most intelligent and lovable of all terriers, and one still unspoilt by the attentions of exhibitors.

It would be possible to go on browsing indefinitely and happily through the pages of this book. There is so much that could be mentioned: the dog in art, in literature, foxhounds, greyhounds, the Samoyed, the Kennel Club and Crufts, the excellent chapters on breeding, training, and showing, and not omitting a scholarly and scientific dissertation on that canine outcast, the pariah—though I cannot share the anxiety of the Menzels for its preservation. It must be left to others to dig in this canine mine with the certainty that they will extract both pleasure and profit from it. C. E. G. HOPE

THE FREE ELECTRON *IN VACUO*

Vacuum Tubes

By Prof. Karl R. Spangenberg. (McGraw-Hill Electrical and Electronic Engineering Series.) Pp. xvii + 860. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 45*s*.

FOR many years the literature of applied physics has lacked a really up-to-date and complete account of the phenomena occurring inside valves. In consequence, students are taught very little about them, a sad contrast with the attention paid to circuit applications. To fill this void, Prof. K. R. Spangenberg has written the present bulky volume, addressed mainly to senior and graduate students, but with the needs of research workers kept in mind. The book begins with the basic physics of the subject: atomic theory, electron emission, electrostatics and the dynamics of charged particles. Potential theory is next discussed, with detailed application to triode and multigrid valves. After a brief consideration of shot effect and resistance noise, a section of 142 pages is devoted to electron optics and the cathode ray tube. Transit-time effects come next, and lead to the elementary theory of velocity modulation valves and cavity magnetrons. Then there are chapters on photo-electric devices and various special tubes, while the final chapter of sixty pages gives a résumé of high-vacuum practice, based on material supplied by C. V. Litton. Some mathematical topics, units, skin effect and Langmuir's diode tables are discussed in appendixes.

This synopsis shows the planning of the book to be logical and comprehensive. Unluckily, the execution is not up to the level of the plan, for the treatment is very uneven in depth and precision. From the point of view of the student, it is particularly unfortunate that the sections on the physical phenomena are the poorest in the book. There is only the most sketchy account of the preparation of oxide cathodes, photo surfaces, fluorescent screens and many other matters essential for the preparation of the simplest valve. On the theoretical side these sections are equally weak. For example, the oxide cathode is not discussed as a semi-conductor, and there is no attempt to derive Richardson's law for a pure metal.

The unfavourable impression made by the first few chapters is largely dispelled by the competent handling of the theory of triodes, tetrodes and pentodes, both as potential problems and in the space charge régime. Prof. Spangenberg has made original contributions to some of the questions discussed here, and on electron optical theory, so it is natural that these should be the best parts of the book. The discussion of transit-time valves is clear and correct so far as it goes; but, considering that nearly two hundred pages are used, this is not far. Some original work on velocity-modulation tubes to cover a frequency-band of more than an octave is, however, included.

A peculiarity of the book is that all the more important expressions are given as nomograms. While this device does give a very clear idea of the magnitudes involved, the accuracy is limited by the page size to a value lower than that of even a six-inch slide rule.

It is to be hoped that, in a second edition, Prof. Spangenberg will divide the work into two separate parts, a students' text-book, and a definitive reference handbook for specialists. This would reduce the bulk of the material sufficiently to allow it to be handled in a university course. In its present form the book, while welcome, will disappoint the more sophisticated readers. A. H. BECK

PHYSICAL PROPERTIES OF RUBBER

Le caoutchouc

Matériau de construction. Par l'Institut français du caoutchouc. Avec le concours de Georges Colin, André Jarrijon et Pierre Thirion. (Etudes de synthèse et de documentation l'Actualité technique.) Pp. viii + 230. (Paris: Libr. Dunod, 1947.) 560 francs.

ALTHOUGH the remarkable physical properties exhibited by rubber are such as to commend its use for certain specialized engineering applications, it has not been easy for designers to obtain reliable quantitative information upon which to base their work. The volume under review goes some considerable way to filling the need felt by the designer for a comprehensive account of the physical attributes of rubber. The reluctance of the rubber technologist to commit himself to figures in describing the properties of this remarkable substance has been due partly to the fact that the word rubber covers materials having a tremendous range of properties. The width of this range is, indeed, indicated by the authors, although it is felt that in some sections figures are presented without sufficient emphasis on the fact that they are typical only of the compounds of particular manufacturers.

The volume includes a short account of the theories of the rubber-like state, a similar amount of space devoted to industrial processing technique, a thorough review of physical properties and finally a section giving details of the various applications of rubber, including methods of calculation. The balance as between these sections is good in view of the needs of the intended reader. There are a few errors in figures, the most serious in Table V, p. 44, where figures for internal friction are too large by a factor of 10^3.

It is a matter for regret that a book such as this, to which frequent reference will be made, should be bound inadequately in paper covers which cannot stand up to a week's careful handling by the reviewer. W. P. FLETCHER