could be described as windy, based on these observations, then consider an alternative to wind power.

Using a Recording Anemometer

If you feel your site is windy, and you are serious about installing a wind turbine, then install a recording anemometer. In some areas, a check with the local weather station might be sufficient to determine average wind speeds. Wind data from airports is not very applicable to wind power sites because airports are intentionally located at sites with minimum winds. Don't consider wind power without a thorough measurement of the wind speed at your specific location. In most cases, four months should be the minimum recording interval and one year is preferred. If you are going to spend a lot of hard earned money on a wind system, this extra eight months could mean the difference between a good investment and a bad one.

Proper Tower Placement

Although a recording anemometer is a very accurate instrument, its output information will be accurate at a specific location. In areas of rolling hills or tree cover, the wind speeds can vary 30% or more between sites only 100 feet apart. The location of an anemometer on a specific site, as well as height above the ground and any obstruction, is critical to recording the highest winds available. On level land with no nearby obstacles, a 40 foot tower should be the minimum height for your anemometer or turbine. It is essential to measure wind speed at the actual height you plan on installing your turbine. Obstacles or short towers are only robbing you of power. If you are considering placing your turbine on a hill to gain wind speed, place the turbine high enough on the hill to enter the smooth undisturbed wind stream.

Installing a wind turbine is not a matter of simply erecting a tower and putting a generator on top. Only through accurate wind speed data on your particular site can you hope to install a wind system that is capable of supplying the power you need.

Larry Elliott

Specifying Wind Systems

Editor's Note: The following wind survey concept arose between Mick and I during a phone conversation. It bears so much relevance that I have included it here. RP.

Alternatives to a Recording Anemometer

Average Wind Speed

While average wind speed is meaningful, there are other wind parameters that are just as meaningful. Other wind parameters worth knowing are maximum wind speed, number of days (hours) between winds of greater than 10 mph. Number of consecutive days (hours) where the wind is in excess of 10 mph, and the times of year where the either wind or not wind periods occur. All this data is not available from garden variety recording anemometers.

A recording anemometer that will take all the data mentioned above will cost a bundle. Such anemometers are more computer than wind sensor and cost between $2,000 and $4,000. I offer the following alternative.

Install a Small Wind Machine

For the cost of a detailed recording anemometer, you can install a working small wind machine. Consider that a Whisper 1000 or a Windseeker can be installed at about the same cost as a sophisticated recording anemometer. With the addition of an accumulative Ampere-hour meter (about $200), this setup not only provides real and hard data about wind powered electric generation, but also supplies power at the same time.

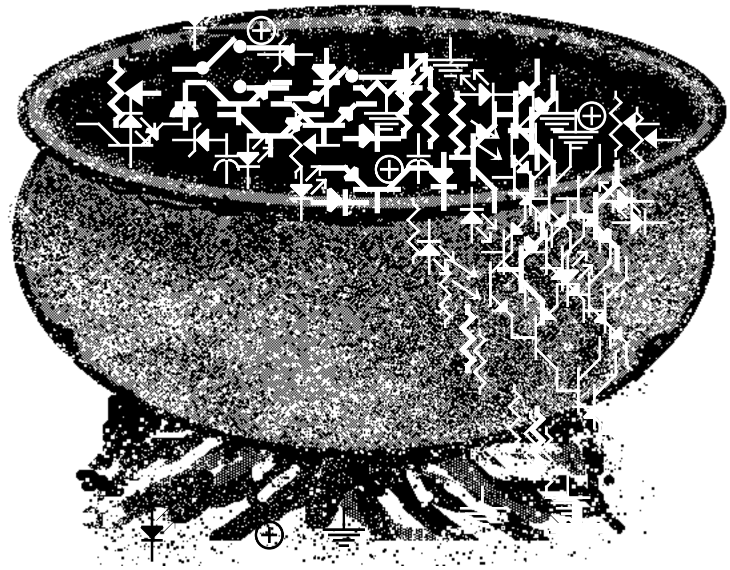
What if I don't really have a site suitable for wind?

It is much easier to sell a working wind machine than a sophisticated recording anemometer. If your site turns out not to have appreciable wind power potential, you can more easily get your money out of a wind machine. If your wind site has potential, then you have a great head start on your wind electric system.

Access

Mick Sagrillo, Lake Michigan Wind and Sun, 3971 E. Bluebird Road, Forestville, WI 54213 • 414-837-2267.

Homebrew



Build a Time Machine

Richard Perez

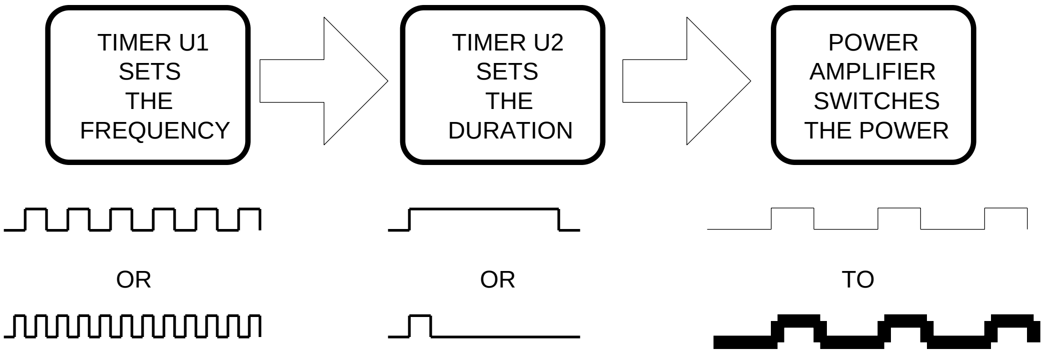
This electronic device is a time machine. It makes precisely timed pulses of electricity. The pulses can occur as often as you wish and last for as long as you wish. Some of the many applications for this device are: a super efficient 12 VDC motor speed controller, an high efficiency electronic rheostat for DC power control, and an electric fence charger that keeps pesky critters where you want them. All of this and more from precisely timed electronic switching!

A Time Machine?

You bet. This circuit uses two NE555 electronic timers to make custom tailored pulses of electricity. The first NE555 timer, U1, is operated astable as an oscillator, or in techie lingo– a multivibrator, or in nerd terms– a flip-flop. U1 determines how often the pulses occur. There could be one pulse every ten seconds or thousands of pulses per second. The second NE555 timer, U2, determines the amount of time that the pulse spends ON, or in other words, the duration of the pulse. U2 is operated as a slave to U1. U2 only emits a pulse when U1 says to do so. U2 is operated in monostable mode, as a "one-shot" multivibrator. The pulse produced by U2 may have a duration of seconds, or may have a period as short as microseconds. The resulting pulse train is fed to a power amplifier that switches the load. And that's the whole point of this device, chopping electricity into pulses in order to control power.

THE TIME MACHINE

using precision pulses to control power



So who needs pulses?

Using pulses of electricity can solve many power control problems in 12 VDC systems. For example, consider controlling the speed of an electric motor. The most common method of controlling 12 VDC electric motors is to insert a resistor in series with the motor. This indeed limits the motor's speed by reducing the amount of power available to the motor. It also wastes gobs of power in the resistor.

Another way of controlling the motor is to rapidly switch its power ON and OFF. The major advantage switching is a vast reduction in power consumption. When the electronic switch is OFF, then virtually no power is used. In this switching scenario, the amount of power the motor uses is proportional to its speed. The slower the motor rotates, the less power it uses. Compare this to the resistor power control method where power consumption remains relatively constant regardless of motor speed.

Notes on the Time Machine

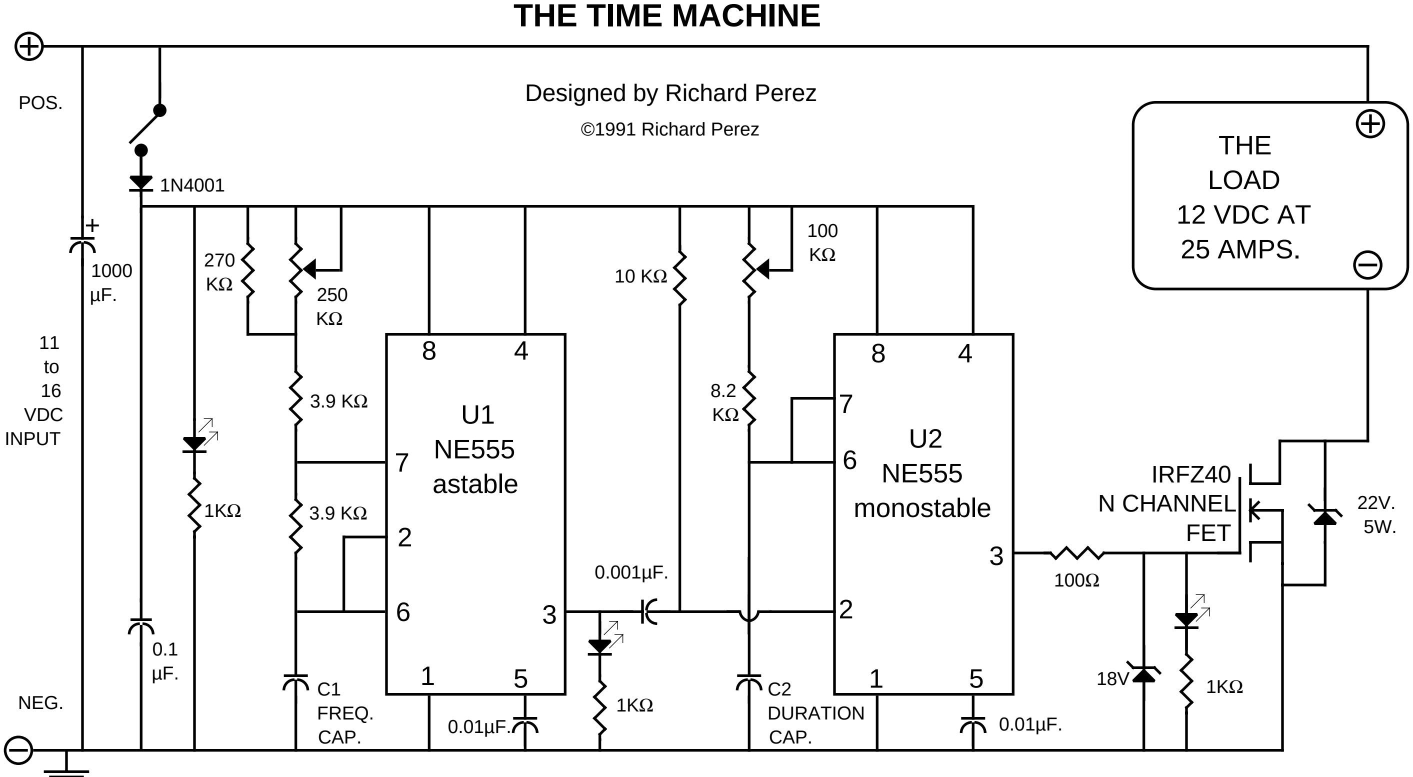
C1 is the timing capacitor for U1, the astable multivibrator. Increasing the value (amount of capacitance) of C1 will decrease the frequency of the pulses that the Time Machine produces. C2 is the timing capacitor for U2, the monostable multivibrator. Increasing the capacitance of C2 will result in pulses of longer duration. The table below shows the values for C1 and C2 and the resulting timing parameters for this circuit. Since the NE555 uses a resistor/capacitor timing chain, these times versus values for C1 and C2 are correct only for the resistor networks shown in the Time Machine's schematic. If you vary the resistors in the NE555 timing chains, then the time parameters (frequency and duration) of the resulting pulse will also change.

Power control often requires custom tailored pulses. Consider that the pulses used for motor speed control need to be synchronized with the rotational dynamics of the motor. And consider that these rotational dynamics change with the type of motor, the number of poles within the motor's windings, and the motor's speed. That is why the Time Machine shines. It can provide whatever pulsation is required.

Flying the Time Machine

The timing chains of both U1 and U2 contain potentiometers. By adjusting these potentiometers, the timing parameters of the resulting pulses changes. If you use the specified

THE TIME MACHINE



TIMING CHART
values of C1 and C2 for the Time Machine

PULSE FREQUENCY	C1 or C2 in µF.	PULSE DURATION
10 kHz. to 100 kHz.	0.001 µF.	10 µs. to 100 µs.
1 kHz. to 10 kHz.	0.01 µF.	100 µs. to 1 ms.
100 Hz. to 1kHz.	0.1 µF.	1 ms. to 10 ms.
10 Hz. to 100 Hz.	1.0 µF.	10 ms. to 100 ms.
1 Hz. to 10 Hz.	10 µF.	100 ms. to 1 s.
0.1 Hz. to 1 Hz.	100 µF.	1 s. to 10 s.

resistor/potentiometer networks shown in the schematic, then your Time Machine will produces pulses as per the Timing Table shown above. This means that the pulses can occur as slowly as very ten seconds (0.1 Hz.), or as rapidly as one hundred thousand times per second (100 kHz.). This also means that the pulse can last as long as ten seconds, or as short as ten millionths of a second (10 µs.). And this covers the frequency and pulse duration ranges needed to efficiently control even the most odd-ball DC motor. The same approach to time related power control can be applied to 12 Volt incandescent lighting, recharging small and large batteries, and even driving transformers to produce higher voltages.

The Timing Capacitors

If you know the range of frequency (C1) and the range of pulse duration (C2), then you can select the appropriate timing capacitors for each function. The potentiometers allow you to fine tune the Time Machine within the timing ranges of the selected capacitors. I built several models of the Time Machine with six pole rotary switches that select the appropriate capacitor for for C1 or C2. I used Radio Shack two-pole, six position, non-shorting rotary switches (RS #275-1386). This allows the Time Machine to produce all the frequency and pulse duration ranges on the table without resoldering capacitors to the circuit. I didn't include the rotary switches in the schematic because they are not required for operation and complicates the device for dedicated applications. If you are building the Time Machine for experimentation, or if you don't really know what frequency and duration ranges you require, then use the rotary switches and install all the capacitors.

Use tantalum or polystyrene capacitors as C1 and C2 if you can get them. Disk ceramics will work OK, but are not as stable. Use electrolytic capacitors for the 1µF., 10µF., and 100µF. timing capacitors.

Other Time Machine Components

The two NE555 timers produce the pulse train which is fed form pin 3 of U2 to a semiconductor acting as a switch. Over the years I have built Time Machines with every sort of power output design imaginable. The output network using the IRFZ40 works very well and will transfer 50 Amperes of current. The IRFZ40 is an International Rectifier HEXFET®, N-channel, Field Effect Transistor rated at 125 Watts, 50 Volts, 51 Amperes continuous at 25°C., and surge to 160 Amperes. The IRFZ40 comes in a standard tab mounted TO-220 case. This amazing FET has an ON resistance of 0.028Ω, and that's low enough to switch prodigious amounts of current with heating up the FET. The output section using the IRFZ40 is negative leg processing. Note that the load is hardwired to positive and controlled via switching its negative line. This works well in most applications and allows the use of inexpensive, high-current FETs. However, the IRFZ40 will not survive a direct short circuit of its output. I've blown up several during R&D and by mis-wiring. However, once installed and operating I have never had one fail.

I got my IRFZ40 from Digi-Key, 701 Brooks Ave. South, Thief River Falls, MN 56701-0677 • 800-344-4539. They sell the IRFZ40 for $6.12 each or for $36.75 for ten. Digi-Key has a $5.00 surcharge on orders under $25.

All resistors are 1/4 Watt unless otherwise noted. All capacitors are 25 Volt rated minimum and 50 Volt is better. All LEDs are optional, but they look pretty flashing away. Also, they provide information about the operation of each of the Time Machines timers.

Using the Time Machine

Use it where you can control power via switching. I have recharged a six volt car battery from my 12 Volt system using the Time Machine. I have recharged all variety of lead-acid gel cells and small nicad cells using the Time Machine. I have controlled the speed of brush -type DC motors, up to 1/2 horsepower. I have pulsed the input of transformers to provide high voltage for applications like fluorescent light tubes. That's right, the Time Machine's pulses can operate transformers and produce a variety of voltages. I even set the Time Machine at 60 Hz, and pulsed a transformer to produce 60 Hz., 120 Vrms, square-wave alternating current,creating a rough–and–ready inverter.

The utility of the Time Machine is limited only by the user's imagination. For example, consider its specialized application as an electric fence.

An Electric Fence is Born!

Nine years ago, we faced a serious equine problem. Karen's horse, an intelligent and sometimes foolhardy Arabian mare named Oozie, kept escaping. She had no respect for barbed wire. Oozie's two pervious encounters with barbed wire resulted in serious cuts, on-site visits by the Vet, and much of Karen' gray hair. We really needed to keep the horse in her 35 acre pasture without allowing her to injure herself on barbed wire.

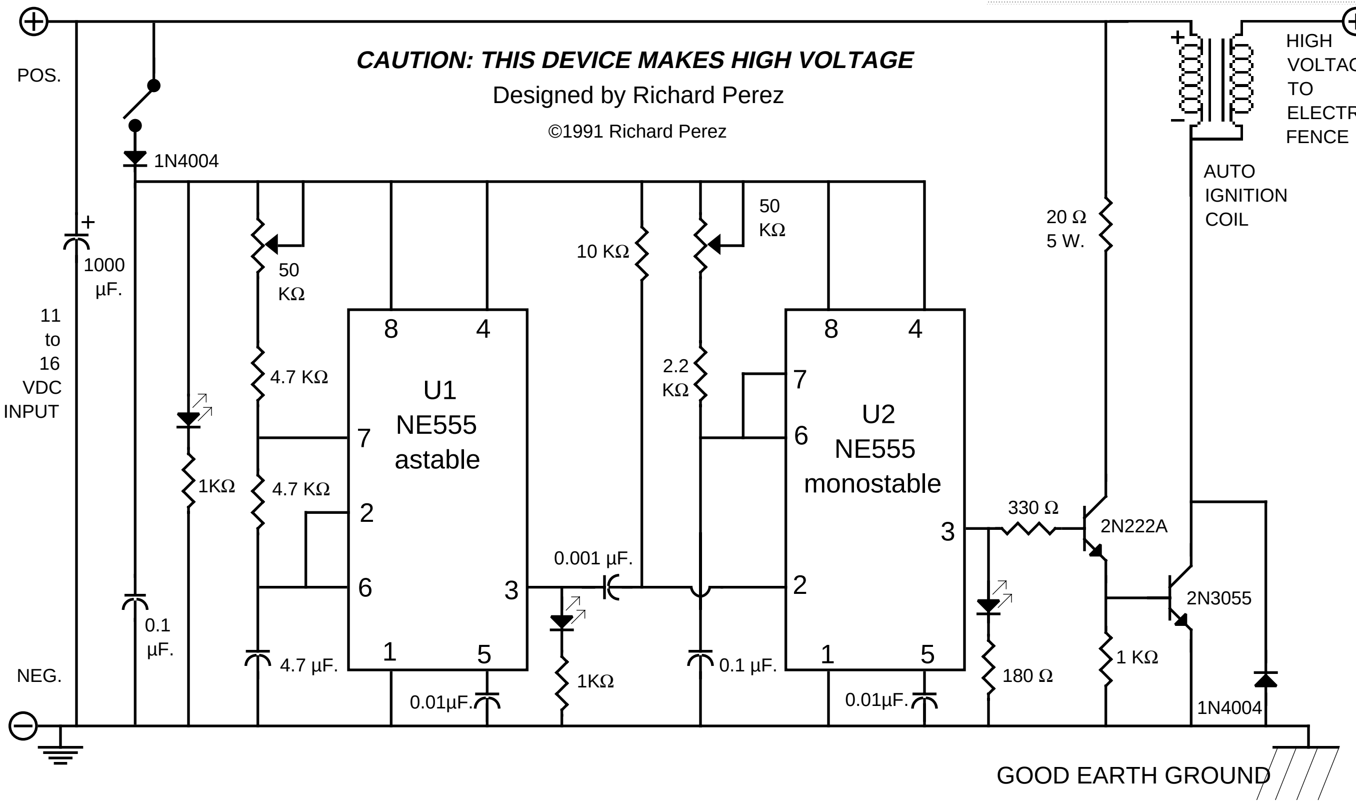
Karen installed over one mile of electric fence to corral her horsie friend. We went to town and bought a commercial electric fence charger powered by a car battery. This did the job. High voltage electricity made a believer of Oozie where the barbed wire failed. And best of all- no more barbed wire cuts. Everyone was happy until the fence charger broke.

The first fence charger lasted about two months and died. We bought another and it lasted about three months. With both chargers, I was far from pleased with their high power consumption. The car battery would last only about three weeks before being totally discharged. These electric fencers were not built to last and they were power pigs. There had to be a better way.

I remembered my Time Machine. I considered that an automotive ignition system used switched pulses into the ignition coil to produce high voltage. I set about adapting the Time Machine as an electric fence charger. Since I didn't want to wind my own coil, I just used an old automotive coil I had on hand. The circuit is a specific adaptation of the Time Machine and its schematic follows below.

The only major difference between the Electric Fence and the Time Machine is the output amplifier. The Electric Fence uses a two

ELECTRIC FENCE



stage silicon power amplifier using a 2N2222A and a 2N3055 bipolar transistors. I used this design because it is very rugged and will survive the incredible high voltage transients that accompany electric fences. This design has been running here at Agate Flat since 1982, and for many of my neighbors since 1985. It works efficiently (average current drain is about 3 Amp-hours per day) and has survived all variety of lightning storms. The exact automotive ignition coil you use is not important. I have used everything from a six volt VW coil to a high energy 12 Volt coil from a late 1970s Ford. They all work well enough, producing over 20,000 volts on the fence.

In order to function properly every electric fence needs a good ground. Consider several grounding rods if your soil is dry. Drive the rods as far as you can into the ground and use at least 8 gauge wire between the charger and the ground rod.

Using the Electric Fence

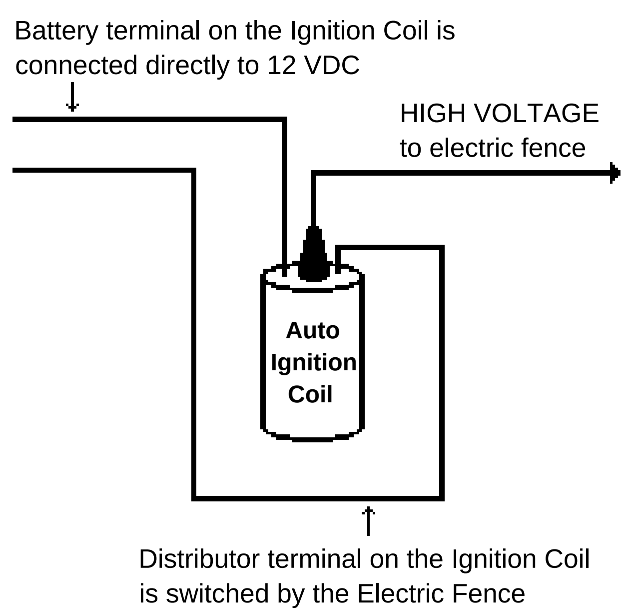
U1 controls how often the pulses of electricity occur on the fence. Using the resistors on the schematic the pulses can occur as often as about 50 pulses per second and as infrequently as one pulse every two seconds. If you are training livestock to an electric fence, then keep the frequency high. After the livestock is wary of the fence, turn the frequency down and save power. U2 controls the amount of power contained within the pulse. You can adjust the amount of power to suit your ground conditions (dry ground has higher resistance and requires more power). I turn our fence up during the Summer and down during the Winter. You can adjust the power to suit the length of your fence. We've charged up over five miles of fence in dry conditions. If you adjust the amount of power, then you will consume no more power than you need. BE CAREFUL HERE! Karen once disconnected the majority of our electric fence and I forgot to reduce the Electric Fence's power output to compensate. Oozie got across the super-hot fence and the shock knocked this 1,000 pound horse off of her feet. She spent the next few hours not feeling at all well. So, listen up, here comes the caution notice!

CAUTION:

THIS ELECTRIC FENCE MAKES

HIGH VOLTAGE!!!

The basics of safety apply here. Don't let your body get between the high voltage output of the coil and ground. I did this once and it



knocked me across the room. Turn the fence OFF if you are doing repairs. Don't grab ahold of the fence if you are wearing wet boots, no shoes, or are otherwise grounded. It will shock you. The pulse emitted by the Electric Fence is high in voltage, but limited in power because the pulses duration is very short (a few milliseconds). While many critters and a few foolish humans have tangled with the fence and gotten shocked plenty, no lifeform has been really injured. We have noticed that this Electric Fence will kill weeds that touch it. This is great because vegetation across the fence will short it out and render it inoperative for shocking livestock. Since the amount of power is controlled and low, the Electric Fence will not burn these weeds, hence no fire danger.

ACCESS

Author: Richard Perez, C/O Home Power, POB 130, Hornbrook, CA 96044 • 916-475-3179.

Time Machine parts: Those interested in mil-spec glass-epoxy, pre-drilled printed circuit boards for the Time Machine should contact Bob-O Schultze at Electron Connection, POB 203, Hornbrook, CA 96044 or call 916-475-3401. Bob-O also has completely assembled and tested models of the Electric Fence and Time Machine. Contact him for specifics.

Above: Karen and her friend, Oozie, discuss electric fences. While Oozie is a notorious escape artist, the electric fence keeps her where she should be.

Build a Constant Current Source

Jeff Damm

The best way to recharge Nickel-Cadmium batteries is with a constant current source. My motivation for designing the circuit in this article was that I wanted a variable current source which had the flexibility to charge a variety of different size "NiCads". I also wanted it to be reproduced easily and relatively inexpensive. Many hours of tinkering finally produced the circuit shown in figure 1.

Figure 1 is a schematic of the components required to make an adjustable constant current source from readily available components. Charging a battery with this circuit is accomplished by placing the circuit between a positive voltage source (or current source, i.e. a PV panel) and the positive terminal of the battery to be charged. The amount of charging current is set with R2, the 10k potentiometer. The current is linearly variable between essentially zero amps and up to 1 amp. More current can be obtained by lowering the value of the 1 ohm sense resistor.

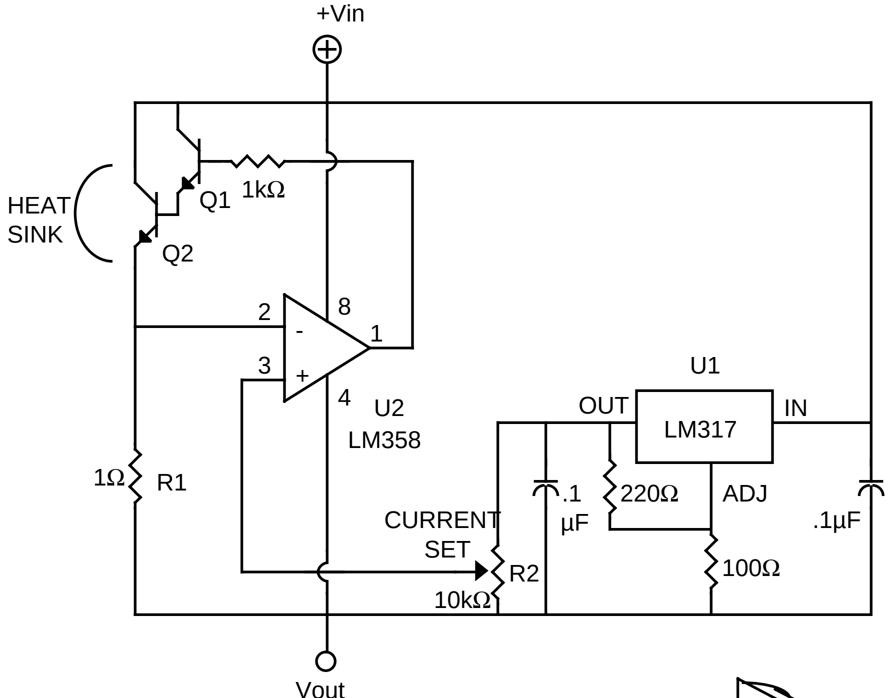


Figure1