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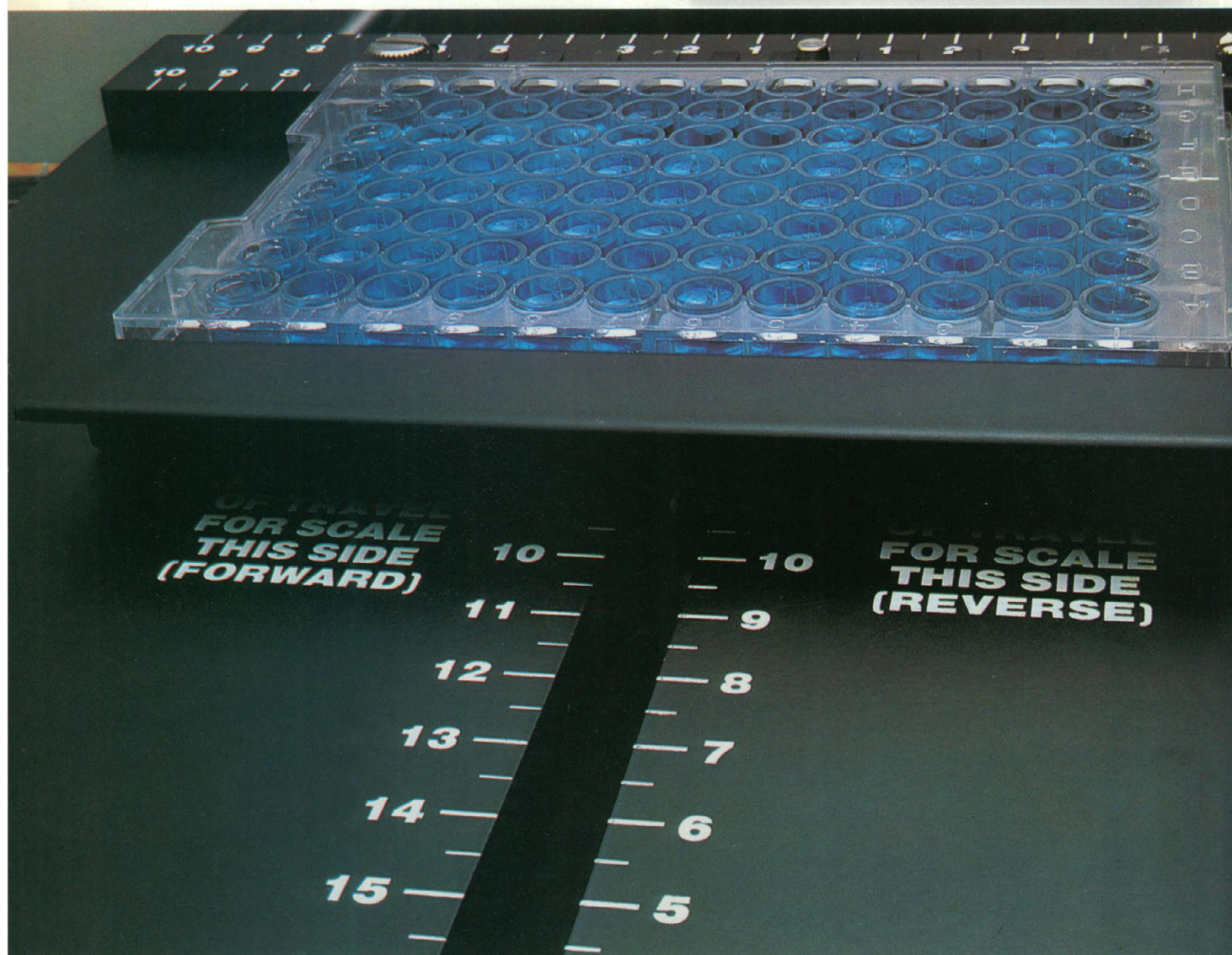
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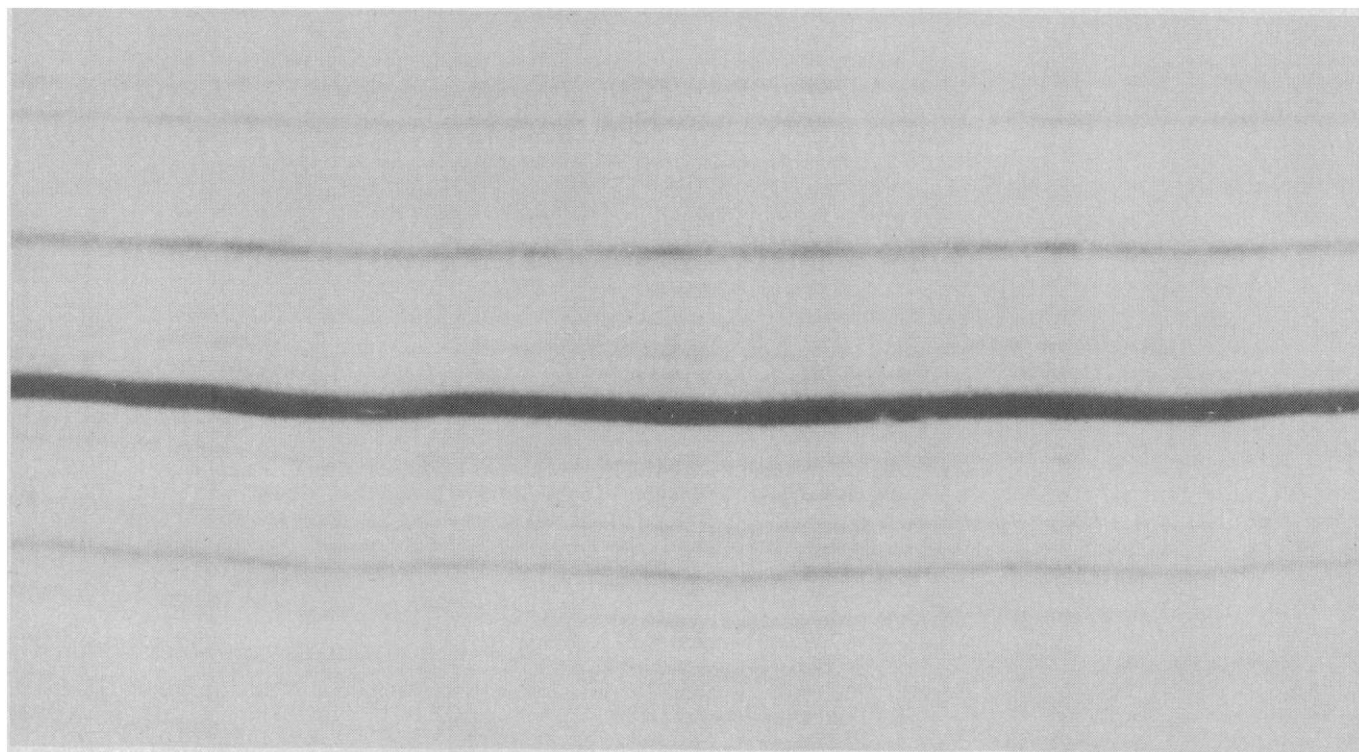
Columbia River Gorge as seen near Crown Point. See page 913. [Photograph courtesy of the Oregon State Highway Department]

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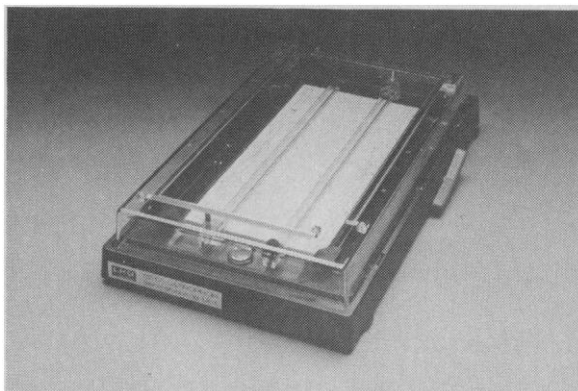
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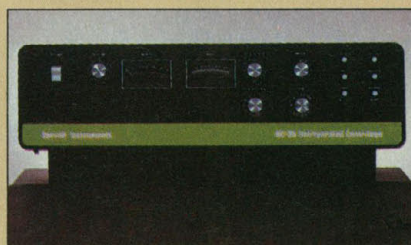


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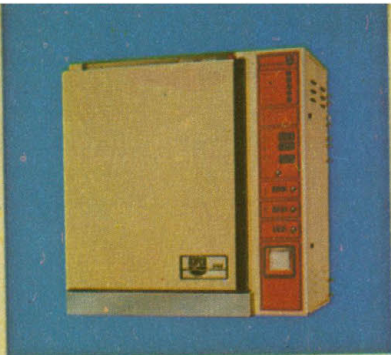
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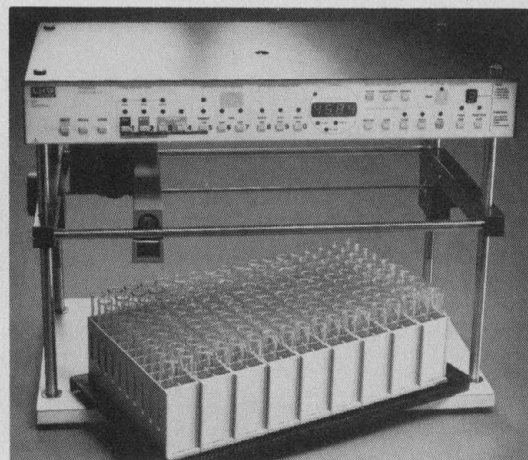
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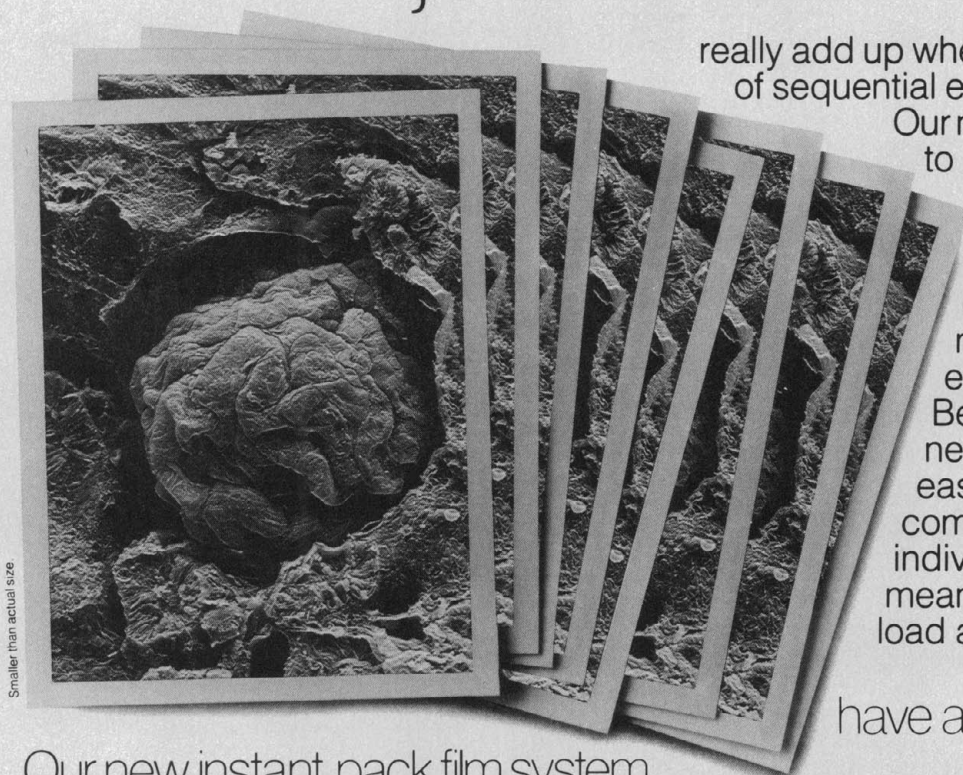
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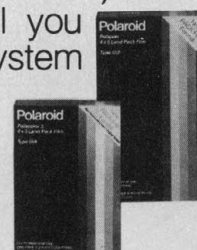
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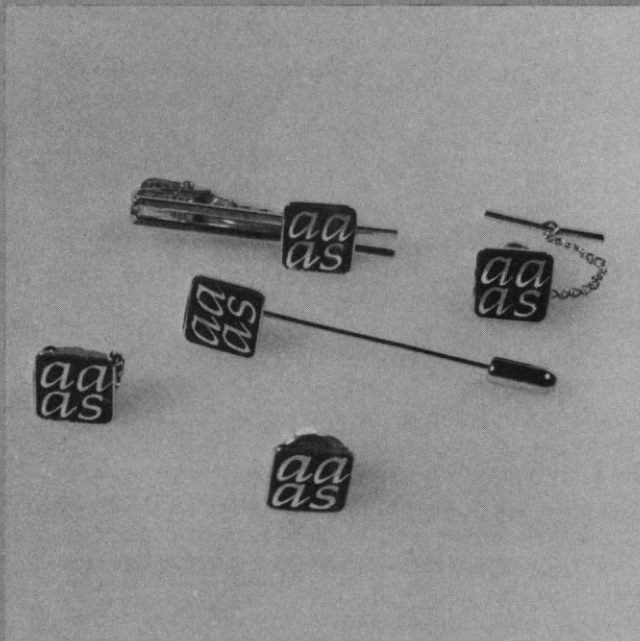
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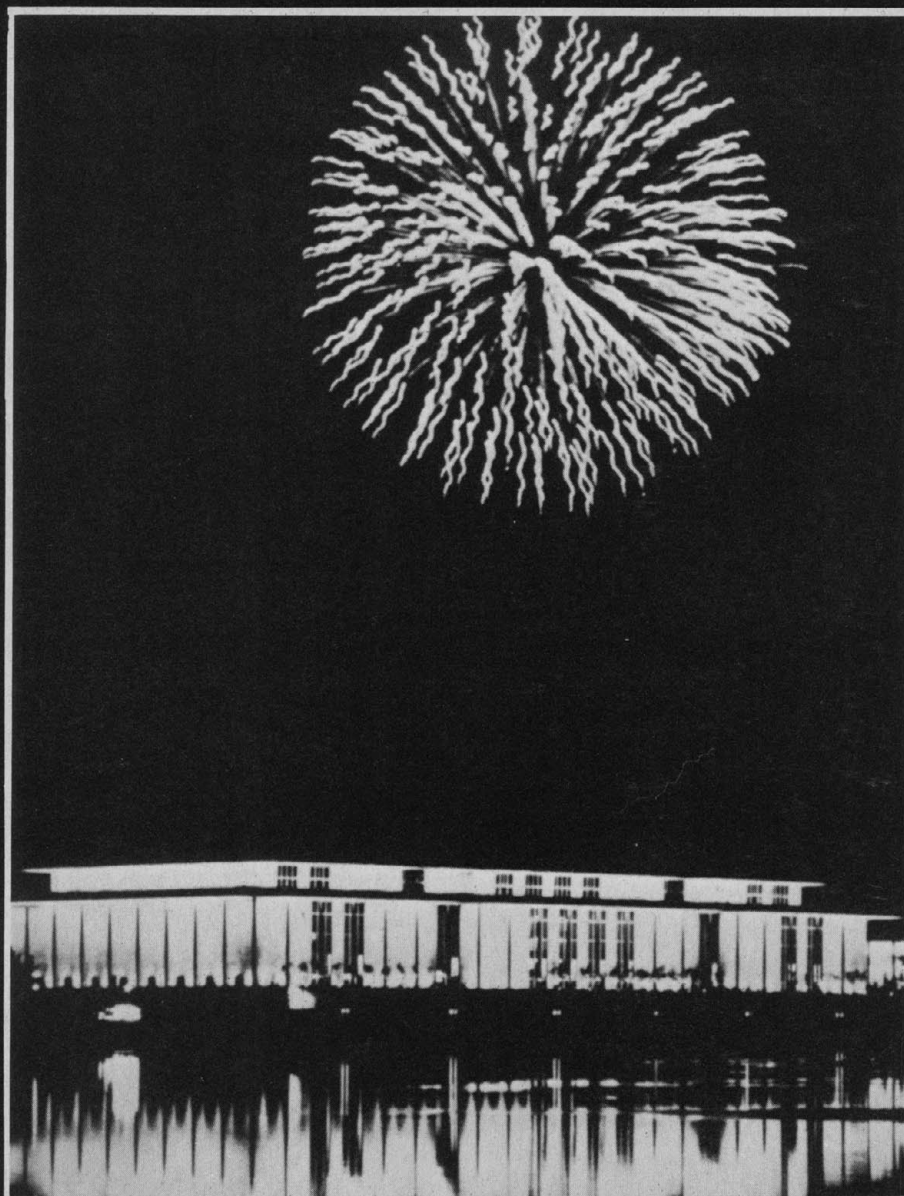
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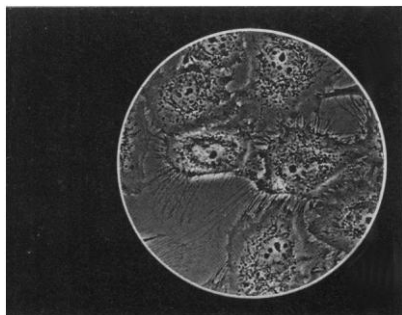
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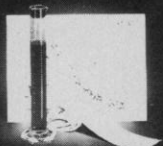


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### Biomass Conversion Technologies

The article by Rathin Datta and Gautam S. Dutt (14 Aug., p. 731) serves a very useful purpose in pointing out the potential to the less-developed countries of using producer gas heat engines. The reference to Stirling engines and their performance is, however, based on data applicable only to very small (less than 1 kilowatt) machines and might be misleading to the reader.

Solid biomass, such as wood chips and agricultural residues, can be used as a fuel for Stirling engines in two different ways. The first method is based on the combination of a gasifier and a Stirling engine. The second method is to burn the solid fuel without previous gasification in an enlarged combustor that forms part of the Stirling engine proper. Both ways are being pursued (1) in current R & D programs aiming at a near-term application in 30- to 60-kilowatt units. The indirect (gasifier-engine) method has the potential of allowing the use of a wide range of solid fuels. The direct method requires the use of a fairly well defined fuel (size, shape, moisture content) but offers the benefit of a higher overall conversion efficiency.

System conversion efficiencies of state-of-the-art 30- to 60-kilowatt Stirling engines are much higher than those indicated by Datta and Dutt for small engines. Actual measurements on liquid-fueled engines combined with component data for the auxiliaries needed in the biomass version form the basis for a predicted overall efficiency of at least 35 percent for the direct combustion method (recent measurements on liquid-fueled 50-kilowatt engines which are being developed for automotive use have veri-

fied a peak efficiency of 37 percent).

The Stirling engine has not yet been mass-produced. Recent cost analyses (2) have, however, concluded that large-scale production would facilitate a manufacturing cost of about \$19 per kilowatt for an automotive version of the Stirling engine.

LARS G. ORTEGREN

United Stirling, Inc., 211 The Strand,  
Alexandria, Virginia 22314

### References and Notes

1. *Bio-Energy '80 World Congress, Proceedings* (Bio-Energy Council, Washington, D.C., 1980).
2. *Automotive Stirling Reference Engine Design Report* (NASA CR 165381, National Aeronautics and Space Administration, Washington, D.C., 1 June 1981).

Our reference to Stirling engines and their performance on biomass fuels in the villages of less-developed countries is based on small (1 to 5 kilowatts) engines. We made this quite clear in our article (p. 735). The power outputs sustainable from renewable resources in the villages of less-developed countries are small and so are their agricultural power needs. Thus, the cost and efficiency of only small engines were discussed in the article. The costs of large internal combustion engines are considerably lower than those shown in table 3 of our article. The current cost of automobile-size (50 kilowatts) internal combustion engines is \$15 per kilowatt and is lower than the anticipated cost of mass-produced Stirling engines (\$19 per kilowatt) quoted by Ortengren.

RATHIN DATTA

Chemical Sciences Laboratory, Exxon  
Research and Engineering Company,  
Post Office Box 45,  
Linden, New Jersey 07036

### The Right Westinghouse

In an article by Eliot Marshall on Nikola Tesla (News and Comment, 30 Oct., p. 524), it is stated that "Tesla himself showed little interest in developing these inventions for commercial application; that he left to his partner, Edward Westinghouse."

Are we rewriting history? Who is Edward Westinghouse? Surely Marshall meant George Westinghouse!

HENRY F. IVEY

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George is indeed correct.—Ed.

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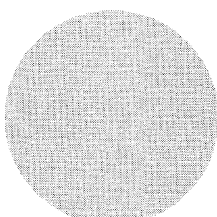
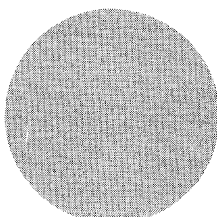
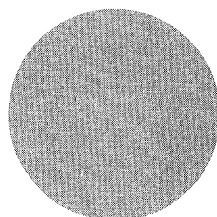
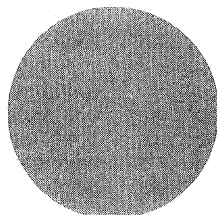
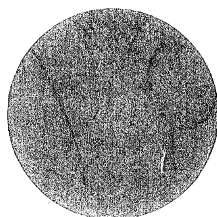
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## Centenary of Joel H. Hildebrand

November 16, 1981, marks the 100th birthday of Joel H. Hildebrand. This venerable scientist has led a rich life with many achievements. One could speak in praise of his writing skill; in admiration of his athletic accomplishments, his appreciation of classical music, his respect for the outdoors; in gratitude for his public service in two World Wars and as president of the American Chemical Society, president of the Sierra Club, manager of the U.S. Olympic ski team of 1936, and chairman of the Academic Senate of the University of California at Berkeley. But we would like to focus on the model he gives us to emulate as a scientist and teacher.

Hildebrand's investigations of the solubility of various nonelectrolytes helped shape our thinking about the liquid state. He began with insightful demonstrations of the importance of molecular interactions in solutions, and these led to his early recognition that entropy provided the primary conceptual framework within which to understand solubility behavior. His reformulation of Trouton's rule by comparing entropies of vaporization at fixed molar volume placed this important rule on a more sound theoretical footing. He provided us with a useful definition of regular solutions and defined the solubility parameter with which to codify solubility behavior. He was one of the earliest to make use of radial distribution functions determined by x-ray diffraction as indicators of molecular packing in liquids. He first recognized the intense optical absorption that occurs when certain liquids are mixed and thereby discovered what we now call charge-transfer complexes. Recently, he proposed a simple but effective theory of the viscosity of liquids. His latest research paper, published in 1981, concerns the state of hydrogen in liquid metals.

While contributing to the advancement of science with these fundamental ideas, he also established a reputation as a science teacher par excellence. In the course of his career, he has challenged and charmed some 40,000 first-year students, many of whom may have forgotten the oxidation states of manganese but remember with pleasure the excitement and inspiration conveyed by Professor Hildebrand in his freshman lectures.

These are days of waning support for science education in our nation's capital. This attitude can only tend to diminish the enthusiasm and energy which our younger academic colleagues bring to their teaching responsibilities. In such times we can all benefit by reading again some of Hildebrand's remarks about science and teaching in his Remsen Lecture to the Maryland section of the American Chemical Society on May 27, 1949:

"A university should be primarily not a place of compulsions but one of opportunities.

"Freshmen . . . are more dependent upon good teaching than at any later period. It is, therefore, more of a challenge to teach at this stage and more of an art to do it well.

"I and my colleagues have experimented for many years upon the problem of presenting chemistry to students in such a way as to activate their minds, to stimulate them to develop some degree of skill to think and act scientifically.

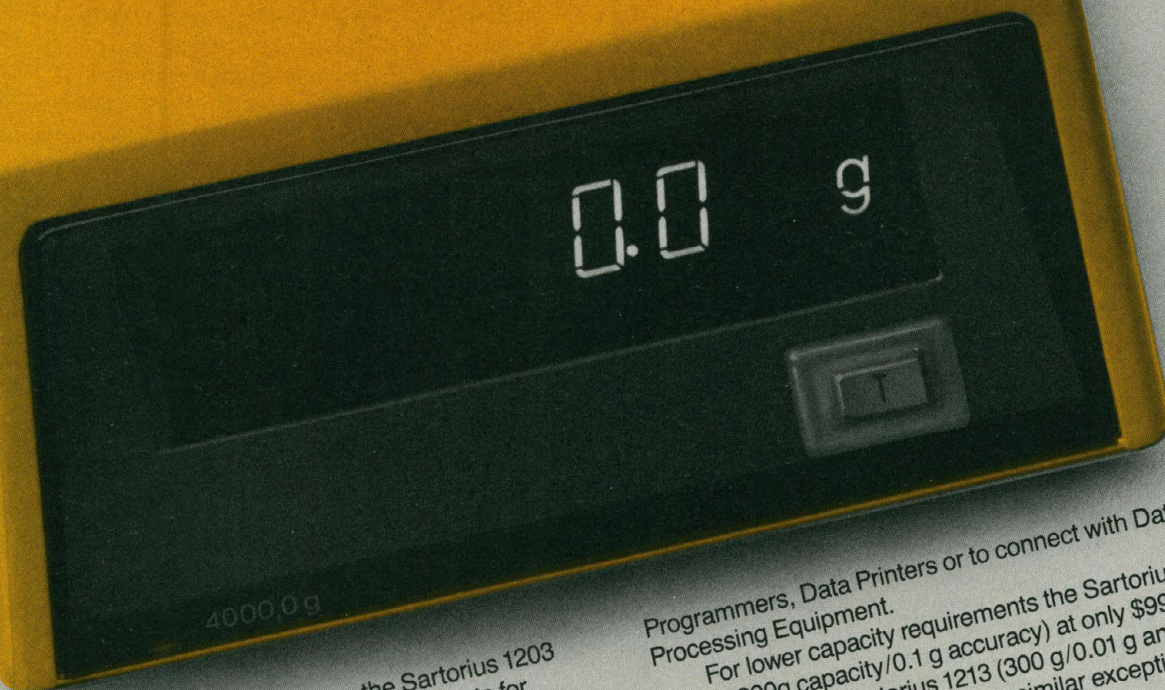
"If we are trying to help graduate students to become scientists, should we not begin by treating them as scientists? Should we not encourage in them the qualities of the scientist, such as imagination, originality, judgment, and curiosity?

"The discovery of truth and its transmission to others belong together, and their joint exercise can afford satisfactions greater than either one practiced by itself."

These are ideas which should be remembered. Putting them into practice is a fitting way to wish Joel Hildebrand a happy 100th birthday.—GEORGE C. PIMENTEL and KENNETH S. PITZER, *Department of Chemistry, University of California, Berkeley 94720*



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For lower capacity requirements the Sartorius 1206 (1200g capacity/0.1 g accuracy) at only \$995 or the Dual-Range Sartorius 1213 (300 g/0.01 g and 3000 g/0.1 g) at only \$1595 offer similar exceptional value.

For literature, write Sartorius Balances Division, Brinkmann Instruments, Inc., Subsidiary of Sybron Corporation, Cantiague Rd., Westbury, NY 11590; or call 516/334-7500.

Circle 246 for more information  
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