matters arising

Energy analysis of wave-power and wind-power systems

MUSGROVE¹ paints a depressing picture of the energy analysis of wave power but seems to have largely overlooked the literature on its progress^{2,3}. The model tested by Swift-Hook *et al.*⁴ was of amateur construction as I can personally vouch. Since then the generous support of the Department of Industry has allowed developments which point to an optimum duck diameter of about 15 m instead of the 50 m suggested by Denton *et al.*⁵. This reduces the displacement to 200 tonnes per metre instead of the 2,000 quoted by Musgrove.

There is a further respect in which Musgrove's analysis is incorrect. He assumes that we intend to use steel, but the high energy content of steel is a strong incentive to use as little of it as possible. Concrete requires only one seventh of the energy of steel⁶ and it is suitable for much of the structure.

I am keenly aware of the many difficulties facing wave power and so I am hesitant to accept his prediction that (with correct input data) the energy repayment period will be 16 years divided by 70 which is eighty or ninety days.

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¹ Musgrove, P. J., *Nature*, **262**, 206 (1976).

² Salter, S. H., *et al.*, *The Naval Architect*, **1**, 21–24 (1976).

³ Salter, S. H., *et al.*, *Proc. 'Energy from the Oceans' Conference, Raleigh, North Carolina. Report No. 76-1 UNC-SG-76-04*, 5–8 (1976).

⁴ Swift-Hook, D. T., *et al.*, *Nature*, **254**, 504–506 (1975).

⁵ Denton, J. D., *et al.*, *CEGB Res.*, **2**, 28–40 (1975).

⁶ Chapman, P. F., *Energy Policy*, **3**, 47–56 (1975).

MUSGROVE REPLIES—In my recent letter¹ I estimated that the energy recovery period of a rocking float wave power system would be about 16 years. Salter believes that this may be greatly reduced. In particular he suggests that reducing the diameter from about 50 m to about 15 m will reduce the energy recovery period by a factor of ten; the use of concrete instead of steel will then, he suggests, reduce the energy

recovery period by a further factor of 7.

My original letter did consider the effect of reducing the diameter of rocking float systems but, as I pointed out, reduced diameter gives reduced efficiency and an increased ratio of structure weight to displacement; the gain is therefore appreciably less than Salter suggests. Moreover, the simple calculation, which in my letter gave an energy recovery period of 16 years, was based on a wave power system sited at Station India, 700 km out in the

that of steel, but no one has yet built a concrete supertanker. I sincerely hope that the use of concrete will allow a seven-fold reduction in the energy recovery period of rocking float wave power systems. However, even if this can be achieved, it should be recognised that wind power systems have the potential to provide as much energy as wave power systems, and present much less formidable development problems.

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¹ Musgrove, P. J., *Nature*, **262**, 206–207 (1976).

² Denton, J. D., *et al.*, *CEGB Res.*, **2**, 28–40 (1975).

[Power outputs for different sizes of installation have been given by Mollison *et al.* in *Nature*, Vol. 263, pp. 223–236, September 16, 1976. Ed.]

Use of mechanical barriers instead of guard rows in field experiments

A TECHNIQUE in which vertical strips of Vinyl copolymer foil were used to separate experimental plots in a large field experiment on fruit trees was reported in *Nature* in 1962¹. The experiment, involving different water and nitrogen regimes, reached a successful conclusion in 1975, and during 1976 an examination was made of the foil and of the behaviour of the roots when they encountered it. The foil was intended to serve as a barrier to root extension across plot boundaries in place of guard rows of trees. This was achieved surprisingly well; roots were contained without any penetration of the foil and remained at the depth at which they had met the barrier and turned.

Since the barriers were laid to a depth of 0.86 m, root exploration downwards might have led to serious poaching from adjacent plots. However, this does not appear to have occurred even after 15 years.

In this experiment the need for 4.4 ha of land with guard trees was reduced to 1.9 ha; this saving of experimental land together with greatly reduced risks of inter-plot variability and the satisfactory containment of treat-

Matters arising

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Atlantic, where the annual average power flux is 77 kW m⁻¹. A more typical location is Seven Stones, off Land's End, where the annual average power flux is 26 kW m⁻¹. At this location a 50 m diameter rocking float system would have an energy recovery period of approximately 47 years, and lack of alignment between the wave power system and the incident waves will tend to increase this figure. Reduced diameter does however give some reduction in the energy recovery period and hence I concluded that overall one could expect to achieve an energy recovery period of about 16 years.

This estimate does assume steel construction, consistent with the assumption, made by Denton *et al.*², that the cost per unit displacement of rocking float wave power systems will be comparable with that of existing supertankers. The specific energy content of concrete is, I agree, much lower than