Letters

Atmospheric Sulfur

Hanley's letter (22 Oct., p. 360) seems to lament the loss to crops of atmospheric sulfur if low-sulfur gas and fuel oil are used. He neglects to point out, as have Bormann and Likens (*1*), that atmospheric sulfates, which originate largely from industrial activities, are a major cause of the leaching of nutrient ions from the soils of forest ecosystems. The "million of tons of sulfur that are released into the atmosphere annually," even when considered by themselves, would not appear to be an unmitigated blessing.

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Reference

1. F. H. Bormann and G. E. Likens, *Sci. Amer.* **223**, 92 (October 1970).

Kinetic Energy: Saltation

I am not sure whether W. F. Tanner's report "Net kinetic energy in littoral transport" (18 June, p. 1231) is meant to be taken literally. Let me point out a few incongruities:

1) Kinetic energy is a measure of a body's capacity to perform work by virtue of its possessing mass and velocity. The work done cannot be estimated by inserting the mass moved and its average velocity over a long period of time into the kinetic energy equation. Even if the motion were steady, this would simply be a measure of the kinetic energy imparted, not expended. In the case of unsteady or intermittent motion, this method of calculation is even more erroneous.

2) The figures quoted in the report indicate that the maximum "energy" estimated for a single cell (length between 5 and 25 kilometers) was approximately 3×10^6 ergs over a period of 68 years. According to my calculations, this is approximately the amount of energy required to lift a mass of 1 kilogram through a height of 3 centimeters. I imagine it might be expended by an energetic crab in the course of a few days.

In the same issue of *Science*, the same writer states in a review of Graf's *Hydraulics of Sediment Transport* (p. 1228) that "saltation is unimportant in water, a fact overlooked by many a textbook writer." This may be true if saltation is defined as the special type of impact saltation first described by Bagnold with reference to wind action on sand. However, both the American Society of Civil Engineers' *Nomenclature for Hydraulics* (*1*) and the American Geological Institute's *Dictionary of Geological Terms* (*2*) define saltation in a more general way, consonant with its Latin root, to mean simply an intermittent jumping of sediment. This is a very common and important form of stream-bed movement—so much so that the derivation of H. A. Einstein's bed-load function depends on a certain assumption about the average length of jump.

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References

1. *Nomenclature for Hydraulics* (Manual on Engineering Practice No. 43, American Society of Civil Engineers, New York, 1962).
2. American Geological Institute, *Dictionary of Geological Terms* (Doubleday, New York, 1962).

The total wave energy for a cell that was studied along the Gulf of Mexico coast of Florida (over a period of about 70 years) was estimated to be about 5×10^{22} ergs. Surf energy was estimated to be about 16 percent of this, or 8×10^{21} ergs. The rest of the energy was used in frictional losses and sediment shuffling. Most of the sediment shuffling, however, was bidirectional (that is, along the coast in one direction, then along the coast in the opposite direction); it is, therefore, not pertinent to the net unidirectional transport of sand, which is important in beach erosion.

Three different methods of estimating the net unidirectional work done in the movement of sediment produce a result of roughly 10^{19} ergs for the study period. From these estimates it can be seen that about 2 percent of 1 percent of the total wave energy in the system was used in net unidirectional transport of sand. The figures in my report represent reasonably precise long-term measurements, not estimates. They are many orders of magnitude lower than the available estimates because they do not include repeated grain accelerations, which cannot be measured in a net sense. The measurements in my report were carefully labeled in terms of net kinetic energy.

Both definitions of saltation that are cited by Neill have been in common use and describe two quite different processes; I prefer to use the term to mean the carefully defined systematic process outlined by Bagnold, rather than the older, less specific concept, which implies (for many persons) an impact-ejection mechanism under water.

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New Science

Pearlman's letter (25 June, p. 1293) perpetrates a popular misconception that scientists seem determined not to correct, which is that only applied research is relevant. On the contrary, to solve our technological problems we need new science, and this can come only from basic research.

As an engineer, I cannot understand why scientists visualize our technological future only in terms of prodigious engineering developments based on yesterday's science, with the implicit assumption that science will do nothing in the future that is relevant to our needs. The subject of fusion power is an excellent example. The engineering problems that must be solved in order to achieve fusion power are formidable indeed, and the most optimistic forecasts do not see their solution in less than 20 years. In all the discussions I have seen on this subject, no scientist has mentioned the possibility that the next 20 years will bring new scientific knowledge that will enable us to convert mass into energy without having to conjure up and contain a major catastrophe.

Since scientists are so free with their predictions about what the engineers will be doing, I don't mind telling scientists that I think they will develop useful new knowledge; astronomy, par-