

Introduction

Cutting foam cores is like bricklaying; everyone can do it but it takes a little practice to perfect. Foam cores have really revolutionised the model building hobby far more than most people think. I can remember when I first started cutting cores back in 1968, all the experts told me that I was wasting good modelling time as they would never take on and could never replace built up wings. Time has shown them to be incorrect.

Foam can be used for many things in our hobby. I built a complete model from it and covered it in very cheap material: brown paper. This was a Britten Norman Islander. In foam it was a very strong, cheap and quickly built model which flies like a dream. I would estimate that you could build this model for about \$20 without the wheels.

The Material

The foam is Expanded Polystyrene, more commonly called Coolite, but known in the trade as Coolfoam, Isolite and other names depending on who makes it. It is all the same thing: that white stuff they make Eskies and stubby holders from. There is another product on the market called Styrofoam which is pale blue in colour, looks like flexible foam but is comparatively rigid. It is much more expensive and more difficult to obtain. This can also be cut with a hot wire and is nice to work with, but, unless you are making a full size aircraft like a Rutan Vari-eze, I would not bother chasing it. Some of you will be thinking at this point, that the blue stuff is not hard to get; the top of your Eskey is made of it. Wrong! That is just white foam dyed blue. Neither of the above should be confused with Expanded Polyurethane such as you may have seen in surfboards. This is normally coloured white, green or buff. Urethane foam should never be cut with a hot wire unless you have a death wish. When you heat urethane foam hot enough to give off fumes, and all hot wire cutting does this, you are producing cyanide gas which is used to execute criminals in the gas chamber.

So, unless you really know your foams, just use the white beady stuff. Needless to say, even the fumes given off by this white foam are toxic and should not be inhaled. Therefore, do all your cutting in a well ventilated area and keep it nice and safe.

Foam starts out life as small plastic beads each about the size of three pinheads and about the same colour as white rice. These beads are shot into a steam heated hopper where they are heated and emerge as white expanded beads of varying sizes. The longer they are heated the bigger they get. They weigh the same as before heating but occupy more space. They are then poured into a big mold roughly 12 feet long by 3 feet by 4 feet. This mold is sealed. Then high pressure steam is introduced and the beads expand a bit more and stick to their neighbours. The result is a very large block of foam which is stored away for a period so that the water content disperses and the block is ready to be cut to size and sold. By dyeing the beads prior to expanding, any colour can be produced. The foam comes in different grades of a specific weight per cubic metre.

For our purposes we can ignore all this and use whatever foam comes along: normally building grade is the most commonly sold. You may see small foam signs made of styrene and for this they use what is called display grade, which is a very small bead and very closely packed so that a smooth surface is achieved after cutting which can readily be painted. This grade of foam is

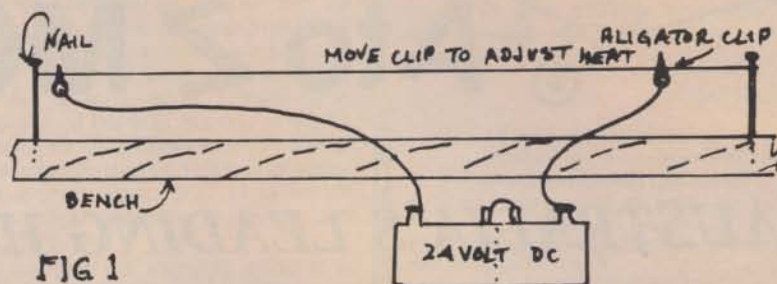


FIG 1

quite dense and is excellent for thin glider wings, but you will pay much more for it and it is not usually able to be bought off the shelf. The blue Styrofoam previously mentioned is made by mixing the appropriate chemicals and gassing it up like a soda syphon, then extruding the lot out of a die. It is rapidly hardened and ends up as a hard mass which is cut to size as needed.

Foam in Use

We can make wing cores, fin and stab cores, floats, fuselages, wheel spats, cowl molds, wheel chocks, fuselage jigs: you are limited only by your imagination. Have you ever been working on a wing or fuselage and had it get hangar rash from being laid on a rough old bench? Well, fret no more. Make a trip to your local fruit shop and ask for a foam fruit box. They are just the right size and by cutting a V out of each end you can rest the object in it and work away with impunity.

To cut the foam we use a device called a hot wire. This is a piece of wire stretched taut between two points, with a current of electricity applied so that it heats up. This hot wire is passed over a pair of templates of the shape you desire with the foam between them and the wire cuts a core of foam from the block.

The Wire

What sort of wire can be used? I use Nichrome wire 16 thousandths of an inch diameter and one metre long. This can be obtained from jug elements or from a shop that makes these elements, but these have a nasty habit of breaking as they are a bit on the thin side. It is better to use stainless steel fishing trace, the E string from a guitar, very thin piano wire or even control line wire. You can experiment here. To this you apply 24 volts which can be obtained by putting two car batteries in series or by obtaining a transformer which will deliver 24 volts at 4 amps continuous current. Another source of power is a battery charger that can be adjusted to supply at least 24 volts. I use a transformer, purchased from an electrical supply house.

When you get your bit of wire, drive a couple of nails about five feet apart into a banch, stretch the wire between them and attach it to the nails (see Figure 1). Get your power supply ready, run a lead to each end of the wire, connect them with alligator clips and turn on the power. The wire should heat up and expand (go slack). What we are trying to determine is how long a piece of wire we need to produce the right temperature to cut the foam. The wire should not be red hot. When the wire heats up you will have no visible change, but DON'T TOUCH it with your pinkies to see how hot it is! You can get a nasty burn, at the least.

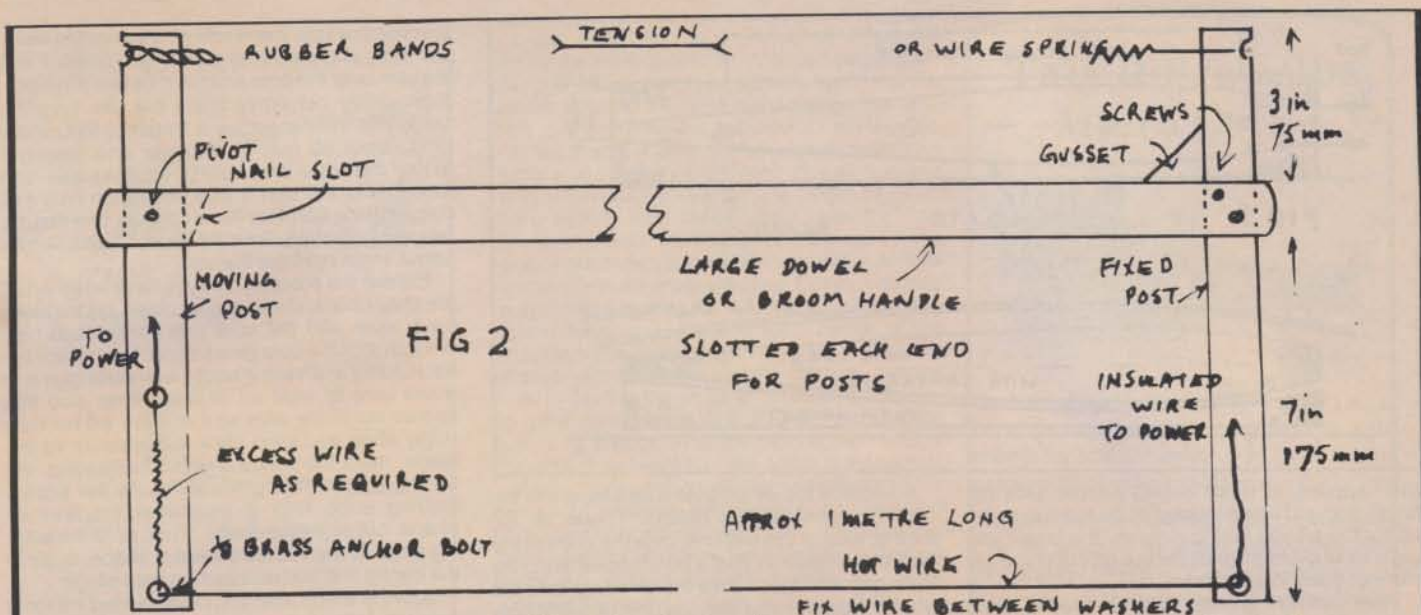
Have on hand a piece of scrap foam and, after the current has been applied for a few seconds, press the foam against the wire. If the wire is hot enough it will start to melt the foam and hence cut

it. It should cut the foam at a rate of approximately 2 feet per minute without feeling like you are extracting a tooth. If the wire is too hot it will cut a slot about 2.5 mm wide or wider in the foam. If it is right it will cut a slot just a bit wider than the wire. If you find that the wire is reluctant to cut, move the alligator clips closer together and try again. If, however, you find that the wire is getting too hot, lengthen the wire or try a different type of wire. Alternatively, reduce the voltage. Most probably you will find that the wire will not be hot enough, so start moving the clips closer together.

Having ascertained the length of wire required, we can get down to making our cutting bow. The ideal is to have the cutting wire about 1 metre long. This should enable you to cut most wings that you will need. See Figure 2 for the cutting bow design. Study the plan and you will see that it is very simple. In the past you may have been put off cutting your own foam cores by reading other articles on foam core cutting, and in particular the construction of cutting bows. When I first started I made the simplest bow that I could think of and it has cut thousands of cores. Every now and then I would read a construction article on cutting bows and would be amazed at how complex and costly they were, and none of them ever did anything more than mine did. I believe in the KISS principle: Keep It Simple Simon.

The idea is to keep the bow as light as possible and therefore easier to use. You will see that one end of the bow is fixed and the other is able to pivot. The reason for this is that the wire will expand when it is hot and you need to be able to keep the tension on it. When the power is turned off the wire will contract. To keep the tension on the wire we use either a spring or the very simple rubber band method. I favour the last. Go to your local tyre dealer and ask for an old tube, and from this cut some rubber rings about 1 inch wide. Join them together and stretch them between the tops of the posts. Needless to say, when your bow is to be stored away, take the tension off the wire by unhooking the bands.

I attach the wire onto a brass bolt as per the diagram and make sure that I have a washer between the wire and the wooden post. This stops the wire from burning into the wood. The leads that go to the power supply are attached under the nut and washer, next to the wire. So that you don't have power leads getting caught up in everything, run one lead up the post, along the dowel and tape it to the other lead. Tape it in place on the post and along the dowel every six inches or so. This means you have the leads coming from only one end of the bow. If you use a power transformer you should put a switch in the power line between the power point and the transformer. If you go for the car battery way, you should have a switch in one of the power leads to the cutting bow. This is better than going to a wall or unclipping leads to turn the power off.



A word of caution. If you are using a transformer as a power source, DO NOT make your cutting bow from aluminium tube or similar. Should your transformer short out for any reason you will have 240 volts in your grip and you will be holding onto it with both hands. If you still don't take heed, make sure that your insurance is up to date. Besides, wood is cheaper than aluminium, even though it may not look as nifty.

If you find that you have to use a good bit more than 1 metre of wire, anchor your wire as per the diagram and about one inch higher than the anchor bolt, put in another bolt then form the excess wire into a spring shaped coil and secure it under the top bolt and attach the power lead to the top bolt (see Figure 2). This little coil is in effect a dropping resistor. If you have an electrical bent, you may want to make up a rheostat and put that in the line to adjust your voltage. All this is great if you want to fiddle around. However, I prefer to get on with the job.

The Wire in Use

Well, we now have our bow and our power source so we need a pair of templates, a block of foam, a good flat table surface and some nice weights like a couple of house bricks or flat pieces of steel. Find yourself a nice plan and make sure that it is one with a constant chord wing section; not tapered, as tapered wings are more difficult to cut. In this case I would recommend that you obtain a plan which uses foam wing cores. Cut the templates out of thin ply, about 2 mm thick, or from thin aluminium sheet, or virtually any material that won't burn easily. I have used balsa, but for this you have to be very careful and experienced.

If you don't have a foam core plan, then trace the outline of the wing aerofoil shape that you want and draw a line 1/16 inch inside this to allow for sheeting; and also allow for the leading edge and trailing edge (see diagram Figure 3). If you use a thicker or thinner covering material then you must make allowance for this in your template size. Cut one template accurately to size

and then cut another template just slightly large and fix the smaller onto the larger with a dab of hot stuff or a couple of small tacks, then sand down the larger template to match the smaller one. This will ensure that both are the same size. Make sure that the edges of the templates are very smooth with no nicks, as the wire will catch in any nicks and leave grooves across your cores. If, however, you do get a few minor grooves across the cores, don't worry about it as the wing skins will hide them.

Along the template, mark a centre line accurately on both sides and mark off one inch sections. With a square, take these lines to the edge of the template and number them. Next drill a few holes along the centre line about two inches apart. The size of the holes will depend on the size of the nail you use to push through these holes to anchor the templates to the end of the foam blanks. I use pop rivets that have not been used previously. I sharpen up the ends that I am going to push into the foam and the flanges on the rivets hold the template in place very nicely.

Now get the plan and measure the size of the blank, that is, the plan view of the block of foam you are going to cut. Measure the length of the wing core (half the wing span less the tips) and the width of the wing (that is, the length of the template) and cut the block of foam to this size. You can do this by putting straight templates on the ends of the block and cutting with the hot wire (see Figure 4). Make sure that the blank is cut square, as the accuracy of the wing will depend on this. Along the ends of the foam block mark a centre line and pin the templates onto this, making sure that the centre lines on the templates are lined up with the centre lines on the block, and are parallel end to end. If they aren't you will cut a warp into the wing core.

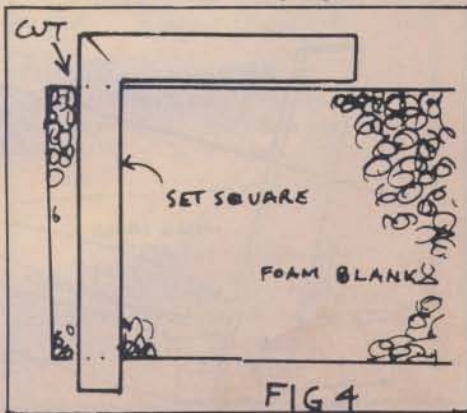
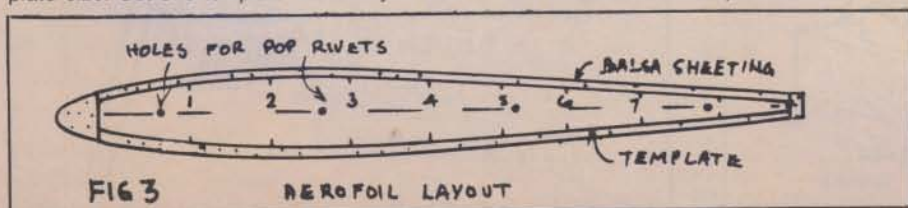
Now add a few pins so that the wire starts into the core properly and does not catch on the front of the template (see Figure 5). On the leading edge of the template push the pop rivets into the foam outside of the template so that when the

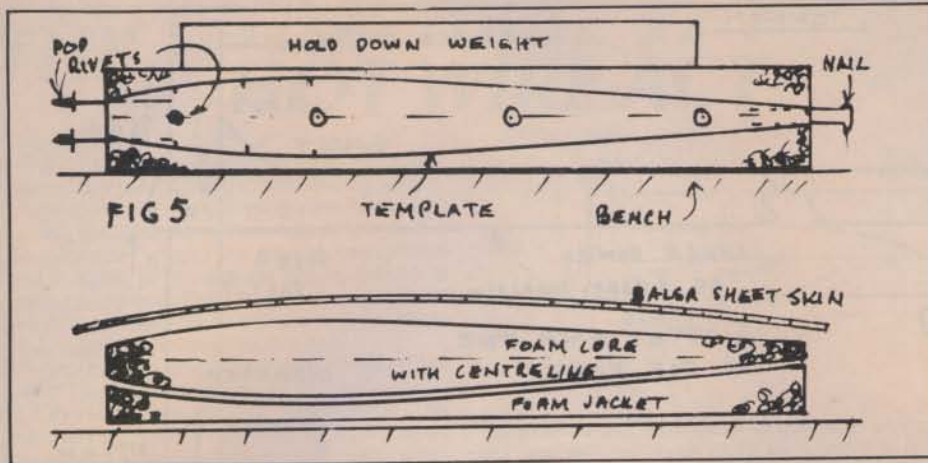
wire starts to cut into the foam it will slide onto the edge of the template and not catch on the front of it. (Or simply extend the template with run-in glides. M.G.) The little bit of foam that sticks up from the leading edge can be sanded off later without any difficulty using medium grade sandpaper. At the trailing edge of the template I use a nail if the trailing edge is not too wide, or a couple of pops if it is going to be wide, the same as for the front.

Cutting

Place the foam blank with the templates attached onto a flat table and on top of this place the bricks or steel plate weights so that the foam blank is dead flat. From now on we need two people, but when you become experienced you can manage by yourself. One person has to be the counter (caller) and the other the follower. The counter calls out each number as the hot wire goes over the mark on one template and the follower makes sure that his wire is passing over the same station number on the other template at the same time. This is not as difficult as it sounds.

When the wire is cutting through the foam it will tend to drag a little in the centre if you are going too fast, but you can still end up with an acceptable core. I find that it is best to cut from the front, i.e. from the leading edge to the trailing edge, as the trailing edge is usually flatter and you will not scallop the centre of the core and end up with a low spot. As you get to within the last inch of the trailing edge, slow down a bit so that you both come out of the foam at the same time. If you don't come out from the foam together you will end up with a wonky trailing edge. However, if



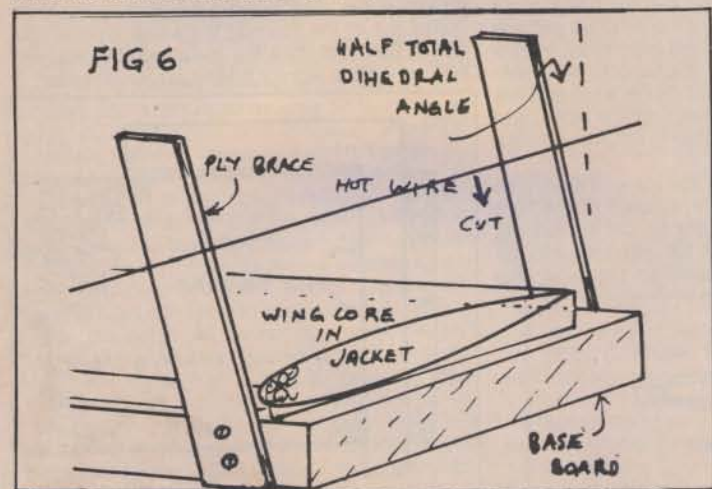


this happens, all is not lost, as you can slice this bit off and add balsa instead of the foam to make up for the bit you had to remove. It is best if you get a bit of old foam and practise on it until you get the exit down to a fine art.

After cutting the cores, cut the dihedral angle on the inner end of the cores. Make a little jig (see Figure 6). I get a piece of thick chip board and screw a guide on each end and place the end of the core in this and slice off a small piece. The result is an accurate dihedral angle. Remember, if you want 8 degrees you make your template for 4 degrees so that when you cut both sides you end up with a total of 8 degrees. If you want to make this little jig adjustable, use just one screw in the end so that you can adjust the angle. Make sure that you have the ply vertical nice and tight before you start cutting though. You will see that if you make the angle greater on your jig you can use it on the other end of the wing to make nice bevelled wing tips. I prefer to cut the dihedral angle prior to sheeting rather than sheet the wings and then sand the dihedral in.

Sheeting

Having done all this, you now have a nice set of cores that need to be covered with something. To start off I would suggest that you use balsa; it is easy to work and is strong. If you like you can use cardboard or ply. Measure the chord of the wing and allow about 15 mm either side bigger and that will give you the width of the sheet required. Add about 15 mm to each end of the core length to get the length of the sheet. Trim the edges of the balsa sheets so that they are straight, and butt them up to the next sheet. Run a strip of masking tape along each join. Do this until you have the required width (see Figure 7).



that you are sure that it will not dissolve the foam. Let it dry and place the core in the jacket. Place the skin over the core and put it squarely in place. Now gently but firmly press the skin onto the core. I do this by getting a length of PVC water pipe about 50 mm in diameter and placing it along the core and rolling it backwards and forwards till the skin is attached. Then I rub it all over with the flat of my hand to make sure that it is properly attached. Trim the excess balsa skin off about 1 mm out from the core.

Repeat the process until you have attached all the sheet skins. Using a razor plane, cut the skins back level with the core and lightly sand until smooth with the core (see step 2). Now attach the flat leading and trailing edges with white glue and make sure to wipe off all the excess glue that comes out at the joins so that there will not be a ridge when you sand back (see step 3). At this stage, mark the centre lines on the leading and trailing edges then gradually plane the square leading edge until it resembles the finished shape, but slightly oversize. Then sand the leading edge to the required aerofoil shape, close to the centre line and constant on both wings.

Join the wings after you have sanded the roots smooth. I use 5 minute epoxy, but you can use what you like, providing that it won't attack the foam. (Before putting any substance onto foam, try it on a piece of scrap foam to make sure it is compatible. There is a rumour that epoxy will not attack foam. This is incorrect as some epoxy compounds will dissolve it in a flash. Please be careful.) After the joining is complete, wrap a piece of 4 inch fibreglass tape around the centre section and epoxy in place. You now have a set of wings. Put the tips on as you would for any other wings. If you propose to use these as high wings, just cut out the servo compartments by marking the outline of the bay, cutting the balsa, and then picking the foam out and lining the hole with a bit of scrap balsa. Pick away neatly and you will have a neat hole. A nice sharp balsa knife will cut the foam around the edge of the hole to keep it square.

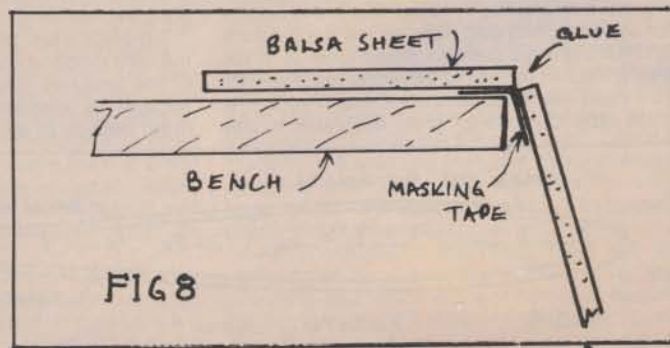
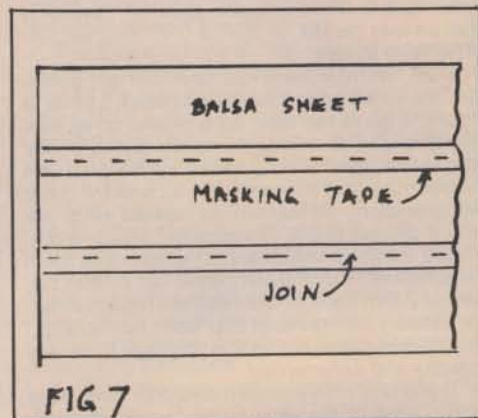
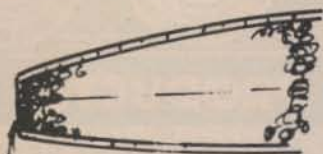
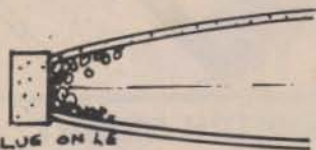


FIG 9 STEP 1



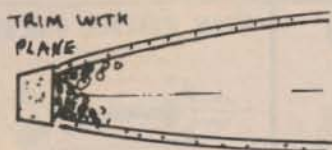
TRIM

FIG 9 STEP 2



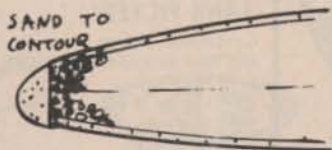
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FIG 9 STEP 3



TRIM WITH PLANE

FIG 9 STEP 4



SAND TO CONTOUR

FIG 9 STEP 5

If you intend to use these as low wings and mount the wheels onto them, obtain your undercarriage blocks and mark around them onto the bottom sheet of the wing in the appropriate position. Cut the balsa out and pick out the foam so that the blocks fit in neatly. Now epoxy the blocks in place so that the blocks don't stick out from the wing. When the epoxy is dry, anchor the blocks in place with 1/4 inch dowel (see Figure 10). Drill down into the u.c. block and into the foam. Drill as far into the foam as possible; you can even drill right through the other sheeting. Cut your dowels roughly to length and epoxy into place. You should have one dowel in each corner of the undercarriage block. When dry, trim the dowels off level with the blocks and the sheeting. You will have to destroy the wings to get these blocks out, so get it right the first time. It is not necessary to put wing braces in a foam wing if it is built correctly: I have not had one break in the centre.

If you follow this guide you will end up with a nice, light, accurate wing that you can be proud of. I have only just touched upon the subject of foam wing construction, but it should be enough to get any average modeller started.

GETTING INTO THE ACT

Since development of the foam cutter I have supplied several to local customers, and the production version is available from me, either as components such as transformer or cutting bow separately, or as the complete unit. The price varies depending on the amount of extra work involved, but is less than \$150. I would be willing to accept orders at: 19 Wyman St., Stafford Heights, Qld., 4053; and may be contacted on: (07) 359 9101.

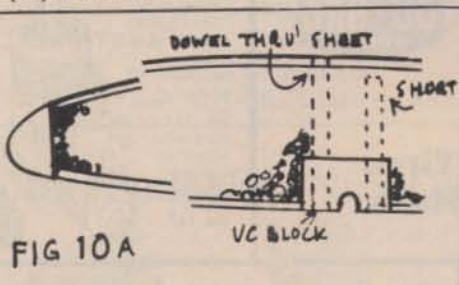
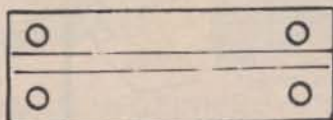


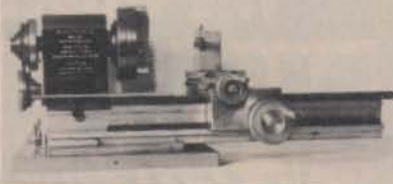
FIG 10A



PLAN POSITION OF DOWELS

FIG 10B

Taig II Precision Micro Lathe



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