

routine firings give muzzle velocity with some accuracy and maximum pressure with somewhat less. Special experimental work may give a time record of pressure in closed chamber firings, or of recoil in gun firings. (This book makes no mention of time records of pressure or projectile travel in gun firings.) Out of this rather scanty information one must answer not only the purely ballistic questions such as concern the law of burning, combustion temperature, composition of the powder gases, band resistance, but also various general questions of physics and chemistry, on which there are no experimental data obtainable elsewhere because of the combination of high temperature and high pressure involved. Chief among these are the characteristic equations and specific heats of the powder gases. To deal with these difficulties, two courses of procedure are open, leading on the one hand to the "outillage expérimental," on the other to the "outillage théorique." In the former, methods are selected mainly with a view to obtaining empirically the observed relations connecting conditions of loading with muzzle velocity and maximum pressure. In the latter a greater endeavor is made to formulate hypotheses which plausibly represent the actual phenomena. The difference is in a sense one of degree rather than kind. In the first method the selection of variables for empirical comparison must have some physical basis; in the second there must always be left various parameters or functions to be determined empirically. The author deals with both methods and various types of each, but devotes most attention to the "outillage théorique." The large number of numerical tables pertain to this part of the book.

In spite of the general excellence of the work it seems open to criticism for provincialism. The author makes only the most cursory reference to writers outside of France, and none to any outside the Latin countries, either in ballistics or relevant parts of general science. While it is undoubtedly true that interior ballistics has had by far the greatest development in France, nevertheless it seems unfortunate to ignore completely, for example, the German work on the conditions of chemical equilibrium in the powder gases. However, it may be said that the author omits no well-established phenomenon of major importance, and presents the principal mathematical methods that are useful.

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*Introduction to Vector Analysis.* By L. R. Shorter. London, Macmillan, 1931. xiv + 355 pp.

In his preface the author says: "My object in writing this introductory book is to furnish a working knowledge of the subject, and so enable a mathematical student to continue his studies with ease in the many excellent existing textbooks. If, on the other hand, the reader is a student of Physics, this book should supply him with a sufficient working knowledge of the methods and enable him to apply them in his physical studies."

To the reviewer it seems that the book will meet both of these aims better than most books with similar purpose. The introduction to new ideas is clear and convincing though not burdened with oppressive rigor. Numerous examples worked out in full detail illustrate the theory, and it should be possible for a student to obtain from the text a working knowledge of the subject with little or no help from a teacher.

Chapters 1, 3, and 5 are entitled respectively *Addition*, *Multiplication*, and