Bulk Rate
U.S. Postage Paid
Permit # 166
Klamath Falls, OR

HOME POWER

Home Power

People

B. Bonipulii
Sam Coleman
Paul Cunningham
Windy Dankoff
Brian Green
Don Hargrove
Glenda Hargrove
Robert Hester
Stan Krute
Richard Measures
Karen Perez
Richard Perez
Wayne Phillips
John Pryor
Dave Winslett

Laser Masters by
IMPAC Publications
Ashland, Oregon

Legal

Home Power Magazine is a division of Electron Connection Ltd.

While we strive for clarity and accuracy, we assume no responsibility or liability for the usage of this information.

Contents

- **From Us to You** – **4**
- **Systems** – The Integrated Energy System – **6**
- **Solar** – How Many PV Cells Per Panel ? – **9**
- **Home Power's Business** – **12**
- **People** – The Power Of Personal Resourcefulness – **13**
- **Hydro** – Induction Generation – **17**
- **Education** – Careers In Photovoltaics – **20**
- **Free Subscription Forms** – **23**
- **Heat** – The Fireside Saves Hot Water BTUs – **27**
- **Things that Work** – The Heliotrope 2.3 Kw Inverter – **29**
- **Engines** – Charging Batteries With A Gas Generator – **32**
- **Batteries** – Lead Acid Battery Internal Resistance – **34**
- **Communications** – CB For You And Me – **36**
- **Basic Electricity** – Ohm's Law, Better Than Ever – **40**
- **Appliances** – 120 VAC Lighting And Inverters – **41**
- **Letters** – **43**
- **MicroAds** – **46**
- **Wizard** – Edge Studies – **47**
- **Humor Power** – One Day In Outer Space… – **47**
- **Index To Advertisers** – **47**
- **Mercantile** – **48**

Access

Home Power Magazine
POB 130
Hornbrook, CA 96044-0130
[916] 475-3179

Think About It

"The best way out
is always through."

Robert Frost

Cover

Students in Colorado Mountain College's PV Program mush in power to a remote high-altitude cabin.

From Us to **You**

Personal Power

There is more to home power than making electricity. It's easy for us to focus on a piece of hardware. What it does, how it works, and how much it costs. It's easy to lose sight of the power that comes first-- personal power. The will to do, and the power to accomplish what we will. No where is this will more vivid than in those who make their own electricity. It is in this spirit that we offer Wayne Phillips' article, "The Power of Personal Resourcefulness", on page 13. This article begins a regular column about the people that make AE a reality. It deals with ideas, desires & emotions, not with nuts and volts. It's about home power people, who they are, and why they do what they do. It's about you. It's about all of us.

Home Power's Growing

You may notice that this month's Home Power Magazine is 8 pages larger than last month's. With your help we are growing. There are two new columns in this issue: People and Education. There are many more articles in this issue that have come from our readers. That last is a trend we want to encourage. Send us your practical info, articles, pictures, essays, equipment reports, letters, pasta recipes, etc. See the top of the next page for submission suggestions. We will print your info and try to find out what you need to know. All we require is that you tell us what you want, and if you have anything to contribute, then send it to us. Home Power is for you. Unfortunately, we can't afford to pay anyone for their info. Yet…

We particularly need articles and information about wind power. We write Home Power from our personal experiences. Unfortunately, none of the Home Power Crew lives with a wind plant. PVs, generators, hydro turbines yes, but no wind plants (yet). We could research wind material and offer a regurgitated article based on book learning rather than experience, but that's just not our style. So, you wind power producers out there, blow us your contributions.

On the financial front…

Home Power is an experiment. Can we publish and distribute a magazine that costs its readers nothing? Can this magazine be supported strictly by its advertising? And still maintain honesty in its editorial content? Can the Home Power Crew earn enough to compensate for the fact that this magazine has completely taken over their lives? Well, stay tuned, the jury is still out.

We want to thank all of you who have been sending contributions to help keep Home Power alive. It has been making a difference. We are still adamant about keeping Home Power free to its readers. We have several reasons for this. First: financial. Unless we charge you a large (over $30 yearly) fee, the revenue from subscriptions is still only a fraction of what's needed to make Home Power work. It is the advertising revenue that really supports any publication. Second practical, we want to get the info in Home Power out there where it will do some good. Our distribution is much wider and simpler if we are free. Third philosophical, all the best information we have ever received has been free.

We encourage you to patronize the advertisers in Home Power. While we work our butts off on Home Power's content, it is the advertisers' bucks that print and mail it to you. Our advertisers measure the performance of their ads (and Home Power) by your responses. So, get on the phone or write them a letter if your are interested in their products. Be sure to remind them that you saw their ad in Home Power.

Our advertisers are an essential link in the process that produces Home Power. Your interaction with them completes this process. It keeps Home Power showing up in your mailbox.

In order to make Home Power advertising more accessible to small companies we have created a new (for us anyway) type of ad. The Home Power Mercantile (see page 48) provides display type advertising at rock bottom cost. We are limiting Mercantilers to one insertion per issue so that this service can be provided to those who need it and can't afford our regular display ads.

Flowers

Special thanks to Stan Krute for his graphics work in this issue. Stan, Master of the Mouse, drew the clip art you'll find scattered throughout this issue.

Richard & Chelius, Karen & Buckwheat

Special thanks to the Postmaster of Hornbrook California, Elden Cibart. Elden takes a look at the stacks of mail we bring in and just smiles.

Special thanks to our printer, Jim Allen, and the people at the Klamath Falls Publishing Co. He's taking the time to turn a bunch of rank novices into magazine publishers.

Special thanks to you, our readers. Your support and praise keeps us going.

RP

Submission Suggestions

You Want Your Stuff Back ???

If you want your submissions returned, include stamped and self-addressed return shipping materials.
We are not responsible for the fate of any submissions that arrive without such intelligence.
They'll probably hang around until spring cleaning, then go to the dump.

Articles

Write from real experience.
Write clearly, with: short sentences, generous use of subheads, and a straightforward organization of ideas.
Write as if you're talking to intelligent friends.

Cooperative Articles

Maybe you know something, but can't/won't write.
Just give us the info, and we'll write it up for you.
Contact us for further details.

Photographs

We like black and white photos with high contrast and a generous range of rich tonalities.
We want the negative to print from. We'll return it to you when we finish.
Compositions should be simple, filled with large objects.

Illustrations

Black and white art only. No pencils, no ball point, no smeary dreary smudgy wudgy.

Payment

Sorry, we cannot afford to pay anything yet. Be ye rich in spirit.

Editing

We edit all submissions for clarity and fit.

Copyright

You can copyright material in your own name by adding the following line to your first page:
"Copyright (c) 1988 by Your Name"
If you don't copyright the material in your name, we'll copyright it in ours.
If we do that, and you want the copyright back, it's yours.

Computerized Submissions

All data is on 400K Macintosh disks.
Graphics can be formatted, in order of preference, as SuperPaint, MacPaint, or FullPaint documents.
Text can be formatted, in order of preference, as text, WriteNow, MacWrite, or Word documents.
Spreadsheet data can be be formatted, in order of preference, as Excel or Multiplan documents.

The Integrated Energy System

by
Windy Dankoff

The integrated system works as a whole which is greater than the sum of its parts. It contains subsystems that optimally work with each other and with your needs as they change through the seasons and the years. The integrated system is an attempt to combine multiple energy sources, storage and usage systems for optimum economy. A well planned "whole system" can temper the feast or famine extremes of alternative energy, and reduce or eliminate the need for a backup mechanical generator.

Integrated system design is very specific to **YOUR** situation and climate. To get started on the right track, follow these

BASIC PRINCIPLES

1) Recognize your Essential Needs.

Your need is not for electricity: it is for light, water, preserved food,... Electricity is ONE way to provide for these needs.

2) Minimize the Steps of Energy Conversion.

Every time energy is gathered, converted, stored, transferred or otherwise processed, a significant amount is lost. Consider the most direct approaches to meeting your needs.

3) Tie All Systems Together

Make all systems function together as efficiently and simply as possible. This allows you to...

4) Balance Needs against Solutions.

Use what we have when we need it.

The typical consumer's home is a model of disjointed energy practices. In summer, inefficient light bulbs and refrigerators generate hundreds of watts of waste heat, causing air conditioners to work overtime. In winter, while cold abounds, refrigerators keep working hard to overcome the home's added heat. Electricity used for heating consumes hundreds of times more energy than other uses. Purified, pressurized drinking quality water is used to flush toilets and water the lawn. The alternative energy household does not have the "unlimited" energy supply that the utility line provides, and cannot afford such carelessness.

Applying principles #1 and 2, we utilize windows or skylight to let in daytime light, store vegetables in a cool pantry or root cellar. We can divert rainwater from the roof to a storage tank to supply garden and trees by gravity flow. We use direct solar heat to warm our home in winter and simple solar collectors to heat our water, with gas or wood fuel backup. We use electricity for those functions that it can do best. Use battery direct DC power directly where feasible, rather than converting it all to AC through an inverter. If we must rely heavily on a gas generator, we use an efficient gas refrigerator, rather than converting fuel's energy through an engine/generator to power an electric fridge.

Applying principles #3 and 4, we might use the sun for pumping irrigation water and/or refrigerating (high summer loads). The reduced demands in winter liberates plenty of energy for the extra winter lighting load. To make this possible, the pump and the home run off the same energy system.

There are endless variations to system design, with new possibilities opening as the technology advances. Assess your needs, read all you can on the subject, talk to PV users and dealers, and use your imagination!

No matter how well balanced your system might be, there are many times when more energy is gathered than is immediately required. Your battery bank becomes fully charged and your voltage regulator will simply "waste off" excess energy. Part of the integrated system involves techniques for...

UTILIZING EXCESS ENERGY

FACT: An alternative energy system designed for year round use will produce excess energy **MOST OF THE TIME**.

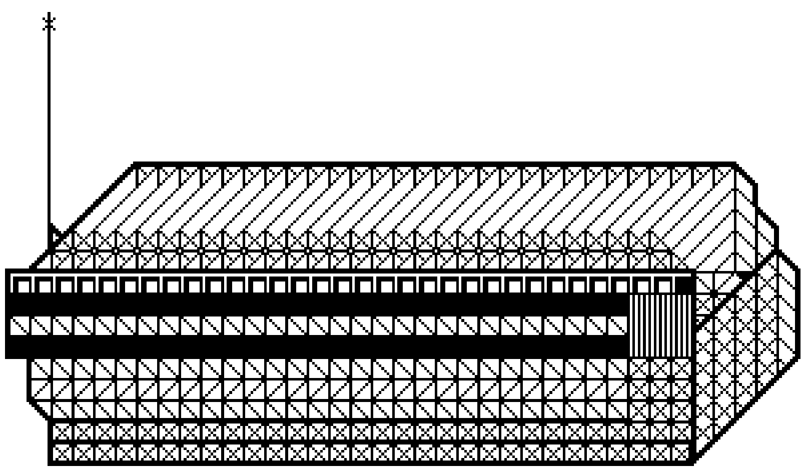
A system providing mostly lights will produce lots of excess in the summer, when days are longer. A system providing irrigation water will produce excess in the winter. Your system must be designed to see you through worse than average conditions. The rest of the time, you have excess energy. Utilizing this excess energy may as much as DOUBLE the effective value of your system.

OVERLOAD DIVERSION

The idea is to automatically switch excess energy to another load. A device that will use energy in an effective manner. Ideal overloads are those that incorporate a form of **STORAGE**, such as: (1) Second battery bank (2) Water or preheater or (3) Water pumping into a storage tank. Another example, (4) home ventilating or cooling uses excess solar power exactly when it is needed most.

(1) A second "reserve" battery bank solves three problems by providing: (A) a place to dump excess energy, (B) enough backup to reduce or eliminate the need for a backup generator, and (C) a way to enlarge or replace your battery bank without discarding the old batteries. You will note in our article on batteries that you should not combine batteries of different types or ages in the same set. Over the years we have had many customers phase out an aging battery bank that has lost capacity or is too small for expanding needs, by using it as the "reserve" set.

(2) Overload water heating can contribute a saving of fuel in the AE home, although it has serious limitations. To understand this limitation, consider that a typical (rapid heating) AC electric water heater of 40 gallon capacity draws 9000 watts, while the average home AE system has only a few hundred watts to dump intermittently! If you have a solar thermal water heating system, you will already have hot water by the time your PV system is ready to dump. If not, an ordinary electric water heater can be refitted with low voltage heating elements to supply more or less warm water for direct use or preheated water to save gas. Or a gas heater can be fitted with an electric element to save gas. A 150 watt (12 amps at 12.5 volts) heating element will heat one gallon of water from 55 to 125 degrees F. in 1.25 hours. This is a useful amount of heat. Excess energy is FREE... we might as well use it!



Da Hausada Fyoochuh

(3) Water storage for irrigation has enormous potential for making the most of solar power, especially because the most water is required when there is the most sun! It is ideal to store at least a two week supply of water. When your storage tank fills, allow it to overflow to some trees; the GROUND stores water/energy too! Use drip irrigation, mulching etc. to minimize evaporation losses.

(4) House or attic ventilation or cooling is a prefect way to "blow off" excess summertime solar power during hot weather.

CONTROL OF OVERLOAD ENERGY

This need not be complex. The simplest "human regulator" is simply a voltmeter, a switch, and you. When you see or anticipate your battery voltage approaching 15 volts (12V system), you flip the switch. The switch transfers all or most of your array to your alternate load, or turns your well pump or cooler on. When your voltage drops to 12.5 or so, then there is no longer excess energy so you flip the switch back to the normal full charge position. A control system can do this automatically for you, switching automatically as clouds come and go, appliances turn on and off, etc. If your control system does not have overload diversion, it may be added without altering existing controls.

By the way, PV modules run cooler when they are connected and working (energy is being removed from them). Modules that are disconnected by regulation that does not use their excess energy actually get a little hotter. The decades may reveal that modules that are used constantly last longer than those that are often disconnected!

"GROWING" A SYSTEM

Many people cannot afford, or do not need, to buy a complete energy system all at once. You may be constructing your homestead gradually, expanding your energy system as your enterprises or your family expand. A system designed for growth from the start will be integrated with your needs and will save you alot of money when the time comes to expand. Balance these suggestions against your budget limitations.

RULE: BUILD A HEAVY INFRASTRUCTURE

This refers to the parts of the system that form its foundation, and are difficult to enlarge later.

(1) WIRE SIZING: If you are burying wire from your PV array, or concealing it in walls, use large enough, heavy gauge, wire to carry sufficient current for your future, enlarged array (or put your wire in oversized conduit so that more, or larger wire may be added easily). Add a "pull me" rope to conduits so that more wires can be added later.

(2) AC DISTRIBUTION: When you wire a new house, distribute AC power lines to receptacle boxes in every room EVEN IF YOU DON'T PLAN to make extensive use of AC power. Inverters will keep improving and getting cheaper. Consider who may live in your home years from now. Future generations or prospective buyers may not accept the limitations you have imposed on them. Hallways tangled with extension cords are NOT a good option! Nor is ripping walls open to add wiring, or adding lots of surface conduit. You may leave unused receptacle boxes unwired until ready for use.

(3) ARRAY SUPPORT: It may cost only a little more to buy or build an array frame or tracker of twice the capacity that you need initially. Future expansion will be easy, less expensive, and better looking. See Home Power #2 for an easy to build, strong PV rack.

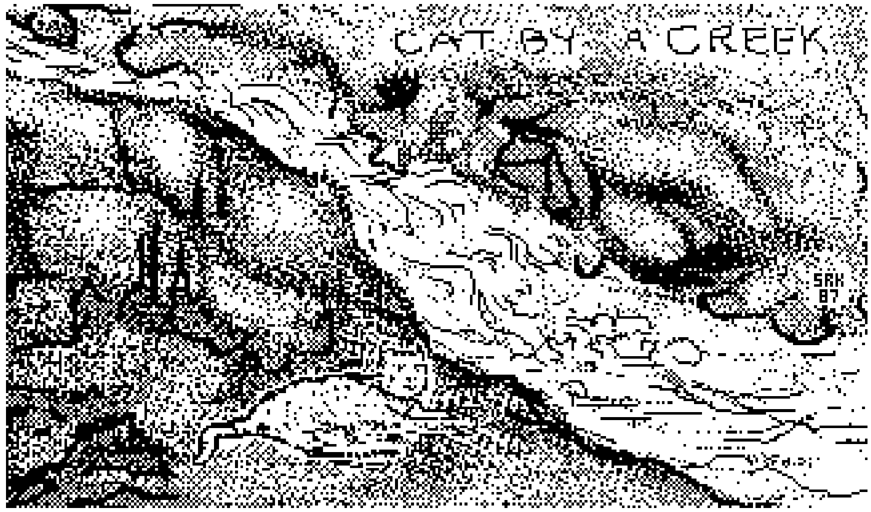
(4) BATTERY BANK: When you connect new batteries to old ones you are inviting problems. Oversize your battery bank and avoid using its full capacity until you expand your array. Or, leave enough space in your battery area for a second, larger bank of batteries to be installed next to your old set.

(5) CONSIDER A 24 VOLT SYSTEM: 12 volts is a vehicle standard. It is still ideal for a modest home system that does not need to run large motors or inverters and does not have long runs. But, a 24 volt system is more efficient and economical for larger systems and for small systems designed to grow. A dual 24/12 volt system need not be complex or costly.

NOTE: Fortunately, there is no strict need for compatibility among PV modules, old and new, different types and power ratings may be mixed into your array.

A photovoltaic system is unique in that its "generator" is composed of small modules and can be expanded over time. This is one of the many factors that make PV power the most liberating energy technology ever developed. Make the most of it by employing integrated system techniques and designing for future needs.

Windy Dankoff is owner and operator of Windlight Workshop, POB 548, Santa Cruz, NM 87567 or telephone: 505-753-9699.



So how many PV cells do I need in my panels, anyway?

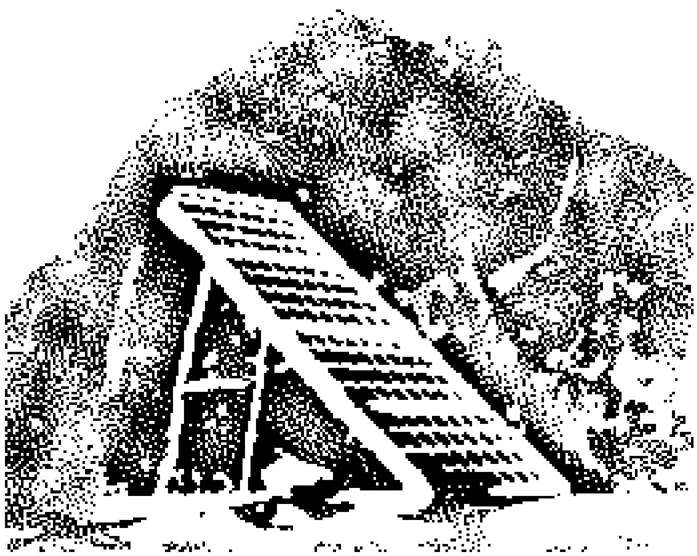
by
Richard Perez

Solar modules are made with between 32 and 44 series cells for 12 VDC battery use. How many cells are enough? How many are too much? What is the optimum number of cells to put in a panel for 12 Volt use? Well, as usual, it depends on our specific application.

The Single PV Cell

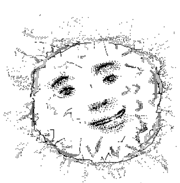
In order to understand why there are differing numbers of PV cells in modules, let's first examine the single cell. This little marvel converts light directly into DC electricity. It does this job within very specific limits. These limits are, according to the quantum mechanics among us, built into the structure of our Universe. The limits of the single PV cell determine the operation of the collection of cells we call a module or panel.

The electrical power generated by the PV cell has two components: voltage (E) and current (I). The output power (Watts or P) that the cell produces is the product of cell's output current times its output voltage. P=IE. The voltage output of the PV remains fairly constant over a wide range of input lighting, just as long as there is some light. The current, however, varies in direct proportion to the amount of light entering the PV cell. The more light entering the cell, the more current it produces. The cell's voltage remains the same from dim to bright lighting.



PV Panels At Play

For the purposes of discussion here, consider a 100mm X 100mm (4 in. by 4 in.) multicrystal silicon PV cell. Monocrystal or amorphous silicon cells will differ slightly. The absolute value of the voltage information will differ, but the general performance trends remain the same for all types of silicon PV cells. This example cell is rated using the standard AM 1.5 Solar Input of 100 milliWatts per square centimeter, about the amount of sunshine you receive on a sunny noontime.



PV Cell Voltage

This multicrystal silicon solar cell has an open circuit voltage of about 0.57 Volts at 25°C. Open circuit voltage means that the cell is not connected to any load and is not moving any current. Under load, the output voltage of the individual cell drops to 0.46 Volts at 25°C. It will remain around this 0.46 V level regardless on the sun's intensity or the amount of current the cell produces. This decrease in voltage is caused by resistance losses within the cell's structure and the metallic conductors deposited on the cell's surfaces.

Temperature affects the PV's cell's voltage. The higher the temperature is, the lower the cell's output voltage becomes. The output voltage falls about 5% for every 25°C. increase.

PV Cell Current

While the voltage of a PV cell is very reliable, its current output is one big, fat variable. The cell's current depends on how intense the light is, and most importantly for this discussion, the voltage difference between the cell (or collection of cells) and the load (in most cases a battery).

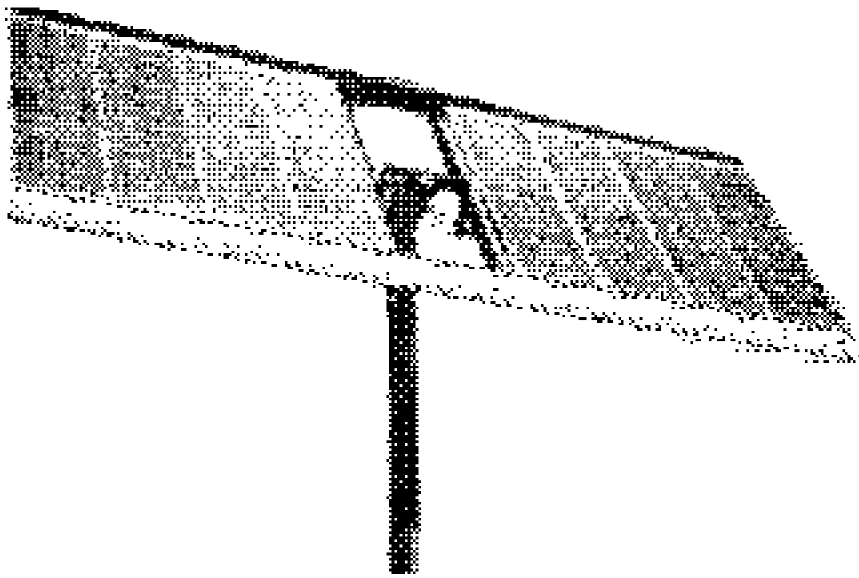
Under operating conditions this cell is rated at 2.87 Amperes of current by its manufacturer. I have measured the current output of this type of cell at 4.2 Amperes on a very cold, very clear, very bright & very snowy Winter's noon. Altitude is a factor that affects the cell's output current. The Earth's atmosphere is absorbs sunlight. The higher you are, the less atmosphere there is above you, and the more sunlight you receive. Expect to see current gains of about 5% for every 5,000 feet above sea level.

Cells into Modules

When PV cells are assembled into modules they are wired in series. The positive pole of the one cell is connected to the negative pole of the next cell, and so on until all the cells in the module are connected in a series string. This series wiring is done to raise the voltage of the module. A single cell has a voltage potential of 0.46 Volts. This is not enough voltage to do any usable work in a 12 Volt system. But if we add the Voltage of say 36 cells by series wiring them, then we have a working voltage 16.7 Volts, and that's enough to charge a 12 Volt battery.

The operational voltage range of a lead acid battery is between 11.6 and 16 volts. The battery's exact voltage depends on state of charge, temperature, and whether the battery is being charged or discharged at the time. It is this battery voltage curve that the modules are designed to fit. After losses in the blocking diode and the wiring are subtracted, the module MUST provide greater voltage than the battery possesses. If PV module cannot do this, then it cannot transfer electrons to the battery. It cannot recharge the battery.

The current produced by the module remains the same as the current produced by a single cell, about 3 Amperes. The series wiring technique causes the voltages to be added, but the current remains the same. We could parallel connect the 36 cells. This would add their currents rather than their voltages. The result would be a module that produces 108 Amperes, but at only 0.46 Volts. Hardly a useful item.



Eight PV Modules On A Tracker

So How Many Cells?

PV module manufacturers make 12 Volt modules with 32, 36, or 44 cells in the series string. They are all rated at about the same current, being composed of the same basic cell. The difference between these modules is one of voltage. The question for us to answer is how their output voltages relate to the voltages we require for our system.

32 Cells in Series

This module has the lowest voltage rating of 14.7 Volts (0.46 Volts times 32 cells). This is because it has the fewest cells in its series string. This module is designed to very closely follow the charge curve of a 12 Volt lead acid battery. As the battery fills, its voltage climbs. When this battery is almost full its voltage is around 15 volts. The 32 cell module simply hasn't enough voltage to continue recharging the battery when its full. These 32 cell modules are commonly called "self regulating" because they lack the voltage to overcharge the average, small, lead acid battery.

The applications suitable for the 32 cell module are RVs, boats, and summer cabins. These applications are characterized by intermittent use and relatively small battery capacity. In these applications, the 32 cell module can be used without a regulator and the batteries will not be overcharged during periods of disuse.

36 Cells in Series

This module has an output voltage of 16.7 Volts (0.46 times 36 cells). This is enough voltage to continue to charge a lead acid battery even though it may be fully recharged. The 36 cell module is the workhorse of the Home Power user. It is most suitable for 12 Volt AE systems with battery capacities over 350 Ampere-hours. It has the higher output voltage necessary to recharge high antimony, deep cycle, lead acid batteries.

It does, however, require regulation in many cases to prevent overcharging the battery during periods of disuse. This type of module needs regulation in systems where the total current generated by the PVs is greater than a C/20 rate to the battery. For example, a 350 Ampere-hour battery has a C/20 rate of 17.5 Amperes (350 Ampere-hours/20 hours). At 3 Amperes per module, the 350 Ampere-hour battery will not require regulation until there are 6 modules within the system. This is true only if the system is in constant use. If a system is unused for days at time, then regulation should be added if the 36 cell modules can produce a C/50 rate or more to the battery.

The 36 cell module is more cost effective in home power applications because of its higher current at higher voltages and temperatures. The higher voltage of 36 series wired cells more effectively recharges the large lead acid batteries. Higher temperatures cause the voltage of any module to drop. The 36 cell module has enough voltage surplus to still be effective at higher temperatures.

44 Cells in Series

The modules are the hot rods of the PV industry. 44 cells in series yields a working output voltage of 20.3 volts. These modules do not diminish in current output into a 12 Volt system, regardless of battery's voltage or high module temperature. They WILL REQUIRE REGULATION in just about every application. They have the voltage to raise the system's voltage, while charging full batteries, to well over 16 volts. This is high enough to make any equipment on line (like an inverter) very unhappy. Over voltage can ruin electronic equipment.

The 44 cell modules have very specific applications. They are designed for systems that must accept voltage losses in transferring the PV energy to its destination. Consider a low voltage pump located some 300 feet down a well. The electricity that powers this pump must travel 300 feet down the well to the pump and 300 feet back up again. This 600 foot long wire run will have appreciable voltage losses even if monster big wire (like 0 or 00 gauge) is used. In order to deliver acceptable voltage levels at the pump we can increase the voltage of the module and just eat the losses in the wire. The 44 cell module, with its 20.3 Volt operating level can stand a loss of over 6 Volts and still be effective at the pump. A word to the wise here. The cost of additional cells within the module is far greater than heavy copper wire. Be sure that it's not cheaper to use big wire in your application before you decide on the 44 cell module to solve voltage loss problems.

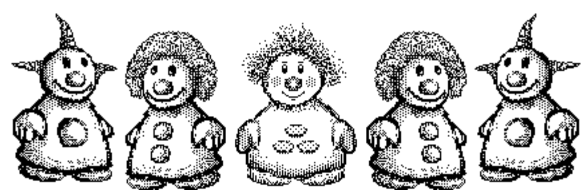
Another side benefit of the 44 cell module is its response in high temperatures and very low levels of light. We ran two modules, each using the same cells, side by side for comparison. The only difference between the modules was one had 36 cells in series, the other 44. The 44 cell module consistently produced more useable power in three situations: 1) The system voltage was above 15 volts, 2) the ambient temperature was very hot (over 40°C.), & 3) the ambient light was very dim (in fog or on overcast days). We tabulated the results and compared performance with price and the 36 cell module was more cost effective. Even though the 44 cell module performed better, this increase in performance was not enough to offset its higher price. If you live in a very hot area, then the additional voltage of the 44 cell module may indeed pay for itself.

In A Nutshell

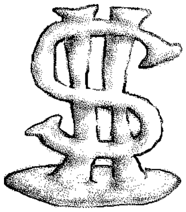
The 32 cell module is for small and often unused 12 volt systems. Its big advantage is it doesn't need a regulator.

The 36 cell module is best for most Home Power systems. It supplies the most cost effective energy to 12 volt systems using lead acid batteries.

The 44 cell module is suited to 12 volt systems with voltage loss problems. Its advantages are higher output voltage and strong performance in very hot locations.



The Cellular Family



Home Power's Business

Display Advertising

Full Page	$1,200	67.5 sq. in.
Half Page	$672	33.8 sq. in.
Third Page	$480	22.5 sq. in.
Quarter Page	$377	16.9 sq. in.
Sixth Page	$267	11.3 sq. in.
Eighth Page	$214	8.5 sq. in.

Maximimum Vertical size is 9 inches
Maximum Horizontal size is 7.5 inches

We use Macintosh computers to publish Home Power. We can set up and lay out your display ad. Camera ready advertising is also accepted.

FIRM advertising deadline is March 10th for the March issue, which will be distributed on March 20th.

Long term display advertising is discounted, so buy ahead and save.

Call **916-475-3179** for further details.

International Subscriptions

Due to the high cost of international mailingand packaging requirements, we must charge for copies of Home Power that are mailed anywhere that doesn't have a US ZIP CODE.

YEARLY INTERNATIONAL RATES:

Mexico or Canada: Air- $24. Surface: $21.
Central America, Bahamas, Bermuda, Columbia and Venezuela: Air- $32. Surface: $ 23.
South America (except Columbia and Venezuela), Europe, North Africa: Air- $40. Surface- $23.
Asia, Australia, New Zealand,Pacific Ocean Islands, Africa (other than North Africa), Indian Ocean Islands, and the Middle East- Air $49. Surface $23.

All payments in US currency ONLY!

Surface shipping may take up to 2 months to get to you. All issues shipped in mailing envelopes to withstand the rigors of international mailing. If you have friends with a US Zip code who regularly send you packages, then we would be glad to ship them an extra free copy for forwarding to you.

Home Power Mercantile

One insertion per customer per issue.
We typeset all ads. We do the best we can to make your ad look good. If you send too much copy, then you're bound to be disappointed. Flat Rate $80. Cheap at twice the price! See other Mercantile suggestions on page 48.

Back Issues

All back issues are $2 each, while they last. Shipped in an envelope via first class mail.

Hurry! Only 200 HP #1s left.

Home Power Magazine
POB 130, Hornbrook, CA 96044

MicroAds

These ads are designed for individuals rather than companies. So use your discretion. The rates are 5¢ per character, including spaces & punctuation.

He Said It All In 1887

"The great business of life is to be, to do,
to do without, and to depart."

John, Viscount Morley of Blackburn

THE POWER OF PERSONAL RESOURCEFULNESS

by
Wayne Phillips

The year was 1928 and the place was a small farm at the upper end of Coonhollow, a watershed near Sublimity, Oregon, named for its raccoon population. Leonard T. Phillips, the tenth child of the eleven children of Riley Polk and Abigail Rice Phillips, then 35 years of age, still resided with his parents. An Albino with an immense crop of bright white hair, he could see little through great thick spectacles. His eyes lacked the heavy pigmentation that surrounds the normal pupil and light diffused in uncontrollably. His poor vision led to poor progress in school.

The school he attended was a one-room, one-teacher affair of perhaps fifteen students altogether. Some of them were his own brothers and sisters. He was big and strong but painfully shy in childhood. He succeeded in passing "The Fifth Reader" in his formal schooling but four of his sisters became school teachers and another became a city librarian. They understood that behind the visual and emotional handicaps there resided an intellectual giant. To read, his nose rubbed the paper and his head shook as his eyes danced rapidly forth and back over a narrow interval that inched slowly along line by line. When the reading became particularly difficult, his glasses were shoved up to hang as though discarded in his bramblebush of hair and the paper was brought still closer to his eyes.

Despite Leonard's handicaps and with his sisters' help he learned to play the pedal organ, the violin, the country fiddle, the banjo, guitar and harmonica with such power and perfection that he was always in demand to play. He provided instrumental and vocal music for any party, picnic, dance, or rally within miles of his parents' farm. This tremendous demand for his musical services forced him out of his childhood shyness to some extent but he remained a gentle recluse all of his life. His memory was astounding. He could read an epic poem once and recite great portions of it from memory long after. Once, when challenged, he is reported to have recited all of "Snowbound" flawlessly. I can still recall with overwhelming nostalgia his whiskey baritone sweetly reciting "Lady of the Lake" to violin music of his own making.

In the 'teens of 1900, Leonard Phillips added popular science to his reading. In 1922 or 1923 he built one of the first (quite possibly the very first) radios in Oregon. That radio's appetite for electricity could be satisfied only briefly by "Hot Shot" batteries. These batteries were of the dry-cell type. They were expensive and the radio played (for a gathering) at any time a transmitter was "on the air." Visitors coming from afar to hear the radio brought news of neighbors who had purchased electric plants. That news was electrifying! An electric plant would make possible another, much more powerful radio.

Installed in 1925 or 1926, all that I now recall of the electric plant, a Delco, was a small shed full of glass-shelled batteries. These batteries were charged by a generator driven by a small one-cylinder engine. When running, the engine continued to run until one battery equipped with a hydrometer was fully charged. The rising hydrometer at that point tripped a switch to open the generator charging circuit and shut the engine down. As the battery bank discharged into the continuing load, the same hydrometer fell to a lower limit closing a switch that recoupled the batteries to the engine's generator.

The generator, now acting as a motor, used some of the remaining stored power of the batteries to crank, and thus restart, the engine. There were flaws in the system. If the engine stopped because it was out of fuel, the hydrometer would ultimately tell it to restart. Without fuel it couldn't start and the fruitless cranking rapidly depleted the remaining energy of the battery bank. Then, in the dark (always in the dark because that's when the engine ran most of the time), in a rainstorm, or fresh snowfall it was necessary to visit the shed with a coal oil lantern, refill the tank and hand crank the stubborn engine back to life.

This flaw, and others leading to frequent shutdowns, led Leonard Phillips to build an overshot waterwheel of the old-mill type on the North Fork of Mill Creek just upstream from Coonhollow Falls. That waterwheel drove a Dodge automobile generator revised by him to produce 32 Volts DC for replacement of the engine, really as a supplement to the engine charging the battery bank.

By 1928, the date of the beginning of this anecdote, the precursors of today's electric appliances were reaching rural American in 32-volt DC versions for use with Delco plants. Curling irons, waffle irons, electric irons for the laundry, electric washing machines, electric outdoor lights, sewing machines, electrically driven grain mills, and other devices such as the electrically driven cream separator and chick hatcher, soon passed from the status of luxury or curiosity items to the status of necessities. The combined efforts of the old-mill style waterwheel and the engine could not satisfy the load.

Improvement was needed!

The North Fork of Mill Creek, originating a mile or two upstream from Riley Polk Phillip's place, drops gently about 30 feet in elevation as it crosses that farm and then drops abruptly an additional 30 feet at Coonhollow Falls just before it leaves the farm. A modest stream of 50 or 60 gallons per minute in mid-August, it is a raging torrent of 100 second-feet in March as the snows melt and spring rains fall.

Uncle Len had by this time, and with the help of his sisters, acquired quite a library on the emerging technology of electricity. He owned a complete set of that early authority, The Hawkins Electrical Handbook Series. Tacky tomes all, they promised the greatest of revelations, new comfort and other advances all through the good offices of electricity. He also now knew about waterwheels other than the old-mill type and correctly concluded that he could utilize a Pelton wheel beneath the falls.

With characteristic directness, he felled two tall fir trees of 20-inch diameter at a point some distance above the falls and dragged them by horse team downstream and over the falls so that their butts lodged twenty feet from the face of the falls while their tops rested on the crest of the falls. With a hand axe he clambered up and down these logs or trunks chopping away limbs and peeling off the bark. With the two trunks lying about 4 feet apart, he nailed short 2 x 4 timbers across both, creating a gaint ladder with 2 x 4 rungs at one-foot intervals.

Searching for pipe to lead the water down the ladder to the waterwheel he learned that the city of Oregon City was replacing all of its wooden water mains with new cast iron mains. He acquired, free, several lengths of these old wooden mains, redwood stave tubes spirally bound by steel wire, of about one-foot diameter and used them to lead the water from a small dam above the falls (a dam just deep enough to cover the entrance to the pipe--a feature that provided nearly steady flow and fixed head since the excess simply ran over the top of the dam) downstream to the crest of the falls thence down the gaint ladder to a nozzle of about 2-inch diameter delivering water to the wheel.

This much of the project completed by a person blind by today's legal standards. This is enough to inspire the title of this tale but there is much still to relate.

Unable to buy a Pelton (impulse) turbine, Leonard built his own. To build it, he started with a worn-out 4-cylinder engine from an early automobile or tractor. This engine had a huge flywheel 2 feet in diameter with a face width of 4 inches and a rim thickness of at least 1 inch. He removed the pistons and head from the engine, placed the engine upside down upon the ground and poured a fair sized pad of concrete around it; the head bolt studs and nuts served to anchor the engine block to the concrete. He then cut 4-inch long segments of U channel from an old automobile frame and bolted these to the flywheel.

Note that he did not have one of today's marvelous electric hand drills. All of these holes through the rim of the flywheel he drilled laboriously with a hand brace and bit. The engine's oil pan he left in place to protect the crank and bearings of the engine. He filled the cylinders and crank space with enough oil so that the crank splashed into this oil, the splashed oil serving to keep filled small pockets he'd provided above each bearing and which by virtue of small drilled passages continuously fed oil to each bearing. On the end of the crankshaft opposite from the flywheel, he mounted a large flat-belt pulley which drove a smaller pulley on the intermediate shaft. A large two-groove V-belt pulley on the opposite end of the intermediate shaft then drove the small double V-groove pulley on the generator.

This arrangement served to step up the speed of the generator above that of the turbine wheel. Total hydraulic head on the turbine nozzle was perhaps 35 feet with a resultant nozzle water velocity of approximately 47 fps. This nozzle velocity required a bucket velocity on the turbine of 24 fps for maximum power extraction. To provide a 24 fps bucket velocity on a wheel of 2-foot diameter required 230 rpm. The belts and pulleys increased this speed to nearly 2000 rpm from the generator, an increase of approximately 9 to 1 or 3 to 1 in each of the pulley sets.

The generator, its particulars now long lost, had an output of perhaps 2 or 3 kW. and was contrived by him with typical ingenuity. He revised or rewound a 110-volt industrial DC motor to function as a generator producing 32 volts DC. The Dodge automobile generator from the old overshot wheel plant upstream returned to service. Driven by another set of pulleys from the intermediate shaft, it now furnished exciter current for the big new generator. We might wonder why he'd not purchased an appropriate generator to begin with but his parents farm was never productive of much but progeny and the great depression of 1929 had now struck. The 110-volt DC motor he'd started with had gone to the junkyard with many others as the early DC electrical utility systems gave way to 60-cycle AC systems. He needed 32 volts DC to avoid replacement of all of his electrical appliances and lights previously driven by the Delco plant.

The resulting system served the farm from 1930 to 1947. In 1947 the REA completed the last leg of a power line whose construction had started before World War II but had not yet reached the upper end of Coonhollow when the war's demand for copper stopped its progress.

Other than the human energy of its builder, the system had cost nothing; a capital outlay of perhaps $100. It ran with but few outages for 17 years. The system had its shortcomings, of course. On one occasion it was stopped by the body of a large water rodent lodged in the turbine nozzle. In 1935 it was shut down for two or three weeks by ice formed in an unusually tough winter.

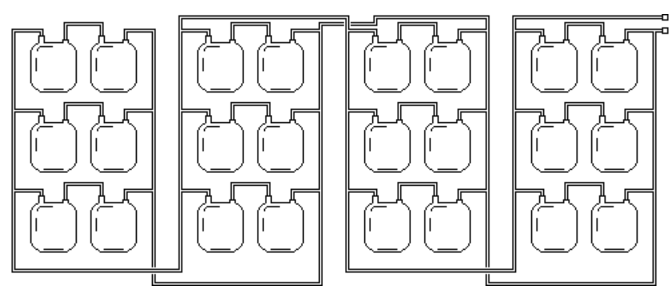
Controls were rudimentary. A steel wire, running from a lever and notched sector mounted on a porch post at the house, passed over pulleys on his power line poles to a head gate at the dam for start up and shut down. A Big rheostat at the power house permitted manual adjustment of exciter current and system voltage. A trembly voltmeter and ammeter on the back porch at the house displayed the system performance.

Generator regulation was so poor that when a significant part of the load was removed, the voltage would rise to such an extent that all remaining lamps burned out. To prevent the unwise from causing such a catastrophe, he simply removed or disabled enough light switches so that a stabilizing base load remained "on" at all times. This led to the making of new acquaintances as strangers of good intent stopped to inform him that his Delco plant was still "on" in broad daylight!

During most summers the creek flow would dwindle to the point that the penstock could no longer be kept full. When this happened, the "head" on the turbine could no longer maintain the required generator speed and a month or more of shutdown was imposed. Fortunately, these shutdowns coincided with the summer's long days when less evening illumination was required. He found too that he could postpone the summer shutdowns by inserting a smaller nozzle inside the regular nozzle at the turbine. The result of this nozzle reduction was to keep the penstock full at a lower flow rate. A full penstock provided the head necessary for normal water velocity at the turbine. The turbine and generator could thus run at the required speed but the load it could serve was reduced to one or two lamps and the radio. The first good rain of the fall was cause for celebration as the lights went on again all over the farm.

If we were to reckon the benefits of the plant at today's energy prices, we might conclude that it had earned (.05$/kW./Hr.) (2kW output) (10 months operation per year) (720 Hrs./Mo.) (17 years) =$12,240. This is not a great deal of money by today's standards but it was a fine return on the original $100. It also earned for him a small place in the history of Coonhollow and monumental stature in the eyes of one of his nephews.

Wayne E. Phillips is a Professor in the Department of Mechanical Engineering at the Oregon Institute Of Technology, Klamath Falls, OR.



Bottled Batteries ?

Induction Generation: *an exciting possibility*

by
Paul Cunningham

Why does it make a difference what type of generator we use to produce power? Let's take a look at the standard types and see what the features are. Two broad categories include most types. Either the output coils can rotate or they can be stationary. Almost all of the older designs used output coils of wire that rotated. These designs used a stationary "field" which provided a magnetic flux for the moving output coils to pass through which in turn generated an electrical flow in the coils. This design is represented by direct current (DC) motors and most older alternating current (AC) generators (alternators). The major disadvantage of this type of machine is that the full output must pass through carbon brushes. Many generators of this type are used in alternative technology applications but they require more maintenance. Also, because of the rotor design, the wire is more difficult to retain at higher speeds as it tries to fly outward from the rotor. It is for these reasons that automotive generators (DC) were replaced by alternators.

The other major category of generators include those designs in which the output coils are stationary and the field rotates. This includes automotive alternators. All machines of this type produce alternating current output. If DC output is required, then RECTIFIERS are used to convert AC to DC. These are solid state electrical one way "valves" usually using silicon diodes.

Thus far, all of these designs mentioned could use permanent magnets for the field. This means several things. The field requires no electricity to operate, so efficiency is higher. It can operate at very low speeds since the power of the field is not taken from the output of the machine. On the negative side, there is no easy way to control the output of such a machine. With a wire wound field the output can easily be varied by alternating field current. A rheostat is a simple way to do this, and in this way output is easily optimized.

EXCITATION IS WHAT AN INDUCTION GENERATOR IS ABOUT

You can use most motors as generators to produce electric power. A standard induction motor can also be used this way. These motors consist of stationary coils of wire that carry the current to operate them wound through slots in steel laminations. The rotor consists of steel laminations with aluminum conductors (usually) cast into slots in the steel. These are called squirrel cage rotors. When alternating current is applied to the stator coils, a rapidly changing magnetic field is produced. Once such a machine is running, there is always a speed difference between the rotor and changing field in the stationary coils. This difference is called "slip". This difference in speed INDUCES an electric current an electric current in the rotor and as a result a magnetic field. It is this field in the rotor that now causes it to "follow" the direction of the field in the stator.

For quite some time it has been recognized that if shaft power were applied to an induction motor already running, it would operate as a generator and push electricity back into the source used to operate it. For this to occur, our motor must now be running slightly faster than the "synchronous" speed instead of slightly slower. This technique is widely used on a large scale in commercial power generation systems. The

electrical power already present provides the necessary "excitation" to correctly operate the machine. In this context, the system is fail safe.... if the grid power fails, generator output ceases also.

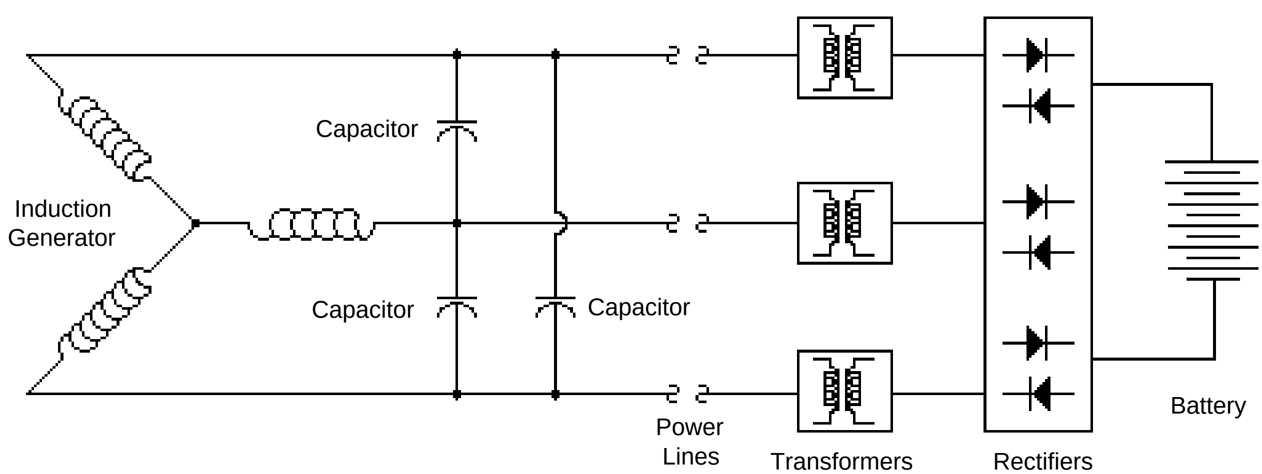
How is all of this going to help us with our stand alone remote system? There is the possibility of using a standard electric motor to efficiently generate electricity. One technique is to generate an "exciting" current for the motor/generator to "follow". Induction seduction, sort of. I have not been successful with this. Anyone who has should contact me with their findings. What DOES work with excellent results is to simply apply capacitance in parallel with the output lines. I ignored this tantalizing possibility until I met Bill Thomson and Fred Howe (of Thomson and Howe, Kimberly, B.C., makers of electronic controllers for hydro systems) at a small hydro conference in March '87. It was their encouragement and information that enabled me to progress. The simplicity, low cost, and high efficiency of such a system were all self evident, once work was begun in this direction.

In the first issue of Home Power, I wrote about the conversion of a standard three phase induction motor to a permanent magnet alternator. With my new information, I removed the P.M. rotor and replaced it with the original. Then I added the 15 microfarad capacitors across each line (parallel). When the machine was started again, I found that not only did it start generating by itself (yes, "self excitation" an interesting term for a dry subject) but the output was identical to the P.M. rotor machine. This was a revelation to me.... how easily it could be done.

It should be instructive to note what makes up a complete battery charging system. The water driven turbine in turn drives a 1/3 H.P. three phase 230 VAC motor that has the three capacitors connected across the output lines. In this case power is generated at 120 VAC and can thus be transmitted very long distances with minimal losses. Then at the point of use three transformers step the 120 volts down to battery voltage and with a bridge rectifier, produce direct current. It looks like this:

You are probably wondering how induction generation works and why it isn't more widely used. In a stand alone system, the key to operation is the presence of capacitance. This gives electricity somewhere to "go" without the capacitors acting as a load. Thus enabling current to flow in the motor and get it all excited. Most motors I have tested as generators will start producing power on their own with the use of capacitors. This is due to the small residual magnetism in the rotor. It is also necessary that the generator not "see" a load until it is up to proper voltage. If a load is present at the start, the voltage will be unable to rise at all. In a battery charging system this is more or less inherently provided for, as the generator only "sees" transformers as a small load until proper voltage is reached.

Induction generation is more limited than a P.M. alternator in the type of situation in which it can be used. The induction machine should be operated at or near its rated speed. This can be as low as 800 rpm depending on the motor specs. A P.M. machine can be operated at very low speeds and still work well. However, if a site can use an induction generator,



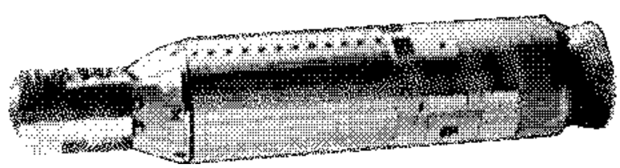
then it can be implemented at low cost since the motors are not expensive and the capacitors are only a few dollars each. Motors are also available in different speed ranges.

You might wonder why I am using three phase systems when a single phase one might do. It is possible to use single phase motors for this. However, they require more capacitance, operate at lower efficiency, and are not easily excited. Three phase alternating current is also more efficiently converted to DC for battery systems.

For those of you wishing to experiment, some further information may prove useful. The size of capacitor will largely control output voltage. Smaller capacitors are needed as voltage rises. Use only AC motor run capacitors. Not all electric motors are created equal and may produce results differing from what I found. Also keep in mind that if the system is to operate at a fairly fixed speed (like most hydro systems) that no adjustments are required from minimum to maximum output. As a starting point, a 1/3 HP 3 phase 230 VAC 4 pole (1800 rpm nominal) Westinghouse motor needs 15 µf. per line to generate 120 VAC at 1500 rpm. A 1 1/2 HP Leeson 3 phase 230 VAC 4 pole motor requires 40 µf. per line at 1500 rpm, 230 VAC. If any readers have trouble getting things to excite, the most effective technique is to apply 12 VDC to one phase (two output wires) of the motor while stopped. After a few minutes remove the DC and try starting again. This "imprints" the rotor with magnetic poles and should get things going. Try no load at first just to see if it works.

There are some further points of interest that will probably be discussed in a future update. Presently there is still much work to be done before a more complete understanding is possible. Readers are encouraged to both try experiments and report their results.

Write Paul Cunningham at Energy Systems & Design,
POB 1557, Sussex, New Brunswick, E0E 1P0, Canada



Early Induction Engine Prototype ?

Careers in Photovoltaics Start with Training

by

the Solar Program Staff of Colorado Mountain College

Job placement in the solar energy field, particularly in photovoltaics, has become more like "job selection" for graduates of the Colorado Mountain College Solar Program.

In fact this year, the 1987-88 school year, there are more job opportunities than students. CMC Solar Program graduates have the luxury of "selecting" which solar option to pursue.

And work in the photovoltaics field is leading the charge.

One CMC Solar graduate recently was hired as an assistant manager in a national photovoltaic company's regional office in Denver. Three other CMC Solar graduates were hired by diversified New England solar companies that are designing, installing and selling PV systems.
Other CMC graduates have started their own PV businesses, including catalog sales. This job success trend in photovoltaics supports the national reputation for excellence, earned by the Colorado Mountain College Solar Program. Numerous national and international publications consistently rate the CMC Solar Program and the photovoltaics division as one of the best in the nation.

Since 1981 the Colorado Mountain College Solar Program has offered a unique combination of photovoltaics skills training. The strength of the program lies in combining classroom design experience, hands on installation and on going

maintenance and troubleshooting.

Full time team instructors Steve McCarney, Ken Olson and Johnny Weiss have developed the PV course and co-authored a concise training manual, "Photovoltaics-- A Manual of Design and Installation for Practitioners." Facilities at the Colorado Mountain College Spring Valley Campus, located eight miles south of Glenwood Springs, Colorado, exhibit both solar heating systems and 10 working PV systems.

Short and long term PV courses are offered throughout the year. Customized training also is available on request.

The CMC instructors are certified state vocational educators with varied backgrounds including contracting, architecture, engineering, and adult education.

More than 300 individuals have completed the Colorado Mountain College photovoltaics training courses. Ten design/installation courses consisting of 80 hours of training have been completed in Colorado and Alaska.

As part of course work, more than 40 stand alone PV systems have been installed including generator hybrids, refrigeration, lighting, pumping and home power. Many of these installations have been in remote areas typical of today's stand alone PV market. In some cases travel to these sites has included dogsleds, snow machines, skis, llamas, backpacks and 4WD vehicles.

In addition, day long workshops by the Colorado Mountain College instructors have been well received at the Renewable Energy Technologies Symposium and International Exposition (RETSIE) and the annual meeting of the American Solar Energy Society (ASES).

Trainees in the Colorado Mountain College program have included licensed electricians, solar technicians, energy efficiency professionals, PV industry trainers and researchers.

Groups and organizations sponsoring CMC trainees include the PV industry, Peace Corps, Department of Defense, World Health Organization, Agency for International Development, state and local governments, university and national solar energy laboratories.

The Colorado Mountain College staff has worked with trainees from Canada, Mexico, Guatemala, Columbia, Argentina, Great Britain, Switzerland, Qatar, the Phillipines, Tanzania, Australia and, of course, the United States.

In addition the CMC instructors have authored numerous technical papers published by the International Solar Energy Society and the American Solar Energy Society. Magazine articles on the CMC Solar program have appeared in PV International, Solar Age, Energy Report, Mother Earth News, and Energy Talk.

To supplement the regular school year Solar Program, Colorado Mountain College also will be offering a special two week photovoltaic training class in the summer of 1988.

For Additional information on the Colorado Mountain College Solar Program and photovoltaics training, contact the CMC

Solar staff at 303-945-7481, or write them at 3000 County Road 114, Glenwood Springs, CO 81601.

Editor's Note: I was part of a PV seminar with Steve McCarney and Johnny Weiss at the 1987 American Solar Energy Society's annual meeting in Portland, Oregon. They have comprehensive knowledge and experience in PVs, and more importantly they can TEACH. If you are considering solar or photovoltaics as a career the CMC is one of the best places to start. Thanks to the CMC crew for the wonderful photos. --Rich

Subscription Form

Home Power Magazine

This Magazine is FREE Monthly

If you want to continue to receive Home Power Magazine free, please completely fill out our free subscription form below, fold it up, tape it, put a 22¢ stamp on it and drop it in the mail

PLEASE PRINT

NAME ______________________________

STREET ______________________________

CITY ____________________ **STATE** __________ **ZIP** __________

The following information regarding your usage of alternative energy will help us produce a magazine that better serves your interests. This information will be held confidential. Completion of the rest of this form is not necessary to receive a free subscription, but we would greatly appreciate this information so we may better serve you.

FOR OUR PURPOSES WE DEFINE ALTERNATIVE ENERGY AS ANY ELECTRICAL POWER NOT PRODUCED BY OR PURCHASED FROM A COMMERCIAL ELECTRIC UTILITY.

I NOW use alternative energy (check one that best applies to your situation).

- ☐ **As my only power source**
- ☐ **As my primary power source**
- ☐ **As my backup power source**
- ☐ **As a recreational power source (RVs etc.)**

I want to use alternative energy in the FUTURE (check one that best applies to your situation).

- ☐ **As my only power source**
- ☐ **As my primary power source**
- ☐ **As my backup power source**
- ☐ **As a recreational power source (RVs etc.)**

My site has the following alternative energy potentials (check all that apply).

- ☐ **Photovoltaic power**
- ☐ **Water power**
- ☐ **Wind Power**
- ☐ **Other** __________

I now use OR plan to use the following alternative energy equipment (check all that apply).

NOW	FUTURE		NOW	FUTURE	
☐	☐	**Photovoltaic cells**	☐	☐	**Gas/Diesel generator**
☐	☐	**Wind generator**	☐	☐	**Batteries**
☐	☐	**Water power generator**	☐	☐	**Inverter**
☐	☐	**Battery Charger**	☐	☐	**Control systems**
☐	☐	**Instrumentation**	☐	☐	**PV Tracker**

FOLD HERE

& TAPE

Please write to us here. Tell us what you liked and didn't like about Home Power. Tell us what you would like to read about in future issues. Thanks for your time, attention & support.

FOLD HERE

Return Address

____

____

____

Place 22¢ Stamp Here

Home Power Magazine
Post Office Box 130
Hornbrook, CA 96044-0130

Subscription Form

Home Power Magazine

This Magazine is FREE Monthly

If you want to continue to receive Home Power Magazine free, please completely fill out our free subscription form below, fold it up, tape it, put a 22¢ stamp on it and drop it in the mail

PLEASE PRINT

NAME ____

STREET ____

CITY ____________________ **STATE** __________ **ZIP**______________

The following information regarding your usage of alternative energy will help us produce a magazine that better serves your interests. This information will be held confidential. Completion of the rest of this form is not necessary to receive a free subscription, but we would greatly appreciate this information so we may better serve you.

FOR OUR PURPOSES WE DEFINE ALTERNATIVE ENERGY AS ANY ELECTRICAL POWER NOT PRODUCED BY OR PURCHASED FROM A COMMERCIAL ELECTRIC UTILITY.

I NOW use alternative energy (check one that best applies to your situation).

- ☐ **As my only power source**
- ☐ **As my primary power source**
- ☐ **As my backup power source**
- ☐ **As a recreational power source (RVs etc.)**

I want to use alternative energy in the FUTURE (check one that best applies to your situation).

- ☐ **As my only power source**
- ☐ **As my primary power source**
- ☐ **As my backup power source**
- ☐ **As a recreational power source (RVs etc.)**

My site has the following alternative energy potentials (check all that apply).

- ☐ **Photovoltaic power**
- ☐ **Water power**
- ☐ **Wind Power**
- ☐ **Other**______________________

I now use OR plan to use the following alternative energy equipment (check all that apply).

NOW	FUTURE		NOW	FUTURE	
☐	☐	**Photovoltaic cells**	☐	☐	**Gas/Diesel generator**
☐	☐	**Wind generator**	☐	☐	**Batteries**
☐	☐	**Water power generator**	☐	☐	**Inverter**
☐	☐	**Battery Charger**	☐	☐	**Control systems**
☐	☐	**Instrumentation**	☐	☐	**PV Tracker**

FOLD HERE

& TAPE

Please write to us here. Tell us what you liked and didn't like about Home Power. Tell us what you would like to read about in future issues. Thanks for your time, attention & support.

FOLD HERE

Return Address

____

____

____

Place 22¢ Stamp Here

Home Power Magazine
Post Office Box 130
Hornbrook, CA 96044-0130

The Fireside

by
Don and Glenda Hargrove

A simple but effective test that will save you BTUs!

Last issue I discussed various definitions of heat and the ways it moves around us. Heat can be moved, stored, contained, or wasted without us realizing what is happening. A case in point is the propane fired water heater. I have one, and many are in use in AE households. Do you know the BTU rating of this most important appliance? Do you know whether it actually delivers the amount of heat it is supposed to? How many of those precious BTUs are being lost through your vent pipe and heater casing?

I want to tell you about a simple performance test you can run on your hot water heater to test its efficiency. You will need a thermometer that registers at least 150°F., an accurate watch, a vacuum and a good stiff wire brush.

Turn the hot water heater control to the pilot position. Allow the water heater to cool, or drain the heater and let it refill with cold water. Now turn on any hot water faucet and record the temperature of the water. I started my test with a water temperature of 60°F. Make a notation of the time, and immediately turn the hot water heater ON. When all the water in the heater reaches the temperature you have set on your thermostat, the burner will go out. Immediately make a note of the time and turn the water heater off. Take another temperature reading at the same hot water faucet you used before.

Some lucky person in your household now has the luxury of an entire tank of hot water while you continue on with the dirty part of the test. Allow the burner to cool off for at least 20 minutes. Cover the burner unit completely with a plastic bag. Using the wire brush and/or sandpaper, clean all the rust and scale from the bottom of the tank. It's rather a tight fit through the small door, but perseverance will pay its rewards. Be sure to wear gloves and a long sleeved shirt. For extra safety, wear goggles. A flashlight helps a lot.

After the bottom of the tank has been thoroughly cleaned, remove the vent pipe from the top of the heater. Pull any baffle inside the heater up and out of the heater. Using a wire brush taped to a handle, clean rust and scale from the tube through the heater's tank. Take a little time and clean this tube well. The result of your efforts may be an impressive pile of gunk in the bottom of the heater. Vacuum all the rust and scale from the bottom of the heater. After I cleaned mine out, I lined the area under the burner with aluminum foil. This will help reflect radiant heat onto the tank.

By now the lucky household member has probably used up all the hot water. If not, you get to use the hot water, but only until its temperature reaches the temperature reading at the very start of the test. In my case 60°F. Now relight the pilot, turn the heater on, and immediately note the time. Wait until the water reaches the same thermostat setting as before and the burner shuts off. Note the time and temperature of the hot water at the same faucet you have been using.

If your heater needed a good cleaning, it should take less time to reheat to the thermostat setting. I was able to reduce burner operating time in my case by 12 minutes. If you don't realize any change after you have cleaned your heater, your water may have high mineral content. This will cause mineral build up inside the tank and insulates the water from the burner's heat. Replacement is the only solution for tanks coated on the inside.

What does all this data we've collected mean in terms of efficiency and BTUs saved? Subtract the start temperature from the final heated temperature for both data runs, one with the dirty heater and the other clean. Subtract the time figures from each other as well for each run. We now have two sets of data about how long it took to heat the water a known number of degrees. Look on the heater and find the manufacturer's info on tank capacity in gallons and burner size in BTUs. My heater has a 40 gallon tank, and is rated to deliver 38,000 BTU per hour.

38,000 BTUs per hr. ÷ 60 min. per hr. = 633.33 BTUs per min.
40 gal. X 8.33 lbs. per gal. = 333.2 lbs. of water in the tank.
1 BTU = 1°F. temperature rise in 1 lb. of water.

Here is the data from my test runs:

BEFORE

Temperature Increase = 72°F.
Heating Time = 72 minutes

AFTER

Temperature Increase = 72°F.
Heating Time = 60 minutes

It took 72 minutes to warm the water up before cleaning the heater and 60 minutes to do the same job after cleaning. Since my burner produces 633.33 BTUs per minute, its operation for 72 minutes produces 45,600 BTUs of heat (633.33 times 72). Its operation for 60 minutes produces 38,000 BTUs.

The amount of heat it takes to raise the temperature of 333.2 lbs. of water (40 gallons- my tank size) 72°F. is 23,990 BTUs (333.2 times 72). This is the amount of usable heat I have gotten from my water heater. If we subtract the amount of heat we have put into the water from the amount of heat we produced on each test run, we can calculate heat lost and the efficiency of the heater. In my case, I lost 21,610 BTUs before the heater was cleaned (45,600 minus 23,990). After cleaning the heater I lost 14,010 BTUs.

This can be calculated as efficiency. Before cleaning, efficiency of the heater was 52.6% (23,990 BTUs of heat into the water divided by 45,600 BTUs used in the burner). After cleaning, the heater is 63.1% efficient. The 7,600 BTUs of heat I saved by cleaning the heater amounts to an efficiency increase of 10.5 %. Not bad for an hours work.

There are 91,500 BTUs in one gallon of propane. This means we have saved about 0.08 gallons of propane per tank full of hot water. Assuming that we use 50 tanks of hot water monthly and a local propane price of $1.20 per gallon, we save $4.98 per month. If I keep the heater clean all the time, then we save $59.76 yearly. If your fuel source is natural gas, there are 100,000 BTUs in one therm (100 cubic feet) of natural gas. Your natural gas meter reads in cubic feet.

You can use the same and similar experiments to check heater efficiency. Try it after adding an insulating blanket to your water heater. Now that you've cleaned your heater and saved some BTUs for future use, use your imagination and go enjoy that full tank of hot water!

Write Don & Glenda Hargrove at 19,101 Camp Creek Road, Hornbrook, CA 96044.

Things that Work!

Here is what it takes to be a Thing that Works:

#1. The device must do what its maker says it will.

#2. The device must survive in home power service.

#3. The device must offer good value.

All the above criteria will be determined by the Home Power Crew in actual testing in working home power systems. You need not be an advertiser in Home Power to have your products considered for the Things that Work column. We follow Thumper Rabbit's advice, ***"If you can't say something nice about something, then don't say anything at all!"*** Devices not meeting the three above criteria will not appear in this column. All tested equipment will be returned.

Readers: **If you see it in Things that Work, then it does. Only products meeting these standards will appear here.**

Things that Work

Home Power tests the Heliotrope PSTT 2.3 kW. Inverter

conducted by Richard Perez & John Pryor

In the past, inverters have been weak links in our power chain. They were very prone to failure, and didn't work well. Well, those days are past. Heliotrope makes an inverter that works extremely well, survives gross abuse, and costs less than its worth. We like this inverter; it's built like a battleship!

Test Environment

We installed the Heliotrope in our shop on a pack of two Trojan L-16W batteries (12 VDC at 350 Ampere-hours). We used low loss 0 gauge copper cables with a combined length of less than six feet to feed the inverter. One of these cables is set up for current measurement, so we can measure the amount of current going into the inverter. Other instrumentation present to monitor the inverter's performance is a battery powered oscilloscope, a Digital Multimeter (DMM), and an iron vane type expanded scale AC voltmeter.

Packing, Installation Instructions, and Owner's Manual

The Heliotrope arrived in good condition being heavily packed. After unpacking we had enough styrofoam peanuts left over to just about insulate a wall in the shop. Shipping containers are important. Nothing is more disappointing than taking delivery on an inverter and finding it damaged in shipment. Heliotrope is obviously spending the money for first class packing so that this doesn't happen.

The installation and operation instructions provided with the inverter are adequate. They could be better. I have discussed this with Heliotrope on the phone and they assured me that a new manual is in production and will be included with future inverters. Complete and organized documentation is essential in complex items like inverters. The manual we received with the Heliotrope is complete, but it's too technical, and needs better illustrations.

Inverter Physical Examination

The first impression this inverter gave us was one of solidity. It's a large, solid, heavy unit. The case, heatsink, circuit boards, and everything connected with the inverter are made from heavy weight materials. Heliotrope has not scrimped on quality hardware. The inverter is 14 inches wide by 18.5 inches tall by 5.25 inches deep. It weighs 56 pounds, which for its power class is very heavy. The Heliotrope has the best and heaviest hardware of any inverter I have ever seen. All exposed metal parts and fasteners are well painted or plated to resist rust and salt water environments.

Inverter Installation

The Heliotrope is designed to mount on a wall. We liked this feature as there is more space available on vertical surfaces than horizontal ones around here. The heavy cables that feed the inverter from the battery are connected in a novel manner. Most inverters use a bolt. You must attach a heavy ring connector to the battery cables in order to bolt them to the inverter. Heliotrope uses power connectors like the heavy connectors in AC distribution panels. These 4/0 -250 MCM connectors are inside the inverter out of harm's (and shorts) way. These connectors are like sockets. The heavy copper cable is inserted inside the connector and a lug is tightened to hold the wire in place. No need for ring connectors and the result is a high contact pressure, low loss, connection that is easier for the user to make. We simply inserted the stripped ends of our 0 gauge cable into the connectors inside the inverter and tightened them down.

Heliotrope also uses two small wires that connect the battery to the inverter. These are in addition to the heavy cables that feed the inverter its current. These smaller wires enable the inverter's logic to measure the battery's actual voltage directly, without the loss present when running large currents through the main cables. This is a very nice feature, allowing the inverter to better control itself by more accurately monitoring the battery's condition.

This Heliotrope inverter has a feature that is unique among inverters of this large power size. **IT IS REVERSE POLARITY PROTECTED.** This means that you can hook it up to the battery backwards and while it won't work, it also won't destroy itself. Try this with any other large inverter and you're looking at hundreds of dollars in repairs. We investigated the manual and found that this reverse polarity protection is accomplished by two large series diodes in the main power line inside the inverter. We also learned from the manual that the voltage drop across these diodes costs us some 2% in efficiency. The manual has instructions for bypassing the diodes and gaining more efficiency. We did this before installing the inverter. The reserve polarity protection is an essential feature for folks who hook and unhook their inverter regularly. Those who wire it once and leave it are advised to get the polarity right the first time and increase the inverter's efficiency 2% by bypassing the diodes.

The Heliotrope inverter has the best connection methods for getting the 120 vac out of the inverter. Most inverters give you regular receptacle type female ac sockets. These are present, times four, in the Heliotrope. What is also present are standard wiring connectors within the inverter that will accept regular, 12 gauge, copper wire. While some other inverters offer interior hardwiring of their output, no one else has the size and installation ease of the connectors Heliotrope uses.

The Heliotrope is a programmable inverter. It has a number of user selectable features that allow you to set it for your own particular needs. The inverter protects itself against the following conditions: over temperature, over current, too low battery voltage, & too high battery voltage. Each of these protection functions can be either manually reset by the user or automatically reset by the inverter's logic. We chose the manual reset for the first portion of this test. This is easily selected on a small DIP switch on the inverter's printed circuit board.

The Heliotrope has two operating modes. One is called "Standard Mode" and the other "Battery Saver Mode". In standard mode, power is continuously available to run very small appliances like micro nicad chargers, electric clocks, etc. In standard mode, no load power consumption is 5 Watts. In battery saver mode, a 5 Watt or greater load is required to start the inverter. In battery saver mode, the inverter's no load consumption is 0.4 Watts and this is very, very low. Being basically tight with the electrons, we configured the Heliotrope for battery saver mode.

Once we wired up the inverter and selected our operating modes, we were ready to fire it up and see how it works!

Inverter Operation

We ran the Heliotrope WF12-2300 for about five weeks in what we like to call "user testing mode". This means that we just used it; we ran whatever we liked off it without paying particular attention to technical details. The idea is to subjectively see how the Heliotrope performed in relation to other inverters we have used.

We were not only surprised but very pleased with how well the Heliotrope worked. For one of many pleasant examples, Karen has a small hand mixer in her kitchen. No inverter we have ever used could spin this mixer as its ONLY load. At best, the hand mixer would sluggishly attempt to do its job. The Heliotrope not only powered this mixer, but ran it better than our ac generator could. This pattern of superb performance was carried through on all of our inductive loads. The Heliotrope inverter powers inductive loads better than any type I have ever used to date. Motors ran faster and cooler, the power supplies in our computer equipment ran cooler, and very small problem loads like electric scissors and electronic sewing machines ran as they never have before on an inverter.

Well, after weeks of enjoying completely trouble free and transparent inverter operation we started to wonder how the Heliotrope worked in a technical sense. We went into the technical testing stage. We watched the inverter's waveform on the scope, in addition to making voltage and frequency measurements. We abused the inverter to see if it would, in fact, protect itself. It did.

Here is a sample of the abuse we put the Heliotrope through.

We used the following loads (ac load amperage draw listed in parenthesis): ShopVac (6 amps.), 7.25 inch circular saw (10 amps.), Blender (3 amps.), Split-phase bench grinder (5.1 amps. running over 25 amp. starting surge), and a motley collection of incandescent light bulbs (about 4 amperes worth). First we started out with the circular saw and the ShopVac for a total ac current load of 16 amperes. Then we started the split phase bench grinder. This is a brutal test. The inverter was already loaded to 84 % of its 19 ampere capability and we asked it to start the grinder. This split phase grinder motor is a real inverter killer, and draws in the neighborhood of 25 amperes when starting. The Heliotrope grunted once and the grinder started & ran. We were amazed. We then started ALL the aforementioned appliances, with the grinder being started last. We basically overloaded the inverter, demanded a super surge to start the grinder and it did it all! We were never even able to get the inverter hot enough to make its internal fan operate.

The output waveform of the Heliotrope stayed incredibly stable over the entire test. Even when we grossly overloaded the Heliotrope, it did its job. We couldn't get it to change its output waveform no matter what, or how much, we plugged in. Voltage and frequency of the inverter's output are not only within Heliotrope's specifications, but according to our instruments better than their specs. In terms of gross wattage output, we were able to take well over the inverter's 2,300 watts out of the unit. By starting all the inductive appliances mentioned at the same time, we determined that the Heliotrope inverter does indeed supply surge power around 7,000 watts.

The Heliotrope inverter's efficiency is just as specified. We measured input current and voltage and compared this to output current and voltage. On very small loads, under 50 watts, efficiency was around 85%. At about the 165 watt level the inverter was 95% efficient. At loadings in the 700 watt range the Heliotrope inverter produced efficiencies up to 98%. The Heliotrope inverter is as efficient as or more efficient than any make we have tested.

We then tested the inverter to see if it would protect itself against too low or too high battery voltage. At about 14.5 VDC input, the Heliotrope shut itself off. On the low side, it turned itself off when the battery voltage fell to 10 VDC. Since the Heliotrope uses separate sense wires to the battery, these voltage switch points are very accurate and neglect losses in the main cables.

On the tech side

The Heliotrope, Phase Shift Two Transformer (PSTT), inverter uses two transformers instead on one. The output waveforms of the two transformers are opposite and compliment each other. To quote their manual, "Depending upon the current draw, the phase position of each transformer is matched to provide a perfect push-pull for each cycle of the 60 Hz. power pulse..." The manual provides a very complete technical explanation of Heliotrope's new inverter design. What really counts to the user is that the PSTT design works better than anything now available with inductive loads like motors, power supplies, fluorescent lighting, etc.

Inverter Overview and Other Stuff

A thermostatically controlled fan is standard equipment on the Heliotrope WF12-2300, PSTT inverter. At 2,300 Watts, it is the highest output inverter we know of that has a 12 VDC input. It is very simple to operate. If automatic mode is chosen by the user, then there is only one on/off switch to deal with. The installation of this inverter is relatively simple and no one should have trouble hooking it up. No battery charger option is available with this inverter. All details of the inverter's operation are indicated by a series of nine LEDs on the front panel. Remote control of this inverter can be accomplished easily via terminals already present on the inverter's printed circuit board. Other inverters charge extra for remote control functions.

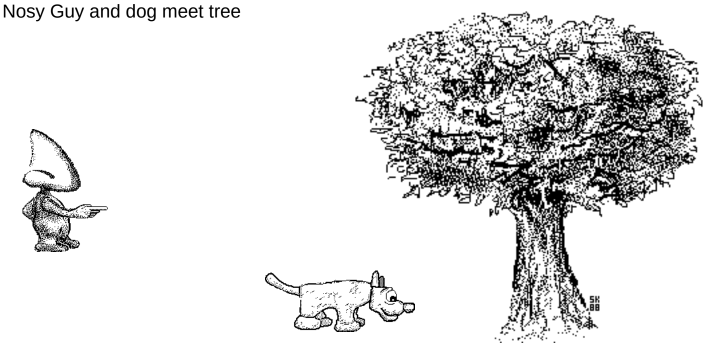
Inverter Warranty

Heliotrope has the following warranty for this inverter, and I quote from their manual. "These products carry a 10 year warranty. During the first year replacement of defective merchandise with a tested replacement will be made at no charge. For years 2 through 5 replacement will be made for a service charge not to exceed 25% of the current list price and for years 6 through 10 the fee will not exceed 50% of the current list price."

Conclusion

We like this inverter. The Heliotrope PSTT inverter powers inductive loads better than any type we have tested to date. Heliotrope's new two transformer inverter design concept really works! This inverter is beautifully made; every part in it is of the highest quality. Heliotrope has obviously spared no expense in construction of this inverter. It meets, and in many cases exceeds, Heliotrope's specifications. We tried to kill it by overloading and couldn't. This inverter has a retail price of $2,300, and is a very good deal. At $1. per continuous output watt, the Heliotrope is priced in line with other inverters. Considering its excellent performance and the very high quality of its hardware, the Heliotrope PSTT inverter is an excellent value. Write: Heliotrope General, 3733 Kenora Drive, Spring Valley, CA 92077, or call toll free inside CA (800) 552-8838, & toll free outside CA (800) 854-2674.

Nosy Guy and dog meet tree



Recharging Batteries With A Gas Generator

by
Windy Dankoff

Many photovoltaic systems begin as gas generator charged battery systems. As the system evolves with your needs and finances, the generator may be semiretired and used only for occasional back up. Either way, an efficient system must be used to deliver DC power to charge the batteries. There are three good methods of charging batteries from a generator.

DC GENERATOR

A gasoline powered DC generator/alternator is a direct approach for battery charging. None are available ready made to the best of my knowledge. Many people build their own using a common gasoline engine of 3 to 5 HP belted to a car or truck alternator. Get an alternator WITHOUT a built in regulator (do not use an auto regulator). A 5 HP engine will drive a 100 Amp alternator to full power (reduced some at high altitudes). Use a rheostat (25 ohm, 25 watt) to regulate the current manually. See Home Power #2, pgs. 23 through 26, for details on construction of this type of unit.

AC GENERATOR with BATTERY CHARGER

This is the most popular method because AC generators are so common and versatile. Many of our customers run an AC generator periodically to pump their water, wash their clothes or run tools. At the same time a battery charger is plugged in to make best use of the generator's capacity by charging their batteries. LP gas is a preferable fuel to gasoline, for cleaner burning and easier starting. Slower, 1800 RPM generators are longer lasting and more efficient than faster 3600 RPM models, but are heavier and more expensive. Many AC generators have 12 Volt charging capability but its current capacity in Amperes is small. The 12V output and the output of a battery charger may BOTH be connected to the battery bank at the same time!

WELDER/GENERATOR

A "portable welder" is a generator built to supply arc welding power. A welder puts out approximately 30 volts, at a current of 200 Amps or more. Perfect for charging a large 24 volt battery bank! On a low setting it will charge at 12 volts. If you KNOW you need to rely largely on your generator (like if you live in Alaska) or if you like to weld AND have a large battery bank (at least 1000 Amp hour) this may be the best way to go. Most portable welders also have AC output for tools etc. Get a DC welder. If you already have an AC welder, a rectifier may be built to convert to DC.

BATTERY CHARGERS

Battery chargers are common devices, available everywhere. Here are a few things to know about them:

(A) Any automotive charger can charge a very large battery bank; it only "sees" the voltage, not the battery's Ampere-hour capacity. If the battery is very large, it will take longer to recharge.

(B) More than one charger may be connected at once, and so can other charge sources such as PV. Each regulator responds as battery voltage rises, regardless of the charge source.

(C) Automatic (regulated) battery chargers tend to regulate too soon for the fast charging that is desirable with a generator AND they may regulate to a low current suited to a small (car) battery. Buy a "manual" charger, or switch your charger to manual. If you will be charging from utility power, use an automatic charger.

(D) Battery chargers are expensive. They contain only one expensive part though, the transformer. Transformers rarely fail. Big garage type battery chargers may often be found in scrap metal yards, beat to hell by such abuse as someone driving away with the charger connected. A little rewiring and replacement of small parts will almost always restore a charger to reliable use, however ugly.

(E) Truck and industrial battery chargers are available for 24 volt charging. If you're a junkie, check scrap yards.

(F) Two 12 volt chargers of equal capacity can charge 24 volts by connecting each one to each half of the bank.

(G) Industrial electric vehicle chargers are of higher quality and efficiency than automotive, but are expensive.

INVERTERS WITH "STANDBY" BATTERY CHARGING OPTION

Trace Engineering and Heart Interface inverters have an optional battery charging function, which works well. This option costs far less than a separate battery charger of equivalent capacity. This inverter's transformer is used "backwards" to step down the voltage. (Remember, the transformer is the expensive part of a battery charger).

The Trace inverters are particularly good in this regard because of their "programmable" regulating response, which you may set optimally for your particular system. Trace features an additional advantage, although not yet clearly documented....charging is accomplished thru pulses of very high current which slightly vibrate the battery plates and knock off inactive sulphate crystals. This tends to restore some capacity in older batteries, and to extend battery life. To obtain the full effect, you need a generator with at least double the wattage of the inverter, and high (over 165 vac PEP) peak voltage output.

FAST CHARGING

Beware.... service station attendants and many auto mechanics do not know what it MEANS to fully recharge a battery. Less than an hour of high current charge on a dead car battery will allow a car to start, but cannot charge the battery anywhere near full. If you take batteries to town to have them charged, be sure they are kept on the charger at least 8 hours. A hydrometer reading is the best way to assure that they are "topped off". Failure to top off or "finish charge" batteries at least every two weeks will reduce their life greatly. Beware of excessive gassing when fast charging.... it's hard on the batteries and creates a very real explosion hazard! Don't make a habit of it.

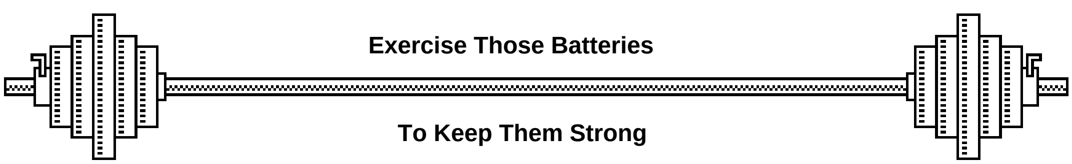
PHOTOVOLTAIC CHARGING AS SUPPLEMENT TO GAS CHARGING

Finish charging, as mentioned, is extremely important to long battery life. Any cell that tends to lag slightly behind the others will be brought up to full, instead of falling further behind. This requires long periods of low current "trickle" charging, which is very wasteful use of a generator BUT perfect use of a small PV array. Although a minimal PV array may contribute relatively little energy to a generator system, it will pay for itself by extending battery life.

If your generator system is used only seasonally, a small PV module should be used to maintain your battery bank at full charge during the months you are gone. A typical deep cycle battery (in GOOD shape) will discharge half way in 6 months, and sitting in a low state of charge is VERY DAMAGING.

Whether you consider your fossil fuel generator to be a luxury, a convenience, or a necessary evil, making the best interface with your battery bank deserves your careful attention.

Windy Dankoff is the owner of WINDLIGHT WORKSHOP and FLOWLIGHT SOLAR PUMPS, POB 548, Santa Cruz, NM 87567 (505) 753-9699. Windlight's 1988 CATALOG AND HANDBOOK is available for $6. For information on DC well and booster pumps, inquire.



Internal Resistance in Lead Acid Batteries

by
Robert G. Hester

This article, by a Home Power reader, is the type of feedback that we are hoping to share in this magazine. While the approach is quite technical, it does demonstrate a simple technique for actually measuring the internal resistance of the batteries you are using. By keeping track of our batteries' internal resistance we can be informed on their condition and reliability. *--Rich*

The internal resistance (Ri) gets its name from the fact that it is located inside the case of the battery and is a characteristic of the battery itself. This resistance is a function of the chemical reaction taking place in the lead-acid battery. Ri is a necessity, an unavoidable evil; any power dissipated here does no useful work. In solar applications, the power dissipated in (Ri) represents wasted solar panel time.

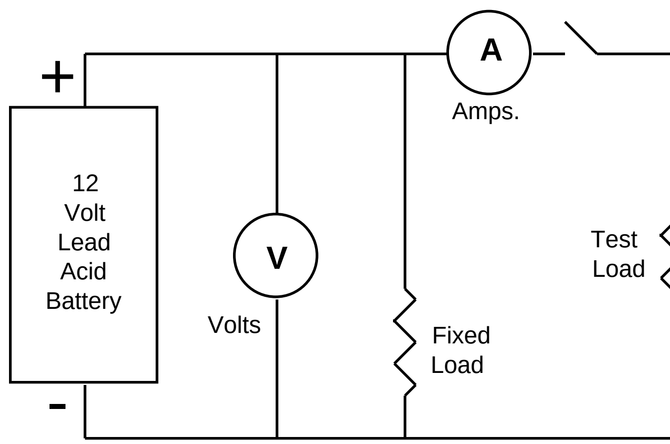
If the useful load Ri is a very large wattage inverter, then the voltage drop caused by the battery's internal resistance Ri may be large enough to reduce the voltage at the battery terminals (Eb) below the operating point of the inverter. When several hundreds of amps are demanded from the battery, its internal resistance may reduce its operating voltage to an unacceptable level.

The internal resistance of a battery pack may be controlled by the system user by paralleling more batteries into the pack. Doubling the number of batteries reduces the pack's resistance by half, each time the number of batteries is doubled. The internal resistance of the batteries forces us to increase the size of the battery pack to handle large surge loads.

Operation of lead-acid batteries at low states of charge should be avoided, as Ri increases as the batteries are discharged. Car battery manufacturers get high cold cranking amps (reducing Ri) by close plate spacing and reasonably high specific gravity. Also, the depth of discharge in car systems is limited in normal operation.

The internal resistance (Ri) is equal to the change in battery voltage when a load is applied, divided by the change in battery current due to the application of this load:

SIMPLIFIED SCHEMATIC FOR TESTING Ri



A test was made to determine what kind of value Ri might have with the author's limited resources of batteries and test instruments.

Two Trojan T105 lead-acid batteries (205 Amp-hrs.) were connected in series (for 12 volts) and charged by 40 watt and 7 watt solar panels connected in parallel to operate an emergency Amateur Radio Station.

A digital Voltmeter having a one tenth volt resolution was used to measure the voltage change. A 300 watt Heart inverter was used to power a 100 watt light bulb as the test load. A 1 CP tail light bulb was used as a fixed load. The test load was calculated to be 9.16 Amps, the fixed load is 1 amp. (estimated).

The test load was turned on to take the "surface charge" off of the battery. After this the load was applied and the voltage dropped almost instantaneously from 12.4 volts to 12.2 volts, then leveled off at 12.1 volts after several seconds.

The behavior of the batteries under load is our concern. The total voltage change was 12.4 - 12.1 = 0.3 volts. The total current change was 9.16 amps.
If a 1,500 watt inverter had been the load the change of current would be 1,500 watts divided by 0.9 inverter efficiency equals 1,660 watts divided by 12 volts equals 138 amps. The voltage drop across Ri (0.0327 ohms) equals 4.5 volts. Therefore the inverter would receive 12.1 - 4.5 = 7.6 volts and would not operate at all. The internal resistance of the battery pack is important. This battery pack is obviously too small to effectively source a 1,500 watt inverter.

$$Ri = \frac{0.3 \text{ Volts}}{9.16 \text{ Amperes}} = 0.0327 \text{ Ohms } (\Omega)$$

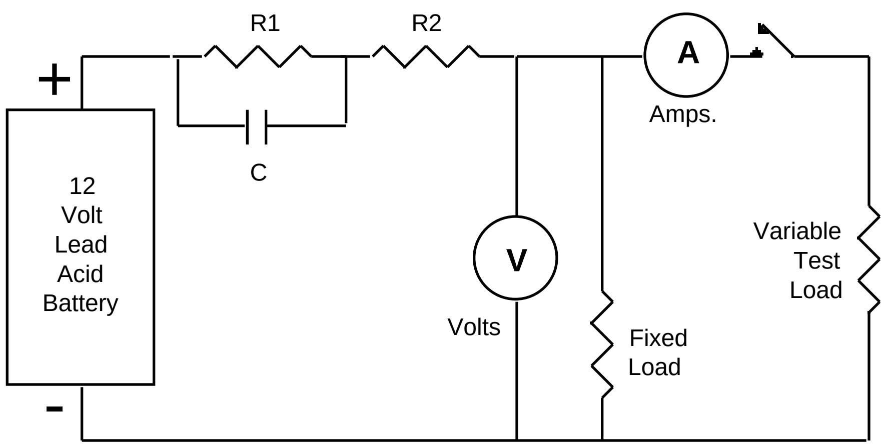
The fact that a fast decrease in voltage was followed by a slow decrease indicates that the equivalent circuit shown was perhaps too simple. We are probably seeing the effects of the mobility of the ions that make up the electrolyte. These ions of hydrogen, oxygen, and sulphate (H_2, O_2, SO_4) must migrate to the battery's plates in order to participate in the chemical reaction. The O_2 (oxygen) ion has 16 times the weight of H_2 (Hydrogen) and has an equal but opposite charge.

THE REVISED EQUIVALENT CIRCUIT

The addition of Capacitor (C) in Parallel with R1 creates a time constant that was estimated at 3 seconds. Ri = R1 + R2

In electrical terms this 275 Farad capacity (in terms of electrical capacitance) of the battery pack is a remarkable value as few Farad capacitors exist. This is the electrical analogy, however.

These simple circuits allow determination of the actual internal resistance of our own batteries. Record the data generated from your tests and compare it to later tests at varying



Ri = R1 + R2
Time Constant (Tsec.) = R1C = about 3 seconds

temperatures and states of charge. By keeping a careful eye on our battery's performance we can detect weakening and possible battery failure long before it actually happens. If a battery pack shows a dramatic increase in internal resistance it is time to run an equalizing charge. If the internal resistance continues to rise in spite of repeated equalizing charges, then it's time to look for a good deal in new batteries.

I would like the following information from various battery manufacturers regarding their batteries.

1. A detailed description of the time constants encountered after the application of a load. How many are there? What are their magnitudes?
2. Is the variation of the internal resistance an inverse linear relation to the state of charge? Probably yes.
3. A chart of internal resistance as a function of temperature at

$$R1 = \frac{\Delta E}{\Delta I} = \frac{0.1 \text{ Volts}}{9.16 \text{ Amperes}} = 0.0109\ \Omega$$

$$R2 = \frac{\Delta E}{\Delta I} = \frac{0.2 \text{ Volts}}{9.16 \text{ Amperes}} = 0.0218\ \Omega$$

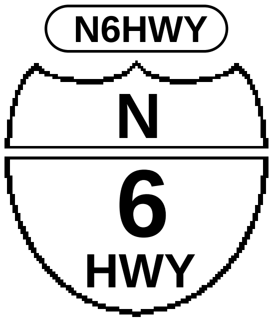
$$C = \frac{T}{R1} = \frac{3 \text{ sec. est.}}{0.0109\ \Omega} = 275 \text{ Farads}$$

several states of charge. Probably goes up as the temperature goes down; but is it a linear relation? *Editor's Note: The lead-acid battery's internal resistance certainly does rise under the following conditions: 1) low temperatures (below 45°F.), 2) at low states of charge (below 15% SOC, & 3) high states of charge (above 90% SOC. --Rich*.

4. A plot of the dynamic (AC) internal resistance seen by a load which has high frequency components. (ie. an inverter load that pulses at a high frequency rate as when powering inductive loads). A plot of Ri (Internal Resistance vs. Load AC Frequency) would be helpful. This is of interest to Ham Radio Operators who power single sideband transmitters where the load varies at the frequency and amplitude of the human voice.

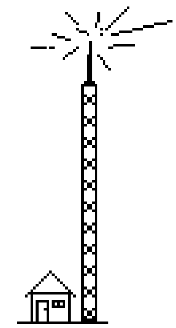
In my personal station a Kenwood TS-130SE 100 watt output high frequency transceiver is powered by stored solar energy. The voice load components on this transmitter interfere with the operation of a Heart HF-300X inverter used to power lights. This should have been predictable, but it wasn't. More battery data is needed by battery users than just Ampere-hours. *Editor's Note: It is possible that this interference is due to RF getting into the inverter's logic, rather than changes in the battery due to loading.--Rich*

Robert G. Hester may be written concerning this information at Box 226, Pearblossom, CA 93553.



CB for You & Me

by
Brian Green



"Break one-nine for the Jolly Roger. This is the Wolfhound frying." It was the beginning of a new era; we were coping with an energy crisis. Gas and heating oil prices doubled, lines formed at gas stations and the speed limit was lowered to 55. So much for the negative. The up side was that we learned to conserve, started to explore alternative energy and everyone discovered citizens band radio (CB).

Truckers had been using CB for years. It wasn't until the gas shortage that "Joe Lunchbucket" began to take an interest in this cheap, effective means of radio communication. With a CB radio, anyone could find out which stations had fuel, where the highway patrol was lurking, or could just carry on a conversation to make the miles go faster. CB is fun, where else can a grown adult call himself "The Rubber Duck" and get away with it!

CB started out as low cost, two way, short wave radio communication. In 1958, the Federal Communications Commission (FCC) created CB from the 11 meter (27 MHz.) amateur radio band. Twenty-three radio channels (frequencies) were allotted to CB. On January 1, 1977, CB was expanded to 40 radio channels.

Once the gas crisis was over with in the early '80s, the CB boom was bust and the dealers couldn't give the radios away. Government sponsored renewable energy projects were abandoned. Alternative energy forged ahead with or without tax credits.

I'm sure that many folks have CBs stuck up on shelves. Those that don't have a rig around can buy one cheap enough ($50 to $150) at department stores. Now is a good time to start planning a worthwhile Spring project. Get a rig on the air and find out what is happening in your neighborhood. Leave a note on the local bulletin board telling people of your radio interests and what channel you monitor. Listen around on your CB, there may already be a local neighborhood channel.

CB was designed to use short ground wave radio propagation, which is more or less line of sight. These RF or radio frequency waves travel in a fairly straight line near the ground, from one transmitter to another receiver. Maximum range for the average CB radio is about 25 to 75 miles, and depends on terrain and antennas. One of the drawbacks of CB at his present time is that we are heading for a peak in the 11 year sunspot cycle. The increased solar activity ionizes the upper levels (between 50 and 250 miles above our surface) of the Earth's atmosphere. This makes these layers reflective to certain wavelengths of radio waves. When the ionosphere becomes reflective, your four watt CB transmitter can travel (skip) over 2,500 miles. This causes a problem, since you can hear at least 1001 stations, all trying to use the same channel at the same time. The good news is that after Sundown the atmosphere cools off and the skip generally fades.

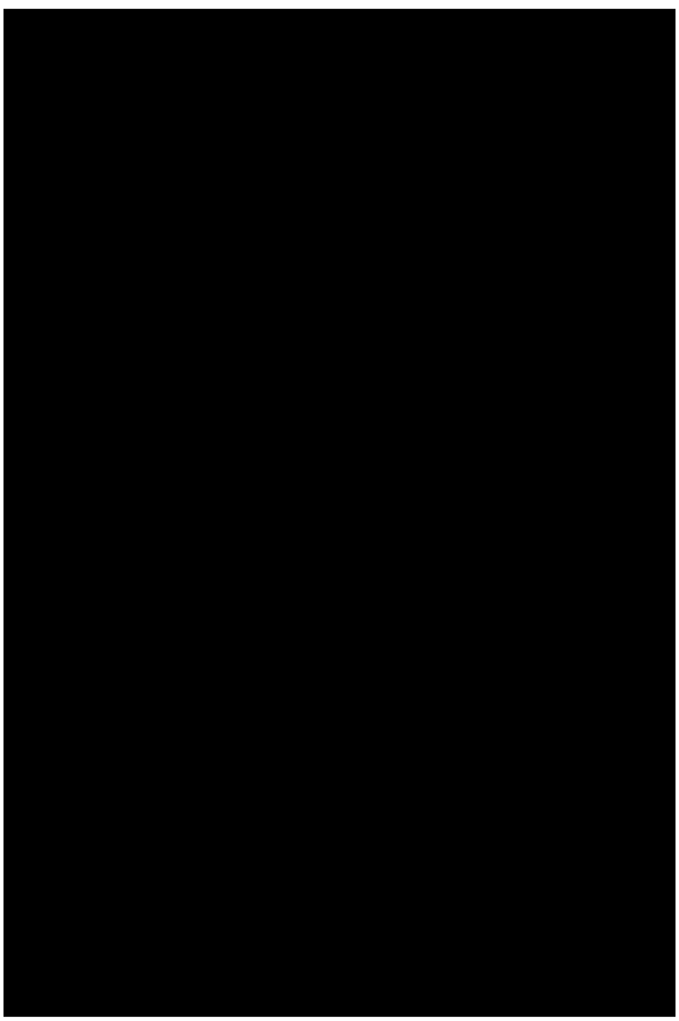
Get It Together and on the Air

If you are going to get a CB on the air, here is what you need.
A RADIO. Use a 40 channel type because the 23 channels radios are no longer legal with the FCC.
A POWER SOURCE. The can be directly off your 12 Volt battery or via a power supply. A power supply converts 120 vac in 12 VDC if your don't have it readily available.
COAXIAL CABLE. This feedline is the connection from your radio to its antenna. Coax has a center conductor surrounded by insulation, over this insulation there is a copper braided tube. Over the copper braid there is a waterproof vinyl jacket. The center conductor carries the signal and the shield braid keep this signal within the coax until it reaches the antenna. Radio Shack sells CB coax, Part # 278-1328 at 21¢ per foot. This a low loss 52Ω coax and comes with or without connectors on its ends. I prefer the RG8X type because of its small size and flexibility.
ANTENNA- the center insulator.
The center insulator (see photo #1) of your antenna can be made out of a number of nonconductive materials, including 1/4" plywood. If you use plywood, give it a couple of coats of water proofing shellac. I used a piece of 1/4 inch thick plexiglass I found at the dump.
INSERT PHOTO
ANTENNA- Wire
Almost any copper wire will work. 12 or 14 gauge is a good size. Even the stuff you can get at the auto parts store in a 35 foot roll will do the job. Leave the insulation on except where soldering is required. Electric fence "egg" insulators, attached to the ends of the wire will insulate your antenna from the cords used to secure it.

Photograph 2 shows how to pig-tail the coax. A bit of silicone sealer is used to keep water from getting inside the coax.

While the silicone is still tacky, wrap the coax with black tape as seen in the photo.

Photograph 3 shows the steps involved in trimming the end of the coax to accept the PL 259 connector that screws into the back of the CB radio. Once you have reached the fourth step (far right), the coax's copper braid will show through the holes in the body of the PL-259 connector. This needs to be



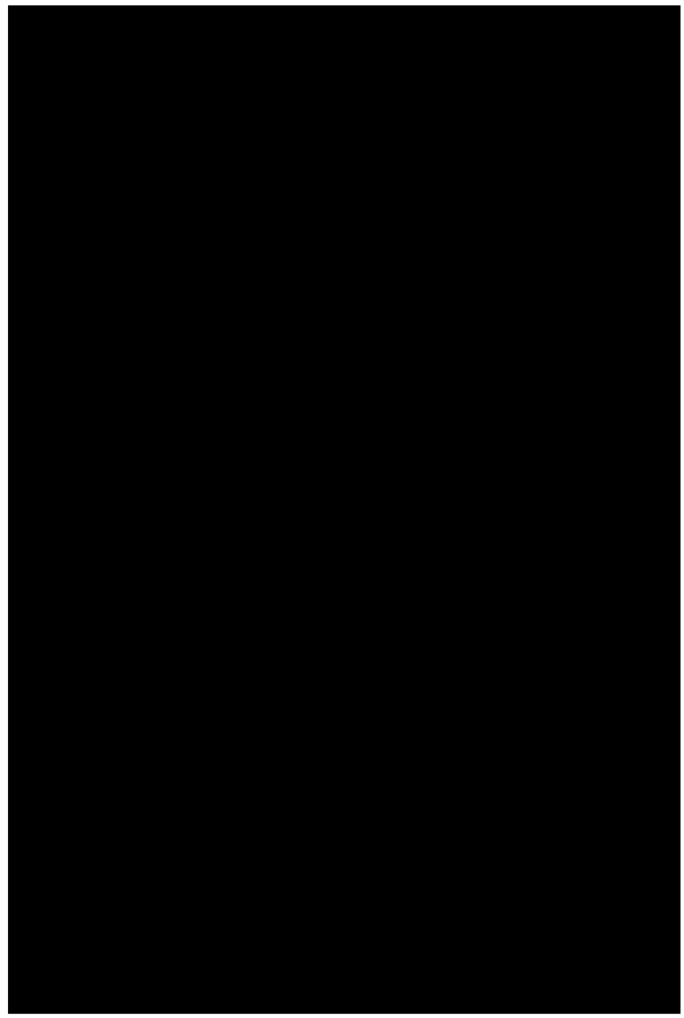
soldered quickly with a high wattage soldering iron so that the insulation within the coax is not melted.

Checking Out your Antenna's Site

Things to think about: Where is the radio going to live? How long will the power lines to the radio be? Where is the antenna going to be erected? Where should the coax enter the house? How long of a coax run is needed? Try to keep the coax as short as possible to minimize losses.

Building the Antenna

If you are like me, this is the fun part. I'm only going to describe a simple dipole antenna. It will get you on the air for



very little money and effort. If you don't like to build your own and are flush, then Radio Shack has a good base station antenna for $79.95 (Part #21-967).

I'm not going into the theory of antennas. If you have an inquiring mind, see the list of reference material at the end of this article. The half wave dipole consists of two pieces of wire each 1/4 wavelength long. There are insulators at the ends of the wire and one in the center mechanically joining the two wires. CBs operate from 26.965 Mhz. to 27.405 MHz. The center frequency of the CB band is 27.185 MHz. Therefore, (just trust me on this or take a short course in antennas) the combined length of both pieces of wire is 17.22 feet. This is 17.22 feet from end to end of the antenna. The feed point is at the center and each of the two wires making up the dipole is 8 feet 7 inches long. These length figures are strictly ballpark. I've had antennas tune up perfectly at this length & others need a bit of trimming. Always leave a little extra wire on the dipole elements for trimming. The dipole can be put up

Tuning your Antenna

I built an inverted V dipole antenna. Two 10 foot sections of Radio Shack antenna masting where get the antenna into the air. The center insulator was tied to the top of the mast. The mast was secured to the ground by hose clamps and a firmly planted T type fence post. A T post at either end of the antenna provided a place to tie down the nylon cords attached to the egg insulators at the ends of the pieces of wire.

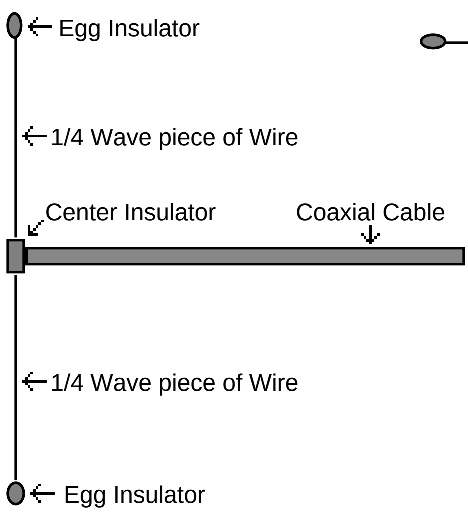
I used a standing wave ratio (SWR) meter to measure the forward and reflected power in the antenna. The SWR meter allows you to tune the antenna for proper performance. If the wires that make up the antenna are too long or too short, then the antenna will reflect the RF energy back to the transmitter rather than radiating it. The basic idea is to have all the CB transmitter's power radiated by the antenna rather than reflected back to the transmitter. If somebody in your neighborhood has an SWR meter to lend you, then fine. If not, Radio Shack sells one for $18.95 (part # 21-525). I leave my SWR meter in line all the time so I can see if everything is working properly.

With the radio all hooked up, I inserted the SWR meter in the coaxial line to the antenna. The moment of truth! I turned the radio on and lots of signals where coming into the receiver. The Skip was howling like a banshee. Well, I knew it would receive but would it transmit on my homemade antenna? I set the radio to channel 19 (the middle of the CB band), selected forward power on the SWR meter. I keyed the microphone to transmit and adjusted the sensitivity knob clockwise until the meter was indicating full scale. Next, while still transmitting, I selected the reflected power reading on the SWR meter. Not bad, my home made antenna has an SWR of 1.3. Anything less than 2 is acceptable.

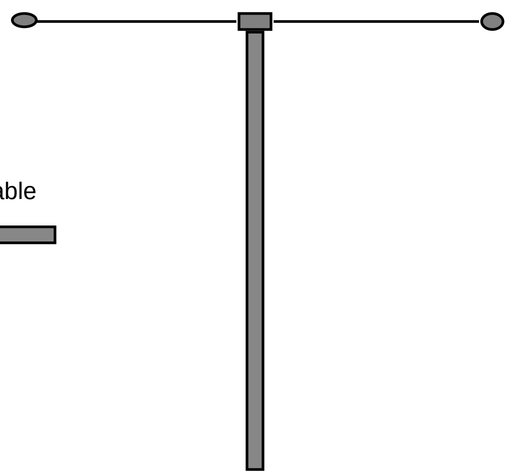
I checked the SWR on channels 1 and 40. This step is important because it tells us if the wires in the dipole are too long or too short. If the wires are too long then the SWR will be lower on channel 1 than channel 40. If the wires are too short, then the SWR will be lower on channel 40 than on channel 1. In my case, the SWR on channel 1 was the same as on 40, so I didn't need to trim the wires. If your antenna is not balanced like this, then add or remove 1/2 inch bits of wire from the ends of the dipole.

If the lengths of wire are correct and you still have some SWR, then another way of reducing SWR is to change the angle at which the wires meet. I my case, I reduced the angle of the wires from 120° to about 100°. This brought the SWR of the antenna down to 1.25 on channels 1 and 40, and to 1.2 on channel 19. I never cease to get a charge when a new antenna flys off the workbench. If you have any questions or experiences to share drop me a line. I'll do my best to answer your questions or point you towards a source of information.

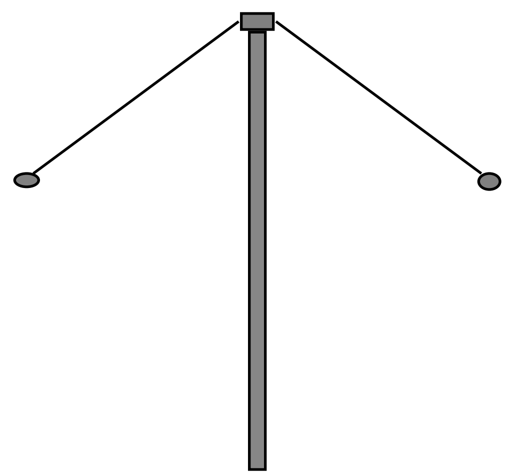
Vertical Dipole Antenna



Horizontal Dipole Antenna



Inverted V Dipole Antenna

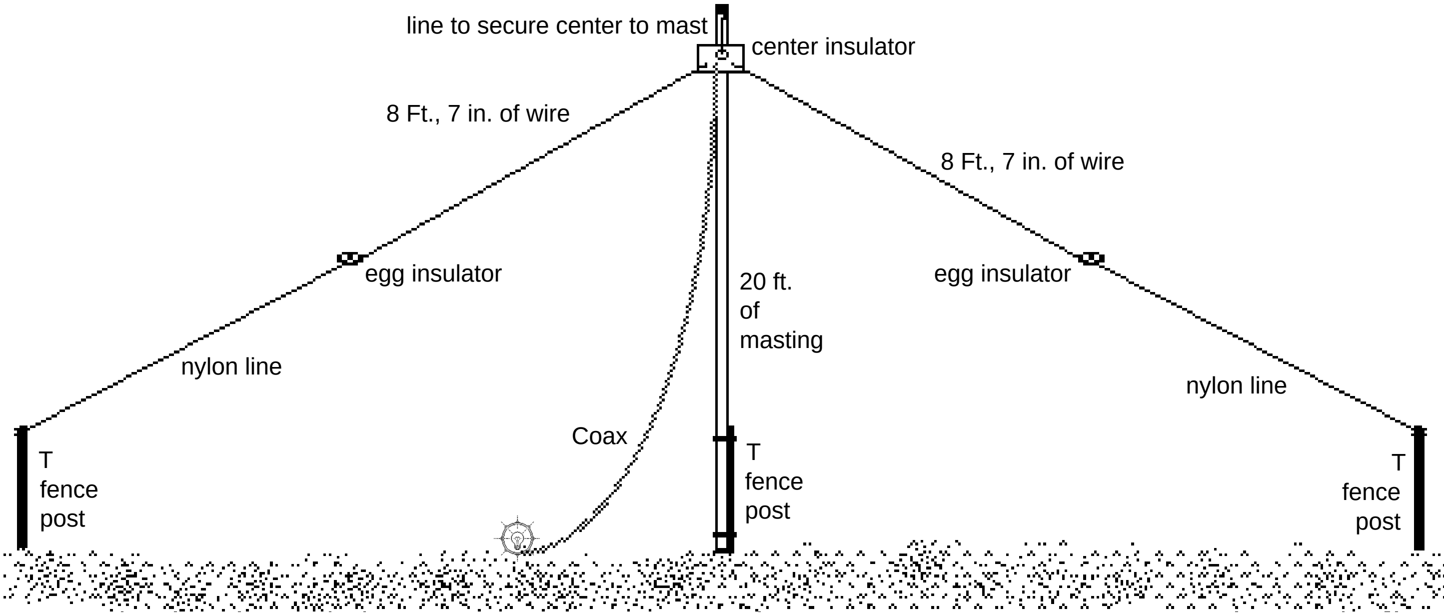


Operating your CB

The first rule of radio courtesy is to listen before you transmit. Only one person can transmit on a channel at a time without having chaos. So give others their chance to talk, just as you want yours. Channel 9 is reserved for emergency use. In some neighborhoods channel 9 is used as a calling channel. This means that after making contact the stations IMMEDIATELY move to another channel to talk. This allows everyone in the neighborhood to monitor channel 9 all the time and increases the chance of an emergency call being heard.

Some Good Antenna Reading

Simple Low Cost Antennas for Radio Amateurs by William I. Orr W6SAI & Stewart D. Cowen W2LX, Radio Publications Inc., Box 149, Wilton, CT 06897. $5.95



ARRL Antenna Handbook, American Radio Relay League, 225 Main St. Newington, CT 06111. Heavy on antenna and feedline theory $5.00.

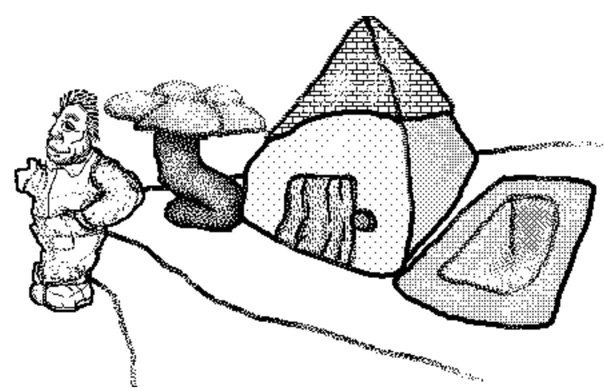
73 Dipole and Longwire Antennas by Edward M. Noll W3FQJ, Editor and Engineers, Howard W. Sams Co. Inc, Indianapolis, IN 46268.

Well, enjoy talking to your neighbors on the CB! If you're around Interstate 5 and the California/Oregon border you can call Home Power People on channel 9 CB, call for Wolfhound, Jolly Roger, FourTrax, Pennyroyal, and/or Oilburner, if you're a Ham, call on 146.400 MHz. Simplex for N6HWY, N7BCR, and/or KF6HG. You can write me at 13109 Norman Drive, Montague, CA 96064.

73s Bri

RF Bands And Transmission Frequencies		
Band	Frequency Spectrum (kilocycles)	Wavelength (meters)
VLF (Very Low)	10 - 30	30,000 - 10,000
LF (Low)	30 - 300	10,000 - 1,000
MF (Medium)	300 - 3,000	1,000 - 100
HF (High)	3,000 - 30,000	100 - 10
VHF (Very High)	30,000 - 300,000	10 - 1
UHF (Ultra High)	300,000 - 3,000,000	1 - 0.1
SHF (Super High)	3,000,000 - 30,000,000	0.1 - 0.01
EHF (Extremely High)	30,000,000 - 300,000,000	0.01 - 0.001

meanwhile, in a suburban setting …



Ohm's Law

by

Richard L. Measures

Electricity

Electricity is a form of energy that is carried by the flow of electrons through the atoms of a conducting medium such as a copper or tungsten wire. An electric wire is a long line of (usually copper) atoms. All atoms like to contain a certain number of electrons. If an atom has one too many electrons, it will immediately shed another electron. If an atom is missing an electron, it starts looking for an electron to steal.

The flow of electrons is like a long pipe that is completely filled with glass marbles. If an extra marble is poked into the input end of the already full pipe, a marble must simultaneously pop of the (output) end of the pipe. If five marbles per second are poked into the input end of the pipe, five marbles per second will simultaneously pop out of the output end of the pipe. It can be said that the flow rate of the marbles is five marbles per second. If a paddle wheel is connected to the output of the pipe, the flow of marbles can be made to perform work.

The flow rate of electrons is called **current** and it is measured in electrons per second. The **ampere** is the unit for the flow rate or current of electrons. One ampere is defined as **6.24 X 10 to the 18th power (6,240,000,000,000,000,000)** electrons per second. That sounds like a lot of electrons but electrons are so small that the ampere unit is very practical. One ampere is the current required to operate the dome light in a typical automobile.

The process of pushing marbles through a pipe, or electrons through a wire is rarely 100% efficient. A certain amount of resistance to movement, due to friction, takes place with the marbles bumping and scraping along the way. Electrons also resist movement and this loss is called resistance. This loss appears as heat.

The electric force or pressure that pushes the electron current through the resistance of the wire is measured in units called volts. The standard unit of energy is the watt (per second) which measures work. A watt is equal to .73756 foot pounds/seconds or 101.9716 gram meters/second or .001341 horse power. *One volt is the amount of electric pressure or potential that it takes to cause one ampere of current to dissipate one watt of energy per second.* Work, or watts, equals volts multiplied by amperes. The resistance (R) to the flow of current can be described as the number of volts it takes to make one ampere of flow rate, or *volts per ampere or volts/ampere.* In this case the resistance (R) would be: one *volt/ampere*. This relationship can be written as R equals volts/amperes. The unit of the volt/ampere was named the **Ohm** to honor Georg Simon Ohm who was an early pioneer in the field of electricity. The abbreviation for the ohm is Ω.

The equations that describe the relationship between voltage, current, power, and resistance are referred to as Ohm's Law. Before getting into these equations, the not always logical, standard abbreviations need to be explained.

Other Abbreviations

Lower case letters are used for ac and upper case letters are used for DC. The abbreviations for alternating current (ac) voltage is **v** and **V** for direct current (DC) voltage. Voltage is referred to in Ohm's Law formulas as electro motive force which is abbreviated as **EMF** or just **E** for DC and **e** for ac. For example: E=3V means that the electro motive force is 3 volts of DC. Voltage is also referred to as a "potential" or a "potential difference", which is the difference between two voltages.

The ampere is abbreviated by the letter **A** for DC and **a** for AC. DC current in formulas is designated I; for AC i. For example, "the AC current is equal to 5 amperes" would be i=5a. Amperes are also referred to as **amps**.

Work or power is referred to as **P** for DC and **p** for AC. Watts are abbreviated by **w** or **W**. For example, "the DC power is equal to 4 watts" would be P=4W. "The AC power is equal to 4 watts" would be p=4w.

OHM'S LAW for DC

Resistance in Ωs equals volts x amperes or R=E/I.
Power in watts equals volts x amperes or P=IE.
By using basic algebra, these formulas can be rearranged and/or combined to yield other formulas such as:

I=E/R, E=IR, P=E /R, P=IR

plus a few other variations of the same information.

For AC, the formulas are similar except that the letters would be lower case instead of upper case.

Next month I will show some practical applications for Ohm's Law.

120 VAC Lighting & Inverters

by
Richard Perez

Regular AC lighting devices are the most commonly used. These devices vary greatly in efficiency. Most homes, even AE homes, are required by building codes to be wired for 120 VAC. This article concentrates on getting the best values in 120 VAC lighting appliances when powered by the batteries & inverters used in home style AE systems.

So Why Use the Inverter?

Lighting devices are prime candidates for inverter supplied electricity. Lights spend an average of over 4 hours per day operating. They generally consume just a few hundred (or less) Watts of power. Running a 120 VAC power source is just not practical for such low powered and continually used appliances. If you are not using 12 VDC for your lighting, then your only other easy choice is 120 VAC. Since most AE sources are low voltage DC, the inverter is necessary to convert the low voltage DC to 120 VAC.

The use of the inverter for lighting also has another advantage. Most already existing homes are not wired to accept 12 VDC. If you consider the cost of retrofitting a home for low voltage wiring, then the use of standard 120 VAC lighting devices and an inverter is a reasonable and cost effective alternative. The inverter allows usage of the already existing wiring and fixtures without modification. This saves considerable money in comparison with a complete rewire job requiring destruction of the walls and installation of specialized wiring. In general, if you are building a new AE powered structure, it is more cost effective to wire the structure for 12 VDC lighting. If you are dealing with a structure that is already constructed and wired for 120 VAC, then using an inverter and the already installed lighting fixtures is much less expensive than ripping apart the walls and installing new wiring.

Incandescent vs. Fluorescent

Once you have decided to use 120 VAC for your lighting, then the next choice is whether to use incandescent or fluorescent lighting. The situation here is the same as we discussed in the lighting article in Home Power #1. Fluorescent lighting offers you the same light at about the quarter the cost of incandescent devices. This is true even if the higher initial cost of the fluorescent fixture is considered. The primary cost of lighting in alternative energy homes is not the lighting fixtures or the bulbs, but the energy it takes to power the lights. As AE users, we pay many times the cost of utility produced electrical power. It pays us to buy efficient appliances even though they may be initially more expensive to purchase.

What really counts is where you put it...

Regardless of the type (or voltage) of lighting you choose, the technique for efficient application remains the same. If you want to save on energy used for lighting the first thing to think about is the position and size of the light. Spot lighting, especially in work areas such as kitchens, desks, and work benches, is most effective. Spot lighting focuses the light where it is needed. This allows usage of lower wattage lights while still maintaining acceptable illumination where it is needed.

The idea is really quite simple. Consider sitting at a desk and reading a book. We could use a 40 watt incandescent desk lamp at a distance of say 1.5 feet from the book for illumination. Or we could use 440 watts worth of light bulbs on the ceiling, some 5 feet above the desk, to provide the **SAME AMOUNT** of light on the book. That's over ten times the energy being consumed to provide the same illumination on the book laying on the desk.

Light is radiant energy, and as such, obeys the inverse square law of radiation. This means that every time you double your distance from a light source, the intensity of the light is divided by four. So give your AE system a break and use spot lighting wherever possible. Locate all sources of light as close as possible to where they are needed.

It is much more efficient to place several smaller spot lights around a room for illumination than it is to use a single large light source on the ceiling. I like to think of this concept as "The Moving Light". The idea is to have several low intensity (thereby low wattage) light sources around a room wherever they are needed. There are only one or two of these lights burning at a time. Where are they burning? They are burning **WHERE YOU ARE**. The light follows you around the room because you switch off the light in an area when you move to another. The Moving Light. You save energy by not illuminating areas that don't need light. This idea is a corollary of the ancient American Indian proverb, *"White man build big fire stand back; Indian build small fire, sit on top."*-- Indian Tom via George F. Wright, Agate Flat OR.

In some cases area lighting is desirable. Most area lighting fixtures are designed with shades, valences and other light diffusers/reflectors. These are designed to prevent the relatively intense (high wattage) light from directly striking our eyes. This technique, while interior designer approved, wastes a hell of a lot of energy. If you are using area lighting dispense with valences and diffusers and use lower wattage lighting units. The best place for area lighting is the ceiling in the center of the room. Use area lighting minimally, only as an occasional supplement to spot lighting in areas of interest and activity. If you use area lighting, with its high intensity requirements, install fluorescent types for their high efficiency.

So the most important factor in any lighting system, whether 12 VDC or 120 VAC, is the sizing and positioning of the fixtures. Put the light where you need it, keep the wattage down, and turn it off when you don't need it. Do these three things and you'll save energy.

Incandescent Light Bulbs & Inverters

Incandescent lightbulbs are perfectly happy when powered by inverter produced electricity. These lightbulbs are resistive loads to the inverter, and even the crudest inverter can handle them with ease. When computing the wattage consumed by an incandescent lightbulb powered via inverter be sure to add an additional 10% for the inverter's inefficiency.

The incandescent lightbulb itself is an efficiency engineer's nightmare. Over 90% of the electrical energy we put into the bulb is wasted as heat, with only about 6% being converted to usable light. This very low efficiency means that we should keep the wattage of our incandescent bulbs as low as possible. Experiment with your incandescent bulbs. If you've been using a 75 watt bulb in a lamp, then try a 60 watt or 40 watt bulb. You may find that the lower light intensity is perfectly acceptable. The human eye automatically adjusts itself to the amount of light available. Provide too much light and the eye's pupil contracts and lets less light into the eye.

Fluorescent Lights on the Inverter

Fluorescent lights are inductive loads to the inverter. This means that their usage with inverters is subject to certain vagaries, or what engineers call "glitches". Inverter manufacturers are attempting to provide a reasonable facsimile of conventional 60 cycle sinusoidal electricity coupled with high inverter efficiency. In fact, all square wave and modified sine wave inverters offer only an approximation of sinusoidal energy. The energy they produce is not IDENTICAL with commercial electricity. How close this approximation is varies very widely from inverter to inverter. Some types will power fluorescent lighting with no problems, while others will not.

From personal experiences we have determined that the following three inverter makes will power most standard fluorescent lighting: Trace, Heliotrope and Heart. Depending on the type of fluorescent and inverter used the light may buzz during operation. Well, in fact all fluorescent lights, even those operated on the grid, buzz somewhat. With some inverters this buzz can be loud enough to be annoying. The three inverters mentioned above provide the minimum amount of noise at the light. The best type of fluorescent we have found for quiet inverter operation are the rapid start ballastless types. We also prefer the warm white type of fluorescent tube for its more frequency balanced light.

The electronic ballast used in many fluorescent fixtures is designed for sinusoidal power input. It is not designed for the modified sine wave power output of today's super efficient inverters. Standard fluorescent ballasts will run hotter, be less efficient, and shorter lived when used on inverter produced electricity. This is one more reason to use the rapid start ballastless type of fluorescent lamps. They are not only quieter, but also more efficient and longer lived.

Several readers of Home Power have written to us mentioning potential health hazards involved in fluorescent lighting. To date, I have yet to see any hard scientific evidence that supports these claims. While I am not particularly a fan of the light produced by fluorescents (its not balanced in frequency output and hard on my eyes), I use them because they are so efficient at their job. If anyone has any real evidence supporting the claim that fluorescent light is damaging to our health, then please write us. We'll print this information if it is scientifically supported.

In summation, the prime reason to use 120 VAC lighting in AE systems is to use already existing wiring and fixtures. Those considering building a new AE home should consider dual lighting systems, both 12 VDC and 120 VAC. This offers maximum efficiency and flexibility. The most efficient form of lighting is spot lighting rather than area lighting, regardless of voltage or lighting type. The most efficient type of commonly available 120 VAC lighting is the fluorescent. So give your system's lighting a second glance and save some energy!

Letters to Home Power

Letters printed unedited. We'll print your name and address if you say it's OK.
Compiled by Glenda Hargrove

Dear Home Power folks:

I somehow just received the second issue of your fine little magazine and I guess if anyone in the world can appreciate such a Brave Beginning, it's me (being the father of Mother, which started a lot of people in the same direction over 18 years ago).

Conversely, you folks (being about the best I've seen currently carrying Mother's banner onward) may well appreciate the enclosed small gift. It's a copy from the original print run of the very first Mother. There have been hundreds of thousands of that issue reprinted since we first went on press for distribution January 1, 1970... but this is a genuine, guaranteed fugitive from the very first press run of 10,000 (it can be identified by the cosmetic ad-- for which we never got paid--on the inside back cover.

Please note, too, the poster that went out with every issue. It promised-- among other coming articles-- pieces on wind, water, solar, and methane power. And that was back when the rest of the world was telling us that "all the streams have already been harnessed, solar energy was tried in the 30's and didn't work, wind power is just too much trouble, and... what the hell is methane anyway?"

Yeah, I'm kinda the guy who kicked off the whole "modern" alternative energy awareness... but only because I grew up on a little family farm in Indiana where we just naturally had to make do and where the only electricity I had until I was seven years old (and moved to a different farm) was from a windplant (Marcellus Jacobs has since told me that he invented the electricity producing wind powered generator and he therefore has the right to name it and , by gadfries, it's not a windmill... windmills pump water). But I digress. I started to say that our windplant was homebuilt and my dad even carved out simitar blades for the unit. Them were the days (I was born in 1937 and liked the depression. While city folks were walking the streets looking for work, we had an attic hung heavy with home-cured hams, a root cellar full of fruit and vegetables, rows of home-canned meats and vegetables in the pantry, crocks of pickles curing away, and all the fresh milk, butter, cream, eggs, etc. we could eat. Likewise later when the city folks had work during WWII and plenty of money... but no ration stamps. Self-sufficiency makes sense to me because I started right off living it).

Anyhow I'm always happy to see a new crew carry on the work. As you may or may not know, we started with $1,500, a donated typewriter, and a third or fourth hand kitchen table (which we ate off of too). We were, at the time, up against directly competitive new magazines with as much as $6,000,000 in backing. Plus the "other guys" had guaranteed advertising contracts, guaranteed distribution contracts, "name" editors and writers, and many other resources that we didn't have. The only thing we had going for us was we-- as you are doing now-- tried to speak truth and be genuinely helpful… while our so-called competition tried to be "hip" and "with it" and "slick". Ten years later they were gone and we were doing a $20,000,000-a-year business.

That's the success part. The other side of the coin is the minimum 18-hour a day I worked, seven days a week for that solid ten years. And I was doing it for virtually nothing... plowing everything back into the business all the time.

BOTTOM LINE: If I hadn't finally just got up and walked out one day, I'd have been dead within another six months. So the best piece of advice I can give you is that they call them deadlines for a reason. If you take it too serious, they'll kill you. And for what? I look back now and, except for a very few bright spots such as the work you folks are doing, the world is in worse shape now that than it was when I started: More pollution, more wars, more waste, more species gone, more people, more disease, more of all the things that rape the planet faster and faster. And I still haven't regained my health from all that overwork.

And MOTHER? Well, I haven't really has anything to do with the magazine for about eight years now (the hotshots I "gave" it to didn't seem interested in anything I had to say) and it's been resold and it's pretty dopey these days. If I were still around, The Mother Earth News would be running a lot of the stuff that you guys are printing. So more power to you! (Solar, wind, water,etc. power of course.)

But I ramble. Perhaps you'll find Mother No.1 worth keeping in your office as a symbol that the torch has been passed. Maybe you'll even swap me a copy of your first issue in exchange. And please do keep me on your mailing list and let me know if I can be of any help to you. I sure don't know it all but I have been down the same path you're now traveling and I did learn a little.

Right now I'm living above the 8,000 ft. level overlooking the lights of Denver at night and my wife and I have been looking for "just the right spot" somewhere in the Pacific to set up a food-and-energy self-sufficient homestead. We've been to Fiji, French Polynesia, New Zealand, Tasmania, and Hawaii. Hawaii (except for the Big Island) is going fast and even the Big Island is increasingly raped these days. French Polynesia is absolutely beautiful but France is drenching it with fallout from nuclear tests. New Zealand is wonderful and will grow anything... but there seems to be a lot of cancer there from all the pesticides the use (many of which have been banned here). Tasmania and other parts of Australia are also being "developed" at an increasing rate and Fiji-- which is still largely organized on a village-by-village self-sufficient basis-- is going through some dangerous political troubles.

There just ain't no place to hide these days. And Big Brother always wants more than his cut. Self-sufficiency is still the best way of life... if you can find a little corner of the world out of the mainstream.

Best,
John Shuttleworth
Founder of the Mother Earth News

Hello John:

You DID change the World. You showed many of us what could be done. Thank you.

The synchronicity of the Universe amazes us. We are starting out with just what you had, we even eat on the same (and only) table that we layout Home Power on. The only difference is that our donated typewriter is a computer. Time marches on. We appreciate your support and the flowers in your letter. Mother No.1 is enshrined in our office. When we get tired and down, we look at it and smile.

We hear you about overwork. We've been wondering when someone would reinvent sleep. Right now we are so enthused by the responses from everyone that we can't even think of anything else we'd rather be doing. There's a copy of HP#1 in the mail for you.

Thank you for passing the torch. We only hope that we can *carry it as high and brightly as you did.*

Great! Been reading #1 & 2 the last two evenings. Been waiting a long time for this. Keep up the good work.

I agree soldering is the way to go. However, solder itself isn't such a good conductor. Stress the need to make a good mechanical connection BEFORE soldering. I.E., Perez, HP#1, pg. #24-- copper tube connectors. Shove the wires in the tube (maybe flux them first) flatten the tube in a vise or whatever, THEN solder and drill your hole.

Same item, different comment. Copper is not so hot, or maybe too hot, around sulfuric acid. Coating all the exposed copper with solder helps. All old battery cables used lead, either made the connector out of it, or coated the connector with it. Some still do.

I agree with all your comments stressing the need for care in making connections in low voltage, high current systems. All the problems are of course magnified in a salt water marine environment. Which is where most of the wiring I do lives.

There are times and places where soldering is either not practical, or desirable for some reason. Like temporary connections, or things you know you'll have to unhook for servicing sometime.

This product recommendation is based on ten years of use, at first hesitant, and now whole hearted. KOPR-SHIELD is a conductive, anticorrosion surface compound and antiseize, made by Thomas & Betts Co., Box 1960, Sparks, NV 89431.

I use this stuff on all mechanically made electrical connections. Bolted ring connectors, split bolts,etc. Even wire nuts (Great AE God forbid!) have given good service when installed on wires liberally coated with Kopr-Shield. Like on a bilge pump down in a salty bilge, where its gotta work, and if it doesn't you gotta rip it out and stuff in another one in a panic, hopefully without too much damage to the wiring harness. Anyway, I've had wire nuts (Kopr-Shielded, of course) working perfectly, down in bilges, for years. Kopr-Shield is great stuff.

Fred Richardson, Richardson Marine Electric, Waldron, WA

I like this Home Power issue and look forward to more. I have a comment about Solar Power that has nothing to do with the efforts of this magazine. I am converting to solar power when I already have commercial AC power. Because I don't believe in fossil fuel pollution or nuclear waste. It bothers me that most people involved in selling solar power insist on making a high wage, which helps to keep solar power very expensive. Therefore, the average homeowner sees no logical reason to convert from AC commercial to clean solar power.

Larry & Nancy Tibbetts, Taos, NM

Good job! I especially liked the articles on batteries. That information is hard to come by. I had never heard of "equalizing charges". Would like to see an article on PV powered water pumps for wells. Your classifieds might become important. Tell your advertisers we actually READ their ads!

Emmett Eiland, Oakland, CA

I enjoyed reading your magazine. The articles were informative without being so technical that the average person gets confused. The advertising is as important to me as the articles because when you make your own power, you have to keep current on where to get parts and supplies, etc. I'll be looking forward to future issues.

James V. Larson, Gheen, MN

Your magazine is excellent for me. I am a foreign student from Zaire, Africa. I am going to live in a remote area back home and work for my church, this will be very important for me. My church back home will be able to buy some equipment from your advertisers. I am going to keep all the magazines I will get from you for future reference for addresses where we can buy this equipment. I am a solar engineering technology student. This is excellent. Don't give up.

Mambo D. Assama, Colorado Springs, CO

I don't know where you found me, but I sure am glad you did. Free, you say? Hell, bill me, this is a bargain at several prices...... Keep these coming, and I don't even mind going on a few mailing lists. Many Thanks.

Lee W. Harwell, Rochester, NY

I would like to know the names of people who are using it IN THIS AREA. I would like to know of classes, training sessions, seminars, workshops, shows, etc. about PV IN THIS AREA.

Donna L. Schrock, Meyersdale, PA

I've just experienced a 49 hour power outage due to a rather typical ice storm. Perhaps with your help, this won't happen to this home again! Believe me, I had visions of wind mills; send more issues of Home Power.

Louise Hansen, Marshfield, MO

I am a woman who is reasonably intelligent, has some mechanical aptitude, and enjoys designing and installing my own systems. However, my area of expertise is NOT electricity or hydraulics! Therefore, I really appreciate information for the lay person that helps me do things efficiently, simply, elegantly! Thanks.

Shelley Hughes, Santa Barbara, CA

I enjoy your magazine tremendously. Of all the publications I receive, yours is the most relevant to my needs, and I have passed the application on to several neighbors in similar situations. I'm enclosing a small contribution toward the cost of mailing Home Power to me, since you are giving it away. Keep up the good work!

P.S.-- My wife and I have lived under our own power for seven years, and we wouldn't have it any other way. The question we are most often asked: "How do you flush the toilet?" Makes you see how little people understand the forces that drive their own lives.

Oskar Riedel, Duvall, WA

Q&A

We try our best to directly answer all your questions. Please remember that we are limited by our own experiences. If we don't have the direct personal experience to answer your question, we will print your question anyway in hopes that a reader with the experience will answer it. So this column is not only for question by Home Power readers, but also answers.

Do you have information on new battery technology?
Eugene LaTenfresse, Willow, AK
There are a number of developing battery technologies. Right now, nickel-cadmium cells are almost ready to be used in home power systems. The only drawback is the price which is still several times that of lead acid types. Other technologies such a rechargeable lithium cells are still some time off. Home Power will be running an article soon on the nicad types.

How about an article on alternators for low power water systems? I know of someone who thinks the Ford 90 amp is the most efficient. Is this so? I have a 12V compact disc player and would like to find a 12V amp with a frequency response of 20 to 20,000 hertz, 30 to 100 watts/channel, and low distortion. Do you know of any way to get that without going to super expensive car stereos? I have an AKAI boom box that I use now. It works OK, but the fidelity isn't that great. I think an article on 12V sound would be well appreciated.
Durga C. Tamm, Fort Jones, CA
Well, our Hydro editor Paul Cunningham runs Energy Systems and Design, POB 1557, Sussex, New Brunswick, Canada E0E 1P0. One of his specialties is using car alternators in low head hydro situations. Write him for info and we'll get an article about this into the pipeline. I don't have any particular data on the efficiency of this Ford alternator. The efficiency of an alternator can be estimated visually by looking at two things. One, the diameter of the wire composing the stator, and Two,the overall diameter of the stator. The larger wire and the bigger overall diameter gives the alternator more efficiency. Our use of Delco and Chrysler alternators has proven to us that there is in fact great efficiency differences be different makes and models. This is a subject for an future article detailing what makes up an efficient alternator and why, complete with side by side testing of various makes and models. Right now, the hottest alternator I know of is the 100 ampere Chrysler model that look like overgrown Delcos. We're not into audio enough to answer your question about 12 VDC sound equipment. How about it, anyone out there who can answer Durga's question?

It is advised, when charging a battery, to continue charging until the battery is completely full. With a PV powered system, with a motorized backup, is it customary to use the motor-gen. every day which the solar power is insufficient to provide full charge? Where can I buy a 0 to 25Ω rheostat for resistive field controller for a home-built motor-gen.?
Robert Weaver, Waldron Island, WA
No, you don't need to run your generator every day the sun doesn't shine. Run it when the batteries are empty, or whenever you need the extra energy (like washing the clothes or vacuuming the floor). If you do start the generator, then keep it running until the batteries are full. One of the big advantages of the engine/generator is ability to completely recharge the battery. This adds years to the battery's life. You can buy a 25 Watt, 25Ω, Rheostat for $15.28 from Allied Electronics, 250 N.W. 39th St., Seattle WA 98107 or call 1-800-444-5700.

My wife and I felt this was a very good mag. for those striving to maintain their own power. We would like to see you include some practical working schematics and drawings. We would also like to be able to write to you with questions or problems or our own ideas. Who do we write to and will you answer?
James F. Carr, Rush, KY
We are happy to answer questions and print answers in this column. We will accept your articles and letters. The volume of specific questions is so great that we are unable to answer every one. We pick those that we feel have the widest interest for this column.

My home power is fine. What I am interested in is future power. The first thing I would like to do is to put a Photovoltaic cell(s) to run a deep well pump, 320 feet deep. When I find out what components I need, I believe I could install it without too much trouble. I have a submersible pump now, I believe that I should go to a jack pump. This is what I need to find out.
H. McManus, El Paso, TX
Write Jim Allen at Solarjack Pumps, 102 West 8th St., Safford, AZ 85546 or call him at 602-428-1092. Jim specializes in PV powered jack pumps that work on very deep wells.

Are water turbines clean downstream?
R.M. Olivar, Yreka, CA
You bet! A properly installed and maintained water turbine should have almost no impact on a stream's environment.

Would like to see information on interior lighting techniques, specifically what people are using for shading and diffusing low wattage stick fluorescents. It seems to me anything commercially available is designed for higher wattages AC.
Mark Shenstone, Trumansburg, NY
See the article on lighting in this issue. In a nutshell, shading and diffusing wastes light. If a light is so bright as to require shading, etc., then use a smaller light! Area lighting is for those with unlimited cheap energy. We use spot lighting. The light is where you need it and not wasted where you don't.

How do you convert appliances to 12V? How about the new plethora of rechargeable appliances? They all work on 2 to 9 VDC.
Bryan S. Thompson, DeKalb Junction, NY
Some appliances, especially electronics like radios, and stereos, are easily converted to 12 VDC by a knowledgeable technician. Others, like appliances using motors, TVs, and VCRs, are anywhere from somewhat difficult to virtually impossible. There are too many differing appliances to be specific. Most appliances that work on DC energy at 12 Volts or less are easily converted to 12 VDC operation. We use many battery operated rechargeable appliances, drills, soldering irons, etc. and recharge their batteries off of the large 12 VDC battery system. An article about this will be forthcoming.

I would like to know if there is a 12V VCR that records and plays back and/or if there is a small (30 to 100 watt) inexpensive inverter suitable for powering a 120 vac VCR.
Richard Wilson, Winter Harbor, ME
Just about every VCR maker has a 12 VDC model for mobile/portable use. Toshiba V-X34, Panasonic Models PV-5800, PV-8500 & PV-9600, JVC models HR-S100 & HR-C3, Hitachi models VT-3P, VT-5P & VT-8P and RCA VKP

170 for example all run on 12 VDC. These units are usually more expensive than the comparable 120 vac units because fewer of them are made. Heliotrope and Trace both make excellent 500 watt inverters. Beware of the small, inexpensive, square wave type of inverters. While they do work (for a while), many VCRs and TV will experience glitches in the video due to their dirty power. A word of advise, don't waste your money on marginal inverters. Once you have an inverter, you'll find many things to plug into it. Consider 500 watts to be a minimum size. Consider only inverters with proven performance and reliability.

Could you recommend an engineering firm to help me decide which source of alternative energy to pursue here in the thumb of Michigan?
M.B. Haney, M.D., Almont, MI
Try Chad Lampkin, Michigan Energy Works, 9605 Potters Rd., Saranac, MI 48881 or Jim Cook with Save On Solar, Inc., 6905 White Rabbit Rd., Battle Creek, MI 49017

Home Power MicroAds

Rates: 5¢ per character, include spaces and punctuation. $10 minimum per insertion. Deadline: 10th for that month's issue. Send check with Ad.

SOLAR ELECTRIC POWER PROVIDES HOME COMFORTS beyond power lines. Our home and business solar powered ten years! Get our 42 page information catalog, $3. Questions personally answered. BACKWOODS CABIN ELECTRIC SYSTEMS - -Stephen, Elizabeth Willey, 8530-HP, Rapid Lightning Creek, Sandpoint, Idaho, 83864. (208) 263-4290.

FOR SALE: NICKEL IRON EDISON BATTERIES. The true lifetime battery for your AE needs. Send SASE to: Utility Free™, Inc., 1953 Old State Rd., Waterford, PA 16441

FOR SALE: Never been used 120 V DC IES Skyhawk 4 KW Wind Generator $3,500 or best offer. Also Rohn 60' SSV free standing tower. 814-796-6022.

WATER POWERED WATER PUMP. Not a Ram Pump! Requires less than 3' of head to operate. Easy and cheap to build! Plans $5. PO Box 203, Wolf Creek, OR 97497.

FOR SALE 32 V 2,500W JACOBS $1700ea, castings, blades, etc., quantity prices. BEST inverters 32V 3KW $1100, 120V 12 KW $2400. Gary Hoffsommer, RT2, Quenemo, KS 66528. (913) 665-7795

USED DYNAMOTE 24 volt 3000 watt inverter for sale. Great for running large motors. 5 years old, works great. $650. We have a complete line of AE products and we would be happy to help you design a power system. See our display ad in this issue. Alternative Energy Engineering 707-923-2277.

DC ELECTRICAL EQUIPMENT- Wind Generators, Kits, Towers, Photovoltaics, Controls, 36VDC Garden Tractors/Lawn Mowers, Snow Throwers, Welders, Chain Saws, Tillers, Tools, Grain Mills, Relay, Motors, Water Pumps, Fans, Water Heater Elements (12v to 36v), Inverters, Refrigerators, Freezers, Solar heaters. Used Equipment: Best Inverter 32v, 3000W, 12,000W surge, with load demand $895, save $1653. 1512 Trace inverter with options- a real bargain. 200w Wincharger $395. NiCad Batteries $1. Sparco Wind Powered Water Pump, 48 gph at 10 mph. 200 watt WhirlWind System, 12' Blade, 120 vdc $990, save $2100. 4000w Induction Generators $120. Diatomaceous Earth- Non-toxic Insecticide. Hydrogen Peroxide makes plants and animal grow better, kills AIDS virus, info $2. Equipment catalog $3. Kansas Wind Power, Route 1, Dept. HP, Holton, KS 66436. Phone: 913-364-4407. Since 1975.

SABIR GAS REFRIGERATORS, SOLAR ELECTRIC SYSTEMS, kits with complete directions, PV Modules, Inverters, batteries, all at great mail order prices plus expert design assistance. Will match most any sale price. Send $12 for my book, "Solar Electricity for the Remote Site Home"- Fowler. For free catalog, briefly state you potential use or need. FOWLER SOLAR ELECTRIC INC, Box 435, Worthington, MA 01098. 413-238-5974.

"SOLAVOLT" 36 Watt solar modules for sale. Brand new, 1st quality modules originally bought for a large water pumping project are now available for incredibly low prices, while they last! Typical output is 2.3 amps at 16 V. $198 each. By 10 or more for $188 each. We will pay the shipping in the continental US. Send a check or money order to Alternative Energy Engineering, Box 339 HP, Redway, CA 95560. or use your credit card and call 707-923-2277.

INSTANT DOMES & GREENHOUSES: 20 minutes set up! Many models. Send $1. for catalog to SHELTER SYSTEMS, POB 67 HP, Aptos, CA 95001. 408-662-2821.

CONGRATULATIONS TO HOME POWER MAGAZINE! Keep up the good work. Joel Davidson, Heliopower, Western Region Sales Manager and author of "The New Solar Electric Home".

SOLAR ELECTRICITY. Lowest cost, call us before you buy. 800-832-1986.

LEARN ABOUT YOUR BATTERIES! The Complete Battery Book by R. Perez. Tells all about 15 different types of batteries. Extensive details on lead acid and NiCd systems. Many details about how to use your batteries in your home power system. 187 pages with over 100 illustrations. THIS BOOK WAS WRITTEN USING ONLY ALTERNATIVE ENERGY! $19.45 postpaid from ELECTRON CONNECTION Ltd., POB 442, Medford, OR 97501.

ENERGY EFFICIENT REFRIGERATION- DC and ac systems for domestic use and vaccine storage. Available in sizes ranging from 1 to 19 cubic feet. Most models can be powered by less than 3 PV modules.. SUN FROST, POB 1101, Dept. HP, Arcata, CA 95521. Call 707-822-9095

PICK UP COPIES OF HOME POWER AT SMALL HYDRO ELECTRIC SYSTEMS & EQUIP., INC. 5141 Wickersham St., Acme, WA 98220. OR at 301 West Holly St., Bellingham, WA 98225. Call 206-671-4326

WANTED: Quantum Mechanic, must have own tools. Send resume to POB 931, Ashland, OR 97501.

The most beautiful thing we can experience is the mysterious. It is the source of all true art and science. - Albert Einstein

the Wizard Speaks:

THE EDGE THE EDGE AH, YES THE EDGE

Now is the time to look at the local technological Edge. How well is present day mass technology creating the path to the future? With the advent of new fuels, new designs, and new control systems, all the old engine technologies are pushing towards their theoretical maximum efficiencies. This coupled with newer fuel cycle designs and such technologies as magnetohydrodynamics (MHD) have made fair progress on the pathway of efficiency. The most promising development in this area is, however, the immanent possibility of room temperature superconductors with the possibility of a 10 fold increase in efficiencies.

On the pathway of source regeneration we now have heat recycling, trash and biomass recycling and the use of regeneratable biomass for fuels and other industrial uses. These and similar processes, such as solid state heat to energy conversion, are beginning to cut down the rate at which resources are being degraded.

We can look at the relatively inexhaustible resources which are available to us right now. If these can be effectively harnessed we will be all right energy wise for at least a million years. Two of these, wind and water, have been used for many years as energy saving and energy creating systems. These will be here as long as the Earth survives. Another, solar, will be around even longer. It is the opinion of many intelligent people that with proper technological engineering these three sources alone could provide all the energy that human society needs. Solar energy is also the best bet to power many extraplanetary ventures.

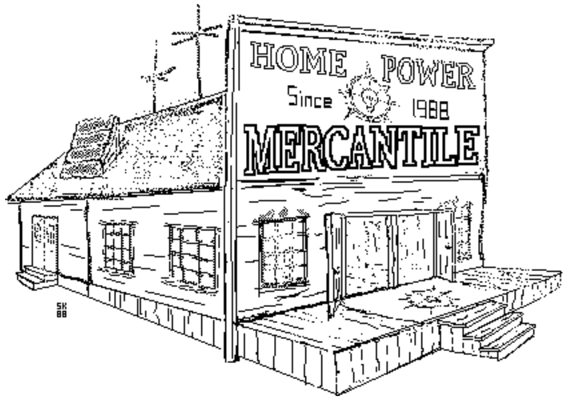
The final energy process to be considered here is the one truly at the edge of modern mass energy development. This is fusion energy: the process at the heart of the sun. If laser fusion processes or certain cold temperature fusion processes can be made feasible, this type of energy could power our civilization until the hydrogen runs out. Even then higher level safe fusion/fission systems could be developed to regenerate the hydrogen and/or other light atomic fusion fuels.

So why not a free lunch? May it be served soon!

Whadda ya mean ya forgot the PV panels?

Index to Advertisers

Alternative Energy Engineering - 11
Electron Connection - 42
Heliotrope General - 31
Integral Energy Systems - 16
Davidson Company - 22
Mendicino Power Co. - 16
Mercantile - 48
MicroAds - 46
PowerHouse Paul - 19
Real Goods - 5
Ramona Works - 33
Solar Retrofit Consortium - 2
Trace Engineering - 22
Windlight Workshop - 8
Zomeworks - 11



Mercantile Points To Ponder

- One insertion per customer per issue
- $80 per insertion, paid with your ad copy
- We typeset all ads
- Sorry, no graphics
- We will do our best to make your ad look good in the available space
- If you send us too much copy, you may not like the result
- Examine other ads for guidance
- FIRM deadline for March issue is March 10, 1988
- Any copy received after that deadline goes into the April issue

Complete PV & Wind Systems, DC Tractors & Equipment, Solar Air & Water Heaters
Kansas Wind Power
Route 1, Dept. HP, Holton KS 66436
913-364-4407. see our MicroAd!

Energy Efficient Refrigeration.
Most models powered by a single PV Panel
Sun Frost
POB 1101, Dept. HP, Arcata, CA 95521
707-822-9095. See our MicroAd!

INSTANT DOMES & GREENHOUSES
20 minutes set up! Many models. Send $1. for catalog to
SHELTER SYSTEMS
POB 67 HP, Aptos, CA 95001
408-662-2821.

Alternative Energy Engineering
Your full source dealer for solar,wind & hydroelectric systems. 80 Page catalog & design manual for $3.
POB 339-HP, Redway, CA 95560

The Complete Battery Book
Essential Information for battery users!
Covers 15 types, 186 pgs. $19.45 postpaid
Electron Connection Ltd.
POB 442, Medford, OR 97501

J. Michael Mooney
Solar Electric Consultant
P.O. Box 667
Heavener, OK 74937
(501) 441-7098

Our handcrafted canisters will add charm & warmth to your kitchen.
ARIVACA CANISTER CO.
P.O. Box 462
Arivaca, AZ 85601
(602) 398-2124

MICRO HYDRO • SOLAR ELECTRIC • SOLAR HOT WATER
MOHA TECHNICAL
P.O. Box 1033
Lillooet, B.C. V0K 1V0 Canada

Fowler Solar Electric Inc.
Photovoltaic System Design
Alternative Energy Equipment • Gas Refrigerators
13 Bashan Hill Road
Worthington, MA 01098
(413) 238-5974

1988 Energy Products Catalog
Photovoltaics, Inverters, Batteries, Hydro Turbines, Windmills, etc. Info $4, refundable with first order.
Small Hydro Electric Systems & Equip., Inc.
5141 Wickersham St., Acme, Wash. 98220 USA
206-671-4326

Stan Krute's Camp Creek Institute Presents
Our Catalog #9
Of Eclectic & Possible Useful Macintosh Software
Education -- Small Business -- Home Power -- Nerd Utilities -- Fonts -- Icons
Hypercard Stacks -- Excel & Reflex Templates -- Standalone Apps -- Resources
Send $2 to us at : 18617 Camp Creek Road
Hornbrook, California 96044

The Home Power Mercantile
will put your ad here on 10,000 copies for only
$80