SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

MYCOLOGY IN RELATION TO PHYTOPATHOLOGY[1]

IN preparing a presidential address one has always to meet and answer the same old question that has confronted presidents and retiring presidents of societies ever since presidents and presidential addresses were invented, *i. e.*, Should the effort be primarily to entertain and amuse, or to instruct? I fear that any effort of mine to entertain would be a grievous failure, while an effort to instruct may be but little more successful. Since of two evils we are advised to choose the lesser, I have decided to attempt something more in the line of instruction than entertainment. Instruction is usually regarded, I believe, as a more or less normal function of a specialist, and as modern social and economic conditions have compelled specialization, we must accept the consequence.

The subject of plant pathology properly includes all the phenomena connected with abnormal forms and functions of plants. These abnormal conditions may be grouped in three classes, according to their origin: First, those which are of non-parasitic origin; second, those which are caused by plant parasites; third, those which are caused by animals. Excluding from present consideration diseases directly due to animals, we have left the two classes, non-parasitic and parasitic. By far the greater part of the trouble with which the phytopathologist has to deal are caused by plant parasites. In fact, the greater part of the phytopathology of to-day might quite properly be designated parasitology, and

[1] Address of the retiring president of the Botanical Society of Washington, March 2, 1915.

broad subject of alternating current and alternating current machinery.

RALPH R. LAWRENCE

Alternating Current Machinery. By BARR and ARCHIBALD. The Macmillan Company. 496 pages and 16 plates.

The title of this book is too broad and somewhat misleading as only certain types of alternating current machinery are considered, namely: the transformer, the alternator, and the rotary converter. No mention is made of induction machines or of the synchronous motor. The first chapters are devoted to complex wave forms and their analysis and to the properties of insulating materials used in alternating current machinery. The insulation of transformers and generators is also briefly considered. The remaining chapters deal with the theory and the design of the transformer, the alternator and the rotary converter. Three chapters are devoted to the transformer. Two of these are given up to the consideration of the fundamental principles, construction and vector diagrams, while the third is confined entirely to design. Some examples of different designs are included. Nine of the remaining twelve chapters deal with the alternator. The mechanical construction of alternators, different types of armature windings, harmonics caused by teeth, and the magnetic circuit are discussed in the first of these chapters. Several chapters are devoted to the discussion of armature reaction, voltage regulation and regulation tests. The effect of a sudden short circuit is also considered. The discussion of the losses, efficiency and heating of alternators is also given considerable space. One chapter is devoted to the parallel operation of alternators. The last chapter on alternators, a chapter of about forty pages, deals only with design. Several examples of design are given. The remaining three chapters are confined to the rotary converter and take up the transformation voltage ratio, armature reaction, armature heating and output. Voltage regulation, losses and efficiency, methods of starting and parallel working are discussed. The last chapter of the book deals entirely with the design of converters, and as in the other chapters on design, examples of the design of several converters are given. It is unfortunate that the author has used clockwise and anticlockwise directions of rotation indiscriminately on the vector diagrams to indicate a positive direction of rotation. Although an arrow is added to each vector diagram to indicate which direction of rotation has been adopted, the lack of a definite convention in this connection is apt to lead to confusion. The book is in general well arranged and should be a valuable one alike to the student and the engineer.

RALPH R. LAWRENCE

SCIENTIFIC JOURNALS AND ARTICLES

THE opening (January) number of volume 16 of the *Transactions of the American Mathematical Society* contains the following papers:

G. M. Green: "On the theory of curved surfaces, and canonical systems in projective differential geometry."

H. S. White: "The multitude of triad systems on 31 letters."

G. A. Miller: "The ϕ-subgroup of a group."

R. L. Moore: "On a set of postulates which suffice to define a number-plane."

W. C. Graustein: "The equivalence of complex points, planes, lines with respect to real motions and certain other groups of real transformations."

J. E. Rowe: "Invariants of the rational plane quintic curve and of any rational curve of odd order."

M. G. Gaba: "A set of postulates for general projective geometry."

Virgil Snyder and F. R. Sharpe: "Certain quartic surfaces belonging to infinite discontinuous cremonian groups."

Joseph Slepian: "The functions of a complex variable defined by an ordinary differential equation of the first order and the first degree."

Arthur Ranum: "On the differential geometry of ruled surfaces in 4-space and cyclic surfaces in 3-space."

THE February number (Vol. 21, No. 5) of the *Bulletin of the American Mathematical Society* contains: Report of the eighth regular meeting of the Southwestern section, by O.

D. Kellogg; "Note on the potential and the antipotential group of a given group," by G. A. Miller; "The equation of Picard-Fuchs for an algebraic surface with arbitrary singularities," by S. Lefschetz; Review of Manning's Geometry of Four Dimensions, by J. L. Coolidge; "Shorter Notices"; Schröder's Entwicklung des mathematischen Unterrichts an den höheren Mädchenschulen Deutschlands, by E. B. Cowley; de Montessus and d'Adhémar's Calcul numérique and Dickson's Elementary Theory of Equations, by R. D. Carmichael; Smith's Teaching of Geometry and Smith and Mikami's History of Japanese Mathematics, by J. V. McKelvey; Study's Die realistische Weltansicht und die Lehre vom Raume and Jordan and Fiedler's Contribution à l'Etude des Courbes convexes fermées et de certaines Courbes qui s'y rattachent, by Arnold Emch; Mrs. Gifford's Natural Sines to Every Second of Arc, and Eight Places of Decimals, by D. E. Smith; Cobb's Applied Mathematics, by E. B. Lytle; von Sanden's Praktische Analysis and Hjelmslev's Darstellende Geometrie, by Virgil Snyder; "Notes"; and "New Publications."

The March number of the *Bulletin* contains: Report of the twenty-first annual meeting of the society, by F. N. Cole; Report of the winter meeting of the society at Chicago, by H. E. Slaught; "The structure of the ether," by Harry Bateman; "Shorter Notices": Killing and Hovestadt's Handbuch des mathematischen Unterrichts, Band II, by D. D. Leib; Cahen's Théorie des Nombres, Tome premier, and Darboux's Théorie générale des Surfaces, première Partie, by T. H. Gronwall; "Notes"; and "New Publications."

SPECIAL ARTICLES

INTERPOLATION AS A MEANS OF APPROXIMATION TO THE GAMMA FUNCTION FOR HIGH VALUES OF n [1]

Various approximations to the value of $\Gamma(n)$ when n is large have been suggested by different workers and are in every-day use. In actual statistical practise the one which has appealed to the writer as most satisfactory, having regard to ease of calculation and degree of accuracy of result, is that of Forsyth,[2] which is

$$\Gamma(n+1) = \sqrt{2\pi}\left(\frac{\sqrt{n^2+n+\frac{1}{6}}}{e}\right)^{n-\frac{1}{2}}.$$

This is in error (in defect) in the proportion of $1/240n^3$.

It lately occurred to me that possibly a further saving of labor in computation, without loss of accuracy, could be made by interpolating in a table of $\log \underline{|n}$ to get $\log \Gamma(n)$. Tables of the sums of the logarithms of the natural numbers have recently been made readily available to statistical workers from different sources.[3] Such tables all proceed, of course, by integral steps of the argument n.

The question then is to determine what the order of magnitude of the error will be if one interpolates from such a table proceeding by integral steps, in order to determine $\Gamma(n)$. The relation

$$\Gamma(n+1) = \underline{|n} \qquad \text{(i)}$$

is exact when n is an integer. How great is the inequality when n is not integral but fairly large?

To test this matter I asked Mr. John Rice Miner, the staff computer of the laboratory, to carry through the computations for a short series of representative values of n. This he has done, with the results set forth in Table I., for which I am greatly obliged. It should be said that in all the computations seven-place logarithms only have been used. The first column, headed "exact value," gives the result obtained by using the value of $\log \Gamma(x)$ for $x = 1.123$ from Legendre's tables, and then summing the logarithms up to $n-1$ for each desired value. This is the usual process, depending on the relation

[1] Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 80.

[2] Forsyth, Brit. Assoc. Rept. for 1883, p. 47.

[3] *Cf.* Pearl and McPheters, *Amer. Nat.*, Vol. XLV., 1911, p. 756. More recently a longer table of sums of logarithms has been published in Pearson's "Tables for Statisticians and Biometricians," Cambridge, 1914.