cluded two articles supplied by the PGEC, one on the PGEC itself and the other on a new photographic storage device. It is hoped that you will see fit to supply our Publications Committee with other such short news articles for inclusion in the Student Quarterly.

The Student Relations Committee has established two new PGEC activities designed to stimulate student interest in the computer field. The first is the establishment of an annual monetary prize for the best Student Quarterly article on computers written by a student. In addition, computer problems will be presented in the Student Quarterly, and a prize awarded for the best solution submitted by a student.

The Student Relations Committee is currently studying the possibility of establishing a computer scholarship sponsored by the PGEC.

Publications—The PGEC is attempting to establish a special annual subscription rate for the PGEC TRANSACTIONS for bona fide members of certain professional societies with which it is hoped to make reciprocal arrangements. This plan is now being worked out under the supervision of the Publications Committee for presentation to the IRE.

It is planned to discontinue the institutional listings in the PGEC TRANSACTIONS.

The Administrative Committee has approved the establishment of awards of $50.00 each for the best three papers appearing in the TRANSACTIONS each year.

Harry T. Larson
Chairman
IRE Professional Group on
Electronic Computers

CHAPTER ACTIVITIES

New York—The October meeting of this chapter was held at the analog-digital computer installation of the Reeves Instrument Company. The Elecom Computers were described at the November meeting, and the "Feasibility of an All-Magnetic Digital Computer" was discussed by Isaac L. Auerbach, Burroughs, in December. A lecture series entitled "Digital Computers in Control Systems" was jointly sponsored by the AIEE during February and March.

Dallas-Fort Worth—Extremely active in the analog computer field, this chapter is compiling a directory of electronic differential analyzer installations and is also proposing a National Simulation Conference in January, 1956, at Dallas. For information on either topic, get in touch with the Chapter Chairman, Louis B. Wadel, 3905 Centenary Drive, Dallas 25, Texas.

Baltimore—Those interested in the formation of the Baltimore Chapter of the PGEC are urged to get in touch with Mr. George W. Oberle, Glenn L. Martin Co., Baltimore 3, Md.

MEETING NOTICES

Mar. 1– 3—Western Joint Computer Conference, Hotel Statler, Los Angeles, Calif.
Mar. 21–24—IRE National Convention, Waldorf-Astoria and Kingsbridge Armory, New York, N. Y.
Apr. 13–15—AIEE Southern District Meeting, St. Petersburg, Fla.
May 4– 6—AIEE Middle Eastern District Meeting, Columbus, Ohio.
May 18–20—IRE-AIEE-IAS-ISA National Telemetering Conference, Hotel Morrison, Chicago, Ill.
May 26–27—IRE-AIEE-RETMA-WCEMA Electronics Components Conference, Los Angeles, Calif.
Sept. 14–16—Annual National Convention, ACM, University of Pennsylvania, Philadelphia, Pa.

COMPUTER PAPERS FOR 1955 WESCON

The annual Western Electronics Show and Convention (WESCON) will be held in San Francisco, from August 24–26, 1955. It is sponsored jointly by the West Coast Electronic Manufacturers' Association and the San Francisco and Los Angeles Sections representing the Seventh Region of the I.R.E.

Papers for this convention should be mailed to Dr. W. A. Edson at the Applied Electronics Laboratory, Stanford, Calif. In addition to the title, authors are asked to submit an abstract of approximately 200 words, suitable for reproduction in the program, and either the complete manuscript or sufficient additional information to permit evaluation by the Technical Program Committee. Early submission of papers is desired, the final deadline being May 1. This is the latest date which is operationally feasible, and papers received thereafter cannot be considered.

Authors should say if demonstrations are planned and should indicate what facilities, such as slide or movie projectors, power sources, etc., are required.

Review of Electronic Computer Progress During 1954

DAVID R. BROWN†, EDITOR

THE ELECTRONIC computer field continues to expand at a rapid rate. New developments, applications, and publications are too numerous for one person to keep informed of all aspects. In this review a complete report will not be attempted, but some highlights and selected references will be reported.

(1) B. V. Bowden, Ed., "Faster Than Thought, A Symposium on Digital Computing Machines," Sir Isaac Pitman and Sons, London; 1953.

SYSTEMS

Business Applications

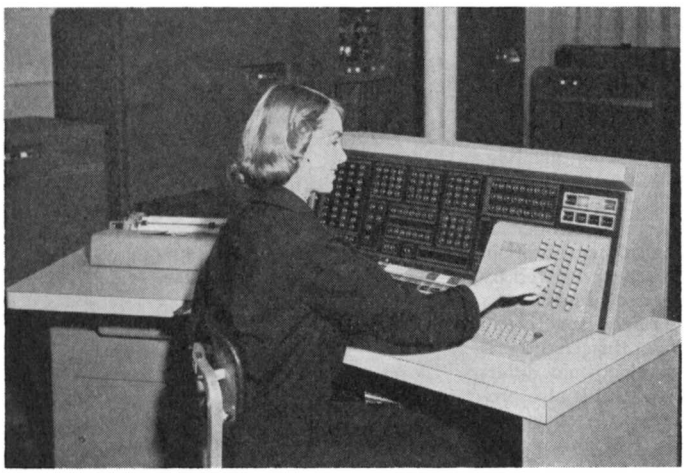
Business applications of electronic digital computers have sharply increased, attracting much attention.

† Lincoln Laboratory, Mass. Inst. Tech., Lexington, Mass.

(2) M. E. Davis, "Use of electronic data-processing systems in the life insurance business," *Proc. of the Eastern Joint Computer Conference*, Washington, D. C., pp. 11–17; December 8–10, 1953.
(3) O. Whitby, "The automatic handling of business data," *Proc. of the Western Computer Conference*, Los Angeles, California, pp. 75–79; February 11–12, 1954.
(4) A. St. Johnston and S. L. H. Clarke, "Applications of high-speed electronic computers to business-accounting problems," *Jour. Brit. I.R.E.*, vol. 14, pp. 293–302; July, 1954.

The different electronic systems used for these applications have a wide range of size, complexity, and cost.

A model of the IBM Type 702, a large-scale electronic data-processing machine for business use, has been in use in the laboratory for the greater part of the year. It is a serial, stored-program, decimal machine. Several unusual logical features, including variable word lengths and variable record lengths, are provided to aid in programming accounting problems. The 702



Operator's console of the IBM Type 702 data-processing machine.

incorporates magnetic tape, electrostatic memory supplemented by magnetic drums, punched-card document input and output, and a page printer. Later in the year the Type 705 was announced as a successor to the Type 702. It has about twice the over-all speed, a magnetic-core memory of twice the size, and several new instruction features.

(5) C. J. Bashe, W. Buchholz, and N. Rochester, "The IBM type 702, an electronic data processing machine for business," presented at the ACM Meeting, Ann Arbor, Michigan, June 23, 1954; to be published in the *Jour. Ass. Computing Machinery.*

Business installations of the Remington Rand UNIVAC electronic data-processing system include the General Electric Company in Louisville, Kentucky, Metropolitan Life Insurance Company in New York, and the National Tube Division of US Steel in Pittsburgh. The first installation, at Appliance Park, newly constructed home of General Electric's major appliance division, is to process payroll, labor distribution, material scheduling, and inventory control. Plans call for the additional processing of commercial service, billing, and general and cost accounting by the end of 1954. Compared with conventional methods in the same administrative areas, annual savings of $500,000 are estimated in performing these initial functions alone. UNIVAC's potential, however, permits planning to enlarge its scope considerably. One of the computer's most important eventual uses at Appliance Park is expected to be in the compilation of sales statistics and the preparation of market forecasts for division and product department management.

In May of 1954, Remington Rand's ERA Division installed an ore-car data-processing system for the Great Northern Railroad in northern Minnesota. This system contains electromechanical data-gathering, storing, and computing equipment for assembling, processing, transmitting, and recording data relative to the automatic weighing of ore cars which are in motion.

The Burroughs Corporation has announced the E101 desk-size electronic digital computer. This is a general-purpose computer with a magnetic-drum memory having a 100-word capacity. Data are introduced into the E101 through a keyboard and printed from the machine at speeds up to 24 characters per second. The machine automatically selects the proper columns to print answers. It is flexible with respect to the size and shape of the document used and will handle up to six carbon copies. Results are immediately available in usable form.

Telecomputing Corporation has announced a large-capacity, random-access, magnetic memory designed for industrial and business data-processing problems. Christened "MASS" (for multiple-access storage system), the unit has a capacity of 120 million bits and an access time of less than one second. Facilities for read-in, read-out, and updating are provided. The first MASS will be delivered to Wright Air Development Center and will be used in a study of Air Force inventory control problems.

(6) A. A. Cohen, "The role of general purpose digital computers in automatic control and information systems," 1954 IRE CONVENTION RECORD, Part 4, Electronic Computers and Information Theory, pp. 82–86.
(7) J. M. M. Pinkerton, E. J. Kaye, E. H. Lenaerts, and G. R. Gibbs, "Leo (Lyons Electronic Office)," *Electronic Eng.* (London), vol. 26, pp. 284–291, 335–341, 386–392; July, August, September, 1954.

High-speed printer of the UNIVAC system for handling large volume output. It is capable of printing 600 lines per minute.

Control Applications

The application of computers to both open- and closed-loop control systems offers a field of tremendous potentiality. The DIGITAC, the first airborne control system employing a general-purpose digital computer, was announced early during the year. This system is an automatic navigation and weapons control system that has been developed and successfully flight tested. The digital computer employed in the system is a general-purpose relative-address machine with a serial magnetic-drum memory. The clock frequency is 100 kilocycles per second and the memory capacity is approximately 1,200 words of 16 bits plus sign. The computer includes 260 electron tubes, 1,300 germanium diodes, and occupies a volume of about 5 cubic feet.

(8) R. B. Conn, "Digital computers for linear real-time control systems," *Proc. of the Eastern Joint Computer Conference*, Washington, D. C., pp. 33–37; December 8–10, 1953.
(9) V. I. Weihe, "Computer applications in air traffic control," *Proc. of the Eastern Joint Computer Conference*, Washington, D. C., pp. 18–21; December 8–10, 1953.
(10) D. W. Burbeck, E. E. Bolles, W. E. Frady, and E. M. Grabbe,

"The DIGITAC airborne control system," *Proc. of the Western Computer Conference*, pp. 38–44; Los Angeles, California, February 11 and 12, 1954.

Scientific Applications

The development of bigger and better large-scale general-purpose computers intended primarily for scientific applications continues at a rate which demonstrates that the number of organizations which need such a computer has been underestimated.

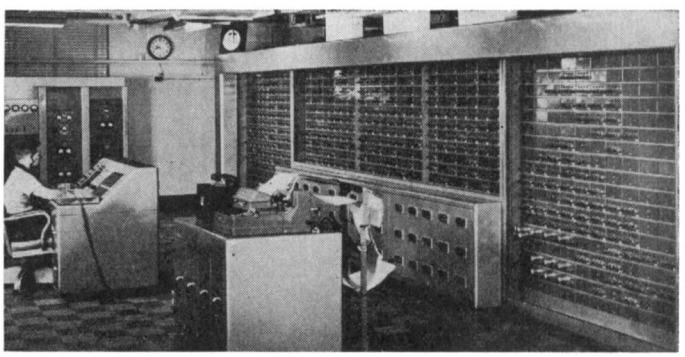
During 1954, IBM announced several additions to its line of electronic data-processing machines following their release in 1953 of the Type 701, a high-speed, parallel, binary machine for scientific computation. At the end of 1954, there were eighteen of the Type 701 machines installed and in full operation. A model of a new machine, Type 704, which is intended for the same general applications, has meanwhile been placed in operation in the laboratory and is scheduled for early production. The Type 704 contains many new features including index registers, logical addition and multiplication, and built-in floating-point arithmetic. It uses a magnetic-core memory of 4,096 words, faster magnetic drums, and faster magnetic-tape. The 704 is at least twice as fast as the 701. In many applications the new features combine to give an even higher over-all speed. Floating-point addition, for instance, is twenty times as fast on the 704 as on the 701, where programmed floating-point addition must be used.

Another IBM computer for scientific problems was announced and demonstrated on December 2, 1954. This is the Naval Ordnance Research Calculator (NORC) built by IBM expressly for the Navy Bureau of Ordnance. According to its designers, it is the fastest existing large-scale computer. It executes about 15,000 three-address stored-program instructions per second including automatic address modification and floating point, operating directly in the decimal system and employing some unusual checking features. Two words of 13 decimal digits (plus a 2-digit exponent and sign) are multiplied in 31 microseconds exclusive of access to the electrostatic memory. The programmer has the option of using floating-point operation or specifying the decimal-point position. The NORC has magnetic-tape input and output of unusually high density and speed attaining a rate of 70,000 decimal digits per second.

Three ERA 1102 digital computer systems were built for the USAF Arnold Engineering Development Center. Each system is operated on line to reduce experimental data to tabular and plotted form. As many as 250 sensing transducers are scanned under computer-programmed control during each data-reduction cycle. The first two of these were delivered in 1954.

During 1954, ERA 1103 computer systems were installed and put into operation on several new types of work, including engineering design computations and data reduction. A comprehensive computer-programmed maintenance technique applicable to the ERA 1103 computer system was developed. During the first six months of 1954 this technique increased the average hours of production time between unscheduled interruptions from 18 to 41 hours.

(11) S. R. Cray, "Computer-Programmed Preventive Maintenance for Internal Memory Sections of the ERA 1103 Computer System," presented at the Western Electronic Show and Convention, August 25–27, 1954, Los Angeles, California.



NAREC installation at the Naval Research Laboratory, Washington, D. C.

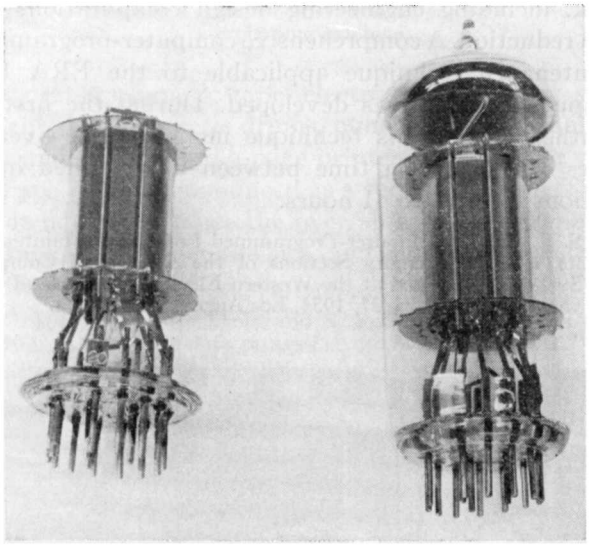
Burroughs E101 desk-size computer.

The NAREC has been placed in operation with its electrostatic-storage system during the past year. This computer, located at the Naval Research Laboratory, Washington, D. C., is a high-speed, asynchronus, 45-bit parallel machine used for mathematical calculations and data reduction associated with many scientific problems of the laboratory. It is equipped with 1,024 words of electrostatic storage and at present 1,536 words of magnetic-drum storage. Early in 1955, the drum capacity will be increased to 8,192 words of storage. Punched paper and magnetic tape are used for input and output with an auxiliary photoelectric punched paper-tape reader, the Flexowriters operating either directly from the computer output or on a delayed basis as read from slowly-moving magnetic-tape playback. The NAREC is built completely on a plug-in chassis system and is provided with automatic checking within the arithmetic section, both of which aid in the main-

tenance problems and location of faults. The electrostatic storage utilizes three standard three-inch cathode ray tubes for each forty-five digits, a system that has proven valuable in avoiding moderate storage-surface blemishes and has increased the usable read-around ratio by an appreciable amount.

At the Ballistic Research Laboratories, Aberdeen Proving Ground, the ENIAC completed its eighth year as an operating machine in February, 1954. A number of basic improvements during this period has enabled the ENIAC to remain efficient of operation.

(12) A. L. Leiner and S. N. Alexander, "System organization of the DYSEAC," *Trans. I.R.E.*, vol. EC-3, pp. 1–10; March, 1954.
(13) D. B. G. Edwards, "The Manchester University high-speed digital computer," *Jour. Brit. I.R.E.*, vol. 14, pp. 269–278; June, 1954.



Burroughs beam-switching tube, a high-vacuum device with ten discrete outputs capable of operating at frequencies greater than 1 megacycle per second.

Operating Experience

Operating experience has been reported for a number of large-scale systems.

(14) P. D. Shupe and R. A. Kirsch, "SEAC—review of three years of operation," *Proc. of the Eastern Joint Computer Conference*, Washington, D. C., pp. 83–90; December 8–10, 1953.
(15) B. Loveman, "Reliability of a large REAC installation," *Proc. of the Eastern Joint Computer Conference*, Washington, D. C., pp. 53–57; December 8–10, 1953.
(16) R. Kopp, "Experience on the Air Force UNIVAC," *Proc. of the Eastern Joint Computer Conference*, Washington, D. C., pp. 62–66; December 8–10, 1953.
(17) R. B. House, "Reliability experience on the OARAC," *Proc. of the Eastern Joint Computer Conference*, Washington, D. C., pp. 43–44; December 8–10, 1953.
(18) C. R. Williams, "A review of the ORDVAC operating experience," *Proc. of the Eastern Joint Computer Conference*, Washington, D. C., pp. 91–95; December 8–10, 1953.
(19) W. G. Bouricius, "Operating experience with the Los Alamos 701," *Proc. of the Eastern Joint Computer Conference*, Washington D. C., pp. 45–47; December 8–10, 1953.
(20) F. J. Murray, "Acceptance test for Raytheon Hurricane computer," *Proc. of the Eastern Joint Computer Conference*, Washington D. C., pp. 48–52; December 8–10, 1953.

General

Selected references dealing with computer systems are listed.

(21) J. Smagorinsky, "Data processing requirements for numerical weather prediction," *Proc. of the Eastern Joint Computer Conference*, Washington, D. C., pp. 22–30; December 8–10, 1953.
(22) J. M. Salzer, "Frequency analysis of digital computers operating in real time," PROC. I.R.E., vol. 42, pp. 457–466; February, 1954.
(23) A. L. Freedman, "Elimination of waiting time in automatic computers with delay-type stores," *Proc. Cambridge Phil. Soc.*, vol. 50, part 3, pp. 426–438; July, 1954.
(24) H. H. Goldstine, "Some remarks on logical design and programming checks," *Proc. of the Eastern Joint Computer Conference*, Washington, D. C., pp. 96–98; December 8–10, 1953.
(25) J. W. Mauchly, "The advantages of built-in checking," *Proc. of the Eastern Joint Computer Conference*, Washington, D. C., pp. 99–101; December 8–10, 1953.
(26) S. N. Alexander and R. D. Elbourn, "National Bureau of Standards performance tests," *Proc. of the Eastern Joint Computer Conference*, Washington, D. C., pp. 58–61; December 8–10, 1953.
(27) E. L. Braun, "Design features of current digital differential analyzers," 1954 IRE CONVENTION RECORD Part 4, "Electronic Computers and Information Theory," pp. 87–97.
(28) W. E. Scott and A. D. C. Haley, "Some comparisons between analogue and digital computers," *Jour. Brit. I.R.E.*, vol. 14, pp. 476–486; October, 1954.

COMPONENTS AND TECHNIQUES

New Components and Circuits

New components, such as the transistor and the magnetic core, are being used to replace electron tubes and make more reliable and compact systems possible. Techniques to use these new components are being investigated intensively in the laboratory but no operational systems employing these techniques have reached the users of computing systems.

An experimental all-transistor calculator, which has the functions of the familiar IBM Type 604 electron-tube calculator, including input and output, was demonstrated publicly on October 7, 1954. This was probably the first showing of an entirely transistorized calculator in operation, complete with input and output. The transistors are of the junction type and mounted on pluggable units with printed wiring. No electron tubes are used in this experimental machine, which is about half the size and requires only 5 per cent of the power production-line electron-tube counterpart.

The Minnesota Electronics Corporation reports operation of an engineering model of an all-magnetic-core data-processing system.

Both transistor circuits and magnetic-core circuits appear promising and large systems employing these techniques can be expected during the next few years.

(29) R. H. Baker, I. L. Lebow and R. E. McMahon, "Transistor shift registers," PROC. I.R.E., vol. 42, pp. 1152–1159; July, 1954.
(30) C. Huang, E. Slobodzinski and B. White, "Transistor shift registers," 1954 IRE CONVENTION RECORD, Part 4, "Electronic Computers and Information Theory," pp. 140–144.
(31) E. U. Cohler, "Transistor flip-flops for high-speed digital computers," presented at the Western Electronic Show and Convention, August 25–27, 1954, Los Angeles, California.
(32) V. L. Newhouse, "Review of magnetic and ferroelectric computing components," *Electronic Eng.* (London), vol. 26, pp. 192–199; May, 1954.
(33) S. Guterman, R. D. Kodis, and S. Ruhman, "Circuits to perform logical and control functions with magnetic cores," 1954 IRE CONVENTION RECORD, Part 4, "Electronic Computers and Information Theory," pp. 124–132.
(34) R. C. Minnick, "Magnetic switching circuits," *Jour. Appl. Phys.*, vol. 25, pp. 479–485; April, 1954.
(35) B. Moffat, "Saturable transformers as gates," *Electronics*, vol. 27, pp. 174–176, 178; September, 1954.
(36) D. A. Buck and W. I. Frank, "Nondestructive sensing of magnetic cores," *Trans. AIEE, Part 1*, "Communication and Electronics," vol. 72, pp. 822–830; January, 1954.
(37) A. Papoulis, "Nondestructive read-out of magnetic cores," PROC. I.R.E., vol. 42, pp. 1283–1288; August, 1954.
(38) R. W. Rutishauser, "Ferroresonant flip-flop design," *Electronics*, vol. 27, pp. 152–153; May, 1954.

(39) S. Guterman and R. D. Kodis, "Magnetic core selection systems," 1954 IRE CONVENTION RECORD, Part 4, "Electronic Computers and Information Theory," pp. 116–123.

An interesting high-speed computer circuit was developed at the Bureau of Standards using neither magnetic cores nor transistors, but using the hole storage in a diode as the basis for operation.

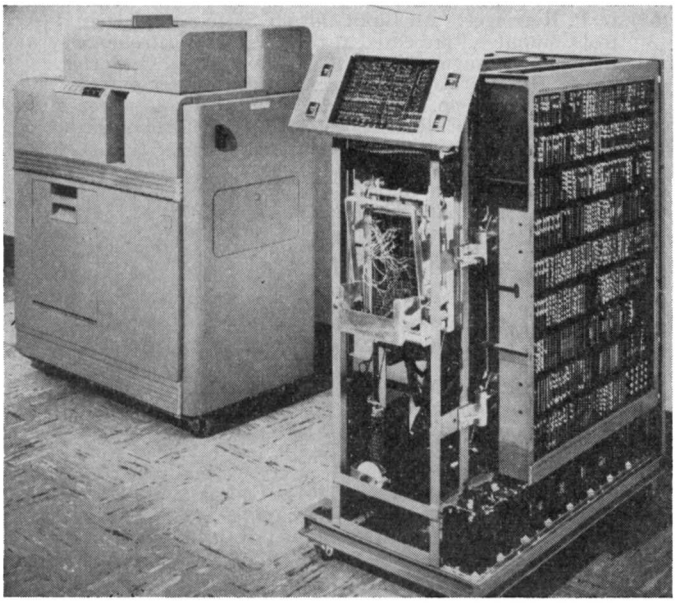
(40) A. W. Holt, "Diode amplifier," *Tech. Bull. Nat. Bur. Stand.*, vol. 38, pp. 145–148; October, 1954.

Some references to other techniques are listed.

(41) D. A. Huffman, "Synthesis of sequential switching circuits," *Jour. Frank. Inst.*, vol. 257, pp. 161–190, 275–303; March, April, 1954.
(42) A. D. Booth and A. D. Holt, "Selenium rectifier in digital computer circuits," *Electronic Eng.* (London), vol. 26, pp. 348–355; August, 1954.
(43) J. J. Bruzac, "New flip-flop chain circuits used in computers for counting to base 10 and base 12," *Onde Elec.*, vol. 34, pp. 59–62; January, 1954.
(44) J. R. Stock, "An arithmetic unit for automatic digital computers," *Z. Angew. Phys.*, vol. 5, pp. 168–172; March 15, 1954.
(45) N. Zimbel, "Packaged logical circuitry for a 4 MC computer," 1954 IRE CONVENTION RECORD, Part 4, "Electronic Computers and Information Theory," pp. 133–139.
(46) G. Piel, "Electronic-circuit technique for a high-speed computer," *Onde Elec.*, vol. 34, pp. 38–46; January, 1954.

Memory Techniques

The magnetic-core memory appears to provide a very successful high-speed memory technique. A 4,096-word magnetic-core memory in MIT's Memory Test Computer is now operated on a routine basis with a read-rewrite cycle of 6 microseconds. A number of magnetic-core memories are being constructed to replace electrostatic storage in existing general-purpose computers. A 4,097-word memory is to be installed in Rand Corporation's JOHNNIAC at the end of 1954. The first ERA 1103 computer system with coincident-current magnetic-core memory was delivered to a government user and placed in operation in November 1954.

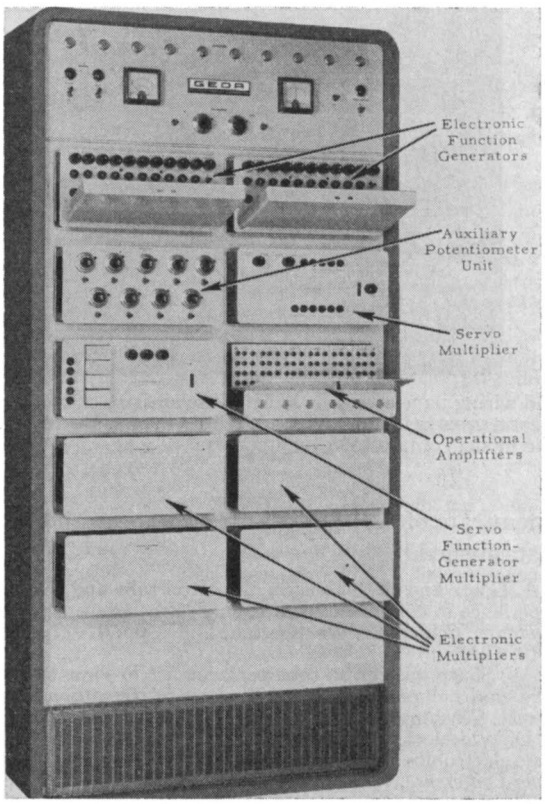


IBM's experimental all-transistor calculator. This new experimental computer is composed of a high-speed punching unit (left) and the transistorized calculating unit at right. The calculating unit is uncovered to show the bank of printed wiring panels on which the transistors are mounted. This "all-transistor" unit is approximately one-half the size of a vacuum-tube unit of comparable capacity and requires only 5 per cent as much power.

(47) W. N. Papian, "The MIT magnetic-core memory," *Proc. of the Eastern Joint Computer Conference*, Washington, D. C., pp. 37–42; December 8–10, 1953.
(48) J. R. Freeman, "Pulse Response of Ferrite Memory Cores," presented at the Western Electronic Show and Convention, August 25–27, 1954, Los Angeles, California.

For descriptions of other memory techniques see:

(49) G. L. Hollander, "Fundamentals of Photographic Data Storage," presented at the Western Electronic Show and Convention, August 25–27, 1954, Los Angeles, California.
(50) J. M. Wier, "Reliability and characteristics of the Illiac electrostatic memory," *Proc. of the Eastern Joint Computer Conference*, Washington, D. C., pp. 72–76; December 8–10, 1953.
(51) R. J. Klein, "Automatic beam current stabilization for Williams tube memories," *Trans. I.R.E.*, vol. EC-2, pp. 8–10; December, 1953.
(52) R. D. Ryan, "A mercury delay-line memory unit," PROC. I.R.E. (Australia), vol. 15, pp. 89–95; April, 1954.
(53) D. R. Quested and A. D. Booth, "Phonic wheel generator for position indication in digital computer magnetic drum storage," *Jour. Sci. Instr.*, vol. 31, pp. 357–360; October, 1954.

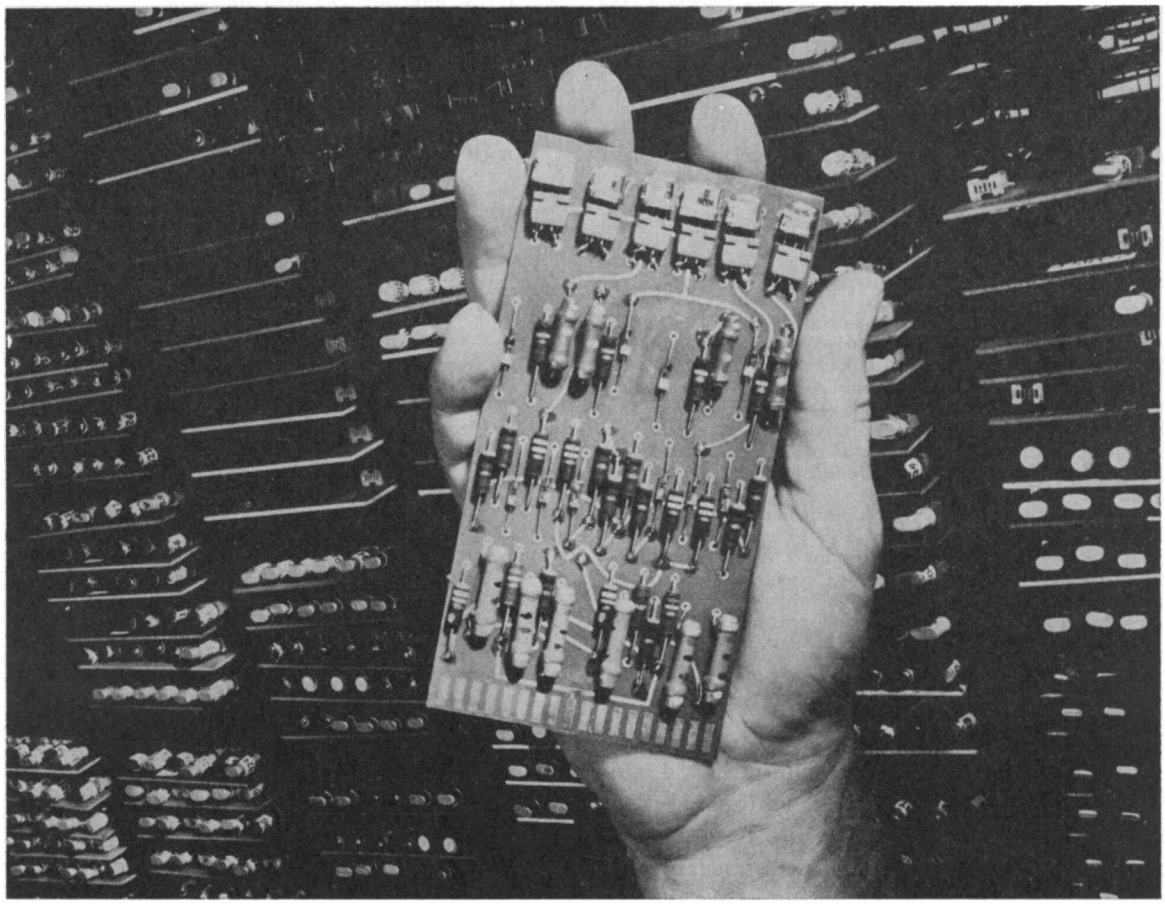


Goodyear Aircraft Corporation's N3GEDA analog computer.

Component Reliability

Component reliability is of primary importance in the design and operation of large electronic computers. Information on reliability is difficult to obtain and difficult to present. More effort is being directed toward understanding and improving reliability.

On May 1, 1954, TRADIC (Transistor Digital Computer) was put on life test at BTL and since then has been running 24 hours a day, 7 days a week. The TRADIC computer was designed for military applications and has a restricted memory capacity. It is, however, a general purpose computer and runs at a megacycle rate. It uses 700 transistors and 11,000 diodes. During its 5,500 hours of operation, a transistor replacement rate of 0.10 per cent per thousand hours and a diode re-



Printed wiring panels used in IBM's all-transistor calculator. These printed wiring panels simplify production and maintenance and also effect a great reduction in space requirements. Devices mounted on the panel include transistors (extreme left), diodes, and resistors. The model contains 595 such panels.

placement rate of 0.01 per cent per thousand hours have been established.

(54) J. A. Goetz and H. J. Geisler, "Electron tube and crystal diode experience in computing equipment," *Proc. of the Eastern Joint Computer Conference*, Washington, D. C., pp. 67–72; December 8–10, 1953,
(55) D. W. Sharp, "Electron tube performance in some typical military environments," *Proc. of the Eastern Joint Computer Conference*, Washington, D. C., pp. 77–83; December 8–10, 1953.
(56) L. D. Whitelock, "Methods used to improve reliability in military electronics equipment," *Proc. of the Eastern Joint Computer Conference*, Washington, D. C., pp. 31–33; December 8–10, 1953.
(57) L. Knight, "Valve reliability in digital calculating machines," *Electronic Eng.* (London), vol. 26, pp. 9–13; January, 1954.
(58) E. B. Ferrell, "Reliability and its relation to suitability and predictability," *Proc. of the Eastern Joint Computer Conference*, Washington, D. C., pp. 113–116; December 8–10, 1953.
(59) J. C. Chapman and W. W. Wetzel, "Recent progress in the production of error-free magnetic computer tape," *Proc. of the Eastern Joint Computer Conference*, Washington, D. C., pp. 102–104; December 8–10, 1953,
(60) M. VanBuskirk, "Reliability of electrolytic capacitors in computers," *Proc. of the Eastern Joint Computer Conference*, Washington, D. C., pp. 105–108; December 8–10, 1953.
(61) J. Marsten, "Resistor reliability—whose responsibility?" *Proc. of the Eastern Joint Computer Conference*, pp. 109–112; December 8–10, 1953.

Input and Output Techniques

As the field of application of electronic computers increases, the many different input-output requirements result in a variety of techniques.

(62) F. Raasch, "A progressive code digital quantizer," *Trans. AIEE*, Part I, "Communication and Electronics," vol. 72, pp. 567–571; November, 1953.
(63) S. Lubkin, "Electrostatic reading of perforated media," 1954 IRE Convention Record, Part 4, "Electronic Computers and Information Theory," pp. 106–108.
(64) R. A. Langevin, "A germanium tape reader," 1954 IRE Convention Record, Part 4, "Electronic Computers and Information Theory," p. 105.
(65) L. P. Retzinger, "An Input-Output System for a Digital Control Computer," presented at the Western Electronic Show and Convention, August 25–27, 1954, Los Angeles, California.
(66) C. W. Fritze, "Tape recorder stores computer output," *Electronics*, vol. 27, pp. 166–169; July, 1954.
(67) T. Kilburn and E. R. Laithwaite, "Servo control of the position and size of an optical scanning system," *Proc. I.E.E.* (London), Part IV, vol. 101, pp. 129–134; February, 1954.
(68) "FOSDIC—A film optical sensing device for input to computers," *Tech. Bull. Nat. Bur. Stand.*, vol. 38, pp. 24–27; February, 1954.

Analog Techniques

A number of new analog techniques have appeared, particularly for the difficult problem of multiplication.

(69) M. Mehron and W. Otto, "Instantaneous multiplier for computers," *Electronics*, vol. 27, pp. 144–148; February, 1954.
(70) G. G. Savant, Jr., and R. C. Howard, "Multiplier for analog computer," *Electronics*, vol. 27, pp. 144–147; September, 1954.
(71) K. H. Norsworthy, "A simple electronic multiplier," *Electronic Eng.* (London), vol. 26, pp. 72–75; February, 1954.
(72) D. W. Slaughter, "Time-shared amplifier stabilizes computers," *Electronics*, vol. 27, pp. 188–190; April, 1954.
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