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Hydropower

Edited by: Andrew MacKillop

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INTRODUCTION

A.

Water power was basic to the growth of western society – but this needn't deter us from using it! If we ensure that the environment is not going to be damaged by a dam, or leats and artificial waterways, then this source of power can probably come closest to the ideal of effective and non-polluting power.

Helsinki's Agit Krop group point out: – "Progress", said Dr. (father of the H-bomb) Teller, "cannot and will not be stopped." The particular form of progress he was referring to is of course that designed for use by industrial technocracy, which knows of nothing more sacred than its own carefully nurtured "demands". In the context of such a definition of progress it is hardly surprising that the support of human-beings is considered the highest possible use for Britain's wild places. Not even tourism's demands for scenic landscape can compete with the increases in short-term profitability and political control which have been the sole reason for the development of the technology of large dam building and large-scale water diversion projects. Considerations of health and conservation of the environment are irrelevant to profit and power motives.

The age of cheap oil, and the promise of something for nothing from nuclear power meant that countries like – especially – Britain could only "afford" to build large hydropower projects. By the 1950's the smallest site potential "worth" considering was up to 350 kilowatts.

The scale of damming and waterway modification required for 350KW turbines virtually guarantees damage to natural systems – especially migratory fish

It is possible, by allowing people to develop their own small scale water power using the smaller rivers and streams not calculated for in official resource estimates, to produce at least three times as much hydro-electricity as is at present generated in Britain. Where there are large rivers to be dammed there are generally also smaller ones. Environmental impact would be reduced, there would be no need for large and ugly electric power grids, and if properly managed such schemes would often be suitable for food production and play.

Many people regard such proposals as "quaint", "primitive", or comical. This is because nearly all the "soft" technologies we know of are from wild and distant times and places. Such ancient or exotic technologies do not necessarily lead to a dead end, just because historically they were suppressed. They were suppressed mostly because they are by their nature not amenable to centralisation and control.

and people living near the affected site who have to become migratory. Until very recently the compensation for flooding out Welsh farmers was reckoned in sterling equivalent of a certain number of *months* of rent value! Cheap electricity of this kind is the result of Big Brother swindles on small groups and isolated communities, to keep the mighty machines of door latch and dildo manufacturers going. It also damages other living things, that in their lives can do no damage to humans.

Small waterpower projects offer all sorts of potential for even improving environmental quality. This can be done by filling in holes left over from quarrying or mining. By increasing the number of habitats in an area – giving food for new species – ecological stability can be enhanced by adding diversity. Not least, new waterbodies whose permanence and nutrient content can be modified are just right for growing fish, many specialised plants (like rush), and other organic materials, like algae.

HAVE YOU GOT A WATERWHEEL?
OR WATER-DRIVEN GRAIN GRINDER?

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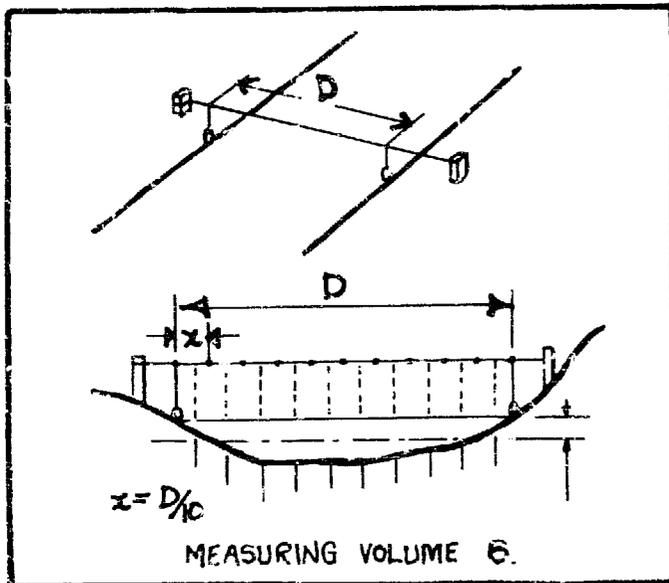
(East Anglia and Midland areas preferred)

B. HOW TO WORK OUT WHAT POWER IS AVAILABLE

The power available is determined by the quantity of water flowing and the drop you can create. The volume of water flowing is found by measuring the capacity of the stream bed, and the flow rate.

i VOLUME: capacity of stream bed

Select a length of the stream that is fairly straight, with sides approximately parallel, and unobstructed by rocks or shoals for a distance of about 100'. Stretch a taut wire squarely across the stream near the middle of this length and measure the width of the stream here in inches. Mark this width off on the wire and divide it into ten equal divisions. From the centre point of each division, measure the depth of the water in inches. Then average the depth figure by adding each value and dividing by 10. The cross-sectional area of the stream, A , is now secured by multiplying this average depth by the width, and dividing the result by 144 to obtain the answer in square feet.

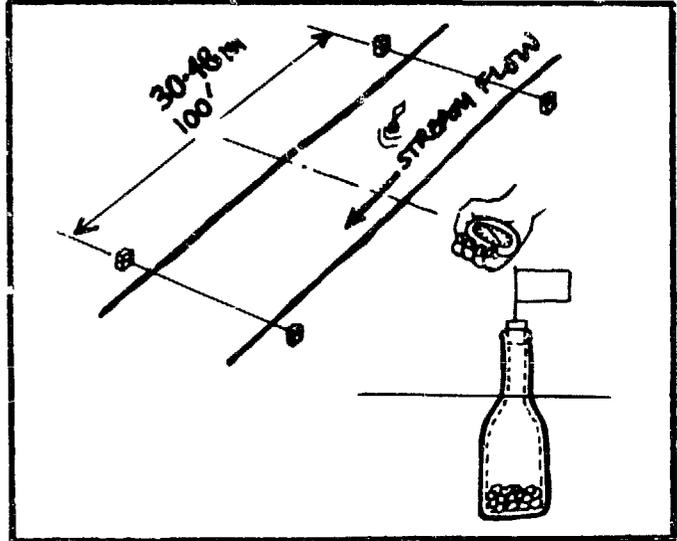


ii RATE OF FLOW USING FLOAT METHOD

Your next step is to measure the rate of flow. Using a steel tape, mark off a course along the bank that is 100' long; the mid-point of this course should be at the line where the cross section was measured. Stretch wires or rope tautly across the stream at each end of the course, and make a float by filling a bottle so that it rides awash. Provide it with a pennant so that you can follow it easily. Then set the float adrift in the middle of the stream timing its progress over the course with a stop watch, beginning just when the pennant passes the first wire and stopping just as it passes the second.

Make a series of runs, averaging the results. The speed of the float is then the length of the course divided by the average time. This result is not, however suitable for immediate use in the flow formula, since not all the water in a stream flows as rapidly as that in the centre and near the top.

Given an estimate of the amount of head to be present at the wheel, you can now make a rough determination of the horsepower your stream can



provide. It's worth emphasizing, though, that this figure is necessarily only as accurate as the measurements that produced it, and that the power indicated is that present *at the time of measuring*. A single stream-flow value is not of itself particularly useful unless it is obtained at the time of lowest water, usually in the late summer months. Moreover, even if you have measured the flow at slackwater time, the figures should if possible be supplemented by others secured during maximum springtime flow, so that you can calculate the size of spillway needed to prevent damage to your installation in times of high water.

It's a good practice, for backyard engineers as well as for professionals, to refine, cross-check, and test your measurements by all means at your disposal. Such checks will not only reduce the chance of disappointment in the final result, but will also permit calculated economics in construction and greater efficiency in operation.

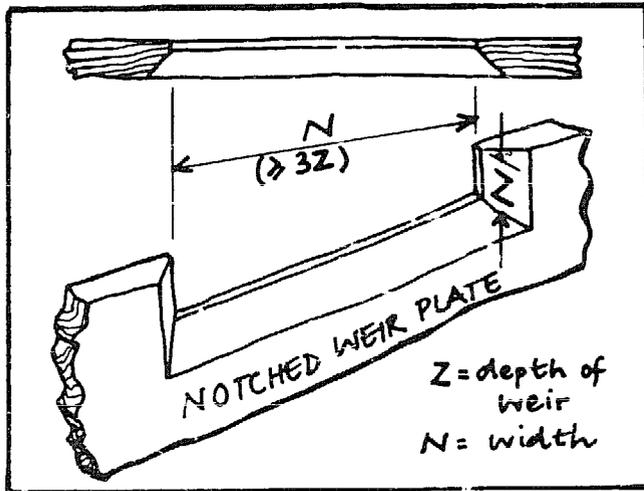
Your estimate of the head present at the wheel, for instance, should be carefully checked, since head is a vital element in the efficiency of any water-power project. Several methods for determining the head rather precisely will be given later.

CROSS CHECKING: THE WEIR METHOD

Measuring the flow of water in the stream or brook on your property is the logical first step in planning a small waterpower project. The float method of making this measurement is generally the easiest to perform and, if done carefully, is accurate enough for most purposes. If, however, a stream is so shallow at low-water time as to impede the progress of a weighted float, the weir method of measuring flow has advantages. Essentially a kind of water meter, a weir is a rectangular notch or spillway of carefully controlled proportions located in the centre of a small temporary dam. Two simple measurements permit the volume of flow to be accurately calculated.

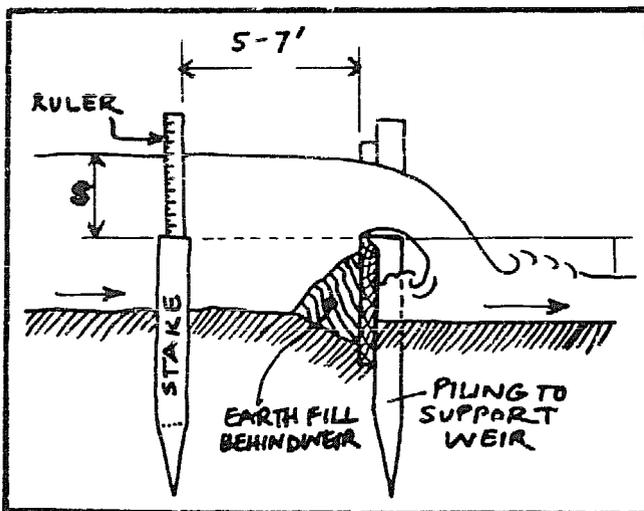
Before constructing the dam, measure the depth of the stream at the site; the depth of the weir notch, Z should equal this. Since the dam need not be permanent, simple plank or tongue-and-groove lumber will serve adequately. No water must flow except through the weir, so care should be taken to seal the

ends and bottom of the dam by extending planks into the banks and below the bed of the stream. Clay or loam puddling on the upstream side will stop minor seepage. Be sure the dam is perpendicular to the flow of the stream.



The weir gap should be located in the centre of the weir dam, with its lower edge not less than 1' above the surface of the water. This lower edge should be accurately levelled. Both this and the vertical edges of the weir should be bevelled with the sharp edge upstream; a 1/8" flat on the bevel will keep the edge from breaking down. Proportion the weir so that its length, N, is not less than 3Z and larger if possible.

Drive a stake in the stream bed at least 5' upstream from the weir, pounding it down until its top is exactly level with the bottom edge of the weir. Allow the stream to reach its maximum flow through the weir and then measure with a ruler the depth in inches of water over the stake. Referring to Table B you can now read the number of cubic feet per min. of water for each inch of N, the weir width.

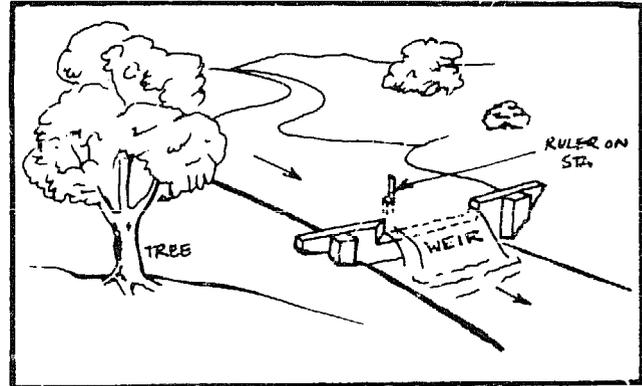


If your stream is already dammed, there is no need to construct another dam just to measure flow. It is quite possible to employ the existing dam, using its spillway as a weir.

Where your stream or river is big, the measurement scene is like Figure 1.

In winding, rocky and very steep streams you can

apply the weir method, but it involves first constructing a dam - which will commit you to spending time and money. If the stream is really small this will not be difficult.



MEANWHILE - BACK AT THE GPO

From Mr. Edgar Mehl

Sir, With further reference to the letters of Mr Bernard Levin and Mr Paul Callan regarding crossed lines, may I tell you that a short while ago I also had a crossed line. The other man was making a bet with his bookmaker - in actual fact £7 to win on As Friendly.

I told various friends of this and we immediately placed similar bets on this horse, which duly came in first at 3 to 1 in the 4.15 at Epsom!

May I therefore, through the courtesy of your Readers column thank the Post Office telecommunications department most sincerely for their excellent service.

Yours faithfully,

EDGAR MEHL,
19 Neville Court,
Abbey Road,
St John's Wood, NW8.
July 5.

WATER TURBINES

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PRICES: Approx. £2,000 for 2.15 kW

QUOTE REFERENCE: L11 W

Speciality: high head turbines

TABLE B FLOW IN CUBIC FEET PER MINUTE FOR EACH INCH OF WATER DEPTH OVER STAKE, PER INCH WIDTH OF WEIR

Depth over stake inches		1/8"	1/4"	3/8"	1/2"	5/8"	3/4"	7/8"
S	O	(0.125)	(0.25)	(0.375)	(0.5)	(0.625)	(0.75)	(0.875)
1	.40	.47	.55	.65	.74	.83	.93	1.03
2	1.14	1.24	1.36	1.47	1.59	1.71	1.83	1.96
3	2.09	2.23	2.36	2.50	2.63	2.78	2.92	3.07
4	3.22	3.37	3.52	3.68	3.83	3.99	4.16	4.32
5	4.50	4.67	4.84	5.01	5.18	5.36	5.54	5.72
6	5.90	6.09	6.28	6.47	6.65	6.85	7.05	7.25
7	7.44	7.64	7.84	8.05	8.25	8.45	8.66	8.86
8	9.10	9.31	9.52	9.74	9.96	10.18	10.40	10.62
9	10.86	11.08	11.31	11.54	11.77	12.00	12.23	12.47
10	12.71	12.95	13.19	13.43	13.67	13.93	14.16	14.42
11	14.67	14.92	15.18	15.43	15.67	15.96	16.20	16.46
12	16.73	16.99	17.26	17.52	17.78	18.05	18.32	18.58
13	18.87	19.14	19.42	19.69	19.97	20.24	20.52	20.80
14	21.09	21.37	21.65	21.94	22.22	22.51	22.79	23.08
15	23.38	23.67	23.97	24.26	24.56	24.86	25.16	25.46
16	25.76	26.06	26.36	26.66	26.97	27.27	27.58	27.89
17	28.20	28.51	28.82	29.14	29.45	29.76	30.08	30.39
18	30.70	31.02	31.34	31.66	31.98	32.31	32.63	32.96
19	33.29	33.61	33.94	34.27	34.60	34.94	35.27	35.60
20	35.94	36.27	36.60	36.94	37.28	37.62	37.96	38.31
21	38.65	39.00	39.34	39.69	40.04	40.39	40.73	41.09
22	41.43	41.78	42.13	42.49	42.84	43.20	43.56	43.92
23	44.28	44.64	45.00	45.38	45.71	46.08	46.43	46.81
24	47.18	47.55	47.91	48.28	48.65	49.02	49.39	49.76

Examples:

Weir width 24" (N) Depth of water over stake: 1 1/2" (S)
 Flow rate is 24 x 0.74 = 18 (approx) CU.FT. PER MIN.

Weir width 30" (N) Depth over stake: 6 1/4" (S)
 Flow rate is: 30 x 6.28 = 188 (approx) CU.FT. PER MIN.



WATER POWER QUESTIONNAIRE



It is only possible to consider the most appropriate type and arrangement of water turbine installation if we know in detail what the conditions are. The particulars requested with an enquiry are listed below together with a full explanation of how to measure the Head and Quantity of water.

- | | |
|--|--|
| 1. Head (Height of fall.) | Determines Turbine Type |
| 2. Estimated quantity of water available :
(a) normal flow.
(b) minimum flow. | Size |
| 3. Will turbine draw from storage dam or open stream? | Flow Rates |
| 4. Does water carry abrasive silt in suspension at any time of year? | Screen/Rack Needs |
| 5. Will pipeline be required? If so state:
(a) length.
(b) diameter (if in existence or already decided). | Turbine Type
Pipe Costs
Dam Sizes etc. |
| 6. Power required (Indicate number of units if more than one). | |
| 7. Does shortage of water at certain times of the year call for a Turbine having a high "Part Load" efficiency? | |
| 8. Arrangement preferred. (If possible suggest Impulse or Reaction Turbine and Horizontal or Vertical Shaft). | Impulse High Head
Reaction Low |
| 9. Machinery to be driven | |
| 10. Is a governor required? | For constant voltage etc. |
| 11. If driving an electric generator indicate the supply required, (D.C., A.C., 50 or 60 cycle, etc.) and whether the new set will have to work in parallel with any existing source of supply. | Alternator
or
Dynamo |
| 12. If the turbine is to replace a water wheel give full particulars of the water wheel dimensions. | Power available |
| 13. If in the United Kingdom state <i>exactly</i> where the turbine will be installed so that, if possible, we can identify the site on an Ordnance survey map. | Water supply
Site details |
| 14. Always try to let us have a sketch indicating the site conditions, particularly if the turbine is to go into an existing water wheel or turbine pit, or is to be arranged to drive existing machinery. Under this heading please include any special information which might be of use in assisting us to prepare an accurate quotation for the plant which will be most suitable for your requirements. | Site details |

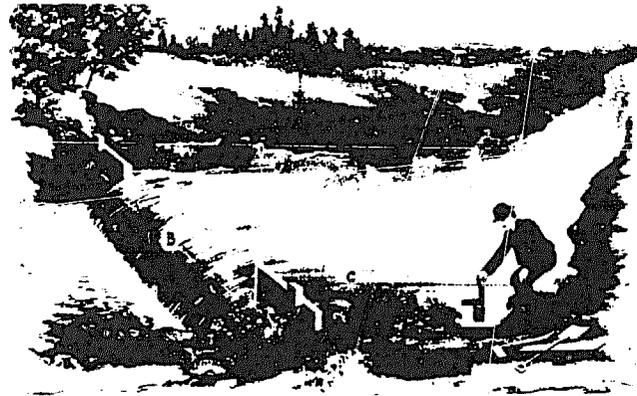
H.P. (Approx.) = $Q \times H$ Based on 80% Turbine Efficiency. Where Q = Cubic feet per minute,
H = Head in feet.

660

Gilkes & Gorton, Westmorland, UK

THE JAM LEFFEL & CHARLIE

Use Different Methods For Measuring Water



Measuring Flow of Water by Weir Method

OTHER METHODS

Recorded Data

On large streams and rivers – where water authority permission can be obtained (see section D) – access to historic, local or central authority information can provide you accurate flow data at certain sites, with indication of yearly variation.

In Britain the Surface Water Yearbook provides data, in cubic metres of waterflow per second, for several thousand sites which can be visited, photographed, etc. to give useful comparative information. This is especially so when the site for potential water power development is on a watercourse that is covered by the Yearbook. Yearly variations on a recent historical basis is given in the book. (Available from many universities, through libraries and Water Authority Offices).

Photogrammetry

If you've got a people's balloon, private plane or helicopter you could take aerial photos of your water catchment area and work out the water available. Using items like panoramas it is possible to measure how much water is in your system. It is also possible to pinpoint the best sites. (For People's Solar-Power Balloon – see Undercurrents, Winter 1973).

C. WHEN THERE ISN'T ENOUGH WATER

1. Use less power, better

If your hydropower potential – and what you can add to this – is not enough for you to run that little arc furnace of yours you don't have to give up water power.

When you want heat and mechanical energy there are plenty of ways to get this without having electricity as a wasteful intermediate stage. In fact, if your choice is restricted to a water wheel, then this, initially, will drive a shaft. Extend this, and fit different size pulleys to it, and you can drive direct to lathes, saws, millers and other workshop equipment. A dynamo pulley and suitable dynamo will give you electricity for purposes where it is essential.

2. Heat pumps

If you need heat, then you can get your water wheel

to chill the air or the water, with a heat pump, and heat your house in return. Heat pumps work with entropy and as a result they get a big extra bonus from nature – they give out *more* heat than power needed to drive them, often by a factor of 5 times.

3. Dams

Where you can get permission, building a dam is a practical solution to increasing power and reliability of water flows. Dams are O.K., like politicians, in small doses. The larger the scale, the more headaches and this is a possible problem for all dams. There is damage to the dam caused by water pressure, abrasion of the dam lip and sides by particles and stone in the water and so on.

Earth dams

Dams such as the one shown in Figure C1 should be layered, approximately as shown in the diagram. The basic idea is to achieve layering in which the outer layers are relatively porous, and each one below is less than the one before. If the layering is not done the dam can still hold, but the tendency will be for chunks to pull out.

In the case of earth dams it is *not* possible to allow water to spill over the lip. For this reason spillways must be installed.

One way is to build-in drains near the dam edge, that prevent water reaching the lip level where it could do damage. If necessary you can fit covers to these drains to alter the amount of water that they spill.

Another way is to build a spillway from planks or stones or blocks. If you choose blocks the Cinva Ram can give tough blocks at a fraction of the cost for concrete blocks. A lip of planks or blocks is then built, as shown in figure C, that permanently lowers the water level above the dam.

Concrete, though desirable, isn't necessary for damming a small stream. Beavers have gotten by for years without it. Suitable materials can be found on almost any farm. Logs, rough-hewn timber, rock, masonry, planking, gravel, sand and clay are all useful. Choose the materials most readily available on your property, or the least expensive if you must

obtain them elsewhere. Remember to visit demolition sites when you have to build your dam. The summer months or a dry month that's good to work outside in, is best. This is because you should construct your dam when the water is at a low, or *lowest* level, so that water causes the least building problems.

Four basic types of small dams are shown in the accompanying drawings. All are adaptable in general to the kind of materials likely to be on hand and also to the head of power desired.

There are two basic principles of design to bear in mind no matter which you build. First a dam should be sealed both above and below its foundation to prevent the seepage of water through or under it. Seepage through a dam, if permitted can soon turn your soft technology so soft that it oozes away.

The earth dam is particularly vulnerable. Sealing this type of dam is most important since seepage will literally carry it away if allowed to progress. The seal is put in first and the dam built around it. How far down it should go depends upon the kind of soil. A sand foundation, for instance, requires the seal to extend deeper than clay. If planking is used, it would be well to apply a protective coat such as tar or creosote.

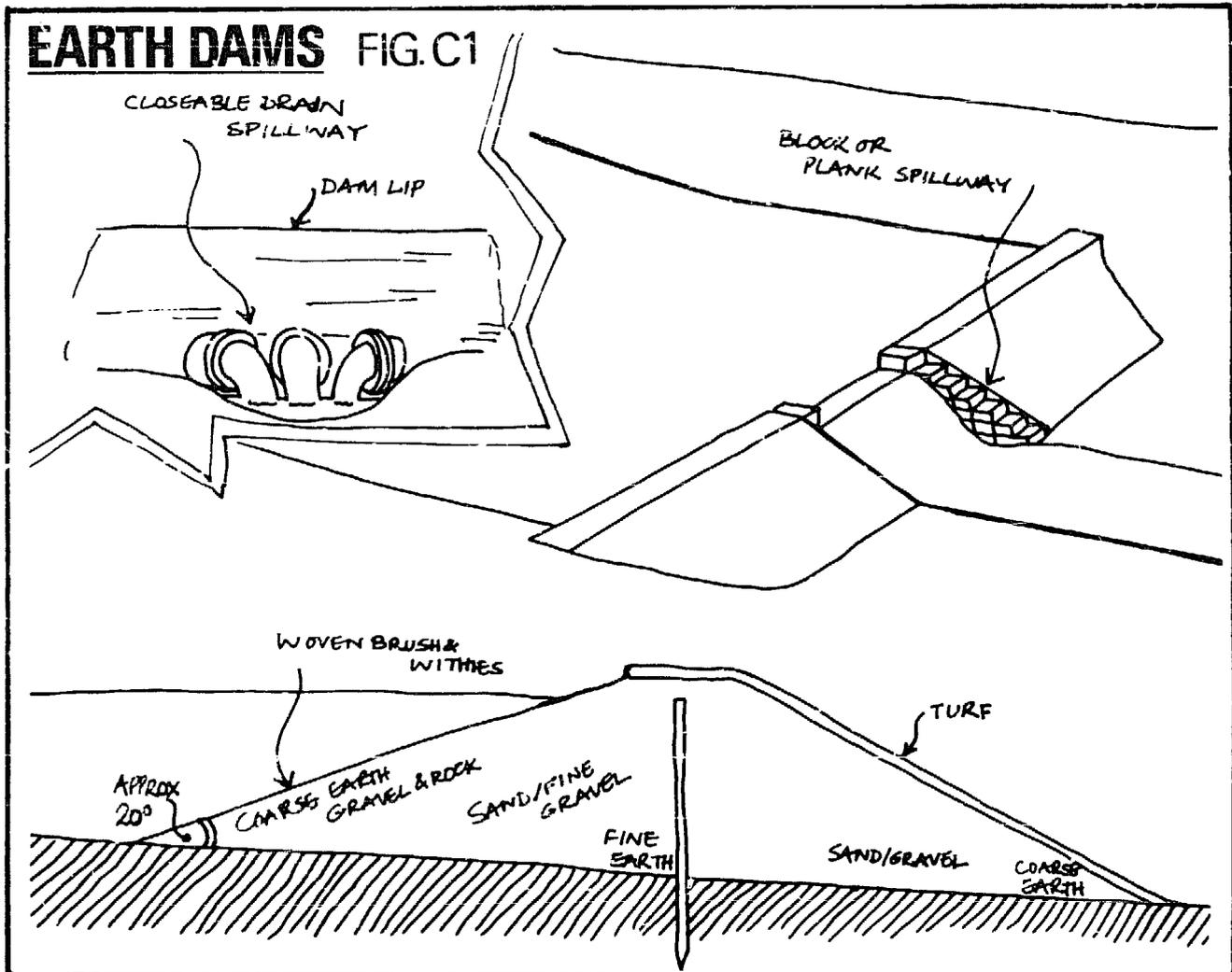
Such a dam obviously cannot have water spilling over its crest since this action would wash it away. Two suggestions for handling the excess water are shown. The spillway must be of some material, such

as masonry or planking, resistant to the erosion of rushing water, and the sides must protect the open ends of the earth dam from spillage water. An alternative method of handling runoff water is with drain tiles instead of a spillway. Some means must be provided for shutting them off. A simple cover on the upstream end would serve.

Figure C.2 shows the framed dam, which likewise can be easily built, particularly on a farm where lumber in any form from logs to planks is abundantly available. Each frame consists of one joist on which the surface timber is laid and one or more struts. Once the height of the dam is determined, the size of individual frames will vary depending on the contour of the gully, those frames located at the lowest part being the largest. The frames are spaced according to the support the surface timber needs, that is, the thinner the surfacing the more supports.

Lay the planking surface or rough-hewn timber horizontally and edge to edge across the frames, and bolt or spike each in place. Calk the joints and apply a protective coating. Fill is put in behind the downstream side. Build the spillway entirely of planking or similar material.

The gravity dam, shown in Fig. C.3, relies upon its weight for its stability. This dam would be most feasible where large rocks or field stones abound. Bricks, concrete or cinder blocks, and even chunks of broken concrete pavement are also excellent



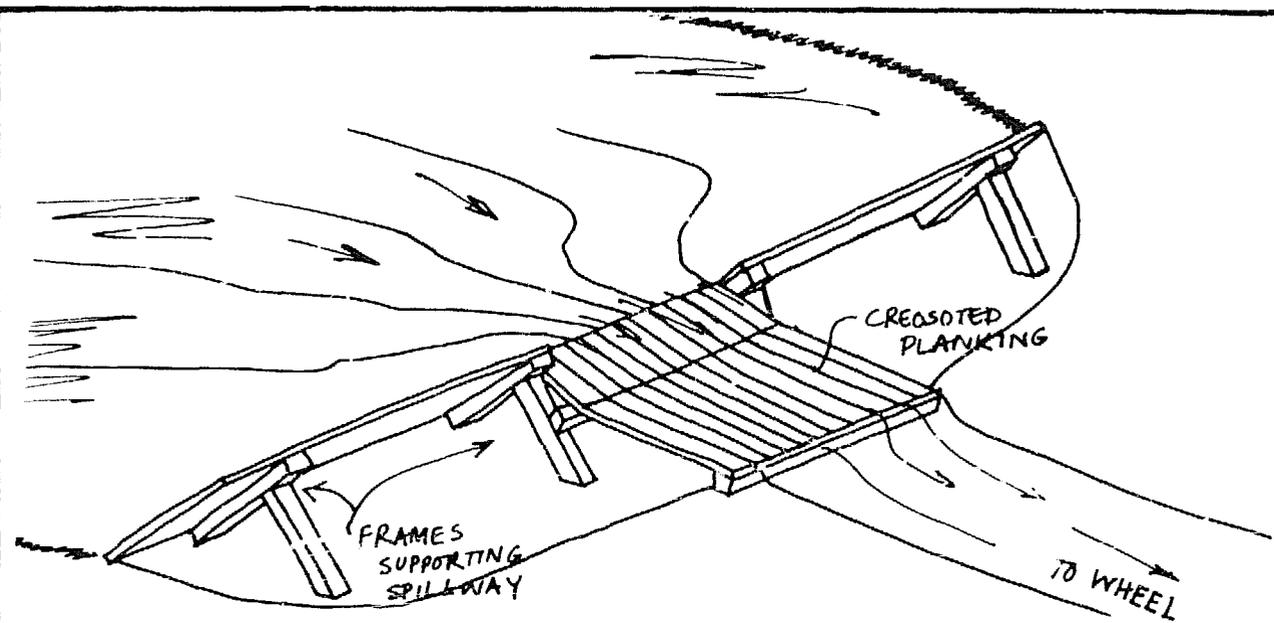


FIG. C2

FRAMED DAMS

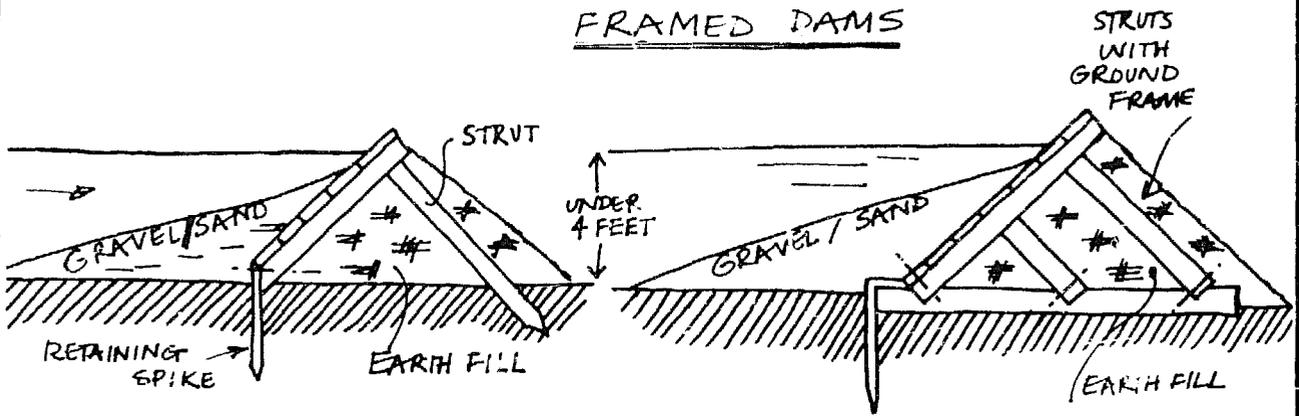
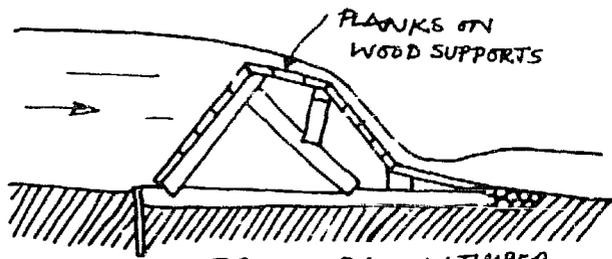


FIGURE C.4 ARCH DAM

- PLAN -



FRAME DAM IN TIMBER
FIGURE 2

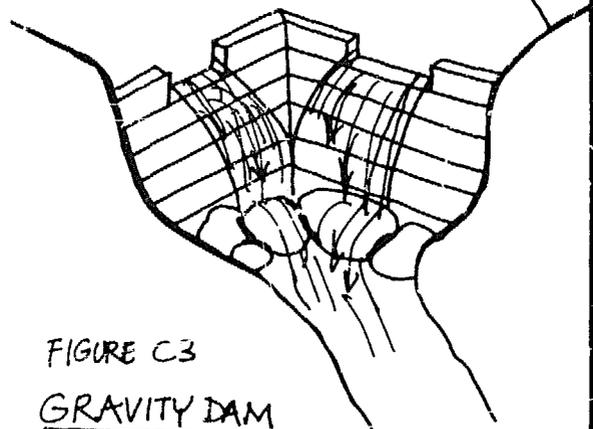
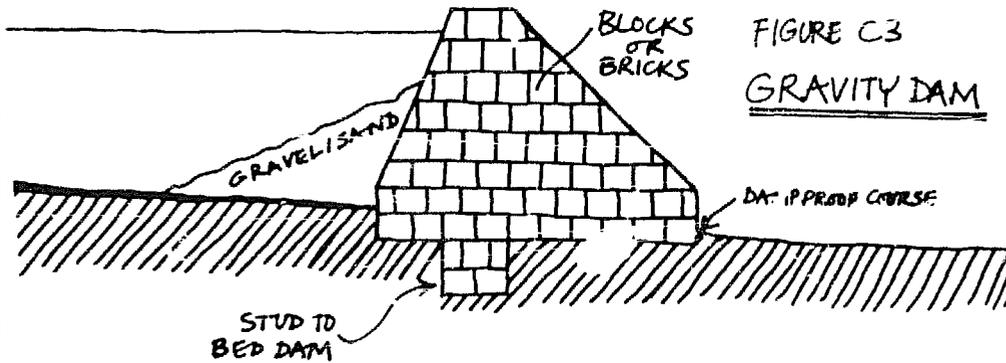


FIGURE C3
GRAVITY DAM



materials. The dam is strictly a masonry type, each block being laid with mortar.

Length is not a critical factor for any of these three dams, but it is important for the arch dam illustrated in Fig. C.4. The placement of such a dam in a gully is limited not only to the point of least width but also to the point where the banks are highest. Otherwise, this dam would impound little water. It would seem unwise to build one to span more than a width of 10'. If the heavy timber is used only as a frame on which to spike or bolt a surface of planking, as shown in one of the drawings in Fig. 4, the number of timber arches will depend on the strength of the planking and also on the height of the dam.

Only earth foundations are considered in the drawings, but you may be fortunate enough to have a solid rock foundation on which to build. In that case a seal below the foundation will not be necessary, but some means must be provided to anchor the dam to the rock, such as with anchor bolts in the case of either the framed or gravity dam. Likewise the dam should be sealed at the rock foundation to prevent seepage under it.

In most instances it will be found best to restrict the width of the spillway for excess water to some part of the total length of the dam. This will always be necessary in the case of an earth dam to prevent washing. The spillage water may be allowed to pour over the entire length of framed, gravity, and arch dams, however, if the precautions shown in Fig. C.5 are taken.

If the downstream side of the dam, or of the spillway, is a curved hard surface of masonry or timber approximating the natural curvature of the water flowing over, it will guide the spillage water so it will be directed downstream without actually falling. Such a curved spillway surface is particularly satisfactory for an earth dam. Large rocks, bricks, or

other hard objects placed on the downstream side of a spillway not having a curved surface will break the force of the free-falling water and prevent erosion.

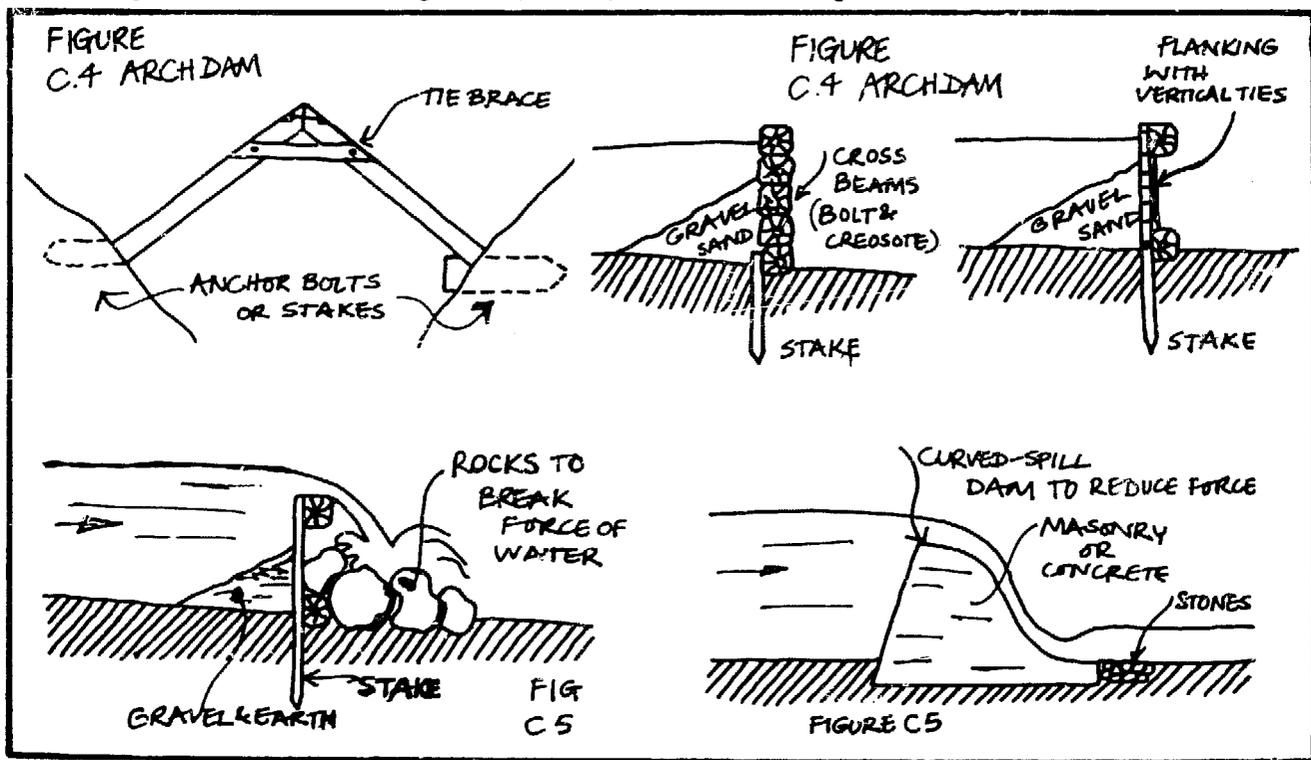
The spillway in its simplest form takes the shape of a rectangular depression in the crest of the dam. It should usually be large enough to carry off sufficient excess water so that impounded waters will not top the dam at any season of the year. This, of course, is quite a problem, since accurate determination of spillway capacity requires a knowledge of the total area drained by the creek being dammed plus data on the amount of rainfall at all seasons.

However, most of us will know whether or not the creek we are damming stays within its banks during the year. If it does, then a safe rule to apply would be to make the area of the spillway equal to the cross-section area of the creek at the dam when it is brimful or just ready to flood. The formula is illustrated in Fig. 6.

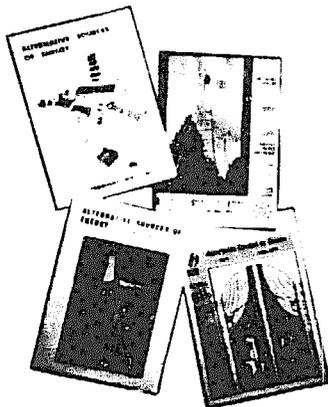
If the stream does flood, then either construct a dam that in an emergency can allow water to top its full length or build some sort of floodgate into the dam so it can be opened when necessary. One form such a floodgate could take is a group of drain tiles through the dam, as shown in Fig. 1.

The height of the dam you build will be determined by the area of land to be covered by the impounded water. In general, the higher the dam, the greater the area covered by water above it.

All vegetation, brush, floatage, and the like in the area to be flooded and for about 15' around it should be burned out or otherwise cleared before the dam is built. This keeps down the breeding of mosquitoes and helps retard pollution. It is required in the regulations of some States and is a wise precaution even when not covered by law. In addition, all trees in the area to be flooded should be cut reasonably close to the ground.



ALTERNATIVE SOURCES OF ENERGY -- MAGAZINE OF TECHNOLOGY ALTERNATIVES --



"A.S.E." was started three years before the "energy crisis," to foster the growth of decentralized, human-scale technology.

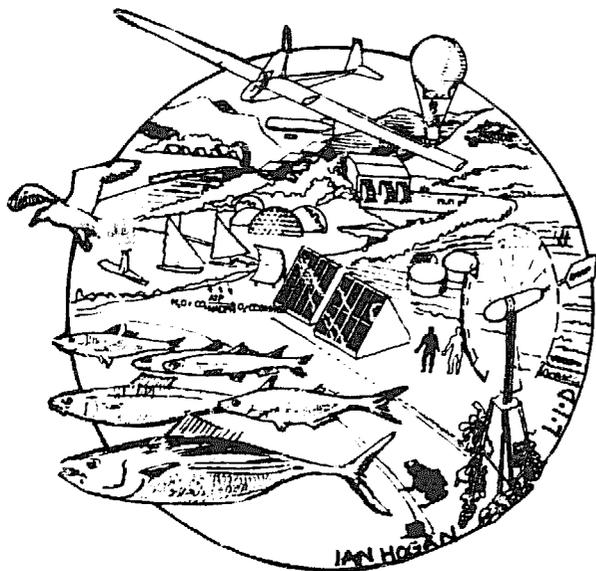
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- HOW TO GET ELECTRIC POWER FROM THE WIND...
- BUILDING SOLAR-HEATED HOUSES...
- GENERATING METHANE FUEL FROM GARBAGE...
- ENERGY CONSERVATION...much more...

ALTERNATIVE SOURCES OF ENERGY is a one-of-a-kind magazine. Favorably reviewed by Stewart Brand in the April '74 issue of HARPER'S MAGAZINE, A.S.E. has also been recommended by: MOTHER EARTH NEWS, SURVIVAL SCRAPBOOK, SMITHSONIAN MAGAZINE, COMMUNITY MARKET CATALOG, THE NEW ALCHEMIST (New Alchemy Institute), and others.

Begun out of a concern over pollution, our depleted supply of fossil fuels, and the dangers of nuclear power, ALTERNATIVE SOURCES OF ENERGY --

- prints new ideas concerning ecological, alternate technologies...
- publishes plans and diagrams so readers can begin to convert to ecological, decentralized energy sources...
- tries to reach all people, not just engineers and scientists. Articles are edited to make complicated ideas clear.



do-it-yourself



Readers use plans and diagrams -- build -- report on results -- generate better designs!

New, speculative ideas go into separate section, "From the Drawing Board."

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HEAT PUMPS

Dear Sir/Madam,

Thank you for your enquiry concerning heat pumps for domestic installations.

Readily-available refrigeration units for heavy-duty applications can be used with coils supplied from specialist manufacturers, for cooling of water (or earth, air, etc.) to give useful room heating. **THREE OR MORE UNITS OF HEAT ARE AVAILABLE FROM EACH UNIT OF ELECTRICITY USED TO DRIVE THE SYSTEM.** Off-the-shelf heat pumps for building heating are available from Sweden and Switzerland. Cost for such units £650 – £2,250 for units giving 7 Kw – 38 Kw of heating, with water temps. of 100 – 120°F.

In connection with Frigidaire U.K., we can provide water-cooled refrigeration units, at costs of £250 – £350, giving heat outputs of approx. 3 Kw – 14 Kw.

These are watercooled, with water passed through the condenser chambers at rates of approx. 20 gallons to 60 gallons per minute. Used in conjunction to panel radiators, radiant floor, or warmed air heating, useful heating of homes can be accomplished, at very low running cost.

Waterbodies such as small-medium ponds, rivers and dammed streams will give most trouble-free heating. In such bodies a specially-made tinned copper heating coil is inserted, and connected to the Frigidaire watercooled condenser. Coil costs: £150 – £350 (approx.)

Competent plumbers, engineering contractors, and refrigeration engineers can install such equipment.

LIT's Service

We can undertake to evaluate the suitability of a site and recommend an installation, using Frigidaire U.K. components, with specially-constructed heat coils made by a specialist manufacturer.

Local building, refrigeration, etc., engineers will also be required. We can undertake to brief such engineers on installation.

Delivery periods:

Packaged heat pumps	10 – 18 weeks
Frigidaire components	12 – 15 weeks
Coils	12 – 15 weeks

LOW IMPACT TECHNOLOGY LTD.,
73 Molesworth St., Wadebridge, Cornwall.
Telephone: Wadebridge 2996.

*We hope to be able to offer complete supply-installation services in the next 6 months.



Undercurrents from 275 Finchley Road, London NW3, England.

Eco-Design
at pre-Poulson
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LID,
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Glos.

tel. Uley 636

Canpa Marine Refrigeration for Yachts and Small Commercial Craft

The major problem in sailing and motor yachts requiring refrigeration is the power supply. The use of a standard domestic type of refrigerator or freezer is invariably ruled out because of its size, shape and power consumption. It has been found that a refrigerator under average conditions will run 40% of the time and use 6-10 amps. while so doing, and use as much as 100 from the battery capacity per day.

The Canpa system of "holdover" operation has overcome the power supply problem by using an ultra efficient refrigeration system which will give as much refrigeration effect as possible per ampere hour of battery drain. The system comprises a 12 or 24 v. D.C. sea water cooled condensing unit connected to a "holdover" eutectic evaporator in the refrigerator or plates in the freezer. The plates, when frozen, will maintain the correct temperature without operation of the condensing unit. An oil pressure switch in the system will ensure that the condensing unit cannot run unless the main engine or charging set is running.

CABINETS

A well-insulated cabinet is essential for an efficient system and is directly related to the amount of drain on the batteries. Design and construction details and suggested cabinet layouts are given later in this brochure.

STANDARD D.C. CONDENSING UNITS

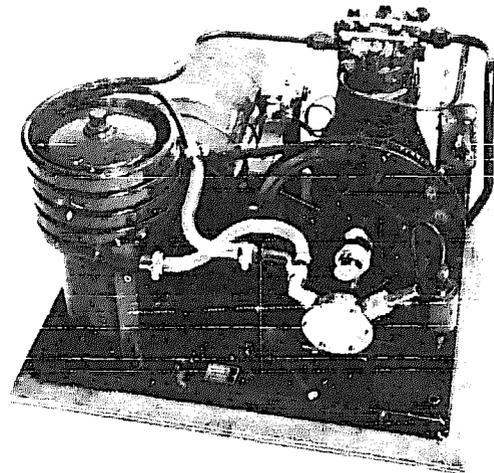
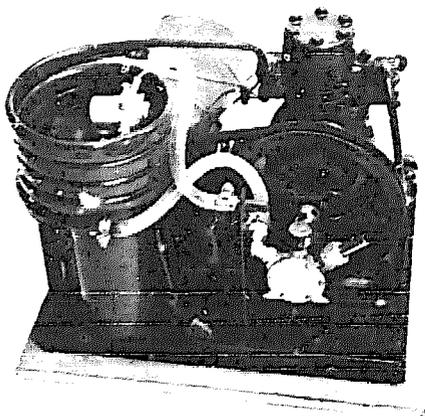
Two D.C. models are standard - Model 25 ($\frac{1}{4}$ h.p.) and Model 33 ($\frac{1}{3}$ h.p.) A $\frac{1}{2}$ h.p. version of the Model 33 is available to special order for larger cabinets and dual installations.

ENGINE DRIVE CONDENSING UNITS

Where larger cabinets are required or where small battery capacity is unavoidable, an engine driven condensing unit is available. In this system a high capacity compressor in two sizes is driven off a pulley on the boat's main engine.

CURRENT REQUIREMENTS

Using a well-insulated cabinet it need only be necessary to run the engine for 1-1 $\frac{1}{2}$ hours per 12 hours. This means that a Model 25 ($\frac{1}{4}$ h.p.) unit will draw a maximum of 50 ampere hours per 24 hours from the battery on a 12 v. system and 25 ampere hours per 24 hours from the battery on a 24 v. system. When the battery is being charged the alternator is in effect powering the condensing unit. Required daily battery charging time can be suited to individual needs with the correct combination of alternator and battery capacity.



Cabinet Design Suggestions for Marine Refrigerators and Freezers

The following suggestions on structural requirements meet the normal conditions encountered in designing and constructing refrigeration cabinets.

GENERAL RULES

Vapour barriers on the warm side of the insulation are recommended for all boxes. They are required on all cabinets to be maintained below 40 °F. Mylar plastic film is an effective barrier as well as aluminium surface paper or foil particularly where structure allows the aluminium surface to be exposed; that is, not in contact with another conducting surface. Barrier seams should be bitumen or heat sealed.

All rigid insulation should have mitered joints and should be secured with a suitable adhesive in accordance with the manufacturer's recommendations. Straight butt joints can reduce the effectiveness of insulation by as much as 25%.

Whenever practical, exceed the recommended insulation thickness. Any increase will reflect in a decrease of the ampere hours required to operate a direct current unit – an important consideration in marine use.

Specification of Condensing Units

	Model 25	Model 33
Motor h.p.	$\frac{1}{2}$ h.p. (180W)	$\frac{1}{2}$ h.p. (250W)
Voltage	12 v. D.C. 24 v. D.C.	12 v. D.C. 24 v. D.C.
Starting surge 12 v.	45 amps	70 amps
Running current 12 v.	20 amps	32 amps
Starting surge 24 v.	40 amps	45 amps
Running current 24 v.	10 amps	15 amps
Capacity at 10 °F. Evaporating (-12 °C.) Temperature	1800 B.T.U./Hr. (0.45 kWh/hrs) 180W	2600 B.T.U./Hr. 710W
Capacity at 10 °F. Evaporating (-23 °C.) Temperature	1200 B.T.U./Hr.	1700 B.T.U./Hr.
Condenser	Cupro-Nickel	Cupro-Nickel
Compressor	Single Cylinder	Twin Cylinder
Weight	(39 kg.) 85 lbs	(61 kg.) 135 lbs

Units can be supplied fitted with 220 v. 50 Hz 1 phase or 110-115 v. 60 Hz 1 phase motors if required.

The $\frac{1}{2}$ h.p. version of the Model 33 is available in 24 v. D.C. and A.C. voltages and has a maximum capacity of 4000 B.T.U./Hr. at 10 °F. evaporating temperature.

CHOICE OF 40 °F. (4 °C.) REFRIGERATOR HOLDOVER EVAPORATOR

The chart below indicates the size of evaporator required for various cabinet sizes.

Evaporator	Holdover Capacity	Cabinet Size
Type 1	480 B.T.U./Hr.	Up to 3 cu. ft.
Type 2	970 B.T.U./Hr.	3 to 6 cu. ft.
Type 3	970 B.T.U./Hr.	3 to 6 cu. ft.
Type 4	1940 B.T.U./Hr.	8 to 13 cu. ft.
Type 5	1350 B.T.U./Hr.	6 to 8 cu. ft.
Type 6	2700 B.T.U./Hr.	13 to 18 cu. ft.

If the shape of the cabinet does not allow these standard evaporators to be fitted, the individual plates can be supplied for wall or top attachment. Our Design Office will be pleased to select the correct condensing unit and "holdover" plates and evaporators for a particular cabinet arrangement, and can advise on installation and cabinet construction.

GETTING IT LEGAL

D.

In the U.K. all streams and rivers are controlled by local Water Authorities, which have recently been amalgamated into a few hundred, from over 1200. The standard refusal grounds that were quoted are that too many dams and waterflow interruptions down the long profile of a stream or river will lead to interference in the load-carrying capacity, to aggradation (sedimentation) of the river bed, more flooding, etc. It is also necessary to obtain permission from river or stream boundary "neighbours", who can be your own local napaalm agriculturalist, or plain bloody-minded, or can possibly even have metaphysical objections to you using water power.

To have rights to a stream you almost certainly have to have land and have dealt with solicitors. Your solicitor can check up on your use of water-power, from the Water Authority and from the local neighbour angle. You could also try your neighbour on a joint development by personal contact. (Who knows, he might not really want to use parathion).

The legal situation is very much an apparently all-embracing thing; but once you have been through it, the actual effects — especially where you own an existing leat, and aren't damming — don't have to be negative.

Control of impounding

36. (1) Subject to the following provisions of this section, no person shall after the end of the initial period begin, or cause or permit any other person to begin, to construct or alter any impounding works at any point in an inland water in a river authority area (not being an inland water falling with section 2 (5) of this Act) unless

- (a) a licence under this Act granted by the river authority to obstruct or impede the flow of that inland water at that point by means of impounding works is in force, and
- (b) the impounding works will not obstruct or impede the flow of the inland water except to the extent, and in the manner, authorised by the licence, and
- (c) any other requirements of the licence, whether as to the provision of compensation water or otherwise, are complied with.

Water Resources Act 1963, Chapt. 38. HMSO, London 95 pence (net)

Supplementary provisions

52. (1) In relation to the abstraction of water by river authorities from sources of supply in their areas, and in relation to the construction or alteration by river authorities of impounding works in their areas, the provisions of this Part of this Act shall have effect subject to such exceptions and modifications as may be prescribed by regulations made under this Act.

(2) Any such regulations may in particular provide for securing

- (a) that any licence required by a river authority in relation to the matters mentioned in the

preceding subsection shall be granted (or be deemed to be granted) by the Minister and not granted by the river authority;

- (b) that, in such cases and subject to such conditions as may be prescribed by the regulations, any licence so required by a river authority shall be deemed to be granted by the Minister unless the Minister requires an application for the licence to be made to him by the river authority; and
- (c) that where a licence is deemed to be granted as mentioned in the last preceding paragraph, the river authority shall give such notice of that fact as may be prescribed by the regulations.

Water Resources Act 1963, Chapt. 38. HMSO, London 95 pence (net)

58.—(1) As soon as practicable after the second appointed day, each river authority shall prepare and submit to the Minister a scheme (in this Act referred to as a "charging scheme") providing for the levying of charges (in addition to fees charged under the last preceding section) in respect of licences to abstract water granted under this Act.

(2) A charging scheme shall provide that the charges to be levied under the scheme in the case of any licence shall be calculated by reference to the quantity of water authorised to be abstracted from time to time in pursuance of the licence.

(3) Subject to the last preceding subsection, a charging scheme may provide for the levying of charges thereunder at different rates in respect of water authorised to be abstracted in different relevant circumstances, but (without prejudice to the effect of any agreement made under the following provisions of this Part of this Act relating to exemption from and reduction of charges) the charges levied under a charging scheme in any financial year of the river authority shall be levied on all persons at the same rates in respect of the same quantity of water authorised to be abstracted in the same relevant circumstances.

(4) For the purposes of the last preceding subsection the following shall be taken to be relevant circumstances, that is to say

- (a) the characteristics (whether general or special) of the source of supply from which the water is authorised to be abstracted;
- (b) the season of the year at which the water is authorised to be abstracted;
- (c) the purposes for which, in accordance with the provision of the licence, the water is authorised to be used; and
- (d) the way in which the water is to be disposed of after being used for the purposes specified in the licence.

Water Resources Act 1963, Chapt. 38. HMSO, London 95 pence (net)

POWERS OF RIVER AUTHORITIES IN RELATION TO LAND AND WORKS

65.—(1) A river authority shall have power to acquire by agreement any land which they require for any

purpose in connection with the performance of any of their functions.

Water Resources Act 1963, Chapt. 38. HMSO, London 95 pence (net)

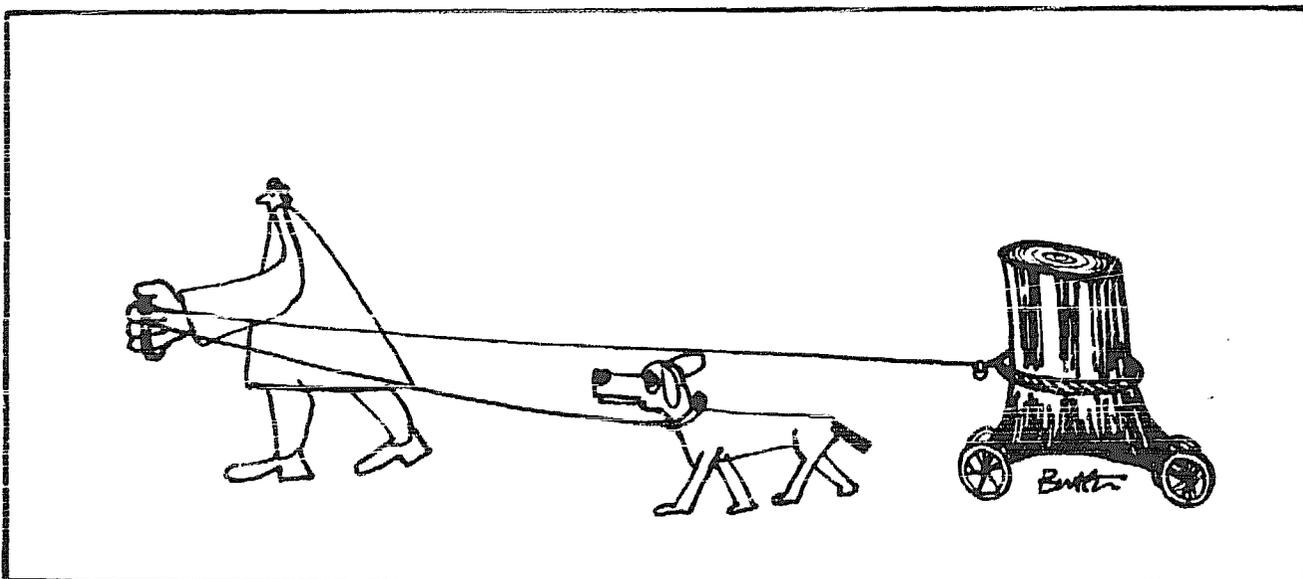
132.—(1) The provisions of this subsection shall have effect with respect to licences under this Act and

with respect to applications for such licences, that is to say —

- (a) an application for such a licence, where the relevant land is land belonging to a benefice which is for the time being vacant, may be made by the Church Commissioners.

RIVER AUTHORITIES

No.	Names of river authorities	River board areas
1	The Northumbrian River Authority	The Northumberland and Tyneside River Board area and the Wear and Tees River Board area.
2	The Yorkshire Ouse and Hull River Authority	The Hull and East Yorkshire River Board area and the Yorkshire Ouse River Board area.
3	The Trent River Authority	The Trent River Board area.
4	The Lincolnshire River Authority	The Lincolnshire River Board area.
5	The Welland and Nene River Authority	The Welland River Board area and the Nene River Board area.
6	The Great Ouse River Authority	The Great Ouse River Board area.
7	The East Suffolk and Norfolk River Authority	The East Suffolk and Norfolk River Board area.
8	The Essex River Authority	The Essex River Board Area
9	The Kent River Authority	The Kent River Board area
10	The Sussex River Authority	The East Sussex River Board area and the West Sussex River Board area.
11	The Hampshire River Authority	The Hampshire River Board area.
12	The Isle of Wight River Authority	The Isle of Wight River Board area
13	The Avon and Dorset River Authority	The Avon and Dorset River Board area.
14	The Devon River Authority	The Devon River Board area.
15	The Cornwall River Authority	The Cornwall River Board area
16	The Somerset River Authority	The Somerset River Board area
17	The Bristol Avon River Authority	The Bristol Avon River Board area
18	The Severn River Authority	The Severn River Board area
19	The Wye River Authority	The Wye River Board area
20	The Usk River Authority	The Usk River Board area
21	The Glamorgan River Authority	The Glamorgan River Board area
22	The South West Wales River Authority	The South West Wales River Board area
23	The Gwynedd River Authority	The Gynedd River Board area.
24	The Dee and Clwyd River Authority	The Dee and Clwyd River Board area
25	The Mersey and Weaver River Authority	The Mersey River Board area and the Cheshire River Board area
26	The Lancashire River Authority	The Lancashire River Board area
27	The Cumberland River Authority	The Cumberland River Board area



The Secretary,
Cornwall River Authority,
County Council Offices,
Sennor, Kernow.

26th April, 1984

Dear Sir,

Part of Mellyn Fm, Gwidhal, Cornwall

We are acting for a proposed purchaser of the property shown edged red on the enclosed plan, such property being crossed by two streams or rivers.

We would be most grateful if you would be kind enough to let us have such information as is in your possession with regard to the following:-

1. Are there any rates charges or outgoings payable to your authority?
2. Is there any liability on the owner of this property for banking or erecting embankments?
3. Are there any existing, proposed or contemplated weirs, blockages, diversions or other works along the full length of the river?
4. Are there any existing proposed or contemplated licences with your authority for the abstraction of water, discharge of drainage or discharge of trade effluent or any other matter along the full length of the river?
5. Is there any liability on the owner of this property to clear the bed of the river?
6. Please confirm that the owner of this property has full fishing and boating rights in the river.
7. To your knowledge has any other person any fishing or other rights in respect of the river where it abuts the land edged red on the plan?
8. Are there any matters relating to the river or the owner of this property concerning reservoirs under the Safety of Reservoirs Act 1930?
9. Are there any present proposed or contemplated reservoirs along the full length of the river?
10. Is there any liability upon the owner of this property with regard to flooding?
11. To your knowledge is the property liable to be flooded at seasonal or unusual periods?
12. Is there any other general liability outgoing or general information with regard to this property which you could let us have?
13. The proposed purchaser is contemplating using the resources of the rivers to generate electricity for the farm and its buildings. Please let us have full details of all licences consents and requirements, if any of your authority in connection with this proposal.

We would be most grateful to hear from you in reply to the above points, and if any fee is involved we shall be glad if you will be kind enough to let us know.

Yours faithfully,

J. S. Leopy.

Enc.

KERNOW RIVER AUTHORITY

**ST. FRED'S,
DUNHEVED,
KERNOW.**

**CHIEF ENGINEER: M.Echanic, Ph.D.
FISHERIES OFFICER: Mr. Fish, B.L.U.B.
WATER QUALITY OFFICER:
J.Sloopy, VC(Retd.)**

Messrs Wood,
York Place,
100 Westminster Bridge Road,
LONDON, E.15.

Please Quote 99XYZ
Our Ref.:
Your Ref.: OM/SKJ
Date: 23 May, 1984

Dear Sirs,

PART OF MELLYN FARM, GWIDHAL, CORNWALLY.

I much regret the delay in replying to your letter dated April 26.

I now reply to the various questions in the order in which the questions appear in your letter.

1. No.
2. The watercourses shown on the plan which you kindly supplied are not "main" river for the purposes of the land drainage legislation, and consequently they do not fall to be maintained by my Authority, nor may my Authority expend money on their maintenance. I am not aware of any liability but I feel that you should reply on the Vendor's reply to this question.
3. No works are contemplated by my Authority and the existing condition of the watercourses is not known. The old leat to the mill is closed and only a few stones remain of the weir that fed this leat. There are no other weirs.
4. I regret this question is too wide to permit me to reply. I can tell you however that there is no licence in being for the abstraction of water for the benefit of the property.
5. Not so far as my Authority is concerned but I would draw your attention, please, to Section 4 of the Rivers (Prevention of Pollution) Act 1951 if any clearing of the river bed is contemplated. If the condition of the river becomes such as to cause an impediment to the flow, the Local Council have power to require your Client to remedy the matter (Land Drainage Acts 1930 and 1961).
6. It is normally the case but you must rely on the Vendor's reply. My Authority has no byelaws to control boating. I enclose a copy of the Authority's Land Drainage, Fisher and Pollution Prevention Byelaws.
7. The Authority's Fisheries Officer informs me that the owner of the land which abuts the land edged red on your plan is a Mr E Trethejohns, Tregawna, Withiel, B. Cornwall. I am told that this gentleman also is the owner of certain fishing rights.
8. I do not hold a copy of the Act referred to.
9. The Chief Engineer instructs me that there are no proposals to locate any reservoirs along the length of river shown on your plan.
10. Not so far as my Authority is aware.
11. There is no record of flooding in this valley. The property is situated above the expected level of floods but the lower meadows will be liable to flooding.
12. None so far as I am aware.

13. Provided the river is used for the "on-stream" generation of electricity for the farm and buildings then no water licence is required. If water is abstracted or diverted from the river i.e. for "off-stream" generation then a water licence will be required. Care should be taken with any plant so employed to avoid pollution of the river by oil etc. This section of the River Ruthern is extremely important as a salmon and sea trout spawning and nursery area. Any contemplated weir must have a fish pass and any intake system for generating electricity whether it be from a leat or pump must have a smolt screen fitted to it.

I hope the above is of assistance to you.

Yours faithfully,

V.D. Clerk.

CLERK

E. CHOOSING WHICH TYPE OF POWER CONVERTOR TO BUILD

As the scale of the waterpower available at a site goes down, the number of potential ways for converting it (e.g. to electricity) at reasonable cost goes up. Small wheels or turbines are easier to build and install. At its very simplest the plant can be 18 inches diameter, with a bucket wheel made from modified teaspoons (i.e. a very easily-made metal pressing). Such wheels were made and marketed in wartime USA (Fits waterwheel Fig E1). They ran on 2-inch diameter hose feed giving power outputs of around 250 Watts. This isn't far off the scale of technology for harnessing drainpipes running bicycle dynamos - for Xmas tree lights? Miniature heat pumps? Budgerigar cage lighting?

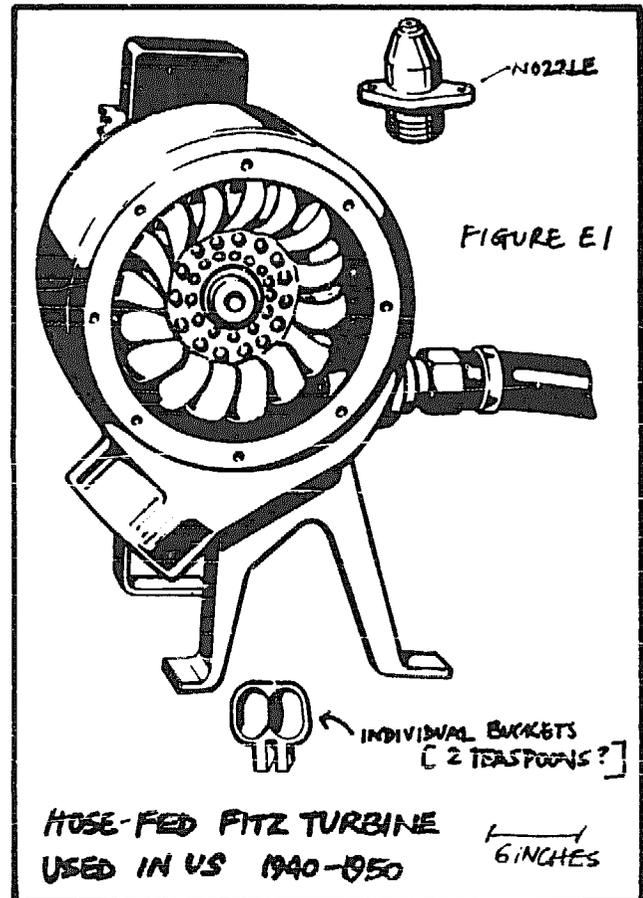
Turbines are much higher efficiency than wheels. When there is little power potential and damming etc. is difficult they can be the rational choice, although a wheel might seem funkier. Wheels often need complex, expensive and even dangerous shaft speed-up systems - so that if the choice is electricity it will often make economic sense to choose a turbine. Wheels like the overshot type we show in detail (section F) needs heads of 10 feet or so to be a good choice; but low head turbines (technically called "reaction turbines") can use heads of 5 - 8 feet. These turbines can be made using propellers like the off-shelf marine variable pitch propellers...

This brings down the cost of an effective and sophisticated turbine, with alternator, to about £750 at present low volume production (basically only 'one off') scale.

Gravity is caused by large scale rotating bodies, constantly expanding away from solar fusion centres. Waterpower translates this raw energy to be your energy slave, with little extra transitions and can therefore be very very efficient. For example a 4-nozzle Pelton turbine can give 98% translation efficiency from falling water to electricity.

Using basic theoretical physics you can get a good approximation for the water volume flow, at a certain head, from the following formula:-

$$Q = \frac{2}{3} b \cdot 2g \cdot H^{3/2}$$



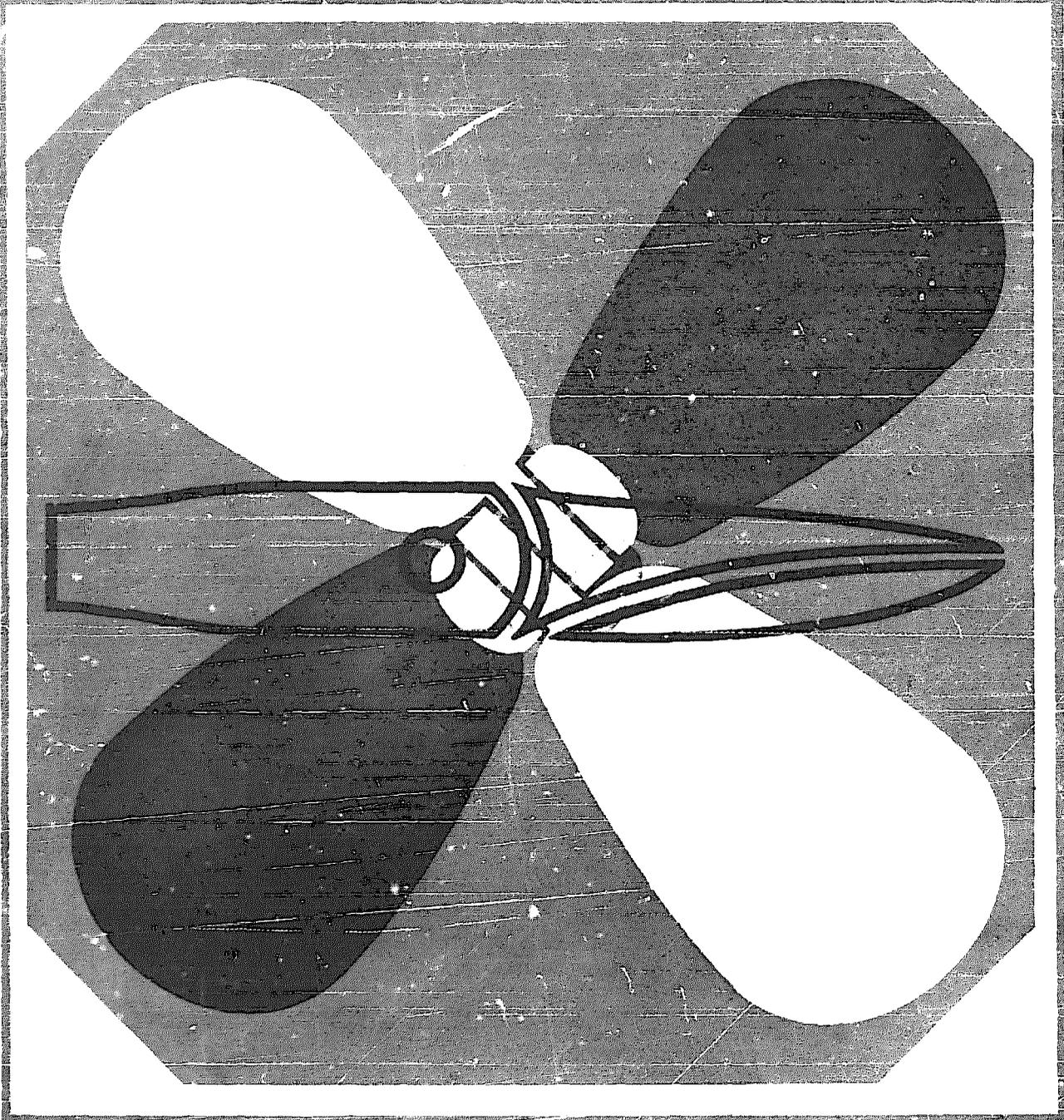
In the equation b is related to the width of notch (in a weir) or nozzle width in a turbine. H is related to the head available. The only other factor is gravity a constant force towards the centre of the earth. This formula gives figures for potential output that relate closely to what actually happens.

We have a few short abstracts from hydrodynamics textbooks so if you prefer formulae to form-filling (to get your leat, dam, water supply etc) you can pause awhile in lush fields of figures. When you have to get on with making a waterpower installation that works you have to make decisions on plant type that control subsequent activity to a large amount. Where a high head is available - say 50 - 100 feet - a high speed "impulse" type turbine, like a Pelton, can be

continued on page 23

Hamblematic

 FOLDING PROPELLERS



The Hamblematic folding propeller has been designed to give the best possible performance under power and a very low drag ration under sail.

Produced by a company having an international reputation for the development and production of craftsmen-built propellers, the blades of the Hamblematic are opened by centrifugal force in conjunction with the thrust created by the pitch faces thus eliminating the need for any mechanical device other than the operation of the engine control.

The Hamblematic has the added advantage of being equally efficient when the engine is engaged forward OR ASTERN and, under sail, the blades fold with the water pressure created by the way of the vessel reducing the drag to approximately 5% of comparable fixed propellers.

Installation of the Hamblematic is straightforward and with basic tools the fitting can be completed in about half an hour as the hub is bored to suit normal propeller shaft tapers and threads. Due to the high quality materials used in manufacture, reliability and resistance to corrosion are assured.

1. Blades completely closed – as when under sail.
2. Blades half open.
3. Blades fully open – as when under power.

Installation guide

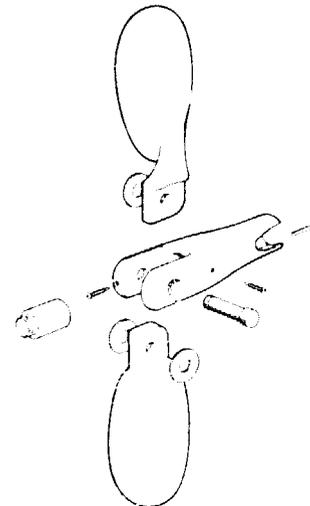
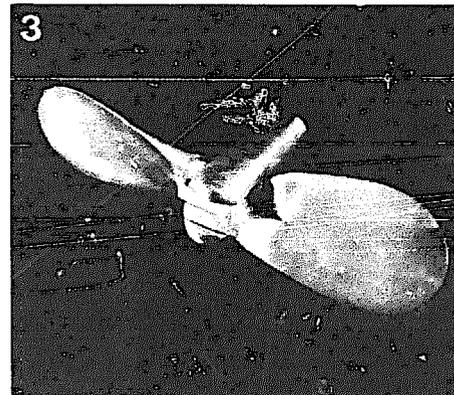
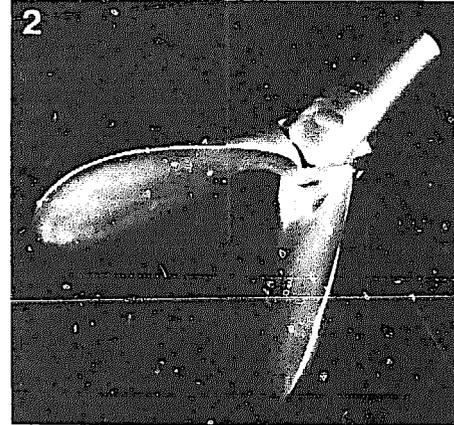
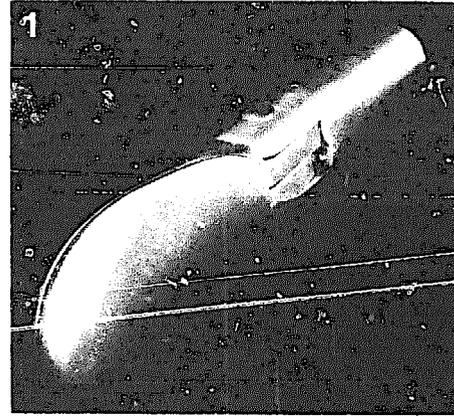
Hamblematics are despatched fully assembled but the dismantling and fitting instructions below, in conjunction with the exploded illustration on page 3, indicate the ease of fitting.

Dismantling

Open the blades fully thus exposing the head of the pivot pin retaining screw which should be removed. After gently tapping out the pivot pin, remove the blades from the hub taking care not to lose the three nylon spacing washers. The shaft retaining nut screw located in the side of the hub should now be removed and, after extracting the shaft retaining nut from the recess, the Hamblematic is ready to be fitted to the shaft.

Fitting and assembly

After wiping both the shaft and propeller bore, fit the key into the shaft recess and position the propeller on the shaft. The retaining nut should then be inserted in the recess and tightened with a box spanner ensuring that when tight one of the holes is aligned with the hole in the hub. The retaining screw can now be positioned and tightened after which the blades can be located making certain that the three nylon spacing washers are in situ. The fitting is completed by inserting the pivot pin and locking with the retaining screw.

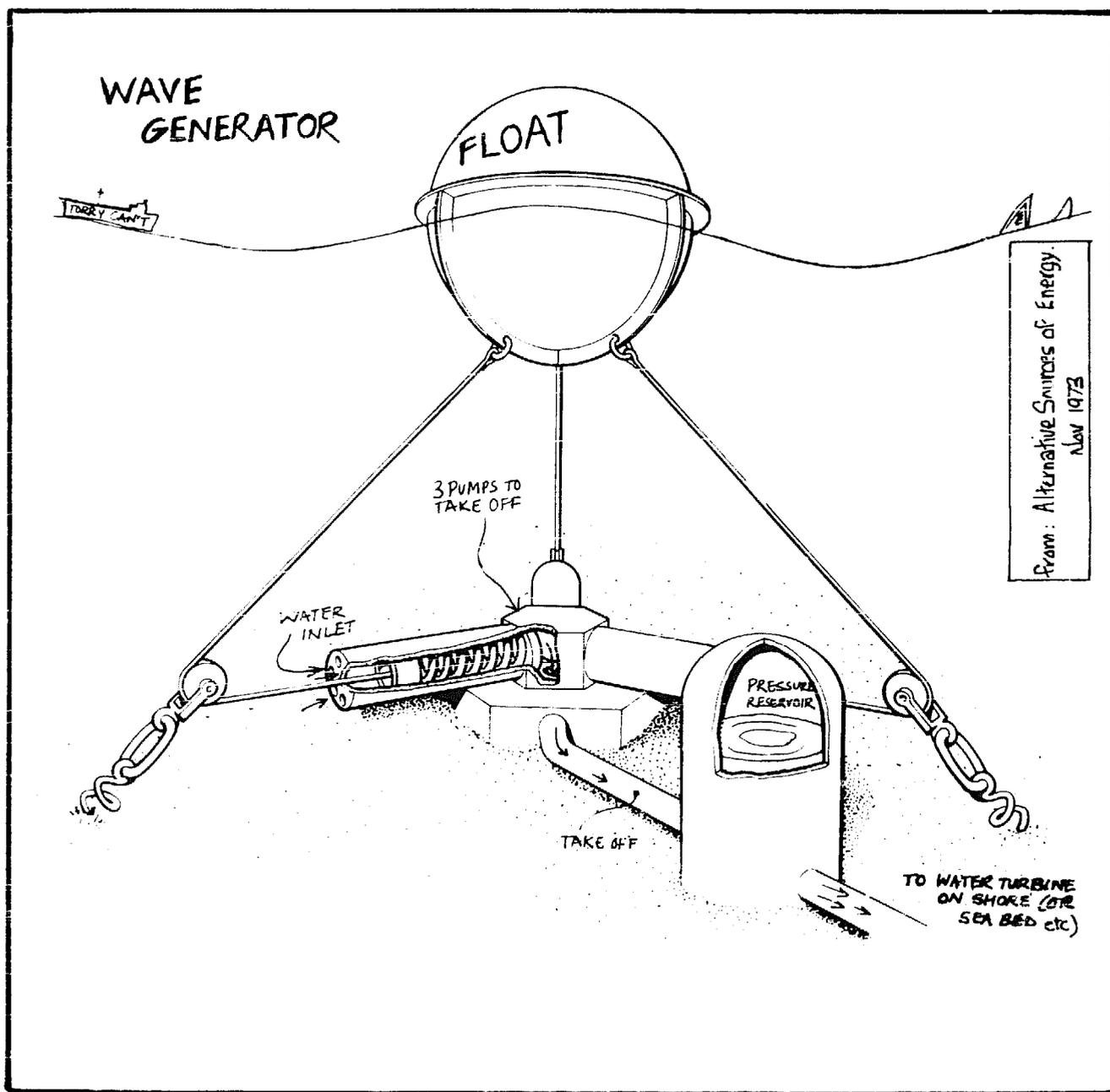


really the best choice. As Rupert Armstrong Evans says later on, waterwheels look inherently simpler than turbines, but if your end product requirement is electricity you need very high shaft speeds. A six or ten pole alternator for 5kW output can weigh a few hundredweight and cost a few hundred. You will need one of these for a relatively simple wheel, to get electricity. Where you can use mechanical energy (machinery, pumps, friction heaters, etc.) direct a wheel's power transmission can be not-expensive. And a wheel comes out as both the simplest and cheapest choice.

In Britain even up to 1945 there were several thousand mills operating at the 5 - 50 kiloWatt level; and there were several times more feasible mill sites. There is no reason, physically, why these could not operate to supply local area grids and energy-use systems. Small scale hydropower solves some of our power problems, would substitute for some thermal energy use (conserving fuel, reducing pollution), and

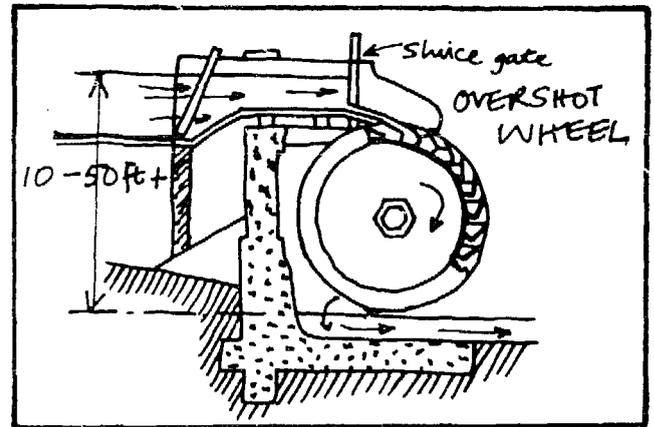
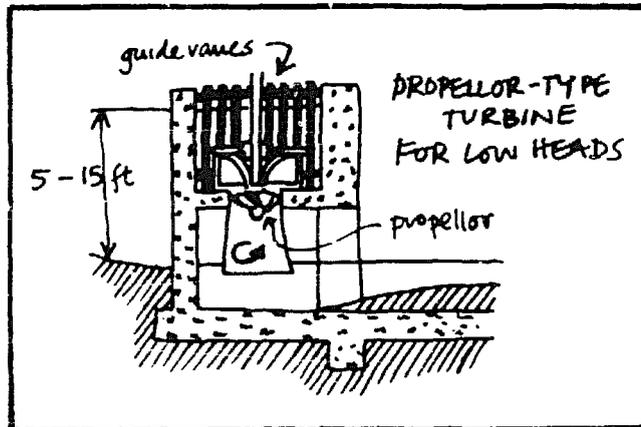
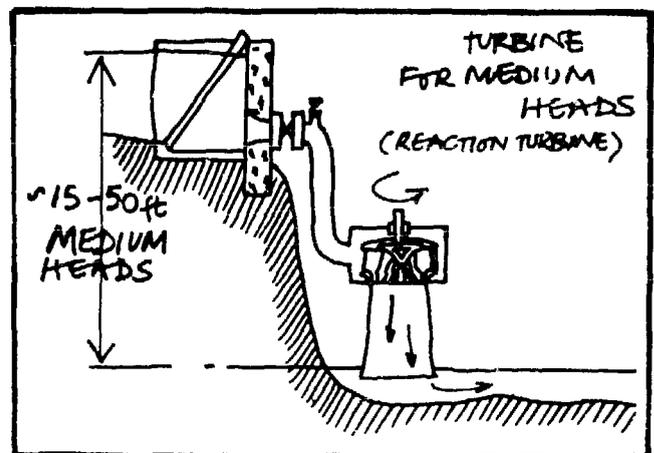
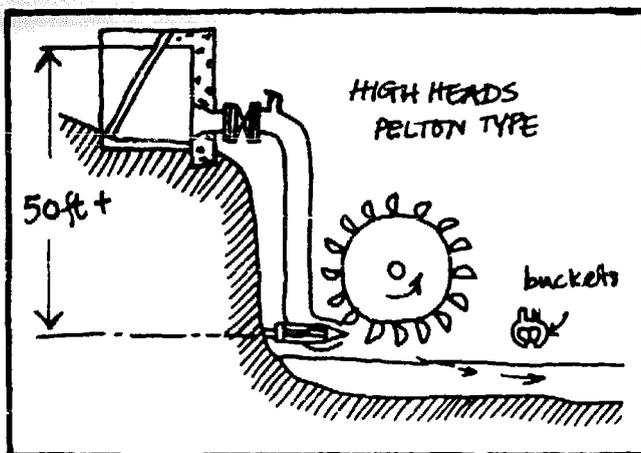
would help create more self-sufficient subregions. Oil and coal, which supply many useful petrochemicals when heat distilled – not just burnt – are being nibbled away frenzidly now; using 'second hand solar energy' by tapping the water cycle we could safeguard supplies of petrochemicals for millenia ahead. At present the 2% of all hydrocarbons going not to fuel, supply all petrochemicals. Switching off the fuel demand enables us to think how to use these chemicals better than "no deposit no return" items – for example when they're used in building damp-proof courses. Our heavy addiction to useless PVC could be moderated, stretching petrochemical supplies, on a world basis of consumption, by yet more millenia.

We can't say that your choice of switching away from your friendly neighbourhood nukie and on to cool water will save the future – but it could help. Please try not to mangle your local environment or limbs with cranky junk strung together with wire and corrugated iron, shafts dangling, chains slipping – and so on.



From: Alternative Sources of Energy.
Nov 1973

FIGURE E2



TURBINE AND WHEEL CHOICE SHOULD RELATE TO THE HEAD AVAILABLE

1.5 Viscosity

Although all real fluids resist any force tending to cause one layer to move over another, the resistance is offered only while the movement is taking place. Thus when the external force is removed, the flow subsides because of the resisting forces, but when the flow stops the particles of fluid stay in the positions they have reached and have no tendency to revert to their original positions. This resistance to the movement of one layer of fluid over an adjacent one is ascribed to the *viscosity* of the fluid. Since relative motion between layers requires shearing forces, that is, forces parallel to the surfaces over which they act, the resisting forces must be in the exactly opposite directions and so they too are parallel to the surfaces.

It is a matter of common experience that the magnitude of the resisting, that is viscous, forces depends not only on external conditions but also on

the fluid itself. Under particular conditions one fluid offers greater resistance to flow than another. Such liquids as tar, treacle and glycerine cannot be rapidly poured or easily stirred, and are commonly spoken of as 'thick'; on the other hand, so-called 'thin' liquids such as water, petrol and paraffin flow much more readily.

Gases as well as liquids have viscosity, although the viscosity of gases is less evident in everyday life.

1.5.5 Fluidity

Instead of viscosity the inverse property of *fluidity* is sometimes considered. It is defined as the reciprocal of viscosity; its usual symbol is ϕ (i.e. $\phi = 1/\mu$) and the usual unit has been the 'reciprocal poise', i.e. $\text{cm}^2/(\text{s dyne})$, occasionally termed 'rhe'. Fluidity, however, is seldom used in engineering practice.

TABLE 3.1

Type	Example
1. Steady uniform flow	Flow at constant rate through a long straight pipe of constant cross-section. (The region close to the walls of the pipe is, however, disregarded.)
2. Steady non-uniform flow	Flow at constant rate through a tapering pipe.
3. Non-steady uniform flow	Accelerating or decelerating flow through a long straight pipe or constant cross-section (Again the region close to the walls of the pipe is ignored.)
4. Non-steady, non-uniform flow	Accelerating or decelerating flow through a tapering pipe.

3.6.1 THE FIRST LAW OF THERMODYNAMICS

One of the fundamental generalizations of science is that, in the absence of nuclear reactions, energy can be neither created nor destroyed. The First Law of Thermodynamics expresses this principle thus:

For any mass system (that is, any identified and unchanging collection of matter) the net heat supplied to the system equals the increase in energy of the system plus all the energy which leaves the system as work is done.

Or, in algebraic terms,

$$\Delta Q = \Delta E + \Delta W$$

6.1 Introduction

Laminar flow may occur in many situations. Its distinguishing features, however, are always the same: individual particles, if fluid follows paths which do not cross those of neighbouring particles. It occurs at velocities low enough for forces due to viscosity to predominate over inertia forces and thus, if any individual particle attempts to stray from its prescribed path, viscosity's restraining hand at once firmly brings back the errant one, and the orderly procession of particles continues.

We recall from Section 1.5.1, that viscous stresses tend to eliminate the relative movement. The basic law of viscous resistance was described by Newton in 1687.

$$\tau = \mu \frac{du}{dy}$$

Here du/dy is the rate at which the velocity u (in straight and parallel flow) increases with coordinate y perpendicular to the velocity, μ represents the coefficient of (absolute) viscosity and τ the resulting shear stress on a surface perpendicular to, and facing the direction of increase of y . The partial derivative du/dy is used because u may vary not only with y but also in other directions.

We now consider a number of cases of laminar flow which are of particular interest.

7.2 Head Lost to Friction in a Pipe

One of the most important items of information the hydraulic engineer needs is the difference of piezometric head required to force fluid at a certain steady rate through a pipe. About the middle of the nineteenth century, therefore, many experimenters devoted attention to this topic. Among them was the French engineer Henri Darcy (1803-58) who investigated the flow of water, under turbulent conditions, in long, unobstructed, straight pipes of uniform diameter. The dissipation of energy by fluid friction results in a fall of piezometric head in the direction of flow, and if the pipe is of uniform cross-section and the flow is 'fully developed', that is, if it is sufficiently far from the inlet of the pipe for conditions to have become settled, the piezometric head falls uniformly. Darcy's results suggest the formula (now commonly named after him);

$$h_f = \frac{\Delta p^*}{w} = \frac{4fl}{d} \frac{u^2}{2g}$$

7.5 Other Head Losses in Pipes

Not only is there a loss of head caused by friction in a uniform straight pipe, but additional losses may be incurred at changes in the cross-section, bends, valves and fittings of all kinds. In long pipes these extra losses may, without serious error, be neglected in comparison with the 'ordinary' friction loss. Although they are often termed 'minor' losses they may, however, actually outweigh the ordinary friction loss in short pipes. The losses invariably arise from sudden changes of velocity (either in magnitude or direction). These changes generate large-scale turbulence in which energy is dissipated as heat.

The source of the loss is usually confined to a very short length of the pipe, but the turbulence produced may persist for considerable distance downstream. The flow after the sudden change of velocity is exceedingly complicated, and the processes of 'ordinary' pipe friction are inevitably affected by the additional turbulence. For the purposes of analysis, however, it is assumed that the effects of ordinary friction and of the additional large-scale turbulence can be separated, and that the additional loss is concentrated at the device causing it. The total head lost in a pipe may then be calculated as the sum of the normal friction for the length of pipe considered and the additional losses.

11.3.1 ENERGY GRADIENT

In practice, as the liquid flows from one section to another, friction causes mechanical energy to be converted into heat, and thus lost. If the loss per unit weight is designated h_f , then for steady flow between two sections (1) and (2),

With reference to Fig. 11.4, the equation may be written

$$h_1 + z_1 + u_1^2/2g = h_2 + z_2 + u_2^2/2g + h_f \quad (11.2)$$

13.4 Surge Tanks

Many of the problems associated with water hammer may be circumvented by the use of a surge tank. In hydro-electric installations for example, the turbines must frequently be supplied with water via a long pipe-line or a tunnel cut through rock. If the electric power taken from the generators is suddenly altered the turbines tend to change speed. The governors must counteract this tendency to change speed, by altering the water flow to the machines. It is the consequent acceleration or deceleration of water in the pipe-line which may give rise to water hammer. The minimizing of water hammer is doubly desirable: not only may water hammer produce dangerously high pressures within the pipe-line or tunnel, but the pressure changes impede the governing.

Figure 13.9 shows the essential features of the arrangement. The simplest

The

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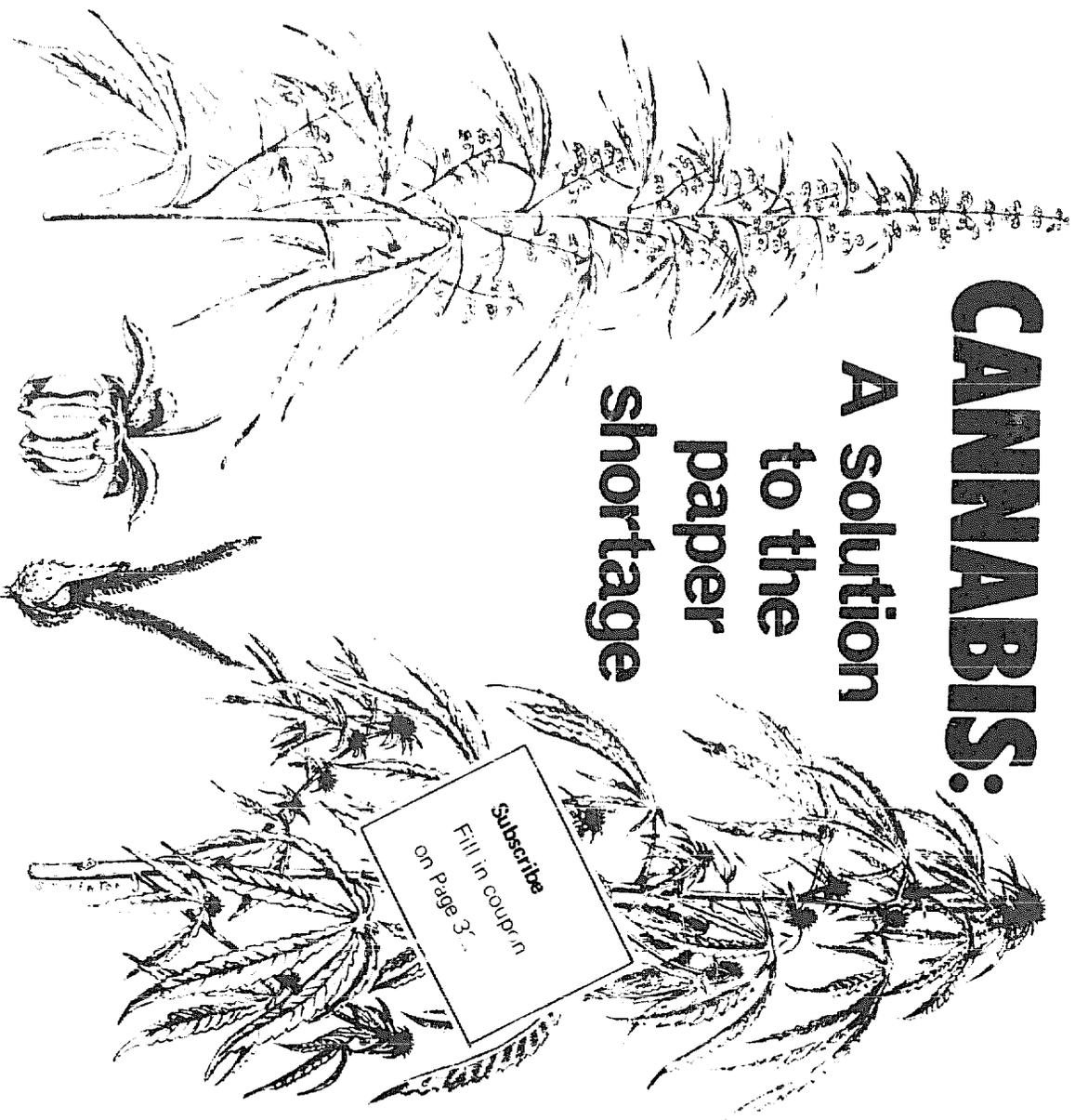
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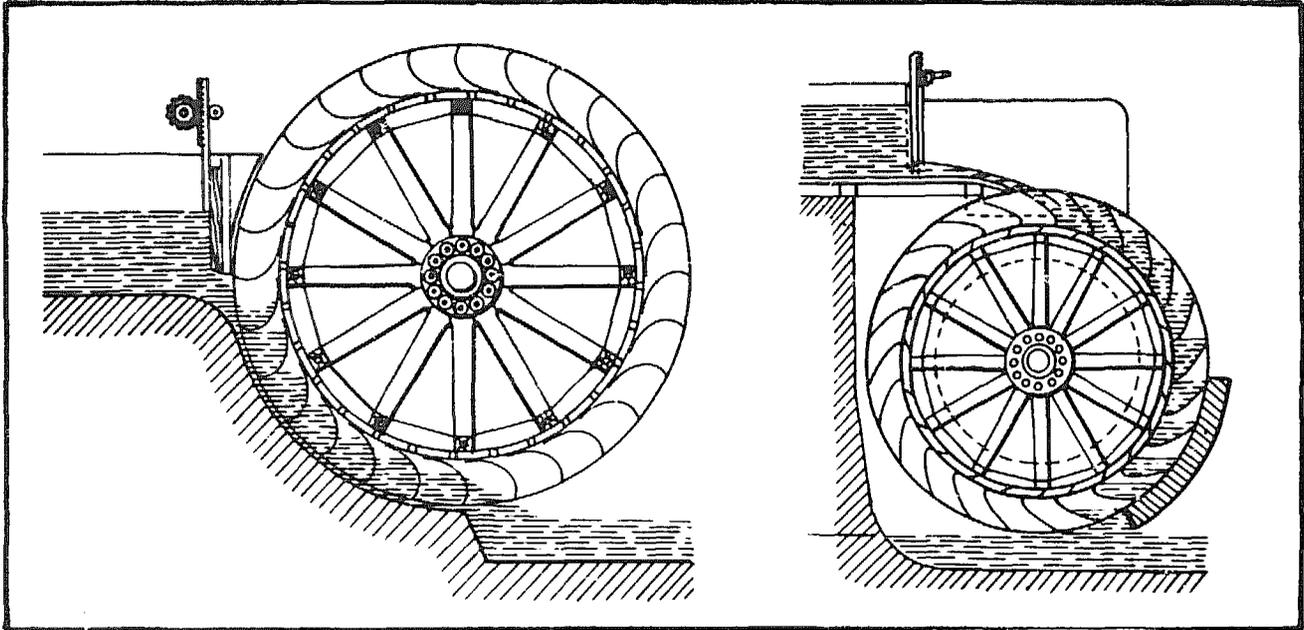
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F. BUILDING AND INSTALLING A WATERWHEEL



Waterwheels offer efficiencies as high as 60% though 30 - 50% is more usual without the complexities and high costs that are often involved in building and installing turbines while a turbine can only give electricity it is easy to make wheels give power for a variety of mechanical equipment.

Examples include seed and flour grinding, wood and metal turning, and driving heat pumps. This is done by installing a clutch and long drive-shaft to the wheel. It can even be linked up in a "straight-through" pattern, direct from an extended main bearing shaft. Although this is the ultimate in simplicity there is a safety problem because the driveshaft can't be disconnected at the wheel end. And there can be big cost problems.

Along the shaft pulleys are fixed, with belts or chains to the machinery to be driven. Estimation of wheel power, or just by testing what the shaft can drive without slowing the wheel, will tell you how much you can drive at any one time. You can also go to the trouble of dynamometers for measuring the power output very accurately (but getting them is difficult).

OVERSHOT WHEELS

Operated by gravity, the overshot wheel derives its name from the manner in which the water enters the buckets set around its periphery. Pouring from a flume above the wheel, the water shoots into buckets on the down-moving side, overbalancing the empty ones opposite and keeping the wheel in slow rotation.

Since such a wheel may be located near but not actually in the stream, it offers endless landscaping possibilities for a country home where a stream with sufficient flow is available. If a site on dry ground is chosen, the foundation may be constructed dry and the water led to the wheel and a tailrace excavated. With very little effort, the scene may be turned into an attractive garden spot the wheel becoming both a landscaping feature and a source of power.

It should be noted, however, that an overshot wheel is practical only for a small-capacity output. How much power it will produce depends upon the weight of water the buckets hold and its radius, or lever arm. Expressed in another way, the output depends upon the weight of water transported and the height, or head, through which it falls while in the buckets. For maximum efficiency, the wheel must use the weight of the water through as much of the head as possible. Therefore, the buckets should not spill or sling water until very near tail water.

Power Increases with Width

Although of simple construction, an overshot wheel is cumbersome in size. For this reason, before attempting to build one be certain you have the facilities to move and lift it into place when completed. Also allow yourself plenty of working floor space. It must be understood, too, that such a wheel is a sizeable project and requires a lot of material and time. Extreme care in cutting and assembling the parts is not essential, however, because the wheel, operating at slow speed, need not be accurately balanced.

The accompanying illustrations are for constructing wheels capable of giving approx. 500W - 1kW. For larger power outputs the dimensions have to be scaled up. In the following the head for the wheel is 7', and the wheel diameter is 5' 6". When enlarging waterwheel output it is advisable to start with the wheel bucket width.

Virtually all large wheels are built with wood or steel arms, and have a shroud plate only around the outer edge, but you may find it simpler and more satisfactory to build the drum-type wheel described here. In this case, each shroud plate is a disk of 1/8" sheet steel. Each disk is braced by a 1/8" sheet steel sole plate to which it is continuously welded, by the buckets, by one of the two large diameter 1/4" steel hub flanges to which it also is continuously welded, and by the long hub itself.

Shrouds and Buckets

You can build the shroud plate from wood. Proofing the wood against dampness and vibration is very important. In most cases people use cast iron or sheet steel shrouds and buckets, because of warpage, vibration and other problems, for example organic matter growing on the wood and accelerating rot.

Large Sheets are Best

Sheet steel for the disks may be ordered direct from several large steel companies in case your local supply house is unable to furnish it. Ordinarily, such steel comes in standard 48" widths, so you may have to weld together two or more sheets to get the required 5' diameter, using either a butt weld or a backing plate. This will produce some distortion or ripple, as will the welding on of the numerous clips required. So long as distortion is local, however, and the main lines of wheel and shaft remain true, this will do no harm.

After the sheet has been prepared, scribe a 5' circle on it and cut it with the cutting flame of a gas welding torch. With ordinary care, this method should give sufficient accuracy. Vent and drainage holes should be drilled as indicated around each disk to lessen corrosion with the drum.

Good Buckets Important

The buckets are the most important element of the

wheel. To give maximum efficiency, they must be formed so that the water enters smoothly at the top of their travel and remains in them until just before they reach the bottom. For this reason, the bucket form indicated on the facing page should be followed faithfully. Either sheet metal or wood is an acceptable material, but metal is better suited to cold climates, since wood is damaged when absorbed water freezes. Because the buckets are subject to wear from the water and sediment that it carries along, you may want to install them so they can be easily replaced.

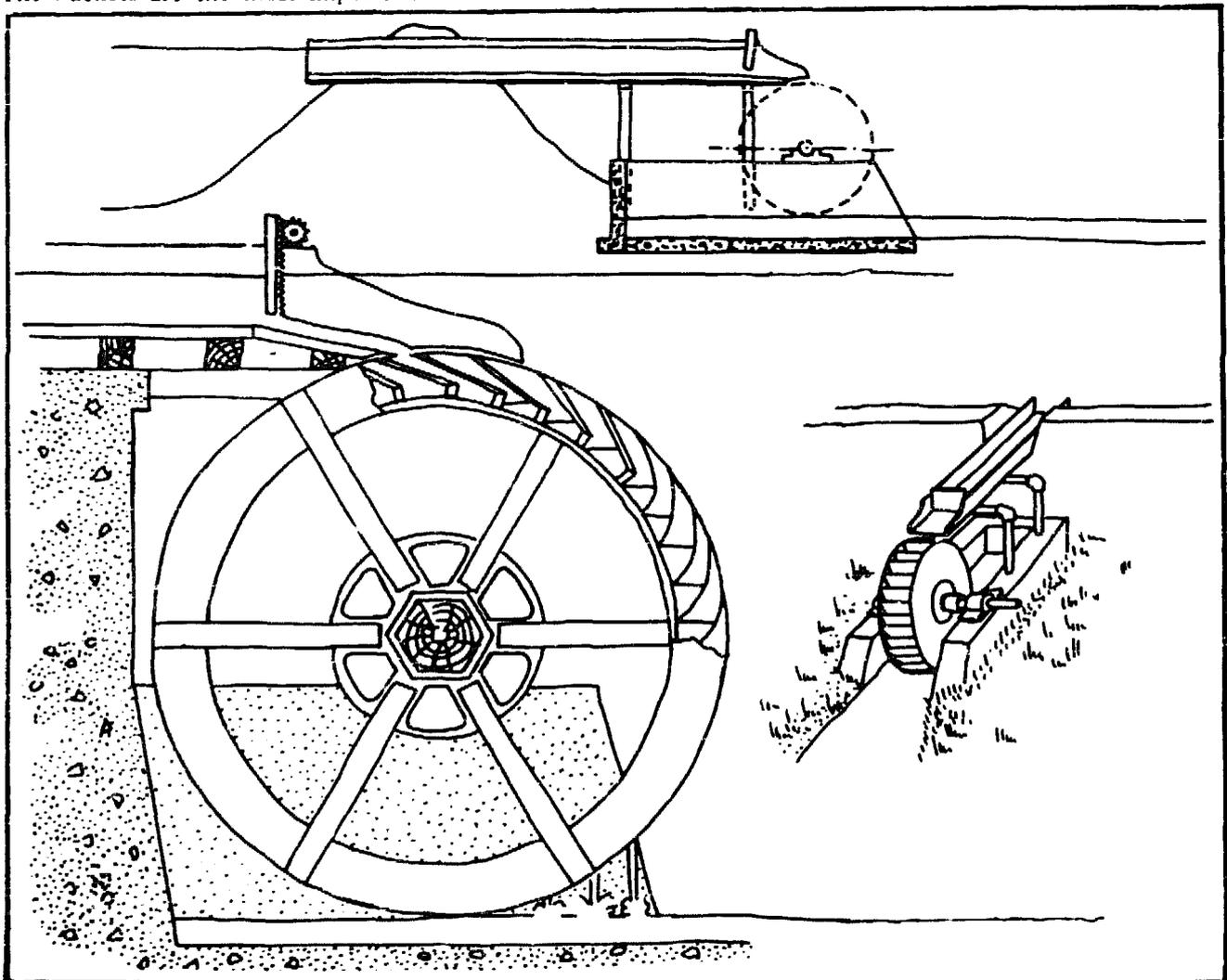
In laying out and making wooden buckets, follow these steps:

Using a common centre, strike off two arcs, one with a 21½" radius and the other with a 2' 6" radius. Then draw a radius line intersecting these arcs.

From the point where the radius crosses the inner arc, measure 2¾" farther along the line and mark the point *E*.

From the point where the radius crosses the outer arc, draw a chord 10½" long and from the new point where this intersects the outer arc draw a line to point *E*. You now have the inner trace of the bucket.

Take a piece of the bucket stock and lay it along the upper edge of this inner trace, and you have a cross section through the bucket. Cut your stock accordingly, making the length equal to *B* in the table of dimensions.



Steel Buckets Require Jig

Steel buckets are only slightly more difficult if you follow these steps:

Using a common centre, strike off two arcs on a piece of plywood, one with a $21\frac{1}{2}$ " radius and the other with a $2' 6"$ radius.

Draw a radius line and then a tangent to the inner arc, making it vertical to the radius. From the point of tangency measure $5"$ along the tangent. Mark this point.

Using this mark as a centre, strike off an arc with a $5"$ radius. This is part of the inner trace of the bucket.

At the point where the original radius line (Step 2) crosses the outer arc, draw a chord $10\frac{1}{2}"$ long, and at point *F* where this chord intersects the outer arc draw a new radius line. Also at point *F* measure off 15 deg. below the new radius and draw line *FG* $11\frac{1}{2}"$ long.

Then, using *G* as a centre, strike an arc with a $11\frac{1}{2}"$ radius. This forms the rest of the inner trace of the bucket.

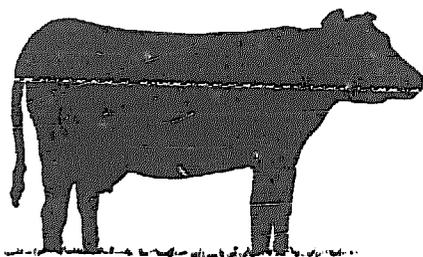
Cut the plywood along this line and along the lines that form a quarter ellipse. Using this as a pattern, cut several more quarter ellipses from scrap. Nail these to stretchers to make a bending jig around which the buckets may be formed.

Sluice Governs Wheel

The sluice gate may be located at any convenient place along the flume. Since it is the governing mechanism of the wheel, its installation should be anything but slipshod. If it is installed at an angle as on the following page, water pressure will keep it at any desired position. If installed vertically, some mechanism, such as a rack and pinion, should be provided to keep it in place.

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**Tim & Cat Clarke,
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Adjust the sluice so that the buckets will run one-quarter full. This will give a wheel speed of 10 r.p.m. If the buckets are allowed to run more than one-quarter full, the efficiency of the wheel will drop for two reasons. Because of the increased speed, centrifugal force will throw water from the buckets. They also will begin to spill before approaching tail water. Although this practice does waste water, it may be profitably employed during a freshet to increase the power output, for at such times the excess water would be wasted anyway.

Weld Wheel Parts

Welding of the various parts of the wheel produces an exceptionally strong construction. After getting together or making all the required parts, begin the assembly by welding four clips to each end of the hub sleeve. Then weld the required number of clips to the shroud plates for the sole plate, and weld the shroud plates to the clips on the hub sleeve. After welding both hub flanges to the shroud plates and the sleeve with a continuous weld, attach the sole plate to the clips on the shroud plates with No. 8 self-tapping screws. Also weld the sole plate to the shroud plates with a continuous weld, and the bucket-support angles to the sole plate.

Attach wooden buckets to the supports with $\frac{1}{4}"$ No. 10 roundhead wood screws, and then drill holes $2"$ from centre to centre through the shroud plates for $1\frac{1}{4}"$ No. 10 roundhead wood screws. If you use steel buckets, rivet or screw 10 clips to each side of each bucket and attach the buckets to the angles with No. 8 self-tapping screws. Then drill holes through the shroud plates in the way of the clips for the same type of screws.

Lubricate Bearings Well

Using locknuts and washers, fasten the hub sleeve to the shaft with two $\frac{3}{8}"$ by $4\frac{1}{2}"$ bolts, placed at right angles to each other. Two bearing mountings having $2.3/8"$ renewable liners with shoulders should be bolted to the foundation. Place shims about $\frac{1}{4}"$ thick under the bearings.

Standard bearing mountings, variously called pedestals or blocks, may be bought complete with wick oiler or cup oil reservoir and with built-in self-aligning features. Standard bronze bearing metal liners or inserts likewise may be bought from any machine component supplier. Babbitt liners are equally satisfactory.

Although the wheel turns slowly, it is heavy and will be running almost constantly, so good lubrication of the bearings is essential. To this end, care should be taken to insure that the bearing lines are finished to the correct fit. Porous inserts or inserts containing graphite are excellent for this application, but may cost more than regular bearing inserts.

It is important that the foundation be carried deep enough so that water falling from the buckets will not undermine it. Avoid a long flume if possible, in order to keep the construction as simple as possible. Strengthen it along its entire length with an exterior frame and support it well from dam to wheel with pipe uprights.

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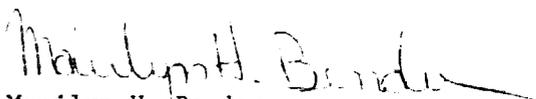
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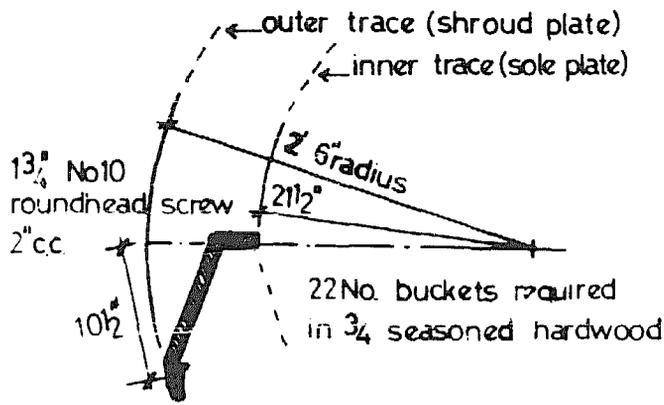
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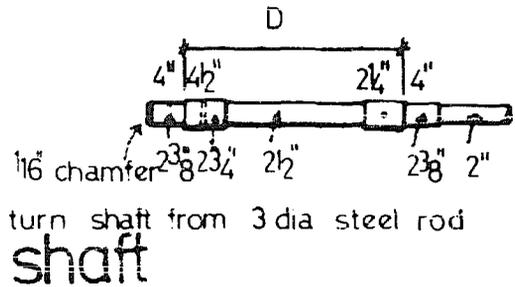
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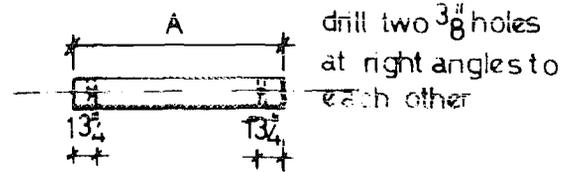
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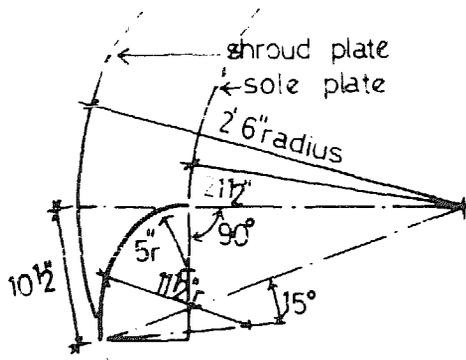
section through
water bucket
timber construction



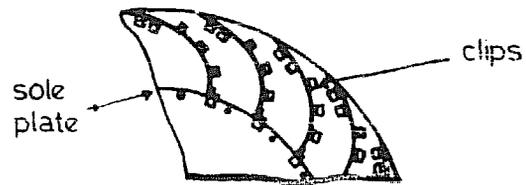
turn shaft from 3 dia steel rod
shaft



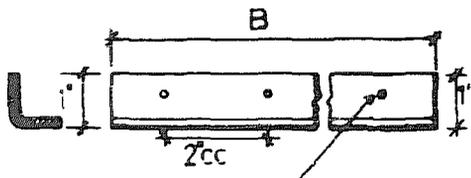
3" extra strong steel pipe
hub sleeve



steel bucket

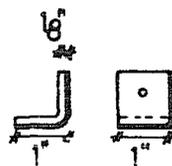


steel bucket fixing



timber buckets 1/2 inch holes
steel buckets No 8 self-tapping screws
22 No. steel sheet construction

bucket support

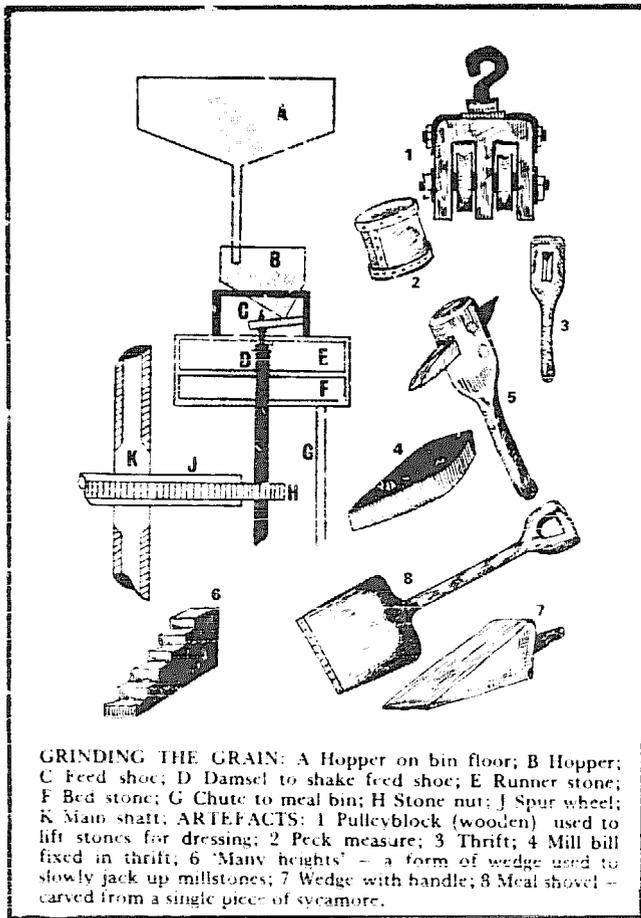


52 No. required for
timber brackets
277 for steel

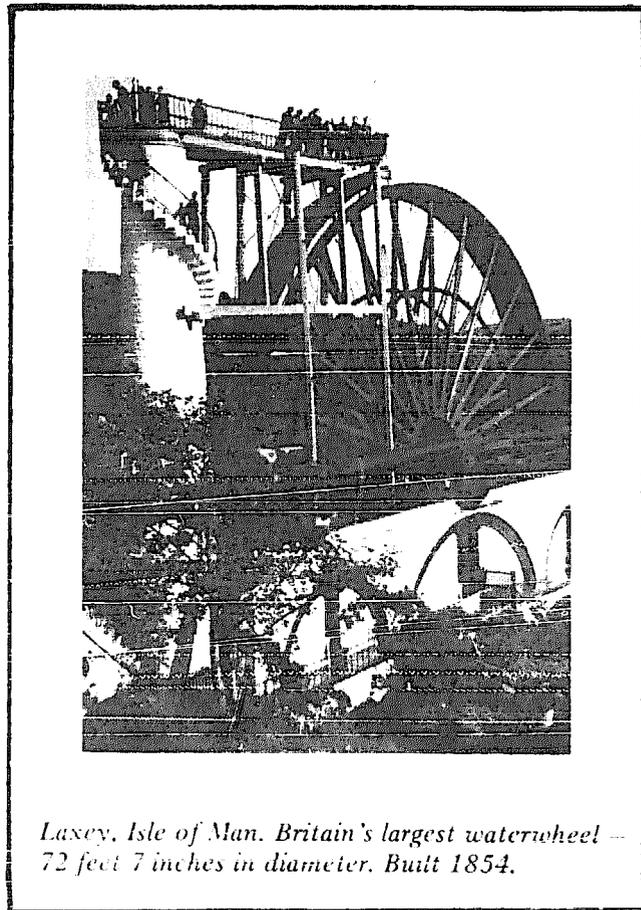
clip

POWER (watts)	A	B	C	D
375 W	24 1/4	16	13	25 1/4
500 W	29 3/4	21 1/4	18	30 1/2
650 W	32 1/4	24	21	33 1/4
750 W	40 1/4	31 7/8	29	41 1/4

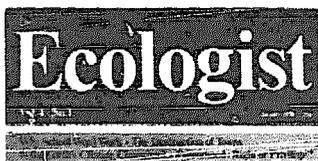
dimensions INCHES



GRINDING THE GRAIN: A Hopper on bin floor; B Hopper; C Feed shoe; D Damsel to shake feed shoe; E Runner stone; F Bed stone; G Chute to meal bin; H Stone nut; J Spur wheel; K Main shaft; ARTEFACTS: 1 Pulleyblock (wooden) used to lift stones for dressing; 2 Peck measure; 3 Thrift; 4 Mill bill fixed in thrift; 6 'Many heights' - a form of wedge used to slowly jack up millstones; 7 Wedge with handle; 8 Meal shovel - carved from a single piece of sycamore.

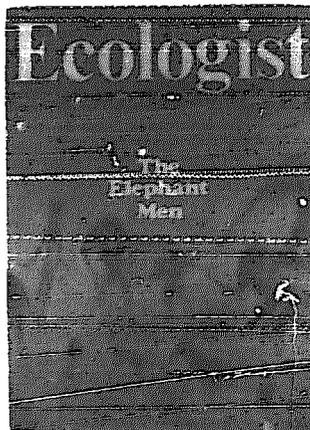


Laxey, Isle of Man. Britain's largest waterwheel - 72 feet 7 inches in diameter. Built 1854.



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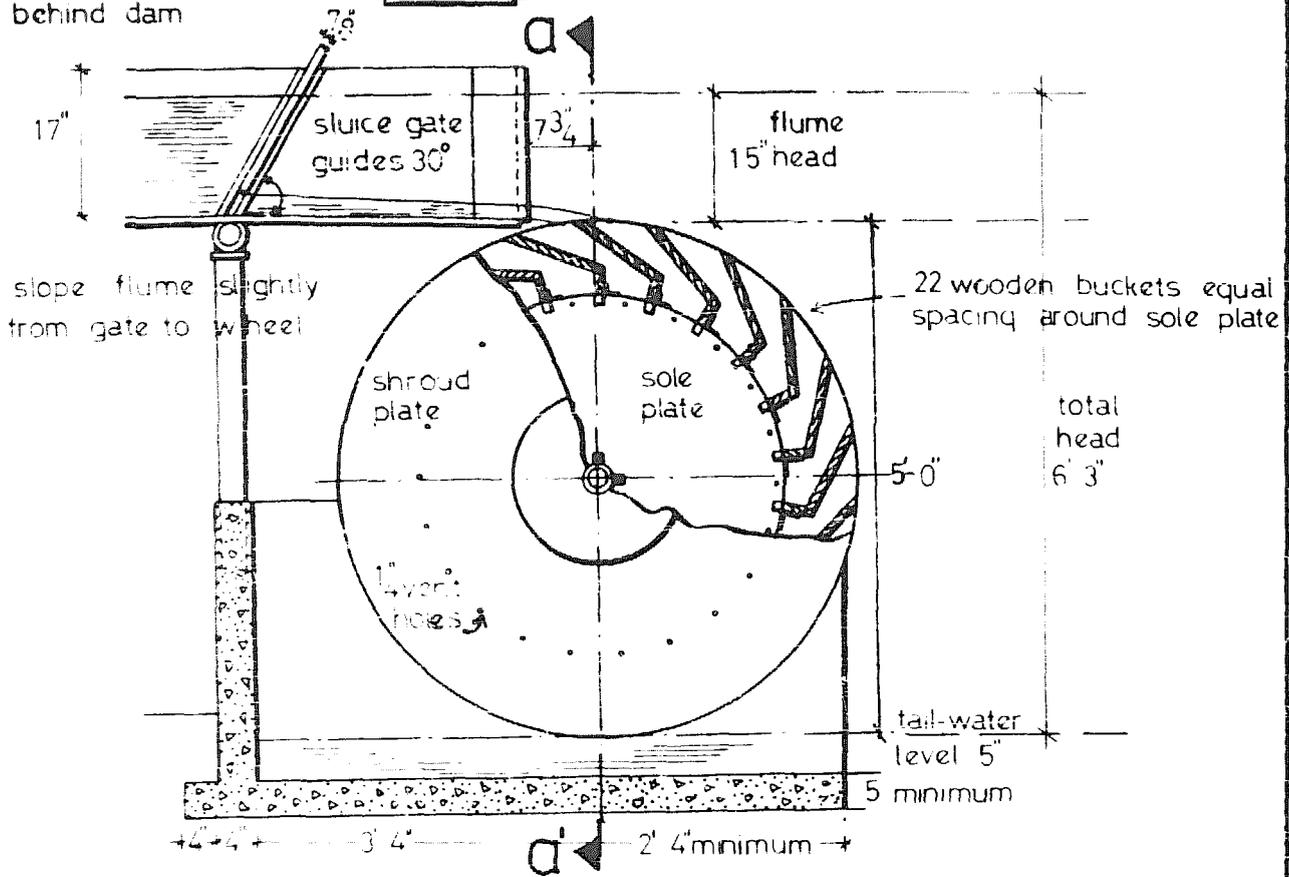
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flume 3/4" seasoned hardwood

6" 1" overhang 1/8" sheet steel file to a knife edge

elevation

headwater level behind dam

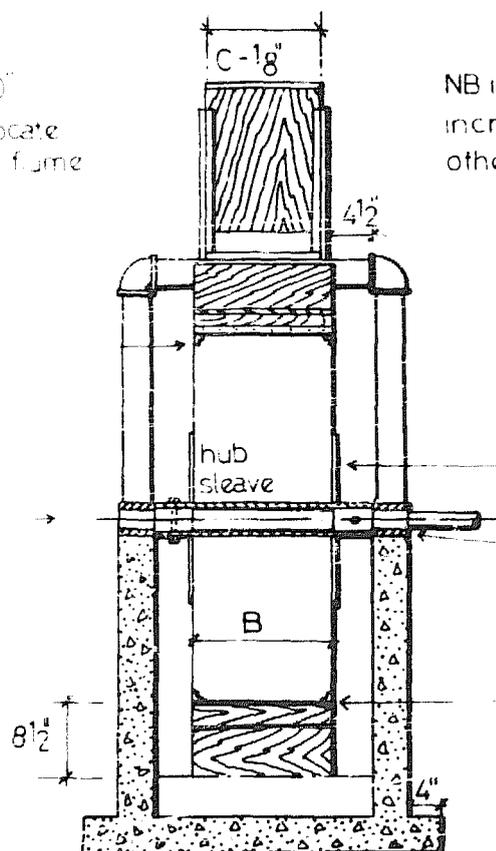


section a-a'

sluice gate C-18x34x20" seasoned hardwood locate where convenient along flume

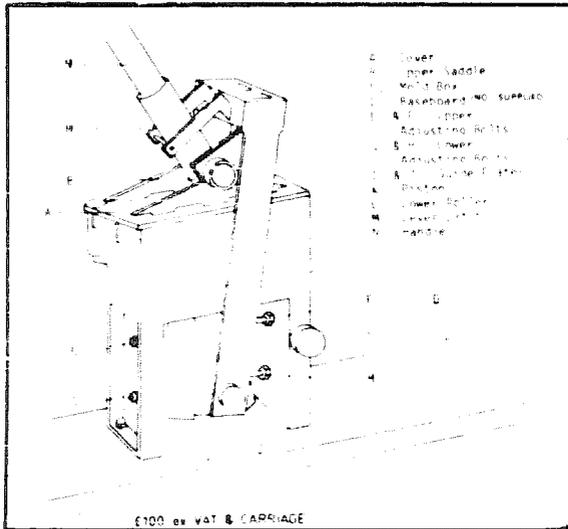
NB increasing wheel width 'C' increases power output other dimensions are unchanged

bucket support
shaft



flume support standard 2 1/2" steel pipe
shroud plate 1/8" x 5' 0" dia steel sheet
hub flange 1 1/4" x 20" dia sheet steel
shim & bearing
sole plate 1/8" x B x 11 3/4" steel sheet

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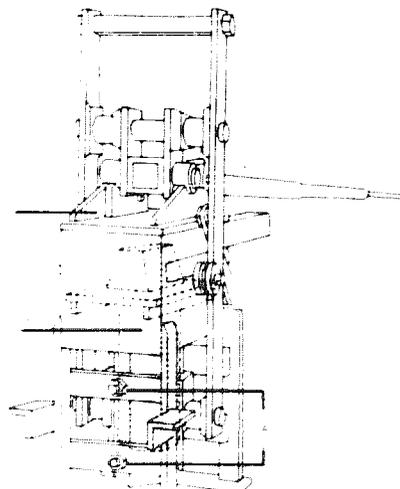
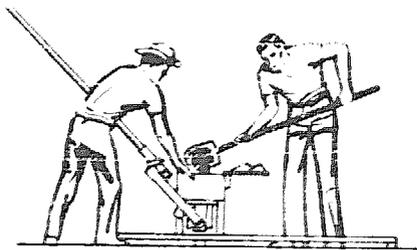
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I built two houses here using CINVA-RAM — where the owners made the bricks using my machine. Both buildings were a success and the machine certainly has its place.

However, I cannot afford to produce the block because of the big labour factor: it is only economical for owner-builder construction. (Which is greatly I still prefer the monolithic wall, and use: Magdiel form and soil-cement mixture. All this info can be found in the 2 chapters of my book (*Owner-Built Home*, p. 94).

Sincerely,
Ken Kern



CINVA-RAM moulder for the production of soil-cement blocks explanatory sketch.

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Lots more, with a bibliography at the end of each chapter for further research.

—Lloyd Kahn

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1. **The Cover.** A rectangle of metal joined to the box by two movable rods at the side to allow it to slide open and to close. Above it are two brackets to house one of the upper shafts of the lever's connecting rods.

2. **The Lever.** Consists of a set of connecting rods operated by hand which set the piston in motion.

3. **The Box.** A metal mould supported by four angular iron legs, constituting the frame of the whole mechanism.

4. **The Piston.** Consists of a cylinder, guided between two adjustable angles and ending in a rectangular plate which serves as a compression plunger. To this plate is screwed a piece of wood, the function of which is to stamp the blocks. If solid blocks are wanted, the wooden piece can be taken off by removing the screws and filling the holes left in the plate with small screws.

A. **Screws for loosening the piston guides.** Are used to loosen the piston if it fits too tightly between the guides, or vice versa.

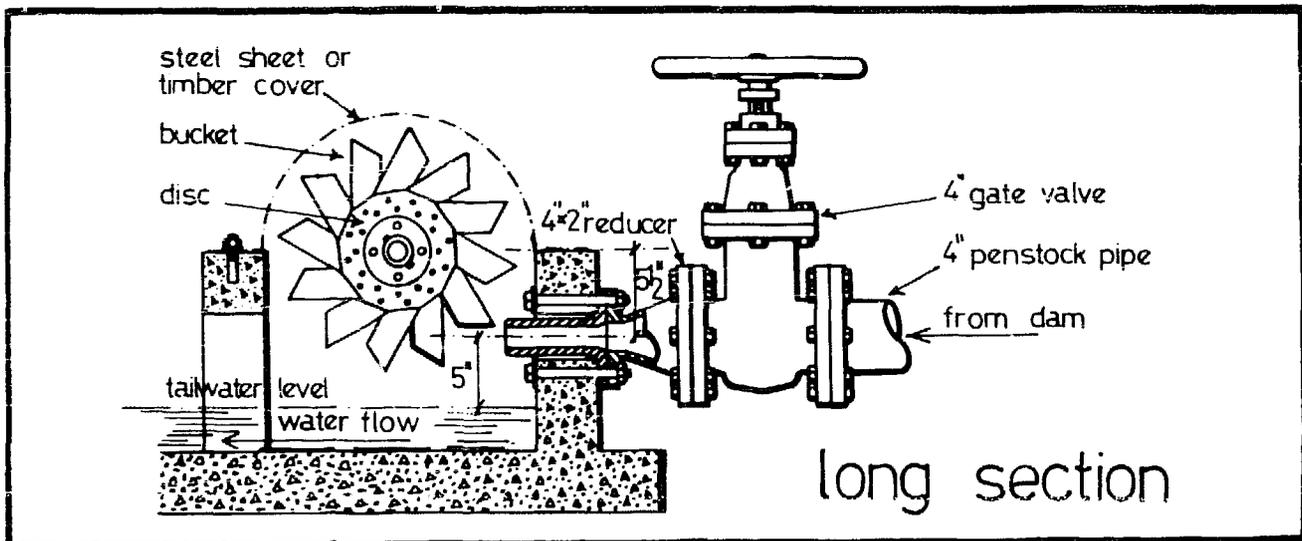
F. IMPULSE TURBINES

Where you can obtain a good tall head of water, an impulse wheel like the Pelton wheel shown here, can be made up, installed, and give useful, cheap power without damaging nature. Where lower heads are available a Kaplan-style reaction turbine can be used. These can be fabricated from readily-available marine screw equipment, and do not necessarily have to be of extreme cost, such as the £6,000 - £10,000 often quoted by established manufacturers for turbines giving 2 - 5 kW of electricity.

For the drawings shown here the head required is from 25 ft. to 60 ft.

HEAD	FLOW CU.FT/sec.	R.P.M.	HP.
25'	0.43	350	1.0
30'	0.51	390	1.3
40'	0.59	450	2.0
50'	0.66	500	2.8
60'	0.73	550	3.75

Thus, if a survey of your stream indicates a head and flow close to these values, this Pelton wheel will fit neatly into your plans.



Strictly speaking (in fact, not!) a water wheel is an engine powered by water, just as an automobile engine is powered by gasoline. The important power-producing elements of the wheel are the buckets and the nozzle, and considerable care should be exercised to see that these parts are made correctly. The nozzle meters the correct amount of water to the wheel, and forms and directs the jet against the buckets. Both the inside diameter and the location of the nozzle with respect to the wheel are very important, since the jet must impinge upon each bucket at the correct wheel radius or lever arm. It must also be divided equally by the centre ridge of each bucket.

The function of the bucket is to convert the energy of the jet, represented by its high speed, into mechanical energy at the wheel shaft. To do this it must slow the water from its high speed in the jet to practically zero speed when it drops into the tail water. Maximum efficiency with this wheel will be obtained if the buckets have the form and size shown

in the drawing. This shape acts to slow the jet by turning it smoothly through 180 deg. The surface of each bucket must be as smooth as possible. A mirror finish is desirable on the inside, and even the back of each bucket should be ground and polished to minimize spray.

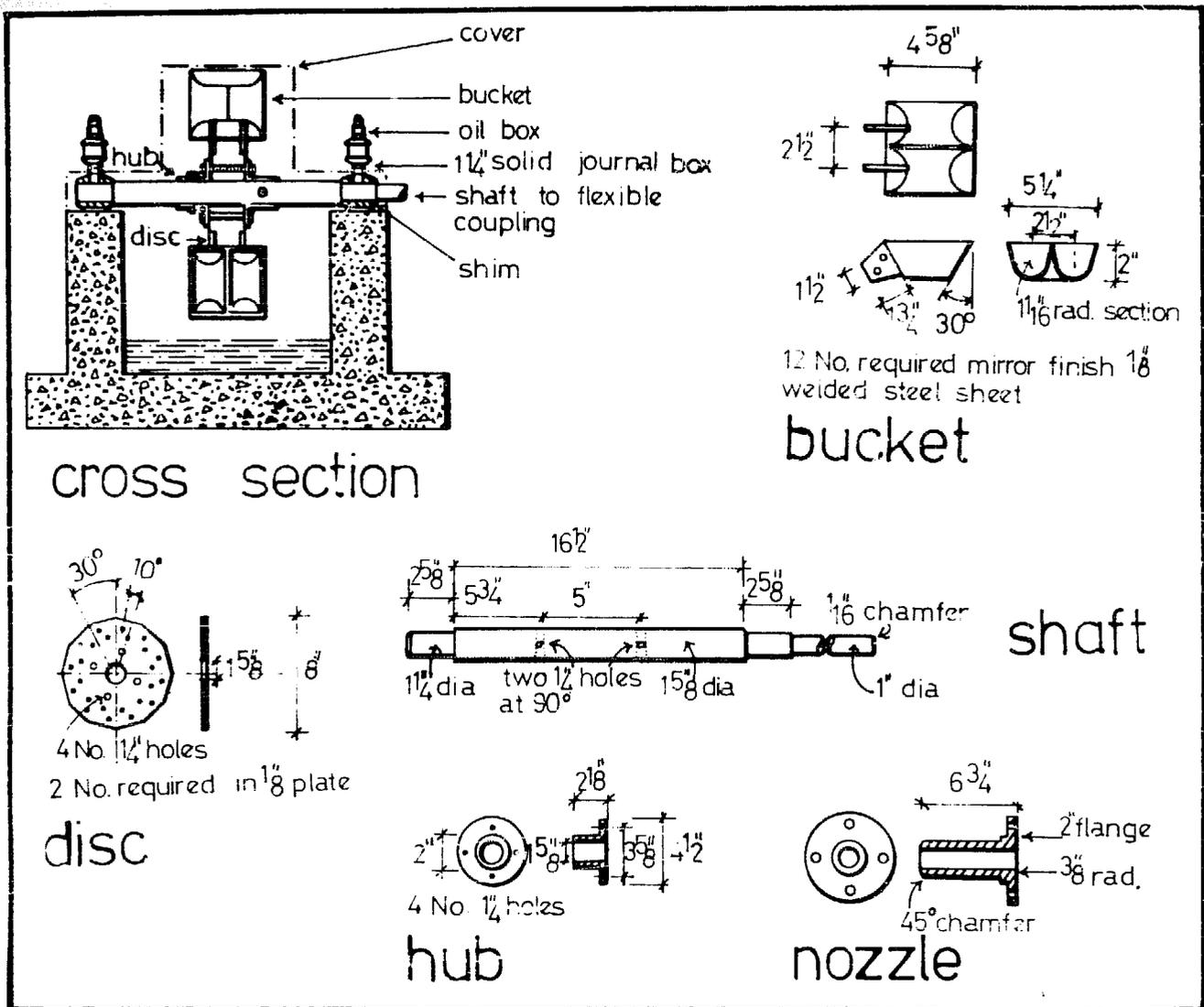
Important also is the correct orientation of the bucket to the jet. When the full jet strikes, the bucket should be perpendicular to it. Both the nozzle and the buckets will wear under the action of the high-speed water, at a rate determined by the silt content and should therefore be made easily removable for replacement.

Above all, buckets must be uniform. If you can get access to a metal-cutting bandsaw, cut the blanks according to a single pattern. This pattern can be shaped so as to form the end bevels automatically when the blanks are bent, and the bending itself can be done in a jig or hammering form. This jig may be made of a piece of pipe of about 2" outside diameter mounted in hardwood endplates. Also provide a holding fixture that will slide in the table groove of the bandsaw to assure that the slots for the end lugs are cut and spaced uniformly. A holding jig should also be made to line up the lugs and buckets for

welding. On completion, balance the wheel by laying weld beads along the backs of any light buckets. Beads should be laid carefully and ground smooth.

Ball bearings may be employed, but are not necessary since the wheel turns at comparatively low speeds. If the builder prefers to use plain bearings, it will simplify machining the shaft, which should present a shoulder to the inside of the bearing so that the wheel may be positioned. If plain bearings are employed, babbitted linings are satisfactory, provided provision is made for proper lubrication.

One vital job that the foundation must do is hold the wheel and the nozzle in correct relative positions. It should be placed on firm ground or piling so that it will not settle unevenly, and must, of course, take advantage of all the head possible. The penstock from the dam should have easy access to the nozzle, and the tail water easy escape to the stream. If possible use 4" or larger pipe for the penstock and lay it out to hold frictional losses to a minimum. The width of the



foundation is such as to allow the water to fly clear of the buckets. The removable cover over the upper half of the wheel may fit more closely, since no water sprays from the buckets through this half of the revolution.

The foundation may be made of such materials as timbers in a framework, masonry, or concrete, so long as it fulfills the above requirements. The wheel and the machinery being driven may then be housed in any suitable, inexpensive shed.

It's not wise to dispense with a gate valve, which is used to cut off or to throttle the water supply to the wheel. Since a gate valve cannot be operated rapidly, it is the best type, eliminating the risk of dangerous water hammer in the penstock. It is also well suited for throttling because fine adjustment is obtainable through the long operating screw. In throttling, the gate valve should be used together with a tachometer or revolution counter connected to the wheel shaft to secure the optimum speed and horsepower for the stream condition and load. Either fasten a tachometer permanently to the shaft, or keep a revolution counter handy in the wheel shed.

Generally the head and volume of water flowing to the wheel will remain constant, resulting in a tail-water surface at the wheel. For an impulse wheel, however, which cannot operate submerged, the

available head is measured from headwater to the centre line of the nozzle. As shown in the construction drawing, there is only 5" difference between the two definitions, but this can make some difference in output when working with the moderate heads for which this wheel is designed.

While many details can be altered, the reader should beware of any that will affect operating characteristics. Thus stainless steel buckets and anti-friction bearings would improve performance, involving only some extra work in building the wheel. Changes in the nozzle diameter, wheel radius, or constant output. If the machinery driven by the wheel has a level power demand there will be little need for constant adjustment of the valve.

The requisite piping, pipe fittings, steel sheet and rod, and bolts, nuts, and gaskets are available at building-supply houses or steel distributors. Machine screws, lock nuts, bearings, and the like may be purchased from good-sized hardware distributors or mail-order houses.

One final point to keep in mind in making your calculations: head is defined as the vertical distance between the water surface behind the dam and the effective head, however, should be undertaken only after careful consideration of the probable effect on performance.

FIRST HAND FIRST RATE

VEGETABLE HOT-POT

4 ozs. potato	2 ozs. soya flour
4 ozs. swede or turnip	1-2 tsp. Barmene
4 ozs. carrots	1 pint water or stock
4 ozs. onions	2 ozs. turnip tops or other dark green vegetable, (nettle in the spring?)
1 tbs. oil or to taste	

Clean and cut vegetables into cubes. Mix soya with 2 tbs. cold water, pour on hot water, add Barmene, stir well and pour over vegetables. Cook in casserole in slow oven 1-2 hours. Add chopped turnip leaves for last 20 minutes. Stir in oil just before serving.

SAVOURY PANCAKES

4 ozs. flour	Pinch of salt
3 ozs. soya flour	oil for frying
12 ozs. of water	

Mix dry ingredients. Stir in water. Beat well or mix in blender. Leave in refrigerator or cool place for at least 30 minutes. Heat 2 tbs. oil in frying pan on a very hot plate until it begins to smoke. Pour in 4 tbs. of pancake mixture. Reduce heat to half. When set shake slightly to prevent sticking. When lightly browned on under side turn and brown on the other side. Spread with a filling of salad of finely chopped onion, grated carrot, or beetroot, and beans or grated nuts and Barmene.

MUSHROOM AND OAT SAVOURY

8 ozs. mushrooms	2 ozs. fine oatmeal
2 ozs. hazel nuts	2 ozs. soya
2 tbs. oil	Salt to taste
½ pint stock or water	

Prepare mushrooms and simmer in the oil. Cut - in the pan - into pieces. Mix oats, soya to a thin cream with a little water. Boil the stock and mix with the cream. Add to pan of mushrooms and stir until the mixture has thickened and simmered for a few minutes. Stir in nuts. Put in fireproof dish and garnish with chopped parsley.

MUESLI CAKE

4 ozs. raisins (preferably seeded)	1 oz. rye flour
¼ pint hot water	1 oz. wheat germ
4 ozs. rolled oats	3 ozs. oil
2 ozs. barley flakes	Salt to taste

Soak raisins in hot water for about 20 minutes. Strain off the water into the oil. Mix dry ingredients together. Chop the raisins and add to the mixture. Stir water and oil and mix well with dry ingredients. Press out onto oiled baking tray. Cook for 35-40 minutes at 300°F. Press down and cut into squares and leave to cook in the tray.

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Historical Background

The harnessing of the 'Forces of Nature' to provide mechanical power has been carried on since the very earliest civilisations. It was the progressive specialization of man's activities which brought about the demand for power which could not be met by the use of human and animal energy. The Chinese, Persians and Romans exhibited considerable skill and ingenuity in the field of civil engineering, many examples of which stand today.

Water power is known to have been used in the British Isles by the Norsemen, but the main growth came from the late 18th century onwards. The power for the Industrial Revolution was supplied by water and latterly by steam. We will describe the designs in detail later. It was the awarding of the prize offered by the Soci t  d'Encouragement to M. Fourneyron in 1827 that heralded the arrival of the water turbine.

There followed more than half a century of development until we arrived at the vast machines producing thousands of horse power for the major hydro-electric schemes of the world, such as the Hoover Dam in Colorado. It was the demand for electricity which then stimulated the construction of power stations in the early 20th century. Many small plants were built, mainly in Scotland, Wales and the West Country to supply the country houses with this fashionable new form of power. Latterly the growth of the National Grid system made most of these plants redundant as they were usually designed to produce 'Direct Current' as opposed to 'Alternating Current'.

In recent years we have seen the continued growth of the large H.E.P. schemes overseas such as the Snowy Mountain scheme and a resurgence of interest in the smaller domestic plants as a result of both economic and environmental pressures.

In this booklet we will endeavour to give an insight into the subject without going into too much technical detail and outline some of the problems and considerations which will be encountered. The later sections are devoted to some practical projects and information for the prospective builder or purchaser.

Engineering Summary

The Site Potential

All hydro-dynamic prime movers (turbines and water-wheels) are machines for concentrating the energy in a flow of water into a usable form, whether it be for sawing wood or generating electricity. The power available is a function of head (the distance the water falls vertically) and the flow (quantity of water passing a given point in a unit of time). The flow of water can be calculated by ascertaining the cross-sectional area of the stream and the average flow; so that you arrive at a figure of x cubic feet of water per minute or litres per second.

To measure the flow -- in an open stream or channel: you should measure the depth at several equi-distant points across the stream, average them and multiply the result by the width of the stream.

Choose a straight uniform length if possible. Using a float (a stick or bottle) time it over a measured distance, say 10 yards (repeat several times) and calculate the volume per unit time. Reduce the final figure by 15% for a well maintained leat, 25% for a stream and 25% for an irregular boulder-strewn brook.

At a weir: Measure the weir and depth of water as shown below and take flow from table.

At a sluice: Measure the width of aperture (w) the height of the aperture (d) and the head of water behind the sluice (h) (from the centre of the aperture) and calculate the discharge in cubic feet per minute from:--

$$336 \times d \times w \times h$$

using a V-notch weir: the notch should be a right angle with the sides of the angle levelled to a sharp edge on the downstream side. The discharge in cubic feet per minute

$$= \frac{11^2 \times h \times 3}{10}$$

The flow is fixed by the supply, but storage is often used so that uneven rates of working can be achieved (e.g. the millpond fills from a small stream when the sluice is closed and it empties rapidly while the mill is in operation.)

The head is governed by the geographical features of the countryside and is realized as the vertical drop over an overshot water-wheel or a pressure within a pipe. Measuring Head: A large scale Ordnance Survey map may be of help on a high head scheme but usually a builders level or a tape measure will do. The total head is from the surface of the inlet water to the bottom of a water-wheel, or the surface of the tail-race water of a reaction turbine when it is running. Note: Up to 1/3 of the 'total head' of a low head reaction turbine is often below the machine due to the vacuum created in the draft pipe, but it will never be more than about 20ft.

Water which is in a state where it can do work (at the top of a fall or in a pressure pipe), possesses 'potential energy'. The potential energy of the water is utilised by: 1) controlling its descent as with an overshot water wheel. The slower the descent the higher the theoretical efficiency due to the relationship with g (acceleration due to gravity - 32ft/sec²). 2) Causing the water to flow through a narrow restriction (a jet or passage), so that the water attains a high velocity. This new energy of motion (kinetic energy) is dissipated by playing the flow of water onto a paddle-wheel which is free to rotate.

In all cases there will be losses in efficiency due to turbulence, friction etc. resulting in an amount of mechanical energy in the rotating shaft; ranging from approx. 50% to 80% of the original theoretical energy available. This power may still not be in a useful form and gearing may be necessary. It should be remembered that the lower the speed the greater the size, weight and cost of the components.

With a water-wheel the speed will usually be between 5 and 30 RPM, and it is the first step up to about 300 RPM which is expensive. It is possible to achieve a step up from 150 RPM to 1500 RPM

(which is the most usual alternator speed) in one belt drive, but the primary pulley will have to be very large. Drives from a shroud gear on the wheel itself are usually very noisy, but there is scope for the use of composition pinions, water-resistant belts and friction drives. Because of this and other problems very few water-wheels are used for electricity generation, though the overshot water-wheel has the advantage of not getting blocked up with leaves and sticks.

Water quality

Unless one is considering installing a relatively high performance machine such as an impulse turbine, the quality of the water will not be very important. Very acid water can be a problem, but it is usually best to make all parts of generous proportions, or plate them. Galvanising, preferably hot dipped, is normally satisfactory, if it is sufficiently thick and is not subject to abrasion due to sand-laden water. A hard coating suitable for fabricated turbine runners is electro-nickel, but this costs up to £5 per sq. ft. Fabrications in stainless steel and bronze are worthwhile in a turbine, although cast iron (and sometimes duralumin) have good wearing properties under a wide range of conditions.

Sand and gravel will erode the impeller of a pelton or similar impulse wheel at a considerable rate, so it is advisable to provide a silt-trap at the top end of the inlet pipeline.

Leaves probably cause the most trouble in hydro-electric power plant and the only ways to overcome the problem are 1) to have a self-cleaning grid (trash-rack); 2) to have a machine which will pass them (most water-wheels, particularly overshot, or a propeller turbine with no guide vanes, or wide clearances); 3) or to shut down the plant while the leaves are falling off the trees.

3) Civil Engineering Works

Dams

For main river schemes in the U.K. the question of dam construction is not likely to arise, due to other considerations, mainly legal. The situations I will deal with are: the repair of an existing dam; the construction of small stream dams; and the construction of earth and temporary barrages.

Repairs to existing structures

There are many dry-stone weirs which have been in existence for hundreds of years without being washed away. Once erosion begins then the structure may be completely washed away: so any damage should be made good as soon as possible. Work will almost certainly have to be carried out during the summer months when the water is low. A coffer-dam may have to be built out of sandbags, or scaffolding, corrugated iron and tarpaulins. It may also be necessary to have a pump to drain the working area. All the silt and debris should be removed so that a good key can be obtained with the rest of the weir. On large areas it may be desirable to use reinforcing bars. The concrete is then poured in, unless the area is under water, in which case the mix should be put in dry.

With most work of this kind it is advisable to discuss it with the Regional Water Authority Engineer.

Damming a side-stream

The process usually involves diverting the stream or part of it while you build a rendered concrete wall and sluice gates. Provision should be made for draining and de-silting the pond.

For many sites semi-permanent structures may be desirable and these include:

- a. Railway sleepers or similar timbers held by concrete or channel-iron supports.
- b. Plastic fertilizer bags filled with sand or a dry concrete mix.
- c. Timber or metal frames covered with a waterproof membrane e.g.: Rick sheet.
- d. Straight trees 18" to 3' in diameter felled into trenches in the banks of the stream.
- e. Special dams such as large tubes filled with water.
- f. Lengths of drain-pipe and paving slabs.

In all cases bank erosion may occur at the edges unless care is taken to reduce leakage as much as possible.

Creating a Lake

If your scheme is in conjunction with a lake, for ornamental or storage purposes then the construction will be as follows:— The site should be accurately surveyed and a plan made and submitted with the relevant form to the Regional Water Authority together with copies of notices that you are required to place in a local paper and the London Gazette. In due course you should receive a lake licence in accordance with the 'Water Resources Act' 1963.

All scrub and turf should be removed from the area of the dam. A drain should be provided at the bottom of the dam so that the pond can be drained if the need should arise. First bulldoze the downhill footing of the dam and work back at a grade of about 1 in 3, consolidating the ground with the machine as you go. Then lay down a thick layer of heavy soil to form an impervious barrier before covering with other soil and if necessary stone at water level to resist erosion.

About 5% of the dam's height should be allowed extra for settling. It should be sown with grass seed to help anchor the surface. Very great care is necessary in designing and constructing spillways as any leakage will result in the whole structure being under-mined.

Inside the dam there will be an artificial water-table and it is vital that this does not emerge on the surface of the dam as seepage will occur and the dam may be eroded from within or slump, due to the flowing of the soil particles.

Leats

The construction of leats follows much the same rules as for the construction of earth dams. They should be excavated if possible and fenced against cattle, which will break down the banks. The longitudinal profile of the leat bed should be level or slightly uphill for the first 100 yds. or so, to help the silt to settle (a by-wash is usually provided for washing out the silt every

few years). The leat thence continues to fall at about 1 in 300 to keep any remaining silt in suspension. The gradient should be such that the leat is kept clear but not eroded, 2ft. - 3ft. per second being the usual range.

Flumes

These are constructed of wood, and are a useful method of crossing difficult country at low cost, provided there is a good supply of local timber. The structure obviously has a limited lifetime and will probably require more maintenance than a leat.

Pipelines

Pipelines should be as short as possible to reduce the cost, so many schemes use a combination of a leat and a pipeline (usually called the penstock). Pipes should be of a material which will resist abrasion and corrosion as well as the pressure. It is fairly common practice with a long pipeline to use cheap low pressure piping (i.e. concrete or plastic) for the top section and steel or cast iron for the bottom section where the pressure is highest.

It is best if the pipeline is buried, provided it is non-corroding, but if this is not possible it should be well-supported and with concrete anchorage points built on steep gradients and at changes in direction. A pressure release valve or swell tower is a vital safety measure if there is any likelihood of the flow being stopped quickly – due to the blockage of a turbine nozzle or the rapid closing of a gate valve.

Spill-ways

These should be more than adequate to carry the greatest amount of flood water and should be so constructed that blockage due to sticks becoming jammed is impossible. The wing-walls and by-water chute should be so constructed that erosion of the banks around and under the structure is unlikely. Once a leak occurs it will wash out the fine fill of a bank and may result in a breach. Circular spillways are often used but mainly where sticks do not present a problem. Railway sleepers, wood or concrete retained by concrete or channel-iron supports, are surprisingly resilient to erosion, provided they have been well dug in and sealed with clay.

Sluices

Sluices must be able to withstand the pressure of a stream in flood, be easily built and maintained. There is no need for them to be too elaborate as the working parts will only become seized up through lack of use.

Screens

It is not usually considered necessary to screen the water feeding a water-wheel, but it is almost an universal practice with turbines. Screens are normally made up of metal bars or strip-welded to a frame. The debris that collects on the screen has to be raked off by hand or by a mechanical rake. Self-cleaning screens work with greatly varying efficiency, depending on design. Water and mechanics don't agree, so the simplest methods are often the best. The most successful involve a rotating screen or a

backwashing system. Clearing the screen is usually a simple operation, taking a few minutes at most, and is a small chore for the benefit of hydro-power, (the exercise also being undoubtedly beneficial!)

The Foundations

The foundations of the screen tank and those to carry the machinery should be carefully designed and constructed, as any settling and subsequent cracking of the concrete work could cause considerable problems, and even a wash-out. The same applies to the support of water-wheel bearings and drive foundations, which have to withstand considerable low frequency vibrations.

4) Engineering Equipment

i) Water wheels

Come in all sizes, shapes and designs, so we have chosen the more usual and interesting ones for consideration.

The Overshot Wheel

simply receives the water from the launder, rotates due to the weight of water and empties the water at the bottom. The bucket design is critical and should be such that the water flows freely into them without causing hammering or trapping of air. The mouth of the bucket should be several inches wider than the stream of water, and the water should be retained as long as possible.

The Breast Wheel

is similar to the overshot wheel, but it takes its water about 2/3 up the periphery of the wheel and rotates towards the launder.

The Undershot Wheel

can be in the form of a simple paddle wheel running in a stream, in which case the effective head is approx. 1 foot, or the water may run down between the wheel and the curved masonry. The leakage reduces the efficiency a lot, and there is a danger of logs damaging the buckets if they become jammed in between the wheel and the masonry.

The Poncelet Wheel

is an undershot wheel of fairly high efficiency, even when working on part gate. The water flows out from under the sluice, down a 1 in 10 race and up the floats (buckets) without any shock. Gliding up the curved floats it comes to rest, falls back, and acquires, at the point of discharge, a backward velocity relative to the wheel, such that the water falls dead into the tail race water, having given up all its kinetic energy. The wheel rotates "against" the water direction.

The Bakti Wheel

is fairly unusual, in that it can work on a head many times its diameter and is principally of the impulse type. The water is led to the wheel in a pipe or flume and is given considerable velocity (kinetic energy) by constricting the outlet. The water enters

the floats (vanes) at the top of the wheel and is deflected across the axis to where it strikes the inside of the floats on the opposite side, which deflect the water forward at a velocity approximately equal and opposite to that of the periphery of the wheel, so that the water falls dead into the tail race. The main advantage of this type of wheel is that it is fast running and eliminates the gearing problem mentioned earlier.

The above wheel could run submerged as a reaction-type wheel, if enclosed in the right kind of case, but the speed and efficiency will be greatly reduced. Other wheels have been built mainly with a vertical shaft, which work on differential drag – like Savonius rota – but they are of low efficiency, and cannot be considered for schemes of any consequence. (Though Savonius rotor boats were feasible. – Ed.).

ii) Water Turbines are classified into impulse and reaction types. The former, which include pelton and turgo-impulse wheels, utilize the kinetic energy (or momentum) in a jet of water which impinges on the buckets of the runner. The buckets are so shaped that they turn the flow of water through as near 180° as possible and move at a speed which results in the spent water falling straight to the bottom of the case, which is mostly full of air. (The reaction turbines can be sub-divided according to the flow of water through the machine, into inward, outward, axial and mixed flow types.) Most machines have a set of guide vanes (deflectors), and the runner from which the power is derived. Unlike the impulse turbine, the case is completely filled with water and the continuation of the outlet (draft pipe) below the machine results in the formation of a slight vacuum, which both increases the total head and reduces turbulence.

The final classification is with regard to the casing. Those which have no exterior case and run submerged in the inlet channel are generally referred to as 'open case'.

Most development has been centred on improving the general efficiency and performance on part gate (when there is a lack of water). Traditionally machines have been designed within the limits imposed by the minimum summer water flow, but now people are considering the winter average flow, which occurs when their demand for the power for heating purposes is greatest. Most homes are connected to a mains supply, so that these plants can be regarded as suppliers of part of the total demand. The complications necessary to achieve accurate governing and capacity to supply peak loadings, can multiply the cost of a plant by 4 - 5 times. The main criteria on which a modern domestic plant should be built, are economics and simplicity of maintenance, for which we are obliged to sacrifice some efficiency, particularly on part gate.

Design Criteria – for low head installations.

If a design is simple, it usually follows that the cost of construction and the maintenance will be low. The most common site is that of an old mill, where there is 6 - 20 ft. head, and up to 3000 cu. ft. of water per

minute.

Unless one has unlimited funds and is prepared to spend in excess of £1000 per kilowatt (£500 per h.p.), the fixed bladed propeller turbine is virtually the only type one should consider. If one has considerable expertise in fabrication, a Francis or Jonval type could be made.

From those firms in Western Europe and the U.S.A. who will build small turbines, virtually nothing is available at less than £2500, plus installation and an alternator.

There are very few second-hand turbines available, so the only alternative is to build your own from drawings or buy a complete kit, and install it yourself or with the help of a builder.

Most turbines are governed hydraulically/mechanically, which is out of the question for most plants with which we will deal. Rather, it is far easier and cheaper to maintain a constant load on the machine and divide the output between a main circuit and a balast circuit. There are several ways in which this can be achieved electronically, and the degree of sophistication and number of safety devices is naturally reflected in the price. Here we are talking in terms of £50 - 100 per h.p. for the materials and drawings, plus your own labour, and an alternator costing at least £30 per kw.

(Included in the next section is a more detailed description of the construction of a vertical propeller turbine.)

High Head Turbines

High head installations using turbines of the impulse type have many problems and additional costs, the greatest of which is usually the pipeline. The size of pipe is most important, as it is necessary to balance cost against the losses due to friction which would occur in a pipe of too small a diameter. Manufactured machines are available with or without governing, but the cost is considerable. For the home builder it is advisable to buy or build the moving parts and build a casing of concrete or brickwork at a fraction of the cost. The two designs suitable are the pelton wheel and a Bakti type cross-flow machine.

iii) Drive – For low speed/high torque, gears and heavy chains are necessary – expensive if purchased new, I would advise those who wish to use a water-wheel to look for suitable second-hand equipment. For higher speed drives vee-belts are the most convenient, as they are quiet and fairly easy to install and renew. Hydraulics are available and some include self-governing systems, but they are expensive and have a limited life.

Bearings – These should be ball or roller and where necessary of the thrust type. Wherever possible you should instal as large bearings as possible, as the increased life will more than offset the extra cost. 10 years should be regarded as the minimum life of low-speed bearings. Well-maintained bearings running at less than 500 r.p.m. may last up to 30 years of continuous running.

Alternators and Dynamos – Not many people are interested in generating 'direct current', though there is quite a lot of good slow-speed equipment available,

which is suitable for water-wheels. Generally we are interested in producing 'alternating current' as supplied by the National Grid.

There are many makes of alternator on the market and most run at 1500 r.p.m. For most purposes single phase is required, and there is a great deal to be said for the brushless (rotating field) machines. It should be checked whether the alternator has suitable bearings for belt driving and, if necessary, for vertical mounting, as required for my own design of propeller turbine.

Governing – This can be the greatest and most difficult problem, as it has traditionally involved regulating the flow of water through the machine. It is now generally accepted that for small plants a fixed load is best. In simplest form the output of the machine is always connected to water or space heaters. In more sophisticated installations, the load is electronically shared among several circuits, by power or frequency monitoring (obviously the cost is related to the degree of control required.) This method of control makes water economy less easy, but cuts the cost of the installation by up to 500%. As mentioned earlier, hydraulic systems have their own built in governing system. With most systems it is vital to have an overspeed safety device, in case the electrical load is removed by the blowing of a main fuse or component failure. Without such a device to shut the plant down most alternators would be destroyed by the very high centrifugal force in the rotating armature, not something one would wish to happen too frequently!

Power Cables – These can be a very expensive part of the installation if they are of any great length, mainly due to the high price of copper. The main disadvantages of overhead cables are that they are unsightly and can be struck by lightning. Underground cables are usually more expensive. For low voltages the wires can be laid in an alkathene pipe which can be pulled in with a mole-drainer. Where there is likely to be excessive power drop or cost in using heavy cables transformers may be used. The cost of the transformers has to be offset against the saving in the size of cable. (The higher the voltage the thinner the cable.)

Switch gear – I would like to emphasize that any wiring and changeover switches that may be necessary should only be installed by a person who knows what they're doing. In no circumstances should any direct connection be made between a mains supply and a private supply. Otherwise it could be your wheel versus an atomic power station!

Appendix : How much do you have to do?

Maintenance

If your plant is near the point of power need you are at a distinct advantage, as you save yourself a walk, and there is less risk of vandalism. The screen should be checked once a day while the leaves are falling off the trees. The machine should be stopped every week or month, depending on the type so that the bearings and belt tension can be checked. Continuous running can be achieved for long periods (i.e. 6 months or so) but checks should still be made

on bearing temperature and this usually involves stopping the machine for safety reasons. The commutators of fast running D.C. generators usually cause a lot of trouble due to sparking of the brushes. The slip-rings of alternators don't usually suffer from such troubles, but it can only be overcome by using a brushless (rotating field) machine.

Legal

The main areas where the Law should be studied are in connection with:

- a. The 'Water Resources Act' 1963.
- b. Water rights and access for maintenance.
- c. Liability for damage caused by flooding etc.
- d. sale of electricity.

The 'Water Resources Act' 1963

Made no specific reference to water-mills and consequently there followed a considerable amount of argument as to the intention of the Act in this respect. The main legal argument hinges on whether the water for a mill is abstracted or diverted. In the light of recent court cases (Dee Mill v Dee River Authority; and Farm Industries v Devon River Authority) it would appear that no charge can be made for water used by a wheel or turbine, as the water is returned to the river in a nonpolluted state. It is reasonable for the river authority to specify minimum flows for the main river during times of drought so that the fish will not be killed.

If water is flowing in a leat and has been for years then you have established a legal right and with it one often has the right of access to maintain the leat and any works in connection with it. It should be remembered that this usually works both ways in that you have an obligation to maintain it should it flood someone else's land. Where the flow has ceased in a leat, or a new scheme is planned, a licence may be required by The 'Regional Water Authority', whether they can charge an annual fee is a matter for debate and there is considerable discrepancy between regions. It should also be mentioned that mills and weirs help to improve the oxygen content of the water, which is vital to fish survival and growth (especially where high-BOD agribusiness waste is dumped in rivers – Ed.).

The right to take water

and to maintain works may be written into the deeds of the property or the local records. A search is often worthwhile, particularly if there is a dispute.

Liability for damage

In general everyone has a duty of care to his neighbour when he is carrying out anything that could endanger his person or property. Provided you have taken all reasonable care you will probably be all right but your insurance in respect of 'Public Liability' should cover you against your own negligence. This is more important in urban areas.

Under the Electricity Nationalisation Act the various boards were given a monopoly of the sale of electricity. By joint ownership of the plant it is possible to run it without money changing hands.

Economics

Does it pay? To be able to answer this question we should calculate or estimate the following:

- a. What will your initial investment be (including or excluding your own labour)
- b. What annual cost will you incur.
- c. How do you value your own time for maintenance
- d. What value of power should you get from your plant.

Fixed costs

For the purpose of calculation capital is costed at average borrowing rate say 10% and the fixed costs are those required to pay for this capital i.e.; interest and repayment over ten years.

Variable costs

These are the annual running costs which are very low with hydro-electric power as the fuel is free.

Cash flow

It is relatively easy to calculate the output of the machine over a period but the costing is more difficult. Firstly you must cost it at the value of the fuel that you are replacing, so it is obviously best to replace the most expensive, usually electricity first. Secondly you must estimate the change in the price of fuel over the next few years (a dangerous past time). It is possible to make allowances for inflation and growth so that you have an elaborate 'Cash flow' programme for several years ahead but in the present time of rising costs, most are out of date in a very short time. There are further advantages with regard to taxation allowances and I would suggest that you consult your accountant.

Safety

I cannot stress too hard the need for the strict safety measures as follows:—

Water

- 1) Design your spillways so that there is no danger of flooding your property or your neighbour.
- 2) Fence all waterways, ponds, water-wheels etc. against livestock and children.

Electrical

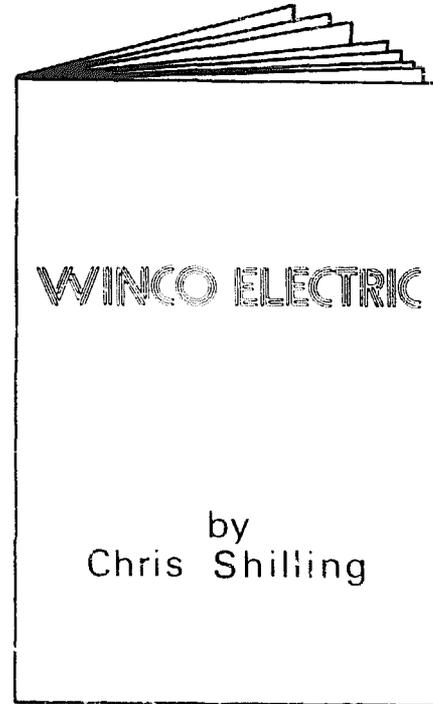
- Keep everything dry
- Stop the machine when making connections
- If in doubt seek professional advice

Mechanical

- Guard all moving parts, belts, gears etc.

By way of warning: An acquaintance of mine returned home to hear a noise coming from his millhouse; he rushed in to stop the machinery but caught his coat in the main drive chain. As he was wound into the sprocket he managed to push a crow-bar into the drive and stop it. Not everyone has a crow-bar to hand at such times, so be warned.

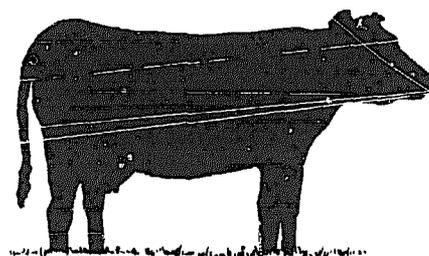
(LIT wishes to point out that it has no financial interest in artificial limbs, solar-powered or otherwise. So please don't practice amputation instead of waterpower.)



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It would be of great help to us if you are able to give us approximate details of head and flow; photographs and drawings would also be of advantage.

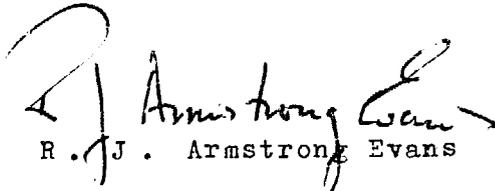
The machinery for a 10Kw plant will cost from £1500 to £2000 plus piping concrete and cable. You will appreciate that the on site costs are the most variable as no two sites are the same.

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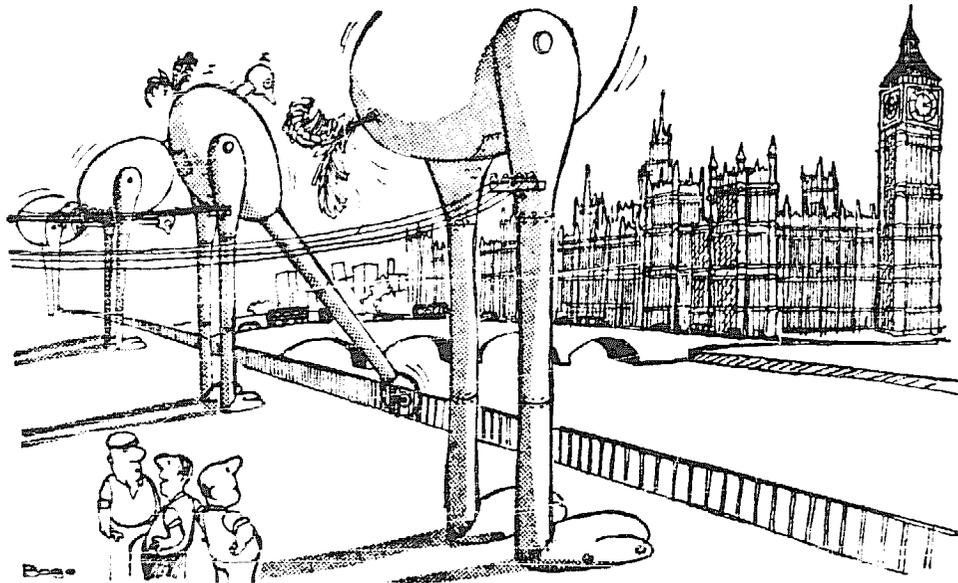
Methane (ATOMIC ROOSTER'S HERE)

by STEVEN SAMPSON
edited by ANDREW MACKILLOP

Published by the Wadefridge Ecological Centre
73 Moleworth Street, Wadefridge, Cornwall

Single copy price £1.50

THE OBSERVER, 28 JULY, 1974



Giving Battersea the bird

The article by Nigel Hawkes on Dr Colin West's solar engine last week prompts me to point out that an engine based on similar, although not identical, principles, has been sold in a number of shops. It is called a 'Crazy Drinking Bird.' One wets the bird's head, the water evaporates, the gas inside contracts, causing liquid to flow up a tube so that the bird over-

balances, dips, its beak in a receptacle of water, returns to its previous position, more water evaporates and the process is repeated again. Both machines depend on the alternate contraction and expansion of an enclosed volume of gas, causing a liquid to flow back and forth, altering the equilibrium of the machine. Both may work indefinitely, given, in the case of

Dr West's machine, a supply of heat, and, in the case of the bird, a supply of water.

In fact, I see no theoretical reason why an array of, say, a hundred Super-Crazy Drinking Birds, perhaps each a hundred feet high, lining the bank of the Thames, should not replace Battersea Power Station. Does anyone?
SE16. C. A. Stickland

Another Turbine Builder comments:

POWER FROM FLOWING WATER

Fuels are no longer cheap. Since the advent of electricity, the limitations on watermill power earlier imposed by the geographical location are no longer important; the energy can be readily transported by wires. The fact that many mill sites produce only small amounts of useful energy is also unimportant; using modern control methods the available power can be used to carry "base load" while peaks of demand can be taken from the national grid. A mill which can develop say 20 hp continuously (or at any rate for several months of the year) will provide heating at about 48,000 B.Th.U per hour, or some 123,000 units of electricity per year. (Value £1230 at 1p per unit.)

The method of extracting this energy from water generally involves passing it through a turbine which then drives an electrical generator. The type of turbine depends upon the pressure head of water available and generally speaking the greater the head, the smaller the quantity of water required for a particular output, and the cheaper the turbine. The available power in kilowatts from a water source is approximately $P = QH/16$ where Q = quantity of water flow in cubic feet per second and H is the working head in feet. (one gallon of water weighs 10lbs and a cubic foot of water weighs 62.4lbs, i.e. 6.24 gallons per cubic foot of water). If metric units are used in the formula, $P = QH/138$ where Q is the quantity of water flow in litres per second and H is the working head in metres, P as before is the electrical power produced in kilowatts.

Using the above formula, the amount of potential power available at a site can readily be calculated.

It can also be seen that if some means of increasing

the working head can be found – say by constructing a weir, dam or sluice or by conducting the water via a pipe from a higher level, the amount of water required for continuous operation is reduced. Any increase in the amount of water stored behind impounding works during wet periods may be utilised during a dry spell to maintain the production of power.

It is sometimes feasible to improve upon an environment while providing a source of low cost power for industrial purposes. Areas of water contained by new dams or impounding works can often be used to hide the scars of past mining or to cover other derelict land. At the same time they can provide water-based leisure facilities which may also yield revenue.

In under-developed countries, impounded water can be a useful source of protein in the form of fish, in addition to being a store for irrigation and drinking water, and can provide potential power for pumping water to more distant areas. This power can be used for the grinding of corn and for processing other foodstuffs, sawing of timber etc. Thus, in remote areas the use of expensive imported high energy fuels may be avoided while the benefits of power may be enjoyed. Much of the cost of a comprehensive water resources development consists of local labour and material which is another advantage the imported machinery and know-how being a proportionately low content in the overall scheme.

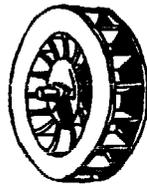
The civil engineer is a practitioner of the art of harnessing such resources of nature as water power for the use of man. He considers alternative arrangements of flow, head, machinery and civil works to obtain the best and most economical scheme at each site while maintaining the balance of nature in the environment.

Vincent Allen Associates, Consulting Civil Engineers 291 High Street, Epping, Essex CM16 4BY, U. K..

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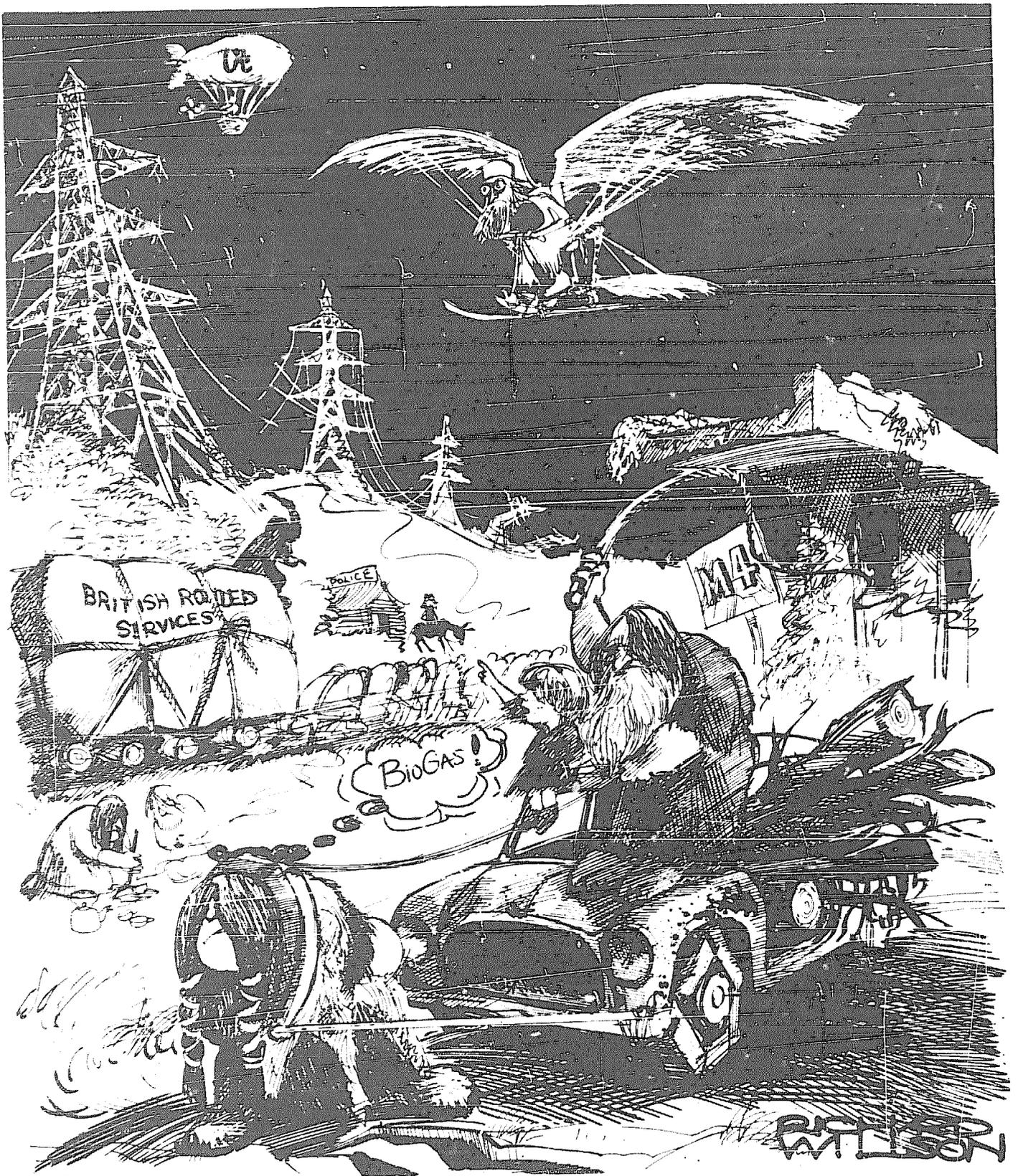
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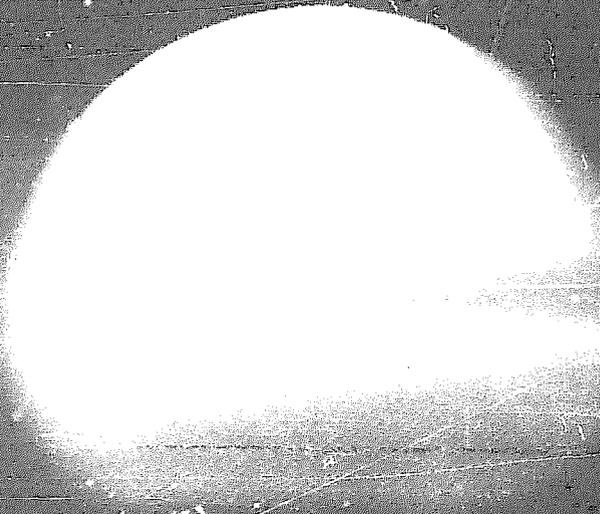
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What were those big metal things used for in the olden days, Grandpa?



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low impact technology

The Independent Petroleum Association of America estimates domestic crude oil prices have increased about 24% since the first of the year (1973). That is more than US Petroleum prices rose in the preceding decade.

DURING THE 12 MONTHS ENDED LAST JUNE 30, only 40.2 per cent of first class seats on U.S. airline planes were filled, compared with 55.9 per cent in coach class.

Of the almost 6% per year load growth predicted for the Pacific Northwest in the next 20 years, only 1½% per year is attributable to population growth.

The amount of oil discovered per foot of exploratory drilling. From 1860 to 1920, when oil was fairly easy to find, the ratio was 194 barrels per foot. From 1920 to 1928 the ratio declined to 167 barrels per foot. Between 1928 and 1938, partly because of the discovery of the large East Texas oil field and partly because of new exploratory techniques, the ratio rose to its maximum of 276 barrels per foot. Since then it has fallen sharply to a nearly constant rate of about 35 barrels per foot.

Even if the Arabs are willing to sell us oil, the investment required by the oil industry to satisfy world demand in the next decade is staggering. According to the Chase Manhattan Bank's annual survey, the petroleum industry will spend \$1,000 billion by 1985. Of this, they will have to borrow \$400 billion. "That the petroleum industry could obtain so much money in competition with all other segments of the worldwide economy is by no means certain."

The Cost of Living Council reports that 53.3 million gallons of fuel oil will be exported from the U.S. during 1973, a figure 284% higher than the past year (1973). (*Energy Digest*, 11.16.73.)

Denis de Rougemont, the Swiss sociologist and writer, defines a civilised country as one that protects its forests. On the basis of this definition, Britain (which is 7 per cent forested) is the second least civilised country, next to Ireland. Finland ranks first with over 60 per cent forests.

According to the UN report, "World Energy Supplies 1968-1971" the United States is still the world's largest oil producer, followed by the Soviet Union, Iran and Saudi Arabia.

For the third time this year, members of President Nixon's personal security force have been relieved of duty because, allegedly, they were smoking dope.

A TYPICAL ROUND TRIP TO SAN CLEMENTE, FOR THE PRESIDENT, consumes a fantastic 71,000 gallons of fuel. For the Key Biscayne trip the figure is 30,000 gallons. Three helicopters with a total fuel consumption of 450 gallons, usually escort the President to Camp David and back.

The latest instance occurred last week at the El Torro Marine Corps air station in California near Nixon's San Clemente home. Eight members of the President's personal security guard, all with high security clearance, have been transferred from the security detail reportedly for smoking marijuana.

When the President is in Florida, the Air Force provides a 24-hour airborne radar patrol over his Key Biscayne retreat. Yet unaccountably, the radar planes are flown to Florida from McClellan Air Force Base, California, though radar planes are available in Florida.

The Japanese Ministry of Construction has estimated that by 1985 industrial waste will lie in a layer 2.5cm thick over the whole inhabited area of the country. By the year 2000, Japan will be consuming 76 per cent of the world's iron ore and 92 per cent of its crude oil in a vast cloud of industrial pollution.

My feeling is that if there were unlimited funds it would take an unlimited length of time. Those working on the problem would just keep working and working on it – why should they worry? They'll always have work and good pay – enough to buy the last gallons of oil.

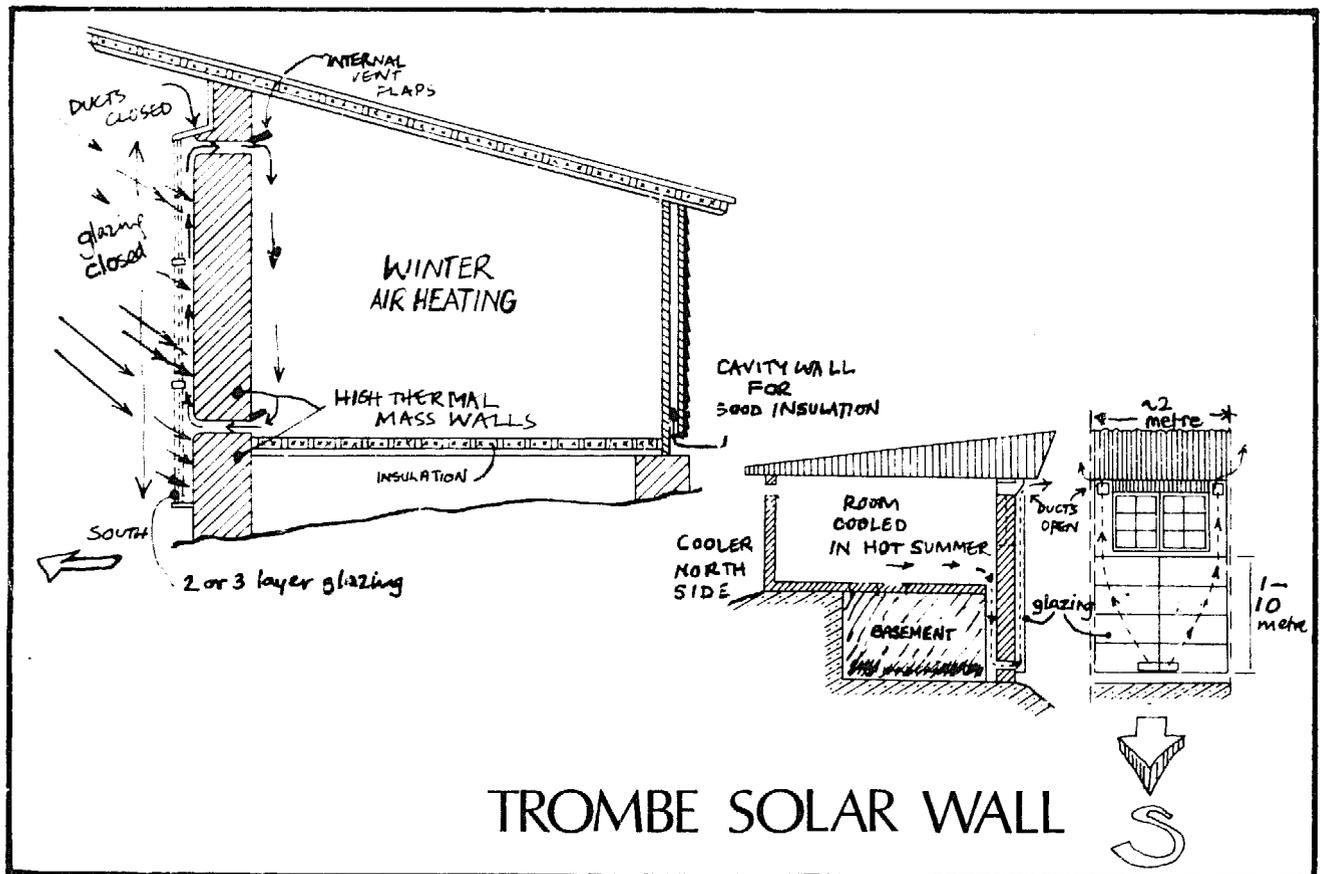


Isn't this all very obvious? Our own dear Bob Stromberg from Sandia, as bright and likeable a gentleman as you would ever wish to meet, might really accomplish something if he and his crew had some good clear goals and the likelihood they'd lose their jobs if they didn't produce. The country seems to regard itself as the custodian of an increasing number of scientists and experts who are rewarded with grants and contracts and the avid attention of the rest of us every time they help us take a bum turn. If the captain of a ship has sunk it through negligence, better to throw him to the floor of the lifeboat and let the amateurs take a try at sailing

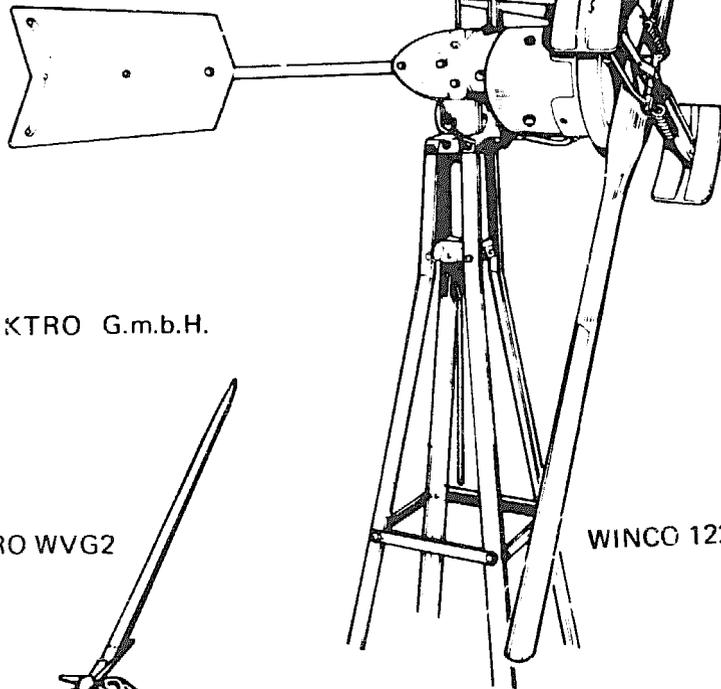
than to help him to the tiller again.

What was interesting at the meeting? Exxon Corporation is selling small silicone cells, each one produces 1½ watts, they are about the size of a sheet of paper folded in half the long way. The cells are enclosed in clear polycarbonate and have an expected life of over 15 years. They are beautiful but terribly expensive. Each one costs \$30 or \$20/watt. The researchers would not guess about how cheap these might become in the future. They showed slides of these cells coupled to batteries on off shore oil rigs in the gulf where warning lights and fog horns must be supplied with energy. An interesting and vital part of these installations was the greasy rubber band they string above each panel of cells – sea gulls don't like greasy rubber bands and therefore perch elsewhere.

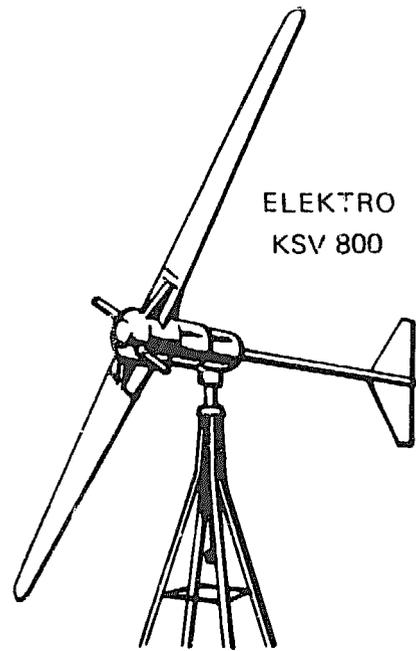
At the end of the meeting a man was outside sweating and laboring to set up a demonstration of a small solar powered steam engine – the concentrating collector consisting of two racks of shaving mirrors (some of the shaving mirrors with plain rims and others with gold culicue designs on the rims). The boiler kept running out of water, the mirrors had to be adjusted constantly as the earth turned. Scattered clouds blocked the sun periodically. The man wrestled with the device, explained that it was a model of a large power plant he wished to build. It seemed wonderful that there on the neat lawn in front of the NASA Lewis research center, a kind of institute to make other institutes feel ashamed of their lack of guards, government limosines and dignity, there was a demonstration relying on hardware purchased at two different drug stores with different brands of shaving mirrors.



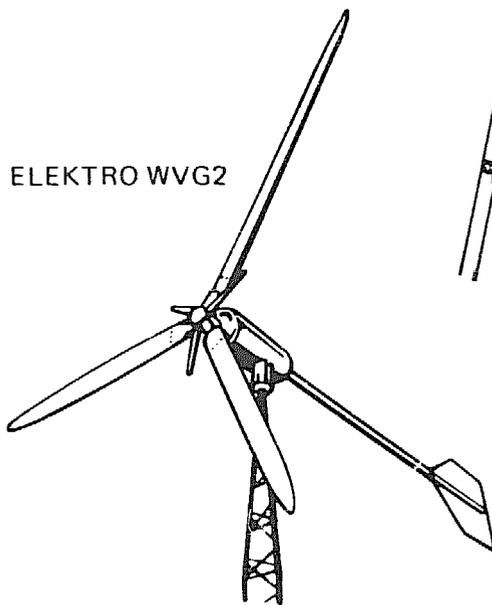
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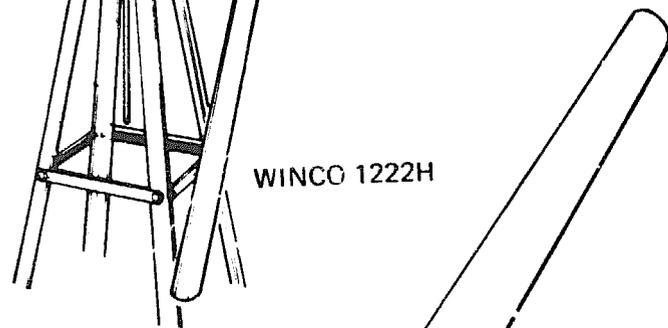
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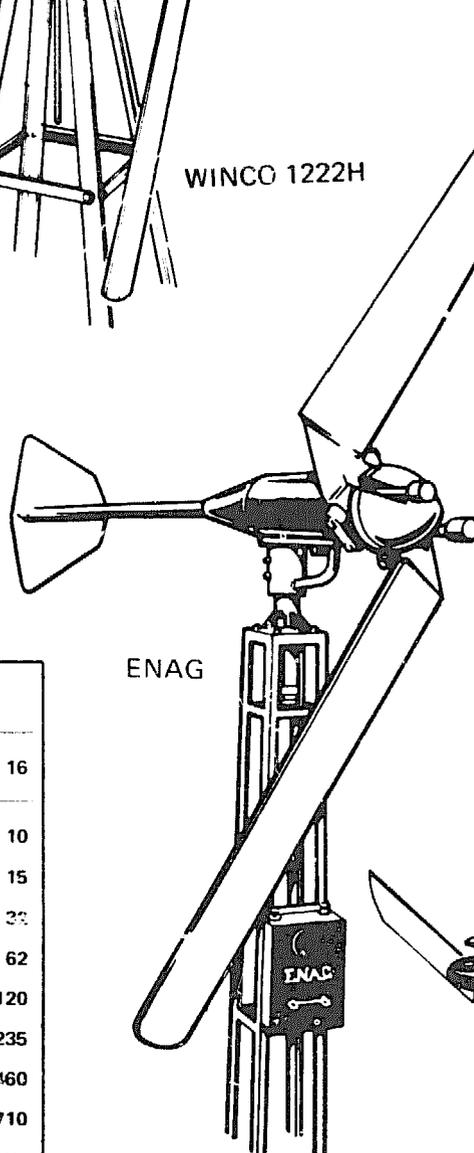
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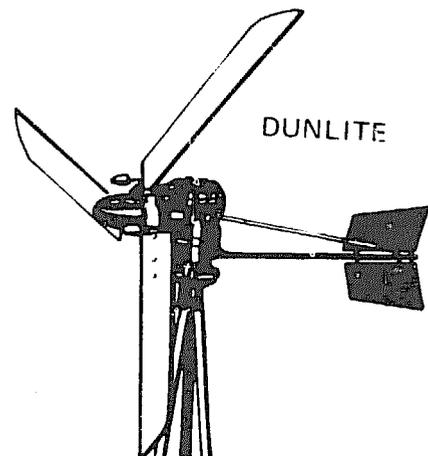
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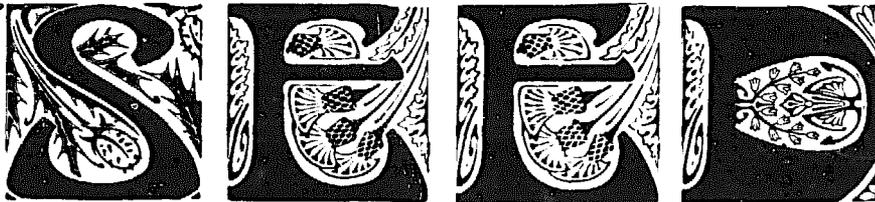


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Nominal Output Rating of Generator in Watts	Average Monthly Wind Speed in mph					
	6	8	10	12	14	16
50	1.5	3	5	7	9	10
100	3	5	8	11	13	15
250	6	12	18	24	29	32
500	12	24	35	46	55	62
1000	22	45	65	86	104	120
2000	40	80	120	160	200	235
4000	75	150	230	310	390	460
6000	115	230	350	470	590	710
AVERAGE MONTHLY OUTPUT IN KILOWATT-HOURS						



THE JOURNAL OF ORGANIC LIVING

If natural foods are a necessary part of your life, then you will welcome *Nature's Foods*, a beautifully illustrated, detailed cookbook by Peter Deadman and Karen Betteridge (available from SEED bookshop).

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"It is mysterious and exciting to rediscover the power and beauty in food, and the uses to which it can be put. Food and its many dimensions becomes a tool by which we can change ourselves from sickness to health, and from unhappiness to happiness. Food is basic, close to the earth, ancient as life, and it unlocks great energies in us. May all be well with you."

Nature's Foods tells us about the importance and uses of various grains, beans, vegetables, breads, spreads, sauces and drinks, and covers everything from travelling foods, seasonal foods, nourishment for nursing mothers and babies, and breakfasts, to wine and beer recipes, herbal remedies, kitchen utensils and the art of washing up.

With AWAKENING SPRING, young and tender wild greens are nature's way of cleansing the body after a winter of eating coarse foods. Foraging for your own food is free and gives you a chance to tune in with all growing things. Some may be found growing along hedgerows, but it is important to know they haven't been sprayed with weed killers or insecticides.

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PARTICLE OF FEAR by Anthony Tucker

Questions of nuclear reactor "safety" pale into insignificance beside the apparent threat, extending hundreds of thousands of years into the future, associated with plutonium. Since nuclear reactors of all kinds, and not only fast breeder reactors as has been suggested in some reports, are associated with plutonium production and release, the latest US assessment of public hazard posed by plutonium blights the whole technology.

Dr. Tamplin and Dr. Cochran, two US experts, now argue that a single plutonium particle, one thousandth of a millimetre (one micron) in diameter or less, can induce lung cancer. Industrial retention of particles of less than a micron cannot be guaranteed by any known or foreseeable technology and, in any case, accidents are bound to happen. They have certainly occurred in the past and, taking the round figure of 24,000 years for the half life of plutonium-239, imply that man has already exposed himself and future generations to some level of hazard for upwards of a quarter of a million years.

According to UN Scientific Committee reports significant quantities of plutonium, which evolutionary processes had more or less eliminated from the surface of the earth before the era of nuclear fission technologies, have already been released by accident or design.

Remembering that a particle of the size suggested as being likely to cause lung cancer has a radioactivity of less than one third of a millionth of a millionth of a curie (0.28 picocuries) these earlier releases look sinister. Bomb tests, for example, released some 300,000 curies of plutonium-239. Bomb accidents, such as those at Palomares and at Thule, have resulted in locally high levels of contamination and, in the Palomares incident, in an unknown amount of plutonium being carried by the wind over a wide area.

Plutonium-238, an isotope hardly less deadly than 239 but less long-lived for its half life is around 90 years, was produced in much smaller quantities by nuclear weapons tests (about 10,000 curies) but has reached us by accident. Some 17,000 curies were "injected into the stratosphere" by a satellite which has a plutonium power source and which burned up on reentry in 1961. A similar power source reentered the atmosphere "and fell into the Pacific Ocean" in 1970, and a similar plutonium generator went into the sea off the Californian coast when a weather satellite exploded during launching in 1968.

Stockpile threat

These recorded events indicate only the tip of the problem. No one really knows what radionuclides, plutonium included, have reached the atmosphere (and us) through mishaps, fires, technical failures of filter systems and the myriad mistakes which men are certain to have made since they first started to handle the material. But the amount of plutonium now stockpiled, either for weapons or for use as nuclear fuel, is now very large and growing at an accelerating rate. As Sir Kingsley Dunham recently pointed out, a few kilograms of plutonium-239 are enough to threaten the whole of mankind. But plutonium-239 is already stored in ton quantities throughout the northern hemisphere.

The true risk of cancer induction might be either greater or somewhat less than that indicated by the assessment. But in either case it appears that the existing levels of permitted exposure are set very much too high. The urgent question is whether it is possible, either technically or economically, to reduce "routine" emissions of plutonium to less than one hundred thousandth part of presently permitted levels. In Britain, where plutonium waste is stored as hot liquid (with such disturbingly dangerous and plutonium-like radionuclides as Americium-241) it will be argued that questions of plutonium particle release are hypothetical. That is not true for, wherever plutonium is handled, separated or processed, there is bound to be some release.

Nor is it reasonable to argue, as has been suggested by nuclear proliferators, that we have to be "reasonable" and relate nuclear risks with other everyday risks, such as those of lung cancer from cigarettes, or injury through road accidents. We are not talking about risks only to ourselves, nor about risks which can be calculated with any certainty. Nor are we talking about a risk which can be avoided by those who wish to avoid it - by not smoking for instance.

We are talking about a risk which is invisible but reaches so far into the future that it is almost beyond comprehension, one which is so uncertain and enormous that a single major accident or error of judgment, or the activity of a single unbalanced human, could entrain an irreversible degradation of earthly life. It is time to pause and reassess, before we go so far that we are hooked on plutonium in the same sick way that we are hooked on oil.

GRADUANI

1974

OIL ADVERTISING: BRAINWASHING AT PUBLIC COST

by Lee Stephenson

Environmental Action, March 2, 1974.

The oil industry has bombarded the American public with a multimillion dollar advertising campaign in recent months carrying its side of the energy crisis. Prime-time television has frequently carried colorful messages, and major newspapers and magazines have had dozens of full-page advertisements with huge bold headlines — all to proclaim the companies' innocence of any wrongdoing.

But the one thing the companies haven't said in their multimillion dollar campaign is that they are getting the public to pay for most of it.

The cost of nearly all of the advertising — all but that which advocates specific changes in legislation — can be deducted from taxable income as a "legitimate business expense" by the oil companies, according to the Internal Revenue Service (IRS). Thus the companies have an indirect public subsidy in their campaign to defend their high profits and proclaim their innocence against charges that they have caused, or at least could have prevented, the current energy crunch.

Although all American industries can use the same deduction, this provision in connection with other special tax favors gives the oil industry a percentage rate of tax on income far lower than the average for U.S. industry. In fact, the companies pay a lower percentage of tax on income than does the average citizen.

The deduction includes all of the costs of advertising, including fees to advertising agencies, preparation and the purchase of expensive print media space or electronic media time. For instance, a 60-second commercial carried coast-to-coast on the NBC evening news program costs \$27,000 and a full-page advertisement in the *Washington Post* on weekdays costs about \$4,670.

Such a television commercial reaches millions of homes (the 60-second spot during the NBC news program reaches about 9.5 million) and full-page newspaper advertisements may reach hundreds of thousands. Most of the energy-crisis-related newspaper ads have appeared in limited markets, such as New York City and Washington, D.C., to reach "decision-makers." However, some companies have taken their ads to wider markets. One full-page newspaper ad in late January by Mobil Oil, which reprinted four earlier messages under the headline "Don't read these ads if you've made up your mind about oil profits," was placed in nine large newspapers with a total circulation of approximately six million. A single ad in late January by Exxon headlined "Exxon plans to spend nearly \$16 billion over the next four years to help get more energy to you," was run in newspapers in the top 50 advertising markets in the country with a combined circulation of over 30 million.

Electrical utilities have also jumped on the energy

advertising bandwagon in recent months, and these companies have a special public subsidy the oil companies do not have. Investor-owned public utilities, which are regulated by state public utility commissions, often have their customers pay for company energy crisis advertising by including the costs in the rates consumers pay. Although some public utility commissions have begun to restrict the inclusion of consumption promotion and controversial issue advertising in the utilities' rate base, in most cases customers will pay for advertisements suggesting steps to meet the energy crisis, criticizing environmental controls promoting nuclear power, and advocating rate increases and the suspension of clean air regulations.

The energy company advertisements have also been criticized for misrepresentation and deception. Calling the recent oil company and utility advertisements a "multimillion-dollar propaganda blitz," six members of Congress petitioned the Federal Trade Commission (FTC) in January to require proof of claims made by companies on energy and environmental issues. In 1971 the FTC started a program to investigate product claims made by companies, but non-product or so-called institutional advertising has never been monitored by the FTC.

The six petitioners include Senators Birch Bayh (D-Ind.), Thomas McIntyre (D-N.H.) and Frank Moss (D-Utah), and Representatives Les Aspin (D-Wis.), Benjamin Rosenthal (D-N.Y.) and Andrew Young (D-Ga.). The companies cited in the complaint include Shell Oil, Tenneco, Champion International, Mobil Oil, Exxon, Pacific Power and Light, Wheelabrator-Frye, General Electric, Amoco Oil, and the Investor-Owned Power and Light Companies.

A second official complaint to the FTC was filed in January by Environmental Protection Agency Administrator Russell Train in response to a Chevrolet advertisement advocating the removal of automobile emission control equipment. The ad's claim that an increase in gasoline mileage of up to 25 percent could be achieved by removing the equipment is "grossly inflated and misleading," according to Train, who asked the FTC to investigate the advertisement and to "prevent such misleading advertisements from occurring in the future."

Richard Herzog, the FTC's assistant director for national advertising, said the Commission has also had an "unusual number" of other letters complaining about the companies' advertisements. But although Herzog acknowledged that he was heading the Commission's review of the complaints, he refused to characterize the work as an investigation and would not speculate as to when or what type of response the FTC would make. Other Commission sources have said a large investigation of energy

advertising is underway and have predicted the FTC would take some action to control non-product energy advertising.

FTC Chairman Lewis Engman has said he favors some curb on image advertising intended to enhance the companies' commercial well-being. However, Engman and FTC investigators have had a difficult time defining the purposes of institutional advertising and do not think that all forms should be controlled under any circumstances. The FTC is very reluctant to tamper with political ads which advocate a legislative position on a controversial issue. The right to express such an opinion — no matter how obnoxious — is guaranteed by the First Amendment. However, when false or misleading information is used to justify such a position, or when an institutional advertisement is clearly intended to improve a company's product appeal, or stock marketability, the FTC is considering action.

The only other federal agency that exercises control over company advertising is the Federal Communications Commission (FCC) under its Fairness Doctrine. That set of regulations requires television and radio stations which present one side of a controversial issue to also allow "reasonable opportunity" for the presentation of contrasting viewpoints.

The initial determination of the fairness issues is left up to the local broadcasters, and most stations claim to meet this requirement with their news and public affairs programming. However, the stations are ultimately responsible to the FCC for the balance they present in these controversial matters, and complaints received by the Commission are supposedly taken into account when the local broadcaster's license comes up for renewal every three years.

The content of advertising presented by a station is also subject to the Fairness Doctrine, and if the opposing viewpoint to an oil industry advertisement is not given a "reasonable opportunity," individuals or groups can file a complaint with the FCC. Few complaints are filed and even fewer decided in

favor of the complainants, although there are some instances of success.

In 1973 a citizen's electric utility monitoring group the Georgia Power Project, and two other local organizations complained to the FCC about a series of Georgia Power Company advertisements in support of a pending rate increase. One broadcaster in Atlanta and a second in Augusta had refused to allow the groups to respond to the company's messages. The FCC ruled in favor of the groups in December of 1973, requiring the stations to allow response times to the groups and setting an important Fairness Doctrine precedent.

The other potential area under FCC regulations for a different viewpoint from advertisements is the public service announcements (PSAs) that local television and radio stations carry. There is no requirement for any specific quantity or subject matter of such announcements, but it is understood the licensee will carry some messages of public interest free of charge.

PSAs most often take the form of broadcasting notices of community meetings or using messages supplied by the Advertising Council. The Council is a non-profit, public service corporation which conceives and pays for the production of advertising messages on a variety of public issues. The ads are then supplied free of charge to radio and television stations to use as PSAs.

The Council's work has been widely praised, but the organization has met some criticism (for conflict of interest due to its industry- and business-dominated board of directors. For instance, the Council prepared a campaign for Keep America Beautiful Inc. (an organization composed mainly of container and beverage manufacturers), suggesting that "People start pollution, people can stop it." The Advertising Council has thus helped to lend credence to the beverage industry's contention that consumers are more responsible for litter and pollution than the industries which create millions of tons of throw-away containers yearly.

Don't read these ads if you've made up your mind about oil profits.

Now about those record profits of ours...

We just spent three months' profits in one morning.

Mobil

Are oil profits big? Big? Big enough? Why?

Mobil

JUST FIVE CENTS.

Mobil

We have more coal than they have oil. Let's use it!

American Electric Power Company, Inc.

Exxon plans to spend nearly \$16 billion over the next 4 years to help get more energy to you.

In 1974 alone, Exxon expects to spend a total of \$3.7 billion. Would you like to know what the money will be used for, where it will come from, and why it's vital for an oil company to make such large investments? Lucky!

Exxon

World's Best Buy to Know!

The board of directors of the Advertising Council is composed entirely of manufacturing, retail, utility, insurance, advertising, publishing and broadcasting corporations. Moral: Don't expect the Advertising Council to produce any public service announcements countering energy company claims.

Of course, the FCC has no control over print advertising, which is why company newspaper and magazine messages are more prone to heavy advocacy. Most television advertisements by the oil companies present a low-key message to minimize Fairness Doctrine problems. But, as newspaper advertising

points probably could not be adequately presented by the use of the letters-to-the-editor column, guest columns, or even editorials, and said "I don't know what could countervail that [the volume of ads] short of having the same amount of money" to buy advertising space. Maynard also said that although the news columns of the newspaper had devoted considerable space to energy problems and some of the company claims, the volume of company advertising seemed to outweigh the exposure of alternate viewpoints.

Environmental Action could not find a single advertisement in a major newspaper or magazine which attempted to counter the energy company line. Groups contacted that have charged the companies with misrepresentation or falsehoods said they simply did not have the money to answer the company claims through advertisements.

A San Francisco-based non-profit communications firm, Public Interest Communications Inc., has asked the *San Francisco Examiner* for regular full-page advertisements free of charge to respond to the oil companies. But there is apparently no precedent for a major newspaper to give free advertising space to an individual or group to balance or respond to advertising campaigns. The *Examiner* has not announced a decision on the request.

The outlook for opposing viewpoints on the air waves is equally complicated. A Washington public interest group, the Media Access Project, is preparing a Fairness Doctrine campaign to force television networks to air counter-industry ads. However, the group says its chance of success is limited because the FCC is likely to rule that the ads are adequately balanced by network news programs.

In an attempt to give citizens the materials to launch a counter-industry energy advertising campaign, Public Interest Communications has prepared a full set of newspaper, magazine, radio and television advertisements. The group is offering the materials at cost to individuals and groups to either purchase or solicit free advertising time from the media. But a spokesman for Public Interest Communications said the group thinks people should not try to buy time because the public has a right to free access to the media.

WHAT TO DO:

Environmental Action is preparing a letter to the publisher of the *Washington Post* to express concern over the large number of prominently displayed energy company advertisements and the inability of most people who might counter those ads to buy advertising space. The newspaper's ombudsman has asked EA to propose a solution to the problem. You might take the same action with your local daily newspaper if it has carried a significant number of national or local energy messages.

Public Interest Communications Inc. (1300 Sansome St., San Francisco, Calif. 94111) also has a free "Handbook on Free Access to the Media for Public Service Advertising" and can supply individuals or groups with its newspaper, magazine, radio and television messages.

from *Environmental Action*.

BUY BUY BUY BUY BUY BUY BUY

STOP BUYING

For years, the big energy companies have been spending millions of dollars encouraging us to buy more energy. Now, as their incompetence has caught up with them, and they've changed their tune. They're telling us to stop buying all these appliances they encourage us to buy. They're asking us to give up the televisions they deliberately created for us. They're asking the shortage to occur, and now they're trying to place the blame for it on us. But we're not buying it.

The energy shortage was caused by a system that more concerned with making profits than with supplying energy. There's no need for manipulating the world energy market

than with developing an intelligent conservation policy. Sooner or later, the world really is going to run out of fossil fuels, and if the oil companies have their way it'll be sooner. That won't bother them at all—using the world's oil profits they're trying to get from the current artificial shortage and the increased government handouts they're asking for—and getting, they'll simply step in and manipulate whatever new energy source the world goes to. But for us, the people, continued profits are the goal of the world's energy sources will mean more crises, more manipulation, more suffering. If you're not buying the oil company line, make your

voice heard. Write your elected representatives and insist on a national energy policy that puts public need before corporate greed.

Company	1973	1972	% Change
Exxon	1,538	1,077	42%
Shell	1,171	814	44%
Texaco	879	614	43%
Amoco	772	542	41%
Standard Oil	561	391	43%
Marathon Petroleum	490	327	49%
Sunoco	293	214	37%
Conoco	193	144	34%
Atlantic Richfield	178	147	21%
Total oil sales	5,170	48.2%	
All oil corporations	5,170	86.9%	

ENERGY SHOULD BE EVERYBODY'S BUSINESS

The oil companies have been pumping out the advertisements almost daily but those who might counter the industry's claims have been unable to pay high ad rates. Above is a sample of counter advertisements available at cost from Public Interest Communications.

executives readily point out, the public owns the air waves and thus has a right to regulate their use; individuals or companies own the press. Again, a constitutional issue is involved.

The *Washington Post's* Vice President for Advertising, Joseph Lynch, told *Environmental Action* there is no limit on the amount of advertising space a company or group of companies can buy and said there shouldn't be. Lynch did say the *Post* regularly screens such advertising for libel, obscenity or factual problems, and said that several oil company ads had recently been questioned and two sent back to the companies for different statistics. But he admitted the newspaper is not in a position to investigate the statistics or alleged facts used and "unless we know for sure that it isn't true" the ad is likely to run.

The *Post's* ombudsman, Robert Maynard, said he had received no complaints about the volume of energy company advertising in the newspaper, but added that he thinks the volume of such advertising presents a problem. Maynard said contrasting view-

Solar-heated future

Advocates of alternative energy sources received good news on February 13 when the House of Representatives passed the Solar Heating and Cooling Act of 1974 with a decisive 253-to-two margin.

The bill, sponsored by Rep. Mike McCormick (D-Wash.), will subsidize the construction of 4000 housing units, half of which will be solar-heated and -cooled. The other half will be solar-heated only. Half the units will be installed in public housing and the other half will be put into private homes.

The bill also gives NASA the authority to contract for solar systems in factories, colleges and barns, as well as homes. It is estimated that \$12 to \$17 million of the \$50 million authorized in the bill will go toward these large units.

McCormick believes that the nation will save \$2 billion a year in fuel bills if only five percent of its buildings receive 80 percent of their energy from the sun.

Action on a similar bill has begun in the Senate, with hearings set to begin at the end of February. S. 2658, the Senate version of the bill, is expected to pass by a wide margin.

from Environmental Action.

What the customer wants is his electricity as cheap and reliable as possible, and his prospects of this hang crucially on the nuclear decision. Coal and oil are becoming scarce and expensive. Development of British mines or North Sea oil cannot bridge the gap. The Generating Board wants to order one or two nuclear reactors a year, or roughly 1,250 megawatts each, to the end of the decade, then speeding up until nuclear covers the entire growth in demand. The detailed figures are arguable, but the overall scale is not.

It was for this reason that the Generating Board chairman Arthur Hawkins is asking for "bread and butter nuclear plant," regarding the reactor purely as a machine for producing his power efficiently and on time. This approach concentrates the mind, but where does it lead?

Thus the AEC says of "hypothetical" LMFBR accidents where safety systems fail that "if a practical means can be found to . . . accommodate the consequences . . . [it] should be considered." Critics would argue that if it cannot be found, proven by experiment, and implemented, then the reactor should not be built. Likewise, the AEC considers it "realistic" to evaluate the effects of postulated accidents only on the assumption that engineered safety features work as designed; but since their failure is considered credible, this line of argument does not seem very promising.

The regulatory and promotional sides of the AEC have recently disagreed by one or two orders of magnitude about potential radioactive releases in a LMFBR accident. Uncertainty in the explosive potential of a LMFBR may be greater still, so that containment that is adequate (on paper) for "design basis accidents" may be too little for other plausible

accidents which the designer prefers to consider "incredible". (Critics point out that the Fermi meltdown, though contained, did technically exceed the "Maximum credible accident".)

Fermi fast breeder reactor,
Michigan, USA.

Born 1967. Died 1967.

THINK YOU GOT PROBLEMS?

Monks' date with death

Seventy monks at the Mount Athos monastic community in north Greece have threatened to burn themselves alive if 11 other monks and two superiors from Mount Athos are dismissed on orders from Istanbul in a dispute over whether they should give up the Julian calendar and use the Gregorian.

— *Agence France Presse.*

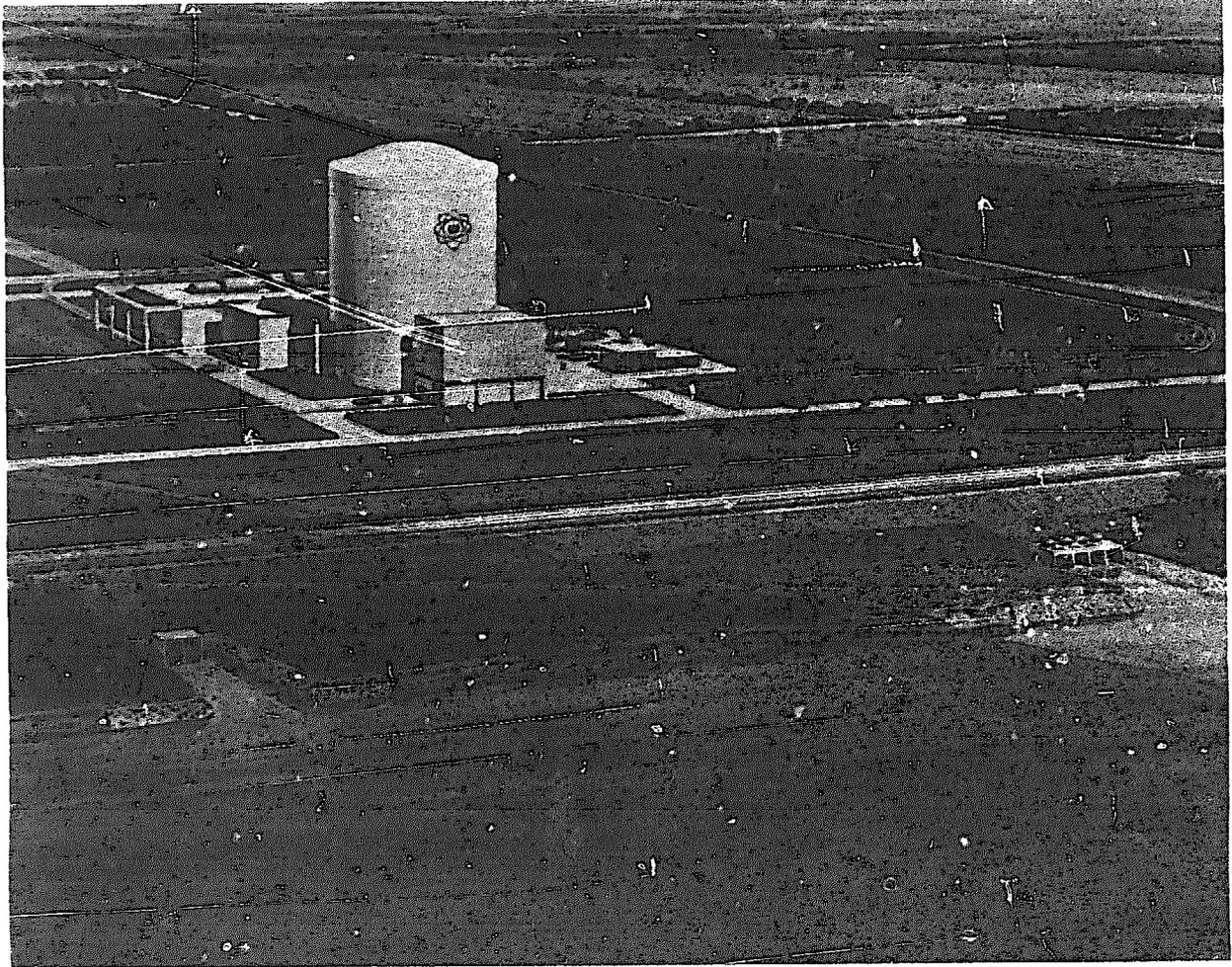


"He used to serve in the canteen at Brixton."

NOLA EXPRESS

NEW ORLEANS, LOUISIANA, Number 144, November 30 - December 13, 1973, Second Class Postage Paid, 35¢

I AM BECOME DEATH, DESTROYER OF CIVILIZATIONS



ARTIST'S CONCEPT

PUBLIC HEARING, JANUARY 8, LP&L PROPOSED NUCLEAR FISSION (ATOMIC) POWER PLANT

Robert Head

The Atomic Energy Commission has scheduled the evidentiary hearing to determine whether or not the Commission will grant Louisiana Power & Light Co., a construction permit for their proposed nuclear fission powerplant near Taft, Louisiana, 21 miles upriver from New Orleans.

Comet Kohoutek will be visible in the evening sky and it's the day after my birthday if you believe in signs.

I am become death, the destroyer

of civilizations - is from the Bhagavad Gita and, according to Oppenheimer (who made the first atomic bomb), it flashed into Oppenheimer's mind as he watched the first explosion in 1945 in New Mexico.

Different words flashed into the mind of a less grandiose man who also watched: "We are all sons of bitches now."

I would remind you that leukemia death rates in Charlevoix County, Michigan, where a nuclear fission reactor 1/15 the size of the proposed

LP&L reactor has been in operation since 1962, are now 400% over the Michigan state average.

(continued on page 3)

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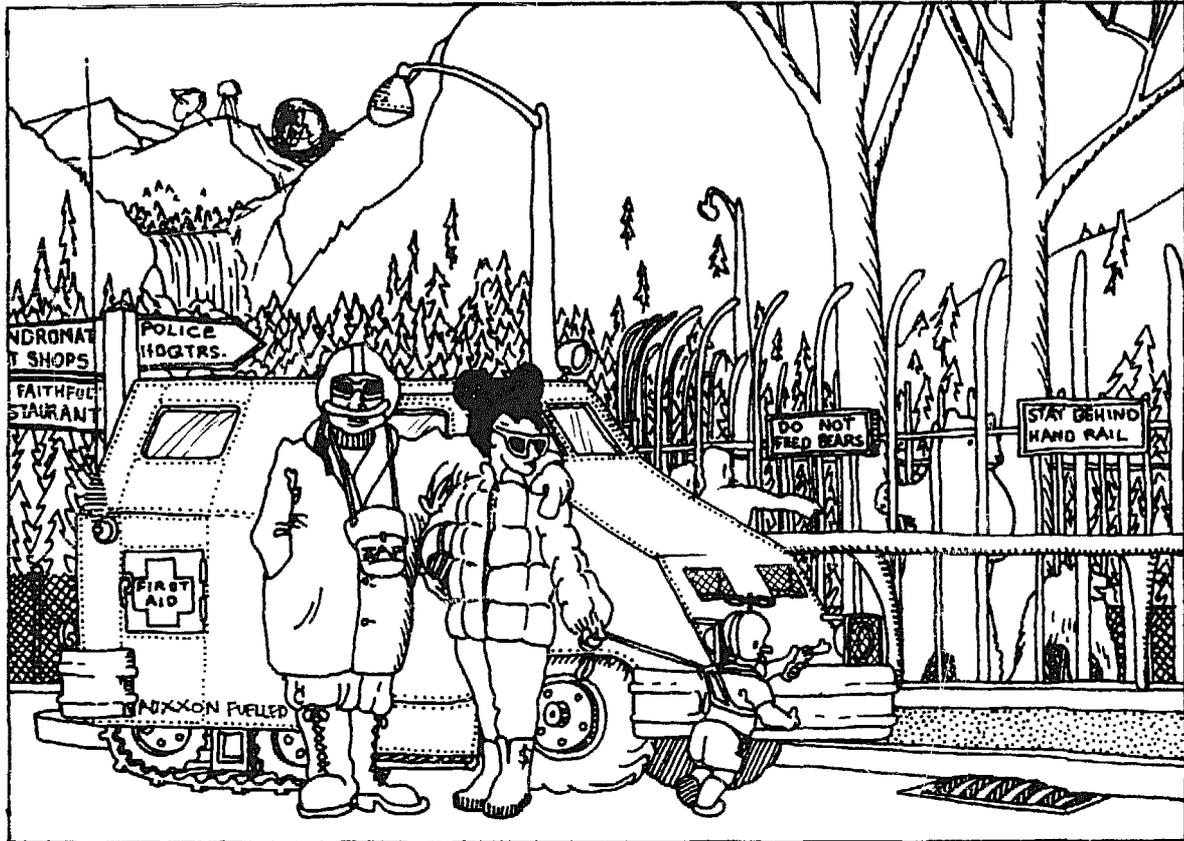
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Taming the National Parks



Birdwatchers -- Binoculars must be equipped with soft rubber eyecups to prevent injury to eyes and facial bones. All field guides carried in the pocket must have soft covers. For added safety, it is recommended that the book's corners be trimmed round. Edges of pages should be ragged, to prevent painful paper burns.

Boaters -- Boats, which must be equipped with Coast Guard-approved safety and survival gear, may not be operated in water over shoulder depth, unless they are equipped with double-outrigger systems.

Campers -- Tents must be constructed of a fabric containing no less than 50 percent asbestos or other fire-retardant fibers and must be equipped with approved sprinkler systems. To reduce fire and carbon-monoxide asphyxiation hazards, all vehicular campers must drain their gas tanks before retiring for the night.

Children -- Park visitors under the age of 21 must be handcuffed at all times to a parent or other responsible adult. Large families or youth groups in which the children outnumber the adults may elect to use leg irons instead.

Climbers -- Parachutes must be worn on all ascents of over 500 feet, both back and chest parachutes must be worn. Climbs during winter months and in inclement weather at any time of year are prohibited.

Fishermen -- Mae Wests or other Coast Guard-approved flotation gear must be worn at all times when within 50 feet of any body of water. Hooks, if used, must be blunt. Waders and hip boots may not

be used unless they are provided with drain holes below the ankle.

Hikers -- Visitors walking the backcountry must stay on the fenced boardwalks provided. Hikers must make five-minute stops at each of the rest stations provided at quarter-mile intervals. (Note: The logs and stumps spotted at irregular intervals along the boardwalks are for local color only. Do not sit on them as there is always danger of picking up splinters from any unfinished wood.)

Picnickers -- Breakable bottles, sharp metal cans, and fires are prohibited. Meat containing bones and other hard foods are permitted, but visitors assume all risks to dentures. Soft foods in pliable packaging are strongly recommended.

Photographers -- Wildlife, trees over 25 feet in height balancing rocks, waterfalls, and other potentially hazardous objects may not be photographed with wide-angle, close-up, or other lenses requiring the photographer to approach within 200 feet.

Senior Citizens -- Visitors over the age of 35 must furnish proof of having passed a cardiac examination within the past six months. Such proof is not necessary in the great majority of cases, since most older visitors will not be leaving their autos.

Sightseers -- Safety goggles must be worn at all times when viewing scenery so that eyes will not be exposed directly to the air, which may be laden with dust, pollen, leaves, or other material potentially injurious to the eyes. Sunsets must be viewed through smoked or heavily tinted lenses.

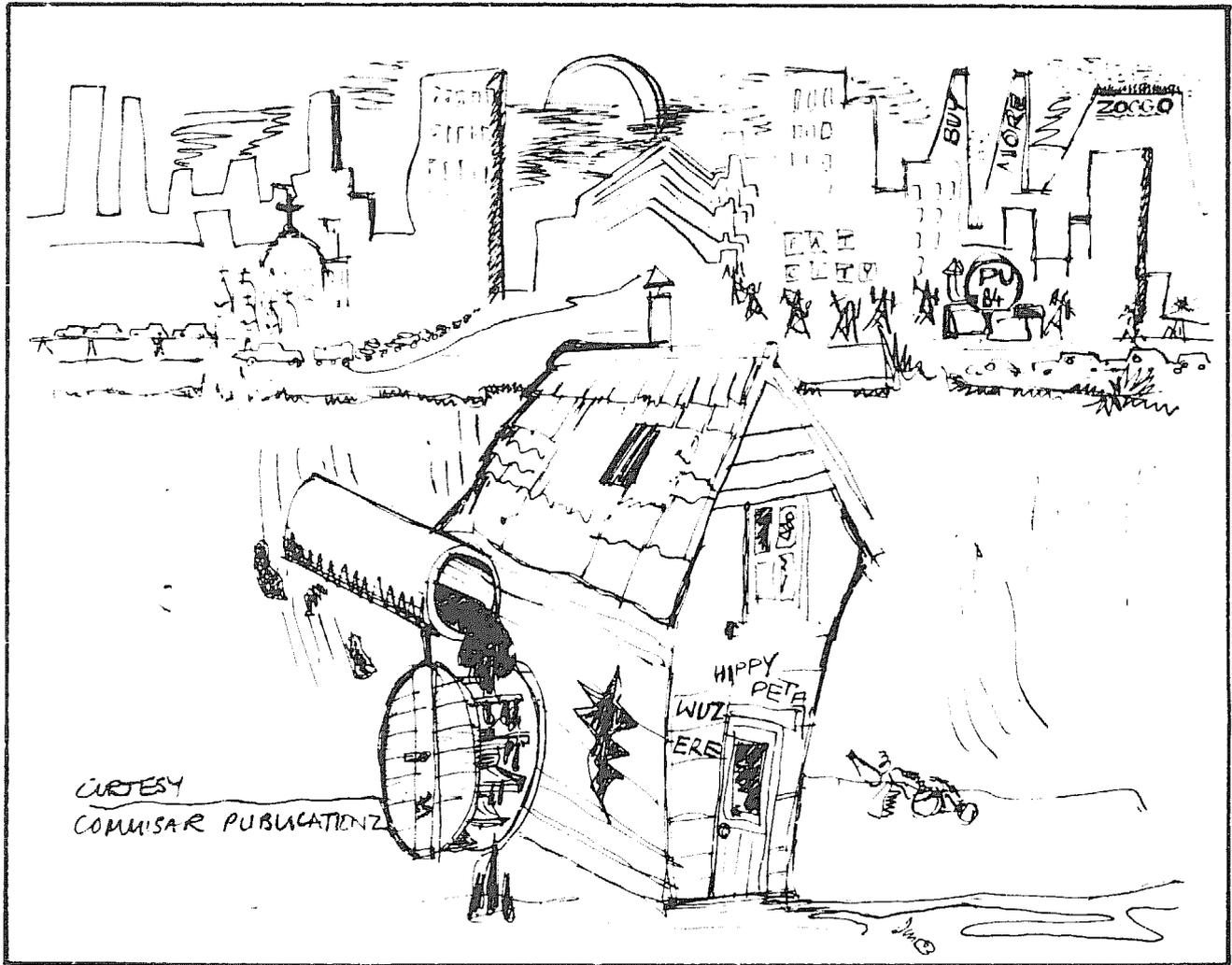
Visitors Generally – Rangers or other park personnel may from time to time require that visitors use parasols, long underwear, rubber boots, rigid headgear, crampons, snowshoes, gasmasks, or other safety equipment, as climatic and other local conditions dictate.

If the Park Service can get its big-brother safety act together, maybe Mr. Walker can accomplish his goal: "I'm not going to be satisfied with merely reducing the number of fatalities in the parks." After all, the national parks already post an enviable safety record: last year, the 298 areas in the National Park System (comprising over 30 million acres of lands and waters) racked up 211.6 million visitor-days and

only 143 fatalities. "As far as I am concerned, a single death in our parks is one death too many."

Hold on, Mr. Director, that's going too far. Your goal is an impossible dream. Even if your keepers prevent every single human visitor from fulfilling what so obviously appears to you to be their unconscious death wishes, there will still be at least one fatality. For, with the snuffing out of adventure, excitement, and exhilaration, the value of the national park visit will have died. And *that* single death will be one death too many.

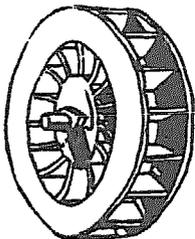
GARY SOUCIE. NOT MAN APART • APRIL 1974



CURTESY
COMMISAR PUBLICATIONZ

HAVE YOU GOT A WATERWHEEL OR WATER-DRIVEN GRAIN GRINDER?

Want repairs? Qualified Millwrights available.



A. COLMAN & P. UNWIN,
91 VICTORIA ROAD,
DISS, NORFOLK.

(East Anglia and Midland areas preferred)

Forest History



MOTHER NATURE SPENT A MILLION YEARS PUTTING UP PRESERVES FOR US—NOW LOCK AT 'EM!



Forest History Society, P.O. Box 1581, Santa Cruz, California 95061.

VOLUME 17 NUMBER 4 • JANUARY 1974

HINTS ON THE DEVELOPMENT OF SMALL WATER POWERS

This pamphlet has been prepared for those who contemplate the construction of small water power plants on small streams for the purpose of generating electric current for general home use and it is intended to convey certain information in order that the subject may be grasped by those unacquainted with the general rules and requirements for such developments.

It is generally understood by all that a flowing stream may be made to produce power, but it is not generally understood what information is required by the manufacturer of water power equipment in order that proper advice and recommendations may be given. Therefore we are outlining below the rules and requirements that must be observed when asking for information pertaining to the development of water power. We will add that the subject matter of this pamphlet applies principally to the smaller developments, but, at the same time, the same rules may be applied to the larger developments to a certain extent.

Fall or Head

In order to produce power from a flowing stream there must be a "fall" in the stream. This "fall" is almost always augmented, or increased by the construction of a dam. A dam in the stream is necessary in order to raise the water to a maximum level to create a head, and to divert the water from the stream to the turbine, or water wheel. This head that is created is the vertical distance from the surface of the water at the dam down to the surface of the water in the stream below the dam and at a point where the turbine will be located.

As the useful power that may be produced from any waterpower is the direct produce of the "head" and the weight of the water, which weighs 62.34 lbs. per cubic foot, it follows that the "head" available and the amount of water flowing in the stream in cubic feet per minute are absolute factors when it is desired to compute the amount of power that may be developed.

It will be understood that the term "fall" means the natural fall or drop in the course of a stream, and that the term "head" defines the vertical drop resulting from the construction of a dam in the stream. Please note Design 30 illustrating how this term is applied to a turbine installation.

How to Determine the "Head"

When selecting the dam site it is well to remember that the higher the dam is built the more the "head" will be, and the greater the "head" the more power a given amount of water will produce; and the smaller will be the turbine. Therefore, it is well to exercise care in the selection of the dam site so that the highest possible head may be realized. However, consideration must be given to the cost and possible damage to your neighbor's property. Usually the

topography of the ground will suggest the logical location for the dam, although there are other determining factors to be taken into consideration, such as character subjects. We will say, however, that area, etc. Space does not permit a more detailed treatment of these subjects. We will say, however, that it may be well to have an engineer or surveyor run out "contour lines" upstream from the dam site representing proposed water levels back of the dam. In this manner the flooded area may be determined before the dam is built, and serious complications avoided if such there may be.

After the height, or elevation, of the water back of the dam has been established, levels may be run downstream with an engineer's level or transit to determine the "fall" or "head" that may be secured below the dam site within a reasonable distance. It follows that the TOTAL HEAD that may be secured is that which is created by the dam plus the "fall" or "head" that may be secured below the dam. This TOTAL HEAD is represented by the VERTICAL DISTANCE from the surface of the water back of the dam down to the surface of the water below the dam and at the point where the turbine may be located.

If the developed "head" is low; that is, from a few feet up to ten to fifteen feet, the turbine is usually located right at, or very close to the dam, the water being conveyed to the turbine through an open flume or penstock. But, in some cases, where the head is not any greater than mentioned above, the turbine may be quite small and for that reason alone it might be more economical to convey the water to the turbine through a steel pipe line.

In some cases, regardless of the head secured, it is desirable to place the turbine some little distance below the dam to secure additional head due to the fall of the stream below the dam. In such cases a pipe line, or an open flume or open ditch may be used to convey the water to the turbine. However, there are cases where an open tail race may be excavated from the stream to the powerhouse to secure at least part of the fall below the dam; this being less expensive than the above mentioned pipe line or ditch.

Measurement of water flowing in the stream

The second absolute factor that determines the amount of power that may be developed is the quantity of water available for power purposes flowing in the stream. Quantity of water for power purposes should be expressed in "cubic feet per minute" (C.F.M.)

There are two well known methods of measuring streams; one by the weir method and the other by the float method. Both methods are fully described and illustrated on a leaflet attached to this pamphlet.

There are cases where it is obvious that the water supply is more than adequate for the power to be developed but in most cases it is highly important that the water be carefully measured.

It will generally be found that the flow of water in any stream will vary greatly with the season of the year and this should be taken into consideration when measurements are taken.

The minimum flow of a stream, in most cases, has a duration of several weeks during the dry season, and this flow, when taken into consideration, represents the amount of water that can be developed continuously, or 100% of the time outside of that period of time the stream may be in flood stage.

As the flow of the stream increases, the amount of power that may be developed increases, although it is true that as the flow increases the actual head on the turbine is decreased somewhat on account of a greater quantity of water being discharged into the tail race which raises the level of the water therein.

As the flow increases beyond the normal, or average stage the head is reduced still further. However, periods of high water and low head are of comparatively short duration and while this condition must be contended with, it should not be allowed to stand in the way of the development of the water power.

It is obvious that a stream should be measured at various times of the year in order that complete data on the flow be established. Daily measurements are ideal and may be made conveniently, especially if the weir method of measuring is used.

It is also obvious that any measurement taken during flood period would be of little value except that such measurements may be used to estimate the size of the flood or waste gate in the dam. It should be noted here that if the stream is subject to floods, provision must be made in the dam to allow the excess water to escape; thereby preventing damage to the dam and powerhouse structure.

Effect of Pondage

When a dam is built in a stream there is created back of the dam a pond that is really a storage reservoir that may be used to very good advantage to conserve the supply of water during times when the turbine is consuming less water than is flowing in the stream, and to supply water over and above that flowing in the stream, and to supply water over and above that flowing in the stream when it is needed. If the pond is of sufficient area the above feature is of much benefit during times when the stream is at minimum flow.

In further explanation it may be stated that the load on any plan is seldom, if ever, fixed as it may and will vary with the needs of the power consumer. For example: Let us assume that the maximum capacity of the turbine is 600 cubic feet of water per minute, and that the load on the turbine at the moment requires all of this water to develop the load. Assume also, that the flow of water in the stream at the same time is only 300 cubic feet per minute. It will be seen that the turbine will consume the 300 cubic feet of water flowing in the stream plus 300 cubic feet more per minute which will be drawn from the pond. Now assume that in a short time the load changes to the extent that the turbine only requires 100 cubic feet of water per minute. Inasmuch as there are 300 cubic feet of water flowing in the stream and the turbine only requires 100 cubic feet of it, the difference, or 200 cubic feet of water per minute, will be stored in the pond to replace that which was drawn out.

A great many water-power feed and flour mills depend a great deal on pondage as they operate during the day, drawing on the pond for excess water not supplied by the normal flow of the stream. At night they shut down and the flow of the stream refills the pond which allows them to start the next morning with a full pond.

From the above we believe it will be seen how important and necessary the pond is to the successful operation of a water power plant during times when the normal flow of the stream is not great enough to supply the maximum capacity of the turbine installed. In other words one may take advantage of the existence of a pond and install a larger turbine than he could otherwise, and, thereby, be able to carry a greater momentary, or peak load for short times.

Therefore, the area of the pond created by the dam should be given along with the information regarding the head and the quantity of water. The area of the pond may be given approximately and in terms of acres.

Estimating the power required

As this pamphlet is principally for those who desire to install water power equipment to drive generators for furnishing electric current for home and farm use, we will confine our remarks to that type of load.

It may be your wish to furnish electricity to only a small cottage, a group of cottages, a group of farm buildings, or perhaps, to a private estate including all the buildings thereon. But, whatever it is, there are certain items of information we should have to be able to advise you regarding the amount of power required to accomplish the results you desire.

A list of the total number of electrical outlets in all of the buildings should be made, and this list should include only the outlets for electric lights.

Then, in addition, list all of the electrical appliances that may be used, including heaters, flat irons, radios, television sets, electrical ranges, milking machines, cream separators, etc. With such a list at hand we can then estimate the approximate peak load that would have to be carried by the turbine and helps us to decide on the proper size of turbine and accessory equipment.

Types of Electric Generators

There are two types of electric generators that may be used, and we are referring to their electrical characteristics in this instance. One type generates Alternating Current and the other type generates Direct Current. The type to be selected depends on a number of factors which must be given consideration. Alternating Current may be transmitted much greater distances than Direct Current without undue loss and with smaller wires. Therefore, the distance from the power plant to the place where the current will be used is a very important factor and should be stated in your inquiry.

The size of the generator is another factor, but that is determined when the power of the turbine is determined, and, therefore, this will be taken into account when the recommendations are made.

The type of equipment to be operated by the electrical current is, also, a factor, and it is well to remember in this connection that any electrical apparatus having heating elements, such as light bulbs and heaters, may be operated by either Alternating or Direct Current. On the other hand, any apparatus operated by electric motors must be equipped with either Alternating Current motors or Direct Current motors as it is substantially true that it is impossible to have a motor that will operate on both A.C. and D.C. current.

If your buildings are already furnished with Alternating Current equipment it is a very deciding factor in the selection of the generator, irrespective of the distance the current must be transmitted. But, if this apparatus is yet to be purchased, consideration may be given to the selection of a Direct Current generator and equipment to suit. Direct Current generators are generally less expensive than the A.C. type, and, if wound in a certain specific manner for constant voltage, expensive governing equipment for the turbine equipment may be omitted.

For additional information on this subject please write to any of the principal electrical manufacturers, or confer with your local electrician.

Types and Styles of Turbines

The James Leffel & Company, with main office and factory located at Springfield, Ohio, having manufactured turbine water wheels since 1862, have many lines of patterns from which a selection may be made to fit practically every condition of installation. We are prepared to furnish turbines developing fractional horsepower up to thousands of horsepower, and these are made in many different styles to meet the requirements of our customers.

No inquiry is neglected regardless of the size of the equipment involved, and each and every inquiry is given prompt and careful attention. We earnestly desire that the party making inquiry correspond with us freely, and we will do everything within our power to advise and counsel him to the end that when the plant is completed it will be a thing of usefulness and not a failure. We urge you to accept our advice and suggestions BEFORE work is started. Altogether too many people have come to us for advice AFTER they have attempted to make an installation, relying on their own limited knowledge of an art that is highly specialized. They have nothing to their credit but failure, loss of time and much money which, if properly directed in the beginning, would have spelled success.

The successful completion of a waterpower plant is not a difficult problem if it is properly engineered in the beginning. If the owner will realize that the problems confronting him are of an unusual nature and that to solve them properly requires special training, he will not start construction or expend his resources without proper advice.

We have endeavored to show in this pamphlet what information we must have in order to properly advise those who are contemplating the construction of small water power plants, and, on receipt of this information, we will promptly advise the amount of power that

may be developed, together with a suggestion as to the type and size of turbine that would best suit the conditions. Quotations on the equipment will also be given at the proper time.

At this point we might describe in detail the various types and styles of turbines which we are in position to furnish, but to do so would have a tendency to confuse and we would, therefore, prefer to dwell on this matter at length after the first preliminary information is at hand which is covered in this pamphlet. We will, however, describe briefly a few of the more common types of turbines and their applications.

A turbine water wheel is a device for transforming the energy of falling water to power in a form which may be applied to the driving of machinery, electrical or otherwise. The impounded water back of the dam flows into a flume or penstock which is built into the dam, and from thence, it flows through the turbine and into what is known as a discharge pit, or tail race, eventually reaching the stream again below the dam.

A turbine may be installed in a vertical or horizontal position, but the vertical position is to be preferred as it is usually more economical and efficient. The illustrative page referred to above shows a typical, vertical, open flume turbine. When this type of turbine is installed an extension shaft is attached to the coupling on the top end of the turbine shaft, and on this extension shaft is mounted a pulley for driving a generator by means of a quarter turn belt. Necessary bearings are also mounted on this extension shaft. Examples of quarter turn belt drives may be found in our bulletin No. 38, copy of which will be sent on request.

The flume in which the turbine is installed is usually built of concrete, but sometimes wood or steel is used. An open flume or penstock is one that is open at the top to the atmosphere, and a closed flume is closed at the top which is below headwater level. In this case (closed flume) the extension turbine shaft and the gate operating shaft pass through suitable packing boxes in the top of the flume.

When turbines of small capacity are used under heads of water of about fifteen feet or more, they are often installed in steel or cast iron cases and the water is conveyed to the turbine by means of a pipe made from steel or wood.

In all cases the turbine is fitted with a set of adjustable gates of the wicket type that may be open or closed to any degree from closed position to open position, and they are located in the gate, or guide casing mentioned above. These gates are used to regulate the flow of water through the turbine runner, and thus regulate the power and speed of the turbine.

In many cases the adjustment of the turbine gates is accomplished by means of a suitable handwheel located at a convenient place in the powerhouse, and connected to the turbine gate operating mechanism by suitable shafting. In other cases the adjustment of the turbine gates is accomplished by an automatic governor, which automatically adjusts the turbine gates to maintain a constant speed on the turbine

when the load is diminishing or increasing. When used this governor is located in the powerhouse and is arranged in such a manner that the turbine gates may be operated by hand if desired.

Whether or not a governor is needed depends on the size of the turbine, type of load on the plant, type of generator used, and the desirability for good speed regulation. It is also a factor in the cost of the equipment as the governor cost is sometimes as much as that of the turbine equipment if the turbine is small. These as well as related questions are covered in detail when the quotation is made.

In instances where the turbine is installed in concrete or wooden flumes, we consider it our duty and a part of our business to furnish information showing the proper size, or the internal dimensions of such flumes, as it is of the utmost importance that these flumes be built sufficient in size to handle the water without undue loss in head. It is well to note here that the water flowing in the flume flows at a velocity determined by the size or area of the flume, and, as it requires a certain amount of head to produce a given velocity, it follows that the higher the velocity the more head is required to produce that velocity. The head is lost to the turbine and, therefore does not produce power. It is highly important, therefore, that the flume, pipe line or penstock, as well as all the water passages conveying water to the turbine be designed with ample dimensions, and we do all that is possible to see that this type of construction is carried out. But, all too frequently, we find flumes and penstocks designed and built altogether too small for the size of the turbine installed. The result is that the turbine does not operate under the head expected and the owner is sorely disappointed with the performance of the plant.

Trash Racks and Head Gates

To prevent trash and floating material from getting into the turbine and plugging up the water passages with a resultant reduction in power and efficiency, and, also, possible damage to the turbine, it is highly desirable to install at the head of the flume or penstock a suitable trash rack made from steel bars set on edge to the flow of the water and properly spaced according to the size of the turbine. It is usual to design trash racks so that the maximum water velocity does not exceed one and one-half feet per second.

Just back of the trash rack should be installed suitable head gates that may be operated easily to close the water out or the flume or penstock to allow the turbine equipment to be inspected, cleaned, or repaired as the case may be.

We manufacture both trash racks and head gate equipment and we will furnish further information regarding these items on request.

Old Water-Power Plants Remodeled

It often happens that an old, abandoned water-power plant is purchased and it is desired to have it remodeled and brought up to date. In such cases it is well for us to know this in the beginning, as we have records of many of these sites, and such information means a saving not only to the customer but to ourselves as well. Quite often existing structures may be saved, and if the old flumes or penstocks are to be used we should have full information regarding them. In most instances of this kind it is desirable to have one of our engineers visit the site in order to get first hand information and data.

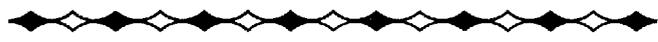
Services of an Engineer

As mentioned in the above paragraphs, we are prepared to have one of our expert engineers visit the water power site to collect the necessary information and data on existing water power structures to assist in the planning of the application of new turbine equipment. This engineer would also be competent to take measurements of the head and to go over the ground in a preliminary manner, advising to the best of his ability and experience, whether or not the project is practical.

Arrangements for the services of such an engineer may be made on written application to The James Leffel & Company, Engineering Department, Springfield, Ohio.

In Conclusion

We have discussed in a general way in this pamphlet several items of information that should be given us when inquiry is made regarding the possibilities of small water powers and, in conclusion, we will group these items in condensed form on the following page in order that they may be readily taken into consideration and proper reply made.



POWER CONVERSION MULTIPLES

kiloWatts (kW) to:—	horsepower (HP) X 1.36	BTU/second X 0.95	kCals/second 0.239	metre kilog.ams/sec X 102	foot pounds/sec X 737
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$1\text{kW} = 1.36\text{HP} = 0.95\text{BTU/sec} = 737\text{fps}$

ENERGY CONVERSION MULTIPLES

kiloWatt hour (kWh) to:—	BTU X 3412	kCals X 860	metrekilograms X 367100	footpounds X 1980000	Joules X 36000000	Calories X 860100
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$1\text{kWh} = 3412\text{BTU} = 367100\text{mkp} = 860100\text{cal}$

Body Energy required by one adult for one day: 2000 - 3000 kCals = 2.2 - 4 kWh
One gallon of petrol: 42.kWh. Year's heating, one UK house: 15,000 - 20,000 kWh

SOME MORE POWER AND ENERGY TABLES

Conversion factors for power units

To convert from a unit in column A into any unit under B, multiply by the factor given in the appropriate column under B

A		B						
		erg s ⁻¹	W	kW	mkp s ⁻¹	HP(int.)	cal ₁₅ ⁻¹	BTU _{mean} s ⁻¹
Erg per second	erg s ⁻¹	1 x 1	1 x 10 ⁻⁷	1 x 10 ⁻¹⁰	1.019716 x 10 ⁻⁸	1.359622 x 10 ⁻¹⁰	2.3892 x 10 ⁻⁸	9.4716 x 10 ⁻¹¹
Watt	W	1 x 10 ⁷	1 x 1	1 x 10 ⁻³	1.019716 x 10 ⁻¹	1.359622 x 10 ⁻³	2.3892 x 10 ⁻¹	9.4716 x 10 ⁻⁴
Kilowatt	kW	1 x 10 ¹⁰	1 x 10 ³	1 x 1	1.019716 x 10 ²	1.359622 x 1	2.3892 x 10 ²	9.4716 x 10 ⁻¹
Meter kilogram force per second	mkp s ⁻¹	9.80665 x 10 ⁷	9.80665 x 1	9.80665 x 10 ⁻³	1 x 1	1.3 x 10 ⁻²	2.3430 x 1	9.2884 x 10 ⁻³
Horsepower international	HP(int.)	7.354988 x 10 ⁹	7.354988 x 10 ²	7.354988 x 10 ⁻¹	7.5 x 10	1 x 1	1.7573 x 10 ²	6.9663 x 10 ⁻¹
15° calorie per second	cal ₁₅ ⁻¹	4.1855 x 10 ⁷	4.1855 x 1	4.1855 x 10 ⁻³	4.2680 x 10 ⁻¹	5.6907 x 10 ⁻³	1 x 1	3.6943 x 10 ⁻³
British thermal unit mean per second	BTU _{mean} s ⁻¹	1.0558 x 10 ¹⁰	1.0558 x 10 ³	1.0558 x 1	1.0766 x 10 ²	1.4355 x 1	2.5225 x 10 ²	1 x 1

Conversion factors for energy units

To convert from a unit in column A into any unit under B multiply by the factor given in the appropriate column under B

A		B								
		J	erg	kWh	HP(int.)	mkp	atm	cal ₁₅	kcal ₁₅	BTU _{mean}
Joule	J	1 x 1	1 x 10 ⁷	2.7 x 10 ⁻⁷	3.776727 x 10 ⁻⁷	1.019716 x 10 ⁻¹	9.868956 x 10 ⁻³	2.3892 x 10 ⁻¹	2.3892 x 10 ⁻⁴	9.4716 x 10 ⁻⁴
Erg	erg	1 x 10 ⁻⁷	1 x 1	2.7 x 10 ⁻¹⁴	3.776727 x 10 ⁻¹¹	1.019716 x 10 ⁻⁸	9.868956 x 10 ⁻¹⁰	2.3892 x 10 ⁻⁸	2.3892 x 10 ⁻¹¹	9.4716 x 10 ⁻¹¹
Kilowatt hour	kWh	3.6 x 10 ⁶	3.6 x 10 ¹³	1 x 1	1.359622 x 1	3.670978 x 10 ⁵	3.552824 x 10 ⁷	8.6011 x 10 ⁵	8.6011 x 10 ²	3.4098 x 10 ³
Horsepower hour(int.)	HP(int.)	2.647796 x 10 ⁶	2.647796 x 10 ¹³	7.354988 x 10 ¹	1 x 1	2.7 x 10 ⁵	2.613098 x 10 ⁴	6.3261 x 10 ⁵	6.3261 x 10 ²	2.5079 x 10 ³
Meter kilogram force	mkp	9.80665 x 10 ⁷	9.80665 x 10 ⁷	2.724069 x 10 ⁶	3.703704 x 10 ⁶	1 x 1	9.678140 x 10 ²	2.3430 x 1	2.3430 x 10 ³	9.2885 x 10 ⁻³
Liter atmosphere	atm	1.013278 x 10 ²	1.013278 x 10 ⁹	3.814662 x 10 ⁵	3.826875 x 10 ⁵	1.033256 x 10	1 x 1	2.4209 x 10	2.4209 x 10 ²	9.5974 x 10 ²
15° calorie	cal ₁₅	4.1855 x 1	4.1855 x 10 ⁷	1.626 x 10 ⁻⁶	1.5808 x 10 ⁻⁶	4.2680 x 10 ⁻¹	4.1307 x 10 ²	1 x 10 ³	1 x 10 ³	3.9643 x 10 ⁻³
15° kilogram calorie	kcal ₁₅	4.1855 x 10 ³	4.1855 x 10 ¹⁰	1.626 x 10 ⁻³	1.5808 x 10 ⁻³	4.2680 x 10 ²	4.1307 x 10	1 x 10 ³	1 x 1	3.9643 x 1
Brit. thermal unit mean	BTU _{mean}	1.0558 x 10 ³	1.0558 x 10 ¹⁰	2.9328 x 10 ⁻⁴	3.9874 x 10 ⁻⁴	1.0766 x 10 ²	1.0420 x 10	2.5225 x 10 ²	2.5225 x 10 ⁻¹	1 x 1

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Generation of Power from Ocean Waves. B. Turley. Alternative Sources of Energy No 7. Sep. 1972.
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Discovering Watermills. J. Vince. Shire 1970.

3.05 Biological Energy

Algae Man and the Environment. (Ed) D. F. Jackson, Syracuse UP 1968.
Power Gas from Sewage Sludge. Science and Culture Vol. 20 7 1955.
Methane Gas on Farm and Plantation. International Sugar Journal. 54 1952
Solution to Pollution. C. E. Burr and K. D. Gilbert. Mother Earth News, May 1970
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Micro-organisms as Allies. C. L. Duddington. Faber 1961.
Industrial Fermentation Industries. L. A. Underkofler and R. J. Hickey. Chemical Publishing Co. 1954.
Mass Cultivation of Algae. H. Tamiya. Annual Review of Plant Physiology. 8 1957.

3.10 Useful Magazines

Alternative Sources of Energy. Route No. 1 Box 36B, Minong Wisconsin 54859, USA.
Mother Earth News. PO Box 38, Madison, Ohio 44057, USA.
New Alchemy Magazine. NA Inst. PO Box 432, Woods Hole, Mass 02543, USA.
Undercurrents, 275 Finchley Road, London NW3.
Ecologist, 73 Molesworth Street, Wadebridge, Cornwall.
Peace News, Caledonian Road, London N1.
Consernus, NUS, 3 Endsleigh Street, London WC1.
Communes, 3 Russell Way, Wootton, Bedfordshire, UK.

3.11 Organisations & Groups & Companies Active in Alternative Energy Sources

Brace Research Institute, McDonald College of McGill Univ. Ste Anne de Belle vue, Que, Canada.
VITA Inc, 3706 Rhode Is Ave, Mt Rainier, MD 20822, USA.
Biotechnic Press. Box 26091, Albuquerque, NM 97125, USA.
Equality, Postfach 3413, Frankfurt/Main, West Germany.
Biotechnic Research & Development. Eithin Y Gaer, Churchstoke, Montgomeryshire, UK.
ITDG, 9 King Street, London WC2.
Survival Technology Inc, 7801 Woodmont Ave, Bethesda, MD 20014, USA.
HYDRA, Gundelingerstrasse 462, Zurich, Switzerland.
Low Impact Technology Ltd. 73, Molesworth Street, Wadebridge, Cornwall. UK.
Council for Small Inds in Rural Areas. 35 Camp Road, London SW19.
Khadi & Village Industry Comm, Vile Parle (W), Bombay 56, India.
The Homesteader, Oxford, New York 3829, USA.
Earth-Star Structures, 30 Benedict Street, Glastonbury, Somerset, UK.
Barglutli-Tribe, 3186 Dudingon. Canton Wallis, Switzerland.
INFO, 6 Bidwill Close, Yarralumla, ACT 2600, Australia.
Shelter Publications, PO Box 279, Bolinas, CAL 94924, UDA.
New Science Group, 2036 Natural Resources Bldg, Michigan Univ. Ann Arbor, MICH 48105, USA.
Compagnons du Colombier, 1274 Chene du Fleuve, Les Cedres, PQ Canada.
Trans-Atlas Ltd, 15 Duke Street, Dublin 2, Eire.
Balaju Yantra Shala Ltd, Balaju, Kathmandu, Nepal.
Dai-Dong, Koningslaan 2A, Bussum, Nederland.

MEANWHILE, AT THE FUNNY PLACE, LIFE GOES ON



WAIT TILL YOU SEE LIT'S SOLAR MANUAL -
IT'LL GET YOU HIGHER THAN THALIDOMIDE

236 COL on Ford Prefect, taxed
M.O.T. Offers over 485
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WDV 2 1957 Rover
miles. Black, tan interior.
Pristine condition. 5625.
Cheltenham 55376.

A PENSIONER'S bedsitter looked like Dracula's Castle, a policeman said yesterday.

For the old man feared that
vampires would invade his tiny
room.

And he surrounded himself
with objects to ward them off as
dusk fell.

There was garlic in the keyhole
and on the windowsill. There were
bags of salt on his pillow and
more salt sprinkled on
the blankets.

Dread

But the dread of the
legendary blood-suckers
finally killed 68-year-old
Folish immigrant Demit-
rius Myciura.

By SUN REPORTER

He went to sleep with
a clove of garlic in his
mouth and choked. Police-
constable John Pye told
an inquest at Stoke-upon-
Trent.

Pc Pye, aged 22, a
horror film fan, said he
studied a book called the
Natural History of the
Vampire.

He found that the bed-
sitter was littered with
ritual objects to drive
away vampires.

Mr Myciura, a retired
pottery worker who came
to Britain 25 years ago,
was found dead in bed.

His landlady, Mrs
Eugizig Rodazichwios, told
coroner Mr Frederic Hails:

Strange

"He thought vampires
were everywhere. He
used salt, pepper and gar-
lic to keep them away."

Mr Hails said: "This is
a very strange case."
Verdict: Accident

YAK
YAK

In Sweden, famed Israeli spoon-
bender Uri Geller has had a
paternity suit filed against him
by a young blonde mother. The
girl does not claim that Mr
Geller is her baby's father. But
she says that his magical bending
powers so altered her contra-
ceptive loop that it became in-
operable. She has produced the
twisted loop in evidence.

A BLACK youth leader from
South-West Africa will go on
trial in Windhoek next month
charged with causing malicious
damage to property - scratching
slogans on the wall of his cell
while held in solitary confine-
ment during five months of
detention without trial under
South Africa's anti-terrorism
laws. Thomas Ndalikutala Komati
22, of the South-West Africa
People's Organisation Youth
league, used a spoon to scratch
political slogans.

Mr. Komati, detained from
January 31 until June 11, has
been charged only with malicious
damage. He originally pleaded
guilty, but in court last week
sought to change his plea to not
guilty on the ground that he had
suffered temporary insanity
following hallucinations during
solitary confinement. He said he
had found himself talking with
some friends who appeared to be
in the cell with him, and he
scratched the slogans during one
of these "visitations". However,
the judge rejected the not guilty
plea.

CHECK OUT

The silliest foreign
story as yet is being enjoyed in
Katmandu. It is headlined: "Girl
Says I was Knocked Out By Yeti."

The girl, 19 year old yak herder
Lakpa Sherpani, said that the
incident occurred in the Khonar
area near Everest. Miss Sherpani
described the yeti as four feet
tall, with thick black hair below
the waist and brownish hair
above. After striking her several
blows, it attacked her grazing
yaks and killed five by twisting
their horns.

YUK YUK

The
funeral of His Most Gracious
Majesty the Lord Grimsby of
Katmandu took place in Lan-
cashire recently, after a lying in
state on a silken bed that lasted
three weeks. The casket was
covered with 1,000 carnations. A
funeral oration of poems by
Shelley and Wordsworth was
read. At £1,500, this was per-
haps the most expensive funeral
a parrot has ever had.

Said the owner, David Bates,
of Preston: "The lying in state
was just like that of Queen
Victoria. He had a diamond ring
on his beak, his favourite piece
of jewellery, and a little crown
on his head. There were silver
candelabra, palm leaves and
other things around him."

