Zero-crossing controller heats beakers noiselessly

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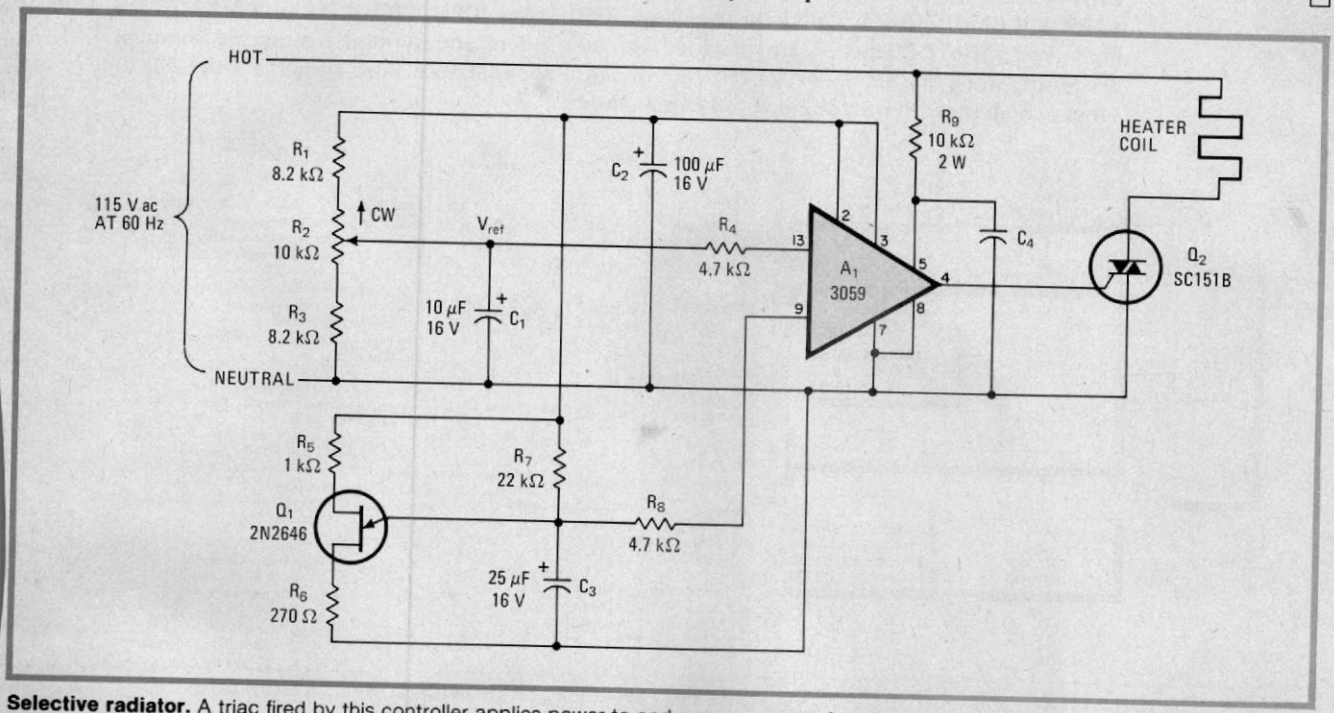
Present-day low-cost heater/dimmer controls of the type used to warm the contents of laboratory beakers and flasks are primarily modeled after the hot-plate burners in electric stoves. Consequently, they feature thermal switches that generate unwanted electronic hash and noise spikes because of the make-and-break operation of the device under a varying thermal load. This circuit controls heat by varying the duty cycle of the heater coil—but it switches the coil on and off during the zero crossings of the 115-volt ac power line, thus eliminating all types of noise. In addition to offering solid-state reliability, it costs no more than the old hot plate. And it is far less costly than the widely used but unnecessary closed-loop controls that use a sensing element.

The heart of the circuit is the CA3059 zero-crossing trigger, A_1, which controls the solid-state switch, triac Q_2. As shown, the ramp output of the unijunction oscillator Q_1 is applied to the on/off sensing amplifier at pin 9. The ramp has a peak amplitude of $\frac{2}{3}$ V_c and a time constant of R_7C_3, which is long compared with the 60-hertz line rate but relatively short with respect to the thermal response time of the hot plate.

A user-set reference voltage is applied to the other input of the sensing amplifier at pin 13. Potentiometer R_2 thus sets the temperature by control of the duty cycle, for when V_{ref} is greater than the instantaneous ramp voltage, A_1 and Q_2 are turned off, and vice versa. Note that the control calibration will be linear to the degree that the ramp voltage is linear. Power is applied to the heater coil during the zero crossings of the line input and removed during these times, too; as a result, switching is achieved at the zero power level, and no noise can be generated.

The choice of the triac will depend upon the amount of current required by the heater coil. In this case, a SC151B has been used, as the heater coil demand was only 6 amperes. □



Selective radiator. A triac fired by this controller applies power to and removes power from heater coil of hot plate during zero crossings of the 115-V ac power line, thus eliminating unwanted electrical hash and noise formerly caused by mechanical-type thermal switches. User sets temperature with duty-cycle control R_2, which turns on A_1 and triac when V_{ref} is less than the instantaneous ramp output of oscillator Q_1.