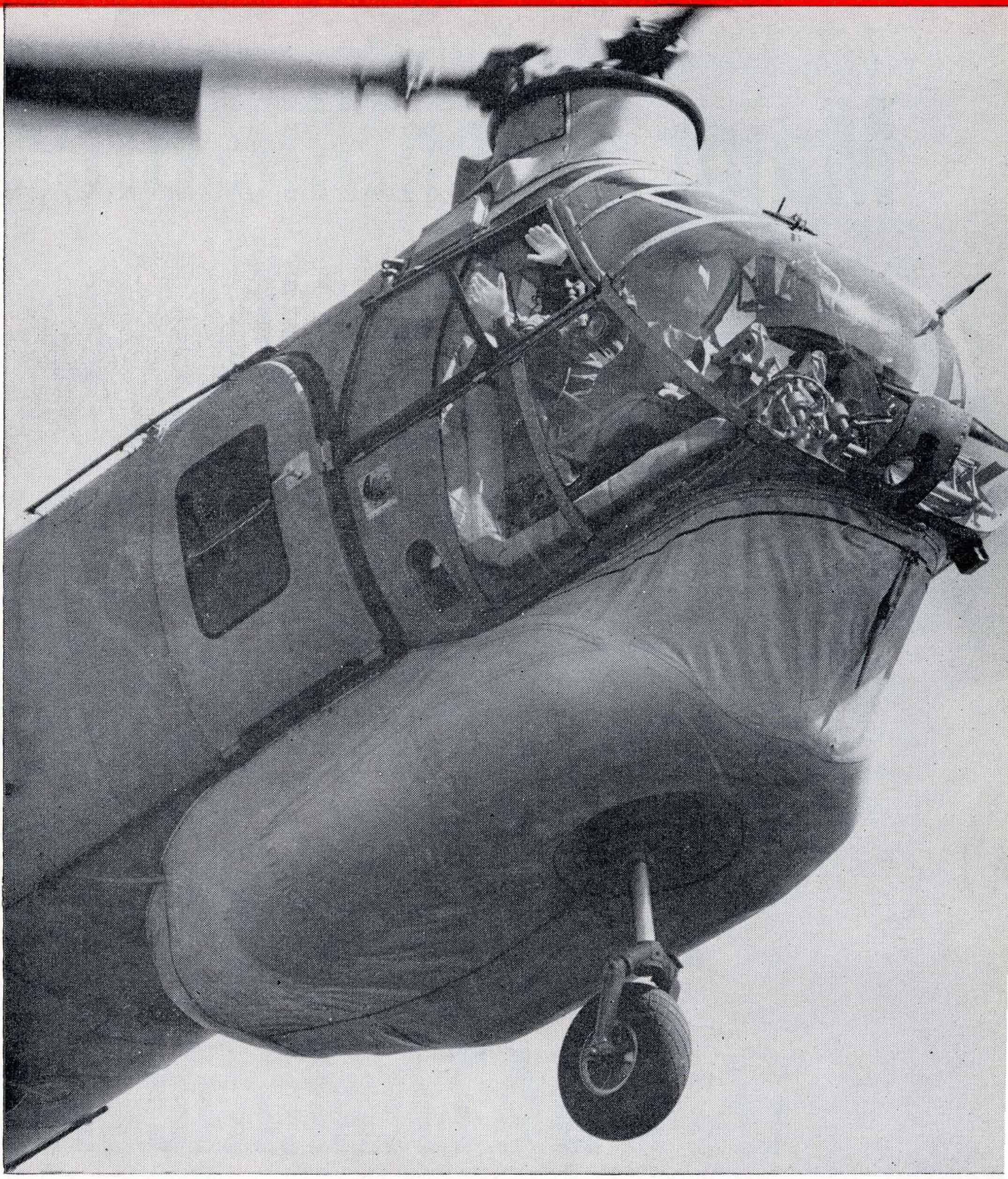
COMPUTERS
and AUTOMATION

DATA PROCESSING • CYBERNETICS • ROBOTS



Survey of Computing Services

The Transportation Problem

The Computer ERMA (Part 2)

Association for Computing Machinery Meeting at Urbana — Program, Titles and Abstracts

JULY
1958
•
VOL. 7 - NO. 7

Honeywell Announces Major Scientific Breakthrough in Business Data Processing: ORTHOTRONIC CONTROL ...Available only on DATAmatic 1000

COMPUTERS

and AUTOMATION

DATA PROCESSING • CYBERNETICS • ROBOTS

Volume 7
Number 7

JULY, 1958

Established
September 1951

Change of Address: If your address changes, please send us both your new address and your old address (as it appears on the magazine address sticker), and allow three weeks for the change to be made.

COMPUTERS and AUTOMATION is published monthly at 160 Warren St., Roxbury 19, Mass., by Berkeley Enterprises, Inc. Printed in U.S.A.

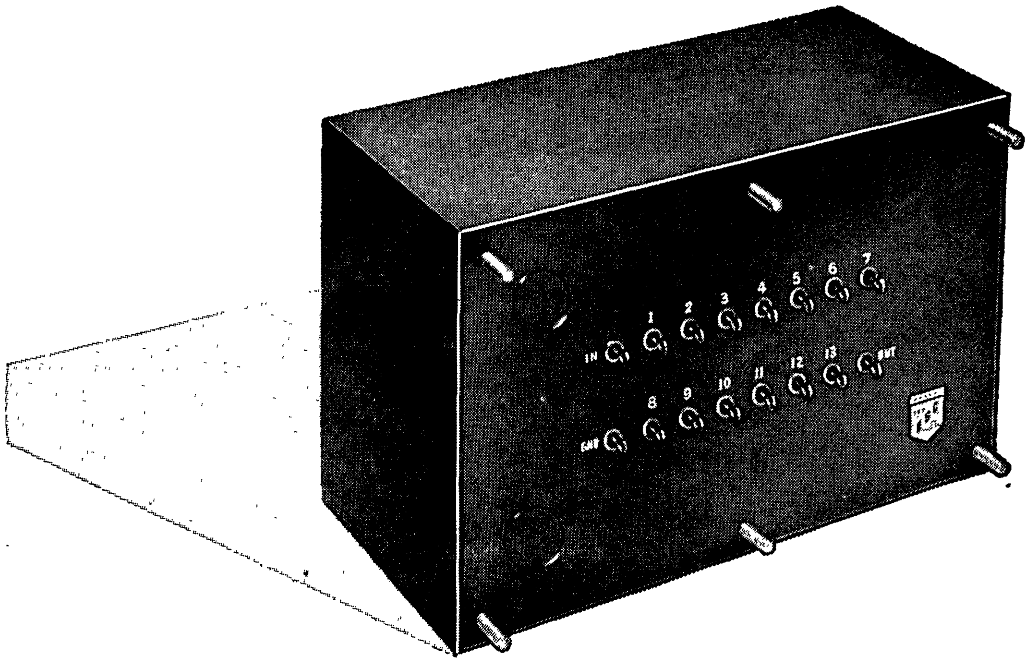
SUBSCRIPTION RATES: (United States) $5.50 for 1 year, $10.50 for 2 years; (Canada) $6.00 for 1 year, $11.50 for 2 years; (Foreign) $6.50 for 1 year, $12.50 for 2 years.

Address all Editorial and Subscription Mail to Berkeley Enterprises, Inc., 815 Washington St., Newtonville 60, Mass.

ENTERED AS SECOND CLASS MATTER at the Post Office at Boston 19, Mass. Postmaster: Please send all Forms 3579 to Berkeley Enterprises, Inc., 160 Warren St., Roxbury 19, Mass.

Because its 145 to 1 delay-to-rise-time ratio was considered impossible

THIS IS THE DELAY LINE THAT COULDN'T BE MADE



...BUT ESC MADE IT!

Compare the new ESC Delay Line Model 51-43 with these competitive units:

TYPE	TOTAL DELAY	RISE TIME	VOLUME, INCHES	Zo OHMS	MAX. NO. PULSES	PULSES PER CU. IN.	TOTAL INSERTION LOSS	INSERTION LOSS PER PULSE	MERIT* FACTOR	MIN. PULSE LENGTH
**Commercial Air Core Delay Line	4.6 µs.	0.1 µs.	92.7	430	23	.248	.7 db	.304 db	0.816	.2 µs.
**Commercial Ferrite Core Delay Line	12 µs.	0.26 µs.	41.2	500	23.1	.56	2 db	.0866 db	6.45	.52 µs.
**Commercial Ferrite Core Delay Line	200 µs.	4.4 µs.	74.4	500	22.8	.306	2 db	.0876 db	3.5	8.8 µs.
**Commercial 1350 Ohm Distributed Line	12 µs.	0.44 µs.	77.7	1350	13.6	.175	12.4 db	.911 db	0.192	.88 µs.
**RG 65 U	8 µs.	0.31 µs.	820	950	12.9	.0157	11.5 db	.892 db	0.0176	.62 µs.
ESC Delay Line Model 51-43	20.3 µs.	.14 µs.	115	470	72	.625	2 db	.0278 db	22.5	.28 µs.

* Merit Factor = Pulses / In.³ ÷ Insertion loss per pulse

**J. R. Anderson, "Electrical Delay Lines for Digital Computer Applications" Transactions of the I.R.E.—June, 1953

ESC CORPORATION

534 Bergen Boulevard, Palisades Park, New Jersey

exceptional employment opportunities for engineers experienced in pulse techniques

Readers' and Editor's Forum

FRONT COVER: "SEE — NO HANDS!"

A HELICOPTER IS precisely stabilized, with the pilot using "no hands," by a new automatic flight control system which applies to all types of commercial and military rotary wing planes. Rotary wing aircraft are hard to fly; yet the new equipment made by Sperry Gyroscope, Great Neck, N.Y., provides these planes also with automatic flight control of advanced type, and makes possible pilotless helicopters. For more information, see "Industry News Notes."

NEW HORIZONS WITH COMPUTER TECHNOLOGY — 1959 WESTERN JOINT COMPUTER CONFERENCE

Murray L. Lesser, Chairman
Technical Program Committee, WJCC
IBM Research Laboratory
San Jose, Calif.

PAPERS ARE BEING solicited for the 1959 Western Joint Computer Conference, to be held at the Fairmount Hotel, San Francisco, on March 3-5, 1959. The theme of this conference will be "New Horizons with Computer Technology."

In keeping with the theme, there is particular emphasis on factual papers dealing with the newer applications of computer techniques, such as Information Retrieval, Operation Control, Pattern Analysis, Decision Making, Computer Communications, Learning Concepts, . . . and the like, as well as on papers dealing with advances in computer component and systems design.

It is also hoped that there will be two sessions of a speculative nature: A "Blue Sky Session," and one on "Philosophy & Responsibility of Computers in Society." Papers intended for the "Blue Sky Session" should deal with the extension of computer technology into areas not considered feasible at present. They should indicate the advantages of such extension, and also the area of research necessary to bring this application into the feasible range.

Papers for the session on "Philosophy & Responsibility of Computers in Society," should deal with the philosophic and/or social implications of the widespread application of automatic computer techniques. The papers for these sessions should be of the type to invite serious discussion. These two sessions will be definitely scheduled only in the event that enough suitable papers are received.

Papers for the 1959 WJCC should be prepared based on a 20-minute delivery time. Selection of papers for presentation will be made from the complete text of the paper. There are no format requirements for these submission drafts. Three copies of the proposed paper should be submitted to the Technical Program Committee by October 1st of this year. After review, final selection of papers will be made and the authors will be notified by December 1, 1958. Submission of final texts of the selected papers, in the form required by the Publications Committee, should be made by February 1, 1959.

The 1959 WJCC makes the classical promise to be an exciting conference. Whether or not you are in a position to present a paper, you will find it well worth while to reserve March 3-5, 1959 to attend.

ROUND-UP ON SR OF COMPUTER SCIENTISTS

I.

On the continuing ballot on presenting discussion of the social responsibility of computer scientists, **Computers and Automation** reports that it has now received 410 votes and expressions of opinion. Of these 245 are "yes, discuss," 138 are "no, stick to technical subjects, leave that discussion to other people," and 27 consist of remarks and comments without voting yes or no.

II.

I'll volunteer my opinion that to have **Computers and Automation** carry the type of controversial articles you are apparently contemplating would be a grave mistake. They would repel me, for one, and probably a great many others who wouldn't bother to express an opinion. However worthy the discussion may be, it is out of place in the type of magazine which I believe **Computers and Automation** is seeking to be. What you need is more worthwhile technical articles, not material which will inevitably irritate a substantial fraction of your subscribers. The polemics belong elsewhere.

Lawrence Wainwright
Encinitas, Calif.

III.

The Neil Macdonald material "An Attempt to Apply Logic and Common Sense to the Social Responsibility of Computer Scientists" is the single most important bit of feature article material that has appeared in print for a long time.

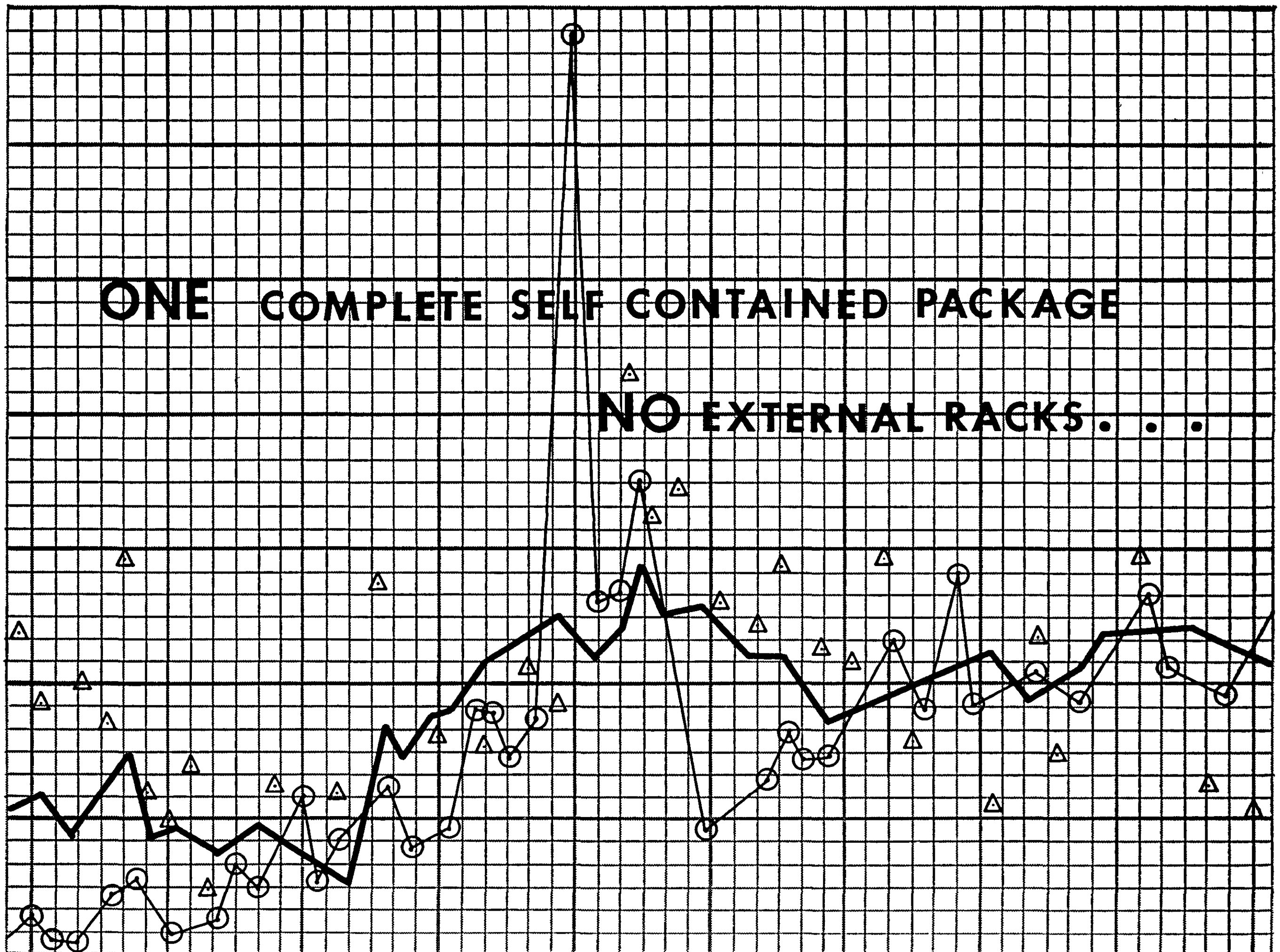
Congratulations to **Computers and Automation** and Mr. Macdonald.

Milton H. Aronson, Editor
Instruments and Automation
Pittsburgh, Pa.

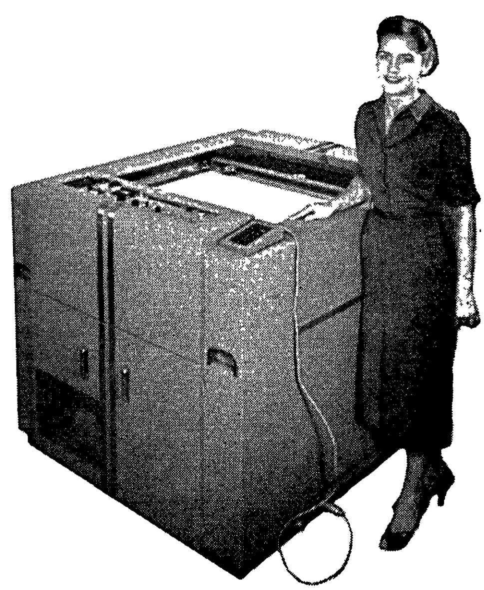
IV.

I have been pleased to read the fine series of statements in the discussion on social responsibility of computer scientists from January to May in your magazine **Computers and Automation.** It is discussion of this sort that will contribute to the solution of the great world problems.

Linus Pauling
California Institute of Technology
Pasadena, Calif.



. . . will quickly and automatically plot your punched card and tape stored research, test, and statistical data.



Data Input

Punched Cards: Read with commercially available equipment.
Punched paper tape: Read with available accessory equipment.
Keyboard: Manually operated (supplied with plotter).

Data Output Available

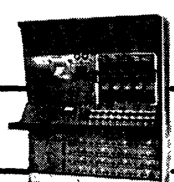
Single points, 12 distinctive symbols, or continuous line.

Output Speed

Points and symbols: Up to 50 points per minute.
Continuous line: Up to 25 points per minute.

Output Accuracy

Points or symbols: 0.05% of full scale.
Continuous line: 0.1% of full scale.



MANUFACTURERS — DEVELOPERS: ANALOG COMPUTERS — PLOTTERS — DATA-REDUCTION EQUIPMENT

ELECTRONIC ASSOCIATES *Incorporated*

LONG BRANCH, NEW JERSEY • TEL. CAPITOL 9-1100

OPERATION upturn Buy now for extra values GENERAL ELECTRIC

COMPUTER PROGRESS

Digital and Analog Computers at Work

ARTICLE 3 VOLUME 1

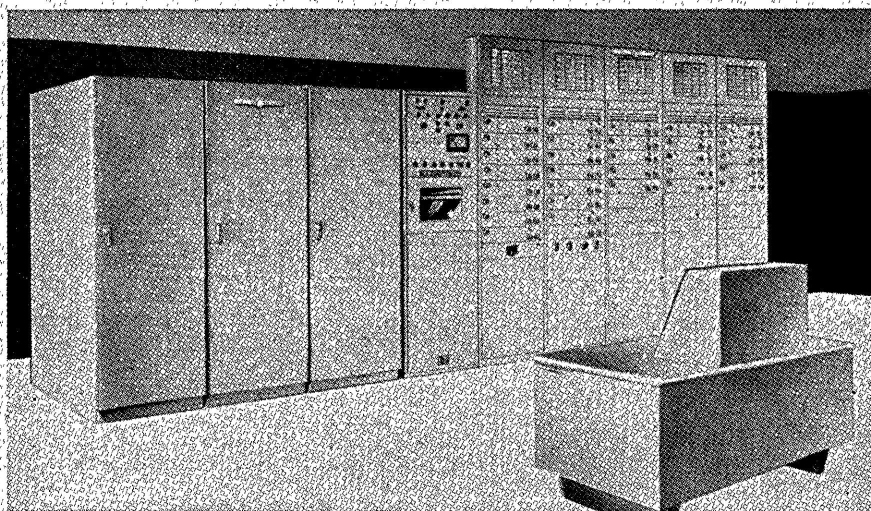
NEW ELECTRONIC HEAT RATE COMPUTER HELPS SLICE THROUGH AIRCRAFT "HEAT WALL"

This latest General Electric Computer helps simulate aerodynamic heating encountered in flight by high speed aircraft. Compression of air around an airframe increases air temperature. The temperature rise can be calculated from wind tunnel test data taken from scale models. Stresses created by artificially heating actual airframe sections in a high temperature test laboratory are then analyzed to aid in structure design. The Heat Rate Computer not only *calculates* the amount of electrical energy required by banks of infra-red lamps or other heat sources, but also *controls* the energy flow.

Calculation of the heat flow necessary for accurate simulation can be made by satisfying the thermal equilibrium equation:

$$Q=A\ [h(T_{aw}-T_s)-BT_s^4]$$

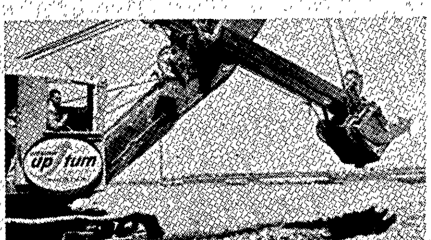
where: Q = heat rate (BTU/hr)
A = area (sq. ft.)
h = heat transfer coefficient (BTU/hr., sq. ft., °R)
T_{aw} = adiabatic wall temperature (°R)
T_s = surface temperature of structure (°R)
B = radiation factor (BTU/hr., sq. ft., °R⁴)



The Heat Rate Computer solves this equation instantaneously using both digital and analog techniques, then sends energy to the heat source at the proper heat rate, Q. Transducers mounted on the airframe provide the feedback signal proportional to T_s.

One large computing system has been designed by General Electric to calculate and control the heat flow to 39 airfoil areas. The unique use of a magnetic drum to digitally store T_{aw} and h curves insures freedom from drift and permits easy storage of, and rapid access to curve data. Multiplexing and time-sharing minimize the amount of electronic circuitry.

COMPUTER DEPARTMENT LAUNCHES OPERATION UPTURN WITH NEW MILLION-DOLLAR PLANT IN PHOENIX, ARIZONA



General Manager H. R. Oldfield, Jr., is pictured at the controls of the Operation Upturn steam shovel which recently broke ground for the new 104,000 square foot permanent plant which is expected to be completed by December of 1958.

"Our business is good and getting better," Oldfield said. "We're going to continue to expand during the year, adding perhaps a hundred or more people." The department now has over 800 employees.

The 160 acre site is located in Deer Valley Park, northwest of Phoenix along the west side of the Black Canyon Highway and south of the intersection with Thunderbird Road.

COMPUTING SERVICES GROUP HANDLES COMPLEX ORIGIN-DESTINATION STUDY FOR WESTERN CITY

The Computing Services Center of the G-E Computer Department recently completed an origin-destination tabulation for the Phoenix-Maricopa County Traffic Study Group in Phoenix, Arizona. The results of this tabulation, when analyzed, will enable the group to plan the street and highway development program of this desert metropolis for years to come.

The original survey information was obtained by the city-county personnel using the interviewing procedures set up by the U. S. Bureau of Public Roads. The data was put on punched cards and then turned over to G-E for processing and tabulation.

Using manual, or simple computing methods, such tabulations often take many months—sometimes years—to complete. However, using the Computing Services Center Computer on a rental basis, the job was completed in just a few weeks. The Computer Department also performed the difficult programming job.

(Programming, simply stated, is the translation of the solution method into the language a computer can understand, and the issuance of instructions to the computer so that it will process the information it is fed.)

The Computing Services Center of G-E's Computer Department is staffed with 125 analysts, programmers, coders—all leaders in the computer field. Their services are available, along with time on the large and versatile type 704 computer, to handle the problems of industry, business, government and education.

For more information contact your nearest Apparatus Sales Office, or Computer Department — Room 101, General Electric Company, 1103 North Central Avenue, Phoenix, Arizona.

CPA—7

COMPUTING SERVICES SURVEY

Neil Macdonald

Assistant Editor
COMPUTERS and AUTOMATION

Introduction

AT THE BEGINNING of April we mailed out to all the computing services of which we had record (about 65) a questionnaire, the main purpose of which was to take a good look at the sector of the computer field which supplies computing services.

A copy of the questionnaire appears below (see I). (Although it was intended to publish this survey in May, it was necessary to delay publication until July, because of the Computer Directory, the June issue.)

Thirty-one organizations kindly replied to us, and a summary of the reply of each organization is included in this report (see II below).

Following are some tables summarizing some of the information given in the replies.

Table 1

SIZE OF COMPUTING SERVICES

Size of Computing Service (in number of people)	*Total Number of Computing Services This Size*	*Total Number of People Employed*
1 to 19	10	117
20 to 39	11	274
40 to 59	2	95
60 to 79	6	403
115	1	115
2000	1	2000
Total reporting	31	3004

It is interesting to note that:

— there are now some 3000 people engaged in this sector of the computer field, of whom 2000 are in one organization, the Service Bureau Corporation, (formerly part of IBM);

— the number of computing services has tripled since the beginning of 1950;

— the most popular automatic computer even among the independent computing services is the IBM 650, although it is reported only 10 times out of the 53 machines reported by the smaller computing services.

The editors will be glad to receive additional entries, or corrections and revisions of these published entries, by September 10, so that the "Computing Services Survey" may be made more complete and brought up to date in the October issue of **Computers and Automation.**

In four of the replies, in the supplementary information sent along with the completed reply form, appeared some interesting information that has resulted in four short articles for this issue of **Computers and Automation:** "The Transportation Problem Solved on the IBM

Table 2

YEAR OF ESTABLISHMENT OF COMPUTING SERVICES

Year	*Number Established*	*Total to Date*
Before 1950	10	10
1950	3	13
1951	2	15
1952	0	15
1953	3	18
1954	4	22
1955	2	24
1956	7	31
1957	0	31

Table 3

MACHINES IN USE IN COMPUTING SERVICES

I. Service Bureau Corporation (formerly International Business Machines Service Bureau):	
IBM 704	2
IBM 650	16
Subtotal	**18**
II. Remaining 30 Organizations Reporting:	
Alwac III	1
Beckman	1
Bendix G15	2
Bureau of Standards, Swac	1
Burroughs, Udec	1
Datamatic	1
Electrodata, Datatron	4
Electronic Associates	7
IBM 650	10
IBM 704 and 701	4
National Cash Register, NCR 102D	1
Readix	1
Reeves, Reac	7
Remington Rand Univac I	3
Royal Precision LGP-30	2
Westinghouse, Anacom	1
Westinghouse, Network Analyzer	1
special machines	3
access to machines outside the computing service	2
Subtotal	53
TOTAL	71

704," "Data Reduction Notes from Telecomputing Corp.," "Current Applications of Computers at Southwestern Computing Service," and "Standard Routines Available for the Datatron Computer at Purdue Statistical and Computing Laboratory."

I. INQUIRY

Director, Computing Service

Dear Sir:

The May issue of **Computers and Automation,** closing about April 12, will contain a survey of computing services.

Will you please send us your announcements, brochures, and literature that you give to prospects who might use your computing service? and also would you please fill in and send us the following information? Please feel free to include any information which you think we should know in making our survey.

Yours sincerely,
Neil Macdonald
May Editor, **Computers and Automation**

REPLY FORM

1. Brief description of the quantity and types of computing machines and equipment which you have ....

....

2. Brief description of the types of computing problems which you specialize in ....

....

....

3. Number of employees.......... 4. Year established ....

5. Any remarks? (attach paper if needed)..........

....

....

Filled in by .... Title ....
Organization ....
Address ....

....

When this is completed, please send it with your literature to:

Neil Macdonald
May Editor, **Computers and Automation**
815 Washington St., Newtonville 60, Mass.

II. SURVEY OF COMPUTING SERVICES

Following is a summary of each reply received. Each reply is in the form Name and address of organization / EQPM: Brief description of quantity and types of computing machines and equipment which organization has / PROB: Types of computing problems which the organization specializes in / Number of employees, Year established. Abbreviations: s — size in number of employees, e — year established, S — small or short time ago, M — medium, L — large or long time ago.

Armour Research Foundation, 10 West 35 St., Chicago 16, Ill. / EQPM: IBM 650 with alphanumeric capacity and standard complement of punched card accounting machines / PROB: operations research, analytical statistics, scientific and engineering calculations, digital simulation and study of air traffic and its control, prediction of traffic distribution over road networks, optimum paths through a maze, geographic patterns, operational reliability of electronic components, multivariate statistical analysis of physical and biological systems, design of experiments, optimization of commercial product mixes by linear programming techniques / Ss(in specialized computer applications, 20; whole foundation, 1250) Se(1950; foundation, 1936)

Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio / EQPM: Electronic Associates 108 amplifier analog computer. IBM 650 with magnetic tape system and peripheral equipment / PROB: general research, engineering development, and engineering / Ms(computing center, 60; whole institute, 2400) Se (computing center, 1951; institute, 1929)

Bendix Aviation Corp., Computer Div., 5630 Arbor Vitae St., Los Angeles 45, Calif. / EQPM: Bendix G-15D general purpose computer, Bendix magnetic tape unit, digital differential analyzer, punched card converter, alphanumeric input-output adapter / PROB: trajectories, missile performance, real-time data processing for aircraft problems, numerical control of machine tools, electrical transmission, pipe lines, hydroelectricity, petroleum exploration, optical lens design, road building, structures, and other engineering, scientific, mathematical, and commercial problems / Ss(15) Se(1956)

Brown University, Applied Mathematics Dept., Providence, R.I. / EQPM: IBM 650 and auxiliary data processing equipment / PROB: scientific; economic research / ?s Se(1956)

Case Institute of Technology, Case Computing Center, University Circle, Cleveland 6, Ohio / EQPM: Univac I, IBM 650 / Ss Se(1956)

Computer Control Co., Inc., Western Division, Mathematical Services Dept., 2251 Barry Ave., Los Angeles 64, Calif. / EQPM: has access to Raydac (for government prime contractors), IBM 704, IBM 650, Univac 1103A, Univac I, Bendix G-15 / PROB: aerodynamic performance analysis, matrix calculations, aircraft simulation, analysis of variance, missile simulation, missile telemetering, trajectories, theodolite data reduction, correlation and autocorrelation coefficients, statistical computations, tables of special mathematical functions, Fourier analysis / Ss(24) Se(1953)

Computer Engineering Associates, Inc., 350 No. Halstead Ave., Pasadena, Calif. / EQPM: direct analog computers, DC network analyzers, special purpose computers, nuclear reactor simulators, etc. / PROB: structural optimization, static stress, normal modes, flutter thermoaeroelasticity, temperature distribution, reactor criticality, etc. / Ms(75) Se(1951)

Computing Devices of Canada, Ltd., P.O. Box 508, Ottawa, Ont. / EQPM: One NCR 102-D computer with high speed photo-electric tape reader, high speed punch, off line Flexowriter. One Bendix G-15 with two magnetic tape units, punched card input and output, paper tape input and output, and auxiliary Flexowriter. Two REAC 400 computers, each with 48 amplifiers, 7 servos, etc. Output equipment includes a Sanborn Instruments recorder, an X-Y plotter, and print-out equipment / PROB: scientific, engineering, military, simulation, data reduction, etc. / Ss(12) Se (1954)

Corporation for Economic and Industrial Research, 734 15th St., N.W., Washington, D.C., and 1200 Jefferson Davis Highway, Arlington 2, Va. / EQPM: IBM 704 and associated peripheral equipment. Also conventional punch card equipment / PROB: mathematical studies, mathematical structuring, sample design, model building, application of Monte Carlo methods, linear programming, market studies, consumer income and expenditure studies, shopping center surveys, magazine readership, rocket engineering, feasibility studies, use of railway system to give maximum transportation capacity, most efficient routing and scheduling of freight cars, development of effective counter-strategies to meet strategies of competitors, identifying combinations of financial investments most likely to achieve investment goal of an investor; improvement of computer supporting techniques such as problem formulation, mathematical structuring, and programming / ?s ?e

Datamatic Service Bureau, 161 Devonshire St., Room 309, Boston 6, Mass., and Architects Bldg., Room 201, 415 Brainerd St., Detroit, Mich. / EQPM: Datamatic 1000 general purpose electronic business data processing system / PROB: business, scientific, operations research / Ss(15) Se(1955)

Datics Corp., 6000 Camp Bowie Blvd., Fort Worth, Texas / EQPM: IBM 650-1, and standard peripheral IBM equipment / PROB: any types, data reduction, data processing, technical and accounting computing / Ss(20) Se(1956)

EAI Computation Center at Los Angeles, Inc., a subsidiary of Electronic Associates Inc., 1500 East Imperial Highway, El Segundo, Calif. / EQPM: two 60 amplifier computers, one 48 amplifier computer, one 20 amplifier computer, of Electronic Associates' manufacture / PROB: aircraft and missile dynamics, control systems and components, petro-chemical process simulation, nuclear reactor simulation, microwave calculations / Ss(8) Se(1956)

Electro Data Division of Burroughs Corp., 460 No. Sierra Madre Villa, Pasadena, Calif. / EQPM: one Datatron 205 computer, and associated equipment / PROB: business, scientific / Ss(26) Se(1953)

General Kinetics, Inc., 555 23rd St. South, Arlington 2, Va. / EQPM: Have computer input equipment. For computation, use customer's machine or rent time on computer best suited to problem / PROB: dynamic stability of complex linear systems, thermodynamic calculations, radiation field patterns, equilibrium of complex chemical systems, system simulation, real-time control studies, matrix calculations, minimax polynomial approximation, design of special purpose and general purpose automatic programming routines and systems / Ss(20) Se(1954)

KCS Data Control Ltd., 20 Spadina Road, Toronto 4, Can., and 640 Cathcart St., Montreal / EQPM: One IBM 650 and complete peripheral punch card equipment. Two Royal McBee LGP-30 computers with punched tape and magnetic drums. On order, one Datatron 220 / PROB: operations research, linear programming, highways engineering, forecasting, statistical data reduction, inventory and transportation problems / Ss(45) Se(1954)

Arthur D. Little, Inc., 35 Acorn Park, Cambridge, Mass. / EQPM: Datatron 205, and Cardatron. Two magnetic tape units. Punched paper tape input, IBM 089; IBM 407, 523 / PROB: inventory control, production scheduling; engineering problems in mechanics, hydrodynamics, heat transfer, nuclear physics; payroll accounting, labor cost distribution, budget analysis; operations research problems in merchandising, banking, insurance, transportation; etc. / Ss(35) Se(1930)

Northrop Aircraft, Inc., Northrop Div., Hawthorne, Calif. / EQPM: IBM 704 computer and data processor with cathode ray tube display and recorder. Electronic Associates analog computer installation including 336 DC operational amplifiers and associated non-linear equipment. IBM 607 computer with Tally Register digital plotter, etc. / PROB: engineering, scientific, simulation, model testing, engineering test, flight test data reduction, reconnaissance data processing. Also design, develop, and build all types of computing and data-handling components and systems / Ms(70) Se(1950)

Purdue Univ., Purdue Statistical and Computing Laboratory, West Lafayette, Ind. / EQPM: Datatron 202, paper tape input and tape plus Flexowriter output. Machine floating point unit. Two magnetic tape units. IBM punched card input and output / PROB: research problems in science and engineering — see article in this issue on library of available routines / Ms(75) Se(1950)

J. B. Rea Co., Inc., Computing Service Division, 1723 Cloverfield Blvd., Santa Monica, Calif. / EQPM: Readix general purpose digital computer, Electronic Associates analog computer, Beckman Ease analog computer, magnetic tape units, etc. / PROB: scientific, engineering / ?s Se(1955)

Reeves Instrument Corp., Project Cyclone (operated for the Bureau of Aeronautics), 225 East 91 St., New York 28, N.Y. / EQPM: REACs (DC electronic analog computers), 680 amplifiers, 78 servos, 1 autocontrol system. Also, one Elecom-100 digital computer / PROB: guided missile, aircraft, nuclear reactor; ordinary partial differential equations, some partial differential equations / Ss(24) Me(1946)

Remington Rand Univac Division, Univac Computing Center, 2601 Wilshire Blvd., Los Angeles, Calif. / EQPM: Univac I, Univac high speed printer, 80 and 90 column card to tape converters, Univac 120, usual complement of punched card equipment including key punches / PROB: recurrent data processing applications / Ms(115) Me(1940)

Remington Rand Univac Div., New York Univac Center, Sperry Rand Corp., 315 Fourth Ave., New York 10, N.Y. / EQPM: Univac I system, including Univac I, Unityper II (8), high speed printer, Uniprinter, 80 and 90 column card to tape converters, and tape to card converter, tape tester / PROB: mathematical, scientific, business, statistical, linear programming, and all types of problems suitable to a large scale computer and data processor / Ms(60) Se(1954)

The Service Bureau Corporation, 425 Park Ave., New York 22, N.Y., and 79 branch offices / EQPM: two IBM 704's with complete peripheral equipment; 16 standard IBM 650 computers; complete line of standard punched card equipment including 604 and 607 calculators / PROB: all types of computing problems (see for example the article in this issue, "The Transportation Problem" / Ls(2000) Se(1957; before then, part of International Business Machines Corp.)

Southwestern Computing Service, 910 So. Boston St., Tulsa 19, Oklahoma, and Security Life Bldg., Room 523, Denver, Colo. / EQPM: one Alwac III, one IBM 650, one IBM 604, and usual complement of punch card machines / PROB: payroll accounting, accounts receivable, accounts payable, etc.; management control, inventory control, production scheduling, sales analysis, sales forecasts; engineering — process, reservoir, seismic, stress analysis, etc. — see brief article in this issue / Ss(20) Se(1953)

Telecomputing Corp., Data Instruments Div., 12838 Saticoy St., North Hollywood, Calif. / EQPM: 2 Teleredexes (film readers), 2 Universal Telereaders (film and oscillogram reader), 4 Telecordexes (electronic digital counters used with readers), 1 contact telereader (oscillogram reader), 1 DataReducer type 099 (oscillogram reader). All of this equipment is of company's own design and manufacture / PROB: specialize in converting data from film and oscillograph records into punched cards, compatible with digital computers; cover the field between the testing phase and the computing phase; do not compute as such / Ss(11) Me(1947)

University of California, Computer Center, Berkeley 4, Calif. / EQPM: IBM 701, and peripheral and punch card equipment / PROB: computations and data processing in connection with basic academic research, for educational institutions in the Western States only / Ss(15) Se(1956)

University of California at Los Angeles, Numerical Analysis Research, 405 Hilgard Ave., Los Angeles 24, Calif. / EQPM: the computer SWAC, high-speed automatic digital computer with 256 words of Williams tube storage and 8192 words of magnetic drum storage / PROB: scientific problems of interest to university researchers / Ss(30) Se(1948, as the National Bureau Standards Institute of Numerical Analysis; 1954, as a part of the Univ. of Calif.)

University of Rochester, Rochester 20, N.Y. / EQPM: IBM 650, Burroughs E 101, and other equipment / PROB: "all types" / Ss(7) Se(1956)

University of Toronto, Computation Centre, McLennan Laboratory, Toronto, Can. / EQPM: IBM 650, with four magnetic tape units and floating point / PROB: scientific calculations, research on programming methods / Ss(10) Se(1948)

Wayne State University, Computation Laboratory, Detroit, Mich. / EQPM: IBM 650, Burroughs UDEC / PROB: business data processing, mathematical and engineering applications / Ss(35) Se(1949)

Westinghouse Elec. Corp., Analytical Dept., Engineering and Service, 700 Braddock Ave., East Pittsburgh, Pa. / EQPM: IBM 704 with 8000 word magnetic core memory, 8 tape units, magnetic drum, etc. Anacom — analog computer — passive element analyzer with several hundred elements (inductors, capacitors, transformers) plus switching, measuring equipment and some nonlinear elements. Electronic differential analyzer — 150 amplifiers, 9 electronic multipliers, 7 servo multiplier resolvers, function generation. Network calculator — largest in the world, with 36 watt regulated generators, 184 pi line units, 120 line units, 108 load units / PROB: performance and design calculations in electrical, mechanical, thermal, control, and nuclear systems; and engineering problems of all types / Ms(63) Se(1947)

Current Application of Computers at Southwestern Computing Service

J. H. Van der Weide

Southwestern Computing Service
Tulsa, Okla.

Following is a list of current applications of computers in our computing service:

Accounting and Sales

1. *Sales Analysis.* Breakdown of sales by product, area, customer, salesman, etc.
2. *Statements.* Open item of balance forward with or without aging the account.
3. *Inventory.* Pricing, sorting and preparation of reports concerned with physical inventory information.
4. *Supply Company Inventory Control.* Perpetual inventory system with development of reorder points and quantities from the analysis of usage information. System affords a means of keeping the overall investment distributed in a manner affording the greatest statistical chance of optimum return.
5. *Cost Accounting.* Job, part, and operation by part costs from labor tickets.
6. *Payroll.* Hourly, salary, incentive, with or without minimums.
7. *Royalty Checks.* Computation of corrected volumes from run tickets, lease income, division of interest, preparation of checks.

Manufacturing

1. *Inventory Control.* Perpetual inventory with cost and quantity control. Forecasting of current and future requirements either from past usage history or by development from bills of material on production forecast. Computation of stock levels to optimize return on investment based on current usage pattern.
2. *Production Scheduling.* Development of net parts requirements to meet production forecasts making allowance for parts in stock, in process, and on order. Putting requirements into lots to minimize manufacturing

and storage costs, or take advantage of purchasing price breaks.

3. *Machine Loading.* A forecast of processing time by machine tool developed from the net parts requirements.

Engineering

1. Flash calculations.
2. Oil reservoir depletion with or without injection programs.
3. Oil property net income forecasts.
4. Pipe stress calculations.
5. Reservoir production bookkeeping.
6. Heat exchanger rating.
7. Compressor performance studies.
8. Pipeline network analysis.
9. Gas plant design.
10. Reduction of strain gage readings to stress values.
11. Seismic data reduction.
12. Instrument response studies.
13. Statistical correlation of data.
14. Gravimeter data reduction.
15. Highway and canal cut and fill.
16. Transformer design.
17. Orifice calculations.
18. Mass spectrometer data reduction.
19. Refinery operational studies.
20. Lofting calculations.
21. Wave transmission studies.
22. Molecular vibration studies.
23. Analysis of variance.
24. Optical ray tracing.
25. Core analysis calculations.
26. Well log computations.

Data Reduction Notes from Telecomputing Corporation

Richard Mickelson
Data Instruments
North Hollywood, Calif.
Division of Telecomputing Corp.

The records received may be transparent, translucent, opaque, and may include every type of film. Some of the typical record types are:

Aero film
Attitude film
Bowen film
Brown recorder records
Cinetheodolite film
Flight test oscillograms
High-speed sled test records
Manometer film
Seismograph records
Spectrograms

The output is punched cards, ready for digital computation.

Some of the fields originating data to be reduced are the following:

Aircraft
Aerodynamics
Automotive
Ballistics
Chemistry
Engines
Geology
Jet Propulsion
Medicine
Missiles
Physics
Ramjets
Rockets
Space Technology
Spectroscopy
Underwater weapons
Wind tunnels

Standard Routines Available for the Datatron Computer at Purdue Statistical and Computing Laboratory

V. L. Anderson and L. D. Pyle
Purdue University, West Lafayette, Ind.

In the operation of the Datatron computer, the following is a partial list of the routines avaialble:

A. Partial List of Standard Routines Available

1. Compiler
   The compiler is a routine that enables a person who desires to solve a problem on the Datatron to by-pass the step of detailed coding in machine language. With the compiler the computer does the coding automatically.
2. Solution of Simultaneous Linear Algebraic Equations and Matrix Inversion
   (a) Maximum of 20 equations in 20 unknowns.
   (b) Maximum of 60 equations in 60 unknowns.
   This routine uses the Gauss-Seidel iteration process.
3. Solution of Linear First Order Systems of Ordinary Differential Equations
   This routine can solve as many as 100 simultaneous equations. The Runge-Kutta method is used.
4. Characteristic Roots and Vectors of a Symmetrical Matrix (n by n), n less than 41
   10 x 10 takes 15-20 minutes
   20 x 20 takes 1-1½ hours
   40 x 40 takes 7-7½ hours
5. Analysis of Variance of Factorial Design
   For a (2 x 3 x 4) factorial it takes about 45 seconds.

6. Factor Analysis (Special case of 4).
7. Linear Programmer.
8. Transportation Problem (Special case of 7) The problem is to allocate shipments of commodities in such a manner, as to minimize the total cost.
9. Regression and Correlation Routines
   (a) A routine providing for as many as 19 independent variables and 99 observations with either tape or card input and output. Approximate time for complete solution is 40 minutes.
   (b) Use IBM 604 on (a) above to compute the simple correlation matrix if the number of observations is larger than 99.
   (c) A routine which will allow the analysis of 19 independent variables and almost any number of observations is being checked out (March, 1958).

B. Subroutines Available

1. Square Root
2. sin X
3. cos X — takes 218 milliseconds
4. arcsin X
5. arctan X
6. $\log_{10}X$ — takes 230 milliseconds
7. $\log_e X$
8. 10^X
9. e^X
10. X!
11. Fix X and Float X
12. Conversion to and from Machine Floating Point and Programmed Floating Point
13. Polynomial Evaluation
14. Polynomial Real Translation
15. Polynomial Multiplication
16. Polynomial Division
17. Print Out with Arbitrary Round Off
18. Solution of Simultaneous Equations (Crout Reduction)
    For 20 x 20, approximately 15 min.
    40 x 40, approximately 1 hr. 45 min.
    60 x 60, approximately 6 hours
19. Matrix Multiplication
20. Three-Point Integration with Unequal Spacing
21. Polynomial Differentiation
22. Polynomial Integration
23. (ber X (real part of J_0 $(i\sqrt{2}\,x)$)
24. (bei X (imaginary part of J_0 $(i\sqrt{2}\,x)$)
25. (ber′ X (imaginary part of J_1 $(i\sqrt{2}\,x)$)
26. (bei′ X (imaginary part of J_1 $(i\sqrt{2}\,x)$)
27. $J_N\ (x)'$ n^a non-hyphen negative integer
28. Normal Equations from Residual Equations

THE TRANSPORTATION PROBLEM

C. F. Graf, Jr.
The Service Bureau Corp.
New York, N.Y.

"Can I reduce transportation costs by changing my present shipping pattern?"

"What effect do seasonal fluctuations have on my transportation costs?"

"Where should I build a new supply warehouse?"

"How should I alter my shipping pattern when production is expanded at a factory?"

EXAMINING THE PROBLEM

These questions and many more can be answered by mathematical techniques used to solve such "transportation problems." Common to all types of transportation problems are four factors which completely define the system: commodity, sources, destinations, and unit costs. Although the interpretation of these factors will vary for different types of problems, the basic concepts involved are the same for all problems. It is this underlying similarity which makes possible the computation of answers for management decision previously obtained by guesswork and intuition.

The Commodity

The item being transported from certain sources to certain destinations is the "commodity." A commodity may be a manufactured product, a barrel of oil, a pound of food, a truckload of paper, a carton of canned goods, or any other unit of merchandise.

For a single problem, only one type of commodity can be analyzed, although the total quantity of the one commodity being shipped is unlimited.

The Sources

The commodity must be available at a number of physical locations called "sources." The quantity of the commodity available at a source is the "supply." Sources may be manufacturing plants, central warehouses, canneries, refineries, supply depots.

There must be a fixed number of sources.

The supply of the commodity at each source must be limited and known.

For a single problem, the supply at a source cannot change.

The Destinations

The commodity is to be shipped to a number of physical locations called "destinations." The quantity of the commodity required by a destination is the "demand." Destinations may be retail stores, fuel reservoirs, local warehouses.

There must be a fixed number of destinations.

The demand for a commodity at each destination must be limited and known.

For a single problem, the demand at a destination cannot change.

The total demand at the destinations must equal the total supply at the sources.

The Cost

Shipping the commodity costs money for railroad, truck, ship or airplane freight charges. The "unit cost" is the cost of shipping one item of the commodity from one source to one destination. Since the distance will vary between sources and destinations, there will be a different unit cost for every pair of sources and destinations.

The "total transportation cost" is the amount of money required to ship all the commodity from the sources to the proper destinations. This cost can be determined from supplies, demands and unit costs. Actual costs are the product of unit costs and quantity shipped.

All unit costs between all sources and destinations must be known. These may include the differences between sources in manufacturing or handling charges.

The actual method of transportation need not be the same throughout the system; only the costs of transportation are important.

For a single problem, the unit costs cannot change.

SOLVING THE TRANSPORTATION PROBLEM

"If the supply at each source, demand at each destination, and all unit costs are known, how can the commodity be apportioned between sources and destinations for the lowest possible total transportation cost?" This is the classical transportation problem. Mathematicians of The Service Bureau Corporation have developed a procedure to solve the problem on the IBM 704 Electronic Data Processing Machine.

Solutions produced are mathematically proved to be the absolute minimum costs. The solution gives the exact quantity of the commodity to be shipped between the sources and destinations. If there is more than one solution for the same minimum cost, the transportation program will supply all such solutions. It is also possible to obtain a number of "second best" solutions which are near the minimum cost.

EXPANDING THE BASIC TRANSPORTATION PROBLEM

Many actual transportation problems do not fit neatly into the classical problem. Very often supply does not equal demand, the supply at each source is not fixed, the demand at each destination is not fixed, more than one commodity is involved, or some destinations also act as sources of the same commodity. The 704 transportation program is designed to produce minimum-cost solutions for these "exceptions" to the classical problem.

Surplus Supply

If the supply at the sources is greater than the demand at the destinations, the solution will show how much of the surplus will be left at each source. Production or inventory can then be reduced at those sources with an excess supply. The most important sources in the system, in terms of minimum transportation cost, will be those left with no surplus.

Excess Demand

If the demand at the destinations exceeds the available supply, the solution will indicate how much of the demand at the destinations was left unfilled. Orders or requirements which add the most to transportation costs are thus revealed.

Combining Sources

The basic problem requires a fixed supply at each source. The transportation program will produce minimum-cost solutions for problems where the total supply is apportioned among a group of sources. In a typical problem, factories A, B and C can produce a total of 5,000 radios. Knowing the number of radios produced at all other factories, and the demands at all outlets, how many radios should each factory produce for minimum transportation cost? The solution will show the exact number of radios to be shipped from Factory A, B and C. Any number of sources can be combined under one supply, and any number of these combinations can be handled in one problem.

Whenever sources are combined, the unit cost between every source and destination must still be known.

Two or More Commodities

The 704 transportation program can produce a solution for a problem involving two or more commodities. If a source ships two commodities, the supply of both commodities must be known. The minimum-cost solution will then indicate the shipping plan for each commodity.

More than two commodities can be solved for, and any source can be involved with any combination of the commodities. For example, some sources may ship only gasoline, or kerosene, or oil; others may ship two of these, and still others may ship all three.

Transhipment

In many cases, a warehouse might receive a certain quantity of a commodity for its own local requirements and also be able to store an excess of that commodity for later shipment elsewhere. Thus, some of the supply might pass through a number of storage points before reaching its destination. These intermediate points are, therefore, both destinations and sources. Minimum-cost solutions to these "transhipment" problems can be obtained by the transportation program if the demand and excess storage capacity of the intermediate points are known.

If an existing transportation problem does not seem to fit into any of these patterns, it may still be possible to obtain a minimum-cost solution with the transportation program.

VALUE OF TRANSPORTATION PROBLEM SOLUTIONS

The 704 transportation program is not merely an aid to reducing existing costs of transporting commodities. It is a powerful tool available to management to provide essential facts for long-range decisions which may involve hundreds of thousands of dollars. Some of the many questions which can be answered by the transportation program are:

How will my transportation costs vary throughout the year? If supply or demand changes with seasonal variations, a forecast solution can be obtained for each specific period so that shipments can be altered to keep costs always at a minimum.

What will happen when freight rates change? If transportation rates are expected to increase or decrease, a new minimum-cost solution will indicate the effect on shipping and total costs. With these answers, management can prepare for any changes before the new rates take effect.

How will strikes, national disasters or the weather affect my transportation cost? If the normal means of transportation is temporarily suspended or discontinued, a new minimum-cost solution can be obtained using the rates for an alternate method of transportation. If the suspension can be anticipated, any changes can be put into effect exactly when needed.

Which of my production plants should be expanded? If an existing source of supply is to be expanded, a forecast solution will show what the altered shipping pattern will be, and how much the total transportation cost will change. Comparing solutions for different sources will indicate the proper one to expand.

Where should I build a new factory? If another source is to be added to an existing system, various locations can be analyzed to determine which location produces the greatest reduction in total transportation costs. The cost reduction will indicate how long it will take for the new facility to pay for itself.

Should I build a new plant or expand an old one? It is often necessary to determine the relative merits of building or expansion. By analyzing various combinations of increased supplies at existing sources and new supplies at new sources, a correct decision can be made, based upon greatest reduction in net costs.

USING THE TRANSPORTATION PROGRAM

Why may I need a transportation problem solution? Computer solutions to transportation problems may save 1% or 5% or even 10% of existing transportation costs. For some concerns this has resulted in a saving of hundreds of thousands of dollars. The 704 transportation program cannot guarantee a certain per cent saving, but it can guarantee that its solution will reveal the lowest possible cost for any system.

Can solutions be obtained by hand calculations? Small problems can be solved by hand, but often at a prohibitive expense of money and time. Seconds of computer calculation replace hours of hand calculation and remove the possibility of human error in the calculations. Large problems are too complicated even to be attempted by hand. The 704 transportation program can solve problems involving hundreds of origins and hundreds of destinations.

How much will a solution cost? In many cases, the major cost of solving a transportation problem is in gathering the data for the problem. The supplies at all origins must be known, the demands at all destinations must be known, and all unit costs must be calculated. The actual cost of a 704 solution is dependent upon the amount of preliminary analysis required and the size of the problem.

The table below illustrates the actual costs of four typical problems solved for SBC customers:

	Customer #1	Customer #2	Customer #3	Customer #4
Number of Origins	11	28	20	50
Number of Destinations	46	128	500	1000
Preliminary Planning	$100	—	$300	$ 300
Keypunching	7	$ 51	120	560
704 Calculation	11*	94	290	3000
Output and Miscellaneous	3	10	30	80
Total	$121	$155	$740	$3940

*150 problems were solved at the same time for $11 each. If only one problem had been solved, the 704 calculation cost would have been $40.

The Special Purpose Computer ERMA for Handling Commercial Bank Checking Accounts

Part 2

(continued from the May issue)

Staff of the Stanford Research Institute Journal

(Reprinted with permission from the *SRI Journal*, Fourth Quarter, 1957, published by Stanford Research Institute, Menlo Park, Calif.)

The Mark II Concept

About midway in the development of ERMA, a group of engineers, working cooperatively with Bank representatives, were separated from the Mark I effort to study what new improvements and features could be incorporated in ERMA's successors. Much had been learned at the Institute with ERMA itself and many developments in electronic techniques and equipments had taken place elsewhere. Transistors were fast becoming more reliable and more suitable for applications of this sort. It was also becoming clear that a fundamental improvement in operation could be made by giving the machine the flexibility of "stored programs" instead of the instructions being "wired in." Experience with the checking-account problem indicated that a greater machine flexibility than originally thought might be desirable, hence the stored-program type of machine looked more attractive. Additionally, recent developments in machine memories had made high-speed stored-program operation more practical. Other modifications also pressed themselves for inclusion in subsequent models. Thus it became clear that future machines — either immediately or eventually — would considerably differ from Mark I. Such is almost always the pattern followed in early major engineering developments.

Thus, from a technical point of view, ERMA could have been physically transported to an actual bank and assumed regular duties there, as indeed was originally envisioned. However, for other reasons the engineering model of ERMA will not enter actual banking service. These stem largely from the fact that production models will differ markedly from the first ERMA. If these new machines will be available in the near future as it is now scheduled, it becomes unwise to place the prototype with its unique problems of maintenance and operation into the banking system. It would require training of personnel not applicable to the production units. These and other similar considerations rule against the rather considerable expense of moving ERMA (it weighs 25 tons) from the Institute to a bank, installing it, and putting it back into operation. ERMA Mark I, having served its purpose, will be moved from the SRI laboratories. Some of the major components will be reused immediately, others will be stored or used for test purposes.

Production Units

Completion of the public demonstrations of ERMA in the fall of 1955 made it possible for the Bank of America to negotiate with prospective manufacturers of the production models of ERMA. Bank representatives undertook a systematic program of evaluation based on the proposals submitted to them by a large number of manufacturers and, in April, 1956, announced that General Electric had been selected to manufacture production models.

Some of the earliest work done by General Elecrtic was a re-evaluation of the current status of the transistor as a reliable computer component. Several alternatives were recommended to General Electric. One was that the early production model should be patterned after Mark I in order to save time. Another was that production models should be of the stored-program type and should utilize transistors to the greatest extent practicable. General Electric has since announced that the first production units will be designed around modern solid-state devices, including transistors as switching elements and amplifiers, and a magnetic-core memory. The manual keyboard system of entering information, such as check amounts, will be replaced in production units with automatic input data taken from the original documents utilizing the magnetic character-reading method. The production equipment, designated by General Electric as the Model 2B-100 Data Processor, will adequately handle the activity of more than 50,000 accounts. SRI has contributed to General Electric's development program for the 2B-100 with consultation on character reading and paper-handling techniques and assistance with the detailed programming of the operational steps to be followed by the new equipment. The SRI long-range program with General Electric calls for work on the extension of character-reading techniques to letters as well as numbers.

Lessons from the ERMA Program

The design and construction of the engineering model produced several important results. One obvious objective of any prototype is to learn ways of improving and simplifying the design. Quite aside from new techniques and components that appeared during the development of ERMA, many lessons were learned in the construction that would make Mark II smaller, lighter, and easier to service.

Most importantly, ERMA proved beyond question that large, complicated problems of business-data computation can be handled by a practical machine. It has given positive evidence that large computers can have a key place in a business world.

Almost equally important, the experience with ERMA lays at rest any fears that the imposition of big electronic machines into a business produces undesirable changes in the scope, concept, operation, or personnel of the organization. Although some special training for existing personnel is obviously necessary, it is in modest amount. Business computers can be operated by existing personnel. Operation of a large computer introduces no major foreign note in a business. It is a new tool, and can be treated as other business tools that have been amalgamated into commercial functions, with consequent benefits.

The cost of a research and development program on the scale of ERMA is obviously a large figure. However, measured against the economies it can effect, the cost is small. This is aside from the fact that in some cases the introduction of data-processing machines is virtually essential to continued business growth.

Development of a large computer to solve a particular problem is likely to have salutory effects on the problem itself. The fresh view of the problem that naturally occurs as it is analyzed for machine solution may result in improved procedures, some simplification perhaps, or other changes that are beneficial. Experience with fitting ERMA into banking operation showed that this is likely to be the general result, probably more so in businesses that have more control over operating practices than does banking.

Two practices were followed throughout the ERMA program that proved to be most desirable, and that should be adopted in future similar efforts. The Bank officials, instead of presenting the development problem to the technical people and waiting for the results, established a parallel group to maintain intimate contact with those in the laboratory throughout every step. This was a wise decision. Not only was this procedure of great benefit in the day-by-day technical problems as they arose, but it served to prepare the organization for the eventual incorporation of electronic machines into its system.

Tomorrow

Accomplishment of the mission of developing a workable model of a machine for performing bank accounting functions enables the Institute staff to again give attention to a new long-range program. Although the focus of the major segment of the scientific and engineering personnel of the SRI Computer Laboratory during the ERMA program was fixed on the completion of the model, considerable attention has been given in recent months to new long-range goals for data-handling machines.

In the light of the ERMA and parallel developments, several horizons of research efforts for the furtherance of electronic data-handling techniques have become evident.

Improve Hardware — One of these is the important but relatively unglamorous detailed improvement of computer hardware. Computer circuits, for example, can be made more rugged, more reliable, and simpler, and less expensive.

Reading Letters — An obvious and highly desirable step from machine reading of Arabic numerals is to reading of the alphabet. The ability of a machine to read printed letters as well as numbers would clearly have great significance, not just in the field of machine accounting but in many distantly related or even unrelated fields. It also appears both desirable and possible to develop machine reading less severely restricted to a particular type face.

Improve Methods of Designing Computers — Another fruitful field of effort is to seek ways to improve the methods by which computers are designed and programmed. Fundamental principles underlying the design of computer systems need to be more clearly understood. Assignments of roles of operation to different computer components and even to different computers within a system of computers, as well as the optimum human roles therein, has not yet reached a scientific basis. New techniques of designing multi-computer systems are needed.

Develop New Areas of Computer Usefulness—The new faculties given to computers point to new fields of usefulness for them. Computers most surely will assume major roles in many fields of control, such as manufacturing, operations, aircraft in flight, and electric-power.

The general area of information retrieval is not only one of the most pressing in today's world of business but also one to which computers may, in the long range, be adaptable. With computers in mind, many questions pose themselves for study. How much of the shortage of engineers is due to "re-inventing" and working on problems already recorded in the literature? What proportion of engineering budgets is spent hunting for information? Can data-handling machines bring help to doctors in their attempt to keep up to date with medical developments and case histories? Or lawyers with court precedents? Or police with criminal information? Are data-machine techniques the answer to problems of searching for patent information? Or the skyrocketing record keeping and information retrieval in social-security, insurance, or investment operations? Would mechanization help solve the problems of supplying information to under-developed countries?

The Cycle Repeats

Such is the nature of technical progress. Five years ago the ERMA assignment seemed difficult if not impossible to meet. However, by focusing intently on the problem with the talent of many professions, both within the Institute and without, the goal was achieved. The machine ERMA was created. Then — inexorably — by the time she had been finally crowned with the laurels of successful testing, she was obsolete. Those who created ERMA have turned their attention to new problems, to new or improved machines. Some of these more distant ones are no more clearly seen or appear to be any more easy of attainment than was the ERMA concept six years ago.

MEETING OF ASSOCIATION FOR COMPUTING MACHINERY

URBANA, ILL., JUNE 11 to 13, 1958

PROGRAM, TITLES and ABSTRACTS

The 13th National Meeting of the Association for Computing Machinery took place at the University of Illinois, Urbana, Ill., Wednesday, June 11, to Friday, June 13, 1958. Following are the program, the titles of the papers and talks, and the abstracts. Three sessions ran concurrently throughout the meeting. It is expected that no proceedings of the meeting will be published. For more information about any paper, please inquire directly of the author, whose address is indicated in the program.

The number in parentheses following a paper refers to the number of the abstract. An asterisk, *, denotes an invited paper.

PROGRAM

Wednesday Morning, June 11

Welcoming Address: **The University of Illinois Computing Program,** Frederick T. Wall, Dean of the Graduate College, University of Illinois, Urbana, Ill.

Retiring President's Address: John W. Carr, III, University of Michigan, Ann Arbor, Mich.

Incoming President's Address

Wednesday Afternoon, June 11

A1. Differential Equations I

Numerical Treatment of a Set of Fourth Order Hyperbolic Differential Equations, Thomas Engelhart, Armour Research Foundation, Chicago, Ill. (1)

Efficient Method for Solving Atomic Schroedinger's Equation, S. Skillman, RCA Laboratories, Princeton, N.J. (2)

A Study of Numerical Methods for Solving Differential Equations, P. D. Williams, Lockheed Aircraft Corp., Marietta, Ga. (3)

B1. Differential Equations II

Alternating Direction Methods for Elliptic Equations,* Garrett Birkhoff, Harvard University, Cambridge, Mass.; Richard Varga, Westinghouse Electric Corp., Pittsburgh, Pa.; and D. M. Young, Jr., Ramo-Wooldridge Corp., Los Angeles, Calif. (4)

An Alternating Direction Method for Solving the Biharmonic Equation, S. D. Conte and R. T. Dames, Ramo-Wooldridge Corp., Los Angeles, Calif. (5)

On the Collocation Method for the Solution of Boundary Value Problems, W. S. Dorn, New York University, New York, N.Y. (6)

Numerical Solution of the Boundary Layer Equations Without Similarity Assumptions, R. Kramer and H. M. Lieberstein, Ramo-Wooldridge Corp., Los Angeles, Calif. (7)

A2. Computer Design

Single Sided Gating, Martin Graham, Rice Institute, Houston, Texas (8)

Logical Design of Maniac III, Nicholas Metropolis and Walter Orvedahl, University of Chicago, Chicago, Ill. (9)

Floating Point Arithmetic for Maniac III, R. L. Ashenhurst and Nicholas Metropolis, University of Chicago, Chicago, Ill. (10)

B2. Computer Research in the University*

(Panel Discussion)

Chairman: Nicholas Metropolis, University of Chicago, Chicago, Ill.

Martin Graham, Rice Institute, Houston, Texas; D. H. Lehmer, University of California, Berkeley, Calif.; Ralph E. Meagher, University of Illinois, Urbana, Ill.; and John R. Pasta, Atomic Energy Commission, Washington, D.C. (11)

A3. Computer Applications

Computations in Magnetic and Gravity Interpretation, R. G. Henderson and J. R. Marsheck, U.S. Geological Survey, Washington, D.C. (12)

Geometrics of Spiral Bridge Design, Jack Belzer, Battelle Memorial Institute, Columbus, Ohio (13)

The Mexican Power and Light Company Introduces a Direct Way for Fast Computation of Industrial Services with Power Factor Adjustment, Raul Pavón, Mexican Power and Light Co., Mexico, D. F., Mexico (14)

B3. The SHARE 709 System

The SHARE 709 System — A Cooperative Effort, Donald L. Shell, General Electric Co., Evendale, Ohio (15)

Programming and Modification in the SHARE 709 System, Irwin Greenwald, Rand Corp., Santa Monica, Calif., and Maureen Kane, IBM, Poughkeepsie, N.Y. (16)

Machine Implementation of Symbolic Programming, T. B. Steel, Jr., System Development Corp., Santa Monica, Calif., and Elaine Boehm, IBM, New York, N.Y. (17)

Input-Output Translation in the SHARE 709 System, Vincent DiGri, IBM, New York, N.Y., and Jane King, General Electric Co., Schenectady, N.Y. (18)

Programmed Buffering of Input-Output on the 709, O. R. Mock, North American Aviation, Los Angeles, California, and Charles Swift, Convair, San Diego, Calif. (19)

SHARE 709 System Supervisory Control Routine, Harvey Bratman, Lockheed Aircraft Corp., Los Angeles, Calif., and Ira Boldt, Douglas Aircraft Corp., Santa Monica, Calif. (20)

Thursday Morning, June 12

C1. Programming

Gradient Projection Method for Nonlinear Programming, J. B. Rosen, Shell Development Co., Emeryville, Calif. (21)

Nonlinear Programming Computations, Philip Wolfe, Rand Corp., Santa Monica, Calif. (22)

An Algorithm for the Determination of the Polynomial of Best Minimax Approximation to a Function Defined on a Finite Point Set, P. C. Curtis, Jr., University of California and Ramo-Wooldridge Corp., Los Angeles, Calif. and Werner L. Frank, Ramo-Wooldridge Corp., Los Angeles, Calif. (23)

D1. Matrix Computations and Programming Methods* (Panel Discussion)

Chairman: George E. Forsythe, Stanford University, Stanford, Calif.

A. C. Downing, Oak Ridge National Laboratory, Oak Ridge, Tenn.; W. L. Frank, Ramo-Wooldridge Corp., Los Angeles, Calif.; Wallace Givens, Wayne State University, Detroit, Mich.; C. C. Gotlieb, University of Toronto, Toronto, Canada; John Greenstadt, IBM, New York, N.Y.; Morris Newman, National Bureau of Standards, Washington, D.C.; J. B. Rosen, Shell Development Co., Emeryville, Calif.; J. H. Wilkinson, National Physical Laboratory, Teddington, England; P. Wolfe, Rand Corp., Santa Monica, Calif. (24)

C2. Digital Computer Arithmetic

Binary Arithmetic for Discretely Variable Word Length in a Serial Computer, Paoli Ercoli and Roberto Vacca, Istituto Nazionale per le Applicazioni del Calcolo, Rome, Italy (25)

On Multiplication and Division with the Fewest Possible Additions and Subtractions, G. W. Reitwiesner, Ballistic Research Laboratories, Aberdeen Proving Ground, Md. (26)

An Analysis of Carry Transmission in Computer Addition, S. G. Campbell, IBM, Poughkeepsie, N.Y., and G. H. Rosser, Jr., Duke University, Durham, N.C. (27)

D2. Algebraic Translation

The Construction of Algebraic Compilers,* Alan J. Perlis, Carnegie Institute of Technology, Pittsburgh, Pa. (28)

Translation Between Algebraic Coding Languages, Robert M. Graham, University of Michigan, Ann Arbor, Mich. (29)

A Command Language for Handling Strings of Symbols, A. J. Perlis and J. W. Smith, Carnegie Institute of Technology, Pittsburgh, Pa. (30)

Computer Language Compatibility Through Multi-Level Processors, R. W. Bemer and D. A. Hemmes, IBM, New York, N.Y. (31)

C3. Data Processing I

A New Method of Symbolic Statement for Data Processing Operations, Ned Chapin, Stanford Research Institute, Menlo Park, Calif. (32)

An Abstract Formulation of Data Processing Problems,* J. W. Young, Jr., and H. K. Kent, National Cash Register Co., Hawthorne, Calif. (33)

D3. Data Processing II

The Role of Isomorphism in Programming, Sidney Kaplan, RCA Laboratories, Princeton, N.J. (34)

Information Retrieval and Report Generation,* W. H. Waldo, Monsanto Chemical Co. (35)

Compilation of Concordances of Printed Works,* Paul Tasman, IBM World Trade Corp., New York, N.Y. (36)

Thursday Afternoon, June 12

E1. Error Analysis

An Analysis of Round-off Error in the Numerical Solution of the Heat Equation, Jim Douglas, Jr., Rice Institute, Houston, Texas (37)

Generated Error in Rotational Tridiagonalization, A. S. Householder, Oak Ridge National Laboratory, Oak Ridge, Tenn. (38)

Automatic Propagated and Round-off Error Analysis, P. C. Fischer, University of Michigan, Ann Arbor, Mich. (39)

F1. Round-off Errors in Floating Point Arithmetic* (Panel Discussion)

Chairman: Alston S. Householder, Oak Ridge National Laboratory, Oak Ridge, Tenn.

J. W. Carr, III, University of Michigan, Ann Arbor, Mich.; D. A. Flanders, Argonne National Laboratory, Lemont, Ill.; Glenn Lewis, New York University, New York, N.Y.; L. Schoenfeld, Westinghouse Electric Corp. (40)

E2. Special Problems

Solutions for Incompatibility in Multiple Media Data Processing, W. S. Knowles and Raymond Stuart-Williams, Telemeter Magnetics, Inc., Los Angeles, Calif. (41)

Computer Transcription of Manual Morse, C. R. Blair, Silver Spring, Md. (42)

A Physical Model of an Abstract Learning Process, J. M. Wier, Bell Telephone Laboratories, Murray Hill, N.J. (43)

F2. Satellite Computations

Computations in Connection with Project Vanguard,* Joseph Siry, Project Vanguard, Washington, D.C. (44)

Methods for the Numerical Minimization of Functions of Several Variables; Evaluated for the Reduction of Satellite Radio Interferometer Data,* J. N. Snyder, D. B. Gillies, and I. R. King, University of Illinois, Urbana, Ill. (45)

Analysis of Satellite Data,* Robert Jastrow, Consultant, Nucleonics Division, Naval Research Laboratory, Washington, D.C. (46)

E3. Statistics; Sorting

A Program for Applying the Principle of Parsimony in Multiple Regression, J. B. Bartoo, Danuta Hiz, and D. T. Laird, Pennsylvania State University, University Park, Pa. (47)

Magnacard Sorting Techniques, R. M. Hayes, Magnavox Company, Los Angeles, Calif. (48)

F3. Sorting* (Panel Discussion)

F. H. Applebaum, RCA, Camden, N.J.; J. C. Batchelder, IBM; L. R. Johnson, Remington Rand Univac; William Orchard-Hays, Corporation for Economic and Industrial Research, Washington, D.C.; B. L. Schwartz, Battelle Memorial Institute, Columbus, Ohio (49)

Friday Morning, June 13

G1. Evaluation of Functions

On Initial Estimates for Computing $a^{1/p}$ by Newton's Method, John I. Derr, Rand Corp., Santa Monica, Calif. (50)

Generation of Spherical Bessel Functions in Digital Computers, F. J. Corbató and J. L. Uretsky, Massachusetts Institute of Technology, Cambridge, Mass. (51)

Second Order Formulas for Fourier Coefficients, Henry F. Hunter, General Electric Co., Schenectady, N.Y. (52)

H1. Algebraic Problems

Resultant Procedures, E. H. Bareiss, Argonne National Laboratory, Lemont, Ill. (53)

Determinants with Polynomial Entries, Max Ojalvo, North American Aviation, Bellflower, Calif. (54)

Related Numerical Problems Arising in the Calculation of the Eigenvectors of Triple Diagonal Forms and the Reduction of a Matrix to Triangular Form,* J. H. Wilkinson, National Physical Laboratory, Teddington, England (55)

Projections, Least Squares, and Constrained Minimization Problems, David Morrison, Ramo-Wooldridge Corp., Los Angeles, Calif. (56)

G2. General Topics in Computing

The Origin of the Abacus and Its Development, Shu-t'ien Li, Palmer and Baker Engineers, Mobile, Ala. (57)

S.E.A. General Purpose Computers C A B, P. Namian and F. H. Raymond, Societé d'Electronique et d'Automatisme, Paris, France (58)

Reporting Computer Performance to Management, J. A. Campise, Hughes Tool Co., Houston, Texas (59)

H2. Language Translation

A Code Matching Technique for Machine Translation,* Ariadne Lukjanow, Georgetown University, Washington, D.C. (60)

Three Levels of Linguistic Analysis in Machine Translation,* Michael Zarechnak, Georgetown University, Washington, D.C. (61)

G3. Computer Logic

Some Remarks on Abstract Machines, Seymour Ginsburg, National Cash Register Co., Hawthorne, Calif. (62)

A Synthesis Procedure for a Class of Asynchronous Circuits in Which a Partial Ordering of the Operations Occurs, W. S. Bartky and D. E. Muller, University of Illinois, Urbana, Ill. (63)

Test Routines Based on Symbolic Logical Statements, Richard D. Eldred, Datamatic, Newton Highlands, Mass. (64)

H3. Simulation

Simulation and Display of Four Interrelated Vehicular Traffic Intersections,* H. H. Goode and W. C. True, University of Michigan, Ann Arbor, Mich. (65)

Function Generation in Flight Simulation, Captain David D. Young, Edwards Air Force Base, Calif. (66)

Computer Simulation of a Machine Job Shop, Ivan Rezucha, IBM, New York, N.Y. (67)

Friday Afternoon, June 13

J1. Mathematical Methods

Some Numerical Investigations of Problems Involving Phase Changes,* M. E. Rose, Brookhaven National Laboratory, Upton, N.Y. (68)

The Solution of Tall Distribution Problems, B. A. Galler and P. S. Dwyer, University of Michigan, Ann Arbor, Mich. (69)

A Method for the Separation of Exponentials, J. C. Gardner, University of Pittsburgh, Pittsburgh, Pa.; D. G. Gardner, Westinghouse Electric Corp., East Pittsburgh, Pa.; and G. Laush, University of Pittsburgh, Pittsburgh, Pa. (70)

An Interpolation Procedure for Closed Curves, T. I. Arnette, Oak Ridge National Laboratory, Oak Ridge, Tenn. (71)

The Design of Fixed Point Iterations, A. C. Downing, Oak Ridge National Laboratory, Oak Ridge, Tenn. (72)

J2. Report of Education Committee*

Chairman: Paul Brock, Monterey, Calif.

Secondary Education, George Forsythe, Stanford University, Stanford, Calif., and Frank Engel, Jr., Westinghouse Electric Corp., Pittsburgh, Pa. (73)

Higher Education, Arvid Lonseth, Oregon State College, Corvallis, Ore., and P. C. Hammer, University of Wisconsin, Madison, Wis. (74)

Industrial Education, Melvin Shader, IBM, New York, N.Y. (75)

ABSTRACTS

1. NUMERICAL TREATMENT OF A SET OF FOURTH ORDER HYPERBOLIC DIFFERENTIAL EQUATIONS

THOMAS ENGELHART
Armour Research Foundation, Chicago, Illinois

The equations discussed here are those governing the bending of an elastic column when one end is given a known axial velocity. Existing solutions to this problem have assumed an infinite speed of propagation of the stress wave. The work described in this paper was originally started to determine when the existing solutions are valid, and to devise practical methods of solution for those situations not adequately covered at present.

A method based on difference equations is presented which is designed to preserve the hyperbolic characteristics of the problem and to handle the coupled set of equations. This procedure was later used successfully on the IBM Model 650 Magnetic Drum Computer.

2. EFFICIENT METHOD FOR SOLVING ATOMIC SCHROEDINGER'S EQUATION

S. SKILLMAN
RCA Laboratories, Princeton, New Jersey

The solution of Schroedinger's wave equation for a spherically symmetric potential requires a systematic method of calculating the eigenvalue. In the method described here, it is possible to obtain the eigenvalue accurate to five significant figures in four or five iterations.

The Schroedinger's equation in atomic units (r in Bohr units, E in Rydbergs) is given by

$$\frac{d^2P(r)}{dr^2} + \left[E - V(r) - \frac{l(l+1)}{r^2}\right] P(r) = 0, \text{for } 0 \leq r \leq \infty.$$

The boundary conditions for all quantum states are $P(0) = 0$ and $P(\infty) = 0$, where $P(r)$ is the radial wave function.

The method uses a technique developed by Numerov to solve the differential equation. The equation is first integrated outwards to an intermediate value $r = R_1$, where R_1 is the point where the kinetic energy becomes negative. Then the equation is integrated inwards from R_2, which for all practical purposes is ∞, to R_1. After performing the outwards and inwards integration, an approximate correction to the trial eigenvalue is calculated by a formula due to D. R. Hartree. This formula makes use of the logarithmic derivative of the wave function at R_1 evaluated at the completion of both the outwards and inwards integration.

The efficiency of this method has been demonstrated using the IBM 650 in application to silicon, gallium, germanium, and cerium atoms. An example showing the convergence of the trial eigenvalues to the final eigenvalue will be given.

3. A STUDY OF NUMERICAL METHODS FOR SOLVING DIFFERENTIAL EQUATIONS

PAUL D. WILLIAMS
Lockheed Aircraft Corporation, Marietta, Georgia

In technical computations the need to solve a differential equation, or system of such equations, arises quite frequently. Inversely, it is rare that these equations possess an analytic solution, or at least that such solution can be found with any practicality. Consequently, a multiplicity of methods have been developed that will solve these equations numerically, and to any desired accuracy.

The methods vary widely. The main points to be considered in comparing them are:

(a) Speed
(b) Stability
(c) Starting procedure
(d) Storage requirement
(e) Truncation error control
(f) Round-off error control

The purpose of this preliminary study was manifold. One was merely to gain a greater knowledge of numerical methods. Another was to develop several usable subroutines embracing points (a) through (f) above. An important task was to decide, from among a host of methods, which were the most practical, and to guard against becoming top-heavy with a number of methods whose similarity was strong.

SHARE, an organization of IBM 704 users, has distributed a minimum amount of usable material in this field. It is believed that this study will contribute greatly to filling that deficit.

5. AN ALTERNATING DIRECTION METHOD FOR SOLVING THE BIHARMONIC EQUATION

S. D. CONTE AND R. T. DAMES
The Ramo-Wooldridge Corporation, Los Angeles, Calif.

An implicit finite difference method for solving the biharmonic equation under arbitrary boundary conditions is presented. The method is based on the following approximation to the biharmonic equation $\Delta\Delta U = 0$,

$$(1)\quad U_{ij}^{(n+1/2)} = U_{ij}^{(n)} - r_{n+1} \nabla_x^4 U_{ij}^{(n+1/2)} - 2r_{n+1} \nabla_y^2 \nabla_x^2 U_{ij}^{(n)} - r_{n+1} \nabla_y^4 U_{ij}^{(n)},$$

$$(2)\quad U_{ij}^{(n+1)} = U_{ij}^{(n)} - r_{n+1} \nabla_y^4 U_{ij}^{(n+1)} + r_{n+1} \nabla_y^4 U_{ij}^{(n)},$$

where $U_{ij} = U(i\triangle x,\ j\triangle y)$, r_{n+1} are parameters chosen so as to accelerate convergence, and $\nabla_x^4 U$ is the fourth order finite difference approximation to $\frac{\partial^4 U}{\partial x^4}$, i.e.,

$$\nabla_x^4 U_{ij} = \left[U_{i+2,j} - 4U_{i+1,j} + 6U_{ij} - 4U_{i-1,j} + U_{i-2,j}\right].$$

Equation (1) is implicit in x alone and represents a system of M-1 equations in M-1 unknowns along a single line in the x-direction while equation (2) is implicit in the y-variable. These equations can be solved efficiently by an algorithm similar to that used for solving systems of equations whose matrices are tridiagonal. The method is iterative in nature, a single iteration consisting of solving

[Please turn to page 24]

INDUSTRY NEWS NOTES

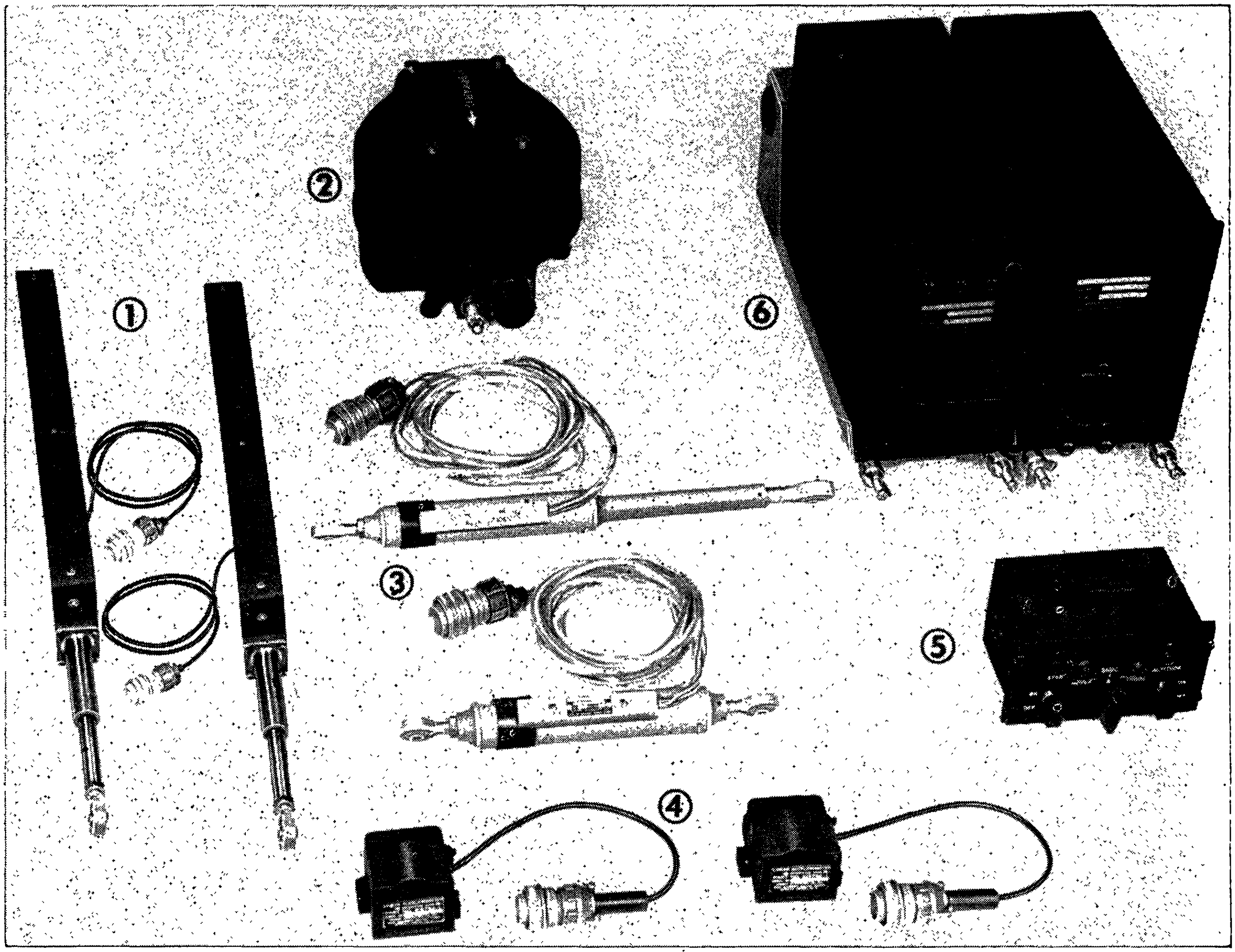


Figure 1. These are the components of the automatic flight control system for helicopters developed by Sperry Gyroscope: (1) bungee pick-offs for centering the control stick and converting pilot applied stick forces into electrical outputs; (2) a vertical gyroscope for providing precise pitch-roll reference for automatic control; (3) force links to convert forces on collective stick and rudder into electrical outputs; (4) linear accelerometers to sense lateral and longitudinal accelerations; (5) pilot console, for engaging the system and selecting various modes of operation; and (6) amplifier assemblies, including altitude sensor, which may be used individually or in combination to provide automatic control on any or all axes.

AUTOMATIC FLIGHT CONTROL SYSTEM FOR HELICOPTERS

On the front cover of this issue, and in Figure 1, appear illustrations of a new automatic flight control system which will automatically and continuously stabilize any helicopter, even in high winds, and with "hands off" control when desired. The system provides complete control of four axes of flight — pitch, roll, heading, and altitude. The system has been designed and developed by Sperry Gyroscope Co., Great Neck, N.Y., and is being installed in helicopters for the Swedish Navy.

The system will automatically compensate for changes in loading, and will automatically coordinate turning of the aircraft. It has push buttons for controlling attitude precisely. Six printed circuit boards inserted into the system "personalize" it for each type of helicopter. A very precise barometric sensor detects deviations of altitude, and keeps the aircraft at its reference altitude by varying the collective pitch of the rotor.

Nearly all field maintenance is accomplished by plugging in replacement components.

Its total weight is under 40 pounds.

ORTHOTRONIC CONTROL

IN JUNE, the Datamatic Division of Minneapolis Honeywell Regulator Co., Newton Mass., announced that it had developed an automatic method, called Orthotronic Control, of recreating at electronic speeds information within an automatic computer found to be erroneous. The process of reconstructing wrong information applies to information recorded in one channel of 31 parallel channels, is based on the information re-

[Please turn to page 24]

BOOKS
and
OTHER
PUBLICATIONS

(List published in COMPUTERS and AUTOMATION, Vol. 7, No. 7, July, 1958.)

WE PUBLISH HERE citations and brief reviews of books, articles, papers, and other publications which have a significant relation to computers, data processing, and 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 / comments. If you write to a publisher or issuer, we would appreciate your mentioning Computers and Automation.

Shera, J. H., A. Kent, and J. W. Perry, editors, and over 45 authors / Information Systems in Documentation / Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N.Y. / 1957, printed, 639 pp., $12.00.

This text comprises Volume II of the series, "Advances in Documentation and Library Science." The editors present the proceedings of the Symposium on Systems for Information Retrieval held in Cleveland, Ohio, on April 15-17, 1957. The text material includes "case-histories and demonstrations of widely-varying but very concrete instances of actual situations involving the need for information-retrieval," and of experiments in methodology.

The symposium proceedings are published here in six parts: 1. Fundamentals in Systems Design, 2. Documentation Problems in Specialized fields, 3. Semi-Automatic Systems, 4. Systems Using Accounting or Statistical Machines, 5. Co-operative Information Processing. The material constitutes a current report of research and development progress in the documentary information-retrieval field.

Shea, Richard F., editor, and 8 authors / Transistor Circuit Engineering / John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. / 1957, printed, 468 pp., $12.00.

This book is written by nine members of the Electronics Laboratory, General Electric Company, Schenectady, New York. Here the authors and editor have combined material in an attempt to give "a proper mixture of basic transistor theory with examples of its proper application in typical circuits." The reader must have a knowledge of modern forms of circuit analysis, "including such tools as matric representations" in order to understand the transistor applications

[Please turn to page 25]

Industry News Notes

[Continued from page 22]

corded in the other 30 channels and a 32nd checking channel, and makes use of the fact that almost always only one channel malfunctions at any one time.

All data-processors have had for some time an automatic checking feature enabling the data processor to detect the occurrence of error made by the system. The new process, Orthotronic Control, proceeds an important step further, enabling the system itself to correct a very great class of errors a split second after the system has detected them. Furthermore, the correction is accomplished automatically, with no cessation of the operation of the system, and with no human intervention required.

Orthotronic Control monitors two areas of the Datamatic 1000 system, the input and output main trunks. These trunks include the areas controlling the transmission of information from the output buffers (or storage areas) of the system to the recording circuitry, the recording circuitry itself, the magnetic tape, the magnetic head which subsequently reads the tape, the circuitry involved in reading, and the transmission of this information into the input buffer channels of the system.

When information is written on the broad magnetic tape of the D-1000, it is arrayed in 31 channels of 2 electronic "words" per channel, yielding a total of 62 "words" to form what is known as one "block." The binary digits of each word are arrayed longitudinally along each channel in successive rows. Each of the 2 words contains 48 binary digits of information, or bits. Each word in addition contains 4 more bits known as a "weight count." Whenever a word is transferred from one location to another location in the Datamatic 1000, the machine automatically reviews the word's information content (the 48 bits) and computes the proper weight count. If this computed weight count agrees with the weight count transmitted with the word, then the machine knows that no error of omission or commission has occurred, and accepts the word as correct.

Orthotronic Control as applied to the Datamatic 1000 utilizes on the magnetic tape an additional channel — the 32nd — called the Correction Monitor Channel. The information contained in this channel is calculated as follows: Each bit in any row is equal to 1 if there is an odd number of 1's in this row in the 31 information channels, and is equal to 0 if there is an even number of 1's in this row in the 31 information channels. Now, suppose the machine finds that a weight count, say in channel 18, is incorrect. Then using the correct information in information channels 1 to 17, 19 to 31, and the Correction Monitor Channel, the machine immediately recomputes every information bit in channel 18, and restores the correct information.

Neat trick, isn't it?

Association for Computing Machinery

[Continued from page 21]

equation (1) for $j = 1, \ldots, M\text{-}1$ and equation (2) for $i = 1, \ldots, N\text{-}1$. Proof of convergence of the process is given for a rectangular region and a method is given for determining an optimum set of iteration parameters r_p Theoretical estimates based on rates of convergence indicate that this alternating direction method is superior to either the method of successive over-relaxation or to the second order Richardson method and that the superiority increases with increasing M.

6. ON THE COLLOCATION METHOD FOR THE SOLUTION OF BOUNDARY VALUE PROBLEMS

W. S. Dorn

New York University, New York, New York

Linear boundary value problems frequently lend themselves to solution by the method of collocation. For this method N functions are chosen in such a way that the boundary conditions are satisfied by a linear combination of these functions. The coefficients of the combination are then chosen so that the differential equation is satisfied at N discrete points in the domain.

The present note is concerned with choosing the N collocating points from among a set of M points $(M>N)$ so that the sum of the absolute errors at the remaining $M-N$ points is a minimum. The problem is shown to be equivalent to a linear programming problem. A simple example is included.

7. NUMERICAL SOLUTION OF THE BOUNDARY LAYER EQUATIONS WITHOUT SIMILARITY ASSUMPTIONS

R. Kramer and H. M. Lieberstein*

The Ramo-Wooldridge Corporation, Los Angeles, Calif.

*Now at Convair, San Diego, Calif.

The Crocco transformation combined with a Mangler transformation is used to carry the boundary layer problem for axially symmetric blunt bodies into a form suitable for direct numerical computation without introduction of similarity assumptions. Conditions which in the original problem appear at infinity now are brought to a finite straight line, and the body is transformed to a parallel line. Data can be generated on the stagnation line (perpendicular to the body) to serve as initial values, and, since equations are a parabolic system of two second order equations, the boundary value problem is analogous to the slab problem for the heat equation. An implicit difference equation is used to reduce stability difficulties. Special techniques in forming the difference equation result in a linear system of algebraic equations to be solved on any given line of integration, and these solutions are computed from recursion relations generated by back substitution. For blunt nosed bodies with approach flow Mach numbers greater than eight (approximately), large temperature gradients occur across a thin boundary layer of dissociated gas, and it is necessary to use real gas effects approximated here by certain fits to the gas tables. A case is computed, however, for a lower Mach number approach flow using perfect gas theory to provide a standard against which similarity solutions may be tested.

8. SINGLE SIDED GATING

Martin Graham

The Rice Institute, Houston, Texas

The gating system used in the Rice Institute Computer is a single sided, simultaneous clearing, system, with delay line intermediate storage. The registers are static flip-flops and control pulse generators via a delay line. The pulse generators have transformer outputs, which allow use of a

[Please turn to page 26]

[Continued from page 23]

presented here. With such a background, he will find the text provides him with necessary tools for designing actual and efficient transistor circuits. New devices and their applications are discussed.

Chapin, Ned / An Introduction to Automatic Computers / D. Van Nostrand Company, Inc., 257 Fourth Ave., New York 10, N.Y. / 1957, printed, 525 pp., $8.75.

The author of this book proposes to describe the functioning of the modern automatic computer, also its uses and limitations, in terms understandable for the businessman, accountant or systems engineer who desires to grasp quickly a knowledge of the profitable uses of the computer. In his text, Mr. Chapin discusses the automatic computer from the business system point of view, rather than from the engineering or scientific point of view. He intends to furnish here generally useful information concerning the automatic computer, and so his material never requires advanced mathematical knowledge on the part of the reader. Besides his chapters describing the functioning and the uses of the computer, Mr. Chapin includes five appendices containing pertinent tables of number systems, information on currently available automatic computers, glossary of terms, etc. The text is basically sound and the material concisely expressed.

Bright, James R. / Automation and Management / Division of Research, Harvard Business School, Soldiers Field, Boston 63, Mass. / 1958, printed, 270 pp., $10.00.

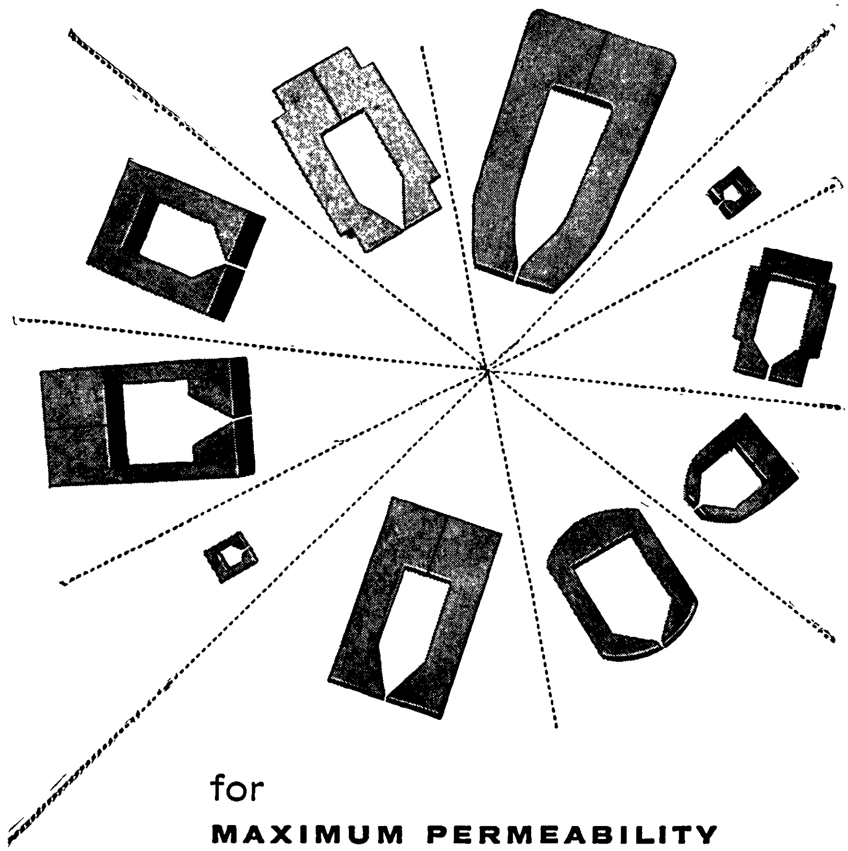
This volume results from a Harvard Business School analysis of the importance of recent automation developments to business management. The material is divided into three parts: "The Nature of Automatic Manufacturing," "Experiences with Automation," and "Critical Areas of Automation." Illustrations — excellent and ample — include 16 pages of photographs; also, thirteen appendices are included which enlarge on certain aspects and problems of automation.

The first part of the study, devoted to "The Nature of Automatic Manufacturing," demonstrates how management must progress on four fronts while increasing mechanized production; these fronts include necessary changes in material, production processes, product design, factory layout. Part II describes the background, technique, objectives and problems of thirteen automation programs applied in certain diverse manufacturing activities. Part III deals specifically with the four prime "Critical Areas of Automation" — maintenance, labor, sales, and management. The entire study shows how only management can plan the automated line to fit properly the technical and economic structure of a business.

Remington Rand Univac, staff of / The Univac II Data Automation System / Remington-Rand Univac, Division of Sperry Rand Corp., 315 Fourth Ave., New York, N.Y. / 1957, photo-offset, 196 pp., limited distribution.

This publication gives management a brief orientation in data processing and computer capability, and then gives

[Please turn to page 27]



Association for Computing Machinery

[Continued from page 24]

voltage coincident (as opposed to a diode-current coincident) AND gate. The simultaneous closing is easily accomplished because of the large excess of power available from the pulse generator over that needed to set a flip-flop. Circuit details for number transfers, shifting, and complementing are included.

9. LOGICAL DESIGN OF MANIAC III

NICHOLAS METROPOLIS AND WALTER ORVEDAHL
University of Chicago, Chicago, Illinois

The arguments for one versus two instructions per word have been reviewed. A new solution which attempts to retain the advantages of each is considered. The familiar idea[1] of extra registers (four in the present instance) associated with the arithmetic unit has also been explored. The general result is that the vocabulary is a single order, *dual operation* set of instructions. All pairs of the four fundamental arithmetical operations are included; one set is for floating point and a separate set for fixed point operations. Significant-digit arithmetic is planned for the floating point mode.[2] The change from dual to single operation per instruction is of course included and is trivial to make.

The address arithmetic is done separately in a smaller arithmetic unit with the use of six B-boxes. A discussion of the associated instructions as well as an account of the remainder of the vocabulary will be presented.

[1]For example, cf. Report No. 80, University of Illinois Digital Computer Laboratory (1957).

10. FLOATING POINT ARITHMETIC FOR MANIAC III

R. L. ASHENHURST AND NICHOLAS METROPOLIS
University of Chicago, Chicago, Illinois

Conventional floating point arithmetic may be thought of as fulfilling two computational needs: first, the stored exponent allows a wide range of numbers to be represented and manipulated, thus making preliminary scaling unnecessary; and second, the normalization procedure used ensures that no significant digits are lost at the right, insofar as possible with fixed register length. However, in the usual normalization, non-significant digits may be introduced at the right, and the end result of a long sequence of floating point calculations contains no indication of cumulative loss of significance, which may be quite serious.

The floating point mode of the arithmetic unit of MANIAC III will employ shifting conventions more in accord with ordinary significance rules. Such conventions must be chosen with care, for excessive protection may result in the loss of digits which could legitimately be retained.

In this report various proposals for significant digit arithmetic are discussed and evaluated, both on the basis of their theoretical justification and their comparative ease of computer realization.

12. COMPUTATIONS IN MAGNETIC AND GRAVITY INTERPRETATION

ROLAND G. HENDERSON AND JAMES R. MARSHECK
U.S. Geological Survey, Washington, D.C.

Magnetic and gravity anomalies in geophysical exploration are frequently made more intelligible by mathematical operations which accentuate the latent features of the data. Downward continuation of fields towards sources and first and second vertical derivatives of fields have been found particularly effective. A system has been devised for the automatic calculation of any or all of these derived fields from the same two-dimensional distribution of "gridded" input data. The integral for analytical continuation above the plane is used with a Lagrange interpolation polynomial to obtain a rather general determinantal expression from which all the required quantities can be obtained with good approximation. The program includes a methodical summing of grid values on a system of concentric circles about each point followed by application of the appropriate set of multi-ring operators. Theoretical and observed aeromagnetic data are used to illustrate the processes and to discuss the errors.

[2]Cf. Paper No. 10.

13. GEOMETRICS OF SPIRAL BRIDGE DESIGN

JACK BELZER
Battelle Memorial Institute, Columbus, Ohio

Highway bridges frequently connect roads not in the same straight line. Such bridges generally contain spiral and circular curves. Computers make the empirically obtained handbook tables for the design of such spiral bridge sections obsolete. A mathematical representation of a spiral transition curve between a straight line and a circle was developed which provides a continuous change in curvature from zero to that of the circle. The solutions to the differential equations are obtained by series approximations which are ultimately solved by methods of iteration. The final numerical results yield coordinates of intersections of piers and the substructure of the bridge, as well as beam lengths between the adjacent points of intersection. The method developed here permits a large number of parallel spirals in the substructure, and a large number of intersection piers not necessarily parallel. It permits the evaluation of the distances of intersection of the piers along the spirals, and determines the stations of all intersections on a base line spiral. The program, developed for the IBM Type 650 Computer, has incorporated the straight line and the circle substructure of the bridge as well and is capable of determining the geometrics of the entire bridge design.

14. THE MEXICAN LIGHT AND POWER COMPANY INTRODUCES A DIRECT WAY FOR FAST COMPUTATION OF INDUSTRIAL SERVICES WITH POWER FACTOR ADJUSTMENT

RAUL PAVÓN
The Mexican Power and Light Company, Mexico D.F., Mexico

Searching for a direct solution to find power factor from active and reactive components, a curve was plotted with

$\text{cotg}\ \varphi \left(= \frac{\text{KWH}}{\text{KVARH}} \right)$ versus $\cos \varphi$ (=Power factor), to relate both functions by a polynomial of the form

$$\cos \varphi = \text{K1}\ \text{cotg}^2\ \varphi + \text{K2}\ \text{cotg}\ \varphi + \text{K3}.$$

Determination of values for K1, K2, and K3 was made by the method of least squares and the aid of a 604-4, starting from 60 different equations of the first degree from which we found the three "normal" equations, solving

[Please turn to page 28]

Books and Other Publications

[Continued from page 25]

much information on programming the Univac II Data Automation System. This machine is a giant electronic computer whose computation speed is twice that of its well known predecessor, the Univac I. The text is clearly written, and well illustrated with diagrams and charts.

Air Coordinating Committee, Air Traffic Control and Navigation Panel / Report on Electronic Systems of Air Navigation: Chapters 1 to 9 / Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C. / 1954, photo-offset, 53 pp., $1.00.

The report describes technical and economic characteristics of LF/MF Non-Directional Beacons, Standard Loran, Consol, Navarho, Decca, "Gee" System, LF/MF Four-Course Radio Range, VHF Omni-Directional Range, and Distance Measuring Equipment. The advantages and the disadvantages of these nine generally-known electronic systems of air navigation are discussed in some detail.

Air Coordinating Committee, Air Traffic Control and Navigation Panel / Report on Electronic Systems of Air Navigation System: Chapter 10 Tacan (Tactical Air Navigation System) / Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C. / 1957, photo-offset, 10 pp., $.50.

This report describes the Tacan System (Tactical Air Navigation System) — its principles, accuracy and equipment. Tacan is a radio air navigation system recently designed to provide a properly equipped aircraft "with bearing and distance from the ground beacon, and beacon identification."

Allen, W. R. / Dynamic Systems Studies: Operation and Maintenance Procedures for Analog Computers / Wright Air Development Center, U.S.A.F., distributed by the Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C. / 1956, photo-offset, 116 pp., $3.25.

This report proposes to show how the analog computer may be used to give useful results to engineers working in the field of air weapon systems dynamics. It recommends careful scientific procedure in using such computers and specifies that the specialists using the computer must study "(1) the limits of the problem representation, (2) the purpose to which computational results will be put, (3) the suitability of the computer for the problem, and (4) the methods for preventing and discovering malfunctions on the part of both operating staff and computer." Procedures, computer personnel, and computer maintenance are discussed.

Gotlieb, C. C., and J. N. P. Hume / High-Speed Data Processing / McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 36, N.Y. / 1958, printed, 338 pp., $9.50.

The authors stress the general techniques and principles of high-speed data processing for business. They use a hypothetical machine in their discussions of information representation, programming, application, etc. Appendices include listings of specific characteristics of some data processors and a general consideration of binary arithmetic. Seven pages of bibliography are also included.

Caldwell, Samuel H. / Switching Circuits and Logical Design / John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. / 1958, printed, 686 pp., $14.00.

This text makes available "an integrated presentation of the fundamentals of switching circuit design," with emphasis on the newly-developed scientific method for solving decision-making problems "by means of those assemblages of switching circuits which constitute the modern digital computer." The author develops switching algebra; describes combinational switching circuits in terms of relay contact networks; discusses the switching aspects of codes and methods for sequential circuit design; and considers pulsed circuit design. He includes instructive problems and five appendices dealing with functions of variables, binary numbers, and decimal-binary conversion.

Susskind, Alfred K., and four more authors / Notes on Analog-Digital Conversion Techniques / John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. / 1958, photooffset, approx. 384 pp., $10.00.

[Please turn to page 30]

[Continued from page 24]
them in the usual way to obtain the constants value. Then, it was necessary to analyse our industrial customers to find the values of power factor which more frequently occurred; K3 was then adjusted to give the formula the best approach between these limits but not exceeding the allowed precision for cases rarely found. The introduction of K3 voids the formula for cos φ smaller than 0.1, cases never encountered in practice. Results were very satisfactory and more accurate than the ones calculated with numerical tables. Owing to this method we can now calculate in only one run of the 604-4 computer the industrial-accounts billing with power factor adjustment.

15. THE SHARE 709 SYSTEM—A COOPERATIVE EFFORT

DONALD L. SHELL
General Electric Company, Evendale, Ohio

The SHARE 709 System development has been a cooperative effort of several SHARE members. The committee charged with this task was organized from representatives volunteered by their respective installations for this purpose. The over-all objectives of the system and methods of attaining them are briefly detailed in this paper. An evaluation of this development procedure is put forth.

16. PROGRAMMING AND MODIFICATION IN THE SHARE 709 SYSTEM

IRWIN GREENWALD
Rand Corporation, Santa Monica, California, AND
MAUREEN KANE
IBM, Poughkeepsie, New York

The system permits the programmer to communicate with the machine and with itself entirely in a symbolic language. The compiler specifications, including instruction format, pseudo operations, program library, and system and programmer macro operation generators, are described. The methods for handling symbolic input-output, symbolic debugging, and symbolic modification of a compiled program are discussed.

17. MACHINE IMPLEMENTATION OF SYMBOLIC PROGRAMMING

THOMAS B. STEEL, JR.
System Development Corporation
Santa Monica, California, AND
ELAINE BOEHM
IBM, New York, New York

A discussion of the implications of symbolic language programming for the system coder. Consideration is given to the availability and flow of information in the system from assembly to debugging output with special emphasis on the symbolic modification process. Particular attention is directed to the problem of efficient encoding of information and its relation to the time versus space question.

18. INPUT-OUTPUT TRANSLATION IN THE SHARE 709 SYSTEM

VINCENT DIGRI
IBM, New York, New York AND
JANE KING
General Electric Company, Schenectady, New York

A complete collection of routines makes up two pseudo-computers for input and output translations. Concise descriptive commands are interpreted by the pseudo-computers to effect the desired translations. By using this innovation, the job of programming any input or output program, whether it is a highly specialized or an extremely general routine, is greatly simplified. Consideration need not be given to the fact that a binary computer is being used to handle the decimal information. One of the features of the system is that modes can be established within the pseudo-computer so that groups of information can be processed in identical ways without supplying the redundant information for each group.

19. PROGRAMMED BUFFERING OF INPUT-OUTPUT ON THE 709

OWEN R. MOCK
North American Aviation, Los Angeles, California AND
CHARLES SWIFT
Convair, San Diego, California

The 709 provides an input-output system which may be made almost independent of the execution of computing instructions. For programs which essentially parallel input-output with computation, existing techniques allow us to utilize efficiently the independentness of this input-output. However, cases in which the logic of the program does not permit simple synchronization of computing and input-output are not easily handled with existing techniques. The paper will describe the method of programming buffering which will allow one to handle efficiently both types of input-output.

20. SHARE 709 SYSTEM SUPERVISORY CONTROL ROUTINE

HARVEY BRATMAN
Lockheed Aircraft Corporation, Los Angeles, Calif., AND
IRA BOLDT
Douglas Aircraft Corporation, Santa Monica, California

The routine processes a peripheral input tape which is composed of a group of jobs, each including program and data. The supervisory control routine has control of the 709 between jobs and performs certain functions such as: time keeping for each job, executing a post-mortem dump if a job "blows up," and initializing the next job in line.

The entire group is processed in one or more succeeding phases. The number of phases needed to complete any particular job depends upon which method of input and output editing has been used for the job.

21. GRADIENT PROJECTION METHOD FOR NONLINEAR PROGRAMMING

J. B. ROSEN
Shell Development Company, Emeryville, California

The nonlinear programming problem considered is the following. A bounded convex region R with boundary B is defined in an s-dimensional space by the set of $k > s$ inequalities,

set of $k > s$ inequalities,

$$\vec{x}^T\vec{n}_i - b_i \equiv \lambda_i(\vec{x}) \geq 0, \quad i = 1, 2, \ldots k.$$

$\vec{x}$ is a vector designating a point in the space and $\vec{x}^T$ its transpose. $\vec{n}_i$ is the unit vector normal to the hyperplane H_i: $\lambda_i(\vec{x}) = 0$, pointing into R. A concave objective function $F(\vec{x})$ with continuous 2nd partials is defined in R and B. It is desired to find the global (interior or constrained) maximum $F(\vec{x}_{max})$ of $F(\vec{x})$ for $\vec{x}$ in R or B.

The gradient projection method for finding Xmax is described and convergence to this maximum point is proved. It is also shown that for functions which are not concave the method will find a local maximum. The relationship between the gradient projection method and the simplex method for a linear objective function is described. Computational experience with the present machine program is briefly discussed.

22. NONLINEAR PROGRAMMING COMPUTATIONS

PHILIP WOLFE
Rand Corporation, Santa Monica, California

The principal features of two mathematical algorithms and their machine codes for nonlinear programming problems recently developed at Rand are described. The first is an adaptation of the Simplex Method for linear programming to the optimization of a quadratic function under linear inequality constraints. Its 704 program has been applied to several large econometric problems. The second is a procedure due to S. M. Johnson for the minimization of a convex function under linear inequality constraints which has been applied to determine the equilibrium composition of complex chemical mixtures.

[To be continued in the August issue]

ADVERTISING INDEX

Books and other Publications

[Continued from page 27]

Staff members of Massachusetts Institute of Technology's Servomechanism Laboratory have prepared this text, based on 1956-57 summer teaching programs, especially for the practicing engineer who may have had little previous background in analog-digital conversion techniques. Text material is divided into three parts: one covering systems aspects of digital information processing; another presenting a detailed engineering analysis of various conversion devices; a third presenting a conversion case study based on development work done at the Servomechanism Laboratory.

Truxal, John G., ed. / Control Engineers' Handbook / McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N. Y. / 1958, printed, 1048 pp., $18.50.

This handbook gives engineers and designers source a source of basic information concerning the techniques and components for use in the design of feedback control systems. In this book linear transistor circuits, magnetic amplifiers, thyratron amplifiers, contactors and relays, power supplies, electromechanical actuators, mechanical components, clutches and brakes, hydraulic components, pneumatic components and signal transducers are all treated from the viewpoint of feedback-control engineering. Specific discussions of regulator and process control systems are included. The text is amply illustrated and indexed.

Wilkes, M. V., D. J. Wheeler, and S. Gill / The Preparation of Programs for an Electronic Computer, 2nd edition / Addison-Wesley Publishing Co., Inc., Reading, Mass. / 1957, printed, 238 pp., $7.50.

This second edition of the volume by the same title published in 1951 broadens its scope to offer a general introduction to programming for any stored-program type of computer, rather than confining itself entirely to programming for the EDSAC. However, since one must use a specific order code to teach programming, the authors continue to use the single-address binary code of the EDSAC. Program design, subroutines, subroutine libraries, and diagnoses of errors in programs are among the topics explored and illustrated. A short bibliography is included.

Savant, C. J., Jr. / Basic Feedback Control System Design / McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 36, N. Y. / 1958, printed, 418 pp., $9.50.

Dr. Savant says in the preface that he believes that engineers can best learn servo design through "learning by doing," and that he proposes to teach such design fundamentals by means of practical examples presented from the student's own point of view. The text emphasizes linear servomechanism design, including only one chapter on nonlinear servo analysis. Because the author feels that feedback control systems are designed by the trial-and-error method, he bases his study of design on complex frequency plane analysis, or the root-locus method. The presentation requires that the reader have a mathematical background giving him a junior-level understanding of alternating-current circuit theory. Good problems are included; there are ten appendices, on the Laplace-transform method, roots of equations, Fourier series, and other topics.

Armour Research Foundation, participants in Symposium of / Proceedings of the Fourth Annual Computer Applications Symposium / Armour Research Foundation of Illinois Institute of Technology, 10 West 35th St., Chicago 16, Illinois / 1958, printed, 126 pp., $3.00.

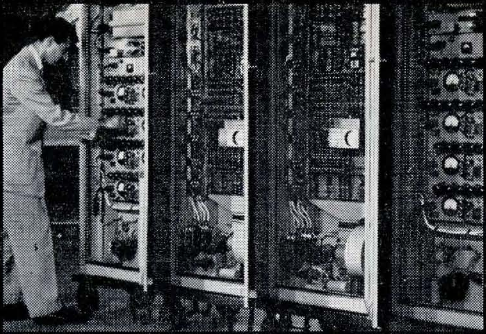
This volume includes fourteen papers which describe the uses and applications of digital computers in business, management, engineering and research. Digital computer systems used in the hospital, the airline reservation office, planning for metropolitan transportation facilities, census-taking, air-defense systems, electrical machine design, the study of fluid flow, and programming for scientific problems are among those described. Some possibilities of new capacities in computers, and rather sophisticated learning, are covered in an illuminating paper "How Lazy Can You Get?" by A. L. Samuel.

Dorfman, Robert, Paul A. Samuelson and Robert M. Solow / Linear Programming and Economic Analysis / McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 36, N. Y. / 1958, printed, 527 pp., $10.00.

This Rand Corporation research study endeavors to show economists how linear programming can be used in traditional economic theory, at the same time not requiring that the reader know higher mathematics. The writers — university professors of economics and statistics — treat in introductory terms such interrelations as those between the von Neumann theory of games and linear programming, the economist's theory of capital and linear programming, also the Leontief input-output theory. Appendices include discussions of "Chance, Utility and Game Theory" and "The Algebra of Matrices."

Adler, Claire Fisher / Modern Geometry / McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 36, N. Y. / 1958, printed, 215 pp., $6.00.

The author intends this text for use in a comprehensive, one-semester college geometry course. She covers here Euclidean, projective, and non-Euclidean geometry. Part I, "Foundations and Selected Euclidean Geometry," requires that the reader have only a limited mathematical background including some knowledge of elementary Euclidean geometry; Part II "Projective Geometry" and Part III "Non-Euclidean and Metric Projective Geometrics" require a more mature mathematical background from the reader. The presentation of text material is interesting and concise. An excellent up-to-date bibliography is included.



Lewyt Coordinate Data Transmission equipments for SAGE uses RCA Radechons.

RCA-6499 RADECHON: Charge Storage Tube; Single-Beam, Barrier-Grid Type; Non-Equilibrium Writing and Capacitance-Discharge Reading. One of a line of RCA Radechons.

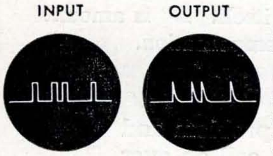
5 ways RCA RADECHONS handle electronic data... effectively

Can you name more?

Designed to "take in" electronic data—store it from microseconds to minutes—*then release the information at the same rate or at different rates,* RCA Radechons can play a key role in electronic data-processing systems for industry and the military.

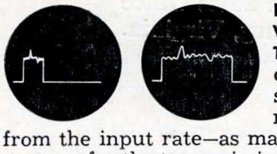
Read what these remarkable RCA Radechons can do for you—and how they do it:

INPUT OUTPUT



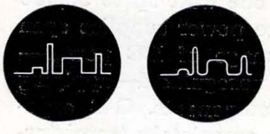
IN DIGITAL DATA STORAGE SYSTEMS, the Radechon acts as a high-speed, random-access, high-capacity memory element.

INPUT OUTPUT



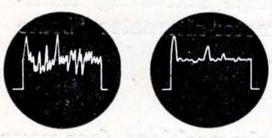
IN TIME-BASE CONVERSION APPLICATIONS, the Radechon releases a stored signal at a rate different from the input rate—as may be required in systems for the transmission of video signals over telephone lines, or in certain systems involving audio-signal multiplexing.

INPUT OUTPUT



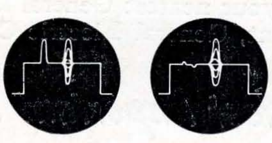
IN SIGNAL DELAY APPLICATIONS, the Radechon stores a signal burst—then releases it after delay periods from microseconds to minutes.

INPUT OUTPUT



IN RADAR SYSTEMS, the Radechon offers better radar signal "detectability"—through charge integration in the storage element.

INPUT OUTPUT



IN FIXED-SIGNAL CANCELLATION APPLICATIONS, the Radechon compares successive signals. Originally designed for "line-by-line" Moving Target Indicators, the Radechon also can be used in "area" MTI systems.

If you are working with these or other Radechon applications, get in touch with the RCA Field Representative at our office nearest you. Remember, RCA is the world leader in Radechon engineering, development, and manufacturing—and welcomes inquiries for Radechon designs to meet specific needs.

Industrial Products Sales

744 Broad Street, Newark 2, N. J.
HUmboldt 5-3900

Suite 1154, Merchandise Mart Plaza
Chicago 54, Illinois • WHitehall 4-2900

6355 E. Washington Blvd.
Los Angeles 22, Calif. • RAymond 3-8361

Government Sales

415 South Fifth Street, Harrison, N. J.
HUmboldt 5-3900

224 N. Wilkinson Street, Dayton 2, Ohio
BAldwin 6-2366

1625 "K" Street, N. W.
Washington 6, D. C. • District 7-1260

RADIO CORPORATION OF AMERICA
Electron Tube Division — *Harrison, N. J.*