Mauchly Computer Corp., the talk was followed by a discussion of the relative merits of the three models.

Dr. HARRY D. HUSKEY of the MDL gave two talks at Ohio State University on May 24 at the invitation of the Graduate Mathematics Club and local chapter of Pi Mu Epsilon. In the afternoon talk, entitled "Mathematical aspects of electronic computing machines," newly planned high-speed digital computers were briefly described; the responsibilities of operating personnel were mentioned; and the impact of such machines on applied mathematics and engineering was considered. The evening talk, "Engineering aspects of electronic digital computers," described typical computer components and gave a brief indication of probable future trends of development.

On June 1 Dr. Huskey gave a one-hour invited address on "The present state of automatic digital computing machinery" at the semiannual meeting of the Association of Mechanical Engineers in Milwaukee. The history of the development of digital computing machines was covered as an introduction to the subject, and the various large-scale digital computing machines were discussed. The proposed new machines which are just now in the manufacturing stage were described in some detail, with special mention of their implications in the fields of applied mathematics and engineering and with particular emphasis on points of difference from the older machines. The generality of the new machines was stressed, and the interpretation as a general model was explained, along with some of the difficulties which must be overcome before this ideal of a general model can be realized.

As a sequel to Mr. Seeber's survey of the IBM Selective Sequence Electronic Computer, on June 15, at the NBS, Mr. KENNETH CLARK, also of the IBM, presented an informative treatment of the coding of an actual problem. In the course of this discussion many essential machine features not previously mentioned were brought out.

Personal.—STIG EKELOF, professor of Electro-Technique at Chalmers University, Göteborg, has recently returned from a trip to the United States, where he reviewed the digital computer program. Professor Ekelof is constructing a mechanical analog computer (differential analyzer).

OTHER AIDS TO COMPUTATION

Electric Root-finder

The analogy between the functions of a complex variable and the flow of electric currents in a conducting sheet has been used extensively to solve problems about currents. The inverse procedure does not seem to have been exploited as profitably as it might.

One useful function of a complex variable is the characteristic determinant whose roots are the natural frequencies of a dynamical system. Unfortunately, it is a tedious calculation to find these roots by any numerical process, when the degree of the determinant is high. An electric root-finder based on the current-flow in a conducting sheet was devised by F. LUCAS,[1] 1888–1890, but it suffers from two practical defects. First, the sheet must theoretically be infinite, which means in practice that it must be very large; and second, the current density at certain current sources must be large.

These defects can be avoided by a conformal transformation of the plane which carries the upper half-plane into a bounded region, but expands the areas surrounding the current sources.

To find the roots of various polynomials in z, we select a set of real values of z, say z_1, z_2 etc., according to any convenient scheme. The number of these values must be greater than the highest degree of the polynomials to be solved. Now form the polynomial

$$Q(z) = (z - z_1)(z - z_2) \cdots (z - z_n).$$

If $P(z)$ is a given polynomial, find the residues of $P(z)/Q(z)$ at $z_1, z_2, \cdots z_n$.

By Lucas's scheme, the upper half of the complex z-plane is plotted on a uniform conducting sheet, that in theory is semi-infinite. Currents proportional to the residues of P/Q are fed into the sheet at the corresponding points in the z-plane. Then the components of the current density at any point in the sheet are proportional to the real and imaginary parts of the function on P/Q. In particular, at a root of $P(z)$, the current density is zero. To find the roots of $P(z)$, therefore, we need only search out the points of null current and read the value of z at these points.

The same relations hold in a w-plane, where w is any analytic function of z. A useful transformation is obtained by writing

$$w = re^{i\theta},$$

where

$$\theta = 2 \tan^{-1} z, \qquad r = 1 + K/(1 - \cos n\theta).$$

This carries the real axis of the z-plane into a symmetric figure with n radial spike-like projections, whose widths are determined by the value of the real constant K.

In particular, if we choose the poles z_1, z_2 etc. at $z = \tan (2\pi/n)$, the poles of the w-plane are at the tips of the spikes. Now the length of any line segment in the w-plane is related to the length of the corresponding line segment in the z-plane by the ratio $|dw/dz|$ which is very large near one of the points $z_1, z_2, \cdots z_n$. Since the same current flows across both line segments, the current density in these regions of the w-plane is reduced, and in fact becomes finite instead of infinite as we approach the poles. Of course this is advantageous in an electrical system, where the energy dissipation must be considered.

G. R. Stibitz

[1] See *MTAC*, v. 1, p. 346–348, 352–353. F. Lucas, Acad. d. Sci., Paris, *Comptes Rendus*, (a) "Généralisation du théorème de Rolle," v. 106, 1888, p. 121–122; (b) "Détermination électrique des racines réelles et imaginaires de la dérivée d'un polynôme quelconque," *l. c.*, p. 195–197; (c) "Résolution électrique des équations algébriques," *l. c.*, p. 268–270; (d) "Détermination électrique des lignes isodynamiques d'un polynôme quelconque," *l. c.*, p. 587–589; (e) "Résolution immédiate des équations au moyen de l'électricité," *l. c.*, p. 645–648; (f) "Résolution des équations par l'électricité," *l. c.*, p. 1072–1074; (g) "Résolution électromagnétique des équations," v. 111, 1890, p. 965–967.

Bibliography Z–V

1. Alfred B. Babcock, "Slide rule for rapid computation of volumes of cylindrical, conical and rectangular tanks," *Chemical Engin.*, v. 55, no. 3, May 1948, p. 142–143. 20.8 × 28.6 cm.

2. Edwin A. Goldberg & George W. Brown, "An electronic simultaneous equation solver," *Jn. Appl. Physics*, v. 19, 1948, p. 339–345. 20 × 26.5 cm.

Summary: "An analogy device for directly solving simultaneous linear equations (without resorting to successive approximation methods) is described. It utilizes a number of high gain amplifiers interconnected by networks whose elements bear definite relationships to the known coefficients and constants of the system of equations. The stability criterion for such a system, and its application to an equation solver are described. Since the device produces the answers to a system of equations without delay, it is adaptable to problems of synthesis as well as those of analysis."

3. FRANCIS J. MURRAY, *The Theory of Mathematical Machines*. New York, Kings Crown Press, [second] revised ed., 1948. viii, 139 p. 21.5 × 28 cm. Lithographed; plastic binding. $3.00.

The general character and contents of this interesting work is indicated in the review of its first (1947) edition; see *MTAC*, v. 2, p. 317–318. Besides minor corrections, the revision of the first edition consists mainly in adding: (A) a detailed account of trigger circuits with a good mathematical treatment; (B) a chapter on electronic digital computers with special reference to the ENIAC, the IBM electronic computer, and the proposed IAS machine; (C) a short chapter entitled "Noise, accuracy and stability"; and (D) a much needed index. The pagination has been altered so that the numbering commences anew with the beginning of each of the four parts.

D. H. L.

4. F. M. TILLER, "Stagewise operations. Graphical solutions of difference equations," *Chemical Engin. Progress*, v. 44, 1948, p. 299–306. 21 × 28.7 cm.

Summary: "Operations of multiple contact extraction, plate fractionation, and plate gas absorption are stagewise by nature. The writing of material balances for these processes leads to difference equations just as material balances for differential processes lead to differential equations. In this paper a summary of graphical methods for a number of different types of equations is given. The methods are illustrated with examples in binary fractionation, plate stripping, and stagewise chemical reactions." Part I of this paper, "Stagewise operations—applications of the calculus of finite differences to chemical engineering," was published in A. I. Chem. Eng., *Trans.*, v. 40, 1944, p. 317–331.

NOTES

95. RYDBERG INTERPOLATION TABLE.—In 1934 the Departments of Physics and Astronomy of Princeton University published at Princeton: *Rydberg Interpolation Table. Values of the function* $109737 \cdot 4/(n+\mu)^2$ for all values of $n+\mu$ from 1.000 to 11.000 in steps of .001. 24 p. 30.7 × 26.9 cm. It is a 4S to 6S table with differences, for $n = 1(1)10$, $\mu = 0(.001)1$. We are told that the original calculations were made by Miss JANET MACINNES and were checked by Dr. DONALD N. READ. There is no suggestion as to any earlier table of the kind (in the field of spectroscopy), as to who Rydberg was, or as to when or where the function here tabulated first appeared. On looking into the matter I found that the function was first given in K. Svensk. Vetensk.-Akad., *Handlingar*, v. 23, no. 11, 1890, p. 42, by JOHANNES ROBERT RYDBERG (1854–1919) who, at the time of his death, was professor of physics and director of the Physical Institute at the University of Lund. The memoir in question is entitled, "Recherches sur la constitution des spectres d'émission des éléments chimiques," and there is a 5S–6S table, p. 48–51, of $109721 \cdot 6/(n+\mu)^2$, for $n = 1(1)9$, $\mu = 0(.01)1$, Δ.

R. C. A.