Electron Tube and Crystal Diode Experience in Computing Equipment	J. A. GOETZ & H. J. GEISLER, IBM Corporation
Reliability and Characteristics of the ILLIAC Electrostatic Memory	JOSEPH M. WIER, University of Illinois
Electron Tube Performance in Some Typical Military Environments	D. W. SHARP, Aeronautical Radio, Inc.
Discussion of papers	

Session V Thursday, December 10, 9:00 AM
Chairman—R. F. CLIPPINGER, Raytheon Manufacturing Company

SEAC—Review of Three Years of Operation	P. D. SHUPE, JR., & R. A. KIRSCH, National Bureau of Standards
A Review of ORDVAC Operating Experience	CHARLES R. WILLIAMS, Ballistic Research Laboratory
Some Remarks on Logical Design and Programming Checks	HERMAN H. GOLDSTINE, The Institute for Advanced Study
The Advantages of Built-in Checking	JOHN W. MAUCHLY, Remington Rand, Inc.
Recent Progress in the Production of Error Free Magnetic Computer Tape	J. C. CHAPMAN & W. W. WETZEL, Minnesota Mining and Manufacturing Company
Discussion of papers	

Session VI Thursday, December 10, 2:00 PM
Chairman—S. B. Williams, President, ACM

Reliability of Electrolytic Capacitors in Computers	MARK VAN BUSKIRK, P. R. MALLORY and Company, Inc.
Reliability and its Relation to Suitability and Predictability	E. B. FERRELL, Bell Telephone Laboratories
Case Histories in Resistor Stability	JESSE MARSTEN, International Resistance Company
Discussion of papers	
Summary	ALLEN V. ASTIN, Director, National Bureau of Standards

Group discussions were held each day at 4 PM which included the following topics:

Wednesday, December 9

Applications—Technical	GEORGE PETRIE, *Chairman*, International Business Machines Corp.
Applications—Commercial and Industrial	WALTER FRESE, *Chairman*, General Accounting Office
Diagnostic Checks	J. J. EACHUS, *Chairman*, Dept. of Defense
Magnetic Tape Standards	ALLEN SHOUP, *Chairman*, Shoup Engineering Co.
Crystal Diodes (design for reliability)	RALPH J. SLUTZ, *Chairman*, National Bureau of Standards

OTHER AIDS TO COMPUTATION

1121. W. G. ANDERSON & E. H. FRITZE, "Instrument approach system steering computer," I. R. E., *Proc.*, v. 41, 1953, p. 219–228.

This paper is mainly devoted to a theoretical discussion of a computer to be used in providing steering indications to an aircraft pilot during a blind landing using the Instrument Landing Approach System. The purpose of the computer considered is to combine signals from three sources used by a pilot in flying such an approach. These sources are the vertical gyro (bank angle), the directional gyro (deviation of heading from runway direction) and localizer receiver (lateral deviation from desired flight path).

The approach procedure is interpreted as a feedback control process. The characteristics of the data sources and the aerodynamic characteristics of the aircraft are considered in order to devise a steering indication capable of yielding suitable approaches. In particular, a system for deriving a desirable signal for rate of change of lateral deviation is described.

The computer is described briefly. It is of conventional 400-cycle analog type. The use of vacuum tubes is held to a minimum and limiters are employed to prevent indication of excessive bank angles.

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1122. A. R. Boothroyd, "Design of electric wave filters with the aid of the electrolytic tank," Inst. Elect. Eng., *Proc.*, v. 98, part IV, 1951, p. 65–93.

This article is intended as a "treatise" on the subject. An appendix gives details of tank construction.

1123. John Broomall & Leon Riebman, "A sampling analogue computer," I. R. E., *Proc.*, v. 40, 1952, p. 568–572.

The analogue computer described in this article is based on an idea of C. J. Hersch and J. F. Felker. The input of the computer consists of three steady d. c. voltages with values X, Y and Z. The computation is based on the sampling of d. c. voltages by means of electronic switching circuits using diodes. The computer has two units; the first of these is an algebraic unit, which produces a voltage pulse whose amplitude W is given by $W = kZYX^{-1}$. The second unit produces a steady voltage U in the form $aZYX^{-1} + b$ for constants a and b. In the algebraic unit the voltages Z and X are sampled and the condensers of identical RC networks are charged to these voltages. At a time t after this sampling, the two condensers have voltages $X\exp(-t/RC)$ and $Z\exp(-t/RC)$. The first of these voltages is compared by an electronic circuit with the voltage Y and when these are equal a sample pulse whose size is proportional to the second voltage is emitted by this unit. At the time t_0 when the first of these voltages equals Y, $\exp(-t_0/RC) = Y/X$, and hence at this time the second voltage has the value ZYX^{-1} up to a constant. The voltages involved have a full-scale range of 0 to 150 volts and accuracy of 1% of full scale is claimed. The "settling time" of the pulse converter is given as 30 milliseconds and presumably this is the limit on the repetition rate of the unit.

F. J. M.

1124. E. H. Fritze, "Punched card controlled aircraft navigation computer," I. R. E., *Proc.*, v. 41, 1953, p. 734–742.

The computer described is for the purpose of enabling an aircraft pilot to fly to an arbitrarily selected point. It provides indications of the heading to be flown, the distance to the selected point and the displacement of the selected point from a "master" ground station. In addition, the equipment indicates the directions from the aircraft to the master station and an auxiliary station. In flight test, the distance indications obtained during a 200 mile flight were in error by less than 2½ miles.

Input data to the computer are obtained from radio receivers which indicate the directions to a "master" and an auxiliary omnirange station. Such stations have been installed throughout the United States by the Civil Aeronautics Administration (CAA). The device is also capable of employing as input data the range and bearing of a single dme omnirange station. dme is a system planned for future installation by the CAA. Through its use, an aircraft pilot can determine the distance to a station in addition to the direction found by means of the omnirange system.

A substantial amount of auxiliary data is needed by the computer to solve its problem. The problem is basically one of triangulation. A unique feature is that such auxiliary data is stored on plastic punched cards. By positioning the card to reveal the identities of the two stations on which the triangulation is based, a set of switches is caused to insert the auxiliary data. This includes information which tunes the receivers to the selected stations, the rectangular coordinates of one station relative to the other, and a correction to account for the difference in magnetic north at the two stations.

The computer is of conventional analog type employing servomechanisms and resolvers. The basic analogy is that of alternating voltage amplitude to distance. Sign is indicated by the time phase of the alternating voltage with respect to a reference. The most severe limitation on accuracy is the uncertainty in the bearing data provided by the omnirange system.

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1125. R. M. Howe & V. S. Haneman, Jr., "The solution of partial differential equations by difference methods using the electronic differential analyzer," I. R. E., *Proc.*, v. 41, 1953, p. 1497–1508.

There exist a number of methods for solving linear partial differential equations. Frequently one can use separation of variables and reduce the problem to ordinary differential equations, which equations can then be solved on an electronic differential analyzer (cf. references 1–4 of the paper). Another way is to replace the partial differential equation by finite differences in all variables and use an arrangement such as a resistance lattice.[1] In the present article the authors consider various partial differential equations (heat equation in one and two variables, wave equation in one dimension, equation of the transverse vibrations of a beam) and replace the *spatial* derivative by finite differences obtaining a differential-difference equation. For example, in the case of the heat equation

$$C(x)\frac{\partial u}{\partial t} = \frac{\partial}{\partial x}\left[K(x)\frac{\partial u}{\partial x}\right] + f(x, t)$$

they obtain

$$C_n(du_n/dt = [K_{n+\frac{1}{2}}/(\Delta x)^2](u_{n+1} - u_n) - [K_{n-\frac{1}{2}}/(\Delta x)^2](u_n - u_{n-1}) + f_n.$$

A circuit is given solving this equation using operational amplifiers and passive elements. Similar differential-difference equations and circuits appear for the other equations considered. Sample solutions are given and comparisons with the solutions obtained by the method of separation of variables are examined.

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[1] F. J. MURRAY, *The Theory of Mathematical Machines*. New York, 1947, p. 77.

1126. R. JENKINS, H. W. BROUGH, & B. H. SAGE, "Prediction of temperature distribution in turbulent flow. Application of the analog computer," *Industrial and Engineering Chemistry*, v. 43, 1951, p. 2483–2486.

A solution obtained on the California Institute of Technology analogue computer is compared with a calculated result. The agreement is described as "fair."

1127. E. F. JOHNSON, "A pneumatic process analog for instruction and research," *Industrial and Engineering Chemistry*, v. 43, 1951, p. 2708–2711.

This instrument is used both for classroom demonstrations and in research as a check against the mathematical analysis.

1128. C. A. MENELEY & C. D. MORRILL, "Application of electronic differential analyzers to engineering problems," I. R. E., *Proc.*, v. 41, 1953, p. 1487–1496.

This is essentially an expository paper. It considers analog electronic differential analyzers of the classical type as well as those involving nonlinear elements. A brief description is given of linear computing elements (operational amplifiers used as summers, integrators, etc.) and their basic computing circuits;[1] nonlinear computing elements such as multipliers and function generators; and input-output elements such as recorders and plotters. Some typical problems in dynamics are outlined mathematically, and closed loop block diagrams for their solution are given. A representative list of applications of electronic differential analyzers is included. Finally, a few brief remarks are made concerning the amount of equipment required for a typical general purpose analyzer.

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[1] J. R. RAGAZZINI, R. H. RANDALL & F. A. RUSSELL, "Analysis of problems in dynamics by electronic circuits," I. R. E., *Proc.*, v. 35, 1947, p. 444–452.

1129. WILLIAM L. MORRIS, "Analogical computing devices in the petroleum industry," *Industrial and Engineering Chemistry*, v. 43, 1951, p. 2478–2483.

Three analog devices are described. One is the Phillips "66 Spectrocomputer," which is a direct current battery device for solving simultaneous linear equations by the Gauss-Seidel method. A second device is a servo device for solving an algebraic equation. The third is an electrical network analogue for flow problems.

1130. D. M. Swingle, "Nomograms for the computation of tropospheric refractive index," I. R. E., *Proc.*, v. 41, 1953, p. 385–391.

1131. P. R. Vance & D. L. Haas, "An input-output unit for analog computers," I. R. E., *Proc.*, v. 41, 1953, p. 1483–1486.

The device described can be used as a recorder in plane cartesian coordinates or as a curve tracer type of function generator. The unit consists of a drum on which is wrapped a piece of graph paper. The drum's rotation corresponds to one variable and the axial movement of a carriage carrying either a pen or a potentiometer type transducer corresponds to the other. Movements in both coordinates are controlled by servos and static accuracies within 0.2 per cent of full scale are claimed.

For recording purposes the unit functions in the same way as a conventional plotting board. When used as a function generator the desired function is plotted with conducting ink or a soft lead pencil and attached to the drum. The transducer, which consists of a printed circuit potentiometer card, makes electrical contact with the curve and provides the carriage servo with the error voltage required to follow the curve as the drum turns. The output is furnished by a potentiometer driven by the carriage motion. Errors in following the curve, caused by dynamic limitations of the carriage servo, are compensated by adding the servo error voltage to the output potentiometer voltage. The over-all accuracy seems to be better than one per cent within the range for which the unit is intended. The device was designed for use with the GEDA computer.

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1132. G. B. Walker, "On the electric field in a multi-grid radio valve," Inst. Elect. Eng., *Proc.*, v. 98, part III, 1951, p. 64–67.

The use of electrolytic tanks for this purpose is described.

NOTES

160.—Inverse Interpolation for the Derivative in the Complex Plane. In a recent note[1] formulas were given for finding the argument for which a function $f(x)$ has a given derivative $f'(x)$, when that function is tabulated for x at equal intervals h. Those formulas are still applicable when dealing with an analytic function $f(z)$ which is tabulated in the complex plane, so long as the arguments lie equally spaced upon any straight line in the complex plane. But for $f(z)$ tabulated over a Cartesian grid $x + iy$ of length h, greater accuracy may be had by locating the arguments $z_k = z_0 + kh$ closer together by choosing k to be small (generally complex) integers. Thus the problem is to find P, or $z = z_0 + Ph$, when given the values of $f'_z \equiv f'(z) \equiv f'(z_0 + Ph)$ and $f_k \equiv f(z_k)$ at any conveniently located points z_k. We choose the following configurations of points z_k for the