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# HOW to BUILD and FLY a Glider

By Arch Whitehouse  
*Technical Editor*  
of FLYING ACES MAGAZINE

PUBLISHED BY  
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New York

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## THE AUTHOR



**ARCH WHITEHOUSE**

*Former Royal Air Force pilot and present technical editor of  
Flying Aces Magazine.*

# How to Build and Fly a Glider

*By*

ARCH WHITEHOUSE

*Technical Editor*

FLYING ACES MAGAZINE



*A complete instruction booklet on the art of  
gliding as it is practiced to-day with plans  
and directions for building a modern  
glider in the home workshop.*



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by Arch Whitehouse

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## HOW TO BUILD AND FLY A GLIDER

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## HOW TO BUILD AND FLY A GLIDER

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### PREFACE

**R**EALIZING the need and demand for an up-to-date article on gliding and the plans for building a modern glider, I spent considerable time interviewing several well known technical aviation men on the subject, hoping to find some one who was well versed in this comparatively new art which is now making itself felt in all aviation circles.

At first I was much discouraged to find that few technical experts knew anything of gliding in a stick-controlled glider such as is now being used with much success in Europe. The days of the old hang-glider have passed and this form of machine is completely taboo in the best gliding circles. Its instability and inefficiency have been condemned by keen glider enthusiasts.

Finally I noticed that Arch Whitehouse, technical editor of the Hersey publications, was putting out several interesting articles on this subject and I approached him with reference to the writing of a booklet on this new art. At first he was reluctant to undertake the task, explaining that gliders were no longer toys but efficient machines that actually flew and required a certain amount of technical skill to build. He pointed

out that these modern gliders do not merely "slide down the wind" but actually fly, gain considerable altitude, and are capable of remaining in the air for considerable lengths of time.

"The man who attempts to design and explain the building of a glider, is taking a great responsibility upon himself, and I would want to spend a little more time studying the situation before I attempted such a booklet. We owe it to aviation in general and the men who are to become our future pilots that this glider, to give them the best, and the best cannot be rushed into print and drawings. Give me reasonable time and I will see what I can do," he said.

That was enough for me. Any man who would attempt such a task with those sentiments in his mind, was good enough for me. He was told to go to it in his own way, regardless of time.

The booklet is now finished and we feel that Arch Whitehouse has contributed something to the sport of gliding that is really worth while. He has missed none of the essential points and tempers his explanations with fair warnings, suggestions and demands. The drawings are clear and concise. They are not too technical and any one with ordinary mechanical knowledge can follow them and complete this glider.

Mr. Whitehouse's technical background was gained while flying in France throughout the war with the Royal Flying Corps. He still does much flying and keeps close tabs on the industry. We have no qualms in offering this booklet to the glider enthusiasts as one of the most authentic and up-to-date booklets on the new art of gliding. Much research work has been undertaken to get the information contained therein and no point has been overlooked in outlining the enclosed plans and instructions.

Young America is beginning to feel its wings. Here's our contribution to the problem of making America air-minded.

HAROLD HERSEY.



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# HOW TO BUILD AND FLY A GLIDER

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## CHAPTER 1

### HOW IT STARTED

**F**OR years and years man has envied the bird in its freedom of the skies. For ages he has felt the urge to invade the blue of the heavens and skim above and through the silky fringes of cloudland. The dusty pages of history are filled with thrilling stories of man's attempts to imitate the bird; and old legends tell us of ancient heroes such as Pegasus, Medea's dragoons and Daedalus, who are supposed to have traveled through the air on fantastic wings of early imagination.

Man's first attempts to fly were by means of artificial wings fastened to the limbs. The pages of early aviation are crammed with the efforts of deep thinkers who girded their loins with crude wings and levers and risked their lives that they might prove to the world that man could fly.

Early in the 16th century Lenardo da Vinci approached the problem in more or less of a scientific manner and his notebook contains many sketches of wings that were to be fastened to the arms and legs of the early bird-man. They were designed with scien-



tific ideas far in advance of the times, but like the others, they failed to render man any material assistance in his search for a solution of the problems of artificial flight.

The age-old desire to fly became the inheritance of all men, and the struggle to conquer the air went on continually. It was not until late in the 19th century that a successful heavier-than-air man-carrying machine was invented. To Otto Lilienthal, a German, goes the honor of constructing the first glider capable of sustaining a man while in flight. Lilienthal depended upon the movements of his own body to maintain stability and balance, and his method of launching his machine for flight was the same as that used by expert soarers of the present day and time. That is, he faced the wind and had himself pulled forward against it until sufficient forward motion was attained to enable the air currents to take hold of his motorless aeroplane. He made over 2,000 successful glides but his idea of trying to maintain balance by his own body movements, rather than to build his glider so that it was inherently stable, proved his undoing. Unfortunately, he was upset by a sudden gust of wind and killed.

However, this German aviator-experimenter had

not died in vain. He had shown that it was possible for a man to fly in a machine of his own construction and his data was taken up later by the Wright brothers, who converted some of it for their own use later on. It is true that the Wrights found many flaws in his work, but the foundation in many respects was sound and they took up the work where Lilienthal left off. The Wrights began in 1900, and after making several improvements on Lilienthal's glider, succeeded in turning out one of their own design to which, three years later, they fastened a motor and accomplished the first successful aeroplane flight ever made.

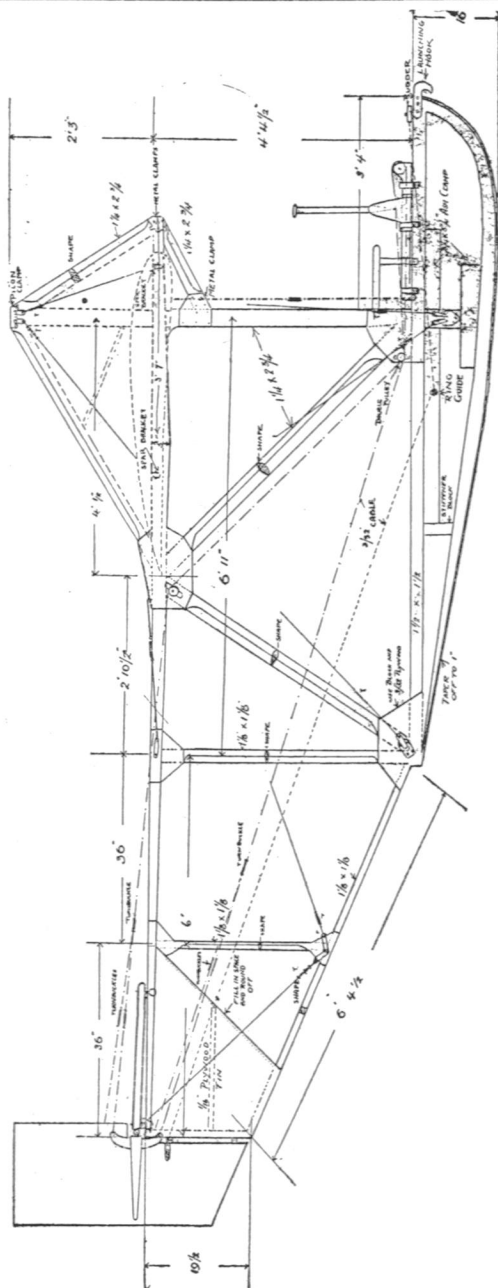
It may be observed that the Wrights used a glider merely as a step in the development of their first aeroplane, and until 1919, the glider was regarded as a stepping stone in the development of the powered ship. In this year a new impetus was given to the development of the glider. The German nation, being prevented by the terms of the Versailles treaty from any extensive aeroplane manufacturing, turned her attention to the sport of gliding. Progress in this art has been so rapid and modern scientific construction and meteorological knowledge have enabled them to set a record of fourteen hours duration flight and to obtain an altitude record of 2,500 feet.

## CHAPTER 2

## WHAT IS GLIDING?

HAVING gone this far on the early history of the glider, we might halt for a time and take up the question as to what gliding actually is. Gliding is comparatively simple, and consists solely of sailing downhill, using the wind resistance offered by the wings of the glider as a means of lessening the pull of gravity; while soaring is accomplished by manipulating the controls of the craft so as to cause it to ride the winds and gain altitude. Soaring is the advanced form of gliding and it is that phase of motorless aircraft activity that offers the greatest sport and is of the most scientific value.

Gliding is not dangerous. There have been accidents in this novel sport in the past, and the records show that four men have been killed while experimenting. Experimenting with new and radical ideas will always exact its toll, but if the gliding student will accept the proven theories and facts there is no reason why he should not enjoy this pastime in comparative safety. Present day gliders are inherently stable and do not depend upon the body movements of the pilot as was Lilienthal's machine. Balance and control are



obtained by building and flying aerodynamically sound gliders. If stalled they can be righted by the most inexperienced pilots, and modern gliders show such little tendency to spin, that they are righted with little or no trouble.

In Germany gliding and soaring are taken so seriously that schools of gliding have been instituted. At Rhoen and Rossitten a student is taught the complete course of gliding and soaring in thirty days. After that his progress depends upon the time he is able to devote to mastering the finer details of flight, the amount of study he can give to wind currents and his natural aptitude for the sport.

For early training work only the very simplest machines are used. These gliders are built with an open framework fuselage and as a rule they are not fitted with vertical fins or stabilizers. They, are, however, fitted with ailerons and rudders, which are controlled precisely as in an aeroplane. They have modern inherent stability, and the pilot's seat is placed well in front of the wing and in an entirely open location. The pupil is thus able to work out his sense of balance without using the edge of the wing and sighting on the horizon. In this way he is compelled to keep the machine on an even keel by the sense of balance alone.

After the student has gone through a ground schooling and becomes familiar with the machine and its controls, he is then launched on a few short glides or hops of only a few seconds duration. This offers him his first real feel of the craft in actual flight. Gradually the length of the glides are increased until finally the student is taken a slight distance up the side of a gentle slope and launched from that point. When he has accomplished a simple down hill glide of at least 30 seconds duration he has passed the "A" test and is ready, after making a few glides of 45 seconds, to take the "B" test, in which it is necessary to glide for at least one minute and make a right and left turn while doing so. The final, or "C" test, is much more difficult. It calls for a flight of at least five minutes ABOVE the starting point. To pass this test the student must use a machine known as a secondary glider, or soarer.

The soarers are usually monoplanes, with a higher aspect ratio than is found in the training gliders and are so designed as to possess the highest possible degree of maneuverability consistent with stability. Great care is exercised in constructing the wings, and in order to design them correctly a thorough knowledge of aerodynamics is necessary. By far the most important part of aircraft building is the design and

construction of the wings. Too much importance cannot be placed upon this point, for at present there is a general impression in this country that gliders may be constructed with no particular pains and that discarded aeroplane wings may be used for the purpose. This is a fallacy and we should not abuse this point in constructing our motorless machines.

The soarer is a more elaborate type of machine. Here we see a ship with an enclosed fuselage and in the better models, it is composed of plywood, and greatly resembles in general appearance the fuselage used on powered machines. Once the student gets to this point in his instruction in gliding he is ready to go further in this fascinating sport. It is here that he becomes familiar with prevailing winds, upward currents which make soaring flight possible. In order to rise with a motorless craft it is necessary to make use of the air currents which move vertically because these winds are themselves rising and are capable of exerting a lifting force upon the aerofoils or wings. For this reason the ideal spot for gliding is a hill of normal slope, well cleared of trees and undergrowth and facing into the wind. The air currents sweeping along the ground are deflected upward upon striking the foot of the hill, proceed up the slope just as a river would do if it flowed backward, and then pass down hill

on the opposite, or leeward side. These air currents passing up the hill form what is called the wind zone and this wind zone is said to extend into the air for a distance of about twice the height of the hill. For the very best results, gliding should be done from the side of a ridge, because the wind zone is evenly distributed along the slope, and does not form a funnel-shaped mass of air currents as is often the case when a breeze moves up a conically shaped hill.



## CHAPTER 3

## BUILDING THE GLIDER

**W**HEN the Editor of Flying Aces asked me to design a glider and write a booklet on this form of aerial sport. I was at first somewhat nonplussed, for it has been many years since I had dabbled in this sport. In the early days, before the war, I had tried gliding in many forms, with none too much success. I had tried hopping off barn roofs, speeding down hill on a bicycle and dashing down hills with fantastic forms of winged contrivances made of bamboo and piano wire. In 1914 I finally managed to get a glider that actually glided well considering the topography available at the time.

This was a wide winged affair with garish planes and a weird tail-section. It was controlled by body movement, but it would get off the ground with a lot of physical effort and glide to various landings in a brush-strewn valley below. The war came along and I bolted off to France and after a short time managed to get into the British Royal Flying Corps, where I was rushed through a maze of training and finally wound up flying real machines, and my joy was unconfined.

Later I came home and returned to my old love of gliders. That is to say, I was very much interested in gliders, and read all that could be obtained on the subject. I have designed several of various forms, some of which reached a completed form, but I have had little chance to do much real gliding owing to my present literary work. I have followed the gliding sport both here and abroad and have attended several meets. Upon seeing the German gliders last summer I soon realized that we had been away off the real track of efficient gliding machines. In the first place their system of launching the gliders was far superior to anything ever tried here, and it gives the pilot a chance to glide and control his ship in the same manner in which a powered aeroplane is handled.

I was surprised at the lack of real information that can be obtained on glider building and flying however, and on the other hand I was astonished to note in how many cases opinions differ as to design and method of flying the gliders. I have been working for the past year gathering data on these aircraft and now I believe I have sorted the wheat from the tares, and hope to be able to present it for my readers.

In the first place I obtained details and specifications on all the popular German gliders to first make

a complete study of their methods. Next I got in touch with the Evans Glider Clubs of America, whose officers are located in Detroit.

From the officials of this organization, I learned that the day of the old hang glider is over, and that construction of these models is frowned upon. It is difficult to handle in the air and is not stable and safe for beginners. It has no aeroplane controls and really offers real gliding possibilities in developing boys or young men into qualified glider or aeroplane pilots.

We want to digress here for the time being in explaining that the building of a so-called simple training glider is no easy matter. It should not be attempted by anyone who is not well versed in the use of tools or the experience of reading blueprints. A glider is not easy to build and many manufacturers are refusing to sell these machines or parts to young people or individuals whom they feel are not competent to handle them correctly. We do not say that a modern glider can be built by the ordinary schoolboy, but a group of schoolboys, under proper supervision, can build a glider and learn to fly it with complete safety. In other words, a glider is an aeroplane in every respect, and not a toy, and only individuals or properly selected groups of students are advised to attempt it.

## THE WHITEHOUSE "WASP"

A MOTORLESS AIRPLANE

DATA

CONTROLS.

AILERONS  
RUDDER  
ELEVATORS

Guys.

} All of  $\frac{3}{32}$  GAUGE.WING  
TAIL PLANE} 32 PLANO WIRE  
CLAMPS.METAL -  $\frac{1}{2}$  CARBON STEEL.WOOD -  $\frac{1}{16}$  PLYWOOD

FUSILIAGE

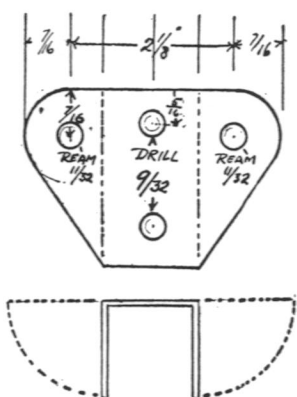
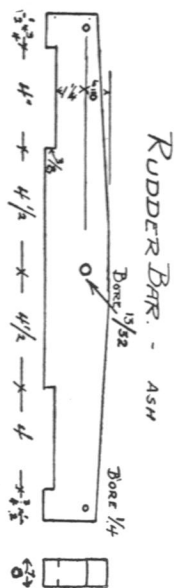
SITKA SPRUCE.—BEST SELECTED

PLYWOOD - BEST  $\frac{3}{16}$  -  $\frac{1}{16}$ SKID - ASH  $\frac{7}{16}$  x  $\frac{3}{4}$ "

FITTINGS SHOULD BE MADE ACCURATELY AS SHOWN AND OF MATERIALS NOTED. CARBON STEEL SHOULD BE ANNEALED BEFORE BENDING AND TEMPERED AFTERWARDS.  
SEAT - SHOULD BE CUT OUT OF  $\frac{3}{8}$ " 3-PY BIRCH SUPPORTED BY TWO  $\frac{1}{8}$ " SPRUCE BRACKETS ON LOWER LONGERON. SPACE FROM SKID UP TO LOWER LONGERON MAY BE COVERED WITH PLYWOOD IF DESIRED.

\*T\* MEANS TURN BUCKLE IN REIGINGING AND CONTROLS.

MAKE LAUNCHING HOOK OF  $\frac{1}{10}$  CARBON STEEL - BEND IT OVER NOSE OF LOWER LONGERON AND BOLT THROUGH.



Some experts have even gone so far as to state that too much has been put out concerning the simple construction of gliders. The general impression has gone out that almost anyone can build a glider or even a soarer. Young boys about twelve years of age have bought blueprints of the Darmstadt soarer, with the hopes of constructing such a machine, and flying it.

Just how much this means is forcibly brought home when it will be remembered that one of the German glider experts crashed his ship against a flagpole at Cape Cod last year, and he was unable to repair it there, owing to the fact that he had no blueprints of the machine in this country.

Gliding and soaring, when properly conducted in proper machines, has a high factor of safety. As soon as amateurs begin to build unstable ships, they eliminate to a large degree that safety factor and accidents result.

It is well to keep these points in mind when contemplating the building of a glider.

## CHAPTER 4

### THE MONOPLANE GLIDER

**A**FTER much investigation and conversation with the few men in this country who really know something about modern gliders, I decided to work out a high wing monoplane glider of the German type, that could be built for a reasonable sum of money. After figuring up the costs, I feel that this ship can be built for anything from \$350 to \$500, according to the skill of the builder and the local costs of materials.

The glider is a comparatively simple affair in construction, but I must insist on the best materials and bona fide aeroplane fittings such as cables, pulleys, wing brace links, spar varnish, dope, aeroplane linen, lumber and joint brackets.

The fuselage is to be constructed of best Sitka spruce, of straight grain and sized to correct dimensions. Steamed parts shall be carefully handled, care being taken not to "burn" the wood in shaping. All outside struts are to be properly streamlined according to drawings and rib stock is to be specially selected for straight grain and sized accurately to dimensions.

All joints in fuselage are to be bolted with plates wherever instruction calls. Never waste or cut down

on these important features. Take time in constructing fuselage and wings, and erection later will be that much easier.

I selected the single runner glider for its ease of operation and cost of construction. The runner is made of selected ash which is sound, straight grain and quarter sawn, kiln dried stock. The skid clamps should be of the same material.

This glider will give much satisfaction if built correctly. Machines of this type have reached heights of 100 feet from a 35-foot starting take-off, in an 18-mile-an-hour-wind. It is gliding of this kind that the beginner should strive for before attempting to build or purchase a soarer. A glider of this type should withstand the severest tests and display the finest of flying qualities. The normal life of such a plane under careful handling should run into thousands of flights. Washouts are next to impossible and repairs are easily and cheaply made, providing the machine is built correctly in the first instance.

The glider builder should put much effort in building his wings, for in this part of the glider is much of its safety and efficiency. In Fig. 6 I have given full details of its construction and by careful workmanship, little difficulty should be encountered.

## CHAPTER 5

## CONSTRUCTING THE WING

IN building the wings we must first take care of the all-important ribs that go to form the wing curve and shape. To make the ribs correctly to the contour and directions shown on the plan, it will be best to set out one on a thin, hard board, and then cut and finish the board accurately to the shape of the rib. This template can be used to set out a jig board on which the ribs will be constructed, checked and finished.

Make an outline true to about  $1/32''$  according to the measurements given for the aerofoil. Make a negative by fastening  $1/4'' \times 3/16''$  strips to wood plate to give outline. Cut accurately and lay all parts of first half ribs into jig and glue all joints, including gusset plates of wood. When glue is set remove ribs and build up with other members when properly fitted into jig of reverse pattern.

It will be noticed that five "A" or compression ribs will be necessary in each wing. Seven "B" or intermediate ribs will be necessary and four "C" ribs in each wing. The "A" rib in the wing near the aileron horn will, of course, be cut for proper length.



Once the ribs are made up, the work on building the wing can go ahead. Lay out spars and drill for all fitting bolts. Slide ribs into position, bolt all fittings into place and glue ribs to spars using shims wherever necessary to insure solid fit. Insert trailing edge strip and glue into place. At this point assemble all bracing wires, tighten wires and align wing true to  $\frac{1}{8}$ ". Install aileron cables through pulleys and see that everything is ready before putting on fabric.

Take care in making ailerons. Make ribs with same care as in wing and assemble complete, cutting out aileron horn from hard wood or fitting regular aircraft aileron horn.

Wings and ailerons can now be covered. Use grade "A" mercerized cotton, drawn tight and cemented at all edges to framework and to ribs on rear half of lower surface, with aircraft dope. The nose of the wing should be covered with plywood bent to shape, glued in place and bradded with cigar box nails to filler strip on top and bottom of spar between ribs. Bend forward edge of fabric. Slit fabric at proper points for guy wires and control cables, and reinforce with fabric patches.

## CHAPTER 6

## HOW TO COVER WING

THE covering having been previously stitched up and all seams carefully examined and the linen or mercerized cotton being quite dry, it will be drawn on to the plane starting behind leading edge plywood and pulling across to the trailing edge, half, of course, will be on the upper side and half on the lower. The fabric will be carefully and evenly pulled taut, and tacked down temporarily, all seams being straightened by pulling the fabric at each end. After this, all surplus fabric will be cut off and the two ends of the fabric sewn up, taking care to turn in the edges of the fabric, the joint being along the center of the trailing edge, and, where the aileron gap occurs, along the top edge of the rear spar.

Having sewn up all the edges neatly, the next operation is stringing the wing to keep the fabric tight to the ribs. This is done with a light fine string which is passed through the fabric from the top to the bottom round each rib about every four inches and knotted at each turn, taking care to knot up fairly tight.

The builder perhaps can obtain the services of a sister, or someone else's sister, to do this knotting and sewing for with little tuition it can soon be understood; but watch the work carefully. One point to be avoided is making holes, with the stringing needle, where it is not intended a string should pass through, the only hole permissible being the one where the string passes through.

When this much is done, weigh each wing, to make sure that they are reasonably equal in poundage. If not, check up.

## CHAPTER 7

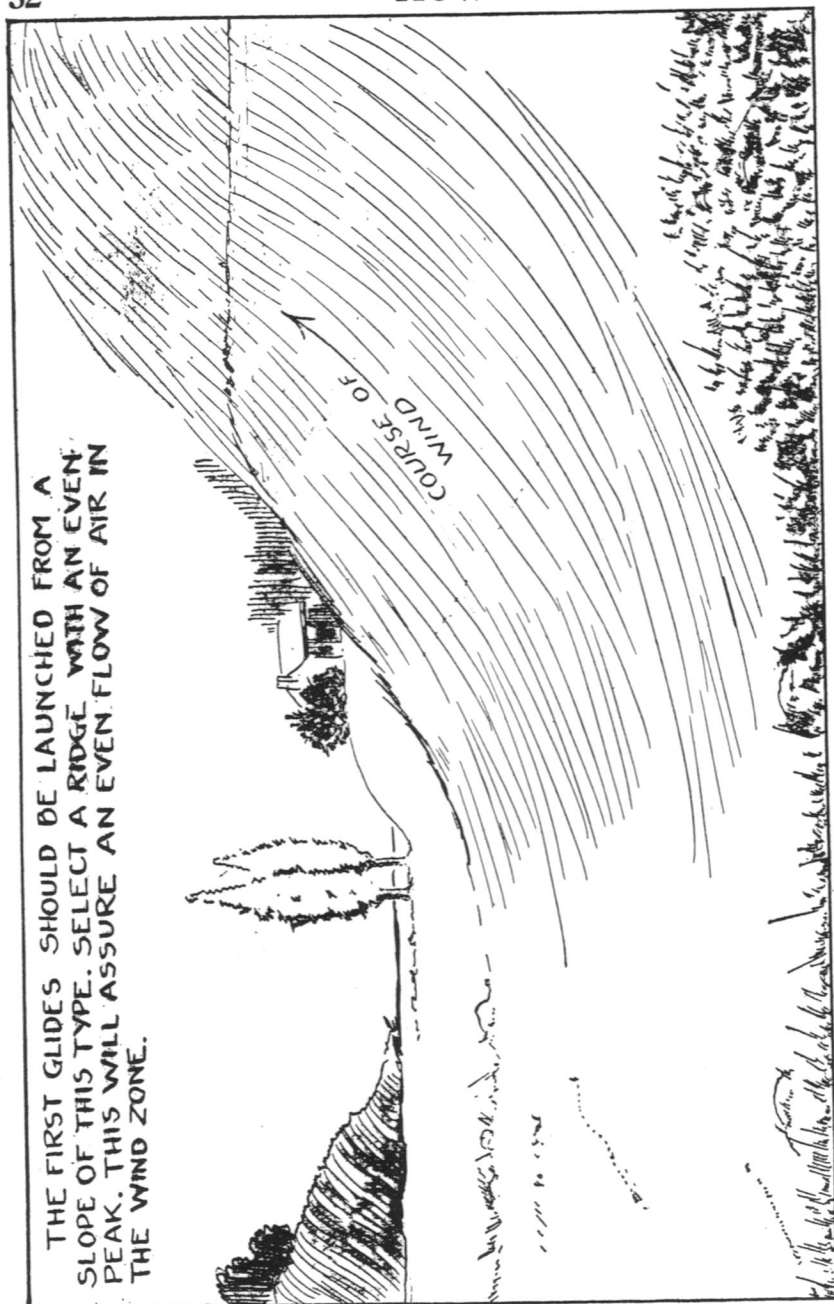
## DOPING THE WING

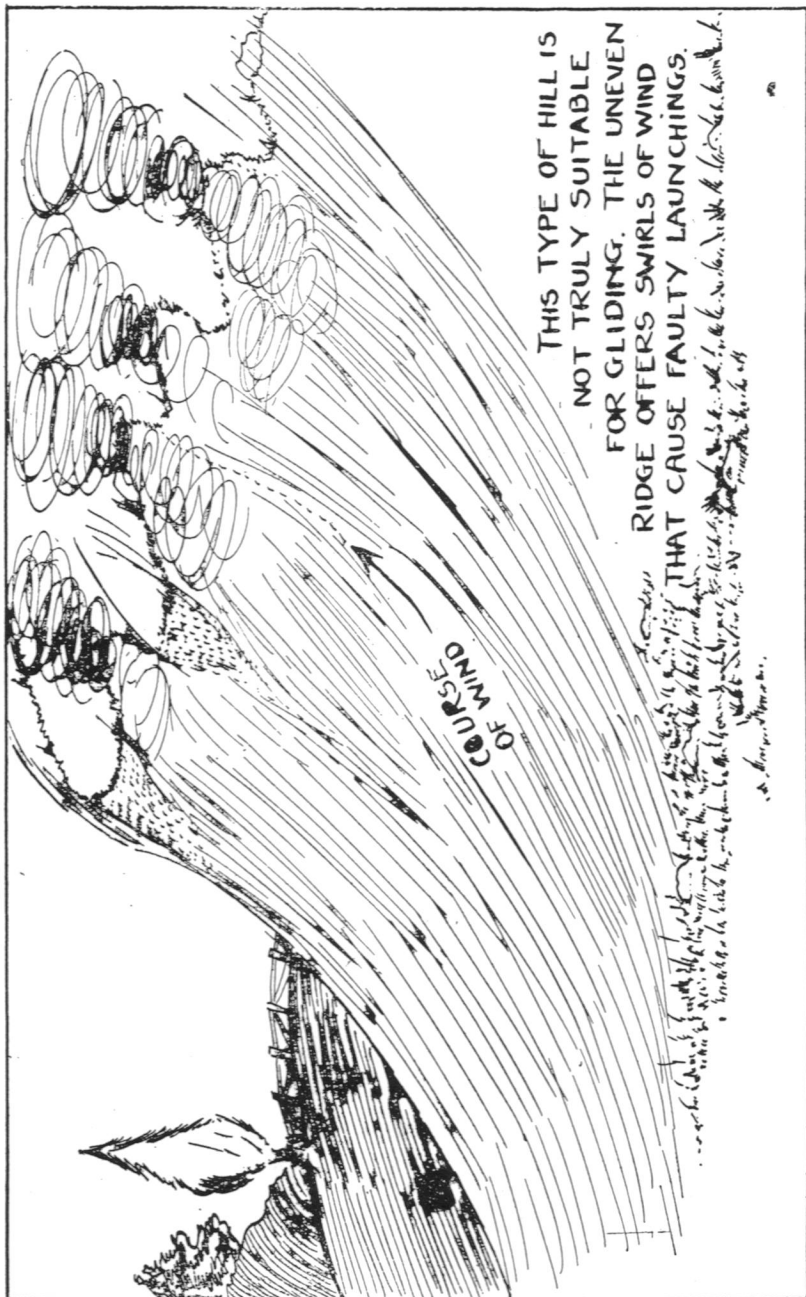
**I**T is best, if possible, to dope planes in a room of moderate temperature, and one where this temperature may be maintained. The plane is laid on bearers running longitudinally under the spars, and these can be supported on horses. The dope can be put into galvanized paint cans for convenience and brushes about 4 inches wide should be used. Common, or cheap brushes should not be used as the hairs are likely to come out and spoil the work.

To start doping take a fair amount of dope on the brush, and work it from the leading edge to the trailing edge, and then from left to right. Spread it evenly, taking care not to start too big a patch at once. In this manner cover the whole plane, after which suitable time must elapse before proceeding.

The next thing to do is the "stripping". This consists of again doping the line of stringing, and at once laying a strip of frayed fabric or tape over the stringing onto the wet dope and finishing it off smooth with the brush. It is well to cover the edges in a similar manner.

THE FIRST GLIDES SHOULD BE LAUNCHED FROM A SLOPE OF THIS TYPE. SELECT A RIDGE WITH AN EVEN PEAK. THIS WILL ASSURE AN EVEN FLOW OF AIR IN THE WIND ZONE.





Allow the whole wing proper time to dry, according to the directions on the particular dope employed. When dry the whole thing should be doped again until it has had about four or five coats. In this manner ailerons, tail plane rudder and elevator may be doped. (Two hours is a reasonable wait between dopes.)

If the builder wishes to put a special insignia on his rudder or wings, this may be done with regular paint, which should be varnished later.

## CHAPTER 8

### ASSEMBLING GLIDER

**I**T is the writer's opinion that it is better to construct the wings, ailerons, tail planes, rudder and control fittings first. Cut and fit all parts for fuselage and skid and have all other materials on hand before attempting to assemble the glider.

Lay out fuselage according to dimensions, taking care in the drilling of all holes and the cutting of angles. Much of the work depends on the craftsmanship of the builder, for the drawings enclosed should be easy to follow. Fit all joints accurately and glue together with necessary blocking and stiffeners. Cover runner, tail fin surface and pylon at joints with plywood as detailed, and glue together. Apply and bolt on all fittings such as wing brace clamps, main wing dismounting fittings, metal launching hook, and other braces.

All fittings should be of the best carbon steel, which is to be annealed before bending and tempered afterwards. Many of these fittings may be purchased from aeroplane supply companies. We advise this type, in case of replacements.



Next prepare to assemble wing. See that metal spar fittings are correctly fitted to spars. Join up and bolt to matched fitting on top fuselage bar and wire up with No. 32 piano wire guys properly fitted with turnbuckles, near the longeron fittings and pylon. See that all loops are "safely" secured with loose end doubled back. Turnbuckles are to be of standard type and of correct size to develop full strength of wire or cable and after tightening secure from turning with copper wire lacing.

Assemble both wings, fit ailerons and connect up control cables to control shaft. Do not tighten until glider is completely assembled.

Next assemble tail surfaces using U bolts that come up through tail plane units from under top longeron. Fit in cross buckle piece and adjust guy wires. Next fit elevators with regular hinges and pins and hook up control wires. Check everything as you proceed so that nothing has to be taken down later on. You are now ready to fit in rudder with hinges and pins. All pins in this glider are to be of carbon steel and of proper length and secured with aircraft safety pins or cotter pins.

Now hook up rudder controls to control column and check up measurements.

See that all units are properly and securely connected. Tighten guy wires, stays and braces so that wings and stabilizer will be straight, level and at right angles to the fuselage. Adjust control wires so that when they are in "neutral" the ailerons conform to the wing shape and the elevator center line conforms with the stabilizer center line.

Check leading edges to see that they are in line and also that they are at right angles with the center line of the fuselage. Put machine up on horses to get correct flying position, to make all final checks.

In putting in control cables which are of 3/32" wire cable, excessive tautness is not desirable as this only puts unnecessary strain on the pins, horns, eye-ends, cable joints, cables, pulleys and other fittings. It also causes excessive resistance to movements and will possibly cause some portion to fracture or bend.

Controls must be absolutely sensitive and the slightest movement of the control lever should correspondingly be transmitted to the ailerons, rudder and elevators. To produce this simultaneous movement there must be perfect and equal tension in the left and right hand cables, without excessive tautness, otherwise the machine will be hard to control, and fatiguing to the pilot.

All controls should respond to any applied force with smoothness and ease of movement right up to the extreme limits of movement possible, and any tightness or stiffness at any part of the movement should be carefully traced from the lever, along the cables to the ailerons, elevators or rudder.



## CHAPTER 9

### CONTROL SYSTEM

THE control system of this glider is the same as in all modern aeroplanes.

In the first place we have adopted the control stick and bracket as used by Marvin A. Northrup of Minneapolis which is one of the finest arrangements for ships of this type in use today. It is simple and easy to make if the drawings are followed carefully.

First carry the rudder controls from the drilled holes in the ash rudder.  $3/32''$  cable should be used and adjusting turnbuckles fitted near the rudder horns. Adjust for tautness and movement before fastening turnbuckles.

Next take over the aileron controls from the control bracket at the rear of the control column, under the seat. Fix each cable to its mate that comes down from the interior of the wing. Make sure that the two ailerons are connected from the horns by the balance wire before tightening up controls with turnbuckles.

Much care and testing should be used in affixing the aileron wires before a flight is attempted. As the

stick is moved over to the right the right aileron should go UP and the left DOWN. The reverse movement should be noted when the stick is carried over to the left. Then the right aileron should go DOWN and the left UP.

The elevator controls are brought back from the elevator horns and carried to a single cable about a foot ahead of the fixed stabilizer. This goes for both upper and lower elevator horns. Then the upper wire or cable is carried to pulley sheave on upper longeron near wing and then down to double pulley behind seat. From here it is carried over control bracket to base of control stick and fastened. Then second wire or cable is carried from base of stick, over forward pulley and under through tubing and out to double pulley from where it is carried out to joint of double lower cables and fastened.

To adjust, tie stick in neutral position and set cables until elevators are dead in line with fixed stabilizer or tail-plane. Do same with aileron and rudder cables and ship is ready to fly.

## CHAPTER 10

## FLYING THE GLIDER

**H**AVING our machine built, we naturally turn to our first flight or glide. Do not be in too much of a hurry to get into the air. First of all, make sure that the glider is complete in every detail. See that the controls are working perfectly and with crisp freedom. Draw the stick back and forth and note whether each control surface moves as it should. Go over all cables again and see that they are lubricated where they run over the pulleys or through guides. Test every guy wire and turnbuckle and see that they are taut, but not too twangy. Check up on measurements again, and above all, make sure that all important nuts, bolts and screws are in place and fast.

All woodwork should be varnished or shellacked to withstand the weather. The fabric of the planes, rudder, elevator and fin should be evenly spread and no dry spots should be left on the material.

Select a suitable day and if possible select a ridge that offers a slope of about one in eight or ten for the preliminary attempts. If possible we suggest a spot somewhere out in the country or an open park. Prob-

ably permission can be obtained at one of your local golf clubs to use a suitable hill that leads down to their fairways, with the use of some tactful appeal. A gently sloping hill that is about 300 feet long is ideal. The next consideration, of course, is the wind, which should not be too strong for a beginner. A light even breeze will help a lot and under no consideration try gliding from any abrupt cliff or steep hill until you have mastered the art of gliding.

Take your glider out and mount the wing at the point of flight and again go over every point to assure yourself that the ship is structurally and aerodynamically O.K. Get your friends to assist in clearing the way in case you have interested spectators. Place the glider on its skid and take your place in the seat. Have a man at each wing-tip, to help in the get-away, and have your launching crew ready at the launching rope. A set of signals should be arranged in advance and a captain of the launching crew should be selected who should be on the rope nearest to the nose of the machine.

When everything is ready, the signal should be given the rope crew. They should start away at a walk until the machine begins to slide easily over the ground. Once the friction has been lessened the order



“Run” should be given and the crew should respond with increased speed which will draw the machine forward with a sure, even movement. As the speed increases the pilot should begin to feel the lift of the air current under his wings and he can begin to try his elevator. He will soon find himself free of the ground and actually flying, or gliding. At this point the rope will release itself and it is up to the pilot to keep the glider in the air. As he gains experience the pilot will be able to control his glider and keep it into the wind, gain altitude and adapt the strength of the rising air flow to keep his machine in the air, for short periods.

A skillful pilot will allow himself to be taken a little above the highest point of his hill and remain at that point until he is ready to land. Do not attempt turns until several hours have been spent in straight glides. To land, depress the nose gently and allow the glider to coast down easily. There should be little trouble in making a successful landing. A little difficulty may be noted at first and minor accidents in the way of bent wing-tips or skids may be experienced, but these are all part of the game. Keep at it as much as possible and the knack of natural flying will come, suddenly and you will wonder why it is so easy and graceful.



Later on you will want to attempt a few turns. Under no circumstances attempt this feat until you really begin to feel the air. "Feel" is everything in gliding, for you have no motor to pull you out of your mistakes.

No turn should be attempted near the ground. Under ideal conditions,—that is to say, with strong, steady winds, one may attempt turns at about 100 feet. It will be found that a turn must be made by first depressing the nose and then feeling the way around with the ailerons and rudder until the circuit or part thereof has been accomplished, then the nose may be drawn back to the horizon line again.

Once the machine is turned around, with its tail to the wind, a new sensation will be noted from the prevailing current. Here a new forward speed will be available, and it is here that the pilot must take care in turning again back into the wind to make his eventual landing. As the pilot gains in this experience he will become more familiar with the tricks of the air currents and will be able to make them do just as he bids.

## CHAPTER 11

### KNOWING THE WIND

AS the wind plays a big part in gliding, it is well to know something about the comparative strengths of the various winds. The Beaufort scale of wind forces which has been accepted by the Army, Navy and Air Force officials all over the world is worth including in this booklet.

#### THE BEAUFORT SCALE

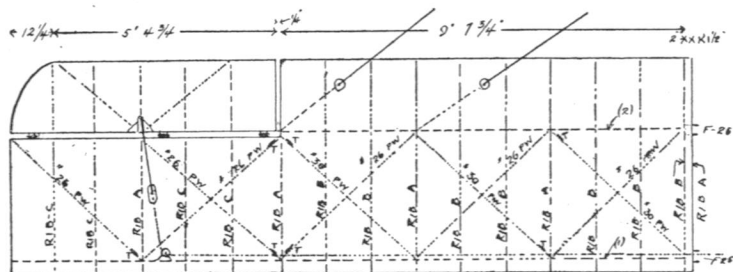
General Description of Wind	Specification of Beaufort Scale for use on Land based on observations made at Land Stations	Mean Wind Force at Standard Density		Velocity in Miles Per Hour
		Mb.	Lbs Per Sq. Foot	
<b>Calm</b>	Calm; smoke rises vertically	.00	.00	0
<b>Light Air</b>	Direction shown by smoke drift but not by wind vanes	.01	.01	2
<b>Slight Breeze</b>	Wind felt on face; leaves rustle; ordinary vane moved by wind	.04	.08	5
<b>Gentle Breeze</b>	Leaves and small twigs in constant motion; wind extends light flag	.13	.28	10
<b>Moderate Breeze</b>	Raises dust and loose paper; small branches are moved	.32	.67	15
<b>Fresh Breeze</b>	Small trees in leaf begin to sway; crested wavelets form on inland waters		1.31	21
<b>Strong Breeze</b>	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty	.62		
<b>High Wind</b>	Whole trees in motion; inconvenience felt when walking against wind	1.1	2.3	27
<b>Gale</b>	Breaks twigs off trees; generally impedes progress	1.7	3.6	35
<b>Strong Gale</b>	Slight structural damage occurs; chimney tops and slates blown off	2.6	5.4	42
<b>Whole Gale</b>	Seldom experienced inland; trees uprooted; considerable structural damage occurs	3.7	7.7	50
<b>Storm</b>	Very rarely experienced; accompanied by widespread damage	5.0	10.5	59
		6.7	14.0	68
<b>Hurricane</b>		8.1	Above	Above
			17.0	75

## CHAPTER 12

## FORM A GLIDER CLUB

**G**LIDING offers much as a sport and as a means of recreation. The nominal cost of a glider makes it possible to bring the thrills and benefits of aviation to thousands of young men and boys who could never afford to buy an aeroplane. As a sport, gliding is healthful and invigorating. It is safe. As a part of the preliminary training of aeroplane pilots, it is invaluable, but in spite of these accepted advantages the question may arise as to what is actually gained from motorless aircraft flight, when it is possible to fly so much faster and farther with powered aircraft. In other words, what benefit may the aviation industry expect to derive from the growing use of the glider?

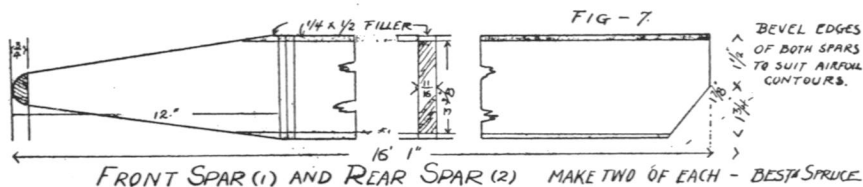
Again we must recall that the glider was man's first step toward successful flight and that it was developed after centuries of brave attempts to break away from the confines of the earth. It is well to recall that the glider played an important part in the development of the aeroplane and today the glider again comes forward to render assistance to the aeroplane designer.



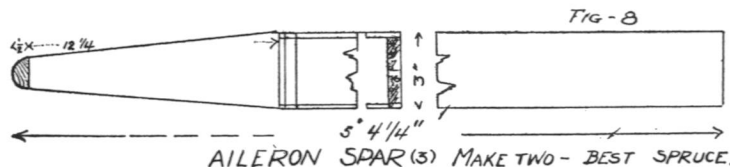
PLAN OF WING

NOTE 'T' = TURNBUCKLE

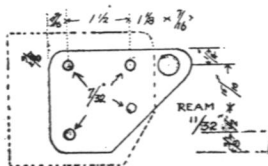
FIG-6



FRONT SPAR (1) AND REAR SPAR (2) MAKE TWO OF EACH - BEST SPRUCE



AILERON SPAR (3) MAKE TWO - BEST SPRUCE.



WING SPAR CLAMP

MAKE 8 #12 CARBON STEEL

It is an ideal way to carry out experiments. The artificial breeze created in wind tunnels is by no means the same as the varying winds encountered by an aeroplane in actual flight. It is believed that in view of the astonishing records set by motorless aircraft it will be possible to construct an aeroplane so well balanced and scientifically designed that it will accomplish with only a small motor, feats which now require hundreds of horsepower. Thus we may look to the glider for improvements in design which will greatly increase the efficiency and range of performance of our powered ships.

The glider, then, is of great value to both the scientific and sporting worlds and is well worth the attention the American people are now giving it. Glider clubs are springing up all over the country and the work they are doing to promote the advancement of gliding and in bringing the glider the recognition it deserves, is worth the compliments of the whole aircraft industry.

A glider club may be formed of a group of interested individuals and the club funds could be efficiently pooled to build the first machine. To have all hands work on the glider will bring a sense of cooperation and fellowship that will assure success right from the start.

All could take their turns in flying the glider and with an efficient launching crew the best could be obtained right from the beginning.

Headquarters for meetings may be obtained in local schoolrooms, American Legion headquarters, service clubs, Y.M.C.A.'s, high schools, churches and other such organizations. The writer started his first flying club with a group of young enthusiasts in a room kindly lent by an American Legion post. With suitable newspaper publicity more offers were made for a hangar and a flying field and within a month we had our own machine. A glider club could be formed under the same conditions.

We advise getting a president who is a glider flier or air pilot. A live wire secretary could obtain all information on gliders and club work from the many organizations throughout the country. The treasurer should be a business man who has good local connections so that all materials bought could be obtained at the usual club discount. Above all, get a good publicity man, who can write good "copy" for the local newspapers to handle. It is good news all the time and no city editor would turn it down. Probably the sporting editor could be interested in a slack season to give a column or so to the club. This always goes well in the formation of such a club.



## SUPPLY HOUSES

**F**OR the benefit of those who wish to purchase materials and fittings for this glider, we offer the following list of manufacturers who can supply any article needed in the building of this glider.

*Spruce*

PIKE-DIAL LUMBER CO.

2251 So. Loomis St.

Chicago

*Shackles and Turnbuckles*

STANDARD AUTOMATIC

PRODUCTS CO.

Corry, Pennsylvania

J. V. G. POSEY AND COMPANY

*Public Service Building*

Portland, Oregon

*Dope*

TITANINE, INC.

Union, Union County, N. J.

*Plywood*

NEW JERSEY VENEER CO.

Paterson, N. J.

*Fabric*

AMERICAN BLEACHED

GOODS CO., INC.

39 Leonard Street

New York City

*Fittings, Pulleys, etc.*

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CO.

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*Bolts and Screws*

REED AND PRINCE MFG. CO.

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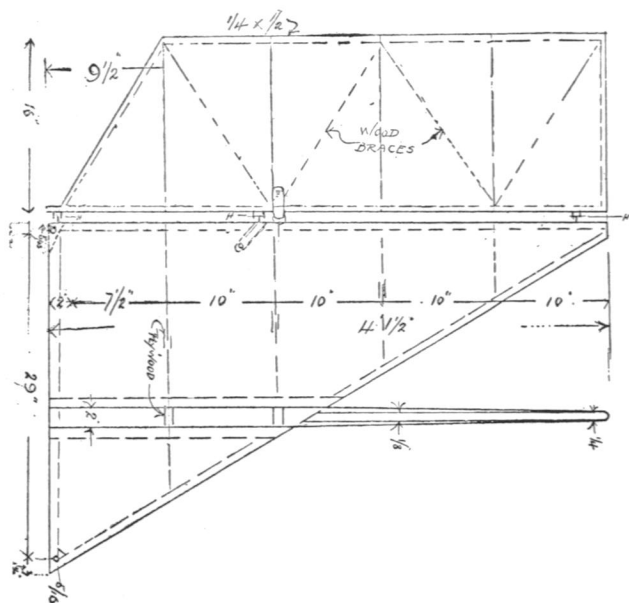


FIG 9

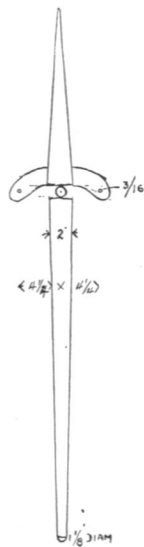
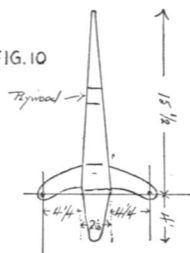
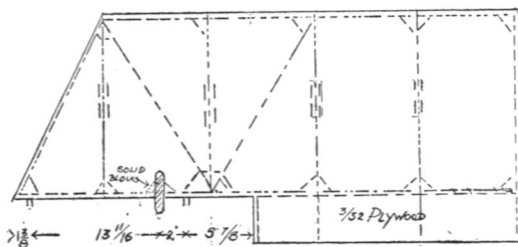


FIG. 10



## ELEVATOR AND STABILIZER



RUDDER

## PASSING IN REVIEW

WE have now gone through the history of the glider and its commercial value to aviation. We have gone through the stages of building our craft and we presume that by this time the reader has probably decided to build his own machine, or, if he is an energetic individual, has already built his ship before reaching this chapter of the book.

It is at this time that we might close with a little passing review of what has gone ahead. A few points here will probably make all the difference in the world in the success or failure of our glider.

For instance, let's go into the control system again and see what it is all about.

In this glider we have adopted the regular aeroplane control system as a means of handling our craft in the air. We have a control stick and a rudder bar. By this time the prospective glider flier will have discovered that when he is seated in the glider his feet will be resting on the rudder bar and his hands grasping the control lever or "joy stick". By working these appliances he will discover the effect they have on the control surfaces of the machine and thus gain an ex-

cellent idea as to how an aeroplane is made to climb, descend, turn and fly in any desired direction.

Let us consider the rudder bar first. This is a piece of wood, pivoted in the center so that the pilot's feet can swing it backward and forward about that center. It is set athwartships and at each end are the control cables which connect the rudder bar with the ruddering surfaces. The rudder is situated at the stern and consists of a vertical surface set parallel with the fore and aft line of the machine. Controlling wires are so adjusted that when the rudder bar is dead athwartships the controlling surfaces are perfectly parallel with the fore-and-aft line.

With the rudder bar square, the machine will fly straight, but when the right side is pushed forward it pulls the controlling surface to the right from its point of attachment and so opposes more controlling surface to the wind on that side which causes resistance and forces the tail of the machine around in the opposite direction, i.e., to the left.

If the tail goes round to the left, the fore part of the machine will turn to the right, so that, to cause the machine to turn to the right, all one does is to

press the right foot on the rudder. The reverse is the case when it is desired to turn the machine to the left.

To make a correct turn, however, it is necessary to do more than press the rudder bar. The vertical control column or "joy stick" is now called into action and must be moved in the right direction. This control column is so fitted that it can be moved backwards and forwards or sideways from its pivoting point. It is used to control the ailerons of the machine.

When we make a turn in a powered aeroplane, it is necessary to give the ship a certain amount of "bank" to prevent outward sideslips owing to the high speed at which the machine is travelling. For the same reason, high speed automobile tracks are banked on the turns. In flying the glider, such excessive forward speed is not apparent of course but when a correct turn is to be made, a certain amount of bank should be applied to make a perfect turn and keep the machine stable.

The elevator, like the rudder, is situated at the back of the machine. The elevator is a horizontal controlling surface or flap set parallel with the main plane and is capable of being worked upward or down-

ward from its hinged position. It is connected to the "joy stick" or control column by wires which are arranged above and below the pivoting point of the control lever. In our case of the glider a special form of control lever and pulley arrangement takes care of this action. When the lever is pushed forward the elevator surface moves down from its forward hinged end presenting more surface to the air, causing a resistance which sends the tail of the machine up and the nose of the machine down. It will be seen from this that, to make the machine descend, the control lever must be pushed forward and to make it climb, it must be eased back. In the latter case the elevator surface will be raised above its neutral line, so that it presents its top surface to the air; the resistance encountered then sends the tail of the machine down and the nose up and the machine is now ascending.

All movements of the control lever are natural ones; i.e., to make the machine descend the lever is pushed forward. To climb, it is pulled backward; and to turn to the right or the left, it is moved to the right or the left.

We must now go into this business of banking on turns. If the rudder only were operated on a turn the

machine would skid on the corner, as it were, and later on the nose would go down because the machine has lost forward flying speed.

To make a gentle turn in the air, while flying a glider under normal conditions, the rudder must be applied with the correct amount of bank, in the following manner: To make a gentle right hand turn, the right rudder is pressed forward and the control lever is moved to the right at the same time, past the central or neutral position. To come off a gentle right hand turn the control lever is moved across in the opposite direction, past the central position—that is to say, to the left—and as the machine approaches the horizontal again a slight amount of opposite rudder (left) may be given. Both controls are then centered.

The pupil should now trace out the wires that connect the control column with the ailerons, or controlling flaps, fitted to the wings. The principle on which the ailerons operate is just the same as in the case of the other controlling surfaces. When the control lever is moved to the right in order to make the machine turn to the right—that is, the right-hand side of the machine will be down and the left up—the controlling surfaces fitted to the left wing are pulled DOWN. The amount is very slight; the trailing edge

of the aileron is perhaps only half an inch below the trailing edge of the wing, but the additional resistance set up by the extra surface exposed to the air causes the wing to rise, while the reverse is the case with the right-hand wing, the aileron of which is connected by a balancing wire to the other aileron, and is so arranged that when the latter is drawn down, it is slightly raised, thus helping the right hand wing to become depressed owing to the added resistance on the top surface of the aileron which is now raised slightly beyond its neutral position. On some machines the wings themselves are made to warp but the control is just the same as on the modern ships fitted with ailerons.

Before attempting his first glider flight the pupil should realize that he cannot learn too much about the theory of flying and the means of controlling a ship before he actually finds himself in the pilot's seat. He will learn much more quickly if he has had a preliminary grounding in the rudiments of mechanical flight than if he starts out without a notion as to how or why a machine flies. Emphasis is laid on the particular importance of the method of controlling the machine and the mistakes to be guarded against in the air.



In learning to fly a glider, the pupil has no method of dual control to help him out. In the old days of power flying the pupil was given the elementary theory of flight and then sent off on rolling practice or taxiing on an under-powered machine which could not possibly leave the ground. The next stage was to give him a machine with sufficient wing surface to get him off the ground in short hops. From this he would advance to machines that would just fly and in which he could make "straights" until he was proficient and later on with more powerful machines he could attempt his turns.

The glider flier today is in much the same situation. He has to learn for himself. One of the best ideas for learning to fly a glider has just been made public, by means of which the launching rope is used as a glorified kite-line and on the first few flights this is kept attached to the machine. When the ship is pulled off, the launching crew is instructed to keep the line taut and attempt to hold the ship into the wind in the same manner in which a kite is flown.

This method will give the glider flier a lot of confidence in his first few attempts. He should be strapped in to prevent tumbles after the first few at-

tempts at landing. The ground crew can also assist greatly by being on hand to take the wing tips.



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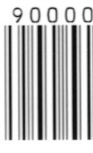
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