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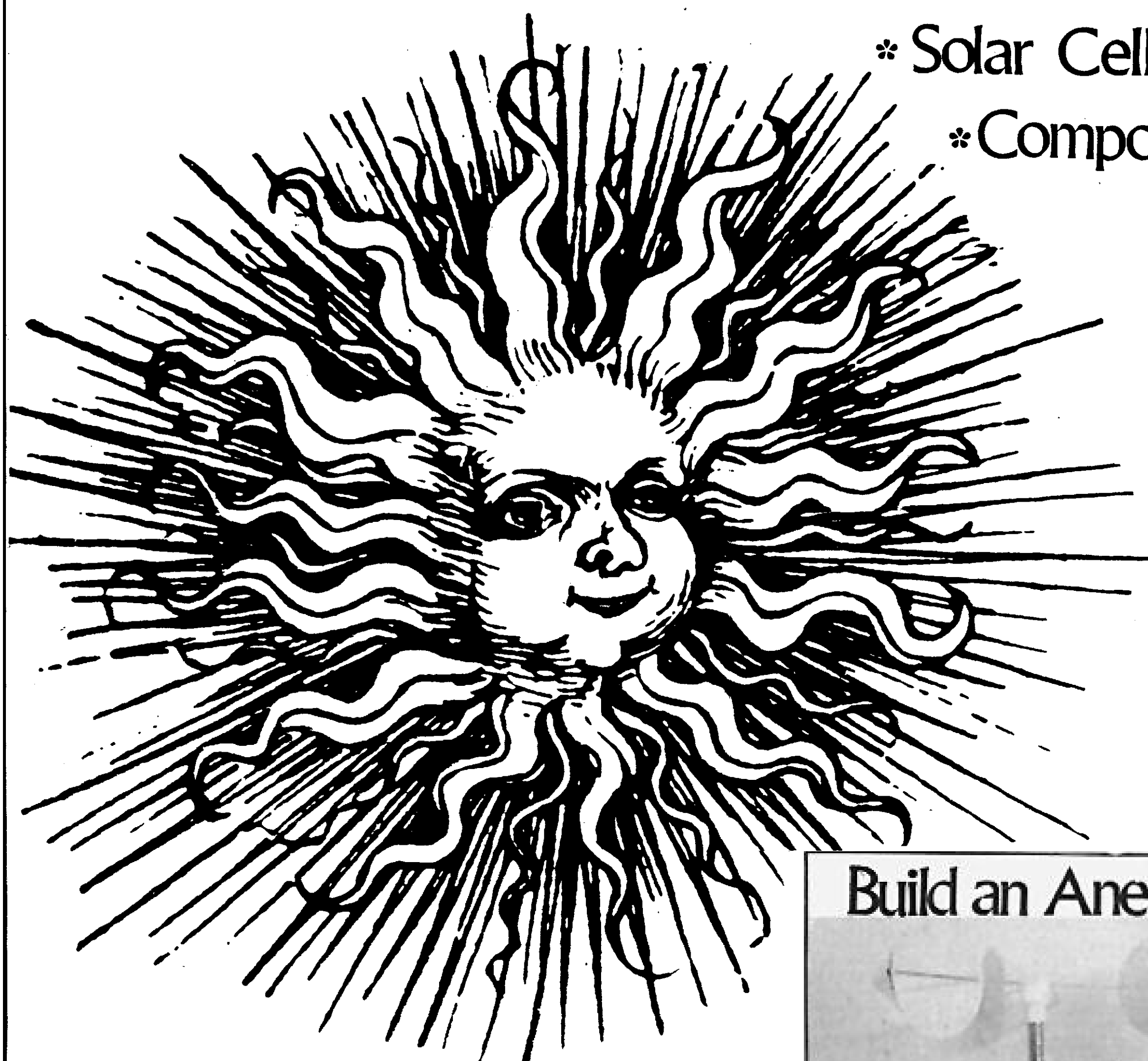
SOFT TECHNOLOGY

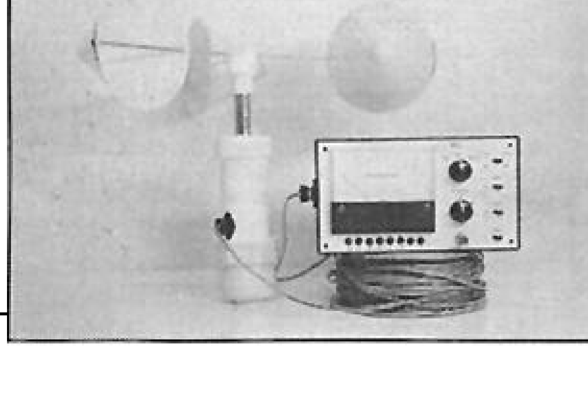
Alternative Technology in Australia

No. 4 May-July 1981

* Buying a Solar Collector
* Solar Cell: Update
* Compost Toilets



Build an Anemometer



Editorial.

So the Rundle project might not be, after all, the panacea for the coming shortage of liquid fuel. Costs have escalated threefold over a period of one year and unforseen difficulties like rock being too crumbly and having water running through it have added to the doubts. One commentator in the Age described the cost problem in classic "chasing your tail" terms. Apparently much of the cost of the Rundle project is constructional and these costs are very much tied to OPEC prices. The more the OPEC prices rise, the greater become the project costs. The greater the project costs, the higher the price of a barrel of shale oil. Economic recovery of shale oil, even if eventually attainable, is obviously a very long way off. This is borne out by the history of the price of shale oil, In 1974 when natural oil cost $4.00/barrel, the cost estimate for a barrel of shale oil was $8.00. Today the price of shale oil is still double that for natural oil.

Of course, the devils advocate would say that even if that's true, OPEC and Bass Strait oil are finite, so we have to accept that we build under uneconomic terms so that we have shale oil progressively ready to supplement and eventually replace those dwindling supplies. Then we will really see some price hikes. It seems we are locked into a vicious spiral as we eat away at nature's capital.

Several writers in the press have quite correctly pointed out that Rundle is not our only alternative. Other shale oil deposits (presumably with better prospects for economic recovery), coal to oil and crop fuels have been put forward as possible solutions to the problem. Not one of these commentators however, could contemplate a situation where we did not have and use as much liquid fuel as we do now.

No one has put forward the alternative policy of actually reducing our usage of fossil fuel. Not just lip service to conservation etc, but active policies which seek to make communities throughout Australia more self sufficient. Transportation account for about 40% of our total energy consumption, Decentralised production and increasing economic self-sufficiency on a regional basis throughout the continent would surely have not only an impact on our oil consumption but also on other desirable spin-offs like creating jobs.

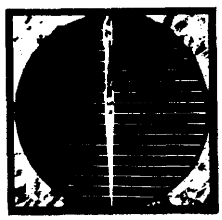
Someone said after the last federal election that the problem with the ALP was it now contained no political visionaries. The only vision that one can imagine the present government having are those of uranium mines and fast breeder reactors. The Labour party should be urged to drop its essentially bi-partisan approach on energy and resources, and put forward "visionary" policies to overcome the impending fuel prices.

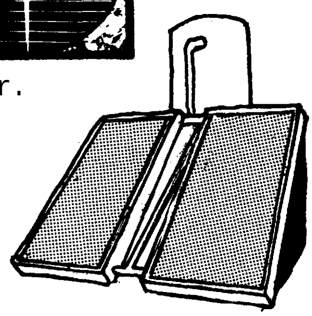
BOB FULLER.

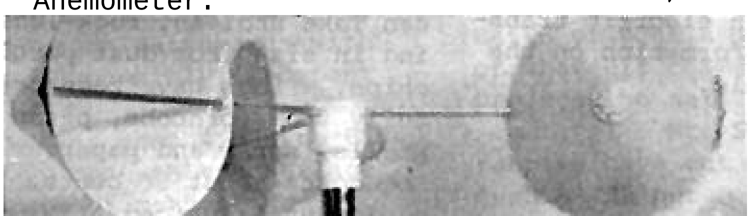
This issue was produced by Mick Harris, Alan Hutchinson, Tony Miller, Michael McCarthy, Bob Fuller, Janet and Richard Llewelyn and Judy Haynes.

Comments, criticisms, articles and other contributions are welcome and should be sent to the "Alternative Technology Association", 366 Smith street, Collingwood, Victoria, 3066.

CONTENTS.







Energy Flashes ......

ELECTRIC BIKE RACE

One Saturday afternoon in October last year saw a group of dedicated bicycle enthusiasts get together in Sydney for the Australian Electric Vehicle Association's (AEVA) 1980 Electric Moped Race.

There were prizes of $300, $150 and $50 for the three top prizewinners, plus trophies for the winners of the categories, but winning did not seem to be the prime motive of most race entrants; they came along for the challenge and the fun.

And there were certainly some strange and wonderful machines vying for the honours. Some used standard bicycle frames modified in various ways; some had custom built frames; one resembled a racing motorbike. Some had friction drive, some chain; some were driven by car dynamos, while others had printed circuit motors.

According to the AEVA, the motive for holding the race was to stimulate public interest in electric vehicles, The AEVA's main aims are to bring together people interested in electric transportation and to make information on the subject readily available.

Points were awarded in five categories; 60 for performance, 10 for ease of control and safety, 10 for appearance and cleanliness and 10 for workmanship, giving a total of 100. Each moped was allowed up to 25 kg of batteries and an adjustment factor for weight was included in the calculation of the scores,

The winning vehicle did 30 laps (uncorrected), performing almost twice as well as any other other contender. It was moulded after a racing motorbike, with its rider wearing a crash helmet and crouching behind a tinted perspex windshield.

RENEWED LOGS

Recycled wood Products, Inc, of Chattanooga Tenn., has come up with a process to fabricate fuel logs for stoves and fireplaces out of virtually any form of organic waste material. The Recycl-Log is produced by heating waste matter that has first been compressed in a mould and treated with a binding agent. Other fuel logs currently on the market are manufactured by a highly pressurised extrusion process that can use only finely ground sawdust. The Recycl-Log system can Take unclean, rock-laden waste ranging in size from dust particles to large chips. Logs have been produced successfully from corncobs, pecan and peanut shells, straw and paper. Each Recycl-Log costs about 50 cents. The production equipment is priced at $195,000.

SOLAR STANLEY STEAMER

An American engineer has built the prototype of a solar powered automobile to demonstrate the new heat storing thermal battery that he has invented. Robert McElroy, president of American Solar Energy Corp., of Arlington, Va., says his vehicle-a converted, compact size station wagon- is driven by the venerable Stanley Steamer steam engine that is coupled to the rear axle. Water

Energy Flashes..............

is pumped through a tank filled with 90 gallons of a patented, proprietary hydrocarbon fluid created from mixture of industrial waste materials. This mixture is heated to about 1,000 degrees Fahrenheit by the sun's rays as they are collected in a small parabolic dish. Once the heavily insulated storage tank is "charged" the solar dish can be detached, and the heat inside the tank is tapped to drive the steam engine.

The one of a kind vehicle is currently undergoing road tests and is expected to have a range of 35 miles at an average speed of 55 miles per hour on a single charge. McElrpy also maintains that with further refinements, such as the possible addition of a conventional fuel source to create a hybrid vehicle, his solar storage battery could be a viable power source for automobiles.

MUCH METHANE

Cornell University's Professor Thomas Gold, the eminent planetologist who has had considerable impact upon projects exploring the solar system, has now turned some of his attention earthwards with a fascinating - and possibly important theory.

He maintains some 4,000 to 6,000 metres or more, beneath the surface are enough pockets of methane gas, formed at the creation of the planet itself, to last our civilisations fuel need for several thousand years.

Professor Gold says this methane is under very high pressure and is continuously forcing its way to the surface through geological weaknesses, with some being absorbed into existing oil reservoirs.

Professor Gold wants $50 million financing for ten deep wells to prove his theory, but so far there have been no takers. However his theory has some circumstantial support from the results of resent observations. In the United States alone, of wells drilled to 5,000 metres or deeper during 1980, 60% yielded methane. Other scientists point out that methane released by undersea earthquakes could account for observations of vast bubbles In the sea, and even flames and explosions following quakes.

FAST BREEDER HEATERS

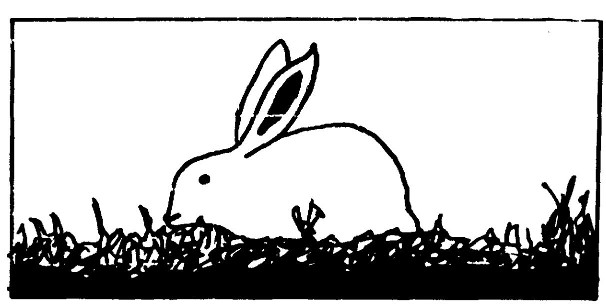
The fuel that heats Bill Schultz's business in Grants Pass, Oregon, is cheap, plentiful, efficient, innovative and clean, if a bit smelly. What more can you ask of a system that runs on carrots?

Mr. Schultz uses rabbit power to heat his commercial greenhouses in a novel experiment which converts their 30 degree body temperature into 15.5 degree room temperature.

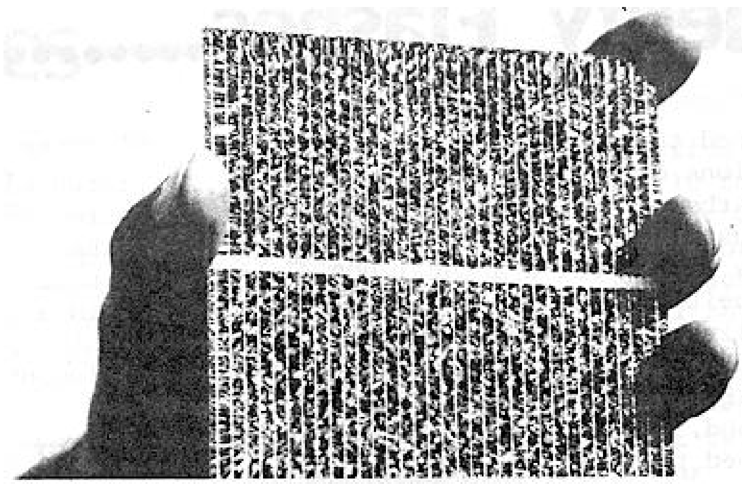
Rabbits' body heat is dissipated through blood vessels in their long ears which act as radiators. Researchers have been trying to turn this to their advantage for years.

Mr. Schultz has about 500 caged rabbits - more are always arriving - that produce about 190,000 British Thermal Units of heat a day. That's about half of what his commercial gas-fired heaters produce, he said.

Mr. Schultz estimates the rabbits have cut his heating bill by as much as 25 per cent.



SOLAR CELL UPDATE



Polysilicon solar cell (10 x **10** cm) was produced by AEG-Telefunken in Germany. Its efficiency is around 10%.

Solar cells are still very expensive. However, there have been many predictions that their price will fall dramatically. This article assesses the chance of a price cut and some of the more promising new technologies.

Until recently, solar cell technology has been dominated by the use of very pure single crystal silicon wafers with diffused junctions. This is an inherently expensive process which has been borrowed from the micro-electronics industry. Its strong points are that it produces cells with good efficiencies and is well understood due to years of development in the space program. Most cells on the market have been made this way.

How can we produce cheaper solar cells? This problem is being tackled in many ways.

The Yanks have tried their own peculiar form of central planning. They hope that by holding up a large enough carrot they can get their industrial barons to jump on the solar band wagon. Under their Dept. of Energy's (DOE) photovoltaic program, contracts have been let for research programs to develop the new technologies needed. In classic American brute force and ignorance style, DOE has been funding a very wide range of techniques and slowly chopping off funds as each looks like becoming a dead duck.

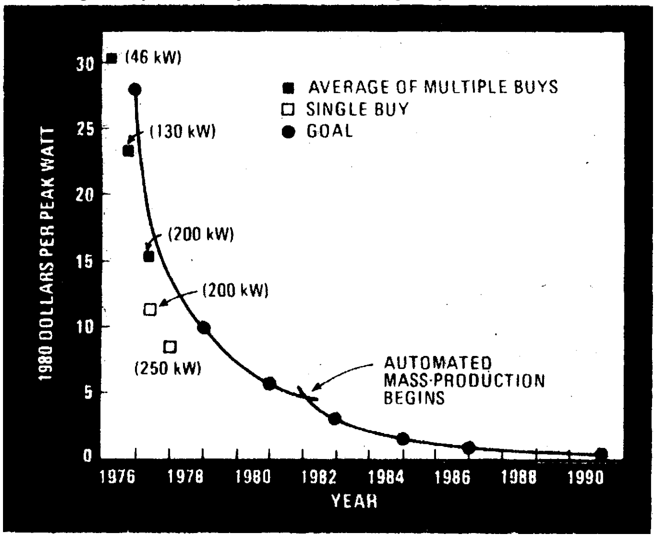
They also have a strategy for bringing the price down. The plan is to make bulk buys of cells - initially at a high price to fund the manufacturers research and development costs. They then gradually reduce the price at which they offer to buy, which is supposed to bring the price down for everyone.

DOE has established a cost reduction timetable (see Fig.1). They have also established price goals for solar cell modules. These are (1980 dollars) $2.80/peak watt by 1982, 70c/watt by 1986 and 15-50c by 1990. At these prices, they estimate that 20% of U.S. energy needs could be supplied from cells by 2000. By way of comparison, the French have a program aiming at $1.60-$2.50/w (1980 $) by 1985. The West Germans and Japanese also have well funded programs.

Will these goals be achieved? Back in 1979, the director of the DOE program was "cautiously optimistic" that the 1982 and 86 targets would be achieved. However, two years and one cowboy later, DOEs photovoltaic budget has been slashed on the grounds that it has already supplied the stimulus that was needed. This may slow the cost reduction process for a while. Allan Barnet, one of the gurus of Cadmium sulphide (CdS) cells, has described a continuous processing approach that would allow 20c/w to be achieved by 1985[1]

This simply scales up existing techniques and assumes 20MW productions per year. (This is about 200,000 sq. metres (50 acres) of cells - 20 times current production.

Back to realities, this is Australia in 1981. A typical conventional silicon cell panel - Solarex X81BG sells for $550 (cells manufactured in America, assembled here). This produces 33 peak watts which means we are paying about $16/w. Can we really expect this to be down to $2.80/w by next year? Obviously not. (NB. The cell output power is expressed in peak watts. This assumes it was measured at an incoming light level of 100 mW/cm^2. This level is the maximum sunlight level (averaged over the world) experienced at the earth's surface: often referred to as AM1 (or air mass one - i.e. one pass through the earth's atmosphere - AM0 is in space). In Melbourne, we get about 5.5 hrs of peak sunlight per day on average.)



1. Racing with the run. WE hopes to cut the cost of solar-cell arrays to $2.80 by 1982 and 15c to 50c by 1990. Besides technical progress, the timetable assumes annual photovoltaics sales will grow to 20 MW by 1982, 500 MW by 1986 and 5,000 MW by 2000.

What difficulties stand in the way of achieving these goals? First, short term effects. Any cell panels in the shops now were probably made 1-2 years ago when the manufacturing costs were higher. Also import attracts a 21% duty according to the Customs Dept. (35% according to Challenge electric.) Also there has been a shortage of silicon wafers which has forced up their price and hence the price of cells has not fallen greatly the last couple of years.

Second, assumptions. The DOE curve assumed that solar cells will follow a cost reduction "learning curve" similar to that observed in the microelectronics industry (i.e. calculator prices). There are substantial differences however. Cell technology is still an open race between those trying to reduce the cost of conventional techniques and those trying to improve the efficiency of low cost techniques. Basic research costs are still high and nobody wants to commit a huge production line until a clear leader emerges. Prices will have to remain high until these costs are recouped.

The microelectronic cost reductions are due to learning how to make smaller and smaller circuits and so use less silicon per circuit. It is not possible to reduce the amount of silicon in a conventional cell and so cost reductions can only come from learning how to reduce the cost of the silicon wafers. There are many promising processes but none have become available at low prices yet.

Will the goals be achieved in the longer term? There is a huge market out there if they can get the price down. In a few years many of the promising new techniques will get into production and then we will see price cuts. There are no fundamental reasons for it to remain high.

New Technologies

New methods are being explored at each stage of the production process.

Materials

The raw material should be plentiful and cheap to extract and purify. Silicon is abundant but currently expensive to extract and purify. Silicon cost is about ¼ -

SOLAR CELLS

1/3 the cost of the cell. This is a prime area for cost reduction.

There are three options - find a cheaper process, use less silicon per cell or change to another material.

Solar cell silicon doesn't need to be as pure as the micro-electronic grade. As part of the DOE program, new cheap processes have been developed. The DOE goal is to reduce the price from about $60/kg to $7-10/kg. Recently plans have been announced for a large silicon production plant in Western Australia.

To use less silicon you have to make the cell thinner. Crystalline silicon cells have to be about 0.1mm thick. One promising approach is to use amorphous (or non crystalline) silicon. Amorphous silicon (a-si) absorbs light more strongly than crystalline silicon and consequently it is typically 0.001mm thick, Thus it uses 100 times less material for the same area. Dalal has shown[2] that a-si cells can realistically achieve 10% efficiency (best to date is round 6%), so this gives a real saving of 50-70 times.

A variety of other materials are being investigated. Gallium Arsenide cells hold the record efficiency at 26% (at AM1) and Indium Phosphide is not far behind. However, both Gallium and Indium are relatively scarce and expensive metals. Gallium Arsenide is the best material to use for cells in concentrators, because it maintains its efficiency at high temperatures. Cadmium Sulphide-Copper Sulphide cells have been developed for a long time and are available commercially ($10-20/w). These use relatively cheap materials but there are still problems with degradation of performance due to environmental effects. 9% efficient cells have been reported recently and they have the potential to be very cheap when made using continuous processing methods.

Processes

The conventional way to make silicon wafers is to melt the silicon in a large crucible and slowly pull a long crystal about 4" in diameter out of this melt. The crystal is then sawn into thin wafers using a diamond saw. This process is expensive because of the large energy input to the furnace and because 50% of the crystal is wasted in the cutting. It is also slow and the crucible often cracks when the furnace is cooled.

Panel of solar cells acts as sunshade and also powers an insecticide sprayer.

Much work is going into using polysilicon. Polysilicon is crystalline silicon but consisting of many small crystals rather than being one large crystal. This performs almost as well as single crystal except that some losses occur at the boundaries between the crystals. Polysilicon can be cast or extruded in thin ribbons. This cuts the cost substantially. Challenge Electric (in Sydney) have ribbon cells made by the Japan Solar Energy Company. These are about 8% efficient but cost $30/w. Amorphous silicon and other thin film materials can be deposited directly on a substrate (such as stainless steel) by decomposition of gasses or vacuum sputtering. These processes are cheaper than the conventional methods.

The next part of the process is to form a p-n junction which is what enables the light to produce an electric currant. These junctions are formed by adding small amounts of impurities into the silicon to alter its electrical characteristics. The conventional process is high temperature solid state diffusion, The impurities start at the surface and slowly seep into the wafer. This uses a lot of energy and also produces a dead layer at the surface which limits the cells efficiency in the blue end of the spectrum.

One new technique is to use ion-implantation. The impurities are shot at the silicon so fast they they bury themselves below the surface. Some damage is caused to the crystal structure and this is annealed out by giving it a quick zap with a high power laser. This method is fast and allows better control of junction depth.

Instead of making a junction, a cheaper way is to induce a junction at the surface using a barrier technique. A junction is formed by using a thin transparent layer of metal on the surface (Schottky junction) or using a thin insulator and then metal (MIS cell).

These are cheaper to make because no junction forming step is required, and no dead layer gives much better response to *w* light. High efficiency MIS cells have recently been made by Godfrey and Green at the University of New South Wales. They have achieved 17.6% and expect to achieve 20%. Dr. Godfrey is now managing the research effort at Tideland Energy Pty. Ltd. in Sydney. Tideland are planning to manufacture cells locally.

Where does this leave someone who is contemplating buying solar panels? There are still many horses in the race. The conventional crystalline silicon cell will become cheaper. The low cost cells probably using amorphous Si or Cadmium Sulphide will improve in efficiency and become available.

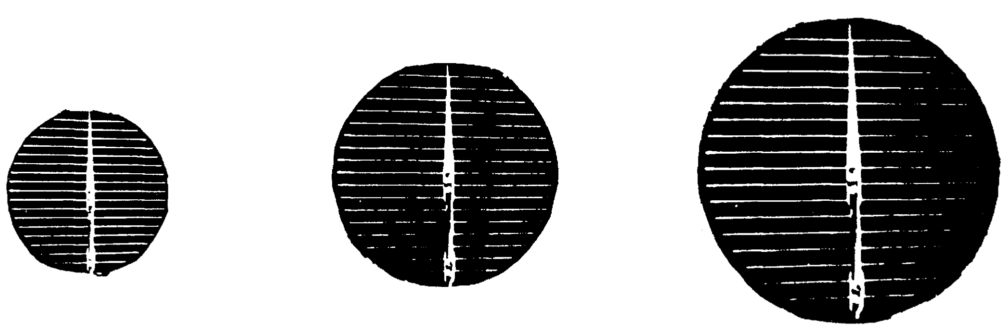
Wacker Chemitronic in West Germany building the capacity to produce large quantities of polysilicon wafers. Probably the best hope for the immediate future is polysilicon cells with the longer term favourite being amorphous silicon.

My prediction is that cheaper prices are at least a couple of years away and the goal of $3/w is probably about 84/5.

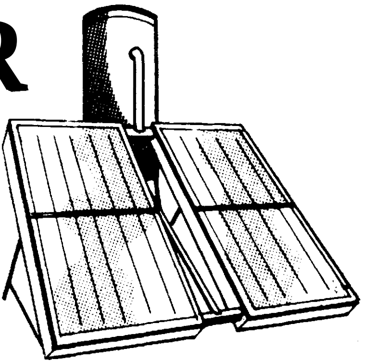
<u>ALAN HUTCHINSON</u>

1. IEEE Transactions on Electron Devices, ED7, No.4, April 1980.

2, Design considerations for a-Si solar cells, IEEE Transactions on Electron Devices, ED7, No.4, April 1980.



BUYING A SOLAR COLLECTOR



The heart. of any domestic solar hot water system is its collector. Over the last few years the upsurge in popular interest in the use of solar energy for home use has spawned a small though not inconsiderable industry manufacturing many different types of solar collectors. To a prospective buyer of a solar system who has little or no knowledge of the thermodynamics of a flat plate collector the range of materials and configurations of the materials used by these manufacturers must surely be a little confusing. Many questions can be generated by looking at today's range of products. Questions such as: "Is one glass cover better than two, or why do some manufacturers use copper and some use aluminium for the absorber plate?"

This article does not attempt to say which collector is the "best". That anyway is probably an unrealistic task for anyone to attempt since in this field as in most others there are 'horses for courses'. A solar collector which may be perfectly adequate for one situation will not necessarily be so for another. What is hoped is that having discussed some of the various options that today's buyer may be faced with, he will be better able to make the decision as to what is "his best buy" or at least to know what he is getting for his money. Finally a reference guide of most of the manufacturers and their products available in Melbourne is included. This lists also the size, materials and price of their units.

The primary objective in the design of an efficient solar collector is to maximise the amount of energy getting into and absorbed by the collector and to minimise the amount that is lost. The difference between these two quantities is the energy that can be put to useful work, namely heating your water. Notwithstanding the amount of radiation available in an area, the value of the useful energy is to a great extent determined by the type of materials used in the collector construction and their physical configuration, i.e. their size, shape, etc. Let us look, therefore, in turn at these variables and their effect on collector performance.

The Absorber Surface

The sun radiates energy and the purpose of the collector absorber plate is to capture as much of this as possible. It is well known that black painted surfaces will absorb this energy. Many collectors with metal absorber plates on the market today have been painted with a high quality matt black paint. A paint of this type will give the plate an absorptance of about 95% Another property, however, of such a coating is that as it gets hot it will also store radiating or emitting heat at the same rate. However this re-radiated energy will be of a different type (infra red wavelength) from the incoming solar energy. The less heat that radiates out from the plate the more that is available for heating the water. Selective surfaces have been developed to overcome this problem. As their name suggests, they are a thin coating put onto the plate which selectively absorbs most of the incoming sunlight, but re-radiates out only a small amount of the heat.

These surfaces therefore have a high absorptance value and a low emittance rate. Copper Oxide, the Amcro Surface and Chromium Black are examples of such surfaces. A good survey of other surfaces and their properties is given in Ref.1. They are all achieved by chemical process and tend to increase the cost of the unit.

The Collector Cover

The purpose of the cover, often glass, on a solar collector is to help reduce the losses from the absorber plate. The plate will do this firstly by radiating to other objects at lower temperatures than itself. Fortunately glass allows virtually none of this infrared radiant energy to pass through it, but heat will be passed to the air next to the absorber plate. This heated air will rise and be replaced by cooler air which in turn is then heated. The effect of placing a cover over an absorber plate is to greatly reduce this mechanism. Heat is still lost, however, even with a cover because the hot air passes its heat to the cover, which in turn loses it to the outside air. This 'cooled' air then is replaced by new 'heated' air coming up from the absorber plate. In this way it can be seen that a continuous cycle of air being heated, rising, heating the cover, cooling and falling can develop (see Fig.1).

One way of reducing this loss mechanism even Further is to place a second cover over the absorber plate. This reduces the possibility of a continuous convection mechanism being established because the inner cover is not being cooled directly by the outside air.

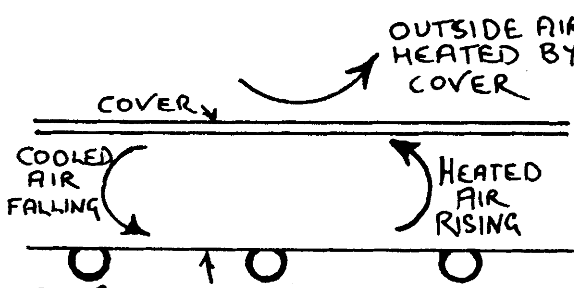


FIG 1

There arc, of course, disadvantages. The cover, no matter what material it is made of, will absorb and reflect some of the sun's incoming radiation. The values for 3mm thick Australian window glass are about 9% for absorptance and 7% for reflectance. This leaves only 84% actually entering the collector and striking the absorber plate. The effect of installing a second cover is to cut the amount of radiation reaching the absorber to approximately 71% ($.84 \times .84 \times 100$). Therefore we have s situation where we have reduced the losses but at the same time reduced the amount of radiation reaching our absorber plate (see Fig.2).

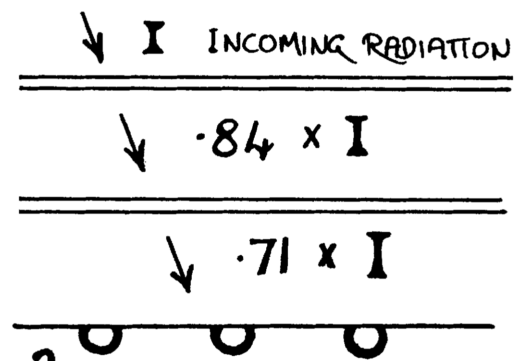


FIG 2

An improved type of glass, usually called LOW IRON GLASS, is now offered on some units. This has a lower iron content than the standard window glass. As a result it has virtually no absorptance and will transmit approximately 91% of the incoming radiation. It can be seen that using a double cover system of such glass 83% ($.91 \times .91 \times 100$) will be transmitted Again, improved performance has been achieved at a price, low iron glass being more expensive than standard window glass.

Acrylic covers are also found nowadays on domestic solar collectors. They offer some advantages over glass. For the same thickness, an acrylic cover will be lighter and more resistant to impact than glass. Like glass, acrylic allows virtually none of the radiant energy coming from the absorber plate to pass through it. In terms of its transmittance to the sun's radiant energy, i.e. its solar transmittance, it is also very comparable with standard window glass. Remember than solar transmittance is dependent on the thickness of the material used. The thicker the material, the less radiation gets through to heat up the absorber and the heavier the unit gets. On the other hand, the thinner the material the more radiation gets into the collector, the lighter the unit, but the greater the likelihood of breakages. Allowance also needs to be made with an acrylic cover for a relatively large amount of expansion and contraction with changes in temperature, e.g. by doming the cover.

Insulation

The heat losses out of the collector, which we are seeking to reduce to a minimum, are the result of a number of heat transfer mechanisms. One of these, conduction out through the sides and back of the collector is reduced if adequate insulation is placed around the edges and the rear of the absorber plate (see Fig.3). Most collectors designed for domestic hot water have some sort of insulation behind the panel, but insulation at the sides and between the absorber heaters and the case is not always included.

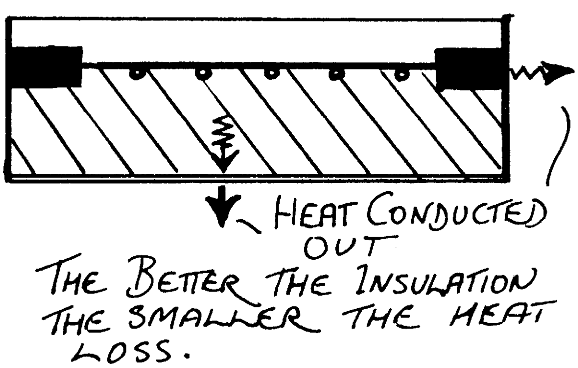


FIG 3.

Insulation materials themselves, of course, can vary, some offering a greater resistance to heat fions than others. (Refer to article on Insulation in Soft Technology, No.3.)

The Absorber Panel Material

The first solar panels which appeared on the market had absorber panels of an all copper construction. Copper had, and still has many advantages: high conductivity, resistance to corrosion, easy forming and joining. However, copper has, over recent years become more and more expensive. Alternative materials have been sought and different options are now available.

A combination of an aluminium plate and copper waterways is now commonly available. A disadvantage of this combination is that the conductivity of aluminium is lower than that of copper (204 W/M °C compared with 325 W/M °C). Furthermore the two metals must be well joined to provide for a satisfactory flow of heat. To obtain an acceptable level of thermal contact a thermal paste is usually placed between the tubes and the panel sheet. Also, no water can be allowed to come into contact with the two metals together because electrolytic corrosion will take place. These disadvantages seem to have been overcome by the manufacturers who use this combination of materials and tests show quite satisfactory performance for domestic solar water heating. Other materials used are stainless steel and plastic.

Steel has an even lower thermal conductivity (i.e. value) than aluminium and copper (54 W/M °C). This disadvantage is compensated for in some panels by producing what is called a FULLY FLOODED plate. In this design, the maximum possible area of the absorber plate is in direct contact with the waterways so that the requirement for good conduction of absorbed heat along the fins to the water 'riser' tubes is virtually eliminated (see Fig.4(c)).

Plastics have normally been associated with unglazed swimming pool collectors. The lower temperature requirement of heating a swimming pool was well suited to plastics, but for the higher temperatures demanded for domestic hot water, the disadvantages such as the very low thermal conductivity, inability to withstand high stagnation temperatures (the temperature reached by the absorber plate with no water/fluid passing through it and also the aging characteristics of some plastics rendered them unsuitable.

However, solar collectors made of materials like EPDM rubber are now being offered for domestic hot water. They offer some advantages like lower cost, ease of installation etc., and should now be considered as a definite option when selecting a solar unit.

Size and Price

When determining the number of panels you require on any given system, take care to ascertain the actual size of each panel in square metres. This not only assists in determining the number of any particular panel that you require for your system (see Table 1), but enables you to compare different manufacturers products on a dollar per square metre basis ($\$/m^2$). Simply divide the cost of panel X by its area. This will give you a $\$/m^2$ figure, which can then be compared directly with panel Y, provided you have carried out the same calculation on that product, This will avoid the confusion of having panels of different prices and areas. Once the units are expressed in the same terms, one can begin to look for the reasons, if any, why Panel X is, say, more expensive than Panel Y.

Waterway Type

Different waterway figurations are employed in various panels on the market at present and some comment on these would be worthwhile. The three configurations which are most commonly used are shown in Fig.4.

With the serpentine, the waterway is constructed from a single length of tubing, and thus avoids the need for joints between the riser and header tubes as in (b). They can be orientated in, either direction (Fig.5), but only when in the vertical direction (b) and with a slight angle Ø, will a thermosyphon system be possible. If a thermosyphon system is intended and you wish to use a serpentine panel, then the manufacturers should be specifically asked if their product is suitable for such a system. The dangers of airlocking in the serpentine may mean that a pumped system must be used.

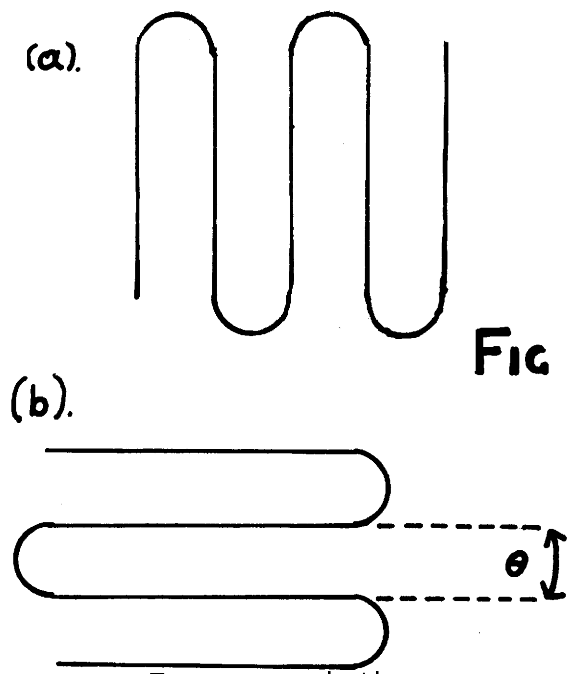
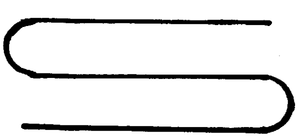


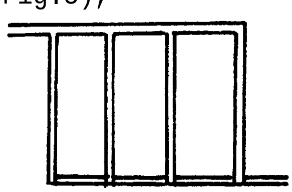
Fig 5.

To assess whether a serpentine configuration is as effective in transferring the heat to the water as a header and riser assembly, measure the distance between the tubes on the panel with headers and risers and compare this to the distance between two successive straight runs of the serpentine (see Fig. 6)

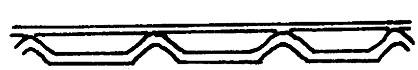
If the collectors were equivalent in all other respects, then if X and Y were the same, very similar performance could be expected.



(a) Serpentine.



(b) Header and Riser Assembly.



(c) Flooded Plate (Cross Section).

MANUFACTURER	PANEL. MODEL NO.	ABSORBER PLATE SURFACE	COVER TYPE	ABSORBER PLATE MATERIALS	ABSORBER PLATE CONFIGURATION	SIZE (M^2)	PRICE OF UNIT$	PRICE PER M^2. ($/$M^2$).
1/. Braemar	Solaline Type 594 Type H92	Matt Black	Single Glass 4mm Thick	All Copper	Serpentine Headers and Risers	1.0 1.0	171 167	171 167
2/. Beasley	Solapak 150 75	Selective Surface	Single Glass	All Copper	Headers and Risers	1.5 .75	183.5 109.0	122 145
3/ Hipeak Solar Industries	D 1000	Matt Black	Single Acrylic Sheet	Steel Plate & Copper Waterways.	Headers and Risers	1.8	250	139
4/ Park Solar Space	-	Matt Black	Acrylic (Domed)	Aluminium Plate & Copper Waterways.	Headers and Risers	2.0	198	99
5/ Raypak	SK 30 SK 40	Semi-Selective	3mm Tempered low iron glass	Copper or Aluminium Plate. Copper Waterways.	Headers and Risers	2.4 3.2	476 548	198 171
	Unipak	Matt Black	Acrylic (Domed) 3mm.	Aluminium Plate & Copper Waterways	Headers and Risers	2.4	348	145
6/. Siddons	MK X	Matt Black	4mm Glass	Aluminium Plate & Copper Waterways	Headers and Risers	2.0	198	99
7/. Smiths	-	Matt Black	Acrylic	Aluminium Plate & Copper Waterways	Headers and Risers	2.2	230	105
8/. Solarhart	300L 160L	Matt Black	Single Glass	Aluminium Plate & Copper Waterways	Headers and Risers	4.0 2.0	795 *1 670 *2	Not Applicable

*1 Price includes 300 litre storage tank.
*2 Price includes [illegible] litre storage tank.

9/. Soleil	-	Matt Black	4mm Glass	Aluminium Plate & Copper Waterways	Headers and Risers.	2.0	195	97.5
10/. Somer Solar	Nova, (Zinc-alume Box) Super Nova (Aluminium Box).	Matt Black	Acrylic 3mm	Aluminium Plate & Copper Waterways	Headers and Risers	2.0 2.0	200 266	100 133
11/. Wilson	-	Matt Black	3mm Glass	Aluminium Plate & Copper Waterways	Headers and Risers	1.0	132	132
12/ Yazaki	Blue Pane-1 SC 201S Blue Pane-1 with controller	Selective Surface	3mm Low Iron Glass	Stainless Steel Plate & Tubes	Headers and Risers	2.0 2.0	404 593	202 Not Applicable

** The information for this guide was collected between February and April, 1981.

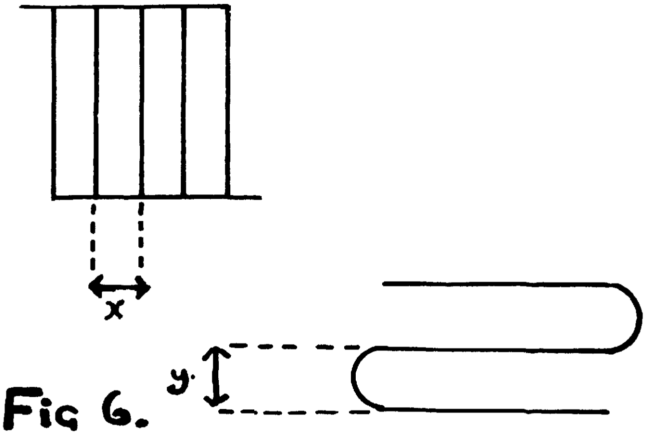


Fig 6.

On the subject of the spacing between tubes, again the following generalisation may be made. If in all other respects, two collectors were identical except that one had one extra riser tube and therefore smaller spacings between tubes, then this collector should be superior, albeit marginally, than the one with the lesser number of tubes.

The limit of increasing the number of tubes is, of course, a collector similar to a flooded plate. It is only in cheaper materials with a low thermal conductivity that one is likely to encounter such a design, since what the manufacturer is doing is offsetting the poorer thermal qualities of the material with the advantages gained from many waterways. Flooded plates are unsuitable for thermosyphon systems.

It is hoped that the information presented above is helpful to anyone contemplating buying a solar collector and may also serve as a useful introduction to solar collector design. The two references cited will provide excellent further reading on the topic for those who may wish to delve deeper.

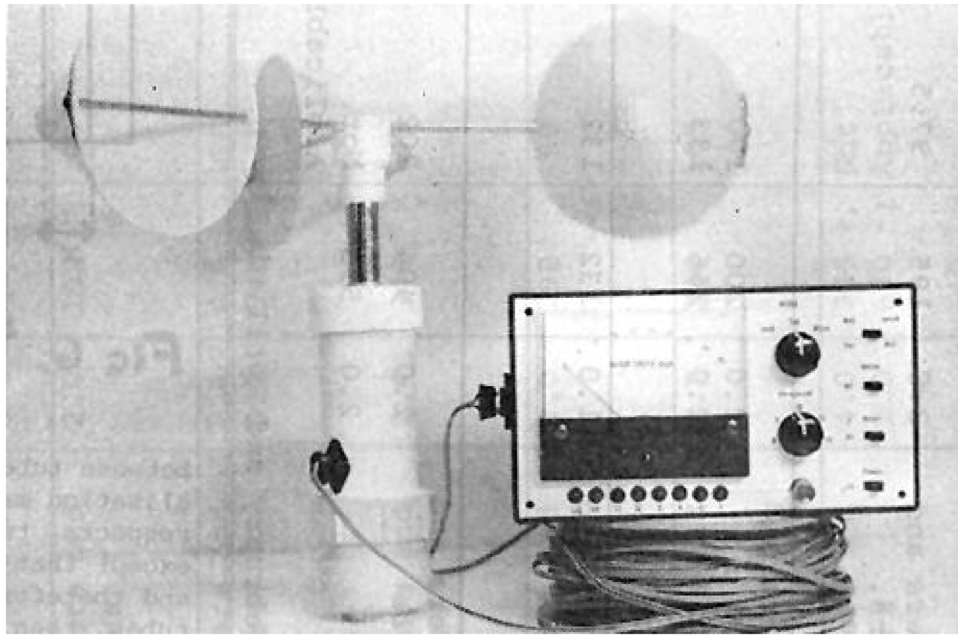
BOB FULLER.

REFERENCES

1. DUFFIE, J.A. and BECKMAN, W.A. Solar Energy Thermal Processes, Wiley, New York (1974).

2. CLOSE, D.J. An Introduction to Solar Energy Systems and System Design. CSIRO, Division of Mechanical Engineering, Technical Report No. TR 26 (1980).

build an



anemometer

There is currently considerable interest in wind power. To select a suitably windy site and to determine the available power, some form of measuring and recording device is useful. A device to measure windspeed is called an anemometer.

Anemometers can operate in three different modes:

a) Instantaneous - measures the wind speed at that moment. Useful for quick comparisons of sites, measuring gusts and testing generator performance. Not much use for site evaluation.

b) Long term Average - this type has a counter which counts the number of revolutions made by the anemometer shaft (assuming a cup type - see below). The number of revolutions converts to the number of kilometers of wind run. The average wind speed is then just the number of kilometres of wind run during a measurement period divided by the length of that period. Average windspeed is a more reliable way to compare different sites.

c) Short term average with recorder - measures average wind speed over a short period (typically one hour) and records the value each hour. The resulting record gives a good indication of the structure of the wind, i.e. length of calm spells, strength of wind during storms, etc. This distribution of wind speeds is very useful in determining how much energy you can actually get from the wind on that site. Long term average can be misleading, as they can conceal long periods of low wind speed.

Windspeed can be measured by using many different effects - e.g. pressure at the end of a tube, rotation of cups, small propellers, the cooling of a hot wire etc. A rotating cup type was chosen because it can be constructed easily, does not require slip rings, is insensitive to wind direction and is a well documented design.

WHAT IT DOES

Since each mode of anemometer operation has its uses, this instrument will do all three. It will measure both instantaneous and average windspeed in the range O-45 mph (O-20 m/s).

Two types of averaging are performed.

a) The long term average. This can be set to be read and reset to zero at either daily or weekly intervals.

b) Sampled average. This records either the average windspeed at either 1 hr or 6 hr intervals. 256 samples are possible. This gives a record length of 11 days or 2 months (64 days).

An additional feature of this design is a threshold control for the averaging sections. The purpose of this control is to allow the averaging circuit to respond only when the instantaneous windspeed is above a set speed, i.e. it ignores any wind that is below the threshold. This is very useful if you have a generator which doesn't begin to cut-in until say 10 mph, then you would set the threshold to 10 mph and you would get an average value of all wind over 10 mph. This allows a much more accurate estimate of how much energy can actually be got from the wind.

The instrument consists of a measuring head designed to screw onto ½" gal. water pipe and should be raised at least 4 metres to be clear of ground effects The head is connected by cheap (6c/metre) 2 wire speaker flex down to a remote control unit. This could be up to ½km from the head. The electronics are powered by a 9V transistor radio battery. Battery life (with an Alkaline cell) should be approximately 6 months.

HOW IT WORKS

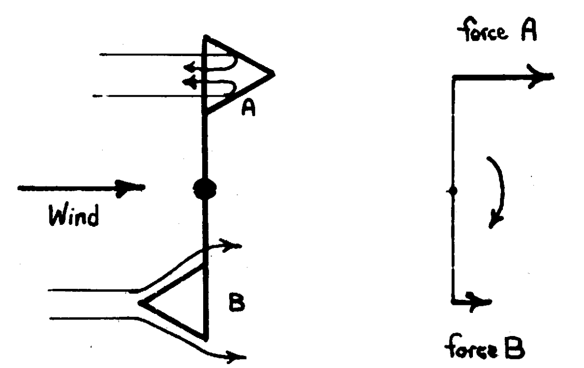
The design of the cup section is based on the British Meteorological Office design cited in Goldings book (E.W. Golding, The Generation of Electricity by Wind Power. Spon 1976). The cups rotate because the force on the concave side is greater than on the pointed side.

For this design, the cups move at about l/3 of the wind speed. The radius of the cup centre from the pivot is 14cm. So if V is the wind speed and f is the number of rotations per second then

$$f = (v/3) / (2\pi \times 14 \text{ cm})$$

$$= 0.38\ V \text{ (in metres/sec) or } 0.168V \text{ (in mph)}.$$

A disc with four holes in it is attached to the anemometer shaft. As it spins round it interrupts a light beam. These interruptions of the light beam produce an electrical pulse which is fed down to the control unit.



Cups rotate because Force A is stronger than Force B.

The average windspeed is obtained by counting the number of pulses and then dividing by the length of time over which you did the count.

This machine is designed for two intervals - 1 day and 1 week. The meter reads directly in mph if it was zeroed at the start of the measurement and then read at the end of the day (or week). It can be used for other intervals but you have to scale the value shown, e.g. to use for a 2 week period instead of 1 week, your average windspeed would be half the value shown on the meter.

CONSTRUCTION

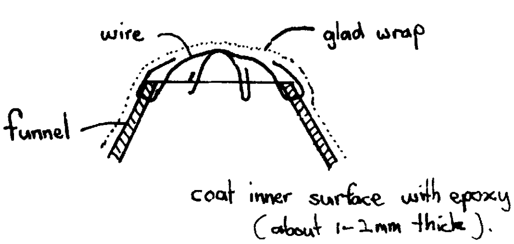
Because of space limits, the mechanical construction will be described this issue and the electronic and how to use it sections will be in the next issue. For those who can't wait, the anemometer and second section of the article will be left at FOE (366 Smith St., Collingwood) for anyone who wants to have a look at it.

I have attempted to make the construction method as simple as possible requiring no exotic tools or polished skills. All parts are standard hardware and I have listed where they are available from and how much I paid for them. The tools assumed in this description are a hacksaw, drill and set of drills, flat file, small round file, a square and a vice or clamp for holding.

MECHANICAL

Refer to mechanical parts list and drawings.

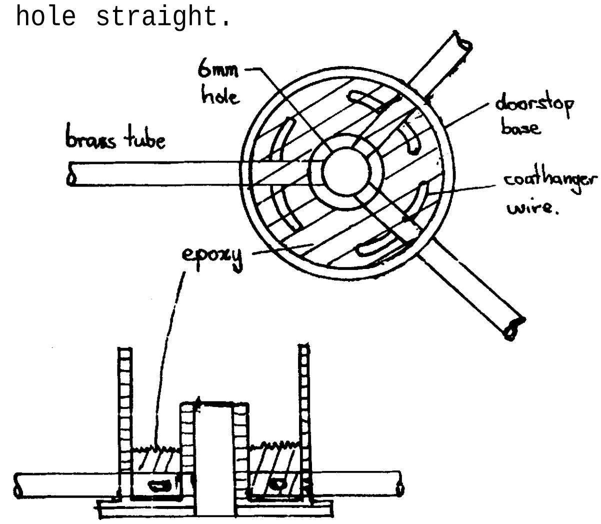
a) Cup assembly. Take the three funnels and cut off the narrow stem at the point at which it starts to widen out. Drill 8 small holes l/32" approx.) around the edge of the cut and with some thin wire join each hole to its opposite so as to create a grid of wires across the hole. Bend the ends of the wire back into the mesh and use your finger from the inside to push the mesh out into a dome shape. Stretch a piece of glad wrap over the mesh and the outside of the funnel. Mix some 5 min. epoxy and put a coating all over the inside of the mesh so that it holds the mesh together and seals the hole. Only use as much epoxy as is necessary to provide a



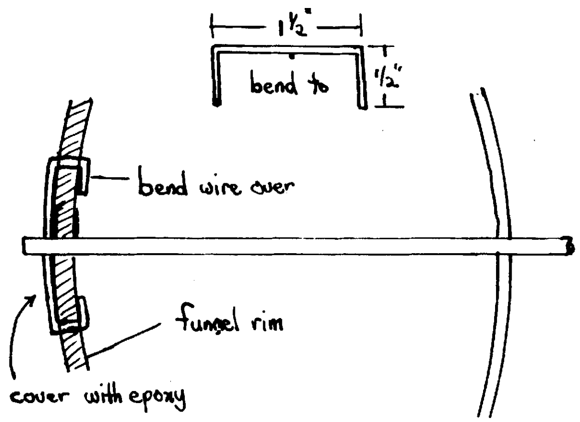
continuous layer. When the epoxy has set, peel the glad wrap off and you should have a nice domed sealed hole.

Cut three 20 cm lengths of Brass tube.
Drill a hole just big enough to take the coathanger wire (about 3/32") in each brass tube about l/16" from one end and about ¼" from the other end. The holes should be at right angles to each other.

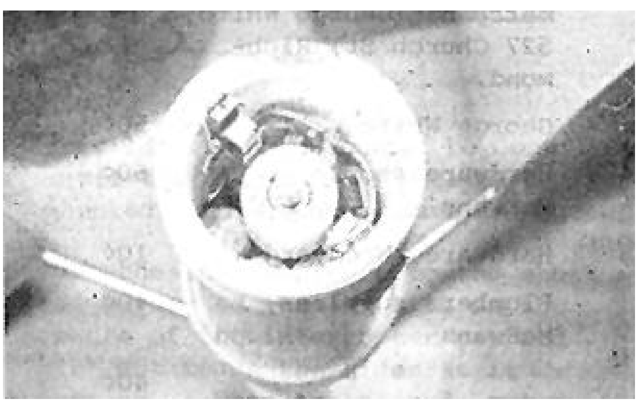
Take the hard plastic base of the cushion door stop and enlarge the centre hole with a 6 mm drill. Take care to drill this hole straight.



Drill 3 3/16" holes around the edge of the base just under the top lip. These should be 120° apart and go all the way into the centre.
Cut 3 lengths of coathanger wire about ½" long. Coat the end of each brass rod (with the hole ¼" from the end) with plastics glue and push them into the holes. Insert the lengths of coathanger wire into the holes in the tube and turn the tube so that the wire sits flat against the bottom. Cover the whole bottom section with epoxy to a depth of ¼" so that it is cast as a solid mass. The length of wire stops the tube from coming out.
Drill two 3/16" holes either side of the rim of the funnels to take



the brass tube. Drill two 3/32" holes 3/4" each side of one of these holes (along the rim). cut 3 2½" lengths of coathanger wire and bend as shown. Assemble the funnels on the tube as shown. Cover the wire with epoxy to make the whole joint solid.



Funnels should be mounted so that when they rotate they will turn from right to left.

b) Housing assembly. Take 5" coupling, cut off the loose screw collar and throw it away. Take one of the 50mm PVC end caps and make a 3/4" diameter hole in the centre. (Drill then use file to enlarge to 3/4"). Glue the cap onto the 5" coupling (other end from the screw thread). Cut seven 2½" lengths of ½" dowel and glue them around the inside of the coupling, evenly spaced with one end against the end cap (plastics glue), 5/8" down from the thread make a 15mm dia. hole to mount the plug in. On the other wide from the plug hole drill a l/8" hole right up against the thread to mount the light beam source.

c) Base. Take the other PVC end cap and make a 3/4" hole in it. Coat round the hole with plastic glue. Push the 3/4" thread of the 3/4 to ½" reduction bush through the hole and screw the 3/4" backnut onto it. (The nut is on the inside), Do up very tightly with lots of glue. Glue the cap onto the 50mm end of the grey PVC coupling (plastic glue).

d) Bearing Assembly. Take the barrel of the Pental pen (or equivalent) and cut a ½" length from the top end. Cut a 9" length of 6mm aluminium rod. Take one of the ball bearings and try to push it onto the rod, If it is too tight use either sand paper or steel wool to thin down the rod until it JUST fits. Glue the ¼" length of pen onto the rod ½" from one end. When set push the bearing onto the rod and cut a 3" length of pen and glue it onto the rod so as to hold the bearing tight. Don't get any glue in the bearing! (Plastics glue)

Cut a 6" length of 3/4" shower curtain rail. Both ends of the tube must be square and flat. File flat and test with a square until it's accurately square.

Take two chair closures and drill a 3/8" hole in their ends.

Take the other bearing, push it up inside a chair closure onto one end of the 6" tube. Coat the dowelling and tube with copious amounts of epoxy and push the tube into the housing assembly from the threaded end so that 2¼" sticks out from the plastic cap.

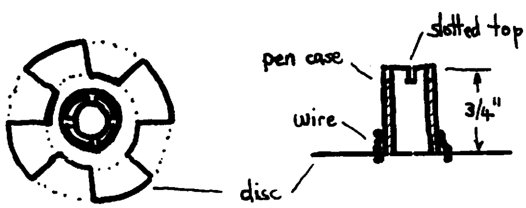
When cured, push the aluminium rod through and push the other closure over the top of the bearing and the exposed tube. The shaft should spin freely,

PARTS LIST mechanical

QUANTITY	DESCRIPTION	SUPPLIER	APP.COST
2	50mm PVC end caps	Plumbers supplies e.g. Reeces	40c ea
1	5" white plastic coupling. male thread to 50mm pipe with screw collar. Made by Caroma. McEwans stock no.365575	Plumbers supplies McEwans	$1.30
1	PVC coupling 50mm tube to female thread. Screws onto make thread of previous item. McEwans stock no.365177 (grey, made by Terrain no.216)	Plumbers supplies, McEwans	$2.90
6"	3/4" (19mm) chrome plated shower curtain rail tube. ($1.60/2ft at McEwans).	Handware shop. Scrap metal merchant.	40c
9"	6mm Aluminium rod (must be 6mm and not ¼" (6.3mm))	Non ferrous metal merchant (George White, 527 Church St, Rich-mond.	20c
2'	3/16" brass tube	George White	50c
1	packet 3/4" round chair leg closures	Hardware shop, McEwans	60c
3'	½" dowel	Hardware, Woodyard	10c
1	3/4" to ½" reduction bush (galvanised iron)	Plumbers supplies, McEwans	40c
1	3/4" gal. iron pipe backnut	" "	40c
1	round plastic cushion door stop (1 3/4" long)	Handware, McEwans	50c
1	tube Selleys plastics glue		
1	epoxy resin glue (e.g. 5 min. Araldite).		
3	approximately 4-5" dia. plastic funnels	Kitchenware (Hostess brand - Myers)	50c ea.
2	No.626 Single row unsealed ball bearings (6mm I.D. 19mm 0.D.).	Bearing suppliers. (SKF, 168 Kingsway, Sth. Melb.)	$2.90 ea.
1	Pental junior marker pen (or any other pen case with a 6mm internal diameter).	Stationers, newagents	20c
1	12" of coathanger wire		
		Approximate Cost	$15.60

The cup assembly can now be glued onto the end of the rod. The cup base covers the top chair closure and bearing providing some protection from the weather.

4 Interrupter Disc. From a piece of thin sheet metal, e.g. a lid of a jar or tin, Cut a 1¼" dia. circle. Drill a 6mm hole in the centre then cut as shown. The centre circle is 3/4" dia. Cut a 3/4" piece of pental pen. Glue the pen onto the disc as shown. Wrapping some fine wire round the pen will increase the gluing area giving a stronger bond). Cut slots in the top of the pen.



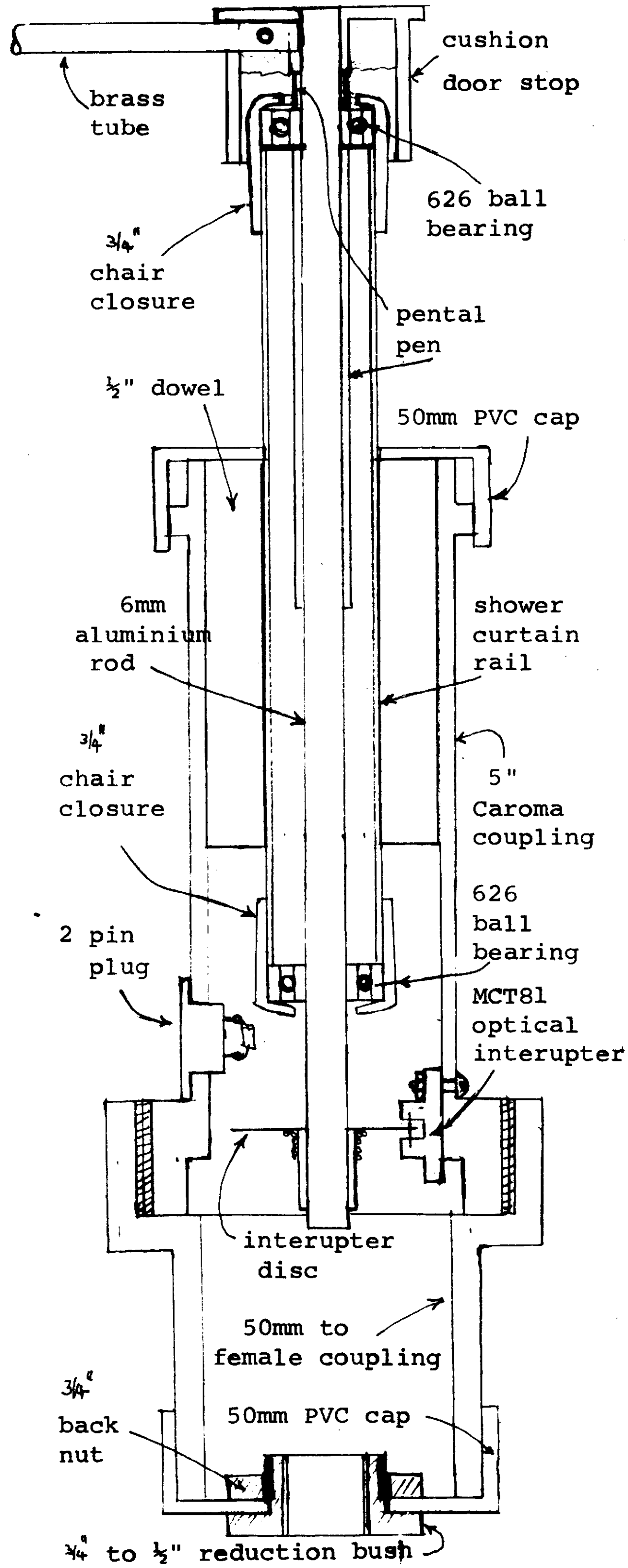
This last section cannot be done until the electronics section is mounted. (See next issue.)

Push the interrupter onto the shaft and adjust so that it sits in the centre of the interrupter gap and will not touch the sides as it rotates. When positioned, put a small blob of plastic glue in one of the slots to hold it. (The purpose of the slots is to allow for possible disassembly by prising loose the glue in one slot. The other slots can then be used in turn to glue in it place.)

I apologise for the mixed imperial and metric units. Australia still has a mixed system and some things are still in imperial units.

Anyone having difficulty with the construction can examine the real McCoy at FOE, or else ring me on (03) 604 9325 (B.H.)

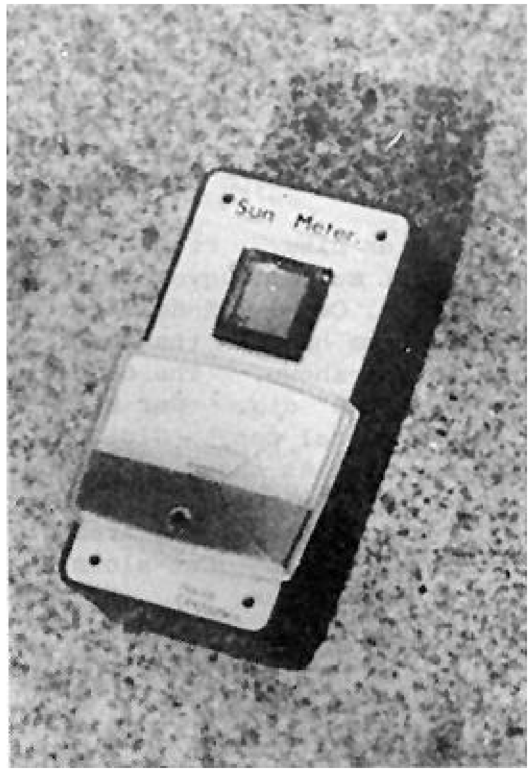
ALAN HUTCHINSON

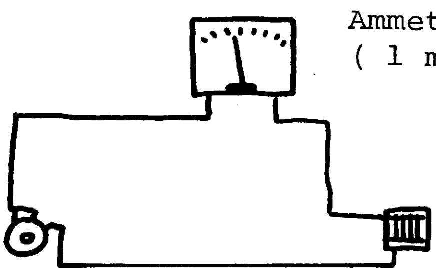


Sunmeter.

If you are using silicon cells or planning to use them in the future a simple meter to give you a basic measure of the strength of sunlight can be very useful. This meter can be used to give an indication of the output of silicon cells under a variety of conditions.

CONSTRUCTION.
Construction of the meter is very simple. You will need a small box, a meter (1 mA or similar), a small silicon cell (available from Dick Smith Electronics for a couple of dollars), a trimpot or potentiometer and some wire.
First mount the meter on the box. Mount the silicon cell in such a way that it will not be shaded by any of the other components. Before doing this solder some wires to it and drill a hole so they can be fed back into the box. Be careful when handling the silicon cell as these cells are very brittle.
Some form of protection will be necessary to protect the silicon cell from shocks or knocks. A small piece of glass or perspex mounted over the cell is the best method of doing this. Fit the trimpot or potentiometer in the box and wire the components as shown.





USING THE METER.
A meter of this type can be used in a variety of ways. You are considering buying a panel of silicon cells for use in some location. Throughout the year there are periods of sunshine and cloud. You want to find out how much energy your your panel would deliver in cloudy conditions. Set the meter so it reads full deflection in bright sunlight. Place the meter in the cloudy light and read off the meter. If you assume you are reading the percentage of maximum possible energy possible in sunny conditions then the meter reading will give you a rough idea of the amount of light you would get from you larger panel.
Another way you could use the meter would be to see how much energy you could get from silicon cells, say inside a greenhouse or in a variety of other places. It's up to your your imagination.

Approximate Cost $13-00

Mick Harris.

COMPOST TOILETS

Much has been written on the problems associated with the current two main methods of sewerage handling in Australia. Reticulated sewerage is becoming increasingly expensive with rising labour and energy costs, with a consequence that the treatment carried out is very often insufficient to prevent pollution of waterways.

Septic systems too are unsuitable where absorption in the soil is poor (e.g. clay, rocky or steep ground), or where seepage into underground domestic water supplies is possible. And of course either method requires in the order of 10,000 gallons/person/year, or ¼ - 4/9 of all domestic water consumption.[2]

Compost toilets, with proper design and care, offer a viable, waterless, environmentally 'soft' alternative to these and other established systems: it therefore seems worthwhile to briefly examine the status of compost toilets in Victoria today.

Like garden compost heaps, compost toilets function via aerobic decomposition by bacteria and other micro-organisms, and therefore certain conditions must be maintained to ensure efficient breakdown into humus[1] - good aeration, moisture content of around 50-65%, good heat retention properties, and a high C/N (carbon to nitrogen) ratio, preferably close to 30:l.

Special considerations mainly centre around the need to ensure:

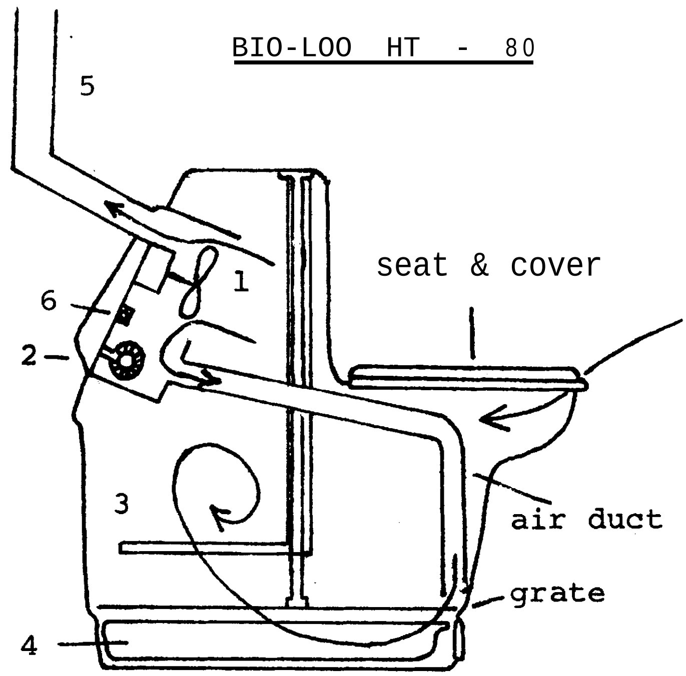
1) safe, convenient maintenance and use procedures, and
a safe disposal or use of the end product, humus.

These two points, as well as being largely the responsibility of the individuals and health authorities concerned, a also design criteria since they can be dealt with by ensuring a suitably low survival rate of any pathogens or parasites which may be present in the compost chamber.

Two models recently approved for use in Victoria[5], the Clivus Multrum and the Bio-Loo HT-80 (known in Scandinavia and North America as the Mull-Toa HT-80), illustrate some of the main ways of meeting these requirements.

The HT-80, like an earlier Bio-Loo, the HT-5, is a semi-portable unit (it weighs 30 kg and measures 29" x 25" x 33") and as such is aimed primarily at installations with intermittent use (e.g. holiday houses, ski-lodges, construction camps, etc.).

BIO-LOO HT - 80



Recommended usage is by six people on this basis, or by four people year-round.

The HT-80 also resembles the HT-5 in that[2] Air is sucked in through the seat by a constantly operating fan (l), passes over the . . . heater (2), circulates several times above the trays (4) and below and through the waste, then escapes through a flue which extends above the roof of the house (5) . . . . This system of air circulation is designed to ensure that no smell escapes into the toilet room (the suction of the fan creates a negative pressure as long as the flue is the only exit point for air from the room".

Changes from the HT-5 design include: a manually operated combination stirrer/rake/leveller (3) which replaces a motor-driven spreader and handrake, and relocation of the electrical apparatus onto a small plate mounted in the back. Included is a combination thermostat/hygrometer (6) which activates the heater whenever either the relative humidity or the temperature of air in the container falls below levels determined by the setting of a single control knob.

After an initial one month "running in" period, weekly stirring and raking via (3) is required, with emptying of the trays being necessary about 4 times per year (note that approximately 90% volume reduction should be taking place). Of course the greater the use, the higher the maintenance and energy requirements, which needs to be considered since maximum power requirement of the HT-80 is 250 watts (the fan requires less than 10% of this).

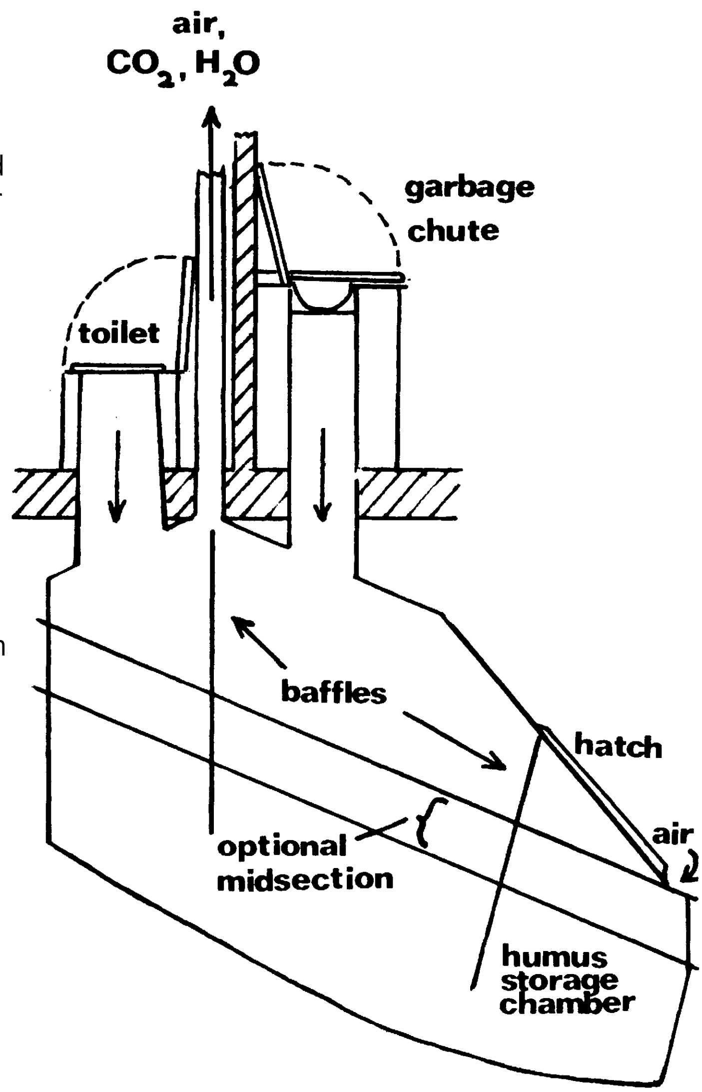
Estimated average total consumption is 1.4 kwh/day, assuming recommended loading, toilet room temperature of at least 64°F, and internal temperature of around 95°F.

There is a good analogy here with refrigerators, a 12 cu. ft. model of which uses an estimated 2 kwh/day on average[4], and in this context it is worth noting that the HT-80 is uninsulated (except for a portion of the vent-pipe). Much of the heat loss is of course via the exhaust vapour, but significant radiation and conduction losses from the pile must occur, as is partly borne out by the manufacturer's recommendation to insulate between the toilet and the floor.

Despite this criticism, and although no Australian research on the HT-80 has yet been carried out, there would seem to be enough design similarities to enable one to apply conclusions from the C.S.I.R.O. study2 of the HT-5.....

"…. it is highly useful in a number of situations. From the point of view of hygiene, aesthetics and cost to the community, it is far superior to the pan system. It can be used in places where septic tanks would be inadvisable or impossible. The toilet will perform satisfactorily as long as it is correctly installed and maintained."

The Clivus Multrum, which, as the first true compost toilet will need no introduction to many, illustrates another possible design approach. Here a much larger cornposting chamber (> 100 ft^3) is employed, thus enabling decomposition to proceed at a slower rate and with fewer energy inputs.



CLIVUS MULTRUM

Theoretically, aeration and evaporation of excess liquid can be achieved with natural updraft alone, but in some locations (due to health regulations, climatic extremes, or obstructions to airflow across the top of the vent pipe) an exhaust fan in the stack will be necessary, as will preheating of incoming air to 65°F. In fact these are Vic. Health Comm. conditions of approval for both Clivus Multrum and the HT-80. Further conditions relate to the necessity of an airlock (e.g. a "sealable" hallway) between any toilet opening and habitable room, and the collection of humus where Council nightsoil services exist. See reference 5.

Addition of dry cellulose material (e.g. kitchen scraps, leaves, sawdust, straw) is essential to maintain favourable carbon and moisture contents, as well as to improve heat retention properties of the pile.

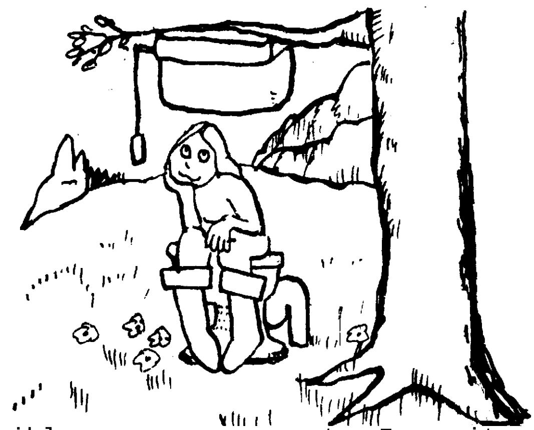
Beyond this, little maintenance is required, as the sloping bottom promotes mixing of the contents, and pushes the composted material into the storage chamber (which need be emptied only every few years or so).

This long holding time also ensures a poor survival rate of any pathogenic organisms which may be present, even though temperatures in the container seldom go above 90°F.[1]

Of course the size of the container can make retrofitting awkward, or even impossible, as it requires a space of depth at least 66" length at least 101", and width 36" beneath the toilet room floor, and access to the storage bin must be possible.

Nevertheless these units, thousands of which are now in use throughout the world[1], have been tested extensively for over 42 years, and there can be little doubt that they perform satisfactorily provided installation, use, and maintenance is carried out as recommended.

This latter point is perhaps the main reason why, until recently, local and state health authorities have been reluctant to approve compost toilets, for it appears that there is a general suspicion of "new" on-site sewerage treatment processes which require res-



ponsible user-management. In spite of this

(i) user managed pit or pan privvies still exist in many parts of Australia, and
(ii) ".... septic tanks are often overloaded and rarely maintained by the user."[2]

Currently, the Health Commission of Victoria will only approve Clivus-Multrum or Bio-Loo toilets where, in the opinion of the local Council chief health surveyor:

"a) a water flush system ... is not practicable,
b) satisfactory means are available for the disposal of polluted household waste water."[5]

Without clear guidelines as to what constitutes 'satisfactory means' or practicability, it is not surprising that, as has happened in Victoria,[2] some Councils will approve a model while others will reject it.

In view of the high cost of septic systems today, which varies between $1,000-$1,500 depending on conditions and capacity, this may be unjustly denying some homeowners the right to a less costly alternative, which must be taken into account, along with environmental and water costs, in assessing practicability.

Nevertheless receptive Councils do exist, as is witnessed by the many Bio-Loos in use around Australia. The Clivus Multrum too has been gaining many supporters, among them the Sherbrooke Shire Council in Victoria, much of whose area is unsuitable for septics because of the rugged terrain, and the Cranbourne Shire Council also in Melbourne (more-in this area next issue).

Obviously there are many aspects which I have not covered; some of the references cited will help here, and if you have any trouble locating these, or any other queries, I will gladly assist if you write care of this association.

The Australian distributor of Bio-Loo toilets is Environment Equipment Pty. Ltd., 24 Herbert St., 'Albert Park. Vic. 3206; the Bio-Loo is available from them for $825, or from retailers such as Self-Sufficiency Supplies in Newcastle, N.S.W. for around $900.

The Australian manufacturing 'and distributing rights to the Clivus Multrum are owned by:

G.V. Valentine and I.D. Jane,
14 Johnson St.,
OAKLEIGH. Vic. 3166

Manufacturing facilities are just being established after two years of testing in Melbourne conditions and Vic. Health Comm. approval in October 1980. These should be available later this year for between $1,500-$1,600.

REFERENCES

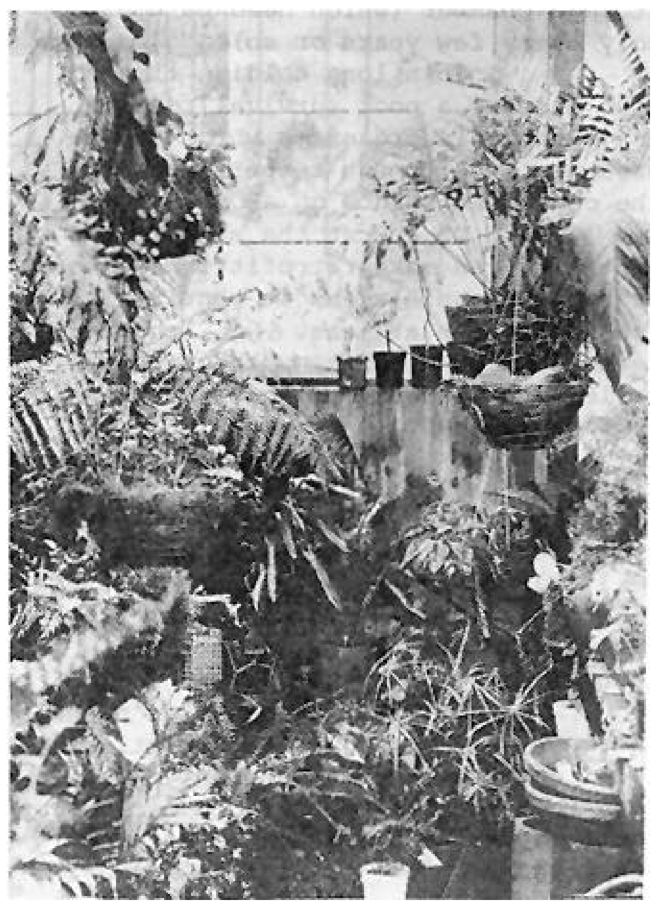
1. "Goodbye to the Flush Toilet". Carol Hupping Stoner, 1977, Rudale Press.
2. "Evaluation of Biological Toilets (Stage l)",. R. Rich. C.S.I.R.O. Div. of Building Research, Highett, Vic. D.B.R. reprint No.853.
3. "The Toilet Papers". Sim Van der Rym available from the Bookshelf, Bridge Rd., Richmond.
4. "Build It Yourself Natural Energy Sources". R.E. Pierson, 1978 Reward,. p-122.
5. Copies of the certificates of approval for the Clivus Multrum and the Bio-Loo HT-80 are available on request from the Health Commission of Victoria (Sanitary Eng.), 555 Collins St., Melb.

Greenhouses.

anybody who has been put off purchasing a commercially built greenhouse by the expense should consider the do-it-yourself approach. Results can be very encouraging and by constructing yourself, you can incorporate some of the features now acknowledged as good energy saving practice.

One such D.I.Y. greenhouse was recently seen in North Fitzroy, Melbourne. The builder-owner had a problem since the house he lived in was only rented. The dilemma of a permanent structure was overcome by building the greenhouse in such a way that it could be relatively easily dismantled. All mortar was made with a very sandy mix to facilitate the "destruction" of the small 'knee' wall at the front and sides of the greenhouse.

The greenhouse was of the lean-to variety which under the right conditions can act as a heating source for the house. This greenhouse was

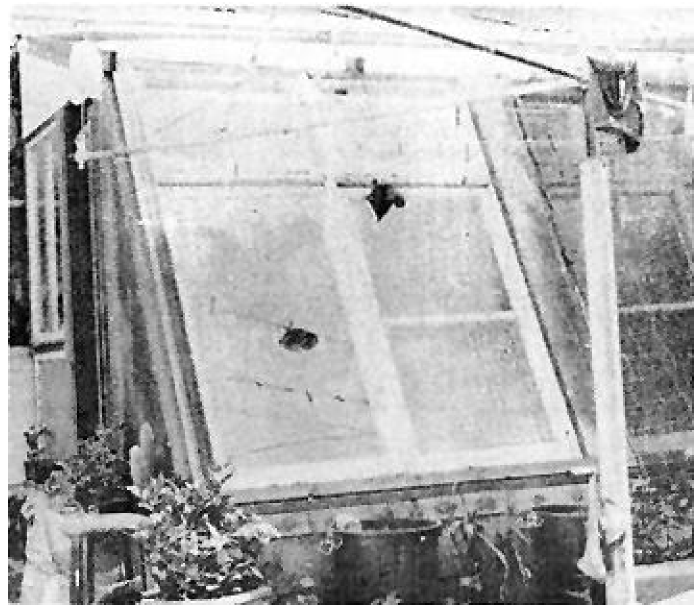


built onto the rear of the house, backing onto the kitchen, and the owner claimed that there was quite a good air interchange between the two spaces.

The main glazed surface was inclined at 60° and was North facing to maximise winter heat gain. However, at the time of the visit there was very little thermal mass (i.e. water or rocks) being used to try to capture and store some of this heat from the winter sun.

The house was constructed from a mixture of recycled and new materials and cost in total about $200. The main items of expenditure were:

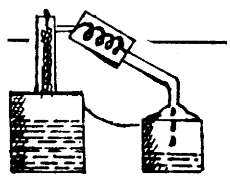
	$
Windows & frame (recycled	52
Reglazing of the above	12
Fibreglass sheet (new) Polyflute sheet (new)	24
Besser bricks (new)	40
Insulation batts (new)	20



The greenhouse took about a week on and off to construct and as our photo inside the greenhouse shows, created a very favourable environment for both plants and people.

BOB FULLER

BOOK REVIEW



MAKING YOUR OWN MOTOR FUEL BY FRED STETSON

The increasing price of petrol has had an important effect in making people look to alcohol as an alternative fuel for vehicles in the future. However, for those seriously interested in the alcohol alternative little information on do-it-yourself alcohol production, has been available. "Making Your Own Motor Fuel" by Stetson goes a long way to fill this gap in the available information,

The book starts by describing construction of a simple 5 gallon still made of such homely components as a pressure cooker, garden hose fittings and some copper pipe. It then goes into description of how to use the still, talking about preparation of the material for fermentation, the fermentation itself, pre-distillation and final distillation.

Next the construction of a 55 gallon still is discussed along with the steps involved in its use. A number of larger farm stills are examined for those who really want to get into the big time,

One chapter looks at the modifications necessary to run an engine on alcohol. These largely involve modification at the carburettor.

Overall the book is well set out and illustrated. It's easy to read and is an extremely valuable information source for the home distillation of alcohol.

Its biggest fault is the same as that for many books that can be found on bookshelves. It's American, and consequently a number of references to parts and organisations have little value here.

Despite this disadvantage, the book is still well worth buying if you want to know about this facet of alcohol production. It really is about making your own motor fuel with alcohol, and gives you all the information you will need to do just that.

Price: $ 10.95

MICK HARRIS

(Copy supplied by ANZ Book Co.)

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The Alternative Technology Association is a group of people interested in the use and promotion of Alternative Technology. Alternative Technology (which can also be thought of as Appropriate Technology), is technology that is ecologically sound and does not conflict with the environment by causing pollution or destruction.

The membership of the Association covers a wide variety of interests and skills. Solar and wind energy are areas of common interest, other important interests include: water power, methane digestion, agriculture, energy efficient houses and other buildings, crop fuels, bicycles, electric vehicles and alternative transport, domes, mudbricks,......etc.

WHAT DOES THE ASSOCIATION DO ?

* We hold regular meetings, with films and guest speakers talking on subjects of interest.
* These meetings are preceeded by a newsletter which provides details of the meetings, and also informs members of any current events of Interest.
* We produce this publication, which has Australian based information on Alternative Technology.
* We hold other activities from time to time: such as day trips to energy saving houses and workshops where members can come and work on individual projects.

If you are not a member already, why not fill in the form below and become a member.........

Fill in this form and send it to the Alternative Technology Association: c/o 366 Smith St. Collingwood, 3066.

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Please find enclosed my membership fee of
$10.00 normal membership.
$ 5.00 students, unemployed, pensioners, etc

Areas of interest...

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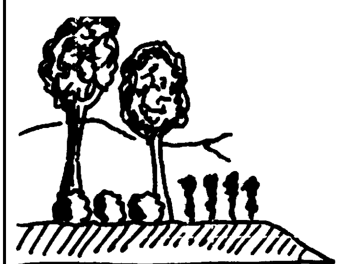

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