

# Hot-Wire-Cutter

## Concept + Specification Brief

**From:** CASA - Sales [mailto:sales@casa.co.nz]

**Sent:** Tuesday, 26 February 2019 11:00 p.m.

**To:** Peter Cobb (for review)

**Subject:** EPS Foam Wire-Cutter Power Supply + Bow & Profile Follower

## Introduction:

This document represents the general considerations and basic design philosophy for a controlled AC power supply deploying a mains-transformer (*from CASA's stock or elsewhere*) suitable for low-voltage alternating current supply and control of a hot-wire cutter for foamed-plastics including expanded-polystyrene (*alias: EPS*).

The design of a portable bow-tensioned linear wire-cutting frame is touched upon in parts of this review to ensure that suitable (optional) remote-control is provided if/as required to facilitate appropriate external connections.

## Wire:

Nichrome Wire is deemed ideal because of its high polish and corrosion resistance. Wires in the range 22 B&S to 1mm would seem suitable depending upon the cutting rate and cutting length required.

CASA has 1mm + 0.643mm (22B&S) Nichrome Wire in stock (amongst other sizes)

<https://nockers.co.za/specifications/nichrome-wire-resistance-and-weight-table>

0.643mm (22B&S/AWG) grade **N80CR20** is 3.495 Ohms/metre

0.643mm (22B&S/AWG) grade **N60CR15** is 3.591 Ohms/metre

1.016mm (18B&S/AWG) grade **N80CR20** is 1.388 Ohms/metre

1.016mm (18B&S/AWG) grade **N60CR15** is 1.426 Ohms/metre

## Temperature Co-efficient:

<https://en.wikipedia.org/wiki/Nichrome>

Nichrome has a positive temperature coefficient, therefore, the power decreases as the wire gets hot. It is deemed desirable that the operating temperature of the cutting wire is kept as low as practical commensurate with an efficient cutting rate, tolerable bending or bowing of the cutting wire, and minimal smoke. Power adjustment will be required to achieve this and address the temperature coefficient of the Nichrome wire and the regulation of the power supply.

## Stretching/Tension & Expansion:

The tension and thermal-expansion of nichrome wire needs to be addressed in the selection of wire-gauge and operating condition (*length of cut-wire*). Beyond interpretation and implications of the below properties, trial and error experimentation may be needed to determine the optimum wire gauge relative to, however, in reviewing some on-line sources 22 B&S (0.643mm diameter) seems to be widely used. CASA also has 1mm and other sizes (in limited stock).

Nichrome wire has a [Modulus of elasticity](#) of  $2.2 \times 10^{11} \text{ Pa}$   
[Thermal expansion](#) is  $14 \times 10^{-6} \text{ K}^{-1}$

These figures need to be reduced to practical consideration in the range of lengths, typically, below 2 meters for practical wire-cut operating temperatures.

## Power:

The optimum power for any cut-wire is a function of the properties of the wire-gauge and the nature of the cut-width required. There are nominal power-limits for each wire-gauge as represented in Table 3 here.

<https://en.wikipedia.org/wiki/Nichrome>

This cut-width and gauge determines the resistance but power is what does the cutting... ..the higher the power the faster the cut-rate but too much power will create smoke and may be a higher risk to the operating environment.

CASA's 140mm bench-top cutter is nominally 22 Watts (5.5Vac @ 4.0A). As an approximation, a **minimum** power per meter is  $1000/140 = 7.14 \times 22\text{W} = 157 \text{ Watts}$ . Typical cutting wire currents up to 12 Amps (for 250 Watt rated appliance) may be practical for small operations. Practical limitations may be imposed by the gauge of wire, cut-rate and other factors.

Based upon simple electrical calculations, a transformer must be selected such as to accommodate the **minimum** power for any hot-wire-cutting condition and match the resistance of the cut-wire.

The appropriate equations as on-line calculators are:

<http://www.sengpielaudio.com/calculator-ohm.htm>

Adjustments to lower the power could be facilitated with an appropriate electrical control unit internal to the case but externally/operator variable (knob or locked potentiometer)

Typical double-wound (isolating) transformers in CASA's stock are represented here:

<http://casa.co.nz/Transformers/DW/>

## Metering:

A suitable low-cost analogue ammeter can be provided to enable current readings, optimum settings to be logged and proportional adjustments readily achieved from meter-measurements.

## Variations & Control:

If shorter bows/cuts (*wires*) are to be provided for then a suitable increase in power will be required OTHERWISE a **triac** voltage controller in the primary of the transformer may give suitable adjustment within the limits of the maximum current available from the transformer.

## Primary Controls & Protection:

- 1) Fuse Protection (needs only be a suitably rated primary fusing, secondary fusing may be regarded and superfluous unless there are special practical/environmental risks.
- 2) Mains on-off switch
- 3) Mains-active indicator light/bezel
- 4) Trigger-Switch mounted conveniently on the bow-handpiece operating a mains relay.

**Note** - the trigger switch should be low-voltage rated to match the relay-coil voltage and current and a low-voltage supply we need to be facilitated (*separate transformer or power-supply according to chosen components and design requirements*).

## Casing:

An industrial-quality casing based upon CASA's CB19 or CB10 Instrument box with pre-machined cut-outs for all external and internal components.

<http://casa.co.nz/MetalProducts/Boxes/Iboxe-kit.pdf>

Otherwise customers may make or buy according to their own preference.

## Components List (*typical/generic*):

- 1) **Nichrome wire**, of standard length, with tension loops at each end
- 2) Mains **Power-Transformer**, 230V to 22v @ 250VA or to suit specified maximum requirements
- 3) Mains **Input-Connection** (*IEC panel-plug or Cable-Clamp grommet*)
- 4) Mains **Power-Switch** - heavy duty industrial rated (or of customer's choosing)
- 5) Mains rated **Fuse-Holder** for 1.25" x 1/4" cartridge fuse - optional **Circuit-Breaker**
- 6) Mains bezel-**Signal-Lamp** for power-condition status - optional
- 7) Output LOW Voltage power **Connector or Terminal-Strip** 15 Amp 2 pole (*or 4 pole with trigger-switch*)
- 8) **Ammeter** - 0~15 Amps AC (*moving iron or suitable Digital-Panel Meter*)
- 9) Mains 240V ac **Light-Dimmer** controller (*1 Amp minimum rated or triac sub-assembly*)
- 10) **Trigger-Switch**, SPST, low-voltage rated, as deemed suitable to hand-grip or remote control
- 11) Optional **Trigger-Relay**, 1~2 pole single throw. 230Vac 2~3 Amp rated with low-voltage coil
- 12) Optional low-voltage **power-supply** (*ac or dc*) as required to suit trigger-relay operation
- 13) Various insulated **electric-wires** and cables to facilitate internal and external connections
- 14) Sundry mechanical **hardware** as required to mount all components into casing etc.
- 15) **Instrument-Case** - optional CASA CB10/19 or similar size to suit project
- 16) **Circuit schematic**, generic or specific according to project requirements

## Project Records:

A special CASA directory is created to contain appropriate **project files** and associated records:

<http://www.casa.co.nz/Equipment/Control/Hot-Wire/>

Kind regards - **CASA Sales** Department

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