Letters

The Pacer Plan

The Research News article by William D. Metz (11 Apr., p. 136) about the Pacer concept for fusion power can lead one to conclude that the use of thermonuclear explosions to produce power is an old, unsound idea that keeps being revived for no good reason and discarded. This impression should be corrected.

It is true that the idea is old, having been introduced at the first Plowshare symposium in 1957 by William Brobeck. After investigation, it was discarded at that time for what were thought to be sound technical arguments concerning the feasibility of constructing large underground cavities that would be stable under the influence of repeated explosions. However, the only resurrection of the idea that we are aware of is the proposal by R & D Associates in 1972. The principal omission in the *Science* article is in not explaining why the idea was revived in view of its earlier rejection.

The reason for the revival is that in the years between 1957 and 1972 a better understanding was gained of the response of large underground cavities to the environment produced by nuclear explosions. In connection with nuclear test ban considerations, it was shown by theoretical arguments (*1*) that the seismic signal from an explosion would be reduced (decoupled) by a factor of about 200 if the explosion was conducted in a cavity whose walls responded only in the elastic range. To achieve elastic response in an underground medium of low tensile strength, the essential condition is that the cavity must be large enough and buried deeply enough so that the walls are always under compressive loading from the overlying earth, even during reflection of the shock wave. This "prestressing" prevents tensile forces from developing and cracks or spalls from occurring, and it decouples the seismic signal. The use of salt deposits as a pure, semiplastic, self-sealing medium is also an important aspect. Together these two factors make for a containment that is inherently leakproof and has no known failure modes. In contrast, these factors were not understood when the earlier concept was proposed in 1957.

The Cowboy series of high-explosive experiments conducted in the Winfield Salt Mine during 1960 verified the essential concepts of decoupling, and subsequently, a nuclear test series—Salmon and Sterling—verified the concept for nuclear explosions. These tests also provided strong experimental support for the feasibility of the Pacer concept. The first test explosion took place in a salt dome without a surrounding cavity. It created an almost spherical standing cavity in the salt, which did not leak or collapse, although it had been formed by violent motion. This same cavity was then used for containment of a second explosion, which produced no adverse effect on the walls and demonstrated the decoupling and containment concept.

Another important contribution to Pacer was the 1970 Payette engineering study (*2*) sponsored by the Defense Advanced Research Projects Agency. This study concluded that cavities of the size needed for the Pacer program could be constructed economically and would be stable. Finally, we find that the petroleum industry routinely uses large cavities in salt for storage of oil and natural gas. Hundreds of such cavities are in daily use; one of the largest—at Brazoria, Texas—is considerably larger than a proposed Pacer cavity and has been in service for 17 years. Thus, several important advances of knowledge led to the proposal in 1972 by R & D Associates and to the association with Los Alamos Scientific Laboratory for further investigation of the Pacer concept.

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2. *Project PAYETTE, Final Summary Report: On the Feasibility of Constructing a Large Underground Chamber for Clandestine Nuclear Testing* (Prepared by Fenix & Scisson, Tulsa, Okla., 1970).

The *Science* article noted that R & D Associates (RDA) revived the Pacer idea, that Albert Latter, president of RDA, was responsible for work that led to the proof of decoupling in large underground cavities, and that the firm was familiar with the feasibility of building such cavities. Although no damage may have been done to the walls of the cavity formed in the Salmon-Sterling experiments, there was some deterioration of the roof, attributed by Pacer Investigators to the particular methods of the test.—W.D.M.

Reply to a Critical Dog

Shades of Aesop and Uncle Remus! Miller, Andresen, and I (Letters, 1 Nov. 1974, p. 394) are being hounded by a speaking dog (Letters, 17 Jan., p. 113) for barking up the wrong tree and bitching. We are accused of hatred of his species and failure to present facts. We do not hate dogs. What we object to is the person who takes no responsibility for the dogs in his ménage.

So far as facts are concerned, our critic—introduced as an avid reader of *Science*—says nothing about the very convincing guest editorial by Feldman (13 Sept. 1974, p. 903) that started the whole discussion. As to whether facts are absent from our letters, I am content to refer readers to the letters themselves.

But there may be times when facts, as Disraeli said of flattery, must be laid on with a trowel. An article in *Ohio Farmer* (*1*) identifies ponies, steers, pigs, sheep, poultry, and people as victims of dog packs. It also reports that the sheep population in eight Ohio counties dropped from 760,000 in 1940 to 131,000 in 1970, and income from sheep during the same period dropped from $7.5 million to $2.75 million. The article cites dog damage as a major reason and includes a photograph from the Newark *Advocate* showing the bodies of 177 sheep and two dogs caught *flagrante delicto*.

At a recent meeting here in Taos County, New Mexico, two farmers told of being forced out of the sheep business by their neighbors' dogs; another reported that dogs burrowed under the fence of his sheepfold to make a kill.

Yet emphasis on the coyote as the chief culprit persists. In three recent reports on predation (*2–4*) the dog is mentioned twice, but otherwise ignored. This may be due to the fact that the studies were made in range country rather than in suburban environments, where surplus dogs are numerous. Coyotes may well prefer lamb to their usual diet of rodents, insects, and

fruits. To what extent they kill more than they eat, as dogs do, is less clear. Lorenzo (*3*) reports that 53 of 116 lamb deaths examined on a large ranch in New Mexico were due to predators, with coyotes causing three-fourths of the predator deaths. He found no evidence of dog predation, but comparison of photographs in the Four Corners report (*4*) and the *Ohio Farmer* article (*1*) shows that injury from the two sources can be quite similar.

The practice of shooting stray dogs on sight is growing. Often this merely maims the animal and is certainly an injustice to dogs that are not killers. Tighter regulations, strictly enforced, and the spaying of female dogs not used for breeding purposes, are imperative. So is more accurate knowledge than is available at the present time.

Both dog and sheep are virtual symbionts with man. One has been his companion, guardian, servant, and friend; the other, a source of food, wool, and a material essential to the music of Kreisler and Casals. It is ironic that man has not yet been able to reconcile the management of these two animals.

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4. J. A. Bennett *et al.*, *Predator Control Study: Final Report to the Four Corners Regional Commission* (Utah State Univ. Press, Logan, 1973).

Ultraviolet Viewer

Our recent reports on ultraviolet patterns on flowers and butterflies (*1*, *2*) have generated frequent inquiries about the techniques that we use for rendering these ordinarily invisible patterns visible to humans. As previously described (*2*), a television camera equipped with an ultraviolet transmitting lens and filter can serve for direct examination of these patterns, which appear as black and white images on the monitor of the camera. Conventional portable video systems, suitable for field use, include both camera and tape recorder. For investigators interested merely in viewing the images, rather than in recording them, the recorder constitutes an unnecessary burden. It is heavy, consumes battery power, and is useful only as it provides a housing for the batteries. We have found that a convenient ultraviolet viewer can be made simply by mounting a battery

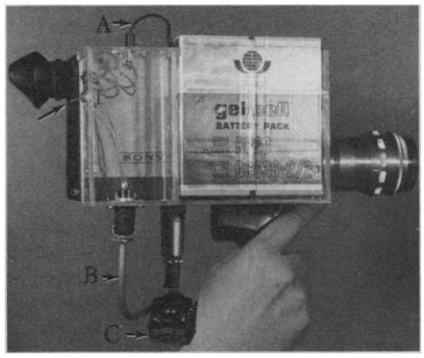

Fig. 1. Television camera (Sony DVC-2400), with attached plastic housing containing battery pack (12 VDC battery from Sony AV-3400 Videocorder). Connection of battery leads (*A*) to camera cable (*B*) is made through plastic housing, where one of the leads is provided with a switch (arrow). A light-emitting diode above switch gives on-off indication. Optional connection to external monitor is possible through plug (*C*).

power source directly on a portable video camera, which can then be used by itself.

For our purposes we use Sony portable video cameras (models AVC-3400 and DVC-2400). The batteries (Sony BP20), together with associated electrical hardware, are enclosed in a fabricated box mounted directly on the housing of the camera. The resulting self-contained ultraviolet viewer is compact and manageably light in weight (Fig. 1). Resolution on the camera's monitor decreases with the uncoupling of the recorder, but image quality is acceptable and full resolution can be restored if desired (*3*). Without the recorder power consumption is markedly reduced (a fully charged battery provides upward of 2 hours of viewing) (*4*).

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References and Notes

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2. T. Eisner, R. E. Silberglied, D. Aneshansley, J. E. Carrel, H. C. Howland, *ibid.* **166**, 1172 (1969).
3. The camera's vertical and horizontal deflection circuits use free-running oscillators locked into fixed-phase relationship by synchronization pulses from the recorder that effect a scanning system having 2:1 interlace. Without this synchronization each scan is independent, and the vertical resolution is half that of the interlaced frame. Interlace can be restored with an oscillator and appropriate divider circuits, which can be mounted with the battery pack on the camera housing.
4. Our Sony equipment was bought before the "Save the Whales" boycott went into effect.