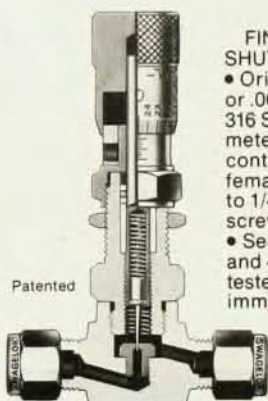


## METERING VALVES

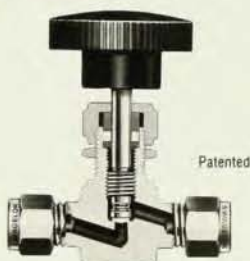


**FINE METERING PLUS SHUT OFF CAPABILITY**  
 • Orifice sizes .020 ( $C_v = .007$ ), or .062 ( $C_v = .04$ ) • Brass or 316 SS construction • Micro-meter handle for exacting control • **SWAGELOK** and female NPT end connections to 1/4" • Union bonnet or screwed bonnet design  
 • Service ratings to 5000 psi and 450°F • 100% factory tested • Stocked locally for immediate delivery.

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## FORGED BODY REGULATING AND SHUT-OFF VALVES

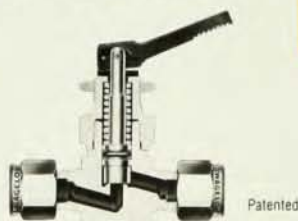


**VERSATILITY TO MATCH EXACTING REQUIREMENTS**  
 • Vee, Kel-F or regulating stem tips • Flow capacities of  $C_v = .09$  to 1.8 (20:1 range) • Choice of brass, carbon steel, 316 SS, aluminum and Monel • **SWAGELOK** or pipe end connections • Globe, angle and cross patterns  
 • Pressures from vacuum to 3000 psi • Temperatures to 450°F • 100% factory tested • Stocked locally for immediate delivery.

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## TOGGLE OPERATED VALVES



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**SWAGELOK** and NPT end connections in a variety of materials • 100% factory tested • Stocked locally for immediate delivery.

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## letters

tion of the easily observed and quite tangible water waves is transposed to the invisible, intangible "ayr," and thus provides a theory of the propagation of sound. This is the kind of mental juggling which was later to make Kelvin famous, when he perceived the analogy between the equations of electrostatics and those of heat flow!

And what are we to make of the "pure kynde" of line 43? A sinusoidal wave? An inkling of Fourier's Theorem?

NEIL ISENER

KEN WOOLNER

University of Waterloo

Waterloo, Ontario, Canada

1/23/80

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## Solar cell

In response to the article "Solar Photovoltaic Energy" (September, page 25). I would like to comment on the statement "The development of other junction configurations such as the vertical multijunction . . . , has been pushed forward rapidly."

There are several different vertical multijunction (VMJ) solar cell configurations. The "etched" VMJ solar cell, being developed by the Air Force as a radiation tolerant device for space applications, is well funded and being pushed rapidly. However, it is not considered a viable candidate for terrestrial applications because of its fabrication cost factors and since it offers little advantage for sunlight concentrator applications.<sup>1</sup> On the other hand, the "laminated" or edge-illuminated VMJ solar cell is certainly a viable contender for large-scale terrestrial application, but funds have not been made available for its development. Thus, unfortunately, it is *not* being pushed forward rapidly, as stated in the article.

The edge-illuminated VMJ solar cell consists of an integrally bonded stack of silicon P<sup>+</sup>NN<sup>+</sup> unit cells connected in series, which provides a high-voltage low-current characteristic. Illumination is parallel to the plane of each vertical junction. This structure eliminates the major problems encountered with conventional solar cell structures for concentrator applications.<sup>2,3</sup> Briefly, in comparison, there is no grid to block illumination, there is an improved spectral response in both the uv and ir regions and, most importantly, there is no series resistance problem with its structure.

Studies show that the edge-illuminated VMJ solar cell has the highest inherent efficiency (30% at 1000 Suns intensity) of any silicon concentrator solar cell.<sup>4</sup> To date, tests with unit cells have demon-

strated efficiencies of the order of 20% at 800 Suns intensity.<sup>5</sup> These unit cells were not optimized and were without anti-reflection coatings but, nevertheless, suggest that silicon VMJ solar cells may be designed to operate efficiently at intensities up to 1000 Suns.

The cost effectiveness of the VMJ solar cells in total energy concentrator systems has also been discussed in the literature.<sup>6</sup> Achieving DOE's 1986 Photovoltaic Program Goals, of a cost of less than \$500/kWe peak with an annual production level of more than 500 MWe average, could be accomplished with such systems. This would be possible with today's silicon cost using only a few percent of the current single-crystal silicon supply and with no major industrial impact.

There is no doubt that the edge-illuminated VMJ solar cell should be a viable candidate for large-scale terrestrial applications. It certainly warrants funding so that its development can be pushed forward rapidly as the "Solar Photovoltaic Energy" article assumes.

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BERNARD L. SATER  
Olmsted Falls, Ohio

11/20/79

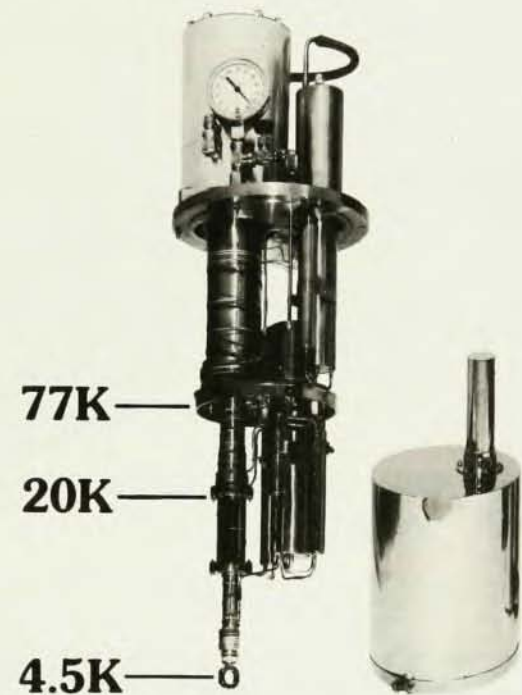
DC solar electricity

While I welcome the APS study on solar photovoltaic energy conversion as providing some needed quantitative inputs in this field (5 September, page 25), I think the conventional grid-connected orientation of the study requires some comment.

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