

# COMPUTERS AND AUTOMATION

CYBERNETICS • ROBOTS • AUTOMATIC CONTROL

Vol. 3  
No. 9

**Computers in Great Britain**

... Stanley Gill

**Analog Computers and their Application to Heat Transfer  
and Fluid Flow – Part I**

... John E. Nolan

**All-Transistor Computer**

... Neil Macdonald

**Roster of Organizations in the Field of Computers and Automation  
(cumulative)**

**Automatic Computing Machinery – List of Types**

NOV.  
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**CYBERNETICS • ROBOTS • AUTOMATIC CONTROL**

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**ARTICLE**

Computers in Great Britain	... Stanley Gill	6
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**PAPER**

Analog Computers and Their Application to Heat Transfer and Fluid Flow -- Part 1	... John E. Nolan	20
----------------------------------------------------------------------------------	-------------------	----

**REFERENCE INFORMATION**

Roster of Organizations in the Field of Computers and Automation (cumulative)		9
-------------------------------------------------------------------------------	--	---

Automatic Computing Machinery -- List of Types		24
------------------------------------------------	--	----

Patents		26
---------	--	----

**FORUM**

Attractive Computers	... Bill Danch	4
----------------------	----------------	---

Assembly Line Control by Punch Cards	... George W. Patterson	26
--------------------------------------	-------------------------	----

All-Transistor Computer	... Neil Macdonald	28
-------------------------	--------------------	----

The Editor's Notes		4
--------------------	--	---

Advertising Index		38
-------------------	--	----

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## THE EDITOR'S NOTES

Crucial Knowledge -- the Knowledge that Something Exists. Often when one investigates a subject, the crucial knowledge is finding out that something exists or can be done. For instance, if you are investigating from whom to buy an automatic inventory machine, the crucial knowledge is finding out who offers such machines for sale. A man who has never heard that the ABC Company offers automatic inventory machines for sale is hardly in a position to consider buying from them.

To supply this crucial knowledge of existence in the field of computers and automation we have published various kinds of rosters and reference lists; there are now ten kinds. And in this issue over 11 pages have been used to give a cumulative Roster of about 230 organizations in the field of computers and automation.

Yet one reader, whom we shall call J. Moines since that is not his real name, has said to us "You should not publish this valuable information for so little; you should restrict it, give it only to advertisers perhaps, keep it for your own advantage." We don't agree with Mr. Moines. Our purpose as a magazine is to be as useful as we can be; and we believe these rosters and lists help the men in the field? What do you think?

Address Changes. If your address changes, please notify us giving both old and new addresses, and allow three weeks for the change.

Back Copies. See the information on page 34.

Manuscripts. We are interested in articles and papers. To be considered for any particular issue, the manuscript should be in our hands by the 5th of the preceding month.

Articles. We desire to publish articles that are factual, useful, understandable, and interesting to many kinds of people engaged in one part or another of the field of computers and automation. In this audience are many people who have expert knowledge of some part of the field, but who are laymen in other parts of it. Consequently a writer should seek to explain his subject, and show its context and significance. He should define unfamiliar terms, or use them in a way that makes their meaning unmistakable. He should identify unfamiliar persons with a few words. He should use examples, details, comparisons, analogies, etc., whenever they may help readers to understand a difficult point. He should give data supporting his argument and evidence for his assertions. We look particularly for articles that explore ideas in the field of computers and automation, and their applications

and implications. An article may certainly be controversial if the subject is discussed reasonably. Ordinarily, the length should be 1000 to 4000 words, and payment will be \$10 to \$50 on publication. A suggestion for an article should be submitted to us before too much work is done.

Technical Papers. Many of the foregoing requirements for articles do not necessarily apply to technical papers. Undefined technical terms, unfamiliar assumptions, mathematics, circuit diagrams, etc., may be entirely appropriate. Topics interesting probably to only a few people are acceptable. No payment will be made for papers. If a manuscript is borderline, it may be returned to the author to be modified to become definitely either an article or a paper.

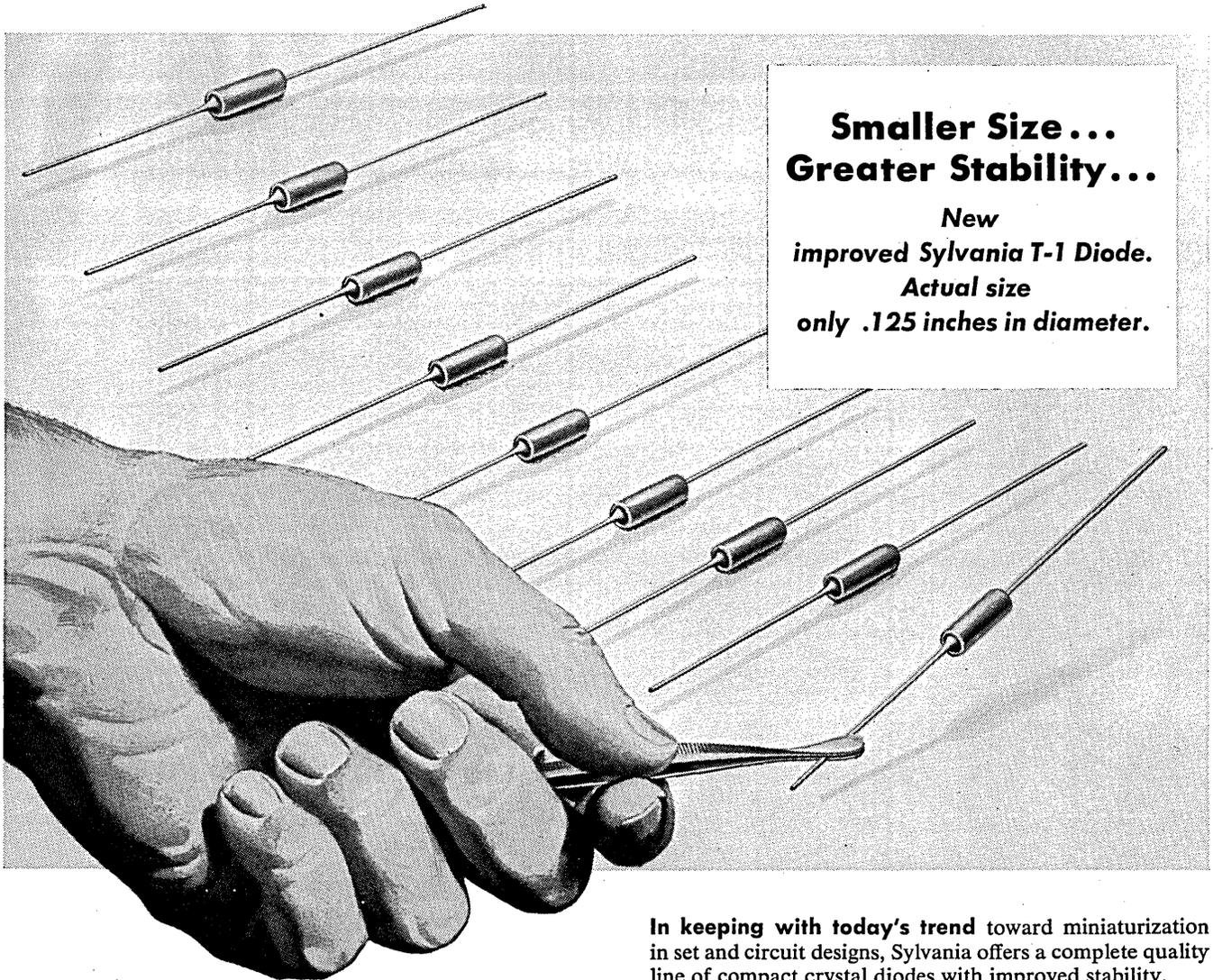
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Forum: ATTRACTIVE COMPUTERS  
Bill Danch, Woodstock, N.Y.



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# COMPUTERS IN GREAT BRITAIN

Stanley Gill

(After luncheon talk delivered at the meeting of the Association for Computing Machinery, Ann Arbor, Michigan, June 25th, 1954)

Eleven lunches ago I was looking through the program for this conference, and I saw that Gordon Welchman was due to speak on the subject of computers in Great Britain. I looked forward to the opportunity of meeting Gordon for the first time, and of hearing the latest news from back home. When I got back from lunch there was a note on my desk: "Please call John Carr." I called John and he said, "Stan, I'm in a hole. Gordon Welchman can't come; can you give his talk?" So it appears that, after all, I am still the bearer of the latest news from back home. However, it is now about a year since I left England, so this talk must necessarily have a somewhat historical bias.

The proper beginning for any historical survey of automatic computers is Charles Babbage. Babbage had a great effect on the development of the subject. However, there can be few here who have not heard a good deal about Babbage and his works; so I will take up the story in more recent times.

D. R. Hartree

A dominating personality in the last few years in Great Britain has been Professor D. R. Hartree, who became interested in computing while investigating the implications of the quantum theory in atomic structure. The latter remains his chief interest, but his concern with computing led to the building for Manchester University, about 1930, of a mechanical differential analyzer of the type which had just been developed by Vannevar Bush at Mass. Inst. of Technology. A similar machine was later built for the University of Cambridge, and installed in the Mathematical Laboratory there when it was opened just before the war.

Although Professor Hartree introduced the differential analyzer to Great Britain, he has always recognized the importance of developments in the digital field. Shortly after the war he moved to Cambridge, where he has been closely associated with the work on the Edsac there. He has willingly accepted scores of invitations to speak on computing subjects; in this way, and by virtue of his position on several influential committees, he has done a great deal to promote the research and development of computers.

In 1947, after visiting many computing centers in America and Europe, he enunciated what has come to be known as Hartree's Law. This states that the difference between the date on which any given machine will be completed, and the date of making the observation, is a constant (Hartree's Constant). For a long time there was very little evidence to refute this; fortunately later work has shown that Hartree's Constant can vary, and may even become zero.

Professor Hartree is best described in the words used by Dr. E. C. Bullard, at the opening of the computer conference at the National Physical Laboratory in March, 1953: "The ideal computing machine should be like Professor Hartree: sweet and reasonable and always willing to oblige."

A. M. Turing

The first plans for an electronic computer in Britain were laid at the National Physical Laboratory, on the formation of the Mathematics Division there immediately after the war. This machine was the ACE. Its broad features were laid down by Dr. A. M. Turing, who was the first leader of the project. Turing has been another prominent personality in the computing field, and has exhibited an amazing variety of capabilities. In 1936 he published a classic paper on a topic which was at that time something completely novel: he used the concept of an ideal computing machine as a tool in the study of mathematical logic. Such ideal machines have come to be known as "Turing machines" -- we have heard them mentioned once or twice at this conference. More recently Turing has published papers on conventional numerical analysis (errors arising in the solution of simultaneous linear equations), and on the popular philosophical question, "Can machines think?" In the latter connection he suggested a criterion by which this question might be settled for any given machine. He suggested that the machine be interviewed by a human examiner, who could communicate with it only through some suitable channel such as a teleprinter circuit, and who could not see it. If the machine can delude the examiner into thinking that he is in fact communicating with a person, then, Turing says, the machine can think. Turing's criterion

would seem rather difficult to satisfy, but if we must have a definite criterion, we could hardly find a better one.

Turing recently published a lengthy treatise on morphology, the study of biological form. He made considerable use of an electronic computer in a theoretical investigation of this subject. After watching with great interest the wealth and variety of Turing's work, it came as a great shock to me, and I am sure to very many others, to hear of his death only two weeks ago. There is no doubt that he would have continued to make invaluable contributions to the computing field if he had lived. He was, I believe, only about 40 years of age.

Unfortunately Turing had an intolerance of those not willing or able to master all the complications which he took in his stride. Thus the ACE has turned out to be a machine demanding considerable skill of the programmer; but this fact has permitted great speed, simplicity and reliability of operation. Also Turing's original design was, at the time, over-ambitious in regard to size. The present ACE follows closely a simple logical design laid down by Dr. Harry Huskey, who spent the year 1947 with this project.

#### The Edsac

The ACE is a mercury-tank machine. In construction, it was overtaken by another mercury-tank machine: the Edsac, at the Cambridge University Mathematical Laboratory. Dr. M. V. Wilkes, who became Director of that Laboratory after the war, visited the Moore School at the University of Pennsylvania in 1946, and immediately began to plan his own machine. The Edsac first worked in 1949 and has worked, on and off, ever since. It was in fact the first stored-program electronic machine designed for practical computing to be completed. Its philosophy is opposite to that of the ACE: it is easy to program, but it was not engineered for very high speed or reliability. Nevertheless we have been able to do a great deal of useful work with it, including a considerable amount of basic research on programming methods. The Laboratory has held summer courses in programming every year since 1950.

#### Other Large Computers

Another great center of computer research is the University of Manchester. Here Professor F. C. Williams went after the war to develop his cathode ray tube storage device. In 1949 the first Manchester computing machine was built to test this store. The electrical firm of Ferranti rapidly developed this machine into a practical computing tool, and the first Ferranti

machine was installed at the University of Manchester in 1951. It is interesting to note that, although Williams' store has since been used in many places, the Manchester machines are the only ones in which it is used in a serial fashion.

The Manchester climate appears to have had a subtle effect on programming. England is known throughout the world for its damp and dismal weather, and Manchester is known among Englishmen for its damp and dismal weather. The Manchester system of coding was laid down by Turing, who moved there as Williams was completing his experimental machine. Turing's love of mystery led to the use of the scale of 32; 26 of the digits are represented by the letters of the alphabet, and the remaining 6 by an assortment of characters to be found on the upper shift of most English typewriters, viz: @, £, :, ", ½, and /. It so happens that zero is represented by /, and since zeros are not suppressed, a page of coding consists of a neat rectangular array of symbols, many of which are /'s. This reminds me of nothing more than looking out of a window on a rainy day.

The Ferranti machine has a most impressive looking control console. At the inaugural conference in 1951, Professor Williams pointed out that this makes it possible to play the machine like an organ. However, Ferranti apparently feared that the sight of the console might frighten away prospective customers. They resorted to a device which has, I believe, been used elsewhere: they included in the picture of the console an attractive young lady to divert the attention.\* They went even further than that: to illustrate the ease with which the machine may be operated, the young lady was taking hardly any notice of the controls at all; she was busy knitting.

The Manchester machines were designed from the start to use two types of storage: electrostatic, and magnetic drum. Apart from this, the development of auxiliary stores has been somewhat slow in Britain. The magnetic drum was in fact pioneered by Dr. A. D. Booth at the University of London, but unfortunately he had difficulty in obtaining enough financial support to develop it rapidly. Recently the British Tabulating Machine Company, which markets IBM-type punched card machines, has put into production a general purpose medium-sized computer based on Booth's designs, selling for about £16,000 (\$45,000). The magnetic drum store has a capacity of 1024 words each of 32 binary digits. These computers are described as well suited for mathematical work in an industrial research laboratory; the Company is developing a computer which will be more suitable for commercial applications.

\*see Bill Danch's comment, page 4

The ACE has recently been equipped with a magnetic drum auxiliary store. Work proceeded for a time on a drum for the Edsac, but this was abandoned and the Edsac now uses magnetic tape. Both the Edsac and the Ferranti machine, though electronic, are somewhat slow -- much slower than the ACE.

None of these machines has built-in division. Each has, on the other hand, produced offspring. The Edsac has given rise to Leo, built for themselves by the firm of J. Lyons and Company, who are roughly the English equivalent of Howard Johnson's. In 1947 Lyons' decided to acquire an electronic computer for payroll calculations, factory analyses, etc. Finding that no electrical firm was prepared to build one, they boldly decided to build their own and modeled it on the Edsac. The computer itself was working in 1951 and has been rented out for scientific applications; its use for its intended purpose has been delayed pending the completion of special input and output equipment.

The Manchester machine has led to a number of Ferranti machines. The second went to the University of Toronto, the third to the British Ministry of Supply and the fourth to Ferranti's own computing bureau in London. These are all substantially the same as the first Ferranti machine at Manchester University.

The British Post Office has built a machine (the MOSAIC) for the Ministry of Supply, based on Turing's original plans for the ACE. Lest it should seem strange for a post office to be found building electronic computers, let me remind you that the British Post Office has a monopoly of means of communication, including telephones, and it maintains a large telephone research laboratory in London. It was here that the Mosaic was built. A small machine of the ACE type is also, I believe, being developed for production by the English Electric Company, who contracted for some of the construction work on the parent machine.

#### Smaller Computers

These, then, are the leading families of British computers. There are a number of smaller machines and projects in existence. Elliott Brothers, a firm with a long established reputation for navigational instruments, has entered the electronic computing field to specialize in machines for naval applications, using "unitized" and "ruggedized" construction. One of their most interesting developments has been the magnetostrictive delay line. They have shown that it is possible to make a very efficient acoustic delay element using as a sound carrier a wire, several feet in length, coiled and mounted in a neat package, and acting as its

own magnetostrictive transducer. Their machine "Nicholas" uses these elements for the entire store; they have also built a machine using a magnetic disc as the main store, with short delay elements for rapid access registers.

There are two interesting low speed machines at the Royal Aircraft Establishment and Atomic Energy Research Establishment respectively. They each use dekatrons in the arithmetical unit. These are cold cathode, gas filled tubes, each forming essentially one stage of a decimal counter. The AERE machine has a small store of dekatrons for numbers and is sequenced directly by a punched tape. The RAE machine is considerably bigger and faster; it has a large main store on a magnetic drum, and is sequenced by instructions in this store. Furthermore it has built-in floating-point arithmetic, so that for calculations which require floating point it is as fast as many high-speed machines.

The Radar Research Establishment has built its own machine using the Williams store -- the first machine in Britain to use this store in a parallel fashion. The second such machine has now been built by Professor Williams himself at Manchester, and christened MEG. Although MEG has a parallel electrostatic store (soon to be supplemented by a drum) it has a serial arithmetic unit working at a megacycle (hence the name). Like the RAE machine, MEG has built-in floating-point arithmetic, and is probably the first machine of this speed to be so equipped. Addition requires 180 microseconds and multiplication 360 microseconds, including access. MEG resembles the ORACLE at Oak Ridge in that transfers may occur in units of 10 bits, instructions comprising two such units and numbers comprising four (one for the exponent and three for the fraction part).

Work is proceeding at Cambridge on a successor (so far unnamed) to the Edsac. The new machine will have a parallel arithmetical unit with built-in floating-point arithmetic. Storage was to have been by mercury tanks, used in parallel fashion, but the design has now been switched to magnetic cores. Details of the arithmetical unit have been settled and some construction has begun, but the complete design is still not fixed. Dr. Wilkes had proposed a "microprogram" scheme in which the operations of the control unit are defined by a diode crystal matrix; but with the advent of magnetic cores this plan needs some reconsideration.

Looking at any of these machines, one can see in them a mixture of both British and American ideas. There is no doubt that our work in Great Britain has been stimulated and influenced to a great extent by developments in America. On the other hand there are some aspects in which

(continued on page 30)

# Roster of Organizations in the Field of Computers and Automation

(Cumulative, information as of October 3, 1954)

The purpose of this Roster is to report organizations (all that are known to us) making or developing computing machinery, or systems, or data-handling equipment, or equipment for automatic control and materials handling. In addition, some organizations making components may be included in some issues of the Roster. Each Roster entry when it becomes complete contains: name of the organization, its address and telephone number, nature of its interest in the field, kinds of activity it engages in, main products in the field, approximate number of employees, year established, and a few comments and current news items. When we do not have complete information, we put down what we have.

We seek to make this Roster as useful and informative as possible, and plan to keep it up to date in each issue. We shall be grateful for any more information, or additions or corrections that any reader is able to send us.

Although we have tried to make the Roster complete and accurate, we assume no liability for any statements expressed or implied.

This listing is cumulative except for omission of about a dozen companies making components which were previously listed but have apparently only remote interests in the field of computers and automation.

## Abbreviations

The key to the abbreviations follows:

### Size

Ls Large size, over 500 employees  
 Ms Medium size, 50 to 500 employees  
 Ss Small size, under 50 employees (no. in parentheses is approx. no. of employees)

### When Established

Le Long established organization (1922 or earlier)  
 Me Organization established a "medium" time ago (1923 to 1941)  
 Se Organization established a short time ago (1942 or later) (no. in parentheses is year of establishment)

### Interest in Computers and Automation

Dc Digital computing machinery  
 Ac Analog computing machinery  
 Ic Incidental interests in computing machinery  
 Sc Servomechanisms  
 Cc Automatic control machinery  
 Mc Automatic materials handling machinery

### Activities

Ma Manufacturing activity  
 Sa Selling activity  
 Ra Research and development  
 Ca Consulting

Ga Government activity  
 Pa Problem-solving  
 Ba Buying activity  
 (Used also in combinations, as in RMSa "research, manufacturing and selling activity")

\*C This organization has kindly furnished us with information expressly for the purposes of the Roster and therefore our report is likely to be more complete and accurate than otherwise might be the case. (C for Checking)

## ROSTER

Adalia Limited, Odeon Bldg., 20 Carlton St. East, Toronto, Ont., Canada / Empire 4-2361

Research and consulting services in the application, design, and construction of computers. Ss Se(1952) RCA

Addressograph-Multigraph Corp., 1200 Babbitt Road, Cleveland 17, Ohio / Redwood 1-8000 / and elsewhere \*C

Addressograph sensing plates, composed automatically from punched tape, which will automatically list and total figures. Data written at speeds up to 30 forty-character lines per second; as a byproduct, codes automatically punched into punch cards. Electronic facsimile printers for high-speed copying of typed data contained in unit card records. Ls(8000) Le(1898) Ic RMSa

Aircraft-Marine Products, Inc., 2100 Paxton St., Harrisburg, Pa. / Harrisburg 4-0101 / \*C  
 Patchcord programming systems, patchcords, automatic wire terminators. Ls(1600) Me(1941) Ic RMSa

Alden Electronic and Impulse Recording Equipment Co., Alden Research Center, Westboro, Mass. / Westboro 467 / \*C

Facsimile recording equipment and facsimile components; "On-the-Spot Fact Finders", pulse records, automatic curve plotters. Recorder that monitors any machine or action and records automatically. Ms(450?) Se Ic RMSa

Alden Products Co., 117 No. Main St., Brockton, Mass. / Brockton 160 / \*C

General and specific components for digital and analog computing machinery; plug-in components, sensing and indicating components, magnetic delay line units, magnetic storage cores, etc. Ms(300) Me(1930) Ic RMSa  
 Alfax Paper and Engineering Co., Alden Research Center, Westboro, Mass. / Westboro 467 / \*C  
 Electrosensitive recording papers. Ms Se(1942) Ic RMSa

R. C. Allen Business Machines, Inc., 678 Front Av., Grand Rapids 4, Mich. / Glendale 6-8541 / \*C

Adding machines, bookkeeping machines, cash registers, etc. Ls(1250) Me(1932) DIc RMSa  
 American Automatic Typewriter Co., 614 North Carpenter St., Chicago 22, Ill. \*C

Pneumatically controlled programming and test-

ROSTER OF ORGANIZATIONS

- ing devices. Automatic selective typing equipment (Autotypist). Testing machines for typewriters, adding machines, calculating machines. Ms(100) Le(1868) Ic RMSa
- American Machine and Foundry, Electronics Division, 1085 Commonwealth Ave., Boston, Mass. / Algonquin 4-4234 / \*C  
Magnetic shift registers, digital data-handling equipment; servomechanisms to specifications. Digital servo with 2<sup>15</sup> quantum units per revolution (shaft to digital conversion). Ls(900) Se(1948) Dc RMSa
- Amperite Co., Inc., 561 Broadway, New York 12, N. Y. / Canal 6-1446 / \*C  
Delay relays and regulators for computers, etc. Ms(75) Me(1923) Ic RMSa
- Ampex Electric Corp., 934 Charter St., Redwood City, Calif. / Emerson 8-1471 / \*C  
Magnetic recording of data. Ls(550) Se(1944) Ic RMSa
- Andersen Laboratories, Inc., 39-C Talcott Road, West Hartford 10, Conn. / Adams 3-4491 / \*C  
Solid ultrasonic delay lines, computer memories, etc., for computer applications. Ss(30) Se(1950) Ic RMSa
- ANelx Corp., Concord, N. H., and 150 Causeway St., Boston 14, Mass. / Richmond 2-3400 / \*C  
High-speed printer (1800 characters per second), numerical and alpha-numeric up to 64 characters and line-lengths up to 120 characters. Ms Se(1952) Dic RMSa
- Applied Science Corporation of Princeton, P.O.Box 44, Princeton, N. J. / Plainsboro 3-4141 / \*C  
Radio telemetering and automatic data conversion. Devices for automatic and semi-automatic reduction and analysis of telemetering and radar data. Analog read-in and read-out devices. Digital storage and computing elements. MADAM (Multipurpose Automatic Data Analysis Machine). Ms(85) Se(1946) DAc RCPMSa
- Argonne National Laboratory, Box 299, Lemont, Ill. / Bishop 2-2750, Lemont 800 / \*C  
Production of big electronic automatic digital computers for use of Atomic Energy Commission only. ?s Se Dc RMa
- Arma Corp., Old Country Rd., Garden City, L. I., N. Y. / Garden City 3-2000 / \*C  
Electronic fire-control apparatus. Analog computer components including resolvers, induction generators, etc. Basic weapon and control systems, navigational systems, precision remote control systems. Automatic machine tool and material handling systems. Analog computer components. Ls(6000) Le DASc RMSPa
- Armour Research Foundation, Illinois Inst. of Technology, 10 West 35 St., Chicago 16, Ill. / Calumet 5-9600 / \*C  
Magnetic recording. Digital, analog and data-handling equipment. Automatic control machinery. Servomechanisms. Instrumentation. Ls(1200) Me(1936) DASCc RCPa
- The Arnold Engineering Co., Marengo, Ill. / Chicago, Andover 3-6300 / \*C  
Magnetic materials for computer components, etc. Ms(425) Me(1936) Ic RMSa
- Askania Regulator Co., 240 E. Ontario St., Chicago, Ill. / Whitehall 4-3700 / \*C  
Hydraulic and electronic automatic control equipment. Use analog computers; manufacture servomechanisms and automatic controls. Ms(400) Me(1930) SCc RMSPa
- Atomic Instrument Co., 84 Mass. Ave., Cambridge 39, Mass. / Eliot 4-4321 / \*C  
Analog to digital converters, printers, counter components and controls; shell velocity computation and recording; etc. Ms(100) Se(1947) DACc RMSCa
- Audio Instrument Co., Inc., 133 West 14 St., New York 11, N. Y. / Oregon 5-7820 / \*C  
Electronic, mechanical, and optical analog computers. Precision electronic instruments. Time-delay units from 10 to 10,000 milliseconds. Fire control equipment, logarithmic amplifiers. Specialized passive computer which corrects for film nonlinearity in photometric work, etc. Ss(10) Se(1949) DASCc RMSCa
- The Austin Co., Special Devices Division, 76 9th Ave., New York 11, N. Y. / Watkins 4-3630 / \*C  
Systems and devices for automatic control in commerce and industry; analog, digital, data-handling, servo, electronic, electromechanical. Shaft position indicators and systems; cathode ray indicators and systems. Ls(division, 125; company 25,000) Le(division, 1943, company, 1878) DASCmc RMSa
- Automacit  Appliqu , 10 rue Saulnier, Paris 9e, France  
Automatic control apparatus. Cc RMSa
- Automatic Electric Co. 1033 West Van Buren St., Chicago 7, Ill. / Haymarket 1-4300 / \*C  
Automatic electrical systems, telephone equipment, relays, stepping switches, etc., for computing machinery and communications companies. Automatic control components. Ls(5700) Le(1892) ICc RMSa
- Automatic Signal Division, Eastern Industries, Inc., Norwalk, Conn.  
Automatic volume-density traffic controllers. Me Ic RMSa
- Automation Consultants, Inc., 1450 Broadway, New York 18, N. Y. / Chickering 4-7800 / \*C  
Consultants in electronic systems and devices, including automatic information-handling. Ss Se(1953) Dc Ca
- Automation Engineers Co., Division of Associated Industrial Consultants, 246 West State Street, Trenton, N. J. / Trenton 3-2603 / \*C  
Consultants in automatic control machinery and automatic materials handling equipment. Ss(20) Me(1942) DACmc Ca
- Avion Instrument Co., Division of American Car and Foundry Industries, Inc., 299 State Highway No. 17, Paramus, N. J. / Oradell 8-4100 / \*C  
Digital and analog computing machinery. Magnetic recorders, amplifiers, electronic choppers, test equipment, servomechanisms, automatic control machinery, etc. Ms(160) Se(1946) DASCmc RMSCPa
- Baird Associates, 33 University Road, Cambridge 38, Mass. / University 4-0101 / \*C  
Spectroscopic analysis equipment; scientific instruments; analog devices, servo-mechanisms; transistors. Instrumentation for industrial control. Research in physical optics. Ms(200) Me(1937) AISc RMSa
- Barber-Colman Co., Rockford, Ill. \*C  
Automatic controls, textile machinery, machine tools, etc. Barber-Colman-Stibitz digital computer, operating. Ls(3000) Le Dc RMSa

ROSTER OF ORGANIZATIONS

- Beckman Division, Beckman Instruments, Inc., Fullerton, Calif. / Lambert 5-8241 / \*C  
Multi-channel digital data-handling systems; 200 channel strain gage recorder. Automatic process control, digital data handling and recording. Ls(1800) Me(1934) DAC RMSa  
See also Berkeley Division, Beckman Instruments.
- Bell Telephone Laboratories, Murray Hill, N. J. / Summit 6-6000 / and 463 West St., New York 14, N. Y. / Chelsea 3-1000 / \*C  
Automatic switching. Bell general purpose computers (relay and electronic, digital and analog) for government use and company's own use. Ls Le DAC RGPa
- Bendix Aviation Corporation, Computer Division, 5630 Arbor Vitae St., Los Angeles 45, Calif. / Oregon 8-2128 / \*C  
Electronic information-processing machines. Electronic computers; data-processing equipment; automatic control systems; Decimal Digital Differential Analyzer; general purpose digital computers Model G-15A and G-15D. Ms(150) Se(1952, division; 1929, corporation) DACc RMSPa
- Bendix Aviation Corp., Pacific Division, North Hollywood, Calif. \*C  
Telemetering systems. Digital systems, controls, and components. Ls(2500) Le(1915, company; 1937, this division) Ic RMSa
- Benson-Lehner Corp., 2340 Sawtelle Blvd., West Los Angeles 64, Calif. / AR-93723, BR-21197 / \*C  
Automatic and semi-automatic devices (both analog and digital) for computing, data analyzing, data reduction, optical measuring, guided missile analysis, etc. Oscillogram trace readers, plotters, etc. Commercial applications of industrial control devices. Ms(118) Se(1950) DAC RCMSa
- Berkeley Division, Beckman Instruments, Inc., 2200 Wright Ave., Richmond, Calif. / Landscape 6-7730  
EASE computer (Electronic Analog Simulating Equipment) for solving equations, simulating systems, etc. Se Ac RMSa
- Edmund C. Berkeley and Associates, 36 West 11 St., New York 11, N. Y. / Algonquin 4-7675 / and 815 Washington St., Newtonville 60, Mass. / Decatur 2-5453 or 2-3928 / \*C  
Logical design, applications, marketing, etc., of automatic information-handling machinery. Publisher of "Computers and Automation". Small one-of-a-kind computers (Simon) and robots (Squee); more under construction. Courses, publications. Ss(8) Se(1948) DC RCMSa
- Berkshire Laboratories, 732 Beaver Pond Road, Lincoln, Mass. / Waltham 5-7000 / \*C  
Special computer components. Ss Se(1949) IAc RMCa
- Birkbeck College, University of London, 21 Torrington Sq., London W.C. 1, England / Langham 1912 / \*C  
Maker of ARC, APEXC, and SEC digital computers; electronic digital computers. Ss(10 to 20) Se(1946) DC RCPa
- Boeing Airplane Company, Industrial Products Division, Seattle 14, Wash. / Mohawk 4444 / \*C  
Boeing Electronic Analog Computer. Associated non-linear equipment. Complete line of auxiliary equipment, including function generator and electronic multiplier. Ls(37,000) Le(1916) Ac RMSa
- Bradley Laboratories, Inc., 168 Columbus Avenue, New Haven, Conn. / Main 4-3123 / \*C  
Selenium rectifier kits, high temperature rectifiers. Ms Me Ic RMSa
- British Tabulating Machine Co., Ltd., 17 Park Lane, London W. 1, England / Hyde Park 8155 / \*C  
Punched card machines. Ls(4500) Le(1908) DC RCPMSa
- Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio (formerly Brush Development Co.) \*C  
Recording analyzers. Magnetic tape, heads, and drums. Computer components. Ls(1300) Le(1921) Ic RMSa
- Bull S. A. Compagnie des Machines, 94 Avenue Gambetta, Paris 20e, France / MEN 8158 / \*C  
Punch card machines. Commercial electronic computers and card-programmed scientific computers. Producing about 10 electronic computers a month; 100 currently in operation. Ls(2500) Me(1931) DC RMSa
- Bureau of the Census, Washington 25, D. C. / \*C  
Tabulation of statistical data by special machines designed and built for own use, by commercial punch-card equipment, and by electronic computing system (the Univac). Ls(1100 in Machine Tabulation Division) Le(1890 in punch card field) DC Ga
- Burlingame Associates, 103 Lafayette St., New York 13, N. Y. / Digby 9-1240 / \*C  
Analog computers, servo analyzers, servo-control devices, digital voltmeters, etc. Ss(35) Me(1928) AIC Ca
- Burroughs Corporation (formerly Burroughs-Adding-Machine-Cor) 6071 Second Ave., Detroit, Mich. / Triangle 5-2260 / ---headquarters; ---Burroughs-Corporation-Research-Center---(formerly-Research-Division), Paoli, Pa.; ---and-elsewhere / \*C  
Automatic electronic digital computer, UDEC. Adding machines, bookkeeping machines, etc. Burroughs Laboratory Computer, an electronic digital test computer, assembled from pulse control units. Fast access magnetic core memory. Pulse control components, servo-mechanisms, etc. This company owns Control Instrument Co. Ls(18,000) Le(1896) DSc RMSPa
- California Computer Products, 3927 West Jefferson Blvd., Los Angeles 16, Calif.  
Digital point plotter (CCP 701) and other equipment. DAC RMSa
- Cambridge Thermionic Corporation, 445 Concord Av., Cambridge 38, Mass. / Trowbridge 6-2800 / \*C  
Components for computers. Ms(150) Me(1940) Ic RMSCa
- Clary Multiplier Corp., 408 Junipero St., San Gabriel, Calif. \*C  
Adding and calculating machines, cash registers, electronic counters, analog-digital converters, input and output equipment for computers, data-reduction systems. Ls(1500) Me(1939) DAC RMSa
- Coleman Engineering Co., 6040 West Jefferson Blvd., Los Angeles 16, Calif. / Vermont 9-7549 / \*C  
Digital data handling systems and components; "Digitizer", device for converting rotational shaft positions into electrical contact settings; etc. Ms(100) Se(1951) DIC RMSa
- Commercial Controls Corp., 1 Leighton Ave., Rochester 2, N. Y. / Culver 5800 /  
Mailroom equipment. "Flexowriter" electric typewriter with punched paper tape control. Ls Le Ic RMSa

ROSTER OF ORGANIZATIONS

- Commonwealth Scientific and Industrial Organization, Radiophysics Division, Sydney, New South Wales, Australia  
 Maker of CSIRO Mark I electronic digital computer of Inst. for Advanced Study type. DAC RCGPa
- Computer Company of America, Division of Bruno-New York Industries Corp., 149 Church St., New York 7, N. Y. / Cortlandt 7-1450 (formerly Comp. Corp. of America) \*C  
 Analog computers, differential analyzers, specialized computers and accessories. Ms (125) Se (1942) DAC RMSPa
- Computer Control Co., 92 Broad St., Babson Park 57, Mass. / Wellesley 5-6220 / and 1429 Promenade Highway, Santa Monica, Calif. / \*C  
 Computers and computer components, digital data-handling systems, solid delay-line acoustic memory, computer test equipment, dual beam conversion kits, specialized systems and instrumentation. Operating and servicing Raydac at Pt. Mugu, Calif. Ss (35) Se (1952) Dc RMSCa
- Computer Research Corporation, Hawthorne, Calif.: Has become "The National Cash Register Co., Electronics Division", which see.
- Computing Devices of Canada, Lim., P. O. Box 508, Ottawa, Ont., Canada / Parkway 2-6541 / \*C  
 Custom-built digital and analog computers, automatic navigation systems, electronic laboratory test equipment, simulators, servomechanisms. Research and development in instrumentation, automatic control, business and scientific sorting, systems analysis. Ms (200) Se (1948) DASCc RCPMSa
- Computyper Corp., subsidiary of Friden Calculating Machine Co., Inc., San Leandro, Calif.  
 See Friden Calculating Machine Co.
- Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif. / Sycamore 6-0173 / \*C  
 Digital and analog data-handling and conversion systems (Sadic, Millisadic, etc.). Automatic translator magnetic tape to punched card. Computers now manufactured by their affiliate, Electro Data Corp., which see. Ls (1400) Me (1937) Dc RMSa
- Control Instrument Co., 67 35th St., Brooklyn, N.Y. / Sterling 8-0658 / \*C  
 Fire-control equipment. 1000-line-a-minute tabulator. Digital and analog machines and components. Now a subsidiary of Burroughs Corporation. Ls (1200) Me (1934) DAC RMSa
- Convair, a Division of General Dynamics Corp., General Offices: San Diego 12, Calif. / Cypress 6-6611 / \*C  
 Research and development in the missile, electronics, and airframe fields. The Charactron, a computer output device for "debugging", tactical display, etc., converting coded information into tabular or graphic alphanumeric information on a cathode ray tube screen. Digital automatic control; analog to digital conversion units. Large analog computer installations. Ls (44,000) Me (1925) Ic DAIC RMSa
- Cook Research Laboratories, Division of Cook Electric Co., 2700 Southport Ave., Chicago 14, Ill. (mail address), 8100 Monticello Ave., Skokie, Ill. (location) / Keystone 9-2060 and Orchard 3-9200 / \*C  
 Magnetic data-recording systems; digital, analog, and hybrid information-processing systems -- particularly for aircraft and airborne applications. Basic and industrial research in servomechanisms, air research, weather reconnaissance, guided missiles, etc. Ms (380) ?e DAIC RCa
- Curta Calculator Co., 3851 West Madison St., Chicago 24, Ill.  
 Eight-ounce, hand-powered, rotary "brief-case" calculator; adds, subtracts, multiplies, divides; totals to 15 decimal places; made in Lichtenstein. Ss (10) Se (1952) Dc Sa
- Daco Machine Co., Brooklyn, N. Y. / Ulster 5-8350 / Computing controls for machine tools. Cc RMSa
- The Daven Company, 191 Central Ave., Newark 4, N. J. / Mitchell 2-6555 / \*C  
 Precision resistors, rotary switches and attenuators. Ms (490) Me (1929) Ic RMSa
- Davies Laboratories, Inc., 4705 Queensbury Road, Riverdale, Md. / Appleton 7-1133 / \*C  
 Automatic data-reduction equipment. Magnetic tape data recorders. Ms (85) Se (1946) Ac RMSCa
- The de Florez Co., 116 East 30 St., New York, N. Y. / Murray Hill 6-5730 /  
 Magazine subscription fulfillment problem, etc. Ss Se DAC RCa
- Digital Control Systems, Inc., Top of Mount Solidad, P. O. Box 779, La Jolla, Calif. / Glencove 5-6109 / \*C  
 Design and construction of laboratory models of many types of digital computers and control systems. Ss Se (1951) DCc RMSa
- Digital Products Inc., 7852 Ivanhoe Ave., La Jolla, Calif. / \*C  
 Digital computers, etched circuitry, magnetic heads, memory drums. Ss Se (1952) DIC RMSa
- Doelcam Corp., 1400 Soldiers Field Rd., Boston 35, Mass. / Algonquin 4-5200 /  
 Servomechanisms, amplifiers, etc. Ls (800?) Me SIC RMSa
- Eckert-Mauchly Div., Remington Rand, Inc., 3747 Ridge Ave., Philadelphia, Pa. / Baldwin 3-7300 / and elsewhere / \*C  
 All purpose electronic digital computers. Univac Factronic System. Ls (600) Se (1946) Dc RCMa Also see Remington Rand, Inc.
- Thomas A. Edison, Inc., Instrument Division, 22 Lakeside Ave., West Orange, N. J. / Orange 3-6800 / \*C  
 Automatic control components, time delay relays. Ms (360 in division; 4000 in company) Le (1888) Ic RMSa
- Electro-Data Corporation, 717 North Lake Ave., Pasadena 6, Calif. / Sycamore 8-6761, Ryan 1-8335 / \*C  
 Automatic electronic digital computers. Electronic data-processing equipment for scientific, industrial and commercial applications. Affiliate of Consolidated Engineering Corp., which see. Ms (150) Se (1950) Dc RMSPa
- Electronic Associates, Inc., Long Branch, N. J. / Long Branch 6-1100 / \*C  
 General purpose precision analog computers, special purpose analog computers, analog computer components, digital-to-analog converter, digital plotting system (Dataplotter). Automatic control of all machine tools. Ms (360) Se (1945) DACc RMSa
- Electronic Computer Div. of Underwood Corp., 35-10 36th Ave., Long Island City 6, N. Y. / Exeter 2-3400 / \*C  
 Constructing five types of electronic digital computers (ELECTOM-100, -120A, -125, -200, and

ROSTER OF ORGANIZATIONS

- a data-handling computer). Delay lines, decade delay lines, pulse transformers, magnetic recording heads, magnetic drums, D.C. plug-in amplifiers. Ms (200) Se (1949) Dc RMSa
- Electronic Control Systems, Inc., 2138 Westwood Blvd., Los Angeles 25, Calif. / Arizona 7-0244 / \*C
- Special purpose computers for military and industrial use; industrial process and machine control systems; automatic test equipment. Ss (20) Se (1953) DASCc RMCSa
- Electronic Engineering Co., 180 South Alvarado St., Los Angeles 57, Calif. / Dunkirk 2-7353 / Analog computing machinery. Analog-to-digital-to-analog converters. Polar-to-rectangular-to-polar converters. Servomechanisms. Ms Se DAc RMSa
- Elliott Addressing Machine Co., 143 Albany St., Cambridge 39, Mass. / Trowbridge 6-2020 / \*C
- Addressing stencils, with selection controlled by punched holes in cardboard margin. Ls (1000) Le (1900) Ic RMSa
- Elliott Bros. (London) Ltd., Century-Works, Lewis-ham, London, S.E. 13, England, and Computing Machine Division, Elstree Way, Borehamwood, Herts., England / Tideway 3232, Elstree 2040 / \*C
- Digital and analog computers; servomechanisms; components, instrumentation and control for process industries. Ls (3500) Le (1800) DASCc RMSCP a
- Engineering Research Associates, Div. of Remington Rand, Inc., 1902 West Minnehaha Ave., St. Paul, Minn., and 510 18th St., South, Arlington, Va. / Nestor 9601, St. Paul / \*C
- Automatic digital computers; ERA 1101, 1102, 1103 electronic digital computers; Speed Tally; CAA Flight Plan Storage Systems; the Logistics Computer. Magnetic storage systems, including magnetic heads, magnetic drums, etc. Shaft position indicator systems, self-recording accelerometers, analog magnetic recording systems, data-handling equipment, special purpose communications equipment, pulse transformers. Ls (1050) Se (1946) Dc RMCPSa
- Also see Remington Rand, Inc.
- Engineers Northwest, 2835 Nicollet Ave., Minneapolis 8, Minn. / Re 5541 / \*C
- Test-scoring machines and equipment. Ss (20) Se (1945) DAc RCMA
- English Electric Co., Stafford, England. \*C
- Manufacturers of fully engineered versions of ACE (see National Physical Laboratory). Ls Le Dic RMSa
- Epsco, Inc., 126 Massachusetts Ave., Boston, Mass. / Kenmore 6-0601 /
- Magnetic shift registers, transistors, delay lines, and other components for computers, systems, automatic control, etc. Ss (20) Se (1954) Dic RMSCa
- E-Z Sort Systems, Ltd., 45 Second St., San Francisco 5, Calif. / Garfield 1-3005 / \*C
- Edge-punched cards for filing and sorting data. Special cards for correlation of facts. Ms (267) Me (1935) Ic RMSa
- Fabrica Addizionatrice Italiana S.S., Viale Umbria 36, Milan, Italy.
- Desk calculators to add, subtract, multiply, divide, print. Dc RMSa
- Facit, Inc., 500 5th Ave., New York 36, N. Y. (subsidiary), Stockholm, Sweden (headquarters), and elsewhere / \*C
- Calculators, adding machines, typewriters, etc. (in 1390 A.D., copper mining). Ls (4000) Le (1390 A.D.) Dc RMSa
- Fairbanks Associates, 248 Greenwich Ave., Greenwich, Conn. / Greenwich 8-7155 / \*C
- Consultants in application and installation of electronic systems in clerical methods and procedures; evaluation of proposed savings; operations research. Ss (7) Se (1952) Dic RCPa
- Farrand Optical Co., Bronx Blvd. and 238 St., New York 70, N. Y. / Fairbanks 4-2200 / \*C
- Gunfire control apparatus, rangefinders, optical and electronic sighting equipment, automatic trackers, infrared search and scanning systems, analog-digital converters, analog computers, etc. Ls (800) Le (1918) DASCa RMSCa
- Federal Telephone and Radio Co., Division of Intern'l Tel. and Tel., 100 Kingsley Rd., Clifton, N.J. / Nutley 2-3600 / \*C
- Vacuum tubes, selenium rectifiers, germanium diodes, contact protectors, coaxial cables, magnetic amplifiers; radio and telephone systems, microwave systems, and associated components. Ls (6500) Me (1941) ISCc RMSPa
- Felt and Tarrant Mfg. Co., Comptometer Div., 1735 No. Paulina St., Chicago 22, Ill. / Brunswick 8-5000 / \*C
- Adding-calculating machines, key-driven, electric and non-electric. Comptometer. Electronic dictating machines. Ls (1700) Le (1886) Dc RMSa
- Ferranti Electric, Inc., 30 Rockefeller Plaza, New York 20, N. Y. / Circle 7-0911 / agent for Ferranti Electric Ltd., Moston, England, and Mount Dennis, Toronto, Canada. \*C
- Complete electronic digital computers (Ferranti; also called "Manchester Universal Electronic Computer"). High-speed photoelectric tape reader, which can read up to 200 characters per second. Magnetic drum and electrostatic storage components, etc. Ls (10,000) Le (1896) Dc RMSa
- Ferroxcube Corporation of America, East Bridge St., Saugerties, N. Y. / Saugerties 1000 / \*C
- Ferrite core materials, including pot cores, cup cores, recording heads, and microminiature toroids with square hysteresis loop. Magnadur permanent magnet materials. Ms (150) Se (1950) Ic RMSa
- Fischer and Porter Company, 330 Warminster Road, Hatboro, Pa. / Osborne 5-6000 / \*C
- Automatic instrumentation, including: measurement of a variable at the point of process; transmission of data, central collection, and display; data reduction systems using a mechanical digital converter (Digi-Coder); tabulated digital data output, etc. Automatic multiple readout systems, converters, computers. Ls (850) Me (1937) DACc RMSa
- Ford Instrument Co., Div. of The Sperry Corporation, 31-10 Thomson Ave., Long Island City 1, N. Y. / Stillwell 4-9000 / \*C
- Gunfire control apparatus. Analog computers and components, magnetic amplifiers, servo motors, differential and integrator elements. Instruments for shipborne and airborne armament and navigational control. Ls (3800) Le (1915) ASc RMPCSa
- The Franklin Institute Laboratories for Research

ROSTER OF ORGANIZATIONS

- and Development, 20th St. & Benjamin Franklin Parkway, Philadelphia 3, Pa. / Locust 4-3600/ \*C  
 Fire-control equipment. Special purpose analog computers, large and small scale. Digital computer components. Prototype construction. Ms (325) Se (1946) DAc Ra
- Friden Calculating Machine Co., Inc., San Leandro, Calif. \*C  
 Desk calculating machines. Computyper. Add-Punch machine. Automatic equipment for punching codes in tape. Ls (2000) Me (1934) Dc RMSa
- General Ceramics Corporation, Keasbey, N. J. (near Perth Amboy) / Valley 6-5100 / \*C  
 Magnetic cores and ferrites for computer components; toroidal ferrite cores as memory devices for computers, as used in Whirlwind (MIT) computer new rapid memory; technical ceramics, insulators, etc. Ls (500) Le (1906) Ic RMSa
- General Controls, 801 Allen Ave., Glendale 1, Calif. \*C  
 Automatic controls (pressure, temperature, level, flow). Ls Cc RMSa
- General Cybernetics Associates, P.O. Box 987, Beverly Hills, Calif. / Vermont 9-0544 / \*C  
 Industrial automation, computers, instrumentation, communication, industrial electronics; linear displacement transducers, digital converters, punch-card-to-tape devices, electronic gages for automation processes, medical electronics research and development; etc. Ss (18) Se (1953) RMSa
- General Electric Co., Tube Department, Schenectady, N. Y. / Schenectady 4-2211, X1027 / \*C  
 Electronic tubes. Ls (15,000+) Le (1878) Ic RMSa
- Gerber Scientific Instrument Co., 89 Spruce St., Hartford 1, Conn. / Ch 6-8539 / \*C  
 Graphical computer "Graphanalogue". Ss Se (1946) Ic RMSa
- G. M. Giannini & Co., Inc., Laboratory Apparatus Division, 918 Green St., Pasadena, Calif. / Ryan 1-7512 / \*C  
 Digitizing analog devices, etc. Ms (100) Se (1952) DAc RMSa
- Goodyear Aircraft Corp., Dept. 931, Akron 15, Ohio / Republic 3-6361 / \*C  
 Goodyear electronic differential analyzers, (GEDA line of analog computing equipment). Ls Me Ac RMSa
- Haller, Raymond, and Brown, Inc., State College, Pa. / Ad 7-7611 / \*C  
 Electronic digital computer for solution of up to 1200 simultaneous equations, using magnetic drum and tape. Research and development on computer components, analog computers, electronic and electromechanical systems. Engineering analysis, operations research, electronic development. Ms (200) Se (1947) Dc Ra
- Hamann Calculating Machine Co., 2118 Land Title Bldg., Philadelphia 10, Pa.  
 Adding, subtracting, multiplying desk calculators. Dc MSa
- Hammarlund Mfg. Co., Inc., 460 West 34 St., New York 1, N. Y. / Longacre 5-1300 / \*C  
 Remote supervisory control and industrial telemetering equipment. Ls (500) Le (1910) ICc RMSa
- Harvard University, Harvard Computation Laboratory, Cambridge 38, Mass. \*C  
 Harvard Mark I, II, III, IV calculators for Navy, Air Force, and own use. Ms Se Dc RPma
- Helipot Corporation, 916 Meridian Ave., South Pasadena, Calif. / PY 1-2164 / \*C  
 Precision potentiometers, single-and-multi-turn, linear and non-linear, turns-counting dials. Ls (600) Se (1943) Ic RMSa
- Hillyer Instrument Co., 54 Lafayette St., New York 13, N. Y. / Digby 9-4485 / \*C  
 Simulators, servomechanisms, sensing, computing, and actuating systems. Automatic machine controls. Ms (100) Se (1945) DAICs RMSa
- Hogan Laboratories, 155 Perry St., New York 14, N. Y. / Chelsea 2-7855 / \*C  
 Circle computer, completed and under test; manufactured by this company. Digital high-speed printers. Associated with Nuclear Development Associates. Ms (60) Me (1929) Dc RMSa
- Hughes Research and Development Laboratories, Hughes Aircraft Co., Culver City, Calif. / Texas 0-7111 / \*C  
 Automatic data-handling systems for commercial and military applications. Industrial control systems. Small, automatic electronic digital and analog computers for airborne use. Fire-control equipment. Aircraft control. Guided missiles. Ls (15,000 company; 4,000 Res. and Devt. Labs, 400 computers) Me (1937) DAc RMSa
- Imperial College, Mathematics Dept., Computer Section, Huxley Bldg., Exhibition Road, So. Kensington, London, England  
 Automatic digital relay computer constructed and in operation; constructing a second computer with neon tube storage. Ss Le (1922) Dc Rma
- Institut Blaise Pascal, Laboratoire de Calcul Analogique, Paris, France:  
 Combined with the Institut Blaise Pascal, Laboratoire de Calcul Mécanique, which see.
- Institut Blaise Pascal, Laboratoire de Calcul Mécanique, 25, Avenue de la Division Le Clerc, Chatillon-sous-Bagneux (Seine), France. \*C  
 Constructing a digital calculator. Ss (9) Me (1939) Dc RPa
- Institute for Advanced Study, Princeton, N. J.  
 Big fast electronic digital calculator, for own use. Dc RPma
- Intelligent Machines Research Corp., 1101 Lee Highway, Arlington, Va. / Jackson 5-6400 / \*C  
 Devices for reading characters on paper, etc. Pattern interpretation equipment. Sensing mechanisms. Digital computer elements. Ss (17) Se (1951) Dc RCMSa
- International Business Machines Corp., 590 Madison Ave., New York 22, N. Y. / Plaza 3-1900 / and elsewhere. \*C  
 Punch card machines. Type 650, Magnetic Drum Calculator. IBM Electronic Data Processing Machines, Type 701, Type 702 and Type 704 (magnetic tape, magnetic drum, electrostatic storage). Card Programmed Calculator. Electronic calculating punch Type 604 and Type 607. Data processing equipment. Automatic Source Recording Equipment. Ls (42,000) Le (1911) Dc RMSa
- International Rectifier Corp., 1521 East Grand Ave.,

ROSTER OF ORGANIZATIONS

- El Segundo, Calif. / Oregon 8-6281 / \*C  
 Manufacturer of germanium diodes, selenium diodes, selenium photocells, selenium rectifiers. Ms (286) Se (1948) Ic RMSa
- International Resistance Co., 403 North Broad St., Philadelphia 8, Pa. / Walnut 2-2166 / \*C  
 Fixed and variable resistors, rectifiers, chokes. Ls (1500) Me (1924) Ic RMSa
- International Telemeter Corp., 2000 Stoner Ave., Los Angeles 25, Calif. / Arizona 8-7751 / \*C  
 Systems and devices for clerical and control applications. High-capacity rapid-access ferrite core memories. High-density photographic information storage. Community TV system equipment; pay-as-you-go TV. Ms (200) Se (1951) DCC RMSa
- International Telephone and Telegraph Corp., 67 Broad St., New York 4, N. Y. / Bowling Green 9-3800 / \*C  
 Equipment for automatic control of repetitive processes, clerical or industrial work, such as inventories. Fully automatic pneumatic tube system, by dialing. Ls (96,000) Le DASCmc RMSCPa
- Jacobs Instrument Co., 4718 Bethesda Ave., Bethesda 14, Md. \*C  
 High-speed small, compact digital computers (Jaincomp A, B, B1, B2, C). Pulse transformers, delay lines, magnetic storage systems. Input and output devices. Complete instrument systems. Ss (30?) Se (1948) DASCc RMSa
- Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena 3, Calif. \*C  
 Analog, digital, and data-handling systems. Research and development in jet propulsion and missile guidance. Ls (1000; about 50 on computers) Me (1942) DAc RCPa
- Kearfott Co., Inc., Clifton, N. J. / Gregory 2-1000 / \*C  
 ADAC (Analog-digital-analog-converter: servoed and direct drive); etc. Ls (3000) Le (1916) ISc RMSa
- Ketay Manufacturing Co., 555 Broadway, New York 12, N. Y. / Digby 9-2717 / and elsewhere \*C  
 Automatic control systems; synchros, servomotors, resolvers; magnetic, electronic, and resolver amplifiers. Electronic equipment; servomechanisms; gears and components. Ls (2000) Se (1943) CISc RMSa
- A. Kimball Co., 307 West Broadway, New York 13, N. Y. / Canal 6-2300 / \*C  
 Machine for printing and punching garment tags and specific type tickets. Input mechanisms. Ms (200) Le (1876) Ic RMSPa
- The Kybernetes Corp., Division of Self-Winding Clock Co., 1100 Raymond Blvd., Newark 5, N. J. / Mitchell 2-0957 / \*C  
 Devices employing high-speed television techniques for: making printed coded characters on paper with automatically translatable coding; reading printed code and translating it into signals; sorting media carrying printed codes, etc. Systems for multiplexing, scanning, telemetering, timing, television, etc. Ms (150) Le (1886, parent company) ICc RMSCa
- Laboratory for Electronics, 75 Pitts St., Boston 14, Mass. / Richmond 2-3200 / \*C  
 Analog and digital computers, special computers to suit customer requirements, delay lines (mercury, quartz), plug-in packages for computer applications, etc. Ls (700) Se (1946) DAc RMSa
- Lanston Monotype Machine Co., Barrett Adding Machine Div., 24th & Locust Sts., Phila. 3, Pa. / Locust 7-4614 /  
 Adding, subtracting, and printing, desk calculators. Dc RMSa
- Leeds and Northrup, 4901 Stenton Ave., Philadelphia 44, Pa. / Michigan 4-4900 / \*C  
 Automatic recorders and controls. Ls (3150) Le (1899) Cc RMSa
- L'Electronique Industrielle, 55 Blvd de la République, Livry-Gargan, Seine-et-Oise, France  
 Automatic electronic measurement, counters, controls. Cc RMSa
- Librascope, Inc., 808 Western Ave., Glendale, Calif. / Ch 5-2677 / \*C  
 Mechanical and electrical computers. Computing and controlling equipment for military applications and for banking, department stores, inventory and production control, etc. Airborne digital computers. General purpose computer under construction. All phases of data-handling. Ls (1200; approximately 350 on digital computers) Me (1937) DASC RMSa
- Arthur D. Little, Inc., 30 Memorial Drive, Cambridge 42, Mass. / University 4-9370 / \*C  
 Analog digital converter, "Automatic Digital Recorder of Analog Data" (ADRAD). Conversion and input devices. Ls (800) Le (1886) Ic RCA
- Log Abax S.A.R.L., 146 Avenue des Champs Elysées, Paris 8, France / Elysées 61-24 / \*C  
 Collaborating with Institut Blaise Pascal on computing devices. 99 register automatic accounting machine. Ms (400) Se (1949) Dc RMSa
- Logistics Research, Inc., 141 So. Pacific Ave., Redondo Beach, Calif. / Oregon 8-7108 / \*C  
 Digital computers and computing systems (AL-WAC). Data-reduction and data-handling systems, input and output equipment; automatic graph-plotters; automatic curve followers; large scale magnetic memories with "air-floating" magnetic heads, etc. Ss (33) Se (1952) DIc RMSa
- W. S. Macdonald Co., Inc., 33 University Road, Cambridge, Mass. / Trowbridge 6-8130 / \*C  
 Digital business and inventory machines using magnetic drum memory for 10,000 registers, etc. Ss (12) Se (1946) Dc RMSa
- Marchant Calculators, Inc., Oakland 8, Calif. \*C  
 Automatic electric calculators (desk type). Marchant-Raytheon Binary-Octal Calculator (desk type). Marchant "Minitac" electronic digital computer. Computer components. Data processing equipment. Ls (2500) Le (1910) DIc RMSa
- Marchant Research, Inc., 1475 Powell St., Oakland 8, Calif. (subsidiary of Marchant Calculators, Inc.) / Piedmont 5-7453 / \*C  
 Electronic digital computers (including Minitac). Magnetic storage systems, magnetic heads, data processing equipment including analog-to-digital converter, computer components. Ss (55 this division) Se (1950 this division) Dc RMSa
- Massachusetts Institute of Technology, Digital Computer Laboratory, 211 Mass. Ave. / Eliot 4-3311 / also Center of Analysis; Cambridge 39, Mass.  
 "Whirlwind" electronic digital computer. Ms (300+) Se (1945?) DAc RCPa
- Mathematisch Centrum, 2e Boerhaavesstraat 49, Am-

ROSTER OF ORGANIZATIONS

- sterdam, Netherlands. \*C  
 Relay computer in use; electronic computer under construction. Ms(60) Se(1946) Dc RCPa
- The W. L. Maxson Corp., 460 West 34 St., New York 1, N. Y. / Longacre 5-1900 / and elsewhere  
 Servomechanisms, analog computers, and digital computers for fire control, navigation, etc. Automatic control machinery. Ls(3000) Me(1935) DAScC RMSa
- Mechanical Handling Systems, Inc., 4600 Nancy Ave., Detroit 12, Mich.  
 Automatic conveyors for moving separate articles, large or small, heavy or light, etc., in manufacturing processes. Ls Me Mc RMSa
- Mellon Institute of Industrial Research, Multiple Fellowship on Computer Components, University of Pittsburgh, Pittsburgh 13, Pa. \*C  
 Ss(6) Se(1950) Dc RCa
- Mid-Century Instrumatic Corp., 611 Broadway, New York 12, N. Y. / Spring 7-4016 / \*C  
 Analog computers; six-channel recorders; electronic function generators; electronic multipliers, etc. Ss(27) Se(1950) Ac RMSa
- William Miller Instruments, Inc., 325 No. Halstead Ave., Pasadena 8, Calif.  
 Milac analog computer. Electronic instruments for precision testing and measurement. Ac RMSa
- Minnesota Electronics Corp., 3101 East 4 St., Minneapolis, Minn. / \*C  
 Digital and analog computers. Magnetic components, magnetic decision elements. Data reduction systems, telemetering. Ss(35) Se(1946) DAic RMSa
- Minneapolis-Honeywell Regulator Co., Industrial Division, 4580 Wayne Ave., Philadelphia 44, Pa. / Michigan 4-8300 / \*C  
 Automatic controllers. Brown Instruments. Servo components used in computers. Recording and indicating instruments and control equipment, etc. Amplifiers, converters, balancing motors, potentiometers, etc. Ls(3500) Le(1859) RMSa
- Monrobot Corp., Morris Plains, N. J. / Morristown 4-7200 / \*C  
 Monrobot automatic electronic digital computers. Subsidiary of Monroe Calculating Machine Co. Ss(32) Se(1952) Dc RMSa
- Monroe Calculating Machine Company, Orange, N. J. / Orange 3-6600 / and elsewhere. \*C  
 Desk calculating machinery for adding, calculating, and bookkeeping. See also Monrobot Corp. Ls(4000) Le(1912) Dc RMSa
- Moore School of Electrical Engineering, Univ. of Pennsylvania, Philadelphia, Pa. / Evergreen 6-0100, X981 / \*C  
 Place where Eniac and Edvac electronic digital computers were constructed. Analog and digital equipment; simulators. Ms(80) Me(1923) DAc RCPa
- F. L. Moseley Co., 409 North Fair Oaks, Pasadena, Calif. / Ryan 1-8998 / \*C  
 "Autograf" X-Y Recorder, point plotter, curve follower, etc. Ss(30) Se(1951) Ic RMSa
- Mountain Systems, Inc., 94 Lake St., White Plains, N. Y. / White Plains 9-0714 /  
 Data processing systems and digital computer systems. Ss Se Dc RMSCa
- National Bureau of Standards, Applied Mathematics Division, Washington 25, D. C. / Em 2-4040 / \*C  
 (1) Numerical Analysis Section: Ss(10) Se(1954) Dc RGa
- (2) Computation Laboratory: SEAC (Bureau of Standards Eastern Automatic Computer). Ms(50) Me(1938) Dc CPGa
- (3) Statistical Engineering Laboratory: Ss(20) Se(1946) Dc RCPGa
- (4) Mathematical Physics Section: Ss(10) Se(1954) Dc CPGa
- National Bureau of Standards, Electronics Division, Electronic Computers Laboratory, Washington 25, D. C. \*C  
 Digital computers, data processing systems, input-output devices. Storage elements, transistors, diodes, delay lines, etc. Have designed and assembled Seac and Dyseac electronic digital computers, etc. Ms(110) Se(1946) Dc RCMBGa
- The National Cash Register Co., Electronics Division, 3348 West El Segundo Blvd., Hawthorne, Calif. / Osborne 5-1171 / \*C  
 Digital computers, data processing machines, decimal digital differential analyzers, computer components, input-output devices, computing systems. CRC 102-A and 102-D general purpose computers and other computers. Ms(350) Se(1950) Dc RCMSa
- National Co., Inc., 61 Sherman St., Malden, Mass. / Malden 2-7954 /  
 Communications receivers; some computing equipment. Ls(700) Ic RMSa
- National Physical Laboratory, Control Mechanisms and Electronics Division, Teddington, Middlesex, England. \*C  
 Digital computers, electronic simulators, data recording. Designer and builder of the Pilot Model of ACE (Automatic Computing Engine). Collaborates with English Electric Co. Ls(1000; this division, 40) Le(1900) DIC RCPMa
- Northrop Aircraft Co., Hawthorne, Calif. \*C  
 Computing center; develops, maintains, operates own computing equipment. Digital plotter. Data reduction and analysis. Development of computing systems on order. Ms(70 this project) Se(1950 this project) DAc RCPa
- Notifier Manufacturing Co., 239 South 11 St., Lincoln 8, Nebraska / Lincoln 5-2946 / \*C  
 Automatic control machinery for fire alarms. Automatic control circuits, computer circuits, switching circuits. Memory and pulse storing devices, transistor devices. Ss(35) Se(1949) C1c RMSCa
- Nuclear Development Associates, 80 Grand St., White Plains, N. Y. / White Plains 8-5800 / \*C  
 Circle Computer design and sales; special purpose data-handling systems, and system design. Associated with Hogan Laboratories. Ms(100) Se(1948) DIC RMSa
- Olivetti Corp. of America, 580 Fifth Ave., New York 36, N. Y. / Judson 2-0637 / and Ing. C. Olivetti & C., S.P.A., Ivrea, Italy. \*C  
 Desk adding, calculating, and printing machines. Fully automatic printing calculators. Ls(6000) Le(1908) Dc RMSa
- Ortho Filter Corp., 196 Albion Ave., Paterson 2, N. J. / Mulberry 4-5858 / \*C  
 Pluggable units for computers, cathode ray amplifiers, power supplies, wiring of complete racks, etc. Ss(43) Se(1946) Ic RMSa
- Panellit, Inc., 7475 North Hamlin Ave., Skokie, Ill. / Orchard 5-2500 / \*C  
 Equipment for automatic control: coordinated and graphic control panels for process vari-

ROSTER OF ORGANIZATIONS

- ables; multiple-point scanning systems, annunciator systems. Ms(375) Se ISCMc RCMSa Pennsylvania State College, X-Ray and Solid State Lab., Dept. of Physics, State College, Pa. \*C X-RAC computer for crystal electron density. functions. S-FAC for structure factor interpretations. Ms(55) Se(1947) Ac RPa
- George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass. / Liberty 2-5464 / \*C Philbrick electronic analog computing equipment and components. Ss(5) Se(1946) Ac RCMSa
- Phillips Control Corp., Joliet, Ill. / Joliet 3-3431 / \*C Relays for computers, etc. Ms(350) Se(1946) Ic RMSa
- Photon, Inc., 58 Charles St., Cambridge 38, Mass. / Trowbridge 6-1177 / \*C Machinery for composing type by photographs. First photographically-composed book has been published. Ms(100) Me(1940) DIc RCMSa
- Pitney-Bowes, Inc., Stamford, Conn. \*C Postage meters. Tax-stamping meters. "Tickometer" counting and/or imprinting machines. Ls(3000) Le(1920) Ic MSA
- Potter Instrument Co., 115 Cutter Mill Rd., Great Neck, N. Y. / Great Neck 2-9532 / \*C Electronic counters. Magnetic tape handler; digital printer. Shift registers. Magnetic core memory. Random access memory. High-speed printer ("Flying Typewriter"). Analog-to-digital converter. Ms(100) Se(1942) Dc RMSa
- Powers-Samas Accounting Machines, Ltd., England. Punch card tabulating equipment using small, medium, and standard cards. Agency is Underwood Corp., which SEE. Ls(6000) Le(1916) DIc RMSa
- Productions Electroniques, 8, rue Laugier, Paris 17, France Collaborating with Institut Blaise Pascal on magnetic recording devices. Ic RMSa
- Radio Corporation of America, Tube Division, 415 South 5 St., Harrison, N. J. / Humboldt 5-3900 / \*C Tubes, transistors for computers. Ls Le Ic RMSa
- Ramo-Wooldridge Corp., 6214 Manchester Blvd., Los Angeles 45, Calif. Digital computers and components, etc. ?s Se(1954) DIc RMSa
- The Rand Corporation, 1700 Main St., Santa Monica, Calif. \*C Electronic digital computer (Johnniac) constructed and operating. Ls(600) Se(1946) DAIC RCPa
- Raytheon Manufacturing Co., Waltham, Mass. / Waltham 5-5860 / \*C Electronic computer systems for general accounting and data-processing operations, and for general scientific applications (RAYDAC). Magnetic-core coincident-current matrix memory systems, magnetic shift registers, binary and decade counters, magnetic core logical components and subsystems, tape-handling mechanisms, magnetic recording heads, magnetic amplifiers. Computing services to analyze and process problems in operations research, applied mathematics, engineering, and general business accounting by digital computer. Machine control, radar, sonar, communications, fire control, microwave and telemetering equipment, power and receiving tubes, diodes, transistors. Ls(20,000) Me(1925) DAc RMSa
- J. B. Rea Co., Inc., 1723 Cloverfield Blvd., Santa Monica, Calif. / Exbrook 3-7201 / \*C Automatic control systems; high-speed analog-to-digital converter (Reacon); analog and digital computing facility; etc. Ms(60) Se(1951) DSCc RMSa
- Reeves Instrument Co., 215 East 91 St., New York 28, N. Y. / Trafalgar 6-6000 / Fire-control equipment. "REAC" electronic analog computers. Ls Me Ac RMSa
- Remington Rand, Inc., 315 4th Ave., New York 10, N. Y. / Spring 7-8000 / and elsewhere / \*C Digital computers (Univac System, ERA 1101 Electronic Computer System, ERA 1103 Electronic Computer System); analog computers; special purpose computers. Card-to-tape and tape-to-card converters. Servomechanisms, magnetic drum storage systems, input and output devices. Adding and calculating machines. Punched-card accounting machines and other accounting machines, etc. SEE also Eckert-Mauchly Division and Engineering Research Associates Division. Ls(over 30,000; 1800 on computers) Le DASC RCMSa
- Robotyper Corporation, 125 Allen St., Hendersonville, N. C. / Hendersonville 4246 / Automatic typing equipment that can be associated with any electric typewriter, using a record roll pneumatically operated. Ic RMSa
- Servo Corporation of America, New Hyde Park, N.Y. / Fieldstone 7-2810 / \*C Servomechanisms. Automatic controls. Analysis and synthesis for controls manufacturers. Temperature controls by infra-red radiation. Industrial controls. Servo components and test equipment. Analog and digital computers. Ms(350) Se(1946) DASCc RMSa
- Servomechanisms, Inc., Post & Stewart Ave., Westbury, L. I., N. Y., and 316 Washington St., El Segundo, Calif. / Westbury 7-2700 and El Segundo 1517 / \*C Automatic electronic and electro-mechanical control systems and components, analog computers, instrumentation. Ls(700) Se(1946) ASICc RMSa
- Shepard Laboratories, Summit, N. J. High-speed typer (up to 1800 characters per second). Ss Se(1950) DIc RMSa
- Société d'Electronique et d'Automatisme, 138 Blvd de Verdun, Courbevoie, Seine, France / Défense 41-20 / \*C Analog and digital computers and components. Servomechanisms; electronic equipment for machine tools; electronic recorders. Analog computer OME-L2. General purpose digital computer CAB 2.022. Ms(320) Se(1948) DASC RMSa
- Société des Servomechanismes Electroniques, 1 rue Chané, Paris 16e, France Sc RMSa
- Soroban Engineering, Inc., Box 117, Melbourne, Fla. Electronic digital computers of the FLAC and SEAC type; computer auxiliaries such as high-speed tape perforators (240 characters per second), coded automatic keyboards, automatic format tabulators, etc. Ss Se(1953) Dc RMSa
- Southern Electronics Corporation, 239 West Orange Grove Ave., Burbank, Calif. / Victoria 9-3193 / \*C

ROSTER OF ORGANIZATIONS

- Precision polystyrene capacitors. Ss (55)  
Se (1951) Ic RMSa
- Sperry Gyroscope Co., Great Neck, N. Y. / Fieldstone 7-3600 / \*C  
Ordnance; fire-control equipment. Automatic controls. Navigation equipment, sea and air. Radar, Loran, gyrocompasses, precision instruments. Ls (18,000) Le (1910) Ac RMSa
- Sprague Electric Co., 377 Marshall Street, North Adams, Mass. \*C  
Capacitors: miniature, and low dielectric hysteresis loss, for computer applications. Standard capacitors; precision and power type resistors; pulse transformers; radio interference filters; printed circuits. Ls (5000) Le (1926) Ic RMSa
- Swedish Board for Computing Machinery, Drottninggatan 95A, (P. O. Box 6131), Stockholm 6, Sweden / Stockholm 23 55 90 / \*C  
State central institution for research, development, and computation service on large-scale machines. Operates two computers, BARK and BESK, designed and built by the Board. They have run commercially, BARK since July 1950, and BESK since March 1954. BARK is a binary, automatic relay computer, orders set up on a plug-board, parallel-operating, three-(four-) address system. BESK is a binary, electronic sequence computer, storing orders and data in a parallel Williams memory or in a magnetic drum memory, one-address system, parallel-operating. Research on numerical analysis; development of new computers. Ss (30) Se (1949) Dc RMCPa
- Sylvania Electric Co., Radio and Television Div., 70 Forsyth St., Boston 15, Mass. / Kenmore 6-8900 / and elsewhere. \*C  
Electronic digital computers using printed circuit techniques. Subassemblies of diodes and triodes. Computer components. Ls (2200; this division 190) Le (1901; this division 1949) DAc RMSa
- Taller and Cooper, 75 Front St., Brooklyn, N. Y. / Ulster 8-0500 / \*C  
Data recording and conversion system, printers, perforators, analog to digital converters. Function generators, computers. Mechanical function generator control of machine tools and allied mechanisms. Toll equipment for bridges, highways, turnpikes. Ms (350) Me (1926) DIc RMSa
- Tally Register Corp., 5300 14th Ave. N.W., Seattle 7, Wash. / Dexter 5500 / \*C  
Special purpose business machines; electromagnetic pulse counters and pulsed relays; high-speed data reduction systems for telemetering applications; digital-input, multiple-symbol X-Y plotter with continuous grid printing; numeric printing tape punch; printing transfer key punch. Ss (15) Se (1948) DICMc RMSCa
- Taylor Instrument Co., Rochester, N. Y.  
Automatic controllers. Ls Le Cc RMSa
- Technitrol Engineering Co., 2751 North 4 St., Philadelphia 33, Pa. / Garfield 6-9105 / \*C  
Computing and control equipment. Complete digital systems. Components, pulse transformers. Electrical and acoustic delay lines. High-speed memories. Time serial computers. Ms (90) Se (1947) DAC RMSa
- Telecomputing Corp., 133 E. Santa Anita Avenue, Burbank, Calif. / Charleston 0-8161 / \*C  
Automatic data reading, recording, and plotting equipment. Automatic business data accumulation and analysis equipment; multiple access storage systems. Ms (250) Se (1947) DICMc RMSPa
- Tequipment Corporation, Sea Cliff, N. Y. / Glen Cove 4-2900 /  
Equipment for attaching to an electric typewriter so that it may produce punched paper tape simultaneously with typing. Ss Se Ic RMSa
- Teleregister Corp., 445 Fairfield Ave., Stamford, Conn. / Stamford 48-4291 / \*C  
Digital and analog special purpose computers. Data inventory systems for special applications: travel reservations, flight data processing, stock market quotations, etc. Magnetronic Reservoir, in use at American Airlines reservations center. Magnetronic stock quotation system in use in Toronto Stock Exchange. Ms (275) Me (1928) DIc RMSa
- Teletypesetter Corporation, 2752 Clybourn Avenue, Chicago 14, Ill. / Graceland 7-5250 / and elsewhere / \*C  
Tape perforators and operating units for local or distant automatic control of Linotypes and Intertypes. Ms (57) Me (1929) Ic RMSa
- Tobe Deutschmann Corporation, 921 Providence Highway, Norwood, Mass. / Norwood 7-2620 / \*C  
Capacitors for computers, etc.; electronic noise suppression products (interference filters). Ls (500+) Le (1922) Ic RMSCPa
- Transistor Products, Inc., 241 Crescent St., Waltham 54, Mass. / Waltham 5-9330 / \*C  
Transistors, diodes. Ms (150) Se (1952) Ic RMSa
- Ultrasonic Corp., 640 Memorial Drive, Cambridge, Mass. / University 4-5400 / \*C  
Automatic control using feedback: development, equipment. Computing controls for machine tools. Etc. Ls (700) Se (1945) DASc RMSa
- Underwood Corp., One Park Ave., New York 16, N.Y. / Lexington 2-7000 / General Research Lab., 56 Arbor St., Hartford 6, Conn.; and elsewhere. \*C  
Accounting machines, adding machines, typewriters. Elliott-Fisher and Sundstrand Machines. Underwood Samas punched card accounting machines and systems. Underwood electric typewriters, used in Harvard Mark II calculator. ELECOM electronic computers. SEE also Electronic Computer Division of Underwood Corporation. Ls (company 10,000; laboratory, 100) Le (1895) DIc RMSa
- Union Switch and Signal Co., Division of Westinghouse Airbrake, Pittsburgh 18, and Swissvale, Pa.  
Railroad signaling and control systems. Ls (4000) Le Ic RMSa
- U. S. Air Force, Aeronautical Research Laboratory, System Dynamics Analysis Branch, Wright Air Development Center, Wright-Patterson Air Force Base, Dayton, Ohio / KE 7111, X28235 / \*C  
Has Oarac, and analog equipment. Ms (65) Se (1948) DAC RCGPa
- U. S. Air Force, Cambridge Research Center, 230 Albany St., Cambridge 39, Mass. / University 4-4720 /  
Developed the ABC (Automatic Binary Computer). Has a Computer Research Corp-102. Ms Me DIc Ga

ROSTER OF ORGANIZATIONS

- U. S. Air Force, Inst. of Technology, Wright-Patterson Air Force Base, Dayton, Ohio, \*C  
Electronic strategy machine, conceived by L. I. Davis. Philbrick and Reac equipment on hand. Ms (300) Se (1946) DAc Ga
- U. S. Army, Ballistic Research Laboratories, Aberdeen Proving Ground, Aberdeen, Md. \*C  
Has Bell, Edvac, Eniac, Ordvac computers and others. Developing supplementary and modernizing components. Ms Le DAc Ga
- U. S. Naval Proving Ground, Computation and Ballistics Department, Dahlgren, Va. / X627 / \*C  
Has three digital computers — Harvard Aiken Relay (Mark II), Aiken Dahlgren Electronic (Mark III), and will have Naval Ordnance Research Calculator (NORC). Ms (110) Se (1942) Dc RCPGa
- U. S. Naval Research Laboratory, Washington 25, D. C. \*C  
Making NAREC digital computer. Ls (3000) Me DAc RCGPa
- U. S. Navy, Office of Naval Research, Special Devices Center, Port Washington, New York / Port Washington 7-2800 / \*C  
Ls (500) Se (1943) DAcMc RMCGBa
- Univ. of California, Berkeley, Calif. \*C  
Constructing CALDIC, California Digital Computer. Ss (10) Se (1947) DAc RPa
- University of Illinois, Urbana, Ill.  
Built electronic digital computer Ordvac for Ballistic Research Laboratory, Aberdeen. Has finished computer Illiac on same design, but with faster input-output using a photoelectric reader. Dc RCPa
- University of Manchester, Mathematical Laboratory, Manchester, England. \*C  
Has automatic electronic digital computer built by Ferranti Electric, Ltd. This laboratory developed much of the design. Ss (8) Se (1947) Dc RPa
- Univ. Mathematical Laboratory, Free School Lane, Cambridge, England  
Has EDSAC electronic digital calculator. Dc RCPa
- Univ. of Michigan, Willow Run Research Center, Willow Run Airport, Ypsilanti, Mich. / Ypsilanti 5110 / \*C  
Digital computers, both special purpose and general purpose, including electronic and electromechanical analog computers; simulators. Data-processing systems, analysis and computation using Midac and Midsac; instruction in programming and numerical methods; simulation, etc. Ls (500) Se (1946) DAc RCPa
- University of Sydney, Dept. of Electrical Engrg., Section of Mathematical Instruments, Sydney, New South Wales, Australia  
Analog computers. Ac Ra
- Univ. of Toronto, Computation Centre, Toronto, Canada / Walnut 3-1327 / \*C  
Digital, electronic computers. Now operating: a Ferranti Electric automatic computer; punch card machines. Ss (15) Se (1947) Dc RCPa
- Vaucanson, 11 rue de Surmelin, Paris 20e, France  
Calculating machines. Dc RMSa
- Victor Adding Machine Co., 3900 No. Rockwell St., Chicago 18, Ill. \*C  
Adding machines. Ls (1600) Le (1918) Dc RMSa
- VISirecord, Inc., Ciopague, L. I., N. Y. / Amityville 4-4900 /  
Filing systems for computer punched paper tape, etc. Ms (100) Ic RMSa
- Wallind-Pierce Corp., 1928 Pacific Coast Highway, Lomita, Calif. \*C  
Digital-to-analog, and analog-to-digital translators. Digital and analog computers, magnetic amplifiers, etc. Ss (18) Se (1951) DAc RCMSa
- Wang Laboratories, 37 Hurley St., Cambridge 39, Mass. / Trowbridge 6-1925 /  
Magnetic delay-line memory units. Digital signal generators. Multiple scalars. Static magnetic memory systems and other devices. Ss Se (1951) Dc RCMSa
- The George Washington Univ., Logistics Research Project, 707 22nd St., Washington 7, D. C. / Sterling 3-4539 / \*C  
ONR relay computer with magnetic drum memory. Data-handling machines. ONR electronic digital computer with magnetic drum memory. Ms (50) Se (1950) Dc RCPa
- Watson Scientific Computing Laboratory, 612 West 116 St., New York, N. Y. / Monument 6-9600 / \*C  
The pure science department of International Business Machines Corp. Simultaneous linear equation solver. Astronomical plate measuring machine. IBM punch card machines. Research and instruction. Constructing NORC. Ms (100) Se (1945) DAc RCPa
- Wayne University, Cass Ave., Detroit 1, Mich. / Temple 1-1450 / \*C  
Computation laboratory. 5300-word magnetic drum computer built of Burroughs pulse control equipment. Has Mass. Inst. of Technology Differential Analyzer No. 1. Acquiring digital differential analyzer and electronic analog equipment. Instruction and training. Ss (30) Se (1950) DAc Ra
- Jervis B. Webb Co., 8951 Alpine Ave., Detroit 4, Mich. / Webster 3-8010 / \*C  
Servomechanisms, automatic control machinery, automatic materials handling machinery. Ls (600) Le (1919) SCMc RMSa
- Weems System of Navigation, 227 Prince George St., Annapolis, Md.  
Automatic navigation systems. Me Ic RCPMSa
- Westinghouse Electric Corp., Industry Engineering Dept., East Pittsburgh, Pa. \*C  
Analog computers for: mechanical and electrical problems; regulating systems; servomechanism behavior; flow of heat, oil, or gas; other purposes. DC and AC calculating boards, ANACOM computer. Ls Le DAc RMSCPa
- Wharf Engineering Labs., Fenny Compton, Warwickshire, England / Fenny Compton 30 / \*C  
Magnetic drums, recording heads, transformers. Ss (15) Se (1949) Ic RMSa
- Zator Co., 79 Milk St., Boston 9, Mass. / Liberty 2-4624 / \*C  
Digital equipment and systems for coding, filing, and finding information (Zato coding systems). High-speed selectors for notched cards. Methods for use of digital computing machines to recover information. Ss Se (1947) Ic RCSa
- Zeuthen & Aagaard Ltd., 6 Esplanaden, Copenhagen, Denmark / Central 3795 / \*C  
Portable adding machine (Context); dictating machine (Rex-Recorder) with magnetic recording on plastic disc using impregnated particles and permitting more than 10,000 reuses; duplicating machines, etc. Ls Le Ic RMSa

(continued on page 30)

# Analog Computers and their Application to Heat Transfer and Fluid Flow — Part 1

(Later Parts and Bibliography will be published in forthcoming issues)

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The purpose of this paper is to survey the field of analog computers with particular reference to their application to heat transfer and fluid flow problems and to present a bibliography.

A computer is an information processing device. It has been defined as a "device which accepts quantitative information, may arrange it and perform mathematical and logical operations on it, and makes available the resulting quantitative information as an output".<sup>15</sup> (The superscript number is the number of the reference listed in the bibliography.) This is a broad definition which includes slide rules, desk calculators, differential analyzers, industrial controllers, telephone exchanges, and large-scale digital computers.

Computers are generally classified as digital, analog, or a combination of both. Digital computers are discrete variable devices which represent numbers by counting discrete objects in space or discrete events in time such as holes in a paper card or tape, the teeth of a gear wheel, or electric pulses in a circuit. Fundamentally, they are machines which perform arithmetical operations on numbers, such as desk calculators or telephone exchanges. Analog computers are continuous variable devices which represent numbers by measuring some physical quantity such as shaft rotation, voltage, resistance, or position of a hand on a scale. Slide rules, differential analyzers, and industrial controllers are analog computers. A computer which employs both digital and analog computing devices would also include converters to change information from one form to another.

## History

In order to gain a proper perspective, it would be good to briefly review the history of computers.<sup>15</sup> One of the oldest forms of computers is the abacus of ancient times. The seventeenth century saw the slide rule and an adding machine invented by Pascal to assist his father in checking accounts. During the first half of the nineteenth century the planimeter came into being and Charles Babbage worked out the concepts of digital machines. In 1876 a ball-and-disk integrator was invented by James Thomson and a harmonic analyzer was conceived by his brother Lord Kelvin. In the last half of the nineteenth century, adding machines, comptometers, calculating cash registers, and billing machines

were developed. In World War I appeared the application of rudimentary electrical computing techniques to anti-aircraft fire control. In 1925 the first large differential analyzer was made by Vannevar Bush at the Massachusetts Institute of Technology. Various electric bridges, field plots by means of poorly conducting liquids and potential probes, and applications of d-c and a-c network analyzers were made during the 1920's. In the 1930's occurred the development of servo methods, potentiometers, resolvers, and feedback amplifiers which gave impetus to electrical analog computation.

Today there are a number of large scale digital and analog computer installations, a number of simple differential analyzers on the market, many available components which a user can assemble to fit his own needs, and a bewildering variety of small special purpose computers for process control and other computing purposes. Analog and digital techniques are used now to supplement each other; a simple analog computer to understand the problem and a digital computer for detailed investigation of areas of the problem are a powerful combination.

## Computers in Design and Research

Computers have been a vital factor in the revolutionary progress in the level of complexity of practical science and engineering during the past century. They make it possible to solve problems faster, to handle problems which formerly required more effort than could economically be expended, and to find solutions to problems which were previously incapable of solution. Today the computer is well established along with the slide rule, balance, and test tube as an essential tool of the industrial researcher.

The technique of simulation is a powerful aid to the system designer. One form of simulation is the study of a system by the cut and try examination of its mathematical representation by means of an analog or digital computer. A modified program of system design would probably include the following steps:<sup>11</sup> (1) description of system inputs, (2) first order design, (3) component analysis, (4) experiments for required parameters, (5) systems analysis, (6) system simulation, and (7) modification toward an optimum design by a repetition of steps (2) through (6).

The competitors of simulation are the mathematical analysis and the "build and discard" techniques. When systems are complicated, simulation shows definite advantages over the other two techniques. The building and testing of prototypes is costly and time consuming. The use of the mathematical analysis technique can result in a disproportionate expenditure of engineering time on extensive calculations and in tests to prove the assumptions underlying these calculations. When applied properly, computers can supply adequate solutions to the problems at hand with a saving in time, money, and engineering personnel.

### Analog Computers

By applying the principle of analogy, whereby various simple laws of nature and various parameters in different physical systems can be related to each other, a designer can translate a given problem from one physical system in which design computations are difficult and test models expensive, to another physical system in which low-cost models with continuously variable parameters can be quickly produced and tested.<sup>38</sup> A physical system is an assemblage of physical elements which may include mechanisms, electric circuits, chemical processes, heat processes, etc. Within the range of operating conditions in which known laws of design apply and by the proper application of conversion factors, data obtained in the analogous system are applicable in the original system.

A physical system can be represented by a physical analog or by an operational analog.<sup>38</sup> If each element or component in an original system is replaced by its analogous element or component in the model system, and if all interactions between elements are appropriately expressed so that the dynamic performance characteristics of the two systems are similar, then the model system is the physical or direct analog of the original system. The chief advantage of this direct technique is that the engineer does not have to write explicit equations for either system, which would be impossible to write for very complex systems. It is only necessary that the analog be a true and valid model and that the applied forces and boundary conditions be known. Data obtained by running tests on the analog, when directly translated back into terms appropriate to the original system, will establish the performance of the original system.

For example, a delta area in California has the ocean on its west, the Sacramento River entering from the north, the San Joaquin River entering from the south, and the Mokelumne River entering from the east. A pumping plant lifts the water out of the channels at the south

end of the delta to supply the San Joaquin Valley. An old network of channels carries the flow through the delta. The problem arose of how to bring the Sacramento River water across the delta to the San Joaquin side while maintaining a pattern of flow in the channels which will hold intrusion of ocean salinity in check and thereby permit the transfer to be made without danger of contamination. An analog computer was set up to study this problem.<sup>144</sup> The analogous hydraulic and electrical relationships were developed and quantity of flow was represented in the analog by electric current, water surface elevations were represented by voltage, inertia by inductance, storage by capacitance, frictional drag by resistance, and time by time. However, the analog runs through five hundred days of actual tide changes in each second of operating time. The analog can reproduce the square-law relation between friction and velocity that is characteristic of fluid flow. Gate keepers are represented by rectifier circuits. Stream flows and currents are represented by controlled d-c currents added to and subtracted from certain points in the analog network. The wave motions associated with tides are represented by a-c voltages of specified magnitude. Net current flows are read on d-c milliammeters and tidal amplitudes and phase differences are read on cathode ray oscilloscopes. The analog has proved to be an effective means for expediting the work of finding the flow distribution patterns in a network of channels. It is particularly effective when tidal effects must be included in addition to gravity flows. The results obtained with the analog have checked well with those obtained by other means.

It is not always necessary, and frequently not desirable, to replace each individual element of an original system with an equivalent in the analog system. Analog models can often be greatly simplified and their usefulness broadened if they reproduce only the functional operations of the original system. This approach is particularly appropriate if the performance of the original system can be formulated mathematically. A model system which can reproduce the mathematical operations implicit in the mathematical formulation of the original system, without regard to the actual nature or elements of that system, is an operational analog. The building blocks of this operational analog may be actual physical elements with near ideal performance or relatively complex devices developed specifically to perform certain mathematical operations. Differential analyzers, mechanical or electronic, are one type of operational analog which have been put to a great multitude and variety of uses.

The dynamic performance of mechanical, hydraulic, thermal, magnetic, and acoustic systems and complex systems containing components

in several of these fields can often be reproduced with simple analogous electrical systems. Electrical models are used more often than other type models, such as air-flow or water-flow models, because they can be produced at low cost in minimum time, and, once assembled, they can easily be modified with the many electrical components mass-produced to fill radio, television, industrial control, and armed services requirements. Also, the computational and recording devices now available are designed to accept the output signals of voltage and current produced in electrical models; complex sensing and conversion devices are required if equivalent measurements are to be made in mechanical, thermal, or fluid systems. Many important mathematical manipulations such as algebraic summation, trigonometric resolution, differentiation, integration, and other data-processing steps can be carried out rapidly with electrical analogs of the mathematical operations.<sup>33, 47, 55</sup>

Planimeters, slide rules, automobile speedometers, industrial controllers, linear equation solvers, fire control computers, network analyzers, and differential analyzers are examples of analog computers. They can be applied to a great variety of problems. They can be used to solve abstract mathematical equations. They can be used to find solutions to systems of linear simultaneous equations where the speed of solution is essential. In the form of pneumatic, mechanical, electrical, electromechanical, or hydraulic industrial regulators they solve continuously, day after day, equations expressing the desired behavior of processes or plants under control. In the automatic control field, they serve as low-cost bench-type prototypes which can be tested conveniently in the laboratory under a variety of conditions. They may be used to represent a part of an over-all system (such as an airplane and its aerodynamic controls) while the actual piece of equipment to be tested (such as an autopilot) completes the system to be studied. They can be used to test systems or devices whose equations or transfer functions are known but which have not yet been built. They can be used to determine transfer functions of systems built up from physical analogs. By generating or displaying a large number of solutions for instant examination on cathode ray tubes or other graphic recorders, optimum system parameters can be determined. They can be used to solve a wide variety of problems whose boundary or initial conditions or both are complex, such as occur in the flow of heat in irregularly shaped bodies or the flow of fluids in reservoirs.

The accuracy to which an analog computer answer is obtained is limited by the precision to which physical displacements, angles, voltages, currents, etc., can be measured. A pre-

cision of  $10^{-3}$  or possibly  $10^{-4}$  is normal and  $10^{-5}$  is obtainable under highly restricted conditions.

Some of the advantages of analog computers are that they are simple enough so that many can be built to solve special problems, that an engineer can keep close track on the physical significance of the computation, and that a broad pattern of solutions representing many different combinations of conditions can be obtained in a short time. They are best for problems where engineering accuracy is sufficient and are the simplest type of computer for problems in which the precision of the computer is greater than the accuracy of the input data. They can handle almost all dynamic problems because the information needed is the presence of instability or the design of devices to prevent instability and not the numerical solutions.

The limitations of analog computers are that the equations for the original system or the transfer functions of the elements or components of the original system must be known, that a considerable amount of time must be allowed for setup of the computation schedule and analysis of results, and that the computing elements themselves, even though they may possess amazing versatility, have physical limitations. Some problems are not complicated enough to justify treatment by such an elaborate means. First cost is a consideration but the first cost of analog computers is low among computers. Analog computers are fundamentally calculus machines and are therefore, of course, inappropriate for basically arithmetical calculations such as census taking or cost accounting.

#### Some Large-Scale Computers and Their Applications

Large-scale general-purpose computers include the differential analyzer at the Massachusetts Institute of Technology, various d-c and a-c network analyzers, and similar analog computers operated by the Westinghouse Electric Corporation and the California Institute of Technology.

The MIT differential analyzer is used primarily for evaluating solutions of ordinary differential equations.<sup>25</sup> It is a mechanical device and the values of the variables involved are represented by positions of rotating shafts or by shaft rates. It has been used for solutions to problems in many branches of engineering and science and has stimulated activity in the fields of mathematical effort where processes of analysis are inadequate.

Network analyzers have been used to solve

quickly the many and various problems concerned with the operation of power systems.<sup>44</sup> They are practical, adjustable miniature power systems. They can be used to analyze results during the progress of a system study and therefore play an active part in system planning as well as checking the performance of completed systems.

The electrical analog computers at Cal Tech and at Westinghouse (the AnaCom) were constructed after a two year survey.<sup>30</sup> Various types of auxiliary equipment has been designed for use with these computers and the computers themselves are made up of many specially developed components.<sup>45</sup> A block diagram of a typical computer setup for solving a problem could consist of three blocks.<sup>37</sup> The first would be the steady-state or transient forcing functions. Electrical voltages are generated and applied to the analog which are equivalent to the forces applied to the actual physical system. The second block is the electrical analog of the system studied. Many analogs of different problems are already known and methods have been developed for systematically determining new ones. The third block is the measuring equipment, which includes oscillographic apparatus for transient problems. The exact type of measuring equipment will vary with each individual analysis. These computers have been used to solve a wide variety of problems including magnetic amplifier studies,<sup>81</sup> nonlinear mechanics and servomechanisms investigation,<sup>95</sup> transient vibration problems,<sup>70</sup> regulator problems,<sup>29</sup> the study of a steel mill drive,<sup>35</sup> and the study of a lubrication system.<sup>45</sup>

#### D-C Electronic Analog Computers and Their Applications

Computations, which are too extensive to be undertaken manually and not so elaborate as to justify using the facilities of a computation laboratory, can be handled easily and adequately by small, compact d-c electronic analog computers. Such computers can be constructed or can be purchased from manufacturers like Reeves,<sup>28</sup> Goodyear,<sup>31, 39</sup> Philbrick, and Boeing. They are easy to operate, easy to maintain and service, and relatively inexpensive. The parameters can be changed easily and the time required for setup is short in comparison with other types of computers. Additional units can be added easily to extend the capacity of the machine and make it more versatile. Such a machine permits convenient and economical testing by straightforward techniques and is an effective tool in the hands of those who understand its capabilities, advantages, and limitations.<sup>33</sup>

In general, the following steps should be followed in handling a problem:<sup>33</sup>

(1) Obtain a complete statement of the problem. This would include the equations to be solved, the initial conditions, the parameters to be varied, any available solutions or checks, numerical values of the parameters, and the estimated ranges of the variables and their derivatives if possible. Since this computer is an operational analog, a given system can be studied only if its response equations are known.

(2) Determine tentative scale factors for each variable and set up the transformation equations. These equations express the relationship between the problem variables and the computer variables.

(3) Choose the time scale and write the transformation equation for the independent variable (time). The computer time may be equal to, slower than, or faster than real time. Do not forget to transform initial conditions, limiting levels, etc., to computer variables.

(4) Establish the machine equations and draw a computer block diagram.

(5) Interconnect the computing elements by patch cords to perform the operations required.

(6) Set potentiometers, initial values, limiting levels, and function generators according to the block diagram. Set or check recorder calibration.

(7) Make the computing devices operative and thereby force the voltages in the machine to vary in the manner prescribed by the machine equations. The voltage variations with time are recorded and constitute the solutions of the problem. The machine is stopped at a time chosen by the operator. The maximum allowable computing time is usually determined by the limitations of the computing elements. Check operation for consistency by means of standard built-in test signals.

(8) Reset the machine for the next run with changed coefficients, initial conditions, etc.

(9) Obtain all the data required.

(10) Reduce the data and analyze and report the test results.

- TO BE CONTINUED -

# Automatic Computing Machinery — List of Types

(Edition 1, cumulative, information as of Oct. 3, 1954)

The purpose of this list is to report types of machinery that may well be considered automatic computing machinery, that is, automatic machinery for handling information or data, reasonably. No objective criterion as to whether or not any particular type should or should not be included has yet been determined. We shall be grateful for any comments, corrections, and proposed additions or deletions which any reader may be able to send us.

## LIST

- Accounting-bookkeeping machines, which take in numbers through a keyboard, and print them on a ledger sheet, but are controlled by "program bars", which according to the column in which the number belongs, causes the number to enter positively or negatively in any one of several totaling counters, which can be optionally printed or cleared.
- Analog computers, which take in numerical information in the form of measurements of physical variables, perform arithmetical operations, are controlled by a program, and give out numerical answers.
- Astronomical telescope aiming equipment, which adjusts the direction of a telescope in an observatory so that it remains pointed at the small section of the heavens which an astronomer intends to study.
- Automobile traffic light controllers, that take in indications of the presence of motor cars from the operation of treadles in the pavement or in other ways, and give out signals, according to a program of response to the volume and density of traffic.
- Control systems for handling connected or flowing materials, which will take in indications of flow, temperature, pressure, volume, liquid level, etc., and give out the settings of valves, rollers, tension arms, etc., depending on the program of control.
- Control systems for handling separate materials, which will move heavy blocks, long rods, or other pieces of material to or from stations and in or out of machines, while taking in indications furnished by the locations of previous pieces of material, the availability of the machines, etc., all depending on the program of control.
- Data sampling systems, which will take in a continuous voltage or other physical variable and give out samples, perhaps once a second or perhaps a thousand times a second; this machine may be combined with an analog-to-digital converter, so that the report on the sample is digital not analog.
- Digital computers, which take in numerical, alphabetic, or other information in the form of characters or patterns of yes-noes, etc., perform arithmetical and logical operations, are controlled by a program, and put out information in any form.
- Digital-to-analog converters, which will take in digital numbers and give out analog measurements.
- Facsimile copying equipment, which scans a document or picture with a phototube line by line and reproduces it by making little dots with a moving stylus or with an electric current through electrosensitive paper.
- Flight simulators, which will take in simulated conditions of flight in airplanes, and the actions of airplane crew members, and show the necessary results, all for purposes of training airplane crews.
- Fire control equipment, that takes in indications of targets from optical or radar perception and puts out directions of bearing and elevation for aiming and time of firing for guns, according to a program that calculates motion of target, motion of the firing vehicle, properties of the air, etc.
- File-searching machines, which will take in an abstract in code and find the reference alluded to.
- Game-playing machines, in which the machine will play a game with a human being, either a simple game such as tic-tac-toe or nim (which have been built into special machines) or a more complicated game such as checkers, chess or billiards (which have been programmed on large automatic digital computers).
- Inventory machines, which will store as many as ten thousand totals in an equal number of registers, and will add into, subtract from, clear, and report the contents of any called-for register (these machines apply to stock control, to railroad and airline reservations, etc.).
- Machine tool control equipment, which takes in a program of instructions equivalent to a blueprint, or a small size model, or the pattern of operations of an expert machinist, and controls a machine tool so that a piece of material is shaped exactly in accordance with the program.

Navigation and piloting systems, which will take in star positions, time, radio beam signals, motion of the air, etc., and deliver steering directions.

Printing devices of high speed, which will take in punched cards or magnetic tape and put out printed information at rates from 600 to 2000 characters per second.

Punch card machines, which will sort, classify, list, total, copy, print, and do many other kinds of office work.

Railway signaling equipment, which for example enables a large railroad terminal to schedule trains in and out every 20 seconds during rush hours with no accidents and almost no delays.

Reading and recognizing machines, which scan a printed figure or letter, observe a pattern of spots, route the pattern through classifying circuits, recognize the figure or letter, and activate output devices accordingly.

Spectroscopic analyzers, which will vaporize a small sample of material, analyze its spectrum, and report the presence and the relative quantities of the chemical elements in it.

Strategy machines, which enable military officers in training to play war games and test strategies, in which electronic devices automatically apply attrition rates to the fighting forces being used in the game, growth rates to the industrial potential of the two sides, etc.

Telemetering transmitting and receiving devices, which enable a weather balloon or a guided missile to transmit information detected by instruments within it as it moves; the information is recorded usually on magnetic tape in such fashion that it can later be used for computing purposes.

Telephone equipment including switching, which enables a subscriber to dial another subscriber and get connected automatically.

Telephone message accounting systems, which record local and long distance telephone calls, assign them to the proper subscriber's account, and compute and print the telephone bills.

Test-scoring machines, which will take in a test paper completed with a pencil making electrically conductive marks, and will give out the score.

Toll recording equipment, which will record, check, and summarize tolls for bridges, highways and turnpikes.

Typing machines of high speed, which will store paragraphs, and combine them according to instructions into correspondence or form letters, stopping and waiting for manual "fill-ins" if so instructed.

(continued on page 30)

# Digital Computer Techniques

Electronic Business Systems

Military Radar Fire  
Control Systems

Aircraft Control and  
Navigation Systems

Applied to  
the design,  
development  
and  
application  
of

*The successful application of Hughes airborne digital computers to high speed aircraft fire control problems has opened up an entire new area for these digital computer techniques.*

*Similar equipment is now under development in the Advanced Electronics Laboratory to apply such digital computer systems to modern business information handling.*

LOGICAL DESIGN  
COMPONENT DEVELOPMENT  
PROGRAMMING  
MAGNETIC RECORDING  
CIRCUIT DESIGN  
INPUT & OUTPUT DEVICES  
SYSTEMS ANALYSIS

Areas include

*Hughes developments in these fields are creating new positions in the Advanced Electronics Laboratory.*

*Exceptional men in the following spheres of endeavor are invited to apply:*

## Engineers and Physicists

Computer activities embrace systems planning and analysis, design and development, system engineering and component development. Experience in these areas, as well as in application of electronic digital computers, is desirable but not essential. Analytically inclined men with backgrounds in systems work are required for this phase.

## Hughes

Scientific  
and  
Engineering  
Staff

RESEARCH AND DEVELOPMENT LABORATORIES  
Culver City, Los Angeles County, California

Assurance is required that relocation of the applicant will not cause disruption of an urgent military project.

# P A T E N T S

Hans Schroeder  
Milwaukee, Wisconsin

The following is a compilation of patents pertaining to computers and associated equipment from the Official Gazette of the United States Patent Office, dates of issue as indicated. Each entry consists of: patent number / inventor(s) / assignee / invention.

August 3, 1954 (issue now received): 2,685,407 / A A Robinson, Scunthorpe, England / Natl Research Development Corp, London, Eng / Multiplying circuit for binary numbers  
2,685,409 / F G S English, Chipstead, and M C P Hewitt, Workingham, England / Powers-Samas Accountg Machines, Ltd, London, Eng / Machine for sensing ferromagnetic marks on statistical record cards

August 24, 1954: 2,687,474 / W F Richmond, Jr, Towson, Md / Glenn L Martin Co, Middle River, Md / Integrating circuit using vacuum tubes in conjunction with an R-C circuit  
2,687,492 / C S Szegho and W O Reed, Chicago, Ill / Rauland Corp / Cathode ray type signal storage tube comprising a two-sided target and two electron guns  
2,687,503 / G M Attura, Levittown, N Y / Servomechanisms, Inc, Mineola, N Y / Modulating device and amplifier for electric servo system

August 31, 1954: 2,687,850 / D Gold, Washington, D C / - / Computer for determining gun aim

September 7, 1954: 2,688,440 / J W Gray, White Plains, and E B Hales, Hawthorne, N Y / General Precision Laboratory, Inc / Electromechanical great circle computer  
2,688,442 / M E Droz, New York, N Y, and W Roth, Cambridge, Mass / U S A, Secy of the Navy / Electromechanical computer for continuous summation of vector quantities  
2,688,681 / E Nyyssonen (sic), Watertown, Mass / U S A Secy of the Air Force / Wirewound potentiometer, resistance of which varies with the square of the displacement of the slider  
2,688,695 / A D Odell, Aldwych, London, Eng / Intl Standard Electric Corp, N Y, N Y / Electrical switching circuit using a vacuum tube  
2,688,696 / P E Reeves, Midland, Mich / - / Pulse generating circuit  
2,688,697 / J L Lawson, Schenectady, N Y, L B Linford, Belmont, Mass, and H L Johnson, Denver, Colo / U S A, Secy of the Navy / Pulse stretcher circuit  
2,688,723 / D T Kadushin, Brooklyn, and H Kaplan, New York, N Y / Sperry Corp / Two-stage magnetic amplifier

2,688,724 / W H Newell, Mount Vernon, NY / Sperry Corp / Magnetic amplifier  
2,688,739 / R Hofgaard, Nordstrandshogda, near Oslo, Norway / - / Process and apparatus for the code recording and the sensing of data on record cards having a metal film surface

September 14, 1954: 2,689,300 / R M M Oberman, and A Snijders, The Hague, Netherlands / - / Voltage interval multiplier  
2,689,301 / A M Skellett, Madison, N J / Natl Union Radio Corp, Newark, N J / Cathode ray type signal storage device  
2,689,319 / W W Shannon, Glenwood Landing, R F Redemske, Huntington Bay Hills, and G M Attura, Levittown, N Y / Servomechanisms, Inc, Mineola, N Y / Servo system  
2,689,320 / J P Aloisio, Somerville, Mass / Raytheon Mfg Co, Newton, Mass / DC-motor speed control system using saturable reactors

\* ————— \*

## Forum

### ASSEMBLY LINE CONTROL BY PUNCHED CARDS

George W. Patterson  
Burroughs Corp., Paoli, Pa.

To the Editor:

In connection with your bibliography on automation, you might be interested in the interesting assembly-line control by punched cards which has been installed at the Austin Motor Company in England. The punched-card equipment was supplied by British Tabulating Machines, Ltd. Literature references are as follows:

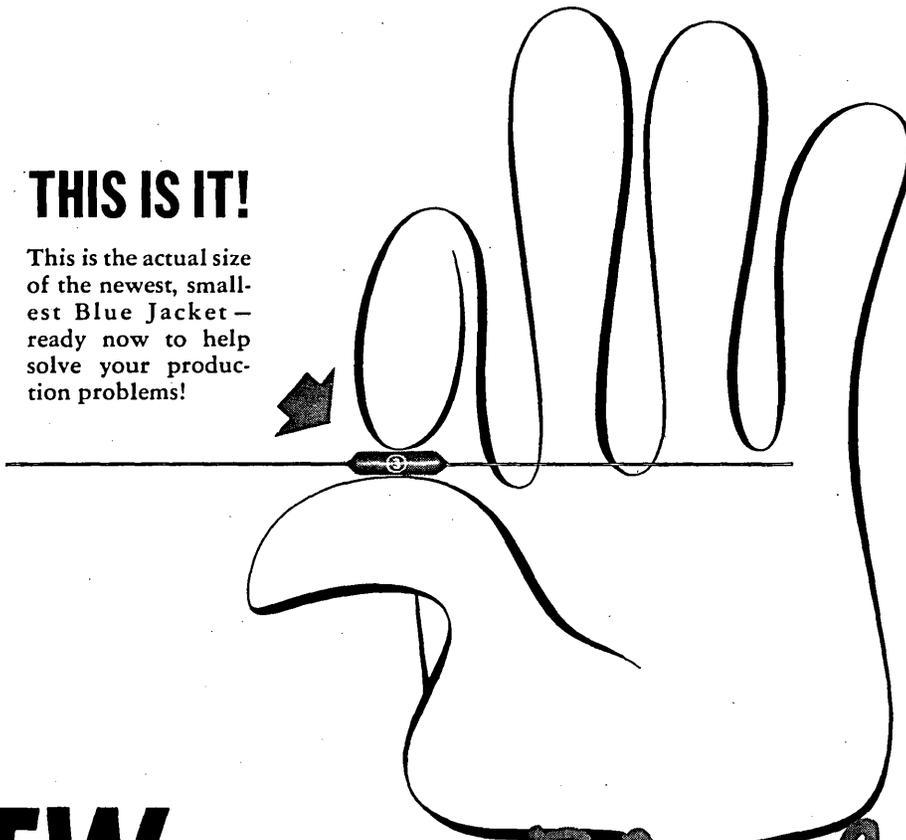
"The Machine Takes Charge", published in Scope, Magazine for Industry for September, 1952. Creative Journals Ltd., 9 Grosvenor Street, London, W.1, Eng.

"The New Technique Synchronizes Feeder Conveyors With Main Production Line by Punched Card Control", published in Mechanical Handling for October, 1951. The Baynard Press, London S.W. 9, Eng.

"A Major Development in Conveyor Technique and Stock and Production Control", published in The Machinist for September 8, 1951. (Geo. W. King Ltd., Hitchin, Herts, Eng. source of reprint).

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Blue Jackets are ideal for dip-soldered sub-assemblies... for point-to-point wiring... for terminal board mounting and processed wiring boards. They're low in cost, eliminate extra hardware, save time and labor in mounting!

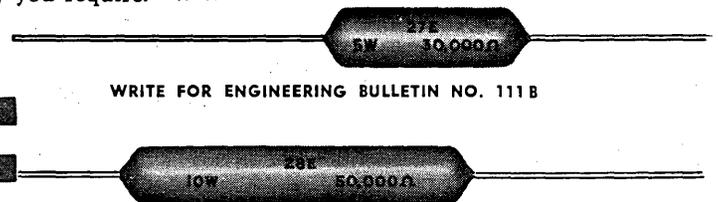
Axial-lead Blue Jackets in 3, 5 and 10 watt ratings are available without delay in any quantity you require. ★ ★

SPRAGUE TYPE NO.	WATTAGE RATING	DIMENSIONS (inches)		MAXIMUM RESISTANCE
		L	D	
151E	3	1/2	1/4	6,000 Ω
27E	5	1 1/4	3/8	30,000 Ω
28E	10	1 3/4	1/2	50,000 Ω

Standard Resistance Tolerance: ±5%

# SPRAGUE

WRITE FOR ENGINEERING BULLETIN NO. 111B



SPRAGUE ELECTRIC COMPANY · 97 MARSHALL ST. · NORTH ADAMS, MASS.

ALL-TRANSISTOR COMPUTER

Neil Macdonald  
New York

On October 7 in Poughkeepsie, N. Y., International Business Machines Corporation exhibited to the press their new experimental electronic computer using transistors.

The transistor computer is about one half the size and requires only a twentieth of the power of a similar vacuum tube computer. The new computer is comparable in capacity to the IBM Type 604 electronic computer (of which

over 2000 are now in use). The speed of the new machine is comparable to the speed of the Type 604. The experimental engineering model is believed by IBM to be the first fully operating transistorized computer having automatic input and output. It contains over 2200 transistors, many of them of a design developed by the IBM engineers to meet certain operating characteristics required in computer circuits. A transistor's longer life than a vacuum tube is another expected saving.

Printed circuits express a great deal of the wiring of the transistorized computer, and it contains 595 printed wiring panels. Many of them show in the accompanying photographs.

Figure 1. IBM's new experimental transistorized 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.

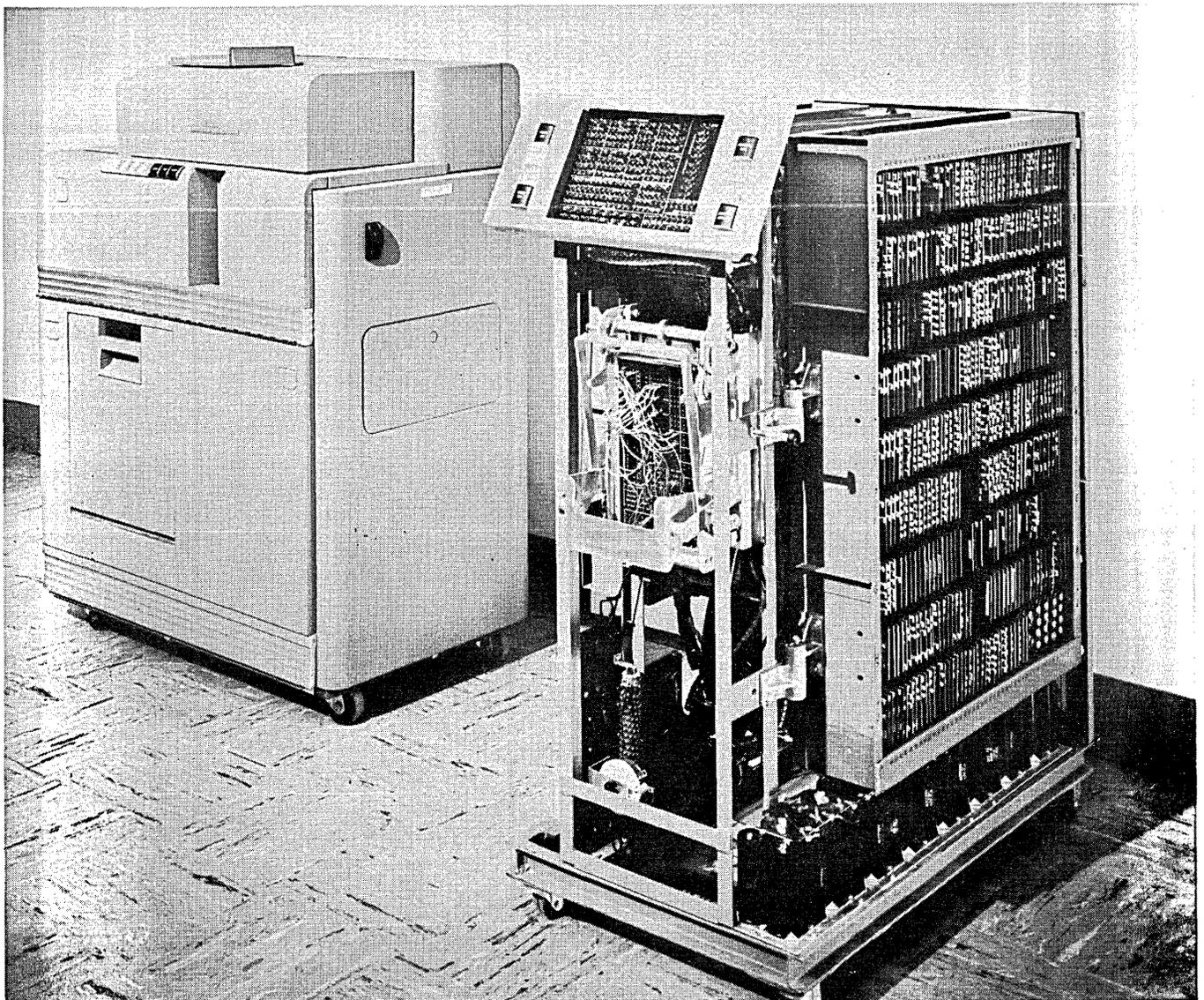


Figure 2. This bank of printed wiring panels in IBM's experimental "all-transistor" computer replaces much of the wiring required for the computing circuits of conventional computers. Mounted on these panels are many of the more than 2,200 transistors used in the machine.

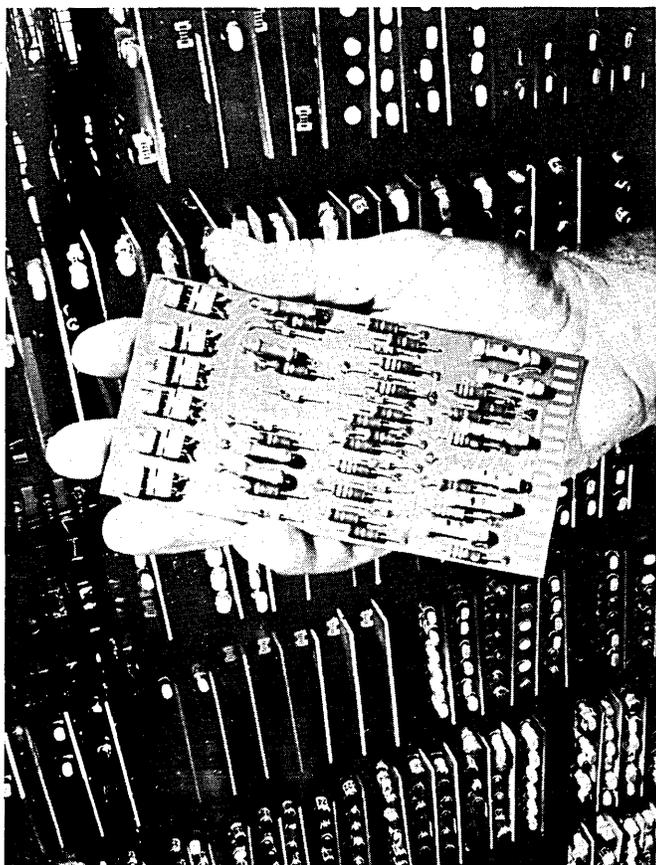
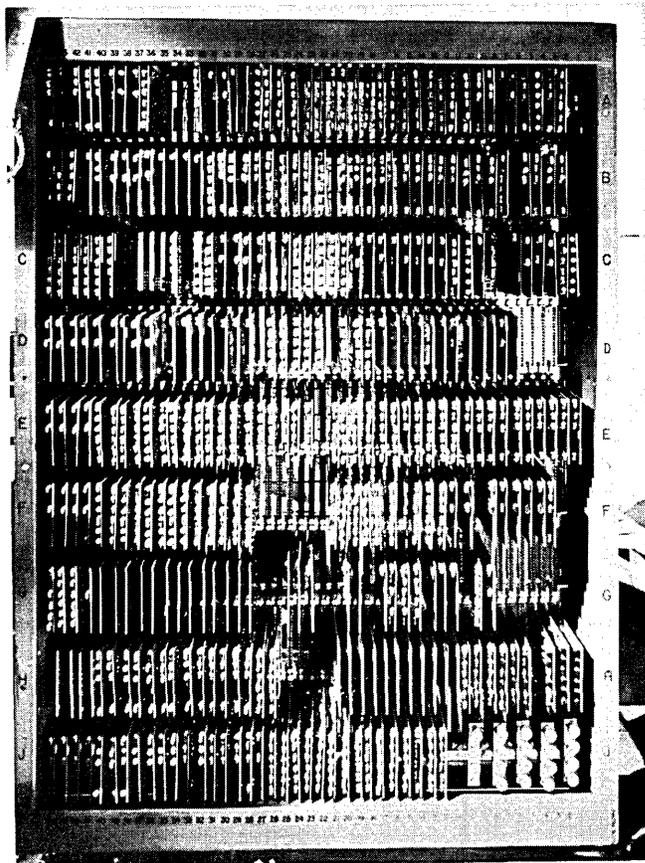


Figure 3. These printed wiring panels, used in IBM's experimental transistor computer to simplify production and maintenance, also reduce space required. Devices mounted on the panel held in the hand include transistors (at the extreme left), diodes, and resistors. The model contains 595 of these panels.

Konrad Zuse, Kreis Hünfeld No. 69, Neukirche n,  
Germany

Electronic digital computers. Has made Zuse  
Model IV and V computers. Ss (90) Se (1949)  
Dc RMSa

- END -

AUTOMATIC COMPUTING MACHINERY  
(continued from page 25)

Vending machines, which will accept different  
coins, make change, give out coffee, soft  
drinks, sandwiches, candy, stockings, and  
a host of other articles, or else allow  
somebody to play a game for a certain num-  
ber of plays, etc.

- END -

we have been privileged to lead the way.

Speaking personally for a moment, I have  
been impressed by the warmth of the personal  
friendships on both sides of the Atlantic, and  
across the Atlantic, that have grown up within  
this computing fraternity. The only regret  
that can be expressed is that the Atlantic is  
so wide.

- END -

Page 1  
Form 3526  
Rev. 8-50

Read the instructions  
on page 2 of this form.

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS  
OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233) SHOWING  
THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF

Computers and Automation published monthly  
(Insert exact title of publication) (State exact frequency of issue)  
at NEW YORK, N. Y. for OCT 1 1954, 19  
(Name of post office and State where publication has second-class entry)

1. The names and addresses of the publisher, editor, managing editor, and business managers are:

	Name	Address
Publisher	Edmund C. Berkeley and Associates	36 West 11 St., New York 11, N.Y.
Editor	Edmund C. Berkeley	36 West 11 St., New York 11, N.Y.
Managing editor	none	
Business manager	none	

2. The owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual member, must be given.)

Name	Address
Edmund C. Berkeley	36 West 11 St., New York 11, N.Y.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

Name	Address
none	

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required from daily, weekly, semiweekly, and triweekly newspapers only.) xxx

Edmund C. Berkeley

(Signature of editor, publisher, business manager, or owner)

Sworn to and subscribed before me this 30th day of September, 1954

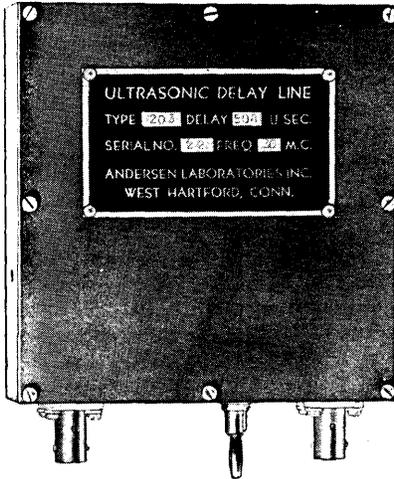
[SEAL]

Irving Cohen

Notary Public, State of New York, No. 24-5739800

(My commission expires March 30, 1956.)

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COMPUTER TEST EQUIPMENT

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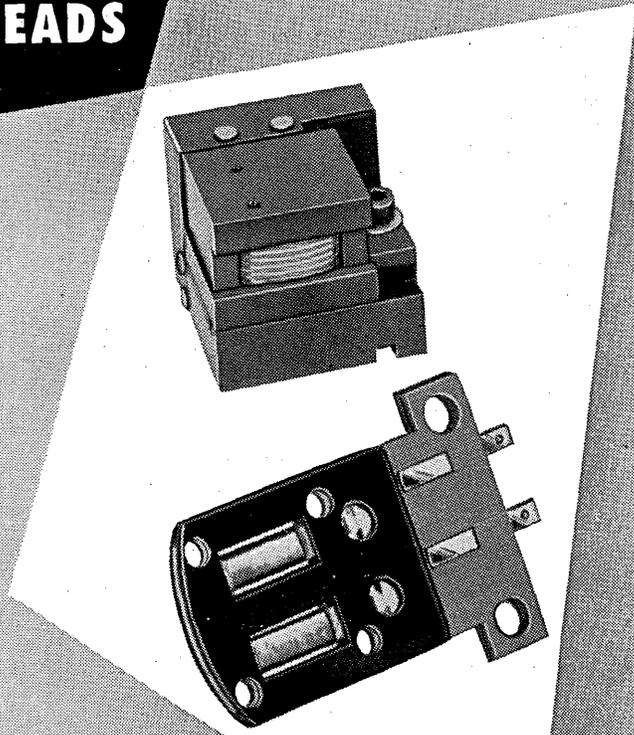
**COMPUTER CONTROL CO. INC.**

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**MAGNETIC  
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Designed for parallel-track pulse recording and reproduction of data on magnetic tapes or drums in high speed digital recorders. Features include: high level performance, relative thinness, interchangeability and adaptability for fabrication of multi-channel assemblies by stacking. Available as narrow or wide gap single channel heads or as six or 21-channel assemblies.



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circuits, using relays, electronic tubes, rectifiers, gates, flip-flops, delay lines, etc. Covers both static and sequential circuits. Applications to control, programming, and computing. Problems and solutions involving circuits. ....\$1.90

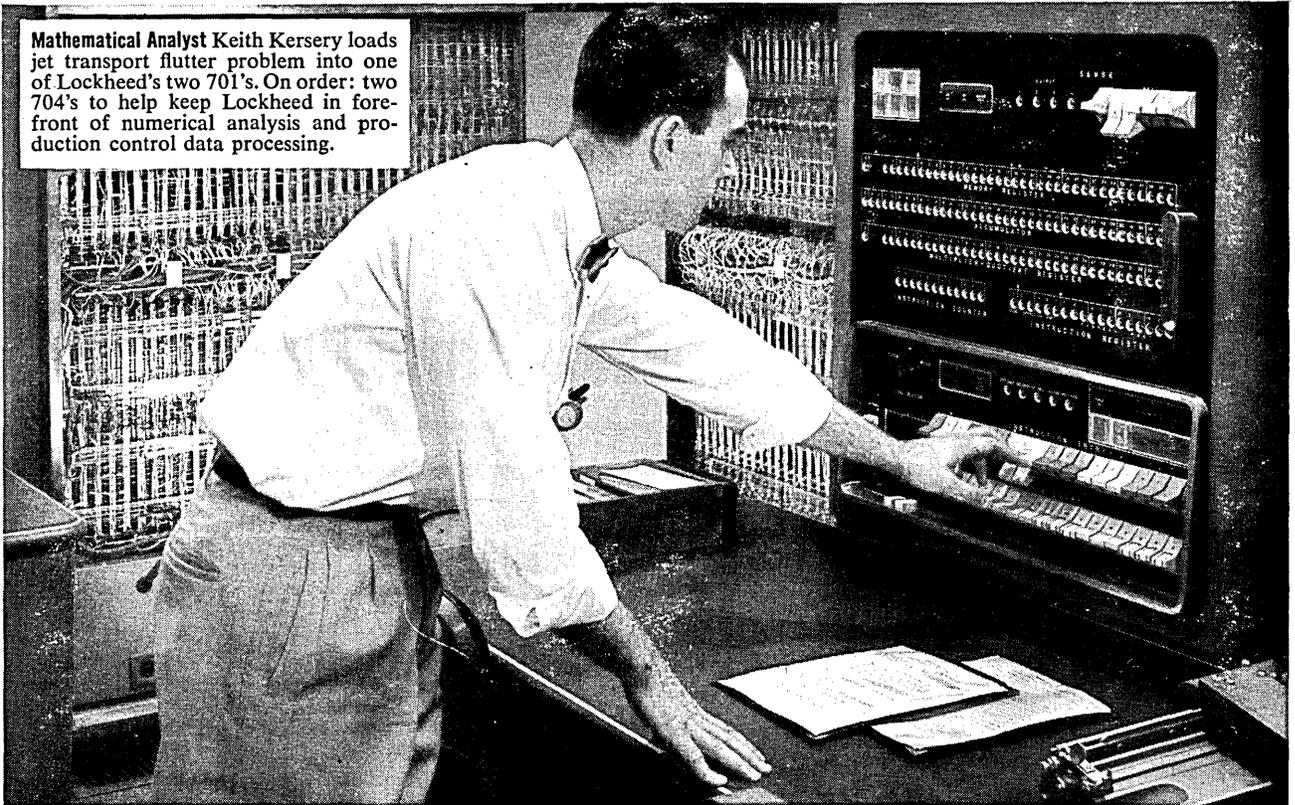
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815 Washington St., R105, Newtonville 60, Mass.

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( ) your announcement of publications.

Returnable in seven days for full refund if not satisfactory. I enclose \$\_\_\_\_\_ in full payment. (Add 10¢ per item to cover cost of handling and mailing.)

My name and address are attached.

Mathematical Analyst Keith Kersery loads jet transport flutter problem into one of Lockheed's two 701's. On order: two 704's to help keep Lockheed in forefront of numerical analysis and production control data processing.



The first airframe manufacturer to order and receive a 701 digital computer, Lockheed has now received a second 701 to handle a constantly increasing computing work load. It gives Lockheed the largest installation of digital computing machines in private industry.

Most of the work in process is classified. However, two significant features to the career-minded Mathematical Analyst are: 1) the wide variety of assignments caused by Lockheed's diversification and 2) the advanced nature of the work, which consists mainly of developing new approaches to aeronautical problems.

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Lockheed's expanding development program in nuclear energy, turbo-prop and jet transports, radar search planes, supersonic aircraft and other classified projects has created a number of openings for Mathematical Analysts to work on the 701's.

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## **New 701's speed Lockheed research in numerical analysis**



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# COMPUTERS AND AUTOMATION - Back Copies & Reprints

**ARTICLES: March, 1953:** Gypsy, Model VI, Claude Shannon, Nimwit, and the Mouse -- George A.W. Boehm  
Water and Computers -- Henry M. Paynter, Jr., Mass. Inst. of Technology, and Neil Macdonald  
The Concept of Automation -- E. C. Berkeley  
The ERA 1103 Automatic Computer -- Neil Macdonald  
**April:** The Art of Solving Secret Ciphers, and the Digital Computer -- Fletcher Pratt  
Avenues for Future Development in Computing Machinery -- Edmund C. Berkeley  
Hungarian Prelude to Automation -- Gene J. Hegedus  
**May:** Compiling Routines -- Grace M. Hopper, Remington Rand  
Mechanical Translation -- Andrew D. Booth, Birkbeck College, London  
Medical Diagnosis -- Marshall Stone, University of Chicago  
**July:** Machine Translation -- Y. Bar-Hillel, Mass. Inst. of Technology  
Robot Traffic Policemen -- George A. W. Boehm  
How to Talk About Computers -- Rudolf Fleisch, Author of "Art of Plain Talk"  
**September:** The Soviet Union: Automatic Digital Computer Research -- Tommaso Fortuna  
Digital Computer Questionnaire -- Lawrence Wainwright  
"How to Talk About Computers": Discussion -- G. G. Hawley and Others  
**October:** Computers in the Factory -- David W. Brown  
The Flood of Automatic Computers -- Neil Macdonald  
The Meeting of the Association for Computing Machinery in Cambridge, Mass., September, 1953 -- E. C. Berkeley  
**November:** Who Will Man the New Digital Computers? -- John W. Carr III  
Electronic Equipment Applied to Periodic Billing -- E. F. Cooley  
Air-Floating: A New Principle in Magnetic Recording of Information -- Glenn E. Hagen  
**December:** How a Central Computing Laboratory Can Help Industry -- Richard F. Clippinger  
"Combined" Operations in a Life Insurance Company Instead of "Fractured" Operations -- R. T. Wiseman  
"Can Machines Think?": Discussion -- J.L. Rogers and A. S. Householder  
**January, 1954:** The End of an Epoch: The Joint Computer Conference, Washington, D. C., December, 1953 -- Alston S. Householder  
Savings and Mortgage Division, American Bankers Association: Report of the Committee on Electronics, September, 1953 -- Joseph E. Perry and Others  
Automation in the Kitchen -- Fletcher Pratt  
**February:** Language Translation by Machine: A Report of the First Successful Trial -- Neil Macdonald  
Reflective Thinking in Machines -- Elliot L. Gruenberg  
Glossary of Terms in Computers and Automation: Discussion -- Alston S. Householder and E. C. Berkeley  
**March:** Towards More Automation in Petroleum Industries -- Sybil M. Rock  
Introducing Computers to Beginners -- Geoffrey Ashe  
Subroutines: Prefabricated Blocks for Building -- Margaret H. Harper

Glossaries of Terms: More Discussion -- Nathaniel Rochester, Willis H. Ware, Grace M. Hopper and Others  
**April:** Processing Information Using a Common Machine Language: The American Management Association Conference, February, 1954 -- Neil Macdonald  
The Concept of Thinking -- Elliot L. Gruenberg  
General Purpose Robots -- Lawrence M. Clark  
**May:** Ferrite Memory Devices -- Ephraim Gelbard and William Olander  
Flight Simulators -- Alfred Pfanstiehl  
Autonomy and Self Repair for Computers -- Elliot L. Gruenberg  
A Glossary of Computer Terminology -- Grace M. Hopper  
**July:** Human Factors in the Design of Electronic Computers -- John Bridgewater  
What is a Computer? -- Neil Macdonald  
**September:** Computer Failures -- Automatic Internal Diagnosis (AID) -- Neil Macdonald  
The Cost of Programming and Coding -- C.C. Gotlieb  
The Development and Use of Automation by Ford Motor Co. -- News Dept., Ford Motor Co.  
Reciprocals -- A. D. Booth  
**October:** Flight Simulators: A New Field -- Alfred Pfanstiehl  
Robots I Have Known -- Isaac Asimov  
The Capacity of Computers Not to Think -- Irving Rosenthal, John H. Troll

## REFERENCE INFORMATION (in various issues):

Roster of Organizations in the Field of Computers and Automation / Roster of Automatic Computing Services / Roster of Magazines Related to Computers and Automation / List of Automatic Computers / Automatic Computing Machinery -- List of Types / Who's Who in the Field of Computers and Automation / Automation -- List of Outstanding Examples / Books and Other Publications / Glossary / Patents

Price of back copies, if available, \$1.25 each.

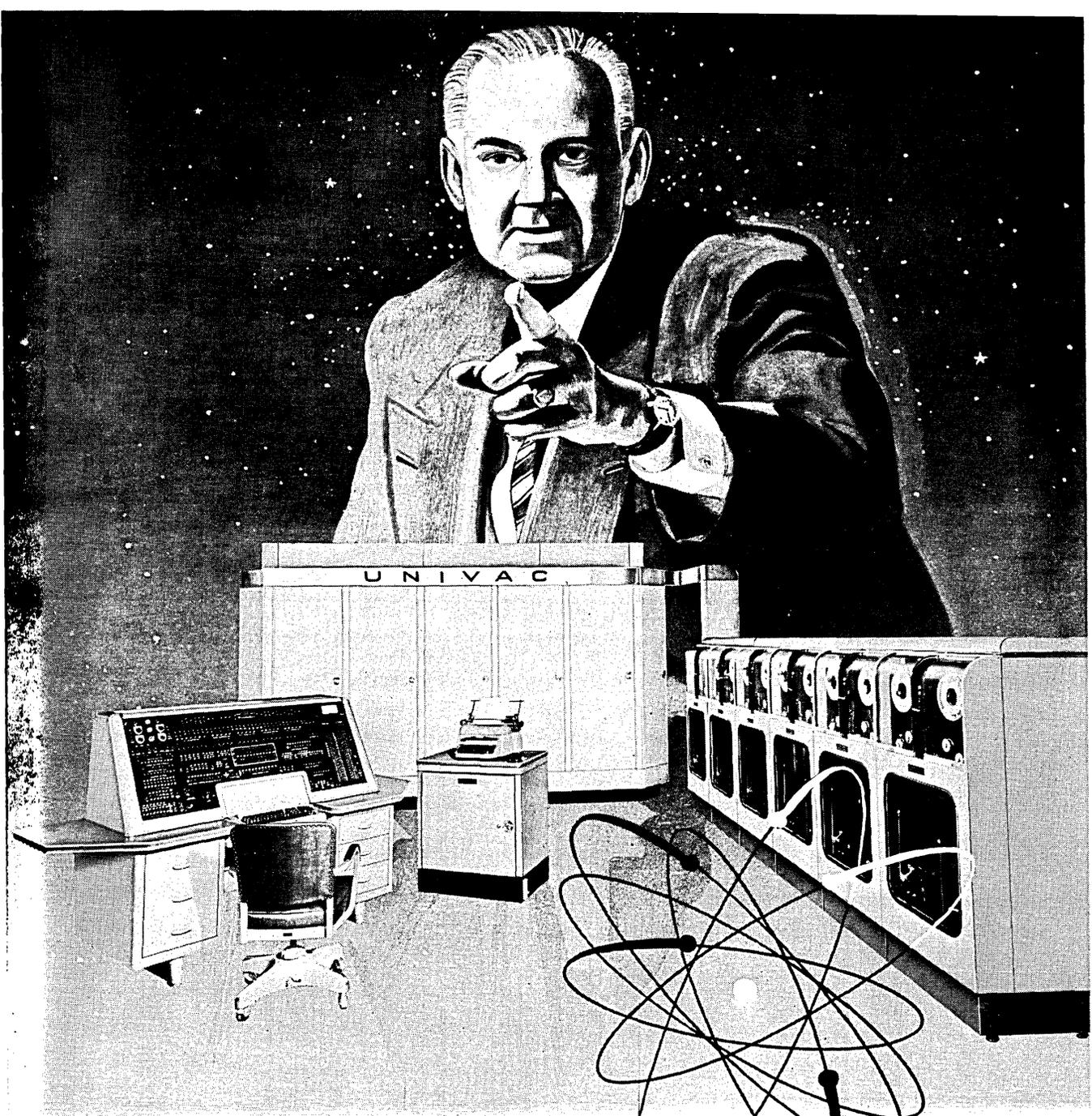
A subscription (see rates on page 4) may be specified to begin with any issue from Oct., 1954, to date.

REPRINTS: Index No. 1 (from December, 1953, issue) -- 20 cents

Glossary of Terms in the Field of Computers and Automation (from three 1953 issues) -- 60 cents

## WRITE TO:

Edmund C. Berkeley and Associates  
Publishers of COMPUTERS AND AUTOMATION  
36 West 11 St., New York 11, N. Y.



*Not a Promise for Tomorrow—An Accomplished Fact Today*

First so-called "giant brain" on the market—first in large-scale production—first electronic computing system to satisfy the diverse needs of business management—it's the Remington Rand Univac, acknowledged leader of the electronic computing field.

Univac is the only system with exclusive self-checking features which ensure complete reliability and accu-

racy, handling alphabetic and numeric data with equal ease.

Now that the amazing speed of electronic computing has been made practical for commercial use, Univac is being put to such down-to-earth, everyday tasks as turning out payrolls and controlling inventories. For these, and its many other uses, Univac is the logical choice of such users as General

Electric, Franklin Life, Metropolitan Life, the National Tube Division of U. S. Steel, and many governmental agencies.

And your company too—large or small—may well profit from Univac—if not through purchase, then through lease of equipment or use of our services. For further information, write to Room 2184, Remington Rand Inc.

ELECTRONIC COMPUTER DEPARTMENT, **Remington Rand** 315 FOURTH AVENUE, NEW YORK 10, N. Y.

# ADVERTISING IN "COMPUTERS AND AUTOMATION"

Memorandum from Edmund C. Berkeley and Associates  
Publishers of COMPUTERS AND AUTOMATION  
36 West 11 St., New York 11, N.Y.

1. What is "COMPUTERS AND AUTOMATION"? It is a monthly magazine containing articles and reference information related to computing machinery, robots, automatic controllers, cybernetics, automation, etc. One important piece of reference information published is the "Roster of Organizations in the Field of Computers and Automation". The basic subscription rate is \$4.50 a year in the United States. Single copies are \$1.25. The magazine was published monthly except June and August between March, 1953, and September, 1954; prior to March 1953 it was called "The Computing Machinery Field" and published less often than ten times a year.

2. What is the circulation? The circulation includes 1200 subscribers (as of Aug. 3); over 300 purchasers of individual back copies; and an estimated 1500 nonsubscribing readers. The logical readers of COMPUTERS AND AUTOMATION are some 3500 or 4000 people concerned with the field of computers and automation. These include a great number of people who will make recommendations to their organizations about purchasing computing machinery, similar machinery, and components, and whose decisions may involve very substantial figures. The print order for the Nov. issue was 2000 copies. The overrun is largely held for eventual sale as back copies, and in the case of several issues the overrun has been exhausted through such sale. A mailing to some 2000 nonsubscribers in December, 1953 (with 173 responses up to March, 1954) indicated that two-thirds of them saw the magazine (library, circulation, or friend's copy) and of these two-thirds over 93% "liked it".

3. What type of advertising does COMPUTERS AND AUTOMATION take? The purpose of the magazine is to be factual and to the point. For this purpose the kind of advertising wanted is the kind that answers questions factually. We recommend for the audience that we reach, that advertising be factual, useful, interesting, understandable, and new from issue to issue.

4. What are the specifications and cost of advertising? COMPUTERS AND AUTOMATION is published on pages 8½" x 11" (ad size, 7"x10") and produced by photooffset, except that printed sheet advertising may be inserted and bound in with the magazine in most cases. The closing date for any issue is approximately the 10th of the month preceding. If possible, the company advertising should produce final copy. For photooffset, the copy should be exactly as desired, actual size, and assembled, and may include typing, writing, line drawing, printing, screened half tones, and any other copy that may be put under the photooffset

camera without further preparation. Unscreened photographic prints and any other copy requiring additional preparation for photooffset should be furnished separately; it will be prepared, finished, and charged to the advertiser at small additional costs. In the case of printed inserts, a sufficient quantity for the issue should be shipped to our printer, address on request.

Display advertising is sold in units of full pages (ad size 7" by 10", basic rate, \$130) and half pages (basic rate, \$70); back cover, \$250; inside front or back cover, \$160. Extra for color red (full pages only and only in certain positions), 35%. Two-page printed insert (one sheet), \$220; four-page printed insert (two sheets), \$400. Classified advertising is sold by the word (40 cents a word) with a minimum of ten words. We reserve the right not to accept advertising that does not meet our standards.

5. Rate Change. Commencing January 1, 1955, the basic rate (full page) will change to \$170, and other rates will change accordingly. The new rates will apply to advertising contracts received after December 1; the old rates will apply until March 1 to advertising contracts received before December 1.

6. Who are our advertisers? Our advertisers in recent issues have included the following companies, among others:

The Austin Co.  
Automatic Electric Co.  
Burroughs Corporation  
Consolidated Engineering Corp.  
Electronic Associates, Inc.  
Federal Telephone and Radio Co.  
Ferranti Electric Co.  
Ferroxcube Corp. of America  
General Ceramics Corp.  
Hughes Research and Development Lab.  
International Business Machines Corp.  
Ketay Manufacturing Co.  
Laboratory for Electronics  
Lockheed Aircraft Corp.  
Logistics Research, Inc.  
The Macmillan Co.  
Monrobot Corp.  
Potter Instrument Co.  
Raytheon Mfg. Co.  
Reeves Instrument Co.  
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Sprague Electric Co.  
Sylvania Electric Products, Inc.  
Telecomputing Corp.



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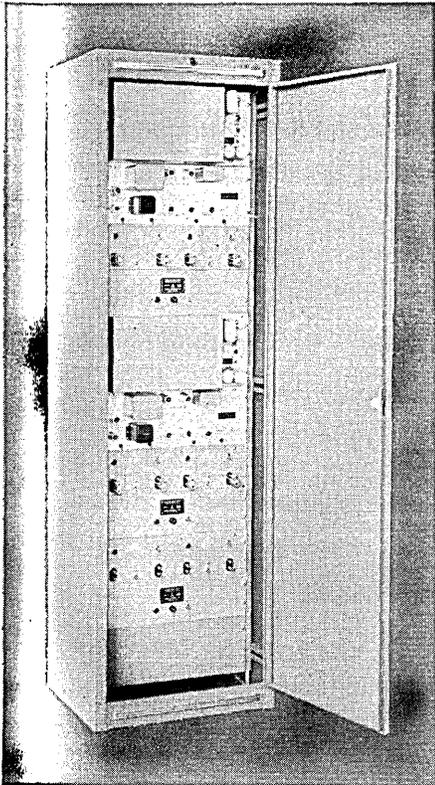
FERROXCUBE CORE MATERIALS ARE FINDING SUCCESSFUL APPLICATION IN MEMORY CIRCUITS REQUIRING RECTANGULAR HYSTERESIS LOOP TOROIDS, IN BLOCKING OSCILLATOR CIRCUITS, IN PULSE TRANSFORMERS, IN DELAY LINES AND IN RECORDING HEADS

MAY WE SEND YOU APPLICATION DATA IN YOUR PARTICULAR FIELD OF INTEREST?

FERROXCUBE CORPORATION OF AMERICA

A Joint Affiliate of Sprague Electric Co. and Philips Industries, Managed by Sprague SAUGERTIES, NEW YORK

In Canada: Rogers Majestic Electronics Limited, 11-19 Brentcliffe Road, Leaside, Toronto 17.



COMPUTROLS COMPUTERS THAT CONTROL

Control devices that supervise processes, make computations based on process conditions, and adjust the process according to the computations. The computing sections of Austin Computrols can be analog or digital.

Computrols are designed for specific applications using Austin Standard Components alone or combined with specially designed units. They provide a new degree of automatic control, promising additional dividends in the form of more product at less cost over present control methods.

Automation is the business of the Austin Special Devices Division. Austin engineers are trained and experienced in the fields of mechanical, electrical, and electronic engineering. The Division can provide specialized engineering service in all types of construction, in-plant labor saving surveys, reports, systems engineering, development, and manufacture to supplement Computrol applications in your operation.

Austin Engineers are available for special problems in automation systems, computers, and automatic data processing, plotting, and recording.

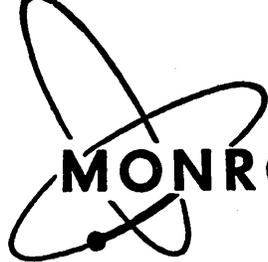
- ★ COMPLETE INTEGRATED SYSTEMS ★ CONTINUOUS, INTERMITTENT, OR IRREGULAR OPERATION
★ DIGITAL OR ANALOG COMPUTATION
★ OUTSTANDING ACCURACY AND RELIABILITY ★ COORDINATED ENGINEERING SERVICE

THE AUSTIN COMPANY 76 NINTH AVENUE

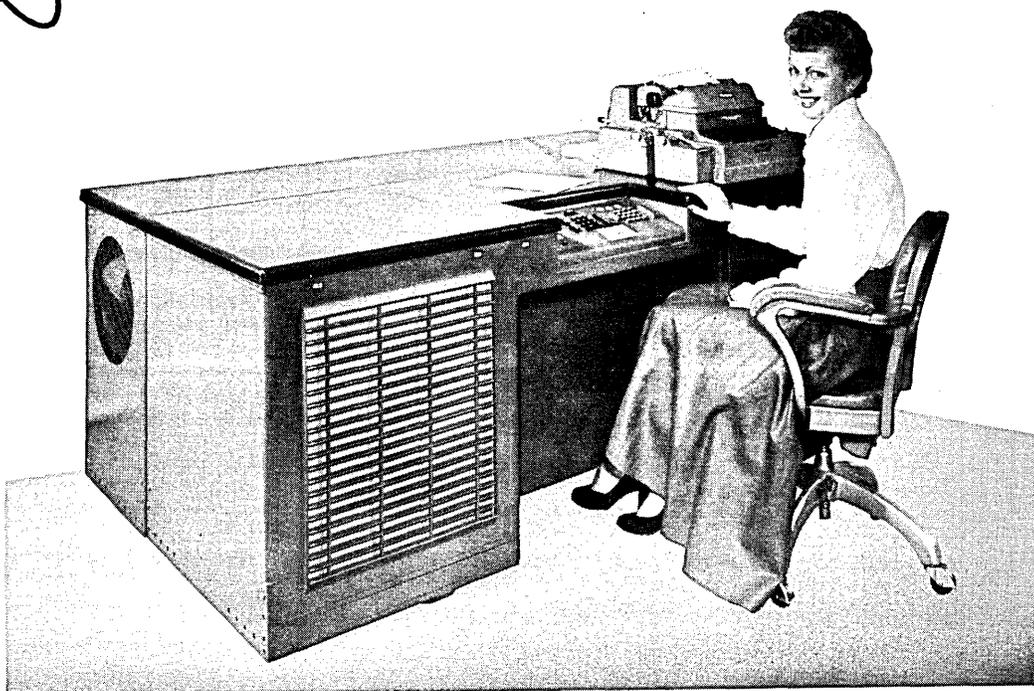


SPECIAL DEVICES DIVISION NEW YORK 11, N. Y.





# MONROBOT ELECTRONIC CALCULATOR



The MONROBOT is a general purpose digital computer, compact, ruggedized, reliable and reasonably priced. In the MONROBOT, decimal numbers are used. Since twenty digits are available, with a centrally located decimal point, there is no need for scaling or setting of decimal point. Neither overflow nor translation techniques are necessary. Orders are written for the calculator in virtually their original algebraic form.

Neither highly trained personnel nor extensive training effort are needed for the MONROBOT. Keyboard and automatic tape operations are counterparts of the simple programming procedures. Average office personnel become familiar with MONROBOT operation the first day. It prints out results on 8-1/2" wide paper roll, or perforates a paper tape as desired.

MONROBOT V is complete in one desk-size unit, ready to plug in and perform. MONROBOTS can be supplied with capacities to suit special requirements, avoiding excess investment for unnecessary facilities.

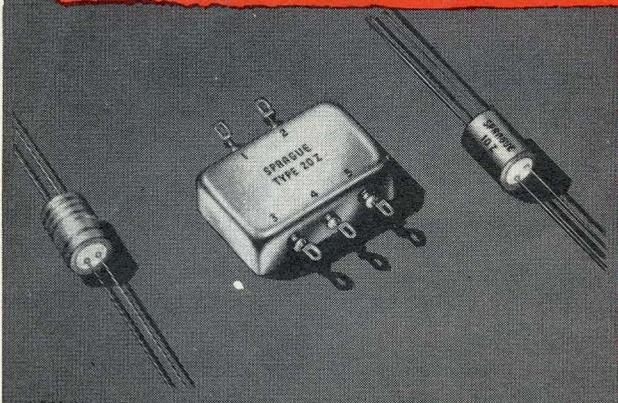
## MONROBOT CORPORATION

MORRIS PLAINS

NEW JERSEY

A SUBSIDIARY OF MONROE CALCULATING MACHINE COMPANY

# Sprague PULSE TRANSFORMERS for digital computers



Type 10Z pulse transformer at left is color-coded to customer specifications. Unit at right is standard.

As a new line of reliable components for digital computers, Sprague has introduced and is in production on pulse transformers of a new type. This transformer line is principally directed to high speed, low power computer circuits, with some designs also finding application in blocking oscillator circuits, memory ring driving circuits, etc.

Two major types are offered: a miniature transformer, Type 10Z, for 0.05 to 0.5 microsecond pulse circuits, and a larger transformer, Type 20Z, for handling pulses up to 20 microseconds in length. Intermediate sizes and plug-in units are also available for special customer requirements.

Basic data on the high reliability miniature transformer is tabulated at right. Complete details are in Engineering Bulletin M 502. A copy will be sent you on letterhead request to the Sprague Electric Company, 377 Marshall Street, North Adams, Massachusetts.

Sprague, on request, will provide you with complete application engineering service for optimum results in the use of pulse transformers for computers.

## BASIC CHARACTERISTICS OF TYPE 10Z PULSE TRANSFORMERS

Pulse Duration	.05 to 0.5 microseconds.
Applications	flipflop circuits • buffer circuits pulse amplifier circuits • gating circuits • other circuits with pulse lengths up to about 0.5 microseconds.
Physical Description	Hermetically sealed. Housed in corrosion-resistant can with glass-to-metal solder-seal terminals at each end. Can length is $\frac{3}{4}$ " and diameter is $\frac{1}{2}$ ". Transformers can be mounted and supported by lead wires in most applications.
Ratios Offered	Ratio 1:1 — Cat. No. 10Z3 Ratio 2:1 — Cat. No. 10Z5 Ratio 3:1 — Cat. No. 10Z4 Ratio 4:1 — Cat. No. 10Z2 Ratio 5:1 — Cat. No. 10Z1 Special Ratios Available
Maximum Repetition Rate	For a pulse length of 0.1 microsecond, pulse repetition rates up to 2 megacycles per second can be employed.
Pulse Amplitude	Normally used in circuits whose pulse amplitude varies up to 60 volts.
D-C Rating	Maximum working voltage, 300VDC. Flash tested between windings at 600VDC. May be life tested at 450 VDC between windings, 85°C, for 250 hours.
Temperature	May be operated between -55°C and +85°C. Higher temperature units available on request.
Insulation Resistance	20,000 megohms minimum between windings, measured at 25°C and 180 Volts DC.

WORLD'S LARGEST  
CAPACITOR MANUFACTURER

# SPRAGUE

Export For The Americas: Sprague Electric International Ltd., North Adams, Mass. CABLE: SPREXINT