Book Reviews

Applications of Energy: Nineteenth Century. By R. Bruce Lindsay, Ed. Dowden, Hutchinson & Ross, Inc., Stroudsburg, Pennsylvania (1976). 420 pp.

This is the second volume in the *Benchmark Papers on Energy*, of which R. Bruce Lindsay is the series co-editor. Like its predecessor, *Energy: Historical Development of the Concept*, it is an annotated collection of the classical papers from the middle and late 19th century. By the 1840's, the idea of energy was understood in a general way; in these papers, it is given sharper definition and is then applied to various branches of science.

The collection is divided into seven sections: I, The Pioneer Work of Helmholtz; II, Contribution of Clausius, Thomson (Kelvin), Rankine, Regnault, and Joule; III, Energy in Cosmical Physics, IV, Energy in Electricity and Magnetism; V, Energy in the Field; VI, The Science of Energetics; and VII, Progress in Equilibrium Thermodynamics. The authors are the great men of energy: Helmholtz, Clausius, Rankine, Kelvin, Regnault, Gibbs, Mayer, Joule, Ostwald, Maxwell, Planck, Poincaré, Raleigh, and Poynting. Lindsay, with his most illuminating annotations, weaves these classical papers together into a fascinating story, one that should be understood by all who are interested in energy.

Most of us nowadays take so much of the theory of heat for granted. It is hard for us to remember that there was a time when no one knew that I^2R was the heat generated by an electrical current or even that mechanical energy could be converted into heat, or that Helmholtz as a young, brash physiologist (not physicist) first generalized the principle of conservation of energy to nonmechanical transformations. All these things required flights of imagination as well as hard analysis and experiment. Sometimes there were false starts and paths that had to be retraced. All this is recounted in these papers.

I found the sections on the source of the sun's energy and the controversy over Ostwald's energetics particularly intriguing. Before nuclear energy, the source of the sun's energy was, of course, a deep mystery. Here we learn that Mayer suggested that bombardment by meteors was that source, a view expressed also by Kelvin. Incredibly, Mayer, realizing that celestial mechanics requires constancy of the sun's mass, comes very close to suggesting that mass and energy were interchangeable, thus in a way anticipating Einstein!

Or the bitter controversy between Ostwald and his extension of Rankine's "energetics," and Boltzmann and Planck, who with their more sophisticated understanding, were able to point to the flaws and inconsistencies in this seemingly simple approach—this one can also find here, in the original words of the protagonists, always with Lindsay's excellent commentary. But these are only a few of the vignettes that will reward the reader.

Here is a lovely book for those who wish to browse, to remember, to savor great moments in the history of energy. Let us hope that the forthcoming volumes in the *Benchmark Series* are as well done as is this one.

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About the Reviewer: Since his retirement from the directorship of the Oak Ridge National Laboratory a few years ago, Alvin Weinberg has applied his keen insight into socio-economic-scientific problems through the Institute for Energy Analysis, a part of the Oak Ridge Associated Universities. Dr. Weinberg has contributed much to the nuclear community since the earliest days of the Manhattan Project at the University of Chicago.

Boiling Liquid-Metal Heat Transfer. By O. E. Dwyer. American Nuclear Society, La Grange Park, Illinois (1976). 448 pp. $37.95.

Liquid-metal two-phase flow and heat transfer is a relatively recent research area. Its principal impetus has been problems connected with hypothetical accidents in the liquid-metal fast breeder reactor (LMFBR), but interest also stems from applications involving space power cycles, lithium-metal blankets surrounding fusion reactors, and liquid-metal magnetohydrodynamic power cycles. The author, who was one of the early contributors to the field of liquid-metal heat transfer, has chosen to concentrate on the literature up to 1972-1973 in pool boiling heat transfer, except for the first chapter dealing with incipient boiling superheat. Thus, the focus is quite narrow, since nearly all the applications of two-phase liquid-metal heat transfer have involved convective boiling rather than pool boiling. Furthermore, a number of new problems have arisen in this field, such as explosive boiling (vapor explosions), which may result from fuel-coolant interactions. Another important pool boiling case that has been omitted involves boiling in fuel-steel pools with internal heat generation.

Experimental work in the boiling liquid-metal area in the 1960's concentrated on pool boiling. The data were generally characterized by large scatter, both in the same apparatus and between different experimenters. This was particularly true for ΔT_{ib}, the incipient-boiling superheat, which varied from essentially zero to ~700°C for the alkali liquid metals. This was a matter of some concern relative to the early expulsion phase of a loss-of-flow (LOF) accident in an LMFBR in the early 1970's. A number of studies were run, both in the U.S. and in Europe, aimed at pinning down these effects. Various parameters were reported to