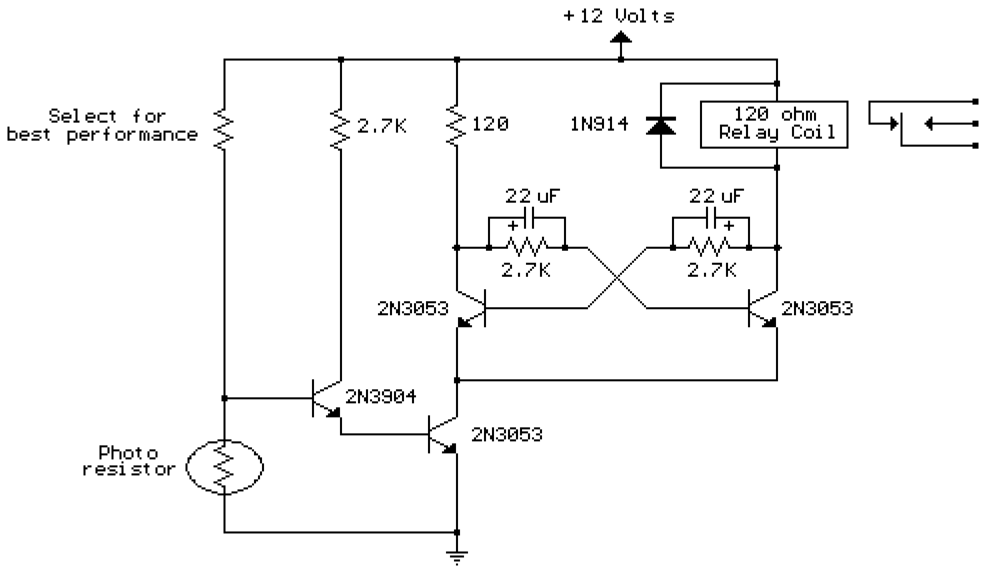
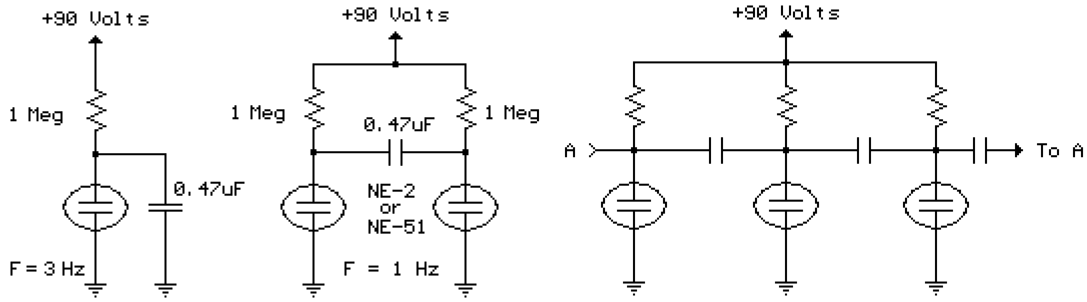
Light Activated Relay

This is same circuit as above with the addition of a photo resistor to trigger the flip flop instead of a push button. The bias resistor in series with photo resistor was chosen so that sufficient voltage is present at the base of the 2N3904 to supply current to the circuit in ambient lighting conditions. The circuit should toggle when the photo resistor is hit by a flashlight beam or other fast changing light source. Slow changes in light intensity will have no effect unless the light gets too bright to maintain sufficient bias for the 2N3904.



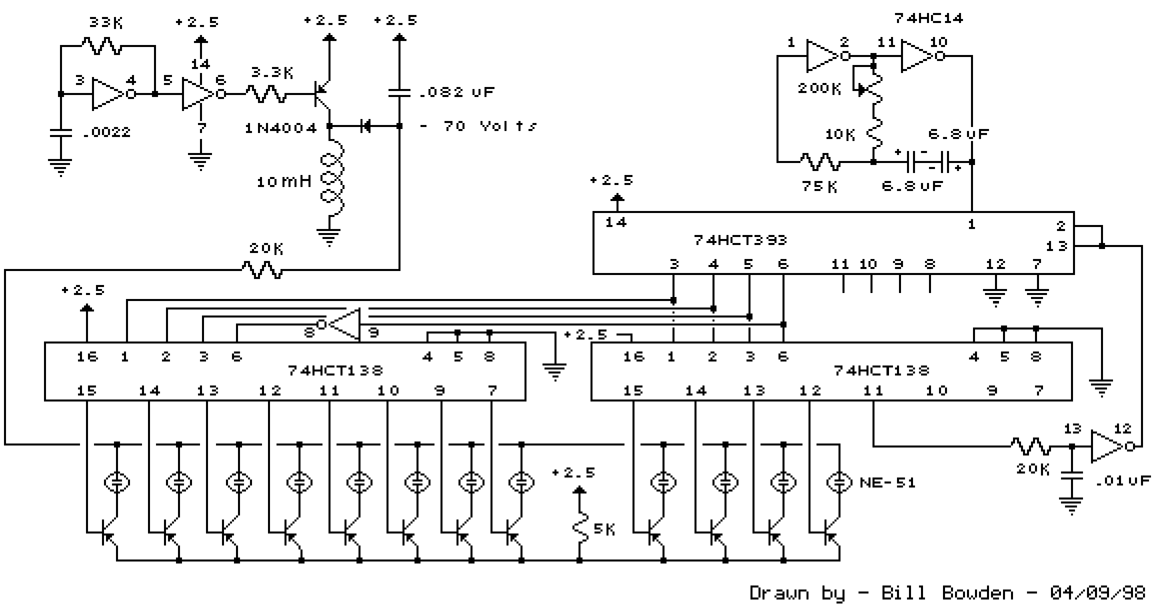
Flashing Neons (NE-2 / NE-51)

In this circuit, one, two or three neon indicator bulbs can be made to flash in sequence at rates determined by the R and C values. In the single stage circuit, using one lamp, the capacitor charges through the resistor until the ionization potential of the neon is reached (about 70 volts) and then discharges quickly through the lamp until the voltage falls below what is needed to sustain the lamp which is approximately 45 volts. The cycle then repeats at a rate of about 3 Hz for values shown. Smaller R or C values increase frequency, larger values decrease frequency. All capacitors should be the non-polarized variety with a 100 volt or more rating. For more than 3 stages, the lamps may need to be matched for similar turn-on voltages.



12 Stage Neon Sequencer (NE-2 / NE-51)

This circuit is similar to the LED clock using 12 neon indicator lamps instead of LEDs. It operates from 2 high capacity ni-cad cells (2.5 volts) which keep it going for a couple weeks. High voltage (70 volts) for the neon lamps is obtained from a small switching power supply using a 74HC14 Schmitt trigger squarewave oscillator, high voltage switching transistor, and 10 mH high Q inductor. Most any small PNP transistors can be used that have a C/E voltage rating of 80 or more. The inverter stage (pins 5,6) is not needed and is just an extra stage. An adjustable low frequency oscillator made from two of the inverter stages generates the clock signal for the 74HCT393 binary counter. In this circuit, the timing capacitor should be non-polarized since the capacitor will charge in both directions, so two 6.8 uF tantalum caps were used back to back which yields about 3.3 uF. The 75K resistor in series with pin 1 limits the current through the input protection diodes when the capacitor voltage exceeds the supply voltage. This resistor may not be necessary with small capacitors at low voltage but was added as a precaution. The binary counts are decoded into 1 of 12 outputs by the 74HCT138 decoders and operates the same way as in the 28 LED clock circuit. The sequence can be extended to 16 by omitting the reset circuit and tying pins 2 and 13 of the counter to ground.

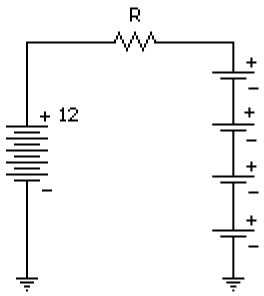


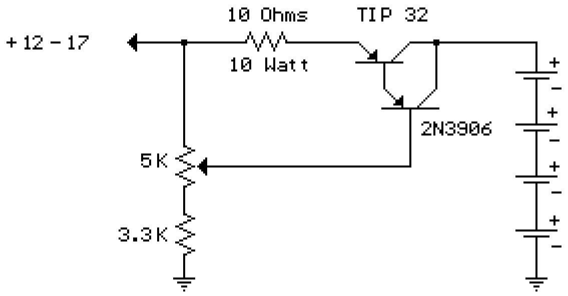
Constant Current Battery Charger

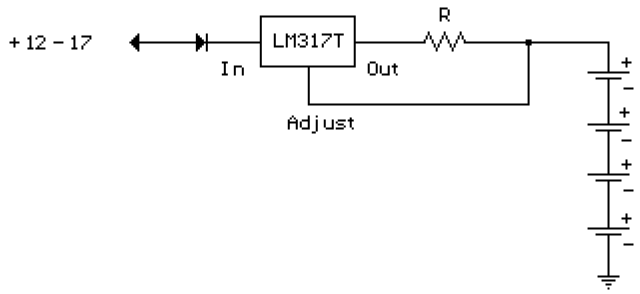
A simple method of charging a battery from a higher voltage battery is shown in the circuit below to the left. Only one resistor is needed to set the desired charging current and is calculated by dividing the difference in battery voltages by the charge current. So, for example if 4 high capacity (4000 mA hour) ni-cads are to be charged at 300 mA from a 12 volt battery, the resistor needed would be 12-(4*1.25)/0.3 = 23.3 ohms, or 22 ohms which is the nearest standard value. The power rating for the resistor is figured from the square of the current times the resistance or (0.3)^2 * 22 = 2 watts which is a standard value but close to the limit, so a 5 watt or greater value is recommended.

The circuit below (right) illustrates a constant current source used to charge a group of 1 to 10 ni-cad batteries. A 5K pot and 3.3K resistor are used to set the voltage at the emitter of the TIP 32 which establishes the current through the output and 10 ohm resistor. The emitter voltage will be about 1.5 volts above the voltage at the wiper of the pot, or about 1/2 the supply voltage when the wiper is in the downward most position. In the fully upward position the transistors will be turned off and the current will be close to zero. This yields a current range of 0 to (0.5*input)/10 or 0 to 850 milliamps using a 17 volt input. This produces about 7 watts of heat dissipation at maximum current for the 10 ohm resistor, so a 10 watt or greater rating is needed. The TIP 32 transistor will also dissipate about 7 watts if the output is shorted and needs to be mounted on a heat sink. If more than 4 cells are connected, the maximum current available will decrease and limits the current setting to about 100 milliamps for 10 cells. The usual charge rate for high capacity (4AH) 'D' cells is 300 to 400 milliamps for 14 hours and 100 milliamps for (1.2AH) 'C' or 'D' cells. For small 9 volt batteries the charge rate is 7 milliamps for 14 hours which would be difficult to set and probably unstable, so you could reduce the range to 0-20 mA by using a 750 ohm resistor in place of the 10. The charge current can be set by connecting a milliamp meter across the output (with the batteries disconnected) and then adjusting the control to the desired current, or by monitoring the voltage across the 10 ohm resistor (1 volt = 100 mA) or (1 volt = 1.33 mA using a 750 ohm resistor). The current control should be set to minimum (wiper in uppermost position) before power is applied, and then adjusted to the desired current.

The circuit (lower right) illustrates using a LM317 variable voltage regulator as a constant current source. The voltage between the adjustment terminal and the output terminal is always 1.25 volts, so by connecting the adjustment terminal to the load and placing a resistor (R) between the load and the output terminal, a constant current of 1.25/R is established. Thus we need a 12 ohm resistor (R) to get 100mA of charge current and a 1.2 ohm, 2 watt resistor for 1 amp of current. A diode is used in series with the input to prevent the batteries from applying a reverse voltage to the regulator if the power is turned off while the batteries are still connected. It's probably a good idea to remove the batteries before turning off the power.

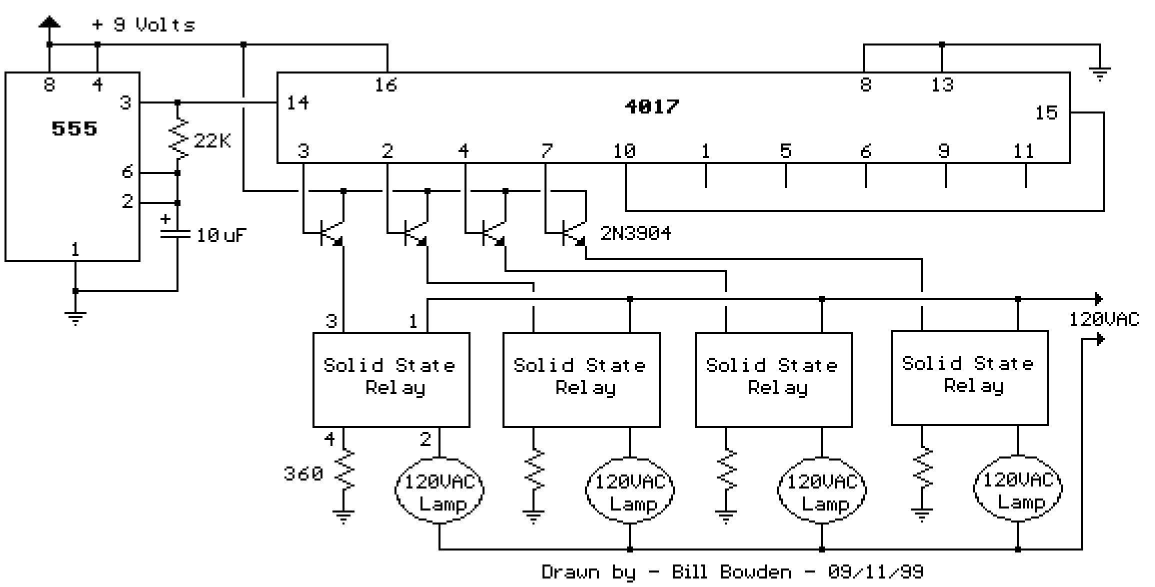

R
+ 12
-
+
-
+
-
+
-
+
-


+ 12 - 17
10 Ohms
10 Watt
TIP 32
2N3906
5K
3.3K


+ 12 - 17
LM317T
In
Out
Adjust
R

120VAC Lamp Chaser

This circuit is basically the same as the 10 channel LED sequencer with the addition of solid state relays to control the AC lamps. The relay shown in the diagram is a Radio Shack 3 amp unit (part no. 275-310) that requires 1.2 volts DC to activate. No current spec was given but I assume it needs just a few milliamps to light the internal LED. A 360 ohm resistor is shown which would limit the current to 17 mA using a 9 volt supply. I tested the circuit using a solid state relay (of unknown type) which required only 1.5 mA at 3 volts but operates up to 30 volts DC and a much higher current. The chaser circuit can be expanded up to 10 channels with additional relays and driver transistors. The 4017 decade counter reset line (pin 15) is connected to the fifth count (pin 10) so that the lamps sequence from 1 to 4 and then repeat. For additional stages the reset pin would be connected to a higher count.



Game Show Indicator Lights (Who's First)

The circuit below turns on a light corresponding to the first of several buttons pressed in a "Who's First" game. Three stages are shown but the circuit can be extended to include any number of buttons and lamps.

Three SCRs (silicon controlled rectifiers) are connected with a common cathode resistor (50 ohm) so that when any SCR conducts, the voltage on the cathodes will rise about 7 volts above the voltage at the junction of the 51K and 1K ohm resistors and prevent triggering of a second SCR. When all lamps are off, and a button is pressed, the corresponding SCR is triggered due to the voltage at the divider junction being higher than the cathode. Once triggered, the SCR will remain conducting until current is interrupted by the reset switch. Or, you can just turn the power off and back on.

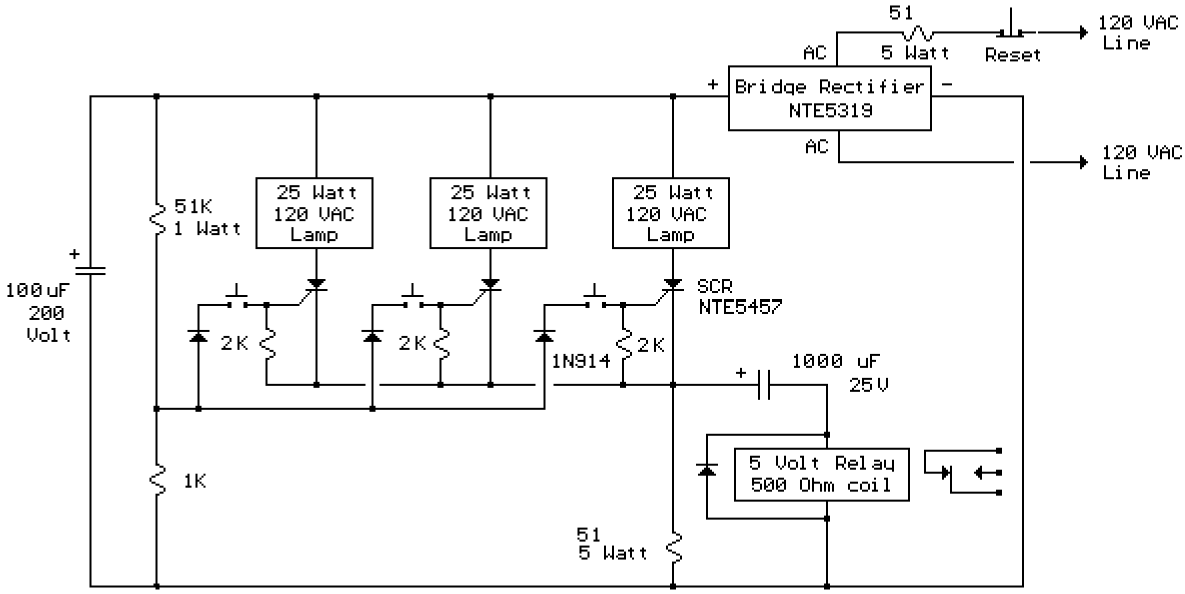
A 50 ohm, 5 watt resistor was selected to produce a 10 volt drop at 200 mA when a single 25 watt lamp comes on. Higher wattage lamps would require a lower value resistor, and visa versa. For example to use 60 watt lamps and maintain the 10 volt drop, the peak current would be 60/160 = 375 mA and the resistance would be E/I = 10/.375 or about 27 ohms at 3.75 watts. The SCRs are "Sensitive Gate' types which trigger on about 200 uA and the gate current is around 1.5 mA when the first button is pressed. The 1N914 diodes in series with the buttons gates are used to prevent a reverse voltage on the gate when a button is pressed after an SCR is conducting. The two resistors (1K and 50 ohm) will be fairly large in physical size (compared to a 1/4 watt size) and should be rated for 5 watts of power or more. Use caution and do not touch any components while the circuit is connected to the AC line.

Adding a Buzzer:

The relay shown in parallel with the 50 ohm cathode resistor can be used to momentarily power a buzzer with an external circuit through the contacts. The 1000 uF capacitor causes the relay to energize for about one second, longer times can be obtained with a larger capacitor.

Parts List:

Quantity	Description	Radio Shack Part Number
1	4 Amp/400 Volt Bridge Rectifier	276-1173
3	Silicon Controlled Rectifier (SCR)	NTE5457
3	120 VAC/ 25 Watt incandescent lamp	
1	50-100 microfarad/ 200 volt capacitor	
1	1000 microfarad / 35 volt capacitor	272-1032
1	50 ohm resistor/ 5 or 10 Watt	271-133
3	Push Button Switch (normally open)	
1	Push Button Switch (normally closed)	
3	2K resistor, 1/4 watt	271-1325
4	1N914 Diode	
1	51K resistor, 1 watt	
1	2 Amp Fuse	270-1064
1	Relay (SPDT) 9 Volt DC, 500 ohm coil	275-005


51
5 Watt
Reset
120 VAC
Line
AC
Bridge Rectifier
NTE5319
AC
120 VAC
Line
51K
1 Watt
25 Watt
120 VAC
Lamp
25 Watt
120 VAC
Lamp
25 Watt
120 VAC
Lamp
100 uF
200
Volt
SCR
NTE5457
2K
2K
1N914
2K
1000 uF
25V
1K
5 Volt Relay
500 Ohm coil
51
5 Watt

Pinewood Derby Finish Line Lamps

The finish line circuit below detects the first of three cars to cross the line and illuminates a 25 watt 120 VAC lamp indicating the winning lane. Three photo transistors are used which can be embedded into the track with a light shining down onto the finish line so that as the car crosses over the sensor, the light is blocked, activating the relay and lighting the lamp for the appropriate track. The light source should be an incandescent type, florescent lights may not work due to low infra-red content. The circuit was tested using a 100 watt incandescent light fixture about 3 feet above the photo transistors.

The photo transistors are connected so that a logic low (0 volts) normally appears at the input to a NAND gate and as a car crosses the line blocking light to the transistor the logic level will move high (+6 volts). The resulting logic low level from the output of the gate (3 input NAND) is fed to a SET/RESET latch made from two dual input NAND gates (1/2 of a 74HC00) the (logic high) output of which controls the MPS2222A buffer transistor and solid state relay. The inverted output of the latch (logic low) is connected back to the remaining two (3 input NAND gate) inputs locking them out. Two extra 74HC00 gates are not used and should have their inputs (pins 9,10,12,13) connected to ground to avoid possible oscillation. The circuit is reset with a momentary push button connected to the reset side of each latch. The reset button may need to be pressed after power is first applied. Components for the circuit may be obtained from Radio Shack, however the RSU numbers may need to be special ordered or obtained from another source. The 74HC00 and 74HC10 are CMOS parts and should be handled carefully to avoid possible damage from static electricity. You may want to use IC sockets so the wiring can be completed before the ICs are inserted into the sockets. You can briefly touch a grounded surface (computer chassis or other metal ground surface) just before handling CMOS circuits to reduce the possibility of damage from static electricity.

Notes:

All ground symbols are connected to the negative side of the battery.
All +6 points are connected to the positive side of the battery.
Transistors and relays for #2 and #3 lights are not shown but are connected the same as shown for #1.
A small LED may be substituted for the solid state relay (pins 3,4) for testing the circuit before the relays are installed.
Pins 8,6 and 12 of the 74HC10 should read +6 volts after reset is pressed and light is shining on the photo transistors.
Pins 1,9 of the top 74HC00 and pin 1 of the lower 74HC00 should read +6 volts with the reset button released. The same pins should read 0 volts with the button pressed.
Pins 2,6,10,11 of upper 74HC00 and 2,6 of lower should read 0 volts after reset button is released and photo transistors are illuminated.
Pins 3,4,8,12 of upper 74HC00 and pins 3,4 of lower should read +6 after reset button is released.
Pins 9,10,12,13 of lower 74HC00 should be grounded

Parts List:

Two - 74HC00 Quad, 2 input NAND gates - RSU 10880045 - $0.89 ea.
One - 74HC10 Triple 3 input NAND gate - RSU 10880540 - .89 ea.
Three - IR photo transistors - 276-145 - .99 ea.
Three - MPS2222A NPN transistors - 276-2030 - .99 ea.
Three - 1/4 watt 150 ohm resistors - 271-1312 - .49/5
Three - Solid state relays, 3 Amp/120VAC - 275-310 - 6.99 ea.
Four - 1/4 watt 3.3K resistors - 271-1328 - .49/5
One - 470 uF/16 volt capacitor - 272-957 - .99 ea.
One - 0.1uF capacitor - 272-135 - .69 ea.
One - Momentary (normally open) push button - 275-1556 or 275-1571
One - 6 volt lantern battery or regulated power supply.
Three - 25 to 60 watt 120VAC lamps and sockets.