BOOKS

ELECTRONS, WAVES AND MESSAGES
by John R. Pierce
Hanover House, Garden City, N.Y. $5

Reviewed by Robert V. Langmuir
Associate Professor of
Electrical Engineering

JOHN R. PIERCE, who received all his degrees at Caltech (BS '33, MS '34, PhD '36) has written a clear and simple book about modern electronics. It is written for the intelligent and interested layman at about the level of the *Scientific American*.

After an introductory section on simple mathematics, Newton's laws of motion, and electric and magnetic fields, he treats simple electron optics, microwave tubes and Maxwell's equations. All this is presented in a beautifully clear fashion and can be easily understood by anyone with some technical training, I am not so sure that it can be understood easily by a person untrained in any scientific discipline.

For non-scientific people there is something basically boring about most introductory discussions of Newton's laws of motion which do not use the calculus. One of the reasons for this is that Newton's laws are often used as a language or tool for further discussion of physical phenomena.

I suspect that this part of the book will be somewhat difficult, and possibly dull, for a layman. Certainly the study of languages was dull for me when I was in college, and physics was very exciting. As a result, I specialized in physics. Other students, who had the reverse reactions to these courses, studied further in languages and never touched science again.

To make Newton's laws interesting to such language majors was a very difficult thing. I hope that Dr. Pierce has succeeded, although I am not sure that he has. He has, however, done a far better job than I have ever seen anywhere else. I cannot think of a better textbook for that one required science course in a liberal arts curriculum.

Once the basic foundations are laid, Pierce discusses microwave systems, noise and information theory. The applications of information theory to the English language and to music are fascinating, and should be studied carefully by all who are interested in these subjects.

In the discussion of microwave tubes Pierce gives the case history of a research project—namely, his own work during the past ten years. He manages to convey the curious feeling that attends much good research; the very poor understanding that accompanies successful "pushing back the frontiers of knowledge," and how simple it all seems a few years later. I particularly liked the lack of unjustified philosophizing on scientific matters and his deep suspicion of all analogies.

This book can be heartily recommended to all Caltech graduates in all fields. It would be very interesting to find out how many of the wives of Caltech graduates can read, understand and enjoy this fine book about science for the layman.

On p. 8, an extract from the book.

QUOTE:

An extract from "Electrons, Waves and Messages"

by John R. Pierce*

LITERATE AND CURIOUS men of every age have thought and read and learned about matters outside of their immediate physical needs and experience. What they have thought and read and learned about has varied from age to age, as both the tasks of everyday life and the aspirations that go beyond these tasks have changed. Sometimes men have been concerned with religion, sometimes with mathematics and philosophy, sometimes with exploration, trade and conquest, sometimes with the theory and practice of government, sometimes with ancient learning, sometimes with the arts.

In different times, in different cultures, these matters have engaged the atttention of the unusually able and intelligent men. When some of the best thought and best effort of a culture is spent in political philosophy, or in classical learning, or in art, the cultured man is the man who is acquainted with, and whose thought reflects, political philosophy, or classical learning, or art.

One can scarcely deny that the most effective thinking of our age, and a great deal of its energy and enterprise, go into science, and especially into the sort of science which guides an immensely complicated technology in doing new things and in doing old things cheaper and better. This prodigious technology in turn supports science with a lavishness unprecedented in any former age.

It is not only true that the world about us would astound a man of a much earlier age. It would astound a man of fifty years ago almost as much. He could not help being astounded by electric power, washing machines, dishwashers, freezers, highways, automobiles, radio, television, airplanes, rockets, nuclear energy. The widespread good living, the rarity of servants, the diminution of great luxury would astound him as much. If he looked more deeply, the growth of science — both in knowledge, in magnitude of effort, and in monetary reward and public recognition as well—would astound him.

The world of fifty years ago had writers, poets, painters, musicians, philosophers, politicians, and governments. No doubt all of these have changed of recent years. It is clear, however, that the great, the characteristic, the significant changes have been in science and technology and in the way the world is divided into countries and governed. We might even argue that the tremendous political upheavals of our age are primarily a consequence of a revolution in science and technology. Whether or not we go this far, it is clear that science and technology, together with political change and turmoil, are the outstanding features of our culture. Many would put science and technology first.

One cannot be in tune with his age without understanding something of science, and yet this does not seem to have dawned on many people who consider themselves educated or, indeed, on professional educators.

The very things that enable a man to understand something of our culture — mathematics, physics, chemistry — are pared away from the curricula of grade schools, high schools, and colleges, to be replaced by generalizations and surveys. Men who profess to be educated flee frantically from the most significant feature of their culture and seek culture in almost any place but where it is to be found. It sometimes seems to me that writing, painting, and music have become weak, ineffective, and discouraged by seeking nourishment in the decaying remains of the past and ignoring the vigorous thought and achievement of the present.

Suppose we do grant that our science and technology are the great and important contributions of our era, the first things that men should know about when they look beyond the tasks and problems of the day and want to partake in some measure of the spirit and achievement of the times. Is it not hopeless to try to understand a science and technology so multifarious that no scientist can grasp all the details of more than a tiny fraction of it? I believe the answer to be no.

In the past there was less technology to understand. However, in the past technology was empirical art. The understanding of those who had mastered its skills and rules did not go beyond those skills and rules themselves. It seems to me that the outstanding feature of modern technology is that skill, rule of thumb, art, are rapidly being replaced or explained by science, by understanding. Engineering education, which waxes brilliantly while much of education flourishes dubiously, is continually being freed from detailed art and special knowledge to make way for more physics and mathematics, for more and wider fundamental understanding. The engineers who are graduated today are far better educated than I was twenty years ago. Their education is tougher, they learn more that is fundamental and broadly important, and they spend less time on special rules and tedious art. Engineering by handbook is not enough in the modern world. Handbooks last scarcely long enough to become familiar before they are outmoded. An engineer must understand and think to keep up with his art.
