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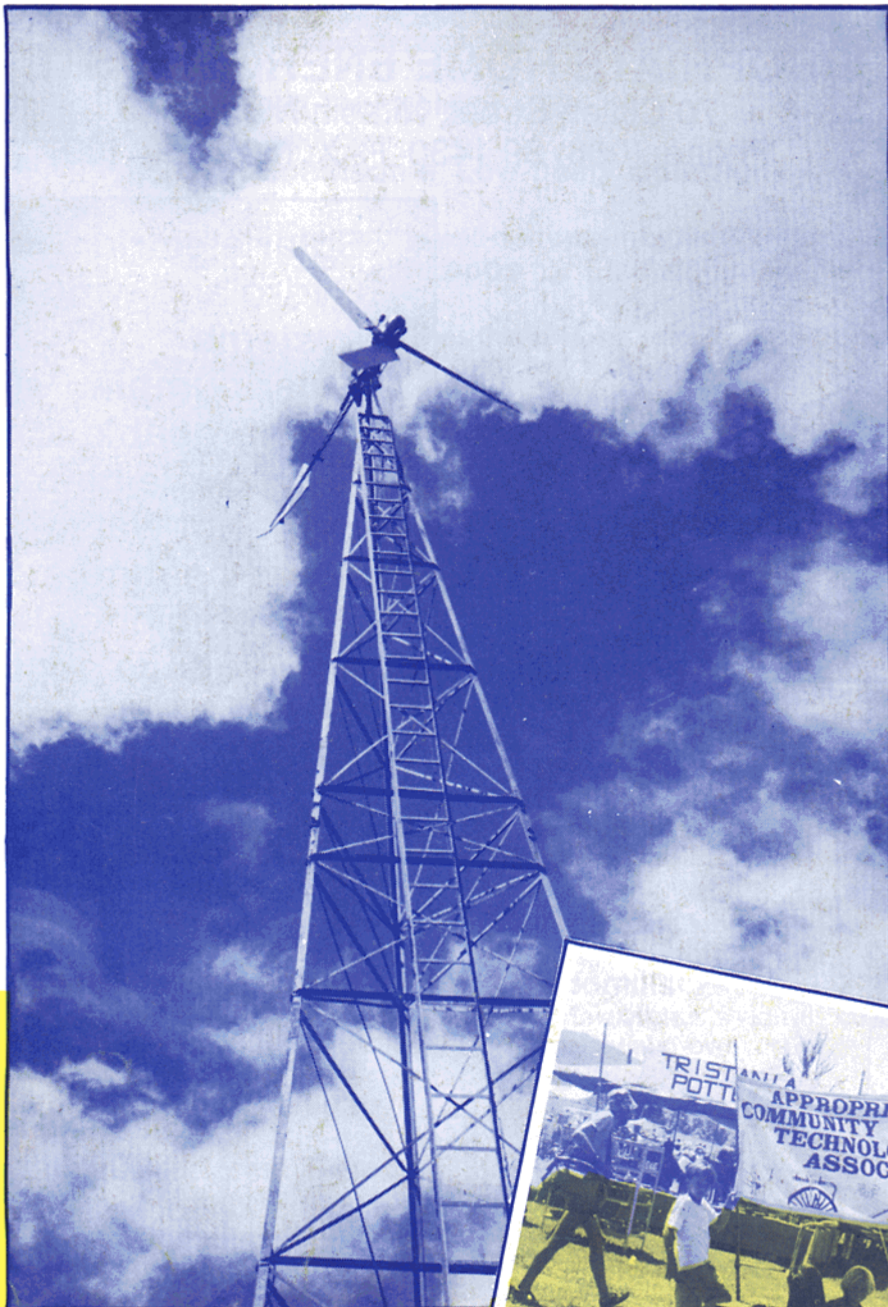

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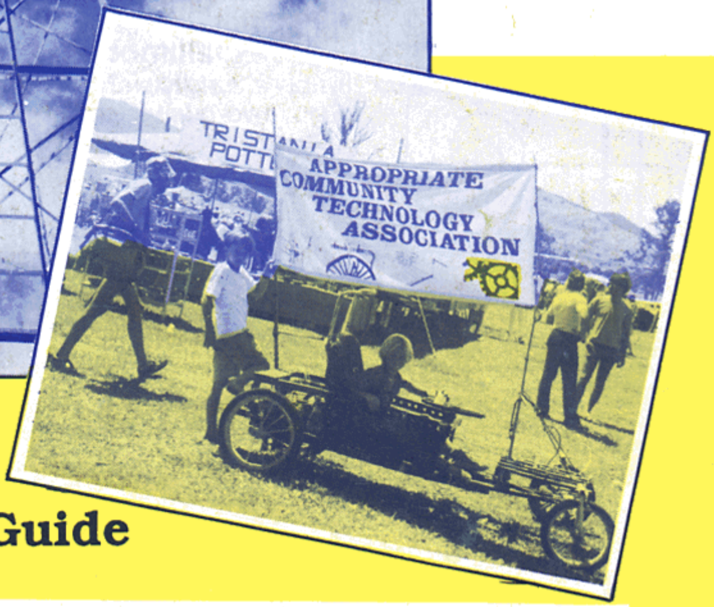

Windgenerator Efficiency

Solar Water Heater Buying Guide

Special Nimbin Double Issue

SOFT TECHNOLOGY

Nimbin Soft Tech. 13

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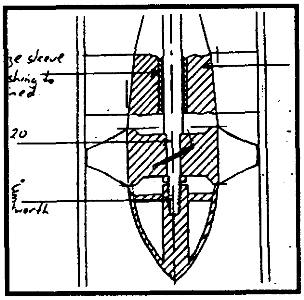

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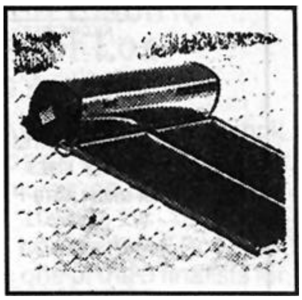

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This issue of Soft Technology was edited by Ian Scales and produced with the help of Jeff Hilder, Alan Hutchinson, Mick Harris, Noel Jeffray and others in Melbourne; Karl McLaughlin, Dave Lambert and others in the Rainbow Power Company, Nimbin.
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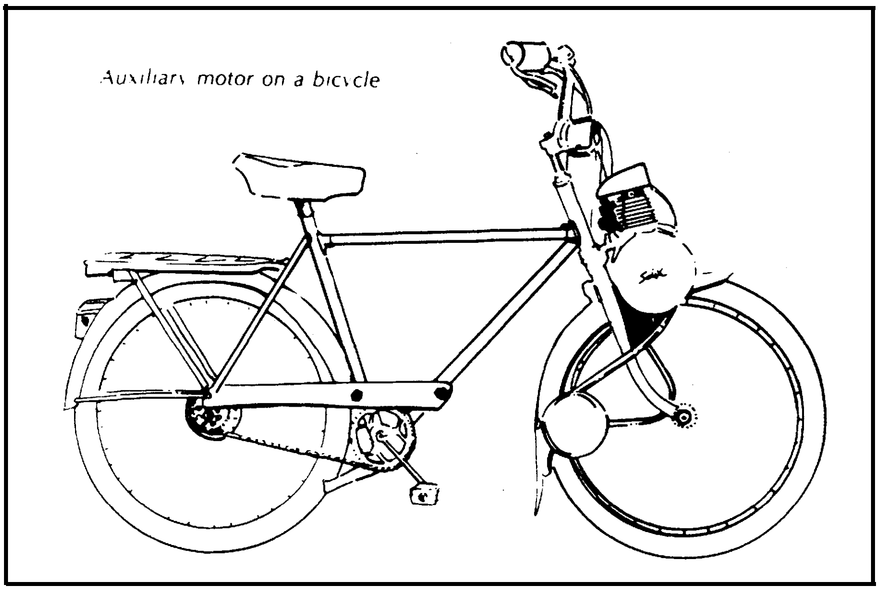
Bicycle Motors Legal in Victoria

The Victorian Government has recently brought in changes to the Road Safety Act (1986) allowing a motor up to 200W to be fitted to a bicycle. The relevant change was gazetted in the 1st March 1988 Victorian Government Gazette.

It says that the following class of motor vehicles are not motor vehicles for the purposes of the Act: "Pedal cycles to which are attached one or more auxiliary propulsion motors having an aggregate maximum power output not exceeding 200 watts."

(Electric Vehicle Assoc. News, Sept)



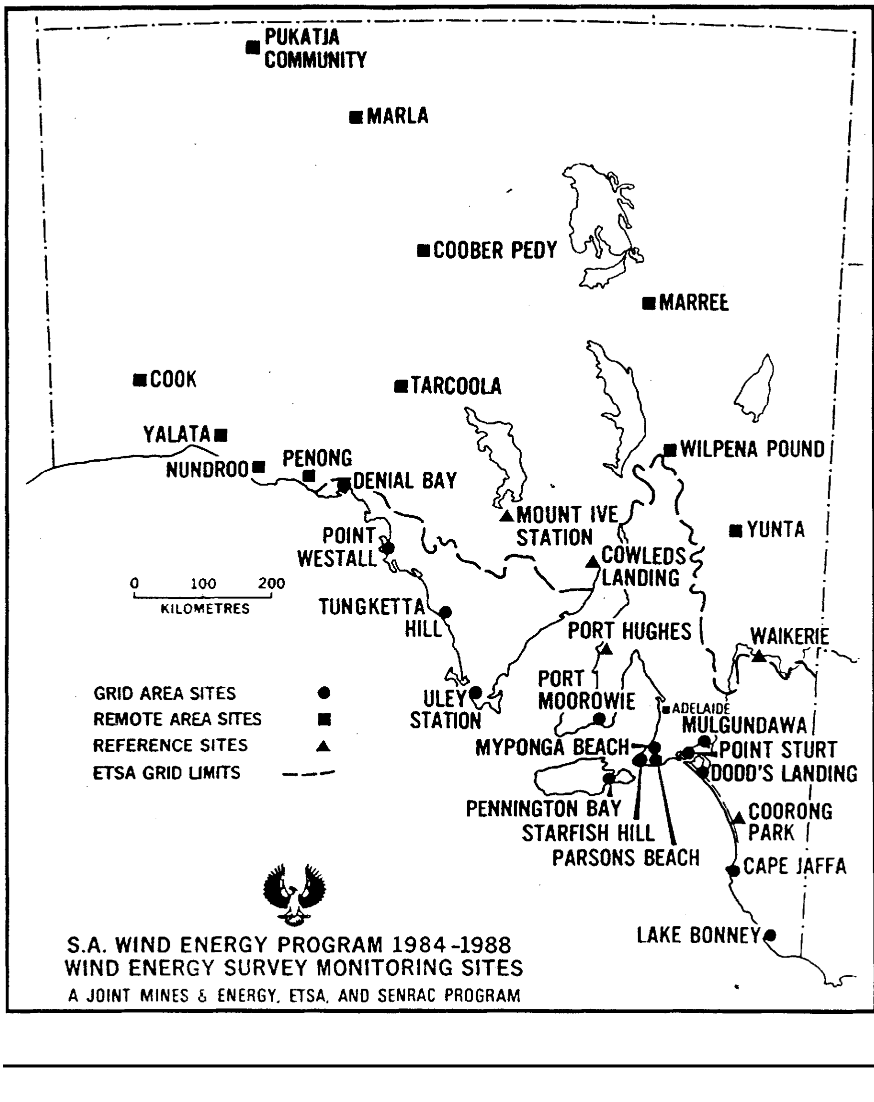
SA Wind Energy Program

Electricity generated by wind farms and delivered to the ETSA grid would still not be competitive with energy delivered by conventional fossil fuelled power stations in the foreseeable future, according to the recently released South Australian Wind Energy Program Report.

However, the cost of electricity generated from wind turbines is only slightly more expensive than the current cost of electricity produced by diesel generators in some remote areas and, with the cost of diesel fuel expected to rise in real terms, wind energy should become competitive with diesel generation in some isolated locations.

On the basis of these results, an application had been made to the Commonwealth's National Energy Research Development and Demonstration Council for part-funding of a 300 Kilowatt wind turbine demonstration facility at Coober Pedy.

(SA Energy News)



Tasmanian Wave Power Project

Australia's first wave power generating station is to be developed at King island in Tasmania at a cost of A$7 million and have a capacity of around 1.3MW.

All necessary technical and financial data is being assembled both in

Australia and overseas and is based on a wave power prototype that has already been built in Norway by Norwave A.S. The station will take about three years to build. It is to be funded by the Tasmanian HEC and Norwave.

Tasmania Considering Wind Power

The Tasmanian Government has just promoted windpower to third place in their list of energy producing options. The decision to adopt wind as a third viable option follows a study carried out with the National Energy Research Demonstration and Development Council (NERDDC).

The HEC and NERDDC is satisfied that wind machines are both reliable and made by reputable manufacturers. The area required for a wind farm is regarded as the only real drawback - they estimate that to generate 120MW requires a coastal strip 70km long and 2km deep. They aren't used to thinking small, are they?

Australia is Solar Leader

Australia is still ahead in commercial solar technology, according to Professor Martin Green of the School of Electrical Engineering at the University of N.S.W.

Australia is the fourth largest traditional solar cell manufacturer in the world and in GNP terms, the world's largest manufacturer of the traditional solar cell type.

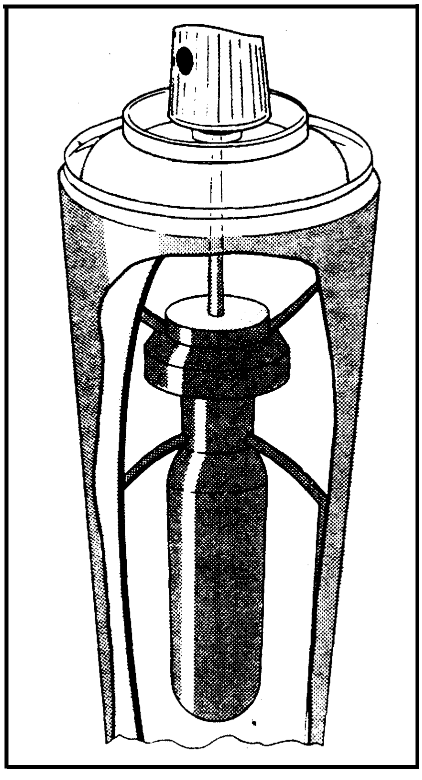
"We just happen to be working on the type of cell which is dominant in commercial technology and we hold all the records made in that particular field," said Green. *(Electrical World,* June)

Access to Sunlight Now a Planning Issue

South Australia's new Urban Consolidation policy seeks to allow houses to be closer together, and supports some medium-rise housing in suitable locations. Shadows cast by new housing will have potential to cause problems in this scheme.

The plan recognises the difficulties which can be caused by shadowing and accordingly allows the impact of such shadows to play a part in any planning approval. In addition to referring to solar energy systems under its objectives, the plan also includes a principle which enables planning approval to be denied if access to incident solar radiation is unreasonably impaired.

As a general policy it puts solar access on the planning agenda. Accordingly, there is now an opportunity for more specific "shadowing" policies to be developed by individual Councils, tailor-made to local circumstances. (S.A. Energy News)



New Australian Aerosol Propellant

Aerosol cans could be soon using nitrogen as their propellant instead of CFC's. However, nitrogen has to be kept at a very high pressure to keep it in its liquid form, and it is far too expensive to strengthen the whole can.

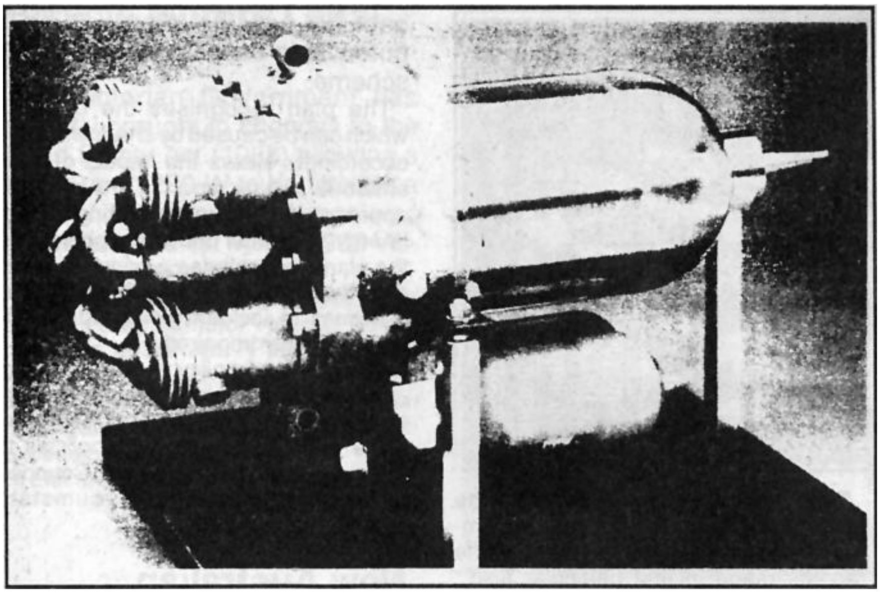
An Australian company, Overseas Technology, has found an economical solution to the problem. it is a can that stores liquid nitrogen in a small metal container, similar to the bulbs used in soda syphons. The bulb and its valve transfer nitrogen evenly to the liquid in the can.

According to Overseas Technology, manufacturers should easily be able to incorporate bulbs into their cans without disrupting their production lines too much. *(New Scientist,* July)

Australian Electric Vehicles for Los Angeles?

The Los Angeles City Council (LACC) hopes to have 3,000 electric vehicles on the road by 1991, and 10,000 by 1995. An Australian company, Elroy Engineering, is one of the 5 finalists for a contract to supply the city with electric cars, vans and buses.

Elroy Engineering has developed 17 models of electric vehicle, ranging from large buses to commuter vans and cars. The company's vehicles use the con-



Stirling Engine

ventional lead acid type of battery. The designer of the cars, Roy Leembruggen, explained that this is because lead acid batteries are the only proven, commercially available, and economically viable batteries.

Despite this, Mr Leembruggen, says that his company's Townmobile vehicles easily meet the LACC standard of a 90km/h road speed and 90km operating range. He described the attitude of Australian governments to electric vehicles as one of "apathy". *(Aust. Electric Vehicle Assoc. News,* Sept.)

Power Politics in Tasmania

Apparently Tasmania's energy policy is about to be renovated for the first time in years now that the Green Independents have the balance of political power firmly in their grasp (incidentally the third instance world wide that enviromentalists have won the right to control parlimentary proceedings).

The Independent's energy policy includes:

1) an increased use of solar water heating

2) the establishment of a greenhouse car registration scheme

3) the establishment of a centre for appropriate technology and an intermediate technology development group

Their intention is also to make greater use of natural resources - such as wood, gas and coal, to place greater emphasis on energy conservation and co-generation (already enjoying some success in Victoria), and to thoroughly investigate all sources of alternate energy. (Electrical World, June)

Stirling Engine Now Looks Practical

The Stirling external-combustion engine runs equally well on gasolene, kerosene, ethanol or virtually any other combustible liquid. After a decade of research by NASA and its contractor Mechanical Technology Incorporated (MTI), one may finally be commercially viable. It is an alternative to internal combustion, but until now has not been available at a reasonable price or performance level.

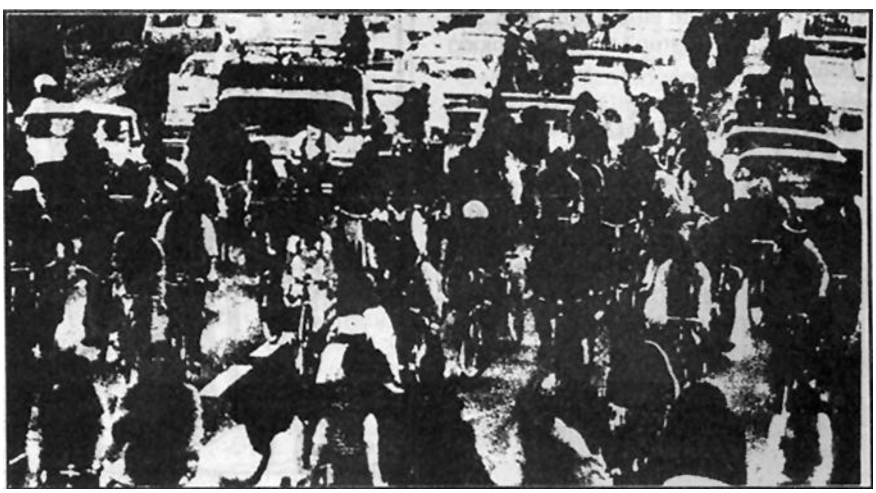
According to MTI, the new Mod.II Stirling engine is competitive in size, weight and performance with conventional spark-ignition engines. Experimental engines installed in U.S. Air Force vans have logged more than 18,000 miles burning a variety of fuels, and they have shown consistently good performance. ***(Scientific American,*** Jan.)

Petrolheads Smokescreen Bicycles

There are 270 million bicycles in China; some 50,000 people on bikes have been counted passing a traffic checkpoint in the city of Tianjin in one hour. Yet the World Bank can produce a report on traffic in China without once mentioning the bicycle.

This is not the **case** for *Worldwatch Magazine,* which in its August 1988 issue had an article by Marcia D Lowe giving facts and statistics in an easy-to-read style on bicycle transportation around the world, including these:

In Japan the city of Kasukabe has a 12 story parking tower; The Netherlands has 9,000 'miles of bikeways; 20,000 bicycle rickshaws have been confiscated in Jakarta, Indonesia to reduce traffic (and make way for cars); and in the United States, statistics on bicycles are gathered only as their use for toys. *(Tranet)*



Los Angeles May Ban Petrol Cars

Cars fuelled by petrol could be banned from much of southern California by the year 2007, according to new proposals for cleaning up the notorious Los Angeles smog. The measures, by which stand a good chance of being implemented, will replace petrol with methanol. They are likely to become a blueprint for other American cities with smogs.

There will be heavy fines for companies that do not introduce compulsory car-pooling among their employees, a limit on the number of cars that each family can own, and an end to free parking. Cars will be required to have radial tyres because these throw less dust into the air. By 1993, all fleet vehicles, including rented cars, should run on fuels, such as methanol, that burn cleanly. The two big American car makers, Ford and General Motors, are expected to be producing up to 100,000 cars that run on methanol by that date.

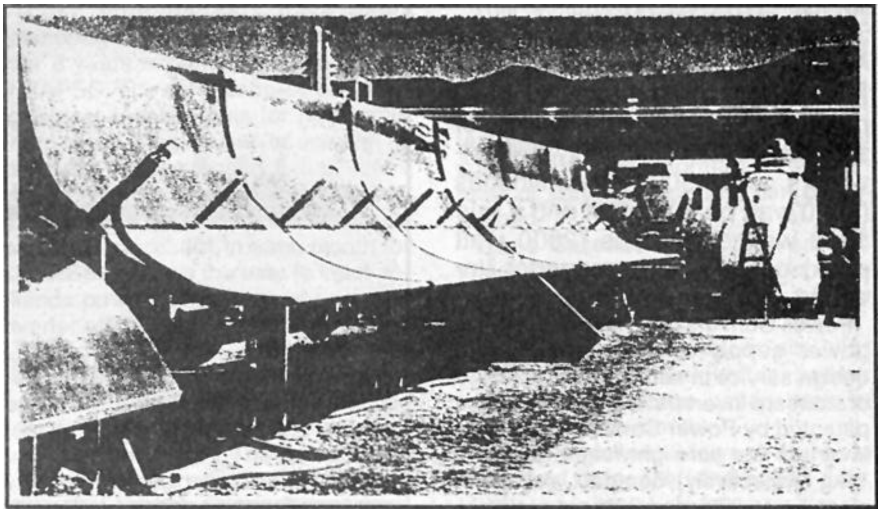
The cost of the measures during the first five years will be about $2.8 billion a year. Air pollution is estimated to cost southern California $13 billion a year in health expenses and damage to crops and property. By 1998, 40% of all cars, 70% of freight vehicles and all buses must convert to cleaner fuels. By 2007, all cars are to be converted to run on clean-burning fuels or electric power.

(New Scientist, April)

Sunlight Destroys Dangerous Chemicals.

In a joint program researchers at the Solar Energy Research Institute (SERI) laboratory and at Sandia National Laboratories in the U.S. are developing ways to destroy toxic chemicals in industrial waste or groundwater using solar collectors.

At Sandia, Craig E. Tyner is testing a process that purifies water contaminated with organic chemicals such as trichloroethylene. The water is mixed with titanium dioxide, which serves as a catalyst, and is pumped through Pyrex tubes at the focus of parabolic trough-shaped mirrors.



Solar toxic waste destruction

The ultraviolet energy in the sunlight generates reactive hydroxyl radicals and peroxide ions that convert a third of the contaminants into benign substances during a 20 second pass over a mirror 120 feet long and 7 feet wide. The titanium dioxide is easily filtered out for re-use. Passing the polluted water through the trough a few times can reduce contaminants present in parts-per- million quantities to levels of parts-per-billion, according to Tyner, who is undertaking larger-scale experiments with groups of mirrors.

Still in its early stages is a process being developed by Jim D. Fish of Sandia for converting waste organic chemicals into fuels. The process relies on the sun's heat rather than on its ultraviolet rays. A catalyst (rhodium is under study) is supported in a chamber at the focus of a dish-shaped reflector. The focusing yields temperatures between 800 and 1,000 degrees C., high enough for the catalyst to convert organic chemicals that are pumped through the chamber into such gases as carbon monoxide and hydrogen. The gases can then be made to react, producing methanol for fuel.

The process is being tested with methane as a raw material, but Fish hopes to make fuels out of chlorinated hydrocarbons, which are strongly toxic pollutants. The waste chlorine could be converted into hydrochloric acid, which is a raw material for many industrial processes.

A further technique, by John P. Thornton of SERI, is a solar furnace where light is focussed at an intensity of 300 suns on a quartz vessel containing a form of dioxin. The sunlight quickly breaks down 99.99% of the dioxin into relatively harmless compounds. According to Thornton, the ultraviolet energy in sunlight ensures that dioxin is effectively destroyed at temperatures as low as 750 degrees C, hundreds of degrees less than must be attained in an incinerator.

(Scientific American, June)

U.S. Exports Rubbish (!)

Power, Water and Waste, a British company has held initial talks with waste disposal and planning officials from Cornwall County Council about importing almost 2 million tons of domestic refuse a year from the U.S.

The garbage will be used to generate large quantities of landfill gas, sufficient to power 25 Megawatt generating station.

(ACTA Newsletter)

Recycling Popular.

Aluminium now sells as scrap at $1.20 a kilogram in the U.S. Last year California lost $200,000 worth of roadsigns and guardrails to highway robbers.

Airforce bomber parts, irrigation pipes and aluminium siding taken from adjacent homes have also been stolen as well as scaffolding from building sites. Light poles knocked down in accidents also disappear rapidly.

(ACTA Newsletter)

New Range of Inverters

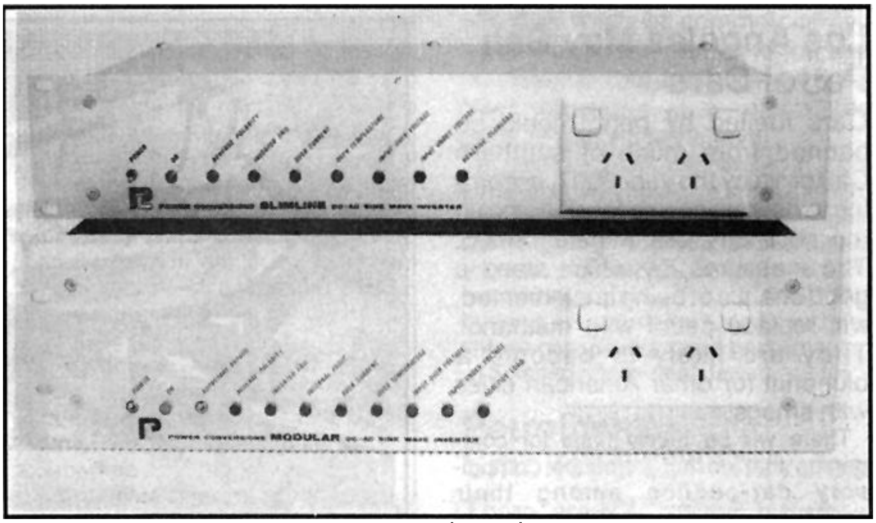
Power Conversions Pty. Ltd. have releases the latest in their range of sine wave DC-AC ultra-lightweight inverters, a true 500 watt continuous (1000 watt peak) output and a true 1200 watt continuous (2000 watt peak) output power converter (inverter).

Power Conversions now also offer a power supply and system custom design service in addition to their range of standard inverters. Using a technique patented by Power Conversions, these inverters are ultralightweight (5kg and 11 kg respectively), compact, quiet, efficient (up to 87% and 90% respectively, 72% and 78% at 10% load) and very competitively priced.

Features include: High efficiency (documentation available), crystal locked 50Hz frequency, sine wave output less than 2% distortion, output voltage regulation +/- 1% from 5% to 100% load full current limiting, full transient protection, input over and under voltage protection, over temperature cutout, +/- 0.9 power factor loads, 19 inch rack mount (3U for 1200 watt unit, 2U for 500 watt unit), foolproof operation, fully isolated to 2kV, reverse polarity protection.

All Power Conversions products have a one year warranty, guaranteed performance and are backed by a free, ongoing product/installation consultation service.

For further information contact the distributor: Ann Cooke ph. (03) 459 7963



Power Conversions inverters

Power Point Tracker for Photovoltaics

Australian Energy Research Laboratories have released a low-cost maximum-power-point tracker which offers high efficiency and reliability. It automatically maximises the electrical power output of all PV systems.

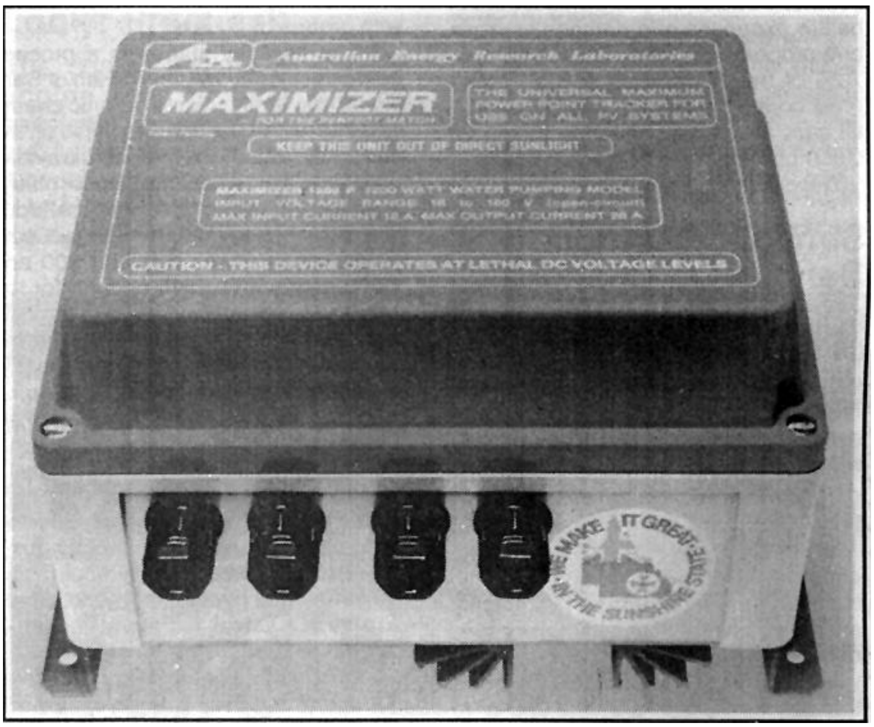
It is designed to solve the problem of extracting maximum available power from PV solar panels. To use a mechanical analogy, the power-point-tracker is like a gearbox.

The *"Maximizer",* as it is called, is manufactured in 8 models; 4 models of various power ratings (300, 600, 900 and 1200W) for water pumping applications and 4 models of similar power ratings for battery charging applications. For battery charging, the *'Maximizer'* will increase the average daily system operating efficiency by up to 15%. For water pumping, it doubles output of Positive Displacement pumps and boosts output of other types of pumping systems. Output voltage from the unit can be set at any level below 160V introducing flexibility to the system.'

For further information contact Rainbow Power Company, 70 Cullen St. Nimbin, NSW 2480; phone (066) 891 430.

Low Speed Generator for Savonius Wind Machine

Fiscar, a company in Victoria markets a Savonius wind generator



The 'Maximizer'

producing one kilowatt from a directly driven generator revolving at 130 rpm.

A complete system with inverter batteries etc. costs $15,000. Cut-in speed is 30 rpm and generator efficiency is 95%. The generator weighs 85 kilograms, uses permanent magnets and sells for about $6,000.

Fiscar can be contacted on (03) 758.2324 or 2 Oaklands Avenue, Ferntree Gully Victoria, 3156.

Computer Spreadsheets for Designing PV and Wind Energy Systems

A package of computer spreadsheets for use with LOTUS 123, release 2, is now available to speed up the design of photovoltaic (PV) and wind energy- conversion systems (WECS) for remote area power supply systems (RAPSS).

These spreadsheets have been developed by Trevor Berrill who has over 8 years experience in the design of RAPSS. The spreadsheets are practical, user friendly tools for renewable energy technologists and educators. At this stage the package includes:

Load Sizing Spreadsheet - This spreadsheet calculates the electrical load for a typical day in each month for a RAPSS. It allows the user to input appliance power rating, time of use, and inverter efficiency.

This data is then combined with climatic data such as mean monthly temperature and heating and cooling degree hours to predict the average daily load per month. The spreadsheet will allow the designer to select the most economical and energy efficient combination of electrical appliances.

PV Sizing Spreadsheet

This spreadsheet calculates the number of PV modules required for a RAPSS. It calculates the battery capacity, predicts the average state of charge of the batteries for each month and then costs the system.

This includes the cost of back-up energy from petrol or diesel generators. It allows the user to input load data, component efficiences, PV module specifications, site insolation and temperature data, battery capacity and component cost information. The effects of varying input data can be examined.

Wecs Spreadsheet - This spreadsheet calculates the size and characteristics of a suitable wind generator for a RAPSS.

The spreadsheet analyses site wind speed data and calculates battery capacity and average battery state of charge for each month.

The spreadsheet allows the user to input load data, site wind speed data, tower height, surface roughness, temperature inversion and speed-up factors, WECS characteristics and power curve data, battery capacity and component cost information. The effects of varying input data can then be examined.

Cost of the RAPSS spreadsheet package including computer disc and instruction manual is $79.00 plus postage.

For further information, contact Trevor Berrill, Ithaca College of TAFE, Fulcher Rd. Red Hill, Qld. 4059 ph. (07) 369-9011

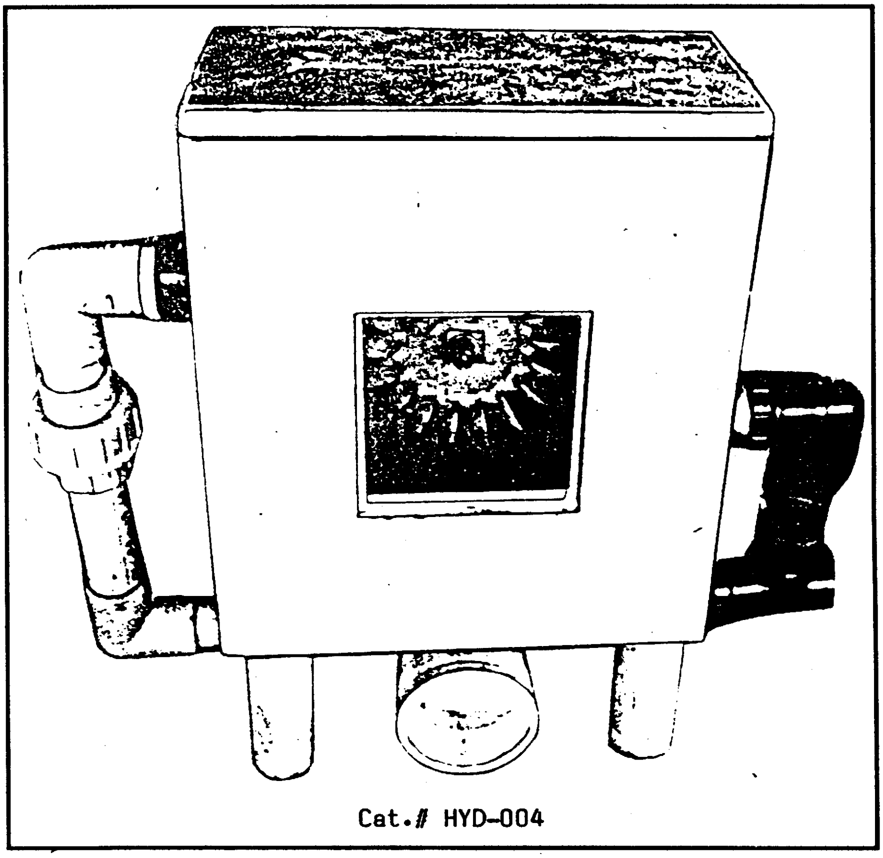
Micro-hydro-electric Generator

The Rainbow Power Company has begun marketing its electronically regulated Pelton Wheel rated for up to 300 watt output. It operates between heads of 12 and 90 metres and is suited to low-flow situations (0.3 to 2.3 litres/second).

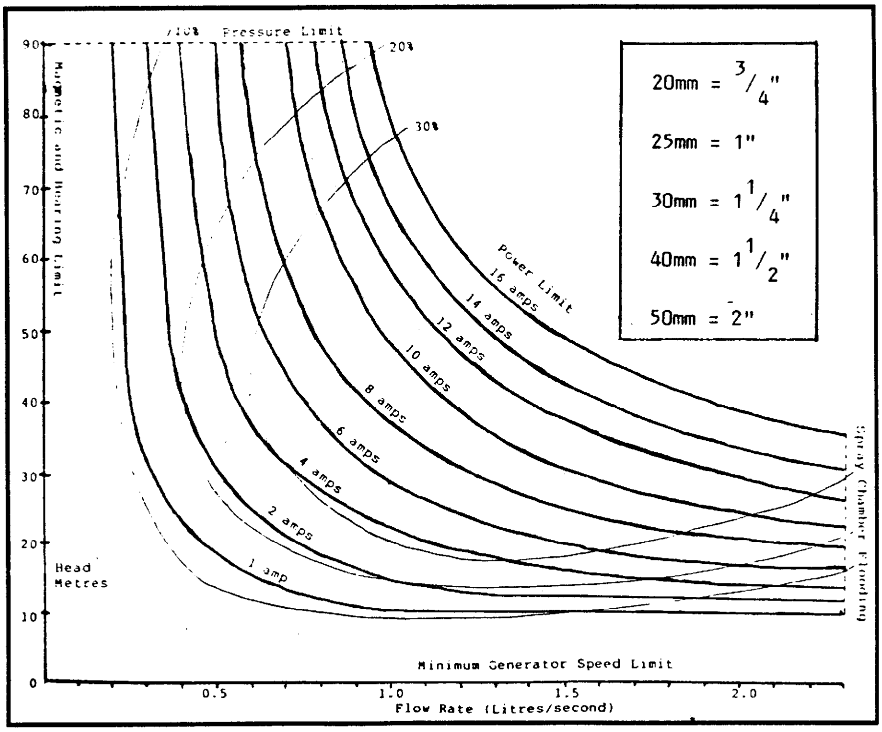
The unit will produce 1.5 amps from as little as 0.4 litres per second at 20 metres head (30 psi with a 3/16" nozzle) and up to 20 amps at 12 volts (10 amps at 24 volts) when both pressure and flow rate are sufficient.

Flow rate is controlled by a choice of nozzle sizes. These nozzles can be changed by the customer very easily. Seasonal variation of flow is catered for by the use of two nozzles. This allows three levels of water consumption and power production, adjusted by two gate valves.

The heart of the machine is a very efficient 3-phase induction generator.



Rainbow Power Co. Pelton wheel



Performance of the R.P.C. Pelton Wheel

Having no slip-rings or carbon brushes, the machine is virtually maintenance-free. A feature of the regulating system is that the machine may be manually adjusted for optimal operation at the particular turbine site.

The unit also incorporates a battery charger which converts the generator output into a form suitable for either 12 V or 24V battery banks. This design uses high efficiency MOSFET technology. The unit has an inbuilt automatic voltage regulator, reducing the charge rate as the batteries reach their full charge. Excess power is burnt off in an onboard load dump.

Power transmission over a distance is possible because the generator puts out a high voltage before being transformed to a low voltage.

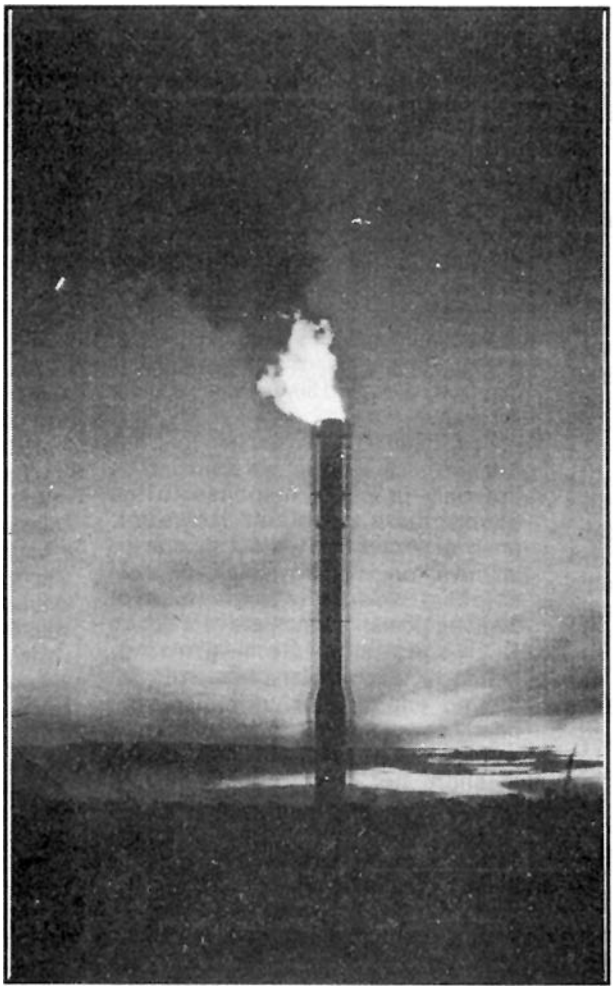
The unit is made of corrosion-resistant and mechanically strong materials throughout for robustness in rugged terrain.

For more information, contact the Rainbow Power Company, 70 Cullen St, Nimbin 2480; ph. (066) 89 1430.

NUCLEAR SOLUTION TO THE GREENHOUSE EFFECT?

By Bill Keepin.

Energy conservation is a far cheaper path by which to address the problem of greenhouse warming when compared to its main rival 'solution', nuclear power; even if we accept the most optimistic economic projections of the nuclear power industry.



A Nuclear Future

It is clear from the energy futures literature that without considerable improvement in energy efficiency, future energy growth will be substantial. In this context, we begin our analysis by selecting state-of-the-art scenarios that span a range from moderate to high energy growth (published by the National Academy of Sciences and the Department of Energy).

Next, we assume conditions that would be highly favourable to a nuclear solution to the greenhouse problem:

(1) large nuclear power plants could be built in just 6 years rather than the usual 10 or 12;

(2) Nuclear power would be relatively inexpensive (we adopt the most optimistic cost projections available from nuclear proponents and (3) all the problems associated with nuclear power would be readily solved or would simply disappear in the future.

Thus in utmost optimism, we specifically exclude any consideration of nuclear waste treatment and storage, all health and safety concerns, decommissioning of retired plants, and the possible impact on the proliferation of nuclear weapons. Finally, since coal is the most carbon-intensive fossil fuel, and given that an early carbon reduction means a greater amelioration of global warming- we assume that nuclear power would displace all coal use worldwide by the year 2025.

These hypothetical assumptions are extreme indeed, but taken together, they embrace the nuclear dream and its best hope for solving the greenhouse problem. What are the implications? It turns out that we must build a new large nuclear power plant every 1 to 3 days for the next 37 years, costing an average $500 to $800 billion per year.

Nuclear programs on such a scale are clearly unfeasible, especially in developing countries that would have to double their current debt burden just to build the required plants. But, for the sake of argument, suppose that such a program could be implemented. What would happen to future CO_2 emissions? Answer: global carbon dioxide emissions from fossil fuel combustion would continue to grow, remaining at or above today's levels for many decades hence! This is due to the expansion of oil and natural gas in these scenarios. Hence, in the absence of substantial energy efficiency improvement, even massive expansion of nuclear power on a global scale to absurd proportions would not prevent future CO_2 emissions from growing, and climactic warming would continue nevertheless.

" ... each dollar invested in improved energy efficiency displaces nearly seven times as much carbon as a dollar invested in new nuclear power."

These startling results follow from two simple factors. First, nuclear power today provides only a few percent of the world's energy supply, and so it would have to expand dramatically to increase its share substantially. Second, nuclear power is practical only for electricity generation, which is responsible for just one- third of fossil fuel consumption. Thus nuclear power's scope for reducing fossil fuel dependence is fundamentally limited.

The rational approach: Energy Efficiency.

In contrast, improvements in energy efficiency are available for the full range of fossil fuel uses. A quiet revolution has been steadily developing since the first oil crisis in 1973, substituting ingenuity for energy. The results are dramatic: a compact fluorescent light bulb consumes only 18 watts but produces as much light as a standard 75 watt incandescent bulb. Thus over its 10 year life time, a single such bulb prevents the burning of 400 pounds of coal, and eliminates the release into the atmosphere of 10 to 12 pounds of sulphur dioxide which is linked to acid rain. Auto manufacturers have developed prototype four-passenger automobiles with composite urban-highway fuel efficiencies between 73 and 124 miles per gallon (mpg). Volvo has a 71 mpg prototype that withstands impacts more severe than many production models, has better acceleration than the average new American car, and could be mass produced for about the same cost as today's subcompacts.

"...(If we are to opt for the nuclear solution), we must build a new large nuclear power plant every 1 to 3 days for the next 37 years..."

In the United States it costs no more to build an energy efficient office building than an inefficient one, and yet if these commercial building improvements were adopted now, then over the next 50 years, the construction of 85 new power plants and the equivalent of two Alaskan pipelines could be avoided. Detailed studies from mainstream research institutions show that by investing in energy efficiency, the U.S. could cut its energy consumption in half - reducing CO_2 emissions and acid rain accordingly - with annual savings of $220 billion and no compromise in lifestyle (see "Energy Efficient Buildings", ***Scientific American,*** April 1988).

Comparison of the Two Strategies

The U.S. is the single largest source of CO_2 emissions in the world. Therefore it is of particular interest to compare efficiency and nuclear investments for abatement of carbon emissions in the U.S. Given today's average costs for new nuclear power (13.5 cents per kilowatt-hour) and electric end-use efficiency (2 cents/kWh), a dollar invested in efficiency displaces *nearly seven times more* CO_2 than a dollar invested in nuclear power. Proponents of nuclear power argue that building standardised plants in a stable regulatory environment would greatly reduce the cost of nuclear electricity, while others argue that electric efficiency would also cost much less. In any case, even under the most optimistic cost projections for nuclear power, electric efficiency still displaces 2.5 to 10 times more CO_2 per dollar invested.

Many people have assumed that, like it or not, nuclear power will ultimately be the only practical response to the greenhouse problem. However, analysis shows that without substantial improvement in energy efficiency, even colossal worldwide expansion of nuclear power cannot prevent future CO_2 emissions from growing. Moreover, each dollar invested in improved energy efficiency displaces nearly seven times as much carbon as a dollar invested in new nuclear power. In short, not only would a nuclear response to the greenhouse effect not succeed, but its pursuit would likely exacerbate global warming by diverting funds and attention away from the most promising abatement strategies.

In the greenhouse debate, as with so many other crises facing modern technological culture, a narrow problem definition has created conceptual blindspots.

" ... a dollar invested in efficiency displaces *nearly seven times more* CO_2 than a dollar invested in nuclear power."

The dilemma has been portrayed as merely a question of where to get tomorrow's pollution-free energy. If we broaden this scope to ask what the energy is to be used for, and how we can best provide these same services in a pollution-free manner, a whole new solution becomes visible - one in which the greenhouse problem is greatly diminished and billions of dollars are saved.

"... in the absence of substantial energy efficiency improvement, even massive expansion of nuclear power on a global scale to absurd proportions would not prevent future CO_2 emissions from growing..."

Just five compact fluorescent light bulbs in a single household create the same rich and cozy light as their incandescent ancestors, and yet they leave two thousand pounds of coal sitting in the ground. The key to reducing future carbon dioxide emissions from the combustion of fossil fuels is to improve the energy efficiency of the global economy.

This article is based on a detailed analysis entitled "Greenhouse Warming: Comparative Analysis of Nuclear and Efficiency Abatement Strategies" published in Energy Policy, *December 1988.*

Dr. William Keepin is an environmental consultant living in Berkeley, California, and an adjunct scholar of the Rocky Mountains Institute in Snowmass, Colorado, which was founded by Elmwood Peers Amory and Hunter Lovins.

His published works on greenhouse warming include detailed reviews of global energy/carbon dioxide projections, and comparative analyses of policies to abate greenhouse warming.

Reprinted from the *Elmwood Newsletter, Vol.* 4 No. 4, 1988.

Nimbin Soft Technology
editorial introduction

This issue of Soft Technology is to a large extent given over to alternative technology developments around the Nimbin district of Northern New South Wales. I visited Nimbin earlier this year, and spoke to a number of people about what they had been doing recently, particularly in the field of renewable energy.

Context

Nimbin is a picturesque sub-tropical rural locality famous as the site of one of Australia's most famous radical events, the Aquarius Festival of 1973. The festival was fuelled by a now-fabulous optimism for the coming of post-industrial paradise.

Many of those present stayed on to form communities; they have made life more comfortable over the years by adopting low-cost and home- made technologies such as low-voltage lighting and appliance systems fed by tiny pelton wheel water turbines or photovoltaic panels (cheaper than the mains!), and owner-built housing.

These improvements are found throughout the region, lending a flavour of autonomy - and not least in a symbolic sense. In urban cosmology Nimbin stands for the hint of a future where the market has once again become subservient to myriad alternative social exchanges that involve community, rather than corporations.

The Nimbin landscape is surely more optimistic than that to which it stands in pastoral counterpoint -the 'late modern' city on which it is, in reality, economically dependent.

Alternative Technology

Around Nimbin can be found plenty of examples following the precepts of the alternative technology movement as expounded during the early 1970's by figures such as Schumacher. Such technologies are small scale, decentralised, under community control, understood by the users themselves, economically feasible and environmentally safe.

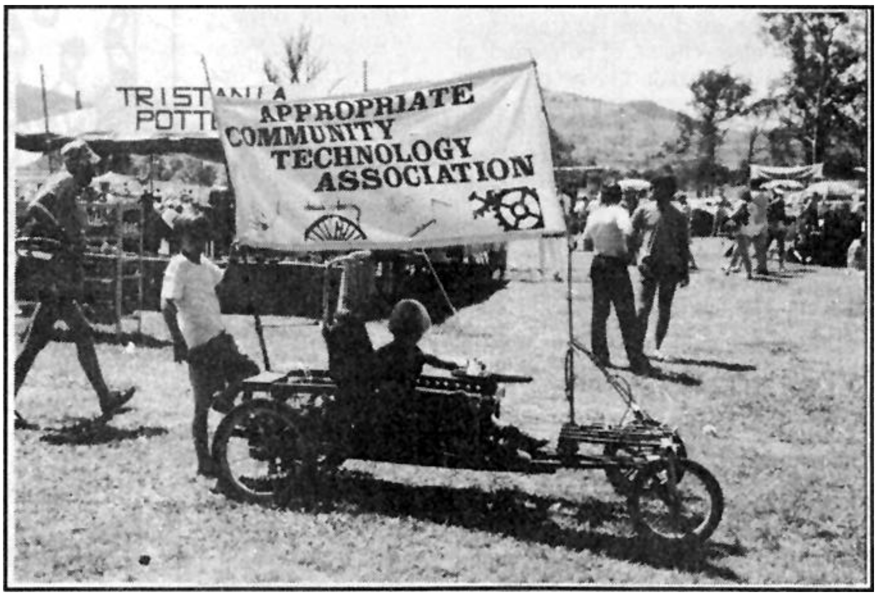
The editor

Historically, it is possible to characterise the alternative technology of the region into an earlier stage of rudimentary technology utilising the basic principles, and a later stage of more elaborate construction.

Very rudimentary technology, epitomised by the pelton wheel made of old soup spoons by Peter Pedals, was inefficient but proved an important point that needed to be made: the principles of modern technology could be applied in a rough and approximate manner by anyone willing to improvise, with a satisfactory result.

This proved beyond doubt that ordinary people can appropriate the power of modern technology from the technocrats, and so become producers of their own destiny rather than mystified consumers of whatever the technocratic State judges suitable.

That point being made, however, leaves one the option of improving on 'in principle' designs and recognising that there are in fact often enough resources around to be quite sophisticated. However this is keeping in mind where such designs are coming from and retains the hallmarks of smallness of scale and the bricolage technique, where the final nature of the design is



The ACTA flagship

to some extent dictated by the particular materials already on hand.

Remote Area Power Schemes

Nimbin is a high rainfall area, and this is reflected in the fact that when it comes to local renewable energy sources, the novel developments are mainly in the field of water power. Many people have their low-voltage lighting system driven by a small pelton wheel fed through plastic poly-pipe from a remote dam high up on a little tributary stream in this hilly area, while some others are supplied by a low-head, high-flow turbine located down in a larger stream.

These developments tend to overshadow wind turbine technology (the district is not on average very windy); and although solar panels are quite common, these are a commercial technology and as such fairly straightforward.

A.T. in the Community

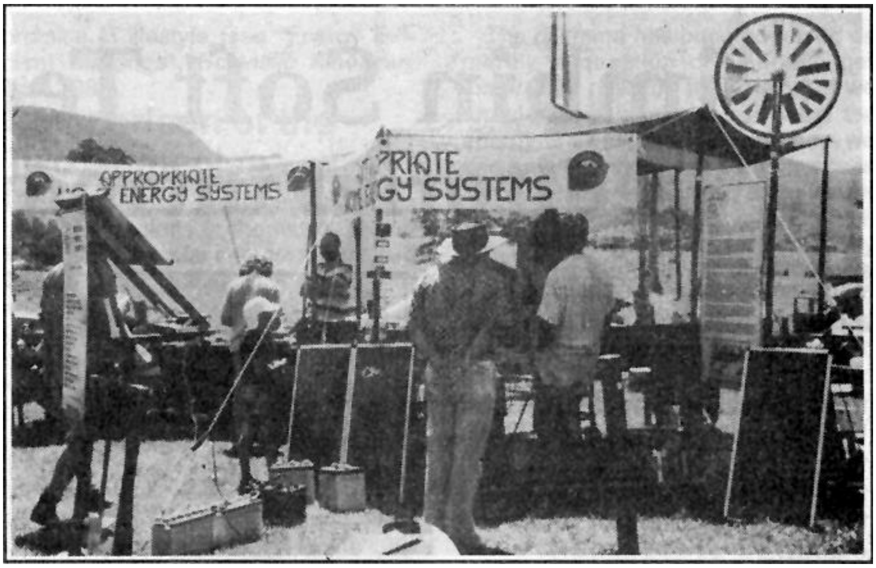
The Nimbin region people set up the Appropriate Community Technology Association to further the development and awareness of alternative technology in the region. This was set up about 1984, had ongoing monthly meetings and remained about two dozen strong until the last year or two, when interest has waned.

However, ACTA has in many ways acheived its purpose, that is to bring awareness of alternative technologies to the region, and raise awareness of the destructive effects of conventional technological thinking. Not only are there many living examples of renewable stand-alone power systems in the area, but a number of ACTA members have gone on to form the Rainbow Power Company.

Local Business Initiatives

A small business has developed in Nimbin to cater for the market in these 'remote area power' technologies, supplying mainly low-voltage domestic equipment and photovoltaic panels. This is the Rainbow Power Company, set up in mid-1987 by local enthusiasts creating and buying shares in the company.

The company aims for worker control of company decisions by encouraging all workers to become shareholders and restricting voting rights to those shareholders who are directly involved at the day-to-day level. Most shareholders live in the vicinity.



Rainbow Power outdoor market

Recently the company has begun manufacture of Pelton wheel units after a long period of local development; and their shop also sells a number of other local innovations in low-voltage electronic equipment.

Possibly the real strength of the company will be in indigenous technology, because there is a concentration of expertise in the district and the practical incentive to apply these devices to everyday situations; and at the same time the technology has good potential for diffusion to other localities in Australia and overseas.

John Hutchinson s Low-head Community Hydro

Reported by Ian Scales

Earlier this year I visited a small rural community hidden away in the bush near Nimbin which is powered by a small hydraulic turbine. Impressed by the design and standard of construction I spoke to John Hutchinson, the community member who, with friends, designed and built the turbine and its distribution system around the community.

Basic Layout

The turbine is a low-head propeller type, designed to supply about 1 kW of electrical power to the communal building and individual houses, of which there are eight at present. Power is used to charge household battery banks, and is consumed in typical low-voltage (12 volt) systems.

Hydraulic System

The creek is subject to seasonal variation, but it was decided to design a system with a flow rate of 100 litres/second from a head of about 2 metres. The water is delivered to the turbine through a pipe from a small dam about 40 metres upstream. The turbine itself is sheltered behind a large rock which offers protection from debris during floods, which occasionally submerge the entire unit.

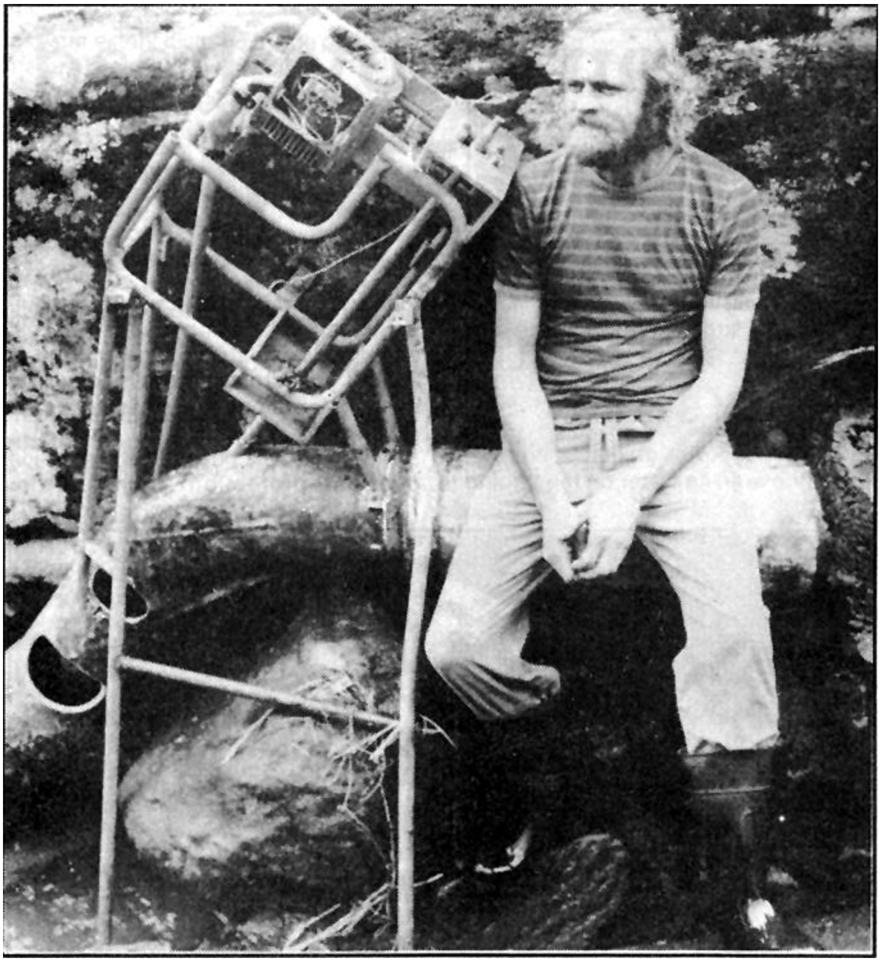
The water enters the supply pipe (penstock) via a trashrack covering the entrance, preventing debris from entering the turbine. Water then passes through a butterfly valve which regulates supply to the turbine (on or off).

The hydraulic machinery itself comes next, consisting of a set of fixed guide vanes inside the pipe that impart a swirling motion to the water; and, directly following, the propeller-shaped turbine runner. The water is then directed back to the creek through a gradually widening tube (draft tube) which terminates beneath the stream surface at the outlet.

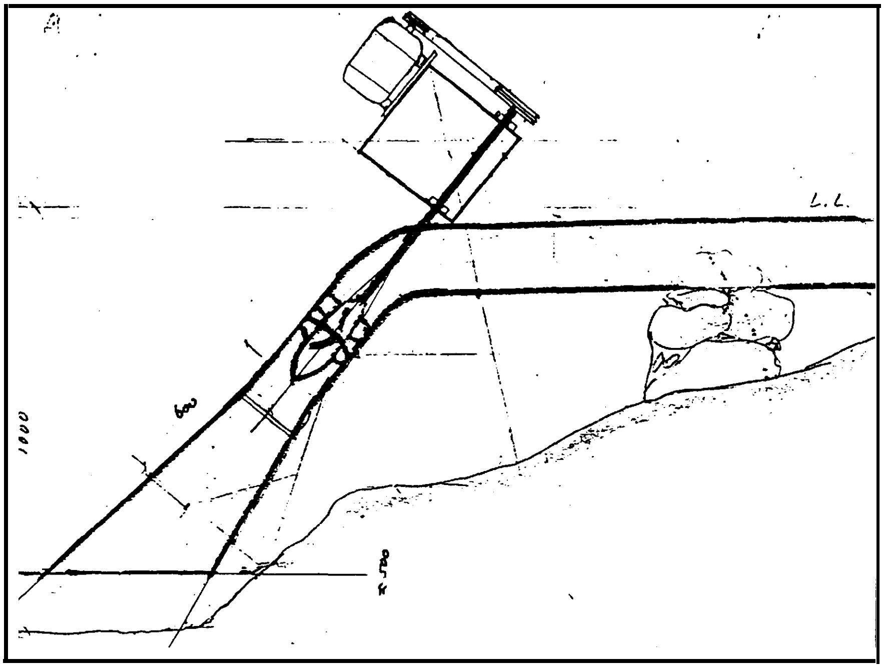
Electrical System

Mechanical power gained by the action of the swirling water on the turbine runner is transferred via a shaft and pulleys to an induction generator. This is an unmodified induction motor rated at 2.2 kW. Mechanical power is converted by the generator into 3-phase alternating current at 240 volts.

Wires take this power to a creek-side overload-protection "dump". From



John despondent after recent flood



there the power lines are laid underground. The power is fed to transformers located around the community, each of which steps the voltage down from the phase voltage of 240V to about 30 or 40V. The power is then fed to each house, where the power is fed into a switching regulator which automatically charges the household batteries.

HYDRAULIC SYSTEM

Runner Design

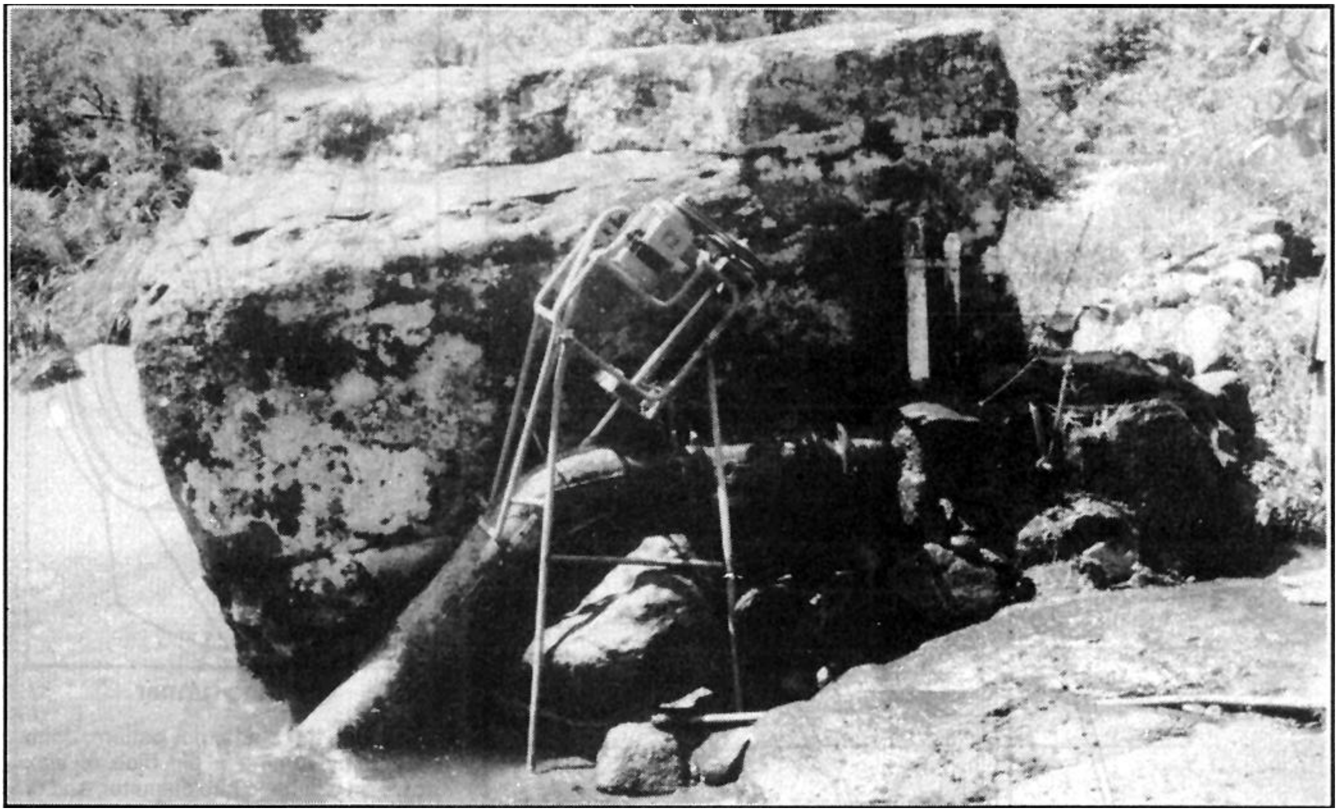
The runner and guide vanes were designed by assuming some initial parameters (head, flow, runner diameter, hub diameter, shaft speed, number of blades, inlet guide vane angles, lift and drag coefficients, and angle of attack. From these were calculated the blade angles and chord lengths of the blades at each of five radii spaced equidistantly from hub to blade tips. This was done by a local engineer friend using a simple computer program (although could equally well have been done with a small calculator).

There are two main problems with the program that was used. Firstly, there are too many variables to be initially assumed, and some such as the inlet guide vane (IGV) angles should be calculated from other variables within the computation sequence. Secondly, the program does not make full allowance for the hydraulic efficiency of the turbine, particularly the runner, which affects all the design parameters. Hence the program gave somewhat erroneous results. A different, more complete design sequence will be published next issue.

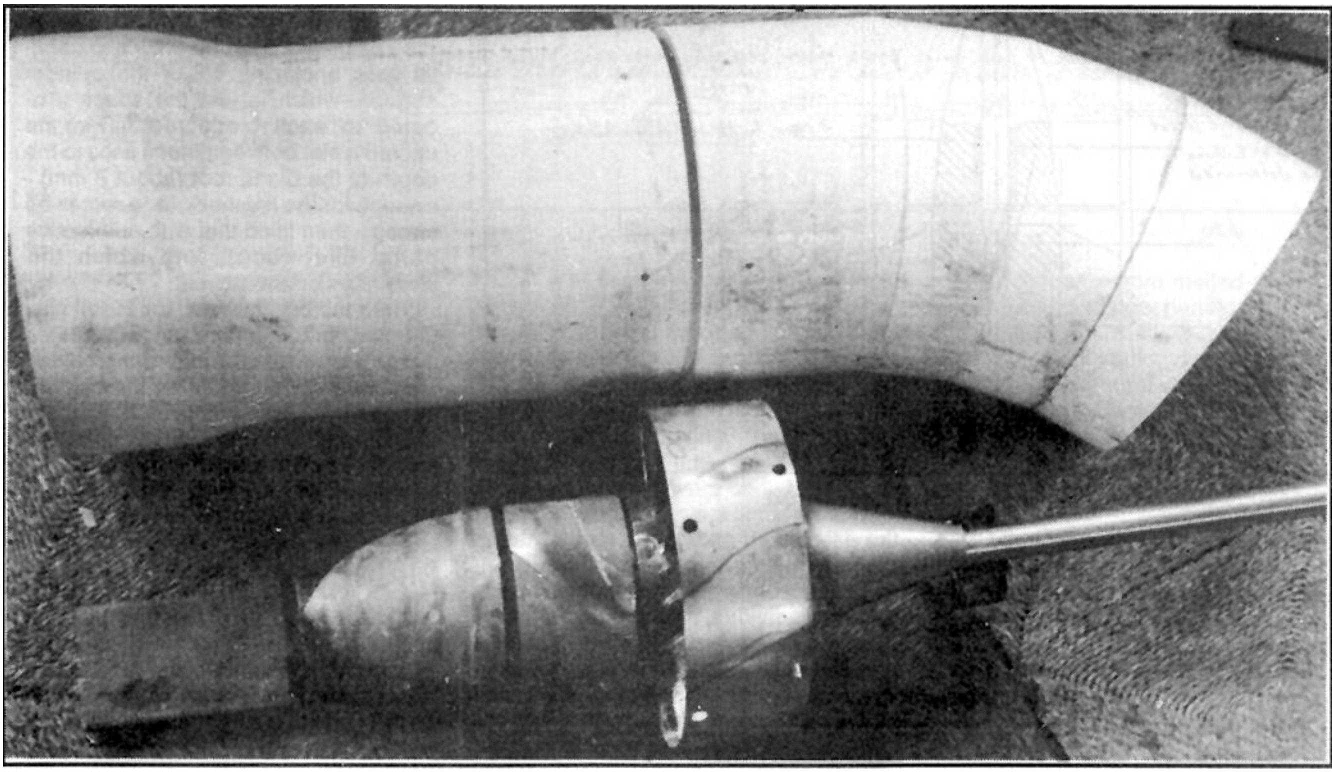
The blade angles are plotted on full-scale velocity diagrams; then these are incorporated with the chord lengths to produce cross-sectional diagrams. The diagrams so drawn become templates for the actual blade profiles at each of the five radial sections (see diagram). The blade profile was then sketched in as a smooth curve. The inlet and outlet angles are tangents to this curve. The curvature was determined by the requirement of constant deceleration. The first two thirds of the blade length is for power, and the last third is to straighten out flow. Hence the curve flattens out toward the trailing edge.

Runner Fabrication

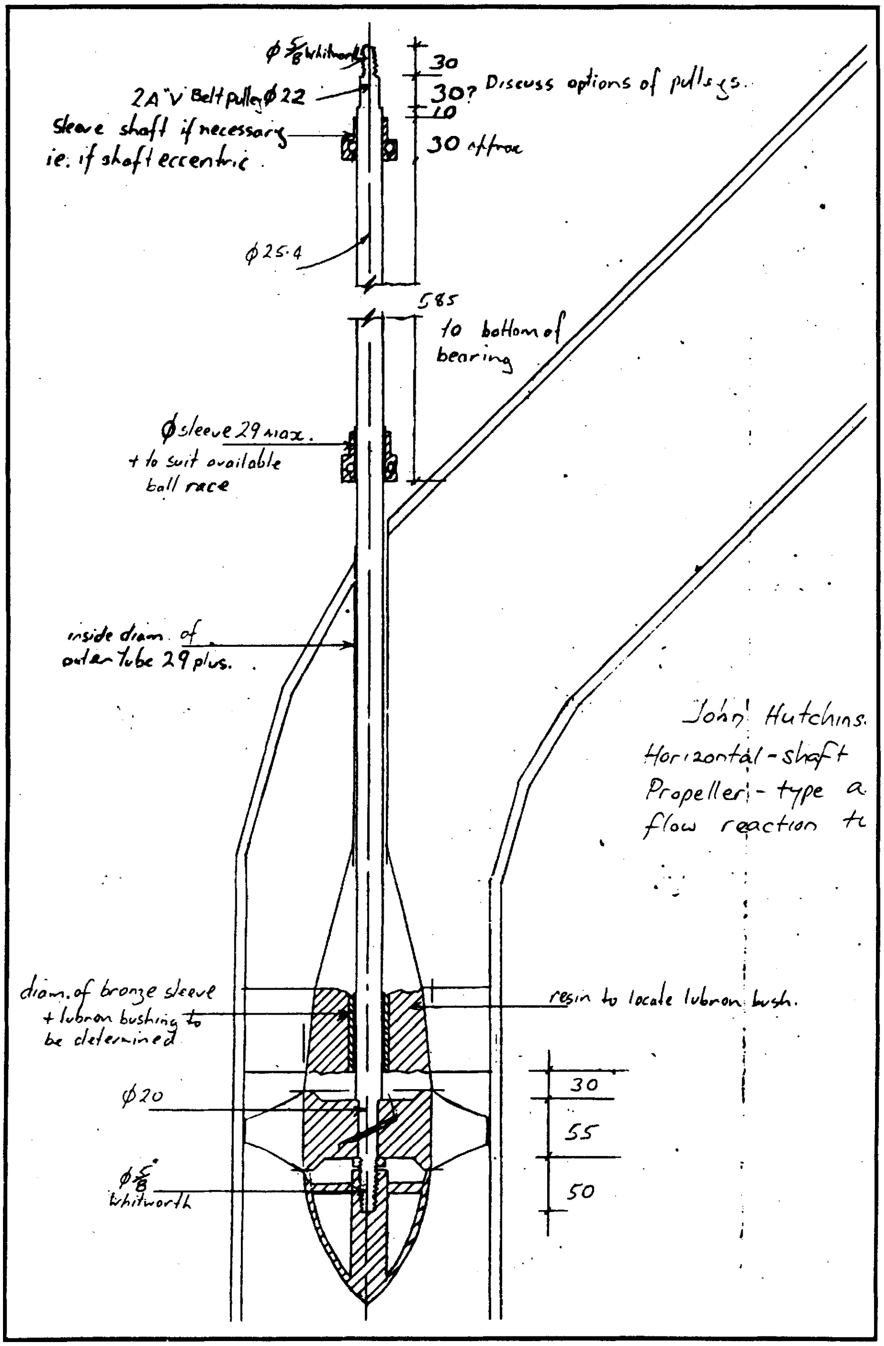
With the principle dimensions of the blades being known, John then set



Looking upstream toward turbine



Turbine mock-up during assembly

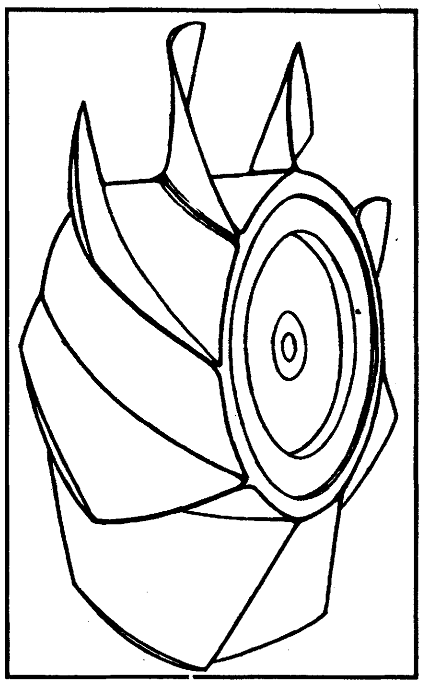


Cross-section of turbine

about making the runner itself. He decided to cast from zinc; this had already been tried successfully in more rudimentary turbines of the same type in the area.

At first, John made a complete wax model of the runner, poured a mould around it and attempted to cast the runner in one piece using the lost wax technique. This failed, which he attributes to the difficulty of getting the temperature of the mould right.

For his second attempt, John decided to cast individual blades and attach them to a separately-cast hub. A prototype blade was pattern made from 3 mm aluminium sheet. This was curved to the right shape with a rubber mallet over an anvil, and then filed to obtain the airfoil profile.



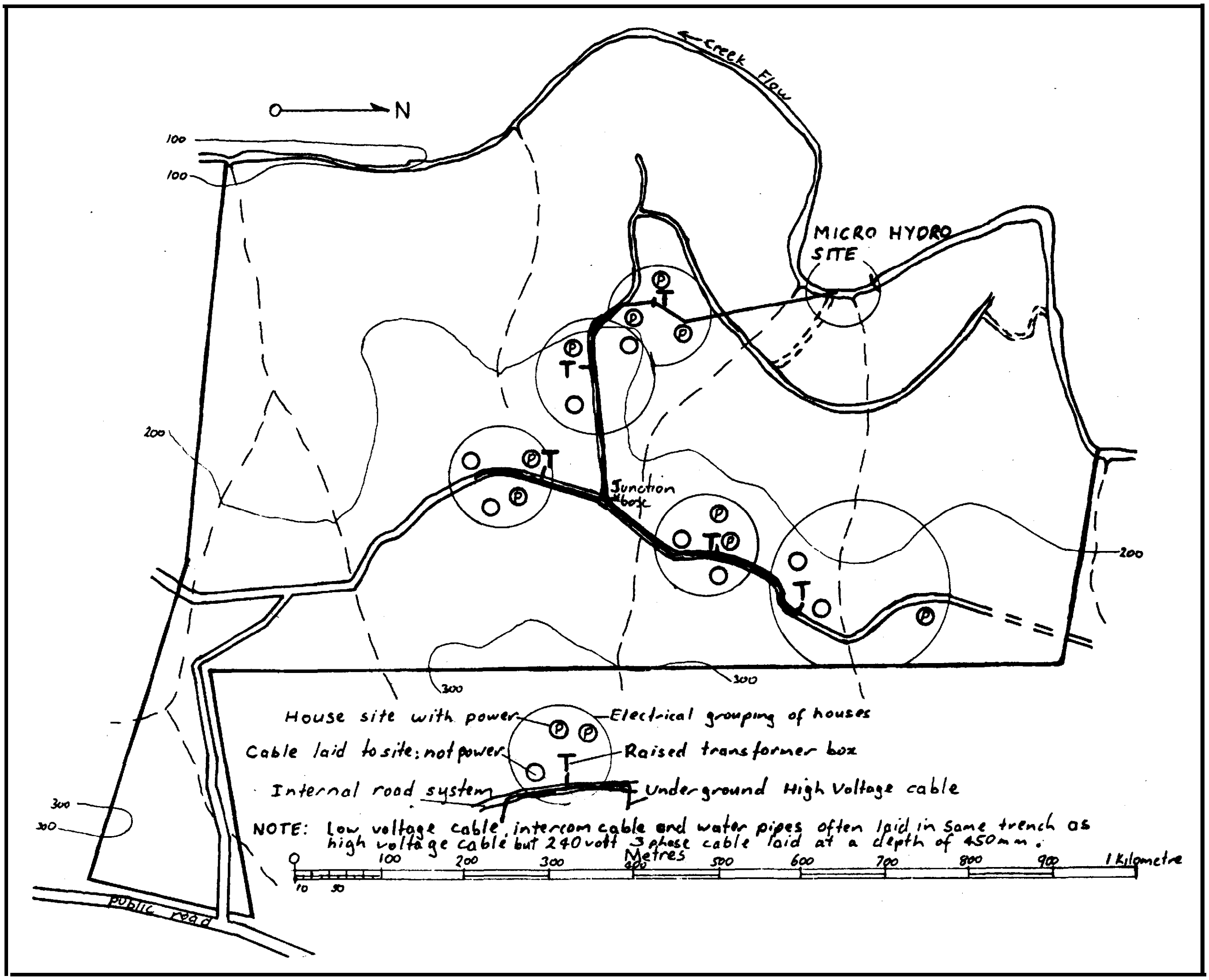
Turbine runner

To make the blade root pattern, John started by turning a big blob of wax down on a lathe to hub diameter, and of the same axial length as the hub. Then he marked out this wax cylinder for eight blades, and made a template of the blade positions as they attach to the hub (see diagram). Next he drew two parallel lines enclosing 1/8 of the cylinder surface, which is just the space allocated to each blade root. Then he carved a slot between these lines to the depth of the blade root (about 8 mm) - enough for the finished blade root to be strong - then filled that with automotive panel filler (bog), into which the aluminium blade was set.

When the bog had set, the result was the exact pattern of the runner blade as it was to be cast. The process didn't work perfectly because as the bog set it melted the wax (bog heats up as it sets). This didn't matter because the tolerances of the union of the blade segments to the runner spider (cylindrical central hub support) were low.

Metal Casting

The blade pattern was then used to cast two sets of three-piece concrete moulds. This was done in two stages: first, a set of plaster-of-paris moulds were made, these in effect being negatives of the exact concrete mould pieces needed. The aluminium - and - bog pat-



Site map

tern was used for these along with wax plugs used to fill up the spaces destined to become sprue channels, down which the molten metal is poured. Zinc is so heavy it tends to expel air easily, so only one vent was needed. The sprue channel and vent were located at the blade root end so that the thinnest section of the blade is cast first. The sprue channel extended right along the leading edge of the blade, to minimise the risk that the metal wouldn't fill the entire mould, especially where the blade was thinnest. The sprue is ground off the cast blade later.

When the concrete moulds were cast, fine sand was used in the mix nearest the plaster blade pattern. That there were no air pockets was ensured by pressing the cement in. The rest of the mould was filled in using a normal mix taking no special care, filling up the space within the wooden former that formed the outer surface of the concrete mould. The blades were then cast in these.

During blade casting, the concrete mould was wired together and sat in sand so any leaks were contained. The concrete moulds have a limited life, because there are stresses, particularly at the blade root, where the odd grain of sand pulls free of the mould. From this point the casting surface quickly disintegrates.

About twice as many blades as needed were cast, allowing the best castings to be selected later. No release agent was used, it was only necessary to have a smooth surface on the mould.

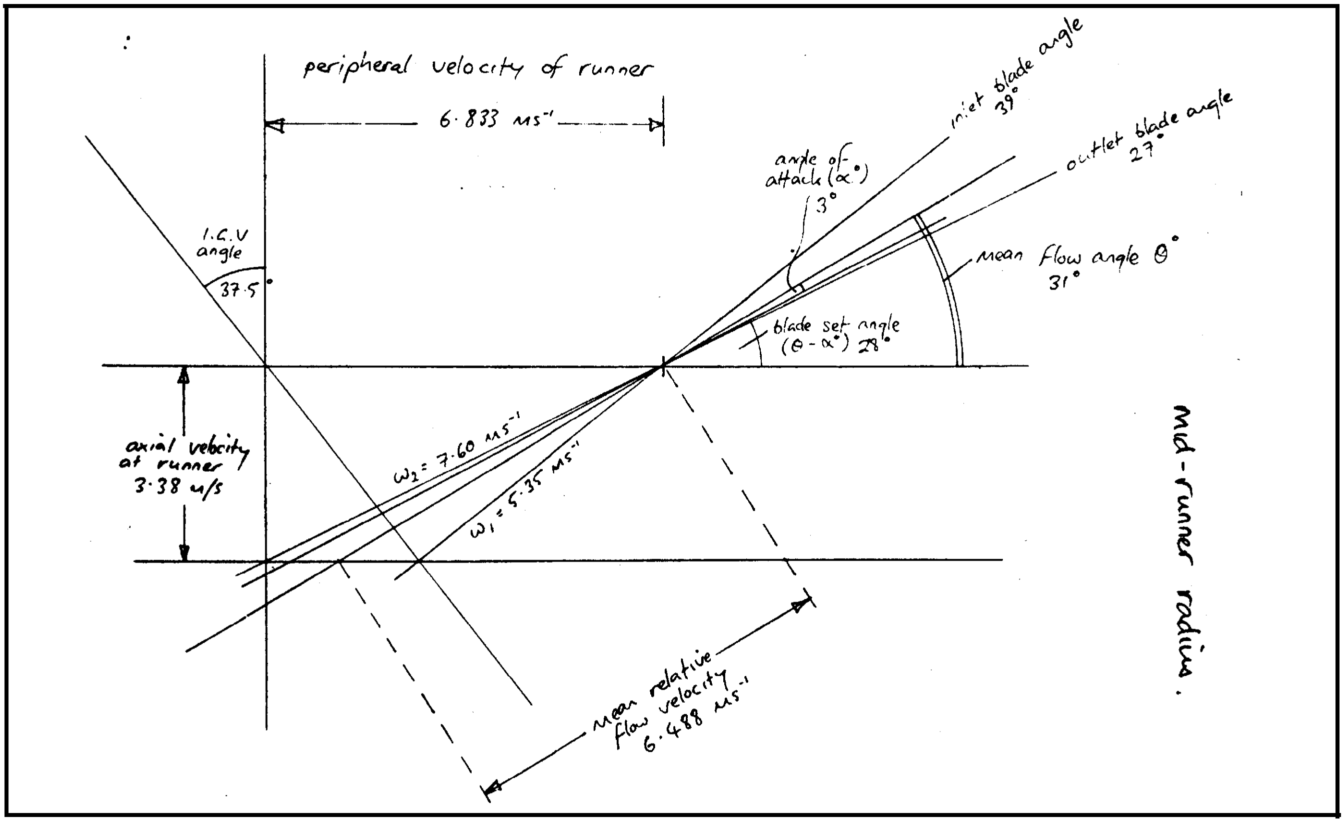
The zinc came from melted-down car decorations and door handles. Zinc has a low enough melting point to use without special equipment: the zinc was melted in a big steel soup ladle placed in among the burning wood in a fuel stove.

Tailcone and Runner Hub

A tailcone was also cast from zinc. This was cast as a shell with a wall thickness of about 6 mm, reinforced with three arms radiating from a thick central spindle; the whole tailcone being cast in one piece. The shaft was threaded to take this, and it was secured with grub screws as well.

	1	2	3	4	5	6	7	8
1	TURBINE CALCULATION - AXIAL I.G.V.s							
2	------------------------------------							
3								
4	CONSTANTS							
5	---------							
6	density	rho	kg/m3	1000				
7	gravity	g	m/s2	9.810				
8								
9								
10	------------------------------------							
11	SELECTED VARIABLES							
12	------------------							
13	Flow	Q	m3/s	0.100				
14	angular velocity	REVS	r.p.m.	750				
15								
16	Pipe diameter	ID	metres	0.228				
17	tip diameter		metres	0.228				
18	hub diameter		metres	0.120				
19	No. of blades			8				
20								
21				HUB		MID		TIP
22				----------	----------	----------	----------	----------
23	lift coefficient	cL		0.800	0.800	0.800	0.800	0.800
24	drag coefficient	cD		0.040	0.040	0.040	0.040	0.040
25	angle of attack	alpha	degrees	3.000	3.000	3.000	3.000	3.000
26	I.G.V. angle		degrees	48.000	42.500	37.500	33.500	30.500
27	------------------------------------							
28	CALCULATED VARIABLES							
29	--------------------							
30	weight density	gamma	N/m3	9810				
31	intake area	A	m2	0.041				
32	Intake velocity		m/s	2.449				
33	annular area	Aa	m2	0.030				
34	glide angle	lambda	degrees	2.862	2.862	2.862	2.862	2.862
35								
36				HUB		MID		TIP
37				----------	----------	----------	----------	----------
38	radius		metres	0.060	0.074	0.087	0.101	0.114
39	dr			0.027		0.027		0.027
40	angular velocity		rad/sec	78.540	78.540	78.540	78.540	78.540
41	runner velocity	u	m/s	4.712	5.773	6.833	7.893	8.954
42								
43		cu1, Vu1	m/s	3.762	3.104	2.599	2.242	1.996
44		cu2, Vu2	m/s	0.000	0.000	0.000	0.000	0.000
45	axial vel. at runner	cm	m/s	3.388	3.388	3.388	3.388	3.388
46	blade pitch	T	m	0.047	0.058	0.068	0.079	0.090
47	cu-average	(cu1+cu2)/2	m/s	1.881	1.552	1.300	1.121	0.998
48	Vu-diff	Vu1-Vu2	m/s	3.762	3.104	2.599	2.242	1.996
49								
50	Head	H	metres	1.807	1.827	1.811	1.804	1.821
51								
52								
53	mean flow angle	theta	degrees	50	39	31	27	23
54	sin(theta)			0.767	0.626	0.522	0.447	0.392
55	cos(lambda)			0.999	0.999	0.999	0.999	0.999
56	sin(th.-la.)			0.734	0.586	0.479	0.402	0.345
57	mean rel. flow vel.	w	m/s	4.415	5.412	6.488	7.572	8.647
58		T/t		0.450	0.654	0.917	1.216	1.530
59	solidity	t/T		2.223	1.529	1.091	0.823	0.654
60	blade chord	t	mm	105	88	75	65	59
61	blade set angle	th.-alpha	degrees	47	36	28	24	20
62	Blade plan width		mm	71	72	66	60	55
63								
64	POWER	P	KWatts	1.773				

Results of the computer calculation



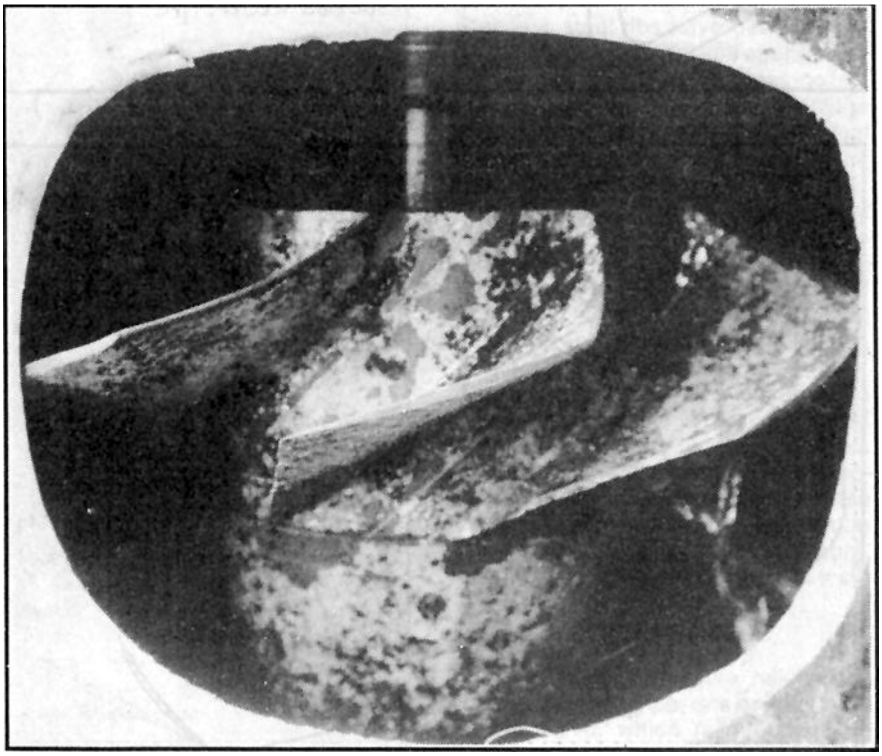
Velocity diagram for mid-radius

The hub spider was cast from aluminium, the result being very porous; this did not matter at all because the loading on it is very low in use. After casting, the spider was turned to the correct diameter. A hole through the middle for the shaft was bored out, and a keyway made for attachment to the shaft.

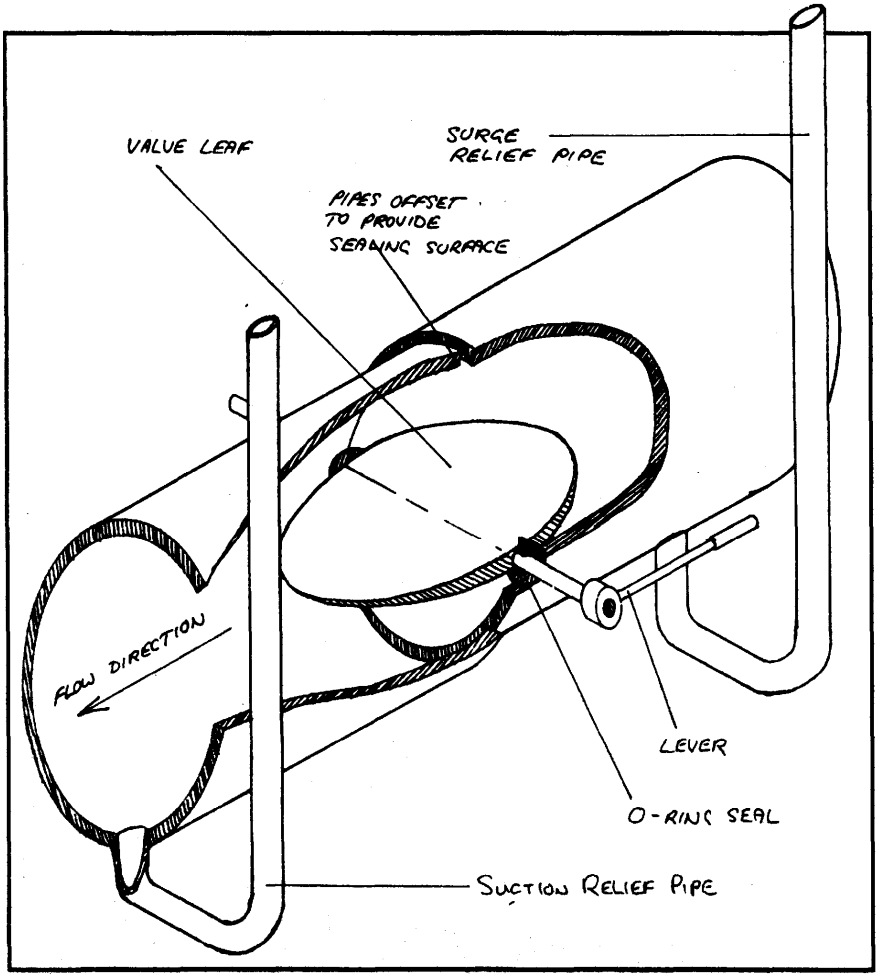
Runner Assembly

To attach the cast blade segments, six to eight holes were drilled through each blade root flange, one in each corner of the flange and one on each side of the blade in the middle, and countersunk. The blades were then set around the hub spider and corresponding holes drilled into the spider. The blades were then attached with 25mm, 8-gauge stainless steel self-tapping screws, and flashed off.

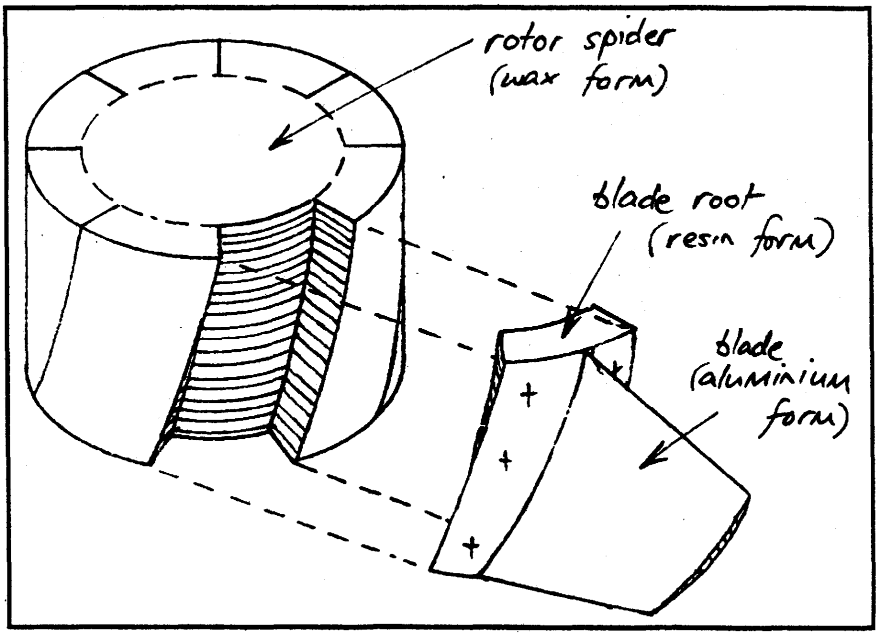
There were still spaces between the blades and the hub spider. Instead of leaving them there, John blocked off the bottom, taped up the joints between the blades and flooded the assembly with fibreglass resin. The runner was then centered in a lathe and the blade tips faced off to make the tip diameter the



The runner as calculated



Cut-away of the butterfly valve



Making the blade pattern

same as the pipe diameter, allowing for a small clearance. The rotor was then balanced on knife edges.

Guide vanes

These were made of stainless steel sheet curved into shape and welded at the roots to a flared cowling which covers the shaft, and at the outside diameter welded to a stainless steel stayring. The whole assembly - runner, guide vanes and shaft - were then ready for mounting into the water passageway.

Shaft and Bearings

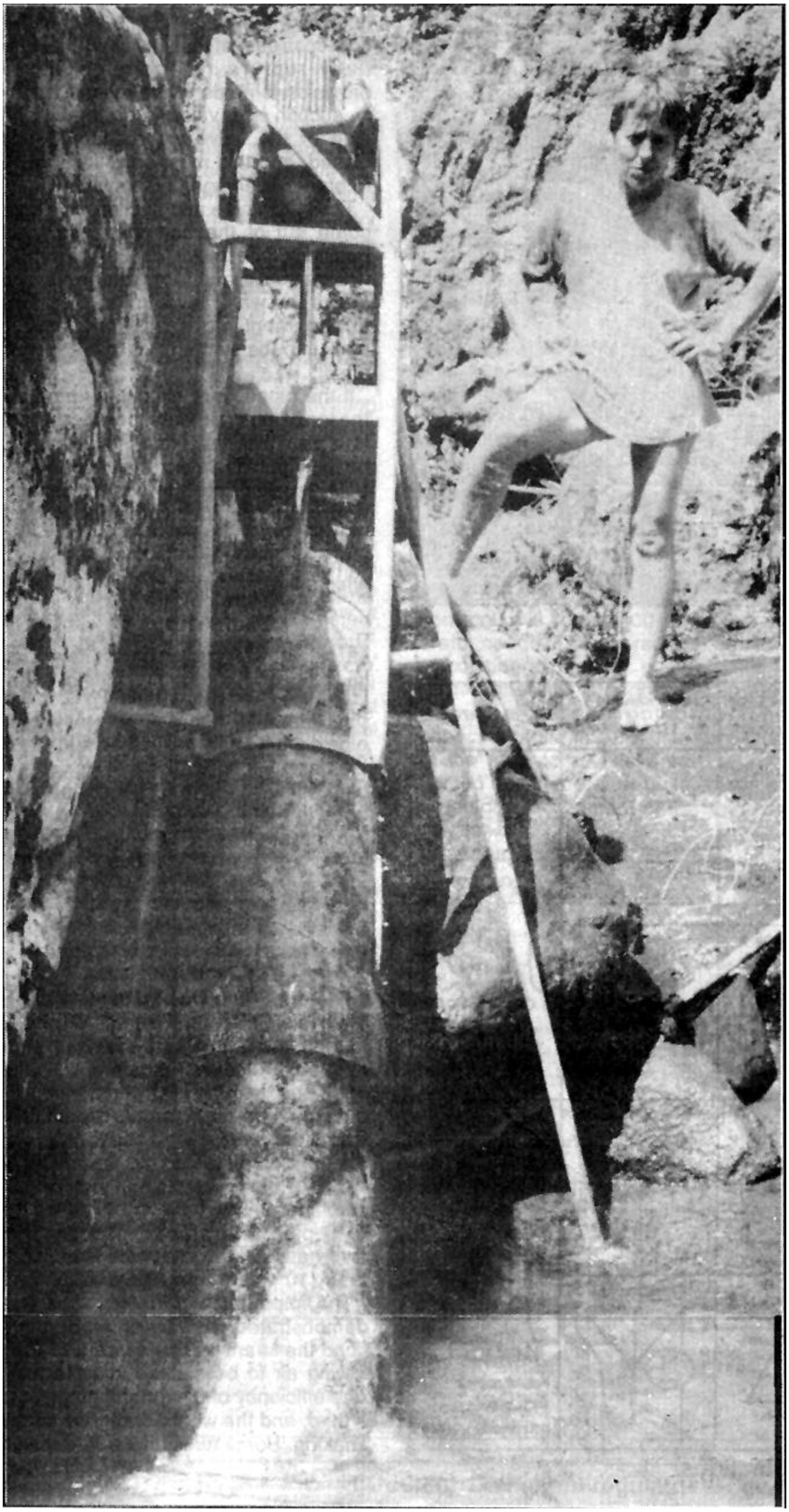
The shaft is made of 25mm stainless steel tube fitted with solid rod at the ends. Final machining of the shaft was done by an outside firm. This included screw-thread cutting at each end.

The shaft is supported by a steel framework which also carries the generator, and runs on two flange-mounted single-row self-aligning radial bearings. There is also a lubron bushing which provides a bearing surface where the shaft passes through the guide vane assembly; hence there are three bearings in total. The thrust load has not been found to present any problems. Load on the bearings is steady, there is no vibration or impact on them.

The middle bearing has a sleeve on it for easier disassembly. This is because the shaft has a seam on it and is not perfectly round so it is hard to seat the bearing directly. Additionally, slipping the bearing down the shaft over that distance when it is close-fitting is difficult, whereas the sleeve was made to fit the shaft, and has a screw going through it and through the shaft to hold it in place.

The middle bearing locates the assembly, and the top bearing is held in place with hardened grub screws. That bites onto the solid stainless steel ends in the shaft. When assembling the turbine, John fixes the middle bearing in place on the shaft and then tightens the grub screws on the top bearing - maybe lifting the shaft a little bit to try and share the weight on both bearings.

The shaft must also be free to turn where it passes through the guide vane assembly. As this bearing surface is exposed to water, a lubron bushing, bought at a bearing shop, was used. Referring to the cross-sectional diagram, it is seen that only one side of the lubron bearing is in the water



stream. To encourage the passage of water across the bearing as a lubricant, the other side of the bearing is at atmospheric pressure.

Hence the bulk of the shaft where it disappears into the penstock is actually enveloped by a tube that joins the penstock wall at one of its ends, flares out at the other end to present the water with a shockless approach to the guide vanes, and joins onto the guide vane hub. The tube is thus open to the atmosphere.

At the generator end of the shaft are two pulley wheels mounted in tandem, about 8" diameter which run a dual V-belt to 3.5" diameter pulley wheels mounted on the generator shaft, to give a ratio of about 1:2 speed increase.

Butterfly Valve

A butterfly rather than a gate valve was built because a gate valve is too hard to seal. The butterfly valve leaf (see diagram) is made of 0.5 mm stainless steel sheet in two layers, one around each side of the 5/8" stainless-steel shaft. It has brass spacers inside it which packs it out to almost 25 mm in the middle, and the two halves that make the leaf wrap around that so it has got some shape, which gives it strength. Stainless steel ribs have been welded on the inside for additional strength.

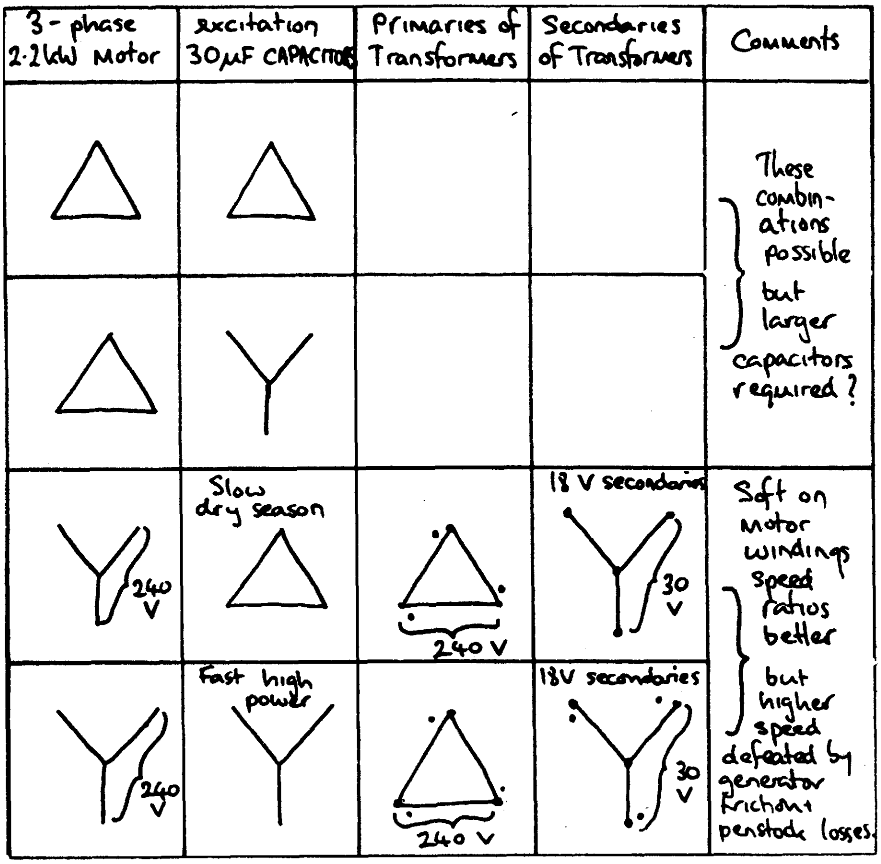
The shaft runs through brass collars brazed to the leaf, and is attached to the collars with grub screws. O-rings seal the valve where the shaft penetrates the pipe wall on each side so it doesn't leak. The valve can be removed if necessary via a hatch.

The valve leaf butts up against pipe ends for sealing when in the closed position. This is achieved by locating the valve at the junction of two lengths of pipe that comprise the water pipe. These are joined with a slight offset so that when the valve is closed, the leaf butts up against the pipe end-surfaces exposed by the slight offset for an effective seal. Silicon was applied to these surfaces (while the valve was in the closed position) to make the seal complete. The whole assembly works well;

Water Hammer

There are two pressure relief pipes made of 2" PVC pipe, one on each side of the valve, which relieve transient pressure when the valve is opened or closed. On the downstream side is a suction pipe and upstream of the valve

The trashrack



Wiring combinations

is a surge pipe. When the butterfly valve is closed, the dynamic pressure of the flow upstream of the valve could potentially rupture the penstock if no provision is made for its relief. Similarly, suction is developed on the turbine side of the valve when the valve is closed, and this must be relieved also to prevent damage to the system.

The surge pipe and suction pipe both come out of the bottom of the main penstock and make a 180° U-turn to rise vertically and terminate in free air above the water level in the weir. This arrangement stops air from sucking back into the system due to the venturi effect.

If the pipes were simply to come out the top of the main water passage, there is a risk that the water level can be pulled right down so that there is air being sucked into the water passage; whereas if the pipes come out from the bottom, the water has to be pulled right down to below the whole main pipe - which will not happen.

Water Passage

The penstock is a rigid PVC mains pipe with a 10 mm wall. At present the pipe diameter is smaller than that which the design specification calls for, so turbine efficiency is in fact impaired. The bend in the pipe at the runner exit was fabricated from PVC pipe sections glued together with silicone and then encased in fibreglass mat to hold it all together.

Draft Tube

The draft tube was made of a single 1 mm stainless steel sheet. This was formed into a tube, and the seam pop-rivetted and silver-soldered. At the open end the tube is strengthened with a hoop made of two semicircular stainless steel brackets. At the runner end the draft tube fits into the flared end of the PVC piping encasing the hydraulic machinery. The tube is bolted to the PVC pipe at this point. The angle of divergence in the draft tube is about 5° to 9° (10° - 18° from wall to wall).

The importance of a draft tube was demonstrated recently when during a flood the seam was ruptured a little, allowing air to be sucked into the tube. The efficiency of the turbine dropped to a third, and the whole draft tube began shaking. Some air is tolerated depending on the situation, but always a loss of efficiency is experienced.

Turbine Installation

The turbine is supported on a galvanised 3/4" water-pipe structure. All the joints were brazed to prevent the rusting associated with welding, and the whole frame was painted with a heavy 'galvanising' paint. The framework is anchored onto the rock base with dynabolts. These were ordinary steel dynabolts and have begun to rust - stainless steel types will be used as replacements. The framework has also begun rusting where it sits in the tailwater. This goes to show that anything permanently wet should be made of stainless steel.

Part-flow Efficiency

Power is only developed if the penstock is filled. If there is any air in the pipe no power will be developed. Since the turbine can't be run at part-flow, it would be best to have a way of automatically operating the butterfly valve to shut off the flow once the water level in the weir falls below a critical level, and then when the water level builds up as the storage is replenished, to open the valve again. This may be best achieved mechanically, using hydraulic pressure to drive the valve mechanism.

Flooding

If the turbine floods the generator windings need to be dried out. This is done by taking off the ends and removing the runner. The bearings must also be cleaned out. The turbine is prevented from running during floods, and the butterfly valve is shut off.

ELECTRICAL SYSTEM

Generator

The generator is an unmodified three-phase 2.2 kW star-wound induction motor run above synchronous speed. The generator is 4-pole so its rated synchronous speed at 50 Hz is 1500 rpm. In this case, it is run at about 40 Hz, (this is approximate - speed depends on the water level in the creek) so its synchronous speed is correspondingly lower, and generator action occurs at about 1400 rpm. The generator needs to be oversize for efficiency considerations.

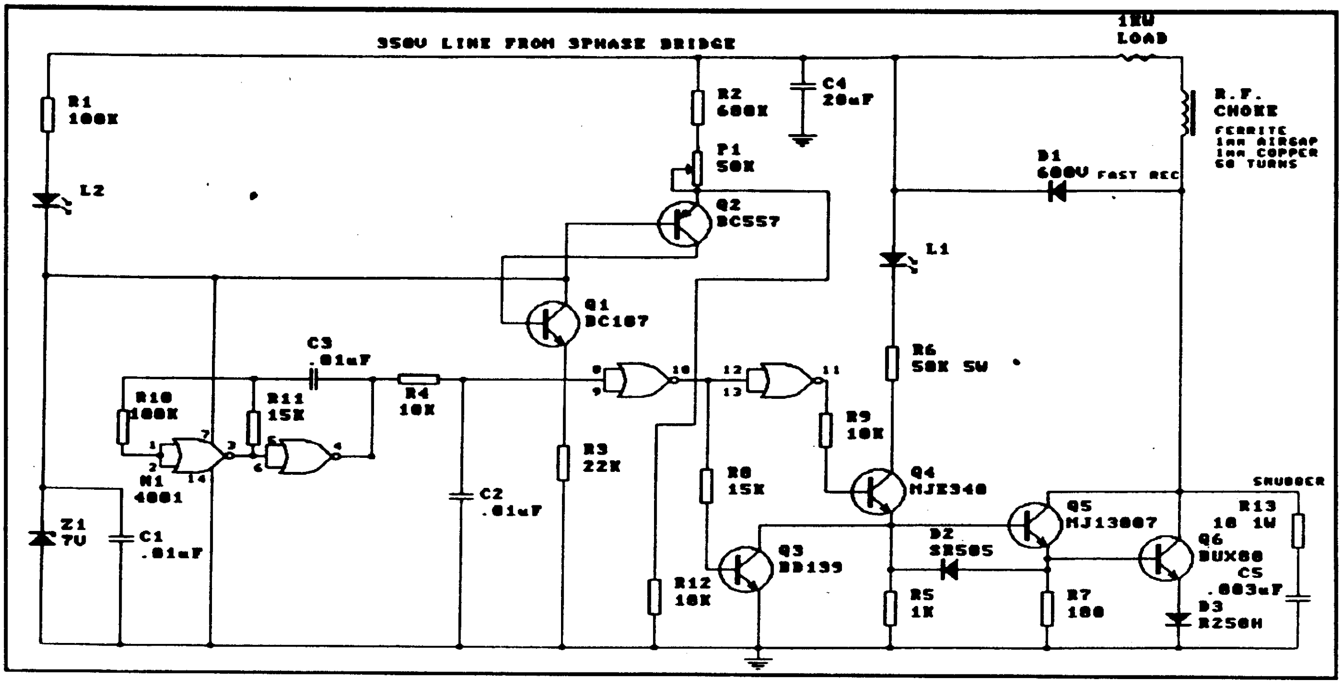
The generator is connected to three 30 microfarad polypropylene capacitors, one in parallel across each of the field coils. These can be connected in either star or delta, which allows some adjustment of the electrical system to seasonal flow variation. For slow running during the dry season, the capacitors are wired in delta; and for fast, high power operation they are wired in star.

John's practical experience has unfortunately been that use of the high-speed option is limited because faster flow through the penstock leads to greater friction losses in the pipe. This results in a situation where the higher flow lowers the head as seen by the turbine. A larger pipe cross-sectional area is planned for this reason.

The capacitors are mounted on the creek bank above flood level along with a three-phase bridge rectifier, made of six IN4007 diodes and a very big polypropylene capacitor for filtering, feeding a shunt regulator.

The 1kW shunt regulator is an overload protection device. It measures the DC voltage from the rectifier. If the voltage exceeds a set level, a power transistor is turned on, which dumps excess power into a 240V heating element at the bottom of a 40 gallon water tank. All these creek-side electrics are housed in a weatherproof box.

A circuit diagram of the shunt regulator is reproduced, but treat this with caution for the following reasons. This was the prototype circuit, and was not totally reliable. The BUX80 power transistor was operating at its specified limit, and



Circuit of 1kW shunt regulator for generator was prone to melt. For this reason, later versions use power FETs. The consequence of this is that all the drive circuitry must be altered. The circuit layout is also important - heavy current flows and high frequencies in some parts of the circuit must not be picked up by the sensitive CMOS circuitry.

Distribution System

The community is fed by a three-phase, three-wire star-connected system with six step-down transformer boxes connected in parallel. The transmission cables are laid underground in poly-pipe at a depth of 300 to 600 mm. The cables are buried beneath roadways for easy location. Because the system is three-wire, there is no earth conductor and so voltage can float above ground potential. The argument is that this system is potentially safer because current is limited if there is a short to ground.

A lot of transformers were used, because each transformer box requires three transformers, one for each phase. The transformers are ordinary off-the-shelf 6A, 18V types, or 12-22V multi-tap types. The latter were used to allow a more even distribution of power. More windings on the secondary are used where the consumer is a long way from the transformer box, so compensating for voltage drop in the line. The power is then rectified and filtered before being passed onto consumers at 30 to 40 volts DC; the farthest consumers being given higher voltage.

The transformers are housed in weatherproof boxes made of ferrocement (chickenwire and concrete), with a peaked roof that lifts off like a cap for servicing. The boxes are raised up about 1.5 metres on a pole. All wiring is concealed.

Switching Regulators

A switching regulator at each house converts the 30V DC to 12V for battery charging, which it regulates automatically. They use a cheap low-voltage FET. The performance and efficiency are both good. There is no instability in the current or voltage feedback loop, but the unit produces some RFI when the mark-space ratio is reduced.

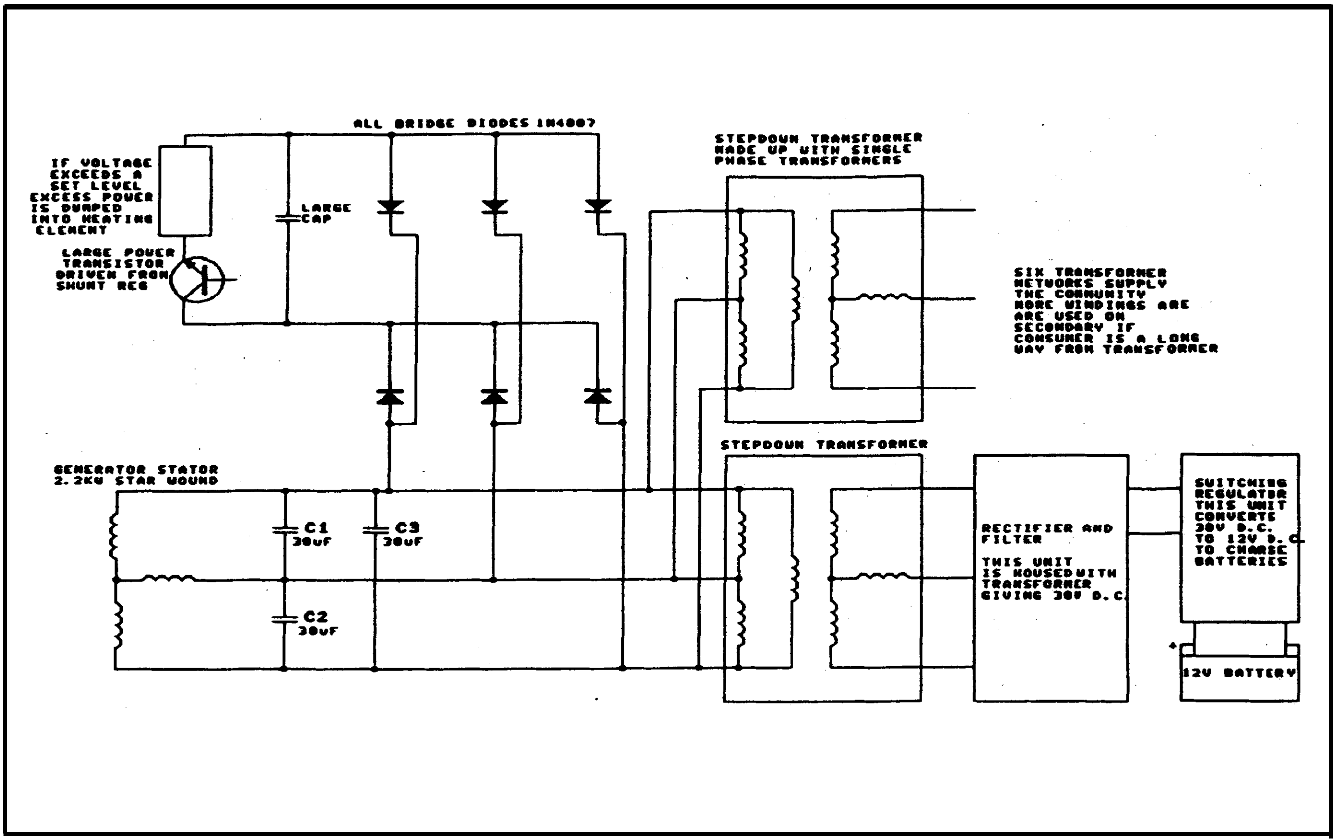
Note that there is a Mock diagram of just such a switching regulator in the Community Power Loops article elsewhere in this issue.

Auxiliary Power

During the dry season, the turbine cannot be relied on to fully cater to the community's power needs. Individual consumers can install solar panels to provide electricity during this sunniest time of the year.

Economics

The system was built between 1985 and 1987, and at that time the manufacturing cost for parts etc. came to about $2000 for the hydro assembly, and about $5400 for the power reticulation. The project took an estimated 150 hours of voluntary labour for manufacture of the hydro system, a further 200 hours to install the reticulation system including the DC-DC converters (switching regulators), and another 150 hours work 'down at the creek'.



Schematic of distribution system

Community Power Loops for Electricity Distribution

by Karl McLaughlin

Extra-low voltage electrical distribution can be set up at the community scale, and offers both a degree of autonomy and cost benefits to users.

Community power loops are a low-voltage alternative to Electricity Authority mains networks for powering small communities. They can be built and operated safely by the community members themselves.

This is the transcript of an interview conducted with Karl, who is familiar with a number of distribution set-ups around the Nimbin district.

Introduction

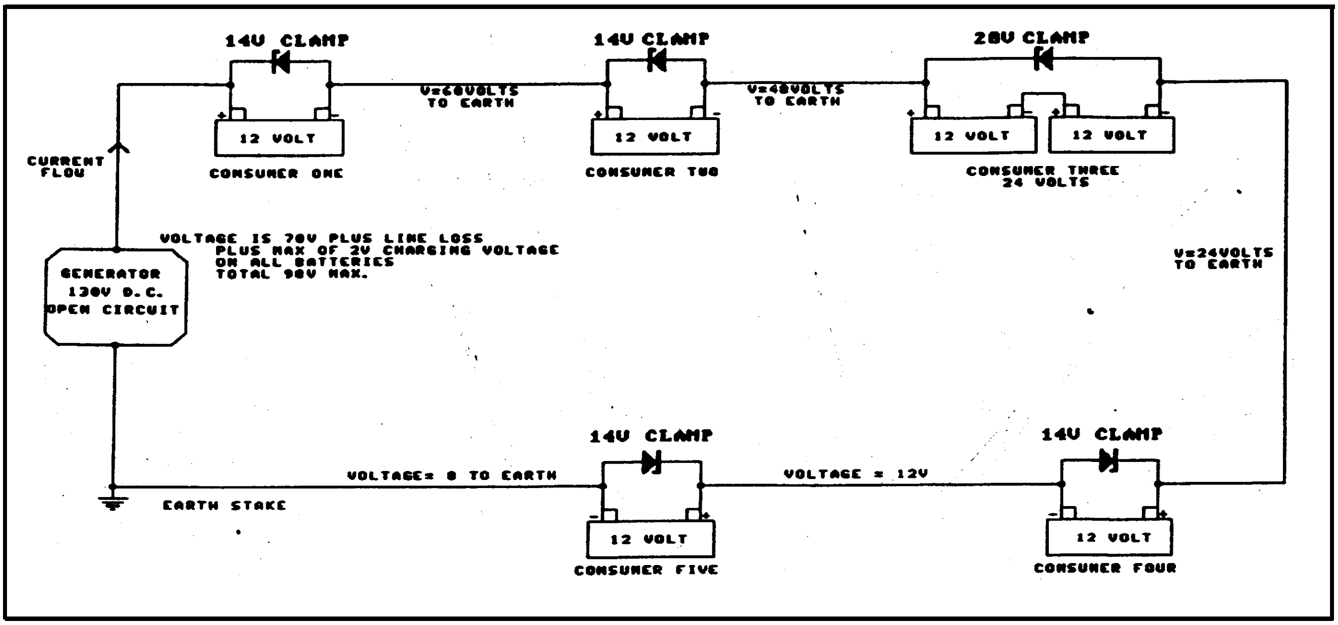
The basic reason for choosing low-voltage distribution around a community is that it is that it is incredibly cost-effective. One big prime-mover is cheaper and inherently more efficient. For example, one 3hp diesel genset is much more cost effective both to run and to buy than 5 little petrol ones. As well as that the noise isn't the same problem.

Community distribution is also absolutely necessary where the power for the area might for example be a low-head turbine, which can only be put in one place, so there is no question whatever that the power has to be distributed around a neighbourhood.

You've always got the trade off between the inherent efficiency of a centralised system versus the inherent chaos of having to communicate between neighbours, and co-operate in a project. I see the whole of life in these terms!

The other main area where community power distribution is useful is where the cost of connection of 240V reticulation is very high (as it usually is!), or where there is some covenant that is a problem; for example we had incredible difficulty making the Northern Rivers Electric put the power underground. They will not believe our community resolution, which is that power lines must go underground. And that is sufficient reason for the power to be routed at low voltage. Also putting 240V underground is often prohibitively expensive.

So for environmental and economic reasons it is often out of the question to provide 240V to each house. The cost to one community here was $70,000 to do a 240V reticulation to the door of about 10 houses. Also the standards of the 240V supply tend to be ridiculously high in terms of voltage maintenance; they make you buy a transformer for each house. They expect you to be able to use the full 10kW per household all



Series DC Distribution System

the time, and all at the same time, with only 10 volts drop. So their sizing of wires, particularly for underground, can be astronomical. More than 50mm^2 of copper was being demanded for one consumer.

If you take the soft option of having a very low energy source, say 4mm^2 wire coming at 100V in a community system, you have a switching regulator, a battery bank and an inverter, and you can often end up with an equivalent voltage maintenance with something like 10% of the cost.

Alternating or Direct Current?

I guess the basic underlying idea to represent is the compromise between legality and electric shock, and energy loss in low-voltage transmission. The real difference is that AC electrocutes you a lot better than DC, at least in low voltage. 100V AC is very painful because it jangles your nerves up, and its also much worse for causing heart attack, because the 50 cycle/second power sets the heart into fibrillation. With 100V DC you get one heavy thump on contact, then the effect fades as your skin polarises, and nerves become desensitised. Of course if you jab a live wire into your flesh, your skin resistance becomes irrelevant!

In terms of legal considerations, you can't go above 32 volts AC without getting out of extra-low voltage regulations. You can't go over 110 volts DC.

Losses must also be considered. A defect of AC is the pulsating nature of the power flow. You get back to mains hum in Hi-fi systems and ripple in battery charge currents. Using 3-phase AC is much kinder on generators and battery chargers. It would seem easier at the receiving end to use AC, as ordinary transformers can be used rather than high frequency DC-DC converters. In practice though, 32V AC systems I know of rectify the AC to DC, then use DC-DC converters anyway! The reasons for this are:

1. 32V transformers are hard to get, and don't work if frequency is under 50 Hz (my generator runs at 30 Hz).
2. Voltage regulation requires phase shift control and tends to instability and noise.
3. Small transformers for 50Hz are inefficient.

As for line losses, AC and DC are equally good for travelling through wire. Your line losses are the same. That is a point many people are confused about. You're limited to 32V with AC therefore you've got lots of copper loss. You need very thick wire. DC up around 100V travels quite well. So within the law the best way of transmitting energy per copper is at 100V DC.

The trouble with this is twofold really. 100 volts DC is pretty useless to use and even at 100V DC you can't use much peak load without running out of juice - you could run a system like that, but its a lot of batteries to pile up.

D.C. Parallel Distribution

If you're going to use less batteries, say a 24 or 32 volt system, you've got to have a way of reducing the voltage back down to charge them. Because its DC you can't just use a transformer, so you have to use a switching regulator. By switching regulator I mean a high frequency DC-DC-down converter which is able to change its ratio of conversion according to what the battery needs.

In a sense this is convenient, because if you're going to have a switching regulator you can make it do a lot of other functions as well. You can make it automatically float the voltage of the battery at the correct level to maintain that energy store, you can make it automatically limit current so if you've got several consumers using the line, and you can to some extent share out the power between them, so they can't hog it.

It can also give isolation from ground, which is a problem for DC systems. You can get a lot of line drop in the negative line, so the earth at one place is different to earth at another. You can get up to 25 V difference between the negative of the system and ground. That has been a problem in a lot of systems because if you use electric motors, say rewound car generators that have got one brush riveted onto the chassis, then you end up with the chassis of the machine connected to negative. It makes it all rather tingly if you're totally covered in water and leeches.

The switching regulator can give DC isolation as well as voltage regulation. There is an optical feedback from the battery side to the brains side. So using one of these black boxes, a switching regulator, isolates between the distribution line which is owned by the community, and the individual person's battery electrics. That's one way of distributing power, which is called the parallel system.

D.C. Series Distribution

Another way to do it is to connect all the consumers in series, to have all their battery systems simply arranged from head to tail, adding up to roughly 100 volts, which would require about eight consumers of 12V each.

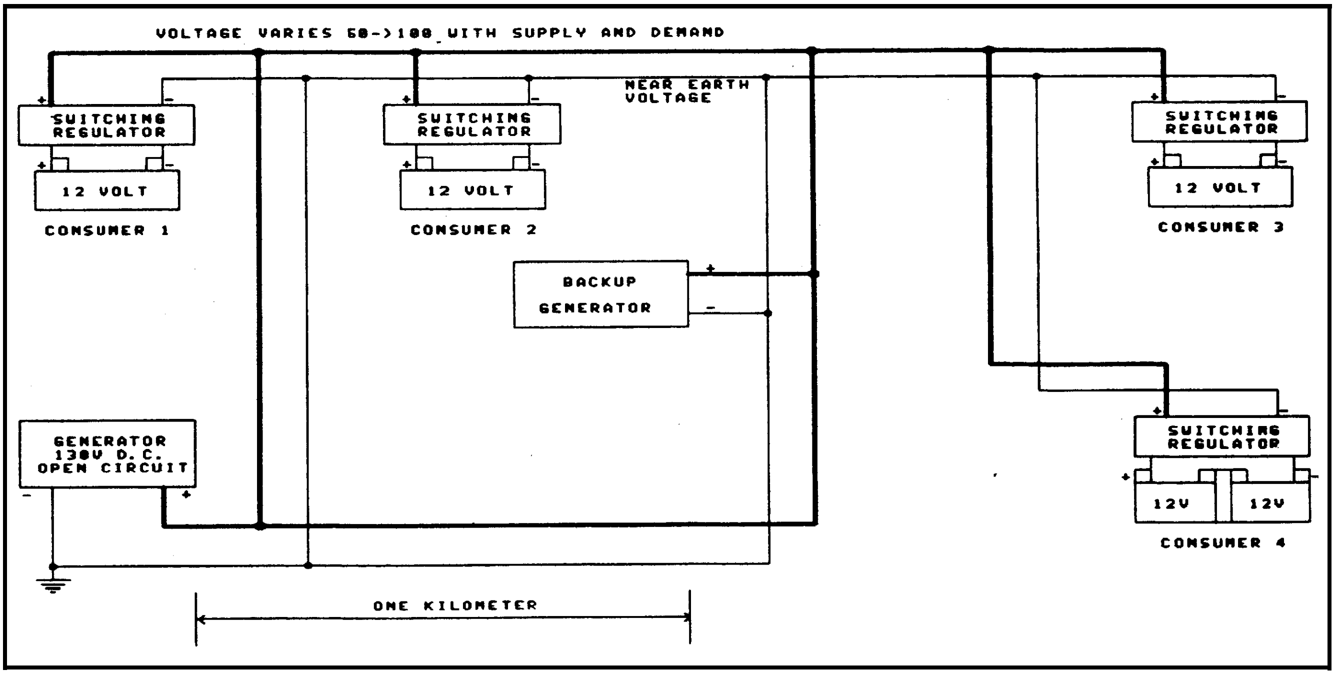
You can't have more than about eight because you go over voltage. But if you're up to eight you can just connect everyone in series, which means you are already splitting the current between the consumers - by definition the current is absolutely identical for everybody and you don't have to use any switching regulators. It is an extremely low-tech sort of solution. But its actually a harder sort of system to operate than you might think.

First of all, because everyone does get equal amounts of power, it is actually wasteful because consumers inevitably go on holidays or aren't there or need different amounts of power, so you haven't got the flexibility. If one person has got 5 visitors and three of the other people are away, there is no way they can use their power.

There are ways of developing a much more sophisticated form of series system, but I won't go into them yet. You can use switching regulators on a series system as well, but that is complex. So in the simple arrangement, everyone gets the same charge, they have to dump it in shunt regulators in order to regulate their batteries and they each get the same current, the same power. If they don't use it they have to throw it away. If they want more they can't get it, even if someone else is throwing it away in their shunt regulator.

System Maintenance

The other real problem with the series system is maintenance. It is very hard to find a fault in a system like that because if there is any fault anywhere the whole system stops. And it is not immediately apparent where that fault is. You can't just find out who's got power still and who hasn't in order to find out where the break must be. In the parallel system you simply go to the last person who has power and start looking. You can find the break in the next leg of



Parallel D.C. Distribution System

the system. Yet in the series system you've got no idea of where to start.

As a means of trying to find out where to start, we've developed the idea of connecting the negative end of the loop to an earth stake driven into the ground. The beauty of this is that it just makes it easier to think about. It means that the negative end of the system is *earth*. That means you can actually find faults in the system by measuring the voltage between the loop wire and ground.

You stick one end of the multimeter into the ground, or hang onto it when you're covered in water and leeches. Then you touch the other end of the multimeter to the wire, and if it goes up in nice logical 12 volt increments with each battery then you know the wire is intact. When it suddenly doesn't, you know there is a break in the wire.

Usually your fingers are more use than a voltmeter because you get a shock every time you hit a fault. And usually a spark is more use than an ammeter because you just touch the ends together and if you get a decent spark you know you have got current flowing. So a pair of pliers and fingers seems to be all you need, and a roll of plastic tape is a good idea. One detail is make sure your wire-stripping pliers have got decent plastic on their handles. There is nothing worse than pulling a wire to strip it and you reach a spot on the handle where the plastic has burnt off.

It depends a bit on what sort of prime mover you've got. The ones we're using are all induction generators, and they've got the characteristic of rising to the maximum legal open-circuit voltage which is 135 volts, and just sitting there while there is a break in the wire and dumping all the power into a block of concrete (concrete-encased resistor).

As you go around downwire from the generator, it will keep dropping by 12 volt increments as it goes through each battery, and suddenly where the break is there will be 50 Volts or so across the two ends. So you find there is a sudden anomalous jump of 50 volts or so as you go past the break. That is the normal way we go about finding breaks, which in practice is the worst thing about the series system.

Another problem with the series system is the person's battery is not sitting at ground potential, which means if they have anything connected to the negative wire of the battery that is metal, they get a bit of a shock to ground, at least an uncomfortable tingle. There is no easy way of doing isolation.

In some systems there are actually two loops because you have more than eight consumers. In that case you need the prime mover switched between the two loops in a regular fashion. All that switchgear, hopefully automatic, needs people to look at it occasionally.

Electrolysis

All of these DC systems are probably worse than AC systems to maintain because of electrolysis. If you get a break in the insulation somewhere where there is an earth contact, you get currents to earth, and damp water in between acts as an electrolyte. There is a nice little aphorism I say: 'water plus electricity equals acid'. That is exactly the way things behave.

You can get $4mm^2$ wire eaten away in a week if you have got contact with groundwater and you've got voltage applied to it. It just fizzles away until there is no copper left. That is worse than alternating current. Alternating current to ground causes a wastage of power, but you get a sort of an oxidisation of the surface of the wire, which to some extent reduces corrosion. With DC it just quietly dissolves off into the dirt.

The powerline, if people do it properly, is placed inside poly-pipe or some conduit and the double insulation afforded is enough to stop that sort of thing from happening. Alternatively you can hang it off the ground on insulators.

But the worst thing possible is to leave it on the ground, particularly in the kikuyu. It gets broken up by cows bending it backwards and forwards, and makes little cracks in the insulation and then it is in contact with soil moisture, so you get an electric path out of the conductor through the cracks to the ground.

You can get the copper eaten away inside the insulation so you can't even realise it's not there. The only way you can find these things is by running your hand along the wire and getting a little shock when you get to the place where the wire has been eaten through. Insulation breaks are a continuing maintenance problem. It is a major nuisance, and as I was saying it is made worse by the fact it is a DC system.

Connections

I used to solder them all and silicon them all, but I'm not that convinced that it is really that necessary. Twisted together seems to work. So long as you tape it all over the top and keep it off the ground. Locating the joints and finding them all later seems to be an important thing, because you get lantana and weeds growing all over everything and you can't find where the join was.

Even if they're up off the ground, groundwater coming up by way of weeds, and sap of weeds, is just as efficient at causing electrolysis. So you've got to keep all the vegetation off the joints. We drive stakes into the ground, tie the wire to it, and then keep the joints up underneath a bottle. The beauty of this is that you keep the rain out. Ultraviolet also attacks the insulation at that point, so it keeps it out of the sun, keeps the rain off and ties it all together neatly.

Aluminium is more available than copper and works fine if you use twice the cross-section. Cable clamps or screw connectors both work fine for contacts. Drop wires to houses can often be bought at scrap yards for $2 a kilo.

Protection of Equipment

Where there is a major bit of circuitry, for switching or fusing or something like that, we have found it absolutely disastrous to leave it out in the weather. It is also not good to connect it to the outside of people's houses, because they always end up changing the houses and building rooms over the top of it and all sorts of amazing things. It is really yukky crawling under houses looking for connections of power lines. It is also probably a fire hazard.

It's really nice if you can build a little chook shed. The smallest type of backyard gal. garden shed is something well worth having. You can keep equipment in it like voltmeters. Voltmeters will not stand being in the rain, neither will ammeters, nor pressure gauges. You can keep information and explanation sheets stuck onto the side of the shed. It can be a place where all the equipment to do with keeping the powerline together can be centralised. In the cases where they have had that in a community grid it has been extremely beneficial.

It's even more the case if you've got a prime mover of some sort, either a pelton wheel or an engine or a battery charger or something like that. It's really great if its got a proper little shed to live in so it doesn't get harassed by everybody and it keeps animals out.

I'm surprised how many damages to the line are caused by animals. Rats chewing them, wallabies knocking them over. Cows - they're the horror of my life. They're funny animals. They'll investigate things, and harass things and trip over things. Trying to keep anything together near a cow paddock is really difficult. So keeping everything in a little shed is a really good start to keeping everything organised that is likely to be damaged.

Laying Extra-low-voltage Lines

You can either put it through conduit or poly-pipe, or double-insulated stuff just buried. Nail it onto cliffs. My favourite way of laying cable through the forest is to hang it on insulators at about the four-foot level. It is easy to get at and it actually works better than having it up over head height. The reason being is that when branches fall off trees they don't break the line they just pull it to the ground. Then you go along and relieve it by cutting the branches away and you haven't done any damage, whereas if you have it up at 10 feet, it is snapped when a branch falls and pulls it to the ground.

Up off the ground makes an enormous difference, You can afford to have bare copper and it won't necessarily get eaten away by electrolysis. You can get away with an amazing amount just so long as it is up above the ground.

Threading Wire Through Poly-pipe

To lay cable in poly-pipe, you basically first thread fishing line or something like that first on a weight. You straighten out the pipe across a paddock and you have a hump. Then you move the hump across the paddock, and you have the weight sliding down the little hill all the way, pulling the fishing line behind it.

The problem is not getting the thread through as you might imagine, the problem is getting the wire through. PVC has got a fairly high co-efficient of friction, and it is cumulative. After the first 30 or 40 metres, it gets very difficult to pull the wire through. The fewer the wires at once the easier, and the straighter they are the better. If you lubricate the poly-pipe first with gearbox oil or something like that, it makes an enormous difference.

It is not easy to pull the wire through. People I know have pulled the poly-pipe straight, usually downhill, and then you've got gravity helping you. You get a windlass effect, where the more kinks you've got, then they all add up, and after a certain number of wriggles and obstructions and so on, it is just impossible to pull the wire through any further, no matter how hard you pull. I think it is quite a problem pulling wire through poly-pipe, but it does give the wire mechanical protection.

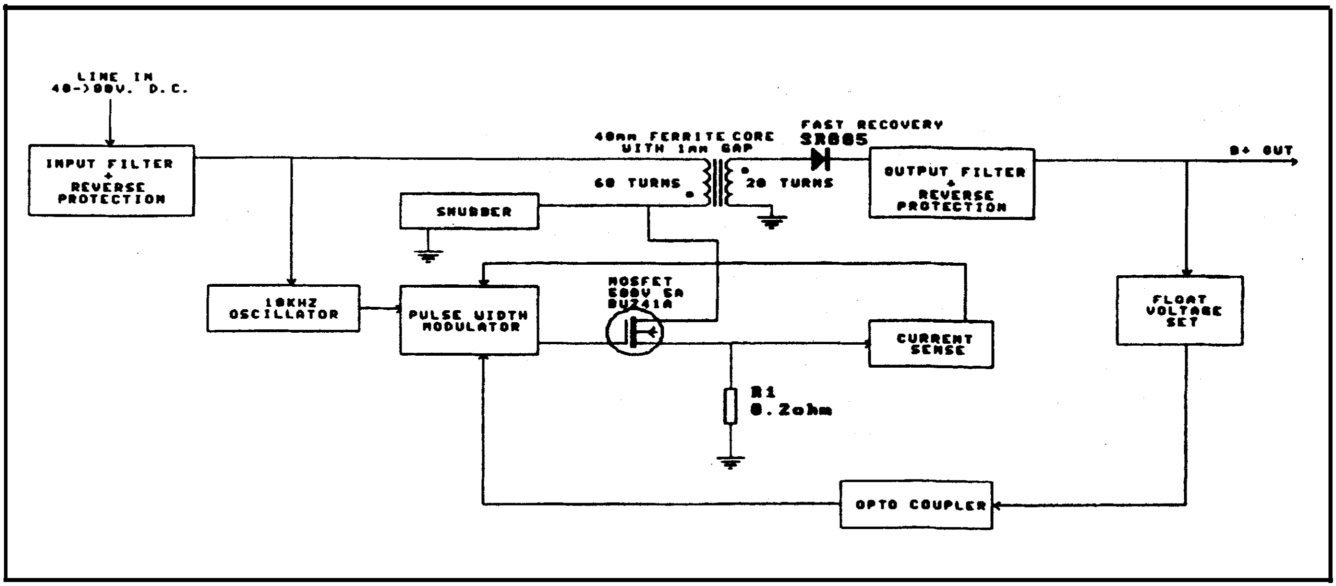
AC Transmission

You've got the option, if you've got to do a really long distance, of running a long leg, say 2km or so at 240V AC, break it down to the legal limit of 32V through a transformer in the middle of a cluster of houses and reticulate out from that point. I like it personally because AC doesn't cause corrosion of the wires to the same extent.

Power Sources

A common system around here is to use a pelton wheel on a high head or a propeller turbine on low head connected to an induction generator as the prime mover.

It could be a diesel generator as well. Diesel generators are very cost-effective. But they are pretty horrible. Hence at least one big improvement is, rather than everyone having one of their own, to have just one in a central quiet place ... or it was quiet, beforehand! It is also better because it can be loaded more



Switching Regulator for a Parallel Type Community Grid

heavily most of the time. Charging up all the batteries gives it some work to do. So a community distribution system would justify itself there as well.

Legal Considerations

Theoretically anyone needs to be qualified to do electrical work, low voltage or not. Technically I think it doesn't make any difference whether you connect it to a hydro generator, or windmill, or a big battery charger plugged into the mains. I think all of this would have to count as permanent wiring, and that is what the rules depend on, not the source of the energy.

I guess the main legal out if you're going to connect it to a mains system is to say that basically it is an appliance, a battery charger. So long as the battery charger complies with ASA standards, your system is going to be safe from 240 V, it's not going to be a shock hazard from the 240V side.

Communication Between Users

This is the biggest problem in the thing, actually. It seems to be one of the laws of nature that people think that other people are stealing their power. They first think that other people are getting more power than them, and secondly they contrive some unlikely theory that other people can steal power out of their battery.

Now it can't happen at all in a parallel system through switching regulators because they are a one-way power flow. It can only happen in a series system if the non-return diodes fail. Non return-diodes are usually built into the alternator at the prime mover end, or the rectifier in a battery charger type arrangement. So again unless the system is broken you can't get power going in the opposite direction.

People also have unbelievable difficulty in comprehending that battery voltages add up. It means they can't find wire breaks through any logic, so they do it just by mechanical inspection.

The other communication problem - or more a problem with responsibility delegation - is that there is always somebody who gets the job of linesperson. It is a very undesirable job, because you've got to crash around through the bush at the worst possible times, trying to find line faults.

If you've got a prime mover to maintain you need to communicate about the maintenance of that. People near it inherently have got to do it more often, if you've got an engine that is going to require very regular maintenance.

As I was saying, it is difficult to get a nasty shock off the system, but of course you can get fires because the battery has enough stored energy to set up enormous currents to start fires.

There is a demarcation between the community distribution network and the individual consumer's electrics. That has got to be made clear. This is hard, though, because you find that people's house electrics start re-organising the community 100V line, and the two get all intrinsically mixed up together. You often can't fix the community system without re-organising people's individual house electrics which are often very irrational.

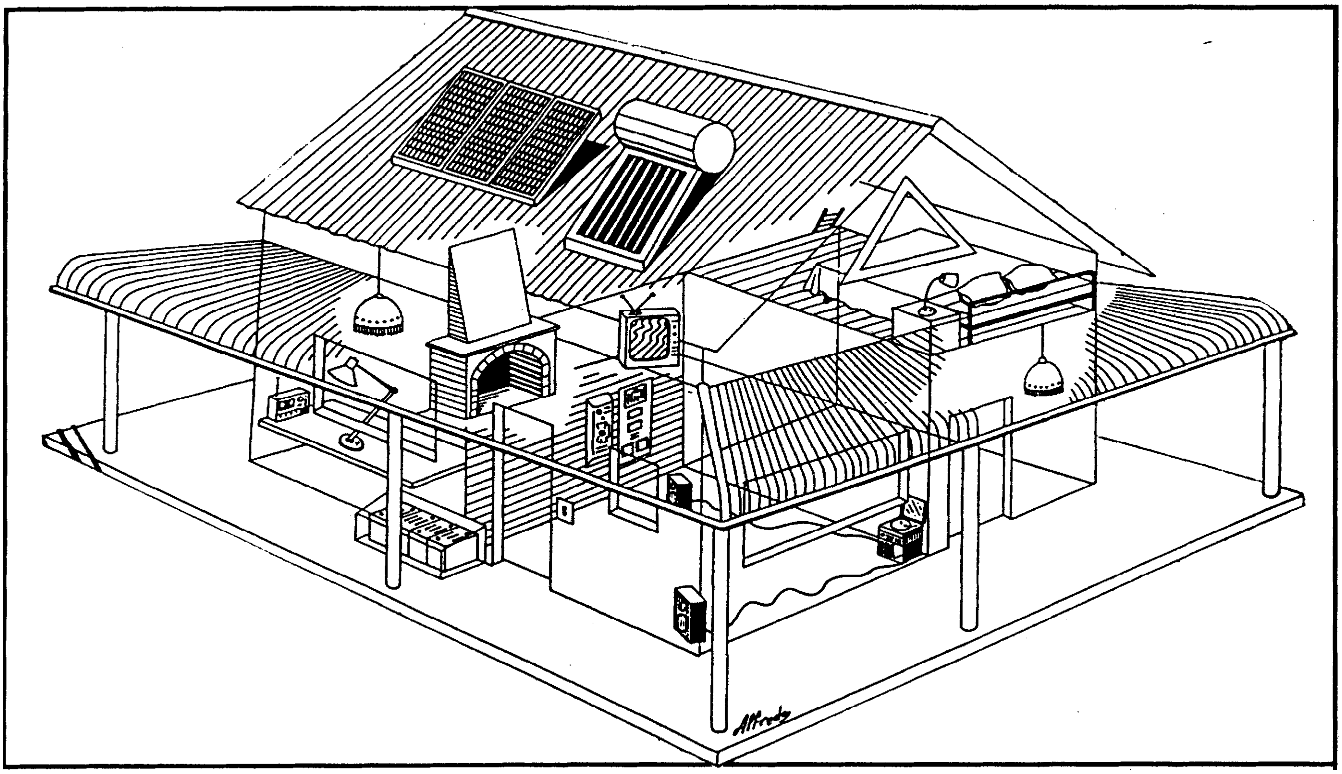
I prefer the parallel system where everyone has a switching regulator, simply because there is a clear demarcation line. There is DC isolation and there is no question whatever, the input and output defines the line between personal electrics, which can be good or bad, and the community system.

Summary

Parallel arranged 100V DC distribution systems have proved the most practical, but at the expense of the hi-tech fix of switching regulators. These have proved efficient and reliable for 10 years so far. Parallel systems are flexible in that power can be added and withdrawn anywhere, the layout can be altered easily, and heavier wires can be put in sectors which see more current. Also fault finding is easier, and derelict non-used parts of the grid do not compromise the functioning of good parts.

The switching regulators we use are a 60 watt flyback transformer circuit operating at 20 kHz. They use CMOS for most functions and consume less than a watt on idle. Efficiency is better than 80% across load range. If there is demand I will publish the full schematics.

32 VOLT
HOUSEHOLD POWER SYSTEMS



by Greg Clitheroe

Prior to the widespread introduction of mains power to rural areas, thousands of Australian homesteads generated their own electricity. These systems typically used low-speed diesel engines to charge a 32 volt battery bank. A wide range of appliances was available to suit this supply. In windy areas sometimes a wind generator was also used to charge the battery.

Introduction

Just why 32 volts was chosen remains a mystery to me as it is not even a multiple of the six volt car systems which were typical at the time. I suspect it may have had something to do with the use of low voltage equipment in industry where low voltages were used for electrical safety. 32 volts A.C. could easily be produced from the mains supply using a transformer.

Conversion to direct current was not necessary to run lighting and the typical universal motors used in drills and other appliances. Indeed the provision of large quantities of direct current was difficult using the existing technology at the time. Expensive mercury arc rectifiers would have been the only real option. Although direct current up to 100 volts is not considered lethal, as little as 36 volts A.C. can be fatal. I guess 32 volts was considered a safe limit.

Recently, remote power installations have operated at either twelve, 24 or 110 volts. This is largely due to the availability of automotive appliances to suit the lower voltages. 110 volts was designed for foreign countries such as the U.S. and allows the use of universal motors and heating appliances built for 110 volts. Fluorescent lighting can also be used directly with only minor modification.

Industry has now opted for tools operating on compressed air where wet environments are encountered. The popular modern trend to double insulation has allowed the use of mains voltages in workplaces once considered too dangerous for high voltage equipment. 32 volt equipment is now considered largely obsolete.

Consequently this equipment is both readily available and cheap to anyone willing to search the back blocks. There are however some difficulties to be overcome to make best use of the equipment.

Over the past few years I have installed and modified a 32 volt system, largely overcoming the problems while discovering some very real advantages over typical modern remote installations operating at lower voltages.

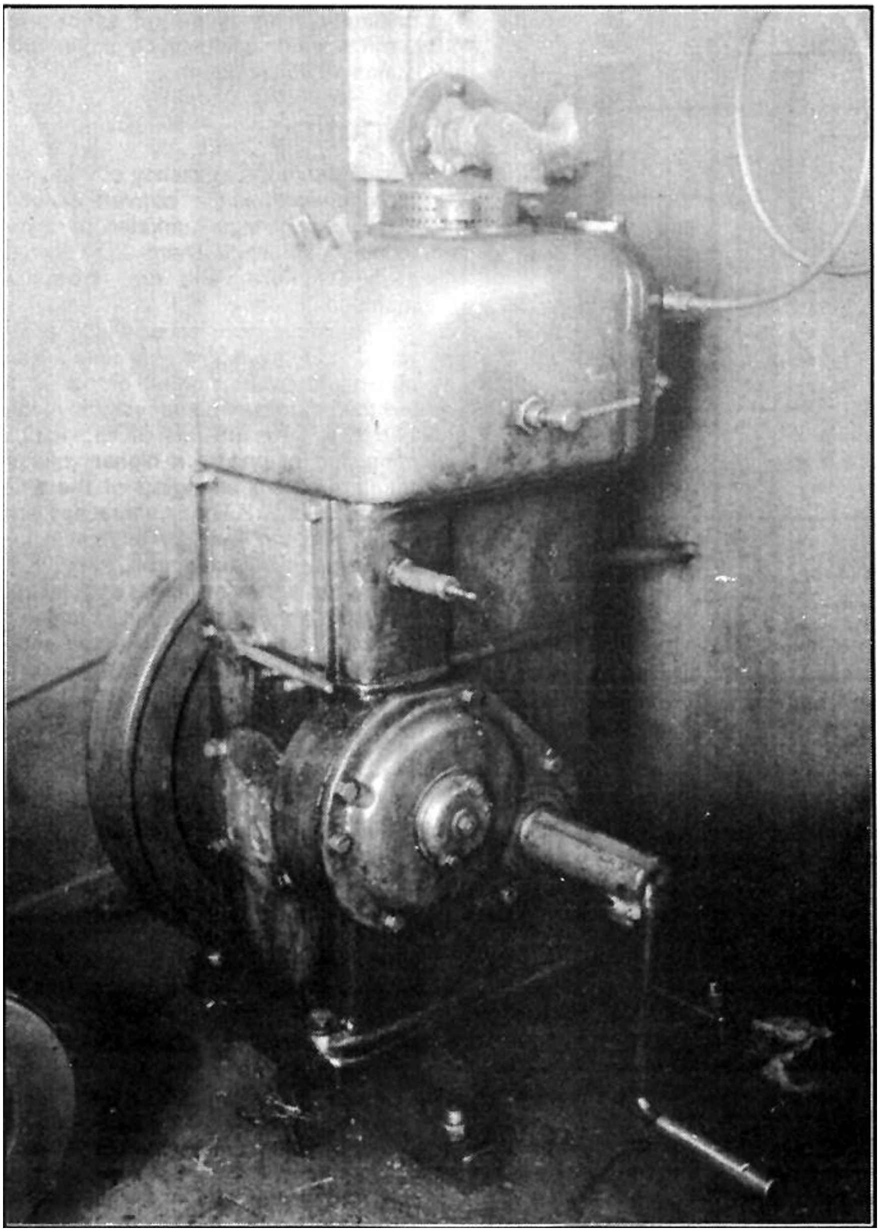


Photo 1. Ronaldson Tippet 3.5 hp diesel

The difficulties included the provision of twelve volts to operate low voltage appliances such as a portable television and radio. You will notice there is no easy way to divide a 32 volt supply to get a multiple of twelve. No high-efficiency lighting is available for 32 volts and the system was largely dependent on incandescent types.

The simplest way around this would be to reduce the system to 24 volts but this would have reduced the capacity of the motors powering the washing machine, Mixmaster and vacuum cleaner. It would have also rendered useless the 150 watt electric soldering iron. Furthermore the output of the generator would have been reduced by some 25 percent and the transmission efficiency by nearly 45 percent. Rather than this I chose to tackle the problems.

Renewable Power

Once contributing to the production of electricity was a Dunlite 750 watt wind generator of 1948 vintage. It is one of the old four-bladed models. The blades were damaged in a storm some time ago when the tail furling stop broke allowing the tail to foul the blades. Eventually the blades cracked at the root as a result. I have since acquired parts of the later three-bladed governor model and hope one day to repair the machine using these later parts.

Three Arco solar modules in series also provide about three amps when the sun shines. The panels nominally charge a twelve volt battery and consequently three panels should charge into 36 volts. However the output of solar panels is not critically affected by the reduced voltage. Indeed they will happily dump their current into a dead short.

Ideally I would like to install a turbine on a nearby seasonal creek. I feel the three renewable energy sources would provide a reasonably reliable electricity supply with minimal use of the diesel engine.

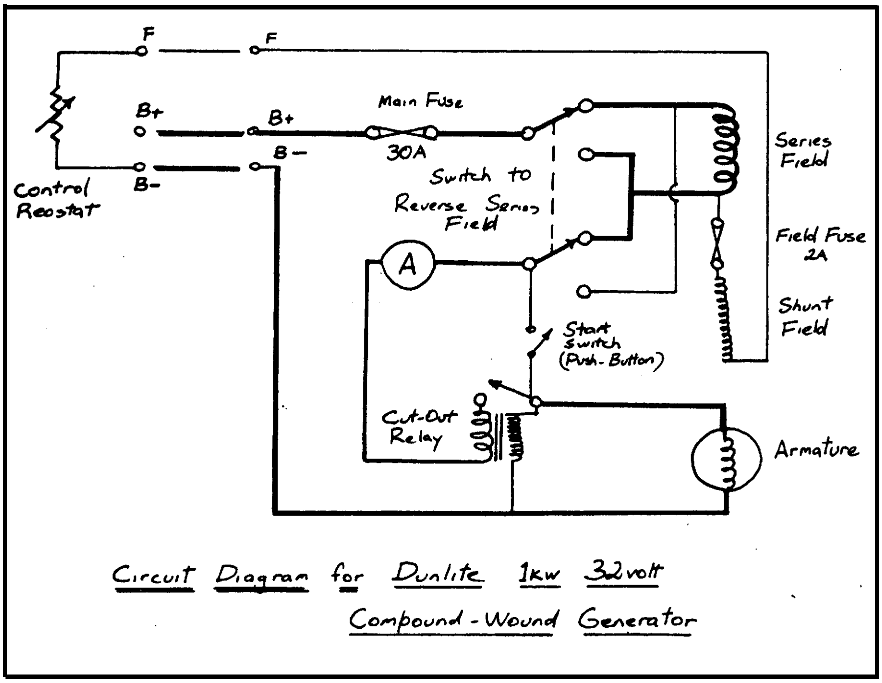
Diesel Back-up

The generator is a robust Dunlite 40 volt, 30 amp compound-wound type. Compound winding automatically compensates the field strength as the output changes resulting in a fairly stable output current with minimum attention (figure 1). It is driven by a Ronaldson-Tippet 3.5hp watercooled diesel engine.

This engine is a particularly elegant example of the engineering of the early 1950s. It is of extremely rugged construction weighing over 250 kilograms. I recently rebuilt the engine and I was very impressed by the design. Both the crankshaft and camshaft are carried in heavy-duty opposed tapered roller bearings. The crank is two inches in diameter and supports a massive flywheel. Maximum operating speed is 900 rpm. The valves are designed to allow their rotation while opening, thus extending their service life considerably. This machine is built to last.

Parts such as piston rings and valves are still available from F.W. Jarky Engineering in Sydney and I had the big-end bearings rebuilt in Brisbane.

The engine is started by motoring the generator while operating the decompression lever. Note however that the series field winding must be reversed while motoring. The installation of the generator caused some headaches as there was no information provided with the machine as to how it was to be connected. Furthermore a local engineering firm contracted to turn the commutator appeared to have inadvertantly switched some of the



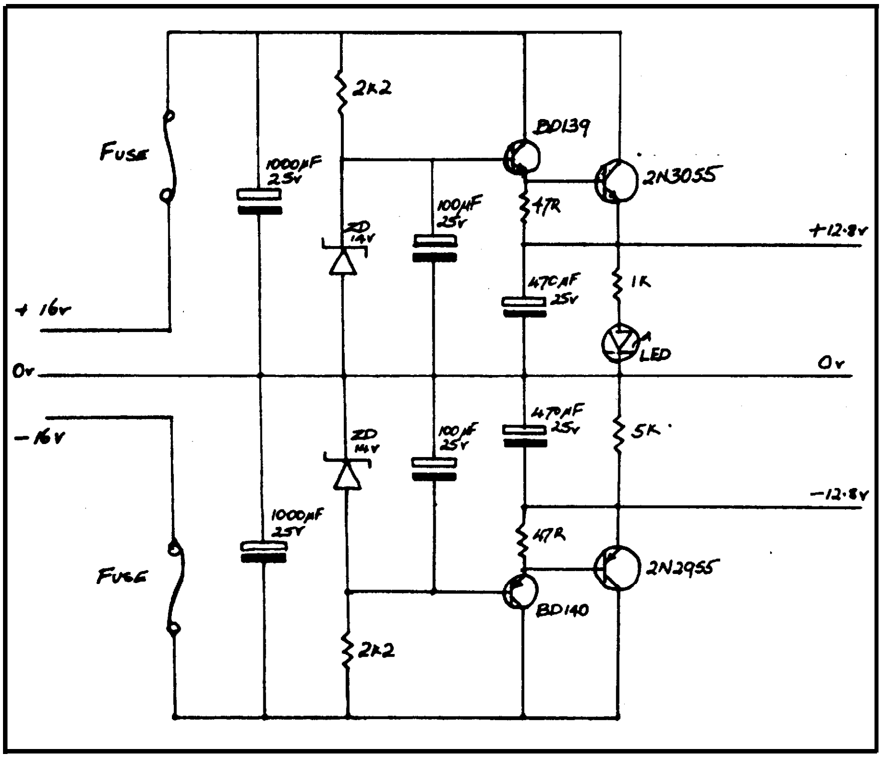


Figure 2. Bipolar series regulator

connections while working on the generator.

Storage

Storage is provided by a 16 cell lead-acid battery bank of 250 amphour capacity. This is centre tapped to provide what is effectively a plus and minus 16 volt supply.

Lighting

To improve the efficiency of the lighting I undertook to convert 24 volt fluorescent fittings marketed by Santech. These are a Thorn 2D 16 watt high pressure tube run from a matched inverter.

By a simple modification which shortened the transistor on- time I was able to maintain normal output at a reduced current. The conversion involves the substitution of the input capacitor for one of a higher voltage rating and the changing of the 2k2 resistor to a 3k3. These alterations are easily accomplished by anyone competent with a soldering iron.

For smaller lamps such as desk lamps and the light in the sewing machine I used 24 volt globes with appropriate series resistors. For a twenty watt bulb this requires about a ten ohm ten watt resistor. For a ten watt globe use a twenty ohm five watt resistor.

I have a Rainbow rechargeable lantern which can be charged directly from the power points. This is an Eveready Dolphin Lantern modified by the Rainbow Power Company. It has been fitted with a sealed lead-acid battery and provided with a built-in intelligent charger capable of being charged from up to twenty volts.

Household Power Supply

Power is also provided to the house via appropriate fuses to conventional three-pin sockets. This allows the connection of both sides of the battery to any appliance depending on how the plug is wired.

Large appliances are connected directly across the full supply voltage while others are powered by the 16 volt supply through an appropriate regulator. The regulator can be switched onto either half of the battery bank with a built-in switch. It then uses a series transistor to adjust the voltage to a steady 13.8 volts.

Equipment designed for automotive use invariably includes the capability to handle 14 volts as part of its normal operation. The electrical system of cars is actually regulated to 14 volts. The design of the regulator is shown in

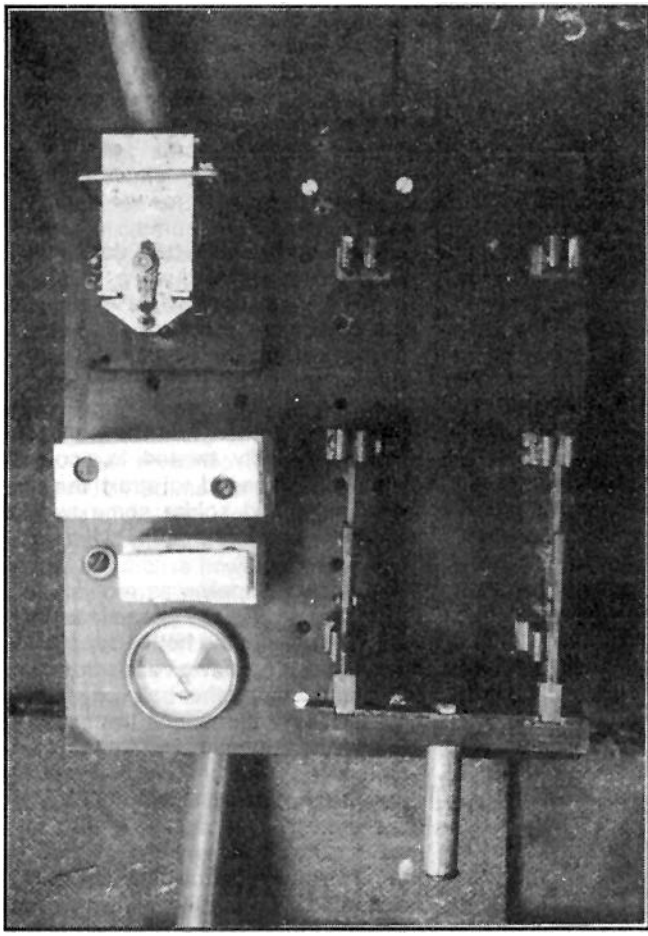
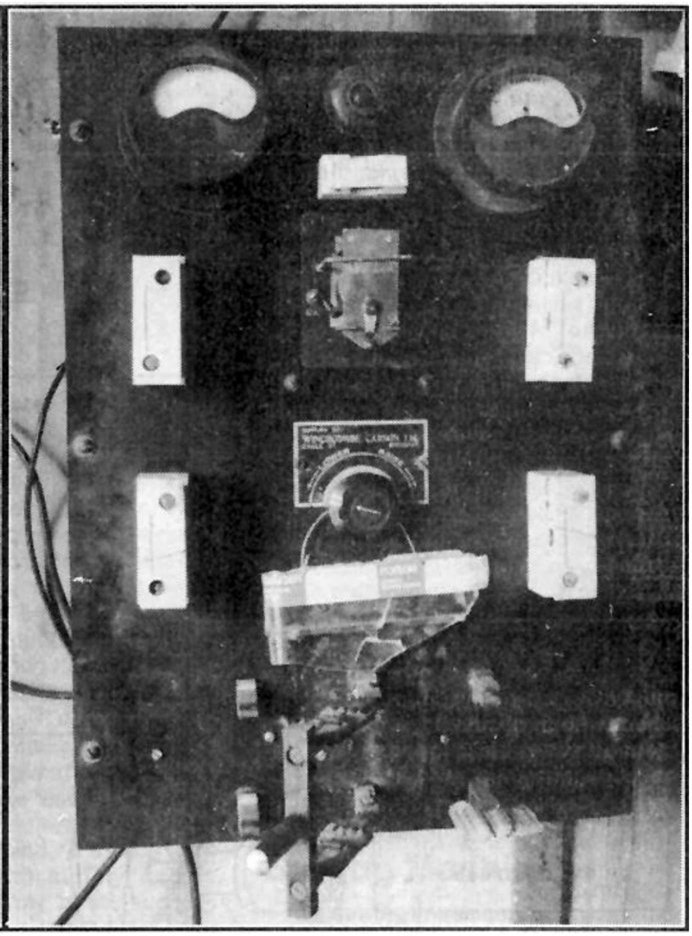


Photo 2. Generator Room switchboard



Battery Room switchboard before installation

figure 2. It is easy to build and reliably simple.

The resulting efficiency of powering 12 volt appliances this way is about 75 percent. Some improvement in performance may be evident particularly in car radios as result of the over-voltage supply. Mains power supplies for CB radios are generally regulated to 13.8 volts to increase power output.

The regulator output can also be used directly to charge a twelve volt battery provided it is not exceptionally flat. A 0.2 ohm five watt series resistor after the regulator will limit the current to a safe level.

An added benefit of the regulator is the ability to power twelve volt appliances at great distances from the main power outlets. For example, the regulator could be plugged into the end of a typical twenty metre extension lead then run a forty watt twelve volt soldering iron at normal power. Without the extra available voltage the resistive drop in the lead would be too large to permit normal operation.

Regulating down to 12 volts from a higher supply is particularly applicable to sensitive electronic equipment as it removes any surges from the supply which might affect a microprocessor.

Interference to supply is rife on low voltage systems due to the profusion of noise generated by numerous fluorescent lights, inverters and motors in addition to the high charging voltages encountered sometimes. This also offers protection against system faults which sometimes lead to expensive repairs.

Once I saw an expensive cassette player badly damaged when a faulty battery terminal added an extra four volts to the supply during charging. The regulator needs at least 1.5 volts to spare over its output so it cannot be utilised on a twelve volt supply. The simpler version of the regulator shown in figure 3 can be used on nine volt radios.

I believe a very real advantage of the 32 volt system is the ability to provide the twelve volt bipolar regulated supply frequently used in many electronic appliances.

Audio Equipment - Amplifiers

It is quite remarkable just how many appliances can be operated from a 32 volt supply. I have converted two amplifiers which used power supplies of almost exactly 32 volts. One was a Pioneer model SA-5300 which used a single sided 32 volt supply. In this conversion I had to remove the transformer to allow the fitting of two alkaline D-cells which powered part of the preamplifier. The current drain on these cells is so small that they last for their shelf-life. The original pilot lamp was also replaced with an LED.

The other conversion was a Hitachi AM/FM Stereo Tuner which used a plus and minus 15 volt supply. This is connected using all three pins of the power plug. Both of these amplifiers are around 20 watts per channel.

Powering conventional amplifiers directly from the battery has substantial advantages over using them in conjunction with an inverter. Firstly it is much more efficient. Secondly the performance of the amp is improved because the battery supply voltage is sustained at peak loading whereas the 240 volt supply is limited by its storage capacitors. Thirdly there is none of the troublesome hum often generated when inverters are used with hi-fi equipment.

This method also compares favourably with the use of automotive audio equipment as it is substantially more efficient. The power output of an amplifier is limited by two criteria. The impedance of the speaker system and the output voltage govern the total power available. A twelve volt supply limits this to modest levels despite the use of low impedance speakers. High-powered automotive equipment overcomes this limit by converting the supply to a higher voltage with a considerable efficiency penalty.

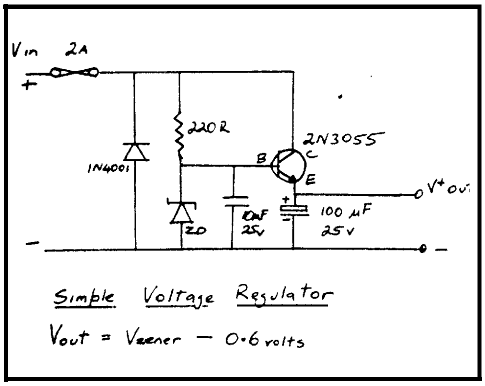


Figure 3. Simple voltage regulator

In addition to these conversions I have studied the power supplies of many amplifier/tuners and they seem to be grouped from about 18 volts to 32 volts. A 100 watt per channel amplifier used a bipolar 28 volt supply. I expect it would operate though at reduced output when supplied at a lower voltage. Machines requiring lower voltages may be easily regulated by the use of simple series regulators as shown in figures 2 to 4.

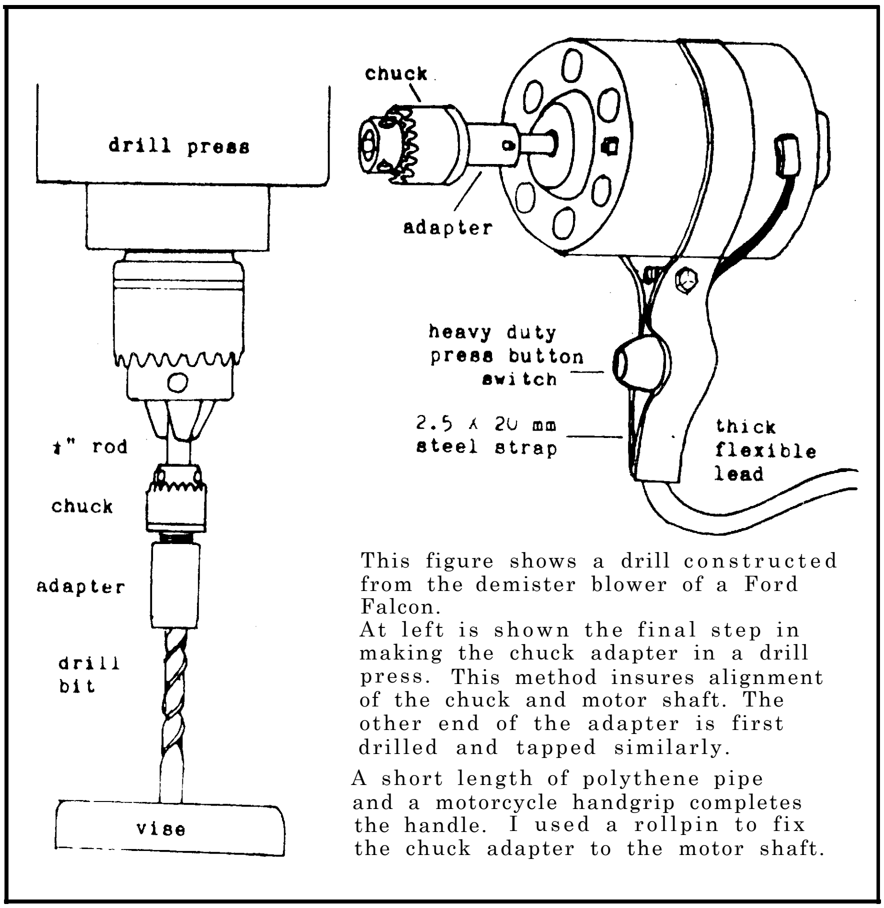


Figure 4. Low-cost electric drill

Tape Deck

A Sony TC-FX220 tape deck which I converted operated on a plus and minus 12 volt supply. This machine I am particularly proud of as I brought it home from the tip. It was very badly damaged having been dropped on its corner. The circuit board was broken and the transport mechanism badly twisted. In a couple of hours I managed to straighten the mechanism and solder some twenty wire bridges across broken PCB tracks.

The power supply was regulated in this machine so it was possible to connect it directly to the house supply. Allowing for a drop of two volts across the regulators and another half volt across the rectifiers this brings the nominal input voltage up to nearly fifteen volts.

Considering that the regulators are designed to supply in excess of an amp they are probably capable of dissipating the extra power involved in such a low powered appliance as a tape deck. For peace of mind a low resistance calculated to drop a volt or two at full load can be installed in the input leads.

For larger appliances it is better to use pre-regulators. If there is any doubt monitor the heatsink temperature with your finger for the first test. Make this test at full charging voltage which in the case of the 32 volt system is about 38 volts.

Audio Conversions

When making conversions such as these it is very important that the earth potentials of each machine be checked for correspondence. A plus and minus system is earthed to the centre-tap while a single sided system is earthed to one side of the full supply. Any attempt to connect say the Sony deck with the Pioneer amp could destroy the equipment. The Sony and the Hitachi may be connected as they both share their earth at the centre tap, (this is not to say all machines of these brands can be connected nor even within the same brand). A simple check with a voltmeter between the two machine earths will confirm their suitability.

A way around the problem is to insert capacitors into the signal leads to isolate the machines. You may find however that some distortion or hum will result. Furthermore the cases of the two machines may short together if you are not careful. In any case the normal earthing leads should not be connected as an earth loop may result in conjunction with the shared power supply earth.

When designing the power supply regulators I have elected to provide an extra 0.8 volts to allow for the drop across the rectifiers in the equipment itself. This simplifies the location of connection points and provides a measure of polarity protection without worrying about the loss across the diodes. In practise however the small loss has not been a problem. The equipment is undoubtedly capable of operating substantially under the nominal supply to allow for sagging mains in remote outposts of the grid. Be sure to disconnect the low-voltage leads from the transformer or it will be destroyed.

In the case of PCB-mounted transformers it is difficult to disconnect the low voltage windings. In this case the new supply must be patched directly across the filter capacitors. The power rectifiers prevent the flow of current back through the transformer. It is a good idea in these cases to fit a diode between the new power supply and the connection to the capacitors. This provides polarity protection and also allows the normal mains supply to be used.

Record Players

Some record players are very easily converted. The type to look for has a twelve volt motor and conversion is simply to bypass the 240 volt transformer. Generally they can be recognised by the use of electrical switching between platter speeds rather than a movement of the belt. If there is any provision for small adjustment to speeds then it is almost certainly convertible.

Usually the low voltage types have a stroboscopic reference on the edge of the platter meant to be adjusted against a built- in mains powered flash. This of course will not operate but speed adjustment may be performed while listening to a familiar recording. Stability is more important than absolute speed.

Computers

This article is being typed on a twelve volt computer. It is one of the cheapest portables available being an Amstrad PPC512S. It is a good machine but I wouldn't recommend them if you plan on expanding your system. The only hard disc available is a 20 megabyte type costing about $1200 or more than the computer itself.

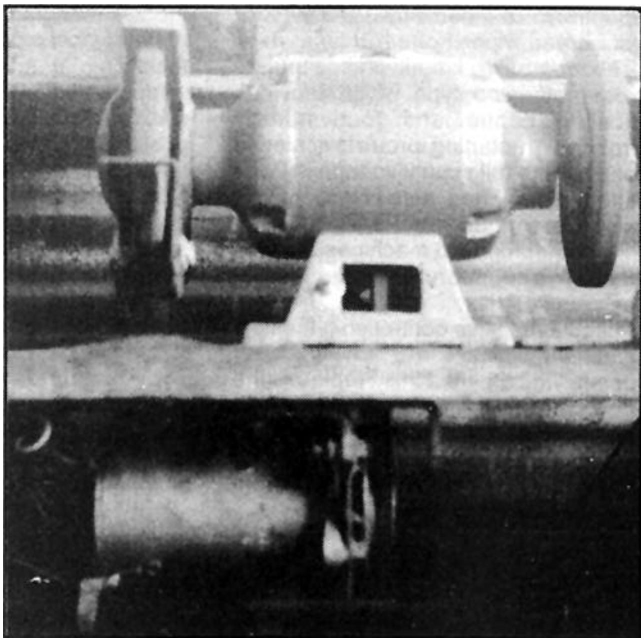


Photo 4. Grinder conversion

My printer is a Tandy DMP105. This is not actually compatible with the computer but some internal wiring changes allowed it to be used successfully for ASCII characters. I bought it cheaply second hand. It uses a plus and minus 12 volt supply and is operated by one of my power supplies which also runs the computer. A later model, the Tandy DMP 106 is IBM compatible and uses an almost identical power supply.

I would expect that most printers would use similar supplies except perhaps for laser types. Checking the manual for a circuit diagram provides the easiest check. Watch out for the use of "N 12" or "M 12" to represent negative voltages. Once again be very wary of the earth potentials between connected equipment.

Sewing Machines

The sewing machine was converted by rewinding the original motor to 32 volts and the construction of an electronic speed control. The machine was a 1960s model Singer which used a fully enclosed motor. Otherwise I would have elected to fit an automotive

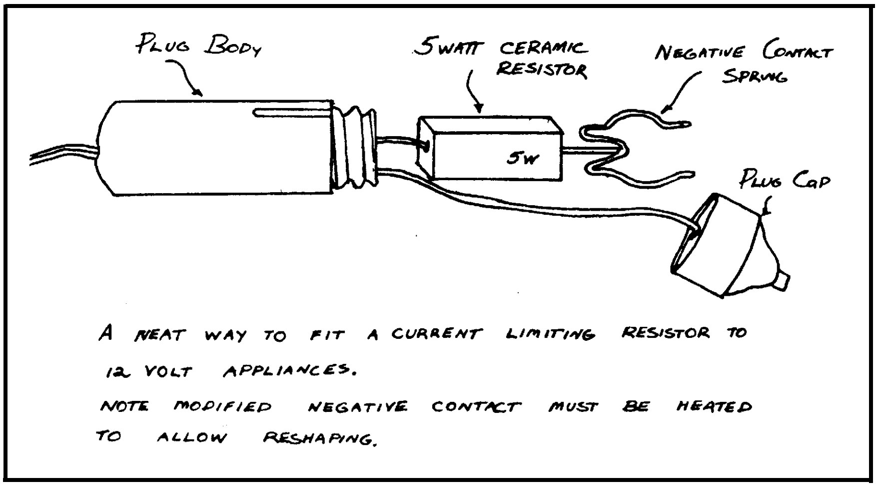


Figure 5. 12 V car plug conversion

type from a demister blower or windscreen wiper.

The controller I built was a pulse-width-modulated type which provides excellent control and good starting torque. High starting torque is achieved because the full supply voltage is intermittently switched across the motor. Resistive controllers such as are typically standard in old machines are less efficient and poorer at starting but easier to construct.

I used a resistive controller in the field circuit of my drill press to provide higher speeds. To construct this I replaced the original resistive wire in an old sewing machine controller with stainless steel wire sold for bee hive frames. The wire I used had a resistance of about three ohms per metre.

Washing Machines

The electric motors used in the washing machine is a 32 volt type using a frame and mounting compatible with the typical Crompton Parkinson 1/3 horsepower AC motors supplied in washing machines for many years. The washing machine itself is an old wringer type.

Although wringers are not my favourite means of removing excess water, the agitator tub is excellent. The larger diameter of these old tubs provides much more efficient use of energy than recent machines designed to fit in pokey modern laundries.

Motors

Twelve volt automotive generators such as was used on Holdens up to about 1963 can also be used as motors on 32 volts. The use of these machines is thoroughly explained in my book *"Backyard Electrical Systems"* where I described their use on 24 volt supplies. I would be reluctant to subject the field windings to a 32 volt supply but rather they should be connected to the centre tap at 16 volts. The armature is quite happy with 32 volts. Powered in this way the machines go somewhat faster.

I used the blower motor from a Ford Falcon to make a 12 volt electric drill. Some detail of this is shown in Figure 5.

Televisions

At the time of writing the only 12 volt colour television available had a small 10 inch screen. Although some older models manufactured by General are around, most people tend to hang on to them.

Importation of low voltage sets was curtailed some years ago due to the imposition of higher tax rates on portable sets. This forced the price of the already expensive DC models to prohibitive levels. Large scale integration of electronic components has led to a return to competitive pricing. I expect that new larger low-voltage sets are to be imported sometime soon but they will be substantially more expensive than equivalent mains powered models.

Currently we are operating a monochrome television from a 12 volt regulator. We have recently bought a JVC 14 inch, mains-powered colour television. A quick look at the power supply revealed some important points. The mains supply is immediately rectified and filtered to produce a high voltage DC supply. This kind of power supply produces a large transient at switch-on due to the charging of the filter capacitor. This easily overloads a small inverter which would otherwise be adequate.

The use of a larger inverter would be an alternative solution to the problem but with a loss of efficiency. For best operation the inverter should be operating close to maximum output. Another alternative is to use a smaller inverter and turn it on softly. This means bringing the output voltage up slowly.

Intent on this approach I have ordered a 40 watt inverter kit available from Altronics in Perth to provide the drive circuitry. This kit is provided with a complete circuit diagram and operation description making any modifications much simpler. Instead of the supplied transformer I will fit an appropriate transformer removed from one of the amplifiers; this is suitable with the only modification necessary being an alteration to the low voltage winding.

I also hope to locate the low voltage supplies to the microprocessor and power these directly from the battery. This will allow the operation of present volume levels, station settings and automatic switch-on information which would otherwise be lost when the inverter was turned off. Furthermore, if I can tap into the power on/off output from the remote sensing circuits I could use this to switch the inverter. This would allow the inverter to be operated from the remote control unit.

Video Recorders

12V videos are available but none are capable of recording as they are primarily manufactured for the vehicular market. We wanted the ability to record late night videos and so chose a Sharp VCR with programmable recording facilities. This could easily be operated on an inverter but any automatic off-air recording would involve leaving the inverter on to maintain the operation of the electronic control and clock. Instead I chose to investigate conversion to DC operation.

The conversion of this machine is quite involved. I don't have the circuit diagram but I measured three power supplies below 12 volts. It appears that these supply all of the power for motors and RF circuitry. In any case just what the supplies are for is unimportant as they are easily obtained from the house system.

Both the microprocessor and clock are timed by the mains frequency. I built a small oscillator to provide the clock timing and this allowed the machine to operate except for the display.

More difficult to cope with is a 100 volt AC supply which operates the electro-luminescent display. This display is quite mysterious and I am only beginning to manage some tentative explanation of its operation. However, it is clear that the logic in the clock driver is powered by a 45 volt bipolar supply derived via regulators from the 100 volt AC line. These high voltage circuits consume minimal current but even so their power consumption on a 24 hour basis warrants their being switched on only when necessary.

With this in mind I reasoned that the display was usually necessary only while the TV was in operation. As luck would have it, the transformer I had selected for the TV inverter was provided with the needs of the video display. Since the main power consumers are the low voltage circuits, the converted appliance will still be substantially more efficient and much more convenient than using an inverter to operate the video via its normal power supply.

As you can see, not all appliances are suited to conversion by inexperienced people but I can assure you that a good many are. My advice is to avoid the very modern machines with clocks and automatic controls and especially electro-luminescent displays.

Vacuum Cleaner

The vacuum cleaner has a story of its own. Some years ago a particularly keen Electrolux salesman went past the end of the grid. My friend pointed out to him that the house had no 240 volt power and asked if he had any 32 volt models. To this he replied negatively but insisted that the vacuum cleaner he wished to demonstrate would operate since the house was wired with conventional three-pin sockets. Rather than argue he was allowed to try. Of course it didn't work and he went off disappointed.

Some years later he returned. Apparently in his travels someone had traded in their old 32 volt Electrolux on a new mains model. He remembered his experience here and so the machine was duly presented for inspection. It worked perfectly. One can be lucky!

Power Outlets

On the subject of the use of conventional sockets I realise that it is probably not the best practice to use these types in a low-voltage system because of the danger of mixing appliances. Until recently 240 volts was not available in the house and so the only way anyone was likely to be injured by applying mains potential to a low-voltage device was after a theft. Frankly I find it hard to be sympathetic

However we recently acquired an old A.W.A. 500 watt inverter and this prompted me to think about the problem. The easiest solution I found was to use round-earth-pin plugs and sockets on the low voltage. These cost the same as conventional connectors and are readily available. A local electrical contractor uses them for protected supplies in computer installations.

A better though more difficult to obtain option would be to use fittings from the United Kingdom. These are a very robust three-pin type using round pins. They are available with a built- in fuse in the plug and are ideally suited to the heavy currents necessary for low-voltage systems. This would ensure no mistaken connections.

Other Devices

Perhaps the most unusual device I have converted is a hair removing tool called an Epilady. It tears out leg hairs using a moving coil spring operating in much the way the springs of a trampoline achieve the same result.

It normally runs via a plug-pack powering a four watt DC. motor rated from nine to twelve volts. The plug-pack is capable of limited current and so reduces the speed when under full load. This prevents burnout of the motor and provides some measure of pity when reluctant hairs are encountered. I powered it from the 13.8 volt regulator using a twelve ohm series resistor. This five watt ceramic type fits neatly within the body of the cigarette lighter plug of the special lead I made up. To provide sufficient space I bent the earth contact of the plug as shown in the figure 6. This arrangement emulated the supply provided by the plug pack.

Conclusion

As I have attempted more conversions I feel more confident that just about anything can be run from this versatile system. Despite early difficulties I now feel that I would again choose a 32 volt system if I was to set up a remote power supply for myself in another home.

Most of the advantages such as regulated power supplies could be achieved using a 28 volt system if that was preferred. If this was attempted the solar component could probably be provided using only two modules in series as long as they were high powered monocrystalline types.

Anyone wishing to set up a similar system should feel free to contact me with any questions you may have regarding conversion of appliances or the installation of generating equipment. I would be more than pleased to assist.

Reference

Greg Clitheroe 1987. *Backyard Electrical Systems.* Appropriate Community Technology Association, Lismore.

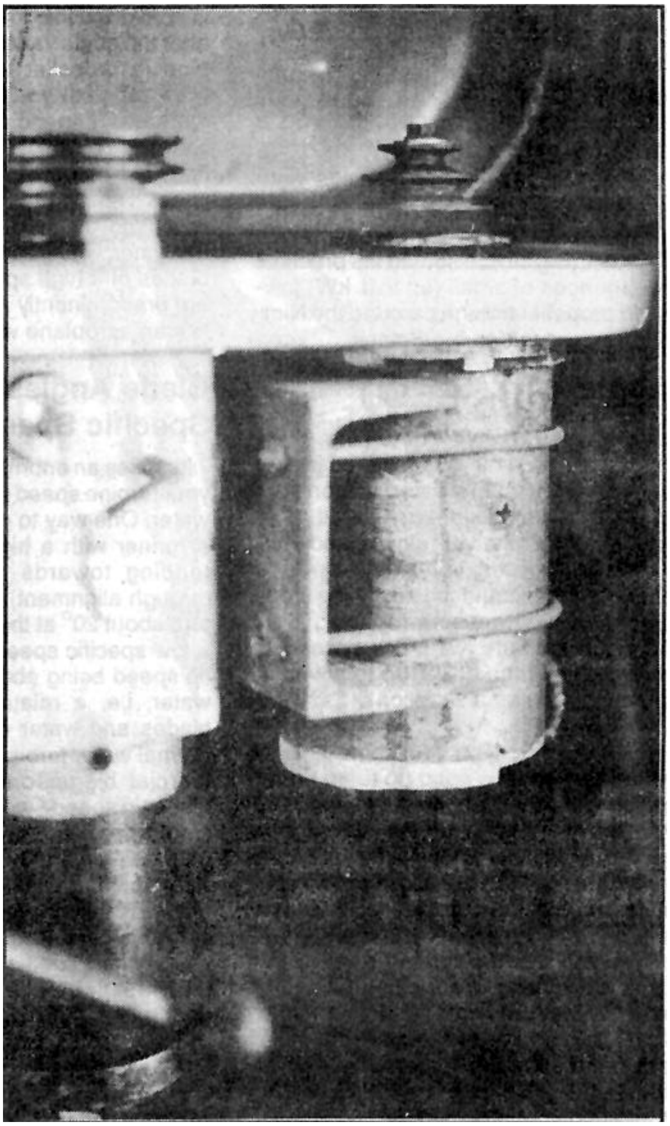


Photo 5. Drill press conversion

SMALL PROPELLER TURBINES

by Karl McLaughlin

Small propeller turbines are promising appropriate technology for many parts of the world. They work wherever there is a good flow and a possibility of constructing a small dam with a wall one or more metres high, or where rapids give sufficient fall.

Here is a transcript of an interview with Karl McLaughlin, based on his practical experiences of small (up to 1kW) low-head propeller turbines around the Nimbin area, as told to Ian Scales.

SPECIFIC SPEED

There are two styles of turbine. Firstly, one in which the guide vanes impart very little swirl to the water, so don't impart much kinetic energy at all. The water moves relatively slowly, and your turbine runs at a very high "specific speed". This could basically be considered as a pressure-reducing disc through which the water flows, and the water at no stage builds up to a kinetic energy of very much fraction of its head.

The opposite type of turbine is one where the water is sped up to an angle of about 30° through the guide vanes. If you didn't have a turbine below, the guide vanes would act like a nozzle; in fact you could have a large proportion of the head being converted into kinetic energy at that point.

Now imagine the turbine after it. Instead of working like a crossflow turbine where the water catches on a single curved blade (another example is a pelton wheel), the turbine runner uses all the blades to catch the water from the guide vanes, decelerate it and drop it out with almost no pressure left. This is the extreme other end of propeller turbine design, with a very low specific speed; it is almost getting to an impulse turbine.

So the issue is how much of the head is converted into kinetic energy directly after the guide vanes. With a Kaplan turbine (a propeller turbine with varying blade angles) you can move between extremes depending on whether you want high power or low water consumption. The steep, curved blades of a low specific speed turbine are predominantly moved by deceleration forces from the water, whereas the flat shallow pitch blades of a high specific speed turbine are predominantly moved by lift forces, like an aeroplane wing.

Blade Angles And Specific Speed

It makes an enormous difference what your turbine speed is compared with the water. One way to go would be to have a runner with a high blade angle (i.e. tending towards an axial, straight-through alignment) at the inlet, eg. 60° and about 20° at the runner exit. This is a low specific speed turbine, the blade tip speed being about the same as the water, i.e. a relative speed between blades and water of about 1. A more normal water turbine, such as the commercial bigger ones, would have a blade tip speed/water speed ratio ('tip-speed' ratio) of 3 or 4.

The advantage of having a relatively slow running turbine with very steep angles is that the passages can be bigger, and there's less tip leakage for the amount of water consumed, which is much higher for a low specific speed rotor of the same diameter.

Note that the actual speed of the runner is not necessarily any different with steep or shallow blades as the water speed is slower with a high specific speed runner. Kaplan turbines vary blade pitch to control power, not speed. Blade tip leakage is a critical factor in small turbines as tolerances are more difficult, and sand in the water does more damage.

Going for a very high specific speed turbine would require a very shallow angle of the blade, much faster blades, and you're chopping up the water into smaller parcels. Another advantage of low specific speed turbines is that the axial thrust which the shaft has to transmit is much less than with shallower blades. Rubber couplings directly onto the generator thus become possible.

Another detail is that with a low specific speed runner there is a much greater difference between the angle of entrance and the angle of departure; so there is a big change in the rotational speed of the water as it decelerates across the turbine. Whereas with a high speed turbine, not only do the blades have a high tip-speed ratio but there's also less difference in the angle between the entrance and the exit, because the rotational energy of the water is relatively small compared with the axial, so it is more like a pressure disc while the low speed runners are more like an impulse turbine.

With a low speed runner, the guide vanes have to be very curved: they have to take the water and spin it up to a very high degree of rotational energy.

General Considerations

Working out blade angles is not a problem. It is basic trigonometry and inlet velocity angles, although guessed, are not crucial because this only affects speed; i.e. the angular velocity of the turbine which is not crucial because the speed of generator shaft can be mediated by pulleys.

Because the angle gradually decreases as the blade trailing edge is approached, the force will be continuous on the blade because the water is decelerating the whole way. That is the basic idea of the curved duct. The blade has to change the rotation of the water. At the runner entrance it comes in with maximum rotation and as it comes out it has minimum rotation; so the water's axial velocity is unchanged, but it does change its rotation velocity as it goes through the turbine.

If you look at a turbine runner, you can see there is much more curvature of the blade near the hub; that indicates the higher forces needed at the hub because the speed of the water is less, it is a much more "lifty" sort of an hydrofoil.

Relationships Between Guide Vanes and Runner

If you have a very high specific speed runner, you're going to have a very "low specific speed" set of guide vanes, so to speak, because you don't need to impart very much spin to the water.

It is interesting that you always get the opposite type of problem in the guide vanes compared with the runner. If you have a very high specific speed runner, you end up with a very large blade area in the guide vanes, which don't have to impart very much circulation. If you have a runner which is of relatively low specific speed, you're going to have to impart a lot of circulation to the water up front.

Note that the number of guide and runner blades are different, usually a co-prime number. This reduces cogging effects and smooths torque. 'Co-prime' needs some explanation - this might be 4 blades on either the runner or the guide vanes and 5 blades on the other, or 6 on one and 7 on the other. Avoid using the same number of blades on both assemblies, and avoid multiples.

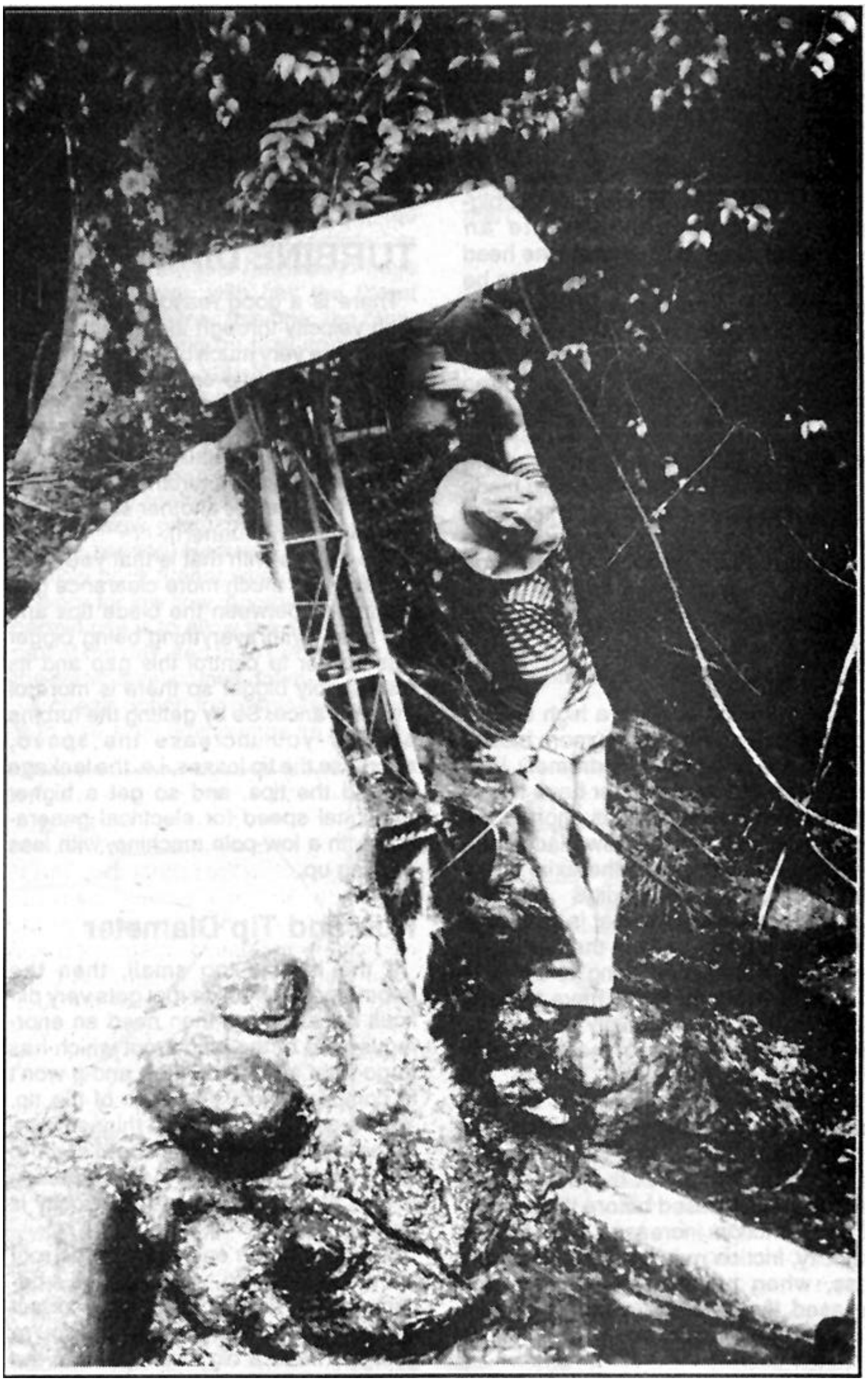
SOLIDITY

One of my attempts at turbine design didn't have sufficient solidity for the corresponding specific speed, and the forces on the blade that were being attempted were just not able to be carried by the amount of water at that velocity.

Worked out as a wing, I was trying to get a lift coefficient of about 2, which is just absolutely stupid. So what was happening, the wing was just stalling, the water was not conforming to the path of the blade at all, it was just going straight through. So there must be enough area of blade to carry the forces. The forces are related to both the lift, because of the profile of the blade, but also the forces are related to the momentum change. It is a trade off between shear friction and the water failing to conform to the hydrofoil section.

Design Solution

I think you have to work it out in terms of loading per unit area, just like in an aeroplane. If you try to load a wing or any hydrofoil surface too much then you're going to get stalling or the equivalent of it.



Karl checking his local turbine

You've got to choose a lift figure somewhere in the middle; it probably doesn't matter too much to get it dead right. Its not going to work if you go for a lift coefficient of 2, and if you go for too low a lift, you're going to start clocking up friction forces.

Solidity and Radius

There is a big difference between the area required near the tip as opposed to the root of the blade, and depending on the angle there is enormous variation.

Particularly near the hub where the water is slower, you need a much bigger hydrofoil area to create an equivalent force to counteract the head force: this is why the root needs to be much thicker. The forces on the blade relate to the square law of the fluid velocity. The fluid is a bit slower near the hub, so you need quite a lot more area to generate enough force.

As we progress radially across the blade toward the tip, the velocity of the water increases; therefore the blade chord needs to decrease. 'You don't need it wide at the tip, and decreasing the chord helps reduce friction. You want the power per volume of water to remain constant along the blade.

Runner Form

If you're going to have a high solidity rotor, you're going to have more blades unless the blades are extremely long axially, so you could either have lots of blades and a hub which is short in the axial direction, or just a few blades and have the hub longer in the axial direction if you want high solidity.

If you have a runner that is very long in the axial direction then the passages between blades are going to be very long and you're going to have to have the section of pipe relatively long so you get more friction against the walls of it, the blades and the hub.

Friction losses appear to be the reason why runners are designed with short blades, i.e. with a short axial length. The velocity of the water is intentionally increased before the runner, and as friction increases with higher velocity, friction may be a considerable loss, when considered over the increased length of an axially long turbine.

Guide Vane Solidity

The first turbine I built also failed because the guide vanes didn't have sufficient area. They simply failed to guide the water. The water went straight past and treated them as a minor obstruction - it didn't spin up at all.

That was particularly bad because you can think you've got enough blades to make the water conform to the new direction, but because the water is slower there, you need much bigger blades. So you need the same solidity even though the blades seem so much bigger, you still need the same solidity at the bigger diameter.

TURBINE DIAMETER

There is a good reason for having a high velocity through the runner. If you don't have very much of the energy converted into kinetic energy, that means you have to have a relatively big turbine to pass the water at low speed and you have to have a shallow blade angle, high specific speed turbine (unless you intend to have yet another set of guide vanes after the runner!).

The trouble with that is that you have to have that much more clearance gap perimeter, between the blade tips and the tube. With everything being bigger it is harder to control this gap and its also simply bigger so there is more of the clearance. So by getting the turbine smaller you increase the speed, decrease the tip losses, i.e. the leakage around the tips, and so get a higher rotational speed for electrical generation with a low-pole machine, with less gearing up.

Hub and Tip Diameter

If the hub is too small, then the geometry of the blade root gets very difficult because you then need an enormous area of the blade root which has to go right around the hub and it won't fit compared with the width of the tip. You've got to have the tip thinner compared with the root - the chord's got to be much less because the blade tends to stall at the hub where the velocity is much lower.

So you want an enormous blade root but a thin blade tip, which means it becomes very difficult to get the correct conditions right across the blade. You're going to need a big swirl space at the entrance; the pressure has to remain constant across the whole circumference of the blade, which is hard to calculate; and basically it lengthens the whole thing in an axial direction so you need a long runner space. So you might as well have a shorter runner with a bigger hub. If the hub is too big then the passages between the hub and the outside start getting thin again so you're getting more friction.

Another advantage of having a big hub is that the amount of change in the geometry of the blade - recalling that its function dictates a doubly-curved surface that is difficult to manufacture cheaply - is relatively little. Smaller hubs require blades with a lot of blade twist.

BLADE PROFILE

The only reason for having a profile in a water turbine is to reduce the shock loss effect, You don't seem to have to have a profile the way you do with a free wing in an aeroplane. The flow is pretty well constrained as it goes between the cascade of blades anyway. The water has little option but to go in the right direction. So you don't get such bad stall characteristics as you do with a single wing.

You mainly need a carefully controlled airfoil section in a single wing because of the danger of stall. That danger is very much reduced where you've got a whole cascade. So the real problem is trying to make it desensitised to shock losses which might occur at the leading edge.

CLOGGING

I tend to favour a turbine that converts a fairly high proportion of the inlet water into kinetic energy of rotation because it has big passages. I like the big passages because they don't clog up so easily. In practice I have found the biggest operating difficulty of low head turbines is sticks between the blades. It is the most common fault - not to mention snakes and eels, and I got a crayfish once. This is particularly the case where you have an open flume or don't maintain the trashrack.

Where you want a certain solidity and have to choose between short and long ducts, the long ducted design requires less blades and so the water passageways are larger. A frog, for example could travel through the latter but perhaps not the former in a small turbine, rather than getting jammed.

Swirl Space,

In terms of the same consideration the swirl space between the guide vanes and the main rotor vanes is important. If the swirl space is too narrow, as well as getting tufting of the vortices off the trailing edges, (causing vibrations which probably don't matter in small turbines), you can get frogs and eels caught between the runner and the guide vanes.

Guide Vanes

Guide vanes tend to be located before the water has reached maximum speed, in other words before the final acceleration of water into the throat. The guide vanes have to be a lot bigger to be further forward. It appears they are placed so as to give more swirl.

The real point seems to be that it is much better, from a clogging point of view to have a bigger set of guide vanes further up the tube where the velocity is lower, because the pipe is bigger.

SEASON & FLOW VARIATION

This is difficult. The Kaplan turbine maintains constant speed by changing both blade angle and guide vane angle, so you don't get any-shock conditions between the two. The curvature of the blades can't be changed so you can't do an optimal design but you can get a reasonably good flow range. With a stand-alone system you've got another option, and this is actually what we do:

You can reduce water consumption simply by reducing the speed of the runner. From the minimum to maximum speed of the runner you can get a 2:1, change in the water consumption. This is done by reducing the load, changing the excitation of the generator or changing a pulley. To make it change speed ideally, you'd change the guide vane angle and change the generator speed, and not try to change the rotor dimensions.

It is very important to be able to run the turbine at low water. I am tempted to think it would be good to have a second turbine with half the throat area; you can either use one, the other or both depending on flow conditions. This also allows you to optimise the generator for lower power. You need to alter excitation current and voltage of the machine.

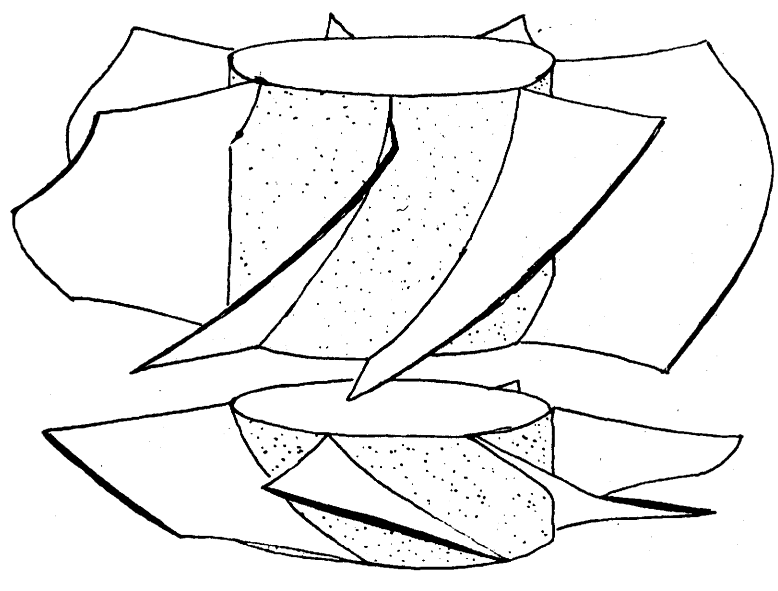
If the complication of a second turbine is too much, another option is a change-over shallow pitch runner to fit during the dry season. Reduced speed and a shallow pitch runner would improve efficiency for low flow. Another idea many people use is to allow the dam to fill for part of the day, and then turbine on until the water level comes down.

A cheap option for propeller turbines is to use axial flow pumps as turbines. Volute centrifugal pumps and even Davey pumps work badly in reverse (efficiency is less than 50%), but axial flow pumps work nearly as well as specially designed turbines. Unfortunately pumps I have seen tend to be high specific speed units to match between high shaft speed and low head lifts. A range of runners is however available. Prices vary from $100 to $400 for a 6" unit. Blade cross- section is almost the same for water flowing in either direction, but the guide vane cross section is rather bad when used in the turbine mode. Some adjustment is probably easy with an angle grinder and hammer!

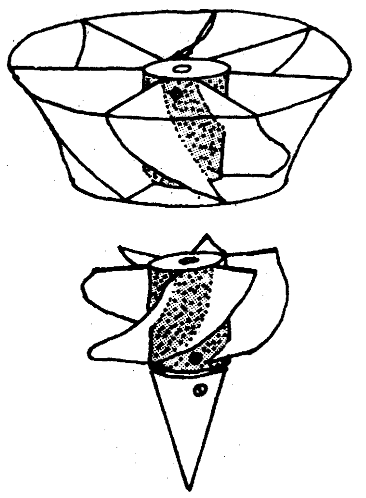
SUMMARY

To reiterate, the important thing is to have the right blade area. That's the one thing you can do very wrong. You've got to work out your angles of course and your speed (using a vector diagram) - that is just so you don't get shock loss. The section (airfoil shape) doesn't seem to be so important.

The big problem is to determine blade area, i.e. rotor solidity. This is crucial to efficiency and is the essence of the design process.



High specific speed guide vanes and runner.



Turbine detail (cut away)

Low specific speed assembly

Dunlite Blade RETROFIT

by Chris Kelman

Chris Kelman is a Nimbin Region resident who has successfully installed a 1kW Dunlite. Here is a tape transcript of his experience in improving the blade performance of this machine.

Initial Attempt

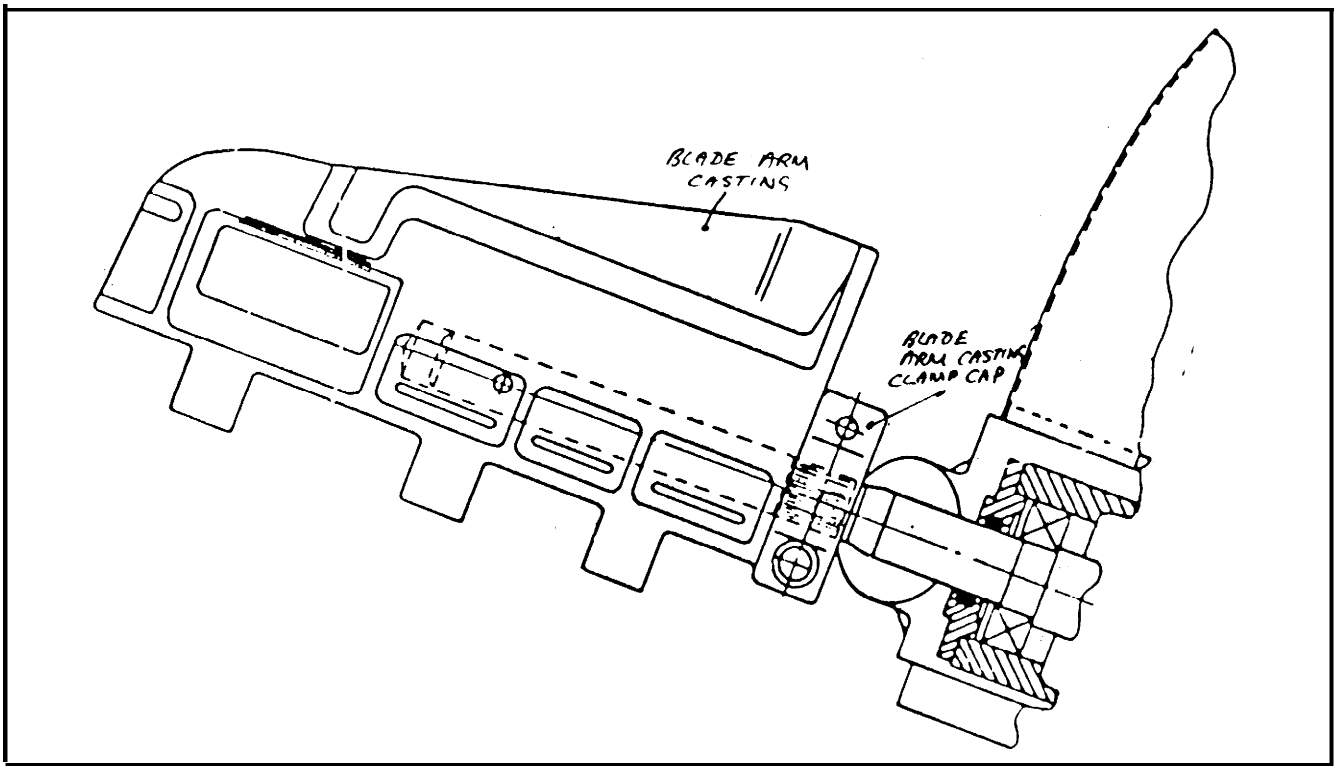
When I received the windmill I had just one blade as a sample, a 1000 watt Dunlite. So I took it into town and got a local tinsmith to bend up some fairly thick galvanised sheet, to try and approximate the airfoil and to try and make them a little bit thinner at the tip. Unfortunately he didn't put any twist into the blades at all and I didn't realise this error until I had them up on the tower and found that they wouldn't spin. They were alright in a low windspeed - they had quite a high torque but as soon as they got up in a high wind they weren't able to pick up speed because the tip of them had far too great an angle of attack, and produced a lot of drag.

Design method

Referring to *"The Wind Power Book"* by Jack Park (Cheshire, Palo Alto 1981 Appendix 3-III) I decided to try and remodel the blades. The first thing to do was to follow his calculations step-by-step - without fully understanding them I must admit - and work out various criteria; angles of attack and so forth.

I made a guess on the sort of airfoil I was going to use, and a guess on its lift-drag performance, which I have to say was a complete guess and more or less modelled out of a typical wind turbine blade which Jack Park quotes in his book.

Anyway I worked out all the angles according to his calculations which meant changing the angle of attack of the blade considerably ranging from about 15° at the root down to about 1° at the tip. So this required quite a lot of bending of the blade. Unfortunately most of the twist occurs at the blade root where the blade is thickest and the torsion box



1kW Dunlite hub

effect of having a thick blade at that point made it very hard to bend. So ultimately the twist is a bit of an approximation, being formed by using angled blocks of wood on the floor and a former and weights to hold its new position.

The calculations that he gives you also give you an idea of the chord width of the blade as well, which can be worked out. This was also somewhat different from the standard blade which has an equal chord width all the way out to the tip. So I found I was able to cut the trailing edge of the blade off, out into a more tapered blade. This also gives you a more accurate airfoil as well.

Metalwork

The secret of getting a twist in is to have the trailing edges folded over and touching each other but not pinned at any point. You find that when you twist the blade the top moves forward on one and back on the other and it is actually quite easy to twist it, but not very easy to twist exactly how you want. You need to get it into shape weighted down on the floor and then you start drilling holes and riveting it. But as soon as you put a rivet in the possibilities of twisting it become reduced. This also means that because it tends to move the chord thickness can be affected too.

You don't trim down to correct size at that stage though because the edges obviously move over each other so you maybe leave an extra 2 centimetres or so, then rivet it, then maybe trim it again and maybe you'd have to move some of the rivets.

The other thing you have to do is flatten the section down a bit towards the tip because if its just been folded in a metal folding machine it'll be of equal thickness all the way out to the tip, so you've got to use a rubber mallet and bash that down, until you get it approximately the right thickness. It is very much guess-work.

I tried to use approximately the same thickness of galvanised steel that Dunlite had used in their original model. It's fairly heavy gauge, and it actually makes quite a rigid blade when you rivet it all together.

Mounting

As for the internal construction, the way Dunlite make it is to have a small spar which maybe goes only a quarter of the blade length, which is just another piece of even heavier galvanised iron bent into the shape of the airfoil and pushed into the wing which has a very short, maybe only 15cm-20cm cast aluminium former which fits inside it, which has the stub axle bolted on to it. So I also copied that in the tin-plate and fitted that in.

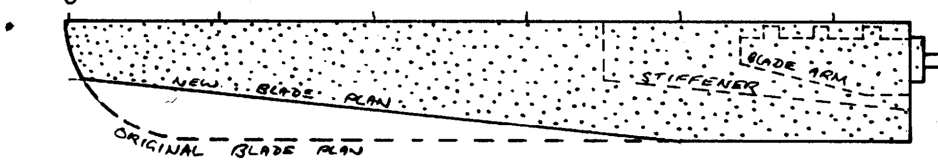
In fact, that was the most difficult part of the job because after you've done the blade folding and trimming, you've then got to try and get the blades mounted so they follow the same path in a circle, which means your axles have got to be straight, no bends allowed. You've got to get the hub formers bolted in exactly the right place, and I found that very difficult, and I still had maybe an inch out of true when the blades were spinning.

Balancing

You've also got to try and balance the blades, which requires accurate scales and lots of patience otherwise you get a lot of vibration which can destroy the machine and the tower. To balance the blades by mounting them into their hub and allowing gravity to determine weight difference would be alright, but you would have to have a room with a fairly high ceiling, you couldn't do it outside unless there was no wind, and its pretty hard to mount them, they're not light - its probably about 40-50 kg by the time you've got them on the hub with the furling mechanism and so on.

So I found I couldn't do that, I had no place to do it. But that would be the best place to do it, possibly to mount the blades on the hub with only one screw, then mount them onto the central mechanism, put that on the wall or something, and then fit the final screws after you had put the blades in their right positions. This is because I found that after I had put all the screws in at the mounting formers, I couldn't move the blades and I couldn't change their tracking. So I think that's really the most difficult part.

S.P.	0·18	0·24	0·37	0·6	1·15	∞
ϕ	6·5°	7·5°	9°	12·5°	18°	30°
S.R.	6	5	4	3	2	1

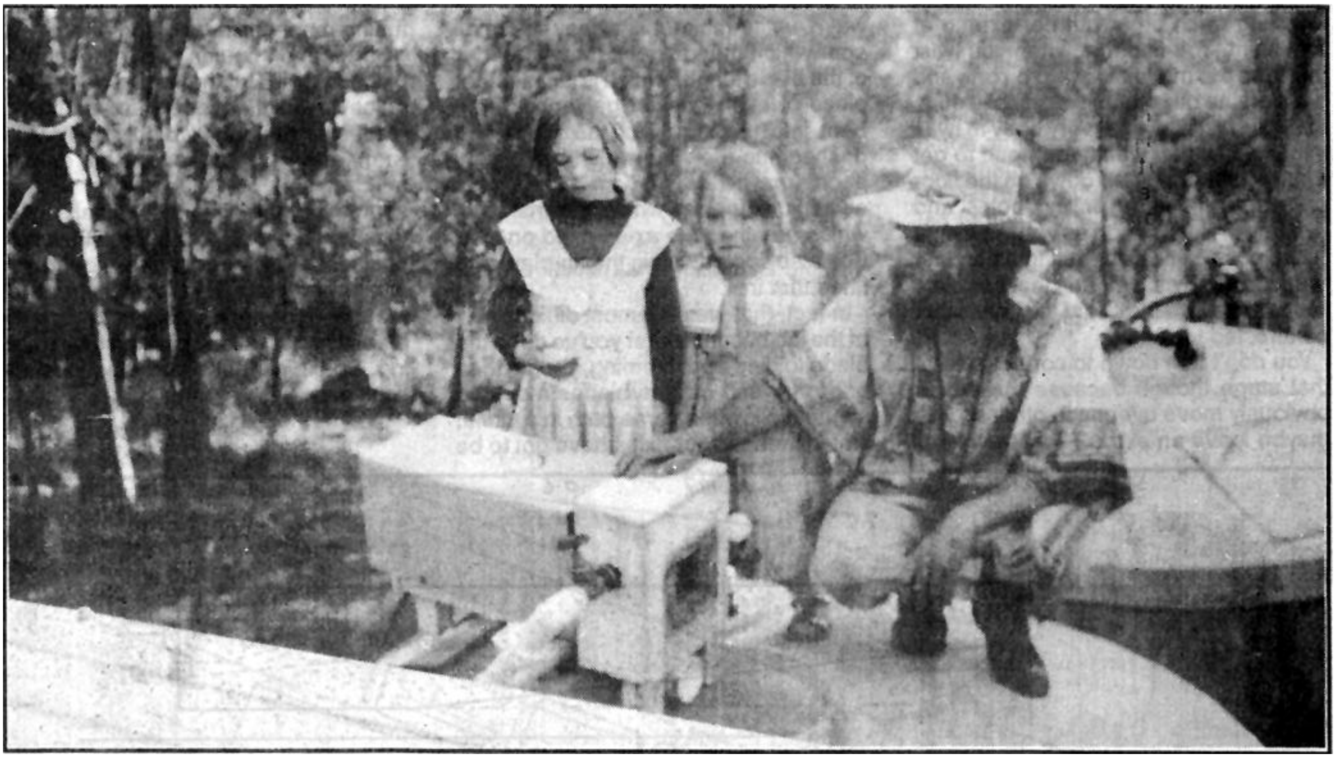


MODIFIED DUNLITE BLADE
DIAMETER = 12'
TIP-SPEED RATIO = 6
ROTOR SWEPT AREA = 112 ft^2
BLADE AREA = 4·2 sq ft × 3
LIFT COEFFICIENT = 1·08
ANGLE OF ATTACK = 5·0°
L/D MAXIMUM = 100

REFER TO JACK PARK 1981. THE WIND POWER BOOK. CHESHIRE.

CHORD	CHORD LENGTH	$\theta_T = (\phi - \theta_L)$	
C_1	$\frac{1 \times \infty}{1·08 \times 3} = \infty = \infty$	23°	15°
C_2	$\frac{2 \times 1·15}{1·08 \times 3} = 0·70' = 8·4''$	11°	11°
C_3	$\frac{3 \times 0·6}{1·08 \times 3} = 0·55' = 6·6''$	5·3°	7°
C_4	$\frac{4 \times 0·37}{1·08 \times 3} = 0·45' = 5·4''$	2°	4°
C_5	$\frac{5 \times 0·37}{1·08 \times 3} = 0·37' = 4·44''$	0·5°	2°
C_6	$\frac{6 \times 0·18}{1·08 \times 3} = 0·33' = 4''$	-0·6°	1°

Peter Pedals Personal Power Production



by Peter Pedals

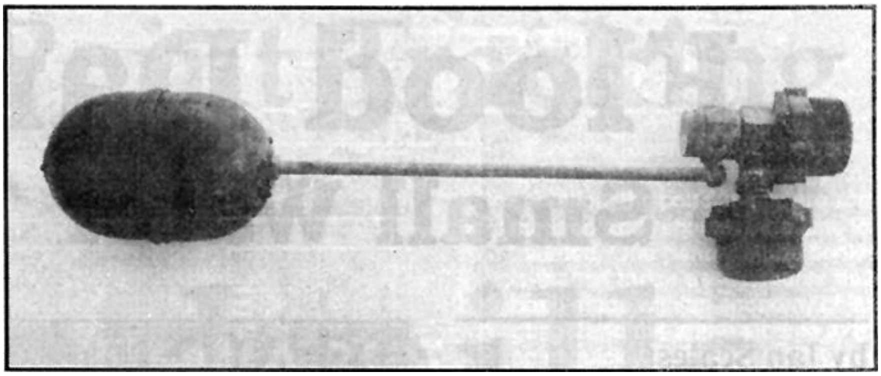
I want to tell you about my latest addition to my power system. It is a Rainbow Power Company Pelton wheel micro-hydro-electric generating system. It is designed as a battery charging system and is capable of producing a constant charge into a 12 volt battery bank of about 15 amps continuous.

This Pelton Wheel is the single biggest improvement in my power supply system yet, it puts me into the big league (4 kilowatt-hours in one day) in one single jump, provided the water supply keeps up with my demand for power. I now have a refrigerator and freezer (12 volt compressor motor type), an agitator type washing machine converted to 12 volt using a Rainbow Power Company 12 volt 1/4 hp motor, a 1400 watt rotary and a 250 watt sine wave inverter, an IBM compatible laptop computer with printer and the possibility of running a wide range of power tools etc.

Supply

I am running the Pelton Wheel on about 220 feet (66 metres) of head and have placed it on top of a 2000 gallon water tank which supplies water to six households below me. The overflow from the tank takes the water back to the creek from whence it came, only further downstream.

The tank that I get my water supply from is uphill from me and will be filled by another Pelton wheel in the same way as my Pelton wheel fills a tank. There is enough of a drop below me to run another similar Pelton wheel which provides both water and electricity for six households. This process could possibly be continued by people on neighbouring properties.



The Float Valve

Regulation

I have two float valves in the tank, one of which can be used to turn the Pelton wheel on and off, depending on whether the tank needs filling. The tank has a float valve half-way up the tank so that if the people below me should require water at a faster rate than the Pelton wheel provides, the float valve comes on. When there is plenty of water available I can operate the Pelton wheel continuously with a separate gate valve.

If I am operating the Pelton wheel via its own float valve I find it works best when I allow the level of the water in the tank to go down by at least several feet before turning the Pelton wheel float valve on to refill the tank. The float valve can then come into its own and turn the Pelton wheel off when the tank is full again. The reason for using this strategy is that when the float valve is half off it does not allow enough water through to operate the Pelton wheel and if the people below me are not using water at a fast enough rate the Pelton wheel may not be producing any power even though water is passing through it.

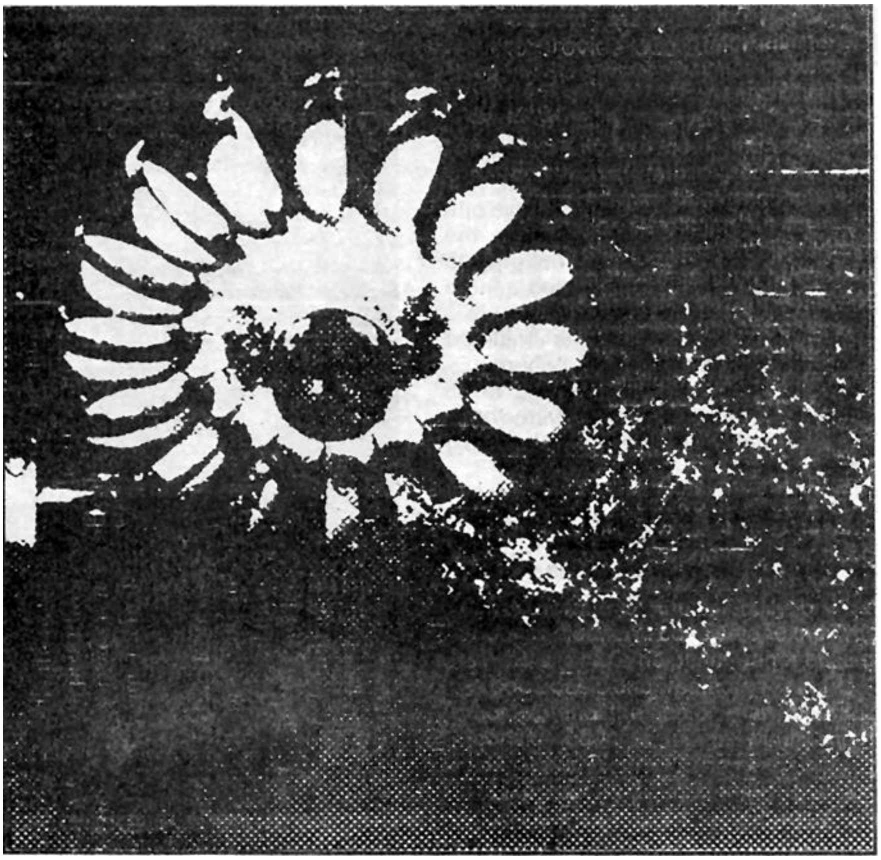
Another solution to this problem would be to use an electrical switch operated by a float and have an electrically operated solenoid valve. This method introduces significantly higher costs, more power consumption and more technology that can break down.

In the photograph you can see that I have my Pelton wheel filling two tanks, one is a community tank and the other is my private tank. Between the two tanks I intend to build a concrete bath and put a roof over the whole lot. One wall of my bathroom will then be made up largely of two concrete tanks.

The other photograph is of a 3/4" float valve with a brass outlet soldered onto it. I have 1.5" pipe connected to both ends of the float valve to keep friction to a minimum (other than that produced by the float valve).

Technical Specifications

The Rainbow Power Company's micro-hydro-electric generator represents a revolution in the production in the production of electricity from small streams. It has been designed entirely by the technical staff of the company to meet specifications arrived at through more than a decade of personal experience in the field. The unit incorporates state of the art design and materials throughout, resulting in a machine with an exceptional service life but requiring minimal maintenance. The Rainbow Power Company Pelton wheel require at least 20 metres of head but as you increase your head you can get the same amount of power out of the Pelton wheel with a lesser flow rate.



Pelton Wheel Runner

Flood Damage
to Small Water Turbines

by Ian Scales

Severe flooding around northern New South Wales recently provided an ideal opportunity to observe the effects of a "once in 50 years" flood on the turbines looked at elsewhere in this issue of Soft Technology.

The photograph is of Karl McLaughlin's turbine in Tuntable Creek (see his article starting page 40). You can see that although the penstock was torn away during the height of the flood, which covered the whole turbine, the turbine itself remains. Only the weather cover over the generator needs fixing.

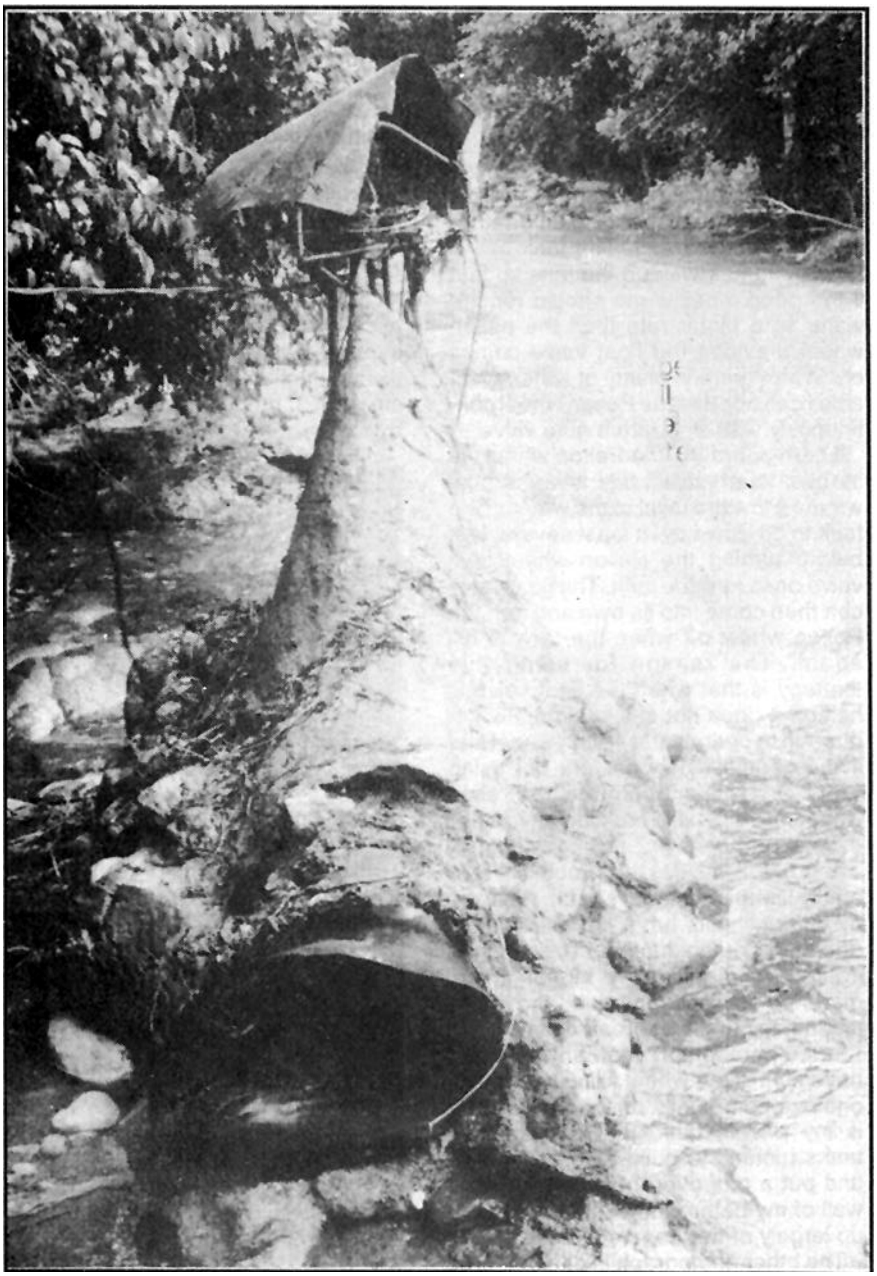
A lot of this is to do with the ferrocement cowling built to deflect debris. It is a shell about 1.5 cm thick, made of a few layers of chicken wire and baling wire with strong cement forced through it. (This ferrocement technique will be covered in a future article).

Another disused turbine near this one was washed away completely - the problem was that it was not fastened to the rock well, and it presented a large drag surface to the torrent.

John Hutchinson's turbine, featured on page 15, survived well, only requiring the generator and bearings to be dried out. This illustrates the virtue of installing the whole turbine behind a big rock.

Lessons Learnt

Turbines can survive floods if you do it right. It has more chance of surviving if bolted to the rock in the creek bed. One fault: pipes not bolted down may lift off in a flood. Pipes and penstock crossing the creek will be washed away. Keep the installation out of the flood path. It is probably better if the penstock is not connected to the turbine housing with reinforcing rod and concrete - this is so the penstock can rip out without taking the turbine with it.



Bedraggled turbine, minus penstock, after flooding

Power Point Tracking for Windmills

by Karl McLaughlin and Ian Scales.

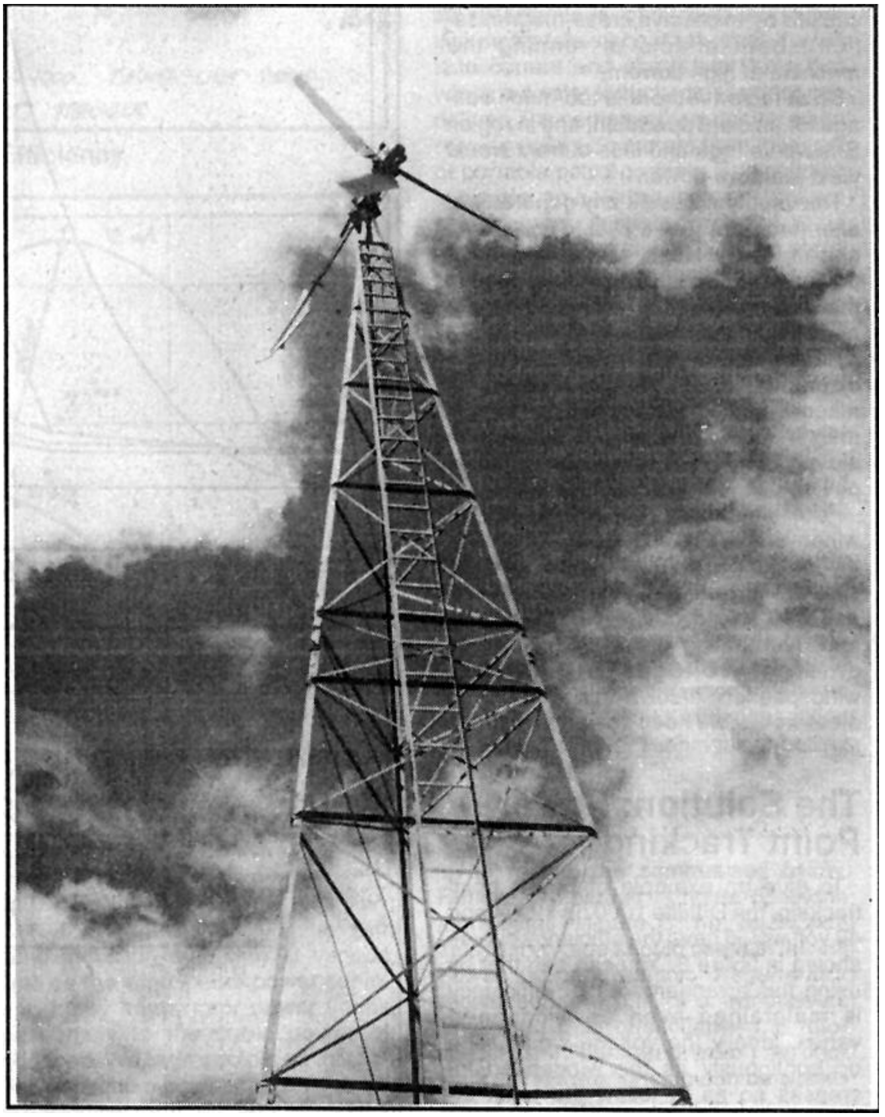
Wind is a particularly difficult natural energy source to use because of its irregularity. Most of the time winds are light, but when they are strong the energy contained is enormous. The fundamental design problem of wind generators is to use both light and strong winds efficiently. The authors have conducted a novel experiment to investigate optimum generator operating points across a range of windspeeds.

The Problem: Generator Efficiency

The rotor efficiency stays high over the range of windspeed, so long as its speed is able to vary in proportion to windspeed or, less ideally, the blade pitch can be made to vary - an option entailing more expense and less efficiency.

The generator, however, has more trouble in maintaining efficiency across the range of useful windspeed, which is from 3m/s to 15m/s, as the power varies in a ratio of 1:125!! The need for shaft speed to vary with windspeed (to keep the propeller happy) makes things even worse for the generator. From cut-in to rated speed the ratio of generator shaft speed is at least 1:3.

Take for example the Dunlite 1000 (fitted with a 1000 Watt D.C. dynamo): a venerable machine and not state of the art, but still not a bad performer. The



1kW Dunlite Wind Generator

performance of this machine is analysed in figure 1 and its overall efficiency sketched in figure 2. The efficiency of this machine has been analysed more fully in McLaughlin 1987.

In region A of figure 2, efficiency is bad because too much power is being used creating the large magnetic field needed to achieve battery voltage at such slow speed. At cut-in, 50 watt is needed before any current flows (90 watt is needed if the machine is run into a 32 V battery rather than 24 V as in this case).

In region B efficiency is indirectly bad because the rotor has to spill wind to prevent excessive current in the generator windings (and brush burning caused by excessive cross-magnetisation), both effects of running the machine at high current.

So at region A there is too much voltage for efficient operation, and in region B more voltage and less current would yield far more power.

This problem besets any generator or alternator, not just a D.C. dynamo. All generators at high windspeed have power limited by high current heating the windings (I*R) or distorting the magnetic flux in the machine.

All generators at low windspeed use disproportionate power to create their magnetic fields, except the permanent magnet machine which has other intrinsic problems (cogging, low specific power, cost, regulation difficulty).

Poor efficiencies in low and high winds are really caused by operating the machine at non-ideal voltage. At low speed, excitation losses predominate, and at high wind, copper resistance loss and overheating prevail. Switching to different voltages at different windspeeds will solve this problem. In other words, we need power point tracking.

The Solution: Power Point Tracking

To give an example of power point tracking, the Dunlite 1000 on 12, 24 and 48 volt would have the efficiency curves shown in figure 3. You can see that by using this arrangement high efficiency is maintained even as windspeed varies. Ideally the voltage would slide up continously as the windspeed increases so as to follow the peak efficiency point of these curves, but actually clunking the wingenerator into dif-

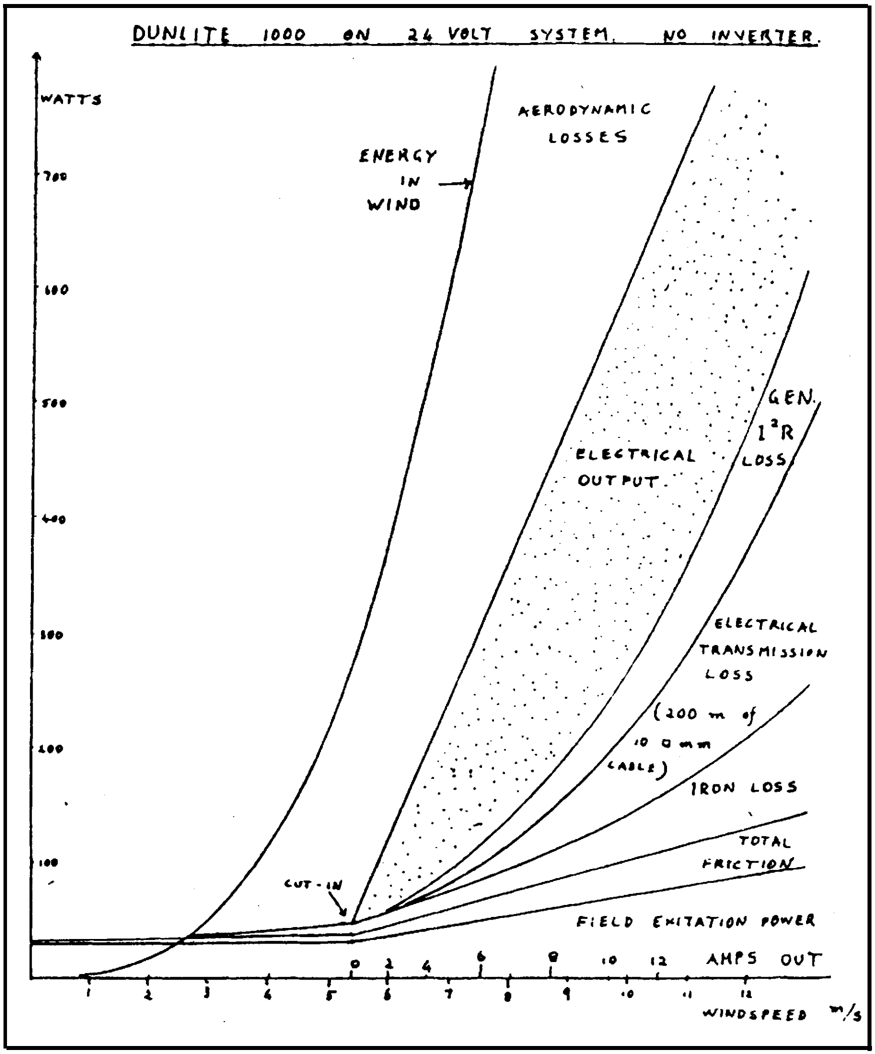


Figure 1.1 **kW** Dunlite Loss Analysis (McLaughlin 1987)

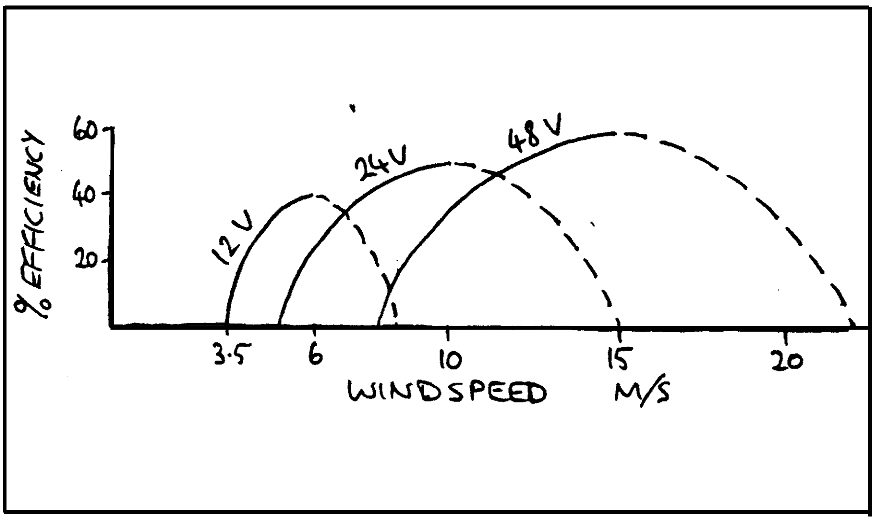


Figure 3. Dunlite at different voltages

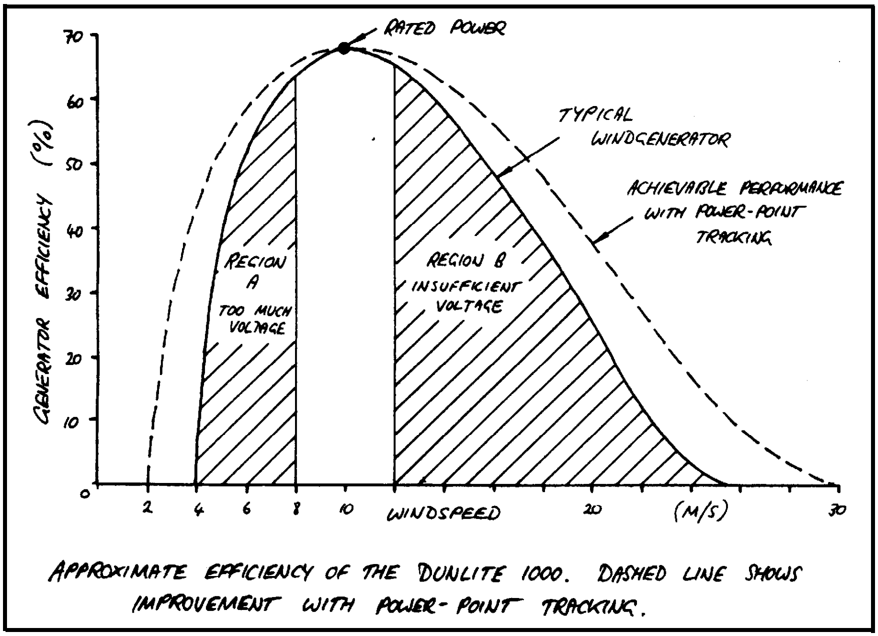


Figure 2. Dunlite Efficiency

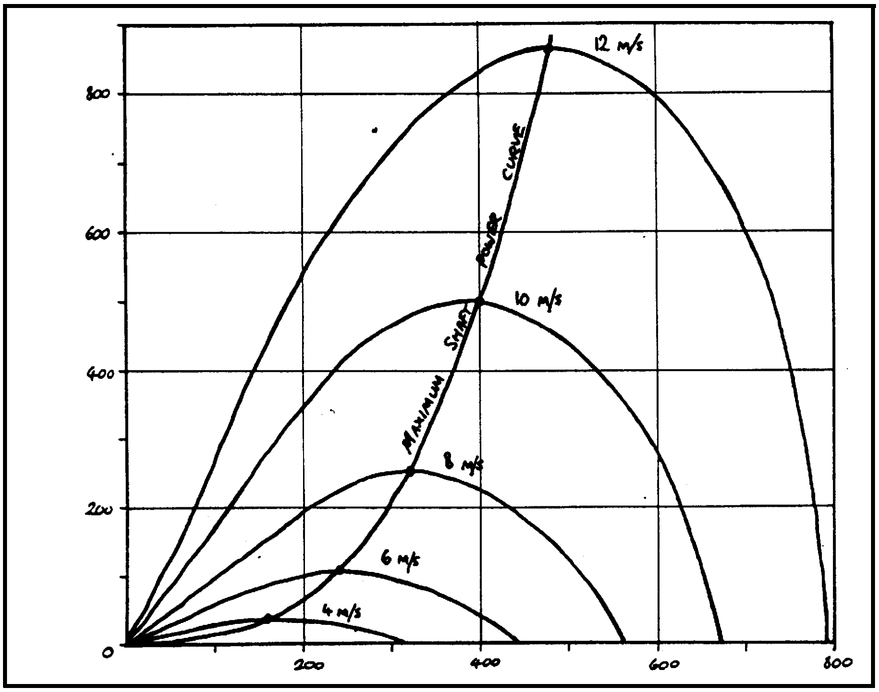


Figure 4. Power output of matched rotor

ferent voltage battery banks has been successfully done with relays.

An Experiment

To ascertain the best relationship between voltage and windspeed the authors measured the efficiency of a generator (a 3-phase 0.55 kW star-wound induction machine) at various points on the windspeed/power curve. As you may know, rotor power varies proportionally to the cubic power of windspeed. We tested points on this so-called 'maximum power curve' to simulate a windmill rotor. Figure 4 illustrates approximately the rotor characteristics that would match with the generator we were testing.

We were interested in the appropriate voltage at which the generator should operate at the different windspeeds. The method used to measure efficiency was to measure no-load losses at various voltages and speeds, then to add the load losses calculated from the currents flowing in each case. The experimental set-up we developed is shown in figure 5.

Frequencies from 15 to 50Hz and voltages from 70 to 500V were set up. Getting the induction motor to run from the induction generator was rather tricky. An induction generator will not start a similar machine running as a motor because when stalled the motor appears as an enormous load. A stalled induction motor takes about ten times the full load current and about five times that which a similar induction generator can deliver. The same problem occurs when running induction motors from inverters or portable petrol gensets. The solution is simple: spin up the motor before applying power. A starter motor of some sort can be used, but a piece of string around the pulley or shaft is sufficient! You must of course spin the motor in the correct direction, which is not always obvious in three phase systems.

In the setup in figure 5 it is not necessary to disconnect the wires, but the generator must be driven at a speed greater than that indicated by half of the capacitors connected as half are used to resonate each machine. (Whether it is a motor or generator makes little difference), then the motor must be spun to more than this speed. Surprisingly enough, stable operation results.

Identical motor and generator, and capacitor banks were used to avoid power factor measurements. Power flowing to the induction motor quantified all losses of motor running light at that speed and voltage.

Results

The results are summarised below. Results are plotted in figure 6, and in more detail in figure 7. The results indicate that voltage should rise with the 4/3 power (approximately) of generator shaftspeed in r.p.m. (i.e. windspeed, where the ratio of windspeed to rotor speed (the 'tip-speed ratio') is constant). This relationship can be written as:

$$V \propto \Omega^{4/3}$$

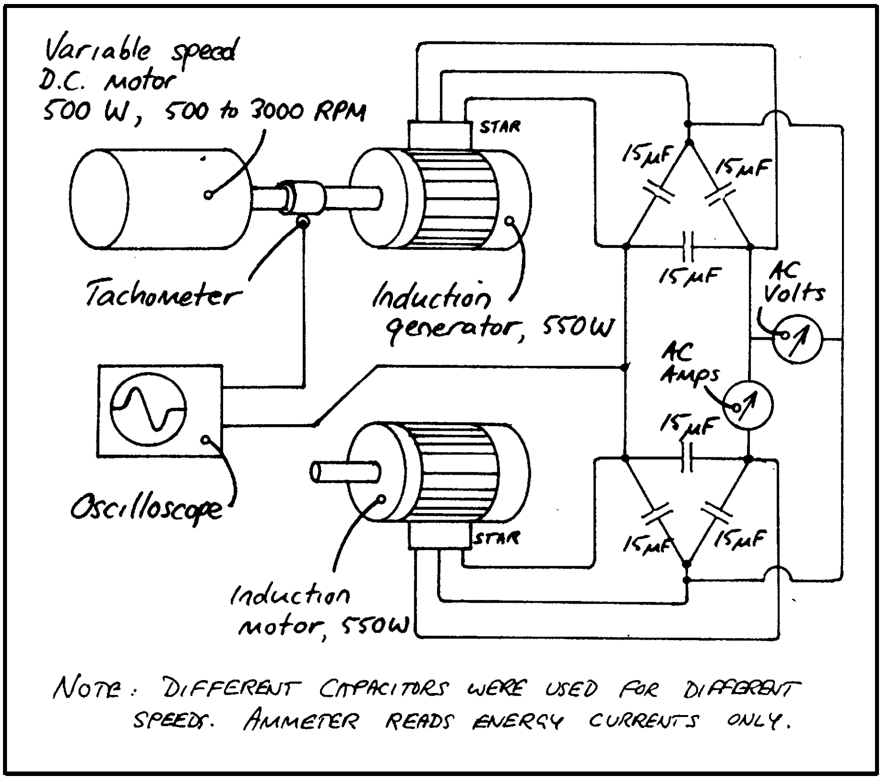


Figure 5. Experiment setup

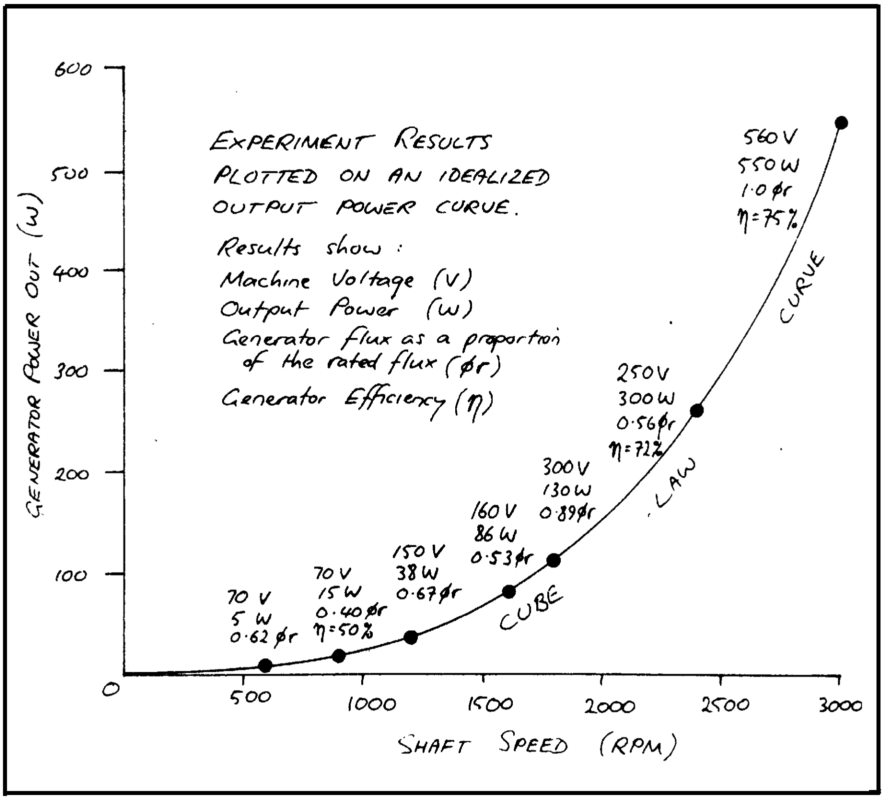


Figure 6. Experiment results

It follows from this relationship that flux must rise as the 1/3 power of speed:

$$\phi \propto \Omega^{1/3}$$

The actual value of flux varies from generator to generator, depending on machine iron losses. Flux relative to the nameplate rated characteristics can be calculated according to the relationship:

$$\phi \propto V/\Omega$$

This relationship remains linear up to 1 Tesla.

Using this principle the dashed outline efficiency of Figure 2 can be achieved, because the effects of over- and under-voltage are ameliorated.

Questions Raised

This of course leaves the question of how to arrange the circuitry so that the generator sees this state of affairs. One idea is the circuit shown in figure 8, which is suitable for induction generators. This set-up works in the following manner: Three stages of operation flow into one another -

1/ At low speed and low current the 80 W ballasts present little impedance and current flows through rectifier bridge B1. The generator runs at minimum speed with the whole 200 microFarad capacitance effectively resonating it at a voltage of maximum iron permeability.

2/ At medium speed the 80 W ballast has increasing impedance and voltage builds up enough to pass through the 10A choke from the transformer secondary, then through bridge B2. Speed has increased because voltage is higher, giving lower permeability to resonate with the 200 microFarad capacitance; also the reactance of the 10A choke tuning out some of the 200 uF.

3/ At high speed the 10A choke creates significant voltage drop both because of higher frequency and current, so voltages in the generator rise sufficiently to allow the transformer tap to charge the battery through B3.

There is nothing special about the 24 V battery bank. What is important is the way the generator voltage goes up with windspeed in the manner of figures 6 and 7.

Discussion

Our experimental set-up prevented high accuracy in our results mainly because of rudimentary equipment. Voltages particularly are found to vary considerably, but we had the voltage of the

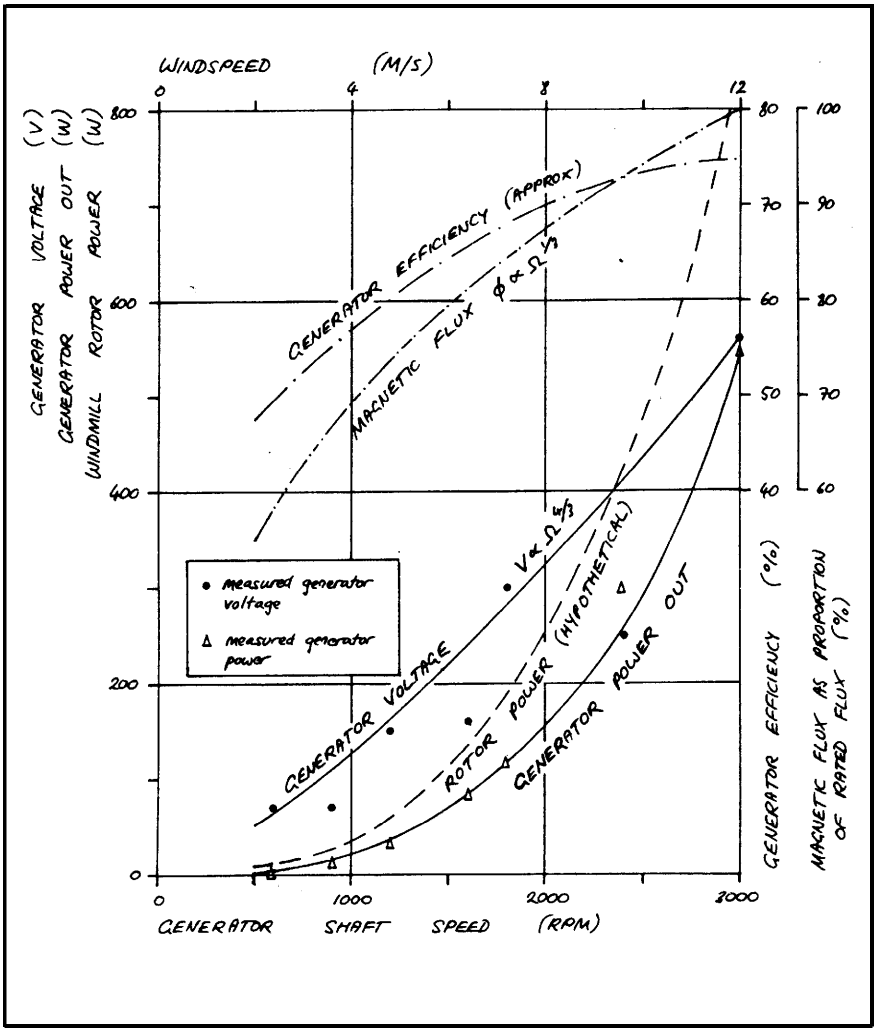


Figure 7. Experiment results in detail

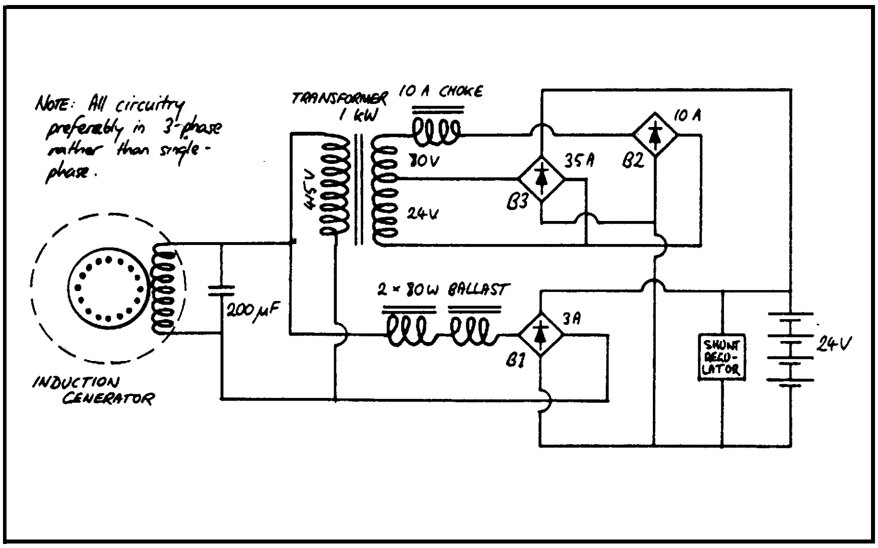


Figure 8. Electrical arrangement for induction generators

machine running at rated speed as a definite point, and could calculate a constant k for this point and use that to find the other valid points. We regard the results as a good estimate only. Publication of results from a well-equipped laboratory would be valuable.

While illustrating the characteristics of any generator operated with varying shaft speeds, the results are particularly interesting in connection with induction generators. Indeed, our initial reason for performing the tests was to understand how induction generators could be used in building economical windmills for remote-area power supplies.

A thorough literature review of published engineering papers on induction generators for windpower applications showed that there is an established assumption that the voltage produced by the machine should remain constant over the operating range. The consequence of this assumption is that complicated electronic circuitry is required to control the electrical characteristics of the machine.

For D.C. loads, this is usually achieved by using a thyristor rectifier with variable firing-angle control to continuously vary the capacitive VArs (see for example Milner and Watson 1985 and Raina and Malik 1983). We wished to consider a scheme avoiding such complications. Although standard research assumes that an induction generator with fixed capacitance exciters has a limited usefulness to wind power applications, we have begun here to explore the idea of using a fixed-value capacitance with rising voltage, yielding varying inductances between the generator and load (figure 8). We hope this initial study is taken up by others.

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SOLAR WATER HEATER BUYING GUIDE

In the last issue of Soft Technology we had a look at the important issues you should consider when looking at buying a Solar Water Heater. In this issue we will have a look at the specific brands of solar water heater which are available.

But before we look at these, lets go over some of the key things to remember when buying.

When you are looking at the solar water heating panel and tank there are a number of features which improve the efficiency and in some cases the life of the panel.

The best panels use toughened, low iron glass. Copper with a good quality selective surface is the best as far as the construction of the panel itself goes.

If these features are included in the panel the efficiency of the panel can be significantly higher than a panel with standard glass, and an aluminium plate with black paint. This means the actual panel size could be smaller than that of the less efficient panels.

As far as the tank goes gravity feed copper tanks last longer than the mains pressure equivalents. However is you are going for mains pressure stainless steel is best.

A general comment on mains pressure versus gravity feed. There has been a strong move over recent years to mains pressure hot water units.

The gravity feed units have probably lost favour because with old or poorly installed plumbing the pressure from these units can drop off. Also, a number of the major water heater manufacturers have aggressively marketed the mains pressure units.

However a properly installed gravity feed heater will supply your hot water needs just as well as mains pressure unit, it will last a lot longer and it is easier to use in conjunction with wood heating and other fuels.

The extra life and flexibility make them better value for money, but make certain the installation is correct.

In this guide we are looking at one model from each` of the manufacturers. So as to be comparing apples with apples we are looking a water heaters which would supply the heating needs of a family of around four people.

When looking at solar water heater costs remember to take installation into account. For a simple installation, the cost could be around $300 to $400. For a more complex job the cost could be much higher.

Be aware that the water heaters we have concentrated on for this buying guide may not necessarily be suitable for your needs. They are a good medium point for comparison, but you may need to look at a different model.

For example some water heating systems are designed for the warmer parts of Australia and hence have no frost protection and may use a smaller area of panels or even less efficient panels. Using one of these systems in the colder areas would be a disaster, you wouldn't get enough hot water and your pipes would burst when it got too far below freezing point. Instead you would need a system with frost protection and high efficiency panels. So look before you leap and buy to suit your individual needs.

We have made every effort that the information in this guide is correct at the time of publication, but if some features are different, we cannot be held responsible.

Now lets have a look at what is on the market.

Make: Beasley.

Model: 5M

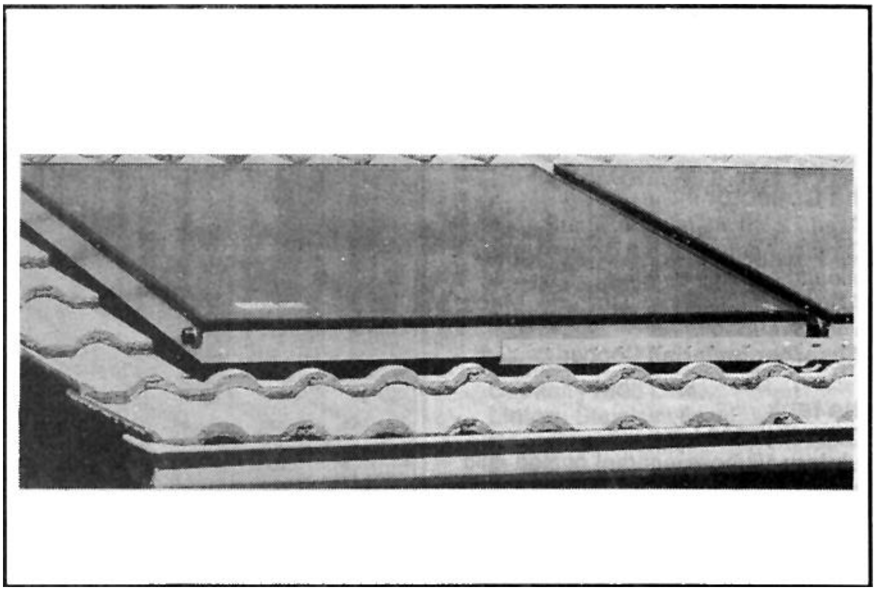
The Collector

Area: 2 x 1.5 m2 = 3 m2.
Cover: Low iron.
Absorber surface: Amcro, Selective Surface.
Absorber material: Copper.

The tank

Capacity: 370 Litre.
Lining: Copper
Boosting: Gas, electric or solid fuel
Pressure: Gravity Feed, (low pressure)

Other models: 26S300; (300 litre, close coupled, stainless steel tank). 26R 160; (Smaller close coupled, with enamel lined tank. 300 litre version also available). 26C 440L; (Larger close coupled with stainless steel tank). C340FC; Remote mains pressure tank with pumped circulation. Solamatic 5M; (a range of gravity feed models, with the tank located in the roof. Sizes available from 280L capacity to 450L. Stove connections optional.



Beasley 5M

Features: Large range of models to suit all situations. All copper construction in collectors.
Warranty: Six years on tank, seven years on panel.
Price: $1,656

Make: Edwards

Model: L 305

The Collector

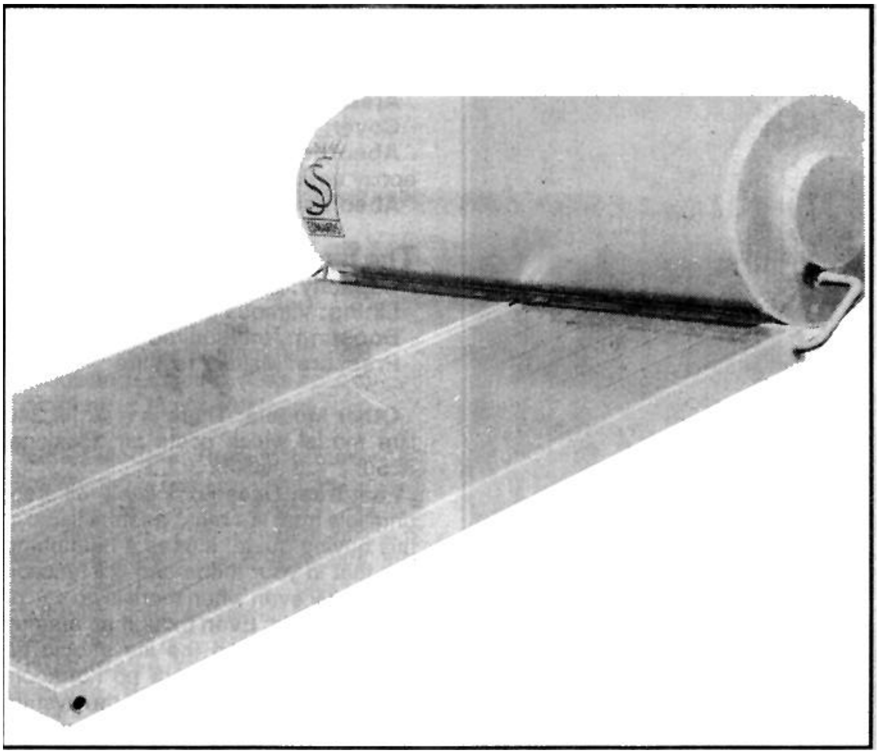
Area: 2 x 2 m2 = 4 m2.
Cover: Standard or tempered glass.
Absorber surface:
Absorber material: Aluminium or copper

The tank

Capacity: 300 Litre.
Lining: Stainless steel
Boosting: Gas, Electric or solid fuel
Pressure: Mains Pressure

Other Models: Roof mounted units vary in capacity from 180 litres, (Model L180) up to 600 litre, (Model L600). The series 250 and 500 are designed for solar, wood fired systems. Another model the GEM/300 uses a Glycol Heat Exchange system. Edwards can also supply roof mounted gravity feed tanks. They can also supply a range of water heating panels to suit individual needs.

Features: Like Beasley a large range of options available to suit most applications. Roof mounted units come in a variety of colours.
Warranty: 7 Years
Price: $1,662



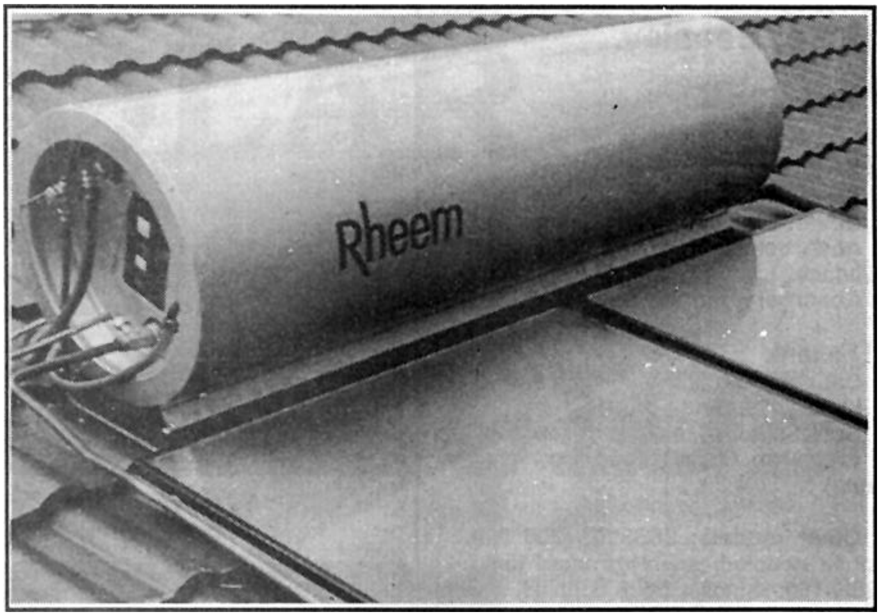
Edwards L305

Make: Rheem
Model: Highline 300L

The Collector
Area: 2 x 1.81 m2 = 3.62 m2.
Cover: Annealed, (toughened glass, optional).
Absorber surface: Chrome black selective surface.
Absorber material: Copper

The tank
Capacity: 300 Litre.
Lining: Vitreous enamel coated mild steel.
Boosting: Electric.
Pressure: Mains Pressure.

Other Models: 52F 300; This is the same as the 52T 300 except that it has frost protection.
Features:
Warranty: 5 years
Price: $1,600



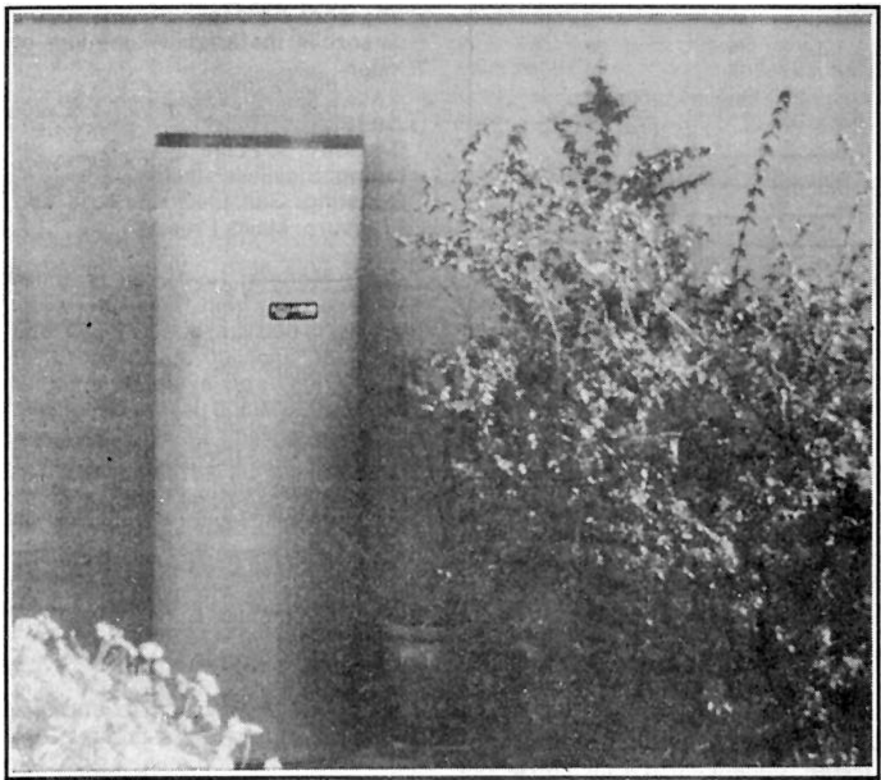
Rheem Highline 300L

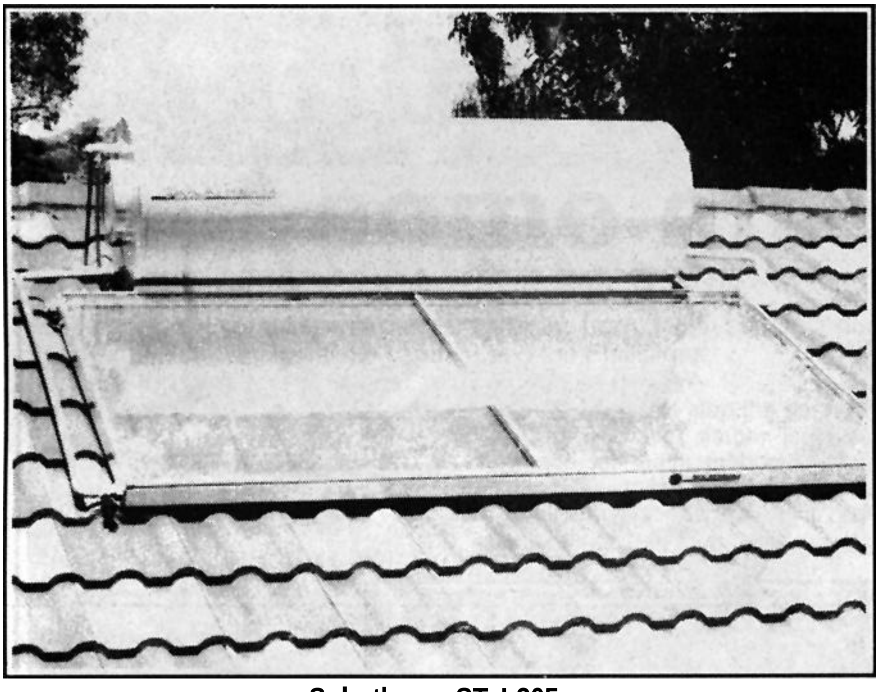
Make: Siddons, (Raypak).
Model: Solarplus, Solar boosted heat Pump.

The Collector
Area: 4 m2.
Cover: No cover required.
Absorber surface: Aircraft grade epoxy enamel.
Absorber material: Aluminium

The tank
Capacity: 270 Litres
Lining: Vitreous enamel.
Boosting: Not required
Pressure: Mains Pressure

Other Models: There is a larger 340 litre model which costs an additional $150.
Features: Uses completely different principle from the other heaters listed in this buying guide. It uses a heat pump like that in your fridge and will function effectively even when there is no sun or it is quite cold. Even though an enamel lined tank is used the life should be good because there are no hot spots from heating elements and the system does not run up to high temperatures as with systems with flat plate collectors.
Warranty: 5 years
Price: $1,914.


Siddons Solarplus



Solartherm ST L305

Make: Solartherm

Model: ST L305

The Collector

Area: 1 x 3 m2.
Cover: Low iron glass.
Absorber surface: Copper Oxide Selective surface.
Absorber material: Copper.

The tank

Capacity: 305 Litre.
Lining: Stainless Steel.
Boosting: Electric.
Pressure: Mains Pressure.

Other Models: A range of other sizes are available including L 180, (180 Litres), L 440 (440 Litres), and L 600 (600 Litres). Other models are suitable for commercial applications such as the P 305 which can be gas or electrically boosted for use in laundries and caravan parks, and the Mx500 to Mx 3,000 which are designed for high temperature recovery.

Features: Stainless steel tank for resistance to corrosion. Silver and beige colours available.

Warranty: 7 years

Price: $1,625

Make: Solarhart

Model: J

The Collector

Area: 2 x 2 m2 = 4m2.
Cover: Toughened low iron glass.
Absorber surface: Black power coating.
Absorber material: Aluminium

The tank

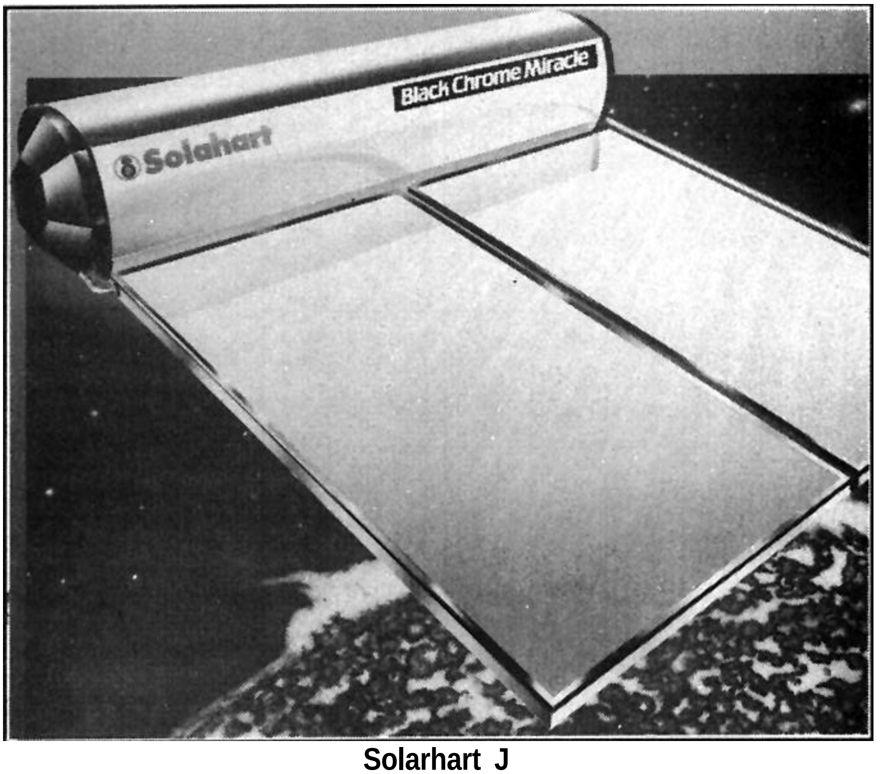
Capacity: 300 Litres
Lining: Vitreous enamelled steel.
Boosting: Electric, (Gas option)
Pressure: Mains Pressure

Other Models: There is a smaller 180 litre version of the J model. The L model does not have frost protection, but is a little cheaper. A combination of the K model collector, (with selective surface), and J model tank gives a unit suited to cold locations at a slightly higher cost.

Features: A range of colours are available. Solarhart is one of largest companies and has a strong track record.

Warranty: 7 years.

Price: $1,715



Solarhart J

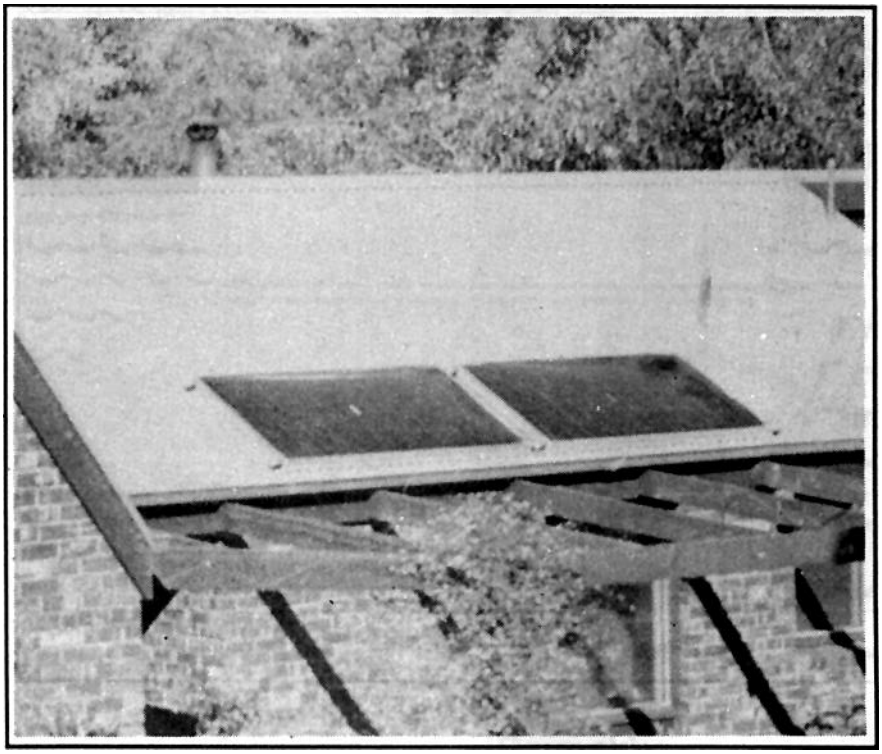
Make: Somer Solar.

Model: Nova 4/335C

The Collector
Area: 2 x 1.8 m2
Cover: Toughened, low iron, textured glass.
Absorber surface: Nickel black selective surface.
Absorber material: Aluminium

The tank
Capacity: 335 litre
Lining: Copper
Boosting: Electric and solid fuel.
Pressure: Gravity feed.

Other Models: A range of models are available including a number of different sized systems. Panels can be connected to a standard Rheem tank by the use of a pump and controller. Another option is the Nova Squat with a 400 litre tank. Stove connections are optional.
Warranty: 5 years
Price: $1,456.



Somer Solar Nova 4/335C

Waterco Solarlink

Make: Waterco.

Model: Solarlink, pre-heating system.

The Collector
Area: Varies according to requirement
Cover: Unglazed or Polycarbonate
Absorber surface: N.A.
Absorber material: EPDM or TPR

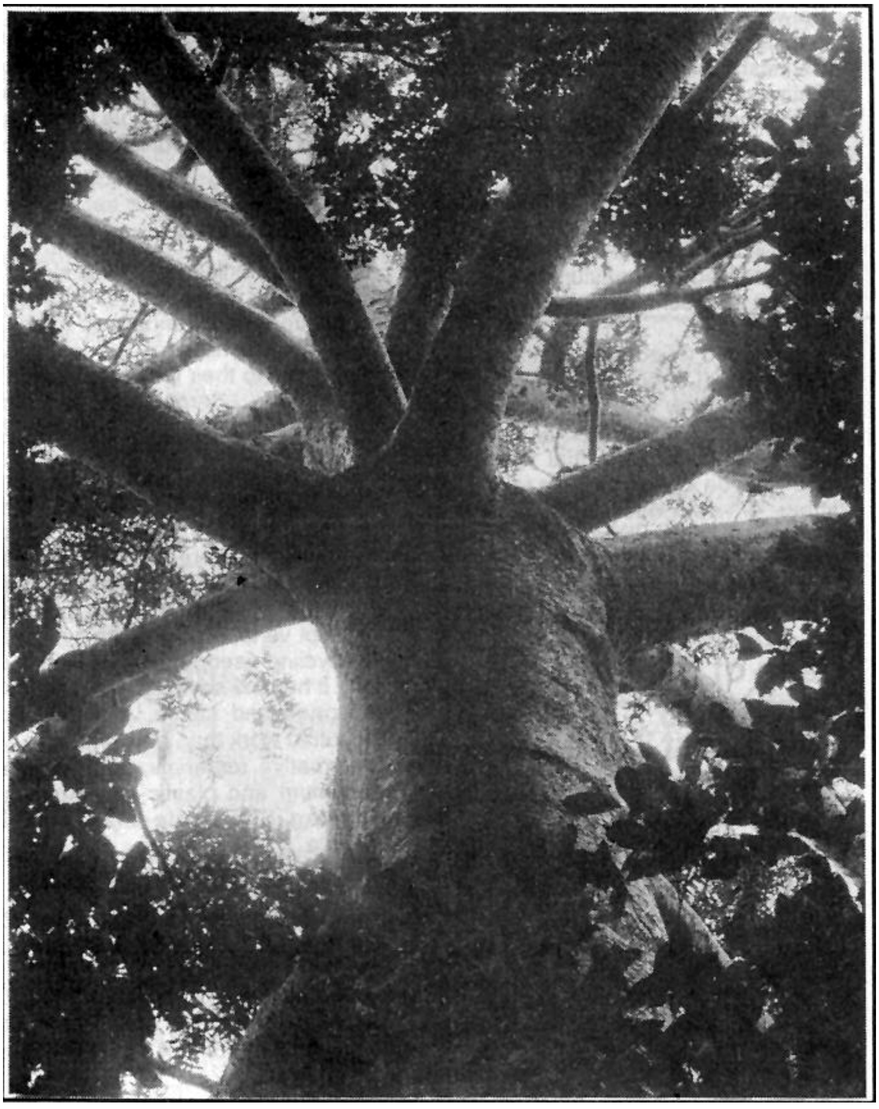
The tank
Capacity: 6,000 l, 10,000 l, 15,000 l or larger.
Lining: Synthetic.
Boosting: Heat exchanger allows the use of different form of boosting
Pressure: Mains Pressure

Features: Produces large quantities of low grade heated water, with **a** flexible absorber size that can be tailored to suit the building. This system is frequently use in commercial applications such as caravan parks, service clubs, etc.
Warranty: 12 months
Price: Price on application.

Rainforest Timbers and some alternatives

At present, rainforest timbers are used extensively in the building and furniture industries in Australia. In recent years supplies of local rainforest timbers have decreased, and imports have increased. We now import over $1.6 billion worth of timber annually. About 1/4 of the total originates in tropical rainforest, mainly from Malaysia, Indonesia and the Philippines.

The best way to stop the destruction of rainforests for timber is to stem demand for these products. Alternatives do exist, and it is also possible to grow some rainforest species in planta-



Imported Rainforest Timbers

- use not recommended

Following is a list of imported rainforest timbers. Often a single name, like Meranti, Phillipine Mahogany, Kapur and Ramin, can include various species.

It should be noted that most imports from Taiwan, Hong Kong, Singapore, South Korea and Japan containing wood in any form are made from these timbers, in particular species of the Shorea genus.

Alan (=Batu)
Almon (=Phillippine Mahogany)
Amboyna wood (=Narra)
Apitong (=Keruing)
Balau (=Batu)
Balam (=Nyatoh)
Balsa
Bangtikan (=Phillippine Mahogany)
Batu
Baygo (=Ramin)
Betis (=Nyatoh)
Beech, New Guinea
Bitis (=Nyatoh)
Borneo Camperwood (=Kapur)
Calantas
Djelutong (=Jelutong)
Gahara Buaja (=Ramin)
Gmelina
Ipil (=Merbau)
Iroko
Jelutong
Kalantas (=Calantas)
Kapoer (=Kapur)
Keroewing (=Keruing)
Keruing
Ketiau (=Nyatoh)
Koto
Kwila (=Murbau)
Lauan (=Meranti)
Lanutan (=Ramin)
Mahogany, African
Mangasinoro (=Batu)
Marfim
Mayapis (=Phillippine Mahogany)

Mavota (=Ramin)
Melawis (=Ramin)
Menkulang
Meranti (=Pacific Maple)
Merawan
Merbau
Narra
New Guinea Beech
Nyatoh
Oba Suluk (=Meranti)
Padauk
Palaquium
Phillipine Mahogany
Ramin
Red Lauan (=Phillipine Mahogany)
Rosewood (=Narra)
Selangan Kacha (=Batu)
Seraya (=Meranti)
Tanguile (=Phillipine Mahogany)
Teak
Vesi (=Merbau)

Australian Rainforest Timbers

-use not recommended

The following is a list of local rainforest timbers. These should not be used unless specifically grown for the purpose. To date hoop Pine and a very small quantity of Bunya Pine are the only Australian rainforest timbers being grown here in plantations.

Alder (Caldcluvia, Slovanea spp.)
Ash (Flindersia spp.)
Backhousia, Stony (Backhousia hughesii)
Basswood (Tieghemopanax spp.)
Bean, Black (Castanospermum australe)
Bean, Red (Dysoxylum muelleri)
Beech (Polyalthia, Citronella, Gmelina spp.)
Birch, White (Schizomera ovata)
Bollywood (Litsea spp.)
Booyong (Argyrodendon spp.)
Bonewood (Emmenosperma alphitoniodes)
Boxwood (Xanthophyllum octandrum & Planchonella pohimaniana)
Butternut, Rose (Blepharocarya involcrigera)
Candlenut (Aleurites moluccana)
Carabeen (Sloanea spp.)
Cedar (Toona, Palaquium, Melia spp.)
Cheesewood, White (Alstonia scholaris)
Coachwood (Ceratoptalum apetalum)
Cudgerie (Canarium australasicum)
Damson (Terminalia sericocarpa)
Euodia (Euodia spp.)
Foambark (Jagera pseudorhus)
Flametree (Brachychiton acerifolius)
Ivorywood (Siphonodon australis)
Jackwood (Cryptocarya glaucescens)
Magnolia (Galbulimima belgraveana)
Mahogany (Gessois, Dysoxium spp.)
Maple (Flindersia & Cryptocarya spp.)
Mararie (Pseudoweinmannia lachnocarpa)
Oak (Carnavonia, Darlingia, Musgravea, Neorites, Orites, Cardwellia, Stenocarpus, Grevillea, Buckinghamia, Argodendron spp.)
Penda, Brown (Xanthostemon chrysanthus)
Pepperwood (Cinnamomum laubatii)
Pine, Black and Brown (podocarpus spp.)
Pine, Hoop (Araucaria cunninghamii)
Pine, Putts (Flindersia acuminata)
Plumwood (Endiandra spp.)
Quandong (Elaeocarpus spp.)
Saffronheart (Halfordia kendack)
Salwood (Acacia aulococarpa)
Sassafras (Doryphora spp.)
Satinash (Eugenia & Syzygium spp.)
Satinheart, Green (Genera salicifolia)
Silkwood (Cryptocarya, Palaquium, Flindersia spp.)
Siris (Albizia spp.)
Sycamore (Ceratopetalum & Cryptocarya spp.)
Teak, Australian (Flindersia australis)
Touriga, Red (Calophylum costalum)
Walnut (Beilschmeidia & Endiandra spp.)
Yellowwood (Flindersia xanthoxyla)

Brushbox (Lophostemon confertus) grows commonly in and on the edge of rainforest and in the moister eucalypt forests. Many believe that brushbox should not be logged as it is a rainforest timber. Where it does occur outside a rainforest it is usually in an area which was once rainforest and would return to rainforest if allowed and encouraged to do so. Its use is not recommended.

Uses of the Most Commonly Imported Rainforest Timbers

Batu *(Shorea spp.)* House posts, wharfage, ship building.

Calantas *(Toona calantas)* Furniture, boatbuilding, joinery and carving.

Jelutong *(Dyera costulafa)* Carving, pattern making, toys.

Keruing *(Dipterocarpus spp.)* Structural work, poles, beams.

Kapur *(Dryobalanops spp.)* Door and window frames, window sills, joinery, furniture, shelving.

Menkulang *(Hiritiera* *spp.)* Usually in plywood imported from Malaysia.

Merantl *(Shorea spp.)* Door and window frames, doors (especially louvre), internal joinery, mouldings.

Merbau *(Intsia bijunga)* Furniture, floorings, sills, boatbuilding and veneer.

Narra *(Pterocarpus Indicus)* Furniture, turning and panelling

Nyatoh *(Sapotoceae spp.)* Plywood, architraves, mouldings and furniture, Interior only.

Phillipine Mahogany *(Shorea and Parashorea spp.)* Furniture, plywood, boatbuilding and joinery.

Ramin *(Gonostylus spp.)* Plywood, blondewood articles fashionable 20 years ago, picture frames, mouldings, dowelling.

Teak *(Tectona grandis)* Furniture, veneer, marine decking.

Cabinet Timber

Imported furniture from ASEAN countries and Taiwan is produced mainly with timber from SE. Asian rainforests. Taiwan is the single largest supplier and about 75% of its timber comes from rainforests.

Alternatives

Design re-thinking is the first step. The challenge for designers lies in minimising environmental impact, in choosing the right materials for the job and in using them to their full potential.

Composite boards, particle boards and plywoods are good choices because they utilise lower grade material and residues than traditional sawmilling, leading to more efficient use of the resource. Note that plywoods often come with rainforest timber veneers, but domestically produced veneers utilising radiata pine, hoop pine and eucalypt veneer facings are available.

Recycling used timber is also an option. It has the advantage of being well seasoned and stable, although more difficult to work than new timber.

Alternative materials, such as steel, aluminium and plastic are worth considering. Concrete may also be suitable.

Further Information:

Rainforest Information Centre, P.O. *Box 368, Lismore, N.S.W., tel. (066) 21 8505;*

The Good Wood Advisory Centre, *GPO Box 3217 GG, Melbourne 3001, tel. (03) 654 4833, fax (03) 650 5684.*

ATA Report

The ATA Annual General Meeting.

The AGM was attended by 26 members who mainly came along to hear Karl McLaughlin down from Nimbin to talk on the Rainbow Power Company - which was very interesting.

At the meeting the President reported on the CAE courses we have held on Welding and Lathe work, which were a success.

Work on the educational display trailer has progressed with the help of a $3,000 VSEC grant which has been used to upgrade models. VSEC will help plan and prepare educational kits to prepare it for use with school visits.

Requests were made for people to help process mail as the public's concern about the Greenhouse Effect have led to more requests for information coming from students and other interested people. We have bought our own computer and that should help us keep membership and word processing up to date.

It was reported that combined membership and Soft Technology subscribers has increased to around 1,000.

Mick Harris and Karl McLaughlin are using the Solar Workshop to construct a windmill and waterwheel for the Brunswick Electric Supply's Energy Park. Karl commented favourably on the workshop and said it was better than anything they had up around Nimbin.

New Committee

The new committee is as follows :-

PRESIDENT Mick Harris
TREASURER Eva Fabian
SECRETARY Herb Wildes
"OFFICIAL" COMMITTEE MEMBERS Alan Hutchinson, Noel Jeffery, Chris Moss, Andrew Barker
COMMITTEE MEMBERS Bob Kealy, Jeff Hilder, Chris Harkin

As the Constitution allows for seven committee members in total, the first seven members are "Official" and the rest unofficial and will not appear on the list going to Corporate Affairs. In the event of any constitutional matter needing to be decided only official members will be allowed to vote. Otherwise there will be no difference between them.

Energy Conservation Efforts

In the last few months the Greenhouse Effect issue has jumped to the forefront of many peoples minds.

The ATA is the only community based energy group in Victoria and as such has had a lot of work and involvement in formulating an anti-nuclear, pro-conservation and renewable energy response to the problem.

We have produced a booklet, entitled "The Renewable Solution", which sets out a renewable energy path for Victoria. This was produced specially for the Bill Keepin tour of Australia. It is our reply to the various reports and draft policies on the Greenhouse Effect, and will be used as a basis for submissions to State and Federal Government.

Bill Keepin came to Australia from the U.S. to spread the word on Energy Conservation and Demand Management, as the answer to energy growth and fossil fuel emissions.

Around 1000 people turned up to the public meeting in Melbourne on a cold July night at Collingwood Town Hall. They were met at the entrance by a spotlit and fairy light bedecked Solar trailer and the usual stall, selling magazines and giving away membership forms. A lot of interest was shown and about 80 copies of *The Renewable Solution* were sold.

Around and About

At last we received some grant money, to finish the trailer and do some policy work. Mick Harris and Jeff Hilder have worked hard to get the trailer ready for the Bill Keepin tour and we have bought new equipment to go with it.

Because of the amount of work facing us and the perilous financial situation we have got into in the last year or so, we made an appeal for money in July. The response was gratifying with sums of up to $1,000 received for which we are most grateful. It is a time when we can really influence other groups and the Government and convince people that there is an alternative to the economic treadmill that we are currently on.

In the spring term, the ATA held CAE. courses in metal working, welding and Powering your home without the SEC. These were held at the Solar Workshop, and were very well attended.

Eva Moss has come to help out as office worker and has brought the books up to date for the AGM. Not an easy task.

Brendan English and Tony Murphy have been very busy around the Solar Workshop. They have opened the Workshop almost every day for quite a few weeks, adding to the general bustle of the CERES site. Very encouraging.

EDITOR S NOTES

Government Kills Off Renewable Energy

The Federal Government has decided to completely withdraw funding from the CSIRO's Renewable Energy Index. This is the only comprehensive, regularly updated bibliography of renewable energy research in the Australia - Pacific region.

The first volume of the index was published in 1981 and the final, 31st, volume is being produced now. One of the small group of workers described the project to me as a 'dead duck'. Of course, there will now be no way to coordinate research in the field, leaving everyone blind as to what others are doing.

News of such subtle sabotage is unlikely to reach the public, and contrasts starkly with the Government's rhetorical blather about their 'concern' for the environment.

Take up thy magazine and flog...

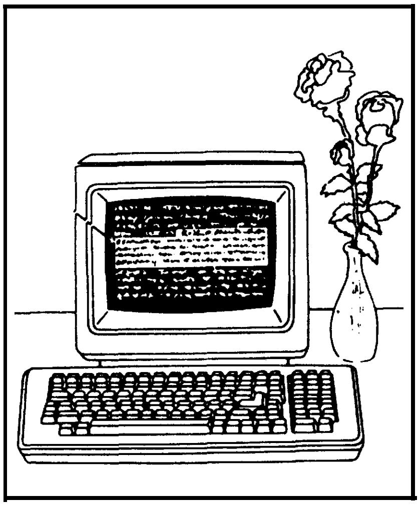
Fancy yourself in the wonderful world of promotions and marketing? Soft Technology needs a little help in that direction -we figure that we could increase circulation simply by telling people we exist. More readers will eventually mean more input and better articles.

Take a copy of Soft Tech along to your local greenie-alternatives shop or newsagent . . if they'll take copies of Soft Technology, please let us know! Ask your school or local library to subscribe. Give us a ring if you'd like to help at this end.

Soft Technology gets its Bearings

In England, the first thrust bearings were developed for windmills in the late eighteenth century.

The radial ball bearing began its development with the introduction of the bicycle in the middle of the nineteenth



century. (from *'Balland Roller Bearings',* Engineering Equipment Users Assoc. 1958)

Your Name in Print

We would like to get articles together on the following topics. If you think you can contribute (complete articles, participation in a group effort, or information and/or contacts you know will be useful), write to us or ring the editorial hotline now!

Here are some of our ideas (can you think of others? Let us know):

-Women in Alternative Technology
-Permaculture Concepts
-Urban House Design
-Energy Conservation
-Composting Toilets
-Hazardous Household Chemicals
-Electronics for RAPSS
-Energy storage
-Solar Ponds
-Wave, Tidal, OETC Energy
-Ergonomic Design
-Spatial concepts for community **layout**

Of course, we're still looking for articles about your latest project!

Brain Food

Here are a few things definitely worth pointing out -

"How Green is the Wind" *New Scientist* May 27 1989. This article raises a number of issues involved in planning a contribution of 10 - 20% of (Britain's) electricity from windpower. The considerations apply to us also **"Energy Efficient Buildings",** *Scientific American* April 1988. Great article reviewing energy conservation and its implementation in the U.S. at present.

"All gas and garbage", *New Scientist 3* June 1989. Again expertly written, this article gives details of (mainly British) experience with biogas electric generation from rubbish tips.

BOOK REVIEWS

The Renewable Solution

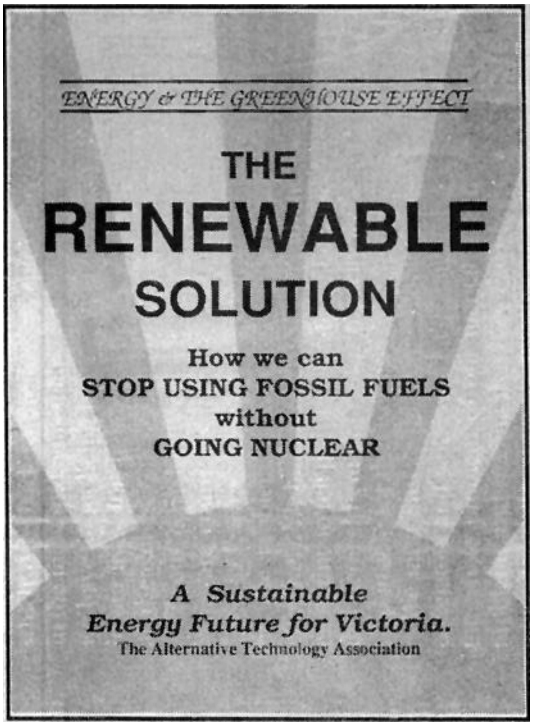
by Alan Hutchinson, Chris Moss and Ian Scales.
Alternative Technology Association, 1989.
A5 format, 20 pp., illustrated.
Reviewed by R. Feynman

The front cover says it all. It has the longest subtitle I've seen for a long time: "Energy and the Greenhouse Effect; how we can stop using fossil fuels without going nuclear; a sustainable energy future for Victoria".

The booklet aims to present the case for energy conservation and the substitution of fossil-fuels with renewable sources, all with the intention of averting the greenhouse effect. It was inspired by the pioneering study by Bill Keepin and Gregory Kats in the U.S., in which nuclear power and energy conservation were compared for economic merit. Their study demonstrated **a** clear, quantitative victory for conservation, As Bill Keepin said in his recent talk in Melbourne: "If you want to take a bath and the bath is full of holes you can do either of two things: keep pouring in more water or plug the holes." Quite.

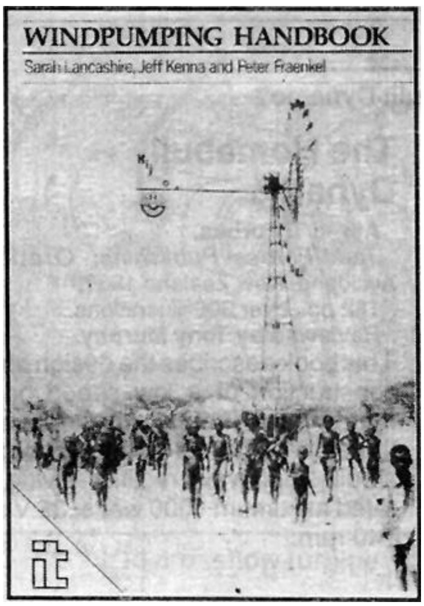
"The Renewable Solution" takes up this lead by gathering together recent Government figures for energy use in Victoria: it then looks at where energy use can be made more efficient by current cost-effective means, and assesses the quantitative impact a concerted effort to adopt these measures would make in the commercial, industrial and domestic sectors. Unfortunately the booklet does not address issues of urban planning or transport policy, both of which affect energy use in transport.

With this information an assessment of energy demand under a conservation scenario is made. Then a quantitative estimate of how much energy could be supplied by non-polluting cost-effective current renewable energy technologies is calculated. Interestingly, the authors conclude that given the contraction of demand (with no loss in 'living standards') that would come from a conservation program, it is entirely feasible to



supply the majority of heating and electricity needs by renewable means such as solar, hydro-electric, windpower etc.

Criticism of present attitudes and policy are made, comparisons made



with other countries of our current (poor) performance in energy conservation; the conclusions are summarised and recommendations formulated. One beauty of the booklet is that all these assessments have been made with an economy of language and the authors come to the point quickly. Sometimes pithy, very informative, and succinct.

Available from the ATA, $2.80 by mail

Windpumping Handbook

by Sarah Lancashire, Jeff Kenna and Peter Frankel.
Intermediate Technology Publications, London, 1987.
Reviewed by Mick Harris.

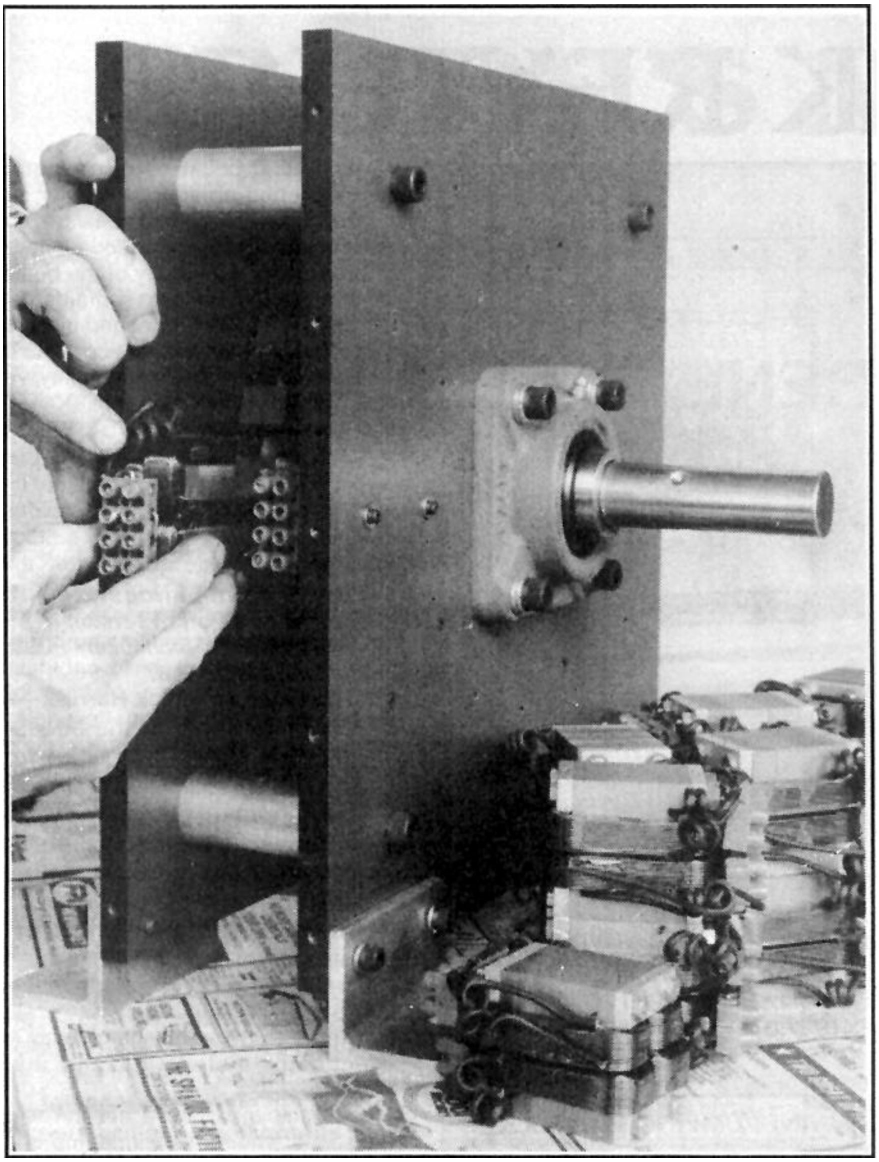
This is another of the series of excellent practical books from the Intermediate Technology Development Group. It is written to provide decision makers and potential users of windpumps with the basic information needed in the selection of a windpump for a particular use.

In particular it covers windpump history, principles of operation, site evaluation, how to go about purchasing the windpump, installation and maintenance.

The book also has a section which questions whether a windpump is the best option at all. Its refreshing to see that rather than just promoting the windpump as the solution to your problems and telling you how to go about sizing and installing the windpump, this book also deals with the hard question of whether this technology is really appropriate to the needs which are at hand.

The format of the windpump handbook is clear and concise and the order of the chapters help the reader build up a good basic understanding of the technology and the factor that should be considered in planning a windpump installation.

Like most Intermediate Technology publications this book is primarily intended for those working in developing countries. But also like most I.T. publi-



"The Homebuilt Dynamo"

cations this does not dominate the book, and there are plenty of facts and figures that are relevant to all potential windpump users.

The book does not cover reconditioning or repair of windmills and its coverage of installation and maintenance is brief. However if you want a good grounding in the principles of windpump operation and designing systems to suit your own particular needs this book could make a good investment.

Copy Supplied by Second Back Row Press, Katoomba, N.S.W.

Price: $9.50

The Homebuilt Dynamo

Alfred T. Forbes.

Todd-Forbes Publishing, Oratia, Auckland, New Zealand 1987,

182 pp., over 300 illustrations.

Reviewed by Tony Murphy.

This book describes the design and construction of a low speed permanent magnet alternator. The three phase output passes through a built-in full-wave rectifier, giving a rated maximum 1000 watts, 36 V at 740 rpm.

Essential reading if you're planning on building a permanent magnet alternator! If you're designing a wind, water or pedal power system, this book would be worth a look too.

Most of the illustrations are good quality black and white photos, so you can see exactly what the author is talking about. The book is suitable for people who have little knowledge about electricity, as the author explains everything well. The step-by-step instructions guide you through the complicated areas of construction and assembly. No welding or even soldering is needed. With the exception of some lathe work on the rotor hub and some spacers, all the construction can be completed with just hand tools, as is shown in the book. However, some of the stages of construction would be speeded up if you have access to power tools.

The design is simple and rugged. Strontium-ferrite magnets are attached to the rotor which spins past the stationary coils in which the electricity is generated. So there are no brushes to cause friction and wear. The only maintenance needed is grease applied to the two main shaft bearings occasionally.

An appendix deals with scaling up the size of the alternator - for example doubling the size gives a bit over 8 kW at below 700 rpm. There is some discussion of design and theory as well.

The only reservation I have about the book is its high price. It is printed on very high quality paper and it is well bound in hard cover - I suppose that explains it. I think the book would have a higher circulation among experimenters and alternative technology enthusiasts if it was cheaper.

A highly recommended book, and the author says he is willing to work by mail with anyone who wants to tackle the project.

Available from Todd-Forbes Publishing, PO Box 3919, Auckland, New Zealand. $85 Aust. by airmail.

Local Experience with Micro-Hydro Technology

Ueli Meier

SKAT/ATOL (Swiss Centre for Appropriate Technology/ Study and Documentation Centre, Belgium), 3rd ed., 1985.

169 pp, many figures, tables, graphics and photographs.

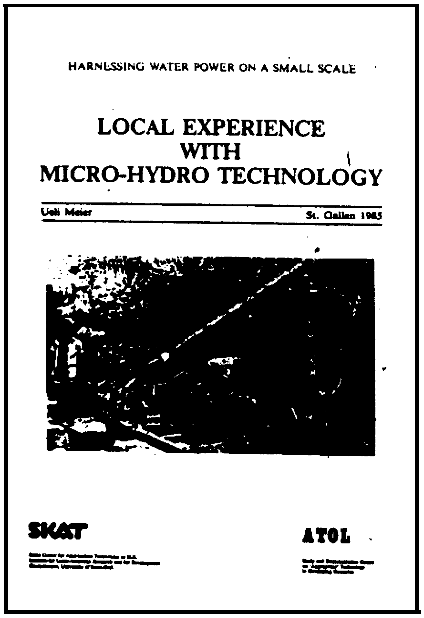
Reviewed by Noel Jeffery

This book forms a useful basis for a practical book on the establishment of Micro-hydro plants in developing countries. It looks at the need to expand domestic energy production in the face of rising petroleum prices and diminishing supplies of biomass energy (firewood, dung etc.)

There is a review of the various new solutions alcohol, biogas and producer gas, the direct use of the sun and wind for pumping, water heating and electricity and finally hydropower. Industrial development in Europe often began with small hydroplants until some 80% of potential was used compared with less than 20% in Asia and Africa.

Large hydro schemes have large river flows, high capital costs for construction and power distribution as well as needing high levels of engineering skills and catering for large industrial demands in urban areas. Small hydros imply decentralisation of manufacture, usage, operation and often ownership. Switzerland and Chinese examples are cited.

A practical section of some 50 pages deals with the constraints of small hydros: lack of hydrological data for small streams, load factors, cost of Government administration and construction compared with local management and construction. Various types of turbines are examined and explained and experience in Nepal with a propel-



ler-type turbine driven and the need for a more versatile turbine for varying flow rates and river loads noted.

The cross-flow turbine (Michell-Banki) invented by an Australian in 1903 shows promise for versatility and ease of manufacture in small (under 100kw) hydros on a low head. Details are given of two turbines, BYS/T1 (25kW) and BYS/T3, a smaller high-head unit (30kW), both of which could be carried in and assembled at remote sites.

General details are given on penstock construction, transmission, electric generators, speed governors, optimum site selection and conduit construction. Project examples are given from Nepal and Thailand covering technical details, organisation and investment costs.

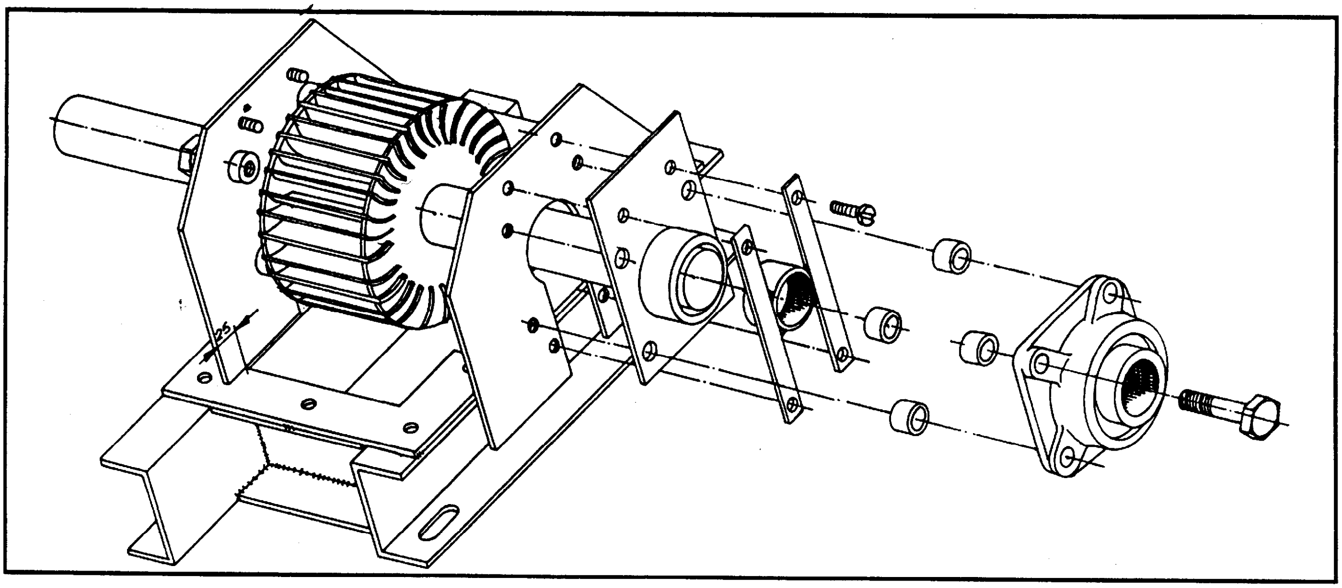
Economic considerations follow using a three level cost-benefit approach to evaluate project viability. A comparison of costs of projects using a variety of turbines, diesel steam, wind and photovoltaics.

The final chapter deals with training needs, legal and institutional considerations in transferring micro-hydro technology to countries lacking this. The book is well printed with plenty of diagrams and photographs. It has appendices giving a useful bibliography, a manufacturers list and organisations involved in micro-hydro development.

Two further books *(Crossflow Turbine Type BYS/T1 and Crossflow Turbine Type* BYS/T3) give detailed drawings and the necessary instructions for the construction of the T1 and T3 turbines respectively, the later being more detailed. A third book *(Manual for the Design of a Simple Mechanical Water-hydraulic Speed Governor)* deals with the construction of a mechanical speed governor. These must be ordered as separate publications.

Available from *Swiss Centre for Appropriate Technology,* Varnbuelstrasse 14, CH-9000 St. Gallen Switzerland.

Price approx 20 Swiss Francs + P&P.



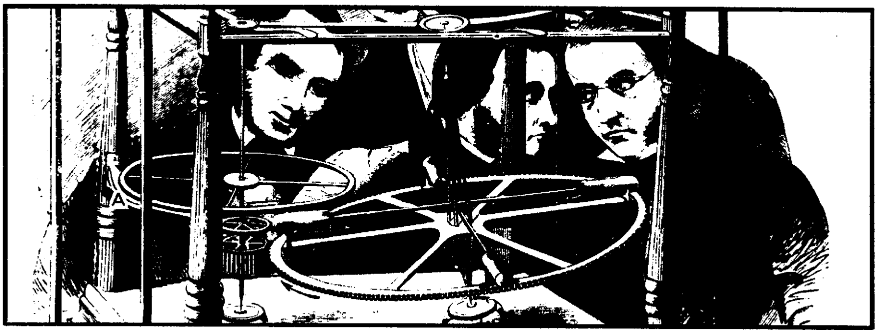
BYS/T3 crossflow turbine

LETTERS TO THE EDITOR

Physics and Perpetual Life

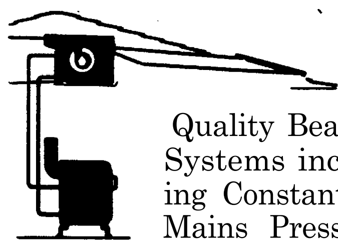
Thank you Stephen Downing for your letter in the last issue expounding clearly the laws of physics as they have been since 1824 on the subject of heat engines.

I weekly get STD calls from proponents of perpetual motion machines. Usually these are based on generators, motors, pumps or turbines working at more than 100% efficiency. Peopleget ideas which seem intuitively credible but they don't bother with working models or calculations. These ideas don't ever come to terms with the subtlety of the second law of thermodynamics, or the vagaries of cost effectiveness or practicality. They fail simply on conservation of energy laws.



The "no free lunch" law really irritates people. Why should the physicists have such authority while in politics, economics, even marital affairs there ARE free lunches! Surely scientists, as the high priests of this materialistic age, have held this credibility by suppressing heresy, inventing their own language and even creating reality by believing in it! Perhaps serendipity works the other way around: laws of physics are created by people doing experiments. It does work like that sometimes in medicine.

The problem, I suggest, is in human personality. People have always believed in everlasting life and the



growth economy. Sustainability is a BORING CONCEPT, and entropy increasing is inherently depressing. It is ironic that the physics of entropy gave us the industrial and the information revolutions, and the concept of sustainability, if it can be enacted, offers perpetual life to our civilisation! Most lifeforms acting freely seem to grow exponentially until they run out of reasons or suffocate on their products, be they bacteria or people. Only when there are constraints, interaction and competition is there stability.

Long live GAIA,

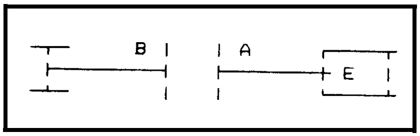
Karli McLaughlin.

Gearbox invention

Dear Sir/Madam,

Between 7 and 10 years ago, when I was living in New Zealand, the NZ. Broadcasting Commission TV had a programme on called *The Inventors.* It was a programme for ordinary New Zealanders to show off what they had invented. One of the inventors was a man who had invented a gear box that had only a few moving parts. The principle was that you had a swivelling gear in front of another fixed gear. The degree of swivel of the front gear changed the ratio of the rear drive. The principle of the gearbox is shown in the drawing below.

The engine (E) drives a shaft onto a coin-like (A) plate with rounded mesh type gears on it. The plate A can swivel



Gearbox concept

and the more it swivels the lower the ratio is. The face of (A) is designed to mesh in with the face of (B) no matter what the swivel of A is. The gear box has such a huge range of ratios that you could connect up a very small electric motor to the gearbox and lift a house up with it. What we could do is buy a video film of the particular programme, to study of the ideas behind the gearbox. If it is not possible to get a video copy of the programme which could be used as the basis for an article in "Soft *Technology*", would it be possible to get the name and address of the inventor.

Yours Sincerely

W.T. Wadsworth

Northcote VIC

(Can anyone help? - Ed.)

Errata

Karl McLaughlin's article in our previous issue **(S.T.31, April '89: *"Induction generators for cheap energy projects"*)** has an error in the last paragraph of page 29.

This should read:

"Induction motors come in different speeds. Depending on whether they are wound 2, 4, or 6 pole they may be rated at 2480, 1440 or 930 rpm respectively."

The figure numbers are also wrong in the article. The reader should be able to sort this out without too much trouble.

Furnace with water-driven bellows, 16th century.

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