but so is the bargaining power of rulers, which has depended on the characteristics of military technology. Throughout history stagnation, rather than growth, has been predominant in nation states. From the Egyptian dynasties to the modern Soviet state, the characteristics of the state and the interests of its rulers have produced stagnation even when the distributional coalitions that are the heart of Olson's study have not evolved.

Equally fundamental is the dilemma that people don't always "free-ride." People frequently act through conviction about the legitimacy or fairness of the set of rules of the game that surrounds them. That is, if people are convinced the rules are fair, they may obey them even when at times they could be better off not obeying them. Conversely, when people are convinced that the rules of the game are unfair, they sometimes form large groups to attempt to overthrow the system and again are not free riders. In Olson's world, in which everybody is narrowly self-interested, stability of any kind would be impossible, because people would cheat, steal, murder, and so on, whenever they could get away with it. The costs of enforcement of any set of rules in such a society would be prohibitive. We do observe theft, shirking, murder, and the like, but we also observe that people do not undertake such actions when they believe the rules to be fair.

The enormous investment that governments and voluntary organizations make to convince people of the fairness and justice (or conversely of the unfairness or injustice) of the rules of the game is evidence enough that ideology matters. People do indeed behave the way Olson argues a good deal of the time—hence the strength of his argument. But many of Olson's distributional coalitions achieved their power and coherence because of strong ideological conviction. This is true equally of the labor movement and of today's environmental groups, such as the Sierra Club and the antinuclear movement.

Ideology also plays a key role in the relative stability of Western democracies in contrast to Latin American countries. Without incorporating the significance of ideology in modifying group behavior, we are missing an essential ingredient in the makeup of institutions.

As a result of a failure to take into account the existence of non–free-riding in the world, Olson gets caught up in a basic contradiction to his argument. The implications of his book are clear—the future of the world is dismal because self-interest groups will tend to form coalitions and throttle economies. In the absence of revolutions, which Olson deplores and argues are not an answer to his problem, there appears no way out of secular stagnation. But wait: at the end Olson says we do have a way out. People can understand the message of his book and act differently. That is, they can act to eliminate distributional coalitions and to force societies to be competitive and, therefore, more productive. But here he has made his contradiction, because that would not be in the interests of the individuals themselves.

The essence of Olson's message is that these distributional coalitions are a natural outcome of individuals' acting in their own self-interest; and indeed it would take some strong conviction for them to act differently—that is, not free-ride. Olson's study does pose a major issue for the Western world: he is quite correct that the growth of special interest groups has led to many of the modern dilemmas. His failure to take into account both the role of the state and the importance of ideological conviction, however, results in his being caught in the trap of his solution's contradicting the basic premise of his book.

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A Wartime Effort

Radiation. One Story of the M.I.T. Radiation Laboratory. ERNEST C. POLLARD. Woodburn Press: Science and People, Durham, N.C., 1982. xvi, 198 pp. Paper, $10.

In recent years, many have reflected on the conception, creation, and use of the atomic bomb during World War II, its subsequent effects on the United States, and the relations it created between the military services and the American scientific community. In contrast, few retrospective analyses have been made of the numerous other major wartime interactions between science and the military, even though their lingering effects have also been extremely important in shaping relations between the federal government and science over the last four decades. In this brief volume, Ernest Pollard reflects on one such interaction, the work of the Radiation Laboratory of the Massachusetts Institute of Technology, where he served as a staff member from 1941 to 1945.

By any measure, the Radiation Laboratory was a remarkable scientific institution. Formed in November 1940, it had a clear, but hardly simple, mission during its five-year life: to develop, from the newly invented multicavity magnetron, microwave radar equipment that could be used during World War II. Many, especially in the military, believed this to be impossible, for the technology was immature and the several attempts to develop microwave radar in service laboratories during the 1930's before the magnetron was available had all failed miserably. Better, they thought, to concentrate on improving the long-wave sets already in operation. The enthusiastic, dedicated employees of the Radiation Laboratory soon proved how wrong such judgments were. By 1942, microwave radars were regularly being delivered to the services, and the laboratory, with a staff that grew to 3900, eventually designed two-thirds of all the U.S. radar equipment built during the war. Then, when the conflict ended, the staff produced a series of authoritative textbooks on radar and its electronic components that are classics in their field. Looking back, Pollard tries to determine how all this happened. What were the qualities of leadership, cooperation, commitment, and intellectual stimulation that made the Radiation Laboratory so successful? And what had it been like to be part of such an institution?

There is much to fault in his answer. The most serious flaw is that the book, despite being aimed at a general audience—the cover, for example, boasts that there is *no* mathematics here and only *three* figures—provides too little general information about the formation, growth, organization, scope and extent of the Radiation Laboratory, and hence fails to give uninformed readers the overview they need to put Pollard's reflections in context. Additionally the chapters are a series of essays written at various times, and they are not well integrated. The text wanders too freely between personal reminiscence, general narrative description, and analysis. Significant conclusions are often poorly explained and supported. The volume is thus less insightful and well crafted than it should be, far less so than its obvious model, A. P. Rowe's *One Story of Radar*.

Yet despite its rough state, this book is a welcome publication. It should prove useful and interesting to all concerned with understanding the varied forms of interaction between science and the military during the war that have influenced American science ever since. Moreover, Pollard's comrades in arms will find his views on them and their joint enterprise quite thought-provoking. Historical writings on the Radiation Laboratory are sparse. These reflections from someone who not only had an inside view but also recognizes the implications of what was done there for comprehending the nature of effective scientific leadership and scientific cooperation are a valuable addition.

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The Storage Battery

Bottled Energy. Electrical Engineering and the Evolution of Chemical Energy Storage. RICHARD H. SCHALLENBERG. American Philosophical Society, Philadelphia, 1982. xvi, 420 pp., illus. Paper, $20. Memoirs Series, vol. 148.

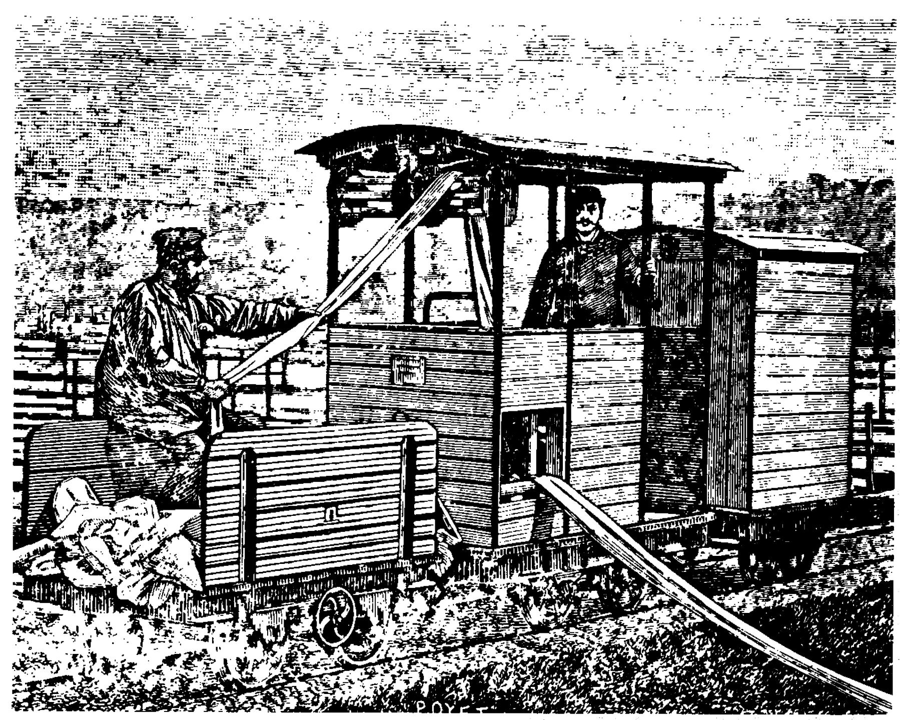
This posthumously published monograph examines the history of the electric storage battery and its applications from the early 19th century to around 1970. The book deals with the interaction of science, technology, and the marketplace. It offers considerable insight into both internal and exogenous factors that influence the process of technological change. With an undergraduate degree in chemical engineering and a doctorate in the history of science, Schallenberg was well equipped to deal with the details of chemical reactions in batteries and to use the development of the battery to illuminate important issues in the history of science, engineering, and invention. An impressive array of patent documents, manuscript sources, and published books and articles are cited, and numerous drawings are included that are very helpful in understanding design changes. Since the account covers a long time span and involves a variety of cultural and economic environments, Schallenberg chose to use biological evolution as an analytical framework, regarding the storage battery as a kind of technological species that survived by adapting to changing environments.

According to Schallenberg, the battery went through a three-phase process of evolution. During the first phase, which lasted from the invention of the battery until the early 1850's, the battery was the object primarily of scientific investigation. Johann Ritter, who is credited with creating the prototype storage battery, was influenced by German nature philosophy in his research, and the battery became the "technological incarnation" of the scientific concept of energy conservation (p. 1). In the second phase, which lasted until the early 1880's, the battery became a tool for members of a scientific tradition of electric meteorology and was used commercially in the telegraph industry. Gaston Planté, a French chemist, developed the lead-acid battery during this period and used it in laboratory simulations of meteorological, solar, and galactic phenomena. He also patented a device known as "Saturn's Tinder Box" that used his battery to operate a combination door bell and cigar or lamp lighter (p. 33).

The third phase of battery development began around 1880 with the advent of the electric light and power industry and saw the storage battery become an engineering tool with a variety of industrial and consumer applications. Schallenberg found that America lagged well behind European countries in battery technology prior to 1895, chiefly, he believes, as a result of "the prejudice of American electrical engineers against storage batteries" (p. 395). American engineers changed their attitude during the period of rapid growth of the electric streetcar industry when banks of batteries were installed in the power plants that furnished power to streetcars. The Electric Storage Battery Company of Philadelphia rose to dominance in the United States with sales of over four million dollars by 1903. The reasons for the failure of the battery-powered passenger car to achieve commercial success are discussed along with the spectacularly successful system invented by Charles Kettering in 1911 that used the battery as part of a starting, ignition, and lighting system for the gasoline-powered automobile. The scale of use of the automobile battery led to American leadership in the mechanization of battery manufacture.

A chapter is devoted to the history of the alkaline storage battery, a type that was pioneered by Thomas A. Edison and by the Swedish chemist Waldemar Jungner. The sintered-plate battery that was developed during the Second World War enabled miniaturization and manufacture in a variety of shapes. Batteries of this type have been used as rechargeable batteries in a wide range of consumer devices.

The interpretative concept of "technological buffering" proposed by Schallenberg should be of interest to historians of technology. Schallenberg defines a buffer technology as "a technique which is introduced for the purpose of adapting a



"In . . . 1882, Force et Lumiere conducted the first experiment with in-plant industrial use of battery transport. The large Duchesne-Fournet bleaching ground wanted to mechanize the laying and take-up of cloth, but the use of a small steam locomotive was precluded, because of the smoke and cinders. Therefore, Force et Lumiere built a small electric locomotive, weighing 2,500 pounds . . . and carrying 1,400 pounds of batteries in a small tender. The locomotive ran up and down the bleaching ground . . . and drew in the cloth by attaching the motor to a small winch. . . . The results heralded an unhappy pattern repeated frequently . . . during the next decade and a half. The batteries worked splendidly for a few runs . . . , but after a few charges, the electrodes . . . refused to receive further charging." [From *The Electrician* (London), 27 May 1882; reproduced in *Bottled Energy*]