# Book Reviews

## How Did It Happen That It Didn't Happen?

**The German Atomic Bomb.** The History of Nuclear Research in Nazi Germany. DAVID IRVING. Simon and Schuster, New York, 1968. 329 pp., illus. $6.95.

This fascinating book was published in London in 1967 (by Kimber) as *The Virus House: Germany's Atomic Research and Allied Counter-Measures.* The incredible story it tells is fascinating in the extreme, especially to all who worked for the Manhattan District.

The beginning, of course, was Hahn and Strassman's great discovery of nuclear fission in December of 1938. Rapidly thereafter the scientific world came to realize the fateful meaning of the splitting of the atom. This is the story of what happened about it in Germany. It is well written and arranged with good pictures.

First, of course, the Germans had an enormous head start. Second, and less obvious, was that they did very well indeed with the means at hand, and it takes a lot of analyzing to discover why they didn't get the bomb well ahead of us. They knew about all the characteristics of the fission reaction; there was nothing we knew about it that they didn't. They knew about plutonium and, in fact, decided that it was easier to make a bomb that way than with the isotope separation process to get $U^{235}$. (We did both; the Hiroshima bomb was uranium, the Nagasaki bomb plutonium.) However, the decision to emphasize reactors and plutonium was a very difficult one, and they never did cease working at separating the uranium isotopes; their best progress was made with the gaseous centrifuge, a device we barely looked at before moving to the mass spectrometer and finally the gaseous-diffusion plant. Apparently they never seriously considered the gaseous-diffusion plant. They must have thought of it, however, for the German Gustav Hertz (who, being Jewish, wasn't allowed on the project) had invented it years before.

Another strange matter was their avoidance of the graphite-moderated reactor (our Hanford, Washington, installation). Thus they voted against both Hanford and Oak Ridge and went directly and essentially totally to the Savannah River route (plutonium-producing reactors with heavy water as moderator).

The reasons against the diffusion plant are very obscure, and the author merely notes in amazement that apparently they never thought of it. Well, it seems clear that they must have. It may be that in excluding Hertz they had made the decision, for everyone else on the isotope-separation side was more or less committed to his own scheme—Clusius to thermal diffusion, Groth to the gas centrifuge, and so forth.

The second decision, not to try to use graphite as a moderator, was based on a very clear fact—Bothe of Heidelberg had measured the absorption cross section of graphite incorrectly! An earlier, correct measurement of this very important quantity had been set aside when this famous experimentalist Bothe turned his hand to the job. Once his result was known, nearly the entire effort was put in the heavy-water project, and Harteck (now at Rensselaer Polytechnic Institute) and Suess (now at the University of California at San Diego), who were experts in this matter here, became very important, with many trips to Norway and much difficulty with the British commando and American bombers, who finally stopped heavy-water production completely and thus stopped the whole project, since all else that was left was the gas centrifuge, which wasn't completed.

In the Germans' eyes (blinded by the Bothe measurement), a graphite-moderated reactor could only operate with uranium enriched in the fissionable isotope $U^{235}$. Therefore they saw uranium isotope enrichment only as a substitute for the heavy-water effort, never really realizing it could do the whole job itself. Yes, they paid dearly for excluding Hertz.

If any one of a dozen events had happened a little differently, there might have been a German A-bomb. What a difference that would have made! A secretary put the wrong agenda in an invitation to the top Nazi and military brass; Bothe mismeasured; Hitler never really heard Heisenberg's description of what an A-bomb would do; and so on. It gives one an eerie feeling.

W. F. LIBBY
*Department of Chemistry, University of California, Los Angeles*

## Thermodynamics

**Entropy and Low Temperature Physics.** J. S. DUGDALE. Hillary House, New York, 1967. 206 pp., illus. $6.

Entropy is a concept which was first introduced by Clausius in 1854 and has since been fruitfully applied to such general physical problems as those of crystallization, magnetization, mixing, radiation, and chemical reactions. Entropy can serve as a measure of disorder, of reversibility, of temperature, and so on. As a subject of such wide interest and application, entropy, like the Exodus, has a story that needs to be frequently retold.

Dugdale's interesting book is an exposition and interpretation of entropy in its natural habitat, problems of heat and temperature change. The book is intended for students, and the writing is so clear and well organized that interested laymen and active researchers can profit from it as well.

The first part of the book is a discussion of entropy in thermodynamics. It starts with a historical introduction rich in quotations, including Count Rumford's observation that the mechanical production of heat might be useful "in a case of necessity . . . in cooking victuals." Dugdale then develops the ideas of temperature, thermodynamic variables, and equations of state and goes on to give careful descriptions of the first and second laws. The approach is fairly rigorous, yet tutorial, so that each abstract concept comes paired with some physical example. In this manner the experimental basis of thermodynamics is illustrated by the measurement of specific heat and the second law is illustrated by a thorough, historical description of the Carnot cycle. Entropy itself