

would have to be used with great caution in estimating tramway requirements in Europe. Fortunately there is no need to use American figures at all, since sufficient data are available from European experience. A curve on p. 14 is interesting as showing that with the expansion of towns the mileage of electric lines per 1000 inhabitants goes down, and the yearly number of journeys made by each inhabitant goes up. The figures are not directly applicable to European towns, but the tendency shown by these curves is the same in Europe. Towns of about 40,000 inhabitants show the greatest mileage, namely 0'76 per 1000 inhabitants, but only 110 journeys per inhabitant yearly, whilst towns of one million inhabitants and above have on the average only half a mile of line per 1000, but each inhabitant uses the cars on an average 230 times a year.

It is not clear from the author's figures whether they refer to what we should term tramways or whether they include railways also; the latter is probable, for tables giving mileage, equipment, cost, and earning of electrified main lines are mixed up with the other statistics. The next three chapters are devoted to what the author calls "Electrical Features," and deal with motor capacity and running diagrams. Various methods for getting out these curves are given, namely, Armstrong's, Storer's, and Hutchinson's methods, the latter at some length. The treatment is by no means lucid, formulæ and coefficients being introduced without explanation. Unless the reader is a thorough expert in this subject (when he needs no further instruction from the author) he will make nothing of these chapters.

Altogether the author's mathematics is not characterised by exactitude. Thus, on a later page, when he treats of converters, following (with due acknowledgment) Mr. Hay's method for the determination of the output, we find him calling a line like the following

$$\frac{1}{4}I_a^2 + \frac{1}{2}I_a^2 - \frac{1}{2}I_a \int_0^\pi \cos 2\left(\alpha - \frac{\pi}{n}\right) \pm I_a I_a \int_0^\pi \sin\left(\alpha - \frac{\pi}{n}\right)$$

an equation, without saying what it is equal to, and omitting the differential  $d\alpha$ . It will also be noticed that the third term should contain either the product of two currents or the square of a current, so that the expression is also wrong in the matter of dimension. A reader having Mr. Hay's book at hand will perhaps be able to find his way through the author's mathematics, but without such aid he had better skip the part on p. 195.

The author seems to pin his faith to the system, almost universal in America, of transmitting by three-phase current and converting into continuous current by means of rotary converters in substations. Motor generators, direct working, or the use of boosting batteries are not even mentioned. The important matter of heating of transformers and means of cooling is dealt with in less than two pages of general remarks, but to make up for this we get plenty of catalogue pictures of plant installed by the two leading American companies. Chapter ix., treating of

insulating oils, is instructive. On p. 234 a curve is given showing the enormous influence on the insulating property of the oil of even slight traces of moisture, and the specification given on p. 239 should prove useful.

GISBERT KAPP.

#### OUR BOOK SHELF.

(1) *Algebraic Equations*. By G. B. Mathews, F.R.S. Pp. viii+64. (2) *The Theory of Optical Instruments*. By E. T. Whittaker. Pp. viii+72. Cambridge Mathematical Tracts, Nos. 6 and 7. (Cambridge: The University Press, 1907.) Price 2s. 6d. each net.

(1) THE solution of a given equation is a problem which has attracted the attention of many of the greatest mathematicians. In this tract we have a short summary of the results arrived at. The solution depends on the properties of a certain permutation-group called the Galoisian group; if this group is soluble, the equation is solvable by radicals. Interesting types of soluble groups are cyclical, Abelian, and metacyclic groups. To each of the corresponding equations is devoted a chapter in which are explained the application of cyclical groups to cyclotomy, the dependence of Abelian on cyclical equations, and Kronecker's solution of the metacyclic equation. Prof. Mathews's masterly epitome of the subject is not very easy reading, and he assumes some knowledge of Tschirnhausen's transformation, the theory of permutation-groups, &c. The student will probably have to prepare himself for the study of this tract by reading some more elementary treatise on the same subject (e.g. Dickson's "Algebraic Equations"), and some book on groups, such as Burnside's.

(2) Dr. Whittaker does not follow Prof. Mathews in writing for the advanced mathematician, but appeals in the first place to those students of physics to whom mathematics is interesting chiefly for its applications. The professed object is to give "a simple theoretical account of those defects of performance of optical instruments to which the names of coma, curvature of field, astigmatism, distortion, secondary spectrum, want of resolving power, &c., are given." Limitations of space necessitate in places proofs which, though clear, are rather too concise; but except for this the beginner will find the tract fairly straightforward reading. The author has succeeded in producing a book which will prove remarkably interesting, not only to the user of optical instruments, but also to any student of mathematics. The leading principles and results are very attractively presented, and can be readily grasped without plodding through every detail of the somewhat laborious approximations which the subject at times requires.

H. H.

*Detection of the Common Food Adulterants*. By E. M. Bruce. Pp. vii+84. (London: A. Constable and Co., Ltd., 1907.) Price 5s. net.

THE United States used popularly to be looked upon as *par excellence* the land of wooden nutmegs and similar examples of perverted manufacturing ingenuity. Perhaps, therefore, it is fitting that what our author calls "the great pure food reform" should find especial favour there. Be that as it may, there has undoubtedly arisen in the States a quickening of interest in the matter of food adulteration; wherefore Mr. Bruce speaks of health officers, food inspectors, chemistry teachers, and even students being constantly called upon to test the purity of various foods—at whose instance is not quite clear. He proposes to help them and others in this task, which he says