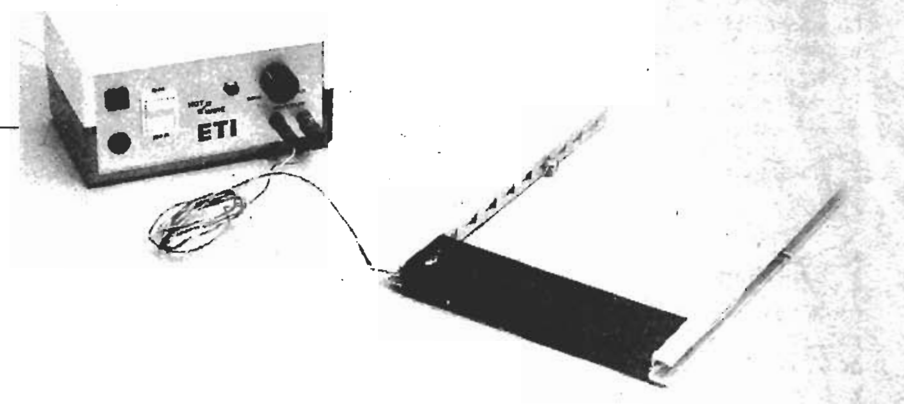
Styrofoam Cutter



The ETI Hotwire is just the thing to get you going. No, it's nor for stealing cars, it's for modelling. Turn that waste foam packing into beautiful models with the Hotwire and some imagination. Design and development by Phil Walker.

THIS EASY-TO-CONSTRUCT project is a controller for a hot-wire styrofoam cutter. This method of cutting foam is probably better than most others as it does not create any rough edges or crumbs; it actually works by melting the material as it comes into contact with the hot wire.

The object of the controller is to maintain the wire at a fairly constant temperature sufficient to melt the styrofoam quickly but without charring. This is accomplished by using a simple type of phase controller to regulate the power applied to the wire. The circuit employs a 747 dual op-amp, both parts of which are used as comparators. Speed of operation is not critical here as the circuit is operating at line frequency (60 Hz).

Taking A Pulse

The first part of the circuit produces a 120 Hz pulse signal which synchronises the rest of the circuit to the output from the bridge rectifier. The second part generates a variable time delay which is used to regulate the amount of power developed in the cutting wire. The longer the time delay, the less power is developed and vice versa.

The control element used in this project is a thyristor as this will withstand the high peak currents in the circuit without the necessity for large drive currents.

Construction

This is fairly simple since most of the components are mounted on the PCB. Make sure that the diodes and IC are the right way round. Bolt the small heatsink to the rectifier bridge using some heatsink compound before mounting it on the board. Allow it to stand about 6 mm away from the board to avoid thermal stress effects. The thyristor is mounted on top of the larger heatsink, both being held by the same screw. Heat conductive paste should be used here as well. R9 will get quite hot in operation and should be stood away from the board if possible to allow air flow around it.

When mounting the PCB in the case, it is advisable to do so with the capacitor C1 at the bottom so that it is not heated by the other components.

Fairly thick wire should be used for connecting to the transformer and output sockets as they will be carrying several amps. RV1 is wired so that minimum resistance occurs at clockwise rotation.

Some Cutting Remarks

In our prototype the cutting head was made from two short pieces of slotted aluminium extrusion of the type sold for shelving systems. These were screwed to a piece of wood to form a handle while also insulating them from each other. The steel wire was clamped with some large nuts and bolts so that it was under some tension. The wires to the control unit were also clamped to the large bolts and held in place along the arms of the head with sticky tape.

It is recommended that the ceramic insulators sold by electrical shops be used for the ends of the cutting wires in order to keep the metalwork isolated. Plastic connector block could be used but may melt under extreme circumstances.

Once everything is working correctly you can begin to exercise your creative talents on the nearest piece of styrofoam. Apart from a modelling tool, a gadget for 3-D doodling and something to keep the kids quiet during the summer holidays, you could use the Hotwire for cutting out large letters — ideal for advertising displays or exhibition stands.

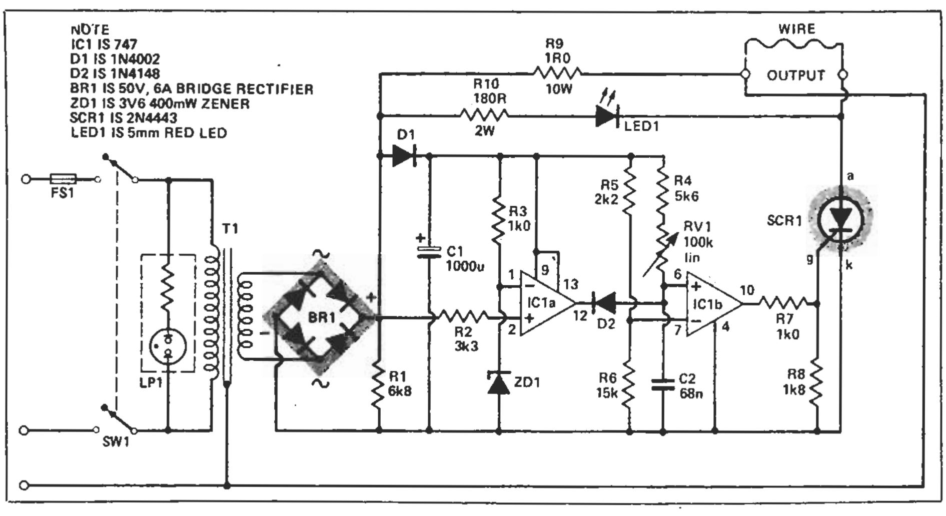


Fig. 1 circuit diagram of the ETI Hotwire.

PARTS LIST Styrofoam Cutter

Resistors (all ¼W, 5% unless stated otherwise)

R1	6k8
R2	3k3
R3,7	1k0
R4	5k6
R5	2k2
R6	15k
R8	1k8
R9	1R0 10W wirewound
R10	180R 2W wirewound

Potentiometer

RV1	100k linear

Capacitors

C1	1000u 25V axial electrolytic
C2	68n ceramic

Semiconductors

IC1	747
D1	1N4002
D2	1N4148
BR1	6 A bridge rectifier, square package, 50 V or greater
ZD1	3V6 400 mW zener
SCR1	2N4443
LED1	5 mm red LED

Miscellaneous

FS1	20 mm 1A6 slow-blow fuse and holder
SW1	Double pole rectangular mains rocker switch
LP1	Mains panel-mounting neon indicator with integral resistor
T1	15 V 60 V A mains transformer

Heatsinks (finger-style for thyristor, for rectifier); PCB; case; panel mounting socket for LED1; two off 4 mm banana sockets, grommet, wire, nuts, bolts, brackets etc; 0.010" steel wire (guitar top 'E').

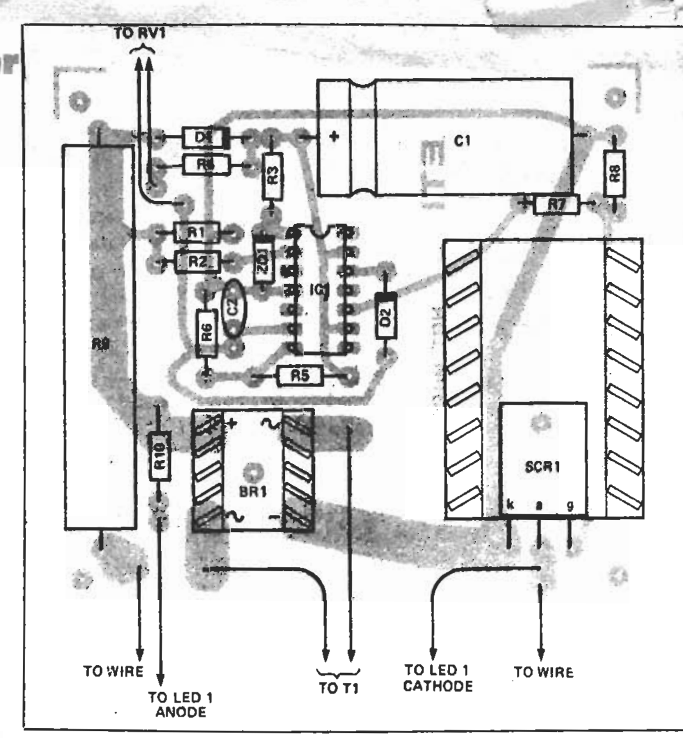
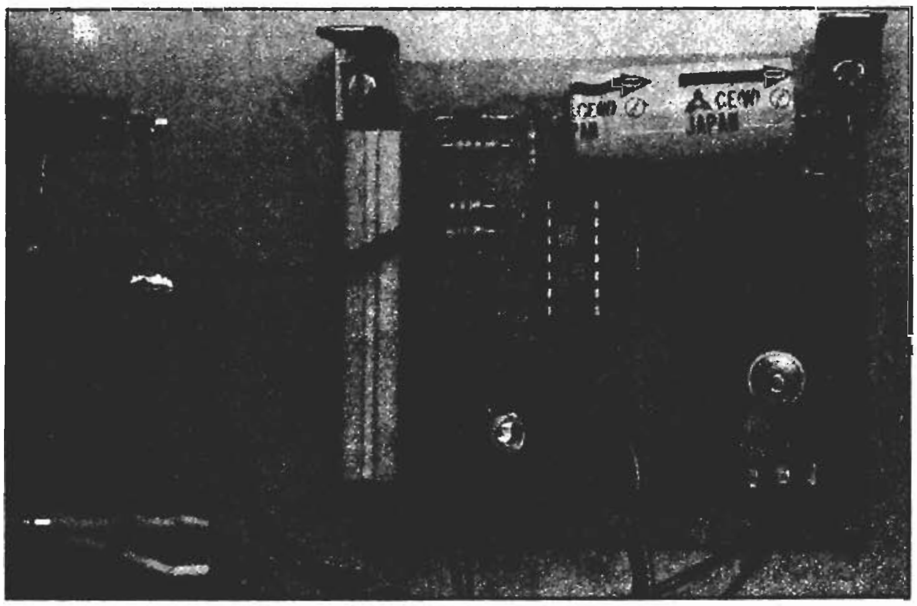
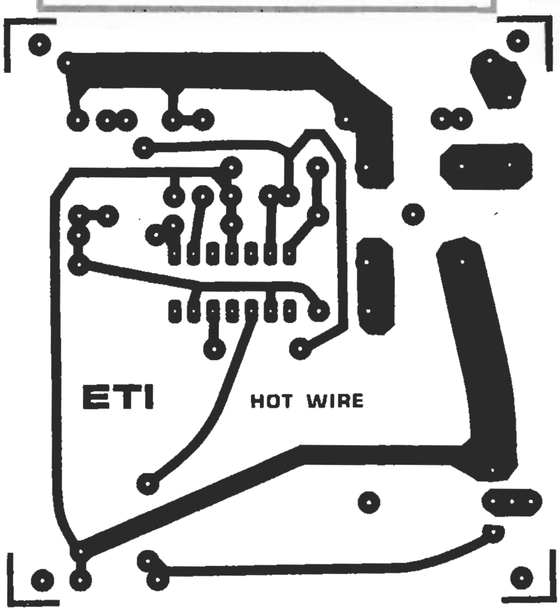


Fig. 2 Component overlay for the polystyrene cutter.



The Hotwire PCB. On the left you can see the ground connection to the pot case.



HOW IT WORKS

The 15 V AC from the transformer is rectified by BR1 to give a raw 120 Hz pulsating DC supply. C1 is charged to the peak voltage of this supply via D1 and provides the power for the circuitry. The raw DC supply is taken via R2 to IC1a where it is compared with the voltage across ZD1. The output from IC1a consists of a train of negative-going pulses which occur around the zero crossings of the AC input. These pulses are used to synchronise the variable time delay circuit by discharging C2 at the zero crossing of the AC input. The capacitor then charges at a rate set by R4 and RV1 until its voltage reaches the level set by R5 and R6. At this point the output of IC1b changes from its low to high state and switches SCR1 into conduction.

Once SCR1 has been switched on it causes the raw DC supply to be applied across R9 and the cutting wire until the voltage falls to zero at the end of the half cycle. At this time the thyristor turns off, the variable time delay circuit is reset and starts again. The proportion of the total time for which the output is on is determined by the time delay set by RV1; hence this controls the amount of power dissipated in R9 and the cutting wire. The main function of R9 is to reduce the peak surge current which would flow in the circuit, but it will also give some protection against inadvertent short circuit (the wire itself has a resistance of a couple of ohms). LED1 is incorporated to indicate when the output is operating and gives a visual indication of the power setting.

ANODE