CHAPTER 9

PROPELLERS

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

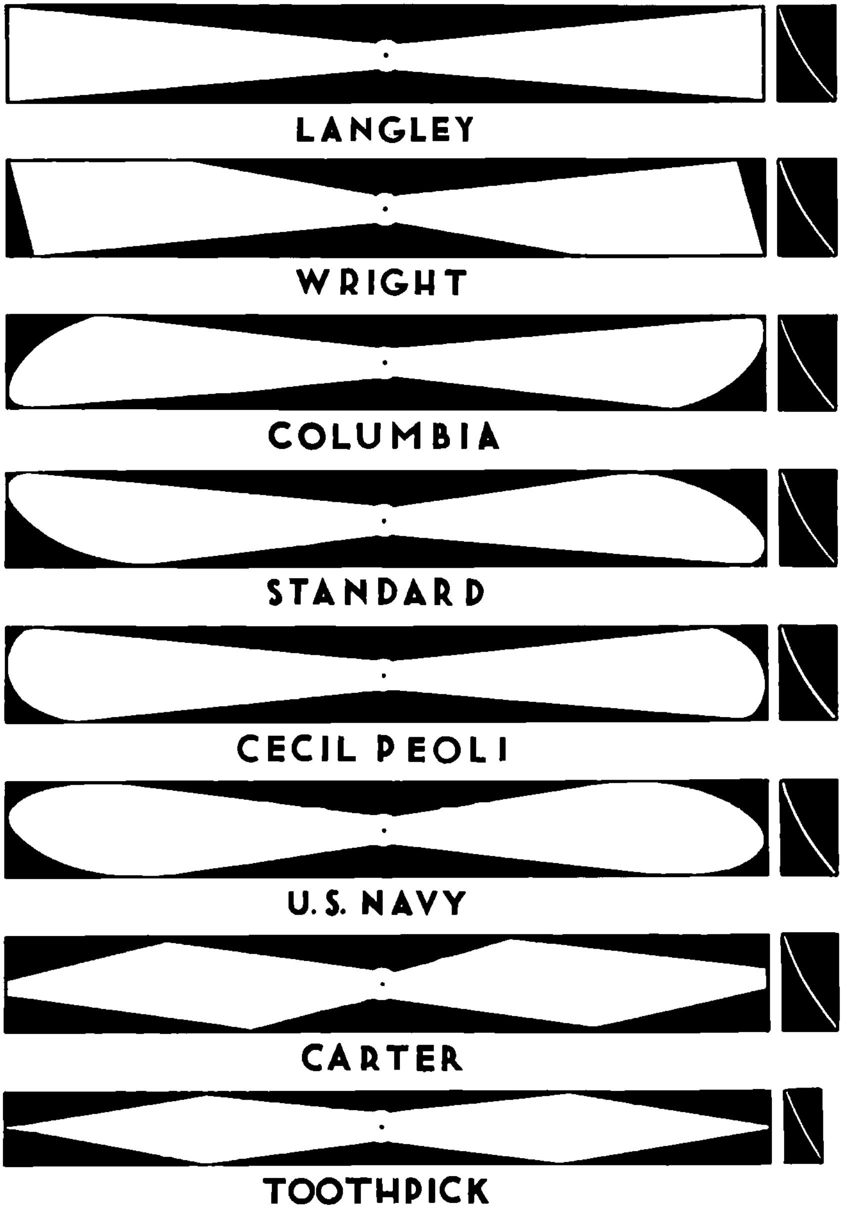
If a model is tested, without power, in respect to its gliding ability and maintains a long, smooth glide, it will fly well provided the correct propeller and motor are applied.

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

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

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

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



PROPELLERS

FIGURE 46

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

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

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

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

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

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

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

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

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

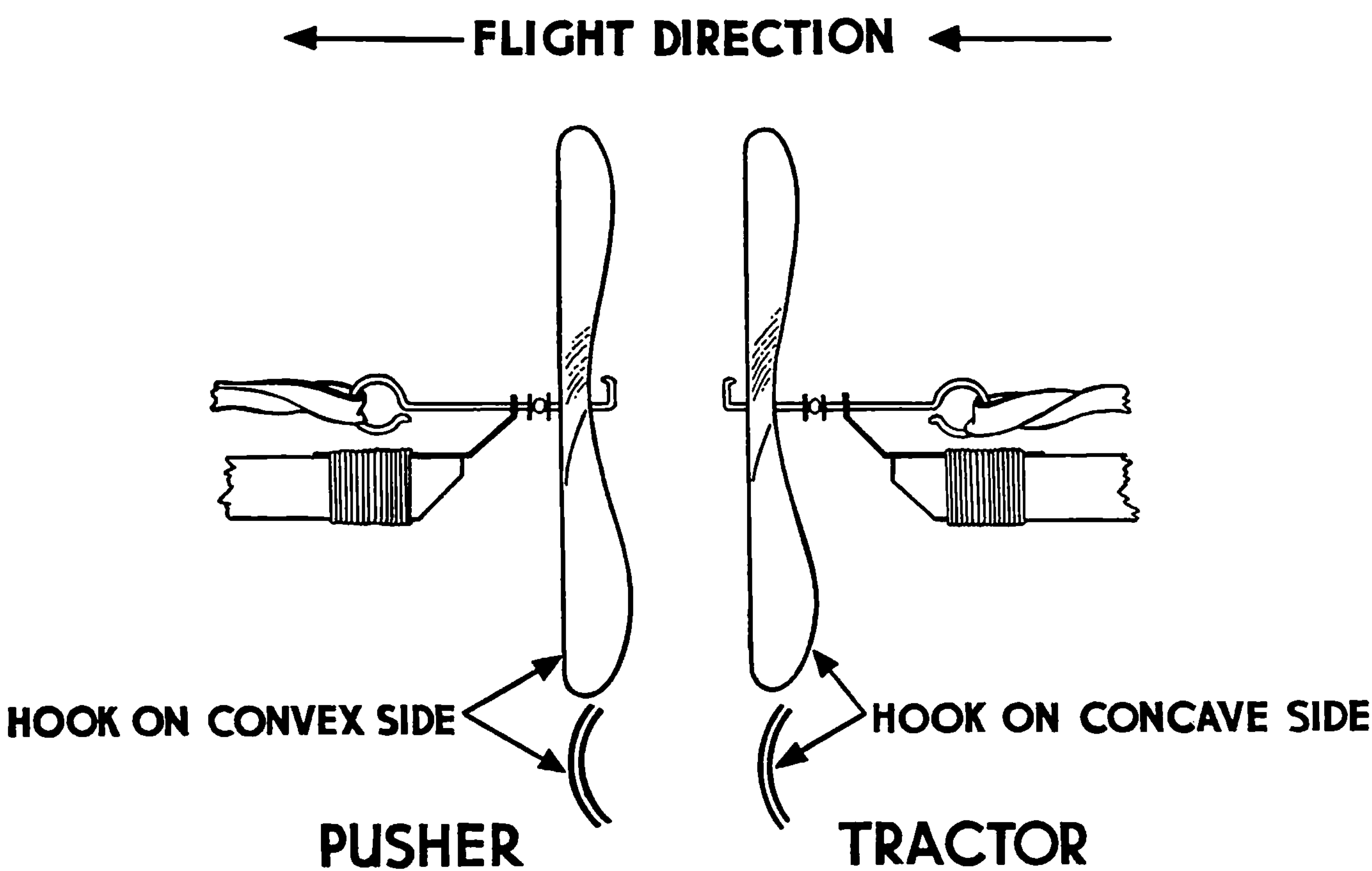
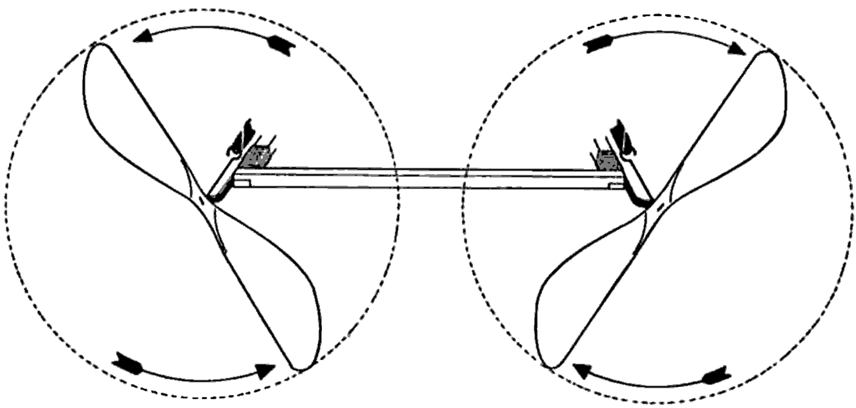


FIGURE 47. PROPELLER ASSEMBLY FOR TRACTOR AND PUSHER MODELS

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

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



LEFT RIGHT

TWIN PROPELLERS

FIGURE 48

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

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

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

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

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

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

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

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

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

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

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

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

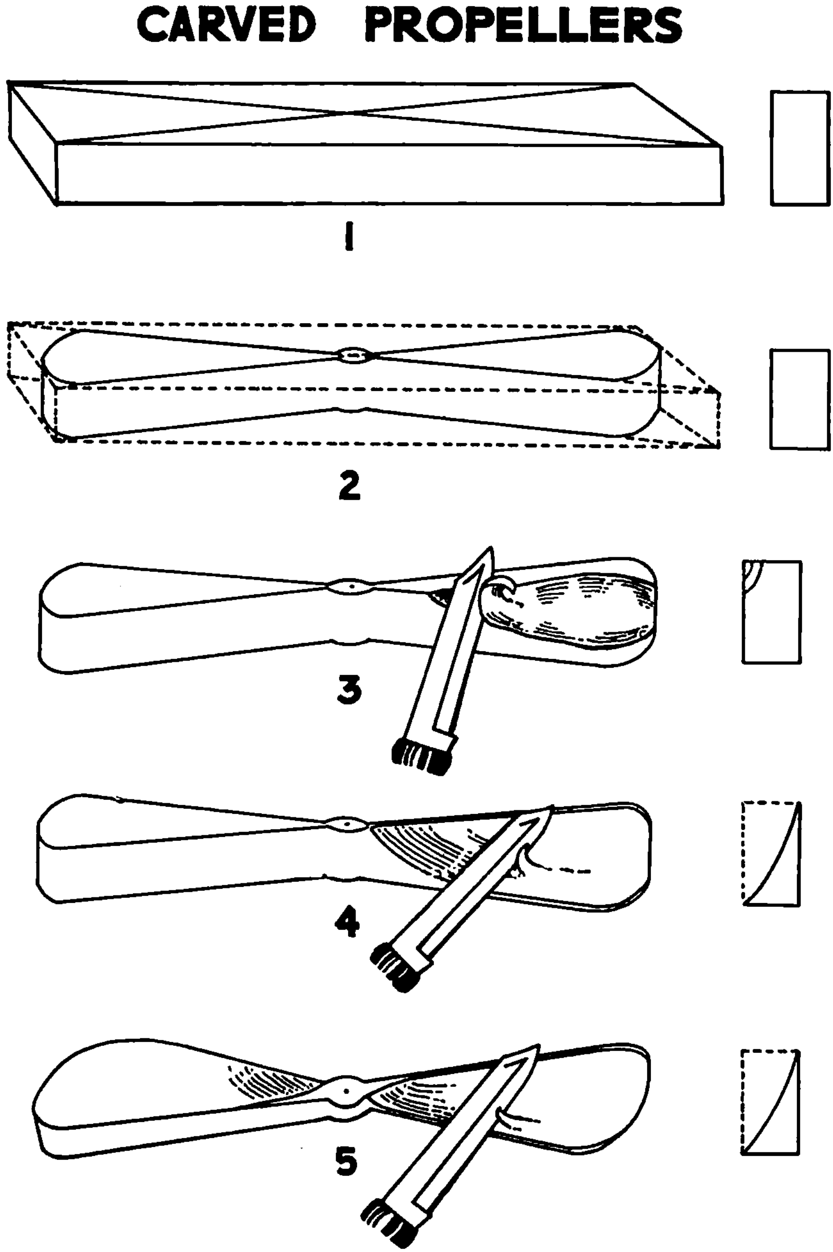


FIGURE 49

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

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

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

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

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

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

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

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

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

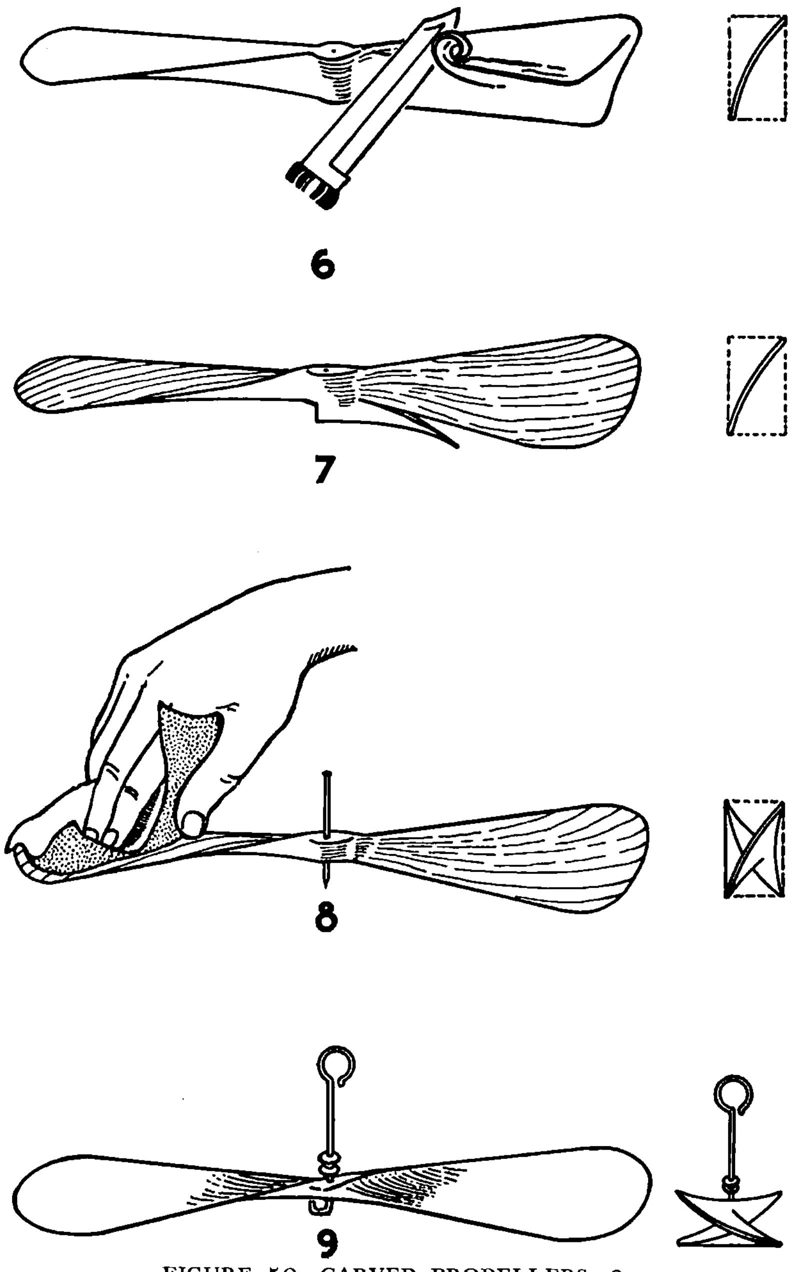


FIGURE 50. CARVED PROPELLERS, 2

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

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

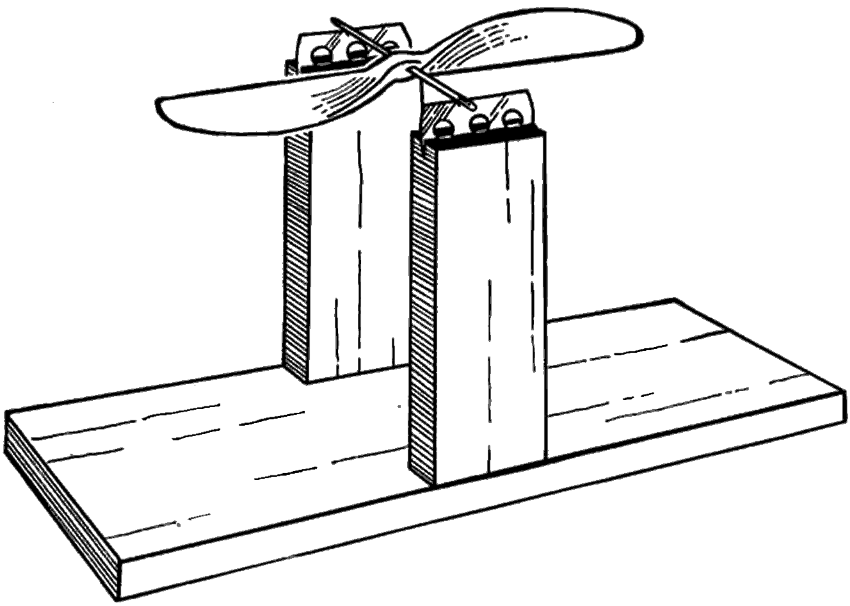


FIGURE 51. PROPELLER BALANCE BLOCK

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

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

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

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

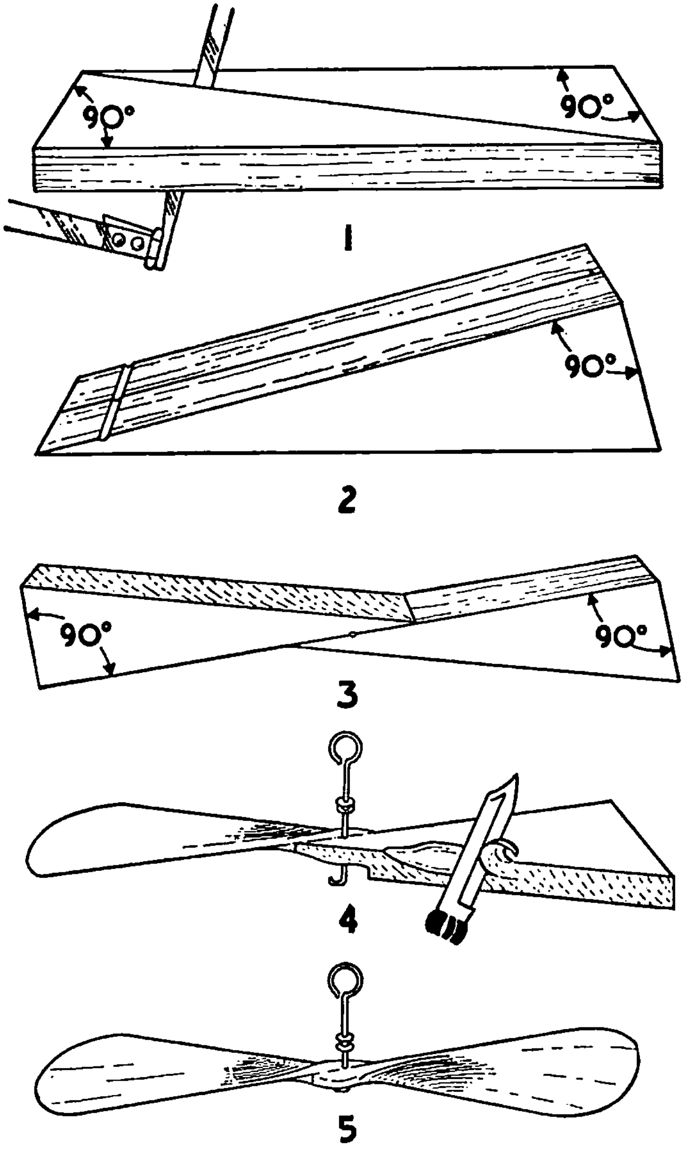
The end of the shaft is then bent around, so that when the shaft is pulled back, the point of the wire will bury itself in the wood of the hub. A drop of cement will hold it in place. Many cement a large washer against the hub, after threading it on the shaft. Two smaller washers are then assembled on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

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

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

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

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



CARVED TRIANGULAR-BLOCK PROPELLER

FIGURE 52

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

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

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

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

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

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

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

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

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

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

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

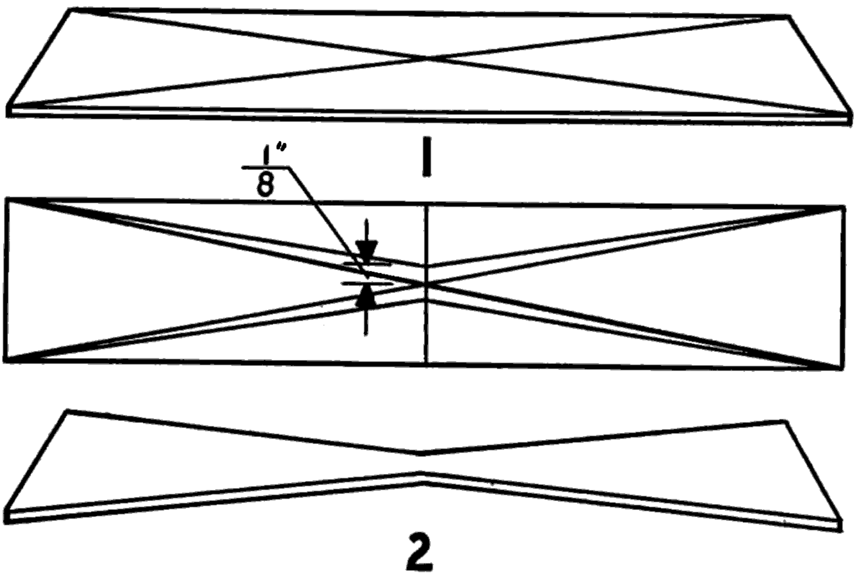


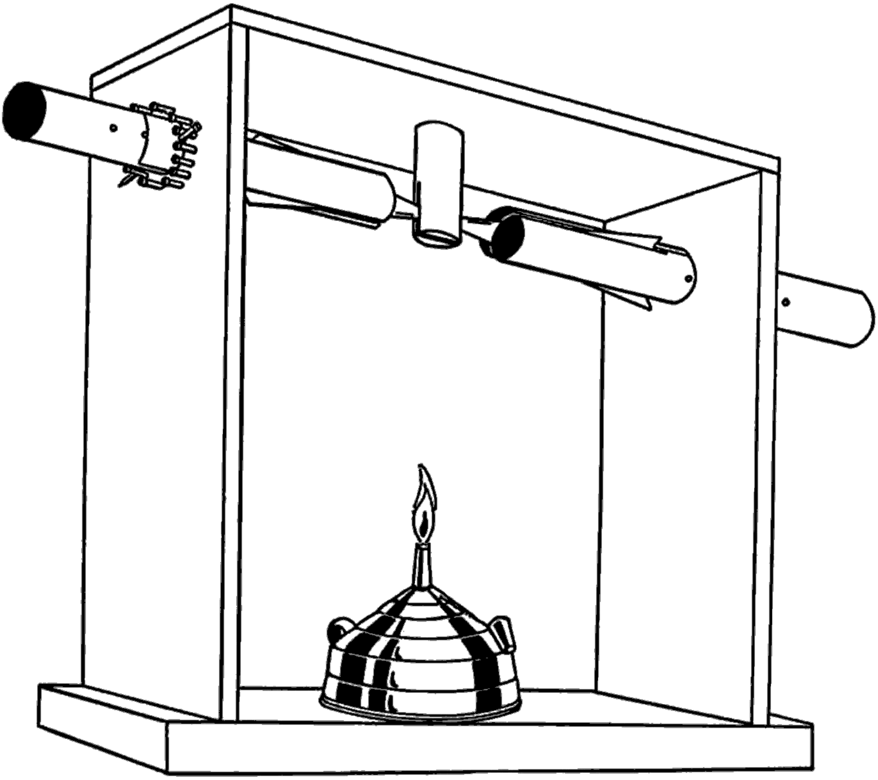
FIGURE 53. CUTTING BENT WOOD PROPELLER BLANK

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

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

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

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



BENDING AND DRYING PRESS

FIGURE 54

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

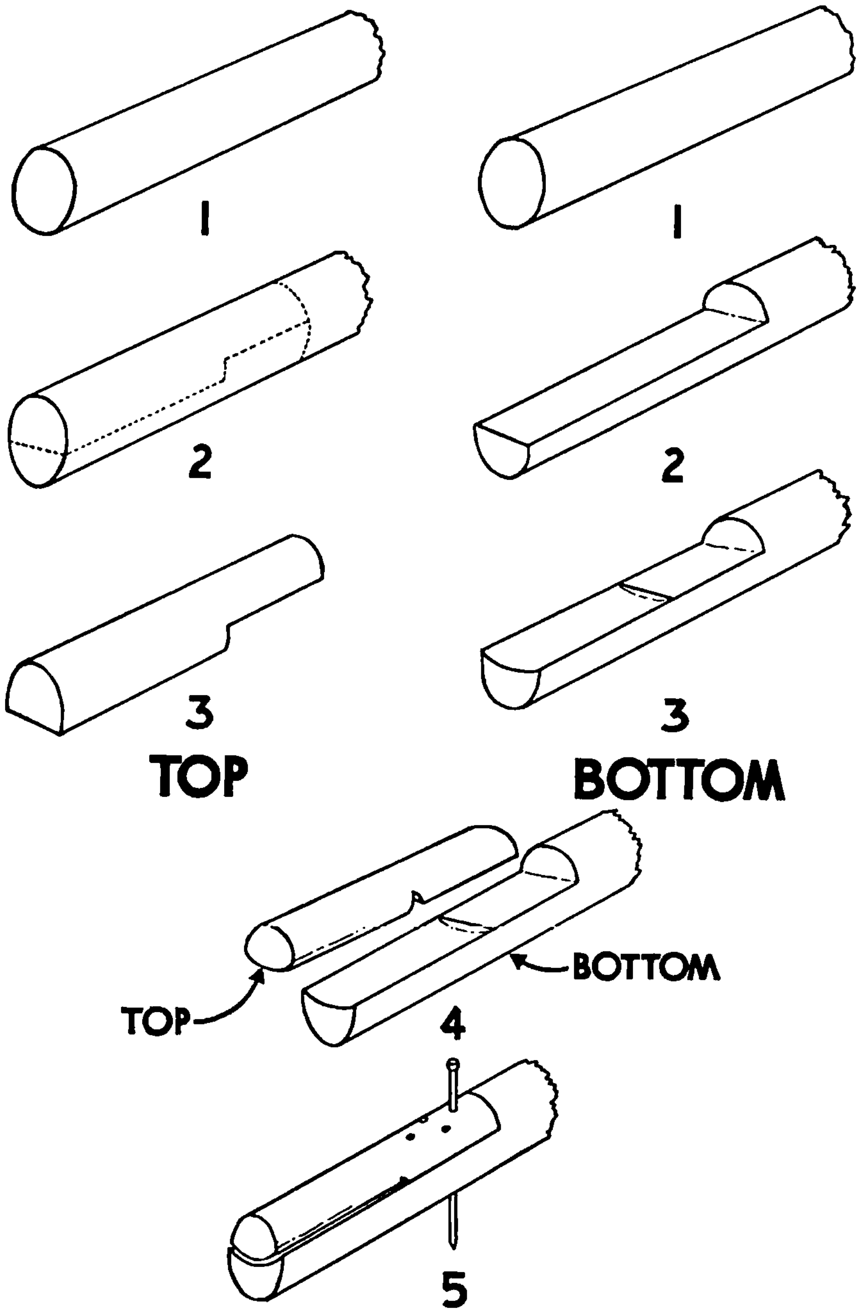


FIGURE 55. STEPS FOR MAKING, BENDING, AND DRYING PRESS GRIPS

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

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

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

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

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

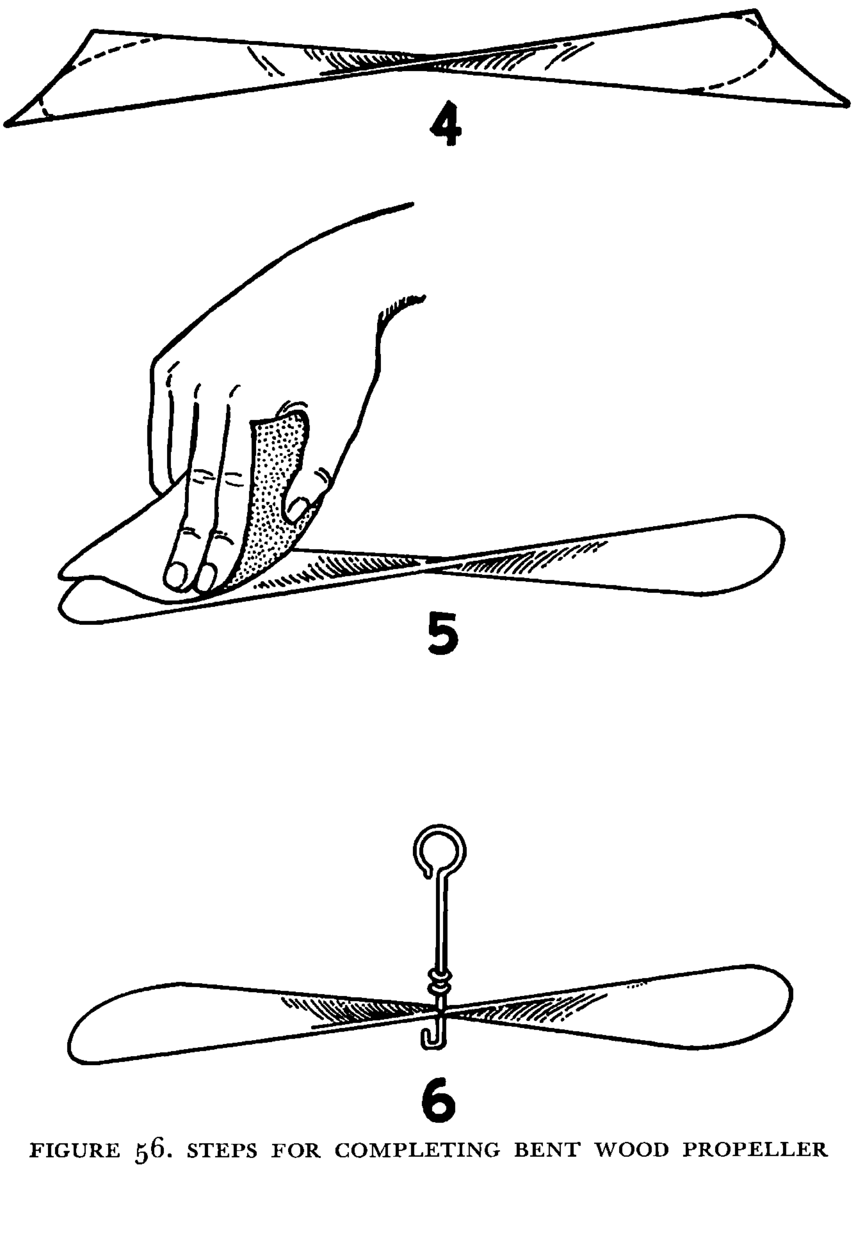


FIGURE 56. STEPS FOR COMPLETING BENT WOOD PROPELLER

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

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

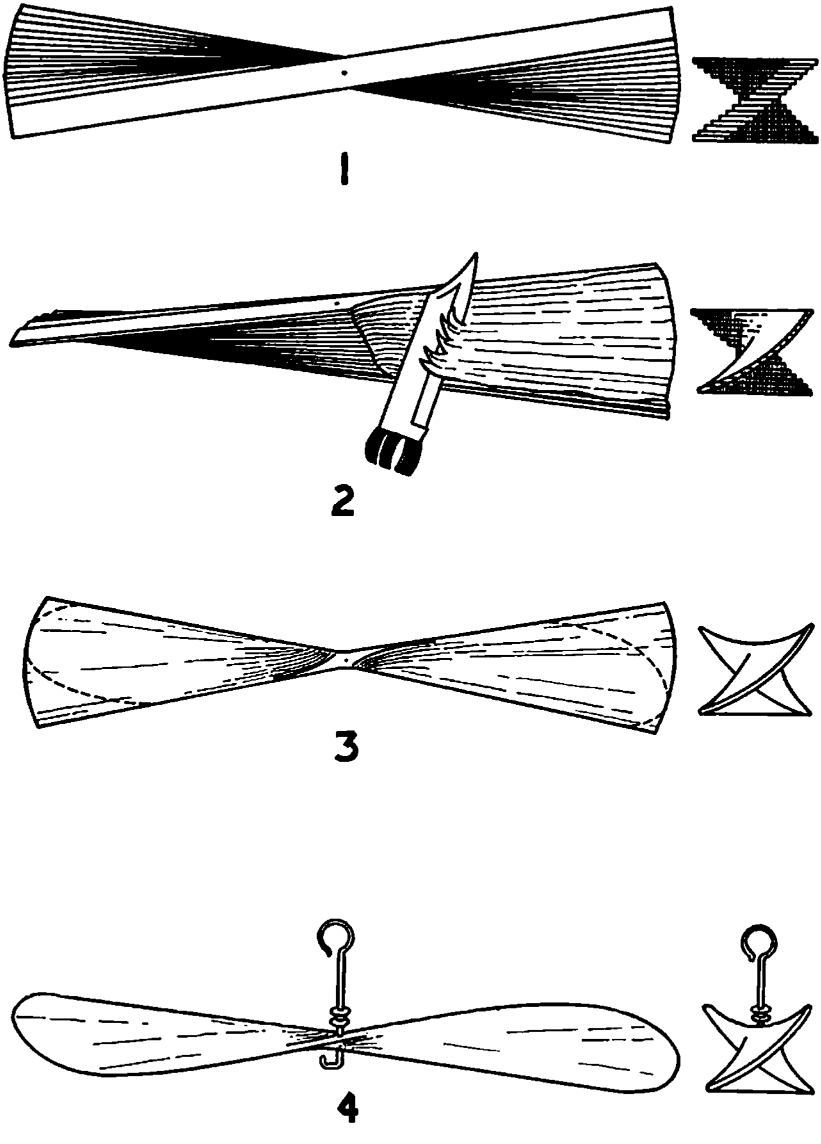
The propeller shaft is attached in the same manner as on any carved propeller.

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

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

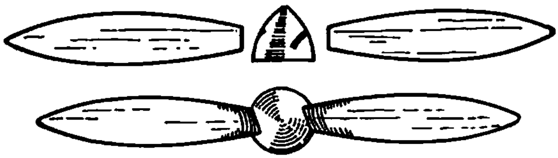
The propeller is then balanced. (See "Carved Propellers, Balance Block.") Care must be taken to see that each blade is directly opposite the other on two-bladed propellers, while three- and four-bladed propellers must have their slots so located in the spinner as to make the blades an equal distance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

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

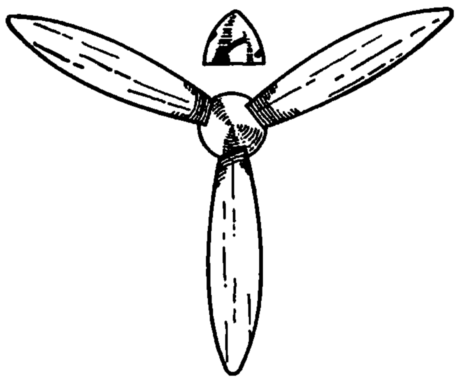


LAMINATED PROPELLER

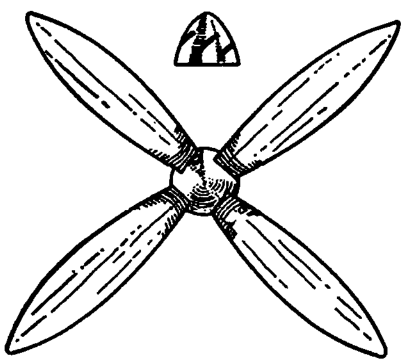
FIGURE 57



DOUBLE BLADED PROPELLER



THREE BLADED PROPELLER



FOUR BLADED PROPELLER

BUILT-UP FLYING PROPELLERS

FIGURE 58

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

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

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

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

(1) The theoretical pitch of the propeller.
(2) The desired width of the blade of the propeller.
(3) The necessary size of the propeller block.

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

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

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

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

For example, if a block measures 1″ x 1½″ x 11″, the formula would read:

$$\frac{11 \times 3.1416 \times 1}{1\frac{1}{2}} = \frac{34.5576}{1\frac{1}{2}} = 23.03'',$$ theoretical pitch.

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

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

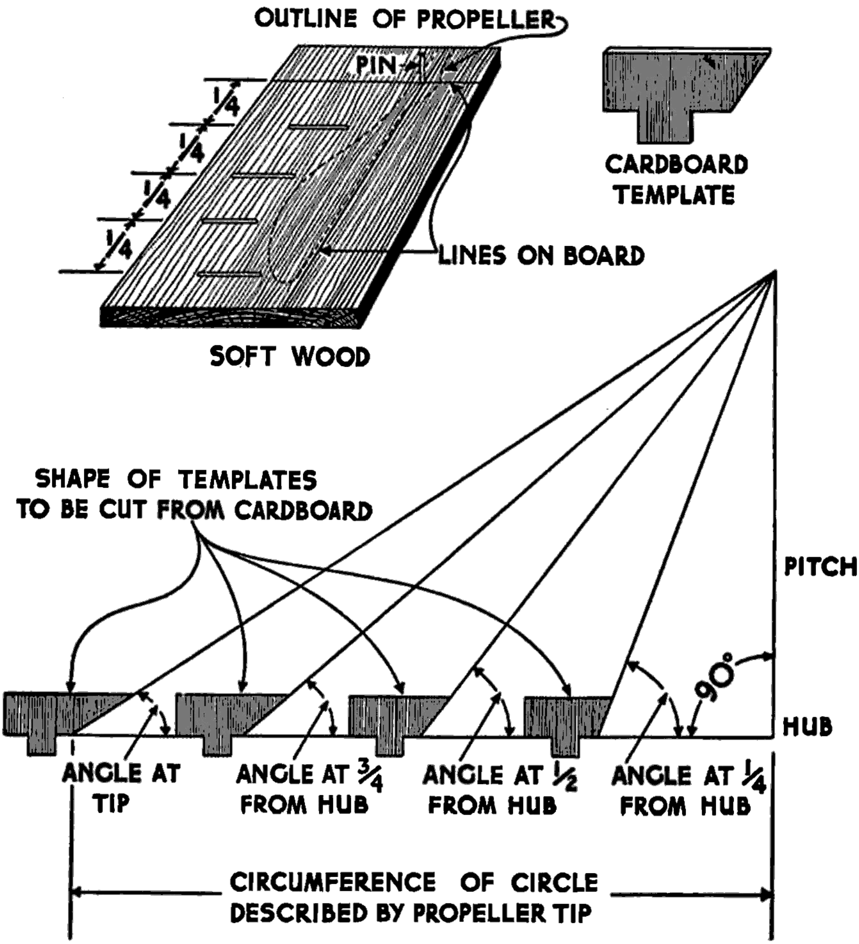


FIGURE 59 TRUE-PITCH PROPELLER LAYOUT

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

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

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

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

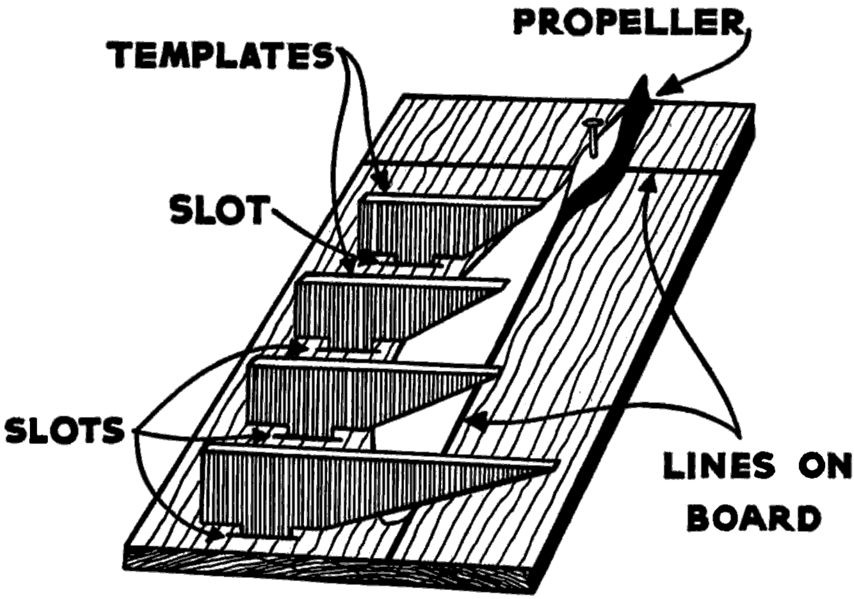


FIGURE 60. TRUE-PITCH PROPELLER PLATFORM ASSEMBLY

point where these two lines intersect. (Note pin location.) Shape the propeller as desired and carve the blades down until they are about 1/4″ thick. Place the propeller on the platform and trace its form with pencil on the board. Draw lines at right angles to the long line, as indicated by the short double lines on the platform, dividing the radius of the propeller into four equal lengths. Cut these lines through the board, but be sure that they are not longer than twice the width of the small extension pieces on the templates.

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

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

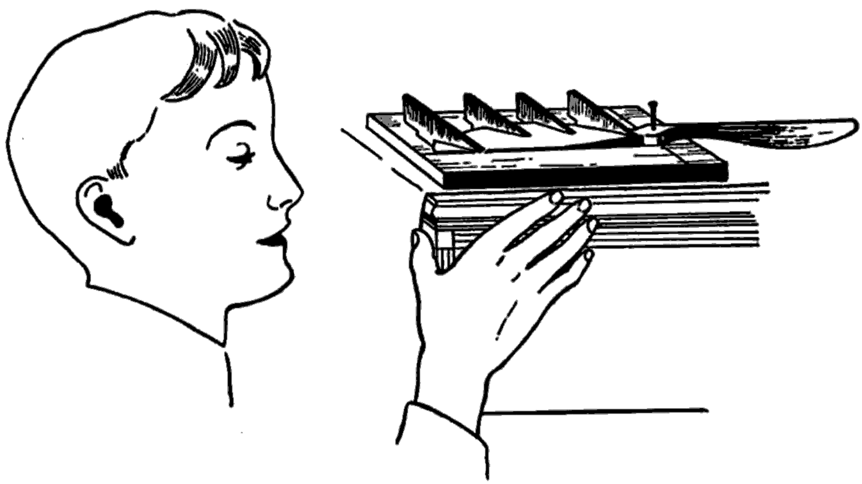
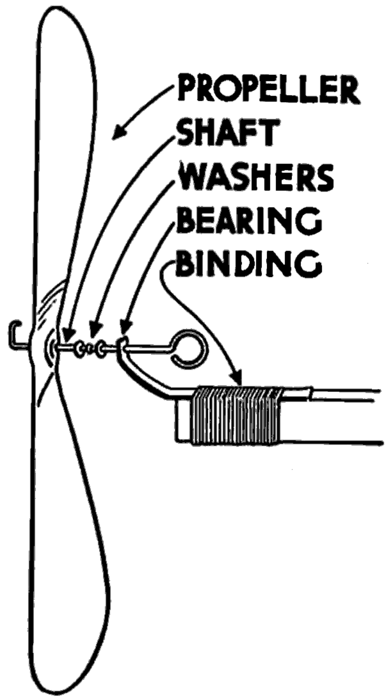


FIGURE 61. METHOD OF SIGHTING PROPELLER PLATFORM

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

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

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



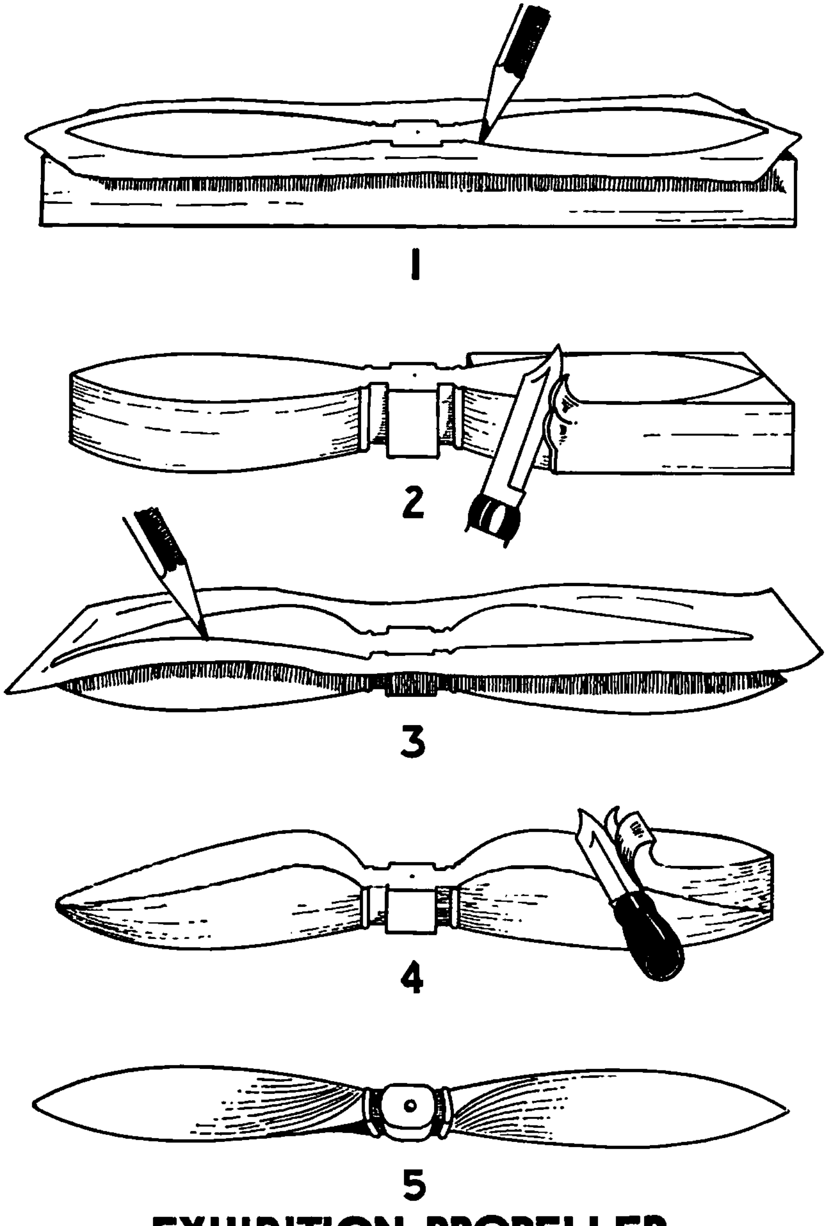
PROPELLER ASSEMBLY

FIGURE 62

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

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

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



EXHIBITION PROPELLER

FIGURE 63

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

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

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

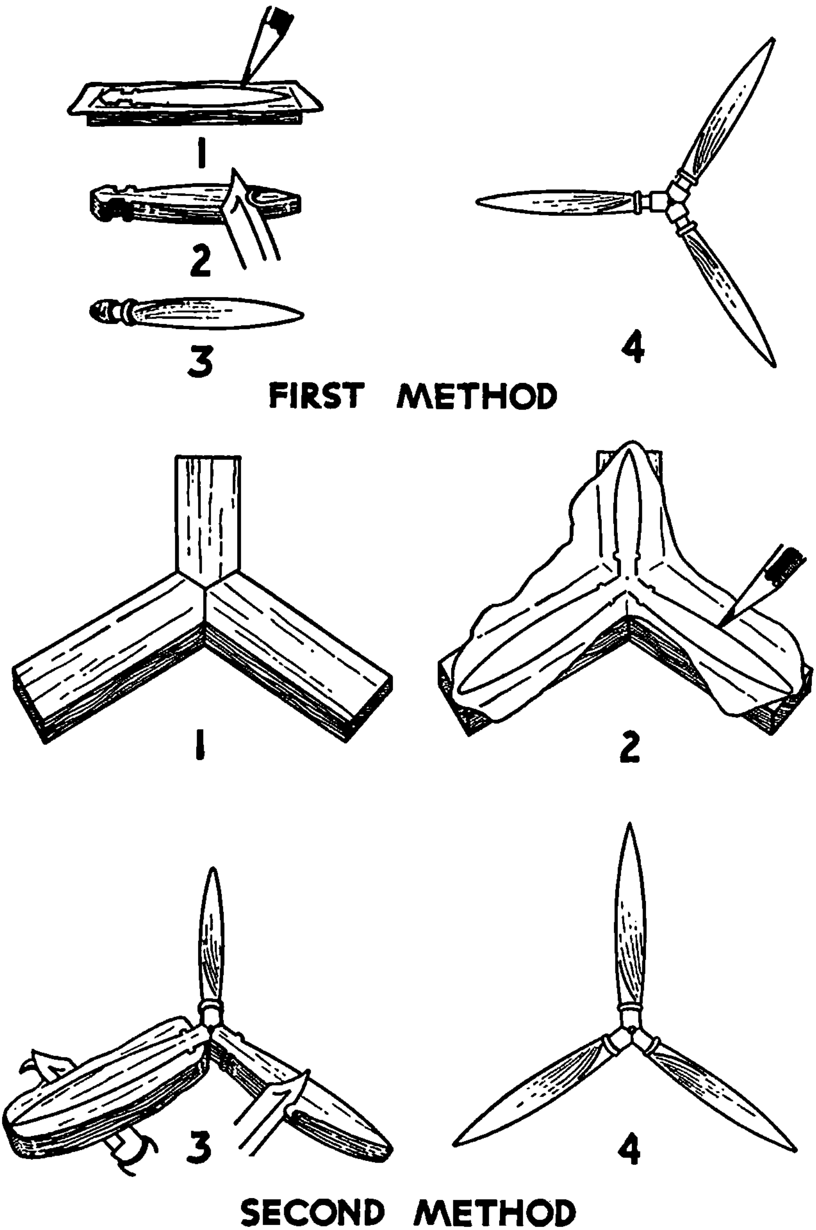
THREE-BLADED EXHIBITION PROPELLER. There are two popular methods of making these. The first, shown in Fig. 64 is the more simple of the two. A pattern of the blade is made and traced on a block already cut to proper size, as in 1. This block is only half as long as the finished propeller.

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

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

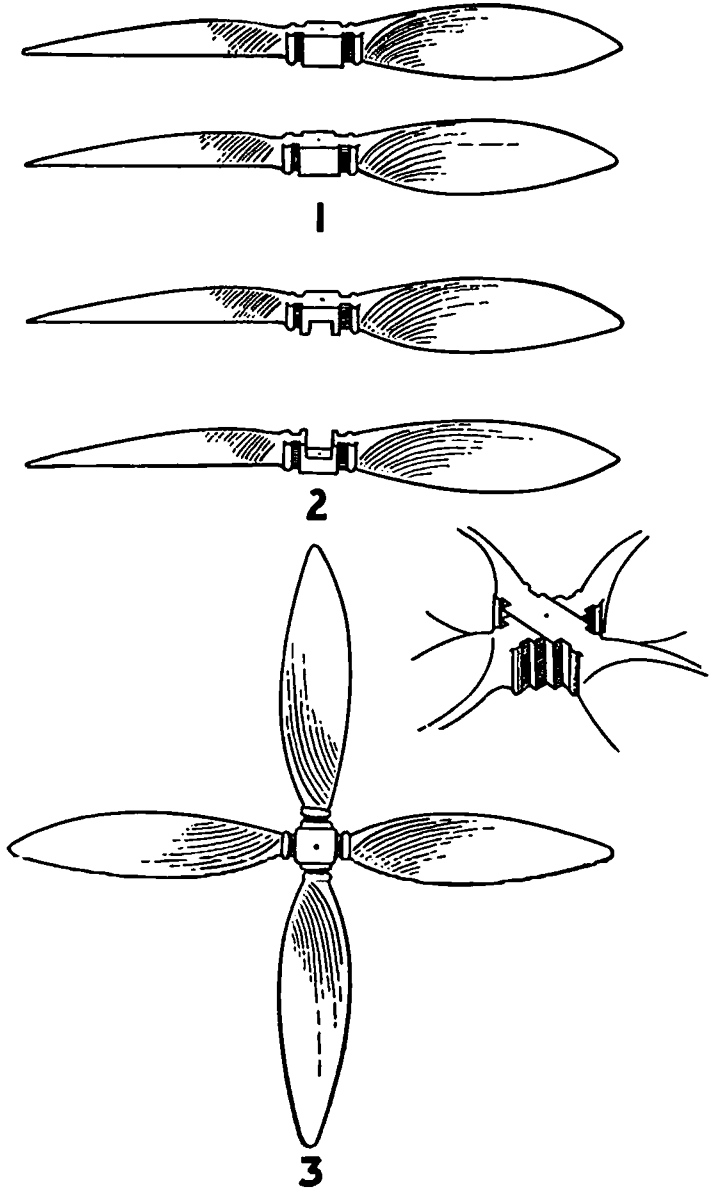
The second method consists of cementing the three original blade blocks together, as in Fig. 64, No. 1 under "Second Method." The outlines of the blades are then traced on this block, as in 2, and cut out. Each of the three blades is then carved. These two operations are shown in 3. The finished propeller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

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



THREE-BLADED EXHIBITION PROPELLER

FIGURE 64



FOUR-BLADED EXHIBITION PROPELLER

FIGURE 65

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