correspondence

Electrostatic energy storage

SIR,—With shortages of oil and petrol clearly facing us, it is time to consider all other ways of storing energy effectively. Although leading possibilities for automotive use include advanced electric batteries and specially designed flywheels, the search for materials (particularly polymers) with high dielectric strength and static dielectric constant must not be overlooked; it might lead to economically attractive electrostatic storage systems.

The efficiency in converting the stored electric energy to mechanical energy to turn wheels can confidently be expected to be very high—close to 90%. This means that substantially less energy (about 1/7) need be stored in a vehicle for range, speed and acceleration on a par with a petrol-burning system. There is no exhaust to pollute the air and even thermal pollution by wasted heat is reduced by a factor of 9 or so at the vehicle. Recharging can be done more rapidly and efficiently than conventional battery charging: a few minutes should suffice at a service station equipped with suitable rectifying equipment and electricity supply lines of industrial capacity. Alternatively, the domestic electricity supply is generally adequate for overnight charging. With programmed parallel–series switching the variation in operating voltage can be kept modest and the extraction of stored energy can be made nearly complete.

The stored energy density in a sheet of dielectric can be expressed as

$$D = 0.4427 \times 10^6 Ka^2$$

with D in kJ m^{-3} and a in V Å^{-1}; K is the low frequency dielectric constant. Many commonly used capacitor dielectrics have dielectric constants below 10, corresponding to strong ionic or more often to non-polar interatomic bonds. A class of metal titanate ceramics, however, has dielectric constants up to 12,000. But the dielectric strength is the more critical parameter and is sharply reduced by various impurities. In paper-thin sheets, appropriate to capacitor construction, high purity can be achieved in mica ($a \simeq 0.022$) and organic polymers ($a \lesssim 0.028$).

Applying the energy storage formula for mica with a dielectric constant of ~ 5 to 7, we might expect a storage capacity of 1,000–1,500 kJ per m^3 of mica. Commercial energy storage capacitors are listed up to 600 kJ m^{-3}, based on a waxed paper dielectric, so this level of energy density is close to commercial practice. Recognising that there will be some additional volume required for the thin electrodes and an outer casing, a comparable organic polymer capacitor should have approximately the density of water, and thus an energy density of 1–2 kJ kg^{-1}.

If we take the lead-acid storage battery, at 44 kJ kg^{-1}, as an aiming point, we would need to develop a material with the dielectric strength of the best plastic, incorporating enough polarisable sites to raise the dielectric constant above 130. This is a reasonable aim in economic terms as the lead-acid battery is already marginally adequate for electric cars and trucks.

A further discussion of promising materials and ideas for study has been prepared (ORNL Report TM-29, June 1976).

Yours faithfully,

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Electrostatic energy discharge from humans

SIR,—The amount of electrostatic energy which can be stored in the capacitance represented by the human body does not appear to have been measured and reported in the literature. Besides being of phenomenological interest, this measurement could be important when considering the explosion hazard represented by anaesthetics and antiseptics when used in close proximity to electrostatically charged humans, such as in operating theatres and intensive care areas. In this regard, it has been suggested that ether vapour will explode when subjected to an electrostatic energy as small as 200 μjoules in magnitude.

An appreciation for the magnitude of the electrostatic voltage which the human body can be charged to; the capacitance represented by the human form; and the electrostatic energy stored by humans, can be obtained by discharging the body through a known resistance, and displaying the discharge curve on a storage oscilloscope.

The results obtained indicate that the electrostatic energy which the human body can store, and consequently dissipate, is in the order of 6.46 ± 3.26 millijoules. The capacitance of the body is 65.9 ± 12.1 pf, and the electrostatic voltages which the body can be charged to is $13{,}802 \pm 4{,}443$ volts. These measurements could be valuable when considering the role that the human body plays in the causing of explosions of volatile chemicals in hospital and industrial environments.

Yours faithfully,

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Competition 8

Du Pont's notepaper has "There's a world of things we're doing something about" imprinted on it, and the slogan for Rockwell International is "Where science gets down to business".

A prize of £10 is offered for the best one-sentence slogan (preferably tongue in cheek) for your (or anyone else's) laboratory, business or university. The closing date for entries is August 31.

Competition 7 requested a modern headline for a scientific achievement, and there was a large entry, on fairly predictable themes. A. L. Mackay (London) receives honourable mention for "Prominent philosopher in public bath scandal". The £10 prize is shared equally between P. J. Fallon (London), for "Role of Earth probed by Pole", and C. F. Hammer (Wilmington, Delaware), whose "Bell discovers new use for wooden poles—wires to carry conversation over distances" seemed just right for the *New York Times*.