

have been carefully brought up to date. They furnish a trustworthy account of the essential facts of anatomy and development, but as occurs in the case of the other groups described in this volume, the problem of their affinities is not set forth with that clearness which is so essential to its comprehension.

Considered as a whole, the volume has not that illuminating and suggestive value which distinguished the earlier volumes of the "Treatise." Nevertheless it will remain for some time the chief work of reference in the language on the anatomy and classification of the groups with which it deals.

#### PRIMARY BATTERIES.

*Primary Batteries: their Theory, Construction and Use.*

By W. R. Cooper. Pp. 4+324. (London: *The Electrician* Printing and Publishing Co., Ltd., on date.) Price 10s. 6d. net.

MR. W. R. COOPER'S book directs attention to a subject which will always be of great historical interest on account of the remarkable stimulus given to electrical science by the discoveries of Galvani and Volta. At the present time, it is true, the primary battery has yielded to cheaper and more convenient sources of electrical energy, and the position which it holds in electrical engineering is comparatively insignificant. It is not improbable that before long it will be displaced from almost all practical applications of electricity and will only be found where the dynamo and accumulator are unavailable. It may, however, be some consolation to those who have not other means at hand to reflect that in the research by which Faraday laid down the fundamental laws of electrolysis he obtained current from a primary battery of the most elementary form. The advantage of amalgamating the zinc had been shown five years earlier (1828) by Kemp, but it was not until 1836 that the first effective depolarising cell, that of Daniell, was described; the invention of the Grove cell followed in 1839. The Leclanché cell, which did not appear until 1868, marks the only other development of the first importance.

In spite of the fact that Volta's discovery is more than a century old, the theory of the primary battery cannot be said to be in a very satisfactory state. Mr. Cooper devotes two chapters to this subject, the first of which deals chiefly with contact-force and the seat of the E.M.F. in the cell. Mr. Cooper, in summing up the various theories, states that "the whole matter (of the seat of the E.M.F.) is largely a question of definition, and is, therefore, of relatively small importance," a conclusion which is not likely to commend itself to those who are anxious to arrive at the truth. In the second chapter, the ionisation theory of Arrhenius is discussed and the calculations of the E.M.F. of a cell from the equations of Helmholtz and Nernst are compared, with results which are not very convincing in either case. The author then passes to a brief consideration of concentration and liquid cells (which are at present only of theoretical interest) and of the thermopile, which, he points out, on account of its high price is not likely to prove a serious competitor to the primary battery.

There follows what may be called the practical part of

NO. 1686, VOL. 65]

the book, in which the various types of existing cells are described and which contains much valuable information collected or directly obtained by the author. Cells are classified under three headings, one-fluid, two-fluid and dry cells. In the first division, the principal examples are the bichromate, Leclanché and copper-oxide cells. Some interesting tests carried out by the author show that in the bichromate cell the most suitable depolariser to use is chromic acid, which gives a discharge curve as good as that given by either sodium or potassium bichromate and is also more convenient and as cheap. The two-fluid cells include the Daniell, with its numerous derivatives, and the Grove and Bunsen cells, which on account of their high E.M.F. and low internal resistance are especially suitable where heavy currents are required. All the dry cells are modifications of the Leclanché and do not differ much from one another except in details of construction. It is somewhat surprising to find that, weight for weight, the dry cell is superior to the wet form of Leclanché. Against this must be set the somewhat higher initial cost and the advantage of the possibility of regenerating an exhausted wet cell, though this latter consideration, as Mr. Cooper shows, is in reality somewhat illusory. The usefulness of this part of the book is greatly increased by the numerous discharge curves which are included and by the many very clear drawings illustrating the various cells described.

The last two chapters deal with standard cells and carbon-consuming batteries. The standard cell is, and is likely always to remain, of the highest practical importance; the chapter dealing with it is consequently of great interest and value, as it contains in a convenient form most of the hitherto scattered information on this subject. The table of constants of standard cells shows that the results of recent determinations point to the value 1.433 volts being more nearly correct for the E.M.F. of a Clark cell at 15° C. than the generally accepted (and legal) value of 1.434 volts. The Helmholtz cell, recently modified by Hibbert, is of interest on account of its having an E.M.F. of 1 volt at 15° C. and also a very low temperature coefficient, though in this latter respect it is inferior to the cadmium cell. The final chapter, on the carbon-consuming cell, is, unfortunately, only a record of failures. It would seem as if commercial success, if ever to be achieved, will have to be sought on entirely new lines. But the problem is not likely to lose its fascination so long as the overall efficiency of steam generation remains as low as 6 per cent. whilst the primary battery holds out a prospect of the attainment of an efficiency of 73 per cent. or more.

M. S.

#### A MEMOIR ON MORAINES.

*Geschichte der Moränenkunde.* Von Dr. August Böhm Edlen von Bömersheim (*Abhandlungen der K. K. Geographischen Gesellschaft in Wien*, iii. Band, No. 4). Pp. viii+334; 4 plates, 2 figures in text. (Wien: R. Lechner, 1901.)

AS to the history of moraines, the author might fairly say "What there is to know, I know it." By patient research in libraries he has collected a great mass of information, of which the present volume is a summary. It also contains, besides the main subject, a