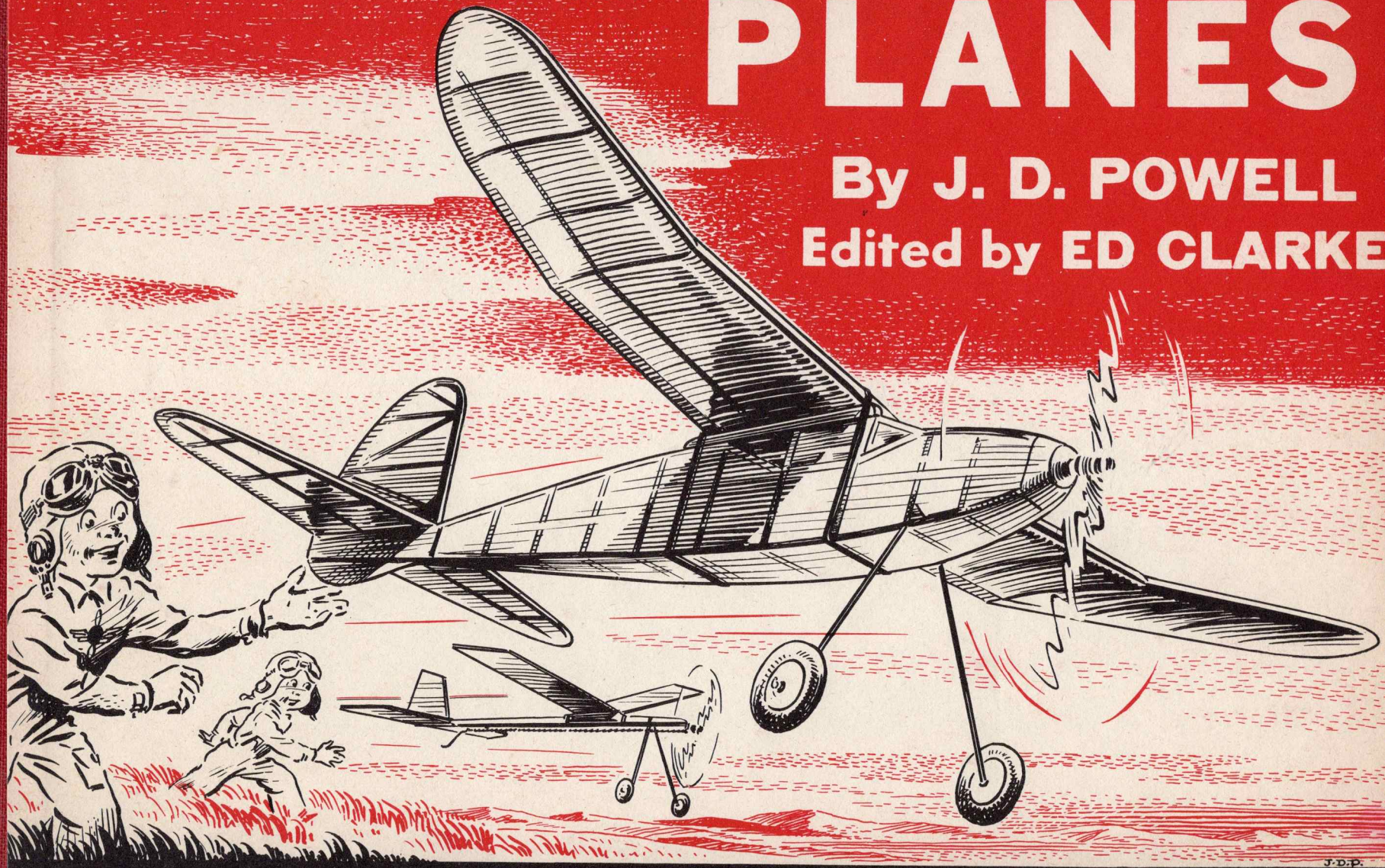
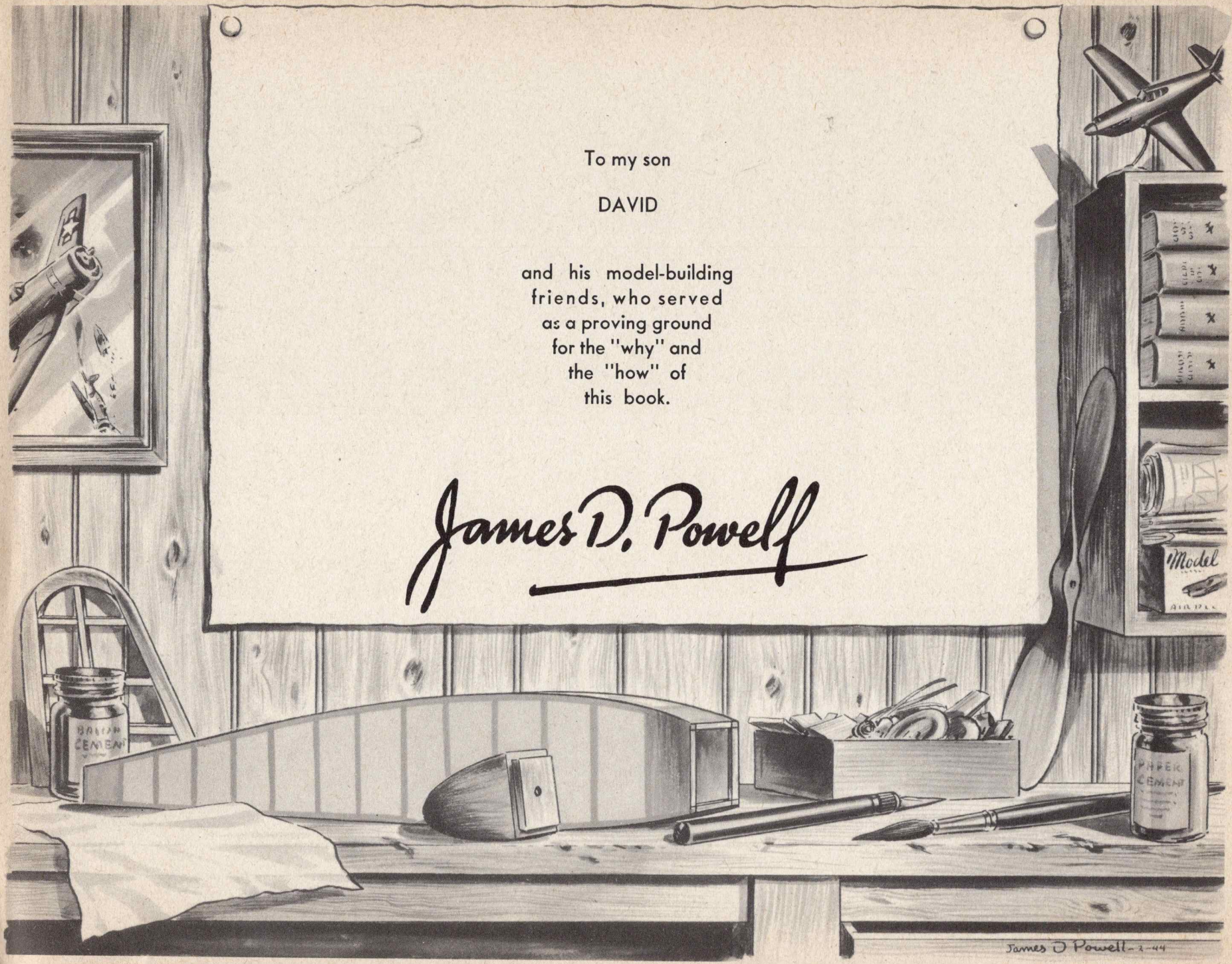
JUNIOR MODEL PLANES

By J. D. POWELL
Edited by ED CLARKE




To my son
DAVID
and his model-building
friends, who served
as a proving ground
for the "why" and
the "how" of
this book.
James D. Powell
Model
PAPER CEMENT
James D Powell-2-44

FOREWORD

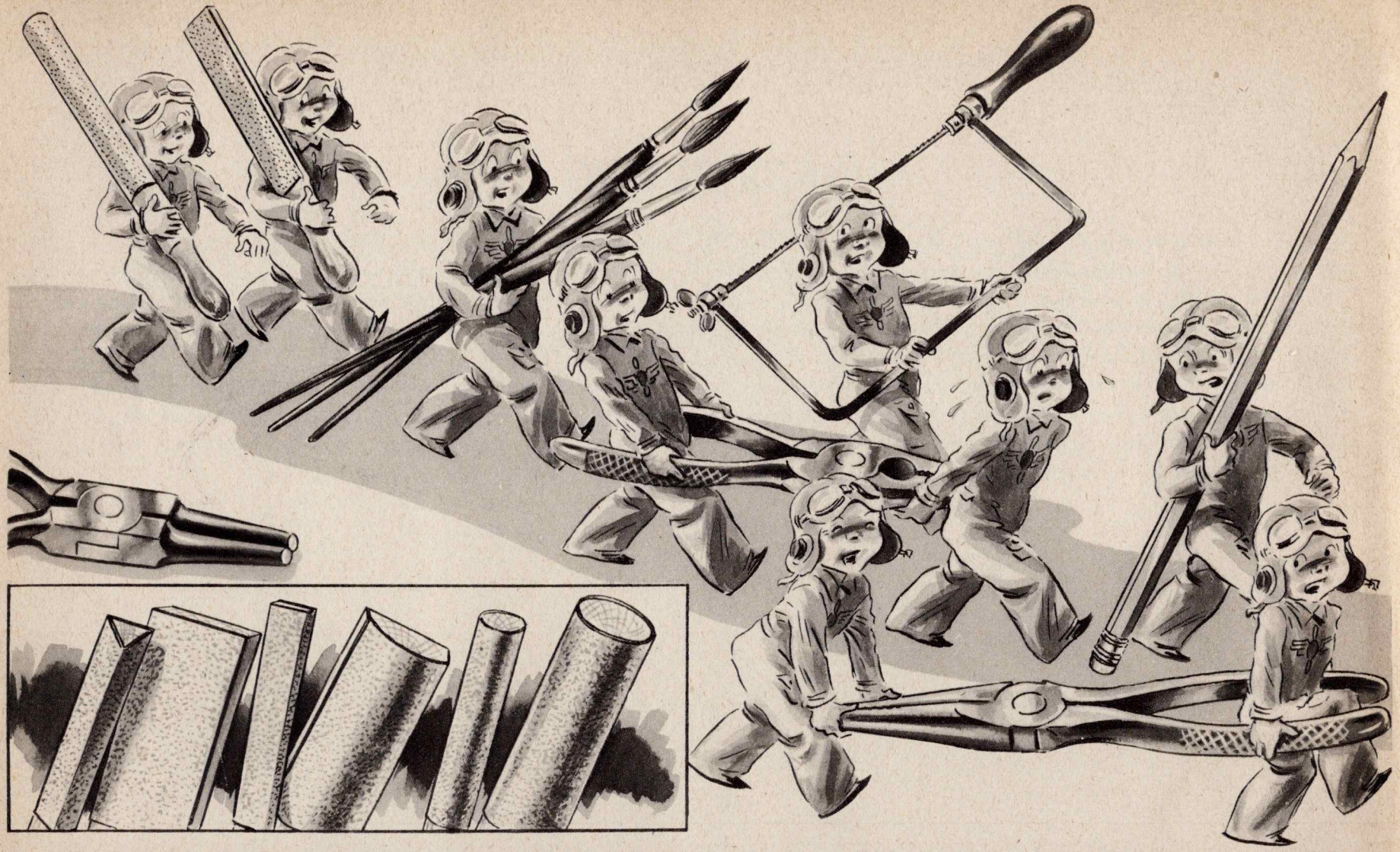
No one can say what is the true worth of model airplane building and flying to the boys and girls who participate in this activity.

Many of the principles of flight were found out through model airplanes. The youth who build and fly models likewise discover for themselves some of the basic principles of the airplane. The theory of flight becomes more than a mere theory when the boy or girl actually sees the result of knowledge and skill applied to materials performing in the air according to the principles of aerodynamics.

The National Advisory Committee for Aeronautics recognizes the worth of the model airplane builder, for the Committee now employs over 400 young persons who have taken part successfully in state and national model airplane contests. The Committee puts weight on hand skill, ingenuity, and resourcefulness—common qualities of the aeromodeler.

This book, which I have read with considerable interest, presents the building and flying of model airplanes in a unique way and will, I believe, add zest to the boy or girl who builds and flies the progressively more difficult models described.

ROBERT W. HAMBROOK

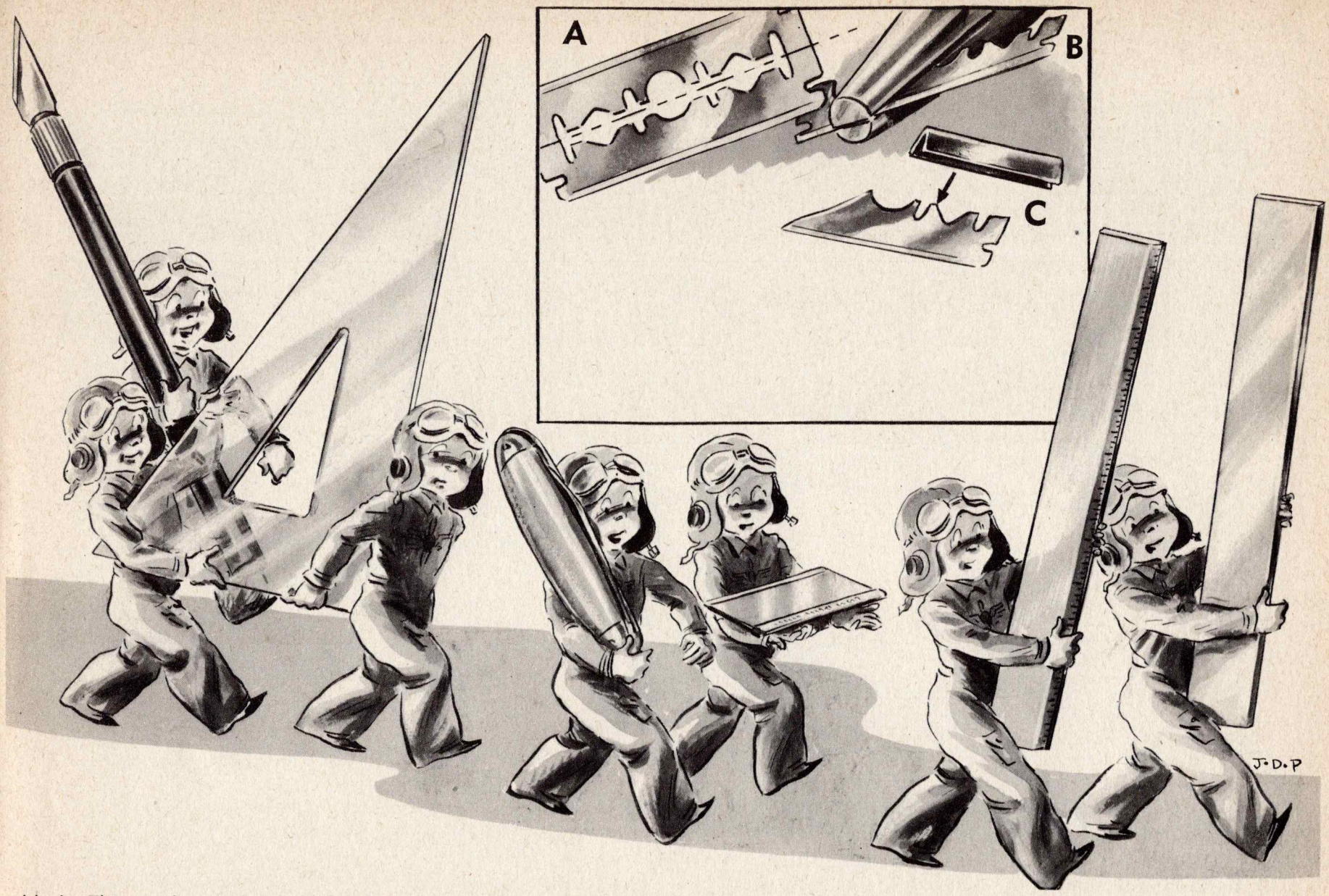


Few tools are needed in model airplanes. A good collection is illustrated on these two pages. Most of them are in the average home toolbox; the rest can be made or purchased quite cheaply.

Starting at the rear of the procession (from left to right), we have *sanding sticks*. Files clog easily when used for working wood. Sanding sticks are about 6 inches long, with a roughly shaped handle. Sandpaper of various grades, from No. 0 to No. 10/0, is cemented to the faces of these sticks (note in panel that sticks are of various shapes—square, flat, round, and so on).

Next in the line are *camel's-hair brushes*, *wire-cutting pliers*, a *small saw*, *needle-nosed pliers*, and the *round-nosed pliers* that appear at the far left. (Buy a good grade of pliers; cheap ones warp and twist in use.) *Pencils* are also needed.

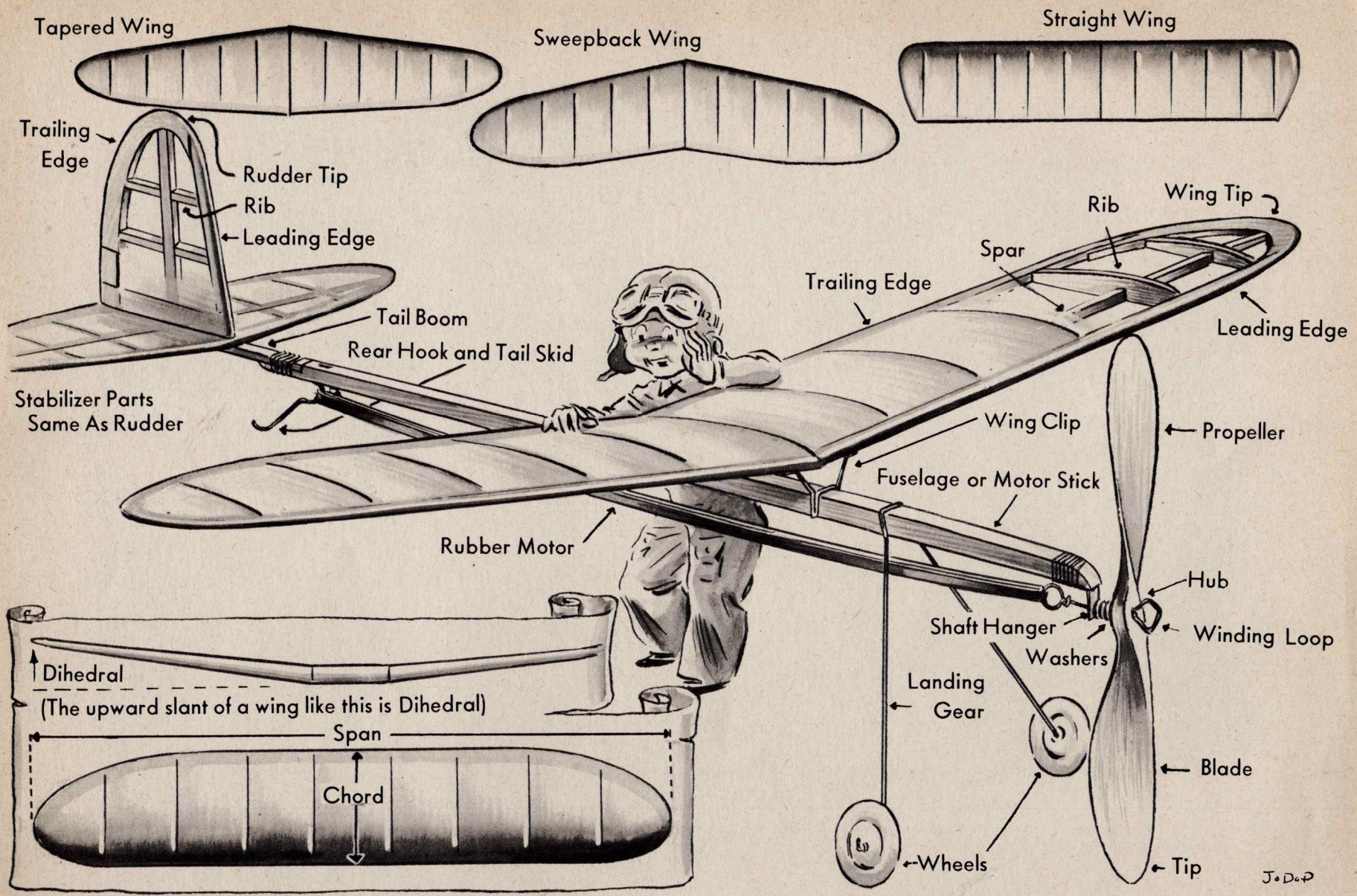
A *precision knife* is a useful tool with its interchangeable blades. A *triangle* and a sharp *pocket knife* follow. Then comes the greatest utility tool of all—a *razor blade*. The one shown is a single-edged



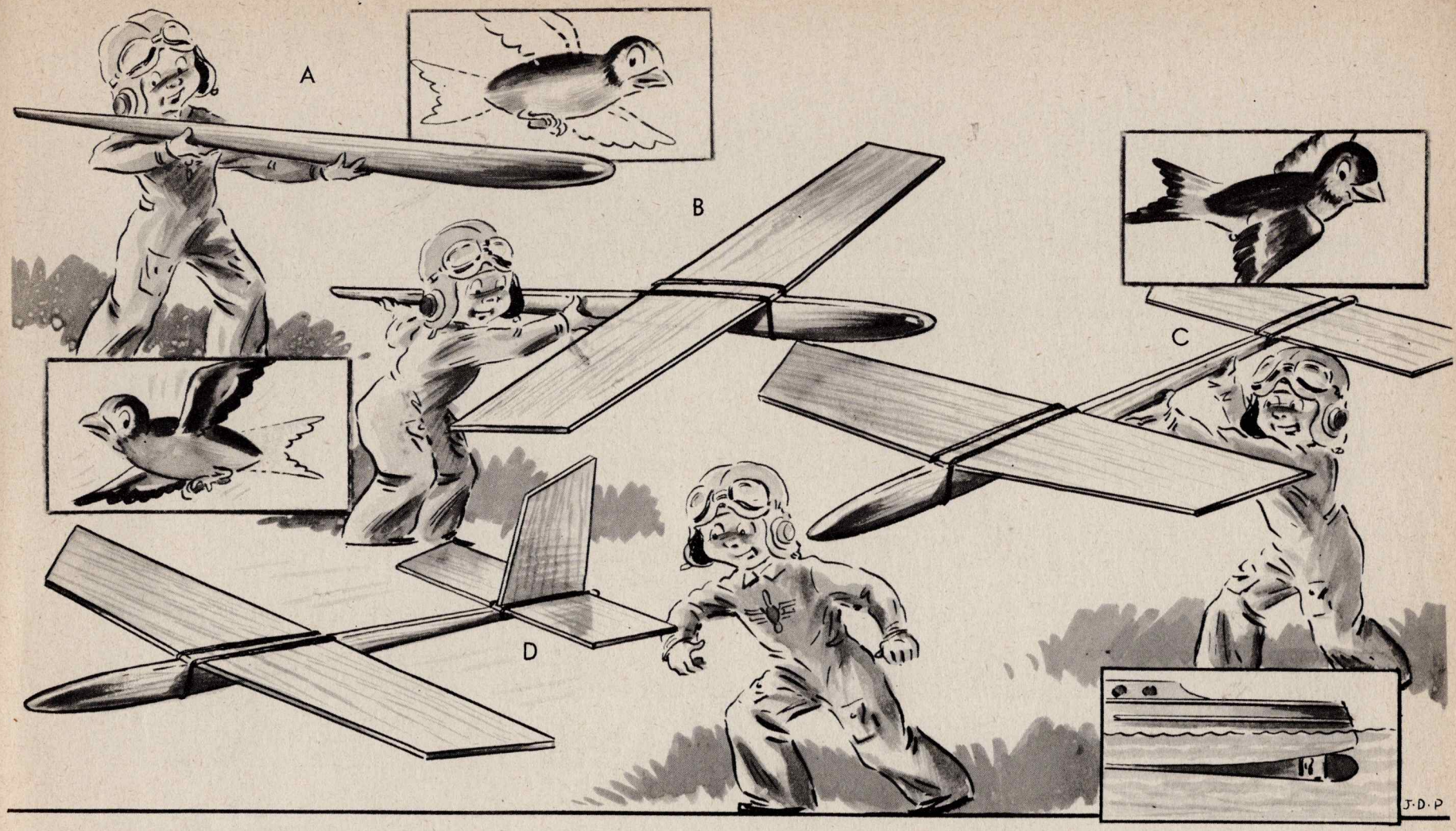
blade. This can be used as it is, for the covered edge protects the fingers. To use a double-edged razor blade, break along dotted line, (*A* in box). Then, with pliers, break at an angle, as in *B*. Cover the top with heavy cardboard, sheet tin, or lead, bent as shown in C. This will prevent the jagged edges from cutting the fingers. A razor-blade holder can also be purchased for 10 or 15 cents.

Finally we have a good *ruler*, preferably a boxwood rule with a metal edge, and a *metal straight edge*, a useful tool in the cutting out of wooden parts.

Along with these you will need a lot of straight pins, a good pair of scissors, some sheets of sandpaper (grades from No. 0 to No. 10 0), model airplane cement, and paper dope.



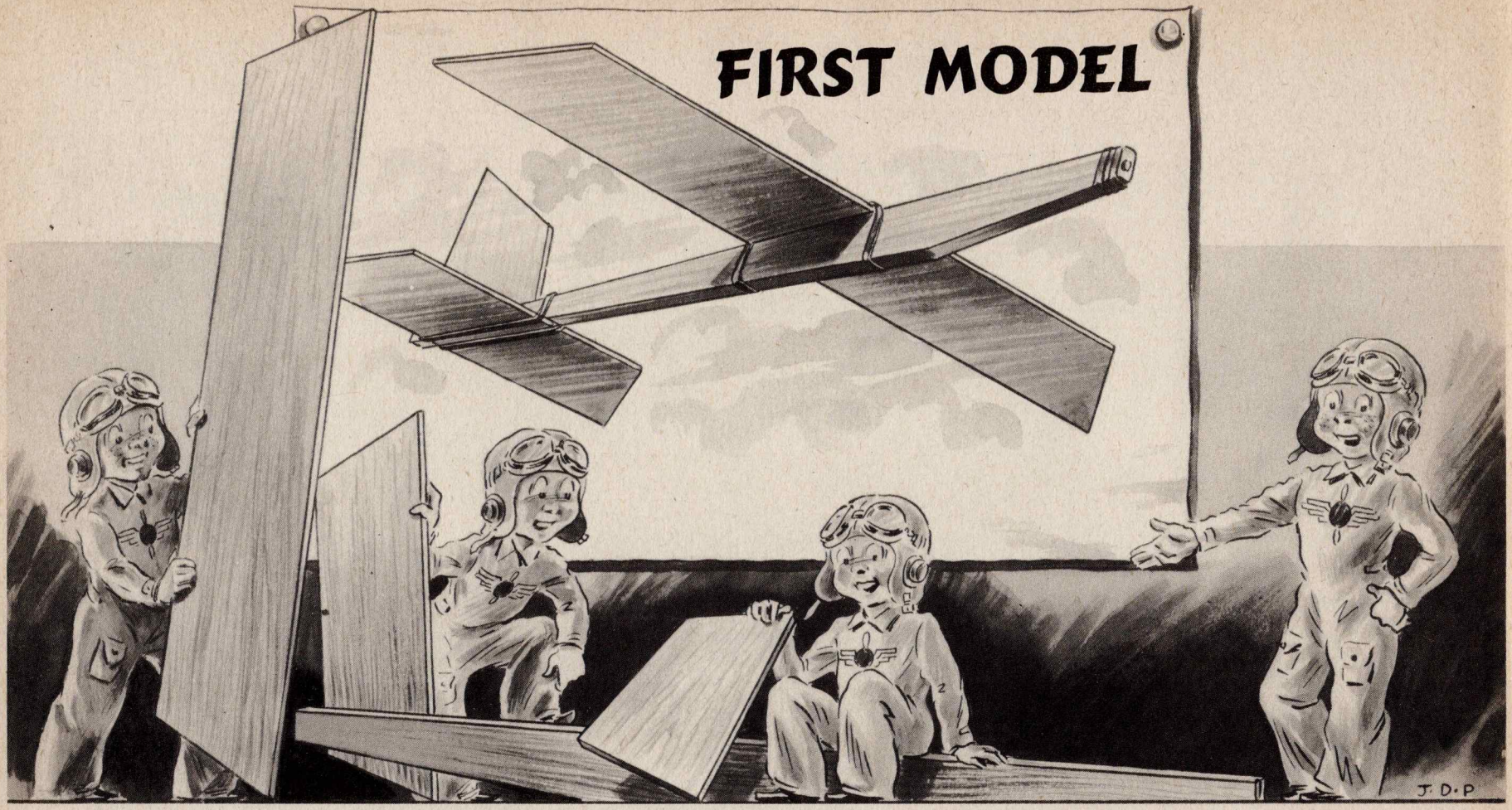
Here are the important parts of a simple model plane. You may already know them all—except perhaps *di-he'dral*. You will probably turn back to this page often.



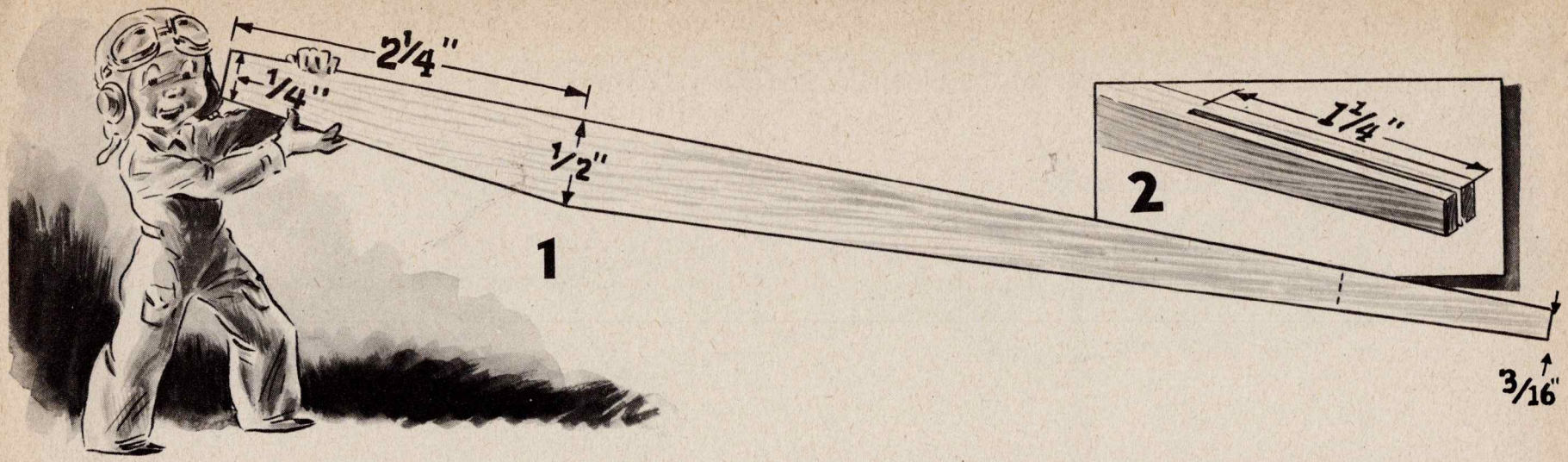
The parts of an airplane are like the parts of a bird. Each has a body, wings, and a tail. This picture shows a simple glider. The fuselage *A* is something like the bird's body. Of course it would not soar into the air because it has nothing to lift it up. The wing *B* supports it like the two wings of the bird. But still it would pitch up and down because it needs a tail. The tail *C* is like the bird's tail. Now the glider will soar, but it will not go straight. A rudder *D*, like that of a boat, is needed. A bird needs no rudder because it is more nearly perfect than an airplane. The tiniest bird is better designed than the finest plane. Also, the bird can flip its tail and flap its wings. Airplanes and gliders—the birds that men make—must have rudders to make them go straight.

Try your glider complete. Then see what happens when you take off the rudder. Now the tail. And now without the wing!

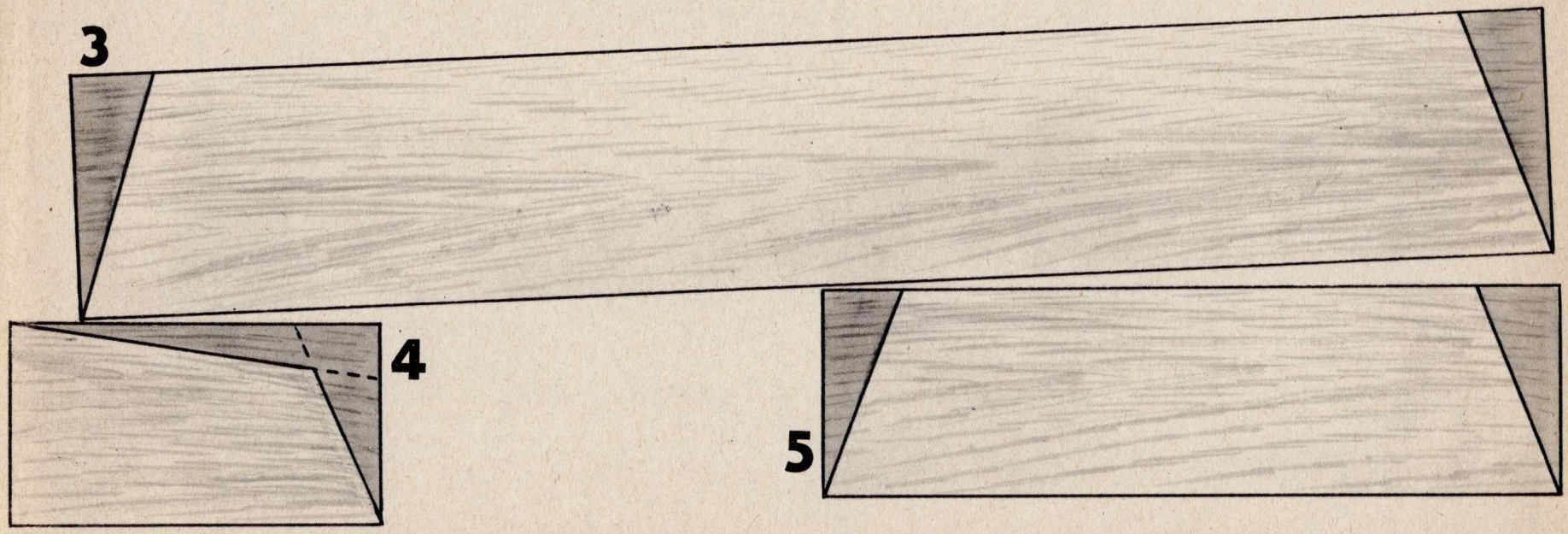
FIRST MODEL



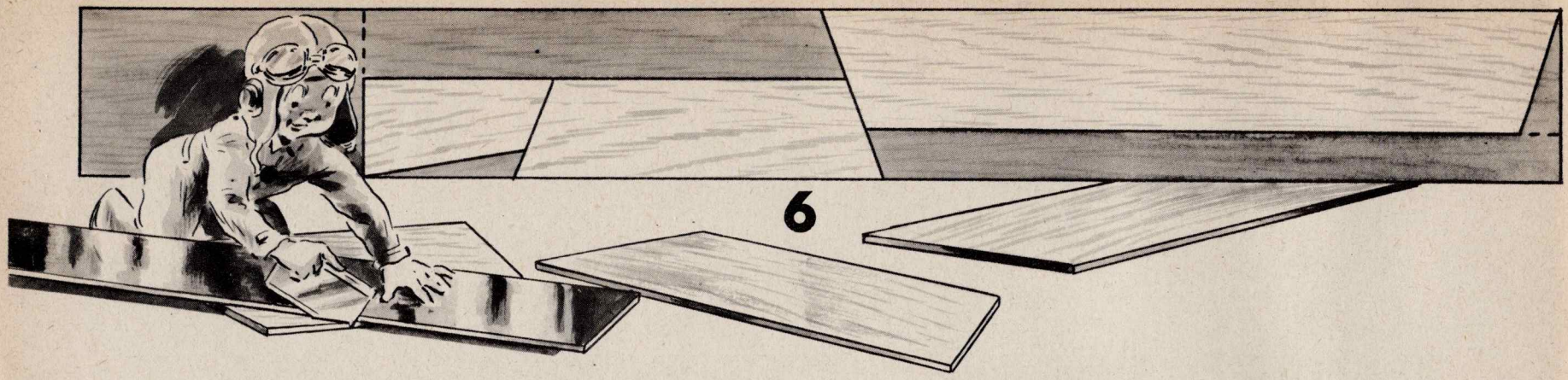
The first model to make is an all-balsa glider. It is an easy one, but you should work carefully just the same. Then you will be surprised at how well your glider will go through the air.



First select a piece of balsa 3/16 inch thick for the fuselage. Cut it 8¼ inches long. Then with your razor blade shape it like the picture (1). At the thinner end cut an up-and-down slot with your saw (2). Be very careful to cut exactly in the middle. Sandpaper the lower edges a little with fine sandpaper. This will make them slightly round.



Now select a piece of balsa 1/16 inch thick, 18 inches long, and 2 inches wide. (This is a stock size.) Three parts come from this piece: the wing (3), the rudder (4), and the stabilizer (5). Each one is to be just the size it is in this book, but do not cut them out one at a time. See how much that would waste (the shaded places in this drawing).



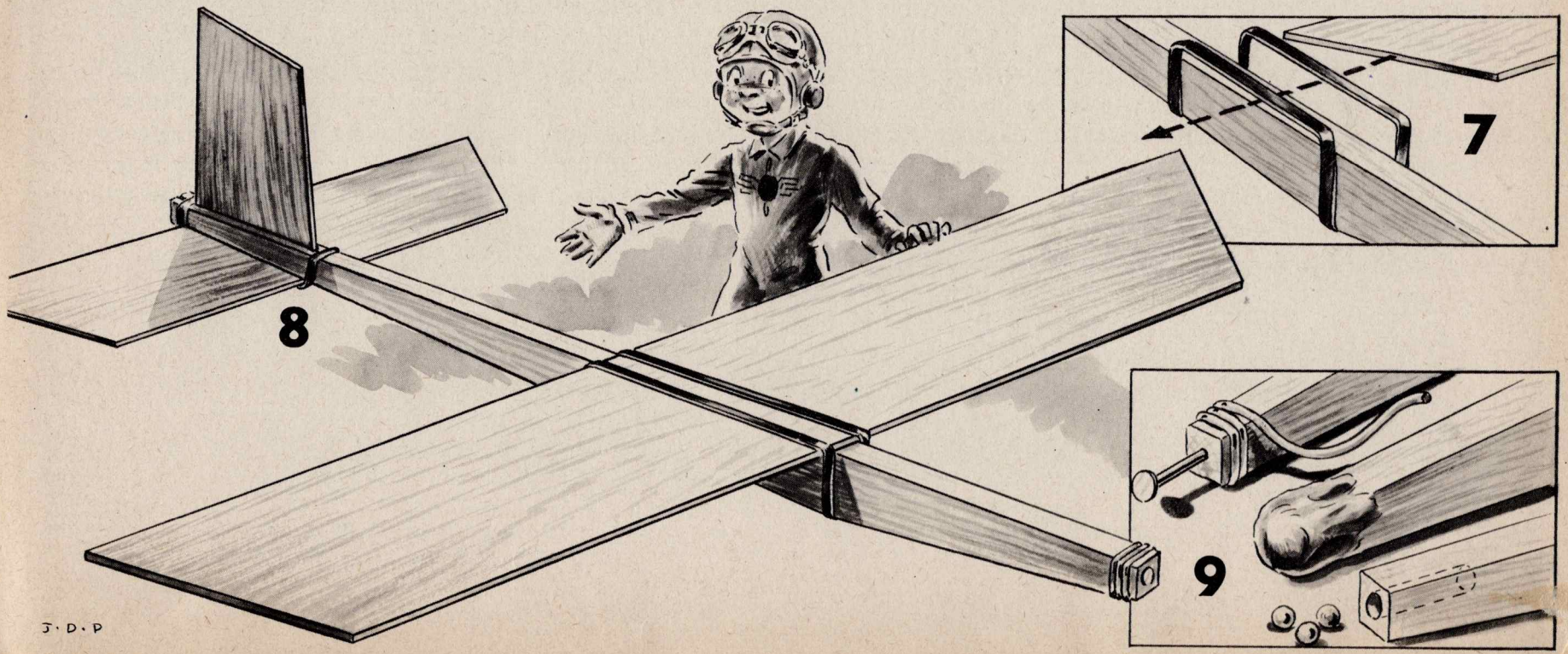
Instead, mark them out as in the drawing (6) and save the left overs to use again.

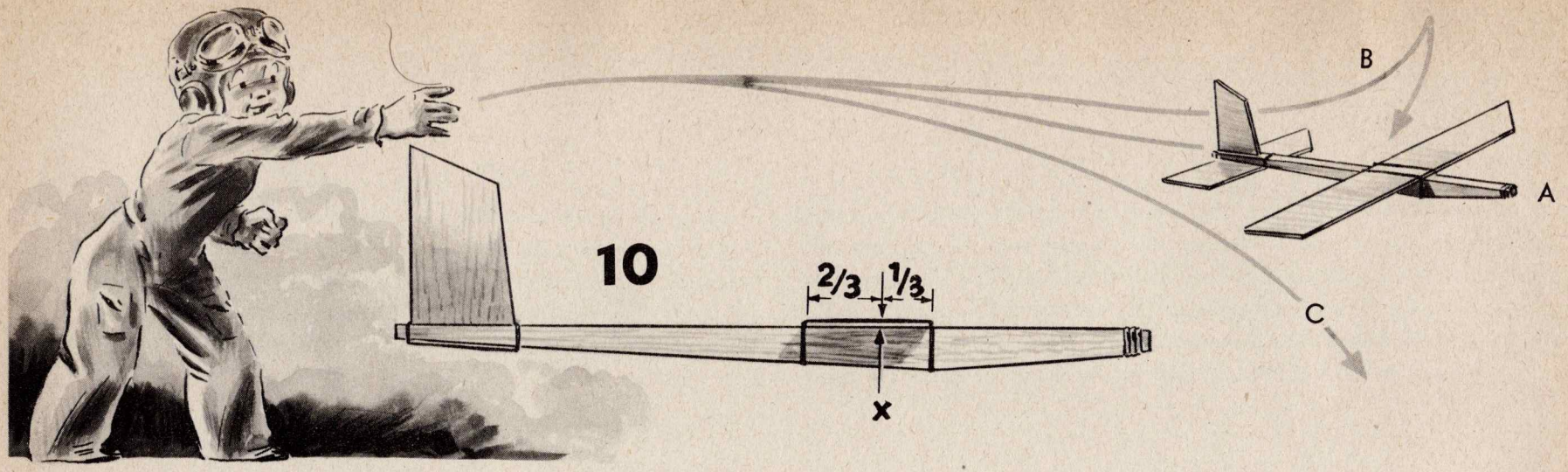
Put a steel ruler or metal straight edge a trifle behind each line, place your razor blade firmly against the ruler's edge, and cut out the parts.

Now sandpaper the edges lightly, keeping them square, and your first model is ready to assemble.

For assembly all you need are two rubber bands. Loop one over the fuselage, as in figure 7, and slip the wing through. Coax the rudder—carefully—into the slot at the rear of the fuselage (8). Loop the other rubber band around this end of the fuselage (the opposite way) and slip the stabilizer into place under the bottom.

You'll have to add a little weight to the nose for balance, and there are three ways in which you can do this (9). (*a*) Wrap the nose with thin wire and drive in a small nail. The wire keeps the wood from splitting. Coat the wire with cement to hold it in place. (*b*) Put a dab of clay over the nose (the best way). Or (c) bore a small hole just large enough to press in a few lead shot. If they fit loosely in the hole, seal the opening with cement.

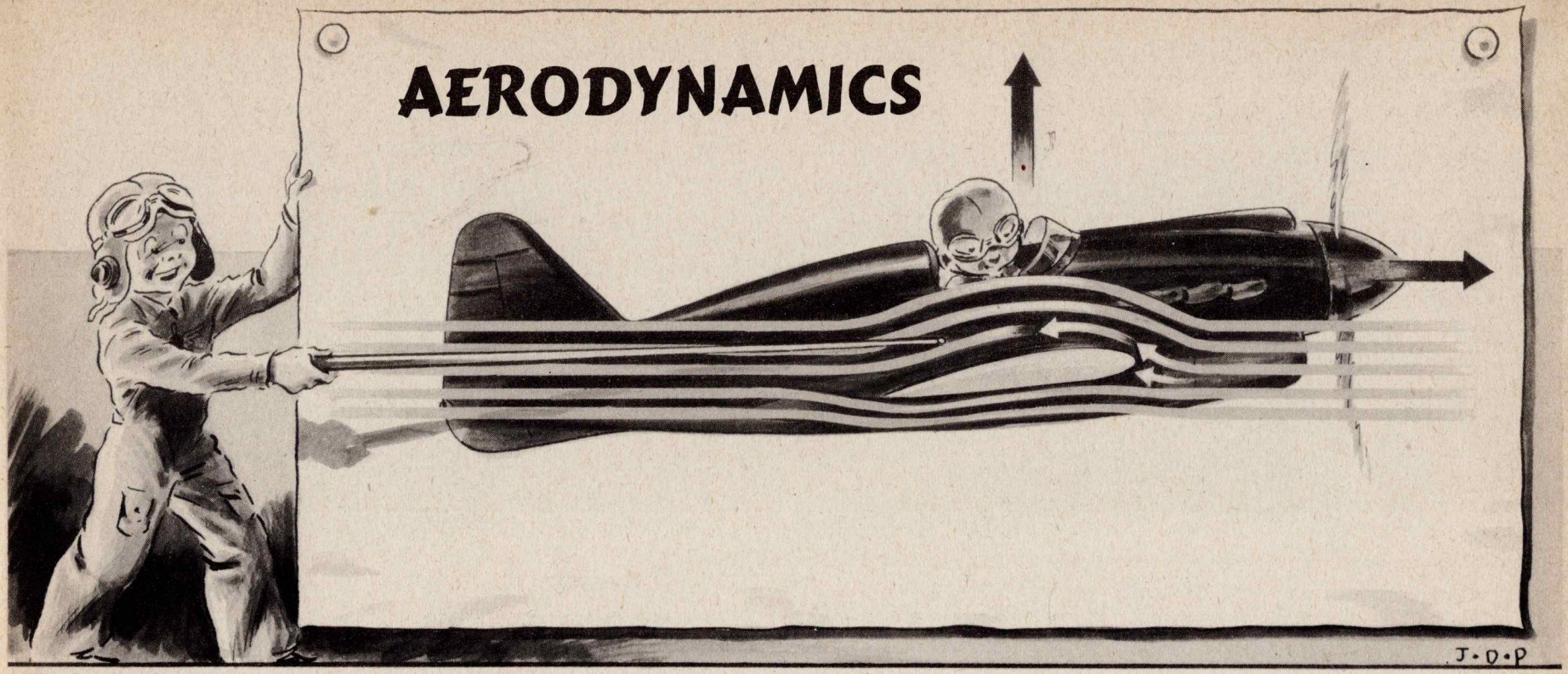




The glider should balance on your finger tip if you hold it up at the point marked X in the picture (10). If the wing is properly centered upon the fuselage, the model will balance levelly in all directions. Note that the leading edge of the wing is directly over the deepest part of the fuselage. The wing may be moved forward or backward slightly until the model balances as desired. It is better to add weight to the nose than to move the wing too far rearward. Don't worry, however, if your glider is a little nose heavy.

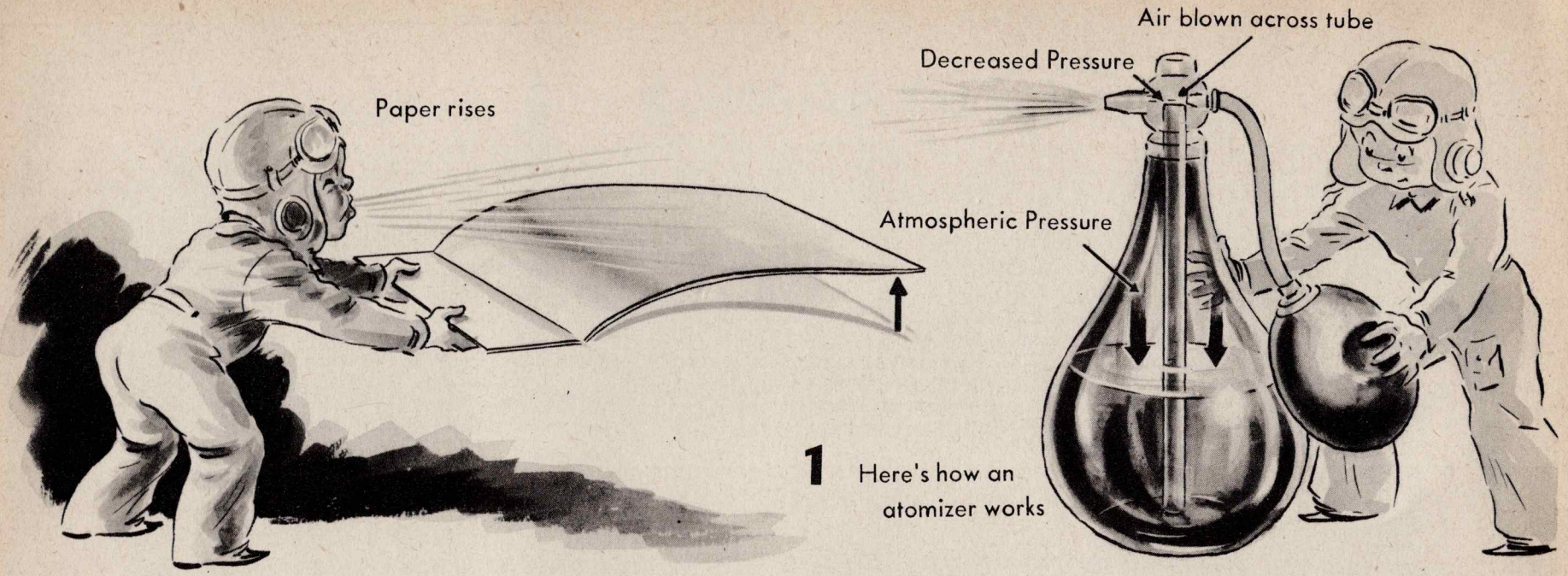
First test the glider. Gently—not too roughly—throw the model forward. The little ship should glide smoothly and follow a line like *A* in the picture (10). Perhaps it noses up (as in *B*) and slides off on its tail. That happens to real airplanes sometimes, and it is called "stalling." Move the wing back and add weight to the nose. If the nose dives (as in *C*), move the wing forward or take some weight from the nose if you have to. (That is why clay is best for weight there.)

Now take her out and give her some flights. When you come in, read the next section—the one on *a-er-o-dy-nam'ics*. It tells what the air does to your ship. Fighter pilots and bomber men, everyone who flies a plane, has to know about these things, too.



In this picture the little airman at the left is pointing at something important; he is pointing at what makes an airplane fly.

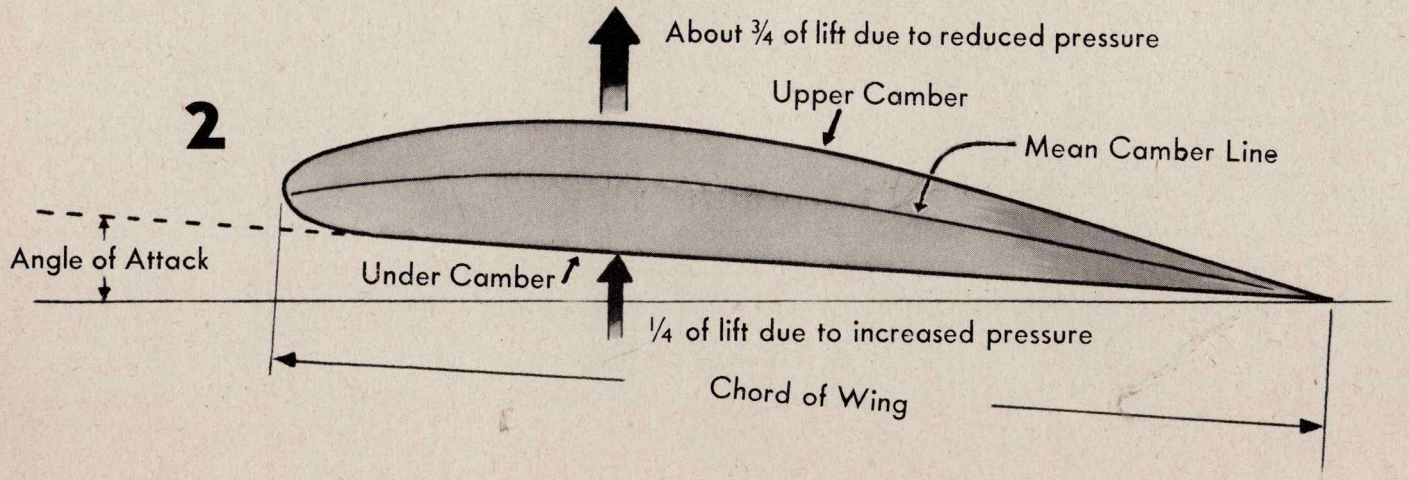
Do you know what it is? Many people think that a plane rises from the ground because the wings are tilted up and the propeller just pulls the airplane forward and upward by main force. This is not true.



1 Here's how an atomizer works

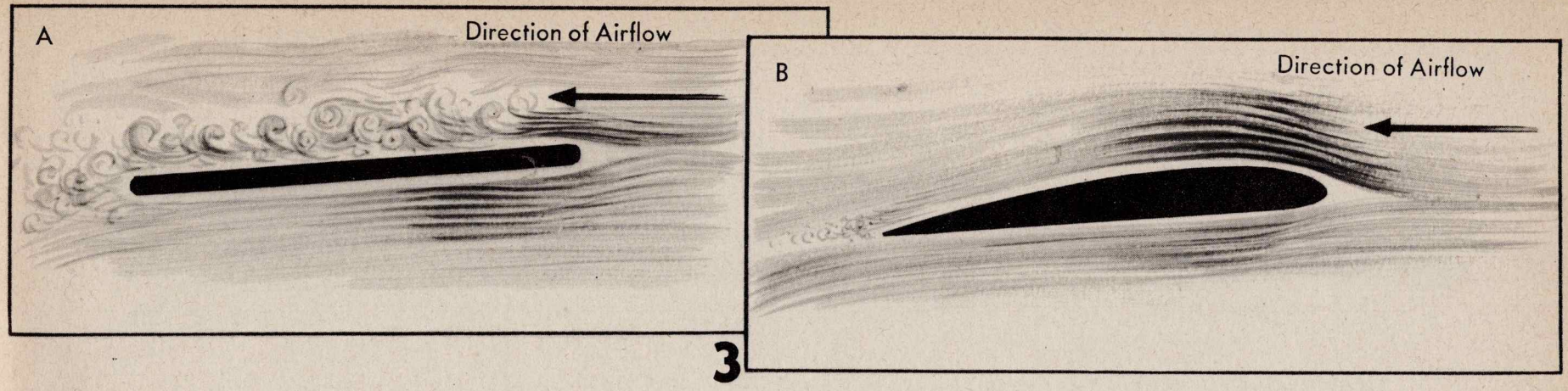
Take a piece of paper and crease it a few inches from one end. Hold it in your two hands, and let it curve down naturally. Now blow over it (1). The paper is not pushed down farther. It seems odd, but it bobs up a little.

That is just what makes an airplane fly. How?



2

Men found out that airplane wings must be curved upward as in figure 2. The wing splits the air which streams over it and under it.



3

When the upper side is curved (3*B*), the upper air must stream over much faster than the lower air. That makes unequal pressure. It is greater below than above. It is less above because there the air is hurrying faster to get up and over the curved surface. That was what happened when you blew over the curved paper. The paper went up because the hurrying air from your mouth made the pressure less on top. So the wing is pushed from below and pulled from above. The same thing happens to both wings. The airplane *has* to go up.

Your first glider has a flat wing. Flat wings do not work so well as curved wings. Nature has given the birds curved wings not unlike those found on airplanes. But, if a wing has to be curved to create lift, how is it that the glider will fly with its simple flat wing?

Here's why. The instant you launch it, your glider immediately tilts ever-so-slightly upward in front (3*A*). This is called the "angle of attack." The wing actually rides the air the way a surfboard rides the water. This angle isn't very noticeable but you can be sure it is there.

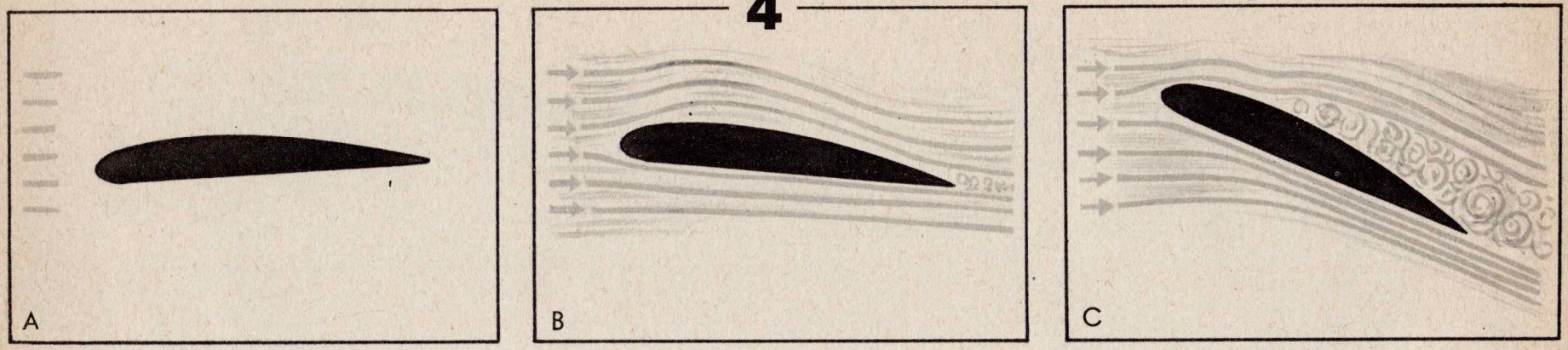
Flat wings are not really the best shape. Not only do they give poor lift; they cause trouble. Over flat wings the air makes little eddies and whirlpools. These hold back the wing. This is called drag. Even the best wings and the biggest planes have some drag.

Other things tug at the plane to hold it back: the air against the wheels, the struts, or anything which sticks out. Even the air passing around the fuselage holds the plane back, too.

On real planes not so much as a rivet head is allowed to stick out. Racing planes are even waxed to make them slip through the air more easily.

Of all the parts of an airplane the shape of the wing is the most important. There must be enough curve to make it lift, but not too much, for then it would create too much drag. Of course a big curved wing does not go forward through the air so well as a flat one. A flat wing would go forward better, but it would not lift well.

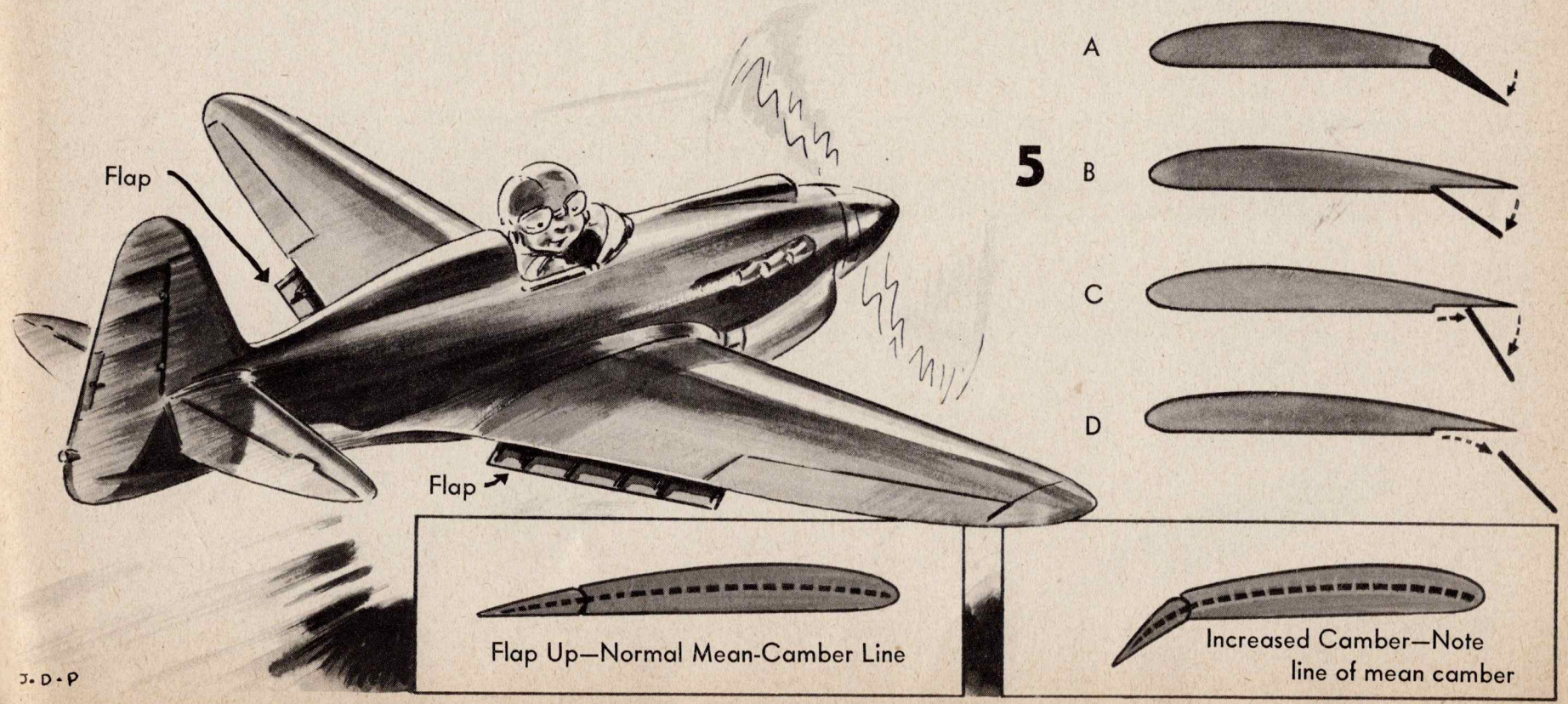
The lift is important at the take-off when the airplane needs to rise as quickly as it can.



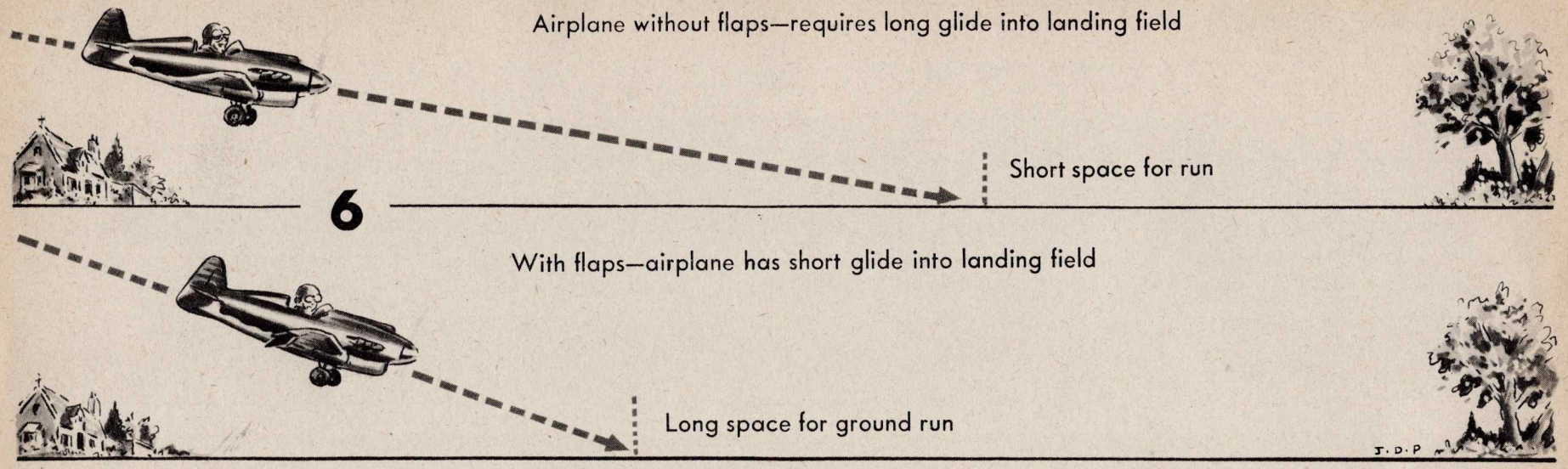
Naturally the wing cannot be slanted down too far forward (as in 4*A*) or the plane will not rise at all. The wing cannot be slanted up too sharply or the air will not flow over that upper surface smoothly (4C). The wing then would lose its lift and the plane would stall. The wing must be slanted to do the most good (4*B*).

At the take-off the wing must give lots of lift. Up in the air it must ride easily. So engineers have made wings with flaps (5). These flaps give extra curve and extra lift at the take-off when they are partly lowered. Then in the air they can be straightened out so the plane will go forward faster. *B*, *C*, and *D* in figure 5 show a split flap in operation, the kind that appears on the plane.

General Doolittle's B-25 land bombers that took off from the carrier to bomb Tokyo had flaps in their wings. These were lowered to give enough lift to get off the short deck of the ship.

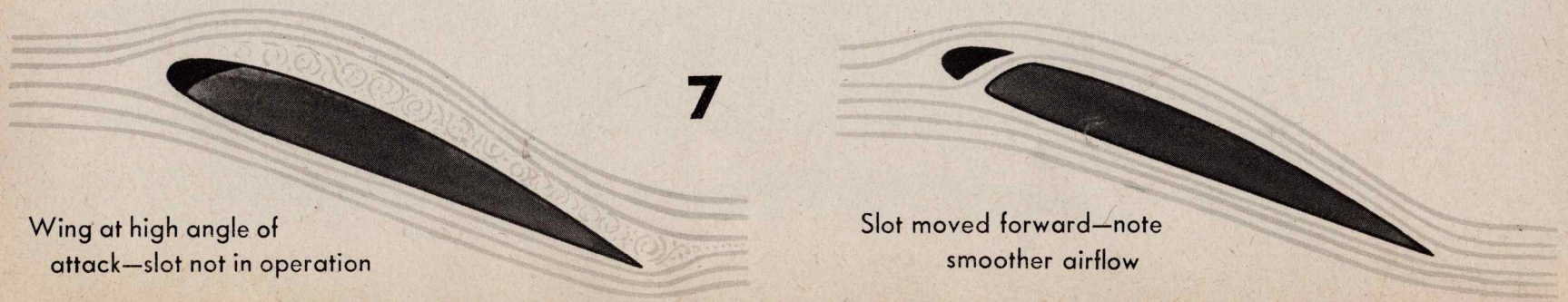


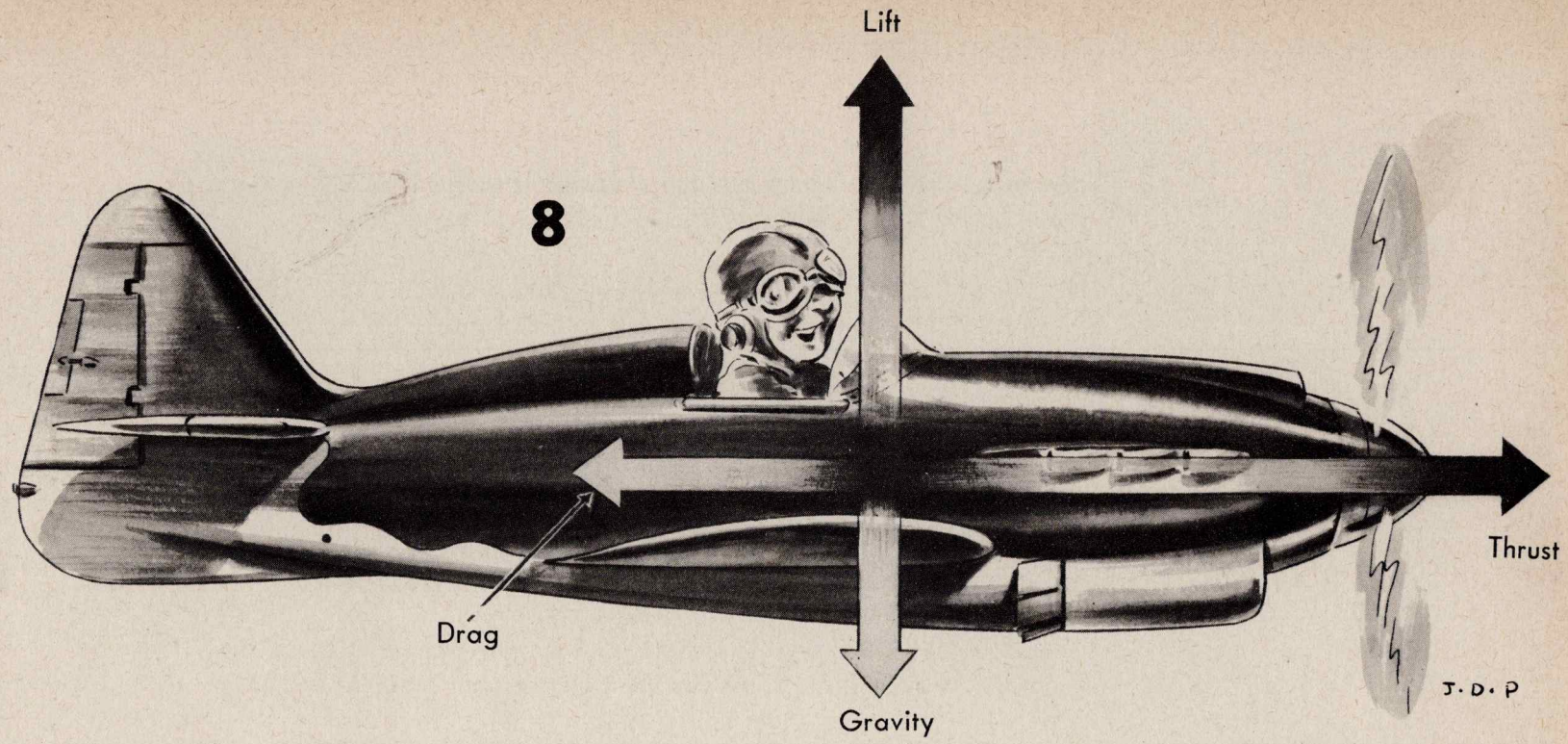
J. D. P



Fully lowered, these flaps act as air brakes to slow down a plane when it is going to land (6).

Another thing that helps the lift of the wing in a steep climb is a slot which is sometimes placed on the leading edge (7). This slot lets some of the air flow through instead of over. Otherwise, with the wing tilted sharply, those whirlpools would form. The slot means that the plane can be slanted up more sharply without any whirlpools' forming.





Why does an airplane fall to the ground? Well, anything falls to the ground if you let go of it. That's right. It's gravity. Gravity is always trying to pull everything down to the ground.

Gravity is pulling down. The wings are pulling and pushing up. Drag is pulling back. The propeller is pulling forward (thrust).

If the wings break off, there is no more lift. The plane crashes.

If the propeller stops, the plane slows down and the wings stop lifting. The plane must dive to land.

If the wings are bearing up and the propeller is pulling forward, the plane will fly. But it may not fly well because of several other things (9):

The plane can pitch up and down around the lateral axis.

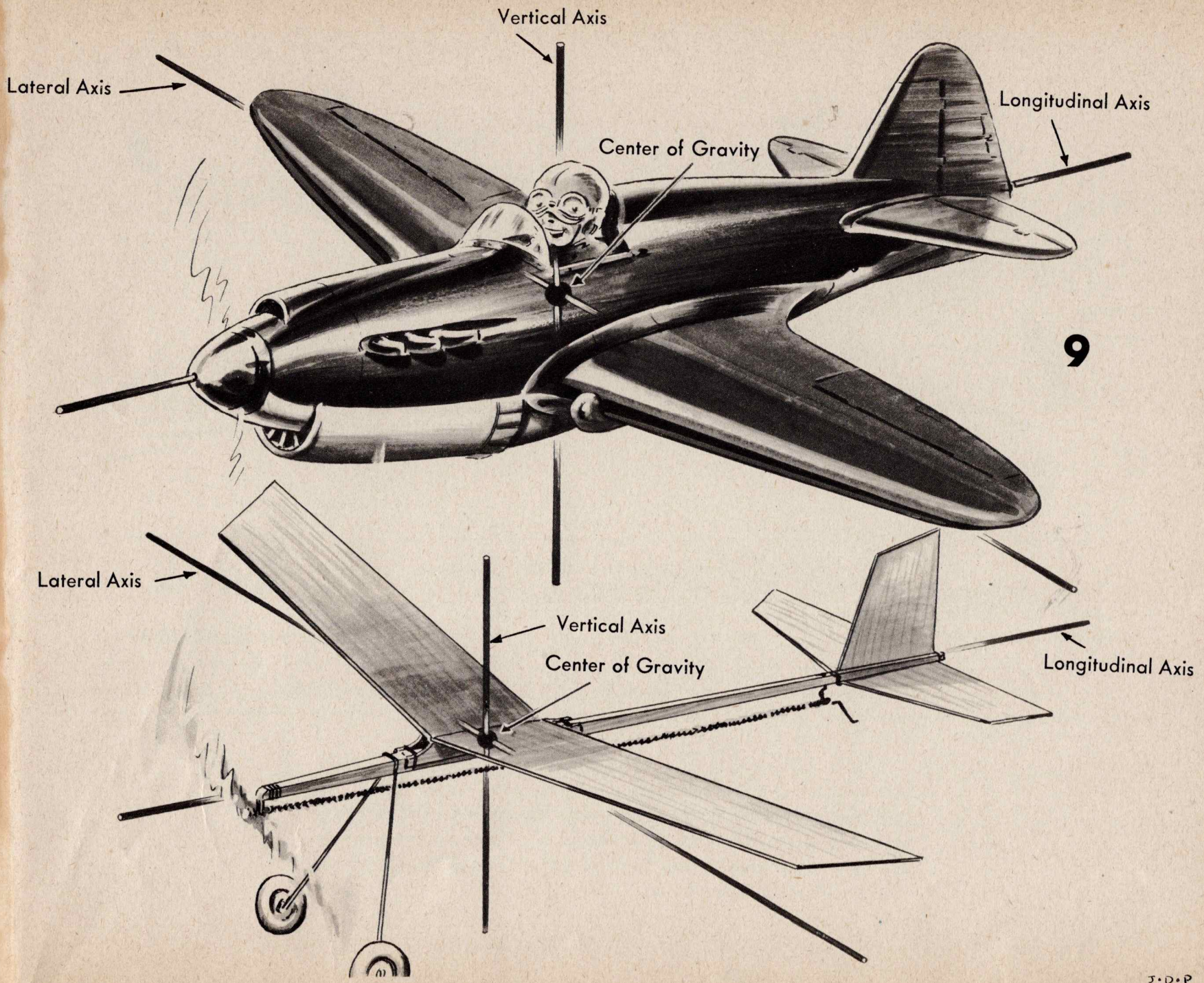
The plane can roll back and forth from side to side around the longitudinal axis.

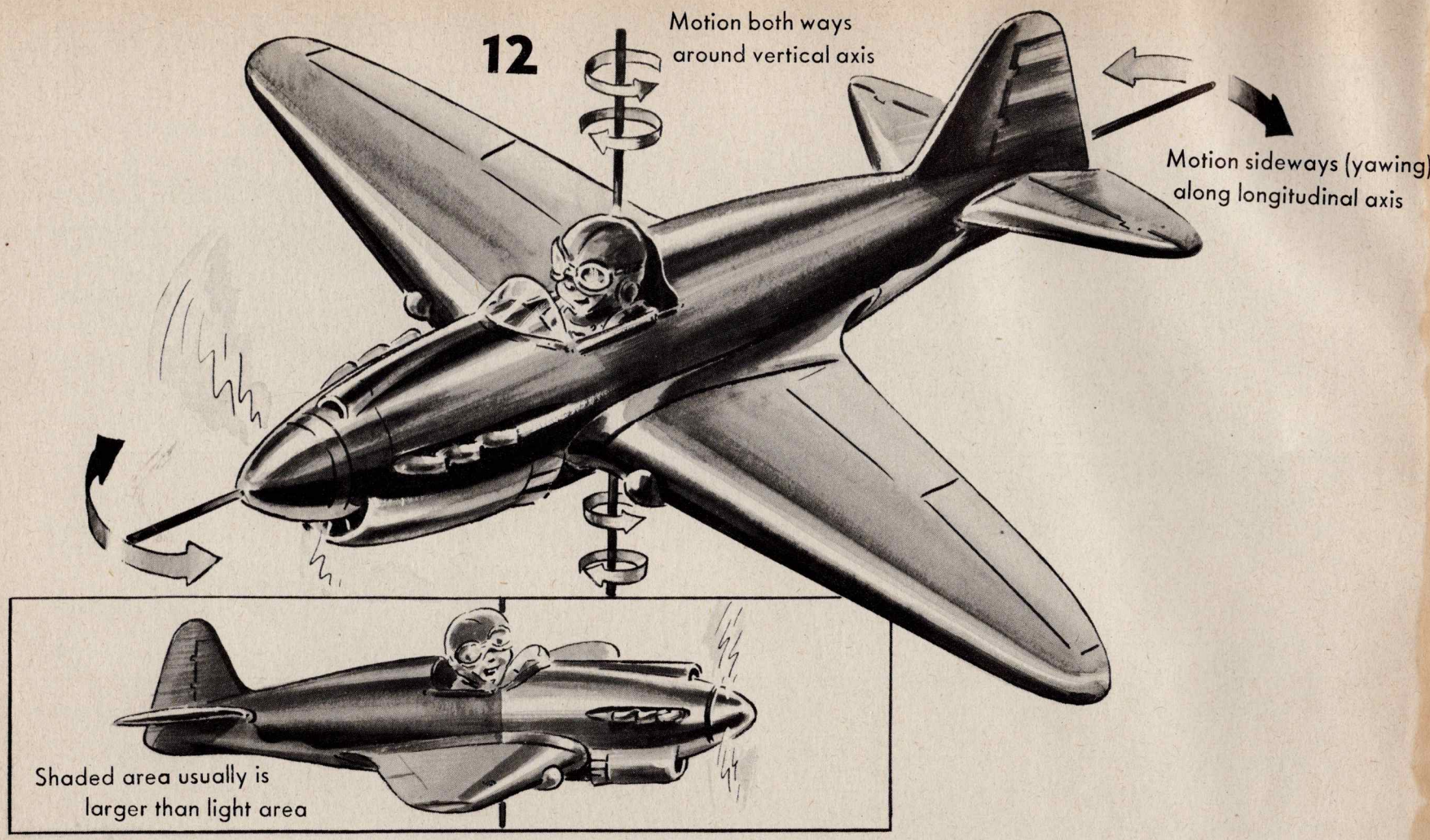
The plane can swing to and fro like a weathervane around the vertical axis.

These things can happen to your model and to real planes too.

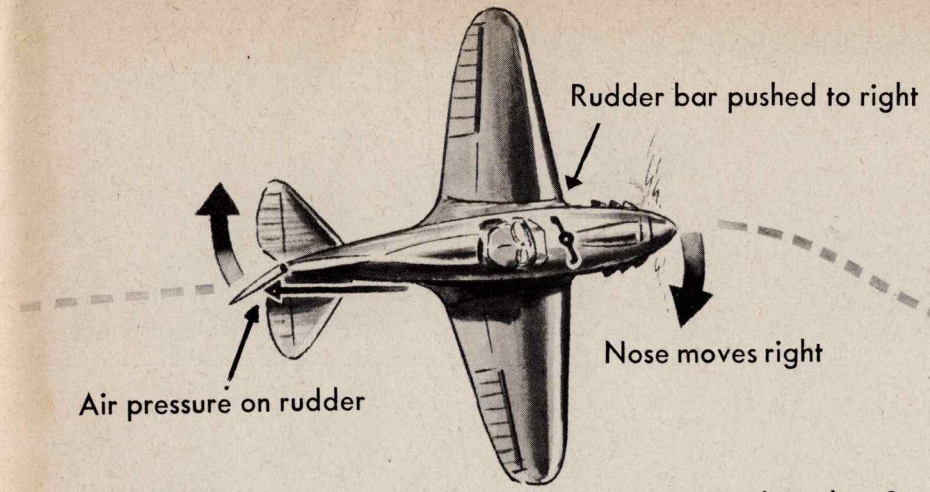
At the same time that an airplane revolves *around* one axis (for example, pitches by revolving around the lateral axis), it is disturbed *along* another axis (in this case, the longitudinal axis), the ends of which move out of their normal positions.

Of course engineers have found ways of stopping these three things, and you will want to know how for building your models.


Vertical Axis
Lateral Axis
Longitudinal Axis
Center of Gravity
9
Lateral Axis
Vertical Axis
Center of Gravity
Longitudinal Axis
J·D·P

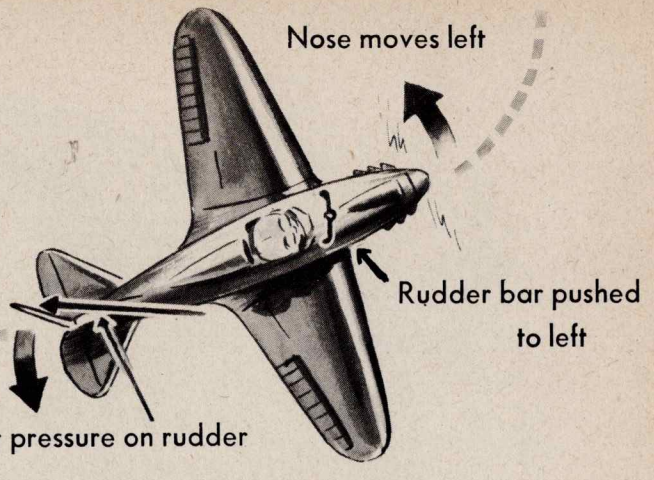


Finally, the thing which keeps a plane from swinging to and fro is a simple thing to remember: There must be a little more airplane behind the middle than in front. Just as the tail of a kite keeps it steady, the design of an airplane, large or small, makes sure that it will keep straight. That is because there is always a bigger surface behind the vertical axis than in front of it. For exactly the same reason a weathervane always points into the wind.

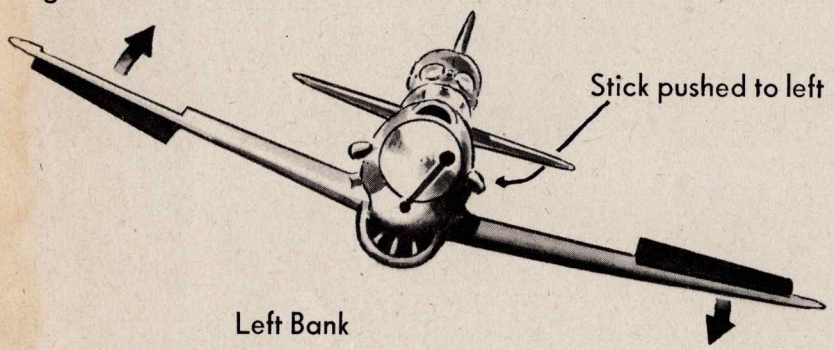


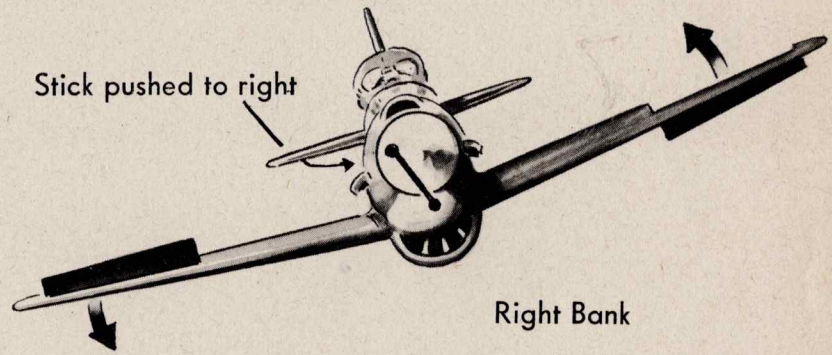
Now would you like to take an imaginary trip in a real airplane? You climb into the cockpit, fasten your safety belt, and soon you are five thousand feet up. Your controls are the rudder foot bar and the stick.

You push the rudder bar to the right. The rudder slants to the right. The plane itself swings to the right. This is opposite to the steering of a sled.



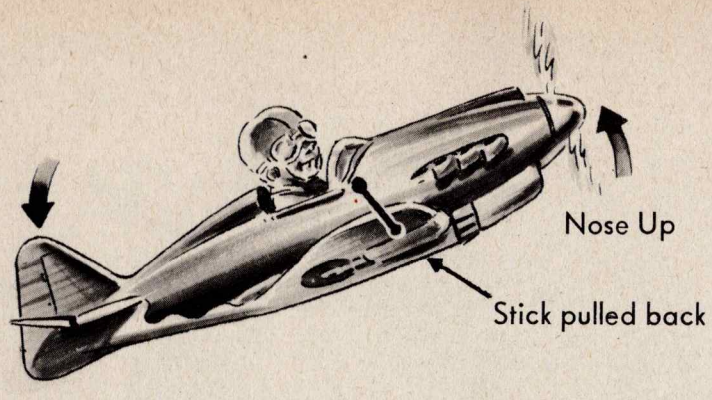
You push the rudder bar to the left. The rudder slants to the left. The plane itself swings to the left.



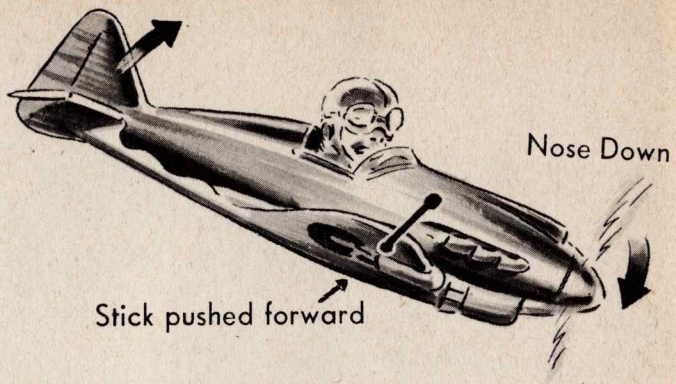


You could turn without the rudder. You could push the stick over to the left. This would make the left aileron go up and the right go down. The plane would bank to the left.

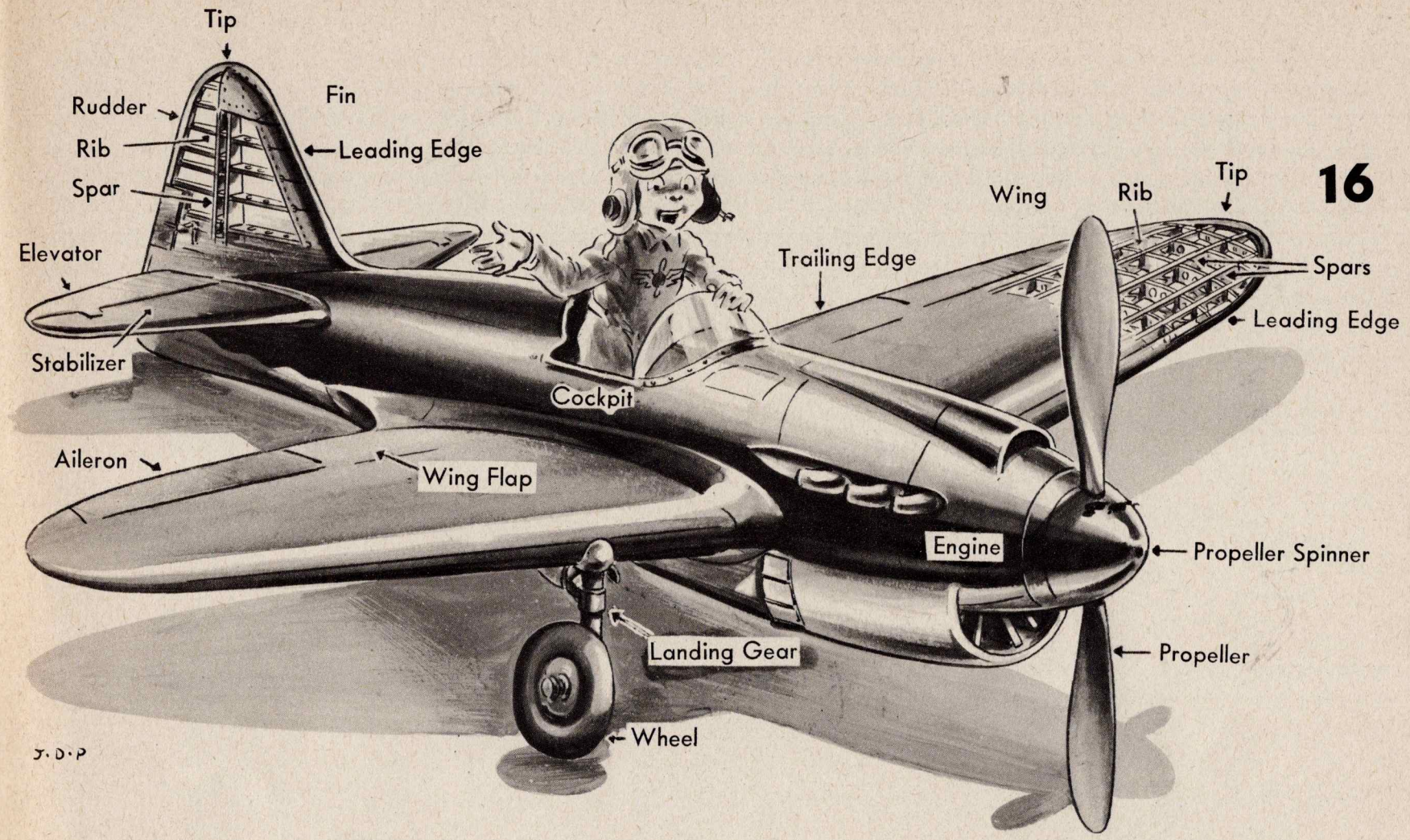
Push the stick to the right. Up goes the right aileron; down goes the left. The plane banks to the right. The best turns are made by moving ailerons and rudder at one time.



Pull the stick back. The elevators slant upward. Down goes the tail and up goes the nose of the plane.



Push the stick forward. The elevators slant down, and down goes the plane's nose.



Now that you have had your first flying lesson with a real plane, here is a picture of one with the names of the parts. Notice that the parts of a model are called the same as those of the real plane in most cases.

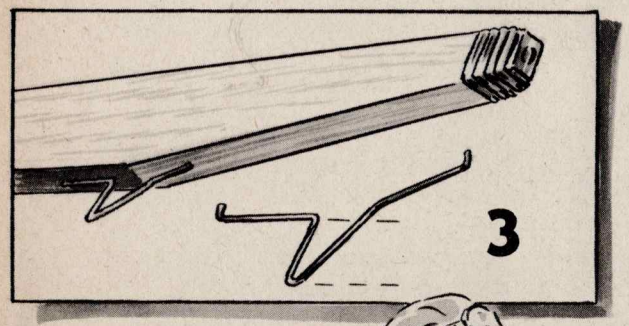
LAUNCHING

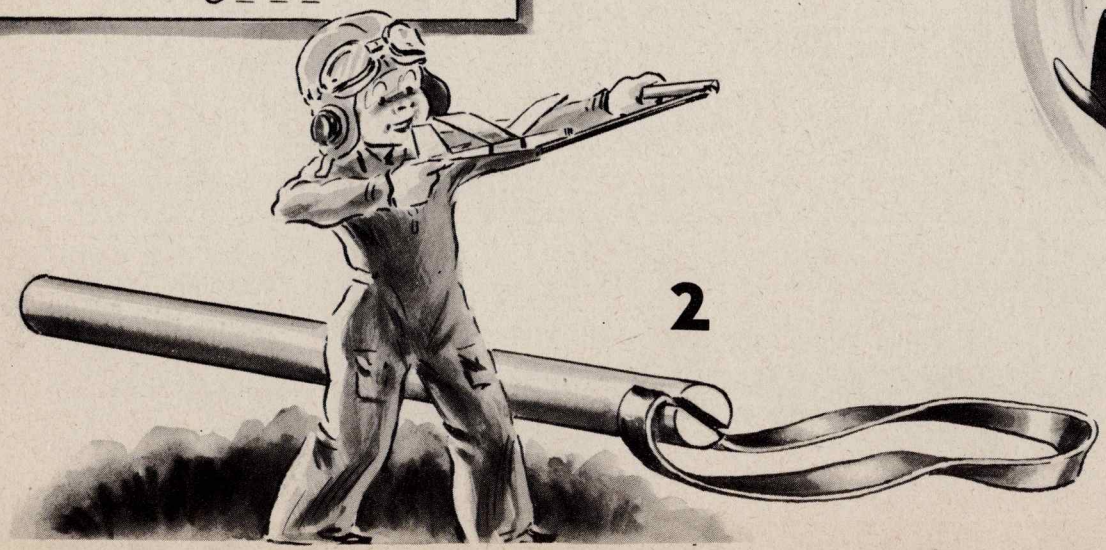
The easiest way to launch your new glider is simply to throw it gently forward with a pushing motion of your whole arm. Point the nose up; bank one side up a little (figure 1). Always launch against the wind. The model will turn around by itself and sail with the breeze, riding the air currents. The outline of the model in these drawings is shown in the next section on drawing to scale.

You can get more distance with a slingshot launcher, which is easy to make. In a piece of ¼-inch dowel (round stick) 8 inches long, cut a ½-inch slot at the end with a saw. (Dowel rods are hard to cut from the end. Clamp it in your vise, and don't be in too much of a hurry.) Slip a ¼-inch flat rubber band (this is a standard size model-airplane rubber) into the slot, as in the picture (2).

A hook must be attached to the under side of the glider. Bend a piece of stiff wire—.028 music wire or baling wire will do—into the shape in the drawing (3). Now force the ends into the wood. To do this, you may have to file them sharp and hammer them lightly into the soft wood. Cement the hook in place.

Now for the launching. Simply loop the free end of the rubber band over the hook, draw the glider back carefully, and let her go. Do not pull back on the rubber all the way at first. Just try short flights until you get the hang of it.







J·D·P

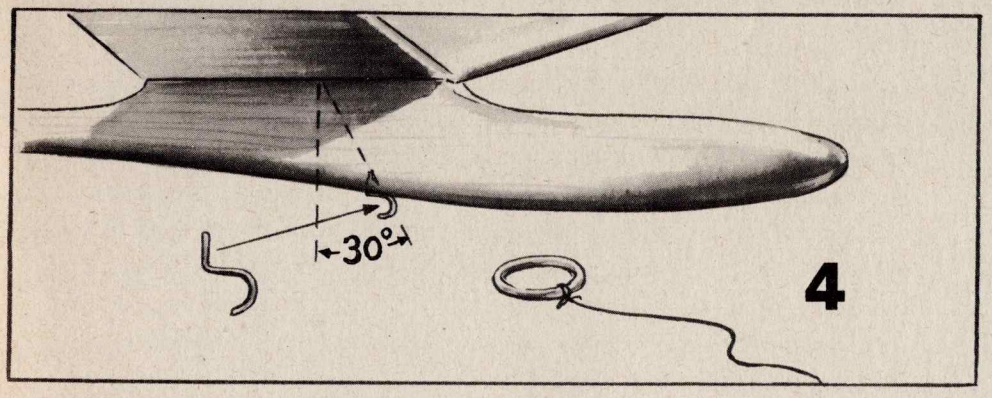
Still more distance can be added to your glider flights by a third kind of launching. This is the catapult. In olden times a catapult was used for throwing large stones at the enemy. A catapult is better for the larger models, but you can certainly make it work with the first, simple glider.

Again make a hook of .028 music wire. A small one as in the drawing (4) will do. Find the point where the model balances on your finger and make a mark ⅜ of an inch forward of it. Attach the hook here. As the glider rises, this will give it an angle that will allow the ring to drop off. Again force the end of the hook into the wood and make it fast with a drop of cement.

In the middle of your own flying field drive a short stake into the ground (figure 5). Next take a loop of ¼-inch flat rubber band from 3 to 6 feet long (or several loops tied end to end) and attach one end to the stake. Tie a 3-foot piece of heavy string to the other end. To the free end of string fasten a small ring, like a curtain ring.

Everything is set. Place the ring over the hook, pull the glider back as far as you dare, and let fly. Remember to point your glider into the wind at a 45-degree angle.

When the wind changes direction, you only need to walk around the stake until you are facing it again.



4

5

DRAWING TO SCALE

The drawings of the first glider were made "life size" in the book. That is, the glider you made was the same length and width as the drawings.

We cannot make all the drawings as large as the other plane models will be. The drawings will have to be shown smaller and you will have to enlarge them.

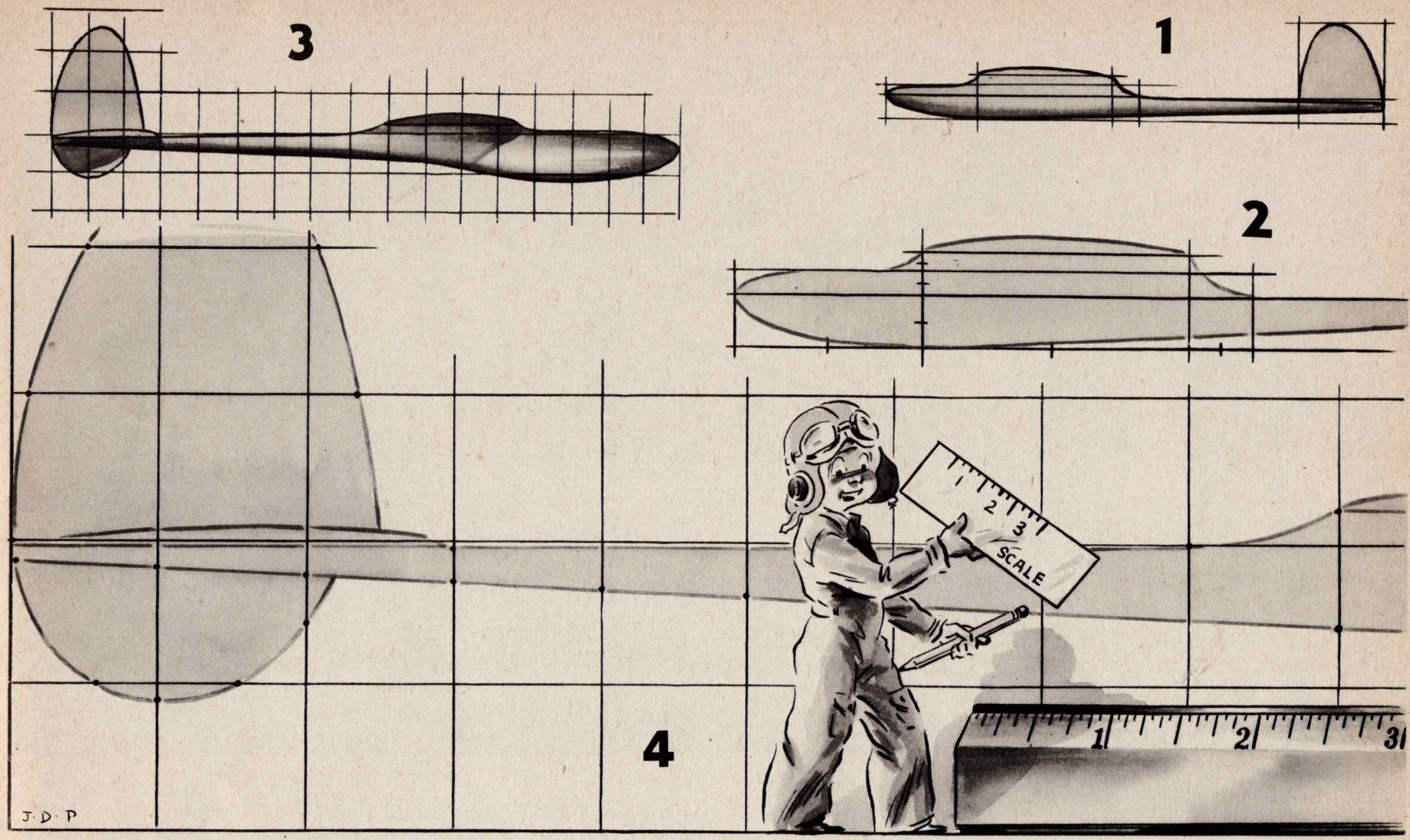
There are two ways to do this.

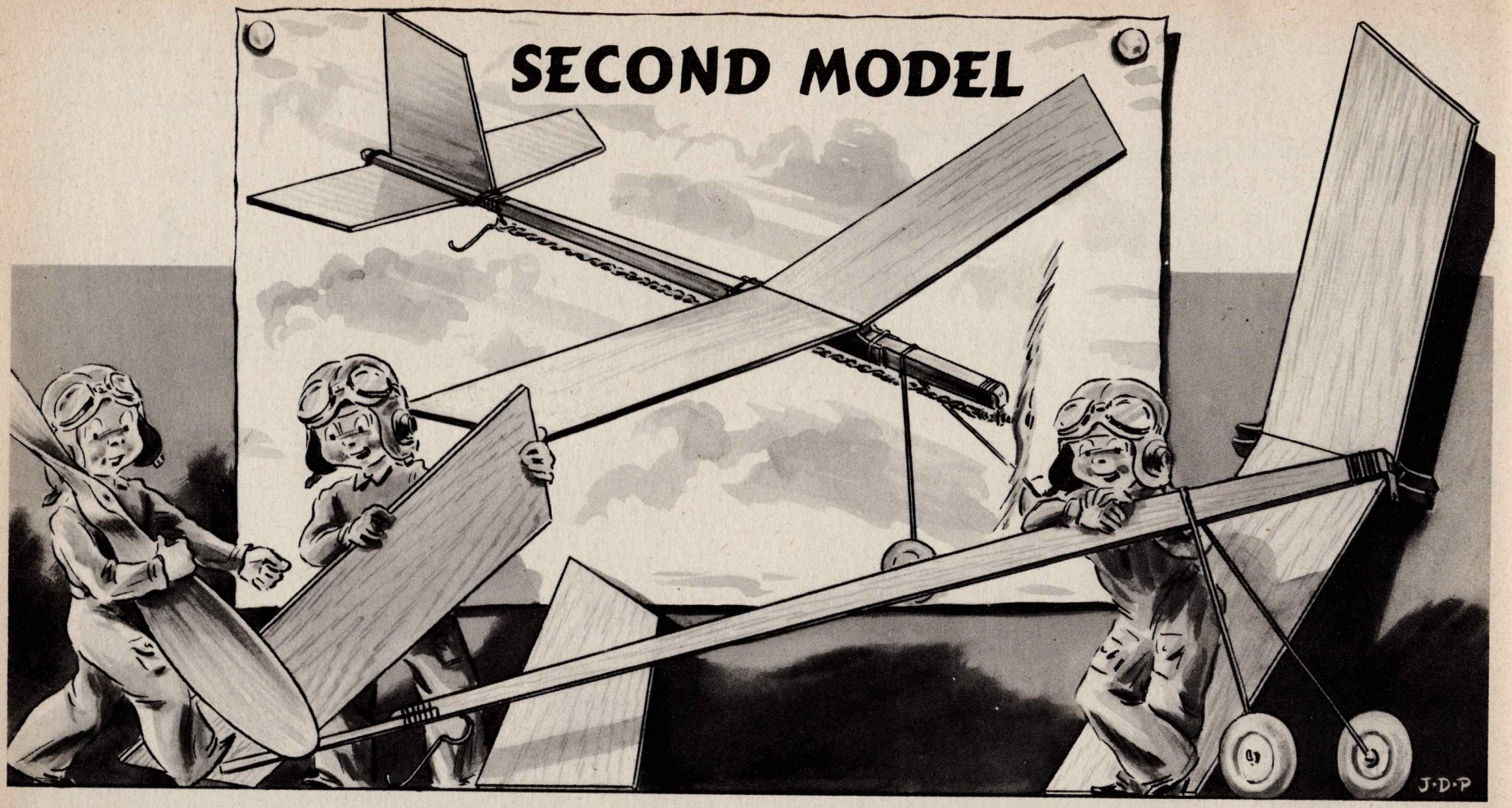
Suppose you want to make a plane twice as large as the drawing is in the book. You measure the length of the drawing (1). It is 3⅜ inches. "Then double that will be 6¾ inches," you say, and you mark out 6¾ inches on another sheet of paper (2). (In this drawing we haven't taken room to mark out the entire length.) You measure the height of the fuselage. It is ¼ inch. You mark out ½ inch at the right place on this piece of paper. And so you continue. Some of the lines you have to sketch in, but at last you have a drawing twice as large as the one in the book. If you want it three times as large, you multiply everything by three; if six times as large, you multiply everything by six.

Now this way works well if there are only a few curved lines. If the drawing has many curved lines, or if it is a complicated model, you'd better make a scale drawing. This is more work, but it is not hard.

Suppose you want plans four times as large as those in the book. Mark off the entire drawing into ¼-inch squares (3). On a large sheet of paper, draw many crossed lines an inch apart so that the paper will be all marked off into one-inch squares as in figure 4. Start at one side of the drawing in the book and, following the outline there, make lines in the big squares that will cut the sides just where they are cut in the little squares. Be careful to keep track of which square you are working in! (You can number them if necessary.) Gradually your working plan will take shape.

If you want a plan eight times as large, divide the book drawing into ⅛-inch squares.


3
1
2
4
SCALE
1
2
3
J·D·P



By this time you are ready to try your hand at another model. The second model will not be a glider, but a plane with a propeller and "motor." It will fly by itself.

Like the glider it will have:

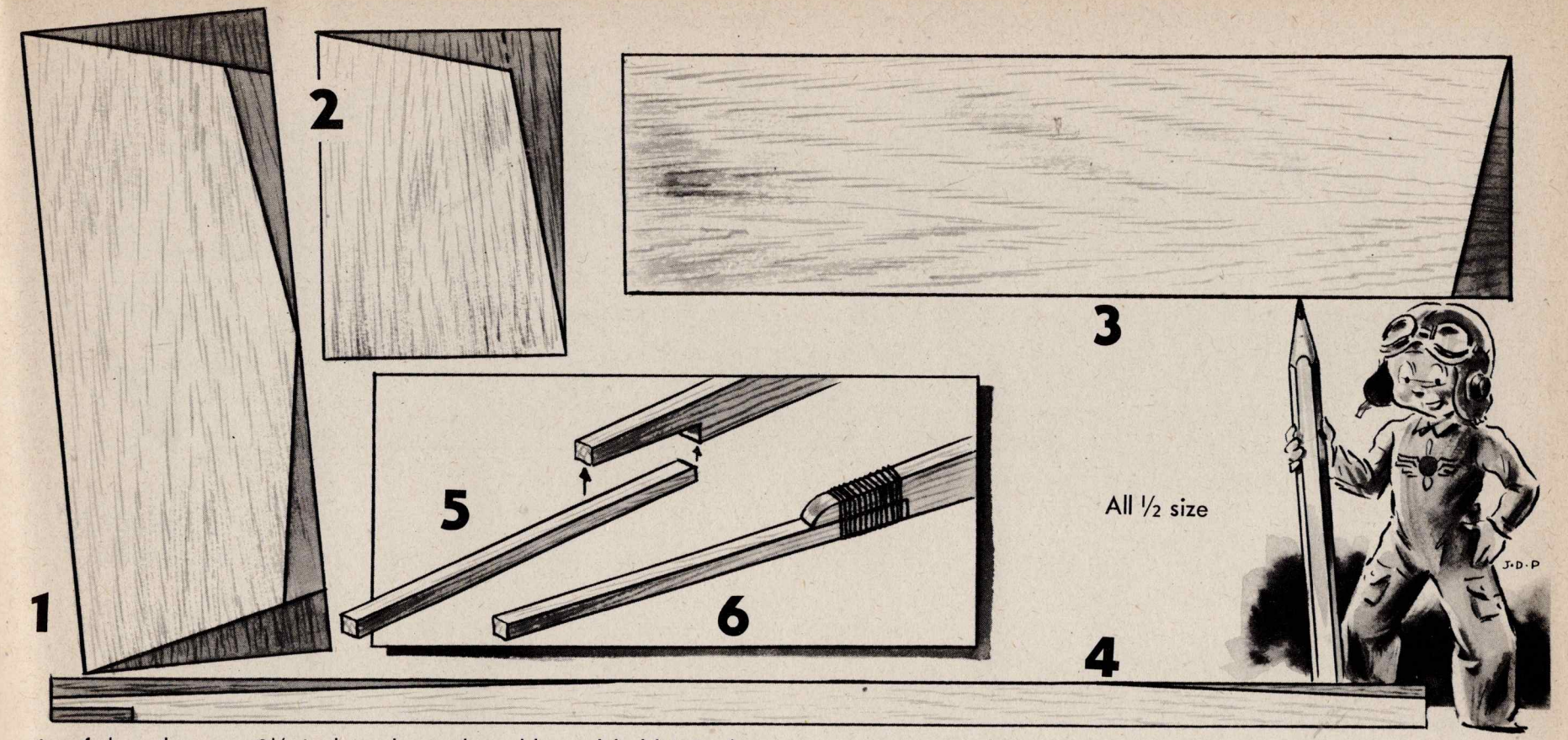
stabilizer (figure 1.)
rudder (figure 2.)
wing (figure 3.)

Notice that, unlike the glider, this plane has a pair of wings. Two pieces like the one shown in the picture (3) will be made.

You will have no trouble in laying out the four pieces: stabilizer, rudder, and two wings. They are drawn in the book one-half of actual size. This means that you will need to double the lengths and widths of the drawings for these pieces. You will not need to make a separate pattern this time. Just take a sheet of 1/16-inch balsa and mark out these parts as they are drawn here (figures 1, 2, and 3). Remember to *double* the size of everything, and remember to make *two* wings!

Again cut out the pieces with razor blade and straight edge. Sand them just enough to make them smooth.

The wings are ready for cementing together, to give them dihedral. Lay the wing panels on the table, square ends together. Pin around the sides and tip of one panel to hold it in place. Raise the

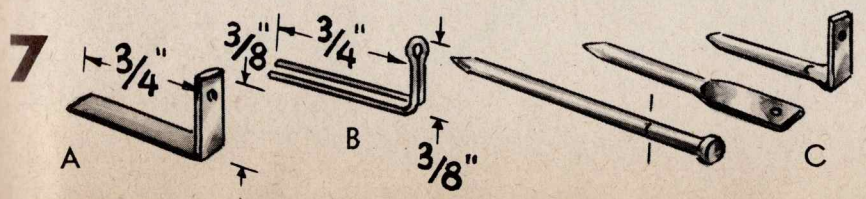


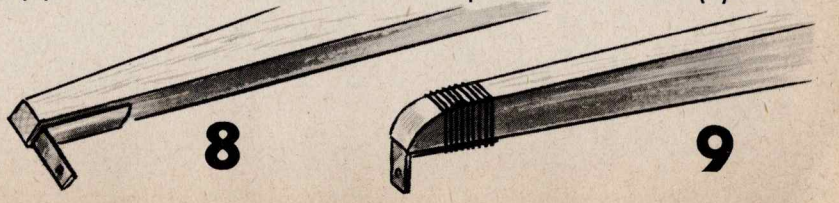
tip of the other one 2½ inches above the table and hold it in this position by means of a block. Cement the panels together at the joint, being certain that the joint is tight before you begin.

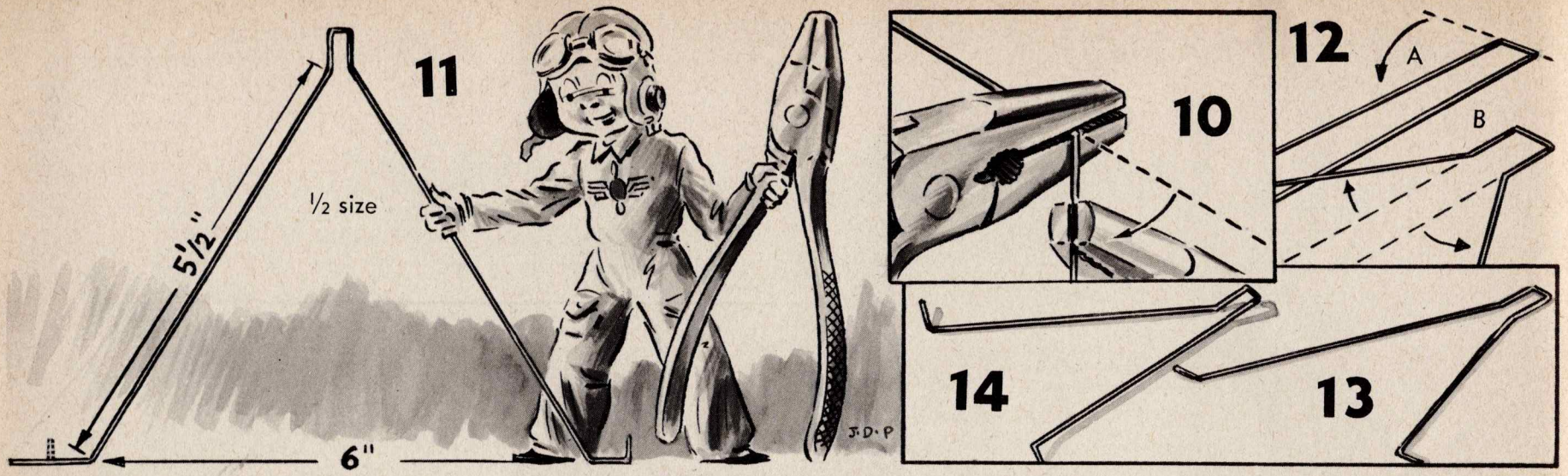
While the cement is drying, begin on the motor stick. This, too, is half size in the picture (4). Cut it out of ¼ x ½-inch balsa. Sand it smooth. Then cut a section of ⅛-inch square hard strip balsa 4¼ inches long as in the picture (5), and cement it in the notch in the rear of the motor stick (6). This is called the tail boom. Sand the motor stick to curve down to ⅛ inch each way at the tail boom, then wrap tightly with thread. A thin coat of cement over this joint will add even more strength.

Next comes the bearing at the nose. You can buy one ready made like that shown in the picture (7*A*). You can make one by bending .020 music wire into the shape shown here (7*B*). Or you can make one out of a brad (7C). To do that, cut the head off with a pair of pliers, then beat out the shank with a hammer until flat. Now drill a hole in the flat portion and you have a bearing as good as you will buy.

Whatever one you use, cement it solidly to the nose as in the picture (8), bind with thread and coat the joint with cement (9).







The next job is to make the wire fittings. This is a little harder. To bend the tough music wire is something that takes practice, and at first you may not find it easy.

Use two pairs of pliers, one in each hand. See how you can bend the wire sharply down to make a right angle, as in figure 10.

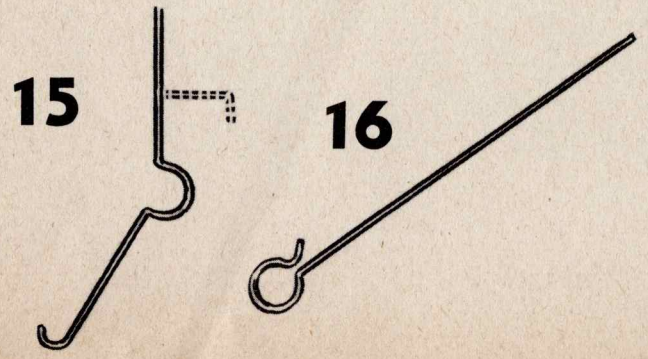
The first wire part on the program is the landing gear. Look it over in the drawing (11). The narrow space at the top clamps tightly onto the motor stick.

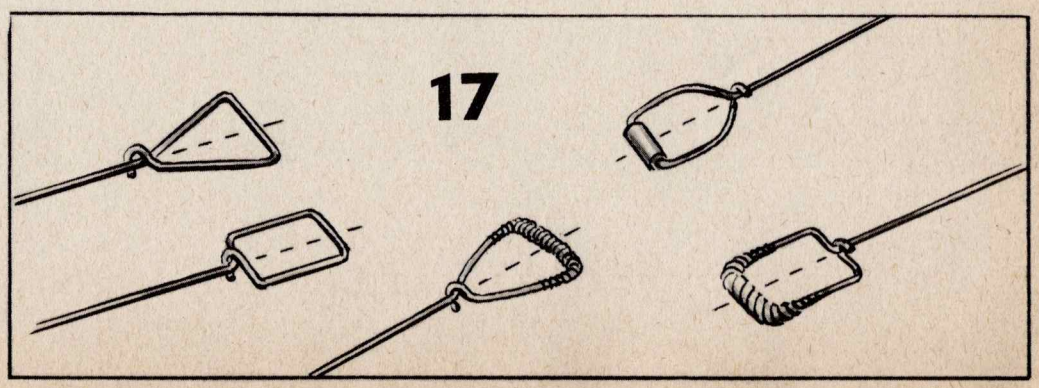
Cut a piece of No. .020 wire 13 inches long. First bend it into a shape something like a square hairpin (12*A*). Now grip one leg of it with one pair of pliers a trifle below the top; hold the top with the other pair; and bend the leg out (12*B*). Then bend the other the same way. You have a piece something like an upside-down *V*. From here on you can bend up the feet and turn up the toes by just following the picture (11). Be careful of one thing: make sure that the finished piece lies flat (13) and does not rise up at various places as the one shown in the other sketch (14).

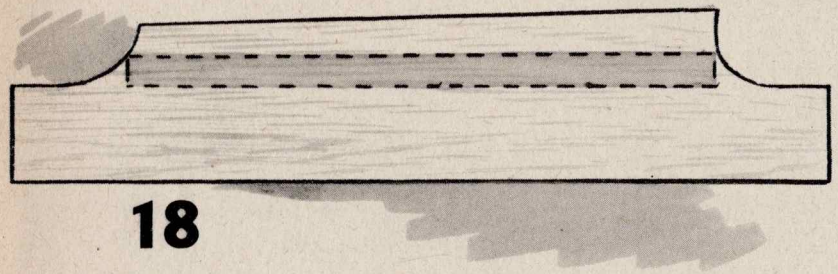
Next is the combined rear hook and tail skid. Cut a piece of No. .020 wire about 2½ inches long and bend it into the shape shown in figure 15. After the straight upper end has been forced through the motor stick, bend it at right angles and then again at right angles and force the last bend back into the stick. That is what the dotted lines show.

Finally comes the propeller shaft. Cut a piece of No. .020 wire 3 inches long and bend it as in figure 16. If you have trouble making bends that are round, try one of the five shown here (17). Some expert modelers prefer the square-shaped hooks. Be very careful, however, to see that the shaft is made straight and true through the center. Otherwise it will wobble. Also notice that these are all made so that they may spring apart in order to loop in the rubber.

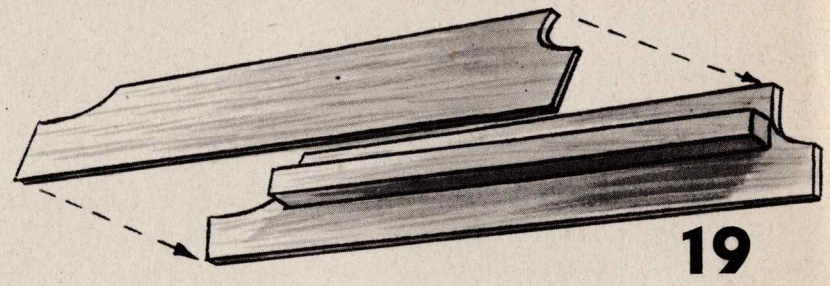
The hook part itself should be covered with rubber tubing, metal tubing, silk thread, or adhesive tape. This will help to prevent the wire from cutting into the rubber.







18



19

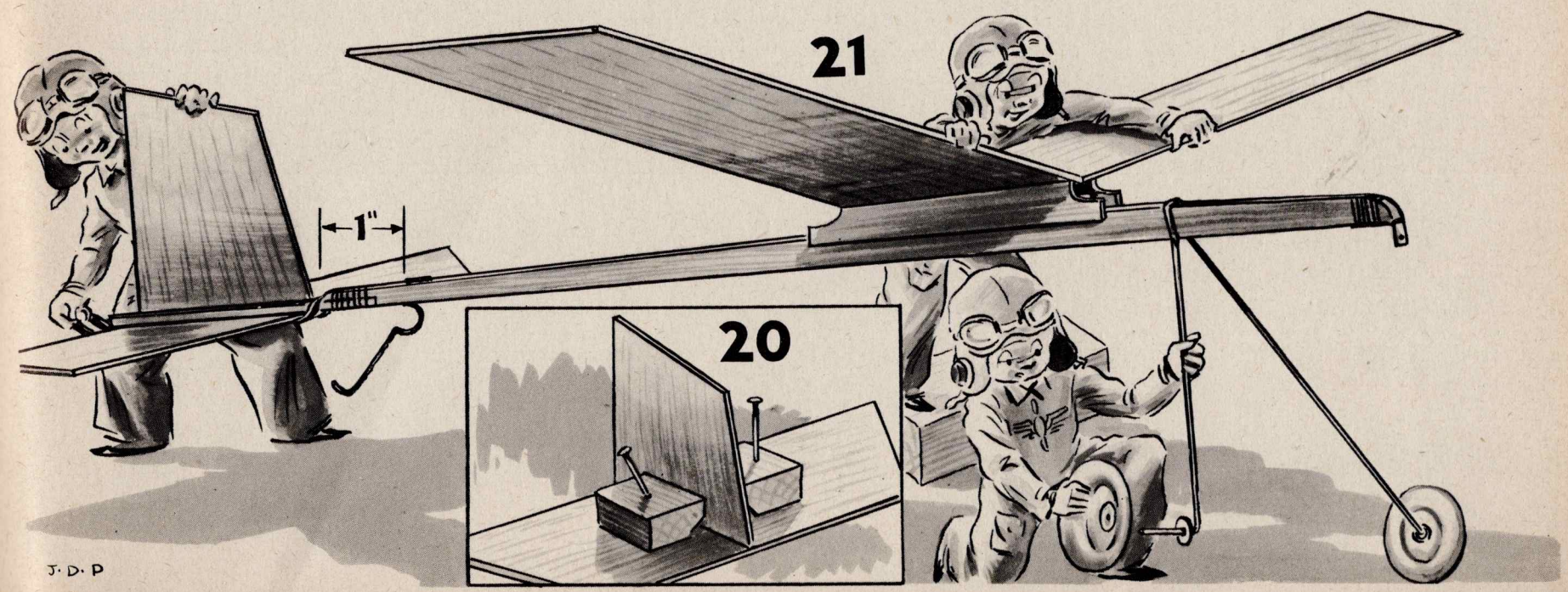
By this time the cemented wings have dried. Make the wing mount by cutting two pieces of 1/16-inch hard sheet balsa exactly the size shown in this picture (18). Between these two, cement a strip of hard balsa 1/4 inch thick. The shaded portion of figure 18 shows where this goes, and figure 19 shows how the three pieces are fitted together. Make sure that the motor stick just fits between the two side pieces. Cement the pair of wings to the mount itself, and put the whole thing aside for a while.

While the cement is drying is a good time to fasten the rudder to the center of the stabilizer. To hold the rudder upright while it is drying, pin scraps of balsa lightly on either side as shown in figure 20. Do you notice that one edge of each block has been whittled off? This is to prevent the cement from sticking to these temporary holders.

When everything is dry, put the ship together (21). Clamp the wire landing gear over the motor stick. Cement washers onto each axle, and then work one-inch balsa wheels onto the two axles. (You will have to buy the wheels.) If necessary bend the "toes" down with the pliers and then back again to hold the wheels on. The combined rear hook and tail skid has already been forced into place. Cement it firmly.

The rudder with stabilizer, now cemented into one unit, is put under the tail boom and held by a rubber band, looped over, under, then over the boom. The rudder simply fits against the side of the boom. Either side will do.

Slide the wing mount with wings over the motor stick and fasten it there with rubber bands as shown in the drawing at the beginning of this section.



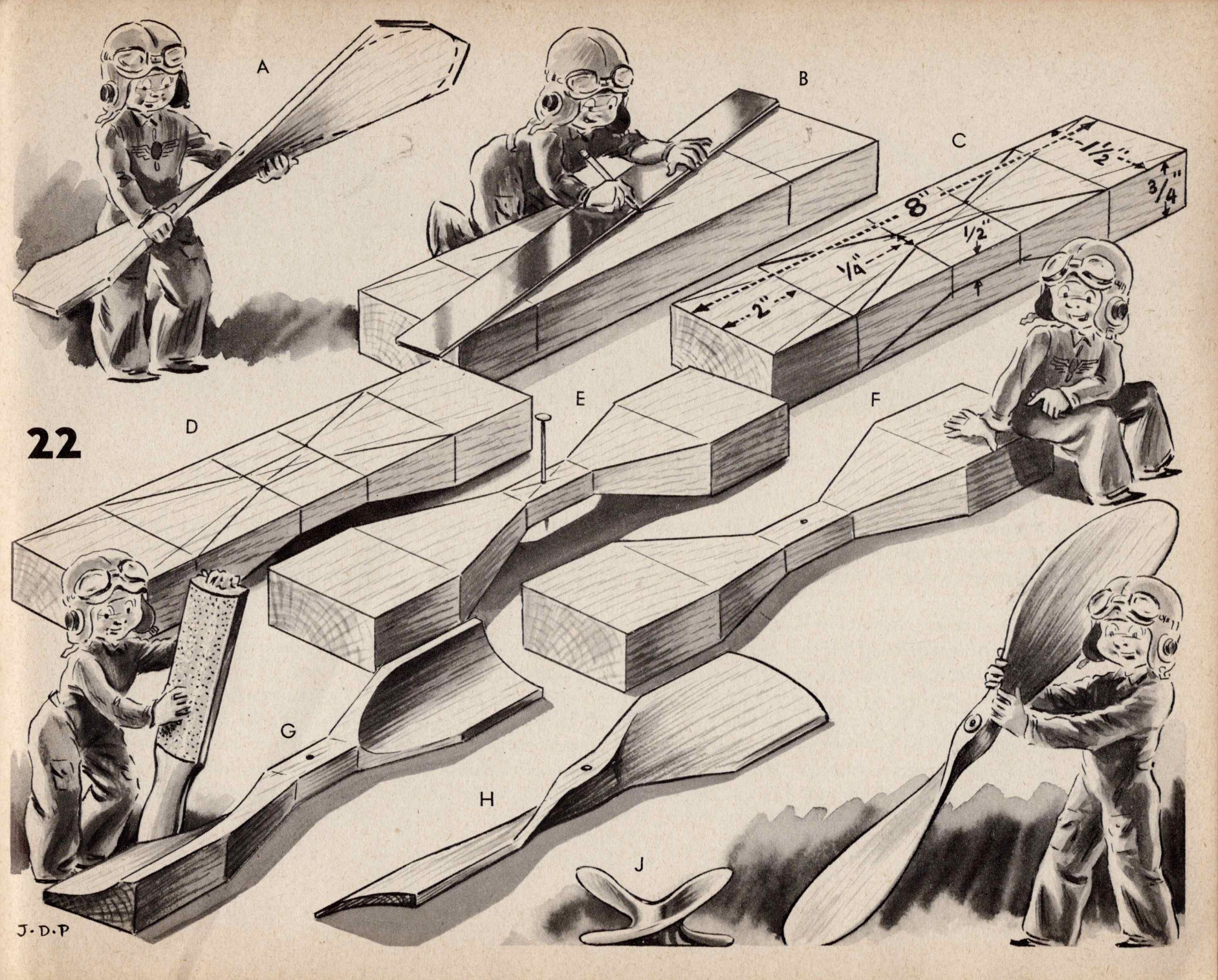
Now all you need is the power for the little ship.

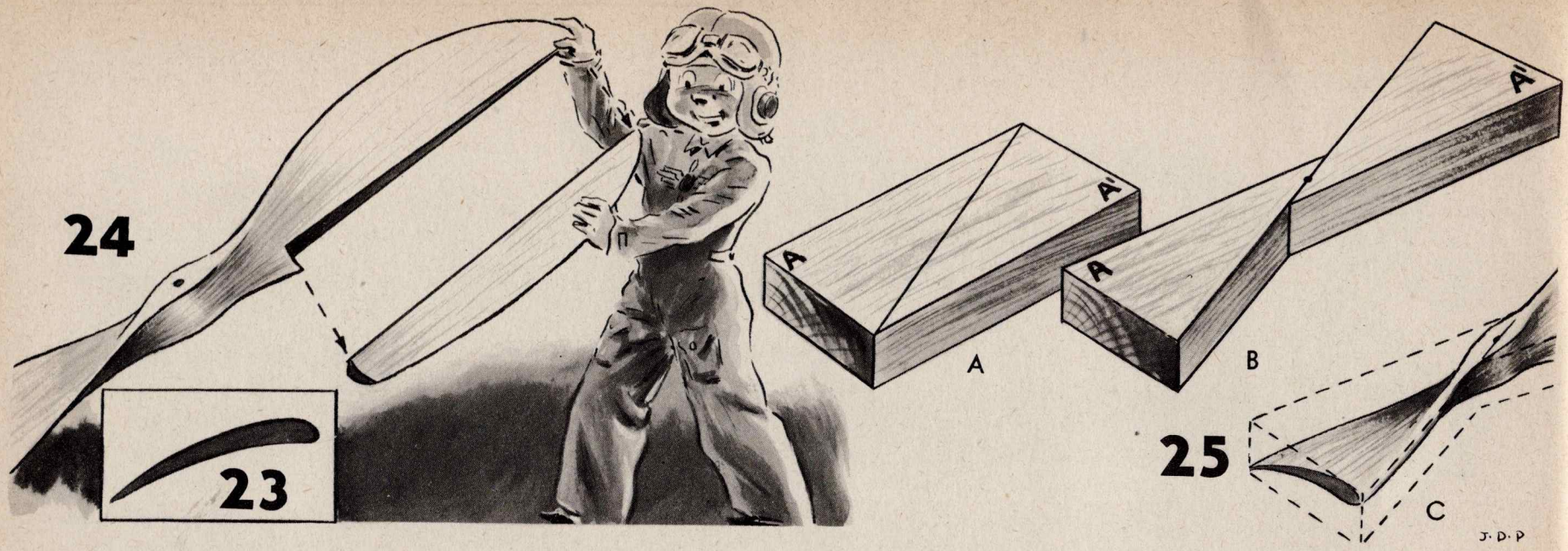
The propeller of your model is a very important unit. A model may be perfectly constructed, carefully assembled, and lightly built, but its success as a flying model depends on its propeller. The "prop" converts the power of the rubber motor into the thrust needed to pull your model forward through the air fast enough for the wings to gain lift and make the model air borne.

The propeller is, perhaps, the most interesting thing about your model. A propeller is nothing but a screw, only it is designed to bore its way forward through the air instead of through wood. Because air is thin, the propeller must whirl rapidly and have long thin blades by comparison with the household wood screw. Many years ago engineers realized that the long thin blades of the propeller actually develop lift as do wings, only the "lift" of the propeller is forward—thrust—instead of up. The engineers discovered that, if the propeller blades are given a cross section like the curved cross section of a wing (see figure 23 later), this thrust is greater.

Figure 22*A* shows a "machine cut" prop such as comes in some model airplane kits. You can buy one in the model store, too. All you have to do to finish such a prop is to sandpaper the blades curved like a cross section of a wing and to round off the tips. It is better, though, to carve your own propeller if you can.

This won't be too hard to do. First, take a soft balsa block—called a prop blank—8 inches long, 1½ inches wide, and ¾ inch thick, as shown in 22*B*. With your metal rule mark out this blank *(C)*. All dimensions are given *(D)*. Now cut out the underside of the blank as in *D*, then the two sides *(E)*. Carefully make a shaft hole by pushing a pin (or by drilling) through the exact center of the blank, and square with the surface in all directions. Now turn the blank over as in *F*, for the back is carved first. Shape the rear surfaces to the concave shape *(G)*. Your sanding sticks are useful here. Now turn it over again and shape the front, or convex, surfaces *(H)*. This will be easy, for you have the rear surface as a guide. Last, shape the blade tips *(I)*. They should be exactly alike. When one blade is shaped, trace the outline on paper, cut it out, and transfer the outline to the other blade. *J* is the end view of the prop.


A
B
C
1½"
3/4"
8"
1/2"
1/4"
2"
D
E
F
G
H
J
22
J·D·P



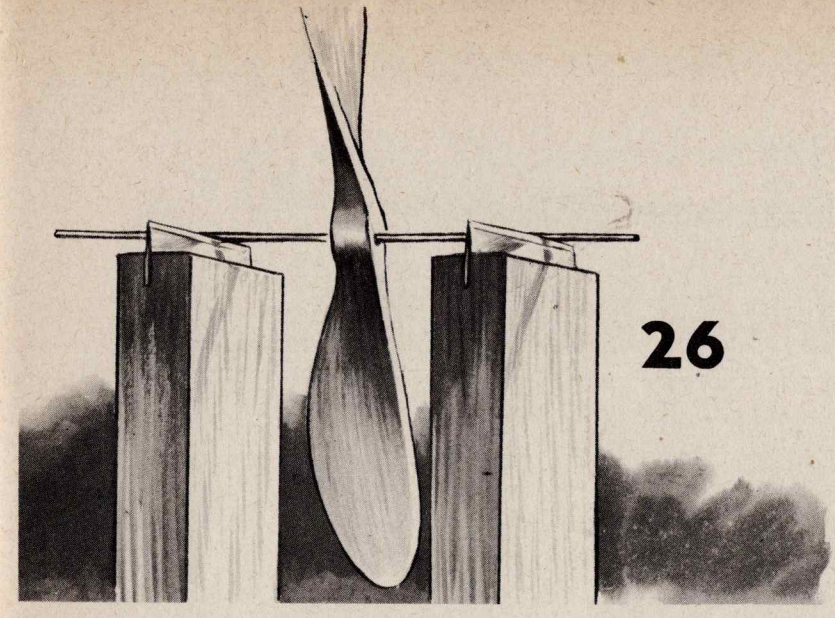
The leading edge of the propeller is the one which cuts into the air. The other is the trailing edge. Although you might not think so, it is the leading edge which must be thicker, and this is shown in the little diagram (23).

Also the blades must be much thicker at the hub than at the tips. They should taper down toward the tips. Figure 24 simply shows how the propeller would look if a piece were cut out. It is easy to see the taper there. Much of this shaping can be done by sanding. Use your sanding sticks, and run the blade up and down between your thumb and forefinger as you work. This will find the thick spots.

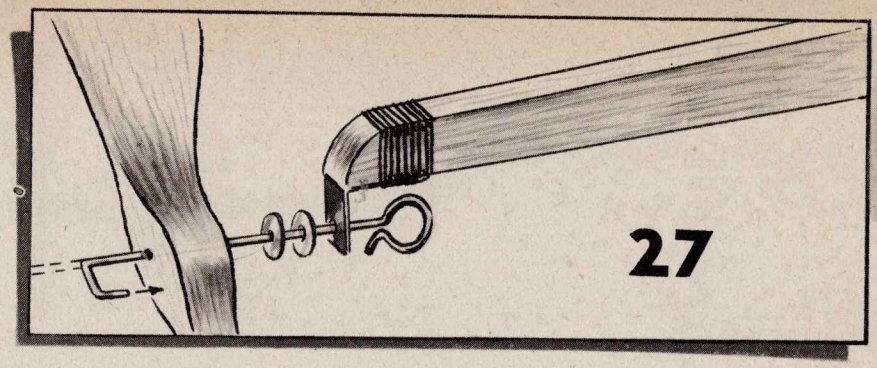
Figure 25 shows how to make a propeller blank from one small block to save wood. First draw the diagonal *(A)* and cut the block in two halves along this line. Glue the two pieces together as in *B;* and, finally, carve it as in *C*.

Now we balance the prop. Run a wire through the shaft hole and set the propeller up on blocks of the same height (figure 26). Spin the propeller. Does it always stop with the same blade down? If so, that blade is too heavy. Sandpaper the heavy one until both are the same.

When you are satisfied, it is time to put on the finish. Your propeller should have two coats of "paper dope," which you buy at any model shop. Between the coats, sand down the propeller again. Now you have a smooth propeller which, like that of a real plane, will have the least amount of wind resistance. Some fellows like to put on a final coat of silver dope so that, when the plane soars high up in the air, it is easy to see the glint of the propeller and keep the plane in sight.



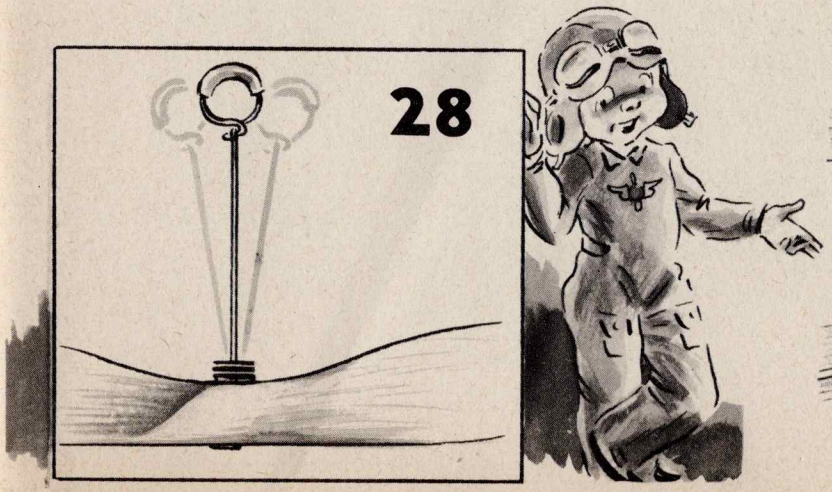
26



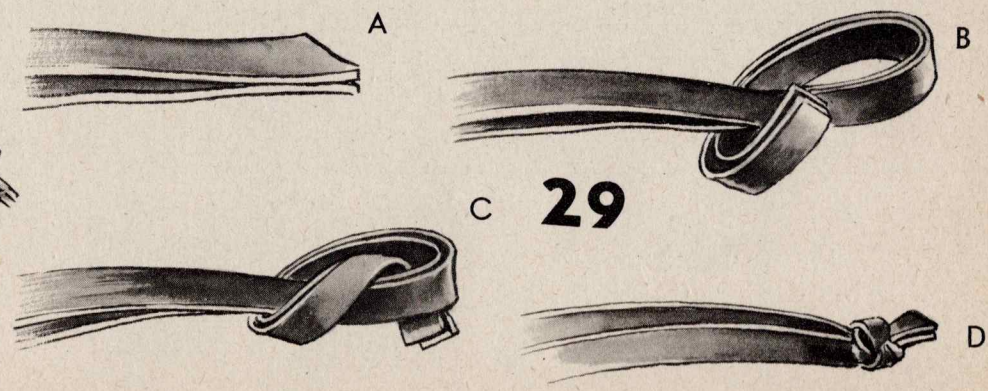
27

Now poke the straight end of the propeller shaft through the bearing, and slip on a couple of washers (27). Push the end through the propeller hub. Now bend it once at right angles, then again, and force this little end back into the shaft to lock it there. Just for good measure cover the front of the hub of the propeller with a heavy coat of cement. It is also good to cement the washer nearest the propeller to the propeller hub. This prevents the shaft from wobbling (figure 28).

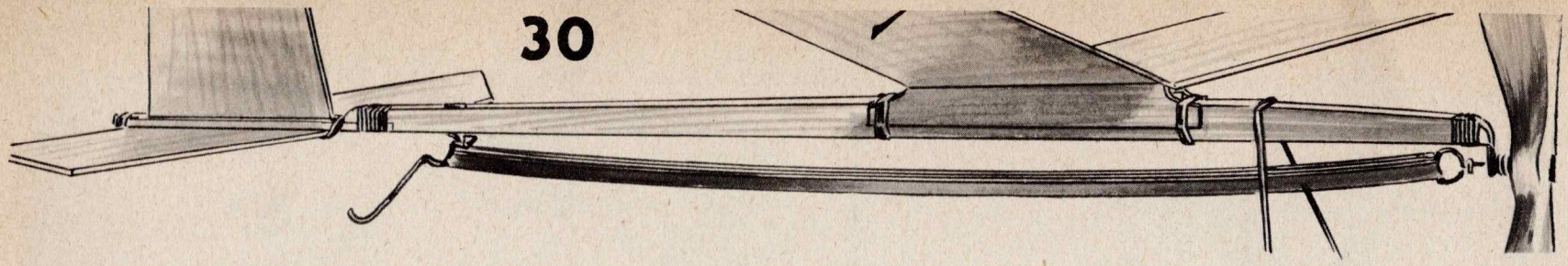
One more thing and your model is done. Take eight strands (or four loops) of ⅛-inch flat rubber. (You buy this by the yard at the model shop.) Loop the bunch through the eye in the propeller shaft and tie the ends together (figure 29). Slip this knot over the rear hook. The knot must be at the rear, or it would tangle with the whirling propeller shaft.



28

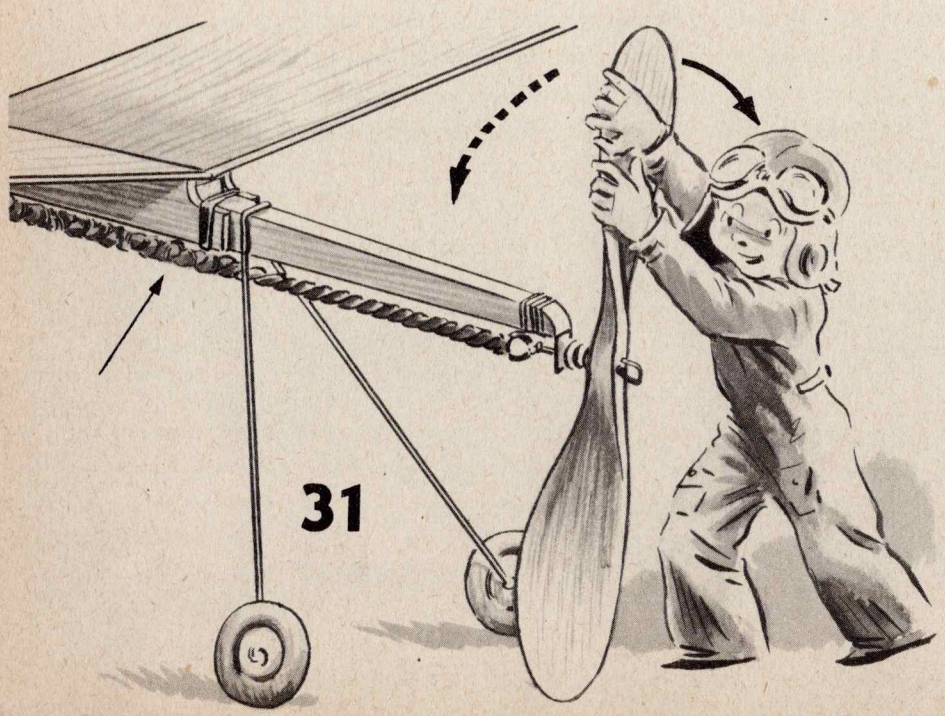


29

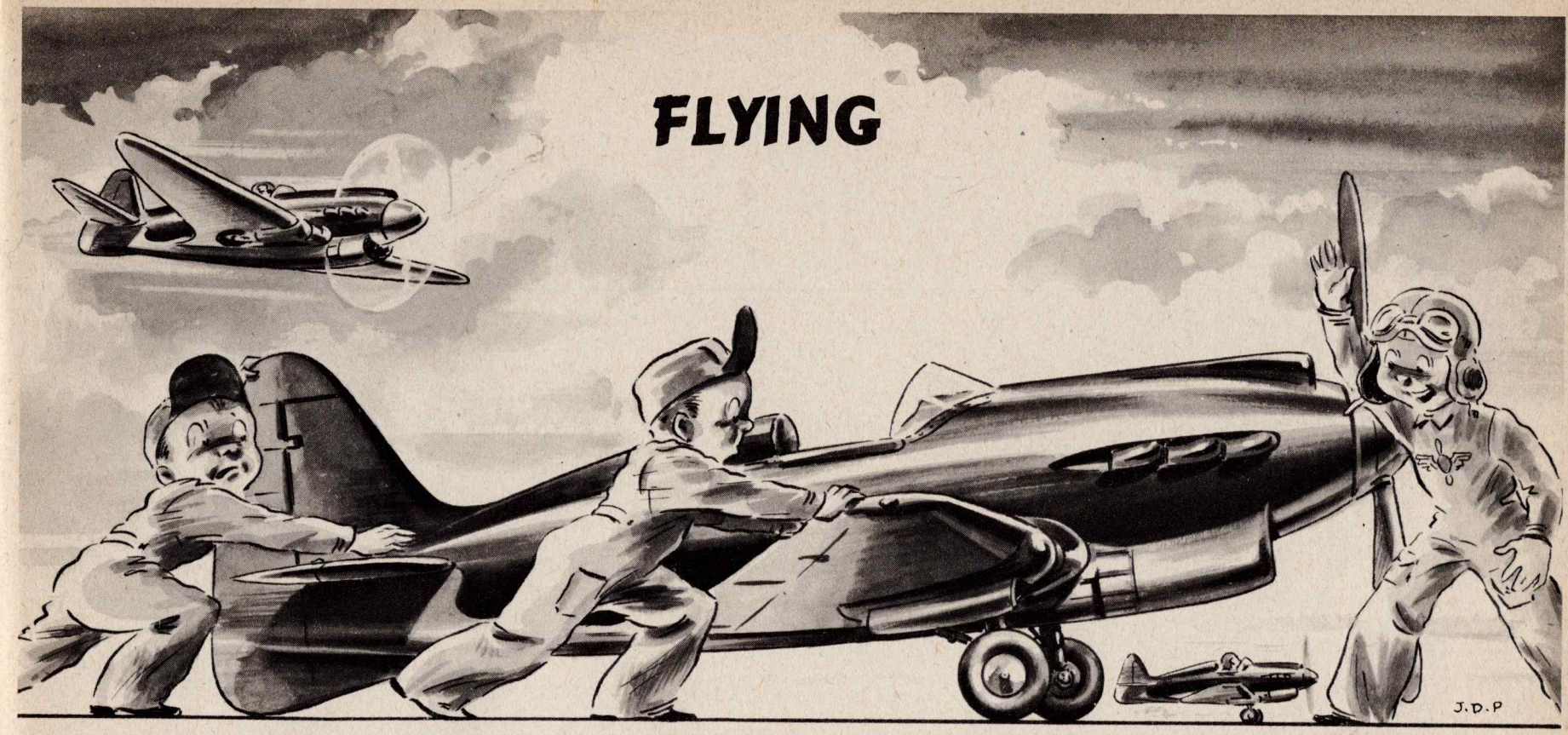


Allow a little sag in the rubber strands (figure 30). Drawing them tight only means fewer turns and shorter flights.

Put a drop of oil on the shaft near the shaft hangar, and wind up the propeller to see how it goes. You twist it to the right (facing the model), and it spins to the left. For tests, twenty-five turns are enough. For flights, wind until there is a double row of knots, as shown in the picture (31).

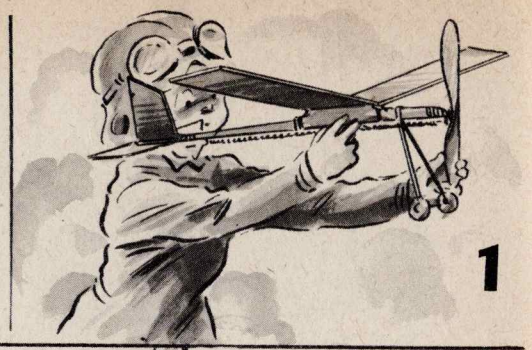


FLYING

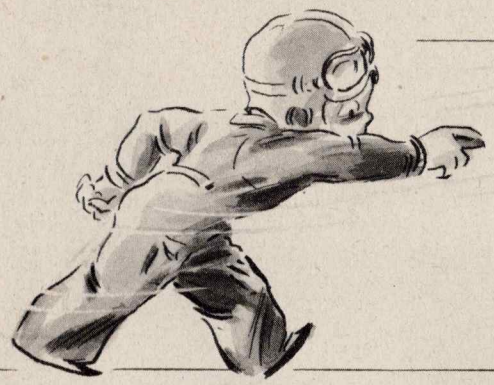


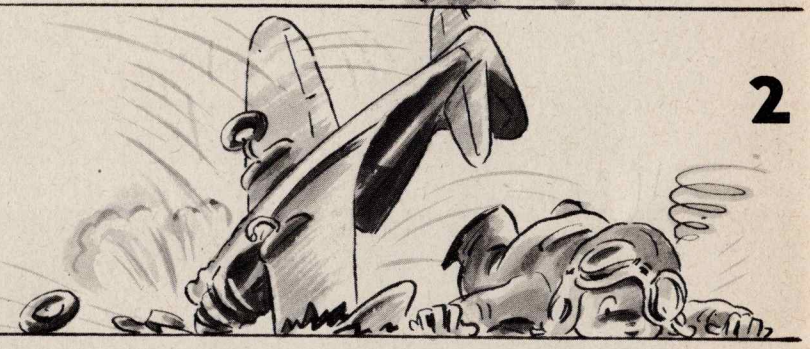
Airplanes made in the great factories all have to be sent up for test flights. Now comes the time for your model's test flight. Always use a field where there is some fairly high grass. That will break the shock, should you have a crash.





1





2

To launch your little ship, hold it as in either figure 1 or figure 3.

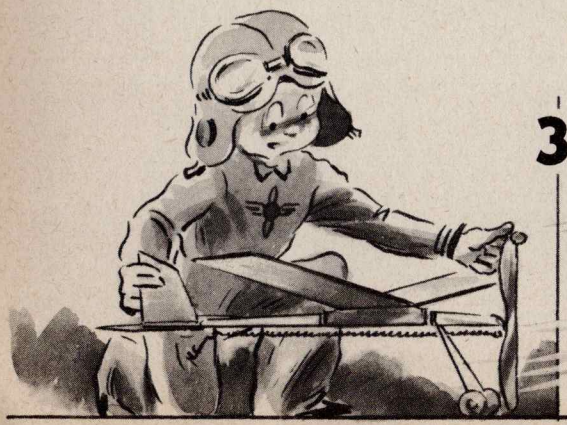
Never throw a model as you would a baseball. It will either stall or land on its nose (2).

Just as a test pilot watches every tiny thing, you must watch every move your model makes. Be sure everything is lined up straight and that all fastenings are secure.

When you attach the rubber strands, stretch them out as far as you can; then let them back slowly. Do this several times, and at the same time rub them with a cloth—or the palm of your hand—which has been soaked with rubber lubricant (not oil) or glycerine. This makes the rubber last longer and you can put in another twenty-five turns of the propeller.

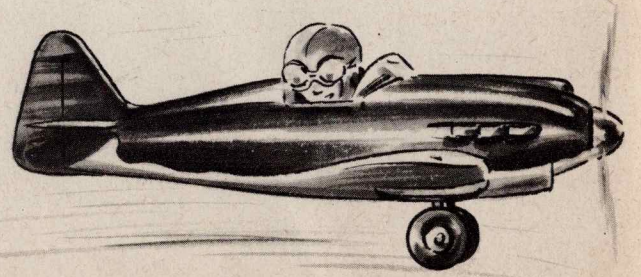
For the first flight, wind the propeller only twenty-five turns or so, although you will increase these more and more for each flight (3).

Point the nose down a little as you hold the plane in your hand, so that the plane may gather speed quickly. Let go of the propeller a second before you let go of the ship. Give her a gentle push, and away she goes.



3





J.D.P





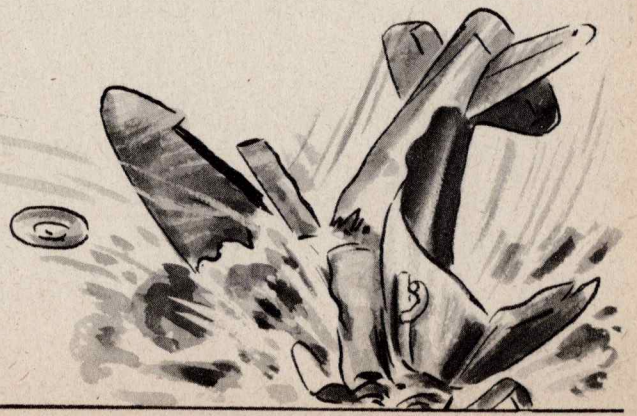
All good pilots watch the weather carefully. You should be careful in the same way. Don't try to fly your model on a windy day. You can't compete with the wind.

Of course the ship may crash for other reasons. Sometimes you have to adjust things several times before they are exactly right. You may have to bring the wings forward or back.

Perhaps it does not climb. Raise the trailing edge of the stabilizer a trifle by sliding under it a very thin sliver of wood. Or, better still, slide the wings forward slightly. If the model stalls, move the wings back a trifle.

A few pains taken in adjusting will be well worth while. Keep at it until the ship behaves as it should.





VARIATIONS OF THE SECOND MODEL

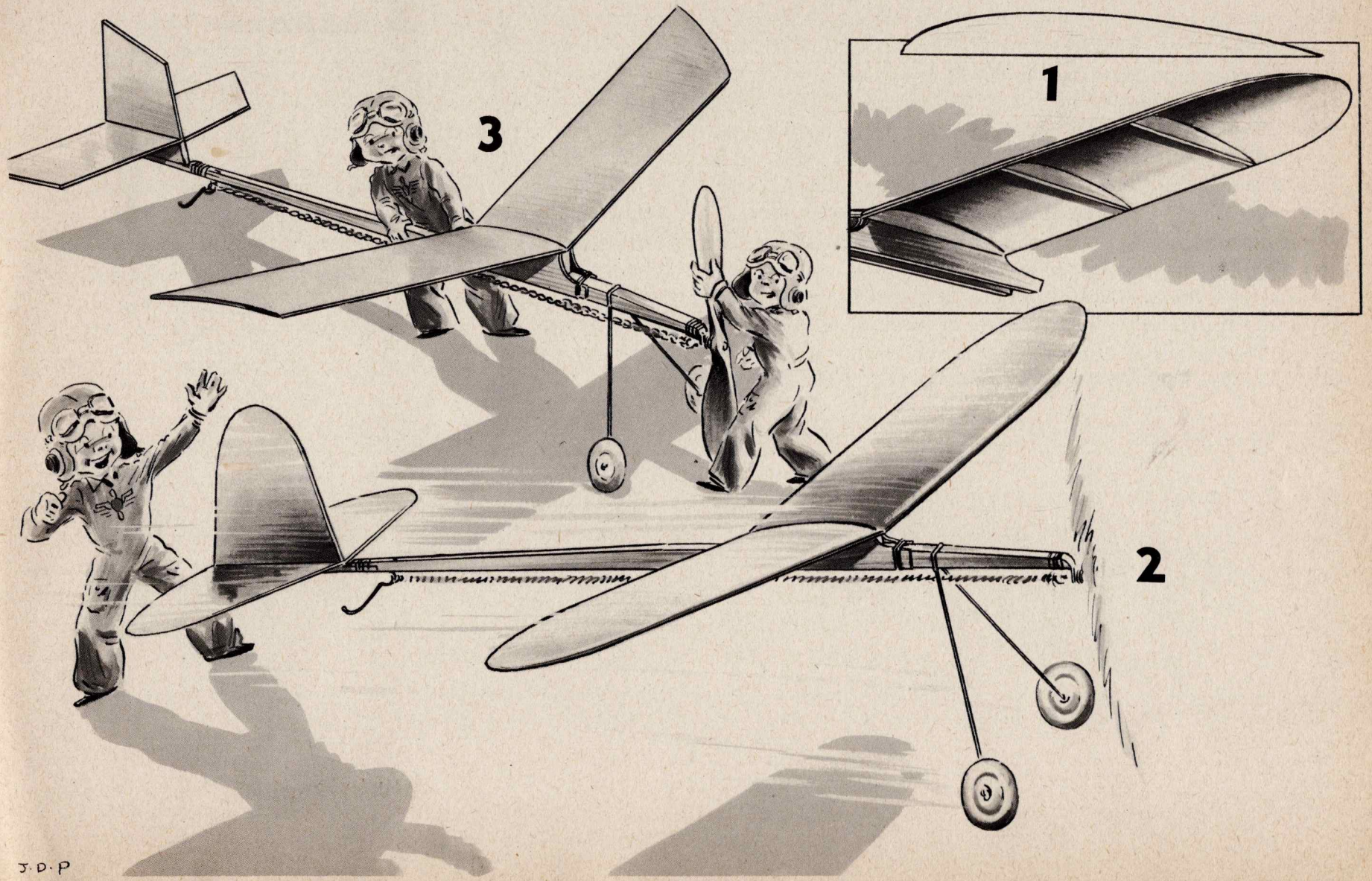
You have probably noticed that some parts of your model do not look like parts of a real plane. The wings are not curved; the tips are not rounded. You can revamp the model and make the wings look like the ones on a real plane.

Here is how. Remove the wings from the wing mount and round the tips with a razor blade or the precision knife. Cut the wings apart along the center line where they are cemented together. Now, from a sheet of soft balsa 3/32 inch thick, cut four ribs exactly like figure 1. To make a pattern, trace the figure on a piece of tracing paper which can be bought at a stationery store. Make one more rib from 1/4-inch wood.

The idea is to make the two wings curve over these ribs. Put some cement on the curved part of the ribs and fasten the thin sheet balsa wings to them with pins. When the cement dries take out the pins. It is necessary to curve first one wing, then the other, and, finally, to fasten the inner edge of each wing to the curved top of the 1/4-inch center rib. Notice that you have to cut away a slightly rounded piece from the center edge of each wing so that they fit together perfectly at the center. The thick center rib fits on top of the wing mount and has to be cemented to it. Last, round the tips of the stabilizer and the rudder (2).

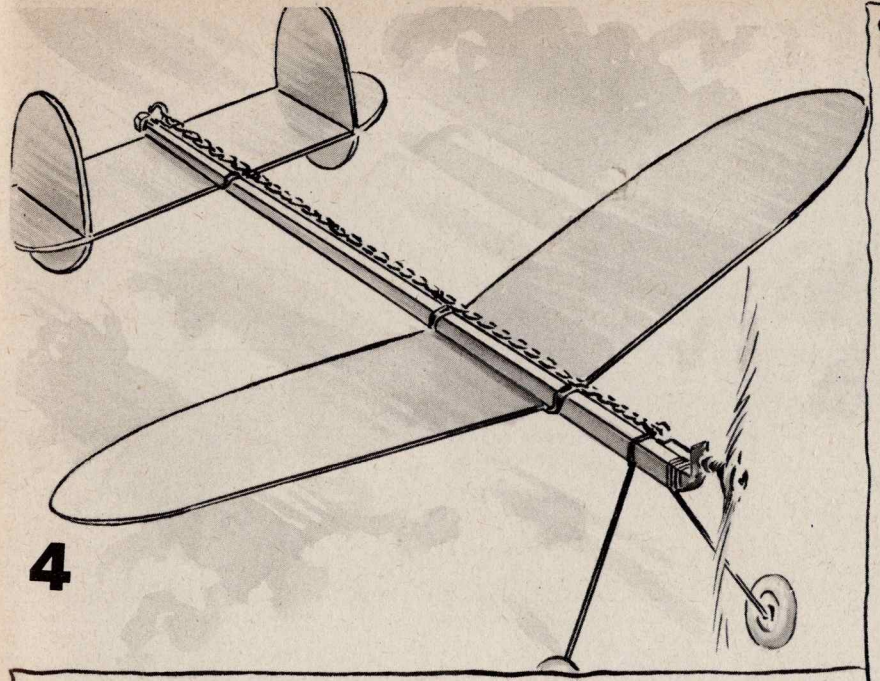
Now your model will fly more slowly, climb higher, and stay in the air longer.

Another variation may be made by adding a block to the tail boom (figure 3) and cementing the tail to this, making a high-tail model. Or you could make a higher wing mount, turning it into a "pylon"-wing model.


1
2
3
J·D·P

By this time you should be fairly expert in handling balsa and will have no trouble in constructing the two models in figures 4—7. Figure 4, an outdoor model, is similar to the model you have just built, and you need only a few extra measurements to turn out a good job. These are shown in figure 5 (half size). The landing gear spreads 4 inches at axles. The stabilizer and rudders are joined by means of the slots and cemented together. Attach the tail and wings to the motor stick with rubber bands the same as the tail surfaces on the last model. Use a 6-inch prop and two loops of rubber for power.

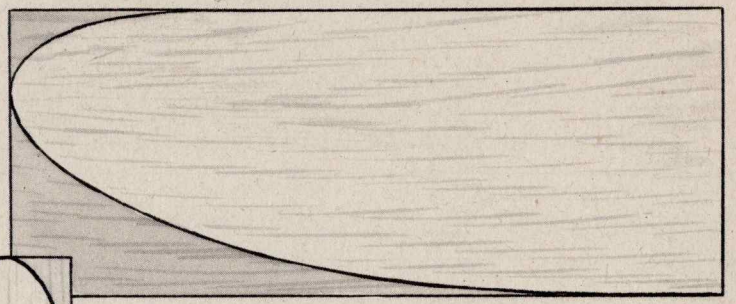
The next model makes a good indoor flyer. Its light weight and easy construction make it good for rainy days for you can build it in a little time. Measurements are shown in figure 7 (half size). The motor stick tapers from 1/8 inch square at the nose to 1/16 inch at the tail. The landing gear, of bamboo or hardwood, spreads 3 1/2 inches at axles. Each leg is sharpened at the top, pushed into the motor stick, and then cemented. Use any material for the tube in the nose—metal, glass, etc.—but try to keep it down to the size shown in the drawings. Tail surfaces are made and assembled the same as in the second model. Cement them to the fuselage as shown in figure 6, stabilizer at the bottom and rudder to one side of the motor stick. Cut out the wing panels from the pattern and cement the centers together to form a 2-inch dihedral. When the curved centers are joined, you will find that the wings will automatically form a curved, cambered section. Help the wings to curve by rolling them over your fingers before cementing them together. A small block 1/8 inch high is cemented under the leading edge; then the wings are carefully cemented to the motor stick. Use a 5-inch wide-bladed prop with blades sanded very thin. Experiment with the amount of rubber to use for power.



4

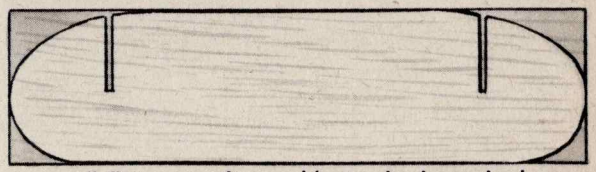
Motor Stick—10 inches long, 1/8-inch sheet balsa

Tapers from 1/4 inch at nose to 1/8 inch at tail



1/2 size

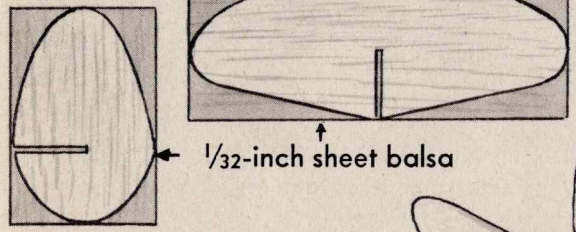
5



All flying surfaces 1/16-inch sheet balsa

Motor Stick—8 1/2 inches long, 1/8-inch strip balsa

Hardwood or bamboo "legs" pushed into stick

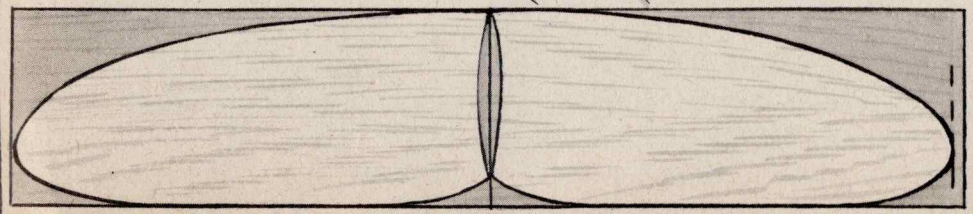


1/32-inch sheet balsa

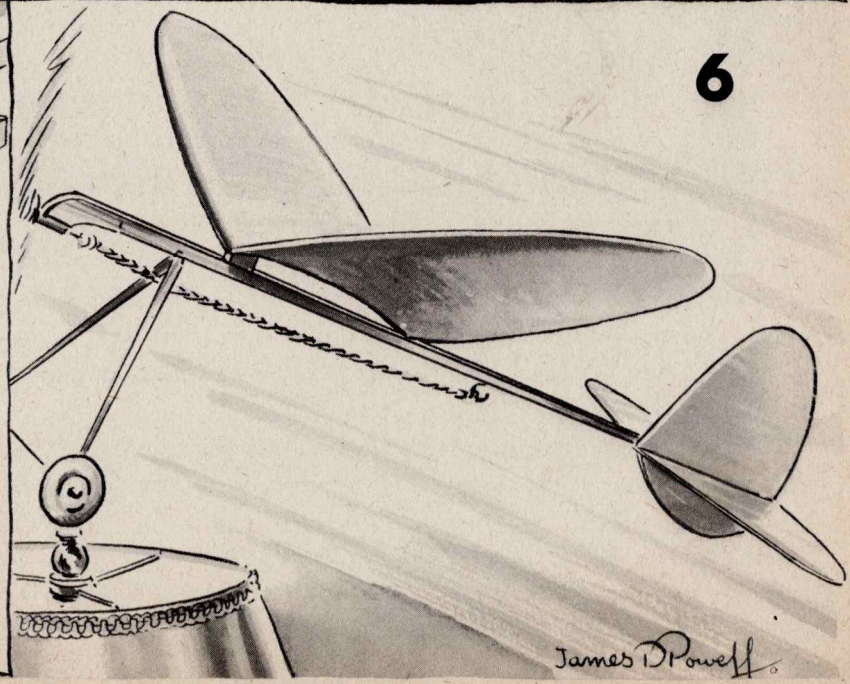
Metal Tube

1/2 size

7

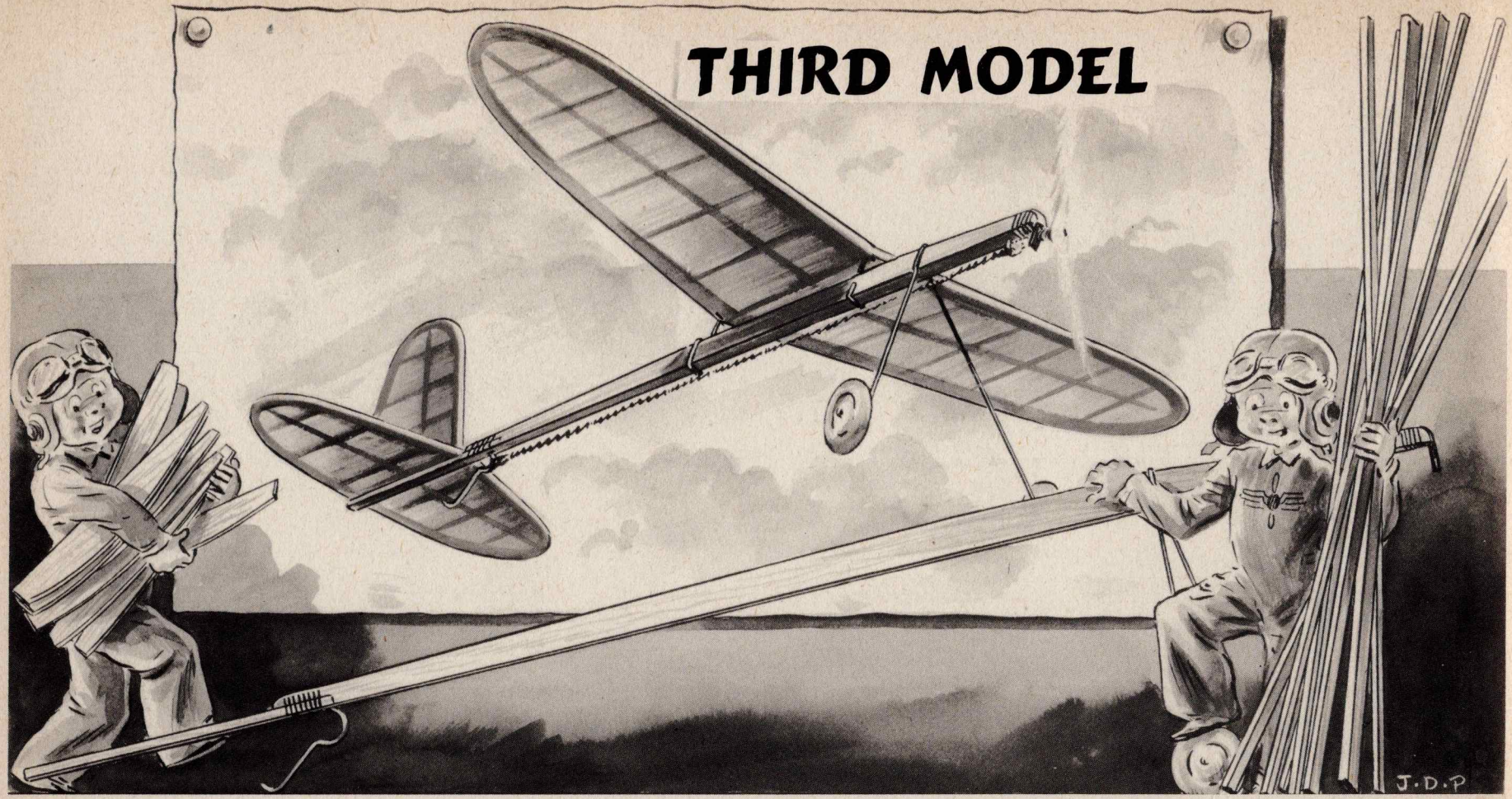


Wings—1/32-inch sheet balsa



6

James D Powell



The curved wings and rounded corners make your second model more like a real ship. However, anyone knows that every plane, from the Spitfire to the B-29, has wings that are built up with ribs, spars, and covering.

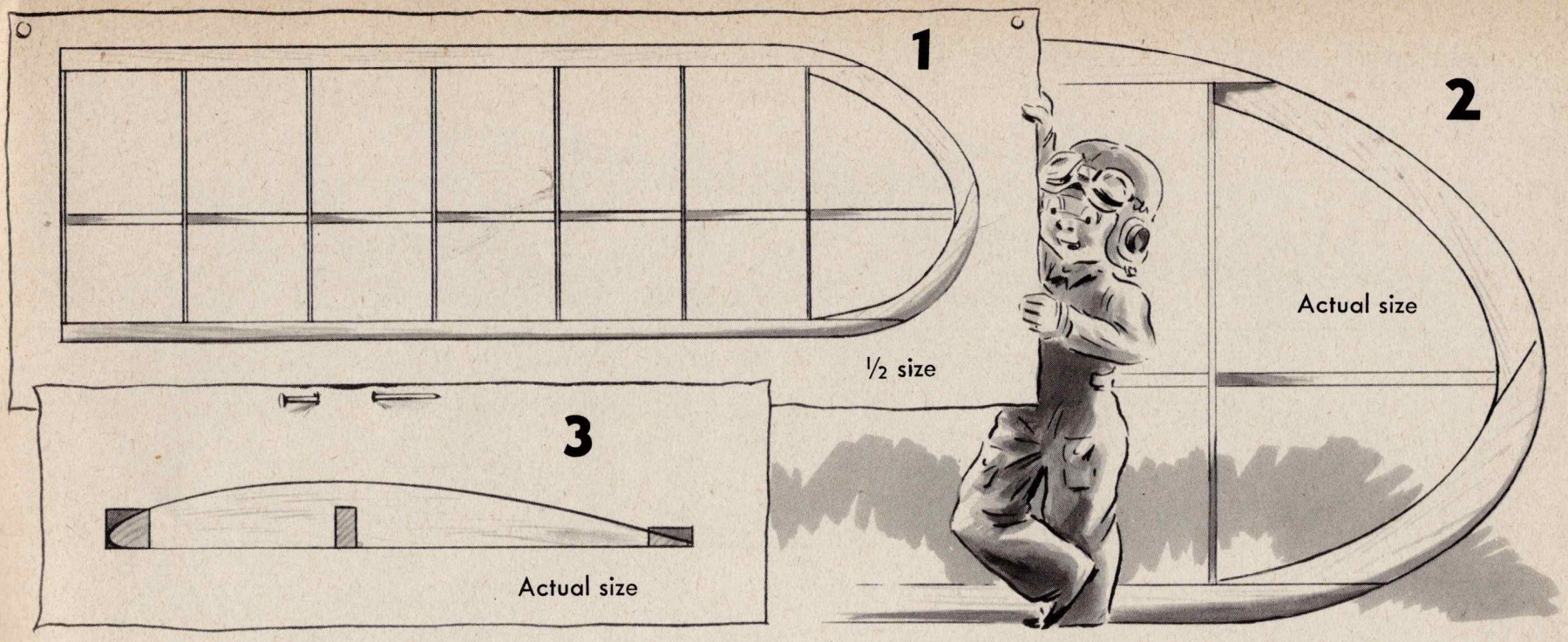
That is what we are going to do right now: build up the wings, stabilizer, and rudder from start to finish.

For this third model, make the fuselage, landing gear, propeller, and motor exactly the same as for the second model. That will be easy for you now.

The pictures of these wing frames may look hard at first. Study them a minute and you will see how neat this plan is. The picture of the wing (1) is exactly half actual size. In other words, you will double this size. Mark off the plan in the book in ¼-inch squares, and transfer it to a piece of paper ruled off in ½-inch squares. That will bring the plan of the wing up to the same scale as the wing tip here (2) and the ribs (3), which are actual size.

The ribs go crosswise in the wing, and there are seven for each wing. The spars go lengthwise, and there are three for each wing.

The first thing to do is to draw your full-size copy of figure 1. At the same time you can make another copy for the other wing by this method: First lay a piece of carbon paper, carbon side *up*, on the table. On top of this lay a piece of plain paper, and on top of that lay your ruled paper. Clip these together with a pin or paper clip. Then as you draw your right wing to scale on the ruled paper, you



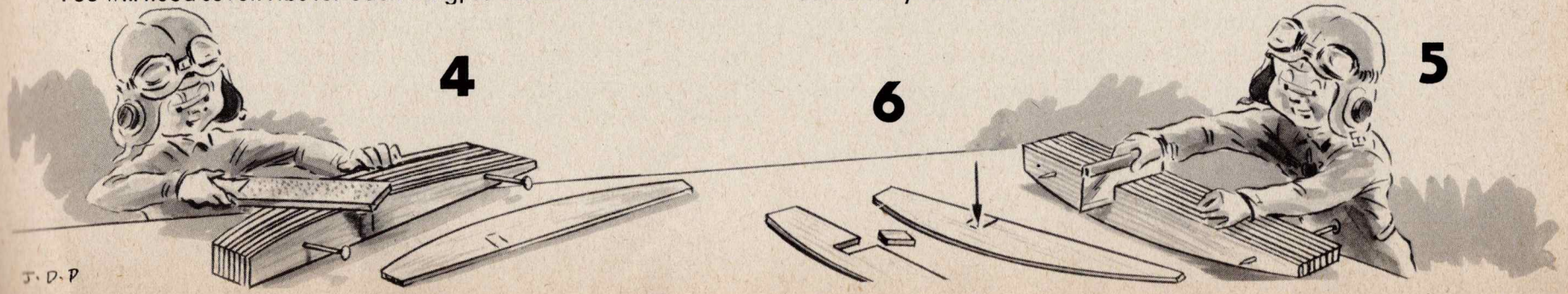
will at the same time draw a carbon copy of it in reverse. Of course, if you should have to erase any mistakes, don't forget to put a piece of paper between the carbon and the plain sheet of paper and to erase on the carbon copy also.

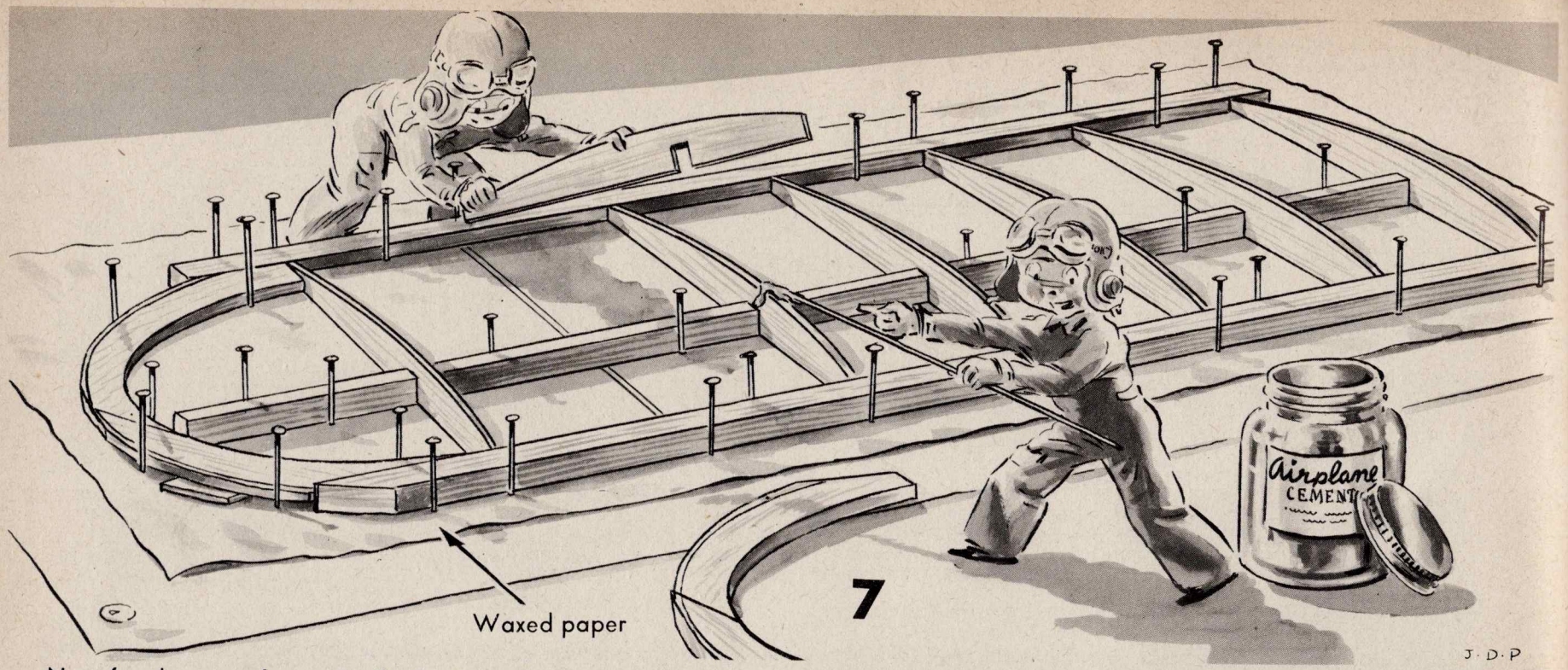
Since the picture of the rib (3) is full size, all you need to do for this pattern is to trace it. Trace the parts outside the shaded areas, since the shading simply indicates joints with other pieces. Transfer this to a piece of 1/16-inch sheet balsa, making sure that the grain runs the length of the rib.

You will need seven ribs for each wing, so cut out fourteen this size.

Pin seven together as shown in the drawing (4) and go over them with your sanding stick. Put them against the pattern in this book just to check and see that they are worked into the exact shape. Be sure that the ends are square to fit the leading and trailing edges.

Each rib must have an oblong notch in its under side where the spar fits. While the ribs are still pinned together, make two cuts with a razor blade for the spar (figure 5) exactly the distance apart (1/8 inch) as shown in the picture (3). Then unfasten them and, one at a time, cut out the little piece shown by the arrow (figure 6) with the corner of your razor blade.





Now for the wing frame itself. Placing your pattern under the material for a guide, cut out three spars. The front spar, or leading edge, is ¼-inch-square strip balsa, the middle spar and trailing edges are ⅛ x ¼ inch. Make them a trifle too long for good measure. Next cut out the wing tip from ⅛-inch sheet balsa. The wing tip is made of two curved pieces. Notice how the grain runs. This is for strength. Cement these two pieces together and sand the inside smooth. (The outside can wait.)

We are now going to do some cementing, so place a piece of wax paper over the wing pattern to keep pieces from sticking to it.

First, put the tip down in its place on the pattern (figure 7). Pin it there with pins on both sides. (Never pin *through* your work when assembling, always *next* to it.)

Second, pin down the two outside spars (the leading and trailing edges). Let the ends stick out a little at the tip.

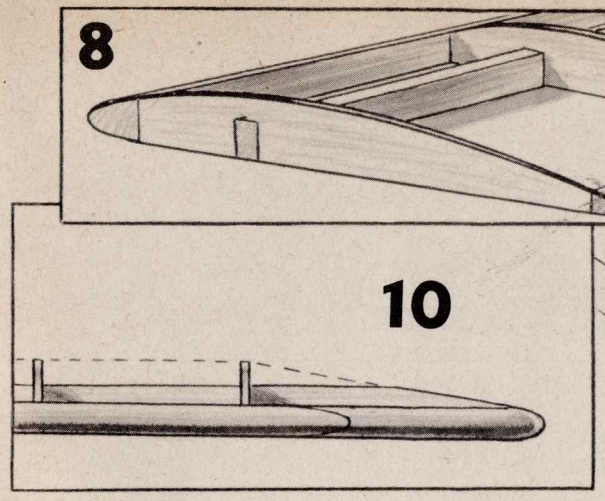
Third, put the center spar in place. You must fit it carefully. Cut off one end until it rests snugly against the inside of the tip.

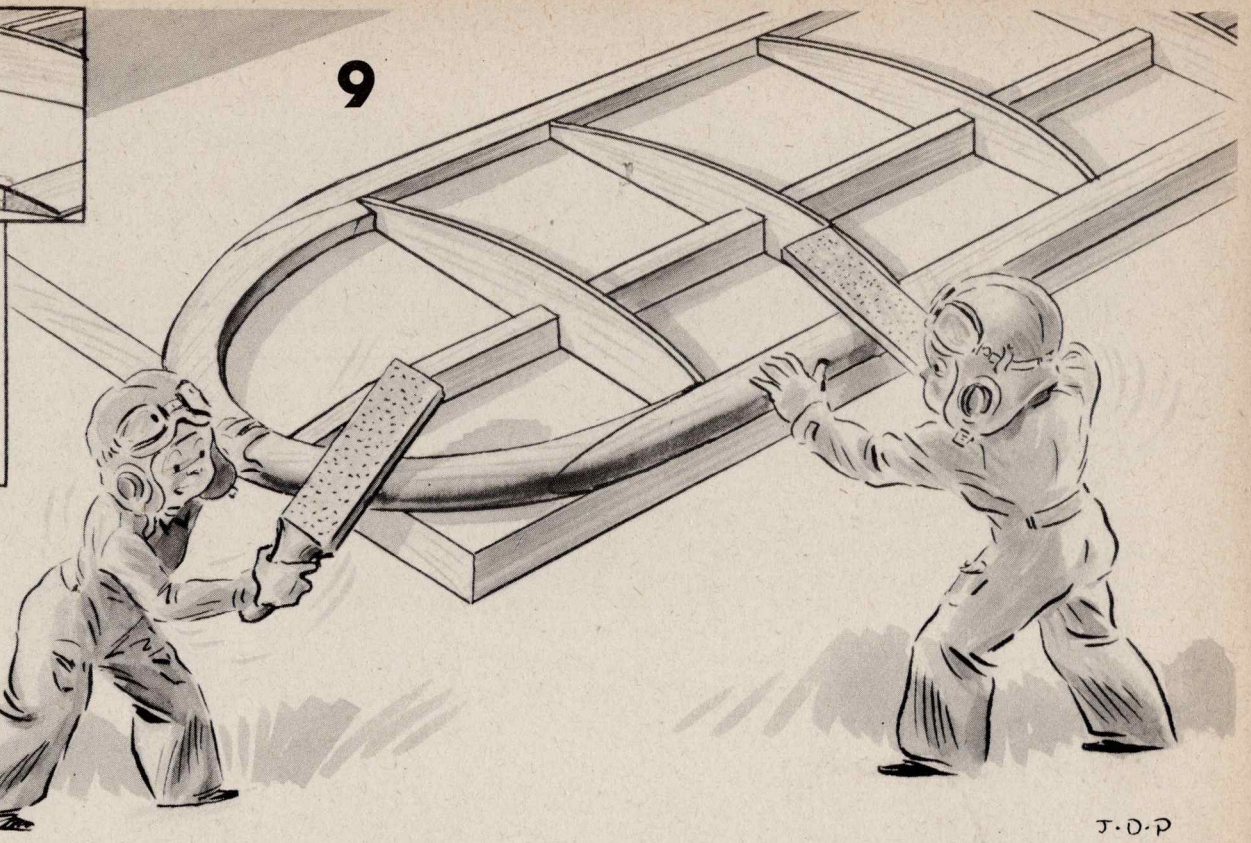
Fourth, carefully coax the ribs into place. If they are too long, you can bring them down a trifle with sandpaper. Put the sandpaper flat on your work table and rub the end of the rib upon it. This keeps the end true, instead of rounded. The ribs should fit tight at ends and middle and will need no pins to hold them up in place if they are carefully made. Notice that the rib nearest the tip not only touches the outside spars with its ends, but *also* fits hard with its sides against the two tip pieces.

Slant the root, or base rib (the rib farthest from the tip), on each wing inward at the top not quite ⅛ inch. This is so that the two wings can be butted together when they are done and in such a fashion that you automatically will have the right dihedral. Remember the upward slanted wings so necessary for stability?

Last, cement the frame together. Use plenty of cement at all joints—twenty-six for each wing (not counting the joint between the two tip pieces)!

Now when you have finished one wing, let it dry and do the other.





Now for finishing up the wings. Wait until they are thoroughly dry, or you will wish you had not been in such a hurry! Carefully lift the wing frames from the work board and with sandpaper smooth them off to the exact shape of the original plan (figures 1 and 2).

With your flat sanding sticks, round the leading edge and taper the trailing edge to a point (figure 8).

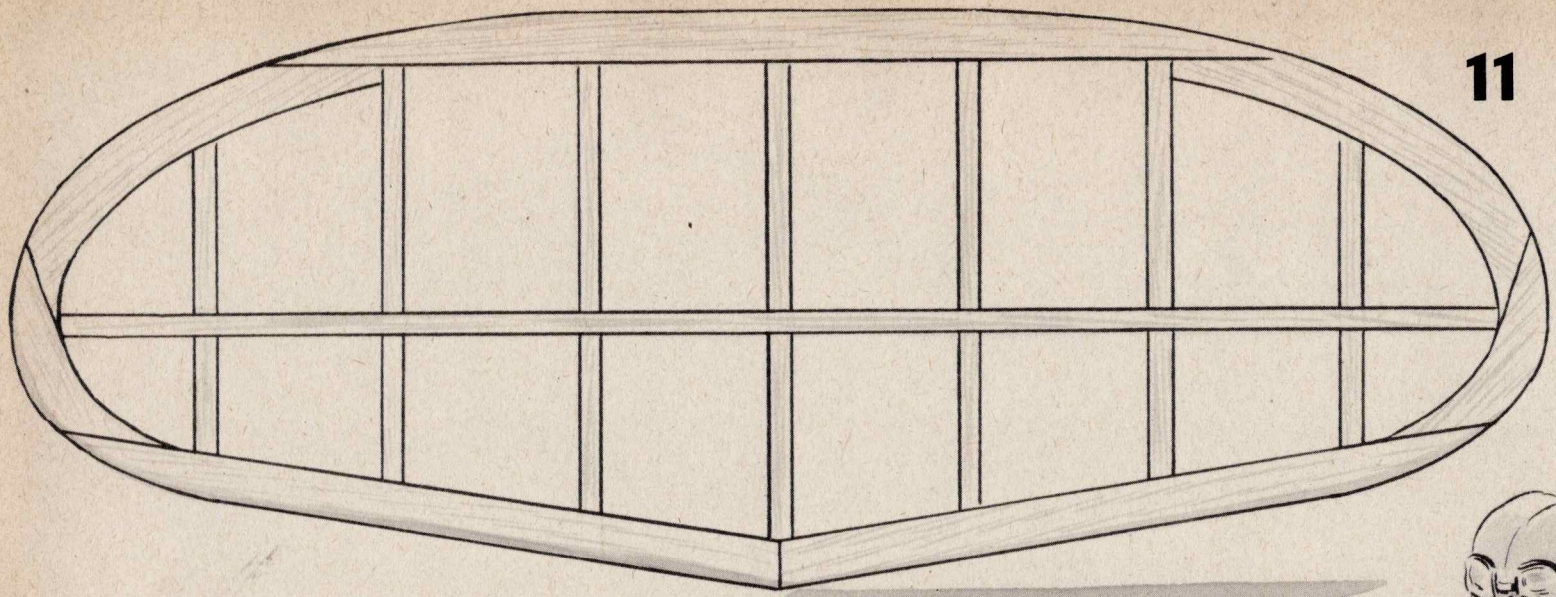
Now you remember that the spars were left longer than necessary and unfinished. You must work down these rough ends with your sanding sticks to "fair in" (that is, make a perfectly smooth surface) with the tip pieces. Then work down the edges of the tip pieces to fair in with the edges of the spars (figures 9 and 10).

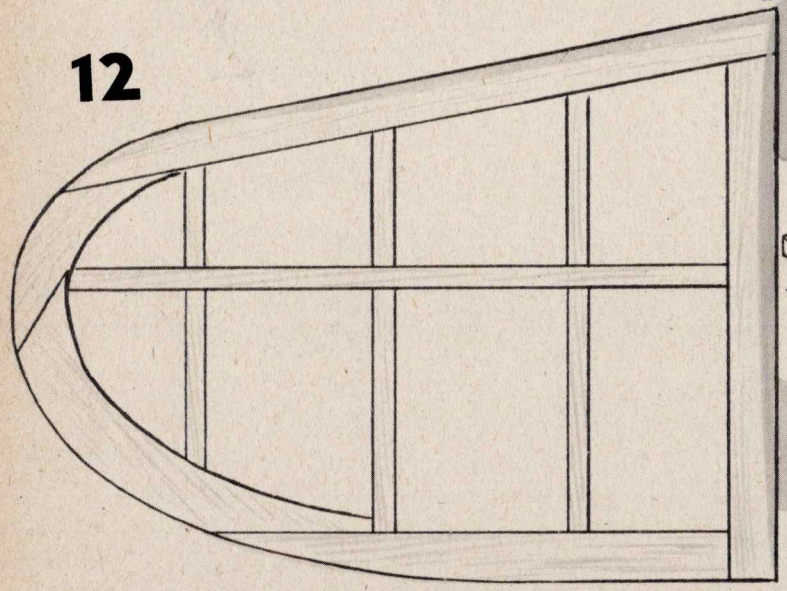
As you work, bring the wing frame—or panel, as it is called—just over the edge of your table so that you will not have an accident.

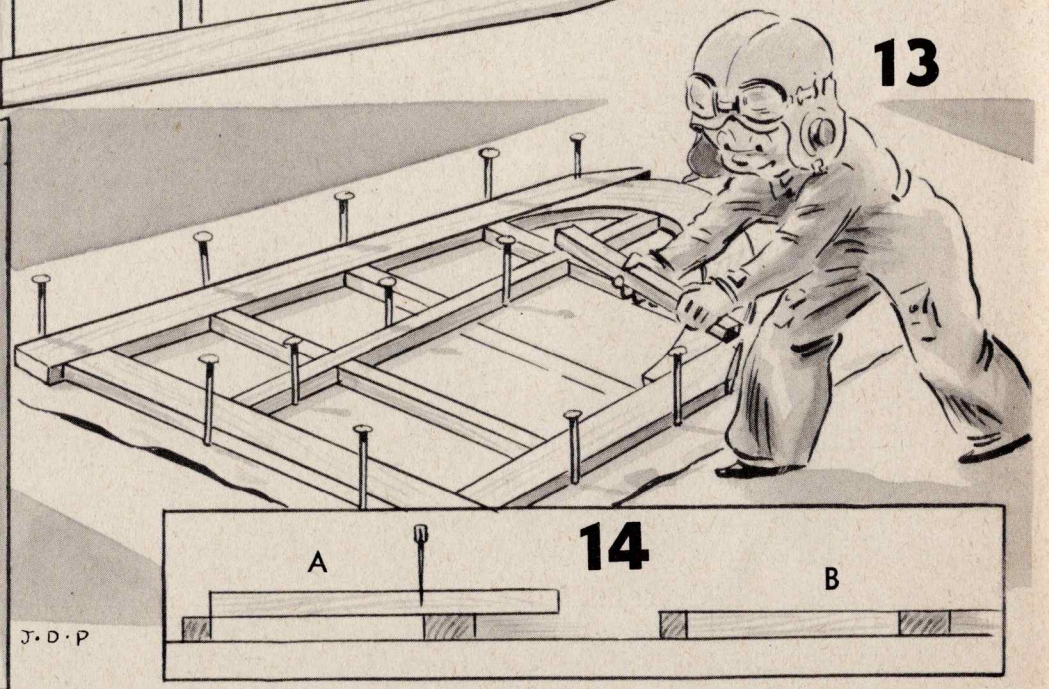
Even the center spar must be sanded down to leave no square corners. Be sure all glued joints are smooth. (You will see why when the covering is put on.) Now butt the wings together at the roots, placing cement between the root ribs as they are faced together.

Since full-size pictures of the stabilizer (11) and the rudder (12) are given here, you don't need to enlarge these. All you have to do is make tracings and cover the tracing with waxed paper as before.

This time you don't need a curved wing surface; the ribs are just straight sections. They are easy, and that is why there is no rib pattern.







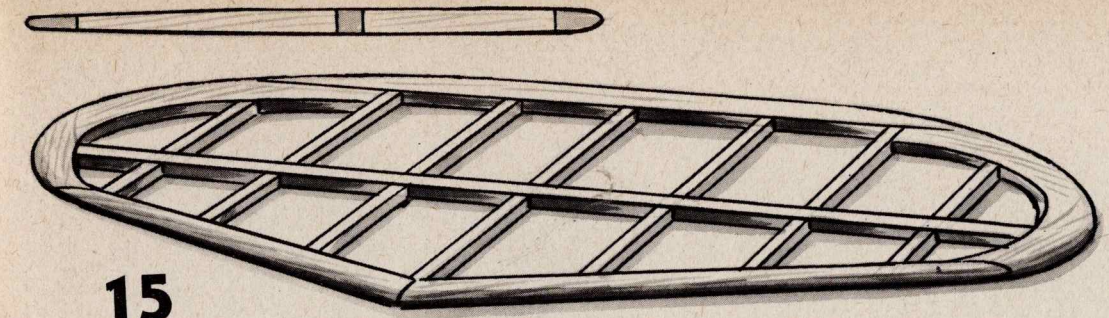
Cutting the pieces will be easier this time. Cut out the tip pieces and the leading and trailing edges from 1/8-inch soft sheet balsa.

Cement the tips and pin them in place, together with the outside spars or edges (figure 13). Fit the center spar (1/8-inch square) in place so that it is snug, and pin it down.

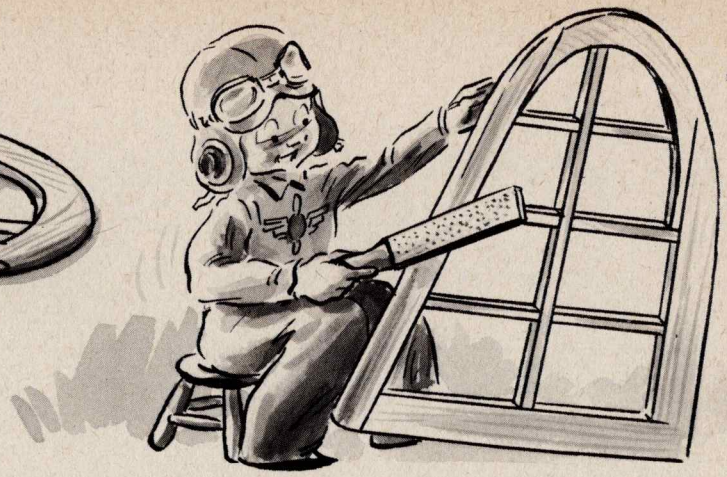
Now to cut out the 1/8-inch square crosspieces: Lay a strip of the proper width in the space to be filled, as the drawing shows (14*A*), and with the razor blade cut exactly at the intersection. The piece will drop into place (14*B*).

Repeat this until you have the fourteen crosspieces for the stabilizer and the six for the rudder.

Cement each one of the joints with plenty of cement, and *leave both frames to dry*.



15



16

Sand both rudder and stabilizer as you did the wings. Give them a good going over. Notice that every edge is rounded except at the base of the rudder. Make sure that there are no cement bumps sticking up. Sand them off.

These four parts are now ready to cover: the wings, stabilizer, and rudder.

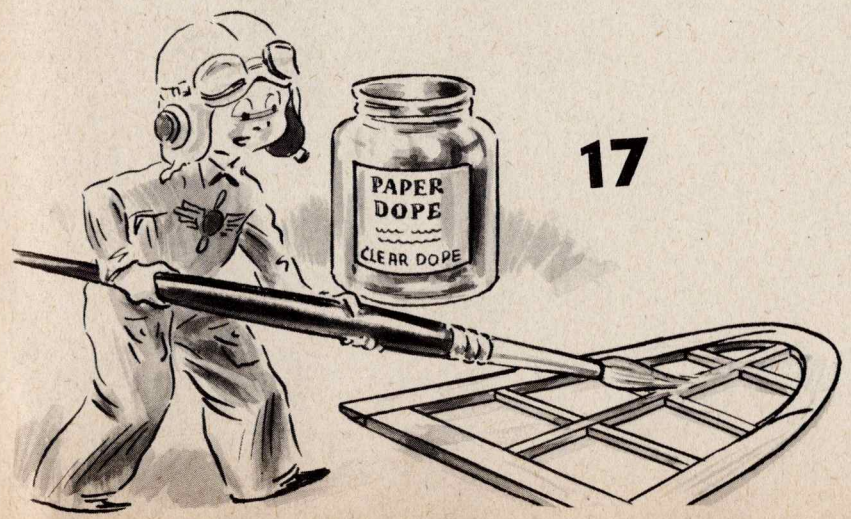
Buy at your model shop some lightweight covering tissue and a bottle of paper dope.

Hold the paper to the light and you will see that it has a grain like wood. This grain should run with the span—or length—of the wing.

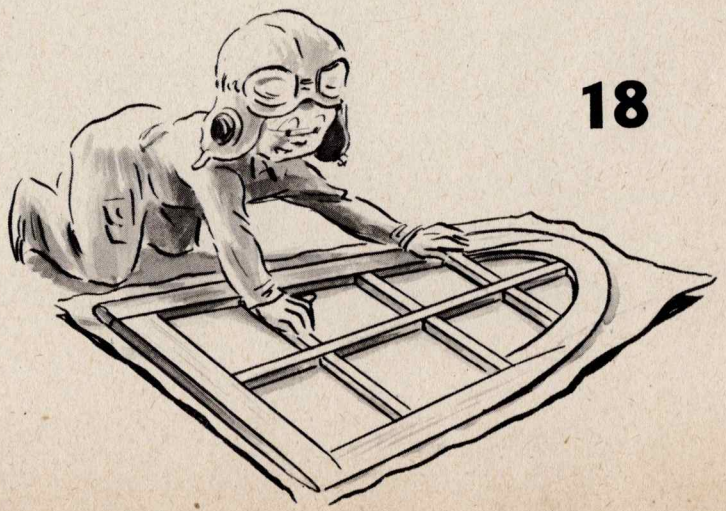
Before trying to use the sheet, iron it out with a warm—not hot—flat iron, to take out the wrinkles.

Better start with the rudder as that is smallest. Cut a piece of the tissue about ¼ inch larger all around than the rudder itself.

Now cover the rudder frame liberally with paper dope (figure 17) and place the sticky side down on the tissue (figure 18). Turn it over and press the paper down on the frame with your fingers. Make sure it binds wherever there is dope. See that the paper pulls taut—but not tight. Be careful not to leave the dope bottle open or the dope will thicken and become so strong that it will warp the frame.

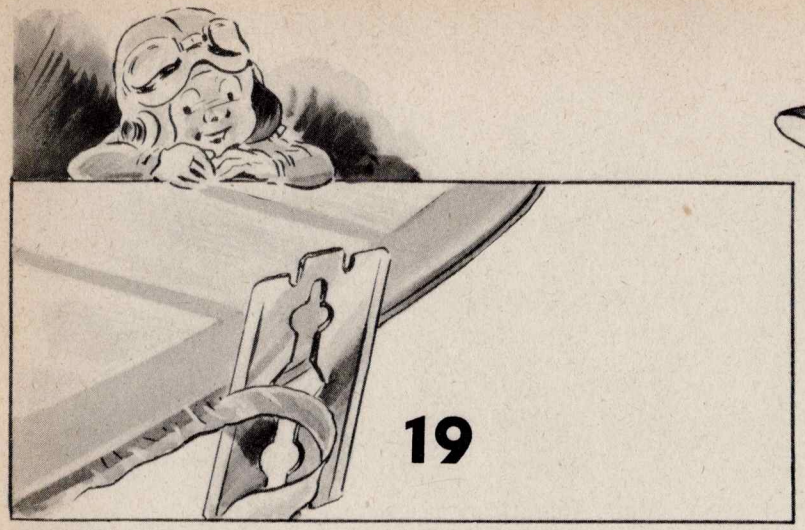


17

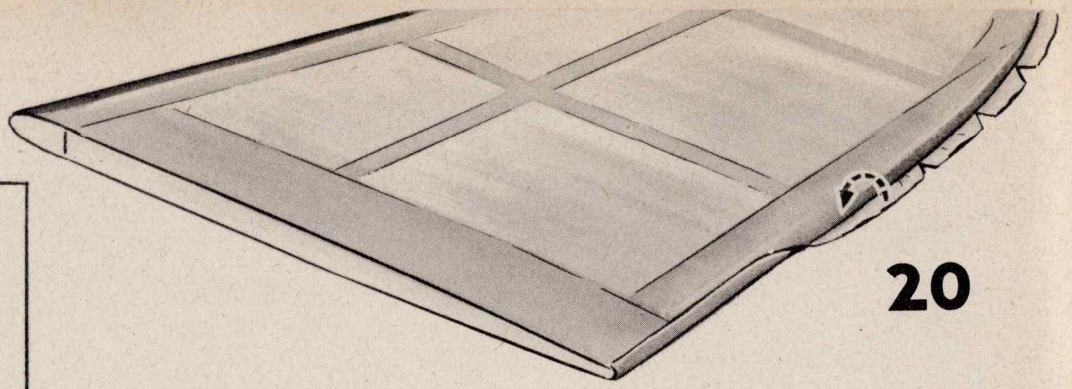


18

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19



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With a good sharp razor blade trim off the paper along the edge of the frame (figure 19). Make sure that the paper is well stuck wherever it does not trim off.

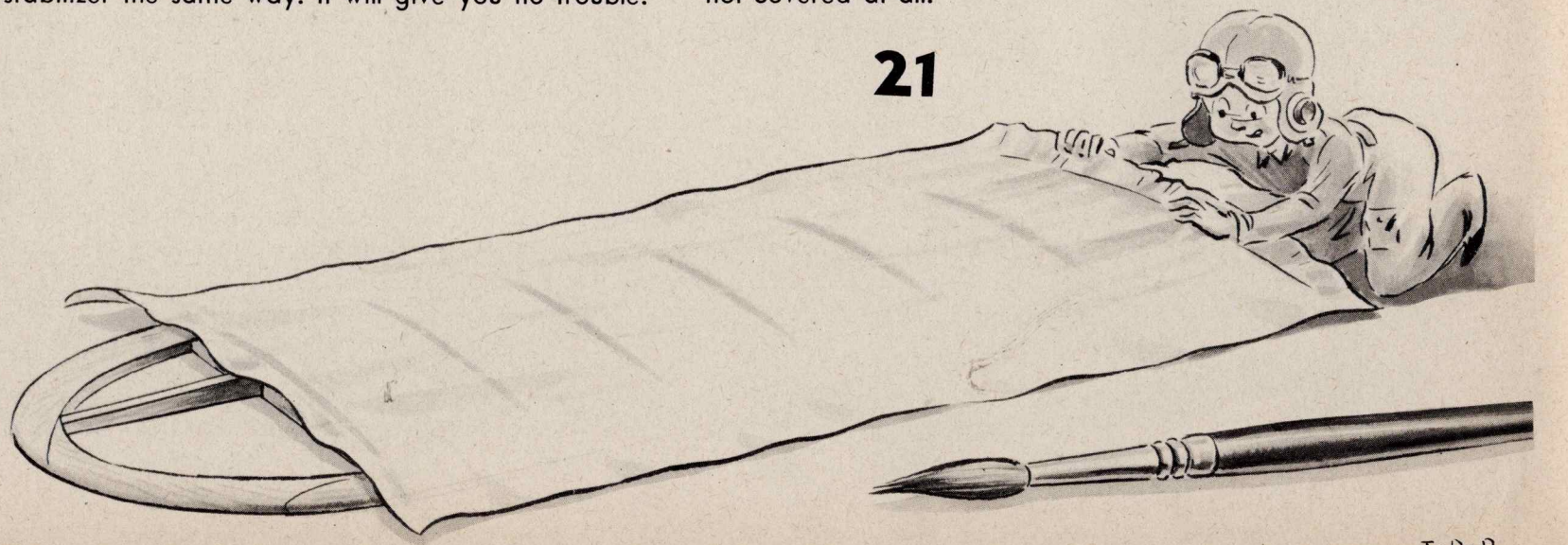
Now cover the other side of the rudder, but this time do not trim off that free edge. Leave at least 1/8 inch overlap to fold over and make a neat seal. Just line this free portion of tissue with dope and rub it down with your finger tips. When it must go around a curved place, notch it (figure 20). It will wrinkle if you don't.

Cover the stabilizer the same way. It will give you no trouble.

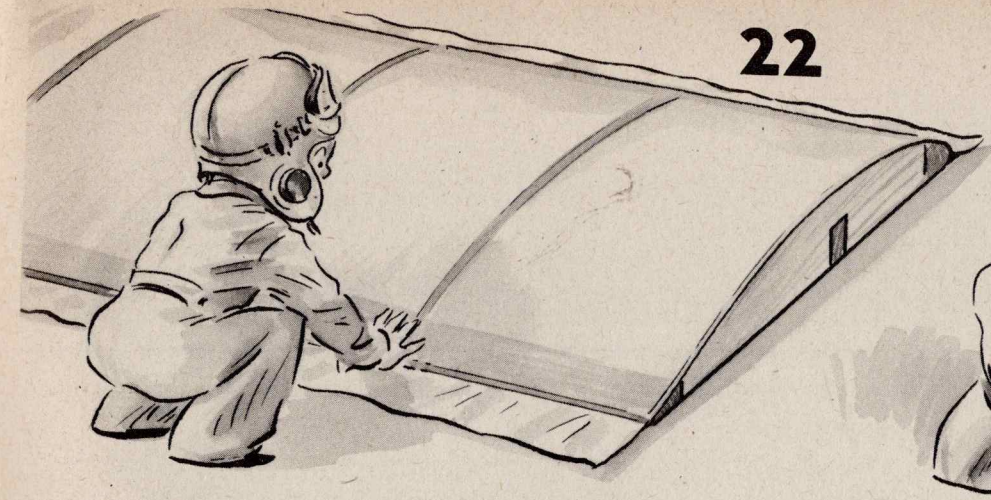
Now when you come to the wings, you don't have to put dope at every point. Light wings like these don't need it. Five pieces of tissue are needed, two for the two flat portions of the top of the wing, two for the top of the wing tips, and one long piece for the entire bottom of the wing.

First apply dope to the root rib (the one at the base of the wing) and the tip rib (the one nearest the tip). On these two ribs put the dope at the center, covering about one half of each rib. Pull the paper taut as before (figure 21). Notice that at this stage the tip is not covered at all.

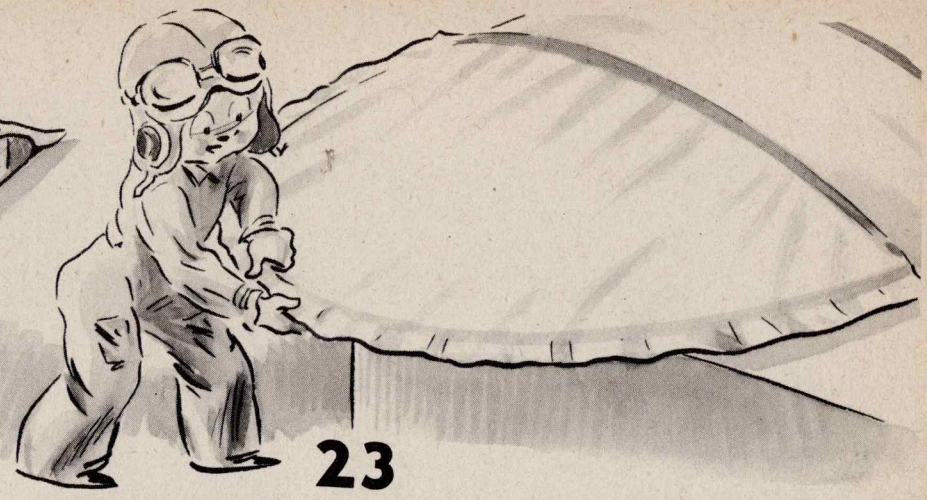
21



J-D-P



22



23

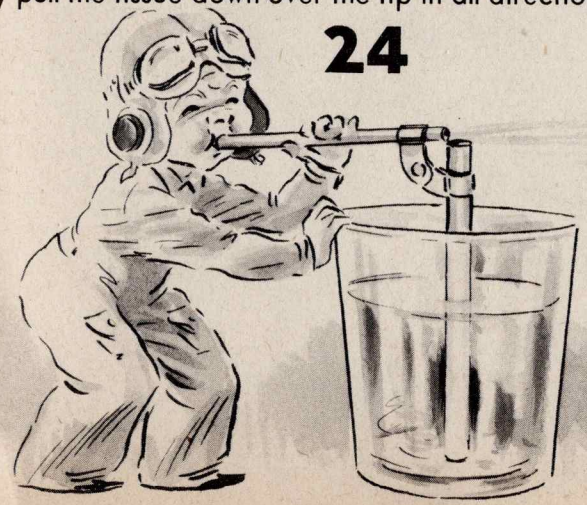
Now when the dope has set on these ribs, put dope on the rest of the root rib and tip rib. Also put some along the edges of the outside spars (the leading edge and trailing edge). Pull down the paper so that it is smooth and rub with your finger tips to make it stick. The most important thing is to have the paper lie smoothly over the ribs (figure 22). Trim the paper right off flush around the edge or outline of the wing.

Covering the tip is a little fussy. Cut a piece of paper too large, but with a straight edge to go on the tip rib. Coat the tip rib with dope, apply the paper, and rub down the edge there until it is fast. When you are sure it will not pull away, coat the tip with dope, carefully pull the tissue down over the tip in all directions (figure 23), and rub the tissue down, especially along the frame. Trim off the waste paper.

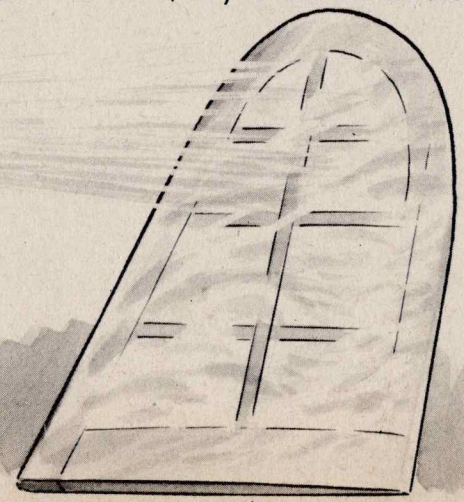
It is easy to cover the bottom. Coat the outline, or outer edges, with dope and press the paper smoothly in place, just as you did for the tail surface. Do one half of the wing at a time. The bottom covering has the overlap. Fold it up around the frame and cement it in place. The bottom covering, of course, takes care of the lower side of the tip. Here you will have to notch it where it overlaps the tip.

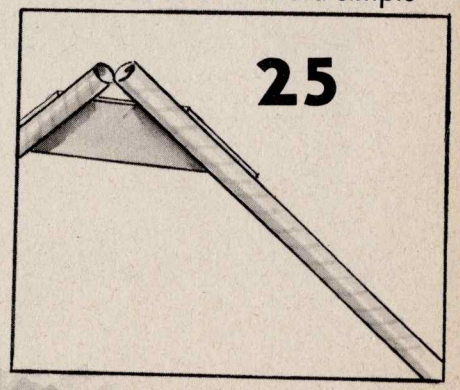
The finishing touch is to shrink the coverings on the frames by blowing a fine spray of water onto the fabric.

You can buy a sprayer like the one in the drawing (24) at any art store, or you can use an atomizer. You can even make a simple



24





25

J. D. P

sprayer out of two soda straws as the picture shows (25).

Do not get too much water on the surfaces. Just send a fine spray all over. Don't worry if the paper wrinkles up, as it will.

After spraying the paper, pin the model at the corners to the table with pins through the wood—using as *few* as possible—to prevent its warping. This is the only exception to the rule against pinning through the model. Dihedral wings have to be sprayed and dried one panel at a time so that each can be pinned down.

When the paper dries, it will be as tight as a drumhead. Finally give the covering a coat of dope.

Your construction work is over. The last step is to put the model together.

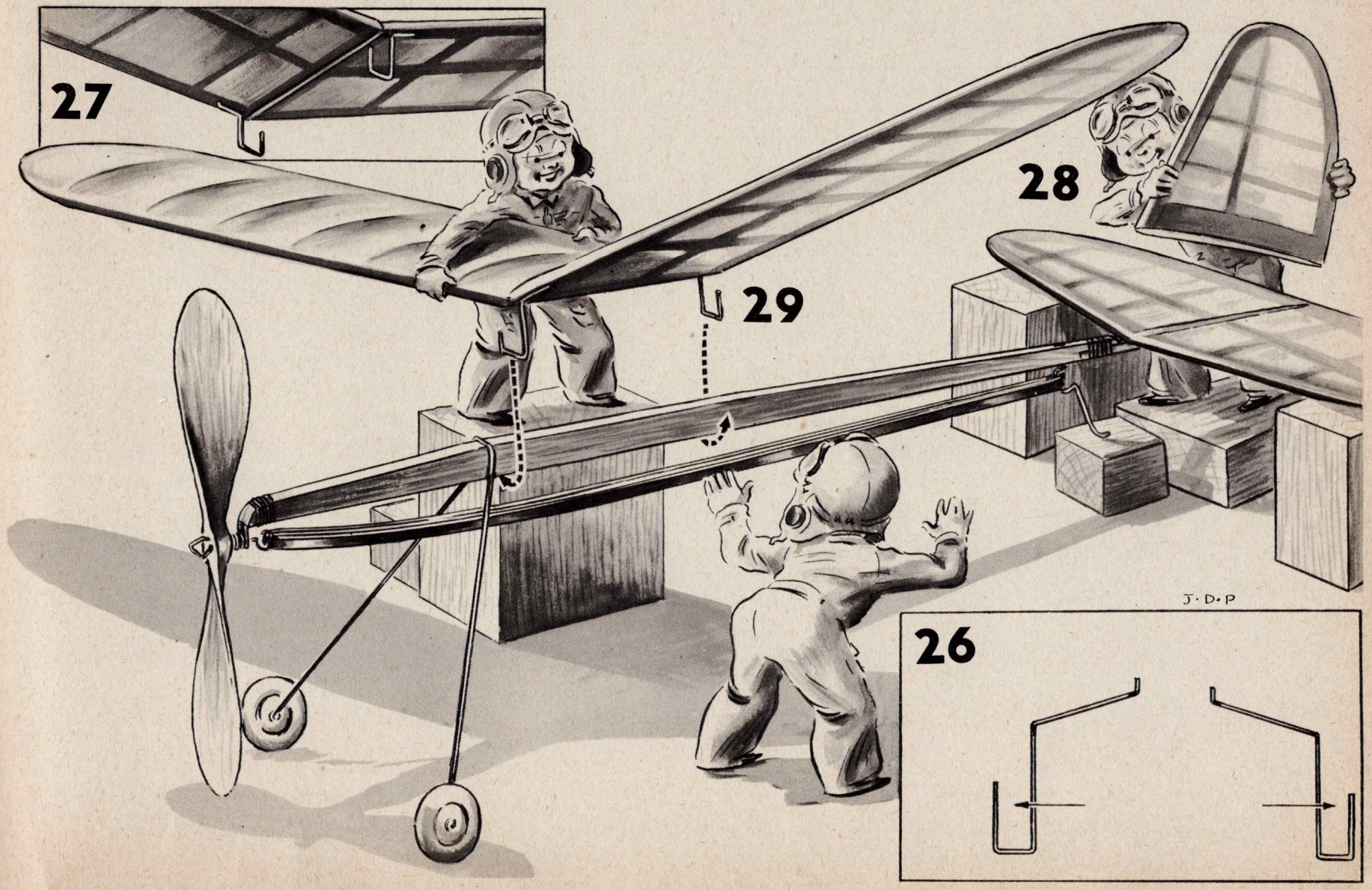
First bend two wing hooks out of No. .020 wire the exact size shown in the little corner picture (26). Cement them to the undersides of the wings (27).

As was explained before, you are using the same type fuselage, landing gear, propeller, and motor as in the second model.

With scraps of wood, block up the tail until the fuselage is perfectly level. Cement the stabilizer to the tail boom. Cut away the paper covering along the middle of the stabilizer. That is because you cannot cement one part to another where paper comes between. Always cement wood to wood. Then cement the rudder to the center of the stabilizer (28).

Figure 29 shows how you slide the wing hooks over the motor stick, one on each side. After catching the hooks under the motor stick, pull the wing up until the bottom of each hook is tight.

The plane is now ready for its first test flight, and from here on you know what to do!


27
28
29
J·D·P
26

This model can be easily changed into a hydroplane, or what they call a flying R.O.W. (rise-off-water). The only changes are in the landing gear.

You will make three pontoons. Cut six pontoon side pieces exactly the size of this pattern (30) from 1/16-inch sheet balsa. Pin them all together and finish them all off at once as you did with the ribs. The pontoons should be made 1 inch wide, that is with the sides one inch apart and bridged by 1/16-inch square strips inset as the drawing shows (31).

Make the landing gear legs 5 inches long out of bamboo or pine strips, say 1/8 x 1/4-inch tapered at one end to 1/16 x 1/8 inch. Streamline these struts by rounding the front edges and pointing the rear ones. Bind each one into a pontoon frame at an angle. Cover the bindings with cement. Having done this, you can cover the pontoons with bond paper, that is writing paper. Give them three or four coats of paper dope.

To attach the legs to the motor stick, cut a slot large enough in the stick to take the sharpened end of the pontoon leg (figure 32). Cement the legs into these slots and then bind them tight. Rub cement over the final joint. Of course you will remember to set the legs at a forward angle.

To make this model still better, you can add another feature: freewheeling.

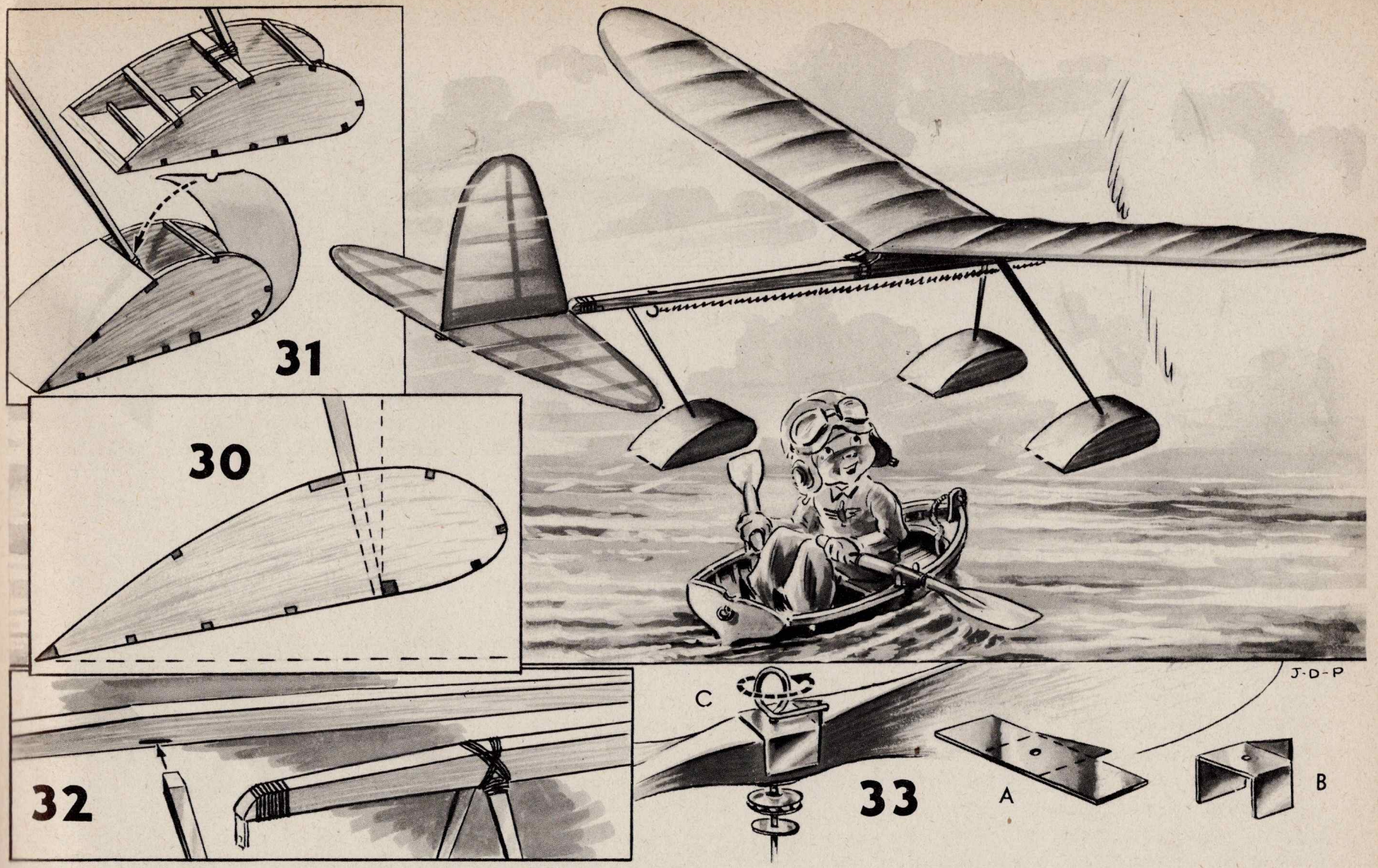
From a bit of tin (or any thin sheet metal) cut a piece like that shown in figure 33*A*. (Notice the slanting lip.) Bend it around as in 33*B*.

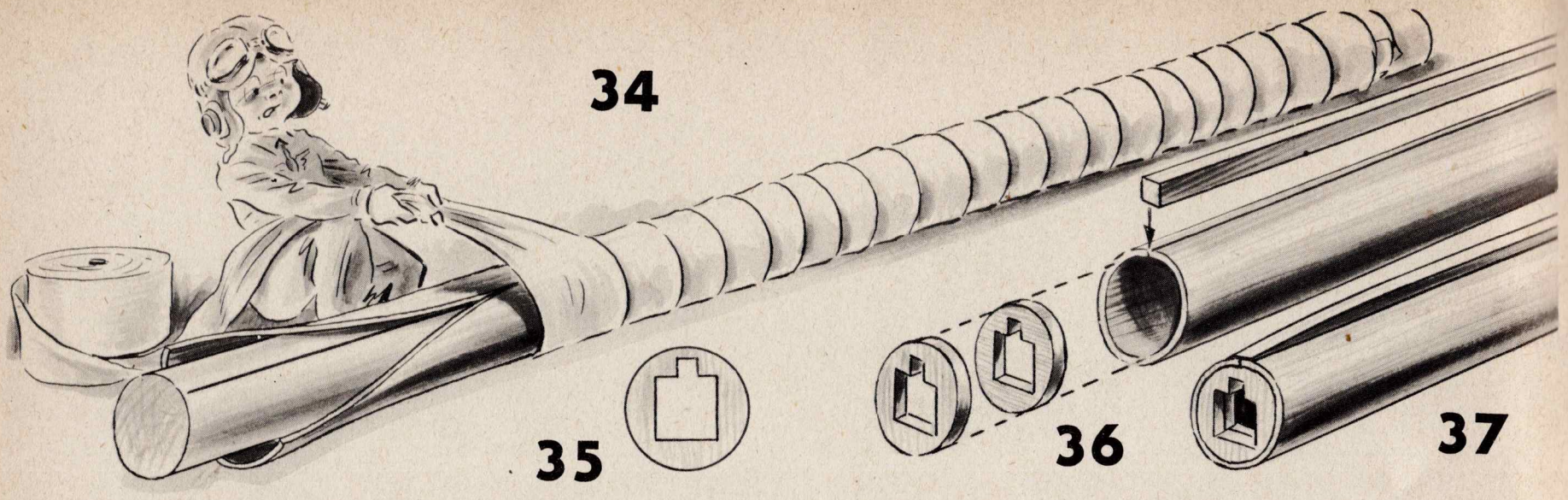
Cement this over the hub of the propeller, lining up the hole in the propeller with the hole in this gadget.

Bend out the end of the propeller shaft to form a little spur as shown in 33C. When the propeller shaft is under power, the rubber draws this shaft tight and the spur catches the lip making the propeller turn.

When the power is off, the rubber bands loosen and the wind continues to spin the prop. Then the spur slides up over the slanting lip each time the prop blows around. This lets the propeller go free and gives your model a longer glide.

The bearing shown here (33C) is a ball-bearing washer such as you can buy. It makes for smoother running.


31
30
32
C
33
A
B
J-D-P



How would you like to convert your stick model into a streamlined speedster with a balsa-tube fuselage?

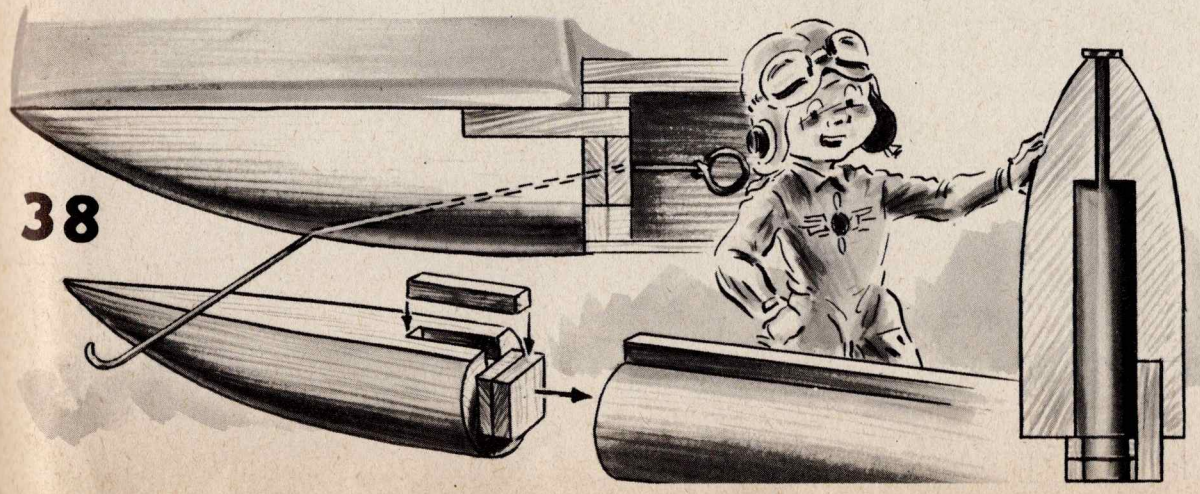
That is not hard. First find a broomstick or dowel rod about ¾ inch in diameter. Now lay out a 1/16-inch sheet of medium-weight balsa 18 inches long and just wide enaugh to go once around the stick. You can find this out by wrapping a bit of string around the stick. Or multiply the diameter by 3 1/7, if you feel like fractions today. For instance, if the broom handle is ¾ inch thick, your balsa should be a trifle less than 2⅜ inches wide.

Soak this sheet of balsa in hot water for ten minutes. It should bend easily by that time. Bend it around the broomstick and make sure that the edges just meet. Now bind it there tight with strips of cloth (figure 34). Don't let the sheet twist away as you bend it and then bind it.

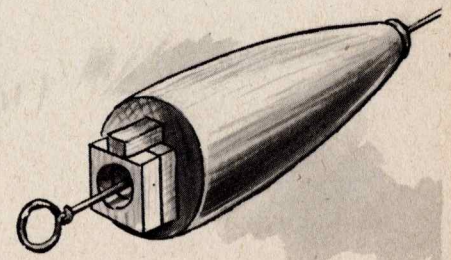
While the tube is drying, make four "formers," or end pieces. Cut them to the inside diameter of the tube (outside diameter of the broomstick or dowel). The pattern shown here (35) has ¾-inch diameter. Keep the pattern of the inside cut-out the same size as here. Be sure that the grain goes up and down in two of them, and across in the other two (36). This is for strength. After the tube has dried into shape, remove the wrappings, slide out the broomstick, and cement the seam together. Cement a strip of hard balsa ⅛ inch square along the seam, making a kind of ridge. Cement one pair of formers together with the grains going at right angles and cement this piece into one end of the tube. Cement the other pair into the other end. Now taper down one end of the top strip (37).

Whittle out a tail plug of soft balsa (38) and a nose plug of hard balsa (39). Figure 38 shows how the combined tail skid and motor mount is bent out of wire and forced through the tail plug. (Better drill a hole first.) Also you can see how the propeller shaft fits through the nose plug. Look carefully at the snugly fitted squares of balsa which are cemented—two to the tail plug and two to the nose plug—with a little oblong piece to fit into the notch.

It is easy to mount the stabilizer with rudder on the flat upper surface of the tail plug. Just cement them together.

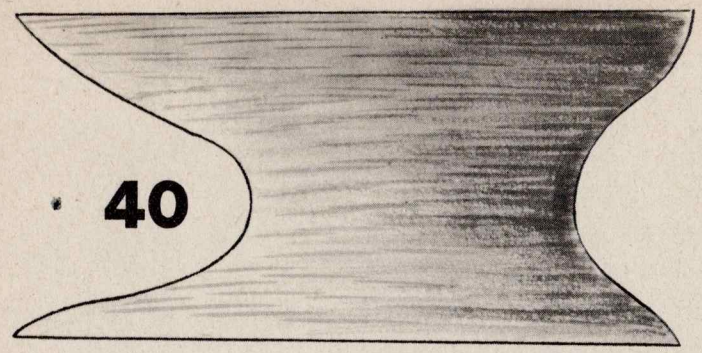


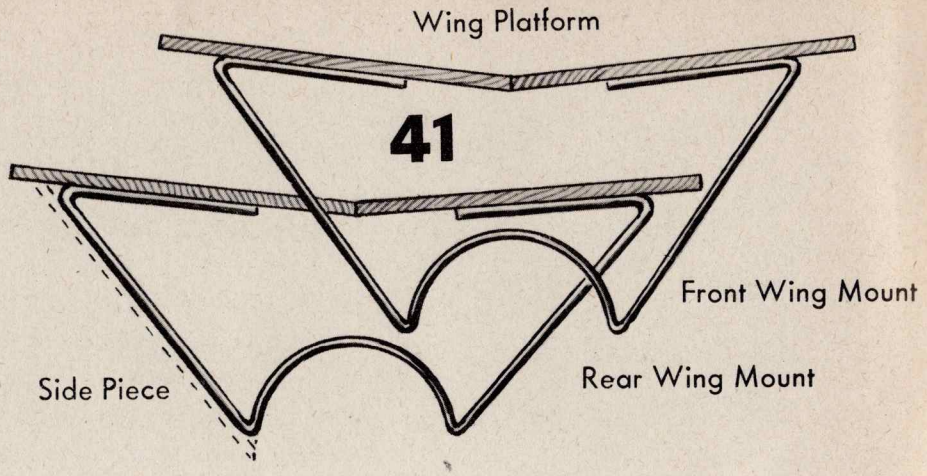
38



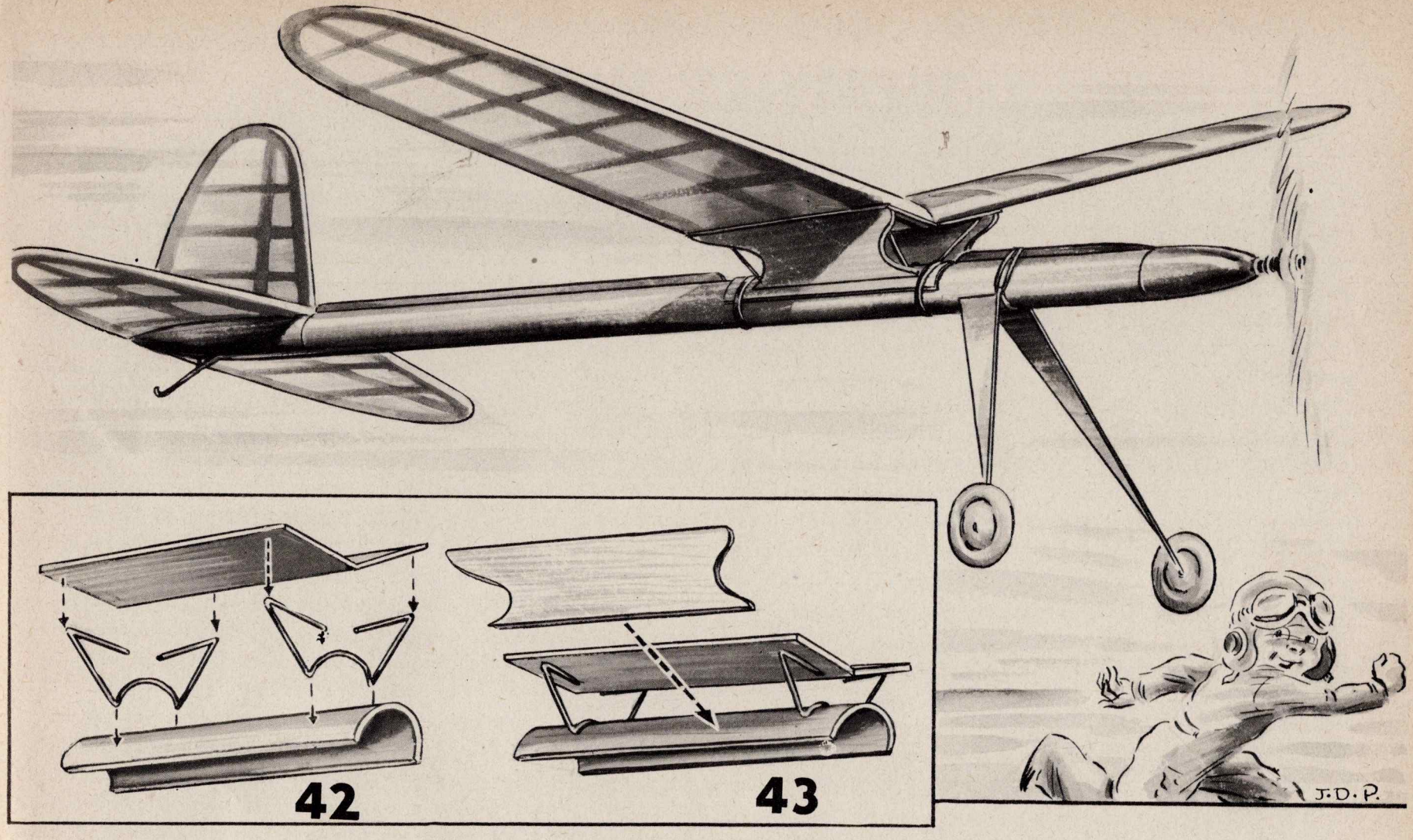
39

J.D.P





However, you will need a streamlined high wing mount. From 1/16-inch hard sheet balsa, cut two side pieces in the shape of figure 40 (actual size). Bend No. .020 music wire into fittings the size and shape of figure 41. Halfway around the same broomstick, bend a 4½-inch piece of sheet balsa as you did for the fuselage tube (42). And from the 1/16-inch hard sheet balsa make a platform as long as the chord of the wing to fit on top of the wire mounts. Crack it down the middle and cement it into shape. Cement all these together (42 and 43). Now it is necessary to cut out a length of that ridge on the top of the motor tube to make a place for the curved wing mount. Cement the wings to the mount and attach the mount to the tube with rubber bands.



The landing gear is bent to fit under the tube and is held in place by rubber bands. To carry out the streamlined effect, you can cut streamliners of 1/16-inch sheet balsa and attach them to the landing legs by binding near both ends with thread and then cementing the wood against the wire.

Before going over to the next ship, you will probably have some ideas and improvements of your own you'd like to try out.

WEATHER VANE

An interesting gadget to construct is a weather vane model that you can put on top of your garage or barn roof. If you don't have a garage roof handy, mount the model on top of a tall, slender pole, and either drive this pole into the lawn or fasten it to a fence post. Pick a good clear spot where the wind can blow freely against the weather vane so that it will always point into the wind with its propeller spinning.

Our model is based on the North American Mustang fighter. The drawing is exactly one-third actual size, which means that you will have to triple the dimensions. All parts are made from pine. The fuselage is made from two pieces measuring 21 3/8 inches by 4 11/16 inches by 3/4 inch. Draw the profile of the fuselage (figure 1) on the side of each block. Notice that the parts marked S have to be made separately and attached when the model is being assembled. Cut along the outline with a scroll saw or jigsaw. Cement and screw the two halves together.

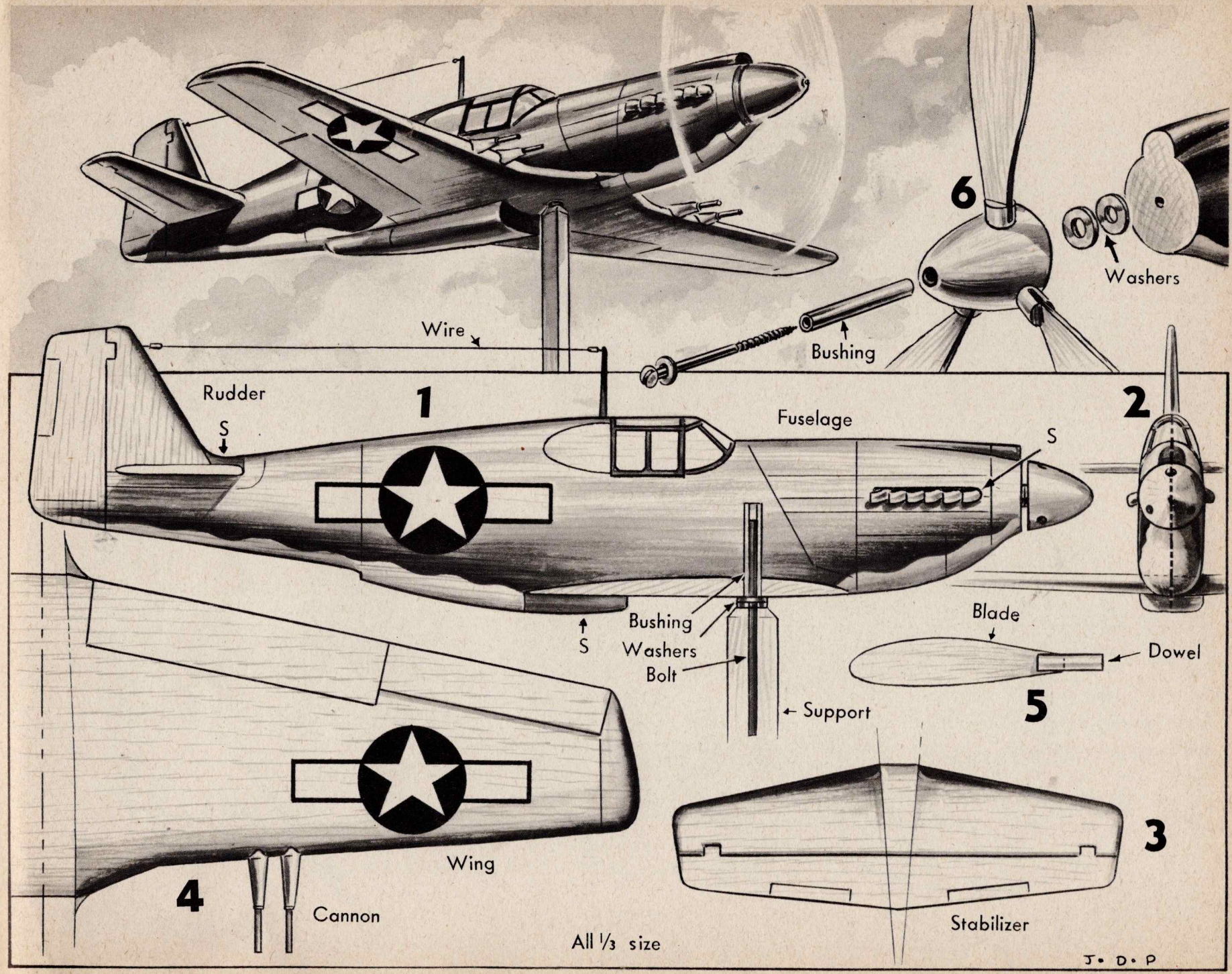
Beginning just behind the cockpit, taper the thickness of the fuselage block gradually down to 1/4 inch at the tail. Finally shape the block to the cross section shown on the front view (2). Cut a notch in the bottom of the fuselage deep enough to hold the wing and another notch to take the stabilizer. Both notches are indicated on the side view.

The stabilizer (3) and the rudder are cut to the outline shown, from a sheet of 1/4-inch wood. Shape them to a streamlined cross section. The wing is made in one piece from 1/2-inch wood. First cut it to the top-view pattern (4) and shape it in cross section like a wing rib. Sand all the parts, first with coarse sandpaper to take off the big bumps and then with fine sandpaper to get a smooth finish. To assemble the model, cement the wing and stabilizer into position and nail them with brads, then do the same with the rudder. Fill in the crevices with plastic wood, or you can make a mixture of cement and sawdust if you can't get plastic wood. Figure 7 shows the parts ready to assemble.

The propeller blades are made from 1/4-inch wood (figure 5) and are inserted in slits cut in small pieces of 3/8-inch dowel. Now carve the propeller cone or spinner (6) from a block 1 1/2 inches square by 1 1/2 inches thick, and drill three holes in the spinner to take the dowels with the propeller blades already in place. Be sure to twist these blades to the proper angle before cementing them permanently in position. Note that a piece of metal tubing or bushing 1 1/2 inches long fits tightly through the center of the spinner to serve as a bearing and that a 3-inch screw is inserted through this tube into the nose of the airplane. A small washer should be placed between the head of the screw and the spinner and two more washers between the spinner and the nose of the airplane. Attach the prop temporarily until the model has been balanced later. Attach the engine exhaust stacks, the air scoop, the front of the radiator tunnel block that goes under the wing, and the four dummy cannon made from dowels.

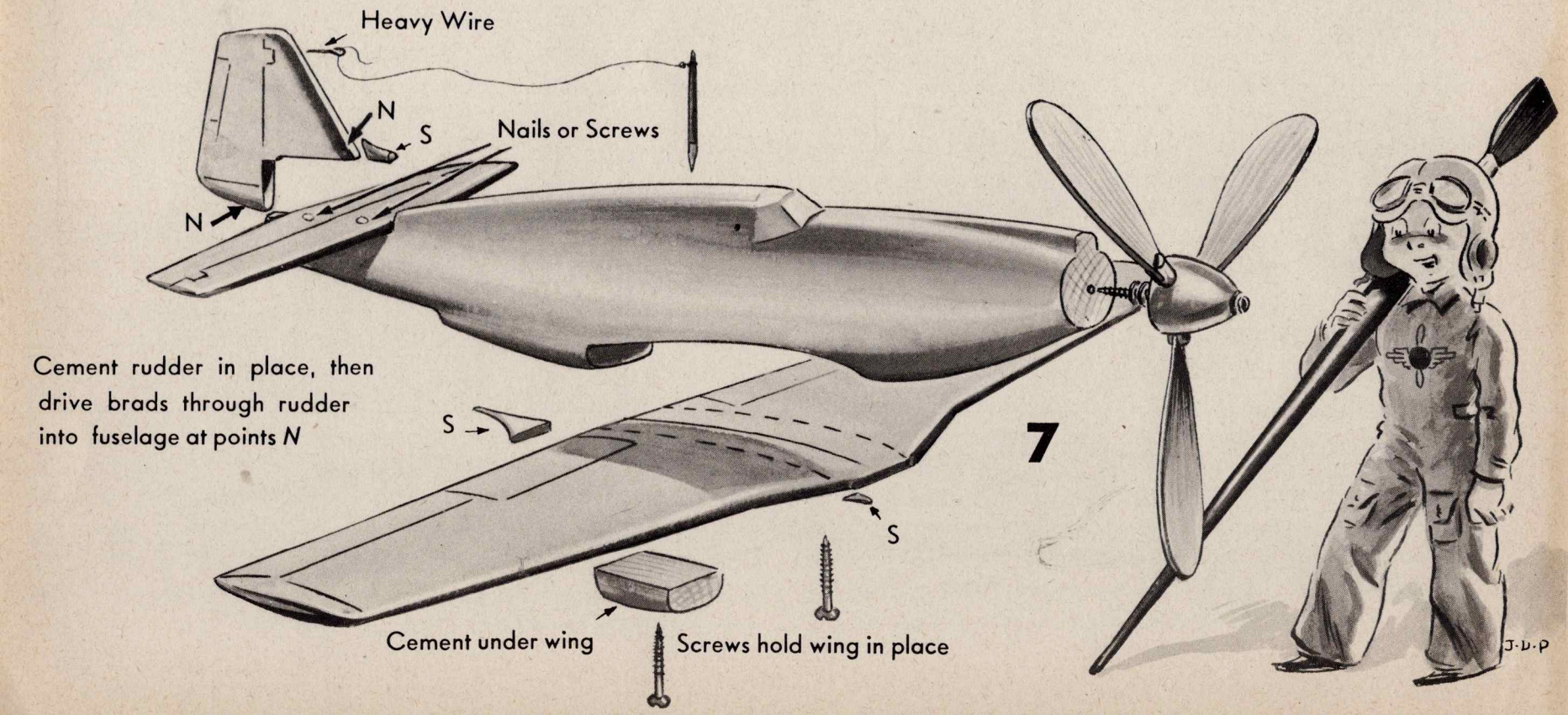
Drill a hole in the bottom of the fuselage as shown on the side view but be sure first that the model balances at this point. Remove the spinner until after the model has been painted. Insert a bushing or a piece of metal tubing into the hole just bored. Later, when the model is finished, this tubing will fit over a bolt on which the model swivels in the wind.

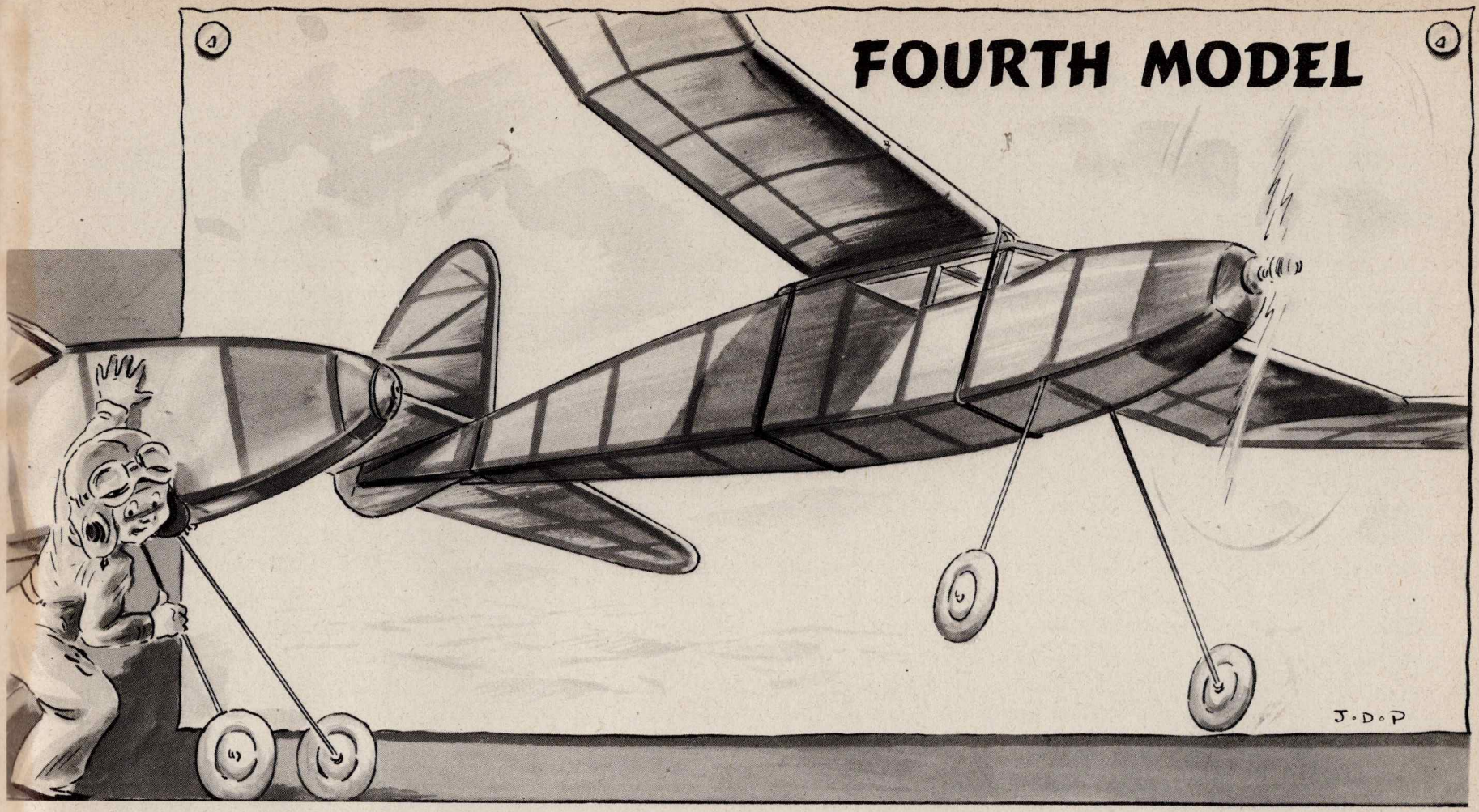
Now you are ready for painting. Remember that this model will be outdoors in the sun and rain, and will have to be well painted. First, give the entire surface of the airplane a couple of coats of "ground" paint. Flat white paint is excellent. Finally, give the surface two coats of colored paint, the top olive drab and the bottom a sort of bluish white, almost on the gray side. "Coach" or "carriage"


6
Washers
Wire
Bushing
Rudder
S
1
Fuselage
S
2
S
Bushing
Washers
Bolt
Support
Blade
Dowel
5
Wing
4
Cannon
3
Stabilizer
All 1/3 size
J. D. P

colors are best. The insignias are decalcomanias; you can buy them from your hobby shop.

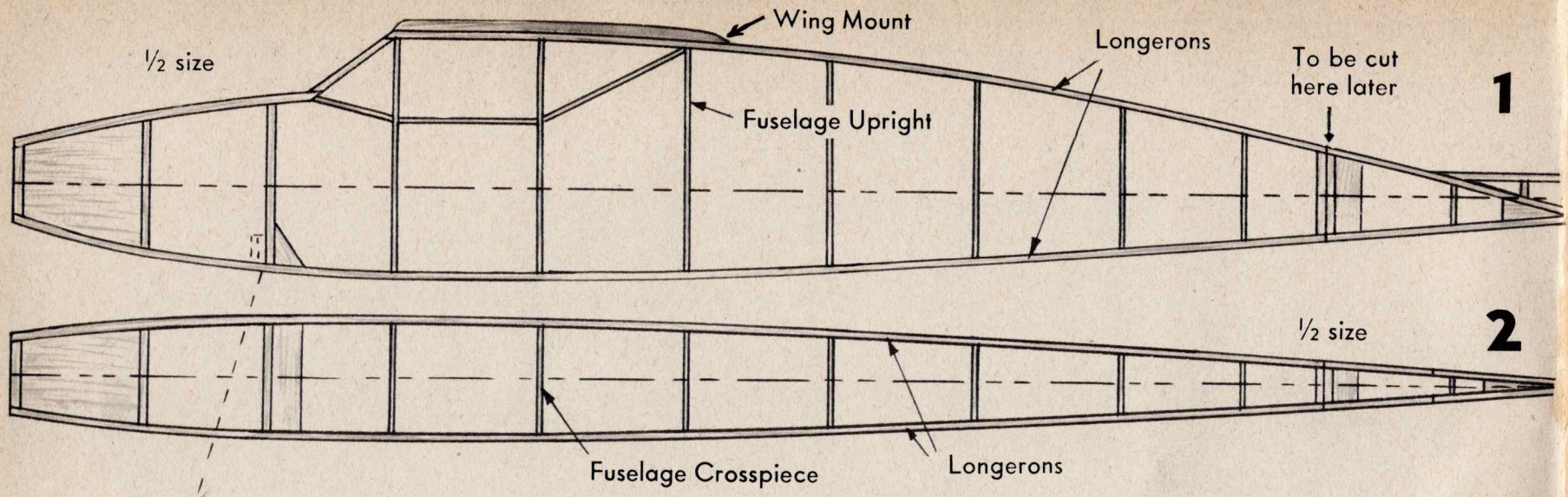
Place the propeller in position. For realism, paint the cockpit white and trim it with thin black lines. Outline the control surfaces with thin black lines also. Finally, put on the aerial mast ($^{1}/_{16}$-inch metal) and aerial. Make the support pole, with the mounting bolt firmly in place, and slide the model over the end of the bolt. It is a good idea to place two washers between the model and the support, one glued to the top of the support and the other to the bottom of the model.





The next model is a built-up fuselage ship. It is the most popular type of all for outdoor flying. This time we'll add a high-lift, load-carrying wing and a lifting-type tail. If you are careful in your work, you'll have a real contest ship that will stand a good chance in any Class "C" contest you may enter—and it might break records!

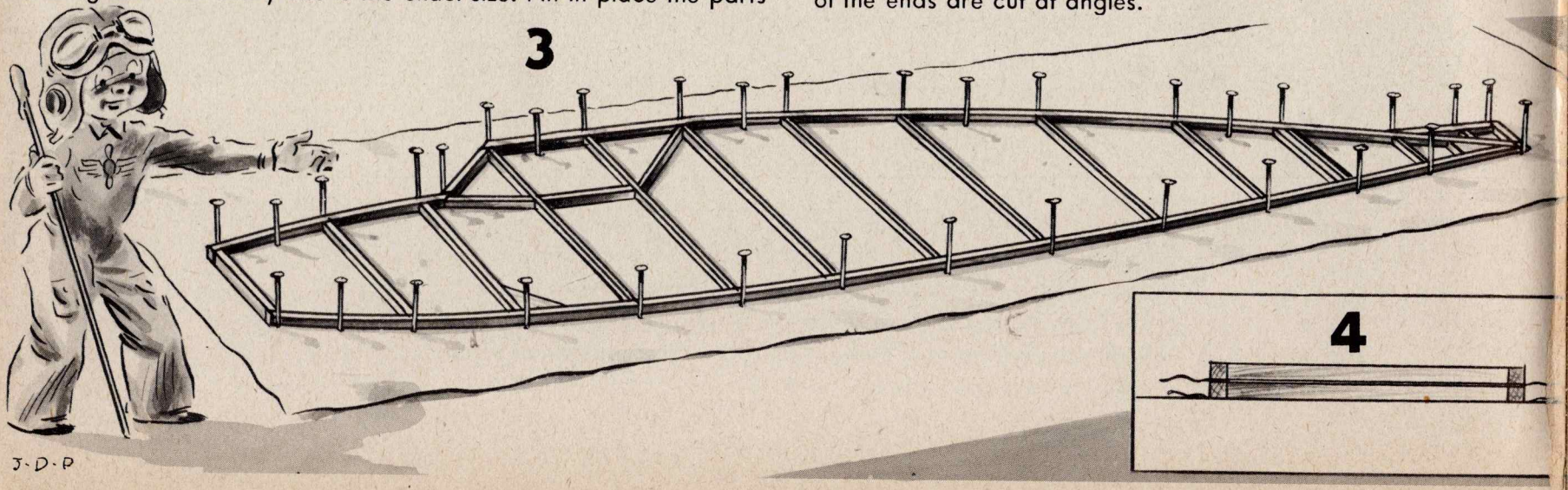
First the instructions for the basic model, which has a real little cabin with windows in it. Then we'll see how this can be changed and improved in many ways.

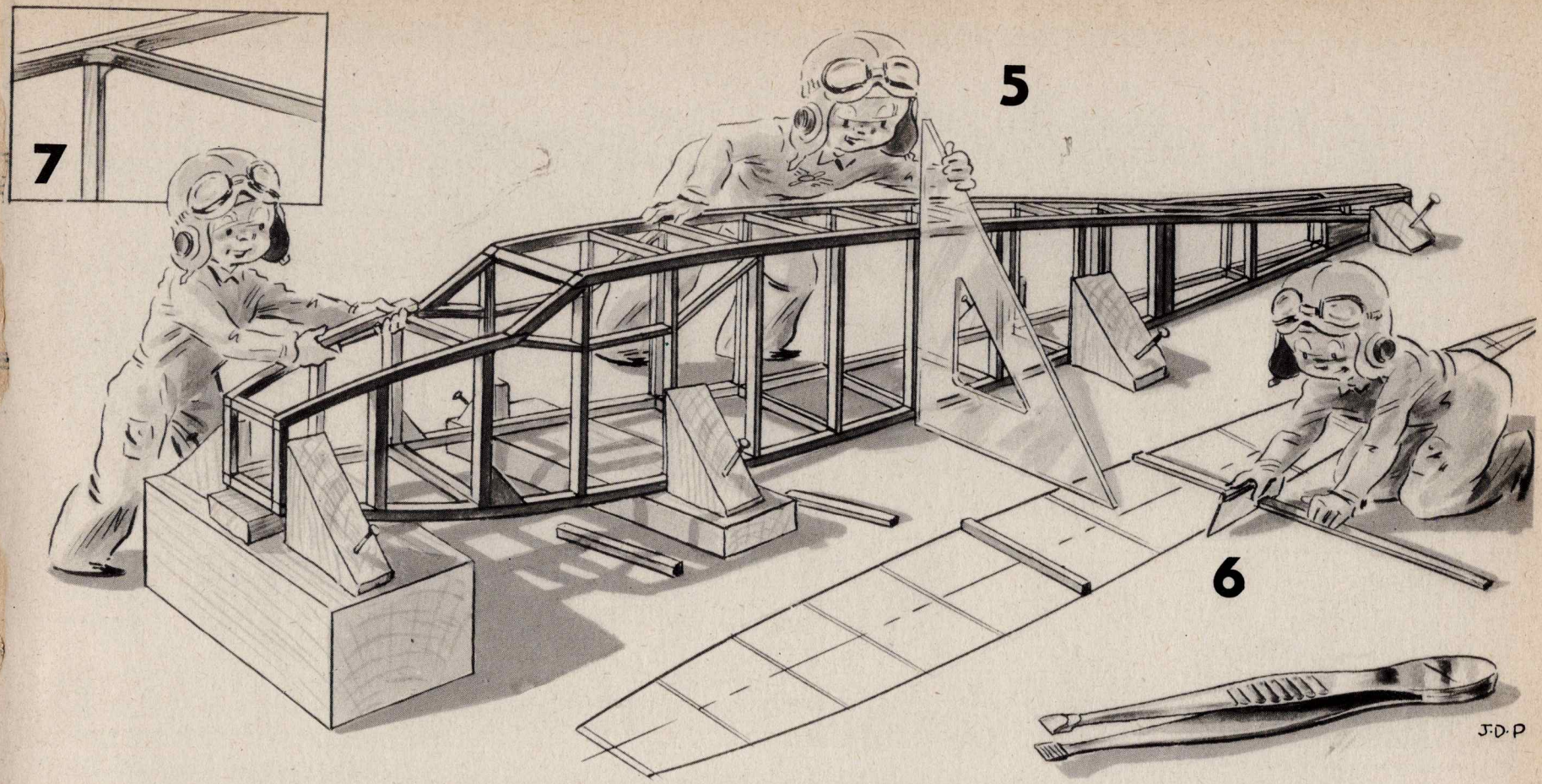


To start with, here are two plans. The top one (1) shows the fuselage as you would see it from the left side. The one beneath (2) shows the same fuselage as it would look from above. Both are half size, and before doing anything else you will have to make a pattern for each twice as large (using the squared paper, you remember).

Cover the side-view pattern with a sheet of waxed paper. Using strip balsa 3/32 inch square and 3/32-inch sheet balsa, cut out all the pieces shown in figure 3, by placing them over the pattern and making sure that every one is the exact size. Pin in place the parts shown in figure 3 and cement all the joints. The parts not yet used here (called fill-ins) will be used later. At this stage the frame will look like the picture. Leave it there until it dries. Now don't lift it up yet. Build the other panel right on top! Just pull out the pins, put another sheet of wax paper over all, and go to work as before (figure 4), putting in pins through the second wax paper. Now both will be the same, and no mistake.

Notice, by the way, that all pieces do not cut off square. Some of the ends are cut at angles.



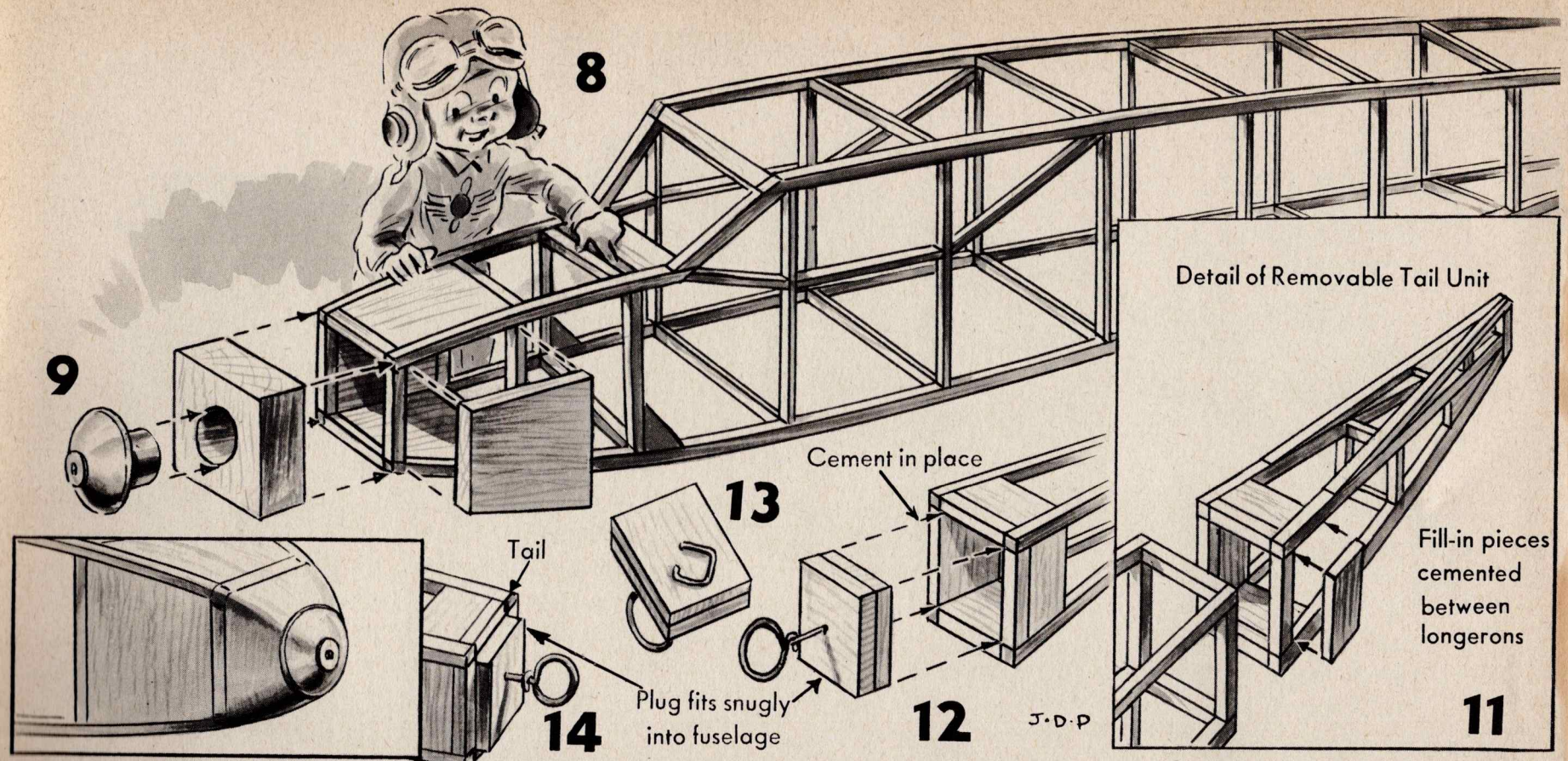


When everything is good and dry, draw out the pins and separate the two frames. Look them over to make sure all is fast.

Assembling can begin, and this time assembly will be more than ever like pictures of what goes on inside an airplane factory. As you know, they use giant jigs to hold parts in place, and you, too, will need jigs. They will be blocks cut out of balsa and pinned down to your work table. Don't cut them too carelessly; they can save a lot of trouble. Measure the width of the fuselage (on figure 2) and set the jigs up at the proper distance to hold the fuselage as the picture shows (5). With a square make sure that everything is true. It is important to have one jig at the center or thickest part of the fuselage as that is where the first crosspieces go.

Now cut out the crosspieces (figure 6). You have already made the looking-down-view pattern. Again using 3/32-inch strip balsa, cut out the crosspieces right on top of the pattern. Cement in place the third and sixth crosspieces at the bottom. Then put the top ones in. Now you might think you would do the next, and the next, but you don't. Pull the tail together, cement it, and pin scrap blocks on either side to hold it tight. Next fit the nose crosspieces in place, pin blocks there to hold the frame, and cement the crosspieces in. When you are sure these have dried, put in the rest of the crosspieces, first along the bottom, then along the top. You will probably have to use tweezers, like those in the picture. It may be easier to put in some of the bottom pieces after the fuselage is taken from the jigs.

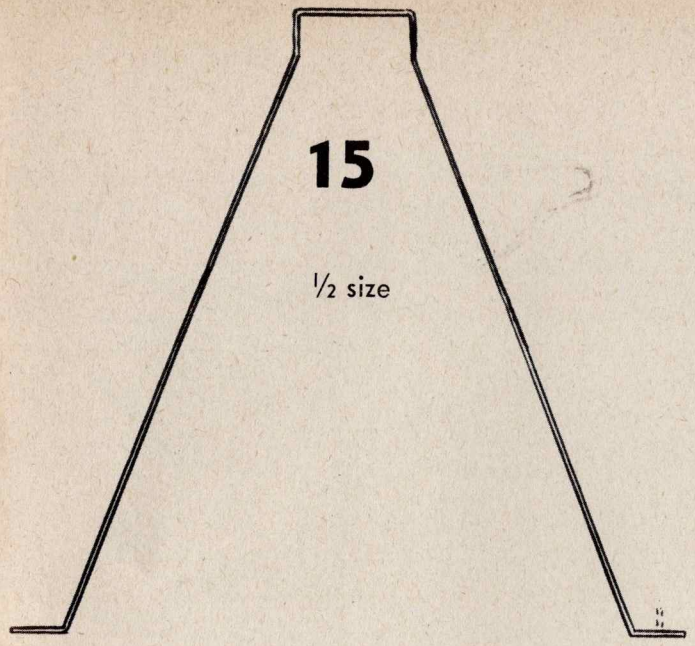
After the first cementing is done, go over and put drops of cement at either side of each joint to make a good strong job (figure 7).

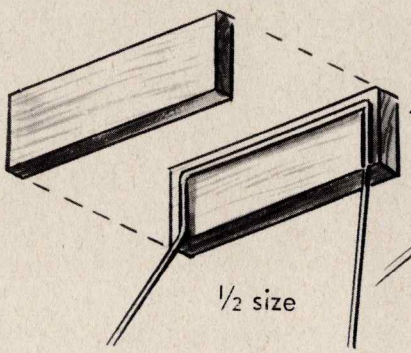


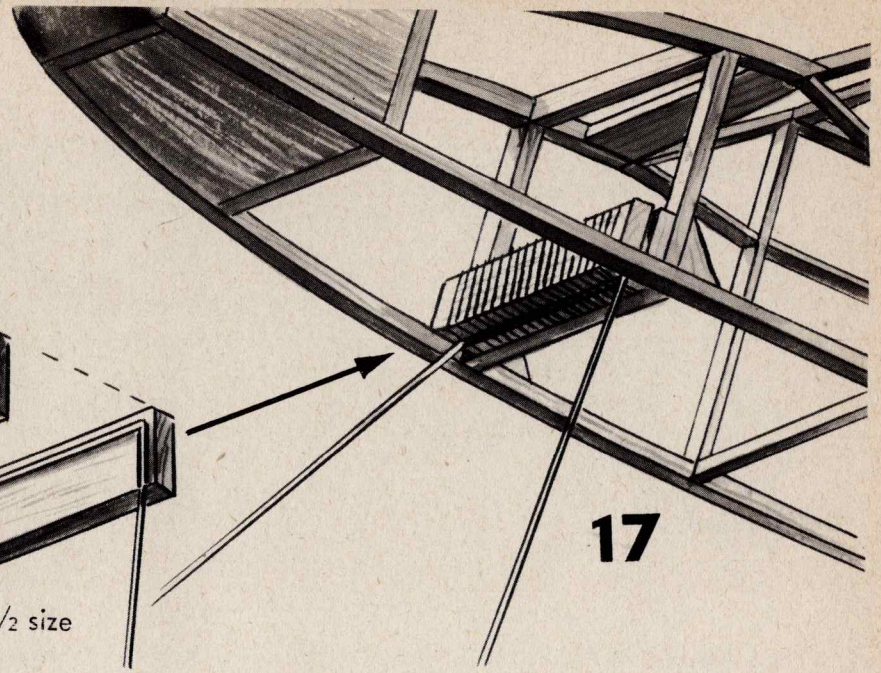
The skeleton of the fuselage is now done and it is time to put in the "fill-in" pieces. There are four in the nose, one at the top behind the third crosspiece, four behind the eleventh and twelfth crosspieces (which are close together) where the tail will be cut apart later, and one each in the top and bottom of the tail. These fill-ins are a little hard to fit in exactly. When they do fit, cement them in place. The remaining two pieces that belong above the cabin are used later.

Next comes the nose block. The best way to get a close fit is to make a little paper pattern of the outside of the square nose where the four arrows point in figure 8. Transfer this onto a piece of soft wood ½ inch thick. Cut it out, sand it, and cement it to the *outside* of the nose opening. As the diagram (9) shows, there is a hole right in the middle for the removable bearing. This you will have to buy, but don't bore the hole until you have it! Otherwise the hole is likely to be the wrong size and your block will be spoiled. Removable bearings are usually of hardwood and have a small brass bushing set into the bearing. After you have inserted the bearing, it is safe to carve down the nose block in curves so that it streamlines into the bearing part (figure 10).

Now we do an odd thing: cut the fuselage apart where the eleventh and twelfth uprights and crosspieces come close together, at the arrow in figure 11. Cut two squares of ⅛-inch sheet balsa for the rear plug—but notice that this plug fits *into* the opening. Cement these two pieces together with the grains running at right angles (figure 12). Again make a hook of No. .020 music wire and anchor it through the plug as the diagram shows (13). Use plenty of cement, too. When you cement this whole part into the detachable tail piece







(figure 14), allow one half of its thickness to stick out, because this is supposed to fit snugly into the same size opening in the rear of the fuselage itself.

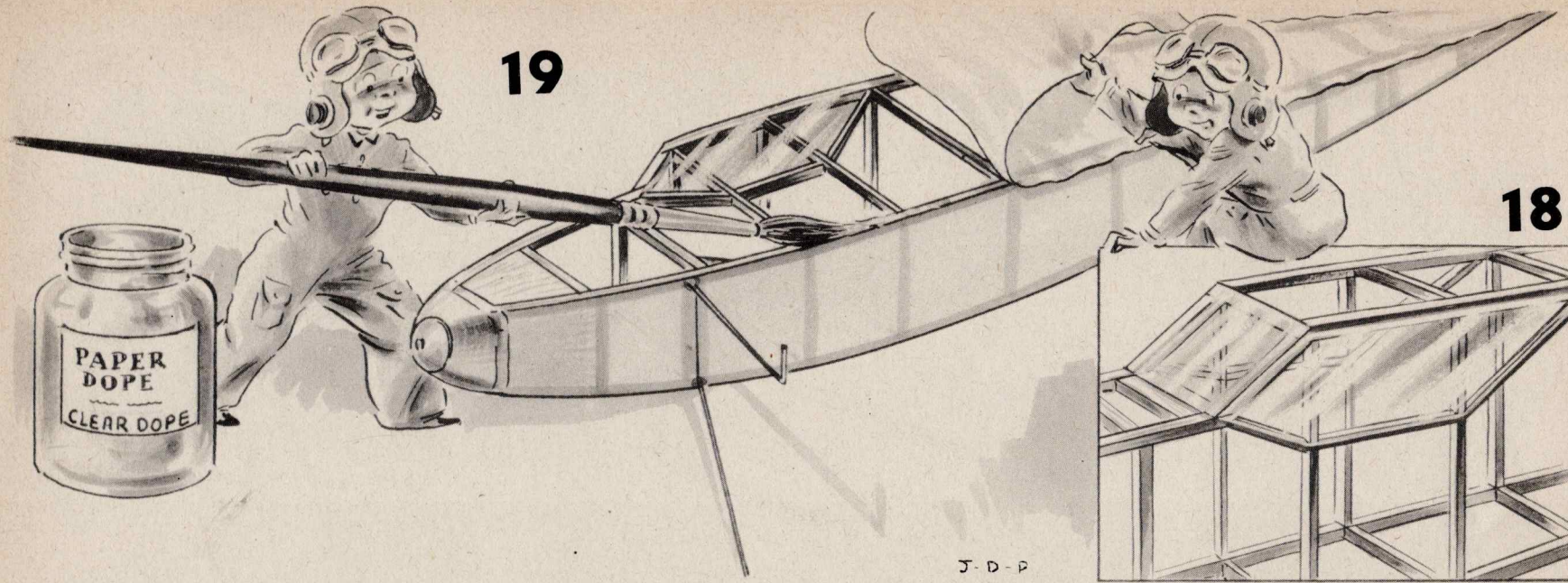
Sand the entire fuselage until it is perfectly smooth. Again make sure that you take off any little bumps of cement that may crop up in the wrong places.

The landing-gear legs are bent from No. .028 music wire in the shape shown in figure 15. This drawing is half size, so make the wire piece just twice as large.

This landing-gear unit is held in place by two blocks as shown in figure 16. This drawing also is half size, so make the blocks just twice as large, cutting them out of ⅛-inch balsa. Just put the top of the bracket between them and wrap very tightly with strong thread. Cover the whole wrapping with a good coat of cement and, after it has dried, cement the mount into the fuselage just forward of the third crosspiece as figure 17 shows.

At this point cement that rear tailpiece of the fuselage lightly in its place. You will be cutting it apart again after the fuselage is covered.

Now for covering the fuselage. This will be easy for you because you have already done the same thing before. However, since this is such a fine model, why not use some bright-colored tissue? Tissue comes in many colors. Try a red or an orange, for instance.



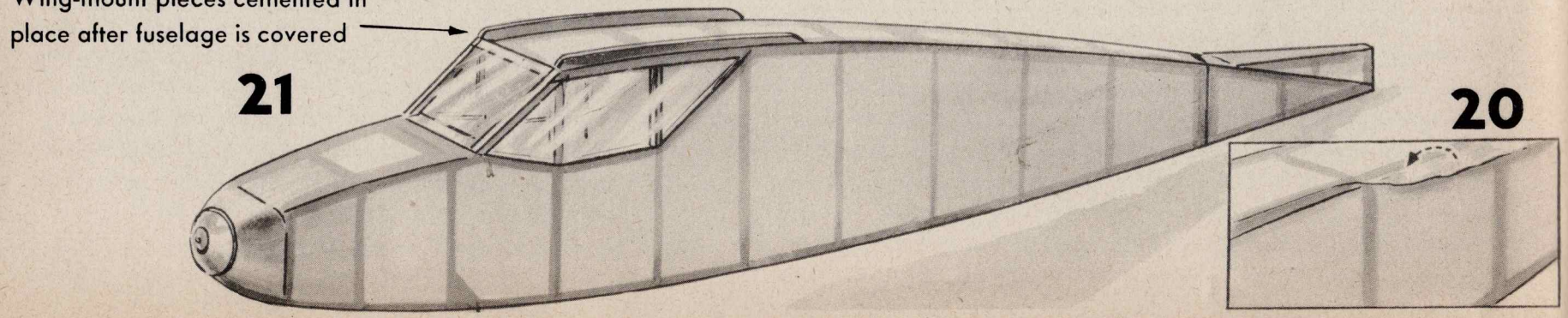
Start with the bottom. First, you remember, iron out the paper flat. Place the paper so that the grain runs the length of the fuselage, and place the fuselage upon the paper. Now cut out a piece a little larger all around. Do the covering as you did before. Dope it in place, pulling taut but not tight, and trim right up to the edges of the longerons. Of course the piece must be notched to go around the landing-gear legs.

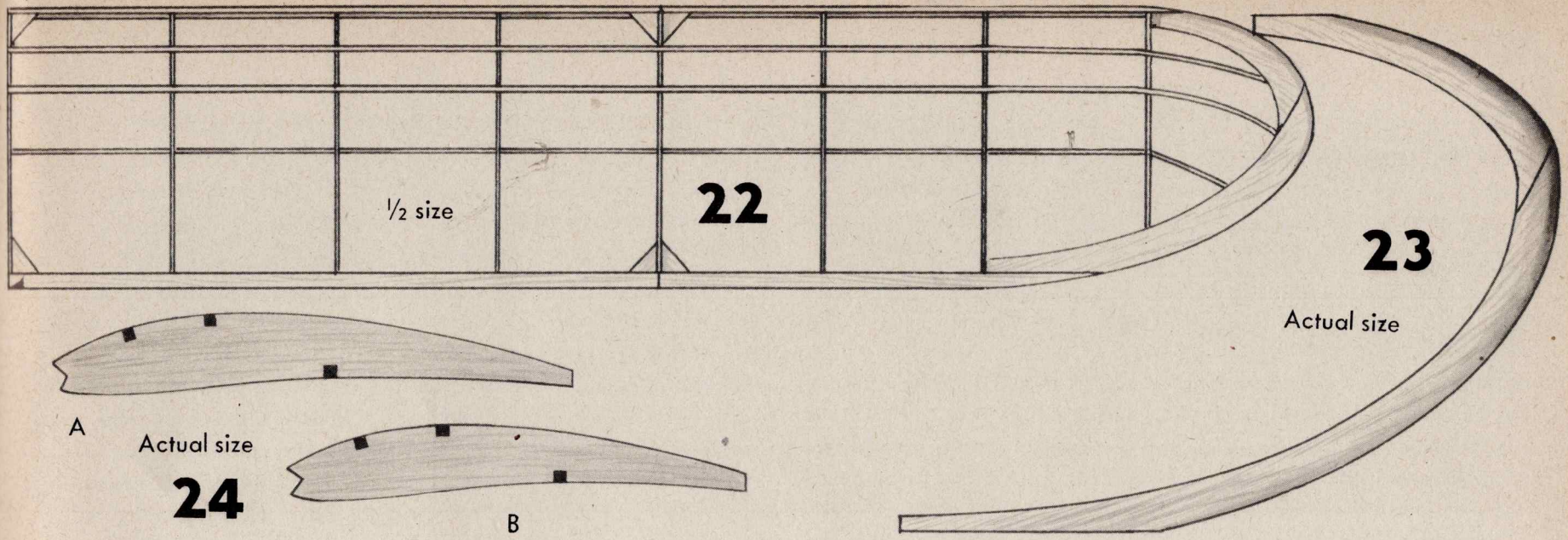
The next step is something that is a lot of fun: making the windows. Cut out three pieces of celluloid. (You'll have to buy this.) These are to fit the two sides and front as in the drawing (18). Of course at the edges they must fit over the longerons so that they may be cemented. Cement them in place, and you have a glassed-in cabin!

Next cover the top as you did the bottom. There are two strips this time, with the windshield between. After the paper dope is dry, cement in place the two wing-mount strips over the cabin.

Finally cover each side (figure 19). Figure 20 shows how these side pieces must lap over at both top and bottom to make a good joint, which you rub down with your fingers. The remaining picture (21) shows the finished fuselage.

Spray the paper lightly with water; set it aside to dry; then give it a coat of dope.





Building the wings may be a little fussier job than building the fuselage—and there are two wings.

Figure 22 is half size; so again make full-size (twice as big) right and left patterns as you did before.

The wing tip (figure 23) is full size. Trace this from the book onto tracing paper and transfer that pattern to ⅛-inch sheet balsa (medium or hard). Notice that there are two pieces in the one tip and that the grain runs the same as in the third model. Cut out the pieces. Now trace the other tip (with the bow the opposite way, of course) and cut it out. Make sure that both pieces are exactly alike. Cement each tip together (figure 23) but don't sand to a finish yet.

There are two kinds of ribs (figure 24): seven *A* ribs for each wing, or fourteen in all, and one *B* rib for each wing, or two in all. These *B* ribs are shorter than the others and fit out at the tips (figure 22). You remember how the ribs are made: trace these two patterns onto 1/16-inch sheet balsa and cut out as many as you need. Then pin them together temporarily and shape them smooth with sandpaper and sanding sticks. Finally cut the notches with care. This time there are three notches in each: two on top and one on the bottom. Also, these notches are only 1/16 inch square.

This wing, you will notice, has five spars: three inside in addition to the two edges. Of these inside three, two go above, one underneath (figure 25). Cut the spars, ten altogether, from strip balsa. The leading edge is 1/8 inch square; the trailing edge 1/8 x 1/4 inch. All other spars are 1/16 inch square. Use your pattern as the guide for length, leaving a little over as in the last model. Allow about 1/2 inch extra in length for the bend in each inside spar (near the tip in figure 22), which we'll explain later.

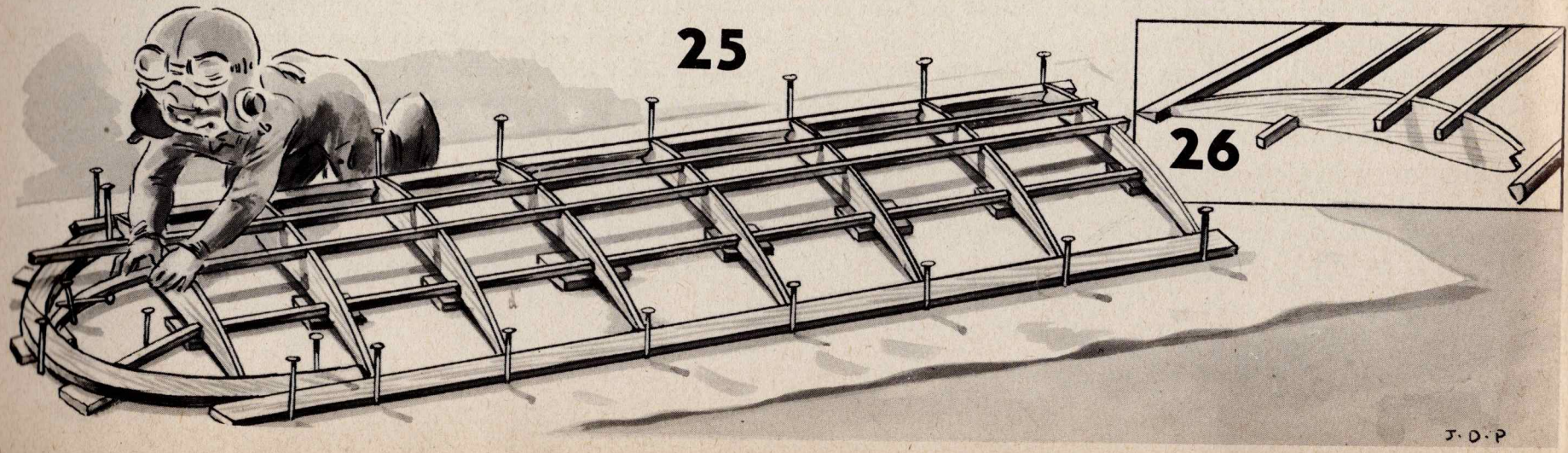
Everything is ready now for the assembling. Upon the pattern (covered with wax paper) lay the tip, raised on 1/16-inch balsa blocks as shown. Put the outside spars in place and pin everything down tight. (Pins around, not through!) Note that the leading edge is set cornerwise into the notches at the front of the ribs (figure 26). Put the underneath spar down on 1/16-inch balsa blocks, and work the ribs into place. They may take some adjusting—also some patience. (Leave all spars straight for the present, unlike the pattern.)

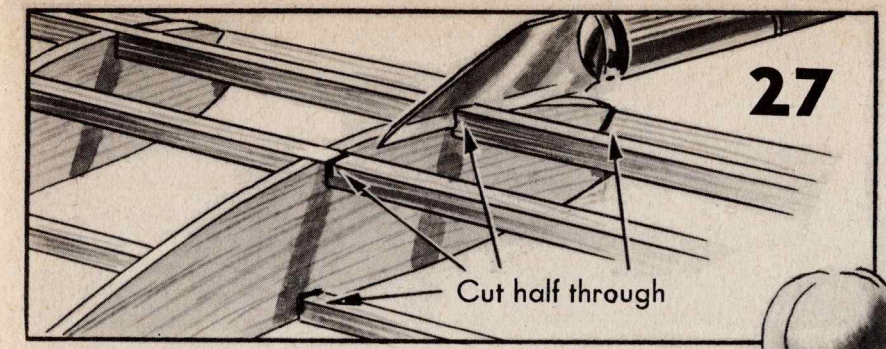
Slant the top of each of the two base or root ribs inward a good 1/16 inch, the same as in the third model for dihedral. When you are sure everything is well fitted, cement the joints and let them dry. You can work on the other wing while the first is drying.

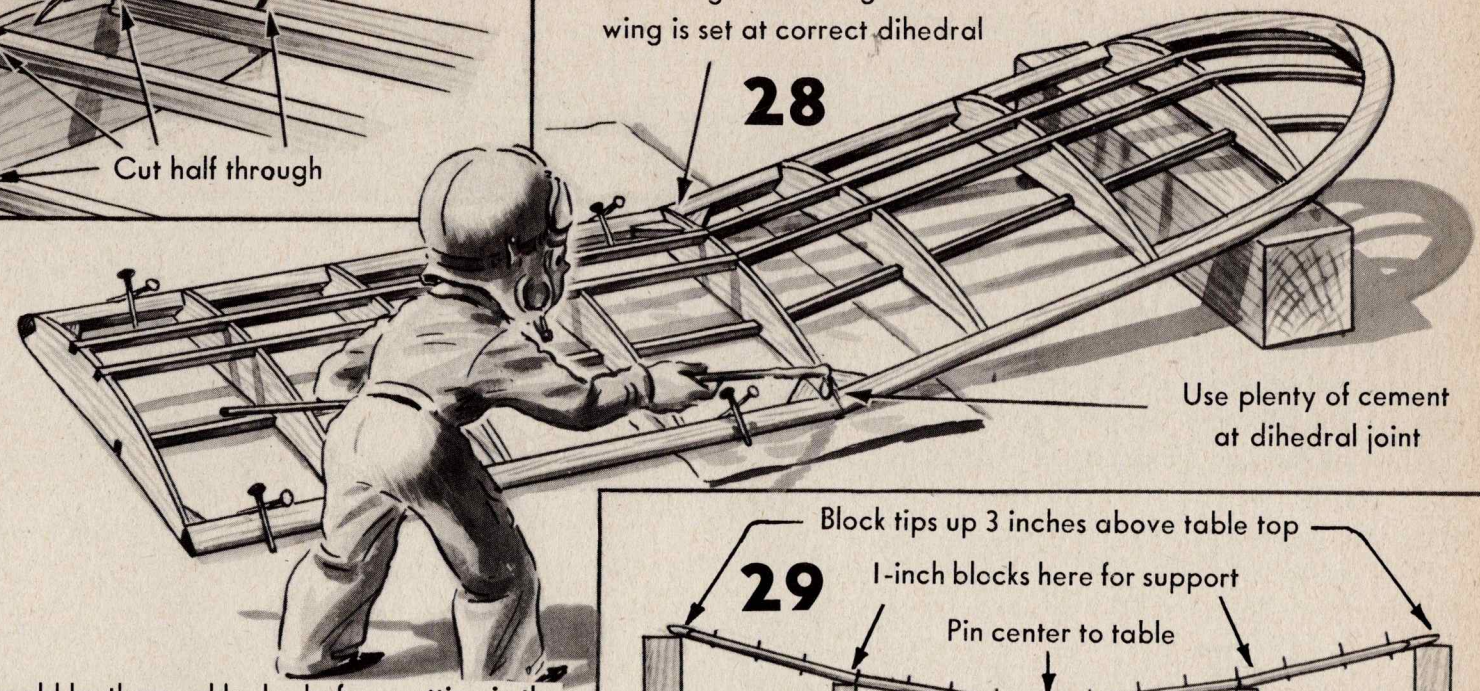
When everything is dry and firm, come back to the first wing and finish the tip structure. To do this you must break (but don't break off) the underneath spar just at the first or tip rib. Bend it back and cement it in place. Now bend the two upper spars down (but don't break them at all) and slightly back. Cement them in position and hold them there with crossed pins stuck into your work board (25).

When everything is well dried, lift the wing frame off the board. Sand it all over and, with sandpaper, round off the leading edge (figure 26) and point the trailing edge.

Don't cover the wings yet.

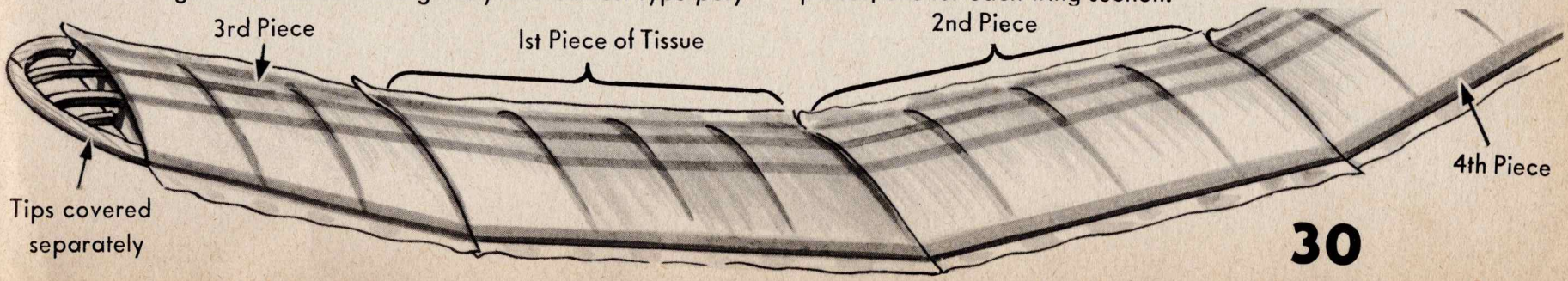






The wing structures should be thoroughly dry before putting in the dihedral. Carefully cut each spar half way through (figure 27) and pin one panel flat to table as shown (28). Lift outer half of each wing panel up to 2 inches above the table top at the tip, block up, and apply plenty of cement at places where spars were cut. Cement in place the triangular gussets—cut out of 1/16-inch sheet. These help to hold the dihedral angle.

When the cement is dry, block the wing panels up as shown (29) and cement together at center. This gives you a contest-type *poly-hedral* wing. Sand off all cement bumps and cover the wing. The method of covering is the same as used in the last model except that this wing will have to be covered in sections to avoid bad wrinkles. Each section needs a separate piece of covering tissue (see figure 30). The wing tips are a separate piece. The bottom of the wing can be covered with one piece, but it is easier and better to use two pieces, one for each wing section.



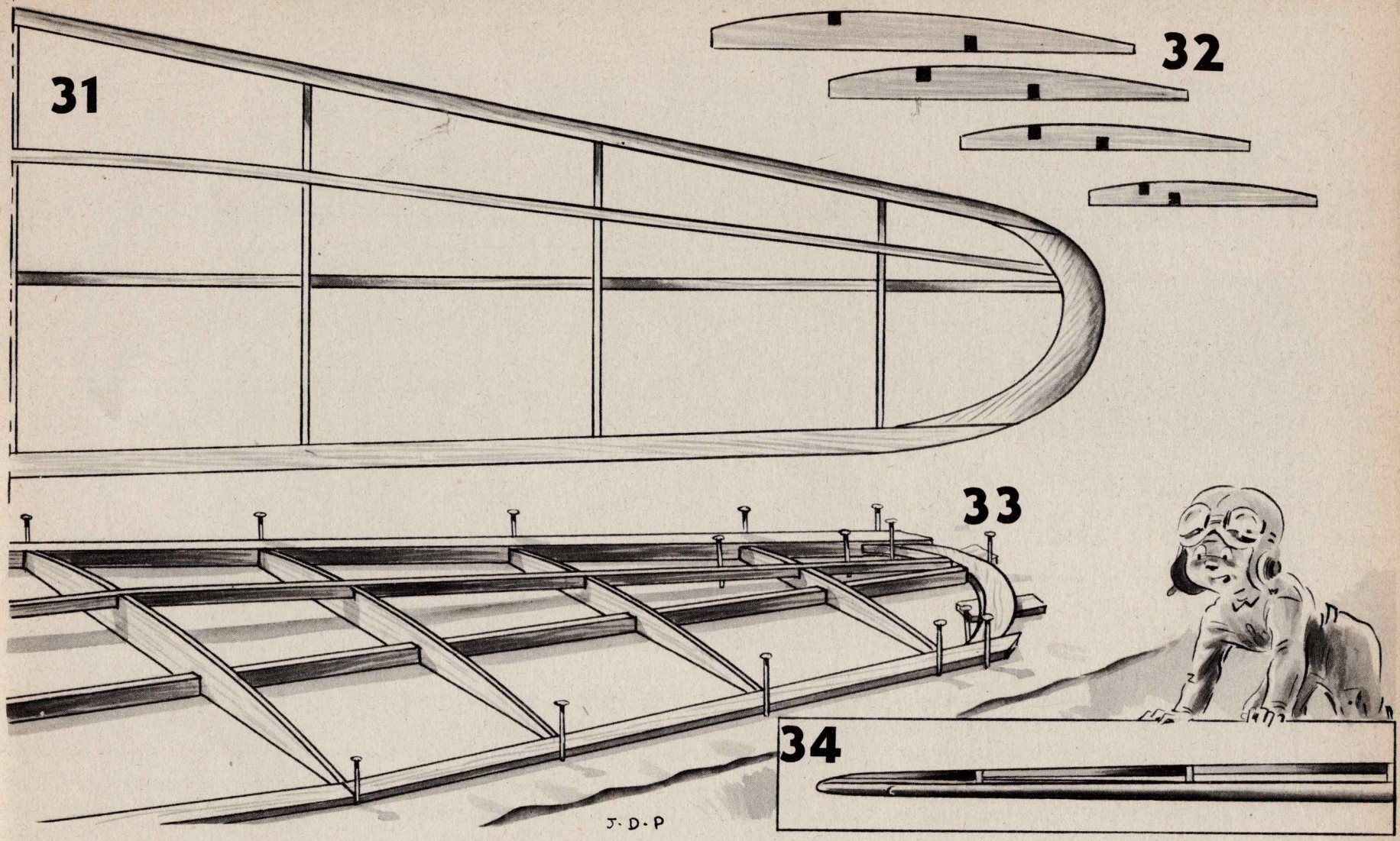
The building of the stabilizer is something like the building of a wing except that you build it in one piece from tip to tip—not in two units. The drawing (31) shows only half of the stabilizer but in figure 33 you can see the left half beginning.

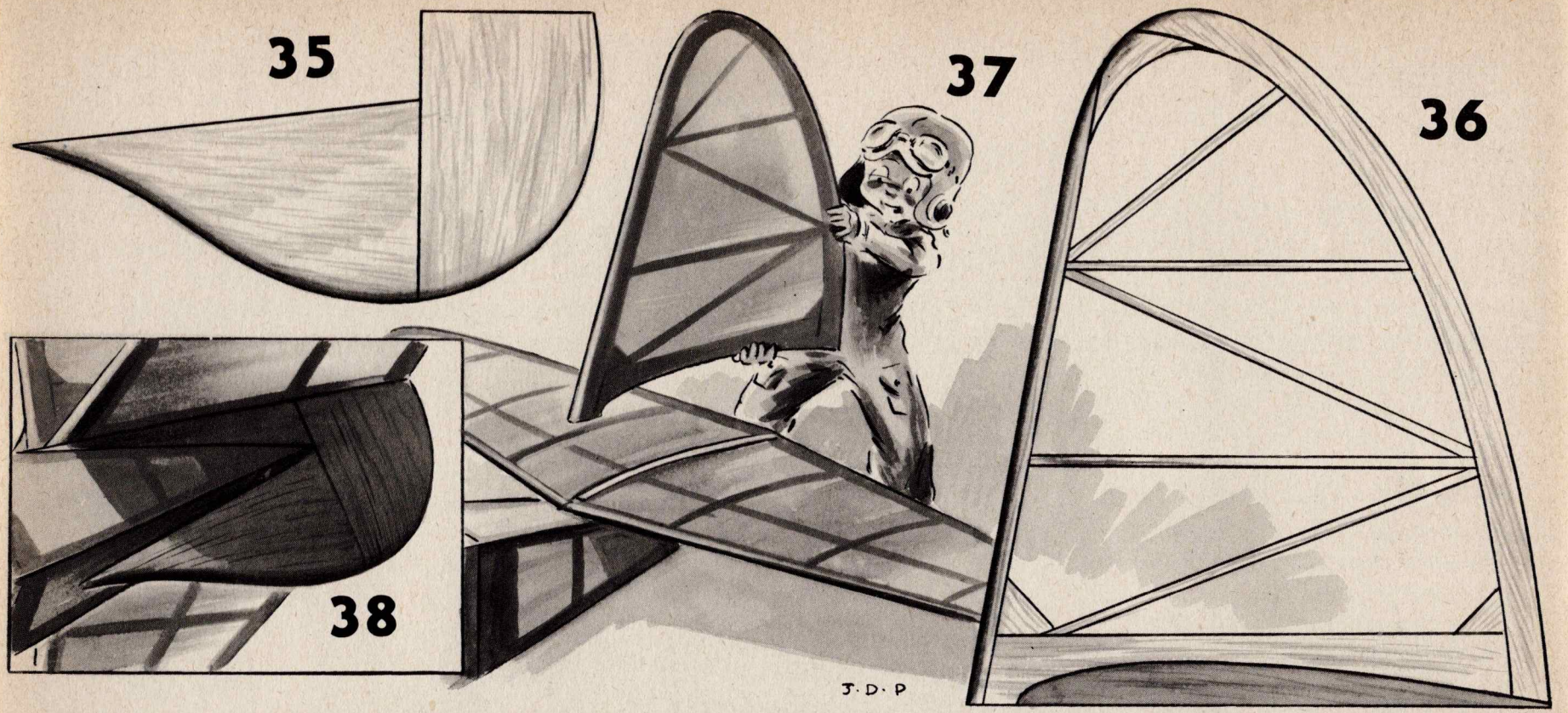
From the half shown here you can make your pattern. Trace it once as it is, on the right half of a 4 x 16-inch piece of tracing paper. Then turn over the sheet (from right to left) and trace it again (on the right half facing you), with the dotted line of your first pattern over the dotted line in the drawing. Finally trace your pencil lines for one side through the paper, so that you will have both left and right sides of your stabilizer on the same side of your pattern sheet, and joined together to make the unit complete.

What pieces will you need? You will need one only of the longest rib (the top one in figure 32) and two each of the others. These are 1/16-inch sheet balsa. Of course you must have two tips of 1/8-inch sheet balsa. You will need two leading-edge spars 1/8 inch square (the same length as shown in figure 31), one 1/16 x 1/4-inch trailing-edge spar (full length, double that of figure 31), and two inside spars, each 1/16 inch square (also double the length in figure 31).

From here on you build this unit up just as you did the wings. Notice, though, that the center spar arches up over the center rib (figure 33). Notice also that all tips of spars have to be rounded down and smoothed to shape as in figure 34.

When everything is finished and sanded smooth, cover the stabilizer, remembering that the grain of the paper runs across the stabilizer from tip to tip. Spray lightly with water, pin it in place while it dries, and give it a coat of dope. Scratch away a little of the covering over the center rib. That is where the rudder will fit.


31
32
33
34
J. D. P

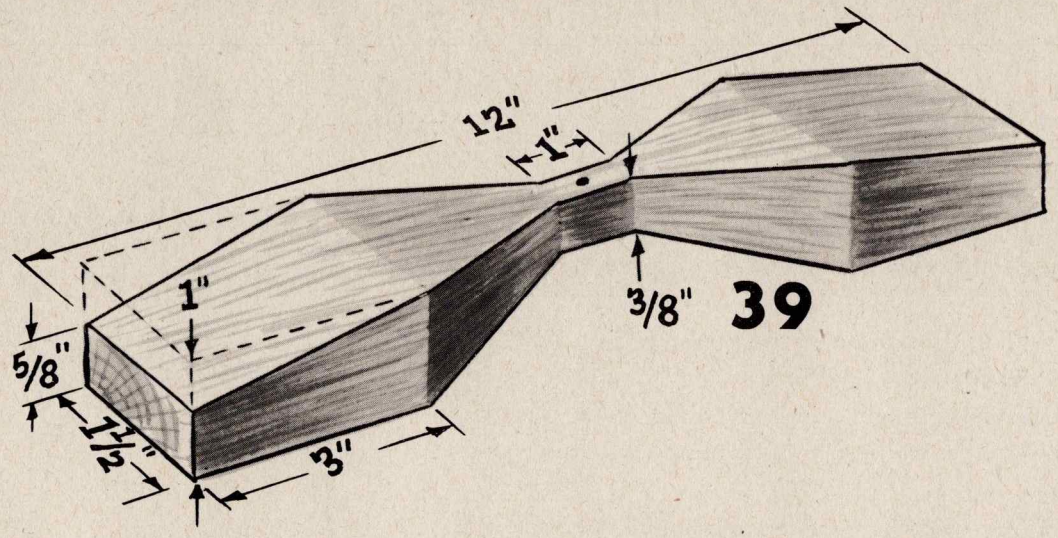


The tail skid of this model is not of wire, but of wood. Cut two pieces of hard 3/32-inch balsa exactly the same size as the drawing (35). Cement them together and sand them into round, streamline shape. It is a good idea to cover this unit with tissue for strength; and, if you do so, use the same color as on the rest of the plane.

The drawing for the rudder (figure 36) is full size. You have already made one very much the same (figure 12, third model), and this part will be easy. Before you cover it with tissue, though, be sure to sand the leading edge round and the trailing edge sharp. Spray the covering, pin it to dry, and dope it lightly. The shaded portion of figure 36 shows how you must cut out a curve in order to cement the rudder to the stabilizer.

Cement the stabilizer in place squarely in the center on the platform at the tail. To put the rudder on, raise the fuselage on blocks to level it and cement the rudder in place (figure 37). Be sure that the rudder is absolutely straight.

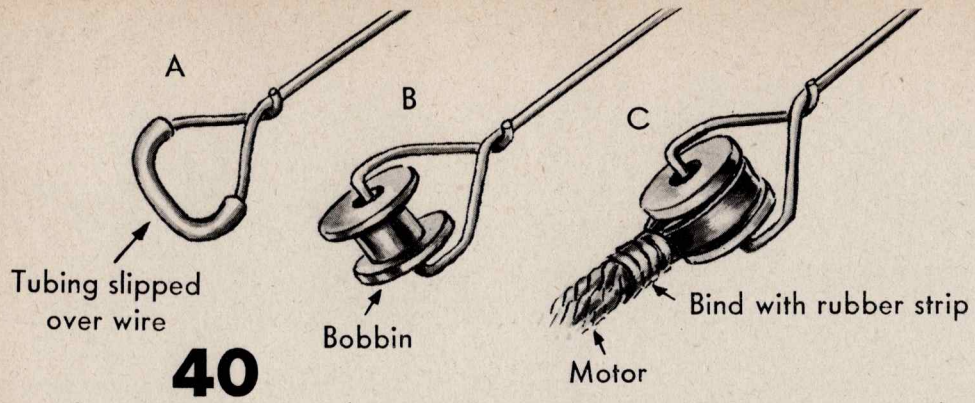
Finally cement the tail skid underneath (figure 38).



39

Only a few parts will now have to be made before your plane is ready for assembly. One is the propeller, which is carved like the one you made before. Observe, though, how the tips of the blank are tapered before they are carved (figure 39).

Install the propeller the same as you did for the second and third models except that you run the shaft through the removable hardwood bearing. In this model, too, you may want to use the freewheeling device described for the third model. A more advanced kind of freewheeling in described at the end of this chapter, together with a few other improvements that experts use.



40

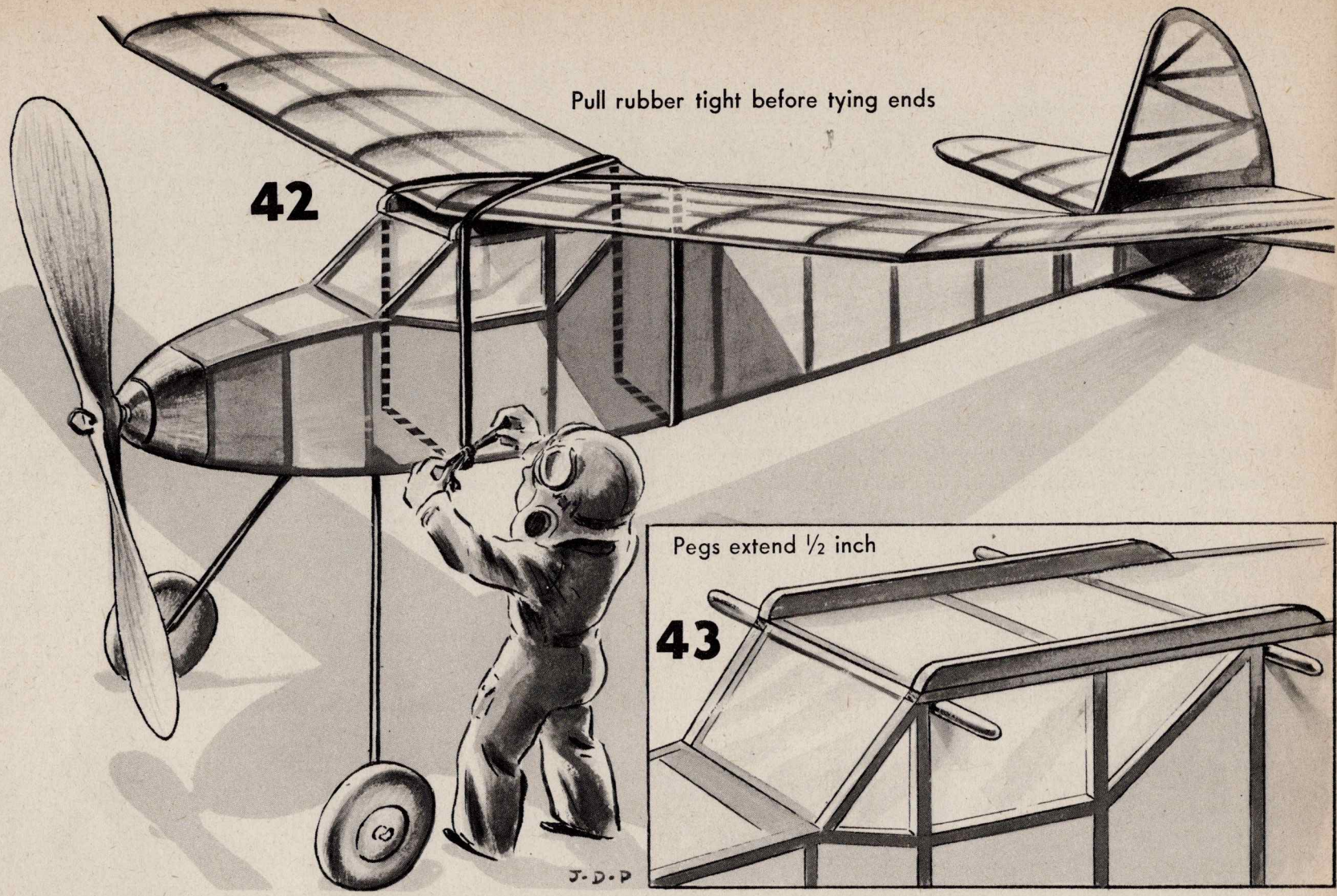


41

Motor hooks, both front and rear must have some sort of a device on them to prevent cutting of the rubber motor, especially when the heavy motors that power a contest model are used. The simplest way to do this is to slide a short piece of rubber tubing or "spaghetti" tubing over the hook as at 40*A*. The best way is to use a bobbin *(B)*. This is simply a pulley slipped onto the hook. When the motor is in place on the bobbin, or on the hook protected by the tubing, bind it tightly in place with a rubber band *(C)*.

This is the point at which you have to cut off the tail again. With a sharp knife cut the paper which holds the tail to the fuselage—right down between the uprights that come together. You can easily find the place by holding the model against the light.

To put the motor into the fuselage, first tie a small weight to a piece of string, carefully drop this weighted string through the fuselage from the nose (figure 41), then tie the motor to the string at the nose end and pull it through the fuselage. The nose assembly, including nose block with prop and shaft in place, is already hooked to the motor. Hook the removable tail end to end of motor. Motor tension will hold the tail in place. If it does not hold it firmly enough, a couple of small pieces of Scotch tape can be used, or a small drop of cement.



Your model is now nearly ready to fly. The motor in is place; prop and tail surfaces are assembled to the fuselage; but the wings are yet to be assembled. Lay the wing on top of the fuselage so that it sits evenly and then bind it firmly to the fuselage with a rubber strip (figure 42). This strip crosses at the top of wing center and runs down fuselage sides and across the bottom. After being pulled up fairly tight, it is tied at side as shown. A rubber binding like this holds the wings firmly yet has enough give so that if a wing hits something it will move a bit instead of breaking.

Another good method is to cement two hard wood pegs firmly under top members of the fuselage as shown (43). The rubber strip is wound over top of wing and under the pegs instead of running around the fuselage.

You will enjoy flying this model, but probably you like to build as much as to fly. You can have a new model but still use the same basic design and still use some of the parts from the plane you have just built.

Here is a speedy pursuit ship. The sides of the fuselage are shown in figure 44. Notice that the design at the top is different. The top longeron goes straight back to the sixth upright and then there is a step up. For the sides, the bottom crosspieces, and the first four top crosspieces, use the original patterns (figures 1 and 2).

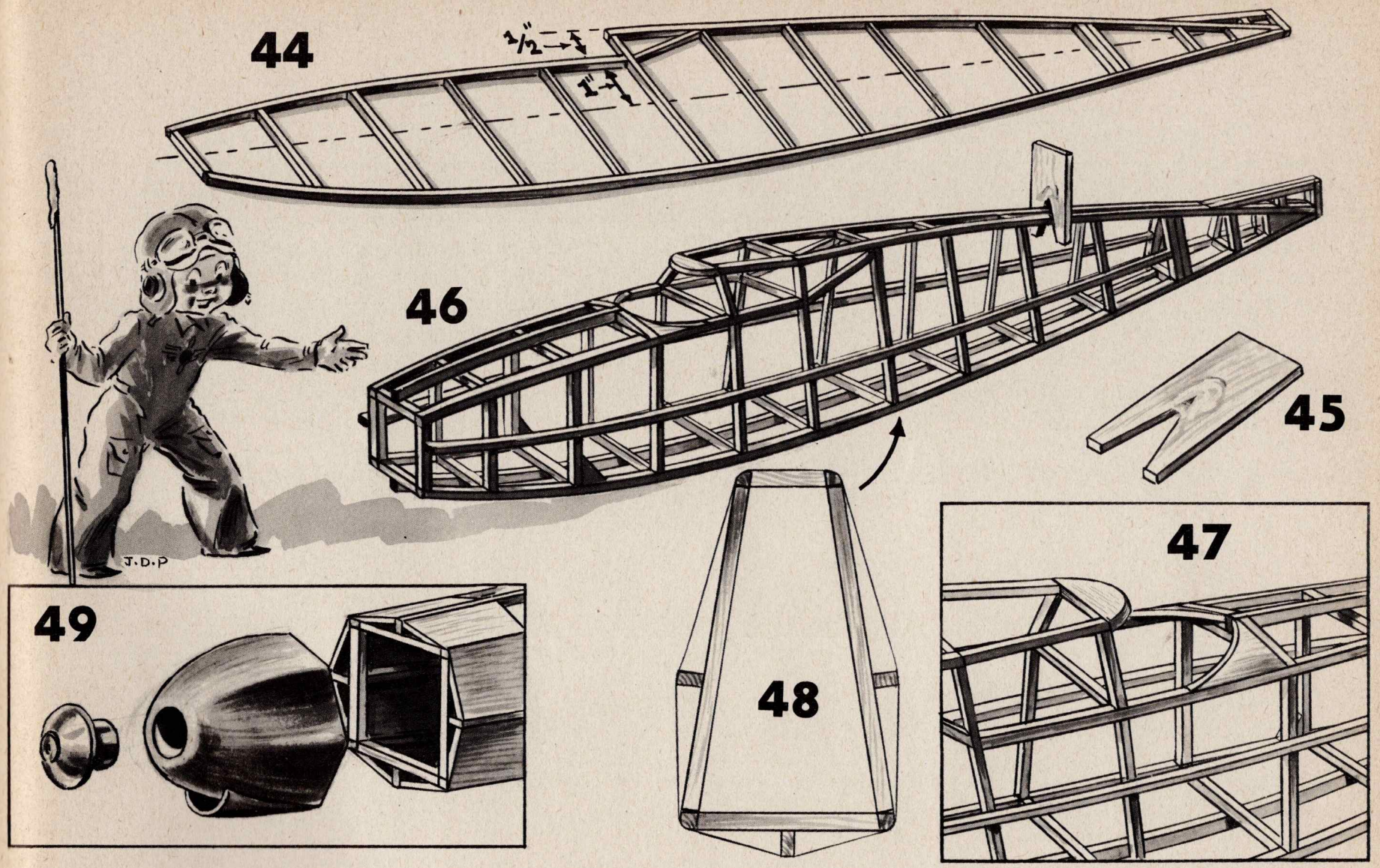
When the two side frames have been made, put them in position for assembly, with balsa blocks and holders as before. But this time put in all the bottom crosspieces first. Brace the top of each frame to hold it upright. When these are dry, put in the first four crosspieces on the top, counting from the nose. Now don't put in any more. Wait until everything is good and dry and cement the tail together.

Then cut a few hard balsa clamps as shown in figure 45. Cement together the top longerons from between No. 9 and No. 10 crosspieces to the tip of the tail and press two or three of these clamps down to hold them together (figure 46). Now you have seven top crosspieces to fit into place, and you can easily fit them right to the space without using a pattern. We do not give any measurements here because it is better to fit them to the work.

Notice, too, that the top of the cockpit has a round piece attached, and that there is a curved filled-in portion on either side between the fourth and fifth crosspieces.

From strip balsa cut longerons to run along both sides, the bottom, and the top (figure 47). The top longeron extends back only to the fourth crosspiece (figure 46). Here attach two strips running out to the sides. Taper these as shown in figure 46. The other three longerons bend in flush where the tail is cut. Over the other uprights they stick out to give more shape to the fuselage. The cross-section picture (48) shows how it will look with the tissue in place.

Make a nose block as shown in figure 49 and underneath attach an air scoop of heavy paper. (This can really be used to hold balancing weights.)


44
1½"
1"
46
45
J.D.P
49
48
47

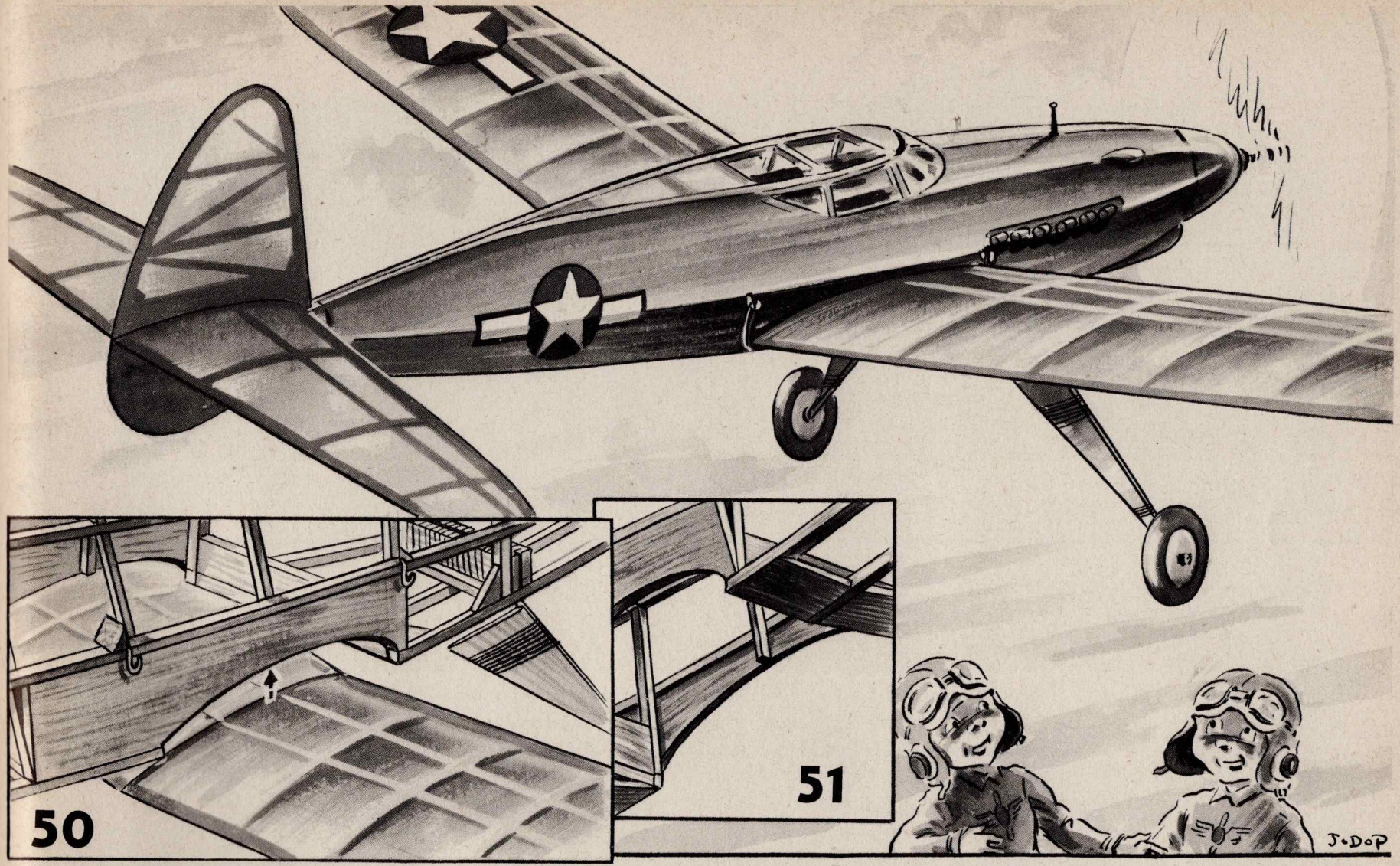
Before you cover the fuselage, another change in design must be made. Fill in the space between bottom and middle longerons (on both sides) from the fifth to the eighth uprights, counting from the front. Use 3/32-inch balsa, cut to shape as shown in figure 50. Use 3/32-inch sheet balsa also to strengthen the wing seat as shown here and in figure 51.

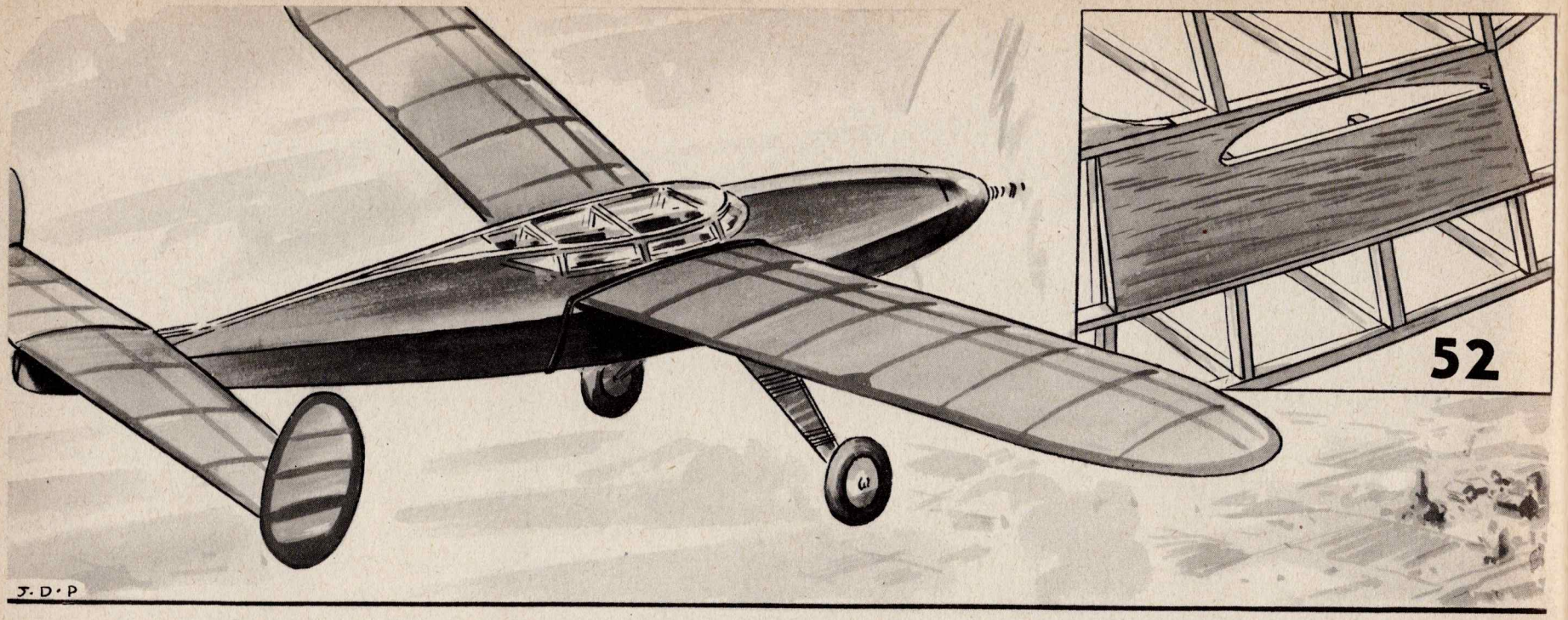
Now make a pair of simple wings, just as you have done before. Cement them together at the butts or roots so that each slants upward and outward in such a way that the tip is 2½ inches higher than the butt. That means a dihedral of 2½ inches. Of course, slant the root ribs so they can butt right for dihedral. Next attach little wire hooks—four of them—on gussets as is shown in figure 50.

You must cut away the under part of the fuselage so that the wings will fit snugly in place. Cut right through the bottom longerons and the two pieces that fill in above. This would weaken the fuselage except that the fill-in pieces hold fast where the longerons are cut. The other drawing (51) also shows this curved cut, but from the bottom. In order to get it exactly the right size and shape, you will have to test the wings against the place where you are working.

Make and install the stabilizer and rudder as you did for the cabin model. Use the same type landing gear, but streamline it with balsa as you did for the streamlined tubular speedster.

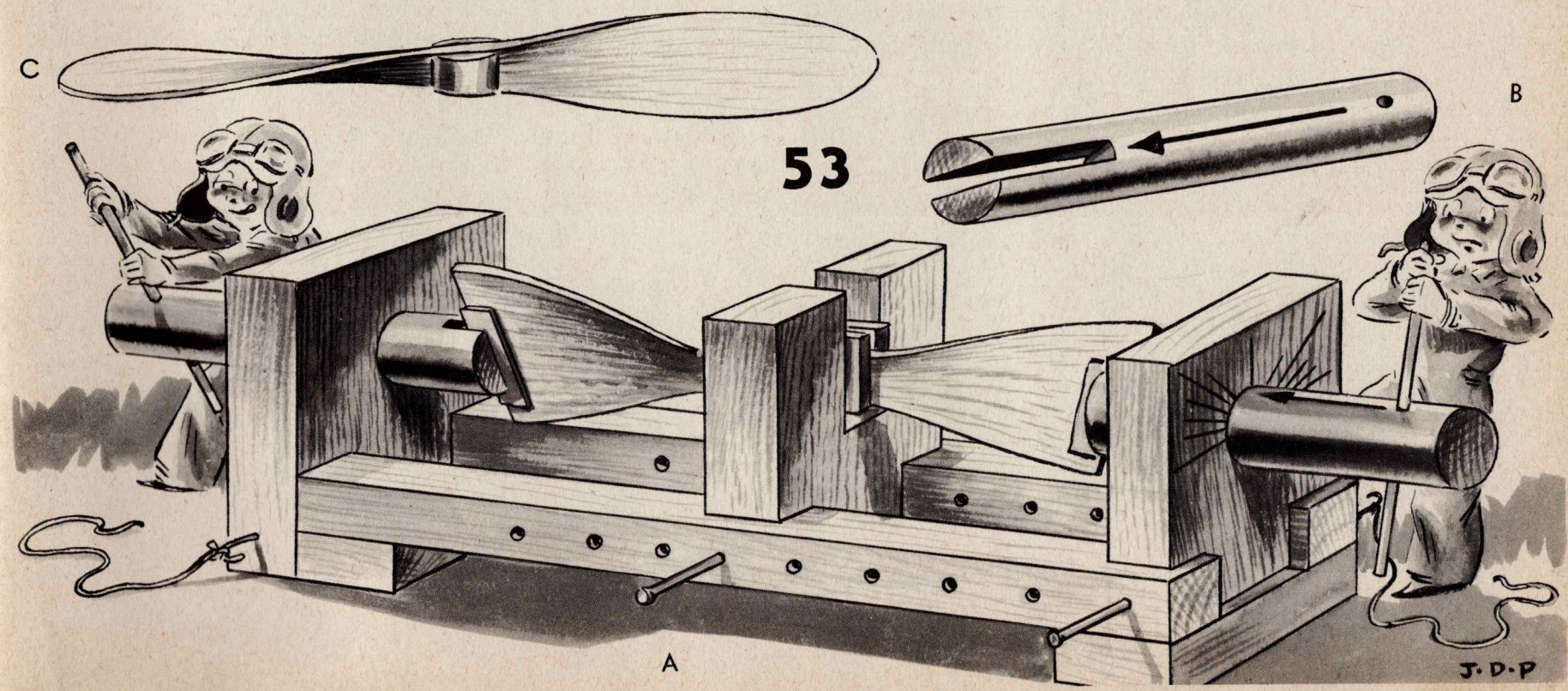
Cover the whole model and dress her up all you like. Add exhaust parts, gun sights, insignia, and streamliners to the landing struts.


50
51
J.DOP



Using the same type of fuselage, you can make a neat little cabin sport plane (figure 52). This time fill in the *upper* part of the fuselage with sheet balsa pieces to hold the wings. Cut openings the shape of the wing cross section. The wings, cemented together in one piece, slide right through the fuselage and are held in place by a rubber band which loops over one, goes down under the fuselage, and loops over the other. Take off the rudder and save it for another model. Neatly cut off the tips of the stabilizer. Make twin rudders after your own design and cement them to each side of the stabilizer. Now your sport model is done.

The time may come when you will want many propellers, and you may want to give them to your friends. If you want them faster than you can whittle them, and would like to try a little propeller "factory," this is how it is done. Make an adjustable frame after the pattern shown in figure 53, with a holder like that in *B* at each end. Cut the propellers out of sheet balsa 1/16 inch thick. These are just flat blanks of course. Soak one in warm water for several minutes. Twist the right holder away from you and the left one toward you *the same distance at the same time;* then tie them in position with the strings from the base of the machine. After the prop is dry, take it out and fit it with a small hub (as in C).



There is another kind of nose plug and freewheeling that is more satisfactory but require more work. Carve a plug out of soft balsa exactly the size and shape shown in figure 54. Cement to the center rear of the plug a ¾-inch square of ⅛-inch balsa (figure 54*A*). Bore right through the middle—making very sure that the hole is true.

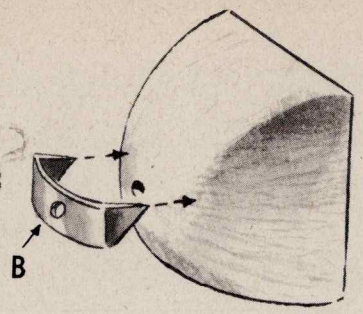
Now cut out little pieces of metal in the shape shown in figures 54*B* and C. Hammer one of these into the front of the nose plug and the other into the back. These will keep the bearings in front and the shaft behind from pulling into the wood. Put in a tiny brass screw (figure 54*D*) and bend your propeller shaft out of No. .028 music wire as shown (54*E*).

You will guess what the spur (54*F*) is for: that little piece catches against the screw as soon as the motor has run down and the tension is off the shaft. (Note the spring in figure 55.)

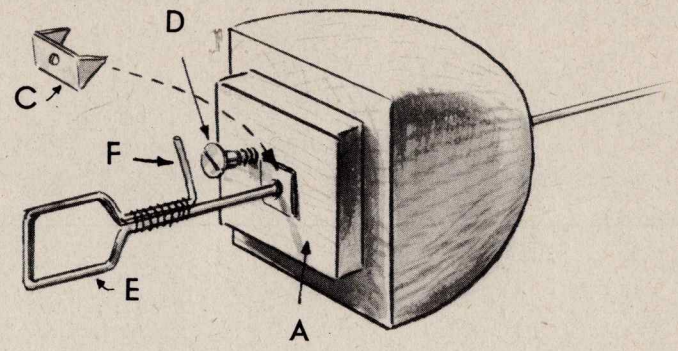
The other half of the freewheeling is out in front. First bore a hole into but not through the hub of the propeller to one side of the shaft hole. Then slip your washers over the shaft to rest between the nose and the propeller. Bend the end of the shaft into the shape shown (55). The straight end sticks into this hole when the motor is wound and under tension. Make sure that it will go in and out of the hole easily. After the tension is off, the end of the shaft slides out of the hole, and the propeller can spin in the air to its heart's content. The *U*-shaped piece of metal (figure 55) protects the hub of the propeller when it spins idly. Of course, you will have to drill holes through this too.

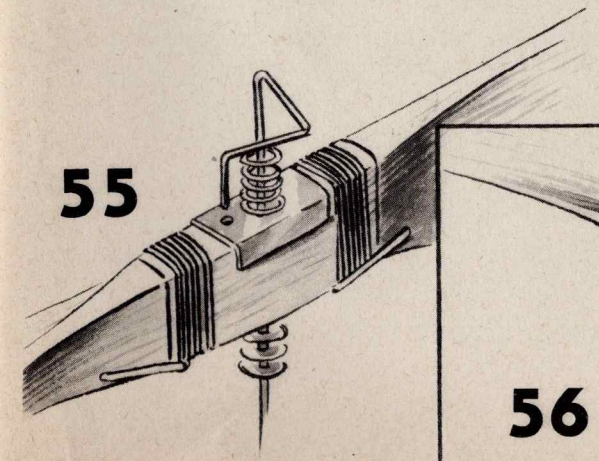
If you want to be very, very fancy, you can make a propeller that will fold back its blades. When it is whirling, the blades will fly out into the right position as if blades and hub were all one piece. When the motor tension is off, the blades will fold back and allow the model to glide farther. The two drawings (56 and 57) show how this is done. The hardest part is making the double-hinge piece. Carefully look at figure 56 and you will see the details. Cut a piece of sheet metal, such as tin from a tin can, the width of your propeller hub, bend the wire pieces as shown, and crimp the ends of the metal over the brackets of wire—folding where you expect to cut the blades through. Fasten the metal to the hub, bore it for the shaft. Then spread the ends of the wire brackets and force them into two sides of the propeller blades. Finally, with a very fine saw cut down through the blades, and your folding propeller will be done.



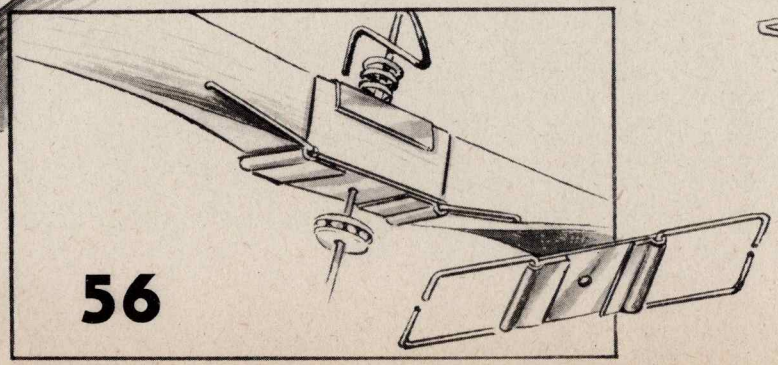


54

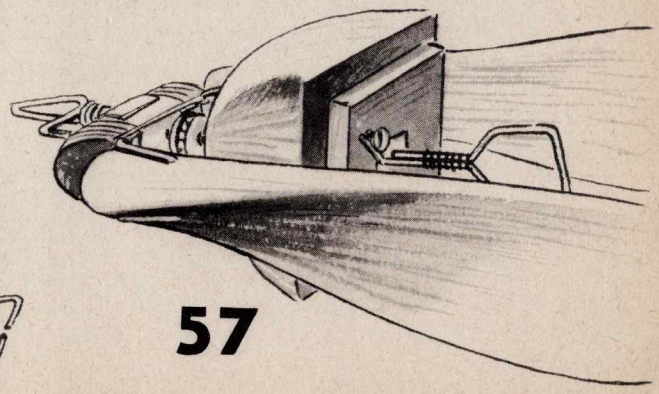




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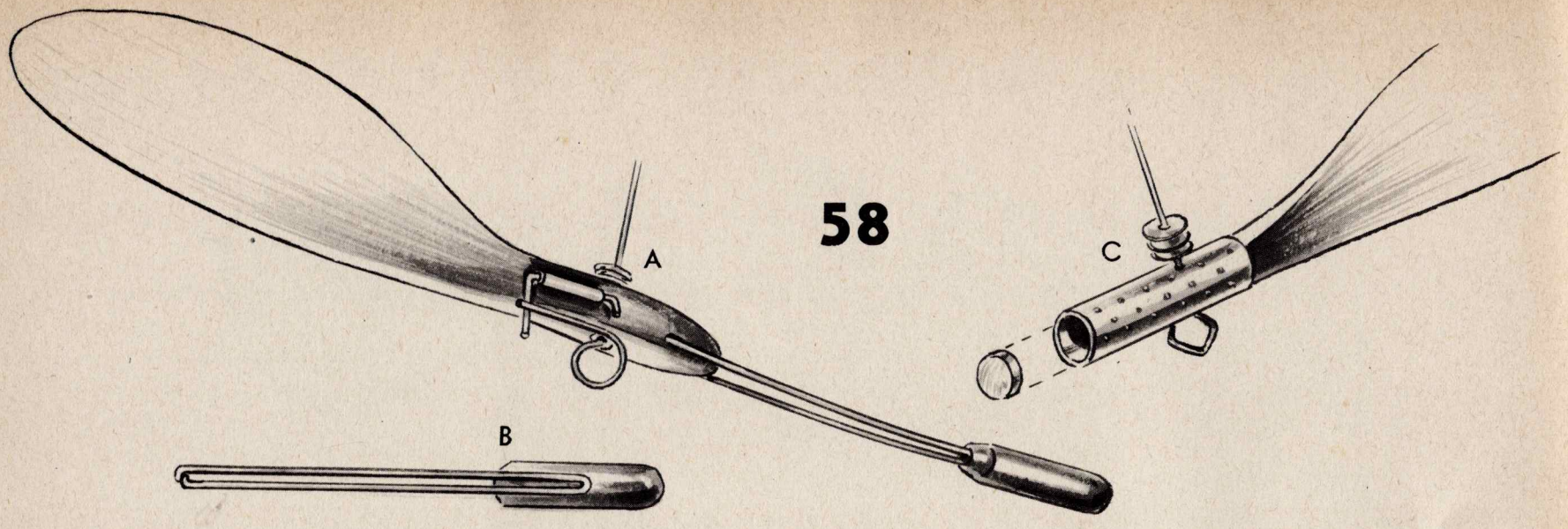


56



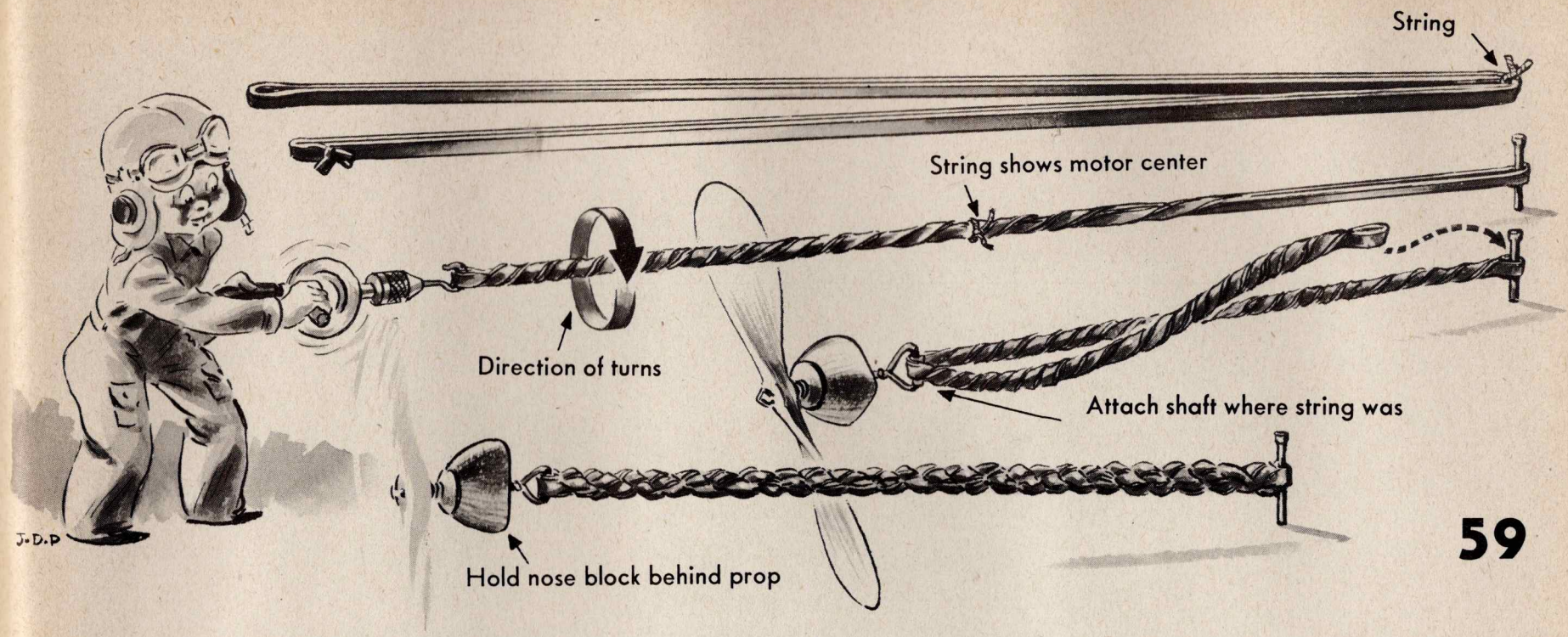
57

J·D·P



58

Another type of propeller used for models, although it is different from those used on real airplanes, is the one-bladed propeller. It is much easier to make; it is easier to balance; and you can salvage broken two-bladed propellers by using one good blade. A weight has to be put where the other blade would go (figure 58*A*). That is easy to do. Bend a piece of No. .020 wire in the shape of the diagram (58*B*) and attach a bit of lead to the end. A simple way of working the lead is to take a cup of moist sand and poke a hole say ¾ inch deep with a lolly pop stick. Melt some lead in a tin can over the kitchen stove (you don't need much); hold the looped wire a trifle off the bottom of the hole with one hand, and pour in the melted lead with the other. Then smooth off the weight with a dull knife and keep testing as you make it smaller until you finally reach the point where the balance is perfect. Another way to get balance is to force a metal tube over the small end of the hub and put the weight inside it (figure 58*C*).



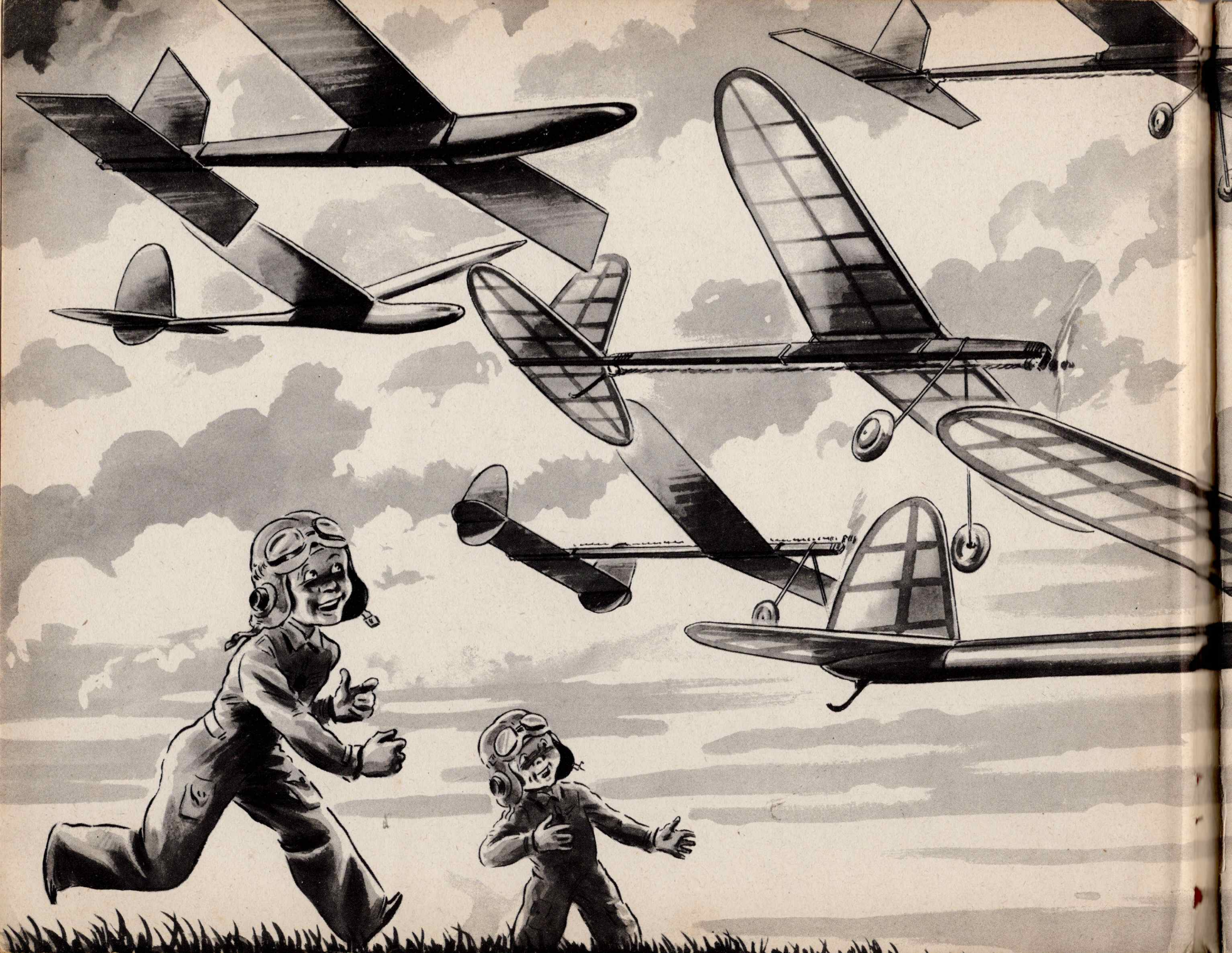
For real contest flying a much longer motor is needed so that extra turns can be put into the motor to obtain longer flights. The trouble with this is that the flying trim is upset because the slack in the unwound motor shifts to the front or the rear. This condition can be overcome by the modern method of "plaiting," an English stunt that is called self-tensioning.

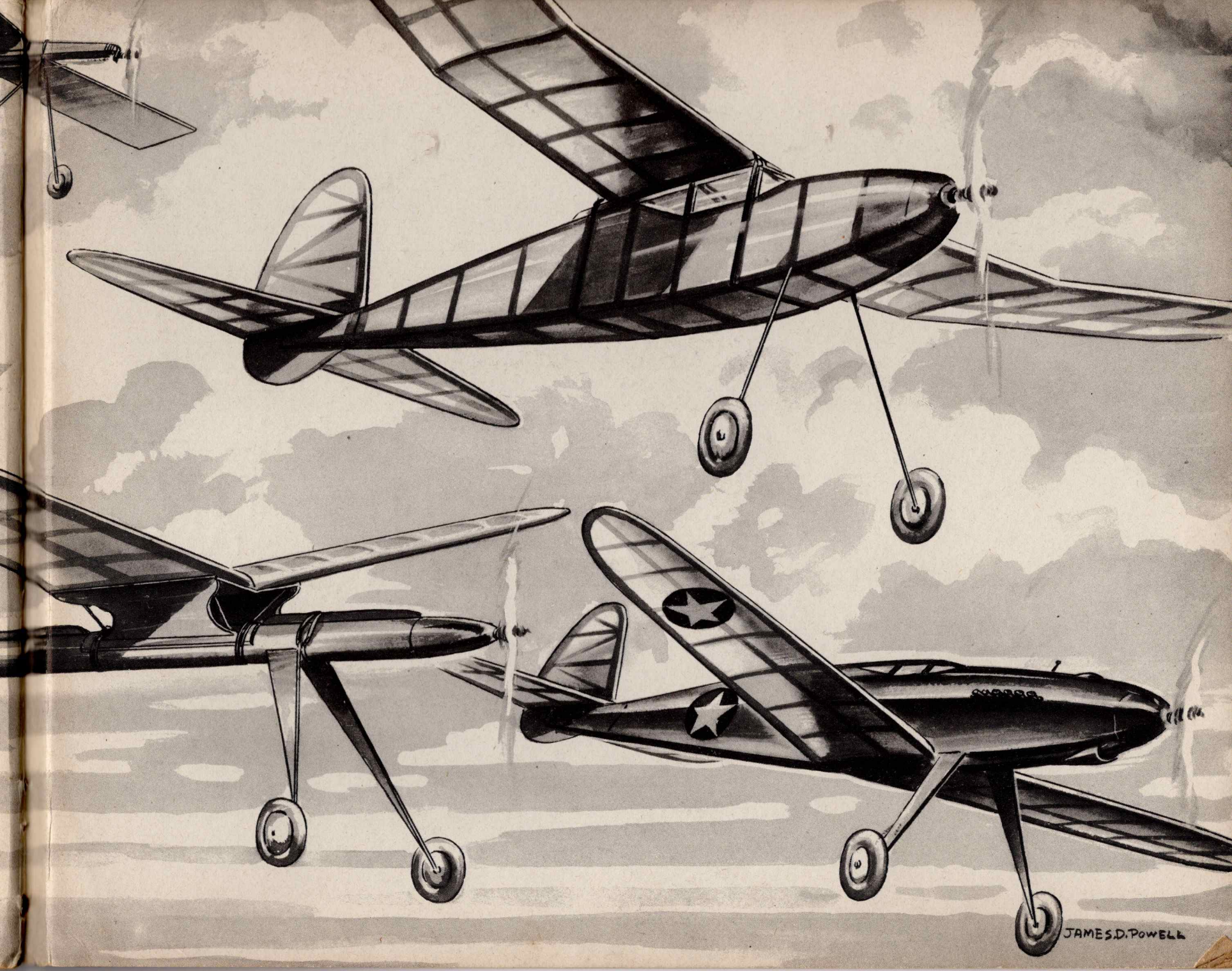
Make up a motor of two loops, a third longer than the distance between the two motor hooks (59*A*), and tie a piece of string at one end. (Note: A skein is the complete made-up motor; a strand is a single strip; and a loop is two strands.)

Open it up into one long loop with string at center *(B)* and wind in about a couple of dozen turns in a *clockwise direction* as shown. Hook the prop shaft (installed in nose block) onto motor at point where string is tied; then bring other end around and hook to peg at end *(C)*. *Do not let prop turn.* Hold nose block behind prop and stretch out wound motor. Now release prop and the motor will wind up over itself *(D)*. Let it contract as it unwinds. You will find that the motor contracts to just about the distance between the hooks. This method of motor preparation takes advantage of extra motor length and more turns without the disadvantage of the motor's shifting and disturbing the balance of your model.

The best method of motor winding for a full flight is to stretch the motor to two or three times its length when you wind it. Use a winder made of a hand drill holding a piece of heavy wire bent into a hook *(B)*.


JAMES D. POWELL




JAMES D. POWELL