

COMPUTERS AND AUTOMATION

CYBERNETICS • ROBOTS • AUTOMATIC CONTROL

A Big Inventory Problem and the IBM 702

... Neil Macdonald

Publications for Business on Automatic Computers: A Basic Listing

... Ned Chapin

Franchise

... Isaac Asimov

Automatic Coding for Digital Computers

... G. M. Hopper

Automatic Programming: The A 2 Compiler System — Part 1

Vol. 4
No. 9

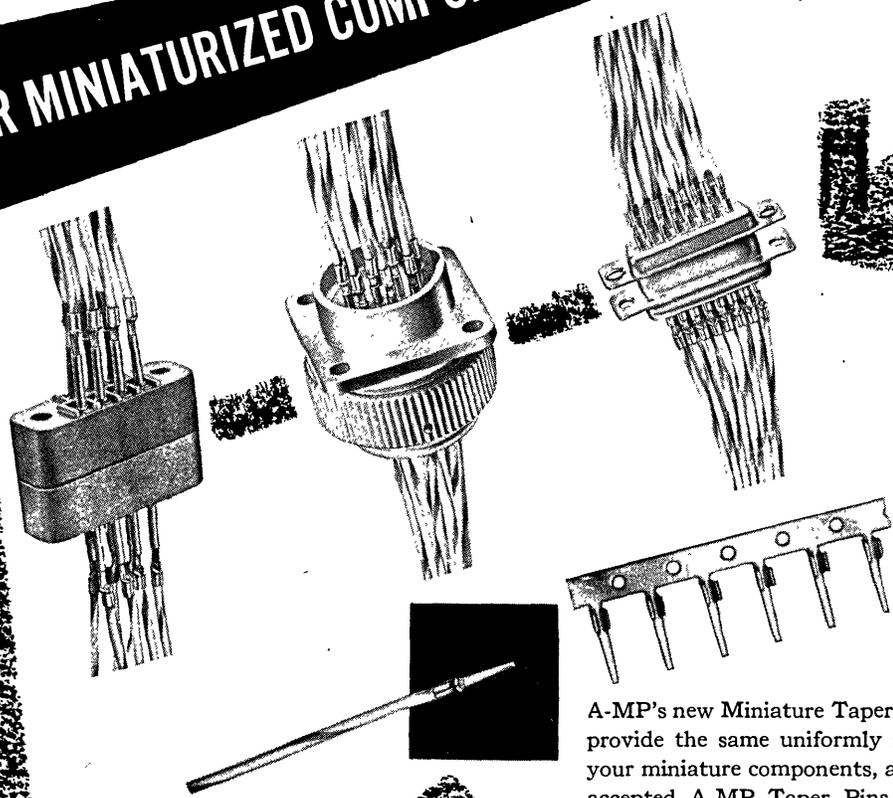
Sept.
1955

33 01
AUTOMATION

Announcing **A-M-P**®

MINIATURE TAPER PINS

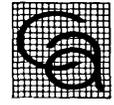
FOR MINIATURIZED COMPONENTS!



A-M-P's new Miniature Taper Pins, shown here actual size, provide the same uniformly reliable wire connections for your miniature components, as the larger, widely used and accepted A-M-P Taper Pins. Miniature Taper Pins are applied to wire with A-M-P Automatic Machines at speeds up to 4000 per hour. They are then inserted into components quickly and easily with A-M-P CERTI-LOK Insertion Tools. Miniature Taper Pins are available for wire sizes #26 to #20.

A-M-P®

©A-M-P



Send today for your copy of "A-M-P's Creative Approach to Better Wiring".



AIRCRAFT-MARINE PRODUCTS, INC., 2100 Paxton Street, Harrisburg, Pa.
In Canada: **AIRCRAFT-MARINE PRODUCTS OF CANADA, LTD., 1764 Avenue Road, Toronto 12, Ontario, Canada**

COMPUTERS AND AUTOMATION

CYBERNETICS • ROBOTS • AUTOMATIC CONTROL

Vol. 4, No. 9

September, 1955

ESTABLISHED SEPTEMBER, 1951

ARTICLES

A Big Inventory Problem and the IBM 702	....Neil Macdonald	6
Automatic Coding for Digital Computers	....G.M. Hopper	21

FICTION

FranchiseIsaac Asimov	17
-----------	------------------	----

PAPERS

Publications for Business on Automatic Computers: A Basic Listing	....Ned Chapin	13
Automatic Programming: The A 2 Compiler System -- Part I		25

REFERENCE INFORMATION

Books and Other Publications		36
------------------------------	--	----

FORUM

National Conference on "The Practical Utilization of Knowledge"	....Western Reserve University	30
Conference on Instrumentation for Data Handling, Atlanta, Nov., 1955	....D.L. Finn	30
Eastern Joint Computer Conference, Boston, November, 1955		30
Computer Session at the Conference on Industrial Hydraulics, Chicago, October, 1955		30
Proposed Symposium on Numerical Analysis	....F.J. Maginniss	31
Program - Association for Computing Machinery - National Meeting - September, 1955, Philadelphia		32
"Square Root to Eight Decimals"	....Bill Danch	40

The Editor's Notes	4
Index of Notices	4
Advertising Index	50

Editor: Edmund C. Berkeley
 Assistant Editors: Eva DiStefano, Jewell Bown, Neil Macdonald,
 Jack Moshman, Gordon Spenser, F. L. Walker

Advisory Committee: Samuel B. Williams,
 Herbert F. Mitchell, Jr., Justin
 Oppenheim

Contributing Editors: Andrew D. Booth, John M. Breen, John W. Carr, III, Alston S. Householder, Fletcher Pratt

Publisher: Berkeley Enterprises, Inc.
 36 West 11 St., New York 11, N. Y. - Algonquin 4 7675
 815 Washington St., Newtonville 60, Mass. - Decatur 2 5453 or 2 3928

Advertising Representatives: San Francisco - W. A. Babcock 605 Market St., San Francisco 5, Calif.
 Los Angeles - Wentworth F. Green, 439 So. Western Ave., Los Angeles 5, Calif.
 elsewhere - the Publisher

COMPUTERS AND AUTOMATION is published monthly. Copyright, 1955 by Berkeley Enterprises, Inc. Subscription rates: \$4.50 for one year, \$8.50 for two years, in the United States: \$5.00 for one year, \$9.50 for two years, in Canada; \$5.50 for one year, \$10.50 for two years elsewhere. Bulk subscription rates: see page 38. Advertising rates: see page 48.

Entered as second class matter at the Post Office, New York, N. Y.

THE EDITOR'S NOTES

AUTOMATIC PROGRAMMING

In this issue we commence publication as a paper, of a manual on automatic programming, "The A 2 Compiler System", written by the Programming Research Section of the Eckert - Mauchly Division of Remington Rand. As we say at the start of the paper, "the subject of automatic programming is so interesting and important that it seems desirable to re-print in these pages a large section" of that manual.

We are interested in printing or reprinting authoritative information on automatic programming. The "education of a computer", to use the phrase of Dr. G.M. Hopper, is in our opinion certainly as important as the creation and propagation of computers.

THE MARKETING OF A COMPUTER

One of the problems which every company that makes a computer faces is "How shall we market this computer?"

It is not an easy question to answer. It has many parts: finding prospective customers; meeting competition; satisfying all the members of the prospective customer's buying committee; keeping the machine sold — there are examples of contracts that have been signed and agreed to, and then later on the customer says "I don't want this computer and I want my advance payments back,"; keeping the machine operating; provision for changes to meet scientific developments, such as the shift from mercury tank memory to magnetic core memory. And more besides. These are easy things to say; and very hard things to carry out in concrete fashion.

Nor can many manufacturers rest in the position where they have at least dozens of orders for nearly every kind of machine they can deliver.

Many people believe that the trend of development in the computer field will be towards fewer and fewer companies — and these the big ones — making and selling computers. The basic answer to marketing a computer would then be, to be part of a big company, or to be bought up by a big company.

But the electronic handling of information, pulses of ones and zeros, basically does not require a huge or very expensive machine. Computers may be expected to develop so that continually less expensive hardware is required for each binary digit of information handled. So some of the market for computers will very likely go to small manufacturers of computers, as well as big manufacturers. The basic answer to marketing a computer made by

(continued in next column)

CORRECTIONS

In the July issue, in Part I of "Linear Programming and Computers," by Chandler Davis, the statement of "The First Problem" on page 10 was unfortunately garbled. It should read as follows:

"The first problem: Suppose we have a plant equipped to produce bottled gin sour or Tom Collins in any amounts. The only materials whose supply is limited are gin, sugar and bottles. Enough sugar is available daily to allow production of 1200 bottles of gin sour, but a bottle of Collins uses twice as much sugar as a bottle of sour. Enough gin is available daily to fill 225 bottles; the gin sour is 3/8 gin, the Collins is 1/8 gin. Only 800 bottles are available daily. The profit per bottle of Collins is \$1.00; per bottle of sour, \$2.00. To maximize total daily profit, how many bottles of each should be produced daily?"

The problem was restated correctly in Part II in the August issue on page 10.

The heading of the article "The Automation of Bank Check Processing" by R. Hunt Brown, on page 6 of the August issue, should have contained the following note preceding the text: "Taken from chapters in a forthcoming book entitled 'Office Automation' by R. Hunt Brown."

INDEX OF NOTICES

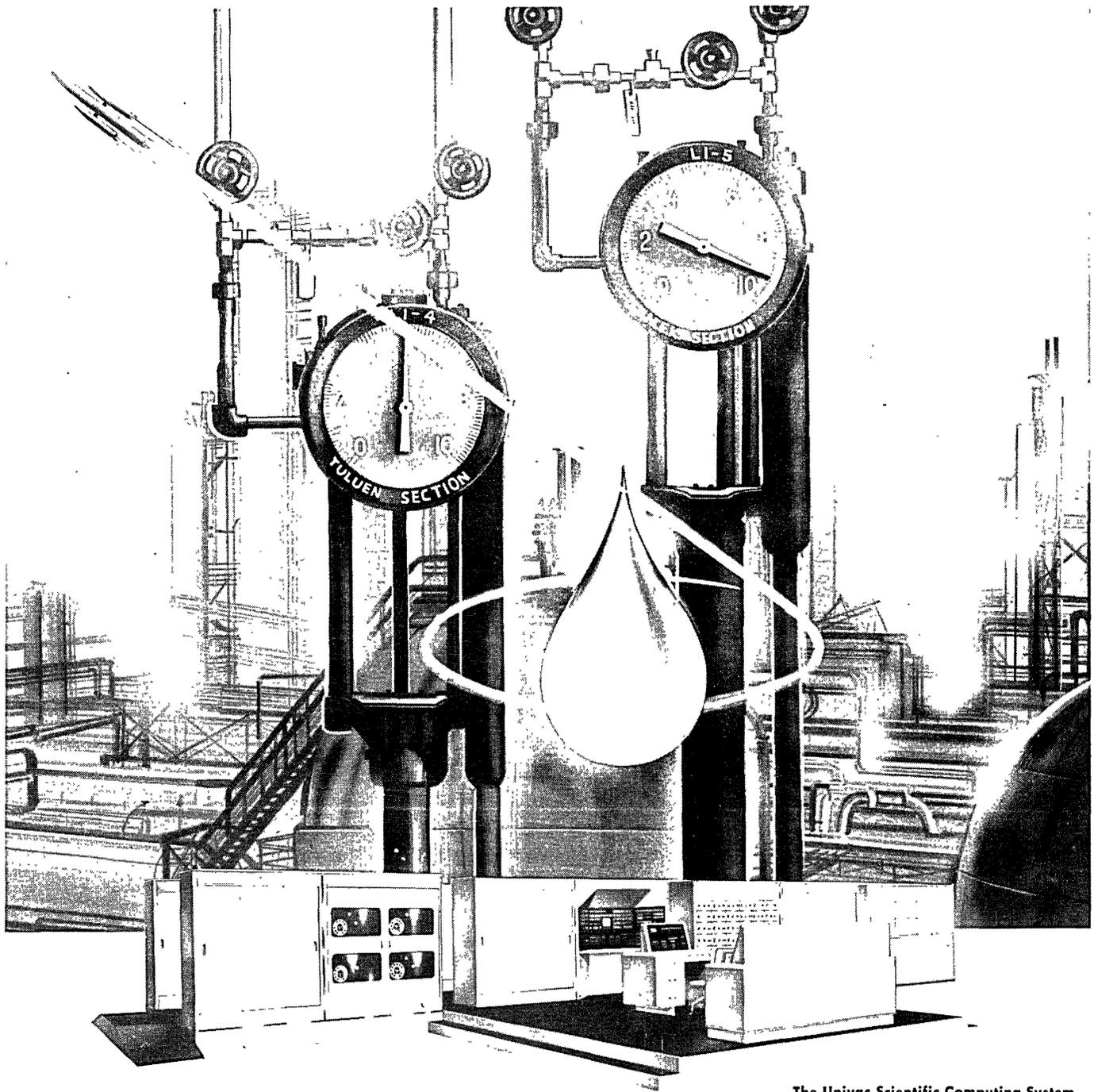
<u>For information on:</u>	<u>See Page:</u>
Advertising Index	50
Advertising Rates	48
Advertising Specifications	48
Back Copies	46
Bulk Subscription Rates	38
Manuscripts	31
Roster Entry Forms	42
Special Issues	38

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

a small manufacturer, will depend on the usual advantages of small companies — when they have advantages —: in a phrase perhaps, superior adaptability. And not the least of this adaptability is the capacity to tell the facts about the manufacturer's computer to many people in terms that they can understand and are interested in.

One of the important functions of "Computers and Automation" is to help in this job.

- END -



The Univac Scientific Computing System

Gauged To Perfection

Perfection of the finished product requires precise control in the manufacture of jet fuel. Such control is vital in the refining of oil, as it is in most industries. And, with the coming of age of automation, the controls must not only be precise—they must also be supervised automatically.

That's the function of such electronic computing systems as the Remington

Rand Univac Scientific. Its ability to control, simultaneously and automatically, a wide variety of input-output devices makes the Univac Scientific ideally suited to on-line operations.

Fully automatic control requires a computing system which is able, for example, to take a meter reading, then—acting on its own instantaneous decision—throw a switch, set a rheostat, or adjust

a valve. This the Univac Scientific can do easily—and much more. Operating at extremely high speeds with superb efficiency, the Univac Scientific provides large storage capacity, great programming versatility, and far greater reliability than any computer in its class.

For information about how a Univac Scientific system might be applied to your particular problem, write to . . .

ELECTRONIC COMPUTER DEPARTMENT **Remington Rand** ROOM 1960, 315 FOURTH AVE., NEW YORK 10
DIVISION OF SPERRY RAND CORPORATION

A BIG INVENTORY PROBLEM AND THE IBM 702

Neil Macdonald
New York, N.Y.

On July 20, 1955, International Business Machines Corporation opened its new center for automatic electronic processing of data on the main floor of the company's headquarters in New York. This center has as one of its main purposes the helping of organizations planning to obtain an EDPM (an Electronic Data Processing Machine) such as the IBM 702, IBM 701, or IBM 650. There a customer can bring his problems and make completely sure that his programming is correct in advance of the delivery of the machine he has ordered.

Of the several new automatic data processing machines operating at the center, the largest, most powerful, and one of the newest machines was the IBM 702. It was busy with calculations of the IBM inventory problem for manufacturing operations in Poughkeepsie. Both the machine and the problem are remarkable and have considerable interest.

1. The Type 702

The machine consists of the following units:

- Type 702, Arithmetic and Logical Unit (containing also the Electrostatic Memory and the Accumulator)
- Type 712, Card Reader
- Type 717, High Speed Printer
- Type 722, Card Punch
- Type 727, Magnetic Tape Units (up to eight units)
- Type 732, Magnetic Drum Storage Unit (one or two)
- Operator's Console

The machine is completely serial, using one million pulses a second, i.e. one microsecond pulses. The basic character rate is 23 microseconds. There is no fixed field length or "machine word" length: a field -- a group of characters to be treated as a unit, a "machine word", -- can be as long or as short as desirable or necessary. A character consists of seven binary digits, yeses or noes, ones or zeroes; the code may represent a letter of the alphabet, a decimal number, or any of eleven different punctuation marks or symbols used in printing reports.

The Rapid Memory

The high-speed memory of the Type 702 consists of electrostatic storage, dots or dashes stored electrostatically on cathode ray tubes of IBM's own manufacture.

Each one of the 10,000 positions of this memory is numbered from 0000 to 9999, and each stored character occupies one of these positions, known as its "address". (Incidentally, all memory positions in the machine are addressable, and therefore data can be handled in non-uniform record lengths, blocks, or words.) In the 702 there are two accumulator storage units, each with a capacity of 512 character positions. An accumulator storage unit is used for temporary storage of information from the electrostatic memory while such information is being acted upon either logically or arithmetically.

The reading and interpretation of an instruction calling for the location of information in the memory is performed in 138 microseconds. Characters are read or stored at the rate of 23 microseconds each. Therefore, a record of 100 characters can be located and transferred to accumulator storage from memory in 2.438 milliseconds.

The Magnetic Drum Memory

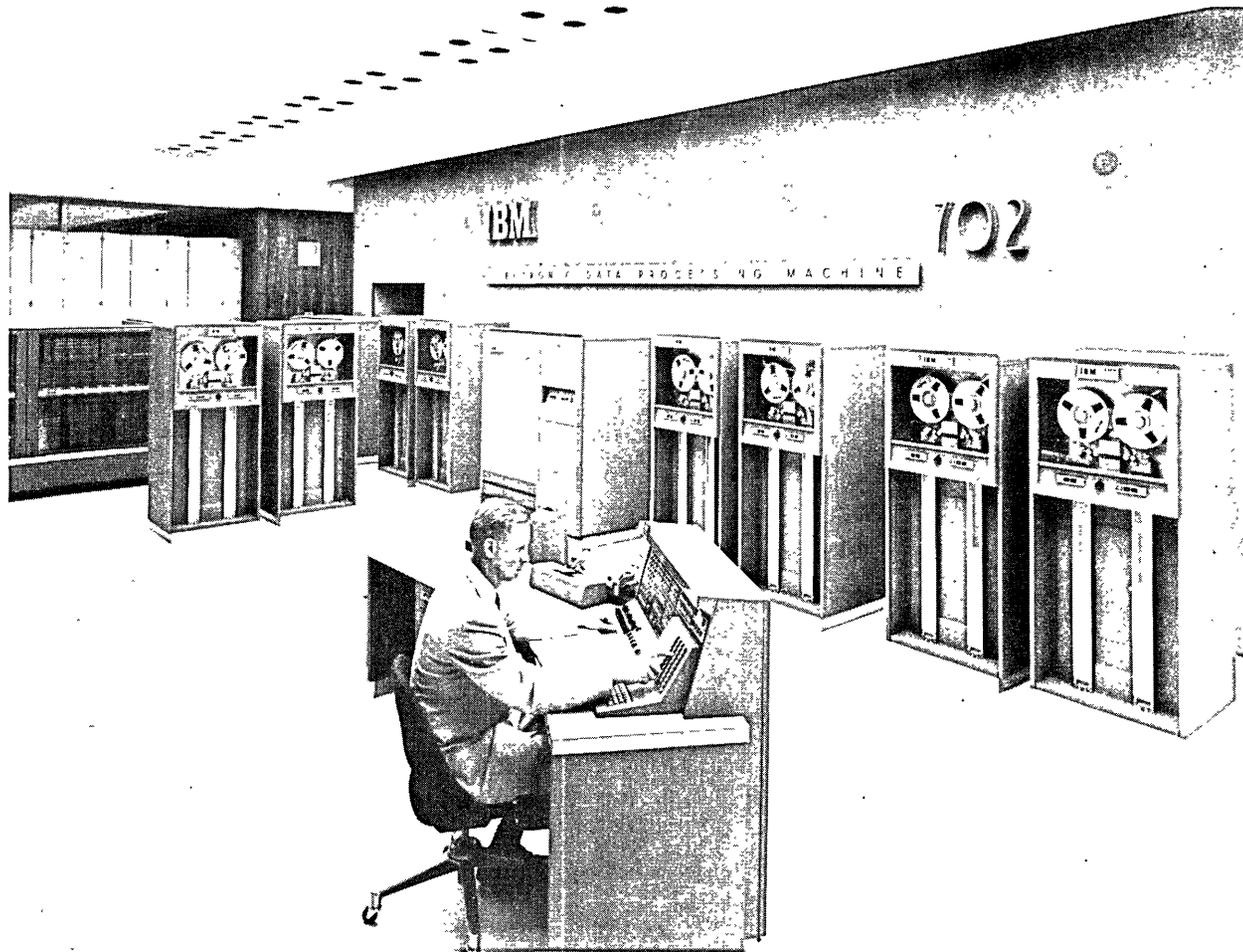
The magnetic drum contains 60,000 characters. The access time to any character stored on it is 40 microseconds.

The Magnetic Tape Memory

The principal medium for storage of records is magnetic tape. This is plastic tape containing magnetizable particles. The machine and the magnetic tapes communicate at the rate of 15,000 characters per second, or 67 microseconds per character: this is the rate for input and output. The magnetic tape can be brought from rest up to full speed in 5 milliseconds, and similarly can be stopped in 5 milliseconds.

Programming and Operations

The Type 702 can perform 32 separate operations, such as reading, writing, comparing, arithmetical operations, and other operations.



- 7 -

A feature of IBM's new Data Processing Center at its New York City headquarters is this 702 Electronic Data Processing Machine. An operator is shown here giving instructions to this "giant brain." In the background are eight magnetic tape units through which information is fed to and delivered from the machine. Each 2,400-foot reel of tape may contain over 5-million characters (either letter, digits, or symbols), so the total "memory capacity" of the units shown is in excess of 40-million characters, all of which are available to the machine at the rate of 15,000 characters per second. In addition to the 702, the new IBM center in New York contains 701 and 650 data processing machines and smaller electronic accounting machines.

INVENTORY PROBLEM

A single instruction or program step consists of two separate parts. The first part is the "operation" part of a character, and it determines the operation to be performed. The second part of the instruction is the "address" part consisting of four digits. This is the address of some position in the memory, an input-output device, a drum section or an "indicator" (such as the instruction check indicator, machine check indicator, read-write check indicator, etc.). The machine automatically checks the validity of each character handled. In addition, of course, programming can be arranged to check consistency of results. When an error is detected, the signal may be used either to stop the machine, or to cause it to take corrective steps, at the choice of the programmer.

The speed of the machine is: 3950 additions or subtractions per second (5 digit); 833 multiplications per second (5 digits by 5 digits); 400 divisions per second (6 digit dividend divided by 4 digit divisor); and 7233 logical decisions per second.

The input speed is 15,000 characters per second from magnetic tape, or 4 and 1/6 punch cards per second. The speed of output is 15,000 characters per second to magnetic tape, 1 and 2/3 punch cards per second to the card punch, 2 and 1/2 lines of characters per second to the regular printer, and 16 and 2/3 lines of characters per second to a new high-speed printer (Type 719 or 730, operating through the use of wire-printing).

2. Applications

The first IBM Type 702 was installed in March, 1955, at the Monsanto Chemical Co. in St. Louis. There it is leading to a fully automatic accounting system. Another 702 in use at the Poughkeepsie plant of IBM calculates an 8,000-employee payroll in 24 minutes, and does other work besides. A 702 installed at the atomic energy plant of General Electric in Hanford, Washington, is devoted part of the time to payroll preparation, inventory control, and general accounting, but is also being used to solve scientific problems. At Poughkeepsie, International Harvester ran an engineering problem on a 702, preparation of cam design reference tables. A single engineer doing nothing else and using manual methods would have completed the tables in 75 weeks. The 702 required a total 20 minutes, a factor of advantage of 9000 to 1.

3. The Big Inventory Problem of IBM

An outstanding application of the Type 702, however, is its use in the inventory

problem of the IBM plant in Poughkeepsie. The machine is now used to control the inventory on approximately 40,000 part numbers. These consist of detail parts, assemblies, purchased parts, and parts manufactured at the Poughkeepsie plant. The requirements planning for component parts is generated from some 2400 major assemblies.

Input

The monthly input into Type 702 consists of:

- the new production schedule, on punch cards;
- the engineering changes, on punch cards;
- the information as to "where used", on magnetic tapes.

The daily input into Type 702 consists of:

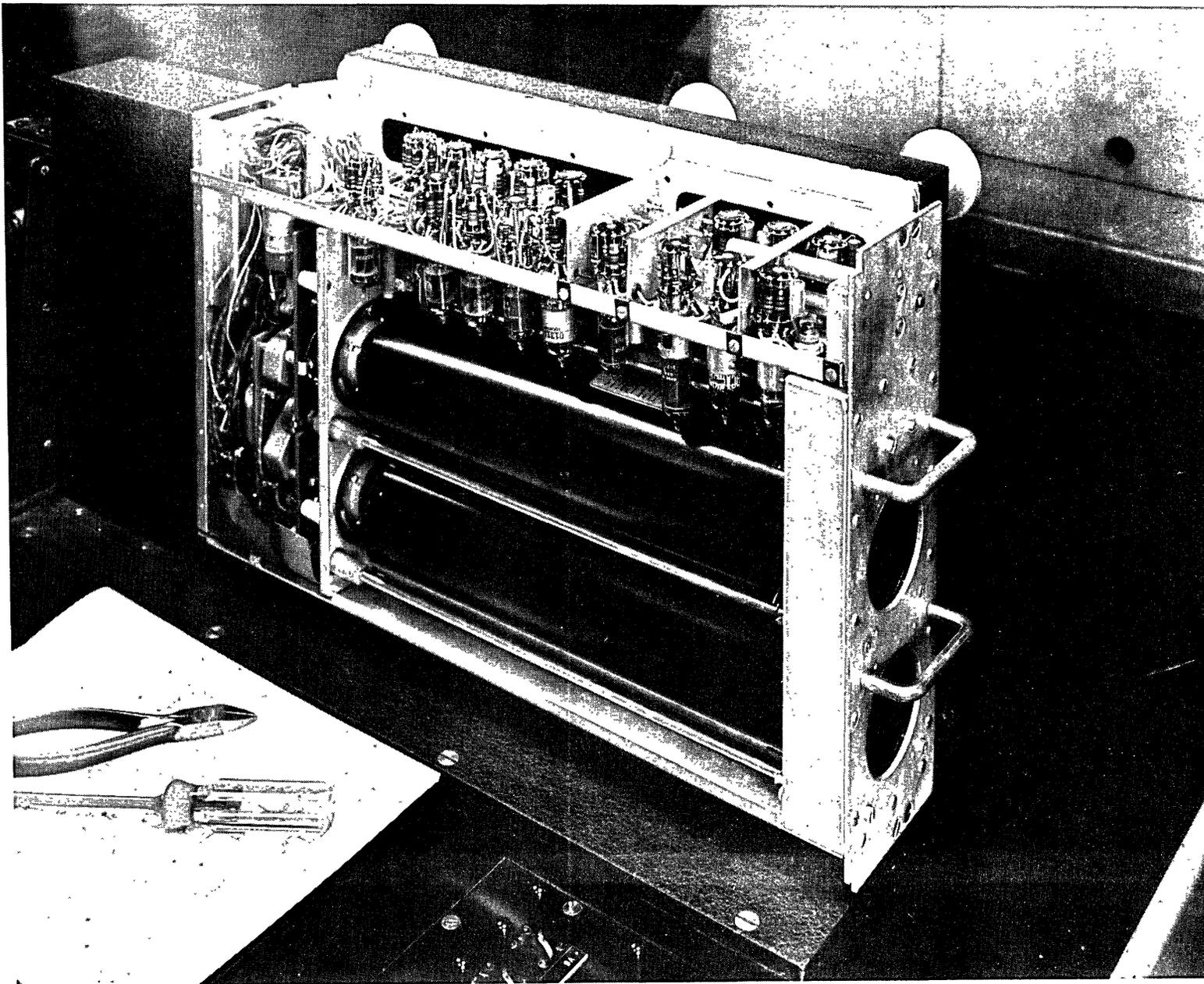
- the "old balance" inventory, on magnetic tape;
- the day's transactions, about 9000 per day.

Materials Requirement Planning

The master magnetic tape showing parts-usage contains a 511 character record for each part. Each record contains all indicative data, each machine in which the part is used, and the quantity required for each machine. This quantity is shown in thirteen sections to indicate the effect of engineering changes for the previous and the next twelve months. Engineering changes affecting the number of parts to be used in a machine are automatically reflected to show in which month the use of the new part should be started. This permits a reduction of inventory of the part presently used, prior to the new part being used in a machine. Each month the thirteen periods are all moved one section to the left, replacing the old previous month with last month and adding a new twelfth month to the forecast. In this way, all engineering changes are reflected in the master parts-usage tape; it presents a "parts per machine" picture for the next twelve months.

After up-dating the master parts-usage tape, the calculation of material requirements begins.

Production schedules provide the basis for setting the daily production quantities for each finished machine during each month in the planning cycle. The schedule of the quantity of machines to be built is stored on the magnetic drum. The machine numbers on the master



Cathode ray tubes used in the IBM 702 are contained in removable sub-assemblies

parts-usage tape for the first part number are compared with the machines scheduled. The quantity scheduled is then multiplied by the quantity of parts required for each machine. This extension is made by part number for each machine which is scheduled for this period. The requirements are accumulated and then written on the material requirements summary tape record for that part number. Material requisition cards are automatically punched for requirements of the month's production schedule.

The material requirements summary tape is now ready for use in the inventory control procedure.

Inventory Control

The summary tape for the master balance forward inventory control summary tape contains 394 characters for each of 40,000 part records. Information contained in this record gives a complete part description, indicative data, and all quantities -- current, monthly and year-to-date -- necessary for complete control of inventory movement to support manufacturing requirements. Twelve months' spread of material requirements, plus quantities of scrap for analysis, are also available. This record contains information at one centralized point which would otherwise require several different files at various locations. Each month the new material requirements are reflected in the master inventory control tape. At this time all monthly inventory calculations are made, in addition to evaluating the inventory, punching overage notices, and requirements variance reports.

Each day the balance forward inventory control summary record, plus all transaction cards for every entry affecting the inventory, are put into the daily inventory control procedure. The transaction cards are in part number sequence like all parts on the magnetic tape. The first part number on the tape is compared with the part number on the first transaction card. If they agree, the 702 performs all necessary tests and calculations, prints the summary of transactions, and records the transactions on the new balance forward inventory control summary tape. All transactions for that part thus are entered. Inactive items are written unchanged on the new balance forward inventory control summary tape. In this way the complete inventory is recorded and controlled each day. The new balance forward inventory control summary tape is the master input for the next day.

Output

The monthly output of the Type 702 consists of the following:

- the "where used" tape, updated for the engineering changes;
- a new material requirements tape;
- inventory overage notices;
- requirements variance notices.

The daily output is:

- the "new balance" inventory tape;
- order cards;
- expediting cards;
- the inventory summary register.

Economic Order Quantity

In determining orders, the machine calculates the "economic order quantity" in the case of those parts where this is needed. The formula used is:

$$Q = \sqrt{\frac{24 \times R \times (s + o)}{2 \times V \times F + I \times C}};$$

the formula is explained in the last part of this report (quoted from a memorandum from Plant 1 of IBM at Endicott, N. Y.). Because of the speed of the computer, the formula, even with its square root, which is carried out by an iterative process of successively improved approximations, is no barrier to swift inventory calculation.

Generality of the Inventory Program

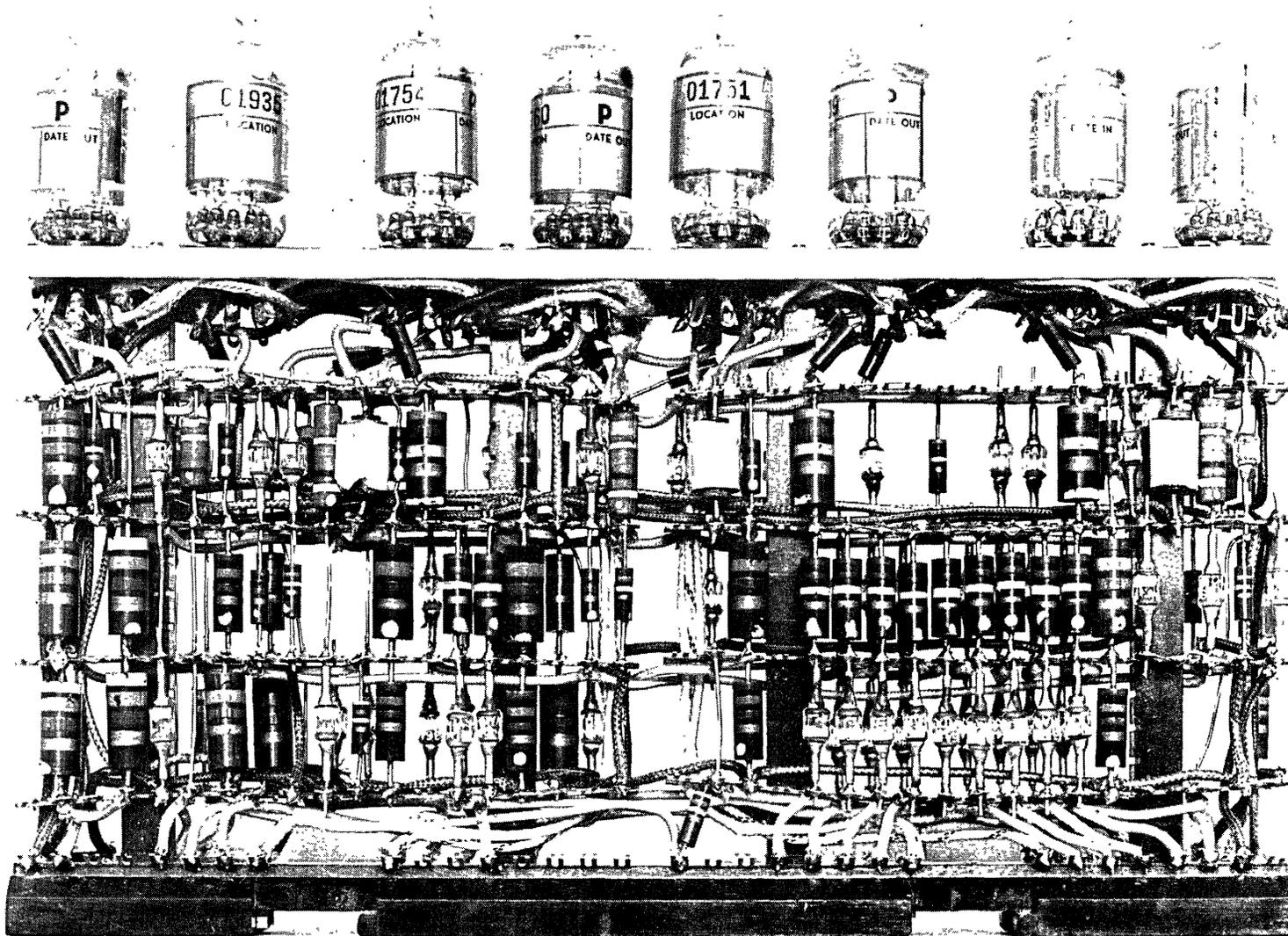
The application of the Type 702 to the IBM inventory calculation is according to the company

"quite flexible and could very easily be used by almost any large manufacturer. In discussing the processing of our inventory with a wide variety of customers (aircraft, automotive, machine tool, Air Force, Navy, Army, mail order house, etc.) each expressed the opinion that with slight modifications the application could be used nicely in their operations."

4. Formula to Calculate "Economical Manufacturing Quantities"

Definition. An economical manufacturing quantity is that order quantity which will yield the lowest ultimate cost per piece, all relevant costs considered.

Explanation. In the manufacture of a particular part, certain costs will result. The more pertinent are:



Electronic tube assembly used in the IBM 702 Electronic Data Processing Machine.

1. The cost of preparing, processing, and controlling the order.
2. The cost of setting-up, or changing over, the manufacturing facilities.
3. The cost of running these facilities.
4. The cost of carrying the inventory.

That portion of the unit cost arising from costs #1 and #2 can be minimized by increasing the lot size. The lot size does not affect #3. That portion of the unit cost caused by #4 can be reduced only by decreasing the lot size. Thus, attempts to reduce cost #1 and #2 conflict with a reduction of #4. To resolve this conflict, formulas have been developed to yield the minimum cost per piece.

This paper will consider just one of many possible formulas. Others may be found in the books listed under bibliography. (For a number of general formulas and their variations, consult "Quantity and Economy in Manufacture" -- F. E. Raymond -- McGraw Hill Book Company). Generally, these differ by the number of cost factors considered. The character of the particular business will determine which must be considered.

For instance, if the manufacturing lead time is usually longer than six months, carrying charges on the work in process should be included. However, to facilitate its use, the formula should be as simple as possible. The addition of several factors to make the formula applicable to every part may not be justified if the formula becomes cumbersome to use.

Cautions. The use of economical order quantities may not increase the inventory turnover. The formulas are designed to yield the lowest total cost of all factors considered in the formula, not just the dollar inventory.

The formulas give the best results in plants manufacturing to a level schedule on a lot size basis. If the parts requirements or other factors considered in the formula are subject to wide fluctuations, the expense of maintaining up-to-date information may be prohibitive.

The formula cannot account for many practical considerations. If tools must be repaired or cutting tools sharpened before a run is completed, either the computed quantity must be reduced or better tools purchased. The latter action is often indicated but might not be possible. Limitations of storage for work in process may also necessitate reducing the calculated quantity.

Factors in IBM Formula

Order Cost. Actual departmental and activity costs were studied to obtain this figure. It includes the cost of automatically scheduling and printing the order, obtaining the part print, processing and expediting the order through the shop, and closing it out. It also includes an allocation of production control expense. It is constant.

Setup Cost. This figure is determined from experience. It includes all expenses involved in gathering tools and preparing machines for the job.

Requirements. This figure is computed by extending a master parts list for each product by the requirements of that product. The lists are then summarized by part number.

Cost Per Piece. This includes all material, direct labor, and burden expenses associated with the part.

Interest Rate. This includes those inventory possession charges which vary with the cost of the part -- insurance, desired return on investment, and obsolescence. A return on investment rate was used rather than the current borrowing rate because it was felt that the inventory investment should be made to earn as much as any other investment in the business. Actually, inventory earns no money. But, charging it with this theoretic cost tends to reduce the size of the order and the size of the inventory.

Space Charge. This is the product of a constant, the storage cost per cubic inch, and a variable, the space required for the particular part. The constant was determined by dividing the annual storage costs not dependent on unit cost by the number of cubic inches of available bin space. These costs included handling, equipment and building depreciation, and moving expenses. The variable was determined for each part by using variable volume boxes to determine the space occupied by a number of parts and dividing that space by the number of parts. The result is the storage space requirements of each. This latter figure was not expensive to obtain and permitted a later determination of the proper bin size needed for each part.

THE FORMULA

$$Q = \sqrt{\frac{24 \times R \times (s + o)}{2 \times V \times F + I \times C}}$$

where:

(continued on page 38)

Publications For Business On Automatic Computers: A Basic Listing

Ned Chapin
Lecturer, Illinois Institute of Technology
Chicago, Ill.

The man who has a business background and business interests is faced with a problem which has become worse and worse as time has passed. To learn about automatic computers and how they can be used in business, he is advised from all sides to read books and articles. But which books and articles? Much of what has been published in the field of automatic computers is repetitious; much is not germane to business; of the remainder, some is well worthwhile and some is not. A few words of guidance appear to be in order.

This paper lists for business men what appears to the author to be a basic reading list of publications in the field of automatic computers. The comments are based on the author's own opinions and experience; the basis for the selections of these publications has been the author's background in explaining automatic computers to businessmen and in advising businesses on automatic computer applications. Someone else with a different background however would probably make different choices and different comments.

The publications listed in this paper are grouped by subject matter. Within each group, the publications are listed approximately in the order of scope and depth of coverage, the more elementary being listed first, the more advanced being listed last. In a few groups, some good background material has been included, and these items have been identified as such.

Most of the books and most of the magazines that carry the articles listed can be found in the business departments of most state libraries, of most university and college libraries, and of the larger municipal libraries. Most of the proceedings of conferences can be purchased from the organization cited in the listing of the item. Many of the authors whose articles are cited here send out reprints of their articles upon request. Addresses of the authors can be obtained by reference to Computers and Automation's Computer Directory (the June 1955 issue), or if missing there, by writing to the magazine or organizations that published the article.

Basic Sources

The following two books appear to be basic sources, and provide a solid foundation for further reading:

Elizabeth Marting, Editor, Electronic Data Pro-

cessing in Industry (New York: American Management Association, Inc., 330 West 42nd St., New York 36, N. Y., 1955), 257 pgs., \$7.75

A very good collection of papers on automatic computers. The general level of the papers is well above average. The papers in the book that are part of this bibliography are cited individually in later listings.

Ned Chapin, An Introduction to Automatic Computers: A Systems Approach for Business (Chicago: Technology Center, 1955; available from Publication Sales, 407-C Gunsaulus Hall, 3140 So. Michigan Ave., Chicago 16, Ill.), 245 pgs., \$9.00

A comprehensive introductory book. Business systems, programming, computer functioning, and comparative data on available automatic computers are included.

A third book is suggested for those who wish to build a library, although it covers little not covered in the two books just cited:

Staff of "Management Methods" as Editors, Workshop for Management: Proceedings of the Seventh Annual Systems Meeting of the Systems and Procedures Association of America (New York: Management Magazines, Inc., 141 E. 44 St., New York 17, N. Y., 1955), pg. 294-436, \$19.00

Part of this book is a collection of papers on automatic computers. Some of the papers are very good; most are average. The papers in the book that are part of this bibliography are cited individually in later listings.

Use of Computers in General

Simon Ramo, "Future Possibilities and Limitations of Electronics in Management", General Management Series Number 164 (New York: American Management Association, Inc., 1953), Pg. 3-11.

Some sound argument on the so-called "Second Industrial Revolution".

John C. Windsor, et. al., The Automatic Office (Westboro, Mass: Alden Systems Co., 1952), 48 pgs. Appears in condensed form in: The Office, V 35, #5 (May 1952), pg. 110-124.

Some good philosophy on how automatic computers can best be used in business.

John F. Feagler, "Making a Feasibility Study: The One-Shot Process", Electronic Data Processing in Industry (New York: American Management Association, Inc., 1955), pg. 74-83.

A presentation of a basic philosophy of computer usage: have the automatic computer do as much as possible at one time, on one input.

Roddy F. Osborn, "GE and Univac," Harvard Business Review, V 32, #4 (July-Aug. 1954), pg. 99-107.

Some popular misconceptions are laid to rest in this article based upon some General Electric applications.

Jay W. Forrester, "Computer Applications to Management Problems", General Management Series Number 178 (New York: American Management Association, Inc., 1955), pg. 22-31

Some illuminating ideas on how to use an automatic computer in business.

Feasibility Studies

Joseph Pelej, et al, Electronics--A Company Program (New York: Price Waterhouse and Co., 1954), 16 pgs. Also in: Electronics Data Processing in Industry (New York: American Management Association, Inc., 1955), pg. 55-64.

A general outline is presented on how to make a feasibility study. Cost matters are only lightly touched upon.

Price, Waterhouse and Co., How to Analyze Your Financial Operations for the Application of Electronics (New York: Price Waterhouse and Co., 1954), 16 pgs.

This is just another name for the Pelej article cited above.

Beardsley Graham, "Reduction of Clerical Costs Through Mechanized Processing", General Management Series Number 164 (New York: American Management Association, Inc., 1953), pg. 12-21.

A discussion of some of the requirements of a sound feasibility study. Some case material is used to illustrate the points.

Ned Chapin, "Determining Automatic Computer Profitability," Automation, V 2, #? (Sept., 1955), pg. unknown.

A presentation, illustrated with a case study, of how to show whether or not an automatic computer will pay for itself.

Richard F. Clippinger, et al, "Automatic Digital Computers in Industrial Research", Journal of Machine Accounting Systems and Management, V 6, #2 (Feb. 1955), pg 7-11, 14-17, and #3 (March 1955), pg 9-11, 19.

A brief but thorough discussion of computer characteristics and computer costs by three experts in the field.

L. R. Johnson, "Installation of a Large Electronic Computer," Proceedings of the Association for Computing Machinery (Washington, D. C.: Sauls Lithograph Co., 1952), pg. 77-81.

An excellent discussion of physical considerations in installing an automatic computer.

Systems Analysis

William B. Worthington, "Application of Electronics to Administrative Systems," Systems and Procedures Quarterly, V 4, #3 (Aug. 1953), pg 3-9. Also in: Systems and Procedures Quarterly, V 4,

#1 (Feb. 1953), pg 12-18.

What every systems man should be aware of about using an automatic computer in business.

Arthur A. Brown and Leslie G. Peck, "How Electronic Machines Handle Clerical Work," Journal of Accountancy, V 99, #1 (Jan. 1955), pg 31-37.

A simple comparison of doing a task by human labor, by an automatic computer, and by punched cards.

A. B. Toan, "Auditing, Control, and Electronics," Journal of Accountancy, V 99, #5 (May, 1955), pg 40-45.

Although there are a number of articles on this general subject, this one covers more ground than most. The reader will probably be impressed with how much thinking is still to be done on auditing and control by electronics.

Dean E. Wooldridge, "Trends in Electronic Business Data Systems Development," Trends in Computers (New York: Institute of Radio Engineers, Inc., 1954), pg 16-22.

High quality systems work on possible automatic computer applications is needed but is lacking. Many systems men seem still to be unprepared for such work.

William B. Worthington, "Business Decisions by Electronic Choice," Office Management Series Number 131 (New York: American Management Association, Inc., 1952), pg 22-29

A brief presentation of how applying an automatic computer could help solve troublesome systems problems.

Claude E. Shannon, "Computers and Automata," Proceedings of the IRE, V 41, #10 (Oct. 1953), pg 1234-1241

A background article. Automatic computers need not be restricted to the obvious business applications like payroll. Because of their logical ability, computers have a very wide area of potential application.

H. John Ross, Technique of Systems and Procedures (New York: Office Research Institute, 1948)

A background book. Although this book says nothing about automatic computers, yet it gives an excellent statement of the principles of systems analysis.

Francis Bello, "Information Theory," Fortune, V 48, #6 (Dec. 1953), pg. 136-158.

A background article. Automatic computers are machines that in effect handle information. This article discusses in readable terms the theory of information itself.

Human Relations

Marion A. Bills, "Human Relations Aspect," Office Management Series Number 135 (New York: American Management Association, Inc., 1953) pg 32-35.

Sound practical advice illustrated with examples drawn from the writer's own experience on how to handle the introducing of

changes in methods and equipment.

- J. Douglas Elliott, "Will Electronics Make People Obsolete?" Office Management Series Number 136 (New York: American Management Association, Inc., 1954), pg 47-60.

A practical discussion of the employee relations problems that arise from the use of an automatic computer, and some suggestions for dealing with the problems.

Examples of Automatic Computer Applications

- W. W. Smith, "Impact of the Computer on Methods," Office Management Series Number 136 (New York: American Management Association, Inc., 1954), pg 3-16. Also in: Automation, V 2, #5 (May 1955), pg 107-110.

A discussion of the benefits expected from the use of an automatic computer by General Electric, in terms of how various clerical tasks are to be performed.

- Byron F. Burch, "The Computer at Work on Payrolls," Office Management Series Number 136 (New York: American Management Association, Inc., 1954), pg 16-25.

A discussion of the General Electric payroll application with some comparisons of systems before and after the use of the computer.

- A. C. Vanselow, "Programming the Computer for Clerical Production," Office Management Series Number 136 (New York: American Management Association, Inc., 1954), pg 26-40.

A discussion of the Franklin Life automatic computer applications and the steps that were taken to put the computer into productive service.

- E. J. Cunningham, "A Case Study in Electronic Accounting," Office Management Series Number 131 (New York: American Management Association, Inc., 1952), pg 3-8.

One of the early users of automatic computers reports on his company's feeling toward and use of automatic computing equipment.

Integrated Data Processing

- Harold F. Van Gorder, et al, A New Approach to Office Mechanization (New York: American Management Association, Inc., 1954), 62 pgs. Also in, in somewhat condensed form: The Office, V 39, #4 (April 1954), pg 66-101.

Integrated data processing presented by the pioneers in the field, with extensive illustrative material on just how the paper tape is used.

Automatic Computer Fundamentals

- Arthur L. Samuel, "Digital Computers Made Easy," Proceedings of the IRE, V 41, #10 (Oct. 1953), pg 1223-1230.

An excellent presentation in very readable language of the machines called "automatic computers."

- Staff of Cresap, McCormick, and Paget, "Evolution of Data Processing," Electronic Data Processing in Industry (New York: American Management Association, Inc., 1955), pg 17-53.

An easily read presentation of the history of data-handling.

- William B. Elmore, "Reliability in Electronic Data Processors," Computers and Automation, V 4, #5 (May 1955), pg 6-9, 38. Also in, in modified form: Electronic Data Processing in Industry (New York: American Management Association, Inc., 1955), pg 139-147.

Automatic computing equipment is very reliable when properly maintained. The writer illustrates the point with some easily understood comparisons.

- J. Melvin Jones, "Marginal Checking—An Aid in Preventive Maintenance of Computers," Computers and Automation, V 4, #4 (April 1955), pg 10-14.

An easily read discussion of what marginal checking is, how it is done, and what can be expected of it.

- R. K. Richards, Arithmetic Operations in Digital Computers (New York: D. Van Nostrand Co., Inc., 1955), 397 pgs.

This book gives a good statement in rather simple language of how arithmetic operations are done in automatic computers.

- John G. Kemeny, "Man Viewed as a Machine," Scientific American, V 192, #4 (April 1955), pg 58-67.

A background article. An important part of the article is the information and explanation supplied on how automatic machines are able to be automatic.

- E. C. Nelson, "An Algebraic Theory for Use in Digital Computer Design," Transactions of the IRE Professional Group on Electronic Computers, V EC-3, #3 (Sept. 1953), pg 12-21.

A background article. The basic point of the article is the relation between the input and output of an automatic computer. Although the diagrams and tables are simple, the writing is rather technical.

- Arnold Tustin, "Feedback," Scientific American, V 187, #3 (Sept. 1952), pg 48-54.

A background article. Feedback is fundamental both in the operation and application of automatic computers. The article explains and discusses feedback in simple language.

Programming

- Walker H. Thomas, "Fundamentals of Digital Computer Programming," Proceedings of the IRE, V 41, #10 (Oct. 1953), pg 1245-1249.

An excellent presentation in rather readable language of the basic aspects of programming, with a few short examples worked out for illustration.

- Everett C. Yowell, "Some General Precepts for Programmers," Proceedings of the Electronic Computer Symposium (Los Angeles: Institute of Radio

Engineers--Professional Group on Electronic Computers, 1952), pg X:1-X:6.

Although the precepts are common sense, they are easy to forget when programming.

Grace M. Hopper, "Education of a Computer," Proceedings of the Association for Computing Machinery (Pittsburgh, Pa.: Richard Rimback Associates, 1952), pg 243-249.

A discussion of programming in terms of the contents of a programmer's possible "set of tools". A little technical.

Grace M. Hopper, "Compiling Routines," Computers and Automation, V 2, #4 (May 1953), pg 1-5.

A discussion of advanced programming techniques by an expert. The writer assumes the reader has a good knowledge of computer terminology.

Storage Devices

Louis Ridenour, "Computer Memories," Scientific American, V 192, #6 (June 1955), pg 92-100.

A well illustrated and somewhat popular presentation of storage devices with some emphasis on magnetic cores.

Isaac L. Auerbach, "Fast-Acting Digital Memory Systems," Electrical Manufacturing, V 52, #4 (Oct. 1953), pg 100-107, and V 52, #5 (Nov. 1953), pg 136-143.

A well illustrated survey article discussing the characteristics of storage devices.

Jasper P. Eckert, "A Survey of Digital Computer Memory Systems," Proceedings of the IRE, V 41, #10 (Oct. 1953), pg 1393-1406.

An authority discusses available types of storage devices in a rather readable way.

Input-Output Devices

Arthur W. Tyler, "Recording Techniques for Digital Coded Data," Review of Input-Output Equipment (New York: Institute of Radio Engineers, Inc., 1953), pg 3-7.

An introductory discussion of input-output devices, and the characteristics needed in such equipment.

S. N. Alexander, "Summary and Forecast," Review of Input-Output Equipment (New York: Institute of Radio Engineers, Inc., 1953), pg 137-139.

Some thoughtful comments on the general area of input-output equipment in terms of data-handling needs.

G. B. Bower, "Versatility in Analog to Digital Conversion," Automation, V 1, #5 (Dec. 1954), pg 98-102.

A good introduction to analog-digital devices. Although work is still not far advanced in this area, the importance of devices like these will increase.

David H. Shepard and Clyde C. Heasley, "Photoelectric Reader Feeds Business Machines," Electronics, V 28, #5 (May 1955), pg 134-138.

The use of the printed word as either storage or input-output for an automatic computer still lies in the future. This article tells of the efforts of one company to bring that future closer to the present.

Particular Automatic Computers

John M. Carroll, "Electronics for the Business Man," Electronics, V 28, #6 (June 1955), pg 122-131.

A survey of computer manufacturers was made and the results tabulated. The data presented suffers somewhat from a lack of thorough editing, but it is still worthwhile. (For other surveys, see the Controllershship bibliography cited later, and the Chapin book cited earlier.

Lawrence Wainwright, "Digital Computer Questionnaire," Computers and Automation, V 2, #6 (Sept. 1953), pg 3-7.

This very comprehensive questionnaire lists the areas of importance in learning about any particular automatic computer, and suggests important questions to ask.

Office of Naval Research, A Survey of Automatic Digital Computers (#PB111293) (Washington, D.C.: Office of Technical Services, Department of Commerce, 1953), 109 pgs.

A comprehensive survey in technical terms of over 90 scientific and commercial automatic computers.

John Plain Company, 140 GP Distributon, (Chicago: John Plain Co., 1953), 24 pgs.

A widely publicized example of special purpose magnetic drum equipment, told in the company's own words and pictures.

Argument on "Can Machines Think?"

Elliot Gruenberg, "What are the Possibilities for Reflective Thinking in Machines," Computers and Automation, V 3, #2 (Feb. 1954), pg 12-19, 26, 28. Also in: Systems and Procedures Quarterly, V 5, #3 (Aug. 1954), pg 10-19.

A well presented defense of the "machines can think" position.

M. V. Wilkes, "Can Machines Think?" Proceedings of the IRE, V 41, #10 (Oct. 1953), pg 1230-1234.

A well presented defense of the "machines cannot think" position.

General Reference Information

The magazine Computers and Automation makes a specialty of regular publication of useful reference information. To cite one example:

Staff of Computers and Automation, "Glossary of Terms in the Field of Computers and Automation," Computers and Automation, V 3 #10 (Dec. 1954) pg 8-23.

One of the two most extensive glossaries presently available.

(continued on page 38)

FRANCHISE

Isaac Asimov
Waltham, Mass.

It was two days before Election Day and Norman Muller swayed with shock as he stared at the Secret Service man who had entered the house. As though from a distance, he heard the man say with ritualistic formality: "Mr. Norman Muller, it is necessary for me to inform you on behalf of the President of the United States that you have been computed as one of those who will represent the American electorate on Tuesday, November 4, 2008."

So the lightning of Multivac, that giant computing machine, had struck. Norman had been computed out of the millions and was chosen.

And in a presidential year at that.

Norman managed, with difficulty, to walk unaided to his chair. He sat there, white-faced and almost insensible, while his wife, Sarah, brought water, and slapped his hands.

The agent said, "Now you're going to have me with you for a while. My name is Phil Handley. None of you will be able to leave the house from now on till Election Day is over. We will transact your business for you, or it will have to wait. You understand?"

Norman, recovering a remnant of self-control muttered, "Yes."

"Your daughter will stay home from school, too. I'll try to be as little a nuisance as possible. The government will pay for my maintenance of course. I'll be relieved each night by someone who will sit up in this room, so there will be no problem about sleeping accommodations. Now, Mr. Muller---"

"Sir?"

"You have two days in which to grow accustomed to the situation. We want to have you face Multivac in as normal a state of mind as possible. Just relax."

But Norman shook his head violently. "Why me? All that responsibility."

"Well," said Handley, "let's get that straight to begin with. Multivac is a computer which can handle in a moment the amount of data the entire human population of the country couldn't deal with in a year---"

"Yes, yes. I understand that."

"Good. Multivac can weigh all sorts of known factors, trillions of them, in attempting to judge for which of the various nominees the American electorate will vote for in all the various elections, federal, state and local. One factor only cannot be handled by Multivac without special conditions because the men who service it cannot evaluate it into numerical relationships.

"This factor is referred to as the 'irrational component' of the human mind. After all, minds can be swayed by impulses, emotions, whims, superstitions and so on. To judge the effect of these irrationals, Multivac must study a number of men and women directly. From those minds, the bent of all other minds in the country can be estimated. At any given time, some men and women are more representative than others. Multivac computes the most representative and you are included among them. Surely you don't question Multivac's competence in making the selection?"

"Couldn't it make a mistake?" asked Norman, wildly. "Couldn't it?"

"Yes, it can," admitted the agent. "In 1993, a selected Voter died of a stroke two hours before it was time for him to be notified. Multivac could not foresee that. Multivac can't know everything about everybody unless it is fed all the data in existence. That's why alternate selections are always held in readiness. They rarely need be used, however. So take it easy, Mr. Muller,---and Vote."

In bed that night, Norman Muller stared blankly up into the darkness: Election time had always been exciting for him as for everybody. There were the Election guesses concerning the states and towns in which the various Voters would live; the excitement as rumor struck close; the political rallies in key areas; the speculations and guesses; the under-cover gambling pools----

It was such a pleasant time in which to be a spectator. Norman Muller had never aspired to anything more. He was a small, quiet man with a thin, blonde mustache that had once given him a debonair quality but which, with gradual graying, had declined merely to lack of distinction. His forehead bore deepening lines

born of the gradual realization that his life as clerk in Kendall Department Store had crystallized and fixed itself into permanence.

Well, he had never thought he was born great or would, under any circumstances, achieve greatness. A job, a wife, a little girl--- It was an adequate bargain he had struck with life.

But now his wife stirred sleeplessly next to him and murmured, "Oh, Norman, I can't believe it. All the excitement and your name in the papers. They'll come to you for endorsements and for articles in magazines. You're sure to get a promotion. Or maybe you can leave Kendall's and start a little business of your own, the way we always wanted---"

But none of that really penetrated. He knew only that he dreaded Multivac.

Less than a week ago, in the growing hub-bub of approaching Election, he had talked about it to Linda, his daughter, who at 10 was beginning to take an interest.

He had said, "In the old days, Linda, everybody voted. We'd all say which man we wanted. Then they'd count how many said this man and how many that man and the man who got the most votes was elected."

Linda nodded and had said, "How did all the people know who to vote for? Did Multivac tell them?"

Norman had shaken his head, "They just decided for themselves. But you see, sometimes it took all night to count all the votes and people were impatient to know who would win. So they invented special computers which could consider the first million votes and compare them with the votes from the same places in previous years. That way the machine could compute how the total vote would be and who would be elected."

"Like Multivac."

"The first computers were much smaller than Multivac. But the machines grew bigger and they could tell how the election would go from fewer and fewer votes. Now Multivac needs only a dozen voters from different parts of the country."

That was it. It had seemed so normal to Norman. But that had been before he had the slightest notion that he himself would become one of the dozen. Who could have dreamed it?

Now it was everything but normal! The whole country would be staring at him!

It was early breakfast, the morning of the 4th. Norman Muller ate mechanically. The grey,

unfriendly dawn did not help. (The weather prediction was for a raw, cloudy day with prospects of rain before noon.)

The Secret Service agent was in full uniform now, including side-arms in heavily-brassed holsters.

"We'll keep this house insulated till Mr. Muller is back," he said to Sarah. "After that, we'll be off your necks."

Norman completed his second cup of black coffee, wiped his lips with a napkin, stood up and said haggardly, "I'm ready."

The armored car purred down empty streets. They were empty even for that hour of the morning.

Handley indicated that and said, "They always shift traffic away from the line of drive ever since the attempted bombing that nearly killed a Voter in '92."

The car stopped in an underground drive whose walls were lined with soldiers at attention.

Norman was led into a brightly-lit room, in which three white-uniformed men greeted him smilingly.

Norman said, sharply, "But this is the hospital?"

One of the three men in white said at once, "There's no significance to that. It's just that the hospital has the necessary facilities." He nodded toward Handley, "I'll take over now, agent."

Handley saluted and left the room.

The man in white said, "Won't you sit down, Mr. Muller? I'm John Paulson, Senior Computer. These are Samson Levine and Peter Dorogobuzh, my assistants."

Norman shook hands numbly all about. Paulson was a man of middle height with a soft face that seemed used to smiling and a very obvious toupee.

Paulson said, "In the first place, Mr. Muller, I want you to feel at ease. Get used to the surroundings. If you wish, we needn't start proceedings till noon."

"It's all right," said Norman. "I just want it to be over." He remained rigidly erect, wondering how the other eleven Voters were feeling at this moment.

"I understand your feelings," said Paulson. "Well, let's run through some things. In the

first place, Multivac isn't here."

"It isn't?" Somehow through all his anxieties, Norman had yet looked forward to seeing Multivac. It was said to be half a mile long, three stories high. Fifty technicians were supposed to patrol the corridors within its structure at all times. It was the wonder of the world.

Paulson smiled. "It's not portable, you know. It's located underground, in fact, and very few people know exactly where. You can understand that, since it is our greatest natural resource. Believe me, elections aren't the only things it's used for."

Norman said, "Then how---"

"How is it done? Well, we are plugged into Multivac right here by beam transmission, as are the other Voters. In a sense, we're in its presence."

Norman looked about. The machines within the room were all meaningless to him.

"But to continue, Mr. Muller," Paulson went on, "Multivac must check certain imponderable attitudes of mind and we cannot predict how it will go about that. We do not know in advance what questions it will ask, and they may not make much sense to you, or even to us. It may ask how you feel about garbage-disposal in your town; whether you favor central incinerators. It might ask you whether you have a doctor of your own or whether you make use of National Medicine, Inc. Do you understand?"

"Yes, sir."

"Whatever it asks, answer in your own words in any way you please. If you feel you must explain a bit, do so."

"Yes, sir."

"One more thing. We will have to make use of some simple devices which will automatically record your blood pressure, heart beat, skin conductivity, and brain wave pattern as you speak. The machinery will seem formidable, but it's all absolutely painless. You won't even know it's going on."

The other two technicians were already busying themselves with apparatus on oiled wheels.

Norman said, "Is that to check on whether I'm lying or not?"

"Not at all, Mr. Muller. There's no question of lying. It's only a matter of emotional intensity. If the machine asks you your opin-

ion of your child's school, you may say, 'I think it is overcrowded.' Those are only words. From the way your brain, heart, and sweat glands work, Multivac can judge exactly how intensely you feel about the matter. It will understand your feelings better than you yourself."

"I never heard of all this," said Norman.

"I'm sure you didn't. Most of the details of Multivac's workings are top secret. For instance, when you leave, you will be asked to sign a paper swearing that you will never reveal the nature of the questions you were asked, the nature of your responses, what was done or how it was done. The less is known about the Multivac, the less chance of attempted outside pressures upon the men who service it." He smiled, grimly, "Our lives are hard enough as it is."

Norman nodded. "I understand."

"Are you ready, then?"

Norman swallowed with difficulty. "Yes, sir."

Paulson nodded, and raised his hand in a gesture to the others.

They advanced with their frightening equipment and Norman Muller felt his breath come a little quicker as he watched.

The ordeal lasted nearly three hours, with one short break for coffee. During all this time, Norman Muller remained encased in machinery. He was bone-weary at the close.

He thought sardonically that his promise to reveal nothing of what had passed would be an easy one to keep. Already the questions were a hazy mish-mash in his mind.

Somehow he had thought Multivac would speak in a sepulchral, superhuman voice, resonant and echoing, but that, after all, was just an idea he had from seeing too many television shows, he decided. The truth was distressingly undramatic. The questions were slips of a kind of metallic foil patterned with numerous punctures. A second machine converted the pattern into words and Paulson read the words to Norman, then gave him the question and let him read it for himself.

Norman's answers were taken down by a recording machine, played back to Norman for confirmation, with emendations and added remarks also taken down. All of that was fed into a pattern-making instrument and that, in turn, was radiated to Multivac.

The one question Norman could remember at

the moment was an incongruously gossipy: "What do you think of the price of eggs?"

He had answered, blankly, "I don't know the price of eggs."

* * *

Now it was over, and gently they removed the electrodes from various portions of his body, unwrapped the pulsating band from his upper arm, moved the machinery away.

He stood up, drew a deep, shuddering breath and said, "Is that all? Am I through?"

"Not quite," Paulson hurried to him, smiling in reassuring fashion. "We'll have to ask you to stay another hour."

"Why?" asked Norman, sharply.

"It will take that long for Multivac to weave its new data from you and the other Voters into the trillions of items it has. Thousands of elections are concerned, you know. It's very complicated. It may be that an odd contest here or there, a comptrollership in Phoenix, Arizona or some council seat in Wilkes-Barre, North Carolina, may be in doubt. In that case, Multivac may be compelled to ask you a deciding question or two."

"Oh, no," groaned Norman.

"It probably won't happen," Paulson said, soothingly. "It rarely does. But just in case, you'll have to stay." A touch of steel, just a touch, entered his voice. "You have no choice, you know. You must."

Norman sat down wearily. "Very well."

The door opened, snapping him to open-eyed attention. For a moment, his stomach constricted. More questions?

But Paulson was smiling. "That will be all, Mr. Muller."

"No more questions, sir?"

"None needed. Everything was quite clear-cut. You will be escorted back to your home and then you will be a private citizen once more. Or as much so as the public will allow."

"Thank you. Thank you."

"But first---"

Norman froze instantly. "What else?" he asked sharply.

"Why, the question of payment."

"Payment?" Norman seemed stunned.

"Oh, not money, of course. We can't pay money for a civic duty. Still, it was a great responsibility and you were put to considerable inconvenience and may be put to more. Multivac has, in the course of questioning you, learned a great deal about your aptitudes and attitudes, your emotions and intelligence. Also, as a result of our investigation, it knows a great many facts about you."

"Well, what about it? Is there anything wrong?"

"Nothing. It is just that we know from past experience that for a period of time to come, you will be of great publicity value to others. You will be asked to endorse and advertise; you will be asked to speak, write, and dedicate buildings. You will be offered business opportunities, chances for investment. Your name is valuable; this year, at any rate."

"I know all that," said Norman, uneasily.

"From past experience, Multivac can evaluate the types of offers you are likely to get. Knowing you, it can estimate the probabilities of success in each of these cases. The last hour has been spent by part of Multivac's vast potential in analyzing your situation. It is customary to advise the Voter on his future actions."

Norman looked astonished. "Do you mean Multivac can foretell the future?"

"Not at all." Paulson smiled wistfully. "It can merely compute probabilities. For instance, Mr. Muller," and he handed a piece of onion-skin paper to Norman, "the probabilities of your attaining appreciable success or happiness in any venture which will be opened to you is quite low. The probability of a continued reasonable happiness in your present position is 0.923. The chances of a rise in happiness with time is 0.841, a moderate rise, of course. The chances of a fall are 0.123. Keep your present position, Mr. Muller."

Norman's face fell. "That's not much of a prediction, is it?"

Paulson looked stern, "You are not obligated to follow Multivac's advice. You can open your own haberdashery and take a 0.052 chance of remaining solvent after five years. That is your privilege. I just want you to realize that your present glimpse of the future is one which is available to very few. The President of the United States himself couldn't get one for his own son unless it involved the public good."

(continued on page 31)

AUTOMATIC CODING FOR DIGITAL COMPUTERS

Dr. G.M. Hopper
Director of Programming Research
Eckert Mauchly Division, Remington Rand
Philadelphia, Pa.

(Presented at Louisiana State University, February, 1955)

Automatic coding is a means for reducing problem costs and is one of the answers to a programmer's prayer. Since every problem must be reduced to a series of elementary steps and transformed into computer instructions, a method which will speed up and reduce the cost of this process is of importance.

Each and every problem must go through the same stages:

- Analysis,
- Programming,
- Coding,
- Debugging,
- Production Running,
- Evaluation

The process of analysis cannot be assisted by the computer itself. For scientific problems, mathematical or engineering, the analysis includes selecting the method of approximation, setting up specifications for accuracy of sub-routines, determining the influence of round-off errors, and finally presenting a list of equations supplemented by definition of tolerances and a diagram of the operations. For the commercial problem, again a detailed statement describing the procedure and covering every eventuality is required. This will usually be presented in English words and accompanied again by a flow diagram.

The analysis is the responsibility of the mathematician or engineer, the methods or systems man. It defines the problem and no attempt should be made to use a computer until such an analysis is complete.

The job of the programmer is that of adapting the problem definition to the abilities and idiosyncracies of the particular computer. He will be vitally concerned with input and output and with the flow of operations through the computer. He must have a thorough knowledge of the computer components and their relative speeds and virtues. Receiving diagrams and equations or statements from the analysts, he will produce detailed flow charts for transmission to the coders. These will differ from the charts produced by the analysts in that they will be suited to a particular computer and will contain more detail. In some cases,

the analyst and programmer will be the same person.

It is then the job of the coder to reduce the flow charts to the detailed list of computer instructions. At this point, an exact and comprehensive knowledge of the computer, its code, coding tricks, details of sentinels and of pulse code are required. The computer is an extremely fast moron. It will, at the speed of light, do exactly what it is told to do -- no more, no less.

After the coder has completed the instructions, it must be "debugged". Few and far between and very rare are those coders, human beings, who can write programs, perhaps consisting of several hundred instructions, perfectly, the first time. The analyzers, auto-monitors, and other mistake hunting routines that have been developed and reported on bear witness to the need of assistance in this area. When the program has been finally debugged, it is ready for production running and thereafter for evaluation or for use of the results.

Automatic coding enters these operations at four points. First, it supplies to the analysts, information about existing chunks of program, subroutines already tested and debugged, which he may choose to use in his problem. Second, it supplies the programmer with similar facilities not only with respect to the mathematics or processing used, but also with respect to using the equipment. For example, a generator may be provided to make editing routines to prepare data for printing, or a generator may be supplied to produce sorting routines.

It is in the third phase that automatic coding comes into its own, for here it can release the coder from most of the routine and drudgery of producing the instruction code. It may, someday, replace the coder or release him to become a programmer. Master or executive routines can be designed which will withdraw subroutines and generators from a library of such routines and link them together to form a running program.

If a routine is produced by a master routine from library components, it does not

require the fourth phase -- debugging -- from the point of view of the coding. Since the library routines will all have been checked and the compiler checked, no errors in coding can be introduced into the program (all of which presupposes a completely checked computer). The only bugs that can remain to be detected and exposed are those in the logic of the original statement of the problem.

Thus, one advantage of automatic coding appears, the reduction of the computer time required for debugging. A still greater advantage, however, is the replacement of the coder by the computer. It is here that the significant time reduction appears. The computer processes the units of coding as it does any other units of data -- accurately and rapidly. The elapsed time from a programmer's flow chart to a running routine may be reduced from a matter of weeks to a matter of minutes. Thus, the need for some type of automatic coding is clear.

Actually, it has been evident ever since the first digital computers first ran. Anyone who has been coding for more than a month has found himself wanting to use pieces of one problem in another. Every programmer had detected like sequences of operations. There is a ten year history of attempts to meet these needs.

The subroutine, the piece of coding, required to calculate a particular function can be wired into the computer and an instruction added to the computer code. However, this construction in hardware is costly and only the most frequently used routines can be treated in this manner. Mark I at Harvard included several such routines -- $\sin x$, $\log_{10} x$, 10^x . However, they had one fault, they were inflexible. Always, they delivered complete accuracy to twenty-two digits. Always, they treated the most general case. Other computers, Mark II and SEAC have included square roots and other subroutines partially or wholly built in. But such subroutines are costly and invariant and have come to be used only when speed without regard to cost is the primary consideration.

It was in the ENIAC that the first use of programmed subroutines appeared. When a certain series of operations was completed, a test could be made to see whether or not it was necessary to repeat them and sequencing control could be transferred on the basis of this test, either to repeat the operations or go on to another set.

At Harvard, Dr. Aiken had envisioned libraries of subroutines. At Pennsylvania, Dr. Mauchly had discussed the techniques of instructing the computer to program itself. At Princeton, Dr. von Neuman had pointed out

that if the instructions were stored in the same fashion as the data, the computer could then operate on these instructions. However, it was not until 1951 that Wheeler, Wilkes, and Gill in England, preparing to run the EDSAC, first set up standards, created a library, and the required satellite routines and wrote a book about it, "The Preparation of Programs for Electronic Digital Computers". In this country, comprehensive automatic techniques first appeared at MIT, where routines to facilitate the use of Whirlwind I by students of computers and programming were developed.

Many different automatic coding systems have been developed -- See-saw, Dual, Speed-Code, the Boeing Assembly, and others for the 701, the A-series of compilers for the UNIVAC, the Summer Session Computer for Whirlwind, MAGIC for the MIDAC and Transcode for the Ferranti Computer at Toronto. The list is long and rapidly growing longer. In the process of development are Fortran for the 704, BIOR and GP for the UNIVAC, a system for the 705, and many more. In fact, all manufacturers now seem to be including an announcement of the form,

"a library of subroutines for standard mathematical analysis operations is available to users",

"interpretive subroutines, easy program debugging - ... - automatic program assembly techniques can be used."

The automatic routines fall into three major classes. Though some may exhibit characteristics of one or more, the classes may be so defined as to distinguish them.

(1) Interpretive routines which translate a machine-like pseudo-code into machine code, refer to stored subroutines and execute them as the computation proceeds -- the MIT Summer Session Computer, 701 Speed-Code, UNIVAC Short-Code are examples.

(2) Compiling routines, which also read a pseudo-code, but which withdraw subroutines from a library and operate upon them, finally linking the pieces together to deliver, as output, a complete specific program for future running -- UNIVAC A -- compilers, BIOR, and the NYU Compiler System.

(3) Generative routines may be called for by compilers, or may be independent routines. Thus, a compiler may call upon a generator to produce a specific input routine. Or, as in the sort-generator, the submission of the specifications such as item-size, position of keyword, etc. instructs the generator to produce a routine to perform the desired operation. The UNIVAC sort-generator, the work of Betty

Holberton, was the first major automatic routine to be completed. It was finished in 1951 and has been in constant use ever since. At the University of California Radiation Laboratory, Livermore, an editing generator was developed by Merrit Ellmore -- later a routine was added to even generate the pseudo-code.

The type of automatic coding used for a particular computer is to some extent dependent upon the facilities of the computer itself. The early computers usually had but a single input-output device, sometimes even manually operated. It was customary to load the computer with program and data, permit it to "cook" on them, and when it signalled completion, the results were unloaded. This procedure led to the development of the interpretive type of routine. Subroutines were stored in closed form and a main program referred to them as they were required. Such a procedure conserved valuable internal storage space and speeded the problem solution.

With the production of computer systems, like the UNIVAC, having, for all practical purposes, infinite storage under the computer's own direction, new techniques became possible. A library of subroutines could be stored on tape, readily available to the computer. Instead of looking up a subroutine every time its operation was needed, it was possible to assemble the required subroutines into a program for a specific problem. Since most problems contain some repetitive elements, this was desirable in order to make the interpretive process a one-time operation.

Among the earliest such routines were the A--series of compilers of which A-0 first ran in May 1952. The A-2 compiler, as it stands at the moment, commands a library of mathematical and logical subroutines of floating decimal operations. It has been successfully applied to many different mathematical problems. In some cases, it has produced finished, checked, and debugged programs in three minutes. Some problems have taken as long as eighteen minutes to code. It is, however, limited by its library which is not as complete as it should be and by the fact that since it produces a program entirely in floating decimal, it is sometimes wasteful of computer time. However, mathematicians have been able rapidly to learn to use it. The elapsed time for problems -- the programming time plus the running time -- has been materially reduced. Improvements and techniques now known, derived from experience with the A--series, will make it possible to produce better compiling systems. Currently, under the direction of Dr. Herbert F. Mitchell, Jr., the BIOR compiler is being checked out. This is the pioneer -- the first of the true data-processing compilers.

At present, the interpretive and compiling systems are as many and as different as were the computers five years ago. This is natural in the early stages of a development. It will be some time before anyone can say this is the way to produce automatic coding.

Even the pseudo-codes vary widely. For mathematical problems, Laning and Zeirlor at MIT have modified a Flexowriter and the pseudo-code in which they state problems clings very closely to the usual mathematical notation. Faced with the problem of coding for ENIAC, EDVAC and/or ORDVAC, Dr. Gorn at Aberdeen has been developing a "universal code". A problem stated in this universal pseudo-code can then be presented to an executive routine pertaining to the particular computer to be used to produce coding for that computer. Of the Bureau of Standards, Dr. Wegstein in Washington and Dr. Huskey on the West Coast have developed techniques and codes for describing a flow chart to a compiler.

In each case, the effort has been three-fold:

- (1) to expand the computer's vocabulary in the direction required by its users.
- (2) to simplify the preparation of programs both in order to reduce the amount of information about a computer a user needed to learn, and to reduce the amount he needed to write.
- (3) to make it easy, to avoid mistakes, to check for them, and to detect them.

The ultimate pseudo-code is not yet in sight. There probably will be at least two in common use; one for the scientific, mathematical and engineering problems using a pseudo-code closely approximating mathematical symbolism; and a second, for the data-processing, commercial, business and accounting problems. In all likelihood, the latter will approximate plain English.

The standardization of pseudo-code and corresponding subroutine is simple for mathematical problems. As a pseudo-code "sin x" is practical and suitable for "compute the sine of x", "PWT" is equally obvious for "compute Philadelphia Wage Tax", but very few commercial subroutines can be standardized in such a fashion. It seems likely that a pseudo-code "gross-pay" will call for a different subroutine in every installation. In some cases, not even the vocabulary will be common since one computer will be producing pay checks and another maintaining an inventory.

Thus, future compiling routines must be

AUTOMATIC CODING

independent of the type of program to be produced. Just as there are now general-purpose computers, there will have to be general-purpose compilers. Auxiliary to the compilers will be vocabularies of pseudo-codes and corresponding volumes of subroutines. These volumes may differ from one installation to another and even within an installation. Thus, a compiler of the future will have a volume of floating-decimal mathematical subroutines, a volume of inventory routines, and a volume of payroll routines. While gross-pay may appear in the payroll volume both at installation A and at installation B, the corresponding subroutine or standard input item may be completely different in the two volumes. Certain more general routines, such as input-output, editing, and sorting generators will remain common and therefore are the first that are being developed.

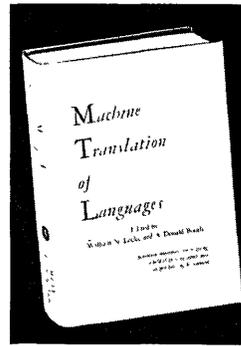
There is little doubt that the development of automatic coding will influence the design of computers. In fact, it is already happening. Instructions will be added to facilitate such coding. Instructions added only for the convenience of the programmer will be omitted since the computer, rather than the programmer, will write the detailed coding. However, all this will not be completed tomorrow. There is much to be learned. So far as each group has completed an interpreter or compiler, they have discovered in using it "what they really wanted to do". Each executive routine produced has led to the writing of specifications for a better routine.

1955 will mark the completion of several ambitious executive routines. It will also see the specifications prepared by each group for much better and more efficient routines since testing in use is necessary to discover these specifications. However, the routines now being completed will materially reduce the time required for problem preparation; that is, the programming, coding, and debugging time. One warning must be sounded, these routines cannot define a problem nor adapt it to a computer. They only eliminate the clerical part of the job.

Analysis, programming, definition of a problem required 85%, coding and debugging 15%, of the preparation time. Automatic coding materially reduces the latter time. It assists the programmer by defining standard procedures which can be frequently used. Please remember, however, that automatic programming does not imply that it is now possible to walk up to a computer, say "write my payroll checks", and push a button. Such efficiency is still in the science-fiction future.

- END -

17 MT experts bring you the first book on...



MACHINE TRANSLATION OF LANGUAGES

Edited by WILLIAM N. LOCKE, the Massachusetts Institute of Technology; and A. DONALD BOOTH, Birkbeck College Computation Laboratory, London; with 17 International Authorities.

Very first to survey the fast-moving field of mechanical translation, this book offers answers to many provocative questions, and provides probing essays on others which cannot yet be answered.

Covers such subjects as: the design of an automatic dictionary; what a "word" is; an operational analysis of Russian; speech input; storage devices; idioms and syntax; model English; and recent experiments. The 17 contributors to this book are the top men in machine translation, a fact that assures as full and authoritative a picture as will be available for years to come.

Co-published with The Technology Press of the Massachusetts Institute of Technology.

1955 243 pages Illus. \$6.00

NUMERICAL ANALYSIS

With emphasis on the application of numerical techniques to problems of infinitesimal calculus in a single variable

By ZDENEK KOPAL,
The University of Manchester, England.

Methods featured in this work are especially valuable for use with large-scale calculating machines, and this application is kept in mind throughout the entire book. Those parts of algebra and analysis on which numerical methods are based, are lucidly presented. Principles are emphasized over such details as checking, layout of work etc. The methods described are selected for their comprehensive nature and freedom from supplementary rules.

1955 Approx. 568 pages Illus. Prob. \$12.00

Mail this coupon today for your ON-APPROVAL copies

JOHN WILEY & SONS, Inc.,
440 Fourth Ave., New York 16, N. Y.

Please send the book(s) checked below for me to examine ON APPROVAL. Within 10 days I will either return same and owe you nothing, or will remit the price(s) indicated, plus postage.

MACHINE TRANSLATION OF LANGUAGES, \$6.00

NUMERICAL ANALYSIS, \$12.00

Name.....

Address.....

City..... Zone..... State.....

SAVE POSTAGE! Check here if you ENCLOSE payment, in which case we pay postage. Same return privilege, of course.

Automatic Programming: The A 2 Compiler System — Part 1

Programming Research Section
Eckert Mauchly Division, Remington Rand
Philadelphia, Pa.

(Editor's Note: — The subject of automatic programming is so interesting and important that it seems desirable to reprint in these pages a large section of the recently issued and authoritative instruction manual for Remington Rand's automatic programming technique known as the "A 2 Compiler".)

PREFACE

The "A-2 Compiler" is a technique developed by the Programming Research Group of the Eckert-Mauchly Division of Remington Rand. Its specific purpose is to expedite the preparation of instructions for the Univac electronic computer when solving mathematical problems. Its use makes possible rapid solution of many mathematical problems previously considered not economical from either a time or cost standpoint.

The A-2 Compiler might be called a "canned program" — a set of instructions previously prepared and stored on metallic magnetic tape. This set of tape recorded instructions act under the direction of a special code called a Pseudo-Code. The Pseudo-code instructs the compiler to assemble, in ordered form, all computer operations needed for the solution of a problem.

This instruction manual has been prepared for those having no previous experience with electronic computers. The text presents application of the A-2 in a simple straightforward manner. A brief description of the Univac System equipment is presented to facilitate a better understanding of the compiler.

Those advanced in the art of writing instructions for the computer will find in the appendices detailed information concerning the compiler.

BRIEF DESCRIPTION OF THE UNIVAC SYSTEM

The Univac System is a large scale general purpose electronic data-processing unit. The name Univac is an abbreviation for Universal Automatic Computer, and, as the term universal implies, the computer can be applied to the solution of complex mathematical problems as well as to the solution of large data-processing operations.

Basic components of the System are: a central computer, input-output devices which transport information into or out of the central computer, and equipment for preparing data for subsequent processing.

The Central Computer

The Central Computer, the core of the Univac System, performs all arithmetic and logical operations. These operations and their sequencing are completely automatic and no human intervention is required once processing has begun.

In the solution of a typical problem the Central Computer performs the following basic operations:

1. It "reads" raw problem data from magnetic tape and stores the data internally.
2. Instructions stating specifically the operations to be performed on the raw problem data are received (or "read in") from magnetic tape and stored internally by the Central Computer.
3. Obeying the stored instructions, the Central Computer then performs all necessary operations and stores results internally.
4. Results are then automatically "read out" of the Central Computer and recorded on magnetic tape, ready for transcription to printed form.

Supervisory Control

The Supervisory Control is a device directly connected to the Central Computer. It contains a control panel of switches and neons which provide a continuous picture of all current operations of the computer and which permit human intervention in the automatic operations of the computer. It is through this means that human control may be maintained over the computer at all times.

Uniservos

Uniservos are magnetic tape handling devices each of which contains a magnetic "read-write" head and a mechanism for moving the magnetic tape past the head. Uniservos are controlled by the Central Computer.

INPUT DEVICES

Unityper II

The Unityper II is a mechanism containing a keyboard similar to that found on a standard electric typewriter. It converts data into a predetermined pattern of pulses on Univac magnetic tape. Each keystroke of the Unityper records on the magnetic tape the specific pulse pattern corresponding to that particular keystroke character.

Punched Card-To-Magnetic-Tape Converter

The Card-to-Magnetic-Tape Converter automatically transcribes data from punched cards to Univac magnetic tape. When the conversion process has been completed the tape may then be mounted on a Uniservo and the recorded information may be read directly into the Central Computer. Data from the punched cards is transcribed to tape at the rate of 240 cards per minute.

Teletype Tape-To-Magnetic Tape Converter

The Teletype Tape-to-Magnetic Tape Converter is a device which converts information on punched paper tape to Univac magnetic tape. As a by-product a printed copy of the information is produced. The most common source of punched paper tape used in this converter is Teletype equipment. Conversion speed is about the same as the receiving speed of a Teletype machine.

OUTPUT DEVICES

High-Speed Printer

Computed results of a problem are automatically read out of the Central Computer and recorded on magnetic tape. The High-Speed Printer is a unit which converts these tape recorded results into printed form. It prints numbers, letters or punctuation marks on a line, a maximum of 130 characters wide at a rate of 600 lines per minute. By means of a plugboard the computed results may be arranged in any desired format. Either blank paper or pre-printed forms may be used. Paper is sprocket fed, and can vary in width between 4" and 27".

Uniprinter

The Uniprinter consists of two assemblies connected by a cable: the Tape Reader and the Printing Unit. A reel of Univac tape, containing the information to be printed and the symbols for the operation of such keys as the carriage return, tabulator and shift keys, is mounted on the Printing Unit. The pulse code for the letters, numbers and symbols (recorded on the tape at a density of 20 characters per inch) is read from the tape and activates the applicable key on the electric typewriter mounted on the Printing Unit. The Uniprinter is usually referred to as the low speed printer inasmuch as it operates at a rate of 10 characters per second. A skip switch allows a tape to be searched quickly, skipping over unwanted data at 18 characters per second in order to print selected areas.

By setting a function switch, either a "normal" or "computer digit" typewritten copy may be produced by the Printing Unit. A computer digit copy provides an exact one to one correspondence between the number of columns or characters on a line of typing and the number of symbols recorded on a corresponding length of tape.

Preprinted forms, with a continuous feed,

may be used. The editing required is usually performed during the final processing of the tape by the Central Computer. The Uniprinter is usually used for low volume output printing, such as the preparation of management reports.

Magnetic Tape-To-Punched-Card Converter

Information stored on Univac magnetic tape can be transferred to 80 column punched cards by means of the Tape-to-Card Converter; information is transferred at the rate of 120 cards per minute.

Magnetic Tape-To-Paper Tape Converter

This is a device which converts information recorded on magnetic tape to five channel punched paper tape. It is primarily used for producing the punched paper tape utilized in the transmission of data over a Teletype Network.

ADDITIONAL EQUIPMENT

Verifier

The Verifier is a machine used for checking the correctness of information recorded on tape; it enables an operator to replace incorrect information on the tape with correct information by depressing the appropriate key on the machine keyboard. The Verifier may also be used as a typewriter or a printer.

CONVENTIONAL METHOD OF PROBLEM SOLUTION

Before Univac can solve a given problem it must receive two essential ingredients; data for the problem and instructions which tell the computer what mathematical operations to perform on this data. The instructions must be prepared in a form understood by the computer. This is known as "C-10" coding. An example of some typical "C-10" coding appears below:

B 001	A 013
L 012	Q 007
H 001	A 014
C 002	U 015

In the conventional method of problem solution using the Univac system, the steps involved are as follows:

1. Analysis of the Problem. Problem analysis is a study necessary to determine the computational steps required for solution.
2. Translation into Computer Language or Code. The computational steps (or operations) indicated by problem analysis are translated into explicit instructions (on paper) in "C-10" computer code. This translation is performed by a computer specialist, one who is familiar with the logic and language of the computer.

3. Recording on Tape. The "C-10" coded instructions are then recorded on metallic, magnetic tape by means of the unityper.
4. Problem Data. All problem data that will enter the calculations is also recorded on separate reels of magnetic tape by use of the unityper.
5. Computation. The instructions and data previously recorded on tape (steps 3 and 4) are then "read" into the central computer and stored there. The central computer then automatically performs all computations according to the stored instructions.
6. Computed results. Results of all computations are automatically read out of the central computer and recorded on magnetic tape.
7. Printed Results. The reels of tape containing computed results may then be mounted on a device which converts the information into printed form.

A-2 COMPILER METHOD OF PROBLEM SOLUTION

Of necessity, there will always be an initial human analysis of a problem. However, the physical preparation of a problem for computer solution can be accomplished more swiftly and economically by turning over much of the preparatory work to Univac itself.

Step two of the conventional method of problem solution, the translation of the problem into computer language, can now be eliminated through use of the A-2 Compiler System. No longer does the problem analyst have to rely on a computer specialist to translate the problem into computer code, for without previous computer knowledge, the analyst can now quickly master a relatively simple A-2 Compiler Code and apply it to code his own problems. The analyst, who certainly has the greatest grasp of the problem, now retains control of his problem from conception to final solution.

The first procedure for preparing a solution to any problem is that the analyst "break down" the problem into computational steps. Sequencing of the steps is determined at this point according to the method of solution. For example, analysis of a problem may call for steps such as addition, subtraction, computing the sine of an angle, etc. The computational steps must then be translated into A-2 pseudo-code, and this is accomplished by referring to the A-2 Compiler manual which contains the method of writing the pseudo-code for each of the computational steps. When all pseudo-coded instructions have been prepared in proper sequence they are recorded on tape.

The Compiler is now read into the computer. It immediately "calls" for pseudo-coded instructions. If one of the pseudo-coded instructions is "take the square root", the Compiler then searches the library tape for the "square root sub-routine", extracts the routine from the library and reads

it into the computer. The square root routine is then processed for integration with all other sub-routines summoned from the library by the Compiler.

When all sub-routines have been summoned, processed, and linked together in proper sequence as specified by the pseudo-code, they are recorded on magnetic tape; this is known as the "Compiled Program". All necessary detailed instructions in C-10 Code that the computer requires to solve the problem are now contained in the "Compiled Program".

It should be emphasized that no computations have been performed on data in processing up to this point. The compiled program is now ready to accomplish the data-processing desired.

BASIC ELEMENTS OF THE A-2 COMPILER SYSTEM

Four basic elements are fundamental to the operation of the A-2 Compiler System. They are:

1. Sub-Routines
2. Library
3. Pseudo-Code
4. Compiler

SUB-ROUTINES. A sub-routine may be defined as a set of instructions necessary to direct the computer to carry out a well defined mathematical or logical operation. For our specific purposes it is a list or set of "C-10" coded instructions. A typical sub-routine may be one that is coded to calculate the sine of an angle, or perform the four basic arithmetic operations of addition, subtraction, multiplication, or division.

LIBRARY. A library is an ordered set or collection of standard and proven sub-routines. In the A-2 Compiler System, these sub-routines are permanently recorded and stored on magnetic tape in alphabetical order.

PSEUDO-CODE. Pseudo-code is a special code which must be translated into computer code if it is to direct the computer. The A-2 Compiler Pseudo-Code is intelligible to the Compiler System only (unintelligible to the computer itself).

THE COMPILER. The A-2 Compiler is a Master Routine which translates the pseudo-code into computer code (C-10). This translation must always be performed prior to the actual solution of the problem since Univac will only execute coded instructions expressed in its own language.

DEFINITION OF TERMS

Before proceeding it is necessary that certain terms relative to the reader's use of the Compiler be defined and clarified.

UNIVAC "WORD". The Univac "Word" is a set of twelve characters which occupy one storage location and are treated by the computer circuits as a unit and transported as such. These characters may be alphabetic, numeric, or a combination of both. When the "word" represents a numeric quantity, the twelve characters in the word are the

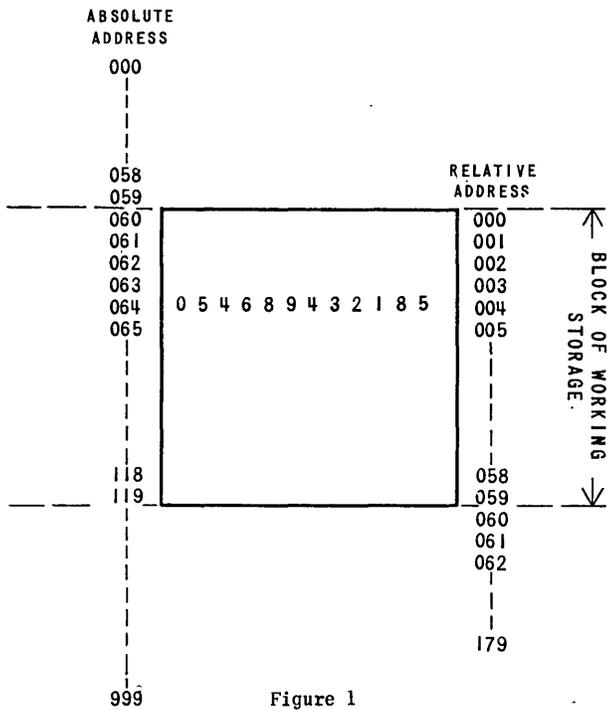
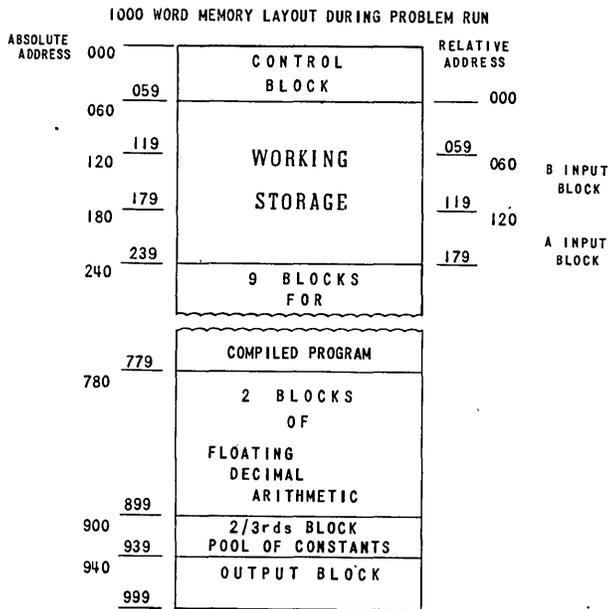


Figure 1



TOTAL - 16 2/3 BLOCKS

Figure 2

SYMBOLIC LOGIC— Part I, Elementary

by Lewis Carroll,

fourth edition, published 1897,
240 pages, and long out of print,
has just been reprinted by Berkeley
Enterprises, Inc.

...

Example No. 22, p. 115

- "(1) No acrobatic feats, that are not announced in the bills of a circus, are ever attempted there;
- (2) No acrobatic feat is possible, if it involves turning a quadruple somersault;
- (3) No impossible acrobatic feat is ever announced in a circus bill."

...

Example No. 35, p. 118

- "(1) No birds except ostriches, are 9 feet high;
- (2) There are no birds in this aviary that belong to any one but me;
- (3) No ostrich lives on mince-pies;
- (4) I have no birds less than 9 feet high.

...

This book contains a large number of problems in symbolic logic, in Lewis Carroll's inimitable and entertaining style, also his method of solution (now partly out of date), and his important sketches of Parts II and III, which he apparently never wrote, since he died in 1898. \$2.50

—Mail This Coupon—

Berkeley Enterprises, Inc.
36 West 11 St., R 126, New York 11, N. Y.

Please send me P 32, Lewis Carroll's "Symbolic Logic", and your announcement of publications. I enclose \$2.50. Returnable in seven days for full refund if not satisfactory.

My name and address are attached.

algebraic sign (a plus or minus), followed by eleven decimal digits. For example: the number 5,152 may be represented as 000000005152. Zero in the sign position represents a positive quantity; a minus in the sign position represents a negative quantity. Univac always assumes that a decimal point lies immediately to the right of the first, or sign position -- that is, the decimal point is assumed to be between the first and second digit positions. Thus, all numeric quantities are regarded by Univac as falling in the range between -1 and 1. It will be seen later how quantities outside this range are handled.

MEMORY. The central computer is capable of storing 1,000 Univac words. These 1,000 word locations are termed the "Memory", are numbered from 000 to 999, and the numbers are called "Absolute Addresses". Transfer of data into a memory location automatically erases previously stored information. When transferring data to a new location, the data is still retained at the old location. Hence information is in both old and new locations.

BLOCK. When the central computer reads information from magnetic tape or writes information on magnetic tape, it always does so in units of sixty words. Sixty word units are called "blocks". Any sixty consecutive locations within the central computer memory also constitute blocks. The first word of the block should have an address ending in zero when reading or writing.

WORKING STORAGE. The area in the computer memory designated by the coder for storing quantities used in the solution of a problem is called working storage. The area used for storing intermediate and final results of computations is also considered working storage.

FLOATING DECIMAL. The A-2 Compiler produces a program that operates on numerical quantities expressed in "two word" form, that is, two Univac words, in consecutive order, are used to represent the complete numeric quantity to be expressed. The first word contains the actual numeric quantity without the decimal point, and the second word contains a number (exponent of 10) whose purpose is to position the decimal point in the numeric quantity represented by the first word. For example, 3186.319 is expressed as:

031863190000 (1st word)
000000000004 (2nd word)

It will be recalled that Univac always assumes that a decimal point lies immediately to the right of the first or sign position. Therefore, the number expressed in the first word above would read 0.31863190000. Since zero is in the sign position, this number represents a positive quantity. It is necessary then, that the second word act upon the number represented by the first word in order to properly position the decimal point. This is done by signifying in the second word (always at the extreme right, or least significant digit position of the word) the power of ten necessary to indicate the proper position of the decimal point. In the above example the necessary power of 10 is 10^4 , for if 0.31863190000

is multiplied by 10^4 (10,000), the result is 3186.319, the desired number.

Additional examples showing how the floating decimal principle is employed are listed below.

Decimal Form	Exponential Form	Floating Decimal Form
31863190000	$.3186319 \times 10^{11}$	031863190000 000000000011
-3186.319	$-.3186319 \times 10^4$	-31863190000 000000000004
.003186319	$.3186319 \times 10^{-2}$	031863190000 -000000000002
-.003186319	$-.3186319 \times 10^{-2}$	-31863190000 -000000000002

ABSOLUTE AND RELATIVE ADDRESSES

As stated previously, an "Absolute Address" refers to a specific word location within the memory of the central computer, and in Univac I absolute addresses are numbered from 000 to 999. Since the coder, when utilizing the A-2 Compiler, will be interested only in the area known as working storage, another numbering system has been employed called Relative Addressing. Although the working storage may occupy Absolute memory address locations 060 to 119, the Relative memory addresses directly corresponding to these absolute addresses are 000 to 059. [This may be seen in Fig. 1 which illustrates the direct relationship between absolute and relative addresses.] [The user of the A-2 Compiler System will always employ relative address coding. As shown in the figure the coder would then regard the number (054689432185) as occupying the relative address location 004, since he will not be concerned with the corresponding absolute address (in this case 064).]

RUNNING MEMORY LAYOUT. It should be clearly borne in mind that there are two distinct phases in which Univac is used for the solution of a problem. Phase one is the compilation during which the compiler produces a program capable of solving the given problem. Phase two consists of the execution of this compiled program. The memory during phase two is utilized in a very specific and predetermined format; this is termed the "running memory layout". Fig. 2 illustrates the running memory layout used during phase two. Any problem solved with a program produced by the A-2 Compiler uses this format.

A detailed description of the running memory layout will be given in Part II.

- TO BE CONTINUED -

Forum

CONFERENCE ON "THE PRACTICAL UTILIZATION OF KNOWLEDGE", CLEVELAND, JANUARY 1956

The School of Library Science of Western Reserve University is now laying plans for a national conference on "The Practical Utilization of Knowledge." It is to be held in January of 1956 in conjunction with the dedication of the University's new Freiburger Library, which will house the School of Library Science and the recently established Center for Documentation and Communication Research.

In connection with these activities, we are arranging an exhibition of equipment, supplies, and services for the benefit of the documentalists, librarians, and information specialists, who will attend the Conference and the dedication ceremonies.

Dean Jesse H. Shera
School of Library Science
11,111 Euclid Ave.
Cleveland 6, Ohio

Forum

CONFERENCE ON INSTRUMENTATION FOR DATA HANDLING, ATLANTA, NOVEMBER, 1955

D. L. Finn
Atlanta, Ga.

The Professional Group on Instrumentation and the Atlanta Section of the Institute of Radio Engineers are holding an Instrumentation Conference and Exhibit at the Atlanta Biltmore Hotel on November 28, 29, and 30, 1955. The theme of this Conference will be "Data Handling." Papers on any topic in the field of instrumentation for data handling will be considered, such as:

- Analog-Digital Conversion
- Computation (use aspects)
 - Analog
 - Digital
- Editing Equipment
- Information Content
- Information Theory Aspects
- Plotters
- Recorders
 - Direct Writing
 - Magnetic
 - Oscillographic
- Tabulators
- Transducers

D. L. Finn
School of Electrical Engineering
Georgia Institute of Technology
Atlanta, Georgia

Forum

EASTERN JOINT COMPUTER CONFERENCE, BOSTON, NOVEMBER, 1955

The 1955 A.I.E.E., I.R.E., A.C.M. Eastern Joint Computer Conference and Exhibition will be held at the Statler Hotel, Boston, Mass. on November 7, 8, and 9, 1955.

The theme is "Computers in Business and Industrial Systems".

Exhibitions have been invited in the following categories:

- Electronic Data Processing Systems
- Process Control Systems
- Storage Systems
- Input-Output Equipment
- Conversion Devices
- Sensing Devices

Detailed information will be sent out by the Local Arrangements Committee, Box 223, Boston 1, Mass.

Forum

COMPUTER SESSION AT THE CONFERENCE ON INDUSTRIAL HYDRAULICS, OCTOBER, 1955

The 11th Annual Meeting of The National Conference on Industrial Hydraulics will be held October 27-28, 1955, at the La Salle Hotel in Chicago. The application of electronic analog computers to hydraulic problems is being discussed in a "Computer Session", which is the General Session, Thursday morning, October 27. The program is:

1. "The Components of an Electronic Analog Computer", John D. Strong, Electronics Associates Inc.
2. "An Introduction to the Use of Electronic Analog Computers", Hugo M. Martinez, Beckman Instruments, Inc.
3. "The Use of the Analog Computer in the Design of a Hydraulic Velocity Control System", Gerhard Reethof, Massachusetts Institute of Technology.

For more information about the conference, please write to:

Chester A. Arents
Conference Secretary
National Conference on Industrial Hydraulics
Technology Center
3300 So. Federal
Chicago 16, Ill.

FRANCHISE

(continued from page 20)

Norman looked at the paper. Its figures were meaningless at first glance. He would have to study it and decide. It might mean an argument with Sarah----

He said, suddenly, "Oh, by the way."

"Yes?"

"I wonder--- Who was elected?"

Slowly, Paulson shook his head. "That will have to wait for the official announcement. The rules are quite strict."

"Oh--- Yes, I suppose so." He felt foolish at having asked.

Holding the paper that carried his future in the figures upon it, Norman Muller let himself be led out of the building and toward home.

- END -

Forum

PROPOSED SYMPOSIUM ON
NUMERICAL ANALYSIS

F. J. Maginniss
Schenectady, N. Y.

I am interested in the possibility of a symposium to bring methods of numerical analysis up to date from the point of view of the man operating a computing center. This might perhaps be the theme of a future Joint Computer Committee Conference.

I think it is probably true in some university installations and certainly in many industrial organizations that digital computers are being improperly or inefficiently used because of ignorance of the appropriate numerical methods. Even people who are familiar with proper methods for analysis or hand calculation frequently fail to recognize the need to change their thinking when they go to large scale computers.

I would certainly appreciate it if any reader of "Computers and Automation" would let me have his thoughts on the feasibility of holding a conference on this theme. I would be particularly glad to have suggestions for participants in such a meeting. For instance, it would be helpful to have suggestions of the names of half a dozen or so people who may be considered to have made the greatest contributions in the field of problem solving as it applies to digital computers.

Please send any ideas or suggestions to:

F. J. Maginniss, Manager,
Special Engineering Investigations,
Analytical Engineering,
Apparatus Sales Division,
General Electric Co.
One River Road
Schenectady 5, N. Y.

MANUSCRIPTS

We are interested in articles, papers, and fiction relating to computers and automation. To be considered for any particular issue, the manuscript should be in our hands by the fifth 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, generally, \$10 to \$40 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. Payments will be made for papers, generally \$5 to \$20 on publication, depending on length, etc.

Fiction. We desire to print or reprint fiction which explores scientific ideas and possibilities about computing machinery, robots, cybernetics, automation, etc., and their implications, and which at the same time is a good story. Ordinarily, the length should be 1000 to 4000 words, and payment will be, generally, \$10 to \$40 on publication if not previously published, and half that if previously published.

Program-Association For Computing Machinery

National Meeting—September 14, 15, 16, 1955 University of Pennsylvania, Philadelphia, Pa.

Wednesday 9:45 A. M.

Opening Remarks: Dr. Morris Rubinoff, Chm., Local Arrangements Comm.

Welcoming Address: Dr. Carl C. Chambers, V.P. in charge of Engr. Affairs

Presidential Address: Dr. Alston S. Householder, Pres. of A. C. M.

Wednesday 10:30 A. M.

Matrices and Linear Equations I

Chm: John Todd,

National Bureau of Standards

1. An Automatic Program for Matrix and Vector Operations (16) *David P. Perry, Sperry Rand Corp.*
2. An Interesting Set of Test Matrices (22) *Mark Lotkin, RCA.*
3. An Iterative Procedure for Calculating the Eigenvectors and Eigenvalues of a Real Symmetric Matrix (77) *Richard E. von Holdt, Univ. of Cal.*
4. Numerical Computation of the Characteristic Vectors of a Real Symmetric Matrix (109) *Wallace Givens, Univ. of Tenn. and Oak Ridge Nat. Lab.*

Programming I

Chm: Dr. Ruth Goodman,

Westinghouse Res. Labs.

5. EASIAC (132) *Robert Perkins, Ramo-Wooldridge Corp.*
6. The 702 Auto Coder System (121) *Hollis A. Kinelow, IBM*
7. Automatic Encoding System I (79) *E. K. Blum, U. S. Naval Ord. Lab.*
8. Transcode (42) *J. N. P. Hume, Univ. of Toronto*
9. Dual-Purpose Use of the 702 (5) *F. J. Gruenberger, G. E.*

Systems Design

Chm: James E. Robertson, Univ. of Ill.

10. The ERMETH and Other European Digital Computers (105) *John R. Stock, Union Carbide & Carbon Corp.*
11. The Logical Design of CONAC (131) *Stanley Frankel, Continental Oil Co.*
12. The System Design of the IBM Type 704 (137) *G. M. Amdahl and J. W. Backus, IBM*
13. The NATPAC General Purpose Digital Computer (139) *William E. Smith, North American Aviation Corp.*
14. Experience with the ERA 1103 Computer (102) *Charles J. Swift, CONVAIR*

Wednesday Luncheon 12:15 P. M. Penn Sherwood Hotel

"Computer Applications in Science and Research"

Dr. Charles R. DeCarlo, Director, Applied Sciences Division, IBM

Wednesday 2:00 P. M.

Data Processing

Chm: Walter K. Halstead;

Radio Corporation of America

15. Wind Tunnel Data Reduction Using Paper-Tape Storage Media (27) *W. R. Hoover, J. J. Wedel, J. R. Bruman, Cal. Inst. of Tech.*
16. Sequencing and Selecting Items on Magnetic Tape (72) *Norman Grieser, Underwood Corp.*
17. File Reference (78) *J. A. Postley, Rand Corp.*
18. Tape Identification and Rerun Procedures (31) *L. Eselsen, Sperry Rand Corp.*

Programming II (Compiling Routines)

Chm: John W. Carr, University of Michigan

19. Automatic Routines for Commercial Installations (26) *Mary K. Hawes, Sperry Rand Corp.*
20. The ELECOM 125 Compiler (71) *Leon Nemerever, Underwood Corp.*
21. Compiler and Assembly Program for the IBM 704 (145) *J. A. Porter and D. L. Shell, G.E. Co.*
22. Compilers with Mathematical Symbol Input (89) *A. E. Roberts, Jr., General Kinetics, Inc.*

Basic Principles of Digital Computers I

Chm: Arvid Jacobson, Wayne University

- *23. General Structure and Basic Components. *Dean Arden, Massachusetts Institute of Technology*
- *24. Arithmetic of Digital Computers. *James E. Robertson, University of Illinois*
- *25. Storage Devices. *Norman R. Scott, University of Michigan*

Sorting

Chm: Sidney Kaplan,

Radio Corporation of America

26. Sorting by Address Calculation (1) *Earl J. Isaac and Richard C. Singleton, Stanford Research Institute*
27. Criteria for Comparing Methods of Sorting (13) *Benjamin L. Schwartz, Battelle Memorial Institute*
28. Sorting and Merging on Electronic Data Processing Machines (122) *R. L. Cline, International Business Machines Corporation*
29. Sorting (40) *Edward H. Friend, New York Life Insurance Company*

Numerical Analysis I

Chm: D. E. Muller, University of Illinois

30. An Unrestricted Method of Stepwise Integration (21) *J. H. Allen, Tenco Aircraft Corp.*
31. The Convergence of Iterative Methods for Solving Linear Systems (25) *A. S. Householder, Oak Ridge Nat. Lab.*
32. Accelerating Convergence of Iterative Processes (47) *J. H. Wegstein, N.B.S.*
33. Numerical Integration for the Digital Computer (31) *S. G. Campbell, Oak Ridge Nat. Lab.*

Basic Principles of Digital Computers II

Chm: Arvid Jacobson, Wayne University

- *34. Input and Output Equipment, *Ragnar Thorsen, Magnavox Corporation Research Laboratories*
- *35. Instruction Codes and Programming. *Alan J. Perlis, Purdue University*
- *36. New Developments and Future Trends. *C. W. Adams, Westinghouse Electric Corporation and Massachusetts Institute of Technology.*

Thursday 9:00 A. M.

Programming III

Chm: Grace M. Hopper, Sperry Rand Corp.

41. An Optimizing Routine for the IBM Type 650 (46) *Barry Gordon, Equitable Life Assurance Soc.*
42. An Integrated Computation System for the ERA 1103 (4) *Walter F. Bauer, Ramo-Wooldridge Corp.*
43. Analysis of Programming Mistakes (58) *J. Wright, Univ. of Mich.*

Linear Programming and Statistics

Chm: Walter F. Bauer,

Ramo-Wooldridge Corporation

45. Multiple Regression and Correlation Analysis on the Type 701 and Type 704 Electronic Data Processing Machines (84) *F. S. Beckman and D. A. Quarles, Jr., IBM*
46. Similarity Analysis on the Illiac (53) *David J. Fitch, Univ. of Ill.*
47. Computing Experience with Linear Programming and Its Variants (98) *William Orchard-Hays, RAND Corp.*

Numerical Analysis II

Differential Equations

Chm: Franz L. Alt,

National Bureau of Standards

37. A Method for the Numerical Solution of End Value Problems (113) *E. M. Oetzel and D. L. Shell, G. E. Co.*
38. A Method for Computation of Solutions of the Equation

$$\Delta\psi(x, y, z) = b(y, z) \psi(x, y, z) \quad (35)$$

Stefan Bergman, Stanford Univ.

Friday 10:30 A.M.**Numerical Analysis IV**

Chm: W. W. Leutert, Ballistic Research Labs.

94. Filtering Sampled Functions (19) *I. McNamee and E. D. Fullenwider, U.S. Naval Ord. Lab., Cal.*
95. Numerical Solution of a System of Partial Differential Equations (106) *H. Flatt, Ballistic Res. Lab.*
96. Pipe Stress Calculations on the Oracle (115) *E. C. Long, Oak Ridge Nat. Lab.*

Switching TheoryChm: Edward F. Moore,
Bell Telephone Labs.

98. Transient Output and Race Conditions in Asynchronous Electronic Switching Circuits (51) *David E. Muller, Univ. of Ill.*
99. The Design and Use of Hazard-Free Switching Networks (93) *D. A. Hoffman, MIT*
100. Networks of Multipole Sequence Transducers (36) *Manfred Kochen, Inst. for Advanced Study*

Statistics IIChm: F. M. Verzuh,
Massachusetts Institute of Technology

101. A General Least Squares Differential Correction Curve Fitting Program (120) *John O. Lilly, U. S. Naval Ord. Test Sta.*
102. Statistical Computations Using the Census Univacs (69) *James L. McPherson, Bur. of the Census*
103. Use of the Digital Computer by an Agriculture Statistical Laboratory (141) *W. C. Jacob, Univ. of Ill.*
104. Factorial Classification of Cerebral and Autonomic Reaction Patterns (142) *Christine Eris, Univ. of Chicago*
105. A Study of the Validity of Multiple-Choice Test Items (55) *Jack C. Merwin, Syracuse Univ.*

Friday Luncheon 12:15 P.M. Penn Sherwood Hotel

"Computer Applications in Accounting and Management Decisions"
Mr. Milton E. Mengel, Vice President, Product Planning, Burroughs Corp.

Friday 2:00 P.M.**Numerical Analysis V**

Chm: V. J. Eckert, IBM Corporation

106. Codes for the Membrane Problem (30) *C. L. Gerberich and W. C. Sangren, Oak Ridge Nat. Lab.*
107. On the use of NORC for Solving Free Boundary Problems in Hydrodynamics (49) *R. J. Arms, D. F. Elieser, L. D. Gates, Jr., and D. M. Young, Jr., U. S. Naval Proving Grd.*
108. A Two-Dimensional Reactor Calculation (70) *Elizabeth Cuthill and Ruth M. Davis, David Taylor Model Basin*
109. Computation of Components for Logarithmic Networks on a High-Speed Digital Computer (116) *Robert C. Miller, Jr., and Ralph G. Selfridge, U. S. Naval Ord. Test Stat.*

Business Applications

Chm: Daniel R. Nason, IBM Corporation

110. The Computer as the Center of the Corporate Accounting Function (126) *W. M. Harris, A. G. Smith Corp.*
111. Extrapolation of Classified Sales Data (14) *P. A. Zephyr, Westinghouse Electric Corp.*
112. Payroll Systems on Univac (90) *Stephen E. Wright, Sperry Rand Corp.*
113. Mathematical Programming in Sales and Marketing (33) *Nyles V. Reinfeld, Executive Services*

Analog and Digital Control

Chm: R. E. Meagher, University of Illinois

114. An Application of a Digital Computer to Numerical Control (17) *Arnold Siegel, MIT*
115. A Study of the Effect of Digitalization on the Performance of a Feedback Control System (75) *R. E. Spero and J. Stuart, Sperry Gyroscope Co.*
116. A Comparison of an Analogue and a High-Speed Digital Solution to a Fuel Tank Heating Problem (82) *J. K. Slap, Northrop Aircraft Corp.*
117. Solution of Large Problems on the REAC (143) *A. Karen and B. Loveman, Reeves Instrument Corp.*

Friday 3:30 P.M.**Business Applications**

Chm: J. Reed Stovall, Sperry Rand Corp.

122. Programming for a Production Operation (10) *R. E. Utman and Margaret H. Harper, Aviation Supply Office*
123. The Mechanization of Stock Transfer (48) *Anthony G. Oettinger, Harvard Computation Lab.*
124. Application of Electronic Data Processors in Shop Loading (87) *W. F. Bauer and A. Vassonyi, Ramo-Wooldridge Corp.*
125. Application of an Electronic Data Processing Machine to Inventory Control (111) *R. P. Beals, Chrysler Corp.*

Analog ComputersChm: Morris Rubinoff,
University of Pennsylvania

126. Automatic Function Recording and Playback in an Electronic Analog Computer (15) *Louis B. Wadel and B. B. Mackey, Chance Vought Aircraft, Inc.*
127. Hitachi Electronic Analog Computers and Their Applications (38) *Takeo Miara and Toshiro Numakura, Hitachi Central Res., Tokyo*
128. Transfer Function Simulation by Means of Amplifiers and Potentiometers (56) *L. E. Heizer, CONVAIR*
129. A Method for Solving Boundary Value Problems on an Electronic Analog Computer (95) *M. Yanowitch, Reeves Instr. Corp.*

Numerical Analysis VIChm: R. F. Clippinger,
Raytheon Corporation

118. On the Propagation of Errors in the Digital Evaluation of Convergents to Continued Fractions (41) *Nathaniel Macon, Alabama Polytechnic Inst.*
119. Programming a Restricted Random Walk (66) *R. S. Lehman and G. N. Weiss, Ballistic Research Labs.*
120. Statistical Study of Non-Intersecting Random Walks (99) *W. F. Atchison, F. T. Wall and L. A. Hiller, Jr., Georgia Institute of Technology and Univ. of Ill.*
121. The Computation of Energy Levels in a One Dimensional Crystal Lattice (133) *J. Gardner, R. Page, and O. L. Tiffany, Univ. of Mich.*

Special Sessions**FRIDAY 9:00 A.M.**

Joint Session with
Society for Industrial and Applied Mathematics (SIAM)
Chm: Dr. John W. Mauchly,
Sperry Rand Corp.

- *84. An Experiment in Universal Coding (101) *Saul Gorn, Aberdeen Proving Grd., Md.*
- *85. State Diagrams of Sequential Machines *Franz Hohn, Univ. of Ill. and Bell Tel. Lab.*
- *86. Numerical Solution of Chemical Processing Problems, *Arthur Hoerl, Engr. Serv. Dept., Du Pont*

FRIDAY 10:30 A.M.**Panel Discussion**Chm: Charles W. Adams, MIT and
Westinghouse Elec., and Mfg., Co.

97. Applying Automatic Coding Techniques to Business Data Processing

39. A General Code for Certain Boundary Value Problems (50) *Stanley Katz and Jack Warga, ElectroData Corp.*
 40. General Code for Elliptic Equations (81) *Jack Heller, H. B. Keller and Samuel Schechter, New York Univ.*

44. Prevention of Propagation of Machine Errors in Long Problems (80) *J. H. Brown, John W. Carr III, Boyd Larowe, and J. R. McReynolds, Univ. of Mich.*

48. New Applications of Linear Programming (134) *Joseph V. Natrella, Directorate of Mgt. Anal., U.S.A.F.*

Thursday 10:30 A. M.

Matrices and Linear Equations II
 Chm: A. H. Taub, University of Illinois

49. A Method for Finding the Roots of Arbitrary Matrices (83) *John Greenstadt, IBM Corp.*
 50. A New Method for Rapid Formation of the Characteristic Equation of a Complex Matrix (86) *E. G. Kogbetliantz, IBM Corp.*
 51. An Inverse Characteristic Value Problem (100) *Arthur G. Downing and Alston S. Householder, Oak Ridge Nat. Lab.*
 52. Codes for the Solution of Systems of Linear Algebraic Equations (110) *Wallace Givens, Univ. of Tenn. and Oak Ridge Nat. Lab.*

Programming
 Chm: J. H. Wegstein,
 National Bureau of Standards

53. An Evaluation of Automatic Programming (91) *Stephen E. Wright, Sperry Rand Corp.*
 54. A General System for Handling Alphameric Information on the 701 (117) *Bruce G. Oldfield and Robert H. Bracken, U. S. Naval Ord. Test Stat.*
 55. How to Solve Simple Problems Economically on a High Speed Digital Computer (118) *Bruce G. Oldfield, U.S. Naval Ord. Test Stat.*

Business Applications I
 Chm: Arthur Wheeler,
 New York Life Insurance Co.

56. Factors Influencing Choice of Electronic Data Processing Systems for Business Use (68) *Howard S. Levin, Ebasco Services Inc.*
 57. The Computer Specialist's Role in a Business Application Group (2) *Helen Meek and Leon Gainen, Hughes Res. and Dev. Lab.*
 58. Justifying Business Applications of Automatic Computers (45) *Ned Chapin, III, Inst. of Tech.*
 59. The Function of Automatic Programming in Business Data Processing (140) *R. J. Rossheim, U. S. Steel Corp.*

Thursday Luncheon 12:15 P.M. Penn Sherwood Hotel

"Computer Control—Scope of the Field"
 Prof. Donald Campbell, Dept. of E. E. at MIT

Thursday 2:00 P.M.

Experimental Mathematics I
 Chm: A. H. Householder,
 Oak Ridge National Laboratory

- *60. Numerical Experiments in Algebra and on the Vibrations of a Membrane, *G. E. Forsythe, Univ. of Cal.*
 *61. Proper Values and Proper Functions of Sturm-Liouville Differential Equations, *A. H. Taub, Univ. of Ill.*

Advanced Programming I (PACT)
 Chm: Paul Armer, Rand Corporation

62. A Description of a Cooperative Venture in the Production of an Automatic Coding System (65) *Wesley S. Melahn, RAND Corp., Cal.*
 63. The PACT I Automatic Coding System for the IBM Type 701 (61) *Charles L. Baker, Douglas Aircraft Co., Cal.*
 64. Logical Organization of the PACT I Compiler (62) *Owen R. Mock, North American Aviation, L. A. Cal.*

Components I
 Chm: Norman R. Scott,
 University of Michigan

65. Ferroelectric Applications to Digital Computers (97) *Ramon Alonzo and Thomas Conley, Ballistic Res. Lab.*
 66. Development of Criteria for the General Use of Magnetic Drums (20) *Bill L. Wadell, G. M. Giannini and Co.*
 67. The IBM 705 EDPM Memory System (138) *R. E. Merwin, IBM*
 68. Core Storage (37) *Raymond Stuart-Williams, Milton Rosenberg and M. A. Alexander, International Telemeter Corp.*

Thursday 3:30 P.M.

Experimental Mathematics II (Panel)
 Chm: A. S. Householder,
 Oak Ridge National Laboratory

- *69. Conformal Mapping, *John Todd and Philip Davis, N. B. S., Computation Group*
 *70. Non-Linear Vibrations, *J. Pasta and S. Ulam, Los Alamos, N. M.*

Advanced Programming II (PACT)
 Chm: Paul Armer, Rand Corporation

71. Producing Computer Instructions for the PACT Project I Compiler (60) *Robert C. Miller, Jr., and Bruce G. Oldfield, Naval Ord. Test Station, Cal.*
 72. Loop Generation (64) *Jules I. Schwartz and Gus S. Hempstead, RAND Corp., Cal.*
 73. Semi-Automatic Allocation of Data Storage for PACT I, (63) *Richard C. Luke, Lockheed Aircraft Co., Cal., and John I. Derr, RAND Corp., Cal.*
 74. Conclusions after Using the PACT I Advanced Coding Techniques (128) *Hiram G. Martin, Douglas Aircraft Co., Cal., and Irwin D. Greenwald, RAND Corp., Cal.*

Components II
 Chm: J. G. Brainerd,
 University of Pennsylvania

75. Optimization of a Non-Saturating Single Transistor Flip-Flop (96) *R. K. Gerlach and D. O. Miles, Ballistic Research Lab.*
 76. A Set of Direct-Coupled Transistorized Logical Elements for the 10-7 Second Range (39) *W. J. Poppelbaum, Univ. of Ill.*
 77. Advances in Beam Switching Tube Computer Techniques (112) *John R. Bethke, Burroughs Corp.*
 78. Accuracy of a Binary Operational Multiplier (88) *E. R. Beck, Bendix Aviation Corp.*
 79. Arithmetic Features of New NBS Computers (124) *J. L. Smith and A. Weinberger, National Bur. of Standards*

Thursday 5:30 P.M. Cocktail Party Penn Sherwood Hotel

Friday 9:00 A.M.

Numerical Analysis III
 Chm: George E. Forsythe,
 University of California

80. Minimizing the Number of Operations in High Speed Computing of Elementary Functions (85) *E. G. Engbretliantz, IBM*
 81. Automatic Computations with Power Series (104) *Peter Henrici, National Bur. of Standards*
 82. Polynomial Relaxation Coefficients (107) *R. W. Bemer, Lockheed Aircraft Corp.*
 83. Rational Approximations of Functions (127) *Bengt Carlsson and Max Goldstein, Los Alamos Lab.*

Logical Algebra

- Chm: Stanley Frankel, Continental Oil Co.
 87. A Truth Function Evaluator (6) *William Miehle, Burroughs Res. Ctr.*
 88. Digital Computer Arithmetic (29) *James L. Maddox and Ralph H. Beter, Philco Corp.*
 89. Arithmetical Analysis of Logical Nets (135) *Richard C. Jeffery, MIT*

Statistics I

- Chm: K. J. Arnold, Michigan State College
 90. Remarks on the Gordon Research Conference (67) *Max A. Woodbury, George Washington Univ.*
 91. Generation of a Random Multivariate Sample (52) *Gene H. Golub, Univ. of Ill.*
 92. Automatic Many-Variate Non-Linear Multiple Regression Analysis on a Large-Scale Computer *A. E. Hoerl, E. I. DuPont*
 93. A General Curve Fitting Subroutine for Transcendental Functions (119) *Robert H. Bracken, U. S. Naval Ord. Test Stat.*

BOOKS AND OTHER PUBLICATIONS

Jewell Bown

(list 17. COMPUTERS AND AUTOMATION, vol. 4, no. 9, Sept. 1955)

This is a list of books, articles, periodicals, papers, and other publications which have a significant relation to computers or automation, and which have come to our attention. We shall be glad to report other information in future lists, if a review copy is sent to us. The plan of each entry is: author or editor / title / publisher or issuer / date, publication process, number of pages, price or its equivalent / a few comments. If you write to a publisher or issuer, we would appreciate your mentioning the listing in COMPUTERS AND AUTOMATION.

LaJoy, Millard H / Industrial Automatic Controls / Prentice-Hall, Inc. 70 5th Ave, New York 11, N.Y. / 1954, printed, 278 pp, \$6.65

This book has been written as a beginning text in the study of industrial automatic controls on the college level.

Two-position, proportional, floating (integral), and rate (derivative) modes of automatic control are analyzed separately and in various combinations.

The internal circuitry of pneumatic, hydraulic, and electronic controls is treated in detail. Concluding chapters consider representative industrial applications and theoretical considerations of the process. A knowledge of differential equations is required for these chapters; a knowledge of calculus for the rest of the book.

Moskowitz, Sidney, and Joseph Racker / Pulse Techniques / Prentice-Hall, Inc, 70 5th Ave, New York 11, N.Y. / January, 1954 (3rd printing), printed, 300 pp, \$6.65

This book is an elaboration of a series of articles prepared by the authors for the Radio-Electronic Engineering section of "Radio and Television News". It comprises a complete manual on pulse generation and reception, containing analysis, design and maintenance data. The book is intended to enable individuals with electrical engineering backgrounds to analyze and design circuits for transmission and utilization of pulses. Sufficient mathematical material is presented to enable such individuals to apply these methods to practical problems; lengthy derivations have been omitted.

Sokolnikoff, I. S. / Tensor Analysis, Theory and Applications / John Wiley & Sons, Inc. 440 4th Ave, New York 16, N.Y. / 1951, printed, 335 pp, \$6

A book in the field of applied mathematics on graduate or professional level. The first two chapters cover linear

vector spaces, linear transformations, matrices, the algebra and calculus of tensors, etc. The remaining four chapters deal with applications to geometry mechanics, relativity, elasticity, fluid dynamics, etc.

Wilder, Raymond L. / Introduction to the Foundations of Mathematics / John Wiley & Sons, Inc. 440 4th Ave, New York 16, N.Y. / 1952, printed, 305 pp, \$5.75

This book offers a broad study of the source and nature of mathematical concepts and methods and should be of interest to mathematicians, scientists, logicians, and others. Among the topics examined are: development of various viewpoints on foundations of mathematics with reference to the theses of Frege, Russell, Zermelo, etc.; the methods of symbolic logic, Intuitionism, etc; what constitutes mathematics and mathematical existence; the axiomatic method, theory of sets, basic concepts of analysis, and basic concepts of algebra and geometry; and the position of mathematics in the culture of human beings. It may be used as a text if desired.

Institute of Radio Engineers / IRE Convention Record, 1955 National Convention, "Part 4-Computers, Information Theory, Automatic Control" / IRE, 1 East 79 St., New York 21, N.Y. / 1955, photooffset, 208 pp, \$6.75

Contains 32 papers presented at the 1955 IRE National Convention relating to computers, information theory, and automatic control. Two sections on automatic control contain 5 papers dealing with trends in automation of procedures in business and industry, and 5 on other subjects. Three sections on information theory include 12 papers. Three sections on electronic computers contain a total of 10 papers dealing with magnetic memories, transistors, electrographic recording technique, and electronic generation of functions.

- END -

Engineers

with experience in

computers
microwave
pulse techniques
servo-mechanisms
related circuit design

leading designers and manufacturers of electronic instrumentation offer outstanding opportunity, top pay, moving allowance, benefits, plus the charm of san francisco living.

please send resume.

Berkeley *division*
BECKMAN INSTRUMENTS INC.

2200 WRIGHT AVE., RICHMOND 3, CALIF.

ENGINEERS

**Creative
Opportunities
with
Republic Aviation**

Dynamics

Dynamics Engineer

A broad program involving analytical and experimental investigations of the complex dynamics problems associated with supersonic aircraft offers a real opportunity for young engineers with ability. You will gain invaluable experience under competent supervision to develop a professional background in such areas as servo-mechanisms, analogue computers, control system dynamics, non-linear mechanics and hydraulic system analysis. A program of laboratory investigations on actual systems in conjunction with analytical work, as well as a coordinated lecture program, offers an outstanding environment for rapid professional development. A degree in ME, AE or Physics with good Math background is preferred.

Research

Computer Engineer

To supervise maintenance and to design special circuitry for computers. Experience with either analogue or digital computers required. College graduate preferred.

NEW ALL-EXPENSE-PAID RELOCATION PLAN

For those living outside the New York City and Long Island area, Republic offers an unusual plan which relieves you of all financial worries. This plan offers these no-cost-to-you benefits: Interview expenses paid for qualified candidates; Educational Refund Plan pays up to 2/3 of tuition and laboratory fees; life, health and accident insurance — up to \$20,000 company-paid; plus hospital-surgical benefits for the whole family. And of course you'll live and work on fabulous Long Island, playground of the east coast.

*Please address complete resume,
outlining details of
your technical background, to:*

Assistant Chief Engineer
Administration

Mr. R. L. Bortner

REPUBLIC AVIATION

FARMINGDALE, LONG ISLAND, NEW YORK

<u>Symbol</u>	<u>Definition</u>	<u>Units</u>
O	Order cost	dollars
S	Set up cost	dollars
R	Average monthly requirements	pieces per month
C	Cost per piece	dollars per piece
I	Interest rate	percent per year
F	Storage cost rate	dollars per cubic inch per year
V	Space requirements per piece	cubic inch per piece
Q	Economical quantity	pieces

* Memorandum from International Business Machines Corp., Plant No. 1, Endicott, N. Y.

- END -

* * * * *

PUBLICATIONS ON AUTOMATIC COMPUTERS
(continued from page 16)

Grace M. Hopper, et al, First Glossary of Programming Terminology (New York: Association for Computing Machinery, 1954), 25 pgs. Also in: Electronic Data Processing in Industry (New York: American Management Association, Inc., 1955), pg 243-257.

One of the two most extensive glossaries presently available.

Staff of Controllershship Foundation, Electronics in Business (New York: Controllershship Foundation, Inc., 2 Park Ave., New York 16, N.Y., 1955), 176 pgs, \$2.00.

This general reference compendium contains a listing of computer installations, descriptive material on the more popular computers, and an extensive bibliography of articles, proceedings, and books.

The author wishes to thank the members in Chicago of the two chapters of the Systems and Procedures Association of America (and in particular, Mr. R. R. Ross) for their encouragement in the preparation of this bibliography.

- END -

SPECIAL ISSUES OF "COMPUTERS AND AUTOMATION"

The issue of "Computers and Automation" in June, 1955, was a special issue: "The Computer Directory, 1955", 164 pages, containing: Part 1, Who's Who in the Computer Field; Part 2, Roster of Organizations in the Computer Field; and Part 3, The Computer Field: Products and Services for Sale. It is expected that the next Computer Directory issue will be June, 1956.

The next two special issues will be December, 1955, and January, 1956. The December issue will be mainly devoted to useful information for people who have been in the computer field for some time: a "Glossary of Terms", and also cumulative editions of other pieces of reference information.

The January, 1956, issue will be mainly devoted to useful information for people who have newly entered the computer field: an introduction to computers (and to "Computers and Automation"); and reprints and revisions of some of the more introductory articles and papers that "Computers and Automation" has published.

* * * * *

BULK SUBSCRIPTION RATES

These rates apply to subscriptions coming in together direct to the publisher. For example, if 5 subscriptions come in together, the saving on each one-year subscription will be 25 percent, and on each two-year subscription will be 33 percent. The bulk subscription rates, depending on the number of simultaneous subscriptions received, are shown below:

Table 1 -- Bulk Subscription Rates
(United States)

Number of Simultaneous Subscriptions	Rate for Each Subscription, and Resulting Saving to Subscriber:	
	One Year	Two Year
10 or more	\$3.00, 33%	\$5.40, 40%
5 to 9	3.38, 25	6.00, 33
4	3.75, 17	7.00, 22
3	4.00, 11	7.50, 17
2	4.25, 5	8.00, 11

For Canada, add 50 cents for each year; outside of the United States and Canada, add \$1.00 for each year.

ROBOT SHOW STOPPERS

From time to time you may need to help organize a display in a business show including some device that you hope will "STOP" every person attending the show and make him notice your display -- a device which may be called a "SHOW STOPPER".

In addition to publishing the magazine "COMPUTERS AND AUTOMATION," we have for five years been developing and constructing "ROBOT SHOW STOPPERS," small robot machines that respond to their environment and behave by themselves. Here are some of them:

RELAY MOE

A machine that will play the game Tit-Tat-Toe with a human being, and either win or draw all the time, or (depending on the setting of a switch) will sometimes lose, so as to make the game more interesting for the human being;

SQUEE

An electronic robot squirrel, that will "hunt" for a "nut" indicated by a person in the audience, pick it up in his "hands", take the nut to his "nest", there leave it, and then hunt for more nuts;

FRANKEN

A mechanical rat that will explore a maze, find "food", and learn the path through; the maze may be set up by any person in the audience, using little partitions in any way that he wants to;

SIMON

A miniature mechanical brain, that displays the powers of a big automatic computer or giant brain, but uses small numbers only.

FOUR-HUNDRED-YEAR CALENDAR MACHINE

A machine that takes in the year, the month, and the day of the month. Gives out the day of the week.

and others

Besides these we have a number of other small robots finished or under development. Some of these machines have been on the front covers of the magazines "Scientific American" and "Radio Electronics". These machines may be rented for shows under certain conditions; also, modifications of the small robots to fit a particular purpose are often possible, such as use of particular components, display of particular slogans, etc.

We are planning to have an exhibit before long of our small robots to whom they are most interested in advertising. If you would like to come to this exhibit, or if you have any questions, please write us or send us the note below.

To: Berkeley Enterprises, Inc., 36 West 11 St., R 125, New York 11, N.Y.

We would like to know more about () your ROBOT SHOW STOPPERS, () the exhibit of them, () "Computers and Automation." The advertising application we have in mind is:

From: Organization _____ Address _____

Filled in by _____ Title _____ Date _____

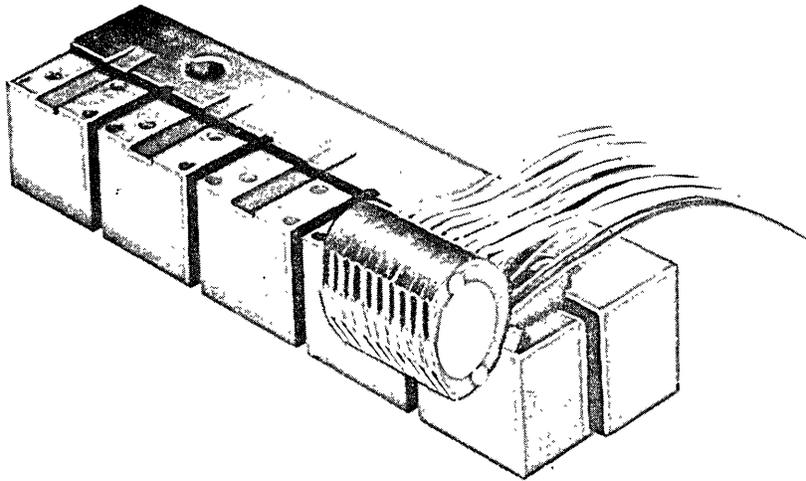
SQUARE ROOT TO EIGHT DECIMALS
Bill Danch
Munich, Germany

$$\begin{array}{r} 2.23 \\ \hline 2 \sqrt{5.00'00'00'00'00'00'00'00} \\ \underline{4} \\ 42 \sqrt{100} \\ \underline{84} \\ 443 \sqrt{1600} \\ \underline{1329} \\ 446 \sqrt{27100} \end{array}$$



Bill Danch

" - But, Miss Feeley, can't you see? This is all so old-fashioned -- we have automatic computers now!"



A bank of Monrobot Ring-type Heads on adjustable mounting

MONROBOT COMPONENTS

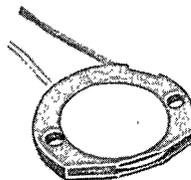
Researched and Developed for the Electronics Field

Monroe, for many years a leader in the design and production of desk calculators, is devoting its experience and research facilities to developing not only digital electronic computers but also component parts that are unique for their originality of design and numerous advantages.

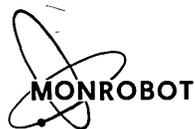
The components, illustrated here, are Monrobot Ring-type Read/Record Heads and an adjustable fixture for magnetic drum memory systems.

Monrobot Read/Record Head assemblies have a place in any magnetic storage or arithmetic drum system. Their advantages are many. They are small and compact. Their mounting design permits accurate placement with a minimum of costly machining. When assembled and mounted they permit fine, accurate adjustments both parallel and perpendicular to the drum. They are ruggedly built to last. In their pre-engineered, precision mounting they cost less than similar unmounted head stacks; also replacement of a single head is easily made.

Monrobot components of this kind offer the user of electronic equipment many worthwhile benefits. There's a lot to the Monrobot component story that's worth investigating. Inquiries are invited.



Monrobot Ring-type Head — small, compact



MONROE CALCULATING MACHINE COMPANY

MONROBOT LABORATORY

MORRIS PLAINS

NEW JERSEY

- 41 -

ROSTER ENTRY FORMS

"Computers and Automation" publishes from time to time reference information of the following three types: (1) a who's who or roster of individuals interested in the computer field; (2) a roster of organizations active in the computer field; and (3) a classified directory or roster of products and services offered in the computer field. The last cumulative roster appeared in "The Computer Directory, 1955", the June 1955 issue of "Computers and Automation." If you are interested in sending information to us for these rosters and their supplements, following is the form of entry for each of these three rosters. To avoid tearing the magazine, the form may be copied on any sheet of paper; or upon request we will send you forms for entries.

(1) Who's Who Entry Form

1. Name (please print) _____
2. Your Address? _____
3. Your Organization? _____
4. Its Address? _____
5. Your Title? _____
6. YOUR MAIN COMPUTER INTERESTS?

<input type="checkbox"/> Applications	<input type="checkbox"/> Mathematics
<input type="checkbox"/> Business	<input type="checkbox"/> Programming
<input type="checkbox"/> Construction	<input type="checkbox"/> Sales
<input type="checkbox"/> Design	<input type="checkbox"/> Other (specify):
<input type="checkbox"/> Electronics	_____
<input type="checkbox"/> Logic	_____
7. Year of birth? _____
8. College or last school? _____
9. Year entered the computer field? _____
10. Occupation? _____
11. Anything else? (publications, distinctions, etc.) _____

(2) Organization Entry Form

1. Your organization's name? _____
2. Address? _____
3. Telephone number? _____
4. Types of computing machinery or components, or computer-field products and services that you are interested in?

5. Types of activity that you engage in:
 research other (please explain):
 manufacturing
 selling _____
 consulting _____
6. Approximate number of your employees? _____
7. Year when you were established? _____
8. Any comments? _____

Filled in by _____
 Title _____ Date _____
 * _____ * _____ *

(3) Product Entry Form

1. Name or identification of product (or service)?

2. Brief description (20 to 40 words)? _____

3. How is it used? _____

4. What is the price range? _____
5. Under what headings should it be listed?

6. Your organization's name? _____

7. Address? _____

Filled in by _____
 Title _____ Date _____

transistor & digital computer techniques

APPLIED TO THE DESIGN, DEVELOPMENT
AND APPLICATION OF

*AUTOMATIC RADAR
DATA PROCESSING,
TRANSMISSION AND
CORRELATION IN LARGE
GROUND NETWORKS*

Engineers & Physicists

*Digital computers similar to
the successful Hughes
airborne fire control computers are
being applied by the Ground
Systems Department to the
information processing and
computing functions of
large ground radar weapons
control systems.*

The application of digital and transistor techniques to the problems of large ground radar networks has created new positions at all levels in the Ground Systems Department. Engineers and physicists with experience in fields listed, or with exceptional ability, are invited to consider joining us.

FIELDS INCLUDE

TRANSISTOR CIRCUITS
DIGITAL COMPUTING NETS
MAGNETIC DRUM AND CORE MEMORY
LOGICAL DESIGN
PROGRAMMING
VERY HIGH POWER MODULATORS
AND TRANSMITTERS
INPUT AND OUTPUT DEVICES
SPECIAL DISPLAYS
MICROWAVE CIRCUITS

Scientific and Engineering Staff

HUGHES

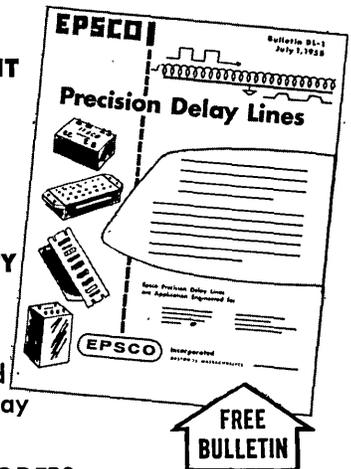
RESEARCH
AND DEVELOPMENT
LABORATORIES

Culver City, Los Angeles County, California

New!

STANDARD HERMETICALLY SEALED AND SPECIAL PURPOSE DELAY LINES

- EXCELLENT TRANSIENT RESPONSE
- LOW ATTENUATION
- EXTREME STABILITY
- MAXIMUM RELIABILITY



A new series of standard
and custom-designed delay
lines for use in:

CODERS AND DECODERS
NAVIGATIONAL SYSTEMS
STABLE TIME REFERENCE UNITS
SERIAL TO PARALLEL CODE CONVERTERS
TELEMETERING SYSTEMS
DIGITAL COMPUTERS
PULSE FORMING CIRCUITS
ANALOG COMPUTING FUNCTIONS
SPECIAL REQUIREMENTS

Current developments in navigational systems, guided missile controls, computers and telemetering have placed increasingly rigid requirements on Delay Lines. EPSCO has paced the delay line field by promptly evaluating new requirements and providing industry with products engineered for tomorrow's applications. The considerable technological advances made by EPSCO in the design of special production and test equipment, plus the utilization of new materials and techniques, allows us to produce delay lines of unusual characteristics at minimum cost.

SEND TODAY FOR YOUR COPY OF BULLETIN DL-55
DESCRIBING THE STANDARD AND SPECIAL EPSCO
DELAY LINES.

EPSCO, INCORPORATED

588 Commonwealth Ave., Boston 15, Mass. COmmonwealth 6-3228

MAKE YOUR OWN BABY GENIUS COMPUTERS WITH

GENIAC

Electric Brain Construction Kit No. 1

SCIENTIFIC -- ENTERTAINING -- INSTRUCTIVE -- SAFE -- INEXPENSIVE

This kit is an introduction to the design of arithmetical, logical, reasoning, computing, puzzle-solving, and game-playing circuits for:

BOYS -- STUDENTS -- SCHOOLS -- COLLEGES -- DESIGNERS

The kit is simple enough for intelligent boys to assemble, and yet is instructive to computer men because it shows how many kinds of computing and reasoning circuits can be made from simple components.

The kit is an outcome of five years of design and development work with small robots by Berkeley Enterprises, Inc., publisher of "Computers and Automation".

With this kit and manual, you can easily make dozens of small electric brain machines that exhibit intelligent behavior. Each runs on one flashlight battery. All connections with nuts and bolts; no soldering required. Price, \$19.95 -- returnable in seven days for full refund if not satisfactory.

SOME OF THE SIMPLE ELECTRIC BRAIN
MACHINES THAT YOU CAN MAKE WITH THE
GENIAC KIT AND THAT ARE DESCRIBED
IN THE MANUAL

Logic Machines

Comparing
Reasoning
Syllogism Machine
Intelligence Testing

Cryptographic Machines

Secret Coder
Secret Decoder
Combination Locks

Game Playing Machines

Tit Tat Toe
Nim

Arithmetic Machines (Decimal and Binary)

Adding Machine
Subtracting Machine
Multiplying Machine
Dividing Machine
Arithmetical Carrying

Simple Circuits

Burglar Alarm
Automatic Oil Furnace Circuit, etc.

Puzzle Machines

The Space Ship Airlock
The Fox, Hen, Corn, and Hired Man
Douglas Macdonald's Will
The Uranium Shipment and the Space
Pirates

MANUAL

"GENIACS -- Simple Electric Brain Machines and How to Make Them" by Edmund C. Berkeley, published by Berkeley Enterprises, Inc., March, 1955, 64 pp. -- Describes over 30 small electric brain machines that reason arithmetically or logically, solve puzzles, play games, etc. Each machine operates on one flashlight battery. Gives sufficient details so that each machine can be constructed with the materials in Geniac Kit No. 1, or with other materials.

PARTS LIST: 1 Manual

6 Multiple Switches, of a new design
1 Mounting Panel
1 Flashlight Battery
1 Battery Clamp
10 Flashlight Bulbs
10 Bulb Sockets
50 Feet of Insulated Wire
Nuts, Bolts, Jumpers, and other necessary hardware

(NO SOLDERING REQUIRED -- COMPLETELY SAFE)

-----Mail this Request or a Copy of It-----

Berkeley Enterprises, Inc.
36 West 11 St., R126, New York 11, N. Y.

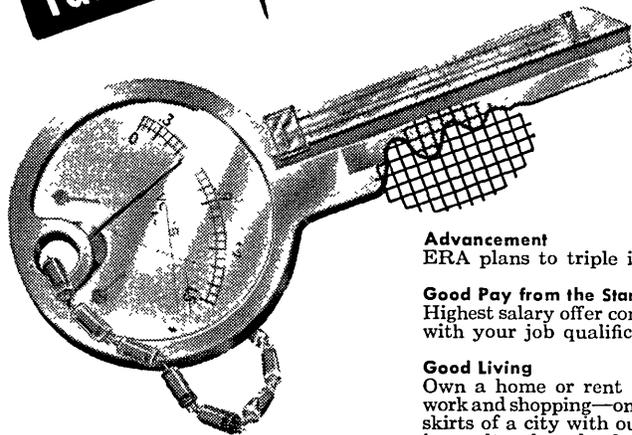
Please send me Geniac Kit No. 1 and Manual.
I enclose in full payment: () \$18.95, U. S.
east of Mississippi; () \$19.95, elsewhere in
U. S.; () \$20.95, outside U. S.
(If in good condition, it is returnable in
seven days for full refund.) My name and
address are attached.

ELECTRONIC **ENGINEERS** MECHANICAL

the Key
to your
future...

opportunities better than ever at
Remington Rand

ENGINEERING RESEARCH ASSOCIATES DIVISION



The ERA Division
Is a leader in developing
Electronic Digital Computers,
Automatic Data-Handling and
Control Systems, Mechanisms,
and Weapons.

Everything you want in a job

Advancement
ERA plans to triple its staff.

Good Pay from the Start
Highest salary offer compatible
with your job qualifications.

Good Living
Own a home or rent close to
work and shopping—on the out-
skirts of a city with outstand-
ing cultural and educational
activities—in a vacation land
of 10,000 lakes.

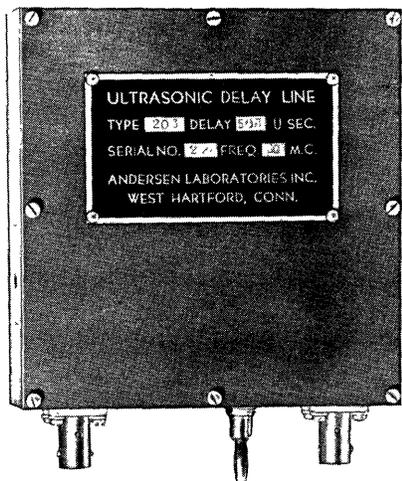
Stimulating Work Most of our engineers are
having the time of their lives doing creative re-
search and development on important new appli-
cations in mechanical and electronic engineering.
Men work as project teams, and each man learns
all aspects of his project. Pulse circuits, magnetic
cores, transistors, printed wiring, miniaturization,
and precise mechanisms are used in designing
computers, automatic data-handling and control
systems, mechanisms, and special weapons.
Other excellent engineering jobs are available in
production, testing, specifications, quality con-
trol, contract administration, and technical
writing.

Send an outline of your training and experience to Dept. S2:

Remington Rand
DIVISION OF
SPERRY RAND
CORPORATION

ENGINEERING RESEARCH ASSOCIATES DIVISION
1902 W. Minnehaha Ave., St. Paul W4, Minn.

andersen SOLID ULTRA-SONIC DELAY LINES



Andersen solid ultrasonic delay lines offer proven advantages for pulse storage in digital computers and special instruments.

DELAY TIMES: 1 to 3300 microseconds.

BANDWIDTHS: Up to 100% of the carrier frequency in some cases.

INSERTION LOSSES: Usually specified between 25 and 60 db.

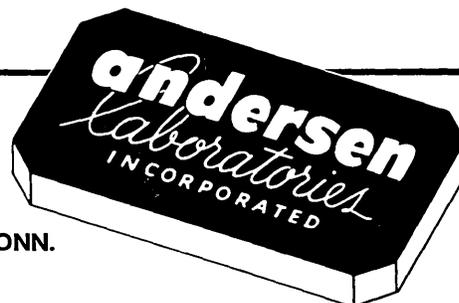
CARRIER FREQUENCIES: From 5 to 70 mc.

Specifications for a typical computer line, in production: 384.6 microseconds delay; 30 mc. carrier, with 7 mc. bandwidth; insertion loss 48 db, with all spurious signals down at least 34 db with respect to desired signals.

Do you have a problem in ultrasonics? Write today for new bulletin on solid ultrasonic delay lines.

Andersen engineers will be glad to design delay lines to meet your specifications, or assist you with special research.

39-C Talcott Road
WEST HARTFORD 10, CONN.
Phone ADams 3-4491



COMPUTERS AND AUTOMATION — Back Copies

ARTICLES, ETC.: May, 1954: 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

November: Computers in Great Britain -- Stanley Gill

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

All-Transistor Computer -- Neil Macdonald

December: The Human Relations of Computers and Automation -- Fletcher Pratt

Analog Computers and Their Application to Heat Transfer and Fluid Flow -- Part 2 -- John E. Nolan

Economies in Design of Incomplete Selection Circuits with Diode Elements -- Arnold I. Dumey

January, 1955: Statistics and Automatic Computers -- Gordon Spenser

Eastern Joint Computer Conference, Philadelphia, Dec. 8-10, 1954 -- Milton Stoller

The Digital Differential Analyzer -- George F. Forbes

A Small High-Speed Magnetic Drum -- M. K. Taylor

An Inside-Out Magnetic Drum -- Neil Macdonald

February: Problems for Students of Computers -- John W. Carr, III

Recognizing Spoken Sounds by Means of a Computer -- Andrew D. Booth

The Significance of the New Computer NORC -- W. J. Eckert

The Finan-Seer -- E. L. Locke

Approaching Automation in a Casualty Insurance Company -- Carl O. Orkild

March: Question -- Isaac Asimov

Computers and Weather Prediction -- Bruce Gilchrist

Random Numbers and Their Generation -- Gordon Spenser

Problems Involved in the Application of Electronic Digital Computers to Business Operations -- John M. Breen

Computers to Make Administrative Decisions? -- Hans Schroeder

April: Thinking Machines and Human Personality -- Elliot L. Gruenberg

Marginal Checking -- An Aid in Preventive Maintenance of Computers -- J. Melvin Jones

May: Reliability in Electronic Data Processors -- William B. Elmore

Numerical Representation in Fixed-Point Computers -- Beatrice H. Worsley

Automation -- A Report to the UAW-CIO Economic and Collective Bargaining Conference

The Skills of the American Labor Force -- James P. Mitchell

Automation Puts Industry on Eve of Fantastic Robot Era -- A. H. Raskin

The Monkey Wrench -- Gordon R. Dickson

June: THE COMPUTER DIRECTORY, 1955 (164 pages):

Part 1: Who's Who in the Computer Field

Part 2: Roster of Organizations in the Computer Field

Part 3: The Computer Field: Products and Services for Sale

July: Mathematics, the Schools, and the Oracle -- Alston S. Householder

The Application of Automatic Computing Equipment to Savings Bank Operations -- R. Hunt Brown

The Book Reviewer -- Rose Orente

Linear Programming and Computers, Part I -- Chandler Davis

August: The Automation of Bank Check Processing -- R. Hunt Brown

Linear Programming and Computers, Part II, -- Chandler Davis

Justifying the Use of an Automatic Computer -- Ned Chapin

Charting on Automatic Data Processing Systems -- Harry Eisenpress, James L. McPherson, and Julius Shiskin

A Rotating Reading Head for Magnetic Tape and Wire -- National Bureau of Standards

Some Curiosities of Binary Arithmetic Useful in Testing Binary Computers -- Andrew D. Booth

REFERENCE INFORMATION (in various issues):

Roster of Organizations in the Computer Field/
Roster of Automatic Computing Services / Roster of Magazines Related to Computers and Automation / Automatic Computers: List / Automatic Computers: Estimated Commercial Population / Automatic Computing Machinery: List of Types / Components of Automatic Computing Machinery: List of Types / Products and Services in the Computer Field / Who's Who in the Computer Field / Automation: List of Outstanding Examples / Books and Other Publications / Glossary / Patents

BACK COPIES: Price, if available, \$1.25 each, except June, 1955, \$6.00. Vol. 1, no. 1, Sept. 1951, to vol. 1, no. 3, July, 1952: out of print. Vol. 1, no. 4, Oct. 1952: in print. Vol. 2, no. 1, Jan. 1953, to vol. 2, no. 9, Dec. 1953: in print except March, no. 2, and May, no. 4. Vol. 3, no. 1, Jan. 1954, to vol. 3, no. 10, Dec. 1954: in print. Vol. 4, 1955: in print.

A subscription (see rates on page 4) may be specified to begin with the current month's or preceding month's issue.

WRITE TO: Berkeley Enterprises, Inc.
Publisher of COMPUTERS AND AUTOMATION
36 West 11 St., New York 11, N. Y.

IBM leadership in action . . .



© IBM

Panel of decision makers

Today, IBM electronic panels like this are paving the way for a whole new family of lightning-fast computers and data processing machines — “decision-makers,” adaptable to large or small business, that can be mass-produced with typical IBM precision.

These tiny, power-packed transistors mounted on printed wiring panels replace bulky vacuum tube assemblies. By greatly reducing heat output and by effecting dramatic savings in space and power requirements, their use in IBM electronic data

processing machines results in vastly simplified installation.

Through the use of developments such as this, IBM is bringing the revolutionary, yet practical, benefits of electronics to more businesses than ever . . . helping America work better and faster—at less cost.

*International Business Machines Corporation
New York 22, N. Y.*



ADVERTISING IN "COMPUTERS AND AUTOMATION"

Memorandum from Berkeley Enterprises, Inc.
Publisher 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, papers, and reference information related to computing machinery, robots, automatic control, 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, except June, 1955, "The Computer Directory" (164 pages, \$6.00). For the titles of articles and papers in recent issues of the magazine, see the "Back Copies" page in this issue.

2. What is the circulation? The circulation includes 1700 subscribers (as of June 20); over 300 purchasers of individual back copies; and an estimated 2500 nonsubscribing readers. The logical readers of COMPUTERS AND AUTOMATION are 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 Sept. issue was 2,300 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.

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" x 10") 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" x 10", basic rate, \$170) and half pages (basic rate, \$90); back cover, \$330; inside front or back cover, \$210. Extra for color red (full pages only and only in certain positions), 35%. Two-page printed insert (one sheet), \$290; four-page printed insert (two sheets), \$530. Classified advertising is sold by the word (50 cents a word) with a minimum of ten words. We reserve the right not to accept advertising that does not meet our standards.

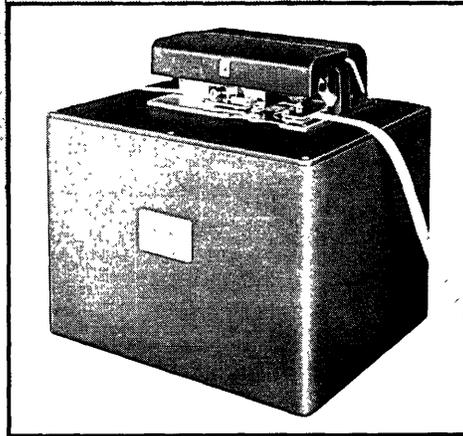
5. Who are our advertisers? Our advertisers in recent issues have included the following companies, among others:

The Austin Co.
Automatic Electric Co.
Cambridge Thermionic Corp.
Federal Telephone and Radio Co.
Ferranti Electric Co.
Ferroxcube Corp. of America
General Ceramics Corp.
General Electric Co.
Hughes Research and Development Lab.
International Business Machines Corp.
Lockheed Aircraft Corp.
Logistics Research, Inc.
Machine Statistics Co.
Monrobot Corp.
Norden-Ketay Corp.
George A. Philbrick Researches, Inc.
Potter Instrument Co.
Raytheon Mfg. Co.
Reeves Instrument Co.
Remington Rand, Inc.
Sprague Electric Co.
Sylvania Electric Products, Inc.
Telecomputing Corp.

FERRANTI

HIGH SPEED TAPE READER

...handles punched tape data
at electronic speeds



The Ferranti High Speed Tape Reader accelerates to full speed within 5 milliseconds and stops within 3 milliseconds. It has been in use at leading computer installations for over two years and has achieved a sound reputation for simplicity and reliability in regular operation.

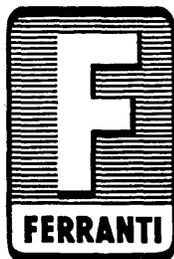
FAST (1) Mark II model reads at speeds up to 200 characters per second, and stops the tape from full speed within a character position — within .03 inch. The tape is accelerated to full speed again in 5 milliseconds and the following character is ready for reading within 6 milliseconds of rest position.

(2) Mark IIA model reads at speeds up to 400 characters per second, and stops within .1 inch.

VERSATILE Both models read either 5 level, 6 level or 7 level tape by simple adjustment of an external lever.

SIMPLE The tape is easily inserted without complicated threading. Lap or butt splices are taken without any difficulty. The same tape may be passed thousands of times without appreciable tape wear. The optical system has no lenses or mirrors to get out of alignment. Friction drive is independent of sprocket hole spacing.

LARGE OUTPUT Amplifiers are included for each channel, including a special squaring circuit for the sprocket hole signal. Output swing between hole and blank is greater than 20 volts.



Dimensions: 9" x 11½" x 11¼" **Weight:** 37 lbs.

For use with long lengths of tape up to 1000 feet, spooling equipment operating up to 40 inches per second for take-up or supply is available separately.

FERRANTI ELECTRIC, INC.

30 Rockefeller Plaza New York 20, N. Y.

ADVERTISING INDEX

The purpose of COMPUTERS AND AUTOMATION is to be factual, useful, and understandable. For this purpose, the kind of advertising we desire to publish is the kind that answers questions, such as: What are your products? What are your services? And for each product: What is it called? What does it do? How well does it work? What are its main specifications? We reserve the right not to accept advertising that does not meet our standards.

Following is the index and a summary of advertisements. Each item contains: Name and address of the advertiser / subject of the advertisement / page number where it appears.

Aircraft Marine Products, Inc., Harrisburg, Pa. / Miniature Taper Pins / page 2
Andersen Laboratories, Inc., 39-C Talcott Rd., West Hartford 10, Conn. / Solid Ultrasonic Delay Lines / page 45
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill. / Relays / page 35
Berkeley Division, Beckman Instruments, Inc., 2200 Wright Ave., Richmond 3, Calif. / Engineers Wanted / page 37
Berkeley Enterprises, Inc., 36 West 11 St., New York 11, N. Y. / Publication on Symbolic Logic; Robot Show Stoppers; Geniac / pages 28, 39, 44

Computers and Automation, 36 West 11 St., New York 11, N. Y. / Roster Entry Forms; Back Copies; Advertising / pages 42, 46, 48
Epsco, Inc., 588 Commonwealth Ave., Boston 15, Mass. / Components, Functional Units, Operational -- Digital Systems / page 43
Ferranti Electric Inc., 30 Rockefeller Plaza, New York 20, N. Y. / High Speed Tape Reader / page 49
Ferroxcube Corp., East Bridge St., Saugerties, N. Y. / Magnetic Core Materials / page 50
Hughes Research and Development Laboratories, Culver City, Calif. / Engineers Wanted / page 43
International Business Machines Corp., 590 Madison Ave., New York, N. Y. / Electronic Panels / page 47
Lockheed Aircraft Corp., Burbank, Calif. / Career Opportunities / page 51
Monrobot Corporation, Morris Plains, N. J. / Computer Components / page 41
Remington Rand, Inc., 315 4th Avenue, New York 10, N. Y. / UNIVAC / page 5
Remington Rand, Inc., ERA Division, 1902 West Minnehaha Ave., St. Paul, Minn. / Engineering Opportunities / page 45
Republic Aviation Corp., Farmingdale, L. I. / Opportunities for Engineers / page 37
Sprague Electric Company, 377 Marshall St., North Adams, Mass. / Pulse Transformer Kit / page 52 (back cover)
John Wiley & Sons, Inc., 440-4th Avenue, New York 16, N. Y. / Book / page 24

*

*

*

The logo consists of the letters 'FXC' in a bold, stylized, sans-serif font. The 'F' and 'X' are connected at the top, and the 'C' is a simple curve. The letters are white and set against a black square background.

first in ferrites...

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

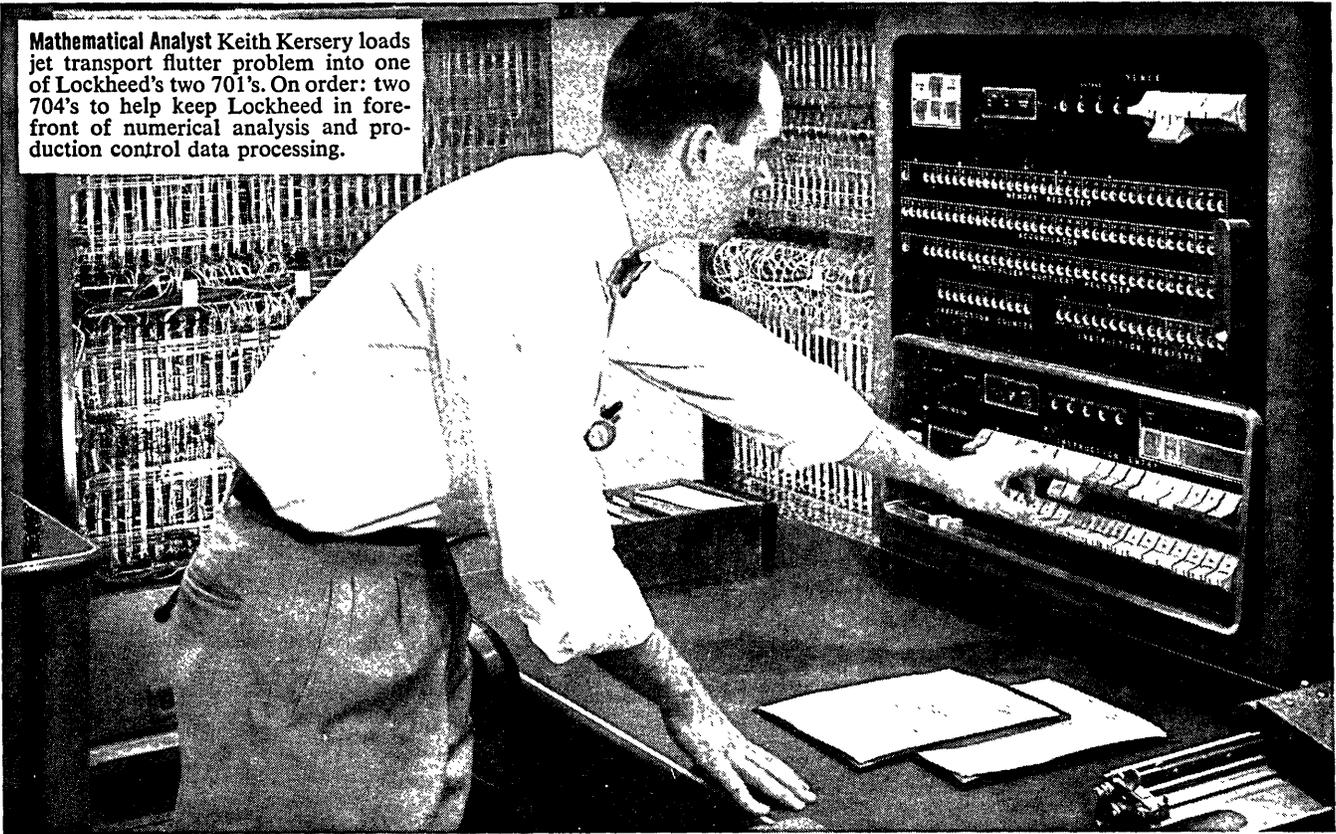
MAY WE SEND YOU APPLICATION DATA IN YOUR PARTICULAR FIELD OF INTEREST?

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.

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.



With two 701 digital computers already in operation, Lockheed has ordered two 704's to permit greater application of numerical analysis to complex aeronautical problems now being approached. Scheduled for delivery early next year, the 704's will replace the 701's.

Much of the work scheduled or in progress is classified. However, two significant features are significant to career-minded Mathematical Analysts: 1) the wide variety of assignments created by Lockheed's diversified development program and 2) the advanced nature of the work, which falls largely into unexplored areas of numerical analysis.

Career positions for Mathematical Analysts

Lockheed's expanding development program in nuclear energy, turbo-prop and jet transports, radar search planes, extremely high-speed aircraft and other classified projects has created a number of openings for Mathematical Analysts to work on the 704's.

Lockheed offers you attractive salaries, generous travel and moving allowances which enable you and your family to move to Southern California at virtually no expense; and an extremely wide range of employe benefits which add approximately 14% to each engineer's salary in the form of insurance, retirement pension, etc.

Those interested in advanced work in this field are invited to write E. W. Des Lauriers, Dept. MA-31-9.

704's and 701's speed Lockheed research in numerical analysis

LOCKHEED

AIRCRAFT CORPORATION • CALIFORNIA DIVISION

BURBANK

CALIFORNIA

Sprague Pulse Transformer Kit Simplifies Circuit Design

HERE'S THE IDEAL TOOL FOR
ENGINEERING DEVELOPMENT
OF CIRCUITS USING
PULSE TRANSFORMERS

CHARACTERISTICS OF KIT TRANSFORMERS

Type	Induct. Pri. (μH)	Leakage (μH)	Dist. Cap. of Pri. ($\mu\text{M}\text{F}$)	Max. Nom. P.W. Range (μSEC)	Avail. Ratios
4122	0.5	2.5	5	0.5	1:1
		4.0			2:1
		4.5			3:1
		7.0			5:1
4123	5.0	13	15	6	1:1
		15			2:1
		25			3:1
		30			5:1
2027	10	20	12	12	1:1
		40			8:1
2028	20	50	15	25	same as 2027
		150			
2029	50	150	20	50	same as 2027
		210			

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



Sprague's new Type 100Z1 Pulse Transformer Kit contains five multiple winding transformers, each chosen for its wide range of practical application.

Complete technical data on each of the transformers is included in the instruction card in each kit so that the circuit designer may readily select the required windings to give transformer characteristics best suited for his applications . . . whether it be push-pull driver, blocking oscillator, pulse gating, pulse amplifier, or impedance matching. The electrical characteristics of the transformers in the kit have been designed so that they may be matched by standard Sprague subminiature hermetically-sealed pulse transformers shown in engineering bulletin 502B.

For complete information on this kit, as well as the extensive line of Sprague pulse transformers, write to the Technical Literature Section, Sprague Electric Company, 377 Marshall Street, North Adams, Massachusetts.

SPRAGUE[®]

the mark of reliability