

realised at an early stage of the existence of the United States. Washington devoted much attention to this subject, and it was under his direction that in 1791 a committee of the Senate entered upon a very full consideration of the questions involved. They reported in favour of a decimal system, and recommended the adoption of a standard of length divided into five equal parts, each of which would correspond to a foot. No legislative action was taken, however, to give effect to these recommendations. In 1819 a committee of the House of Representatives submitted a report advocating that models of the yard, bushel, and pound, conforming to those in most common use, should be made and adopted as the standard weights and measures of the United States. This proposal also proved abortive. The elaborate report prepared in 1821 by Mr. Secretary (afterwards President) Adams, a warm admirer of the metric system, was likewise without any immediate effect. The metric system was not seriously considered in the United States until 1866, when the use of the system was authorised by Congress. In 1889 copies of the international metric standards were distributed by the International Committee to the various States which were parties to the Metric Convention. The copies received by the United States were immediately adopted as primary standards, and in 1893 a formal order of the Treasury Department recognised the international prototype metre and kilogram as fundamental standards, and directed that the customary units, the yard, and pound were to be derived therefrom.

Chapters vi., vii., and viii. deal with the advantages which would be derived from the universal employment of the metric system in commerce, manufactures, and medicine. The authors admit having a bias in favour of this system, and they make out a very good case for its general adoption. In the next chapter international electrical units are considered, and attention is directed to the benefits conferred upon electrical science by the introduction of the C.G.S. system at the instance of the British Association. The United States specifications for the practical application of the definitions of the ampere and volt were prepared by the National Academy of Science in 1895, in compliance with the provisions of an Act of Congress. These specifications, which are quoted *in extenso* on pp. 211-215, differ in some slight respects from those prepared in this country about the same time by the Board of Trade.

A most instructive chapter is the tenth, which relates to the construction and comparison of standards. The various physical properties which should be possessed by primary standards are discussed, and an account is given of the different alloys which have been used in the construction of such standards. The relative merits of line and end standards are next considered, the method of subdividing a scale by means of a dividing engine being well described. It is mentioned that at the International Bureau the graduation of a metre into millimetres in this way occupies about sixteen hours. The footnote on p. 226

quoted from Guillaume appears to contradict the statement in the text respecting the accuracy attainable by this method.

A very good description is given of the comparators employed in the verification of standards of length, and the mode of using them is explained. After some account of balances of precision, the British imperial standards of length and weight are described with illustrations. The name of Mr. Chaney, the late superintendent of weights and measures, is misspelt on p. 247, and the position which he occupied is inaccurately designated as Warden of the Standards. The latter office has been since 1878 an honorary adjunct to the permanent secretaryship of the Board of Trade.

The chapter concludes with a simple and interesting explanation of measurement by means of wavelengths of light. This method was originally only applicable to the measurement of very short intervals, but Michelson has extended its application to lengths of any magnitude. It is of great interest in metrology, since by making re-determinations from time to time positive testimony may be obtained as to whether any variation is taking place in the length of a standard. At the present day the permanency of bronze standards of length is regarded with suspicion by metrologists. The authors refer on p. 219 to the fact that many of the bronze copies of the British yard which were distributed to various nations and scientific institutions in 1855 are believed to have since undergone changes in length due to molecular rearrangement. This casts some doubt upon the invariability of the Imperial Standard Yard, which is made of the same material. The recent developments of Michelson's method afford a ready means of deciding this important question.

Some useful tables are appended, and a comprehensive index brings this well-conceived work to a close.

ITALIAN SCIENTIFIC WORKS.

- I grandi Trafori Alpini.* By G. B. Biadego. Vol. i. Pp. xvi+1228; in addition to about 36 folded pages of tabular matter. Vol. ii. 30 large folded plates. (Milan: Ulrico Hoepli.) Price 45 lire (1l. 16s.).
- Opere matematiche di Francesco Brioschi.* Vol. iv. Pp. ix+418. (Milan: Ulrico Hoepli, 1906.) Price 1l.
- I Motori a Gaz.* By Vittorio Calzavara. Pp. xxx+424. Manuelli Hoepli. (Milan: Ulrico Hoepli, 1906.) Price 4.50 lire.
- I Motori ad Esplosione, a Gas luce e Gas povero.* By Ing. Fosco Laurenti. Pp. xii+361. Manuelli Hoepli. (Milan: Ulrico Hoepli, 1906.) Price 4.50 lire.

THE opening of the Simplon tunnel amid a flourish of Italian trumpets was a fitting opportunity for the publication of a book dealing with this and other mountain borings. That the author might have written a book on the Simplon tunnel alone is evidenced by the fact that the part he devotes to this tunnel occupies the space of an average-size volume

But he wisely points out that the Simplon is only one of a series of enterprises of the same kind, and while there have been improvements in the methods of working, as well as in the use of better explosives, the merit of originality belongs more properly to what is commonly known as the Mont Cenis tunnel. Tourists to whom the name Fréjus represents a town on the Riviera will be somewhat surprised to find this tunnel described as the Galleria del Fréjus, which appears to be its correct name. In addition to this, the St. Gothard, the Arlberg, and other well-known tunnels, the author describes several minor borings not commonly noticed by tourists, but which possess points of special interest; for example, one at Laveno, on Lago Maggiore. The result is a volume of 1228 pages (excluding tables), and a second volume of plates, which form a striking contrast to the small Manuelli Hoepli of the same publisher. When we come to eighty pages of "Final Considerations," we cannot help being reminded of the typical interminable sermon of our early days, and the analogy is further increased by finding 115 pages of "appendix to the final considerations" to follow. But all the same, the author cannot be accused of long-windedness. There are a great many details connected with the boring of a tunnel, such as the rate of progress through different rocks, temperature conditions, descriptions of the machinery and of the accommodation for the workpeople, which interest not only the engineer, but also the general reader, and it cannot be said that the author has encumbered his subject with unimportant or uninteresting details to any appreciable extent. The only exception we notice is that the tables of mean temperatures of such places as Venice, Alassio, and San Remo do not appear to have much bearing on the Simplon tunnel, under which heading they are tabulated. The text would have been handier had it been bound in two volumes.

From the same publisher we have the fourth volume of Brioschi's works, comprising mainly papers contributed to the Lincei Academy (1885-1896), the *Comptes rendus* (1858-1878), and miscellaneous journals, together with the preface and notes written for the Italian translation of Cayley's "Elliptic Functions." The papers for this volume have all been edited by Profs. Francesco Gerbaldi and Ernest Pascal, and the volume is uniform in style with its predecessors. In view of the rapid growth of mathematical literature, one cannot help wondering, however, if it is desirable to publish collected works in such an irreproachable style. This reflection is suggested partly by the fact that though one or two English transactions have recently appeared with larger pages than formerly, they do not contain a corresponding increase in the number of words per page, though there is a great increase in their *weight*. And it should be the object of the purchaser to obtain Brioschi's works, not merely to buy good paper and printing.

The series of Manuelli Hoepli, published in the form of pocket-books, numbered 900 volumes in April last. Among the latest ones dealing with technical applications of science we have before us two books on gas engines, both written by authors living in Venice,

and containing respectively 160 and 162 woodcuts. The objects of the books, as stated in the prefaces, are nearly identical. Both authors point out that while other countries have advanced greatly in the study and construction of gas engines, the subject has received little attention in Italy. Curiously enough, Signor Calzavara, who is a gas engineer, says less about the question of gas than Signor Laurenti. The latter's book is divided into three parts, the first dealing with the combustibles (illuminating gas and heating gas, or "gas povero," as it is called in Italy), the second with gas generators, and the third with the gas engines themselves. On the other hand, Signor Calzavara only devotes a single chapter to the gas question. This chapter is, however, a long one, and it must be remembered that he has written several previous books on gas and gas motors.

Other differences may be noted. Thus Signor Calzavara gives a really full bibliography, while Signor Laurenti's book contains more numerical data in the form of tables. Signor Laurenti goes into detail regarding cams; the other author only just refers to distributors without discussing the cam. Signor Calzavara considers that a "poor gas" engine, with its own generator, cannot be used efficiently for installations of less than 25 horse-power; Signor Laurenti fixes the limit at 15 horse-power. These are the differences one would expect to find in two books written on the same subject by different authors, and they show that anyone interested in the subject would derive undoubted advantages from having both books for reference.

G. H. B.

THE ATOMIC THEORY OF ELECTRICITY.

The Electron Theory; a Popular Introduction to the New Theory of Electricity and Magnetism. By E. E. Fournier d'Albe. Pp. xxiii+311. (London: Longmans, Green and Co., 1906.) Price 5s. net.

A GLANCE at the table of contents of this book is sufficient to show that it fills an acute want at the present time. It attempts the consistent application of the all-embracing electron theory in an elementary manner to the whole range of electromagnetic phenomena. In making this attempt, the author is to be congratulated both on the choice of his subject and the skill and originality he has displayed in accomplishing it. It is a relief to find that the treatment, though popular, is to the point, and little or nothing is said of those vague and vast speculations as to the ultimate constitution of matter which have unfortunately become identified with the words "the electronic theory."

Few possess the necessary qualifications for a task which covers such a wide range of subjects, and, so far as we know, this is the first time it has been seriously attempted. The book is therefore unique, and should prove of value to the student, the teacher, and the investigator. Although, no doubt, it would be possible to go through the work pointing out where a fuller treatment of the subject-matter would have been advantageous, this would hardly be fair in the present state of the science. We have rather to be grateful that a trustworthy guide