the labels by rubbing the surface in a moistened groove in a cake of sapolio.

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MOST IS—WHAT?

To the Editor of Science: Since the natural sciences came into their inheritance, about thirty years ago, it has been quite the orthodox thing with the "humanists" to demonstrate the inherent disability of these subjects to impart "culture" by satirically deriding the English of embryonic doctorial dissertations. Judge, therefore, of the shock to my esthetic sensibilities occasioned by this sentence, which stands on page 61 in the issue of Science for January 10: "*most of the brotherhood of teachers of English is in the same state,*" where the adjective-noun most, having the plural form because clearly referring to number and not quantity, is made the subject of a verb in the singular number. This communication appears to have been written by a professor of English and, presumably, a humanist.

F. W. Martin

SCIENTIFIC BOOKS

Methods of Measuring Electrical Resistance. By Edwin F. Northrup, Ph.D. New York, McGraw-Hill Book Company. 1912. Pp. xiii + 389. Price $4.00.

The measurement of electrical resistance is of interest not only to the physicists but to engineers and others engaged in scientific, technical and commercial work. The methods used are described in various technical and scientific papers and in text-books on electrical measurements. But only a few of these are described in any one place, if we except Price's book written about twenty years ago. The author "has selected for presentation all those methods which in his judgment are useful, for commercial tests and measurements, for purposes of instruction in educational institutions and for application in technical and research laboratories." So we have collected in one book a large number of methods covering practically the entire field of electrical resistance measurements.

The first part of the book is of an introductory character and better than any other shows the wide experience and sound judgment of the author in matters pertaining to electrical measurements. Particularly good are his comments on accuracy and method and few there are, of those who make electrical measurements, who could not read with profit the first six pages. Then follows a discussion of errors and estimation of the accuracy obtainable by deflection methods. The way an error in measurement may affect the result desired is clearly shown, but no effort is made to arrive at the probable accuracy by the means of the theory of probabilities.

Deflection methods are taken up first. Various voltmeter methods and voltmeter and ammeter methods are considered very fully. Then follows a discussion of null methods and of these the differential galvanometer methods are considered first. In this connection no mention is made of the Kohlrausch method, which is generally considered to be by far the best and by some to be the only differential galvanometer method suitable for use in the precise comparison of resistances.

In the discussion of the Wheatstone bridge methods the Carey Foster method receives the fullest consideration. Six kinds of measurements are listed for which it is stated that this method "is especially useful." For one of these measurements deflection methods give all that is usually desired. When a higher accuracy is necessary it is easily obtained by the simplest kind of a bridge. Another is of interest only to the manufacturer in the adjustment of resistance coils. The other four can, provided a substitution method is used, be made much better with a simple bridge costing not more than half as much as the Carey Foster bridge.

In the discussion concerning Wheatstone bridges various arrangements of ratio and rheostat coils, including the author's four-coil decade, are considered; the author's special bridge for reading directly the per cent. error

in the adjustment of resistance coils is described; and valuable suggestions given in regard to the selection and use of bridges and auxiliary apparatus.

Methods and apparatus for measuring low resistances and calculation of conductivities are treated fully, as are also the methods and apparatus for measuring high resistance and the insulation resistance of cables. A chapter is devoted to the measurement of resistance-containing electromotive forces, insulation resistance with power on, resistances of batteries and electrolytes. Some of the methods described here were developed by the author.

A description is given of the author's dynamometer method for measuring the resistance of an inductive conductor to alternating current. A non-inductive resistance is adjusted so that the power dissipated in it is equal to the power dissipated in the inductive resistance as shown by the dynamometer. The two resistances being in series carry the same current and therefore have the same resistance.

The methods and apparatus used in locating faults are fully described. Here again some of the methods were developed by the author.

One of the important applications of electrical methods to other physical measurements is that of the measurement of temperature or temperature changes by means of the resistance thermometer. Apparatus intended for use between 0 and 100° C. should be capable of indicating small changes in temperature with certainty to .001° C. This means that changes in the resistance of the thermometer must be measured to better than 3½ parts per million of its total resistance. Therefore, careful attention must be given to the compensation for the various changes in resistance of leads, changes in resistance of contacts, etc. As the resistance thermometer must have a small heat capacity to follow temperature changes quickly and as it has a large temperature coefficient, the power supplied by the test current must be kept very small in comparison with that which might be used in the measurement of ordinary manganin coils of the same resistance. For this reason a sensitive galvanometer is required and care must be taken to correct for the thermo-electromotive forces, practically always large enough to introduce an error of a few thousandths of a degree. In discussing resistance thermometers the author apparently fails to appreciate the importance of some of these matters, for the arrangement which he is inclined to believe "offers more advantages than any other" if used in ordinary calorimetric work should hardly be expected to give satisfactory results. Much difficulty would be experienced in an accurate compensation for the changes in the resistance of the galvanometer windings. Then unless the galvanometer were more sensitive than the one which the author states "is amply sensitive for the purpose" we should hardly expect an accuracy better than that obtainable with a good mercury in glass thermometer. The galvanometer should be at least a hundred and preferably over a thousand times more sensitive.

Under the heading "Instruments Used for Measuring Resistances" the reader will find much in the nature of good advice both to the intending purchaser and user of such apparatus.

In the consideration of deflection instruments and galvanometers attention is called to what constitutes desirable qualities in anmeters, voltmeters, pointer galvanometers and mirror galvanometers. Instruments designed by the author and constructed under his supervision are described. The author's method of comparing galvanometers is given fully, together with a table giving constants of sixteen galvanometers. In this connection no reference is made to the important papers of White and Jaeger.

In an appendix a few mathematical formulas and tables, and physical constants are given.

Practically the entire field of resistance measurements is covered and most of the methods used are well described. However it is assumed that a .01 or even a .1 per cent. is a high accuracy and sufficient for all but very exceptional cases. The book will be welcomed by almost every one who uses resistance appa-

ratus and galvanometers—by the men engaged in commercial testing because of the description of the methods suited to the needs and the good advice given in regard to the selection of apparatus for different kinds of work; by the instructor in our educational institutions because it constitutes a valuable reference book for him and his students; by the specialist because to him the author succeeds in a marked degree in giving the benefit of his wide experience in the design, construction, and use of resistance and electrical measuring apparatus.

Frank Wenner
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Metabolic Water: Its Production and Rôle in Vital Phenomena. By S. M. Babcock. Research Bulletin No. 22, The University of Wisconsin Agricultural Experiment Station, March, 1912.

The purpose of the author in this paper of 181 pages is to show that metabolic water is not only produced in considerable quantity from the organic constituents of the foods and tissues of plants and animals by oxidation and hydration, but also that water from such sources exercises a different function from imbibed water, and that in very many cases is essential to the growth and continued life of the organism in question. The studies were conducted with corn plants for the most part. The studies from the zoological standpoint were not so extensive. The animals used were clothes moth (*Tinea pellionella*); bee moth (*Galleria mellonella*); pea weevil (*Bruchus quadri-maculatus*); flour beetle (*Tribolium confusum* and *Ephestia kuehniella*).

The scope of the study is indicated by the following selected headings taken from the table of contents: Sources of metabolic water (respiration, etc.); metabolic water in seeds; germination phenomena; metabolic water in mature plants; composition of plant tissues; development of hydrolytic ferments in seeds; imbibition; reserve nutrients in plants; water content of green and ripe fruits; intramolecular respiration; water produced in animal metabolism; water requirements of animals. The author seems to have shown in a rather convincing manner that metabolic water plays an immensely important rôle in the life of both plants and animals. The paper contains many facts collected together in a form such that they should be interesting to every plant physiologist.

Raymond J. Pool
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Fresh Air and How to Use It. By Thomas Spees Carrington, M.D. The National Association for the Study and Prevention of Tuberculosis. 1912.

This little book is timely and well conceived. It finds an enormous audience prepared to welcome it through sanitary precepts from press and platform for many years. Therefore the responsibility of the author is somewhat unique. One could wish that the execution of the work might deserve unqualified praise. Fortunately it should be easy for the author to correct such matters as call for adverse criticism.

We believe that it is better to be true than to be convincing. Our author's introduction needs rewriting, for it is founded on the old conception that the prime danger from "bad air" lies in its chemical composition. His effort to put a known good thing on a scientific basis suggests the abominable method of instruction by which many popular school physiologies have been perverted for the purpose of lambasting narcotic drugs and alcohol.

In spite of a vast amount of research we are still none too well informed as to the essential physiological relations of "pure" air.

But it seems to have been demonstrated that all *morbid sensations* attributable to "foul air" depend wholly upon the effects of combined humidity and heat upon the skin. *Moving* air—a breeze—accelerates heat loss from the body, stimulates the skin in other ways and brings subjective comfort. Now in nature moving air is found most easily in the open or at least in apartments exposed to the open. Sanitary architects—God save the mark—find their task in evolving intricacies of construction whose design it is to obviate