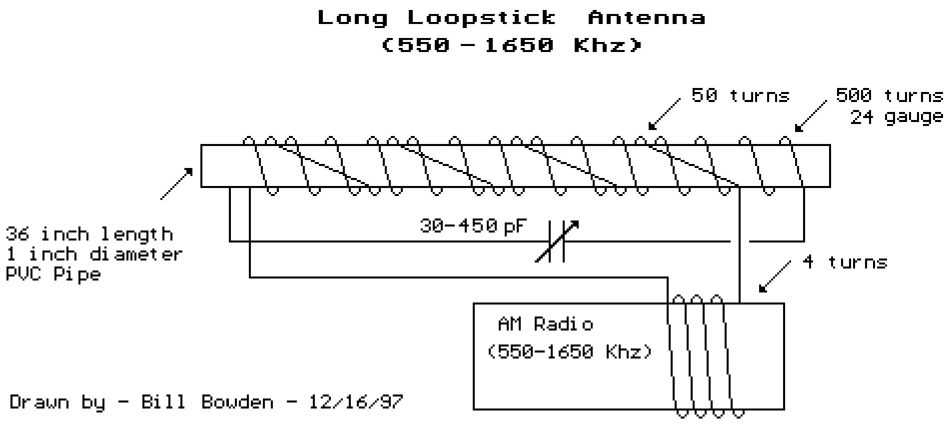
Long Loopstick Antenna

Wound on a 3 foot length of PVC pipe, the long loopstick antenna was an experiment to try to improve AM radio reception without using a long wire or ground. It works fairly well and greatly improved reception of a weak station 130 miles away. A longer rod antenna will probably work better if space allows. The number of turns of wire needed for the loopstick can be worked out from the single layer, air core inductance formula:

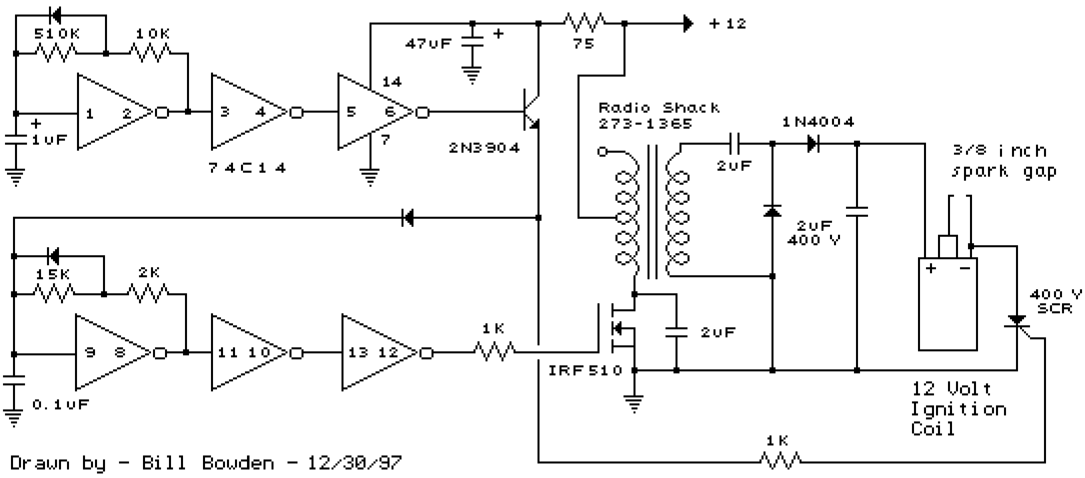
Inductance = (radius^2 * turns^2) / ((9*radius)+(10*length))

where dimensions are in inches and inductance is in microhenrys. The inductance should be about 230 microhenrys to operate with a standard AM radio tuning capacitor (33-330 pF). The 3 foot PVC pipe is wound with approximately 500 evenly spaced turns of #24 copper wire which forms an inductor of about 170 microhenrys, but I ended up with a little more (213uH) because the winding spacing wasn't exactly even. A secondary coil of about 50 turns is wound along the length of the pipe on top of the primary and then connected to 4 turns of wire wound directly around the radio. The windings around the radio are orientated so that the radio's internal antenna rod passes through the external windings. A better method of coupling would be to wind a few turns directly around the internal rod antenna inside the radio itself, but you would have to open the radio to do that. In operation, the antenna should be horizontal to the ground and at right angles to the direction of the radio station of interest. Tune the radio to a weak station so you can hear a definite amount of noise, and then tune the antenna capacitor and rotate the antenna for the best response. The antenna should also be located away from lamp dimmers, computer monitors and other devices that cause electrical interference.



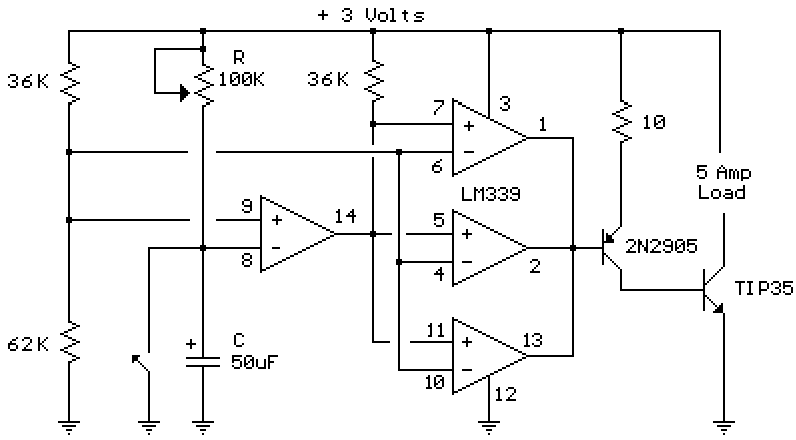
Capacitor Discharge Ignition Circuit (CDI)

The CDI ignition circuit produces a spark from an ignition coil by discharging a capacitor across the primary of the coil. A 2uF capacitor is charged to about 340 volts and the discharge is controlled by an SCR. A Schmitt trigger oscillator (74C14) and MOSFET (IRF510) are used to drive the low voltage side of a small (120/12 volt) power transformer and a voltage doubler arrangement is used on the high voltage side to increase the capacitor voltage to about 340 volts. A similar Schmitt trigger oscillator is used to trigger the SCR about 4 times per second. The power supply is gated off during the discharge time so that the SCR will stop conducting and return to it's blocking state. The diode connected from the 3904 to pin 9 of the 74C14 causes the power supply oscillator to stop during discharge time. The circuit draws only about 200 milliamps from a 12 volt source and delivers almost twice the normal energy of a conventional ignition circuit. High voltage from the coil is about 10KV using a 3/8 inch spark gap at normal air temperature and pressure. Spark rate can be increased to possibly 10 Hertz without losing much spark intensity, but is limited by the low frequency power transformer and duty cycle of the oscillator. For faster spark rates, a higher frequency and lower impedance supply would be required. Note that the ignition coil is not grounded and presents a shock hazard on all of it's terminals. Use CAUTION when operating the circuit. An alternate method of connecting the coil is to ground the (-) terminal and relocate the capacitor between the cathode of the rectifier diode and the positive coil terminal. The SCR is then placed between ground and the +340 volt side of the capacitor. This reduces the shock hazard and is the usual configuration in automotive applications.



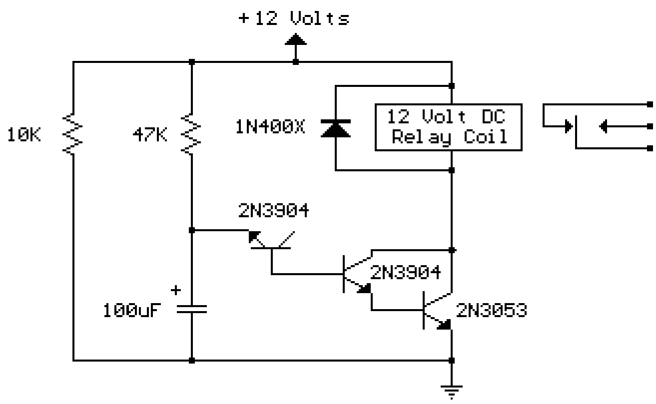
Low Voltage, High Current Time Delay Circuit

In this circuit a LM339 quad voltage comparator is used to generate a time delay and control a high current output at low voltage. Approximatey 5 amps of current can be obtained using a couple fresh alkaline D batteries. Three of the comparators are wired in parallel to drive a medium power PNP transistor (2N2905 or similar) which in turn drives a high current NPN transistor (TIP35 or similar). The 4th comparator is used to generate a time delay after the normally closed switch is opened. Two resistors (36K and 62K) are used as a voltage divider which applies about two-thirds of the battery voltage to the (+) comparator input, or about 2 volts. The delay time after the switch is opened will be around one time constant using a 50uF capacitor and 100K variable resistor, or about (50u * 100K) = 5 seconds. The time can be reduced by adjusting the resistor to a lower value or using a smaller capacitor. Longer times can be obtained with a larger resistor or capacitor. To operate the circuit on higher voltages, the 10 ohm resistor should be increased proportionally, (4.5 volts = 15 ohms).



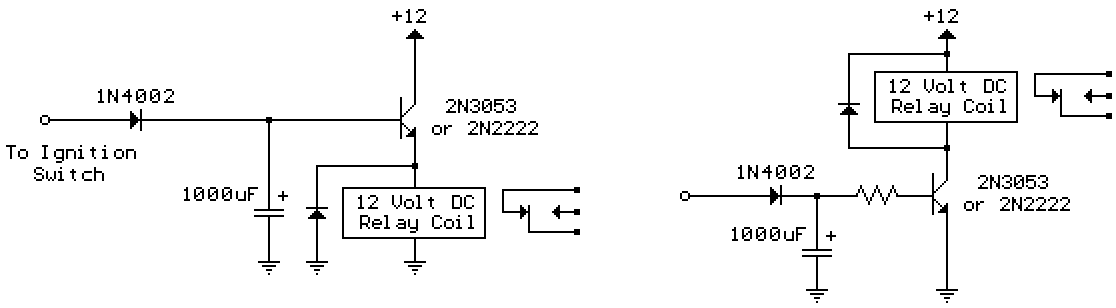
Power-On Time Delay Relay

Here's a power-on time delay relay circuit that takes advantage of the emitter/base breakdown voltage of an ordinary bi-polar transistor. The reverse connected emitter/base junction of a 2N3904 transistor is used as an 8 volt zener diode which creates a higher turn-on voltage for the Darlington connected transistor pair. Most any bi-polar transistor may be used, but the zener voltage will vary from about 6 to 9 volts depending on the particular transistor used. Time delay is roughly 7 seconds using a 47K resistor and 100uF capacitor and can be reduced by reducing the R or C values. Longer delays can be obtained with a larger capacitor, the timing resistor probably shouldn't be increased past 47K. The circuit should work with most any 12 volt DC relay that has a coil resistance of 75 ohms or more. The 10K resistor connected across the supply provides a discharge path for the capacitor when power is turned off and is not needed if the power supply already has a bleeder resistor.



Power-Off Time Delay Relay

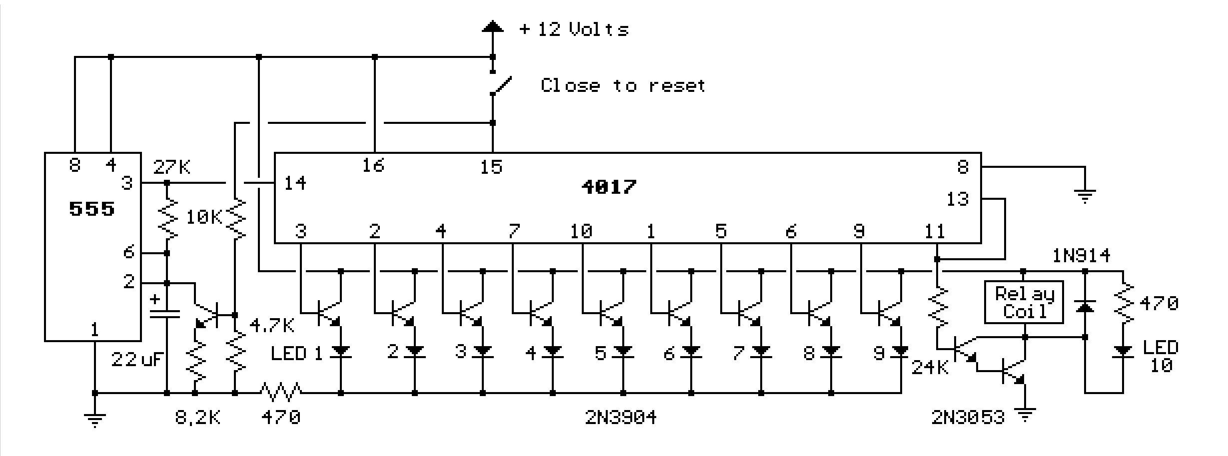
The two circuits below illustrate opening a relay contact a short time after the ignition or ligh switch is turned off. The capacitor is charged and the relay is closed when the voltage at the diode anode rises to +12 volts. The circuit on the left is a common collector or emitter follower and has the advantage of one less part since a resistor is not needed in series with the transistor base. However the voltage across the relay coil will be two diode drops less than the supply voltage, or about 11 volts for a 12.5 volt input. The common emitter configuration on the right offers the advantage of the full supply voltage across the load for most of the delay time, which makes the relay pull-in and drop-out voltages less of a concern but requires an extra resistor in series with transistor base. The common emitter (circuit on the right) is the better circuit since the series base resistor can be selected to obtain the desired delay time whereas the capacitor must be selected for the common collector (or an additional resistor used in parallel with the capacitor). The time delay for the common emitter will be approximately 3 time constants or 3*R*C. The capacitor/resistor values can be worked out from the relay coil current and transistor gain. For example a 120 ohm relay coil will draw 100 mA at 12 volts and assumming a transistor gain of 30, the base current will be 100/30 = 3 mA. The voltage across the resistor will be the supply voltage minus two diode drops or 12-1.4 = 10.6. The resistor value will be the voltage/current = 10.6/0.003 = 3533 or about 3.6K. The capacitor value for a 15 second delay will be 15/3R = 1327 uF. We can use a standard 1000 uF capacitor and increase the resistor proportionally to get 15 seconds.



Drawn by - Bill Bowden - 11/14/99

9 Second LED Timer and Relay Circuit

This circuit provides a visual 9 second delay using 10 LEDs before closing a 12 volt relay. When the reset switch is closed, the 4017 decade counter will be reset to the 0 count which illuminates the LED driven from pin 3. The 555 timer output at pin 3 will be high and the voltage at pins 6 and 2 of the timer will be a little less than the lower trigger point, or about 3 volts. When the switch is opened, the transistor in parallel with the timing capacitor (22uF) is shut off allowing the capacitor to begin charging and the 555 timer circuit to produce an approximate 1 second clock signal to the decade counter. The counter advances on each positive going change at pin 14 and is enabled with pin 13 terminated low. When the 9th count is reached, pin 11 and 13 will be high, stopping the counter and energizing the relay. Longer delay times can be obtained with a larger capacitor or larger resistor at pins 2 and 6 of the 555 timer.

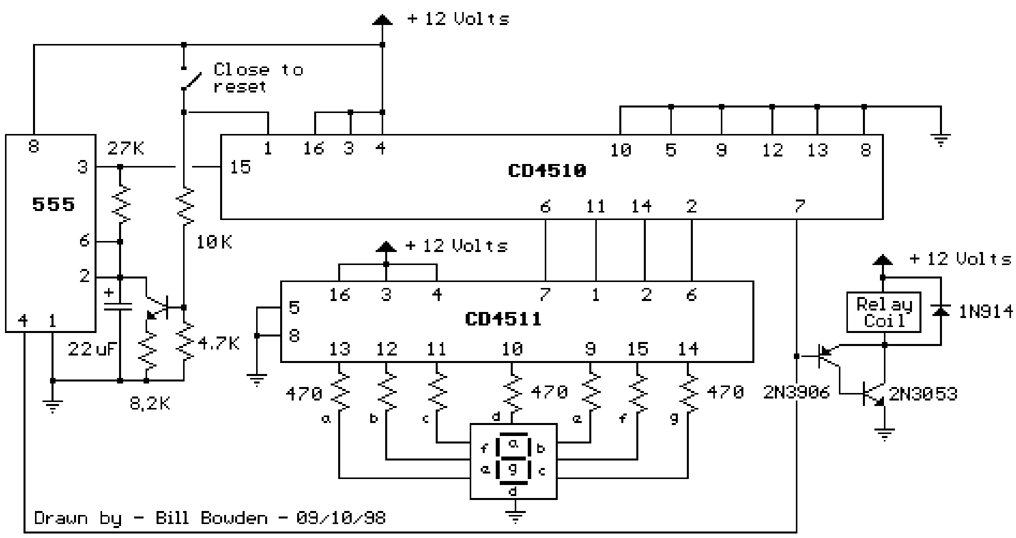


9 Second Digital Readout Countdown Timer

This circuit provides a visual 9 second delay using a 7 segment digital readout LED. When the switch is closed, the CD4010 up/down counter is preset to 9 and the 555 timer is disabled with the output held high. When the switch is opened, the timer produces an approximate 1 second clock signal, decrementing the counter until the 0 count is reached. When the zero count is reached, the 'carry out' signal at pin 7 of the counter moves low, energizing the 12 volt relay and stopping the clock with a low signal on the reset line (pin 4). The relay will remain energized until the switch is again closed, resetting the counter to 9. The 1 second clock signal from the 555 timer can be adjusted slightly longer or shorter by increasing or decreasing the resistor value at pin 3 of the timer.

The CD4510 is a CMOS Presettable BCD Up/Down counter which can be preset to any number between 0 and 9 with a high level on the PRESET ENABLE line, (pin 1) or reset to 0 with a high level on the RESET line (pin 9). Inputs for presetting the counter (P1, P2, P3, P4) are on pins (4, 12, 13, 3) respectively. The counter advances up or down on each positive-going clock transition (pin 15) and the counting direction (up or down) is controlled by the logic level on the UP/DOWN input (pin 10, high=up, low=down). The CARRY-IN signal (pin 5) disables the counter with a high logic level.

The CD4511 is a CMOS BCD to 7 segment latch decoder capable of sourcing up to 25 mA which allows it to drive LEDs and other displays directly. A LATCH-ENABLE line (pin 5, active low) stores data from the BCD input lines. A LAMP-TEST input (pin 3, active low) can be used to illuminate all 7 segments, and a BLANKING input (pin 4, active low) can be used to turn all segments off. The LED display must be a common cathode type so that the segments are illuminated with a positive voltage on their respective connections. Complete data sheets for the CD4510 and CD4511 can be obtained by answer fax from
Harris Semiconductors (search)

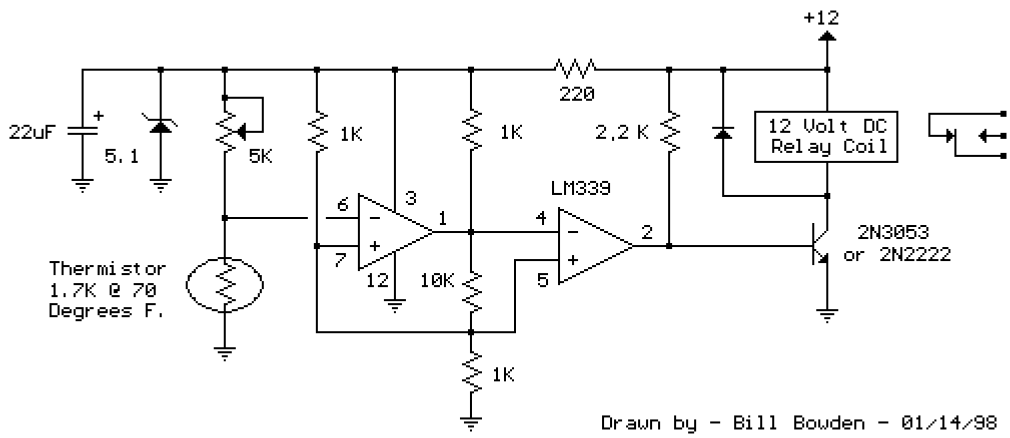


Electronic Thermostat and Relay Circuit

Here is a simple thermostat circuit that can be used to control a relay and supply power to a small space heater through the relay contacts. The relay contacts should be rated above the current requirements for the heater.

Temperature changes are detected by a (1.7K @ 70F) thermistor placed in series with a 5K potentiometer which produces about 50 millivolts per degree F at the input of the LM339 voltage comparator. The two 1K resistors connected to pin 7 set the reference voltage at half the supply voltage and the hysteresis range to about 3 degrees or 150 millivolts. The hysteresis range (temperature range where the relay engages and disengages) can be adjusted with the 10K resistor between pins 1 and 7. A higher value will narrow the range.

In operation, the series resistor is adjusted so that the relay just toggles off at the desired temperature. A three degree drop in temperature should cause the relay to toggle back on and remain on until the temperature again rises to the preset level. The relay action can be reversed so it toggles off at the lower end of the range by reversing the locations of the 5K potentiometer and thermistor. The 5.1 volt zener diode regulates the circuit voltage so that small changes in the 12 volt supply will not effect operation. The voltage across the thermistor should be half the supply or about 2.6 volts when the temperature is within the 3 degree range set by the potentiometer. Most any thermistor can be used, but the resistance should be above 1K ohm at the temperature of interest. The series resistor selected should be about twice the resistance of the thermistor so the adjustment ends up near the center of the control.



Thermostat for 1KW Space Heater (SCR controlled)

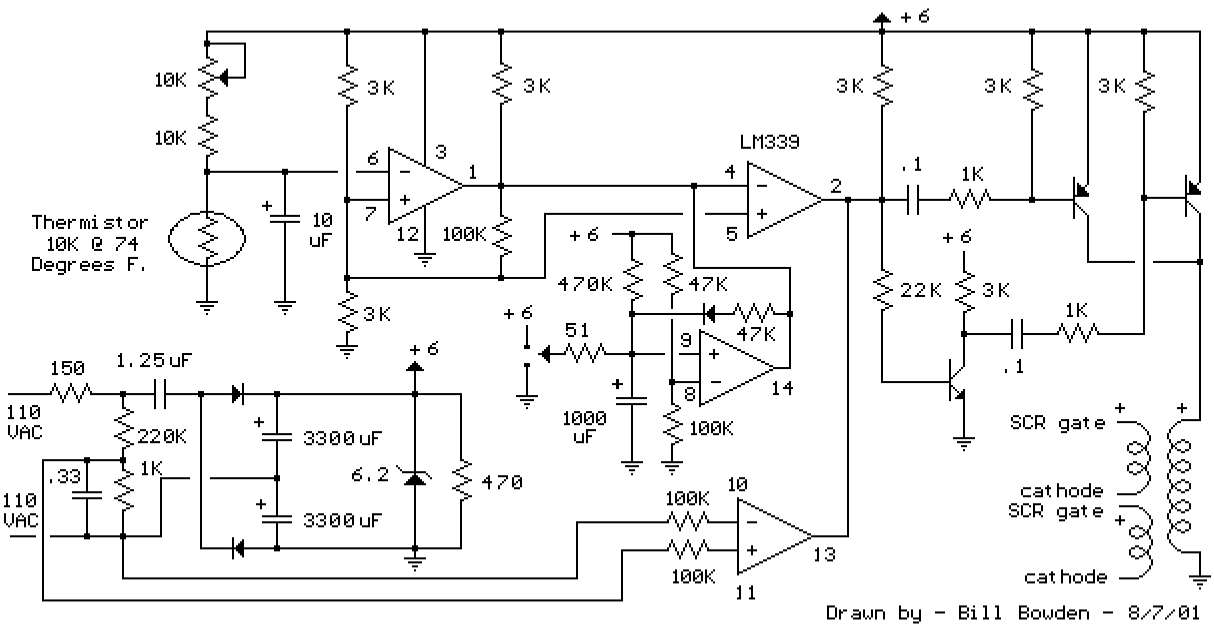
Below is a thermostat circuit I recently built to control a 1300 watt space heater. The heater element (not shown) is connected in series with two back to back 16 amp SCRs (not shown) which are controlled with a small pulse transformer. The pulse transformer has 3 identical windings, two of which are used to supply trigger pulses to the SCRs, and the third winding is connected to a PNP transistor pair that alternately supply pulses to the transformer at the beginning of each AC half cycle. The trigger pulses are applied to both SCRs near the beginning of each AC half cycle but only one conducts depending on the AC polarity.

DC power for the circuit is shown in the lower left section of the drawing and uses a 1.25uF, 400 volt non-polarized capacitor to obtain about 50mA of current from the AC line. The current is rectified by 2 diodes and used to charge a couple larger low voltage capacitors (3300uF) which provide about 6 volts DC for the circuit. The DC voltage is regulated by the 6.2 volt zener and the 150 ohm resistor in series with the line limits the surge current when power is first applied.

The lower comparator (output at pin 13) serves as a zero crossing detector and produces a 60 Hz square wave in phase with the AC line. The phase is shifted slightly by the 0.33 uF, 220K and 1K network so that the SCR trigger pulse arrives when the line voltage is a few volts above or below zero. The SCRs will not trigger at exactly zero since there will be no voltage to maintain conduction.

The upper two comparators operate in same manner as described in the "Electronic thermostat and relay" circuit. A low level at pin 2 is produced when the temperature is above the desired level and inhibits the square wave at pin 13 and prevents triggering of the SCRs. When the temperature drops below the desired level, pin 2 will move to an open circuit condition allowing the square wave at pin 13 to trigger the SCRs.

The comparator near the center of the drawing (pins 8,9,14) is used to allow the heater to be manually run for a few minutes and automatically shut off. A momentary toggle switch (shown connected to a 51 ohm resistor) is used to discharge the 1000uF capacitor so that pin 2 of the upper comparator moves to a open circuit state allowing the 60 Hz square wave to trigger the SCRs and power the heater. When the capacitor reaches about 4 volts the circuit returns to normal operation where the thermistor controls the operation. The momentary switch can also be toggled so that the capacitor charges above 4 volts and shuts off the heater if the temperature is above the setting of the pot.



10K
10K
Thermistor
10K @ 74
Degrees F.
10
uF
3K
3K
3K
6
7
3
1
12
100K
LM339
4
5
2
+6
470K
47K
47K
51
9
8
14
1000
uF
100K
150
1.25uF
110
VAC
220K
.33
1K
110
VAC
3300uF
6.2
470
3300uF
100K
10
100K
11
13
+6
3K
3K
3K
.1
1K
22K
3K
.1
1K
SCR gate
cathode
SCR gate
cathode
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