Model Aeroplanes

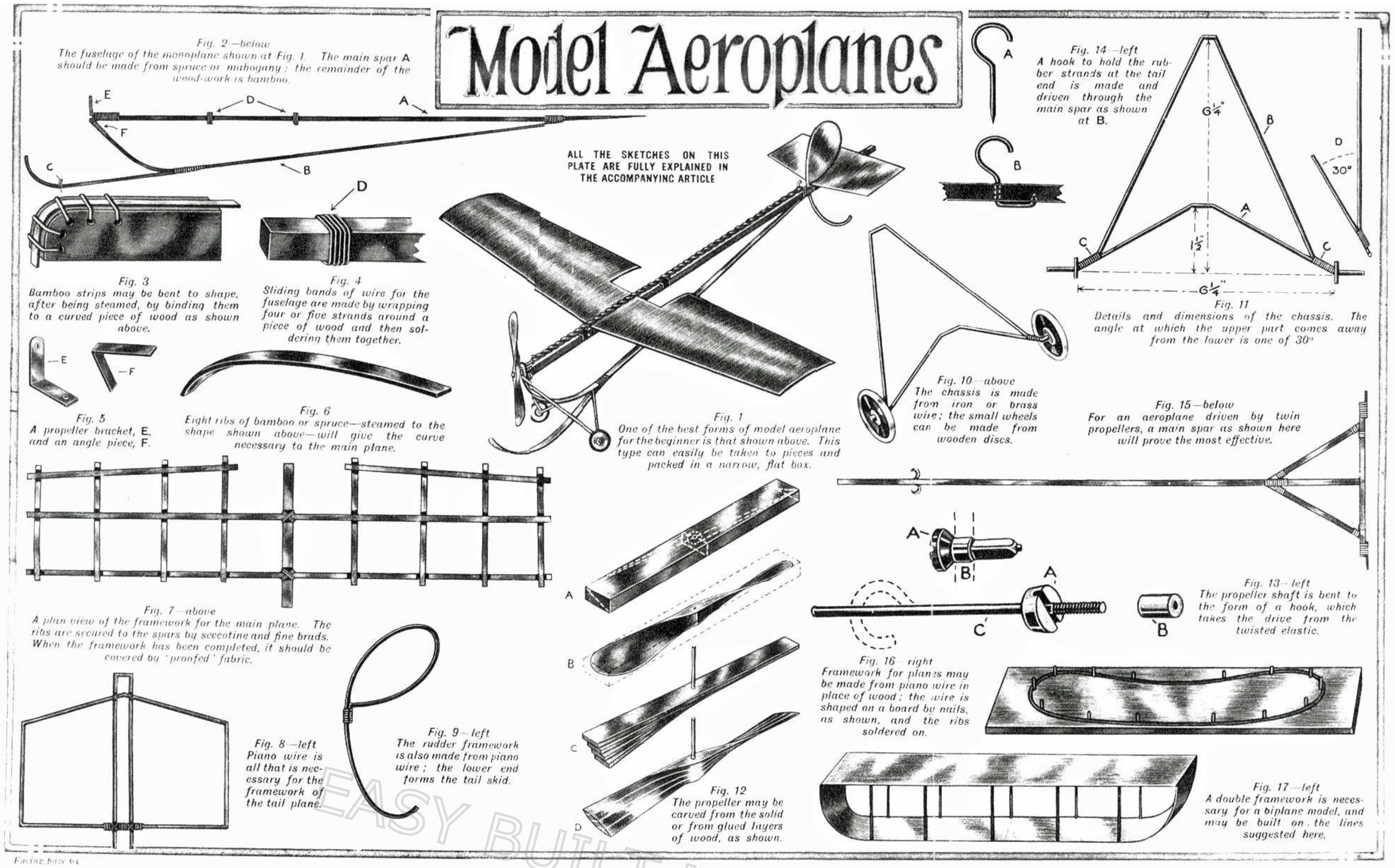

Fig. 2—below The fuselage of the monoplane shown at Fig. 1. The main spar A should be made from spruce or mahogany; the remainder of the wood-work is bamboo.

Fig. 3 Bamboo strips may be bent to shape, after being steamed, by binding them to a curved piece of wood as shown above.

Fig. 4 Sliding bands of wire for the fuselage are made by wrapping four or five strands around a piece of wood and then soldering them together.

Fig. 5 A propeller bracket, E, and an angle piece, F.

Fig. 6 Eight ribs of bamboo or spruce—steamed to the shape shown above—will give the curve necessary to the main plane.

Fig. 7—above A plan view of the framework for the main plane. The ribs are secured to the spars by seccotine and fine brads. When the framework has been completed, it should be covered by 'proofed' fabric.

Fig. 8—left Piano wire is all that is necessary for the framework of the tail plane.

Fig. 9—left The rudder framework is also made from piano wire; the lower end forms the tail skid.

Fig. 1 One of the best forms of model aeroplane for the beginner is that shown above. This type can easily be taken to pieces and packed in a narrow, flat box.

Fig. 12 The propeller may be carved from the solid or from glued layers of wood, as shown.

Fig. 14—left A hook to hold the rubber strands at the tail end is made and driven through the main spar as shown at B.

Fig. 10—above The chassis is made from iron or brass wire; the small wheels can be made from wooden discs.

Fig. 11 Details and dimensions of the chassis. The angle at which the upper part comes away from the lower is one of 30°

Fig. 15—below For an aeroplane driven by twin propellers, a main spar as shown here will prove the most effective.

Fig. 13—left The propeller shaft is bent to the form of a hook, which takes the drive from the twisted elastic.

Fig. 16 right Framework for planes may be made from piano wire in place of wood; the wire is shaped on a board by nails, as shown, and the ribs soldered on.

Fig. 17—left A double framework is necessary for a biplane model, and may be built on the lines suggested here.

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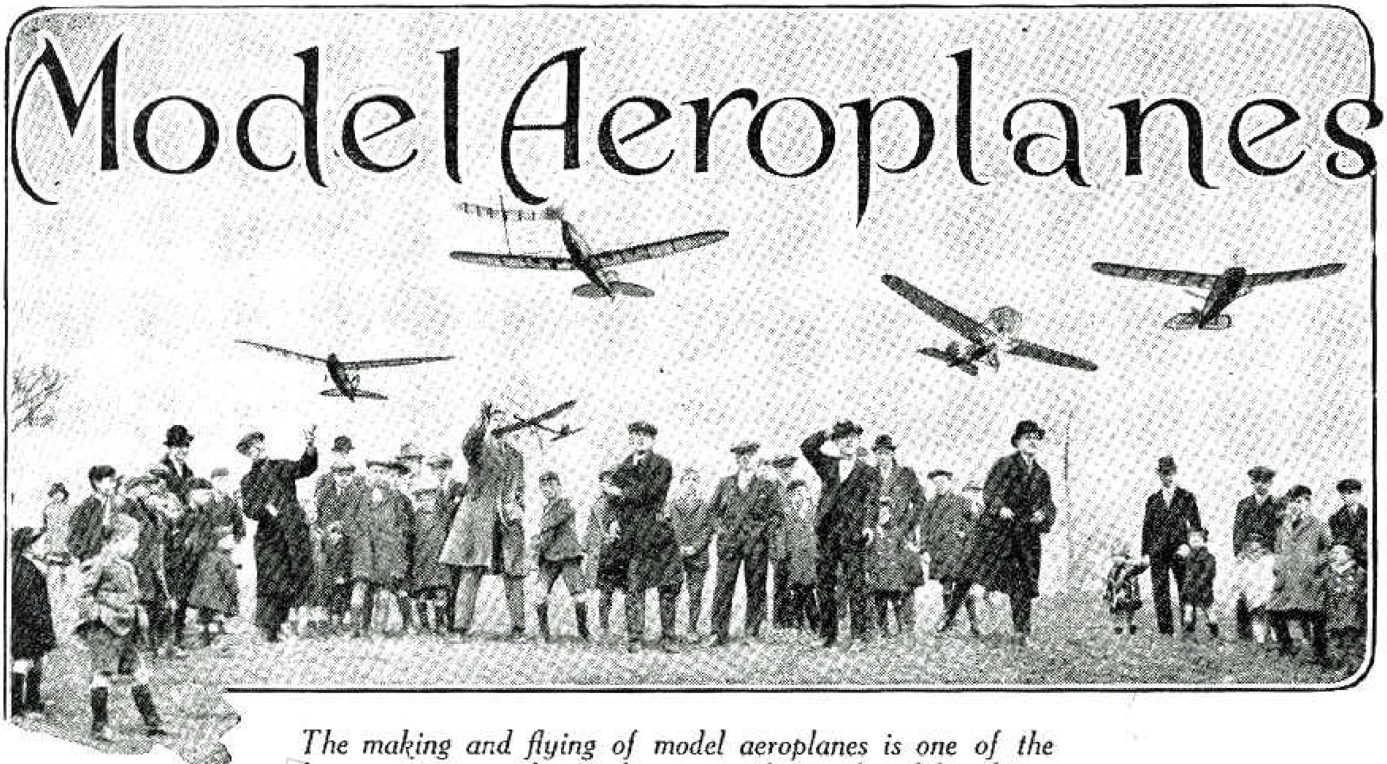


The making and flying of model aeroplanes is one of the least expensive and most fascinating forms of model making.

A CERTAIN amount of skill is required in the construction of model aeroplanes, but all the work can be done with a few tools. There is considerable scope for experimenting, and it may be noted that many of the well-known makers of the high-powered aeroplanes of the present time were enthusiastic model aeroplane makers in their younger days.

Before attempting the construction of any form of model aeroplane it is advisable to have a clear understanding of the simple principles which govern the flight of aeroplanes. Those who have flown kites will have realised that they are heavier than air, and that it is the pressure of the wind which causes them to rise, and that the pull of the string causes them to remain in the air. The inclination of a kite is an important factor in its flight, and for every kite there is a particular inclination, called the angle of incidence; generally, this angle is found by experiment.

A somewhat similar effect is seen in the flight of an aeroplane, but instead of allowing the pressure of the wind to lift the aeroplane—by continually pushing it back against the restraining effect of a string as in a kite—a propeller is used to push the plane, or planes, against the wind; by altering the angle of incidence, upward, level, and downward flights are possible. The area of the surface of an aeroplane and the angle of its inclination to the air depends mainly on the speed at which it is driven, and, as a general rule, the higher the speed the smaller the area and the angle of incidence. This is not an accurate theory, but it is sufficient for the model maker to begin with.

It is recognised that the aeroplane must of necessity be heavier than air, and that the heavier it is the greater the power required to drive it through the air. In model aeroplanes, the motive power is limited to either a steam plant driven by superheated steam, a compressed air plant, or a simple elastic motor. The first two are expensive to make and require large models to carry them; the elastic motor is light, inexpensive, easily renewed, and quite effective for short distances. As it is impossible to avoid accidents which may damage parts of the model, it is much the better plan to use a form of construction and a power plant which is easily renewed at a minimum of cost and time.

One of the best forms of model aeroplane for the beginner is the monoplane, illustrated at Fig. 1 on the accompanying plate; all the material for its construction is readily obtainable, and the parts are detachable sufficiently to render the model portable; it can be packed in a flat box measuring 27 in. by 8 in. by $1\frac{3}{4}$ in.

The main advantage of this particular design is that duplicate parts can be carried, so that in the event of breakage, flying experiments need not be interrupted. Exact measurements are given of each detail and, in addition, suggestions for experimenting in the construction of the essential parts of model aeroplanes will be outlined. These parts are the plane, fuselage or framework, chassis or carriage, rudder, propeller and motor.

The best part to begin with is the fuselage, shown separately at Fig. 2. The main spar, A, is made from a 24-in. length of selected spruce or mahogany. It must be free from knots, and quite straight in the grain. First of all, plane it to $\frac{1}{4}$ in. square, and, at a distance of 4 in., taper one end to $\frac{1}{16}$ in., using the plane on one side only. A strip of fine glasspaper should be stretched across a small block of square-section wood, and rubbed along each side of the spar, from one end to the other, in order to make it quite smooth.

The spring underneath at B, and the skid at C, are made from bamboo, and in order to provide the material a 21-in. length of fairly large diameter bamboo should be split and planed down to $\frac{1}{4}$ in. by $\frac{1}{16}$ in., and a 9-in. length planed down to the same width but a little thicker. One end of each of these pieces should be tapered to a fine edge from about $\frac{3}{4}$ in. from the end.

The next step is to bend the ends of the bamboo strips. This is done by holding them in front of the spout of a kettle when the water is boiling; the steam will soften the wood, and then it should be tied to pieces of wood shaped to a sharper curve than actually needed, to allow for the natural inclination of the wood to resume its original shape. This is shown at Fig. 3.

The bamboo is now rubbed over with fine glasspaper. The bamboo, as well as the spar, should be coated with size, lightly rubbed down again when dry, and again sized. After the second coat of size has dried, rub lightly with some used glasspaper and then coat with shellac varnish; this is made by dissolving shellac in methylated spirit. French polish can be used instead, if it can be obtained.

Two sliding bands, D, made of wire, are now slipped on the spar. The method of forming the bands is to wrap two or three strands of some fairly fine wire—about No. 20 S.W.G.—around a $\frac{1}{16}$ in. by $\frac{1}{4}$ in. strip of wood, and then solder them close together, as at Fig. 4.

Next, prepare the propeller bracket, E, from a $1\frac{5}{8}$ in. by $\frac{1}{4}$ in. strip of hard brass, about No. 18 S.W.G. The ends are rounded and drilled with a No. 18 gauge hole, and then bent as at Fig. 5. An angle piece, F, $1\frac{1}{2}$ in. by $\frac{1}{4}$ in., is cut from a strip of tin and bent to the angle formed by the curved piece B and the strut A.

The several parts of the fuselage can now be bound together, using strong linen thread or fine twine. First bind up the skid, C, to the spring length, B; the end of the skid should be $14\frac{1}{2}$ in. from the end of the length B, and bound for a distance of $1\frac{1}{2}$ in.

Rub some seccotine on the thread as it is wrapped, and pull the end of the thread through the last two strands when finished. The long end of the B length should now be bound to the tapered end of the strut A, beginning $4\frac{1}{4}$ in. from the end and continuing with seccotined thread for about $\frac{3}{4}$ in. The long side of the propeller bracket, E, should be attached to the end of the spar with a fine brad; the angle piece, F, should be bound $\frac{1}{8}$ in. from the end of B and then bound tightly to the spar, leaving about $\frac{1}{4}$ in. of the latter exposed. The distance between the hole in the top of the propeller bracket and the lowest portion of the curve of the skid should be 4 in. The fuselage is now placed on one side.

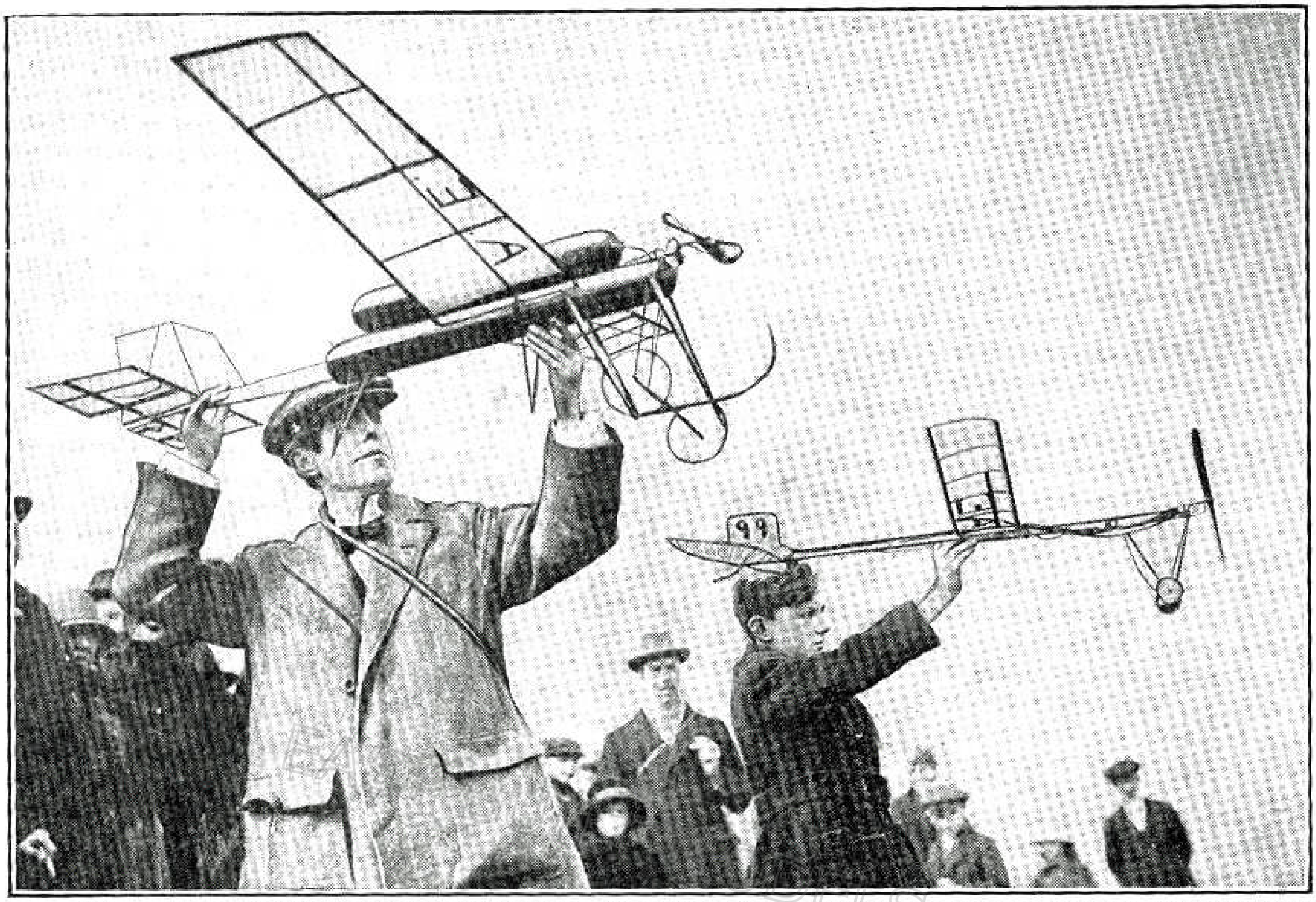
For the framework of the main plane it will be necessary to prepare two 22-in. and two 9-in. lengths of bamboo or spruce, planed to $\frac{1}{4}$ in. by $\frac{1}{16}$ in., and eight $5\frac{1}{2}$-in. lengths, the same width and a trifle thinner. The latter pieces should be steamed and bent to the shape shown at Fig. 6; the highest point of the rise should be $1\frac{3}{4}$ in. from one end and $\frac{1}{2}$ in. high. When ready, mark off $\frac{1}{2}$ in. from the front of each piece and then set out the front spar of the plane to a length of 21 in., leaving $\frac{1}{2}$ in. waste at each end. Next mark off $2\frac{7}{8}$ in., $5\frac{3}{8}$ in., and $7\frac{7}{8}$ in. from the $\frac{1}{2}$-in. marks each side; then attach, first with seccotine and then with a fine brad, a bent rib at each mark. As the brads must go right through the two pieces of wood, the nailing should be done on a piece of waste wood, over a small hole.

The next long spar should be marked off in the same way and placed on top of the ribs, the inside distance between the two being 2 in. The joints are glued and nailed in the same way as before. The two short spars are fastened on the end ribs, to give a total width of 4 in., and on the last inner rib to give a width of $4\frac{1}{2}$ in., as at Fig. 7.

The projecting ends of all the brads should be nipped off close to the wood with a pair of pliers or sharp pincers and then lightly tapped with a hammer, the head of each brad being placed on another hammer head or on the edge of a flat iron. The projecting ends of the spars and ribs should be cut off with a sharp chisel and rubbed over with a piece of glasspaper to remove any roughness. At this stage, the centre of the two main spars should be steamed and the sides bent upwards so that the ends are 2 in. higher than the centre.

The centre rib is made from a 6 in. length of $\frac{1}{4}$ in. by $\frac{1}{16}$ in. bamboo, tapered to a thin edge from $\frac{1}{2}$ in. at each end, and should be bound with thread to the two spars to project $1\frac{1}{4}$ in. in front.

The framework of the main plane, now complete, should be covered with fabric. This material, already proofed, can be obtained from several firms who

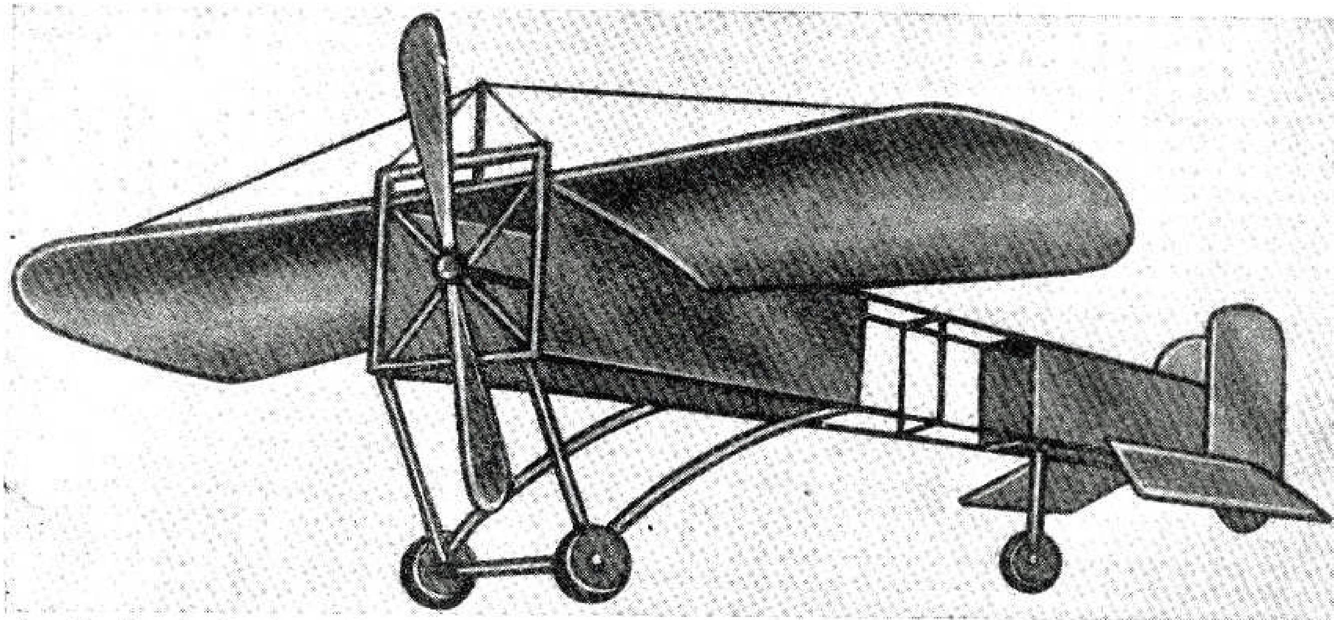


Two model aeroplane enthusiasts about to launch their craft. The model in the foreground is driven by compressed air ; the other derives its motive power from twisted elastic.

specialise in materials for model makers, but it is easily prepared from Jap silk coated with a solution made by dissolving shredded celluloid in amyl-acetate. Sufficient celluloid should be added to the liquid to form a thin, cream-like consistency, when it can be applied to the silk, when attached, with a brush. An alternative method of proofing is to dilute ordinary rubber solution so that it runs easily from a brush. The fabric should be cut with about $\frac{5}{16}$ in. to spare on all sides, the spars and ribs which come into contact with the fabric should be coated thinly with seccotine, and then the material is stretched over the top and the surplus pressed down on the under-surface. The proofing solution, if required, should be applied when the fabric is quite dry.

The rudder and the tail plane should be made next; they are both covered with proofed fabric similar to the main plane, but constructed with wire frames. The best material is piano wire; No. 20 S.W.G. will be quite stout enough. Short lengths of piano wire are readily obtained from any piano repairer and most piano tuners; it is in coils, and, in using it, the main thing to remember is to avoid twisting it when bending. The plane is made from two lengths of wire, one cut to a length of 20 in. and the other to $8\frac{3}{4}$ in. The long length should be allowed to spring out and lie naturally on the table, the centre is measured and held with a pair of round-nose pliers and the two halves bent inwards; the amount can be gauged from the plan view at Fig. 8. At a distance of $3\frac{1}{2}$ in., the pliers are used again to form another bend each side; this should give a width across of 7 in. The next bend is $2\frac{5}{8}$ in. away, and should bring the two ends together. The remaining length is held in the centre, with flat-nose pliers if possible, and the two portions each side bent parallel.

The top portion of the large frame, together with the two ends, should be cleaned quite bright with emery cloth; a short distance at the top and bottom of the short piece is also cleaned in the same way, and then the two parts are bound together with flower wire similar to that used by florists. The bound joints are now soldered, remembering to coat the joints with flux. The frame should be perfectly flat; the slightest curve will spoil the accuracy of the plane. The frame is now covered with fabric, at least $\frac{1}{4}$ in. being allowed for overlapping on the other side, but care



A model with a closed fuselage ; this sketch should be helpful to an enthusiast who wishes to experiment with different types of aircraft.

should be taken to avoid an excess of seccotine.

The rudder, as at Fig. 9, is made from piano wire of the same gauge as the tail plane, a length of 15 in. being required. One end is bent over to form a frame, with a length of $4\frac{1}{4}$ in. and a total width of 2 in. This is done by first bending $\frac{1}{2}$ in. at one end at right angles, and binding it to the lower portion at a distance of $4\frac{1}{4}$ in. from the other end and soldering the join. The single end is bent to form a tail skid. The upper portion is covered with fabric as in the tail plane.

The chassis, as shown at Fig. 10, is made of two thicknesses of iron or brass wire ; one piece is $7\frac{3}{4}$ in., cut from No. 15 gauge, and the other 14 in., cut from No. 17 gauge. The thicker piece is bent to the shape and dimensions shown at A of Fig. 11, using flat-nose pliers, and the thinner one is shaped as at B. The two portions are now bound together at the ends with flower wire as at C, and bent outwards to the angle indicated at D, which is about 30%. Taking care not to alter the angle, the joints should be soldered with a small washer close up to the wire binding. Two small wheels—of metal if easily obtainable, but $1\frac{1}{4}$-in. discs of $\frac{1}{8}$-in. or $\frac{3}{16}$-in. wood will answer, especially if they can be shaped on a lathe—should be slipped on the projecting ends ; small washers are fitted and secured with a touch of solder.

There are several methods of making a propeller, either by steaming and bending, by glueing thin strips and shaping, or by carving from the solid. For this particular model, the carved propeller is the most efficient, and, if worked from glued-up layers, is not difficult to make. The diameter of the propeller is 8 in., the centre width is $\frac{1}{2}$ in., and the widest part of the blades $1\frac{1}{8}$ in. In order to realise the construction of the carved propeller, first imagine a block of wood, 8 in. by 1 in. by 1 in., as at A, Fig. 12, the diagonal lines being roughly the shape of the carving as shown at B. With the built-up propeller shown at C, part of the shaping is done, and it is a simple stage to the roughing at D.

The first thing is to prepare four strips of wood, planed perfectly on both surfaces to $8\frac{1}{8}$ in. by $\frac{5}{8}$ in. by $\frac{1}{8}$ in. Next drill a No. 15 gauge hole through the centre of each piece, and then provide a short bicycle spoke ; saw or file off the end of the nipple, as at A of Fig. 13, and cut off a portion of the remainder as at B. Screw the latter on as far as it will go, as at C, so as to leave at least $\frac{5}{8}$ in. of thread.

The four strips of wood are now coated with seccotine as thinly as possible and then threaded on the end of the spoke, the detached end of the nipple at B being screwed on tightly. The pieces of wood are now spread as shown at C, Fig. 12, to give a width, between parallel lines, of $1\frac{1}{4}$ in. To make quite sure that all the surfaces are in perfect contact, two small G cramps should be applied each side, about a third of the way from the end, and left on until the seccotine has had plenty of time to set hard. A rasp is the best tool for shaping the sides, the finishing can be done with a half-round file followed by glasspaper ; but a few preliminary cuts can be made with a sharp pocket-knife and the finishing done with a file, instead of first using a rasp. The propeller should be coated with shellac varnish, rubbed down with used glasspaper, and again varnished to ensure a smooth surface. The spoke is cut off to $2\frac{1}{2}$ in. and the end bent to hook shape—see Fig. 13—with a pair of round-nose pliers, but it will be as well to fit on a domed washer or a small bead first to act as a bearing.

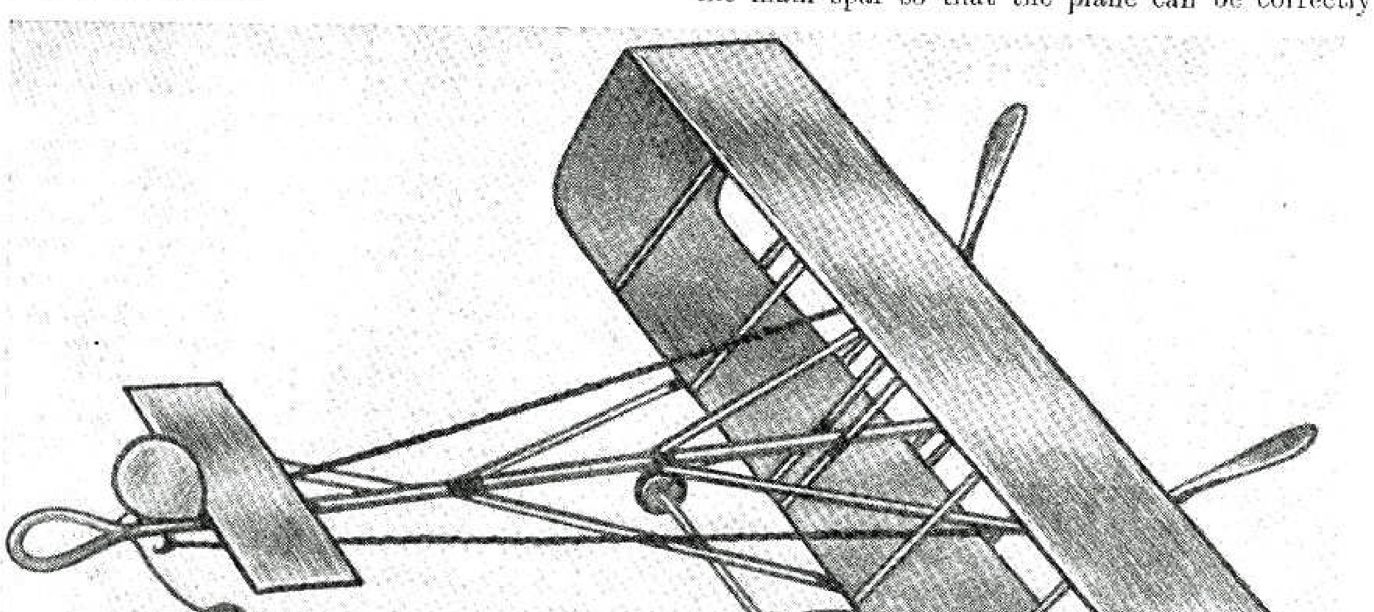
The various parts of the model are now assembled. First drill a hole to take a rubber hook, made as at A, Fig. 14, from some No. 17 or 18 gauge wire, $4\frac{5}{8}$ in. from the end of the spar. Push the end of the wire through the hole, bend it twice as shown in the section at B, and tap it into the underside of the spar. At a distance of $4\frac{5}{8}$ in. from the end, drill a hole to take the end of the rudder wire, push the latter through and then give the two pieces of metal a touch of solder where they cross each other, first wrapping some flower wire diagonally across.

The chassis is now fitted in position, a shallow slot being sawn across the front of the main spar, just under the propeller bracket. The upper portion of the chassis fits in this slot and the lower portion is clipped by the two lengths of bamboo underneath the spar. Two small rubber bands are used to attach the tail plane to the tapered end of the spar and the main plane is attached by the two metal bands—D, of Fig. 2—already in place. It is impossible to give the exact position of the main plane, so much depends on the weight of the materials used, but for an approximate position for a trial flight fix the front of the plane $6\frac{1}{4}$ in. from the propeller bracket.

The elastic motor consists of four to six strands of good-quality strip rubber. Square section rubber is sold for use with model aeroplanes, but the thin strip, about $\frac{1}{8}$ in. or more wide, is much more satisfactory in use. In order to prolong the life of the strip, the fixed hook and the propeller hook should be covered with valve rubber. In winding up, turn the propeller anti-clockwise, and continue until the strands of rubber appear to be knotted up and it is difficult to turn any more. A short length of wire slipped through the propeller hook will prevent the elastic unwinding until ready for a flight.

A level piece of asphalt is a good starting-ground; short grass will do, but the position should be fairly open. Do not attempt to fly the model on a very windy day, but a slight breeze will not matter. Point the model against what breeze there is and then let the propeller go. If the plane has been properly balanced, the model should rise steadily from the ground and mount to a good height. When the motive power has expended itself, the model should glide gracefully to the ground. A model that rises up at a sharp angle and comes down almost vertically is too heavily weighted in front. The remedy is to move the main plane further away from the propeller.

A few trial flights will soon give the best position for the plane. When it is found, mark the side of the main spar so that the plane can be correctly

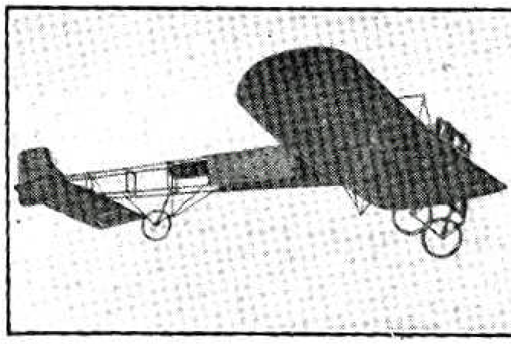


A model biplane. This sketch shows an experimental model which exhibited astounding powers of flying ***backwards!***

placed before each flight.

Having made a few successful flights with a single propeller, the keen model-maker will naturally wish to experiment with twin propellers. The following suggestions are intended to guide the model-maker along the right lines, rather than lay down definite rules.

The fitting of twin propellers involves additions to the fuselage and an alteration of the position of the main plane. Having carried this out, further experiments can be made with a larger main and tail plane. The most suitable method of fitting two propellers is to make a cross-bar to attach to the end of the main spar and to strengthen it by means of struts, as at Fig. 15. The method of construction is similar to that used in securing the spring under-part, suitable angle pieces being made from brass for the end of the spar and from thin tin for the struts, the binding being done as before. The propeller bearings can be made from short lengths of brass bound to the ends of the cross-bar. The rear rubber hooks can be made of one length, passed through a hole in the spar and then bent with round-nose pliers.



This photograph is of M. Louis Bleriot's monoplane in which he flew across the English channel in 1909. Note its resemblance to the model illustrated on page 66.

The best efficiency in propeller design, when two propellers are used, is obtained by making their combined diameters equal to the effective span of the main plane, but as a considerable amount of power would be used up in driving 11 in. propellers it will be as well to try two 8 in. or 9 in. diameters to begin with. It is generally better to have smaller propellers with a coarse pitch, than large ones with a fine pitch, and for model work it is usual to have a pitch from two and a half to three times the diameter.

This means that in one revolution, the propeller —which is a form of screw—would move a distance equal to two and a half to three times the diameter —that is, theoretically; but, practically, the pitch is concerned with pulling or driving power only. If a propeller is carved from a block of wood 9 in. by 1 in. by 1 in., it would have a coarser pitch than one carved from a block 9 in. by 1 in. by ½ in. The first one would cover a greater distance if allowed to follow its own path, than the second; and, when revolving, the first one would have a greater thrust or pulling power in one revolution than the second. Other considerations come into the problem of propeller design, but they need not be seriously considered at this stage.

The advantages of fitting twin propellers are soon evident; in the first place, they tend to give greater stability to the model, for there is always a tendency for a single-propeller model to fly to one side, and in the second, greater speed and longer flights are possible. It should be noted that the propellers must revolve in opposite directions, and care should be taken to make them in pairs.

It is not possible to make much advance in the provision of motive power. Considerable experimenting has been carried out with geared elastic motors, but experience has proved that the extra friction caused through the cogged wheels and the weight of the wheels themselves prevents an increase of power. It has been found that lubricating the strands of rubber with soft soap increases the efficiency for a time, but the effect of the soap is to shorten the life of the rubber. Much depends on the quality of the rubber; the best para strip will give good service for a long time.

Various methods have been suggested to overcome the tediousness of winding up the propellers by hand. One of the best appliances for rapid winding can be made from the ordinary egg-beater which is fitted with a geared wheel. The ends are cut off and a wire clip substituted, the latter being shaped to fit on the centre or boss of the propeller.

In making planes, it is not essential to use wood for the framework, piano wire is quite suitable—but some skill is required when using it for large planes. Wire framework should be shaped on a board, care being taken not to twist the wire. If the shape is drawn out full size, and nails are driven in at intervals, as shown at Fig. 16, it will not be difficult to run the wire round and to solder on the required ribs. Extra strength can be given to large planes, made either of wood or wire, by diagonal struts of linen thread or flower wire.

Biplane models are not difficult to make, but care is needed in placing struts between the two planes to give rigidity. A popular form of biplane can be made with a bamboo framework on the lines suggested at Fig. 17, but a double framework is essential. The extra weight of the framework is compensated by the increased lifting surface of the plane, but it will be necessary to fit a fairly large tail plane.

There is unlimited scope for experimenting in connection with model aeroplane construction, but a certain amount of data should be collected from previous successful models and flight observances.

Model construction of any kind cannot be carried out entirely by rule-of-thumb methods; there are certain rules and regulations that must be followed and, as well, the model-maker should know something about the weight and strength of the materials that are available.

The first consideration is the shape and size of the main plane, the second is the size of the propellers, and the third, the shape and strength of the frame. If the main plane is large in area, the construction must be sufficiently strong to resist damage, but it must be as light as possible; the propeller or propellers must be fairly large and be attached to sufficient rubber to drive them; the approximate weight should be determined; the framework must be of sufficient length to allow for the elevating or tail plane, and be strong enough to stand up to the strain of the elastic motor when fully wound.

As the lifting power of an aeroplane depends on both speed and area, the approximate weight of the materials used in the construction forms an important factor in design. As a rule, a comparatively narrow plane, travelling at a high speed, will carry the same weight as a larger plane moving at a slow speed, but for a model for ordinary flying, the supporting surface should be able to lift at least six ounces per square foot of surface. The area of the elevating or tail plane can be neglected as far as the lifting or weight-bearing capacity of the main plane is concerned, but it should not weigh more than about one-eighth of the large plane.

When the area of the main plane is known, and the approximate weight that it can lift worked out, the total weight of the materials can be determined.

For example—supposing that it is decided to make a main plane with a span of 30 in. and a depth from front to back averaging 4 in., the area of the plane—120 sq. in.—would allow of 5 oz. for the materials. For certain materials, such as rubber, fabric, wire, etc., the limit of weight would be known, but the weight of the remainder of the materials for the construction of the framework and the propellers would have to be very carefully proportioned so as to give the greatest stability for the lowest weight. On the other hand, the area of the main plane could be determined after the whole of the framework, propellers, etc., have been constructed and weighed.

For the framework of model aeroplanes there are several kinds of suitable wood. Those in ordinary use are yellow pine, spruce, cedar, mahogany, birch, American yew, ash and beech. The average weight in pounds per cubic foot varies from 28 for yellow pine to 50 for beech, but it is often possible to obtain extra-light specimens. Bamboo varies very much in weight, but it averages about 40 when prepared in suitable strips.

In addition to the weight of the wood, it is important to know something about the strength as well; the strength is usually in inverse ratio to the weight. Beech is very much stronger than yellow pine, and as a rule it is necessary in a large framework to use diagonal bracing wires when either pine or spruce is used, and if the weight of the bracing wires amounts to more than the difference between a light and a heavy wood, the designer must take this into consideration.

A speedy-looking monoplane driven by compressed air. The cylinder is lying along the fuselage.