holes in these ribs, space them properly and cement in place.

The short false ribs are 1/16" x 1/8" x 15/16". The bamboo outline piece is bent from 1/32" x 1/16" split bamboo. If a single piece cannot be obtained



WING **LANDING GEAR**

PITCAIRN AUTOGIRO PCA-3 PLAN 2

long enough for the elevator, two lengths must be used. Cement it in place, without the false spars. Set the elevator aside uncovered until later.

RUDDER. Spar E is 1/16" square and 2 1/16" long while the short spar is 1 1/16" long and the same size. Both are cut from balsa wood. The long rib D is 1/16" x 1/8" x 2 7/8" long balsa, and is streamlined. The short under rib is the same size and 3/4" long. Cut a 1/16" square hole through rib D 3/4" from its trailing end.

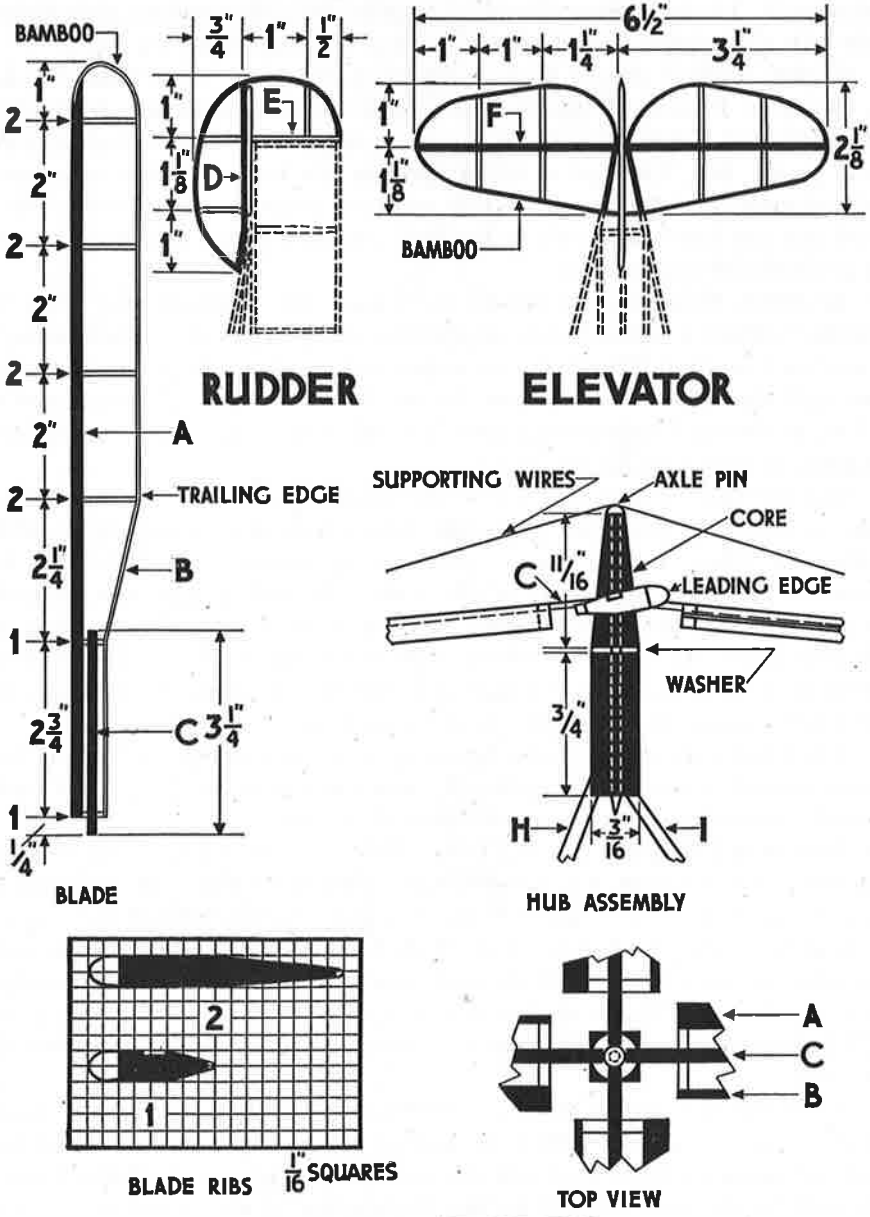
Slip E through the hole in D until it protrudes 9/16". Cement in place. Bend a length of 1/32" x 1/16" split bamboo to shape. Cement one of its ends to the lower end of spar E, bring it around the trailing end of rib D, and cement its other end to the leading end of D. Slip the short rib in place between this outline piece and spar E. Cement the short spar between rib D and the outline piece.

COVERING AND ASSEMBLY. Cover the fuselage with Japanese tissue (see Chapter 8, "Fuselage Covering"), and water-spray, but do not dope. The elevator is assembled on the model before it is covered. (See Plan 3.) Each false rib is cemented on top of each A longeron, while spar F is centered on and cemented to the tops of these longerons, where they meet. The outline piece is cemented to the leading ends of the false ribs. Spar F must be at right angles to stringer C.

Cover the elevator on both sides with Japanese tissue, and water-spray. The rudder is cemented over the end of the fuselage, with rib D, bent up to fit on top of stringer C, while spar E is cemented against the rear upright strut. See that it is at right angles with the elevator.

The wings are cemented to the wing mounts with their leading edges 1 1/2" behind the back of the engine cowling. Each wing is given a 3/4" dihedral, as shown in Plan 2. Lift rib 1 of each half 3/4" above rib 7, cement and hold in position until dry. Wing struts K are cut and streamlined from 1/16" square balsa, and extend from rib 5 at the leading edge of each half to longerons A at their intersection with former 2. Cement in place.

ROTOR SYSTEM. *HUB.* The hub is a 3/16" x 3/16" x 7/8" long balsa piece, shown in Plan 3 under "Hub Assembly." It is mounted by three 1/16" square balsa struts, shown in Plans 1, 2, and 3 by H and I. Strut H is 1 15/16" long, while the I struts are 2 1/4" long. The hub is mounted on its supports, as shown in Plan 1. Cement the three struts to the lower end of the hub. Bring front strut H down to the intersection of former 2 and stringer C, and cement in place. The I struts are brought down and cemented to former 4 at the points of intersection of this former and



ROTOR SYSTEM

PITCAIRN AUTOGIRO PCA-3 PLAN 3

stringers B. The hub piece should be parallel with the formers, directly in line with top stringer C, and located halfway between formers 2 and 3.

CORE. This is shaped from a 3/16" x 3/16" x 1 1/16" long balsa block, as shown in Plan 3, giving the entire hub assembly enlarged. It retains its full diameter of 3/16" at the bottom and tapers to the diameter of the pin head at the top. The pin is thrust through the center of this core, and twisted until the hole is considerably enlarged, so that it will rotate easily. Press the pin into the center of the hub, and test to see that both pieces fit perfectly one on the other.

BLADES. Four of these blades or "vanes" are required. (See Plan 3, "Blade.") Make a full-size plan of the ribs, as shown under "Blade Ribs." Two No. 1 and four No. 2 ribs are required for each blade. Trace these on the 1/32" sheet balsa and cut out. In the No. 1 ribs a 1/64" x 3/32" notch is cut, as shown. Leading edge spar A is 1/8" x 1/8" x 12" long. It requires shaping as shown in the rib graph.

Cement spar A in place against the front ends of the ribs. Space the ribs, as shown, see that they form right angles with spar A and are parallel with each other. A 1/64" square split bamboo trailing edge B is bent to form the tip and trailing edge of the blade. The end of spar A is grooved to accommodate this bamboo piece. Cement it to A spar and the ends of the ribs, and bend it in to reach the ends of the No. 1 ribs, as shown. The blade hinge C is 1/64" x 3/32" x 3 1/4" split bamboo. Cement this in place, as shown. Complete all four blades in the same manner.

The blades are covered with Japanese tissue on one side only. Iron the tissue smooth before applying, but do not water-spray or dope it, as such delicate construction will not withstand shrinkage.

ASSEMBLING ROTOR SYSTEM. This is the most important step in the entire construction. The blades of the rotor system have been designed to move up in flight and droop down when not rotating. This is the correct motion of such blades, and to obtain it the hinge pieces C must be cemented into the core exactly right. If these are not correctly assembled, the model may not fly at all. The blades must be spaced evenly around the rotor core 1/4" from its lower end. They are cemented into holes cut in the sides of the core.

To obtain the correct droop of the blades, place the core on a 1" high block set on a level table. Place the end of hinge C against the side of the core 1/4" from its lower end, and the tip of the blade on the table. Pierce the core at the slant formed by the blade when in this position, so that the end of C hinge will be 1 1/4" above the tip of the blade when assembled on the model. Place the pin through the hole of the core, so that the end

of C will not enter the pin's hole. Cement C in place at a slight angle, so that the leading edge of the blade will be 1/8" higher than the trailing edge.

Leave each blade in position until dry, and then proceed with the next until all four are mounted. The supporting wires, shown in Plan 3 under "Hub Assembly," are white silk thread. Cement one end to the first No. 2 rib from the hub in the center of the blade. Bring it up to the top of the core, wrap it around the core once, cement it in place, and bring it down to the same position on the opposite blade, where it is cemented. Another length is attached between the remaining two blades in the same manner. Connecting threads are cemented between each blade at the ends of these supporting pieces.

Do this work while the rotor blades are in position on the 1" block set on a level table. The thread between the blades and the pin should be taut, but not stretched enough to lift the tips of the blades off the table.

When all cement has hardened, pick the rotor assembly up and test it to see that the blades have their tips evenly separated from each other. If not, the connecting threads between the blades must be cut and new lengths substituted.

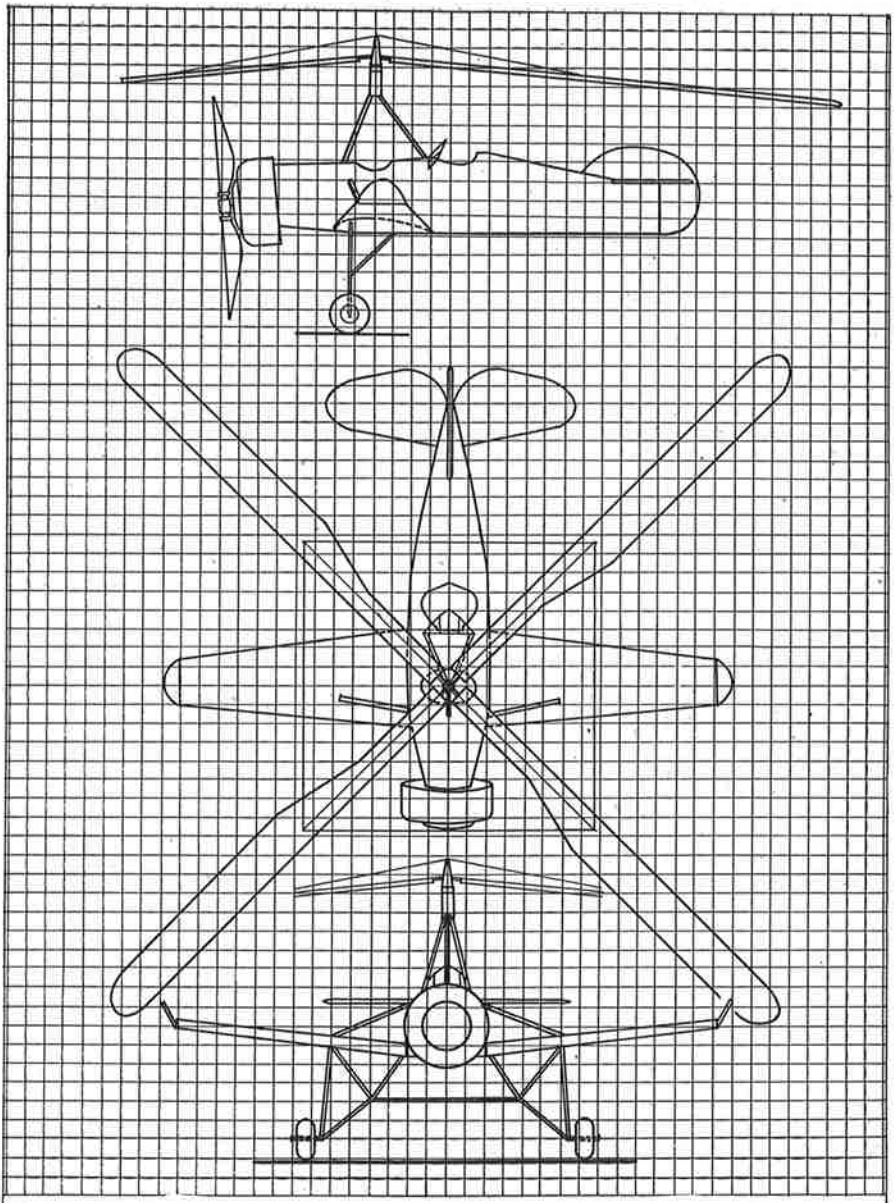
A large copper washer is placed on top of the hub and the core set in position by forcing its pin into the hole of the hub. Test the freedom of the core by blowing on the vanes. If they do not rotate freely, the hole in the core must be enlarged.

PROPELLER. This is carved from a 3/4" x 1" x 6" balsa propeller block. (See Chapter 9, "Carved Propellers.") A No. 9 piano wire propeller shaft is thrust through the hub of the propeller, bent around, and firmly cemented in place. Remove the plug from the engine cowling and fit a bushing eyelet into its cap. The wire shaft is then fitted with two small copper washers, thrust through the hole in the plug, and a hook bent in its end.

MOTIVE POWER. This requires four strands of 1/16" flat rubber. Obtain a 36" length and tie its ends together. This is looped twice and one end slipped over the hook of the propeller shaft. The under side of the fuselage from the rear cross brace to the end must now be opened. Cut the tissue along the longerons E and carefully remove it. The rubber motor is passed into the fuselage, the engine cowling plug fitted in place, and the ends of the loops passed over the end hook.

The open section of the fuselage may be recovered, or it can be left open, as desired.

LANDING GEAR. This is made of eleven lengths of 1/16" square split



SOLID SCALE PLAN FOR PITCAIRN AUTOGIRO PCA-3

bamboo. Build it on a flat surface and then assemble it on the model. The J struts are 2½" long with ¾" turned up to form the axles. The struts F are 2½" long, while the connecting struts G between F and J are 1¾" long. The prolongation struts E are 1⅜" long and the horizontal strut M is 3¾" long. Struts L, shown in Plan 2 under "Landing Gear," are 2" long.

Cut these struts and finish them with sandpaper. Make a full-size drawing of the landing gear, place the struts on it and cement them together. A drop of cement should be applied to each joint. When dry, assemble the structure to the under side of the wings. Note their various points of contact. The ends of the landing gear struts should come halfway between the leading edge spar A and the leading inner wing spar B on ribs 7 and 5 of each wing half.

Struts L are cemented at the intersections of struts J, G, M, and E. Their other ends are cemented to ribs 7 where these intersect the trailing inner wing spars C, as shown in the side view. At the intersections of the lower ends of struts F with struts J, the latter struts are cracked and bent up to form the wheel axles. A drop of cement should be applied to the crack and the strut held in place until dry.

Two 1⅛" sheet balsa wheels are made and attached to the flying model. (See Chapter 10, "Solid Balsa Wheels.") If the model is to be doped and painted for exhibition purposes, the wide solid balsa "doughnut" wheels should be made, as shown. These are used on the real autogiro. (See Chapter 10, "Balsa Doughnut Wheels.")

FLYING. See Chapter 51, "Flying."

SOLID SCALE MODEL. See Chapter 46 under "Solid Scale Model" for general building instructions for a solid scale model of this plane.

CHAPTER 56

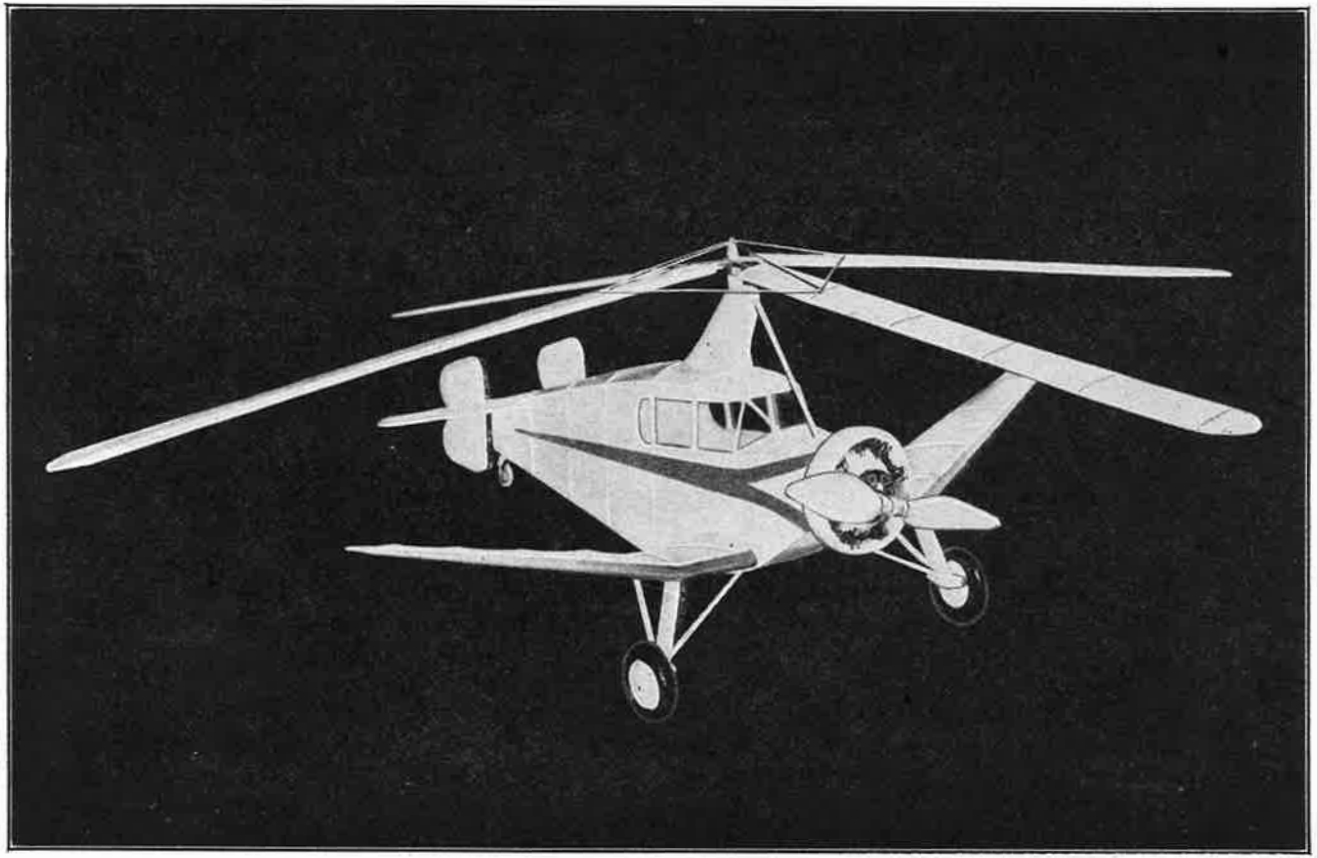
PITCAIRN AUTOGIRO PA-19

THIS is the largest autogiro thus far built and flown. It is a four-passenger, cabin plane built in Philadelphia for use as an air taxi in Florida, and is the first full-cabin autogiro produced. Powered with a 420 horsepower engine, it has a gross weight of 4,035 pounds with pilot and three passengers, a cruising speed of 100 miles an hour, and a technical landing speed of zero.

The model given here is a perfectly scaled and true-actioned replica of this "flying windmill" with vanes pointing upward in flight and drooping down when not rotating. It is, to the best of the author's knowledge, the first flying model of a cabin autogiro ever produced, and should offer its builder many interesting hours of experimentation. The completed model weighs less than an ounce.

MATERIAL LIST

5 pcs.—1/32" x 1/32" x 36" —Balsa for fuselage stringers, struts, and braces
2 pcs.—1/32" x 3" x 24" —Sheet balsa for formers, wing, tail, and rotor ribs
1 pc. —1/2" x 2" x 2" —Balsa block for ring cowling
1 pc. —1/2" x 1 1/2" x 1 1/2" —Balsa block for fuselage former 1
1 pc. —1/4" x 1/4" x 5" —Balsa for dummy engine cylinders
1 pc. —1/8" x 3/16" x 10 5/16" —Balsa for motor stick
1 pc. —5/8" x 1" x 1" —Balsa for motor stick plug
2 pcs.—1/16" x 1/4" x 15" —Bamboo for window frames F, wing tips, blade spars B and C and tail outline pieces
2 pcs.—1/4" x 3/8" x 6 1/2" —Balsa for leading edge spars A
2 pcs.—1/8" x 1/8" x 6 1/2" —Balsa for inner wing spars B
2 pcs.—3/16" x 1/4" x 6 1/2" —Balsa for trailing edge spars C
1 pc. —1/16" x 1/16" x 5 1/4" —Balsa for inner elevator spar D
1 pc. —1/16" x 1/16" x 4 3/4" —Balsa for inner rudder spars E
4 pcs.—1/8". x 1/8" x 12" —Balsa for leading edge spars A of rotor blades
1 pc. —1/2" x 1 5/8" x 1 7/8" —Balsa block for rotor mount
1 pc. —1/16" x 1/16" x 2 1/2" —Balsa for rotor mount strut H
1 pc. —1/4" x 1/4" x 3/4" —Balsa for rotor core
1 pc. —1/4" x 1/4" x 1/4" —Balsa for rotor hub
1 pc. —1/16" x 1/8" x 8" —Balsa for landing gear struts E and F
1 pc. —1/8" x 3/8" x 2 1/2" —Balsa for landing gear struts D
1 pc. —1/4" x 1/4" x 2" —Balsa for landing gear streamlines G



PITCAIRN AUTOGIRO PA-19

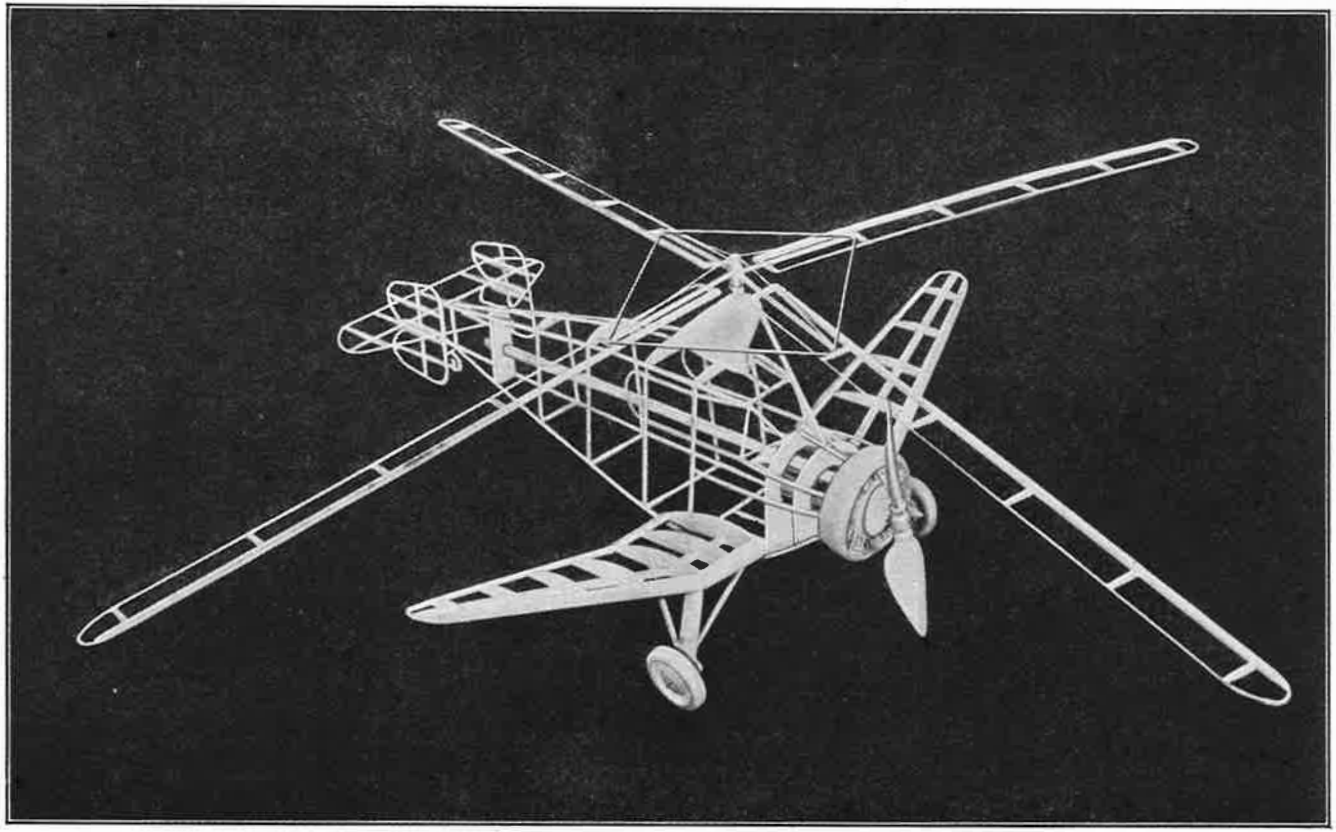
1 pc. —5/8" x 1" x 5"	—Balsa propeller block
1 pc. —2" x 7"	—Isinglass or sheet celluloid for cabin windows
1 38" length	—1/8" flat pure Para rubber for motor
1 pair 1 1/4" diameter	—Wheels
1 1/2" diameter	—Tail wheel
1 sheet	—Japanese tissue for covering
1 pc. 6" long	—No. 9 piano wire for fittings .
1 1/4" outside diameter	—Copper washer for rotor hub
1 1 3/4" or over	—Common pin for rotor axle
1	—Small bushing eyelet for motor stick plug
1 oz.	—Colorless dope for adhesive purposes
1 oz.	—Colorless cement
1 spool	—White silk thread for rotor blade supports

FUSELAGE. Make a full-size copy of the side view of the fuselage on 1/2" squares, as shown on the solid scale plan. All stringers are 1/32" square balsa. Soak, bend, and pin stringers A and B on the full-size plan. Note their positions in Plan 1.

Make full-size copies of all formers shown in Plan 1 under "Fuselage Formers." Trace former 1 on the 1/2" x 1 1/2" x 1 1/2" balsa block and cut out. Trace all others on 1/32" sheet balsa and cut out. The notches in these are 1/32" square.

When dry, cement stringer A to formers 4, 5, 6, 7, and 8. Bend stringers C and cement them in the side notches of these formers. Join the front ends of these three stringers A and C by a 1/32" x 1/32" x 1 1/4" balsa cross brace, as shown in the top view of Plan 1. Cement the ends of stringers C together to the end of stringer A. Cement stringers B to formers 1, 2, and 3 with 1/2" between formers 1 and 2. Cement short stringer A into the top center notches of formers 1, 2, and 3 with 3/4" between formers 1 and 2, which gives former 1 a 1/4" offset, as shown in Plan 1. Cut and cement stringers D and E to formers 1, 2, and 3 so they extend 1 3/4" behind former 3, as shown in the side view. Cement the ends of stringers B together. Cut end strut G 1/32" x 1/32" x 1 3/16" and cement it between the ends of top stringers C and the bottom stringers B. Cement former 9 directly under former 8 with stringers B fitted into its bottom notches. The upright strut under former 4 is 2 13/16" long. Cut two of these and cement them between stringers C and B on each side of the fuselage and under former 4.

Stringers E and D have their ends cemented against these struts, after D stringers have been bent parallel with stringers E, as shown in the side view. Struts of the same length are cut and cemented between stringers C and B on each side under former 5. Cut and cement the two remaining pairs of struts located under formers 6 and 7. The cabin windows are



PITCAIRN AUTOGIRO PA-19 SKELETON

completed with stringers I on each side of the fuselage, as shown. The windows have end pieces F to complete their form. These are 1/32" bamboo, bent to shape, and cemented in place.

A 1/64" square bamboo windshield frame joins stringers C and former 3, as shown in the top view. Isinglass is cut to size and cemented over this, as well as the cabin side windows, as shown by the shading in Plan 1.

A 1/32" sheet balsa wing mount is cemented on each side of the fuselage between former 3 and the upright struts under former 4 on top of stringers B. Bottom cross braces of 1/32" balsa are cemented between stringers B along the bottom of the fuselage under formers 4, 5, 6, and 7 in line with the side upright struts. A short stringer is cemented into the center bottom notches of formers 1, 2, and 3. It ends at the bottom cross brace under former 4.

Cover the fuselage with Japanese tissue and water-spray, but do not dope. (See Chapter 8, "Fuselage Covering.")

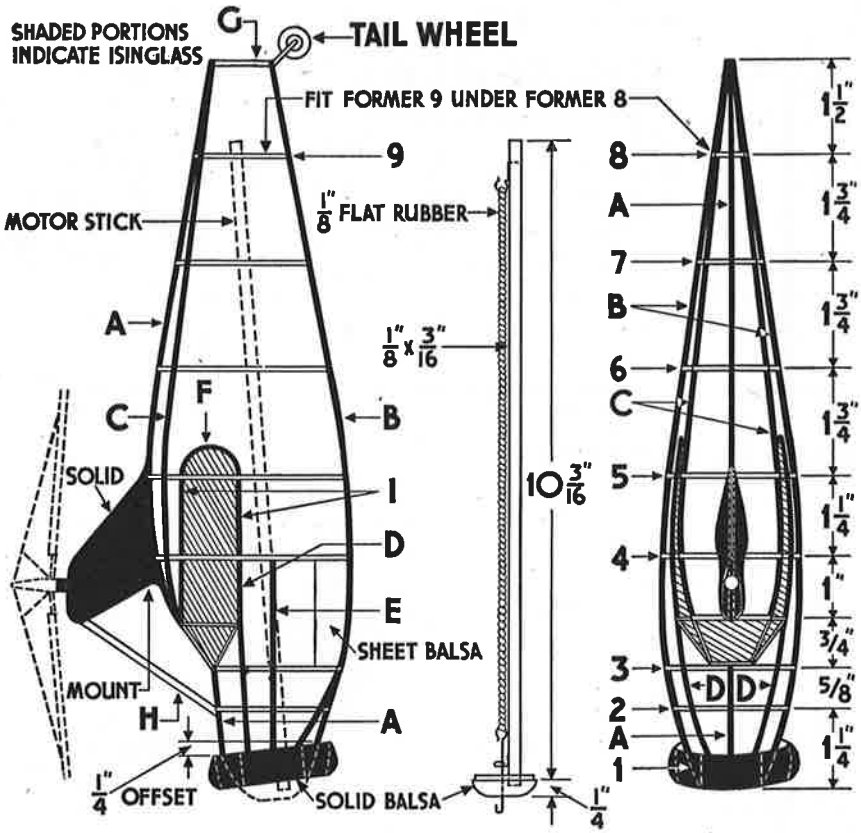
ELEVATOR. Spar D is 1/16" x 1/16" x 5 3/16" balsa. All ribs are 1/32" x 1/8" balsa. The outer pair is 1 7/16" long, and the center ones are 2" long. The inner ribs are 1 1/2" long, while the single trailing center rib is 1 5/16" long. Streamline these and cut 1/16" square holes 1 5/16" from the trailing ends of the outer and center pair. Thread these on the spar and cement in place. Cement the center of spar D against the ends of stringers A and C at right angles to upright strut G, and cement the two inner ribs against stringers C with their ends against spar D, as shown in Plan 2, "Elevator."

Cement 1/32" square bamboo along the trailing ends of the ribs. Bend it around and cement it to the ends of spar D and the leading ends of the inner ribs. Cement the center rib between spar D and the bamboo trailing edge. Cover on both sides with Japanese tissue and water-spray, but do not dope.

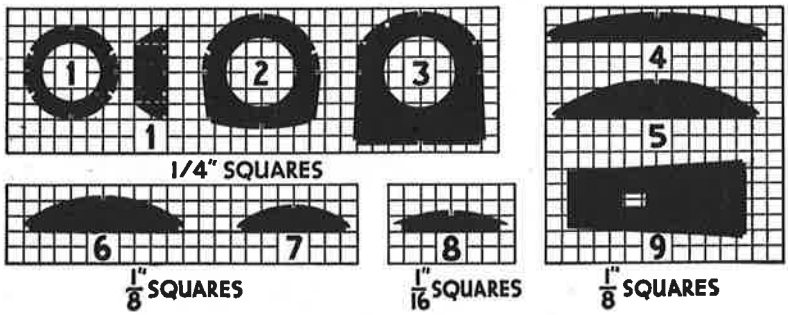
RUDDERS. Cut two 1/32" x 1/8" x 1 11/16" balsa ribs and make a 1/16" square hole 1 5/16" from the trailing ends of each. Cut two 1/16" x 1/16" x 1" balsa spars E, as shown in Plan 2, "Rudder." Bend a single length of 1/32" square bamboo, and cement it in place to the spars and ribs, as shown. The center slot of the rudder should be shaped to fit snugly over the front of the center elevator ribs. Complete a second rudder in the same manner. Cement them over the leading edge of the elevator around the center ribs. Cover on both sides with Japanese tissue and water-spray.

TAIL WHEEL. A length of No. 9 piano wire is thrust through the hub of the wheel, bent around in a loop, and its ends twisted together. These ends are cemented around the ends of stringers B, as shown in Plan 1.

WING. Make a full-size drawing of one half of the wing. Make a full-



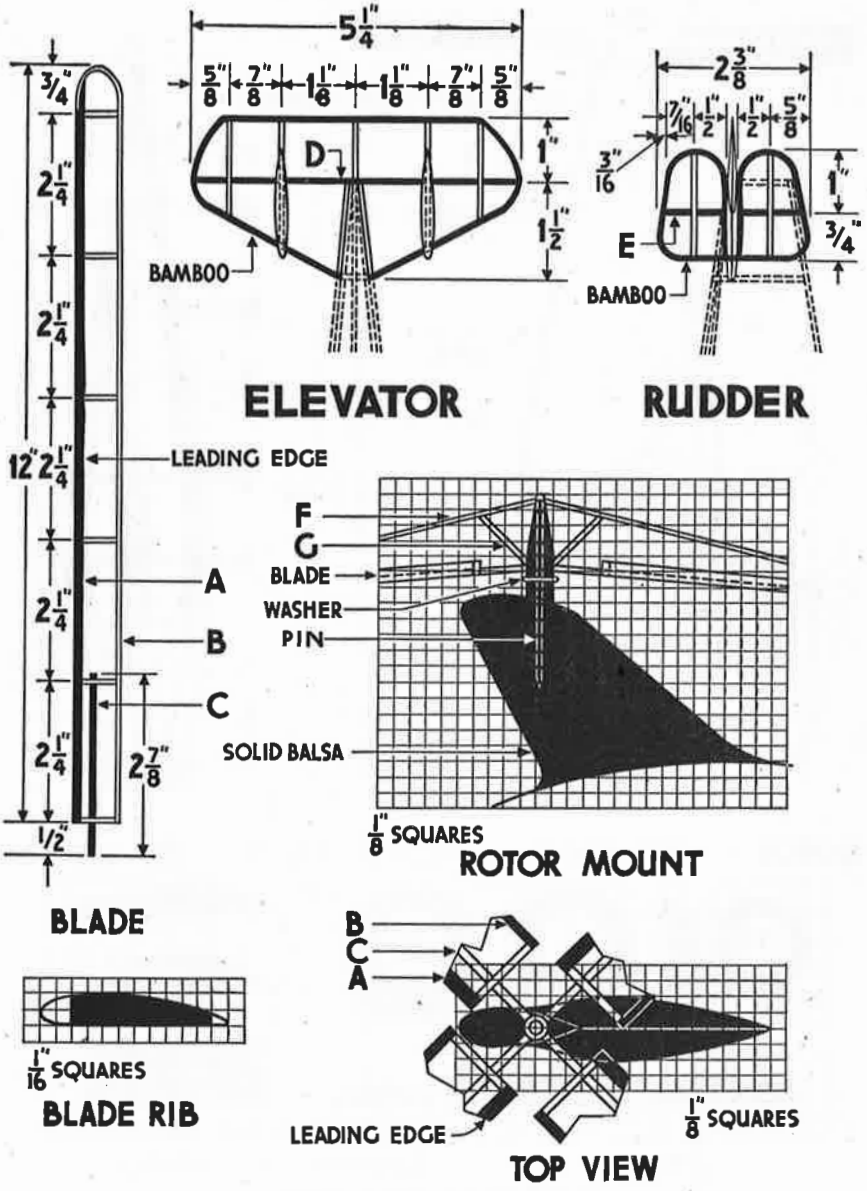
ROTOR SIDE VIEW MOTOR STICK TOP VIEW



FUSELAGE FORMERS

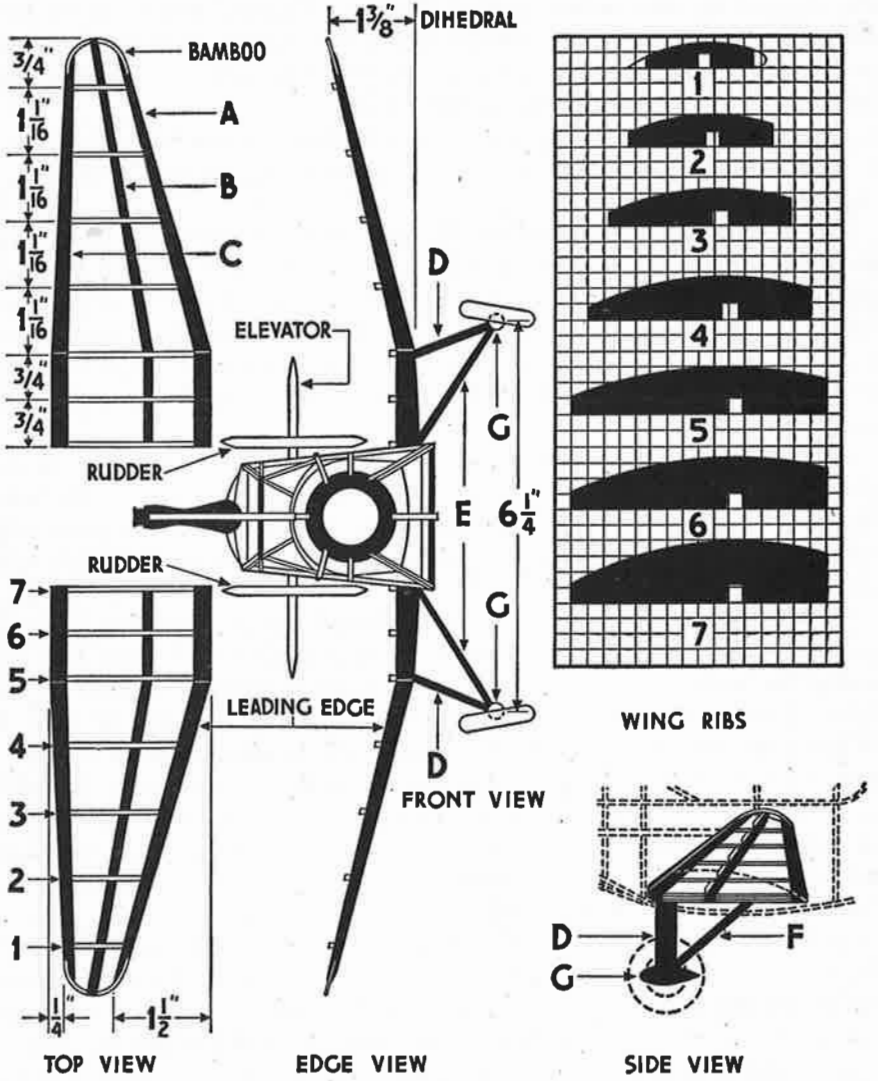
FUSELAGE

PITCAIRN AUTOGIRO PA-19 PLAN 1



ROTOR SYSTEM

PITCAIRN AUTOGIRO PA-19 PLAN 2



WING AND LANDING GEAR

PITCAIRN AUTOGIRO PA-19 PLAN 3

size copy of the ribs shown in Plan 3 on 1/8" squares. Trace two of each rib on 1/32" sheet balsa and cut out with a 1/8" square notch in each. Cut two leading edge spars A 1/4" x 3/8" x 6 1/2" long, and two trailing edge spars C 3/16" x 1/4" x 6 1/2" long of balsa wood.

Spars A are tapered from their original thickness at one end to 1/8" x 1/8" at their outer ends, while spars C are tapered to 1/16" x 1/8". Each spar is shaped as shown in Plan 3 on rib 1.

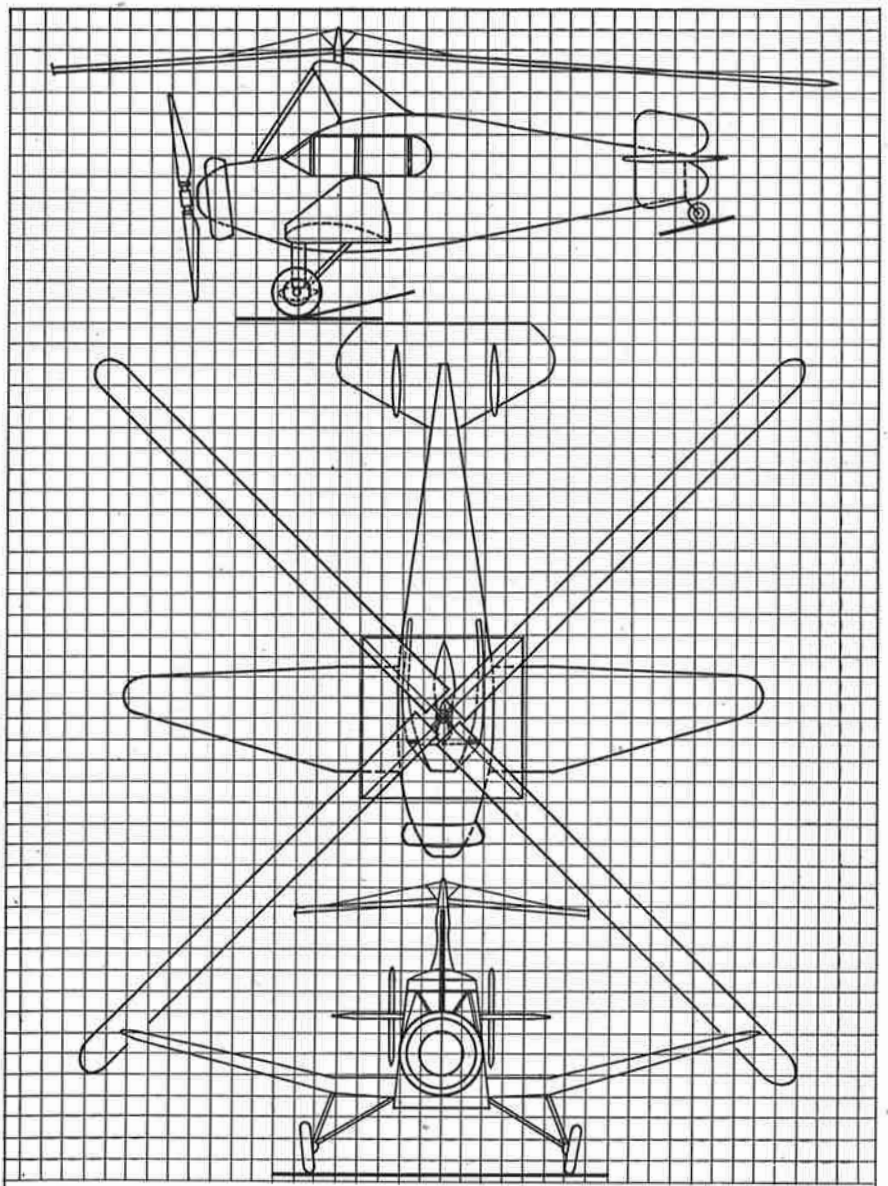
Place each spar in position on the plan. Snap the spars and bend them into proper position. Apply cement to their cracks after pinning them on the plan. Cement the ribs on spar B. Cement spars A and C in position. Bend 1/32" square bamboo wing tips and cement them in place. Both halves are given a 1 3/8" dihedral from ribs 5 to their tips. Crack the spars again at these points, bend up their tips, and while holding in this position, apply cement to the cracks.

Cover on both sides with Japanese tissue and water-spray, but do not dope. (See Chapter 7, "Wing Covering.") Cement the wings to the wing mounts on each side of the fuselage. Their leading edges are even with former 3 and their under sides just above stringers B and parallel with stringers E.

LANDING GEAR. Struts D are 1/8" x 3/8" x 1 1/4" long, and struts E are 1/16" x 1/8" x 2 3/16" long. Struts F are 1/16" x 1/8" x 1 5/8" long. Cut and streamline each of these pairs of struts. Cement struts D to ribs 5, and struts E at the intersection of stringers B and the inner edge of spars A. Cement the ends of struts D and E together. Cement struts F to ribs 5 between spars A and C, and their other ends to the joints of struts D and E, as shown in Plan 3 under "Landing Gear." Two streamlines G are shaped, as shown, and cemented to the ends of struts D. Two 1 1/4" diameter sheet balsa wheels are made and attached with bent model pins to streamlines G. (See Chapter 10, "Solid Balsa Wheels.")

MOTOR STICK. This is 1/8" x 3/16" x 10 5/16" long balsa. Shape a 1" diameter motor stick plug 5/8" thick, as shown in Plan 1 under "Motor Stick." Its flat back has a 7/8" diameter for 1/8" of its thickness to fit the hole in former 1, as shown. Make this a snug fit. Force a pin through its exact center and just below this hole cut a 1/8" x 1/8" x 3/16" hole. Cement the end of the motor stick into this, testing for right angles between the stick and the back of the plug. Bend an end hook of No. 9 piano wire and cement it on the stick 1/2" from its end. Place the end of the stick through the hole cut in former 9 and the plug into that of former 1.

PROPELLER. This is carved from a 5/8" x 1" x 5" balsa propeller block. (See Chapter 9, "Carved Propellers.") A propeller shaft is bent from



SOLID SCALE PLAN FOR PITCAIRN AUTOGIRO PA-19

No. 9 piano wire, thrust through the hub, and cemented in place. The end of the shaft must be inserted through the motor stick plug before its hook is bent, and two copper washers should be fitted on the shaft between the plug and the propeller. (See Chapter 6, "Propeller Shafts.")

MOTOR. Obtain a 38″ length of pure Para rubber, tie its ends together, and loop it between the end hook and the propeller shaft hook.

ROTOR SYSTEM. Follow instructions in Chapter 55 "Rotor System" for this work. While the blades of this model are slightly different in shape, all spars, ribs, and tips are the same size and material. The rotor mount consists of a solid block of balsa shaped as shown in Plan 3 under "Rotor Mount." Make full-size drawings of this piece, and shape the ½″ x 1⅝″ x 1⅞″ balsa block, as shown. A hub ¼″ in diameter and ¼″ high is cemented on top of this mount. The balance of the assembly is exactly like that of the open autogiro model in Chapter 55.

The mount is cemented on stringer A over formers 4 and 5, as shown in Plan 1. A rotor mount strut H is cut 1/16″ x 1/16″ x 2½″ long, and cemented on the top of the mount and former 2, as shown.

FLYING. See Chapter 51, "Flying."

SOLID SCALE MODEL. See Chapter 46 under "Solid Scale Model" for general building instructions for a solid scale model of this plane.

CHAPTER 57

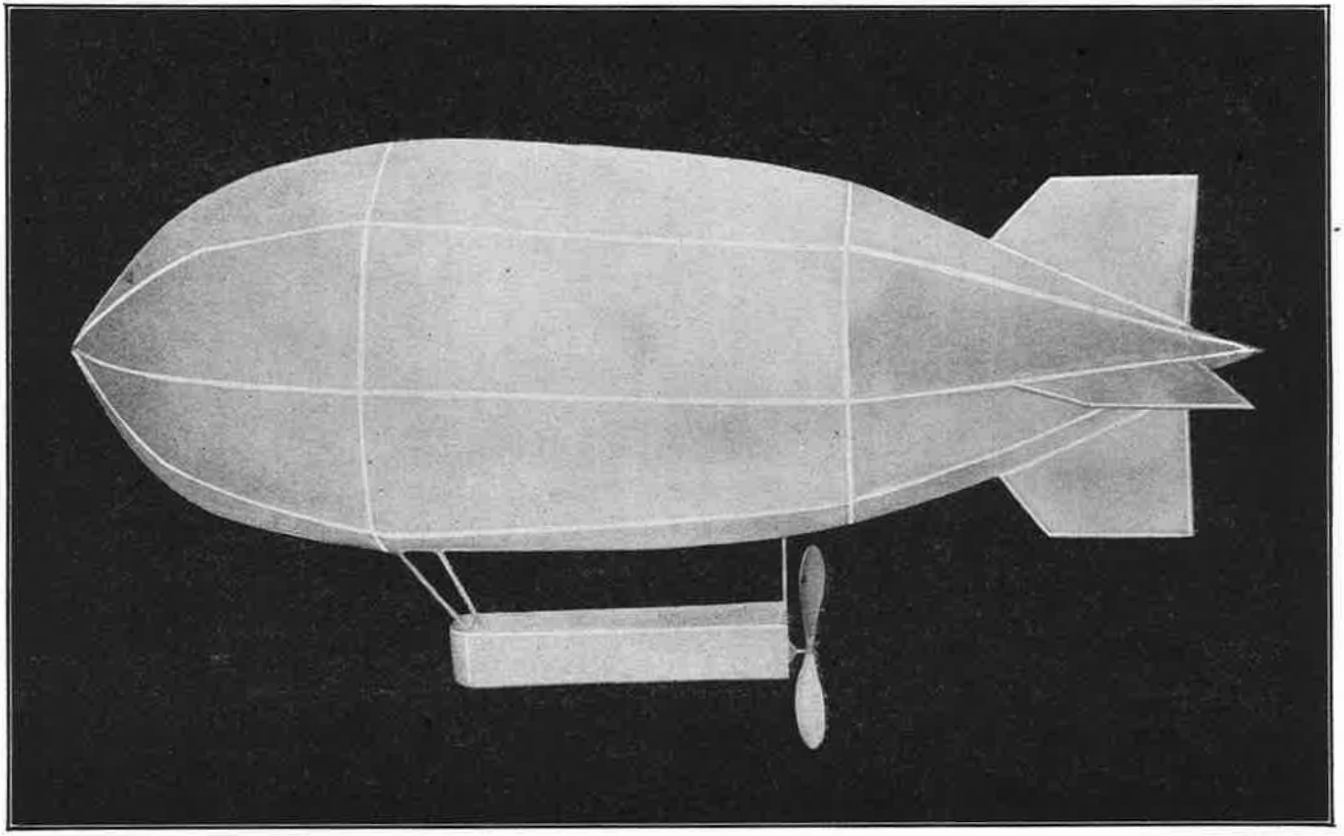
FLYING ARMY BLIMP

HERE is something new for the model airplane enthusiast to tackle! It is a self-propelling, flying model of an Army blimp. If properly constructed, it will slowly rise through its own gas capacity, while its propeller will give it the necessary forward motion to carry it along in flight. While simple in construction, it nevertheless must be built with great care, as weight spells the difference between success and failure.

Due to this extremely light construction, it is strictly an indoor flyer, although if used on days when no wind whatever is stirring, it can safely be operated outside. The model, when completed, should not weigh over eight drams (16 drams to an ounce) as the gas capacity of the envelope will not lift much more than this weight. The instructions given here should enable any model builder to complete this interesting and new model.

ENVELOPE. This consists of two formers, or rings, and eight longerons, or stringers. We first construct the formers, shown in the plan by D and E. These are made from sheet balsa. The large one, D, is $\frac{3}{32}$" thick, $\frac{1}{4}$" wide, and 36" long, while the smaller E is $\frac{1}{16}$" thick, $\frac{1}{4}$" wide, and 30" long. Cut these two pieces. These must be bent in a perfect circle, and to do this, the wood must first be thoroughly soaked in water. When this is done, start bending one piece at a time. Do not attempt to do this at one time, but proceed slowly until you can bring the ends of each piece together. The ends are now overlapped $\frac{1}{4}$", and held together with a pin. Set them both aside to dry. When thoroughly dry, remove the pin, apply cement, and bind with silk thread. The large one will now have a circumference of $35\frac{3}{4}$", while the other will be $29\frac{3}{4}$". Finish by giving each a light sandpapering. The stringers "A," "B," and "C," are $\frac{1}{16}$" square and 36" long, being cut from balsa. Cut one piece $\frac{1}{16}$" square, and soak it in water. Now bend this over the two formers until it has the desired form. Pin it to a wood base in this form, and allow to dry. This is your master stringer, from which the others are formed. Cut a piece of $\frac{1}{16}$" sheet balsa $\frac{1}{2}$" wide and 36" long. Soak in water thoroughly. This is now bent to the exact form of your master longeron, pinned in position, and allowed to dry.

When dry, cut this piece into eight $\frac{1}{16}$" square strips, which can best be



FLYING ARMY BLIMP

done with a safety-razor blade. Complete the stringers by giving each a careful sandpapering. On each of the formers mark off eight equal sectors, or arcs. These marks indicate the position where each stringer is attached to the formers.

Cement is used for all assembly work. Attach the eight stringers to the smaller former E with cement and allow to dry. Each stringer should extend back from this former 12⅛". When dry, the rear ends of the stringers are cemented together, and held with thread until dry. These form the stern section of the envelope.

Proceed in a like manner by attaching the stringers in place on the large former. When dry, cement the front ends of the stringers together, holding until dry with thread. This forms the bow of the envelope, which should measure about 35" long. This completes the envelope construction.

FINS. Study carefully the "Side View" shown in the plans. Note the position of the fins. Four are required, and one is attached to every other stringer. Made of 1/16" square balsa, only three pieces are required to complete each fin. Cut these, and attach with cement, following the dimensions given in the plans under "Fin."

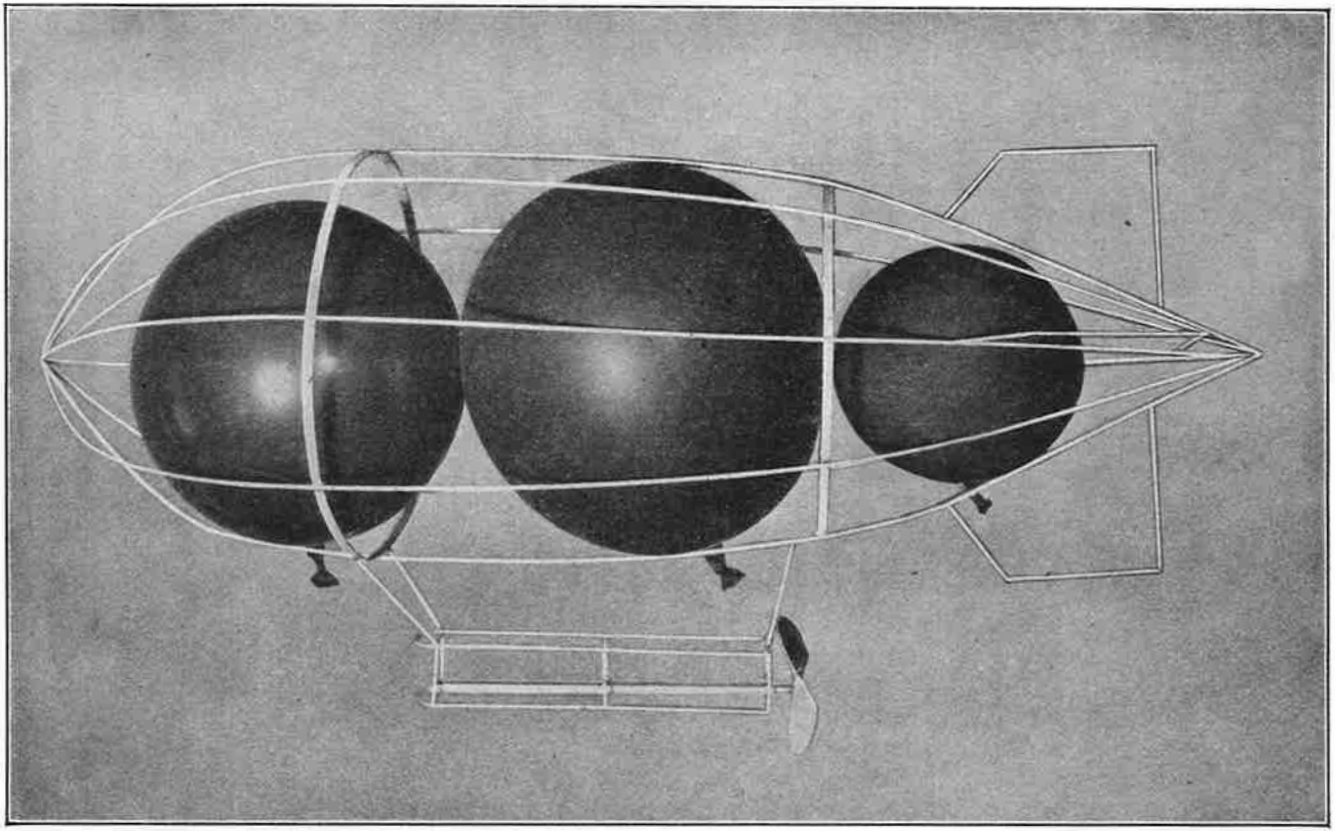
GONDOLA. This is constructed of 1/32" square balsa. Study the "Top View" and the "Side View" of this, given in the plans. The top and bottom formers are made of one length, being bent in the shape of a hairpin. The bottom has three cross braces, one at each end, and one in the center. The top has only two braces, both being at the ends. The supports are constructed of 1/16" square balsa. Two are used at the bow, while the stern of the gondola is held to the envelope with one. On the bottom cross braces located at the stern and bow, two motor stick clips are attached. These are formed from No. 6 piano wire.

MOTOR STICK AND PROPELLER. The motor stick is 1/8" x 3/16" x 10" long. Cut this from balsa. A propeller bearing and a rear hook are cemented in place as on any model airplane. The propeller is made of a 6" length of 1/16" sheet balsa, 1¼" wide. (See Chapter 9, "Bent Wood Propellers.") The propeller hook is bent from No. 6 piano wire, inserted through the hub, and cemented in place. Apply two washers between the bearing and the propeller on the propeller hook to insure free motion.

MOTOR. The motor consists of three strands of 1/8" flat rubber. Attach it so that each strand is about 9½" long, which will allow the necessary slack for winding.

GAS CONTAINERS. The gas containers are ordinary balloons, which can be purchased at any five-and-ten-cent store. Three are required.

COVERING. The model is now covered with Japanese tissue. Cover



FLYING ARMY BLIMP SKELETON

the envelope first, and then finish the fins, which are covered on one side only. The gondola is left open for handling the motor stick. On the under side of the envelope, the covering is left off, so that the balloons can be easily handled.

GAS FOR BALLOONS. As many will find it difficult to obtain gas for their blimp, a simple method of making your own, putting it under pressure, and filling the balloons is given here. Obtain a five-gallon water jar; a one-gallon jar; a length of rubber tubing; two rubber corks, one to fit each bottle, and three lengths of glass tubing. These can usually be purchased at your nearest drug store, or your druggist will be able to tell you where to obtain them. Add to this a pint of hydrochloric, or muriatic acid, and a pound of zinc filings. A small stand to hold the large bottle when upside down should be made of any scrap wood, as shown in the plan.

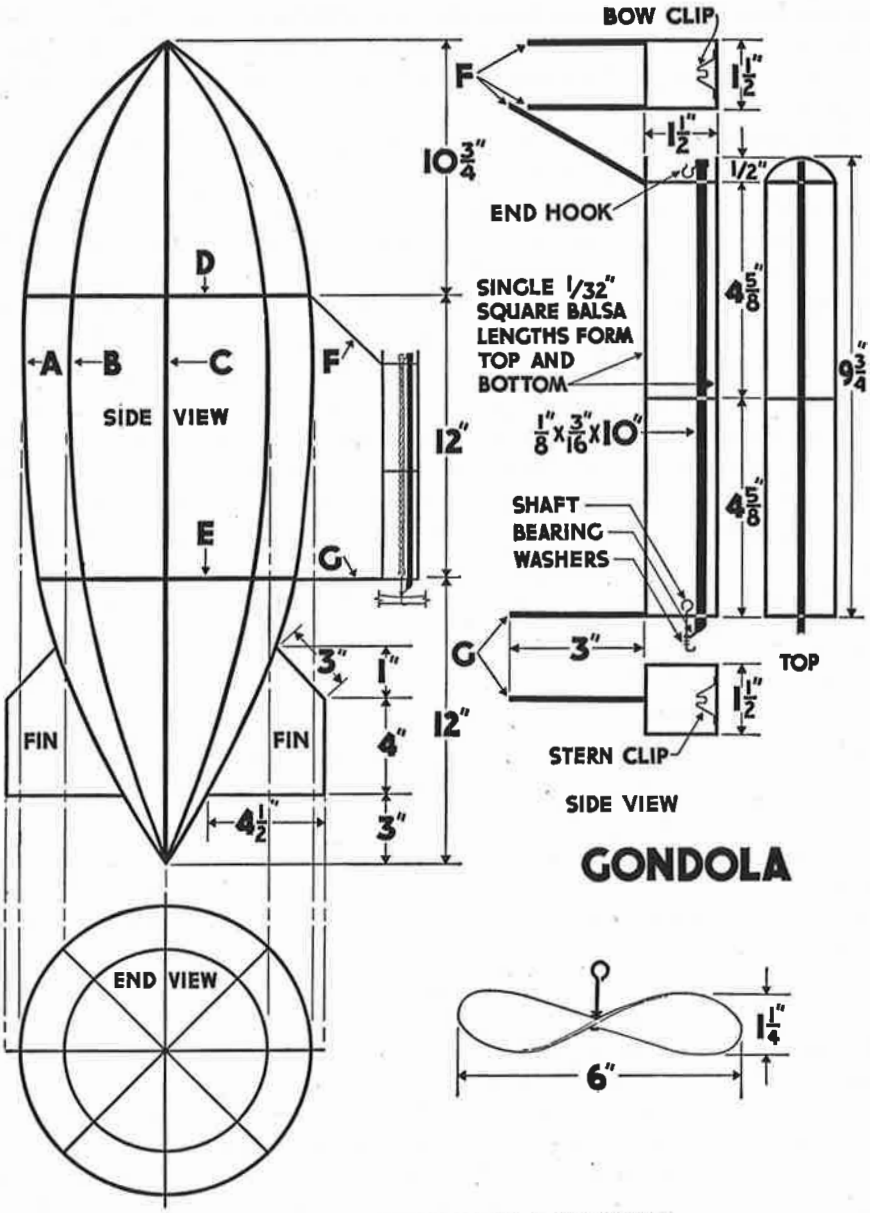
The rubber cork for the large bottle is now fitted with two of the glass tubes, each being about 8″ long. The small cork holds the remaining tube. These should be cemented in place so as to be perfectly air-tight. Fill the large bottle to its top with water, and turn it over into a tub which should be half full of water. Place the stand on the bottom of the tub, and the bottle on it, as shown. In this way, no air can be in the bottle. Place a handful of the zinc filings in the small bottle.

WARNING! FROM NOW ON, WEAR RUBBER GLOVES, AND MAKE SURE THAT NO FLAME IS WITHIN FIFTY FEET OF YOUR OPERATIONS.

Attach one end of the rubber hose to the glass tube in the cork of the smaller bottle, which contains the zinc filings. Run the other end of the hose up into the large bottle. Hold the cork ready and pour some acid into the small bottle. Quickly cork it. The acid will immediately start working, forcing gas into the large bottle. When the gas is forced in this manner into the large bottle, it, in turn, forces the water out of the bottle, and into the tub.

If the action of the acid stops, more acid and filings must be added to start it again. When all the water in the large bottle has been forced out into the tub, the bottle is filled with gas. Remove the rubber hose and place the cork of the large bottle in position, while holding the opening under water. Make sure that the tubes in the cork are stopped up, so that no gas can escape. Remove the large bottle from the water.

Attach the rubber hose to one of the tubes in the cork of the large bottle, making sure to remove the stopper before attaching it. Connect its other end to a water faucet. The blimp is brought down just over the bottle, and a tight connection made between the bottle tube and the mouth of one

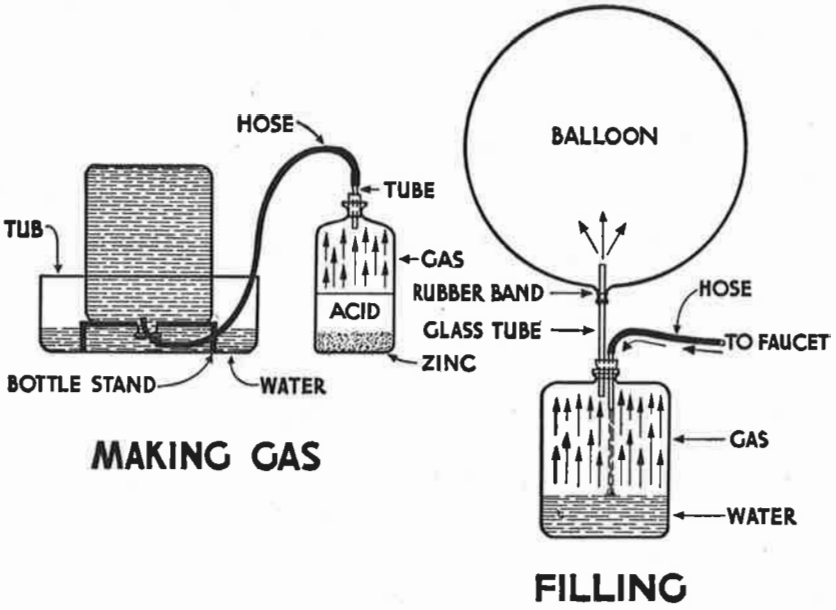


FLYING ARMY BLIMP

FLYING ARMY BLIMP PLAN

of the balloons. If directions have been followed, a rubber tube connects the water faucet with one of the glass tubes in the cork of the large bottle, while the mouth of one of the balloons is tightly fastened over the second glass tube in the cork of the bottle.

Now turn on the water slowly, which, as it fills the bottle, will force the gas from the bottle into the balloon. Fill each of the three balloons



METHOD FOR MANUFACTURING GAS AND FILLING BALLOONS

until its sides touch the stringers of the envelope, and then fasten the mouth of each with rubber bands. If you find that the large bottle has filled with gas before the acid in the smaller bottle has stopped working, a few drops of ammonia will stop the action.

FLYING. Before winding the propeller, the blimp should be tested for level floating. If it appears tail heavy, which is a common fault, a slight weight should be attached to the nose. If constructed properly, it will lift such a weight easily. The builder must remember that his model will not rise unless dimensions have been followed exactly, as half a dram makes the difference between success and failure. Here's good luck for those who have decided to go the "lighter-than-air" way!

COMPLETE AVIATION DICTIONARY

GLOSSARY OF MODEL TERMS

DEALERS LIST

INDEX

MODEL PILOT'S LOG

AERIAL. Of or like the air. Atmospheric. High in air. Above earth.

AERO. Any vehicle used in the air.

AERODONETICS. The science pertaining to climbing or soaring flight.

AERODYNAMICS. That branch of dynamics which treats of the laws of motion of the air and other gaseous fluids in connection with gravity and other mechanical forces.

AEROGRAPHY. A written study of the atmosphere and its phenomena.

AEROIST. One versed in aircraft.

AEROMECHANICS. Same as *aerostatics* and *aero-dynamics.*

AERONAUT. Same as balloonist or *aviator.*

AERONAUTICS. The art and science pertaining to the flight of aircraft.

AEROPLANE. Same as *airplane.*

AEROSTAT. A general term used for lighter-than-air craft such as balloons, airships, dirigibles, etc.

AEROSTATICS. The science relating to the mastering of fluids which are lighter than air.

AILERON. A hinged or pivoted, movable, auxiliary surface of an aircraft, usually part of the trailing edge of each wing. Its function is to cause a rolling movement of the plane about its longitudinal axis. It also gives side-to-side stability to the plane.

AILERON CONTROL HORN. See *horn, aileron.*

AIR-BASE. The landing-field or operation center of airships.

AIRCRAFT. A general term used for any and all airplanes, balloons, dirigibles, etc. Any device or structure which will carry weight, designed to be supported by the air, either by buoyancy or dynamic action.

AIRDROME. A landing field for airplanes.

AIRFOIL. Any surface of an aircraft designed to be propelled through the air in order to produce a directional or lifting effect.

AIR-MINDED. Interested in aeronautics. Desiring knowledge of aeronautics.

AIRPLANE. A heavier-than-air machine, mechanically driven, which is fitted with fixed wings and supports itself in the air by its own power. It may have any number of wings.

AIRPLANE, PUSHER. An airplane that has the propeller or propellers behind or at the rear of the main supporting surfaces. Aircraft with pusher propellers.

AIRPLANE, TRACTOR. An airplane which has the propeller or propellers in front of the main supporting surfaces.

AIR-POCKET. Same as *pocket.*

AIRPORT. A locality, either on water or land, which is adapted for the landing and taking off of aircraft and which provides shelter, supplies, and repairs for aircraft. A place used regularly for receiving or discharging passengers or cargo by air.

AIR SPEED. The speed of aircraft through perfectly still air. When air is active, it either increases or decreases the air speed.

AIR SPEED INDICATOR. An instrument so designed as to indicate the speed of an aircraft relative to the air.

AIRWAY. An air route between air traffic centers. An airway is mapped out over ground on which there are good landing-fields, airdromes, etc., for the convenience of the flyers.

ALTIMETER. An instrument which indicates the height of an aircraft above sea level.

ALTITUDE. Any height above land or water.

AMPHIBIAN. A plane equipped for taking off from and landing on both land and water.

ANGLE OF ATTACK. The acute angle of the main supporting surface of an aircraft and its direction of motion relative to the air.

ANGLE, DIHEDRAL. This is obtained by inclining the main wings of an airplane up from the center of the fuselage so that the tips are higher than any other portion of the wings. This angle is measured from the chord of the wing to a line drawn perpendicular at the intersection of the two wings, if they were elongated equally at the fuselage until they met.

ANGLE, ELEVATOR. The angular displacement allowed in the setting of the elevator from its normal position with reference to the trailing edge of the wing.

ANGLE, GLIDING. The angle of flight of an aircraft when gliding down preparatory to landing.

ANGLE, GROUND. The acute angle between the longitudinal axis of an airplane and the horizontal when the plane is resting on the ground in its normal position.

ANGLE, LONGITUDINAL DIHEDRAL. The difference between the angle of wing setting and the angle of stabilizer setting.

ANGLE OF STABILIZER SETTING. The acute angle between the line of thrust of a plane and the chord of the stabilizer.

ANGLE OF WING SETTING. The acute angle between the line of thrust of an airplane and the chord of the wing.

ANGLE OF YAW. An angular deviation of an aircraft along the fore-and-aft axis from its course.

ANTIDRAG WIRE. A wire, usually inclosed in the wing, designed to resist forces acting parallel to the chord of that wing and in the same direction as that of the flight.

ANTILIFT WIRE. Same as landing wire.

AREA, WING. See *wing area.*

ARTILLERY PLANE. An airplane which works with and for the artillery. Its chief duties are aerial observation, range finding, photography, etc.

AUTOGIRO. A form of airplane whose support in the air is maintained by propellers with vertical axes. The aim of the autogiro is to land and take off almost vertically.

AVIATOR. One who operates an airplane and makes a study of the art of flight.

AVIATRIX. A woman who operates an airplane and makes a study of the art of flight.

AXIS. See *lateral axis, longitudinal axis, vertical axis,* wing axis, fore-and-aft axis.

BACK WASH. The blast of air driven to the rear of an aircraft by the revolving propeller.

BANK. (Verb) To incline an airplane laterally by rolling it on its fore-and-aft axis. "The plane banked to the left."
(Noun) The position of an airplane when its lateral axis is inclined toward the earth. To make a left bank the plane must be inclined to the left with the left wing down.

BAROGRAPH. An instrument which makes a permanent record in ink of the various altitudes attained by an aircraft in flight.

BAY. The portion of the face of a truss, or of a fuselage, between adjacent bulkheads or adjacent struts or frame positions.

BIPLANE. An airplane with two main supporting surfaces, or wings, one over the other.

BLIMP. A small, non-rigid airship. Used extensively in the World War.

BODY. Same as *fuselage.*

BRACE WIRE. See *wire, brace.*

BRACE-WIRE BRACKET. A light, metal stamping used to attach the brace wire to the surfaces which it braces.

BUMP. A natural disturbance of air currents which causes uneven or rough flight. "The airplane hit a bump." "The air was bumpy."

CABANE. The framework which supports the wings at the fuselage. This term is also applied to the system of trussing upon the wing of an airplane to which the stays, landing wires, etc., are secured.

CABIN. An enclosed cockpit of any aircraft. The enclosure of an aircraft designed to accommodate passengers and pilot.

CAMBER. The curve of a wing surface from the front, or leading edge, to the rear, or trailing edge. *Top camber* refers to the top surface of a wing, and *bottom camber* refers to the bottom surface of a wing.

CENTER OF GRAVITY. Incorrect. See *center of mass.*

CENTER OF MASS. The point in an aircraft at which the greatest portion of weight lies. The one point on which an aircraft would balance itself longitudinally and laterally when in contact with nothing but that point. That point in an aircraft about which all other parts which are acted upon by the attraction of gravity, balance each other in every position.

CENTER OF PRESSURE. Usually used in reference to an airfoil. See *airfoil.* The point at which the surface of an airfoil is intersected by the resultant force of all the pressures acting on its surface.

CHORD. The shortest width of the wing from front, or leading edge, to rear, or trailing edge.

CLIMB INDICATOR. An instrument which indicates the amount of a dive or a climb of an aircraft.

CLOCK. This indicates the passage of time similar to an automobile clock.

COCKPIT. The open spaces in the fuselage, or body, of an airplane which accommodate the pilot and passengers, and in which the controls and instruments are housed.

COMPASS. An instrument which indicates the magnetic north, the dial of which is so graduated as to indicate all directions. The most important instrument on aircraft.

COMPRESSION MEMBER. Same as compression rib. See *rib, compression.*

COMPRESSION RIB. See *rib, compression.*

CONNECTING ROD, TAIL-SKID. See *tail-skid connecting rod.*

CONTACT. The act of switching on the motor of an aircraft. Used as a warning to the man starting the propeller that the switch is on.

CONTROL COLUMN. Same as *control-stick.*

CONTROL HORN. See *horn.*

CONTROLLABILITY. The quality in aircraft which allows the pilot full control as to its direction and stability with little effort.

CONTROLLABLE PITCH PROPELLER. See *propeller, controllable pitch.*

CONTROLS. A general term applied to the apparatus provided for operating the devices which control the speed, direction, altitude and motor power of aircraft.

CONTROLS, AIR. The devices employed for operating the control surfaces of aircraft.

CONTROLS, ENGINE. The devices employed for operating the power output of the engine or engines.

CONTROL-STICK. A vertical lever which operates the longitudinal and lateral control surfaces of an airplane. Pitching is mastered by a forward and backward movement of the stick, while rolling is controlled by a side-to-side movement.

CONTROL SURFACES. The surfaces which control the action of aircraft in motion. These are the ailerons, the elevators, and the rudder.

CONTROL WIRES. Any and all wires, cables, or other devices used to connect the controls with the control surfaces.

COWLING. A removable covering which extends over and on the sides of the motor, over the portion of the fuselage just in front of the front cockpit, and sometimes over a portion of the fuselage at the back of the rear cockpit. It is used to decrease wind resistance and protect the parts enclosed.

CRACK-UP. An accident in which the plane is damaged. Usually used to designate a partial wreck, or one of minor degree.

CRASH. A fall or landing in which the plane is badly damaged. This term is used in reference to more serious accidents than usually result from a crack-up.

DEAD-LINE. The line, actual or imaginary, on the airdrome from which airplanes start for their take-off. Also the line where the pilot must cease handling the airplane under its own power. "Never run your motor past the dead-line."

DECALAGE. The angle between the wing chords of a biplane or multiplane. In a monoplane, the angle between the chord of the main wings and the chord of the stabilizers, with the elevators at neutral.

DIHEDRAL ANGLE. See *angle, dihedral.*

DIRIGIBLE. Steerable. That which can be directed. To be used as "a dirigible balloon" or "a dirigible airship." Erroneously used to indicate an elongated airship.

DIVE. A steep descent, with or without the aid of the motor, in which the speed of the airplane is greater than its maximum speed in horizontal flight.

DIVING RUDDER. Same as *elevator.*

DOPE. A waterproof varnish used to cover the fabric of aircraft. Usually consists of cellulose acetate dissolved in solvent such as ether, alcohol or acetone.

DOPE, PIGMENTED. Dope to which a pigment has been added to protect it from the effects of sunlight.

DRAG. The total resistance, from any source, to an aircraft's motion through the air.

DRAG STRUT. A fore-and-aft compression member of the internal bracing system of a wing of an airplane.

DRAG WIRE. All cables, or wires, designed primarily to resist the action of drag forces on aircraft.

DRIFT. Cross currents of wind which produce an angular deviation from a set course over the earth.

DRIFT METER. An instrument for measuring drift, in relation to the angular deviation from a set course.

DRIFT WIRE. A wire which extends between two compression members. Its function is to add strength and stability to the wing structure.

DURALUMIN. An aluminum alloy comprising strength and lightness which is used in the structures of aircraft.

EDGE, LEADING. See *leading edge.*

EDGE, TRAILING. See *trailing edge.*

ELEVATION. Any height above sea level. "His airplane did not have enough elevation and he crashed into the tree tops."

ELEVATOR. A hinged or pivoted, auxiliary, horizontal surface or wing which controls the up-and-down direction of the airplane. It is part of the tail assembly.

EMPENNAGE. Same as *tail.*

ENDURANCE. The maximum length of time of flight of an aircraft at a given altitude and speed.

ENGINE. The power plant of aircraft which rotates the propeller.

ENGINE, RADIAL. An engine having stationary cylinders arranged in a radial manner around a fixed crankshaft.

ENGINE, SUPERCHARGED. An engine equipped with mechanical means which allow an increase in the cylinder charge beyond that normally taken in at the existing atmospheric temperature and pressure.

ENGINE, V-TYPE. An engine whose cylinders are in two rows in the form of a "V."

ENGINE, W-TYPE. An engine whose cylinders are in three rows in the form of a "W."

ENTERING EDGE. Same as *leading edge.*

EXTRA LIFTING SURFACE. A small, supporting surface, or wing placed beneath the fuselage and between the two wheels of an airplane. This extra wing was employed on several airplanes used in the World War by the German Air Force.

FABRIC. A fine, closely woven linen comprising both strength and lightness which is used to cover the airfoils and fuselage of an airplane. Usually an Irish linen.

FACTOR OF SAFETY. The ratio of the maximum strength of a member to the maximum probable load on that member in normal use.

FALSE RIB. See *rib, false.*

FIN. A small, fixed auxiliary surface attached to aircraft to promote stability.

FIN, HORIZONTAL TAIL. Same as *stabilizer.*

FIN, VERTICAL TAIL. A small, fixed, auxiliary, vertical surface, attached to the tail of an airplane directly in front of the rudder.

FITTING. A term used to denote any small part used in the structure of aircraft. Usually used in reference to small metal parts.

FLIGHT PATH. The path of the center of mass of an aircraft in relation to the earth.

FLOAT. An enclosed, water-tight structure, which is a portion of the landing-gear of an airplane, and which provides buoyancy when in contact with the surface of the water.

FLOAT TYPE LANDING-GEAR. A landing-gear which supports the airplane by means of floats. See *float.*

FLOTATION GEAR. An emergency gear which, when attached to a landplane, permits it to land and float on water.

FLYING-BOAT. A seaplane. An airplane whose fuselage consists of a hull, or hulls, which provide flotation on the water.

FOKKER. A German pursuit airplane. Used extensively in the World War.

FORE-AND-AFT AXIS. Same as *longitudinal axis.*

FORMER RIB. Same as false rib. See *rib, false.*

FRAMEWORK. An expression used in reference to the general skeleton form of the airfoils or fuselage of an airplane, or the skeleton structure of a rigid airship.

FRONT SPAR. Front wing spar. See *wing spar.*

FUSELAGE. Body. That portion of an airplane to which the wings, tail unit and landing-gear are attached. It is streamline and it contains the power plant, cockpit or cabin for passengers and pilot, cargo, gasoline, etc.

GAP. The shortest distance between the chords of any two wings of an airplane, whose positions are one above the other.

GAS GAUGE. An instrument which indicates the amount of gasoline in the tank of an aircraft.

GLIDE. A gradual descent without engine power sufficient for level flight.

GLIDER. A light, motorless form of aircraft similar to the airplane. One who glides.

GLIDING ANGLE. See *angle, gliding.*

GROUND ANGLE. See *angle, ground.*

GUY. A rope, wire, rod, or chain which is stretched between two objects. Used to add strength or stability.

HANGAR. A building, shed, tent, or any other form of housing used to shelter aircraft.

HELICOPTER. See *autogiro.*

HORIZONTAL TAIL FIN. Same as *stabilizer.*

HORN. A small lever extending out from a control surface of an airplane, to which are attached the control wires of that surface.

HORN, AILERON. A small lever extending out from the aileron, to which are attached the control wires from the control-stick.

HORN, ELEVATOR. A small lever extending out from the elevator, to which are attached the control wires from the control-stick.

HORN, RUDDER. A small lever extending out from the rudder, to which are attached the control wires from the rudder-bar.

HORSEPOWER OF AN ENGINE, MAXIMUM. The greatest amount of power which any motor is able to develop.

HORSEPOWER OF AN ENGINE, RATED. The average horsepower an engine develops in passing the standard fifty-hour endurance test.

HULL, AIRSHIP. The complete unit of any aerostat which gives it buoyancy. Often referred to as the "gas bag."

HULL, SEAPLANE. The portion of a seaplane which furnishes buoyancy when on the surface of water. It also accommodates the pilot and passengers, controls, instruments, etc.

HYDROPLANE. Erroneously used to denote a seaplane. A hydroplane is a type of boat, designed for great speed, but not built to leave the water.

IMPACT PRESSURE. The quantity measured by most instruments which are used to express, or measure, air speed.

INCLINOMETER. An instrument which indicates the angle of an aircraft in flight, along its lateral and longitudinal axes, with relation to the horizontal.

INDICATOR, AIR-SPEED. See *air-speed indicator.*

INDICATOR, DRIFT. Same as *drift meter.*

INDICATOR, FLIGHT. Same as *turn and bank indicator.*

INDRAFT. The flow of air which strikes the propeller blades from in front of them.

INFLATION. The act of filling an airship or balloon with gas.

INFLOW. Same as *indraft.*

INSPECTION WINDOW. A small, transparent window, or opening, in the envelope of an airship, or balloon, or in the wings of an airplane to allow inspection of interiors.

INSTRUMENT BOARD. The panel in the pilot's cockpit, on which the instruments are mounted.

JOY-STICK. Nickname for control-stick. This nickname is a deviation from the word *Joyce stick.*

JOYCE STICK. Same as *control-stick.* Named after its inventor, Joyce, a British officer.

KING POST. A main compression member, usually vertical, designed to support a single or triangular member subject to bending.

LANDING. To propel aircraft from the air to earth. The act of making a landing. The degree of skill displayed in bringing aircraft to land, such as "A good landing."

LANDING-ANGLE. Same as ground angle. See *angle, ground.*

LANDING-FIELD. Any field, whether a complete airport or not, which is suitable for the landing and taking off of aircraft. See *airport* and *airdrome.*

LANDING GEAR. The understructure which supports aircraft when in contact with land or water. Also called *undercarriage.*

LANDING GEAR, BOAT TYPE. Same as hull type landing gear. See *hull* and *flying-boat.*

LANDING GEAR, FLOAT TYPE. See *float-type landing gear.*

LANDING GEAR, HULL TYPE. See *hull* and *flying-boat.*

LANDING GEAR, SKI TYPE. See *ski type landing gear.*

LANDING GEAR, SKID TYPE. See *skid type landing gear.*

LANDING GEAR, WHEEL TYPE. See *wheel type landing gear.*

LANDING WIRE. A wire designed to oppose the lift wire and prevent distortion of the structure to which both are attached. Usually refers to the wires on the main supporting surfaces, or wings, of a biplane or multiplane.

LATERAL AXIS. The axis which extends from wing-tip to wing-tip of an airplane, at right angles to the longitudinal and lateral axes, both of which pass through its center.

LEADING EDGE. The edge that leads. The foremost, or front, edge of a wing or a propeller

LEEWAY. Same as *drift.*

LEWIS MACHINE GUN. An automatic machine gun, named after its inventor, Colonel Isaac N. Lewis. Used extensively by the Allies in the World War.

LIFT. The component of the total air force on an aircraft, or airfoil, which is perpendicular to the relative wind in the plane of symmetry.

LIFT WIRE. Opposite of landing wire. See *landing wire.*

A wire designed to oppose the landing wire and transfer the lift on the end, or outer portion, of a wing in toward the fuselage. Usually extends from the under side of the upper wing to the top side of the lower wing of a biplane.

LINE OF FLIGHT. Same as *line of thrust.*

LINE OF THRUST. An imaginary line, parallel to the longitudinal axis, extending

from the rear to the front of an airplane, and passing through the center of the fuselage and the shaft of the propeller.

LOAD, DEAD. The weight of an aircraft unloaded. This comprises the power-plant, structure, and necessary accessories.

LOAD, FULL. The gross weight of an aircraft. The dead weight of an aircraft and its maximum load. The greatest weight an aircraft can support in flight. The total weight of the dead load plus the useful load.

LOAD, USEFUL. The weight of the cargo. Obtained by extracting the dead load from the full load.

LOADING. Same as *wing loading.*

LONGERON. A fore-and-aft, structural member of the fuselage of an airplane. A long spar which extends from the extreme bow to the rudder-post, at the extreme stern of an airplane, continuing across several points of support.

LONGITUDINAL. Same as *longeron.*

LONGITUDINAL AXIS. The long axis. The *fore-and-aft axis.* The axis which passes from the front to the rear of an airplane, at right angles to the vertical and lateral axes, and passes through their intersection point.

LONGITUDINAL DIHEDRAL. Same as *longitudinal dihedral angle.*

LONGITUDINAL DIHEDRAL ANGLE. See *angle, longitudinal dihedral.*

MAIN SUPPORTING SURFACE. The main wing, or wings, of an airplane, extending on the same general line from tip to tip. A monoplane has one main supporting surface; a biplane has two; a triplane has three, etc.

MEAN CHORD OF A WING. The result obtained by dividing the wing area by the depth of the thickest portion of the wing, which is measured at right angles to the chord.

MONOCOUPE. A small, light airplane, equipped with an enclosed cabin.

MONOCOUPE FUSELAGE. A type of fuselage, usually without longitudinal members, or supports, consisting of a thin shell of wood, or metal, covering its vertical, bracing members. It is so designed as to carry any stress to which it may be subjected without the usual aid of longerons.

MONOPLANE. An airplane with one main supporting surface, which extends equally on each side of the fuselage. Sometimes this main supporting surface is divided into two equal parts by the fuselage.

MOTOR. Same as *engine.*

MULTIPLANE. An airplane having two or more main supporting surfaces placed one above the other.

NACELLE. An enclosure designed to accommodate the passengers or power plant, or both. Usually limited to the pusher type of aircraft, it is shorter than the average fuselage and larger than the average cockpit. When used in reference to balloons, it indicates the passenger basket suspended from the gas bag.

NEUTRAL. The position of all the controls at which they have no effect. When the control-stick is parallel to the vertical axis and the rudder-bar is parallel to the lateral axis.

NOSE. The front point of an aircraft. The leading, or foremost point. The hub, or boss of the propeller on all tractor airplanes.

NOSE-HEAVY. The condition of an aircraft, when the nose drops in normal flight, with the controls at neutral. See *neutral.* When the pilot is forced to pull the control-stick toward him to maintain normal, level flight.

NOSE SPAR. A streamlined, longitudinal member of a wing structure which forms the curvature at the leading edge and extends outward from the front spar of the wing.

OIL-PRESSURE GAUGE. An instrument which indicates the full pressure of the oil in the motor of an aircraft.

OIL THERMOMETER. An instrument which indicates the temperature of the oil in the motor of an aircraft.

ORNITHOPTER. A heavier-than-air craft, which derives its main support and propelling force from its flapping wings.

OVER-ALL LENGTH. The shortest distance from the extreme front to the extreme rear of an aircraft, including all and any extending, longitudinal parts.

OVERHANG. The portion which extends over. In aircraft there are two such measurements. (1) One half of the difference in the length of spans of any two main supporting surfaces, providing they lie one above the other. (2) The shortest distance from the outer strut attachment to the tip of the wing.

PANEL. A unit of the whole. A wing surface is constructed of several units, which are called panels.

PANELS, GROUND. Large, white strips of cloth. Used to signal aircraft in flight, from the ground, by placing strips in such a manner on the ground as to resemble letters or signals.

PARACHUTE. An apparatus designed to retard the descent of a falling weight. When used by aviators, it is usually folded in a compact bundle, which has straps for securing it to the wearer's body. It is equipped with a rip cord, which the wearer pulls just after the jump is made, thus opening the parachute. When opened, it resembles a huge umbrella.

PATH OF FLIGHT. Same as *flight path.*

PETROL. Gasoline. The use of this word is usually confined to the British who seldom use the common American term gasoline.

PILOT. One who pilots. Act of steering. Art of handling aircraft. See *aviator.*

PITOT TUBE. An instrument designed to measure the velocity of an aircraft.

PLANE. An abbreviation for "airplane."

POCKET. When varying and irregular air-currents tend to lessen their usual upward lift on the supporting surfaces of an aircraft, the craft suddenly drops as if in a hole, or a so-called air-pocket.

PONTOON. Now obsolete. Same as *float.*

POWER LOADING. The gross weight, or full load, of an aircraft divided by the normal brake horsepower of its engine, computed usually for air of standard density.

POWER PLANT. Same as *engine.*

PROP. Abbreviation for *propeller.* Slang for *propeller.*

PROPELLER. That which propels. The air screw which, when rotated on its axis at high speed, pulls or pushes an aircraft ahead. A propeller may have any number of blades, but the most commonly used type has only two.

PROPELLER, ADJUSTABLE PITCH. A propeller whose blades are so attached to the hub as to allow them to be set to any desired pitch when the propeller is not rotating.

PROPELLER BOSS. The central portion of a propeller where the blades of the propeller meet and where the hub is formed.

PROPELLER, CONTROLLABLE PITCH. A propeller whose blades are so attached to

the hub as to allow them to be set to any desired pitch when the propeller is rotating.

PROPELLER HUB. The metal fitting at the boss of the propeller which is used as a means of mounting it on the engine, or propeller, shaft.

PROPELLER, PUSHER. The propeller used on a pusher airplane. See *airplane, pusher.*

PROPELLER, DISK AREA. The area of a circle made by a rotating propeller which has a diameter equal to the over-all length of the propeller.

PROPELLER, TRACTOR. The propeller used on a tractor airplane. See *airplane, tractor.*

PUSHER AIRPLANE. See *airplane, pusher.*

QUADRUPLANE. An airplane with four main supporting surfaces, or wings, one above the other.

RANGE. Distance.

RANGE, ECONOMIC SPEED. The maximum distance an aircraft can cover when traveling at its most economical speed and altitude at all stages of its flight.

RANGE, FULL SPEED. The maximum distance an aircraft can cover when traveling at its full speed at sea level.

RATE OF CLIMB. The vertical velocity of an aircraft in relation to the air.

REAR SPAR. The rear wing spar. See *wing spar.*

REV. (Noun) Slang for revolutions or speed of motor. See R.P.M.
(Verb) Slang for intermittently speeding of motor. "He revved his motor."

REVERSE TURN. An acrobatic maneuver of an airplane which results in an about-face turn, consisting of a half loop and a half roll. The airplane follows the path of an inside loop until on its back in an inverted flight position; then the half roll takes place, which leaves the airplane facing in the opposite direction from which it started and at a greatly increased height. See *roll.*

REVOLUTIONS, MAXIMUM. The number of revolutions per minute of a motor at maximum horsepower.

REVOLUTIONS, RATED. The number of revolutions of a motor in relation to its rated horsepower.

RIB. A horizontal, structural member of a framework, which is so designed and placed as to add strength and stability to it.

RIB, COMPRESSION. Same as *drag strut.*

RIB, FALSE. A short fore-and-aft rib, sometimes referred to as an incomplete rib, which frequently consists of only a curved strip of wood extending from the leading edge of the wing to the front spar of that wing. This rib is so designed as to maintain the desired form of the wing at its point of greatest curvature.

RIB, FORMER. Same as false rib. See *rib, false.*

RIB, WING. A fore-and-aft structural member of a wing unit. Used to give a wing its form and to support the covering of the wing. Extends from the front wing spar to the rear wing spar.

RIGGER. One who assembles and aligns aircraft. One who rigs.

RIP CORD. A cord designed to rip. When used with reference to a parachute it is the cord that, when pulled, opens the parachute. See *parachute.*

ROLL. An acrobatic maneuver in which the airplane makes a complete revolution about its longitudinal axis, while maintaining its approximate normal direction of flight.

R.P.M. Abbreviation for "revolutions per minute." Used with reference to the speed

of a power plant. On aircraft this is indicated by the tachometer. See *tachometer.*

RUDDER. A hinged and pivoted, movable, vertical, auxiliary airfoil or surface, designed to steer an aircraft about its vertical axis. A flap, or vertical wing, situated on the stern of aircraft, which controls the left-to-right movement horizontally.

RUDDER-BAR. The foot lever, or foot pedals, by which the rudder is controlled.

RUDDER CONTROL HORN. See *horn, rudder.*

RUDDER-POST. The vertical upright which holds the rudder in place and on which the rudder swings.

RUNWAY. Any path over an airdrome on which airplanes can land or take off. Often used in reference to a specially built, inclined runway down which airplanes can gain the necessary excess speed to take off when heavily loaded.

SEAPLANE. Any airplane designed to land on and rise from water.

SHIPPLANE. A landplane designed to rise and land on the deck of a ship.

SHOCK ABSORBER. A device which absorbs the shock on an airplane when in contact with land. A part of the landing-gear of a landplane whose function is to reduce the strain, or shock, on the structure when landing, taking off, or taxying.

SKI TYPE, LANDING GEAR. A landing gear designed to support an airplane by the means of two long, flat runners, or skis, which allow the airplane to slide over snow or ice. The skis take the place of the wheels used on the wheel type landing gear.

SKID. A member which is attached to airplanes as a protection against damage to its various parts from contact with the ground.

SKID, TAIL. A short, curved arm, attached under the tail of an airplane, which extends down in such a manner as to protect the tail unit when the airplane is in contact with the ground.

SKID, WING. A member projecting down from under the wing, near the tip, designed to protect the wing from contact with the ground.

SKID TYPE, LANDING GEAR. A landing gear equipped with a long, flat runner which extends horizontally beneath the fuselage and midway between the two wheels. Its function is to aid the airplane in landing, taking off or taxying.

SKIN FRICTION. The tangential component of the fluid force at any given point on a surface.

SLIP STREAM. Same as *back wash.*

SOARING. The art of performing sustained free flight without the use of a power plant or other means of self-propulsion.

SOARING, DYNAMIC. When soaring is performed in all conditions other than in up-current or ascending air.

SOARING, UP-CURRENT. When soaring is performed in ascending air.

SPAN OF AIRFOIL. The over-all length of an airfoil measured along a line at right angles to its chord.

SPAN OF AIRPLANE. The maximum distance measured parallel to the lateral axis from tip to tip of an airplane inclusive of ailerons.

SPANDAU. A high-powered, German machine-gun, named after the town in which it was manufactured in Brandenburg, Prussia.

SPEAKING TUBE. An arrangement of earphone and transmitter through which the occupants of aircraft can speak to each other.

SPEED, CRITICAL. The lowest possible speed of an aircraft at any angle whatever at which control is still maintained.

SPEED, ECONOMIC. The speed at which an airplane can travel in level flight in which its fuel consumption is at a minimum.

SPEED, GROUND. The velocity in which an aircraft in flight covers a given distance over the ground.

SPEED, LANDING. The minimum speed at which an airplane can maintain itself in level flight and still remain under control.

SPEED, MAXIMUM. The greatest possible speed an airplane can maintain in level flight.

SPEED, MINIMUM. The lowest possible speed which can be maintained by an airplane in level flight and still be under control.

SPINNER. A cone-formed covering which is fitted over the propeller hub and rotates with the propeller.

STABILITY. The quality of an aircraft which causes it to regain a condition of equilibrium when it has been disturbed from its course of steady flight.

STABILITY, DIRECTIONAL. That which has to do with the stability of an aircraft along its vertical axis.

STABILITY, INHERENT. That which has to do with the stability of an aircraft with relation to the disposition of its stationary parts.

STABILITY, LATERAL. That which has to do with the stability of an aircraft along its longitudinal axis.

STABILITY, LONGITUDINAL. That which has to do with the stability of an aircraft along its lateral axis.

STABILIZER. A small, fixed auxiliary, horizontal surface attached to the tail of an airplane to which is attached the elevator.

STAGGER. The length which the entering edge of one wing of a biplane, triplane or multiplane extends ahead of the entering edge of another wing.

STAGGER, NEGATIVE. When the lower wing is set ahead of the upper wing.

STAGGER, POSITIVE. When the upper wing is set ahead of the lower wing.

STAGGER WIRE. A wire which connects the upper and lower main supporting surfaces, or wings, of an airplane, and which extends practically parallel with the plane of symmetry.

STAY. A wire, chain or rope used to connect and promote stability and stiffness between various parts of an aircraft.

STEP, LANDPLANE. A small break in the side of a fuselage used as a means for gaining the open cockpit of a plane.

STEP, SEAPLANE. A break in the shape or form of the bottom of a float or hull of a seaplane, so designed as to reduce resistance when in motion through water.

STICK. Same as *control-stick.*

STICK TRIGGER. A small, metal lever attached to the control-stick which operates the machine-gun on an aircraft.

STREAMLINE. A term used to describe a continuous flow of a fluid where discontinuity takes place as distinguished from eddying flow.

STREAMLINE FORM. A shape which tends to preserve a streamline flow of a fluid, thus minimizing any resistance to progress.

STRUT. A compression member of a truss frame. The most common struts on an airplane are those which separate the upper and the lower wings.

SUPERCHARGER. A device used to supply the engine with a greater volume of charge

than would normally be induced at the prevailing atmospheric pressure and temperature.

SUPERCHARGER, CENTRIFUGAL. A supercharging device having several rotating impellers which generate centrifugal force. It is used for the transmission and compression of the air against resistance.

SUPERCHARGER, POSITIVE-DRIVEN. A supercharging device which is driven by gears from the engine shaft at a fixed speed ratio.

SUPERCHARGER, ROTARY-BLOWER. A supercharging device with one or more low speed rotors which revolve in a stationary case in such a manner as to produce a positive displacement.

SUPERCHARGER, TURBO. A supercharging device which is driven by a turbine case operated by exhaust gases from the engine.

SWEEPBACK. The horizontal angle between the lateral axis of an airplane and the leading edge of the main supporting surface, or wing.

SWITCH. A small lever or button used to make contact, much the same as the switch of an automobile.

SYNCHRONIZED GUNS. Fixed machine guns mounted on the front cowling of aircraft and synchronized with the motor in such a manner as to allow the guns to shoot between the bades of the revolving propeller. The nose of the airplane must be pointed at the target.

TACHOMETER. An instrument which indicates upon its dial the number of revolutions per minute of the motor. See R.P.M.

TAIL. The rear portion of aircraft which usually includes the rudder, elevators, fin and stabilizers.

TAIL BOOM. An outrigger or spar used to connect the tail surfaces with the main supporting surfaces or wings of an aircraft.

TAIL GROUP. The rudder, elevators, fin, and stabilizers. See *tail.*

TAIL-HEAVY. A condition in which the tail of an aircraft sinks when the controls are set to maintain level flight. The condition in which the pilot must exert a forward push on the control-stick to keep the aircraft in level flight.

TAIL SKID. See *skid.*

TAIL-SKID CONNECTING ROD. A rod which connects the tail skid to its shock absorber.

TAXI. To run aircraft on the ground or water under its own power. Usually accomplished by short spurts of the motor.

THROTTLE. A small lever used for controlling the amount of gasoline fed to the motor which in turn regulates the speed of the engine. Pushing the throttle forward increases the flow of gasoline and pulling it back decreases the flow.

THRUST. The push created by a revolving propeller.

THRUST DEDUCTION. The reduction of pressure under the tail unit of aircraft due to the action of the propeller which tends to reduce the forward thrust. This loss of thrust is termed thrust deduction.

TIP. The point of extremity.

TIP, PROPELLER. The farthest point on a propeller from the boss or center.

TIP, WING. The farthest point on a wing of an aircraft from the center of the fuselage.

TORGUE. The force caused by a revolving propeller which tends to turn an aircraft over sideways.

TRACTOR. See *airplane.*

TRAILING EDGE, PROPELLER. The rear edge of the propeller. The edge which trails. The edge which enters into the wind currents last.

TRAILING EDGE, WING. The rear edge of the main supporting surface. The edge which trails. The edge which enters into the wind currents last.

TRANSVERSE AXIS. See *lateral axis.*

TRIPLANE. An aircraft having three main supporting surfaces which are placed one above another.

TRUSS. The struts, stays, spars or any other framing members which are designed to transmit the wing loads to the body.

TURN AND BANK INDICATOR. An instrument which indicates the course of a turn as well as that of a bank.

TURNBUCKLE. A device consisting of a threaded barrel into which bolts are screwed at each end. On the end of each bolt is an eye. A wire is fastened through the eye of each bolt and the bolts are then screwed into the barrel, thus tightening and giving tension to the wires. This buckle is used to give tension to the wires of an aircraft.

UNDERCARRIAGE. See *landing-gear.*

VERTICAL AXIS. The axis extending perpendicularly from the lateral and longitudinal axes and passing through a point at which the lateral and longitudinal axes cross.

VERTICAL TAIL FIN. See *fin, vertical tail.*

VERY LIGHTS. Various colored lights which may be shot from a specially built pistol used for signals.

VICKERS MACHINE GUN. A machine gun of high power used extensively during the World War.

WAKE. See *wash.* Generally used with reference to a solid body.

WARP. To change a natural form by twisting.

WARP, WING. To change the form of the rear wing spar by twisting.

WASH. The natural air disturbance made by the motion of an airfoil through the air.

WASH-IN. The designing of a wing in such a manner as to increase the angle of attack near the tip.

WASH-OUT. The designing of a wing in such a manner as to decrease the angle of attack near the tip. Slang for the complete wreck of an aircraft.

WEIGHT PER HORSEPOWER. See *engine, dry weight.* The dry weight of an engine divided by the rated horsepower of that engine.

WHEEL TYPE LANDING-GEAR. A landing-gear designed for landplanes equipped with wheels which allow the aircraft to roll when in contact with the ground. Usually landplanes have two wheels, but there is a form of landing-gear used which has a third wheel in front of the two main wheels.

WIND-BREAK. Same as *windshield.*

WINDSHIELD. A transparent shield usually made of non-breakable glass or celluloid and placed in front of each cockpit as a safeguard to the occupant against wind, rain, hail, oil, etc.

WIND TUNNEL. A tube-shaped, elongated tunnel through which may be forced or drawn a steady stream of air. In the center section of the tunnel is a so-called experiment chamber, or working chamber, in which models of aircraft, wings or propellers may be placed. Those are then supported by suitable balances

which are placed outside of the air stream allowing the action of the air on the models to be registered or measured.

WING. A general term used to express the main supporting surface of an airplane. Usually designated as the right, left, upper or lower wing.

WING AREA. The total number of square feet of a wing. This is found by multiplying the length of the wing by the distance from the leading edge to the trailing edge along the chord.

WING DIHEDRAL. See *angle, dihedral.*

WING HEAVY. A condition in which the left or right wing of an aircraft sinks below its normal level flight position when the controls are set to maintain level flight. The condition in which the pilot has to exert a lateral force on the control-stick to keep the lateral axis of aircraft horizontal when in flight.

WING LOADING. The gross weight of a full loaded airplane divided by the area of its supporting surfaces. In this computation the supporting surfaces should include ailerons but not stabilizers nor elevators.

WING SPAR. The principal transverse member of the wing structure of an airplane. Each wing contains a front and a rear spar which extend the entire length of the structure.

WIRE, BRACE. Wire used for bracing.

GLOSSARY OF MODEL TERMS

The words and terms defined here are specifically those used for model airplane work. All general aviation terms will be found in the Complete Aviation Dictionary. *If a word is not given here, it will be found in the* Aviation Dictionary.

A-FRAME. The fuselage of a twin-stick model made of two twin sticks assembled in the form of a large "A."

AMBROID. The trade name of a model airplane cement.

BALSA WOOD. See Chapter 3, "Balsa Wood."

BEARING. See Chapter 6, "Propeller Bearings."

CAN HOOK. See Chapter 3, "Can Hooks."

CEMENT. A strong and quick-drying cement used for model airplane construction.

CENTER SECTION. The center portion of a wing. Usually refers to that part of the wing which is located in the exact center and is constructed on a level.

CLIP. See Chapter 6, "Wing Clips," "Elevator Clips," "Rudder Clips."

COWLING. Engine Cowling: See Chapter 11, "Cowlings." Cockpit Cowlings: A sheeting, usually of balsa wood, which fits over the top of a cockpit.

CROSS BRACES. Side-to-side members of the framework of a model airplane. Often refers to those braces which extend between longerons or stringers of a fuselage. Horizontal bracing.

DIHEDRAL. "See Dihedral Angle" in "Complete Avaition Dictionary." In model airplane construction and designing, refers to the height above the center of a wing that the wing's tips are set.

DOPE. See Chapter 3, "Dope."

END HOOK. Also called "Rear Hook." See Chapter 6, "End Hooks."

ENDURANCE MODELS. A model built primarily for time flights and judged by the elapsed time between take-off and landing.

EXHIBITION MODELS. A model built primarily for appearance. A model used for exhibiting purposes only, which may be either a flying or non-flying model.

FORMERS. Side-to-side members of the fuselage construction used to give that portion of the model its form. Usually made of sheet balsa wood. Side-to-side members of floats and hulls used to give them form.

FUSELAGE MODELS. Model airplanes with fuselages having built-up construction giving specific form. Any fuselages other than stick fuselages.

GRAPH. Plans shown on squares to assist the builder in making full-size copies. See Chapter 36, "Reading Plans."

H.L. Abbreviation for "Hand Launched." All models which are launched from the hand.

INNER WING SPAR. Longitudinal spars extending through the inside of a wing.

LEADING EDGE. That part of a wing, elevator, fin, or rudder which leads all other parts of the structure to which it is attached.

LEADING EDGE SPAR. The member of the wing, elevator, fin, or rudder which forms all or part of the leading edge of the structure to which it is attached.

MOTOR STICK. The stick holding the rubber motor. The stick to which are attached the end hook, the propeller bearing, and in some cases, the can hook. Also often referred to as the fuselage of a stick model, as it holds the wing, elevator, rudder, tail skid, and landing gear. See Chapter 12, "Motor Sticks."

MUSIC WIRE. Same as *piano wire*. See Chapter 3, "Wire."

NOSE HOOK. See Chapter 6, "Nose Hooks."

OUTLINE PIECE. The small sized edging used around elevators and rudders. Usually of balsa or bamboo. Often referred to as "outliner."

PIANO WIRE. See Chapter 3, "Wire."

PREWINDING. The winding and running of a rubber motor before actual launching to stretch the rubber. See Chapter 16.

PUSHER. A model having the propeller behind or in the rear of the main wing.

R.O.G. An abbreviation of "rise-off-ground." A model airplane equipped with a landing gear to allow it to rise from the ground under its own power.

R.O.S. An abbreviation of "rise-off-snow." A model airplane equipped with a landing gear to allow it to rise from snow under its own power.

R.O.W. An abbreviation of "rise-off-water." A model airplane equipped with a landing gear to allow it to rise from water under its own power.

SCALE MODEL. A model airplane built to exact scale from a real airplane. Also widely used for model replicas of real airplanes not following exact dimensions.

SHEET BALSA. Balsa wood sheeting. Very thin boards of balsa wood.

"S" HOOK. See Chapter 6, "'S' Hooks."

SPEED MODELS. Model airplanes built primarily for fast flights. A model judged by its speed only.

SPLIT BAMBOO. Bamboo lengths which have been split to varying widths and thicknesses.

STICK MODELS. Model airplanes having one or more main sticks acting as fuselages.

STRINGERS. Longitudinal members of a fuselage.

STRUTS. Horizontal braces of wings, fuselage, or landing gear.

SWEEPBACK. See Chapter 7, "Wing Designing."

TRACTOR MODEL. A model airplane having the propeller in front of the main wing.

TRAILING EDGE. That part of a wing, elevator, fin, or rudder which trails all other parts of the structure to which it is attached.

TRAILING EDGE SPAR. The member of the wing, elevator, fin, or rudder which forms all or part of the trailing edge of the structure to which it is attached.

TWIN-STICK PUSHER. A pusher model airplane having two twin propellers.

DEALERS LIST

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ARKANSAS

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Model Airplane Motors, 2322 Stuart Street, Berkeley
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Hornet Aircraft Company, 1515 North Gardner Street, Hollywood
Ned Van Buren, Blue Prints, 1759 North Orange Drive, Hollywood
George Carter, 267 Newport Avenue, Long Beach
Long Beach Balsa Syndicate, 548 W. 6th Street, Long Beach
Hetherington Manufacturing Company, 4526 Corliss Street, Los Angeles
Model Aircraft Engineering Company, 3627 East First Street, Los Angeles
Pacific Model Aircraft Supply, 6308 S. Broadway, Los Angeles
Western Aircraft Manufacturing Company, 4137 W. Pico Street, Los Angeles
M. & L. Model Supply Company, 3211 Filbert Street, Oakland
Model Aircraft Supply, 1600 39th Street, Oakland
Davies Aircraft Company, Inc., 1553-63 Page Street, San Francisco
California Model Aircraft Supply, 918 Tennessee Street, Vallejo

COLORADO

Alexander Industries Inc., Colorado Springs
Travis Model Airplane Company, Box 873, Colorado Springs

CONNECTICUT

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John Heidtmann, The Deep River Toy Company, Deep River
Albatross Model Aircraft Company, 13 Hawthorne Street, Hartford
Kensington Kraft, Box 263, Kensington
Daniel C. Dodge, 53 Capital Avenue, Meriden
Murray Model Shop, 167 Hart Street, New Britain
Clifford M. Brown, 508 Winchester Avenue, New Haven
"Happy Landings" Model Aircraft Company, 12 Ridge Street, New Haven

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Gil Manufacturing Company, 3408 N. Cicero Avenue, Chicago
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George Koch, 15246 Center Avenue, Harvey
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H. W. Butterfield, 311 Walnut Street, Momence
Bildon Company, 709 Wenonah Avenue, Oak Park

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Mattes Brothers, 2001 Calhoun at Williams, Ft. Wayne
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Ray Duffy, 117 Fir Street, Michigan City
Hoosier Model Company, 311 E. Main Street, Muncie
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B. C. Meister Company, 8 Sunset Avenue, Methuen
Paul Guillow, Wakefield
Bell Model Aircraft Shop, Keane Road, Wellesley
West Roxbury Model Aero Shop, 280 Temple Street, West Roxbury
Woburn Model Airplane Shop, 17 Belmont Street, Woburn

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Ontario Model Aircraft Supplies, 819 Gerrard Street, East, Toronto, 8
St. John Bros. & Twomey, 644 Portage Avenue, Winnipeg

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MODEL PILOT'S LOG

DATE	TYPE OF MODEL	TIME	PLACE	WITNESS

MODEL PILOT'S LOG

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