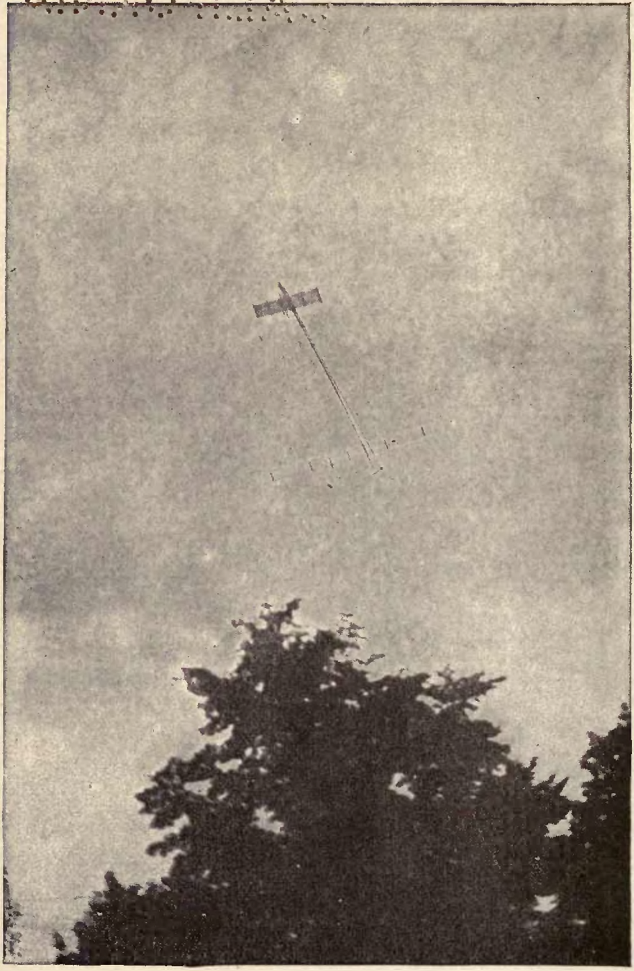
MODEL AEROPLANES
AND THEIR MOTORS



Waid Carl's model in flight
Courtesy Edward P. Warner, Concord Model Club

MODEL AEROPLANES

AND THEIR MOTORS

A Practical Book for Beginners

BY

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NEW YORK

MOFFAT, YARD & COMPANY

1916

TO

M. T. H.

INTRODUCTION

History tells us—what some of us luckier ones heard the Wright Brothers themselves tell—that the Wrights' active work in aëronautics was a result of the interest aroused by a toy helicopter presented to them by the Reverend Bishop Milton Wright, their father.

Tremendous developments have taken place in aëronautics and aircraft are fast developing in size, speed, and range of action. They have revolutionized warfare, and seem to be destined to become a most important factor in the reconstruction that will follow the war.

The greater the development the truer the fact that model aëroplanes may be instrumental in bringing to aëronautics men who may make valuable contributions to aëronautics. As a matter of fact, there are already in active life, contributing their share to the development of aëronautics, young men who only a few years ago competed for prizes which the writer offered for model competition.

The young men who are now flying models will live in the new age—and they have much to give and much to receive from it.

Through the tremendous strides forward of aëronautics there are wonderful possibilities for the employment of ingenuity, genius and skill, and business opportunities, as great as have ever been created by progress in important lines of human endeavor. Problems of engineering as huge as were solved by master builders; juridical and legal questions to be decided as stupendously difficult as any Gladstone would wish them; possibilities for the development of international relations greater than were ever conceived; problems of transportation to be solved by the application of aircraft, as wonderful as any economist could wish; opportunities to gain distinction splendid enough to satisfy the most ambitious person.

HENRY WOODHOUSE.

New York, June 5th, 1916.

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HISTORY OF MODEL AVIATION

Model aëroplaning, as a sport, was first introduced in America during the year of 1907. It was then that the first model aëroplane club in America was formed by Miss E. L. Todd, with the assistance of Mr. Edward Durant, now Director of the Aëro Science Club of America. Prior to this the model aëroplane was considered an instrument of experimentation or, when built to resemble a full sized machine, was used for exhibition purposes. Noted scientists, men such as Maxim, Langley, Eiffel and others, depended largely on models to bring about the desired results during their experiments. Before the Wright Brothers brought forth and launched the first heavier than air machine their experiments, to a great extent, were confined to model aëroplanes. There is little doubt but that a large majority of aviators engaged in flying machines in different parts of the world were at one time in their career interested in the construction and flying of model aircraft, and from which no doubt they obtained their initial knowledge of the aëroplane, in so far as the same principles and laws apply to any aëroplane, regardless of its size.

The first model aëroplane club went under the name of the New York Model Aëro Club and during its existence a great many of its contests were carried on in armories. The reason for this was because of the fact that the greater number of the models prevalent at that time were built along the lines of full sized machines, and their manner of construction was such as to interfere with the flying efficiency of the model. Streamline construction was something unknown to model constructors in those days and, in consequence, crudely constructed and heavy models were very often evidenced, and, as a result, flights of over one hundred feet were very seldom made. At about the same time model enthusiasts in both England and France were actively engaged in constructing and flying models, but the type of model used was of a different design from those flown by the American modelists and as a result of this innovation many of the early records were held abroad. The type of model flown by the English modelists resembled in appearance the letter "A," hence the term "A" type.

It was not long after the introduction of this type of model in America that model aëroplaning as a sport began to assume an aspect of great interest. Models were constructed along simpler lines and with a greater tendency toward doing away with all unnecessary parts, thus increasing the flying qualities of the models. Flights of greater distance and duration were the objects sought and, in their efforts to achieve them new records were made at most every contest, until flights of from 500 to 1000 feet were common occurrences. By the use of the A type model and the single stick model which made its appearance shortly after the A type model, American modelists succeeded in breaking most of the world records for this type of model which is now termed by English modelists "flying sticks."

One by one model aëroplane clubs were formed in different parts of the country until to-day there are in existence about twenty-five clubs and all with memberships of from two to eight times that of the first model aëro club. The work which was started by the New York Model Aëro Club is now being carried on by the Aëro Science Club of America and its affiliated clubs. The interest in model flying grew to such an extent that during the year of 1915 the Aëro Club of America decided to hold the First National Model Aëroplane Competition for the purpose of offering to the young men of America an opportunity of becoming acquainted with this new sport and its advantages. The results of this competition were beyond expec-

First model aëroplane exhibition held at Boston, 1910

tation. Models were made capable of flying distances and with durations that, to the early flyers, seemed impossible. In the hand launched contests models were flown for distances ranging from 2000 to 2500 feet, the winning flight being 3537 feet, and it might also be said that the contestant who flew this model, with a model of the same design established a duration record of 195 seconds. As this goes to press, information is received that the World's Record for distance for hand launched models has been broken by Thomas Hall, of Chicago, Ill., an Illinois Model Aëro Club member, with a flight of 5337 feet. Another interesting result of the competition was the establishing of a world hydroaëroplane record by a member of the Illinois Model Aëro Club with a model of the tractor type, a four-bladed propeller being used in connection with the model. The flying boat which is a late advent to the field of model flying also proved a record breaker in this competition, having remained in the air after rising from the surface of the water, for a duration of 43 seconds. This model was flown by a member of the Pacific Northwest Model Aëro Club of Seattle, Washington. The establishing of these records clearly indicates the advantage of scientific designing and construction and careful handling.

So satisfactory have been the results of the First National Model Aëroplane Competition that the Aëro Club of America has made arrangements for holding the Second National Model Aëroplane Competition during the year 1916. But in the announcement of the Second National Competition the Aëro Club of America has made provision for the holding of contests for mechanically driven models, in view of the interest which is being shown by model flyers in the construction of models more closely resembling large machines to be driven by compressed air, steam and gasoline power plants. This is the outcome of a desire on the part of model constructors to substitute for what is now commonly known as the "flying stick," models more closely resembling large machines, which models can be more satisfactorily flown by the use of compressed air, steam or gasoline power plants. As in the early days, the best flights made by models using compressed air and steam have been made by English flyers, the duration of the flights ranging anywhere from 25 to 50 seconds.

Whether or not the American flyers will repeat history and achieve greater results with this type of model motive power is something that can only be determined in the future. But in any event the scientific mechanically driven model will, without doubt, assume an important position in the field of model aviation.

CONSTRUCTION

PROPELLERS

Propellers may be cut from various kinds of wood, but the most suitable, from every standpoint, is white pine. The advantage of using this wood lies in the fact that the propellers may be cut more rapidly and when cut are lighter than those made from most other kinds of wood. When coated with the proper kind of varnish they are sufficiently strong for ordinary flying. Wood selected for propellers should be free from knots, holes and other imperfections and it is very desirable that it should be of perfectly straight grain.

A piece of such clear white pine 8″ long, 1″ wide and ¾″ thick should be selected and on one side marked Top. A tracing of the propeller similar in design to Figure 1, should be laid on this piece of wood and an imprint of the propeller design drawn on the Top side. To

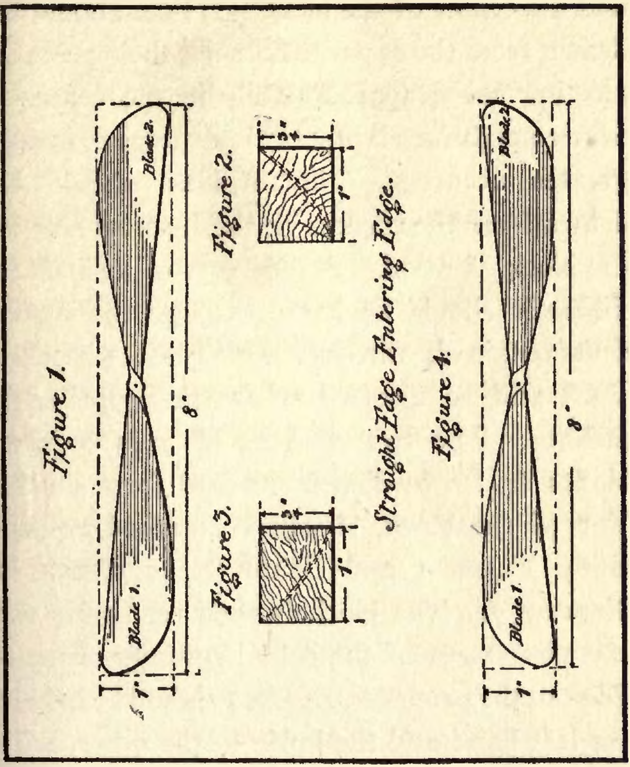


Figure 1.
Blade 1.
Blade 2.
8"
1"
Figure 2.
Figure 3.
Straight Edge Entering Edge.
Figure 4.

Diagram 1

find the center of the block two lines should be drawn from the opposite corners, their point of meeting being approximately in the center—near enough for all practical purposes to insure greater accuracy. Similar lines should be drawn from the corners on the BOTTOM side of the block of wood. A hole 3-32 of an inch in diameter should be bored through the center thus obtained, through which the propeller shaft will be inserted when the propeller is finished. The two sections of the propeller blades drawn in diagrammatical form on the TOP of the block, should be marked respectively BLADE 1 and BLADE 2, as shown in diagram 1. The block is then ready for the commencement of the actual cutting. In cutting out the propeller, BLADE 1 should be held in the left hand and the knife in the other, with the blade of the knife on the straight edge of BLADE 1. The cutting should be carried out very carefully with attention constantly paid to Fig. 2, and should be stopped when the line shown in Fig. 2 has been reached. The semi-

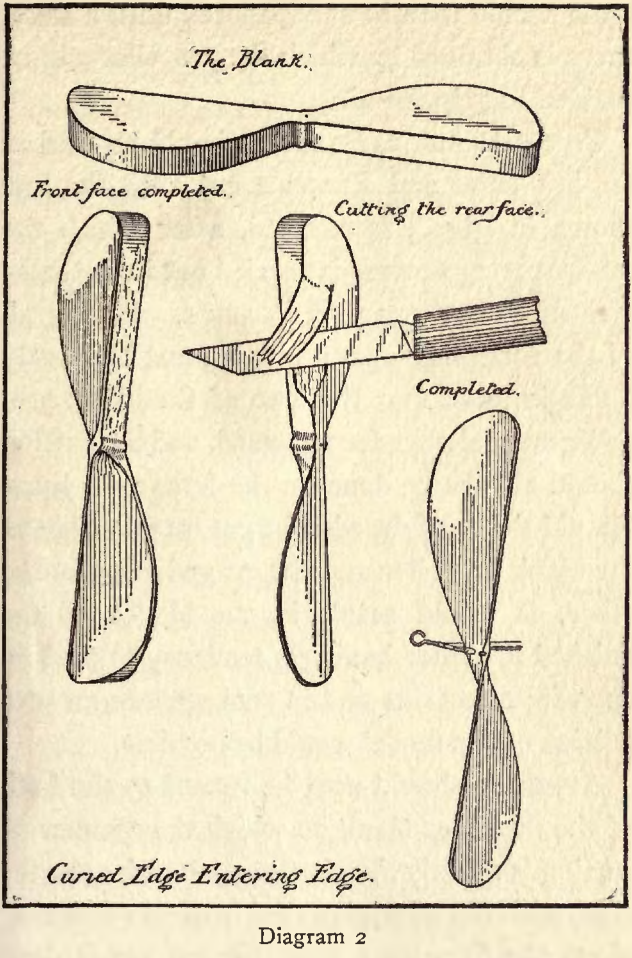

The Blank.
Front face completed.
Cutting the rear face.
Completed.
Curved Edge Entering Edge.

Diagram 2

blade should then be sandpapered until a small curve is obtained by which the propeller will be enabled to grip the air.

To cut Blade 2, Blade 1 should be held in the left hand and Blade 2 cut until the line shown in Fig. 3 is reached, after which the sandpapering process is carried out in the same manner as in the case of Blade 1. During all of the foregoing operations it must be clearly borne in mind that the Top of the blank propeller must always face upward, and the cutting should always be done on the Straight lines. Should the straight edge be cut on one edge of the blank propeller and the curved edge on the other, it would result in the blades of the finished propeller having a tendency to push in opposite directions and in consequence no propulsion of the model would be possible.

Attention should next be turned to the back of the propeller blank on which the manner of cutting is exactly like that suggested for the top side, with the exception that instead of cutting along the Straight lines, the cutting is done along the CURVED lines. In this part of the work great care is to be exercised for by the time the necessary cutting has been done on the back of the propeller the entire structure is very fragile and one excessive stroke of the knife may result in destroying the entire propeller blade. By constantly holding the wood to the light it is possible to determine with a reasonable degree of accuracy the evenness of thickness. To complete the BOTTOM side of the propeller the blade should be sandpapered as was the top.

The method of cutting the second propeller is exactly that used in cutting the first propeller, only that the diagram shown in Fig. 4 should be used. This will result in two propellers being made that will revolve in opposite directions in order to produce even and balanced propulsion. If both propellers revolved in the same direction the effect would be to overturn the model.

In diagram 1 the propellers are shown with the straight edge as the entering or cutting edge of the blade. Some of the model builders

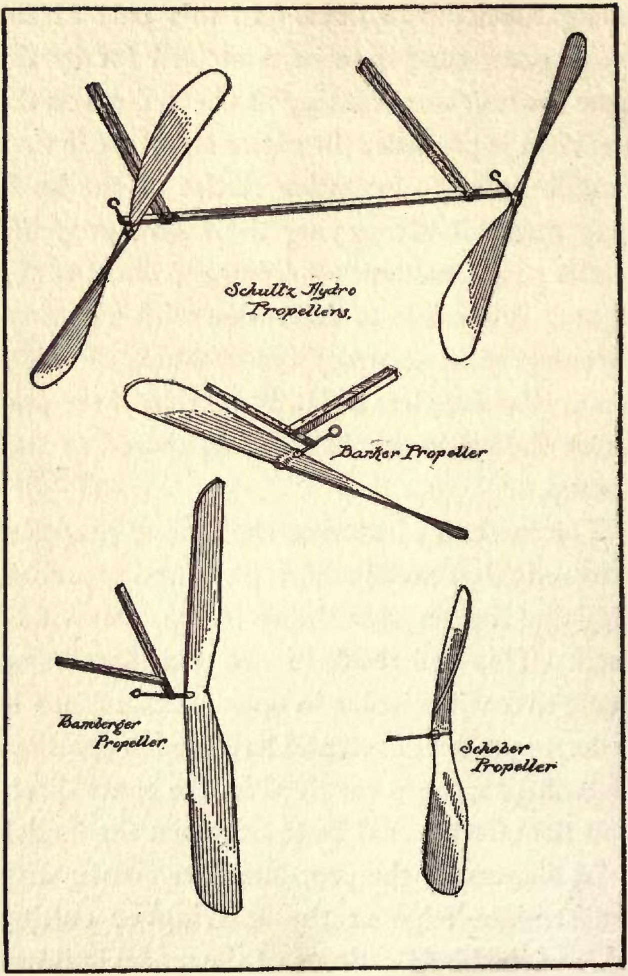

Schultz Hydro
Propellers.
Barker Propeller
Bamberger
Propeller
Schober
Propeller

Diagram 3

prefer the curved edge as the cutting edge (diagram 2). It is significant that Mr. Frank Schober, a well known model constructor, tested both designs on his compressed air driven model, and while both propellers were the same in weight, diameter and pitch, the one having the straight edge as the cutting edge was found one-third more efficient.

When the propellers have been given a light coat of shellac they should be laid aside until the assembling of the complete model.

By following the foregoing instructions a simple and effective set of propellers will be produced. But in order to vary the experimental practice of the constructor various other diagrams, Nos. 3 and 4, illustrating suitable designs, are provided and can be made by applying the above general theory and using the diagrams herewith.

WINGS

One of the most important considerations in the construction of a model is the making of the wings. To obtain the greatest efficiency the wings must be carefully designed, with due attention to whether the model is being constructed for speed, duration or climbing ability. Attention should be given to streamline construction; that is, the parts of the wing should be so assembled that the completed wing would offer the least possible resistance to the air, if the best results are to be obtained.

For the main wing three strips of spruce, each 30″ in length, two of them being 3-16″ x ¼″ and the third 3-16″ x 1-16″ are required. To make them thoroughly streamline all edges should be carefully rounded off and all surfaces should be smooth. A strip of bamboo at least 20″ long, ½″ wide, ⅛″ thick, should be cut into pieces, each piece to be 5 in. long. To secure the necessary curve, ½″ depth, the pieces of bamboo should be held in steam and slowly bent in a manner closely resembling the skids of an ordinary bob-sled. When the curvature has been obtained, care should be exercised in cutting each piece into four longi-

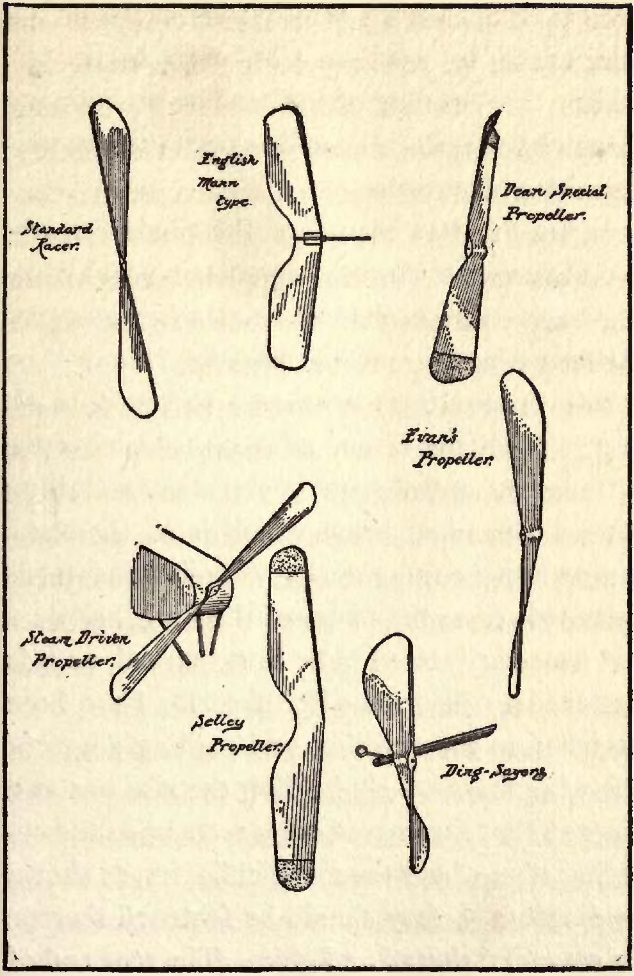

English
Mann
type.
Standard
Racer.
Dean Special
Propeller.
Evan's
Propeller.
Steam Driven
Propeller.
Selley
Propeller.
Ding-Sayers

Diagram 4

tudinal strips, from which twelve should be selected to be used as ribs, each to be ⅛″ wide. The bending of the bamboo preliminary to making the ribs is done in order to secure uniformity of curvature.

When this has been done the ribs are ready for fastening to the sticks—entering and trailing edges—and each must be attached an equal distance apart. In order that the ribs may be evenly spaced it is necessary to put a mark every 3″ on the larger stick or entering edge of the wing, and also on the flat stick or trailing edge. The main beam which is of the same dimensions as the entering edge is afterwards fastened across the center of the wing, and does not necessarily need to be thus marked, as it is fastened to the ribs after the ribs have been attached to the entering and trailing edges of the wing frame. By holding the ribs one at a time so that the curved edge rests upon the entering edge where the mark indicates, as shown in diagram 5, they should be fastened thereon by means of thread and glue. The rear end of the rib must be fastened to the trailing edge where the mark indicates, also by thread and glue.

After all ribs have been thus securely fastened to both edges of the frame the third stick, or main beam, should be attached to the frame on the underside, the fastening being made at the highest point of the curve of each rib. This main beam prevents the wing covering from drawing in the end ribs and adds very materially to the strength of the entire wing structure. To cover the wings fiber paper may be used and is a suitable material, but the best results, from a standpoint of flying efficiency and long service, are obtained by the use of China silk.

The frame of the forward wing or elevator is made in the same manner as is the main wing, but it is only 12″ in span by 4″ in chord, and is constructed without the use of a main beam. This wing has only five ribs which are made in the same manner as those for the rear wing, and each is placed a distance of 3″ apart.

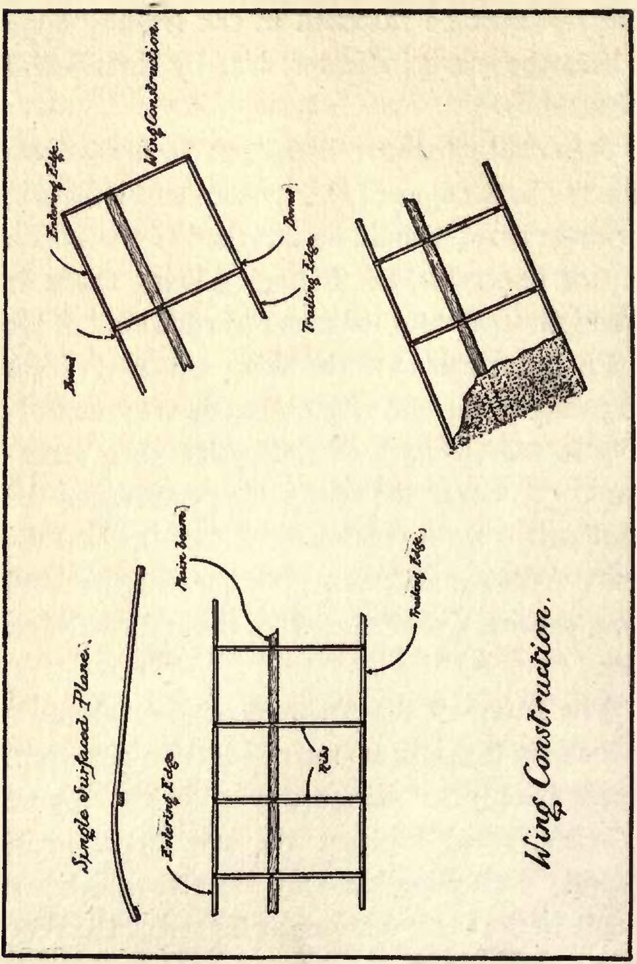

Wing Construction.
Entering Edge
Trailing Edge
Single Surfaced Plane.
Main beam
Ribs
Entering Edge
Trailing Edge
Wing Construction.

Diagram 5

A piece of silk measuring 2″ longer and 2″ wider than each of the wing frames should be used in covering the wings, and this can be held in position by the use of pins prior to the actual sewing. The extra inch of silk on all sides of the frame is placed around the under side of the frame—in order that it can be made thoroughly taut when the silk has been sewn close to the edges of the frame. After the silk has been sewn close to the edges the pins may be removed and the surplus silk that hangs from the under side of the frame may be cut off. To make this silk airproof it should be coated with a thin coat of shellac or varnish and the wings should be thoroughly dry before being used. This coating, in addition to airproofing, will assist in making the covering perfectly taut, and also in making the wing ready for service when the entire model is ready to be assembled.

FRAME

As all other parts of the model are attached to the frame in addition to its having to stand the strain of the tightly wound rubber strands which serve as the motive power for the model, it must be made strong. It is therefore necessary to exercise care and judgment in making certain that the different units that make up the frame are rightly proportioned and are of the proper material. Just as in the large sized aëroplanes there are many types of bodies, so there are many different types of frames in use in model construction, but the standard, and for all practical purposes the best frame, resembles the letter A in shape, hence the name A type. The lightness of the frame depends entirely on the materials used and the manner in which it is constructed.

Some model flyers use but a single stick for the frame, but generally the A type frame is preferred for the reason that it is more durable, the wings can be more securely attached to it, and that it is possible of developing very much better results.

To construct such an A type frame 2 main sticks to serve as frame side members are neces-

Members of the Aero Science Club

Members of the Milwaukee and Illinois Model Aëro Clubs

sary and are made from spruce. Each member should be 36″ in length, ⅜″ in depth by ¼″ in width. By rounding the edges and smoothing the various surfaces with sandpaper streamline effect will be secured and will add to the efficiency of the machine as well as to its appearance. When the side members are placed in A formation the extremity of the sticks at which they meet should be so tapered in the inner sides that when they meet and are permanently fastened the result will be a continuance of the general streamline effect. The permanent fastening of the frame side members at the point of the A may be accomplished by using either strong fish glue or better, a good waterproof glue and then have the jointure reinforced by securing a piece of 3-32″ steel wire 3″ in length and placing the center of it at the point of the A, afterwards bending the wire along either outer edge of the frame side members, putting as much pressure on the wire as the strength of the structure will permit; after this the reinforced jointure should have thread wound around it to insure even greater strength. About ½″ of the wire on each side of the point should be left clear and afterwards turned into a loop as shown in diagram 6, for the purpose of attaching the hooks that hold the rubber strands. To hold the side members apart at the rear end and for a propeller brace, a piece of bamboo 10″ long, ⅛″ thick by ½″ in width is required and this should be fastened to the extreme rear ends of the frame side members, allowing the propeller brace to protrude on either side 1½″ as illustrated. To put the propeller brace in position a slot ½″ deep by ⅛″ wide should be cut into the rear ends of the frame side members for the reception of the propeller brace. After the brace has been placed in position the outer edge should come flush with the rear ends of the side members. To hold the brace in place thread and glue should be used in the same manner as described for the point of the frame side members. Between the point of the frame and the propeller brace two bamboo pieces, one 9″ long and an-

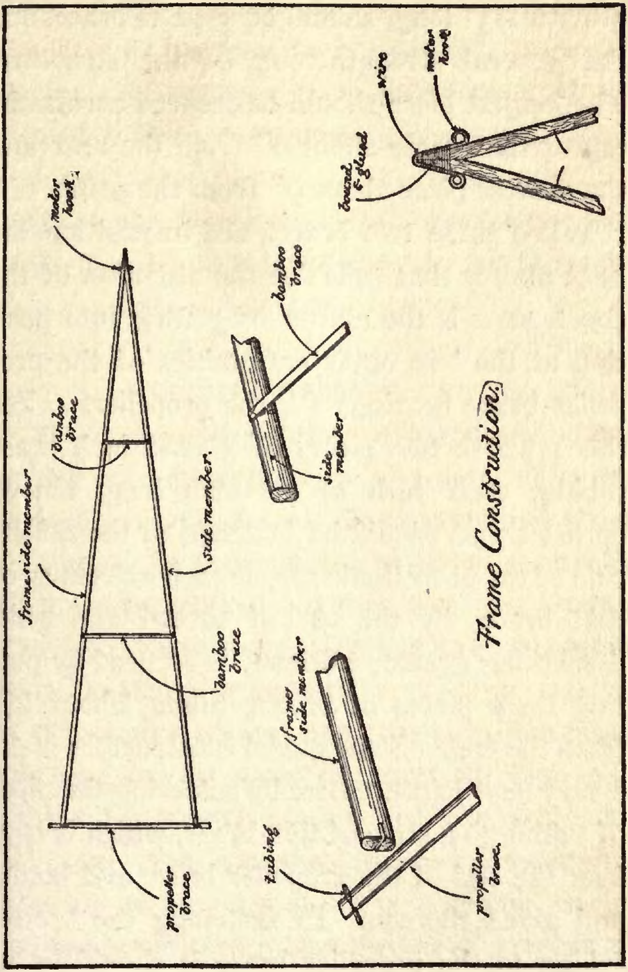

motor hook
bamboo brace
frame side member
side member.
bamboo brace
propeller brace
wire
motor hook
bound & glued
bamboo brace
side member
frame side member
tubing
propeller brace.
Frame Construction.

Diagram 6

other 2 1-3″ long, should be used as braces for the general strengthening of the structure. The longest piece should be secured across the top of the frame about 9″ from the rear and the shorter piece about 9″ from the point.

When these two braces are in position the next matter that calls for the attention of the constructor is the matter of getting into position at the two outer extremities of the propeller brace bearings for the propellers. For this purpose two pieces of 3-32nd inch brass tubing, each ¾th of an inch long, should be used, and should be fastened to the underside of the propeller brace, at each extremity of that brace, by the use of thread and glue. Sometimes greater efficiency is secured by putting these pieces of bronze tubing about ¼″ from the end. Some model constructors make a very neat jointure here by soldering the piece of tubing to a strip of thin brass, which is bent over the end of the propeller brace and bound and glued thereon. In fastening the bronze tubing to the propeller brace it should be so adjusted that it will run parallel to the side members of the frame and will therefore offer the least possible resistance to the shaft of the propeller when the rubber strands have been attached.

When the frame has been completed a coat of shellac should be applied to the entire structure to render it damp-proof.

ASSEMBLING

The proper assembling of the parts of the model is as essential to good results as is the designing and making. Parts, although properly made, if improperly placed in relation to each other will very often lead to trouble. Therefore very great care must be exercised in the assembling process.

When all the parts have been prepared and are ready to be assembled the first thing that should be done is to mount the propellers in position. This must be done very carefully on account of the fact that the propeller shafts are easily bent and if bent the result is considerable trouble, for such a bend in the propeller shaft will cause the propeller to revolve irregularly with a consequent loss of thrust. Before inserting the propeller shafts in the tubing 4 washers each ¼″ in diameter should be cut from hard metal, and a hole large enough for the propeller shaft to pass through should be bored in the center of each washer. The metal washers should be passed over the straight ends of the shafts which extend from the rear of the tubing, after they have been inserted in the tubing, and in this manner the cutting into the hubs of the propellers which would follow is avoided. The propellers are now to be mounted and this is accomplished by allowing the ends of the shafts, which extend out from the rear of the tubing, to pass through the hole in the hub of each propeller. In mounting the propellers it is absolutely necessary to have the straight edge of the propellers to face the point or front end of the model. The propeller shown in Fig. 4 of diagram 1, should be mounted on the left side of the frame to revolve to the left, while the propeller shown in Fig. 1 should be mounted on the right side of the frame to revolve to the right. When the propellers have thus been mounted the one-half inch of shafting which extends out from the hubs of the propellers should be bent over to grip the propeller hub and thereby prevent the shaft from slipping during the unwinding of the rubber strands. For the reception of the rubber strands to provide motive power a hook must be formed in each shaft and this can be done by holding securely that portion of the shaft which extends toward the point of the model, while the end is being formed into a hook as illustrated in diagram 7.

Eighty-four feet of 1/8th" flat rubber is necessary to propel the model. This should be strung on each side from the hooks (see diagram) at the front part of the model to the propeller shafts at the rear of the model. In this way 14 strands of rubber will be evenly strung on each side of the frame. To facilitate the winding of the rubbers two double hooks made

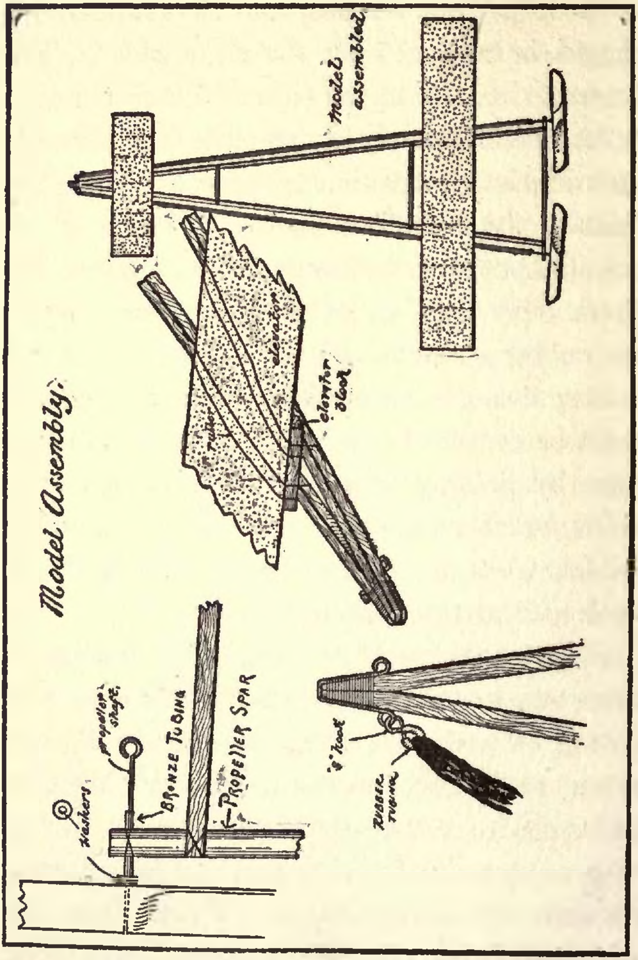

Model Assembly.
model assembled
elevator
elevator block
Washers
propeller shaft
BRONZE TUBING
PROPELLER SPAR
"S" hook
RUBBER TUBING

Diagram 7

of 3-32″ steel wire to resemble the letter S, as shown in diagram 7, should be made. One end of this S hook should be caught on the frame hook, while the other end is attached to the strands of rubber, and to prevent the possible cutting of the strands a piece of rubber tubing is used to cover over all wire hooks that come in contact with the rubber strands providing propelling power.

The wings are mounted on the top side of the frame members by means of rubber bands and in placing them upon the frame it should be noted that the entering edge of each wing must face the point or front of the model. The wings must be so adjusted on the frame that they result in perfect side balance which means that there is an even amount of surface on either side of the model. To secure a longitudinal balance it will be found that the entering edge of the main wing should be placed approximately 8″ from the propeller brace or rear of the model, and the entering edge of the small wing or elevator approximately 6″ from the point. But it is only by test flying that a true balance of the entire model can be obtained. To give the necessary power of elevation (or lifting ability) to make the model rise, a small block of wood about 1″ long by ¼″ square must be placed between the entering edge of the small wing and the frame of the model.

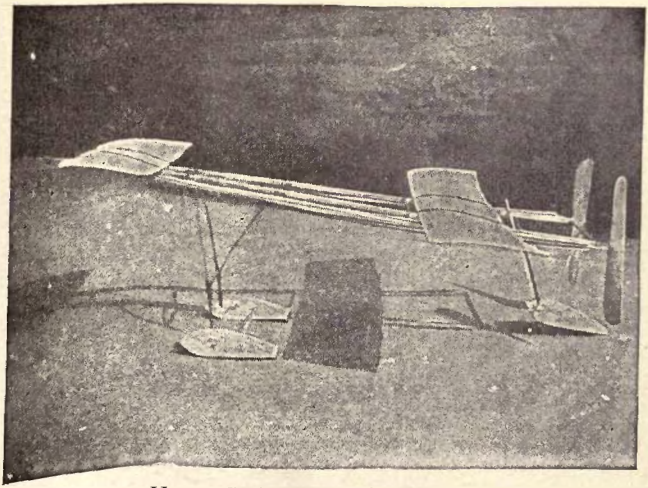
After the wings have been thus adjusted and a short test flight made to perfect the flying and elevating ability of the model, and this test flight has been satisfactory, the model is ready for launching under its full motive power.

LAUNCHING

In the preliminary trials of a model close attention must be paid to the few structural adjustments that will be found to be necessary and which if not properly and quickly remedied will result in the prevention of good flights or even in possible wrecking of the model. Careful designing and construction are necessary but it is equally as important that the model

Charles W. Meyers and William Hodgins exhibiting models of early design.

Henry Criscouli and his five foot model. This model may be disassembled and packed conveniently in small package



Harry G. Schultz hydroaeroplane

should be properly handled when it is complete and ready for flying.

The approximate idea of the balance of a model can be secured by launching it gently into the air. If the model dives down point first it indicates that the main wing should be moved a little toward the front. If it rises abruptly the main wing should be moved slightly toward the rear. In this way by moving the wing forward or rearward until the model glides away gracefully and lands flat upon the ground, proper adjustment of the balance can be effected. If when launching from the hand the model should curve to the left the main wing should be moved slightly to the left of the frame members. And if the curve is to the right the main wing should be moved in that direction. This process can be continued until the model flies in the course desired.

The winding of the rubber strands to get the necessary propelling power is an important detail. The model should be firmly held by some one at the rear with the thumb on either side member, pressing down on the jointure and with the four fingers of each hand gripping the under side of the frame members, and in this way holding the model steady and until the rubber strands have been sufficiently wound. With the hands in this position the propellers, of course, cannot and should not revolve. The hooks attached to the rubber strands at the point or front of the model should be detached from the side members and affixed to the hooks of the winder. A winder may be made from an ordinary egg beater as is shown in diagram 8. When the hooks attached to the rubber strands at the point of the model have been affixed to the winder the rubbers should be stretched four times their ordinary length (good rubber being capable of being stretched seven times its length) and the winding commenced, the person winding slowly moving in towards the model as the strands are wound. If the ratio of the winder is 5 to 1, that is if the rubber is twisted five times to every revolution of the main wheel of the winder, 100 turns of

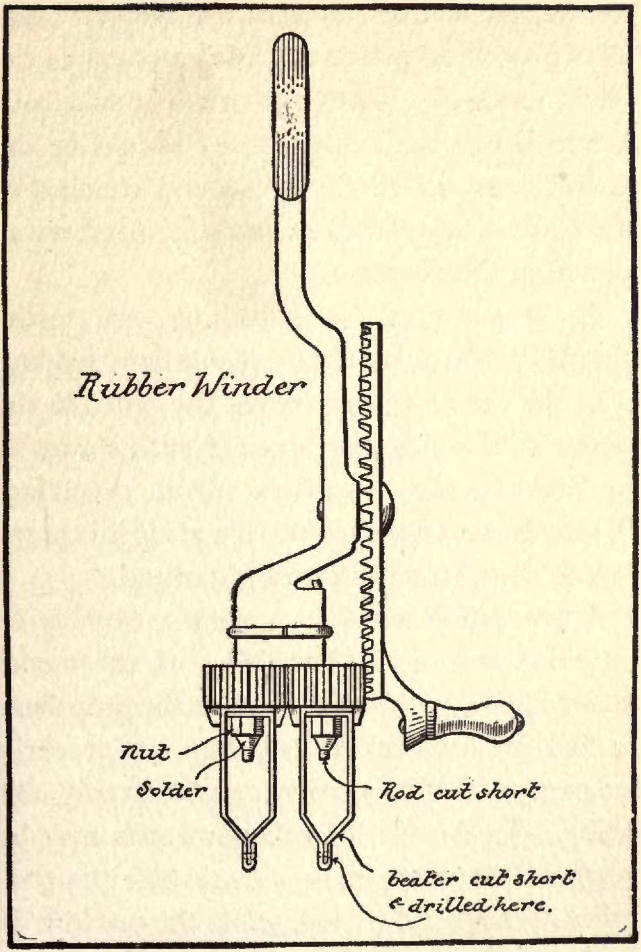

Rubber Winder
nut
Solder
Rod cut short
beater cut short
& drilled here.

Diagram 8

the winder will be sufficient for the first trial. This propelling power can be increased as the trials proceed. When the winding has been accomplished the rubber hooks should be detached from the winder hooks and attached to the hooks at the front of the side members as shown in the diagram.

In preparation for launching, the model should be held above the head, one hand holding it at the center of the frame, the other in the center of the propeller brace in such a way as to prevent the propellers from revolving. When the model is cast into the air if it is properly adjusted it will fly straight ahead.

A precaution which is sometimes worthy of attention before the launching of the model under its full power is to test out the propellers to find out whether or not they are properly mounted and whether they revolve evenly and easily. To do this the rubber strands may be given a few turns, enough to revolve the propellers for a brief period, while the machine is held stationary. If the shafts have been properly inserted in the hubs of the propellers and have not been bent during the winding of the rubbers, the propellers will revolve evenly and readily. If the propellers revolve unsteadily it indicates that there is a bend in the propeller shafts or the propellers have not been properly balanced. If the trouble is a bend in the shaft, it must be removed before the model is launched on actual flight. If the propeller does not revolve freely the application of some lubrication (such as vaseline) to the shaft will eliminate this trouble. With these adjustments made satisfactorily, the model can be launched with the anticipation of good flying.

CHASSIS

The preceding instructions and discussions have dealt with different parts of a simple model to be used as a hand-launched type of model. The experience which will come as the result of flying this type of model for a period will undoubtedly tend toward a desire on the part of the constructor to make his model more

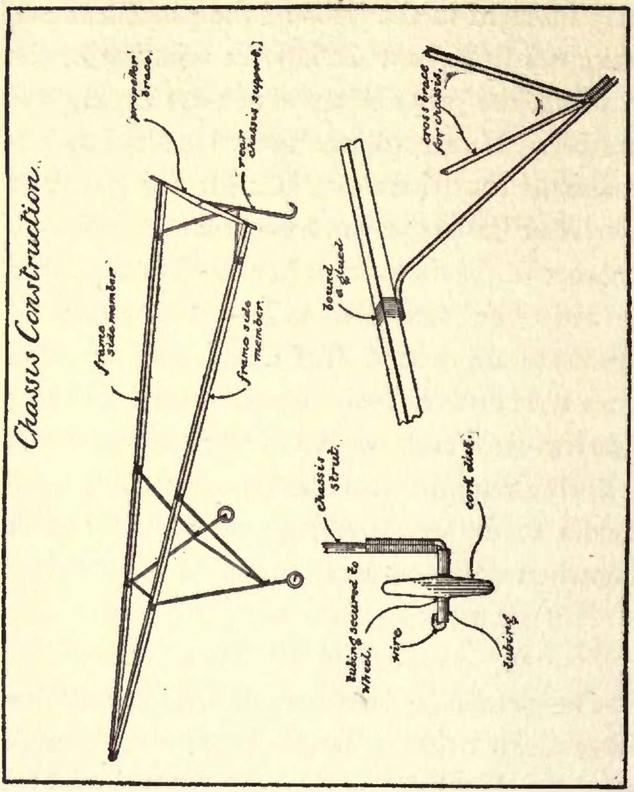

Chassis Construction.
propeller brace.
rear chassis support.
frame side member
frame side member.
bound & glued
cross brace for chassis.
chassis strut.
cork disk.
tubing secured to wheel.
wire
tubing

Diagram 9

nearly represent a large sized aëroplane and will make him want to have his model rise from the ground under its own power. Such a model is known as an R. O. G. type, that is, rises off the ground. To meet this desire all that it is necessary to do is to make a chassis, or carriage, which can be secured to the frame of the model, and with extra power added, will result in a practical R. O. G. model. In constructing such a chassis or carriage it is necessary to bear in mind that it must be made sufficiently strong to withstand the shock and stress which it will be called upon to stand when the model descends to the ground.

For the main struts of the chassis two pieces of bamboo each 9″ in length are needed and these should be bent over 1″ on one end as shown in the diagram, that they may be fastened to the under side of the frame members, one on either side, at a point on that member 12″ from the front. Two similar pieces of bamboo, each piece about 7″ in length, are required to act as braces between the frame members and the main chassis struts. Each end of each of the braces should be bent over in the same direction and in the same manner as that described for the main strut so that the fastening to the main frame member and the main chassis strut may be accomplished. Steam may be used in bending the ends of the pieces of bamboo. To make the landing chassis sufficiently stable to withstand landing shocks a piece of bamboo 9″ should be fastened from either side of the main chassis struts at the point where the chassis brace on either side meets with main strut. The ends of this cross brace should be bent in similar fashion to the other braces to enable its being fastened easily and securely.

Two small wheels constitute the running gear for the front part of the chassis, for which two pieces of 1-16″ steel wire each 2¼″ long are required. These small wires are fastened to the bottom ends of the main struts, and to accomplish this the wire should be bent in the center at right angles; one leg of the angle is attached to the bottom end of the main strut as shown in the diagram. Disks for wheels may be cut from a bottle cork which should be ¾″ in diameter by approximately ¼″ in thickness. The edges should be rounded off to prevent chipping. Before mounting the wheels on the axles which have been provided by the wires attached to the bottom of the main struts, a piece of bronze tubing 3-32″ inside diameter and 3-16″ long should be inserted in the center of each disk. To secure the least possible resistance on the revolutions of the wheels, there should be placed on the wire axles pieces of bronze tubing similar in diameter and ⅛″ in length on either side of the wheel (see illustration). When the wheel is thus placed in position with the pieces of bronze tubing on either side about ¼″ of the axle wire will extend from the outward end of the outside piece of tubing. This should be bent over the tubing to prevent its falling off and at the same time hold the wheel securely in position.

For the rear skid a piece of bamboo 6″ long is used, one end of which is curved as in a hockey stick so that it will glide smoothly over the ground. The other end of the rear skid should be bent over about ½″ so that it can be securely fastened to the propeller braces, as illustrated in the diagram. Two 7″ pieces of bamboo are required to act as braces for the rear skid. Both ends of each brace strut are bent over ½″ in the same direction, one end of each strut is securely fastened to a side member 3″ from the rear and the other end of each strut is fastened to the rear skid, at their point of meeting as shown in diagram 9, the method of attaching being the same as in the case of the forward portion of the chassis. All joining should be accomplished by first gluing the braces and then binding with thread. When completed, the rear skid should glide along the ground in bobsled fashion, thus preventing the propellers from hitting the ground.

In making such a chassis or carriage the endeavor should be made to use, as near as possible, the same weight of material on either side

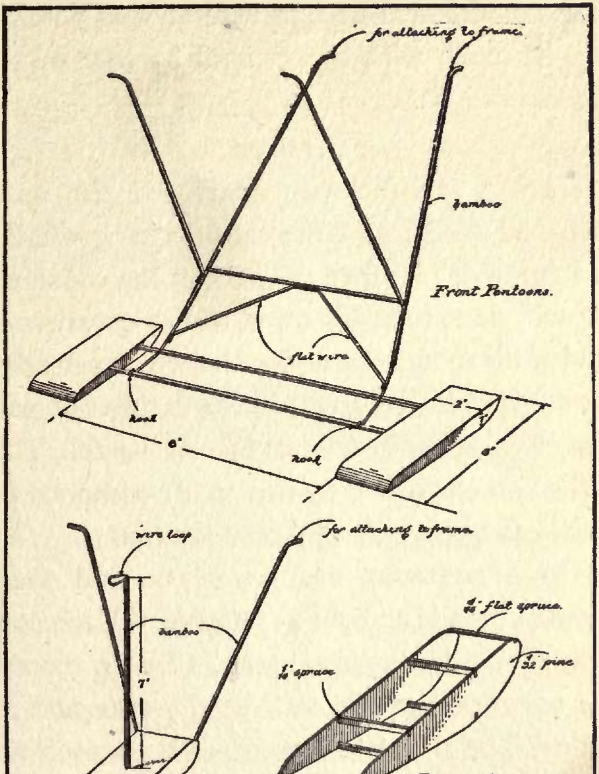

for attaching to frame
bamboo
Front Pontoons.
flat wire
hook
hook
6'
2'
1'
wire loop
for attaching to frame
bamboo
7'
flat spruce.
1/32" pine
1/16" spruce
Pontoon Construction.
Rear Pontoon

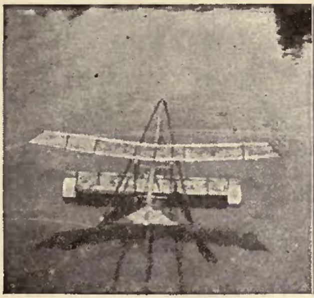
Diagram 10

of the model so as little interference as possible will be made with the general balance of the model in flight.

PONTOONS

Having satisfactorily developed the hand launched model and the model rising off the ground under its own propulsion the constructor will next turn his mind to the question of having his model rise under its own power from the surface of the water in the fashion of passenger-carrying hydros and flying boats. This will be accomplished by the use of pontoons attached to a specially designed chassis.

Three pontoons are necessary and these should be made as light as possible. Each pontoon should be made 6″ long, 1″ deep toward the forward part, by ¾″ at the rear and 2″ wide. The side members of each pontoon are made from pieces of thin white pine wood 1-32nd of an inch thick, slightly curved up at the front and sloped down toward the rear. Small niches should be made on the top and bottom sides of the pontoons into which the cross



C. V. Obst World record flying boat

Twin tractor Hydroaeroplane designed and constructed by George F. McLaughlin

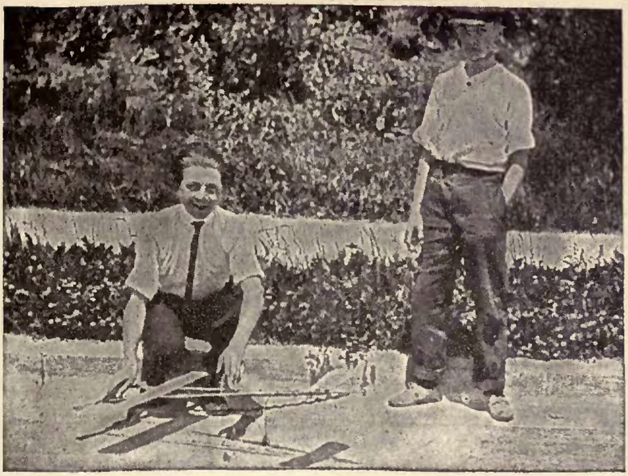
Louis Bamberger's hydro about to leave surface of water

braces are inserted and glued. Further reference to diagram 10 will show that at the extreme forward end of the sides a cut is made large enough to receive a flat piece of spruce 1-16″ wide. Another cut of the same dimensions is made at the extreme rear end. Still further cuts are made on the top and bottom sides of the pontoons, the forward cuts measuring 1½″ from the front and the rear cuts 1½″ from the rear, to join the sides of the pontoons as illustrated in diagram 10. Six pieces of 1-16″ flat spruce are required for the rear pontoon, the ends of which are held in position by glue. For the forward pontoon only 4 braces are required in so far as the ends of the two main brace spars of the forward part of chassis are inserted in the cuts on the top sides of the pontoon. These brace spars measure 10 inches in length and are made from bamboo ⅛th inch in diameter, which necessitates enlargement of the cuts on the top sides of the forward pontoons so that the extreme ends of the spars can be inserted in the cuts in the place of the braces. To complete the rear pontoon and prepare it for covering, three strips of 1/8" bamboo are required for struts. Two of these strips should measure 9" in length and should be attached to the front of the pontoon on the inner side as shown in diagram 10. Thread and glue should be used in attaching the ends of the strips to the pontoon. To enable fastening to the frame the upper ends of the bamboo strips should be bent over about 1/2". The third strip should measure 8" in length and is attached to the upper and lower braces toward the front of the pontoon as shown in the diagram. It is necessary that this strip be secured in the approximate center of the pontoon to insure a good balance. For the purpose of securing the upper end of the third strut to the center of the propeller brace a piece of wire 1 1/2" long should be secured to the upper end of the strut and looped as shown in diagram 10. The three pontoons should now be covered with fiber paper and it is necessary to exercise care to avoid punctures. For the purpose of coating the fiber paper to render it waterproof, a satisfactory solution can be made by mixing banana oil with celluloid until it has attained the desired thickness, after which it should be applied to the covering of the pontoons with a soft brush.

For the main strut of the forward portion of the chassis two pieces of ⅛″ bamboo, each 11″ in length, are required and these should be bent over 1″ on one end as shown in the diagram, that they may be fastened to the under side of the frame members, one on either side at a point on that member 11″ from the front. Two similar pieces of bamboo, each piece 8″ in length, are required to act as braces between the frame members and the main chassis struts. Each end of the braces should be bent over in the same direction and in the same manner as that described for the main struts so that the fastening to the main frame member and the main chassis struts may be accomplished. Steam or an alcohol lamp may be used in bending the ends of the pieces of bamboo. To make the chassis sufficiently stable a piece of bamboo 7½″ should be fastened from either side of the main chassis struts at the point where the chassis brace on either side meets with the main strut. The ends of this cross brace should be bent in similar fashion to the other braces to enable its being fastened easily and permanently.

For the accommodation of the pontoons two strips of flat steel wire, each 4″ in length, should be attached to the ends of the main struts, about one inch from the bottom, the farthest ends should be bent to grip the second spar which joins the pontoons. Note diagram 10.

To further strengthen the chassis a strip of flat steel wire sufficiently long enough should be bent so that ½″ of the central portion can be securely fastened to the center of the cross brace as shown in diagram 10. The two outer ends should be bent down and are fastened to the wires which are attached to the bottom ends of the struts. This method of at-



Erwin B. Eiring about to release R. O. G. Model. (Note manner of holding propellers.) Kennith Sedgwick, tractor record holder Milwaukee Model Club. Courtesy Gilbert Counsell.

Waid Carl releasing R. O. G. Model. Courtesy Edward P. Warner.

taching the forward pontoons enables the constructor to adjust them to any desired angle and also detach them when not in use.

A model hydroaëroplane is one of the most interesting types of models and if properly taken care of will afford the constructor many pleasant moments.

LAUNCHING AN R. O. G. OR MODEL HYDROAËROPLANE

Although the method of determining the balance of an R. O. G. or a model hydroaëroplane is exactly the same as that of a hand launched model, the manner of launching is somewhat different. Instead of holding the model one hand in the center of the frame and the other at the rear as in the case of the hand launched model, in launching an R. O. G. or hydro, the model should be rested upon the ground or water, as the case may be, with both hands holding tightly to the propellers. Then when about to let the model go release both propellers instantly. If the model has sufficient power and it has been properly adjusted it will glide over the surface of the ground or water for a short distance, then rise into the air. Should the model fail to rise into the air additional strands of rubber should be added, after which it should be rewound and a second attempt made.

Should the model fail to respond after the addition of extra rubber, the indications are that something requires further adjustment. Perhaps the pontoons need further elevation if the model is a hydro, or if it be an R. O. G. model the forward wing may require an increase of elevation. In any event the model should be carefully examined and adjustments made where necessary, after which the model should be tested for balance and elevation. If satisfied with the behavior of the model after test flights have been made, another attempt should be made to launch the model from the ground or water.

On no account try to fly the model in the house, or see, supposing the model is of the R.

O. G. type, if it will rise from the dining room floor. This advice may seem unnecessary, but it is not so, for there has been quite a number of instances in which the above has been done, nearly always with disastrous results, not always to the model, more often to something of much greater value. The smashing of windows has often resulted from such attempts, but generally speaking pictures are the worst sufferers. It is equally unwise to attempt to fly the model in a garden in which there are numerous obstructions, such as trees and so forth. A wrecked model is very often the result of such experimenting. The safest way to determine the flying ability of any model is to take it out in an open field where its flight is less apt to be interrupted.

WORLD RECORD MODELS

THE LAUDER DISTANCE AND DURATION MODEL

After many months of experimentation Mr. Wallace A. Lauder succeeded in producing a model that proved to be one of his most successful models. But a few years ago flights of 1000 feet with a duration of 60 seconds were considered remarkable. But so rapid has been the development of the rubber strand driven model that to-day it is hardly considered worth while to measure a flight of 1000 feet, especially in contests where models fly over 2500 feet or 3537 feet which was the distance flown by Mr. Lauder's model during one of the contests of the National Model Aëroplane competition of 1915. Mr. Lauder's model on several occasions made flights of over 3500 feet with a duration in each event of over 195 seconds. It is therefore to be remembered that this model is both a distance and duration model, both qualities being seldom found in one model.

Reference to the accompanying drawing will give a clear idea of the constructional details.

The frame or fuselage consists of two side members 40″ in length, of straight grained spruce. At the center each member is of approximately cross section, and is ¼″ in diameter. The members taper to about 3-16″ at the ends, the circular cross section being maintained throughout. The frame is braced by a strip of bamboo of streamline form, extending from one side member to the other, 18″ from the apex of the frame. The ends of this frame are bent to run parallel to the side members of the frame where they are secured by binding with silk thread and gluing. Piano wire hooks are also secured to the side members of the frame adjacent the ends of the cross brace, and from these hooks extend wires of steel (No. 2 music wire) which run diagonally to the rear brace or propeller spar where they are secured.

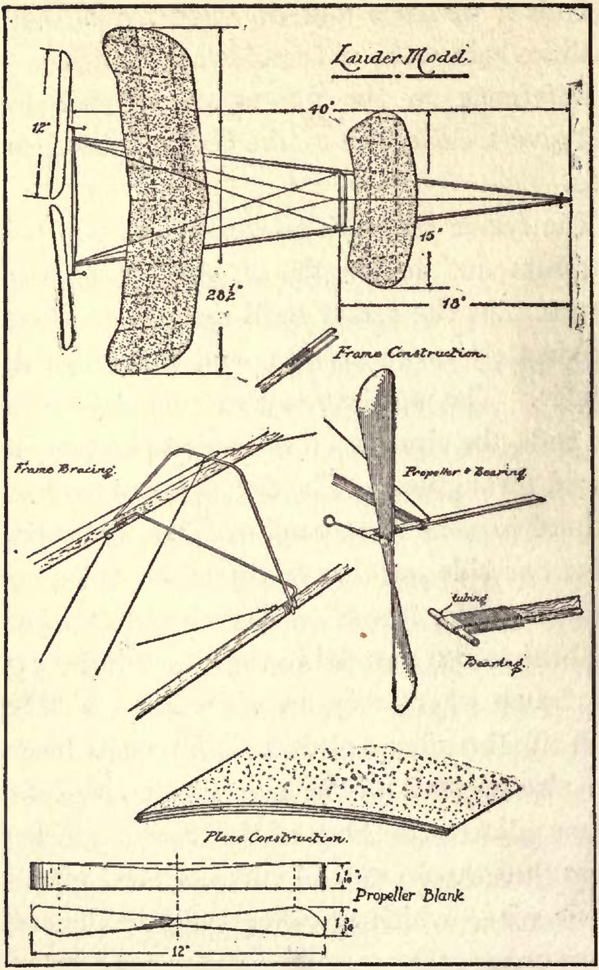

Lauder Model.
40"
12"
15"
28½"
18"
Frame Construction.
Frame Bracing.
Propeller & Bearing.
tubing
Bearing.
Plane Construction.
Propeller Blank
12"

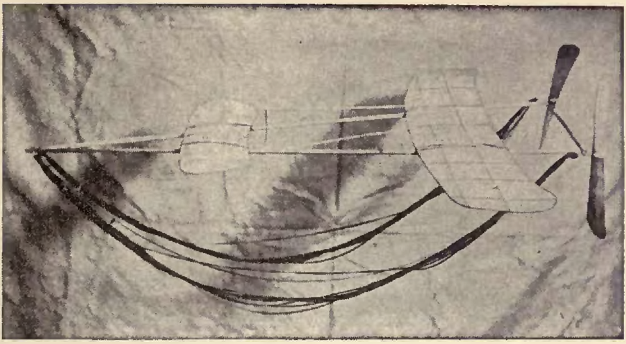
Diagram 11

The frame is braced further by an upwardly arched strip of bamboo, as shown in diagram 11, this strip being 2½" in height. At the top of this brace are two bronze strips of No. 32 gauge brass, one above the other, one on top of the brace and the other below.

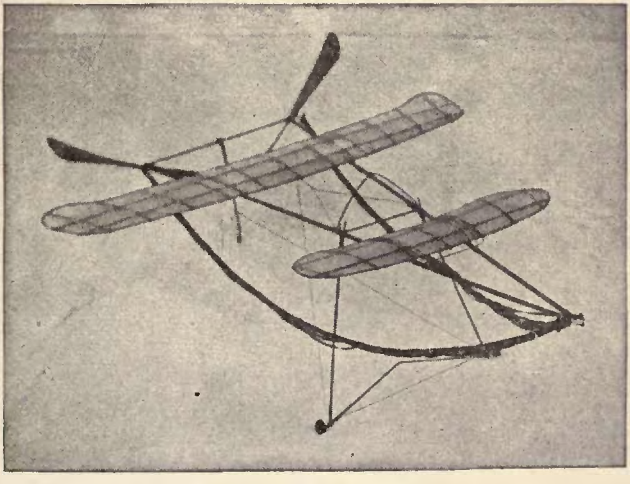
Adjacent the ends of these strips of metal are perforations through which pass bracing wires, one of which wires run to the front of the frame where a hook is mounted for its reception, and the other two wires extend to the rear of the frame where they are secured to the propeller brace. The propeller brace consists of a strip of streamlined spruce 11¾" in length, the propellers being at an angle, thus clearance is allowed ¼" wide at the center, tapering to 3-16" at the ends. The ends of the propeller brace extend out one inch from the side members of the frame, to allow room for the rubber strands to be used as motive power. In order to avoid slotting the ends of the side members of the frame so that the propeller brace can be secured therein, thin strips of bamboo are secured above and below the end of each side member, by binding with silk thread and gluing, the space between these bamboo strips being utilized for the brace which is securely bound and glued therein. The propeller bearings consist of strips of very thin bronze (No. 32 gauge), about 3-16″ in width, bent over ⅝″ strips of German silver tubing, the tubing being soldered to the bronze strips and the propeller brace, which fits between the upper and lower portions of the bronze strips, is securely bound and glued thereto.

The propellers are cut from solid blocks of pine, and are 12″ in diameter. The blade, at its widest portion, measures 1⅜″. The blades are cut very thin, and in order to save weight, they are not shellacked or painted.

The propeller shafts are of piano wire (No. 20 size) to fit the tubing used in the bearings, pass through the propellers and are bent over on the outer side to prevent turning. A few small bronze washers are interposed between the propellers and the outer ends of the tubing



Wallace A. Lauder distance and duration model



Wallace A. Lauder R. O. G. Model

to minimize friction when the propellers are revolving. Twelve strands of rubber are used for each propeller, the rubber being 1/8" flat.

The wings are both double surfaced, and are of the swept back type. The span of the main wing is 28½", with a chord of 6½". The elevator has a span of 15" with a chord of 4¾". The main wing has eleven double ribs, these ribs being built up on mean beams of spruce 1-16" x 3-16", the front beam being placed 1¼" from the entering edge, and the second beam being 2" back from the front beam. The entering and trailing edges are formed from a single strip of thin split bamboo, all the joints being made by binding with thin silk and gluing.

The elevator is constructed in like manner, except that it only has seven ribs, and the measurements are as above set forth. Both planes are covered with goldbeater's skin, sometimes known as "Zephyr" skin, which is first glued in place and then steamed, which tightens the same on the plane, and given a coat of preparation used for this purpose.

THE HITTLE WORLD RECORD MODEL

(SINGLE TRACTOR MONOPLANE, 116 SECONDS DURATION RISING FROM WATER)

THE Hittle World record model hydroaëroplane, designed and constructed by Mr. Lindsay Hittle of the Illinois Model Aëro Club, is perhaps one of the most interesting types of models yet produced. The establishing of this record illustrates the value of careful designing and construction and offers to the beginner an example which might be followed if good results are sought. In having broken the world's model hydroaëroplane record with a tractor type model Mr. Hittle accomplished a feat of twofold importance. First, in having advanced the possibilities of the tractor model, and, second, in illustrating the value of scientific construction. The previous record for this type of model has been but 29 seconds, just one-fourth of the duration made by Mr. Hittle's model.

Mr. Hittle's model shows many new and original features not hitherto combined on any one model. Note diagram 12. The model is of extremely light weight, weighing complete but 1.75 ounces. The floats and their attachments have been so designed as to offer the least possible wind resistance. In fact every possible method was utilized in order to cut down weight and resistance on every part of the model. As a result of this doing away with resistance an excellent gliding ratio of 8¾ to 1 has been obtained.

For the motor base of the model a single stick of white pine ⅝″ deep and 45″ in length is used. On the front end the bearing for the propeller is bound with silk thread and a waterproof glue of the constructor's own composition being used to hold it secure. For the bearing a small light weight forging somewhat in the shape of the letter "L" is used, this being made streamline. At the rear end of the motor base is attached a piano wire hook for the rubber. The stabilizer consisting of a segment of a circle measuring 12″ x 8″ is attached to the under side of the motor base. The rudder measuring 3½″ x 3½″ is attached to the stabilizer at the rear of the motor base.

The wing is built up of two beams of white pine with ribs and tips of bamboo and has an area of 215 square inches

The wing which has a total span of 43″ and a chord of 5⅛″ is built up of two beams of white pine with ribs and tips of bamboo and has a total area of 215 square inches. The wing is given a small dihedral and the wing tips are slightly upturned at the rear.

The trailing edge is longer than the entering edge the ribs being placed somewhat oblique in order to secure an even spacing. The wing is attached to the frame by two small bamboo clips which hold it rigidly and permit easy adjustment and is set at an angle of about 4 degrees with the line of thrust. Both the

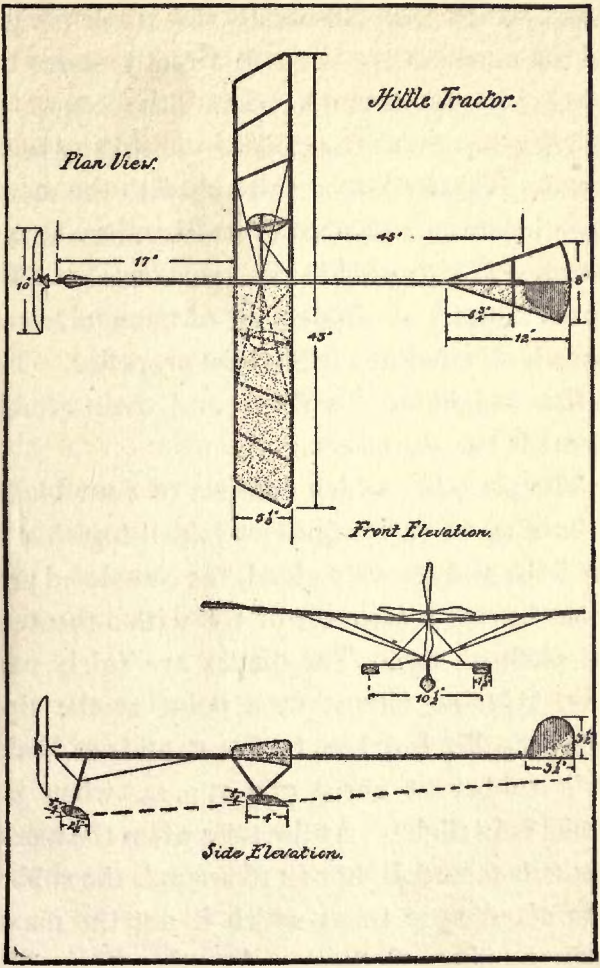

Hittle Tractor.
Plan View.
17"
45"
45"
10"
8"
6¾"
12"
5½"
Front Elevation.
10½"
Side Elevation.
3½"
4"

Diagram 12

floats which take practically the whole weight of the machine are situated directly under the wing just far enough behind the center of gravity to prevent the model from tipping backward. These floats are attached to the motor base by means of streamlined bamboo struts. Bamboo is also used in the construction of the float frames. A single float of triangular sections is situated just behind the propeller. The entire weight of the floats and their attachments is but .23 ounces.

The propeller which consists of four blades is built up of two propellers joined together at the hubs and securely glued, the completed propeller having a diameter of 10″ with a theoretical pitch of 14″. The blades are fairly narrow, tapering almost to a point at the tips. The propeller is driven by five strands of 3/16th″ strip rubber at about 760 r. p. m. when the model is in flight. At the time when the model made its record flight of 116 seconds the rubber was given 1500 turns which is not the maximum number of turns. At other times the model has flown satisfactorily with less turns of the rubber. While in the air the model flies very slow and stable notwithstanding its light weight and large surface. On three occasions the model has made durations of approximately 90 seconds which rather dispenses the possibility of its being termed a freak.

THE LA TOUR FLYING BOAT

One of the most notable results of the National Model Aëroplane Competition of 1915 was the establishing of a new world's record for flying boats. Considering that the model flying boat is a difficult type of model to construct and fly, the establishing of this new world record of 43 seconds is remarkable. Credit for this performance is due Mr. Robert La Tour of the Pacific Northwest Model Aëro Club, who designed, constructed and flew the model flying boat which is herewith described and illustrated. Diagram 13.

The frame is made of laminated spruce 40″ in length, made of two strips glued together. They are 3/8″ x 1/8″ at the center tapering to 3/16″ x 1/8″ at the ends. The cross braces are of split bamboo and are fastened to the frame side members by bringing them to a wedge at the ends and then inserting them into slots in the sides of the frame side members and are finally drilled and bound to the latter. The rear brace is of streamlined spruce ¼" x ⅛"; this butts against the frame side members and is bound to them. The propeller accommodations are made of brass.

The propellers are 10" in diameter with a 19" pitch. These are carved from a block of Alaska cedar 1¼" wide by ¾" thick. Of course the propellers may also be made from white pine. To turn the propellers 15 strands of ⅛" flat rubber are used.

Bamboo about 1/16" square is used to obtain the outline of the wings. The main wing has a span of 33" with a chord of 5½". Split bamboo is used for the making of the 9 ribs. The wing spar or brace is of spruce 3/16" x ⅛" and is fastened below the ribs as illustrated in diagram 13. The elevator is constructed in like manner but has a span of only 17" x 4¾" and has only 5 ribs. A block ¾" high is used for elevation. Both wings have a camber of ½" and are covered on the upper side with silk

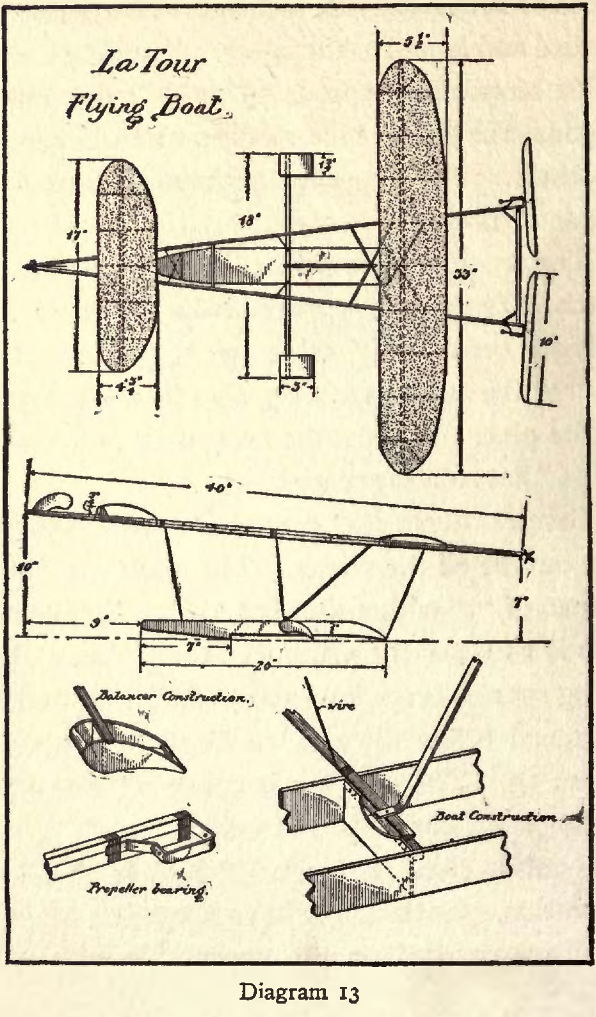

La Tour
Flying Boat
Balancer Construction
Propeller bearing
wire
Boat Construction

Diagram 13

doped with a special varnish and a few coats of white shellac.

The boat is 20″ long, 3″ in width and shaped as shown. The slip is ½″ deep and is located 7″ from the bow. The rear end is brought down steeply to avoid the drag of the water on this point when the boat is leaving the surface of the water. Spruce $\frac{3}{64}$ths of an inch thick is used for the making of the sides, but the cross bracing is of slightly heavier material, there being six braces used throughout. The rear brace is much heavier in order to withstand the pull of the covering and to receive the ends of the wire connections. The outriggers or balancing pontoons are constructed of the same material as that of the boat and are held together by a spruce beam 18″ long, ½″ wide by $\frac{3}{16}$″ thick, streamlined. This beam is fastened to the boat by means of three brads to permit changing if necessary. The lower edges of the outriggers should clear the water about ⅛″ before the steps on the boat leave the water. The boat and outriggers are covered with silk, shrunk with a special solution and then coated several times with white shellac. It is a good plan to shellac the interior walls of the boat and pontoons before covering to prevent them from losing their form by becoming soft from the influence of water in the case of a puncture.

The boat is connected to the frame at its front by two steel wires, their ends being inserted into the cross members of the boat, and then brought up along the sides, crossed and then bound to the frame. A similar pair of connecting wires are used to connect the rear end of the boat to the rear end of the frame. A U-shaped wire is bound to the outrigger beam and frame. A single diagonal strip of bamboo is also fastened to the outrigger beam with a brad, its upper end being bound to the cross bracing of the frame, making a very solid connection.

Under ideal weather conditions this model will fly on 12 strands of rubber with the possibility of a better duration than has been made. But, however, with 15 strands the model will rise at every attempt. More rubber, however, causes the bow of the boat to nose under and to accommodate this increase of power the boat should be lengthened.

THE COOK NO. 42 WORLD RECORD MODEL

(TWIN PROPELLER HYDROAËROPLANE, 100.6 SECONDS RISING FROM WATER)

DURING the National Model Aëroplane Competition of 1915 held under the auspices of the Aëro Club of America, a number of new world records were established, one of which was for twin propeller hydroaëroplanes. The credit for this record is due Mr. Ellis C. Cook of the Illinois Model Aëro Club, who succeeded in getting his model hydroaëroplane—which by the way is a rather difficult type of model to operate—to rise from the water and remain in the air for a duration of 100.6 seconds. This model is of the common A frame design with the floats or pontoons arranged in the familiar fashion, two forward and one aft. The model is fairly light, weighing, when complete, 3.33

ounces, ½ ounce of which is made up in rubber strands for motive power. Diagram 14.

The frame is made of two sticks of white pine for side members, each member measuring 38¼" in length, ⁵⁄₁₆" in depth, by ⅛" in width. These are cut to taper toward the ends where they are only ⅛" in width by ³⁄₁₆" in depth in the front and rear respectively. Three "X" strips of streamlined bamboo measuring ³⁄₁₆" in width by ³⁄₆₄ths of an inch in depth, are used for bracing the frame between the front and rear and are arranged as shown in diagram 14. The propeller bearings are of small streamlined forgings of light weight, and are bound to the rear end of each side member first by gluing, then binding around with thread. The front hook is made of No. 16 piano wire and is bound to the frame as shown in diagram 14. The chassis which holds the floats or pontoons is made of ³⁄₃₂" bamboo bent to shape and bound to the frame members. By the use of rubber strands the floats are attached to the chassis;

the forward ones being attached so that angle may be adjusted.

The main wing has a span of 36″ and a chord of 5″ and is constructed of two white pine beams each 39″ long, with bamboo wing tips. The ribs, seven in number, are also made of bamboo and are spaced along the edges of the wing at a distance of 4½″ apart. The "elevator" or front wing has a span of 14″ and a chord of 3¼″, the framework of which is made entirely of bamboo. The entering edge of this wing is given a slightly greater dihedral so that the angle of incidence at the tips is greater than at the center. By this method the added incidence in the front wing is obtained. By the use of rubber bands both wings are attached to the frame.

The two forward floats are spaced eight inches apart and are of the stepped type, the step being 3½″ from the front and has a depth of ⅛″. These two floats are separated by two bamboo strips as shown in the diagram,

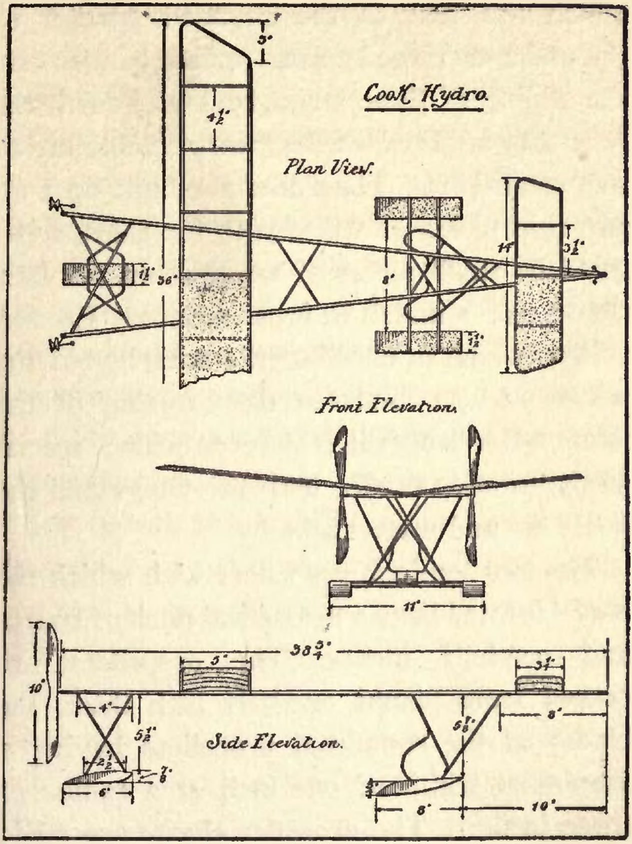

Cook Hydro.
Plan View.
Front Elevation.
Side Elevation.
5"
4½"
36"
1½"
8"
14"
3½"
11"
38¾"
10"
4"
5½"
2½"
6"
5"
3¼"
5⅞"
10"

Diagram 14

which are tied to the rounded portion of the under carriage by small rubber bands. By the sliding of these strips back and forth the necessary angle of the floats may be obtained to suit conditions. The floats are built up with two thin pieces of white pine for sides, separated by small pieces of wood about one-half the size of a match in cross section. Chiffon veiling which is used for the covering of the wings, is also used for the covering of the floats, after which it is covered with a special preparation to render both the wings and the floats air and water-tight.

The two ten-inch propellers with which the model is fitted have a theoretical pitch of twelve and one-half inches. The propellers are carved from blanks one-half inch thick, the blades of the completed propellers having a maximum width of one inch at a radius of three inches. The propeller shafts are made from No. 16 piano wire and have small washers for bearings. Each propeller is driven by three strands of ¼″ strip elastic. The rubber is given 1700 to 1750 turns and revolves the propellers at 1150–1200 r. p. m., when the model is in flight.

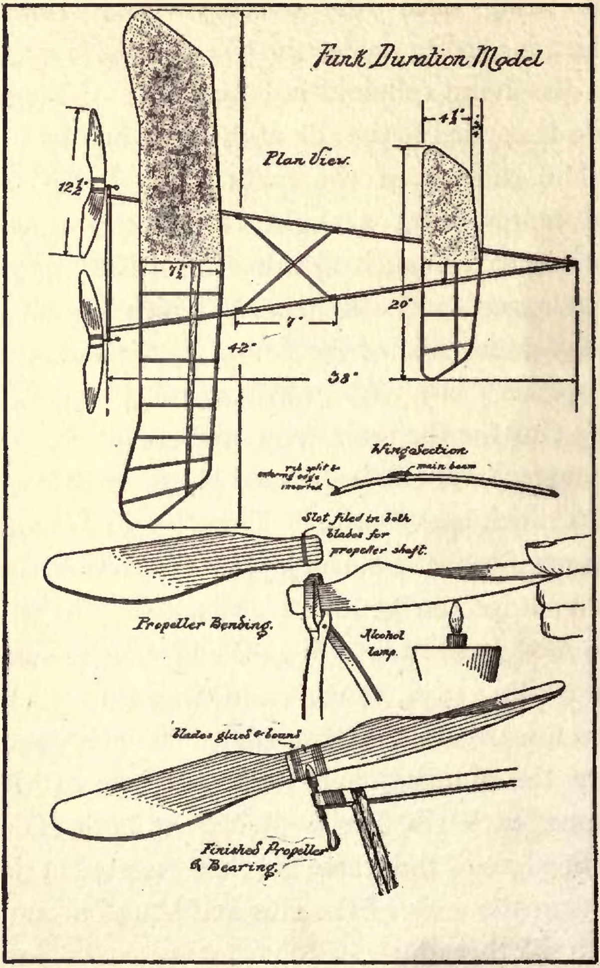
The model usually runs over the surface of the water for a distance of from two to three feet before it rises, after which it climbs at a very steep angle to the necessary altitude. The model seems, when in flight, to be slightly overpowered but this is misleading. The rubbers usually unwind in from 85 to 90 seconds. On four out of six flights this model has made a duration of between 98 and 100 seconds which is rather unusual for a model of this type.

THE RUDY FUNK DURATION MODEL

Of the many different types of duration models that have made their appearance during the year of 1915 perhaps the model described herewith, constructed and flown by Mr. Rudolph Funk, of the Aëro Science Club, was one of the most successful. Unlike most models the propellers of this model are bent and not cut. This model made its appearance during the latter part of 1915, on several occasions having flown for over 100 seconds duration. Diagram 15.

While retaining the important characteristics of his standard model, slight changes have been made. Instead of the usual wire for the construction of the frame of the wings, bamboo is used in its place for lightness and strength. The wing frames are single surfaced, China silk being used for covering. The "dope" which is used to render the silk airtight is made by dissolving celluloid in banana oil. This in turn is applied to the silk with a soft brush.

The camber of the main wing is ¾" at the center, with a slight reduction towards the negative tips; it also has a dihedral angle of 2 degrees. The main beam, which is secured to the under side of the frame for rigidness, is of spruce 1" by 5-64", tapering to ¾" x 5-64". The ribs for the main wing and small wing or "elevator" are cut from solid pieces of bamboo 3-16" thick by ¼" wide. These pieces of bamboo are first bent to the proper camber and are then cut into strips each 1-16" wide. The ribs are next tapered to a V at the bottom, toward the trailing edge, as shown in diagram 15, and also toward the entering edge. To accommodate the entering and trailing edges of the frame, each rib is slit slightly at both ends. Both edges of the frame are then inserted in the slots at the ends of the ribs and bound around with silk thread.



Funk Duration Model
Plan View.
12½"
7½"
4½"
20"
7"
42"
38"
Wing Section
rib split & entering edge inserted
main beam
Slot filed in both blades for propeller shaft.
Propeller Bending.
Alcohol lamp.
Blades glued & bound
Finished Propeller & Bearing.

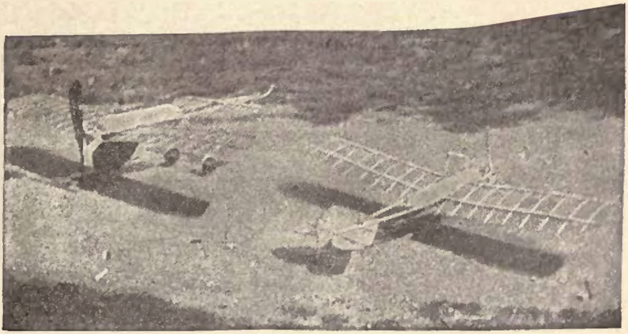
Diagram 15

The frame is composed of two sticks of silver spruce 38″ in length, 5-16″ x 3-16″, tapering to ¼″ x 5-32″, held apart by a streamline bamboo cross brace in the center. An additional brace of bamboo is securely fastened across the frame toward the front. The propeller brace consists of a streamline-cut piece of bamboo 12½″ in length by ⅜″ in width at the center, tapering to ¼″ toward the ends. The propeller brace is inserted in slots cut in the rear ends of the frame members, then bound and glued.

The propellers are bent from birch veneer, the bending being done over an alcohol flame as illustrated in diagram 15. But first of all the blades are cut to shape, sandpapered and finished before they are bent. As shown in the drawing a slot is filed in the hub of each blade to enable the propeller shaft to pass through when both have been glued together. The blades are then glued and bound together, first by placing a piece of wire in the slots to insure their being centered and also to prevent their being filled with glue. After this has been done each propeller is given three coats of the same dope as is used on the wings.

The propeller bearings are turned out of 1-32″ bronze tubing, the length of each bearing being ½″. Steel washers are slipped over the propeller shaft, between the bearing and propeller to insure smooth running. The propeller shafts are made from steel hatpins which are heated at both ends, one end of which is bent into a loop to receive the rubber strands, the other end being bent around the hub of the propeller to prevent the shaft from slipping during the unwinding of the rubbers. Two strips of brass, each ¼″ x 2″, are bent around the one-half inch bearing and soldered. The brass strips are then glued and bound onto the ends of the propeller brace as shown in diagram 15.

Rudy Funk speed model



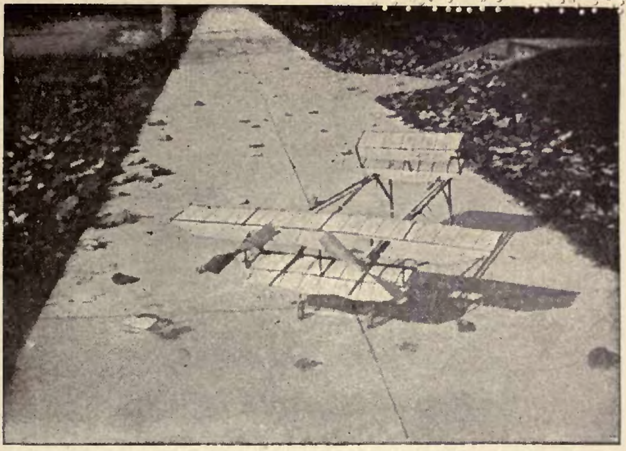
Schober compressed air driven monoplane. McMahon compressed air driven tractor (right)

THE ALSON H. WHEELER WORLD RECORD MODEL

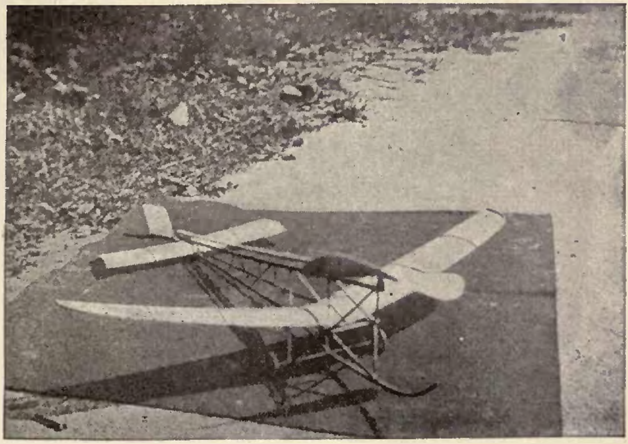
(TWIN PUSHER BIPLANE 143 SEC. DURATION RISING FROM THE GROUND)

SINCE the beginning of model flying very little attention has been paid to the model biplane. Practically all records are held by model aëroplanes of the monoplane type. With this fact in view, the record established by Mr. Wheeler with his Twin Pusher Biplane is extraordinary, in so far as it surpasses many of the monoplane records. This model is a very slow flyer, and has excellent gliding ability. At the time when this model flew and broke the world's record, the greater portion of the flight consisted of a beautiful glide of 86 seconds' duration, after the power gave out, making it possible for the model to remain in the air for a duration of 143 seconds.

The frame consists of two I-beams, each 48″ in length, running parallel, and spaced by cross pieces, each piece 11½″ long. The bearing blocks used made it possible for the propellers to clear by one-half inch. Two 12″ expanding pitch racing propellers are used and these are mounted on ball bearing shafts. The main upper plane has a span of 34″ with a chord of 5″, the lower plane being 26″ by 5″. The elevator consists of two planes, each measuring 14″ by 5″. Cork wheels are used, each being one inch in diameter. For motive power one-eighth inch flat rubber is used, this being coated with glycerine to prevent sticking.



Alson H. Wheeler twin pusher Biplane



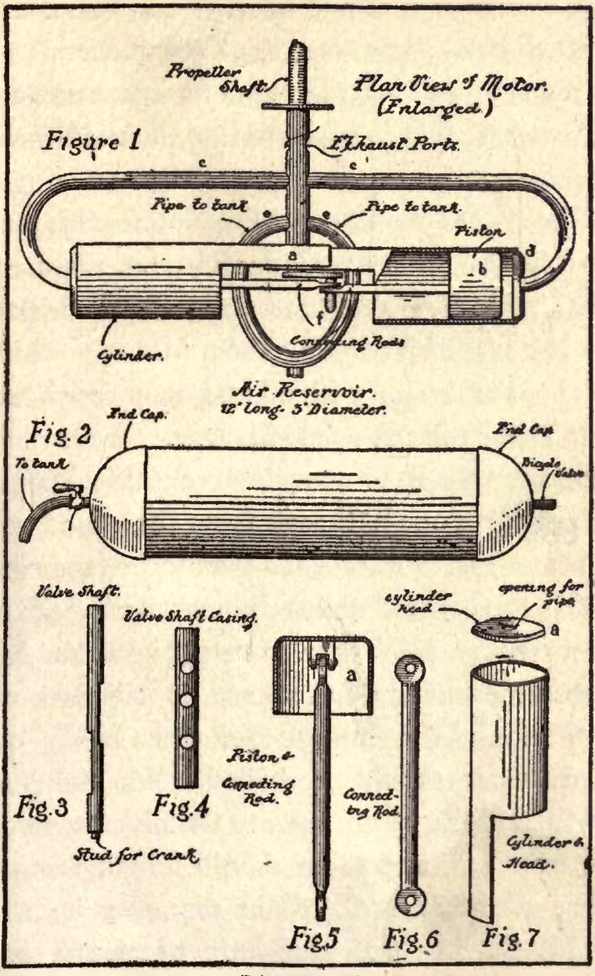
C. V. Obst tractor model

A SIMPLE COMPRESSED AIR MOTOR

During the past few years model flyers in America have shown a tendency toward the adoption of compressed air motors for use in connection with model aëroplanes. Hitherto, England has been the home of the compressed air motor, where a great deal of experimenting has been carried on, to a considerable degree of success. Flights of over 40 seconds have been made with models in which compressed air power plants were used. But, however, the desire on the part of a large majority of model flyers in America to build scientific models, that is, models more closely resembling large machines, has made it necessary to find a more suitable means of propulsion; rubber strands being unsatisfactory for such purposes. Many different types of compressed air motors have made their appearance during the past few years, among which the two cylinder opposed type is very favorably looked upon, because it is perhaps one of the easiest to construct.

To make a simple two cylinder opposed compressed air power plant, as illustrated in Figure 1 of diagram 16, it is not necessary that the builder be in possession of a machine shop. A file, drill, small gas blow torch and a small vise comprise the principal tools for the making of the motor.

The first things needed in the making of this motor are cylinders. For the making of the cylinders two fishing rod ferrules, known as female ferrules, are required. And for the heads of the cylinders, two male ferrules are required. Such ferrules can be secured at most any sporting goods store. The female ferrules should be filed down to a length of 2″, cut down on one side a distance of ¾ of the diameter, then cut in from the end as shown in Figure 7. When this has been done the two male ferrules should be cut off a distance of ⅛″ from the top as shown in Figure 7a, to serve as heads for the cylinders. A hole



Propeller Shaft
Plan View of Motor. (Enlarged)
Figure 1
Exhaust Ports.
c
c'
Pipe to tank
Pipe to tank.
e
e
Piston
a
b
d
f
Connecting Rods
Cylinder.
Air Reservoir.
12" Long - 3" Diameter.
Fig. 2
End Cap.
End Cap
To tank
Bicycle Valve
Valve Shaft.
Valve Shaft Casing.
cylinder head
opening for pipe
a
a
Piston & Connecting Rod.
Connecting Rod
Cylinder & Head.
Fig.3
Fig.4
Stud for Crank
Fig.5
Fig.6
Fig.7

Diagram 16

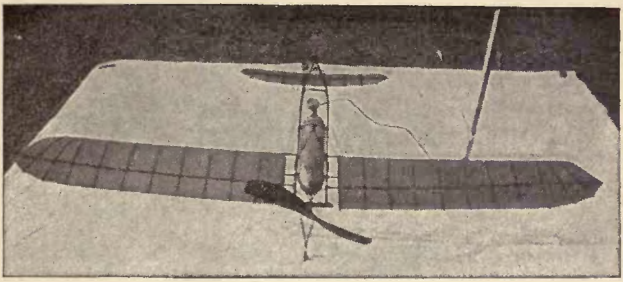
⅛″ in diameter should be drilled in the center of each head so as to enable the connecting of the intake pipes. By the use of soft wire solder the heads should be soldered into the ends of the cylinders as shown in Figure 1d.

The pistons should now be made; for this purpose two additional male ferrules are required. These should be made to operate freely within the cylinders by twisting them in a rag which has been saturated with oil and upon which has been shaken fine powdered emery. When they have been made to operate freely they should be cut down one-half inch from the closed end as shown in Figure 5a. For the connecting rods, 2 pieces of brass tubing, each ⅛″ in diameter by 1¼″ long, are required, and, as illustrated in Figure 6, should be flattened out at either end and through each end a hole 3-32″ in diameter should be drilled. For the connecting of the piston rods to the pistons, studs are required, and these should be cut from a piece of brass rod ¼″ in diameter by ½″ in length. As two studs are necessary, one for each piston, this piece should be cut in half, after which each piece should be filed in at one end deep enough to receive the end of the connecting rod. Before soldering the studs to the heads of the pistons, however, the connecting rods should be joined to the studs by the use of a steel pin which is passed through the stud and connecting rod, after which the ends of the pin are flattened, to keep it in position as shown in Figure 5a.

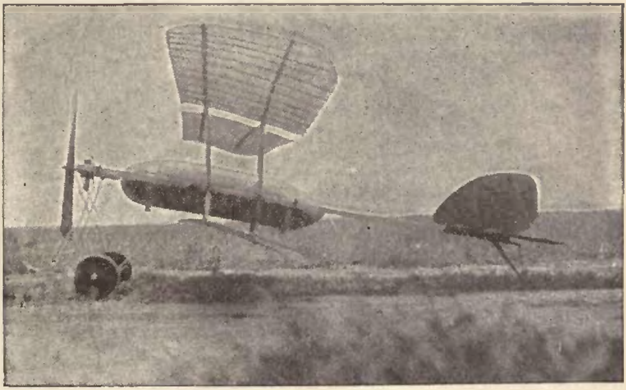
For the outside valve mechanism and also to serve in the capacity as a bearing for the crank-shaft, a piece of brass tubing 1/4" in diameter by 1 1/2" long is required. Into this should be drilled three holes, each 1/8" in diameter, and each 1/2" apart as shown in Figure 4. Next, for the valve shaft and also propeller accommodation, secure a piece of 3-16" drill rod 2" long. On the left hand side of the valve shaft, as shown in Figure 3, a cut 1-32" deep by 1/2" in length is made 1" from the end. Another cut of the same dimensions is made on the right side only; this cut is made at a distance of 3/8" from the stud end.

As shown in Figure 1f, the crank throw consists of a flat piece of steel, 3-32″ thick, ⅜″ in length by ¼″ in width. At each end of the crank throw a hole 3-16″ in diameter should be drilled, the holes to be one-half inch apart. Into one hole a piece of steel drill rod 3-32″ in diameter by ¼″ long is soldered, to which the connecting rods are mounted, as shown in Figure 1f. Into the other hole the stud end of the crank throw is soldered.

Before making the tank it is most desirable to assemble the parts of the motor, and this may be done by first fitting the pistons into the cylinders as shown in Figure 1-b, after which the cylinders should be lapped one over the other and soldered as shown in Figure 1-a. When this has been done a hole one-fourth of an inch in diameter should be drilled half way between the ends of the cylinders, and into this hole should be soldered one end of the valve casing shown in Figure 4. For the inlet pipes as shown in Figure 1-c secure two pieces of ⅛″ brass tubing and after heating until soft,



Schober pusher type compressed air driven monoplane



Schober compressed air driven biplane

bend both to a shape similar to that shown in Figure 1-c. When this has been done solder one end to the end of the cylinder and the other in the second hole of the valve shaft casing. The valve shaft should now be inserted in the valve shaft casing and the connecting rods sprung onto the crank throw as shown in Figure 1-d. To loosen up the parts of the motor which have just been assembled it should be filled with oil and by tightly holding the crank-shaft in the jaws of a drill the motor can be worked for a few minutes.

The tank is made from a sheet of brass or copper foil 15″ long by 1-100″ thick. This is made in the form of a cylinder, the edges of which are soldered together as shown in Figure 2. Sometimes this seam is riveted every one-half inch to increase its strength, but in most cases solder is all that is required to hold the edges together. For the caps, or ends, the tops of two small oil cans are used, each can measuring 2½″ in diameter. To complete the caps two discs of metal should be soldered over the ends of the cans where formerly the spouts were inserted, the bottoms of the cans having been removed. The bottom edges of the cans should be soldered to the ends of the tank as shown in Figure 2. Into one end of the completed tank a hole large enough to receive an ordinary bicycle air valve should be drilled. Figure 2. Another hole is drilled into the other end of the tank, into which is soldered a small gas cock to act as a valve. Figure 2. This should be filed down where necessary, to eliminate unnecessary weight. To connect the tank with the motor, a piece of 1/8″ brass tubing 3″ long is required, the ends of which are soldered into the holes in the valve shaft casing nearest the cylinders, as shown in Figure 1 ee. As shown in Figure 1 ee, a hole 1/8″ in diameter is drilled in one side of this piece, but not through, in the end nearest the tank. Another piece of brass tubing 1/8″ in diameter is required to connect the tank with the motor, one end of which is soldered to the cock in the tank, the other in the hole in the pipe which leads from the motor to the tank, illustrated in Figure 1 ee, thus completing the motor.

In conclusion it is suggested that the builder exercise careful judgment in both the making and assembling of the different parts of the motor in order to avoid unnecessary trouble and secure satisfactory results. After having constructed a motor as has just been described, the constructor may find it to his desire to construct a different type of motor for experimental purposes. The constructor therefore may find the descriptions of satisfactory compressed air motors in the following paragraphs of suggestive value.

COMPRESSED AIR MODELS

THE MC MAHON COMPRESSED AIR DRIVEN MONOPLANE

One of the latest developments in the field of model flying is the McMahon compressed air driven monoplane. This model was built to be used as either a tractor or pusher, but in view of its ability to balance more easily as a pusher most of the experiments have been carried out on this machine as a pusher. The machine in itself is simple and inexpensive to construct, the chief portion of the expense being involved in the making of the motor. By using the machine as a pusher a great deal of protection is afforded both the propeller and motor, and this protection helps to avoid damaging the propeller or motor, which would mean an additional expenditure for repairs, thus minimizing the cost of flying the model.

The frame has been made to accommodate both the tank and motor, and this is done by using two 30″ strips of spruce, each 1/4″ wide by 3/8″ deep, laid side by side, a distance of three inches apart, up to within 10″ of the front, as shown in the accompanying photograph. No braces are used on the frame, as the tank, when securely fastened between the frame, acts in that capacity.

The wings are made in two sections, each section measuring 24″ in span by 8″ in chord, consisting of two main spars, 3-16″ in diameter, one for the entering edge and one for the trailing edge. To these edges, at a distance of three inches apart, are attached bamboo ribs, 18 in all, each measuring 8″ in length by 1/8″ in width by 1-16″ thick. The wings are round at the tips, and have a camber of approximately one-half inch, but they are not set at an angle of incidence. Light China silk is used for covering and after being glued over the top of the wing frame is given two coats of dope to shrink and fill the pores of the fabric. A good "dope" for the purpose can be made from celluloid dissolved in banana oil. The wing sections are attached to the frame and braced by light wire. The forward wing or "elevator" is made in the same manner as the main wing, but should measure only 18″ x 3″. Instead of being made in two sections as the main wing, the forward wing is made in one piece.

The chassis is made by forming two V struts from strong steel wire sufficiently large enough so that when they are attached to the frame of the model the forward part will be 9″ above the ground. One V strut is securely fastened to either side of the frame, at a distance of 8″ from the front. A 7″ axle is fastened to the ends of these struts. On the axle are mounted two light wheels, each about 2″ in diameter. The chassis is braced by light piano wire.

The rear skid is made in the same manner as the forward skid, only that the ends of the struts are brought together and a wheel 1 inch in diameter is mounted at the bottom ends by means of a short axle. The struts are not

John McMahon and his compressed air driven monoplane

Frank Schober preparing his model for flight. Gauge to determine pressure of air may be seen in photograph

more than 7½″ long, thus allowing a slight angle to the machine when it is resting upon the ground.

The machine complete does not weigh over 7 ounces. The power plant used in connection with this model is of the two cylinder opposed motor type, with tank such as has just been described in the foregoing chapter.

The tank is mounted in the frame by drilling a 1-16″ hole through either end of the tank, through which a drill rod of this diameter can be inserted. About ¾ths of the drill rod should extend out on each side of the tank, to permit the fastening of the tank to the frame side members. This method of mounting the tank serves two purposes to a satisfactory degree. First, it permits secure fastening; second, as the rods are passed through the side and cap of the tank they help materially in preventing the caps from being blown off in the event of excessive pressure.

The McMahon Compressed Air Driven Biplane

In the McMahon model we find a very satisfactory type of compressed air driven model. On several occasions this model has made flights of over 200 feet with a duration of between 10 and 15 seconds, and the indications are that by the use of a more powerful motor the model can be made to fly a greater distance, with a corresponding increase of duration. The motor used in connection with the model is of the two cylinder opposed type, such as described in the foregoing paragraphs. The tank, however, is somewhat different in design from that just described, it having been made of 28 gauge sheet bronze, riveted every one-half inch. The two long bolts that hold the steel caps on either end of the tank also serve as attachments for the spars that hold the tank to the engine bed, as shown in diagram 18. The tank has been satisfactorily charged to a pressure of 200 lbs. per square inch, but only a pressure of 150 lbs. is necessary to operate the motor. The tank measures 10″ in length by 3″ in diameter and weighs 7 ounces.

The wings of this machine are single surfaced and covered with fiber paper. The top wing measures 42″ in span by 6″ in chord. The lower wing is 24″ by 6″. The wings have a total surface of 396 square inches and are built up of two 3-16″ dowel sticks, flattened to streamline shape. Only two sets of uprights separate the wings, thus adding to the streamline appearance of the machine.

Both tail and rudder are double surfaced and are built entirely of bamboo for lightness, the tail being made in the form of a half circle measuring 12″ by 8″. Steel wire is used on the construction of the landing chassis, the chassis being so designed as to render it capable of withstanding the most violent shock that it may possibly receive in landing. The propeller used in connection with the model is 14″ in diameter and has an approximate pitch of 18″.

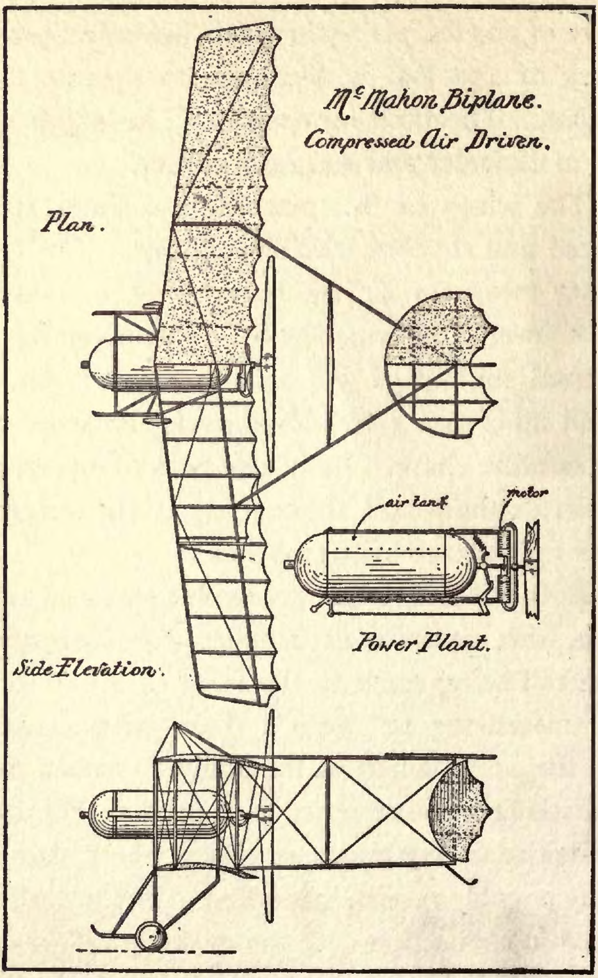

Mc Mahon Biplane.
Compressed Air Driven.
Plan.
air tank
motor
Power Plant.
Side Elevation.

Diagram 17

COMPRESSED AIR MOTORS

THE WISE COMPRESSED AIR MOTOR

ALTHOUGH of peculiar construction, the Wise rotary compressed air motor offers a very interesting design from a viewpoint of ingenuity. This motor embodies a number of novel features not hitherto employed in the construction of compressed air motors, and in view of the fact that the majority of compressed air motors are made on the principle of the opposed type, this motor suggests many possibilities for the rotary type motor.

The motor consists of five cylinders and weighs four ounces, including the propeller and mounting frame. On a pressure of 15 lbs. the motor will revolve at a speed of 1000 r.p.m. The connecting rods are fastened to the crankshaft by means of segments and are held by two rings, making it possible to remove any one piston without disturbing the others. This is done by simply removing a nut and one ring. The crank case is made from seamless brass tubing, into which the cylinders are brazed. The valve cage and cylinder heads are also turned separately and brazed. One ring only is used in connection with the pistons. The cylinders have a bore of 11-32″, with a piston stroke of 7-16″. In view of the fact that pull rods show a greater tendency to overcome centrifugal force, they are used instead of push rods to operate the valves. The crankshaft has but one post, which is uncovered in turn by each inlet pipe as the motor revolves. The "overhang" method is used to mount this motor to the model. With the exception of the valve springs, the entire motor, including the mounting frame and tank, is made of brass.

The Schober-Funk Compressed Air Motor

Two of the most enthusiastic advocates of the compressed air motor for use in model aëroplanes are Messrs. Frank Schober and Rudolph

Funk, both members of the Aëro Science Club. For a number of months both these gentlemen have experimented with compressed air motors of various designs, until they finally produced what is perhaps one of the most satisfactory rotary motors now in use, from a standpoint of simplicity and results.

As can be seen from the accompanying illustration, this little engine is remarkably simple in appearance. The motor complete, with equipment, weighs at the most but 14 ounces. The cylinders, three in all, are stamped from brass shells for strength and lightness. The pistons are made from ebony fiber. The cylinders have a bore of ⅝″, with a piston stroke of ½″. The crank case is built up from a small piece of brass tubing and is drilled out for lightness. The crankshaft is hollow, and is supported at the rear by a special bearing which acts as a rotary valve, admitting the intake through the crankshaft and permitting the exhaust to escape through a specially constructed bearing.

The tank is constructed of 30 gauge sheet bronze, wire wound, and fitted at the ends with spun brass caps. The actual weight of the engine alone is 2½ ounces, the tank and fittings weighing 11½ ounces, making the total weight of the complete power plant 14 ounces.

THE SCHOBER FOUR CYLINDER OPPOSED MOTOR

Another interesting type of compressed air motor that has been developed in America is the Schober four cylinder opposed motor. While this motor is different in appearance from most compressed air motors, it has been made to work satisfactorily and is consistent with the same high class construction that is displayed in most all of Mr. Schober's motors. The accompanying diagram 17 illustrates the method of operation of the four cylinder motor.

The crank case is constructed from four pieces of 24 gauge spring brass, substantially connected in the form of a rectangle, the top and bottom being left open. The front and

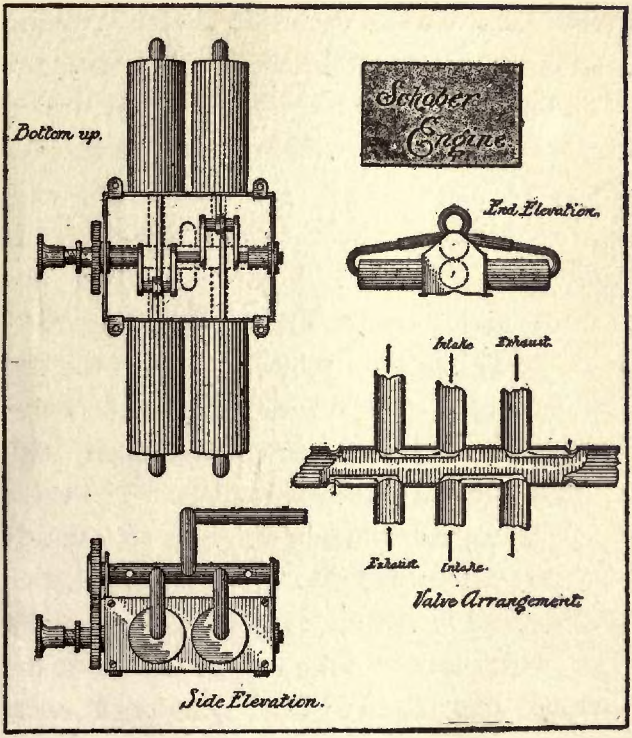
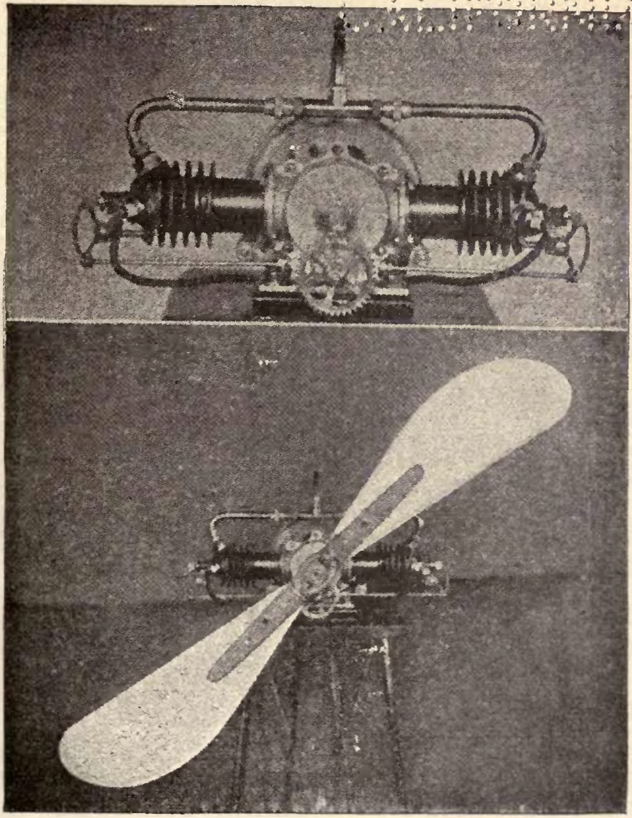

Bottom up.
Schober Engine
End Elevation.
Intake
Exhaust.
Exhaust.
Intake.
Valve Arrangement.
Side Elevation.

Diagram 18

rear walls have flanges which engage the inside of the side walls and are secured thereto by four small screws on each side, thereby making it an easy matter to take the crank case apart.

The four cylinders are made from drawn brass shells and have a bore of ½" and stroke of ½". The pistons are made of solid red fiber. The two-throw crank-shaft is built up of steel with brass webs. The bearings are of steel. The valves, being overhead, are driven by a gear mounted at the end of the crankshaft, the gear driving the valve shaft by means of a gear on that shaft, with which the crankshaft gear meshes. The valve arrangement, as shown in diagram 18, consists of four recesses cut into the valve shaft, two of which allow the air to pass from the inlet pipes, which lead into the valve chamber at the center of same, to two of the cylinders at once, while the other two recesses allow the exhaust to pass from openings in the sides of the valve chamber.

The cylinders are secured to the side plates



The interesting horizontal-opposed Jopson gasoline motor for model aëroplanes. The top photograph shows the half-speed shaft and the arrangement of the valve mechanism. This engine is air cooled, develops 1 h.p. at 1,500 r.p.m., and weighs 7½ lbs., including gasoline tank and propeller. The bottom view shows the engine with propeller *in situ*. Courtesy *Flight*.

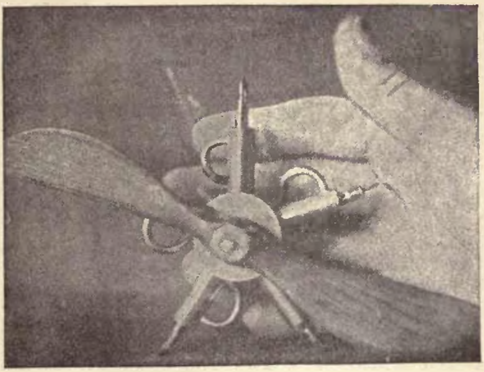
of the crank case so that when those side plates are removed, the cylinders are removed with them. The pipes are detachable at their centers; small pipes running to the heads of the cylinders extending into the larger pipes which run to the valve chamber. This arrangement is shown in the end view of the engine. A 17″ propeller is used in connection with this engine.

GASOLINE MOTORS

THE JOPSON 1 H. P. GASOLINE MOTOR FOR MODEL AËROPLANES

DURING the past few years several attempts have been made, both in this country and abroad, to produce a reliable gasoline motor for model aëroplane work, but mostly without any degree of success. The reason for this inability, no doubt, is due to the scarcity of small working parts sufficiently light and at the same time reliable. The engine described herewith, designed by Mr. W. G. Jopson, a member of the Manchester Aëro Club, England, is one of the few that have been made to work satisfactorily.

As the accompanying diagrams 19 and 20 and photograph show, the engine is of the four-cycle, horizontal opposed type, having two cast-iron cylinders of 1¼″ bore and 1⅜″ stroke. Each cylinder is cast in one piece, and as the



Wise five cylinder rotary compressed air motor

Schober-Funk five cylinder rotary motor

engine is air cooled, they are cast with radiating fins. One h.p. is developed at 1500 r.p.m. The total weight of the engine, gasoline tank and propeller is 7½ lbs. In preparing the design of this motor, the designs of similar full-sized aëro motors were followed as far as possible. The pistons are similar to those used on large aëromotors and are fitted with two rings; the crankshaft is turned out of two inch special bar steel, and is carried in two phosphor-bronze bearings. There is no special feature about the connecting rods, these being of the standard type, but very strong and light. To enable the two cylinders to be exactly opposite one another, the connecting-rods are offset in the pistons and are connected to the latter by gudgeonpins. The aluminum crank-case is extremely simple, being cylindrical and vertically divided. The inlet valves are automatic, the exhaust valves being mechanically operated; the cam-shaft is driven from the main shaft by two-to-one gearing. To assist the exhaust, and also the cooling, small holes

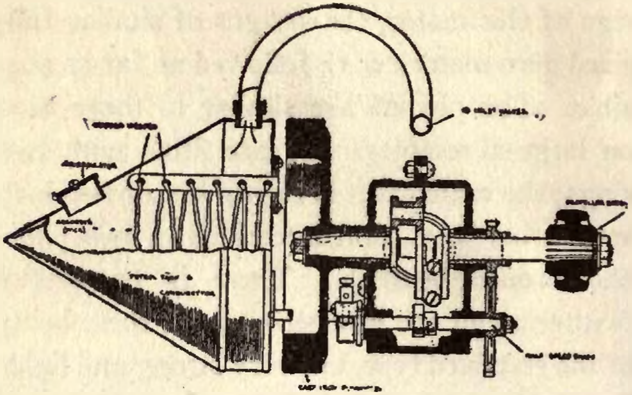


Diagram 19

Sectional elevation of the 1 h.p. Jopson gasoline motor for models. The disposition of the gasoline tank and wick carburettor is particularly noteworthy. It will be seen that metal journals are provided for the crank-shaft, which is turned out of 2-inch bar steel. Courtesy *Flight*.

are drilled round the cylinder in such a position that when the piston is at the inner end of its stroke, these holes are uncovered, thus permitting the hot exhaust to escape, and so relieve the amount passing through the exhaust valves. The commutator is also driven off the camshaft, as shown in the drawing. No distributor is fitted to the commutator, as small ones are somewhat troublesome and very light coils are obtainable at a reasonable price.

The gasoline tank is made of copper in stream-line form, and is usually fitted to the back of the crankcase, thus reducing the head resistance, but if desired it can be fitted in any other position. The action of the carburettor can be easily seen from the drawings; it is of the surface type and much simpler, lighter and quite as efficient as the spray type. Specially light and simple spark plugs are used, that give very little trouble. The propeller used in connection with this motor is somewhat out of the ordinary, having been specially designed for this engine, and patented. The propeller is made entirely of aluminum and has a variable pitch, this being easily obtainable, as the blades are graduated so that any desired pitch, within certain limits, may be given at once. The results of a series of tests on a 30 inch propeller are shown on the accompanying chart, and from it the thrust as certain speeds with a certain pitch can be obtained. Taking the engine running at 1540 r.p.m. with a pitch of 15″, the thrust comes out at 9½ lbs., or more than the weight of the motor and accessories.

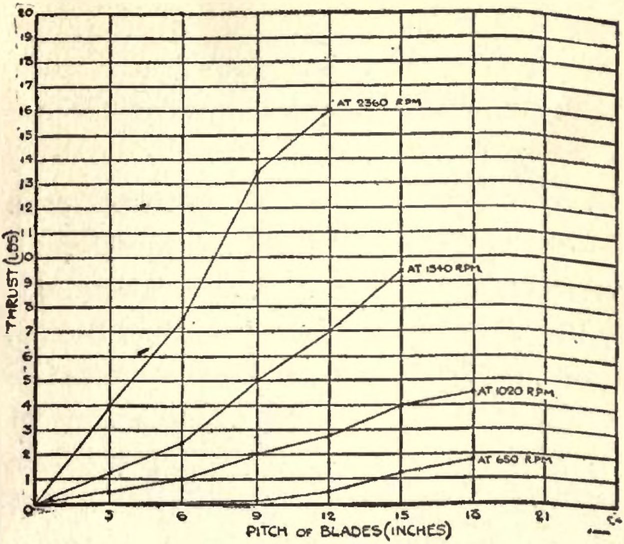


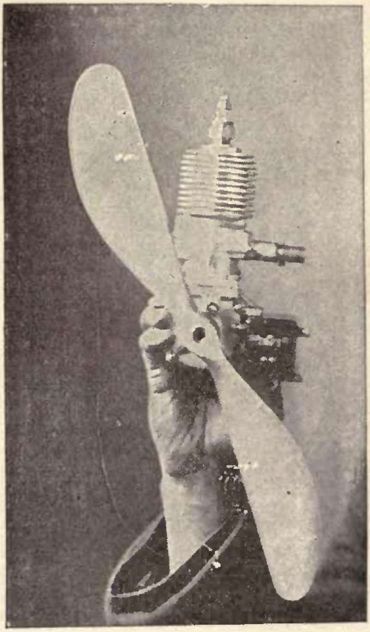
Diagram 20

Diagram of results obtained from tests of the 1 h.p. Jopson model gasoline motor, showing the thrust in pounds at varying speeds with propellers of different pitch. Courtesy *Flight*

THE MIDGET AERO GASOLINE MOTOR

ALTHOUGH numerous model constructors in America are experimenting with model gasoline motors, the Midget Gasoline Motor, the product of the Aëro Engine Company, Boston, Massachusetts, is perhaps the most satisfactory up to the present time. An engine of this type was used by Mr. P. C. McCutchen of Philadelphia, Pennsylvania, in his 8 foot Voisin Type Bi-plane Model, for which he claims a number of satisfactory flights.

The motor is made from the best iron, steel, aluminum and bronze and the complete weight including a special carburettor, spark plug and spark coil is 2½ lbs. From the top of the cylinder head to the bottom of the crank case the motor measures 7″. It is possible to obtain from this motor various speeds from 400 to



The Midget ½ H. P. gasoline motor

2700 r.p.m., at which speed it develops ½ h.p. The propeller used in connection with this motor measures 18″ in diameter and has a 13″ pitch.

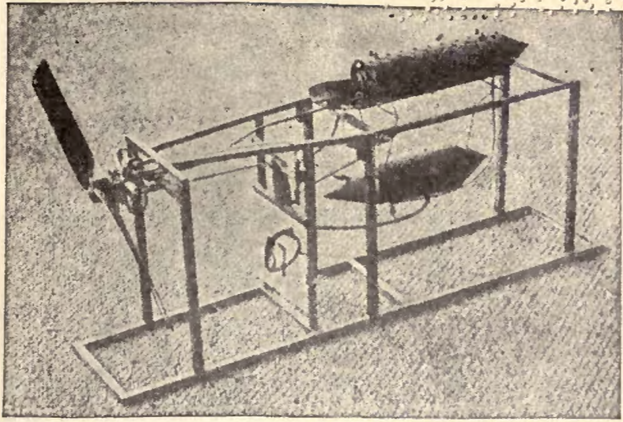
It might be of interest to know that one of the parties responsible for the development of this motor is Mr. H. W. Aitken, a former model maker and who is now connected with one of the largest aëromotor manufacturing companies in America.

STEAM POWER PLANTS

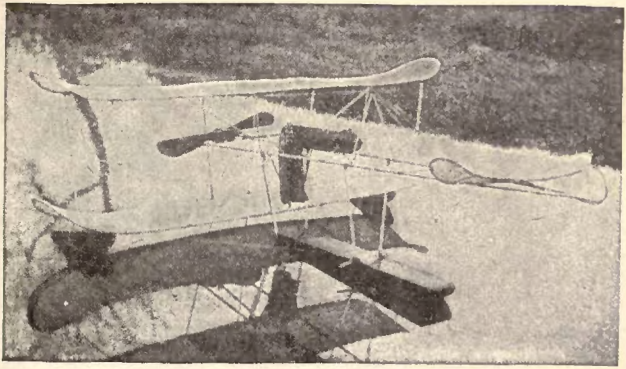
Aside from the compressed air motor there is the steam driven motor which has been used abroad to a considerable degree of success. Owing to the difficulty in constructing and operating a steam driven motor, very few model flyers in America have devoted any attention to the development of this motor as a means of propulsion for model aëroplanes. But irrespective of the limitations of the steam motor a great deal of experimentation has been carried on in England, and without doubt it will soon be experimented with in America. Perhaps one of the most successful steam power plants to have been designed since the development of the Langley steam driven model, is the Groves type of steam power plant, designed by Mr. H. H. Groves, of England. On one occasion several flights were made with a model driven by a small steam engine of the Groves type weighing 3 lbs. The model proved itself capable of rising from the ground under its own power and when launched it flew a distance of 450 feet. This is not a long flight when compared with the flight made by Prof. Langley's steam driven model on November 28, 1896, of three-quarters of a mile in 1 minute and 45 seconds, but the size of the models and also that Mr. Groves' model only made a duration of 30 seconds, must be considered. The model was loaded 12 ounces to the square foot and had a soaring velocity of some 20 m.p.h. The total weight of the power plant was 1½ lbs. Propeller thrust 10 to 12 ounces. The total weight of the model was 48 ounces. The type of steam plant used in connection with this model was of the flash boiler, pressure fed type, with benzoline for fuel.

Mr. Groves has done considerable experimenting with the steam driven type power plant. Many of the designs used in the construction of steam plants for models are taken from his designs. A Groves steam power plant is employed in one of Mr. V. E. Johnson's (Model Editor of *Flight*) model hydroaëroplanes, the first power-driven, or "mechanically driven" model hydroaëroplane (so far as can be learned) to rise from the surface of the water under its own power. This model has a total weight of 3 lbs. 4 ounces.

Another advocate of the steam driven type model is Mr. G. Harris, also of England. Several good flights were made by Mr. Harris with his pusher type monoplane equipped with a steam driven motor. As a result of his experiments he concluded that mushroom valves with a lift of 1-64 part of an inch were best, used in connection with the pump, and at least 12 feet of steel tubing should be used for boiler coils. The first power plant constructed by Mr. Harris contained a boiler coil 8 feet long, but after he had replaced this coil with one 12 feet long, irrespective of the fact that the extra length of tube weighed a couple of ounces, the thrust was increased by nearly a half pound.



An English steam power plant for model aëroplanes. Courtesy *Flight.*

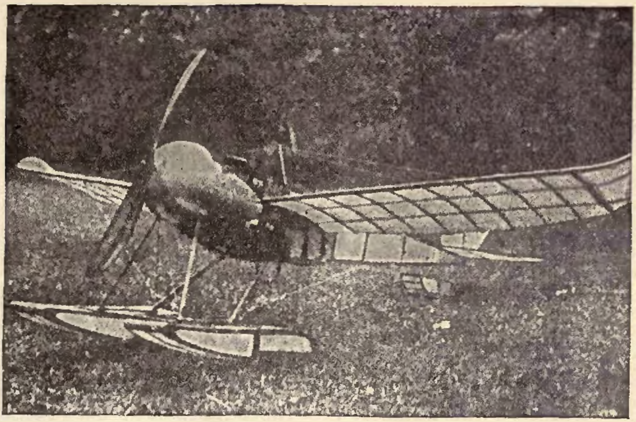


Model hydroaëroplane owned by V. E. Johnson, Model Editor of *Flight,* England, equipped with an H. H. Groves steam power plant. This model is the first power driven—as far as can be learned—to rise from the surface of the water under its own power. Courtesy *Flight.*

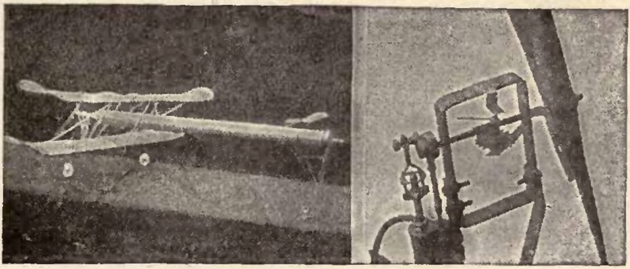
The principal parts used in Mr. Harris's steam power plant was an engine of the H. H. Groves type, twin cylinder, 7/8" bore with a piston stroke of 1/2". The boiler was made from 12" of 3-16" x 20" G. steel tubing, weighing 10.5 ounces. The blow lamp consisted of a steel tube, 5-32" x 22" G. wound round a carbide carrier for a nozzle. The tank was made of brass 5-1000" thick. The pump, 7-32" bore, stroke variable to 1/2", fitted with two non-return valves (mushroom type) and was geared down from the engine 4.5 to 1.

The Langley steam driven model, of which so much has been said, and which on one occasion flew a distance of one-half mile in 90 seconds, had a total weight of 30 lbs., the motor and generating plant constituting one-quarter of this weight. The weight of the complete plant worked out to 7 lbs. per h.p. The engine developed from 1 to 1 1/2 h.p. A flash type boiler was used, with a steam pressure of from 150 to 200 lbs., the coils having been made of copper. A modified naphtha blow-torch, such as is used by plumbers, was used to eject a blast or flame about 2000 Fahrenheit through the center of this coil. A pump was used for circulation purposes. With the best mechanical assistance that could be obtained at that date, it took Professor Langley one year to construct the model.

About ten months after Langley's results, some experiments were carried out by the French at Carquenez, near Toulon. The model used for the experiments weighed in total 70 lbs., the engine developing more than 1 h.p. As in the Langley case, twin propellers were used, but instead of being mounted side by side, they were mounted one in front and the other behind. The result of these experiments compared very poorly with Langley's. A flight of only 462 feet was made, with a duration of a few seconds. The maximum velocity is stated to have been 40 m.p.h. The span of this model was a little more than 6 meters, or about 19 feet, with a surface of more than 8 square meters, or about 80 square feet.



An English hydroaeroplane of tractor design equipped with steam power plant. Courtesy *Flight.*



On the right an English 10 oz. Compressed air driven biplane. On the left, the engine shown fitted with a simple speedometer for experimental purposes. Courtesy *Flight.*

WORLD'S MODEL FLYING RECORDS

(Twin Propeller Pusher Type Models)

MONOPLANE

Year 1916. Thomas Hall (America), hand launched, distance 5337 feet.

Year 1915. Wallace A. Lauder (America), hand launched, distance 3537 feet.

Year 1915. Wallace A. Lauder (America), hand launched, duration 195 seconds.

Year 1914. Fred Watkins (America), rise off ground, distance 1761 feet.

Year 1914. J. E. Louch (England), rise off ground, duration 169 seconds.

Year 1915. E. C. Cook (America), rise off water, duration 100 seconds.

(Twin Propeller Tractor Type)

MONOPLANE

Year 1913. Harry Herzog (America), rise off water, duration 28 seconds.

(Twin Propeller Pusher Type)

BIPLANE

Year 1915. A. H. Wheeler (America), rise off ground, duration 143 seconds.

(Single Propeller Pusher Type)

MONOPLANE

Year 1914. J. E. Louch (England), hand launched, duration 95 seconds.

Year 1914. W. E. Evans (England), rise from ground, distance 870 feet.

Year 1914. J. E. Louch (England), rise from ground, duration 68 seconds.

Year 1914. L. H. Slatter (England), rise from water, duration 35 seconds.

(Single Propeller Tractor Type)

MONOPLANE

Year 1915. D. Lathrop (America), hand launched, distance 1039 feet.

Year 1915. D. Lathrop (America), hand launched, duration 240 seconds.

Year 1914. C. D. Dutton (England), rise from ground, distance 570 feet.

Year 1914. J. E. Louch (England), rise from ground, duration 94 seconds.

Year 1915. L. Hittle (America), rise from water, duration 116 seconds.

(Single Propeller Tractor Type)

BIPLANE

Year 1915. Laird Hall (America), rise from ground, duration 76 seconds.

(FLYING BOAT TYPE)

MONOPLANE

Year 1915. Robert La Tour (America), rise from water, duration 43 seconds.

(FLYING BOAT TYPE)

BIPLANE

Year 1914. C. V. Obst (America), rise from water, duration 27 seconds.

(MECHANICAL DRIVEN MODEL)

Year 1914. D. Stanger (England), rise from ground, duration 51 seconds.

(All British records are quoted from *Flight*)

DICTIONARY OF AËRONAUTICAL TERMS

A

Aërodrome—A tract of land selected for flying purposes.

Aërodynamics—The science of Aviation, literally the study of the influence of air in motion.

Aërofoil—A flat or flexed plane which lends support to an aëroplane.

Aëronaut—One engaged in navigating the air.

Aëronautics—The science of navigating the air.

Aëroplane—A heavier than air machine supported by one or more fixed wings or planes.

Aërostatics—The science of aërostation, or of buoyancy caused by displacement, ballooning.

Aërostation—The science of lighter than air or gas-born machines.

Aileron—The outer edge or tip of a wing, usually adjustable, used to balance or stabilize.

Airship—Commonly used to denote both heavier and lighter than air machines; correctly a dirigible balloon.

Angle of Incidence—The angle of the wing with the line of travel.

AREA—In the case of wings, the extent of surface measured on both the upper and lower sides. An area of one square foot comprises the actual surface of two square feet.

ASPECT RATIO—The proportion of the chord to the span of a wing. For example if the wing has a span of 30 inches and a chord of 6 inches the aspect ratio will be 5 or $\frac{\text{span}}{\text{Chord}}$.

AUTOMATIC STABILITY—Stability secured by fins, the angle of the wings and similar devices.

AVIATOR—One engaged in Aviation.

AVIATION—The science of heavier than air machines.

ANGLE OF BLADE—The angle of the blade of a propeller to the axis of the shaft.

B

BALANCER—A plane or other part intended for lateral equilibrium.

BEARING BLOCK—Used in connection with the mounting of propellers on model aëroplanes. Made from wood and metal.

BRACE—Strip of bamboo or other material used to join together the frame side members. Also used in joining other parts of a model.

BIPLANE—An aëroplane or model aëroplane with two wings superposed.

BODY—The main framework supporting the wing or wings and the machinery.

BANKING—The lateral tilting of an aëroplane when taking a turn.

C

CAMBER—The rise of the curved contour of an arched surface above the Chord Line.

CENTER OF GRAVITY—The point at which the aëroplane balances.

CENTER OF PRESSURE—The imaginary line beneath the wing at which the pressure balances.

CHASSIS (CARRIAGE)—The part on which the main body of an aëroplane or model aëroplane is supported on land or water.

CHORD—The distance between the entering and trailing edges of a wing.

D

DECK—The main surface of a biplane or multiplane.

DIRECTIONAL CONTROL—The ability to determine the direction of the flight of an aëroplane.

DIRIGIBLE—A balloon driven by power.

DOPE—A coating for wings.

DOWN WING—With the wind.

DRIFT—The resistance of the wing to the forward movement.

DIHEDRAL ANGLE—The inclination of the wings to each other usually bent up from the center in the form of a flat V.

E

ELEVATOR—The plane or wing intended to control the vertical flight of the machine.

ENGINEER—One who controls the power, driving the machinery.

ENTERING EDGE *or* LEADING EDGE—Front edge or edge of the surface upon which the air impinges.

EQUILIBRATOR—A plane or other contrivance which makes for stability.

F

FIN—A fixed vertical plane.

FLEXED—A wing is said to be flexed when it curves upward forming an arc of a circle.

FLYING STICK—Name applied to ordinary A type and single stick models.

FLYING MACHINE—Literally a form of lighter than air craft; a gas-borne airship.

FLYING BOAT—A hull or large float used in connection with an aëroplane to enable its rising from and alighting upon the surface of the water.

FRAME—A single or double stick structure to which all parts of a model are attached. Three or more sticks are sometimes employed in the construction of a frame. However, the usual number is two, joined together in the form of letter "A."

FRAME HOOKS—The looped ends of a piece of wire attached to the point of the frame to accommodate the S hooks attached to the rubber strands.

FRAME SIDE MEMBERS—Two main sticks of an A type frame.

FUSELAGE—The body or framework of an aëroplane.

G

GLIDER—An aëroplane without motive power.

GUY—A brace, usually a wire or cord used for tuning up the aëroplane.

GROSS WEIGHT—The weight of the aircraft, comprising fuel, lubricating oils and the pilot.

GYROSCOPE—A rotating mechanism for maintaining equilibrium.

GAP—The vertical distance between the superposed wings.

H

HANGAR—A shed for housing an aëroplane.

HARBOR—A shelter for aircraft.

HEAVIER THAN AIR—A machine weighing more than the air it displaces.

HELLICOPTER—A flying machine in which propellers are utilized to give a lifting effect by their own direct action on the air. In aviation the term implies that the screw exerts a direct lift.

HELMSMAN—One in charge of the steering device.

HYDROAËROPLANE—An aëroplane with pontoons to enable its rising from the surface of the water. Known as hydro in model circles.

K

KEEL—A vertical plane or planes arranged longitudinally either above or below the body for the purpose of giving stability.

L

LATERAL STABILITY—Stability which prevents side motion.

LOADING—The gross weight divided by the supporting area measured in square feet.

LONGITUDINAL STABILITY—Stability which prevents fore and aft motion or pitching.

LONGERONS—Main members of the fuselage. Sometimes called longitudinals.

M

MAST—A perpendicular stick holding the stays or struts which keep the wings rigid.

MODEL AËROPLANE—A scale reproduction of a man-carrying machine.

MECHANICAL POWER—A model driven by means other than rubber strands such as compressed air, steam, gasoline, spring, electricity and so forth is termed a mechanical driven model. The power used is termed mechanical power.

MOTIVE POWER—In connection with model aëroplanes a number of rubber strands evenly strung from the propeller shaft to the frame hooks which while unwinding furnish the necessary power to propel the model.

MAIN BEAM—In connection with model aëroplanes a long stick which is secured to the under side of the wing frame at the highest point in the curve of the ribs adding materially to the rigidity of the wing.

MONOPLANE—An aëroplane or heavier than air machine supported by a single main wing which may be formed of two wings extending from a central body.

MOTOR—A contrivance for generating driving power.

MULTIPLANE—An aëroplane with more than four wings superposed.

MOTOR BASE—Main stick used for frame of single stick model.

N

NACELLE—The car of a dirigible balloon, literally a cradle. Also applied to short body used in connection with aëroplanes for the accommodation of the pilot and motor.

NET WEIGHT—Complete weight of the machine without pilot, fuel or oil.

O

ORNITHOPTER—A flapping wing machine which has arched wings like those of a bird.

ORTHOGONAL—A flight maintained by flapping wings.

OUTPIGGERS—Members which extend forward or rearward from the main planes for the purpose of supporting the elevator or tail planes of an aëroplane.

P

PLANE—A surface or wing, either plain or flexed, employed to support or control an aëroplane.

PILOT—One directing an aëroplane in flight.

PITCH—Theoretical distance covered by a propeller in making one revolution.

PROPELLER—The screw used for driving an aëroplane.

PROPELLER BEARINGS—Pieces of bronze tubing or strips of metal formed to the shape of the letter "L" used to mount propellers. Also made from blocks of wood.

PROPELLER BLANK—A block of wood cut to the design of a propeller.

PROPELLER SPAR(S)—The heavy stick or sticks upon which the bearing or bearings of a single or twin propeller model are mounted.

PROPELLER SHAFT—A piece of wire which is run through the hub of the propeller and tubing in mounting the propeller.

PYLON—Correctly, a structure housing a falling weight used for starting an aëroplane, commonly a turning point in aëroplane flights.

PUSHER—An aëroplane with the propeller or propellers situated in back of the main supporting surfaces.

Q

QUADRUPLANE—An aëroplane with four wings superposed.

R

RUDDER—A plane or group of planes used to steer an aëroplane.

RUNNER—Strip beneath an aëroplane used for a skid.

Running Gear *or* Landing Gear—That portion of the chassis consisting of the axle, wheels and shock absorber.

Rib—Curved brace fastened to the entering and trailing edges of a wing.

S

Scale Model—A miniature aëroplane exactly reproducing the proportions of an original.

Spar—A mast strut or brace.

Side Slip—The tendency of an aëroplane to slide or slip sideways when too steep banking is attempted.

Stability—The power to maintain an even keel in flight.

Starting Platform—A runway to enable an aëroplane to leave the ground.

Surface Friction—Resistance offered by planes or wings.

Slip—The difference between the distance actually traveled by a propeller and that measured by the pitch.

Soaring Flight—A gliding movement without apparent effort.

Sustaining Surface—Extent of the wings or planes which lend support to an aëroplane.

Span (Spread)—The dimension of a surface across the air stream.

Streamline—Exposing as little surface as possible to offer resistance to air.

SKIDS—In connection with model aëroplanes, steel wires or strips of bamboo allowed to extend below the frame to protect the model in landing and to permit its rising off the ground or ice.

S OR MOTOR HOOKS—A piece of wire bent in a double hook to resemble the letter "S." One end to be attached to the frame hook, the other serving as accommodation for the rubber strands.

T

TAIL—The plane or planes, both horizontal and vertical, carried behind the main planes.

TANDEM—An arrangement of two planes one behind the other.

THRUST—The power exerted by the propeller of an aëroplane.

TENSION—The power exerted by twisted strands of rubber in unwinding.

TRACTOR—An aëroplane with the propeller situated before the main supporting surfaces.

TRIPLANE—An aëroplane with three wings superposed.

TRAILING EDGE—The rear edge of a surface.

TORQUE—The twisting force of a propeller tending to overturn or swerve an aëroplane sideways.

U

UP WIND—Against the wind.

W

WAKE—The churned or disturbed air in the track of a moving aëroplane.

WASH—The movement of the air radiating from the sides of an aëroplane in flight.

WINGS—Planes or supporting surfaces, commonly a pair of wings extending out from a central body.

WINDER—An apparatus used for winding two sets of rubber strands at the same time in opposite directions or one at a time. Very often made from an egg beater or hand drill.

WARPING—The springing of a wing out of its normal shape, thereby creating a temporary difference in the extremities of the wing which enables the wind to heel the machine back again into balance.

ABREVIATIONS

H. P. Horse Power.
R. P. M. Revolutions per minute.
H. L. Hand launched.
R. O. G. Rise off ground model.
R. O. W. Rise off water model.
M. P. H. Miles per hour.

THE END