TECHNICAL SOURCE GUIDE

ELECTRICALLY SAFE HOT WIRE CUTTER

by Will Bellman

edited by Patrick J. Immel

Cutting expanded foam with a hot wire is a convenient and economical way for scenery studios to create a wide variety of cornices, moldings and similar decorative elements. However this process is not without risks—hazardous chemicals may be liberated when some foams are heated, and, if the hot wire cutter itself is not properly wired, severe electrical shock may await the unwary. This article will explain what the electrical hazards are and how to avoid them.

Hot wire cutters, by their very nature, have uninsulated current-carrying parts exposed where they can be touched. If these parts are electrically live to ground they can give someone touching them a dangerous shock. Therefore safe operation requires that these live parts be "floating." This is electrician's jargon for the condition of live parts that show no voltage to ground even when in full operation. Floating parts may be safely handled while live by a person who is grounded; the only way that one can get a shock is to manage to insert oneself into the circuit itself. A shock hazard exists when the cutter is controlled directly by an autotransformer as in Figure 1. This unsafe set up is recommended on at least one Internet site and suggested by drawings in some published texts. This simple and inexpensive wiring scheme works just fine—at least until the autotransformer gets overloaded should the cutting wire draw more current than it can handle. However, it can be deadly.

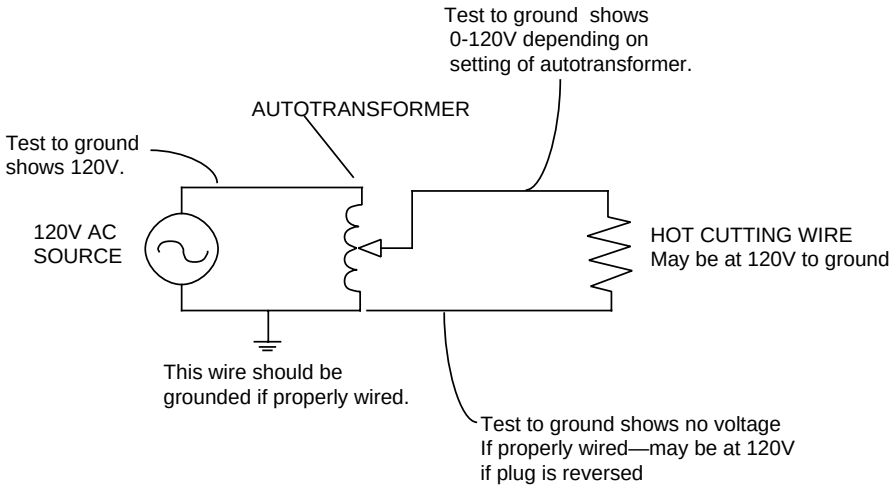

Figure 1. Dangerous circuit for operating hot wire cutter. May also overload autotransformer.

If the exposed cutting wire is not floating, the following common scenario may result in the operator receiving a potentially fatal shock: The foam cutter is on an outdoor concrete loading deck (an excellent ground) to help dissipate toxic fumes. A barefoot or otherwise grounded technician, needing to adjust or change the cutting wire, turns the autotransformer to OFF and proceeds to grasp the wire or its metal support. If the transformer is plugged into an ungrounded convenience outlet, there is a 50-50 chance that the worker will get a full-line-voltage shock through his or her body. If the autotransformer is fed from a grounded outlet and properly wired, the odds are better. In this case, the worker can receive a shock only if he or she turns the transformer the wrong way after disconnecting the cutting wire. Note that if the transformer is turned the wrong way (to full ON instead of OFF) with the cutting wire intact, there will be an overload which will probably burn up the transformer or at least open a circuit breaker. Not good, but better than electrocution.

TECHNICAL SOURCE GUIDE #34 – Electrically Safe Hot Wire Cutter

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Figure 2 shows a proper circuit for an electrically safe hot wire cutter. Note that the auto-transformer is NOT connected directly to the hot wire, but instead feeds a step-down and isolating transformer. This avoids the possibility that 120 volts can be found on the wire or its supports at any time whether the cutter is in use or under maintenance. This circuit also has the advantage of utilizing the auto-transformer in a way that is less likely to overload it than is the shortcut circuit shown in Figure 1. Auto-transformers have much less current carrying capacity at low settings than they do at higher ones. (They are effectively out of the circuit when at full.) Thus an auto-transformer adjusted to a low reading to get the low voltage and high current necessary to heat a wire is working at its poorest current-carrying range and will be prone to overheating.

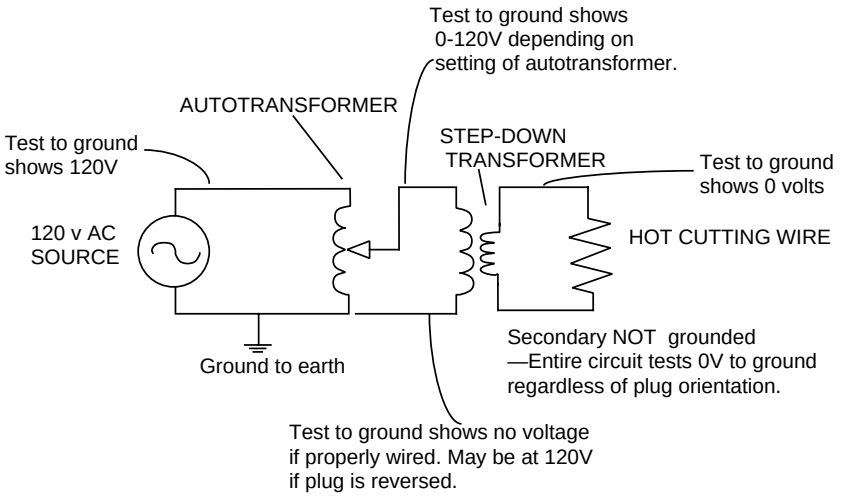

Figure 2. Proper circuit for hot wire cutter. Avoids shock danger and protects autotransformer.

SOME CAVEATS:

—The step-down transformer must completely isolate the secondary from line voltage. This should be checked with a good voltmeter before the transformer is used. While most step-down transformers are built to isolate the secondary from the primary, those bought at surplus, where many of us go for such items, may no longer really isolate the circuits.

—The step-down transformer must have adequate amperage capacity to handle the lowest resistance hot wire to be used. This can translate into some very high amperage loads. For instance, at least one very useful cutter I have seen in action uses a short piece of electrician's "fish tape" as the cutting wire. This material holds its shape despite being occasionally heated red-hot, but it draws many, many amps.

—It is a good idea to build a stop onto the auto-transformer so it may not be turned past the point where it produces the highest current needed to run the cutting wire. A short screw tapped into the calibration plate works well on rotary transformers.

—The step-down transformer should be properly enclosed in either a nonconductive enclosure or a properly grounded metal one. No 120-volt connections should be exposed. Wiring from the step-down transformer to the cutting wire should be very heavy. Welding cable is a good choice. Connections should be firmly secured. Remember, you are dealing with high amperages; a loose connection will generate a lot of heat very rapidly.

FINAL PRECAUTION:

Instructions for using hot wire cutters should insist that they be completely disconnected from the power source before making any changes in the cutting wire and re-plugged only after the work is finished. It is not worth a human life to take the chance that the isolation built into the transformer won't break down.

It is impractical to recommend a particular transformer for this application—size will depend on the resistance of the hot wire to be used, how long it is etc.—but in general, the larger the current capacity of the transformer, the better. The point of this article is that whomever is planning on setting up a cutter should avoid the practice of going directly from an auto-transformer to the cutting wire—that's dangerous. A safe hot wire cutter utilizes a step-down transformer to effectively isolate the hot wire (and thus the operator) from the 120-volt supply.

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