Foam Cutter Power Supply Project – by Mark Saunders Nov 2017

With a view to being able to scratch make or modify 'foamies', I looked into buying a foam cutter, only to find that the affordable, hand-held ones were battery powered and therefore could only be used with the cutter supplied with them, which were inevitably fine wires held in a bow. If you want to make shaped cutters for cutting channels or servo holes, then you would want to use a thicker stiff wire, which accordingly would have a much lower resistance and need a higher current than a battery powered device could provide.

Now for the physics:

The Resistance of a conductor is proportional to Length/Cross Sectional Area. (eg Short fat wires have a lower resistance than long thin ones).

Resistance determines how much current flows for a given voltage according to Ohm'sLaw, R=V/I.

Power dissipated in a conductor is V x I (or I^2R, by substituting V). Seeing as R is proportional to Length, the power dissipated per unit length for a given cross section is determined by I^2 alone. So for a piece of 20 Gauge piano wire, 5A would dissipate the same power per inch independent of the length. This means you need to be able to adjust the voltage of the Power Supply to get the right current for the length and type of wire you are using for your cutter. However, you want to measure the current, so as to set the required power per unit length for the gauge of wire you are using.

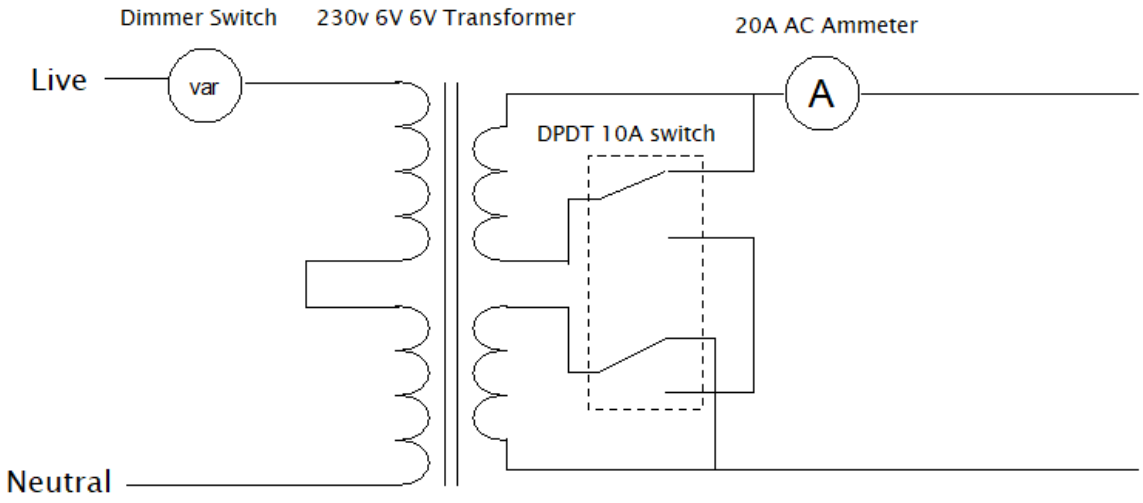
Component Selection

The types of wire suitable for foam cutting are generally very low resistivity, meaning that the power supply needs to produce plenty of current. It turns out that this could be as high as 10A for a 16 Gauge piece of piano wire. Voltages will be low (although proportional to the length of wire), so for long, thin cutting wires, such as those needed to cut a 1.5m wing core, you may need up to 12V. Overall, 100W of power at up to 10A and 12V (although not at the same time) should cover it.

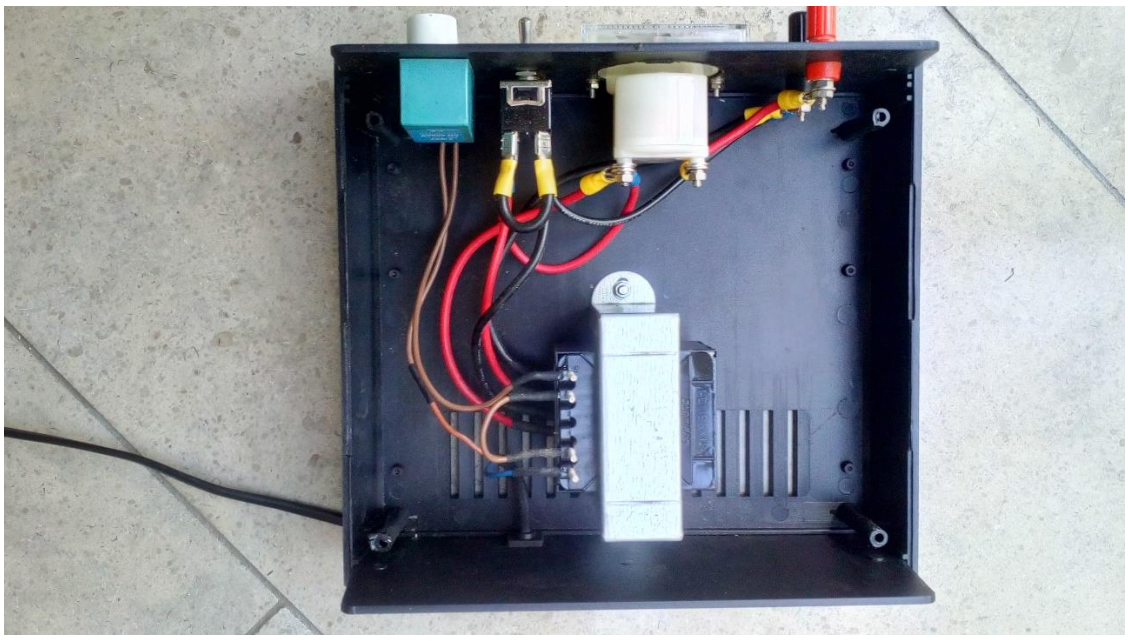
In the olden days it would have been very difficult to make a variable power supply to do this, and you would have probably ended up having to use a Variac, a type of mechanically variable transformer. However, the humble dimmer light switch provides finely adjustable power at mains voltages, which it achieves by crudely chopping the AC signal using a semiconductor thyristor switch. Dimmer switches come in lots of guises, but you need to choose one which is suitable for inductive loads (such as your transformer). The one I chose was £7 from ToolStation, and has the benefit that the electronics module just unscrews from the light switch faceplate for easy re-mounting.

Next in the circuit is a transformer to reduce the high voltage/low current mains input to a low voltage/high current output. At 100VA (100W) power rating the most suitable is the lowest voltage option commonly available, which has Dual 6V output coils. These two output coils can be connected in series to give a 12V/9A output or in parallel to give 6V/18A output. A Dual-Pole Dual-Throw (DPDT) switch connected to the centre tap outputs of the low voltage side of the transformer is used to make this selection. A 20 AC Ammeter to measure the output current completes the circuit. There is no need to

rectify the output convert to DC, although you could do this (with the addition of a diode bridge) if you were planning to use the output for something else as well as foam cutting.

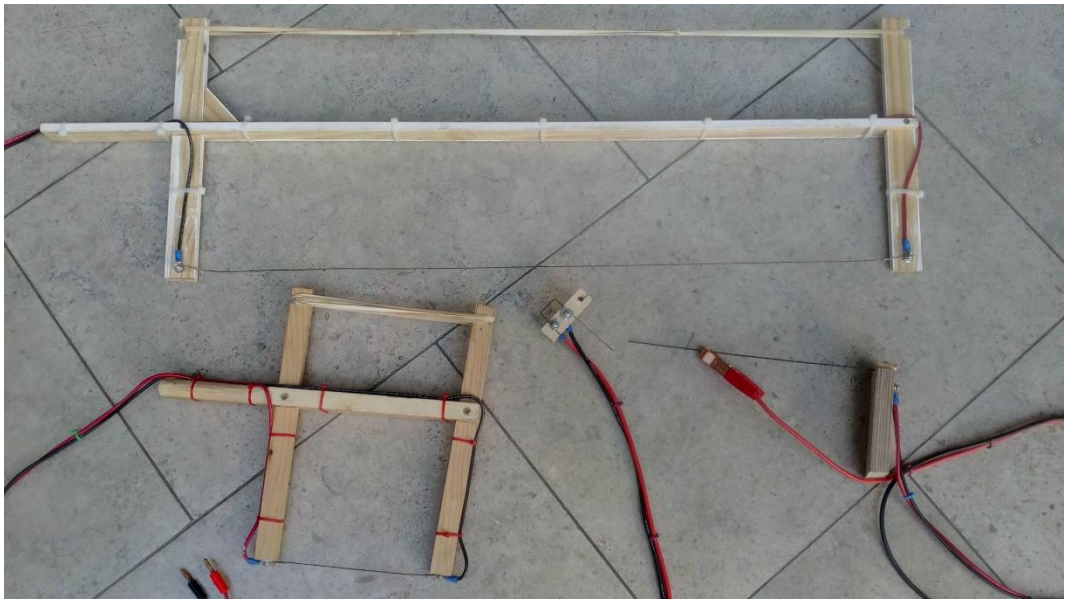


So with all the components selected, all that remained was to find a suitable enclosure (ebay) and get drilling and soldering. The result is very satisfactory. The dimmer switch provides suitable adjustable precision to set the current for long-thin and short-thick cutters. There is no appreciable heating of the transformer so far (although, to be honest, foam cutting is a fairly quick process). You do notice that once you have set a current and the blade warms up, the current drops off. This is because the resistance of wire is dependent on temperature. Let the temperature settle, and adjust the current again. The 6V range is suitable for everything I have attempted so far, but I haven't made a really long fine cutter yet.

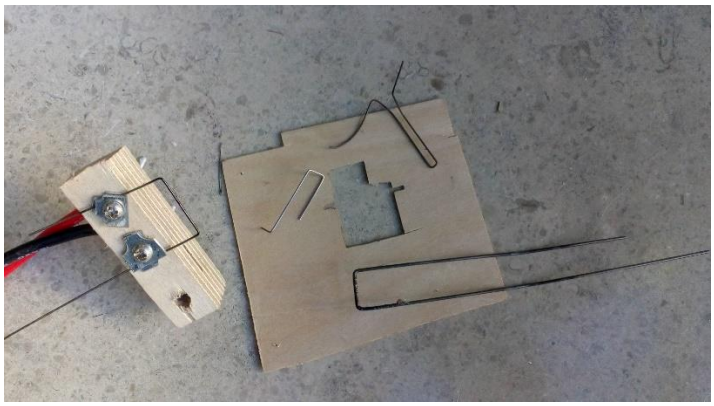


Layout of the internal components

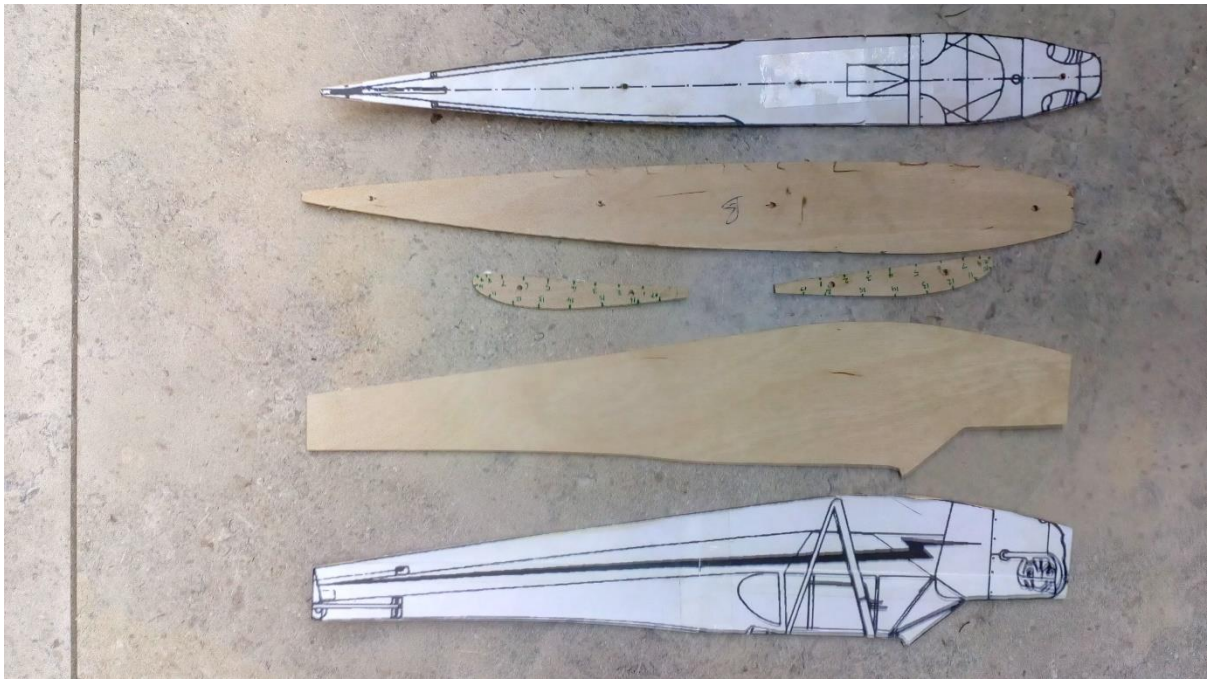
Front panel layout. Note the maximum current markers on the meter



A selection of different cutters



Various profile cutters and a servo cut-out template



Templates in 1mm ply for a DIY Foamie

And the resulting 24” 4-channel model (as yet unflown). Can you tell what it is yet?

Just a word of caution. The input side of the circuit does use potentially lethal mains voltages, so if you are not qualified or competent to do so, do not attempt to make this yourself, or at least get someone who is to inspect and test your work! The coffin-dodging age profile of IVCMAC’s membership might suggest that a Darwinian process should have already weeded out any self-euthanasia candidates, but don’t mess with The Mains unless you know what you are doing. Specifically, my implementation used a plastic box, with everything mains inside insulated again (so-called ‘double insulated’), so no earth connection is required. However, if you are using a metal box, it must be earthed from the mains lead. Likewise, an appropriate (3A) fuse is fitted in the plug.

Because of the relatively high currents used on the low voltage side of the design, a heavy gauge of cable should be used to prevent it getting too hot. (I used 30A wire). You should also be aware that foam gives off noxious fumes while being cut, so do your cutting in a well-ventilated area (and hold your breath!). By far, the biggest risk is burning yourself or setting fire to something, so be careful!