COMPLETE MODEL AIRCRAFT MANUAL

REVISED EDITION

ACKNOWLEDGMENTS

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Such models as the "Darmstadt," "Westland Coöperation," "Fairey 'Battle,'" "Curtiss Scout" and the "Mureaux" came from the pages of Model Airplane News, the finest and oldest magazine in this country published solely for the model airplane enthusiast. It is to its publisher, George C. Johnson, and its able editor, Charles Hampson Grant, that the author sends his thanks for permitting the use of such splendid models. He could have found no finer source for material.

For those of wider interests who want good models to build, thrilling fiction to read and sound facts to study, the magazine Flying Aces heads my personal list. Such stick models as the "Championship Solid Balsa Glider," "Gull Wing," "Condor Tractor," "Profile Speedster" and the "Champion Outdoor Tractor" came from its pages. For permission to use these models here, the author wishes to thank its publisher, A. A. Wyn, and its editor, Herb Powell.

He likewise expresses his appreciation to other magazines whose publishers have permitted the reprinting of certain material and photographs of his own which have appeared from time to time in their publications:

Boys' Life
Avio News
St. Nicholas
Flying Stories
Everyday Mechanics
The Country Gentleman
King Features Syndicate
Popular Science Monthly

To my aeronautically-minded nephew
Ernest Bevier Wright

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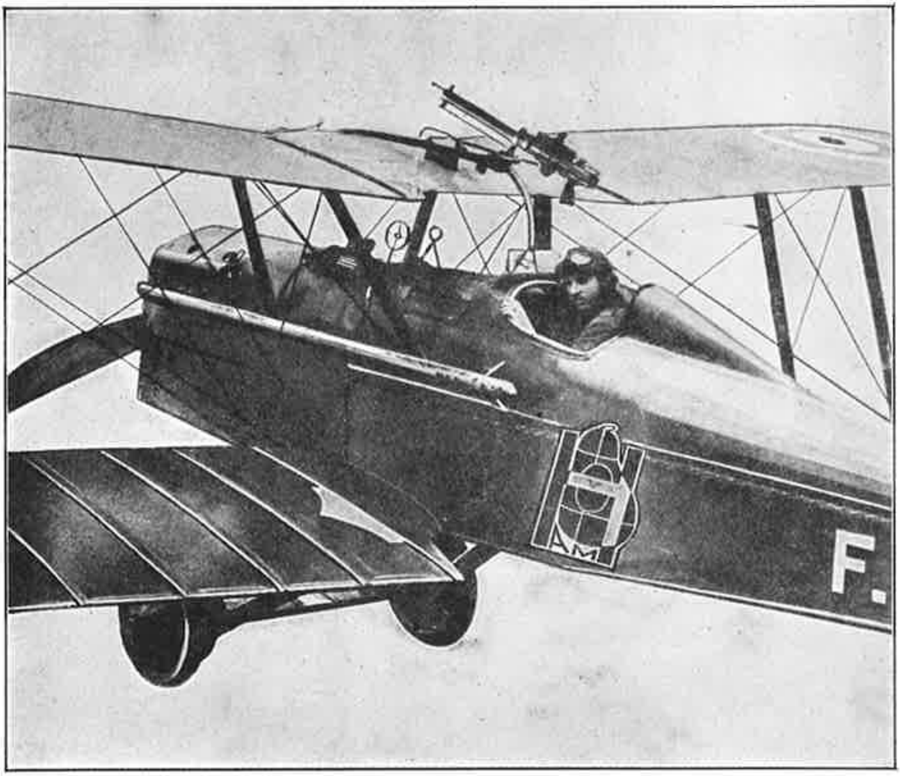
COMPLETE MODEL AIRCRAFT MANUAL

NEW AND REVISED EDITION

PLANS BY THE AUTHOR AND FRANK MONAGHAN
ILLUSTRATIONS BY G. RUTH TAYLOR
PHOTOGRAPHS BY RALPH SOMMER

DODD, MEAD & COMPANY
NEW YORK



THE AUTHOR IN HIS S.E.5 SINGLE-SEATER PURSUIT PLANE WHEN AN OFFICER IN THE BRITISH ROYAL AIR FORCE DURING SERVICE IN THE WORLD WAR

See Chapter 49 for instructions for model of this plane

by the same author

TIN CAN CRAFT
THE BOY BUILDER
PRIZES AND PRESENTS
HANDICRAFT FOR GIRLS
POPULAR CRAFTS FOR BOYS

COMPLETE MODEL AIRCRAFT MANUAL

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CHAPTER 1

AIRPLANE ALPHABET

THE first step toward becoming a model airplane builder is to be able to recognize and name every part of a model. Some beginners know the name of a part but are unable to locate it on a model, while others find themselves in the predicament of knowing a part by sight but not by name. The latter problem presents the greater difficulties, as all building instructions refer to parts by their correct names. This is true, not only here, but in all magazines, manufactured kits and other model books where plans are given, so it is most important to master names of parts if you hope to be able to read plans.

This chapter has been prepared as a solution for such problems. Whenever you require the name of a part, look for it here. Two illustrations have been provided to cover both stick and scale models. When finding a name, the illustration showing the type of model you are building should be consulted. As will be seen, each part is designated by a letter which appears in its alphabetical order in the listing below. After each letter appears the proper name of that particular part, together with the chapter in which are given the building instructions for it.

If you wish a definition for it, the name may be looked up in the glossary of terms. If you wish the definition covering that particular part on a real airplane, it can be found in the aviation dictionary. It must be remembered, however, that all the parts appearing on a model airplane do not necessarily belong to real planes, in which case they would not appear in the aviation dictionary.

STICK MODELS: FIGURE 1

LETTER	NAME	CHAPTER
A	Propeller	9
B	Washers	6
C	Propeller Bearing	6
D	Propeller Shaft	6
E	Can Hook	6

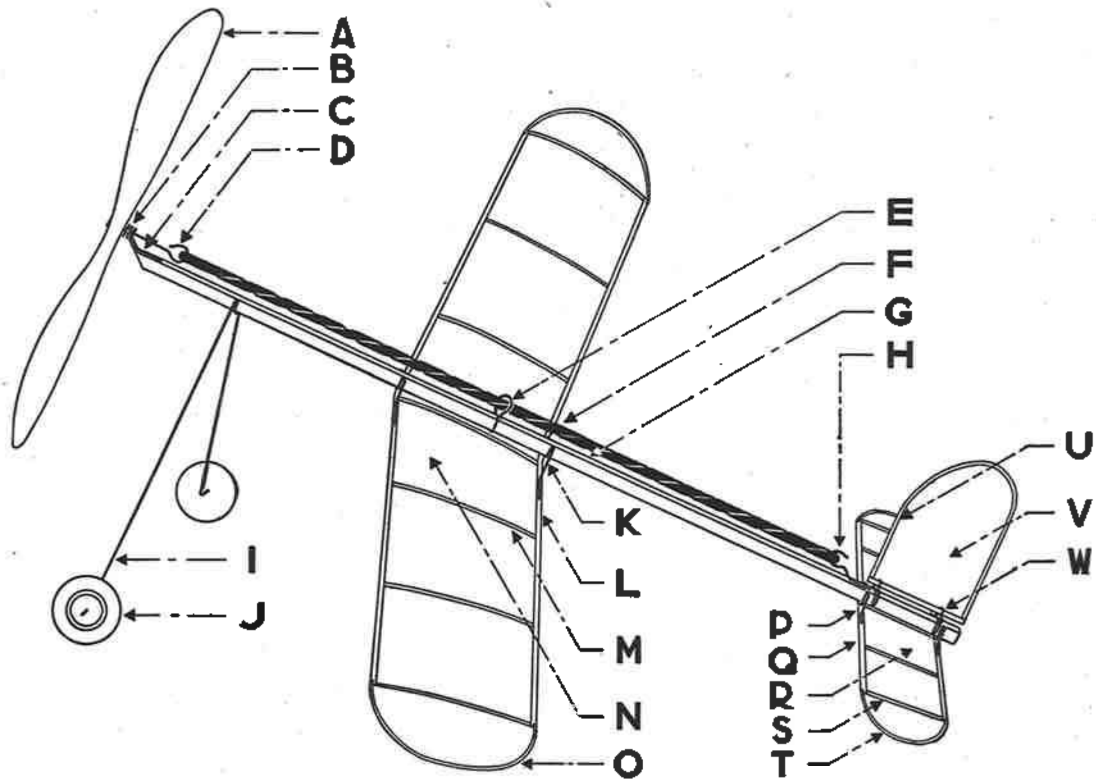


FIGURE 1. STICK MODELS

AIRPLANE ALPHABET

LETTER	NAME	CHAPTER
F	Rubber Motor	12
G	Motor Stick	12
H	End Hook	6
I	Landing Gear	10
J	Wheel	10
K	Wing Clip	6
L	Trailing Edge	7
M	Wing Rib	7
N	Wing	7
O	Wing Tip	7
P	Elevator Clip	6
Q	Leading Edge	7
R	Elevator	Any Stick Model Plan
S	Elevator Rib	48
T	Elevator Tip	7
U	Leading Edge	7
V	Rudder	Any Stick Model Plan
W	Rudder Clip	6

SCALE MODELS: FIGURE 2

LETTER	NAME	CHAPTER
A	Fuselage	8
B	Instrument Board	15
C	Windshield	15
D	Control or Joy Stick	15
E	Pilot's Seat	15
F	Leading Edge Spar	7
G	Inner Wing Spars	7
H	Wing Tip	7
I	Wing Rib	7
J	Trailing Edge Spar	7
K	Cockpit	15
L	Fin Outline Stringer	Any Flying Scale Model Plan
M	Fin	Any Flying Scale Model Plan
N	Tail Braces	Any Flying Scale Model Plan
O	Rubber Motor	12
P	Fuselage Stringers	8
Q	Fuselage Formers	8

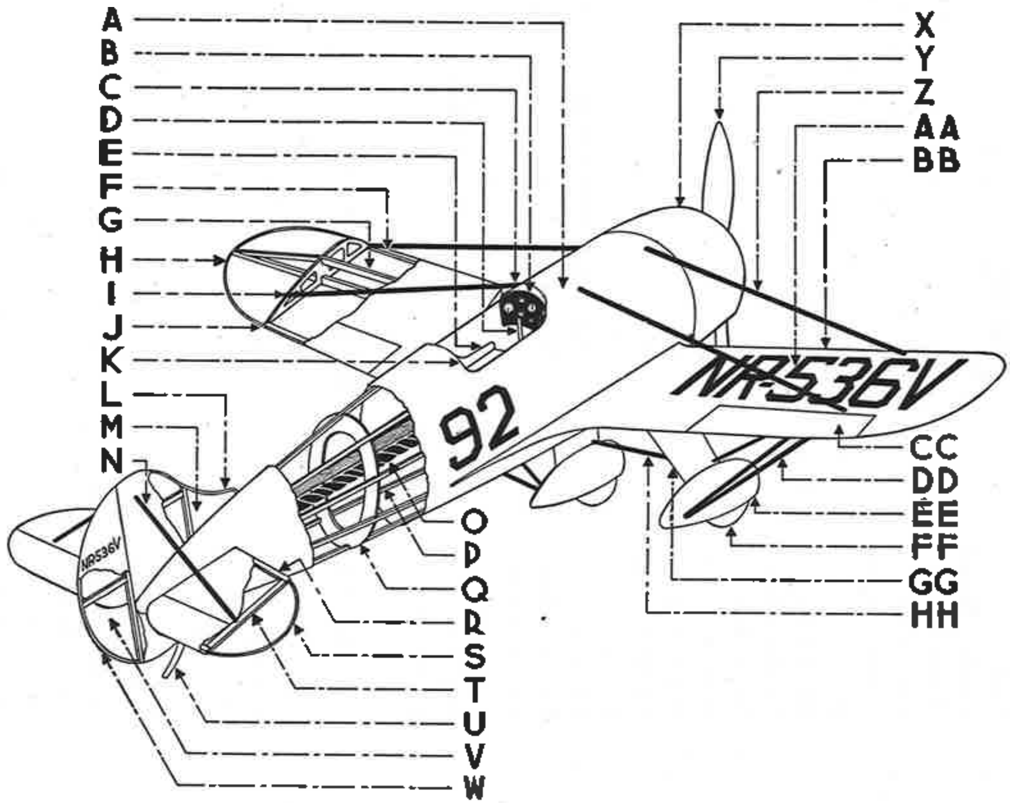


FIGURE. 2. SCALE MODELS

AIRPLANE ALPHABET

LETTER	NAME	CHAPTER
R	Elevator Leading Spar	Any Flying Scale Model Plan
S	Elevator Tip	7
T	Elevator Rib	Any Flying Scale Model Plan
U	Tail Skid	6
V	Rudder	Any Flying Scale Model Plan
W	Rudder Outline Stringer	Any Flying Scale Model Plan
X	Engine Cowling	11
Y	Propeller	9
Z	Landing Wires	49
AA	License Numbers	3
BB	Leading Edge	7
CC	Aileron	49
DD	Flying or Lift Wires	49
EE	Wheel Pants	10
FF	Wheel	10
GG	Landing Gear Strut	10
HH	Landing Gear Brace Wire	10

CHAPTER 2

TOOLS

ONE of the reasons behind the world-wide popularity of model airplane building is that it is a hobby requiring few and inexpensive tools. Many model airplane builders use only a pocket knife, a razor blade and sandpaper, but the ten tools shown here form an assortment complete enough for all model work.

The two pairs of pliers shown in Fig. 3, Nos. 1 and 2 are recommended for this work. The round-nosed pliers shown in No. 1 are splendid for bending all wire fittings, especially those requiring round hooks, such as can, rear and "S" hooks, and propeller shafts. (See Chapter 6.) By bending the wire around the round ends of the pliers, perfect circles can be obtained.

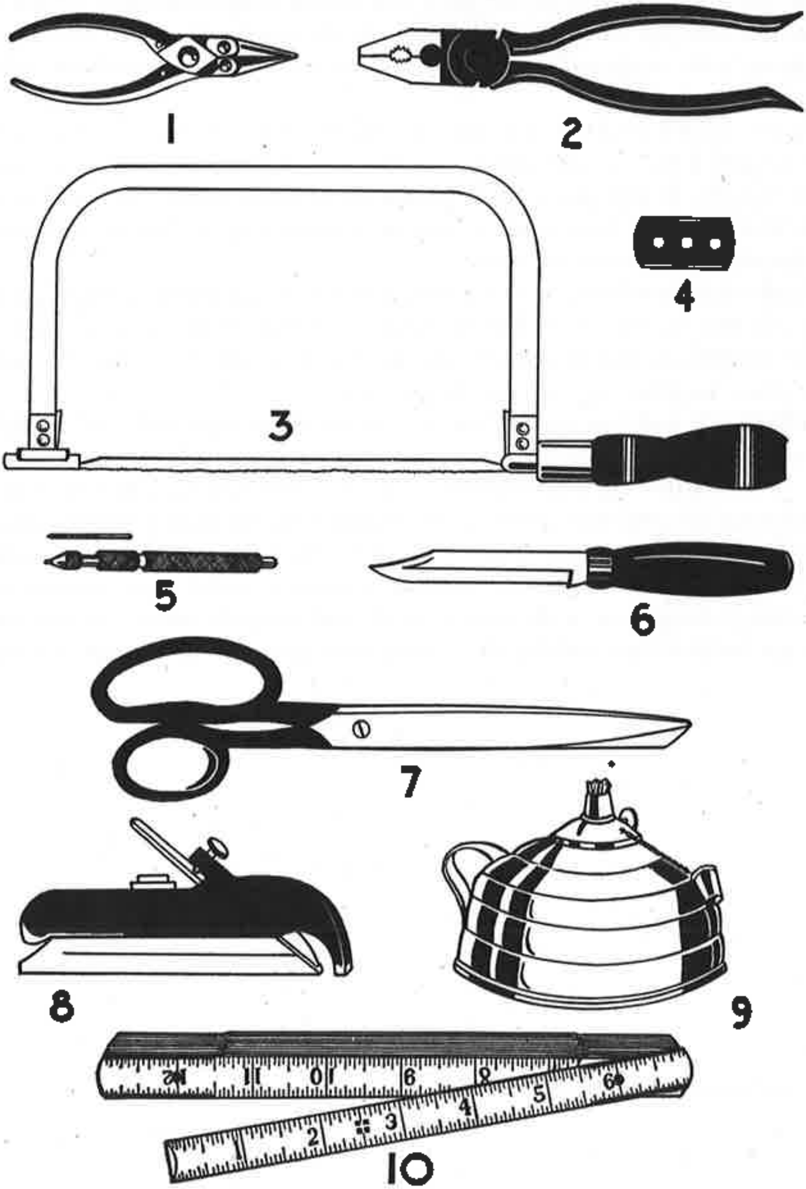
The pliers shown in No. 2 are flat-nosed and have side cutters. These are good for making square bends over the square edge of the ends. They also serve for gripping and straightening wire. The side cutters are used to cut the wire. Both these pliers can be purchased at most five-and-ten-cent stores or at any hardware or model airplane supply house.

The coping saw shown in No. 3, helps in cutting out propeller blanks, solid-scale wings and fuselages, and sawing thick pieces of balsa. The frame and saws to fit it can be purchased with the pliers.

Razor blades make good tools for cutting and trimming balsa, slitting bamboo, and trimming tissue coverings. In Chapter 3, Figs. 4 and 5 are balsa cutters which use razor blades for cutting. They make quick and clean cutting jobs on all balsa pieces.

A small hand drill, known as a "pin vise," is of great use for boring propeller hubs, wheels, and other holes required in solid and built-up models. Tiny drills of 1/64", 1/32", 1/16", and 1/8" diameter can be purchased to fit the chuck of this type of drill. The drill is held in the hand and rotated through the wood. Model airplane supply houses and hardware stores handle these. Such a drill is shown in Fig. 3, No. 5.

The knife shown in No. 6 is a propeller carving knife, which should be used for all propeller carving. While this knife can be used for all cutting work, it is best to keep it for propellers only. Use a regular pocket knife for other jobs. Model supply houses handle these knives and their cost is trivial.



TOOLS

FIGURE 3

In No. 7 will be seen an ordinary pair of long-bladed scissors, which will come in handy for cutting tissue paper for all coverings, as well as ordinary trimming jobs. Such scissors should also be used to cut strands of rubber used for motors.

Many model builders use ordinary block planes for all heavy cutting and shaping jobs, but the author recommends the Stanley bull nose rabbet plane No. 75. It will prove most useful for shaping wings and fuselages of solid scale models. Such a plane can be seen in Fig. 3, No. 8, and can be purchased at any hardware store.

Bamboo is best bent over a flame, and for this purpose a small alcohol lamp, shown in No. 9, should be kept on hand. With such a lamp, the model builder is not dependent on gas fixtures, which cannot be moved from place to place, as can this simple lamp.

The tenth and last tool of our list is the most necessary and useful of them all, as nothing can be built from a plan without its aid. This is the rule. The Stanley zig zag, four-foot rule No. 404 can be purchased at all hardware stores and will answer every demand of the model builder. Simple home-made tool accessories will be given in the various chapters to follow, and the builder will soon find himself designing useful new ones as occasions arise. Keep your tools sharp, clean, and in good order, so that when they are needed they will be in condition to give you the required service.

CHAPTER 3

MATERIALS

BALSA WOOD. Today balsa wood is used exclusively on all flying models, and, because of the ease with which it can be worked, many builders use it on exhibition models.

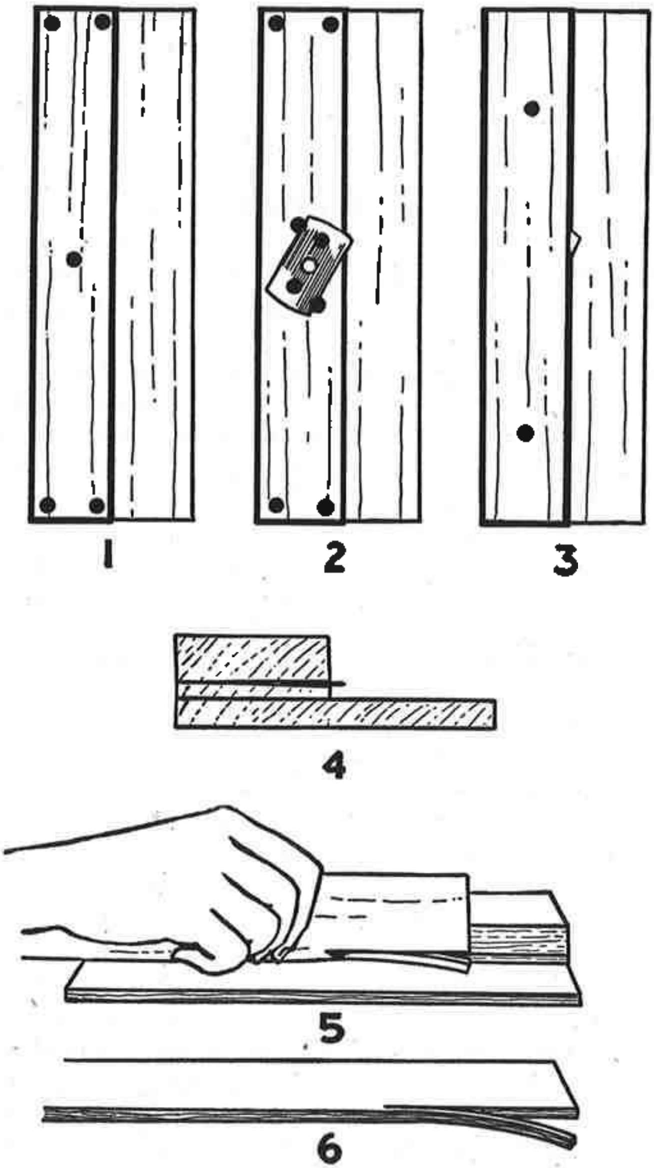
Balsa wood comes from a tree found in the tropical jungles, which resembles the North American cottonwood. It has a smooth bark and grows to considerable height. The name balsa is the Spanish word for raft, applied to this particular wood because its logs were used for rafts on which heavier woods were floated down the rivers from the interior to the seacoast.

Balsa is the lightest wood that grows, being about half the weight of good cork and averaging about six pounds per cubic foot. It is comparatively strong, extremely light, and so easily worked that it can be cut with the thumb nail. All model airplane supply houses carry balsa wood in a number of sizes, and usually in three weights, known as soft, medium, and hard.

Balsa sticks of varying widths and thickness can be purchased, or "sheet balsa" in the form of thin boards can be obtained and cut into sticks. The builder should use the latter type of balsa when cutting his own strips. As all companies charge for cutting balsa wood into various sizes, the builder will find it cheaper to purchase large boards and do the cutting himself. With this in mind, the author has developed the small balsa cutter shown in Fig. 4. This consists of a 1/4" x 2 1/2" x 9" block of wood to which is nailed another piece of the same thickness as you wish to cut your wood. The second piece should be as long as the first but only half as wide. (See Fig. 4, No. 1.) For example, if you wish to cut 1/16" square strips, this second piece should be 1/16" thick and the stock used in the cutter should be the same.

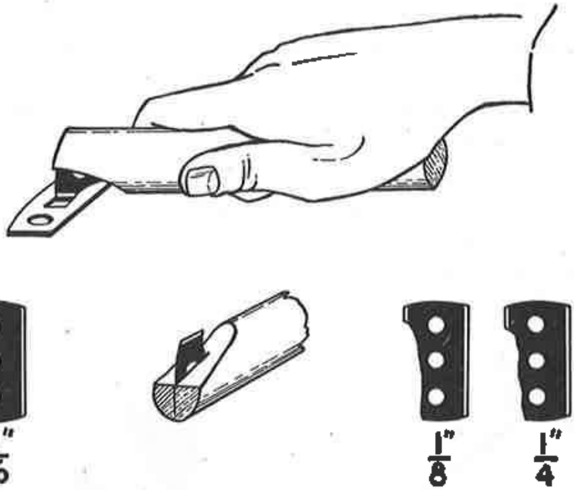
A safety razor blade is now nailed in position, as shown in 2. One corner of the blade should extend about 1/8" beyond the edge of the second piece of wood. On this assembly a third piece is now nailed. It should be the same length and width as the second piece but about 3/8" thick. A top view of this assembly is shown in 3, while the end view appears in 4. Note the edge of the blade protruding from the second and third pieces of wood.

The edges of the second and third pieces serve as a guide for the stock

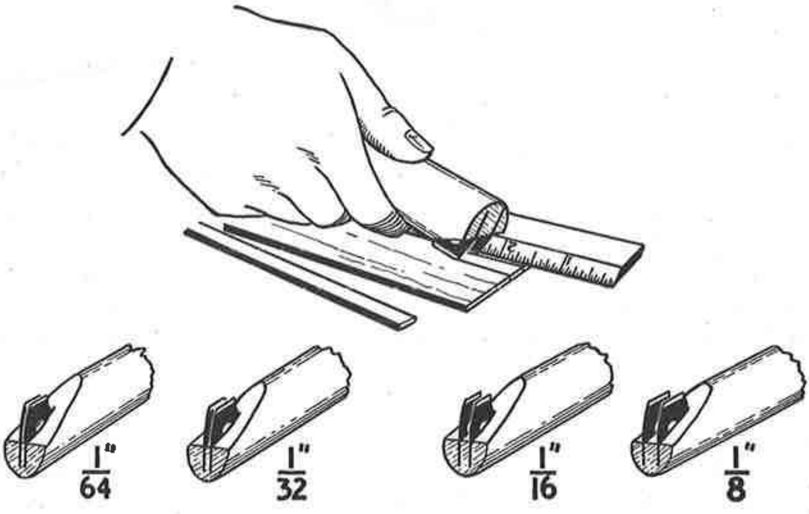


BALSA CUTTER

FIGURE 4



HANDY CUTTERS



STRIP CUTTERS

BALSA CUTTERS

FIGURE 5

being cut, which is moved along them and at the same time pressed against the first piece of wood, which serves as a base for the cutter, as shown in 5. The resulting strip of balsa is shown in 6. It will be found that the best results can be obtained when the cutter is held in a vise.

Another method of cutting balsa strips is shown in Fig. 5 under "Strip Cutters." The handle consists of a round length of wood, about 1″ in diameter. A dowel stick would serve splendidly. It should be about 6″ long. Its end is beveled, and two safety razor blades are cemented into slots cut in the stick for that purpose, as shown. The edge of the blade should extend

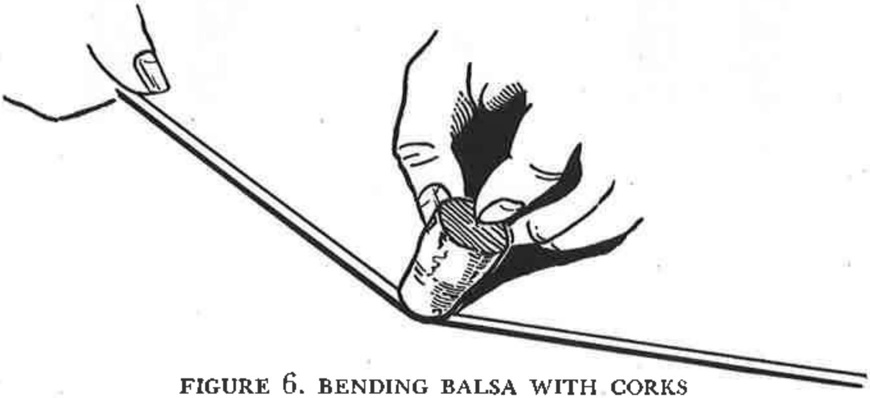


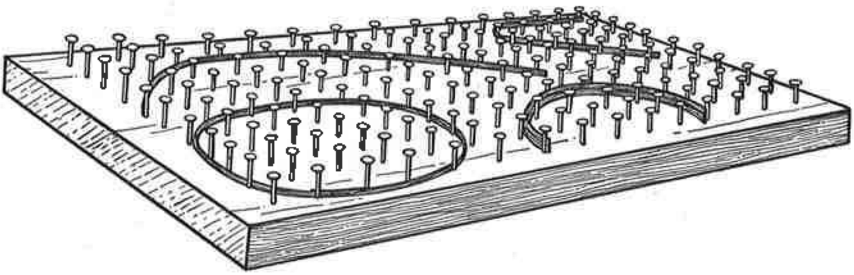
FIGURE 6. BENDING BALSA WITH CORKS

out of the beveled portion of the stick about 1/8″ to 1/4″. The distance between these two blades is determined by the width of strips you wish to cut. If this distance is 1/4″, the strips cut will be 1/4″ wide, etc. Four of the most popular sizes are shown. Note how the cutter is held while being used. A rule is used to guide the cutter. In this manner, strips of any desired width can be cut with ease. Always cut your wood with the grain.

When cutting circles, holes, or balsa wood to proper length, the blade of a safety razor will be found best. Another type of balsa cutter, designed expressly for such work, is shown in Fig. 5 under "Handy Cutters." For such a cutter, the blade has one edge cut or broken until only the desired length of the blade remains, as shown. It is then assembled in the same manner as the double-bladed cutter. Bevel the end of your stick, cut a slot, and cement the blade in place, allowing the edge of the blade to protrude about 1/8″ from the stick, as shown. A number of these cutters in different sizes should be made and kept handy for various cutting operations.

Because of its texture, balsa wood lends itself to bending quite easily. To do this, the balsa wood is usually soaked in hot water from five to ten minutes, after which it can be safely bent. Another novel method, one which eliminates the soaking of the wood, is to heat corks by boiling them in water and then to apply them to the point on the wood where the bend is to be made. This is shown in Fig. 6. Keep applying the corks and keep bending the wood until the desired form is obtained.

Many builders find difficulty in holding the balsa wood in position until its fibers "set" through natural drying. To improve the usual method of pinning the wood in position to a base while drying, the author has designed two presses to do this work. In Fig. 7 will be seen a stick balsa press,



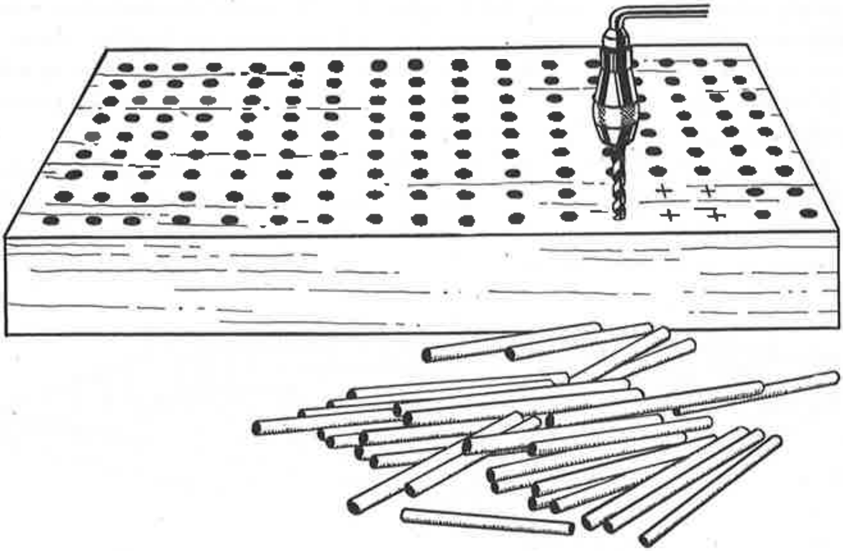
STICK BALSA PRESS

FIGURE 7. BENDING BALSA STRIPS

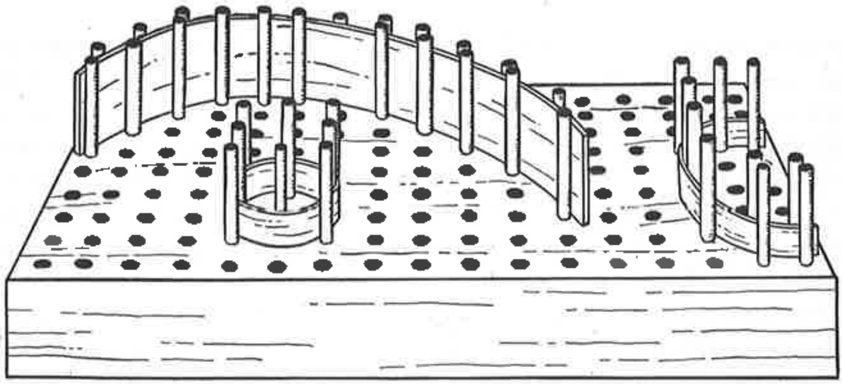
especially useful for the holding of all small pieces, such as single ribs, wing tips, light-weight formers, etc. It consists of a flat board into which small box nails have been driven in rows. The board should be of any desired size and about ½″ thick. The nails should be driven into the board until they extend about ¼″ above its surface. Large-head nails are used to prevent the balsa sticks from slipping up and off them, when forced into position. The wood is soaked, and then placed on the press in the desired position until dry.

For wide balsa boards, the sheet balsa press, shown in Fig. 8, will be found best. When cutting a number of ribs, it is often easiest to bend a piece of sheet balsa to the proper wing rib camber and then cut the ribs from this. In this manner, the builder is assured that all the ribs will have the same identical curve. Sheet balsa formers, cowling covers, etc., can be easily handled in this press.

It consists of a board of any desired size and about 1″ thick. In its top a number of holes are bored in rows, as shown in Fig. 8, No. 1. These should be $\frac{1}{16}$″ or ⅛″ in diameter and about ¾″ deep. Into these, 1″ or 2″ long



1



2

SHEET BALSA PRESS

FIGURE 8

dowel sticks are fitted, which must, of course, be the same diameter as the bored holes.

Fig. 8, No. 2, shows how the press is used. The wood is soaked and bent as desired, and then placed on the press, where the dowel sticks are inserted into as many adjoining holes as necessary to hold it in position until dry.

BAMBOO. Bamboo is a wood consisting of a round, hollow cane, divided into sections by knotty knobs, or joints, called "nodes." One of its surfaces has a hard, glazed coat, which is the portion best suited to model work. In early days, model builders used a great amount of reed, but with the necessity of cutting down weight on model construction bamboo soon replaced it.

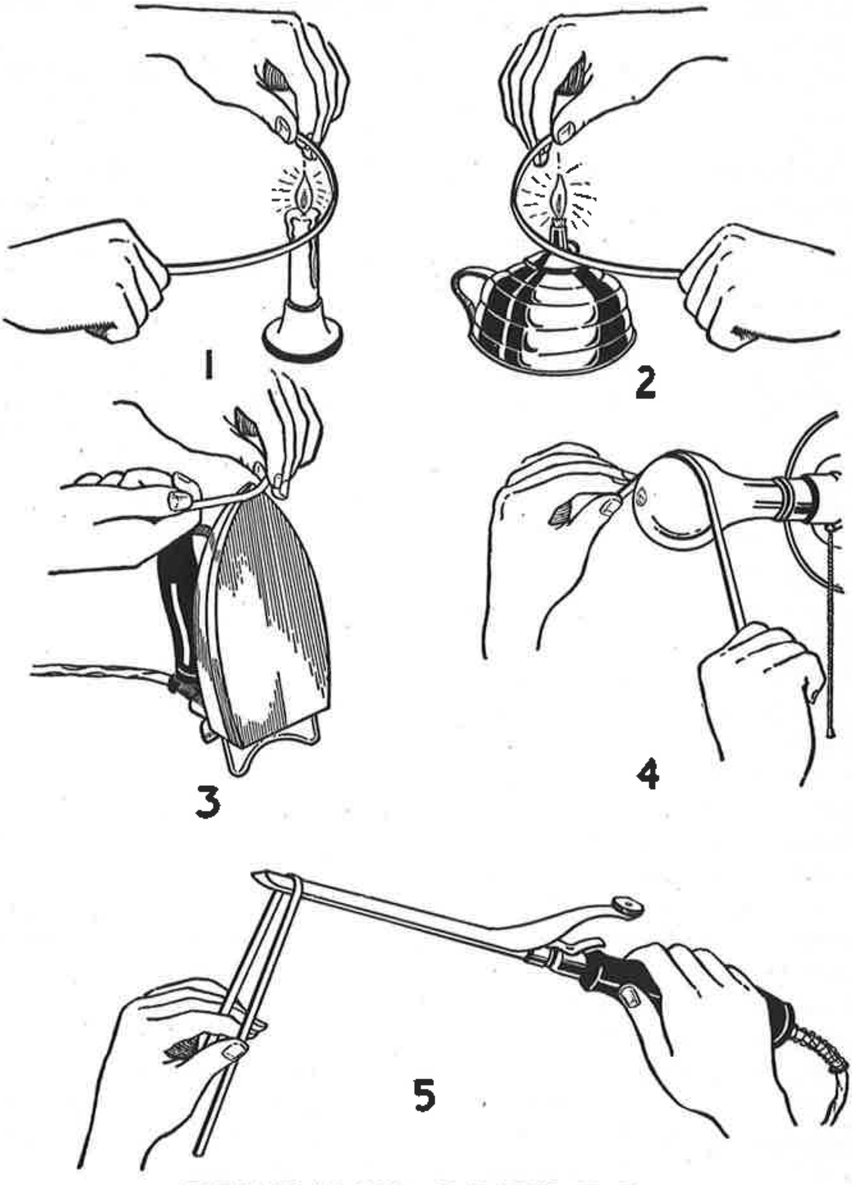
This was because of several qualities found in bamboo and lacking in reed. The former could be split to very small diameters, such as 1/64", 1/32", etc. It is tough, straight-grained and flexible in fiber content, which allows it to be easily worked, makes it practically unbreakable, and permits bending to any required form.

Split bamboo can be purchased in any model supply house, or the builder can secure a pole and do his own cutting. Cut the piece into sections at its nodes, and then split its shiny side into strips. These can be smoothed with your block plane. For model work, only the parts having the original glazed surface are suitable.

Bends can be easily made in bamboo and will hold indefinitely. Heat is used for bending it. In Fig. 9 five methods are illustrated. The oldest of these is the open flame, shown in 1 and 2. Here the bend is made over the flame of a candle or alcohol lamp. Builders use this method today, but the danger of scorching or burning the wood is great, and experience is required to make proper bends in this manner.

A safer method is shown by 3. Here the bamboo is bent over the tip of an electric iron. This eliminates the danger of burning the wood, permitting sharp bends to be made. An electric light bulb can also be used, as in 4. If the bend is circular in form, this method is splendid, although sharp bends cannot be made.

For sharp bends the end of a regular electric curling iron gives ideal results, as shown in 5. After the heat has made the fibers of the wood thoroughly pliable, it should be removed from the heating device and allowed to cool while held in position. It will then retain its curve. Bamboo is used for such parts as wing tips, landing gears, ribs, and skids. Modern construction of very light, small, endurance models, on which every part must be as light as possible, has replaced bamboo parts with balsa to a great



BENDING BAMBOO

FIGURE 9

extent, although the beginner will find the former much easier to handle and bend than the balsa.

PINE. While balsa wood is now used for flying models of all types, many builders prefer pine for certain parts on exhibition planes such as solid scale and built-up, non-flying models. This is done chiefly to strengthen such models against the wear and tear of handling and moving them from exhibition to exhibition. Pine will stand such rough usage better than balsa wood, and as weight is not a factor for consideration in non-flying models, the former wood is often preferred. Many builders prefer to use pine for cutting solid scale fuselages, but chiefly because pine is more easily obtained and costs less.

Aside from these factors, balsa wood will be found superior, as it can be worked with an ease impossible with pine. Pine sticks and boards of various sizes can be had from any model supply store.

RUBBER. After long experimentation, it has been found that the most efficient rubber for motive power on model airplanes is pure Para rubber. It can be obtained from all supply houses in various sizes. (See Chapter 12.)

FILLER. Wood fillers can be used to fill cracks, make small parts, streamline cowlings, wings, and fuselages. There are several of these on the market which are obtainable at model supply houses, hardware stores, or five-and-ten-cent stores. Possibly the best known of these is Plastic Wood. The Northrop Gamma shown in Chapter 48 has its wing tapered into the fuselage with the aid of such a filler, and the builder will find it of aid in forming small parts, such as gun mounts, exhaust pipes, steps, and many other minute parts.

Plastic Wood can be purchased in cans and has the consistency of putty. When it becomes dry it is practically wood, and can be sawed, planed, cut, or sandpapered. For its proper use, follow the instructions on the can.

COVERING MATERIALS. *JAPANESE TISSUES.* These are classed as rice and bamboo papers. Of the former, two grades are the most popular in model building. These are superfine Japanese tissue and Hakone tissue. The former is the best of these, but it is also the most expensive. Hakone is a very popular paper, being extremely light and tough.

Both are splendid for all models weighing less than four ounces, but for models of greater weight bamboo tissues are preferable. Throughout this book all reference to Japanese tissue indicates rice paper of either grade.

Bamboo tissues are extremely tough and at the same time light enough for all flying models over four ounces. All model supply houses handle a full line of these papers, and the novice should experiment with various strengths, weights, and grades of these tissues in determining the kind best suited for his models. For instructions on using these tissues see Chapter 7, "Wing Covering."

SILK. Many builders prefer to use Japanese silk for covering non-flying scale models. All supply houses handle this silk. The method of using it is the same as that for tissue coverings, except that the silk should be pulled taut to prevent it from sagging. If the model is not painted, the silk must be given a preservative to make it air-tight. After stretching it with the usual water-spray, a thin coat of clear banana oil should be applied. This fills up the pores and makes it air-tight. All other instructions covering the use of Japanese tissue apply to silk.

Silk for covering flying models is not recommended because of its excess weight and the possibilities of warping fragile construction. On solid scale models silk is sometimes used to imitate built-up construction. (See Chapter 7, "Solid Wing Construction.")

GOLD BEATER'S SKIN. This is sometimes used for model airplanes, but does not enjoy the popularity of either tissue or silk. It is an animal product stripped from the lining of a cow's stomach. It is by far the strongest covering obtainable, and is tough, thin, and quite light. It can be purchased in a variety of colors, and has more resistance against puncture than silk or tissue. It is not suitable for flying models, but is quite adaptable for others.

WIRE. Practically all metal fittings necessary on flying models are bent from wire. Because of its strong tensile properties, a high grade of piano wire is used for these parts. It can be purchased in various diameters from all model supply companies. Because of its great strength, stiffness, and toughness, this wire can be used in extremely small diameters with perfect safety, while other types of wire would require larger diameters to produce the same strength and consequently would weigh much more. (See Chapter 6.)

WASHERS. On all parts requiring free motion, small $\frac{1}{16}''$ or $\frac{1}{8}''$ outside diameter washers of either brass or aluminum are used. These can be purchased at model supply houses, and are necessary for propeller shafts, landing gear wheels, etc. In some cases, beads and spangles have been substituted for these washers, and they are quite efficient on all small, light flying models, but for the larger types of flying planes, the regulation washers should be used.

CEMENT. The demand for a quick-drying, waterproof, light-weight adhesive produced a number of first-class cements. The most popular of these is known as "Ambroid." This is still used by many model builders, but colorless cements are fast replacing it. The adhesive power of these cements is so great that minute parts can be joined together so tightly that the surrounding wood will break before the cemented joint will give.

DOPE. Another liquid well-known to the model airplane world is a rather thick substance known as "dope." Its main use is to pull the covering of a model taut, giving it a smooth, drum-like surface. It preserves and strengthens the covering and protects it from dust, dampness, and wear.

It is also widely used as an adhesive to hold the covering to the framework. Many builders strengthen propellers on larger models by brushing a coat of dope over their surface.

The best known of these so-called "dopes" is banana oil, which is often thickened with celluloid. While some builders purchase banana oil and mix it with celluloid, this is not recommended inasmuch as it requires considerable knowledge to do. It is better to purchase regular dope prepared especially for model airplane work. This comes already mixed to proper consistency. Clear dope can be purchased for models that do not require color, or, if desired, dope can be had in a variety of colors.

For all large models, the dope can be safely used as it comes, but for all those of fragile construction, it should be thinned with acetone. Some builders use clear banana oil for fastening their coverings over models, and then thin it with acetone for stretching the tissue or silk. Silk can best be tightened and made air-tight by a thin coat of clear banana oil. This is given the silk after the usual water-spraying. (See Chapter 7, "Wing Covering.")

Dope often becomes very thick and sometimes turns completely hard. When this occurs it can be restored to its original consistency by adding acetone, but when it is perfectly hard it will be found best to throw it away and purchase a new supply inasmuch as the acetone may cost as much as a new can of dope.

EMBLEMS AND LICENSE NUMBERS. Various emblems and insignia, as well as license numbers, are required for true scale models. The former can often be purchased from model supply stores, although these are usually limited to war insignia. For this reason 120 of the most commonly used insignia have been reproduced in Chapter 14 with full instructions for their proper use.

License numbers are another important detail of the true scale model. They may be painted directly on the wing, or can be drawn, cut out, and glued to the surface. Another method is to cut the numbers from large calendars. Small calendars provide splendid numbers for tail units and fuselages, but it must be remembered that these must be the correct size. The large wing license numbers should have a height equal to two-thirds the width of the wing. They are located on the under side of the left wing and on the upper side of the right wing. The under numerals should read from the front of the plane, while the upper ones should read from the rear.

PAINT. See Chapter 13.

MODEL ACCESSORIES. In Chapter 15 a number of model airplane accessories are shown together with full instructions for making each, but the average model supply company can furnish these if you do not wish to make them. Bombs, machine guns, steps, instrument boards, seats, cowlings, engines, parachutes, and many other accessories can be purchased to improve the appearance of scale models. In Chapter 11 the building of motors and cowlings is fully covered, and in Chapter 10 such things as wheels, wheel pants, and various types of landing gears are given. All model builders should keep a library of dealers' catalogues, so that they can become familiar with all the various parts and accessories these companies have to offer.

CHAPTER 4

READING AND USING PLANS

STICK MODEL PLANS. For each model appearing in this book complete plans are given together with step-by-step directions for its construction. Because of the simplicity of the average stick model, the plan for each of these has been confined to one page, except in one or two cases. All dimensions have been shown on the plan and are again repeated in the instructions.

Before any actual construction is begun, the builder should carefully study the plan of the particular model he intends to build, together with its written instructions. Turn to the first instructions in the text and then locate that particular part on the plan. Read the instructions and at the same time follow each item by locating it on the plan, checking its dimensions against the text, and then carefully following it on the plan from end to end. In this manner, its proper location on the model can be quickly seen.

Do not proceed to the next part of the text until you feel confident that you thoroughly understand all details of the one you are studying. Most motor sticks are shown in two views, the top and the side. On the top view will be seen the elevator top view, while the side view of the motor stick will usually contain the side view of the rudder. In this way, the construction of these parts can be seen together with their proper location on the motor stick. All parts are clearly marked. Wing construction is also shown by a top and edge view. The edge view shows the necessary dihedral angle of the wing. (See Chapter 7, "Wing Assembly.") The propeller is usually shown by a perspective view of the propeller block from which it is carved. (See Chapter 9, "Carved Propellers.")

If the model has a landing gear, this is usually shown by a side view of the gear attached to the motor stick, which shows its location on that member. Another plan of the front view of the landing gear, showing its dimensions, construction, and material, is also given in most cases. If the wing has sheet ribs, a side view of these is given on squares, so that the builder can quickly draw full-size rib plans.

To do this, rule a sheet of paper with cross lines, making squares of the size called for in the plan. The outline of the rib is then drawn through these squares, which act as a guide. To make an exact copy of the rib, each line crossing each square must be located in exactly the same position as that in which the same line crosses the same square in the plan.

On wings having a sweepback, a full-size copy of the top view of the wing should be made. In this manner each part of the wing can then be cut to match the size shown on the full-size plan, placed on the plan in proper position, and the assembly made directly on the plan. In this way the necessary sweepback of the wing is obtained automatically. This is a good plan to follow whenever a wing, fuselage, rudder, or elevator has a difficult or peculiar outline.

When reading plans the builder must keep in mind that the written instructions are quite as much a part of the building instructions as the plan itself. For this reason constant checking of written instructions should be made while the model is being built.

SOLID SCALE MODEL PLANS. Because of the various sizes in which model builders construct solid scale models, these plans have been made up to cater to all tastes. To do so, a plan had to be devised whereby a model of any size could be made from the plans covering each of them. It can be readily understood that it would be impossible to give complete plans for models having a 6″, 12″, 18″, 24″, or 36″ wing length, so the graph method of presentation has been used.

With such a plan, the builder can make his model any size. To use such a graph plan is quite simple once the procedure is understood. These solid scale model plans are drawn up with twenty-four squares from wing tip to wing tip. If these squares were to be drawn 1″ square, the model built from that plan would be a 24″ model. If, however, a 6″ model is desired, each of the squares would have to be drawn ¼″ square.

The first step in the work is to rule off a piece of paper with squares of a size corresponding to the size you wish your model. Each of the three views of the model is then copied from the page plan in the book on your ruled paper. This is done by guiding the pencil through each square, making sure that the line being drawn passes through the square in exactly the same location it takes on the page plan.

When a full-size duplicate of the page plan has been drawn, it becomes a simple matter for the builder to cut his various parts exactly the size given on the plan he has drawn. With the three views, side, top, and front, each part is shown three times, so that its length, width, and thickness will appear on the plan. To aid the builder further, instructions accompany each plan and give the various sizes necessary for each part. These are given for models measuring 12″ from wing tip to wing tip. If a 6″ model is being made, these written dimensions would have to be cut in half, or if a 24″ model is desired, each dimension appearing in the text would have to be doubled.

Such written instructions are given merely as a further aid to the builder, and the 12″ model has been taken as a standard.

BUILT-UP, NON-FLYING AND FLYING SCALE MODELS. These plans are more closely allied to their accompanying text than any of the others, because space would not allow full dimensions to be printed on the plans. To avoid a crowded page, the author has used letters and numbers to indicate the various parts of the model, and has then given the length, width, and thickness of each of these in the text, together with step-by-step instructions on assembling.

Fuselages have been given in great detail, many of them taking a full page and sometimes two full pages of plans. Each former of a fuselage has been given in graph, or squares, so that the builder can easily redraw them full-size.

All longerons and stringers of the fuselage have been numbered or lettered, the sizes given in the text, and full data on location clearly shown. Most fuselages appear on the plans in three views, side, top, and bottom. Each of these shows only that particular side of the fuselage. In other words, if a bottom view of the fuselage is shown, only the braces, formers, and stringers along the bottom appear. If a skeleton model of the fuselage was held bottom side up, a number of parts on the top of the fuselage would be seen, but on the bottom view of the plans these are not shown, because of the possibility of confusing them with those of the bottom. This is also true with the top and side views of the fuselage in the plans.

Each former location on the fuselage has been numbered or lettered and these numbers or letters appear under each individual drawing of each former in the plans. Top and edge views of the wing have been provided in the plans. The first shows the location of all ribs, wing tips, inner wing spars, and leading and trailing edge spars. The latter shows the necessary dihedral angle of the wing, given in inches, and appearing under "Dihedral." All wing ribs are numbered or lettered on the top view of the plan. These ribs are then shown in squares in the plans under their particular letters or numbers. Thus the builder can see at a glance the exact location on the wing of each rib. All ribs appearing in the plans in graph require redrawing full size, as already explained for solid scale models.

Various other parts having curved outlines, such as wheel pants, landing gears, etc., are also given in graph.

A three-view plan in graph appears with each flying or built-up, non-flying scale model, as an aid to the builder when assembling his model. These do not require redrawing, since for assembly work only locations are required, and they can easily be found on the plan as it appears on the page. These three-view plans have been given in graph so that the builder can make from them a solid scale model of any of these flying or built-up, non-flying scale models. The same procedure is used for these models as for the solid scale models and their plans.

With each flying or built-up, non-flying scale model, two photographs are provided. One of these shows the model assembled uncovered, so that the model can be studied by the builder. The second shows the finished model. While these are not part of the plans, the builder will find them of assistance when making the model.

CHAPTER 5

MODEL CARRYING CASES

A CARRYING case for the model builder is quite as important to him as a brief-case is to a lawyer. Any well-made airplane model is a delicate affair at best, because of the fact that the lightest of woods are used in its construction and its wings are usually covered with tissue paper. Each part is so fragile that great care must be exercised in handling and especially in transportation.

Here are two boxes designed for just this purpose, and they are so simple in construction, so handy to carry, so cheap to build, and so useful that no first-class modeler can afford to be without one.

They are carried like a suitcase, and will be found commodious enough to hold ten stick models, all extra parts, necessary tools for repairs, and a winder. Lids are provided for the compartments where small articles are stored, so that they will not spill out when the box is opened. Some builders cover their boxes with oilcloth, and the author recommends it. Such boxes are often placed on the ground at outdoor meets, where dampness from rain or dew might ruin weeks of work and many dollars' worth of materials.

Two designs are given, complete with plans, so the builder has only to choose the one he prefers. The first one (see Figs. 10 and 11) is the shape of any common suitcase, and requires the following pieces of pine:

2 pcs.—3/8" x 11 1/4" x 42"	—Box bottom (E) and Lid Bottom (G)
2 pcs.—3/8" x 6" x 42"	—Box sides (A and C)
2 pcs.—3/8" x 6" x 12"	—Box ends (B and D)
2 pcs.—3/8" x 3" x 42"	—Lid sides (F and H)
2 pcs.—3/8" x 3" x 12"	—Lid ends (I and J)
2 pcs.—3/8" x 5" x 5 7/16"	—Box partitions (1 and 2)
1 pc. —3/8" x 5" x 11 1/4"	—Box partition (4)
1 pc. —3/8" x 5" x 35 13/16"	—Box partition (3)
2 pcs.—3/8" x 2 1/2" x 3"	—Lid partitions (1 and 4)
2 pcs.—3/8" x 2 1/2" x 20 1/4"	—Lid partitions (2 and 3)

Each of these eighteen pieces should be squared up, planed smooth, and then finished with sandpaper. We are now ready to assemble our box. Nail the two side pieces A and C to the sides of E. Complete the box by nailing

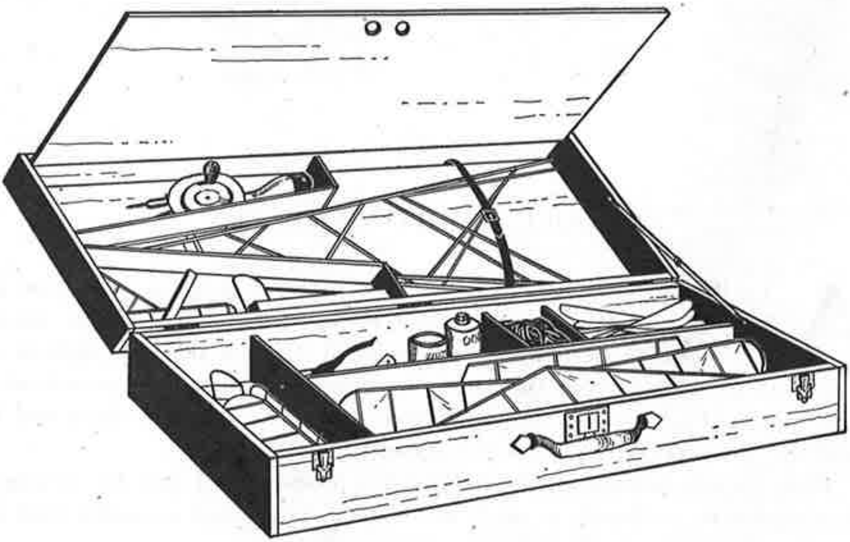


FIGURE 10. CARRYING CASE—SUITCASE TYPE

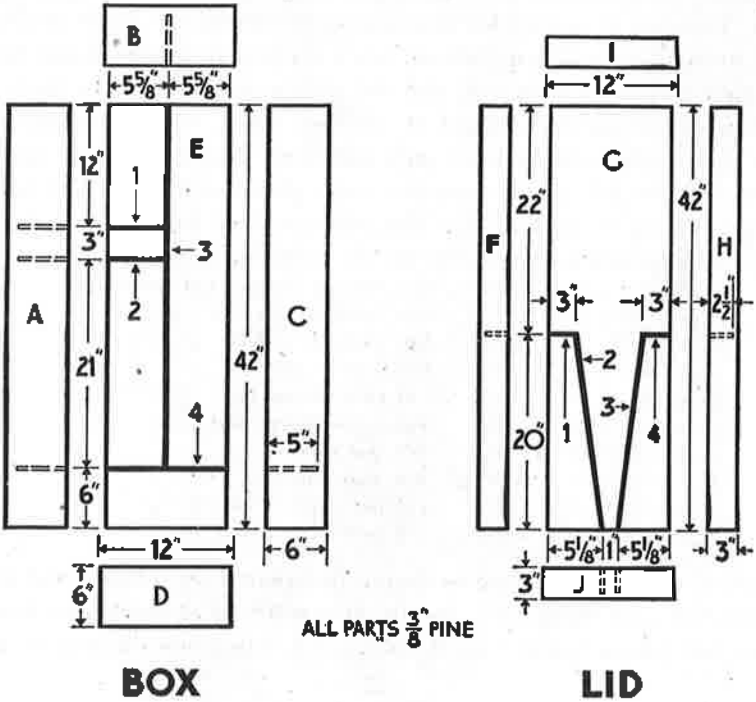


FIGURE 11. PLAN FOR CARRYING CASE—SUITCASE TYPE

the ends B and D to the bottom piece E and the side pieces A and C. The partition boards are attached. Piece 4 is nailed between A and C, and further strengthened by nailing to piece E. The long partition board 3 is nailed between piece 4 and the end board B. This should also be nailed to the bottom board E. The partitions are completed by nailing the two short pieces 1 and 2 between partition board 3 and the side board A, which completes the box portion of our case.

The lid is now assembled. Proceed in the same manner, nailing the side boards F and H to the sides of the bottom board G. Nail the end boards I and J to the ends of F and H, as well as to the ends of bottom board G. The four partition boards are now assembled. Nail the short ones 1 and 4 to the sides F and H. These should also be nailed to the bottom board G. The two remaining partition boards 2 and 3 are nailed to the ends of boards 1 and 4, and then nailed in position to end board J. These should also be nailed securely to the bottom board, completing the lid with the exception of its cover. This should be made of 1/8″ stock, so that it will come flush with the top of the lid's sides. Cut it 11¼″ wide and 42″ long, and attach it, as shown in the illustration, with three hinges. Two small holes can be bored in it to aid in lifting.

Three 3″ hinges are used to hinge the lid in place on the box, and it is then equipped with regular fasteners such as are used on ordinary suitcases. A suitcase handle and a lock complete the box. When packing it, all "A-Frames" are placed in the lid, as well as the winder and spare parts, as shown. The long compartment holds wings, being long enough to take a 36″ length, while the small end compartment holds all elevators and rudders. The other three compartments are for propellers, rubber motors, and miscellaneous tools, dope, ambroid, etc.

The second box is made in the shape of an "A-Frame," as shown in the illustration. (See Figs. 12 and 13.) It requires the following pieces of pine:

2 pcs.—3/8″ x 15″ x 48″ —Box bottom (E) and Lid bottom (G)
2 pcs.—3/8″ x 6″ x 48¾″—Box sides (A and C)
1 pc. —3/8″ x 6″ x 15″ —Box end (B)
1 pc. —3/8″ x 6″ x 9″ —Box end (D)
2 pcs.—3/8″ x 3″ x 48¾″—Lid sides (H and J)
1 pc. —3/8″ x 3″ x 15″ —Lid end (I)
1 pc. —3/8″ x 3″ x 9″ —Lid end (K)
1 pc. —3/8″ x 5⅝″ x 36¾″—Box partition (2)
1 pc. —3/8″ x 5⅝″ x 13½″—Box partition (1)
2 pcs.—3/8″ x 5⅝″ x 5¼″—Box partitions (3 and 4)
1 pc. —3/8″ x 2½″ x 48″ —Lid partition (F)
1 pc. —3/8″ x 2½″ x 5″ —Lid partition (E)
1 pc. —1/8″ x 5″ x 48″ —Partition cover

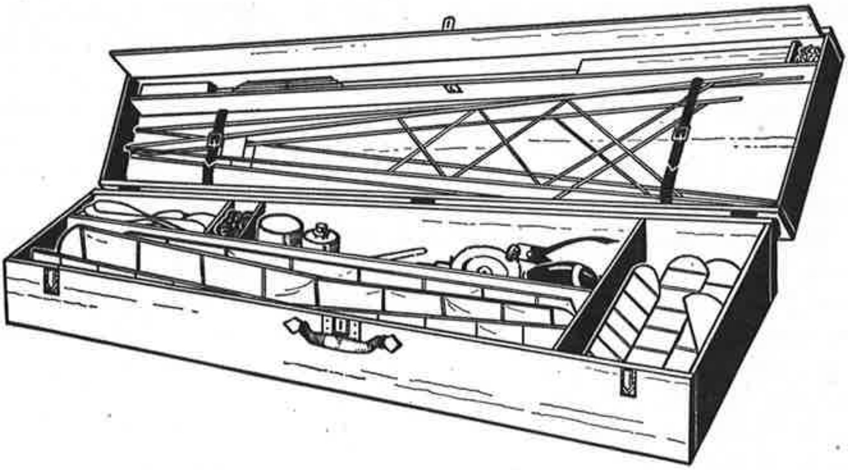


FIGURE 12. CARRYING CASE—TRIANGULAR TYPE

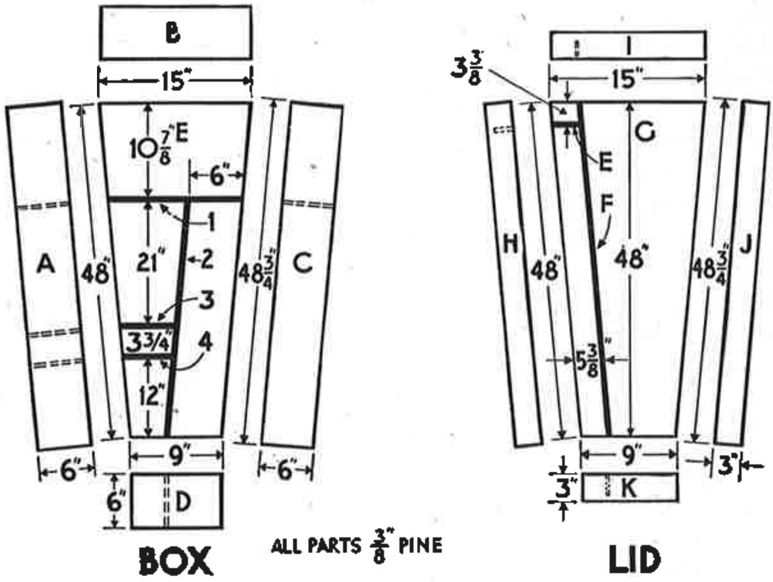


FIGURE 13. PLAN FOR CARRYING CASE—TRIANGULAR TYPE

The two bottom pieces E and G should be cut, as shown in the plans. One end of these two pieces measures 15″ and the other 9″ in width. Take all measurements from a line drawn through the center of each board along its length.

When these pieces have been sawed, the entire seventeen should be planed smooth and completed with a careful sanding. The box is now assembled. Attach the side pieces A and C by nailing them to bottom piece E, after which the end boards B and D are nailed in place between side boards A and C. These end boards must also be nailed to the bottom E.

The partition board 1 is nailed between A and C 10⅞″ from the 15″ wide end of E. Nail this to the bottom board E as well as to the sides. The long partition board 2 is now attached between end board D and partition board 1. This is placed 6″ in from side C, parallel with it, and nailed securely to partition 1, end board D, and bottom E.

The two short partition boards are now attached. Board 4 is nailed between partition 2 and side A 12″ from end D, while the other partition (3) is located 21″ from partition 1, or 3″ from partition 4. These should be nailed to the bottom E, the side A, and the partition 2, completing the box part of our case. We now assemble the lid.

The sides H and J are nailed to the sides of the bottom G. Nail the end pieces I and K between the sides H and J. Strengthen them by nailing to the bottom piece G. The long partition board F is nailed between the end pieces I and K 5″ from the side board H. The short partition board is nailed between the long partition board F and the side board H 3″ from end board I, as shown. The cover for the narrow lid compartment is held with three hinges, being fastened to the side board H.

Hinge the lid of the case to the box with three 3″ hinges, and cover it carefully with oilcloth, attaching it with glue. The large compartment in the lid holds "A-Frames," motor sticks, and extra long sticks, while the small corner one is for metal fittings. The third lid compartment is for spare wood pieces.

In the box, the largest of the five compartments is for wings, while the end one holds elevators and rudders. The third compartment in the opposite corner holds propellers, while that next to it is for rubber motors. The fifth compartment holds dope, tools, winder, and other necessary materials.

CHAPTER 6

METAL FITTINGS

THE construction of a model airplane requires metal parts which must be of such quality as to give the necessary strength and at the same time add a minimum amount of weight. Experimentation has proved that a high-grade piano wire has these qualities. All model stores handle this wire, but the purchaser should specify piano wire. Having an unusually great tensile strength, it allows the thinnest wire to be used and guarantees strength and lightness.

While all fittings are not made of this wire, the few exceptions are made from the lightest possible metals, as explained later. The diameter of wire is designated by a gauge number. There are times when it becomes necessary to know the actual diameter of the wire in inches, which the gauge number represents. The most common sizes are:

GAUGE NUMBER	WIRE DIAMETER
5	0.014″
6	0.016″
7	0.018″
8	0.0197″
9	0.022″
10	0.0236″
11	0.026″
12	0.0283″
13	0.031″
14	0.033″
15	0.035″
16	0.037″

For the average model work, Nos. 6, 8, 10, 12, and 14 will be all that the builder will require. Bending of wire parts is difficult. All the various parts shown in Figs. 16 and 17 can be purchased from model houses, but their cost is far greater than the price of the wire, and the types of fittings available are limited. An end hook may be purchased, but seldom more than one type will be available, so if you wish another form of end hook you must bend your own.

Special wire cutters should be purchased, as piano wire will ruin an ordinary pair of pliers in a short time. Round-nosed pliers should be used for bending piano wire, and two pairs will be useful. While one holds the end of the wire, the second can do the bending.

BENDING WIRE

FIGURE 14

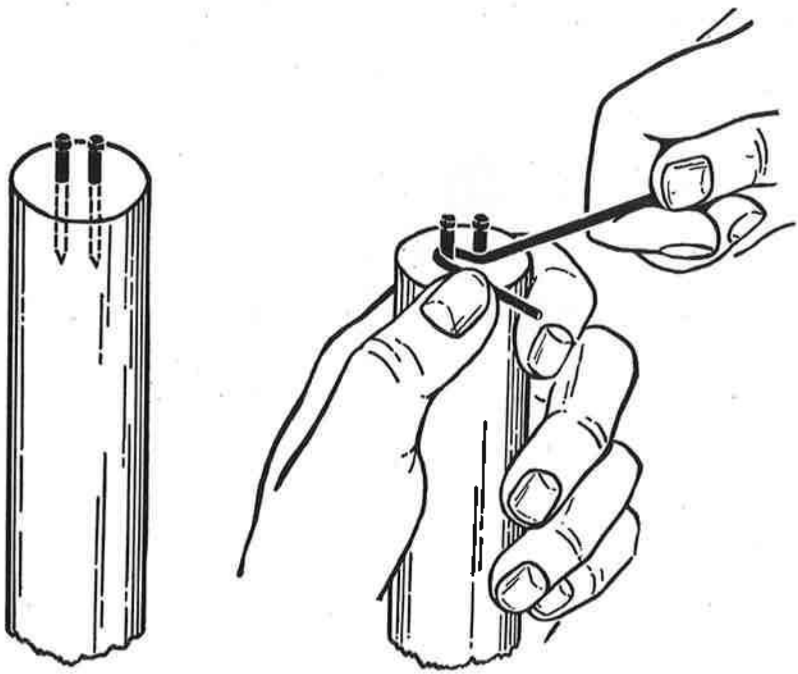
Fig. 14 shows the usual method of bending wire. The pliers hold the wire at the point of bend, while the hand or a second pair brings the wire over for the bend. Small circles can be made in this manner.

Fig. 15 shows a simple wire bender. It consists of a short length of 1″ dowel, or piece of broomhandle, into the end of which two small brads have been driven. The heads of the brads keep the wire in place. The illustration shows how the bender is used. Several of these benders can be made, each with nails of different diameters for bends of different sizes. The handle is 6″ or 8″ long.

TAIL SKIDS. In Fig. 16 six popular tail skids are shown. These are bent to shape and cemented to the under side of the fuselage or motor stick.

It will sometimes be necessary to strengthen the connection by binding the wire with silk thread, after which it should be given a coat of cement.

"S" HOOKS. These are bent in the form of a letter "S." They are used as a connecting link between rear hooks, as well as nose hooks, and the rub-



WIRE BENDER

FIGURE 15

ber motor, as in Fig. 16 B. Such hooks are necessary only when the motor carries a number of strands. Their main use is to give the strands a loose connection on which to turn. The rubber strands are looped over one half of the hook, while the other half is connected to the nose or end hook. For especially large motors, the hook for the rubber is made larger than the connecting hook, as shown by A. B shows the most commonly used "S" hook, while C, D, and E show various forms of it. The builder can make his own choice of these, as they all function alike.

CLIPS. There are four main uses for clips. The wing and elevator clips hold these parts in place on the motor stick or fuselage. The rudder clip holds that member in position, while the motor stick clip holds the motor stick in position in the fuselage.

A in Fig. 16 shows a popular wing clip for single stick endurance models. It can be used on models carrying the wing above or under the motor stick, as the small squared portion at the top is bent to fit the width and thickness of the motor stick. With such a clip, the wing can be hung from the stick or supported above it. Two are required for each wing. A large one is used on the leading edge, while a small one is cemented to the trailing edge, as shown in B. The type of clip shown by B is possibly the most common on stick models where the wing is above the motor stick. The view shown is from the under side of the wing. Two of these clips are used for each wing, as in the case of the A clip.

The clip marked C is another form of B clip, with the bend in front of or behind the main supporting wires rather than at their sides.

Both these clips are used as motor stick clips inside a fuselage model where cross top struts or cross bottom struts have the clips cemented to them. If these clips are attached to top struts, the motor stick becomes a "hanging" stick, while it is called a "supported" stick if the clips are attached to bottom struts. Another clip is shown by D. This has a small saddle bent in it, which serves as an extra support along the motor stick. A single wire support often allows the wing to "rock" on the stick, but the saddle on this one prevents this because of the surplus purchase it has on the stick.

For twin stick models, the wire clips shown by E make splendid wing fasteners. These are bent to fit around the members of the A-frame, and the wing is held with a single rubber band stretched across the top surface of the wing and held by the small hooks of the clips. Four such clips are necessary for each wing, two being placed as shown on each beam.

The odd-shaped clip shown by F can be used for motor sticks as well as rudders. The ends of the wire fit over the bottom rib of the rudder, where they are cemented in place, while the lower portion is bent to the size of the motor stick, fuselage longeron, or the center rib of the elevator. For motor sticks, the ends are cemented to the top center stringer, while the lower portion is bent to fit the motor stick tightly. This clip can be used only for hanging motor sticks.

Clips A, B, C, and D can be used for elevators on single stick models. They are made proportionately smaller than when used for wings.

CAN HOOKS. These are used for a two-fold purpose on all models having strong rubber motors. They keep the rubber in place on the stick, and

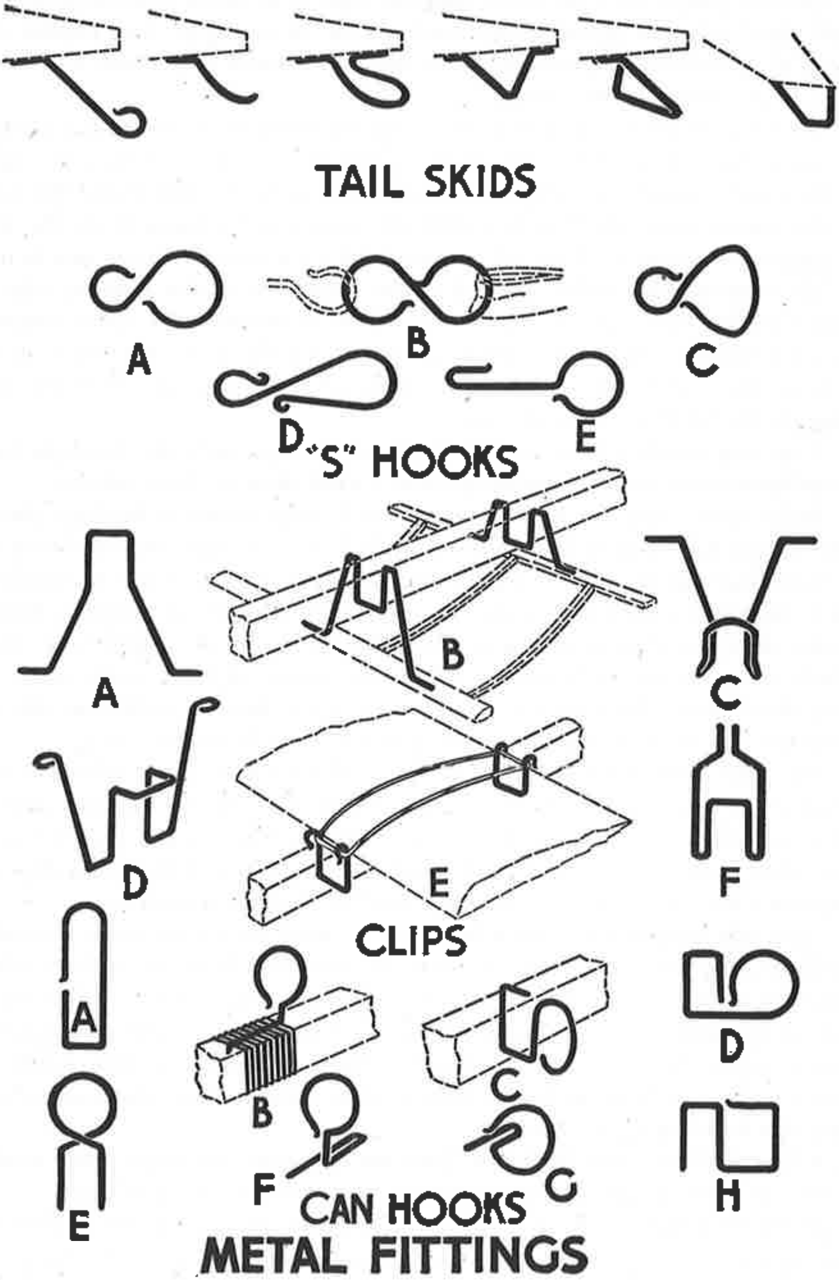

TAIL SKIDS
A
B
C
D
E
"S" HOOKS
A
B
C
D
E
F
CLIPS
A
B
C
D
E
F
G
H
CAN HOOKS
METAL FITTINGS

FIGURE 16

aid in distributing the tension of the wound motor. Practically all outdoor endurance models are equipped with one or more can hooks, depending on the length of the motor stick. For short sticks carrying only two or three strands of rubber, one is placed at the center of the stick. When more are used, they should be equally spaced.

Can hook A, Fig. 16, is bent to fit over the motor stick on its top or bottom, the lower bend being made to fit around the stick, where it is cemented in place. B may be attached to the stick on either side, top or bottom, where it is cemented and bound with silk thread. Can hooks C and D show two side hooks of common variety, while E shows a top or bottom can hook of simple lines. This is made with its ends crossed and then bent to fit the motor stick, where they are cemented in place.

F and G are two side can hooks usually found on twin-stick pushers. The closely bent portion of the wire is cemented and lashed with silk thread against the side of the A-frame beam, allowing the large circle to extend out from it. F has a small extension which keeps the rubber well away from the beam. This is usually used on motors having a great number of strands. For smaller motors, the G hook will serve.

H is another side hook. The smaller square is cemented around the stick, while the rubber fits through the other square.

PROPELLER SHAFTS. Every propeller must have a shaft by which it is attached to the fuselage. This shaft should be of the same gauge wire used for the rear hook, which must be sufficiently strong to stand the strain of a wound motor.

From a length of piano wire a hook is bent as shown by Fig. 17 A. The straight end of the wire is then thrust through the center of the propeller's hub. When through the hub, the wire is bent around, as in B. The wire is then pulled back until its end is forced into the wood of the hub, where a drop of cement holds it tightly in place. Washers are then threaded over the hook, which in turn is passed through the hole in the propeller bearing, as in C.

PROPELLER BEARINGS. These are often called "thrust bearings," being the metal or wood part holding the shaft of the propeller in place on the motor stick or fuselage. A simple needle bearing is shown in Fig. 17 A. It does away with all drilling. For small indoor models, a $1/32''$ diameter needle serves well, while a darning needle should be used for larger models. It will save time if a needle having an eye large enough to admit your propeller shaft is found. The temper must be taken out of the needle before it can be bent. Heat it to a white heat and allow it to cool naturally. Do not place it in water. When cool, bend it to the required shape. If too long, it can be cut to any length with pliers or tin snips.

Try the propeller shaft through the eye. If the eye is too small, heat to a cherry red and while still red, force the shaft through. The needle must now be retempered. Heat it again to a cherry red and plunge it into a glass of cool water, continuing the process until it is a blue color; but do not temper it too much, as it will become brittle and break.

A propeller bearing can also be made with a nail. Cut the head from any nail of desired diameter. Place it on a steel block and hammer its end flat. A hole slightly larger than the diameter of your propeller shaft is bored through the nail, which is bent and cemented to the motor stick, shown by Fig. 17 B. If too long, it can be cut. Many builders prefer to substitute a cotter pin for the nail. When this is done, the cotter pin is broken in half, leaving a single flat length of metal, which is then bored and bent.

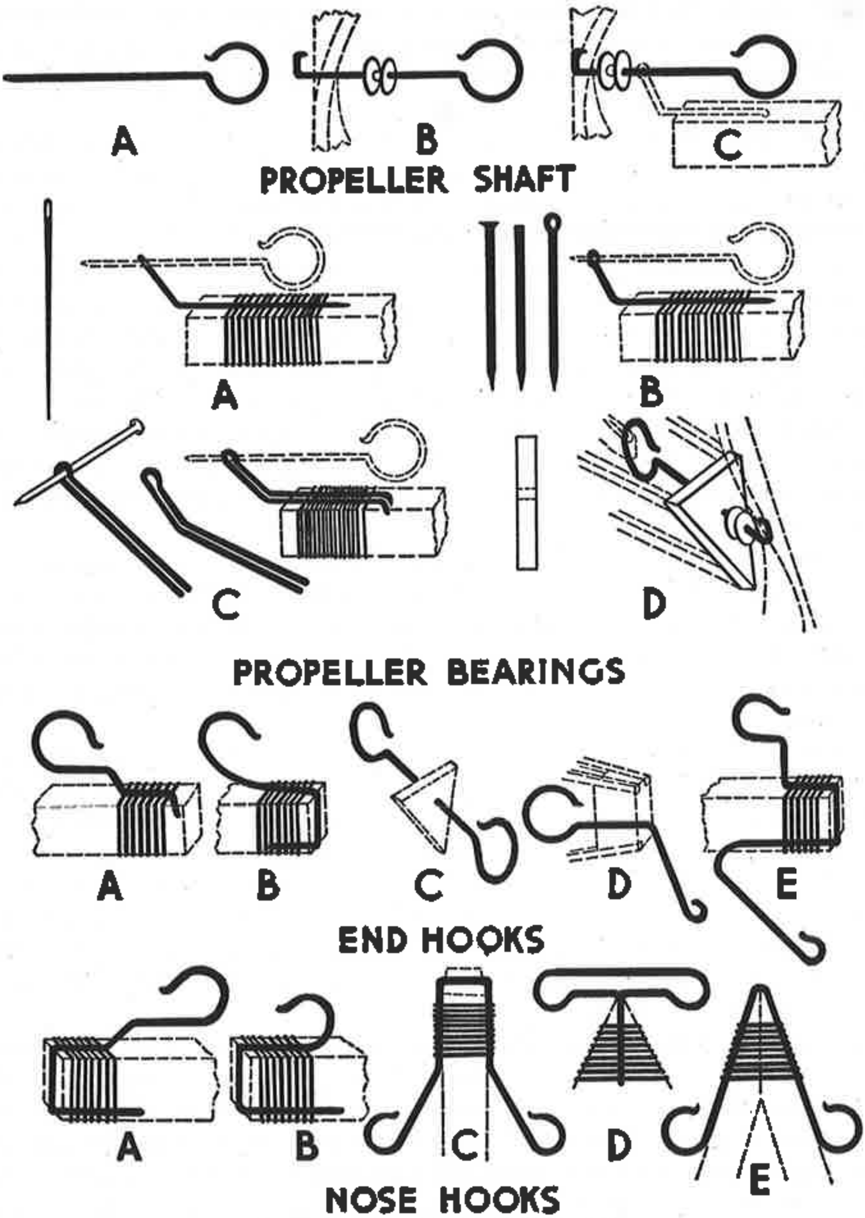
C shows a bearing made from piano wire, which can be used on small models. The wire is bent around a nail, its ends brought together and bent to form the bearing. This is then cemented to the motor stick. If further binding is desired, the ends of the wire can be bent down, forced into the wood of the motor stick and cemented and lashed.

On fuselage models having no motor stick, the bearing is made from a plug which fits into the end of the fuselage, or is cemented in place to the ends of the stringers, as shown in D. (See Chapter 35.) Through the center of the nose piece, a hole is made large enough to allow the propeller shaft to turn freely. Some fit a bushing eyelet into the plug. If this is done, it must have an inside diameter slightly larger than the propeller shaft, but not so large as to make the fit too loose, or the propeller will not turn true. This can be purchased at most model houses.

END HOOKS. End hooks are used on all tractor models powered with rubber. They form the rear connection for the motor. On most large models, the end hooks are equipped with "S" hooks (see Fig. 16), but those having small motors usually attach the rubber directly to the hook. These are sometimes called "Rear Hooks."

A in Fig 17 shows the most commonly used end hook. A short arm extends the hook above the top of the motor stick, while its end is bent and buried in the wood. Another is shown by B. Here the hook is bent around the end of the stick, making a strong connection. Such hooks are extensively used on fuselage models with removable motor sticks.

The double hook C is used on some commercial models. The extra hook extending out from the rear of the model allows the motor to be wound with a winder. The rear plug shown on the hook is removable, so that the



METAL FITTINGS

FIGURE 17

rubber can be stretched before winding. Such a hook is not cemented to the plug, as the pull of a wound motor will hold the plug in place, and at the same time pull the outside hook tightly against the outer side of the plug. (See Chapter 35.)

Sometimes solid blocks are used to plug the end of a fuselage. When this is done, a combination end hook and tail skid can be used, as shown by D. The wire is firmly cemented to the block through which it passes, one end forming the skid and the other the end hook.

Another combination end hook and tail skid is shown by E. While D is designed for fuselages without motor sticks, this fitting is expressly for single-stick models. One end forms the hook above the stick while the center of the wire is bent around the end of the motor stick, and the other end forms the skid. These are cemented and then lashed with silk thread.

NOSE HOOKS. Nose hooks hold the rear end of rubber motors on pusher models. On such models, the opposite end from the propeller becomes the nose of the model inasmuch as the propeller pushes the model in front of it.

The nose hooks shown by A and B in Fig. 17 are exact duplicates of those shown under the same letters for end hooks, so will require no further explaining. The double hook C is fashioned for single-stick, twin-propeller models. Few of these are made today, having been replaced by the twin-stick pushers, but are given for the builder wishing to experiment along this line.

The double nose hook D is a hook seldom used today. It is bent from a single length of piano wire with its ends brought together between the ends of the A-frame beams, which are cemented and lashed together.

The most popular nose hook for the twin-stick model of today is E. A single length of piano wire is bent in a "V" to conform to the angle made by the joining beams of the A-frame. Its ends are then bent to form hooks over which "S" hooks are placed. The hook is cemented and bound with silk thread to the beams, which holds it tightly in place and at the same time strengthens the joint of the A-frame.

WASHERS. Washers of various sizes can be purchased at all model supply houses or the builder can easily make his own. For this work an ordinary paper punch, which can be obtained at any stationery or five-and-ten-cent store, should be used. Such a punch will work on sheet tin or copper of the usual washer thickness. After punching out the washer, complete it by carefully driving a small brad through its center. Small beads or dress spangles also make excellent washers for propeller shafts. A spangle between two washers will be found the best combination.

CHAPTER 7

WINGS

WING DESIGNING. The wing of a model airplane, being its main supporting surface, should be given the builder's utmost care in design and construction. As it is usually the largest part of a model, it must be designed so that its weight will be at a minimum; yet, as it receives the maximum of air pressure, its strength must be maintained. During the growth of the model airplane, many unique and ingenious wing designs have made their appearance. Practically all of these are the result of fighting the model plane's greatest enemy—weight. Some designs have failed because the builder has sacrificed strength in his effort to eliminate weight, but great advances have been made and all model builders should be familiar with them.

When building solid, built-up, or flying scale models, little designing of wings is required, because the wing of the real ship must be followed closely. On solid and built-up non-flying models, every dimension of the wing on the real ship should be scaled down and a true copy of it constructed for the model. In the case of flying scale models, the general form of the wing of the real plane must be adhered to, but it is often necessary to enlarge its proportions, since the exact scale of the wing may prove too small to sustain flight.

It therefore follows that when we speak of wing designing we refer to wings that are to be used on stick or commercial models.

When designing a wing, the builder has from three to six important steps to consider. These are *size, type, weight, camber, sweepback,* and *dihedral.* On all wings the first three must be considered, and on many the builder will find all six desirable. By size we refer to the actual length and width of the wing. Aeronautical engineers have perfected the wing of real planes through a thorough study and careful application of aerodynamics, but for the average model that would require far too much time and effort for the results gained. Too many factors enter into the case, such as type of model, weight, speed, and strength, to permit a hard and fast rule for choosing proper wing size on any given model.

As a guide by which the builder can obtain an approximate idea of

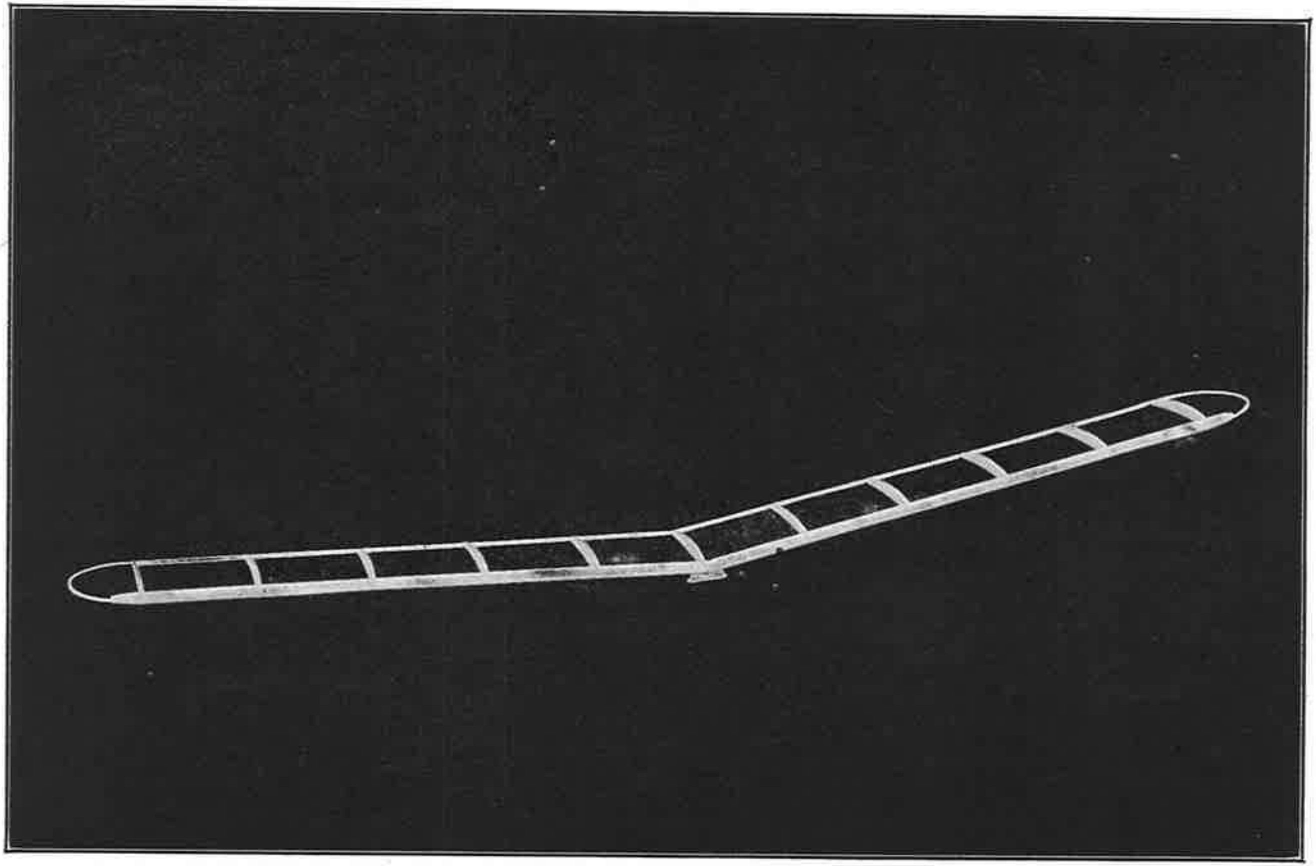


FIGURE 18. STRAIGHT WING

wing size in relation to length of motor stick, the author has chosen twenty model airplanes, all of which have won honors at national meets. These can be safely followed on models the builder designs, but the value of experimentation cannot be too strongly stressed.

A careful study of the models given here will show the wide variation these expert model builders have used on their planes, and yet we find every one a winner. Undoubtedly chosen after careful trial flights, each wing size has proved best for the particular model on which it is attached. Experience will soon bring perfection in such choices, but the beginner should make many attempts before deciding that his model has the most efficient wing.

As a start, the amateur can safely follow the sizes given here. It is recommended that this chart be referred to when designing a wing, until the builder feels confident of his own judgment.

WING SIZES OF CHAMPIONSHIP MODELS

LENGTH OF MOTOR BASE	TYPE OF MODEL	WING WIDTH	WING LENGTH
8″	Stick Tractor	2″	15″
8″	Stick Pusher	2″	13″
8½″	Stick Tractor	2¼″	15″
9″	Stick Pusher	2½″	12″
10″	Stick Tractor	1½″	12″
15″	Stick Tractor	3½″	25″
15″	Stick Pusher	3″	20″
15″	Stick Tractor	3¼″	28″
16″	Stick Pusher	2½″	19″
17″	Stick Tractor	3¼″	22″
17¼″	Stick Tractor	3½″	23″
18″	Commercial	3″	26″
20″	Stick Tractor	3″	24″
24″	Commercial	4½″	34¾″
25″	Stick Tractor	3½″	30″
30″	Commercial	4½″	42″
36″	Twin Pusher	4½″	32″
40″	Twin Pusher	4¾″	32″
41″	Twin Pusher	4⅛″	31½″

The next step in wing designing is to choose the type of wing desired. For all practical model purposes only two require consideration. The first

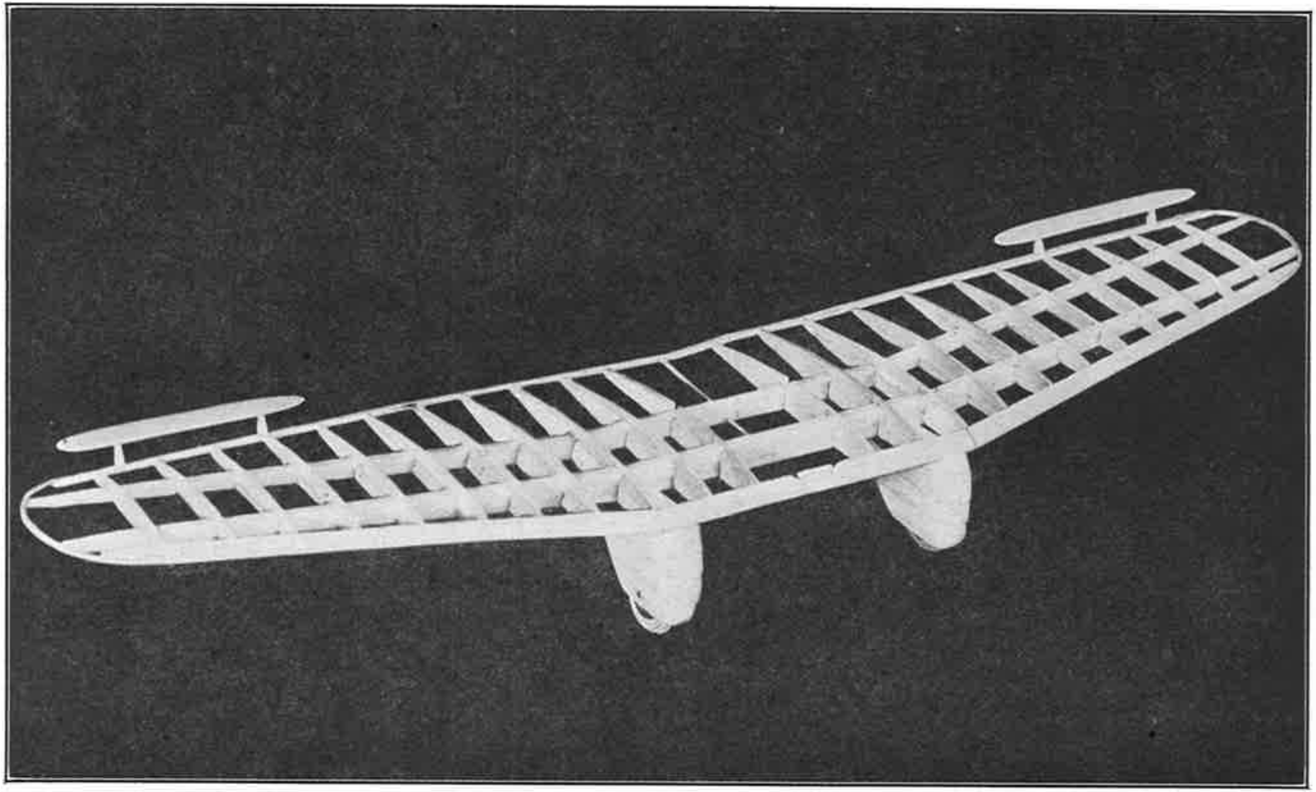


FIGURE 19. TAPERED WING

of these is the *straight wing*, so called because it retains the same width and thickness throughout its entire length. (See Fig. 18.) Because it is strong, light, and simple to build, it is by far the most popular wing today on all single-stick models. It must be remembered that the *shape* of the wing is now being discussed and not the method by which we gain that shape. Such straight wings can be built-up, made exceedingly heavy, strong, and durable, or they can be of the lightest construction, very fragile, and fit only for the smallest and lightest endurance models.

The second type is called the *tapered wing*, because it tapers in width and thickness from its center toward both ends. (See Fig. 19.) A tapered wing can be built as light in weight as a straight wing, and is often used on endurance twin pushers. It requires more construction work, as each rib is different in size, but when completed gives a better appearance than the straight wing. Aside from this, however, the author has been unable to find any advantage it may have over the straight wing.

The third factor in wing designing is the most important of all. This is the weight of the finished wing. A good rule to follow, when considering the weight of a wing, is to make it as light as possible without weakening its structure too much for efficient use. There are many ways to accomplish this. A wing is made up of five main parts. These are its tips, ribs, leading edge spar, trailing edge spar, and inner spar. The last named is often left out, but on all large wings it is necessary for proper bracing.

The various ways and means employed to lighten these five parts of a wing are more a question of wing construction than design, so this subject has been dealt with in detail under "Wing Tip Construction," "Wing Rib Construction," "Leading Edge Spars," "Trailing Edge Spars," and "Wing Inner Spars."

Camber is simply the curve of a wing from its front, or leading edge, to its rear, or trailing edge. From an aerodynamic standpoint, it is a form designed to produce a maximum of lift with a minimum of resistance. If you would remember the meaning of the word, think of it in terms of shape. Camber is the shape of a wing, after covering, when viewed from the end. To obtain this shape, one, two, or three parts of the wing are employed. The ribs are the part of a wing that chiefly determine its camber. As these are formed, so will the greatest portion of the wing's width be formed. Study Fig. 22. No. 1 completes the entire form from leading to trailing edge, while No. 7 requires the leading edge spar form to complete the camber. No. 13 needs both the leading and trailing edge spars to give perfect streamlining.

Sweepback is a term that practically explains itself, inasmuch as it means the distance the wing extends backward from its own leading edge, or the distance it sweeps back. This is measured from a straight line passing through the leading point of the leading edge and registering an equal distance from both wing tips. The distance must be taken at right angles to this extended line, and is usually expressed in inches. The proper method of measuring sweepback is shown in Fig. 20. Note that a straight edge, such as a ruler or T-square, is placed against one half of the wing along its leading edge spar, and that the distance from this straight edge to the leading edge at the wing tip is then measured. This measurement represents twice the sweepback of the wing, as the sweepback of each half of the wing

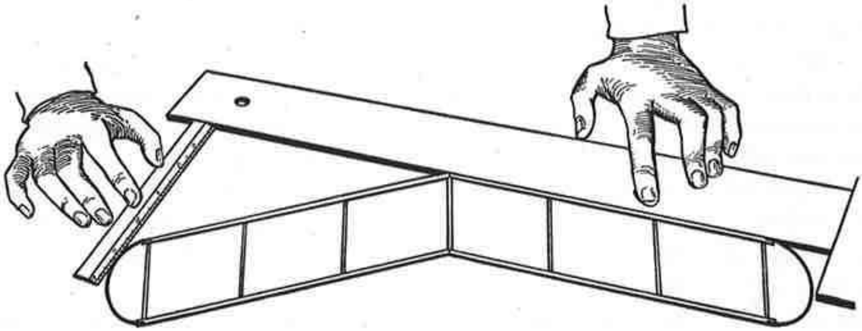


FIGURE 20. MEASURING SWEEPBACK

is the distance usually specified as "wing sweepback." In other words, if the measurement taken in the manner shown in the illustration should prove to be 6″, the sweepback of the wing would be 3″.

Our last step in wing designing is one of the most important of all. It is the angle at which each half of the wing extends up from its own center. Its proper name is *dihedral angle,* so called because of the angle the wing forms with level. For model work, this is usually referred to as "wing dihedral," or simply as "dihedral." It is indicated on all plans in this book by the latter word. It is obtained by inclining the wing of a model up from the center of the fuselage so that the tips are higher than any other portion of the wing.

All stick and commercial flying models should have wings with dihedral, as it is the greatest means of obtaining stability in flight. For example, let us assume that a perfectly straight, flat wing is in flight. Suddenly a gust of wind strikes one half of it and forces one side up and the other down. The result will be that the wing will "slip" through the air to the ground. On the other hand, if the wing has a dihedral and the same thing happens, the half that is forced down by the upward pressure on the other side will move down from its inclined position to one of level flight, thus sustaining the other half of the wing until its position is corrected. This prevents "slipping."

The dihedral angle of a model wing is usually given in inches. If the plan shows a dihedral of 3″, it means that each wing tip must be that much higher than the center of the wing. A simple method of measuring the dihedral of a wing is shown in Fig. 21. Lay one half of the wing on a flat surface, and note the distance of the opposite wing tip above the surface.

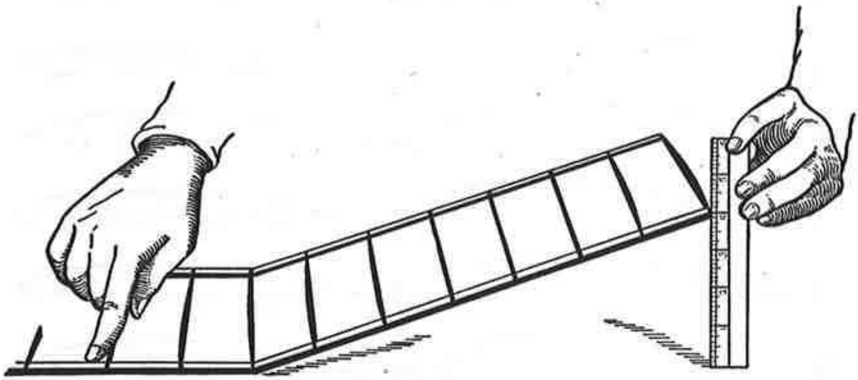
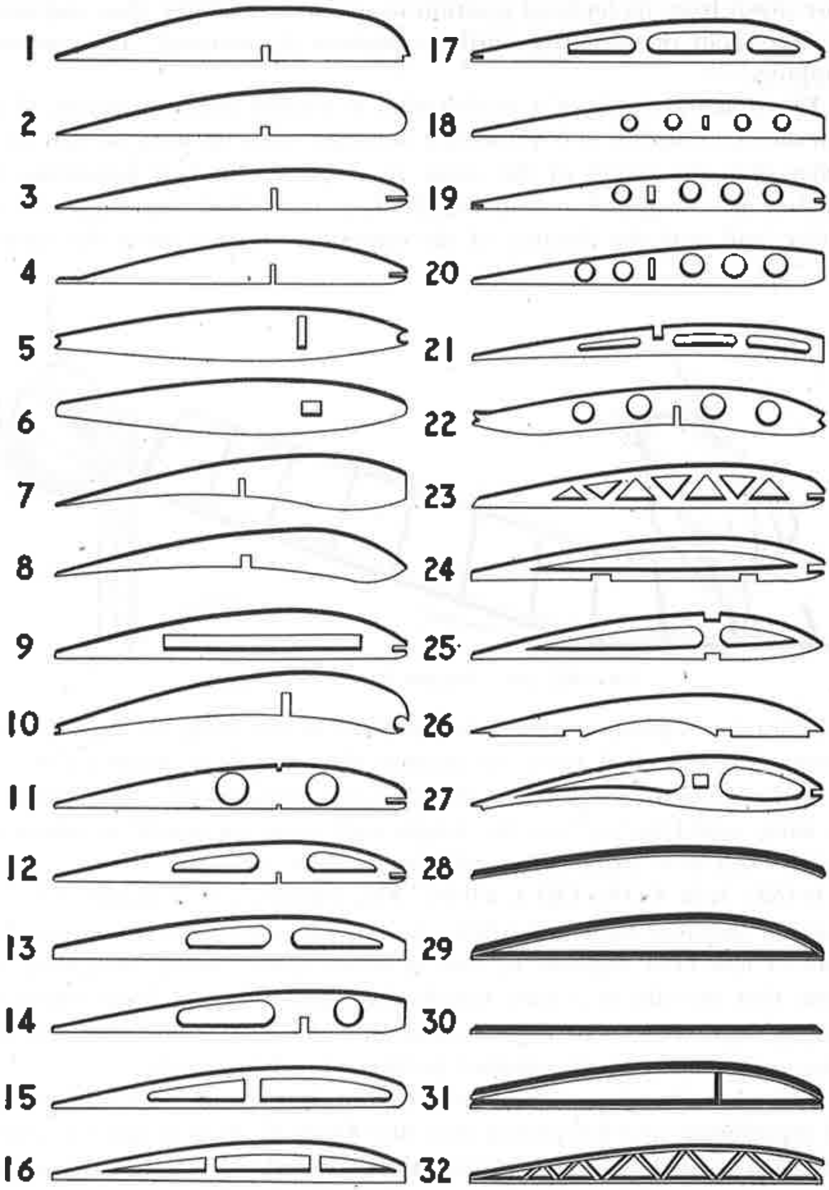


FIGURE 21. MEASURING DIHEDRAL

This distance represents twice the dihedral of the wing, as the tip being measured is extended twice its normal distance above level due to the other tip being on the level. If this distance measures 3″, the dihedral of the wing would be 1½″, or the height each wing tip would be above the level if both were extended equally, as in flight position.

WING RIB CONSTRUCTION. The importance of proper rib construction becomes apparent when one considers that a wing is merely a series of ribs held together by two or more spars. "Wing Designing" explains that the ribs of a wing largely determine its shape from leading to trailing edge. They also largely determine the weight and strength of a wing, as they make up the greatest portion of its framework.

There have been any number of rib forms introduced for model aircraft, but experimentation has proven that the "Clark-Y" form is best for general model wings. In Fig. 22 will be seen thirty-two ribs that have been successfully used on models in the last ten years. The Clark-Y form is shown by Nos. 1, 2, 3, 9, 11, 12, 13, 15, 16, 18, 23, 29, 31, and 32. It must be understood that the designation "Clark-Y" refers only to the outside form of the



WING RIBS

FIGURE 22

rib, or the form the wing will take when covered, and that it has nothing to do with the means by which that form has been gained. A close study of the ribs referred to above will show that each is alike in outside outline, although each gains that outline in a different way. Their greatest difference lies in the fact that their excess weight has been removed in varying ways, although each would give a covered wing the same general shape.

Another difference lies in their relations to leading and trailing edge spars. While such spars are used to hold the ribs together, some ribs are so formed as to use these spars to complete their streamline form. On Nos. 1, 2, 3, and 9, spars add nothing to the outline of the ribs. Nos. 13, 16, 18, and 31 depend on the leading and trailing edge spars to complete their form.

In the past, wing ribs were solid, as shown by Nos. 1 to 8, 10, and 26. When, however, the importance of weight became apparent, it was found that such ribs contained an excess of weight. In an effort to lighten models, the ribs were cut out in various forms. Note Nos. 9, 11 to 25, 27, 29, 31, and 32.

The actual construction of ribs is not a difficult task, but one requiring great care. For all single-stick, endurance models of light weight and small size, single stick ribs are used, as shown by Nos. 28 and 30. The latter, being without any camber, is not desirable.

These simple ribs are usually cut from 1/32″ or 1/16″ balsa. They may be square, or about twice as wide as they are thick. A 1/32″ square, a 1/32″ x 1/16″, a 1/16″ square, or a 1/16″ x 1/8″ single stick rib is considered good practice on light models, the size increasing according to the size of the wing, which is covered on the top side only.

As it is difficult to bend individual sticks exactly alike, it is best to obtain a wide piece of sheet balsa of the thickness required, bend the sheet, and then cut the ribs, after it has dried in the desired shape.

Wing ribs for all larger models are cut from sheet balsa wood of various thicknesses. For light models, a 1/32″ sheet balsa should be used, and this thickness increased according to the size and weight of the model being built. Such ribs are used on all wings which are to be covered on both sides.

It is seldom necessary to use wood thicker than 1/8″, although on some very large models the author has seen 3/16″ ribs. This gradual increase in rib thickness should also be applied to built-up, non-flying models. While strength and weight mean very little on such models, the thickness of ribs should be kept in relative proportion with other members of the framework.

To cut such ribs, the builder should draw his rib on paper and then trace its outline on the wood. This is then cut out with a razor blade and inside excess weight removed. The circles are punched out with the eraser ferrule of a lead pencil. (See Fig. 23.) The eraser is removed and its small, round holder slowly pressed into the wood with a screwing motion.

Where the wing must come in contact with a strut, a heavy-duty rib may be inserted, as shown in Fig. 24. This is left solid for strengthening the

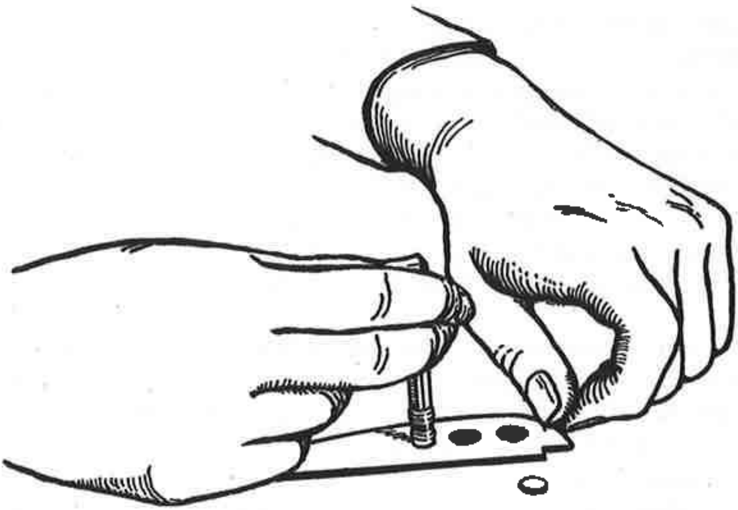


FIGURE 23. USING PENCIL FERRULE FOR LIGHTENING RIBS

structure and insuring it against breaking. Such ribs are usually twice the thickness of the ordinary ribs, and are given their same shape.

The ribs in Fig. 22 should give the beginner considerable aid in choosing proper design and construction for all and any models on which he may work. All notches shown between the ends of the rib, whether on top or bottom, are made to accommodate inner wing spars, while those at the front end of the ribs are for leading edge spars. Those at the rear are for the trailing edge spars.

Most ribs are cut from solid sheeting, as has been explained, but some builders prefer the built-up rib as shown by Nos. 29, 31, and 32 in Fig. 22. The first consists of two balsa lengths. The top one is bent in the Clark-Y form, and the bottom stick left straight. Their ends are then cemented together. No. 31 is constructed in the same manner, except that a small brace is added, because the ends are not cemented together. These are left open to accommodate the leading and trailing edge spars, which are rounded to complete the form of the rib.

No. 32 presents the greatest construction problem, although it is by far the strongest. It consists of two balsa lengths, one of which is bent in the Clark-Y form and is used for the top of the rib. Short braces are then cut and inserted into place, being held with cement, after the two ends of the balsa lengths have been cemented together.

Those other than the Clark-Y form are shown as a comparison between

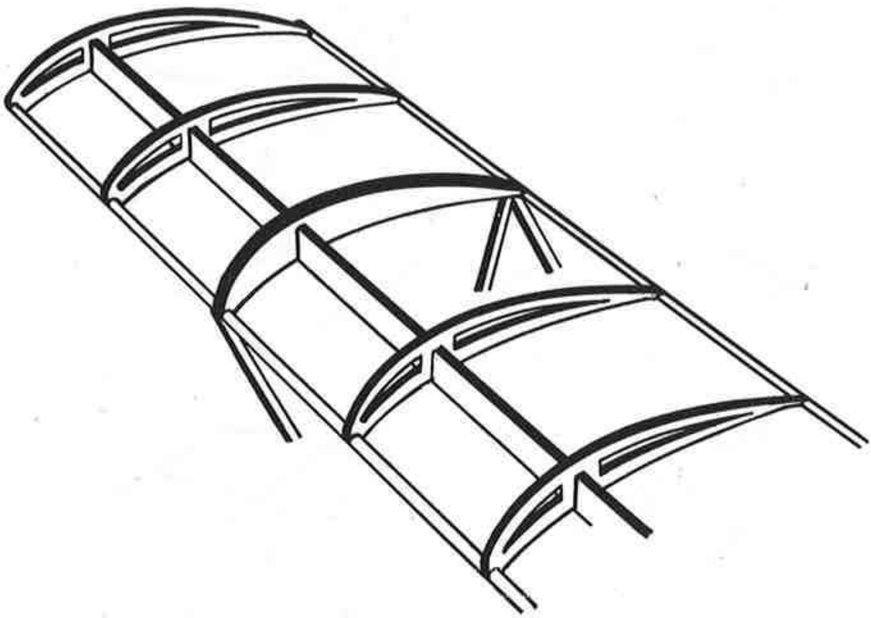


FIGURE 24. HEAVY DUTY RIB

it and various other shapes, and the author recommends the beginner to experiment with various forms.

Fig. 25, No. 1 shows a false rib, which is often employed to strengthen the front of a wing structure, and yet add less weight than a full-length rib. They are made in the same manner as the full rib, and are usually inserted between full-length ribs, alternately along the wing structure.

WING TIP CONSTRUCTION. The various tests made from time to time on wing tip efficiency tend to show that tips with a negative rake prove more efficient on airplanes. This means a rounded tip having a longer leading edge than a trailing edge. (See Fig. 25, No. 7.) Note that both wing spars are equal in length, but that the tip is given such a shape as to cause the leading edge of the wing to extend beyond the trailing edge.

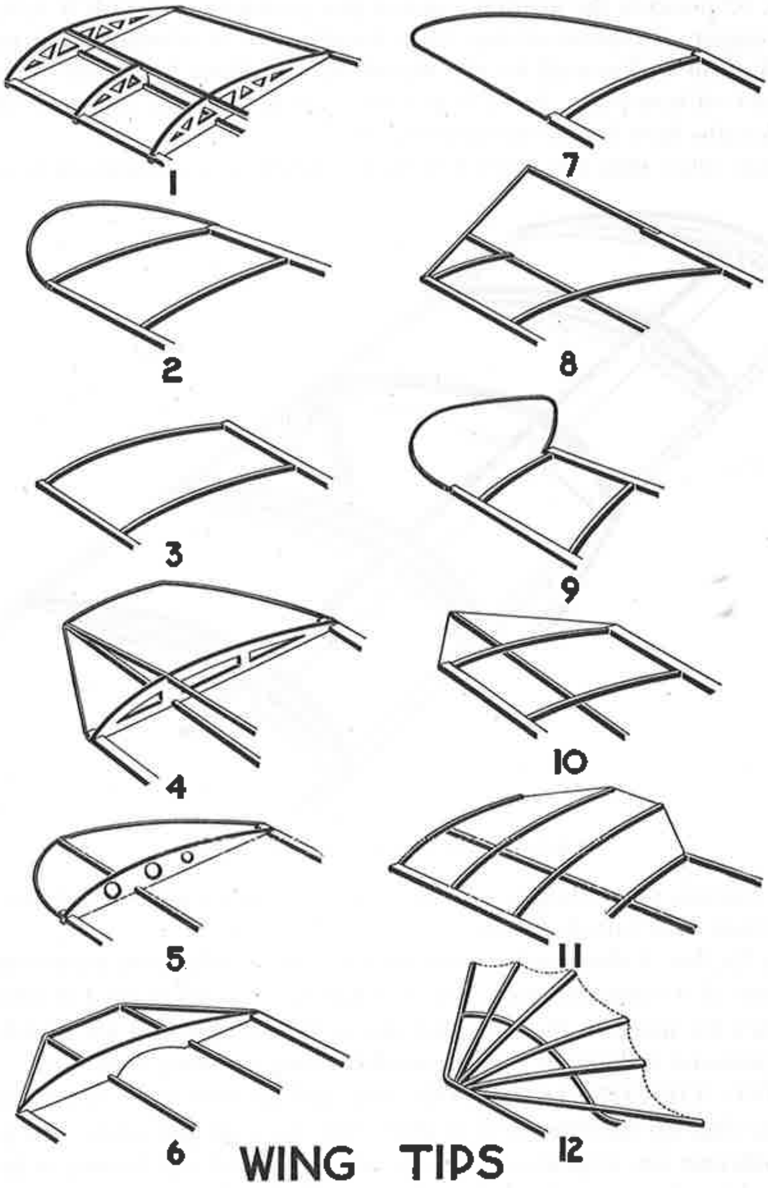


FIGURE 25

Many model builders confuse the leading or trailing edge of a wing with its leading or trailing edge spar. Both are different. The former refers to the edge of a wing only, without consideration as to how that edge is gained, while the latter refers to a structural member of the wing, so placed as to lead or trail the wing.

Either of these edges may be formed by a single spar, or by a number of short spars. In No. 7, one is formed by the spar and the tip combined, or, as in No. 11, a trailing edge may be formed by a trailing edge spar and thread. No matter how they are made, the front and rear edges of a wing are called the leading and trailing edges of that wing, while the leading or trailing edge spar indicates that spars are used to form all or part of these edges.

The fact that tips with a negative rake prove more efficient might be taken to mean that all wing tips should be of this form, but the author has found through tests that the difference is so slight on the model airplane as to be practically negligible.

As a guide for the beginner, twelve wing tips are shown in Fig. 25, all of which have proved successful on model airplanes. Before going into actual construction, let us consider the merits of these. No. 1 shows the blunt, square end of a wing having no specific wing tip. Note the false rib between the leading edge spar and the inner wing spars. This wing, having sheet balsa ribs, gives a very blunt appearance at the end, which makes it unpopular with model builders, more because of its ungraceful form than through any lack of efficiency. Single surface wings, having only one side covered, are sometimes left square, and while their appearance is not as graceful as the wing with a formed tip, they are not as blunt as the thick wing. (See Fig. 25, No. 3.)

Possibly the most popular tip for wings covered on one side only is the rounded tip shown by No. 2. It will be found on more models than any other. This is because it is easy to construct, and gives the wing a finished appearance. No. 7 shows practically the same tip, though more difficult to construct, because of the necessity of keeping its front on a line with the leading edge spar to serve as a portion of the leading edge of the wing. It, also, is for wings covered on one side only.

No. 5 is designed to give approximately the same lines to a thick wing as No. 7 gives to the thin one. The inner wing spar extends out beyond the leading and trailing edge spars to further strengthen the tip structure. Such a wing is covered on both sides. Both these wings have negative rake.

No. 4 tip is similar to No. 5 in general lines, but is not curved. It is often used on large wings having two inner wing spars, one located over the other. The curved tip of No. 5 can also be applied to such a wing structure, and should prove slightly more efficient. No. 6 tip is an interesting treatment of a wing having two inner wing spars located parallel to each other on the same level. Note that the two inner spars are longer than the other wing spars.

Nos. 8 to 12 are designs for thin wings covered on one side only. No. 8 was taken from a fuselage model which won the English record for endurance in 1928. Aerodynamically, such a form is not considered good practice. No. 9 shows the tip used on the tailless model given in Chapter 29. These tips bend slightly up with their trailing edges higher than their leading edges.

No. 10 is made of a thread outline to which the single tissue covering of the wing is attached. Such a tip is not at all strong and will break at the slightest touch, but eliminates weight.

No. 11 is wider than the main portion of the wing, on the order of the tailless model tip. The inner wing spar and the leading edge spar are the same length, both being longer than the trailing edge spar. The trailing edge of this tip is formed with thread.

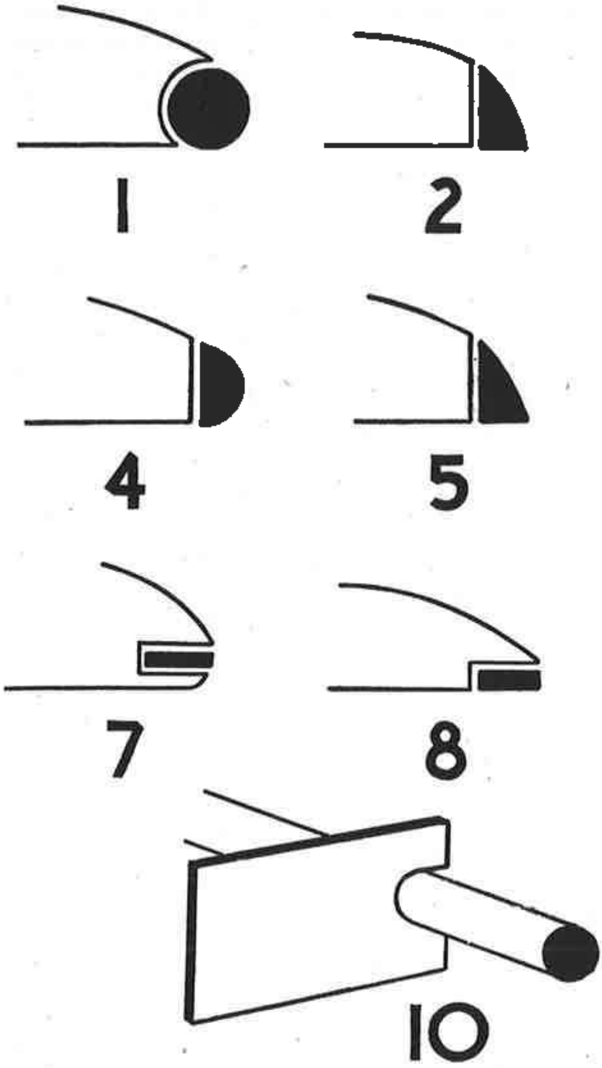
No. 12 has nothing along the trailing edge on which to fasten the tissue covering. The paper is cut to form, and cemented in place. Many small, light, endurance models of modern design appear with this feature, although the general lines of their wings may differ in many respects.

In the past $\frac{1}{32}''$ or $\frac{1}{16}''$ split bamboo has been the most popular material used on wing tips, but balsa is fast replacing it for this purpose. Balsa can be bent quite as easily as bamboo, and while it is not as tough, it is far lighter.

Some wings are built in two half-sections, and completed by joining them together. The tips are then added. When bending tips, bend wide enough stock to make both tips, and then split the wood in half. This assures the builder identical tips.

As the tip is not expected to contribute toward the strength of the wing, it must be as light as possible, so excessive weight will not be added to the wing structure. However, on flying models it should be given a design strong enough to withstand shocks in case of wings striking the ground when the model lands.

LEADING EDGE SPARS. It is hardly necessary to define the term "leading edge spar," as the name is self-explanatory. It is the spar of a wing that would lead all others if the wing were put in forward motion. In other words, it is the spar that leads. Its chief purpose is to hold the ribs of the wing together at the leading edge.



LEADING EDGE SPARS

FIGURE 26

But leading edge spars often serve another purpose. This is as a means of completing the desired form of the wing ribs. On all thin wings, having single stick ribs and covered on one side only, such as those shown in Fig. 25, Nos. 2, 3, 7-12, leading edge spars play no part in the camber of the wing, but on those having thickness, through the use of sheet balsa ribs, leading edge spars are often called upon to complete the desired rib form.

Fig. 26 shows a number of these leading edge spars. Note how Nos. 1, 2, 3-6, 8, and 9 carry on and complete the general streamline form of the ribs to which they are attached. Strictly speaking, Nos. 7 and 8 also complete this outline of the rib form but over such a short length as to be practically useless as an addition to the rib contour. In other words, a tissue covering attached over such ribs and leading edge spars would continue on in the general rib form even if the spar was not there, while on the others, a covering over the ribs without the continued lines of the leading edge spars would result in an entirely different and undesirable contour.

Whenever ribs are used requiring their leading edge spars to complete their form, the builder must take every precaution to see that his spars are so shaped as to continue the lines of the ribs in one perfect outline. In Fig. 26 various forms of leading edges are shown in black, with their corresponding ribs outlined. Nos. 7 and 8 will require nothing but squaring up a length of balsa, but all the others must be shaped. As balsa wood is very soft and easily worked, sandpaper is the best tool for roughing out these shapes. When completed, the shape is perfected. The first edge of the spar to be finished to exact size should be the one fitting against the rib, so that it can be placed against it from time to time as a guide when shaping the other sides.

One of the best methods of shaping such spars is to make a number of small brass scrapers such as shown in Fig. 26, No. 10. These should be made of stiff brass. At each end of the scraper, a small slot is cut in the form desired for the spar. The builder should make a set of these scrapers of various designs used for spars, so that he will be prepared at all times to cut a spar to any shape desired. When the wood has been roughed out, the scraper should be used to complete the job. Rub the scraper back and forth over the wood until it is perfectly smooth and has the exact form desired. This can be followed with No. 00 sandpaper, but care must be taken to see that the original form is not changed. Do not be disappointed if you spoil a few spars in your first attempts, for shaping such pieces requires skill which can only be gained through experience.

TRAILING EDGES. Unlike the leading edge of a wing, which is always equipped with a leading edge spar, the trailing edge is not dependent on such a spar. For wings having single stick ribs, no inner spars, and covered on one side only, a trailing edge spar is a necessity, as shown in Fig. 25, Nos. 1, 2, 7, and 9. But when the same type of wing has inner spars, a trailing edge spar is not necessary. In Fig. 25, Nos. 8, 10, 11, and 12, such construction is shown. If an inner spar is used, it can be made to serve the same purpose the leading edge spar serves at the leading edge of a wing, which is to hold the ribs together.

Fig. 25, Nos. 11 and 12, give two examples of this use of inner spars. No. 11 is equipped with a trailing edge spar, but if the builder desired he could safely continue the thread outline shown at the tip along the entire trailing edge of the wing. If this was done, the inner spar would be sufficient to hold the ribs in place.

Fig. 25, No. 12, shows a wing having nothing along its trailing edge. In this case the inner spar serves to hold the ribs together, while the tissue used to cover one side of the wing is cut to shape the trailing edge, cemented firmly along the entire rib lengths, and left without further support along the trailing edge.

In wings having sheet balsa ribs which require covering on both sides, a trailing edge spar is always used. This is due to the fact that the two sides of the paper must have a structural member of the wing at the trailing edge for proper attaching. Such spars are usually made of balsa lengths, though many builders use bamboo stripping for this purpose. In some cases, the trailing edge spar completes the form of the rib, as many leading edge spars do, but this is not as common as in the case of the leading edge spar. However, in Fig. 22, Nos. 5, 10, 13, 22, 24, and 31, will be seen ribs requiring various trailing edge spar forms to complete their general outline, so it is sometimes necessary to form trailing edge spars in the same manner in which leading edge spars require shaping.

The same method is used on these trailing edge spars as has already been explained in the section on leading edge spars. When bamboo is used, it is never shaped in this manner, being merely a $\frac{1}{32}''$ or $\frac{1}{16}''$ split bamboo length.

WING ASSEMBLY. After all ribs, spars, and wing tips have been cut to size and properly formed, the wing is ready to be assembled. The first requirement for this work is a full-size plan of the wing. If the builder has not been working from full-size plans, he should draw such a plan, showing the top view of the wing. (See Fig. 27.)

Each piece of the wing structure is then placed in position on the plan to see that all parts fit perfectly.

Except in the case of straight wings having no sweepback or dihedral,

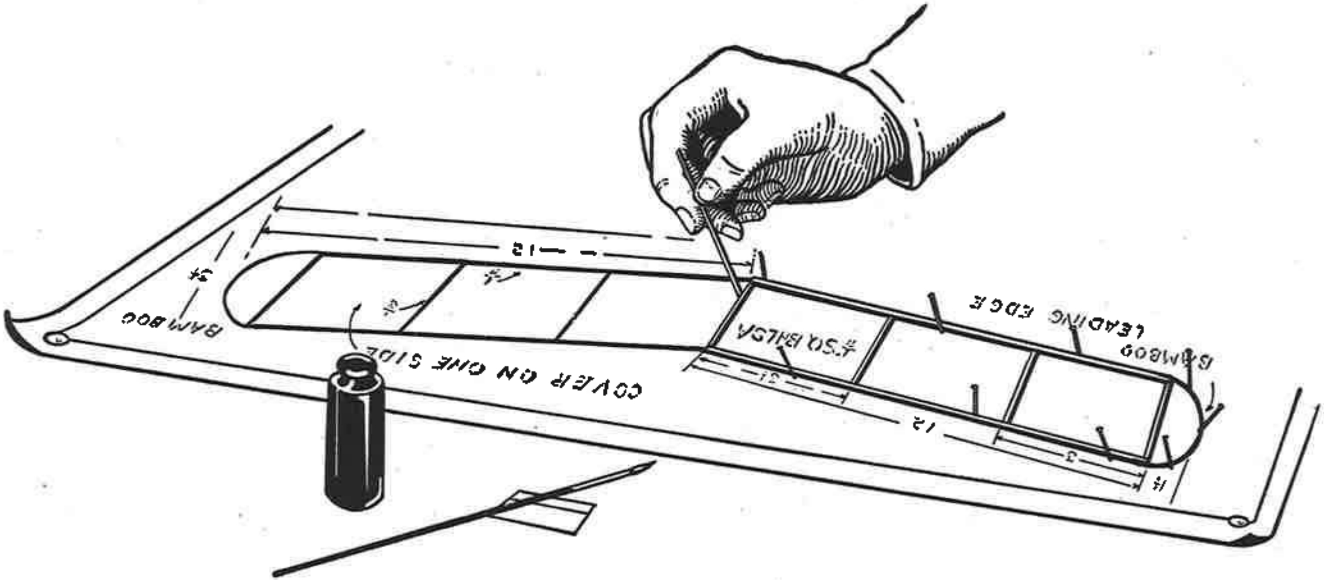


FIGURE 27. ASSEMBLING WING ON PLAN

all others are made and assembled in two parts. Note how one half of the wing is being assembled in Fig. 27. After both halves are assembled separately, they are joined together with cement.

For wings covered on one side only and having single-stick ribs, the process of assembly is quite simple. All parts of the wing are held on the plan by model pins. These are placed on each side of the piece, as shown, and serve to hold it firmly in position during cementing.

Place the leading and trailing edge spars in position on the plan and hold them with pins. The stick ribs are cemented in place between them,

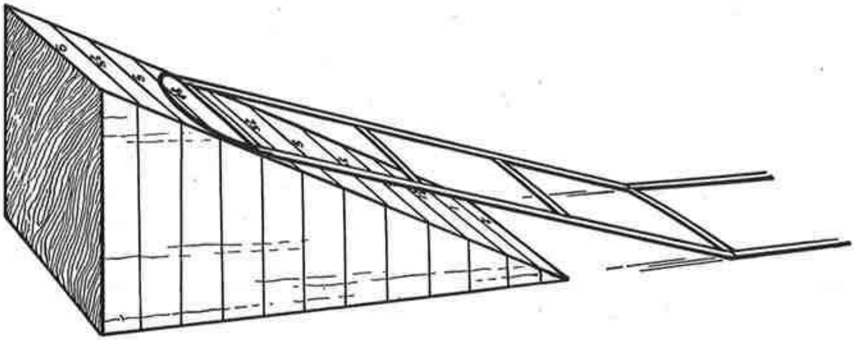


FIGURE 28. DIHEDRAL BLOCK

followed by the wing tip, which has already been bent to proper form. Allow the cement to dry thoroughly before starting work on the other half. This is merely an added safeguard against possible shifting of the parts already assembled, while working on the second half. After both halves have been assembled and all joints are perfectly dry, they are ready to be joined. The wing dihedral is obtained at this time. This is found on the edge view in the plans of the wing. (See plan in Chapter 21.)

Many builders have experienced trouble when giving a wing its proper dihedral. It not only requires proper measuring, but also careful holding while the cement at the joint dries. As the tip of the wing must be held up in position, only one hand is available for cementing, which is often difficult and clumsy. To eliminate this awkwardness, make a dihedral block, shown in Fig. 28. This is simply a triangular block of wood with a height of 6″. Along its base, points are marked off every ½″ as shown. Lines are then drawn up both sides and across its top, which complete it.

To use the block, place both halves of the wing in position on a level table, and slip the block under one tip. While holding one half of the wing flat on the table, continue to slip the block under the other half until its tip reaches a line on the block which represents twice the desired dihedral. For example, if the wing calls for a dihedral of 1½″, the block should be moved under the wing until the wing tip reaches the 3″ line. The two halves of the wing are then cemented together, and the structure left in this position on the block until dry. This eliminates all difficulty in measuring, holding in position for cementing, and keeping that position during drying.

As the plan calls for a 1½″ dihedral, which means that each wing tip must be raised 1½″ above level, giving one wing tip twice the dihedral while the other tip remains at level results in the correct angle for both halves of the wing, or the desired height of 1½″ for each tip. Such a block being 6″ high can be used for all wings having dihedrals of 3″, which will be found sufficient. If extraordinarily large models are being built, the block may be made higher so as to produce larger dihedrals.

After the wing has been assembled, it should be given a light sandpapering to remove excess cement, rough and uneven joints, and other blemishes. It should then be carefully tested for proper balance. Many model builders neglect this step, which often results in a model flying with one wing low. A novel wing balancing apparatus is shown in Fig. 29. It consists of a flat base, about 1″ x 4″ x 48″, with a back of the same dimensions, but which can be cut from thinner stock. In the center of the base, a 1″ thick, 3″ wide, and 4″ long block is nailed on its edge, as shown. Into the upper edge of this block, four safety razor blades are inserted. These are cemented in place. A number of lines are drawn along the length of the back board parallel to the base, each being numbered at both ends. This completes the apparatus.

Its design accommodates both single and double wings. Fig. 29 A shows a single wing being balanced. Needles are thrust into the leading and trailing edge spars exactly in the center of the wing. They are then placed through the holes in the upright blades. If the blades used on the apparatus have no such holes, small notches should be filed in their top edges to accommodate the needles.

The lines on the back board are used to aid the builder in judging the balance of his wing. If the wing levels with both its tips along the same line, the wing is perfectly balanced, but if one tip is lower, the heavier side must be corrected. To do this, remove the wing, and lightly sandpaper the spars of the heavy side, frequently testing its balance in the apparatus until perfected.

The type of wing having sheet balsa ribs and no inner spars is assembled in the same manner. If the wing has one or a number of inner spars,

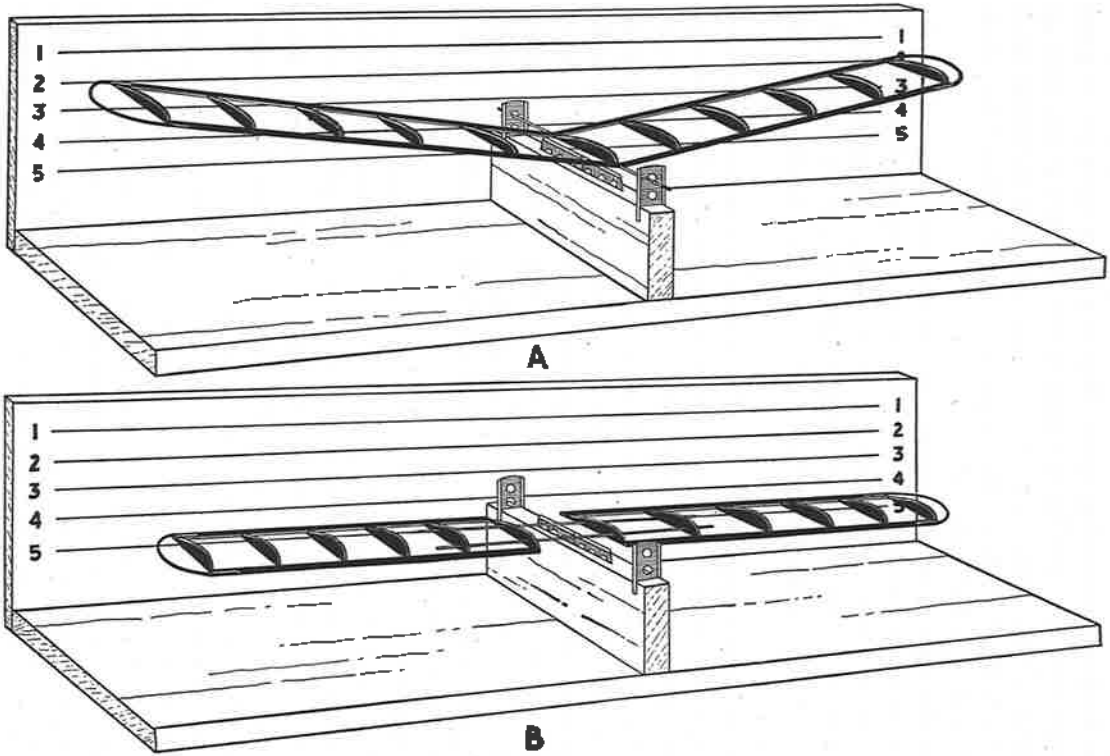


FIGURE 29. TWO-WAY WING BALANCING APPARATUS

the inner spar or spars should be cemented in place to the ribs before attaching the leading and trailing spars. After the inner spars are in place and the cement hard, the process of finishing the assembly is the same as that of the wing having single-stick ribs. This procedure of attaching inner spars before leading and trailing edge spars must also be followed for wings having single-stick ribs and such spars.

On practically all biplanes (airplanes with upper and lower wings) the lower wing is made in two parts, as in Fig. 30. It is attached against the sides of the fuselage. Both these halves must be perfect duplicates and of the same weight. In such wings, the assembly procedure is the same as described for wings with inner spars, but the balancing is obtained in a different manner.

The same balancing apparatus is used, but in this case, the wing rests on the center blades, as in Fig. 29 B. Two long needles are thrust through the two center ribs of each half of the wing. If needles cannot be found long enough for this work, two lengths of music wire can be cut and inserted in the same manner. The centers of these wires are then balanced on the lower two blades of the apparatus and the wing's balance checked as in the case of a single wing. If one proves heavy, it must be lightly sandpapered until it balances equally with the other. Always thrust the needles or wires through two ribs on each half, as they will not hold the wing up if only inserted through its center ribs.

WING COVERING. The covering of a wing often decides the success or failure of a model. This is true with both flying and exhibition models. In the former case, a poor covering may result in loss of speed and endurance, or in an uneven flight, while in the latter case, the careless appearance of a poorly covered wing is usually enough to make an otherwise splendid model lose all consideration of the judges.

All thin wings having single-stick ribs are covered on one side only, while wings of thickness are covered on both sides. The covering of both these types is the same, except that the latter requires more steps to complete the job. While such work requires considerable practice, any beginner can master the art of wing covering. To do so, however, he must be willing to spoil a few wings in the process, and must not get discouraged when he does.

After a wing has been assembled and balanced, it is ready for covering. For wing covering materials, see Chapter 3—"Covering Materials." As the majority of models are covered with Japanese tissue, the first step is to obtain your paper. As this is often wrinkled when purchased, it should be

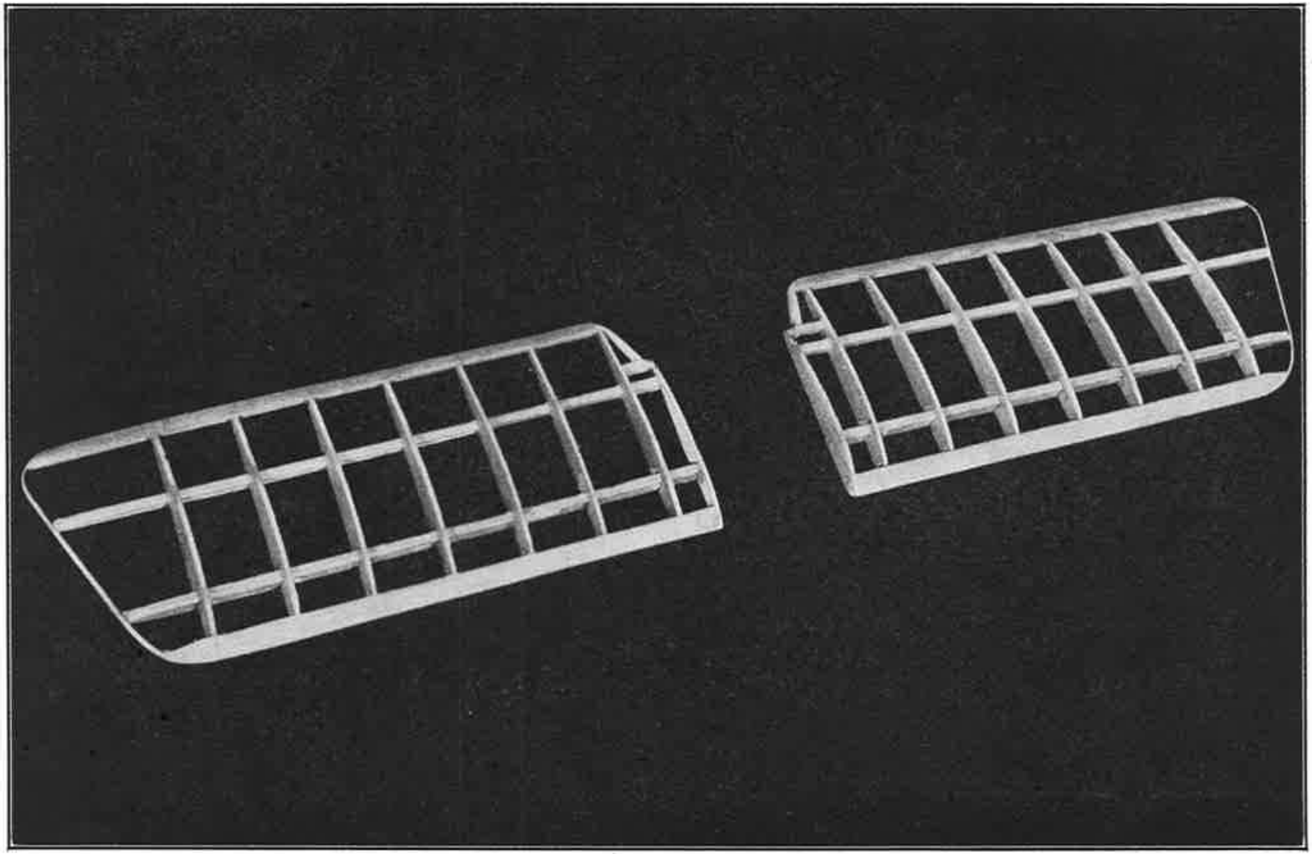


FIGURE 30. LOWER BIPLANE WING

carefully ironed out before being used. (See Fig. 31.) The wing is then placed on the tissue and the tissue cut to approximate size. (See Fig. 32.) The paper should be cut so as to provide generous margins beyond the dimensions of the wing itself. On double surface wings the paper is cut over twice as wide as the wing's width, but for a wing with covering on one side only, the paper is cut the width of the wing plus about 1″ over on each edge.

For double surface wings, the covering is applied to the under side

FIGURE 31. IRONING TISSUE

first. Turn the wing over and give all its spars and rib edges a thin coat of clear dope or banana oil, as shown in Fig. 33.

As soon as these parts have been coated, turn the wing over on the paper and press it gently along all parts. Make sure that it adheres to all points on the structure. When completed, the upper edges of the ribs and spars are given a like coat of dope or banana oil, and the paper quickly turned over and pressed in place on them. (See Fig. 34.) The wrinkles appearing in the tissue at this time can be quickly removed later.

The next step is trimming the excess paper from the wing. (See Fig. 35.) A razor blade does this splendidly if care is taken not to cut into the spar as the blade is moved along the edge. Nail scissors also do a good job, as they cut much closer than ordinary scissors with little chance of cutting the spar.

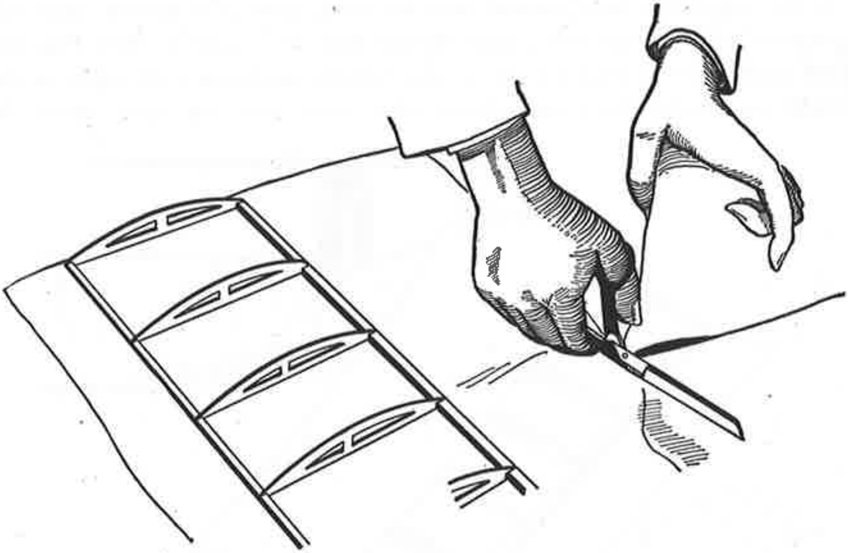


FIGURE 32. FIRST CUTTING OF TISSUE

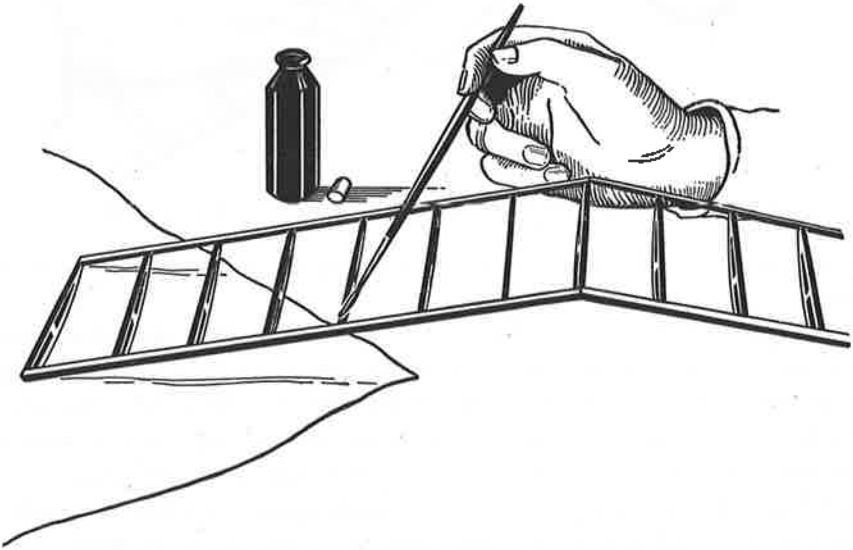


FIGURE 33. DOPING WING STRUCTURE

As the paper has been turned over the wing spar, at least one spar will be covered with it, and this paper should now be removed. (See Fig. 36.) No. 00 sandpaper is used for this work. Lightly sandpaper all edges of the covering to remove the paper's loose edges and leave the spars open. Do

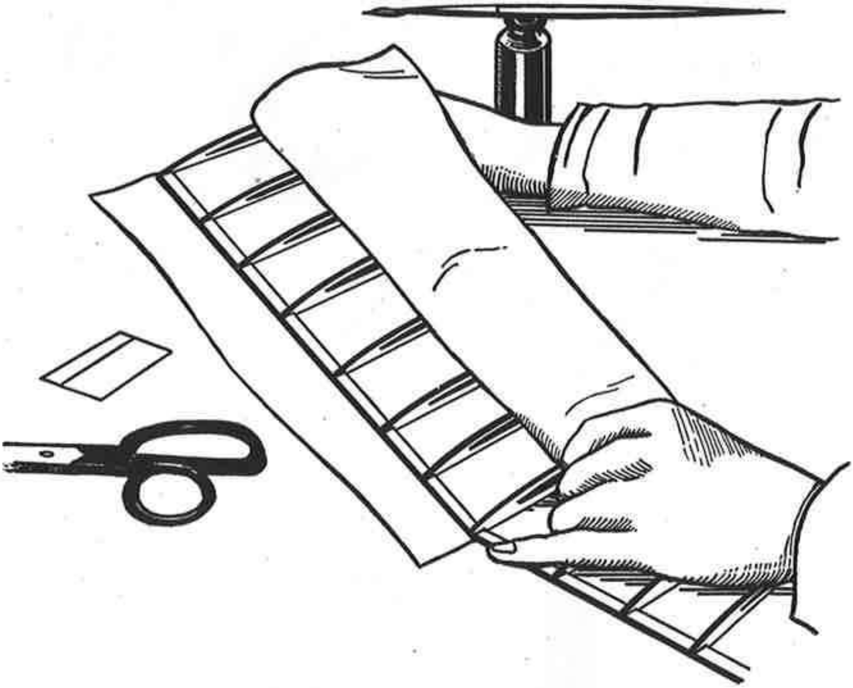


FIGURE 34. ATTACHING TISSUE TO WING STRUCTURE

not sandpaper on the top or bottom of the spars, as this will loosen the paper.

The paper on the wing is now tightened. Flying models should not have their wings doped, as this adds weight and often warps a light structure. On all single-stick twin pushers and flying commercial models, the wings are left without dope. To tighten the covering on the wings of such models, clear water is used. Many modelers apply this with a small sponge, as in Fig. 37, but the best method is to use a mouth spray. (See Fig. 38.) Such a spray can be purchased at any drug store for a few cents. A mouth spray allows the builder to apply the water in a more even manner than with a sponge. On very light wings, even water is dangerous, as the shrinking of the paper often pulls a wing out of shape, and for this reason many leave the tissue without any treatment at all.

For all exhibition models, the wing should first be sprayed with water and when thoroughly dry a coat of clear dope should be applied. This can then be followed with color dope or lacquer. (See Chapter 13.)

The author recommends spraying one half of a wing at a time, so that the part just sprayed can be placed under a light weight to insure it against

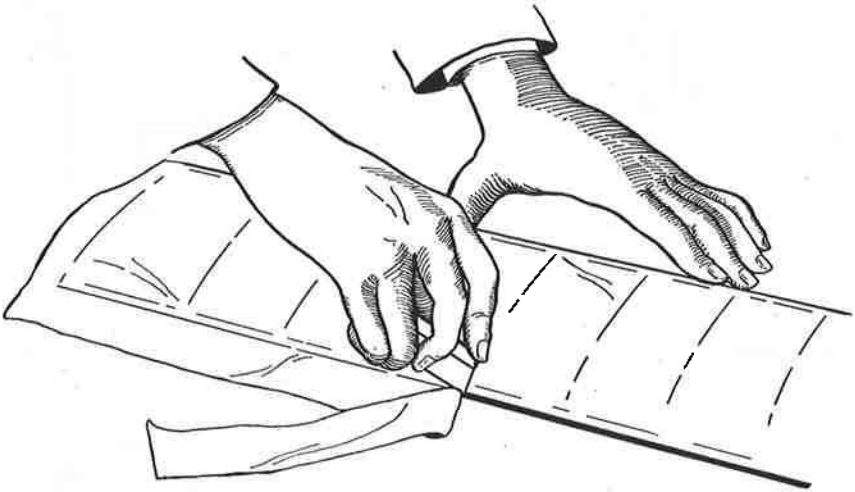


FIGURE 35. TRIMMING EXCESS TISSUE

warping. When thoroughly dry, the wing can be removed from under its weight and the other half sprayed. When water or dope is applied to a wing, it causes the paper to shrink, which removes the wrinkles, but at the same time pulls the frame of the wing. Care must be taken to prevent this pull from changing the shape of the wing.

Another method is to steam the wing instead of using the water-spray. This requires a kettle of boiling water. The wing is moved back and forth over the jet of steam until all parts have been covered. The steam does a splendid job, and has the advantage over the water method of drying immediately.

MICROFILM. This is a new wing covering for indoor endurance tractors, which has become popular at meets because it is twelve times lighter than ordinary tissue paper. So thin that a sheet of it cannot be touched with the hands, it nevertheless makes a more efficient covering than tissue if properly attached.

There are a number of formulas from which Microfilm can be made, such as rubber cement, nail polish, acetone, banana oil, and wood alcohol, but the author can recommend a mixture of three parts of collodion and

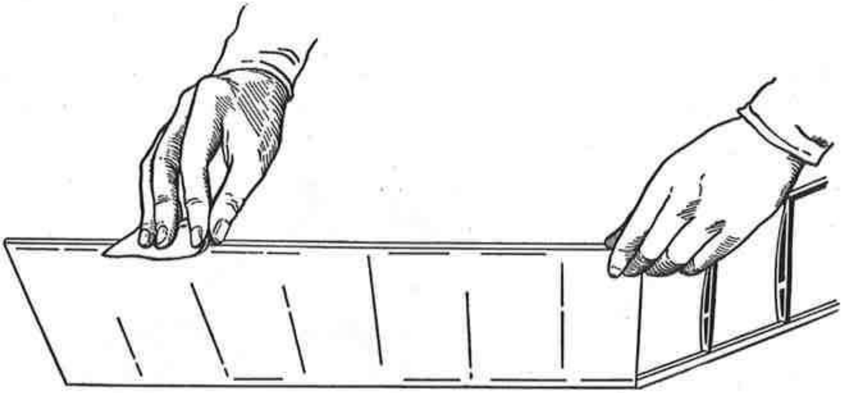


FIGURE 36. REMOVING EXCESS TISSUE FROM SPARS

one part of liquid ether, both of which can be purchased at any drug store. As the sheet cannot be handled, a wire frame must be made. This should be of 1/8″ wire and slightly larger than the wing being covered. Fill a tub

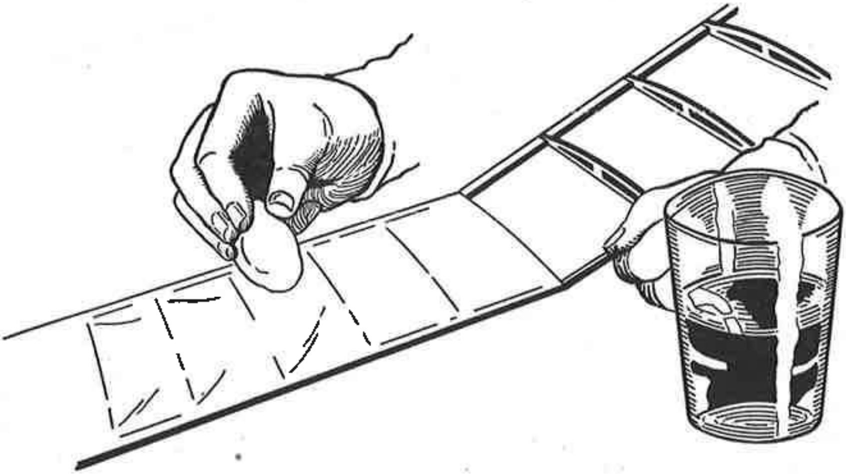


FIGURE 37. OLD METHOD OF APPLYING WATER

with water, place the wire frame in it, and then pour a half teaspoon of the mixture on the surface of the water. The contact with the water will immediately turn the mixture into a thin sheet of Microfilm.

The wire frame is brought under the sheet and it is lifted from the water, which will bring the Microfilm with it. Lay it in place on the wing and hold its edges to the wing frame with a diluted rubber cement.

FIGURE 38. NEW METHOD OF APPLYING WATER

Excess Microfilm can then be trimmed from the edges of the wing. This new substance will readily bend to any contour of a wing, but must not be touched at any time. Model builders should experiment on waste wing frames, before attempting to cover good wing frames.

SOLID WING CONSTRUCTION. Solid wings are used on two types of model aircraft. Their most popular use is on the solid scale, exhibition

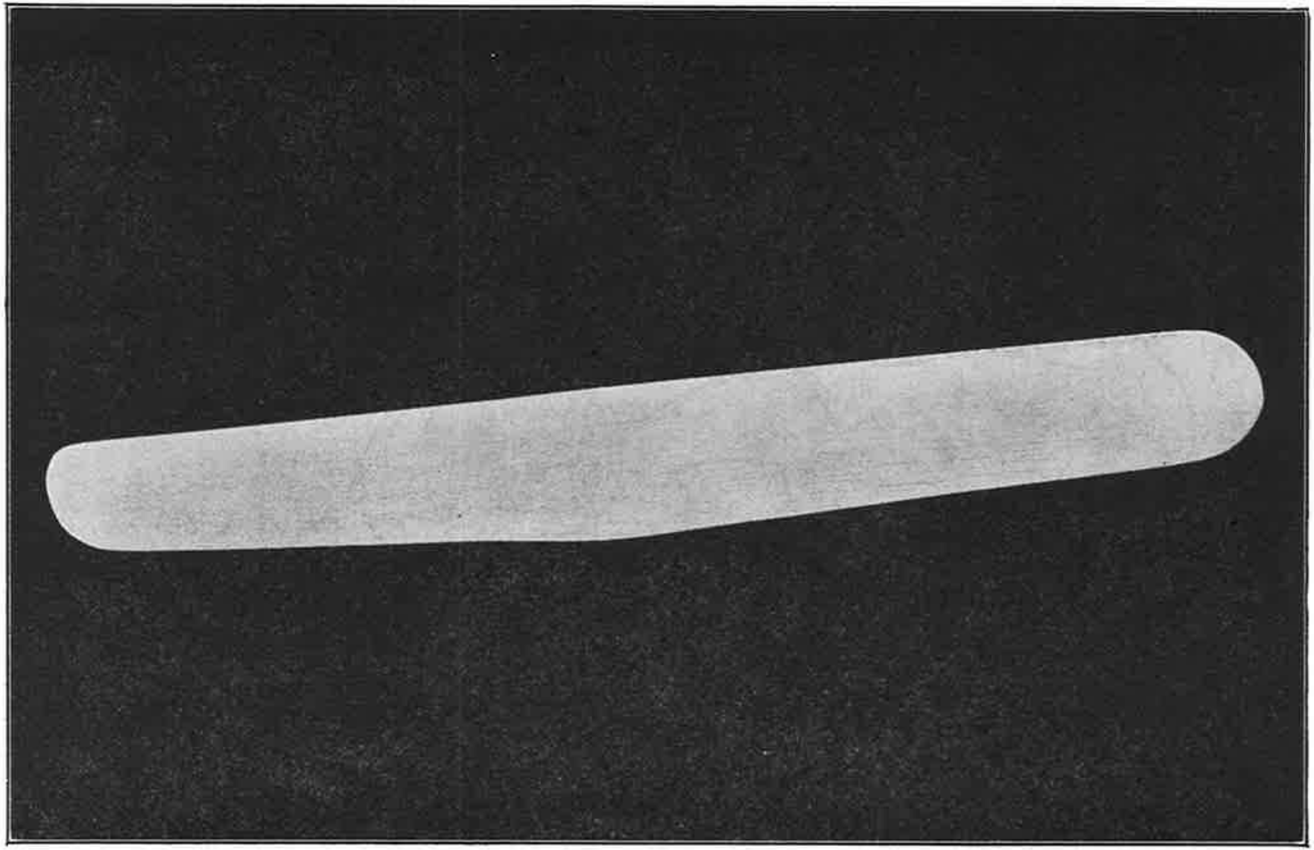


FIGURE 39. SOLID WING

model, but they are also used on solid balsa flying models. (See Chapter 17.)

Solid balsa gliders and flying planes of solid construction usually have their wings made from 1/8″ sheet balsa. (See Fig. 39.) This thickness increases or decreases in relation to the size of the model being built. The wood is cut to the necessary length and width, squared up, and then given its wing camber, or curve, with sandpaper. As balsa is extremely easy to work, sandpaper can replace the block plane on all stock under 1/4″ in thickness. The camber is gained by shaping the top surface only, while the under side is left flat. The wing is sandpapered to make a curved tapering surface from leading to trailing edge. The leading edge is left quite thick, while the surface tapers off to a sharp edge at the trailing edge. When this has been completed, the leading edge of the wing is rounded to complete the form of the Clark-Y rib. (See Fig. 22, No. 2.)

The wing tips are now rounded and the wing carefully balanced, as shown in Fig. 29 A. To obtain a dihedral in a solid wing it is necessary to cut it in half, and then cement it together with the desired angle. (See Fig. 28.) When dry, it is given a final sandpapering to remove excess cement.

Solid wings for exhibition models are usually made of balsa wood because of the ease with which it can be worked, but some builders prefer pine. In both cases, the process is the same. Fig 40 shows the six necessary steps to complete such a wing.

Step 1 shows the shape of the wing being traced on the wood stock. To obtain such a tracing, it is necessary to draw a full-size pattern of the wing you are building. Make the pencil marks heavy, so that when completed they may be seen through the paper. The side on which you have marked the outline is now placed on the wood face down and traced with the pencil. This transfers the pattern to the wood.

Step 2 illustrates the cutting of the wing form. This can best be done with a coping saw. The next step is cutting the camber in the top surface. Do this with a knife, unless the structure is of such a thin nature as to make it possible to do this work with sandpaper, as is done with flying models.

The wing shown in the illustration is of the tapered type. It not only tapers in width toward the tips, but also in thickness. All such wing forms are gained by cutting the wood away from the top side of the wing, while the under side is left flat. (Note Step 3.)

After the proper camber and taper have been given the wing, its leading edge is rounded. This can be done with sandpaper held in the palm of the hand, or a small block plane can be used, as in Fig. 40, Step 4. When the rounded form has been obtained, the entire wing should be given a careful sandpapering. (See Step 5.) The small notch in the leading edge of the wing

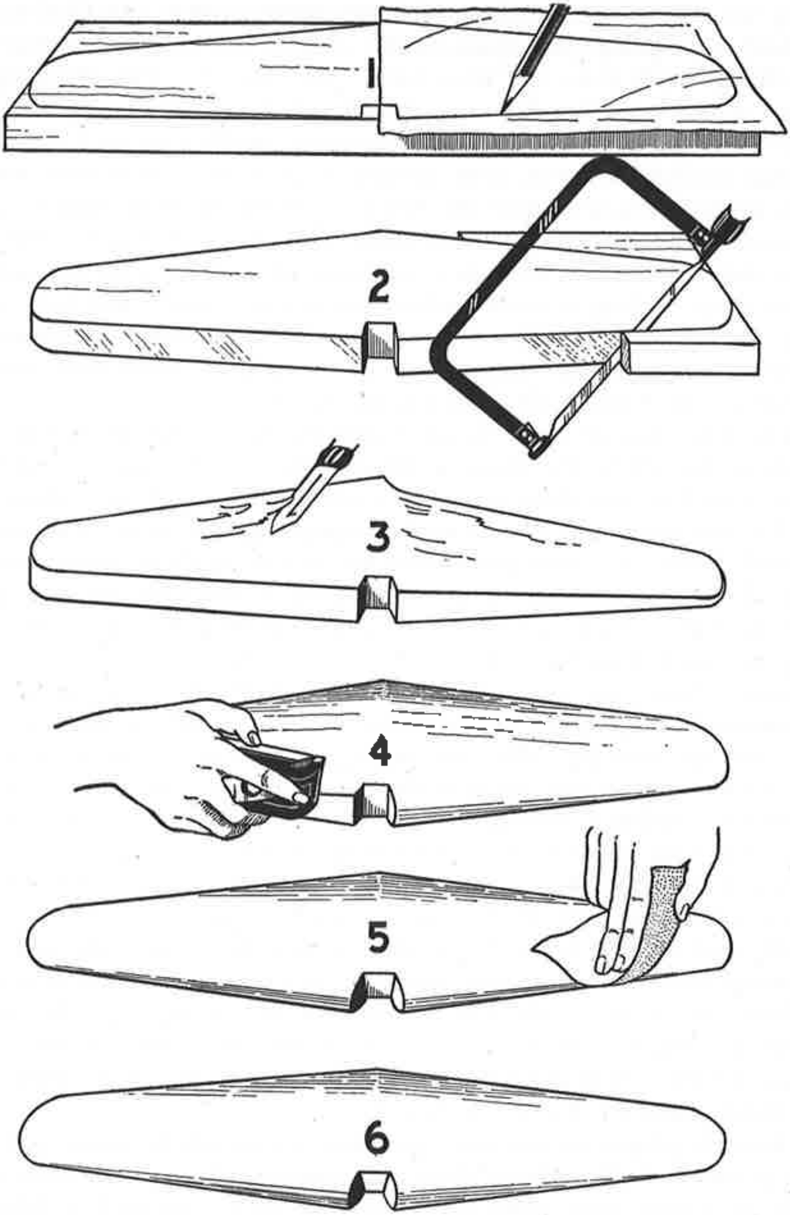


FIGURE 40. PROCESS OF CUTTING SOLID WING

is cut out to form the front of the inclosed cockpit of the Lockheed Vega which is used for illustration purposes, and has nothing to do with the making of ordinary solid wings.

Step 6 shows the finished wing. When the entire work has been done, it should be carefully checked to see that all dimensions have been followed. If the model is to be hung up, the wing should be given a balance test to see that each half of the wing is equal in weight. (See Fig. 29.)

CHAPTER 8

FUSELAGES

THE proper construction of the fuselage is of utmost importance. It must have the structural strength to support the motor, motor stick, wings, elevator, rudder, landing gear, tail skid, and propeller; and, on the other hand, being the second largest unit of a model, it must be designed for lightness.

FUSELAGE FORMS. For built-up, non-flying scale models, flying scale models, and commercial models, there are six common shapes given to fuselages which are shown in Fig. 41. The first one is triangular shaped, often found in commercial models. (See Chapter 35.) It consists of three longerons, or stringers, separated by upright struts and cross braces. No motor stick is used in this form of fuselage, as its strength is sufficient to hold the motor alone.

The second is a half-round and square-shaped fuselage, which is a common one among real planes. The one shown here is taken from the S.E.5 in Chapter 49. It has a number of formers along the upper portion of the fuselage, which are connected by stringers. The lower portion is made of stringers connected by upright struts and horizontal braces.

A rectangular shaped fuselage is shown by 3. Because of its squared corners, no formers are required to give it shape. It consists of four longerons, connected by upright struts and horizontal cross braces. Such fuselages are seldom found in a real plane of today, but War models often had them. Portions of modern fuselages have this form, such as the Curtiss-Wright Junior in Chapter 46. While the front of this plane is rounded, the rear is rectangular.

The square fuselage, shown by 4, is of the same construction as the rectangular one, 3, except that diagonal braces have been added for strength. This is a popular commercial shape, but is seldom found in real planes.

5 shows the oval fuselage, which is a popular form of fuselage in real planes of today. Note the Curtiss Shrike YA-8 Attack in Chapter 52 and the Waco Taper Wing in Chapter 47. The oval form is obtained through the use of oval formers connected by stringers, as shown.

The round fuselage, shown by 6, is another shape popular in real planes,

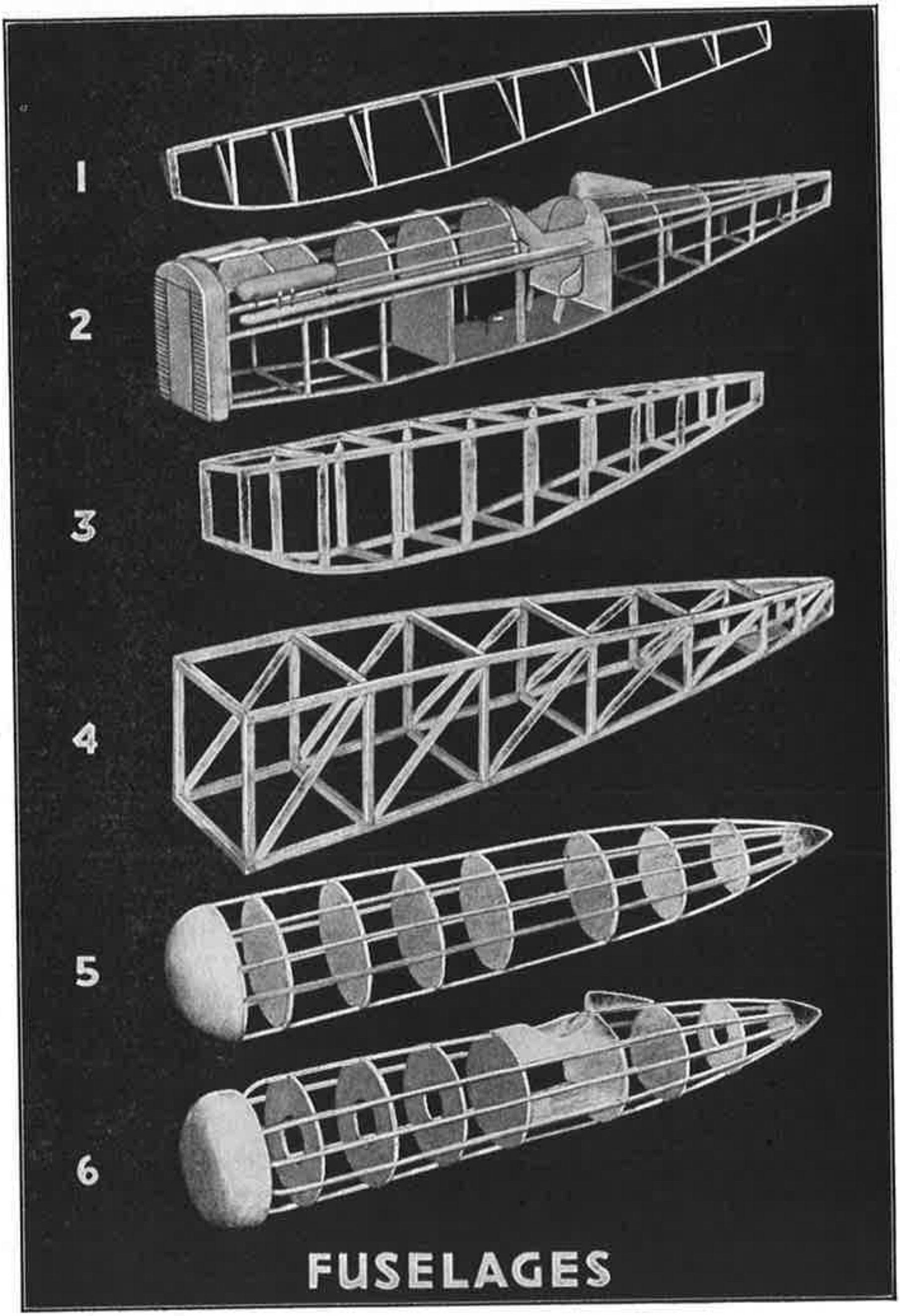


FIGURE 41

although few are perfectly round as in Chapter 48. This is made of formers connected with stringers running the full length of the fuselage.

All these fuselages can be made to carry motor sticks, or carry motors without motor sticks, or they can be made as non-flying models. In 6, a few of the formers have been cut out to show their construction for flying scale models, while in 5 they are left solid for exhibition models.

In the last two the formers must be full height to give the bottom of the fuselage its shape as well as the top. In 2, however, the formers give the fuselage its shape only on the top, so these need only be half-round forms, as shown.

FUSELAGE CONSTRUCTION WITHOUT FORMERS. Fuselages can best be made without formers when their shapes are square, triangular, or rectangular throughout. If they have rounded or curved portions, however, formers should be used.

There are many ways of making fuselages, but the three steps given here will be found practically foolproof, if followed correctly. These are layout, cutting, and assembly. Fig. 42 shows these steps.

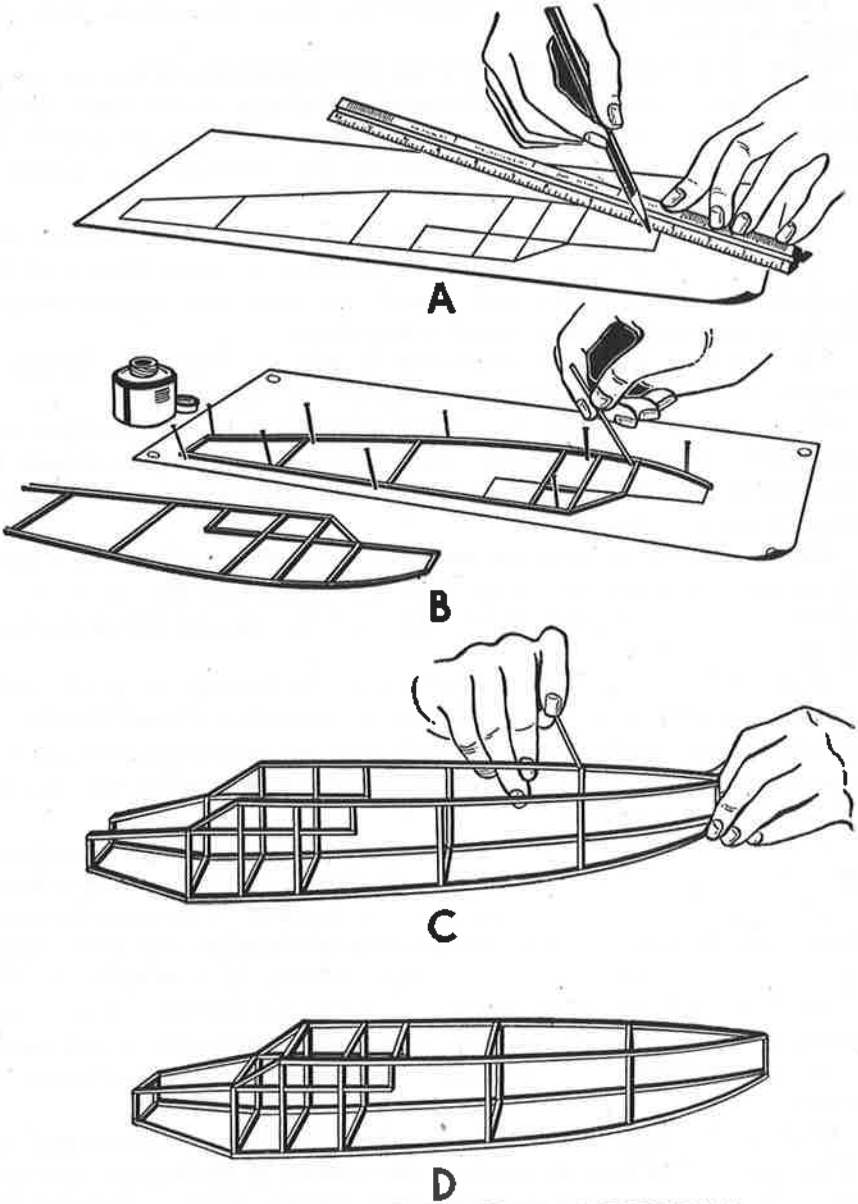
A shows the making of the *layout*. This is a full-size copy of the plan from which the fuselage is being constructed. The best view is the side of the fuselage, as both sides of any fuselage are alike. Care must be taken to insure correct dimensions because actual construction is done on this layout sheet.

When completed, the longerons, struts, and cross braces are cut to proper length and size. (See Chapter 3, "Balsa Wood.") Complete all *cutting* before assembly starts. The parts for each side, top, and bottom should be in separate piles for quick identification.

Fig. 42 B shows the *assembly*. One side of the fuselage is assembled at a time. Lay each part in its proper position on the layout sheet. Hold the longerons in place with model pins, as shown, while the struts are slipped between them. To make sure that each part fits perfectly, assemble the entire side on the sheet before doing any cementing.

While the longerons are held with pins, cement all struts and braces between them, as in B. Allow the structure to dry while in this position. A duplicate side is made in the same manner on the layout sheet.

When both sides are dry, the top and bottom cross braces are cemented in place, as shown in C. Though the sides of the fuselage may have a slight fore-and-aft bend in them, they should be assembled on a flat surface, and, when the top and bottom cross braces are ready to be applied, they are then bent.



FUSELAGE CONSTRUCTION
WITHOUT FORMERS

FIGURE 42

The completed fuselage is shown in D. These illustrations show the fuselage of a Stinson-Detroiter.

FUSELAGE CONSTRUCTION WITH FORMERS. When the shape of the fuselage is round, oval, half-round and square, or any other curved form, its construction will require the use of formers. These are usually cut from sheet balsa and take the place of struts and cross braces on square or rectangular fuselages.

It is obviously impossible to illustrate the constructional steps for every curved form of fuselage, so the Curtiss Shrike in Chapter 52 is used for illustration purposes. It has oval, round, and flat-round shaped formers, which are the most commonly used former shapes.

The necessary four steps are shown in Fig. 43. These are cutting of stringers and formers, two bending operations, and assembly.

Fig. 43 A shows the first step. All stringers must be cut to proper size with their lengths slightly longer than necessary. All formers should be redrawn full size from the original plan, and traced on the sheet balsa, as shown. These are then cut out.

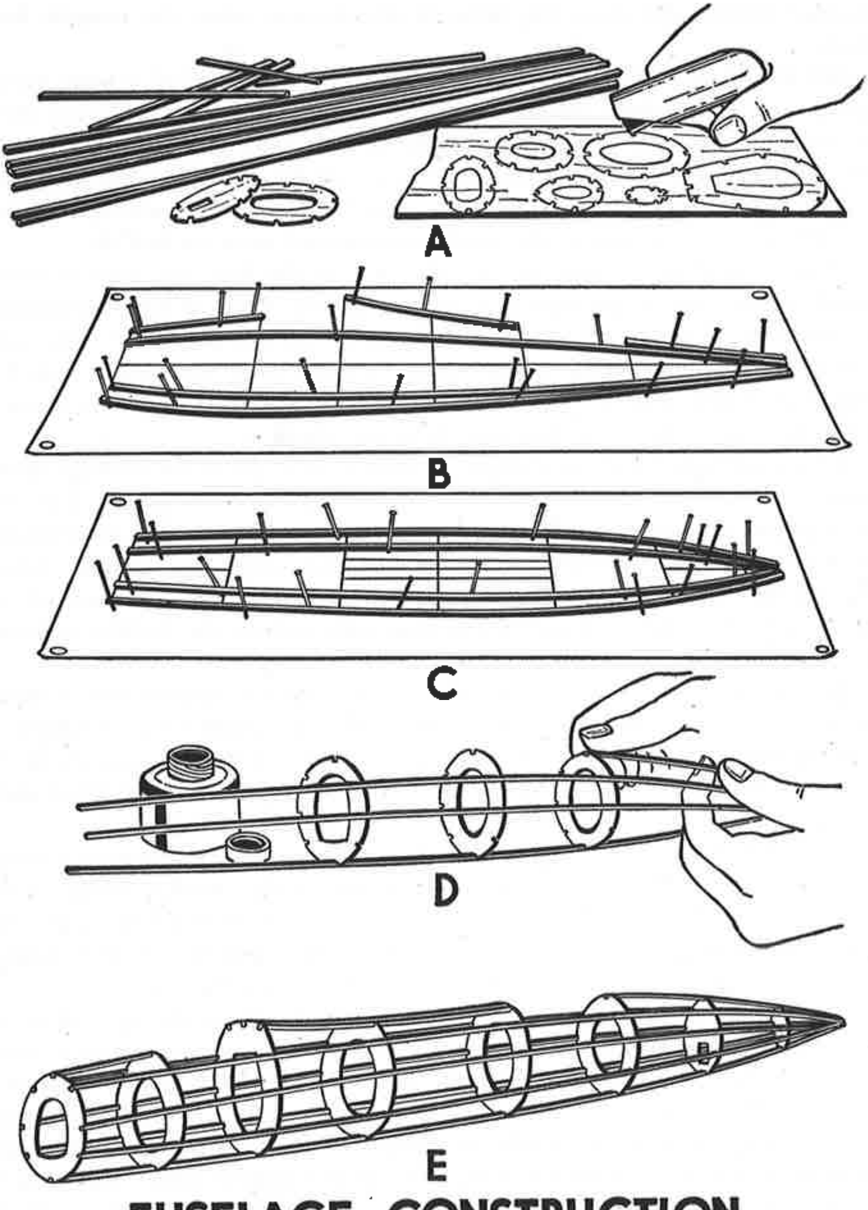
The next step is bending the stringers. On most curved fuselages, these will require two bends—the shape from side-to-side and the one from top to bottom. For this bending, full-size views of the top and side of the fuselage are drawn from the plans.

Draw a full-size plan of the side view of the fuselage, as in Fig. 43 B. The stringers are now bent. (See Chapter 3, "Balsa Wood" and "Bamboo.") Bend the stringers until each fits its particular line on the side-view plan. If balsa has been used for these, place the wet balsa in position on the plan and hold with pins until dry.

A full-size plan of the top view of the fuselage is drawn from the original plan, or laid out by the builder himself, and the various stringers again bent to conform to their side shapes, as in Fig. 43 C. Care must be taken when doing this, as the second preparation for bending the wood makes it pliable again and it might lose its original bend. Many builders, for this reason, make only one bend in their stringers, depending on force, carefully applied, to bring the stringers into position along the second curve.

When the stringers are bent and the formers cut, the fuselage is assembled.

D shows the assembling of the fuselage. One stringer, preferably the bottom one, is cemented into each of the formers. If this stringer has been bent perfectly, the position of the formers will be exactly as desired when the other stringers are added. E shows the finished fuselage. The three top stringers are cut to form the front and rear cockpits. These should be



FUSELAGE CONSTRUCTION
WITH FORMERS

FIGURE 43

attached whole, and then cut between the formers after the cement has dried.

SOLID FUSELAGE CONSTRUCTION. The carving of a solid fuselage is done in six steps, shown in Fig. 44. Some builders use pine for this, but balsa is recommended because of the ease with which it can be carved. The block of wood is first squared up. It should be as long as the fuselage, as wide as its widest part, and as thick as its height. If the cowling is to be carved from the same block, the length of the block must include it.

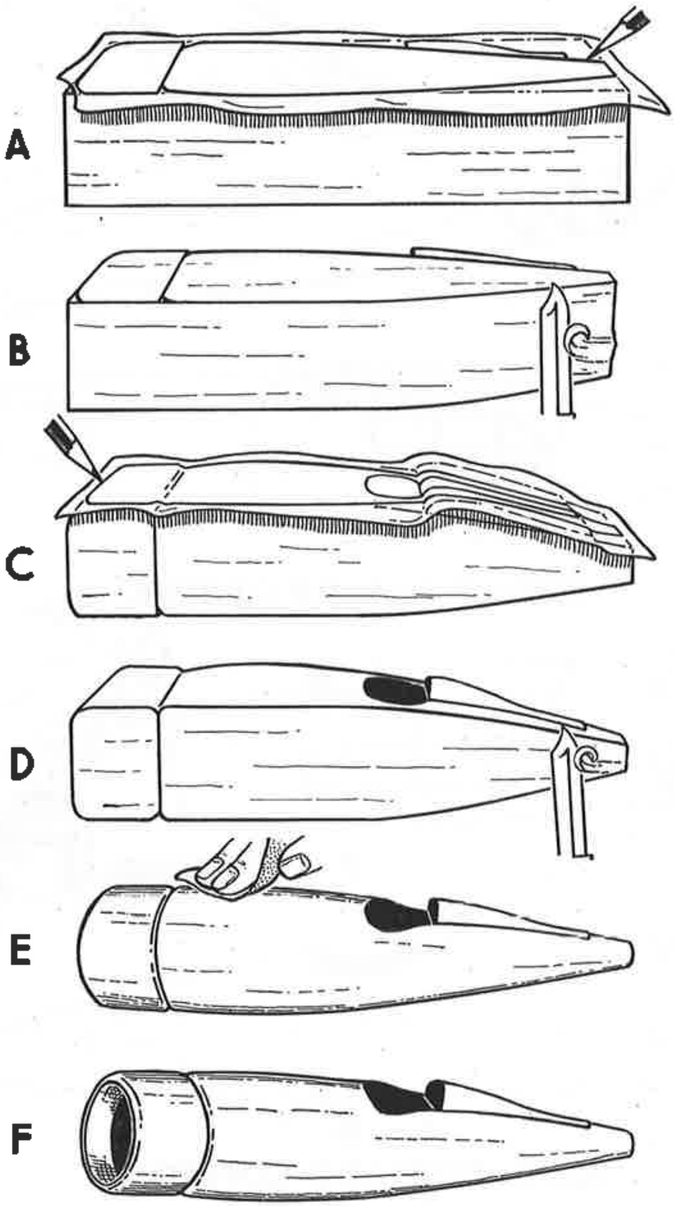
Make a full-size drawing of the side view of the fuselage. This is then traced on the side of the block, as shown in Fig. 44 A. When completed, the block is cut along this outline, as in B. A full-size drawing of the top view of the fuselage is made, and traced on the top of the block, as in C. The block is cut along this outline, as in D. The block has the general lines of the fuselage at this time, but not its proper shape.

This is obtained with sandpaper, as shown in E. Here the builder must follow cross-section views given in the plans, descriptions in the text, or photographs of a like model or the real ship. While the three-view plans given for solid scale models in this book do not carry cross-section views, the general shape of the fuselage is given in the text, and a photograph of the completed model is shown. From these two sources, the builder will experience little trouble in finishing the fuselage to its proper form.

When the fuselage has been carved and finished smooth, its cockpit should be cut out and equipped, as described in Chapter 15, "Cockpits." If an engine is to be added, the cowling requires hollowing out, as in F, to accommodate it. If this is not done, it is left solid and later painted with a black circle to represent the engine. (See Chapter 11, "Engines.")

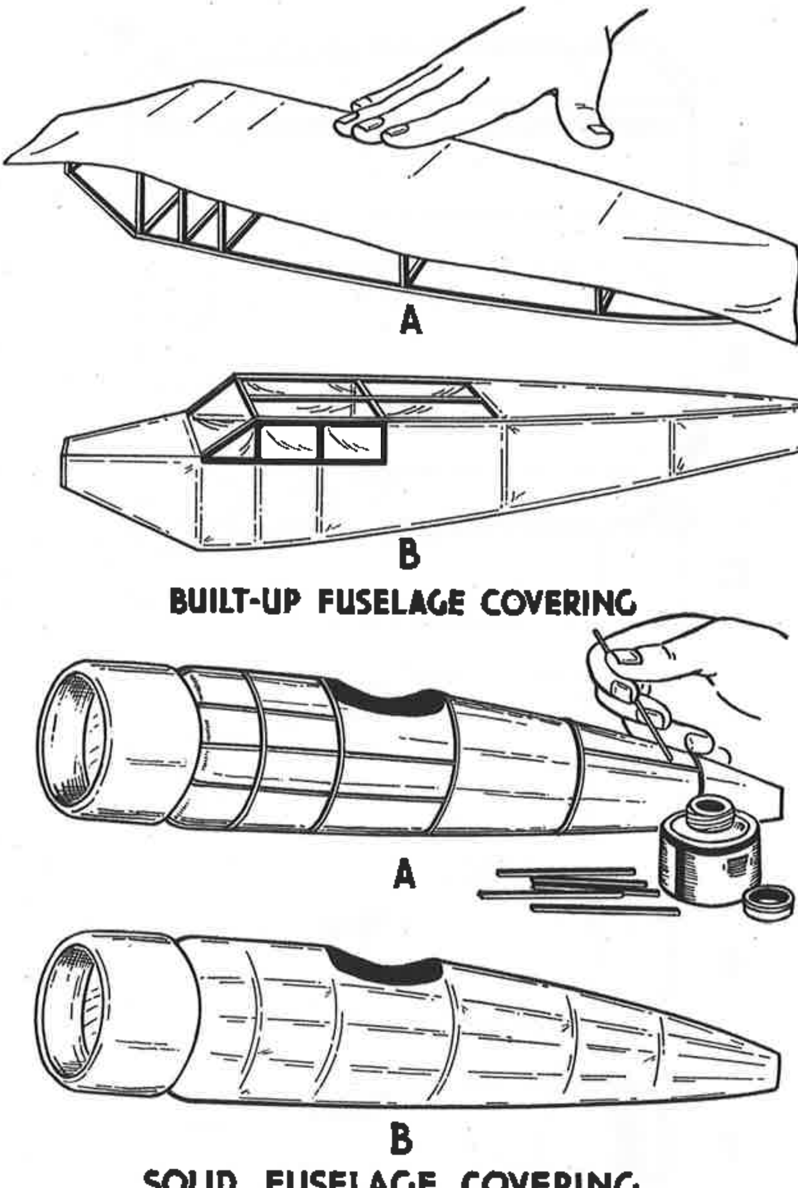
BUILT-UP FUSELAGE COVERING. The proper covering of a fuselage is a more difficult job than the covering of the average wing, as its curves, various bends, and open spaces for cockpits present a task requiring careful handling. The same covering used on the wing of a model should also be used on its fuselage. (See Chapter 3, "Covering Materials.")

For square, rectangular, or triangular fuselages, the covering is done as shown in Fig. 45, "Built-up Fuselage Covering." One side at a time is covered on such models, as in A. Coat the structure with clear dope or banana oil, and, cutting the covering to approximate size, press it in position on the side. If tissue is used, it should be ironed free of wrinkles before being applied. When dry, the overlapping material is trimmed away. Nail scissors are best for this work, as small curves can be easily cut with them. Each of the sides is covered in the same manner. When completed, the material should be water-sprayed. (See Chapter 7, "Wing Covering.") This will re-



SOLID FUSELAGE CONSTRUCTION

FIGURE 44



FUSELAGE COVERING

FIGURE 45

move any sagging, or wrinkles. For a drum-like tightness, the material must be doped. Give tissue a coat of clear dope, but if silk is the covering material, clear banana oil should be used.

The method of covering round, oval, or half-round fuselages is the same, except that the covering material should be cut into strips before being applied. These strips run the entire length of the fuselage and are wide enough to cover the space between three or four stringers. Each must be carefully trimmed before the next strip is applied. The fuselage is then finished in the same manner as the square one.

SOLID FUSELAGE COVERING. Solid scale models can be covered in such a manner as to look like built-up planes. The model is completed, but not assembled. Before this is done, 1/64″ or 1/32″ square balsa strips are cemented to the solid surface to represent formers, struts, and cross braces, as in Fig. 45, "Solid Fuselage Covering." Ordinary string is sometimes used to build up solid fuselages.

When all outline strips have been cemented in place on the fuselage, it is covered with a heavy-grade tissue or a very fine grade of silk. The process is the same as covering the built-up fuselage. The covering is water-sprayed and doped in the same manner as any covering. When this construction is used, the builder must remember that not only the fuselage must be outlined with the strips, but also the wing, elevator, and rudder, so that the entire model will look like a built-up job. The completed fuselage is shown in Fig. 45 B under "Solid Fuselage Covering."

CHAPTER 9

PROPELLERS

THE heart of a model airplane is its propeller. No matter how aerodynamically perfect in design, how light in weight, how skillful in construction, or how beautiful in workmanship a model may be, its propeller determines its success or failure when launched.

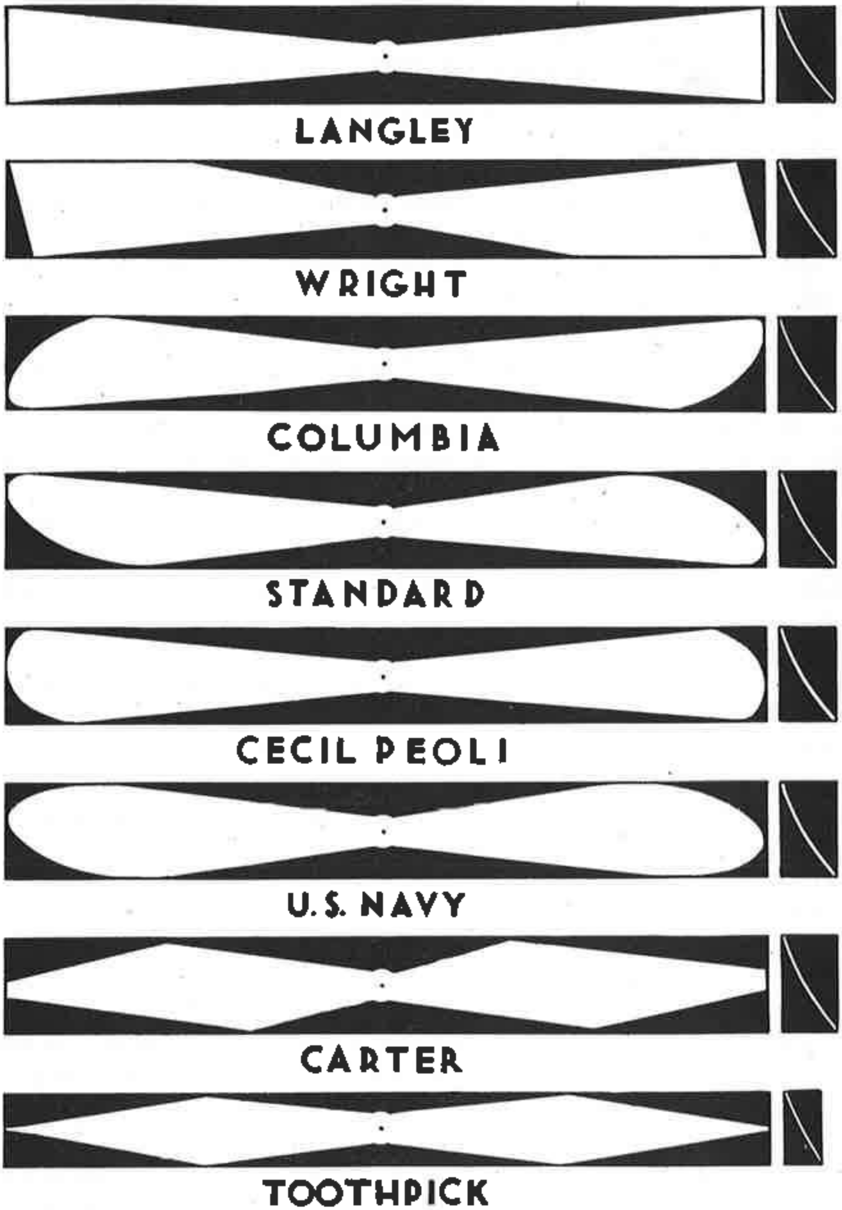
If a model is tested, without power, in respect to its gliding ability and maintains a long, smooth glide, it will fly well provided the correct propeller and motor are applied.

PROPELLER TYPES. Fig. 46 shows eight of the most popular types of propellers. The difference between these propellers is the form of their blades. The Langley propeller was made famous on the airplanes of Samuel Pierpont Langley. This shape of propeller is popular among model builders desiring endurance flight. Its corners are rounded to increase efficiency.

The Wright propeller is similar to the Langley, except that one corner has been cut off, while the Columbia is an adaptation of the Wright propeller with its corners rounded. The Standard propeller is an efficient copy of the Langley, widely used on models of today. It is the reverse of the Columbia propeller, with a slightly longer curvature along the blade. It makes an efficient speed propeller.

The Cecil Peoli propeller was the design used on early models made and flown by this New Yorker. In 1911, Cecil Peoli made his model fly over 1,600 feet, which was considered at that time a wonderful feat. His model became both famous and popular over night, and even today we find model builders making and flying this early bird.

The U. S. Navy type of propeller is basically a Columbia propeller, except that both its edges are rounded. The Carter propeller makes a good speed propeller, being slender in blade width, which allows the blades to cut through the air at a faster rate of speed than wide blades could do. The toothpick propeller, so named because of its narrow blades, is a development of model builders for use on speed planes. It is an adaptation of the Carter propeller, being narrower in the blades and having their projecting points along the edges opposite each other, while those of the Carter blades are slightly staggered. Builders should experiment with all these



PROPELLERS

FIGURE 46

forms of propellers and choose that which they consider best for their speed and endurance models.

TRACTOR AND PUSHER PROPELLERS. When the propeller is in front of the main wing of an airplane, it is known as a tractor propeller, and the plane is called a tractor airplane. Most of the modern airplanes are tractors, although the new Curtiss-Wright Junior, in Chapter 46, is an exception. This is called a pusher airplane, because its propeller is behind the main wing, and its propeller is known as a pusher propeller.

The tractor is "pulled" by its tractor propeller, while the pusher is "pushed" by its pusher propeller.

Many model builders have difficulty in recognizing the difference between tractor and pusher propellers. As far as the actual propeller is concerned, there is no difference whatever. Both are carved in exactly the same way. Both are mounted with the concave side of the blades trailing. In other words, when viewing the propeller from behind the model, you will always see the concave sides of the blades.

The only difference between a tractor and pusher propeller is that the hook of the propeller shaft extends out from the hub of the propeller on different sides. Study Fig. 47. This shows two views of the same propeller, and yet one is a pusher propeller and the other is a tractor, because the propeller shaft extends out on opposite sides.

The propeller shaft of a *tractor* propeller extends out from the hub on the *concave* side of the blades. The propeller shaft of a *pusher* propeller extends out from the hub on the opposite, or *convex*, side of the blades. A tractor propeller can be changed into a pusher propeller by simply changing the propeller shaft so that the hook of the shaft is on the other side.

RIGHT AND LEFT HAND PROPELLERS. When a propeller turns clockwise, when viewed from the rear or concave side of the blades, it is known as a right hand propeller. This means that the propeller is wound in the opposite way, and that when released it turns in the same direction as that in which the hands of a clock turn.

When the propellor turns counter-clockwise, when viewed from the rear or concave side of its blades, it is known as a left hand propeller. In other words, it is wound in the same direction as that in which the hands of a clock travel, but when released, it travels in the opposite direction to those of a clock.

When only one propeller is used on a model, it is the custom to make it a right hand propeller, but when two propellers are used, one must be a right and the other a left hand propeller. All illustrations in this chapter show right hand propellers, except where two propellers are illustrated.

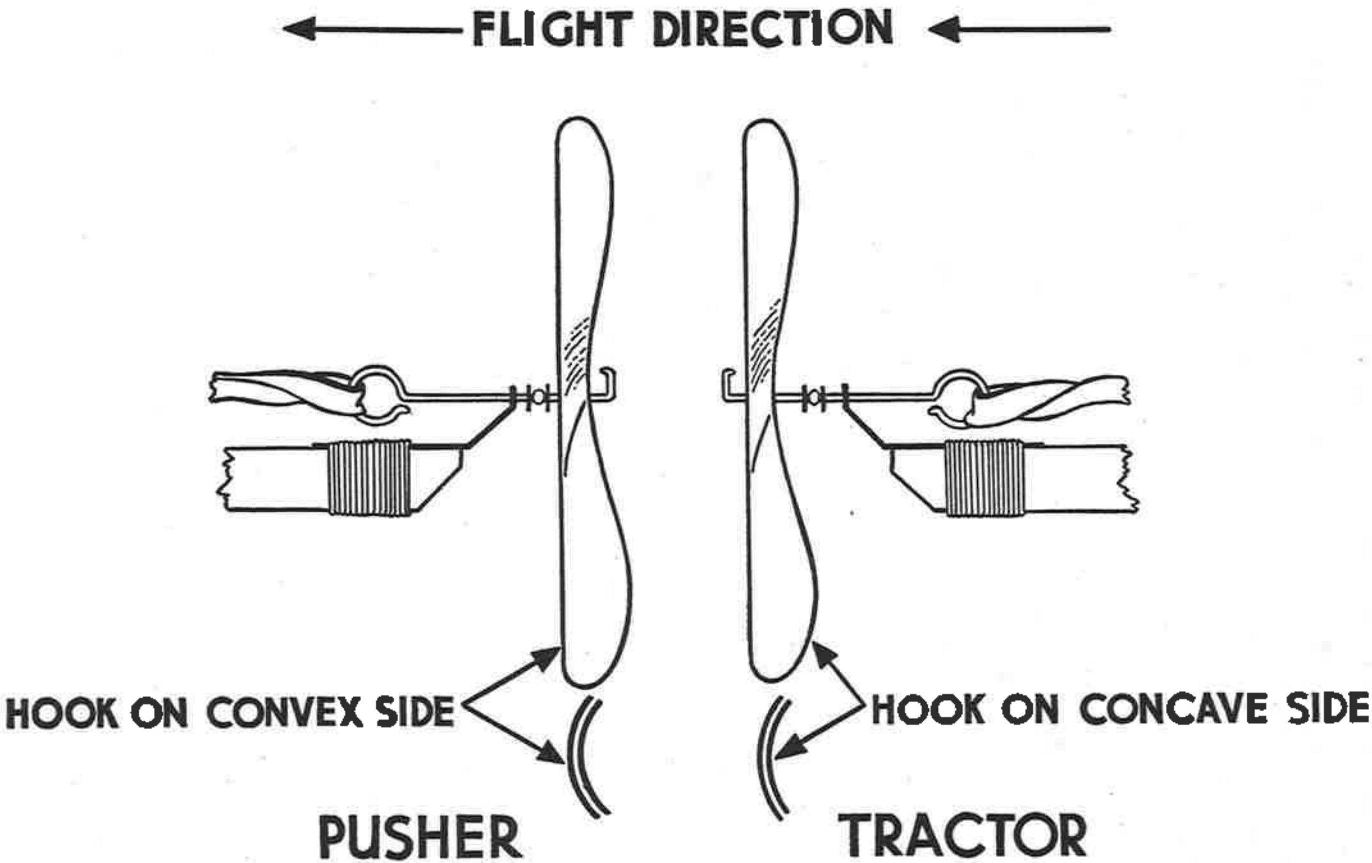
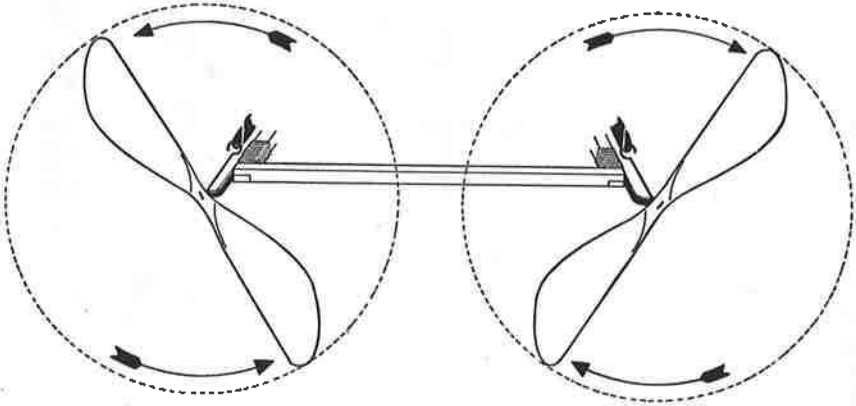


FIGURE 47. PROPELLER ASSEMBLY FOR TRACTOR AND PUSHER MODELS

When two propellers are required on a model, they must be made to turn in opposite directions so that the directional pull of one propeller will offset that of the other. For this reason, twin propeller units are always made up of one right and one left propeller.

The most common use for twin propeller units is on twin pushers, so called because of their two propellers. These should be mounted on the A-frame so that both turn up and out, as shown by the arrows in Fig. 48.



TWIN PROPELLERS

FIGURE 48

This shows the view of the model from the rear, so the eye rests on the concave side of the propeller's blades.

The carving of a left hand propeller is opposite to that of a right hand propeller. Fig. 49, No. 3, shows the start of carving a right hand propeller. The cut is made along the right top edge at the front. If a left hand propeller was being carved, this cut would start along the left top edge at the front, which would make the blade slant from the rear top edge to the front bottom edge. On the right hand propeller, this slant would be from the front top edge to the rear bottom edge. On the right side, the cut of the blade would slant from the front top edge to the rear bottom edge, or exactly opposite to that of the right hand propeller, as in Fig. 49, No. 3.

The method employed to carve a left hand propeller is the same as the right hand propeller, and the steps in Figs. 49 and 50 can safely be followed once the opposite slants of the blade cuts have been correctly started.

PROPELLER SIZES. Before it is possible to decide the size of a propeller, the builder must know whether his model is a speed or endurance flyer. With this in mind, the builder should glide his model, observe its speed and general behavior, and through these observations decide its type. If the model is fast in gliding, a speed propeller should be applied; while if slow, an endurance propeller is indicated.

After determining the type of propeller required, the builder must choose its correct size. This is largely a matter of trial and error. All plans for model building carry with them propeller specifications. The builder will do well to follow these dimensions, for it is assumed that they have been thoroughly tested by the designer and found best for the model in question. With this in mind, the builder should study the propeller sizes used on the various models contained in this book, as these have been carefully tested on the models to which they are attached.

Indoor endurance models are usually equipped with propellers about half the length of the wing span, while outdoor models have propellers about a third of the wing length.

However, this rule is not a fast one by any means, and a check of the propeller lengths with relation to wing lengths will prove many discrepancies. When fitting a propeller on a model with a wing span not comparable to a known success, the approximate length should be chosen, the propeller carved, and then tested on the model by actual timing of its flights. Other tests should follow with other sizes and lengths until the one best suited to the model being fitted has been found.

The extra propellers can be kept for future use on other models. In time the builder will be able to determine the correct size of propellers without much actual testing.

All model supply houses carry propeller blocks such as in Fig. 49, No. 1. They also sell propeller "blanks," which are cut to the general shape shown in Fig. 49, No. 2. Purchasing such blanks eliminates steps 1 and 2 of Fig. 49. However, the laying out and cutting the block into a propeller blank is a simple task.

Propeller blocks and blanks can be had from 5″ to 15″ long, or other lengths can be cut by the builder himself from balsa planks. All model airplane catalogues will list the various sizes obtainable.

PROPELLER WOODS. Before weight was discovered to be of such importance, propellers were carved of pine, or other woods, but today practically all model propellers are of balsa wood. While some still use other woods on exhibition models, they are not recommended, as balsa is far easier to work.

A hard, straight-grained, kiln-dried, and good grade of balsa wood should

CARVED PROPELLERS

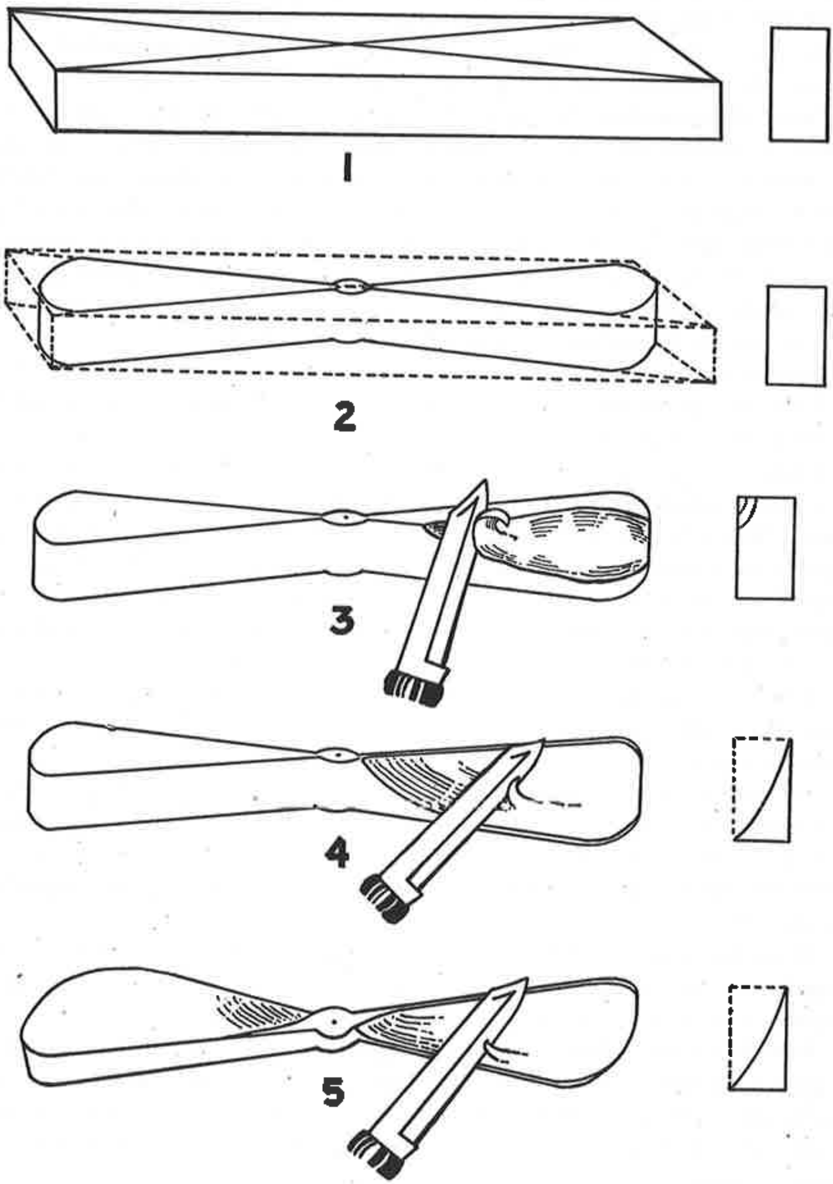


FIGURE 49

be chosen for propellers. The purchaser must remember that all balsa wood is not fit for model building. Some of it is bias-grained, pithy, and generally unfit for model work of any kind, and the propeller requires even better balsa wood than other parts.

CARVED PROPELLERS. After the proper size of propeller block has been obtained, diagonal lines are drawn across its face from corner to corner, as in Fig. 49, No. 1. The shape of whatever type propeller has been chosen is now drawn with the diagonal lines acting as edge guides. The blank is cut out with a coping saw or knife, as in No. 2.

Step 3 shows the first cutting operation. The blade attacks the right top edge at the front with a scooping motion to give the cuts a concave form. Step 4 shows this same operation being finished, as the knife removes the wood in a concave form which slants from the rear top edge to the front bottom edge.

Step 5 shows the blank turned around, and the knife making a duplicate concave cut on the other side, or the original left side of the blank. All cuts are made from the hub toward the ends of the wood, to eliminate false cuts or possible splitting. The hub is left its original thickness, while the carving is being done.

At this point both concave cuts have been made, and when the blank is viewed from on top of the hub, both these cut sides must appear on the same side, while the untouched sides will not be seen, or will appear on the opposite side.

The blank is now turned over and the convex sides are cut. The first cut is shown in Fig. 50, No. 6. These must run parallel to the concave cuts on the other side, and should be continued until the blades of the propeller are about 1/8" thick, gradually increasing toward the hub.

Following the carving of the blades, the hub of the propeller should be cut away, as this is the most inefficient part of the propeller. Experts cut the hubs of their propellers down to 1/8" thickness, but the beginner should leave his hubs at least 1/4" thick. As the thickness of the hub decreases, the possibility of breakage increases.

Step 7 shows the cutting down of the hub. On ordinary propellers this should be done at this time, but on extremely light endurance propellers, it should be deferred until after the blades have been sandpapered. Some complete their propellers, cement the shaft in place, and then cut down the hub by removing the excess thickness around the projecting shaft.

As the shaft of a tractor propeller extends out from the concave side of the blades, it therefore follows that the excess hub material is removed from that side.

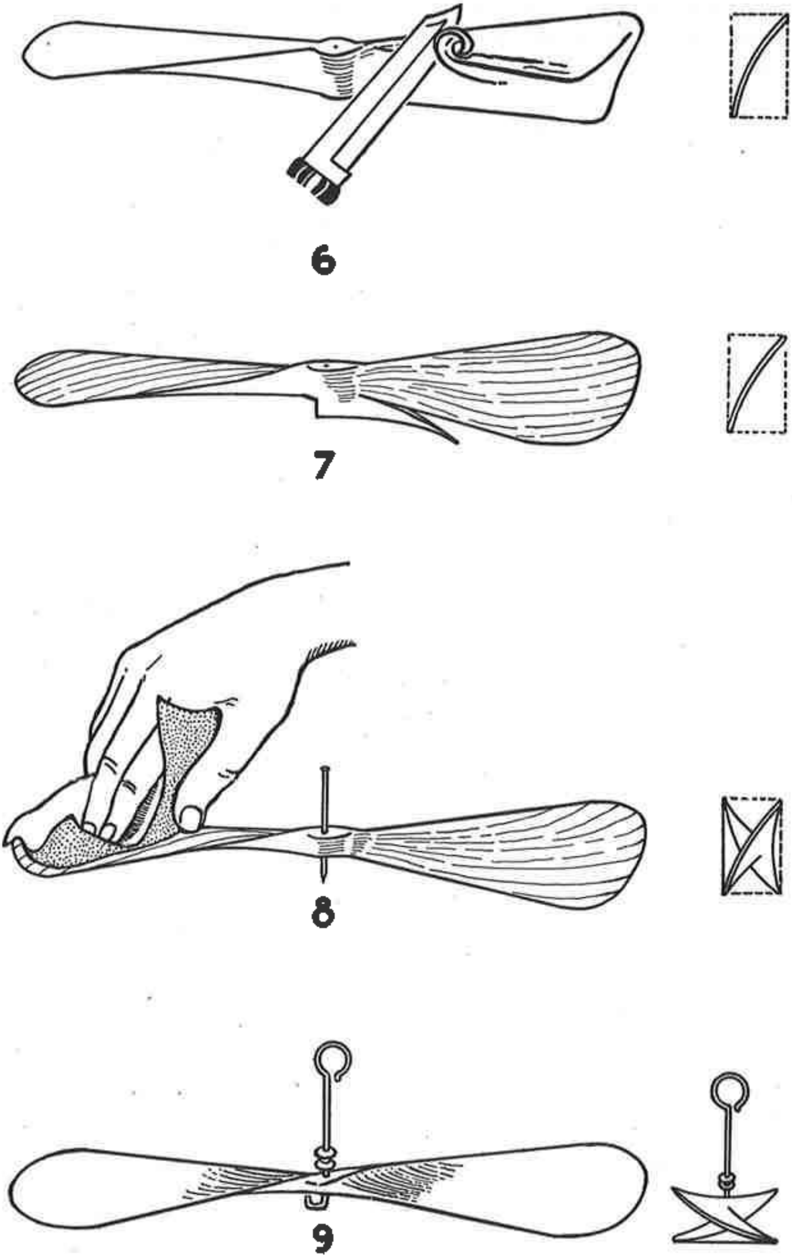


FIGURE 50. CARVED PROPELLERS, 2

Step 8 shows the sandpapering of the blades. This is an important step. On a speed propeller, the blades may be $\frac{1}{32}''$ to $\frac{1}{16}''$ thick, but for endurance models, they should be sandpapered so thin that light will show through them.

The propeller is now tested for proper balance. To insure even rotation of a propeller, the blades must be exactly the same weight. As it is obviously impossible to weigh each blade, the balance method is used.

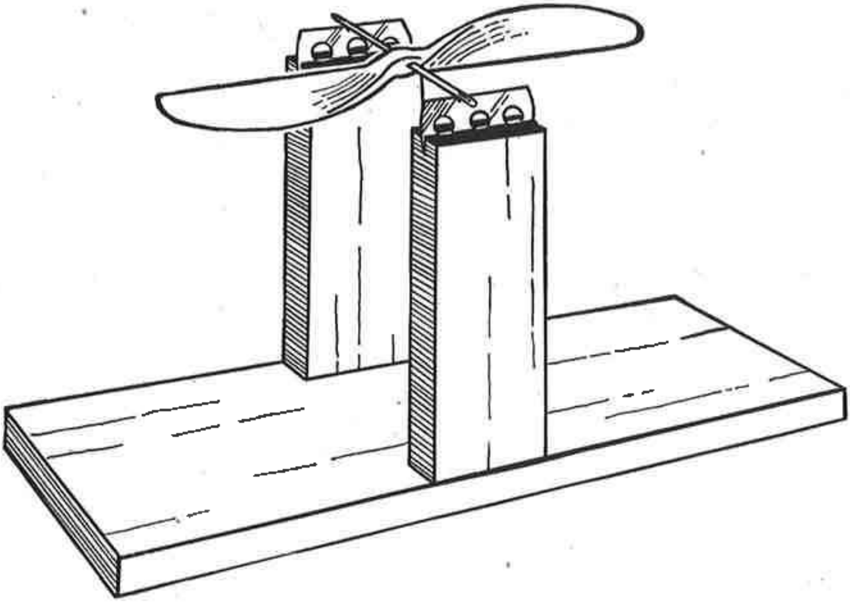


FIGURE 51. PROPELLER BALANCE BLOCK

BALANCE BLOCK. A simple balancing apparatus is shown in Fig. 51. It consists of a base board from which extend two arms. These are 2" wide and should be at least 6" high, so that a 12" long propeller, when mounted on them, will be able to rotate without striking the base board. Two safety razor blades are sunk into the ends of these arms, and in the exposed edges of the blades notches are filed.

The propeller shaft is now thrust through the center of the hub, removed, and a needle, slightly smaller in diameter than the shaft, inserted through the hole. The ends of the needle protruding from the hub are placed in the notches cut in the blades.

The propeller should now rotate easily on the needle when blown on. If the two blades are of the same weight, the propeller will stay at whatever angle it is stopped in. If not, the heavier of the two will drop down. If this is the case, the propeller must be removed, and the heavier of the blades sandpapered. It is then retested, and the process continued until perfect balance results.

The propeller shaft is now attached to the propeller. Insert the shaft through its hole in the hub. If the propeller is to be a tractor, fit the shaft so that it extends out from the concave side of the blades. If a pusher propeller is desired, the shaft must extend out from the convex side of the blades.

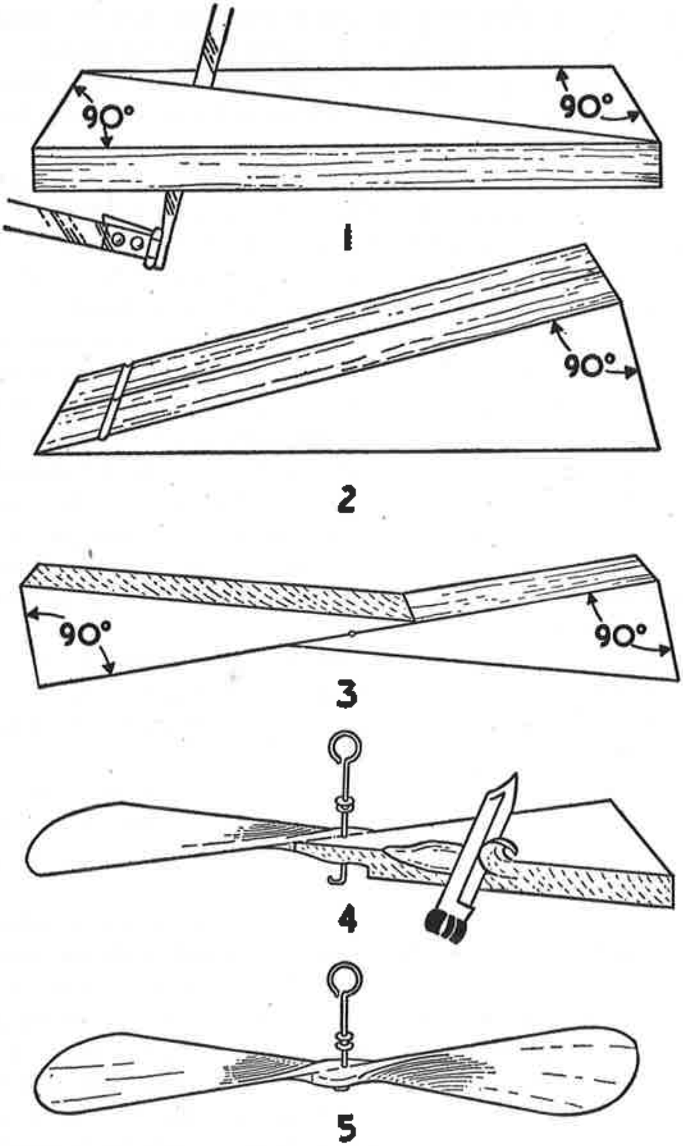
The end of the shaft is then bent around, so that when the shaft is pulled back, the point of the wire will bury itself in the wood of the hub. A drop of cement will hold it in place. Many cement a large washer against the hub, after threading it on the shaft. Two smaller washers are then assembled on the shaft.

Another method is to apply one washer, followed by a steel bead or dress spangle, and then a second washer.

If the propeller is for a light endurance model, it can be left in its natural state, but for scale, commercial, speed, and heavier models, it can be reënforced with a few coats of banana oil. After each coat, the propeller should be given a light sandpapering.

CARVED TRIANGULAR-BLOCK PROPELLER. For this type of carving, a block only about half as long as the desired length of the propeller is required. This has two advantages over the type just described. Balsa wood seldom maintains the same hardness and weight over any great length, with the result that propellers 10″ or 12″ long seldom have the same degree of hardness and weight in both blades. On this type of propeller, however, the cutting of the block into two triangles guarantees that the traits of one part will be those of the other. The second advantage is that costs are cut in half. Instead of purchasing a 12″ block for a 12″ propeller, the builder buys one only 6½″ to 7″ long, depending on the amount he wishes to use for the overlap joint.

Fig. 52 shows the various steps for carving a triangular-block propeller. Step No. 1 shows the block with one diagonal line drawn from corner to corner. Before deciding the length of block required, the exact amount of overlap at the hub must be determined. Some use only ¼″ for this center joint, but a ½″ lap is safer. For example, let us say that we must carve a 10″ long propeller, and that we have decided to overlap our triangular blocks ½″. We will then require a block half as long as the propeller's finished length plus ½″ for each half, or an extra 1″. In the case of this example,



CARVED TRIANGULAR-BLOCK PROPELLER

FIGURE 52

we must purchase a block 6″ long, which represents half the length of our finished propeller, or 5″, plus the 1″ for overlapping the blocks.

The block should be tested to see that each corner is a right angle as in Step 1. When this has been done, a diagonal line is drawn from corner to corner, and the block sawed through on this line.

The two triangular blocks are shown in Step 2. These are placed side by side with their sawed portions facing down. The small groove running across both of them is located half the length of the desired overlap from the ends. In other words, if our overlap is to be ½″, as in the above example, it would be ¼″ from the pointed ends of the blocks.

This groove represents the propeller shaft hole. The best method of making it is to heat a length of piano wire red hot and place it in position on the blocks. The wire must be the same diameter as that used for the shaft, but must not be the same wire. After the groove has been made half as deep as the diameter of the wire, the blocks are ready for joining.

Apply cement to the portions being joined; line up the two grooves together, and press the blocks tightly together until the cement dries as in 3. The same wire used for the grooves should be inserted in the shaft hole, worked through the cement, and moved around while it is drying. This prevents the cement from closing the hole.

The block is now a perfect propeller blank, and the carving is started, as in Step 4. All further work is a duplicate of that described for the ordinary carved block, which is given under "Carved Propellers." The finished propeller is shown in 5.

BENT WOOD PROPELLERS. Another method is the bending of propellers from sheet balsa wood. These are good for ordinary flying models, but not for contest work, as they have not the strength or accuracy of the carved propeller.

These can be made of a veener, but sheet balsa makes splendid bent wood propellers, weighs less, and can be worked with far greater ease. Obtain a piece of 1/64″ or 1/32″ sheet balsa. This is cut as wide as you wish your blades to be when finished, and as long as the overall length of the propeller. Square up the piece and draw two diagonal lines on one face from corner to corner, as in Fig. 53, No. 1. As considerable width must be left for the hub, a ¼″ wide section is left in the center for this, as in Fig. 53, No. 2. This form is now cut out, and the sheet is ready for bending.

BENDING AND DRYING PRESS. To bend such a propeller, a press is made, as shown in Fig. 54. Some merely soak their balsa, twist its blades, and hold them over a flame until dry, but hand twisting is seldom uniform, and holding the blades while drying is difficult.

Such a press as shown is not difficult to make, can be used for any size propeller, and gives perfectly uniform blades. Any available wood can be used. It should be made large enough to take at least a 12″ long propeller, and high enough to allow the flame of the alcohol lamp to be at least 6″ from the propeller when in place in the press.

Cut the base 1″ x 3″ x 14″, and the sides ½″ x 3″ x 12″. Directly in the center and 2″ from one end, bore one 1″ diameter hole through each of the

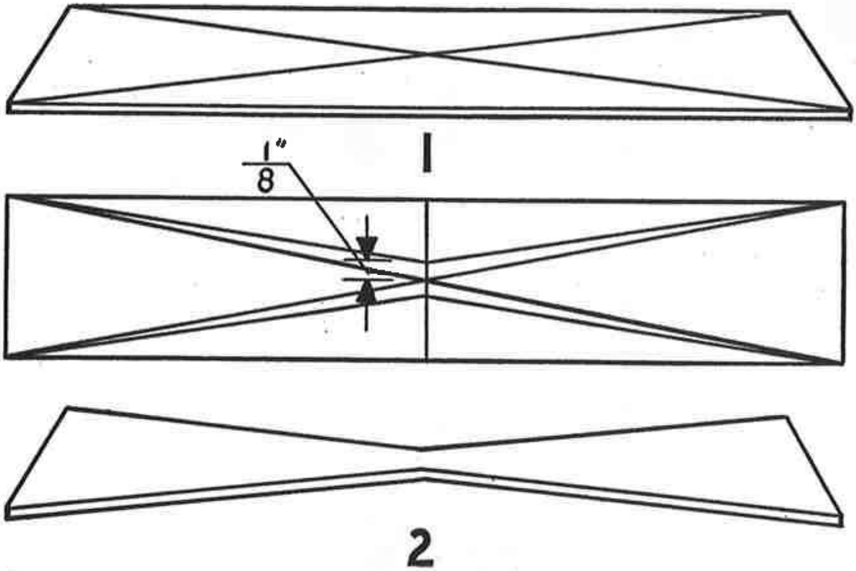


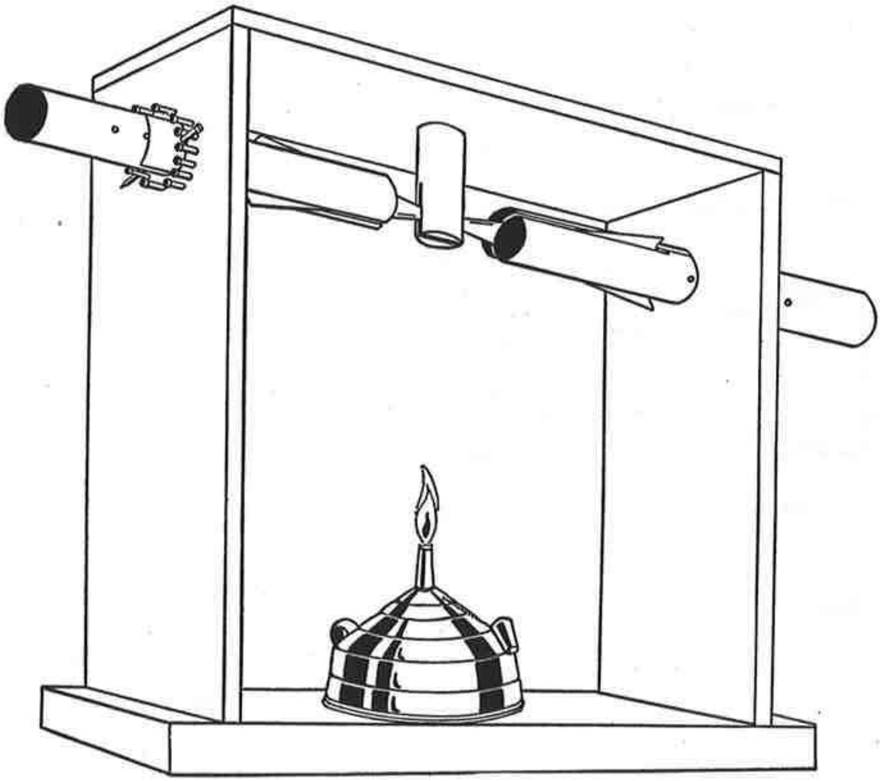
FIGURE 53. CUTTING BENT WOOD PROPELLER BLANK

side pieces. Drive two-penny (1″) brads in a circle around each of these holes, as shown, but do not allow them to protrude through the wood. When doing this, make sure that the nails are on the outer side of these side pieces, which are now nailed to the base board ½″ in from its ends.

In one end of a 2½″ length of broomhandle, a saw slot is cut about 1″ deep. This is now centered on a ½″ x 3″ x 13″ top board, and nailed firmly in place. The top board is nailed across the ends of the side boards. The two grips are made so that the blades are not only twisted, but also given the necessary curves to produce concave and convex sides, when in them.

Study Fig. 55. The top is a 1″ diameter piece of stock as in Fig. 55, No. 1. This is cut 5″ long. The dotted lines shown in 2 represent the saw cuts. The straight portion of the cut is made ⅛″ off center and 4″ long. Another cut is made from the other end of the length through the dead center of the stock and parallel with the first. The third cut joins the first and second, as shown in 3.

To complete the piece, the long cut edge is rounded to a convex form, as in 4 "Top." The bottom piece is the same diameter, but 7″ long. It is sawed



BENDING AND DRYING PRESS

FIGURE 54

through the center 5″ deep, while another cut severs the piece, as in Fig. 55, No. 2 "Bottom." The piece is now given a concave form for a distance of 4″ along its length, as in 3. Tests are now made to see that the convex portion of the top piece fits the concave portion of the bottom. These are completed and smoothed with sandpaper, so that when nailed together the slot between them is about $\frac{1}{32}$″, as in 5. A second grip is now made in the same manner. Place both grips through the holes in the sides of the press and

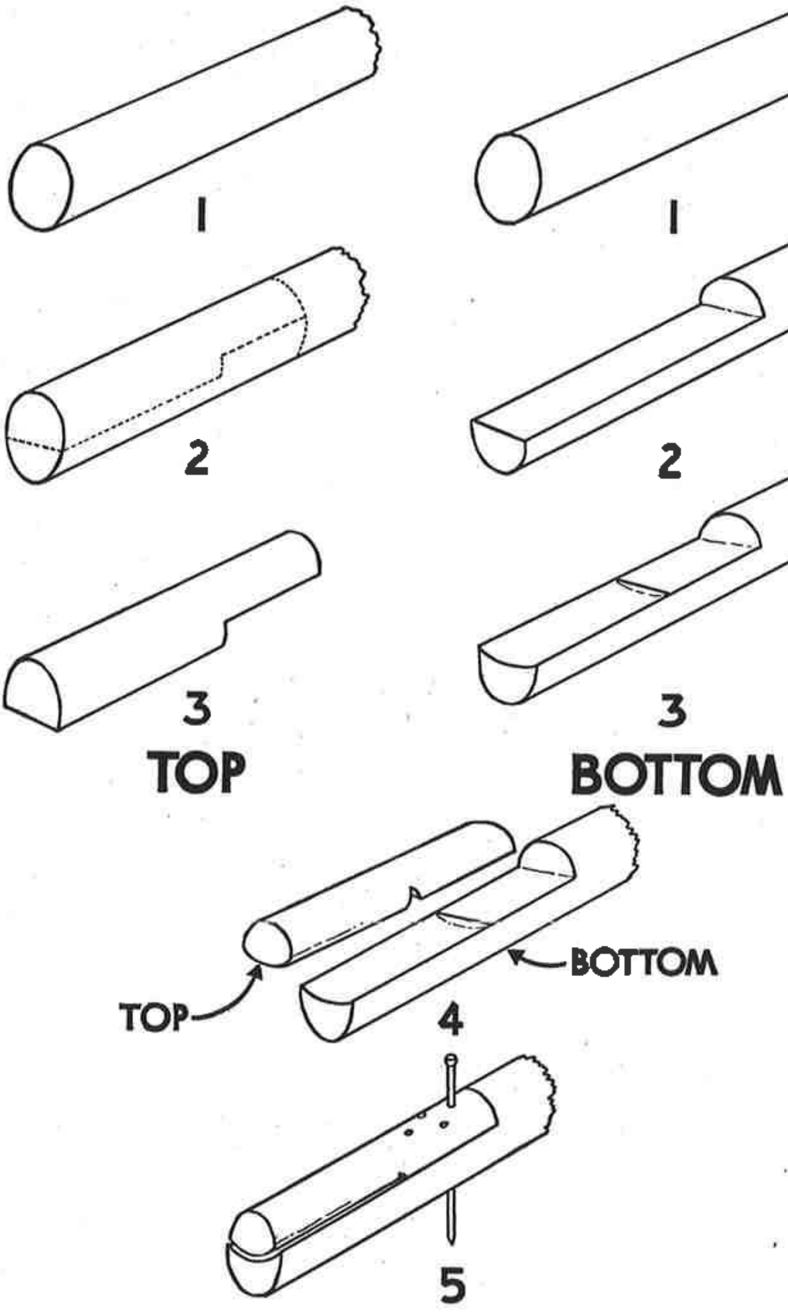


FIGURE 55. STEPS FOR MAKING, BENDING, AND DRYING PRESS GRIPS

work them back and forth until they turn in the holes easily. If the fit is too tight, sandpaper the grips. Place them in the holes with their inner ends 1″ from the center broomhandle piece. Mark on the grips the points of intersection between them and the outer side of the side boards when in this position. Remove the grips and drive a seven-penny (2¼″) brad through the center of each grip at these points. Make two or three more holes at ½″ intervals back of the first one through the centers of the grips with the brads. Remove all brads, and test six-penny (2″) brads in the holes to see that they slip in and out easily. This completes the press.

The sheet balsa blank shown in Fig. 53, No. 2, is thoroughly soaked in hot water, and then placed in the press. To do this, place the hub portion of the blank in the center grip. Thrust one side grip through its hole, slightly curve the blade of the blank with the fingers, and fit it into the slot of the grip, which is worked toward its hub. The second side grip is assembled on the second blade in the same manner. The first blade is then twisted as desired and the nail thrust through the hole between the nails in the side, which hold the grip and its blade in position. The second blade is then twisted and held in the same manner.

The propeller can be dried naturally, or an alcohol lamp may be placed on the base of the press, as in Fig. 54, so that its heat will create forced drying. The lamp should be moved from time to time to obtain even drying. When dry, the nails are removed, the grips pulled out, and the propeller released.

When the bending is completed, the form of the blades is drawn or traced on the balsa, as in Fig. 56, No. 4. The tips are now cut and the blades lightly sandpapered, as in 5. Test the propeller for balance. (See "Carved Propellers—Balance Block.") The usual propeller shaft of piano wire is inserted through the hub of the propeller and bent around. The point of the wire is not allowed to enter the wood at the hub, as in carved propellers, for this might split the wood. The last bend overlaps the hub and cement is applied, which will hold it firmly in place. The finished propeller is shown in 6.

LAMINATED PROPELLER. As far as flying models are concerned, the laminated propeller is seldom used. It has no advantages and is a complicated way to make a propeller blank. However, as an exhibition propeller on War models such as the S.E.5 and the Fokker, which are in this book, it cannot be surpassed. These planes had the old wood propellers of laminated construction, and, if great accuracy of detail is desired, models of these planes should be equipped with laminated propellers, which should be stained and then rubbed with pumice and oil.

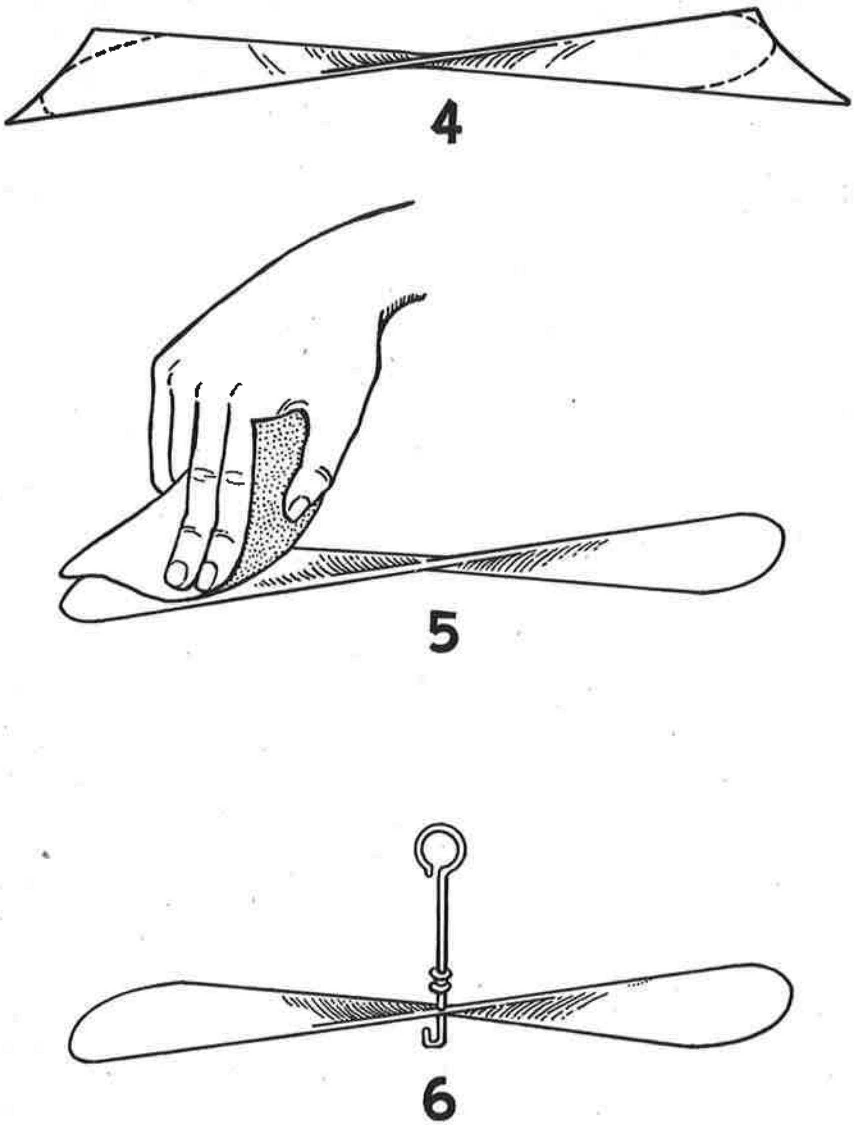


FIGURE 56. STEPS FOR COMPLETING BENT WOOD PROPELLER

A laminated propeller consists of a number of 1/64" or 1/32" sheet balsa lengths. They are assembled on top of each other and a long pin, such as an old hat pin, is forced through their exact center. Cement is applied between each face of these sheets, and as each is pressed to the under one, it is slightly pivoted on the pin, until the assembly is formed as in Fig. 57, No. 1.

This is allowed to dry. It is then carved the same as a regular carved propeller. This is shown in 2.

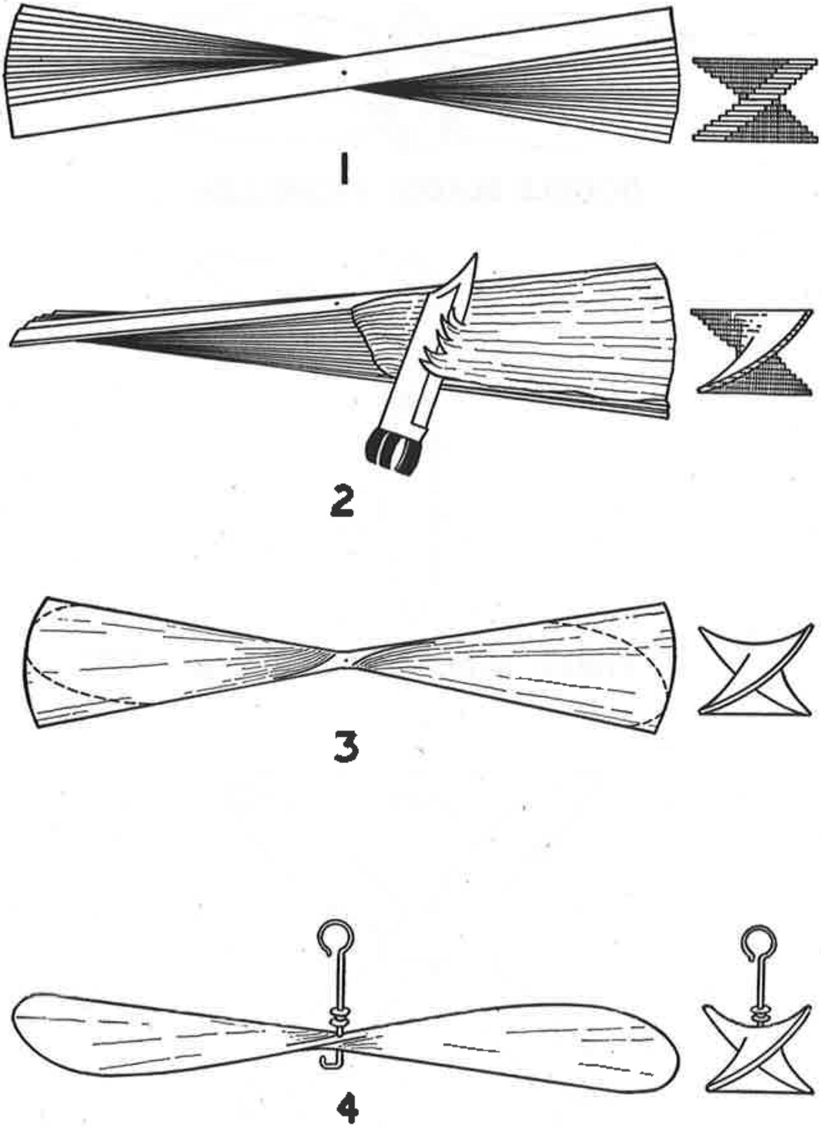
The propeller shaft is attached in the same manner as on any carved propeller.

BUILT-UP FLYING PROPELLER. Many flying scale models of modern design require this type of propeller, as they represent metal propellers with spinners. Fig. 58 shows three types of these propellers. The two-bladed propeller will be required on such flying models as the Autogiro PA-19, the Stearman Mailplane, and the Curtiss-Wright Sedan, while the three-bladed propeller is necessary for the Curtiss Shrike YA-8 Attack, all of which are in this book. While no four-bladed propellers will be required for the models in this book, such models as the Ford 8-A and others do require them.

These propellers are made of two, three, or four blades and a hub called the "spinner." All parts are of balsa. The blades are cut to shape and size from 1/32" or 1/16" sheet balsa. The most usual shape for these is shown in Fig. 58 under "Double Bladed Propeller." The spinner is carved from a square or round piece of balsa into the form of a cone. Slots are cut in the side of the spinner at an angle sufficient to produce the proper slant to the blades, as in the top views of Fig. 58. The blades are sandpapered smooth with a slight curve to produce a concave and convex side, and their ends tapered to fit deep into the spinner slots, where they are firmly cemented.

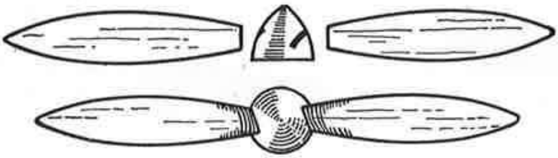
The propeller is then balanced. (See "Carved Propellers, Balance Block.") Care must be taken to see that each blade is directly opposite the other on two-bladed propellers, while three- and four-bladed propellers must have their slots so located in the spinner as to make the blades an equal distance apart when assembled. They are finished in the same manner as carved propellers.

TRUE-PITCH PROPELLER. Any discussion or instructions on the making of true-pitch propellers should rightly be placed after "Propeller Sizes" in this chapter, but it has been purposely placed after the various methods of cutting propellers, because few builders make true-pitch propellers. Others, novices in model airplane construction, might consider that every propeller must be a true-pitch one, which is not the case. It is true that

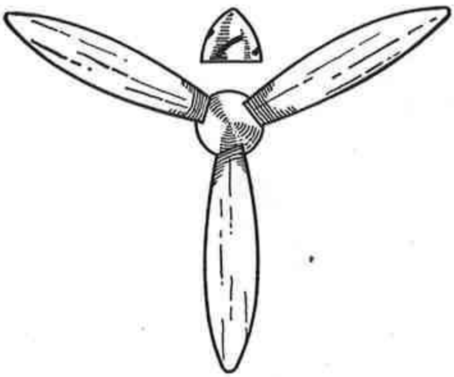


LAMINATED PROPELLER

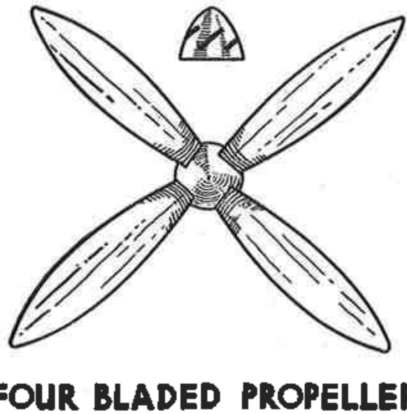
FIGURE 57



DOUBLE BLADED PROPELLER



THREE BLADED PROPELLER



FOUR BLADED PROPELLER

BUILT-UP FLYING PROPELLERS

FIGURE 58

if you wish a maximum of efficiency, your propellers should be true-pitch, but the beginner should not attempt designing these for his first models.

Even some experts are in the habit of thinking that the designing and cutting of true-pitch propellers is a most difficult task. This is due to a mistaken belief that no one but an aeronautical engineer can understand propeller mathematics. The author hopes the following information will abolish this belief, and that all builders of model aircraft will sooner or later make and use true-pitch propellers.

It must be understood that all the various methods so far described for carving propellers can be used for true-pitch propellers, and that the method used for carving or making the propeller is in no way affected by the fact that it is, or is not, to be a true-pitch propeller.

Three main factors must be considered in the shaping of such propellers:

(1) The theoretical pitch of the propeller.

(2) The desired width of the blade of the propeller.

(3) The necessary size of the propeller block.

The theoretical pitch of a propeller is the distance it would travel forward in one revolution if operating like a screw in solid material. We know that a certain amount of slippage prevents any propeller from boring through air as it would through a solid, so when we speak of the "theoretical pitch" we must speak in terms of theory. We likewise know that the slant of the propeller's blades forces the propeller through the air as the slant of the threads of a screw forces it through wood.

The theoretical pitch of a propeller is found by the following formula:

$$\text{Theoretical Pitch} = \frac{D \times \pi \times T}{W}$$

where D = the length of the propeller block, π = the constant 3.1416, T = the thickness of the propeller block, and W = the width of the propeller block.

For example, if a block measures 1″ x 1½″ x 11″, the formula would read: $\frac{11 \times 3.1416 \times 1}{1\frac{1}{2}} = \frac{34.5576}{1\frac{1}{2}} = 23.03''$, theoretical pitch.

On a sheet of paper — graph or cross section paper will be found best — draw a horizontal line which is as long as the circumference of the circle made by the tip of the propeller in one revolution, as in Fig. 59. In other words, it represents the length or diameter of the propeller multiplied by the constant 3.1416.

From the hub point and perpendicular to the circumference line, draw another line, which must be as long as the theoretical pitch of the propeller being designed. These measurements must be exact, but can be drawn to scale if desired. Divide the circumference line into four equal parts and

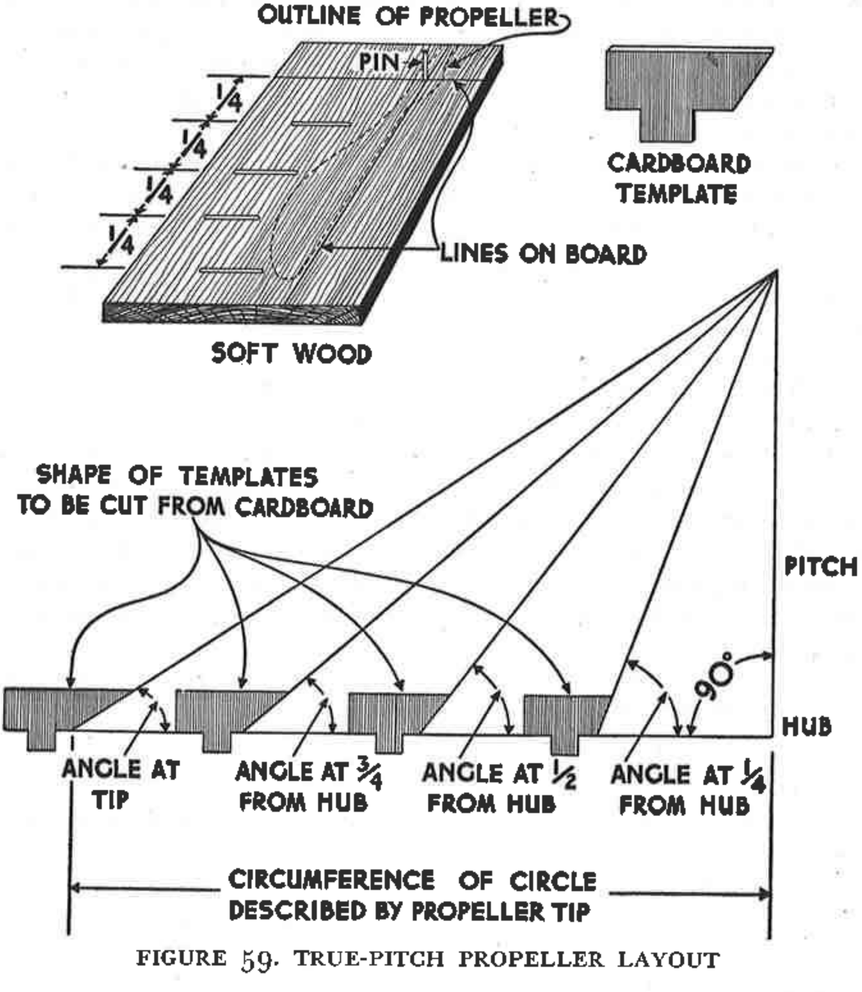


FIGURE 59. TRUE-PITCH PROPELLER LAYOUT

draw lines from these division points to the upper end of the pitch line, as in Fig. 59. These lines form with the base line the correct angle to be cut at each of their respective positions on each blade of the propeller. Block out the templates, as shown, and mark each according to its position along the propeller blade. Cut out each of them, trace the outline on tin or stiff cardboard, and cut the finished templates, which will appear as in Fig. 59

under "Cardboard Template." Note that these templates have small extensions on their bottom edges.

The next step is to prepare a soft wood platform. This should be slightly longer than the radius of the propeller, which includes one blade and half the hub. A line is drawn the length of the board and another line at right angles to it, as shown in Fig. 59.

A pin is thrust through the propeller shaft hole and into the board at the

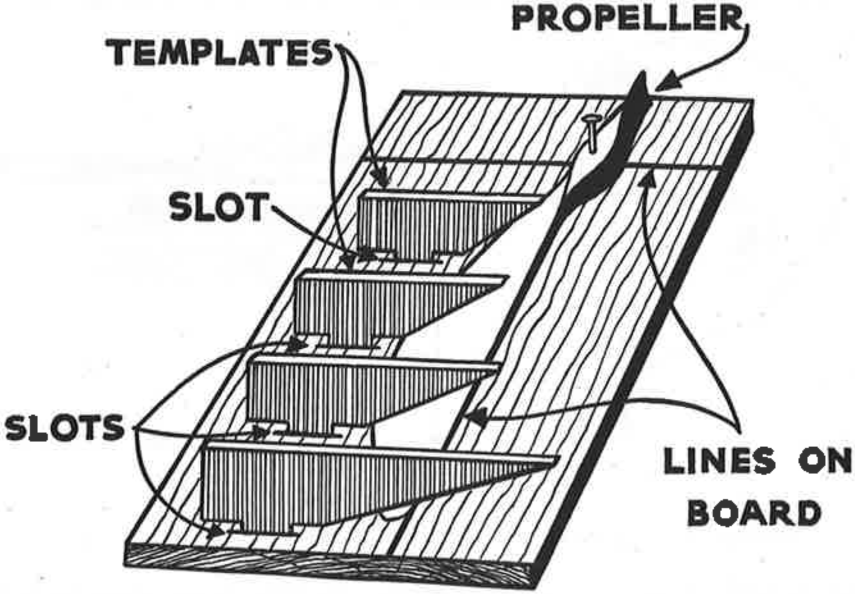


FIGURE 60. TRUE-PITCH PROPELLER PLATFORM ASSEMBLY

point where these two lines intersect. (Note pin location.) Shape the propeller as desired and carve the blades down until they are about ¼″ thick. Place the propeller on the platform and trace its form with pencil on the board. Draw lines at right angles to the long line, as indicated by the short double lines on the platform, dividing the radius of the propeller into four equal lengths. Cut these lines through the board, but be sure that they are not longer than twice the width of the small extension pieces on the templates.

Again lay the propeller in place, slip the flap of each template into its respective slot, and push it up to the edge of the propeller blade, so that the angle of the template extends over the face of the propeller blade. Be sure that the bottom edge of each template is resting on, and is parallel to, the top of the platform. Fig. 60 shows the finished platform, with each template in place, and the propeller ready to be tested. Fig. 61 shows the correct method of using the platform. As the blades are cut thinner, the templates must be pushed up, so that the angle at each point will remain correct. More templates can be used, if desired, simply by drawing more lines forming more angles and fitting the added templates into the platform at their respective positions.

Fig. 61 shows the platform placed on a surface level with the eyes, so

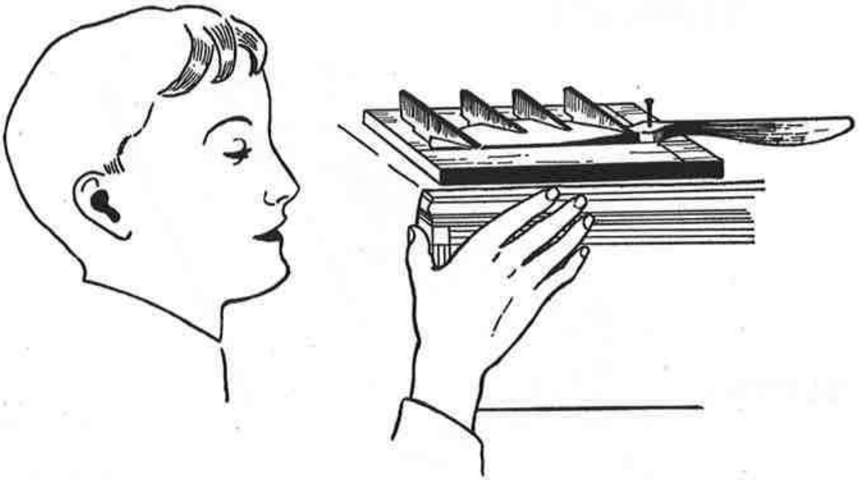
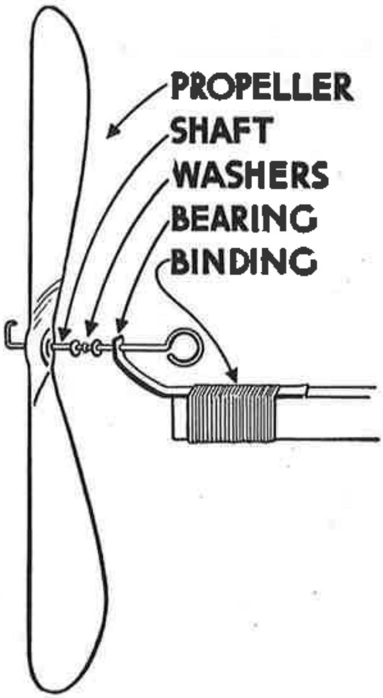


FIGURE 61. METHOD OF SIGHTING PROPELLER PLATFORM

that the builder can see at a glance whether the slant he has given his blade coincides with the angle of the template at each particular point. Of course, the blades must be sandpapered until the templates fit tightly against the blade at all points. When one blade has been perfected in this manner, the propeller is swung around and the other blade completed. Such templates and platform, as described here, may be kept for future use, but they can be used for one size of propeller block only. Others must be made to fit other sizes.

Great care should be taken to see that the platform is perfectly level at all points and that the bottom edge of each template is flat on the base.

PROPELLER ASSEMBLY. Fig. 62 shows the assembly of a propeller on a motor stick. Some fuselage models have no motor sticks, in which case a front plug is used for the propeller bearing, but aside from this difference, both assemblies are alike. The propeller shaft is of piano wire, shaped as shown. (See Chapter 6, "Propeller Shafts.") The illustration shows the shaft before it has been cemented to the hub. When the shaft has been bent to this form, it is pulled back, as if to draw it back through its own hole. The point of the wire is guided into the wood of the hub, where it is pressed



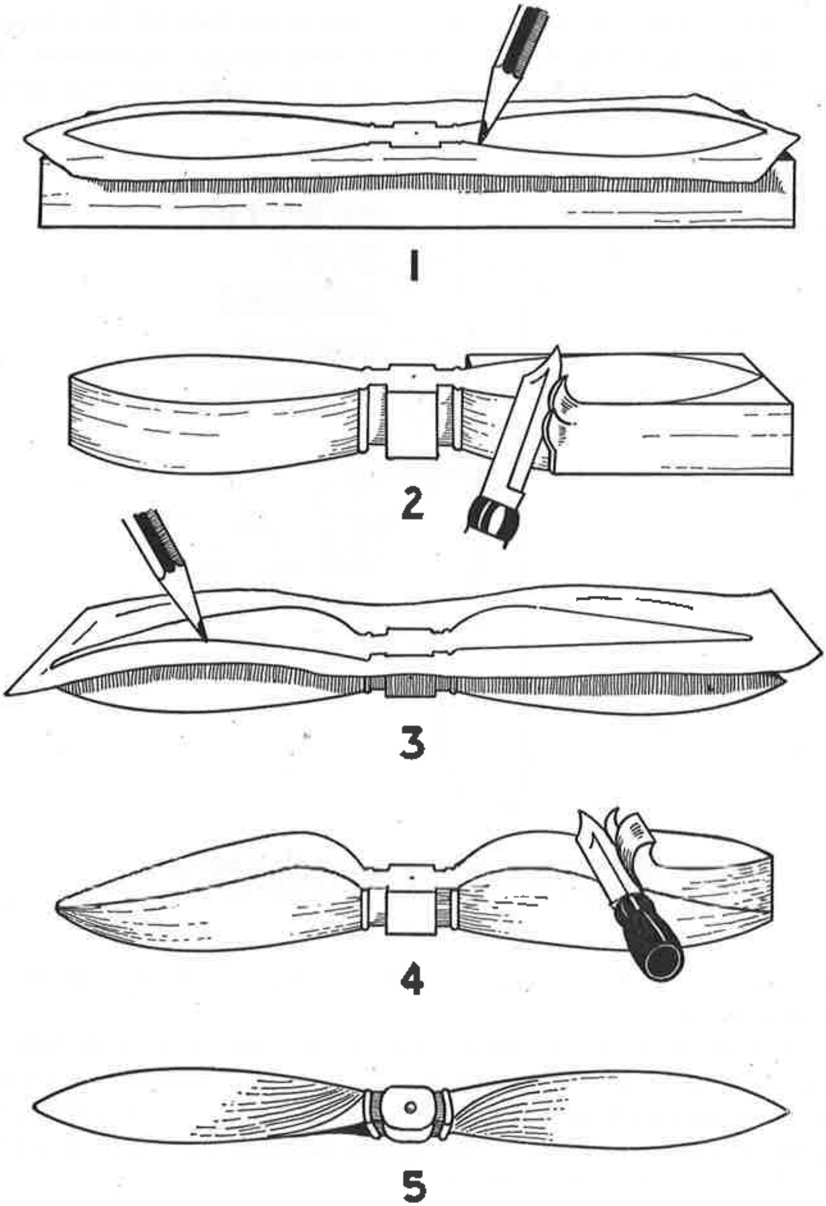
PROPELLER ASSEMBLY

FIGURE 62

into place, and cement is applied to the face of the hub over the bend of the shaft.

Many builders cement a large washer to the inside face of the hub, and then apply other washers to eliminate friction. The hub washer prevents the others from wearing into the face of the hub. Two small washers, with a bead of steel or an ordinary dress spangle between them, make a splendid assembly against friction, as shown.

For all small propeller bearings, it is best to cement the bearing to the stick, and further strengthen it with silk thread binding, as shown. When



EXHIBITION PROPELLER

FIGURE 63

fully wound, the thread is coated with cement or dope to tighten and hold it in place.

EXHIBITION PROPELLER. All non-flying models require exhibition propellers. Balsa wood is recommended for these because they require considerable carving. Fig. 63 shows the five steps for carving an exhibition propeller. Square up a block to the necessary length, width, and thickness. Make a full-size top and side pattern of the finished propeller. Trace the outline of the top on the block, as in Fig. 63, No. 1. This is then cut out, as in 2.

The side form of the propeller is traced on the side of the block, as in 3. This is then cut out, giving a perfect propeller blank, which is shown in 4. The propeller now has its blades carved as explained under "Carved Propellers." When completed, the propeller is given two coats of banana oil with a light sandpapering between coats. This is followed by three coats of aluminum paint. A model pin, thrust through the hub, is used to assemble the propeller to the nose of the fuselage or engine core. The finished propeller is shown in Fig. 63, No. 5.

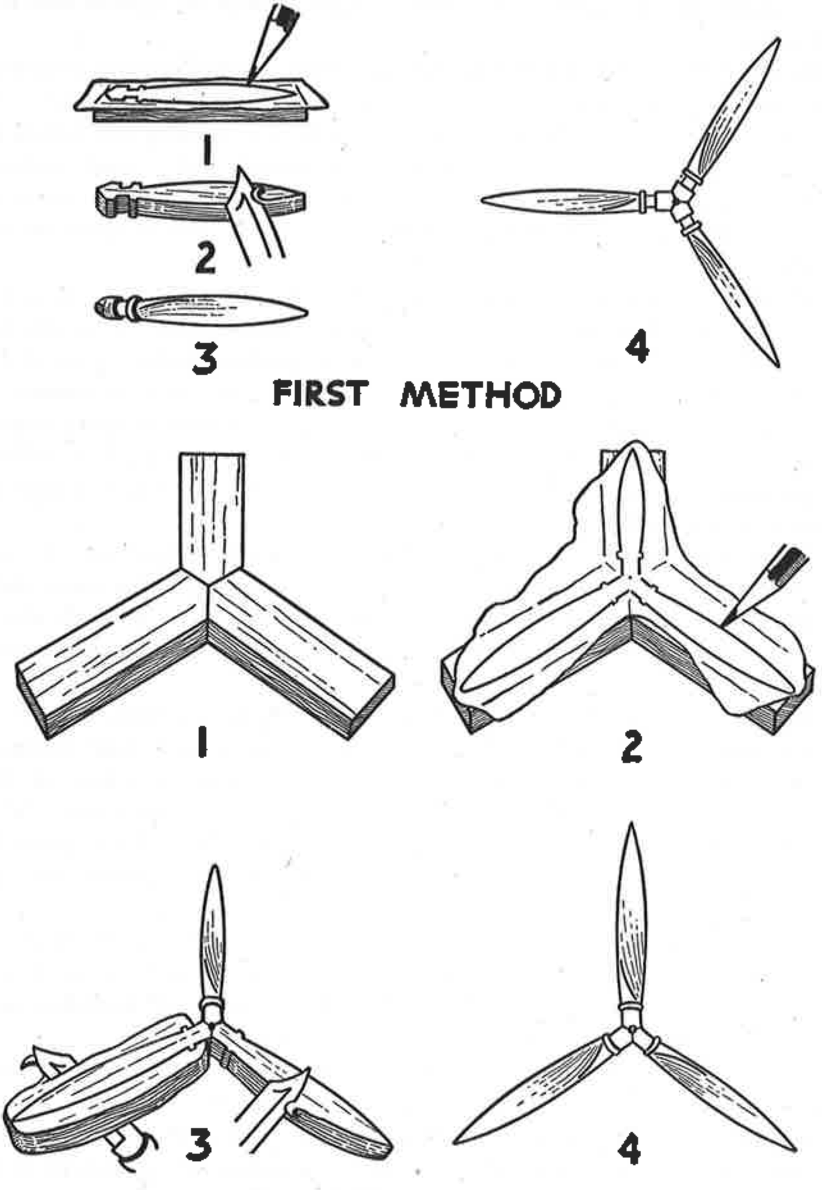
THREE-BLADED EXHIBITION PROPELLER. There are two popular methods of making these. The first, shown in Fig. 64 is the more simple of the two. A pattern of the blade is made and traced on a block already cut to proper size, as in 1. This block is only half as long as the finished propeller.

It is then cut out, and the blade carved from the top back edge to the bottom front edge, as in 2. Half the hub shape is cut, plus a small triangular piece at the end, as shown. The blade is sanded smooth. Three of these blades are made. A circle is drawn to represent the circumference of the propeller, divided into three equally long arcs, and the blades placed in position on the drawing with their tips at the division points and their hubs together in the center.

The triangular ends are now cut to fit each other, while the blades are in position. When completed, they are cemented together, as in Fig. 64, No. 4. The propeller is then finished as was the two-bladed propeller, and a pin is thrust through its hub for assembly on the model.

The second method consists of cementing the three original blade blocks together, as in Fig. 64, No. 1 under "Second Method." The outlines of the blades are then traced on this block, as in 2, and cut out. Each of the three blades is then carved. These two operations are shown in 3. The finished propeller is shown in 4.

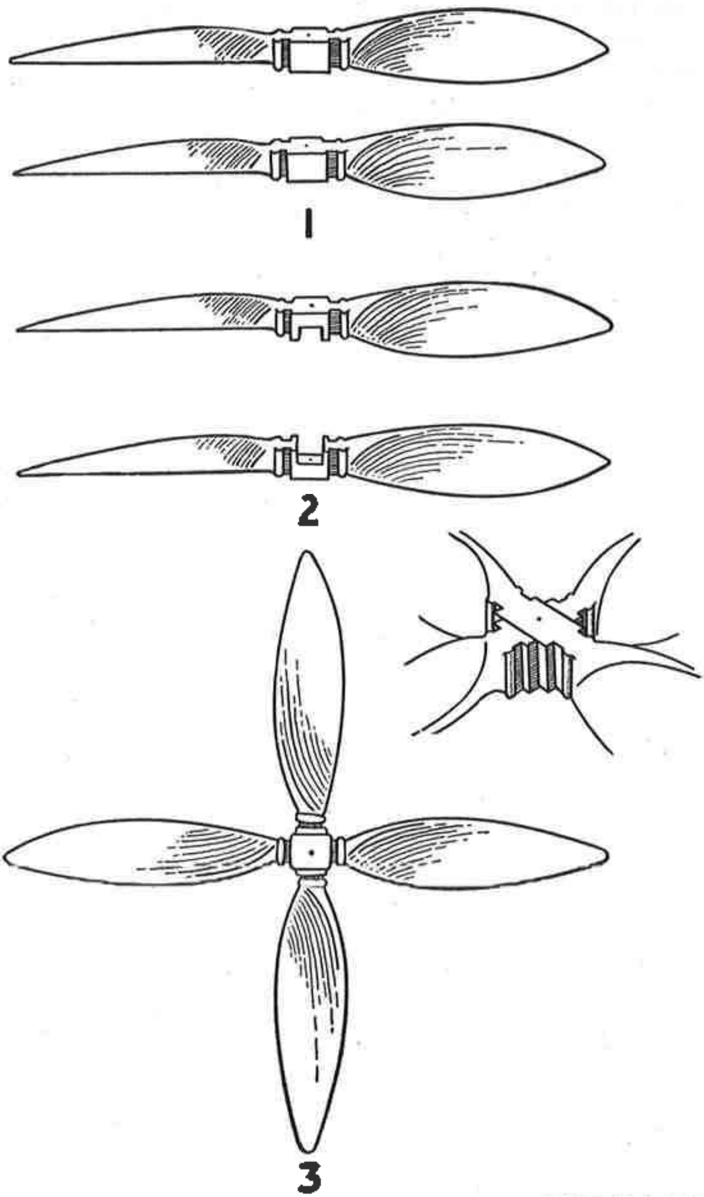
FOUR-BLADED EXHIBITION PROPELLER. As shown in Fig. 65, No. 1, two exhibition propellers are carved as described in this chapter. See



SECOND METHOD

THREE-BLADED EXHIBITION PROPELLER

FIGURE 64



FOUR-BLADED EXHIBITION PROPELLER

FIGURE 65

Fig. 63. The thickness of their hubs is now notched halfway through, as in 2. To complete such a propeller, the notched portion of one is fitted into the notched portion of the other, and held with cement. Make sure that their hubs are notched only half their thickness, and that the walls of the notches are straight, so that when the propellers are fitted together, the tips of the blades will be an equal distance apart. This type of blade is also finished as were the other exhibition propellers.

CHAPTER 10

LANDING GEARS

SINGLE-STICK LANDING GEARS. Landing gears for these models serve only one purpose. This is to enable them to take off from or land on ground, water, or snow. They are not added for appearance, nor are they used particularly as a safeguard for the model upon landing.

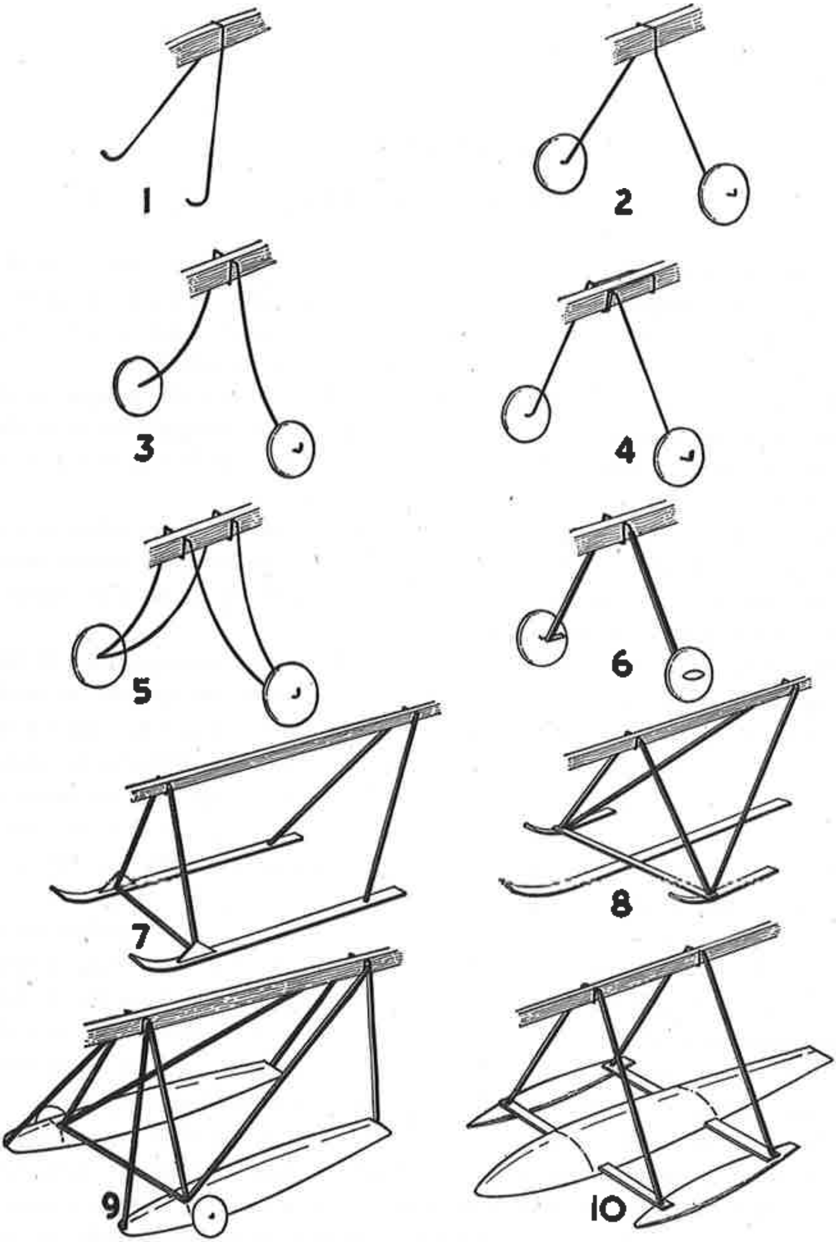
They should be as light as possible in order to keep the weight of the model at a minimum, but at the same time, strong enough to bear that weight, whatever it may be. In Fig. 66 ten popular landing gear types are shown.

No. 1 shows a skid gear used without wheels. At one time, when models weighed considerably, such skids were added to keep the model from breaking on landing. The skid consists of a single length of piano wire, bent to fit the motor stick, and having its ends turned up.

No. 2 shows the most popular type of landing gear used on light R.O.G. single-stick models. A length of piano wire is bent in the middle to fit the motor stick, from which it extends down on both sides. The ends of the wire gear are bent parallel to the ground to act as axles. Wheels are placed on the axles, and the tips of the axles are then bent up to keep them on. Another method of keeping the wheels in place is to apply a drop of cement to the ends of the axles after the wheels are in place. In this way, the ends do not require bending.

No. 3 illustrates another R.O.G. landing gear. This is attached to the under side of the motor stick, and the supporting wire struts have a slight bend. Such a gear has a certain amount of spring on touching the ground. The connection at the motor stick has no particular advantage over that of No. 2. On extremely light models builders prefer No. 2 stick connection, because it requires about ½″ to 1″ less wire, and saves that weight.

No. 4 landing gear is an exact copy of No. 2 except that its motor stick connection has been supplied with a saddle. Single wire connections sometimes allow the gear to fold against the stick when the model receives a sudden forward or backward shock on landing. With the saddle arrangement the gear has two points of contact with the motor stick, which prevent



SINGLE STICK LANDING GEARS

FIGURE 66

it from being folded forward or backward. Note how this saddle is bent, as shown at the right of the illustration.

No. 5 shows another method of obtaining the same effect as the saddle. Here two lengths of piano wire are bent as shown in No. 3 gear. Only one of these is thrust through the wheels, while the second is either twisted around the first one, soldered, or cemented to it. Notice, however, that such a gear requires about twice the amount of wire that is needed for the others. Because of this added weight it is seldom used on endurance models.

No. 6 is constructed of piano wire and balsa or bamboo. A wire clip fits under the motor stick, as in No. 3. Its ends extend down just far enough to be cemented into the ends of the landing gear struts, which are of balsa or bamboo. Short lengths of wire are cut and bent to form axles. These are thrust into the other ends of the upright struts and cemented. Wheels are then fitted on the axles. Small streamlined pieces of balsa wood are shaped and cemented over the ends of the wire.

No. 7 shows an R.O.S. (rise-off-snow) landing gear. It consists of two wire clips as shown for No. 6. These fit into balsa struts and are cemented in place. The distance between these clips on the stick should be great enough to hold the stick above the snow. The leading pair of balsa struts is at right angles to the stick, while the trailing pair extends back from the ends of the skis. Bamboo is usually used for skis, but to cut weight they can be made from 1/32″ sheet balsa, cut 1/4″ wide and sandpapered smooth. The ends of the skis should be bent up, as shown. Small triangular braces are used to strengthen the connection of the front struts, as these receive the greatest strain.

No. 8 shows another R.O.S. landing gear which has proved practical. Its motor stick connection is a duplicate of that of No. 7, but in this case only one long center ski is used, while two shorter ones act as balancers.

No. 9 illustrates an amphibian landing gear. It consists of the usual wire motor stick connection clip, balsa struts, and built-up floats. These are made of balsa formers with bamboo stringers forming their outline. This frame is then covered with tissue, water-sprayed, and doped. The latter makes it water-tight, which is of utmost importance. The general construction details of such a float are shown in Fig. 67, No. 1.

Small balsa wheels are used for R.O.G. purposes. These are attached with large-head pins, which are thrust into the sides of the float former. For landing on the water, these wheels need not be removed, as they will not interfere with the action of the floats.

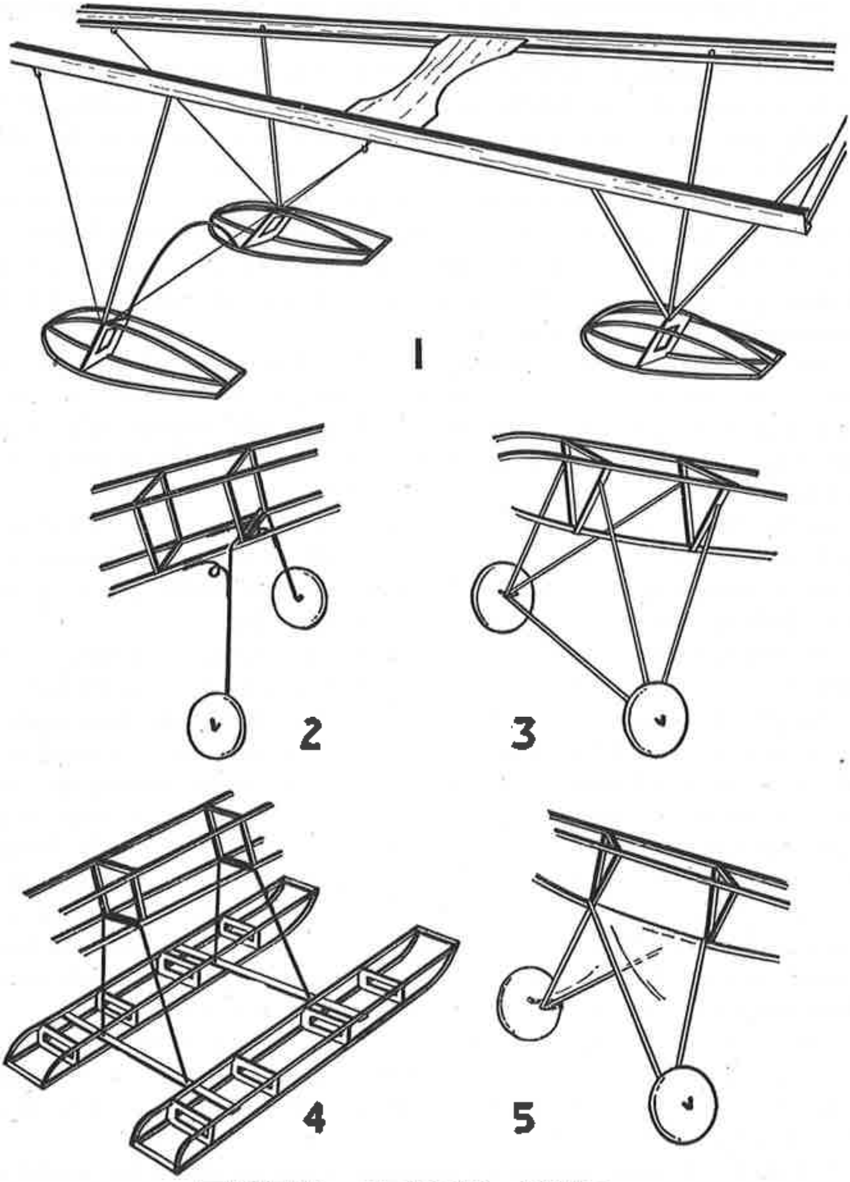
No. 10 is an illustration of the R.O.W. (rise-off-water) type of landing gear. Its construction is much the same as the amphibian gear, except that it has only one large float of the built-up type, while the two small side floats act as balancers. The small floats are of solid balsa, which has been well doped to make them water-tight. The large center float is constructed with two balsa formers and bamboo stringers. The small side floats are connected to the center built-up float by two lengths of balsa wood, which are cemented to the side bamboo stringers as well as to the two formers. Full instructions for making this gear will be found in Chapter 31. Either No. 9 or No. 10 can be made amphibian or just R.O.W. by adding or removing the side wheels.

TWIN-STICK AND COMMERCIAL LANDING GEARS. In Fig. 67, No. 1, is shown an R.O.W. (rise-off-water) landing gear, as applied to a twin-stick pusher. Full instructions for making such a gear will be found in Chapter 28.

No. 2 is designed for commercial models. A length of piano wire is bent in a "U" with its cross portion cemented to the under side of the fuselage and strengthened with silk thread binding. The upright portions are then spread apart about twice the width of the fuselage, and wheels are attached in the usual manner. Small lengths of piano wire are bent in loops, and attached between the fuselage and the upright strut sections of the landing gear. These are cemented in place and strengthened with silk thread binding, as shown. They function as springs, tending to absorb the shock of landing.

No. 3 is an R.O.G. gear especially adaptable to triangular fuselages. No wire is used on this gear, except very short lengths for axles. Bamboo is used in place of the wire, and balsa wood is not recommended, as any severe landing shocks will quickly break it, while bamboo is practically unbreakable.

No. 4 is an R.O.W. landing gear often found on commercial models. The form of the floats, shown in Fig. 66, Nos. 9 and 10, and in Fig. 67, No. 1, gives graceful streamlining, although it is a question as to which construction is the more simple. No. 4 is shown uncovered, so that all details can be seen. It consists of four formers, all square, with a bamboo stringer passing through each corner. These four stringers are united at both ends with a balsa cross brace. The float is covered with Japanese tissue, water-sprayed, and doped. Bent piano wire in the form of an inverted "U" makes the connection to the fuselage. The cross portion of the "U" is cemented and bound with silk thread to a bottom cross brace of the fuselage. The ends of the wire are bent and then cemented to the under side of the two connecting axles of the gear after they pass through each.



TWIN-STICK AND COMMERCIAL MODEL LANDING GEARS

FIGURE 67

No. 5 illustrates another R.O.G. landing gear for triangular fuselages. See building instructions in Chapter 35.

SCALE MODEL LANDING GEARS. In Fig. 68 and Fig. 69, fifteen of the most commonly seen landing gears are shown. These are replicas of the landing gears of various real airplanes, as of course they must be when attached to true scale models. As all of these are fully explained in the text covering the particular model to which each belongs, details will not be repeated here. No. 1 is the landing gear of the S.E.5 in Chapter 49. No. 2 is that of open cockpit Pitcairn Autogiro in Chapter 55. No. 3 is the landing gear of the Curtiss-Wright Sedan in Chapter 51, while No. 4 is the Stearman Mailplane in Chapter 54.

No. 5 shows the landing gear of the Waco Taper Wing in Chapter 47, and No. 6 is the Curtiss-Wright Junior in Chapter 46. In No. 7 we see a landing gear not given in this book. It belongs to the Stinson Monoplane. Such a gear is built up of bamboo lengths. No. 8 is the German Fokker D-7 in Chapter 53.

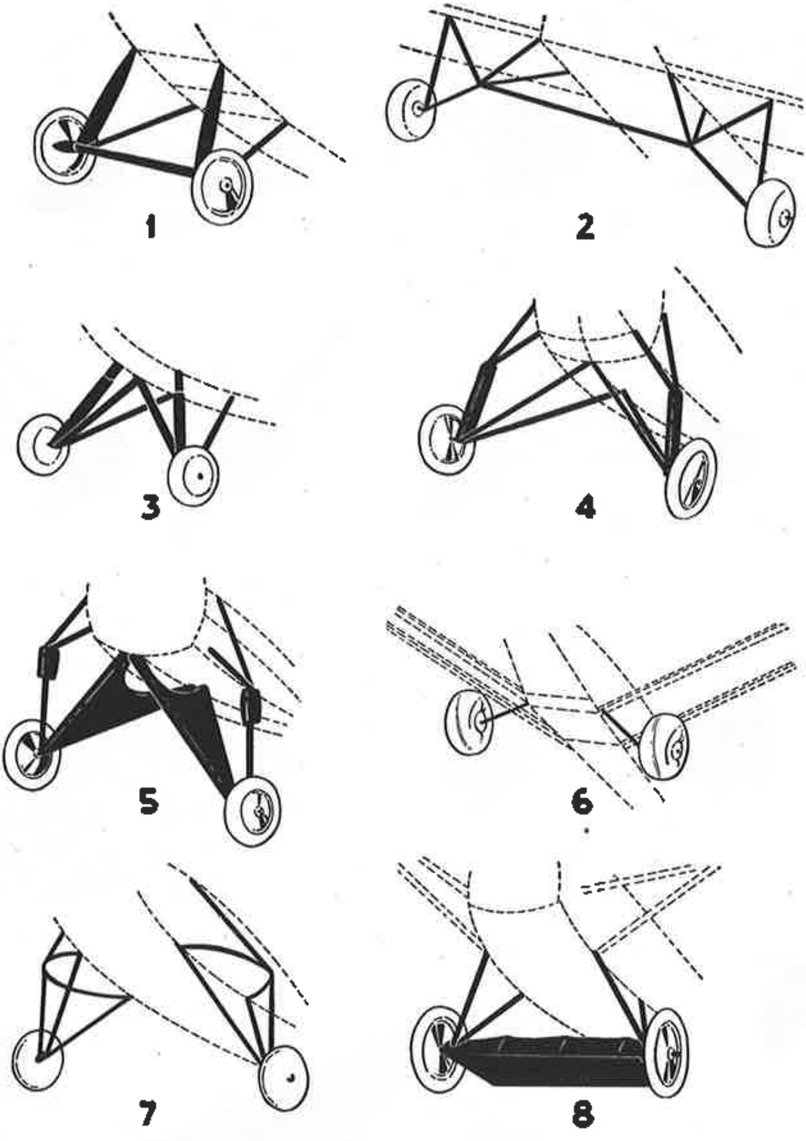
In Fig. 69, seven other popular landing gears are shown. No. 9 is that of the Gee Bee Super-Sportster in Chapter 40. No. 10 shows the landing gear of the Lockheed-Vega "Winnie Mae" in Chapter 42, while No. 11 is that of the Bellanca Pacemaker "Cape Cod" in Chapter 36.

No. 12 shows the landing gear of the Wedell Williams in Chapter 44, while No. 13 is the gear belonging to the Northrop Gamma in Chapter 48.

No. 14 has been added to this group to show the inside framework of the average scale model R.O.W. floats. These are built up of a number of balsa formers, with bamboo stringers connecting them and shaping the structure. While floats gain their forms from those of the real ships being copied, practically all are constructed in the same manner, so the builder can gain a general working knowledge of float construction through studying these. It has been found that bamboo is best for the stringers of such floats, as it is practically unbreakable, resists water splendidly, and has a certain amount of spring which balsa wood lacks. While the weight of the bamboo is slightly greater, the above factors offset this disadvantage.

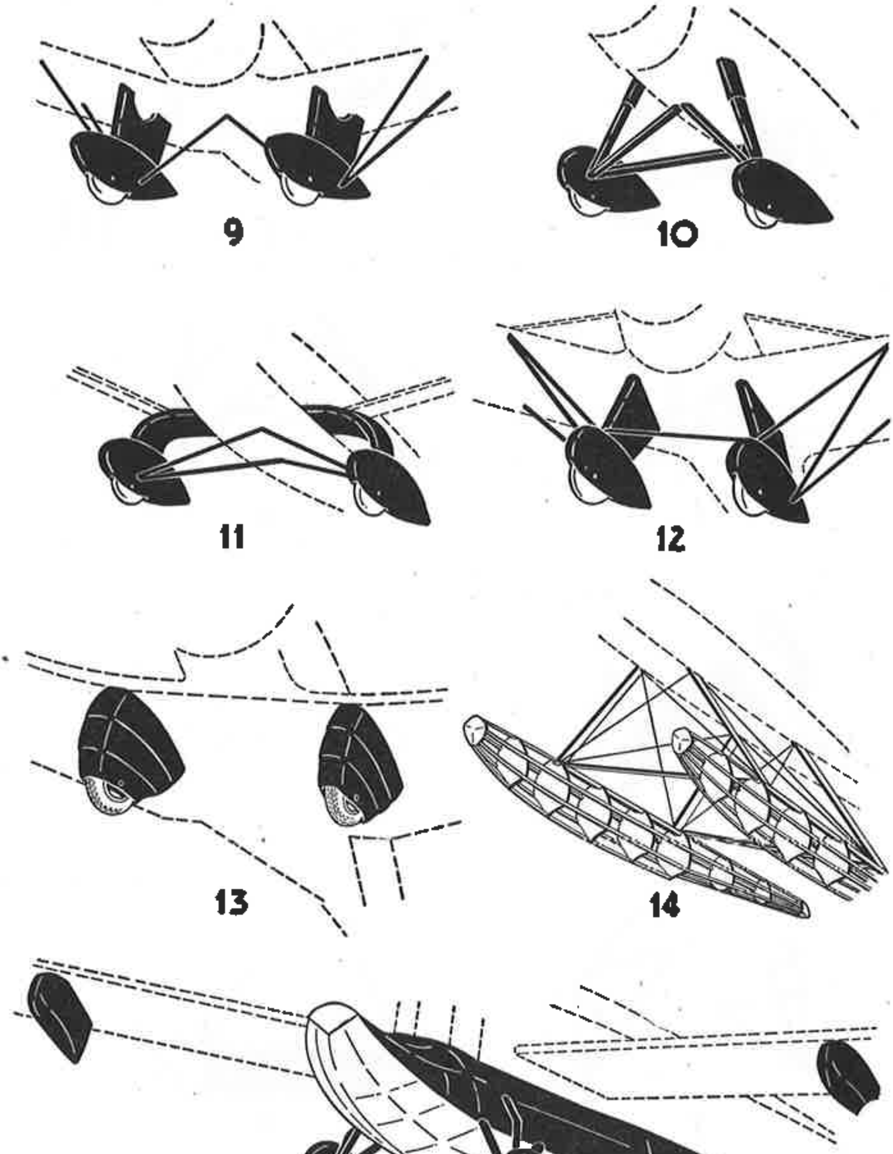
No. 15 shows the hull of the Loening Amphibian in Chapter 50. All of these gears are shown here to acquaint the reader with the various popular forms of landing gears, and a close study of each should prove of great aid when building scale models.

WHEELS. A great assortment of various types of wheels for model airplanes are carried by practically every model supply house. Some builders, when turning out a perfect scale model, prefer to buy the wheels, but for flying models they are usually made.



SCALE MODEL LANDING GEARS

FIGURE 68



SCALE MODEL LANDING GEARS

FIGURE 69

Several methods of building wheels are given here. These not only include flying model wheels, but those for scale models as well. If the builder will master these, he will be able to make wheels quite as good as those he can buy.

SOLID BALSA WHEELS. Fig. 70 shows the three steps in making a solid balsa wheel, the most popular wheel for flying stick models. A piece of 1/32", 1/16", or 1/8" sheet balsa, depending on the size and weight of the model, is cut out to form a disk. In A is shown the laying out of the wheel on the balsa with a pencil compass. B shows the cutting of the circle just drawn. (See Chapter 3, "Balsa Wood.") The edge of the disk is sandpapered perfectly round, and a hole slightly larger than the diameter of the axle wire is made in its center. It is then placed on the wire axle, which is bent up to prevent it from falling off, as shown in C.

SOLID BALSA RUBBER-TIRED WHEELS. These are exactly the same as the solid balsa wheels except for the addition of a rubber tire. Spectacle tubing is used for this purpose. It can be purchased at any optician's shop and most model supply companies now carry it. In A is shown the disk finished as shown in C for the solid balsa wheel. The tubing is split along one side, as shown in B. Cement is applied to the inner surface of the tubing and it is spread on the edge of the wheel, as in C. D shows the finished and mounted wheel. These make splendid wheels for large flying models or scale models. If the model is to be painted, the disk should be sandpapered, given two coats of dope, and painted any desired color. The rubber tubing is then mounted. If you wish to paint the tubing black, it should be done before the tubing is mounted, as the painting of the edge of the rubber will prove difficult if on the disk.

DISK RUBBER-TIRED WHEELS. This wheel should not be used on endurance models, as it is heavier than the others, but for flying scale and exhibition models it gives a splendid appearance. The usual disk of sheet balsa is finished as for the solid balsa wheel. In this case, however, the balsa should be cut from 1/32" stock. (Note A.) In B is shown a smaller disk cut in the same manner, but from 1/4" stock. The diameter of this second disk should be 1/8" less than that of the larger disk. Two of these smaller disks are required for each wheel. When cut out, they are sandpapered to a cone-like form, as in C, with their high point centering at the axle hole. These are then cemented on each side of the larger disk, after being carefully centered, as at D. Rubber tubing is split along one side and cemented in place around the edge of the large center disk, as in E. The finished wheel is shown in F. If the wheel is painted, as such wheels usually are, this is done before the tire is attached in place. (See "Solid Balsa Rubber-tired Wheels.")

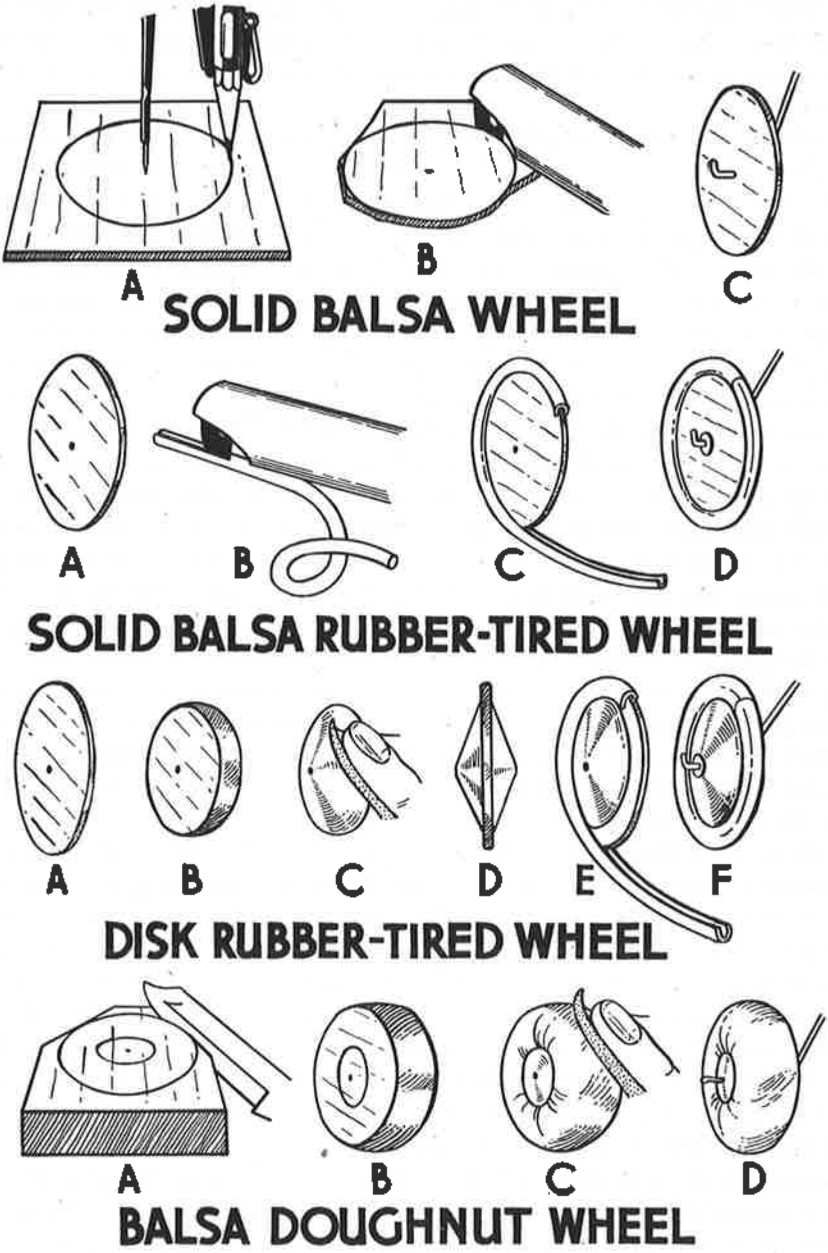


FIGURE 70. WHEELS, 1.

BALSA DOUGHNUT WHEELS. Balloon tires are often called "Doughnut" wheels, and they will be found on such planes as the Curtiss-Wright Junior and the Pitcairn Autogiro. (See Chapters 46 and 55.) For model work, these can be easily cut from a 1/2″ or 5/8″ thick balsa board. Trace the wheel outline on the balsa, and then cut it out, as in A. The disk is then finished perfectly round by sandpapering, as in B. The tire outline is made with sandpaper, making it round from side to side, and carrying out the shape of the tire to a 1/2″ diameter circle at the hub of the wheel, as in C. The mounted and finished wheel is shown in D. Such wheels are usually painted black around the form of the tire, with another color for the hub circle.

PAPER WHEELS. These are very light, quite strong, and give a most realistic appearance. They are splendid for flying models. On fairly stiff paper, a circle is drawn with the compass slightly larger than you wish the finished wheel to be, as in Fig. 71 A. A small section of the circle is then ruled from its center to its edge, as shown. The circle is cut out and from this disk the ruled section is also removed, as in B. Two of these disks, exact copies of each other, are required for each wheel. They should be bent into the form of shallow cones by closing the edges of the cut sections and cementing them together, as in C. The edges of these disks, or cones, are now matched together and cemented.

At the center of each cone, a hole is cut, into which is fitted a small roll of paper, as in D. The length of this strip of paper, after it has been rolled, should be slightly longer than the thickness at the hub center of the joined cones. Cement is applied and the roll of paper is thrust through the holes made in the cones.

With scissors, trim off the ends of the roll until they extend out from both cones about 1/16″, as in E. This small roll of paper forms an excellent wheel hub for the axle of the landing gear to turn in. The finished assembly requires two small washers, which should be cemented to the ends of the paper roll, as in F. The cement must not close up the ends of the roll, or the wire axle will not fit into it. Dope can be applied to such a wheel for weatherproofing and stiffening.

BUILT-UP BALSA WHEEL. This makes a light, serviceable, and strong wheel for any model. In A is shown the tracing of the wheel on sheet balsa with a compass, and in B is seen how the wheel is cut out. It is then sandpapered smooth, as in C. A small roll of paper is thrust through a hole made in the center of the disk, and allowed to extend out 1/4″ from each side of the balsa disk, as in D. Japanese tissue or Japanese silk is then applied to each side of the disk, passing over the end of the roll, and being

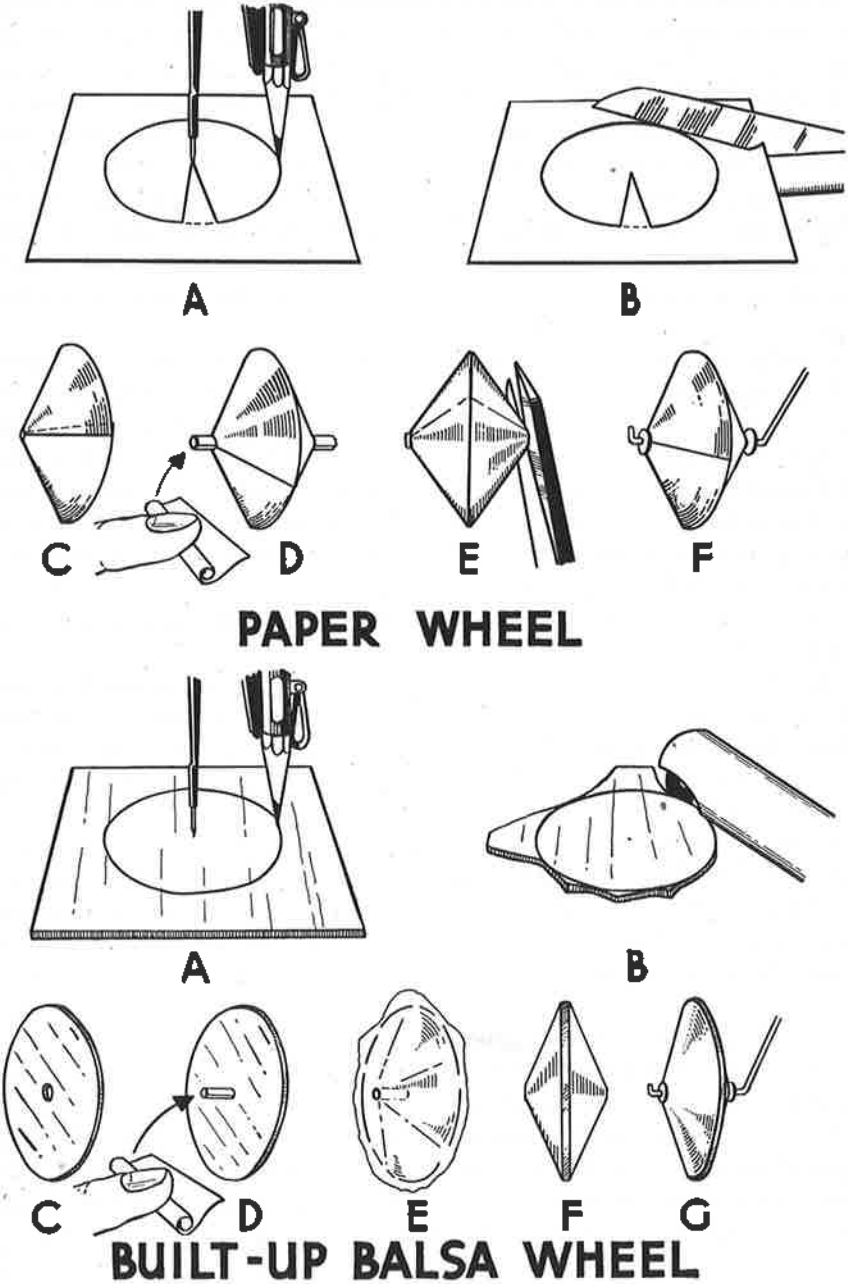
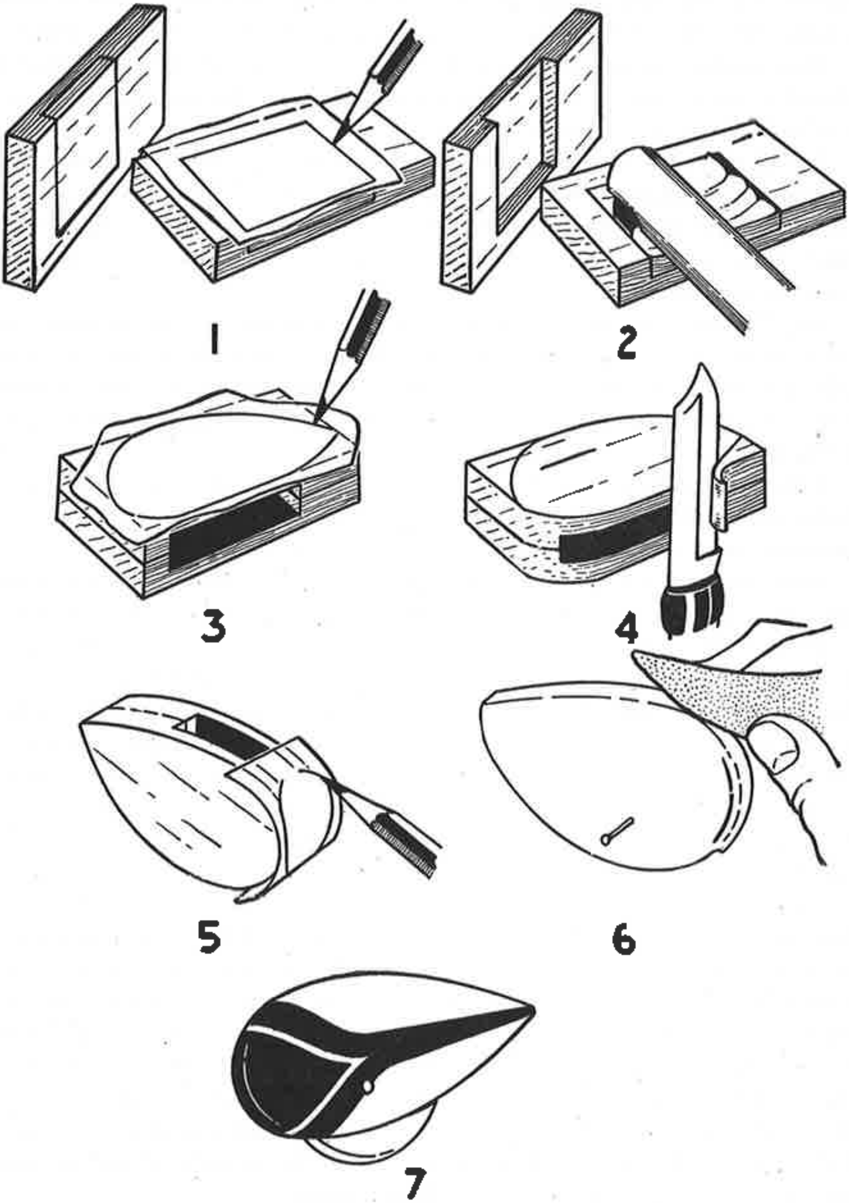


FIGURE 71. WHEELS, 2



WHEEL PANTS

FIGURE 72

cemented to the edge of the wood, as in E. The covering is then trimmed around the edge of the disk, and water-sprayed. The result is shown in F. Two washers are cemented to the ends of the paper roll, the covering pierced at both ends of the roll, and the axle fitted through the hub, as in G, which completes the wheel.

WHEEL PANTS. As the majority of modern airplanes have their wheels equipped with wheel pants, it will be necessary to add them to many solid scale and built-up, non-flying scale models. They are a form of wheel guard which serves to streamline the shape of the wheels, and by so doing to cut down air resistance.

Fig. 72 illustrates the seven steps necessary to make a wheel pant. Step No. 1 shows the laying out of the two blocks which make up one wheel pant. The necessary size of the material used depends on the size of wheels used, the type of pant, etc., all of which must be determined from the plans of the model.

Some pants also serve as landing gear struts, as in the case of the Curtiss Shrike in Chapter 52 and the Northrop Gamma in Chapter 48, but the majority are of the type shown in the illustration.

Sheet balsa of 1/8″ or 1/4″ thickness is used, depending on the thickness called for in the plans. Two duplicate pieces of this stock are squared up to the necessary length and width, as shown in Step 1. The inside cut for the wheel is then traced on each and cut out, as shown in Steps No. 1 and No. 2. These cuts must be large enough to allow the wheel to turn in them freely. Note that these cuts are located on the blocks slightly nearer one end than the other, and that they are made on opposite sides of the blocks, so that when the blocks are fitted together, the cuts in them will also fit, as shown in Step No. 3. The cuts must be a little deeper in each block than half the thickness of the wheel.

The two blocks are then cemented together, as shown in Step No. 3, and their outside shape traced on one face, as in No. 3. This outline is then cut out with a knife, as seen in Step No. 4. Step No. 5 shows the thickness being shaped by first tracing it on the blocks. This is then completed by sandpaper, as in No. 6. The wheel is mounted in the pant by means of a model pin, or a regular pin may be used. Test to see that the wheel moves freely when in place, and then cut off any excess length of the pin flush with the side of the pant. A drop of cement over the cut end will hold it firmly in place. The head of the pin should appear on the outside of the assembled pant, as shown in Step No. 7. It is then painted.

CHAPTER 11

ENGINES AND COWLINGS

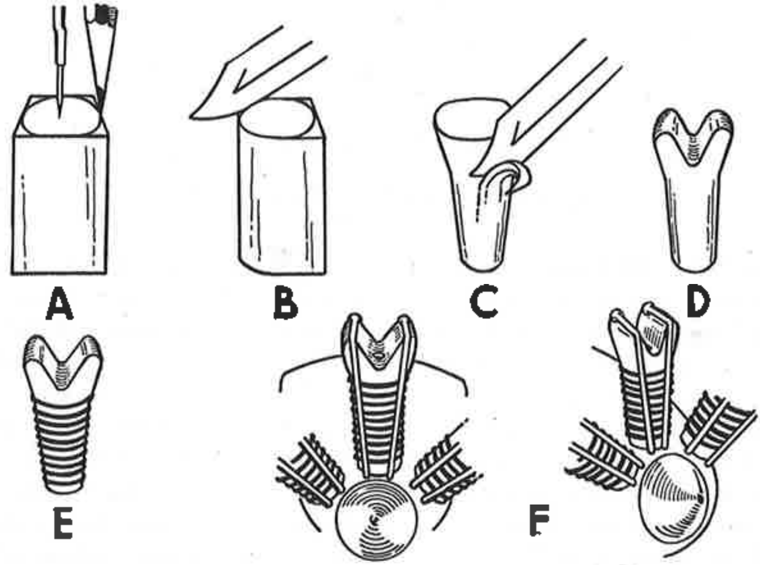
ENGINES. All engines are made up of a number of cylinders, and the builder must determine beforehand how many cylinders the engine he is copying requires. On most of those given in this book, nine cylinders are required, with the two exceptions of the Curtiss-Wright Junior, which has only three cylinders, and the Northrop Gamma, which has fourteen.

The height of each cylinder depends on the size of the cowling into which it is to fit. As the cylinders are attached around a center core, they must be long enough to extend from this core to the inner face of the cowling, which fits around them. Some builders prefer to make their cylinders free of all contact with the cowling, which is the proper method of construction, as in real engines the cylinders do not touch the cowling, but if the engine is very small, the safest method is to attach one end of the cylinders to the core and the top of them to the cowling.

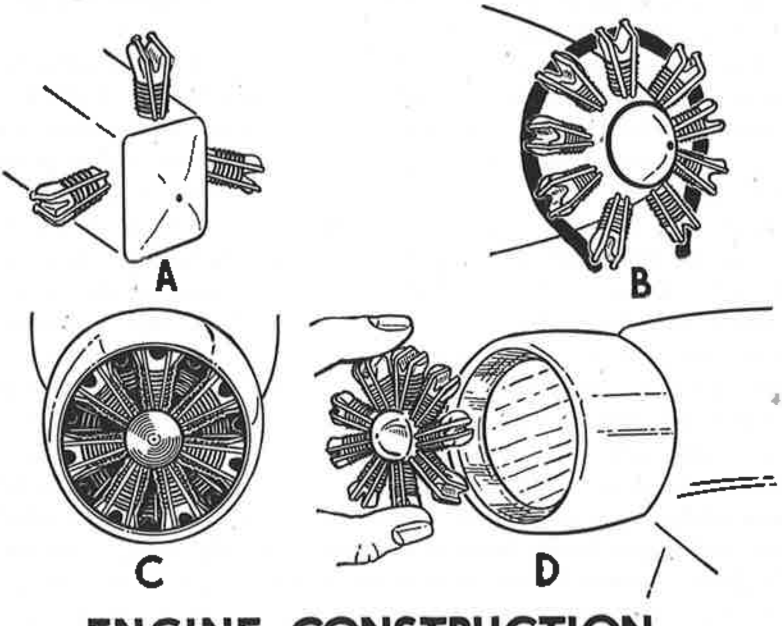
In Fig. 73 six steps in the construction of a cylinder are shown. In A is shown a square block of balsa wood cut to proper length. A circle of desired diameter is drawn on both ends, and the block is rounded, as in B. This is then tapered from its original diameter at one end to a slightly smaller one at the other, as in C. This shape should be that of a cork. The block is then shaped as shown in D. This consists of cutting a groove in the top of the block and then rounding the edges. Balsa is the best material for these blocks, although small corks or blocks of pine or other woods are sometimes used. Each block is painted black. A blue ink treatment gives the bluish tinge of steel which is desirable.

The block is wrapped with soft copper wire. No fastening is required, as it will stay in place on the block when it is wrapped. This is shown in E. The two illustrations in F show the final assembly of the cylinder on its core. On some models, this core may be a separate part of the model, but on most of them it is the nose of the fuselage. The cylinder is attached with cement and a pin thrust through its center into the core, as shown in F. The cylinders should be attached to the front portion of the core, so that when assembled in the cowling they will be just inside its front edge.

Two more pins are thrust into the core next to the front side of the



CYLINDER CONSTRUCTION



ENGINE CONSTRUCTION

FIGURE 73

cylinder, after their stems have been bent at right angles to fit over the top of the cylinder. To finish the effect, the core of the engine should be colored in the same manner as each cylinder, after which the propeller is attached to the tip of the core with a pin.

The various assemblies of engines most commonly used in exhibition models are also shown in Fig. 73. A shows the assembly of the three-cylinder engine of the Curtiss-Wright Junior. B shows the assembly of an engine without a cowling, as in Chapter 47, while the fourteen-cylinder engine of the Northrop Gamma in Chapter 48 is shown in C.

The nine-cylinder Wright "Whirlwind" engine of the Waco, shown in B, has its pipe made of reed bent to shape and painted black. The fourteen-cylinder engine of the Northrop consists of two seven-cylinder assemblies around the same core, one behind the other, and so staggered that the rear cylinders will show between the front cylinders.

On most solid scale models, the cowling is not a separate part of the fuselage, as the front portion of the block from which the fuselage has been shaped is cut into the form of a cowling. When this is the case, the inside of the cowling must be hollowed out deep enough to accommodate the engine assembly.

When the cowling has been cut out, the cylinders are assembled on a separate core no longer than the cowling is deep. After the assembly has been completed, as in D, cement is applied to the end of the core and it is attached into the hollow of the cowling with its coated end against the inner wall of the cowling. A long pin can be thrust through the center of the core and into the back of the cowling to hold the assembly in place until the cement dries.

COWLINGS. There are only two types of cowlings the model builder will need to consider. These are the N.A.C.A. and ring cowlings.

SOLID N.A.C.A. COWLING. Fig. 74 under "Solid N.A.C.A. Cowling" shows the five steps for making this type of cowling from a solid block. As these cowlings are used on built-up, non-flying scale models, the inside diameter at their back should be just large enough to fit over the leading former of the fuselage, and their front diameter should be the same size.

A shows the first step of the work, after the block has been cut to proper size. A hard grade of balsa should be selected for these cowlings. After the outside diameter has been drawn on the face of the block, an inner circle is made to indicate the inside diameter of the cowling. This should be about ¼" smaller than the outside diameter, and the exact diameter of the front former.

The square block is now cut round, as in B, which is followed by scooping out the inside of the block, as in C.

The outer side of the block is now given a streamlined form, which is shown in D. The outer circle is tapered down to meet the inner circle at both leading and trailing edges of the block.

The block is now brought to a satin finish with No. 000 sandpaper, as in E. The completed cowling can be seen in F. The engine assembly for such a cowling should be made around a small center core of the same length as the cowling.

RING COWLING. Technically known as an "anti-drag ring," this so-called cowling aids in increasing the speed of the plane. It looks much like an enormous wedding ring. Slightly wider than the tops of the cylinders, it is streamlined in the same manner as the N.A.C.A. cowling.

In Fig. 74 under "Ring Cowling," the five steps for making this are shown, as were those of the N.A.C.A. cowling. Follow each step, as shown, when making this type of engine covering. These are used on engines assembled around the nose of solid fuselages, where they are fitted over the cylinders after these engine units have been attached in place. For this reason, such cowlings must have inside diameters equal to the diameter of the circle formed by the tops of the cylinders, when these are in position around the core.

BUILT-UP N.A.C.A. COWLING. For all flying models, the engine cowling must be of very light construction to keep weight at a minimum. For such models, having no engines, cowlings are used only to complete the general outline of the fuselage, and hold the front motor stick clip. The four necessary steps for building such cowlings are shown in Fig. 74 under "Built-up N.A.C.A. Cowling."

On $1/32''$ sheet balsa, the two circular formers and six or eight former struts are traced with pencil, as seen in A. The next step, B, shows these after they have been cut out. The large former must have a diameter equal to that of the front fuselage former, while the small one need only be large enough to allow the motor stick and rubber motor to be removed through it. The width of these formers, or the distance from the inside to the outside diameters, should be about $3/16''$. These are now assembled, as in C, and a piano wire motor stick clip is cemented to the inside face of the front, or small, former. When it is fully assembled and the cement has dried, the cowling framework is covered with Japanese tissue, silk, or whatever has been used on the fuselage. This can best be done by cutting the paper into strips wide enough to reach from one former strut to the next

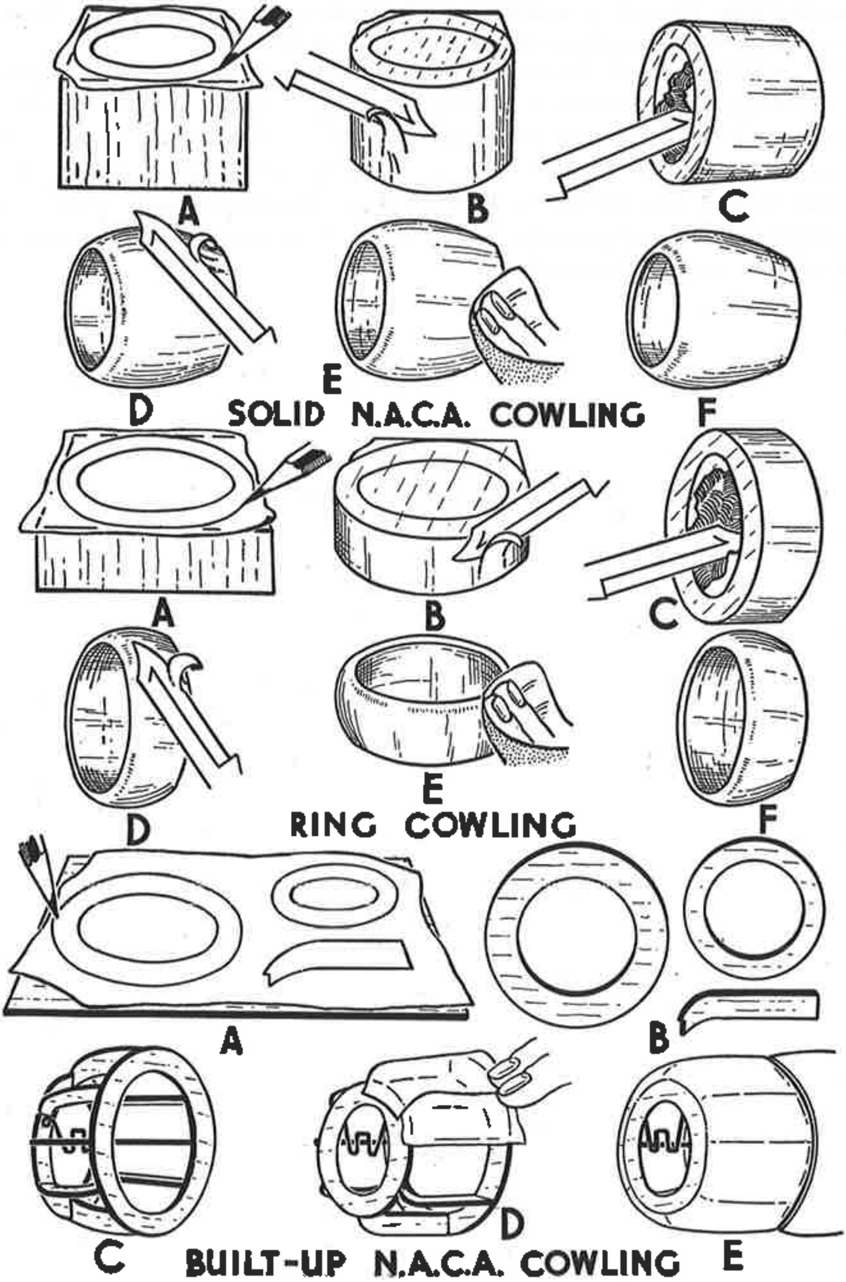


FIGURE 74. ENGINE COWLINGS

one, and long enough to reach from the front to the back former. Attach the covering with clear dope or banana oil, as in D.

When fully covered, the tissue or silk should be water-sprayed to tighten the covering. (See Chapter 7, "Wing Covering.") If the fuselage has been doped, the cowling should be finished in the same manner. When completed, all edges should be trimmed to remove any excess covering. The cowling is then attached to the fuselage. Coat the front former of the fuselage with cement, and press the large former of the cowling in place against it, holding it in position until dry.

CHAPTER 12

RUBBER MOTORS AND MOTOR STICKS

MANY different means of motive power have been suggested for model airplanes, but none has proved as efficient as rubber.

Every model enthusiast should understand a few of the basic facts concerning rubber and its action. In the first place, rubber has life. There is live rubber and dead rubber. The former allows more energy to be stored in it than in any other source of power of equal weight, while the latter is useless. Through constant use, rubber becomes tired, and it must be rested before it will regain its energy. Sunlight, oil, grease, certain metals, and the stretching of it beyond its elastic limit will quickly affect rubber, and it becomes hardened, cracked, and dead.

Every model supply house carries rubber for model airplanes. The finest is pure Para rubber. It comes in various sizes, the most common being 1/32″ and 3/64″ in the square, and 1/8″ and 3/16″ in the flat rubber.

The 1/32″ square rubber is best adaptable to very light indoor and R.O.G. flying models, while the 3/64″ square is suitable for heavier models of the same type. The 1/8″ flat rubber is by far the most popular size, being the best suited for indoor and outdoor endurance models. Such rubber is usually used on championship models found at most national meets. The 3/16″ flat rubber can be used on all outdoor models and is especially good for large high-speed ones.

The builder should make actual flying experiments, using various sizes of rubber, noting the performance of each, and then choosing the best size for the model being tested. The number of strands is governed chiefly by trial and error. Baby tractors and pushers usually give the best results on one or two strands; larger models require from four to twelve strands, depending on the strength of the motor stick, the size of the propeller, and the weight of the model. If the model is heavy, more rubber will be required.

Rubber always should be applied to a model with a certain amount of slack allowed. In other words, it should never be taut between the propeller shaft and the rear hook. Builders have their pet ideas on the amount of this slack that is necessary, but for a beginner, here is a simple way of calculating it until definite decisions are reached through trials:

If using the average length propeller shaft and rear hook, each strand of the rubber should be just the length of the motor stick. When the rubber is attached, it will have a slack equal to the combined lengths of the rear hook and propeller shaft. For example, the motor stick of the model is 12″ long and is to be fitted with one strand of rubber for the motor. The rubber strand is then cut 12″ long, plus whatever surplus is necessary for binding the rubber in place to the end hook and propeller shaft. Further, let us assume that the end hook of this particular model extends from the end of the motor stick forward for a length of 1/4″. On the other end, the propeller shaft extends over the motor stick for a distance of 3/4″. The combined length of these hook extensions over the motor stick is 1″. In other words, the distance between them is 1″ less than the length of the 12″ motor stick, or 11″. By cutting the rubber 12″, a slack of 1″ is obtained.

Various kinds of rubber will stretch in different degrees, but good Para rubber will elongate about seven times its length. The purchaser can test the rubber by stretching a measured piece about seven times its original length, releasing it, and then measuring it again. If the rubber returns to its original length, it is "live" and good for use in a motor; if it remains longer than it was before the test, it is not first-class rubber. Any rubber, however, can be distorted by stretching it past its "live length," so care must be taken not to stretch it past this point.

Dr. William F. Tuley, of the research laboratories of a leading rubber company, gives this hint to model builders concerning the purchase of rubber: "Chemical substances known as 'antioxidants' have been discovered which greatly increase the life of rubber when compounded with it. These substances retard the destructive action of air and sunlight on rubber. They are being extensively used in tires, bathing caps, raincoats, and other rubber articles, and purchasers of rubber strands for model airplanes might find it advantageous to specify that they be included in the composition of the rubber. There are a number of good commercial antioxidants on the market."

Another point to watch when purchasing your rubber is that you specify and obtain pure Para rubber. This contains a minimum of nonrubber ingredients, making it the finest of all grades for model work. See that the rubber you purchase has been kept in a dark place. Do not buy rubber from an open shelf where the destructive elements of sunlight may harden and crack it. See that it has not been under tension.

The safest way to keep rubber when not in use is in a bottle which has been painted black, so that sunlight and air cannot reach it. A Mason jar is excellent. Obtain one, pour a little black paint in it, shake it around until thoroughly covered, and then empty out the balance. When the paint is dry, rubber can be kept in the jar without fear of damage from light.

When more than one strand is used for a motor, the winding tends to cause the strands to stick together. Lubricants are used to prevent this on the theory that they make it easier for the strands to slip over each other when unwinding. Wound lubricated rubber contains a greater amount of energy than rubber not lubricated, and the author recommends it.

There are a number of commercial lubricants on the market, or plain glycerine will be found excellent for this purpose. Another splendid lubricant, but one requiring a little more attention, is made of soap, water, and glycerine. Cut Ivory soap into small shavings and boil it in a little water to make a thick liquid, then add a like amount of the glycerine, making a fifty percent glycerine and fifty percent soap and water solution.

The above lubricant is used by an expert model builder, who claims that he lubricates his rubber the day before it is to be used in a contest. He then packs it away in a dark receptacle well coated with talc. After it has been used, he replaces it in the same manner and keeps it this way.

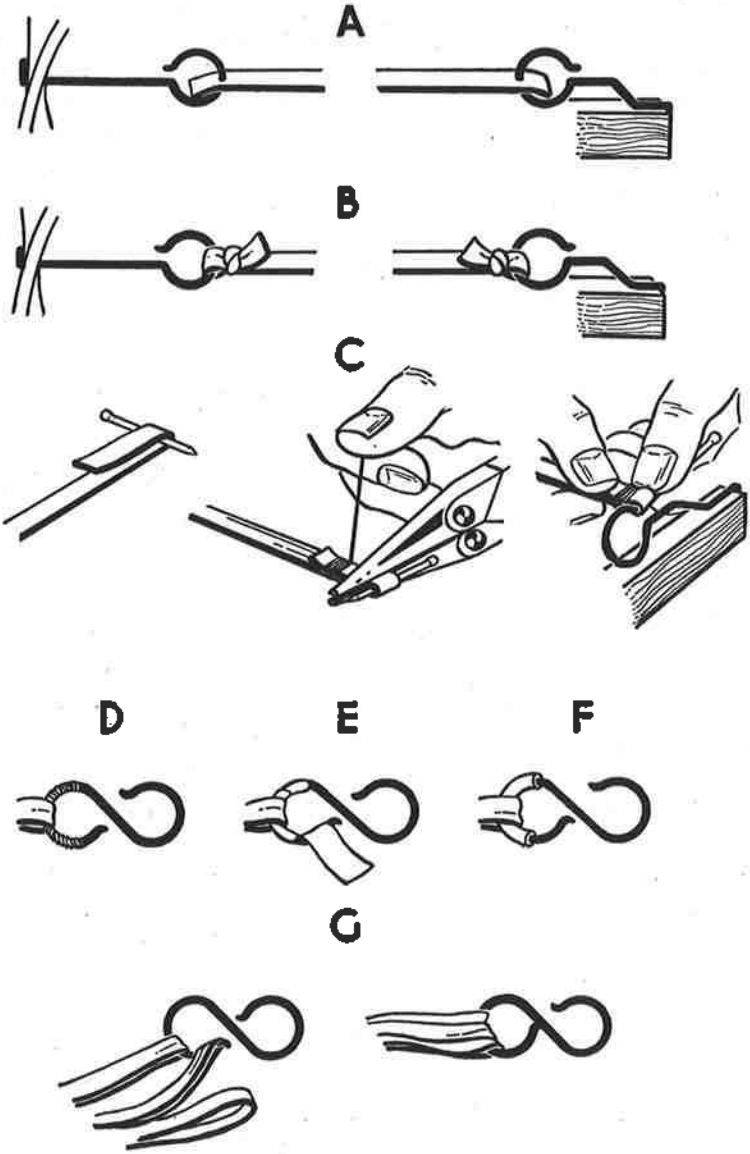
Others prefer to wash the rubber after it has been used. This is done in warm water with a pinch of soda added. After washing and removing all lubricant, the rubber is carefully dried before being packed away. When placed in the jar, it should be sprinkled with either common talc or cornstarch, after making sure that all strands are separated.

Never use oil or grease as lubricants, as these weaken and soften the finest of rubber. Tests should be made by the amateur with lubricated and unlubricated rubber. Various lubricants should be thoroughly tested to obtain the best, and the two methods of packing away and keeping rubber should be tried to determine which is preferred.

Experiments show that the best winding results can be obtained by stretching the rubber three or four times its length before starting to wind. Two should do this operation together, especially on large models: one holds the rubber while the other does the winding. Full instructions are given in Chapter 16 under "Winding."

There are several popular methods of connecting rubber to hooks. When a single strand is used, the rubber can be pierced, as in Fig. 75 A. However, the rubber will take many more turns if it is tied about the hook, as in Fig. 75 B.

As single strands are used only on small models with correspondingly small fittings, it is often difficult to make the knot. Fig. 75 C shows an easy



RUBBER MOTOR ATTACHMENTS

FIGURE 75

way to accomplish this. Fold the strand over a nail, hold the fold together with small-nose pliers, tightly wrap with silk thread, and tie. The nail is then held next to the hook, the rubber slipped off it on the hook, and the nail removed. The deterioration of rubber is accelerated by certain metals, the most common of which are copper and brass. If these should be used for propeller shafts, can hooks, "S" hooks, or end hooks, which come in contact with the motor, they should be wound with silk thread, Fig. 75 D, adhesive tape, E, or covered with spectacle tubing as shown in F.

When using "S" hooks, closing the hook, as shown in G, will keep the strands together on the hook. For motors having a number of strands, "election" bands are used on both ends to keep the strands of equal length. These are small rubber bands tied around the strands, just in front of the "S" hook or end hook at the rear of the motor stick, and just behind the propeller shaft hook at the front end of the stick.

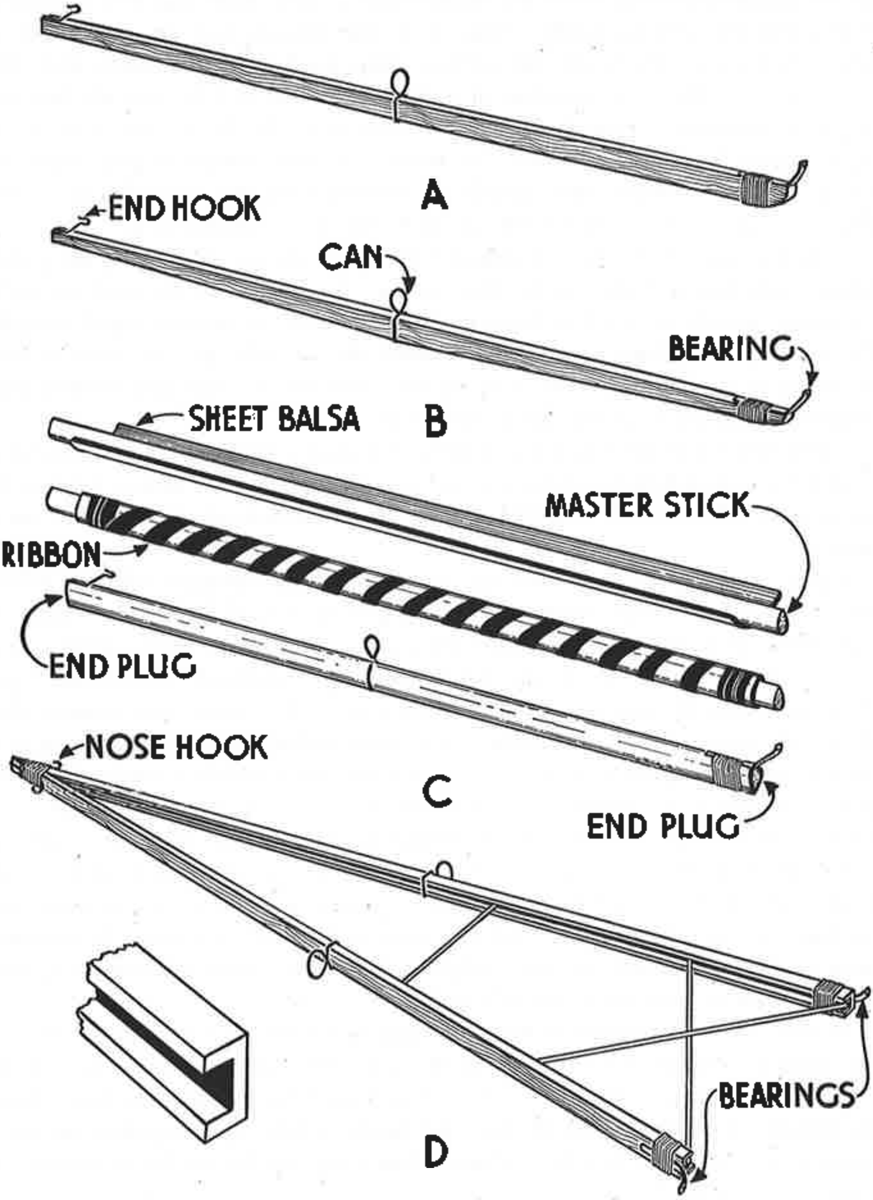
MOTOR STICKS. On stick models, the motor stick serves as a fuselage to which are attached the wing, elevator, rudder, propeller, motor, and landing gear if one is used. For this reason, these models are known as "stick models."

Flying fuselage models have the usual built-up fuselages with or without motor sticks. Some fuselages are so strengthened in their structural framework as to require no motor sticks, in which cases their rubbor motors are attached directly to the members of the fuselages. When this type of fuselage first became popular, it was considered a great asset to save the weight of a motor stick, but close study soon revealed the fact that such a fuselage required heavier construction, which often weighed more than the stick it eliminated. Another great disadvantage to this type of motor asbly was the danger of twisting the entire fuselage frame through winding.

For these reasons, the author recommends the use of a motor stick on all flying scale models. Such a stick allows the motor to be removed from the fuselage, so that the rubber can be stretched before winding. It permits more turns to be made in the rubber, which gives longer endurance, and allows motor repairs to be made easily.

While all scale models should be equipped with motor sticks, commercial models seldom need them. On such models, the construction can be so designed as to give the necessary strength with little added weight. They are usually left uncovered at the end hook, while the propeller bearing consists of a removable plug, which allows the rubber to be removed, as shown in Chapter 35.

Fig. 76 shows a number of the most important types and forms of motor sticks. In A is shown the most common form of motor stick, which is usually



MOTOR STICKS

FIGURE 76

twice as wide as it is thick. Such sticks usually are cut 1/16" x 1/8", 1/8" x 1/4", and 1/4" x 1/2". Occasionally we find a stick cut square, as on the tractor in Chapter 21, but these are unusual. The nose, or propeller end, of the stick is usually beveled, allowing the propeller free motion without danger of striking the stick.

B shows the tapered stick, which is the same as A except that it is slightly tapered toward both ends to eliminate excess weight. Such a stick is usually twice as wide as it is thick at its center and then tapers toward both ends until square. For example, a stick 1/8" x 1/4" at the center would taper to 1/8" x 1/8" at both ends.

C shows the three steps for making a hollow stick. On extremely light, endurance stick models, these sticks are very popular. Some builders make their sticks large enough to hold the rubber motor inside the stick, but weight tests made by the author seem to prove that such sticks weigh too much for any advantage gained.

For such hollow sticks, 1/64" or 1/32" sheet balsa is used. A master stick of pine is shaped as desired and cut about 1" longer than the required motor stick. Some make their motor sticks perfectly round, which can be done by forming the sheet balsa around a dowel stick. The shape given here is for the tractor in Chapter 33.

After the master stick has been prepared, the sheet balsa is cut to size. Its length must equal the required length of the finished stick, and its width must equal its desired circumference. A quick way to determine this is to tie a string around the master stick, remove the string while still knotted, cut it, and measure its length. This will represent the width required for the stick.

When the sheet balsa has been cut to size, it must be thoroughly soaked in hot water. Remove it from the water, place it on a flat table, and lay the master stick on it, so that the side of the stick and the edges of the sheet are parallel with each other. The balsa sheet is then bent up around the stick and tied in place with ribbon. Do not use string, rubber bands, or wire for this work, as any of these will quickly cut into the soft wood. Use a wide ribbon, and wrap it carefully around the entire length of the stick, as shown.

When the balsa has dried, the ribbon is removed and the edges of the sheet balsa cemented together. Some prefer to leave the master stick in position while doing this work. If this is done, it must be pulled back and forth while the cement is drying, so that the cement will not fasten it and the sheet balsa together.

The ribbon may be replaced until the cement has dried, but if this is done, a thin coat of vaseline should be given the ribbon to keep it from adhering to the crack of the sheeting. After the cement has become thoroughly hard, two small end plugs are shaped to fit the inside form of the stick. These are cemented into the ends of the motor stick. When dry, the entire stick is sandpapered smooth and fitted with the usual end hook, can hook, if used, and propeller bearing.

On twin stick pusher models, the A-frame is often made of two U-beams, so named because they resemble a U in form. Note this type of construction in Fig. 76 D. The open side of the beam faces toward the inside of the A-frame, as shown. Such a beam is used on the model in Chapter 28. Note that the braces of the A-frame fit between the sides of the U-beams, where they are cemented into small holes cut for them. Such beams can be made by cementing three pieces of sheet balsa together, or they can usually be purchased from supply dealers.

CHAPTER 13

PAINTING

ENDURANCE CONTEST MODELS. Endurance models for contest purposes should never be painted. There are no exceptions to this rule, whether the model is a single-stick, twin-stick, commercial, or flying scale plane. All endurance models depend greatly on their lightness, and paint has weight. In fact, during tests to determine the effect of paint on models, one model so tested had its endurance cut in half. While this was not true with all the models so tested, each showed a decided drop in flying time when painted, which should give an idea of the harm paint can do to a flying model when its endurance is counted in seconds.

Many experts refuse even to give their wing surfaces a water-spray because of this danger and that of warping. When $1/32''$ balsa is used on such parts as wing tips, it is not hard to realize the effect paint has on such models.

SPEED FLYING MODELS. Paint makes little difference on speed models, as they are of sturdy construction in which weight is not an important item. A close study of the speed twin pusher in Chapter 34 will prove this fact. With solid balsa wing and elevator, heavy balsa propellers, pine A-frame, and considerable weight from its two rubber motors alone, paint would have practically no effect on its flying ability.

The sole question of such a model is, "How fast will it cover the course?" Built to fly only a comparatively short distance, its action is more that of a bullet than the slow, steady, soaring flight of an endurance model. Such planes may safely be painted any color you wish. Give the A-frame, wing, elevator, and propellers two coats of banana oil, a careful sandpapering, and then apply any paint, lacquer, or enamel desired. However, few such models are ever painted, because their appearance counts nothing in a contest.

EXHIBITION FLYING MODELS. There are occasions when the appearance of flying models should be taken into consideration. If you intend to sell your model, give it as a present, or display it to a public which knows nothing about such models, its appearance will count for as much if not more than its flying ability. For such flying models, the author recommends the use of colored dope, which is now carried by practically all model supply houses. It comes in a number of bright colors and is applied with a soft camel hair brush. It requires no undercoating.

However, before applying any dope to wing sections, the builder should make sure that the construction of his model is strong enough to withstand the strain of shrinkage. Otherwise, he may find his wing sections warped beyond repair.

If the model is a stick type, sandpaper the wood parts and leave them without any finish, unless they are given a single coat of dope and finished with another sandpapering. The wing, rudder, and elevator covering can then be given a coat of colored dope, after each has been water-sprayed.

Models finished in this manner have a "professional" appearance, and while they will not be championship flyers, they seldom lose enough flying ability to be noticed.

SOLID SCALE MODELS. Solid scale models should always be painted. The sole purpose of such models is appearance. They are replicas of real planes and must therefore be finished like the planes they represent.

Such models usually require a certain amount of filling. This is done with a wood filler, of which various makes can be found in hardware stores or model supply houses. The author can recommend Plastic Wood as a splendid filler. This is used to fill all cracks, construction errors, wood defects, or to make streamline wings, cowlings, fuselages, etc. Wings are often tapered into fuselages, and for this purpose, a wood filler is excellent. After such a filler has become perfectly dry, it can be cut, planed, or sandpapered like wood, and will take paint splendidly.

Whether the model is of balsa, pine, or another wood, it should be given an undercoating to prevent the paint, enamel, or lacquer from seeping into the surface. For this purpose, use clear banana oil. The number of coats necessary depends on the hardness of the wood. For balsa, from four to seven coats of banana oil are usually necessary. The surface should be lightly sandpapered after each coat, which will give a splendid base for painting.

There are a number of paints, enamels, and lacquers for finishing work. Lacquer or enamel proves the best, although many builders use ordinary gloss paint. Model supply houses carry such finishers, and lacquer may be bought at the five-and-ten-cent store. Rogers lacquer has proved the best, but the beginner should try both lacquers and enamels to determine which give the best results.

After one or two coats of enamel or lacquer have been applied and allowed to dry thoroughly, a final coat of Valspar varnish will provide an increased luster. After this finish, the proper insignia should be added to the model. (See Chapter 14.)

The wings are then given their proper numbers, which should be the same as those of the real plane being copied. If a manufacturer's plane is being made, any numbers you wish may be used. (See Chapter 3, "Emblems and License Numbers.")

Propellers are finished with aluminum paint if metal, or if they represent wood propellers, they should be stained oak or mahogany and then given two coats of varnish. All wires, cables, cockpit seats, steps, etc., should also be finished to represent metal.

Cockpits should be finished as shown in Chapter 15.

If the solid wood has been covered with tissue or silk, as shown in Chapter 8 under "Solid Fuselage Covering," this is doped and finished as explained under "Built-up, Non-flying Scale Models" in this chapter.

BUILT-UP, NON-FLYING SCALE MODELS. The object of these models is the same as that of solid scale models. Their framework construction, however, gives them a closer resemblance to real planes than solid models, because the methods employed to build them come very close to actual airplane construction.

If tissue has been used for covering, this should be given the usual water-spray. (See Chapter 7, "Wing Covering.") This is followed by clear dope slightly thinned with acetone. All wood parts, such as cowlings, cockpit formers, landing gears, etc., that have been left uncovered should be given two or more coats of clear dope and sandpapered between each.

Lacquer, enamel, or gloss paint is then applied as described under "Solid Scale Models." The tissue will take these coats quite as well as wood parts. When the last coat has dried, Valspar varnish should be applied. Propellers, wires, instrument boards, insignia, license numbers, seats, etc., are finished in the same way as solid scale models.

If the model has been covered with silk, the entire process is exactly the same, except that the undercoating should be clear banana oil without any thinner. This should be carefully applied with a camel hair brush. Use it sparingly, brush it well, and a perfect painting surface will result. If applied too thickly, the oil will penetrate the silk and deposit on its under side.

Silk covering treated in this manner will take enamel, lacquer, or paint splendidly. However, the silk must be water-sprayed before the banana oil is applied.

FLYING SCALE MODELS. Scale models entering endurance contests should not be painted, but as most flying scale model contests are judged by appearance alone, a perfect paint job is usually essential. If the contest should be one judged on appearance and flying ability, the model should be water-sprayed and finished with colored dope, as this treatment will seldom harm the flying ability of the model. If, however, the model must merely prove that it can fly and then is judged on appearance alone, it should be finished completely. To paint a flying scale model, follow all the instructions given for built-up, non-flying scale models in this chapter. Proof of the flying ability of a scale model simply means it must fly on its own power a few feet, so the builder should test his model, as his finishing job progresses, for such flying ability. One builder known to the author finishes all insignia, license numbers, cockpits, etc., after giving his covering a color doping. The model is then tested. If it flies more than he thinks necessary to prove its ability at the meet, he gives his covering a coat of lacquer, and retests his model. In this way, he obtains a maximum of finish, and his successes at meets indicate the worth of his plan.

Some meets do not require flying scale models to prove their flying ability, and a close study of the rules governing the meet will show the builder such facts. If models are not required actually to fly, all that is necessary is to have the model carry a rubber motor. When this is the case, the model can be finished in the same way as any built-up, non-flying scale model.

Care of detail is most important when giving an exhibition model its final touches. Do not spoil an otherwise splendid building job by stinting work in finishing it. Remember that the paint on a model is the thing that is usually judged, as it has thoroughly covered all construction work.

CHAPTER 14

AIRPLANE INSIGNIA

WHEN building models for exhibition purposes, the painting of names, license numbers or insignia on them is of the utmost importance. Such models are usually judged solely for their resemblance to the real planes they represent, and such details often decide the success or failure of a model. The general painting of models has been covered in Chapter 13, and the painting of license numbers is explained in Chapter 3.

When building any model of a real plane, the builder should do so with the aid of photographs of the plane which show the proper positions of all insignia. As these locations often differ among planes, it would be impossible to give individual data on each one. Photographs can usually be found in aviation magazines or newspapers. Others can be obtained direct from the manufacturers.

Unfortunately, while such photographs show the location of the insignia, they seldom appear large enough to give detail. For this reason 120 of the most popular and interesting insignia are reproduced here. Each is an exact copy of the one appearing on the real plane, and they represent manufacturers, transport lines, individuals, and countries, as well as war and peace fighting squadrons.

It must be remembered that many planes carry insignia of the manufacturer as well as that of the transport company, squadron, or individual owner.

Two methods are used for transferring such designs to models. The experienced expert with a steady hand can paint them directly on the model, but the beginner should not attempt to do so, as he might ruin an otherwise perfect model. An easier method is to make an exact copy of the insignia on paper, using light pencil lines for its outline. This is then filled in and completed with colored inks or paints. When dry, cut out the design and glue it in position on the fuselage of the model. Its edges should then be touched up with paint the color of the surrounding area. As the majority of insignia are in black and white, much of the work can be done with black ink or paint.

The illustrations have been numbered, and are listed alphabetically under "Aircraft Manufacturers," "Transport Lines," "Miscellaneous" and "Military." Under the latter will be found such divisions as "Attack Groups," "Bombardment Groups," "Pursuit Groups," "Aero Squadrons," "Navy Squadrons," etc.

AIRCRAFT MANUFACTURERS

TRANSPORT LINES

MISCELLANEOUS

AMERICAN MILITARY INSIGNIA

MODERN ARMY INSIGNIA

MODERN NAVY INSIGNIA

GERMAN MILITARY INSIGNIA

FIGURE 77. AIRPLANE INSIGNIA, I

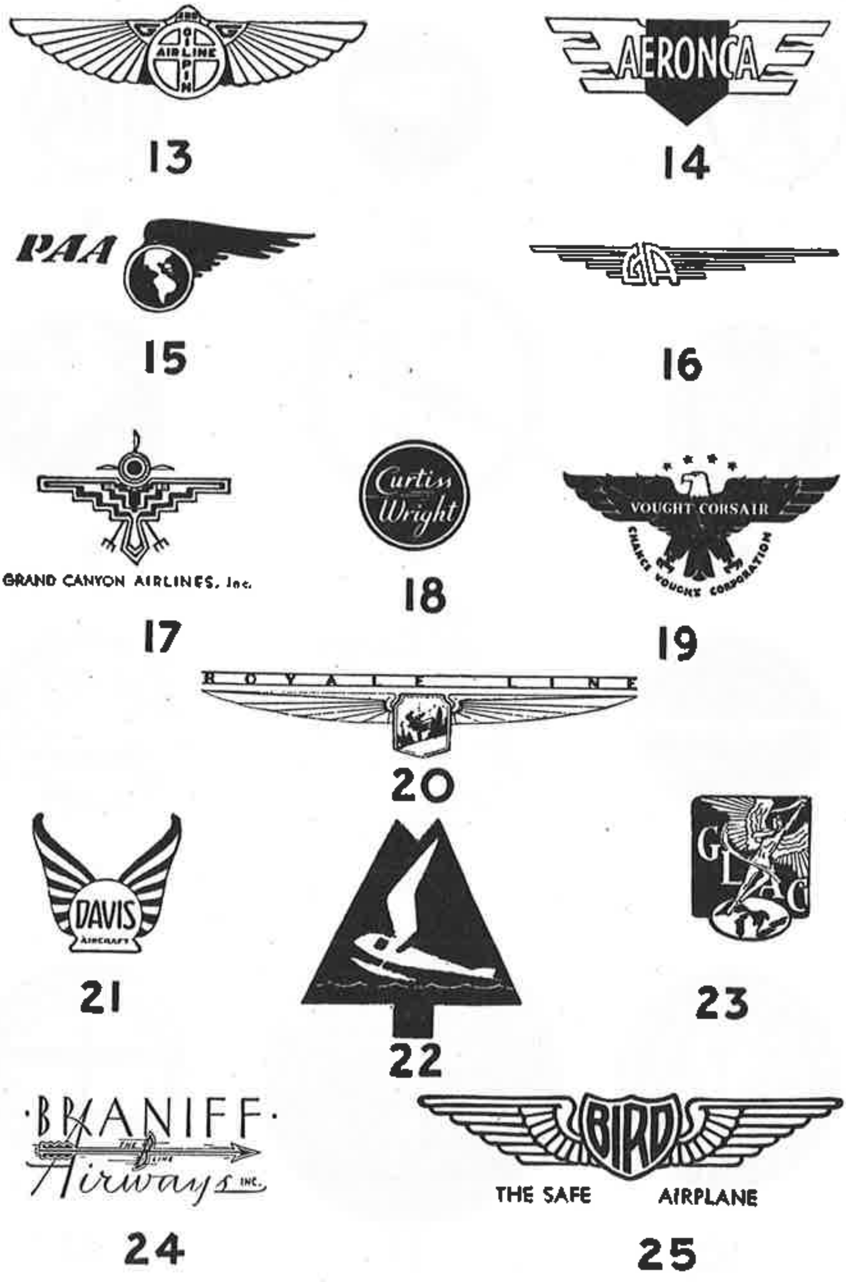


FIGURE 78. AIRPLANE INSIGNIA, 2

FIGURE 79. AIRPLANE INSIGNIA, 3

Transamerican Airlines Corp.

TAC

42

WHITTELSEY AVIAN

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AMPHIBIONS

44

NORTHROP

46

INTER-ISLAND AIRWAYS

48

47

AMERICAN AA AIRWAYS

49

NPA

NATIONAL PARKS AIRWAYS, Inc.

WACO AIRPLANES

50

ALEXANDER AIRCRAFT CO.

51

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PENNSYLVANIA AIRLINES · INC.

AMII

WESTERN AIR EXPRESS

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NAT

BELLANCA

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FIGURE 80. AIRPLANE INSIGNIA, 4

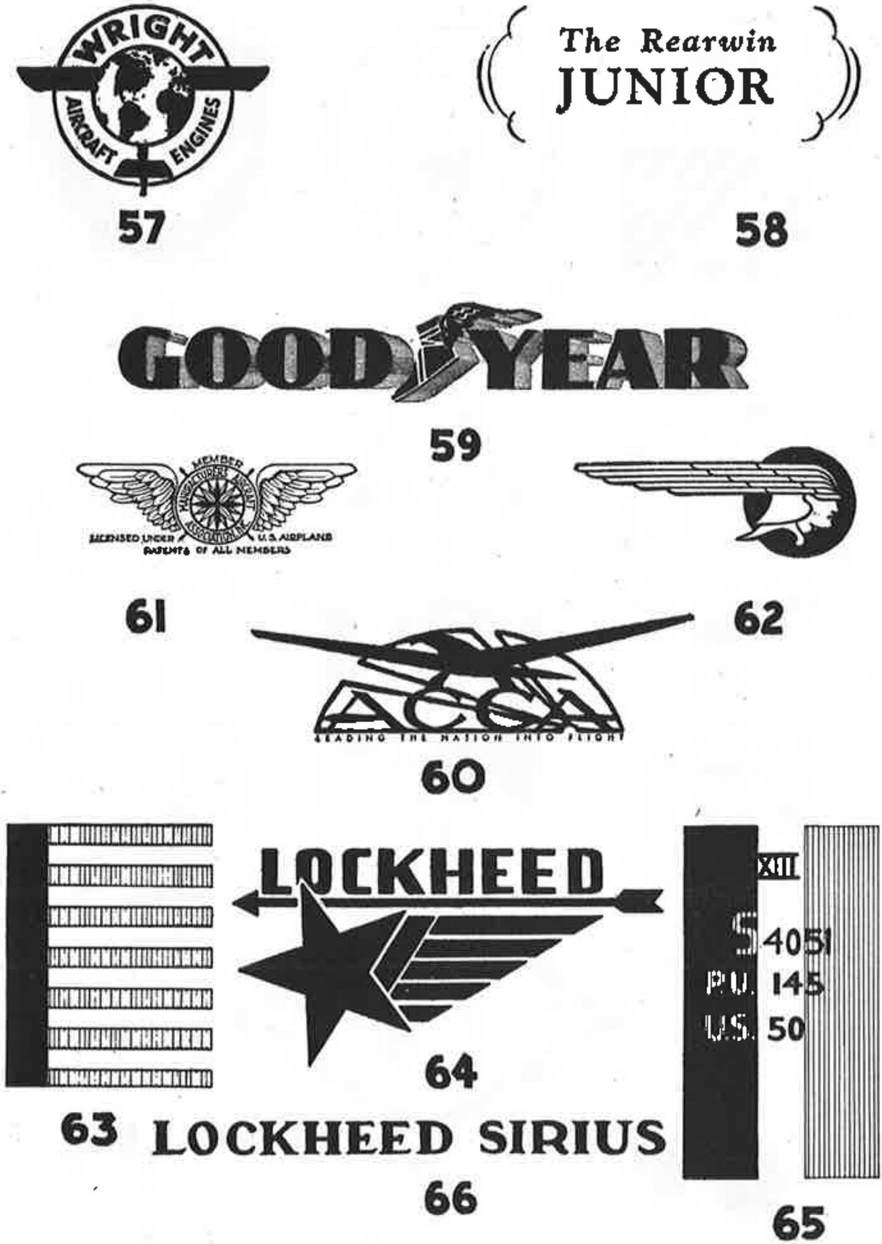

FIGURE 81. AIRPLANE INSIGNIA, 5

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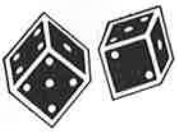

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FIGURE 82. AIRPLANE INSIGNIA, 6

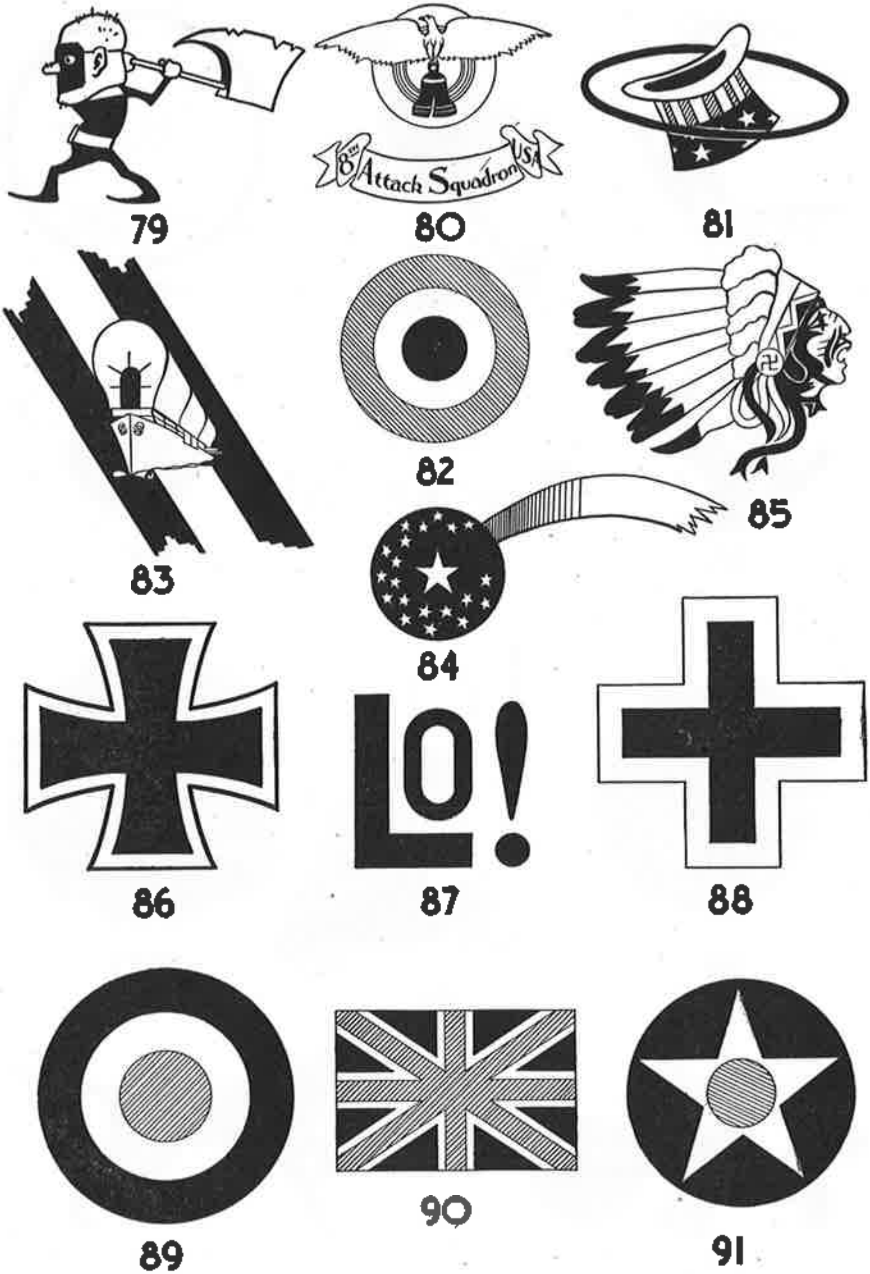

FIGURE 83. AIRPLANE INSIGNIA, 7

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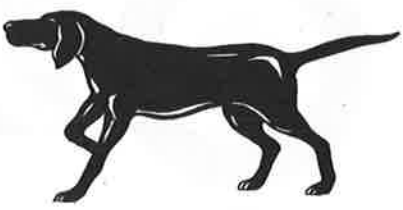

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FIGURE 84. AIRPLANE INSIGNIA, 8

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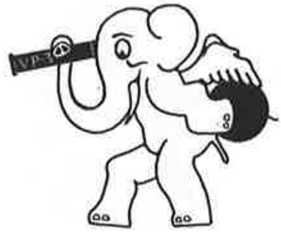

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FIGURE 85. AIRPLANE INSIGNIA, 9

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FIGURE 86. AIRPLANE INSIGNIA, 10

CHAPTER 15

MODEL ACCESSORIES

WHEN the painting of an exhibition model has been completed, many builders make the mistake of considering it a finished job. They forget the necessary accessories which often mean the difference between first and second honors. A fighting plane requires machine guns quite as much as a peace plane requires license numbers. Bombs hanging under a bombing plane are quite as important as the proper insignia painted on its wings and fuselage.

Many finely constructed models have failed to take first honors at meets because the builder failed to complete his job by adding details.

COCKPITS. On all exhibition models with cockpits cut out, an instrument board, windshield, rudder bar, joy stick, and seat should be added. If you do not intend to do this, leave the model without a cockpit.

Fig. 87 shows four of these additions. Most of them can be purchased, but they are so simple to build that any model builder should make his own. The *instrument board* of a built-up model is usually located on the upper portion of the fuselage former situated directly in front of the cockpit. On solid scale models, it is located on the forward wall of the cut-out portion, which forms the cockpit. The dimensions of this should be taken and the instrument board drawn on paper to size. This is done by drawing circles on the paper, adding pointers, divisions, etc., and then filling in around the circles with black ink, as shown. This is then cut out and glued in place in the cockpit.

A *joy stick* can be sandpapered down from a match or balsa stick, and set in a small hole made in the floor of the cockpit. The *seat* is made of two pieces of 1/16" or 1/32" sheet balsa. Cut the seat out and bend a piece of balsa to fit its back curve. When dry, this is shaped and cemented in place. Three balsa sticks are cut for legs and cemented in position to the under side of the seat. The *rudder bar* is cut from sheet balsa, as shown.

When assembling these parts in the cockpit, the rudder bar should be attached first. This is placed in front of the instrument board and in the center of the floor board. It is pivoted on a model pin thrust through its

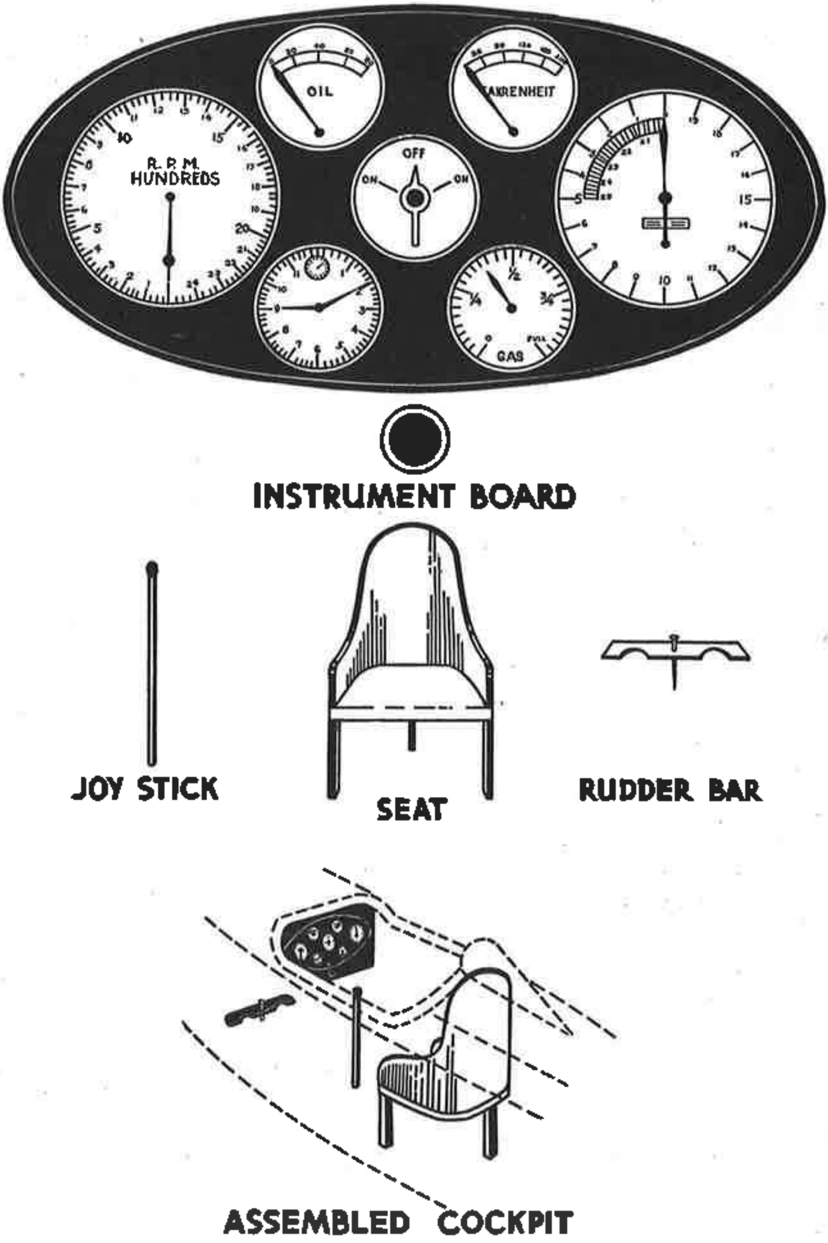


FIGURE 87. COCKPIT ACCESSORIES

center, as shown. This is followed by the instrument board, which is glued into position.

The seat should be painted before it is placed in the cockpit. As the majority of these are made of aluminum, give it two coats of aluminum paint. When dry, apply cement to the ends of each leg and also to the back. Place in position, and press the back of the seat against the back wall of the cockpit. The joy stick is added last. This may be painted black, brown, or white, as you wish. It is then placed in a shallow hole cut for it halfway between the edge of the seat and the instrument board. Make this hole in the floor board in line with the pin of the rudder bar, coat the end of the stick with cement and hold in place until dry. *Cushion seats* can be added for passenger planes, if you wish, by cutting cloth and gluing it to the seat bottom.

Study the assembled cockpit, as shown in Fig. 87, so that no mistakes will be made when assembling is done. If an additional touch is desired, the sides and floor of the cockpit may be painted any natural wood finish, or if the plane is metal, a coat of aluminum paint will give a realistic effect.

Windshields of various designs can be made from isinglass or sheet celluloid. The former is recommended. Most windshields do not require an edging, but when this is necessary one should be shaped from $1/64''$ split bamboo which can be glued to the edge of the isinglass or celluloid. (See Fig. 88, "Cockpit Edging.")

MISCELLANEOUS. In Fig. 88 will be seen a number of interesting model accessories. Ideal *head rests* may be made from an upholstery tack, as shown. *Exhaust pipes* are easily made from soda straws cut to length, or if they require painting, short lengths of brass, copper, or aluminum tubing may be used. With the advent of *corrugated* metal planes, many builders have experienced trouble obtaining realistic effects. If balsa wood has been used, a strong comb can be used to get the corrugated effect of metal. Place a straight block of wood against the fuselage, and using this as a guide for straight lines, press the teeth of the comb into the soft balsa as it is drawn over the surface. The model is then painted with aluminum paint.

The *edge of cockpits* can be given a finished appearance by adding spectacle tubing, which can be purchased at any optician's shop. Cut a straight line along its length severing the tubing on one side. Apply cement to the inside of the tubing and force it over the edge of the cockpit. (See Fig. 88.)

BOMBS. Bombs are cut from balsa blocks and small fins of paper are cemented to their ends, as shown. From No. 5 or 6 piano wire, bend a small hook and cement it to the bomb as its balancing point. This is then hung

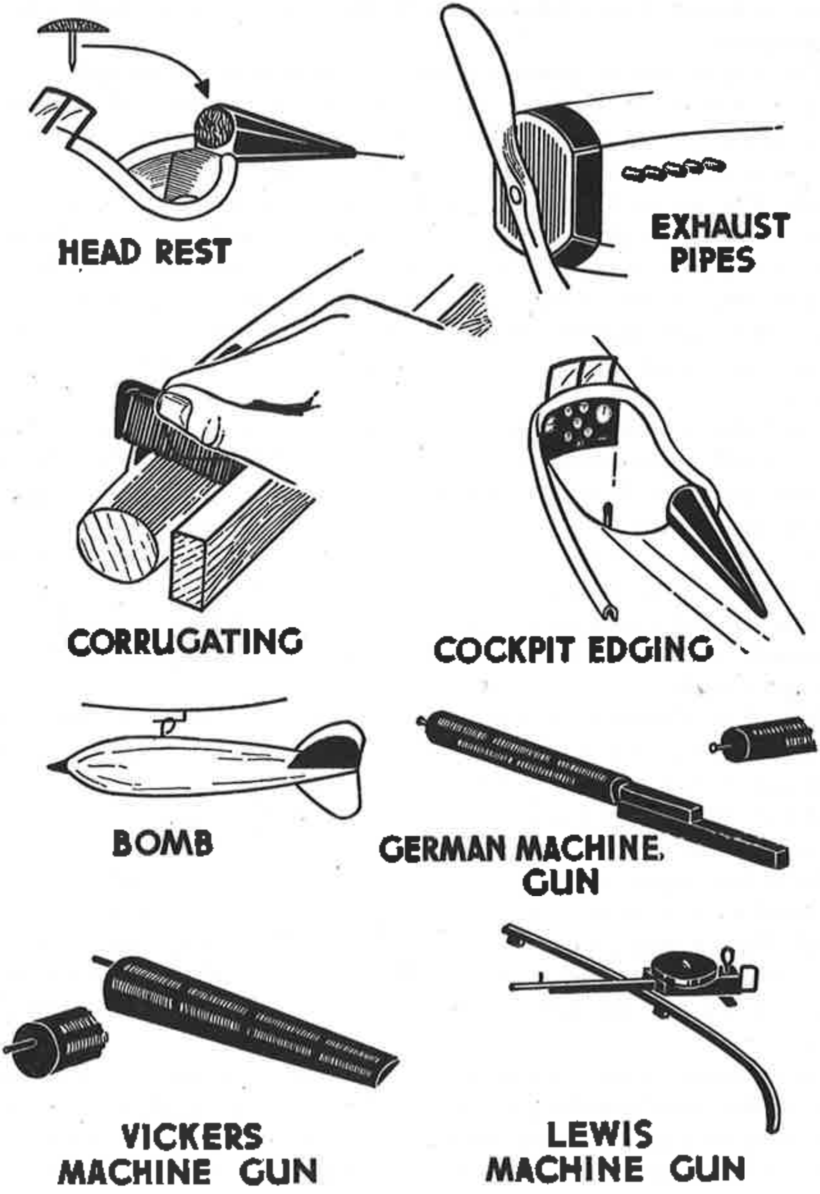


FIGURE 88. MISCELLANEOUS ACCESSORIES

on a small hook of the same wire cemented to the center bottom of the fuselage. When the plane climbs, the hook holds the bomb in place, but when it dives, the end of the holding hook points down and the bomb slides off. A model pin can be thrust into the nose of the bomb to act as a weight. The head is cut off, allowing the pin to protrude about 1/4".

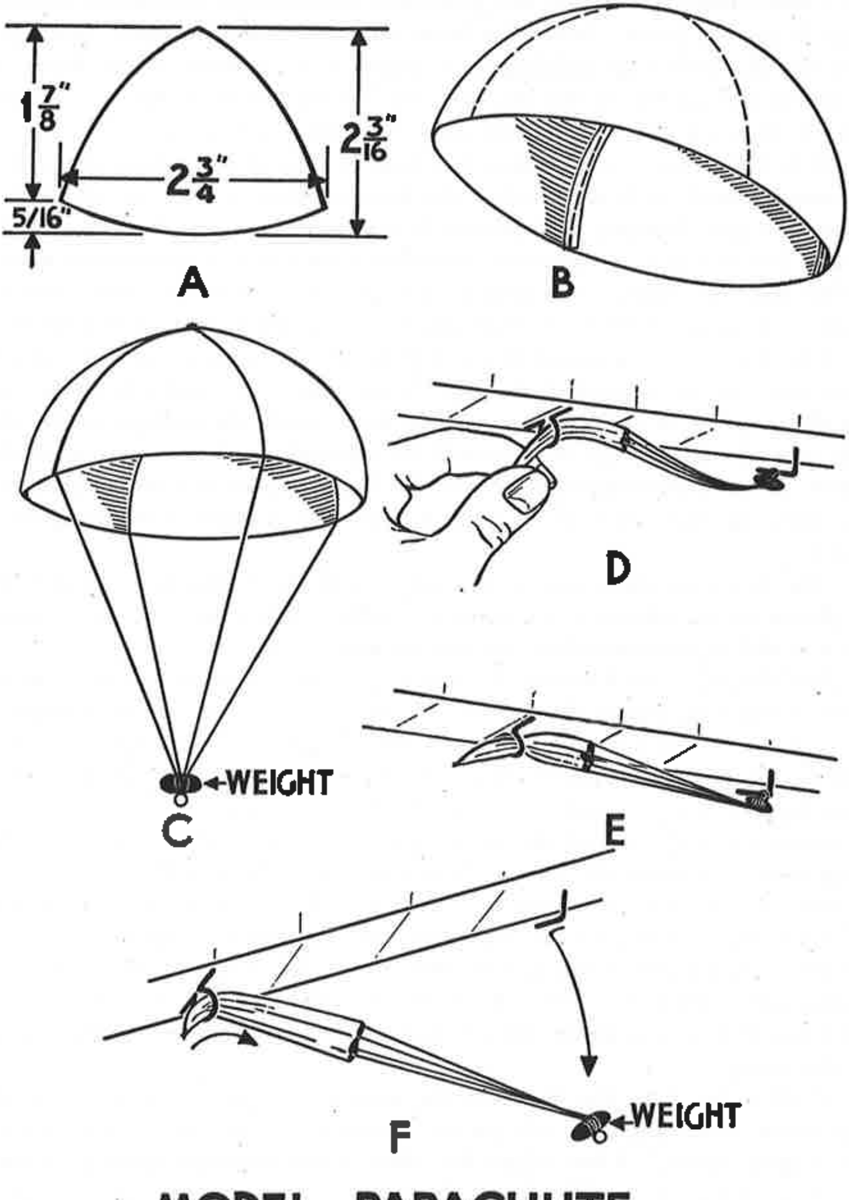
MACHINE GUNS. The three machine guns shown represent those most commonly used on War models. The German gun is used on all Fokker, Albatross, and Rumpler War planes. It is constructed of two pieces of balsa wood. The first piece is the barrel to which is cemented a standard to hold it off the fuselage. Small ventilation grooves are cut around the barrel, and the entire gun painted black. A small pin is used as the barrel, as in Fig. 88.

The Vickers gun consists of a round length of balsa wood with ventilation slots cut at intervals around it. A pin barrel protrudes from its end. As the majority of these guns extended from inside the cockpit to the outside top of the fuselage, they should be tapered, as shown, to obtain this effect. When cemented to the top of the fuselage just in front of the cockpit, they appear to pass through the top into the cockpit. They are painted black.

The Lewis machine gun is the father of them all. On some models this is placed in the observer's or gunner's cockpit. When used in this position on a model, it is mounted on a swivel mount.

For the S.E.5 in Chapter 49, the Lewis gun is mounted on a swivel mount extending from the top of the fuselage in front of the cockpit to the top of the upper wing. See the photographs of this model. A small square length of balsa wood represents the stock of the gun, while another cemented to it at an angle is the handle grip. A round piece of sheet balsa is cemented to the top of the stock to represent the bullet drum, and two large pins represent the barrel. A piano wire sight is added, and a wire handle on the end of the stock is used for directional handling. Another wire handle is added to the top center of the drum, completing the gun which is then painted black. The swivel is made of split bamboo, bent to form, and cemented to the top of the fuselage and the top of the wing with small elevation blocks placed under it to keep it raised off the surface of the wing.

PARACHUTES. Fig. 89 shows the making and attaching of a workable parachute. Four Japanese silk pieces, shown in A, are cut to shape. These are called "gores." Their edges are then sewed together with a running stitch, as shown in B. Silk thread should be used for the sewing as well as the shroud lines. The shroud lines are those running to the weight from the parachute.



MODEL PARACHUTE

FIGURE 89

These lines should be equal in length, meeting directly under the peak of the parachute, where they are tied to any weight sufficient to create a fall. BB shots, small dress weights, or any other type of weight can be used, as shown in C.

A unique method of assembling the parachute to the model is shown in D. A small length of piano wire is bent and attached to the under side of the fuselage or motor stick, so that its protruding portion will be parallel to the fuselage. Another piano wire part is then bent something on the order of a can hook, as shown. This should be just large enough to allow the parachute to be pulled through it, as shown in E, while the weight is attached over the first wire by means of a small wire loop made around the parachute weight.

While the model is flying level or while it is climbing, the apparatus will stay in the position as in E, but when the model glides down, the weight will slide off its hook and pull the silk through its hook, which will open the parachute, as shown in F. When assembling the model, hold it in the hand and point the nose down. If the assembly is correct, the weight will leave its hook, drag the silk through the forward hoop, and fall.

Every builder of exhibition models should have a number of dealers' catalogues handy, so that he can be familiar with the various accessories offered. These can then be copied and made by the builder or bought from dealers.

CHAPTER 16

THE ART OF FLYING MODELS

WHILE the builder may have designed and constructed an excellent flying model, there still remain four important steps to master before he can hope to make it fly to the best of its ability. These are proper wing adjustment, tail unit inspection, winding, and launching.

If the wing of a flying model is not correctly located on its fuselage, the model will stall or dive, either of which is disastrous to good flight. If the rudder and elevator are not perfectly straight and correctly located, the model may fly straight when circular flight is desired, or it may stall, dive, fly one wing low, side-slip, or do any number of undesirable things, any of which may ruin its flying possibilities.

If its motor is wound too much, the rubber will break, or if too few winds are given it, the motor will fail to give the propeller its maximum number of turns, which will cut down the model's endurance or speed in the air. The last of these four steps is one often given the least attention and yet it often proves to be the most important. If a model is poorly launched, its chances of a good flight are greatly lessened. As in real flying, the most ticklish and important part of any flight is the take-off, so do not handicap your model by a careless launching.

GLIDING METHOD OF WING ADJUSTMENT. The importance of proper wing location cannot be stressed too greatly. The wing location on a model can be found through an application of aerodynamics, as is done in real planes, but that would require such an amount of calculation for each model that the builder of today relies on the gliding method for obtaining this information. Its results are sure, while its method is simple.

When a model is being given this test, it must be complete with propeller and motor. If any accessories, such as bombs, parachutes, etc., are to be carried in flight, these, too, must be attached in place on the model before it is given the gliding test.

The model is then held between the fingers of the right hand at approximately its balancing point, with its nose pointing slightly down. It is launched with a slight forward motion of the forearm, and its performance

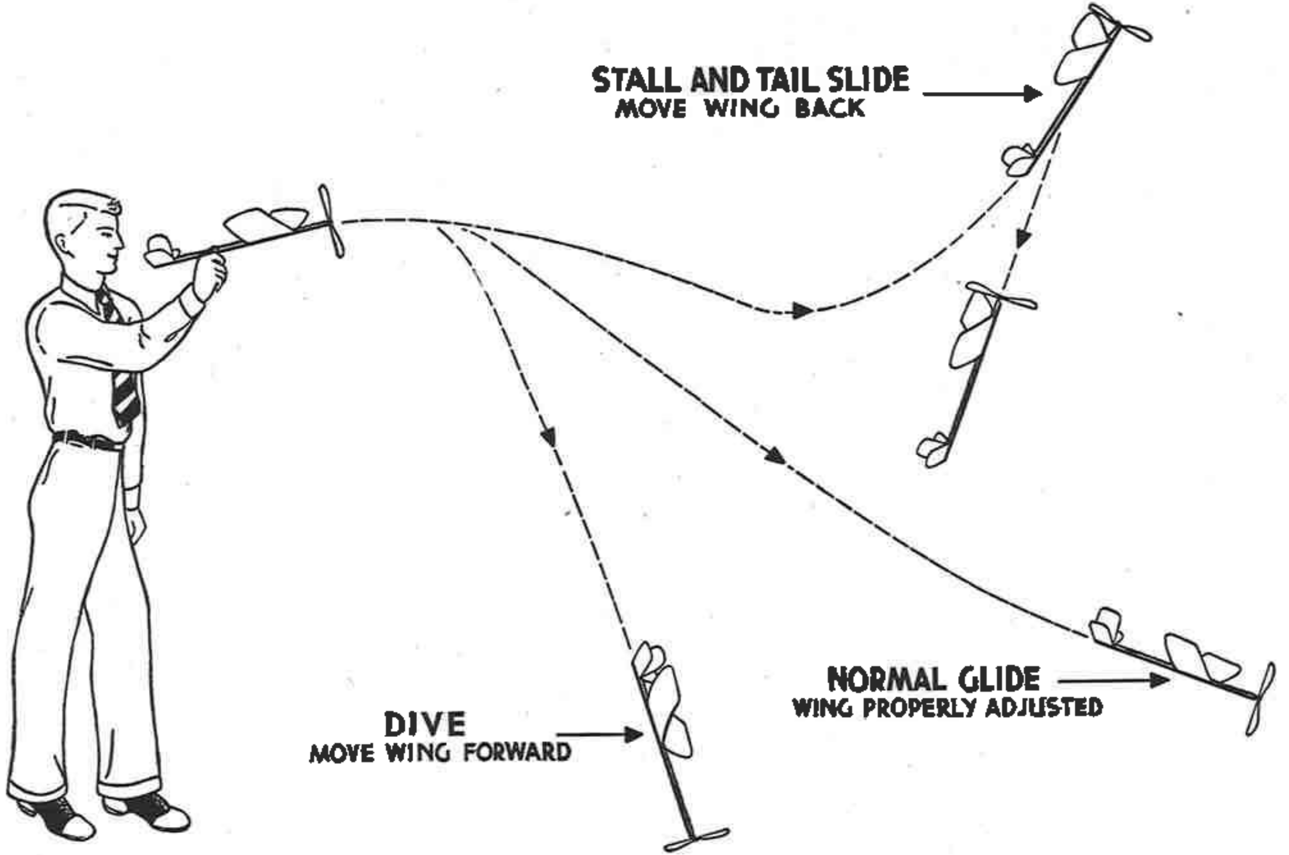


FIGURE 90. GLIDING METHOD OF WING ADJUSTMENT

carefully noted. In Fig. 90 are shown the three possible results of this test. If the model stalls, it indicates the wing is too far forward and must be brought back along the fuselage. After each adjustment, the model is again glided. If it should dive, the wing is too far back and must be brought forward along the fuselage. When a long, even, straight glide has been obtained, the wing location is correct. Mark the point on the fuselage. This mark will enable the builder to find the correct location quickly after the model has been dismantled, or in case it should strike an object in flight and its wing fly off. It is sometimes found that a new elevator or rudder, or a repair to a motor stick, will make a great difference in the location of the model's wing, so the model should be tested each time it is to be flown. Study Fig. 90 carefully and memorize its details, so that the adjusting of a wing becomes second nature.

TAIL UNIT INSPECTION. The elevator and rudder, which the author refers to as the model's tail unit, require attention before flight. On speed models, where straight, fast flights are required, inspect the rudder to see that it is perfectly straight in line with the motor stick, top stringer of the fuselage, or an imaginary line running fore-and-aft through the center of the fuselage. The elevator must be inspected to see that it forms right angles with the rudder, and that its main spars, if straight, are at right angles with the motor stick.

If the model is an indoor flyer, its rudder must be offset, as shown in Chapter 33, or, if a boom is not used and the rudder is attached directly on the motor stick, it must be slightly warped to one side, so that the model will fly in circles. Indoor models must be made to fly in circles, or they will travel the length or width of the room, strike a wall, and crash. As the rudder twist is increased, the circles of flight will become smaller.

If balsa and tissue construction has been used, breathing on the rudder will soften the structure enough to allow it to be bent a slight amount each time. If a heavy construction is used, the bend in the rudder must be built in.

WINDING. There are two methods of winding a motor. For models carrying light rubber, the hand method is used, but for all contest models, twin-stick pushers, and all others carrying heavy motors, a winder is used.

HAND WINDING. Hold the model in the left hand and with the right index finger twist the propeller around in the opposite direction from which it turns when in flight. The usual right-hand propeller turns clockwise when viewed from the rear, so it must be wound in the opposite direction, or counter-clockwise. Many methods have been propounded to calculate the breaking point of rubber motors, but none of these calculations can be counted on at all times. For this reason, the author recommends the winding of rubber by feel alone. When the rubber feels as if it had no more elasticity left, cease winding. Do not be afraid of breaking a few rubber motors, as it is in this way only that the proper feel of rubber can be learned.

WINDERS. These may be purchased from any model supply house, or they can be easily made. If purchased, the handle of the winder can be improved by adding a pistol grip, as in Fig. 91. Two wood sides are cut

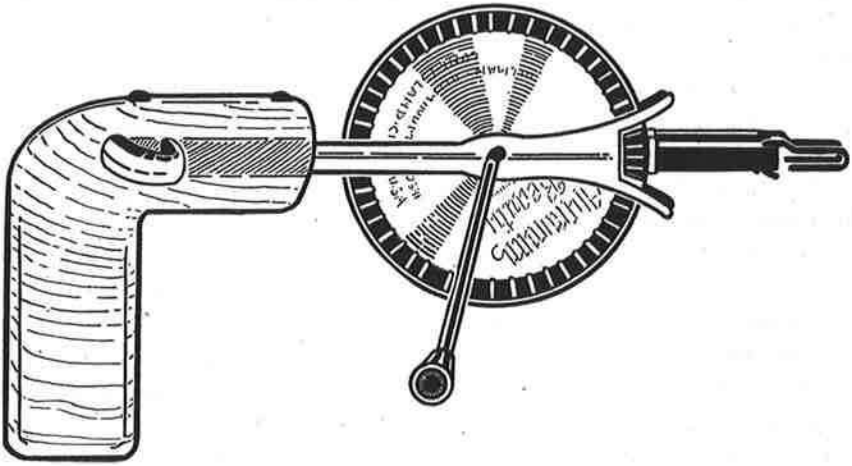


FIGURE 91. COMMERCIAL WINDER WITH HOMEMADE PISTOL GRIP

to shape and fitted to each side of the original handle. These are nailed or cemented together, and wood filler is used to fill in the wide space between the handle and the pistol grip. The assembly is then sandpapered until perfectly smooth. The handle can then be stained, painted, or left the natural shade of the wood.

The home-made winder, while not as strong as the manufactured article, is, nevertheless, strong enough for all average winding purposes. An egg-beater from your nearest five-and-ten-cent store can be quickly converted into a perfect winder, as in Fig. 92. With a hack saw, cut the extensions of the beater, as in A. The center core rod of each of these extensions is cut shorter than the stirring arms, as seen in B.

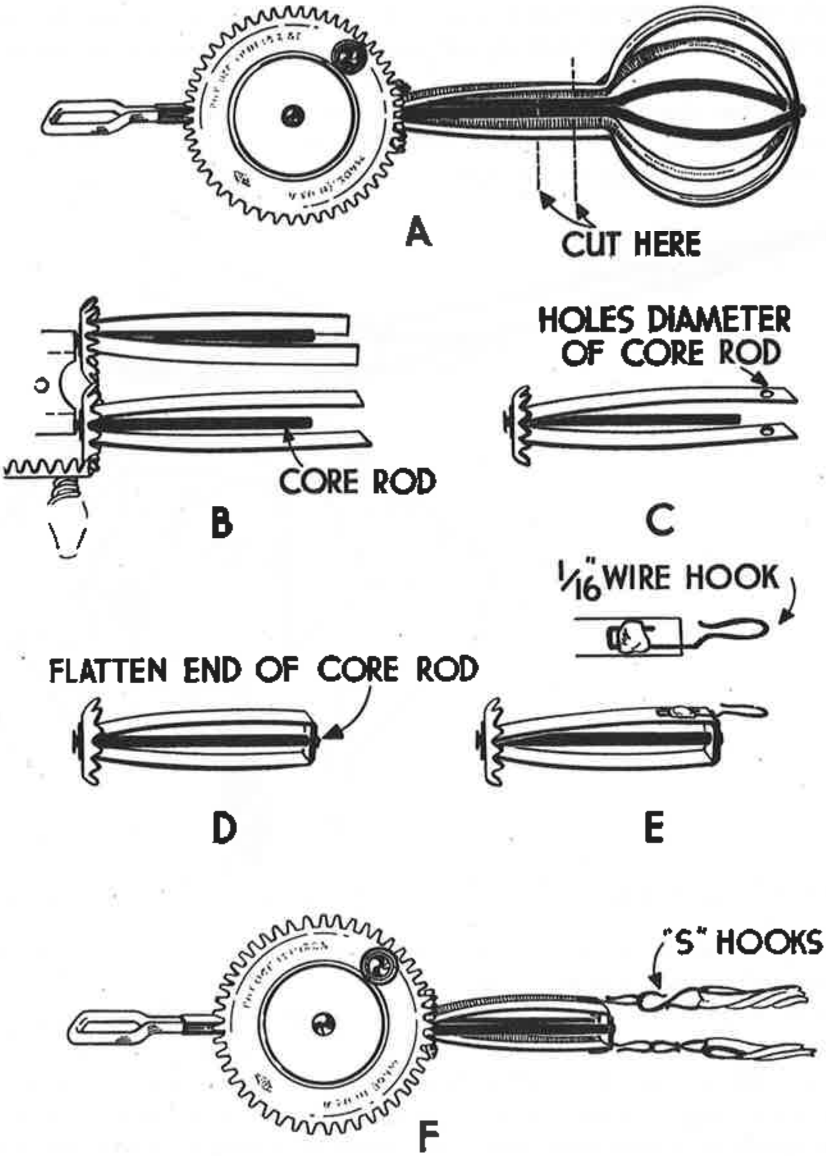
Two holes must now be drilled. These are drilled through the stirring arms close to their ends and must be the same diameter as the core rod, as in C. The ends of the stirring arms are bent over so that their holes fit over the end of the rod, as in D. The end of the rod is now flattened with a ball-pein hammer, or the arms are soldered in place on the rod. While C, D, and E show only one extension assembly, both of these extensions must be treated in the same way. Hooks are bent from $1/16''$ diameter wire, and soldered to the arms of the extension assemblies, as in E. Bend these two hooks, as shown in the enlarged illustration, and solder them in place, one on each extension arm. If you have no soldering outfit, your nearest carpenter, roofer, or hardware store will be able to do this for you.

The completed winder is shown in F. The great advantage of such a winder is that it can wind twin motors at one time, and insure both motors having an equal number of turns. It can also be used on single motors by attaching the hook of only one extension arm. As the two arms of the winder rotate in opposite directions, they are especially adaptable to twin pusher motors whose propellers turn in opposite directions. (See Chapter 9, "Right and Left Hand Propellers.")

To obtain the maximum number of turns possible in a rubber motor, the rubber should be stretched while being wound. For ordinary use, a motor can be stretched four times its own length. In other words, if the strands were 12″ long, they could be stretched to 48″ long and then wound. For contest work, where every second counts, this could be increased to 60″ with the motor used here as an example, or five times the motor strand length. Stretching rubber beyond that point is not recommended, as the rubber quickly reaches a point where its elasticity is lost.

When using a winder, two people are required. One holds the propeller shaft while the other handles the winder. The process is simple. Measure the length of your rubber strands. Unhook the rubber from its end hook, while your friend holds the propeller shaft firmly in his hand. Walk away from him a distance of four or five times the length of the strands, stretching the rubber as you proceed. Attach the rubber to the winder with the usual "S" hook. When reaching the proper distance, start winding the rubber, slowly walking toward your friend as you wind. Some experts prefer to wind the motor tight, then take a step toward their holder, wind again, take another step, and so on until the motor is fully wound.

This is all right for the expert but is not recommended to the novice. When the motor feels as if it could not stand another turn, stop winding! The end of the motor is then transferred from the hook of the winder to the end hook, while the propeller is carefully held. The model is then ready for launching. Always wind a rubber motor just before flight, as wound rubber quickly becomes "dead" when left under strain. Rest the rubber at least ten minutes between flights, so that it will have a chance to



EGG-BEATER WINDER

FIGURE 92

regain its energy. Many builders favor the prewinding of a motor. By "prewinding" is meant the winding and running of a motor before actual flight tests.

It is true that second windings are usually the most efficient, but as a model should be tested by actual flight just before being used in contests, the necessary winding of the motor for this test will serve quite as well.

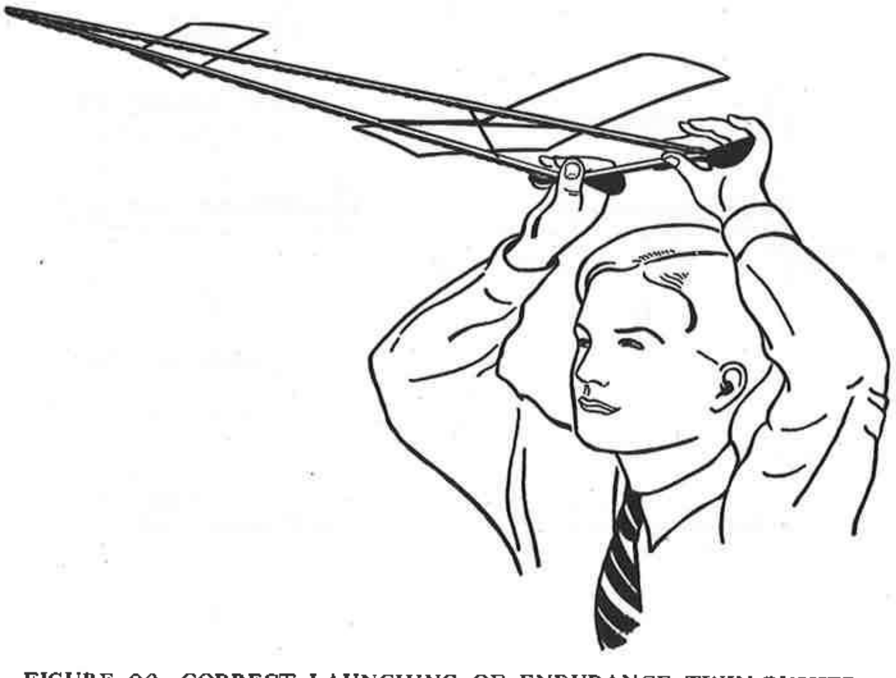


FIGURE 93. CORRECT LAUNCHING OF ENDURANCE TWIN-PUSHER

When prewinding a motor, never give it its full amount of turns. Save this for the judge's stop watch!

LAUNCHING. Every model requires individual launching. There can be no set rules governing all models. By this, we mean that each model will present different problems when being launched. Some models will prove best when facing a wind, others will give their best performance when no wind whatever is noticeable, while still others will show best with the wind on their tails. Some models must be launched slightly down, others with one wing slightly up, while still other models require other and different treatment.

The builder must determine the idiosyncrasies of his model by repeated launching, but there are certain fundamental laws governing every model launching which he should learn.

CORRECT LAUNCHING OF ENDURANCE TWIN PUSHERS. In Fig. 93 is shown the most common position used for launching a twin-stick pusher. The thumb and index finger of each hand grasp the beams of the A-frame just in front of the propellers which rest in the palms of the hands, as shown. This keeps the propellers from moving, and allows the launcher to release his model by simply opening his fingers. The model is held with its nose slightly raised and the propellers parallel with the ground.

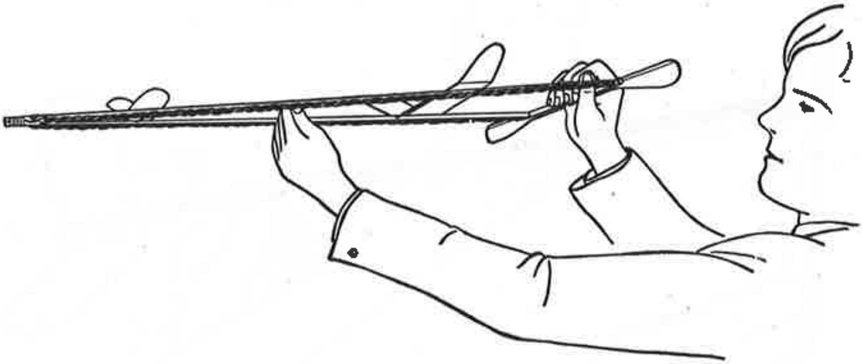


FIGURE 94. CORRECT LAUNCHING OF SPEED TWIN-PUSHER

The majority of builders launch their models from a position above their heads, but this is a question of choice. Some prefer to launch near the ground, getting down on one knee to do so, but this method is seldom used. The position shown in the illustration is the most popular today, but each builder should decide this question for himself from actual trials with his model.

The greatest consideration in launching a twin pusher is to be sure that both hands are released simultaneously, and that if any forward push is given the model, both hands are brought forward with equal strength, so that the model will not be launched with one propeller ahead of the other.

CORRECT LAUNCHING OF SPEED TWIN PUSHERS. Without a doubt, the most difficult model to launch properly is the speed twin pusher. In the first place, its propellers have been wound by such a strong motor that real strength is required to hold them before launching. In the second place, the action of a speed model is that of a bullet rather than an airplane, so that it will travel in a straight line in the direction in which it is facing when launched. Nothing can change its course. Wind currents have no effect on such a model, so the secret of launching a speed plane is to be able to hold its propellers and at the same time launch it in a dead straight line. This requires a hold on the propellers that can be released without jarring or moving the model. Fig. 94 shows the proper way to launch such a model. The hand is doubled loosely around the rear brace

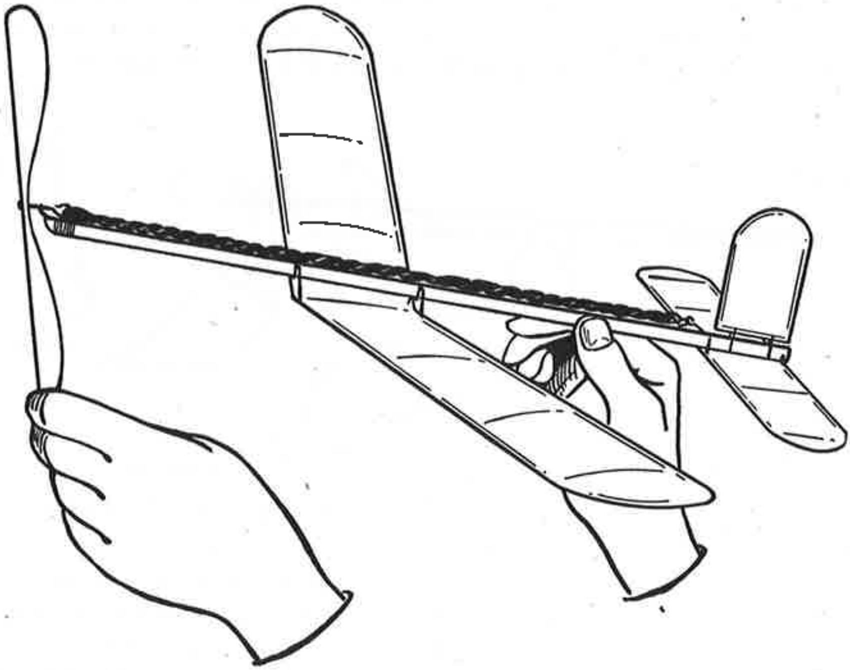


FIGURE 95. CORRECT LAUNCHING OF SINGLE STICK TRACTOR

of the A-frame, with the inner blades of the two propellers held in the palm of the hand, which is pushed against the brace. The other hand holds the model by its forward brace.

The model is then raised to eye level, so that the launcher can aim it at a distant point and at the same time see that the A-frame is perfectly parallel with the ground. When ready to release, the right hand is quickly opened wide, which releases the powerful propellers, and the left hand is dropped, sending the model on its arrow-like dash down the course. The builder must remember that he is holding in his hand a model capable of traveling a mile a minute, which is the speed that won the famous Barney Oldfield his reputation as a dare-devil automobile racer. You are not strapped into a seat with a powerful motor in front of you and four great wheels to carry you along, but actually holding in your two hands a machine that is able to break half the world's records in the days of that famous racer.

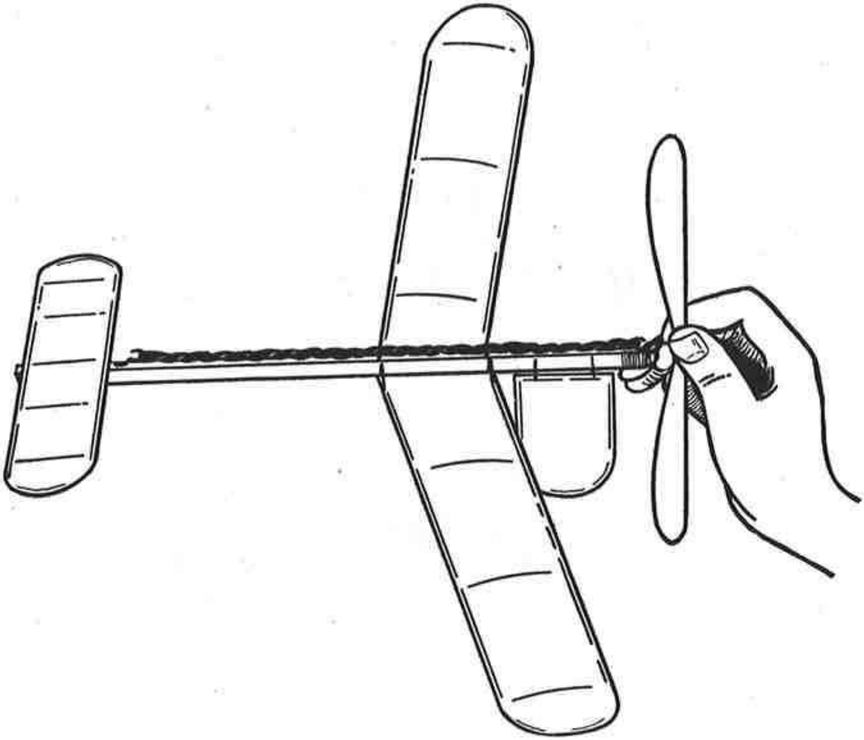


FIGURE 96. CORRECT LAUNCHING OF SINGLE STICK PUSHER

It is capable of producing a speed equal to the Twentieth Century Limited, so be careful!

CORRECT LAUNCHING OF SINGLE-STICK TRACTOR. When launching a single-stick tractor, the left hand holds the tip of one of the propeller blades, while the right hand holds the stick between the main wing and the elevator with finger and thumb. This is shown in Fig. 95. The model is given a slight forward push with the right hand, while the left releases the propeller. Such models may be launched with their nose slightly tilted up, or the entire motor stick can be held parallel with the ground.

CORRECT LAUNCHING OF SINGLE-STICK PUSHERS. Single-stick pushers, if small, can be easily launched with one hand. Hold the hub of the propeller between the thumb and index finger, which should also extend over the propeller bearing, as shown in Fig. 96. The middle finger rests under the motor stick and supports it. The launching consists of bringing the forearm forward and releasing the model. If the model is a large one, the left hand should be used to steady and support it at the front. Place the

FIGURE 97. CORRECT LAUNCHING OF R.O.G. MODEL

thumb and forefinger under the motor stick between the main wing and the elevator, and drop the hand away as the model is released by the right hand.

CORRECT LAUNCHING OF R.O.G. MODEL. In Fig. 97 is shown the correct position for launching any rise-off-ground or rise-off-snow model, whether it is a stick or fuselage model. The launcher gets down on one knee, places his left thumb and index finger over the tip of one blade of the propeller to keep it from turning. The right hand holds the trailing edge of the rudder in the same manner. No forward motion should be applied to an R.O.G. or R.O.S. model. It should simply be released, whereupon it will race across the ground and rise on its own power. The danger of applying forward motion to such a model is that the force may not be perfectly centered, in which case the model will start with one wing low or in another direction than that desired. Giving forward motion to such a model while on the ground causes more "ground loops" than anything else.

Another interesting method is shown in Fig. 98. This is especially good when racing with R.O.G. or R.O.S. models. Instead of holding the tip of

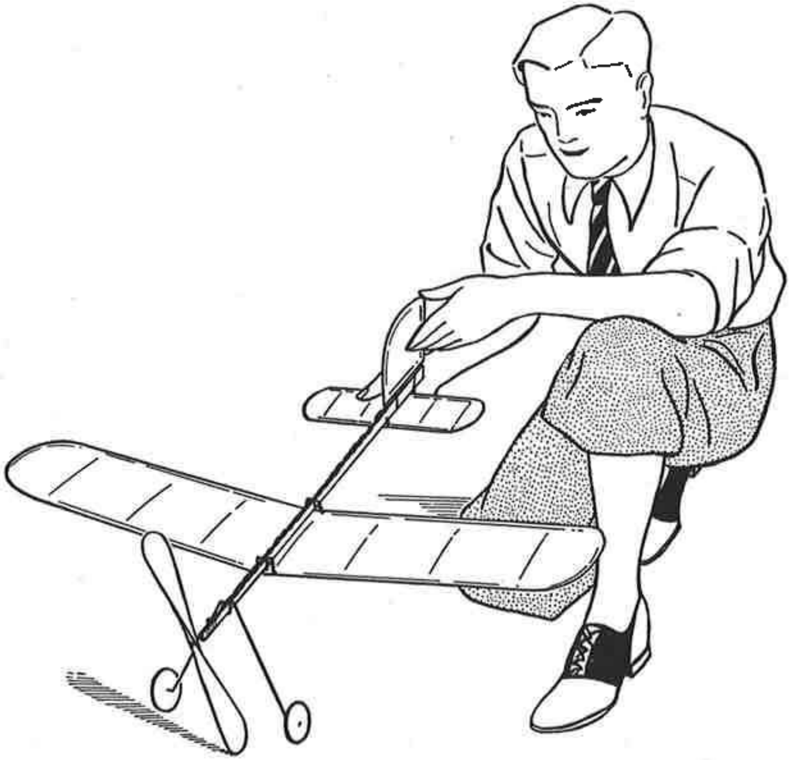


FIGURE 98. NOVEL METHOD OF LAUNCHING R.O.G. MODEL

the propeller, the tail of the model is raised sufficiently to allow the tip to touch the ground, which keeps it from turning. When ready to launch the model, simply drop the tail to the ground. This releases the propeller and the model is launched.

The reader must remember that these facts on the launching of models are gained through experimentation only, and that in this manner he, too, must learn and constantly improve until perfection has been gained.

GLIDERS

CHAPTER 17

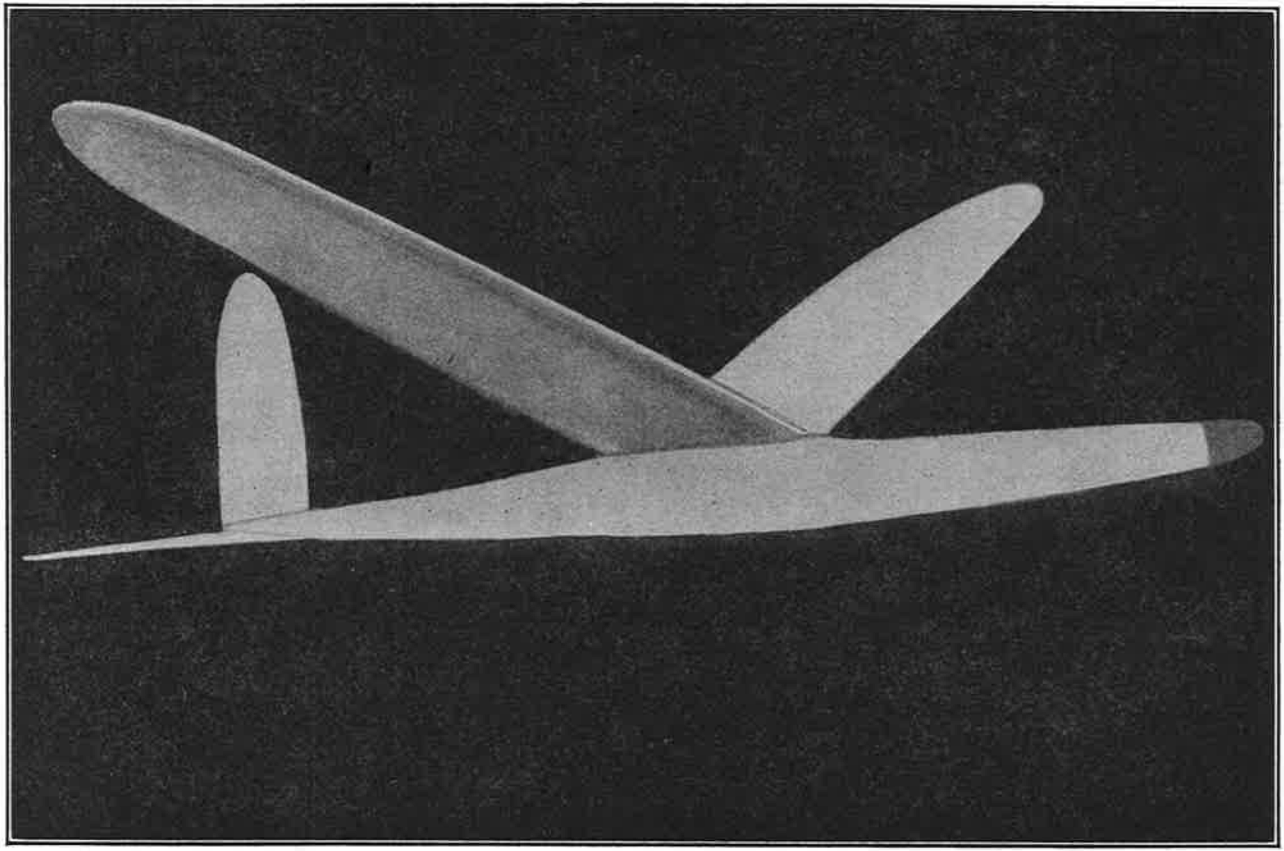
CHAMPIONSHIP SOLID BALSA GLIDER

IF records mean anything, here's the champion of champions in the all-balsa glider class. Designed and built by Louis Milowitz, it has made official and unofficial records surpassing anything of which the author has yet heard. The best performance it has been known to give took place in the Bronx, New York, where it was timed in the air for thirty minutes before flying over the Harlem River and out of sight. Official records show that it was clocked four minutes out of sight to win the 1935 Junior Birdmen Novice Contest, and that in a high wind under adverse conditions it flew for forty-seven seconds to win the New York City Park Department Contest. Later in the same contest it flew three minutes out of sight and was later found on the roof of one of New York's skyscraper hotels. Here is a glider you can't afford to miss, so get busy, build it, and when the next glider contest comes along you'll go home with the prize!

MATERIAL LIST

1 pc.—1/4" x 3/4" x 18" long—Sheet Balsa (Fuselage)
1 pc.—1/16" x 2" x 12" long—Sheet Balsa (Tail unit)
1 pc.—1/8" x 3" x 18" long—Sheet Balsa (Wing)
Banana oil
Colorless cement
Sandpaper

FUSELAGE. The fuselage is carved to shape from a single sheet of balsa 1/4" x 3/4" x 18" long. Study the accompanying plan. In the side view shown at the bottom of the plan are three cross-sectional views of the fuselage. These are "A-A," "B-B" and "C-C." It will be noted that at "B-B" the full width of the fuselage is kept, while it tapers off toward both ends. Square up the sheet balsa to 1/4" x 3/4" x 17 1/2" long. Make a full-size drawing of its outline on paper. The part that is kept 3/4" wide is the wing location. This begins 5 1/2" back from the nose and continues for 3". Start at this point, which is 8 1/2" back from the nose, to work out your drawing. Draw the slight dip just behind this point, as shown in the plan. Measure



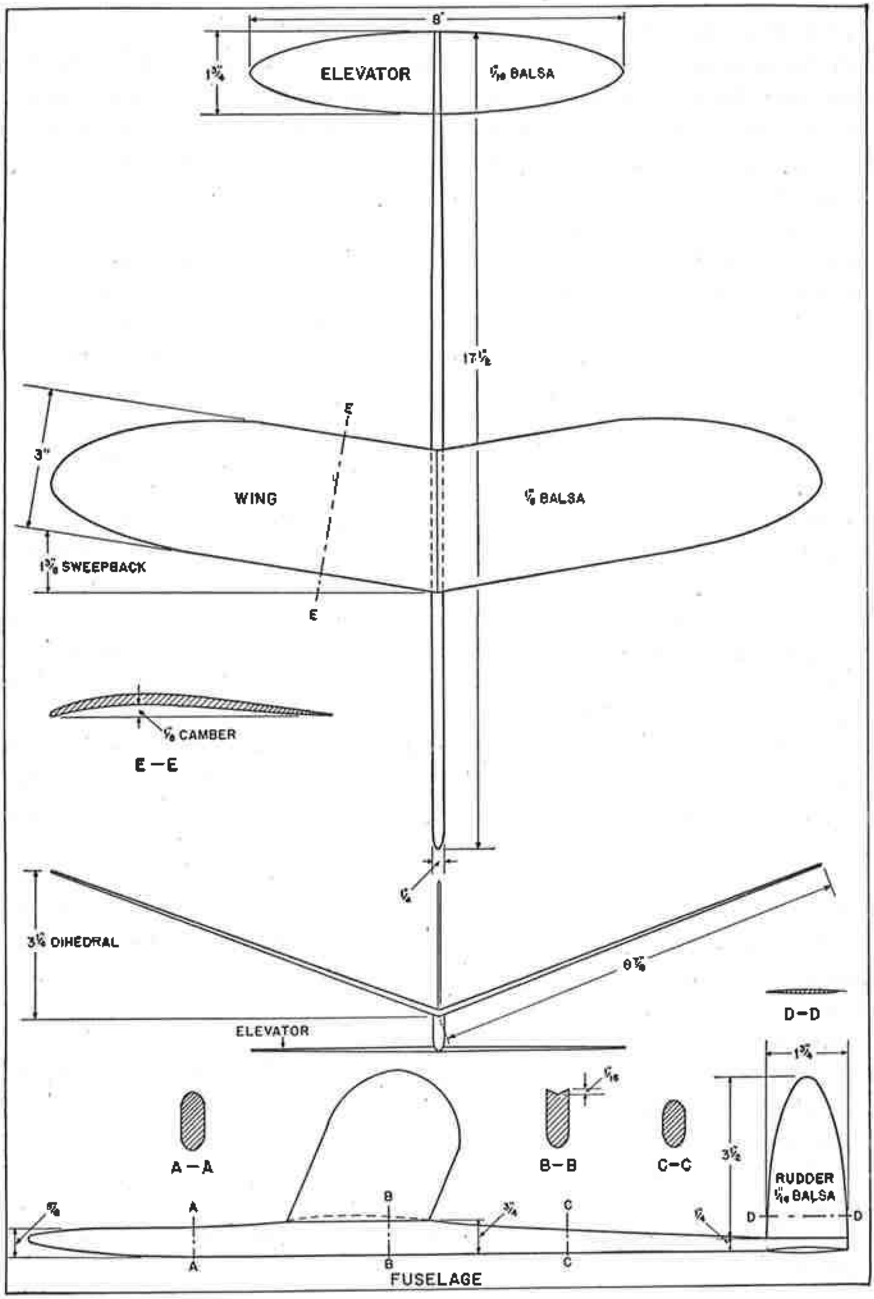
CHAMPIONSHIP SOLID BALSA GLIDER

1¾" in from the end of the fuselage. Draw a line ¼" above and parallel with the bottom edge of the layout board. This is the width of the fuselage along this distance. Join the front end of this line with the rear point of the dip just drawn by a straight line. The bottom edge of the board remains straight until within 3" of its front end, where it curves up ⅜" to form a blunt nose. Draw a slight dip from the front of the wing location on the upper edge of the drawing to the nose, which completes it. This is then traced on the ¼" sheet balsa and cut out. Note that the fuselage is cut out under the rudder location to accommodate half the thickness of the elevator. The cross-section "B-B" shows the "V" cut along the 3" of the wing location to accommodate it, and the top view of the plan shows how the fuselage tapers slightly in thickness toward the tail. When this taper and the other cuts have been made, bring the fuselage to a satin smoothness with fine sandpaper. Apply three coats of banana oil sanding between each coat.

WING. The wing is shaped from a ⅛" sheet of balsa 3" wide and 17¾" long. The tips are shaped first. The tip curves on both ends start at a point 3¼" in from the ends of the wing board along the leading edge. They start 4½" in from the ends along the trailing edge. Shape these tips and then give the entire length of the wing a natural camber. Note that the thickness of the wing tapers from its full thickness at the center to a knife edge at both tips. This taper must be given when the camber is being obtained. The camber forming an under-chamber is not given the wing at this time. Note this at "E-E." Cut the wing in half. Obtain the 1⅜" sweepback at each tip by tapering the inner end of each wing half ½" on its trailing edge. Bevel the inner ends and then obtain the necessary dihedral. Lay the wing halves in position flat on the bench. Hold their inner ends together and lift one tip 6½" off the bench. Cement the halves together and hold in this position until dry. Apply three coats of banana oil and sand between each coat for proper finish. Cement the wing in the "V" cut for it on top of the fuselage at zero degrees.

ELEVATOR. The elevator is shaped from 1/16" sheet balsa cut 1¾" wide and 8" long. Give it proper camber, as shown in the plan, and finish smooth with sandpaper. Apply three coats of banana oil and sand lightly between each coat. Cement it in place on the upper side of the fuselage at zero degrees. Test to see that it is perfectly level and at right angles to the fuselage.

RUDDER. The rudder is cut from 1/16" sheet balsa 1¾" wide and 3½" high. It is given the same form as one end of the elevator and then streamlined, as shown in the cross-sectional view "D-D." When finally sanded



CHAMPIONSHIP SOLID BALSA GLIDER PLAN

smooth, apply three coats of banana oil and sand between each coat with fine paper. Cement the rudder to the top-center of the fuselage just above the location of the elevator. Test to see that it is at right angles to the elevator.

ADJUSTING. The tips of the wing should be given a 1/8" under-chamber, as shown in the plan at "E-E." In adjusting the glider, clay is used on the nose to produce proper weight. The amount required to gain this longitudinal stability is determined by gliding it from the hand. For a right hand adjustment the glider should be made to turn to the left in a circle about thirty-five feet in diameter. This can be done by warping the trailing edge of the rudder to the left. When launching the model, it should be given an almost vertical thrust upward into the air with a slight right bank. The glider has a very slow glide which allows it to take full advantage of upward currents. Here's to hours of fun for future glider experts!

GLIDING. The secret of proper gliding is to have the weight of the model located just in front of the center of pressure. Then if the model stalls, this forward weight will pull the nose of the glider down and allow it to continue its glide. If the nose of the glider were not heavier than its tail, and the model should stall, it might drop into a tail slip which would carry it to the ground.

To prevent this a piece of sheet lead, or any other appropriate weight, is added to the nose of the model, and the builder must determine the exact amount of this weight necessary to give the best results. This is not difficult, but requires careful tests of the gliding ability of the model. If the model stalls, the weight must be increased, and if it dives, too much weight has been applied.

The builder will find that the sheet of lead called for in the material list is larger than necessary for such a model, but this has been done purposely. Adding weight to a model is far more difficult than removing it. This is true because a single piece of lead is easier to attach to the upper edge of a fuselage than two or more small pieces. So we start our trial glides with too much weight, and then slowly cut away the excess material until a single piece of the correct weight remains, which is then cemented in place.

Bend the sheet of lead so that it will fit over the top edge of the fuselage, as shown. When launching the model, do not thrust it from you with force, but allow it to leave the hand lightly. When the model dives, cut a small amount of the lead away, replace it in position on the fuselage, and relaunch. Continue these tests until the model continues in a straight path with its nose pointing slightly down in a rather fast glide.

When a long, smooth glide of this type has been obtained, give the model more force by swinging the arm forward and releasing it. If it stalls, you have cut off too much weight, which must be corrected by additional lead. If, however, the model tends to sail up, stall slightly, drop its nose into a dive, and then straighten into another glide, its action is correct, and long glides should result. When such flights have been obtained, the lead should be cemented in place.

If the glide is not straight, the builder must examine his rudder, as this is usually the cause of any turning in flight. Make sure it is perfectly straight up and down. If this does not correct the fault, the wing should be removed and given the balance test. (See Chapter 7, "Wing Assembly.")

The builder wishing a larger glider can easily build one by doubling all dimensions given in the plan, and following building instructions given in the text.

CHAPTER 18

PRIMARY GLIDER

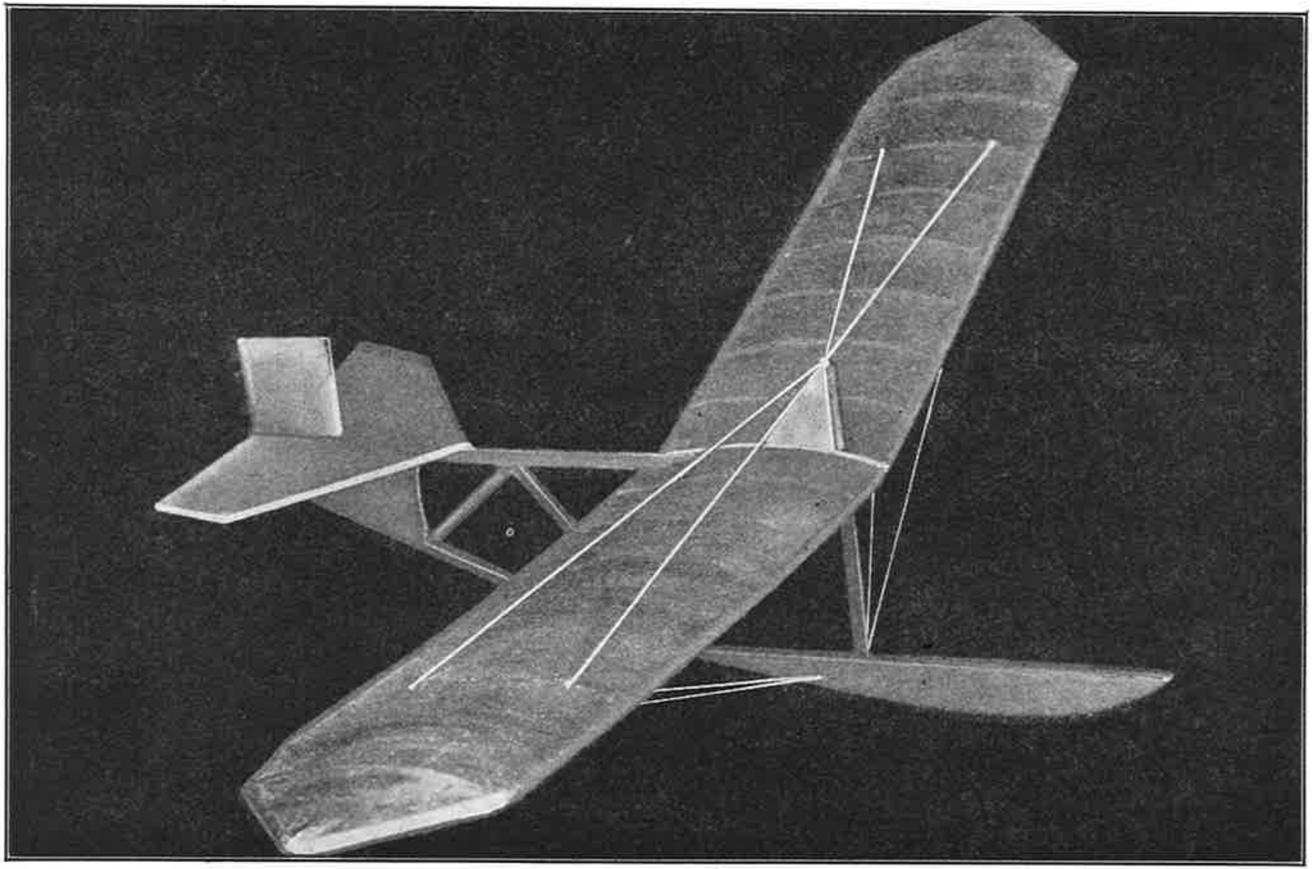
PRIMARY gliders obtain their name through the fact that they are the first on which new students learn the fundamentals behind soaring, or motorless, flight. From these, they graduate to secondary gliders and then to soaring gliders. This model is a true design of the best known primary glider. It adapts itself to the necessary small dimensions in a remarkable way, and its builder will find it a splendid performer in the air.

MATERIAL LIST

1 pc. —1/16" x 3" x 36"	—Sheet balsa for wing ribs and gusset plates
2 pcs.—1/4" x 1/4" x 18"	—Balsa for inner wing spar
2 pcs.—1/4" x 1/4" x 18"	—Balsa for leading edge spar
2 pcs.—1/8" x 1/8" x 18"	—Balsa for trailing edge spar
1 pc. —3/8" x 1 1/8" x 10 1/8"	—Balsa wood for skid of fuselage
1 pc. —1/4" x 1/4" x 36"	—Balsa for fuselage, wing tips, and fin
1 pc. —1/8" x 1/8" x 30"	—Balsa for rudder and elevator
1 1/2 sheets	—Japanese tissue paper for covering
1/2 oz.	—Colorless cement
1/2 oz.	—Dope
1 yard	—White cotton thread
Sheet lead weight	

FUSELAGE. On this type of model, the fuselage can be divided into two parts, the skid and the frame. On the 3/8" x 1 1/8" x 10 1/8" piece of balsa, trace with pencil the shape of the skid, as shown in Plan 1. This consists of the solid piece located along the bottom of the fuselage. When the shape has been traced, the piece is cut out and its edges sandpapered smooth. An edge view of the fuselage skid is shown in Plan 2. It is 3/8" thick at the front end and tapers to 1/4" thick at the end. This is also shown in the edge view, and is called for in Plan 1. Sandpaper both faces of this balsa piece until it tapers from its original thickness at the nose to 1/4" thickness at its rear end.

The frame of the fuselage is built up on the skid with 1/4" square balsa lengths. Cut your 1/4" x 1/4" x 36" length of balsa wood into the required nine pieces, which will leave enough wood to make the necessary wing tips.



PRIMARY GLIDER

Assemble these pieces to the skid, and cement each in place. Cement the four uprights to the skid, follow with the long cross piece, and then cut and cement in the diagonal cross braces. The gusset plates are added to strengthen the frame. The plates A are cut first. Draw a 1½″ diameter circle in pencil on the $\frac{1}{16}$″ sheet balsa. This circle is cut out, and split into two halves. Along the straight edge of each half circle, the form of the fuselage is cut, so that it will fit perfectly in place, as shown in the plan. One of these gusset plates is cemented on each side of skid and frame upright.

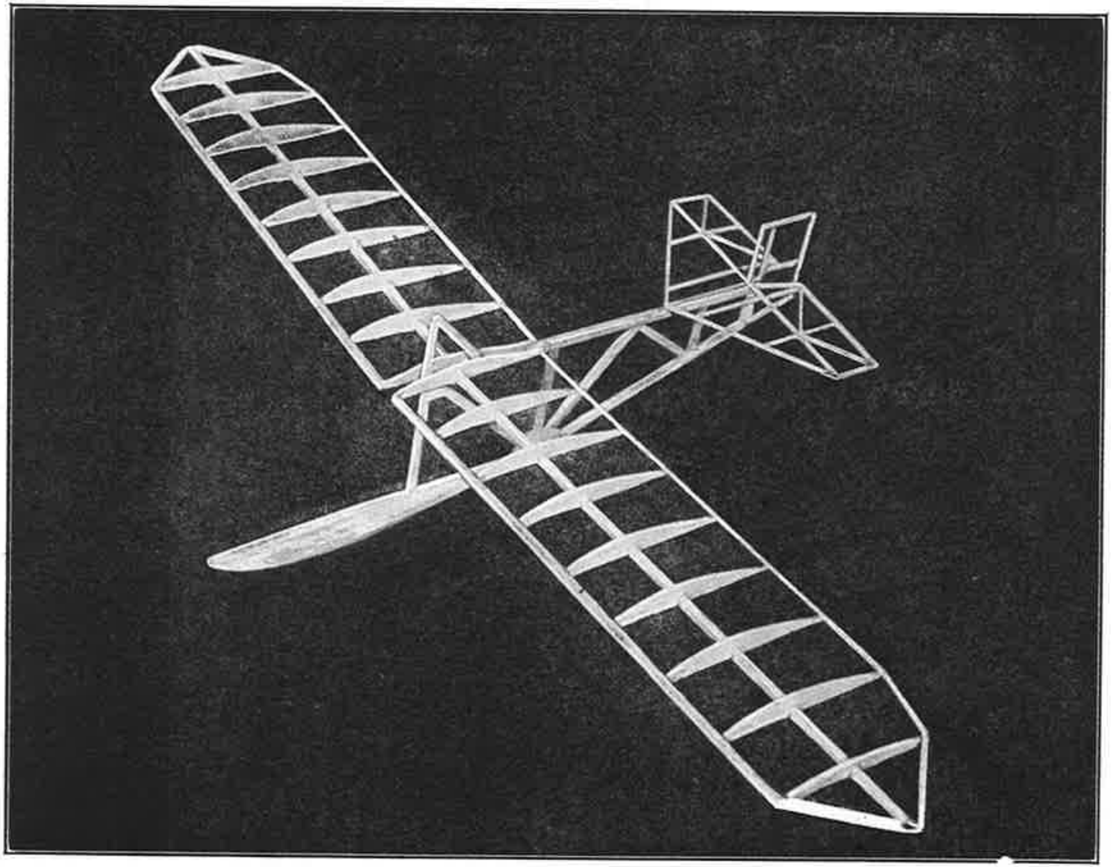
The smaller plates B are also cut from the $\frac{1}{16}$″ sheet balsa. These are ¾″ wide and 1″ long. Cut them out and cement one on each side of the front upright and the long top member of the frame. The assembly should dry for an hour, after which it is lightly sandpapered to remove all traces of cement.

RUDDER. As the rudder is built on the fuselage and is therefore a part of it, this should be cut and assembled at this time. It requires seven pieces of ⅛″ x ⅛″ balsa. Cut these pieces and assemble them in position to the end of the fuselage, as shown. Each should be carefully cemented in place, and when dry, given a light sandpapering for a smooth finish and to remove excess cement.

When assembled and sandpapered, the rudder is covered on both sides. At the same time, the frame section next to the rudder is also covered on both sides. This can be seen in the photograph of the finished model. Cut the Japanese tissue to proper shape, coat all parts the paper will cover with dope, or clear banana oil, and press the tissue in place on them. When dry, water-spray the paper, and give it a coat of dope. (See Chapter 7, "Wing Covering.")

ELEVATOR. The elevator is constructed of ⅛″ square balsa lengths. As it is fully assembled before being attached to the fuselage, the builder should make a full-size working drawing of the elevator. (See Plan 2.)

Cut one balsa length 8″, which forms the longest member of its frame. This is the inner spar. Place it in position on your drawing. Cut two leading edge spars long enough to extend from the ends of the inner spar to a point 3″ in front of it, where the ends of the leading edge spars meet. Cement these three pieces together. A center rib 3″ long is cemented in place from the center of the inner spar to the point where the leading edge spars meet. Two more ribs are cemented between the leading edge spars and the inner spar ½″ on each side of this center rib. The remaining two ribs, which complete the front of the elevator, are cemented between the lead-



PRIMARY GLIDER SKELETON

ing edge spars and the inner spar. These are located 1¾″ out from the last attached ribs, and complete the front section of the elevator.

The trailing edge spars are both 3½″ long and are located 1½″ behind the inner spar. Note that each of the 1½″ ribs used on this part of the elevator are so placed as to look like continuations of the forward ribs, but that they are further strengthened by diagonally placed spars. Lay each piece in its proper position on the plan, and when complete, cement each in place.

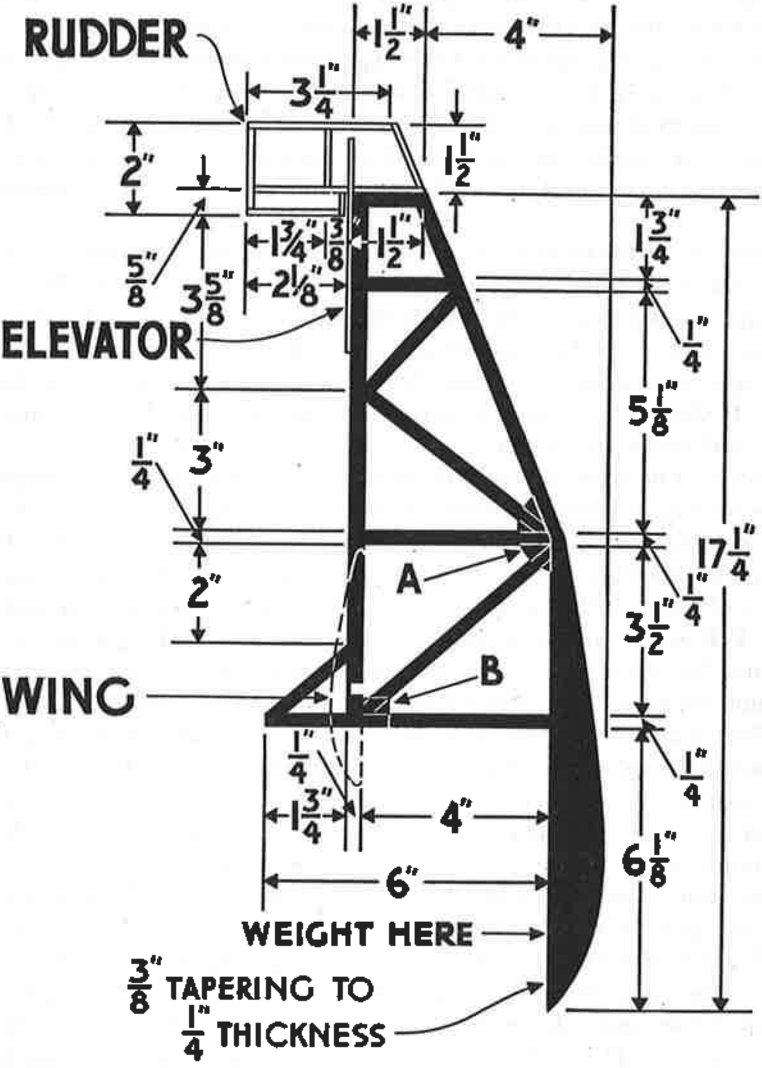
When the construction of the elevator has been completed, cover its upper side with Japanese tissue. (See Chapter 7, "Wing Covering.") Give the surface a water-spraying and then a thin coat of dope. The elevator is now attached to the fuselage. Note its position in Plan 1 and Plan 2. The inner spar fits under the rudder between it and the edge of the fuselage frame. It should be located directly over the end strut of the frame, with its covered surface facing up.

WING. The wing is made in two parts. As both are exact duplicates, these instructions cover the building of only one. From the 1/16″ x 3″ x 36″ sheet of balsa wood, cut eight A ribs, as shown in the plan. To do this, a template should be cut to the full size of these ribs. Draw ½″ squares on a sheet of paper. The outline of the rib is drawn full size on this ruled paper. Follow the outline as shown in the plan under "Wing Ribs—A," making sure that each part of the line passes through each square in exactly the same location it takes through the squares of the plan.

When completed, trace the outline of the rib on the balsa sheet, by cutting out the drawing and using it as a template. After one rib has been cut out, sandpaper its edges smooth, and test to see that its shape is an exact copy of the one in the plan. When completed, all other ribs can be cut from this master one by tracing its outline on the sheet balsa.

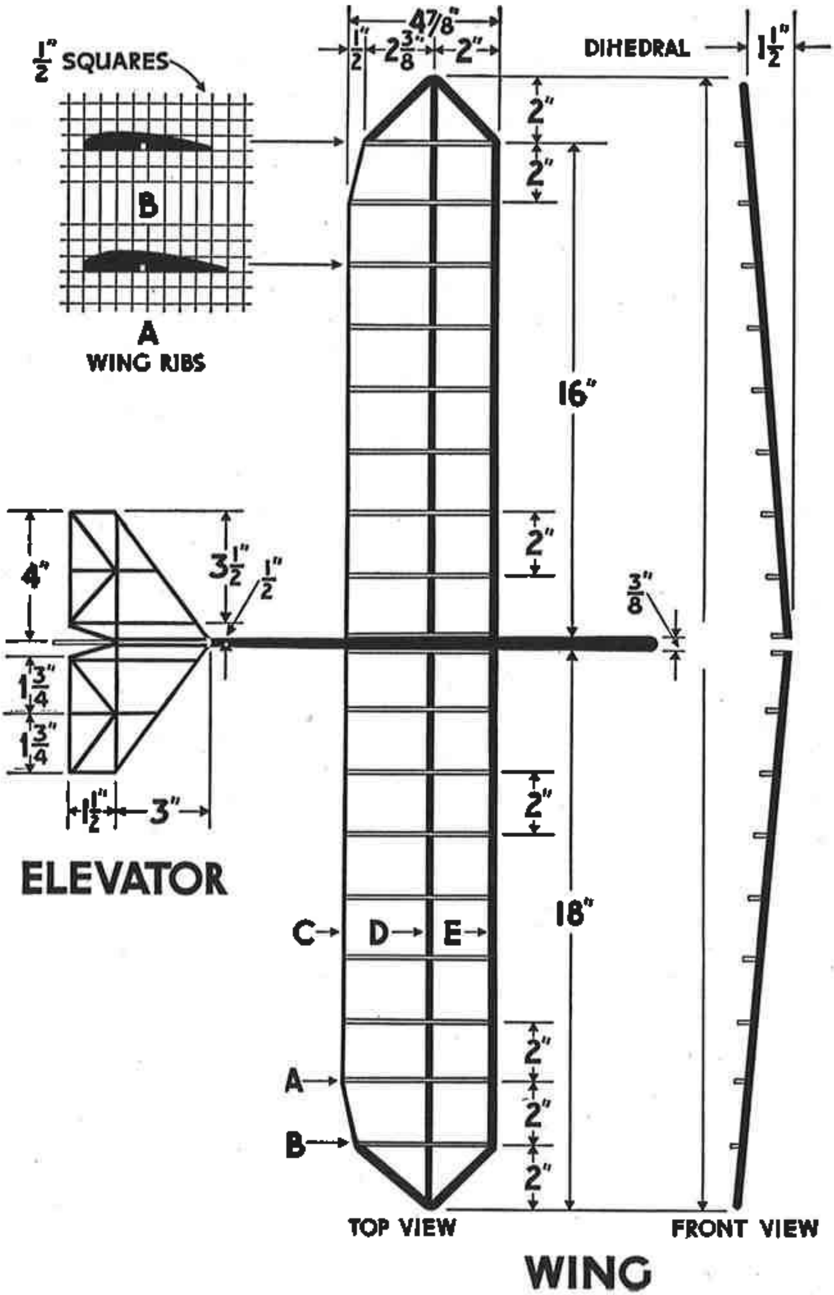
The same process should be used for cutting the end rib B. For each half wing, eight A ribs and one B rib will be required. When these are completed, the leading edge, trailing edge, and inner spars should be cut. The leading edge spar, shown in the plan by E, is ¼″ x ¼″ x 16″ long. It should be rounded on one side to carry out the front curve of the wing ribs. The inner wing spar D is ¼″ x ¼″ x 18″ long. It is left square, as can be seen from the side view of the ribs under "Wing Ribs." Each rib is notched on its straight under edge to accommodate this spar.

The trailing edge spar is cut from a balsa piece ⅛″ x ⅛″ x 16″ long. It is shown in the plan by C. Cement the eight ribs 2″ apart along the inner wing spar D. Cement the leading edge spar E to the front ends of each of these ribs. The short rib B is cemented 2″ from the last A rib on the inner



FUSELAGE

PRIMARY GLIDER PLAN 1



PRIMARY GLIDER PLAN 2

spar. The trailing edge spar is attached with cement to the ends of the eight A ribs. Note that it will require bending to be cemented to the end of the short B rib. Crack it slightly at this point, fill the crack with cement, and cement its end to the trailing end of B rib, at the same time cementing the other end of B rib to the end of E spar.

The wing tip is formed of two lengths of 1/4" x 1/4" balsa. These are cut and cemented in place. The wing is covered on both sides with Japanese tissue. (See Chapter 7, "Wing Covering.") Give the tissue a water-spraying and then finish with a thin coat of dope. This completes one half of the wing. The second half is constructed in the same manner.

The wing is now assembled on the model. Each half is fitted to each side of the fuselage frame, as shown in Plan 1. Note that the wing has a 1 1/2" dihedral angle. To obtain this, each half of the wing must be attached to the fuselage with its tip 1 1/2" higher than the point of attachment at the fuselage. When doing this work, hold the wing in place on the side of the fuselage frame with model pins until the exact dihedral is obtained. When in proper position, fill the crack between the inner rib and the fuselage side with cement and allow to dry for one hour. The model pins can then be removed.

To complete the model, the small forward fin just above the wing is covered on both sides with Japanese tissue, as shown in the photograph of the finished model, and then water-sprayed and given a thin coat of dope.

The landing and flying wires are added, as shown in the photograph. These are of white cotton thread. For determining the proper amount of weight, its location, and the flying of glider models, see Chapter 17. If you wish a larger model than the one given here, all measurements should be increased in the same proportions.

CHAPTER 19

GERMAN "HANGWIND" SECONDARY GLIDER

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

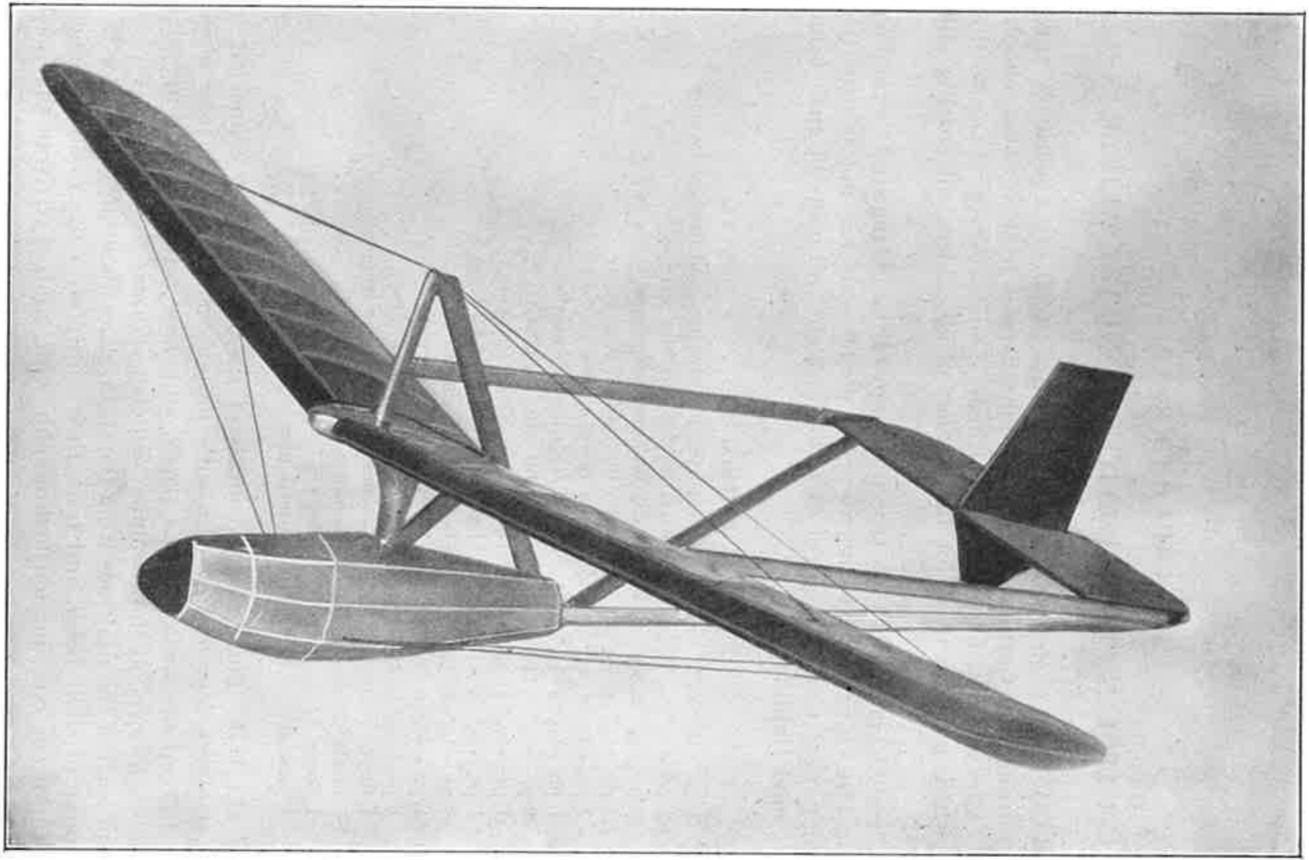
The model given here is a true scale copy of the "Hangwind" secondary glider. The cutting of its dimensions to model scale has not lessened its gliding powers. Careful study of its action in flight will prove of great value to any model builder.

MATERIAL LIST

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

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

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



GERMAN "HANGWIND" SECONDARY GLIDER

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

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

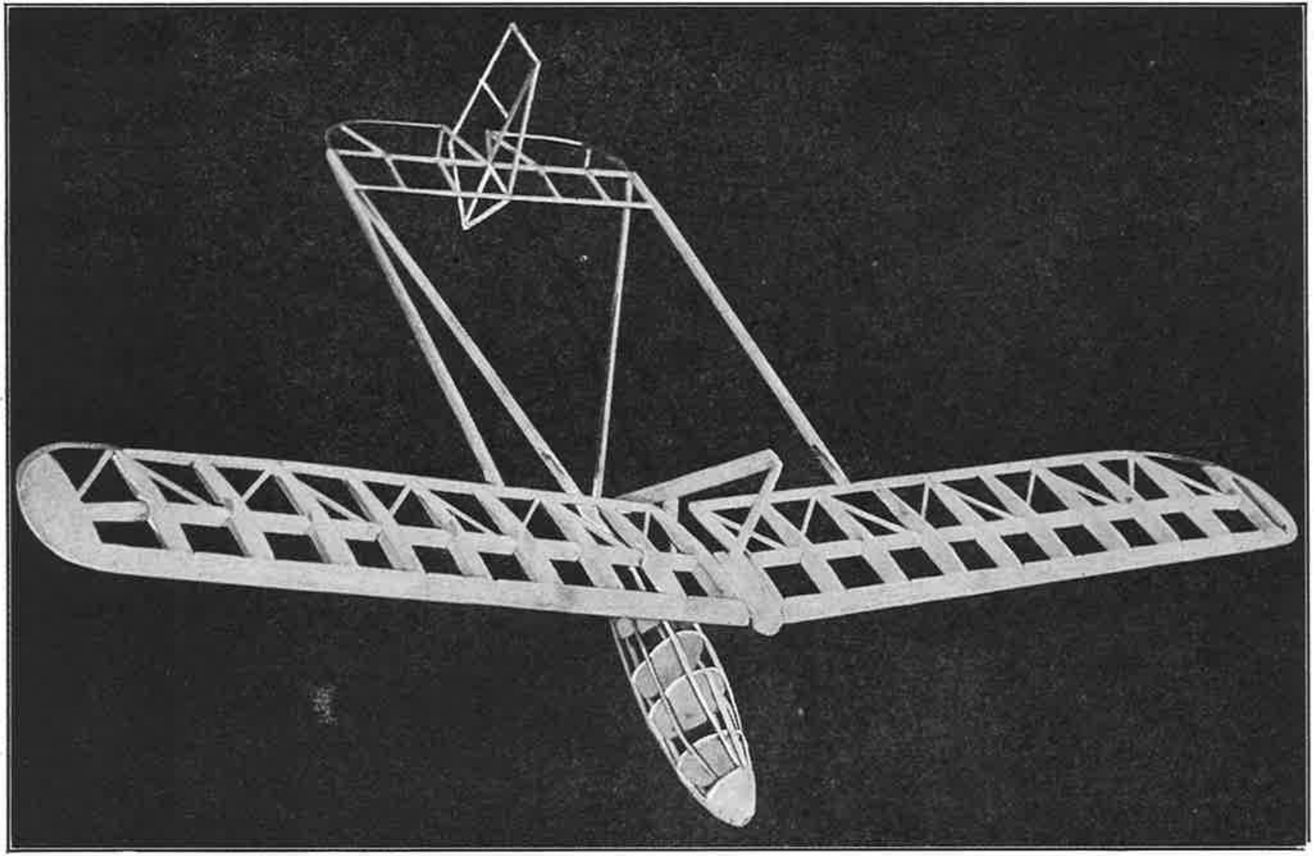
On this fuselage, only two stringers extend in a straight line. These are shown in the plan by the letter K. On the top and side view, these have been clearly marked, while the notches they fit into on the first two formers are designated on the graph plan of the fuselage formers. To start these stringers,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

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

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

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

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



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

Four outriggers are cut from the 1/8" x 1/4" x 36" long piece of balsa. The two D pieces, as shown in the plan, are cut 7" long and then sandpapered to a streamline, while the outriggers E are cut 65/8" long and finished in the same manner. These are not assembled at this time.

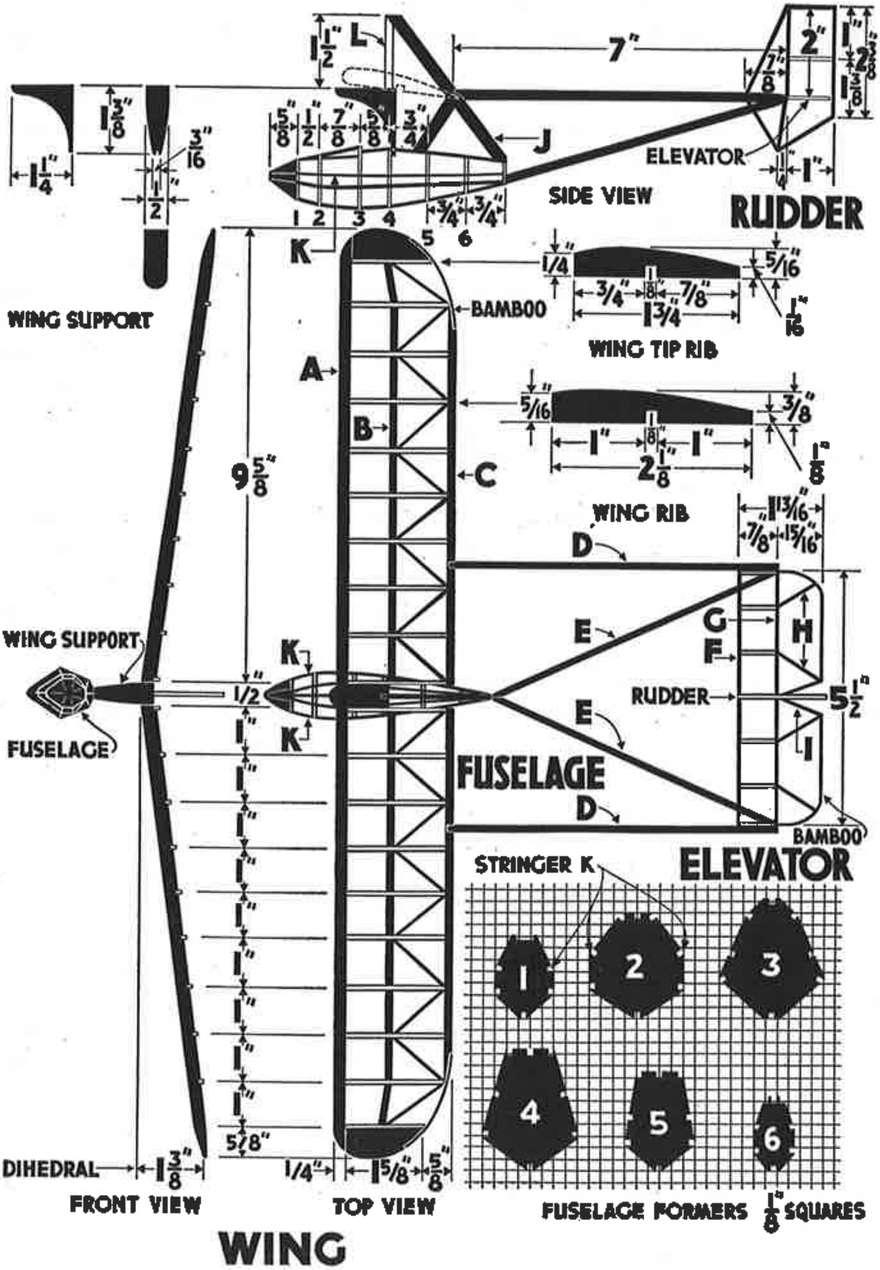
ELEVATOR. The elevator consists of a leading edge spar F cut 1/16" x 1/16" x 51/2" long. An inner elevator spar of the same dimensions is cut, as shown by G. These two spars are joined together by 1/16" x 1/16" x 3/4" long balsa ribs. Cut seven of these ribs and cement them in place between the leading edge spar and the inner spar G. The rear portion of the elevator is constructed of 1/16" x 1/16" x 11/8" balsa braces, each of which should be cemented in place and then cut to exact length. These braces are shown by letters H and I. The trailing edge of the elevator is formed from bent 1/32" split bamboo. (See Chapter 3, "Bamboo.") The elevator is covered on its upper side only with Japanese tissue. (See Chapter 7, "Wing Covering.") Give the surface a spraying with water and finish with a coat of banana oil or dope.

RUDDER. The rudder is also made of 1/16" x 1/16" balsa lengths. The trailing edge piece is 23/8" long, while the inner spar upright is 2" long above the elevator and 11/8" below it. When all pieces have been cut to proper length, assemble the rudder on the elevator with cement. This is done before covering because the rudder fits over the elevator and extends up and down from it. Cover the rudder on both sides with Japanese tissue, water-spray, and coat with banana oil or dope.

WING. The wing is made in two halves, but all parts for both should be cut and shaped before assembling takes place. Cut a pattern of the wing rib, as shown in the plan, out of tin or paper. On the 1/16" x 3" x 28" sheet of balsa wood, trace the outlines of eighteen of these ribs. These are cut out and notched to accommodate the inner wing spar B, as shown under "Wing Rib." Finish each with sandpaper. Both leading edges are now shaped from the two 1/4" x 5/16" x 95/8" balsa pieces. These should be made half round to carry out the curvature of the wing ribs at their front. Do this work with sandpaper.

The inner wing spar is 1/8" x 1/8" x 9" long for each half of the wing. These require no shaping. The trailing edge spars are shaped from 1/8" x 3/32" x 81/8" long balsa pieces. They are shaped half round to conform with the ribs at their trailing ends.

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



GERMAN "HANGWIND" SECONDARY GLIDER PLAN

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

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

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

To strengthen the wing structure, bracing is cut from 1/16" x 1/16" balsa wood. Nine 1 1/2" long pieces of this bracing are required for each wing half. Cut these and cement them in place to the trailing edge spar and the inner wing spar, as shown in the top view of the wing.

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

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

Attach the wing halves to the support with model pins until the proper angles of incidence and dihedral have been obtained, and then apply cement between the inner end of the wing and the side of the support. Allow one hour for drying.

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

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

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

CHAPTER 20

BOWLUS SAILPLANE

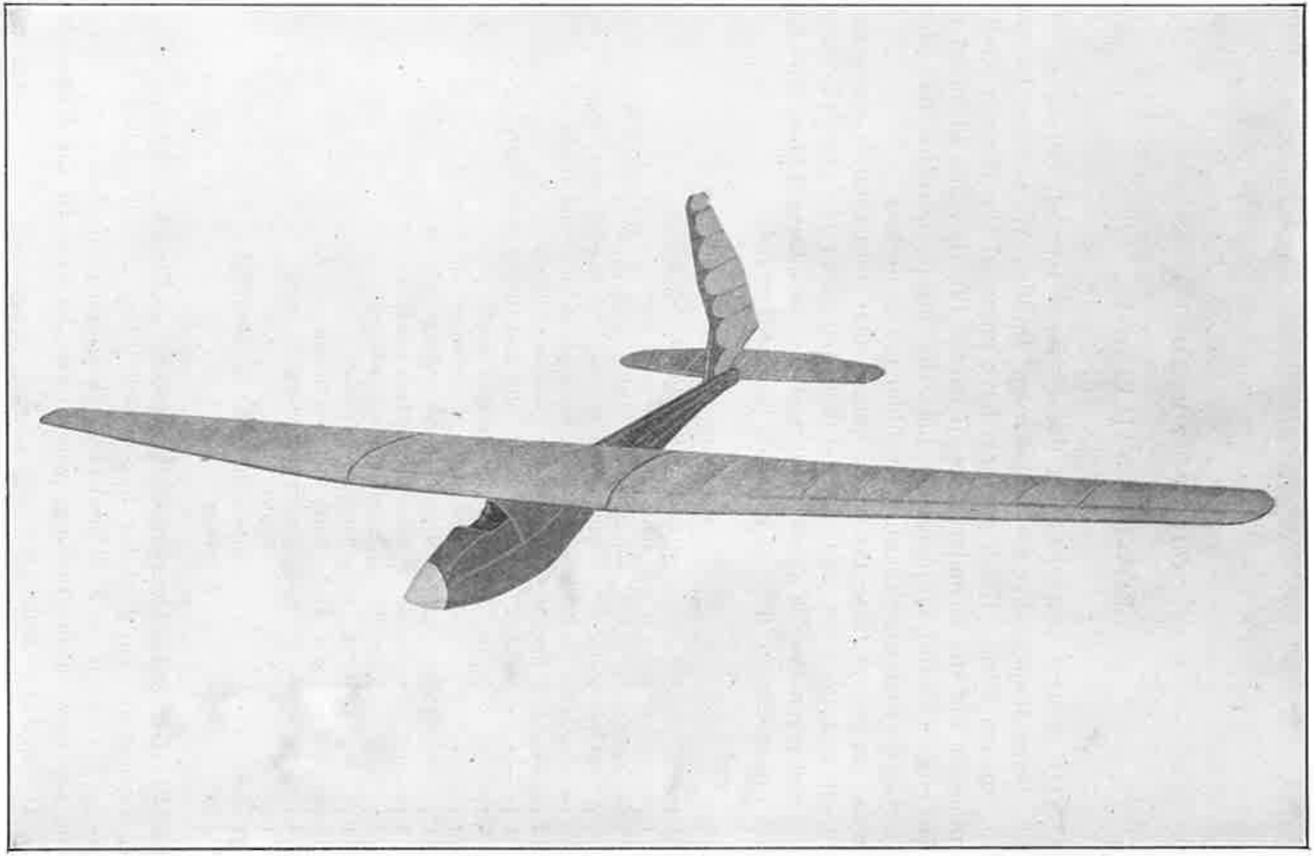
THE Bowlus sailplane is of the advanced type of soaring glider, being named after its designer and builder, W. Hawley Bowlus of San Diego. When students have mastered the primary glider (Chapter 18) and the secondary type (Chapter 19), they are advanced to this last type of soaring sailplane. On these,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

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

MATERIAL LIST

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

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



BOWLUS SAILPLANE

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

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

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

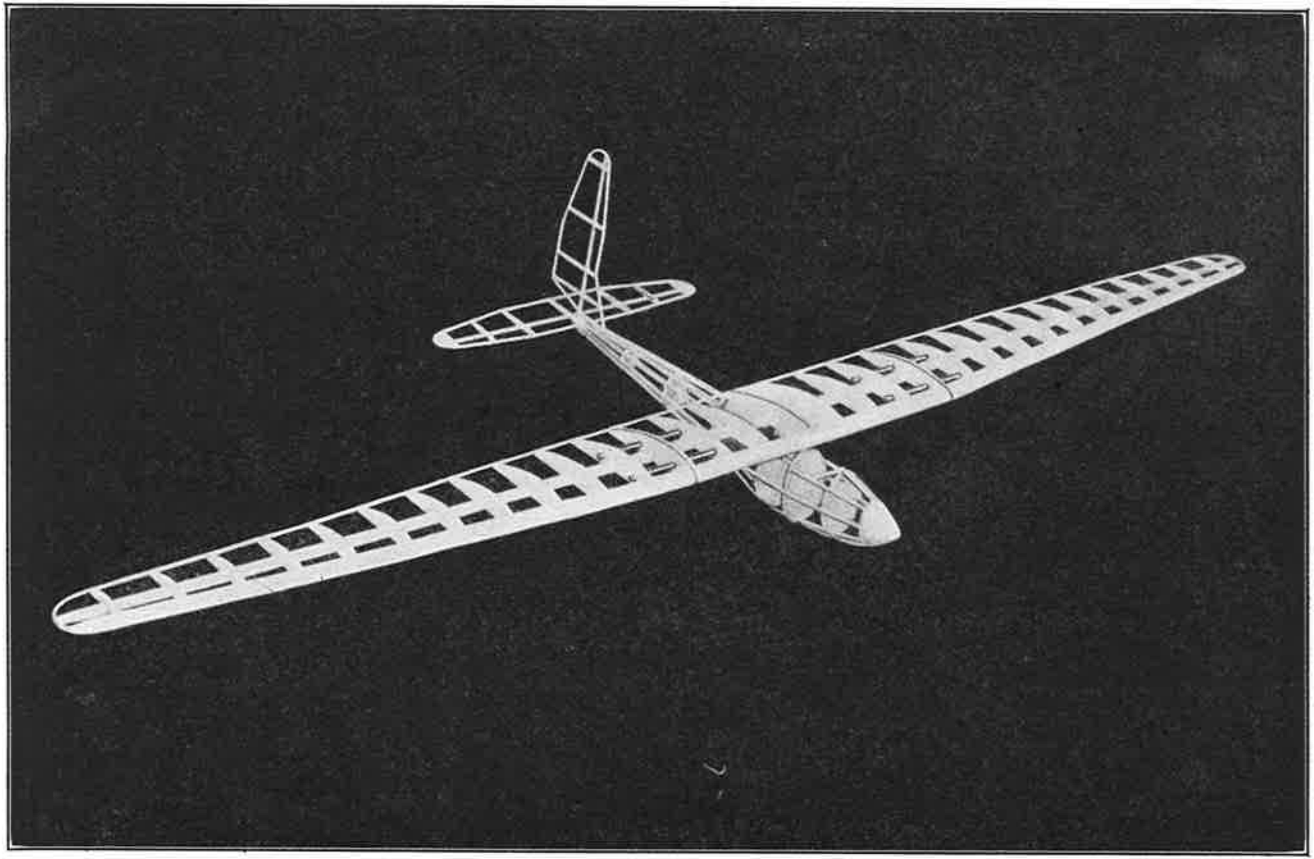
The tail block is also solid balsa. It should be given the form of fuselage former H, as it is cemented against the outside face of this piece. It is 7/16" x 7/16" x 3/8".

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

The formers B and A are added, and the nose and tail blocks cemented to formers A and H respectively. The main wing support block is shaped from a balsa block measuring 5/16" x 7/16" x 2½" long. This wing mount is shown in the top and side views of the fuselage in solid black. Cut it to shape, and cement it to the tops of stringers No. 6, locating it at the front on former C. The fuselage is covered with Japanese tissue, as explained for round fuselages in Chapter 8. Water-spray the tissue and finish it with a single coat of dope.

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

The inner spar R is 1/16" x 1/16" x 3⅞" long balsa wood. Thrust this spar through the holes cut for it in each rib, space the ribs on it, as shown, and cement each in position, making sure that they are on a line with each other. The edge of the rudder is made of 1/16" square split bamboo. Heat



BOWLUS SAILPLANE SKELETON

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

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

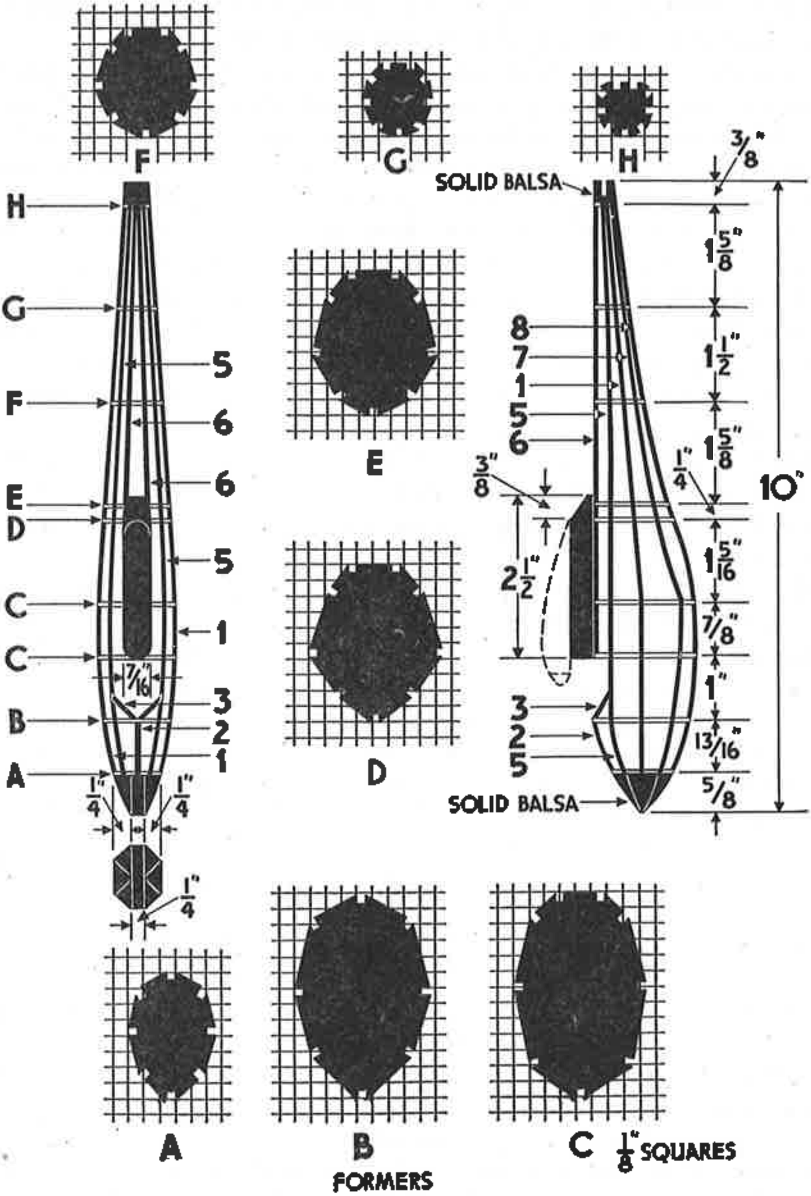
ELEVATOR. The elevator requires seven 1/16" sheet balsa ribs. These are shown in Plan 2 under "Elevator" as S, T, and U. Follow the same method used in cutting the ribs of the rudder, when cutting these ribs, making two S, two T, and three U ribs. These are also 1/8" at their widest part, tapering to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

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

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

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

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



FUSELAGE

BOWLUS SAILPLANE PLAN 1

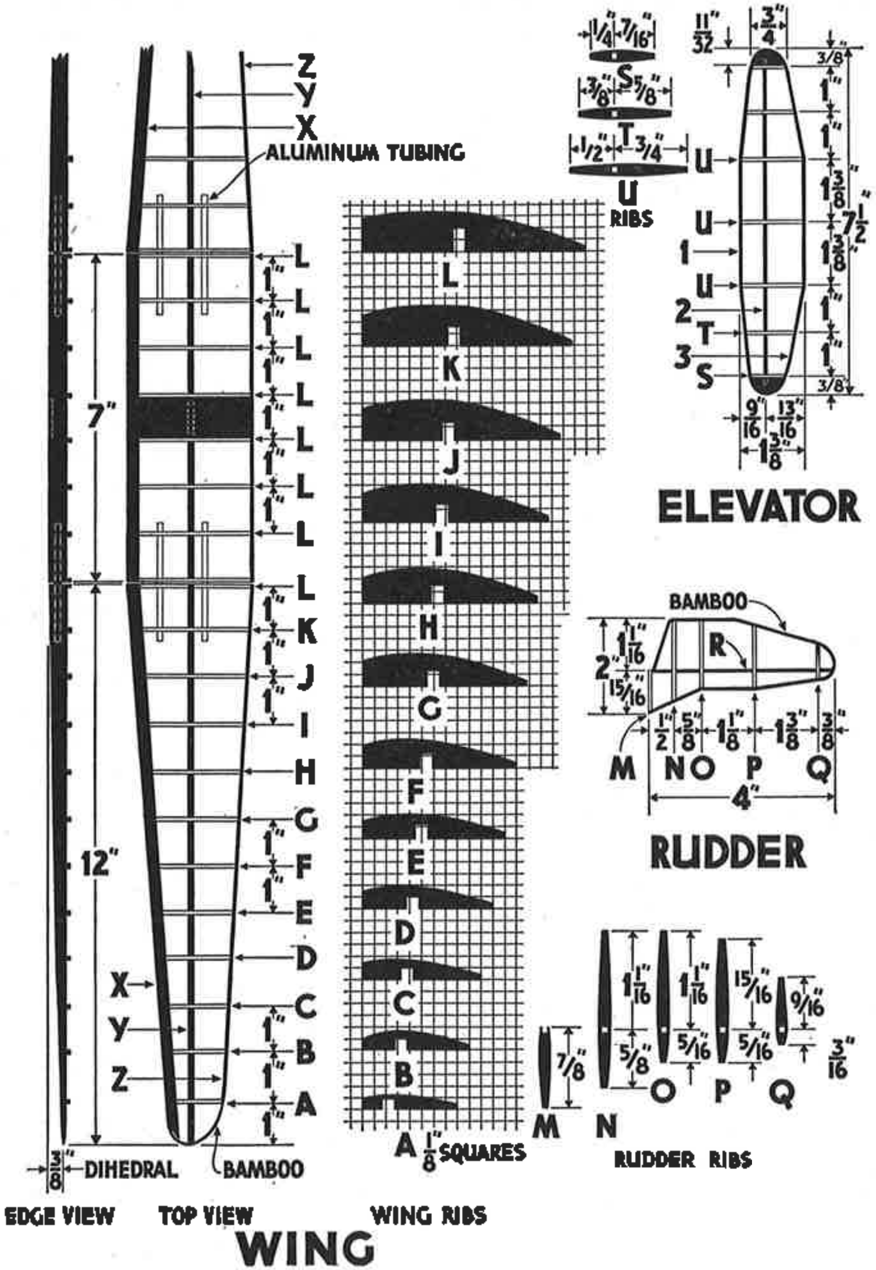
rib L, which is used on the inner end of each side section and for the entire center section, making ten necessary in all. Trace the rib outline on the 1/16" sheet balsa, and then cut them out. Make the necessary inner spar notch in each, as shown.

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

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

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

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



BOWLUS SAILPLANE PLAN 2

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

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

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

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

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

STICK MODELS

CHAPTER 21

GRANT "MINUTE MAN" TRACTOR

BECAUSE of its simplicity of construction, an all-balsa tractor should be the logical model for the beginner, but as few of them prove exceptional flyers, they are seldom used to introduce model building.

Through the courtesy of Charles Hampson Grant, Editor of "Universal Model Airplane News" and a model designer of national reputation, the author is able to present here an unusually fine all-balsa tractor. Its simplicity of construction, exceptional flying ability, and almost unbreakable sturdiness, have given it a country-wide popularity.

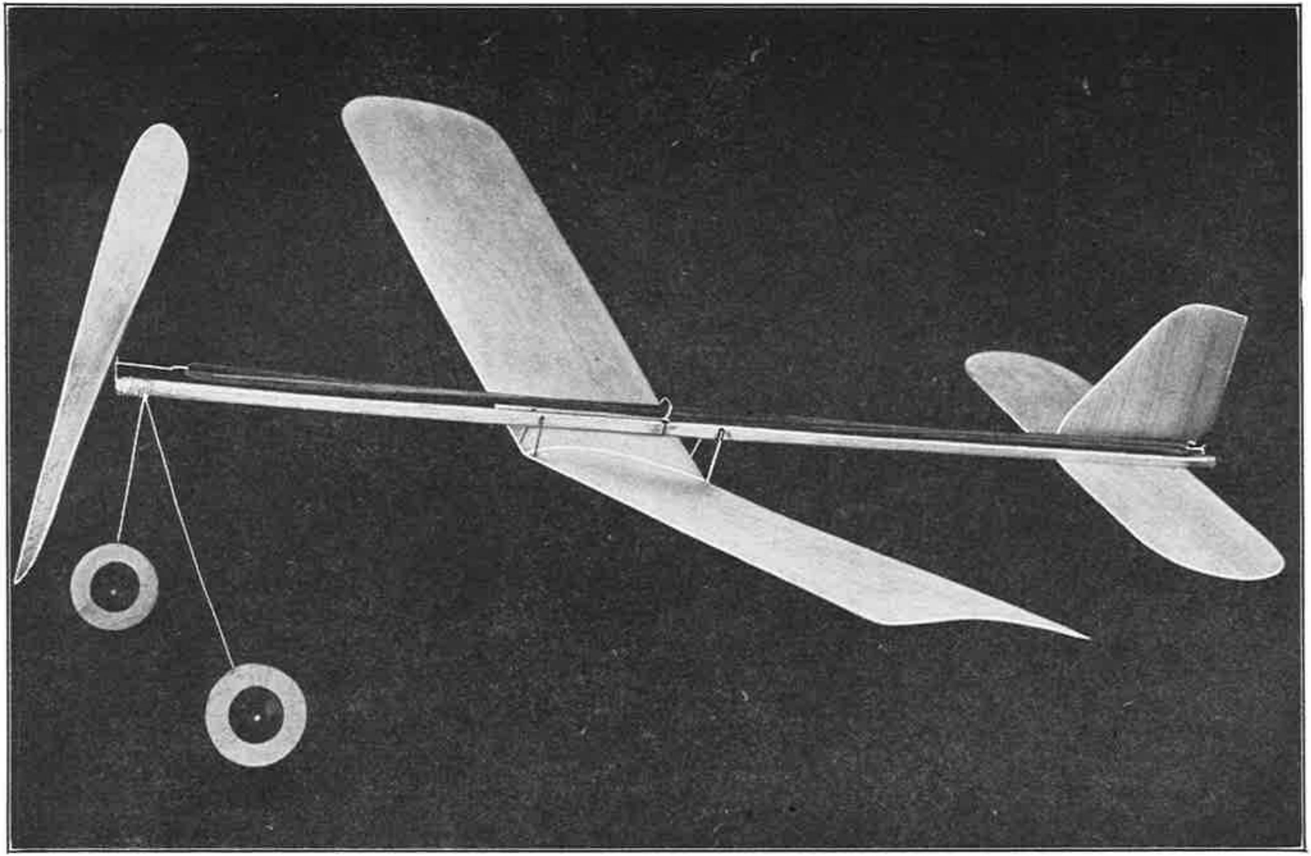
The fact that it has only five balsa parts speaks for its simplicity, while such flights as that made by Thomas W. MacLean of Charlotte, N. C., who flew his "Minute Man" over 1,500 feet for a duration of six minutes and a height of 300 feet, prove its flying ability. Here is a model any beginner can build with ease, and at the same time be assured of many hours of excellent flights and happy landings.

MATERIAL LIST

2 pcs.	—1/32" x 3"	x 10½"	—Sheet balsa for wing
1 pc.	—1/32" x 2¾"	x 3"	—Sheet balsa for rudder
1 pc.	—1/32" x 2⅜"	x 7¾"	—Sheet balsa for elevator
1 pc.	—3/16" x 3/16"	x 18"	—Balsa for motor stick
1 pc.	—⅝" x 1⅜"	x 8"	—Balsa propeller block
1 pc.	—1/16" x 2"	x 3½"	—Sheet balsa for wing ribs
1 pc.	—3/16" x ¾"	x 3½"	—Balsa for center wing ribs
1 pc.	—⅛" x 1½"	x 3"	—Sheet balsa for wheels
1 pc.	—1/32" x ⅛"	x 64"	—Pure Para rubber for motor
1 pc.	—12" long		—No. 7 piano wire for wing clips and can hook
1 pc.	—24" long		—No. 12 piano wire for landing gear, "S" hook, shaft, etc.

Washers
Propeller bearing
Cement

MOTOR STICK. The motor stick consists of a 3/16" x 3/16" x 18" long balsa stick. Its front end is beveled, as shown. Sandpaper the stick until perfectly smooth. On the beveled end, the usual propeller bearing is ce-



GRANT "MINUTE MAN" TRACTOR

mented, but is not bound with silk thread until the landing gear is in place. (See Chapter 6, "Propeller Bearings.") In the center of the stick, a can hook is attached. This is bent from No. 7 piano wire, as shown in the plan under "Can Hook," and cemented in place on the stick with the loop on the same side as the bearing. The trailing end of the stick is equipped with a combination end hook and tail skid, as seen in the plans. Follow the dimensions given for this in the plan, and then cement it over the end of the stick, with the hook on the same side of the stick as the hook of the can. It should then be tightly bound with silk thread over which a thin coat of cement is applied to bind it in place.

RUDDER. Make a full-size drawing of the rudder, as shown. This is then placed on the 2¾" x 3" piece of $\frac{1}{32}$" sheet balsa and carefully traced. Place the tracing on the wood, so that when the rudder is attached on the motor stick, its grain will run up and down. Cut the rudder out and finish all edges and both faces with sandpaper. It is now cemented to the side of the motor stick, as shown. Note that when looking at the stick held in flying position from the front, the rudder is cemented to its left side. The bottom edge of the rudder and the bottom edge of the motor stick should be flush, while the back, or trailing edge of the rudder, forms right angles with the stick.

ELEVATOR. The elevator is made of a single piece of $\frac{1}{32}$" sheet balsa. Cut the stock 2⅜" wide and 7¾" long, making sure that all corners are square. The rounded tips are formed from a half circle with a radius of 1$\frac{3}{16}$", as shown under "Elevator."

Lay these out with a compass, and then cut them with a razor blade. Finish the elevator with a careful sandpapering. It can be attached to the stick with cement, which gives a permanent connection, or a single rubber band may be used. Note the position of the elevator on the motor stick. If the former method is used, apply cement along the under side of the stick, and press the elevator tightly against it, making sure that it extends out from the stick evenly on both sides, that its leading and trailing edges form right angles with the stick, and that its trailing edge is ¾" in from the end of the stick.

If the rubber is used, pass one end of the rubber over the stick. Place the elevator in position and bring the band under the elevator, and its loop up and over the end of the stick, which will hold it in position.

LANDING GEAR. This is bent from a single length of No. 12 piano wire. The front view of the landing gear, shown in the plan, illustrates how the wire looks after it is bent. Above this illustration is a top view of the wire. The small U-shaped section is bent down at right angles with the other sections of the wire.

When bent as shown, apply cement and press the "U" of the wire to the under side of the motor stick on top of the propeller bearing. Both the bearing and this portion of the landing gear wire are now bound with silk thread, which is given a thin coat of cement to strengthen it. As the "U" of the gear was bent at right angles to the rest of the wire, or the wire struts of the landing gear, these will extend straight down and out from the stick. Note in the plans that these struts not only extend out on each side of the stick, but also 1¼" back from the wire "U."

When completed, the wire gear is equipped with two ⅛" sheet balsa wheels. (See Chapter 10, "Solid Balsa Wheels.") When these are finished, slip them on the axles of the gear, and bend the wires up to prevent them from falling off.

PROPELLER. The propeller is carved from a ⅝" x 1⅜" x 8" long balsa propeller block. (See Chapter 9, "Carved Propellers.") A propeller shaft is bent from No. 12 piano wire. (See Chapter 6, "Propeller Shafts.")

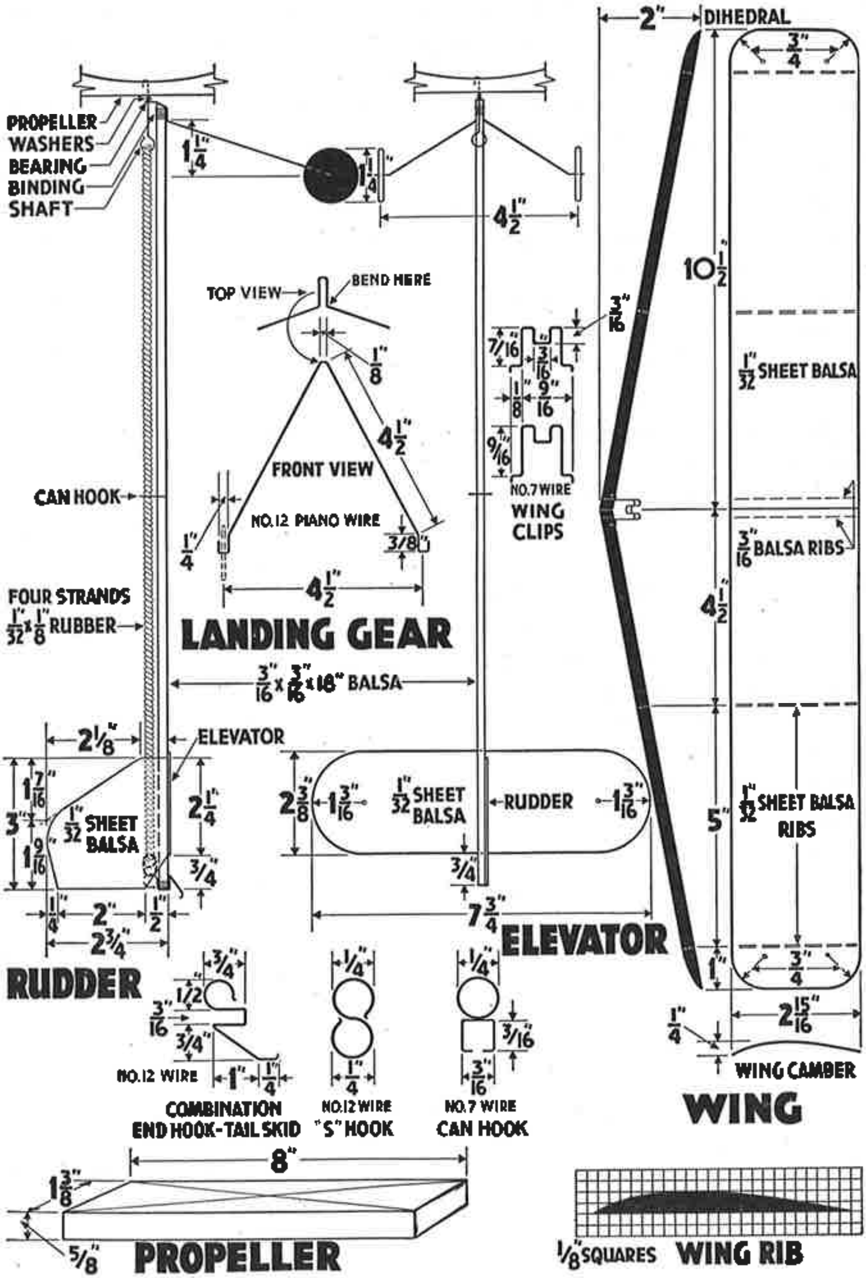
Thread the shaft through the hub, bend it around, and pull it back, allowing its point to bury itself in the hub, and apply cement to the bend.

MOTOR. This consists of a 64" length of 1/32" x ⅛" pure Para rubber, tied, and looped four times. An "S" hook is bent from No. 12 piano wire, as shown in the plans, and one of its hooks is fastened through the end hook. The rubber strands are then looped around the other end of the "S" hook, threaded through the can hook, and looped over the hook of the propeller shaft, after two washers have been applied to it and it has been passed through the propeller bearing hole.

WING. The wing is made in two parts, each half being 2 15/16" wide and 10½" long. It is made of 1/32" sheet balsa. Cut these to size, rounding two corners of each half, as shown in the plans, with the arc of a circle having a ¾" radius. Sandpaper all edges and both faces until smooth.

Four 1/16" sheet balsa ribs are used to give the wing its necessary camber. Note the size of these in the plans under "Wing Rib." Draw a full-size plan of the rib on ⅛" squared paper, as shown. Trace this on the 1/16" sheet balsa piece, and cut out each rib. Sandpaper them smooth. To make sure they are alike, the ribs should be placed together with all sides flush, and then sandpapered as a whole.

They are now cemented to the under side of the wing, which must be bent to their top curve. Paper clips can be used to hold the sheet balsa to the ribs until the cement is dry. Slip one clip over the wing and rib at the leading edge and another at the trailing edge. When all four ribs are in



GRANT "MINUTE MAN" TRACTOR PLAN

place and firmly cemented, the wing halves are joined together. Note that the wing has a 2″ dihedral. Lay the two halves with their inner ends together on a flat table. Holding one half flat on the table, lift the tip of the other 4″ off the surface. Apply cement along their center joint while in this position, and allow the cement to become hard before freeing the wing. (See Chapter 7, "Wing Assembly.")

To give the wing the same camber along its center section and to strengthen its joint, two $\frac{3}{16}$″ thick heavy-duty ribs are used. These are cut from balsa wood, after being traced on it. Use the same tracing as used for the outer ribs. The tops of these ribs must be beveled to fit the angle made by both halves of the wing when they were joined and given the dihedral.

Cement these two ribs together side by side, and then bevel the top in the form of a shallow V to fit the angle of the wing. Cement them in place, so that the cemented crack of the ribs fits directly under the cemented crack of the wing.

Two wing clips are bent from No. 7 piano wire, as shown in the plan. The small clip fits on the leading edge of the wing, while the large one is cemented to the trailing edge. The small prongs of these clips are pressed into the surface of the wing, while cement is added to give further strength to the connection. Both clips are located on the upper side of the wing directly over its center joint.

FLYING. Slip the clips of the wing over the under side of the motor stick to attach the wing to the model. Give the model the gliding test. (See Chapter 16, "Gliding Method of Wing Adjustment.")

If hand winding, the motor may be safely wound about 325 turns, while a winder allows it to be wound 575 turns. Before launching your model, make sure that its wing, elevator, and rudder are perfectly straight and not warped in any manner. For the proper method of launching, see Chapter 16, "Correct Launching of R.O.G. Model."

CHAPTER 22

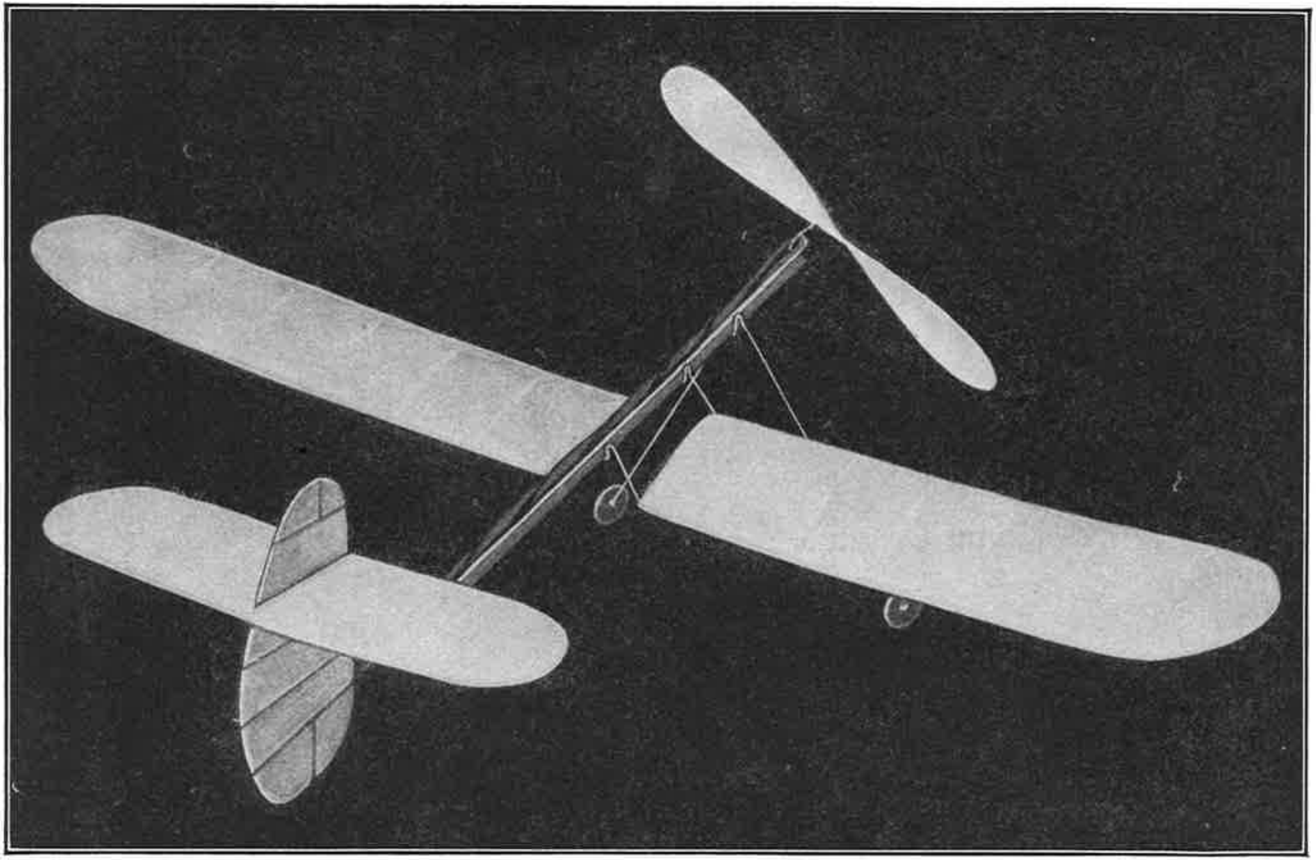
CONDOR TRACTOR

HERE is a splendid model with which the beginner can experiment to his heart's content. When Nick Limber designs and builds a model, he does so for a specific reason and with such great success that today he is considered among the finest designers and builders in this country. The author greatly appreciates the opportunity given him by Mr. Limber to present such a fine example of tractor type model in these pages. The specific reason behind the designing of the "Condor" was a curiosity to discover the effect a high set tail would have on a light model. Results in the air proved that such a tail was a distinct success. Many German light planes have such tails and it was from them that Mr. Limber took his example. The model not only gave a fine endurance and stability performance, but also proved a graceful and smooth flier. When the builder saw this, he immediately called it the "Condor" after that most graceful bird. So get busy and build your own "Condor."

MATERIAL LIST

1 pc. — 1/8" x 3/8" x 13"—Balsa (Motor Stick)
2 pcs.— 1/16" x 1/8" x 10"—Balsa (Leading Edges of Wings)
1 pc. — 1/16" x 3/8" x 15"—Bamboo (Trailing Edge, Tail, etc.)
1 pc. — 1/16" x 2" x 12"—Balsa (Wing and Tail Ribs)
1 pc. — 1/16" diameter —Aluminum Tubing (Bearing)
1 pc. —.020 x 15" long —Music Wire (All Metal Parts)
1 pc. — 1/8" x 26" long —Flat Rubber (Motor)
1 pc. — 3/4" x 1 1/8" x 8"—Balsa Block (Propeller)
Japanese Tissue
Banana Oil
Copper Washers
Sandpaper

MOTOR STICK. The fuselage on a stick model is known as the "Motor Stick." It is shown in detail under "Motor Stick" in the plans. It is cut from a 1/8" x 3/8" x 13" long piece of hard balsa. It is tapered along its bottom edge to 1/4" width at the nose and 3/16" at the tail. The thickness



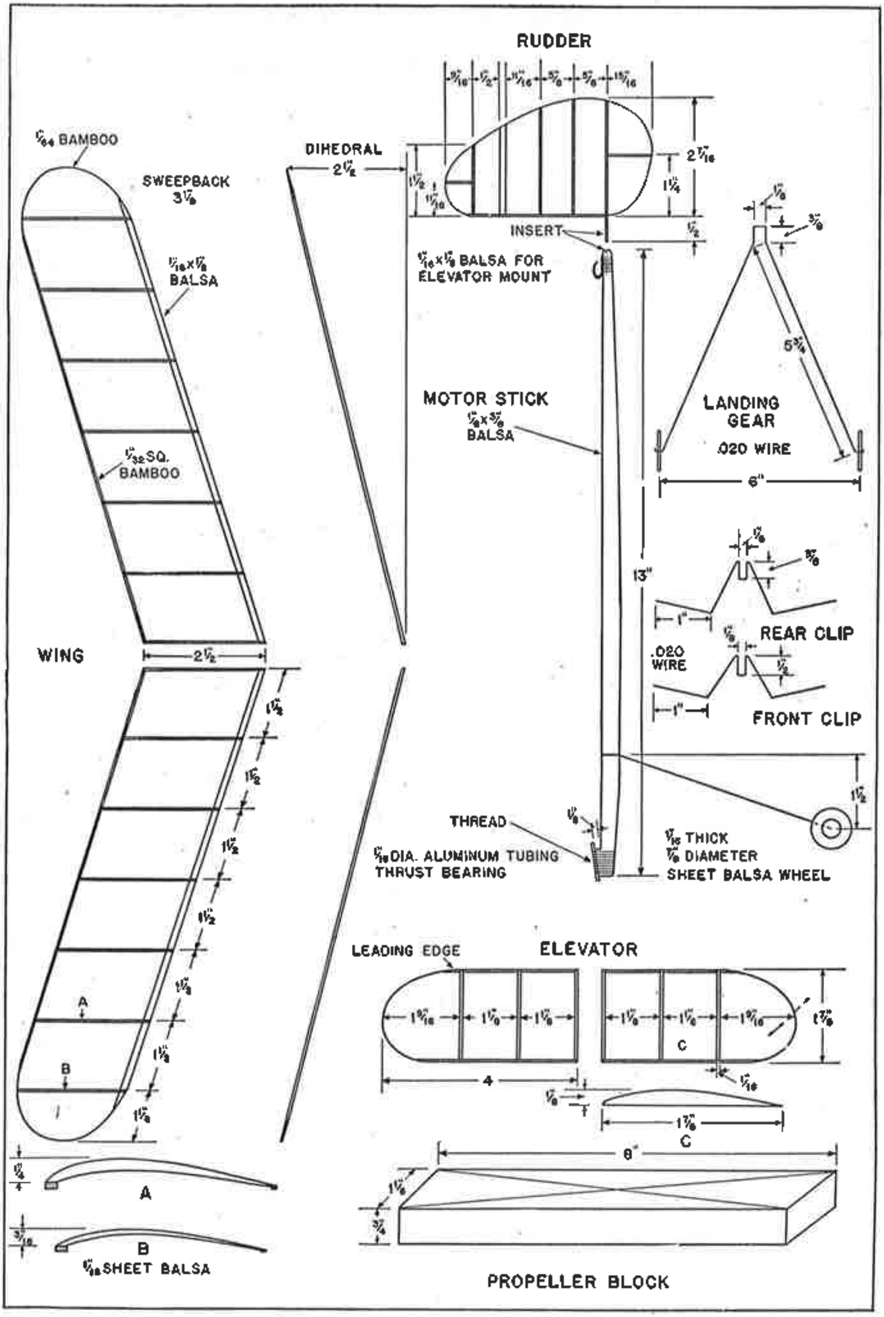
CONDOR TRACTOR

is also tapered along its entire length from its original thickness of 1/8" along the top to 1/16" along the bottom. Note that the upper edge of the fuselage remains perfectly straight. Carve the stick in this manner and finish smooth with sandpaper. A strip of 1/8" square balsa is cemented to the top-front of the stick, which is then shaved at a slant so that it is only 1/16" wide at the front, as shown. A 3/4" long aluminum tube is then cemented along this strip and bound with silk thread, as shown in the plan. A rear hook is bent from .020 music wire, cemented in place on top of the stick, and then bound with the thread, as shown.

RUDDER. The rudder has a strip of hard balsa measuring 1/32" square and 4" long. The trailing edge is made up of a single length of split bamboo making the rounded form of this part. All cross pieces are of 1/32" square balsa. Cement the lower brace, which extends out 1/2" and is of 1/32" square bamboo, in place across the leading edge. Cement the top 1 1/2" long cross piece in place against the leading edge. The bamboo is then shaped from the leading edge, around these two braces, and then back to the leading edge piece. Cement the other braces in place as shown. The elevator mount is a length of 1/16" sheet balsa 1/8" wide located 1 1/16" down from the top of the rudder, as shown. This should be sanded down to match the leading and trailing edges. Cover the rudder with Japanese tissue on one side only using banana oil as an adhesive. When completed, insert the 1/2" of projecting bamboo into the end of the stick by making a small hole to take it. Line the rudder up with the motor stick and cement it in place.

LANDING GEAR. This is made of a single length of .020 music wire. Note it in the plan. It is first bent around the stick for a tight fit. Each "leg" is 5 3/4" long, as shown, and the axles should be 1/8" long. In the side view of the motor stick is shown the forward thrust of the landing gear. Bend yours in this manner. The "track," or distance between the wheels, must be 6" long. Two 1/16" sheet balsa wheels are cut to 7/8" diameter and threaded on the axles which are turned up to hold them in place. The landing gear is now attached in place on the fuselage stick 2 1/2" back from its nose, as shown.

ELEVATOR. The elevator is made in two halves, as shown in the plan. The leading edge is 1/32" strip bamboo 2 3/4" long. The trailing edge is 1/32" strip bamboo cut 3" long. The three ribs are shaped from 1/16" sheet balsa, as shown at "C." Each one is 1/8" wide at its widest point and all are cut 1 7/8" long. Cement the ribs in place between the leading and trailing edge spars, and then make the tip of thin bamboo. When complete, make the other half in the same manner. Both halves are covered on the top side only with Japanese tissue using banana oil as an adhesive. If the



CONDOR TRACTOR PLAN

rudder was properly made, the sheet balsa mounting on it should be exactly 1⅞″ long, which is just the width of the elevator halves. Cement each half on a side of this mount, and check to see that they are in line with each other, perfectly level, and at right angles to the rudder.

WING. The wing is also made in two halves, as shown in the plan. The leading edge spar is 1/16″ x ⅛″ x 9½″ long, and is of strip balsa. Note its shape in the plan under "A" and "B." The trailing edge spar is 1/32″ square bamboo cut 8½″ long. For one half of the wing, you will require seven ribs. These are cut from 1/16″ sheet balsa. Six "A" ribs are 2½″ long, and the one "B" rib is 2 5/16″ long. The "A" ribs are ⅛″ at their widest point and the "B" rib is only 1/16″ at its widest point. Trace these on 1/16″ sheet balsa and cut them out. Finish with sandpaper. Draw a straight line on paper and place the leading edge spar directly over it. Hold the inner end to the line and move its outer end back 3⅛″. Mark this location on the paper. The ribs are now cemented in place to the leading edge while that spar is held on the second line. Each rib, however, must be at right angles to the first line drawn. In this manner the correct sweepback is obtained. The trailing edge spar is then cemented in place. Note that the leading edge spar fits under the entering end of the ribs. A split bamboo wing tip completes the half. The opposite half is made in the same way except that the leading edge is moved back along the other half of the straight line, as it would be when in flying position. While the frame is drying, make the two wing clips of .020 music wire, as shown in the plan under "Front Clip" and "Rear Clip." The wing halves are now covered on their top sides only with Japanese tissue. Use banana oil as an adhesive and stretch the paper as tightly as possible without tearing it. Cement the wing clips to the leading and trailing edge spars, as shown in the photograph. Slip the wings in place under the stick, test each for proper sweepback and bend their clips up to obtain a 2½″ dihedral at each tip. See that both tips are level with each other.

PROPELLER. Carve the propeller from the block shown in the plans as explained on page 91 under "Carved Propellers." Use hard balsa for this, and when finished apply three coats of dope and sand between each coat. Make a shaft from .020 music wire and cement it to the propeller hub. It is then passed through the aluminum tubing and its hook bent properly. Bend two "S" hooks of the same wire, as explained on page 139, attach the rubber motor, and the model is ready for its maiden voyage. Glide without power to obtain the best wing location. When a long even glide has been obtained, wind the motor and let her go.

CHAPTER 23

BABY R.O.G. TRACTOR

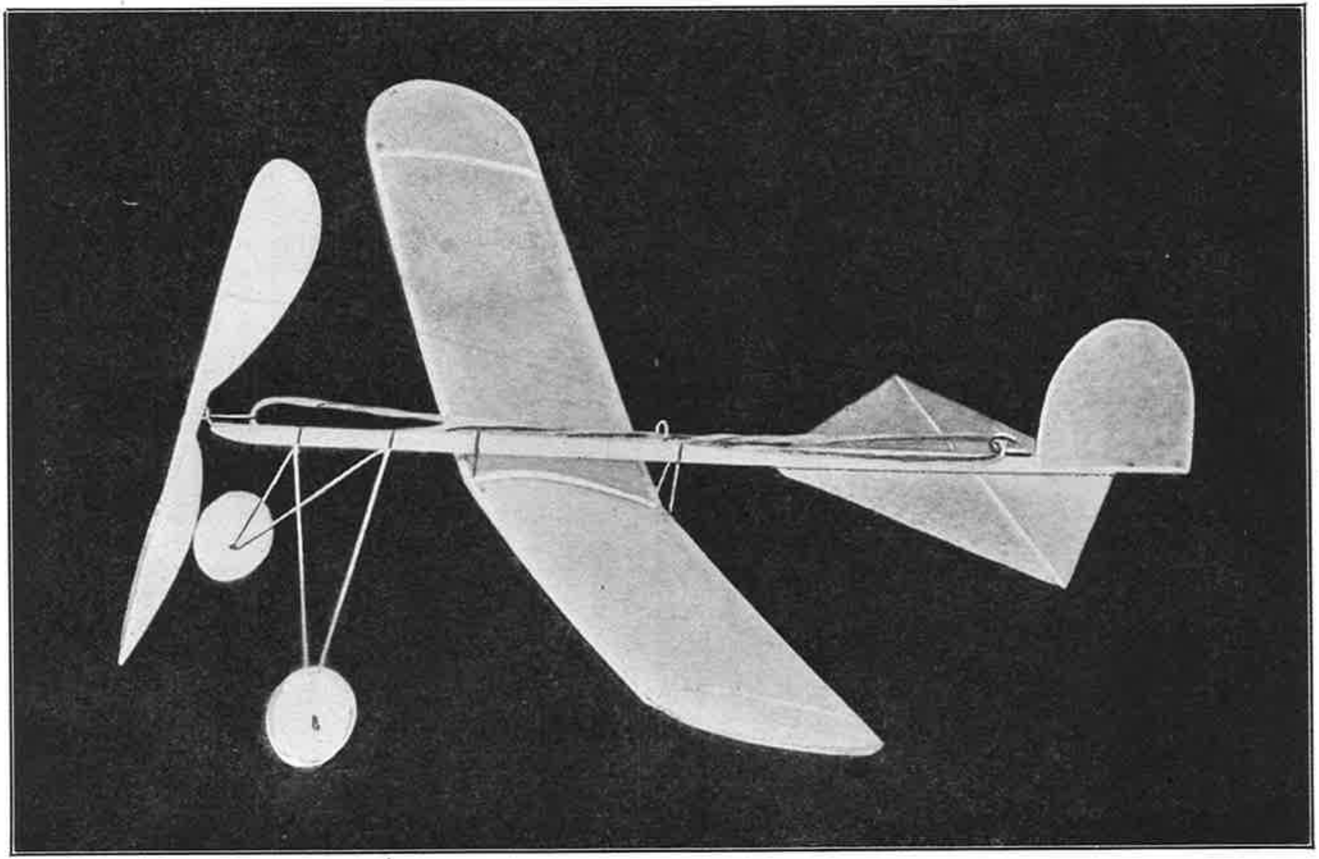
THIS rise-off-ground (R.O.G.) tractor is practically the same size as the indoor tractor of the preceding chapter. Its construction is much the same, except that it is equipped with a landing gear and has a thread outline for the elevator in place of the usual balsa spars and ribs. This model has proved an excellent flyer.

MOTOR STICK. From balsa wood, cut a piece measuring 1/16" x 1/8" x 8" long. A regulation propeller bearing is cemented to the top edge of the stick at its front end. This can be purchased or made. (See Chapter 6, "Propeller Bearings.") On the rear end of the stick and in the same position, a rear or end hook is cemented in place. This is bent from No. 6 piano wire. (See Chapter 6, "End Hooks.") Note in the plans that the propeller bearing is shown with thread wound around it, which acts as an extra binding for the bearing. On models of this size, such treatment is optional with the builder, but on large models carrying a great amount of rubber, all bearings should be reënforced in this manner.

RUDDER. This is made of two lengths of 1/32" x 1/32" split bamboo. The base of the rudder is made of one length of this bamboo 1¾" long. The ¼" at the front of this length is allowed to protrude out from the rudder to act as a cementing surface to hold it in position on the motor stick, as shown in the plans. The second length of bamboo is bent over heat to form the outline of the rudder, as shown. (See Chapter 3, "Bamboo.")

Cement the horizontal piece to the under side of the motor stick by applying cement to its forward ¼" portion, and then press it in position. The bent outline length of bamboo is now cemented in place. Apply cement to the end of the motor stick, the front of the horizontal piece and also to its trailing end, and then press the outline piece in position. Make sure that the straight sides of this length are at right angles to the motor stick and that it is also straight up and down.

The rudder is covered with Japanese tissue. Cut the tissue to the exact size and shape of the rudder, coat the outline bamboo with clear dope or banana oil, and press the paper to it. When dry, the paper may be water-



BABY R.O.G. TRACTOR

sprayed to tighten it on the frame. Hold under weights until the paper covering becomes dry.

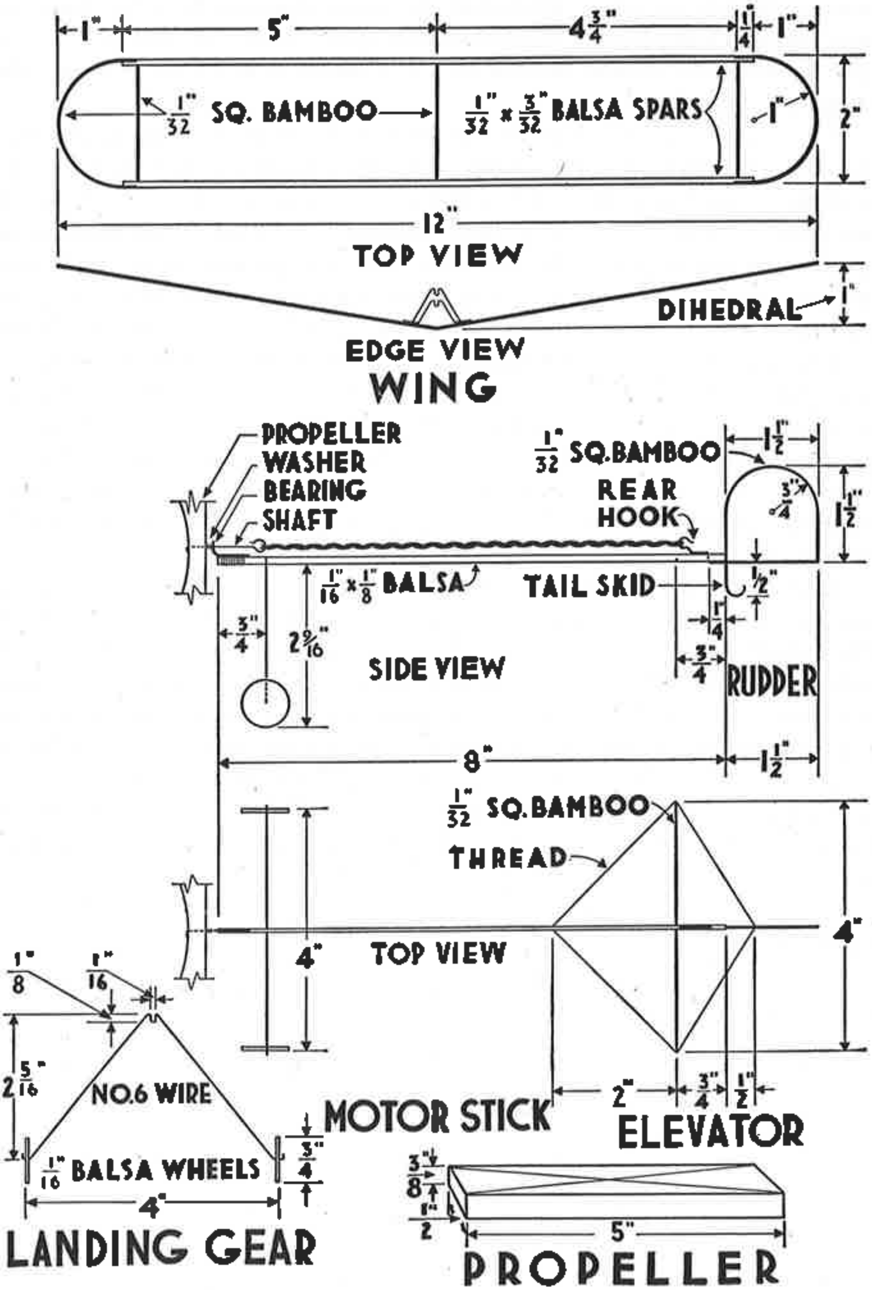
ELEVATOR. The elevator consists of one length of $\frac{1}{32}''$ x $\frac{1}{32}''$ split bamboo and a thread outline. Cut the bamboo piece 4″ long, notch the under side of the motor stick ¾″ in from its rear end, and fasten the bamboo spar in place in it. When doing this, make sure that the spar is at right angles to the motor stick and that it extends out from both its sides an equal distance. A length of silk thread completes the framework of the elevator. Cement the end of the thread to the under side of the motor stick 2¾″ in from its rear end, or 2″ in front of the elevator spar. Pass the thread to one end of the spar, and then to a point on the horizontal spar of the rudder ½″ from the rear end of the motor stick. Both these points of contact should be held with cement. The thread is continued to the opposite end of the elevator spar, cemented, and then back to the original point of starting on the motor stick, where it is cemented in place.

When completed, the elevator outline is covered with Japanese tissue. Cut the paper to the exact size and shape of the elevator, coat the elevator spar, under side of the motor stick and rudder spar, and press the paper in place. When hard, the outline thread should be coated in the same manner with clear dope or banana oil, and the edging of the paper pressed on it. The paper should be trimmed if any excess has been left. Water-spraying should not be done on the elevator, because of the delicate framework, so that the paper should be carefully ironed before being applied.

PROPELLER. This is hand carved from a ⅜″ x ½″ x 5″ balsa propeller block. Sandpaper until light will show through the blades. (See Chapter 9, "Carved Propellers.") The propeller is completed by bending a propeller shaft from No. 6 piano wire, as shown. (See Chapter 6, "Propeller Shafts.") Force the end of the shaft through the center of the propeller hub, bend it around, and pull the shaft back until the point buries itself in the wood of the hub. A drop of cement at the bend will hold it securely in place.

MOTOR. Two strands of ⅛″ flat rubber are used for motive power. Obtain a 15″ length of this rubber and tie its ends together to form a loop. Assemble the motor at this time. Place two washers on the propeller shaft and pass it through the hole in the propeller bearing. Loop one end of the rubber over the hook of the propeller bearing and the other end over the end hook, which completes the motor assembly.

WING. Cut two $\frac{1}{32}''$ x $\frac{3}{32}''$ x 10″ long balsa pieces for the leading and trailing edge spars. Cut three $\frac{1}{32}''$ x $\frac{1}{32}''$ split bamboo ribs 2″ long. Bend these slightly over heat to give the wing a small curve or camber. Lay the spars on a table parallel to each other and 2″ apart, and then proceed to



BABY R.O.G. TRACTOR PLAN

cement the ribs in place. Complete the wing structure by cementing two bent bamboo wing tips to the ends of the spars. These are also 1/32" x 1/32" split bamboo, and should be bent in a 1" diameter circle over a flame. (See Chapter 3, "Bamboo.")

The wing is now given its 1" dihedral angle. Snap the leading and trailing edge spars between the thumb and index finger in their exact center, or at the point where the center rib has been cemented in place. Place the two halves in position on a flat table, with the convex side of the wing facing up, and while holding the broken joints together, lift the tip of one half off the table 2". While in this position, apply cement to the broken joints, and hold until dry. This will give each wing tip the necessary 1" dihedral angle.

The wing is covered with Japanese tissue on its upper side only. Coat all spars, ribs, and wing tips with clear dope or banana oil, and press the paper in place. Trim all edges and give the wing a water-spray treatment to tighten it. Two wing clips are bent from No. 6 piano wire. (See Chapter 6, "Clips.") The large one is cemented to the upper side of the trailing edge, while the small one is located on the leading edge. Note the position of these in the plans.

LANDING GEAR. This is bent from a single length of No. 6 piano wire, as shown in the plans. Two wheels are cut from 1/16" sheet balsa. They should be 3/4" in diameter. (See Chapter 10, "Wheels.") Thrust the ends of the landing gear wire through the centers of the wheels and bend them up to keep them in place. The small notch at the top of the landing gear wire has been made the same size as the motor stick, so that it can be slipped over the stick. See that this fit is snug enough to hold the landing gear without the aid of cement. Locate it 3/4" from the front end of the motor stick. Give the model the usual gliding tests to determine proper location of the wing, which is clipped to the under side of the motor stick. For the proper method of launching, see Chapter 16, "Correct Launching of R.O.G. Model."

CHAPTER 24

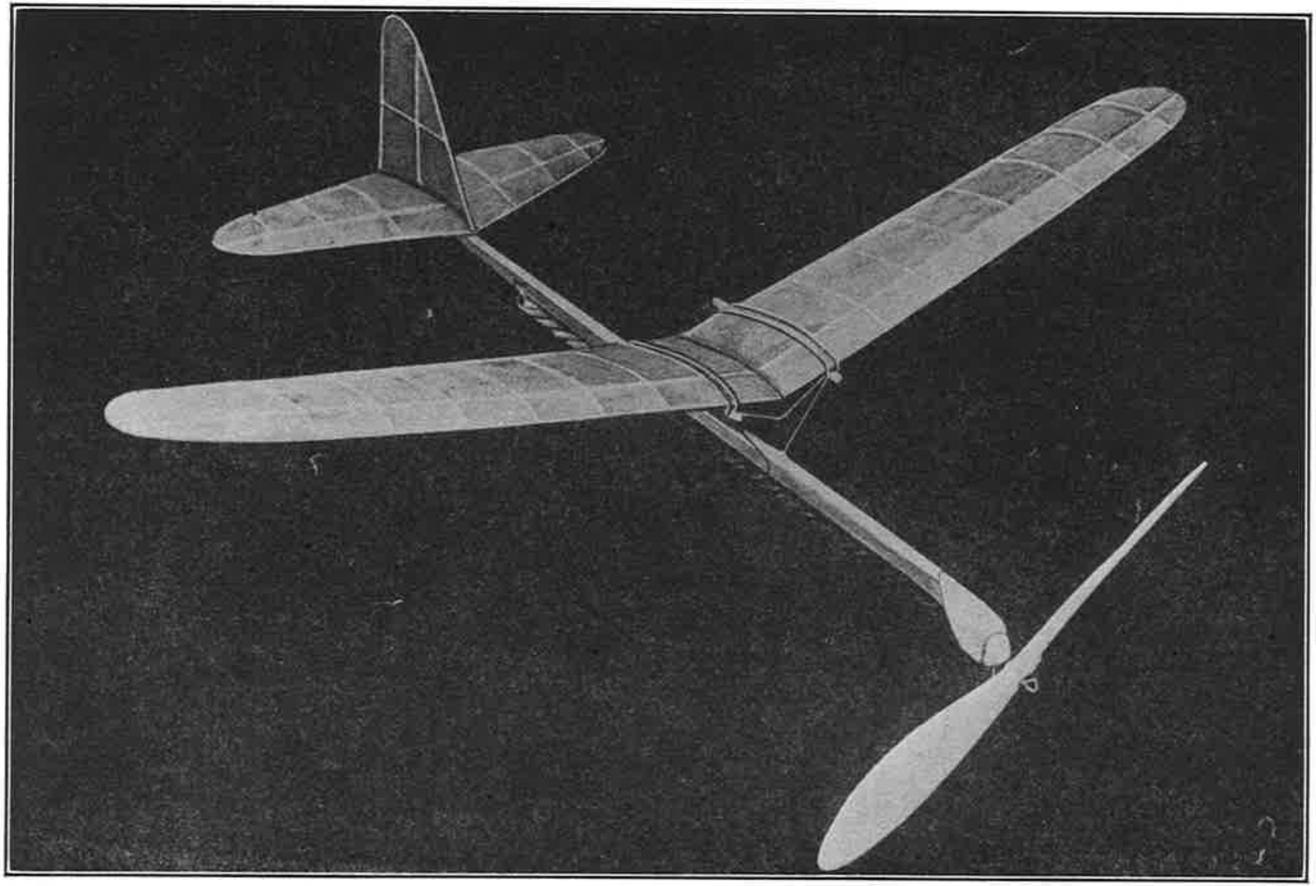
CHAMPION OUTDOOR TRACTOR

AMONG the various winners that made their appearance in 1936, this remarkable outdoor tractor, designed and built by Henry Struck, turned in some of the best endurance flights ever recorded. The author appreciates the permission given him by Mr. Struck to bring it to these pages. At the 1936 Junior Birdmen Outdoor Air Races this model demonstrated its worth by turning in an official winning time of 12 minutes and 47 seconds, when unfortunately it flew out of sight while still at a great height. Interesting to note is the fact that the shortest flight it made that day was over four minutes. In the calm air of the evening, this model has often flown for over three minutes, and flights of over two minutes are made consistently. It was designed to conform with the new rules governing stick models as drafted by the Junior Birdmen, which allows no landing gears and nothing but solid motor sticks. When the model is built, use nothing but strong balsa of medium hardness throughout.

MATERIAL LIST

1 pc. —	1/8″	x 1/8″	x 36″	—Balsa (Leading edge spar)
2 pcs.—	1/16″	x 3/16″	x 36″	—Balsa (Wing spars)
1 pc. —	1/18″	x 1/2″	x 36″	—Balsa (Trailing edge spar)
1 pc. —	1/2″	x 3/4″	x 30″	—Balsa (Motor Stick)
1 pc. —	1/16″	x 3″	x 36″	—Sheet Balsa (Ribs and Wing tips)
2 pcs.—	3/16″	x 3/16″	x 6″	—Balsa (Wing Mount)
1 pc. —	1″	x 1″	x 1″	—Balsa (Nose Plug)
1 pc. —	1/8″	x 1 1/2″	x 1 1/2″	—Sheet Balsa (Thrust bearing sides)
1 pc. —	.034	x 12″ long		—Music Wire (Wing clips)
1 pc. —	.040	x 6″ long		—Music Wire (Shaft and Hook)
1 pc. —	1 1/8″	x 1 3/4″	x 14″	—Balsa (Propeller)
2 sheets				—Japanese tissue
Cement				
Banana Oil				
Sandpaper				

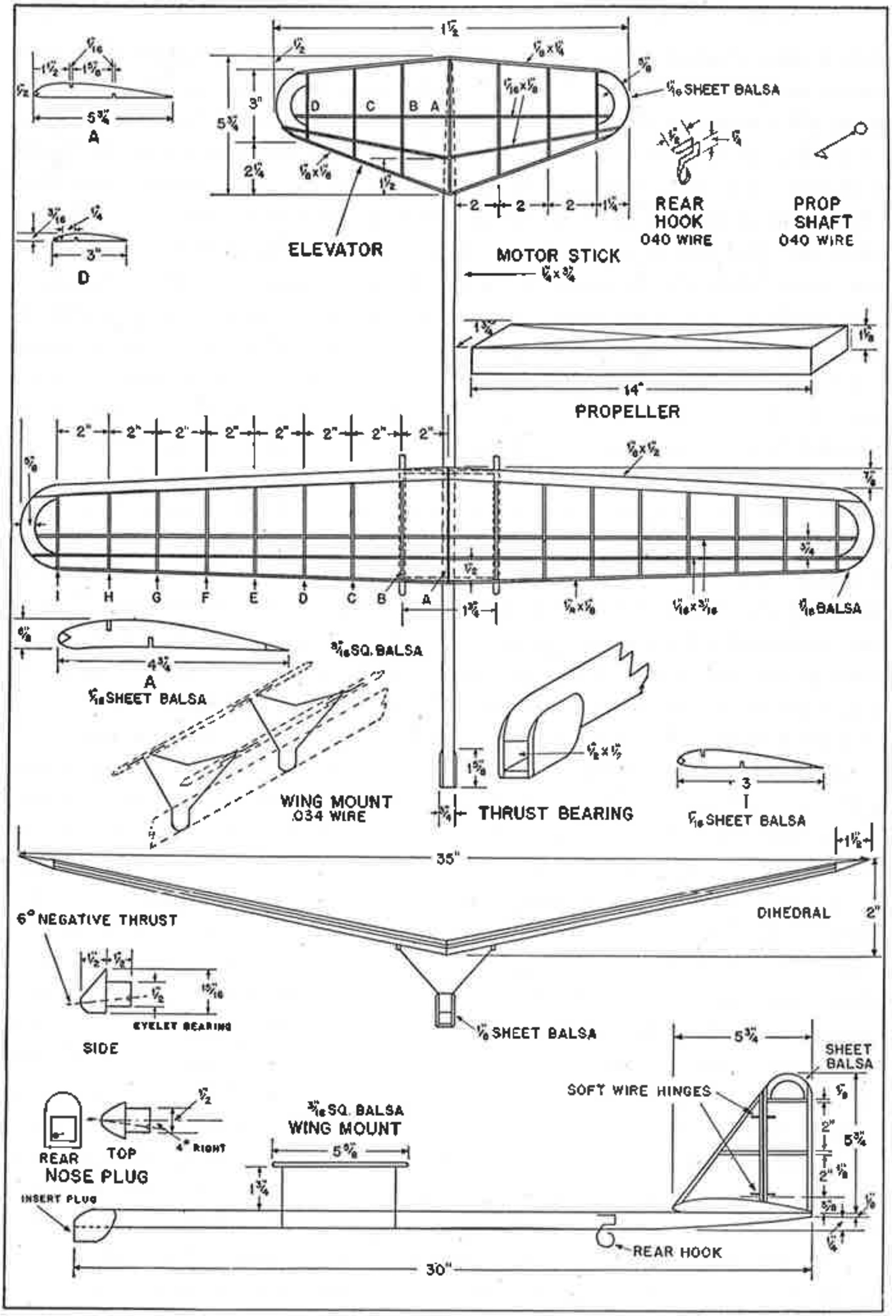
MOTOR STICK. The motor stick is shaped from a 1/2″ x 3/4″ x 30″ long piece of straight-grained, unwarped balsa. Its thickness is tapered from the leading edge of the elevator to its rear end, as shown in the top view. The



CHAMPION OUTDOOR TRACTOR

width is also tapered from a point 8″ in from its rear end, which decreases from its original width of 3/4″ to 1/8″ at the rear, as shown in the side view. Round all corners of the stick with sandpaper. The thrust bearing consists of a small pocket into which fits a nose plug. Note this pocket at the front end of the stick. It is made up of three pieces of 1/8″ sheet balsa. Note this construction under "Thrust Bearing." When assembling the sides of this pocket, see that the grain in these pieces runs at right angles to the grain in the stick. Make the opening of this pocket 1/2″ square. Cement it in place on the leading end of the motor stick. The top of the stick is then rounded, as shown, and a nose plug made to fit the pocket. This is cut to shape from the 1″ x 1″ x 1″ balsa block. Carve it as shown in the plan under "Nose Plug." Test constantly during this work for a snug fit in the pocket. This removable nose plug eliminates the necessity of the usual "S" hook that is so troublesome to fit on when the motor is wound. When the plug is finished, washers with bushings at front and rear are added for bearings. Note that the thrust line is tilted down six degrees and two degrees to the right. When completed, give it a single coat of cement to toughen it. The rear hook is bent from .040 music wire, as shown in the plan under "Rear Hook." It is then cemented with its end prongs buried into the sides of the stick, as shown in the side view. Three or four coats of cement should be applied around the stick and over the hook to form a strong binding.

ELEVATOR. The elevator is made in one piece. The ribs "A" and "D" are cut from 1/16″ sheet balsa. Cut out one "A" rib, locate its notches, and cut these 1/16″ wide and 1/8″ high. Cut out two "D" ribs without their notches. Cut two elevator tips from 1/16″ sheet balsa. These have outside diameters of 3″ and are 5/8″ wide. Cement the two "D" ribs against the opening side of these half-round tips, as shown in the plan. Cut the straight inner spar 1/16″ x 1/8″ x 13 3/4″ long. Cement this spar in its notch in the "A" rib. Test to see that it is at right angles to the rib. Shape the trailing edge spar from 1/8″ x 1/4″ x 14 1/2″ long balsa. Rule a straight line on paper and place this spar on it. Snap the spar in its exact center and bring its ends forward of the line 1/2″. While in this position, cement the trailing end of "A" rib to the center of this trailing edge spar. See that "A" is at right angles to the drawn line. The inner spar already cemented on "A" should be parallel to it. Place a tip with its inner circle against the end of the spar on "A" and its trailing edge against the trailing edge spar. When in this position mark the point where the spar on "A" passes over "D" rib. Cut a notch for the inner spar at this point. The notch location on the other "D" rib is located in the same way. Cement the inner spar in these notches and against the inner circle of each tip. The trailing



CHAMPION OUTDOOR TRACTOR PLAN

edge spar is now trimmed to proper length, the tip notched to receive it, and the two joined with cement. Cement the other tip in the same manner to the opposite end of the trailing edge spar. Cut a leading edge spar of 1/8″ square balsa, snap it in its center, and cement it in place against the tips and the three ribs. Cut ribs "B" and "C" from 1/16″ sheet balsa, shape them exactly as the others, cut them to proper length and cement in place. The leading inner spar, which fits in the upper edge of the ribs, is now cut from 1/16″ x 1/8″ balsa. Notch each rib to receive it, snap the spar in its center, cement it in each rib notch and to the tips, and then trim to proper length at both ends. Cover the elevator on both sides with tissue, water spray, and dope.

RUDDER. The rudder is made in two parts, which form the fin (forward) and the rudder (rear). Note its construction in the plan showing the side view. Draw the upper curve of elevator rib "A" on paper. Cut the trailing edge spar of the rudder 1/16″ x 1/4″ balsa. Cut its leading edge of the same material and size. The tip of the rudder is of 1/16″ sheet balsa. This consists of a half-circle 2″ in diameter. Trim its ends on its outersides so that the trailing and leading edge spars fit it 2″ apart from each other. Place these spars in position on the "A" elevator rib and cement the tip in place between these spars so that its highest point is 5 3/4″ above the lower end of the trailing spar. The two rudder ribs are cut of 1/16″ x 1/8″ balsa. Cement them in place as shown. Build up the fin in the same manner. The rudder is joined to the fin by two soft wire hinges cemented in place. Cover on both sides, water spray, and dope.

WING. The wing is made and assembled exactly as was the elevator. When covering it, dope the tissue to the under side of the ribs to hold their contour. Water spray and dope when held in position to the bench.

PROPELLER. Carve the propeller from the 1 1/8″ x 1 3/4″ x 14″ long balsa block. When finished, sand smooth, and then cement a washer with a small bushing inserted on each side of the hub. Dope and sand between coats. Bend the shaft from .040 wire, pass it through the nose plug, and cement in place. Attach 14 strands of rubber.

ASSEMBLY. Bend the two wing mounts to shape and cement them to two 3/16″ square balsa wing tracks cut 5 1/4″ long, which are set at an angle of three degrees incidence. Cement the elevator to the stick at a zero degree incidence. Cement just the fin of the rudder in place at right angles to the elevator directly over its center. Locate the center of gravity by balancing the stick when the elevator and rudder are in place, and cement the mounts so that this point comes directly halfway between them. Attach the wing with rubber bands, as shown in the photograph.

CHAPTER 25

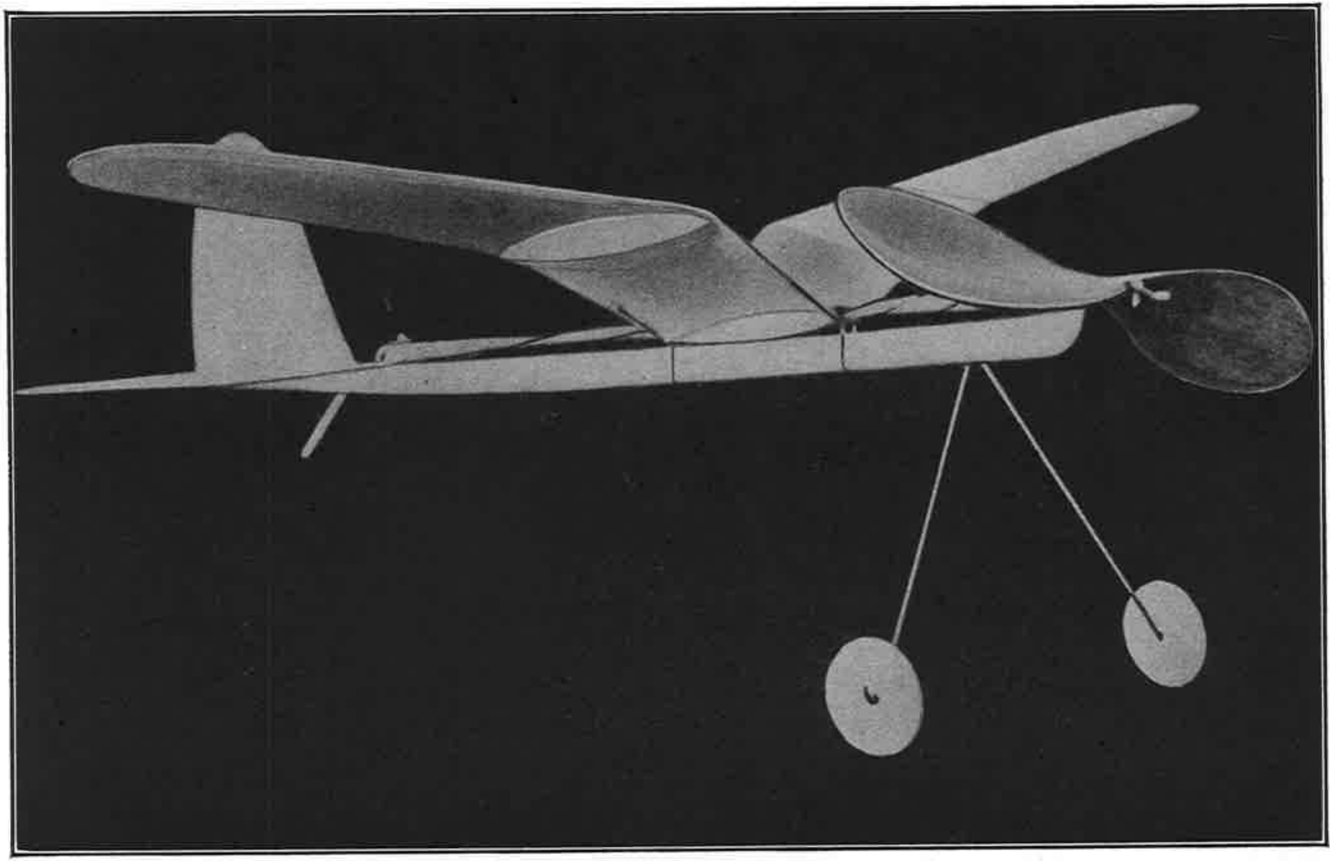
GULL WING

IF you have ever seen a gull pointed for flight on a sandy beach, you will know the incentive that prompted Louis Garami to design and build this all-balsa tractor model. Not only has he incorporated into it the grace and beauty of the gull, but he has also designed a model having considerable of the flying and soaring ability of that well-known bird. The author wishes to thank Mr. Garami for permission to reproduce his successful effort here.

MATERIAL LIST

2 pcs.—1/32″ x 2 3/4″ x 5 1/2″	—Sheet Balsa (Wings)
2 pcs.—1/32″ x 2 3/4″ x 2″	—Sheet Balsa (Center-section)
1 pc. —1/32″ x 2 1/2″ x 2 1/2″	—Sheet Balsa (Rudder)
1 pc. —1/32″ x 2 1/2″ x 6″	—Sheet Balsa (Elevator)
1 pc. —1/8″ x 3/8″ x 12″	—Hard Balsa (Motor stick)
1 pc. —1/16″ x 3″ x 6″	—Sheet Balsa (Ribs and Wheels)
1 pc. —3/4″ x 1 1/8″ x 6″	—Balsa (Propeller)
1 pc. —1/16″ x 1/16″ x 1 3/16″	—Bamboo (Tail skid)
1 pc. —.028 x 18″ long	—Music Wire (Metal fittings)
1 pc. —1/16″ O.D. x 3/8″	—Aluminum Tubing (Bearing)
2 pcs.—1/16″ O.D. x 1/16″	—Aluminum Tubing (Wheel Hubs)
6 —1/8″ diameter	—Washers (Shaft and Hubs)
1 pc. —1/8″ x 17″ long	—Flat Rubber (Motor)
Cement	
Sandpaper (00)	
Clear Dope	

MOTOR STICK. The motor stick is shaped from a 1/8″ x 3/8″ x 12″ long piece of hard balsa. It remains this size with the exception of the taper given it along its under side. Note this in the side view in the plan. This starts 4 1/2″ from the rear end and tapers to 1/8″ wide at the end. Round all edges, as shown in the "A-A" and "B-B" cross-sectional views, and then cut the small thrust bearing mount shown on top of the stick at its entering end. This is 1/8″ thick, 1/4″ wide, and 7/16″ long. It is of balsa and should be grooved along the top to take the tubing. Note that the stick is notched out to accommodate it. Cut this notch now and cement the block in place.



GULL WING

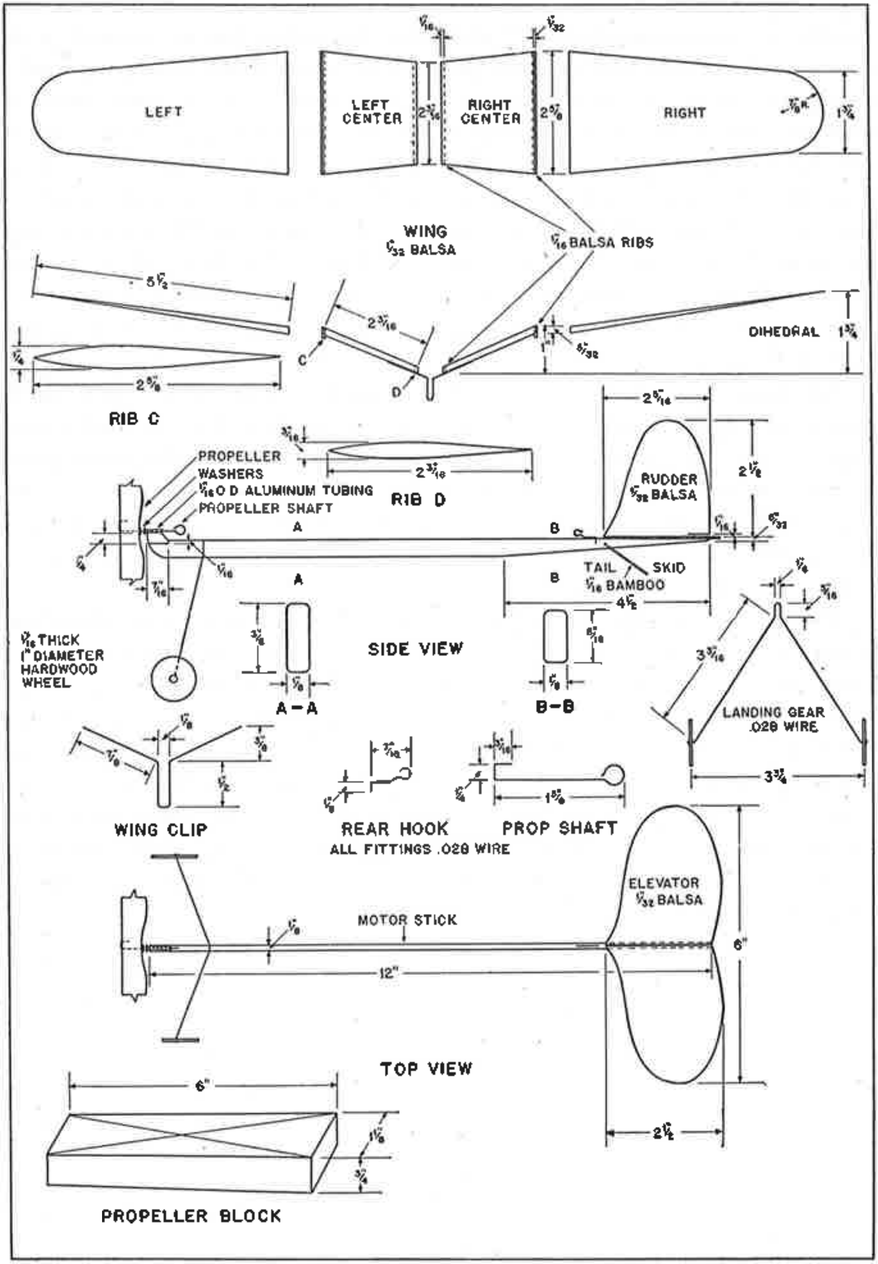
The under edge of the stick is then rounded directly under this mount. Cement the 3/8" long aluminum tubing in place on the thrust bearing mount, as shown in the side view. Use plenty of cement for this joint. Bend the rear hook of .028 music wire, as shown under "Rear Hook," and after thrusting its end into the top of the stick 23/8" in from the trailing end of the stick, cement is applied to hold it firmly in place. The tail skid is a length of 1/16" split bamboo inserted in the under side of the stick 25/16" in from the stick's rear end, as shown in the plan. Apply two coats of dope to the stick rubbing down between coats with fine sandpaper.

LANDING GEAR. The landing gear details are shown in the plan. This is bent from a single length of .028 music wire. Two solid balsa wheels are cut of 1/16" sheet balsa to diameters of 1" each. Use hard balsa for these. Cement the 1/16" lengths of aluminum tubing in their hubs, thread on the wire axles, and bend the axles up to prevent them from falling off. A washer can be cemented on each side of the wheels over the aluminum tubing's ends if desired. Cement the landing gear 11/4" in from the nose of the stick, as shown. The legs of the landing gear are bent forward so that the lower ends of the legs extend 1/4" in front of their upper ends connecting with the stick. The wheels must be in line with each other and 33/4" apart.

ELEVATOR. The elevator is shaped from a single piece of 1/32" sheet balsa. It is 21/2" wide and 6" long. Cut it to the shape shown in the plan and then sand it to streamlined form. Apply two coats of dope and sand between coats. Cement the elevator on top of the motor stick at its trailing end. Make sure that it is perfectly level and that it is at right angles to the sides of the stick.

RUDDER. The rudder is shaped from a single piece of 1/32" sheet balsa. It is 25/16" wide and 21/2" long. Shape it as shown in the side view and then streamline it with sandpaper. Apply two coats of clear dope and sand between the coats. A short groove is cut out of the lower edge from the trailing edge of the rudder to permit the rudder being adjusted either way without fear of cracking the wood. When completed the rudder is cemented to the top-center of the elevator at right angles to it. Note that the leading edge of the rudder fits flush with the leading edge of the elevator, which extends out beyond the rear end of the motor stick.

WING. The wing is made in four parts consisting of two center-sections and two outer panels. All four pieces are cut from 1/32" sheet balsa. Start by squaring up two pieces 25/8" wide and 23/16" long. Taper their sides from this width to 23/16" wide at their opposite ends. Sand carefully. The outer panels are cut from original pieces squared up to measure 25/8" wide and



GULL WING PLAN

5½″ long. Rule a straight line along their lengths directly through their centers. Set your compass at ⅞″ and using this center line as a center, scribe a half circle at one end of each piece. This circle must touch the end of each piece with the center line as a pivot. Rule straight lines from the opposite end of the piece to connect the sides of the drawn circles and the sides of the piece at the other end. Cut out these forms and sand smooth. Note that the piece tapers from the wide end to the tip end. Sand this taper in each piece. All four pieces are doped and sanded between coats. Cut two "D" and two "C" ribs from 1/16″ sheet balsa. Bevel their tops and cement the two "D" ribs under the short ends of the center-sections. The long ribs "C" are cemented halfway under their wide ends. Use pins to hold the sheeting to the curve of the ribs until dry. Bend two wing clips of .028 music wire, as shown in the plan under "Wing Clip." Cement the clips to the under sides of the center-sections at their leading and trailing edges. Test each clip for alignment and proper dihedral. The outer panels are then cemented in place against the outer ends of the center-section pieces and over the exposed half of the "C" rib in each case. Check for required dihedral and proper alignment, and make any corrections required by bending the wing clips.

PROPELLER. The propeller is carved from a block of medium balsa measuring ¾″ x 1⅛″ x 6″ long. Full instructions covering this work will be found on page 91 under "Carved Propellers." Sand the blades to 1/16″ thickness at their tips. A large copper washer and a small eyelet cemented in its hub hole completes it. Apply a single coat of dope to the propeller and sand. Bend a propeller shaft of .028 music wire. Cement it in the hub, thread a washer over the protruding shaft, insert it through the aluminum tubing bearing, and bend the hook. A single loop of ⅛″ flat rubber forms the motive power. Tie it in a loop and place it over the shaft and the end hook. The model is now ready for flight.

CHAPTER 26

SINGLE-STICK OUTDOOR PUSHER

THE pusher airplane is so called because the propeller, being in the rear, pushes the model through the air, instead of pulling it as in the case of tractor models. Many pusher models have proved successful at national meets recently, and it would be difficult to say which type of model airplane is more popular.

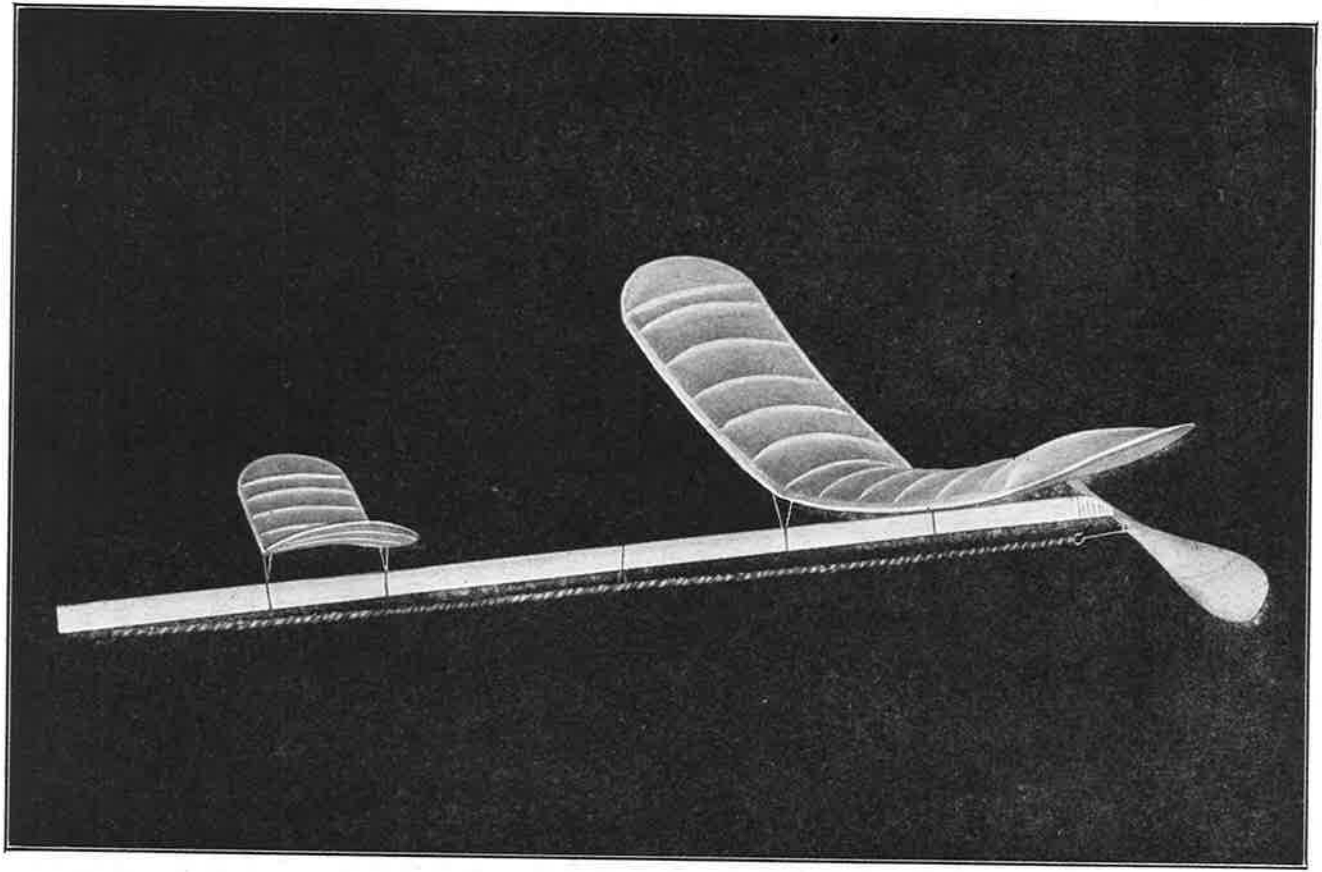
The model given here, while rather complicated in design and construction, embodies practically every detail found in pusher models, and has been chosen to represent this type of model because of this fact, plus its superb flying qualities. Each step in its construction should be carefully followed by the beginner, as many seemingly unimportant details in its design prove of utmost importance when the model is launched.

MOTOR STICK. The motor stick of this model consists of a 1/8" x 1/4" x 24" balsa piece. Study the plan of this stick. Note that its direction of flight is opposite to that of the tractor models. The regulation propeller bearing can be purchased or made. (See Chapter 6, "Propeller Bearings.") This is cemented and bound with silk thread to the end of the motor stick on its under surface. When in position, this end becomes the rear of the model.

At the opposite or front end, a nose hook is cemented over the end of the stick, which becomes the nose or forward end of the motor stick. This nose hook is similar to the regulation rear or end hook of the tractor model, except that it is attached differently. Its function, however, is the same as a rear hook. This nose hook can be bent from No. 9 piano wire, as shown in the plans. (See Chapter 6, "Nose Hooks.")

A can hook is provided to hold the rubber motor in place on the stick. It can be bent from No. 8 piano wire, as shown. (See Chapter 6, "Can Hooks.") The nose hook is cemented in place on the end of the motor stick, while the can hook is fastened in the same manner to the center of the stick.

WING. The wing requires two spars, two wing tips, and thirteen wing ribs. The leading and trailing edge spars are duplicates, both being 1/8" x 1/4" x 24" long. They are cut to size from balsa wood, and tapered as shown in the plans under "Camber of Wing Rib." The thirteen wing ribs are 1/16"



SINGLE-STICK OUTDOOR PUSHER

x $\frac{1}{16}''$ x 4″ balsa wood. While the distance from the inside of the leading edge spar to the inside of the trailing edge spar is only $3\frac{1}{2}''$, the ribs should be cut 4″ long to allow for their necessary wing camber. This is shown in the plans under "Camber of Wing Rib." A single piece of $\frac{1}{16}''$ sheet balsa wood 1″ wide should be soaked and bent to proper shape, and the ribs are cut $\frac{1}{16}''$ wide from this piece. Each rib will then have the same bend as all the others. (See Chapter 3, "Balsa Wood.")

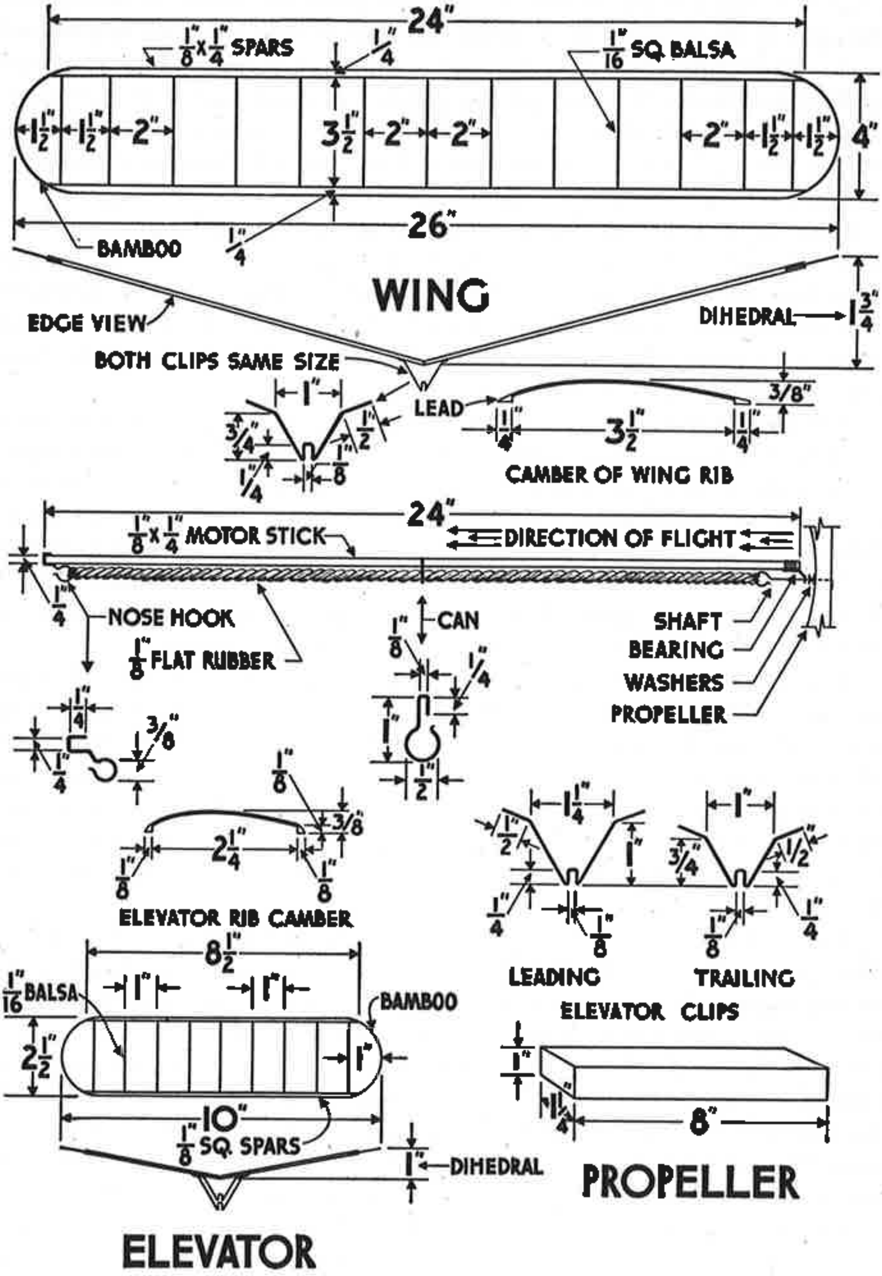
Place the leading and trailing edge spars parallel to each other and $3\frac{1}{2}''$ apart. Proceed to cement each of the thirteen ribs in place. Do not cement the center rib at this time, as this can best be done after the necessary wing dihedral has been obtained. Two $\frac{1}{16}''$ x $\frac{1}{16}''$ split bamboo wing tips are bent to proper form, and cemented in place to the ends of the wing spars. (See Chapter 3, "Bamboo.")

The wing dihedral on this model is more than average models require, being $1\frac{3}{4}''$. This is now obtained. Snap the leading and trailing edge spars between the thumb and index finger in their centers, or at the location of the center rib. Place both halves in line with each other on a flat table. Holding them at the point of their broken joints, lift the tip of one half $3\frac{1}{2}''$ off the table. While in this position, cement the leading and trailing edge spars together again. Hold in position until dry. (See Chapter 7, "Wing Assembly.") The center rib is now cemented in place.

The wing is covered with Japanese tissue. Coat both wing tips, all spars, and ribs on their upper side, and then press the paper on them, making sure it adheres at all points. Use clear dope or banana oil for this work. After the dope has dried, trim all edges of the paper, and give the wing a thorough water-spraying. (See Chapter 7, "Wing Covering.") Two wing clips of the same size are bent from No. 9 piano wire, as shown in the plan. These are cemented over the center wing rib to the under side of the leading and trailing edge spars.

ELEVATOR. The elevator is built up in much the same manner as the wing. Two $\frac{1}{8}''$ x $\frac{1}{8}''$ x $8\frac{1}{2}''$ long balsa wood spars form the leading and trailing edges. These are streamlined, as were those of the wing. Note their form in the plans under "Elevator Rib Camber." Nine $\frac{1}{16}''$ x $\frac{1}{16}''$ x $2\frac{1}{2}''$ long balsa elevator ribs are now cut and bent, as shown under "Elevator Rib Camber." These should be made in the same manner as those of the wing. Assemble the elevator ribs between the spars as already instructed for the wing. Bend two bamboo elevator tips from $\frac{1}{32}''$ x $\frac{1}{32}''$ split bamboo, and cement them in place at the ends of the leading and trailing edge spars.

Give the elevator a 1″ dihedral, by the same method used in obtaining the wing dihedral. Two elevator wing clips are bent from No. 9 piano wire,



SINGLE-STICK OUTDOOR PUSHER PLAN

as shown under "Elevator Clips." The larger of these is cemented to the leading edge spar on its under side, while the smaller one is located on the trailing edge spar. Note their location in the plan of the elevator.

The elevator is covered on its top side with Japanese tissue, which is held with clear dope or banana oil. Do this in the same manner as in covering the wing.

PROPELLER. This is cut from a 1″ x 1¼″ x 8″ balsa propeller block, and should have its blades sandpapered until light will show through them. The regulation propeller shaft is bent from No. 9 piano wire. (See Chapter 6, "Propeller Shafts.") Thrust the end of the shaft through the center of the propeller hub, bend it around, and pull the shaft back until the point buries itself in the wood of the hub. A drop of cement at this bend will hold the shaft firmly in place. The builder must keep in mind that the propeller is to be a pusher propeller, and while it is carved in exactly the same manner as a tractor propeller, the shaft must be inserted through the hub from the opposite side to that of a tractor propeller. In other words, the hook of the propeller must be on the convex side of the blade on a pusher propeller, while it is on the concave side for tractor models. (See Chapter 9, Fig. 47.)

MOTOR. This consists of four strands of ⅛″ flat rubber. Obtain a 92″ length of this rubber, tie its ends together, and loop it into four strands. The propeller and motor assembly is now mounted on the stick. To do this, apply two washers to the propeller shaft and then pass the shaft through the hole in the propeller bearing. One end of the two loops of the rubber motor is looped over the hook of the propeller shaft, passed through the can hook in the center of the motor stick, and the other end of the loops is passed over the nose hook, which completes the motor assembly.

ASSEMBLY. Clip the elevator to the top of the motor stick about 3″ back of the nose hook. The location of the wing should be determined by gliding tests. Change the wing back and forth on the motor stick until a long, even glide is obtained. It may be found that the elevator will also need adjusting, which can be determined by the same gliding tests. When launching the model, remember that the wing trails the elevator with the propeller pushing the model from the end of the motor stick. For the proper method of launching, see Chapter 16, "Correct Launching of Single-Stick Pushers."

CHAPTER 27

HAND-LAUNCHED TWIN PUSHER

PRACTICALLY every endurance record made at outdoor meets has been won by this popular type of model airplane. The twin pusher has become the standard for endurance competition throughout the world and at every meet it wins the greatest amount of awards.

The model given here is a record breaker for endurance flights, being an improved composite of various championship models of the past three years. With a forty-inch A-frame and a thirty-four-inch wing, it lends itself to speed as well as endurance flying. The wing camber and dihedral given in the plans are the result of over a hundred flying tests. The builder should take every precaution to make these as perfect as possible, for the flying ability of the model depends on these main dimensions.

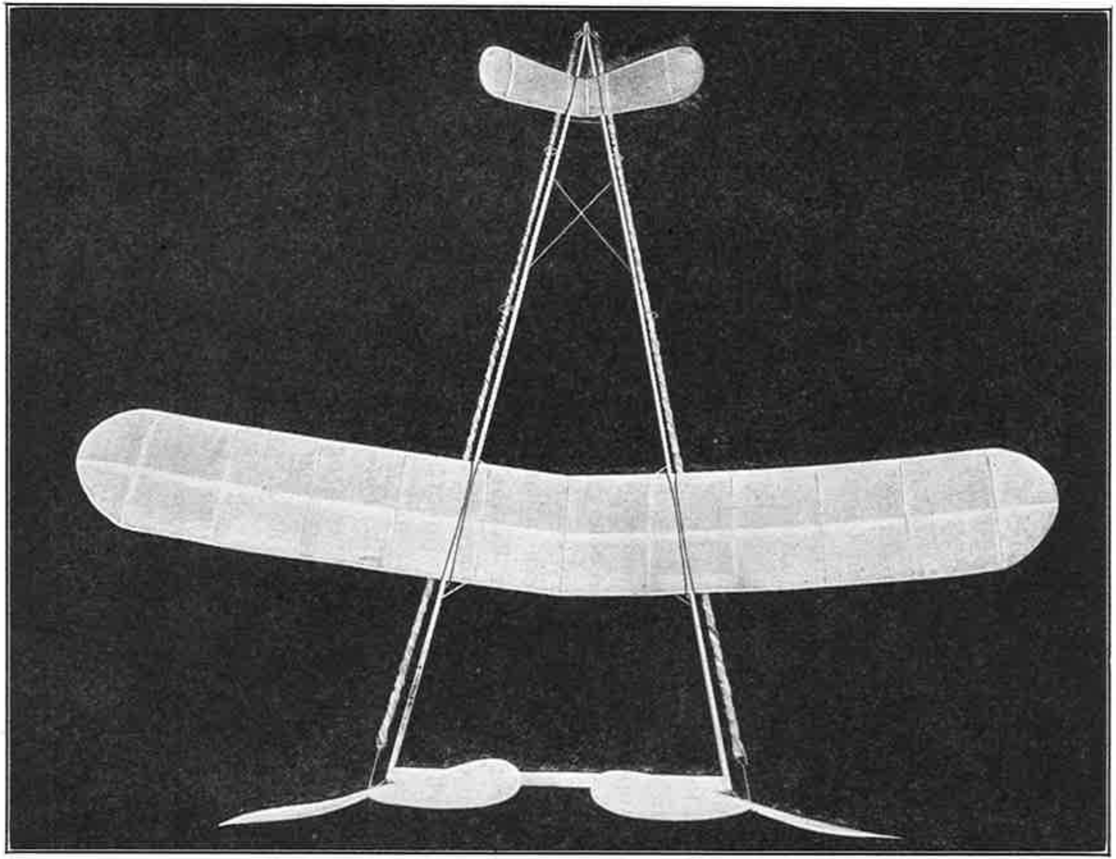
FUSELAGE. The fuselage of such a model is known as the "A-frame," and consists of two long sticks strengthened by various cross bracing. For this model, the following material will be needed:

2 pcs.	—3/16" x 3/8" x 40"	—Balsa
1 pc.	—3/16" x 3/8" x 9 3/8"	—Balsa
4 pcs.	—1/32"	—Split bamboo

If balsa cannot be obtained long enough for the long twin sticks, two pieces should be spliced together, firmly cemented, and bound with silk thread, to make the necessary 40" length. If this is necessary, the splices should be made as near to the front end as possible. As this model is a pusher, the front end is the one equipped with the nose hook, as shown in the plans.

After these pieces have been cut to proper size and sandpapered smooth, they should be equipped with all metal parts before being assembled. A standard propeller bearing is attached to the outer side of each stick at the rear, as shown in the plans. (See Chapter 6, "Propeller Bearings.")

When these are cemented in place, silk thread should be wound around them for added strength. Six can hooks are shaped from No. 12 piano wire. These are used to hold the rubber in position along the fuselage. Each stick is equipped with three of these hooks. They should be placed 10"



HAND-LAUNCHED TWIN PUSHER

apart on the outer side of the sticks and held with cement and thread bindings. (See Chapter 6, "Can Hooks.")

The sticks are now joined together. Taper the front ends of the sticks on their inner sides so that when matched together the propeller bearing holes will be spread 11″ apart, as shown in the plan. From No. 12 piano wire, a nose hook is formed, as shown. (See Chapter 6, "Nose Hooks.") This hook not only serves to hold the "S" hooks, but also forms a strong binding for the joint at the front end of the fuselage.

The front joint is cemented together, the nose hook cemented over it, and the entire joint bound tightly with silk thread, as shown in the plan. The 3/16″ x 3/8″ x 9 3/8″ long balsa rear brace is cut and sandpapered smooth. Its ends are notched and the ends of the fuselage sticks are also cut to form a half lap joint. When completed, the brace is cemented in place. This is followed by the inner bamboo bracing. Small holes are cut on the inner side of the sticks to hold this bracing. From 1/32″ split bamboo, the braces are cut to proper length and cemented in place. At their intersection, a drop of cement should be applied to hold them together.

WING. From the plan of the wing rib, cut a paper template to exact size. The rounded part, shown in white at the front, is left off the template as this form is gained by the leading edge spar. From 1/16″ sheet balsa, cut out eleven of these ribs. Remove their inner excess material by cutting the small circles in them, as shown. Give them a careful sandpapering for smoothness. The leading edge spar is now cut to length and then shaped, as shown by the plan of the rib. This is made from 5/16″ square balsa and should be 30 1/2″ long. The inner wing spar is made from 1/16″ x 1/4″ x 34″ long balsa, while the trailing edge spar is 1/32″ x 1/16″ x 30″ long balsa.

The small holes in the ribs for the inner wing spar are now cut, and the ribs are properly spaced on this spar and held with cement. Allow this assembly to dry thoroughly. To the blunt front end of each rib, the leading edge spar is cemented. Note that this spar extends only 1/4″ beyond the outer rib on each end. The trailing edge spar is cemented in place, and the structure set aside to dry.

The wing tip can be bent to shape while the wing structure is drying. When completed, the ends of the leading and trailing edge spars are tapered to accommodate the 1/32″ split bamboo wing tips, which are cemented in place.

To obtain the 1 7/8″ dihedral angle, carefully snap the leading and trailing edge spars between the thumb and finger. Lay one side of the wing flat on a table and lift the other end up until it is 3 3/4″ above the table top. A drop of cement at the joint of these spars will hold the wing in this position. The wing is covered on both sides with Japanese tissue, and steamed or water-sprayed to tighten the covering. (See Chapter 7, "Wing Covering.") The wing of this model is held to the A-frame with rubber bands, so no clips will be needed.

ELEVATOR. On twin-stick pushers, the elevator is often called the "nose wing," because of its position on the fuselage. This elevator is constructed of 1/32" x 1/16" split bamboo throughout. Cut five ribs, slightly camber them, and then attach them between the leading and trailing edge spars, which are constructed of one length of bamboo. When the cement is thoroughly dry, snap the leading and trailing edge spars in their centers to obtain the necessary dihedral. Note that both these spars have different dihedral angles. The leading edge has a 1½" dihedral, while the trailing edge has one only ¾" high, as shown in the plan. Obtain these dihedrals in the same manner as for the main wing and hold with cement. (See Chapter 7, "Wing Assembly.")

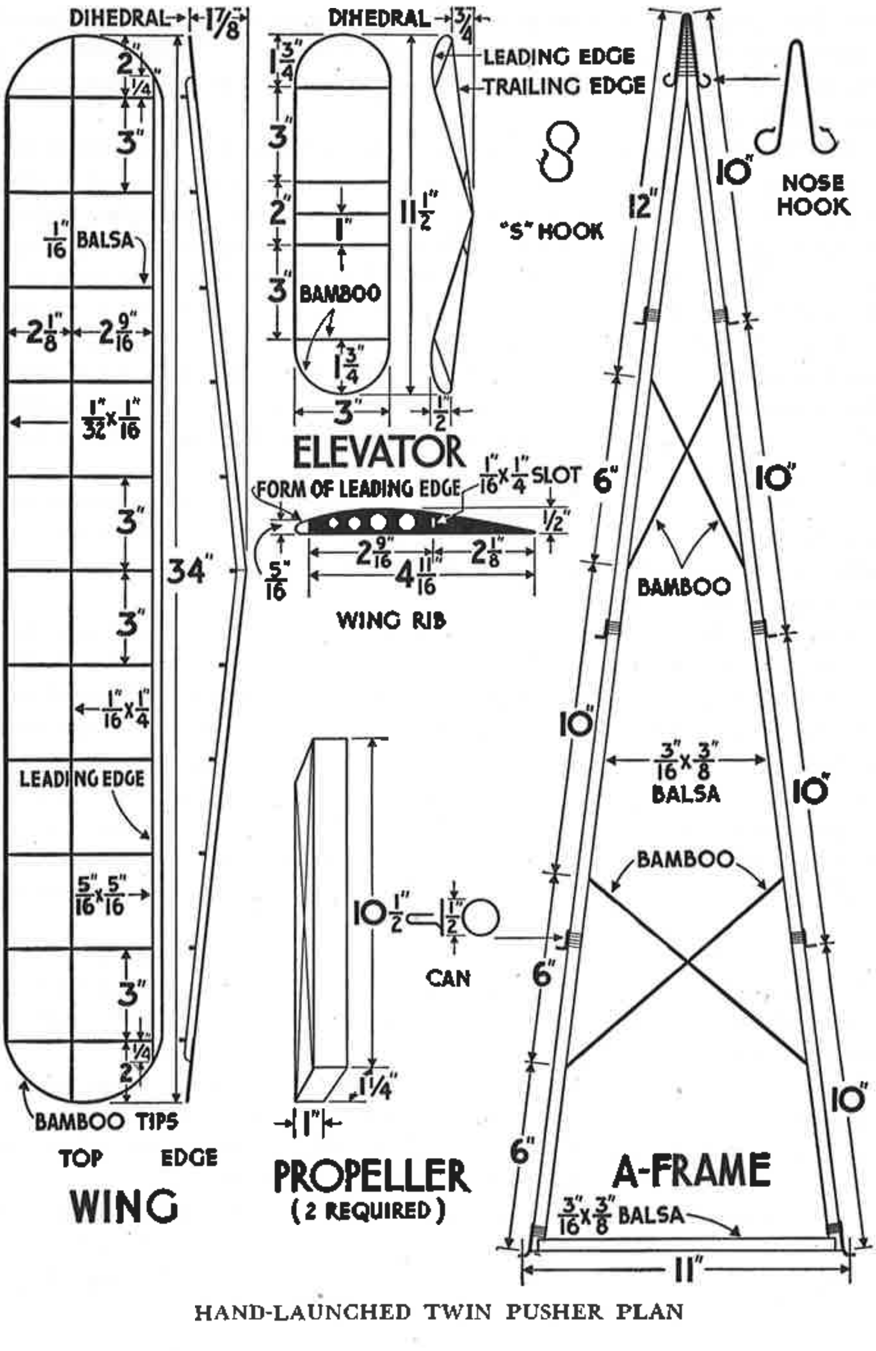
The elevator is covered on one side only with Japanese tissue, which can then be water-sprayed or steamed to tighten the paper. (See Chapter 7, "Wing Covering.") This part is also held on with rubber bands, and therefore requires no metal clips.

PROPELLERS. Twin-pushers obtain their name through the fact that they have two or "twin" pusher propellers. These are cut from 1" x 1¼" x 10½" balsa propeller blocks. Remember that they must be left hand and right hand propellers, so carving must start on opposite edges. (See Chapter 9, "Right and Left Hand Propellers.") As they are pusher propellers, their shafts must be inserted so that their hooks are on the convex side of the propellers. Bend two propeller shafts from No. 12 piano wire, insert them through the hubs of the propellers, bend their ends over, and cement in place. Two washers should be provided for each shaft. When complete, thread them through the holes in the propeller bearings.

MOTIVE POWER. The motor of this model consists of eight strands of ⅛" flat pure Para rubber for each propeller. Obtain a fifty-four-foot length of this rubber, cut it into two twenty-seven-foot lengths, and tie the ends of each piece together to form two loops.

These are then ready for assembly. Form two "S" hooks from No. 12 piano wire, as shown. (See Chapter 6, "'S' Hooks.") Attach these hooks to the nose hook, and then make eight equally long strands of the rubber by looping it between the propeller hooks and the "S" hooks.

ASSEMBLY. To attach the wing and elevator, strong rubber bands will be required. (See Chapter 28, "Assembly.") After these parts have been assembled, the model must be glided to test for their proper location. If the



HAND-LAUNCHED TWIN PUSHER PLAN

model dives, the wing should be pushed forward on the fuselage. If it stalls, the wing should be brought back. The nose wing, or elevator, should be attached about 3″ to 5″ from the nose hook. After the location of the wing has been determined, an egg-beater winder should be used to wind the motors. For the proper method of launching, see Chapter 16, "Correct Launching of Endurance Twin Pushers."

CHAPTER 28

R.O.W. TWIN-STICK PUSHER

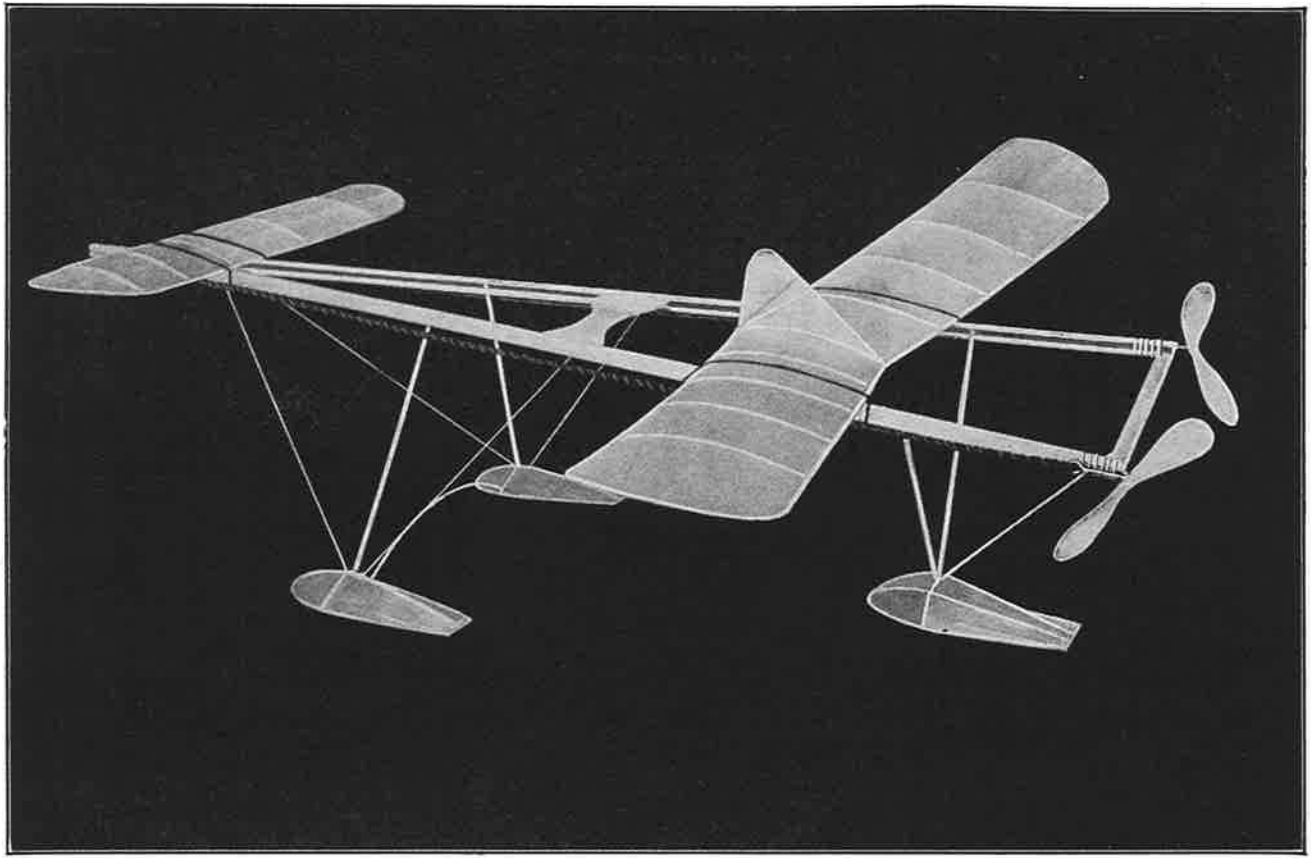
ONE of the most interesting performers of all the stick model group is the rise-off-water (R.O.W.) twin-stick pusher. It is a splendid endurance flyer and possesses a natural grace seldom found in model airplanes. Its ability to take off from the water and its attractive flying qualities make it a model well worth building.

It is a model for the advanced builder rather than for the beginner, as its construction is considerably more difficult than ordinary stick airplanes. However, if the amateur will carefully follow the plans and instructions, doing the work step by step, he should experience little trouble.

FUSELAGE. The fuselage of a twin-stick pusher is known as the "A-frame" because its general form often resembles a large letter "A." Two lengths of 1/4″ x 3/8″ balsa wood "U" beam are used for our fuselage, with the opening of the "U" on the inside. In case "U" beam cannot be obtained, solid pieces of balsa wood may be used. These should be 30″ long. At one end the "U" beams are held apart by a 1/16″ x 5/16″ x 8 3/4″ balsa length, known as a "spreader." The ends of the two beams are notched to allow the ends of the spreader to fit into them, as shown in Plan 1.

A piece of 1/16″ sheet balsa wood is used as a center brace between the two beams. It is 2″ wide and is cut out as shown to eliminate weight. As the openings of the "U" beams are wider than the thickness of this center brace, small wedges are placed between the sides of the beams and the brace. Cement the brace and these wedges in place between the beams, after the front ends of the beams have been tapered and brought together to fit. Note that the ends of the center brace must be tapered to fit the slant of the "U" beams. When this is in place, cement the ends of the beams together.

A nose hook is bent from No. 11 piano wire. This is sometimes called the "yoke," as it serves a double purpose by holding the front end of the frame together and also as a means for fastening the front ends of the rubber motor. (See Chapter 6, "Nose Hooks.") This is attached over the ends of the beams with cement and silk thread, as shown. Two propeller bearings are purchased or made. (See Chapter 6, "Propeller Bearings.") These are



R.O.W. TWIN-STICK PUSHER

cemented and bound with silk thread to the outer side of the "U" beams at their rear ends.

Two small elevator blocks are now cut from balsa wood as shown in Plan 1. These are cemented to the upper side of the beams 2″ from their front ends. The thick part of these blocks should be facing toward the nose of the frame.

ELEVATOR. As the elevator has a sweepback of 1¾″, it must be built in two parts, or halves. The leading edge spar is ⅛″ x ⅛″ x 15″ long, and is cut from balsa wood. When this piece has been shaped, as shown under "Elevator Rib," it must be cut into two 7½″ lengths. The trailing edge of the elevator consists of two lengths of balsa wood. Cut these two pieces 1/16″ x ⅛″ x 6″ long. Five sheet balsa ribs are now provided. Cut these from 1/32″ sheet balsa in the form shown in Plan 1 under "Elevator Rib."

The inner elevator spar is 1/16″ x ⅛″ x 15″ long balsa. As the wing must be built by halves, this spar must be cut into two equal lengths of 7½″ each. Make a full-size drawing of the elevator, and place each part in its proper location on your plan. Cement the inner elevator spar of one half to its two ribs, leaving the center rib until later. Notch the front end of the ribs and cement the leading edge spar to them, which should be followed by cementing the trailing edge spar. Bend two 1/32″ split bamboo elevator tips over a flame, as shown in the plans. Complete one half of the elevator by cementing one of the tips to the ends of the spars.

The second half of the elevator is assembled in the same manner. The elevator is given its 1″ dihedral angle. Place the two halves together on a flat table. Holding them to the table at their joints, lift the tip of one of the halves off the table 2″, and while in this position, cement the joints together. (See Chapter 7, "Wing Assembly.") The center rib is now attached.

The elevator is covered on both sides with Japanese tissue. Coat the under side of all ribs, spars, and wing tips with clear dope or banana oil, and press the paper in place. Follow this by covering the top in the same manner. (See Chapter 7, "Wing Covering.") The elevator should be water-sprayed or steamed to tighten the paper.

WING. The wing is constructed much in the same manner as the elevator. As it, too, has a sweepback, it must be built one half at a time. Cut the leading edge spar from balsa wood measuring ⅛″ x ⅛″ x 30½″ long. An inner wing spar is cut from the same wood 1/16″ x ⅛″ x 30½″ long. Cut these into two equal lengths of 15¼″. Shape the leading edge spar, as shown in Plan 1 under "Wing Section." From 1/16″ sheet balsa, cut the nine wing ribs to proper shape and size, as shown under "Wing Rib." Remove excess material from the center of each to reduce weight. Notch their front ends to fit the form of the leading edge spar.

Draw a full-size copy of the top view of the wing, as shown in Plan 1. Lay each piece in its proper place on the drawing. Building one half at a time, the various pieces are now assembled. Space the ribs on the inner wing spar at their correct positions and cement in place. Do not cement the center rib at this time.

The leading edge spar is attached to the front ends of the ribs with cement. A $\frac{1}{16}''$ x $\frac{1}{8}''$ x 25″ long balsa trailing edge spar is now cut. While this requires no shaping, it must be cut into two equal lengths of $11\frac{1}{2}''$ each. When completed, cement one half to the trailing ends of the ribs of the half wing on which you are now working.

Two $\frac{1}{32}''$ x $\frac{1}{32}''$ split bamboo wing tips are formed by heating over a flame. (See Chapter 3, "Bamboo.") When completed, one of these tips should be cemented in place on the wing half you are assembling by cementing its ends to the ends of the leading and trailing edge spars.

When one half of the wing has been completed, the other half should be assembled in the same manner. The structure should now fit the full-size drawing of the plan when placed on it. When in this position, the necessary wing dihedral is obtained. (See Chapter 7, "Wing Assembly.") The center rib is now cemented in place. Cover the wing on both sides with Japanese tissue. Spray the covering with water and when dry, give it a thin coat of dope or banana oil. A wing stabilizer is bent from $\frac{1}{16}''$ split bamboo and attached to the center rib of the wing. Cement one end to the trailing edge spar at the trailing end of the center rib. Bring the bamboo forward and up to a point 2″ above the leading edge spar, bend it sharply, and bring it down to this spar at the leading end of the center rib, where it is cemented in place.

A small $\frac{1}{16}''$ split bamboo brace is inserted with cement between the bamboo outline and the leading edge spar, as shown in Plan 1. Cover the stabilizer with Japanese tissue on one side only. Note this in the plans under "Stabilizer." This completes the wing, which requires no clips as it is held with rubber bands. (See "Assembly.")

PROPELLERS. Two propellers are necessary for this model. They are carved from 1″ x $1\frac{1}{4}''$ x 9″ propeller blocks of balsa wood, as shown under "Propeller." One of these is a right hand, while the other is a left hand propeller. (See Chapter 9, "Right and Left Hand Propellers.")

When viewed from the rear, as shown in Fig. 48 in Chapter 9, the right hand propeller turns clockwise, while the left hand turns counter-clockwise.

In other words, both propellers turn up and out, when viewed from the rear of the model.

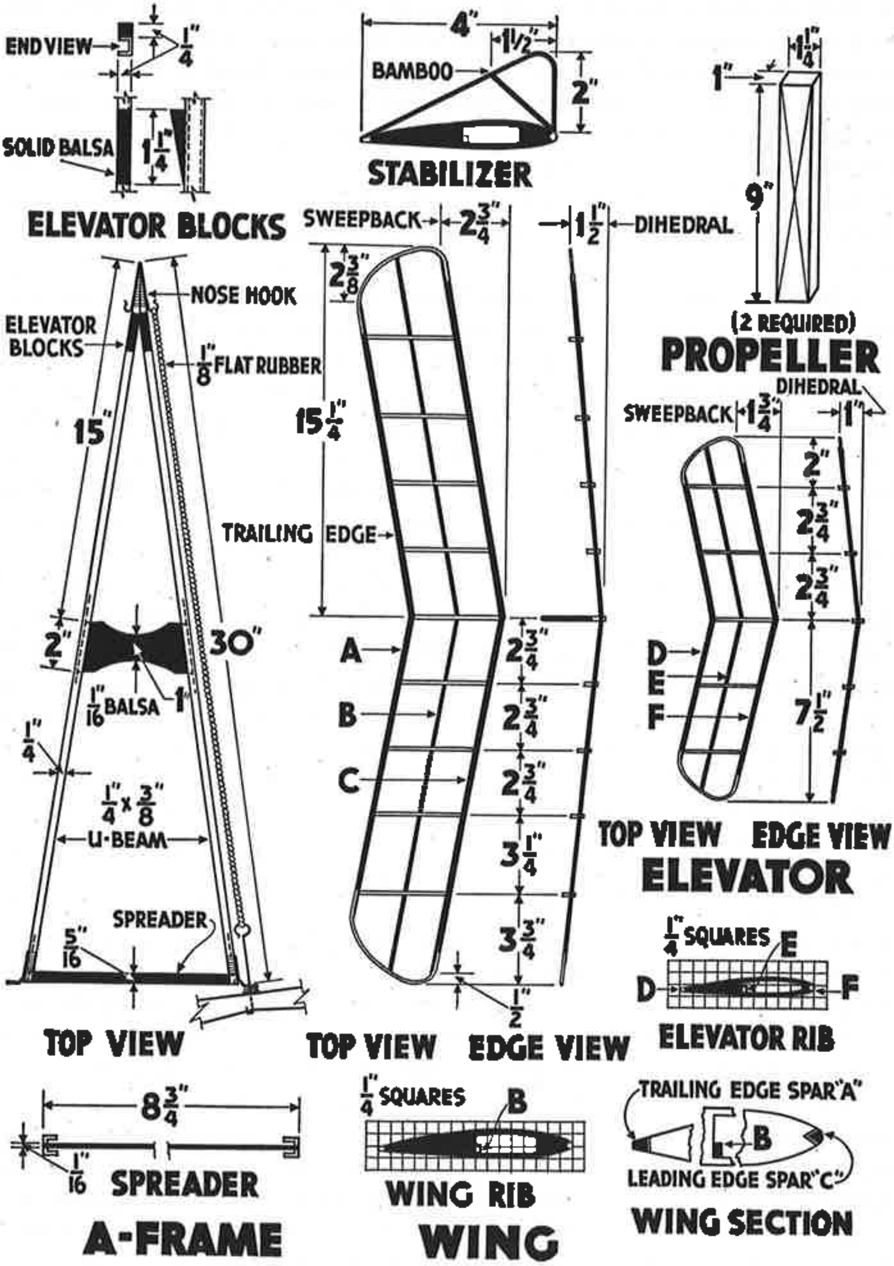
When the carving has been completed, propeller shafts are bent from No. 14 piano wire. (See Chapter 6, "Propeller Shafts.") As these are pusher propellers, the shafts should be inserted through the hubs of the propellers so that the hooks of the shafts are on the convex side of the blades. Remember that the convex side of the blade always leads on both tractor and pusher models.

LANDING GEAR. The floats are extremely important on any rise-off-water model. Those shown for this model have been designed to give the least resistance in the water, a minimum of weight, and quick rising. Floats should be large enough to displace water weighing at least three times the weight of the model, when they are fully submerged. When this is done, they will carry the model while riding high on the water. If the floats are smaller, the weight of the model will sink them deeper into the water, which will retard forward motion, making the take-off difficult if not impossible. The "V" bottom form also assists the floats to cut through the water much in the manner of a boat, giving rapid rising, keeping the course of the model in a straight line, and assisting in landing.

Their construction is simple, but the beginner should carefully follow these directions when making his first floats. The trailing end of the model has a single float, while the leading end is equipped with a duplicate pair. The single float is necessarily larger than the front floats, but the construction is practically the same.

The rear float is made first. For this the builder will require one 1/16" sheet balsa former, one balsa rear brace, and three lengths of 1/16" square bamboo. Draw a full-size plan of the former on a sheet of paper, which has been ruled with 1/4" squares. See Plan 2. Trace this drawing on a piece of 1/16" thick sheet balsa. Cut the former from the balsa sheet, remove excess material from its center, and cut the five necessary 1/16" x 1/16" notches to accommodate the split bamboo lengths. The second balsa piece required in the construction is 1/16" x 1/4" x 1 3/4" long. Four notches should be cut on the top of this length to accommodate the top bamboo stringers, while one is cut on the bottom to fit the bottom, center, bamboo stringer.

Study the plan of the rear float. Three bamboo lengths, marked 1, 2, and 3, are required to complete the necessary materials for this job. The longest stringer (2) starts at one end of the rear balsa brace, where it is cemented into the notch cut for it. From this point it extends 3 1/4" forward to the side of the balsa former, where it is cemented into the side notch of the former. It is then bent in a wide curve 1 3/4" in front of the former,



R.O.W. TWIN-STICK PUSHER PLAN 1

brought around, cemented to the opposite side notch of the former, and back to the opposite end notch of the rear balsa brace. The second stringer is attached in the same manner, although its forward bend is a sharper one than the first stringer. When in place, this second stringer is cemented to the first at the point of their curves where they meet. Note that while the first stringer attached (2) remains straight, as shown in the side view, the second stringer (1) must be bent in a curve from the rear brace to the top of the former, and then down again to meet the first stringer at its forward point.

The third stringer (3) is a single length running in a curve from the forward point of contact of the first two stringers, through the bottom notch of the former, and on back to the bottom notch of the rear brace. When fully assembled, the float is covered with Japanese tissue, water-sprayed, and then given a single coat of dope. The struts used to attach this float to the model are of 1/16″ square bamboo. Three are used. These struts can be cemented to the float and the A-frame, or they can be attached by using 1/16″ diameter bushing eyelets, which can be purchased at any model supply house.

For builders carrying their models some distance the latter is recommended, as the floats can then be removed and the entire model carried as easily as any hand-launched type. If bushings are used, care must be taken when cementing them to the former of the float. Small notches are cut in the top of the former, directly over the stringer 3. These three notches are then coated with cement and the three eyelets set in them at their required angles. The middle one points to the spreader of the A-frame, while the two outer ones point toward the A-frame beams. When these are set in position and the first cement has dried, additional cement should be applied to bind them in one coating of cement. Allow an hour for drying.

Three eyelets are also used on the A-frame into which fit the other ends of the struts. One of these is located in the center of the spreader, while the two others fit into the beams of the A-frame 5″ from their trailing ends. To do this, make holes in the under side of the "U" beams, insert the eyelets into them, and apply cement. The ends of the struts should be tapered to allow them to enter the eyelets, but only enough to give a tight fit.

The duplicate pair of floats for the front of the model are made in the same manner as the rear one. Only two lengths of bamboo are necessary for each of these. The former and trailing edge have the same dimensions as the large rear float. Note, however, that the dimensions of these floats are smaller than the overall dimensions of the rear float. When completed, they are joined together by a 1/16″ square split bamboo length, as shown in the front view of the model in Plan 2. This piece is bent with a 1″ arch and is cut long enough to spread the floats 9¼″ apart. Each of these floats has one $\frac{1}{16}$″ square bamboo strut running from the float former directly over the No. 1 stringer to a point on the "U" beam 12″ from the nose of the A-frame. They can be cemented or fitted with bushing eyelets, in the manner already described. A length of silk thread is used to strengthen this assembly on each side. Small hooks are bent from No. 6 piano wire and tied to each end of the thread, as shown. Before this is done, however, the thread should be passed through the tissue, around the top portion of the former, and out the other side. This can be done with a bent pin. At the points where the thread comes through the tissue, cement is applied to hold the thread in position. The hooks are then tied in place. One end of the thread is attached to the A-frame 5″ from the nose, while its other end is attached 16″ from the nose, as shown. The connection at the A-frame is made by similar hooks cemented in place on the beams. Both sides are connected in the same manner.

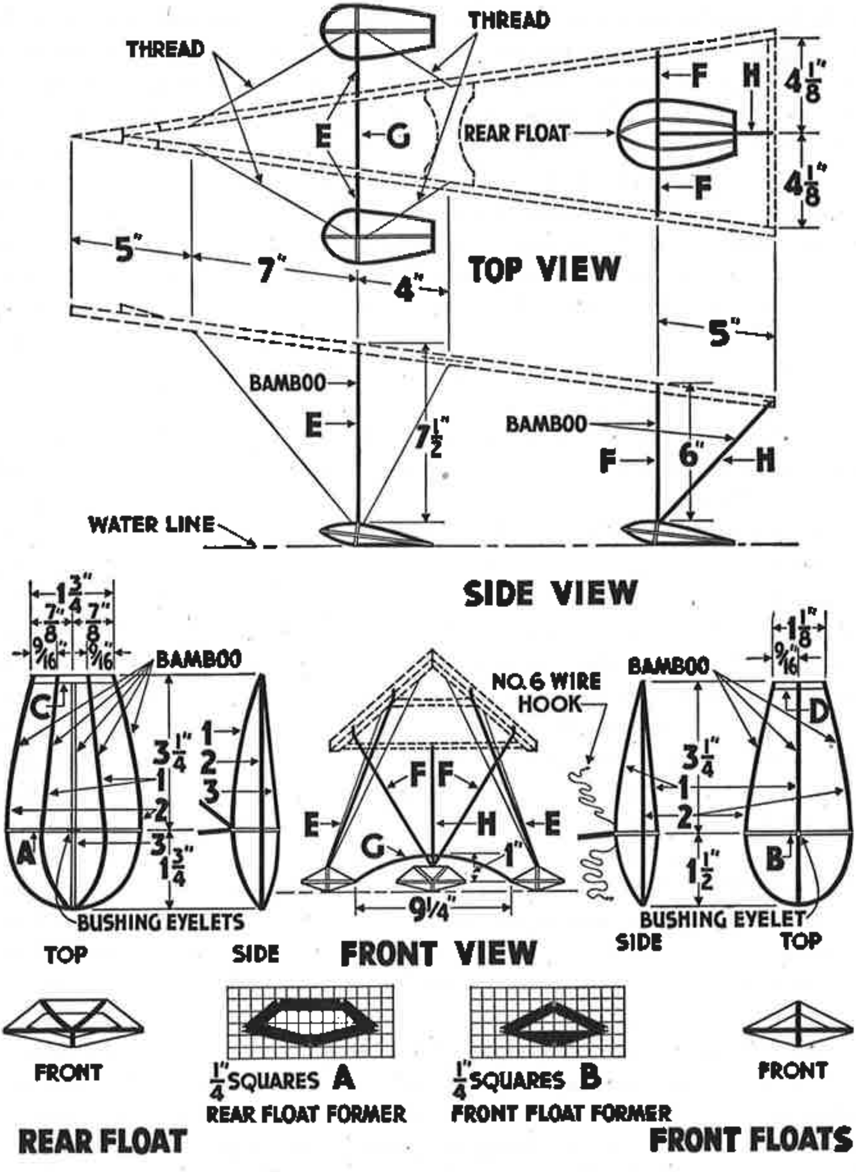
WATERPROOFING. As such models are bound to get wet, they should be thoroughly waterproofed before being flown. As the average dope is too thin for good waterproofing, a small quantity of cement should be mixed with the dope to give it thickness. The propellers should be given five coats of this mixture. After each coat has become thoroughly dry, the propellers should be carefully sandpapered, leaving the last coat untouched.

The entire A-frame should be treated in the same manner. The wing and elevator should not be treated with this mixture, as sandpaper cannot be used on these parts. Give each from three to five coats of clear banana oil to make them watertight. The floats should be given the same treatment, and tests must be made to see that these are especially waterproof.

ASSEMBLY. The wing and elevator are held with rubber bands. The leading edge of the elevator fits on the top of the small triangular blocks attached to the "U" beams near the nose, while the wing is located near the propellers. The elevator adjustment is practically stationary, but the wing must be adjusted by gliding tests before the motors are used.

One rubber band holds the elevator in place. Slip the band over the nose of the model and work the loop along the "U" beams to the point where the trailing edge of the elevator crosses them. Place the elevator in position on the "U" beams, bring the rubber band loop over the top of the elevator, and then slip the loop under the nose of the model. This will hold the elevator in place and at the same time allow it to be moved forward or backward as the flyer adjusts his model.

The main wing requires two rubber bands, both of which must be



R.O.W. LANDING GEAR

R.O.W. TWIN-STICK PUSHER PLAN 2

broken inasmuch as the closed ends of the A-frame prevent the bands from being passed over each beam. Break one of the bands, pass one end under the "U" beam, and bring the ends of the band together over the frame. Place the wing on the A-frame, bring the band strands over the top of the wing and under the "U" beam, where they are tied together. The other band is attached in the same manner.

The propellers are now assembled. Two small washers, which can be purchased at any model supply store, are placed on each propeller shaft. They are then passed through the holes in the propeller bearings, and the rubber motors are attached. For this model, six strands of 1/8" flat rubber are used on each propeller. As considerable slack is desirable, 180" of rubber should be applied in six strands for each motor. From No. 14 piano wire, bend two "S" hooks. (See Chapter 6, "'S' Hooks.") One end of these hooks is attached to the nose hook, while the loops of the rubber motor are passed over the other.

FLYING. Before winding the motors, glide the model to determine the best wing location. As the floats are delicate, this should be done over shallow water or deep grass, so that the landing will not harm them.

If the model stalls, the wing should be moved back on the A-frame, or if its glide takes the form of a dive, move the wing forward. Continue these gliding tests until a long, smooth, and gradual glide has been obtained. On the "U" beams, mark the wing location, so that when the model has been taken apart, it can be assembled again without the necessity of tests.

The motor should be wound with an egg-beater winder to about four hundred turns. Remember that each propeller must be wound in opposite directions, or down, out, and up, when viewed from the rear of the model. For the proper method of launching, see Chapter 16, "Correct Launching of R.O.G. Model," as this method also applies to R.O.W. types.

CHAPTER 29

TAILLESS TRACTOR

ALL experienced model airplane builders enjoy attempting the construction of new types of aircraft. The "tailless" tractor is presented here—not so much to show how it can be done as to prove it possible, and in the hope that the reader will experiment with it in an effort to develop this type of model. Simplicity is the main advantage of the model, as it is a single-stick tractor without the usual elevator, the lack of which is corrected through the specially designed wing.

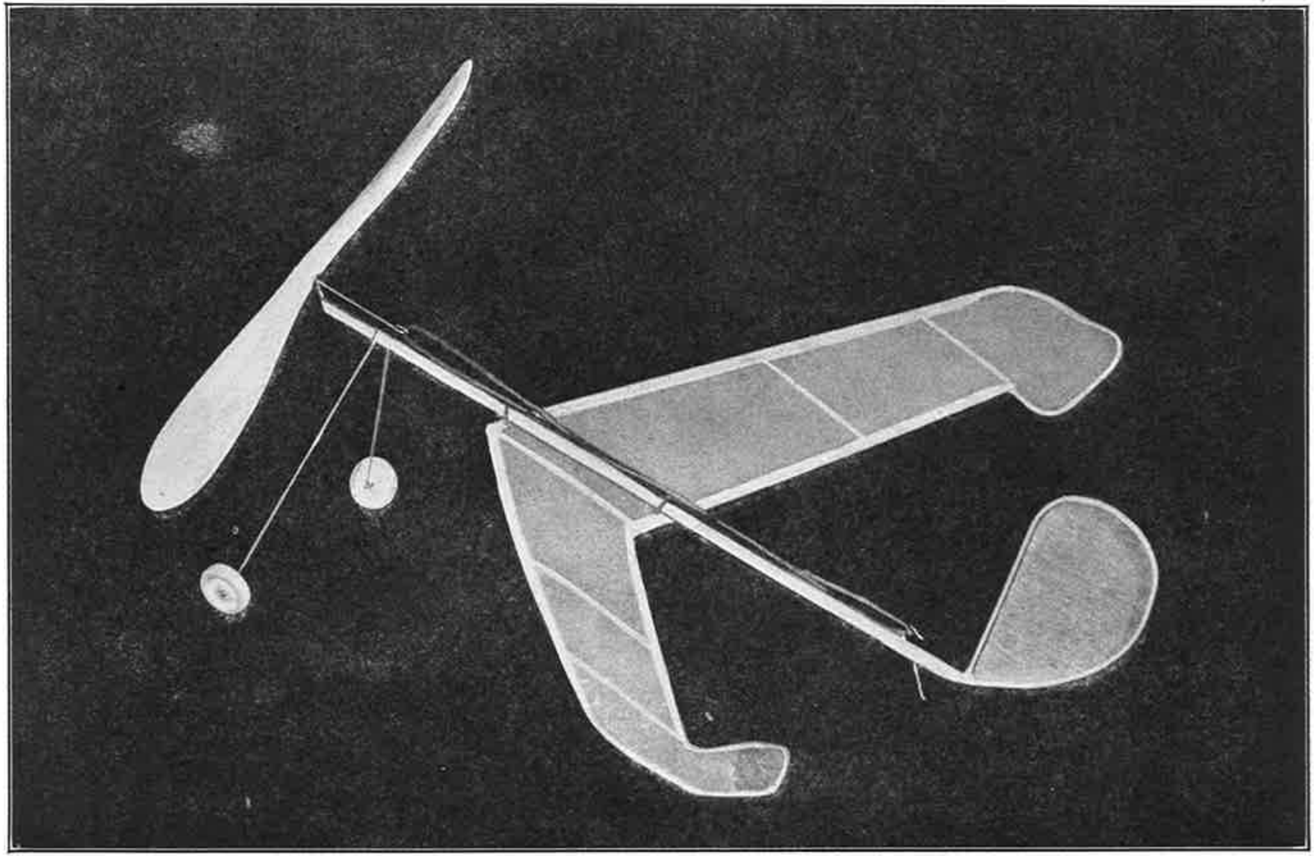
MOTOR STICK. This consists of a balsa stick 1/16" x 1/8" x 8" long. Its rear end is left square, while the front or nose of the stick has a 1/8" bevel, as shown. A lightweight propeller bearing is cemented on the 1/16" top edge of the motor stick at its front end, while a rear or end hook is attached in the same way at the rear end. These fittings may be bent from No. 8 piano wire. (See Chapter 6, "End Hooks" and "Propeller Bearings.")

RUDDER. One piece of 1/32" split bamboo forms the outline edge of the rudder. This is bent to proper shape by heating. (See Chapter 3, "Bamboo.") Cement the ends together. Cover the structure with Japanese tissue on one side only, holding it tightly with dope. (See Chapter 7, "Wing Covering.")

LANDING GEAR. This consists of one length of No. 8 piano wire bent to shape, as shown in the plans under "Landing Gear." Two wheels are cut from 1/32" sheet balsa. These should be 3/4" in diameter. After they are threaded on the axles, the axles are bent up to keep them in place.

PROPELLER. The propeller is carved from a 1/2" x 3/4" x 6" balsa propeller blank. (See Chapter 9, "Carved Propellers.") A propeller shaft of No. 8 piano wire is bent to form and inserted through the center of the hub. It should then be bent over, and a drop of cement applied on the bend to hold the shaft in position.

MOTOR. The motive power is obtained through a length of 3/16" flat rubber. This should be long enough to allow a slack of 1/2" between the hook of the propeller shaft and the rear hook. The rubber is held in place by piercing the ends with the hooks.



TAILLESS TRACTOR

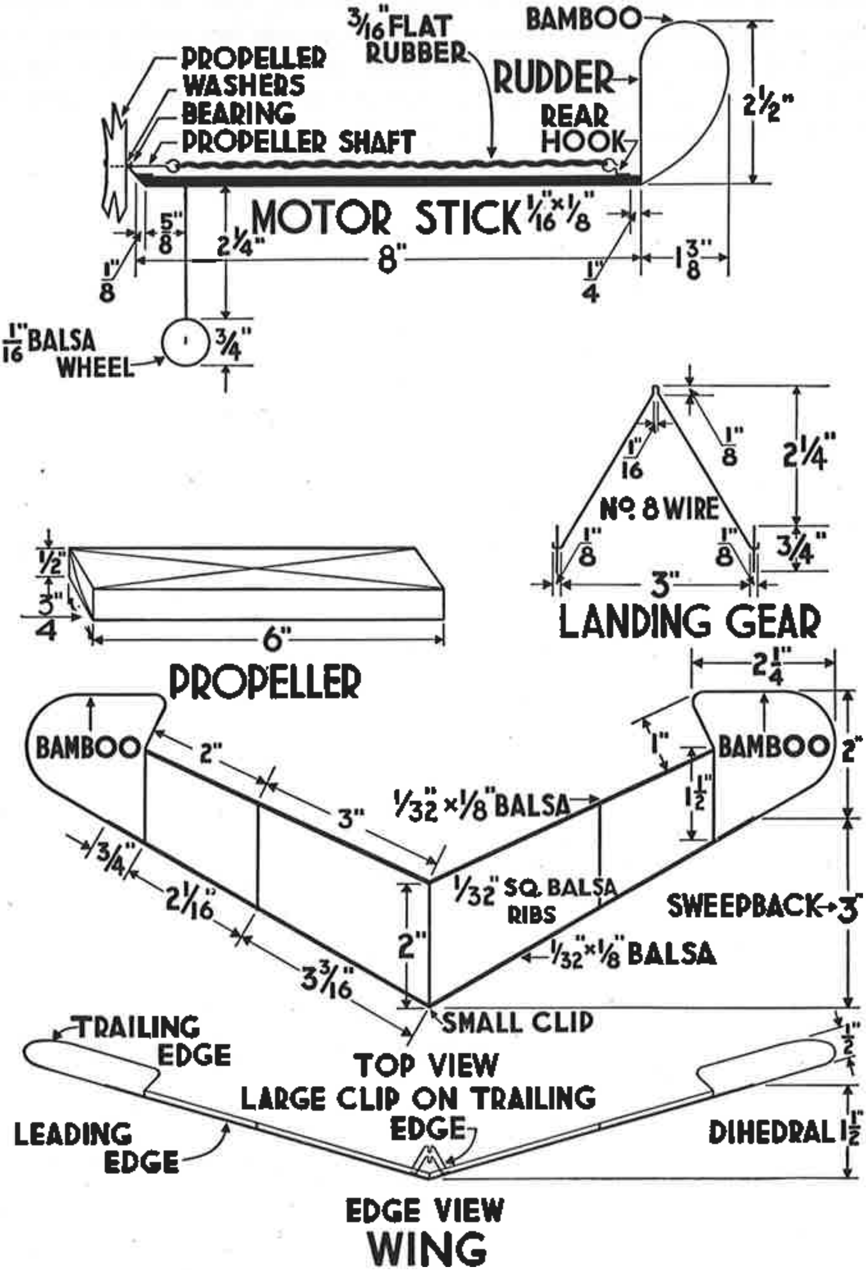
WING. The leading edge spar of each half of the wing is constructed from a 1/32" x 1/8" x 6" long piece of balsa, while the trailing edge spars are 1/32" x 1/8" x 5" long. The five ribs are of 1/32" square balsa wood and are given a slight curve, as shown.

Draw a full-size working layout of one half of the wing exactly as given in the plans. Bend a length of 1/32" split bamboo over a flame to the form shown for the tip. Cut out the leading and trailing edge spars and the ribs. This half of the wing is now assembled on the layout drawing by placing each part of it in its proper position.

Cement the ribs and tip to the balsa spars. When attaching the tip, see that the bamboo length, which is attached to the trailing spar, is at right angles to it. At this point, construct the other half of the wing by following the same directions and using the same full-size layout drawing.

The sweepback of the wing is gained through the difference in length of the leading and trailing edge spars, so that when the two halves of the wing are cemented together, they give the desired shape. The wing has a 1½" dihedral angle, which is obtained by cementing the two halves together. (See Chapter 7, "Wing Assembly.") The structure is now covered. Cut out a pattern of the wing from Japanese tissue, allowing about ¼" surplus material around all sides in order that the paper can be wrapped over the edges of the wing structure. Cover the wing on one side only—the top—and hold the covering in place with dope or banana oil. A close study of the plan, as well as the photograph, will show that the tips of the wing are turned up. This is now done. As shown in the plan, the trailing edges of the tips are ½" higher than the leading edges. This is done by heating the bamboo framework, but be careful not to burn the paper. When completed, the wing is fitted with the usual wing clips, as shown in the plans. These are bent from No. 8 piano wire. The large clip is cemented to the center top of the wing on the trailing edge spar, while the small one is fastened to the leading edge spar. (See Chapter 6, "Clips.") The wing can now be water-sprayed or steamed. As it is of delicate construction, spray one half at a time, allowing it to dry thoroughly under weight before proceeding with the other half.

ASSEMBLY. Cement the rudder to the end of the motor stick, as shown in the plans. The landing gear is cemented or pressed in position on the motor stick ¾" from the front end of the stick, as shown. Slip the propeller shaft through the propeller bearing, and attach the rubber motor, as already instructed. The wing is attached in position to the under side of the motor stick, as shown in the photograph. Glide the model to obtain the correct



TAILLESS TRACTOR PLAN

position of the wing. If the glide results in a stall, move the wing slightly back, or if the model dives, move the wing forward. Test until a long even glide is obtained, and then wind the motor and send your "tailless" model on its maiden voyage. For the proper method of launching, see Chapter 16, "Correct Launching of R.O.G. Model."

CHAPTER 30

UMBRELLA-TAIL TRACTOR

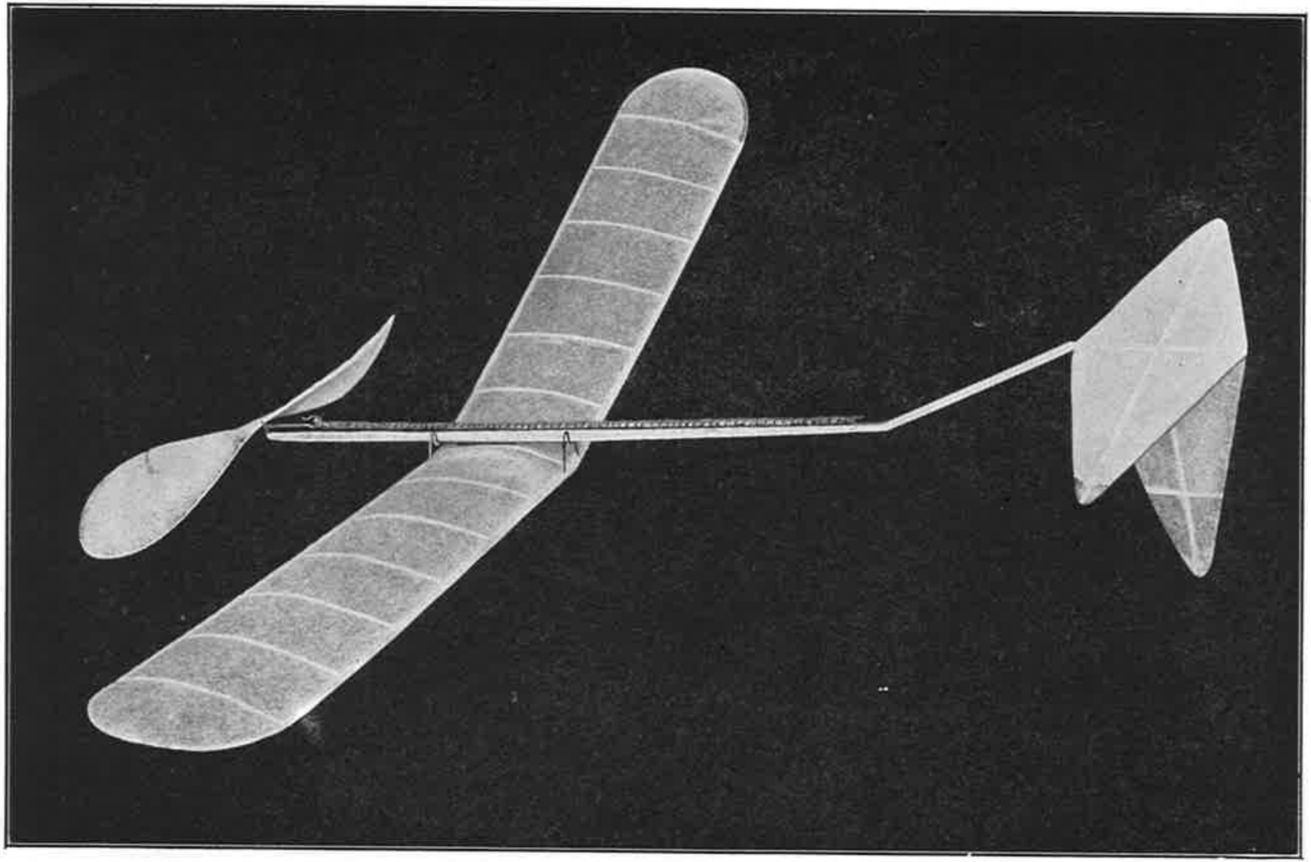
THIS type of model is a splendid endurance flyer. It is similar to other stick tractors, except for the peculiar form of its tail. As can be seen in the plans and photograph, the tail unit is connected to the motor stick by means of a tail boom, which extends up from and slightly to one side of the motor stick. As with all light endurance models, its construction is most delicate, requiring careful adjusting and handling for proper flight results.

FUSELAGE. This model has its length made up of three different parts, the motor stick, the tail boom, and the center spar of the elevator. The motor stick on such models can be hollow, if extreme lightness is desired, or it can be cut from a solid length of balsa. (See Chapter 12, "Motor Sticks.") The latter form of motor stick is used on the model given here. It consists of a 15″ length of balsa 1/8″ x 1/4″ at its center and tapering off to 1/8″ x 1/8″ at both ends. Note this in the side view of the plans. From No. 6 piano wire, the usual rear or end hook and can hook are bent and then cemented in place, as shown in the plans. A regulation propeller bearing is made or purchased, and cemented to the front end of the stick. (See Chapter 6, "Propeller Bearings.")

The tail boom consists of a 5″ length of 1/8″ x 1/8″ balsa. Note this in the plan shown by F. Do not cement this in place on the motor stick at this time.

ELEVATOR. The elevator consists of two lengths of balsa wood. The short piece C is 1/8″ x 1/8″ at the forward end and tapers to 1/8″ x 1/16″ at the rear end. It is 3 1/2″ long, and not only forms the center cross brace of the elevator, but also the top brace of the rudder. The second length of balsa used for the elevator is shown in the plan by E. It is 1/32″ x 1/16″ x 9 1/2″ long. This second piece is cemented over the first length at right angles to it, and exactly over its center point. Japanese tissue is cut to the proper elevator shape, as shown in the plans, and attached to these spars with clear dope or banana oil. Only the top side of these is covered, and no edging is used for the elevator.

RUDDER. The rudder extends down from the short spar of the ele-



UMBRELLA-TAIL TRACTOR

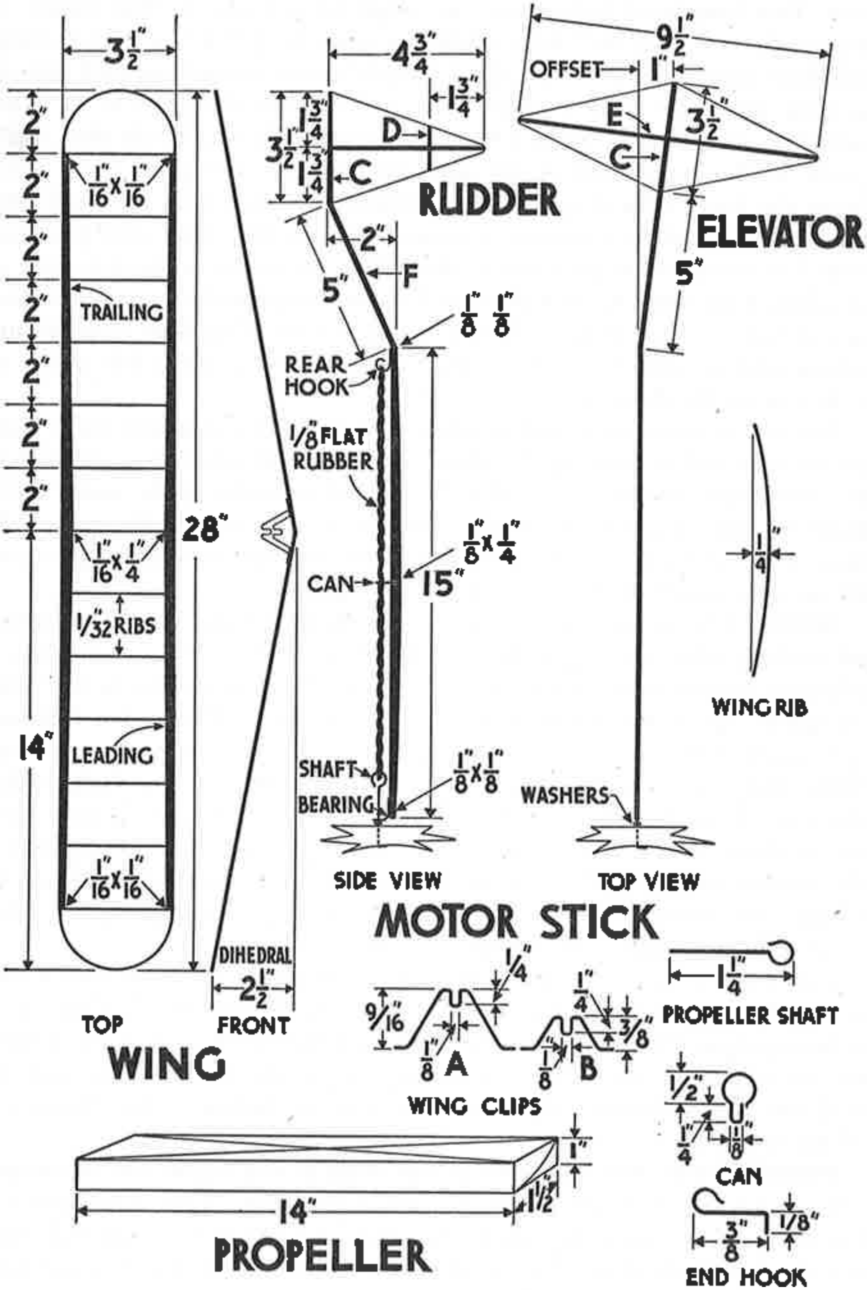
vator. Two lengths of balsa wood are required to make it. The longer of these is $1/32''$ x $1/16''$ x $4\frac{3}{4}''$ long, while the other is $1/32''$ x $1/16''$ x $1\frac{1}{2}''$ long. This short spar is cut into two equal lengths and cemented on each side of the long spar $1\frac{3}{4}''$ from its lower end, as shown in the plan by D. This assembly is cemented to the spar C in its center, as shown. To do this, apply cement to the upper end of the long rudder spar and press it in place against the lower edge of spar C. This rudder spar should be perpendicular to spar C. The rudder structure is covered on one side only with Japanese tissue. Cut the tissue to the form of the rudder, as shown in the side view of the plans. Coat spars C and D, as well as the long rudder spar with clear dope or banana oil, and press the paper in place on them. Note that no supporting edge around the rudder is used, but that the paper is left as cut, as in the case of the elevator.

The tail boom is cemented in place to the end of the motor stick. Note that its rear end extends up 2″ above its front end, which is cemented to the motor stick, and that it is offset 1″ toward the right of the motor stick. When dry, the elevator and rudder assembly is cemented to the end of the boom. The $1/8''$ x $1/8''$ end of spar C is cemented to the boom F. When doing this, see that spar C is parallel to the motor stick.

WING. The wing is made in two duplicate halves. Cut the leading and trailing edge spars from balsa. These are $1/16''$ x $1/4''$ at their centers and taper toward both their ends to $1/16''$ x $1/16''$. They should be 24″ long and when completed should be cut in half to give 12″ lengths. Thirteen $1/32''$ square balsa ribs are cut and cambered, as shown in the plans under "Wing Rib." Cement the ribs in place between the leading and trailing edge spars. Complete the assembly by bending two $1/32''$ split bamboo wing tips, as shown, and then cement them in place. (See Chapter 3, "Bamboo.") The wing is now ready to have its halves assembled together. Cement the leading and trailing edge spars together, at the same time giving the wing a $2\frac{1}{2}''$ dihedral angle. (See Chapter 7, "Wing Assembly.")

Cover the wing on its upper side only with Japanese tissue. (See Chapter 7, "Wing Covering.") Two wing clips are bent from No. 6 piano wire, as shown under "Wing Clips." These are cemented to the top of the leading and trailing edge spars. Place the large clip on the trailing edge and the small one on the leading edge. Test the wing for balance. (See Chapter 7, "Wing Assembly.")

PROPELLER. The propeller is cut from a 1″ x $1\frac{1}{2}''$ x 14″ balsa propeller blank in the standard manner. (See Chapter 9, "Carved Propellers.") The blades of this propeller should be sandpapered until so thin that light will show through them. A propeller shaft is bent from No. 8 piano wire,



UMBRELLA-TAIL TRACTOR PLAN

as shown under "Propeller Shaft." Thrust it through the hub of the propeller, bend it around, and pull the end of the shaft into the face of the hub. A drop of cement at this point will hold it in place. Two light brass washers should be used on the shaft between the propeller hub and the propeller bearing.

MOTOR. This consists of two strands of 1/8" flat rubber, and should be cut long enough to allow about 1" of slack when in place. Obtain a 30" length of this rubber, and tie its ends together. Assemble the propeller by slipping its shaft through the hole in the propeller bearing, and loop the rubber motor over the hook. The other end of the rubber is placed over the end hook, after being placed through the can hook.

ASSEMBLY. As all parts of the model with the exception of the wing have been assembled as made, we have only to place the wing on the model to complete it. When in place and before attempting motored flight, test for correct wing position by gliding the model. Keep adjusting the wing forward or backward until a long, even glide is obtained. When the model glides properly, wind up the motor for its first flight. Do not wind the motor to capacity until short flights have been made, so that all wing, elevator, or rudder adjustments may be made before endurance flights are attempted. For the proper method of launching, see Chapter 16, "Correct Launching of Single-Stick Tractor."

CHAPTER 31

ALL-IN-ONE MODEL

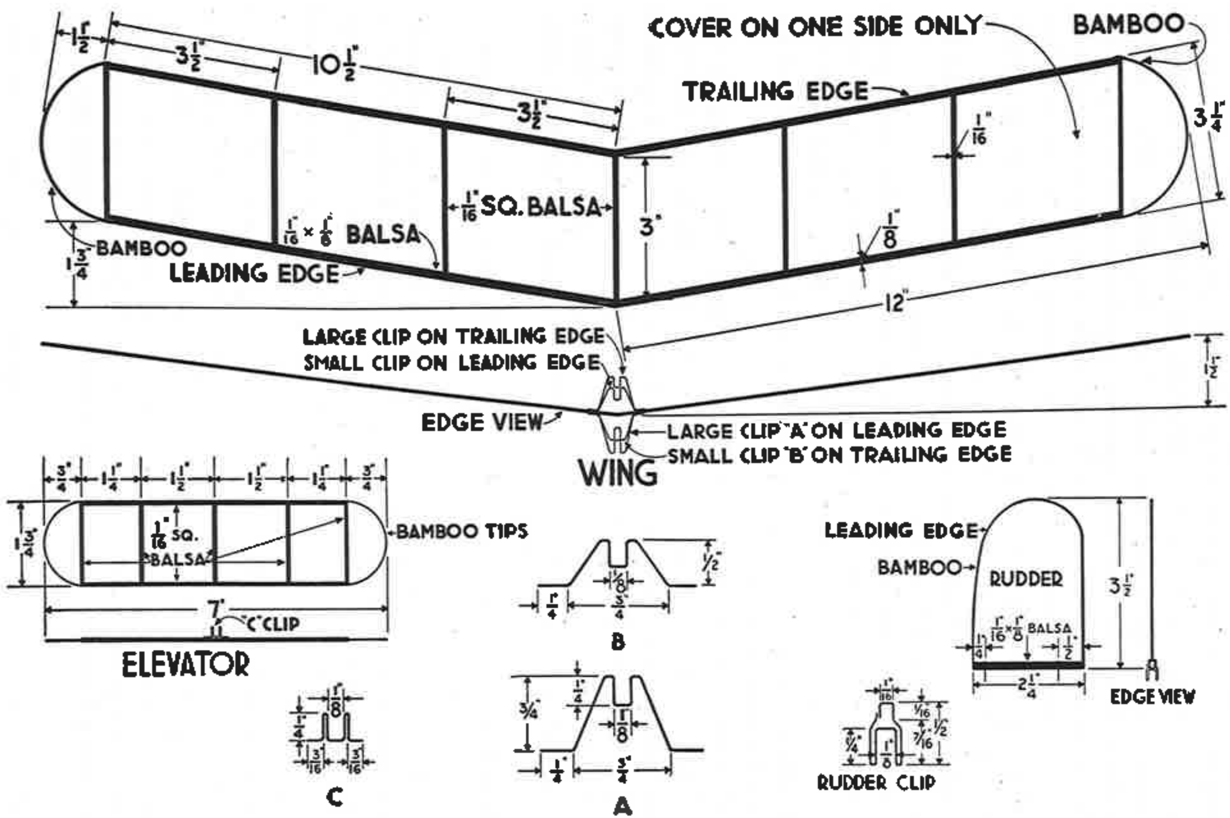
THERE are fifteen different types of model airplanes used for endurance flights. These are divided into three classes, the stick tractors, the stick pushers and the fuselage models. There are five of each of these three classes: the hand launched; the R.O.G.—rise-off-ground; the R.O.W.—rise-off-water; 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.")

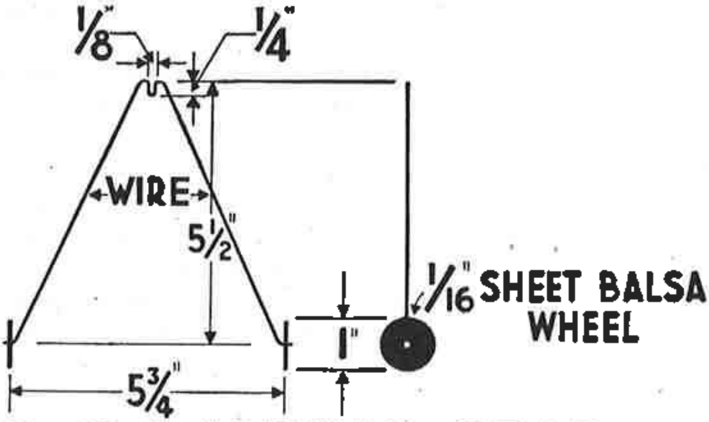
Four wing clips, two large and two small, are bent from No. 6 piano wire, as shown in Plan 1 under A and B. These are cemented to the leading and trailing edge spars of the wing directly over their joint, as shown. Two are placed on top and two under them on the under surface of the spars. (See Chapter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

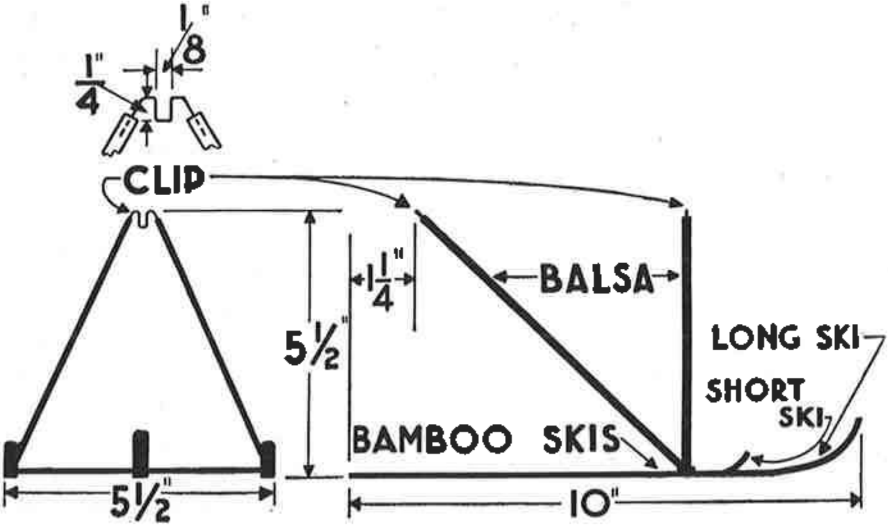
RUDDER. Cut one 2¼″ length of 1/16″ x ⅛″ balsa. Bend a length of 1/32″ split bamboo to form the outline of the rudder. Cement its ends to the ends of the balsa length. Cover with Japanese tissue on one side only. Bend two clips from No. 6 piano wire, as shown under "Rudder Clip" in Plan 1. Cement one 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 ⅛″ x ¼″ balsa. From No. 8 piano wire, bend an end hook, as shown in Plan 4 under D. Cement this on the ⅛″ 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

ALL-IN-ONE MODEL PLAN 2

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.

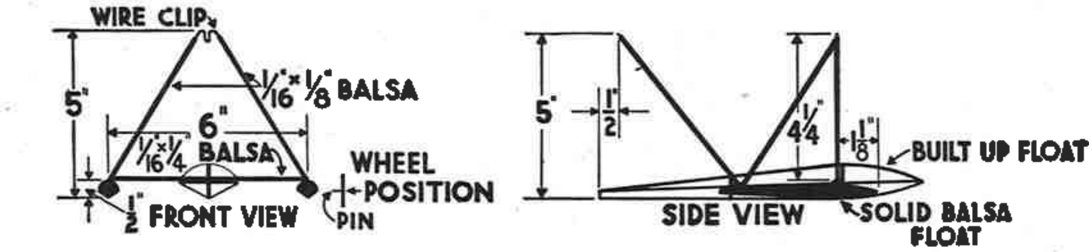
R.O.G. LANDING GEAR. This is bent from a length of No. 10 piano wire, as shown in Plan 2. The small notch at the top allows it to slip on the motor stick. Two 1" diameter wheels are cut from 1/16" sheet balsa. (See Chapter 10, "Solid Balsa Wheels.") These are fitted to the wire axles, which can then 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.

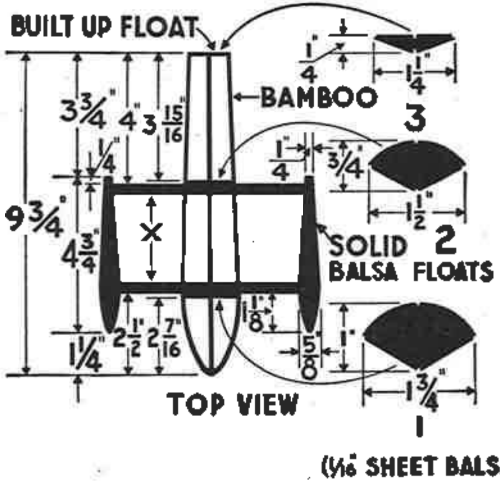
R.O.S. LANDING GEAR. Cut two 2½" lengths and one 10¼" length of 1/16" x ¼" bamboo. Bend the end of the long piece until its tip is 1" high, and bend the short pieces until their tips are ½" high. (See Chapter 3, "Bamboo.") These form the skis of the gear. Cut a 5½" length of 1/16" x ¼" balsa, which serves 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





FLOAT FORMERS

R.O.W.:AMPHIBIAN GEAR

ALL-IN-ONE MODEL PLAN 3

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 27/16″, 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.

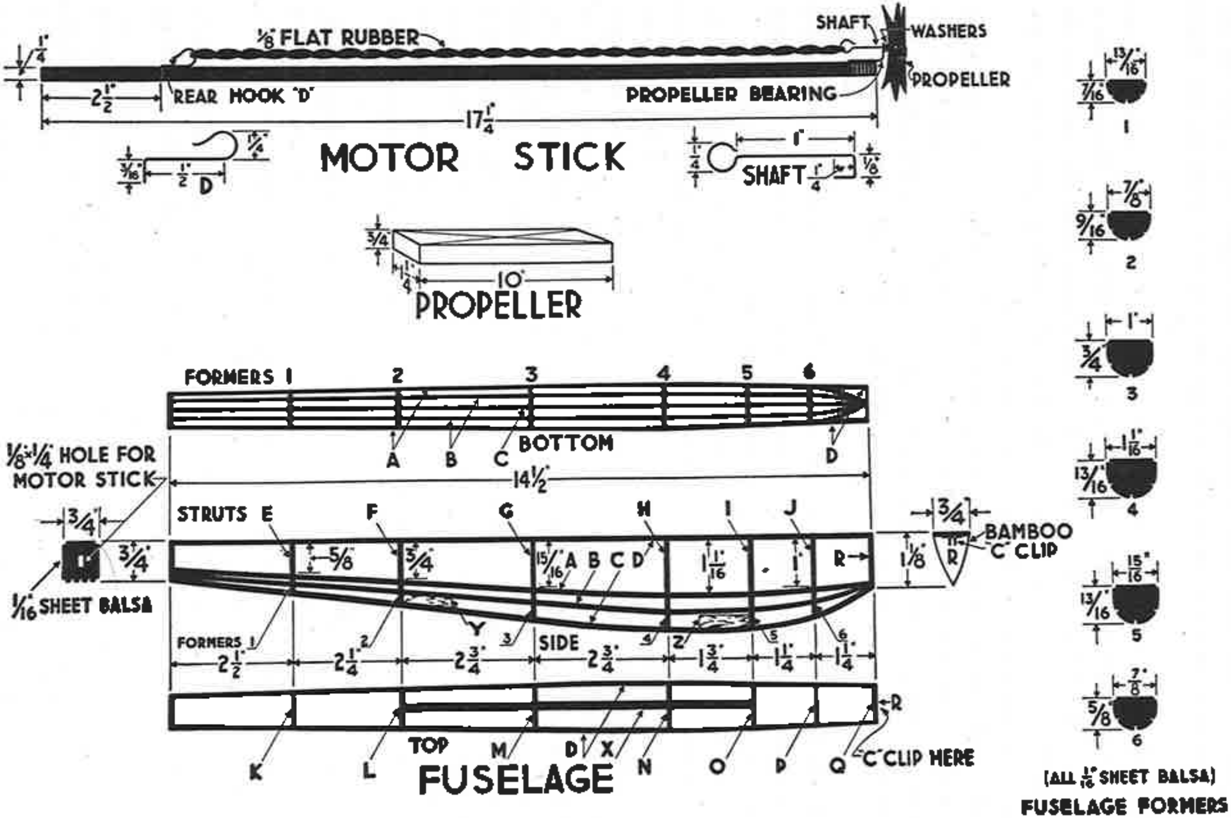
The second stringer starts from the top notch in former 3, passes through and is cemented to the top notches of formers 2 and 1, continues out to the bend of the side stringer, where it is likewise bent and cemented to the side stringer. It then passes through the bottom notches of the three formers,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

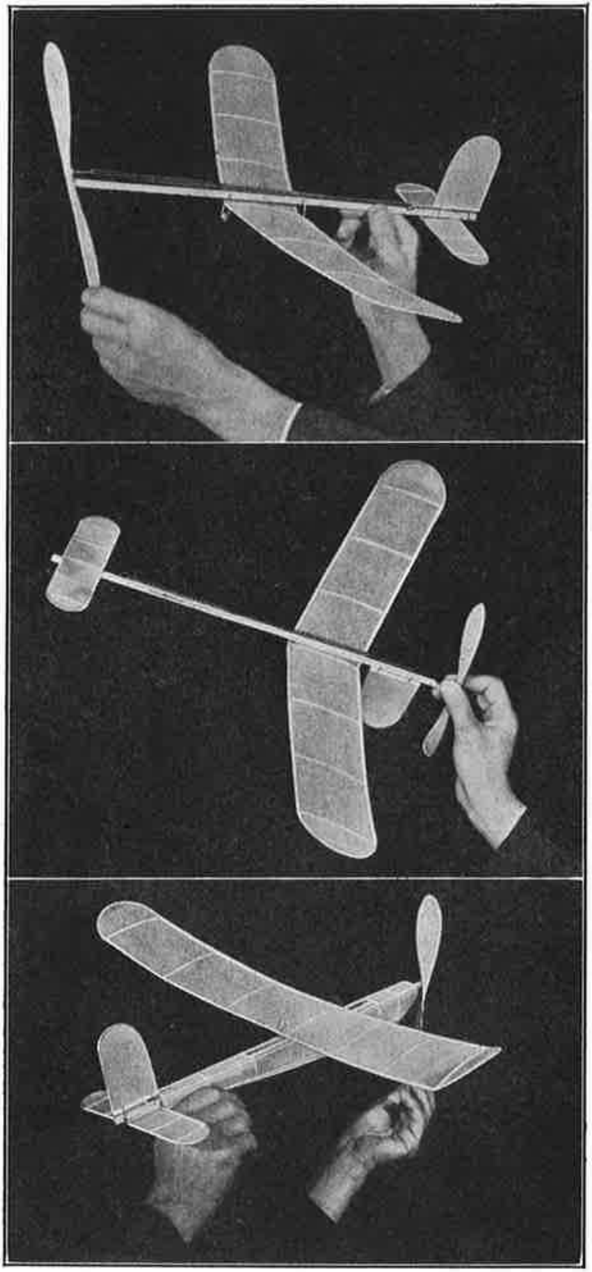
FUSELAGE. From 1/16″ sheet balsa, cut the six formers, as shown in Plan 4, under "Fuselage Formers." The fuselage is built in two sections, the half-round portion, which is obtained by the formers, and the oblong section, which is built on the half-round portion, and made of balsa stringers and struts.

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.

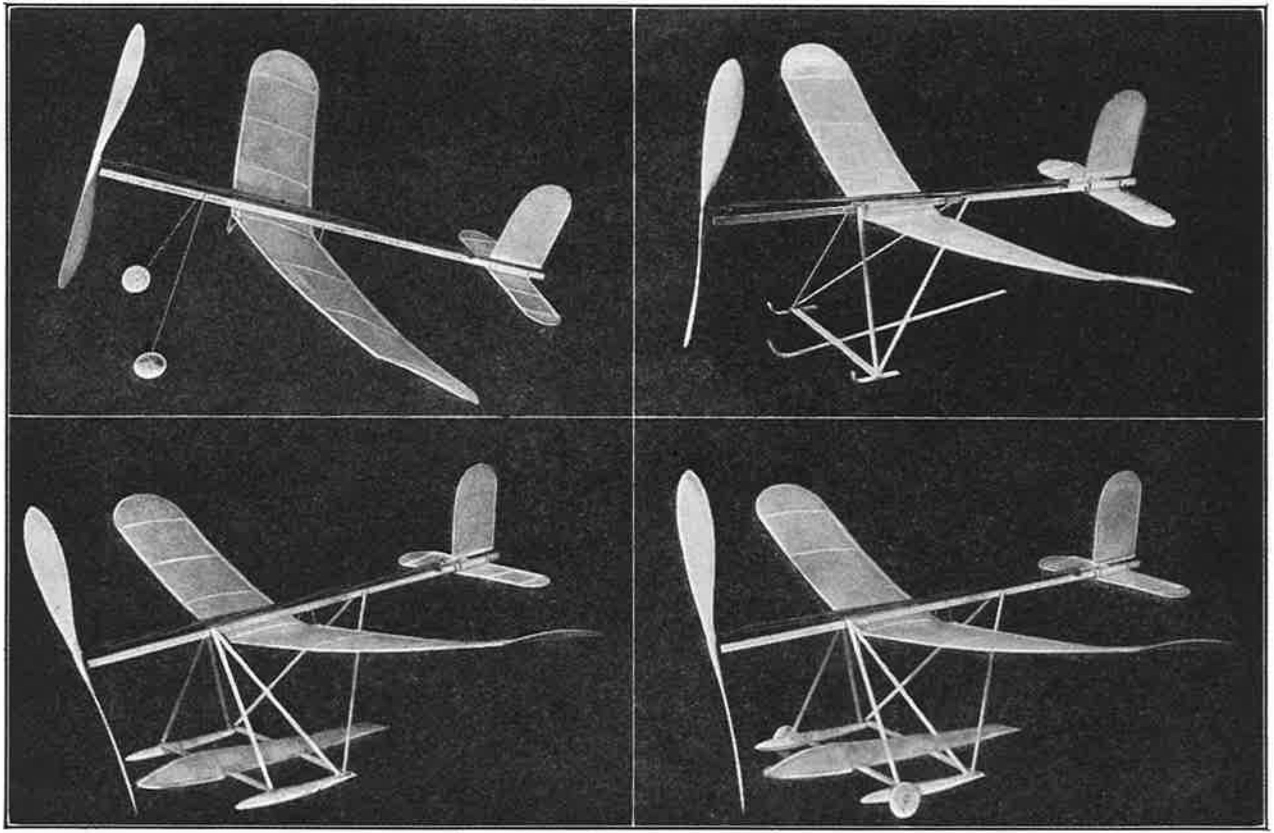
SINGLE-STICK TRACTOR (RISE-OFF-GROUND). Assemble as above. Attach R.O.G. landing gear about 2″ to 3″ back from front end of motor stick by forcing opening of clip on under side of stick.

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.

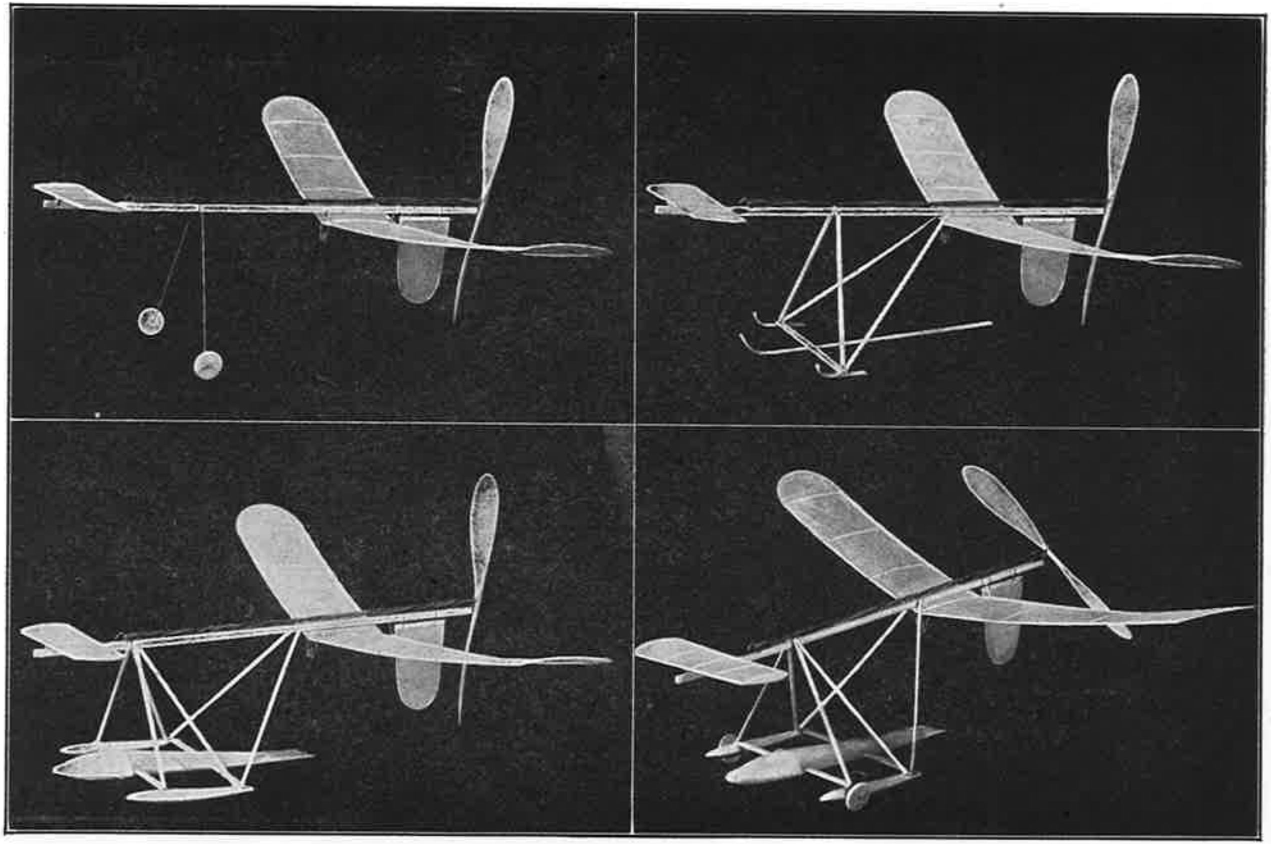
SINGLE-STICK TRACTOR (AMPHIBIAN). Same assembly as above. Add wheels to sides of small floats.

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



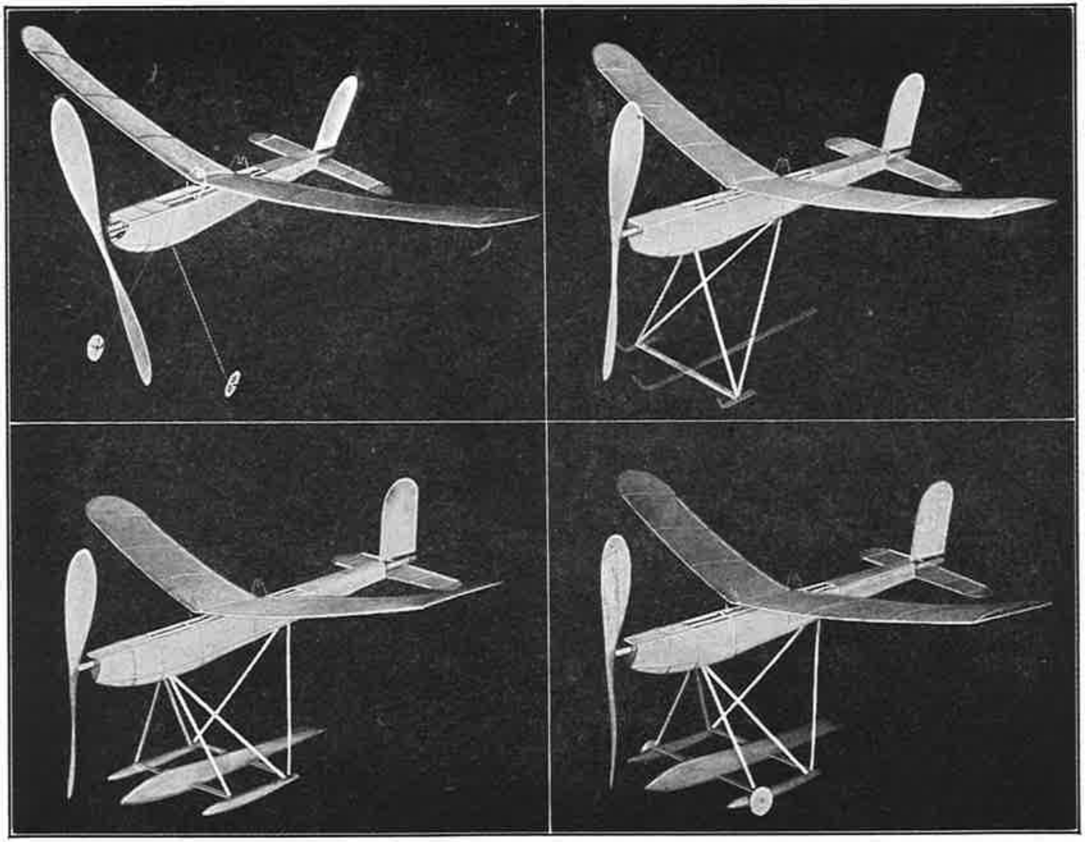
R.O.G. SINGLE-STICK TRACTOR R.O.S. SINGLE-STICK TRACTOR

R.O.W. 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

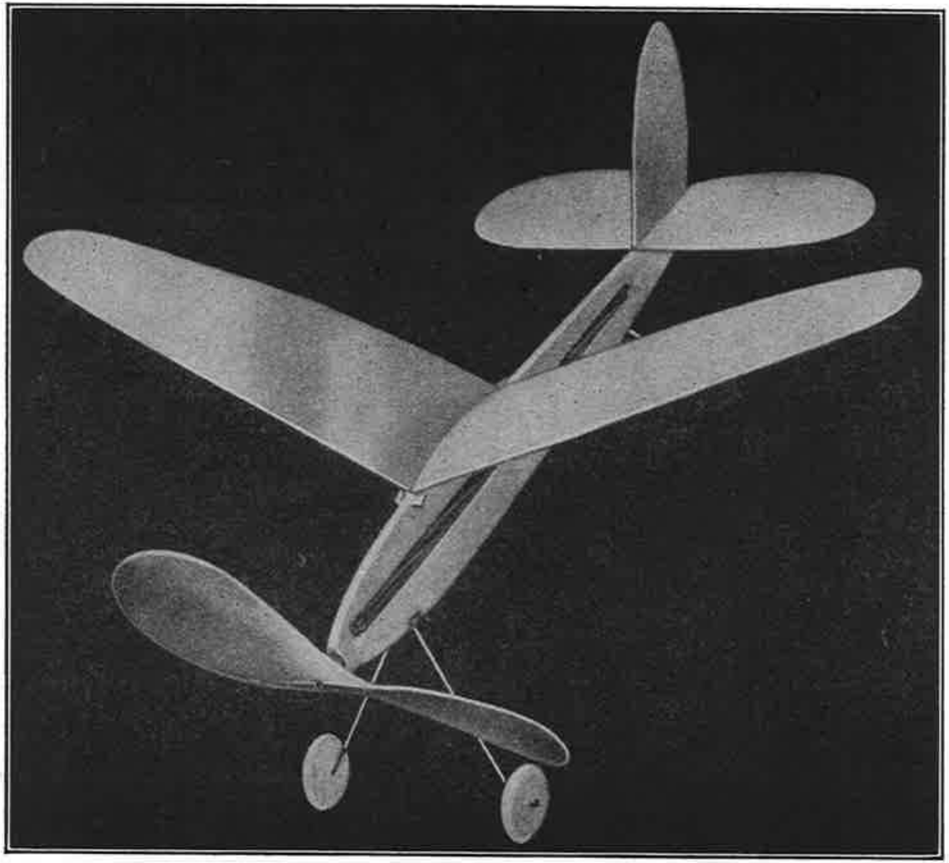
PROFILE SPEEDSTER

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.—⅛″ x 1¾″ x 11½″	—Sheet Balsa (Fuselage)
1 pc.—1/32″ x 3″ x 24″	—Sheet Balsa (Wing, Rudder, Elevator)
1 pc.—⅛″ x 1″ x 6″	—Sheet Balsa (Wing Ribs)
1 pc.—¾″ x 1 1/16″ x 6″	—Balsa Block (Propeller)
1 pc.—⅛″ x 16½″ long	—Flat Rubber (Motor)
1 pc.—.028 x 12″ long	—Music Wire (Fittings)
1 pc.—⅛″ 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 ⅛″ 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

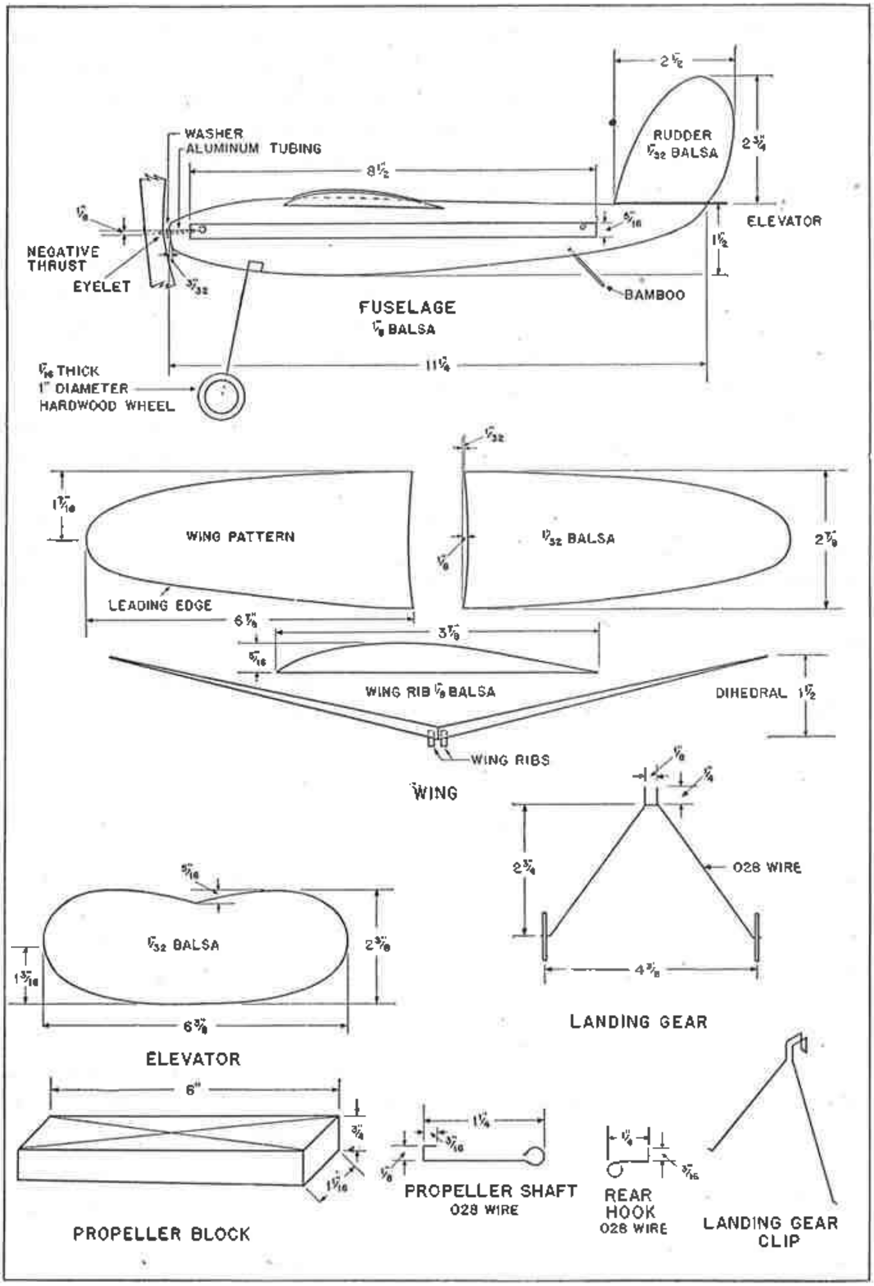
lel with the center one through these two points and from the front vertical line to the rear vertical line. This 5/8″ wide and 8½″ long area is cut out for the motor. Cut out the outline of the fuselage. Note that the nose of the fuselage, which is ½″ in length, is slanted so that its base is 3/32″ 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 1⅝″ behind the nose of the fuselage, as shown in the plan. Line up the wheels and see that they are 4⅜″ 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 2⅜″ wide and 6⅜″ 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 ⅜″. 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 2½″ wide and 2¾″ 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 ¾″ 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

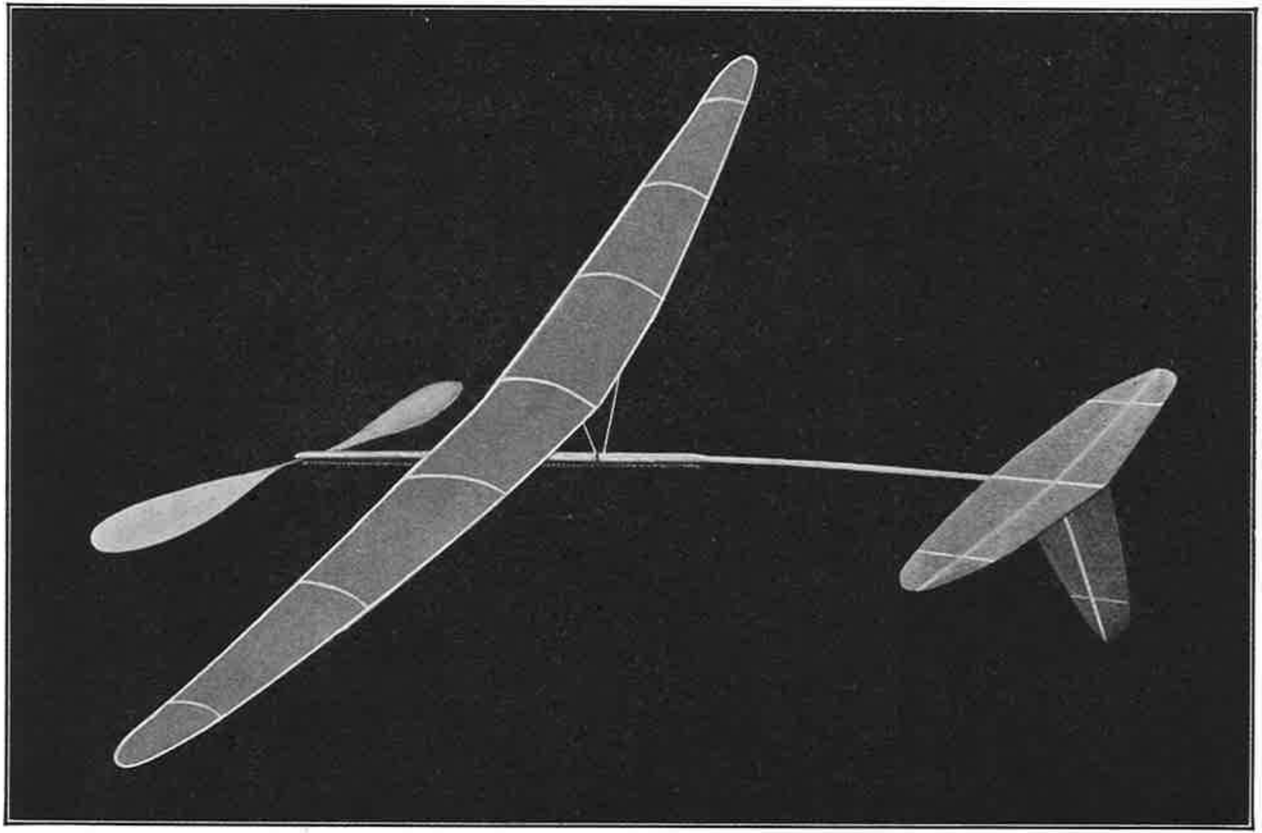
HERE is a perfectly designed and finely balanced single-stick tractor, especially built for indoor endurance competition. This superb example of model airplane construction is presented here through the kindness of its designer and builder, Edward H. Beshar, well-known model expert, who has flown it 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.



FIFTEEN-MINUTE CHAMPIONSHIP TRACTOR

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.

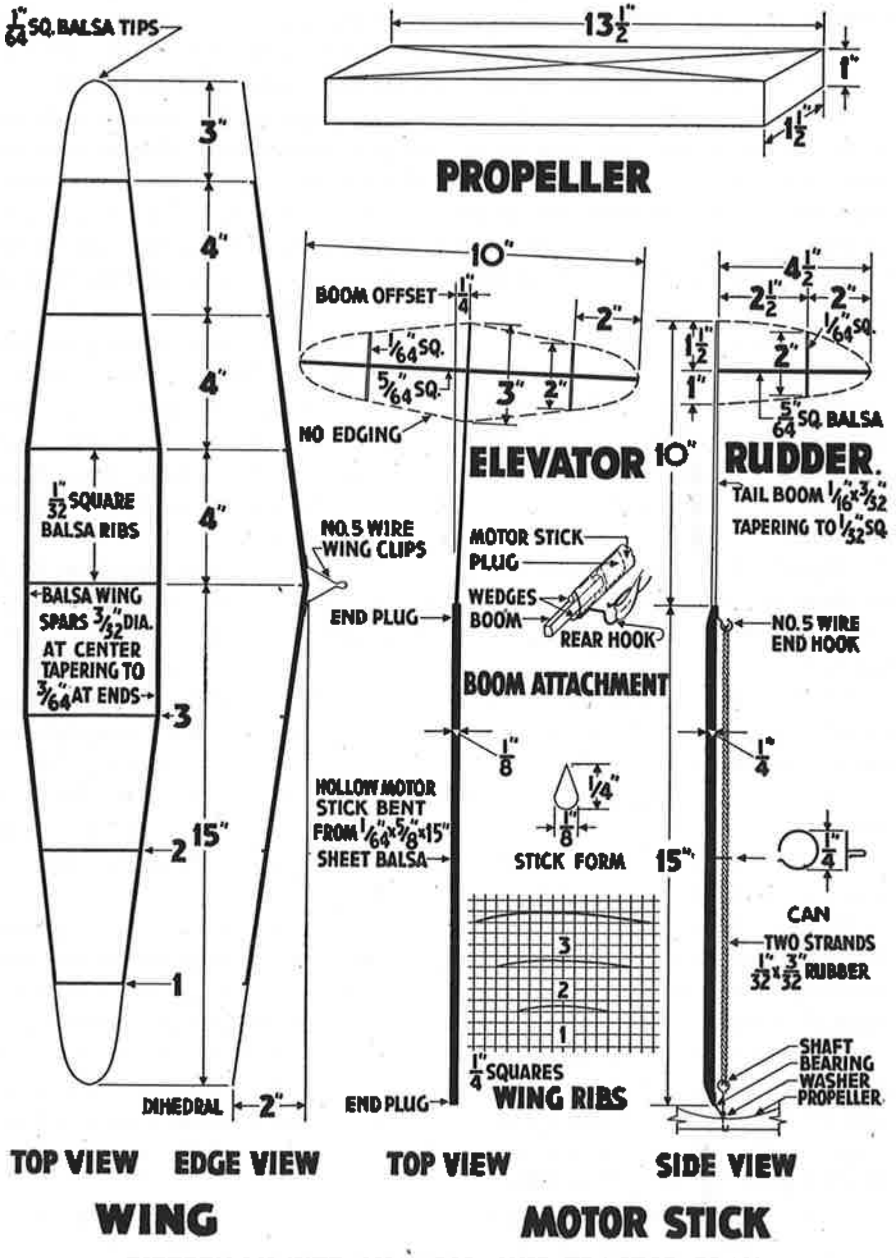
WING. The wing requires two balsa spars, 24″ long. They must be 3/32″ in diameter at their center points tapering to 3/64″ at their ends. This work should be done with No. 000 sandpaper, and great care should be taken to see that each spar is round with a gradual taper toward both ends.

Seven balsa wing ribs are required. These should be 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 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



FIFTEEN-MINUTE CHAMPIONSHIP TRACTOR PLAN 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

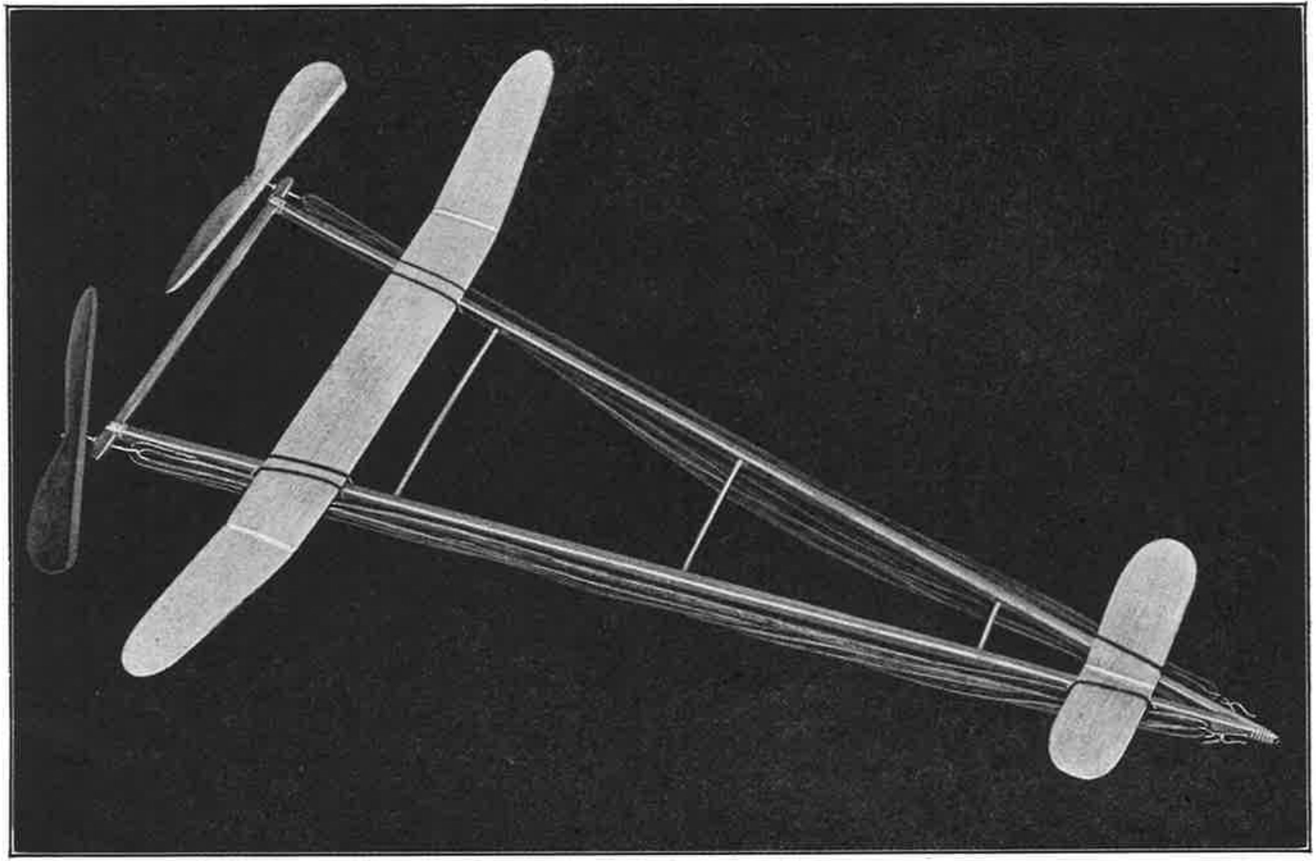
HERE is a record-breaking model for all enthusiasts who like speed. Designed and built by Edward H. Beshar, nationally known model builder, it has been officially clocked 56.2 miles per hour over a two-hundred-yard course at a recent Eastern meet.

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.

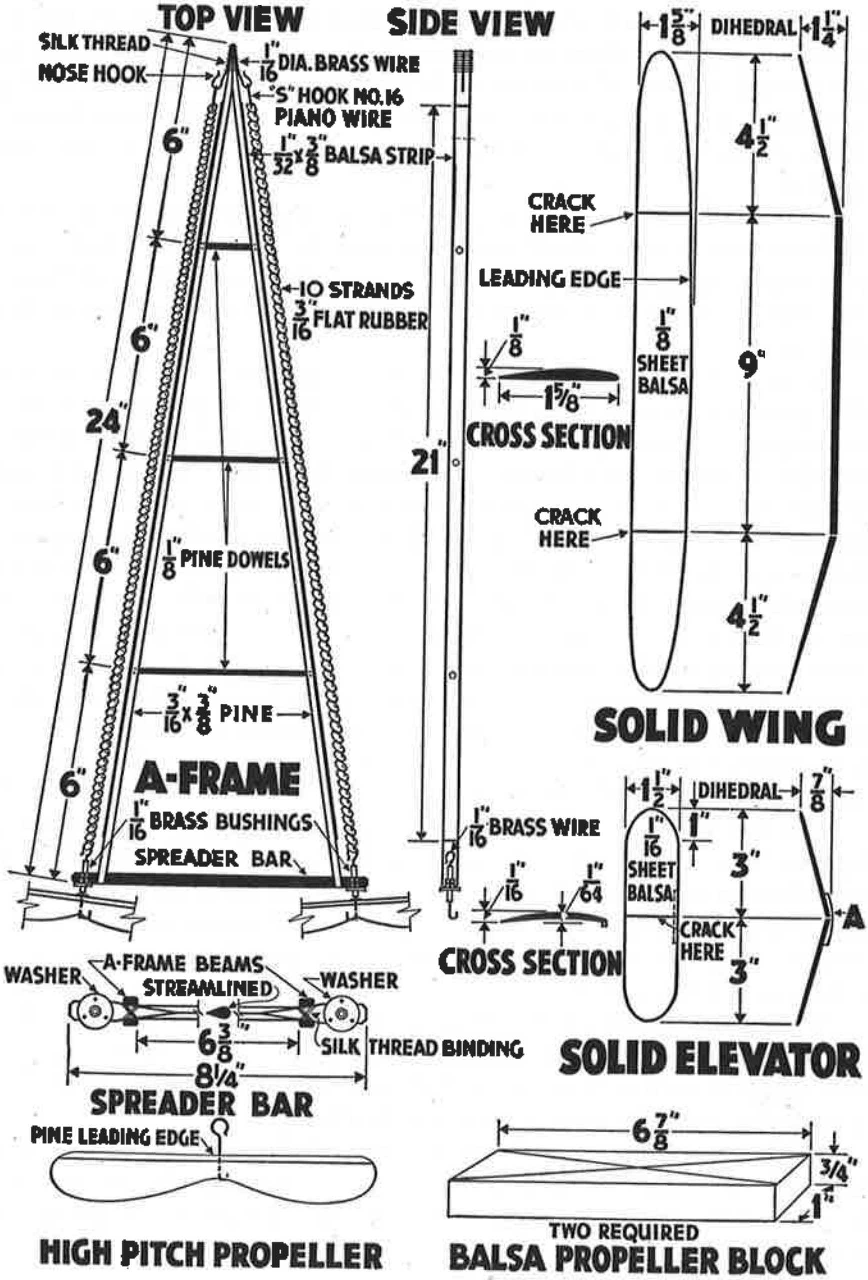
PROPELLERS. Two pusher propellers are required for this model. A left hand and a right hand propeller must be carved from balsa propeller blocks measuring 3/4″ x 1″ x 6 7/8″. (See Chapter 9, "Carved Propellers," "Right and Left Hand Propellers" and "Tractor and Pusher Propellers.")

To strengthen the leading edges of the propellers, a 1/4″ 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 1/8″ sheet balsa. Obtain a piece 1 5/8″ 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."

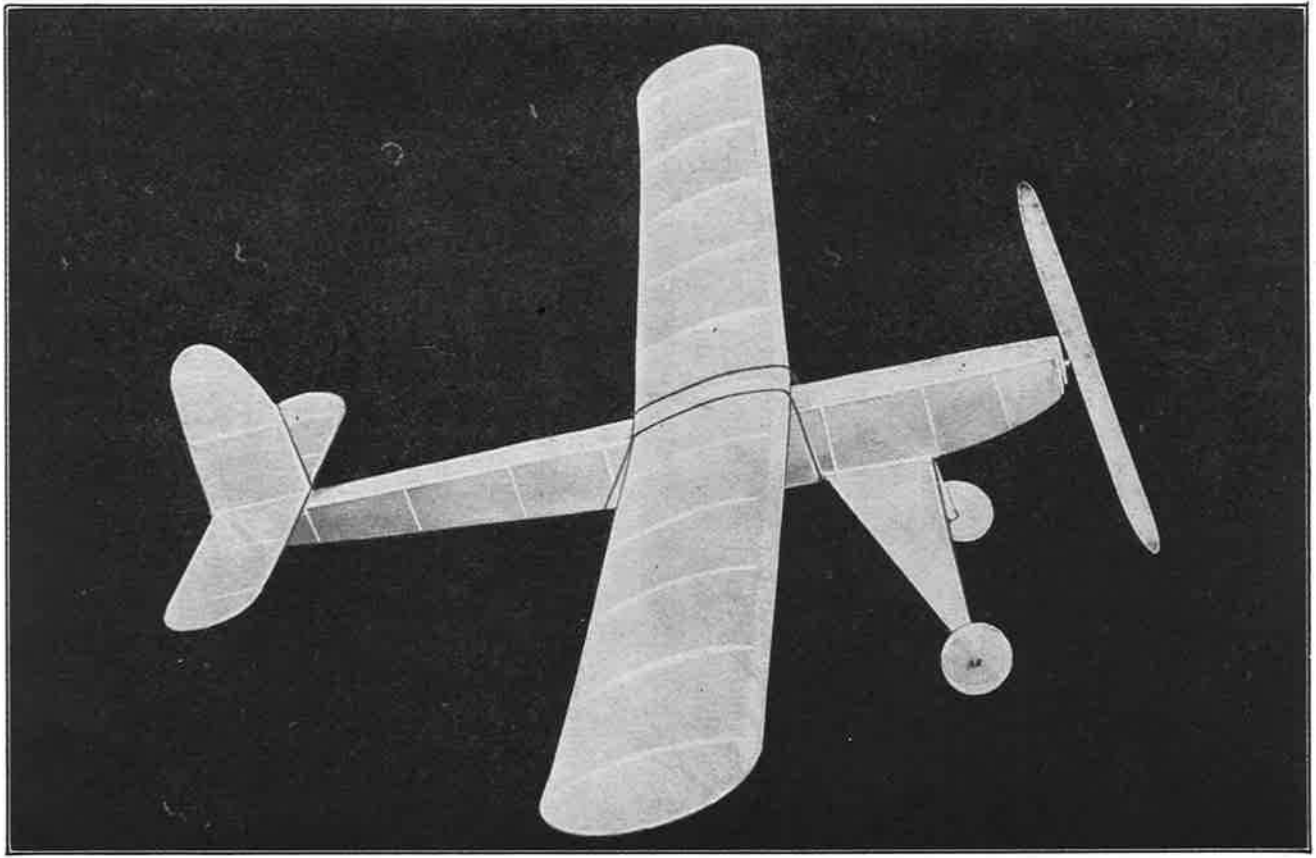
CHAPTER 35

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 3/8" long, measure 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 1/2" long, so must extend on each side of the center line 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 5/8" long, so must extend 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 5/8" long; No. 5, 5/8"; No. 6, 9/16"; No. 7, 7/16"; No. 8, 3/8"; No. 9, 1/4", and No. 10 is 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 1/16" x 1/16" balsa. Cut the ten struts to their proper lengths,



OUTDOOR COMMERCIAL TRACTOR

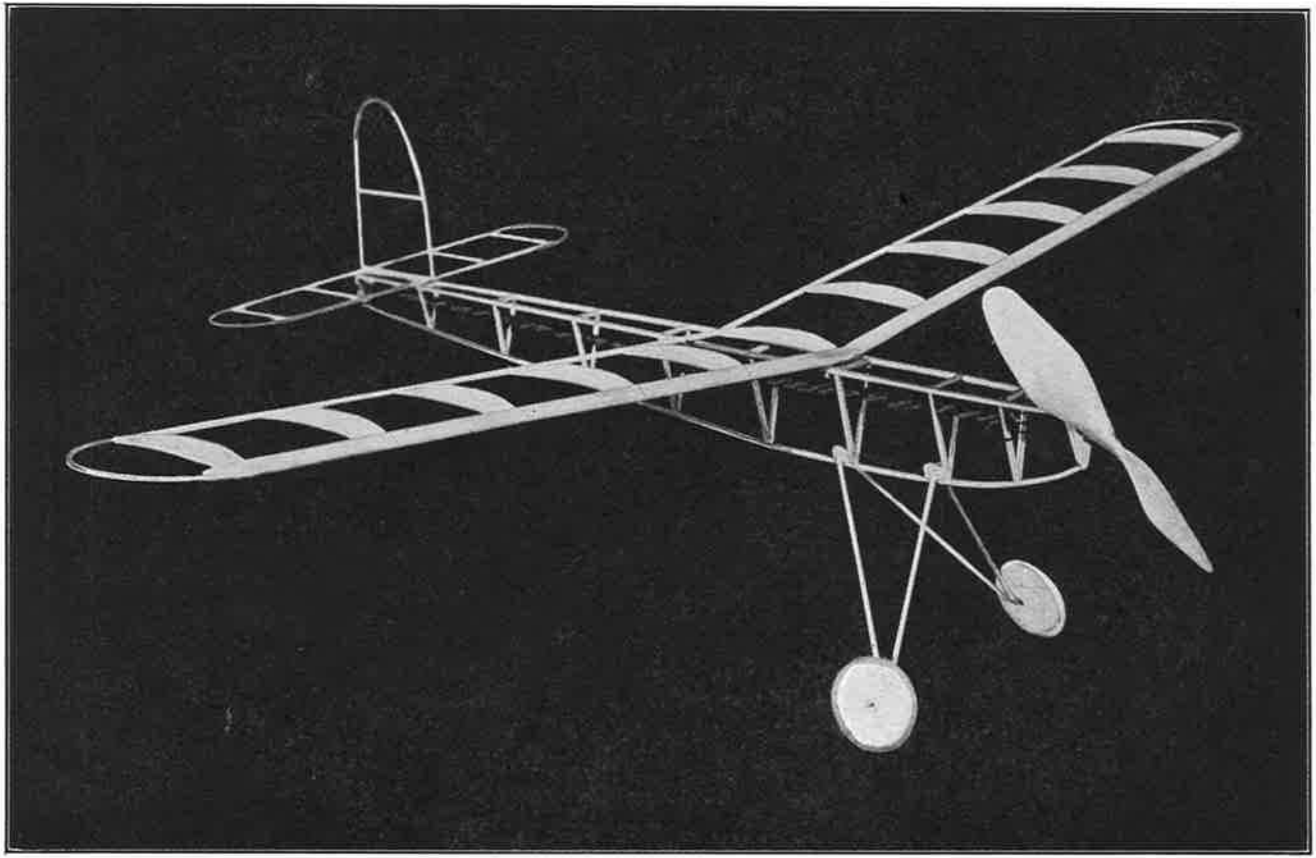
placing each in position on the plan. The two longerons are cut from the same size balsa, soaked and bent to conform with the curve given them in the plans. (See Chapter 3, "Balsa Wood.")

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.

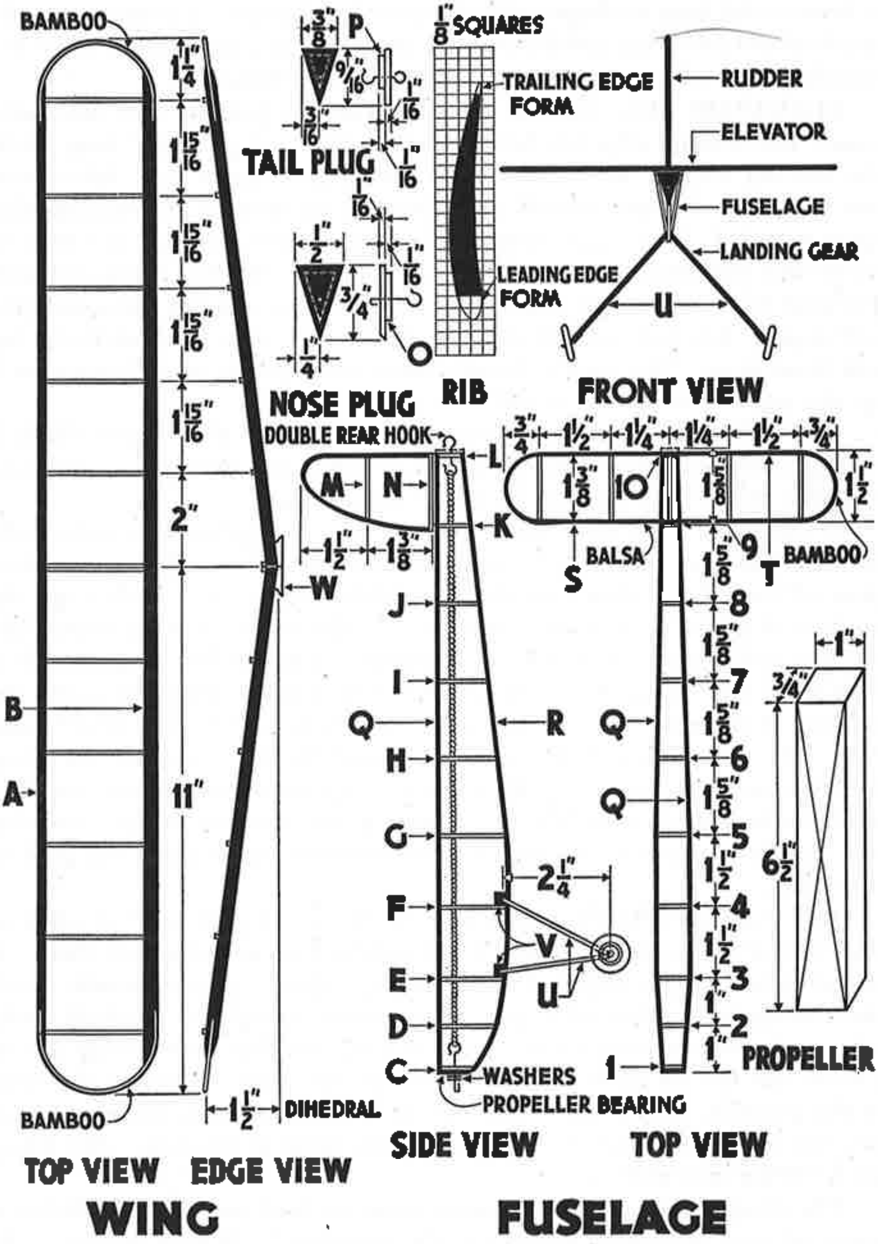
MOTOR. Three strands of 1/8" flat rubber are used for motive power. Considerable slack should be allowed in the rubber, so obtain a piece 35" long. This is attached to the rear hook, passed through the hook of the propeller shaft, looped around the rear hook, and brought to the front where it is fastened 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 5½" long, while the trailing edge T is the same size. Five 1/16" x 1/16" x 1⅜" 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 ¼" 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 ⅛" x 20¼" 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 1½", 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

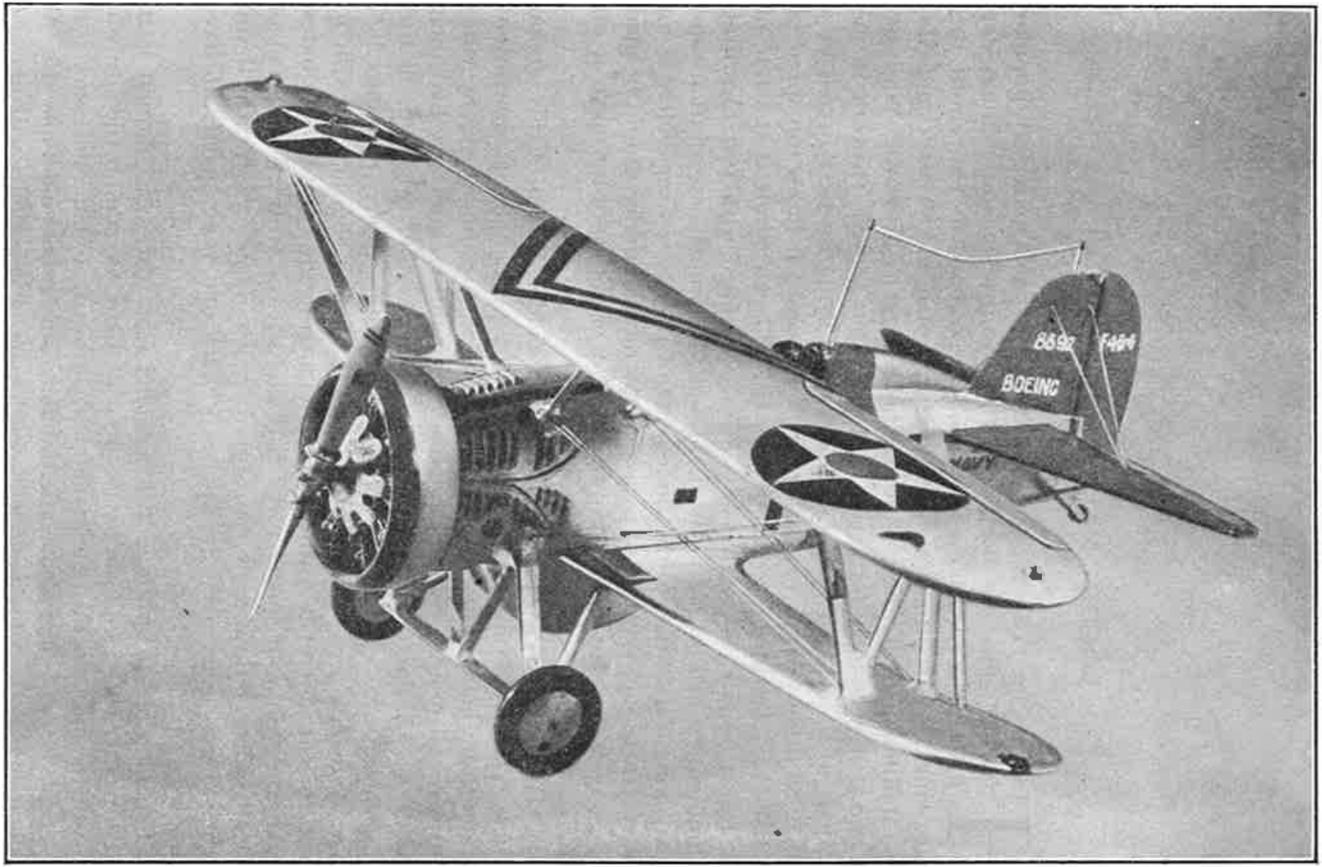
CHAPTER 36

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.

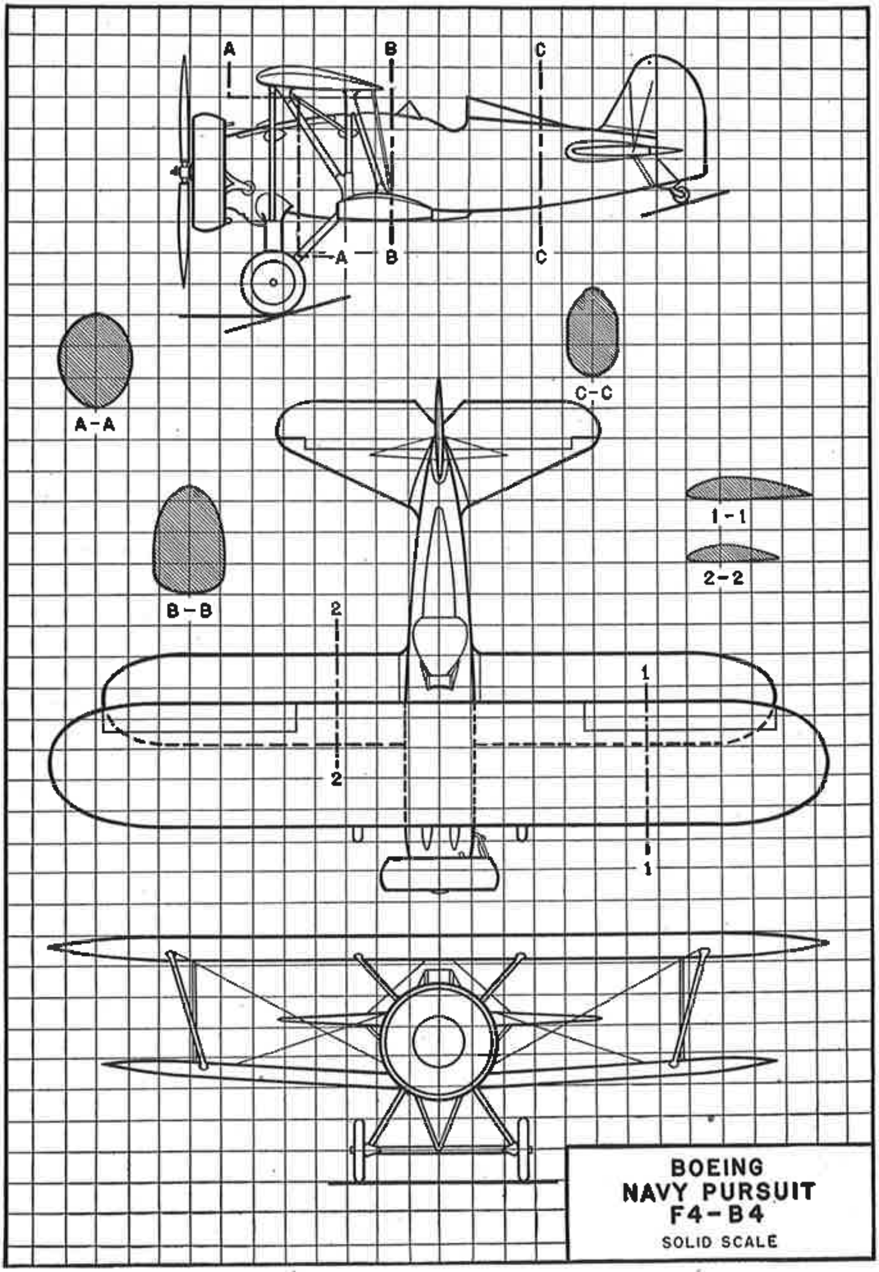
PROPELLER. The propeller for this model is cut from a ⅛″ thick, ½″ wide, and 3¾″ long balsa block. (See Chapter 9, "Exhibition Propellers.") This is the usual two-bladed propeller and is attached to the engine core with a model pin.

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.

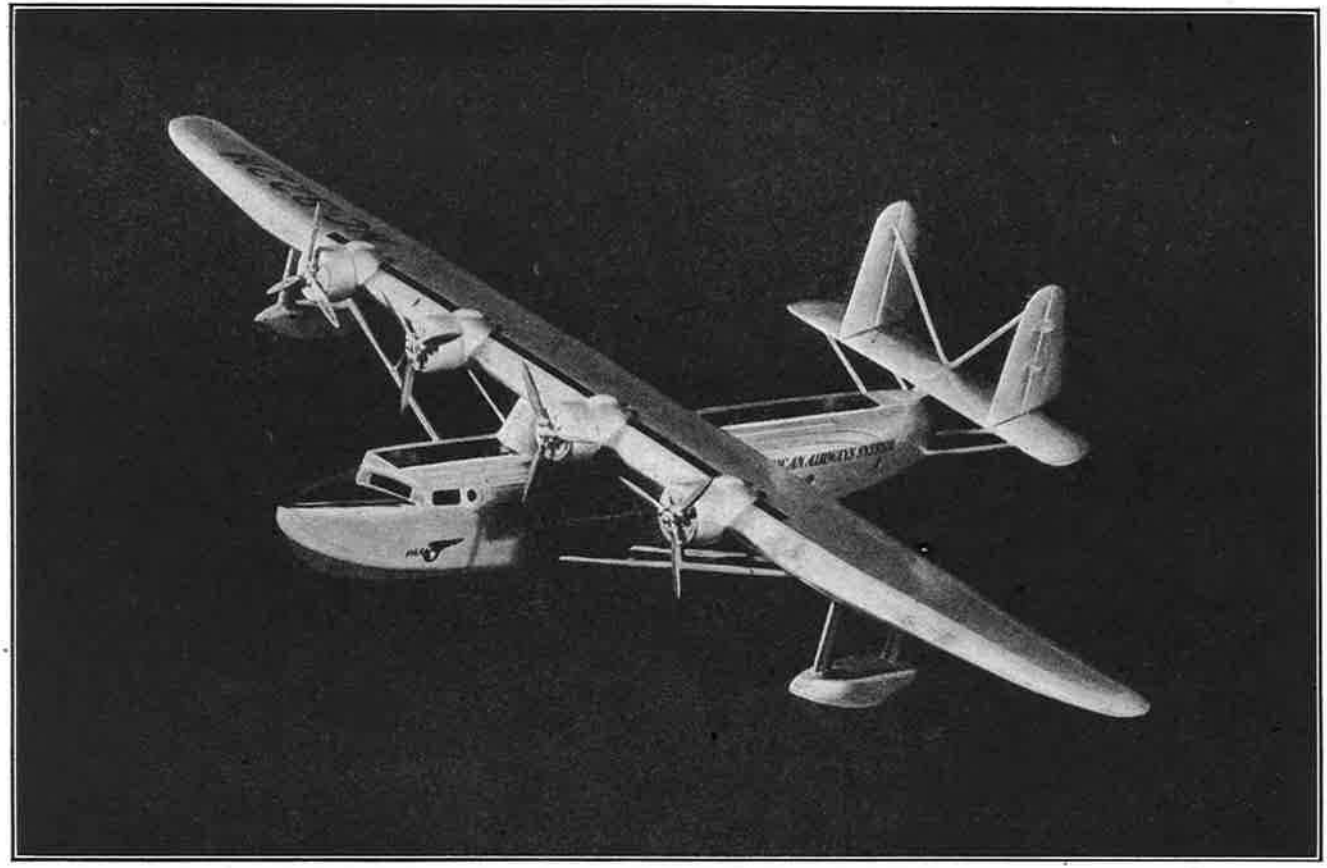
CHAPTER 37

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.

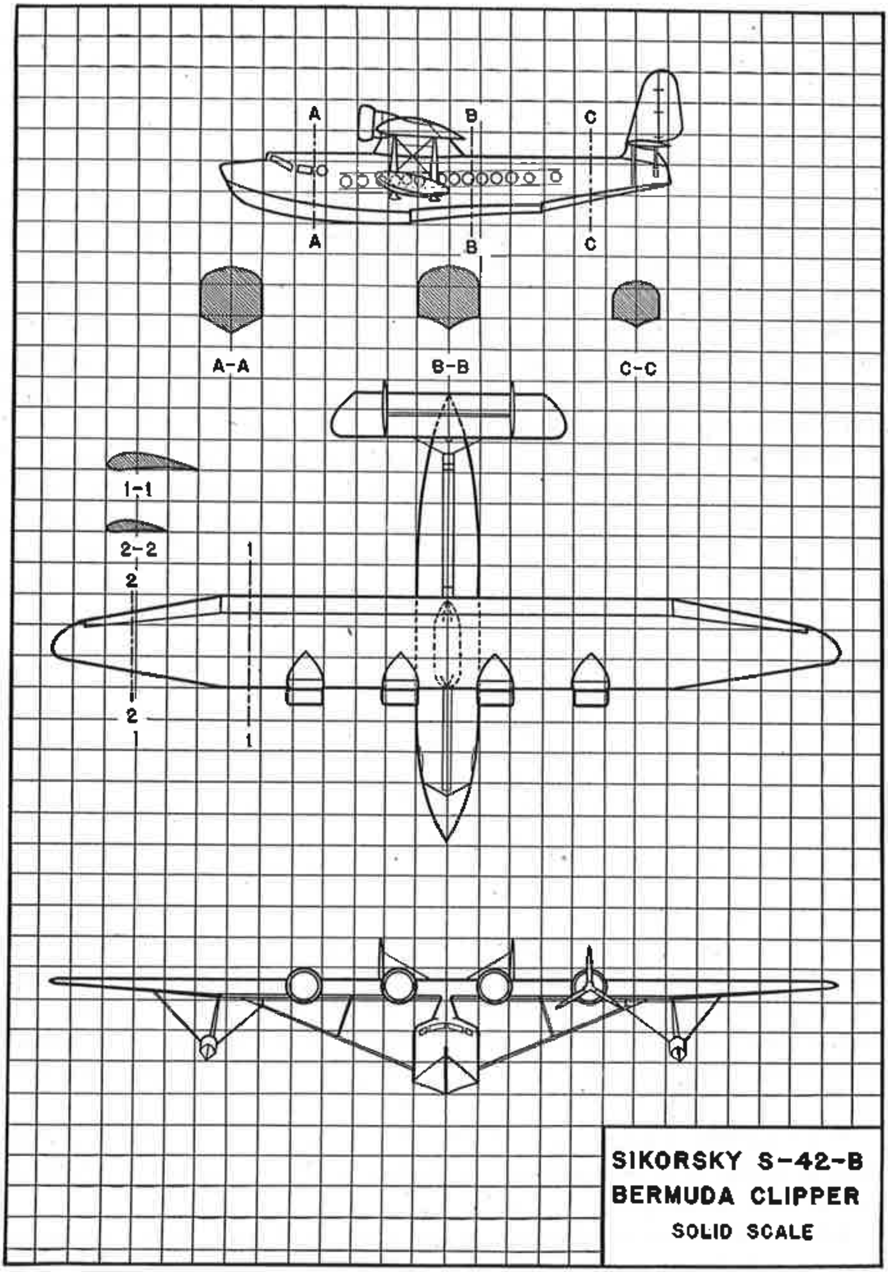
FUSELAGE. The fuselage is carved from a balsa block measuring 1″ thick, 1¼″ wide, and 7½″ long. Such a fuselage is known as the "hull," as it is actually a boat type designed to ride on the water. Make a full-size copy of the three cross-sectional views, as shown under A-A, B-B, and C-C. From these cut 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

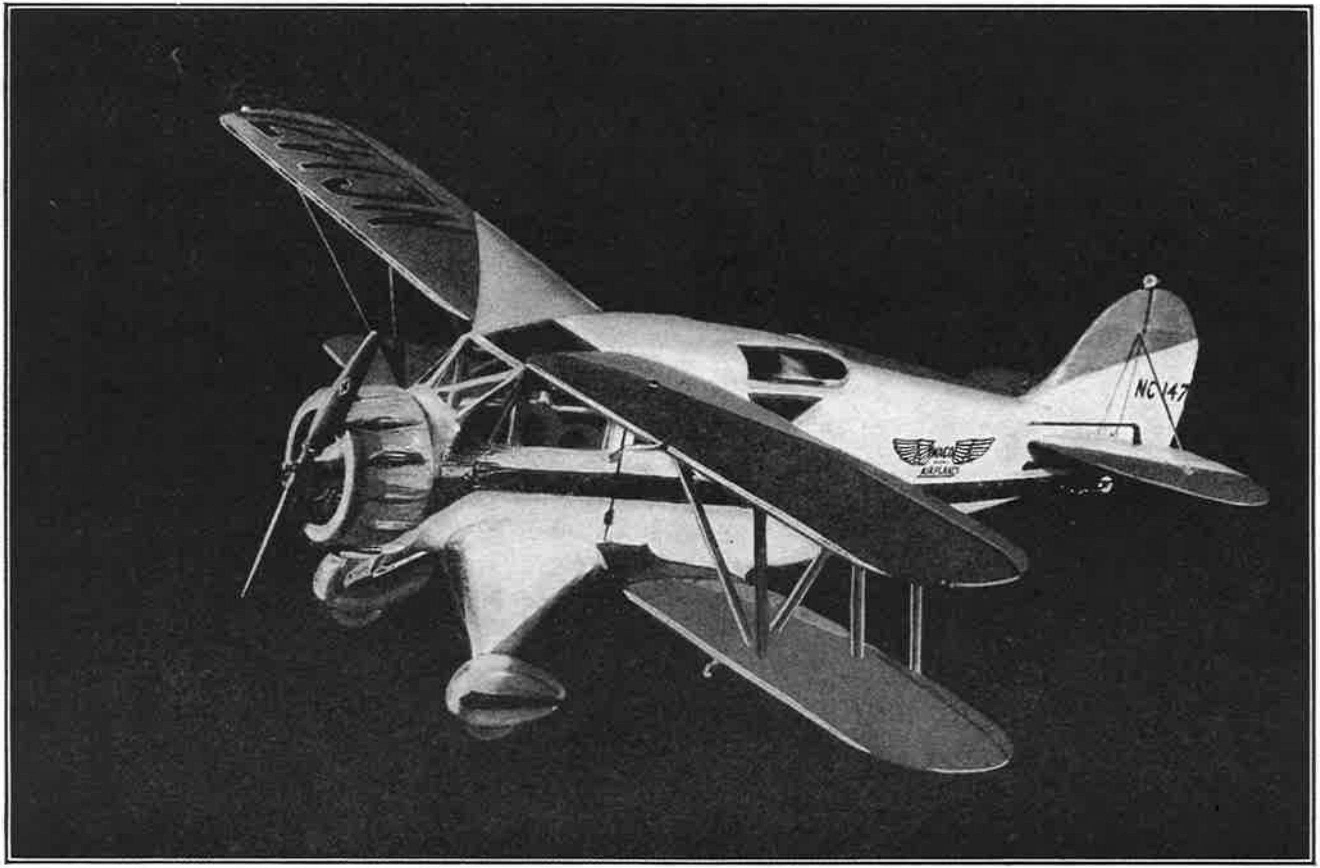
WACO CABIN

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 1/2" and leaving its walls 1/8" 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.

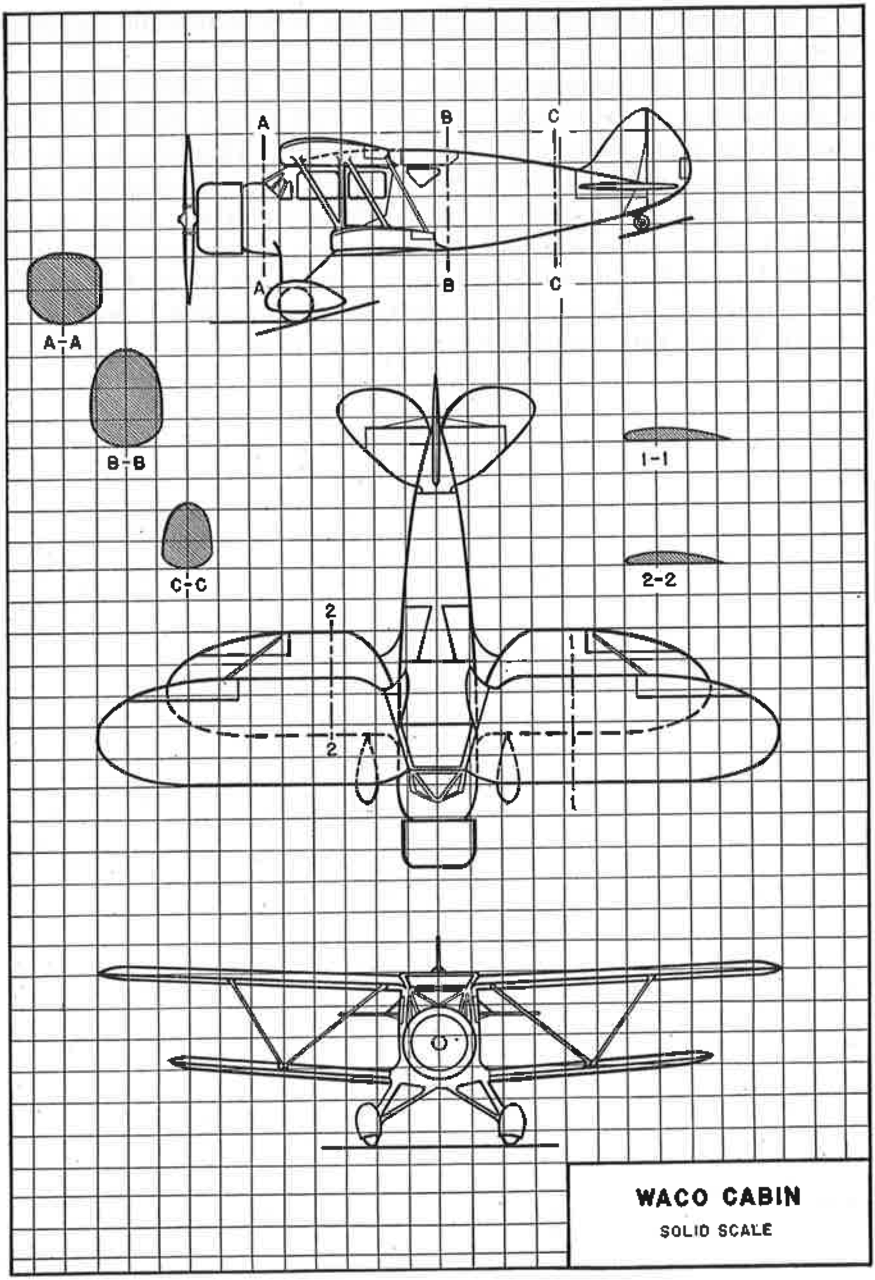
ELEVATOR. The elevator is carved from a single piece of sheet balsa wood measuring 1/8" thick, 1 1/2" wide, and 1 3/4" long. Note its size, shape, and streamlined appearance in the center and top views of the plans. Give it a smooth finish with sandpaper.

RUDDER. The rudder is carved from a single piece of balsa wood measuring 1/8" thick, 1 1/2" 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 1/2" in diameter of 1/4" sheet balsa. (See Chapter 10, "Solid Balsa Rubber-tired Wheels.") Wheel pants are cut from 3/16" thick, 1/2" wide, and 1 1/2" 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 1/8" thick, 3/4" wide, and 3/4" 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, 2 3/4" 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 5/8″ thick, 3¼″ wide, and 7½″ 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 1½″ 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 ½″ deep and its side walls 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 1/16″ sheet balsa to a diameter of ¼″. 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.

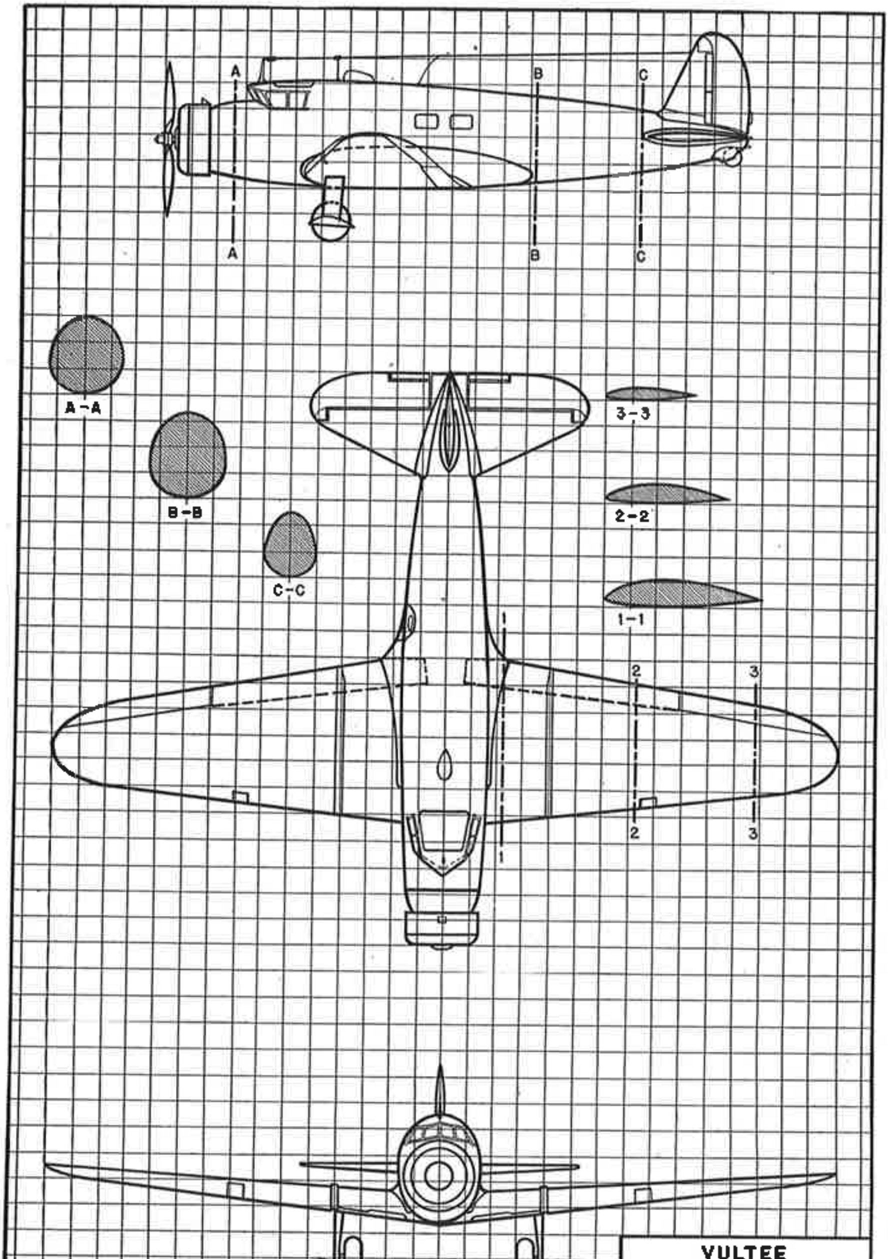
ELEVATOR. The elevator is carved from a piece of sheet balsa measuring 1/4″ thick, 2″ wide, and 5 1/2″ long. Note its shape in the center view of the plans. Its streamlined form is shown in the top and bottom plans. Give the entire elevator a thorough sanding with a fine sandpaper.

RUDDER. The rudder is carved from a 1/4″ thick, 1 3/4″ 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 5/8″ thick, and 3/4″ 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, 3/8″ 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.

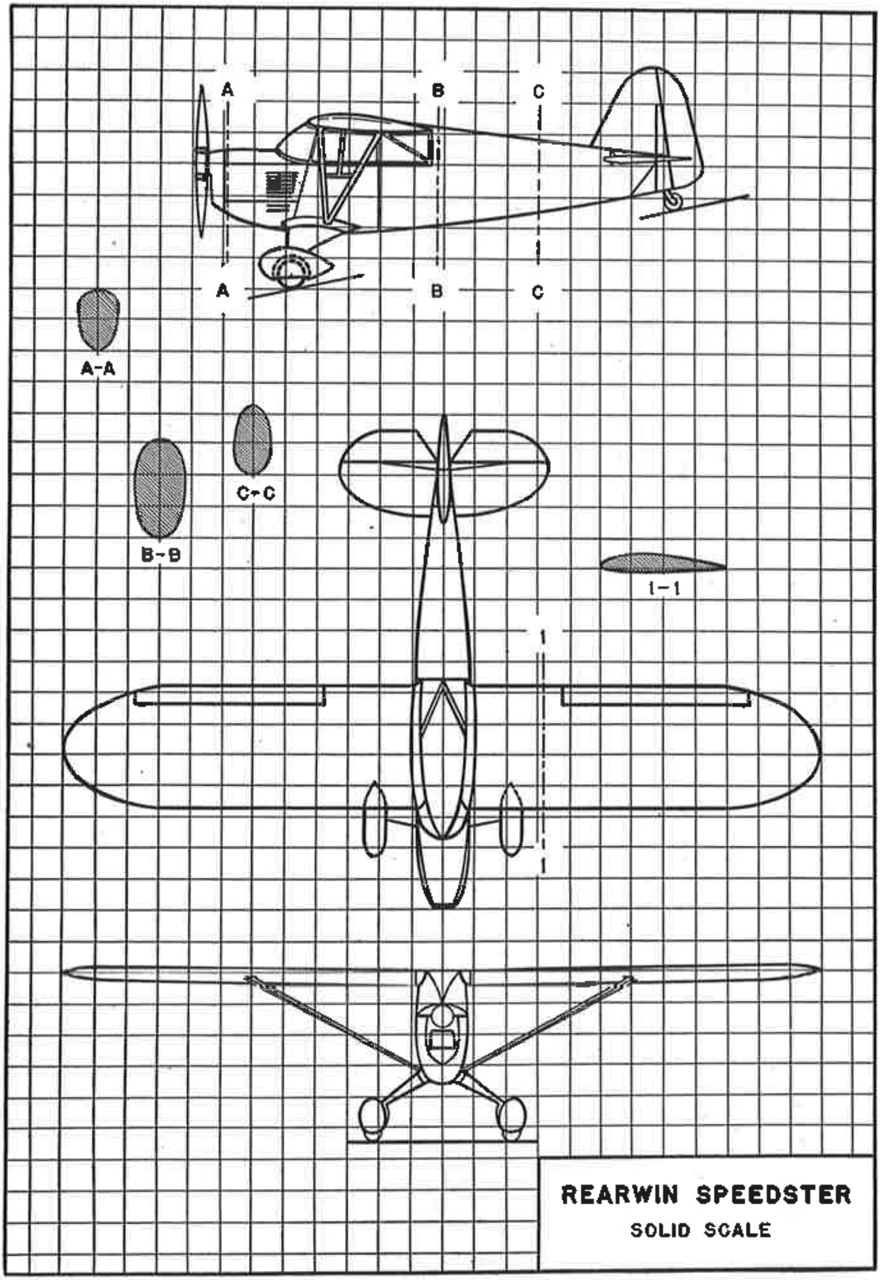
PROPELLER. A single-blade, exhibition propeller is carved from a 1/4" thick, 1/2" wide, and 2 1/2" long balsa block. This is fully explained in Chapter 9 under "Exhibition Propellers." When finished, give the propeller a thorough sanding with a fine sandpaper, and fasten it in place to the nose of the fuselage with a model pin.

ELEVATOR. The elevator is carved from a sheet balsa strip measuring 1/8" thick, 1 1/2" wide, and 3 3/8" 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 1/8" thick, 1 3/4" 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 1/4" thick, 1 3/4" wide, and 1 3/4 long. Cut their upper ends to fit the side of the fuselage. The wheel pants are made from balsa blocks measuring 1/2" thick, 5/8" wide, and 1 1/8" 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.

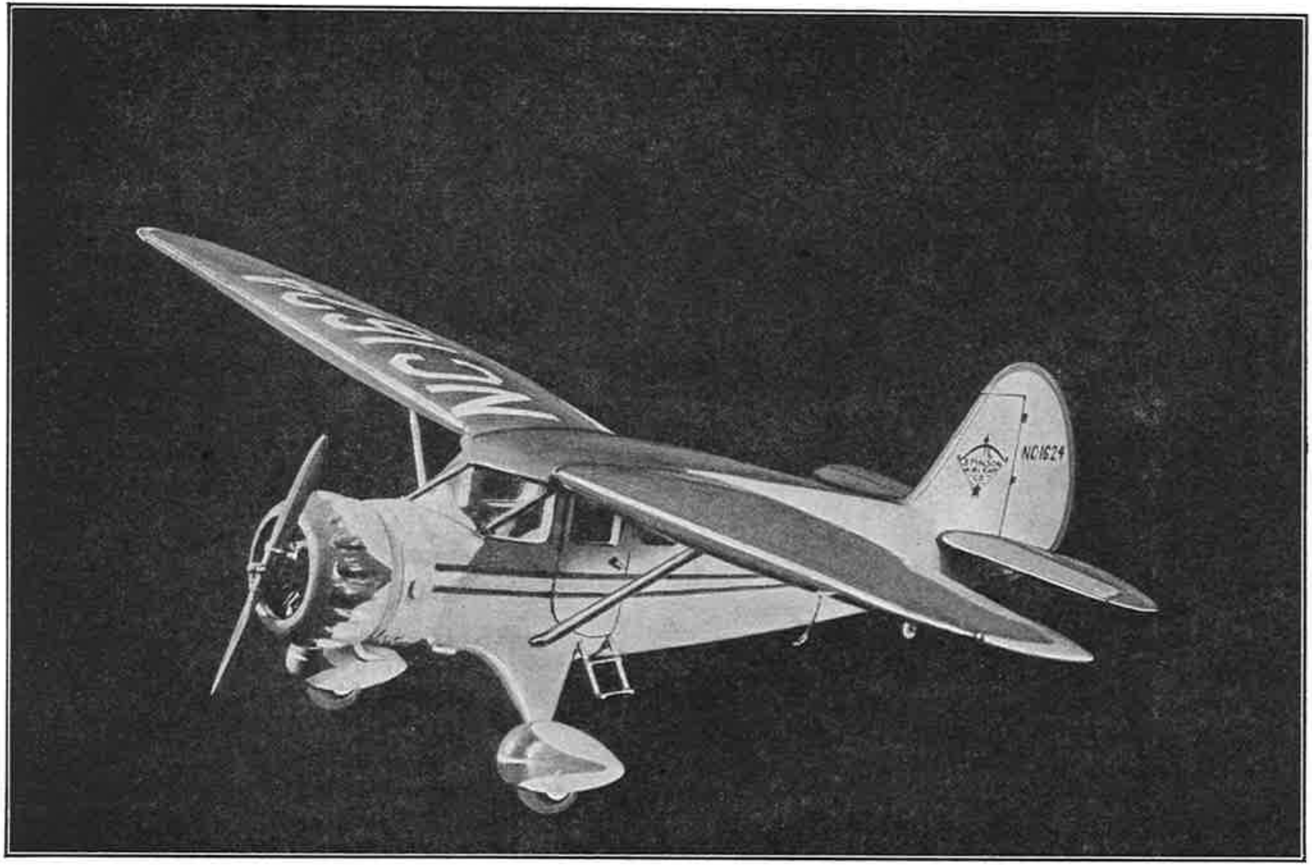
CHAPTER 41

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 3/8″ thick, 2½″ wide, and 5½″ 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 1⅜″ thick, 2″ wide, and 6⅜″ 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.

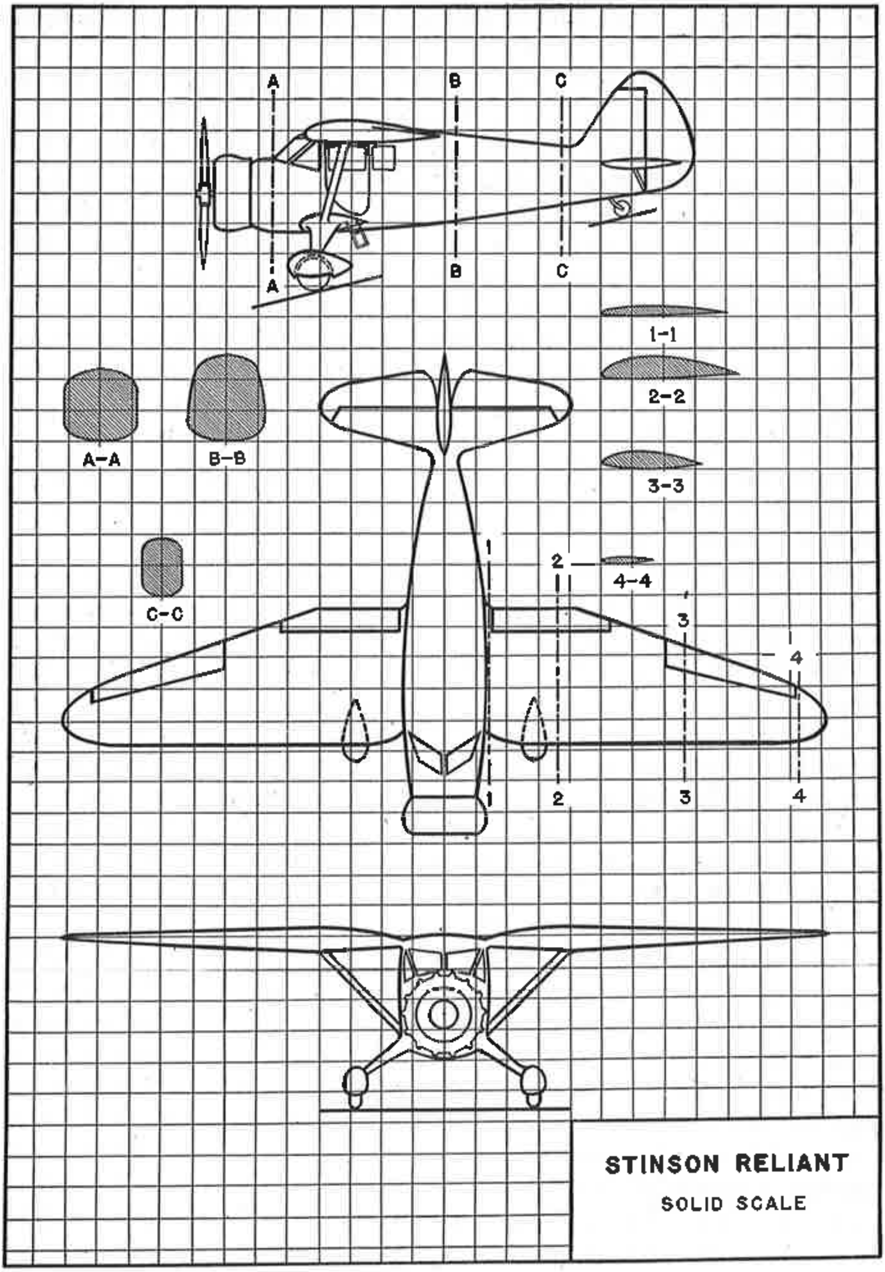
PROPELLER. This model requires a two-bladed, exhibition propeller, which can be carved from a balsa block measuring 1/8" thick, 1/4" wide, and 2 1/2" long. See Chapter 9, "Exhibition Propellers." Finish smooth with sandpaper and attach to the core of the engine with a model pin.

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.)

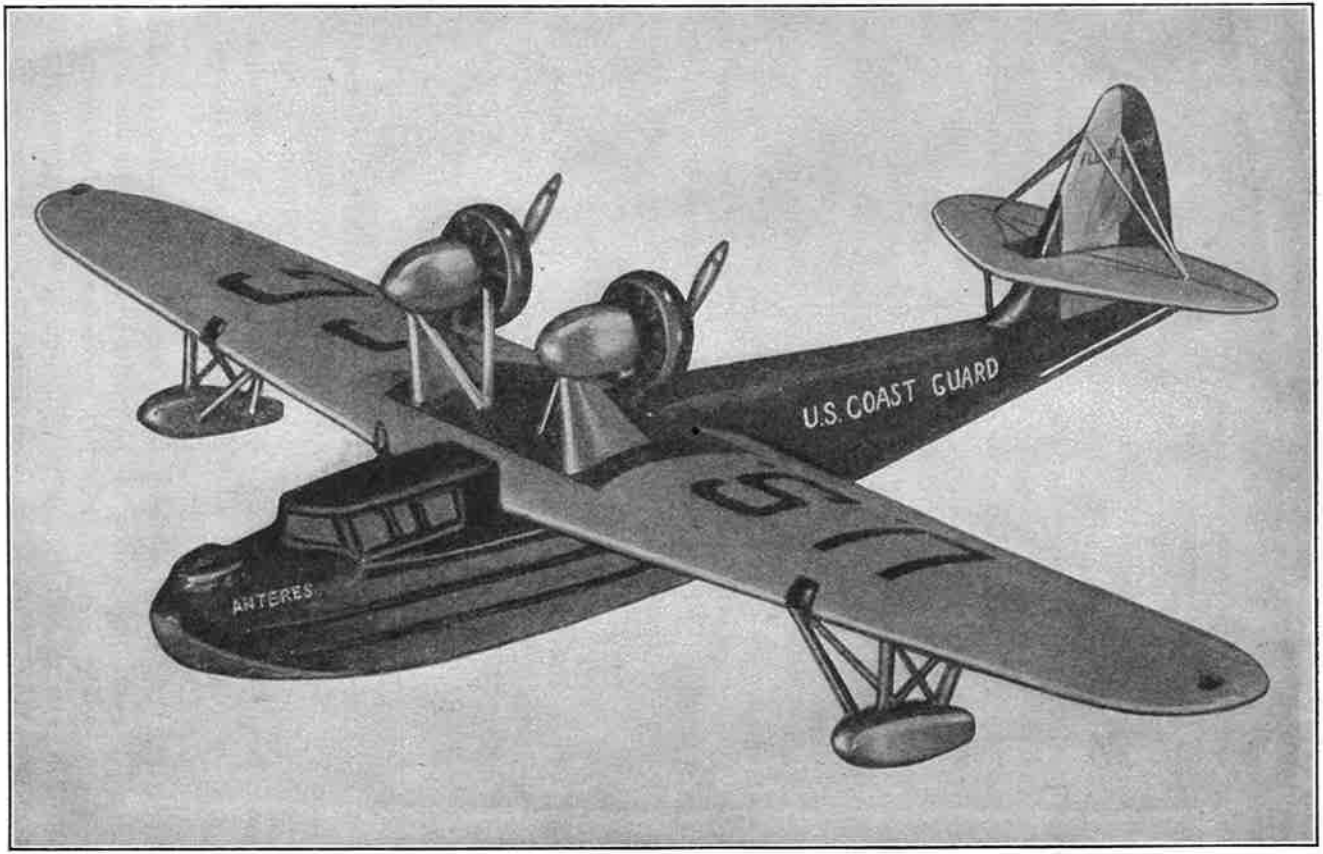
CHAPTER 42

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

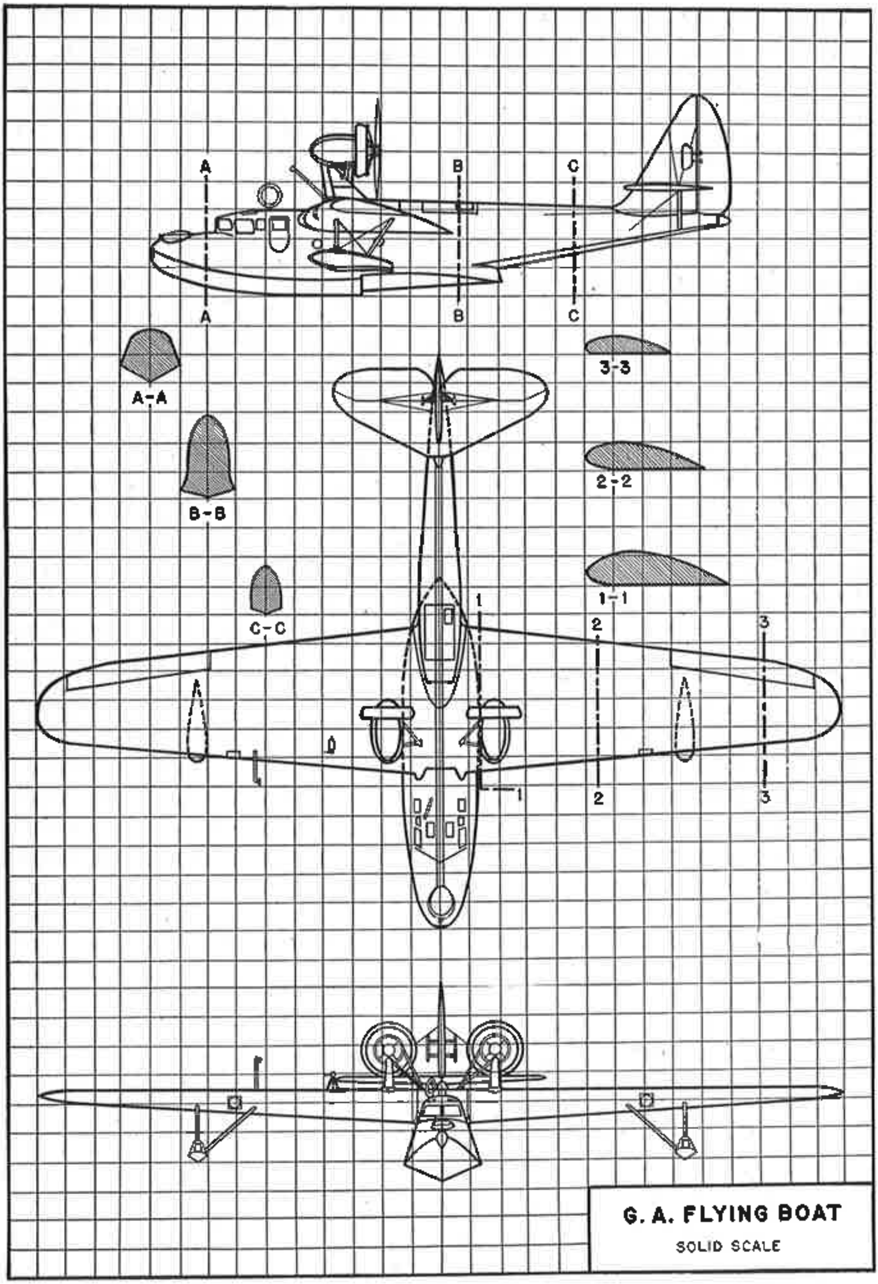
fitted to the fuselage at this time. Note that the top of the fuselage is cut so that the wing can fit into it. This cut in the fuselage must be deep enough to allow the wing to fit down flush with the top of the fuselage. It must also be so cut as to permit the fuselage to fit around both the leading 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, 1 1/2" wide, and 3 5/8" 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.

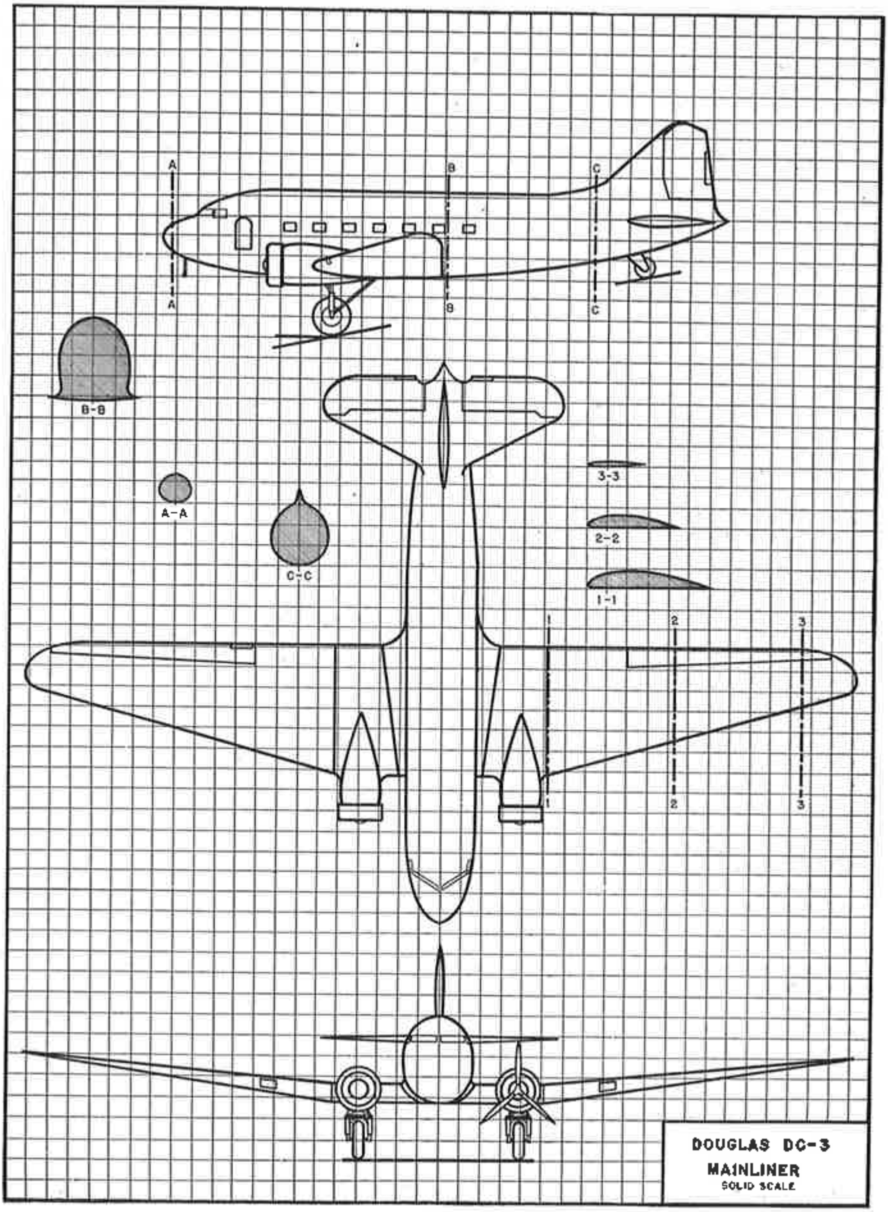
PROPELLERS. Two three-bladed exhibition propellers are required for this model. These have 1½″ long blades and are carved from balsa wood. This work is fully described in Chapter 9, page 111, "Three-bladed Exhibition Propeller." Finish smooth with sandpaper and then mount each one to the center of the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

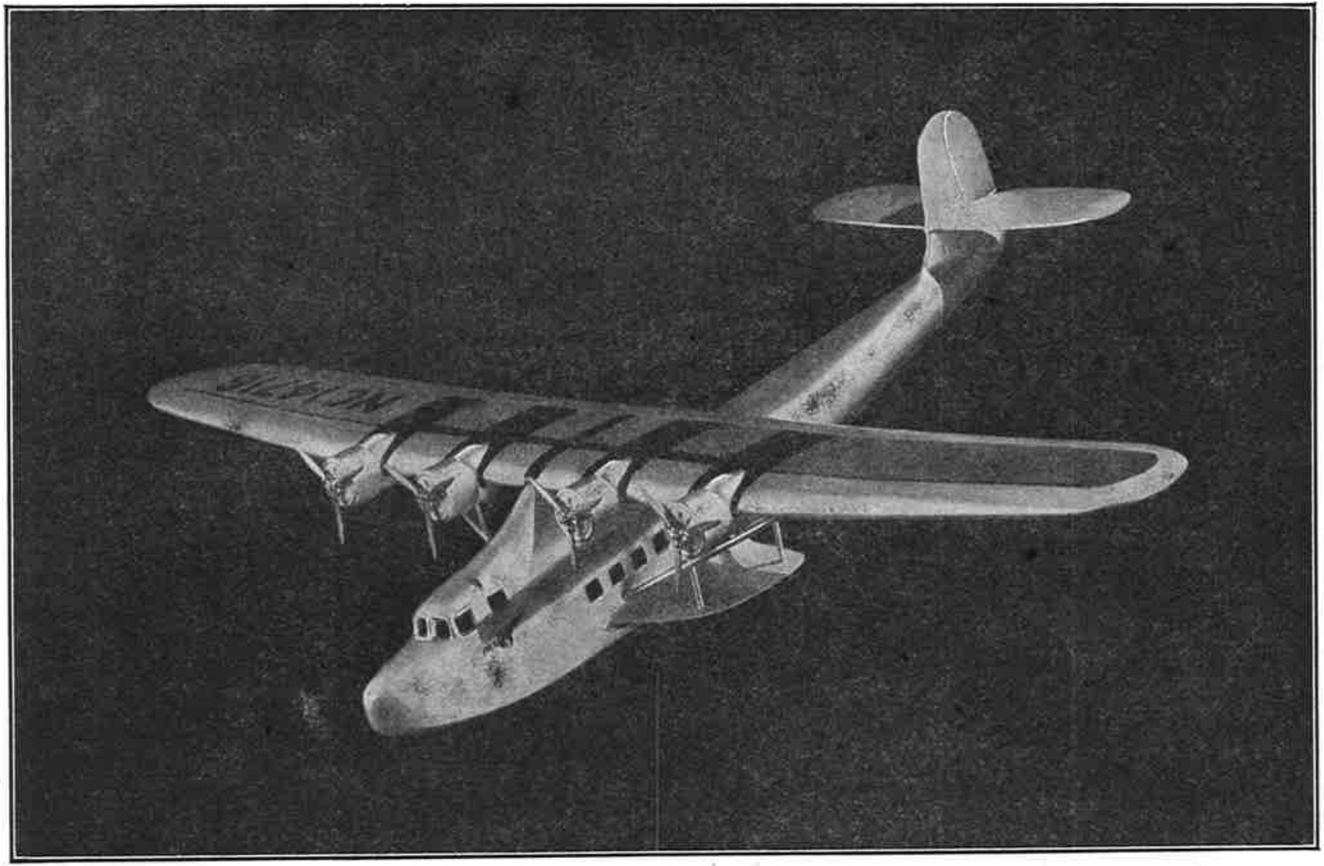
CHAPTER 44

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

I-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.

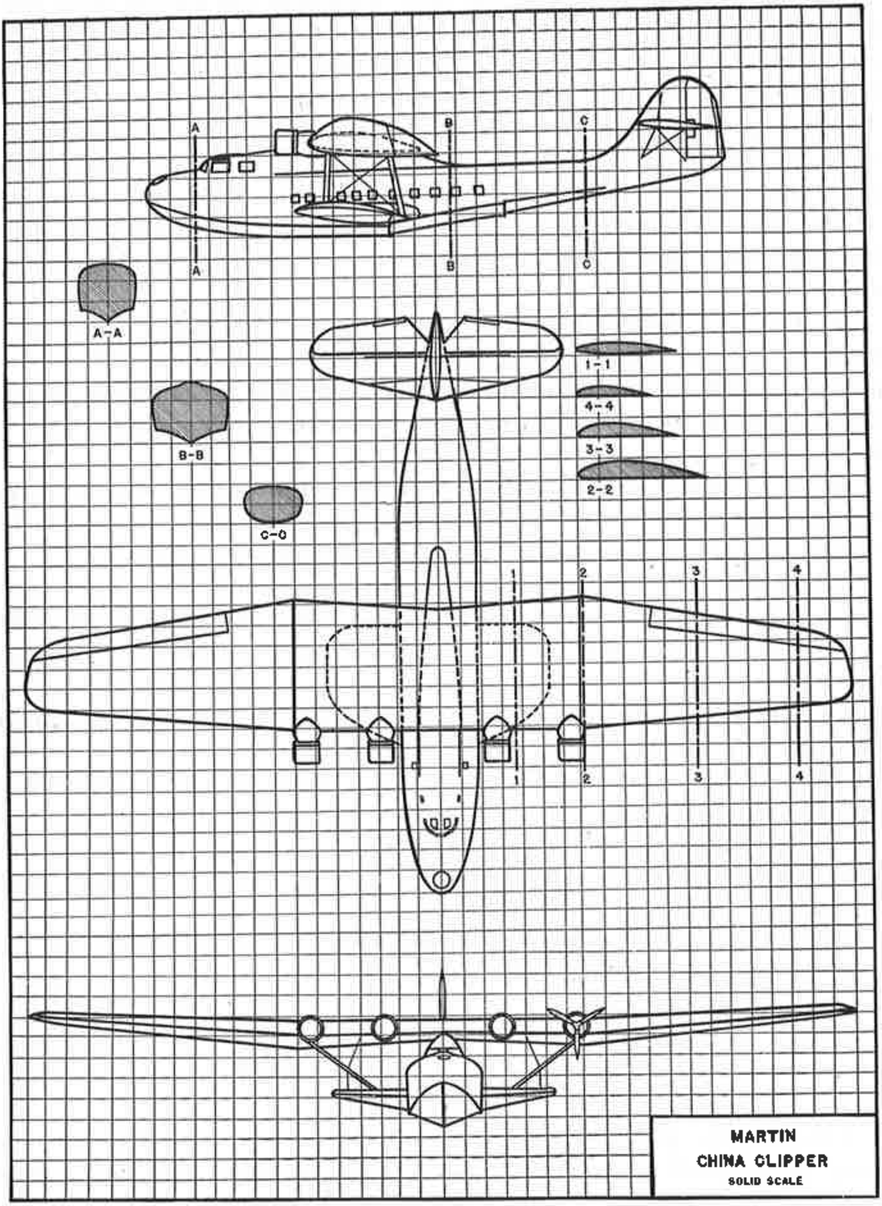
NACELLES. Four engine nacelles are carved from balsa blocks measuring ⅝″ square and 1½″ long. Do not attempt to fit these with engines because of their extremely small size. Note how these are slotted to fit over the leading edge of the main wing. Make these slots and test for fit. Cement in place.

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.

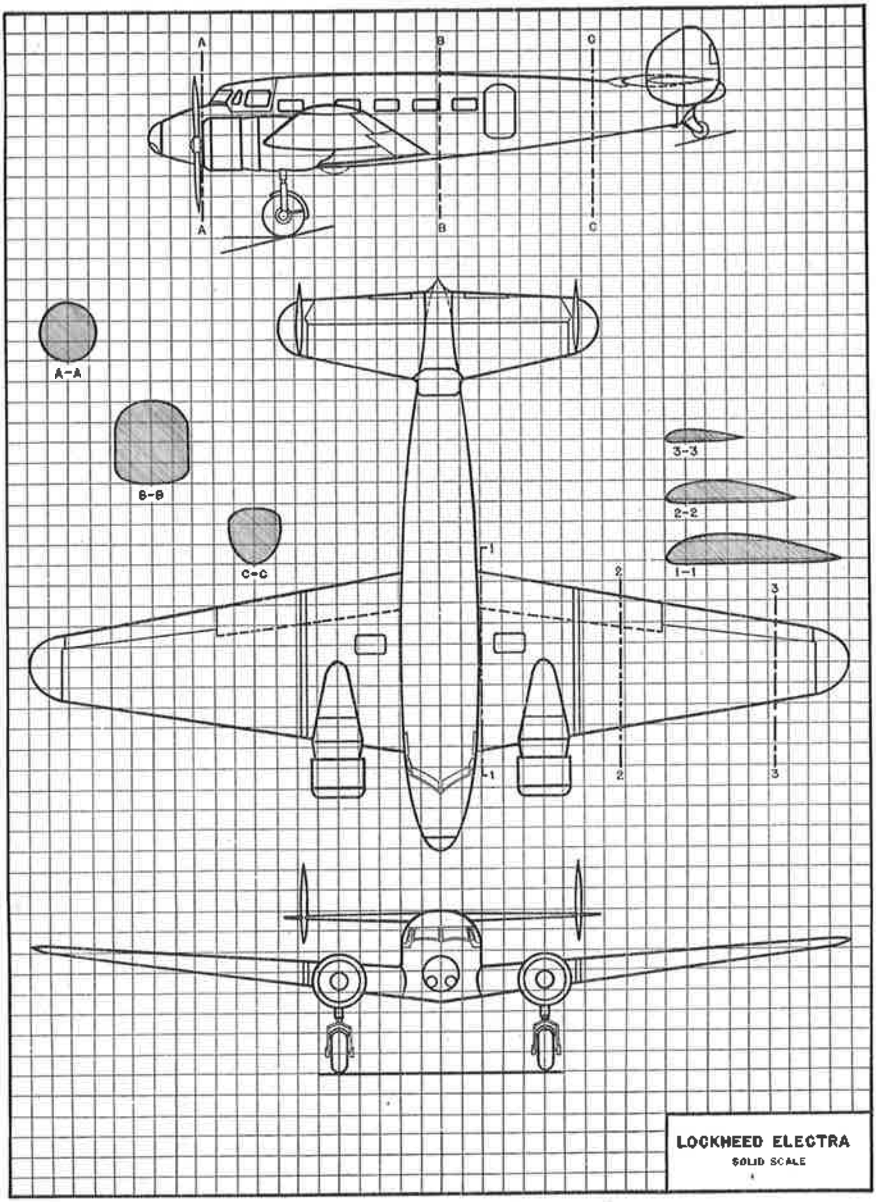
ENGINES. Two nine-cylinder radial engines are made to fit into the nacelles. Full instructions for making these will be found on page 129 under "Engines." If the builder does not wish to go to such detail, small 1″ diameter blocks may be inserted into the hollowed-out nacelles and cemented in place to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

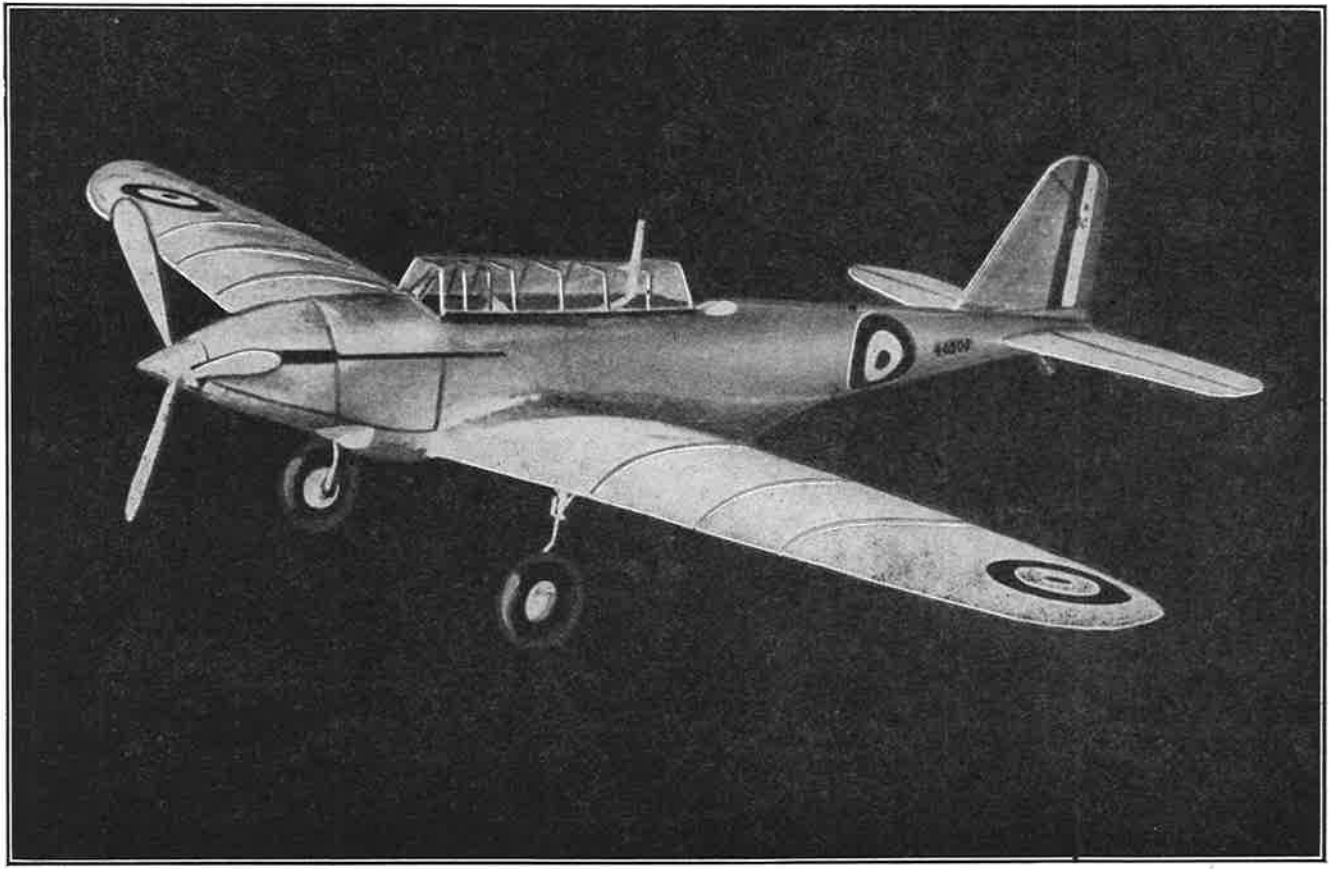
CHAPTER 46

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 1 7/8"	—Balsa blocks
1 pc. —3/4" x 1 7/8" 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	



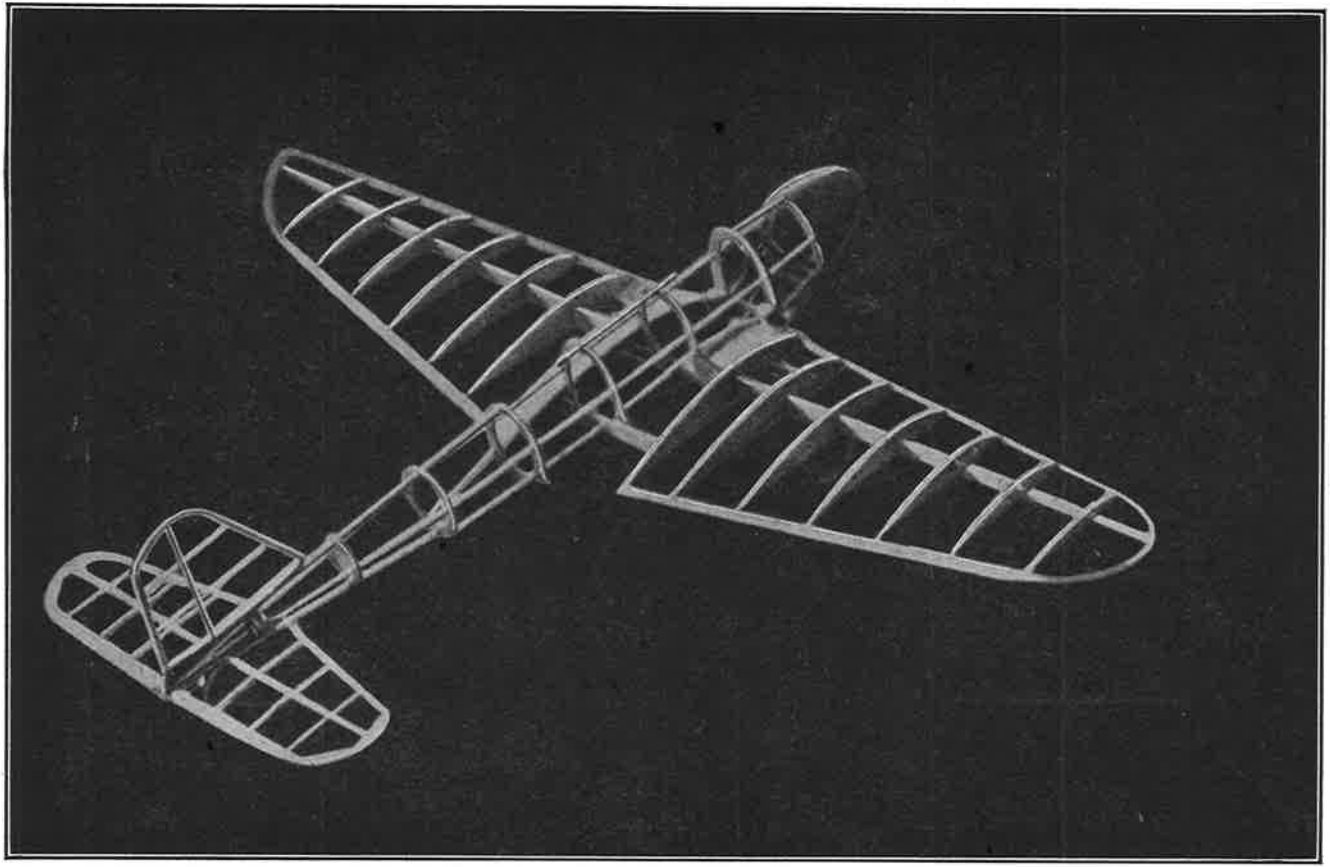
FAIREY "BATTLE"

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"

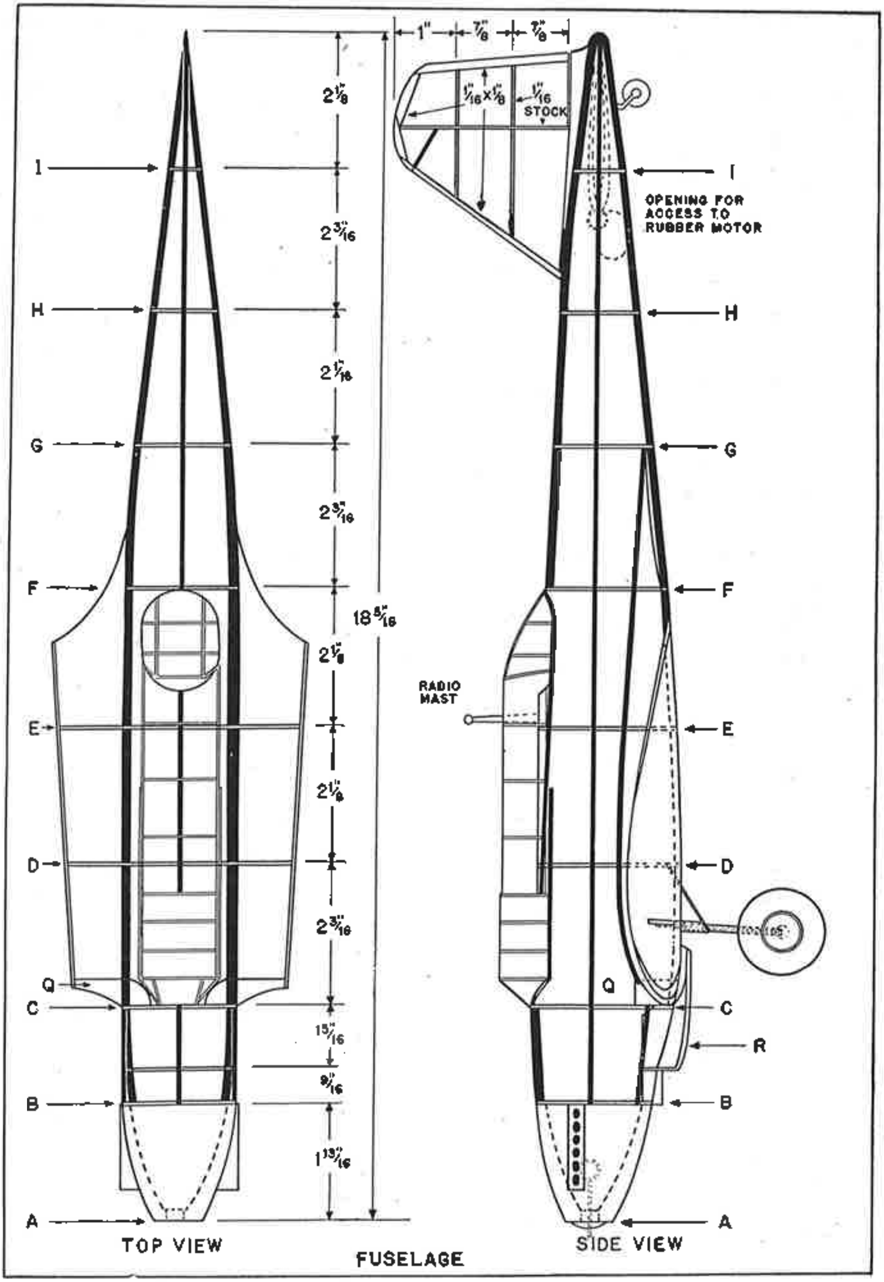


FAIREY "BATTLE" SKELETON

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 $3/32'' \times 1/8''$ 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.

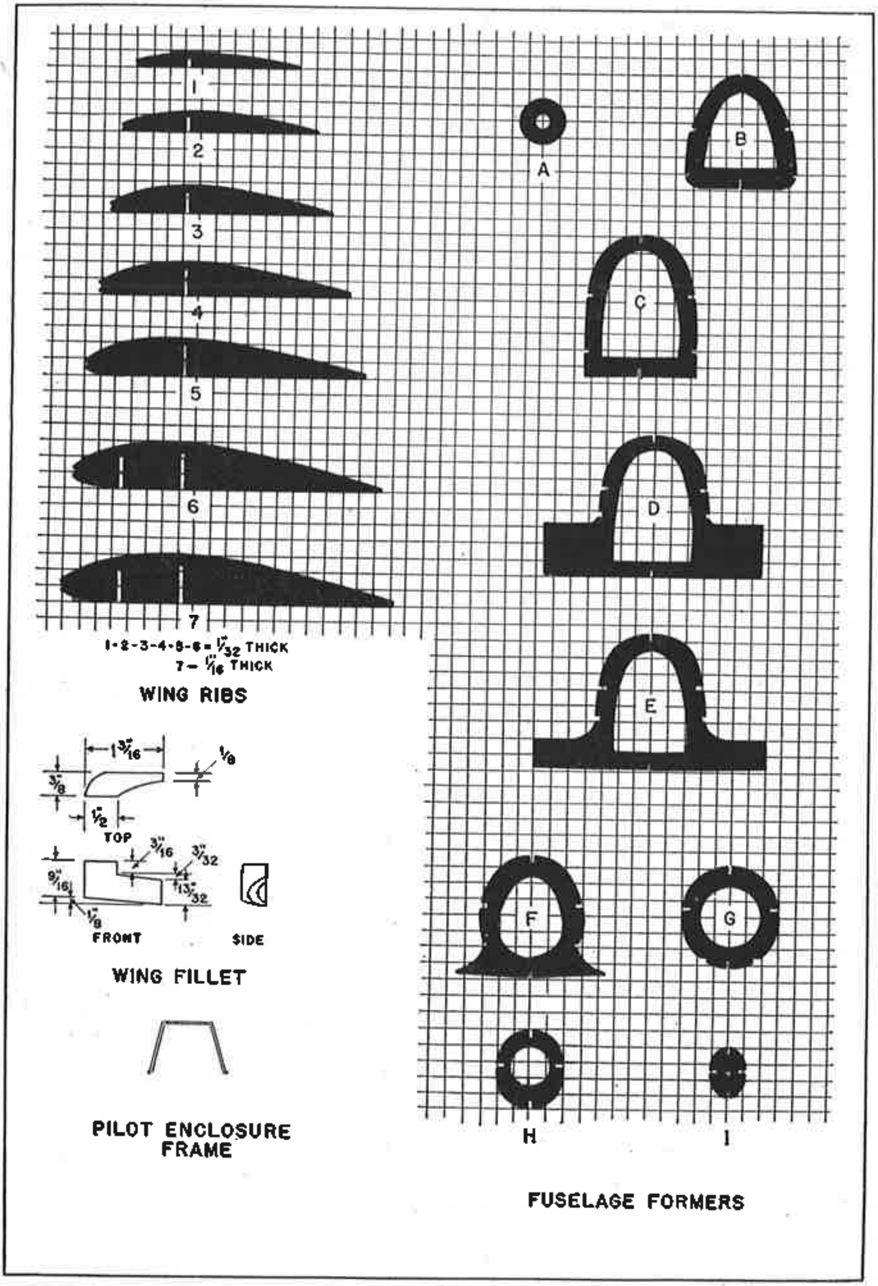
LANDING GEAR. Bend two landing gear "legs" from No. 15 music wire, as shown in Plan 3. The lower ends are bent to form axles, but the upper bends, made to attach to the short wing spar, are not bent until later. Slip either spaghetti tubing or plain rubber tubing over these wires down to the portions 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" 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.

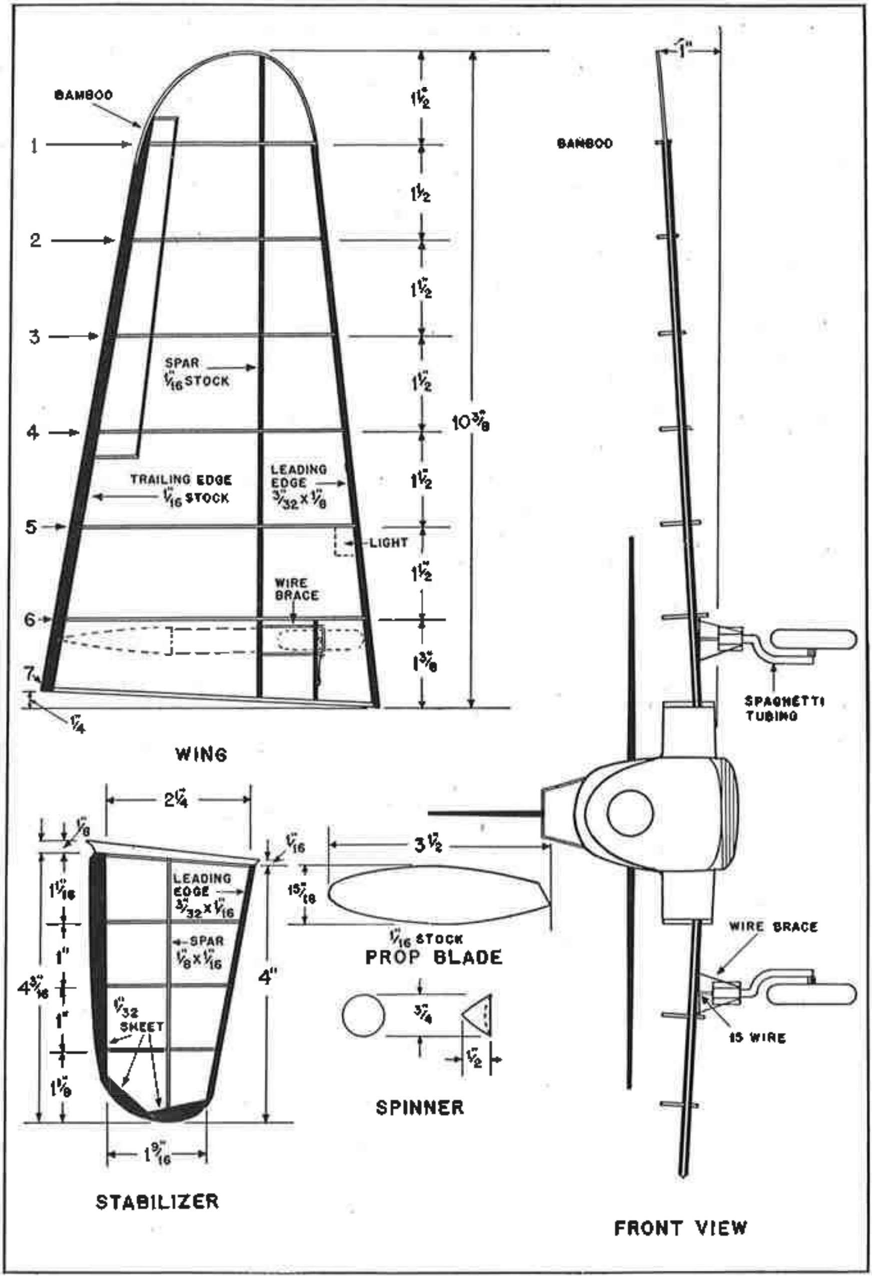
STABILIZER. This is made in two parts, as shown in Plan 3. Cut all parts to proper size. The fillets shown in the plan are carved from soft balsa and cemented in place when the structure is assembled. When completed, cover each half with tissue and set aside to dry.

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

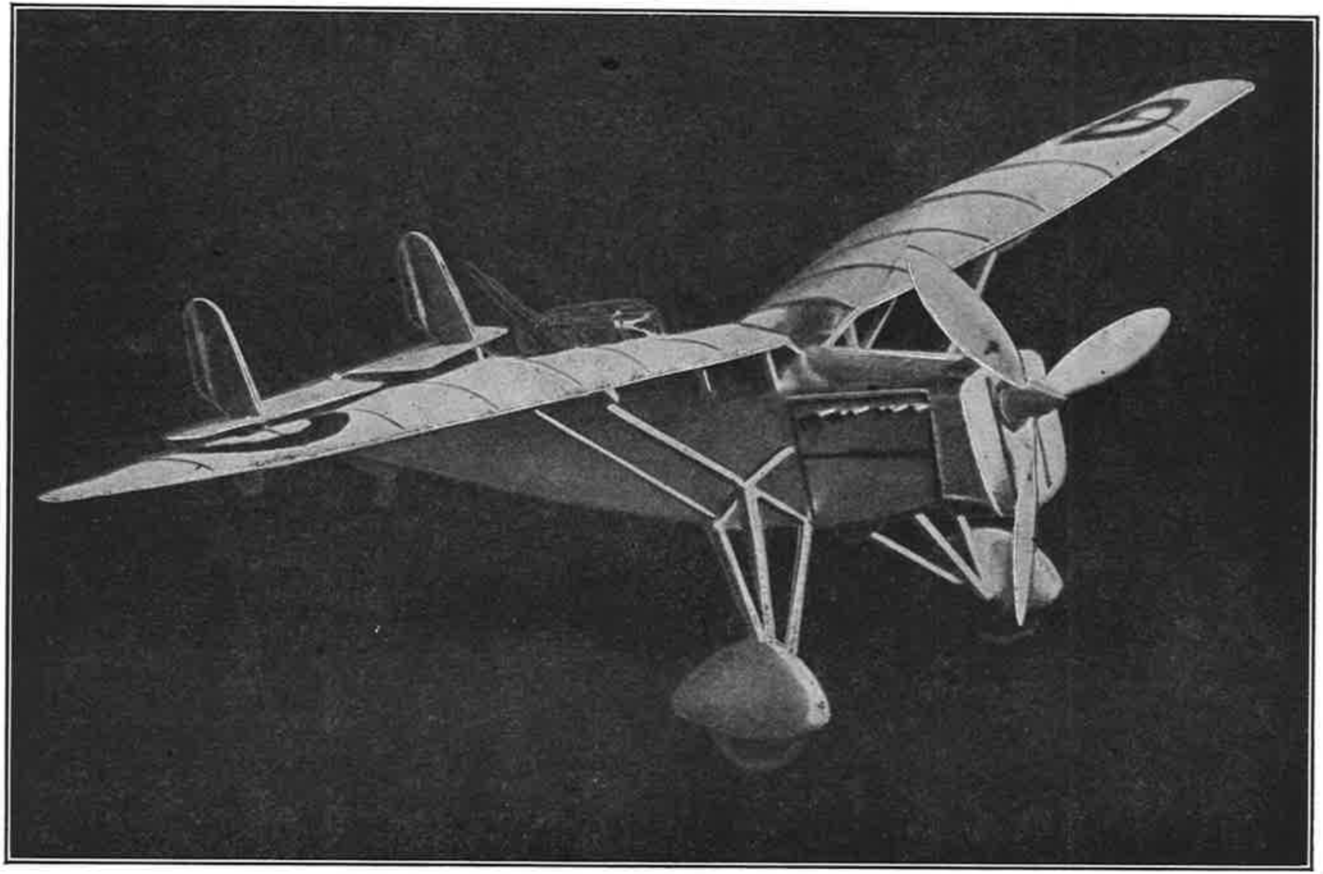
MUREAUX 180-C2 PURSUIT

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

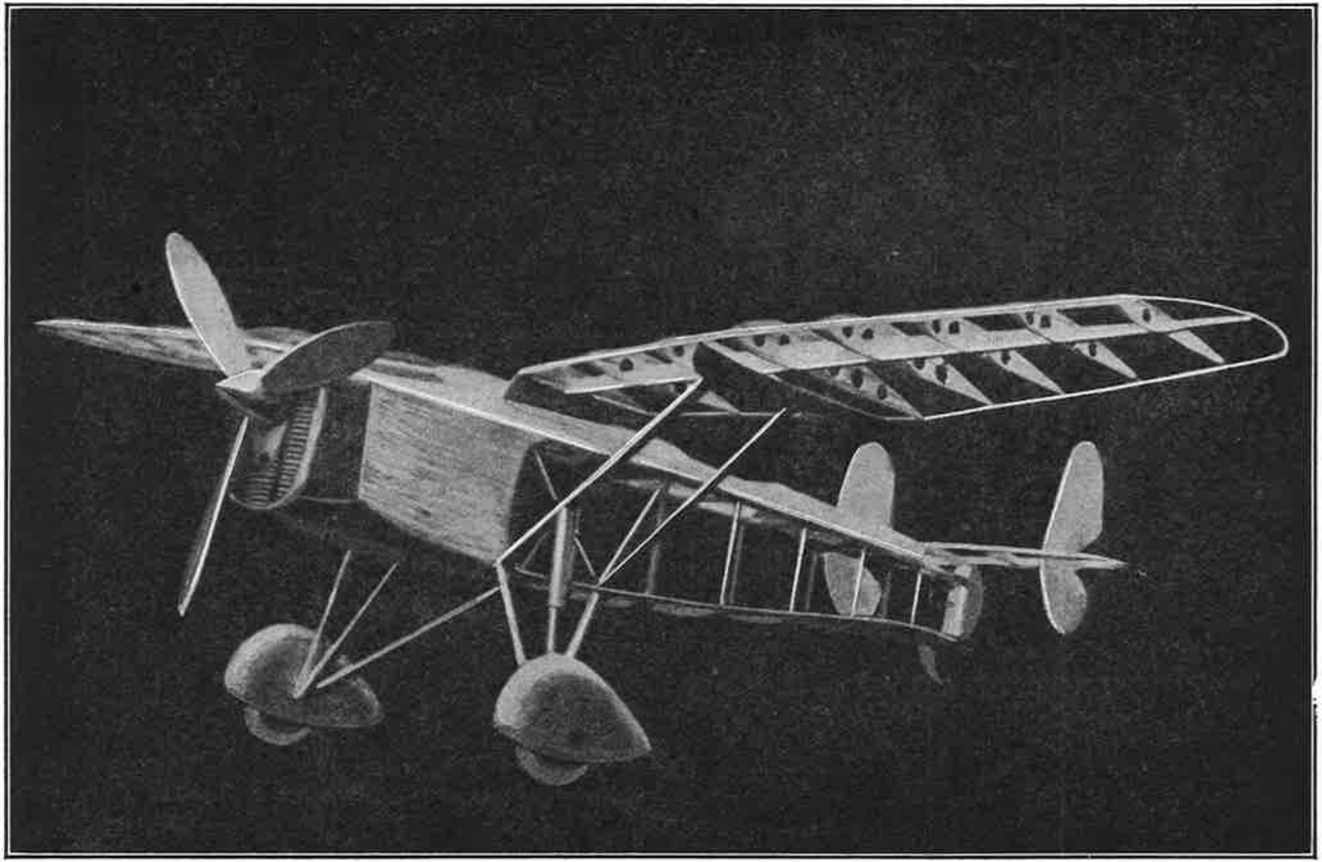
1 sheet—1″ x 7″	—Aluminum (cowling)
1 pc. —⅛″ x 7′ 0″	—Rubber
3	—Dural washers
1 pc. —12″ long	—.028 piano wire
1 pc. —⅛″ x 6″ long	—O. D. aluminum tubing

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 ¼″ 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

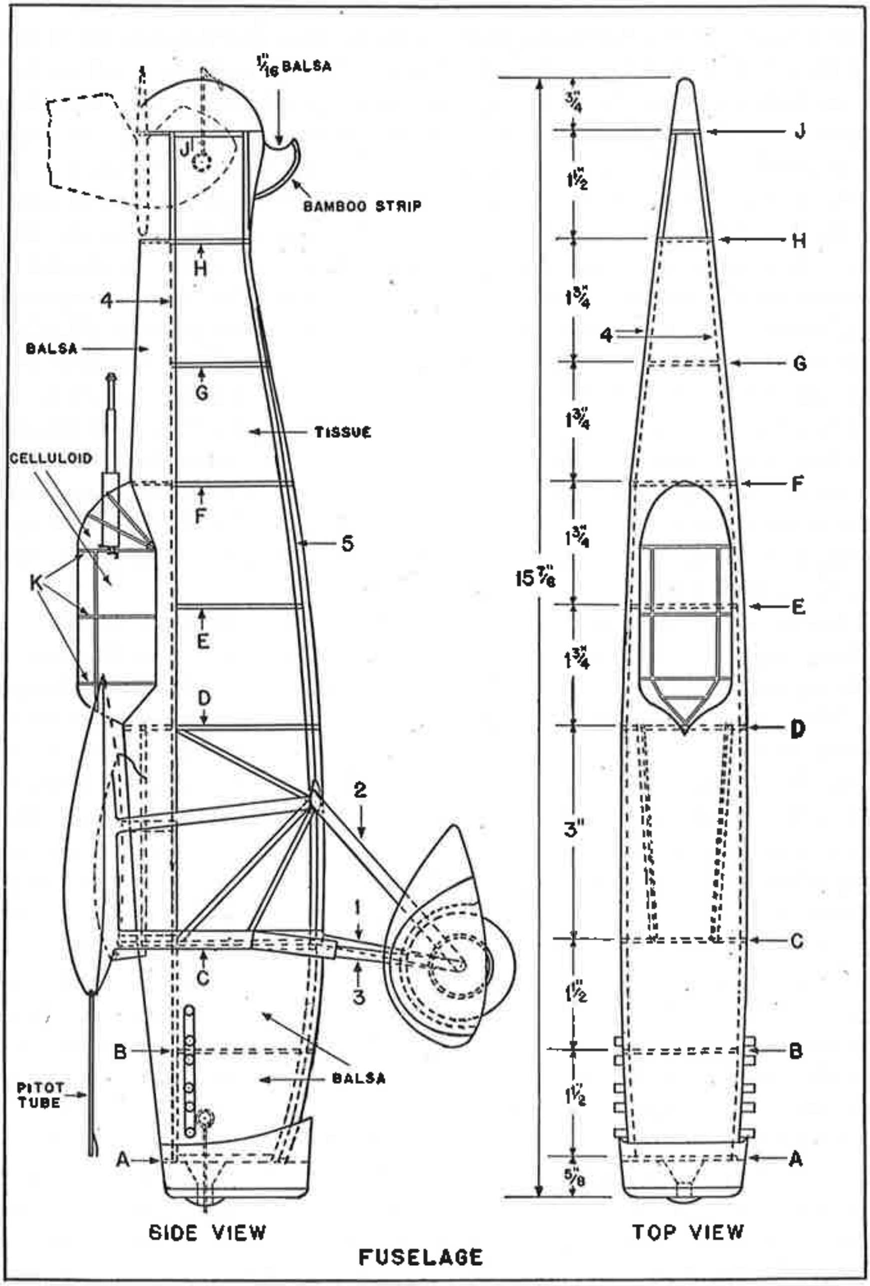


MUREAUX 180-C2 PURSUIT SKELETON

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 ⅛″ 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 ¼″ 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



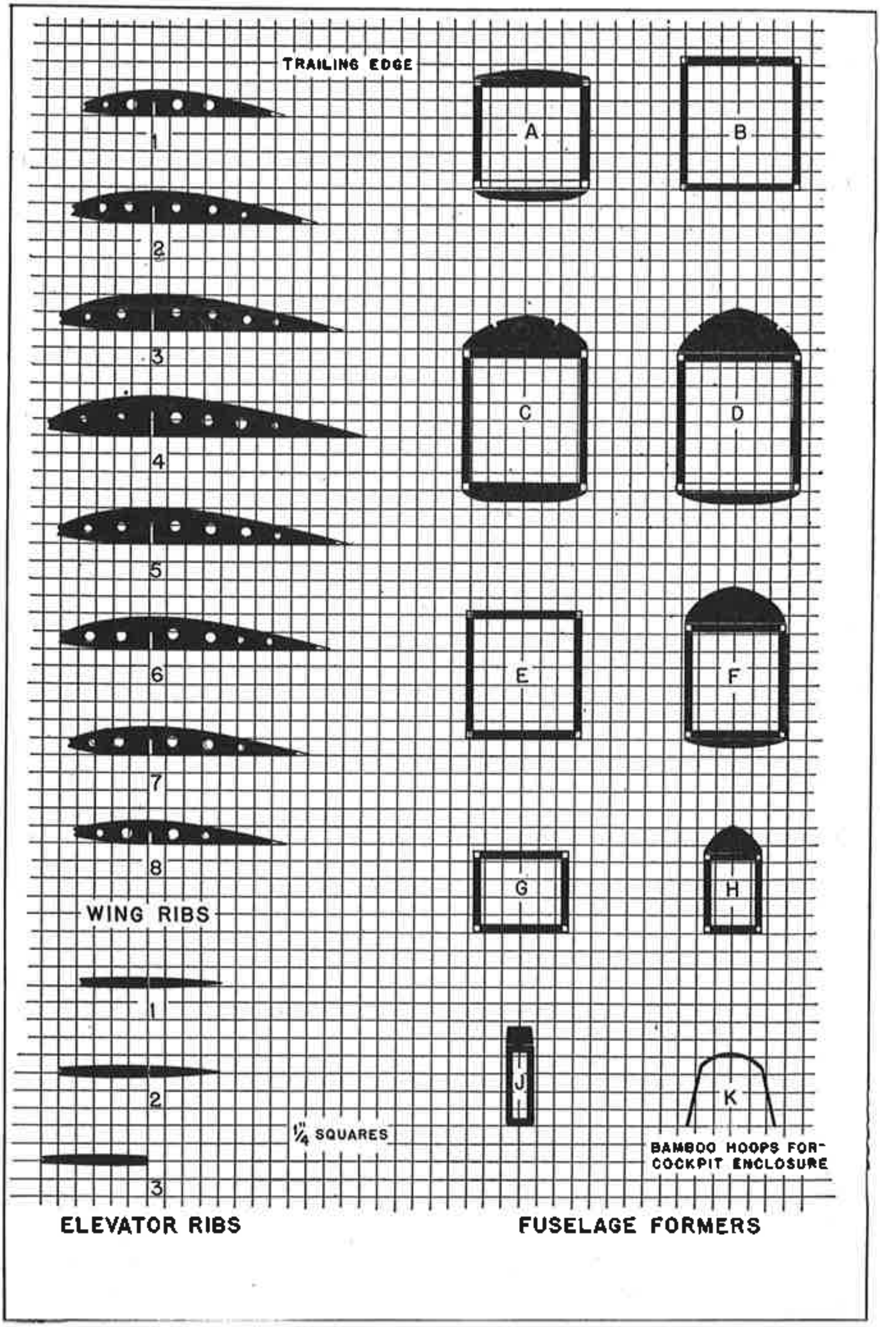
MUREAUX 180-C2 PURSUIT PLAN 1

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.

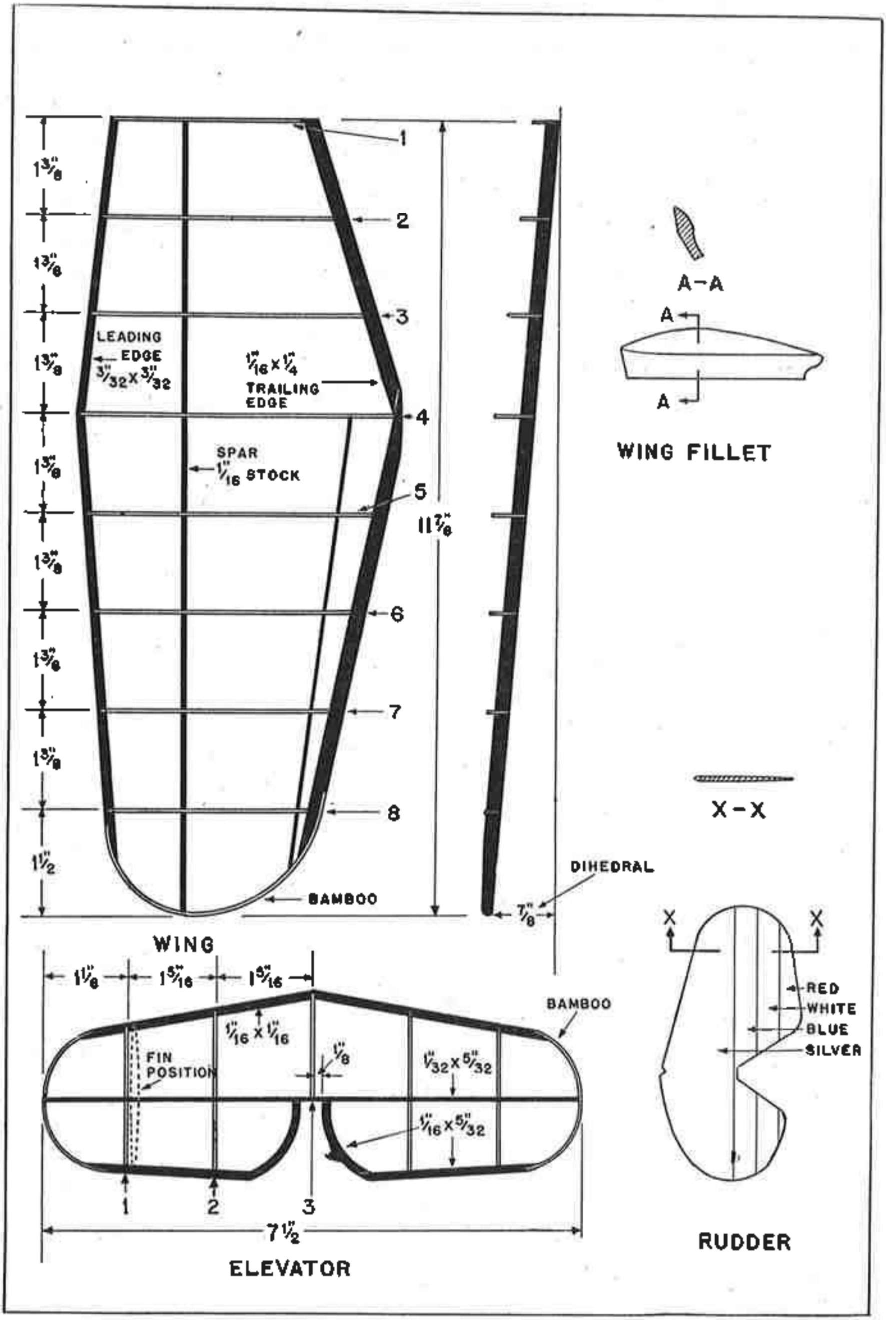
TAIL SKID. The fuselage with its tail unit is completed by adding the tail skid, which is shown in detail in Plan 4. A tail block is cut from hard balsa measuring 3/8" x 3/4" x 1 3/8". It should be carved to the shape shown in the plan, and then slit to receive the balsa skid. This piece is then cut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

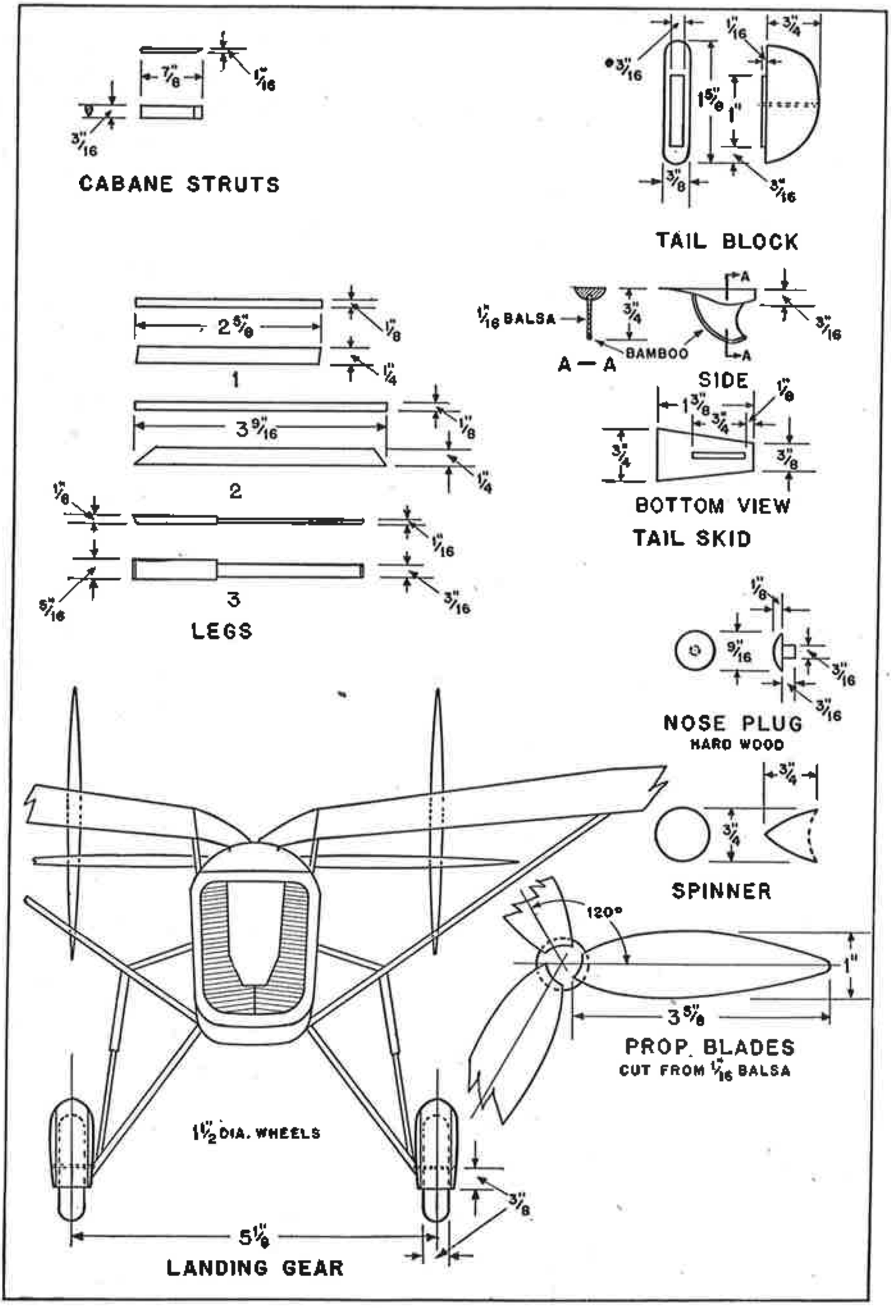
WING. One half of the wing is shown in detail in Plan 3. As will be seen, this is actually the left half when looking at the model from its tail surfaces forward. The right half is made exactly the same with the ribs reversed. The ribs for the wing are shown in Plan 2 under "Wing Ribs." These are drawn 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 readv to be mounted. Note that each wing tip



MUREAUX 180-C2 PURSUIT PLAN 4

is given a $\frac{7}{8}''$ 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 $\frac{1}{8}''$ 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 $1\frac{7}{16}''$ 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 $\frac{7}{8}''$ 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 $1\frac{7}{16}''$ wide, or high, and $3\frac{1}{8}''$ long. If the original stock of $\frac{9}{16}''$ was used, this must then be split into two pieces of $\frac{9}{32}''$ thick. These are then carved out to take a $1\frac{1}{2}''$ diameter wheel $\frac{3}{8}''$ 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 $5\frac{1}{8}''$ 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.

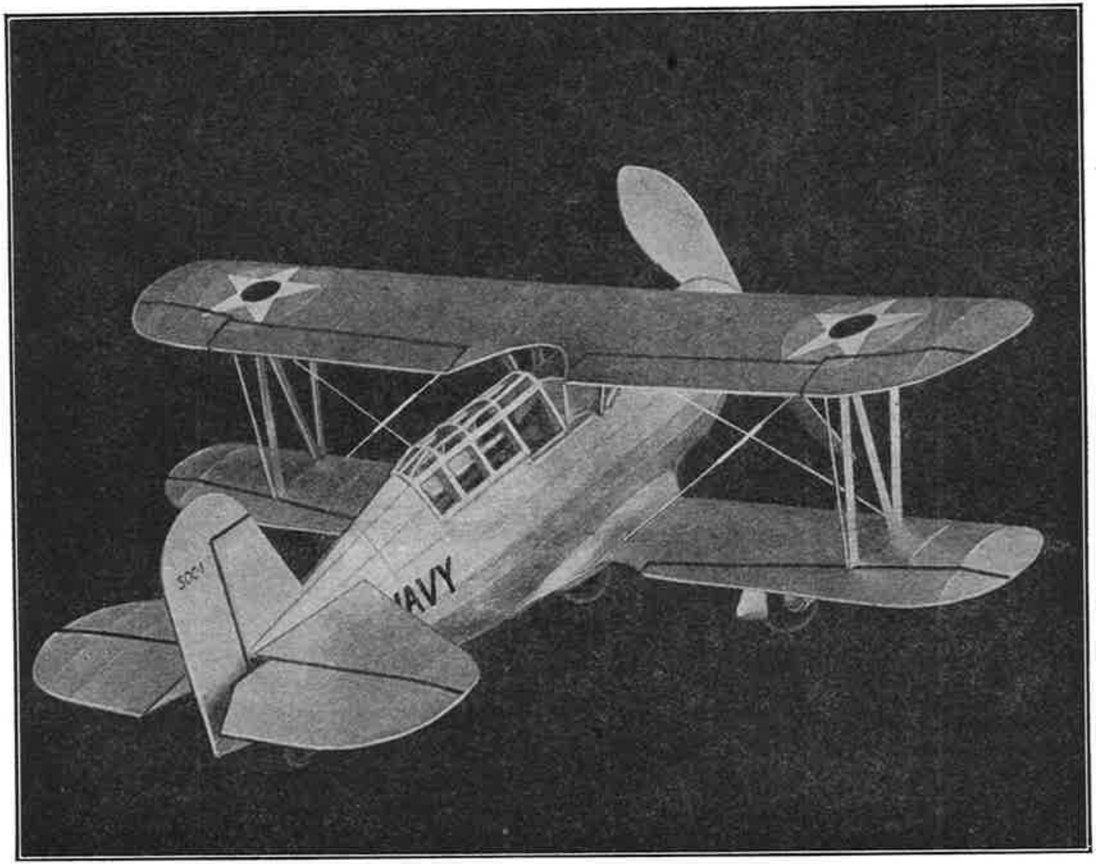
MATERIAL LIST

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

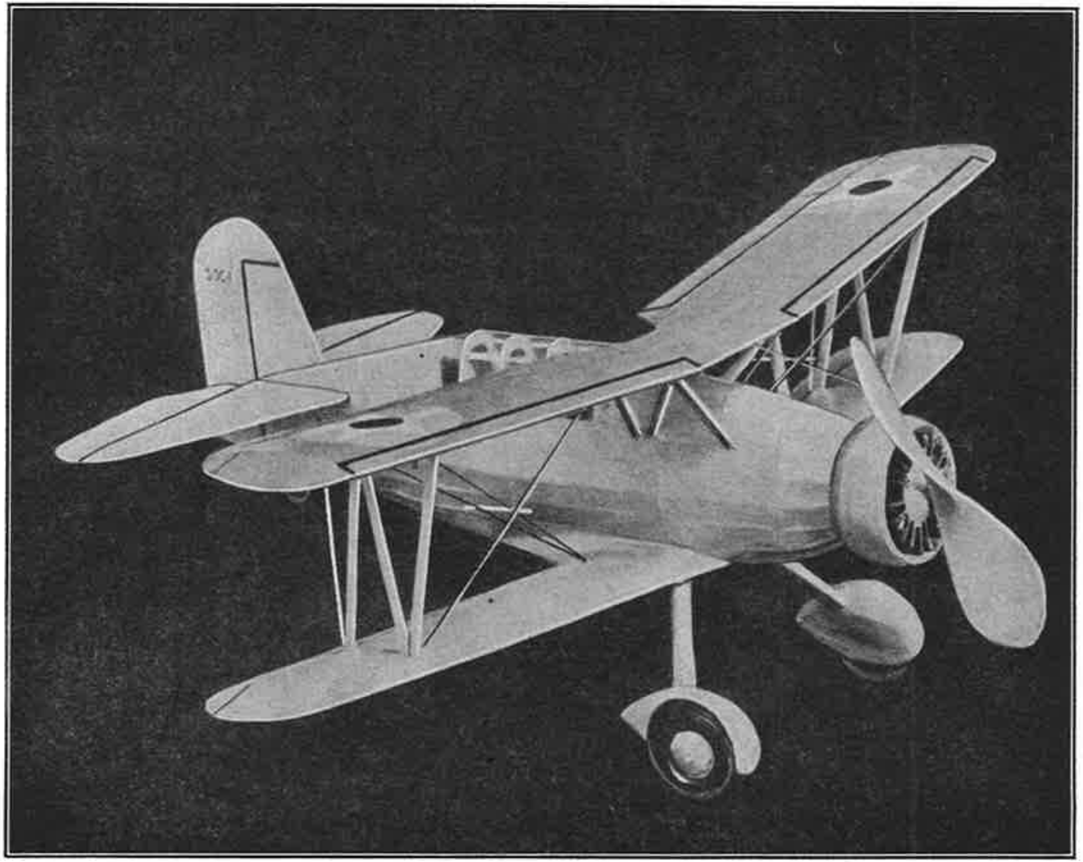


CURTISS SOC-1 NAVY SCOUT

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.

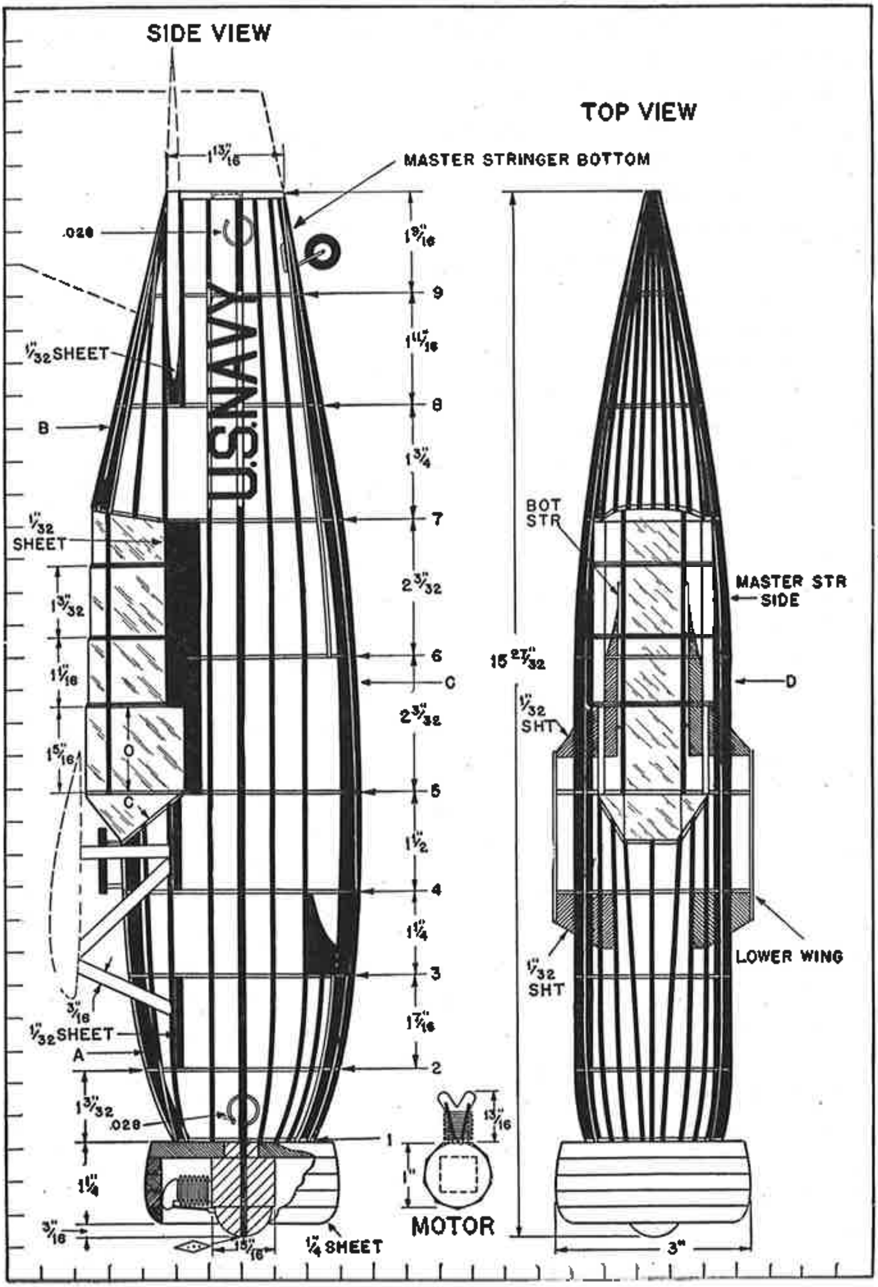
The cockpit overhang located on each side of the cockpit between formers "5" and "7" is shown in solid black in the side view of Plan 1. Both these pieces are cut from 1/32" sheet balsa. The lower portion of the fuselage between formers "3" and "4" is also covered with 1/32" sheet balsa to act as a support 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 I 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



CURTISS SOC-1 NAVY SCOUT

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.

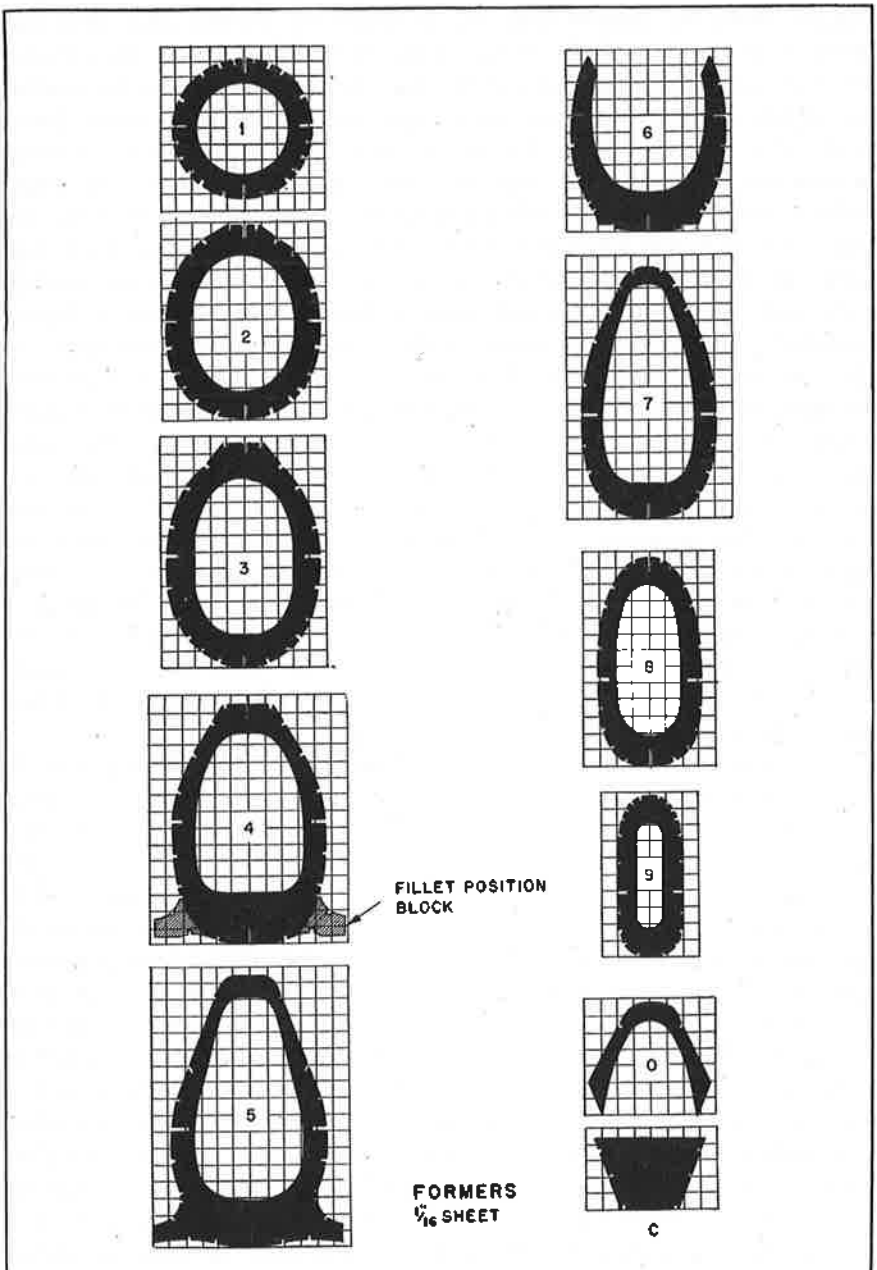
LANDING GEAR. The landing gear of this model consists of two wheels, two wheel pants and two landing gear struts. The assembly and its various parts are shown in Plan 4 under "Landing Gear." The pants are made up of two pieces each. Both these pieces are shown on squares representing 1/4" each. One is 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



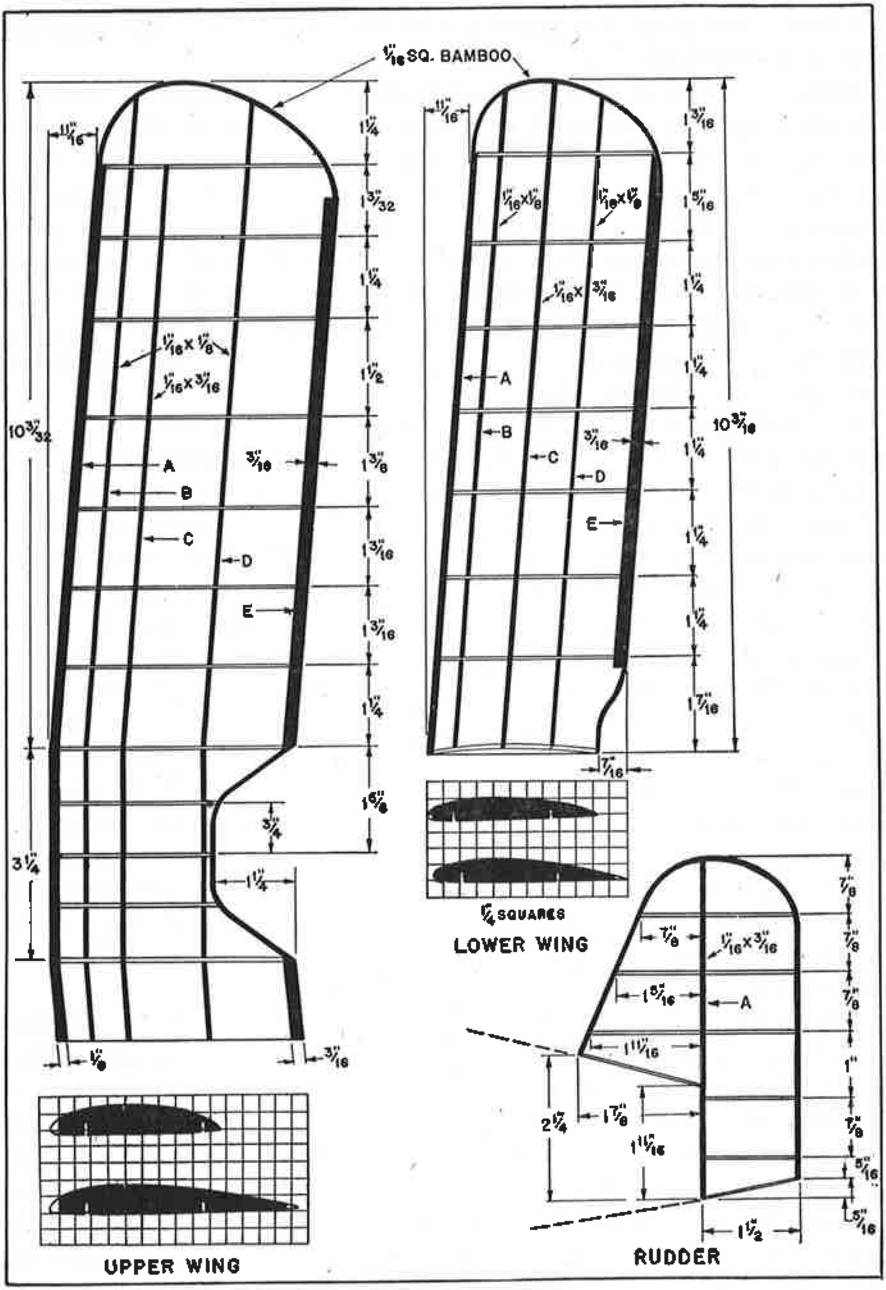
CURTISS SOC-1 NAVY SCOUT PLAN 2

in place. Shave the ends of spar "B" to match the leading edge slant and cement it to the end of the $2^{11}/_{16}''$ 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 11/16" 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 $\frac{1}{16}''$ x $\frac{1}{8}''$. 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 $1\frac{1}{16}''$ 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 $\frac{1}{16}''$ 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 $\frac{3}{4}''$ 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 $\frac{1}{32}''$ x $\frac{1}{4}''$ 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 $2\frac{1}{2}''$ 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 $\frac{1}{16}''$ x $\frac{3}{16}''$ 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 $1\frac{3}{16}''$ long. The center ones are $2\frac{3}{16}''$ long. The trailing struts are $1\frac{9}{32}''$ 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

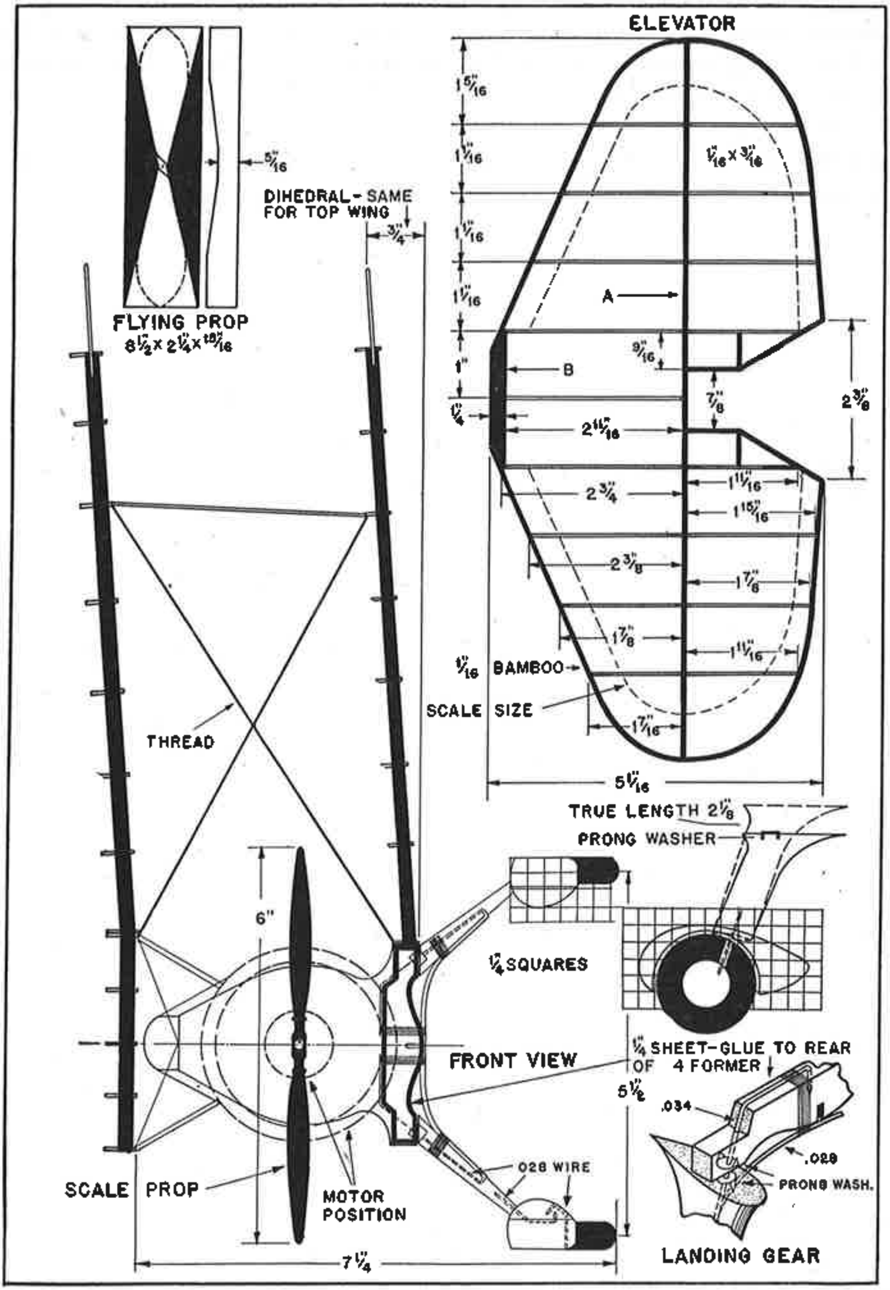
This insures fast joints. The paper around the struts can be easily replaced, sprayed, and then painted.

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 $\frac{1}{16}''$ thick and $\frac{3}{16}''$ wide. The leading and trailing struts are $4\frac{1}{8}''$ 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 $\frac{1}{4}''$ sheeting. The first four are laminated roughly and cut out $2\frac{1}{2}''$ in diameter with a jig-saw when dry. The rear ply has a $\frac{1}{2}''$ 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 $1\frac{3}{16}''$ thick. It is shaped for $\frac{3}{4}''$ 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 $\frac{1}{4}''$ thick and $\frac{1}{2}''$ 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 $\frac{15}{16}''$ x $2\frac{1}{4}''$ x $8\frac{1}{2}''$ 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 $\frac{1}{8}''$ 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

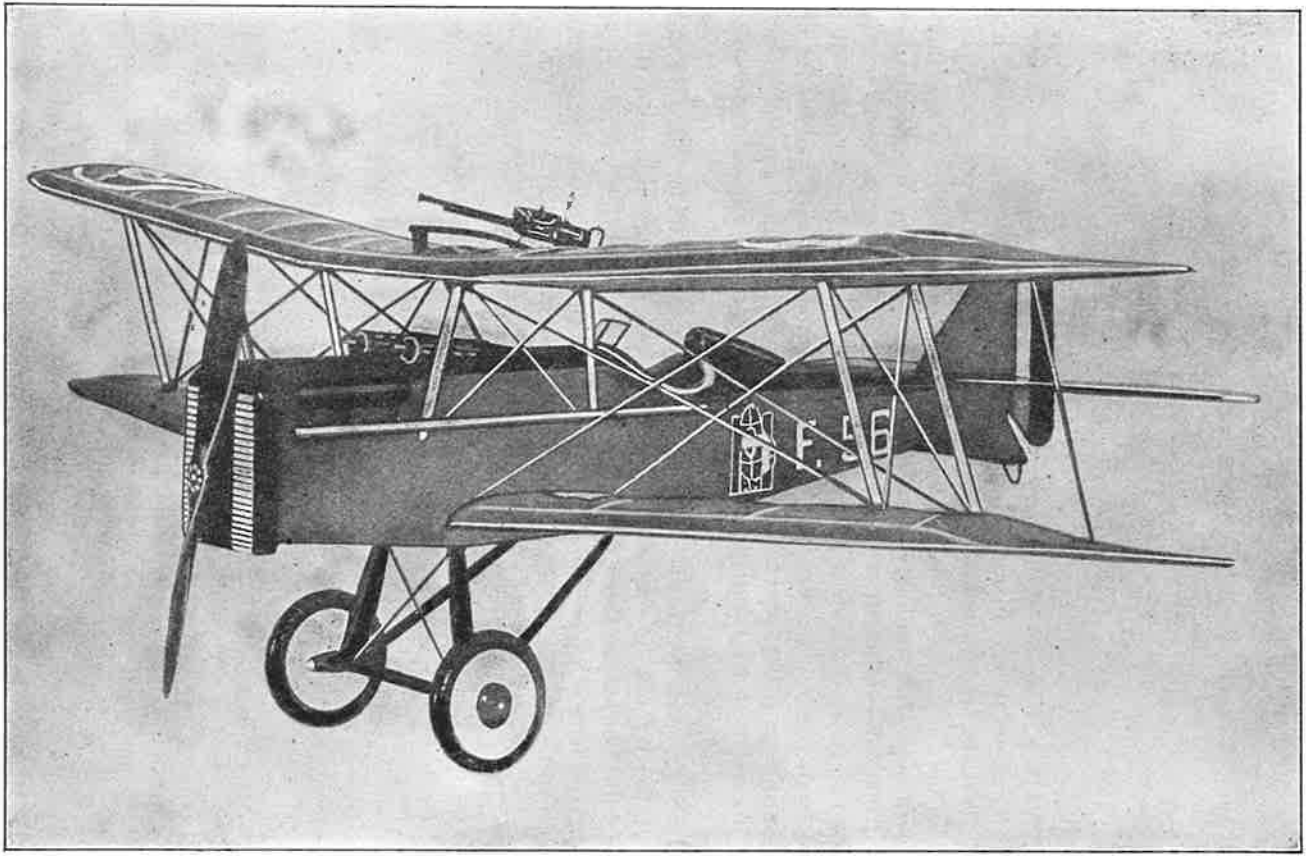
S. E. 5

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

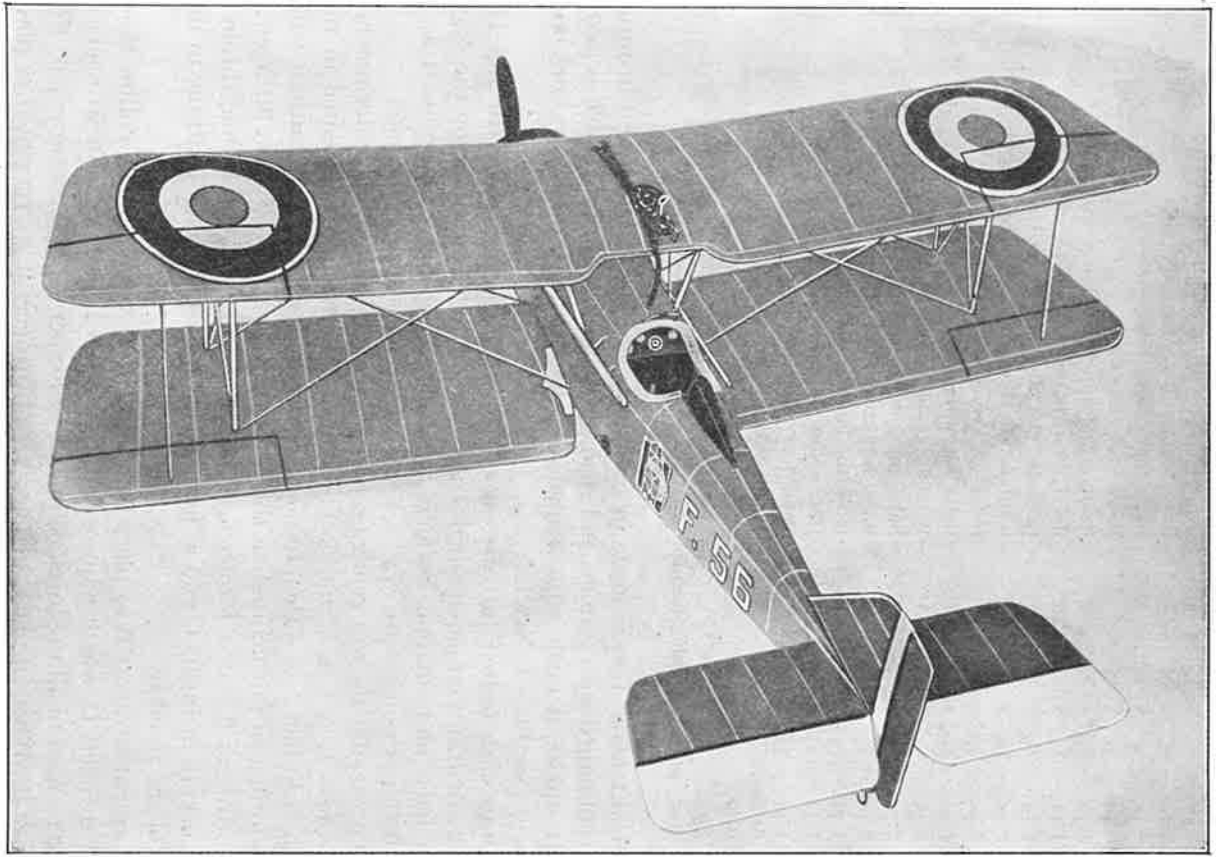
2 pcs.– 1/8″ x 1/4″ x 7 1/2″	–Balsa for leading inner wing spars (H)
2 pcs.– 1/8″ x 1/8″ x 7 15/16″	–Balsa for trailing inner wing spars (I)
2 pcs.– 1/8″ x 1/4″ x 7 3/4″	–Balsa for trailing edge spars (J)
2 pcs.– 1/8″ x 1/8″ x 5/8″	–Balsa for trailing edge spars (L)
2 pcs.– 1/8″ x 1/8″ x 1/2″	–Balsa 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

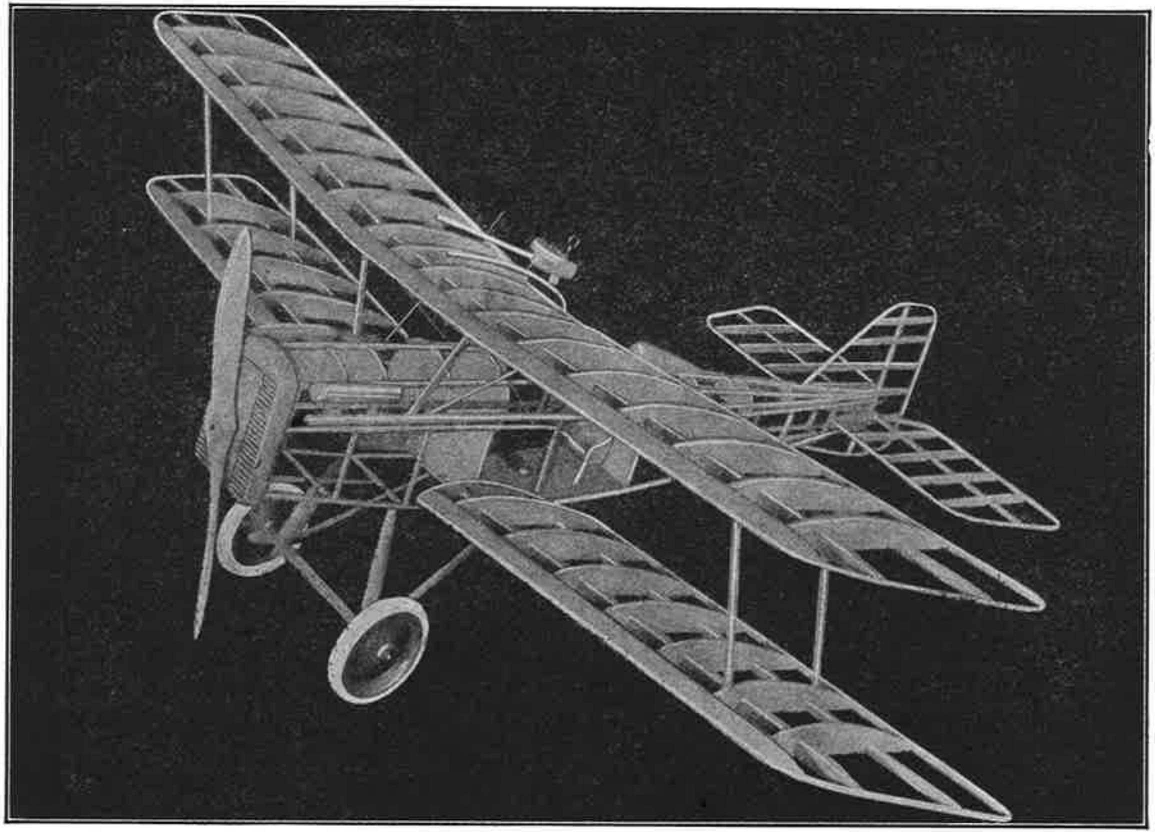
S.E.5

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 1/16" x 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 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.

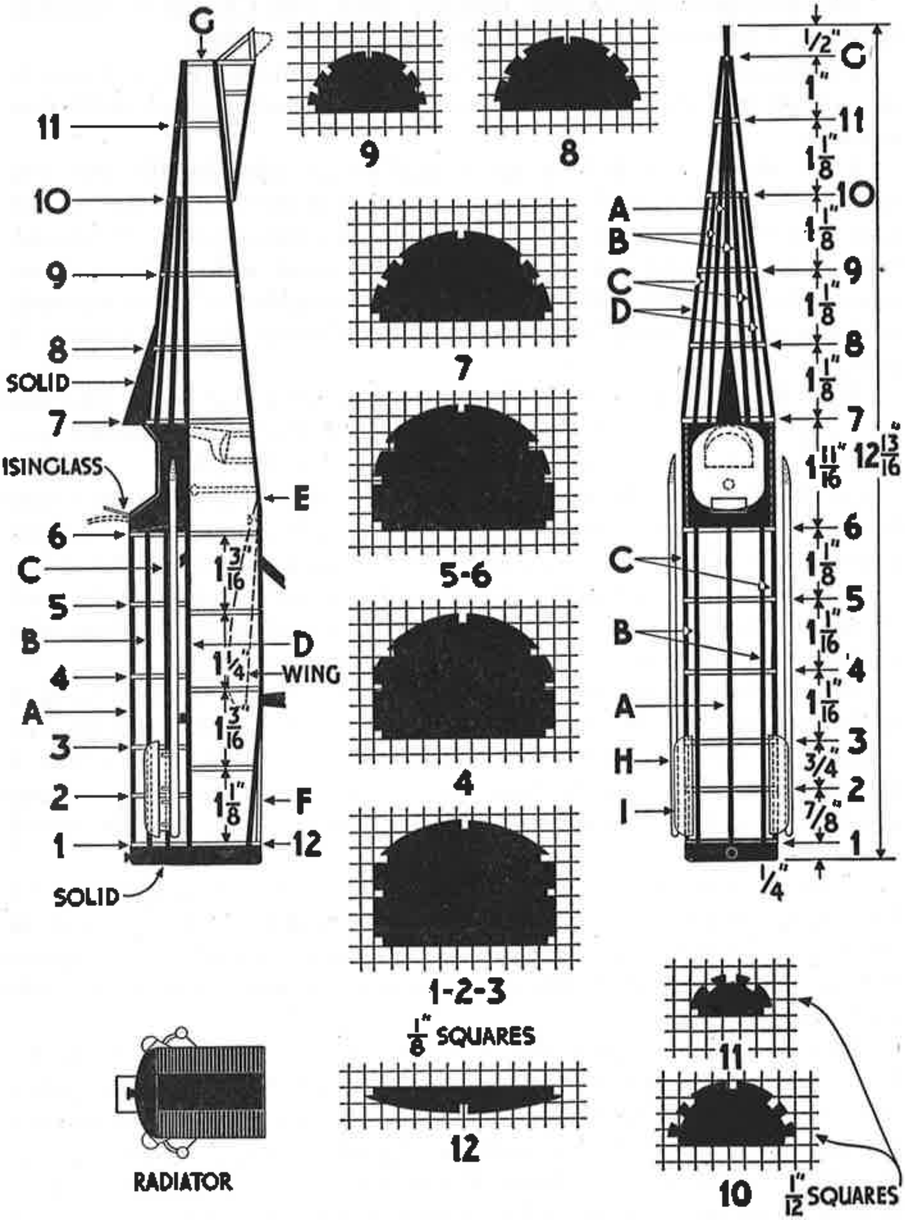
ELEVATOR. This is built of eight 1/16" x 1/8" x 2 1/8" balsa ribs, two 1/16" x 1/8" x 1 1/8" center C ribs, one 1/16" x 1/16" x 6 1/2" inner elevator spar, and a 1/16" x 1/16" bamboo outline edge piece, as in Plan 3.

Cut the eight straight ribs, streamline them, and cut a 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 1/16" x 1/8" balsa ribs, one 1/16" x 1/16" x 2 1/16" balsa inner spar A, and a 1/16" x 1/16" split bamboo outline piece. The ribs are 3/4", 2 3/4", 2 1/4", 1 3/4" and 1 3/8" long, counting from the bottom rib up. Cut these ribs, streamline each, and cut a 1/16" square hole 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.

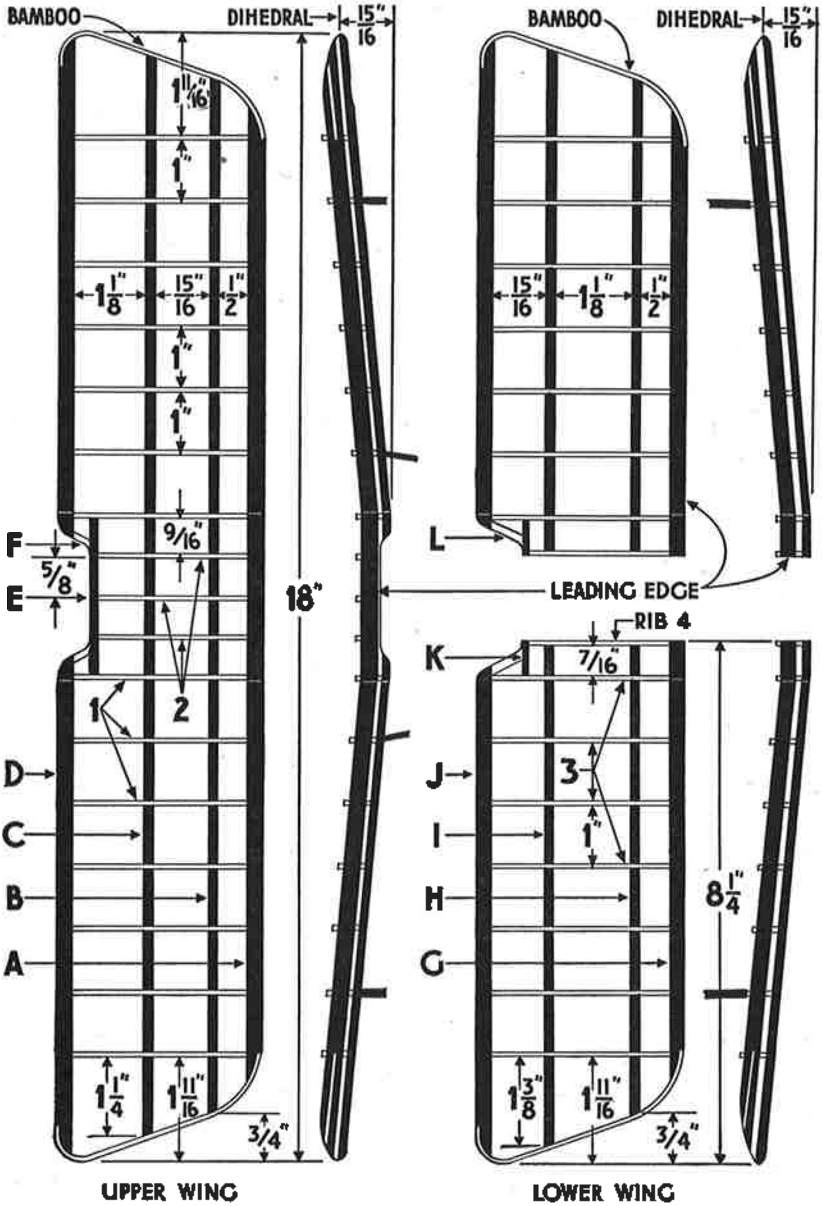
WINGS (Upper Wing). This is made in one piece. Its ribs are shown in graph in Plan 3 under "Wing Ribs." Draw full-size copies of these ribs on 1/4" squares. Fourteen No. 1 ribs and three No. 2 ribs are traced on 1/16" sheet balsa, cut out, and properly notched. The leading notch is 1/8" x 1/4", while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

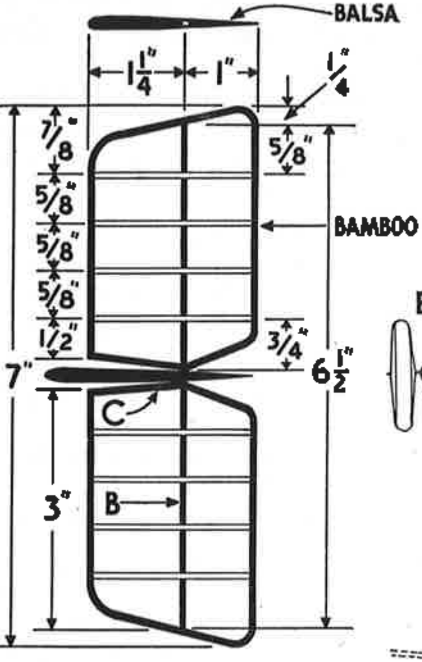
The wing is covered on both sides with Japanese tissue, water-sprayed, and finished with dope.

(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 $1/8'' \times 1/4''$ and $1/8'' \times 1/8''$.

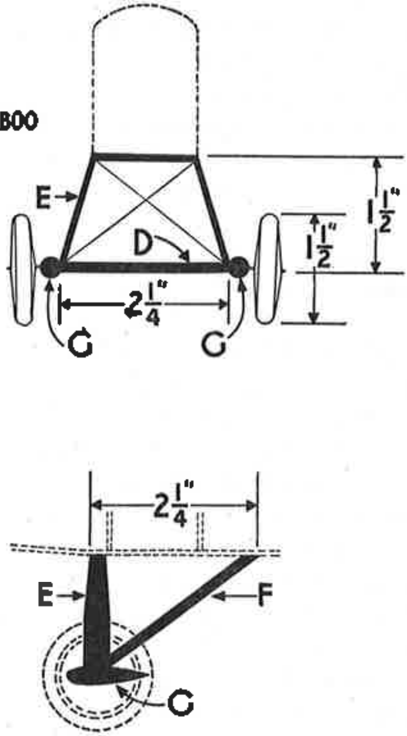
The leading edge spar G is $1/4'' \times 1/4'' \times 7''$ long for each wing. It is shaped like the corresponding spar of the upper wing. The leading inner wing spar H is $1/8'' \times 1/4'' \times 7\frac{1}{2}''$ long, and the trailing inner wing spar I is $1/8'' \times 1/8'' \times 7\frac{15}{16}''$ long for each half. The trailing edge spar J is $1/8'' \times 1/4'' \times 7\frac{3}{4}''$, and is shaped like the trailing edge spar of the upper wing. The short spars K are $1/8'' \times 1/8'' \times 1/2''$, while the trailing edge spars L, which join K and J, are $1/8'' \times 1/8'' \times 5/8''$ 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.

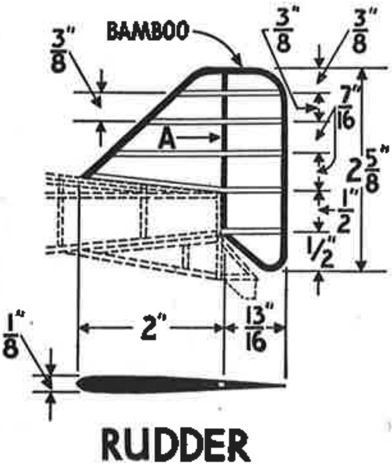
The upper wing is attached above the fuselage by means of center section struts, and outer wing struts connect it and the lower wing. The four center section struts are $1/16'' \times 1/8'' \times 1\frac{3}{4}''$ balsa, streamlined, and finished with sandpaper. The leading pair of these struts extends 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



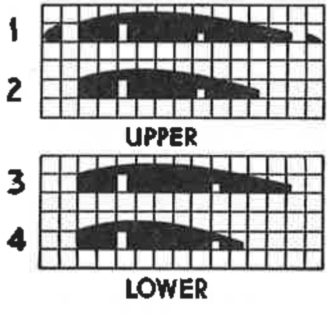
ELEVATOR



LANDING GEAR



RUDDER



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.

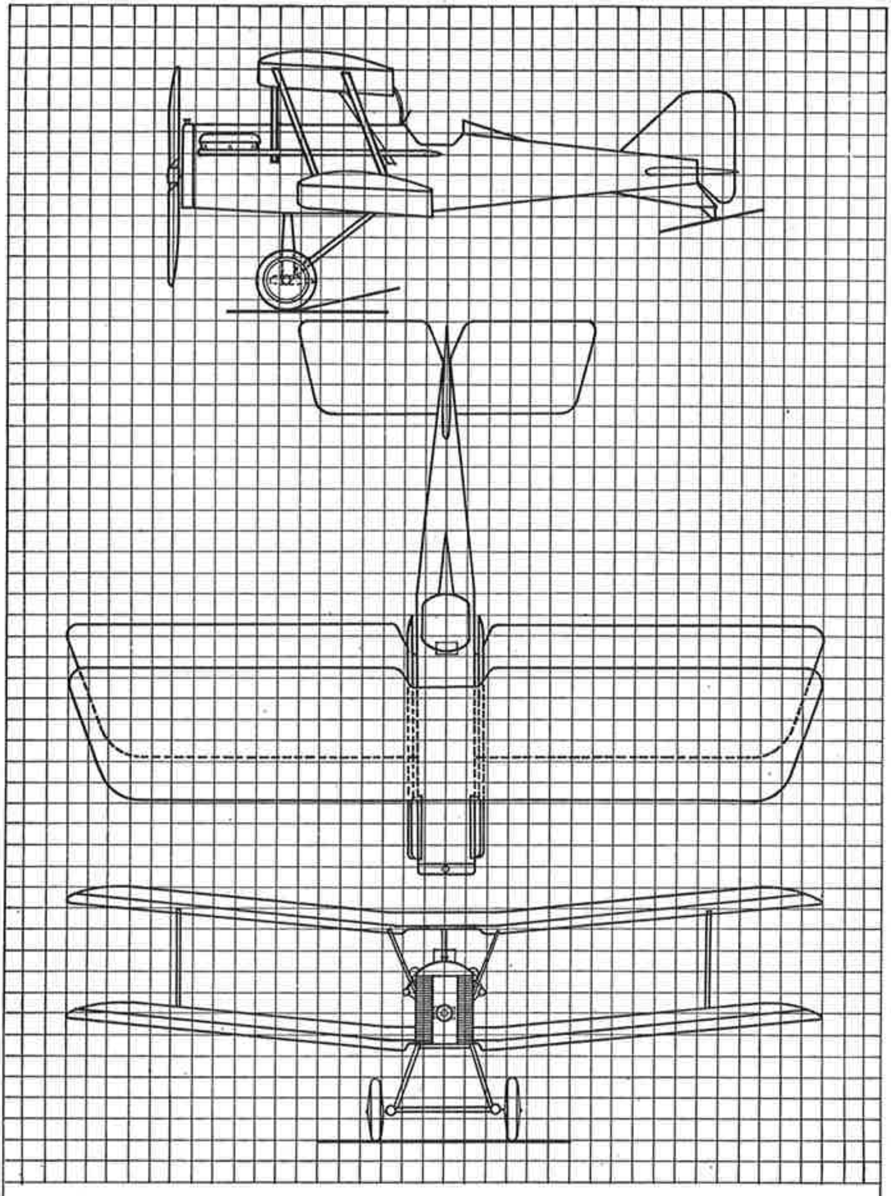
The trailing pair of these center section struts extends from stringers D on each side of the fuselage to the under sides of the No. 1 ribs on each end of the center section of the upper wing. They are located 3/8″ in front of former 6 on stringers D and on spar C on the No. 1 ribs. Cement these struts 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 $1/32''$ 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 $1/16''$ 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

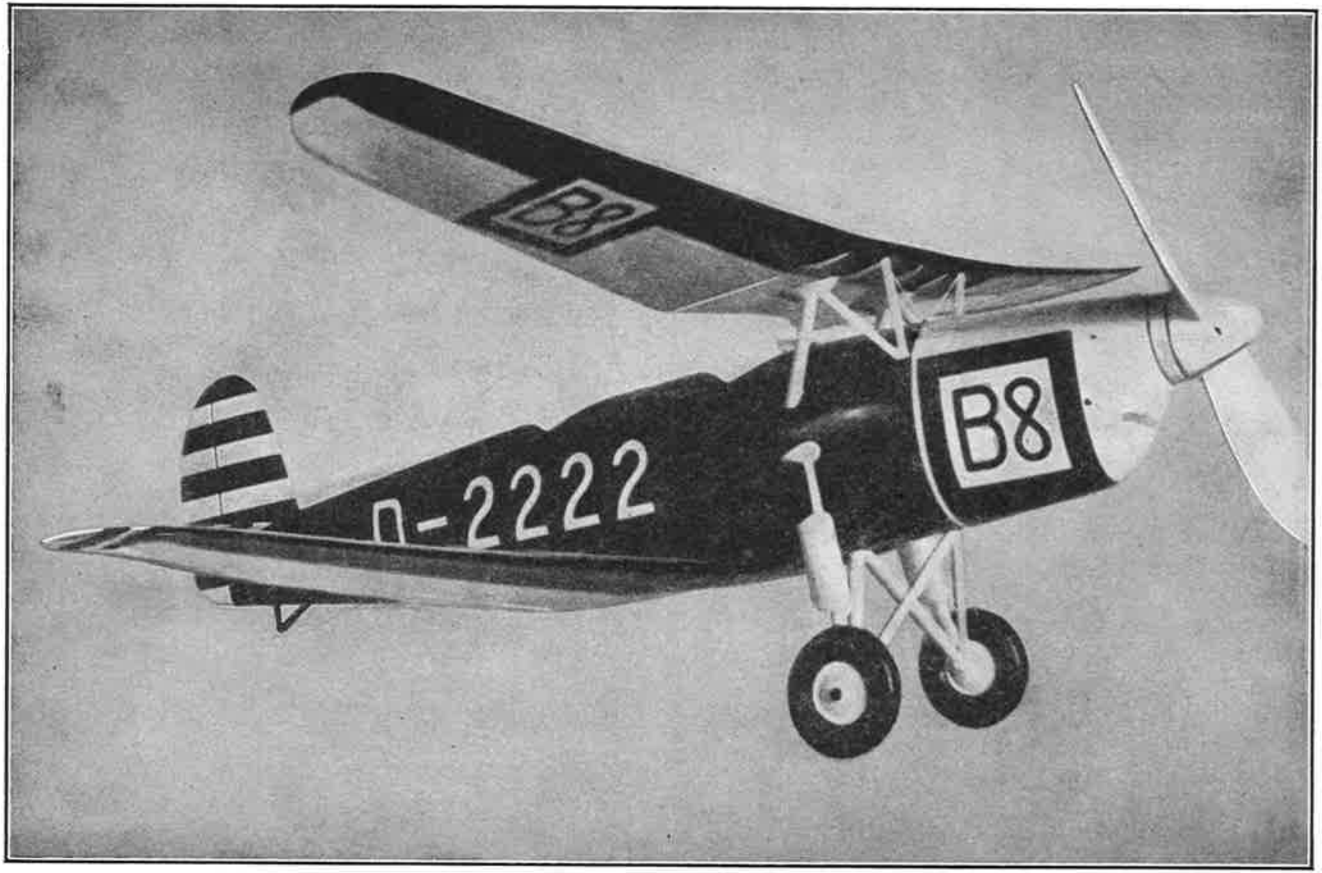
HERE is a modern German biplane the design of which follows along strikingly different lines than those usually found in planes of today. This is likewise true of several other German types of today. The Darmstadt D-22 is the product of The Darmstadt University Aviation Society (Academische Fliegruppe) 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

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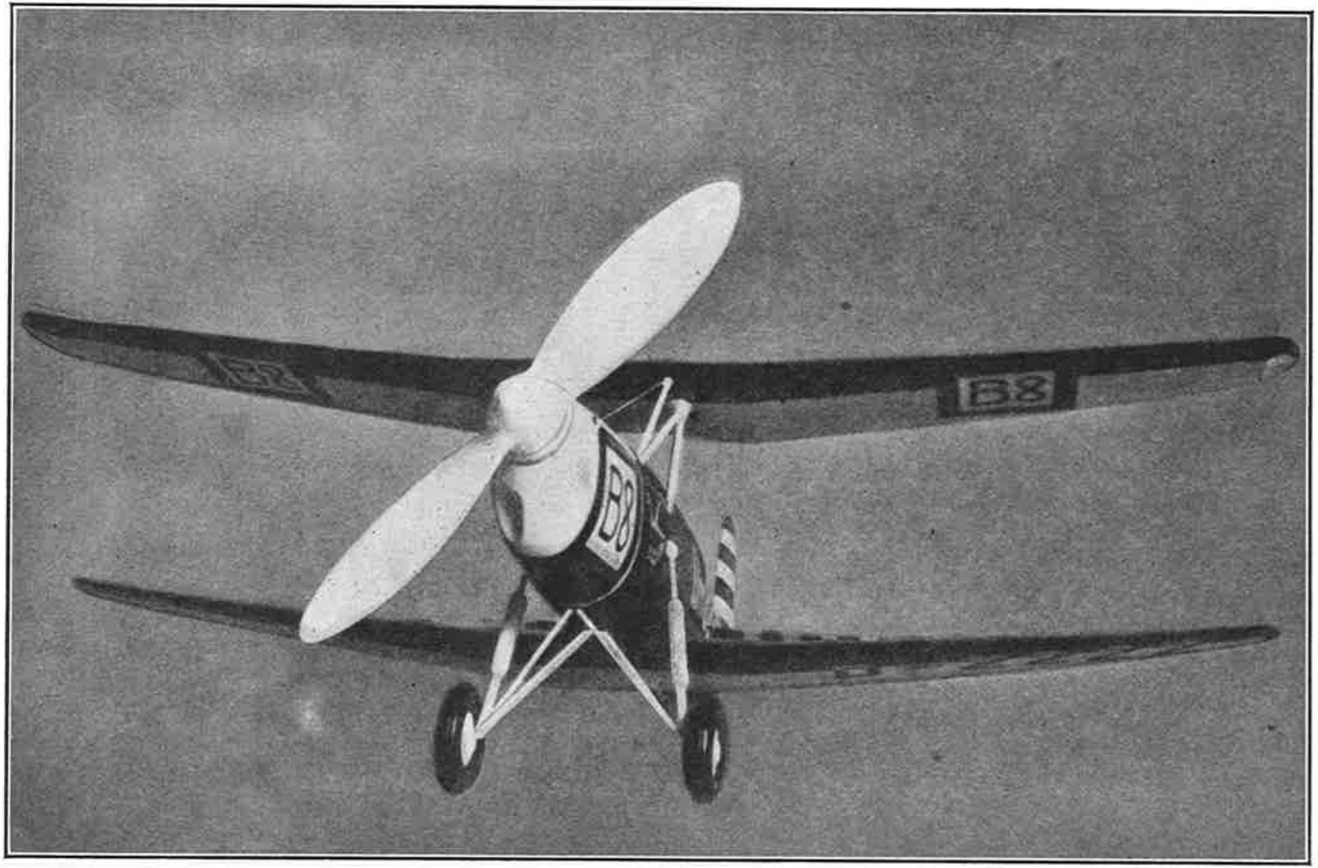
1 pc. —1/8" x 1/4" x 36"	—Balsa (Tail surface spars)
1 pc. —1/8" x 1/8" x 24"	—Balsa (Landing gear struts)
1 pc. —1/8" x 1/4" x 18"	—Balsa (Wing struts, Landing gear, etc.)
2 pcs.—1/4" x 5/8" x 1 1/2"	—Balsa (Landing gear struts)
1 pc. —1/16" x 1/8" x 12"	—Balsa (Tail unit struts, Tail skid)
1 pc. —1/64" 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

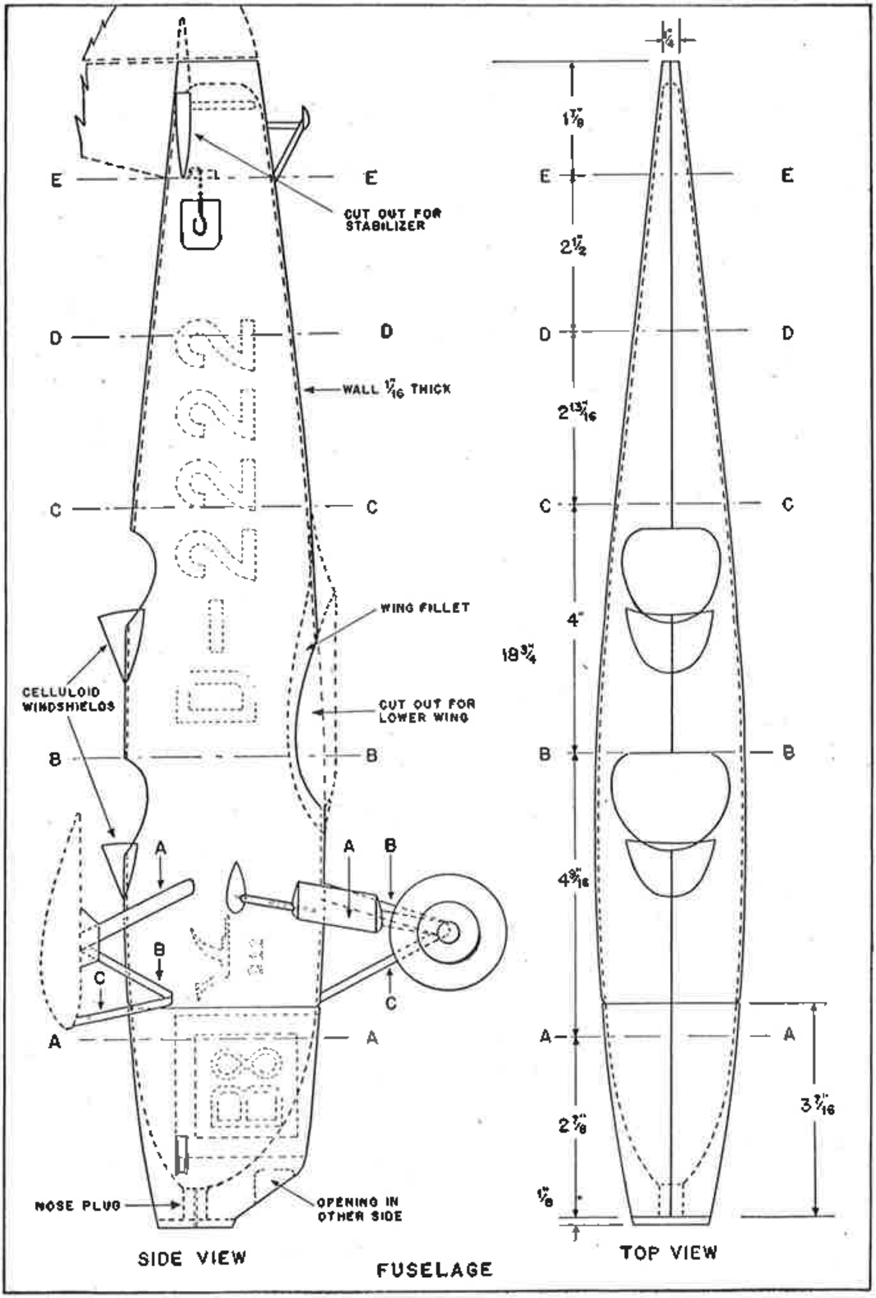


GERMAN DARMSTADT D-22

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.

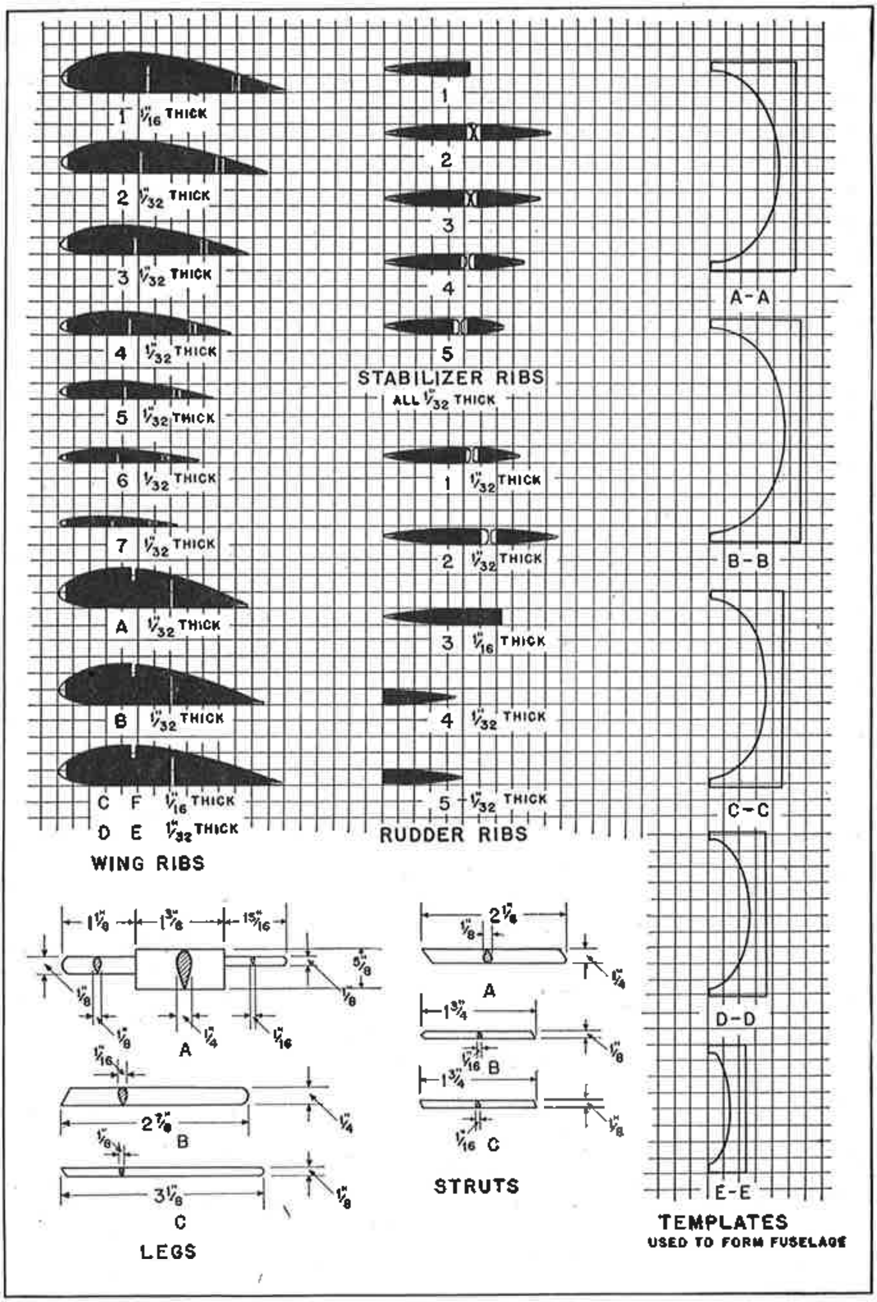
WINGS (Upper Wing). The upper wing is built in three main sections. These are the center-section, the left panel and the right panel. Both panels are duplicates. In Plan 3 the right panel is shown together with the center-section. The ribs for both wings are shown in Plan 2 under "Wing Ribs." These have 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

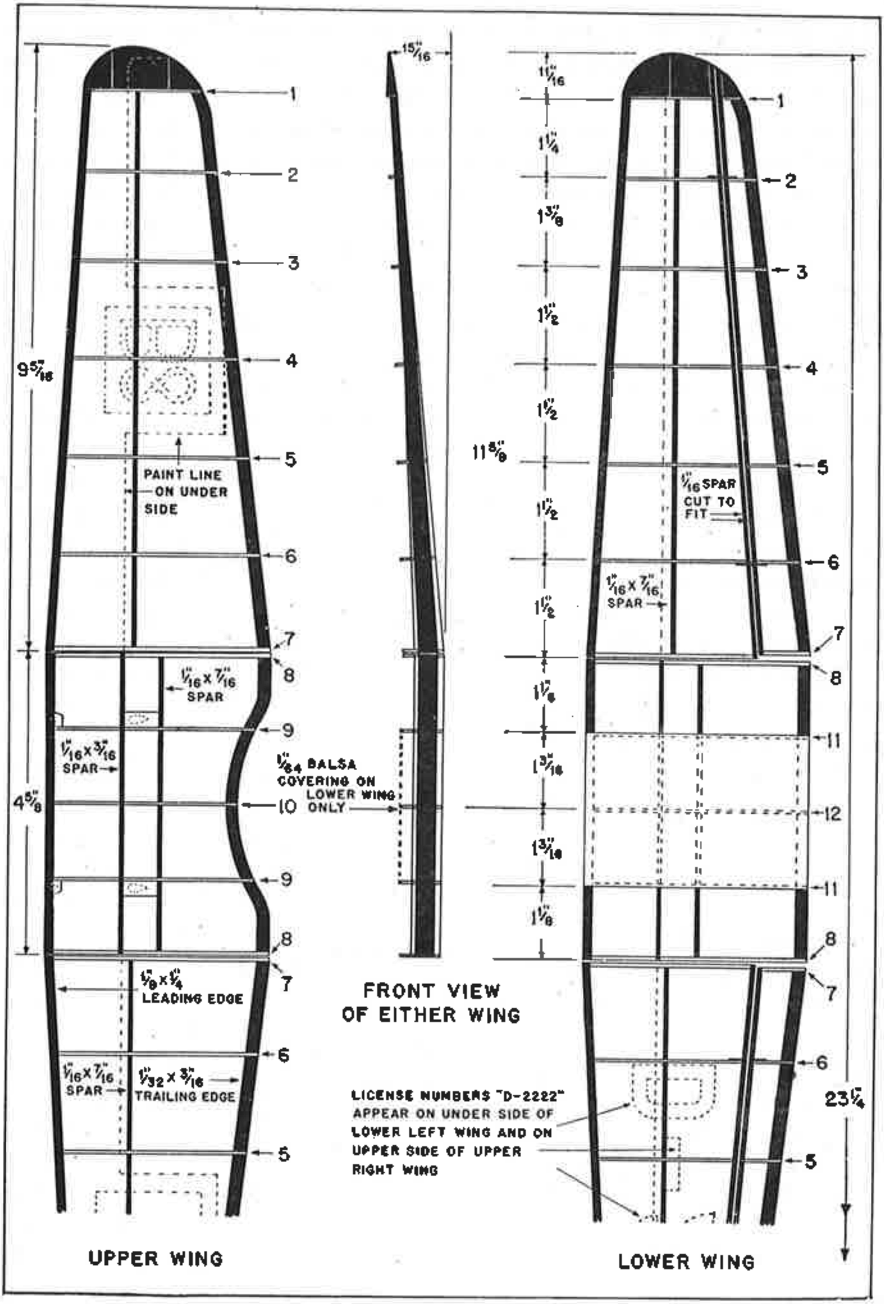
ing its inner end flat on the table, lift its tip 15/16″ above the bench. Move rib "8" until its face is flat against rib "7" of the tilted panel. Cement it in this position. The opposite end rib is then given its proper angle found in the same manner. When completed, cement the three sections together.

(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 $\frac{1}{32}''$ sheet balsa. It is $\frac{3}{16}''$ 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 $\frac{5}{8}''$ wide portion and the $\frac{1}{4}''$ part at the left are cut to shape and streamlined as shown from a single block. The short $\frac{1}{8}''$ 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 $\frac{1}{16}'' \times \frac{1}{4}'' \times 2\frac{7}{8}''$ 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 $\frac{1}{8}''$ square balsa streamlined as shown in its cross section. Make two of these also. The wheels are manufactured ones of $1\frac{7}{8}''$ diameter and are made of celluloid. These can be made of $\frac{13}{16}''$ 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.

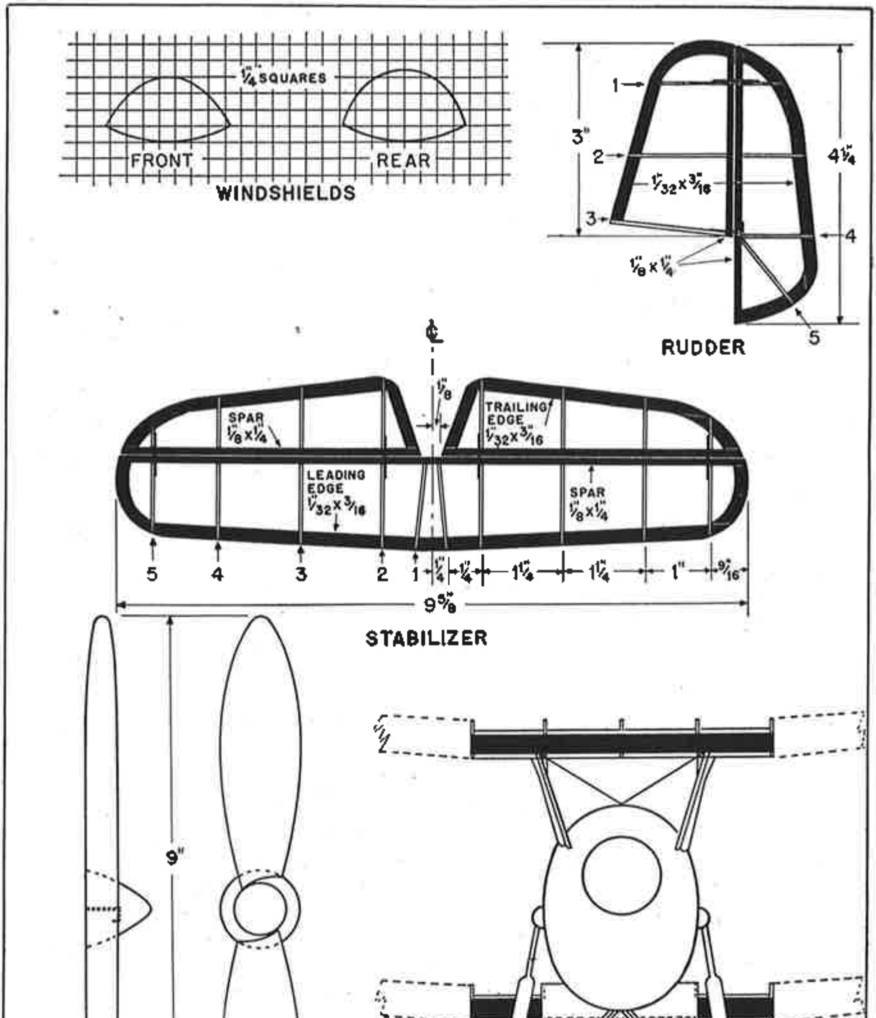


GERMAN DARMSTADT D-22 PLAN 3

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 $\frac{1}{8}$" 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.

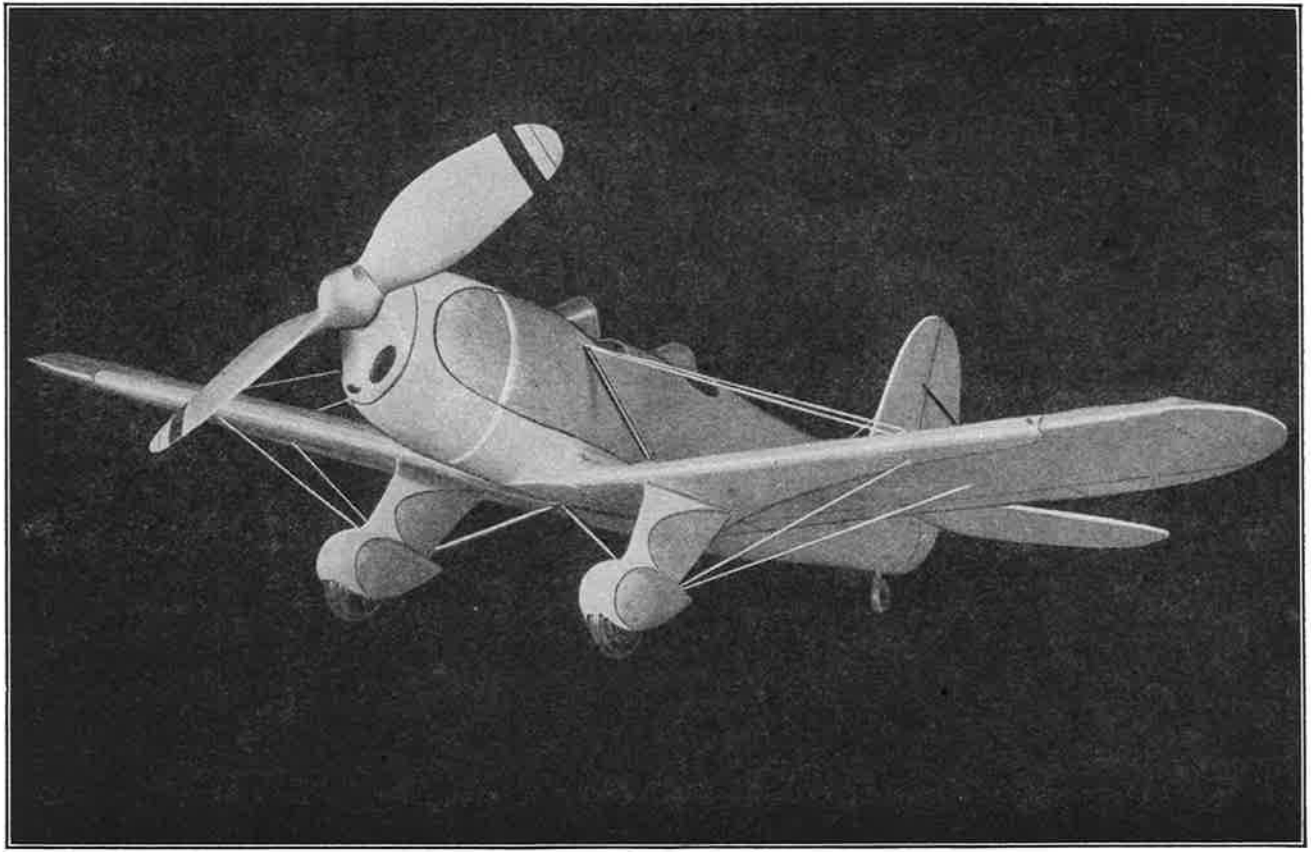
CHAPTER 51

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

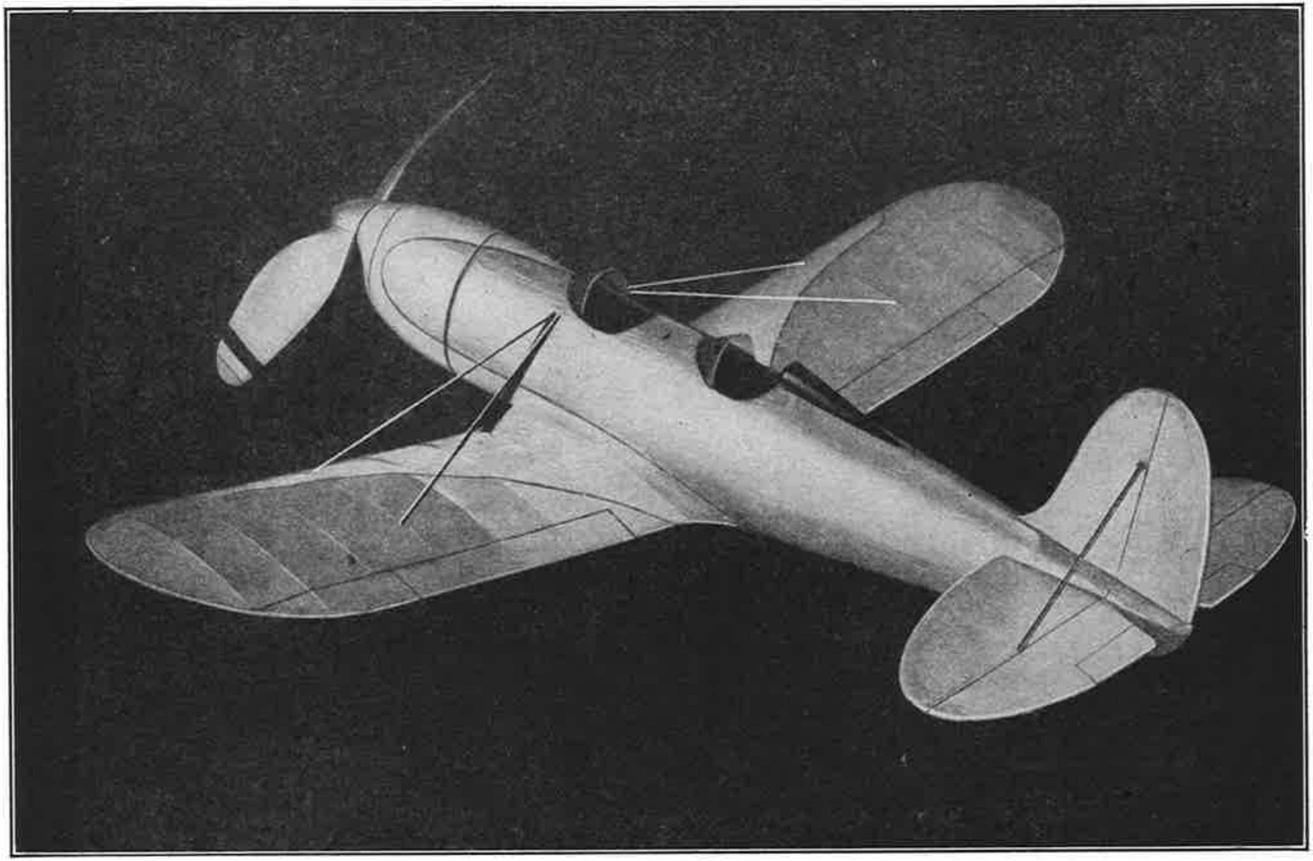
2 pcs.—1″	x 2¾″	x 15″	—Balsa	(Fuselage)
2 pcs.—1″	x 1⅟₁₆″	x 5″	—Balsa	(Fillet Blocks)
1 pc. —½″	x 1⅛″	x 2″	—Balsa	(Nose plug)
1 pc. —½″	x ¾″	x ⅞″	—Balsa	(Tail plug)
1 pc. —⅟₁₆″	x 3″	x 36″	—Balsa	(Ribs and Outlines)
1 pc. —⅟₃₂″	x 2″	x 36″	—Balsa	(Wing edge covering)
2 pcs.—⅟₁₆″	x ⅟₁₆″	x 12″	—Hard Balsa	(Leading Spars)
2 pcs.—⅟₁₆″	x ⅟₁₆″	x 12″	—Hard Balsa	(Lower wing spar)
2 pcs.—⅟₁₆″	x ⅛″	x 12″	—Hard Balsa	(Upper wing spar)
2 pcs.—⅟₁₆″	x ⅟₁₆″	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. —⅟₁₆″	diameter	x 1″	—Pine	(Dowel Bushing)
1 pc. —⅟₁₆″	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

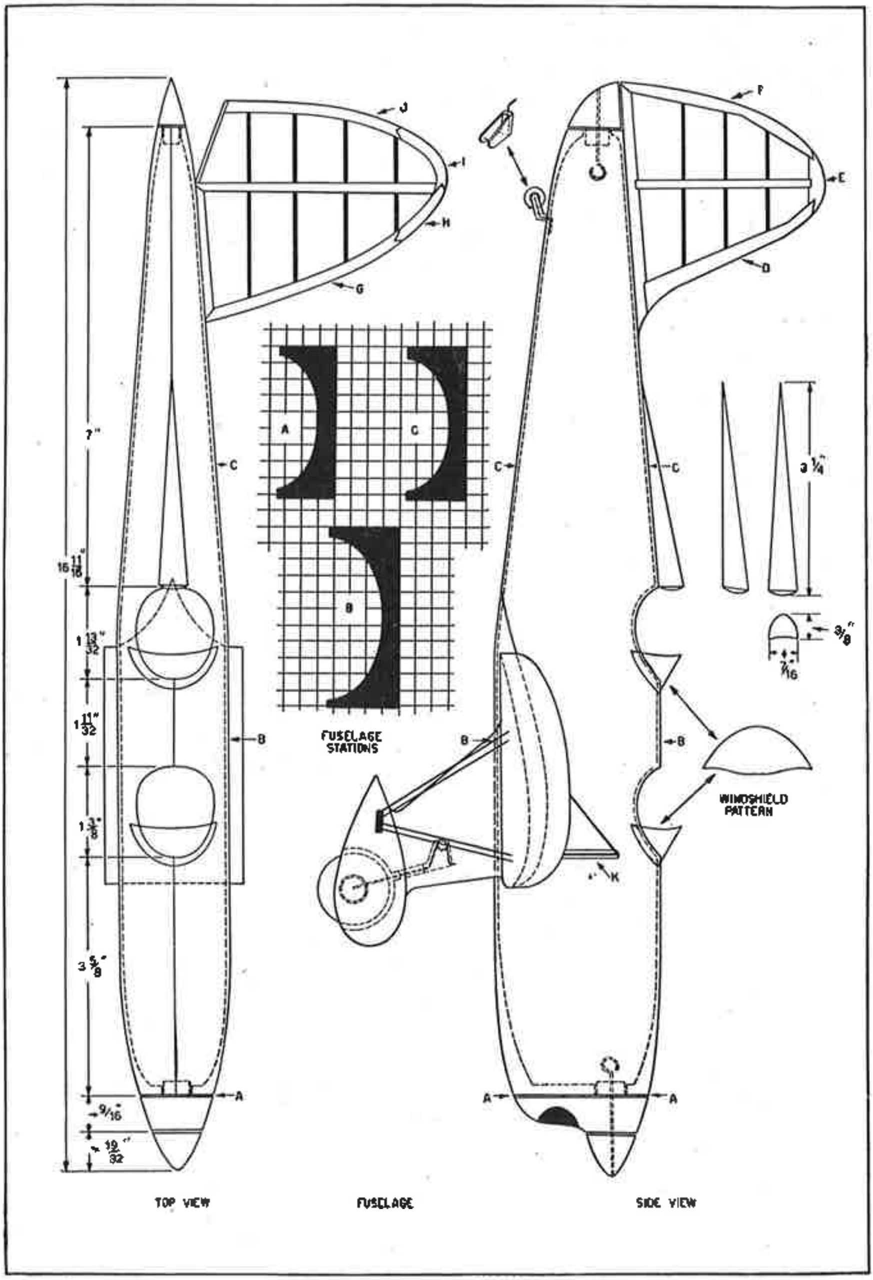
1 pc. —12" long —Music Wire No. .010 (Fittings)
1 pc. —1/8" flat x 11' 0" long—Rubber (Motor)
2 sheets —Japanese Tissue
Fine Sandpaper
Celluloid
Brass Eyelet
White Thread
Cement
Banana Oil
Silver, Yellow and Red Dope
Washers

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

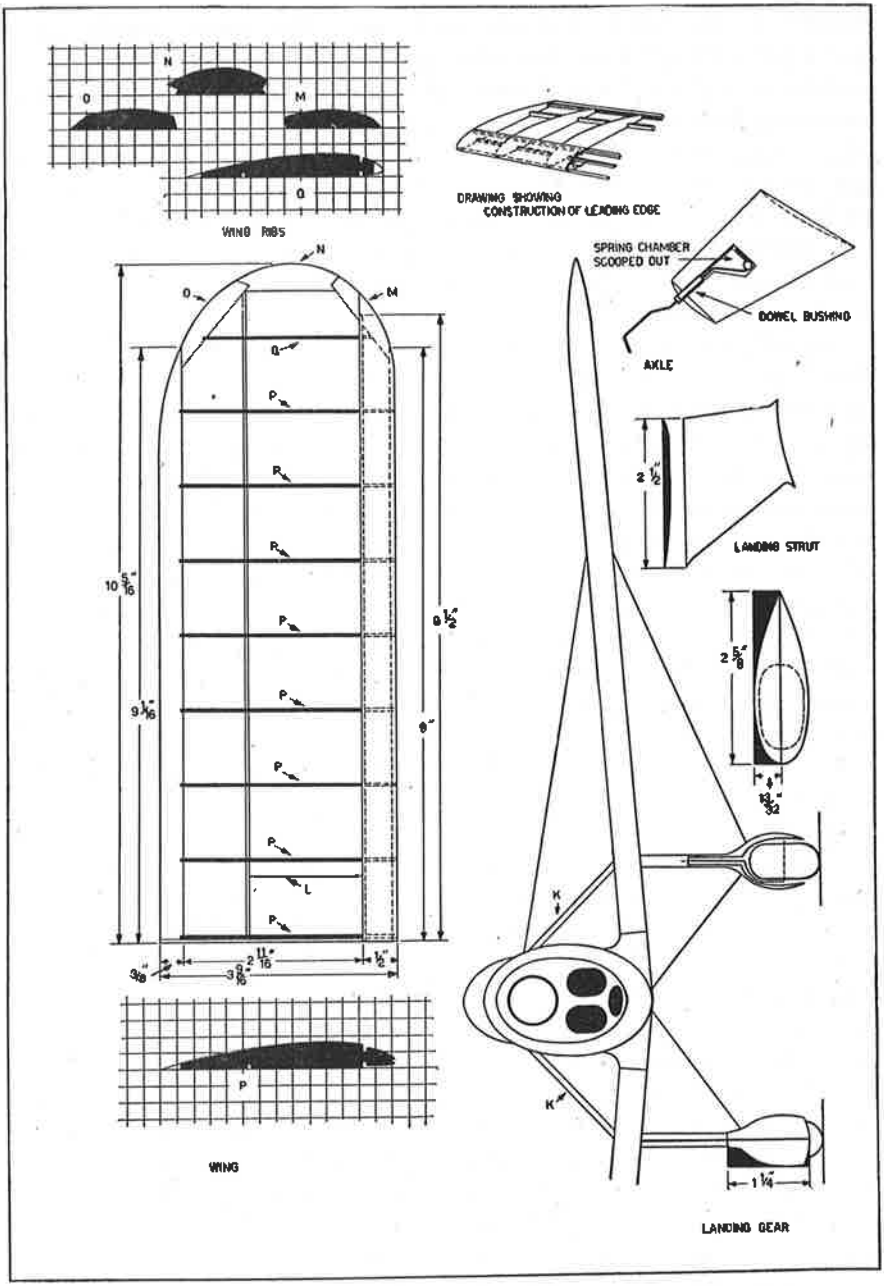


RYAN S-T PLAN 1

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 7/8" x 1 1/16" x 4 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 1/16" x 1/8" x 2 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 1/16" x 1/8" x 3 5/8" long. Cut both these pieces from 1/16" sheet balsa. The ribs are all 1/16" square balsa. The forward ones, which extend from the inner spar to the leading edge spar "G" are 1 5/8", 1 1/8", 1" and 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 1/16", 1 1/32", 15/16" and 11/16" 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 1/16" sheet balsa 1/8" wide. These are shown on 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 1/16" sheet balsa. These are shown in Plan 3 under "Rudder." Make full-size copies of pieces "D," "E" and "F" on 1/4" squares,



RYAN S-T PLAN 2

transfer to the balsa, and cut each out. The inner rudder spar is $\frac{1}{16}$" x $\frac{1}{8}$" x $2\frac{11}{16}$" long. The edge spar, which fits against the top of the fuselage, is $\frac{1}{16}$" x $\frac{1}{8}$" x $3\frac{7}{8}$" long. All ribs are $\frac{1}{16}$" square. Their lengths, measuring from the inner spar forward to the leading edge spar "D," are $1\frac{3}{16}$", $\frac{15}{16}$" and $\frac{5}{8}$". Their corresponding ones running from the inner spar back to the trailing edge spar "F" are $1\frac{3}{16}$", 1" and $\frac{3}{4}$" 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 $\frac{1}{4}$" squares and make a full-size tracing of both these ribs. Note that the leading nose of each of these ribs is recessed $\frac{1}{64}$". 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 $\frac{1}{16}$" sheet balsa and cut them out. Note that each of these has three $\frac{1}{16}$" 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 $\frac{1}{16}$" x $\frac{1}{16}$" x 9" long. The leading top and bottom inner wing spars are $\frac{1}{16}$" x $\frac{1}{16}$" x $9\frac{1}{2}$" long. The trailing edge spar is $\frac{1}{16}$" x $\frac{3}{8}$" 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 $\frac{1}{4}$" squares as "M," "N" and "O." Piece "M" is traced on $\frac{3}{16}$" sheet balsa and cut out. Pieces "N" and "O" are traced on $\frac{1}{16}$" 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.

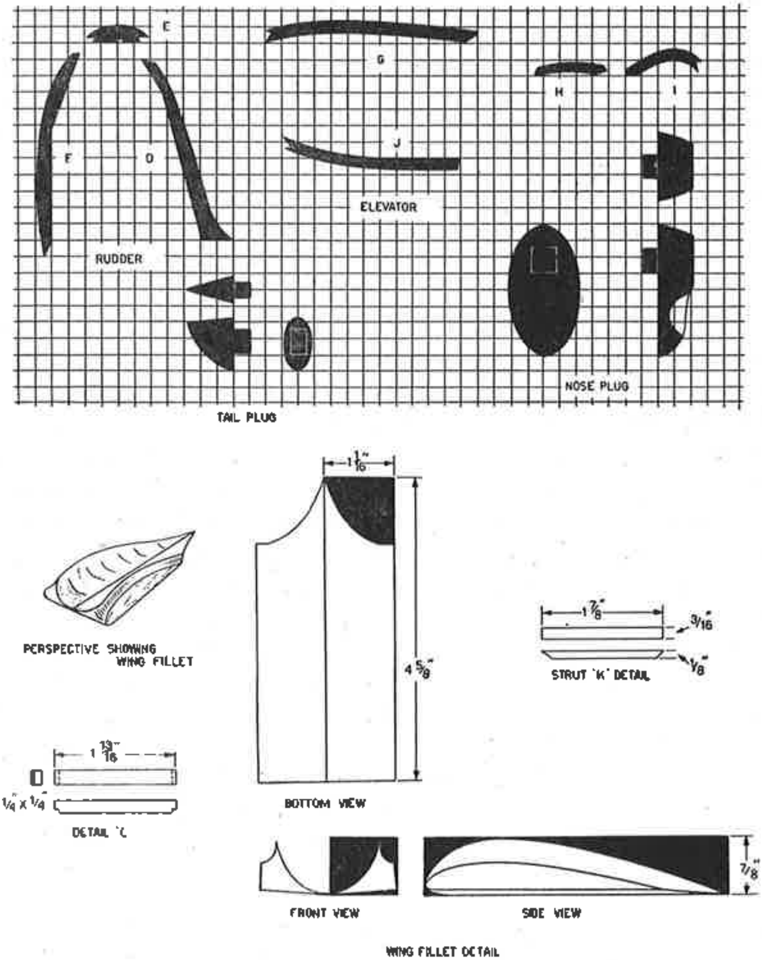
LANDING GEAR. The landing gear consists of two landing gear struts, two wheel pants and two wheels. The struts are constructed in halves. These are shown in Plan 2 under "Landing Strut." Each half is cut to shape from a 1/8″ x 2 1/2″ x 1 7/8″ long piece of balsa. The lower end, which fits on top of the 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 13/16″ 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



RYAN S-T PLAN 3

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 1/16" x 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 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.

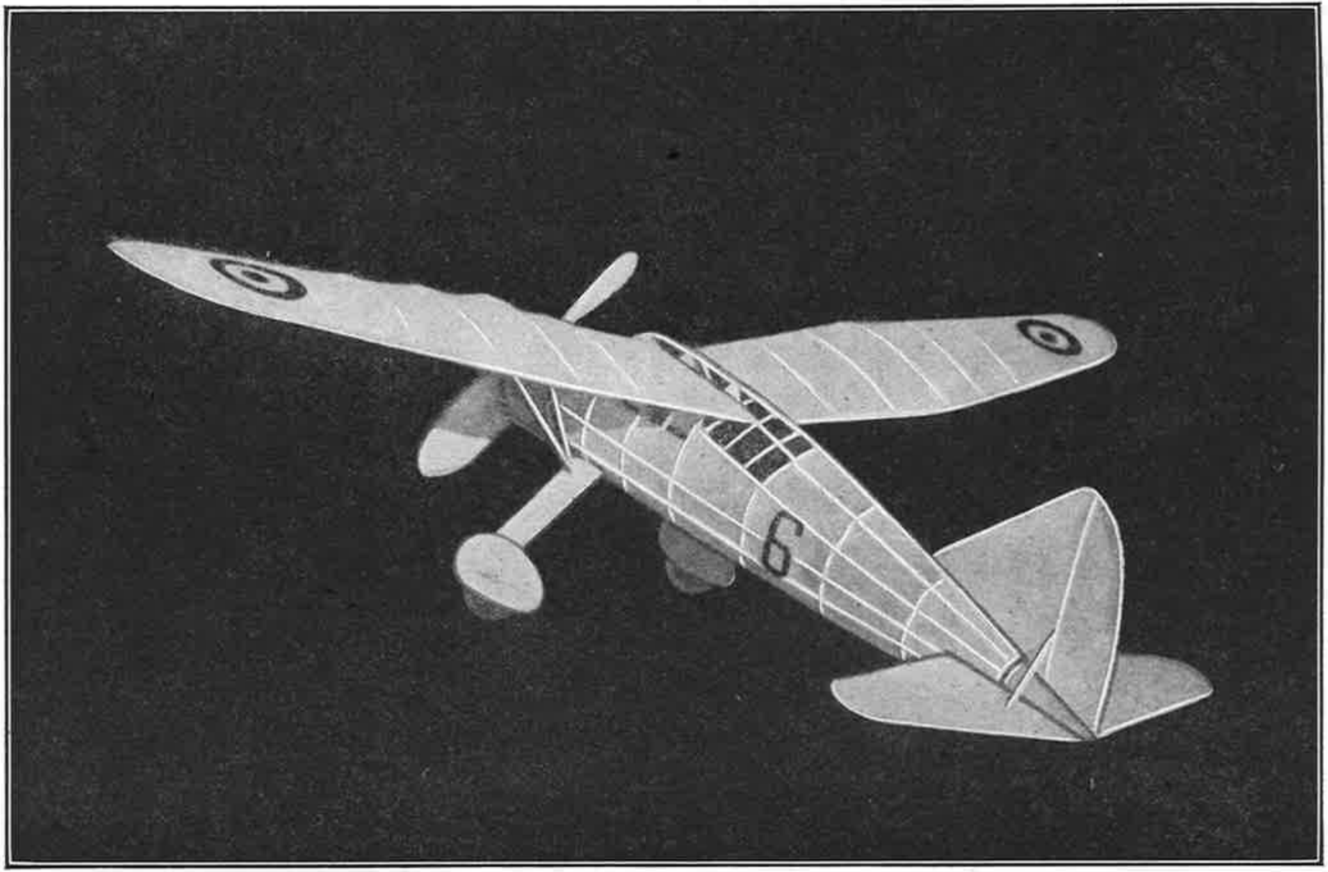
The author expresses his appreciation to the builder of the model, Robert Harrison, who co-operated in permitting it to appear in these pages. The flyability of the model is quite good due to the gull-shaped wings and the lightness of its construction. Mr. Harrison's model, as shown here, has flown for 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 2 1/4" 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)

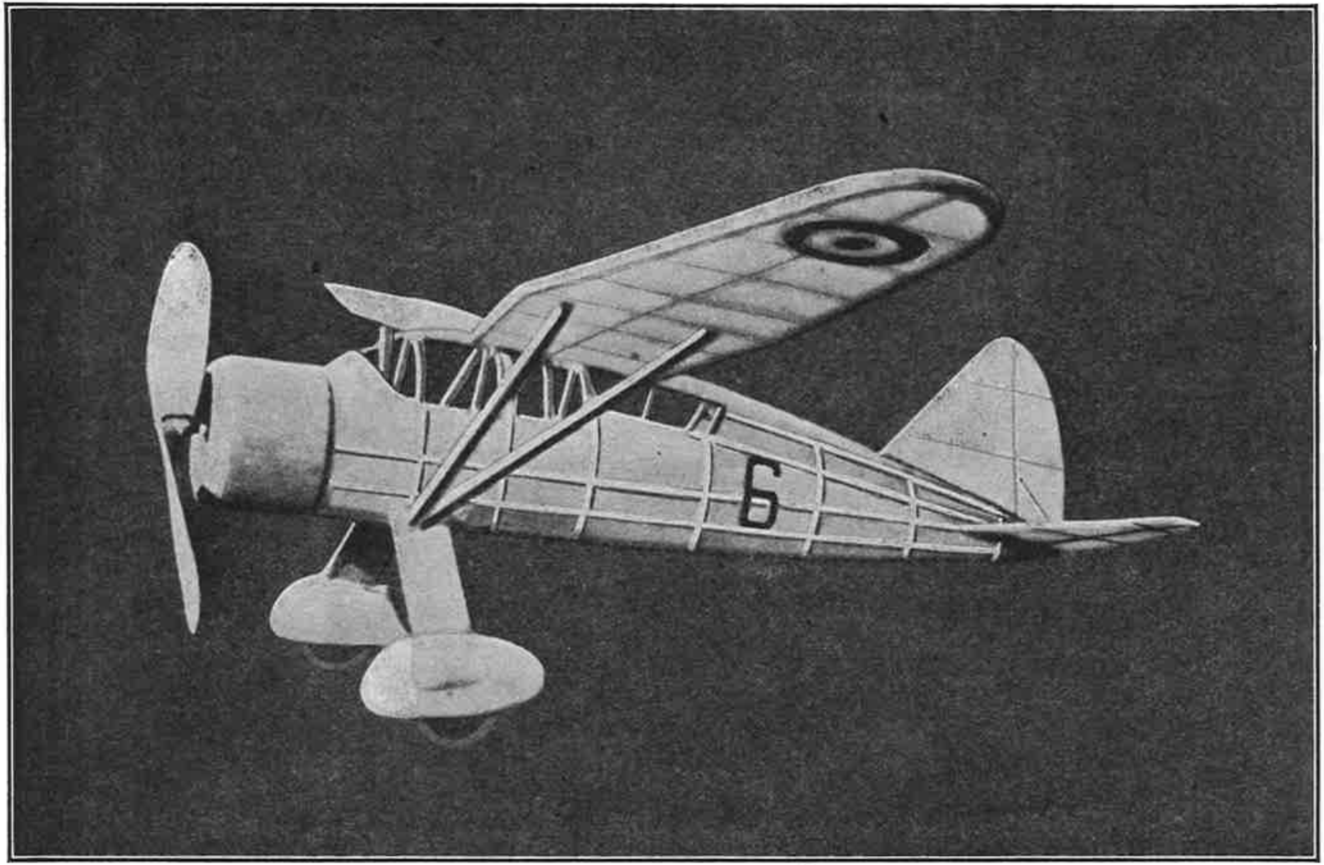
FUSELAGE. The fuselage with its formers is shown on Plan 1. The formers have been drawn on squares representing 1/4" each. Rule a sheet of paper with 1/4" squares and make full-size copies on it of each of the eight regular full formers and the half former "K." These are then traced on 1/16" sheet balsa 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 13/16" 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 nalves 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-

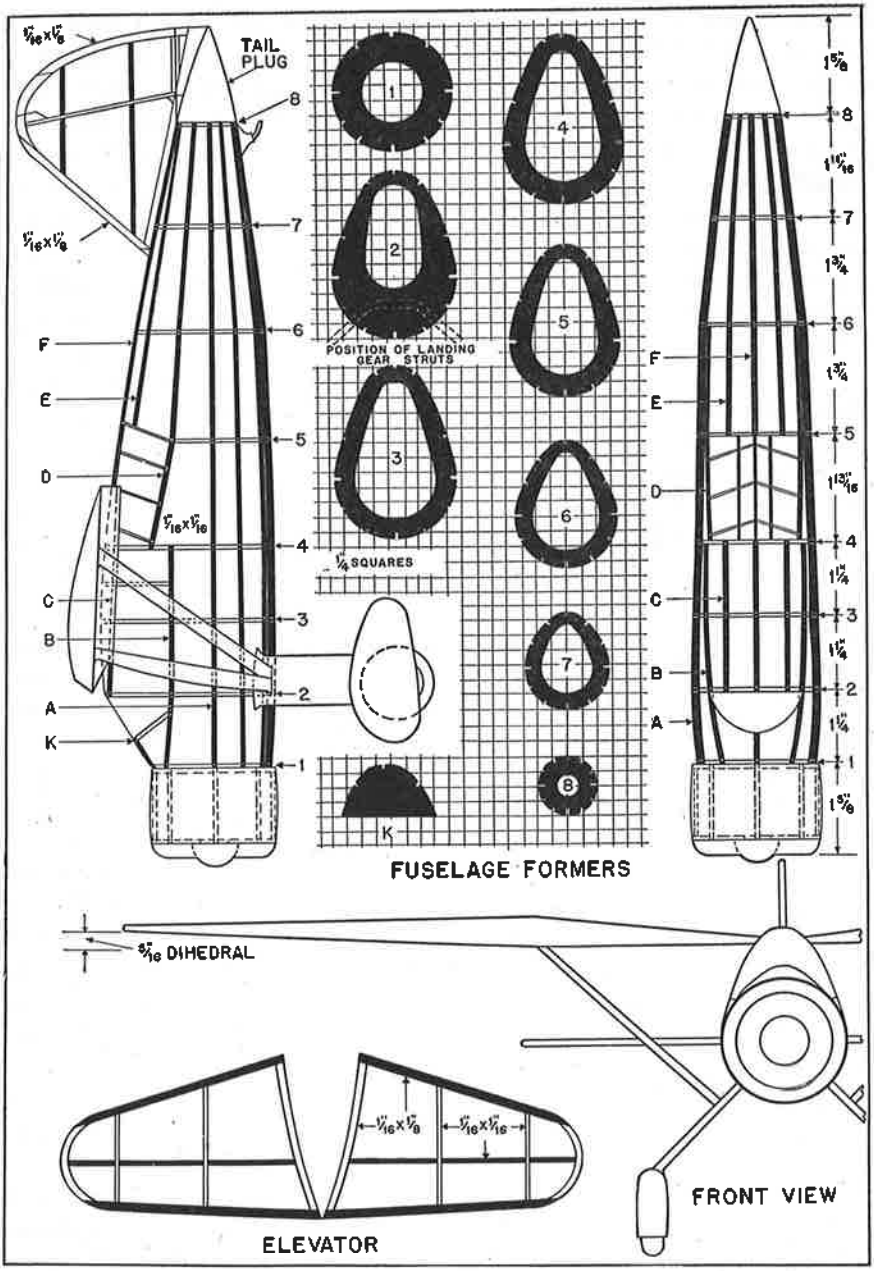


BRITISH WESTLAND COÖPERATION

sembly has been started. The tip rib is 1$\frac{1}{16}$" long between the inner spar and the leading edge spar. It is only $\frac{5}{8}$" long between the inner spar and the trailing edge. Locate these two ribs, which actually form only one, $\frac{3}{4}$" from the outer end of the inner spar. It is cut $\frac{1}{16}$" 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$\frac{3}{8}$" in from the tip spar. It is 1$\frac{3}{16}$" long between the inner spar and the leading edge spar. It is only 1$\frac{1}{16}$" 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 $\frac{1}{16}$" x $\frac{1}{8}$" 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 $\frac{1}{16}$" 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 $\frac{1}{8}$" wide at its widest point. It is then cut 3$\frac{3}{4}$" long. The center spar is $\frac{1}{16}$" square cut exactly 2$\frac{3}{4}$" 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 $\frac{1}{16}$" square cut 2$\frac{3}{16}$" long from the inner spar to the leading edge. It is only 1" long from this spar to the trailing edge, and is located $\frac{7}{8}$" up from the keel edging. The short bottom rib is $\frac{1}{16}$" x $\frac{1}{8}$" x 1$\frac{5}{16}$" 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 $\frac{7}{8}$" from the base of the keel edging piece. Cut the leading edge spar $\frac{1}{16}$" x $\frac{1}{8}$" x 3" long. Cement it to the front end of the keel edging and the large rib. Complete the curve, as shown, with $\frac{1}{16}$" x $\frac{1}{8}$" balsa forming the upper tip and trailing edge spars. Add the top rib $\frac{5}{8}$" 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 $\frac{1}{4}$" 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 $\frac{1}{16}$" sheet balsa. Notches are $\frac{1}{16}$" square and must be carefully located. Cut out these sixteen ribs and lay aside one set for the other half of the wing.

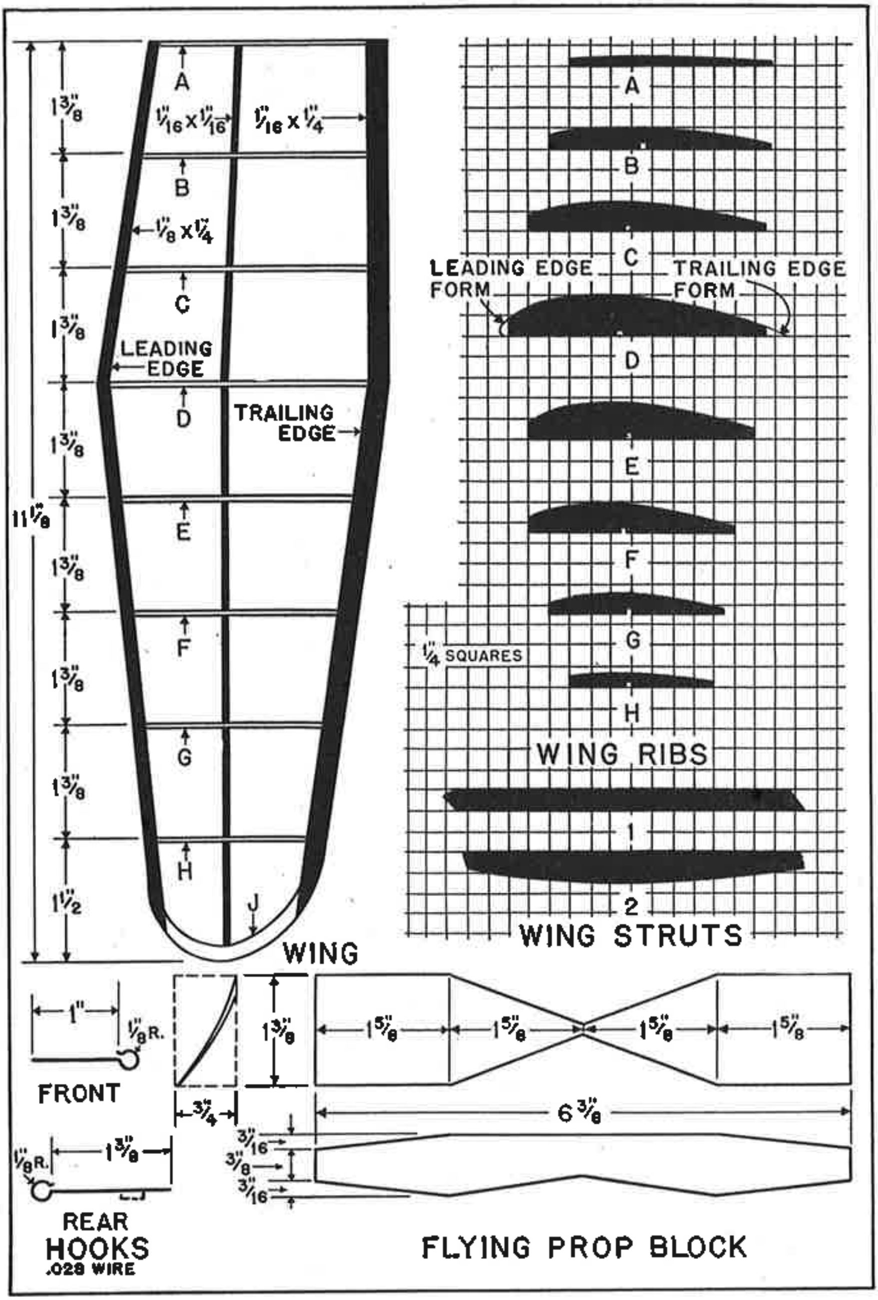


BRITISH WESTLAND COÖPERATION PLAN 1

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

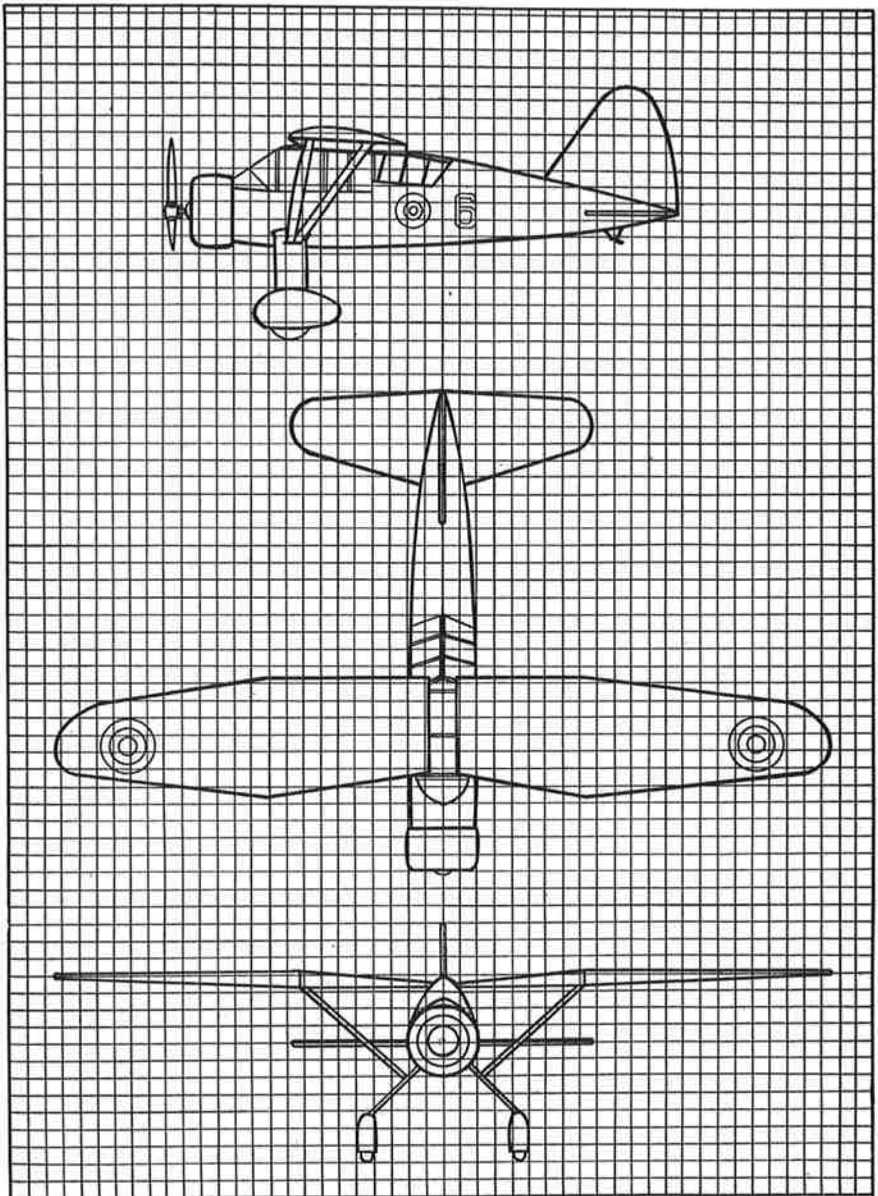


BRITISH WESTLAND COÖPERATION PLAN 2

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

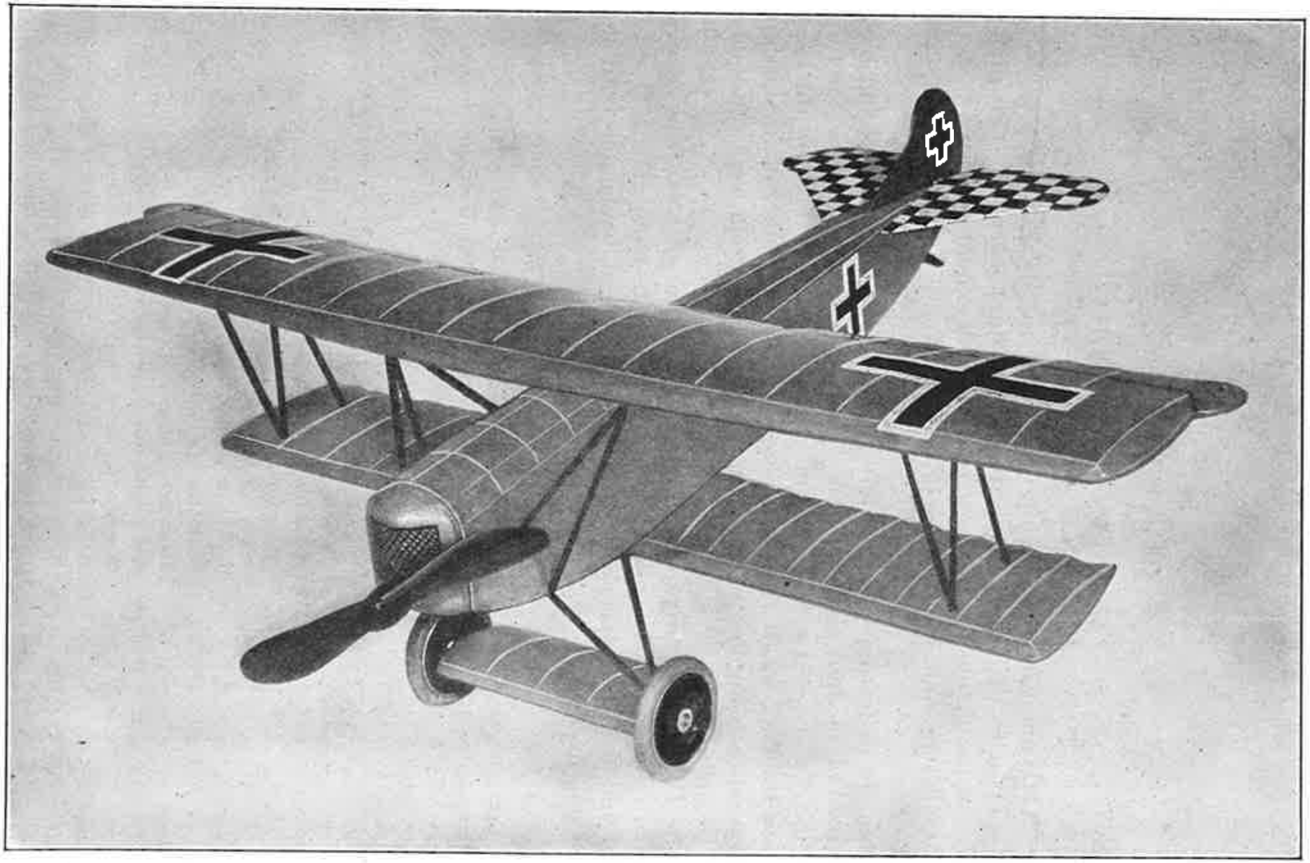
THE finest fighting machine developed and used during the World War by the German Government was the Fokker D-7. This single-seater fighter was powered by a Mercedes engine, had a top speed of 120 miles an hour, and was the pride and glory of the German Imperial Air Force.

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 1 1/2"	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 1 1/8"	x 4"	—Sheet balsa for cockpit cowling
1 pc.	—1/8"	x 1/4"	x 12 1/2"	—Balsa for motor stick
1 pc.	—1/2"	x 1 1/2"	x 1 3/4"	—Balsa block for fuselage radiator
1 pc.	—1/4"	x 3/8"	x 16 5/16"	—Balsa for upper leading edge spar A
1 pc.	—1/8"	x 3/8"	x 16 5/8"	—Balsa for inner wing spar B
1 pc.	—1/8"	x 1/4"	x 16 5/8"	—Balsa for inner wing spar C
2 pcs.	—1/8"	x 1/4"	x 7 11/16"	—Balsa for trailing edge spars D
2 pcs.	—1/4"	x 1/4"	x 6 1/4"	—Balsa for lower wing leading edge spars H
2 pcs.	—1/8"	x 1/4"	x 6 1/4"	—Balsa for leading inner wing spars G
2 pcs.	—1/8"	x 1/8"	x 6 1/8"	—Balsa for trailing inner wing spars F
2 pcs.	—1/8"	x 1/4"	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 1/4"	x 15"	—Bamboo for wing tips, tail outlines, etc.
1 pc.	—1/4"	x 1/4"	x 3 1/2"	—Balsa for leading edge spar F of landing gear wing
1 pc.	—1/8"	x 1/4"	x 3 1/2"	—Balsa for inner spar G of landing gear wing
1 pc.	—1/8"	x 1/4"	x 3 1/2"	—Balsa for trailing edge spar H of landing gear wing



GERMAN FOKKER D-7

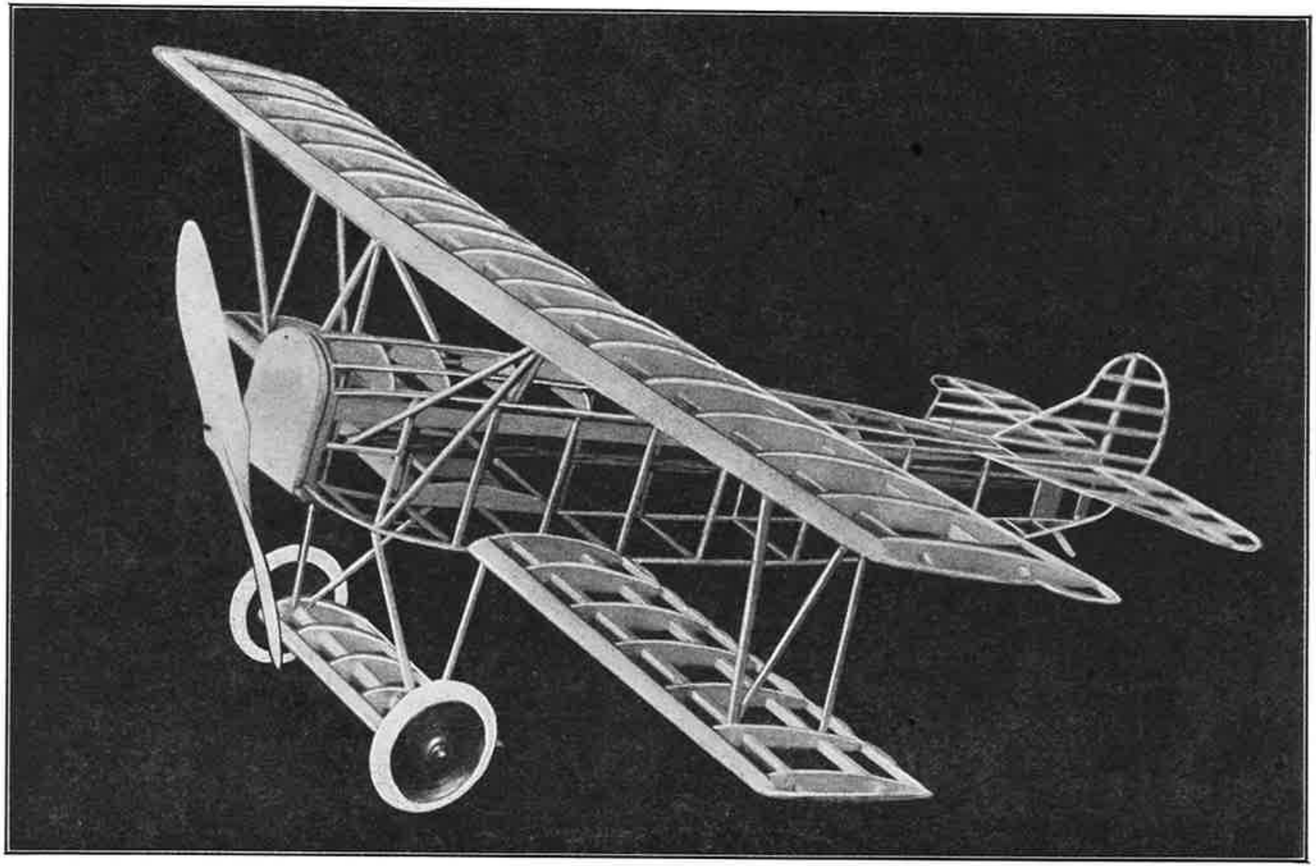
1 pc. —1/16" x 3/8" x 6"	—Sheet balsa for ribs of landing gear wing
1 pc. —1/16" x 1/16" x 6½"	—Balsa for elevator spar A
1 pc. —1/16" x 1/16" x 2⅜"	—Balsa for rudder spar C
1 pc. —1/16" x ⅛" x 42"	—Balsa for wing, center section, and landing gear struts
1 pc. —½" x ⅝" x 6"	—Balsa propeller block
1 pc. —4" long	—No. 9 piano wire for fittings
2 —1⅝" diameter	—Rubber-tired wheels
2 sheets	—Japanese tissue for covering
1 pc. —42" long	—⅛" flat pure Para rubber for motive power
1 pc. —¼" x ¾"	—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 ⅛" 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 ⅛" x ¼" 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.

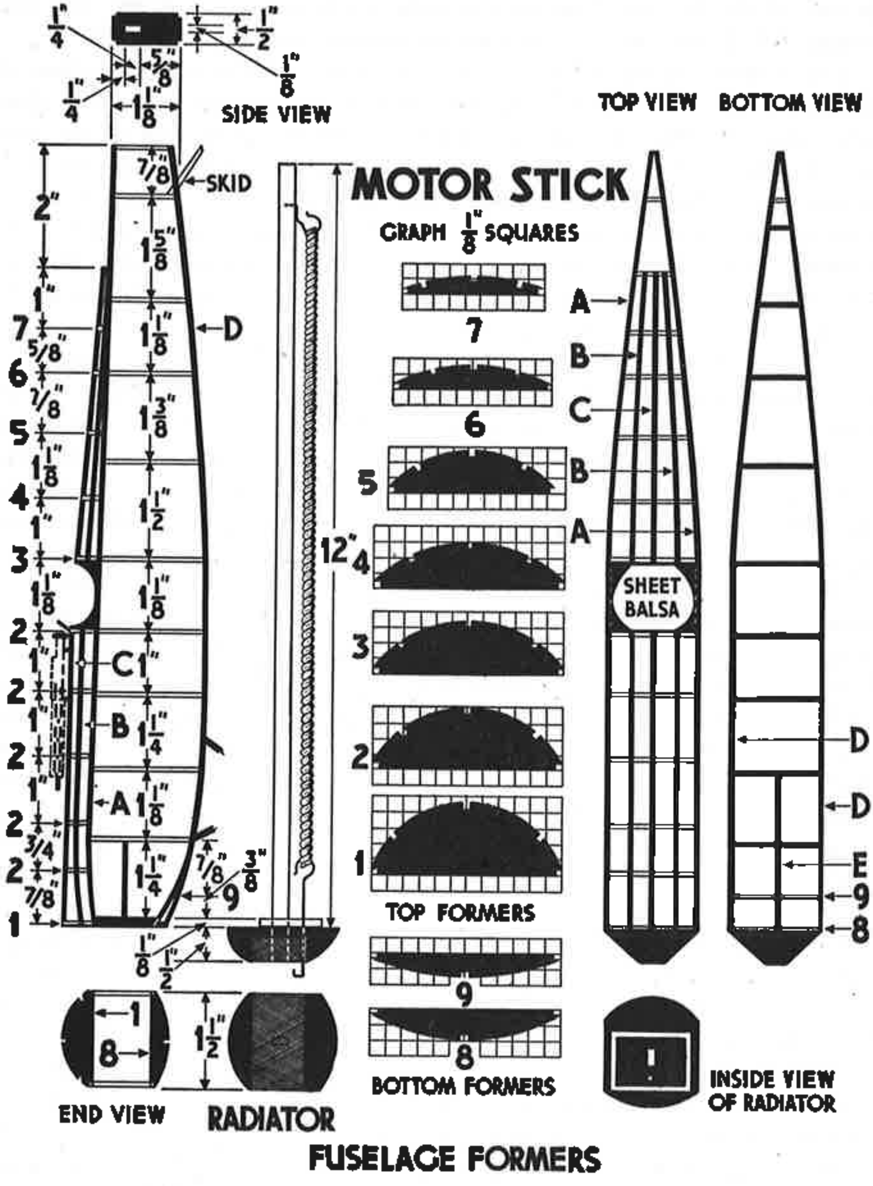
The remaining top formers 3, 4, 5, 6, and 7 are attached to these A stringers, which are cemented into their bottom side notches. Make sure that these added formers are spaced properly, as shown on the left of the side view. These formers are first attached to the main assembly by stringers A, because 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.

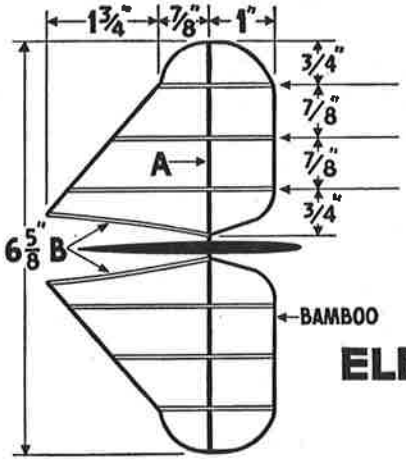
MOTOR STICK. The motor stick is 1/8" x 1/4" x 12 1/2" long. It is cemented into a fuselage nose piece, which forms the radiator. This is cut from the 1/2" x 1 1/2" x 1 3/4" solid balsa block. (See Plan 1, "Radiator.") Its flat back must be the exact size and form of the top of former 1 and the bottom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

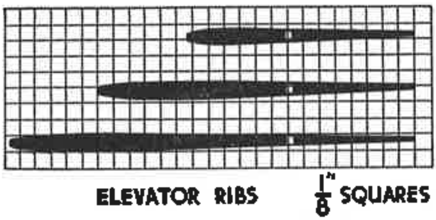
Its thickness is rounded as shown at the end of the motor stick. A 1/8" x 1/4" hole is cut through the center of this radiator piece, and the end of the motor stick is cemented in it, as shown. On the inside or back face of this piece, a plug is formed of 1/16" square balsa lengths. These are cut and 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.

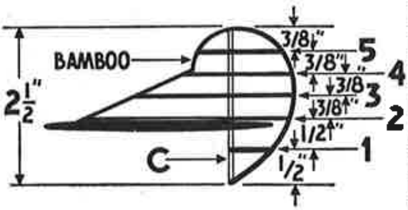
The radiator is painted with red dope, and a black radiator grill is drawn on it with thin crossed lines, as shown.

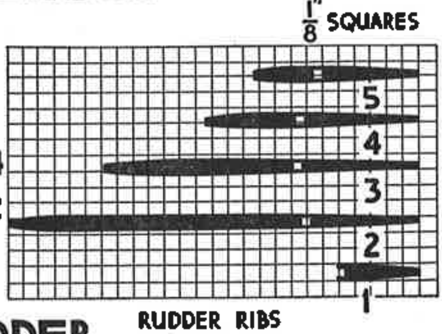
ELEVATOR. The elevator consists of a 1/16" x 1/16" x 6 5/8" long balsa inner spar A, six 1/16" sheet balsa ribs, two 1/16" square balsa fuselage brace ribs B, and two 1/16" square bamboo outline lengths. (See Plan 2, "Elevator.") Make a full-size copy of the ribs on paper ruled with 1/8" squares,



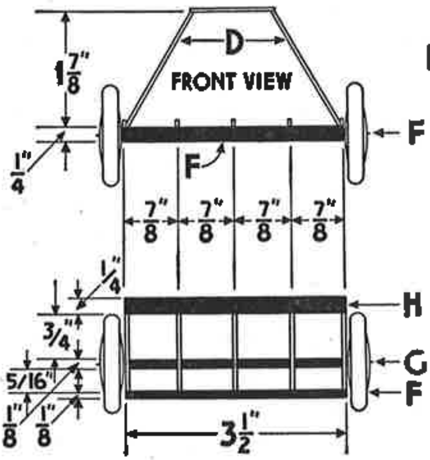


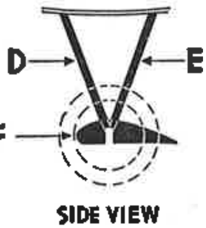
ELEVATOR

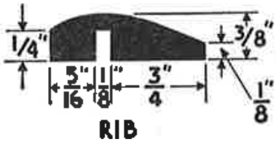




RUDDER







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 2½" 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 ¼" squares, and the alternating squares in each row are painted black.

RUDDER. A 1/16" x 1/16" x 2⅜" 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 ⅛" 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 2⅜" 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 ⅛" 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 ¼" x ¼" x 3½" long, and must be shaped to carry out the general form of the rib. The inner spar G is ⅛" x ¼" x 3½" 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.

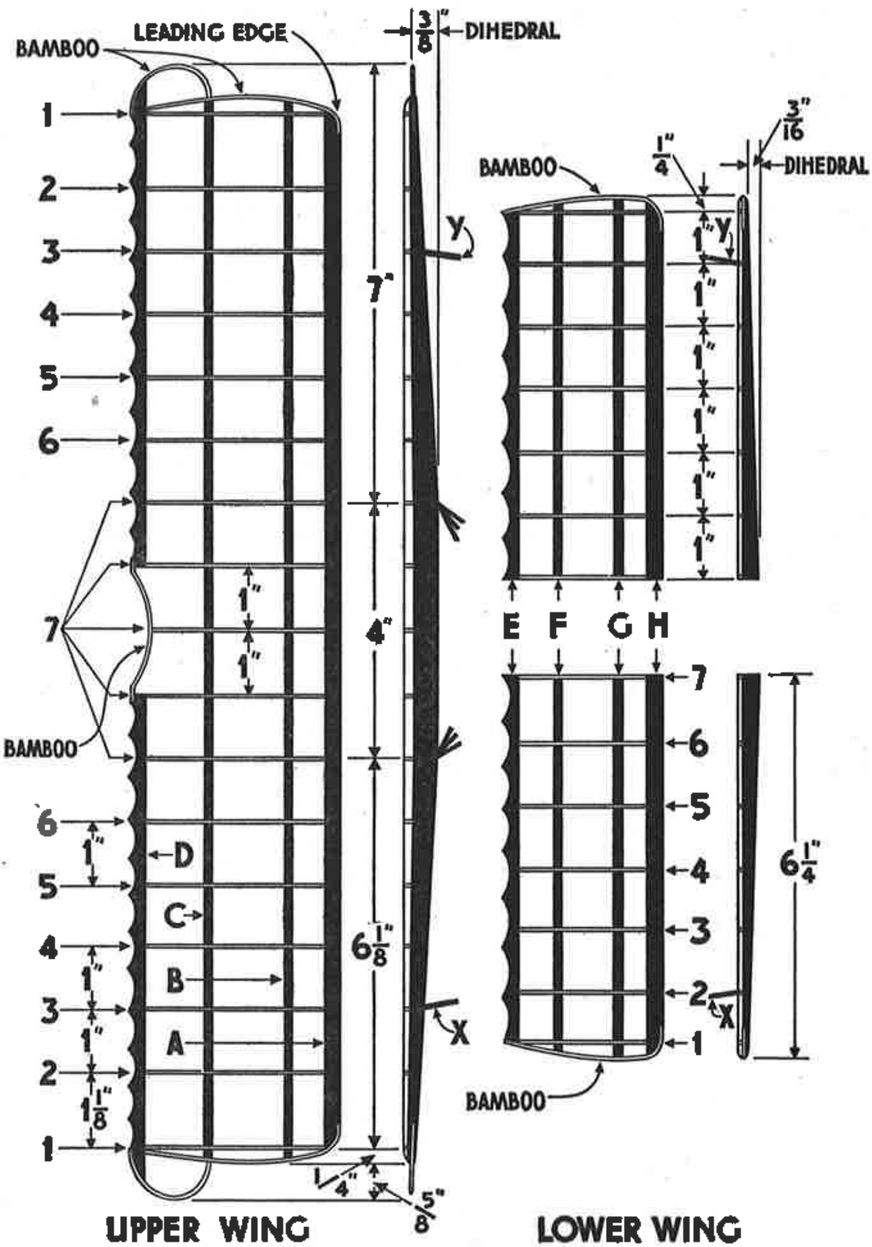
The trailing struts E extend up from the same points on the landing gear wing to stringers D on each side of the fuselage at points 1/2" behind the second upright side struts behind former 9. All four of these struts should be cut the same length so that the landing gear wing will be correctly centered 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 $\frac{1}{8}''$ x $\frac{3}{8}''$ along the center section and then is tapered toward both ends to $\frac{1}{8}''$ x $\frac{1}{8}''$, while the trailing inner wing spar C remains $\frac{1}{8}''$ x $\frac{1}{4}''$ along the center section and is then tapered toward both ends to $\frac{1}{8}''$ x $\frac{1}{8}''$. The trailing edge spars D are both $\frac{1}{8}''$ x $\frac{1}{4}''$ 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 $\frac{1}{2}''$ points along the entire lengths of these spars. Measure $\frac{1}{8}''$ 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 $\frac{1}{2}''$ long rectangle, and the curve drawn with a pencil. These are then cut out, and finished smooth with sandpaper.

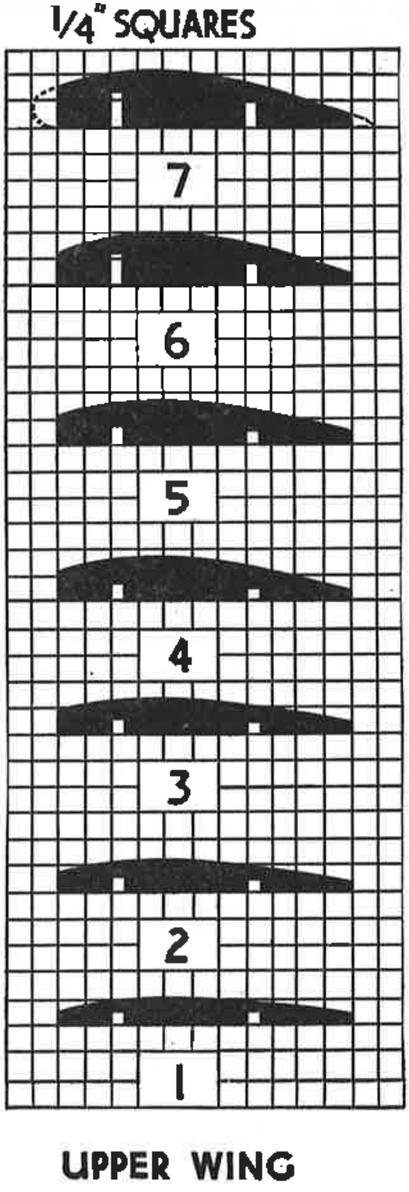
A full-size drawing of each rib is made on paper ruled with $\frac{1}{4}''$ squares, as shown in Plan 4 under "Upper Wing." These are traced on the $\frac{1}{16}''$ sheet balsa stock. Remember that two of each of the ribs 1, 2, 3, 4, 5, and 6 are required, while five of rib 7 will be needed for the center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

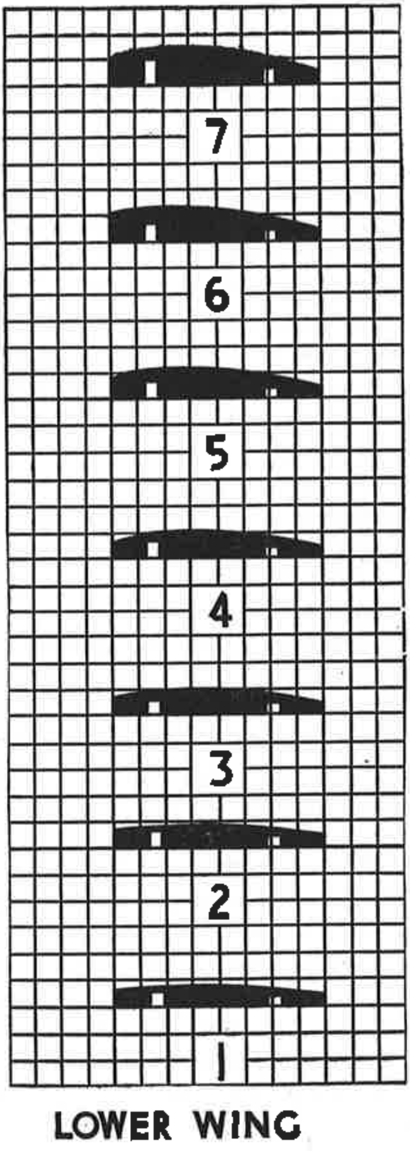
When these have been cut out, two notches must be cut in each. These must be tapered in size from rib 7, where they are the original width and thickness of the inner spars, down to rib 1, where both are $\frac{1}{8}''$ square. Finish each rib by a light sandpapering.

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 $1\frac{1}{8}''$ 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 $\frac{1}{16}''$ 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.

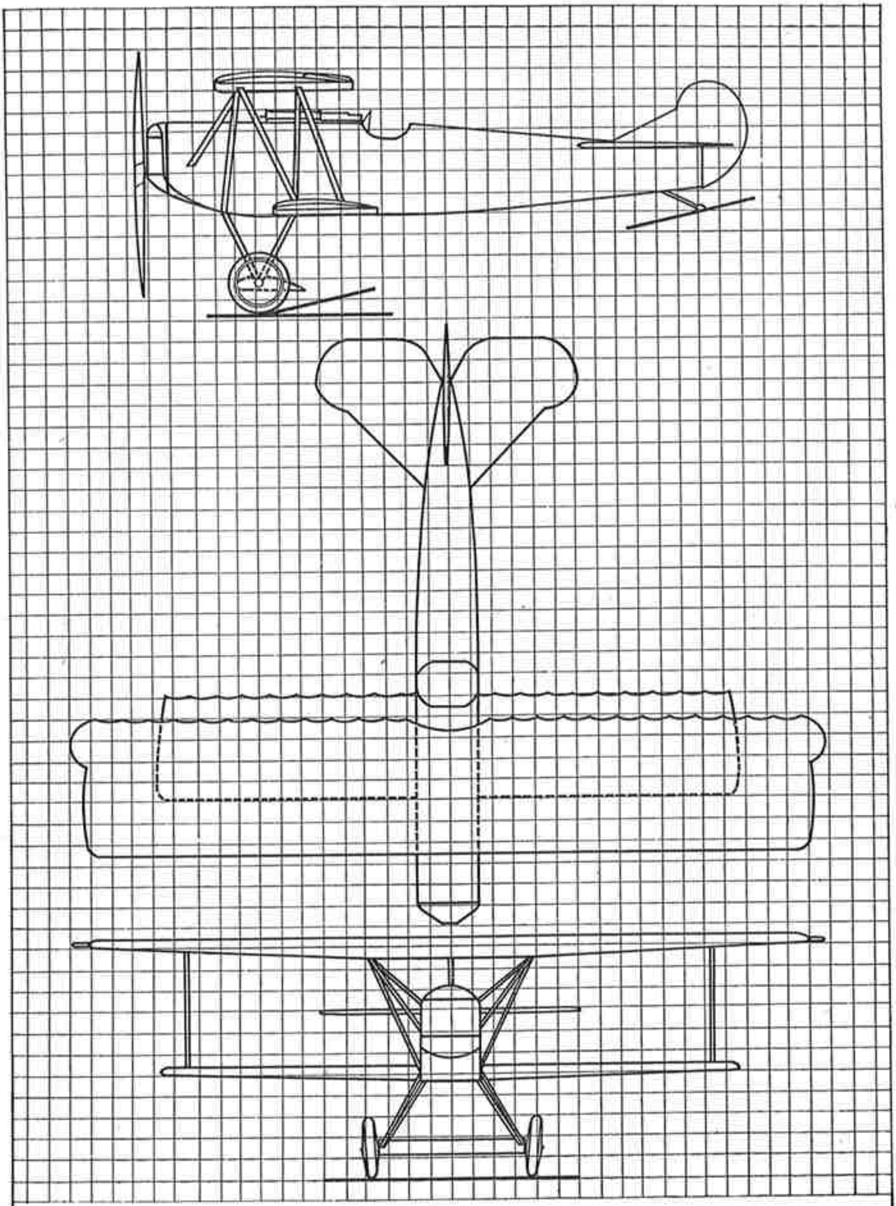
The two wings are joined together by two units of "N" struts, as shown in the side view of the solid scale plan. On the upper wing, these units are located on the under sides of ribs 3 at each end, as shown by Y and X on the edge view of Plan 3 under "Upper Wing." On the lower wing they are located on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

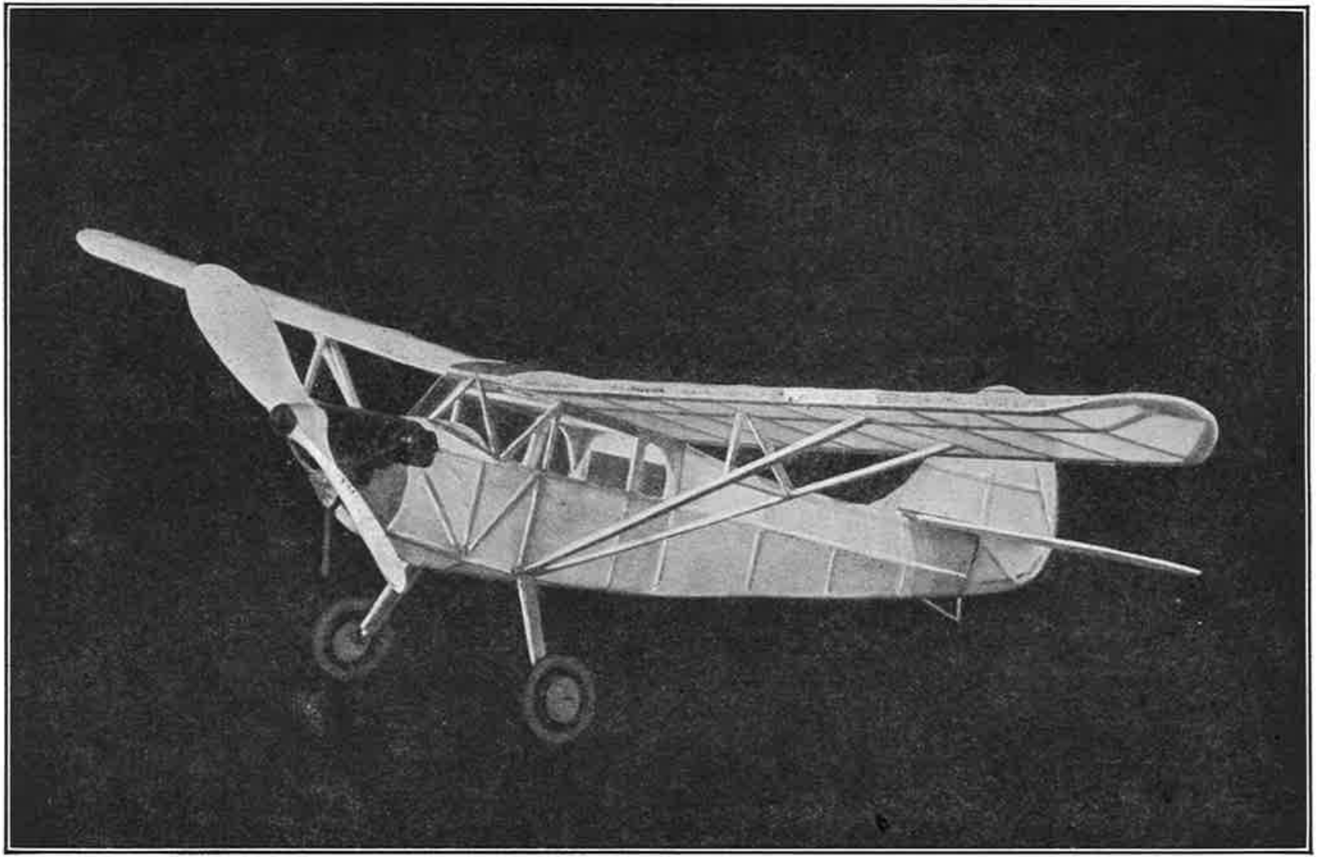
CHAPTER 54

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.

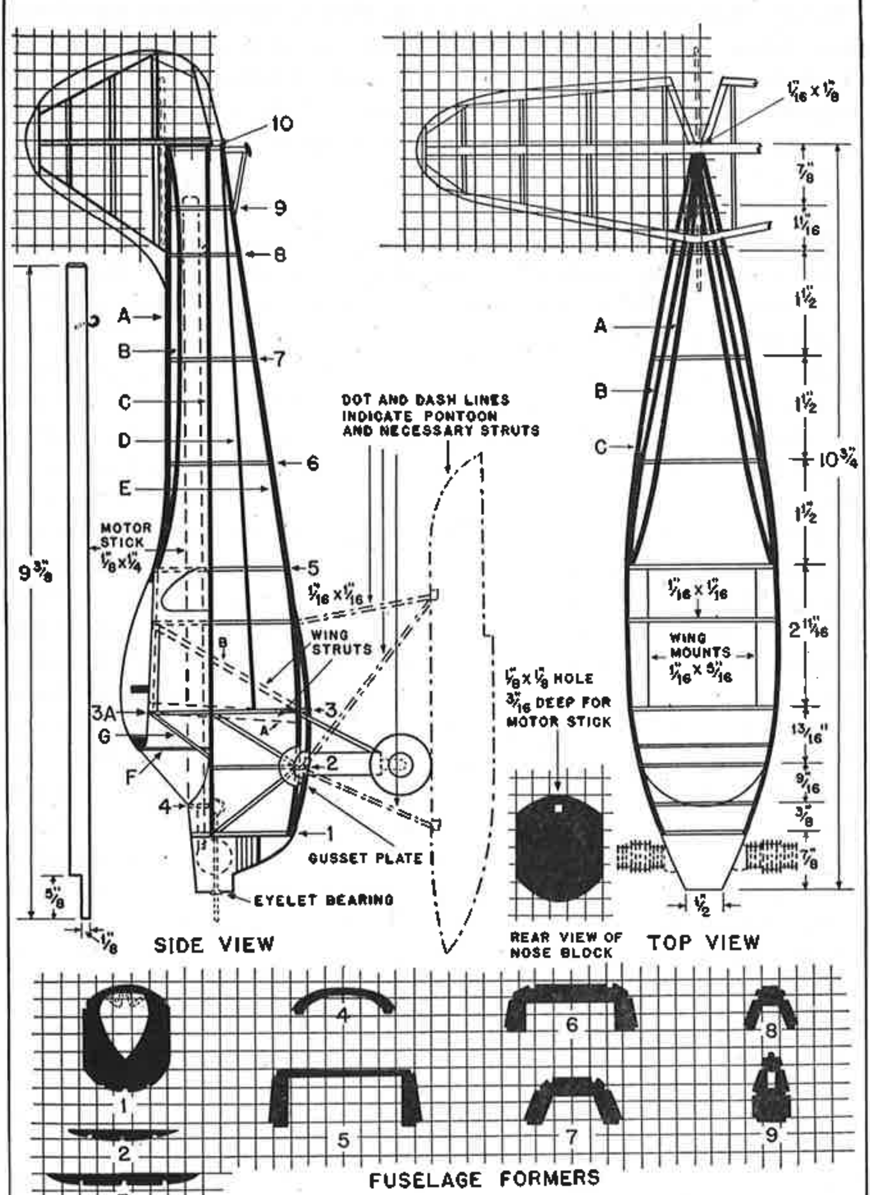
MATERIAL LIST

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

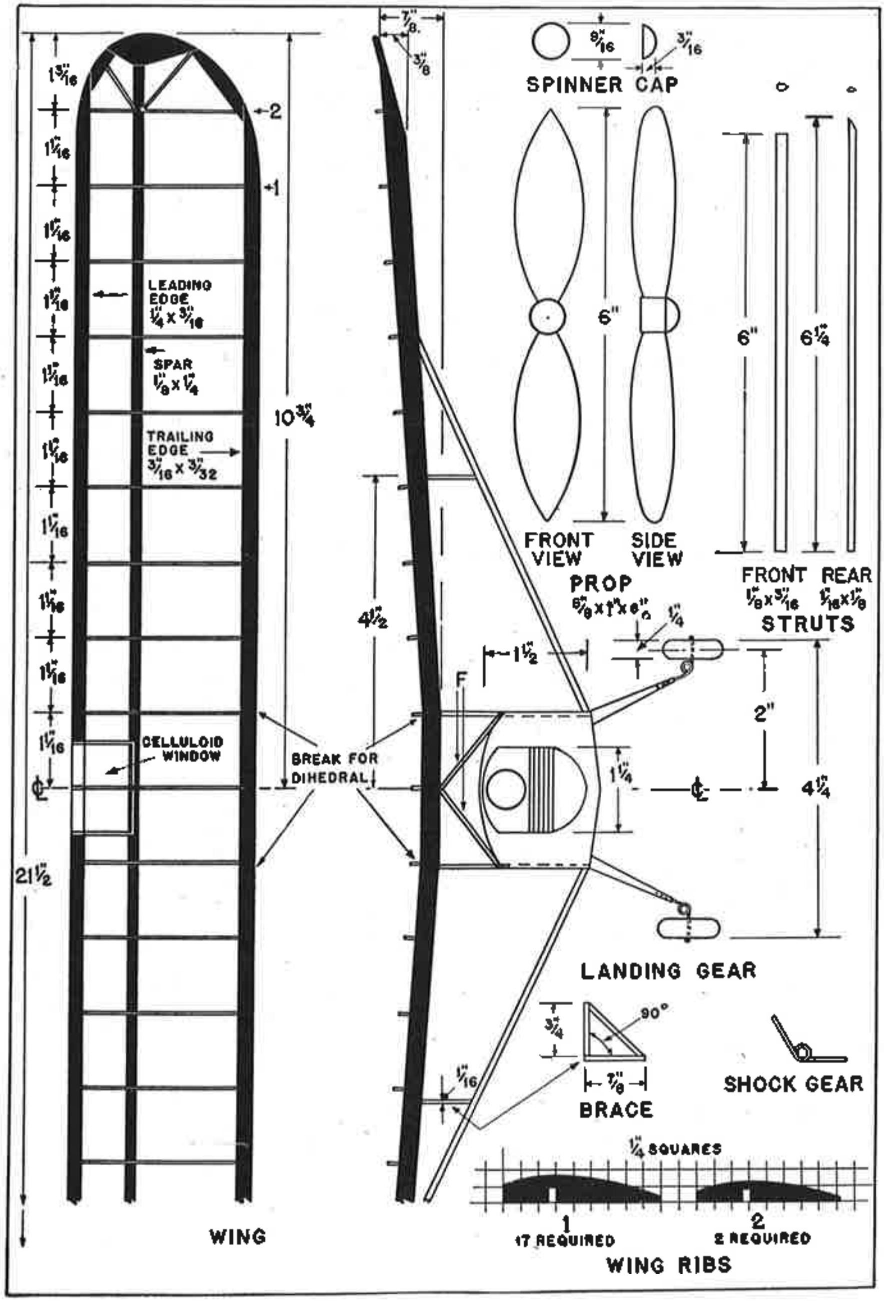
FUSELAGE. The fuselage is shown in Plan I. All stringers are of 1/16" square balsa. The nine formers are shown on squares representing 1/4" each. Rule paper with such squares and make a full-size tracing of each former on them. These are then traced on 1/16" sheet balsa and cut out. Make sure that all 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 1 3/16" 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 1 3/4" 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 ⅛" square in its back face, as shown under "Rear View of Nose Block" in Plan 1. This has been shown on ¼" 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 ⅛" square and locate it at the top-center of the former. The motor stick is shaped from a piece of ⅛" x ¼" x 9⅜" 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 ⅛" for a distance of ⅝", as shown on the left of Plan 1. Slip this ⅛" 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 ⅞" from its end.

The tail skid is of balsa. The front piece is 1/16" square and the upright is 1/16" x ⅛". 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

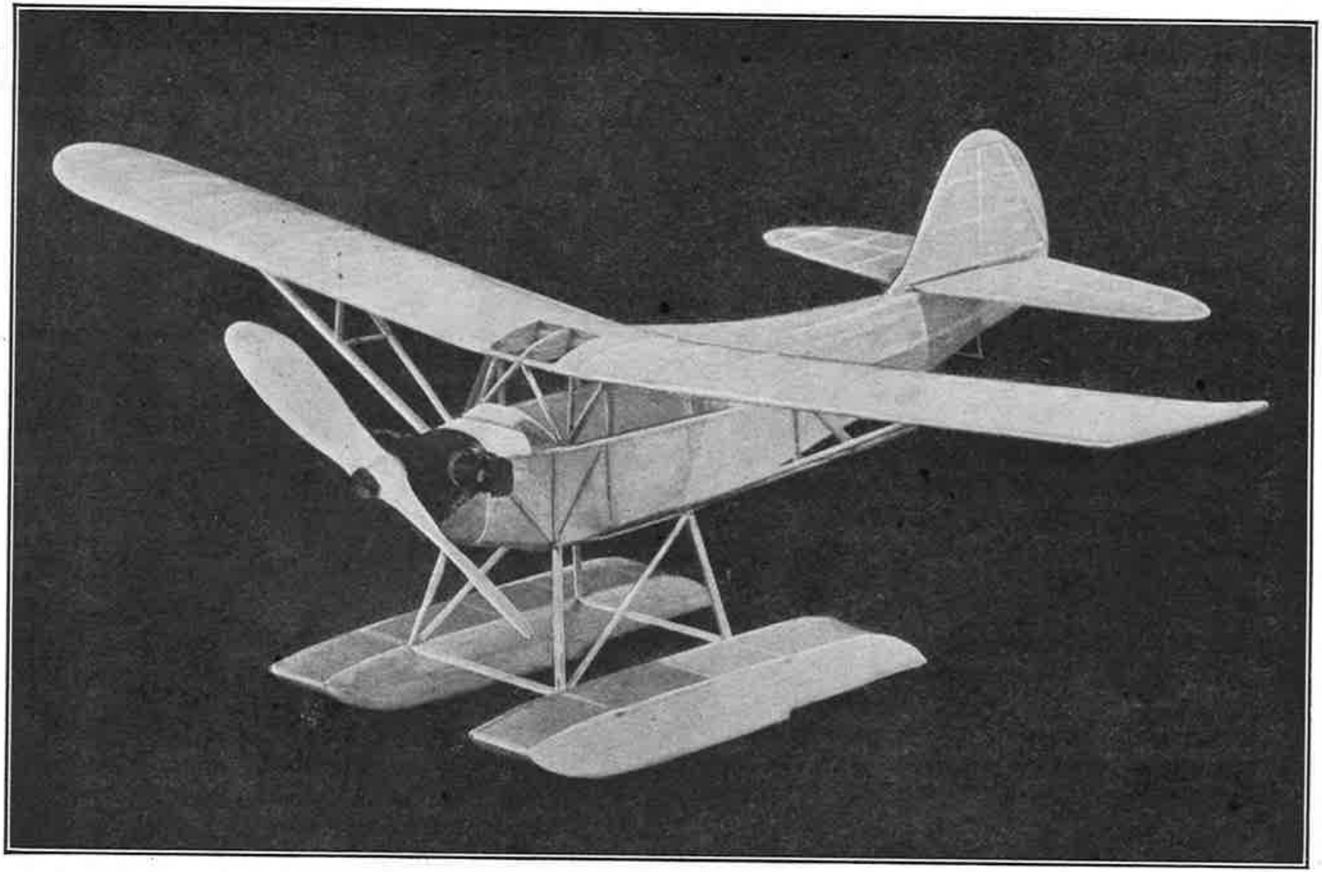
tissue using banana oil as an adhesive. Water spray the tissue when in place to shrink it, but take care not to warp the frame.

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 1 7/16" 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"



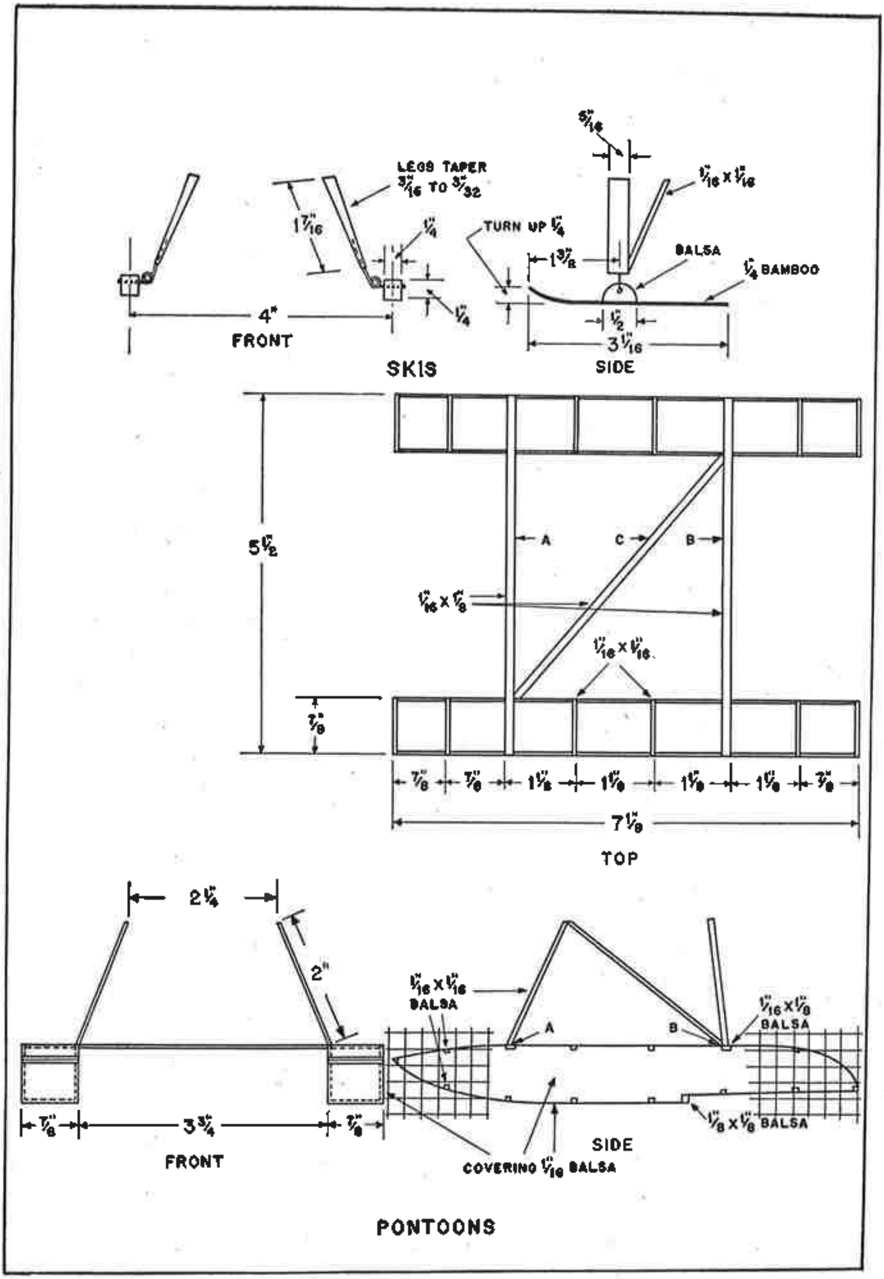
AERONCA SPORTPLANE ON PONTOONS

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 $\frac{1}{16}''$ sheet balsa, and shaped as shown on the graphs. These sides are held by top and bottom cross braces of $\frac{1}{16}''$ 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

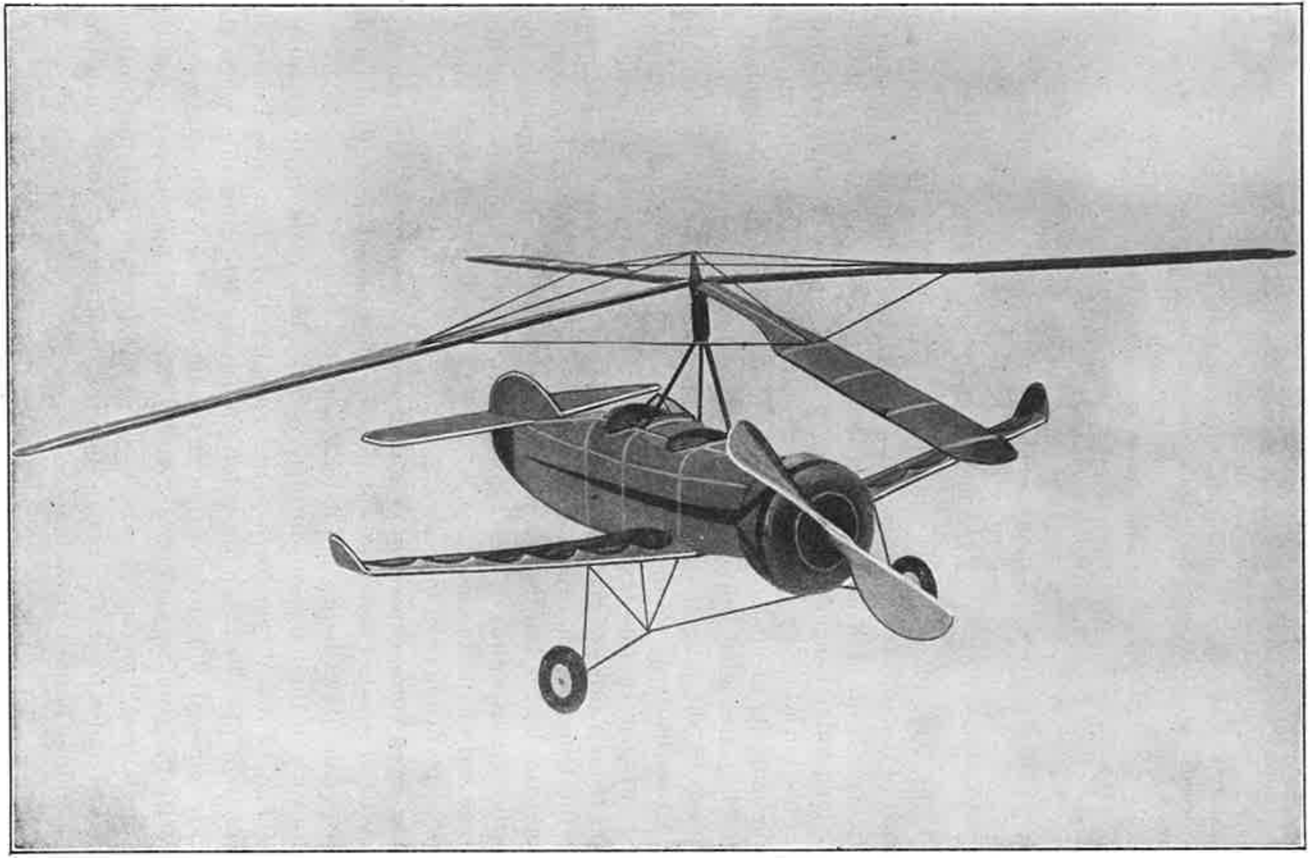
THE Pitcairn PCA-3 is a 3,000 pound autogiro produced by Pitcairn Aircraft, Inc., the first licensee of the Autogiro Company of America. It carries a pilot and two passengers and is powered with a Wright "Whirlwind" engine developing 300 horsepower.

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



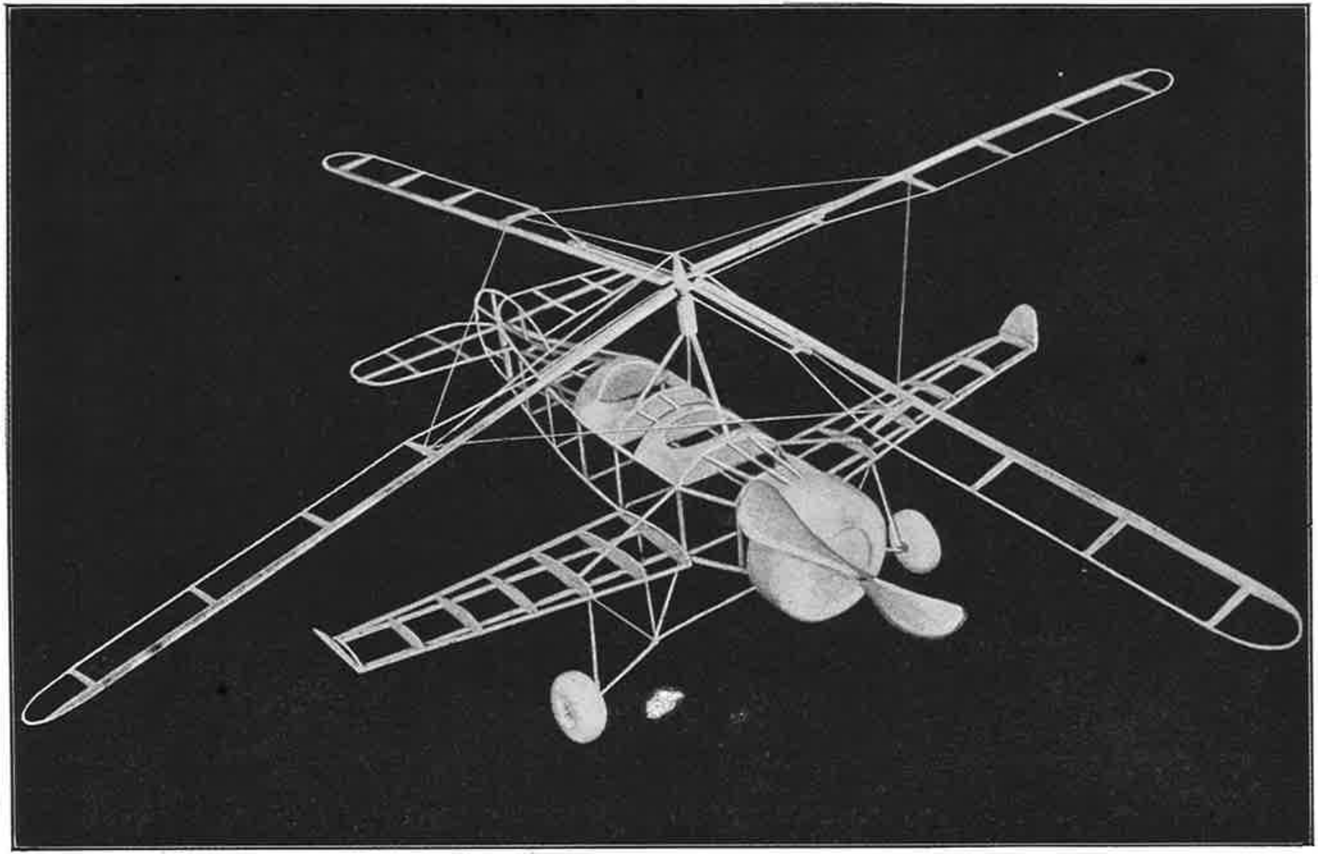
PITCAIRN AUTOGIRO PCA-3

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

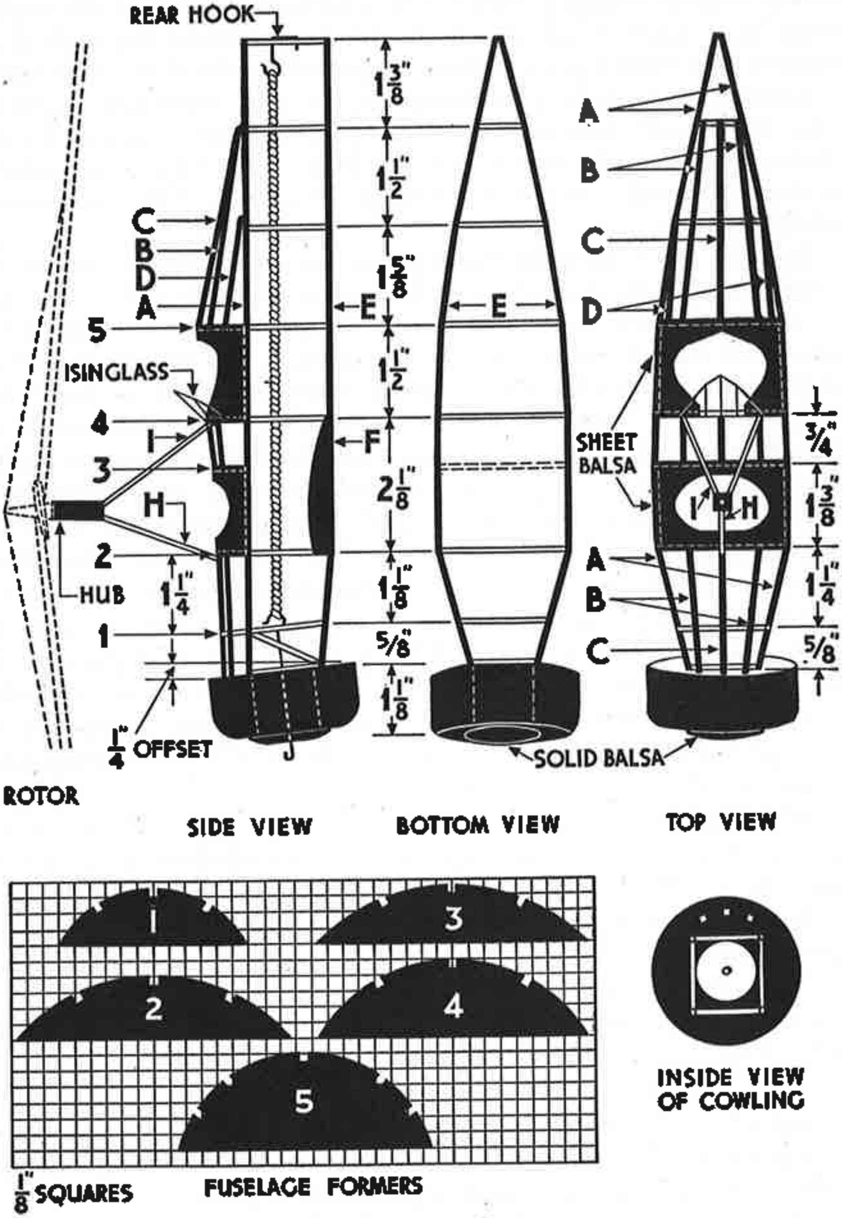
This is necessary because the autogiro flies with its tail low, so that its motor must be set at a slight angle to allow the propeller to be perpendicular. Study the side view of the solid scale plan. The fuselage is shown on a level, while the propeller is tipped. This is not its flying position. When 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



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.

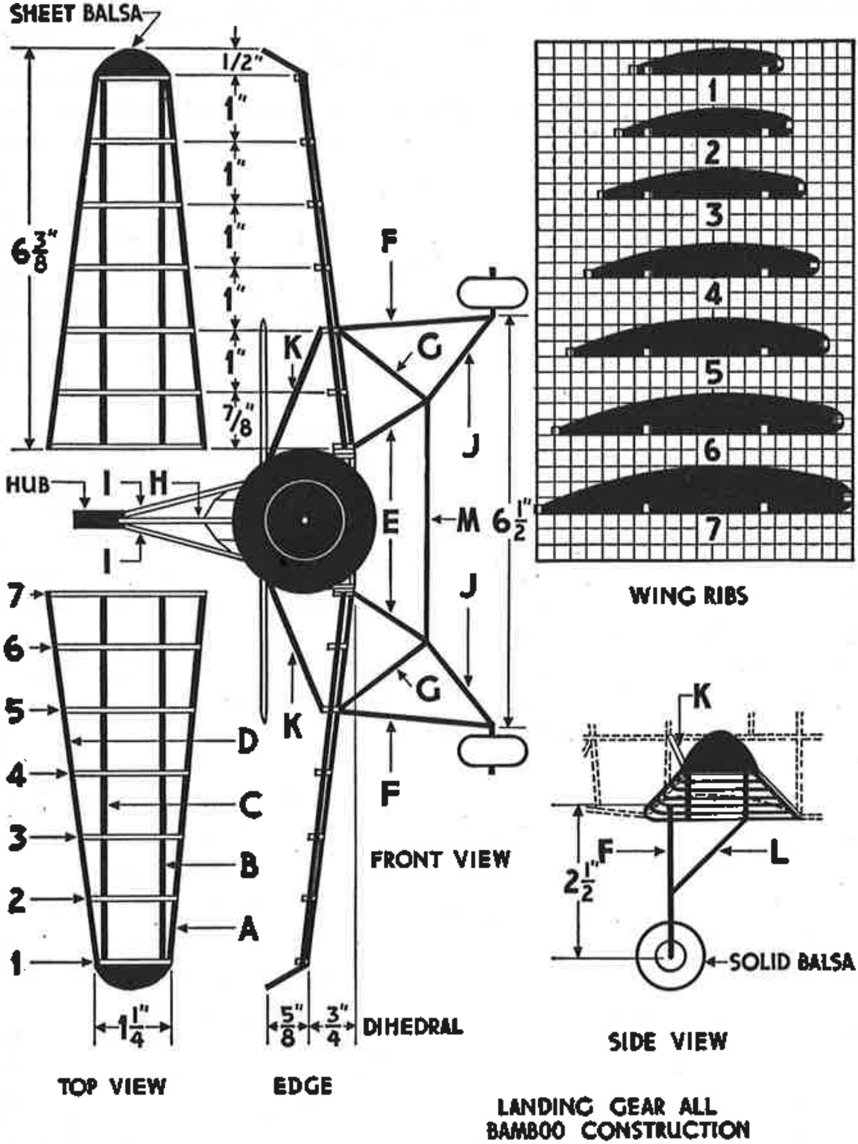
WING. The wing is made in two parts, as shown in Plan 2. Draw full-size patterns of the wing ribs on 1/8" squares, as shown under "Wing Ribs." Trace two of each of these ribs on 1/32" sheet balsa, and cut them out with 1/16" square notches in their leading ends, and under sides. Cement the two 1/16" 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.

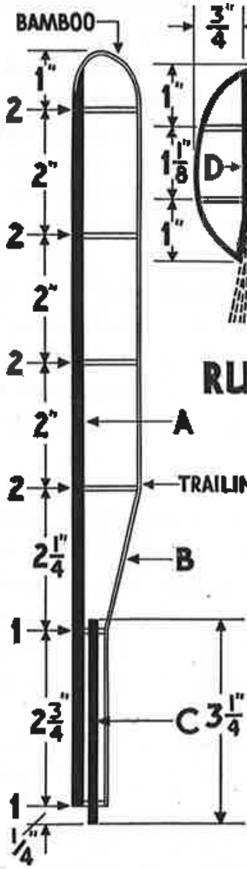
Slip E through the hole in D until it protrudes 9/16″. Cement in place. Bend a length of 1/32″ x 1/16″ split bamboo to shape. Cement one of its ends to the lower end of spar E, bring it around the trailing end of rib D, and cement its other end to the leading end of D. Slip the short rib in place between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

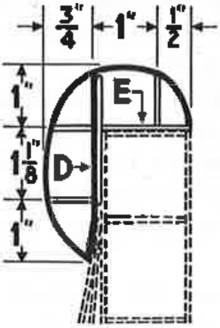
Cover the elevator on both sides with Japanese tissue, and water-spray. The rudder is cemented over the end of the fuselage, with rib D, bent up to fit on top of stringer C, while spar E is cemented against the rear upright strut. See that it is at right angles with the elevator.

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.

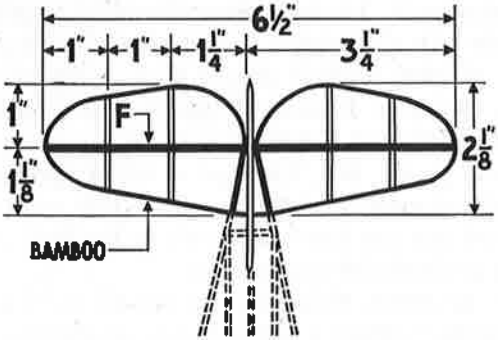
ROTOR SYSTEM. *HUB*. The hub is a 3/16″ x 3/16″ x 7/8″ long balsa piece, shown in Plan 3 under "Hub Assembly." It is mounted by three 1/16″ square balsa struts, shown in Plans 1, 2, and 3 by H and I. Strut H is 1 15/16″ long, while the I struts are 2 1/4″ long. The hub is mounted on its supports, as 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



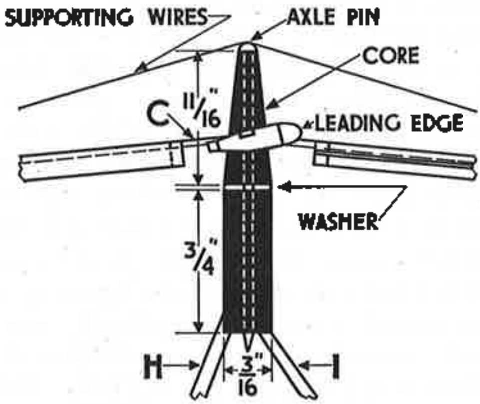
BLADE



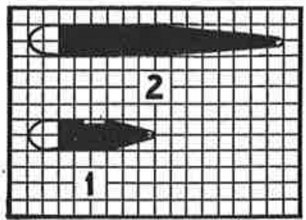
RUDDER



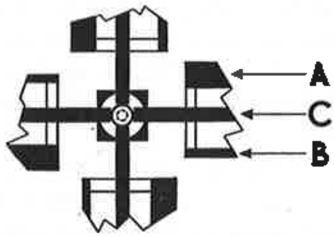
ELEVATOR



HUB ASSEMBLY



BLADE RIBS 1/16" SQUARES



TOP VIEW

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 11/16" 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.

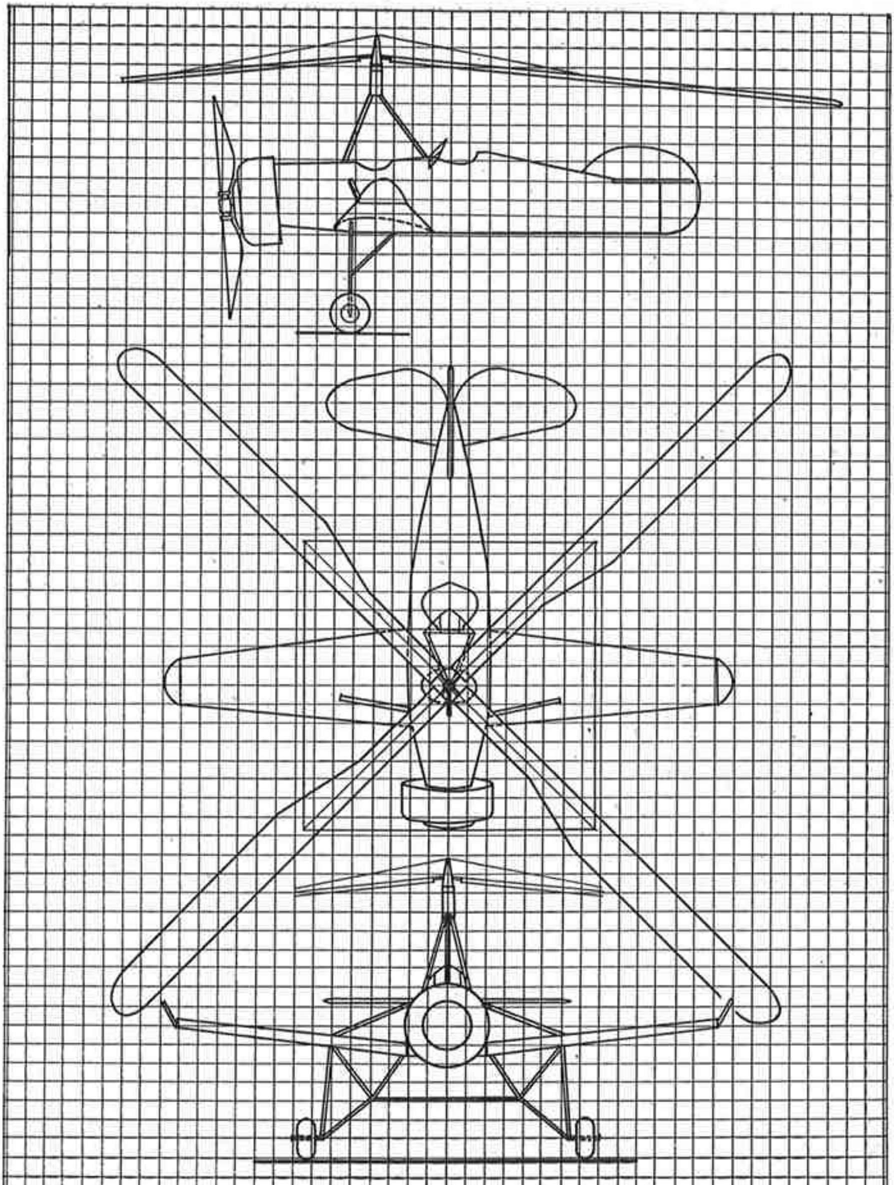
A large copper washer is placed on top of the hub and the core set in position by forcing its pin into the hole of the hub. Test the freedom of the core by blowing on the vanes. If they do not rotate freely, the hole in the core must be enlarged.

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

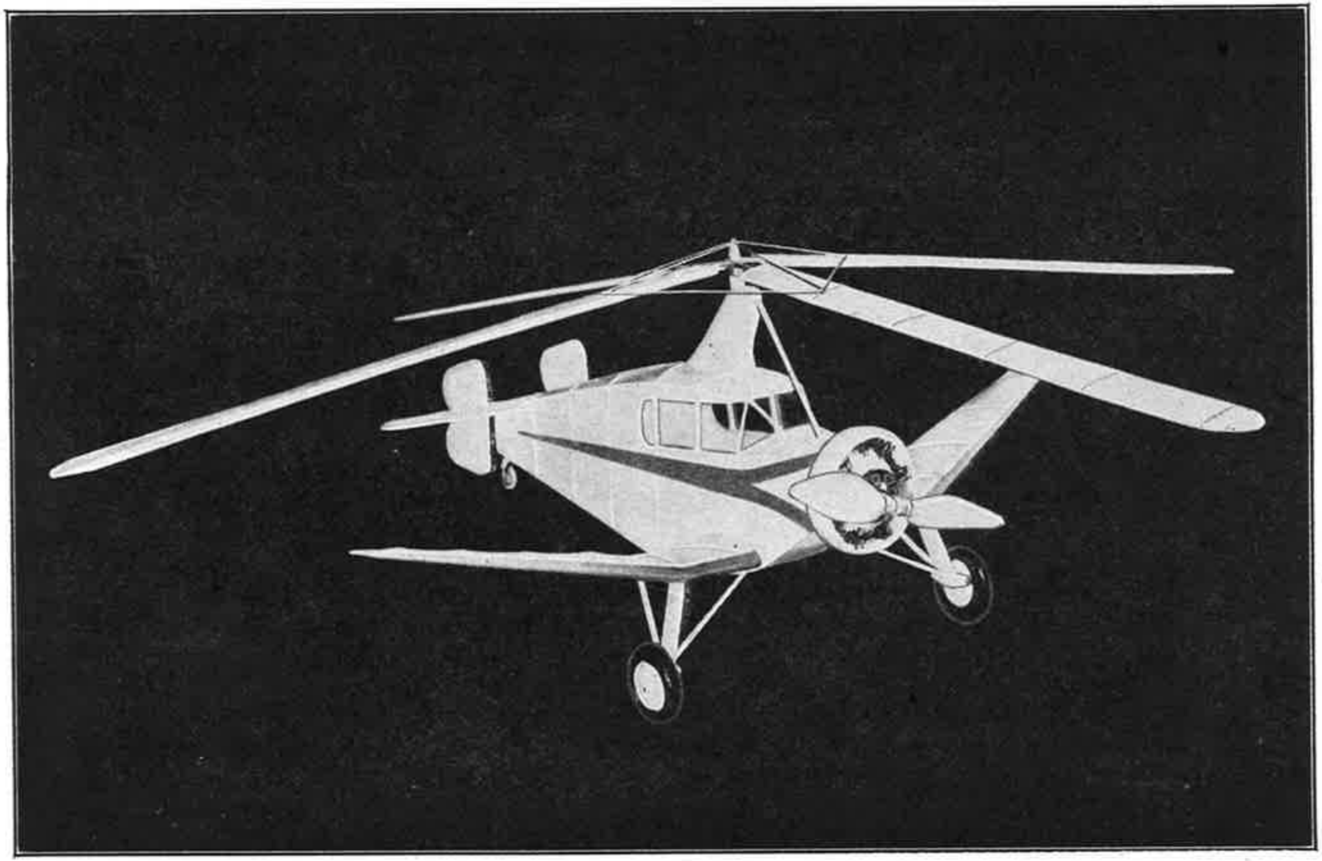
PITCAIRN AUTOGIRO PA-19

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

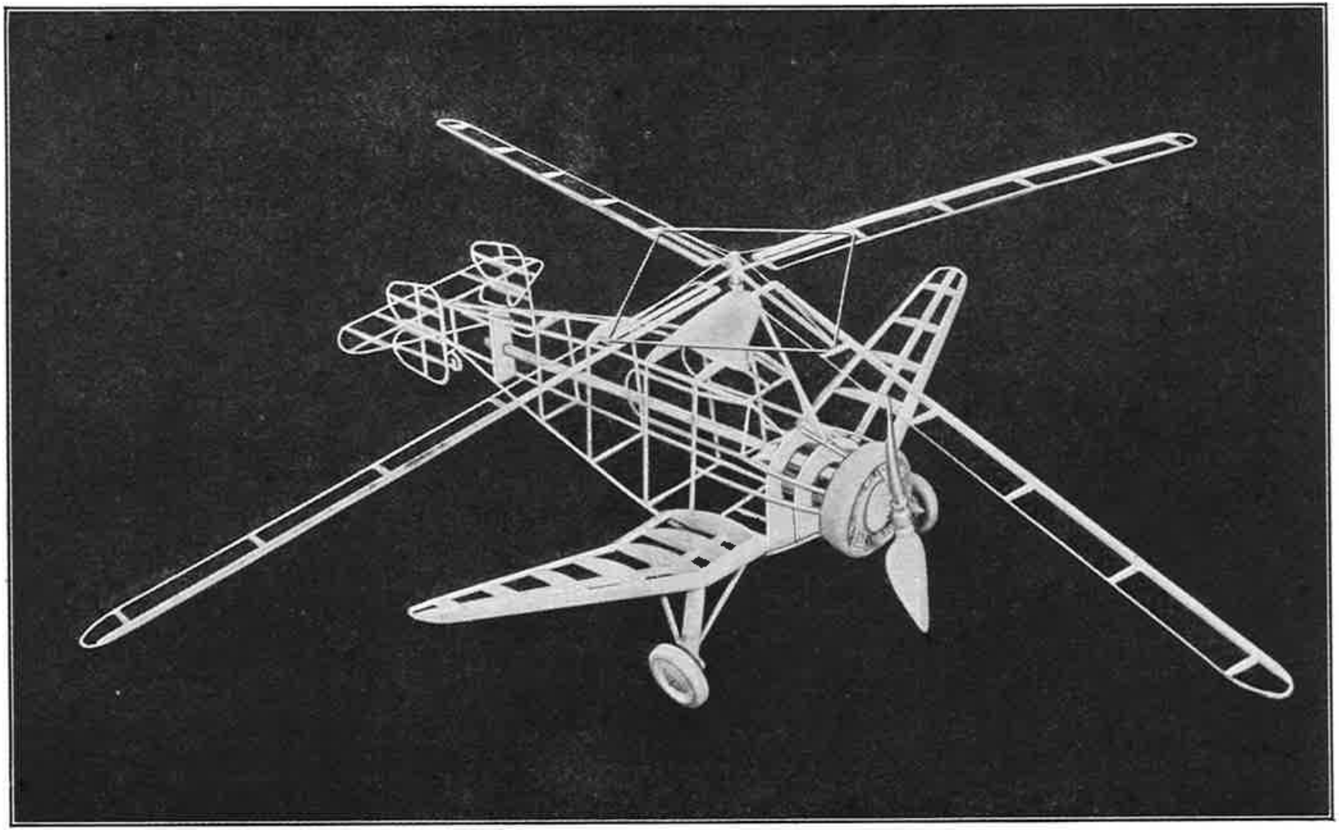
1 pc. —5/8″ x 1″ x 5″	—Balsa propeller block
1 pc. —2″ x 7″	—Isinglass or sheet celluloid for cabin windows
1 38″ length	—1/8″ flat pure Para rubber for motor
1 pair 1¼″ diameter	—Wheels
1 ½″ diameter	—Tail wheel
1 sheet	—Japanese tissue for covering
1 pc. 6″ long	—No. 9 piano wire for fittings .
1 ¼″ outside diameter	—Copper washer for rotor hub
1 1¾″ 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 ½″ 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 ½″ x 1½″ x 1½″ 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 1¼″ 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 ½″ between formers 1 and 2. Cement short stringer A into the top center notches of formers 1, 2, and 3 with ¾″ between formers 1 and 2, which gives former 1 a ¼″ offset, as shown in Plan 1. Cut and cement stringers D and E to formers 1, 2, and 3 so they extend 1¾″ 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 13/16″ 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.")

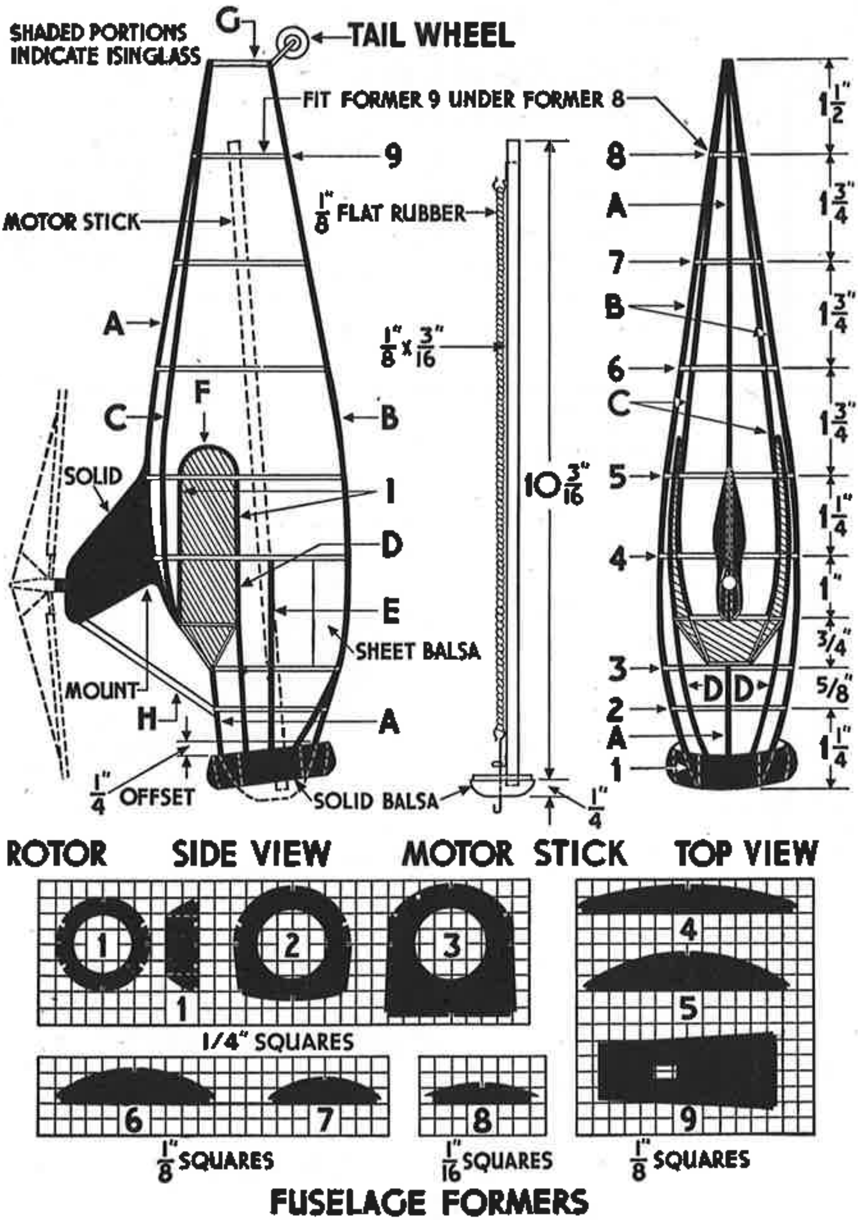
ELEVATOR. Spar D is 1/16" x 1/16" x 5 3/16" balsa. All ribs are 1/32" x 1/8" balsa. The outer pair is 1 7/16" long, and the center ones are 2" long. The inner ribs are 1 1/2" long, while the single trailing center rib is 15/16" long. Streamline these and cut 1/16" square holes 15/16" from the trailing 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 15/16" 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.

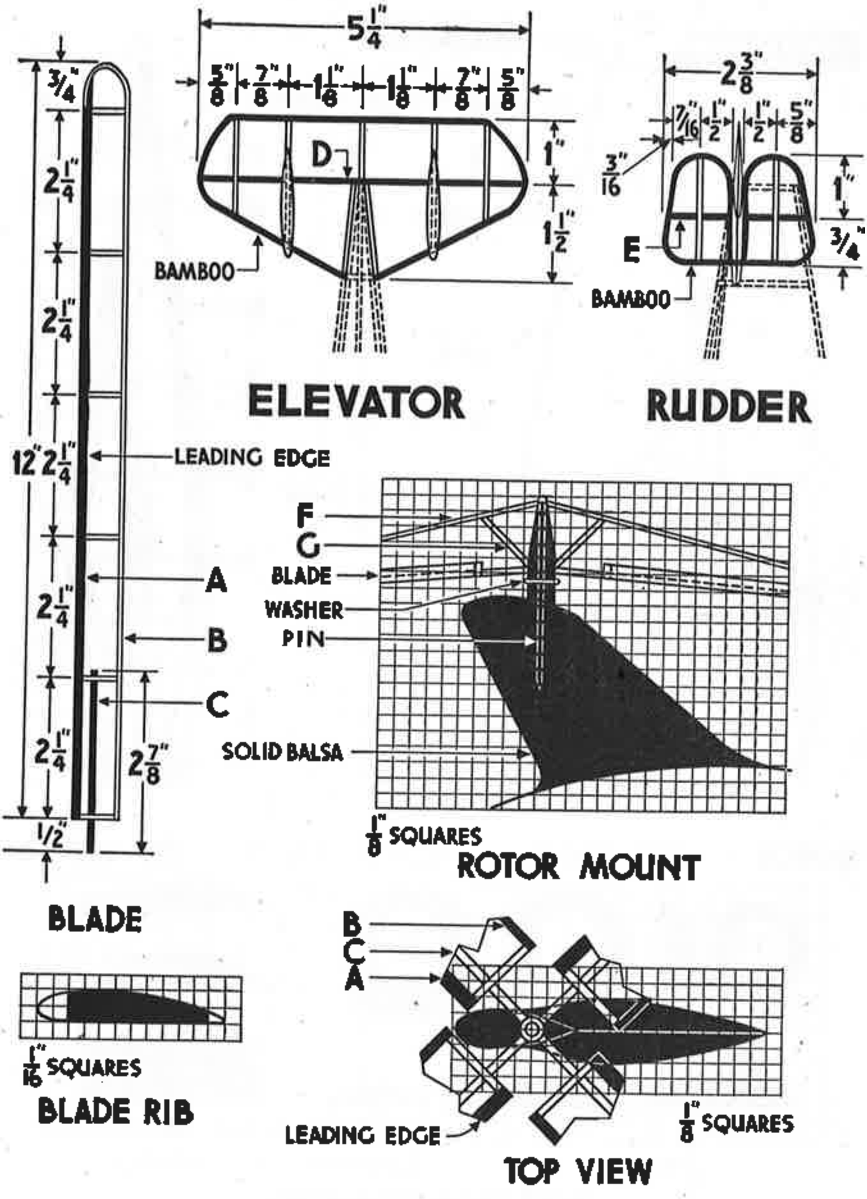
TAIL WHEEL. A length of No. 9 piano wire is thrust through the hub of the wheel, bent around in a loop, and its ends twisted together. These ends are cemented around the ends of stringers B, as shown in Plan 1.

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



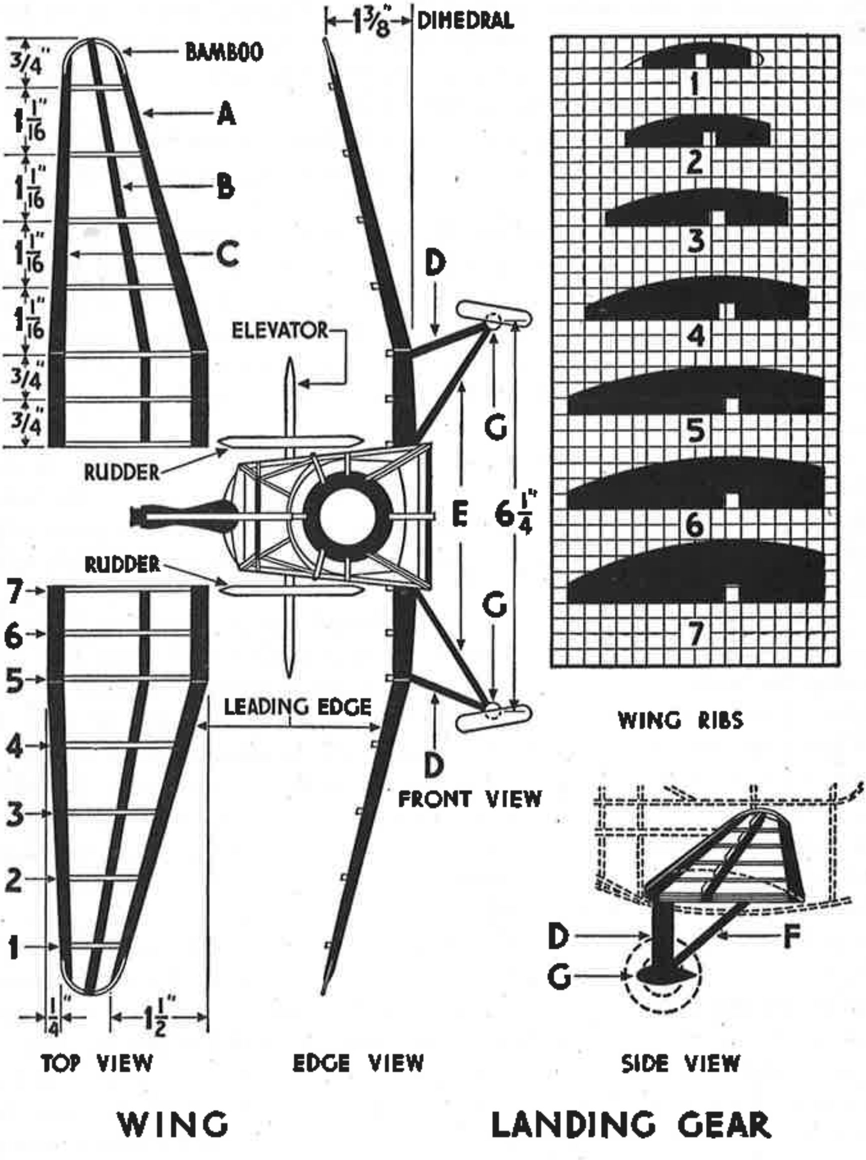
FUSELAGE

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 $1/4'' \times 3/8'' \times 6\frac{1}{2}''$ long, and two trailing edge spars C $3/16'' \times 1/4'' \times 6\frac{1}{2}''$ long of balsa wood.

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

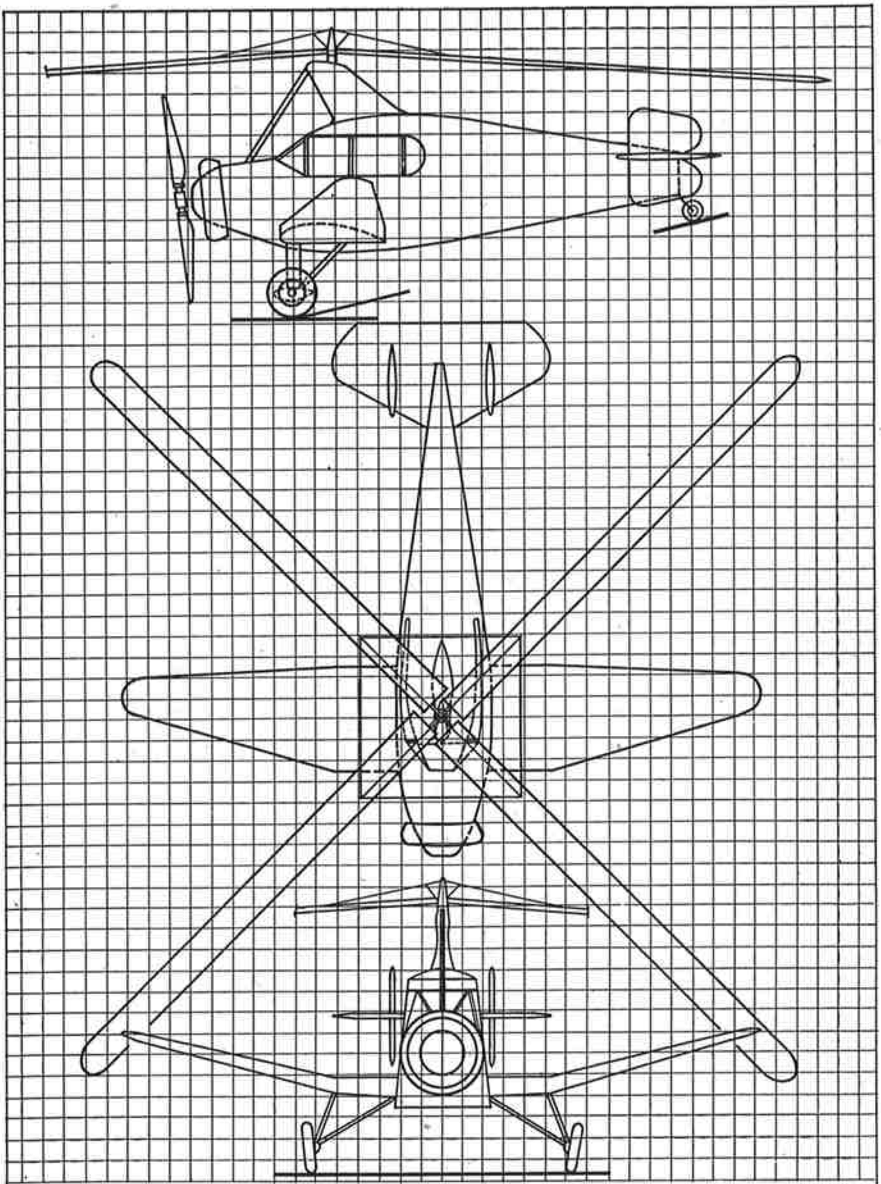
Place each spar in position on the plan. Snap the spars and bend them into proper position. Apply cement to their cracks after pinning them on the plan. Cement the ribs on spar B. Cement spars A and C in position. Bend $1/32''$ square bamboo wing tips and cement them in place. Both halves are given a $1\frac{3}{8}''$ 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 $1/8'' \times 3/8'' \times 1\frac{1}{4}''$ long, and struts E are $1/16'' \times 1/8'' \times 2\frac{3}{16}''$ long. Struts F are $1/16'' \times 1/8'' \times 1\frac{5}{8}''$ 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 $1\frac{1}{4}''$ 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 $1/8'' \times 3/16'' \times 10\frac{5}{16}''$ 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 $1/8'' \times 1/8'' \times 3/16''$ 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 $5/8'' \times 1'' \times 5''$ 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 1/2″ x 1 5/8″ x 1 7/8″ balsa block, as shown. A hub 1/4″ in diameter and 1/4″ 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 2 1/2″ 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

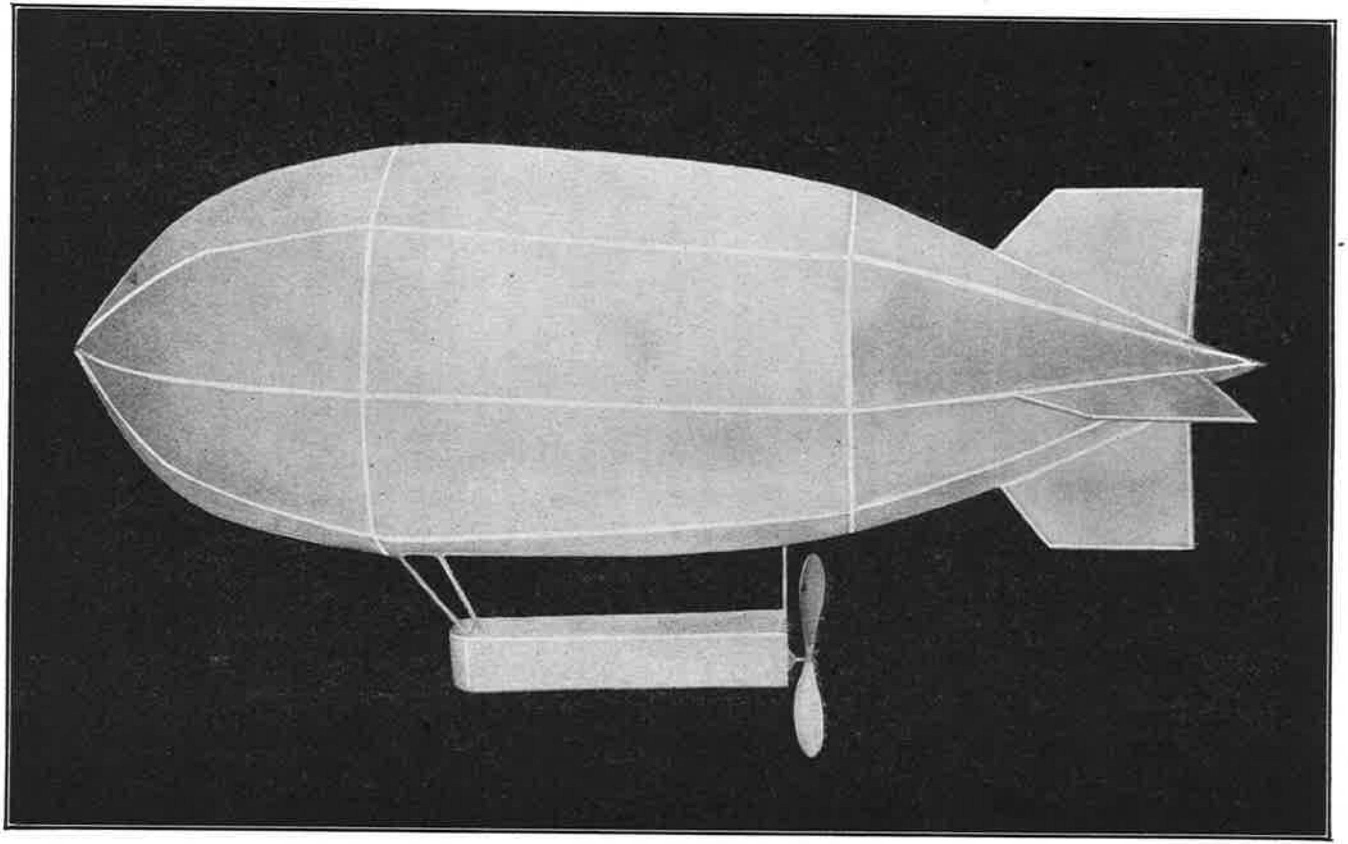
FLYING ARMY BLIMP

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 3/32″ thick, 1/4″ wide, and 36″ long, while the smaller E is 1/16″ thick, 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 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 3/4″, while the other will be 29 3/4″. Finish by giving each a light sand-papering. The stringers "A," "B," and "C," are 1/16″ square and 36″ long, being cut from balsa. Cut one piece 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 1/16″ sheet balsa 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 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."

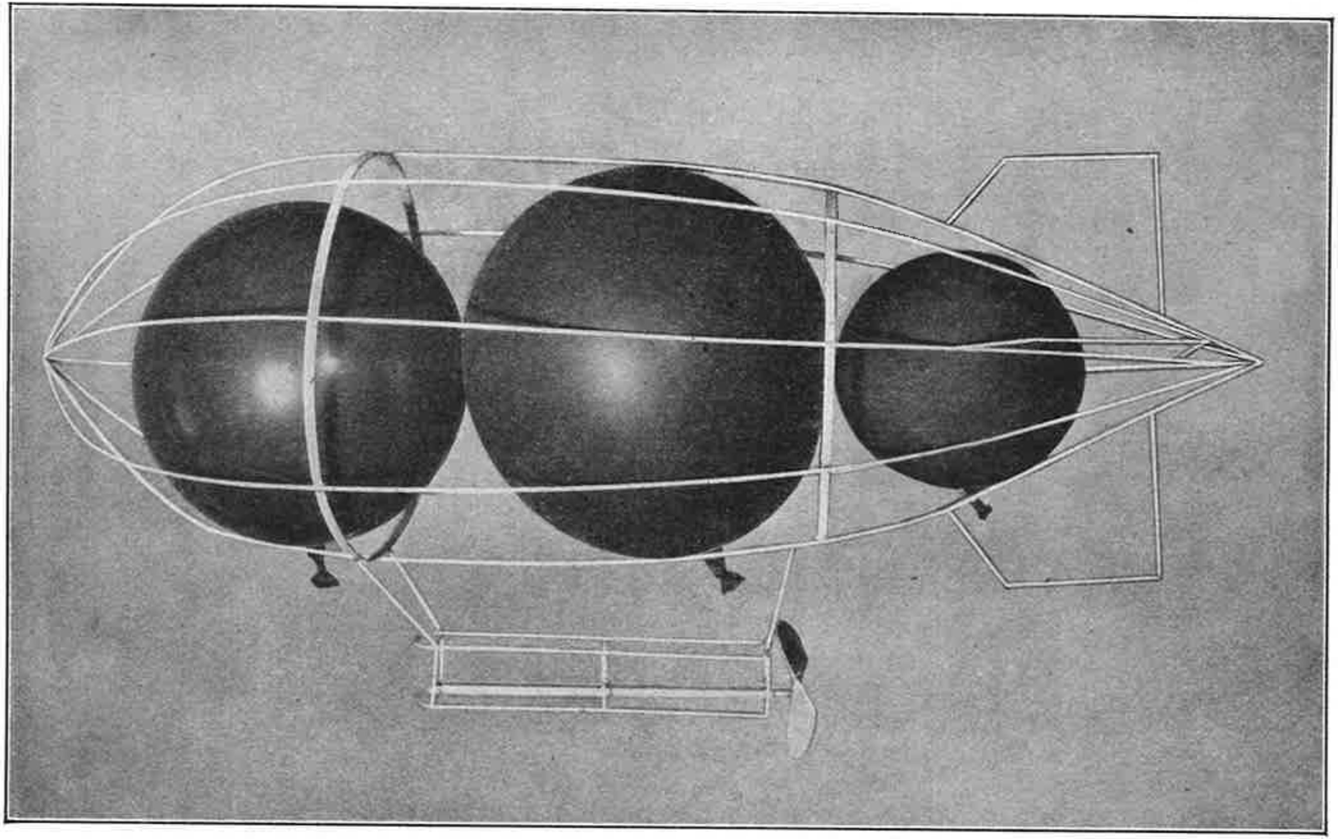
GONDOLA. This is constructed of 1/32" square balsa. Study the "Top View" and the "Side View" of this, given in the plans. The top and bottom formers are made of one length, being bent in the shape of a hairpin. The bottom has three cross braces, one at each end, and one in the center. The top has only 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 ⅛" 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 ⅛" 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.

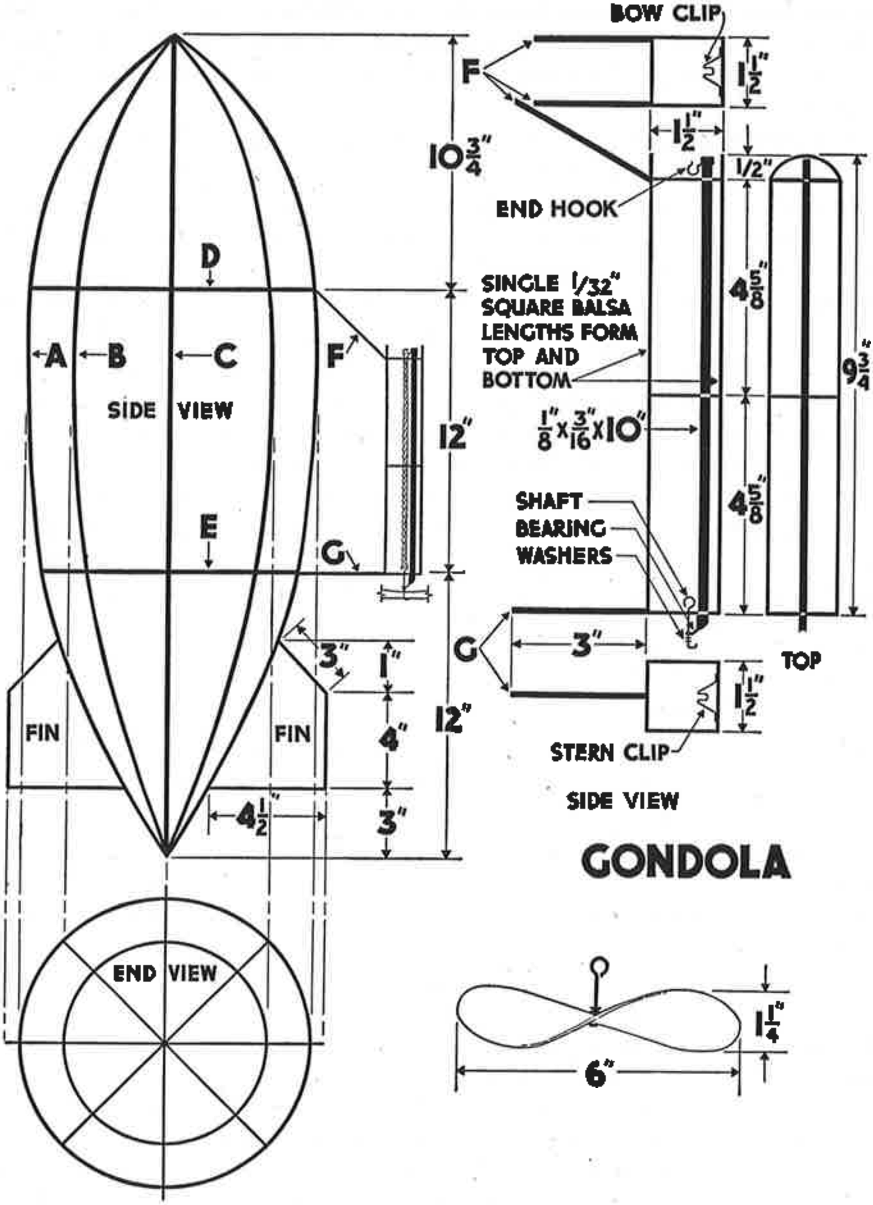
The rubber cork for the large bottle is now fitted with two of the glass tubes, each being about 8″ long. The small cork holds the remaining tube. These should be cemented in place so as to be perfectly air-tight. Fill the large bottle to its top with water, and turn it over into a tub which should be 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

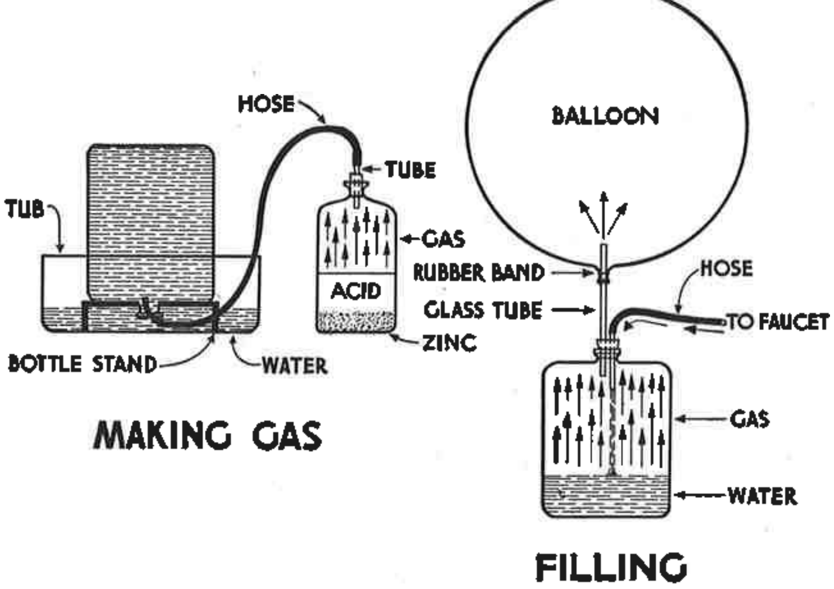


FLYING ARMY BLIMP

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

COMPLETE AVIATION DICTIONARY

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

ALABAMA

Brentnall & Johnston, 3502 Cliff Road, Birmingham

ARKANSAS

Peter Narey, 213 E. 20th Street, North Little Rock

CALIFORNIA

Eugene A. Myers, 2201 N. Baker Street, East Bakersfield
Alfred A. Hovespian, 2322 Stuart Street, Berkeley
Model Airplane Motors, 2322 Stuart Street, Berkeley
Williams Model Airplane Company, 1545 Derby Street, Berkeley
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

Truflight Model Airplane Company, 353 East Main Street, Bridgeport
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

DEALERS LIST

WASHINGTON, D. C.

Capital Model Aircraft Company, 613 Roxboro Place, N. W.
"Dragon Fly" Model Airplanes, 459 Delafield Place, N. W.

FLORIDA

Daytona Model Supply Company, 444 N. Beach Street, Daytona Beach
J. K. Hodgson, Eau Gallie
Homestead Electrical Shop, 10 North Krome Avenue, Homestead
Biltmore Model Aircraft Supply, Lakeland
Lawrence Smith, 128 N. E. 94th Street, Miami

ILLINOIS

Airplane Supply Shop, 1221 South Grove Avenue, Berwyn
Model Airplane Supply, 3638 Oak Park Avenue, Berwyn
Pioneer Model Airplane Supply Company, Champaign
Accurate Model Aircraft Company, 1632 N. Halsted Street, Chicago
Comet Model Airplane & Supply Company, 3114 W. Harrison Street, Chicago
Dale L. Carlson, Y.M.C.A.—Boys' Section, 4251 Irving Park Boulevard, Chicago
Community Aircraft, 5908 Irving Park Boulevard, Chicago
Douglas Model Airplane Supply Company, 3540 Douglas Boulevard, Chicago
Eagle Kit Manufacturing Company, 1346 South Karlov Avenue, Chicago
Famous Model Aircraft, 3229 Sheffield Avenue, Chicago
Joseph Geidar, 1944 W 51st Street, Chicago
Gil Manufacturing Company, 3408 N. Cicero Avenue, Chicago
Hawk Model Aeroplanes, 4944 Irving Park Boulevard, Chicago
Hirsch School Store, 7756 Drexel Avenue, Chicago
Charles J. Hull, Universal Model Aero Supply, 811 Galt Avenue, Chicago
Kahn Aircraft Company, 5710 Woodlawn Avenue, Chicago
R. B. Krelle, De Luxe Model Airplane Company, 3156 Belle Plaine Avenue, Chicago
Lawrence Airplane Models, 1319 Hood Avenue, Chicago
Lockhart Model Airplane Company, 5533 S. Lincoln Street, Chicago
Model Airplane Supply Company, 2906 W. 22nd Street, Chicago
Model Aviator Products, 3335 Eastwood Avenue, Chicago
Red Wing Model Airplane and Supply Company, 4600 N. Carelia Avenue, Chicago
Sky-Rider Airplane Model and Supply Company, 3046 N. Keating Avenue, Chicago
South Town Model Aircraft, 6821 S. Union Avenue, Chicago
Sparton Model Airplane Company, 1224 S. Karlov Avenue, Chicago
Success Model Airplane and Supply Company, 1846 W. 34 Place, Chicago
Swallow Model Aircraft, 3840 N. Newland Avenue, Chicago
Roy Swanson, 6208 W. Grand Avenue, Chicago
Trost Model and Supply Company, 3111 W. 63rd Street, Chicago
Typhoon Model Airoplane Company, 5632 S. California Avenue, Chicago
Wings Model Airplane Company, 2444 Montrose Avenue, Chicago
Super Model Aircraft Supplies, 1243 S. 58th Street, Cicero
The Hi-Flier Manufacturing Co., Decatur
R. H. May, Jr., 909 Washington Street, Evanston

Monroe Model Aircraft, 1718 Harrison Street, Evanston
Aerocraft, Galva
George Koch, 15246 Center Avenue, Harvey
Model Airplane Shop, 1727 5th Street, Moline
H. W. Butterfield, 311 Walnut Street, Momence
Bildon Company, 709 Wenonah Avenue, Oak Park

INDIANA

Hawkins Model Engineering Company, Box 191, Ashley
J. Thomas, 2042 Ohio Avenue, Connersville
Mattes Brothers, 2001 Calhoun at Williams, Ft. Wayne
Royal Model Aircraft Company, 6131 Calumet Avenue, Hammond
Ray Duffy, 117 Fir Street, Michigan City
Hoosier Model Company, 311 E. Main Street, Muncie
Peru Model Airplane Shop, Peru

IOWA

N. A. Lorenzen, 206 S. 4th Avenue, Marshalltown
George Reynolds, 814 E. Fifth Street, North, Newton

KANSAS

Emporia Model Aircraft and Supply Company, 111 E. 6th Street, Emporia
Frank Helt, 1510 Chess Street, Parsons

KENTUCKY

Crimson Model Aircraft Company, 1355 Cypress Street, Louisville
Glenn's Model Airplane Supply Company, 1208 S. 41st Street, Louisville
Pop Eye Model Company, 938 S. 3rd Street, Louisville

LOUISIANA

Mod-Kraft Mfg. Company, 7801 Jeannette Street, New Orleans

MAINE

Airways Inc. of Maine, Waterville

MARYLAND

Brigham Model Airplanes, Ashton
Burd Model Airplane Supply Company, 201 W. Mulberry Street, Baltimore
Paul Kemper, 1330 Pennsylvania Avenue, Baltimore

MASSACHUSETTS

Kronjelt's Model Supply, 215 Mountain Avenue, Arlington
Modern Model Airplane Supply Company, 66 Cogswell Street, Haverhill

DEALERS LIST

James Carter, 21 Wilson Street, Lowell
I. Johnson, American Sailplane Company, Lynn
Marlboro Airplane Model & Supply, 68 Washington Street, Marlboro
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

MICHIGAN

Brockett's Aero Supply Company, 10-12 West State Street, Battle Creek
Aero Shop, 3050 Hulibut Avenue, Detroit
Airco Models and Supplies, 2193 Alter Road, Detroit
All-American Model Airplane Supply Company, 4626 Manistique Avenue, Detroit
Arrow Model Supply, 14606 Charlvoix Avenue, Detroit
Ben Averbach, 9527 Goodwin Street, Detroit
Cardinal Aero Supply Company, 9018 Linwood Avenue, Detroit
Crescent Novelty and Toy Company, 13646 Cedargrove Avenue, Detroit
Dallaire Model Aircraft Company, 10140 Crocuslawn Avenue, Detroit
Del Tin Model Aero Supply, 5033 Parker Avenue, Detroit
Michigan Model Airplane and Supply Company, 4768 Grand River Avenue, Detroit
Owen Rothrock, 17004 Log Cabin, Detroit
Schroder Model Airplane Shop, 818 Wheelock Street, Detroit
Daniel Applegate, 2421 Ried Street, Flint
Donald Hughson, 1418 Scribner Avenue, Grand Rapids
Howard R. Munshaw & Company, 1243 Calvin Avenue, S. E., Grand Rapids
Model Airplane Shop, 1311 Michigan Avenue, Jackson
Model Aeronautical Engineering Company, 334 W. Kalamazoo Avenue, Kalamazoo
W. P. Feeney, Wright Model Airplane Corp., Lansing
Oliver P. Dunstan, 53 Vinewood Avenue, Pontiac
Reliable Model Aeroplane Company, 133 Orchard Lake Avenue. Pontiac
South Haven Model Airplane Supply, South Haven

MINNESOTA

Buffalo Model Shop, c/o Ivan Walters, Buffalo
Airplane Model & Toy Company, 203A Eustis Building, Minneapolis
Marvin Northrup, 730 Washington Avenue, North, Minneapolis
Northwest Model Airplane & Supply Company, 732 E. Lake Street, Minneapolis
Oak Island Trading Post, Oak Island
Cunard Aircraft Company, St. Paul

MISSISSIPPI

John Lloyd Frye, Glendora

DEALERS LIST

MISSOURI

Country Club Aero Supply Company, 5821 Homes Street, Kansas City
Unitite Liquid Cement Company, 3513 Agnes Avenue, Kansas City
Universal Model Aircraft Co., 2905 East 33rd Street, Kansas City
Vespa Model Airplane Supply Co., 3307 Virginia, Kansas City
Dudley Duton, Vice-Pres., Nu Craft Corp., 4101-9 Sarpy Avenue, St. Louis
Ehrhardt's Model Aircraft Supply Co., 7020 Wise Avenue, St. Louis
Missouri Aero Club, 3106 Morganford Avenue, St. Louis
Frank Wheeling, 4539 Page Avenue, St. Louis

MONTANA

Donald F. Sump, 120 Custer Avenue, Billings

NEBRASKA

Costellow-Bulger Mfg. Co., 2049 S. 19th Street, Lincoln
Eagle Model Airplane Company, 5331 N. 26th Street, Omaha
Junior Aircraft Co., 4327 North 40th Street, Omaha
Midwest Model Airplane and Supplies, S. E. Corners 50th and Miami Streets, Omaha
Red Bird Model Airplane & Supply Co., 1615 Maple Street, Omaha

NEW JERSEY

Elray Model Aircraft Co., 620 Garden Street, Carlstadt
McCoy Model Aircraft, 10 New Brier Lane, Allwood, Clifton
Paul Hoppe, 66 Prospect Street, Dumont
Aero Model Builder's Guild, 231 Halsted Road, Elizabeth
Clarycraft Shops, 86 Spring Lane, Englewood
Neigel Model Aero Co., 10 Park Avenue, Fairlawn
S-L Aircraft Co., 344 River Drive, Garfield
Hawthorne Model Aero Co., Hawthorne
Orion Model Airplane Supply Co., 349 So. 21st Street, Irvington
United Model Airplane & Supply Co., 1291 Clinton Avenue, Irvington
Judson H. Groves, Box 322, Jamesburg
Frank T. Roberts, Box 294, Jamesburg
Ace Aeroplane & Model Supply, 131 Prospect Street, Jersey City
George J. Terpok, 57 Monitor Street, Jersey City
J. R. Bernard, 113 Ridge Road, Lyndhurst
Frank Muller, Jr., 69 Highland Avenue, Midland Park
Williams Aircraft, 118 Edgemont Road, Montclair
Albatross Model Airplane & Supply Co., 306 S. Orange Avenue, Newark
Bamberger Aero Club, L. Bamberger & Company, Newark
Scientific Model Airplane Co., 277 Halsey Street, Newark
Akron Model Aircraft Co., Toms River
Benner Brothers, Trenton
Metal Craft Novelty Co., 748 Bergenline Avenue, West New York

DEALERS LIST

NEW YORK

Linson Model Aero Co., 32-01 Grand Avenue, Astoria, L. I.
Sea Gull Model Aero Co., 153 Beach, 126 Street, Belle Harbor, L. I.
G. H. O. Model Airplane Supply Co., 558 Southern Boulevard, Bronx
Hub Model Airplane & Supply Co., 475 Brook Avenue, Bronx
Modern Model Aeroplane Co., 992 Trinity Avenue, Bronx
Nu-Ace Model Aircrafters, 2615 Webster Avenue, Bronx
Universal Model Aero Plan Co., 1315 Clinton Avenue, Bronx
American Aero Works, 262 Schenectady Avenue, Brooklyn
Major J. T. Anek, 2021 E. 17th Street, Brooklyn
Bernard's Model Supply Shop, 15 Hanover Place, Brooklyn
Brooklyn Model Aircraft Co., 1326 Flatbush Avenue, Brooklyn
Construct-A-Plane Co., 285 Bushwick Avenue, Brooklyn
Eagle Model Aircraft Co., 962 59th Street, Brooklyn
Flatbush Model Aircraft Co., 714 Foster Avenue, Brooklyn
Floyd Bennett Model Supplies, 8509 21st Street, Brooklyn
Heathe Model Aeroplanes, 438 E. 98th Street, Brooklyn
Leroy Model Airplane Co., 184 Norman Avenue, Brooklyn
Madison Model Airplanes, 134 Livingston Street, Brooklyn
Mercury Model Airplane Company, 1592 Lincoln Place, Brooklyn
Meyer Model Aircraft, 371 Clinton Street, Brooklyn
Model Aircraft Producers, 772 42nd Street, Brooklyn
Model Airplane Utility Co., 1140 53rd Street, Brooklyn
Roy Palmer, 800 McDonough Street, Brooklyn
Paragon Model Aircraft, 1479 70th Street, Brooklyn
Ripin Model Airplane Co., 915 Franklin Avenue, Brooklyn
Selly Mfg. Co., 1405 Gates Avenue, Brooklyn
Sirus Model Aero Co., 62 Livonia Avenue, Brooklyn
I. Sturiale, Crescent Model Aircraft, 1805 Benson Avenue, Brooklyn
U. S. Model Aircraft Co., 443 Hudson Street, Brooklyn
Victory Model Airplane Supply, 6725 10th Avenue, Brooklyn
United Model Supply Co., P. O. Box 351, 16 Court Street, Brooklyn
Louis Waldman, 1343 50th Street, Brooklyn
Crem Model Aircraft Co., 80 Roxbury Road, Garden City
Sholman Model Builders Service, 89 Glen Cove Avenue, Glen Cove
The Model Shop, 321 67th Street, Glendale, L. I.
J. Broadfield Billings, Broadfield Aeroplane Co., Hempstead, L. I.
Model Aero Shop, c/o Julius Van Hoven, Bay Crest, Huntington, L. I.
Ski-Hi Model Aircrafters, 333 Central Avenue, Lawrence, L. I.
R. L. Model Co., 33 Sunset Avenue, Lynbrook
Miniature Aircraft Corp., 83 Low Terrace, New Brighton
S. J. Cutting, National Model Aircraft & Supply Co., Blue Bird Bldg., New Rochelle
Ariel Model Planes, 622 Hegney Place, New York
Bensid Aircraft Co., 29 W. 26th Street, New York
Ideal Aeroplane & Supply Co., Inc., 18-22 W. 19th Street, New York
International Models, 1775 Broadway, New York

Linke Model Aircraft, 80 E. 235th Street, New York
Majestic Model Aircraft Co., 100 Fifth Avenue, New York
Modern Technical Models, 117-121 W. 128th Street, New York
Moskito Flyer Airplane Co., 693 Washington Street, New York
Novelty & Premium House, 258 Broadway, New York
P. Smookler, Box 89, G. P. O., 8th Avenue, New York
American Model Aircraft Co., 102-02 Liberty Avenue, Ozone Park, L. I.
Denny's Sport Shop, 123 North Main Street, Port Chester
B. E. Norton, Mgr., Norton Model Aircraft, Richfield Springs
Model Airplane Associates of Rochester, 179 Crawford Street, Rochester
Rochester Model Airplane Co., 110 Delray Road, Rochester
E-Z Aviation System, Box 6, Rosedale
E. Crosse, 898 Eggert Road, Tonawanda
Standard Aeronautical Model Supplies, 2898 Eggert Road, Tonawanda
A. L. Jones, 51 Greenland Avenue, West New Brighton
W. B. Lawrence, 54 Quinlan Avenue, West New Brighton
Master Model Aircraft, 150 Main Street, White Plains
Woodhaven Model Shop, 8928 90th Street, Woodhaven
Advance Aircraft, 114 Oliver Avenue, Yonkers
Super Service Model Engineers, 123 Lake Avenue, Yonkers

NORTH CAROLINA

L. S. Bridgers, Red Top Cab Co., Page Ave. at Battery Park Hill, Asheville
Piedmont Model Aircraft Supply Co., Greensboro
E. S. Browning, Replica Model Airplane Co., Hendersonville

OHIO

Franklin Model Aero Supply Co., 172 W. Center Street, Akron
Swift Air Model Supplies, 363 Brittain Road, Akron
Midland Model Works, Chillicothe
Hill-Top Model Aircraft Co., 2553 Ring Place, Cincinnati
Ace Model & Supply, 3340 West 61st Street, Cleveland
Anderson Model Supply Co., 1219 E. 81st Street, Cleveland
Cleveland Model & Supply Co., 1866 W. 57th Street, Cleveland
Cyril A. Kremser, 4029 W. 157th Street, Cleveland
John Mackenzie, 2162 W. 100th Street, Cleveland
Walter Smith, Model Aeronautical Engineers, 1247 E. 102nd Street, Cleveland
Model Airplane Supply Co., Southern Hobby Lobby, Columbus
George D. Wanner Co., 300 Davis Avenue, Dayton
Hamilton Model Airplane & Supply, P. O. Box 287, Hamilton
Viking Aircraft Co., Box 286, Hamilton
John Dempsey, 1525 Larchmont Avenue, Lakewood
Gee Pee Model Engineering Co., 2165 Wascana Avenue, Lakewood
Peerless Model Airplane Co., 15205 Madison Avenue, Lakewood
Velia Craft, 1518 Westwood Avenue, Lakewood
Niles Model Aircraft Supply, 49 State Street, Niles

Model Glider & Airoplane Shop, 1001 S. Center Street, Springfield
H. P. Robertson, c/o Lamson Brothers, Huron & Erie Streets, Toledo
Toledo Model Airplane Supply Co., 707 Jefferson Avenue, Toledo
The Advance Aircraft Co., Troy

OREGON

Falcon Model Airplane Co., 9610 Division Street, Portland
Sturdi-Built Model Aero Works, 1310 Sandy Blvd., Portland
Western Model Airplane Co., 746 E. 28th Street, Portland

PENNSYLVANIA

Allentown Model Airplane and Supply Co., 1249 Chew Street, Allentown
Presque Isle Model Aircraft Co., 926 W. 6th Street, Erie
Thaydom Model Aircraft Co., Atlantic
Fullerton Aero Club, 822 Third Street, Fullerton
W. Burr Bennett, Box 213, Honesdale
Big Top Airplane Shop, 7037 Woodward Avenue, W., Philadelphia
August M. Grasmeder, Reliance Model Aircraft Co., 1304-1318 N. Howard St., Philadelphia
Fred W. Megow, Model Airplane Shop, 6527 N. Bouvier Street, Philadelphia
Philadelphia Model Aeroplane Co., 10 E. Church Lane, Philadelphia
Wynne Model Aero Shop, 5240 Lebanon Avenue, Philadelphia
Biddle Arthurs, Jr., 4716 Ellsworth Avenue, Pittsburgh
John H. Herb, 3400 Allendale Street, Pittsburgh
Model Zeppelin Shop, 1119 Lamont Street, N., S. Pittsburgh
Silver Flash Models, Portland
Nativity Aero & Supply Co., 801 South Webster Avenue, Scranton
Neil H. Tasker, Shamokin
Karl Ort, 609 N. Poplar Street, York

RHODE ISLAND

New England Model Airplane Association, 65 Glen Avenue, Edgewood
William A. Snow, P. O. Box 521, Pawtucket
Aero Shop, 210 Highland Avenue, Providence
Lennon Model Aero Club, 37 Lennon Street, Providence
New England Model Aero Supply, 49 Ardmore Avenue, Providence
Henry Owens & Co., Inc., 1734 Westminster St., Providence
Modelcraft Supply Shop, 15 Cottage Ave., North Providence

SOUTH DAKOTA

Hub City Model Airplane Co., 707 N. 2nd Street, Aberdeen

TENNESSEE

Justin W. Brown, 208 Poplar Street, Chattanooga

DEALERS LIST

TEXAS

L. D. Allen, 1705 S. Henderson Street, Fort Worth
Premier Specialty Co., 2501 Fairview Station, Houston
Harvey D. Rockwell, Box 161, Pampa
Oberthier Modelcraft Co., 709 Oakland Street, Plainview
Victor Stanzel, Schulenberg

UTAH

Douglass Model Aircraft Co., 227 South Fourth, East, Salt Lake City
Heinz Drug Co., 2102 S. State Street, Salt Lake City
Model Aircraft, 668 E. 8th Street, South, Salt Lake City

VIRGINIA

Ames-Harrell Model Aeronautical Co., 1319 Graydon Avenue, Norfolk
Gregory-Halleman Aircraft, 1642 Monticello Avenue, Petersburg
Old Dominion Model Aircrafters, 305 N. 28th Street, Richmond

WASHINGTON

Lloyd A. Nachtway, Washington Model Aircraft Co., 1408 E. 65th Street, Seattle
A. C. Hamilton, 418 Kittitas, Wenatchee

WEST VIRGINIA

W. W. Brust, 708 Sixth Street, Huntington
West Virginia Model Aircraft Co., 916 Fifth Avenue, Huntington
Christie Batlas, P. O. Box 149, Morgantown
England Model Airplane Co., 1311 McCollock Street, Wheeling

WISCONSIN

Clement J. Wallon, Chippewa Falls
Mat Schleck, 1308 Eberhardt Court, Madison
Capital Aircraft, Madison
Corben Sport Plane Co., Model Department, Madison
Four Lake Models, 2146 Center Avenue, Madison
Chieftain Model & Supply Co., 2123 N. Farwell Avenue, Milwaukee
K. A. C. Model Aircraft, 3323 North 3rd Street, Milwaukee
Hamilton Metalplane Co., Milwaukee

CANADA

E. H. Harris, 1837 Crescent Road, Victoria, B. C.
Hyak Model Airplane Co., 1202 Wharf Street, Victoria, B. C.
Fred White, 1027 Eleventh Street, Brandon, Man.
Maple Leaf Model & Supply, P. O. Box 26, Quebec
G. F. George Company, Kingston Road, Scarboro Bluffs, Ont.

DEALERS LIST

Homer Kells, Y.M.C.A., Saute Ste. Marie, Ont.
Jack Denay, 132 Graham Avenue, S., Hamilton, Ont.
Model Aeroplane Supply, R. R. 5, Welland, Ont.
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

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