



foam wings

By J. Alexander

A STEP-BY-STEP INSTRUCTION
MANUAL AND REFERENCE HANDBOOK
WITH OVER 80 ILLUSTRATIONS AND
PHOTOGRAPHS OF TECHNIQUES AND PROCEDURES



Foam Wing Anthology

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I EXPANDED BEAD FOAM

One material that has perhaps done more to revolutionize RC aircraft development and construction in recent years than any other is expanded bead foam. Proven in the field by week-end pilots and at contests and pylon races across the country, it has become one of the basic construction mediums.

The advantages of foam structures to radio control aviation are many with high strength, light weight, accuracy, and speed of construction being dominant. Widespread inclusion of foam components in commercial kit and pre-fab aircraft attest two more features important to the home craftsman — low cost and ease of fabrication.

Because of the somewhat fragile nature of unsheeted foam, the potential craftsman must be aware of the "do's" and "don'ts." Unlike balsa crafting, mistakes in foam working are not easily corrected. The rapidity with which a foam core can be ruined will amaze the uninitiated. Though the speed inherent in foam construction is a big factor in its favor, more wings have been lost through haste than for any other reason. So until thoroughly familiar with the material and working techniques — take it slow!

For best results, use expanded bead polystyrene foam and not styrofoam. Styrofoam, besides being more costly, is heavier and must be hollowed to achieve comparable lightness. This is the material from which many of the first cores were made. Excessive use of dubious quality cements, unfamiliarity with proper techniques, and failure to heed instructions, gave rise to some poor opinions of foam wings completely unjustified with present day foams and compatible materials.

Polystyrene foams are available in densities ranging from .8 to twenty pounds per cubic foot. For wings, stabs, etc., a density of around one pound is recommended. This will furnish lightweight structures with excellent strength factors.

Foam, especially expanded bead foam, is easily dissolved by a distressing array of chemicals and solvents. This problem has been eased somewhat by recent development of formulas resistant to chemical damage. But, as these newer foams are not always available, it is well to keep the danger in mind and handle all foams as being susceptible.

The best way to assure a chemical or adhesive will not destroy foam is to try it on a piece of scrap first. This rule applies to any product used on foam for the first time. There is absolutely nothing that will drive you to heights of fury or depths of depression faster than watching your beautiful core melt into a blob of nothingness!

Expanded bead foam is composed of small plastic crystals that have been enlarged to form a

multi-beaded, closed cellular mass through which air cannot circulate. For this reason, glues requiring air exposure (evaporation) are not recommended for installation of joiners or gear blocks in foam cores. Evaporative glues, in this application, will be effectively shielded from atmospheric exposure on three sides by foam and sheeting on the fourth. They will take an eternity to dry, if they ever do, and may result in untimely failure. Epoxy glues, curing through chemical rather than evaporative action, should be used in such instances.

The first step in coring is to locate a foam supply. This is made easier if some idea of the industrial applications of the material is known. Once the industrial usage is determined, it becomes relatively simple to track down a supplier. This reasoning applies also to many other materials used for RC construction in which an appreciable saving can be realized.

Expanded bead foams are used by some industries as an insulation and/or sound proofing medium. It is also used in various forms for such items as toys, coolers, decorations, etc. Because of its lightweight and excellent shock-absorbent characteristics, it is used extensively in packaging and shipping industries. Inquiries at such firms should prove productive.

Perhaps the easiest way to contact a supplier is through the telephone book. If you happen to reside in a small town, it may be necessary to check the book for the largest city near you as distributors tend to locate in heavily industrialized areas. Look under the heading "Plastics — Foam" in the advertising pages.

If a distributor cannot be located in the phone book, the next step is to contact a large chemical company such as Dow, Armstrong, Monsanto, etc., and request the location of a firm near you that handles expanded bead foam.

In talking to suppliers, it may be just as well not to mention model airplanes. Chances are they'll have no idea what you're talking about and you'll only waste time and cloud the issue. All you need do is ask for prices and request samples. You may have to visit the supplier and select your material if he doesn't send samples or if he doesn't have a large variety.

Most suppliers will furnish the material cut to size. There is usually a small charge for this service, but handling is made much easier as is home storage. Blocks pre-cut to 24" x 36" x 4" would be a good choice. From a block this size two pairs of wings can be cored with spans to 72 inches and chords to twelve. For exceptionally thick sectioned wings a block five or six inches thick might be better. This will increase the scrap ratio somewhat, but for the individual not engaged in commercial

operations, this aspect is relatively unimportant.

As an indication of the savings to be realized by the builder equipped to core his own wings, a block of foam as recommended above will usually cost in the neighborhood of four dollars. As two sets of wings can usually be had from a block this

II CORING EQUIPMENT

(Further testing has proven that Nichrome wire, now available through RCM Products, is superior to music wire for cutting foam wing cores. Any reference to music wire can apply to Nichrome wire, as well, according to the reader's preference. See page 9 for details.)

Since foam cutters and allied equipment are not readily available commercially, the home craftsman must build his own. Any coring system, and especially one designed for the home shop must be first of all efficient — capable of doing the job with a minimum of fuss — and easily assembled from readily available parts.

The cutter described in this chapter not only meets these requirements, but is capable of turning out top quality cores with a minimum of practice by the operators. Assuming well sanded templates are properly placed on the foam block, even the most inexperienced builder should have no trouble.

The cutter may be considered in three parts as illustrated in Figure 1.

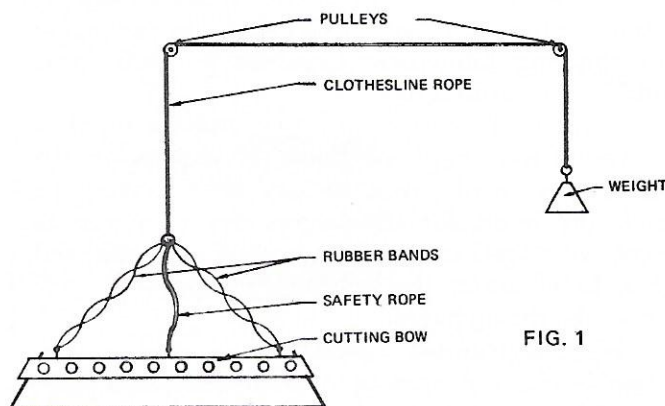


FIG. 1

1. An electrical power supply for heating the cutting wire.
2. The frame, or bow, which serves to keep the cutting wire taut.
3. A suspension system to support the bow.

Because quality cores are directly related to proper cutting wire temperatures, the power supply might be considered the most critical of cutter components. If the wire is too cool it will not cut properly. If too hot, scrap panels are assured because of ridges or wire lag. For this reason adjustable supplies are often used which, if properly designed, allow minute adjustment of current flow through the cutting wire for heat regulation.

A power supply may take either of two basic forms, a step-down transformer converting 115 volt household supplies into a reduced value, or it may be nothing more than an ordinary auto battery.

size, the cost per set is around two dollars. Naturally, costs may vary with area, supplier, quantity, and material selected. Also, do not overlook the possibility of purchasing odds and ends of material from processors at a fraction of the usual cost or perhaps carting it away for nothing.

The ideal supply is one of the many inexpensive auto battery chargers widely distributed by auto supply or hardware outlets. Chargers similar to the unit shown in photo #1 which produce either 6 or 12 volts from 115 volt residential power with an output meter are available for around \$15.00. Single voltage units, less the meter, retail for about half that. As suitable step-down transformers cost as much or more than a complete charger, the cost and time advantage is apparent.

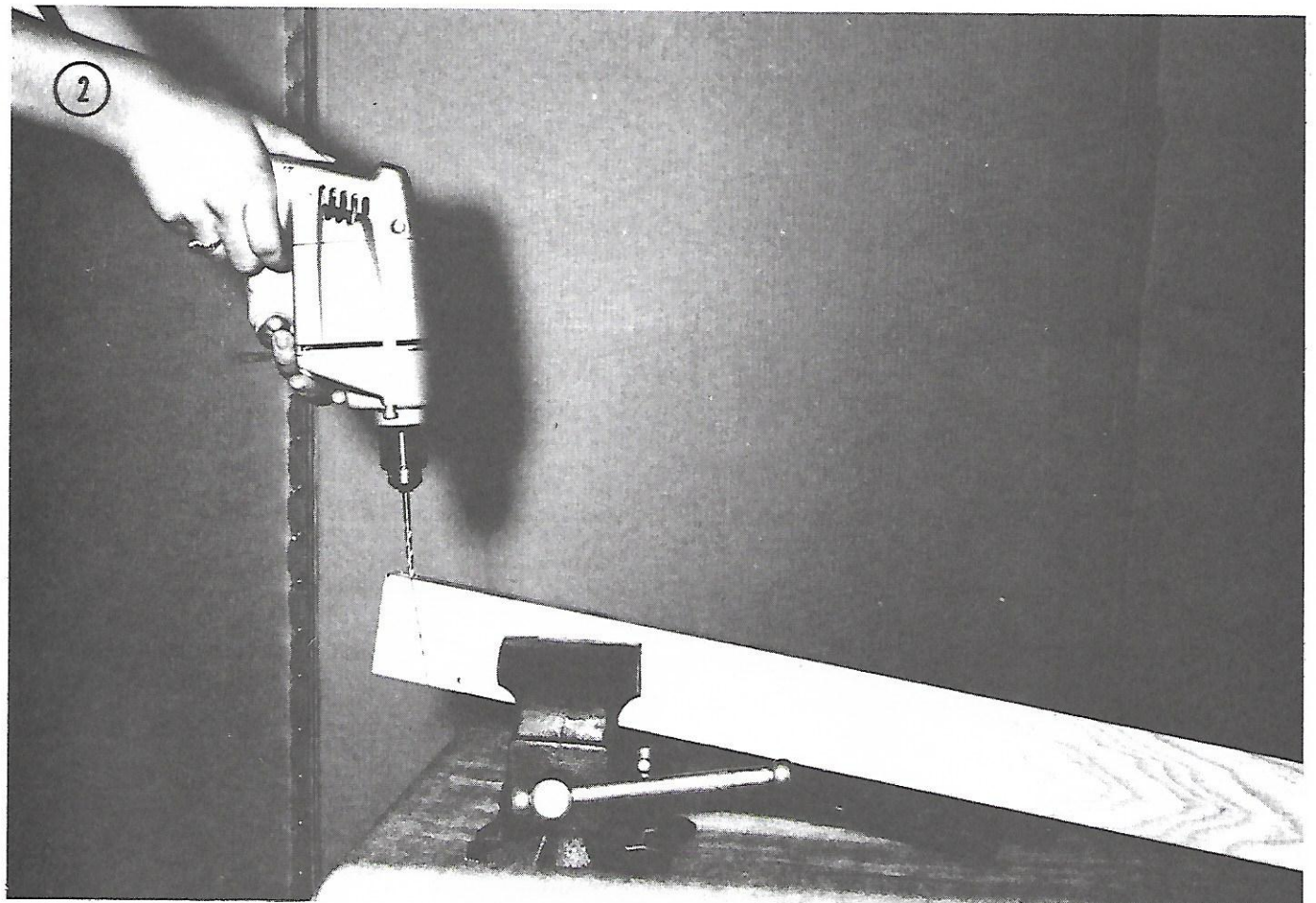
A word of caution. The cutter described here was designed and parts selected for use with either an auto battery or a charger. As all metal parts form a portion of the electrical circuit, no substitutions other than power wire length should be made.

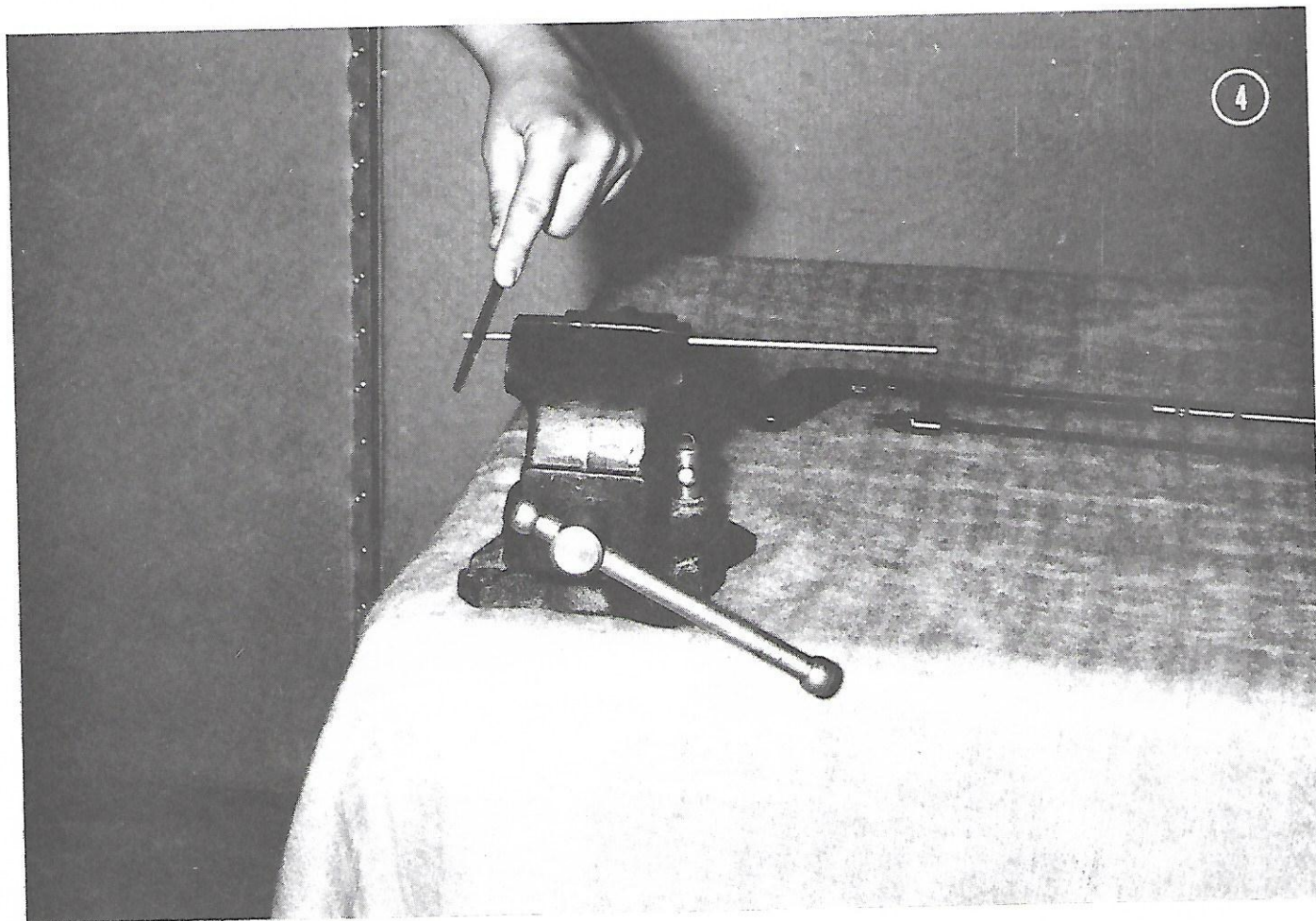
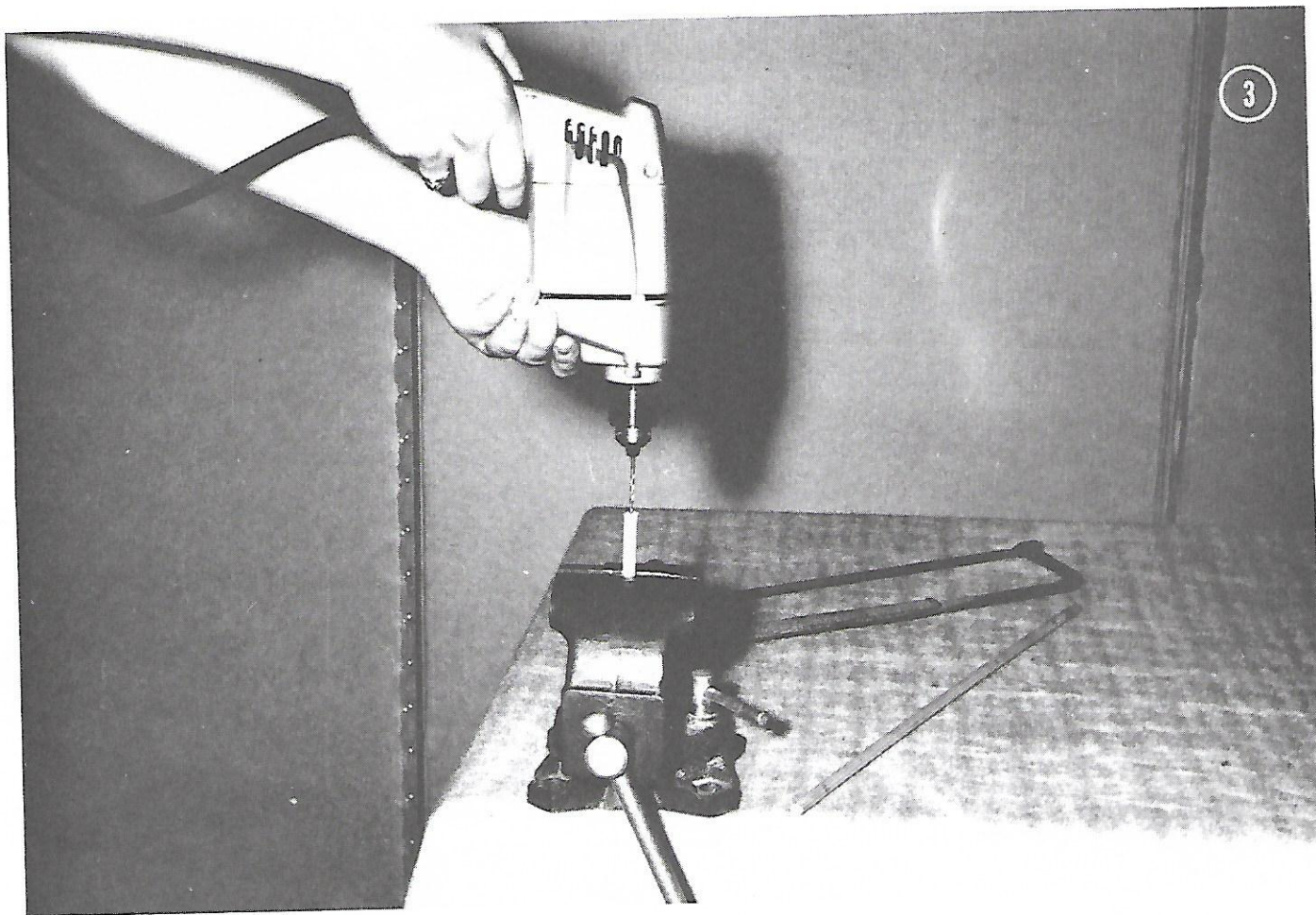
A cutter frame, as stated earlier, serves only to keep the cutting wire taut. Any number of schemes ranging from aluminum tubing to dowel frameworks have been used and are probably satisfactory. However, the main disadvantage of such designs is the necessity of manual adjustment to set and maintain the cutting wire tension. This is eliminated here by the spring action of heavy music wire. By mounting the music wire at an angle, the correct tension is maintained automatically.

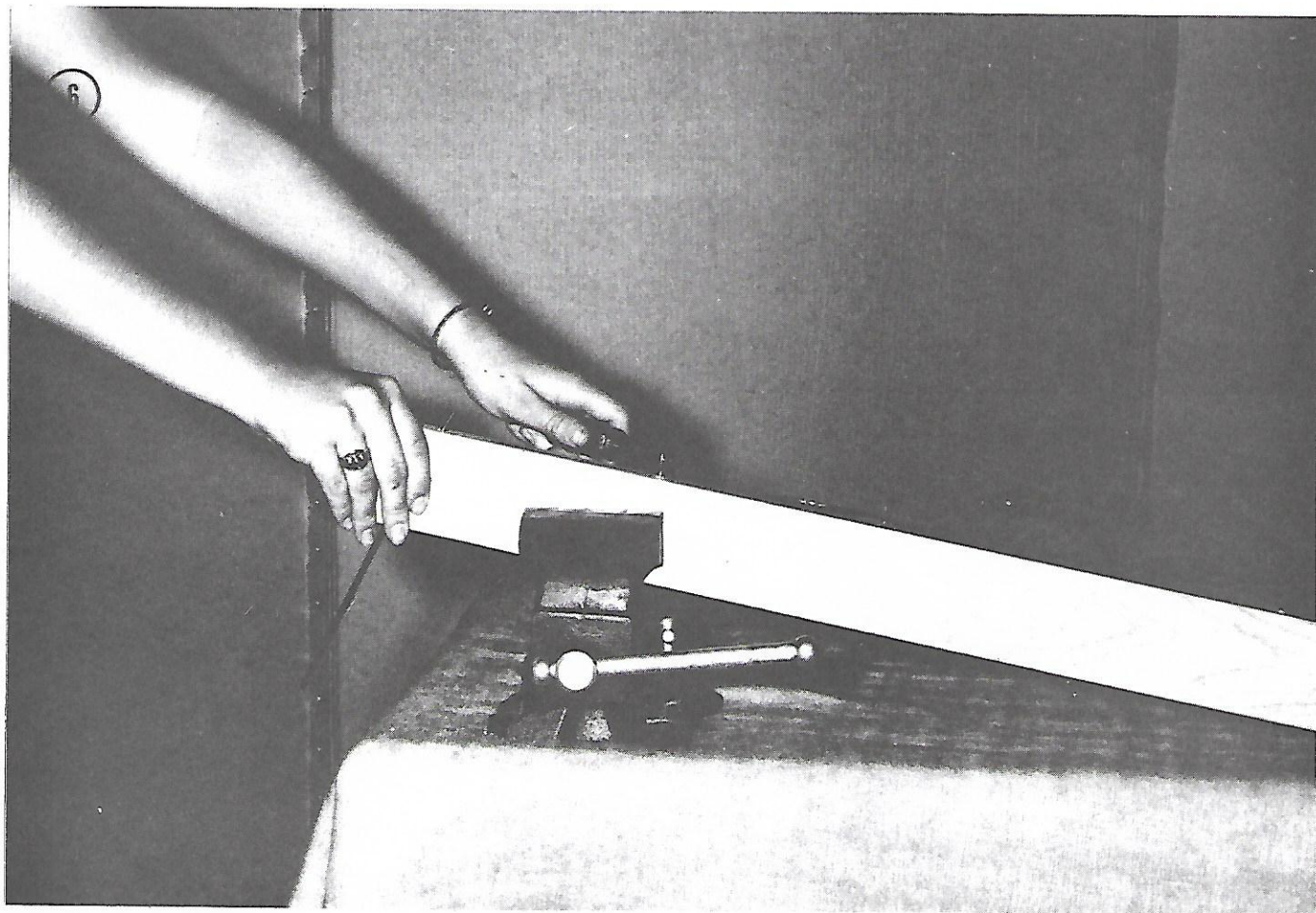
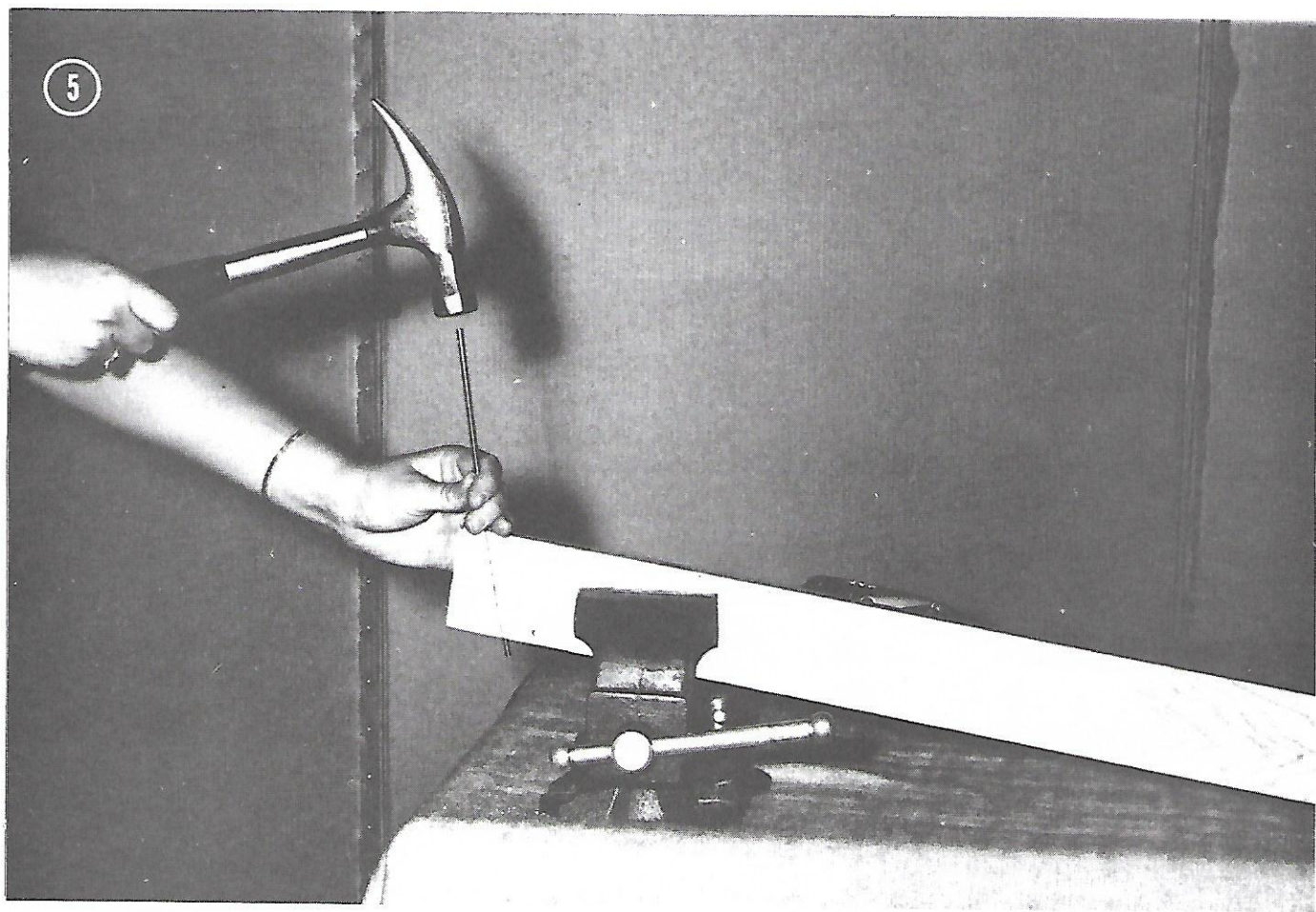
The third part of the cutter, and one sometimes omitted, is the suspension. Coring can be done without such an arrangement — there are those who dislike having the bow suspended — but it's sometimes a rather cumbersome affair. Without support of some kind, the chances of accidentally damaging the core or burning operators is increased.

Essentially a counter-balance, the weights are adjusted so the bow remains at any height without attention of the operators. This permits the bow to be pulled down for coring, then raised when the operation is completed. The reason for this is that immediately upon finishing the core, the wire is still hot. It is therefore prudent to assure it can be quickly pushed out of the way.

The function of the heavy rubber bands is to allow further flexibility of the bow when in the cutting position. This way the operators are provided further latitude in changing bow height and cant, a valuable feature on difficult cores.







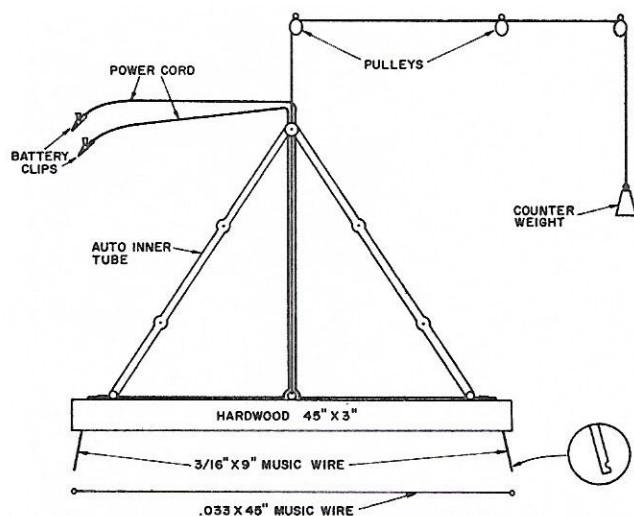


FIG. 2

Construction of the foam cutter is actually quite simple and straightforward. Reference to Figure 2 for dimensions and pertinent photos should make it's assembly painless. About the only precautions necessary are adherence to instructions, and when installing the cutting wire on it's supports, remember the spring tension involved and take care the wire does not slip.

The first, and perhaps most difficult step, is drilling holes in the hardwood frame piece to receive the 3/16" music wire supports. If an adjustable drill press is used, set it for about seventy degrees. The job can be done equally well with a quarter inch electric hand drill, though it may be a bit more tedious.

Measure in one-half inch from each end of the hardwood piece and mark. This becomes the bottom side. Now measure in one and a half inches from the top side. The measurements indicate where the drill is to enter and exit for the proper angle. If drilling by hand, draw lines down each side from one hole mark to it's mate. This will serve as a visual guide and help bit alignment while drilling.

Chuck a bit — 1/16" or thereabouts — in a drill and using the guide lines for reference align the bit and begin. Do not force the drilling because the bit is likely to "walk" if you do. Turn the board over and drill from the other side (assuming a short bit was used). Now chuck a 3/16" bit in the drill and repeat. You should have a 3/16" hole into which the wire will be a tight fit. Refer to photo #2. Do the other side in like manner.

Before stowing the drill, rummage around the scrap pile and rustle up some half-inch doweling. A broom handle will suffice. Saw off two pieces, approximately two inches long. Clamp these in a vise or drill press and bore a 1/16" hole the long way through each. These are insulators which fit over the cutting wire and function as handles to guide the wire when coring. See photo #3.

Clamp a piece of 3/16" x 9" music wire in a

vise and file a notch about 1/4" in from one end. Make the notch deep enough to retain whatever size cutting wire you intend using. See photo #4. Music wire of .033 diameter is recommended. Be sure to smooth the notch surfaces. Sharp edges will nick, and weaken, the cutting wire under tension. Repeat for the second piece of wire.

Insert the two pieces, notched ends down and facing out from each end of the hardwood, into their respective holes and tap into place. Leave around 1/4" protruding from the top of the board for later attachment of an alligator clip. See photo #5.

Measure in five inches from each end of the board and install two half-inch eye-hooks in the top side. Install another in the center. See photo #6.

From an old auto inner tube, cut six rubber bands about a half-inch wide. Loop these together so that two long bands result. Loop one end of each of these through the outer eye-hooks. See photo #7.

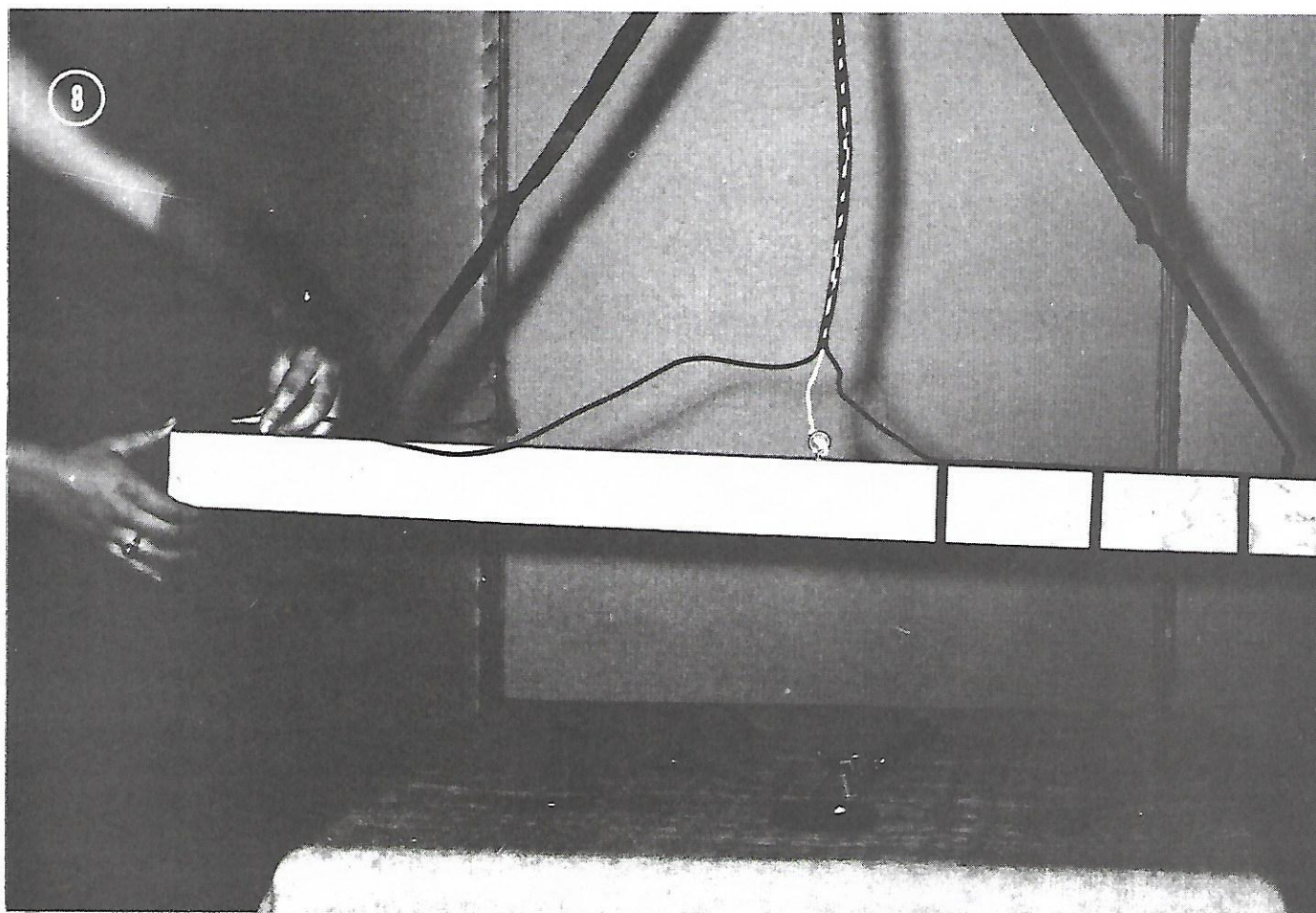
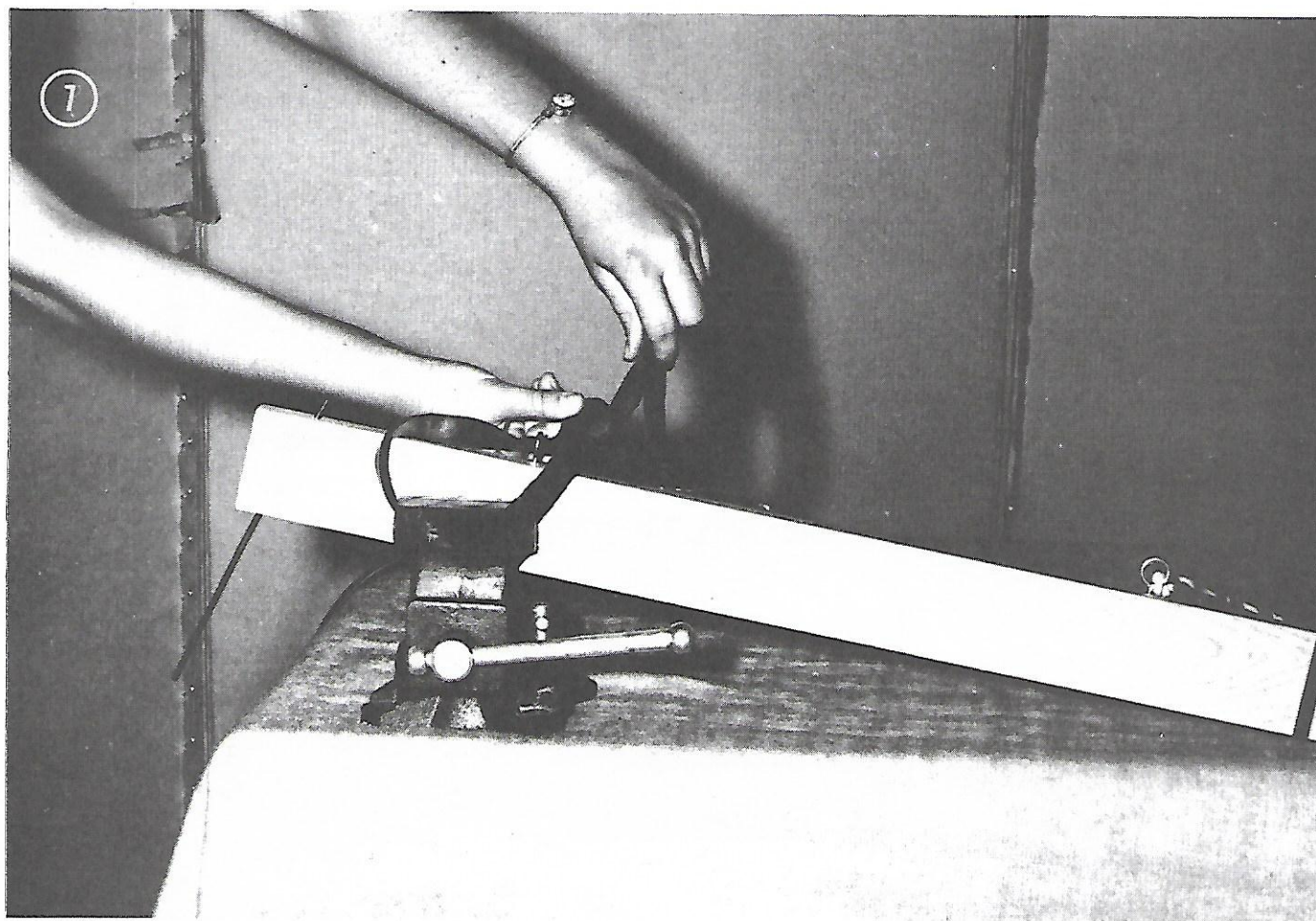
Snap a metal notebook ring through each of the other band ends. Tie a length of clothesline or equivalent rope to the notebook ring, then to the center eye-hook. Be sure to leave slack between the eye-hook and ring so the rubber bands support all cutter weight.

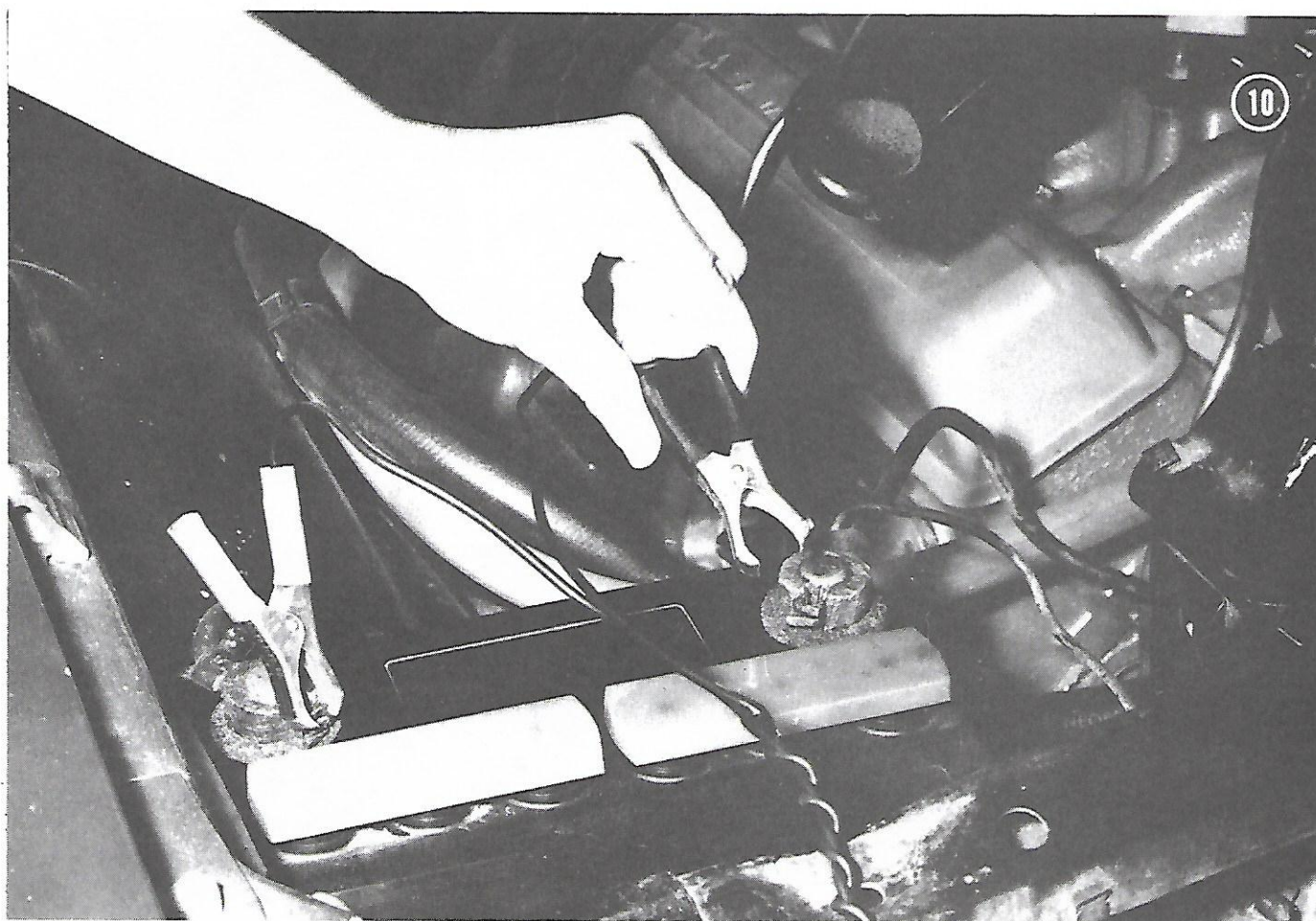
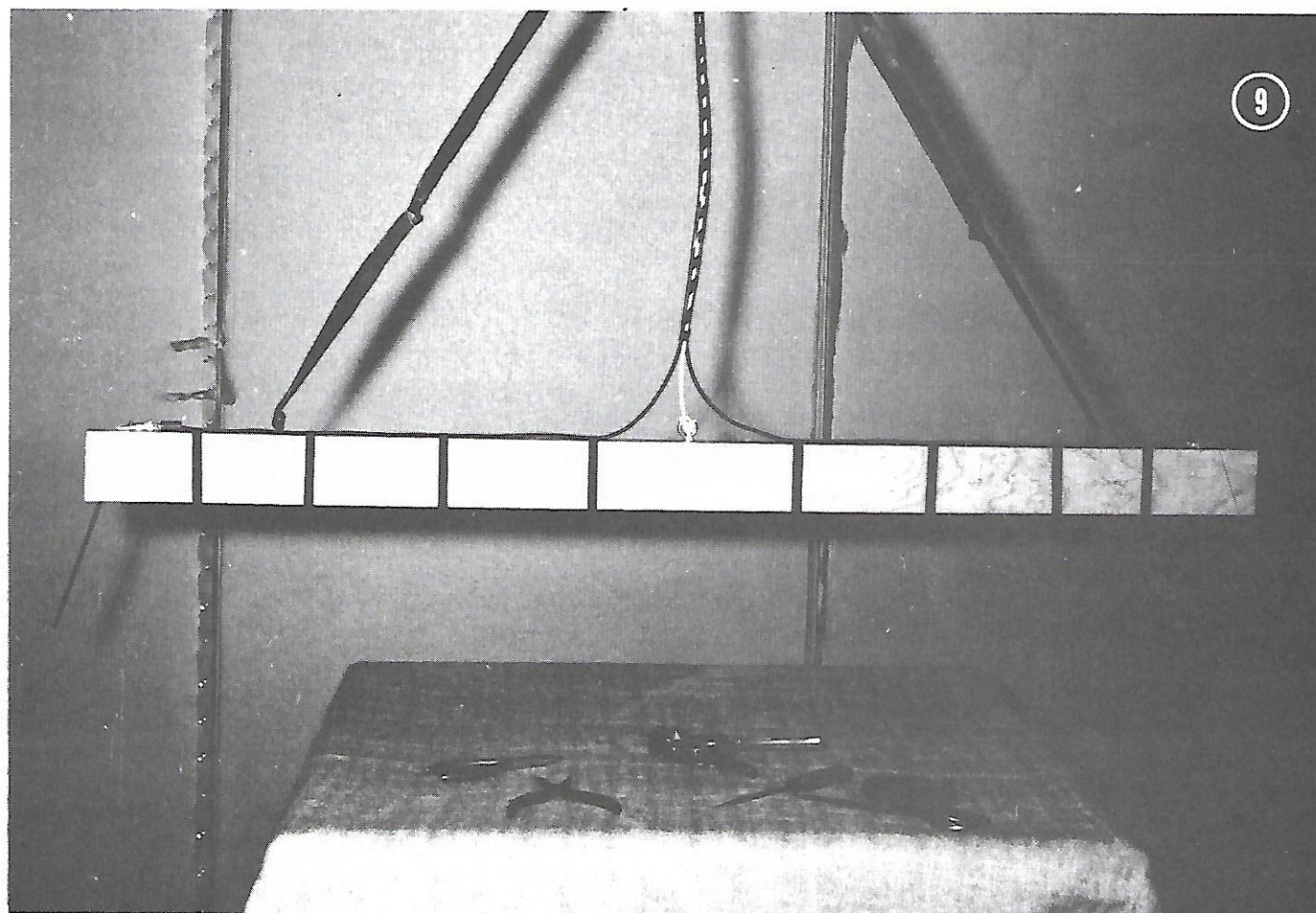
The purpose of this arrangement is greater flexibility of the bow in operation and freedom from counter-weight drag. The slack rope between the center eye-hook and notebook ring acts as a safety feature. Should the rubber break while coring, the cutter cannot fall. This has happened and could result in core damage, operator burns, or both. In this respect it may be well to say that cutter burns, though painful, are usually not serious. Just the same, prolonged contact with the hot wire is not recommended!

Next comes the power cord. That used in the photos is single lead sixteen gauge flexible insulated material, similar to heavy lamp cord. Twin lead, of the type simply pulled apart to make connections, would be ideal here. Length is optional and may vary with each installation. The prototype required fifteen feet. Be sure to allow sufficient length for the cord to run along the suspension rope to a break-away point a few inches above the notebook ring.

Begin installation by attaching an auto battery spring clip to the end of one lead and an alligator clip of the type used with electronic test equipment to the other. Repeat for the second lead.

Attach the alligator clip to the 3/16" cutting wire support, route the cord along the top of the board and secure with tape or clamps. See photo #8. Though black electricians tape was used on the prototype, ordinary paint masking tape will do as well. Repeat the connection and routing of the second lead. Run the power cord up along the





suspension rope and secure it with tape, lacing cord, or what-have-you so the end product resembles that shown in the photos. This completes the cutter and frame suspension.

Next comes the counter-weight. The first step in it's installation is to decide where coring is to be done. The next is to pick an out-of-the-way spot for the weight to hang, preferably a corner or along a wall. The counter-weight is more or less a permanent installation, so pick a spot where it need not be taken down after each coring session. Wing coring will probably not be done often, but set-up and tear-down each time is a nuisance.

With the location picked, install a pulley suitable for whatever suspension rope is used directly above the center point of the cutter. Install another about midway between the cutter and weight, and a third directly above the counter-weight. Three pulleys are usually sufficient, but use whatever number are required. Make certain the pulleys operate without any binding. Oil them if necessary.

The actual weight can be as simple or elaborate as taste dictates. That used with the prototype consists of nuts, bolts, lead fishing weights, etc., contained in an old sock tied to the suspension rope.

Correct adjustment is dependent on the rope and pulley system operating freely. Binding will cause drag which, if occurring at operating level, may cause problems while coring. Add or subtract weight until a very slight push or pull will change cutter height and it remains there of its own accord. This, together with the elasticity of the rubber, makes all elevation changes almost automatic curing coring.

The final step in cutter assembly is preparation and installation of the cutting wire. Here the builder is faced with alternate choices as to wire type and size. That most widely used for foam coring is probably Nichrome. Nichrome wire is now available from RCM Products, c/o R/C Modeler Magazine, P.O. Box 487, Sierra Madre, Calif. 91024. It is the finest quality Nichrome wire of its kind available for foam wing cutters. It comes in packaged 5 foot lengths.

Designed for extremely precise and smooth cutting of foam wing cores, it can be used with any commercial or home-built foam wing cutter. Available direct only, postage paid. Ordinary music wire, of .033 to .063 (1/32 to 1/16) diameter is a second choice.

A 45" length of Nichrome wire was found to yield best results on the prototype. Used with a 12V auto battery or charger, the current stabilized at just under 9 amps. With 6V, the current draw settled in at 6.5 amps, but coring was considered a bit slow. However, the individual duplicating this unit who will be coring for the first time may find a 6V supply preferable. Power requirements may vary somewhat with any material or length changes, but should remain comparable with the

prototype barring drastic changes.

To prepare the cutting wire, begin by forming a loop in one end sized to slip over the 3/16" wire support and seat in its notch. Slide the 2 dowel pieces onto the wire and form a loop on the remaining end. To install, slip one end of the cutting wire over a support, making sure it is seated in the notch. Force the two supports toward each other and slip the free end over the other support and into its notch. This completes the foam cutter. Photo #10 shows the cutter being attached to an auto battery for coring. Polarity is unimportant here. In addition to the cutter for forming core blanks, the home shop should also be equipped with a dihedral angle and tip cutting jig. Another useful accessory is a cut-out tool for landing gear blocks, servo cavities, bellcrank platforms, etc.

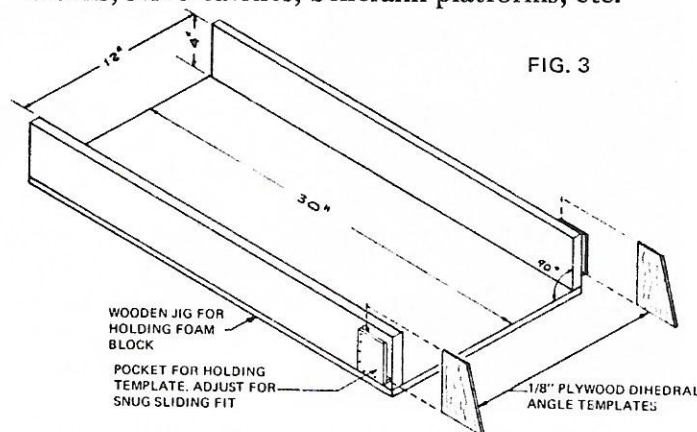
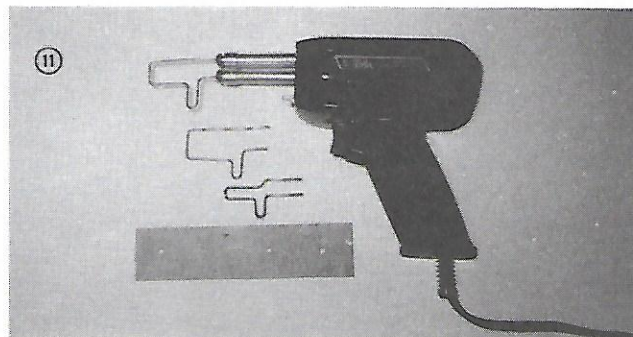


FIG. 3

Figure 3 illustrates a dihedral and tip cutting jig. It is strongly suggested the reader make and use a jig for these cuts as accuracy is paramount. Essentially an open-ended trough with receptacles for insertion of angled templates, the fixture is simple and quickly made. Though these cuts can be made without a jig, accuracy is sometimes doubtful.

A simple cut-out tool is shown in photo #11. The fourteen gauge solid copper wire is bent to shape and inserted in a soldering gun. When used with simple plywood guides or jigs, such a tool results in smooth, accurate channels in foam cores.

When forming the wire to a desired shape, it is advisable to make it a fraction smaller than the finish cut size. This allows for slight over-melt of the foam. Heat regulation is obtained by rapidly pressing and releasing the soldering gun trigger. With practice, excellent control is possible.



III TEMPLATES

With the foam at hand and equipment ready, there remains only wing selection and preparation of suitable templates to core it. Any size or design can be cored. The principles remain the same, only templates and their position on the foam block differs. However, it should be remembered that any core will be only as good as the templates used to form it.

Though template design is influenced chiefly by airfoil shape, a number of other factors must also be considered. Strip, as opposed to in-set ailerons, may effect trailing edge stock and therefore panel chord. Where a thin sectioned wing is to be highly stressed in service — as in pylon racing — it may be advisable to incorporate full length spars. In this case, templates might be modified to cut spar slots while coring the panel. Should the wing be of unusual or complicated design, it may require sectioning (see chapter IV), which would mean extra templates.

1/16th to 1/8th plywood is probably the most satisfactory template material. It is readily available, cheap, easily worked with basic hand tools. Any grade may be used, the only real difference being that better grades are usually finer and sanding somewhat easier.

Time spent carefully tracing, cutting, and sanding will pay big dividends in quality cores. It is imperative that edges be perfectly smooth so the wire passes over them easily. However, care must be exercised in sanding not to alter the airfoil. As the wire follows the template edge and produces a core exactly that shape, any dips or waves will be reflected on the core.

The easiest way to lay out templates is by tracing the pattern from a kit rib onto plywood and carefully cutting it out. The same can be accomplished from plans by tracing the outline minus sheeting thickness.

Make two templates — one for the root and one for the tip. A constant-chord barn door type wing usually requires two of identical size and shape.

Figure 4 illustrates a set of templates as may be used in coring a tapered wing. Note the numbered marks around each. These aid the operators to maintain a constant cutting speed and helps keep the wire relatively straight, span-wise, while coring. Note the marks are wide-spaced at the trailing edge, become closer near the front, are quite close around the leading edge, then become wide-spaced again. This is to prevent wire lag around the leading edge. As the operator counts the marks, he maintains a constant rate. The wire is therefore automatically slowed when the marks become close together.

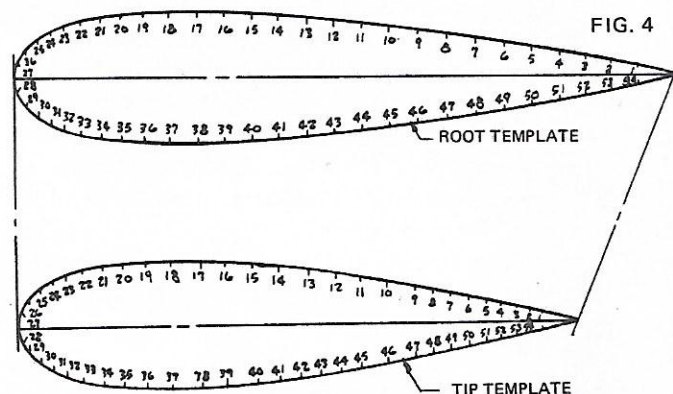
Figure 5 illustrates trailing edge stock and

construction differences for strip and inset ailerons. The same basic airfoil template could be used in coring wings for both ailerons by simply moving the template further ahead — or back — on the foam block. However, this must be determined by available pre-cut stock sizes for in-set ailerons.

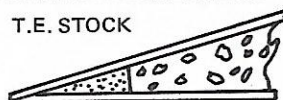
Photos 12a, b, c, d, and e, show the preparation of a set of templates. Note the use of clamps while sanding. To assure identical position of numbered marks on both templates, the clamps should also be used when numbering.

Some means must be provided for attaching templates to the foam block and keeping them there while coring. This is most easily done by drilling three holes for insertion of large head roofing nails through the templates and into the foam block. Drill two holes as near each end of the template as possible, taking care the numbered lines are not covered with nails in place. Drill a third hole in the template middle. Holes should be sized for snug nail fit. If too tight, accurate placement on the block is difficult. If too loose, the templates may move while coring.

Photo #13 shows an assortment of templates for block trimming, wing tip and dihedral cuts, servo cavities, etc. Block templates, being simply oblong pieces of plywood in various lengths for sizing and squaring, are quickly made from remnants of panel template material. About the only precaution is that the sides must be perfectly straight and well matched.



T.E. STOCK

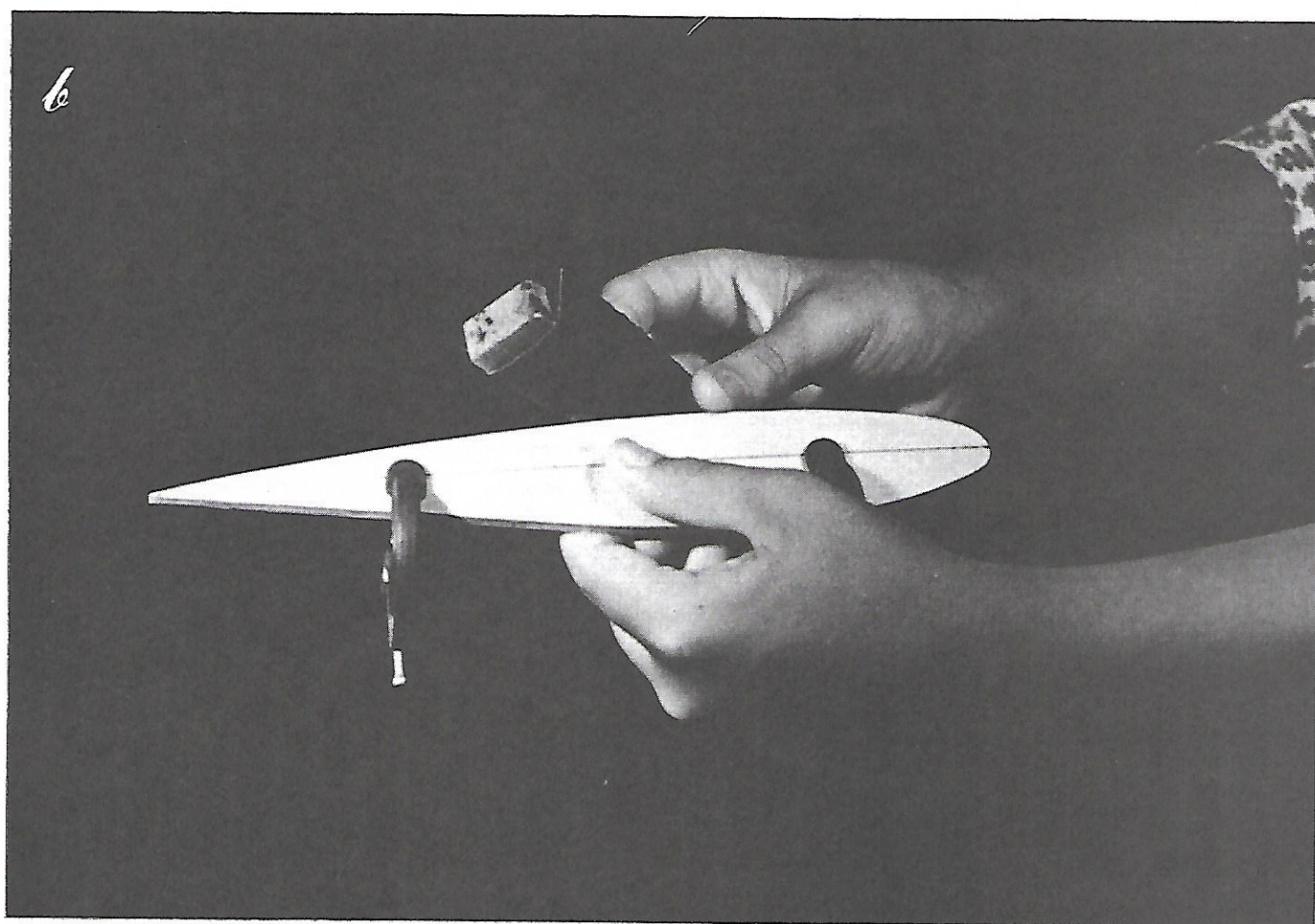
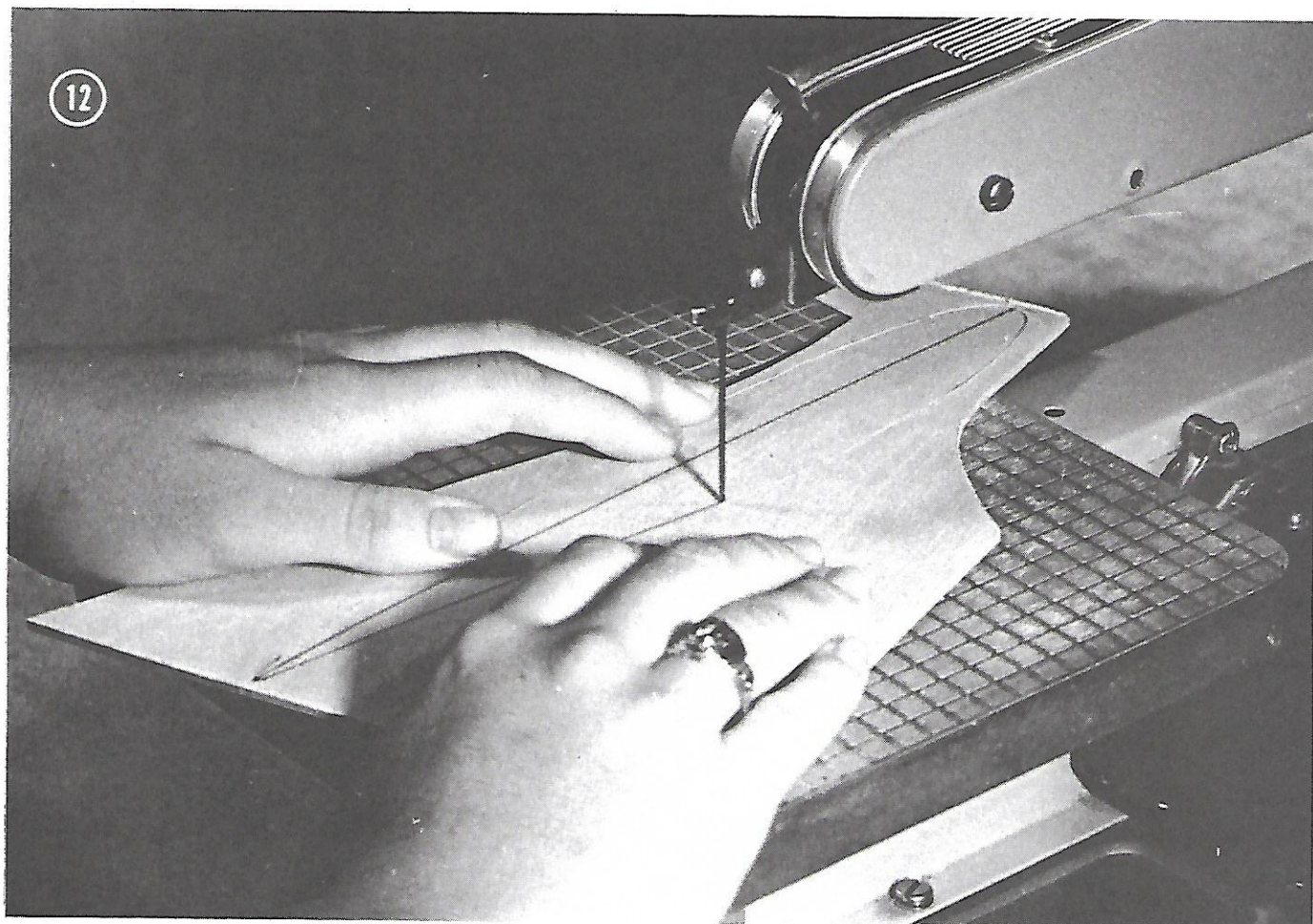


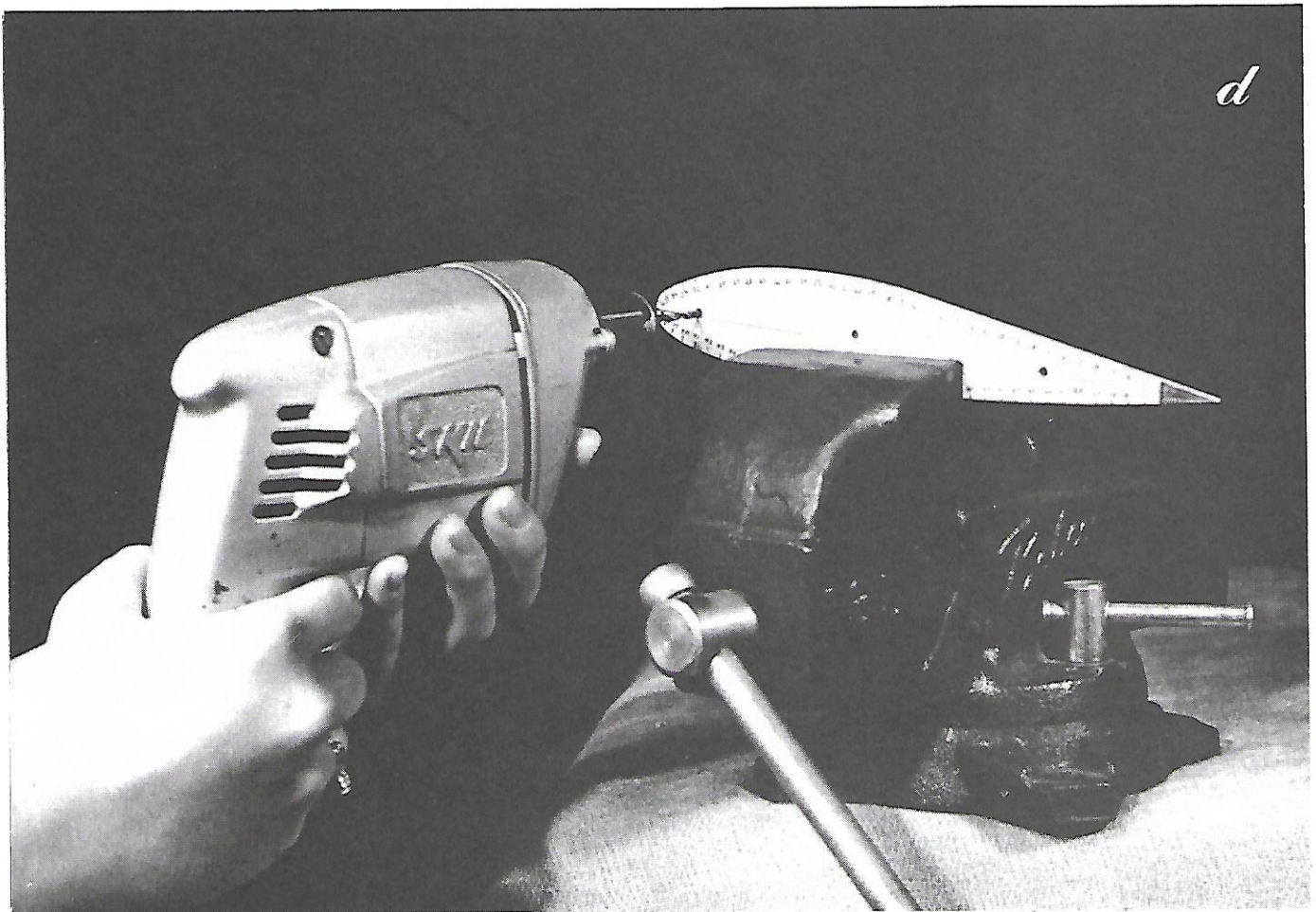
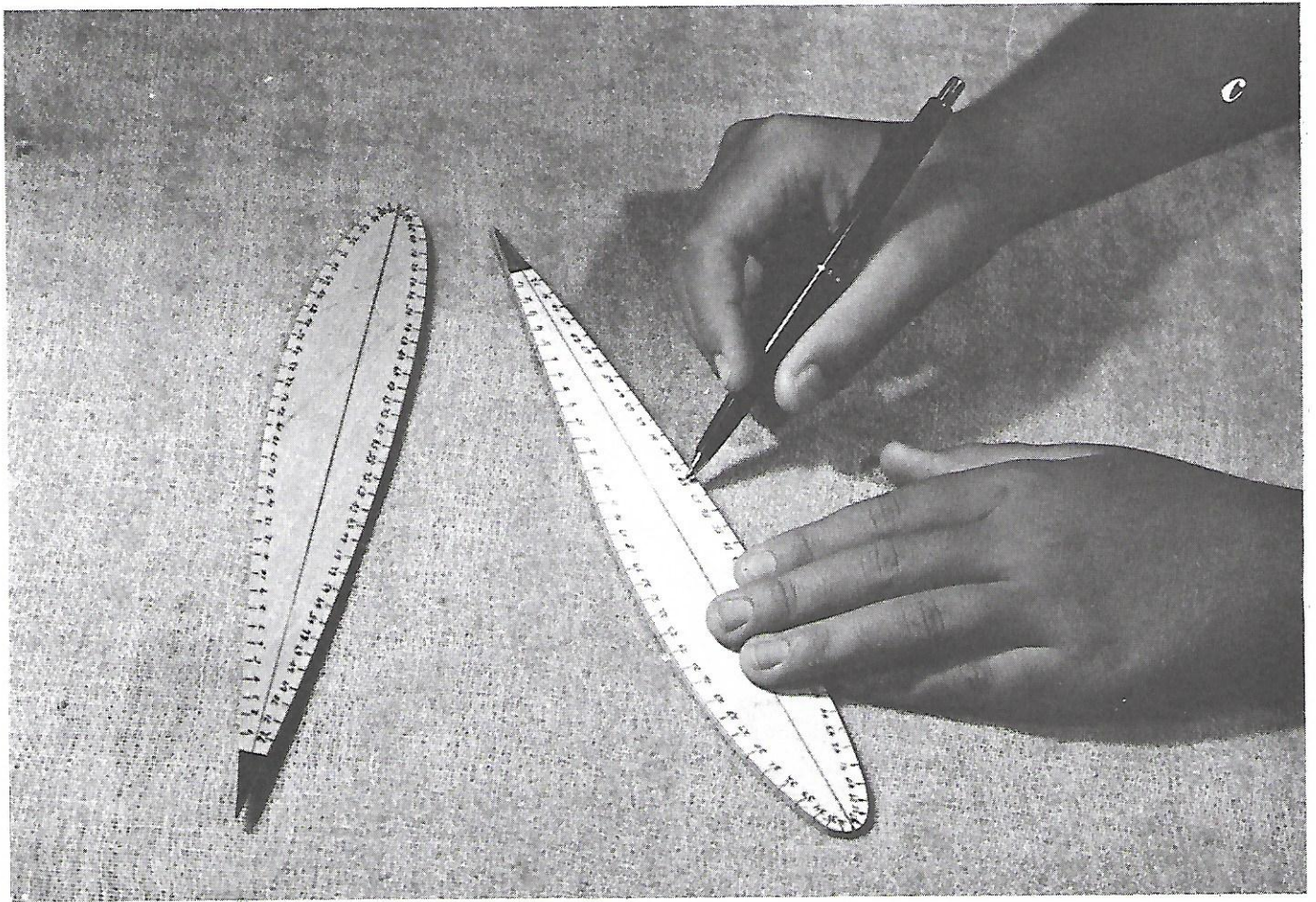
FOR INSET AILERONS — CORES ARE CUT SO THAT ST'D T.E. STOCK TITE-BOND GLUED TO T.E. OF CORE, FORMS THE FINAL WING T.E.

FIG. 5

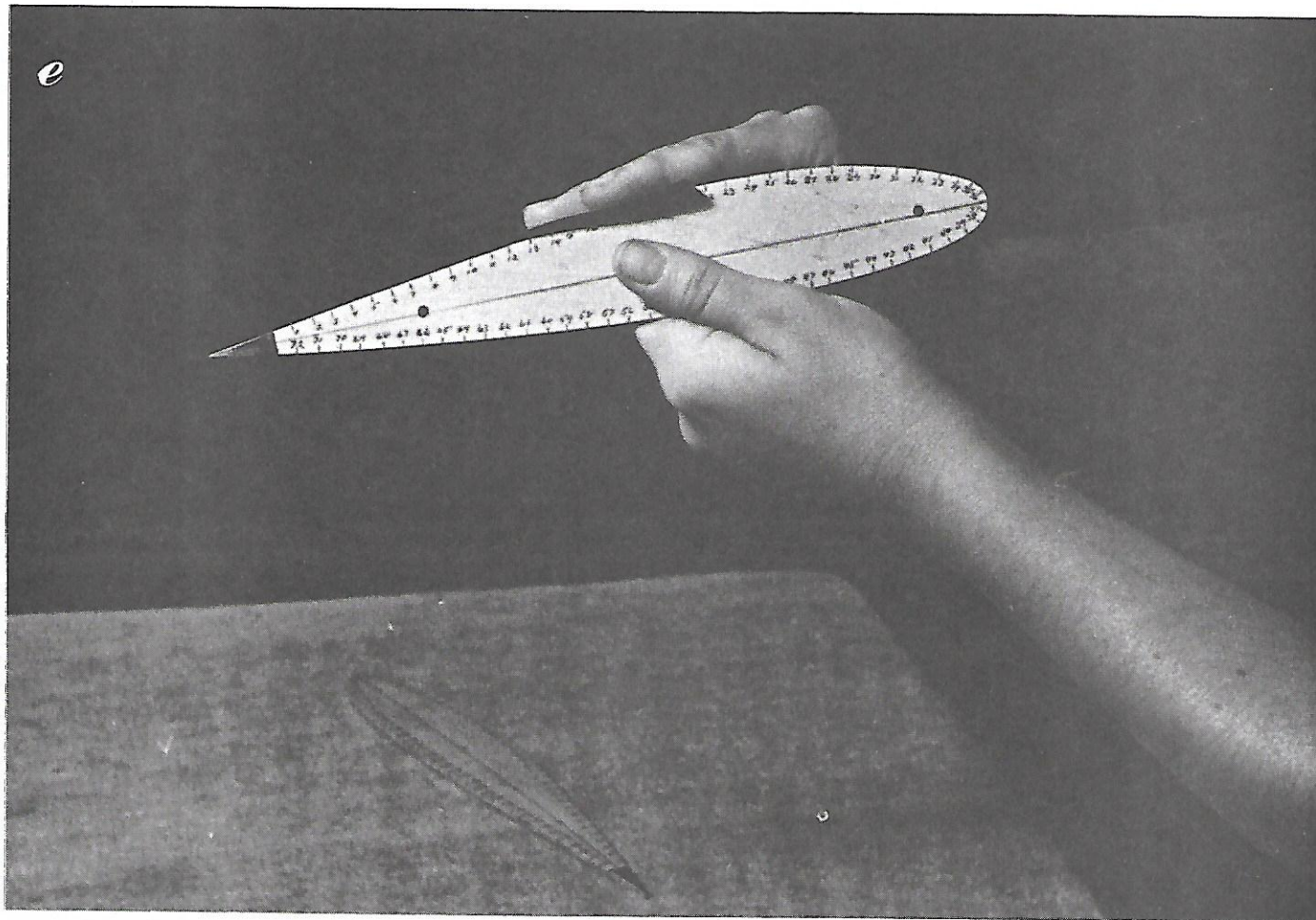


STRIP AILERON CORES ARE CUT SO THAT T.E.'S ARE SQUARE. EPOXY OR TITEBOND T.E. STOCK TO THE FINAL T.E. AFTER BOTH TOP & BOTTOM WING SKINS HAVE BEEN CEMENTED TO CORE.

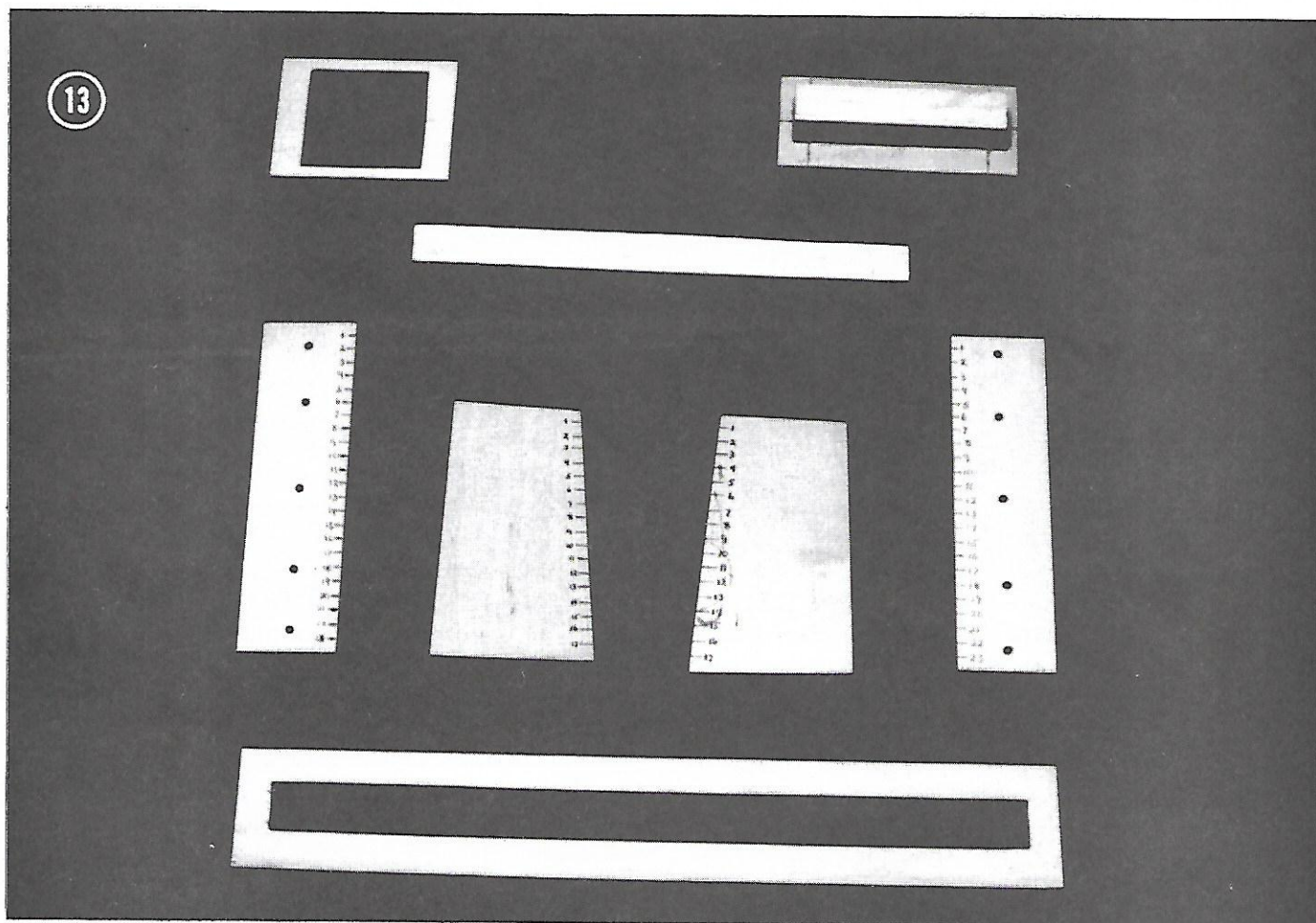




e



13



Dihedral or wing tip templates for the dihedral jig are somewhat more difficult because of receptacle fit and the precision angles required. Keep in mind that true angle cuts depend on square mounting of templates in the jig.

Channeling templates for use with formed soldering gun tips may range from rather

complicated units — as might be used for terraced retracting gear cut-outs — to a long piece of wood stock. Or, in the case of one piece main gear blocks, the block itself might be used. The main requirement here is that template and tip be matched to obtain proper cut-out depth and width.

IV CORING

Accurate foam wings require the block from which they are cored be square. A block $1/8$ " out-of-square could result in a cumulative error of one quarter inch in panel mating which may throw the leading edges out of alignment. This condition could also adversely effect dihedral angles. A combination of both, if uncorrected, may result in a resounding crash when the wing becomes airborne. Therefore, a square block and precise template positions cannot be over-emphasized. However, these precautions are easier taken than described.

A metal square and wide yardstick are valuable tools for squaring. A quick check of the block can be made with the square. Do not force it too hard against the foam as resiliency may give a false indication. Use only enough force to support it. You'll usually find one corner, and possibly one end square. If not, the job is somewhat more difficult. At any rate, draw lines across the top of the block to indicate any cuts necessary to effect squaring, then extend them down the sides.

The block shown in photo #14 measures 24" x 36" x 4". Squaring lines have been drawn and after squaring the block will be halved. Since the wing is to have a sixty inch span and eleven inch chord, only half the block is used. Two panels thirty inches long will be cored from this half.

For ease of coring and accurate template positioning, elevate the working surface to near eye level to eliminate bending or stooping. Your first cores may be somewhat of a tense business and anything you do to ease it will help. In trimming cuts, be sure to make provision for the severed portion to fall away and wire withdrawal. This can be done by placing boards under the block or extending the block over an edge of the working surface.

Align the numbered edge of one of the trimming templates with the squaring line drawn down the side at one end of the block. Insert nails through the template and push firmly into the foam. Repeat for the other side. Lay the yardstick across the top of the block and flush with the template edges. The line drawn across the top of the block should match. If not, the templates are not aligned properly or the squaring lines are off.

Two persons are required for hot-wire coring — one we'll call the pacer, the other a

follower. The pacer sets the speed of cut and compensates for any possible wire lag. His instructions are passed to the follower by counting aloud the marks on his template as the wire passes them. The follower adjusts his speed to match. Any change in speed by either operator must be gradual. Sudden jerking or stopping will cause the wire to jump or lag which will melt grooves and may cause a reject.

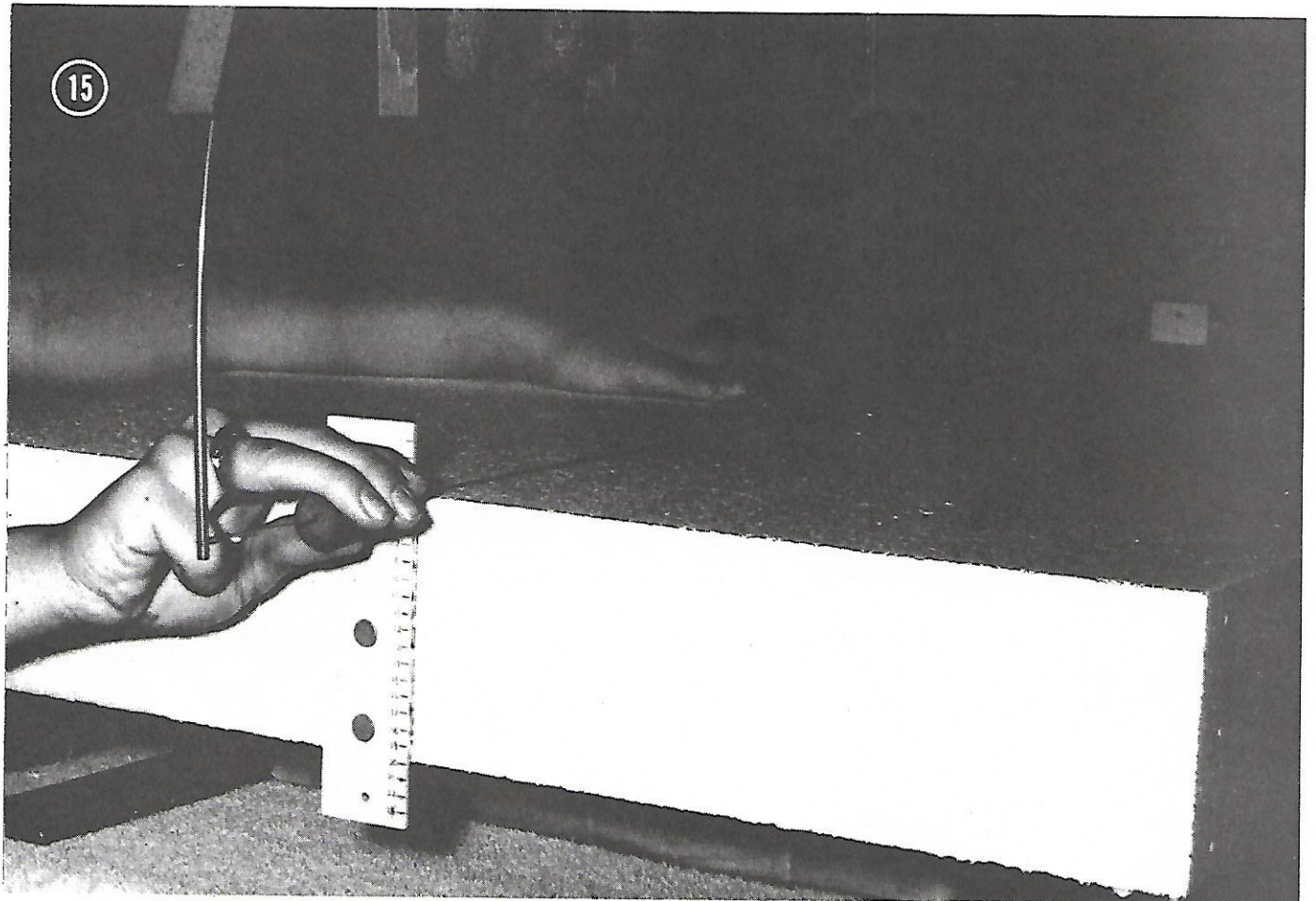
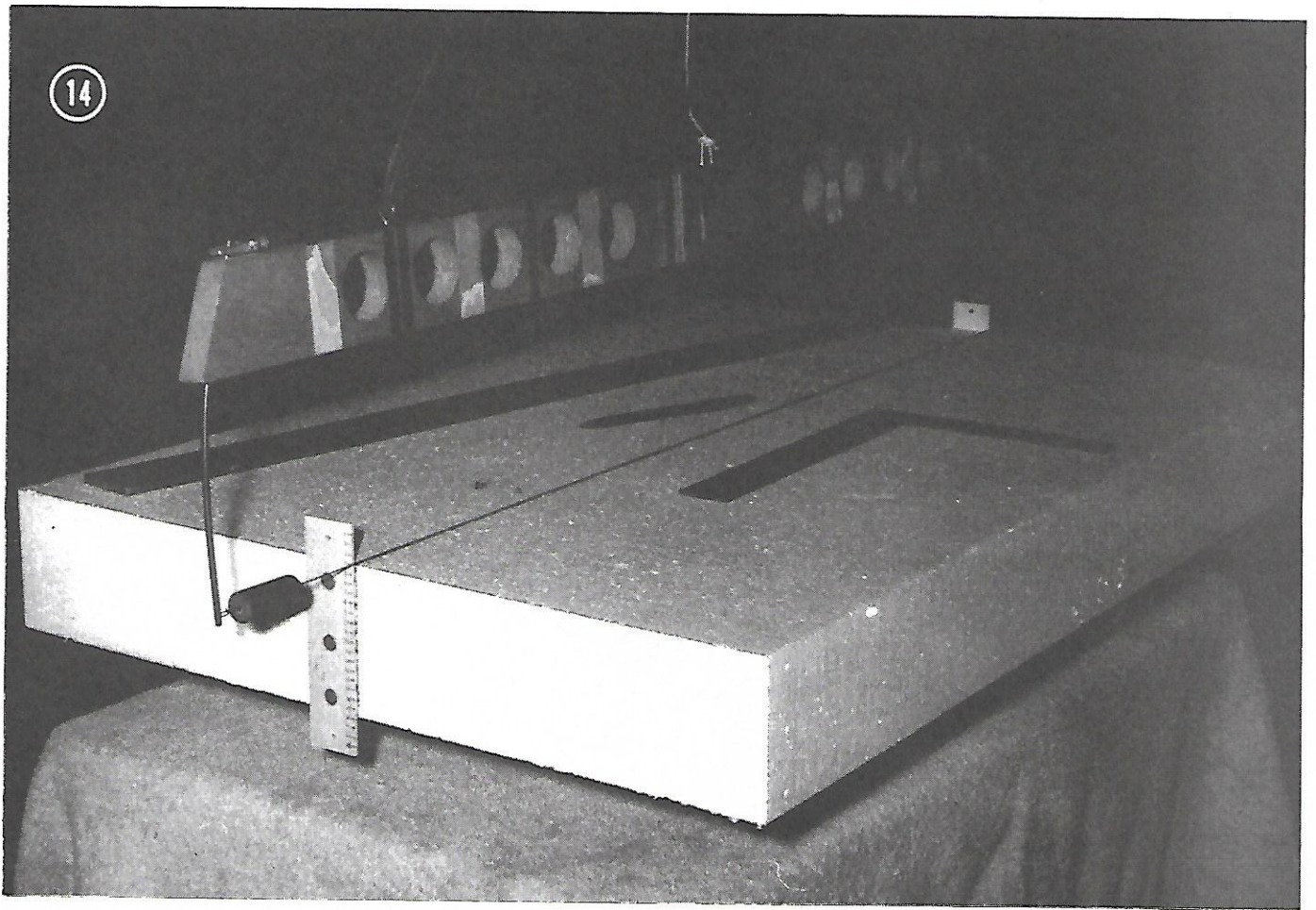
Pull the bow down so the wire is suspended just above the foam as in photo #15. If the bow is hung properly and counter-weights adjusted correctly, the wire can be pulled through and out the bottom of the block with very slight effort.

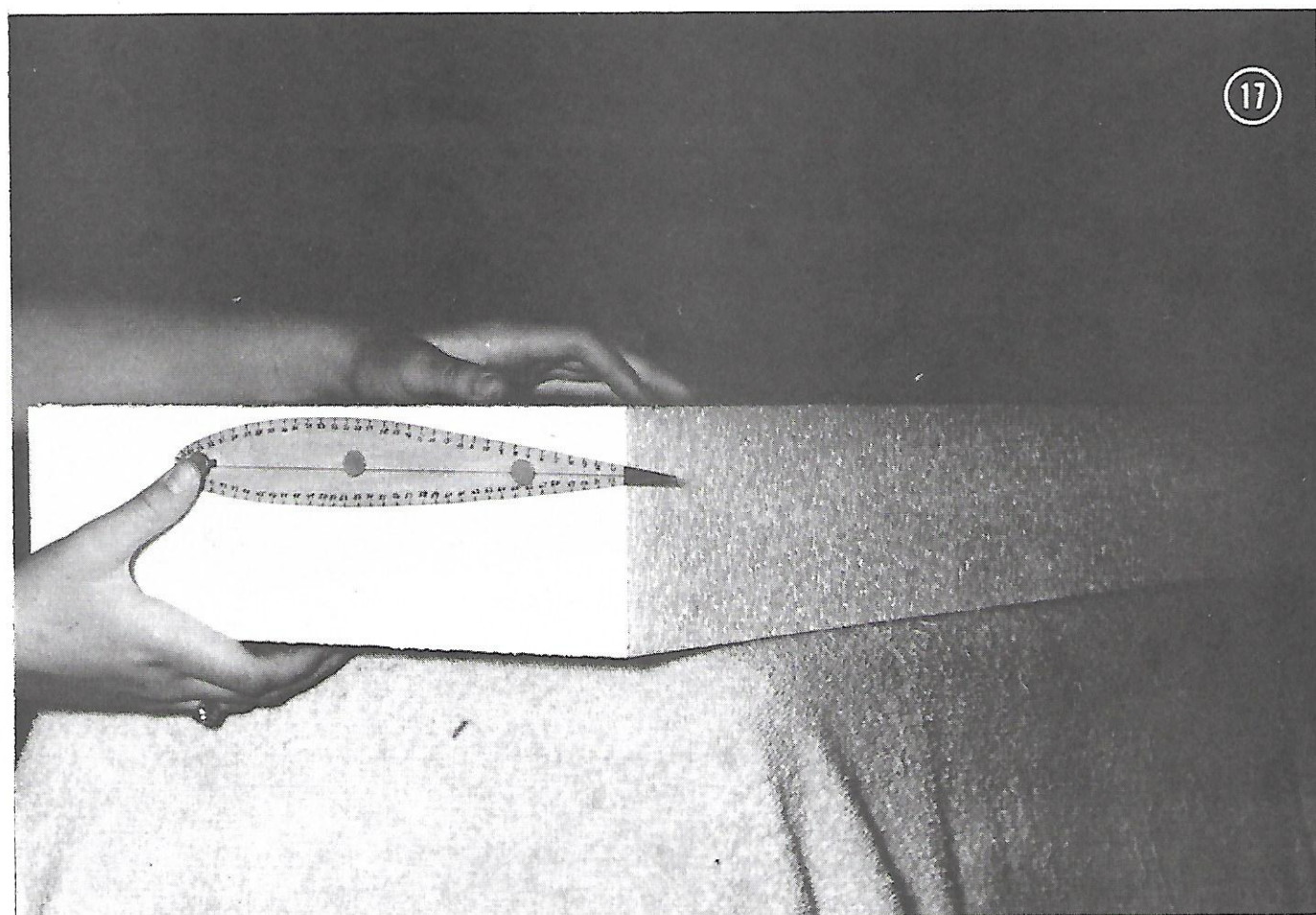
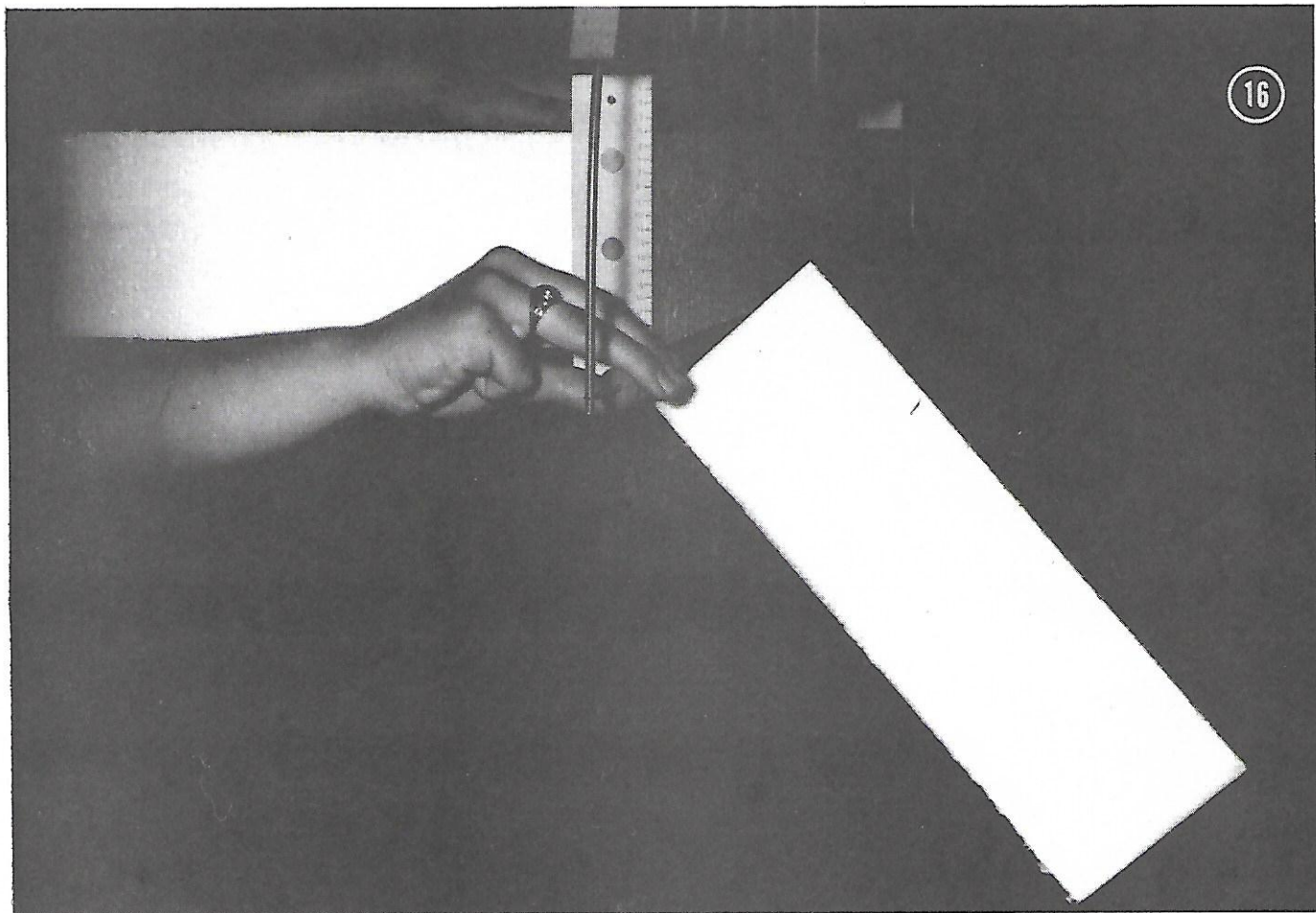
Block trimming cuts are from top to bottom. A suggested procedure is:

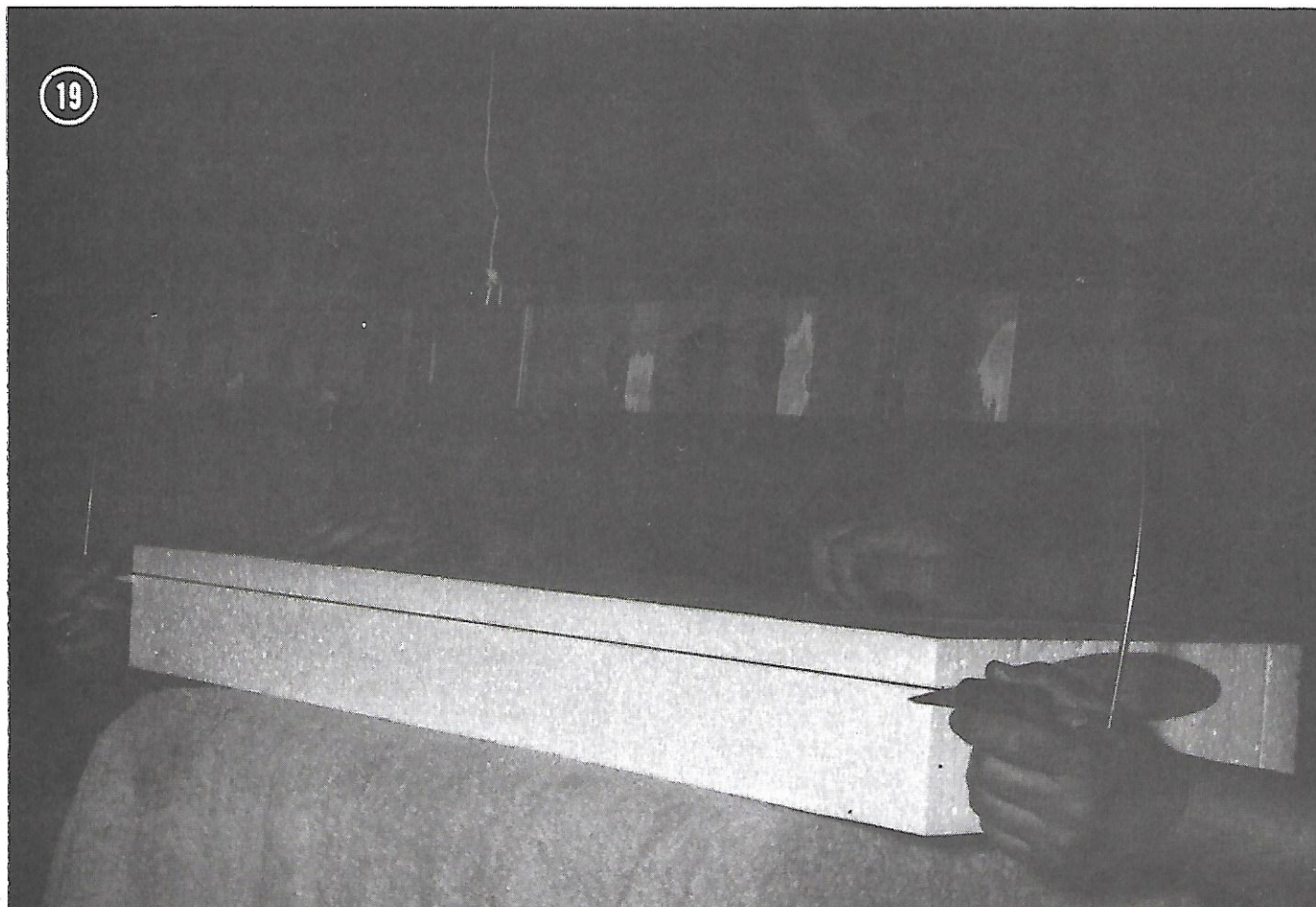
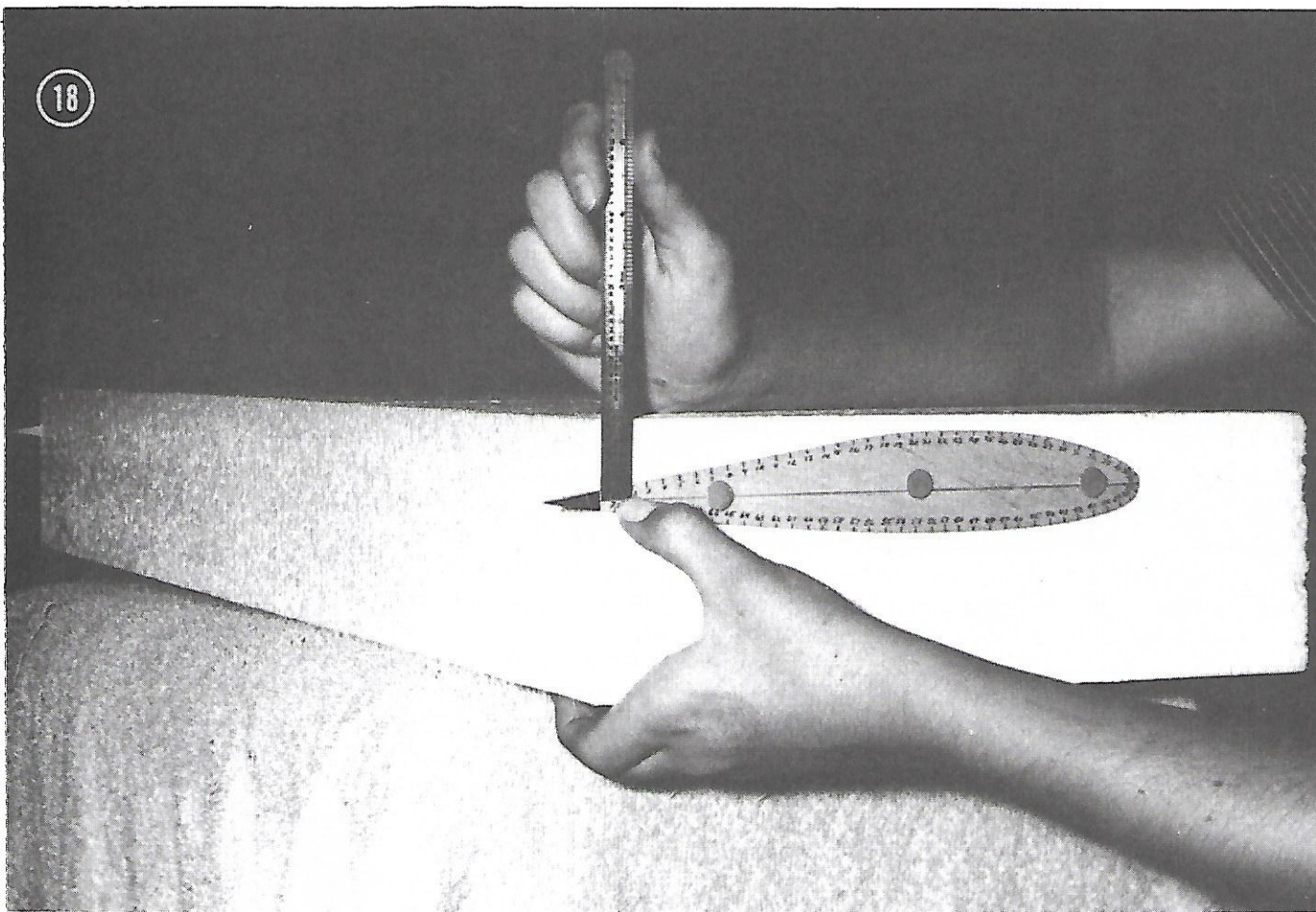
1. Operators place the wire against the template edges and just above the foam.
2. Pacer throws the switch and allows a couple seconds for the wire to come to temperature.
3. Pacer says "To the foam . . . now," and begins counting as the wire passes the marks on his template. At the word "now," the wire should contact the foam and cut begun.
4. As the wire clears the bottom of the block, pacer says "Through the foam and . . . out." At the word "out," both operators withdraw the wire from the bottom of the block and out, being sure the hot wire does not touch the foam.

In photo #16, the wire has completed it's cut and the severed block half is being removed. Note the wire is being held in position to prevent further foam contact. When the severed portion is out of the way, the cutter will be raised. While making block trimming cuts, some idea of the proper speed for the readers' particular cutter installation will be gained. A similar rate will be used for panel coring, and this should be reduced to about half as the wire passes around the template leading edge, depending on the wing being cored. Reduced speed around the leading edge will help keep the wire straight, span-wise, and prevent center-lag, which will result in bowed leading edges.

Photo #17 shows the root template being attached to the block for the first panel. Notice the back of the template extends beyond the block edge. This assures a square trailing edge by providing a resting place for the wire as the core is







begun as well as a supported exit. This method is recommended for the beginner. The trailing edge can be made by squaring the template and running the wire around it. In fact, some designs must be cored this way, but a certain amount of experience is required to prevent wire jump or lag which will cause rounded or bowed trailing edges.

Photo #18 shows the tip template being attached. It is essential the template be positioned exactly as the root. This is accomplished by transferring position measurements from the root template to the tip. Accuracy requires relative positions of the two templates be identical, with neither further ahead, back, higher or lower than the other. The one exception to this is swept designs where template off-set is intentional.

Photo #19 shows the wire in position for coring. The wire is resting on template edges just short of the foam. The pacer begins the operation just as with block cuts by counting, adjusting speed, and signalling withdrawal of the wire on completion. Coring may be started from either top or bottom of the template and is largely a matter of preference.

In photo #20, coring has started from top rear of the template and will proceed on around and out the bottom. Very light pressure — vertically against the template edge, and horizontally through the foam is sufficient. Excessive pressure against the template may cause movement with consequent airfoil distortion. Forcing the wire in it's cut will most likely cause wire lag. Allow it to melt it's way through the foam. If using the cutter described in Chapter III on six volts, switch to twelve volts if cutting speed seems too slow. But remember that with power increase comes also higher wire temperature and reduced error tolerance.

In photo #21, the cut has been completed and core withdrawn from the block. Immediately upon removing the core, sight along it's leading and trailing edges. They should, of course, be straight. Any tendency of the core to curl is due to heat and stress relief and normal. The slight curl can be remedied by flexing slightly in the opposite direction if desired, but it will soon straighten itself out. Replace the core in the block and repeat for the second panel.

Photo #22 shows the dihedral cut. The foam block, with cores inside, is inserted into the jig previously made. One panel is pulled out so that the wire will make the cut as it passes along the templates. In photo #23 the cut is completed and severed portion removed.

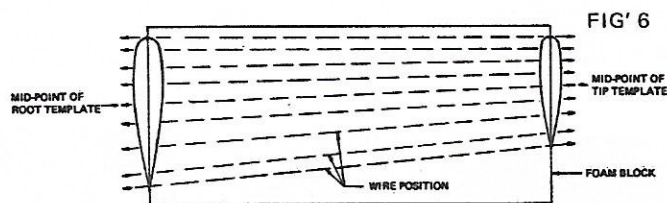
Tip cuts are made in the same way with suitable (usually 45 degree) templates. Take care that cuts are made on the correct end of each panel. It is somewhat embarrassing to end up with two identical panels, or worse, cuts in the wrong direction.

Dihedral cuts can also be made during coring, by elevating the tip template the required distance above the root. This method requires extremely accurate block squaring, and because of increased error possibility is not recommended.

Coring Tapered Wings

Coring a tapered wing is a bit more difficult than the constant chord type shown in the photos because of different size templates used. The tip being shorter than the root means the wire must move faster around the root template than the tip. To prevent wire lag it is necessary the wire remain parallel with leading and trailing edges while coring.

The principle is somewhat similar to pendulum action. If the tip is considered an anchor point, and the root an arc a weight would follow, it becomes apparent the wire must remain straight at any given position between these two points in order to maintain linearity. Non-linearity of the wire during a taper cut, especially at the leading or trailing edge, may result in a scrap panel. Figure 6 illustrates the relative position the wire should assume between templates at various stages of the cut.

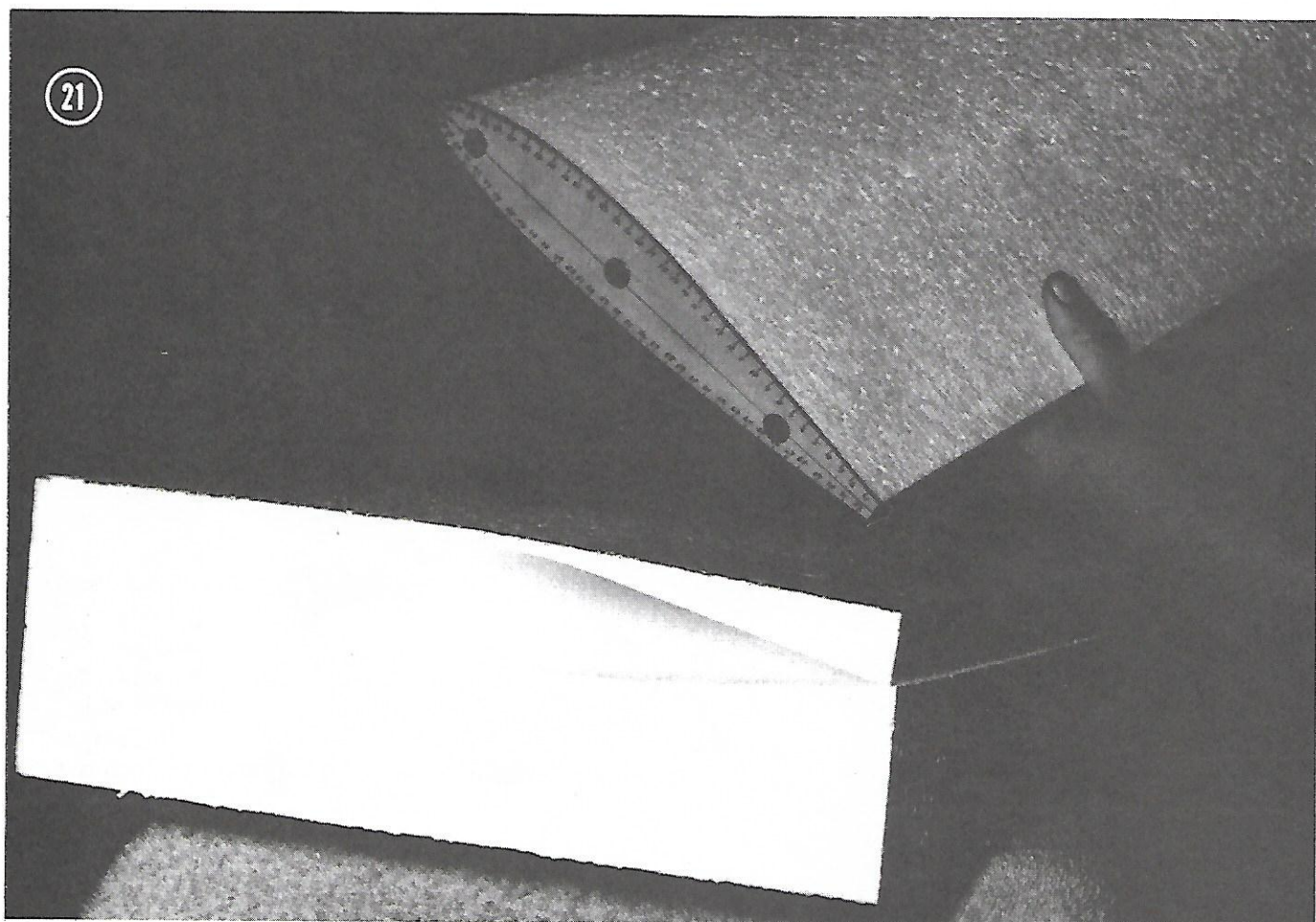
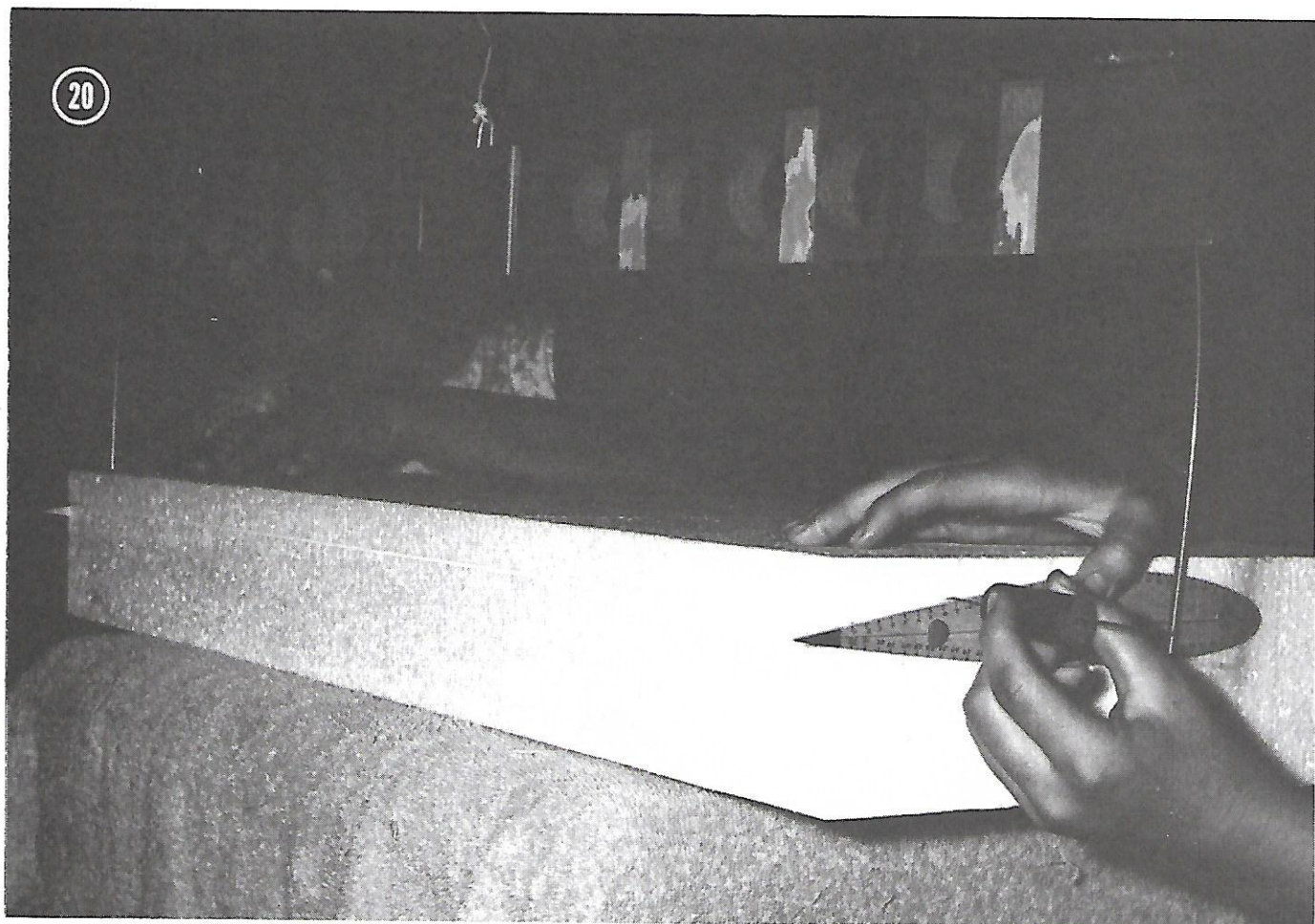


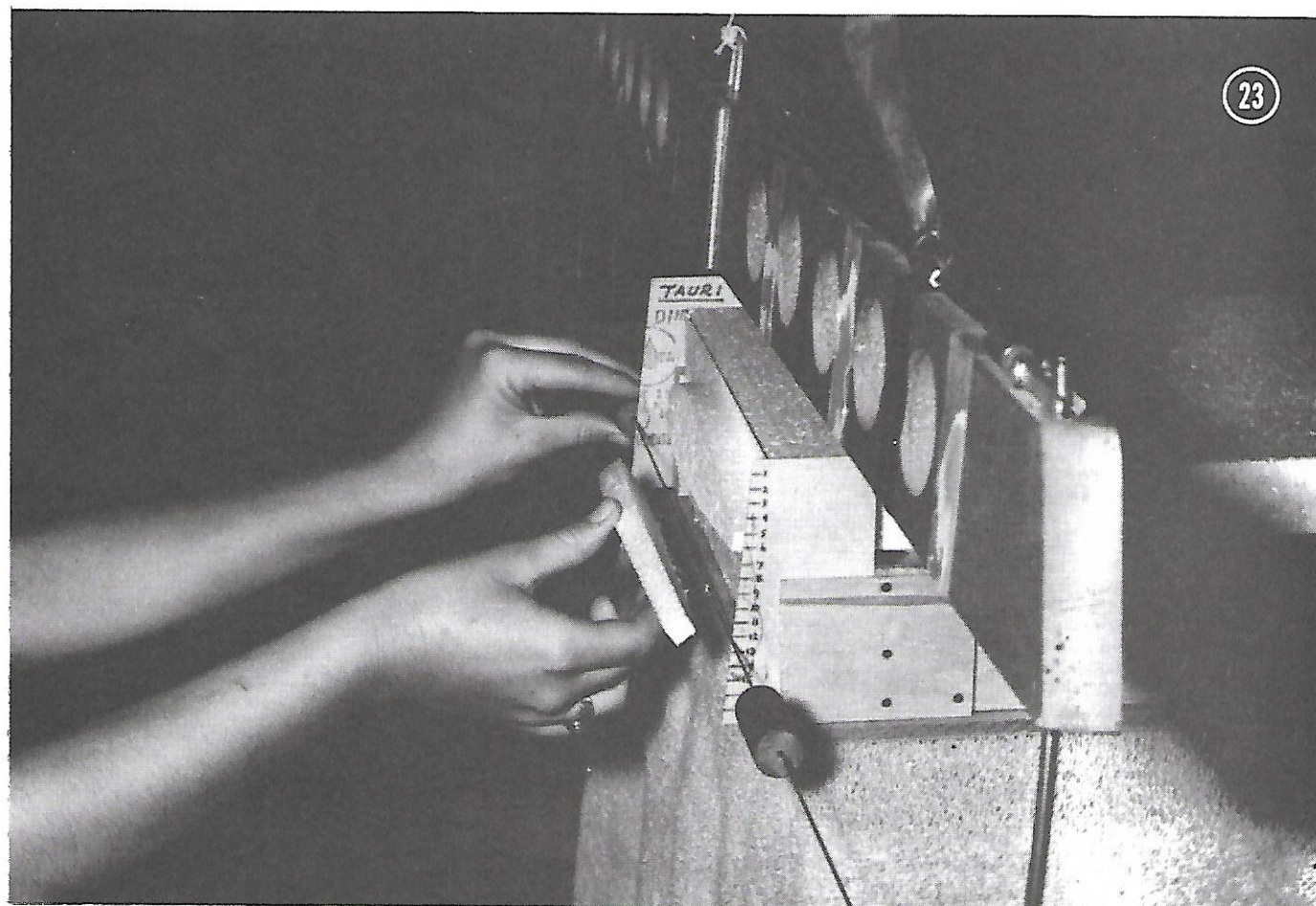
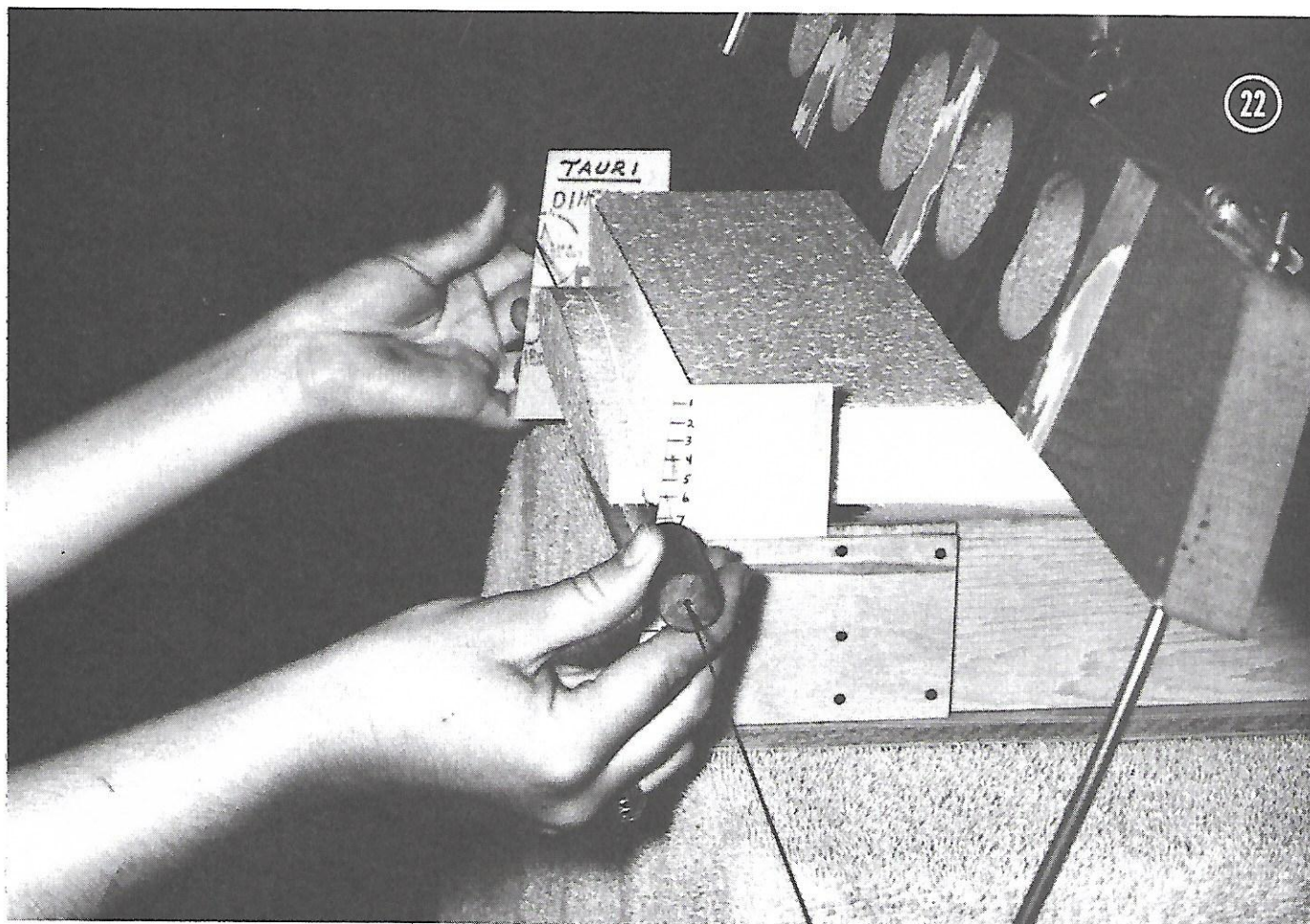
In any coring operation where one end of the wire must move faster than the other, it is easier to feel and correct wire lag from the faster moving end, and this is where the pacer should be. Though the marks serve as a reliable guide to wire position, the pacer must be alert to sense lag and vary cutting speed accordingly. It is extremely important for the follower to keep the wire moving over his template at a smooth, constant rate. Any variation other than signaled by the pacer may transmit a false lag indication and result in erroneous correction by the pacer.

Swept Wings

Because of the angles and sometimes severe template off-set, swept wings can become extremely complex and difficult to core. This is especially so if the sweep is combined with a taper and thin-sectioned tip. An example of this is the full scale jet fighter in which the wing may vary from a near constant chord and gentle sweep to the dart wing of sonic aircraft.

Figure 7 depicts a foam block and the placing of templates on it for a swept panel. The numbering system is similar to that for tapered





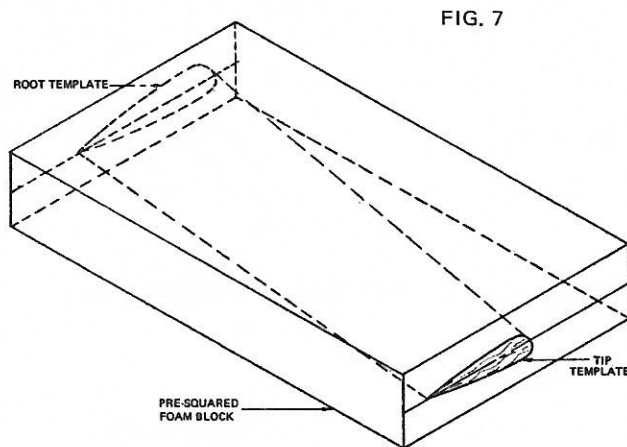


FIG. 7

wings as are wire positions throughout the cut.

For accurate root mating of swept wing panels, it is imperative that center joint angles be identical. This is dependent on initial block squaring and template position, and will be assured by careful measurements before coring.

Sectioning

One limitation of the hot-wire method of coring is that the wire must remain in a straight line. Therefore all cuts must be linear. We cannot, for example, make a foam ball in one pass. But we can make a ball. Simple geometry and the orange show us the way.

By making two half-circle templates and cutting a sufficient length of foam in the form of a half-round piece of wood molding, then sectioning with angular cuts, we have a number of pieces the shape of orange sections. When the pieces are glued together — a ball.

Though it is not suggested the reader begin madly cutting foam balls, the illustration is apt in that by sectioning, we can develop wings such as gull, double swept, dual tapered, or any other configuration desired. Sectioning is also employed for fuselage components.

To illustrate the designs available and how sectioning can be used to core them, the following hypothetical wing is presented. Such an inverted gull wing, with its taper and thin-sectioned tip, would be virtually impossible to core without

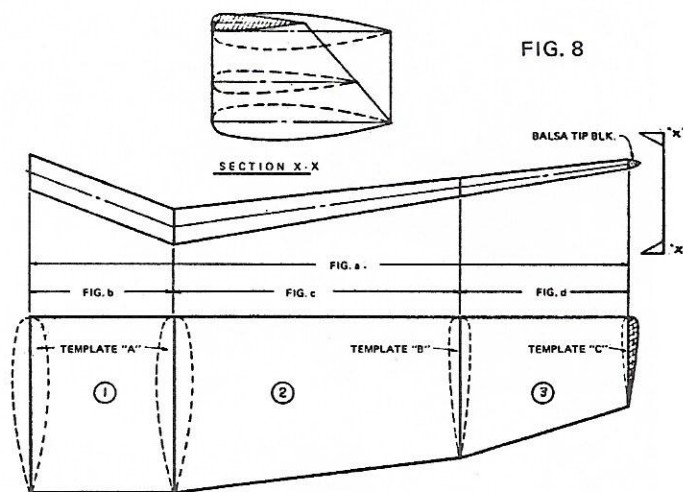


FIG. 8

sectioning. It would, in fact, be somewhat troublesome with balsa.

Figure 8 illustrates a three-view of the wing, with circled numbers indicating the parts required to make it. The completed wing requires six foam sections (three per panel) and two balsa tips.

To make these six sections two identical templates are used for the center section, one for the middle, and another for the outer, or a total of four templates.

Figure 8A illustrates the templates and parts for one wing panel.

Figure 8B illustrates the center section (1) and the two templates and dihedral cuts to form the inverted gull shape.

Figure 8C illustrates the middle section (2). Note that one template for the center section ("A") is combined with the middle section ("B") in this cut.

Figure 8D illustrates the outer section (3) and how templates ("B") and ("C") are combined to core it.

The wing is completed by sheeting the sections, joining, installation of tip blocks, mating the wing halves and finishing. Each joint should be re-inforced with glass cloth and resin or epoxy and tape.

As with the usual RC wing having two panels, a square block before coring will ensure accurate panel mating. Because of the additional joints in a sectioned wing, accurate angles and template position becomes even more critical.

V SHEETING

Because bare foam is extremely vulnerable to physical and chemical damage, some form of protection is necessary. To be most effective, any protective measures will preferably complement the foam wings favorable weight-to-strength, cost, and assembly factors.

With so much having been said of the foam wings strength and durability, the above statement

may seem inconsistent. Clarification lies in bare as opposed to protected foam and an understanding of materials — their function and relation to each other — in a completed wing. These are best realized by appraisal of foam characteristics and compatible materials.

The primary purpose of a core is to create an airfoil shape, to become, in effect, a mold.

Expanded bead foam is an ideal core material because it is easily formed and will retain a form indefinitely. Being impervious to moisture and of extremely light weight, there is no need to remove the core, or mold, from a finished wing. By so doing, we take advantage of another favorable foam characteristic — it's excellent shock absorbent ability.

Our problem, then, is to minimize weak points and exploit the strong. Doing so inevitably results in compromise. We could, for example, cover the core with steel to prevent physical damage but must then cope with weight and adhesion problems. So we compromise with a lighter material, not so strong and offering comparatively less protection but with much lighter weight and reduced adhesion difficulty.

A number of protective materials have been tried on foam cores ranging from chemical coatings to metal sheet. Some of these, though effective, have proven impractical from the standpoints of cost, application, and availability. Sprayed mixtures of white glue and water or thinned epoxy have also been tried and may be worth consideration by the home builder, but appear most suited for very light aircraft.

Glue coatings, though sometimes an effective chemical barrier, offer little tensile strength or rigidity to a wing and are consequently not recommended for typically larger RC aircraft. The detrimental effects of such coatings can be overcome to an extent by employing layers of silk or tissue, but rapidly increasing weight and the time involved negate most benefits. Metal sheeting, though somewhat better, is usually more costly, presents adhesion problems, and is chiefly of an esthetic value.

As of this writing, the most practical protection for foam cores is either balsa, hardwood veneer, or cardboard. Another material, plastic sheet, is being used by some kit and pre-fab manufacturers but has not, as yet, found much favor in the home shop.

Balsa is probably the most widely used covering material at present due to familiarity of the builder with it and easy availability. Though well suited for core sheeting, there are drawbacks. Balsa has become increasingly expensive, one might even say exorbitant, and promises to become more so. The average aircraft wing requires somewhere in the vicinity of ten square feet of sheeting. This means that in addition to cost the builder is faced with butt-joining a number of smaller sheets. A third disadvantage of balsa is the sanding, filling, and multi-coated finishes required to produce an acceptable product.

Certain types of cardboard, besides being much cheaper than balsa, offer many advantages over it. Cardboard as a foam wing covering is becoming increasingly popular and may in time

largely replace balsa for this application.

Hardwood veneer, though admirably suited for wing covering, has enjoyed relatively little popularity because of high cost and somewhat limited availability. However, the builder desiring an exceptionally rugged wing would be well advised to consider its use.

Once a covering material is selected, some means of securing it to the core must be found which leads to the field of adhesives. And here we find that although countless types of glues and cements are available, few are suitable for use on foam wings. The primary concern here is that any adhesive used will not destroy foam. This requirement narrows the field considerably. Secondary, but equally important considerations, are strength, weight, drying time and ease of application.

Because of their successful use by numerous builders and wide availability, two contact cements are specifically recommended in this chapter. One, marketed under the trade name "Core Grip," is a brush type cement of rather heavy consistency which dries to an extremely light weight. This product is manufactured for, and distributed through, hobby outlets. The second is a spray adhesive known as "Scotch-Grip 77." Manufactured by the Minnesota Mining and Manufacturing Company for the commercial and industrial markets, it is widely available through hardware and industrial outlets. Use of each will be evident on the following pages.

This chapter will consist of two parts describing the most widely used covering materials — cardboard and balsa. Two wing designs are illustrated in the photos, one of constant chord and the other tapered. Covering procedures are similar for both and alternatives noted.

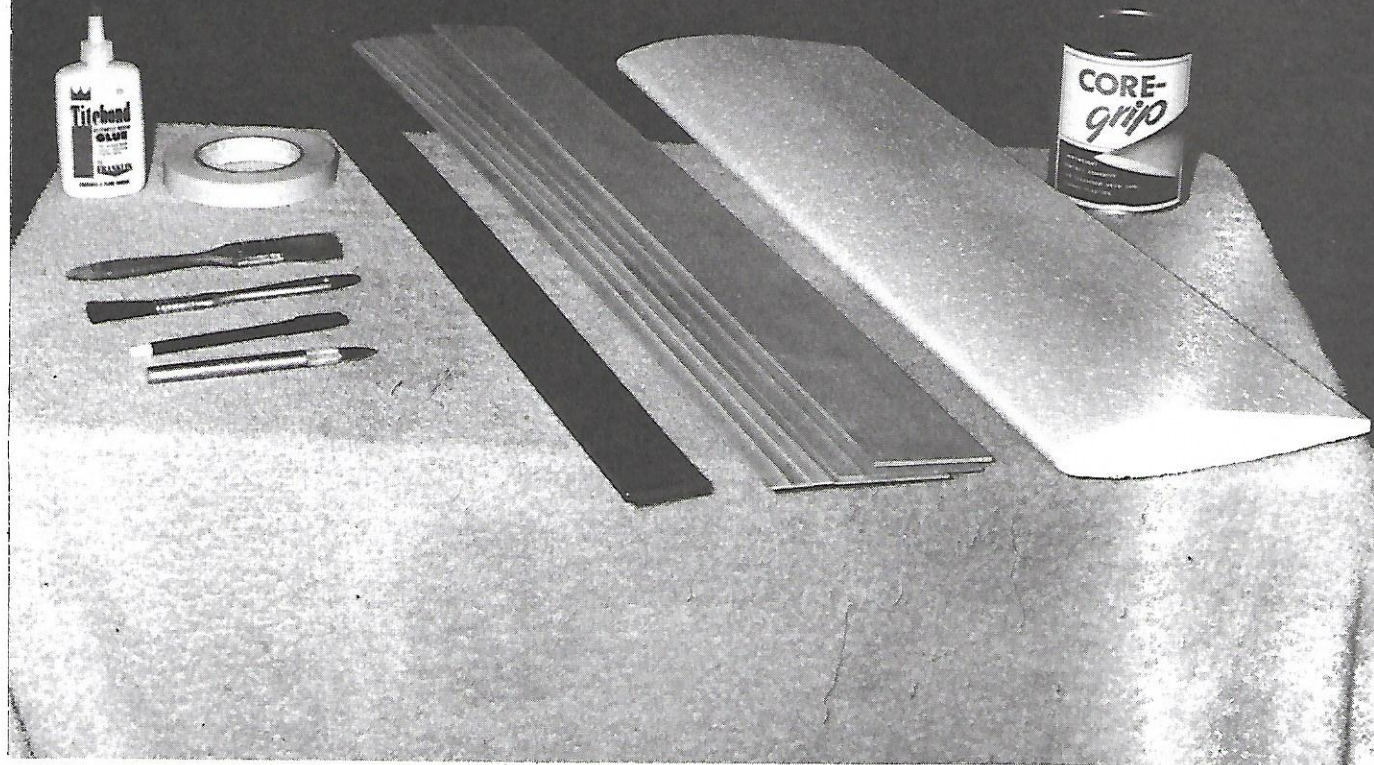
Though wing covering is actually a simple operation, it must be remembered that the best cores can be quickly rendered useless by poor covering jobs. Care by the builder in sheeting, as in all other phases of foam wing construction, will enable a pilot to realize the foam wings full potential.

Balsa Sheeting

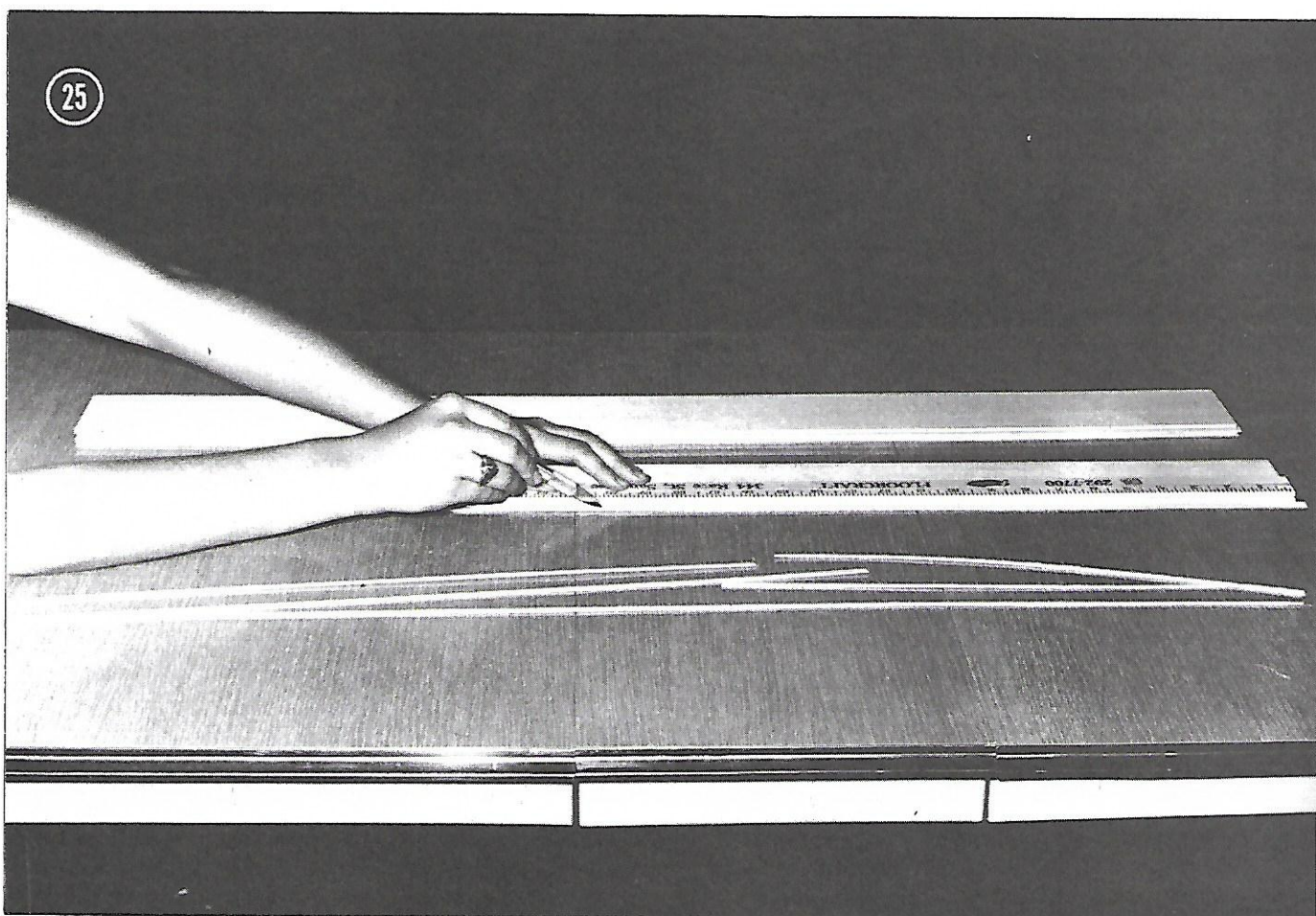
The first requirement for balsa sheeting is a flat work surface. Though foam cores are, or should be, accurate in all respects and perfectly straight, a warp can be built in while sheeting. In some instances this may be a desirable trait, but is not usually needed or recommended. Any warp — or wash-out — should be incorporated in the core itself and not required by sheeting.

Covering is begun by selecting the amount of balsa as dictated by core size. For instance, a thirty by eleven inch panel would require a covering of approximately 24" x 32" as a minimum to allow

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for ample coverage and trimming. As balsa sheets this size are not available, a number of smaller sheets must be butted together. The most desirable balsa for this purpose is 1/16" contest grade of varying widths.

For the leading edge select a four inch width of soft, pliable material. This results in less tension on the bonded edges and minimizes pull-away tendencies at these points. A pliable sheet also reduces the possibility of cracking when the sheet is formed around the leading edge of the core.

The balance is made up of either four or three inch widths. As a general rule, it is advisable to select wider sheets as fewer seams will result. However, rising balsa prices may influence sheet selection and warrant the additional seams and work involved in joining them. But, regardless of number, each seam must be tight to prevent dope or paint solvents seeping through to the foam.

Sheet preparation is determined by which of several alternate methods will be used to cover the core. Those most commonly used are the wrap-around or three-step.

As the wrap-around method is illustrated in the section on cardboard covering, the three-step method is used here as well as skin preparation for it. The chief difference in skin preparation for the two methods is that all sheets are joined for wrap-around.

Photo #24 shows a foam core, an assortment of balsa sheets, and tools required for covering. The panel has a thirty inch span and eleven inch chord. It will be covered with 1/16" balsa of the following widths:

- 1 each 4" leading edge sheet.
- 2 each 4" sheet — one top and one bottom.
- 4 each 3" sheets for balance of top & bottom.

The balsa sheet skin preparation is begun by selecting one four and two three inch sheets. These are laid flat on the working surface. With a sharp X-acto or razor blade and straight edge, all edges are trimmed straight as shown in photo #25.

One of the three inch sheets is then butted to the four inch and, after making sure the joint is a flush mate, tape is run along the seam. The result should be a near invisible joint. Either scotch or ordinary paint masking tape may be used. The last three inch sheet is butted and taped to the remaining edge of the three inch sheet previously joined. See photo #26.

The sheet is then turned over and supported with one hand under the center in such manner that the seams open up and Tite-Bond glue beaded the length of each. The sheet is now turned over and laid flat on the working surface to close the seams and all excess glue removed with a squeegee or razor blade.

The assembled sheet is now laid aside to dry. Weights can be used to hold it flat if required. A second identical sheet is prepared in the same manner. Photo #28 shows all panel sheeting

assembled and drying.

While waiting for the sheets to dry, the wing tip and trailing edge strips are attached to the core. 1/8" balsa sheet is adequate for 45 degree wing tips. If the wing were to have rounded tips, balsa blocks would suffice and be attached and contoured after covering was completed. Balsa strips, of a size dictated by the wing, are adequate for full span ailerons. Formed trailing edge stock is usually employed in place of strips for conventional, or in-set, ailerons.

Wing tips are best attached with contact cement for the 45 degree type and epoxy for round. Trailing edge strips can be attached with Tite-Bond and held in place with masking tape while drying. Refer to photos #29 & 30.

Leading edge installation is begun by marking its location on the core. This is most easily done by wrapping a four inch piece of cardboard around the leading edge at each end, marking, laying a yardstick flush with the marks, then drawing lines across the core on both top and bottom. See photos #31-a, b, & c. These lines aid glue application and sheet positioning.

By the time the preceding steps are completed, the skins should have dried and be ready for sanding as shown in photo #32. This pre-sanding of wing skins is an important step if an above average finish job is desired, as it removes ridges and any grain swelling usually present on a balsa sheeted surface. A small orbital sander such as the Sears unit shown makes skin sanding as well as trailing edge, wing tip contouring and a host of other sanding jobs much quicker and easier than if done by hand.

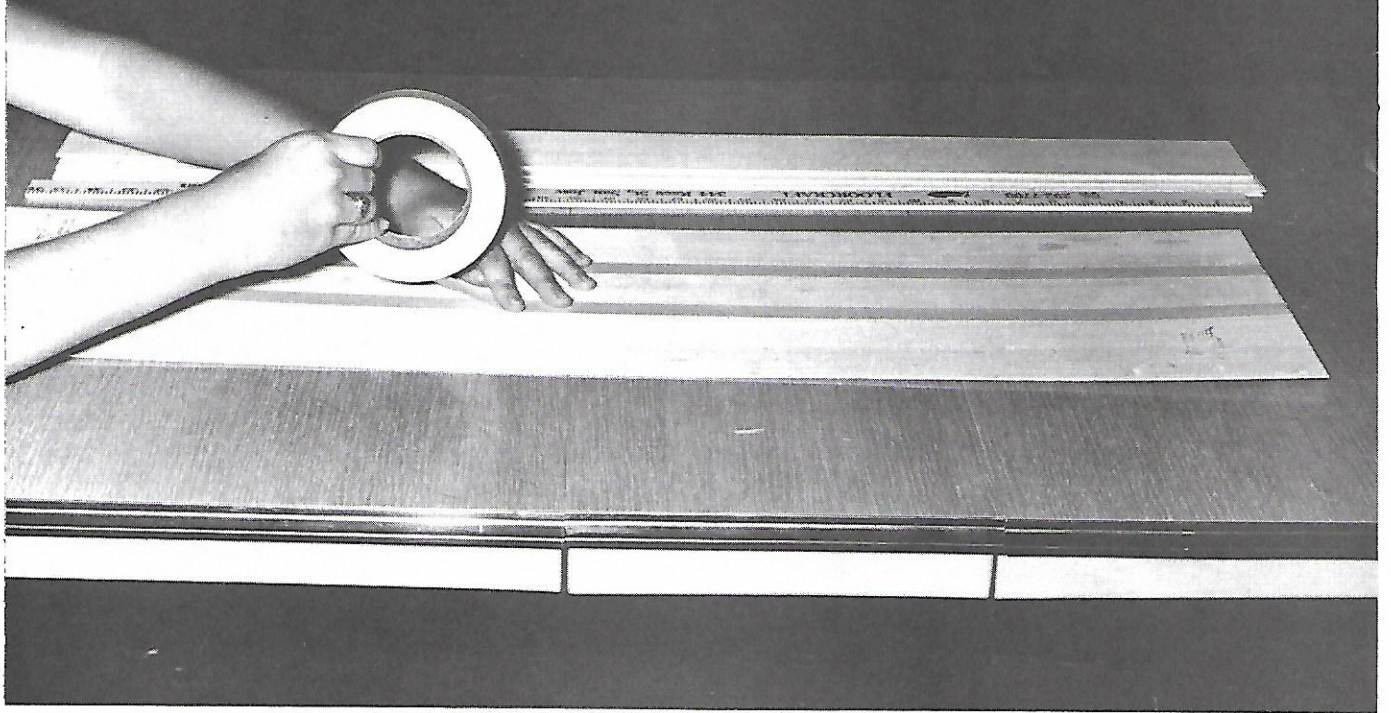
After skin sanding, and following directions on the can, contact cement is applied to one side of the leading edge sheet and the core area it is to cover. Wax paper or Saran Wrap laid under the parts as shown in photo #33 will help keep cement off the working surface. It is extremely important that ample time be allowed for solvent evaporation before preceding. Failure to do this may result in trapped vapors and possible foam damage.

Now, with the core lying flat on the work surface, match one edge of the leading edge sheet with a guide-line previously drawn across the core. Run the fingers back and forth, spanwise, to assure complete adhesion and eliminate possible air gaps, stopping just short of the leading edge. See photo #34.

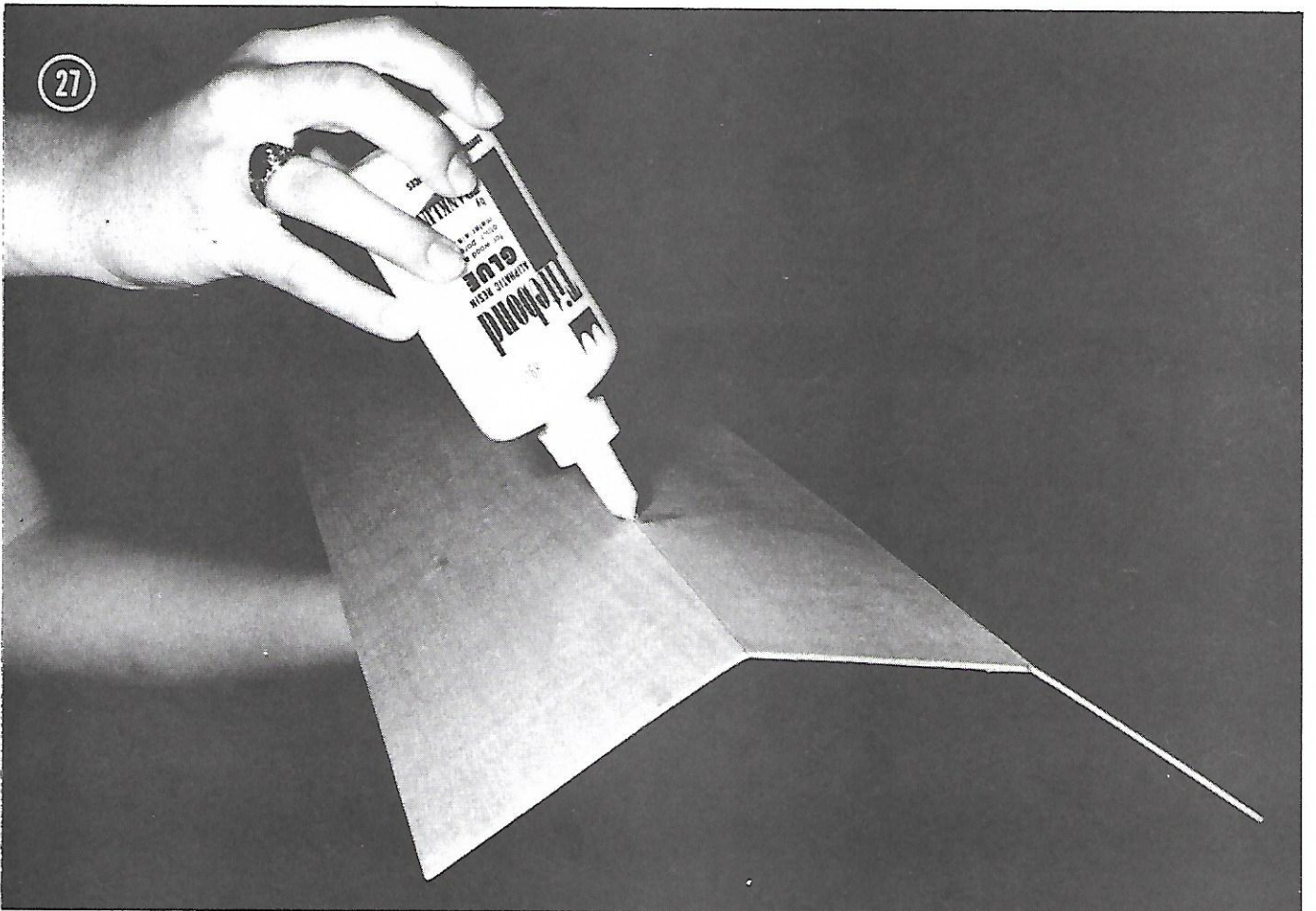
While holding the sheet away from the core to prevent any further contact, moisten that part of the sheet which is to round the core leading edge with hot water as shown in photo #35. Continue wetting and flexing the sheet until it becomes pliable enough to round the core leading edge without cracking.

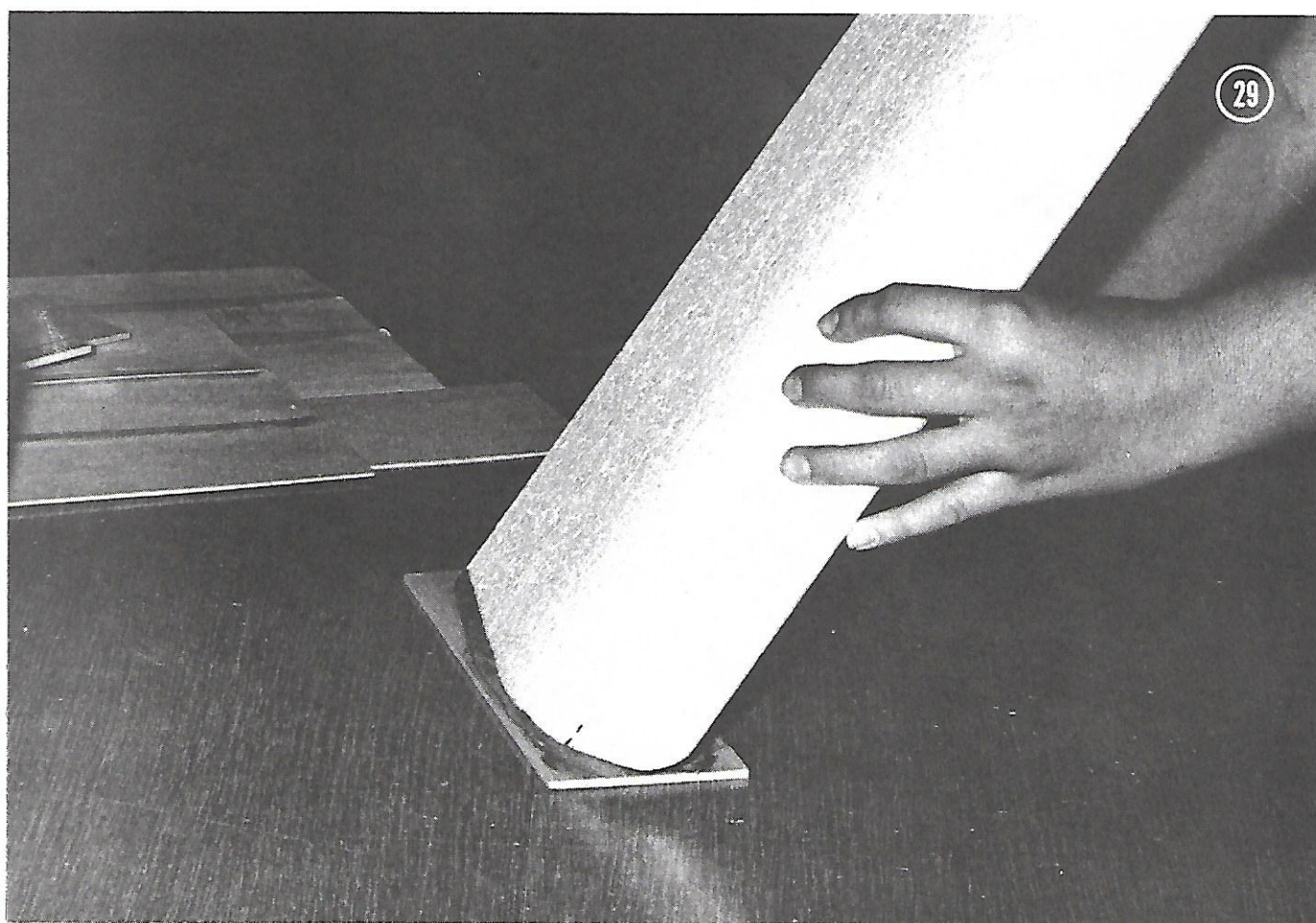
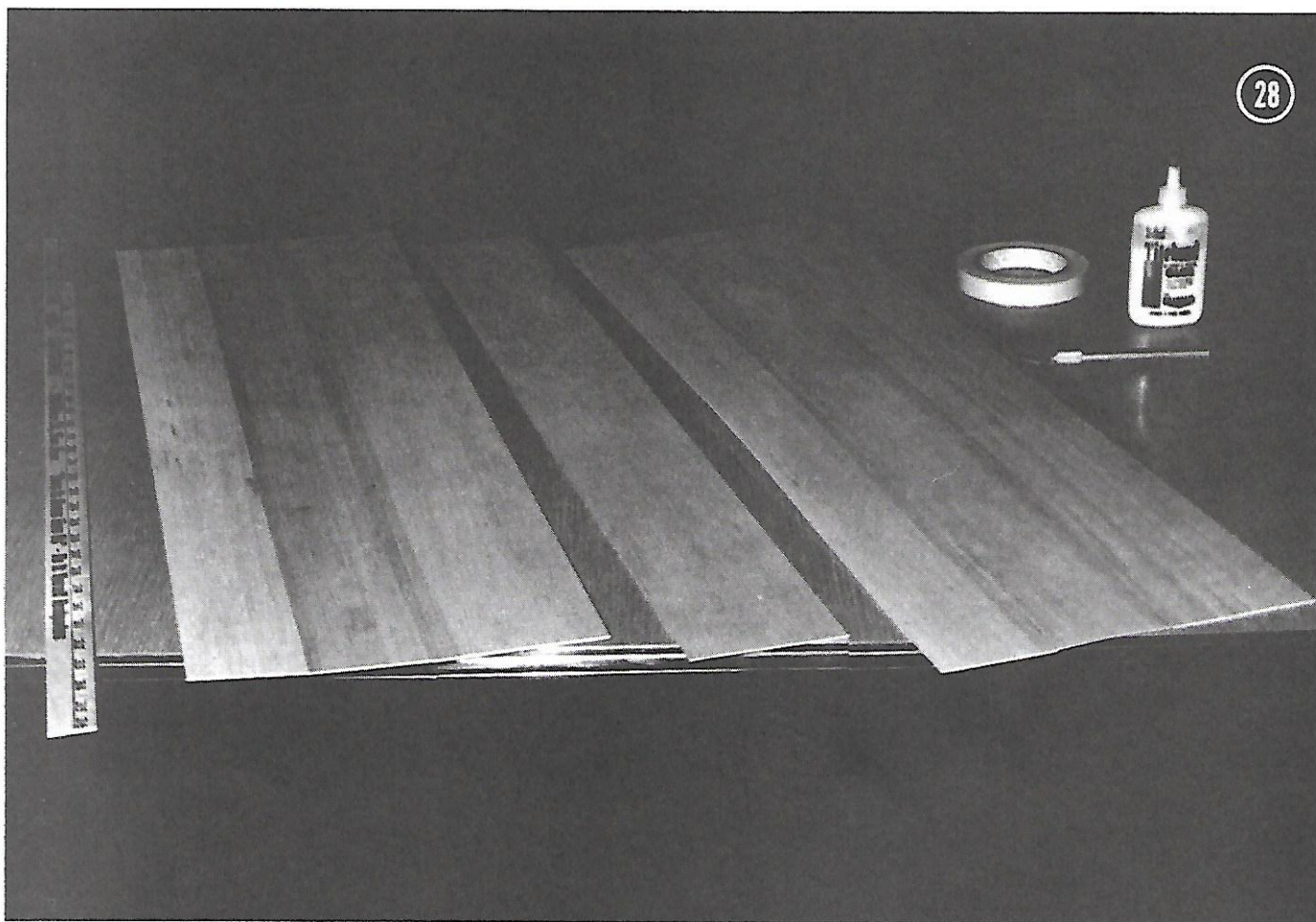
When the sheet is sufficiently pliable, the installation is finished by working the sheet on around the core by running both hands firmly over

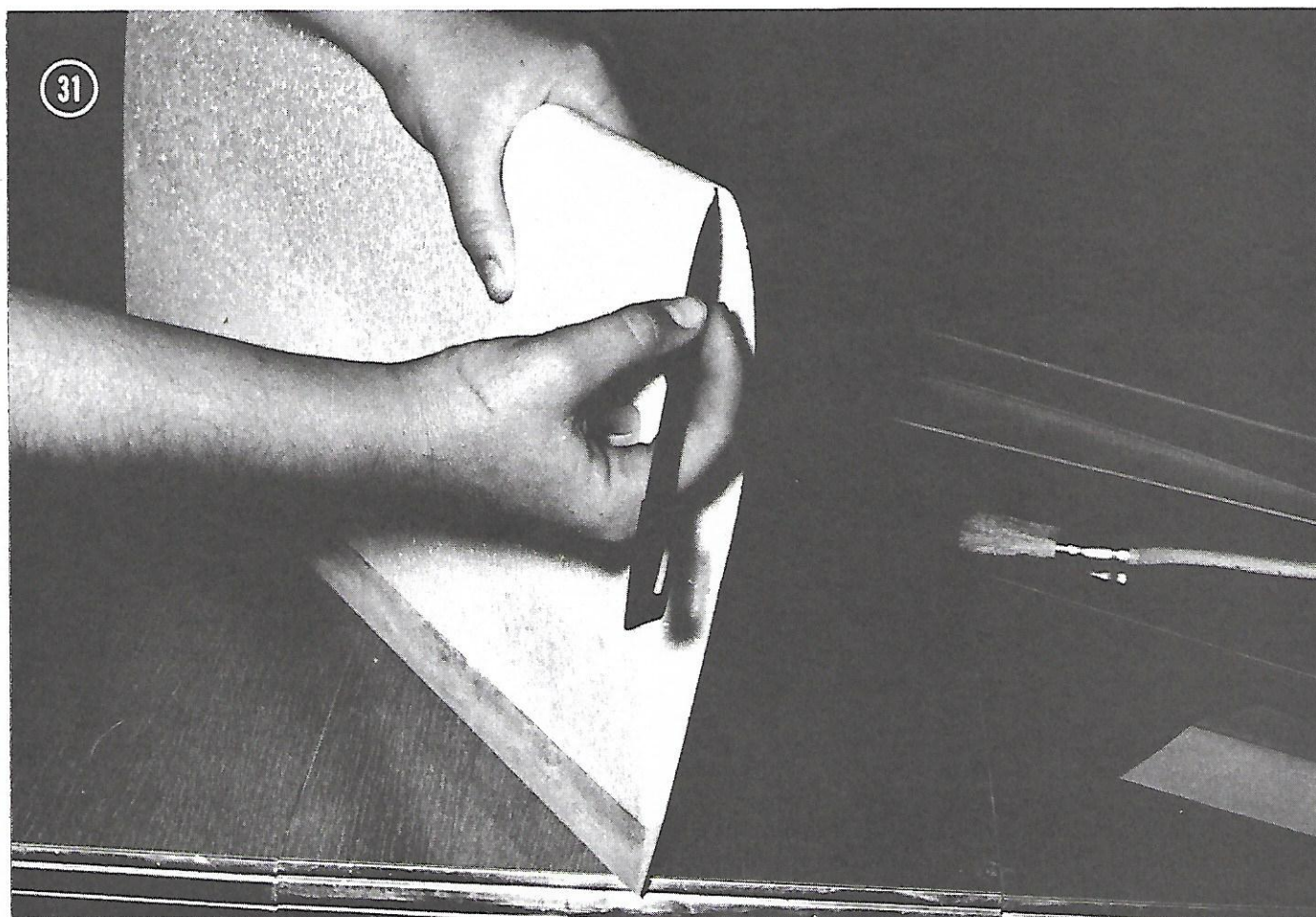
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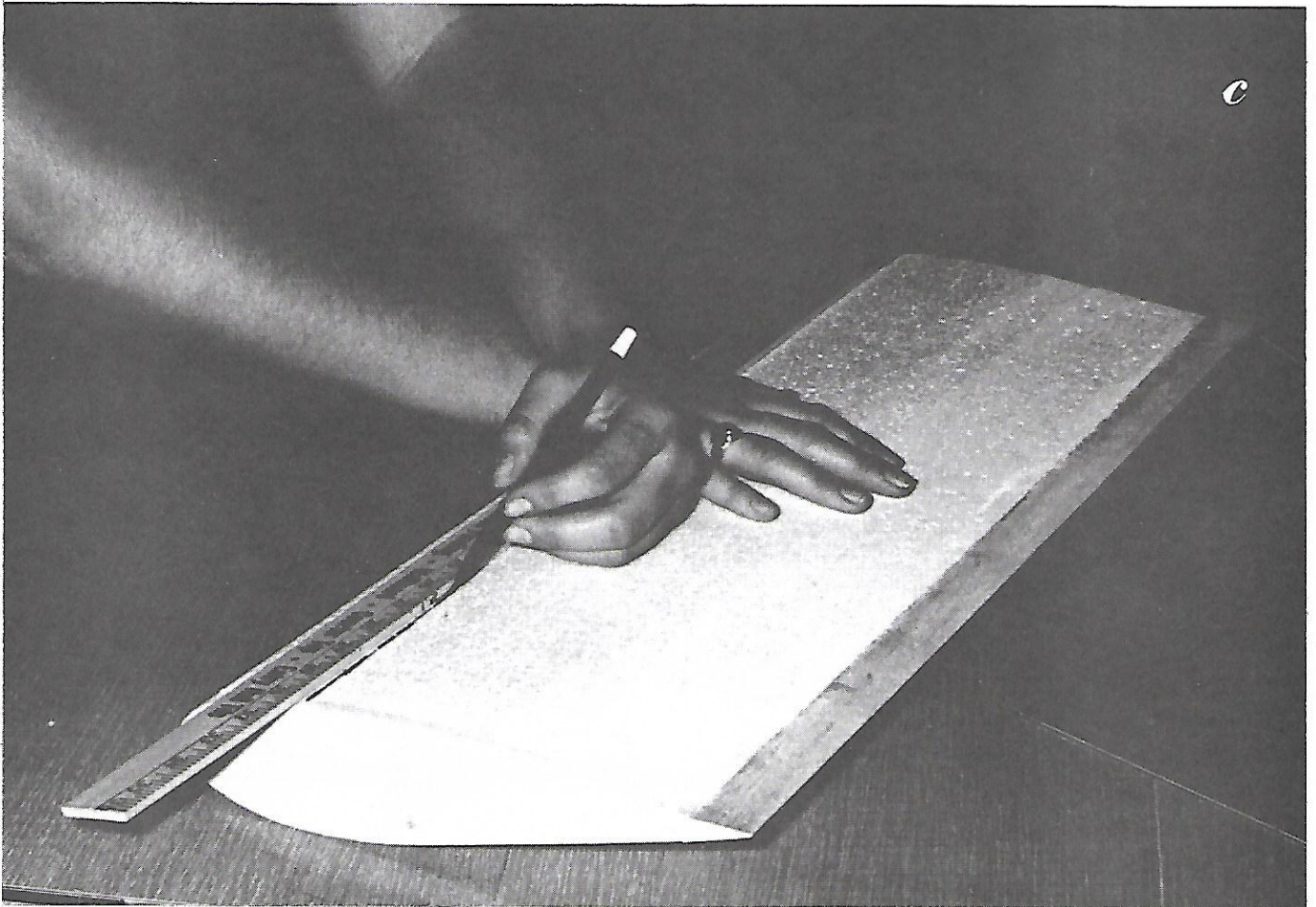
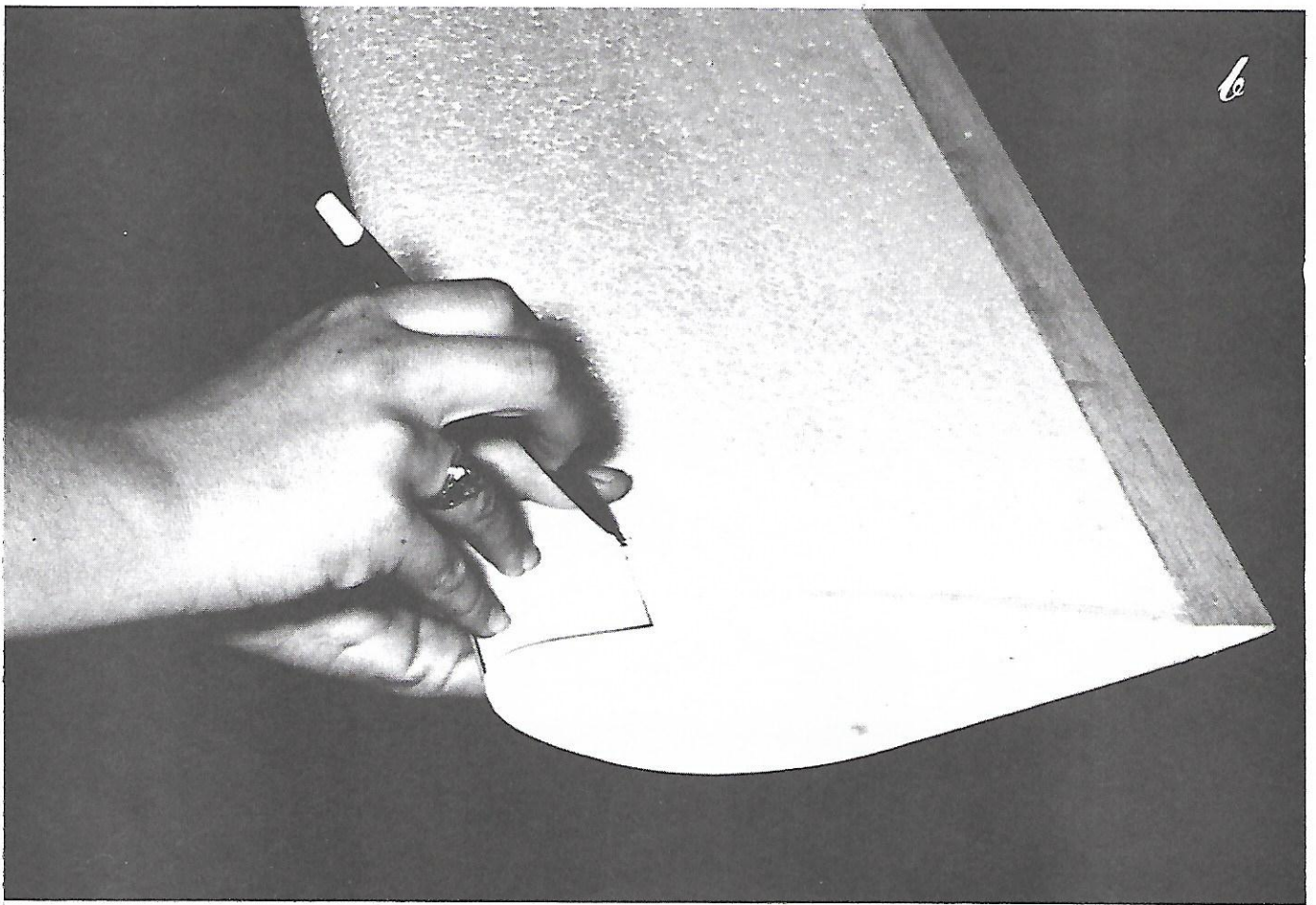


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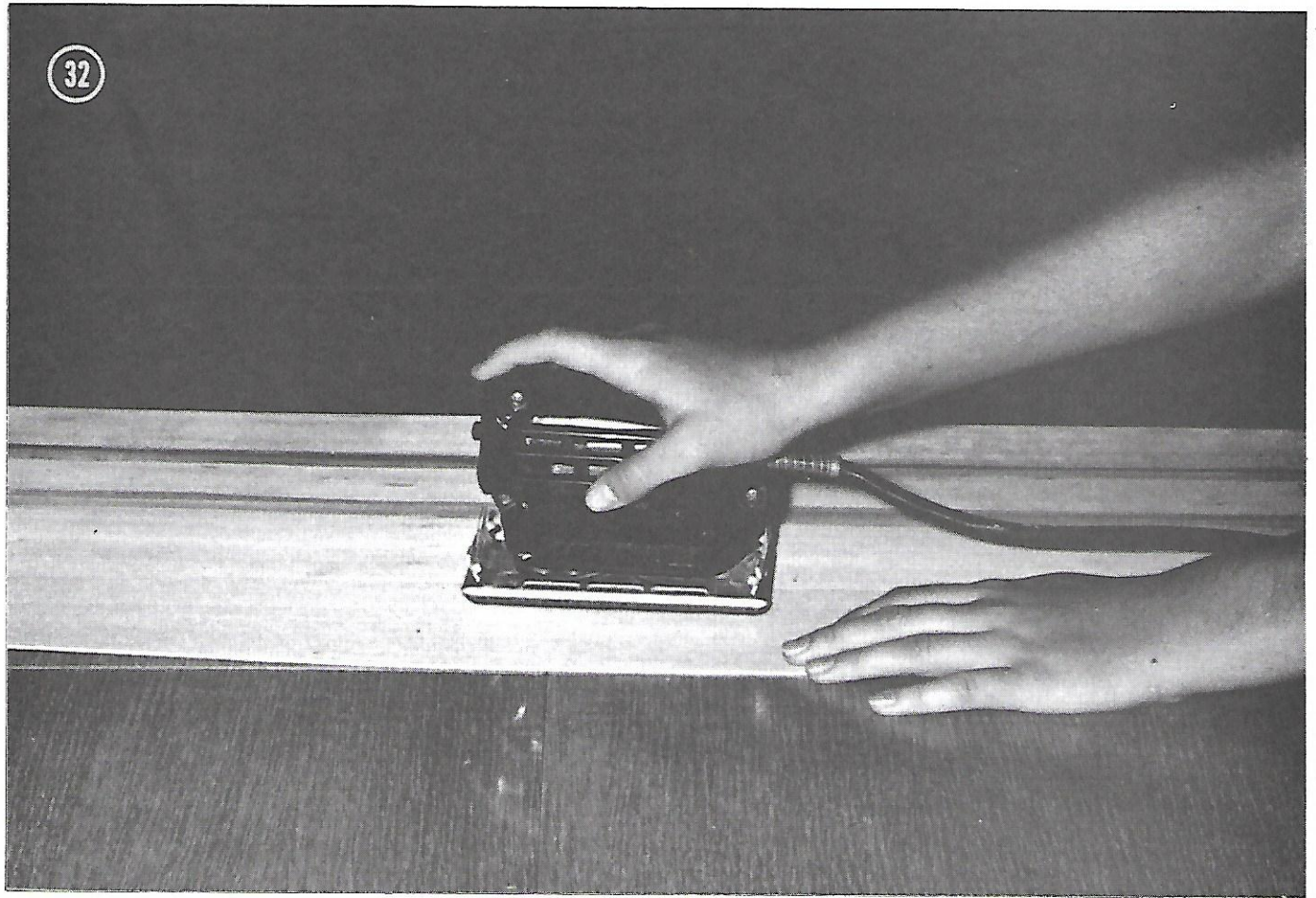




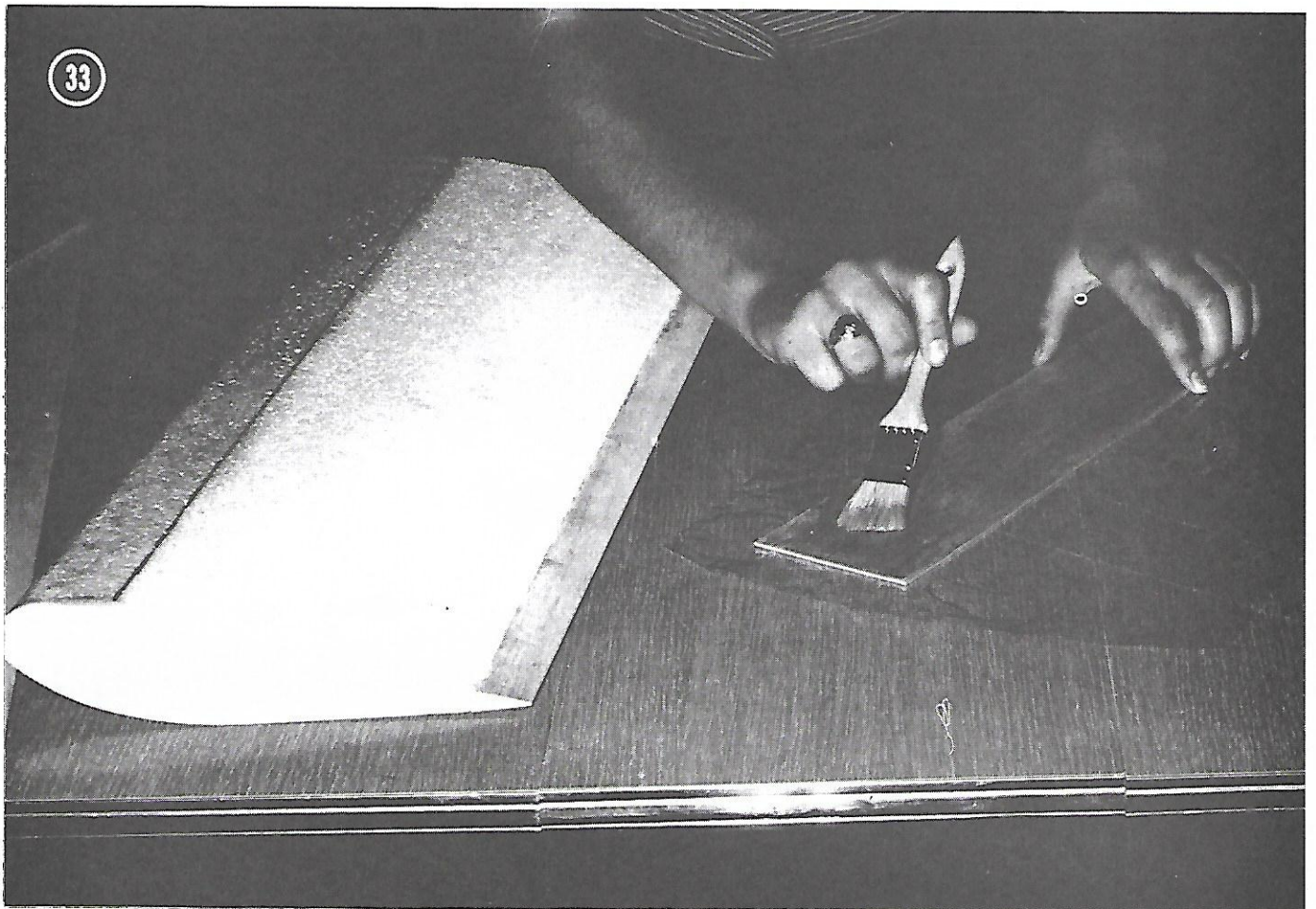




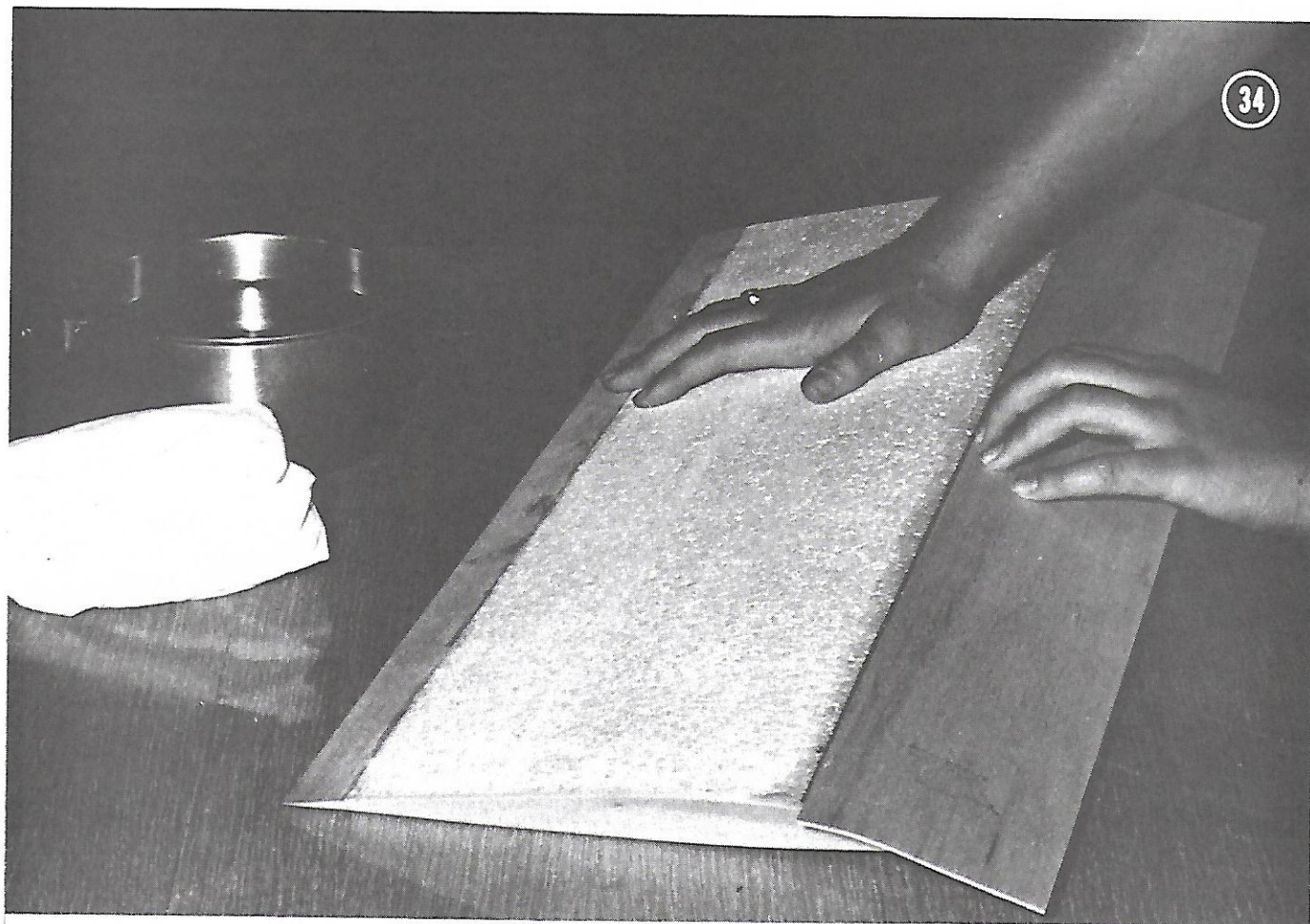
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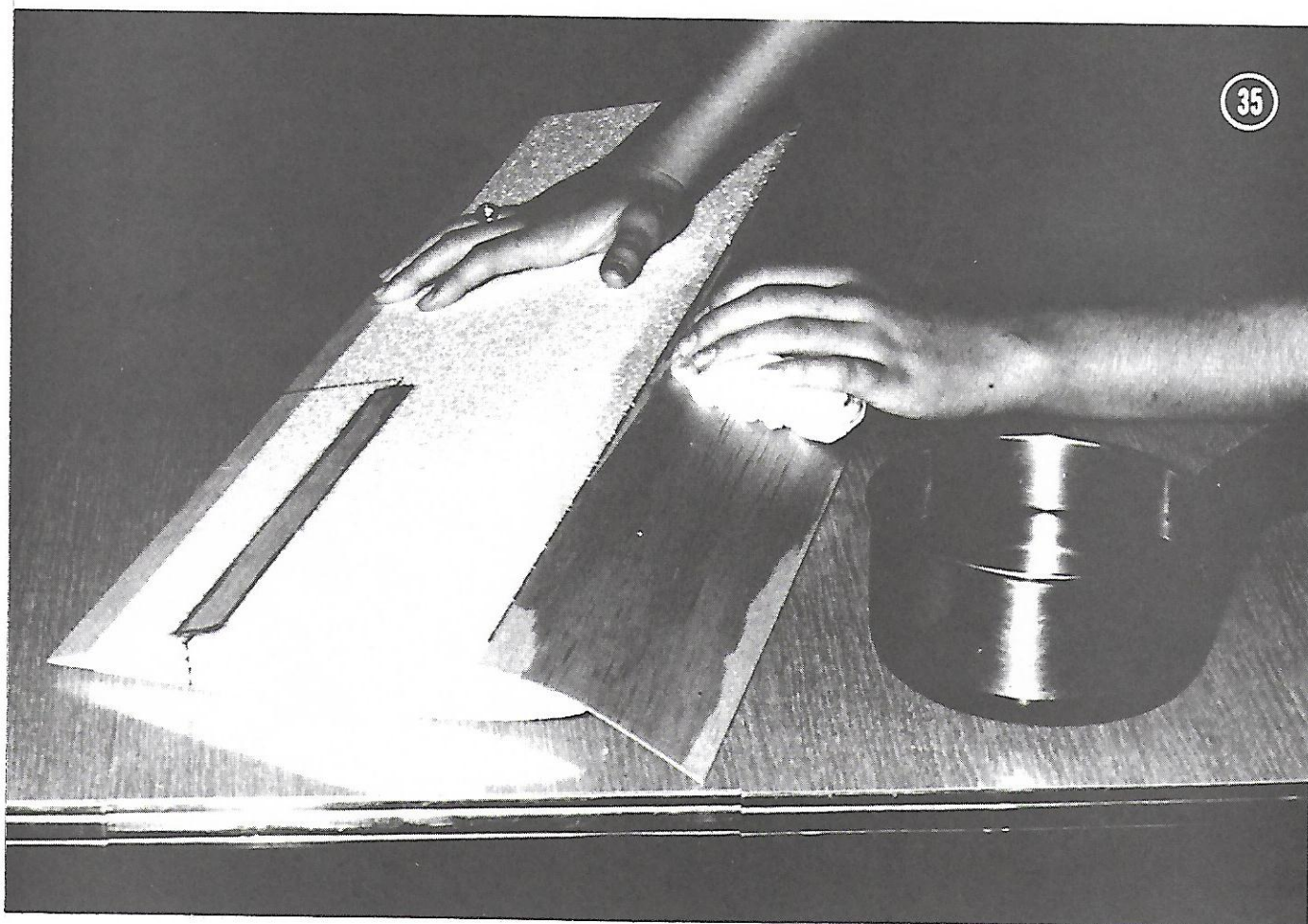
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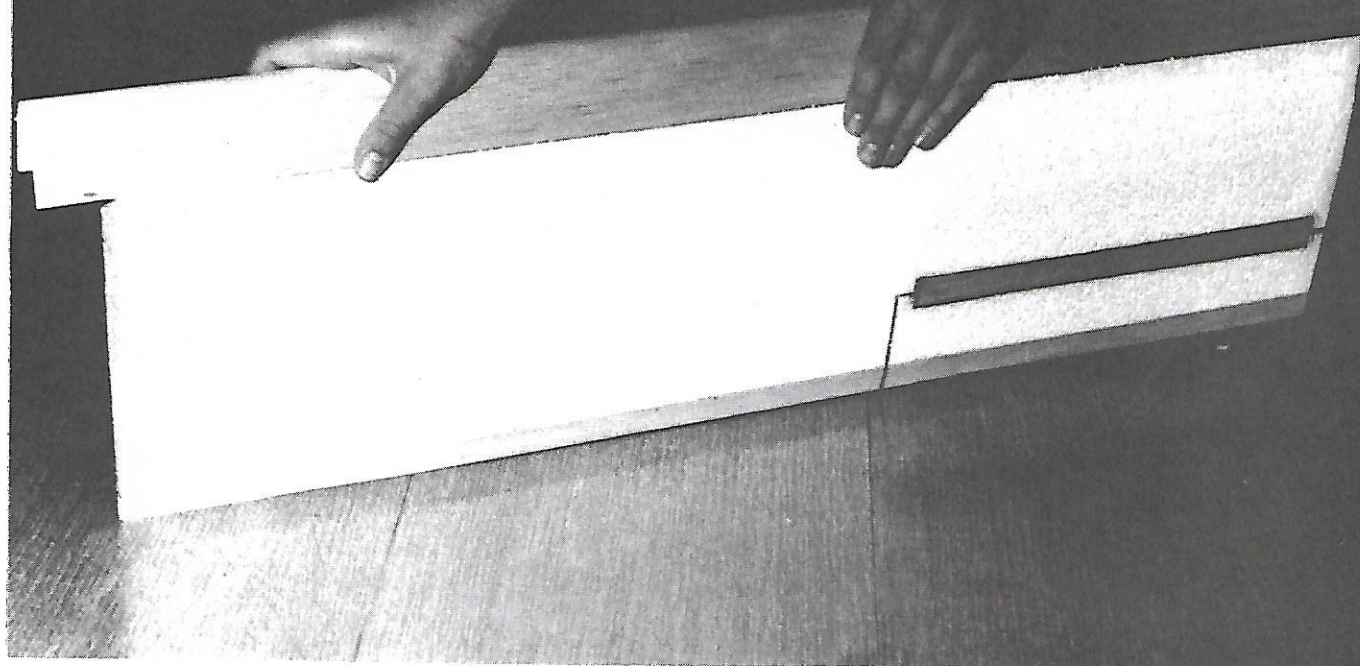
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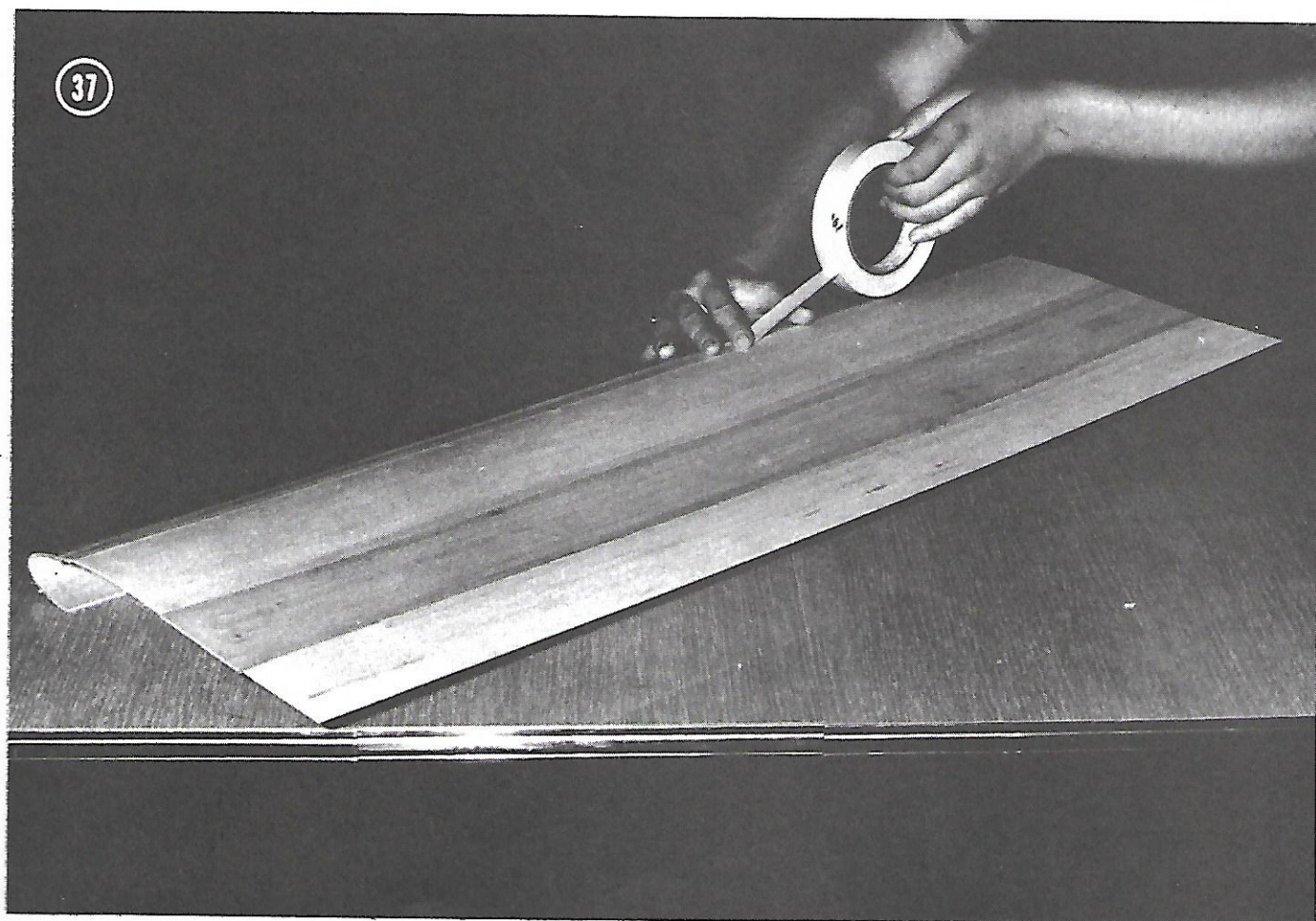
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it as shown in photo #36. It is imperative, especially at the leading edge, that the sheet be in full contact with the core. Any gaps or air pockets will weaken the covering and, if excessive, impair airfoil efficiency.

With the leading edge installed, select one of the two large skins previously assembled and trial butt the free four inch edge against the installed leading edge sheet. After assuring a tight joint, run tape along the seam as was done in skin assembly and shown in photo #37.

Referring to photo #38, apply contact cement to the core and skin. Make certain all surfaces are properly coated but do not apply too much to avoid unwanted weight build-up.

Following solvent evaporation, run a bead of Tite-Bond along the open seam as in photo #39. A light bead is adequate as only enough is required to join the balsa edges.

Before the Tite-Bond dries, close the seam by rolling the skin slowly toward the core trailing edge, running the hand back and forth over it as contact is made between core and sheet. See photo #40.

After assuring complete skin-to-core contact, rough trim away the excess trailing edge sheet as shown in photo #41.

The core is now turned over and the remaining side covered in like manner. See photos #42, 43, and 44. Make sure all sheeting adheres properly.

The panel is completed by trimming and sanding as in photos #45 and 46. The orbital sander is ideal for pre-finish sanding, but finish sanding is best done by hand with fine paper.

Cardboard Sheeting

Cardboard, as a foam wing covering, offers a number of advantages over balsa or hardwood veneer. Foremost of these is economy. Available everywhere from pennies to four or more dollars per sheet, the potential saving is readily apparent.

Because cardboard is a one piece seam-free covering, the filling, sanding, and multi-coated finishes commonly used on other materials is eliminated. It offers a firm, ding-resistant surface and, depending on material used, the finished wing should weigh about the same, or less, than a comparable balsa covered unit.

But, as with any material, there are techniques peculiar to cardboard and requirements to be met. Failure to observe some rather simple rules will likely result in grief.

First, is cardboard selection. Marketed in myriad types under many trade names, the builder should have no trouble finding material. Cardboards similar to that used in file folders or matchbook and menu covers are good as are sign

and art types. Thicknesses approximating that of playing or business cards are most suitable and should have a fairly hard surface. Avoid the porous types (blotters are an extreme example) as weight would suffer because of dope or paint absorption. Such places as stationery or art stores usually stock suitable material or know of others who do.

Because of the rigidity of cardboard, a strong cement is mandatory. Some cements suitable for balsa do not work well with cardboards. A good way to check cement for cardboard is to sheet a scrap panel and let it lay around for a week or so then try to pull it off. Some cements may also require a double coating for proper adhesion.

Cardboards have a grain. This grain must parallel the core leading edge to prevent wrinkles. Not knowing of, or failing to check grain, follows poor or improperly applied cement as the leading cause of poor cardboard covering jobs.

Unfortunately for the builder, many cardboards are factory cut with the grain running parallel to the short side. For example, a sheet measuring 24" x 35" would be ideal for a wing panel 32 inches long if the grain runs the long direction. If it runs the 24", or cross-wise direction, we will surely have a wrinkled leading edge if we use it.

As a preliminary to covering, it is a good idea to attach balsa tip and trailing edge strips or stock just as with balsa skins. Cardboard has been used for 45 degree tips, but balsa does a better sealing job.

After sanding the tip and trailing edge strips to contour, the cardboard sheet is prepared. Cut a piece from one corner of the sheet and mark so it can be returned to it's original position as in photo #47.

Referring to photo #48, fold this piece so it approximates the core leading edge. If in doubt, keep folding until nearly flat or a crease develops. Fold in both directions. When a wrinkle(s) appears, you are bending cross-grain. Return the piece to it's position on the sheet, noting grain direction.

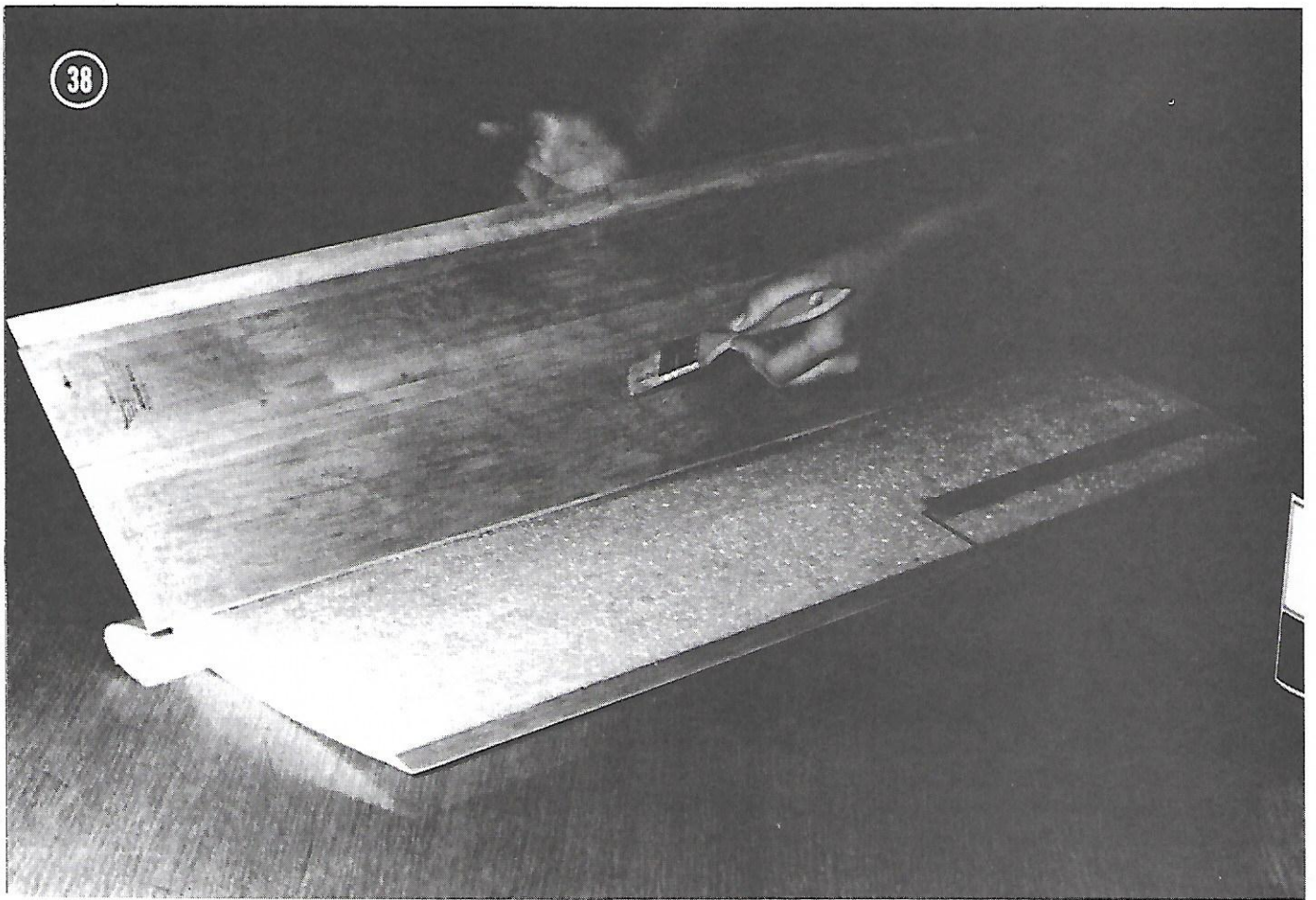
With a yardstick, draw a line across the middle of the sheet indicating grain direction as in photo #49.

Now mark the center line of the core leading edge at both tip and root so the marks are visible with the core resting on it's leading edge. See photo #50.

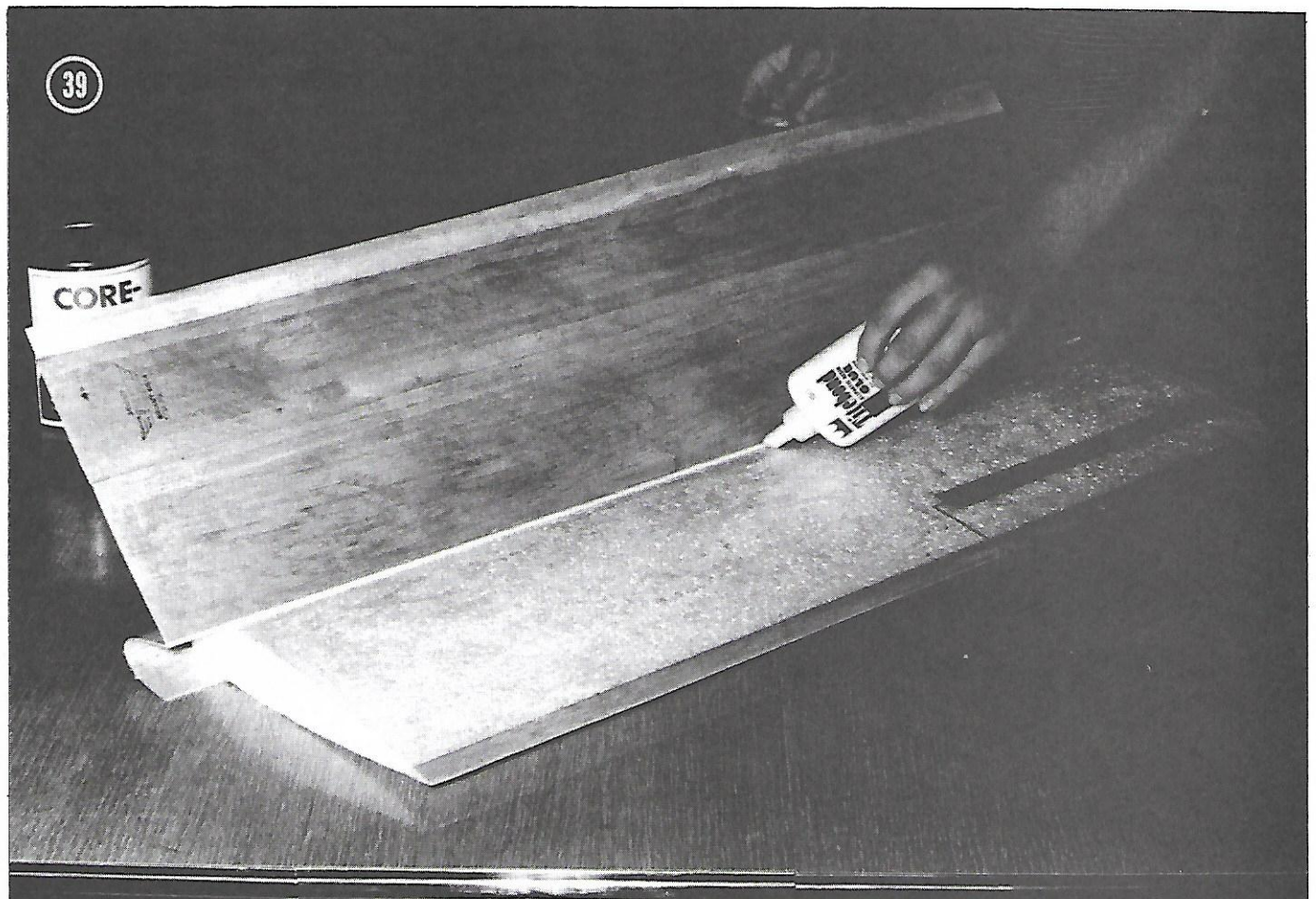
The next step depends on wing design. If the core is a straight constant chord type, the following paragraph need not apply. For the more complex wing, like that illustrated in the photos which has a full symmetrical root, semi-symmetrical tip and is tapered with a three degree wash-out, this additional step is recommended.

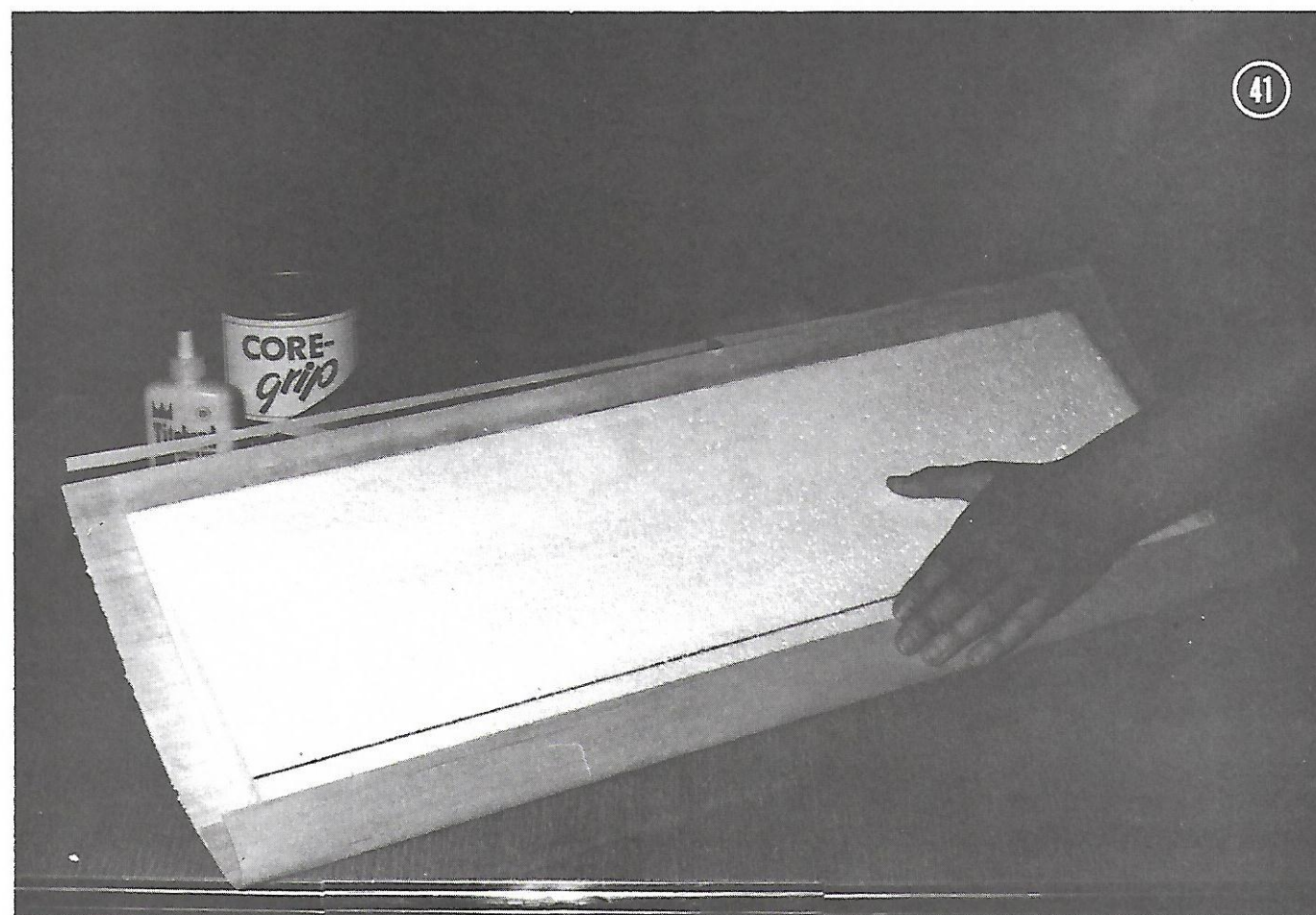
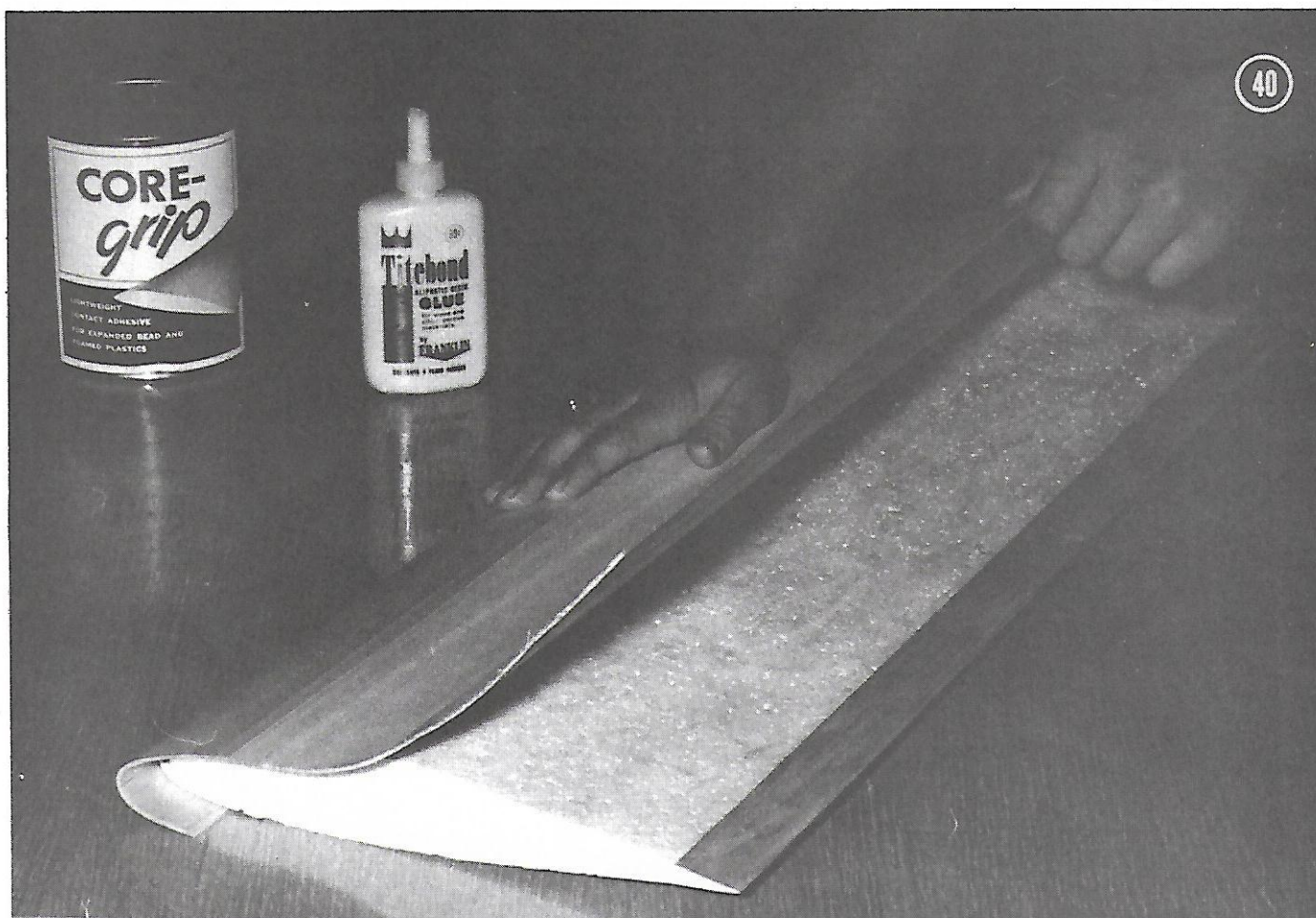
Rest the core leading edge on the sheet so its center marks are aligned with the grain direction line on the sheet as shown in photo #51.

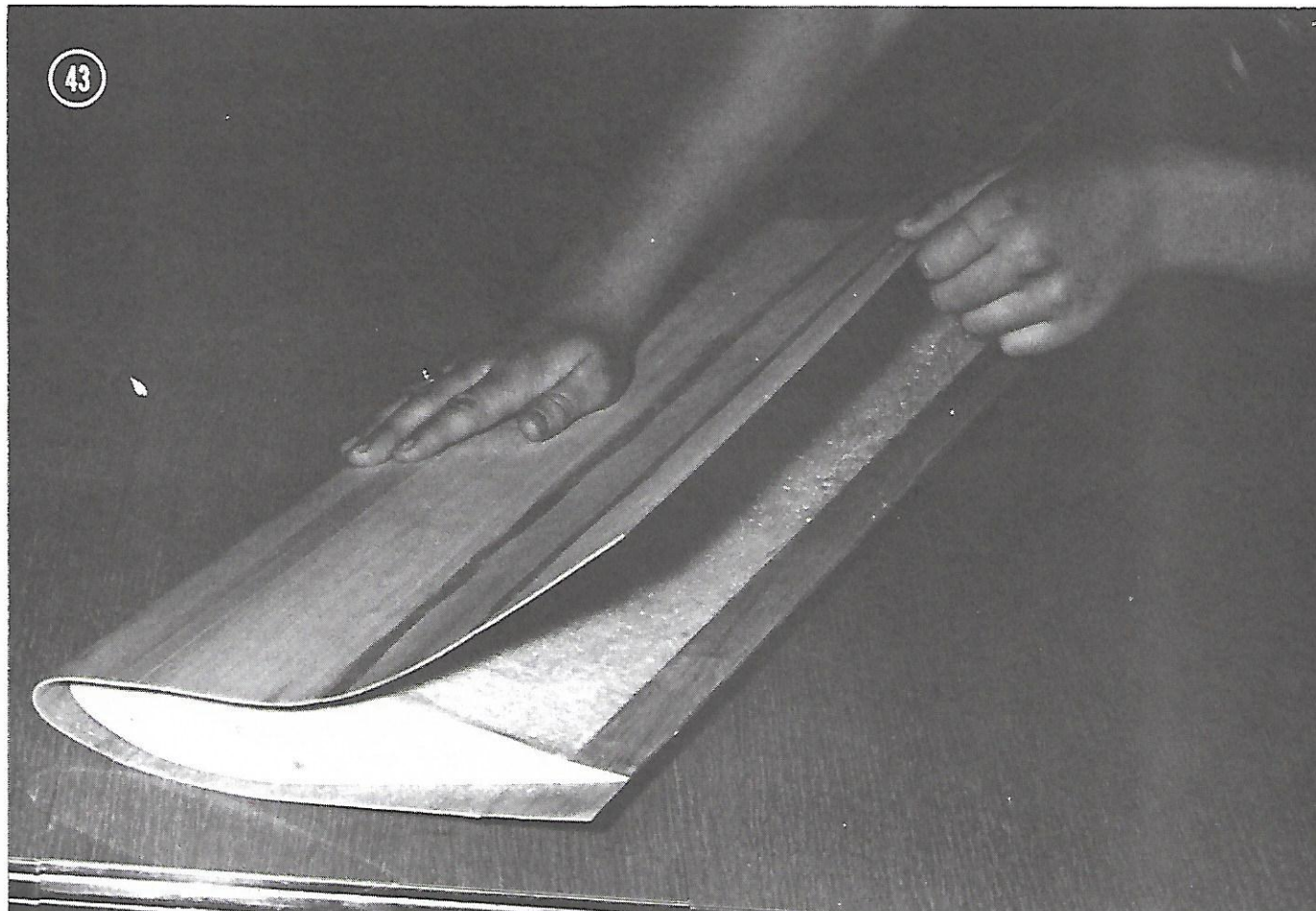
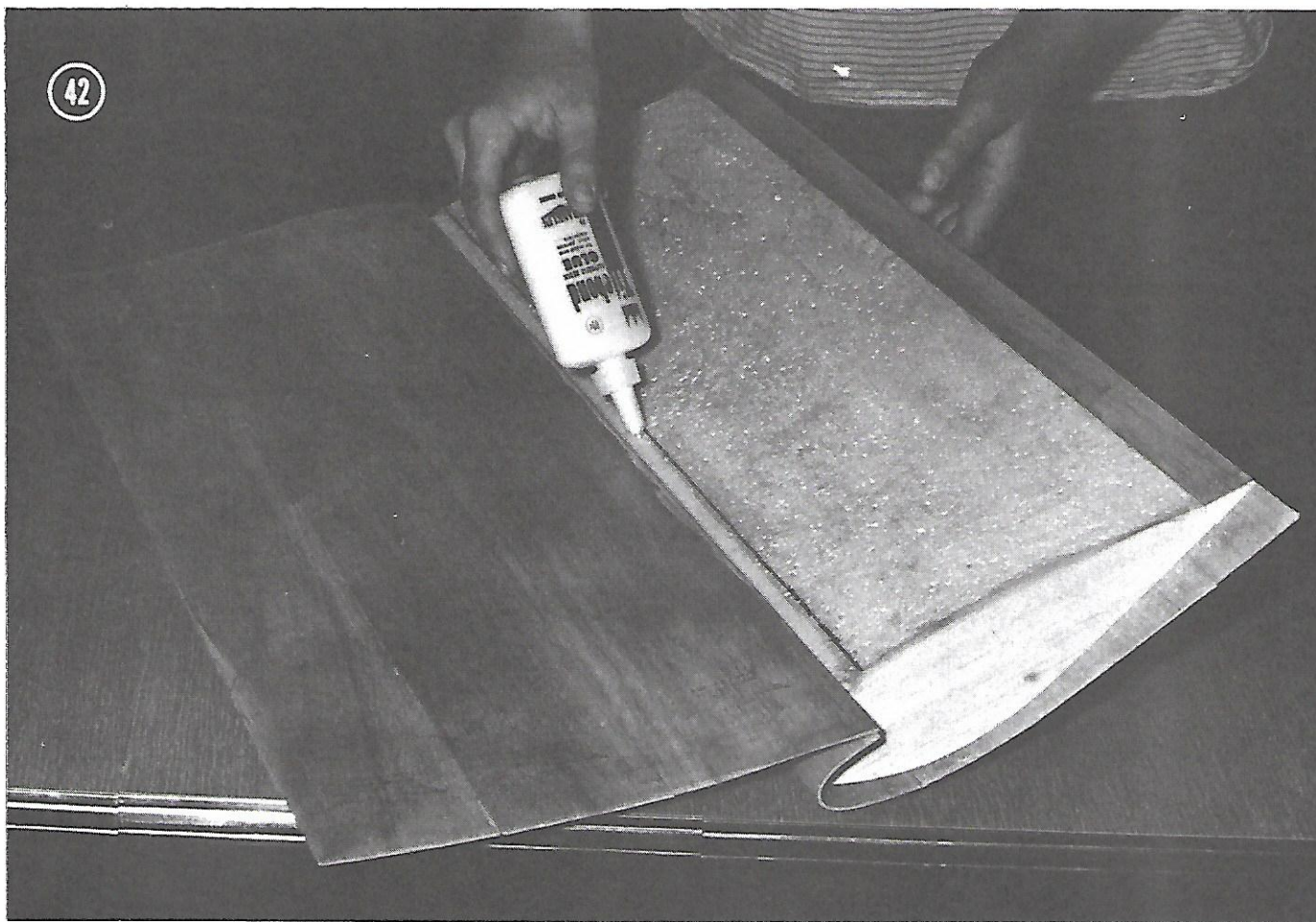
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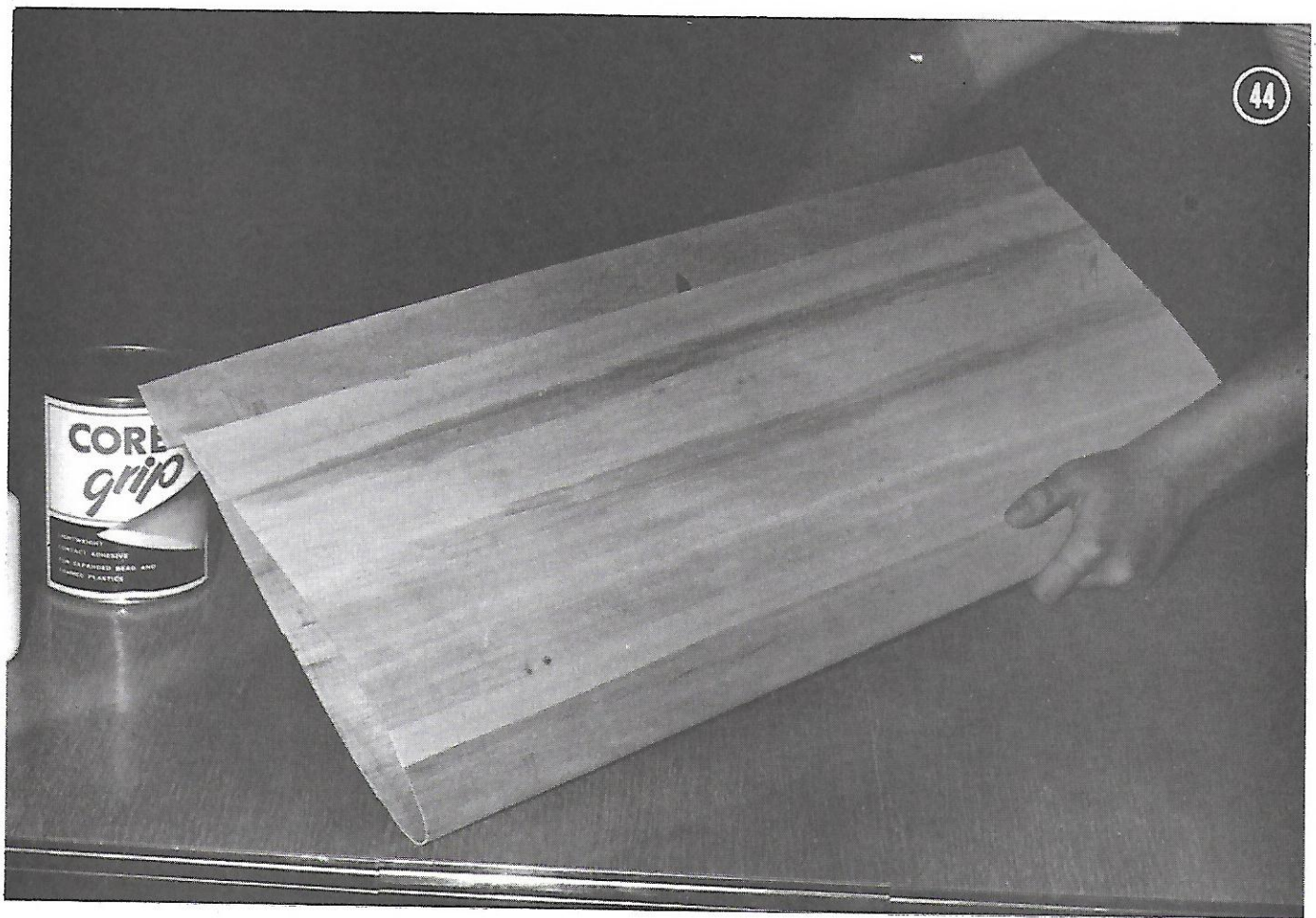
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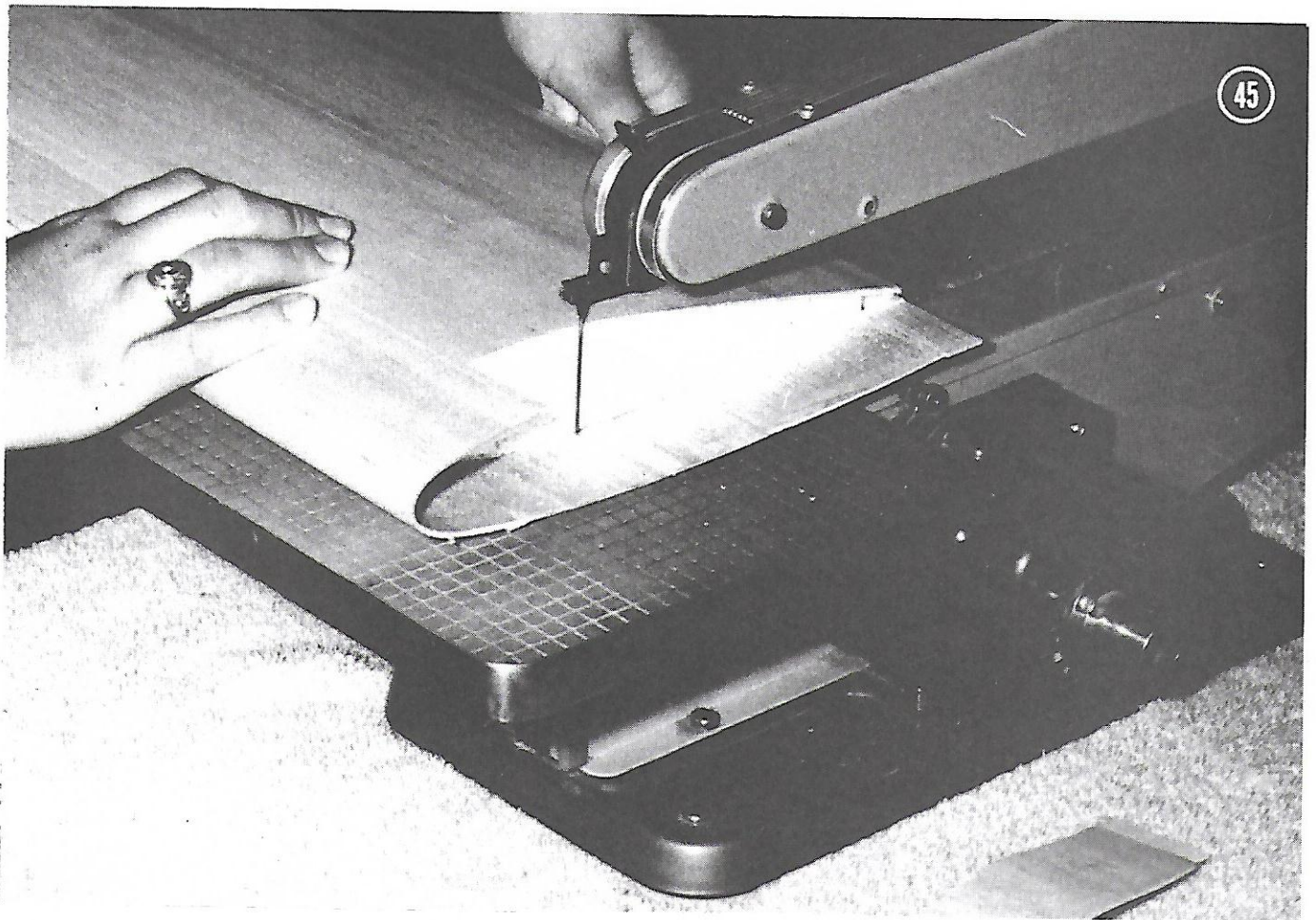




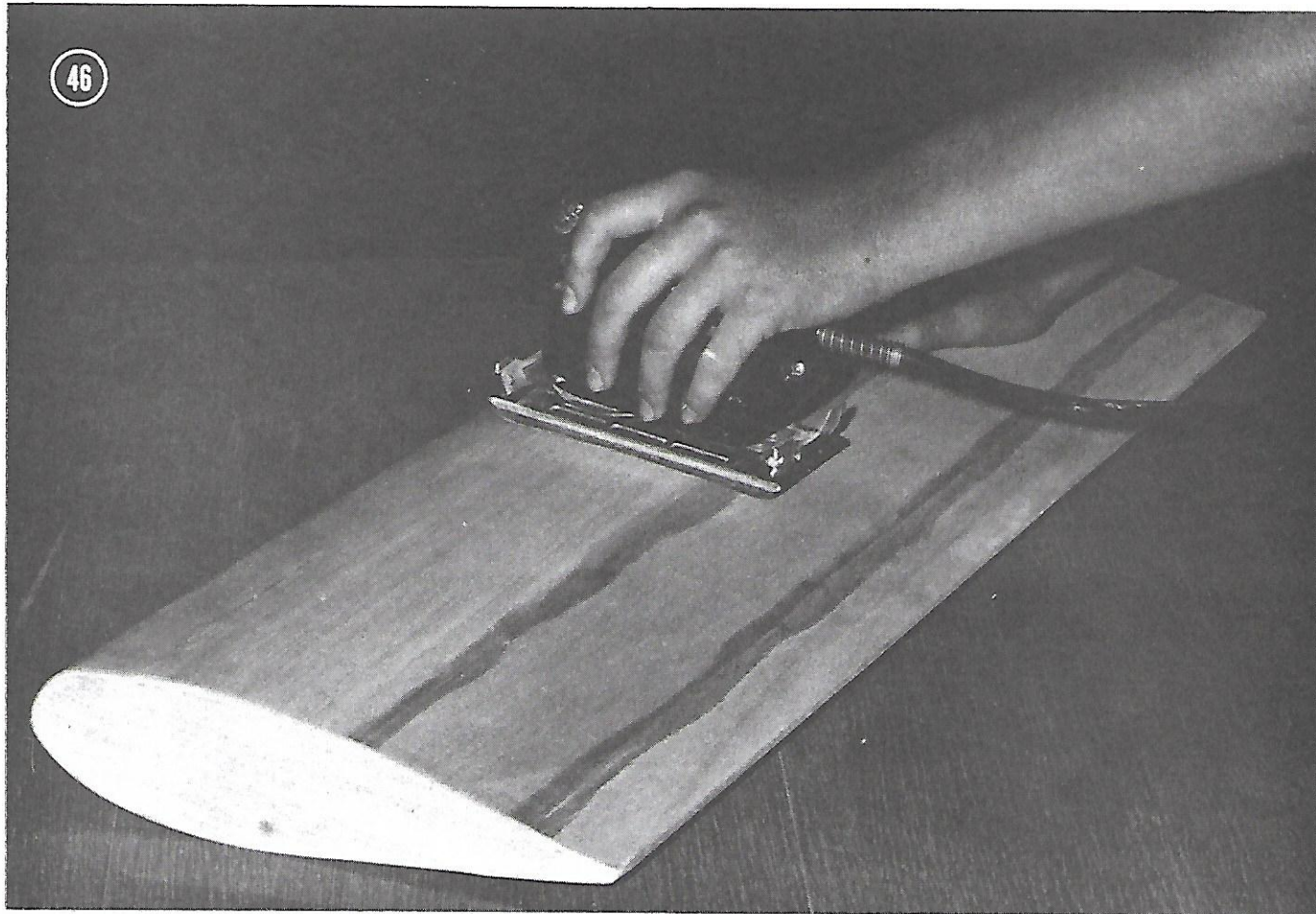
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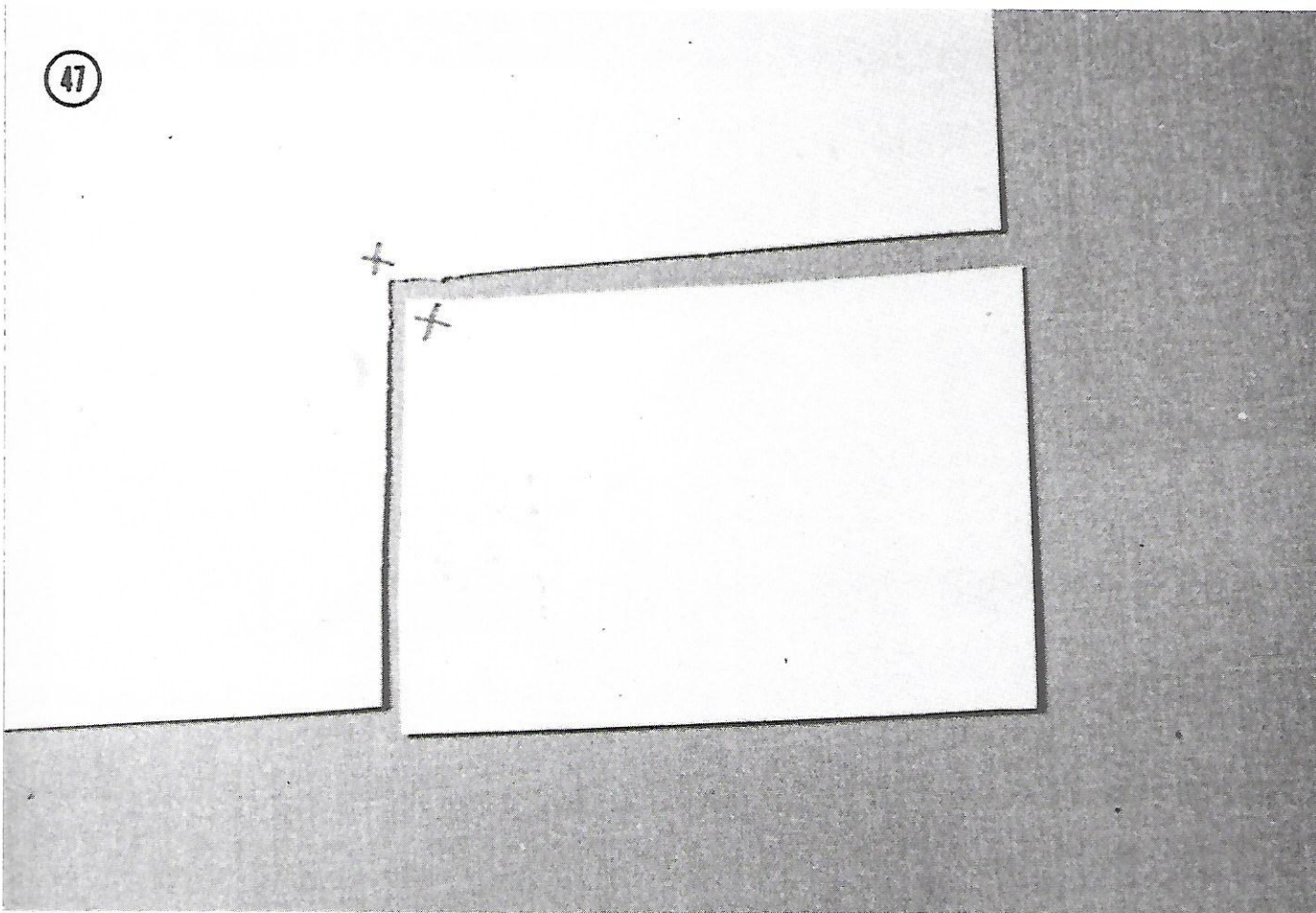
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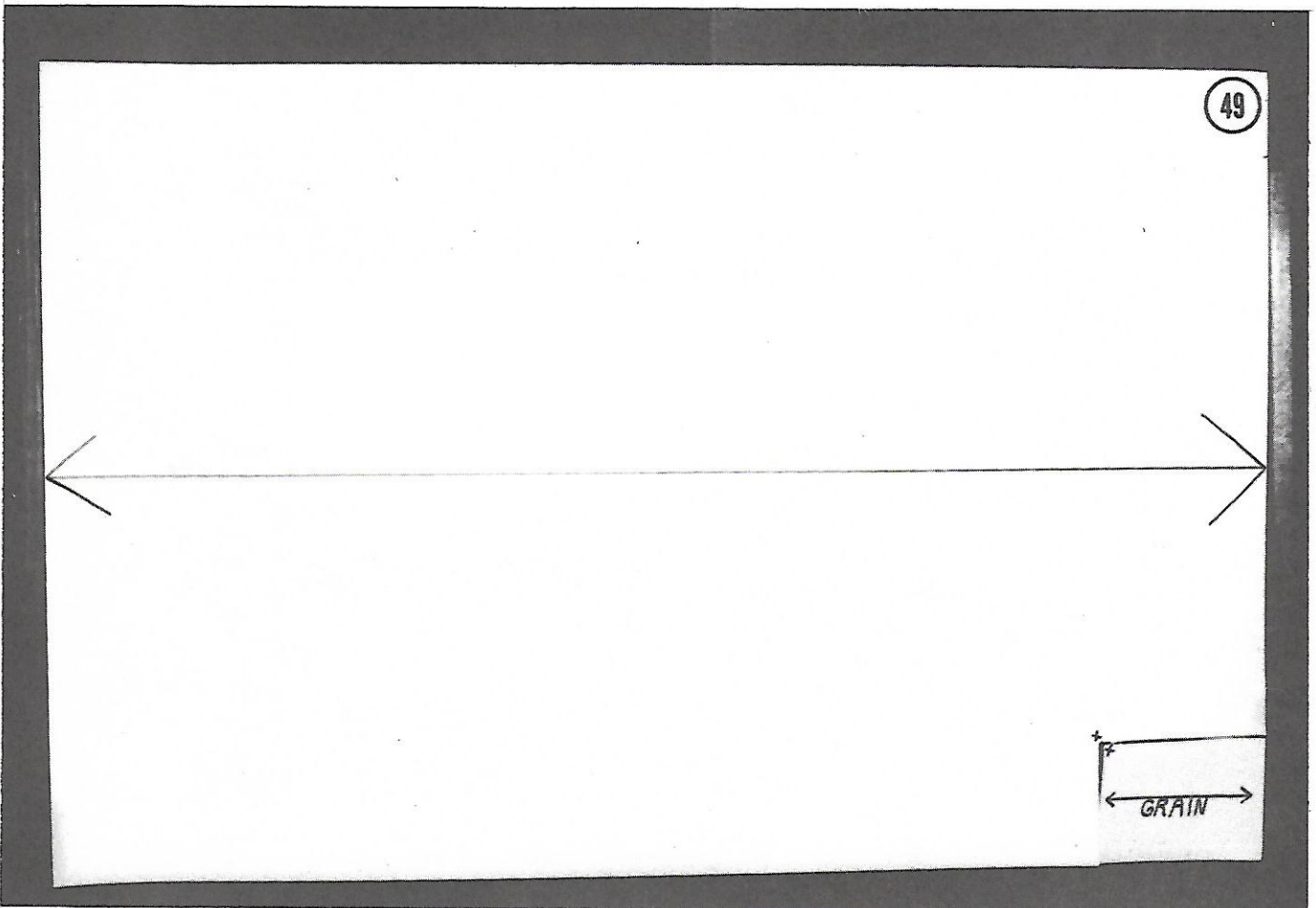
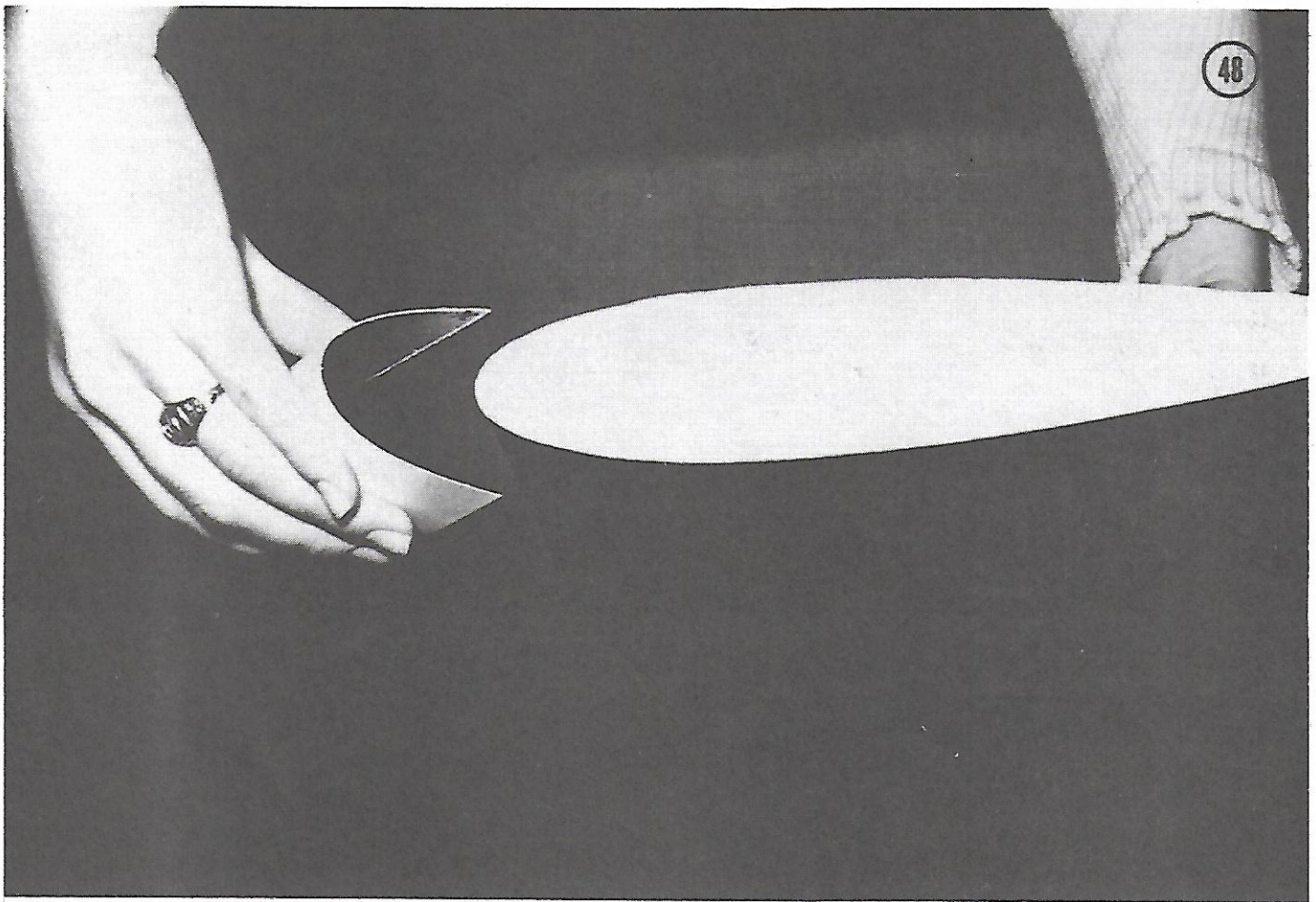


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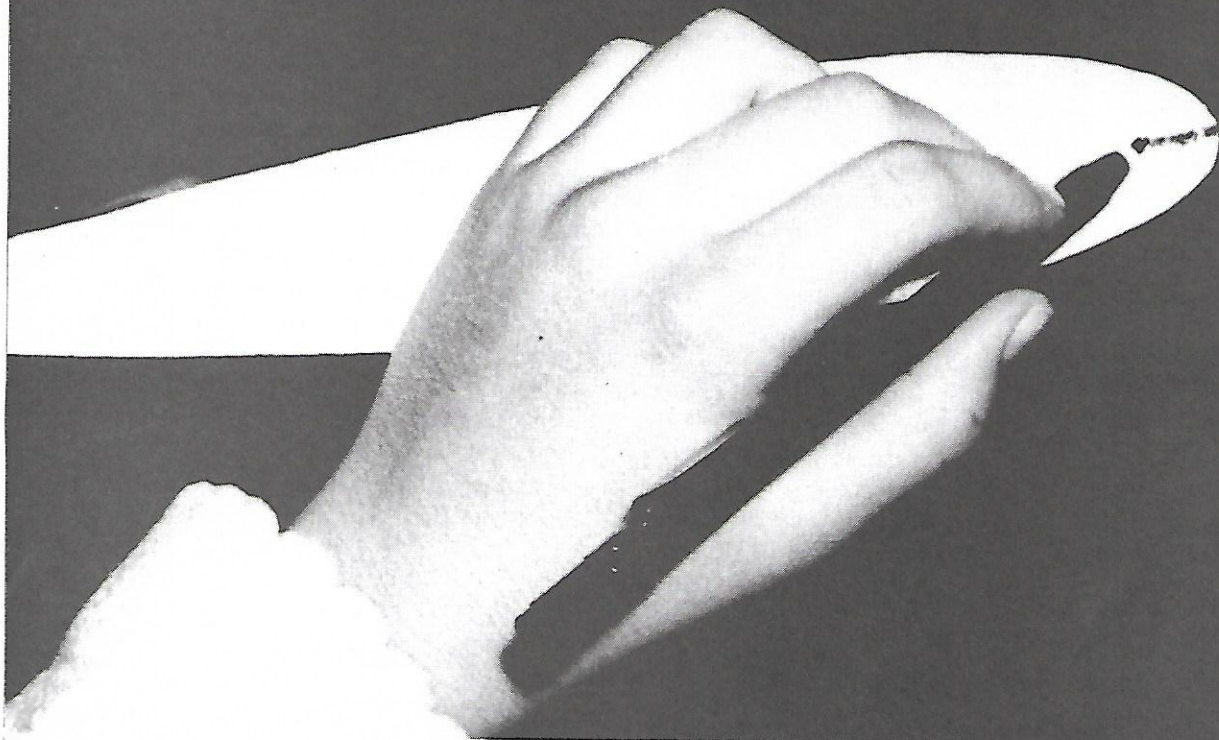


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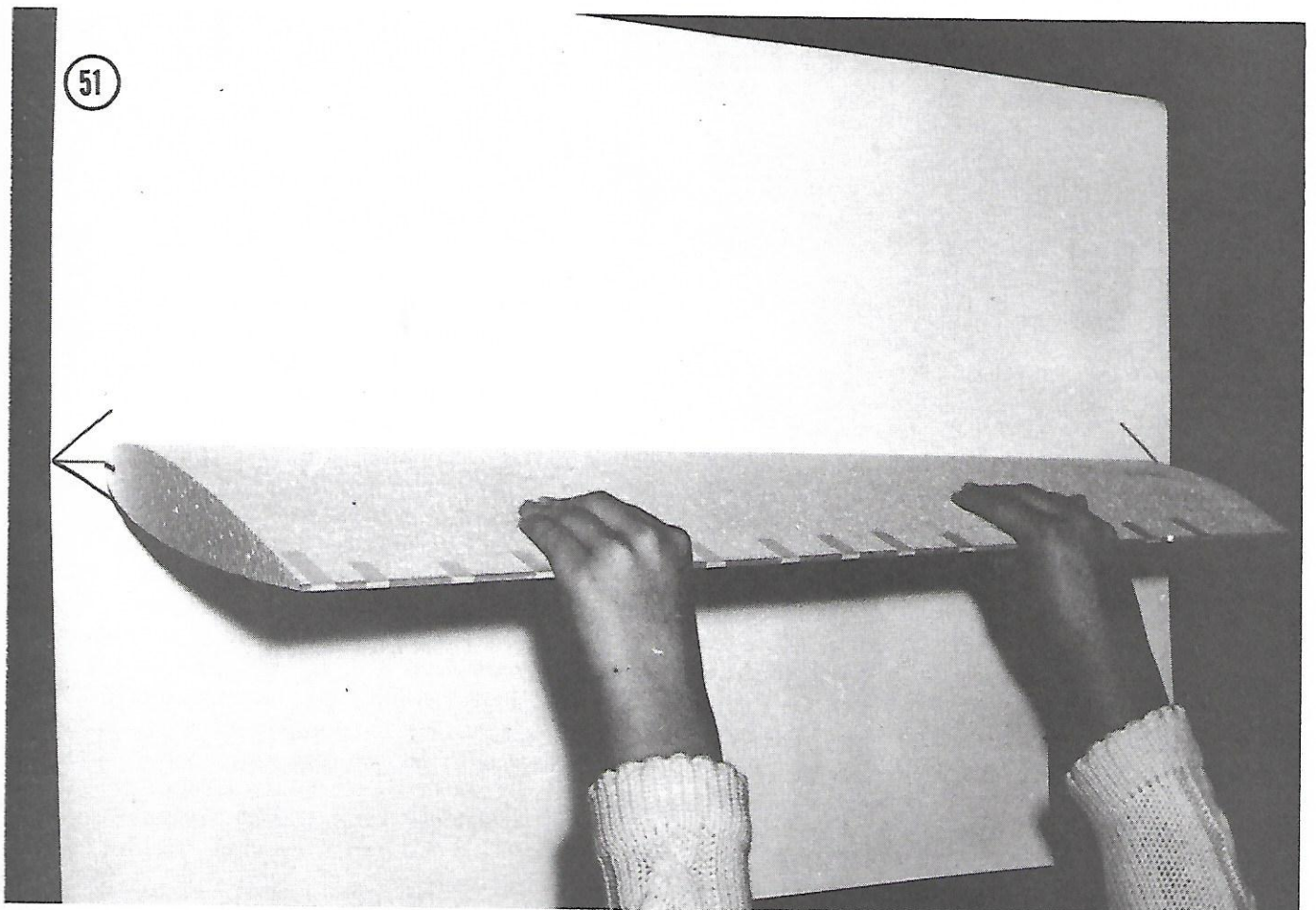




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51



Now lay the core first one way, then the other, drawing lines around it. See photo #52. These are guide lines, so they must be accurate. Be sure the core does not slip out of position or the cardboard grain will not parallel the leading edge when the covering operation is started. Allowing ample overhang, trim away all excess sheet for easier handling.

Run sandpaper lightly over the core to break any glaze and smooth any ridges. Now scuff that side of the cardboard which is to contact the foam. This will aid adhesion.

Coat one half the core and corresponding cardboard area with contact cement to a point just around the leading edge. Allow the cement to dry for the specified time as stated on the can. As mentioned earlier, some cements may require two coats. See photo #53.

Following evaporation, procedure is again governed by wing design. With the constant chord barn door type, covering can be started at the leading edge and proceed on back to one trailing edge. The core is then turned over, cement applied and the other side done in like manner. For more difficult designs like that illustrated, the operation starts at one trailing edge and continues on around the core to the other. Aside from the starting points, covering is similar for all wings and reference to the photos should clarify remaining steps.

With the core leading edge upright, match the trailing edge with its proper guide line previously drawn on the sheet, then slowly lean it forward. As the cemented surfaces meet, press firmly to obtain proper adhesion. Continue laying the core forward until flat, then slightly more until the cardboard just begins to start around the leading edge. **Stop at this point!** See photo #54.

Slide the half covered core back so the trailing edge hangs over the table. With a sharp X-acto or razor blade, trim away the excess cardboard flush with the trailing edge strip. See photo #55.

Now turn the core so its leading edge hangs over the table. With one hand holding the core flat, work the cardboard around the leading edge from the bottom by running the heel of the other hand back and forth span-wise as in photo #56.

Now apply cement as before, being particularly sure the area at the leading edge is properly coated. See photo #57.

After evaporation, move the core so it's leading edge extends a short distance from the working surface. Lay a piece of wax paper over the cemented foam to a point about one half inch short of the leading edge, then with one hand resting on it, hold the core flat. The wax paper keeps cement off the hand and prevents premature cardboard-foam contact.

Work the cardboard over the leading edge with the heel of the hand as before until the

covering adheres smoothly with no gaps or air pockets. Shift one hand to the wax paper and begin slowly pulling it out toward the trailing edge until the core is completely covered as in photo #58.

Now trim away all excess cardboard as shown in photo #59.

White or epoxy glue is sometimes used in conjunction with contact cement to insure adhesion of covering to wing tips and trailing edge strips. This is dependent on individual preferences and the contact cement used. If you're in doubt as to the ability of your contact cement to hold at these points, by all means use the extra insurance.

As with all construction methods, there are variations in wing covering. Most notable is the practice of completely coating both core and sheeting with cement then covering in one continuous operation. Though admirably suited for balsa and considerably faster than the method illustrated here, it is recommended only for those with previous covering experience, especially with cardboard. Premature contact presents problems here and the new foam craftsman is advised to avoid it.

Finishing

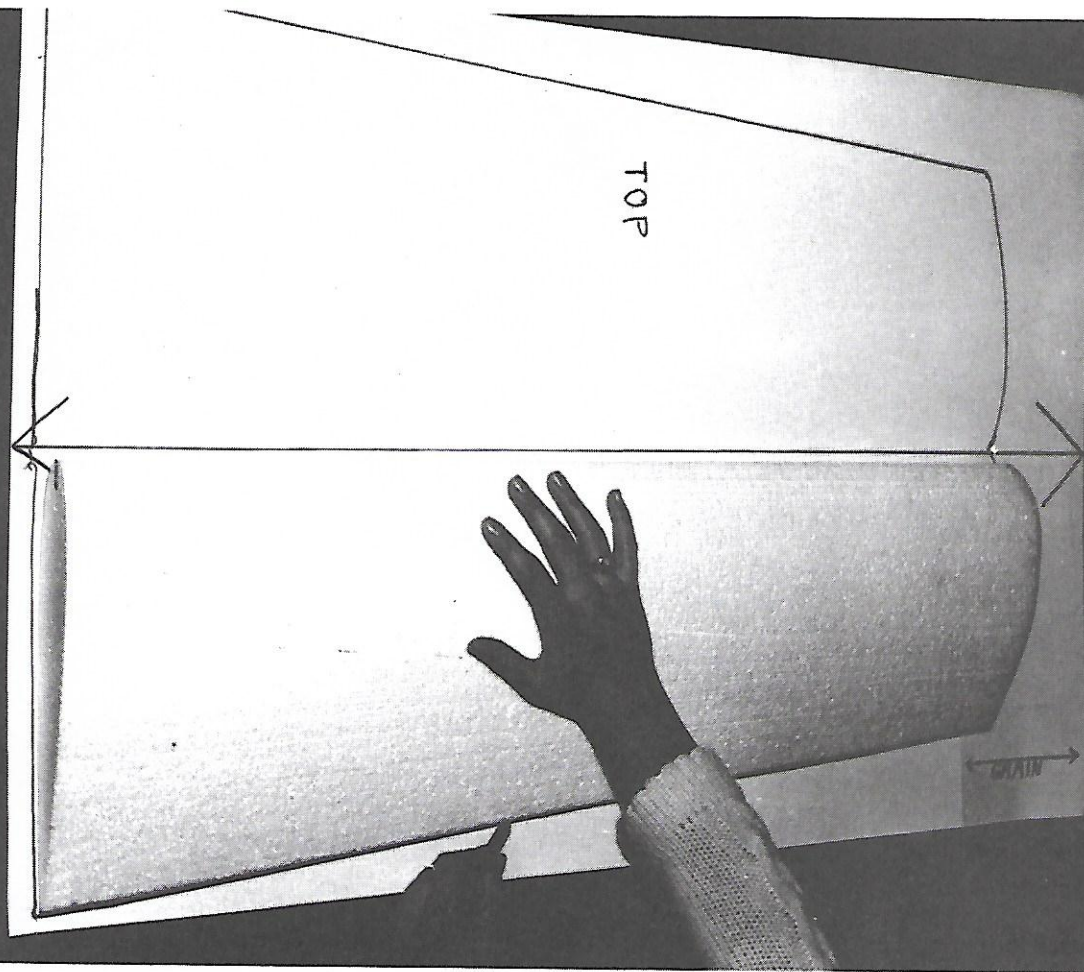
When both panels have been covered with whatever material is selected, and landing gear, aileron linkage and control systems provided for, the halves are ready for joining. This is usually done with epoxy glue or resin and glass tape.

If the wing has been covered with cardboard it can be very quickly finished and made ready for service by applying one or two light coats of dope or paint. If balsa or hardwood veneer was used, finishing is somewhat more involved.

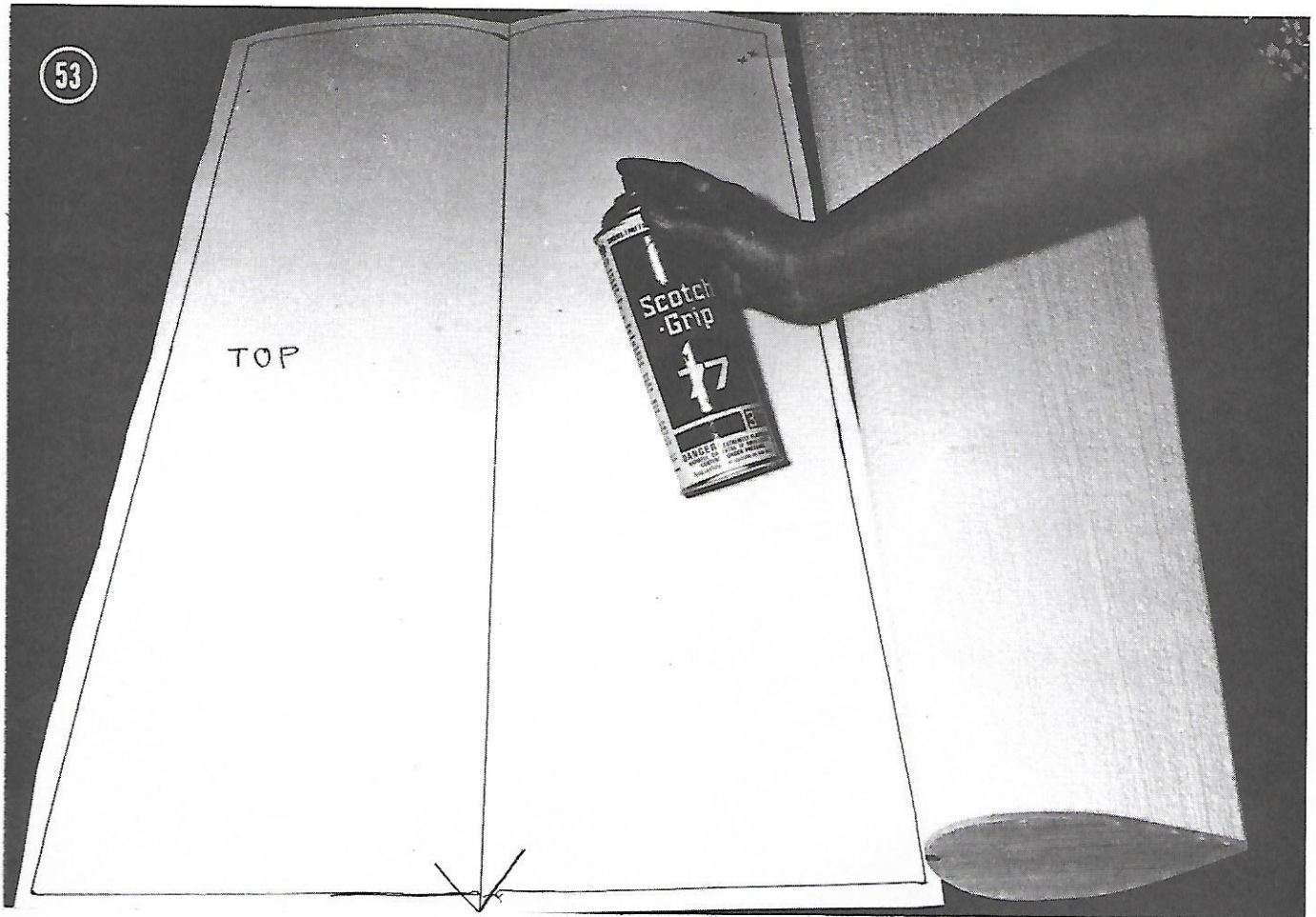
Sand the entire wing with #200 followed by #300 wet-or-dry paper used dry. Now determine just what kind of finish you want. The quickest that can be applied to a wood covered wing is one of the thin plastic films, such as MonoKote. It is not a purist finish but if properly applied looks quite well. A bonus of these films is that they are lightweight as compared to dope or paint. Normal heat used for shrinking these finishes will not damage covered foam if the iron is kept moving.

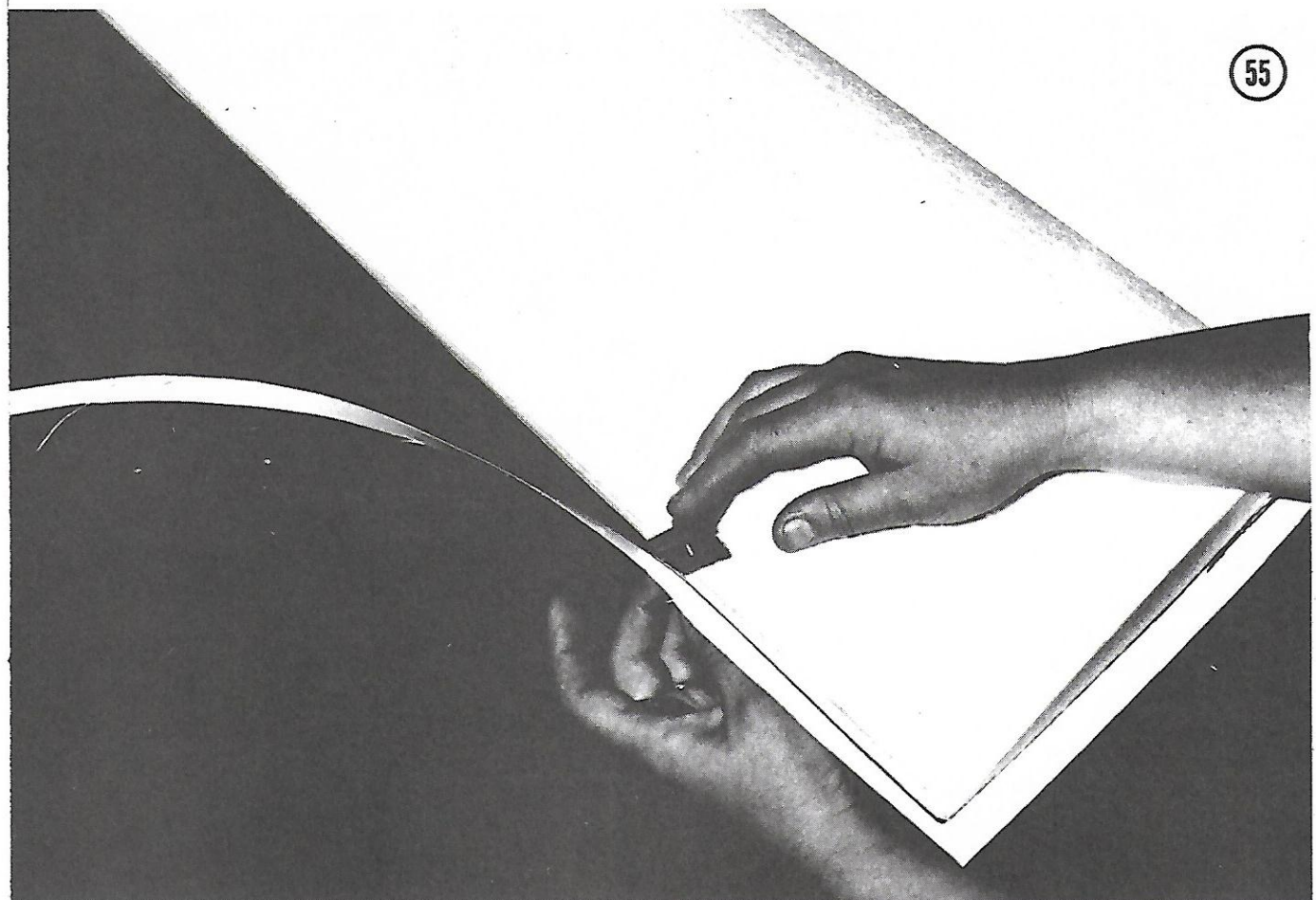
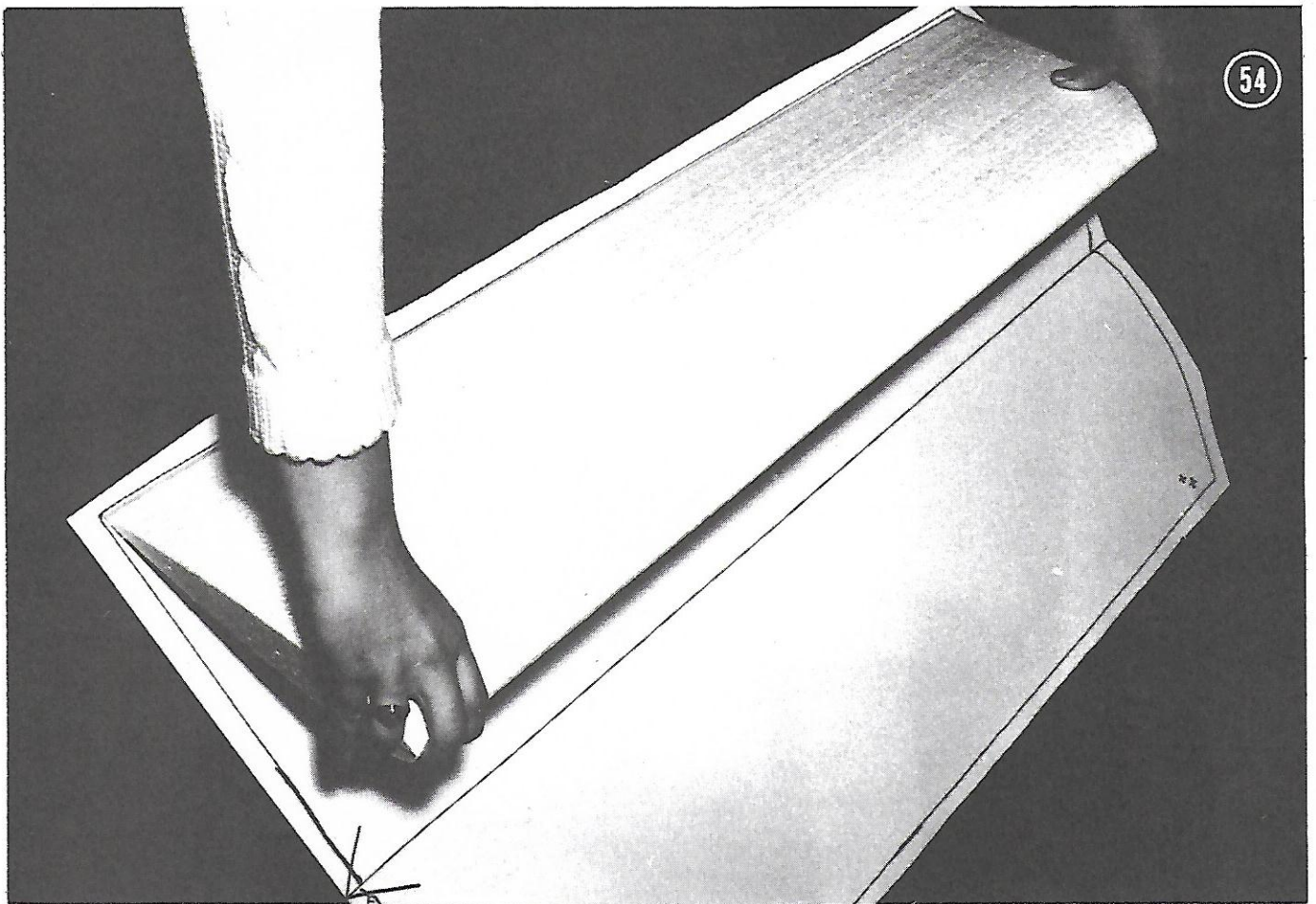
As previously stated, dope solvents or paint thinners will damage foam, so do not thin the first coats of liquid finishes too much. Be sure to let each coat dry for a period of at least six hours at around seventy degrees or above, otherwise the top coats dry first trapping the solvents in the first coats and resulting in possible seepage through wood pores with consequent long term attack on the foam beneath. The contact cement provides some barrier against this, but if multi-coated layers are applied in the same evening, trouble will probably result.

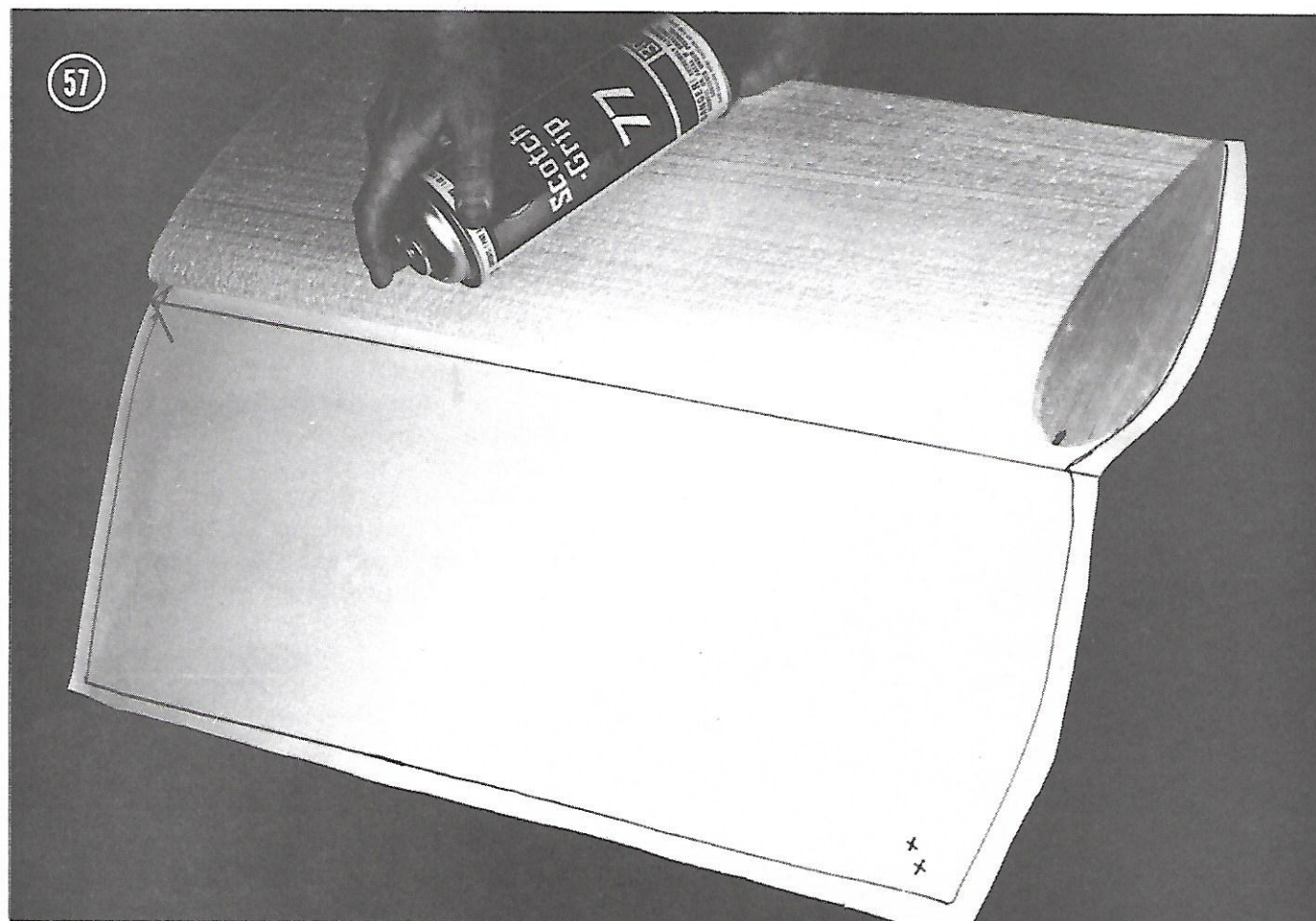
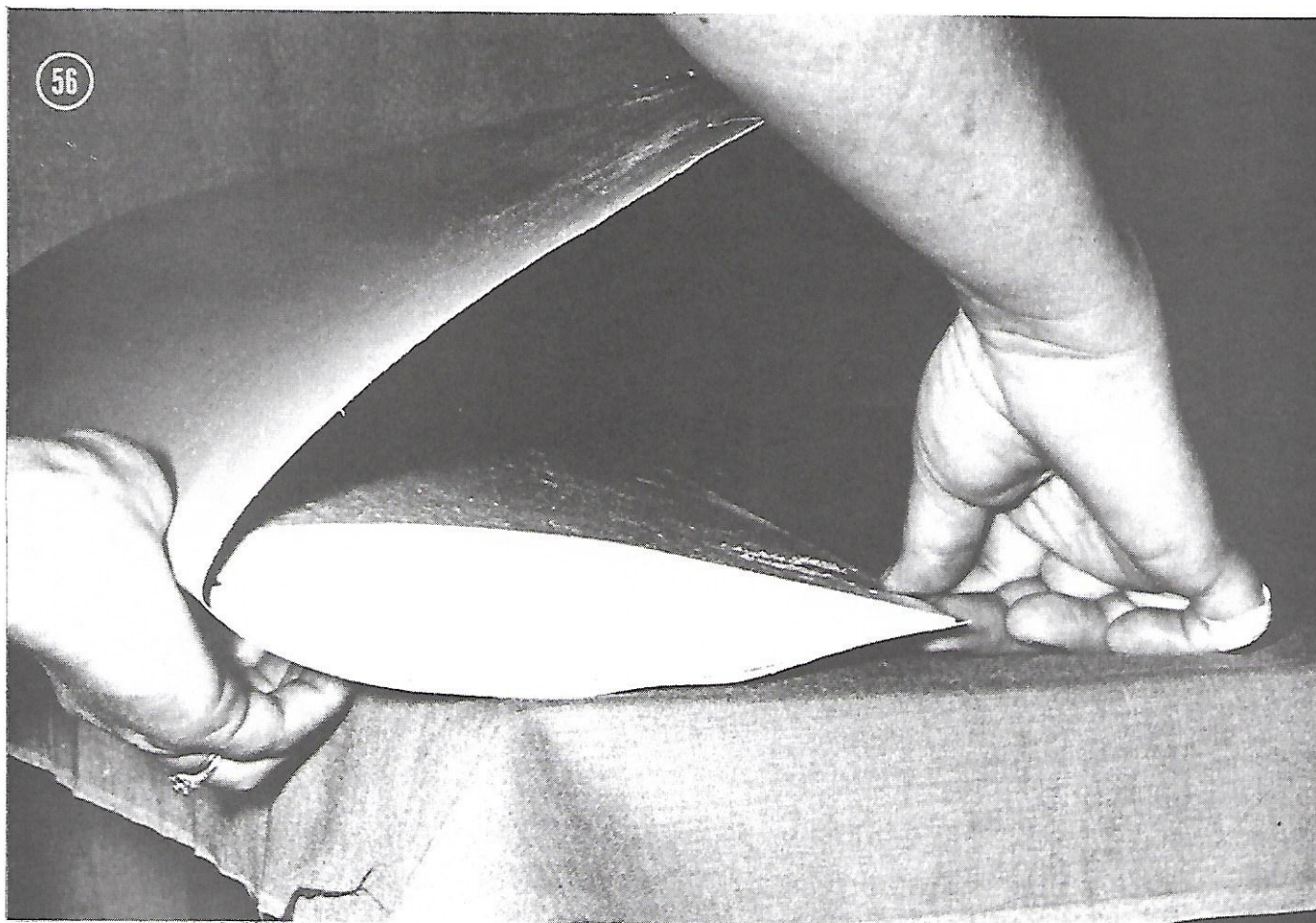
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53







There is no need to cover a balsa sheeted foam wing with silk as it only adds unnecessary weight and expense. If it must be covered with something, lightweight silkspan is recommended but, again, this is not necessary. Normal filling and finishing techniques can be used and this, of course, is dependent on the finish desired.

Excellent appearance and finish durability can be obtained through various synthetic materials widely available. But the surface must be properly prepared to receive them. This is best done with Hobbypoxy or equivalent clear coating.

Mix according to the manufacturer's instructions and heat until hot to the touch. Brush on a coat and let it dry for at least twenty four hours, then sand with #320 wet-or-dry used wet with a touch of household detergent added to the water. Brush on a second coat and again allow ample drying time, then sand. This is usually sufficient for surface preparation, but a third coat may be applied if desired.

Now, spray on two coats of Du Pont Hi-Speed or equivalent lacquer primer/surfacer (available at most auto supply stores) and let dry, preferably

three days.

Remove most of this primer with #360 paper. The surface at this point should be glassy smooth and rather hard.

Spray Du Pont Dulux synthetic automotive color enamel per can directions. This results in lightweight, fuel-proof mirror finish with no rubbing. If preferred, Nason acrylic lacquer or dope may be substituted for Du Pont Dulux.

An alternate acrylic finish involves a combination of dope and lacquer. Here two coats of dope-talc lacquer primer is applied and wet sanded until very thin. A 50-50 mixture of butyrate color dope and Nason acrylic lacquer is thinned to spraying consistency with acrylic or butyrate dope thinner and applied. When dry it is wet sanded with #600 wet-or-dry paper and rubbed.

The resultant finish is of extremely high gloss with none of the brittleness normally associated with acrylic finishes. It is flexible, fuelproof, and beautiful. It should be remembered that acrylic may be applied over butyrate dope, but butyrate dope will not work over acrylic lacquer.

VI LANDING GEAR AND CONTROL SYSTEMS

Unless the wing is intended for a rudder or rudder/elevator controlled aircraft, consideration must be given to landing gear, aileron, and control linkage systems. These installations are, or should be, somewhat easier in commercial than home produced wings as provision should be made for them. The home craftsman, on the other hand, has no such help. His is the sole responsibility for lay-out and installation of these items with satisfactory results dependent on properly doing so.

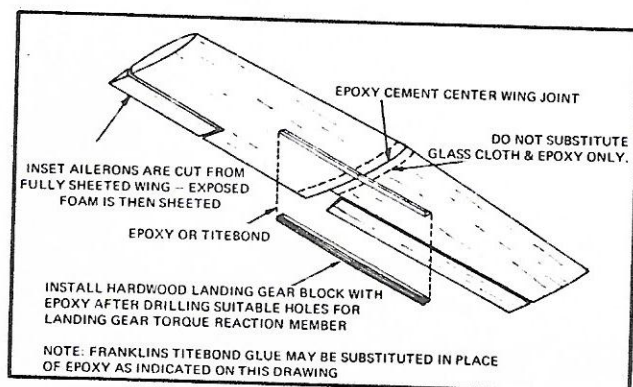


FIG. 9

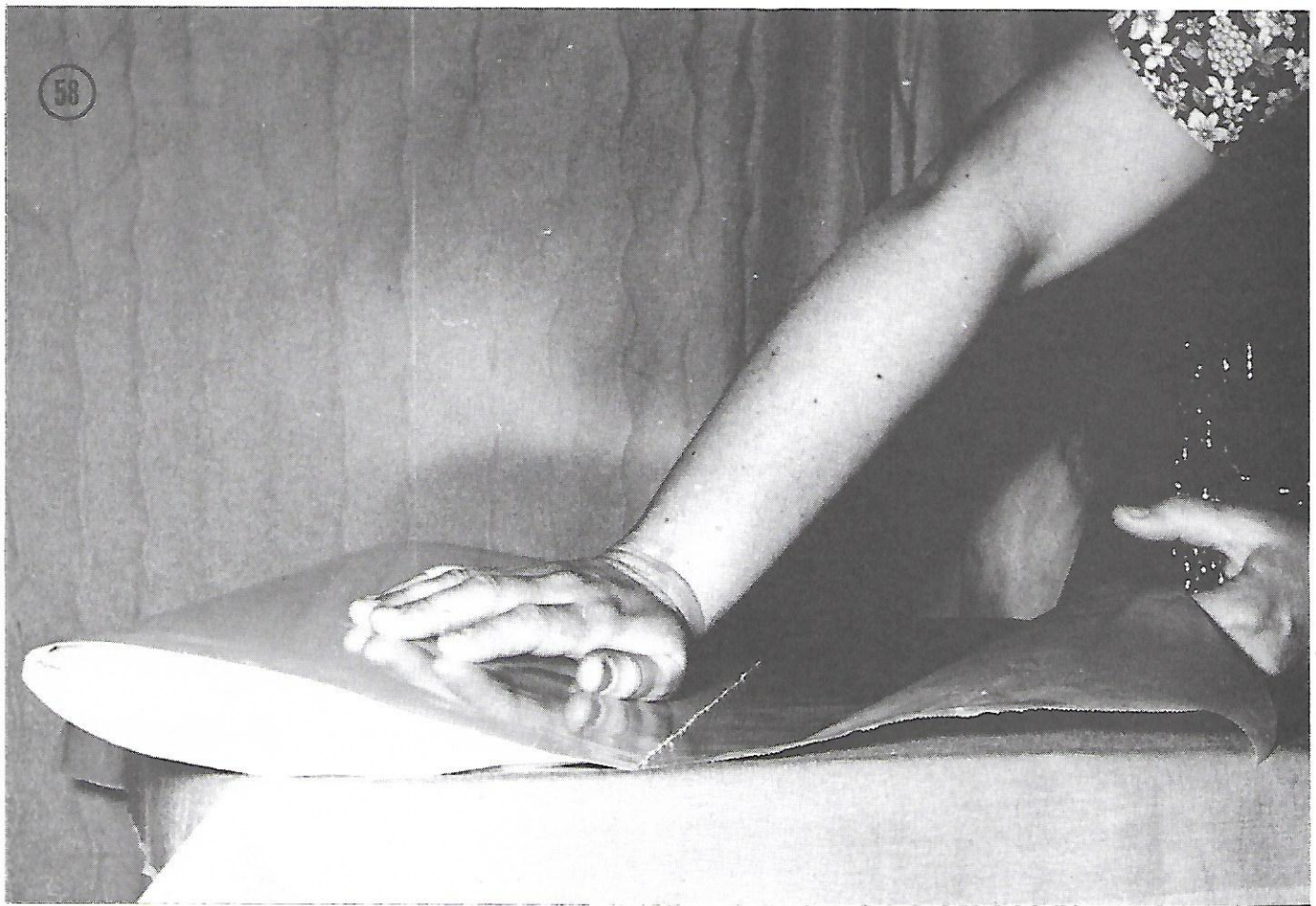
Figure 9 illustrates the various components of a typical foam wing. Note that the chord would be shorter for a strip than in-set aileron design. Note particularly that rounded tip blocks are installed after the wing has been sheeted. This facilitates in-set aileron installation.

Consider first the landing gear. One and two piece blocks have been used with both working equally well in service. However, the one piece block adds strength to the center joint and helps panel mating and joining. If the wing is of such a design that weight is a major factor, the two piece block may be better. But, regardless which is used, the core must be channeled to receive them and the channels must be accurate.

Channeling can be done either before or after sheeting. Most commercial cores have pre-cut channels, so the builder has no choice but to sheet over the cavities. Blocks can, and have, been installed permanently prior to sheeting but the covering operation may become a rather aggravating affair, especially with the wrap-around method where one is working with a large sheet.

Gear block channels are usually made in one of two ways. The first, and perhaps most common, is to use a sharp X-acto or equivalent to make vertical cuts sized to whatever gear block is to be installed, then rooting out the foam to the proper depth. Though perhaps satisfactory, it is difficult to obtain a smooth bed and adhesion is not as good because of the rough surface inherent in this method of channeling.

The preferred method is a tool such as described in Chapter II. Because it operates as does the foam cutter i.e. melts instead of gouging the foam, smooth cut-outs result. As with any tool, it will be only as accurate as it's working surface, in



this case the formed wire tips. Equally important is the manner in which it is used. Though the tool can be employed for free-hand smoothing or trimming of foam surfaces, it is best used with a guide or jig for gear block, servo, or linkage cut-outs.

Landing gear installation is begun by laying out it's shape and location on the panel as shown in photo #60. Though a one piece block is shown, the following steps also apply to a two piece installation with the exception of a separate template for channeling the two piece bed might be used.

After lay-out, remove sheeting to expose the foam as shown in photo #61. This step, of course, does not apply if the unsheeted core is being channeled.

Photo #62 shows completion of the gear block channel. Note the block is being used as a template and reversed with it's tip at the core root and it's thick center section where the block end will be on installation. This is done to provide the angled bed required. In this way the cut is deep at one end (the root) and shallow at the outer end to conform with wing dihedral.

Photo #63 shows the block being installed. It should be slid in from the root rather than pushed down from the top to prevent crunching the covering as damage may result because of what should be a tight fit between core sheeting and gear block.

In photo #64 the block is in place. It is sometimes a good idea to forestall glue application until the cores are trial joined to reveal any discrepancies. When proper mating is assured, the block can be epoxied in place and, due to the close fit, helps hold the two wing halves in place for epoxy curing.

Aileron and servo installation in a foam wing is much the same as that in a built-up balsa type with the strip aileron being simpler. If in-set ailerons are to be used, some means of transmitting servo movement through the panel to the aileron horn must be provided. Figure 10 illustrates three ways of doing this.

In figure 10-a, the pushrod is passed through a hole cut span-wise through the panel. This is accomplished by drilling holes in the template large enough for the pushrod to fit through. A thin slot is cut from the bottom edge of the template to intersect the holes. Coring is begun from the bottom edge of the template, through the slot, around the hole, back out the slot, and on around the template. A neater job can be done by inserting a dowel or piece of 5/32 music wire through the panel in the desired location, fishing the cutting wire through, installing templates with holes to the core, hooking the wire to the bow, and coring out the holes.

A quicker method is to heat a piece of steel

rod, longer than a panel, to foam melting temperature, then run it through the core in the desired location. This is an excellent method but care must be taken to prevent over melt. A rifle or shotgun cleaning rod is ideal for this application. It is recommended that jigs be made and used to prevent wandering as the rod passes through the panel.

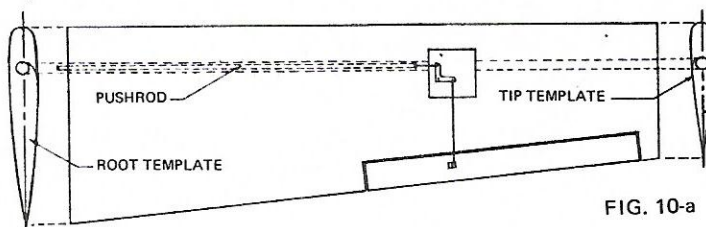


FIG. 10-a

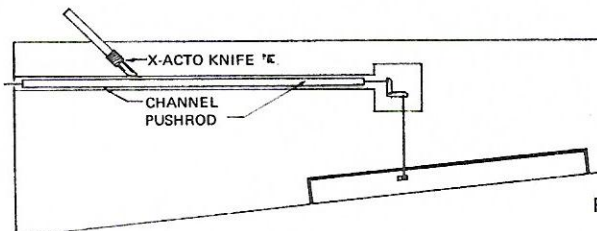


FIG. 10-b

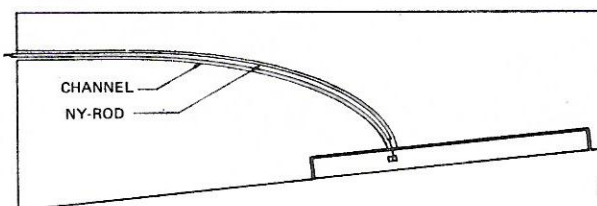


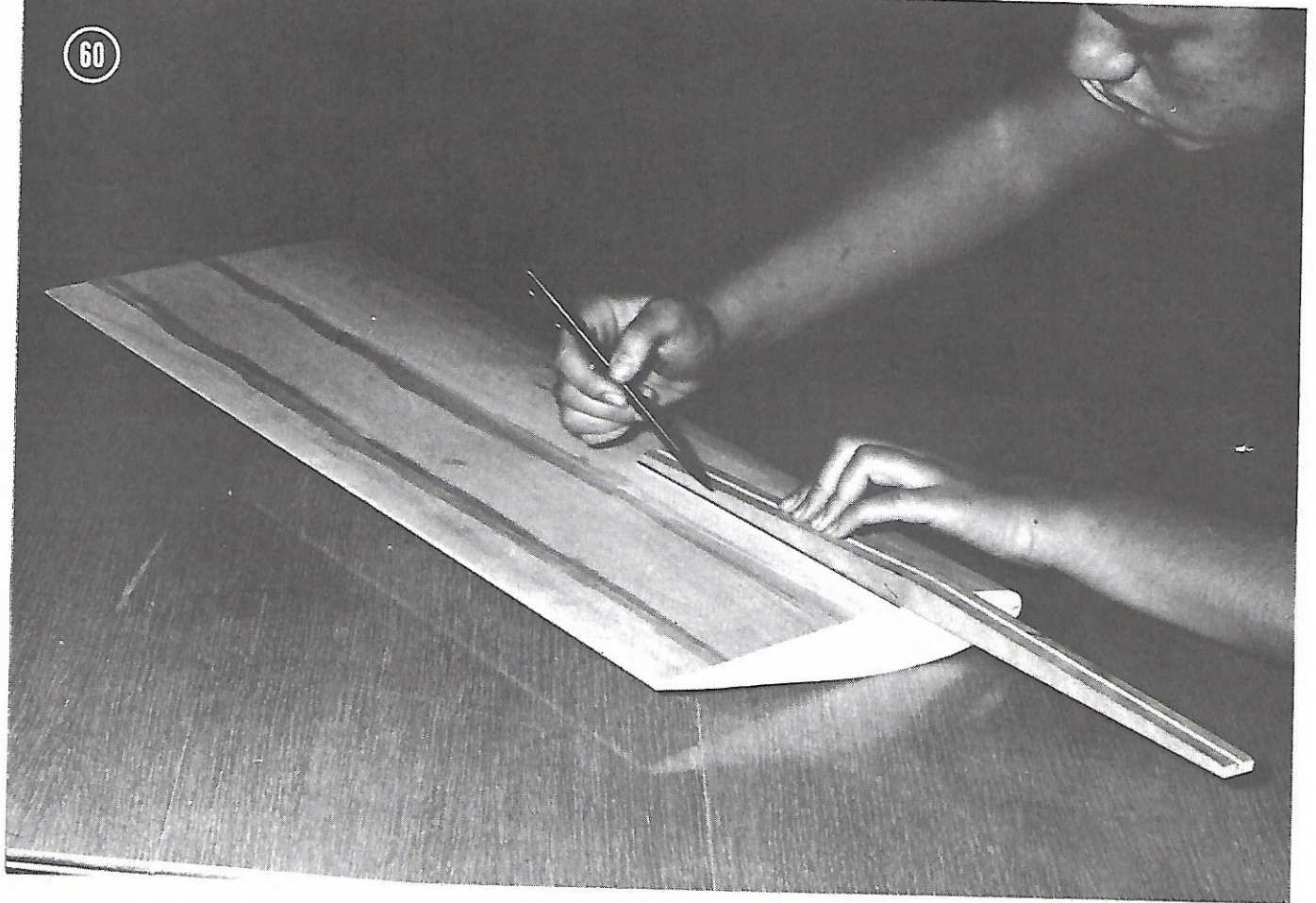
FIG. 10-c

In figure 10-b, a channel extending from the servo cavity to the bell-crank is cut into the bottom of the core just wide and deep enough to accept the pushrod without binding. After pushrod and bell-crank installation, the channel is sheeted over.

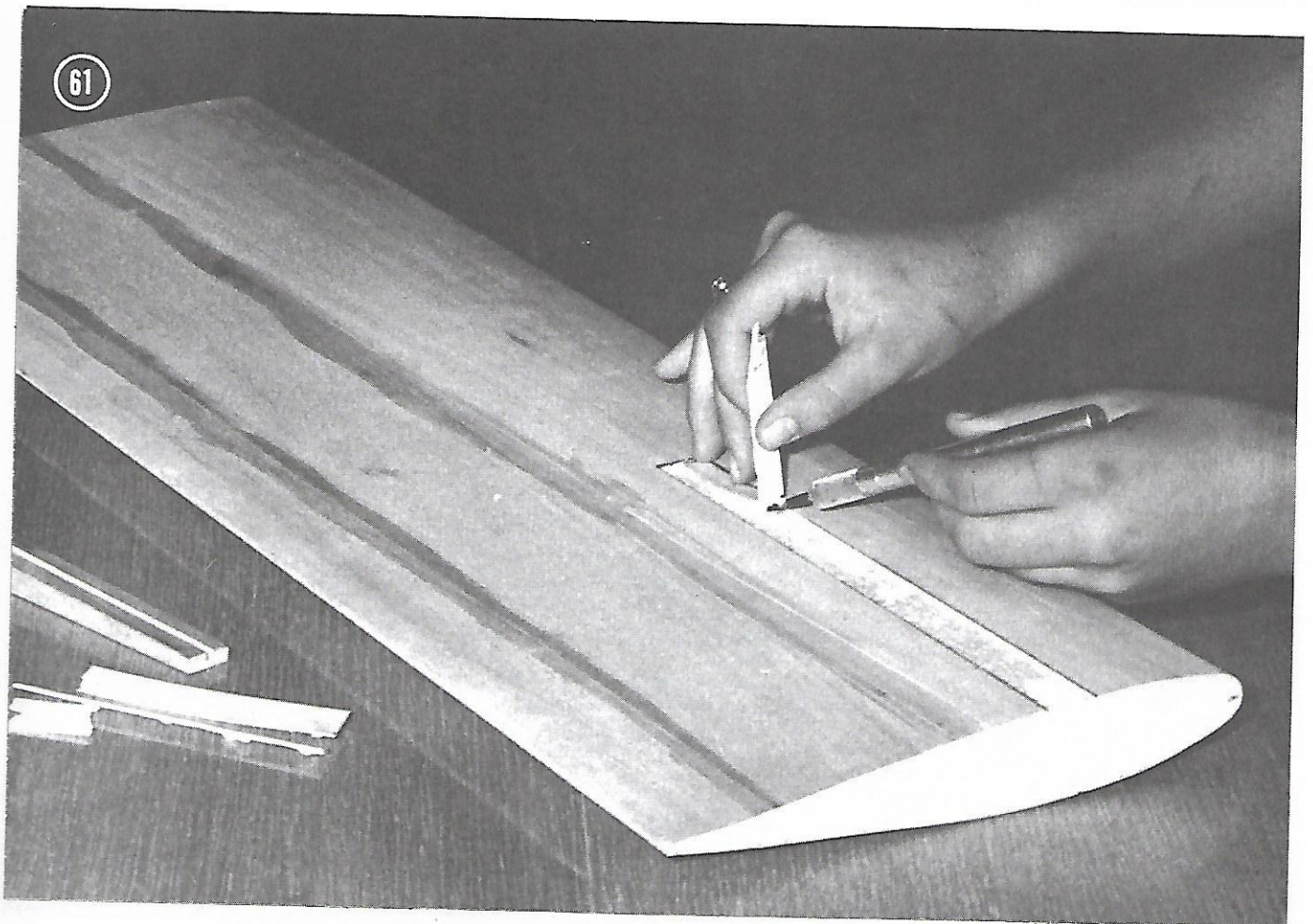
In figure 10-c, a channel is cut from the servo to a point near the aileron horn. A length of flexible nylon control cable, such as NyRod, is inserted into the channel. After the linkage is completed the channel is sheeted over. This method offers the advantage of a narrow channel and eliminates the bell-crank.

Still another method, not illustrated, is a combination of that in figures 10-b & c. A bell-crank is installed, except the cavity is not as deep as usual. A groove just wide and deep enough to accept a length of nylon tubing, such as the inside tube of a NyRod, is cut into the bottom of the panel, one from the servo cavity to the bell-crank, and another from the bell-crank to a point near the aileron horn. The linkage is completed by insertion of a length of 1/16" music wire from the servo to the bell-crank and another from the bell-crank to the aileron horn. This method has the advantage of an exceptionally frictionless operation and eliminates the usual holes and relatively large channels required of typical pushrod installation.

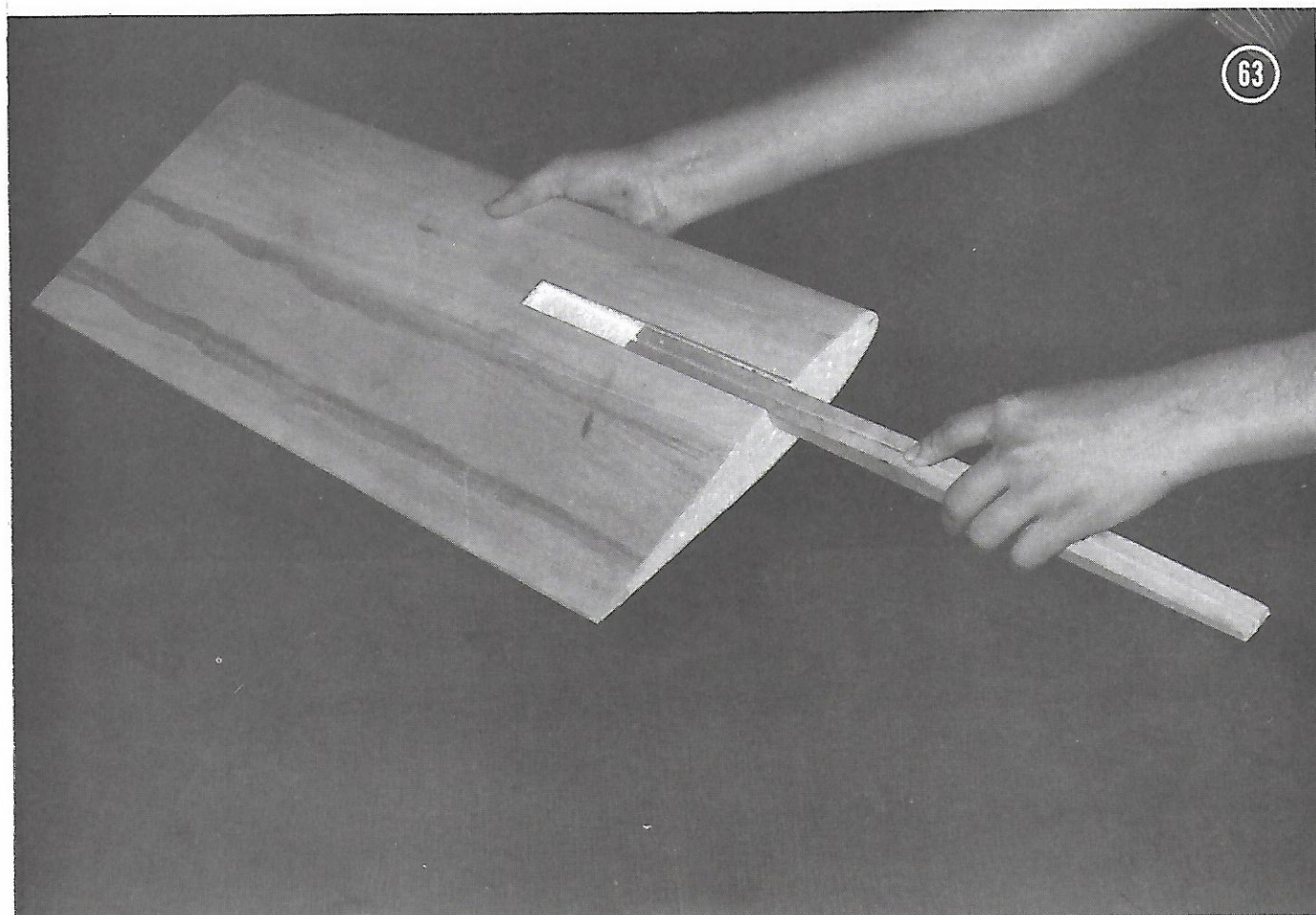
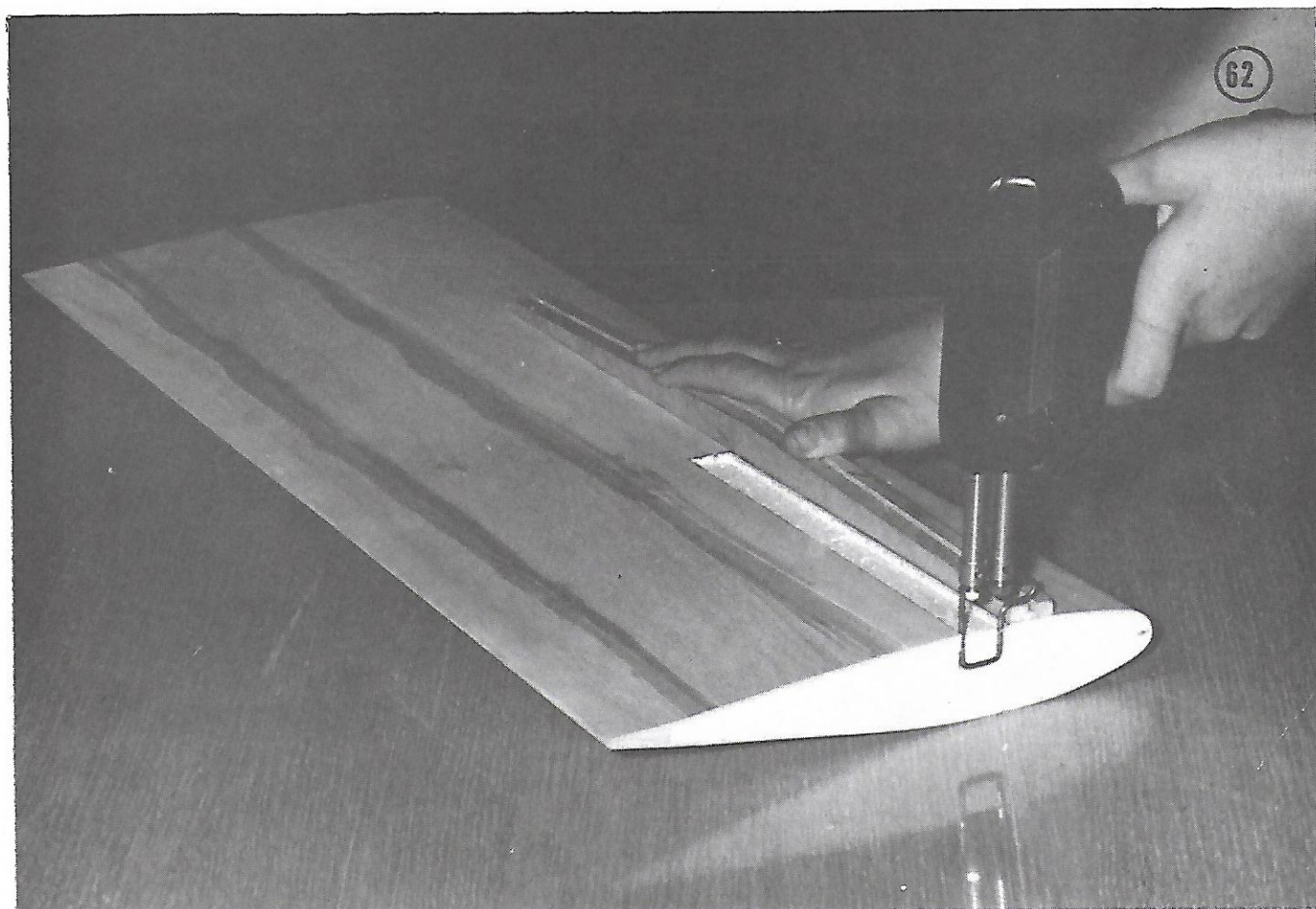
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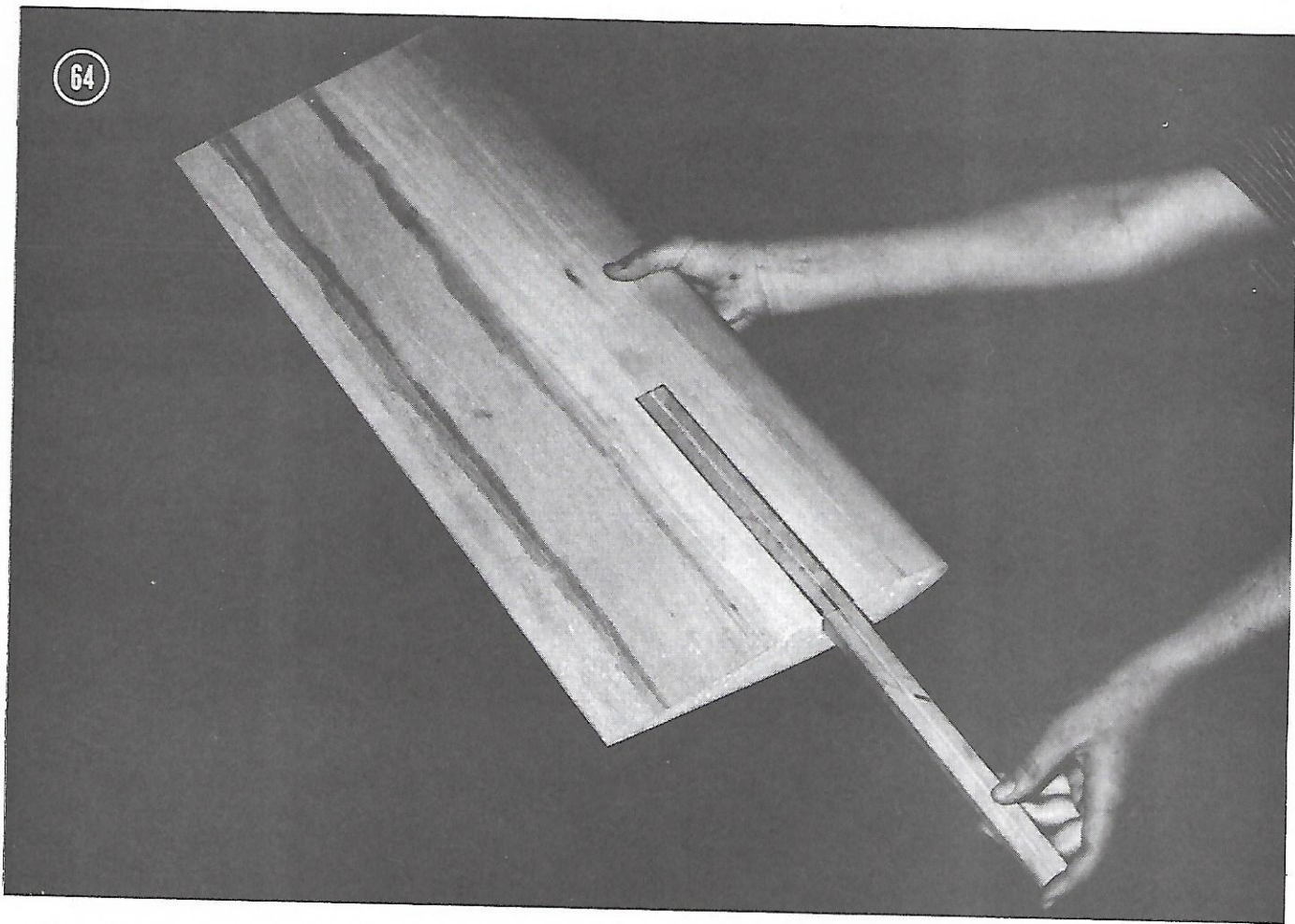
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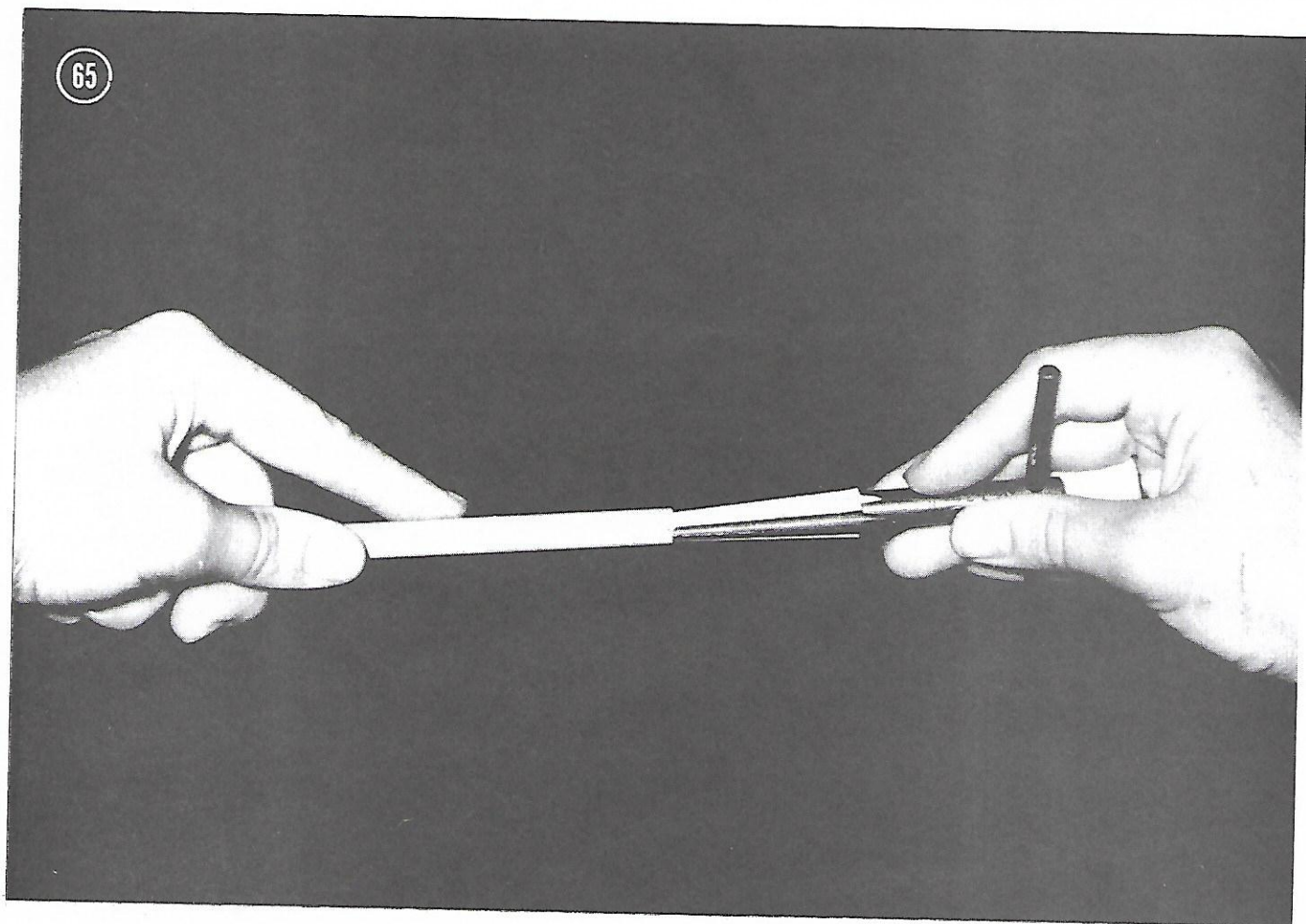
Foam Wing



64



65



Foam Wing

Pushrods

An excellent set of pushrods, for fuselage as well as aileron linkage, can be made from fiberglass tubing, similar to that used in the manufacture of arrow shafts. These pushrods will not flex or break in service and make for an exceptionally neat installation.

The first step is to bevel each end of the tube to about a thirty degree angle so the very outside edge acts as a cutting surface. Refer to photo #65. A reamer does this job quickly but an X-acto or knife will do as well.

Push the rod into a two inch block of soft balsa, with the grain, rotating it back and forth as you do so. See photo #66. The rod will cut into the balsa and jam itself full of wood. Repeat for each end.

With an ice pick or awl, prick a starter hole in the center of each wood plug as shown in photo #67.

Now apply epoxy cement to a Kwik-Link or equivalent shaft and insert it into the starter hole as shown in photo #68. Keep pushing the shaft into the wood plug until it has penetrated about an inch and a half or so, then apply more epoxy around the shaft and plug. Filing a point on the shaft end will make it's insertion into the wood a bit easier. When the epoxy has cured, the pushrods are ready for installation.

In-set Ailerons

Radio control aircraft, like their full scale counterparts, generally utilize one of two aileron configurations — strip (full span) or the increasingly popular in-set type. Strip ailerons, as the name implies, are simply long strips, usually of pre-cut balsa stock, hinged to the wing trailing edge and running the full span of each panel. Because of simple installation and linkage requirements they have been, and are perhaps now, seen on more aircraft than any other design.

From the standpoint of design and flight efficiency, the in-set aileron could be correctly said to be superior to the strip, though in practical flight conditions the average miniature aircraft pilot would probably be hard pressed to discriminate between the two.

On some aircraft, particularly those designed for high speed, most obvious would be an increased turn and roll rate as the in-set aileron, being nearer each wing tip and exerting more control at that spot, tends to cause quicker response and somewhat less drag. But the chief advantage of in-set ailerons, again from the standpoint of the average flyer, is that of appearance.

However, their installation is more difficult than strip, and requiring more precision in fitting

and hinge installation. In this respect it should be noted that the builder capable of coring his own wings is most certainly able to handle in-set aileron installation and encouraged to do so.

Because strip ailerons are extremely simple and their installation requiring little more than alignment of hinges with the wing trailing edge and easy servo linkage, detailed instructions for them are not included as the builder should have no trouble with them. In-set aileron installation in a foam wing, however, may present the newcomer with problems, so the following step-by-step method is likely to be of help.

Aileron installation begins with the hinge mount which is inlaid into the core prior to the covering operation. Because of flight loads imposed on an aileron, it is advisable to provide a stronger hinge mount than that offered by the sheeting and foam of a core.

Begin by laying out the aileron shape on the foam core with a fine tip felt pen. If working from plans, be sure the shape and size is correct as ailerons often make the difference between proper and mediocre flight characteristics of an aircraft.

Now select a piece of 1/8" balsa stock and cut a piece 3/4" by about an inch shorter than the aileron length. This is the hinge mount, so take care the cuts are accurate and straight.

Using the mount as a guide, saw out a channeling template from plywood. Be sure to mark the hinge mount center-line on the template. Sand the inside cuts smooth so the channeling tip will pass over them easily.

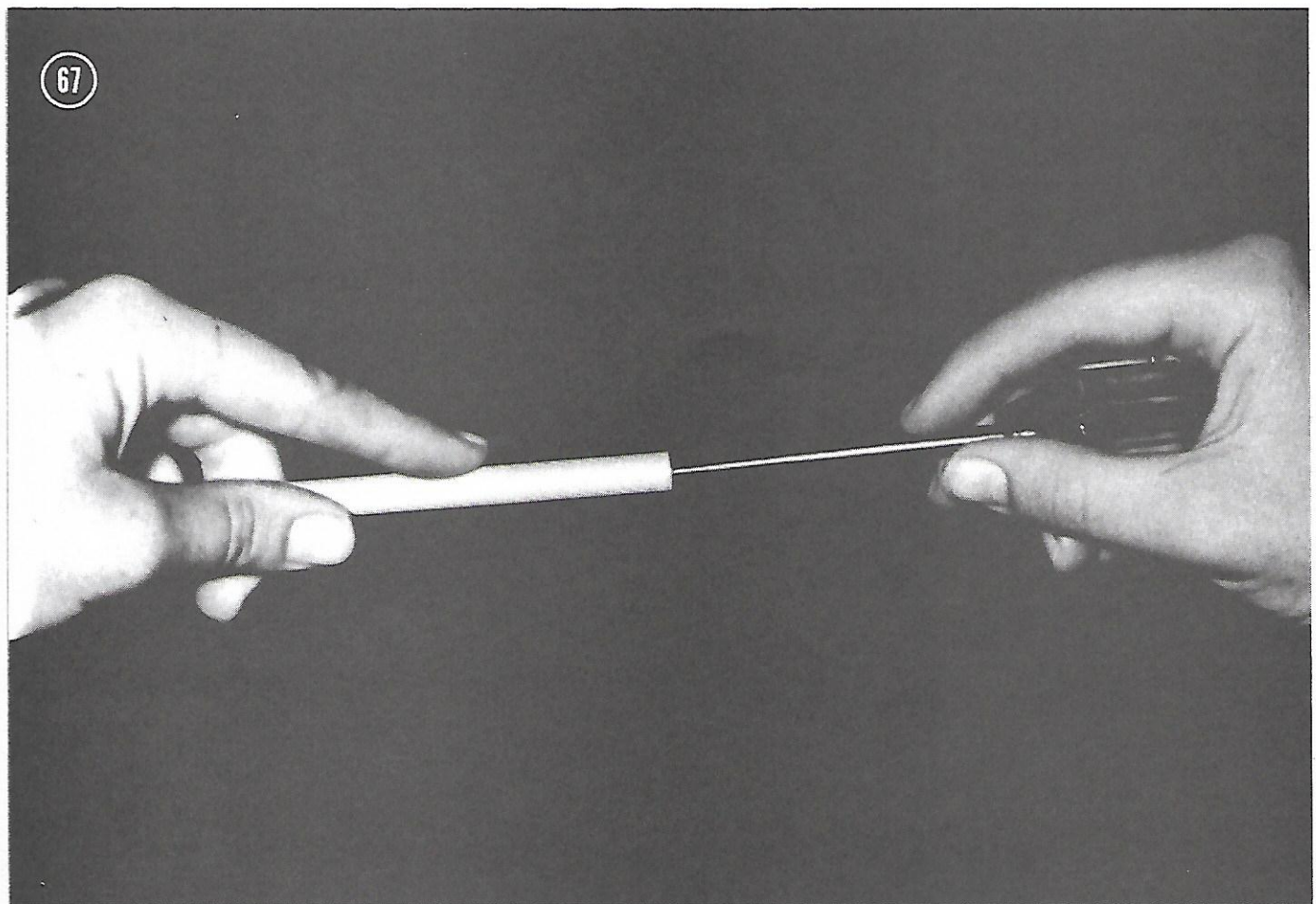
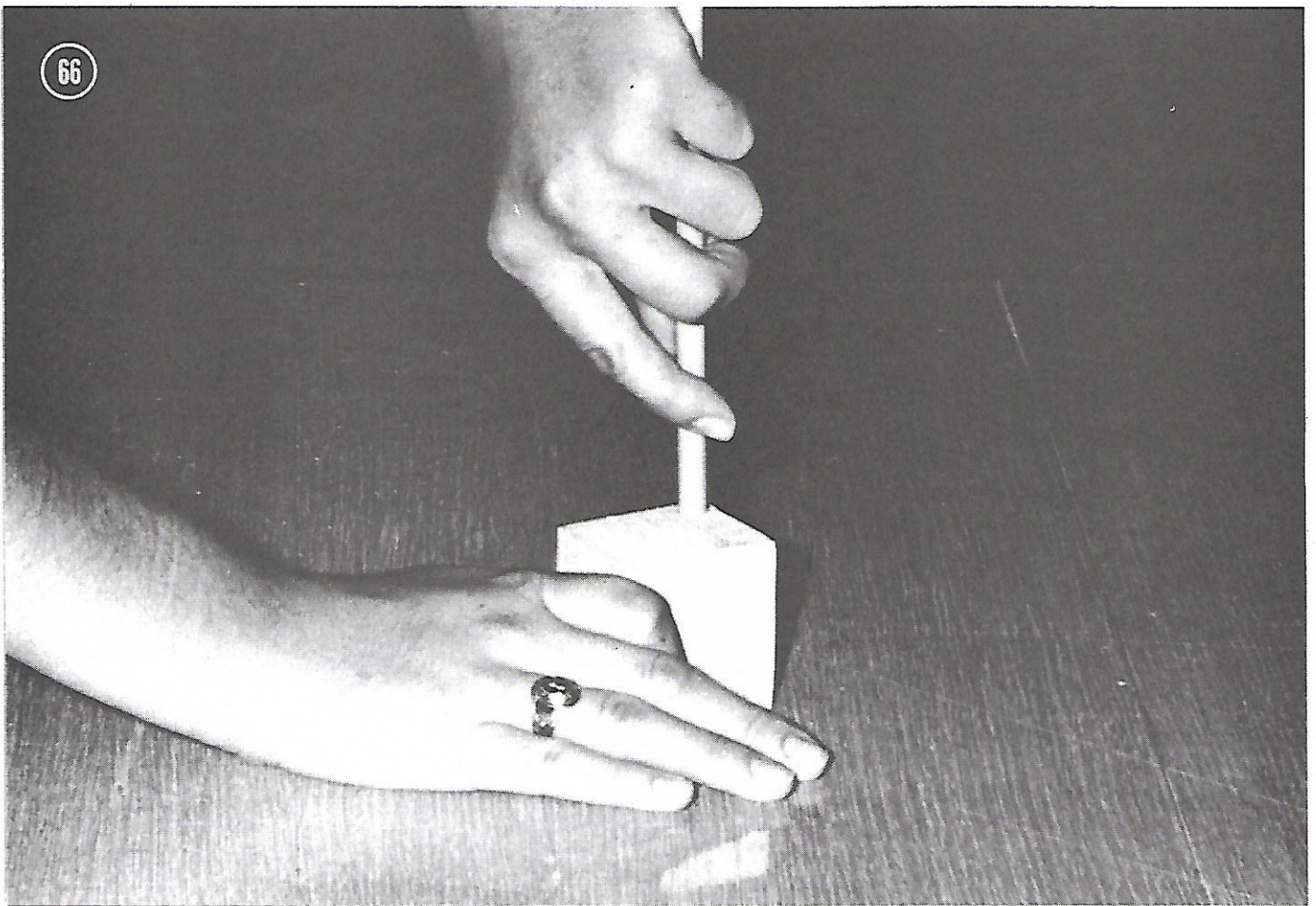
Matching the center line on the template with the front aileron lay-out line, draw the hinge mount location onto the core as shown in photo #69.

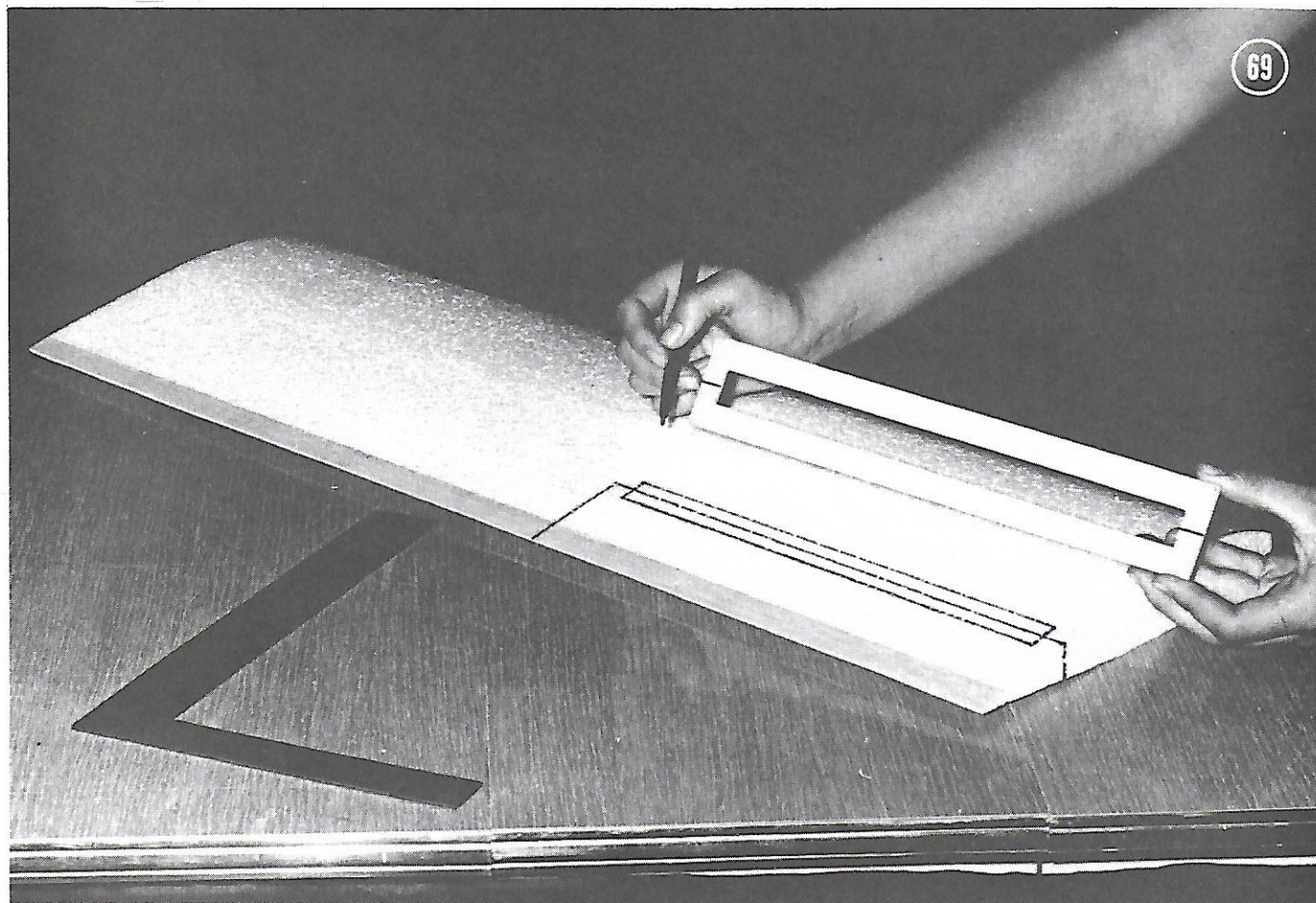
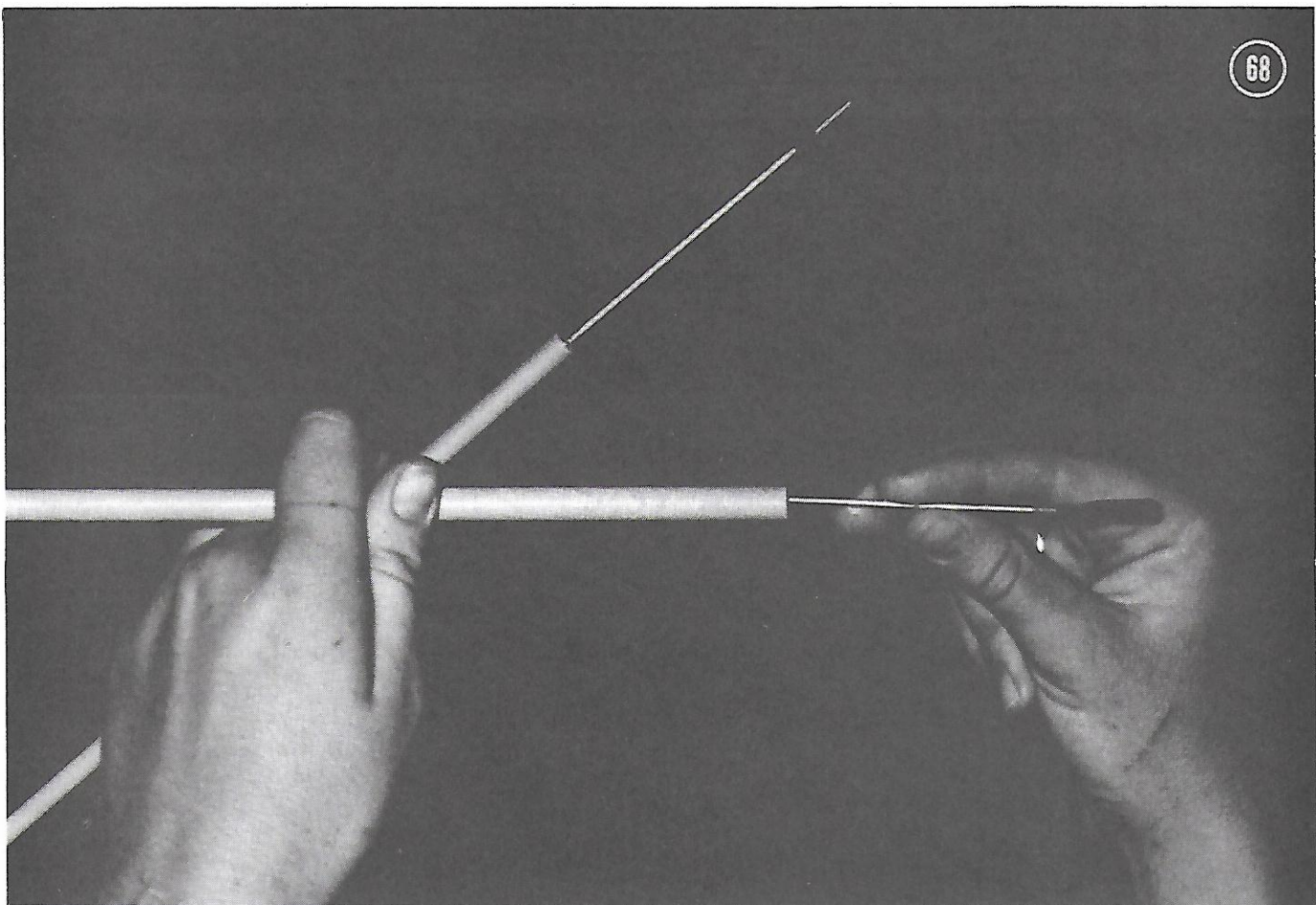
Align the center line of the template with the lay-out on the core. Now, taking care the template doesn't slip, use the channeling tool and make a bed for the hinge mount. It may help to tape the template in position to prevent slipping. Photo #70 shows the channeling operation.

It is important the channel be neither too shallow or deep. The top of the mount should be flush with the core surface. A low mount will cause a dip or low spot after sheeting. A high mount will cause skin bulge. Using Tite-Bond, glue the mount in place and, when dry, sand as necessary to match the core contour. Tite-Bond is advisable here as the mount will be sawed in two later. Photo #71 shows the hinge mount in place.

If an aileron linkage system utilizing a bell-crank is to be used, the cavity to receive it should also be channeled at this time, or at least prior to sheeting. Figure 11 shows a typical bell-crank installation. Note the cavity floor is angled to conform with the aileron horn mounting angle to permit free operation.

Prepare a bell-crank platform channeling





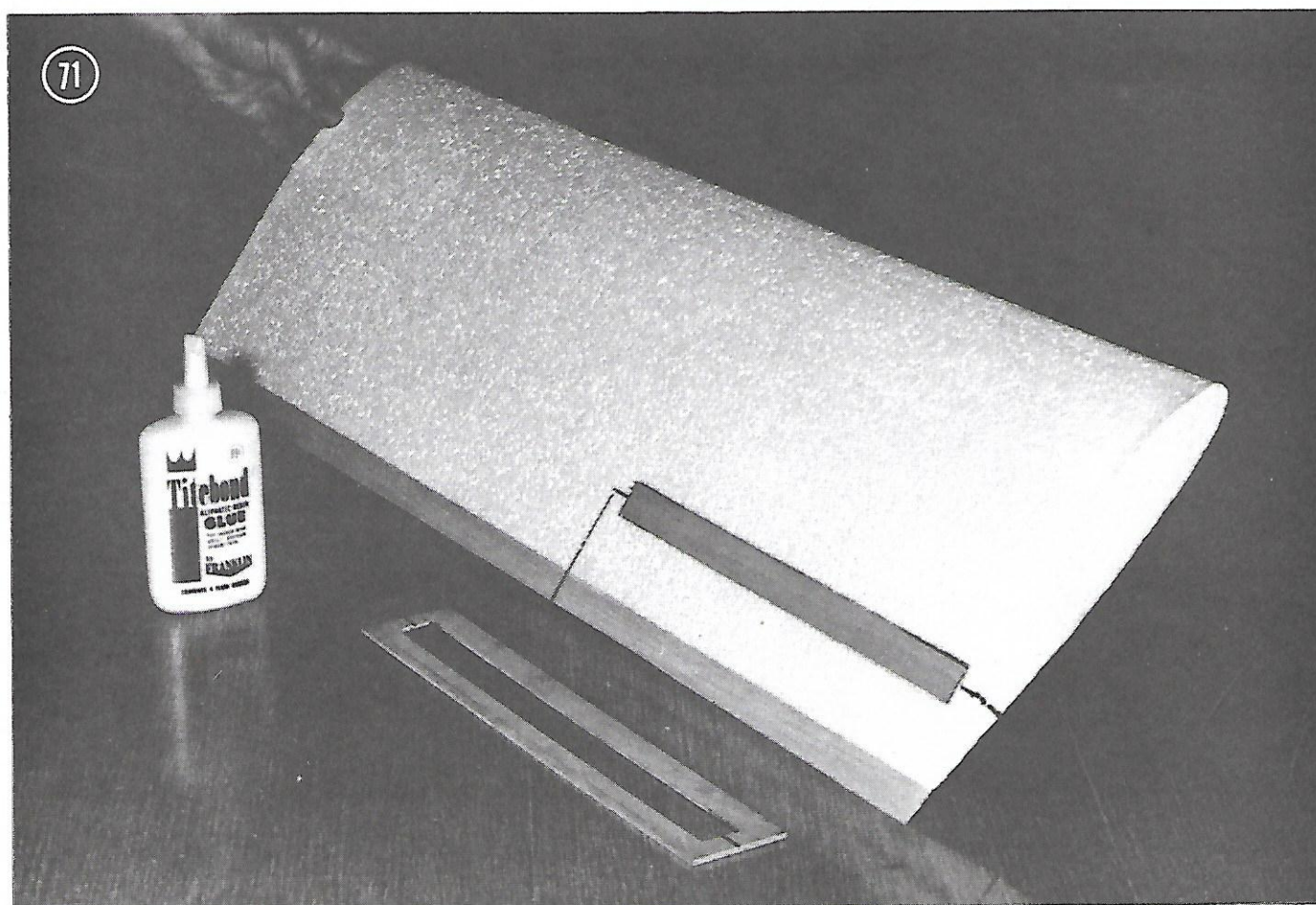
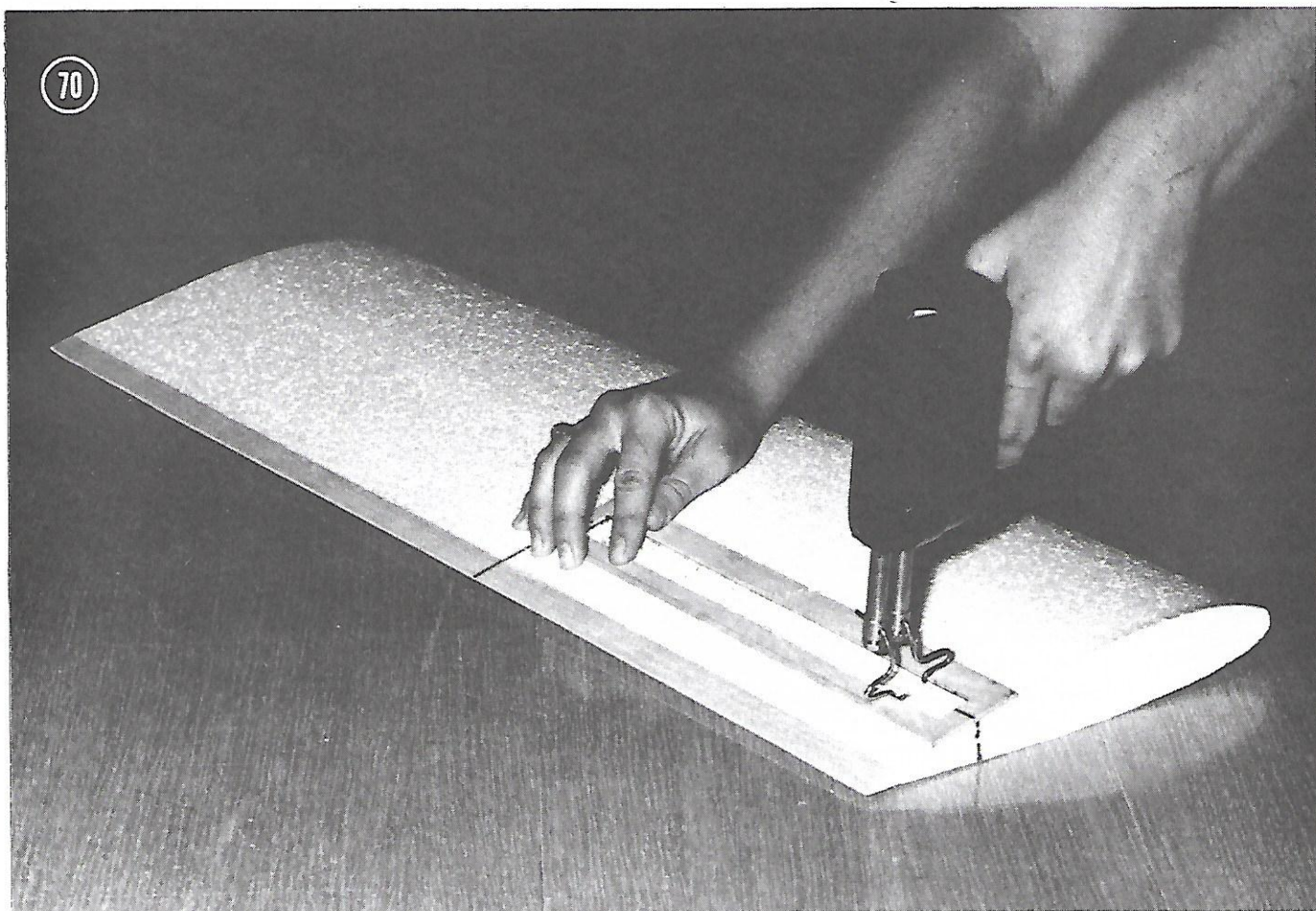
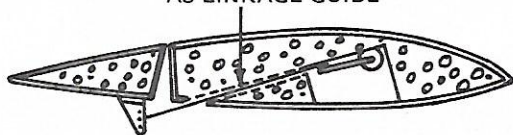


FIG. 11 FIBER GLASS PUSHROD INSTALLED AS LINKAGE GUIDE



WHEN INSTALLING INSET AILERONS, CUT HOLE FOR BELLCRANK PLATFORM. EPOXY PLYWOOD PLATFORM IN PLACE. CUT HOLE FOR LINKAGE WITH GLASS PUSHROD & GLUE PUSHROD IN PLACE. NOW INSTALL PUSHROD LINKAGE. BELLCRANK HOLE WILL BE COVERED WHEN BOTTOM WING SKIN IS CEMENTED IN PLACE.

template similar to that used for the hinge mount and sized to allow adequate crank arm movement but no larger than necessary. A two-by-two inch cavity is usually ample. Now channel the cavity, being sure here, as in all channeling, to make vertical entry and exit of the tip from the template. Do not force the tip in it's cut as the wire may be deformed with consequent cut-out distortion and inaccuracy.

Make up a bell-crank assembly per the manufacturer's instructions. Drill a suitable hole in a piece of 3/32" plywood to receive the bell-crank bolt. Tighten and either mutilate the threads, coat with epoxy, or both to insure the assembly will not vibrate loose. Epoxy the platform in place.

After the core has been sheeted, trimmed and rough sanded, ailerons are cut from it. Begin by laying out the aileron with a fine tip felt pen as shown in photo #72. Be sure the lay-out is correct. The leading edge (hinge line) of the aileron must match the center line of the mount previously inlaid in the core.

Ailerons should be cut with the core laying flat. This is best done by returning the sheeted core to the block it came from which then becomes a sawing jig, as shown in photo #73.

Cut the ailerons from the core at the hinge line. This splits the hinge mount in two pieces so one side is in the wing and the other in the aileron as shown in photo #74.

To allow for down aileron position, the aileron must be bevel cut as shown in photo #75. Use the smallest bevel angle which will allow adequate down position. Twenty degrees is usually ample.

To permit proper fit of the aileron into the wing, allowance must be made for sheeting thickness along the mounting edge and inside end. For example, if 1/16" sheet is used for the core, the top of the beveling cut is in-set 1/16" along the hinge line and an equal amount cut off the inside end of the aileron. If the wing has been covered with cardboard, little practical difference is involved and can usually be disregarded.

With beveling and trimming cuts completed, both the core and aileron exposed foam surfaces are sheeted. Photo #76 shows the cap sheeted aileron and core. Contact cement is adequate for these surfaces.

The next step is hinge lay-out and installation. It is important here that all hinges operate freely to reduce servo loads. This is accomplished by carefully measuring and installing hinges in as near perfect alignment with each other as possible.

Photo #77 shows hinge lay-out and installation. Begin by plotting locations — both vertically and horizontally — as required by whatever hinges are selected. An X-acto is then used to slot the wing and aileron for hinge tabs.

Photo #78 shows an aileron with hinges mounted and pinned. Flex the aileron to check for free operation and, should any binding or roughness be detected, find and remove the cause. As stated earlier, it is important that ailerons move freely.

With the aileron properly mounted the control horn is attached per the manufacturer's instructions. For correct operation, it is essential that linkage from the bell-crank to aileron horn run in a straight line, with provision made for the slight vertical movement of the wire link in it's travel. Photo #79 shows the horn mounted and control wire clevis in place.

Photo #80 shows the aileron being activated manually with the servo link prior to wing joining. This is the final acid test. Final because this is where it counts, and acid because if any previous binding was not corrected, it is now necessary to tear into the sheeting to fix it.

Servo installation is similar to bell-crank and landing gear installations except for size and that the cavity is sheeted. The servo itself is mounted with hardware or double back tape. The cut-out can be made either before or after sheeting, but linkage channels must be provided prior to sheeting along with the bell-crank cavity. The main requirement here is that the installed servo arm and throw lines up with the bell-crank arm.

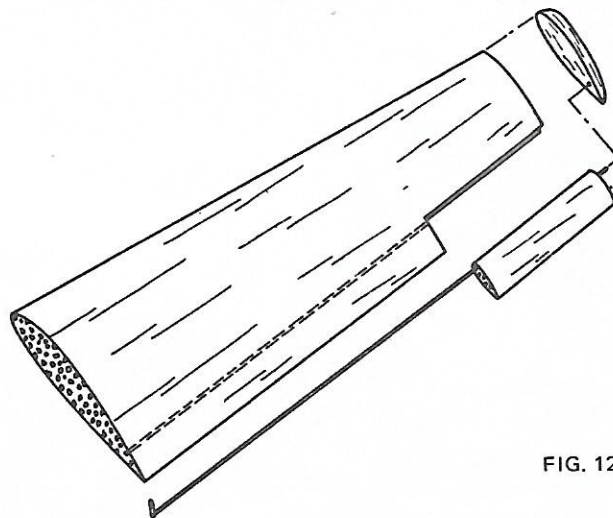
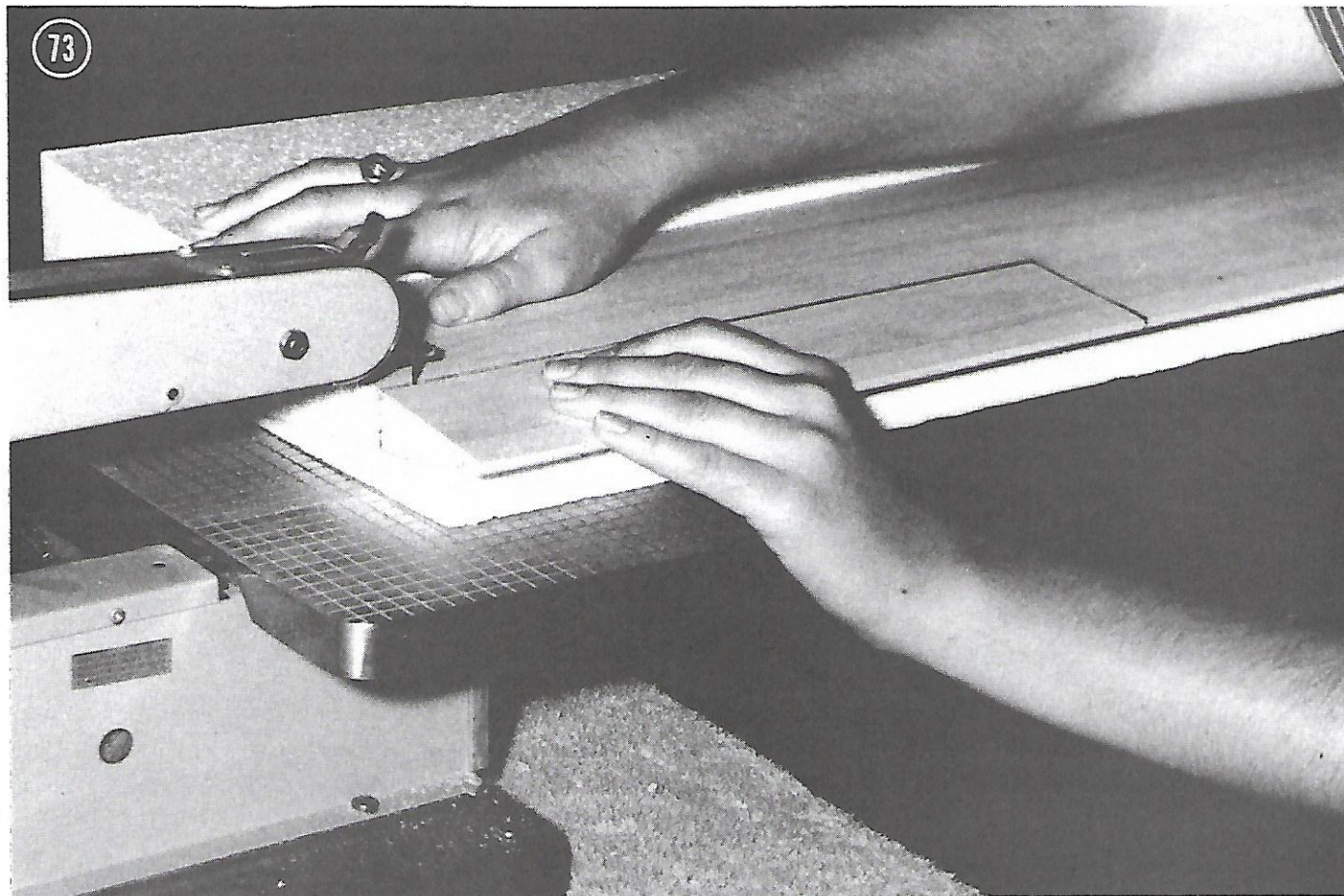
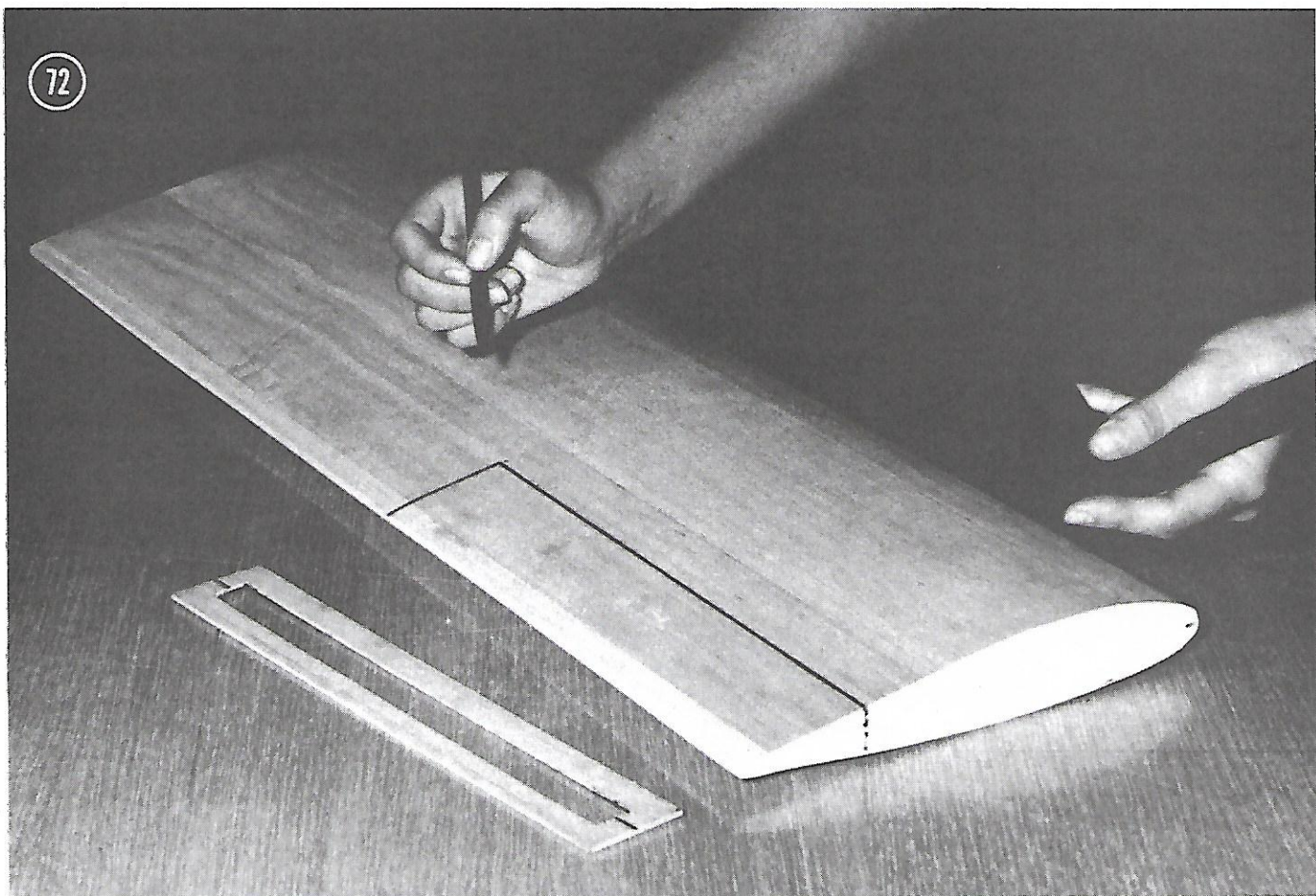
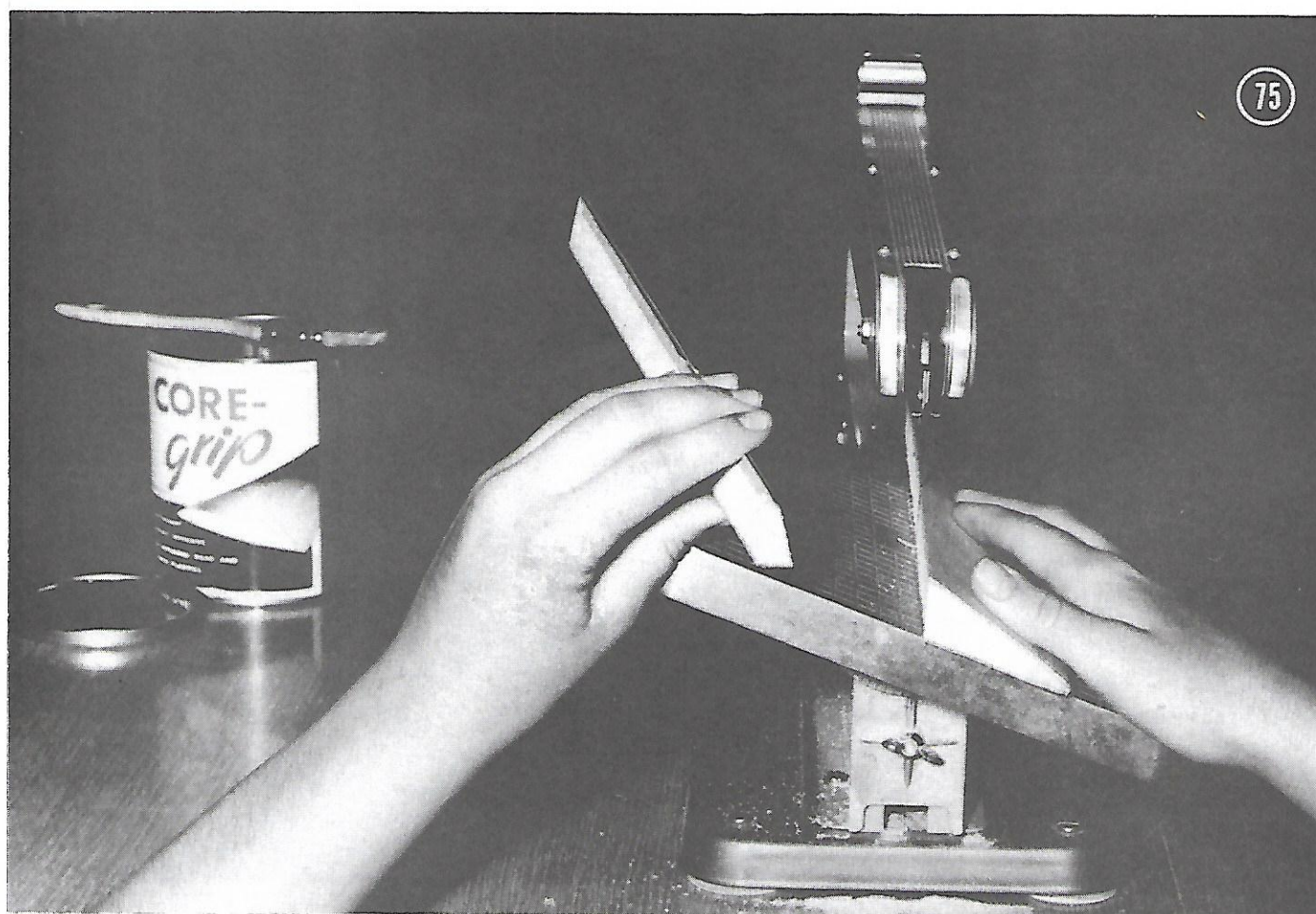
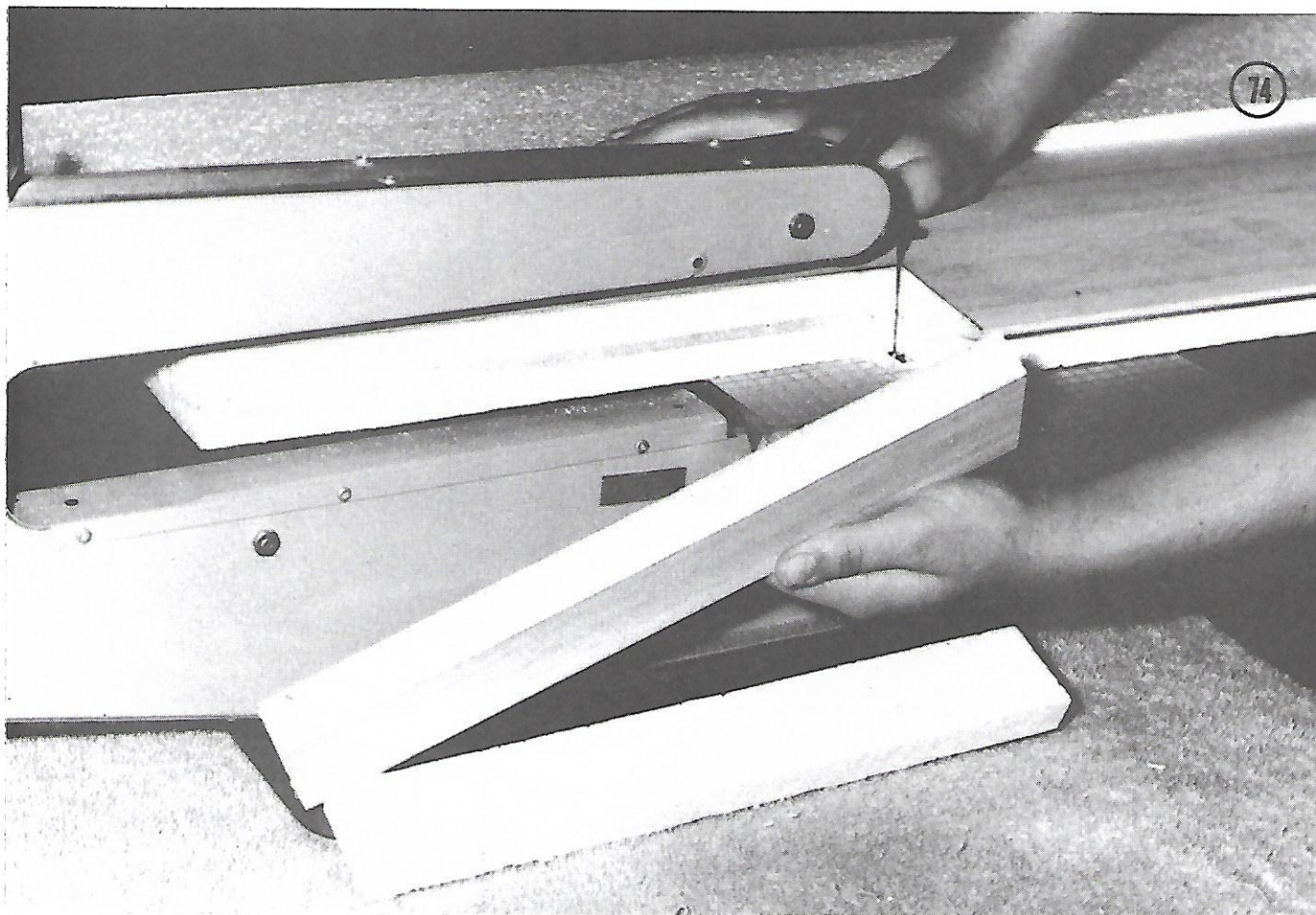


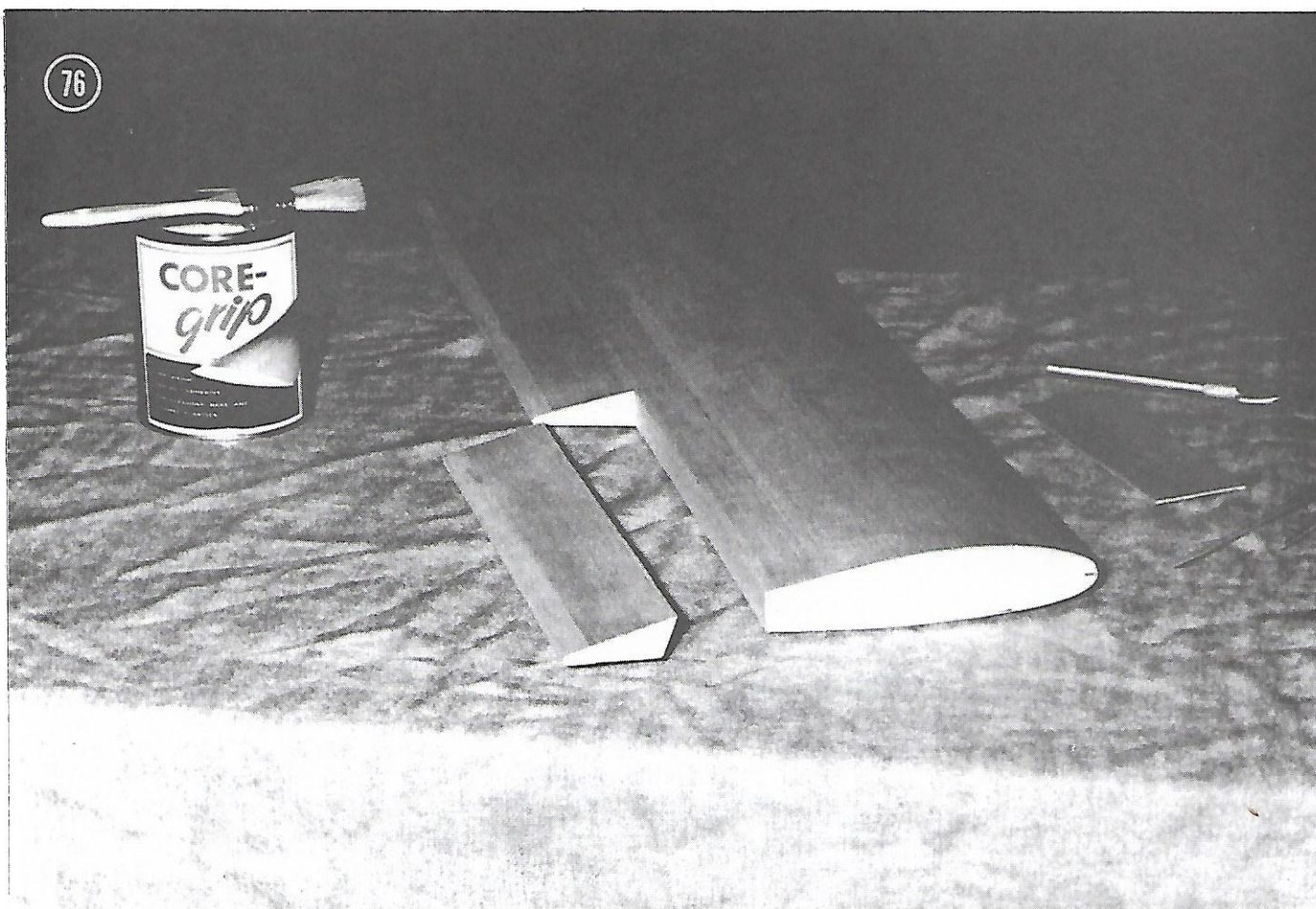
FIG. 12

Figure 12 illustrates an aileron and linkage system that, though more difficult and requiring precision fitting, is superior to the more commonly used exposed horn systems. The installation is similar to that used in full scale aircraft and lends

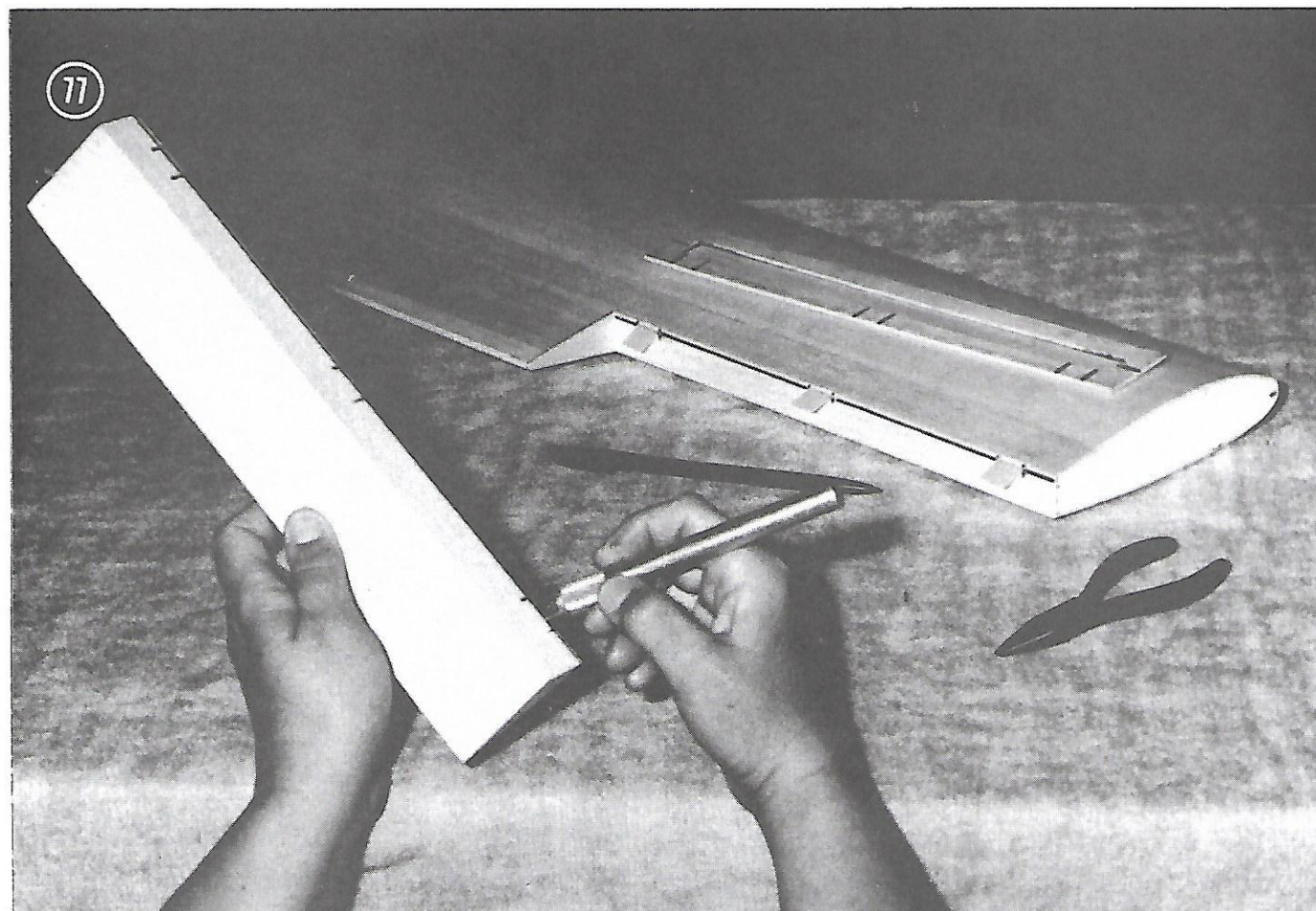


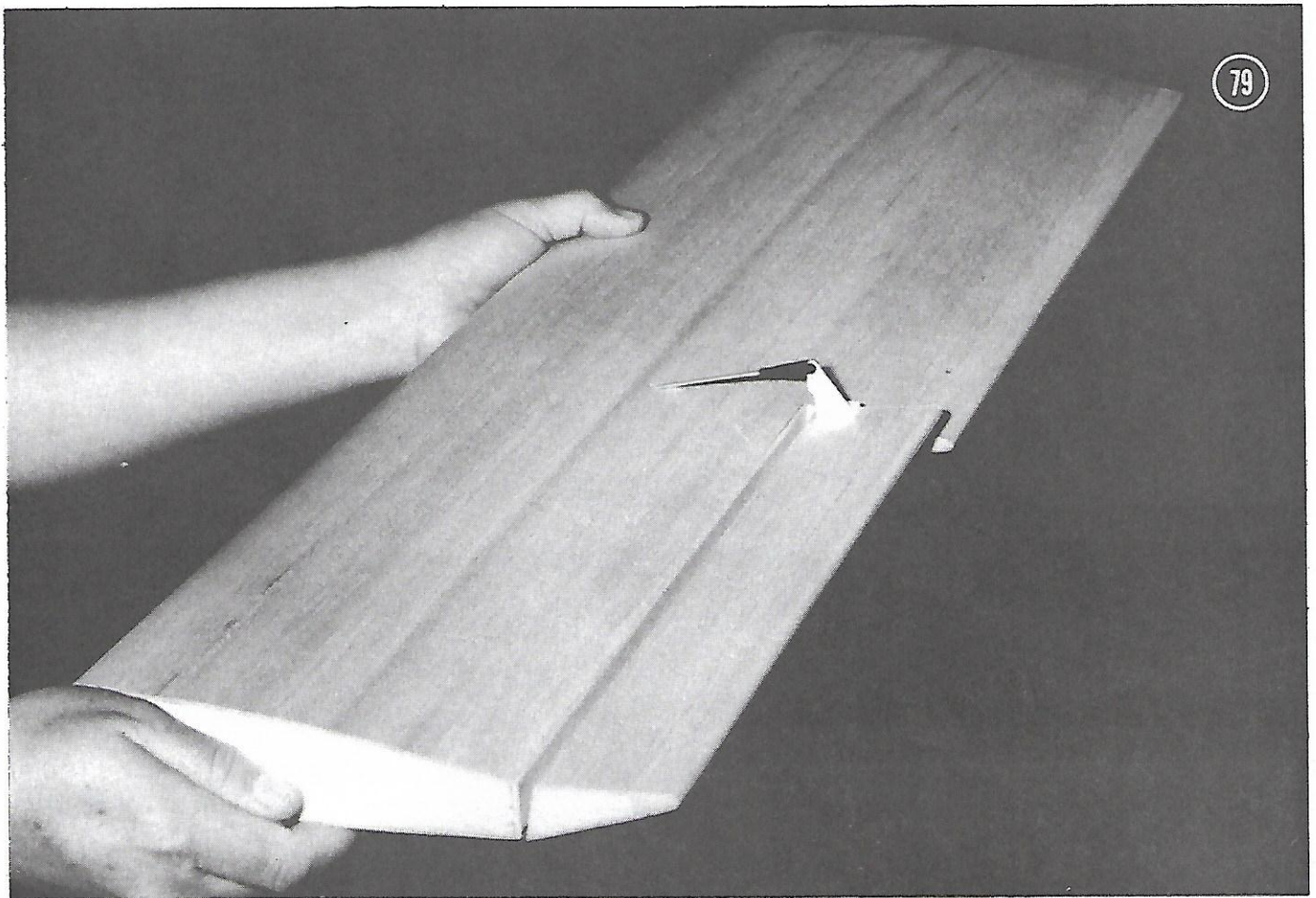
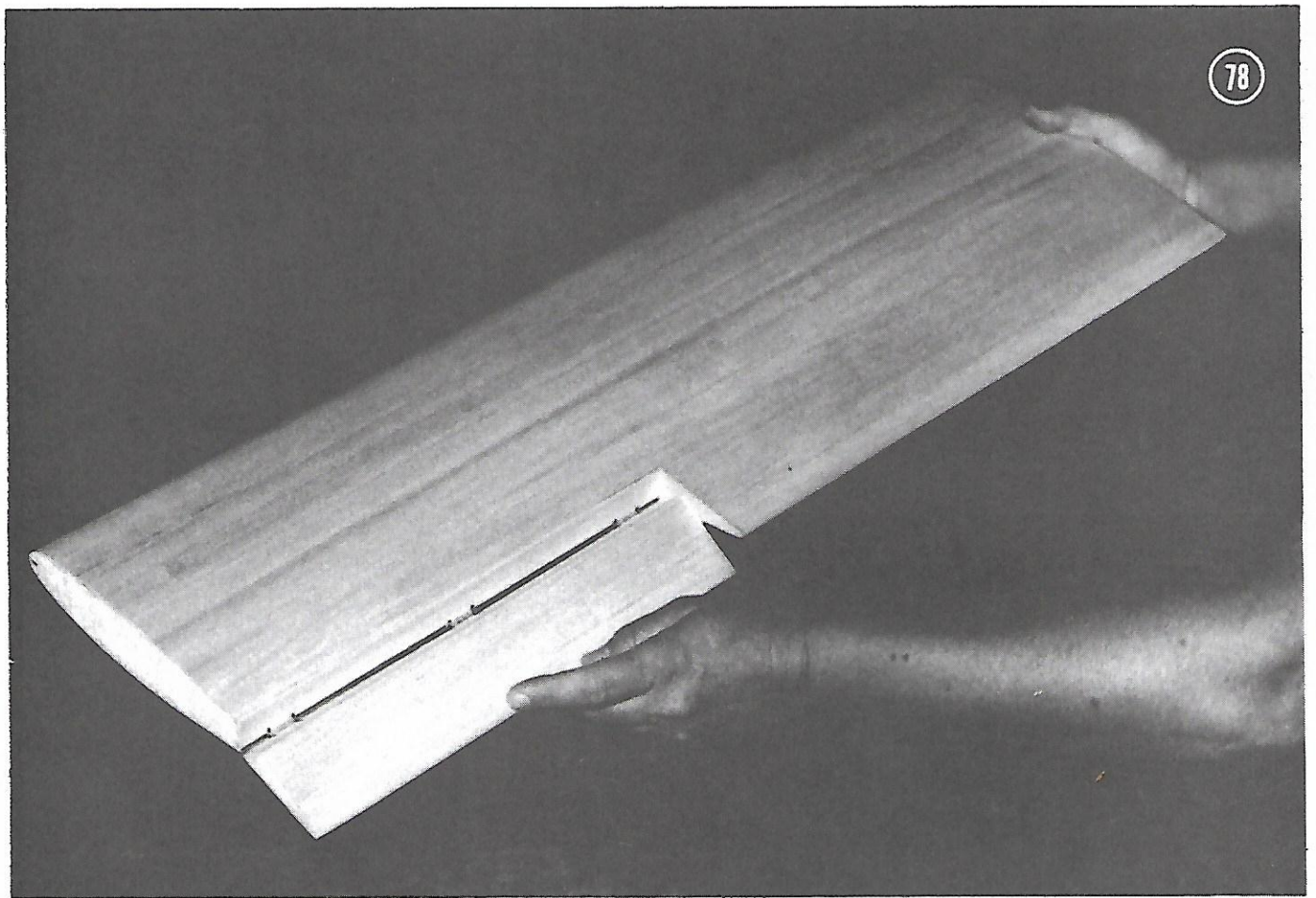


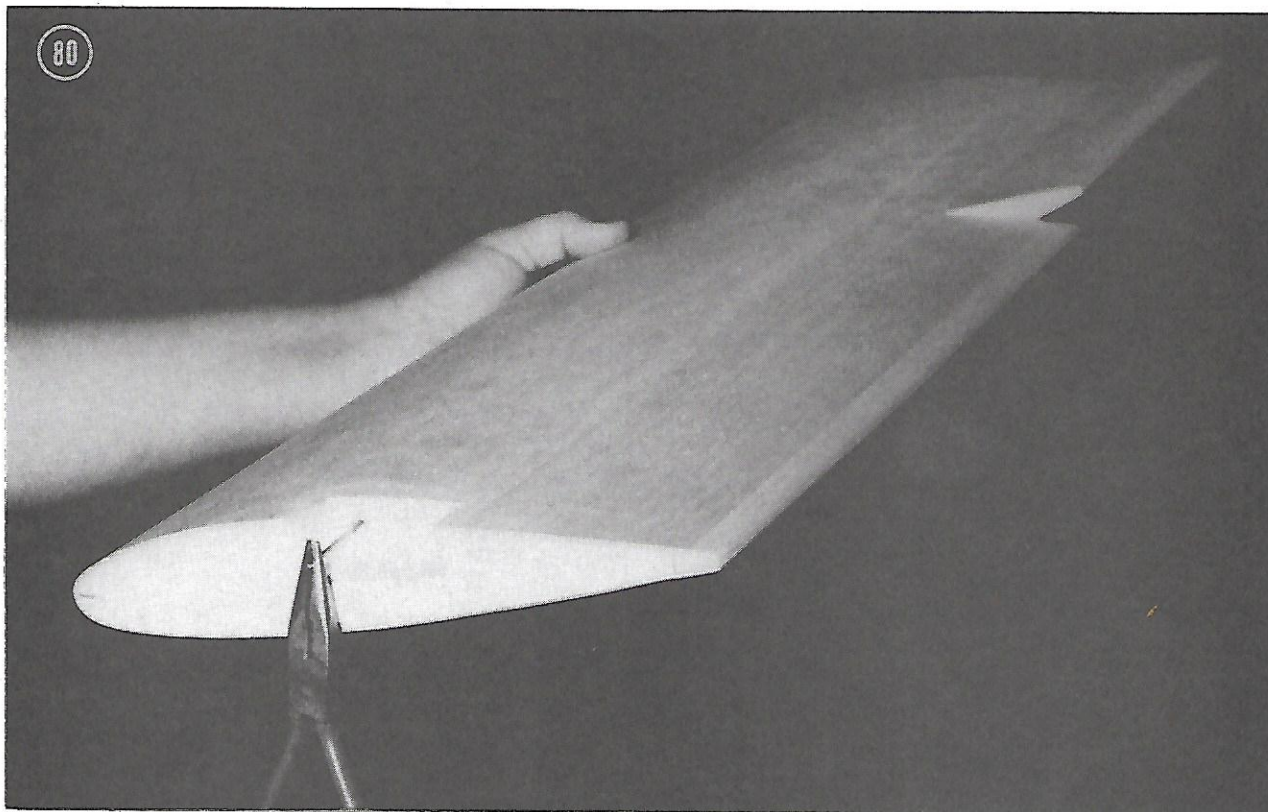
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itself to RC duplicates. An additional advantage is that multi-linkage control systems are eliminated as are core channels and bell-crank cavities.

In this system, formed trailing edge stock is used and sheeting performed as for the usual aileron installation except the hinge mount is eliminated. The aileron is then laid out on the core as before and cut out. The aileron is then discarded.

A new aileron with rounded leading edge is then made up of either balsa or foam. If foam is used, a set of templates minus whatever sheeting thickness was used on the core is prepared and the aileron cored and sheeted.

Form a piece of sheet brass or equivalent metal to match the aileron leading edge. Use heavy enough stock so it will take and retain the form. This metal form is then heated to foam melting temperature.

Alternately apply and quickly remove the heated form from the foam surface in the wing until the proper concave cavity is formed for receipt of the rounded aileron edge. Then sheet the cavity with either plywood, balsa, or cardboard.

The inboard end of the aileron, as well as the mating wing surface, is sheeted with plywood. These surfaces act as a bearing and retaining mount and must be strong enough to support the loads imposed on them without deforming or tearing out.

Select a piece of brass tubing heavy enough to act as a torque member and hinge mount and attach a fitting similar to a bell-crank arm with holes to receive Kwik-Link clevis pins. The installation is similar to that used for strip ailerons

and their servo links.

A hole for this shaft must now be provided for it to run through the wing, aileron (the shaft is secured permanently to the aileron), and into the wing tips. As rounded tips are recommended with this installation, they are attached after the aileron and shaft are inserted into the wing. The tips therefore act as an outer aileron shaft mount.

A variation, should the shaft aileron mounting system not be desired, is to simply utilize it as a transmission member by reducing it's length and securing it to the inboard end of the aileron. In this case, the aileron could be hinged at it's leading edge center line with multiple hinges as for the beveled aileron installation.

A somewhat easier method, providing the core is of suitable dimensions, is to use the recently available concave-convex hardwood in-set aileron fittings. Here the aileron cut-outs are made in the core as for a beveled installation, allowing for proper fit of the fittings. The concave aileron mount is then epoxied to the core cut-out. The aileron leading edge is cut to receive the convex hardwood piece being sure the cut is located in such position that the aileron will mate properly into the wing. Multiple hinges are installed and linkage set as before.

As mentioned earlier, the above system is demanding of greater precision and therefore more work than the usual exposed horn aileron installation. However, the additional work is justified by a very smooth and responsive control system and does away with an unsightly aileron horn.

