Book Reviews

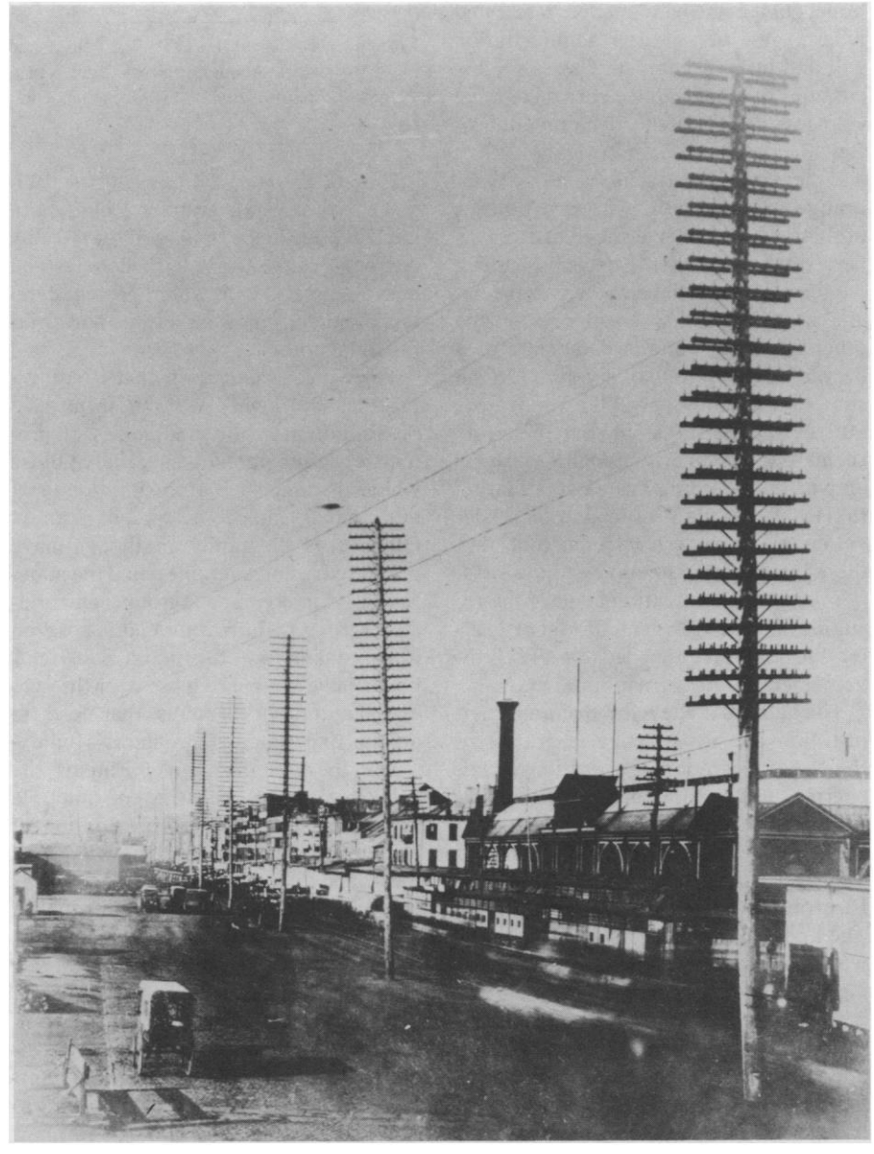
Industrial Research: A History

A History of Engineering and Science in the Bell System. The Early Years (1875–1925). M. D. Fagen, Ed. Bell Telephone Laboratories, Murray Hill, N.J., 1975. xiv, 1074 pp., illus. $15.

This is the first of several volumes on the "science and technology of telephony." Initiated at the suggestion of James B. Fisk when he headed Bell Telephone Laboratories, it serves to commemorate the 50th anniversary of the Laboratories' founding as well as the centennial of the invention of the telephone.

Two initial decisions were necessary when the study was undertaken: Who was going to research and write the account, and how would it be organized? The first question was answered by using Bell personnel in the team approach that had proved so effective in Bell scientific research. The research was provided by several members of the Laboratories; the writing was largely the responsibility of two individuals. Finally, "in the manner of all Bell Laboratories technical writing, the material, after preparation by experts, was reviewed and criticized by other experts" (p. xii). The authors answered the second question by organizing their account around technical issues. Two opening chapters on "Bell's telephone" and "Early corporate history" are followed by seven chapters each organized around an aspect of communications technology: "Station apparatus," "Telephone transmission—The wire plant," "Telephone transmission—The advent of radio," "Switching and signaling systems," "Non-voice communications," "Materials and components," and "Quality assurance." The volume concludes with a chapter entitled "The spirit of research" chronicling some of the basic scientific research performed in three areas: electrical communication theory; speech, hearing, and sound; and the nature of materials.

How well does this approach to writing the history of technology work? Quite well, within certain severe limitations. The job has certainly been done with great care. The technical information is authoritative; it would take experts in specialized aspects of communications technology to detect significant errors. This authoritativeness extends from matters of detail to larger questions of the development of certain lines of scientific thought and engineering practice. The volume is filled with well-proportioned accounts of the movement from initial problems through conceptual solutions to the final practice or piece of equipment. The writing, too, is marvel-



Telephone pole line in New York City, erected in 1887. In telegraphy, "attenuation was very small and transmission was possible over considerable distances even in the early days of the art. . . . Telephony, on the other hand, required the transmission of frequencies 50 to 100 times those used in telegraphy, and . . . the attenuation was many times greater." This difficulty, along with the problem of relaying or amplifying weak voice signals, "retarded the evolution of long-distance telephone transmission up to about 1915." In the early days of telephony, telephone transmission, following telegraph practice, "employed . . . spaced wires with sufficient strength to be self-sustaining between infrequent supports." As congestion increased, the rooftop supports initially used were replaced with lines of poles. "It was not until . . . 1891, however, that the first standard specification for pole lines was issued, calling for 40-foot poles of live cedar or chestnut. . . . Poles, however, could not always be limited in height to 40 feet." Those shown here are 90 feet high. "The early specifications called for pole spacing of 130 feet . . . , which is still standard today for toll lines. . . . At about the same time, 10-foot crossarms spaced 2 feet apart, carrying ten wires each, became standard. . . . Practically from the beginning, the wires were [attached to] glass insulators screwed onto threaded wooden pins. . . . This . . . was one of the few basic telegraph practices carried over into telephone line construction." [From *A History of Engineering and Science in the Bell System: The Early Years (1875–1925)*]

ously clear. A reader with little scientific or engineering background should have no difficulty in understanding the text, supported as it is with numerous well-chosen illustrations. Obviously the writers have had long experience in elucidating complex technical questions.

These very real virtues are, however, achieved at considerable cost. The clear, technically precise, and authoritative accounts produce an abstract, bloodless, and largely anonymous history; the scientists and engineers responsible for some very remarkable achievements are little more than names attached to ideas or artifacts. The general impression conveyed is one of inevitable technological progress with few evidences of misdirected efforts, scientific failures, or technical frustrations. Readers interested in the processes of scientific creativity or technological innovation will be disappointed in these pages.

This volume also demonstrates some paradoxical attitudes toward institutions. On the one hand readers interested in problems of research administration will find little of interest. There is a discussion of the various organizational changes that resulted in the creation of Bell Telephone Laboratories in 1925, and there is conventional praise of collaborative research. But we learn little or nothing about such critical matters as personnel recruitment, decision-making on research and development projects, and changing levels of support. On the other hand the volume demonstrates a degree of institutional myopia. To be sure, due credit is given to innovators outside the Bell System, but their role seems extraordinarily small. For example, the volume pays close attention to H. D. Arnold's crucial role in developing the modern vacuum tube, but there is little attention given to the work of others and no mention at all of the resulting tangled patent situation shortly after World War I that led to AT&T involvement in the formation of RCA.

The authors do develop one important institutional thesis. They characterize the close integration of operations, engineering, and manufacture as a "wise and productive move" (p. 1008). At a time when the federal government seeks to force AT&T to divest itself of Western Electric this is a most important point. The argument is often persuasive, but it would have been more persuasive coming from independent scholars writing with free access to Bell materials. The matter of materials presents one final disappointment. The bibliography and scattered footnotes refer almost exclusively to published materials. There are some references to internal documents, but we are left with no clear indication of the richness (or poverty) of Bell archives for students of the history of American technology and industrial research.

This is obviously an important work. No one interested in the development of communications technology can afford to overlook it. It has provided clear and authoritative answers to some important questions. But the authors' range of interest was narrow. The Bell System could make a further contribution to the history of American technology if it would permit qualified scholars to use its archives to seek answers to some of the questions the authors of this volume chose not to ask.

KENDALL BIRR
History Department,
State University of New York, Albany

Biochemical Method

Protein Crystallography. T. L. BLUNDELL and L. N. JOHNSON. Academic Press, New York, 1976. xvi, 568 pp., illus. $43. Molecular Biology.

Protein Crystallography will be welcomed by crystallographers, but, more important, I believe it will be readily comprehensible to protein chemists and enzymologists, with whom protein crystallographers enjoy important and fruitful collaborations.

The book is unique in that it gathers together in a highly readable form most of the important methodologies of protein crystallography, especially those which distinguish it from its older sibling, small molecule crystallography. Other crystallography textbooks have presented in considerable detail the material on symmetry, space groups, and principles of x-ray diffraction that is covered in two chapters of this book. Such textbooks have tended to gloss over the special features of proteins that lead to unique experimental problems—for example, the crystallization of proteins, the collection and processing of multiple large data sets, and the preparation of heavy atom derivatives. Knowledge of these and other specialized techniques had to be gleaned from journal articles, reviews, and attendance at the numerous protein workshops and by apprenticing oneself to a proven leader in the field. Now, for the first time, we have a comprehensive protein crystallography textbook, complete with a few hundred references, practical hints (such as where to buy crystal mounting tools), warnings (don't ingest heavy atoms), illustrations (some of which reflect the authors' own research experiences), and an adequate theoretical background. The book can be used by a beginning student to learn the field and by an experienced protein crystallographer as a handy reference guide.

What about the noncrystallographer? A few chapters of the book can be read by those interested in a better perspective of the study of protein structure. The principles of protein structure are discussed, and summaries of the techniques used in x-ray and neutron diffraction and in electron microscopy are given. There are referenced tables of the enzymes studied by x-ray diffraction and a discussion of some of the results. In addition, the chapter on crystallization and the chapter on heavy atom preparation, with its extensive tables of binding sites, should provide invaluable information for protein chemists and enzymologists. Finally, it is a credit to the authors that the chapters on crystallographic techniques are written in such a way that someone outside the field could, if he or she so desired, learn more about the tool that has become so crucial to our understanding of molecular structure and function.

HELEN M. BERMAN
Institute for Cancer Research,
Philadelphia, Pennsylvania

Hard-Working Intact Muscles

Biomechanics and Energetics of Muscular Exercise. RODOLFO MARGARIA. Clarendon (Oxford University Press), New York, 1976. x, 146 pp., illus. $15.75.

Despite its misleadingly comprehensive title, but as is made clear in the preface, the contents and style of this small book are very personal and relate mainly to the researches that Margaria (and his colleagues) have carried out in the last ten years in the Institute of Human Physiology of the Medical School of the University of Milan. Thus, although the book is intended to cover the fundamentals of the physiology of exercise, it has many large gaps. There is no mention, for example, of myosin and actin, of enzymes, of controls at the cellular level, of adenosine monophosphate (AMP) or cyclic AMP, of the significance of changes in the respiratory quotient for the energy available from a given amount of oxygen, or even of fat metabolism, without doubt by far the largest source of energy for low-level muscular exercise.

These gaps make it impossible to rec-