# COMPUTERS
## *and* AUTOMATION

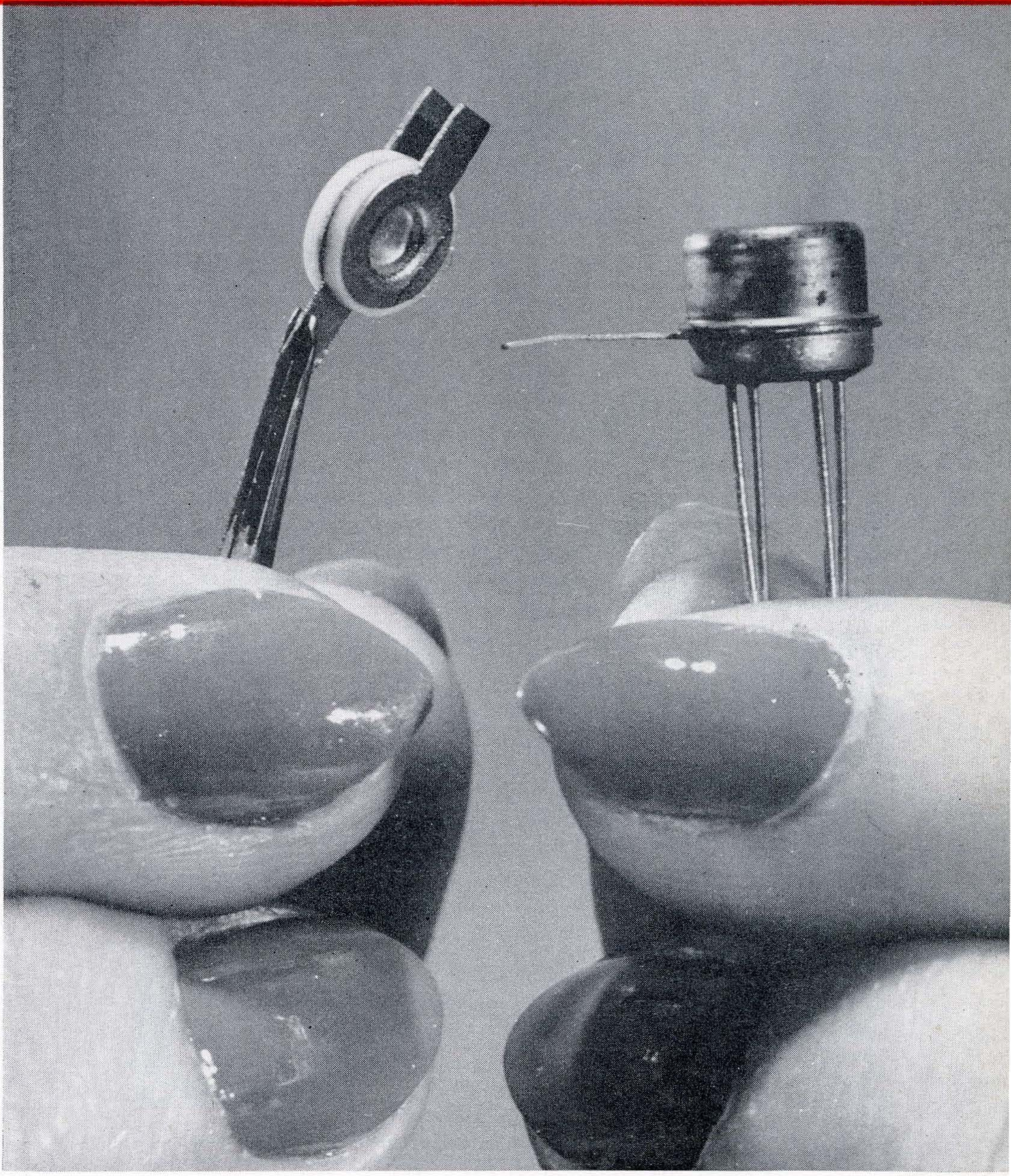
DATA PROCESSING • CYBERNETICS • ROBOTS

ANNUAL COMPUTER CENSUS

REGULATED POWER SUPPLIES FOR COMPUTERS

PICTORIAL INFORMATION PROCESSED ON A COMPUTER

THE COMPUTER ERMA



MAY
1958
•
VOL. 7 - NO. 5

## WHO'S WHO IN THE COMPUTER FIELD, 1958

Once a year we like to bring up to date our Who's Who in the Computer Field." We are currently asking all computer people to fill in the following Who's Who Entry Form, and send it to us for their free listing in the Who's Who that we publish from time to time in **Computers and Automation.** We are often asked questions about computer people — and if we have up to date information in our file, we can answer those questions.

If you are interested in the computer field, please fill in and send us the following Who's Who Entry Form (to avoid tearing the magazine, the form may be copied on any piece of paper).

Name? (please print) ....................

..........................................

Your Address? ..........................

..........................................

Your Organization? ....................

..........................................

Its Address? ............................

..........................................

Your Title? ..............................

Your Main Computer Interests?

( ) Applications
( ) Business
( ) Construction
( ) Design
( ) Electronics
( ) Logic
( ) Mathematics
( ) Programming
( ) Sales
( ) Other (specify):

..........................................

..........................................

Year of birth? ..........................

College or last school? ..............

Year entered the computer field?

Occupation? ............................

Anything else? (publications, distinctions, etc.) ..........................

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..........................................

When you have filled in this entry form please send it to: Who's Who Editor, **Computers and Automation,** 815 Washington Street, Newtonville 60, Mass.

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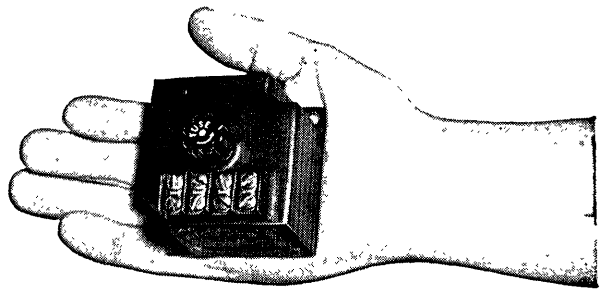
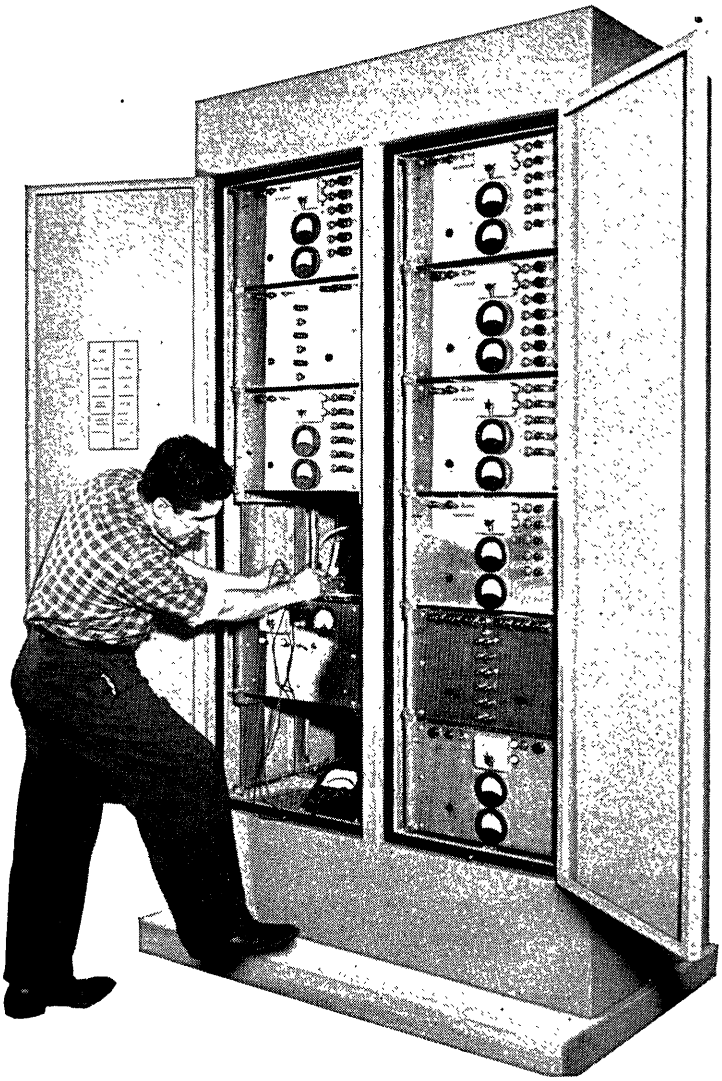
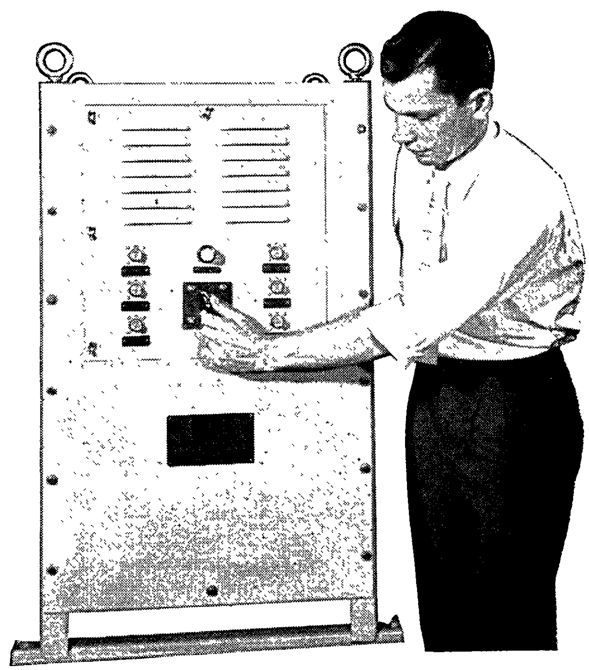


**Individual packages**



**Complete systems**



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# COMPUTERS

## *and* AUTOMATION

DATA PROCESSING • CYBERNETICS • ROBOTS

Volume 7
Number 5

MAY, 1958

Established
September 1951

FRONT COVER



ARTICLES



READERS' AND EDITOR'S FORUM



REFERENCE INFORMATION



INDEX OF NOTICES



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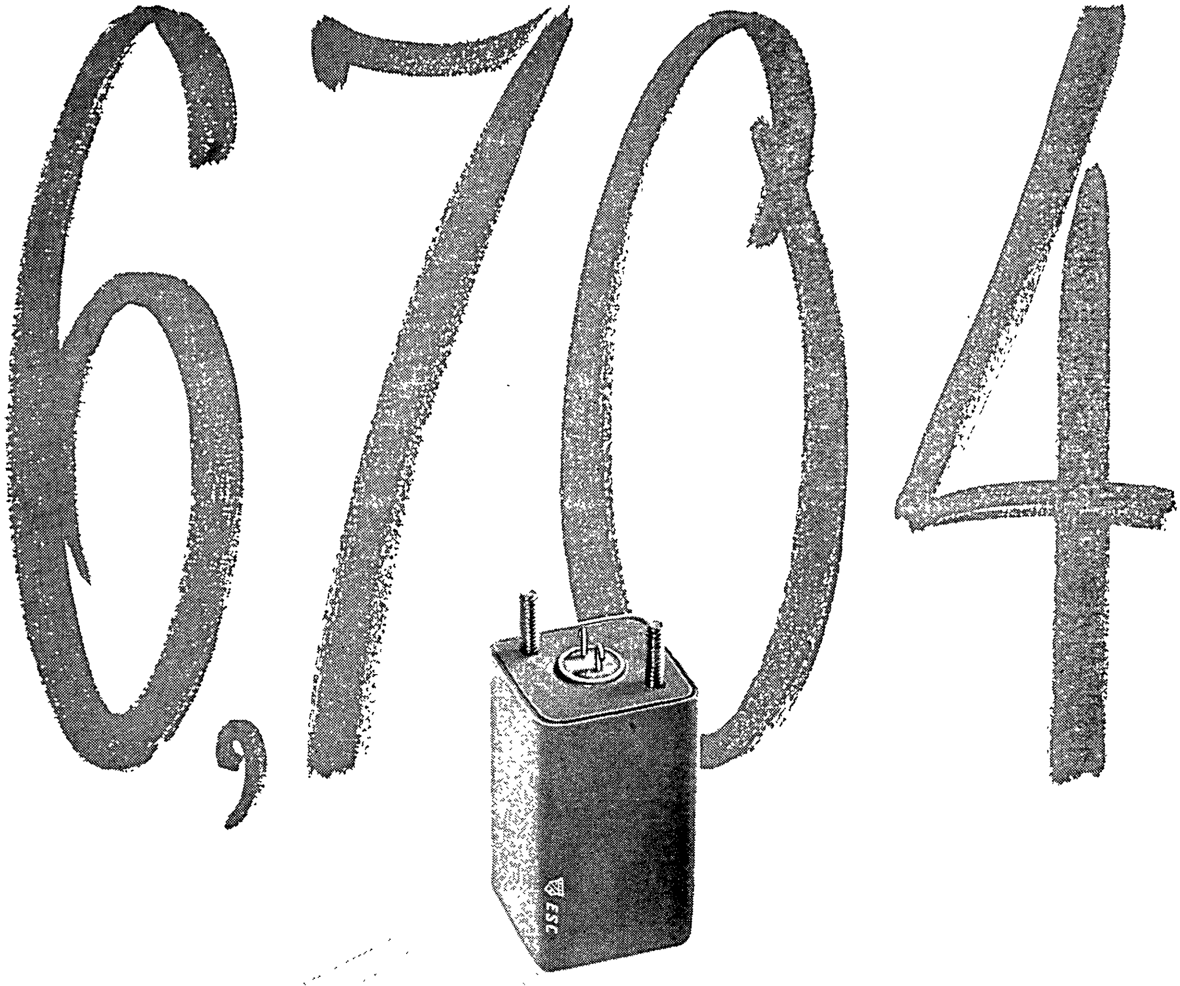
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# Readers' and Editor's Forum

## FRONT COVER: MINIATURE ELECTRONIC TUBE

An electronic tube shaped like a flat disc 1/4 inch in diameter and 1/8 inch thick has been developed, able to operate at temperatures from 900 degrees Fahrenheit to 1500 degrees. It has been designed and developed by General Electric Research Laboratory, Schenectady, N.Y.; the experimental models are now under test. In the picture on the front cover, the new tube (on the left) is being compared with a transistor (on the right).

The extremely small size of the tube (of course, it is hardly a "tube" any more — though the English could still call it a "valve") is due in part to the fact that it contains no heater, since all the heat is provided by its environment. The tube is constructed of layers of titanium metal and a special ceramic.

## BALLOT ON DISCUSSION OF SOCIAL RESPONSIBILITY OF COMPUTER SCIENTISTS

In April, **Computers and Automation** sent out a letter to some 18,000 computer people, asking for an up-to-date Who's Who Entry (see page 2), inviting a new subscription to the magazine with the premium of a free copy of "A Pictorial Manual on Computers" and requesting a vote on discussion of the social responsibility of computer scientists.

The question asked in the letter was:

> In **Computers and Automation** we have been discussing recently the social responsibility of computer scientists, and the relation of computers and automatic guidance systems to ballistic missiles and war. Do you think we should discuss and argue the social responsibility of computer scientists? or do you think that we should stick to the discussion of technical computer subjects? What are your views? See the enclosed ballot; tell us what you think; we shall be much interested.

The ballot enclosed was:

**Ballot on Social Responsibility of Computer Scientists**

( ) I believe we should discuss and argue the social responsibility of computer scientists.

( ) I believe we should leave this discussion to other people and stick to the discussion of technical computer subjects.

( ) Other views? (please express yourself freely) ......

.......................................................................

.......................................................................

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If you read **Computers and Automation** and did not receive one of these ballots, we ask you please to tear out this ballot and vote it, or if you prefer, write on any piece of paper "Ballot on SR" and your vote YES or NO and/or YOUR VIEWS — and send your vote to us, putting your name and address on the envelope.

In the first two weeks, from April 10 to April 23, we have received 365 responses. Of these 148 filled out other parts of the reply form without showing in any way how they would have voted on the ballot; their views consequently are a mystery. But the score on the 217 voted ballots was:

| | |
|---|---|
| Yes, discuss | 118 |
| No, stick to technical subjects | 83 |
| Other views (neither yes nor no indicated) | 16 |

This is a much more believable sampling of the opinion of computer people than the 8 votes for and the 0 votes against, reported in the April issue of **Computers and Automation.**

Even if there were hardly any votes in favor of the discussion of a subject, a magazine clearly has a duty to bring up and discuss subjects that appear to be important and related to its function as a magazine, even if only a small percent of readers may be concerned with the subject. But it now appears that a majority of the readers of **Computers and Automation** are in favor of discussion and argument on the social responsibility of computer scientists.

Only one reader has telephoned the editor and stated that he plans to have the laboratory at Mass. Institute of Technology, where he works, cancel their subscription to **Computers and Automation** because it has begun to discuss the social responsibility of computer scientists. Fortunately we are sure that not many readers of the magazine agree with his viewpoint.

## COMMENTS ON "DESTRUCTION OF CIVILIZED EXISTENCE BY AUTOMATIC COMPUTING CONTROLS"

**Louis Sutro**

Needham, Mass.

You rendered a service by publishing in the March issue the two reports by Admiral Burke and Dr. Pickering under the heading "Destruction of Civilized Existence by Automatic Computing Controls." However I believe the facts presented by those authors need not lead to their conclusions.

Two trends are observed. One is toward equipment that will launch a nuclear war with the closing of a switch circuit. The other trend is towards complex automatic computer controls for this equipment. Dr. Pickering observes that these computer controls may be unreliable, and concludes that in a long period of international tension, the controls would set off the nuclear missiles "and mutual destruction cannot be avoided."

There are other minds also interpreting these trends. One of these is W. R. Ashby, who in his paper "Intelligence Amplifiers" (in "Automata Studies," Princeton Univ. Press) sees man's intelligence being increasingly amplified by the computing equipment that he builds.

That man should put together nuclear equipment and unreliable controls to threaten civilized existence is unintelligent. But perhaps man by himself cannot help it. As Ashby points out, the evolution of man's intelligence is now on a plateau. Computing systems are needed

[Please turn to page 31]

# ANNUAL COMPUTER CENSUS

John Diebold and Associates, Inc.
New York, N.Y.

(Reprinted with permission from *Automatic Data Processing Service Newsletter*, March 3, 1958, published by John Diebold and Associates, Inc. 40 Wall St., New York 5, N.Y.)

In the late 1940's a prediction was made that "fewer than a dozen electronic computers will be able to satisfy the entire computational requirements of this country." Whether or not use of a computer would have improved the accuracy of this forecast will never be known. What is known, as a result of a census of digital computer installations completed in February by the research staff of John Diebold & Associates, Inc., is that a total of 241 large scale and 1036 medium scale computers have already been installed. When added to the 4,720 small scale machines in the field, a whopping total of nearly 6,000 digital computers is reached.

That even this impressive total is not yet satisfying the "entire computational requirements of the country" is evident in the approximately 3,267 (279 large scale, 1,321 medium scale and 1,667 small scale) computers currently on order from U.S. manufacturers. Clearly, the digital computer has arrived as a working tool of business and industry. To the engineering development of the 1940's and scientific usage of the early 1950's has been added a new phase — major and widespread business application.

The figures presented in the accompanying tables understate the number of actual digital installations for the following reasons:

"One of a type" general purpose machines, primarily built for scientific and engineering work, are not included. This should account for something in excess of 60 additional machines, primarily large scale. Special purpose machines are not included. Depending upon definition, the number of these would vary widely. They would fall predominantly into the medium and small scale categories.

An undetermined number of special military computers, such as the truly giant Sage computers, are not included. A significant number of classified machines are known to exist.

Computers of foreign manufacture have not been included. A census of these is now being conducted by John Diebold & Associates, Inc./Europe, and will be published in a forthcoming issue of this newsletter.

How effectively all this hardware is being used is another matter. This question is the subject of a major field survey by the research department of John Diebold & Associates, Inc. The results of this study are currently being analyzed and will be published shortly in this newsletter.

Computer manufacturers are considerably more chary these days about parting with "on order" figures than they were a year or two ago when many rather startling totals were freely bandied about. The current reluctance may well be due to anticipation of a declining rate of new orders during 1958 — a potential result of both the general economic recession and the soul searching already underway by many users as to the effectiveness of utilization of

### John Diebold & Associates Annual Computer Census

### LARGE SCALE GENERAL PURPOSE DIGITAL COMPUTERS

| *Manufacturer* | *Computer* | *Delivered* | *On Order* |
|---|---|---|---|
| IBM | 701§ | 9 | 0 |
| | 702§ | 11 | 0 |
| | 704 | 72 | 200† (704, 705, 709) |
| | 705 | 73 | |
| | 709 | 0 | |
| Remington Rand | 1101, 1102§ | 10† | 0 |
| | 1103, 1103A | 25† | 15† |
| | Univac I | 36† | 12† |
| | Univac II | 1† | 30† |
| RCA | Bizmac I§ | 3* | 0 |
| | Bizmac II | 0 | 2* |
| Datamatic Corp. | Datamatic 1000 | 1 | 7 |
| Philco Corp. | Transac S-2000 | 0 | 4 |
| Burroughs Corp. | Datatron 220 | 0 | 9 |
| Total Large Scale Computers | | 241 | 279 |

†=*Unofficial estimate;* §=*No longer in production;* *=*Bizmac totals are for number of installations, not numbers of computers.*

### MEDIUM SCALE GENERAL PURPOSE DIGITAL COMPUTERS

| *Manufacturer* | *Computer* | *Delivered* | *On Order* |
|---|---|---|---|
| IBM | 650, 650 w/tapes | 750 plus | 1,200† |
| Bendix Computer Div. | G-15 | 104 | unknown |
| Burroughs Corp. | Datatron 205 | 81 | 70† |
| Alwac Corp. | Alwac II§ | 2 | 0 |
| | Alwac III§ | 6 | 0 |
| | Alwac III-E | 27 | 8 |
| | Alwac III-E w/tapes | 2 | 7 |
| National Cash Register | 102§ | 30 | 0 |
| | 303§ | 1 | 0 |
| | 304 | 0 | 6 |
| Remington Rand | Univac File Computer 0 | 12† | 29† |
| | Univac File Computer I | 3† | unknown |
| Underwood Corp. | Elecom 100§, 120§, 120A§, 125§, 200§ | 13 | 0 |
| J. B. Rea Co. | Readix | 3 | 1 |
| Monroe Calculating Machine Co. | Monrobot VII§, VIII§ | 2 | 0 |
| Total Medium Scale Computers | | 1,036 | 1,321 |

†=*Unofficial estimate* §=*no longer in production*

the computers they already possess. Manufacturers, of course, advance quite different reasons for their reticence to part with the "on order" figures. These range from IBM's antitrust consent decree, on the one hand, to Remington Rand's "against company policy."

### IBM Climbs Ahead in Large Scale Deliveries

IBM, still the leader in installations of computers of all sizes, has increased its portion of the total number of large scale general purpose computer installations by about 6%, raising it from 62% eighteen months ago to 68%, according to this survey and an earlier JD & A survey completed in September of 1956 (See ADP Newsletter Vol. I, No. 10). Remington Rand now shows 30% of the deliveries in contrast to 37% a year and one-half earlier. New machines such as Burroughs' Datatron 220 and Philco's fully transistorized Transac S-2000, the first of which is scheduled for installation in August of this year, could easily alter the large computer market picture. Additional installations of the Datamatic 1000 and the Bizmac II are expected to produce some additional changes.

### Bendix Climbs to Second Place in Medium Field

Bendix Computer Division of Bendix Aviation Corp., however, has climbed rapidly from fourth to second place in the number of medium scale computers delivered. With only 4% of the market in the earlier survey, Bendix now holds a 10% slice. IBM has dropped from 80% to 75% of this market, according to the recent survey. Remington Rand, slow in getting its File Computers into production, has just begun to figure in this market and still accounts for less than 2% of the installations. Burroughs Corp., formerly occupying second place in this market, scarcely has been able to maintain its long-standing 8% share of the medium scale computer deliveries.

In fourth place is Alwac Corp. with about 4% of the medium scale installations. National Cash Register, having discontinued its Model 102 some time ago, recently announced its readiness to take orders for the new fully transistorized NCR-304. (See Newsletter Vol. II, No. 20) Two companies, Monroe Calculating Machine Co. and Underwood Corp., have dropped out of the medium scale

SMALL SCALE GENERAL PURPOSE DIGITAL COMPUTERS

| *Manufacturer* | *Computer* | *Delivered* | *On Order* |
|---|---|---|---|
| IBM | 604 | 3,500 | |
| | 607 | 350 | |
| | 608 | 1 | |
| | 610 | 0 | 1,500† |
| | CPC | 60† | |
| | Ramac 305 | 20 | |
| | Ramac 650 | 0 | |
| Remington Rand | Univac 60 and 120 | 500† | 100† |
| Burroughs Corp. | E-101 | 164 | 30† |
| Royal Precision Corp. | LGP-30 | 102 | 15 |
| Underwood Corp. | Electronic Business Computer (formerly Elecom-50) | 12 | 10 |
| Monroe Calculating Machine Co. | Monrobot III§, V§ | 2 | 0 |
| | Monrobot VI§ | 9 | 0 |
| | Monrobot IX | 0 | 12 |
| Total Small Scale Computers | | 4,720 | 1,667 |
| Total All Sizes Computers | | 5,997 | 3,267 |

†=*Unofficial estimate* §=*No longer in production*

computer market, shifting emphasis to their small scale machines. J. B. Rea's total installations have not altered since the earlier survey.

### Royal Precision Shows Fastest Growth Rate in Small Market

Although occupying only fourth place, Royal Precision Corp. presents the fastest growing element in the small scale computer market. The remarkable performance of the firm is evidenced by reports of no LGP-30 installations eighteen months ago, 33 in July, 62 in October, and 104 this February. Still one notch ahead of Royal Precision is Burroughs Corp. which has more than tripled its deliveries of E-101 computers since the earlier survey. IBM, and to a lesser extent Remington Rand, are still the dominant elements in the small computer market. IBM's new 610 machine is very likely to soon take as leading a role in the small scale market as their 650 has in the medium scale field.

# Regulated Power Supplies for Computers

J. L. Fink
General Electric Co.
Rectifier Department
Lynchburg, Va.

THE AMOUNT of power consumed by computers is often large. Since a large portion of this power is closely regulated direct current, it is clear that good design of the power supplies is a project of considerable importance in computer development.

It was estimated in 1955 that there were more than 2800 electronic digital computers installed and performing work related to business operations. These machines represented an investment of more than $227 million; furthermore more than 1700 computers were then on order, representing a backlog of more than $186 million. In addition, large numbers of computers are being used in military and scientific applications. Now, three years later, the corresponding figures would be larger still.

The power requirements of some of the better known digital computers are:

Electrodata / Datatron / 19 kva
Elliot Bros. Ltd. / 402 / 6 kva
Bendix Computer Division / D-12 / 8 kva

International Business Machines Corp.:
607 / 9 to 11 kva
650 / 17 kva
702 / 75 kva
705 / 87 kva
Monroe Calculating Machine Co. / Monrobot / 3 kw to 75 kw
Sperry Rand:
Univac 60 / 10 kva
Univac 120 / 10 kva
Univac / 120 kva
Univac Scientific / 45 kva
Univac File Computer / 10 kw
Underwood Corp. / Elecom 125 / 15 kva

The object of this paper is to discuss the power supplies used in large computers.

A figure of merit for computers has been offered as a function of speed, storage capacity, reliability, and simplicity. The same general type of measurement may be applied to power supplies where the figure of merit may be considered as a function of regulation, rating, reliability, and simplicity.

More specifically the requirements of digital computer power supplies are listed below:

1. Good transient regulation against line and load transients.
2. Good slow regulation.
3. Low ripple.
4. Reliability.
5. Simplicity.
6. Stability against drift.
7. High efficiency.

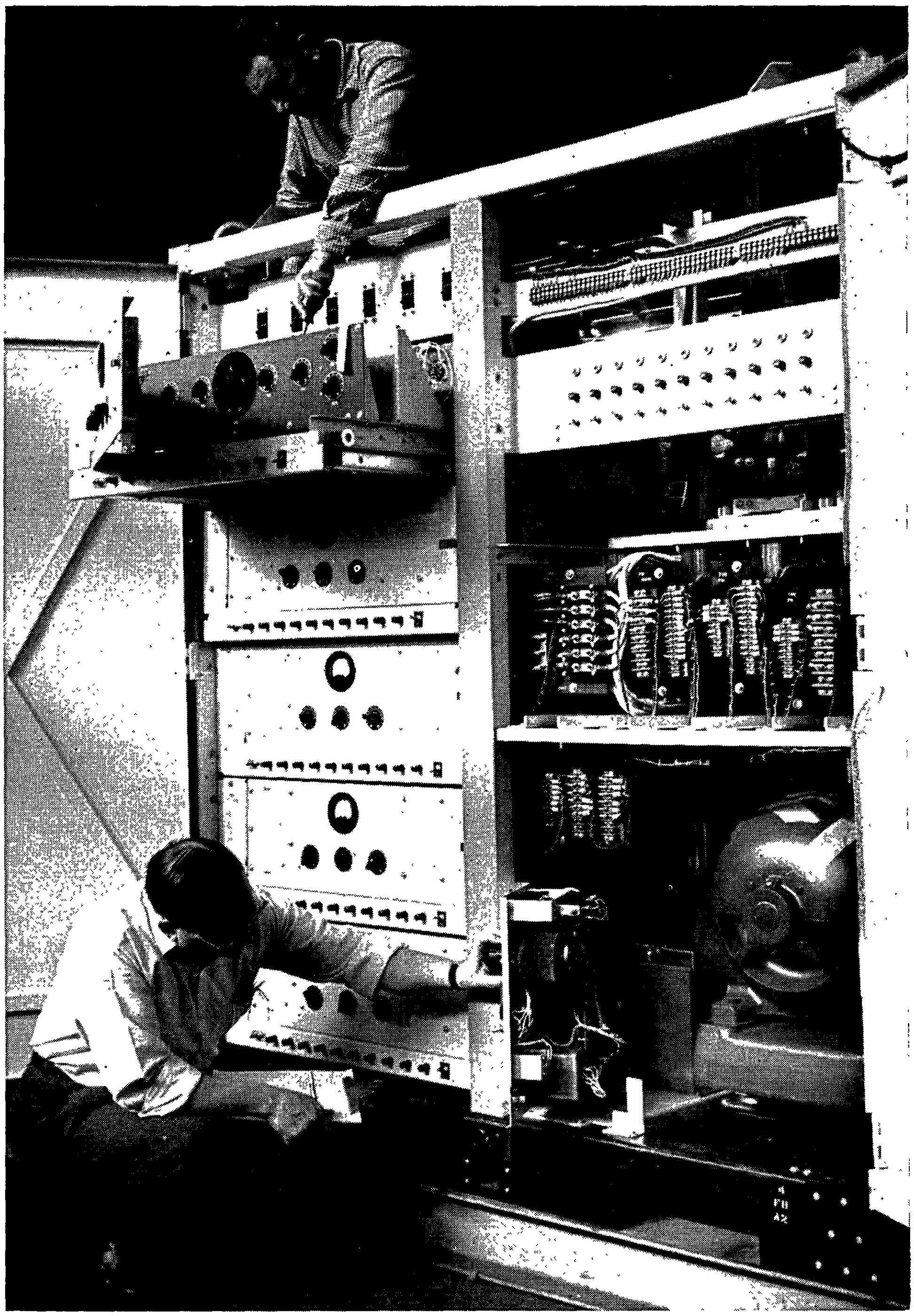


Figure 1

Part of a large computer power supply system, which furnishes 21 highly regulated dc output voltages and provides over 250 kw.

8. Low acoustical noise level.
9. Mechanical design features — portability, accessibility, and external appearance.
10. Auxiliary devices such as circuit breakers, sequencing systems, and fault indicators of various types.
11. Flexibility of electrical rating.

Of the requirements above, the most important is the electrical requirement of good transient regulation. This is due to the pulse nature of many of the computer operations. Any step variation of the dc source may trigger pulse circuits with false signals.

The requirement of good slow regulation is often debated since it is sometimes felt by power systems designers that electronic requirements are unnecessarily critical. The degree of regulation required by various computers seems to be governed largely by the experience of the circuit designers and no general limits can be given.

The slow regulation of the small tube-type power supplies such as are shown in Figure 2 is very good, and since most electronic breadboard circuits are developed using supplies of this type, it is easy to see why many circuits have been developed and approved with little thought being given to the general problem of generating and distributing precise voltages over large areas at relatively high current levels.

## Performance Characteristics

The two supplies discussed in detail in this paper are a magnetic amplifier regulated, static, selenium unit, and a regulated alternator type which utilizes a closely regulated motor-alternator set supplying unregulated germanium rectifiers. Both types are competitive with tube type supplies or dc machines in sizes of several kilowatts and up.

The first type of supply to be described was constructed for a military application and was designed to meet the following electrical specifications:

1. Slow regulation within 0.2% for all combinations of load from no load to full load with input line voltage variations of plus or minus 5% and frequency variations of plus or minus 3%.
2. Peak transient excursion of plus or minus 0.3% for a step change of 5% of the input voltage or a 20% step change in load.
3. Ripple of 0.3% peak-to-peak maximum.

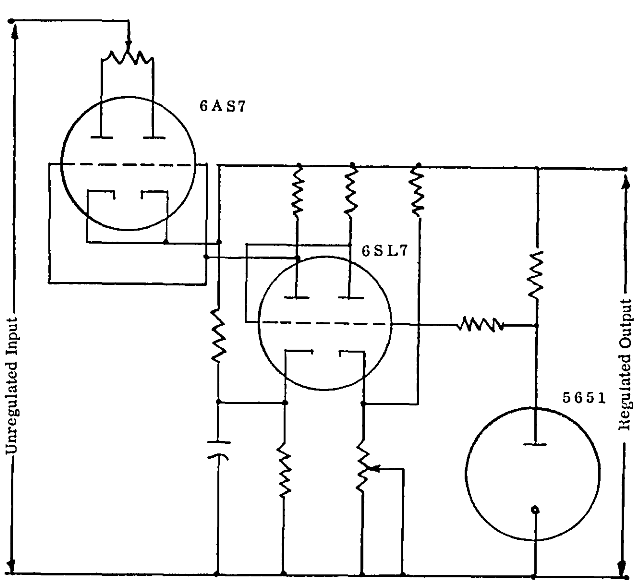
The rating of the supply described here was 150 volts dc at 300 amperes. This 45 kilowatt unit was part of a series of 11 power supplies with a total rating of 240 kilowatts and voltage ratings of from 10 to 600 volts dc. The balance of the supplies was built to overall electrical limits twice as liberal as the one described here in detail.

The design method used is of interest since a supply of this size and precision had not been built previously. The services of the Control Analysis Group of the General Electric General Engineering Laboratory were engaged to make studies of the proposed designs and then to prove the suitability of the final design by simulating the operation of the supply on an analog computer. This novel approach made possible the straightforward design of the components of the power supply with a minimum of concern over the practicability of the completed system.

The very short production time allowed on the order for this supply necessitated the manufacture of a large number of components based only on analog computer results. Fortunately, the analytical work proved to be highly accurate; the supplies when assembled and tested met the specifications with only a moderate amount of field adjustment.

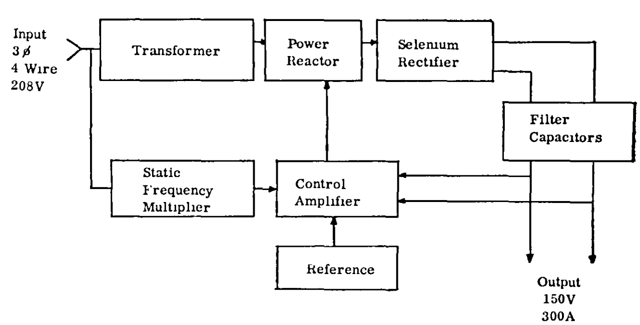
The system was required to be as reliable as possible. Accordingly proven components were used wherever possible; where necessary components were selected on the basis of freedom from sudden unpredictable failure. Therefore, every effort was made to eliminate vacuum tubes, relays, rotating machinery, and moving parts of all kinds. The degree to which this was attained is shown in Figure 3, which is the block diagram of the final circuit.

One of the important design features was the use of mercury batteries for voltage references because of their accuracy and freedom from sudden failure. The amplifier stages operated from 360 cycle power generated by a static frequency multiplier. A high frequency supply for the amplifier stages was selected since the gain of magnetic amplifiers is proportional to the power frequency and a short time constant in these stages was necessary in order to maintain dynamic stability.



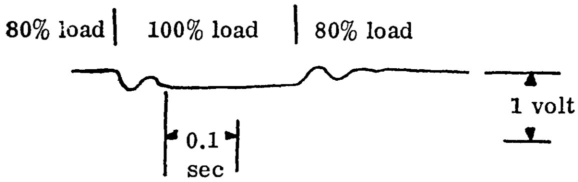

Regulated Power Supply

Figure 2




Block Diagram of Magnetic Amplifier System

Figure 3




Tracing of Transient Response Recording
80% to 100% Step Load Change
150 Volt, 300 Amp Supply

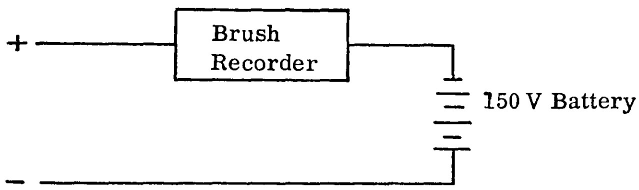



Figure 4

In order to filter the output voltage and to stabilize the system, a total of nearly 2 farads of electrolytic capacitors was connected across the output of the 150 volt supply. Of interest is the fact that approximately 32 farads of capacity were used in the 240 kilowatt installation. The capacitors were of a special high quality type and were arranged in trays with separate fuses for each tray to protect faulty capacitors from the enormous short circuit capacity of such an installation.

The power stage consisted of toroidal power reactors wound on grain oriented silicon steel cores. These reactors were connected as self-saturating magnetic amplifiers with selenium rectifiers. Selenium rectifiers were selected because of their known characteristics and freedom from sudden failure.

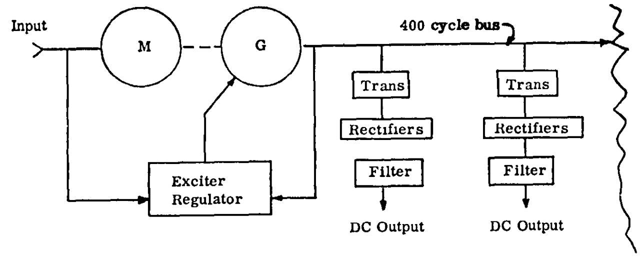
Actual test demonstrated that the supplies met the requirements of the specification. A transient response recording is shown in Figure 4.

Operating experience on this type of supply has shown that it leaves much to be desired in terms of simplicity, especially since very few people are as familiar with magnetic amplifiers as conventional tube circuits; but as a tubeless unit without moving parts and only one relay, it has met the requirement of reliable operation for which it was designed.

The second type of supply to be described was designed in response to the need for a less complex supply with less critical slow regulation limits, while maintaining good operating characteristics against line and load transients.

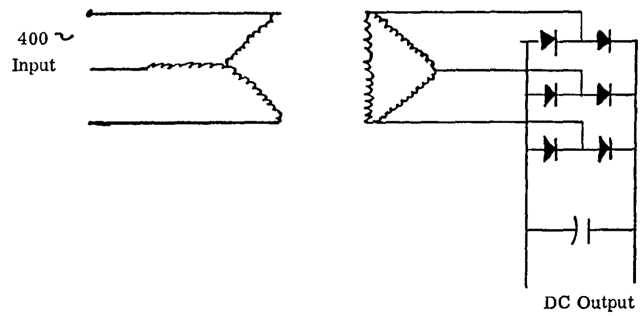
This second type of supply consisted of an induction motor driving an alternator, the output of which was held within very close limits by a static excitor-regulator of special design. The regulated output of the alternator supplied simple germanium rectifier circuits with good inherent regulation.

With this system it is possible to hold dc voltage within a plus or minus 3% band for all combinations of plus or minus 10% slow line voltage change, 10% step change of line voltage, 3% line frequency change, 50% to 100% slow load current change, and 20% load current step change. The 3% band includes peak-to-peak ripple.




Block Diagram of
Motor Alternator System

Figure 5




Individual Power Supply in
Motor Alternator System

Figure 6

## Comparison of Systems

The basic advantage of the second system is that the only closed loop regulator, with its attendant complexity, is in the excitor-regulator. All other supplies are simple circuits consisting of transformers, rectifiers, and filters. The simplification of the individual supplies is important since computers require from 8 to 14 different power supplies. A block diagram of this system is shown in Figure 5 and a schematic of a typical supply is shown in Figure 6.

In the design of computers, the power requirements are often not defined accurately until the design phase is well advanced; in some instances, only the measurements made on the complete system finally resolve the actual system rating. Despite this, the power supply is one of the first items which must be available as the computer is being assembled and tested. This places emphasis on the power system designer's ability to change voltage or current rating without delaying delivery or operation.

The flexibility of the motor-alternator system is outstanding, since any change in individual supply rating involves only a transformer, rectifier, and filter. For simple systems, such as the three-phase bridge circuit which is often used, the design parameters are well known and changes can be made with a minimum of engineering calculation. In order to hold the regulation and reactance of the rotating machine to levels compatible with the degree of transient regulation required, it is generally necessary to use a machine larger than that indicated by consideration of the power requirements of the dc supplies alone. This extra capacity often is useful when it is found necessary to make general changes in the rating of the power supply system.

As an example of what can be done, systems have been delivered in 14 weeks with a change occurring in rating of from 10 to 14 kilowatts and the number of supplies increasing from 12 to 17 only 8 weeks before shipment of the equipment.

Regulation curves of the motor-alternator system are shown in Figure 8. A transient recording is shown in Figure 8.

In comparing these two supplies with the ideal it should be noted that excessive emphasis on very close regulation is not always warranted due to losses in the distribution system. Therefore, even perfect regulation at the power supply is something less than perfect by the time the power is distributed over a wide area.

The magnetic amplifier type supply can hold slow regulation to a degree which cannot be approached by the motor-alternator system. The transient response of the two systems is not dissimilar. The efficiency of the magnetic amplifier system is about 78% at full load and the power factor ranges from 70% to 75%. The motor-alternator system has an overall efficiency of about 70% in the 15 kilowatt rating. The power factor is dependent upon the type of motor used. It would be possible to obtain a leading power factor by using an over-excited synchronous motor. In sizes of 100 kilowatts and above the overall efficiency will be approximately 80%.

### Rectifier Elements

It is of interest to compare the characteristics of the power rectifiers used in these supplies. The magnetic amplifier system utilizes selenium rectifiers while the motor-alternator system utilizes germanium. Selenium rectifiers have been manufactured commercially in the United States since 1938 and their characteristics and ratings are well known. Germanium rectifiers exhibit many superior electrical characteristics but are less well known, having been in production in power ratings for only a little over two years. Germanium rectifiers are smaller, have lower forward voltage drop, and less leakage current in the reverse direction than selenium by several orders of magnitude. In addition, germanium shows no tendency to age as does selenium. Aging is the gradual increase in forward voltage drop with time. This, of course, lowers the efficiency and regulation of the rectifier circuit. Germanium cells must be carefully protected against the effects of humidity and until very recently reliable hermetically sealed cells were not available.

It is thus seen in the magnetic amplifier type of supply the regulation of the rectifier cells was compensated for by the regulating system and the well-known characteristics of the selenium rectifiers were utilized. In the motor alternator system it is necessary to use germanium rectifiers in order to utilize their own forward drop in the meeting of the slow regulation specifications. Small hermetically sealed germanium cells are now available which have a very high degree of reliability. Larger ratings of these cells should be incorporated in the magnetic amplifier system and would result in an increase of efficiency due to the low forward drop while the low leakage would increase the gain of the power stages with a resultant improvement in overall circuit performance.

The silicon rectifier may well be competitive with both germanium and selenium in the future if its excellent characteristics can be duplicated at lower cost as production increases. Silicon cells can operate at temperatures of over 200 degrees Centigrade as compared with a maximum of about 100 degrees Centigrade for germanium. For long life, selenium cells are limited to approximately 80 degrees Centigrade though for short life application they can operate at temperatures of up to 150 degrees Centigrade. The physical size of silicon cells is comparable to that of germanium while their forward voltage drop per cell is only slightly higher.

The operating temperature is not of special importance at the present time in business computers and in military computers for ground use, but with the increasing use of air conditioning for the computer proper it may be found advantageous in some applications to locate the power supplies outside the airconditioned area, in which case the temperature characteristics of silicon would be of importance. Another advantage of the silicon cell is in the fact that thermal efficiency of a heat transfer system is higher when transmitting heat from hotter components to the cooling air. This means that it may be possible to utilize a smaller volume of cooling air with silicon cells.

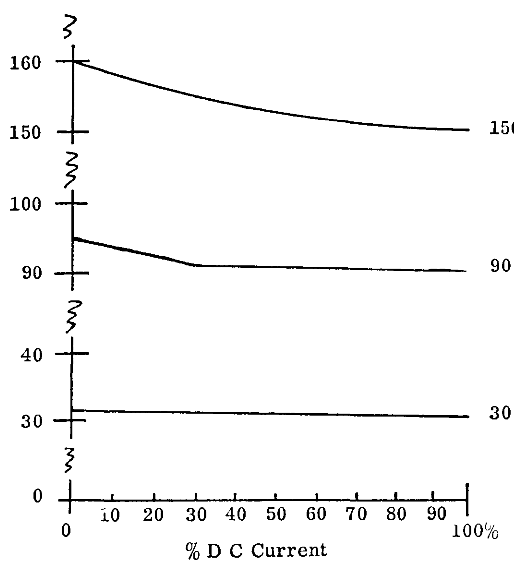



Figure 7

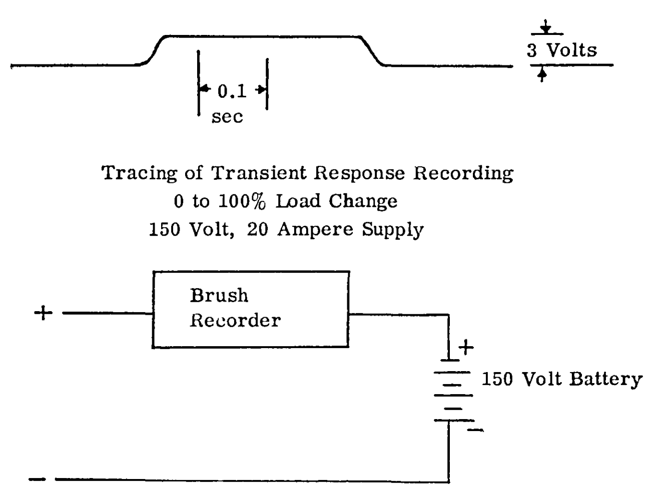



Figure 8

### Summary

In summing up the comparison of these two types of computer supplies it appears that as is often the case, the final choice is a matter of compromise. The most precise is the most elaborate and the simplest is the least accurate.

The basic disadvantages of the motor-alternator system involve the use of the rotating machine. If the slightly higher acoustical noise level and maintenance of the machine can be tolerated, it is the recommended system. It cannot match the slow regulation of the magnetic amplifier system from no load to full load, but in most computer applications this can be tolerated, especially if transformer taps are provided for precise voltage settings. In actual use the computer loads center about a point and the voltage can be set for this condition. The simplicity, serviceability, and excellent isolation from line transients of the motor-alternator system are such as to recommend its consideration wherever precise dc power is desired.

# A Component Case History:

# INFORMATION STORAGE DEVICES: A KEY TO AUTOMATION

## Part 2

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(Continued from the April issue, Vol. 7, no. 4, p. 13)

### Physical Methods of Storing Information in Devices

Many principles have been applied to information storage: heat, light, mechanical, chemical, acoustical, electrostatic, magnetic, and electronic. Based on these principles, many information-storage devices have been developed. Some of these are:

| | |
|---|---|
| Punched-card | Flip-flop |
| Punched-tape | Diode-capacitor |
| Relay | Thermal |
| Capacitor | Phosphor |
| Chemical | Cathode ray tube |
| Electrochemical | Ferroelectric |
| Magnetic drum | Nuclear resonance |
| Magnetic disc | Photographic film |
| Magnetic tape | Mercury acoustic delay line |
| Magnetic core | Solid acoustic delay line |

Only a few of these methods of storing information are of current importance. For primary and auxiliary memories, magnetic cores, magnetic drums, and magnetic discs are widely used. For external storage of information, magnetic drums, magnetic discs, magnetic tape, punched cards, and punched tape are widely used. Magnetic drums, magnetic tape, and acoustic delay lines are often used as buffers and delay lines.

Table I gives some characteristics of these four devices plus three others.

### Magnetic Core Memory

Small magnetic cores are used as the primary memory in all large-sized computers. The magnetic core is the only electro-magnetic memory which provides true random access, e.g., any specific bit of information can be obtained directly. The extremely fast access time of less than 10 microseconds makes the magnetic core the best primary memory for the large, very fast computers.

Magnetic cores have, however, many disadvantages. The foremost disadvantage is that of cost. Most core memories run over 15c per bit for the core assembled in the matrix. Automated assembly methods may possibly reduce the cost to the order of 1c per bit. Some research engineers think that by depositing a magnetic film, the cost could be reduced to a fraction of a cent per bit.

Each core handles one bit of information. This core must be separately switched into operation, energized and highly amplified to be identified. This requires extensive and complex electronic circuitry, which adds substantial cost to the complete magnetic core memory systems.

Other disadvantages include: sensitivity to temperature changes, poor shock resistance, high ratio of space to capacity, and extremely difficult manufacturing problems. In spite of this, the advantages of cores in access time alone establishes their use in the primary memories of computers today.

### Magnetic Drums

Magnetic drum memories are now used as the primary memories for most small and medium-sized commercial computers. Magnetic drums do not offer true random access, since a particular bit must usually travel one revolution of the drum before it is again accessible to the reading head. The reading head thus "reads" all of the bits in its particular track or channel. Since each bit passes under the heads at intervals from a few milliseconds to less than a millisecond, drums offer "simulated random access." This partial randomness of the drum, however, is one of its principal advantages, in that the magnetic reading head scanning all of the bits in a track or channel inherently provides by choice of time for reading a great deal of the switching which must be accomplished by electronic circuitry in the core memory.

TABLE 1. CHARACTERISTICS OF SELECTED TYPES OF MEMORY DEVICES

| Type | Status | Cost, cents per bit | Access Time, milliseconds | Capacity per Unit Volume | Reliability | Driving Circuits | Permanence with Power Failure |
|---|---|---|---|---|---|---|---|
| Acoustic delay line | Obsolete for primary and auxiliary memories | variable | 0.1 to 1 | Low | Good | Complex | Not permanent |
| Cathode ray tube | Obsolete | Over 1 | Under 0.2 | Medium | Poor | Simple | Not permanent |
| Magnetic drum | Widely used | 0.1 to 1.0 | 1 to 10 | High | Excellent | Simple | Permanent |
| Magnetic disc | Used in airborne computers and being developed for commercial computers | 0.1 to 1.0 | 1 to 1000 | Very high | Excellent | Simple | Permanent |
| Magnetic tape | Widely used | Under 0.001 | Over 1000 | Extremely high | Excellent | Simple | Permanent |
| Magnetic core | Widely used | Over 15 | 0.001 to 0.02 | Medium | Good | Complex | Not permanent |
| Ferroelectric | Experimental; not promising for use in next 10 years | — — | — — | Potentially high | — — | Complex | Not permanent |

Sources: (1) Trade Literature
(2) Battelle Staff

Magnetic drums offer considerable flexibility in systems design. A single drum may incorporate general storage, delay lines, and buffer memory. In general, the high reliability, high capacity per unit volume, low cost per bit and relatively simple electronic circuitry, have established the magnetic drum as a basic information storage device.

The only real disadvantage of the drum has been access time, due to the limitations on the rotational speed. Due to lack of mechanical know-how, the design of many magnetic drums has been somewhat abortive resulting in a lack of acceptance on the part of many systems engineers. Within the last three years, however, specialists in precision and high speed rotating equipment have entered the magnetic drum field and supply precise, reliable equipment.

Future developments in drum design will be extremely significant to the systems designer. Speeds beyond 100,000 RPM have been accomplished on development drums, using air bearings and head-to-drum spacing of one to five ten-thousandths of an inch. This permits higher packing densities and track densities, with the result that drums of the future will require a fraction of the space now required. Transistorized circuits and power supplies will further reduce the cost of the drum memory. These dynamic air bearings provide infinite trouble-free bearing life, and extremely high signal-to-noise ratio.

## Magnetic Discs

Magnetic discs operate like drums, except that discs offer greater recording area per cubic foot than do drums. Single discs have been used in certain airborne computers, and have been small in size, with fixed heads. Magnetic disc memories are likely to provide in the future extremely large information storage as in: inventory systems, subscription systems, banking systems, and the like. Such systems are very large and very active. Fast access time, random access, a high degree of reliability, and large capacity for the space, are required. It is possible that magnetic discs will supplant magnetic tape and large magnetic drums in many applications. One company is now producing a multiple disc magnetic storage unit serving as an auxiliary memory to a computer. Another company currently has under development a multiple disc unit which will be available in models of 100,000,000 bits or more. The cost per bit of systems such as these, the fast access time and reliability, make them competitive with tape, in many applications.

## Magnetic Tape

Magnetic tape is the external memory for most large electronic computers today. Data carried on punched cards, punched tape, or written documents are nearly always transferred to magnetic tape for computer input. Conversely, computer output is first recorded on magnetic tape even though the data are later transferred to some other media. At present, tape has no real competitors in this application. Punched cards and punched paper tape are too slow to keep up with modern large computers. Direct sensing of written documents is also likely to be too slow. Some claims have been made that photographic emulsions can provide higher packing densities than magnetic coatings, but the easy recording, erasing, and rerecording on magnetic tape are likely to keep it ahead of photographic film.

In a very real sense, magnetic tape competes with drum and other intermediate-speed memories. Access time is, of course, much greater with tape than with drums, but integration of several tape units, faster tape-handling mechanisms, and better programming can minimize or eliminate the need for intermediate-speed memories. One manufacturer of large-scale computers with core primary memories does not offer auxiliary drum memories as other manufacturers do. Rather this company has developed tape handling to the point where intermediate-speed auxiliary memories are unnecessary. This cannot yet be called a trend at present, but the possible threat to magnetic drums is clear.

The primary advantages of tape over other memory media are very low cost and very high capacity per unit volume. If the primary disadvantage of high access time is minimized, magnetic tape will find greatly increased markets during the coming 10 years.

# Pictorial Information Processed on a Digital Computer

National Bureau of Standards
Washington 25, D.C.

Exploratory experiments in manipulating the information content of pictures have recently been carried out on SEAC, the National Bureau of Standards Electronic Automatic Computer. With the aid of appropriate scanning and display equipment, the computer converts pictures into digital form suitable for input, processes the information according to some pre-arranged routine, and displays the results as a visual output. Experiments are being carried out by R. A. Kirsch of the Bureau's Data Processing Systems Laboratory to increase knowledge in the possible applications of high-speed electronic computers for picture processing.

The greatest impetus for the development of automatic data processing techniques has been the need to process at high speed alphabetical or numerical information. Ordinarily, such information exists already in digital form. If not, it can be translated into digits. In either case, it can be assembled manually to be fed into computers with suitable input devices. As a result of the great need for processing data of such conventional types, only recently has any attention been given to the use of general-purpose computers in conjunction with special-purpose input devices for gathering unconventional types of data. In particular, there has been a lack of investigation into the use of digital computers for automatically gathering and processing information that naturally occurs in the form of pictures, diagrams, or other graphical configurations designed for visual use by human beings.

Although considerable effort has been directed to problems such as recognition of printed alphabetical and numerical characters, this effort has been concerned mostly with the construction of specialized equipment for performing very specific functions. To provide more general information, the Bureau initiated a series of exploratory experiments involving the use of general-purpose digital computers to help understand the nature of pictorial information.

## Equipment for Input and Output

In order to feed pictorial information into SEAC, a simple mechanical drum scanning device is used to digitalize the information in a picture. The photograph to be scanned is mounted on a drum approximately ⅔ in. in diameter. As the drum rotates, a photomultiplier and a source of illumination mounted on a lead screw move parallel to the axis of the drum. The pitch of the lead screw is such that the photomultiplier moves 0.25 mm for each revolution of the drum. A mask in the optical system illuminates a 0.25-mm square, and a strobe disc produces optical pulses each 0.25 mm of drum rotation. Thus, the photomultiplier can examine the relative reflectance of each 0.25-mm square. Through the electronic circuitry of the scanner, a dark square on the picture is converted into a binary 1. A sufficiently white square produces a binary 0. The entire picture is scanned in 25 sec. or less. Since the picture is 44 by 44 mm, it is converted into 30,976 binary digits, occupying 704 words of SEAC's memory.

To display a picture that has been fed into the computer from the scanner, a program was prepared to derive a pair of coordinate numbers for the position of each binary 1 in the picture stored in the memory. When decoded, the numbers produce a pair of analog voltages that are applied to the vertical and horizontal inputs of an oscilloscope, thus generating a visual display.

## Processing Pictures on SEAC

In pattern recognition the aim is to reduce the amount of information to the minimum necessary for recognizing one pattern from a group of patterns. In these experiments the approach was to develop a library of computational processes for simplifying patterns in order to obtain their most significant features. Preliminary experiments were concerned with determining those manipulations which would prove to be the most informative. The compilation of discrete routines for the performance of these elementary manipulations would provide the basis of a flexible system for simulating many widely diversified pattern identification logics. After determining the intended course of his pattern analysis, the programmer needs only to refer to this file and to select those routines which in combination will best serve his purpose.

Furthermore, the analyst can sit at the computer console and draw from this tape library several routines which he can select pragmatically after studying the results of any preceding operations, and in this way guide the computer step by step toward recognition of the pattern being studied. Two forms of output can be distinguished in these routines — numerical data and transformed pictures. Numerical data can be read directly from the computer but pictorial information must be converted before it can be displayed by the picture output scope. The picture display routine is used in such cases.

One of the simplest routines in the library counts the total black area in a pattern. This program examines each bit in sequence and tallies when the bit represents a black area. Advantage is taken of the fact that in many patterns there will be numerous words that are all black or all white. By comparing whole words against constants of all zeros or all ones, much time is saved. The area counting process requires approximately thirty seconds on SEAC.

A routine was designed to count the number of objects in a picture. A black area is defined to be an "object" when it is completely surrounded by white areas. When a photograph containing 53 objects was fed into SEAC, the computer produced the correct count. Although some of the objects might be intuitively interpreted as two or more overlapping objects, this intuitive definition of an object was not used.

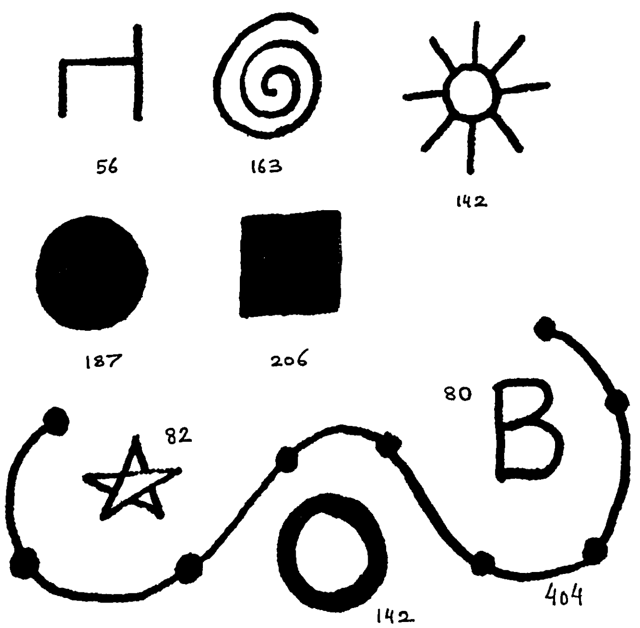
The routine for counting objects was not limited to counting solid, simply connected objects. When a picture of 9 abstract shapes was fed into SEAC, it produced the correct count even though the objects contained re-entrant profiles (i.e., a spiral) or were multiply connected (a letter B) or were interspersed among other objects. Another type of question that SEAC was programmed to answer involved evaluating the area of each of the objects counted. The area of an object was defined as the total black part of the object and did not include, for example, the white circle enclosed by a black annular area.

By combining the object-counting routine with the area-counting routine, it became possible to feed a picture into the scanner on SEAC to determine the number of objects having areas greater than a certain value. This eliminated specks of dirt from consideration. By a trivial modification of the program objects could have been counted and put into classes according to their areas.

### Simulating Complex Processes on SEAC

One of the most powerful features of a general-purpose computer with a picture input and output facility is the ability to study the performance of picture-procesisng mechanisms by simulating their behavior with a computer program. In this way mechanisms can be "tested" in some cases under conditions that would be difficult to create under laboratory conditions.

Automatic character-sensing (print reading) machines constitute a particularly important class of picture-processing devices. A study was undertaken of various logical schemes that have been proposed for the recognition of printed characters. A routine was written to study a character recognition logic based upon the identification of unique areas for each character in an alphabet. Under such a logical procedure for recognizing printed characters there are certain parts of each character which are black for that character and not for any other character. These unique areas serve to identify the characters.




A computer routine correctly counted the number of abstract shapes shown in this drawing (nine), and another computer routine determined the area (expressed in the number next to each shape) of each of the shapes, counted in squares one quarter millimeter on each side.

The routine that was proposed for SEAC to study this recognition logic compared several photographs of different characters and determined which parts of the viewing matrix were (1) black for all letters concerned, (2) white for all letters concerned, or (3) sometimes black and sometimes white. This last area is the only part of the whole viewing frame that can be used to identify characters. Studies can now be made of characters in different fonts to determine the percentage of useful recognition areas that characterize the different fonts.

One shortcoming in this routine is the fact that it produces results that are very sensitive to rectilinear translations of the characters being analyzed. To overcome this difficulty, a SEAC program was prepared that calculates the center of gravity of any picture and then shifts the picture so as to move the center of gravity to any desired place in the matrix — usually the center. The overlapping areas routine is being used to study characters that have been oriented with the shifting routine.

### Effects of Simple Operations on Pictures

Programs were coded for SEAC to perform simple operations on each of the spots in a 30,000-spot picture. In each of these operations only the immediate neighborhood of a spot was considered by the computer in determining how to operate on that spot. Simple routines of this type can readily be mechanized in the form of equipment, so experiments were performed to see whether such simple operations could produce important overall effects on a picture.

The first routine was one to add noise to a picture. It was coded so that random binary digits could be used to replace any spot in the picture. Another random number generating routine was used to determine which spots would be disturbed by the noise. The ability of the computer to simulate any desired type of noise distribution and to produce corresponding photographs enables quite elaborate studies to be made of the effects of noise upon ease of recognizing photographic information.

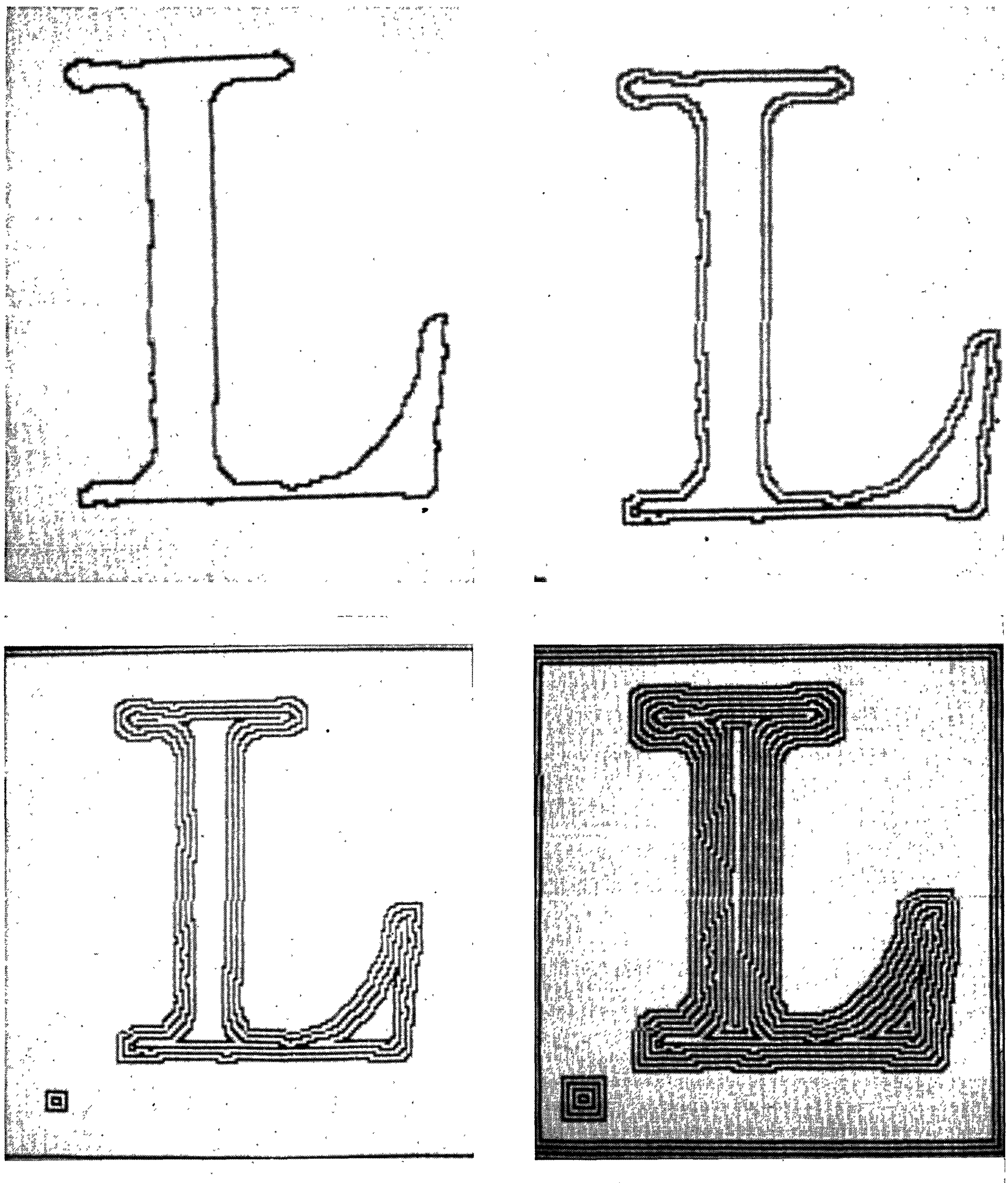
Another simple operation on pictures that produced unusual results was a kind of spatial differentiation. In this operation the computer investigates every black spot. If it is completely surrounded by eight other black spots, then it is converted to a white spot. In any other case, a black spot is written. The effect of such an operation is to preserve the boundaries of an image while erasing all the internal area. After doing this operation the computer inverts all the digits of the picture, that is, it converts black to white and vice versa. This constitutes one so-called "custer" of a picture. Even after custering 50 times, some traces of the image still remain. Additional trials show also that noisy figures seem to be stable under the custering operation.

### Other Picture-Processing Routines

In addition to these routines some other simple routines have been written. These include routines to superimpose pictures, to smear pictures by translating and superimposing them, to magnify pictures so as to make their fine detail visible, to record pictures in permanent form on tapes and wire, and a routine to analyze a set of pictures to determine the number of spots that are always black or always white in the set of pictures.

These experimental picture-processing routines serve mainly to illustrate the variety of picture-processing procedures that can be performed on a general purpose facility like SEAC with its picture input and output. In addition to these experimental investigations, studies have been made of the feasibility of programming SEAC to demonstrate some picture-processing operations of considerable practical importance. In each of the following cases these studies have shown that SEAC could be programmed to do the operation described, although none of the programs has actually been written.

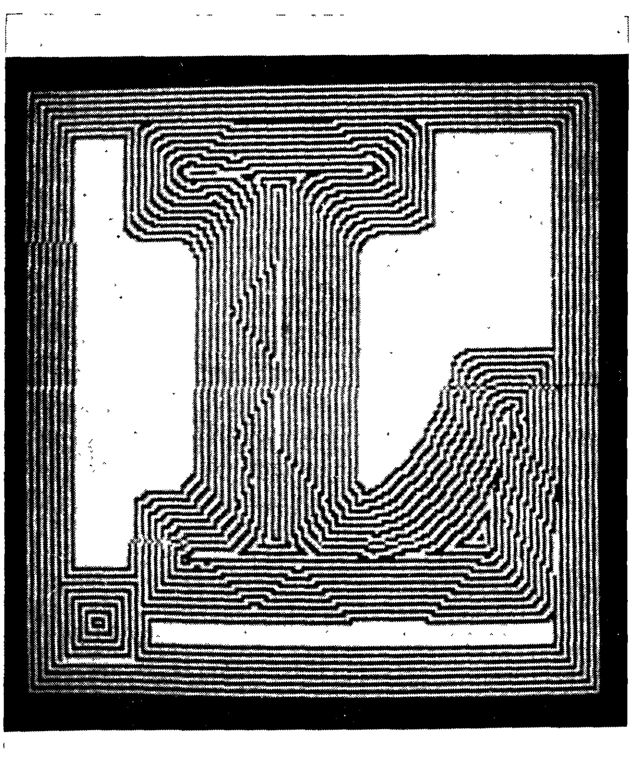
1. *Automatic coding of chemical and electrical diagrams.* For purposes of storage of information, pictorial representation of diagrams is very inefficient. For example, in a pic-



ture of the size used as SEAC input one could represent a simple transistor oscillator schematic or a structure diagram for the chemical compound phenol. But the useful information in each of these cases is no more than about 100 or 200 bits (binary digits), whereas 30,000 bits are needed in the picture. Thus a machine procedure to accept a photograph and produce a coded output for storage by a computer would result, in this case, in a storage capacity requirement of less than one-half percent of that needed for storing the picture.

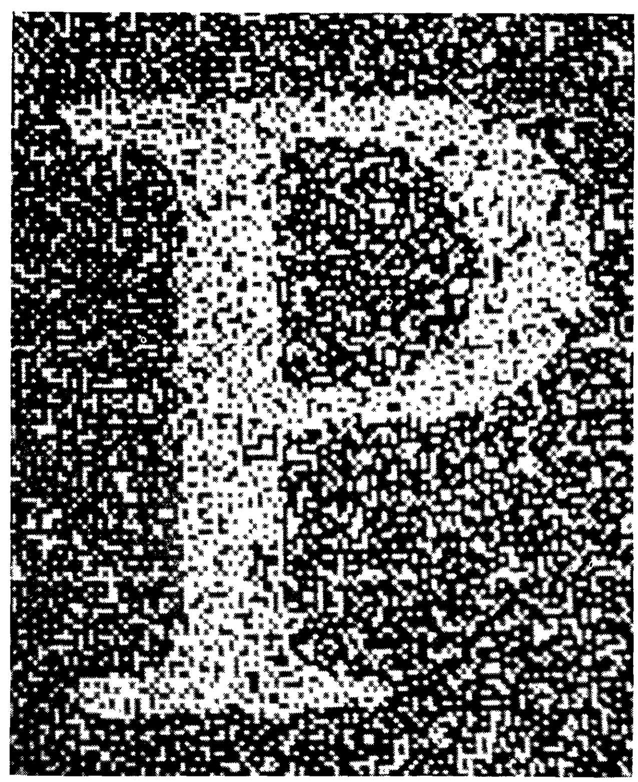
2. *Simulation of logical procedures for recognition of printed characters.* If the more complex recognition schemes were programmed and analyzed, the result might be a saving in equipment construction costs since a simulated test might lead to radical changes in a piece of proposed equipment.

3. *Photogrammetric analysis of stereographic photographs.* The intended purpose here is to produce contour maps from photographic information. There is reason to believe that it may even be possible to do photo interpretation by machine. This would require that a program be prepared to recognize and classify objects in an aerial photograph in order to superimpose cultural information on a map or to provide various other types of overlays. Some of the problems encountered here border upon the subject that has come to be known as "pattern recognition," and further research is still needed in this area.



The series of L photographs demonstrates the changes in the typewritten letter L when subjected to the "custering" process a number of times. Essentially this process preserves the boundaries of an image while erasing the internal area. Note how speck of dirt in lower left corner apparently grows as picture is "custered" many times.

For further technical information, see "Experiments in processing pictorial information with a digital computer," by R. A. Kirsch, L. Cahn, L. C. Ray, and G. H. Urban, Proceedings of the Eastern Joint Computer Conference, (IRE-AIEE-ACM), 1957.



The typewritten letter P with random digits superimposed upon it was "custered" 8 times. Note that practically no changes occurred.

# The Special Purpose Computer ERMA for Handling Commercial Bank Checking Accounts

## Part 1

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 PROGRAM for ERMA (Electronic Recording Machine Accounting) is now seven years old. The prototype machine ERMA I was first operated late in 1955 and completed its tests under banking conditions in the early part of 1957. Decisions regarding the future of the engineering model have been made; the general character of its successors has been established; and Model II of ERMA will soon be in production.

The contract between General Electric and the Bank of America for the production of systems gives assurance that the equipment will be in operation on a very large scale. Hence, the story of ERMA today not only presents an account of this particular solution to a specific, extremely important problem of commercial banking, but also displays broad hints as to what business can expect of data-processing machines and some of the problems attendant to their development and eventual widespread use.

### The Origins of ERMA

Machines, like most men, are products of their day. They can best be interpreted or evaluated in terms of the environment existing during their development. Certainly this is true of ERMA.

Early in 1950 Mr. Clark Beise, now president of the Bank of America, was concerned about the growing problem in large banking systems of the accounting in connection with commercial checking accounts. The remarkable accomplishments of electronic computers were being reported; might computers, he wondered, be the answer to the banking problem?

Accordingly, the Bank of America, in discussions with SRI staff, posed two questions: Was a machine to perform bank accounting functions technically possible? If so, could it conceivably be acceptable in cost?

No machine remotely resembling what would be required to serve the bank's needs had been attempted. The computer art generally was still in a comparatively kindergarten stage by today's standards. In spite of these facts, the feasibility study, issued by SRI in May 1951, was sufficiently encouraging for the Bank of America to authorize a major development, one that would require several years to complete and cost a large sum of money.

### Status of the Computer Art in 1951

Considered in the light of the electronic-computer art in 1951, this was a large undertaking. Success was not assured. Computers, for all their awe-inspiring abilities of rapid computation, had comparatively little facility for the problems posed by bank accounting. No large-scale electronic machine for any bank was under development. Computers then in operation had been designed for scientific calculation. They possessed extremely limited input and output facilities, but had extensive capacity for internal calculation. A large accounting machine, however, must accept large amounts of input information and deliver corresponding quantities of data. Day-by-day dependability for long periods had not yet been achieved and delays of a few hours or a day or so with scientific computers were being tolerated. A business machine must operate in synchronism with the business operations; reliability is of first-order importance.

Many basic components needed in an accounting machine and taken for granted today were non-existent or in an early state of development. Magnetic-core memories were only in the laboratory stage. Magnetic-tape memories had been built but little was known about their reliability for business use. The banking machine would require magnetic drums larger than had yet been used. Transistors were available from pilot manufacturing operations in limited quantities, but were not yet trustworthy as to characteristics. No machine capable of the speeds needed for printing output data was in sight.

These deficiencies in components and techniques presented challenges to the designers. They called for considerable courage on the part of the Bank officials to authorize an obviously long and costly development program in which success was not assured.

### The Banking Problems

The problem posed by the bank for solution by machine included all accounting that normally attends many thousand commercial checking accounts of a bank. Such a machine must be able to keep record of deposits and withdrawals for each client, make current-balance information available at an instant's notice, watch for overdrafts, stop payments, and held funds. It must be able to provide, on strict schedule, periodic statements of the account along with the accumulated checks. The machine must not only perform all necessary voluminous arithmetic but also handle the paper documents in whatever physical condition they exist after passage through many hands. All machine operations must, furthermore, be as exact as banking accounting calls for and be in constant step with hourly, daily, and monthly routines of the banking system.

### The Engineering Model

At the outset the engineers were faced with the dilemma that confronts all major technical developments. Should an engineering model be undertaken early or should the design be left open in order to accept the improvements in basic technology that were sure to come along? The merits of a full-scale working model were, as always, clear and strong. It would serve as an ideal testing ground for the system concepts. It would allow rigid evaluation of the reliability in hard service of the many new kinds of components and construction techniques contemplated. Also it would enable Bank of America personnel to become acquainted with the new operating requirements to be faced in the future. A working model of the equipment would help encourage enthusiasm of equipment manufacturers when the time came to contract for the construction of production models.

On the other hand, attempting to freeze hardware design at an early stage of development entailed hazards. Once long-range basic concepts and basic elements of design were established and a target date fixed for completion of a model, it would be necessary for the attention of the group to focus on that point, and, to a large degree, forego the benefits of improved techniques and components which lay (as always) "just around the corner."

Early in 1952 the decision was made to create a full-scale working model based on the most reliable techniques of the time, and a target date was accordingly established. The pilot model was to be one that could be expanded to encompass a full inventory of 30,000 accounts. It was to be constructed in a manner that would allow for its possible installation and routine use by the Bank after completion of the test program. Its design was to serve as a model for additional equipments under the production program.

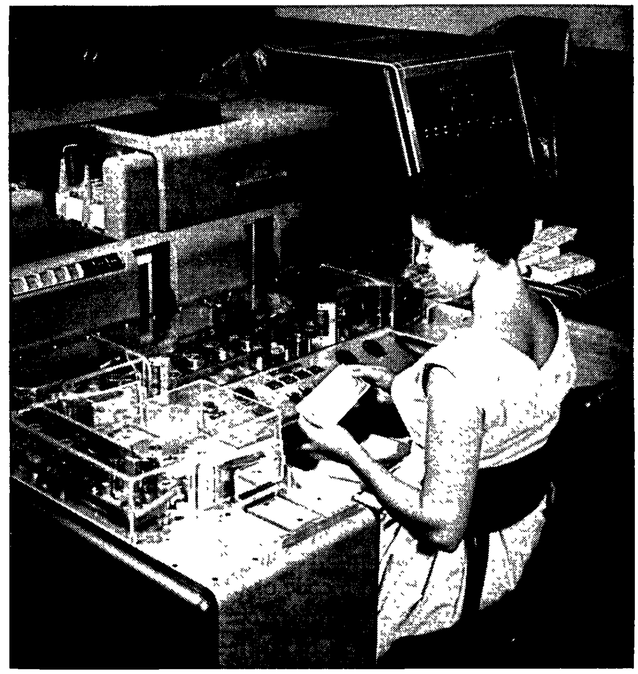
As concepts were converted to hardware specifications, the choice between transistors and vacuum tubes was typical of the decisions confronting designers. The urge to use transistors to achieve a design requiring less power, generating less heat, and with the obvious advantage of smaller volume, was nearly irresistible. In fact, only after parallel developments using transistors and tubes had been carried for several months did circuit designers reluctantly admit that the state of the art in production of transistors left little hope that a sufficient number of reliable units would be available as needed. Transistors would have to wait for Model II.

At the outset it was recognized that the development, construction, and testing of such an imposing array of electronic hardware was an expensive and time-consuming effort. Major components, adapted to the kind of system proposed, were in many cases not available, and would require extensive efforts in the laboratory. Liaison with prospective manufacturers was needed before usable units could be obtained for a construction program.

An intensive survey was made of manufacturers and of equipment that was similar in nature to that indicated in the basic logical design. Only those elements were developed at the Institute that could not be purchased or obtained by cooperative development with manufacturers.

## Printed-Character Reading and Paper Handling

Two problems, absolutely basic to successful operation of an accounting machine, were without easy or obvious solution. One was enabling the machine to read the necessary information from checks, deposit slips, and other routine documents. The other was the necessity of physi-



cally handling tens of thousands of pieces of paper daily in normal routine work. Any real solution to the general problem of better handling of the Bank's commercial checking accounts would have to begin with the "impossible" assignment of providing fully automatic equipment that can pick up, transport, read, and sort or stack a wide variety of sizes and thicknesses of paper checks at high speed. Nor could it choke on checks creased, torn, or stapled.

Techniques involving photo-electric scanning of characters and codes printed in a variety of colors and with fluorescent inks were examined. All displayed a common fault. Such schemes were successful when tested in the laboratory under controlled conditions. However, when required to scan material on which the characters were overprinted with cancellation stamps, endorsements and the like, the error and reject rates rose to prohibitive levels.

*Magnetic-ink reading* — Breakthrough on this problem came with the development of techniques for reading magnetically characters printed in a black ink containing particles of a magnetizable oxide. Because the reading element is sensitive only to the magnetized ink, subsequent overprinting or visual obliteration has no effect on the machine's ability to read. The magnetic technique has the additional advantage that if two checks go through together — for example, if they are stapled, the magnetic read head, by reading through the top check, senses the second check. The machine thus rejects such a "double," making it almost impossible for two checks to go through simultaneously with the lower one undetected.

Obviously it would be highly desirable if the new-found ability of the machine to "read" information printed in magnetic ink could be incorporated into the engineering model on the basis of conventional appearing characters, specifically Arabic numbers. However, while development of machine techniques for reading Arabic characters appeared solvable, the problems were formidable. There was no assurance that these problems could be resolved without delaying the appearance of the Mark I version of the system.

As a consequence it was decided to "educate" the machine to the simpler task of electronically reading numbers printed in code instead of numerals. Meanwhile, a parallel development of Arabic-character reading was conducted with the expectation that it would be ready for inclusion in subsequent editions of the accounting machine. The problem chosen for the development of number reading was recognition of serial numbers on paid Bank of America Traveller's Checks.

This development has been successfully completed. The technique of reading conventional appearing numbers and symbols has been thoroughly tested, is in actual use on Traveller's Checks, and is available for application to production models of the accounting machine. Error rates on the circulated checks are so much lower than with the equivalent manual system that there is no precise way of measurement. The system can process 99.5 percent of the returned checks automatically.

The techniques of machine reading of characters printed in magnetic ink — both in a code of bars and spaces and in actual Arabic numerals — were demonstrated in July, 1956, to the Bank Management Committee of the American Bankers' Association. The recommendation of that committee led to the adoption of the principle of magnetic-ink character reading as a standard for all member banks.

*Handling Paper at High Speed* — Development of apparatus for handling the paper accurately and at high speed proceeded in parallel with that for character reading. An electro-pneumatic machine was designed, built, and tested by which cancelled checks, for example, can be rapidly sorted. Stacks of checks are fed to the machine, which removes checks one at a time, reads the number, and transports it to the appropriate bin according to the digit read. Very reliable sorting speeds of 600 per minute have been achieved and laboratory devices have handled checks at rates of over 3000 per minute. The prototype check sorter operates on the basis of reading numbers printed in code; however, no difficult problem of equipping future models for Arabic number reading is anticipated.

### ERMA Makes Its Debut

The engineering model of the electronic accounting machine, which meanwhile had been designated ERMA (for *E*lectronic *R*ecording *M*achine *A*ccounting), was given public and press demonstration on September 21, 1955. Its performance proved the soundness of the concepts and workability of the electrical and mechanical elements. After that, ERMA underwent the tedious piece by piece evaluation of components, shakedown tests of the printers, tape transports, keyboards, and circuits, and general preparation for the final evaluation.

The true test of ERMA began in the Fall of 1956. This was to process the accounts of a branch bank in the same manner — and at the same pace — that would be required if it was in use as a central accounting facility serving that branch and others. Except for a few false starts, which necessitated ironing out minor equipment difficulties, the tests continued for about three months. These day-by-day tests proved ERMA's ability to perform all accounting routines, and in synchronism with the records kept by the bank.

(To be continued in the July issue, since the June issue is the Computer Directory)

# An Attempt to Apply LOGIC AND COMMON SENSE TO THE SOCIAL RESPONSIBILITY OF COMPUTER SCIENTISTS

Neil Macdonald
New York, N.Y.

### Some Comments

From Edward I. Jordan
Poughkeepsie, N.Y.

In regard to discussing and arguing the social responsibility of computer scientists, I believe an occasional article on this is worthwhile; however, such subjects are usually treated with too much emotion and sentiment and too little logic and common sense.

From Carl Berkley
Great Notch, N.J.

As to discussing the social responsibility of computer scientists, it seems to me that computer scientists are just as unqualified as other people in the social sciences.

From Herbert B. Keller
New York, N.Y.

. . . I think that computer scientists have no special responsibilities as *computer* scientists, just the responsibilities of all scientists and citizens.

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In discussing the social responsibility of computer scientists, it is highly desirable to apply a maximum of "logic and common sense" and a minimum of "emotion and sentiment." Let us try to apply logic and common sense to this subject.

The arguments cited above appear to reduce to the following asserted propositions:

1. It is not reasonable to discuss the subject of the social responsibility of computer scientists more often than occasionally.
2. It is not logical for computer scientists to consider themselves qualified as social scientists, and the social responsibility of computer scientists is a subject belonging not in computer science but in the social sciences.
3. It is not logical that computer scientists should have special social responsibilities as computer scientists — they have only the general social responsibilities of all scientists and citizens.

### The Frequency of Discussion of a Subject in a Magazine

The first proposition that we need to examine is:

> It is not reasonable to discuss the subject of the social responsibility of computer scientists more often than occasionally.

How often should any subject be discussed in the pages of a magazine?

There is a natural frequency of discussion of any subject: the more important subjects are discussed often; the less important subjects are discussed seldom. The importance of a subject depends as a rule on the extent to which problems connected with it are urgently calling for solution.

In the period 1945 to 1952, computer people were faced mainly with such problems as fast computing by electronic devices, achieving a great increase in reliability, inventing a satisfactory rapid memory, and the persuading of businesses that computers could help in the solution of their problem.

In the years since 1952, the whole computer industry has been shaking down and becoming more mature and stable. Many of the big problems now deal with improving the application of computers. Also wide-ranging attention is being given to new kinds of applications of computers. In this issue of **Computers and Automation** for example, an analysis of pictorial representation by digital computers appears — an example of a new computer application. Problems of applications are mainly important now.

Of the various kinds of applications of computers, their applications to problems of society, and its chief representative, the government, always have been important and are steadily becoming more important. Government has long been one of the main users of computers, not only for military purposes, but also for civilian and scientific purposes. The United States Bureau of the Census was the first purchaser of a giant automatic electronic digital computer. The Atomic Energy Commission's investigations would be hamstrung without the use of automatic computers for solving problems.

At this particular time, for example, a good social application of computers would be to study problems related to the current economic recession in the United States. With more than 5 million people unemployed, a tremendous and irretrievable waste of labor time is taking place. It is clearly not a necessary waste nor a desirable waste; and if the problem is difficult to solve, there is all the more reason to apply computation, reasoning, and data processing machines to its solution. In large businesses that have computers, problems of decline in sales, falling off of income, search for possible new products, reallocation of productive facilities, etc., have all been solved on computers, for the benefit of the business. Why not do likewise for society? It would make sense to employ a good computing service and competent operations research men to calculate answers to questions connected with the recession. We can express the questions; much data is available; the methods of solution have at least partially been worked out; even relatively inefficient arithmetical methods can be used to give approximate answers with a fast computer.

Another example, out of many possible applications of computers to problems of society, is the important problem of rendering accessible the enormous flood of scientific books and technical papers flowing out in present-day publication. There is an urgent need to proceed on a large scale with the application of computing methods and data processing techniques to the social purpose of making information available.

There is good evidence, therefore, that computers have many important applications to the problems of society. If so, do computer scientists have a responsibility for doing anything in particular about these possibilities? Do they have a responsibility to society for calling attention to the possibilities, and recommending courses of action in regard to them?

In years past, computer scientists rang a large number of business doorbells, and displayed a great deal of initiative selling computers to businesses that did not know they wanted computers. And when certain atomic scientists found out about atomic fission, and realized its importance, they went to President Roosevelt and persuaded him to start the Manhattan Project. Both precedent and common sense are in favor of the thesis: computer scientists should take the initiative in pushing the social applications of computers.

A professional organization of computer scientists might very well appoint a committee to study the application of computers and computation to solve problems related to the current economic recession. Computer scientists, and especially those who are experts as well in operations research, scheduling problems, linear programming, etc., could make a large contribution.

Therefore, taking into account the importance of social applications of computers, and the social responsibilities of computer scientists to study and promote such applications, it seems to me that we should support the contrary proposition:

> It is logical to discuss often the subject of the social responsibility of computer scientists.

It is reasonable that computer scientists should share in the responsibility of finding and initiating new and socially useful applications of computers.

## The Qualification of Computer Scientists to Deal with Subjects Outside the Field of Computers

The next proposition we wish to examine is the second one:

> It is not logical for computer scientists to consider themselves qualified as social scientists, and the social responsibility of computer scientists is a subject belonging not in computer science but in the social sciences.

It is true that a scientist qualified in one field of science is not necessarily qualified in another field of science. But there are many exceptions, depending on the versatility of the scientist, the specific nature of the fields of science being discussed, and the specific problems being discussed.

In fact, even an ordinary man with common sense, as well as a capable scientist in another field, can often make pertinent and important criticisms of the statements of scientists (or experts) who question the qualifications of outsiders to criticize and judge. Indeed, it seems that attacking the competence of a critic instead of the validity of his arguments, is a favorite technique of those whose arguments are a little weak and who would prefer not to be criticized.

Now the science that studies computation, data processing, and the machines for these purposes is an unusual science. In reality, it is mathematics plus logic PLUS machines to do a great deal of the labor.

So the statement "computer scientists are not qualified as social scientists" is equivalent to asserting that "mathematicians and logicians with powerful calculating machines are not qualified as social scientists."

This statement therefore involves two questions: whether or not mathematicians can deal with problems in the social sciences; and how long a time it would take mathematicians to become qualified to deal with problems in the social sciences.

Mathematicians can, of course, deal with other subjects than mathematics, because mathematics is essentially the science of generality — the science of counting, measuring, calculating, reasoning, and estimating, without regard to the particular nature of the objects or entities one is momentarily dealing with. This is why the same numbers can be used to count marbles in a bag or to count planets in the solar system.

How much time would it take mathematicians to become qualified as social scientists? A fairly long time for a large collection of different problems, but only a short time for any one problem, or a small collection of related problems — because as soon as a mathematician has absorbed the conditions of a problem, he can begin to apply mathematics fruitfully to obtain its solution. In most cases a mathematician has begun to do good work on a problem after he has studied the conditions for a few days.

For example, a mathematician with a knowledge of probability and statistics can take in a problem about hazards and begin to make estimates of probabilities in a very short time. He can take in data about radioactive fallout, and discuss with authority the chances of wide deviations. He can take in data about the spread of nuclear weapons among more and more nations, and discuss with authority the increase of the probability of nuclear war. These are simple mathematical probabilitity questions founded on universal laws of nature. In fact, it might be argued that a scientist with thorough training in the exact sciences like physics and mathematics would regularly be well qualified to do good work in the social sciences, especially because he would be likely to resist the pressure of drawing conclusions from inadequate data and insufficient experimentation.

Of course, many of the problems in the social sciences are innately difficult problems to deal with. In most cases, this is because the instances being studied are hard to observe, and change a good deal while they are being observed. For example, an objective scientific study of children, and the conditions under which it is best to teach them how to read, is very hard to carry out. There is a lot of complex variability among children. And a parent most of the time is not a good observer of a child's behavior, which is continually being altered as the parent corrects the child, and as the child grows older. In many social science problems there is little data to go on and reliable observations are difficult to make. Therefore subjective interpretations abound and it is hard for either social scientists or mathematicians to get far.

But even so, there may be analogs of these problems to be found in large businesses, where they may have been studied scientifically by teams of operations research men and computer scientists. And this experience of computer scientists can advance them in the direction of being qualified as social scientists — if not for a very wide range of problems, then at least for some problems that are important.

So it seems to me that we have to support the proposition:

> Computer scientists like any mathematicians can quickly become fairly well qualified as scientists in other fields including the social sciences, when they absorb the conditions of the problems and applications they work on.

For after all, capacity to apply technique in new fields is the stock in trade of teams of operations research men, computer scientists, and mathematicians, such as is offered by a number of management and consulting services.

This being so, the question remains: "Is the social responsibility of computer scientists a subject that belongs not in computer science but in the social sciences?" This question is equivalent to: "Is the social responsibility of mathematicians a subject that belongs in the study of mathematics?" In this form, it can be answered "No" — but this does not mean that mathematicians need have no concern for the applications or effects of their mathematics. We shall proceed to discuss this next.

### The Special Responsibility of Computer Scientists for the Social Applications and Effects of Computers

The last of the three propositions that we wish to examine here is:

Computer scientists have no special responsibilities as computer scientists, just the responsibilities of all scientists and citizens.

Let us begin the discussion of this proposition with the inquiry "What are the special social responsibilities that computer scientists have already accepted?"

In the first place, computer scientists have already accepted at least some special social responsibilities. For example, a computer scientist when comparing the design of one kind of machine with the design of another kind of machine, appraises the designs objectively — not according as to how it may suit the doctrine of a political party. In fact, it is very unlikely that a computer scientist in the United States would fit his appraisal of machines to the doctrine of a political party, in the way that the Soviet geneticist Lysenko, during Stalin's regime, fitted his theory of the inheritance of acquired characteristics to the doctrine of the Russian Communist Party under Stalin.

On the other hand, in considering and appraising the possible applications of computers to problems of social planning, many computer scientists in the United States, I believe, might fit their views to the doctrine of one of the major political parties — more for unconscious reasons than conscious reasons, however.

In general, a computer scientist tries to do honest work, of which he can be proud. In addition, he accepts a loyalty and an honorableness towards his employer, to his colleagues, to his profession and professional societies, and to the customers that buy the products which he shares in constructing or applying. Often included among these groups as employer or customer are the military forces or the government.

But what about a loyalty and an honorableness towards his country as distinct from the government, and towards all of mankind?

Let us consider the story of a certain locksmith.

### The Story of the Locksmith

Once there was a man who was in the business of making locks and keys, and who was very skillful. One day a stranger walked into his shop and said to him "I want you to make a key which will open a certain safe." The locksmith said to him "Whose is the safe?" The stranger said "Never you mind whose is the safe. I will pay you handsomely for the key. I'll blindfold you, and take you to the place where the safe is. You can have all the tools you want — I'll pay for them — and you make me a key. Besides, while you make the key, you will have a chance to work out some intensely interesting scientific theories, and after the safe is cracked open, I will give you permission to publish some papers, those that don't reveal too much information. Think it over, I'll be back tomorrow."

So the locksmith wondered about the remark "Never you mind," and the blindfolding, and the secrecy; but he knew it was hard enough to earn a living; and the promises of the stranger sounded attractive and exciting. So he said to himself "Well, that fellow would just get another locksmith if I did not go," and so he decided he would go. And the next morning the stranger came for him, and he allowed himself to be blindfolded and went.

For several years the locksmith tried to open the safe, and then at last he succeeded. But the stranger did not allow him to look inside; all the locksmith saw was the door swing open. The stranger then said to him, "Here is your pay — now go away — and remember not to talk about this — or you will get into a lot of trouble."

After a few more weeks, the locksmith read in the newspaper that what the stranger had taken out of the safe was a supremely intelligent directing mechanism for flying weapons, from the size of a wasp to the size of an eagle, which would enable him to pinpoint and exterminate any person, any community, any town, any city in the whole world. And he read the stranger's declaration that henceforth the world was to do exactly what he commanded, and that any opposition to his commands or dictates would be precisely and completely destroyed.

### The Questions Presented

This story presents us with four questions at least: Is the story entirely fictitious and impossible? Was the stranger a criminal? Could the locksmith have recognized the stranger as a criminal? Did the locksmith do what was right?

The story of course is more parable than it is fiction. We know with sadness the many points where it agrees with the facts of past and current history, and predictions of the future.

As to the second question, it seems to me that it is not necessary for us to argue the criminality of the stranger because that has been settled, by the Nuremberg trial after World War II of the leaders of Nazi Germany. This trial is reported well in "Tyranny on Trial: The Evidence at Nuremberg" by Whitney R. Harris, published by the Southern Methodist University Press, Dallas, Texas, 1954, 608 pp. The book has an introduction by Justice Robert H. Jackson of the Supreme Court of the United States, who participated in that trial; and contains a full story of the trial of the German war criminals. The author Harris served as trial counsel on Justice Jackson's staff. The report is an extraordinary, breath-taking, and bloodcurdling story, worth careful reading today to show how and in what way the German state under Hitler planned, prepared, and carried out aggressive war under a thick screen of lies. Let me now quote from Chapter 38, "The Law and Aggressive War" (p. 514 ff.):

> . . . In the first few years of the thermonuclear age there has been placed in the hands of men a new power potential capable of such destructiveness as to threaten the users of the power as well as the intended victims. War has always been homicidal; now it has become suicidal. Civilization may see an end to war, because it cannot survive a renewal of war. The second factor [possibly causing the end of war] is the universal condemnation of aggressive war, of which the Nuremberg judgment is both source and reflection. For many years prior to World War II, the peoples of the world had thought of aggressive war as wrongful and wicked. The Nuremberg judgment gave expression to that feeling by punishing the individuals responsible for launching World War II.
>
> . . . The difficulty of applying the concept [of aggressive war] in close cases does not mean that the courts are powerless to recognize inexcusable aggressive action when it clearly occurs.
>
> . . . The defendants could not have been surprised as to the moral aspects of their conduct. No one sends millions to die without a qualm of conscience.
>
> . . . Aggressive war does not become defensive war by the simple act of calling it such.
>
> . . . The slaughter of civilians in concentration camps, ordered by Hitler, was a crime of Hitler, even though he directed this mass killing as head of the German state.
>
> . . . It is after all moral condemnation which underlies legal prosecution. The killing of innocent human beings by order of heads of states is subject to substantially the same moral blame whether it is the killing of civilian populations in connection with war or the killing of troops resisting unlawful aggression.
>
> . . . Of course, no one should be heard to assert absolute immunity for acting in accordance with the orders of anyone else, even in such a fundamental matter as war."

At almost the end of the chapter, the International Military tribunal is quoted:

> . . . "War is essentially an evil thing. Its consequences are not confined to belligerent States alone, but affect the whole world. To initiate a war of aggression, therefore, is not only an international crime; it is the supreme international crime different only from other war crimes in that it contains within itself the accumulated evil of the whole."

Harris continues:

> This statement is law, and what is more, "This law applies for all times, in all places, and for everyone, victor and vanquished." The initiating and waging of aggressive war is now indisputably criminal. No more important decision was ever made by any court.

It seems to me that this settles the second question, the criminality of the stranger; it settles the law and the morality; the wrongfulness and wickedness of aggressive war; of sending millions to die with or without qualms of conscience; the moral condemnation that underlies legal prosecution; and the impermissibility of arguing immunity for acting in accordance with the orders of someone else.

As to the last two questions, the responsibility of the locksmith for recognizing the stranger as a criminal and for doing what was right, there is no doubt that according to law a locksmith has to satisfy himself that a customer has a bona fide right to the locksmith's help in opening a safe. Locks and keys and safes have been in existence long enough for the judgment of society to agree that a locksmith must satisfy himself that a man who comes to him to open a safe has a good right to have the safe opened. The more valuable the goods in the safe, the more necessary is the examination of the stranger.

So much for the general argument. Now for a specific example. In the case of intercontinental ballistic missiles with hydrogen bomb warheads, three groups of scientists play the role of locksmith: the men who make the nuclear warheads, who are the atomic scientists; the men who make the rocket motors that will propel the missiles; and the men who make the guidance systems, the computer scientists. Let us talk about the computer scientist.

The computer scientist, according to law and morality, does not have the right to shut his eyes in regard to the stranger, no more than the locksmith has. Both have to keep their eyes open.

The computer scientist like the locksmith must judge the stranger. The stranger will not say what his real purpose is. The stranger, in fact, may be unable to say what his purpose is; he may be in the grip of strong psychological forces (paranoia, for example) that he has no understanding of whatever. Certainly Hitler did not consider that he was a psychopath. But deeds speak louder than words, and the locksmith must look at the deeds.

Therefore, let us set up a number of criteria, for the locksmith to decide what is the purpose of the preparations for opening the safe. For example, in the case of an arms race between two countries A and B, in order to decide what their preparations really mean, the locksmith can make up a long list of objective tests:

Test 1: Does country A have armed bases surrounding country B? and vice versa?

Test 2: Is country A (or country B) increasing or decreasing its military forces? expanding or contracting its testing of nuclear weapons? . . .

Test 3: What are the claims announced by each country for political or territorial changes, which probably can be obtained only by force?

Test 4: Can the economy of country A (and country B) remain stable and function well without heavy war preparations?

. . . . .

The computer scientist, like the locksmith, has the moral and legal duty to study these questions and answer them objectively. He does have a special responsibility because without him the safe cannot be opened.

And so we arrive at the proposition that it seems to me we have to support:

Computer scientists have a special social responsibility as computer scientists, more than and in addition to the responsibilities of most other scientists and citizens — the responsibility of the locksmith.

## The Avoidance of a Certain Logical Fallacy

In all the discussion and argument about the social responsibility of computer scientists, there is undoubtedly present in the minds of all of us a logical fallacy that is begging continually to be accepted as truth, because it is truth so much of the time. We want to go on with "business as usual." We do not want to see that "something new has been added." We want to work tomorrow and the next day on our usual problems and not think about the new ones. We do not want to act on the basis that something has really changed — that a new and most terrible power has come into the possession of the governments of the United States and the Soviet Union. As expressed in the statement of the National Committee for a Sane Nuclear Policy in November 1957 in the New York Times:

> In our possession and in the possession of the Russians are more than enough nuclear explosives to put an end to the life of man on earth.

We want to say "Yes, that may be, but somebody will do something about it, and I do not have to make any change in what I am doing."

The logical fallacy is the failure to respond realistically to a real change when a real change has occurred.

I know this fallacy is present in my mind — for even as I write this, I keep hoping and even half believing that I shall wake up from the bad dream I am having, and that when I wake up this fact will be gone, eliminated, false, vanished into thin air.

The same fallacy operated widely before World War II. In 1938, the government of Great Britain under Chamberlain and the government of France under Daladier, renounced their agreement with Czechoslovakia and told Hitler that it was all right for him to take the Sudetenland from Czechoslovakia, since Hitler said this was his last demand; and Chamberlain returned from Munich announcing "Peace in our time!" The governments of Great Britain and France were in the grip of this same fallacy, the failure to see that a new and very real and terrible change had actually occurred.

In one of the best books on logic that I know, "Applied Logic" by W. W. Little, W. H. Wilson, and W. E. Moore, published by Houghton Mifflin Co., Boston, this fallacy, the failure to acknowledge a real change, is given a name, "The Argument of the Beard." Let me quote from the book:

> In a sense, the *argument of the beard*, may be considered the opposite of the black-or-white fallacy. We are guilty of the black-or-white fallacy if we fail to admit the possibility of middle ground between two extremes. We are guilty of the argument of the beard if we use the middle ground, or the fact of continuous and gradual shading, to raise doubt about the existence of real differences between such opposites as strong and weak, good and bad, and white and black. . . . The fact that we cannot determine the exact point at which white ceases to be white does not prove that there is no difference between white and black.
>
> The very name of the fallacy is derived from the difficulty of deciding just how many whiskers it takes to make a beard. Surely *one* whisker is not sufficient. Possibly even 25 are too few. Then let us say that 350 whiskers make a beard. Why not 349? 348? and so on. We would have trouble determining an exact minimum. Does this fact mean that there is no difference between having a beard and not having one?
>
> . . . If a car can carry seven persons in an emergency, why not just one more? and if eight, why not just one more? By the argument of the beard, a car should be able to carry an infinite number of passengers.
>
> . . . This error . . . is especially pernicious in value judgments because it is frequently used to justify unethical conduct.
>
> We may guard against the argument of the beard by reminding ourselves that although a difference may be small, it is nevertheless so real that an accumulation of such differences may bridge the distance between great extremes.

Now a computer scientist may say:

> "Well, it makes no difference if I work on an early warning radar network, and the computers that go with it, because I help to defend my country against attack."

And another computer scientist may say:

> "I am not doing any worse than that fellow in the early warning radar network, because I am working on the guidance system for an air-to-air missile which can be used to knock down an

enemy missile to be detected by the early warning system."

And a third computer scientist may say:

"Well, it is true that I am working on the guidance system for an intercontinental ballistic missile, BUT it will only be launched if an enemy ICBM comes over to destroy one of the cities in my country."

And a fourth computer scientist may say:

"Well, I am working on the computations relating to the spread of poison gases, BUT I am very sure that my country will only use poison gas if the enemy uses poison gas."

And finally some kind of mistake occurs in the whole tragic pattern — information comes in that poison gas has been used when in fact it has not, or that an ICBM is on the way when in fact it is only a meteor, or some poorly maintained computer in a distant country has a failure (the situation that W. H. Pickering describes in "Machine's Mistake May Doom World" — see **Computers and Automation** for March, p. 14). Then all these fine differences count for nothing at all — ICBMs land on New York and Chicago, others land on Moscow and Leningrad, and at least 20 million human beings are dead — more deaths in two days from less than 10 bombs than all the deaths of World War II in six years from all weapons combined.

Reliance upon trifling differences, and inattention to the accumulation of differences, constitute the fallacy of the argument of the beard, the fallacy of failure to acknowledge a real and huge change.

We need to stop justifying our conduct on the basis of small differences that are really not important, and base our conduct on the real and huge differences that need to shake and change our basic assumptions. The atom bomb dropped by the Americans on Hiroshima in 1945, and the half ton Sputnik launched by the Russians in 1957, make a real and huge difference.

And if a single computer scientist has trouble thinking all this out logically, then let's have a committee of computer scientists to get together and think this out, and study the social responsibility of computer scientists, with due regard to objective evidence, the toughest of sound logic, and the most practical of common sense.

# NEW PATENTS

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THE following is a compilation of patents pertaining to computers and associated equipment from the "Official Gazette of the United States Patent Office," dates of issue as indicated. Each entry consists of: patent number / inventor(s) / assignee / invention. Printed copies of patents may be obtained from the U.S. Commissioner of Patents, Washington 25, D.C., at a cost of 25 cents each.

Nov. 19, 1957 (cont'd) — 2,814,006 / Edward E. Wilde, Wiesbaden, Germany / U.S.A. / An apparatus for decoding electrical pulses from digital to analog representation.
2,814,013 / Horst M. Schweighofer, Cedar Rapids, Iowa / Collins Radio Co., Cedar Rapids, Iowa / A bidirectional servomotor shaft positioning means.
2,814,031 / Roderic A. Davis, Hopewell Junction, N.Y. / International Business Machine Corp., New York, N.Y. / A magnetic storage keyboard.
Nov. 26, 1957: 2,814,437 / James R. Woodbury, Newark, N.J. / Bell Telephone Laboratories, Inc., New York, N.Y. / A translator for obtaining the binary coded decimal equivalent of a serial binary input number having a predetermined number of bits.
2,814,440 / Eric M. McWhirter and Frederick W. Warden, London, Eng. / International Standard Electric Corp., New York, N.Y. / A memory system.
Dec. 3, 1957: 2,815,168 / Arthur S. Zukin, Los Angeles, Calif. / Hughes Aircraft Co., Del. / An automatic program control system for a digital computer.
2,815,169 / Henry F. McKenney, Valley Stream and Richard C. Gilbert, Rego Park, N.Y. / Sperry Rand Corp., Del. / A secant solver computer.
2,815,454 / Philip Gilbert, Ferguson, Mo. / Universal Match Corp., St. Louis, Mo. / An electronic computing device.
Dec. 10, 1957: 2,815,913 / John H. Lucas, Caterham, Eng. / Powers-Samas Accounting Machines Lim., London, Eng. / An electronic binary adding circuit.
2,816,223 / Eldred C. Nelson, Los Angeles, Calif. / Hughes Aircraft Co., Del. / A binary coded flip-flop counter.
2,816,224 / Albert M. Skellett, Madison, N.J. / National Union Electric Corp., Hatboro, Pa. / A signal storage device of the Magnetron Type.
2,816,250 / John Reginald Acton, Beeston, Nottingham, Eng. / Ericsson Telephone Lim., Eng. / An electronic counting and computing arrangement.
2,816,256 / Murray J. Harpole and Thomas R. James, St. Paul, Minn. / An extrapolating servosystem.
2,816,448 / Bruce E. Dixson, Hawthorne, Calif. / Northrop Aircraft Co., Hawthorne, Calif. / A directional gyro.
2,816,451 / George A. Van Lear, Palos Verdes Estates, and William J. Glasson, Los Angeles, Calif. / Hughes Aircraft Co., Culver City, Calif. / Servo-Torquer System.
2,816,705 / Lewis L. Throll, Inglewood, and Joseph Allan Beck, Jr., Palos Verdes, Calif. / Alwac International, Bahamas, British West Indies / A computing device for producing a train of impulses indicative in number of the change in one variable corresponding to a predetermined change of a second variable bearing a continuous functional relationship to such first variable.
2,816,709 / Hans Barth, Palo Alto, Calif. / O'Dell Brothers, Mountain View, Calif. / A differential pulse counter.
2,817,071 / Harry D. Smith, Massapequa, N.Y. / Sperry Rand Corp., Del. / A failure warning device for servo systems.
2,817,072 / Kun Li Chien and Charles H. Propster, Jr., Haddonfield, N.J. / Radio Corp. of America, Del. / A serial memory system.
2,817,073 / John R. Sorrells, Hyattsville, Md. / U.S.A. / A multichannel tape system of storage.
2,817,078 / Sigmund B. Pfeiffer, New Providence, N.J. / Bell Telephone Labs., Inc., New York, N.Y. / A binary digital-to-analog converter for synchro devices.
Dec. 24. 1957: 2,817,148 / Allyn C. Vine, Woods Hole, Mass. / U.S.A. / An integrating device.
2,817,292 / Otto E. Kase, Stamford, Conn. / Sperry Rand Corp., New York, N.Y. / A card position selecting means.
2,817,477 / Samuel B. Williams, Brooklyn, N.Y. / Bell Telephone Lab., Inc., New York, N.Y. / An electronic computing device.
2,817,478 / William H. Newell, Mount Vernon, N.Y. / Sperry Rand Corp., New York, N.Y. / A computer for solving an equation having three independent variables.
2,817,479 / William H. Newell, Mount Vernon, Edward G. Burgess, Jr., Kew Gardens, Norman J. Zabb, Brooklyn, and Stamates I. Frangoulis, Flushing, N.Y. / Sperry Rand Corp., New York, N.Y. / Method and device for predicting values of a fluctuating system at a predetermined future time.
2,817,480 / Ewart M. Baldwin, Los Angeles, Calif. / Hughes Aircraft Co., Culver City, Calif. / An electronic data translating system.
2,817,481 / John Henry Beesley, Coventry, Eng. / General Electric Co., Lim., London, Eng. / An electrical pulse counting circuit.
2,817,757 / Edward Durbin, Valley Stream, N.Y. / Sperry Rand Corp., New York, N.Y. / An electronic switching circuit.
2,817,770 / Walter R. Oppen, Plandome, N.Y. / Sperry Rand Corp., New York, N.Y. / A power transfer circuit.
2,817,773 / Henry F. McKenney, Weston, Mass. / Sperry Rand Corp., New York, N.Y. / A magnetic pulse generator.
2,817,800 / George F. Schroeder, Paterson, N.J. / Sperry Rand Corp., New York, N.Y. / A system for eliminating time reference for synchronous motors used in conjunction with mechanical integrators.
2,817,801 / George A. Brettell, Jr., Newark, N.J. / U.S.A. / A plotting electric servo system.

# ADVERTISING INDEX

**Following is the index of advertisements. Each item contains: Name and address of the advertiser / page number where the advertisement appears / name of agency if any.**

2,817,824 / James E. Albright, Collingswood, N.J. / Radio Corp. of America, Del. / A card switching device.

Dec. 31, 1957: 2,818,017 / John Toggenburger, Hartford, Conn. / Underwood Corporation, New York, N.Y. / A combined typewriter and printing computing machine.

2,818,211 / F. Sutherland Macklem, Freeport, N.Y. / U.S.A. / A navigational computer and plotter for a mercator projection.

2,818,212 / Robert A. Oberdorf, Merchantville, N.J. / Radio Corp. of America, Del. / A card reader device.

2,818,322 / Robert T. Blakely, Lagrange, N.Y. / International Business Machines Corp., New York, N.Y. / A sorter for tape recorded data.

2,818,473 / Harold J. Geder, Wauwatosa, Wis. / Counter and Control Corp., Milwaukee, Wis. / An automatic program controller.

2,818,557 / Robert L. Sink, Altadena, Calif., Arvo A. Lahti, Scottsdale, Ariz., and Duncan N. MacDonald, Arcadia, and Milton L. Patrick, Anaheim, Calif. / Consolidated Electrodynamics Corp., Pasadena, Calif. / A digitizer apparatus for providing electrical contact closures in accordance with the rotational position of an input shaft.

Jan. 7, 1958: 2,819,017 / Richard C. Palmer, Pompton Plains, N.J. / Allan B. Du Mont Lab., Inc., Clifton, N.J. / An electrical circuit for performing division.

2,819,018 / Edward W. Yetter, Chadds Ford, Pa. / Sperry Rand Corp., New York, N.Y. / A magnetic device for adding and subtracting binary numbers.

2,819,019 / Edward W. Yetter, Chadds Ford, Pa. / Sperry Rand Corp., New York, N.Y. / A device for adding and subtracting binary numbers.

2,819,456 / Raymond Stuart-Williams, Princeton, N.J. / Radio Corp. of America, Del. / A memory system.

Jan. 14, 1958: 2,819,839 / Donald H. Jacobs, Brookdale, and Michael May, Chevy Chase, Md. / Donald H. Jacobs, Brookdale, Md. / A high speed register using gating circuits to bypass delay elements.

2,819,840 / Keith G. Huntley, Harlington, Hayes, and Eric L. White, Iver, Eng. / Electrical & Musical Industries, Limited, Hayes, Middlesex, Eng. / A binary counter and shift register apparatus.

2,820,186 / Leroy U. Kelling, Waynesboro, Va. / General Electric Co., New York / A director positioning system.

Jan. 21, 1958: 2,820,688 / Everett D. Philbrick, Jr., Beverly Hills, Calif. / Northrop Aircraft, Inc., Hawthorne, Calif. / A digital differential analyzer magnetic drum.

2,820,897 / Franklin R. Dean and Robert W. Brooks, Needham, Mass. / Computer Control Co., Inc., Wellesley, Mass. / A universal gating package.

2,820,937 / Max Fogiel, New York, N.Y. / ——— / A digital to analogue converter servosystem.

2,820,956 / William J. Rueger, Pleasant Valley, N.Y. / I.B.M. Corp., New York, N.Y. / A mechanism for forming a character pattern on a moving magnetic surface.

Jan. 28, 1958: 2,821,068 / George Orloff, Arthur E. Elmer, and Richard A. Chorley, Glouchester, Eng. / British Messier Limited, Glouchester, Eng. / A servo actuating system.

2,821,638 / Alan S. FitzGerald, Mill Valley, Calif. / ——— / A binary counting system.

2,821,653 / John N. Dyer, Oyster Bay Cover, N.Y. / Airborne Inst. Lab., Inc., Mineola, N.Y. / The method of storing electrical information in the form of distributed electrical charges.

## *Readers' and Editor's Forum*

[Continued from page 6]

which by assisting men in key governmental positions may enable them to act with greater intelligence.

What this would lead to we can only guess. But it might bring a worldwide system to observe preparations for war and knock down missiles coming from any source. Or it might lead simply to building redundancy into the controls of the ICBM's of both ours and our enemies so that they will not be unreliable. These possibilities suggest that the development of automatic computing controls, instead of precipitating a nuclear war, may help prevent it.