COMPUTERS AND AUTOMATION

CYBERNETICS · ROBOTS · AUTOMATIC CONTROL

Vol. 5
No. 9

Sept.
1956

The IBM Computer AN/FSQ-7 and the Electronic Air Defense System SAGE

Glass and Metal Honeycomb Type of Electrostatic Storage Memory

The Computer Age

An Ocean-Based Automatic Weather Station

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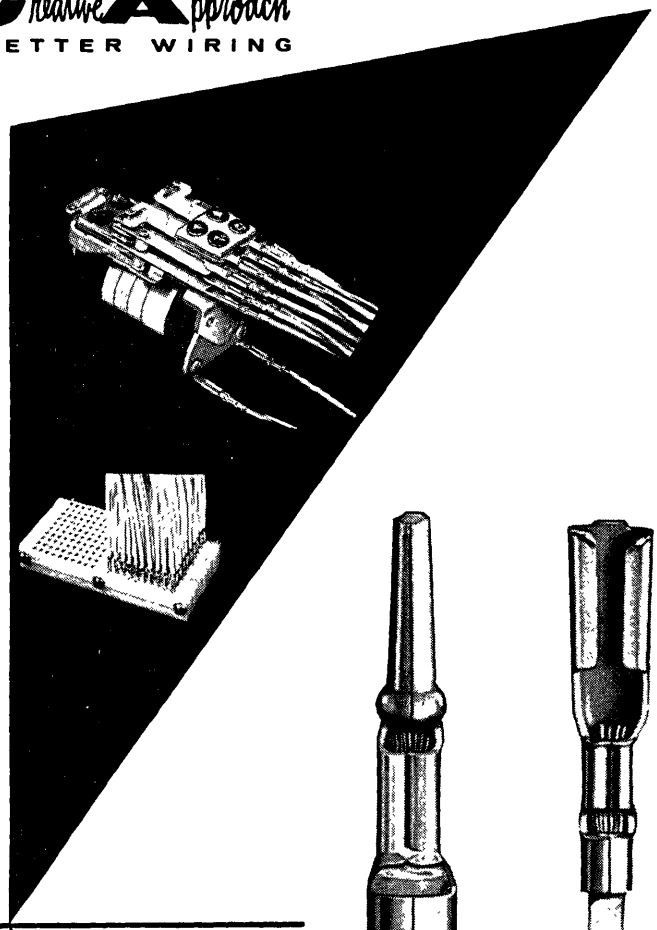

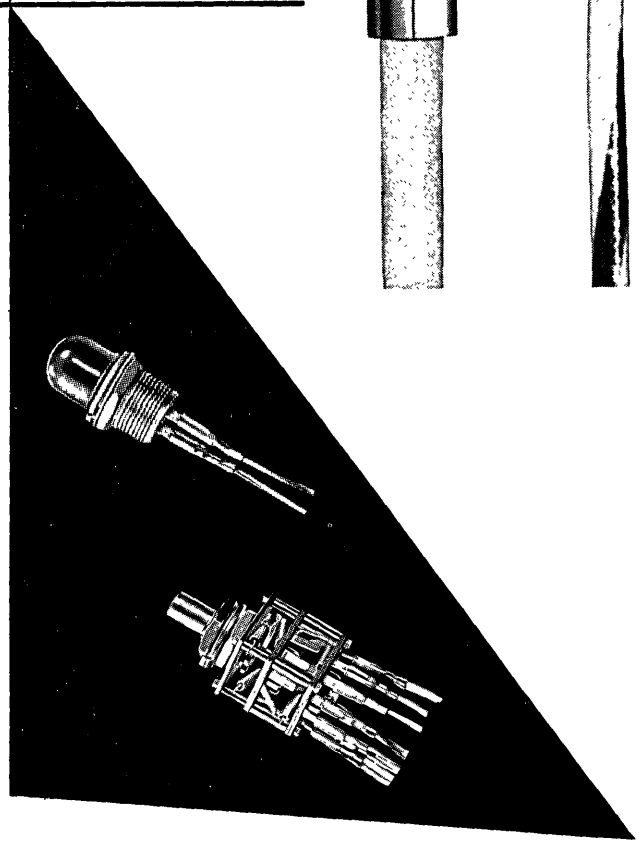

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COMPUTERS AND AUTOMATION

CYBERNETICS • ROBOTS • AUTOMATIC CONTROL

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THE EDITOR'S NOTES

WHO'S WHO IN THE COMPUTER FIELD

We have had several helpful comments and suggestions from our readers, in regard to publishing a cumulative and up-to-date "Who's Who in the Computer Field", as a business proposition instead of an eleemosynary one. People have told us that they want it and need it, in order to find out information about computer people. They have also told us that users of a Who's Who, not the persons listed within it, should pay the price, and the price should be set high enough to cover the cost. They suggested a partially separate publication of the "Who's Who".

Accordingly, we plan to publish this autumn 800 copies of Edition No. 2 of a cumulative up-to-date "Who's Who in the Computer Field", at a price of $15. It will probably be well over 100 pages long, since Edition No. 1 published in the June, 1955 issue of "Computers and Automation" was 95 pages long. Edition No. 2 will be published as an extra number of "Computers and Automation", and will not be included in the subscription (we now have 2400 subscribers). The first 800 paid orders to come in to us will receive the 800 copies; if more paid orders come in by October 10, we shall print a sufficiently larger number to fill those orders. A small surplus of perhaps 40 copies may also be printed.

We shall send out a mailing soon to all computer people we know of, collecting an up-to-date Who's Who entry from whoever wishes to send us one. We shall also gather up and publish again all Who's Who entries that we have published in "Computers and Automation" July 1955 and later. If anyone reading this paragraph wishes to send us an entry, he will find an entry form on page 14 of this issue. If the entry form has been used by somebody else, here is the information we want (written on any piece of paper):

1. Name (please print) / 2. Your Address? / 3. Your Organization? / 4. Its Address? / 5. Your Title? / 6. Your main computer interests? — Applications, Business, Construction, Design, Electronics, Logic, Mathematics, Programming, Sales, other (specify) / 7. Year of birth? / 8. College or last school? / 9. Year entered the computer field? / 10. Occupation? / 11. Anything else? (publications, distinctions, etc.)

(cont'd on page 35)

——————————————*

CORRECTIONS

In the July, 1956, issue, vol. 5, no. 7, in "The Editor's Notes", page 4, second column, first entry in the table, second column, the word "increasing" should read "decreasing", so that the first line of the table should read:

	Union of Soviet Socialist Republics	United States
1. Average number of students in class per teacher	19 or 20 and decreasing	34 or 35 and increasing

In the same issue, on page 28, in the left-hand column, top line, the last word should be "magenta-colored".

——————————————*

INDEX OF NOTICES

Address Changes: If your address changes, please send us both your new and your old address (torn off from the wrapper if possible), and allow three weeks for the change.

The First in a Series of Announcements on Progressive Expansion of Program and Facilities in Mathematics at the Knolls Atomic Power Laboratory:

GENERAL ELECTRIC'S

KNOLLS ATOMIC POWER LABORATORY

Announces

CONSTRUCTION OF A MODERN CENTER FOR MATHEMATICS

Because we believe that theory is our most powerful weapon in dealing with reality, we are expanding our Mathematical Analysis Program. One of the first elements in this expansion is the creation of a new and modern building for mathematicians and physicists, which will be the center of the Laboratory's efforts to meet by theoretical means the challenges of the nuclear energy field.

We are seeking men with strong mathematical training at all degree levels to participate in this expanding Numerical Analysis Program — a program growing not only in staff, equipment, and facilities, but also in concept and function. They will work in close association with our theoretical and experimental physicists. There are openings in each of the following fields:

RESEARCH IN MATHEMATICAL TECHNIQUES

Numerical solution of the diffusion equation for complicated geometrical arrays taxes even the most powerful electronic computers. Fundamental work in iterative techniques must be carried out.

FORMULATION AND EVALUATION OF THEORIES

Due to the nature of physical situations now being encountered, the rough approximations which were formerly adequate must now be improved. The ultimate test of such improvement is comparison with experiment.

APPLICATIONS TO REACTOR PROBLEMS

A broad program of computational tools for reactor design must be effected incorporating the best available techniques. Strong interests in computation and in machine properties are indicated. The program at Knolls offers the atmosphere, the equipment, the richness of subject matter and the material benefits conducive to a satisfying career in applications of mathematics.

A LETTER TO DR. S. R. ACKER, EXPRESSING YOUR INTEREST WILL RECEIVE IMMEDIATE ATTENTION.

Knolls Atomic Power Laboratory

GENERAL ELECTRIC

SCHENECTADY, N. Y.

THE IBM COMPUTER AN/FSQ-7 AND THE ELECTRONIC AIR DEFENSE SYSTEM SAGE

H. T. Rowe
International Business Machines Corp.
New York, N. Y.

The first large-scale computer for the nation's vast, new electronic air warning network is being shipped from the International Business Machines Corporation plant at Kingston, N.Y. to McGuire Air Force Base in New Jersey. It is a giant "electronic brain", and will become the first of many great computers to fit into an integrated complex of radar, ships, jet aircraft, communications networks, missiles, and people that is rapidly taking shape as a supersensitive continental air defense system.

This immense project is known as the Semi-Automatic Ground Environment (SAGE) system. It takes the abilities of some of the world's fastest electronic computers to receive information, to memorize, to calculate, and to record and present answers, and combines these abilities with the perceptive and display talents of radar to present an instantaneous graphic picture of the location, speed, and direction of all planes within radar range of one of the installations. With a knowledge of flight plans of friendly planes available in the computer, hostile planes can be identified immediately and the most effective defense action taken — again on the basis of computer information and instruction.

The computer was designed by International Business Machines Corporation at its Military Products Division Laboratory, Poughkeepsie, N.Y., in cooperation with Massachusetts Institute of Technology Lincoln Laboratory. It was manufactured at the company's Kingston Military Products Division plant. The plans for production were laid in 1953 by IBM. The first machine is being completed and shipped in accordance with the schedule.

The SAGE system starts with a radar ring — on land, on Navy picket ships at sea, on offshore Texas Towers, and on airborne early warning planes ranging far out over the ocean. These radars are linked by telephone lines or ultrahigh-frequency radio directly to the high-speed computer. Information about aircraft anywhere within the radar area is relayed continuously and automatically to the computer. The equipment is called the AN/FSQ-7; it digests all of this information plus Ground Observer reports, flight plans, and weather information as fast as it is received and translates it into an over-all picture of the air situation, and produces TV-like pictures. The pictures would show an air battle as it develops and would provide the basis for necessary human judgements.

The computer automatically calculates for the operator the most effective employment of defensive weapons such as guided missiles, anti-aircraft batteries, and jet interceptors. For example, jet interceptors may be controlled by directions fed by radio directly from the computer to the automatic pilot in the plane. Missiles may be controlled similarly. At any time, the commander of an air battle can have the computer display the over-all situation or whatever part of it he wishes to monitor in detail. As the battle moves, information is transferred spontaneously to an adjacent computer.

The SAGE computer built by IBM incorporates very advanced electronic components. One of these is a high-speed magnetic core memory. The memory is made up of thousands of tiny, doughnut-shaped cores. Several cores in a row store a single word or number, the identity of which is determined code fashion according to whether or not individual cores in the row are magnetized. Data may be "read" into or out of this memory in millionths of a second, sufficiently fast to deal with the speed of a hostile jet bomber; the computer also makes considerable use of other new and economical developments such as printed wiring and miniaturized components. Many fully automatic and semiautomatic production manufacturing techniques were used in the construction of the computer.

The AN/FSQ-7 is designed to operate 24 hours a day, 7 days a week. Facilities are provided so that preventive maintenance can be per-

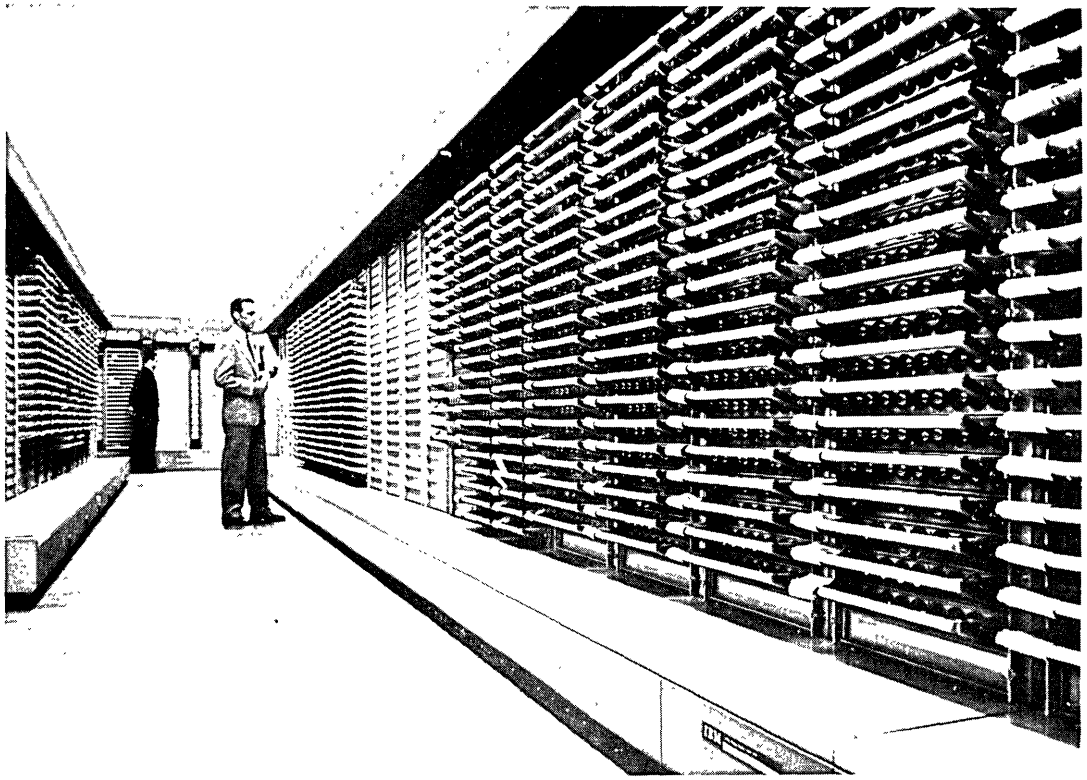

Figure 1 — Input Frames (Front View). Through these input frames all the radar information is processed automatically and continuously.

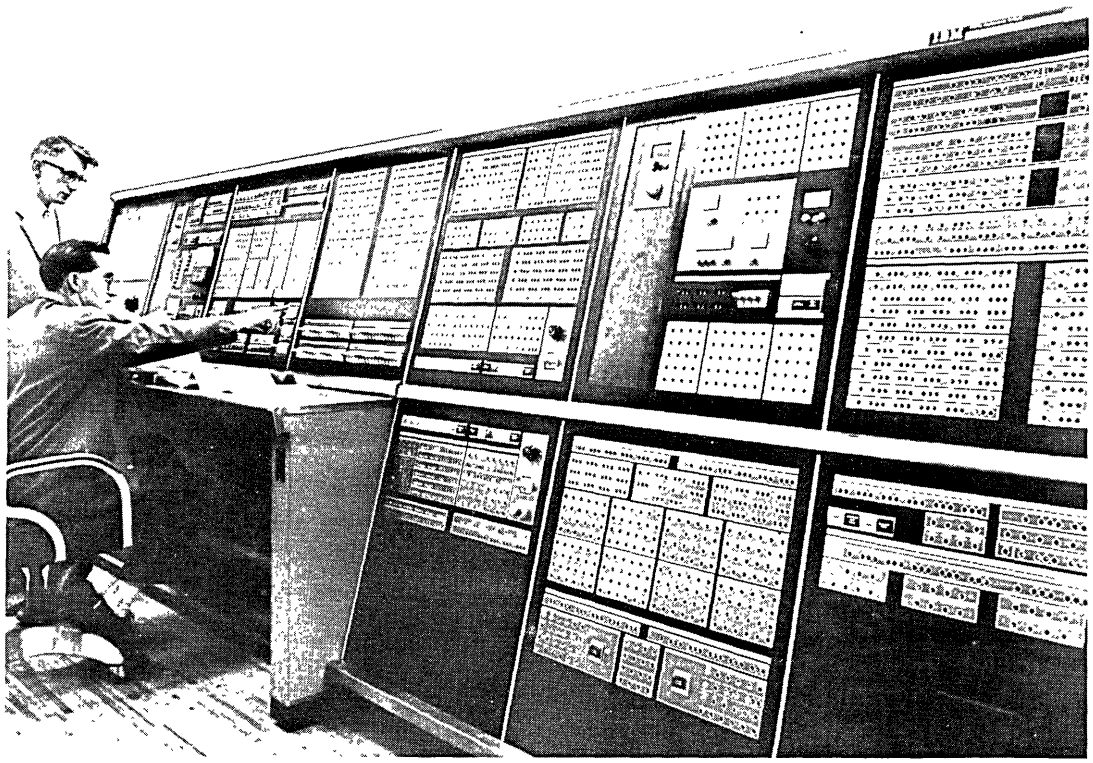

Figure 2 — Computer Operating Console. This console contains the controls for operating the computer. It displays the operating status of the equipment to persons who monitor the computer's operation.

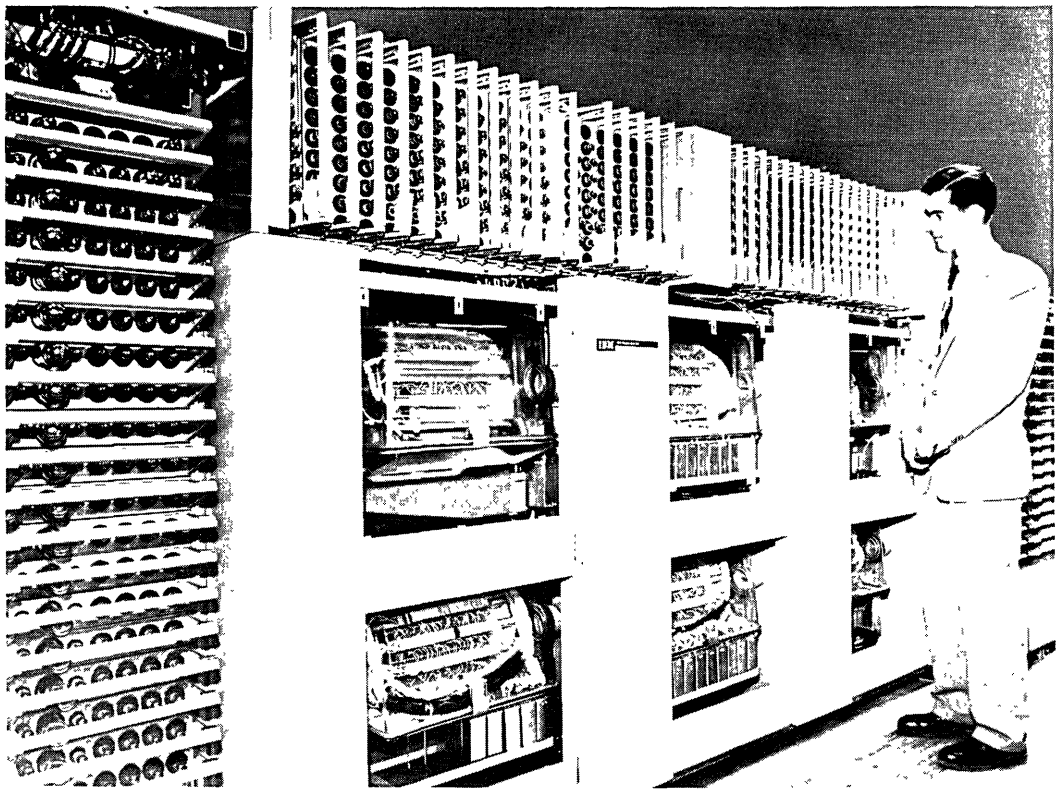

Figure 3 — Main Drum Housing Frame in Front. Selection Control Frame in Rear. The AN/FSQ-7 contains magnetic drums with a total capacity of millions of bits. All information which is processed through the machine is stored on the drums which act as a high-speed buffer storage.

The frame in the rear is the Selection Control Frame. The electronics of this frame will keep track of and control the operations of all the inputs and outputs of the machine.

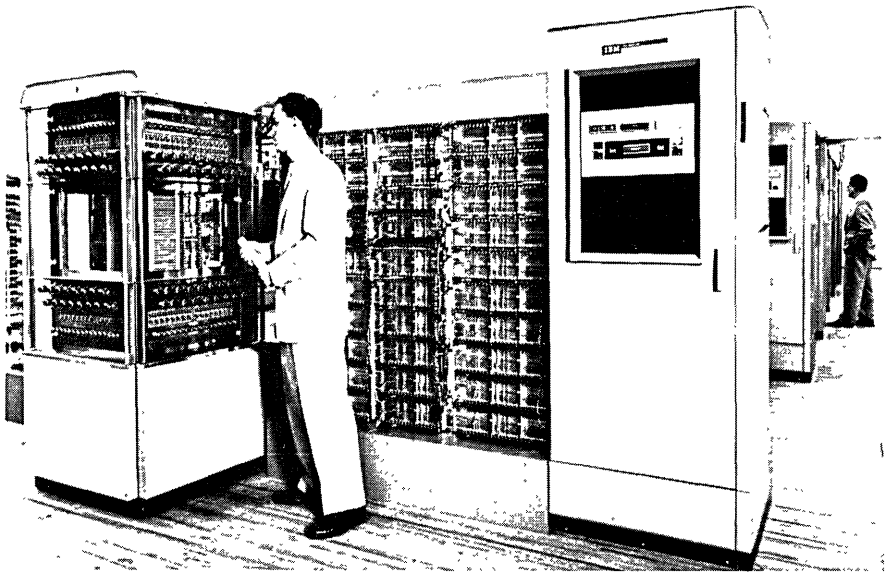

Figure 4 — Power Module on Right. Memory Frame in Center. Memory Array Frame on Left. The heart of the AN/FSQ-7 air defense computer is the magnetic core memory. This memory contains over 500,000 bits of high-speed storage with an access time of six millionths of a second to any group of 32 bits. It will contain the instructions that the computer will follow during its normal operation and the data which is being correlated and processed at that time.

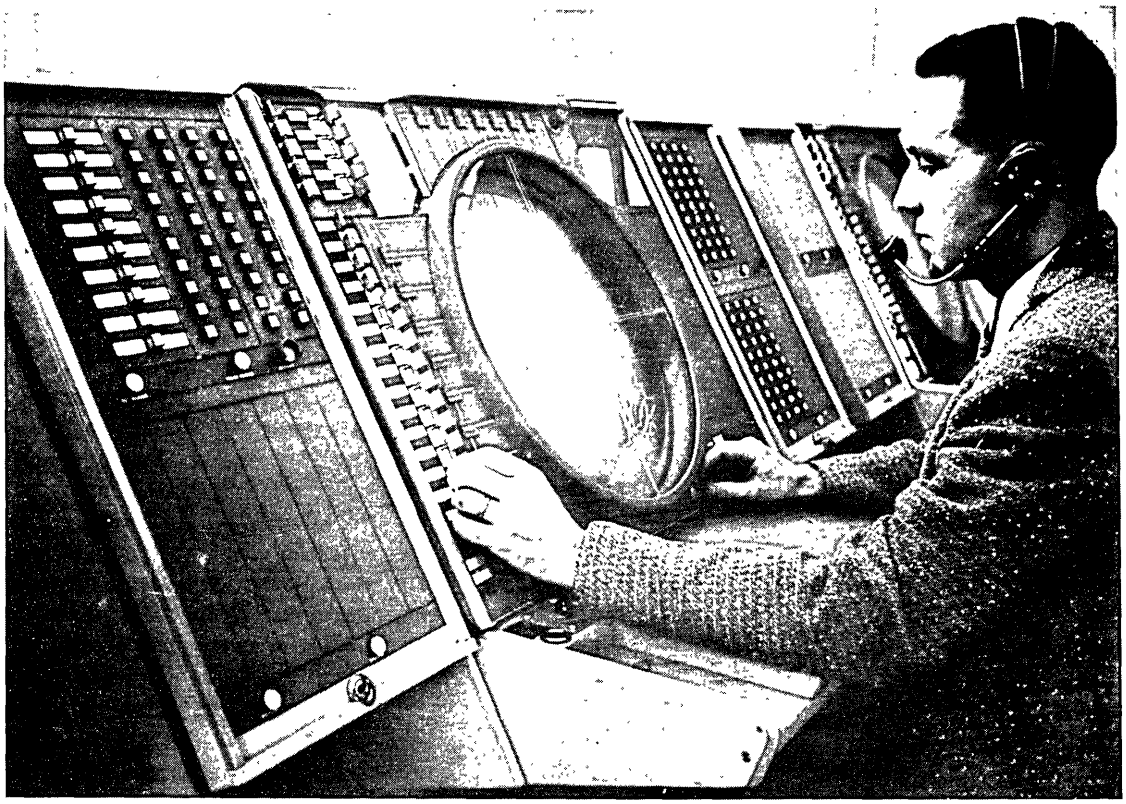

Figure 5 — Display Console. The Display Console presents a picture of the air defense situation to operating personnel. Using buttons and switches located on the side of the consoles, Air Force personnel will make tactical decisions which in turn will be carried out automatically by the computer. From this location, the operator can request additional information from the computer, can select certain features and exclude all others, can expant his scope picture to look at a smaller area, and can monitor the action of enemy planes and our own interceptors and guided missiles.

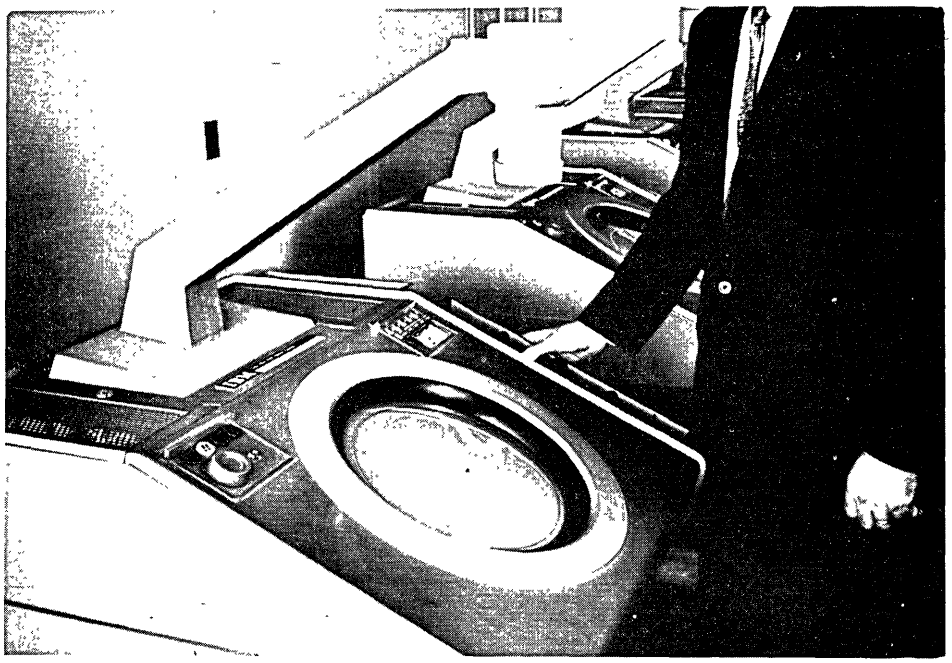

Figure 6 — Mapper Consoles. The Mapper Console is a unit used for screening out unwanted radar information such as cloud returns, mountains, buildings.

GLASS AND METAL HONEYCOMB TYPE OF ELECTROSTATIC STORAGE MEMORY

General Electric Research Laboratory
Schenectady, New York

An inch-square "honeycomb" developed in Schenectady by a General Electric scientist will store nearly a million bits of information. Smaller electronic computers with bigger memories are among the anticipated applications.

Dr. Harold R. Day of the General Electric Research Laboratory described his new information storage tube at a recent electronics conference. At the heart of the tube is a thin sheet of glass in which small holes have been etched and then filled with metal. In practice, information is written onto one side of the honeycomb by an electron-beam scanning method similar to that used in television. A "reading gun" picks up the information from the opposite side. Early laboratory models have permitted storage for several minutes and Day is confident the time can be extended.

Since the holes in the honeycomb are spaced 500 to the inch, each square inch has 250,000 individual storage cells — and each cell will recognize at least 10 different levels of intensity from the writing gun. Therefore, more than 800,000 bits of information can be stored at one time — 250,000 times log of 10 to the base 2.

Possible applications for the new storage tube besides computer memory include television cameras and "scan converters" in which radar information is collected and then displayed on an ordinary television screen.

The "mosaic" principle has long been recognized as ideal for storage tubes, but Day's device is believed to be the first developed with sufficient resolution and ruggedness to be suitable for most applications.

Day also has apparently solved the problems of "leaking" and "smearing" frequently encountered when individual storage cells are placed very close together. Each storage cell "remembers" by building up charge in the capacitance formed between the recessed metal plugs and the conducting layers deposited on both surfaces of the glass. The glass honeycomb acts as an insulator between the plugs and the surface layers — and between the plugs themselves.

Another advantage of Day's system is that the problem of registration is eliminated because the surface layers and the recessed metal plugs are inherently "lined up". Because the spacing between elements is rigidly maintained, the entire structure is rugged and the usual problem of microphonics — electronic noise caused by mechanical vibration — apparently does not arise.

Two methods of reading the information are available. In one method the electron beam erases the screen as it picks off the stored information; in the other the information can be left for re-reading or to be altered or added to by the writing beam.

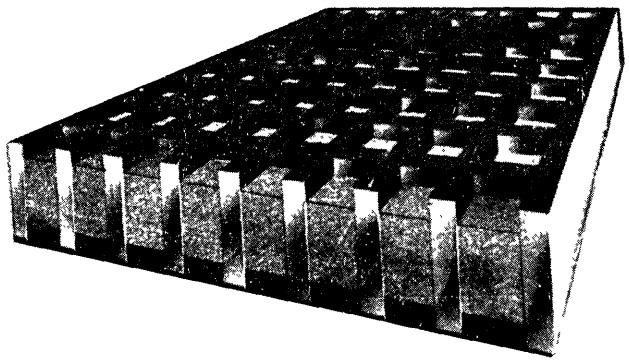

Figure 1 — A greatly enlarged view of part of the glass honeycomb mesh and its recessed metal plugs. The plugs are only 1/500 of an inch apart. One square inch of the honeycomb can store nearly a million "bits" of information.

(Cont'd on pages 11 and 42)

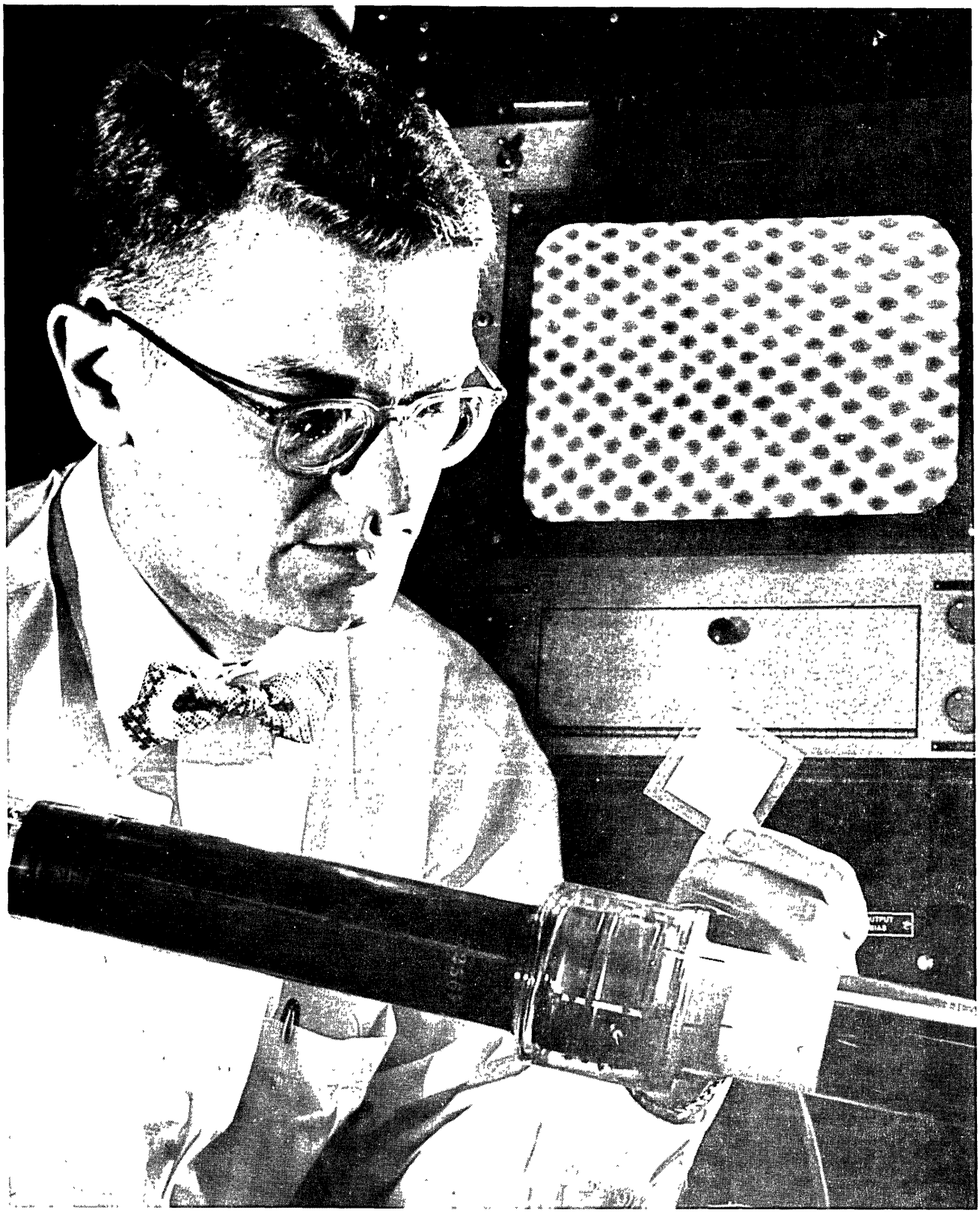

Figure 2 — Dr. Harold R. Day, scientist at the General Electric Research Laboratory, holds a thin information storage mesh above the "reading and writing" tube in which it operates. There are 250,000 holes (not visible in the photograph) in each square inch of the mesh, each filled with a recessed metal plug. The tiny honeycomb is electronically magnified on the television screen in the background.

THE COMPUTER AGE

Staff of
Business Week
New York, N. Y.

(Reprinted with permission from "Business Week", April 7, 1956)

1. RUNNING PLANTS BY MATHEMATICS

You can run an oil refinery a million different ways. You have many different kinds of crude coming in, and you can vary the mixture. Your still can be operated to produce usable products directly, or it can produce feedstock for a reforming unit or a cracking unit. And dozens of other choices are possible, each one of which changes the operation of every other unit in the complex process.

Finding a combination of operations that will produce the products you want on any particular day from the crude you have is no easy task — and finding the best and most economical combination can be almost impossible.

That's where electronic computers come to the aid of management. And the flow chart (Fig. 1) provides one of the best examples you can find of new management thinking about how to use computers to improve operations.

Fast Answers — The flow chart represents a complete mathematical simulation of a big Texas Co. oil refinery in operation. It presents this very complicated operation in terms of the mathematical and logical relationships among its parts.

By breaking down the many variables involved in the operation into language a large digital computer — in this case a giant IBM 705 — can understand, Texas Co. scientists were able to build a logical model of the refinery. With its aid, they can try out on the computer new ideas to increase production efficiency. This gives them answers faster and cheaper — and more accurately than any previous method short of actual refinery tryouts.

By reading the printed output of the computer, Texaco process engineers will get new and better ways to balance the variables involved in refining — such things as the grades and amounts of crude oil pumped in, the plant's characteristics, the types and specifications of finished petroleum products wanted, or possible. The big computer will interpret or account for constantly changing factors — changes in feed rates, temperatures, methods of blending, and so on — that occur rapidly and simultaneously in a refinery.

According to one Texaco scientist, "A complete material balance under a given set of conditions could be obtained in about 15 minutes, as compared with a week or more for the hand calculation. There is no doubt that .... computers... will achieve a significant increase in refinery operating efficiency."

Other Uses — Texaco is also renting time on a big machine to compute two very large problems that may provide answers for improving discovery and production of crude oil. These problems involve oil reservoir engineering and the correlation of vast amounts of geological data from many areas.

Still another program covers key accounting operations. Texaco is awaiting delivery of an IBM 705 which will be the heart of a company data processing service center.

I. Turning Point

The Texas Co. refinery simulation program is a sharp breakaway from the way most companies up to now have got into electric data processing. It's moving in the direction that top operations researchers and computer designers have been mapping out for management.

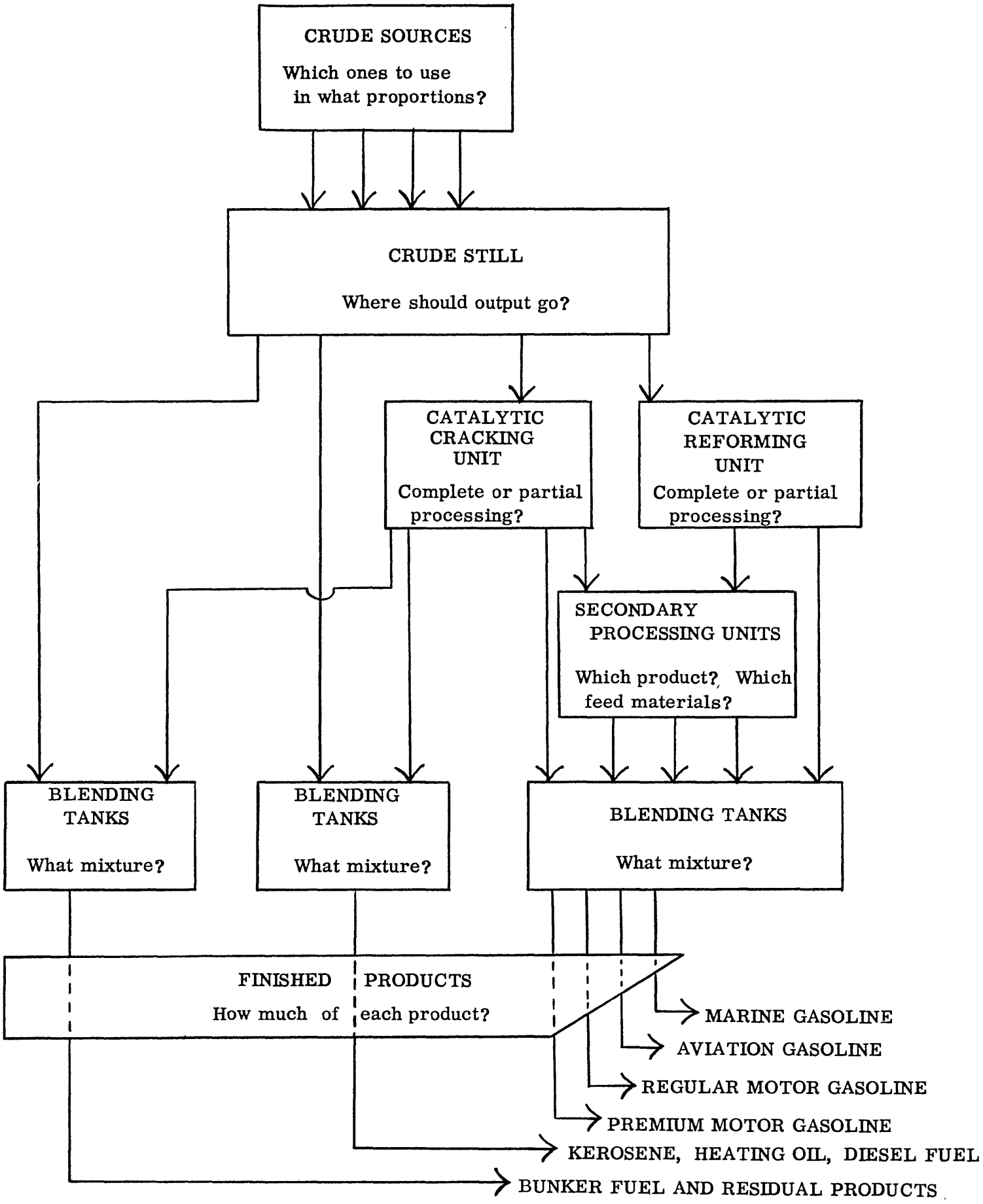

Figure 1 — This is a Computer's Eye View of a Refinery

What these men are aiming toward is the building of mathematical models that will include, to begin with, parts of a business' operations, and eventually expand to the mathematical and logical simulation of complete company setups.

This kind of thinking is becoming more evident daily among companies that are taking their first steps into the world of computers and those already committed that are wading in deeper.

Besides booming sales of all types of computers, this is having some immediate side effects in promoting use of computers in other ways. Sylvania Electric Products, Inc., this year will begin operating its whole company on data transmitted over an electronic communications nervous system, with a giant computer as its center. Across the country, a rash of computation centers is springing up, and computer consultants are setting up shop in major cities and on campuses.

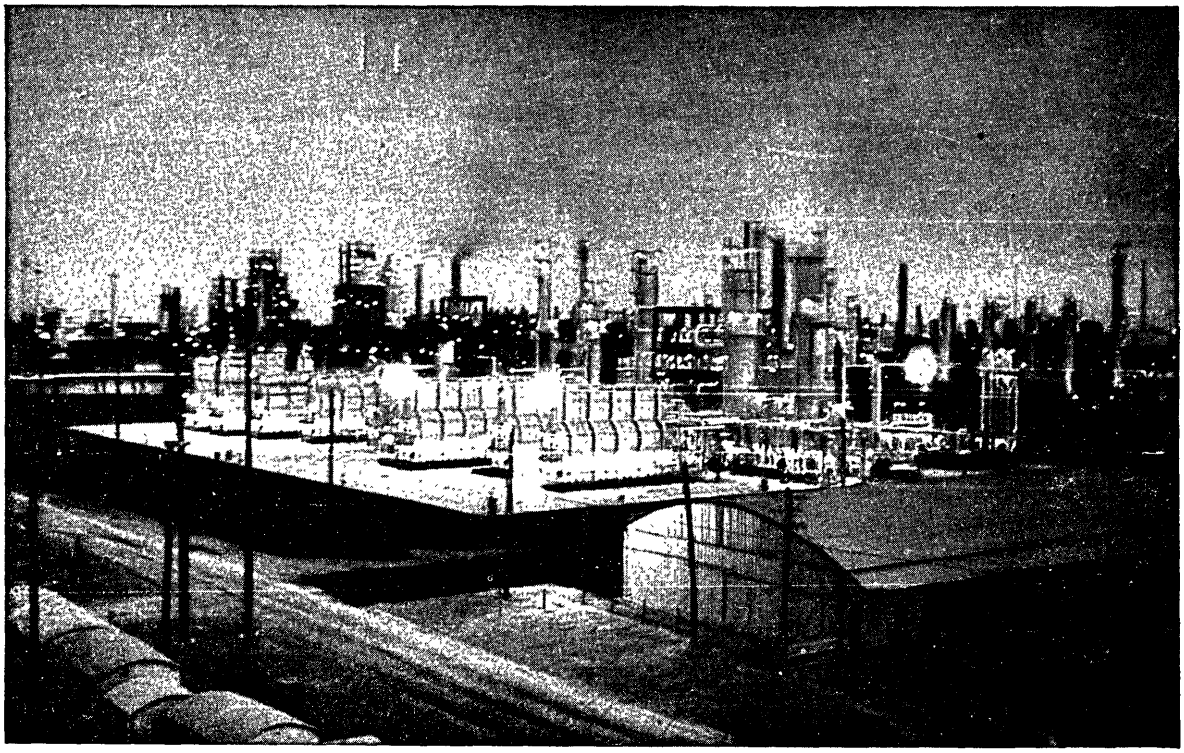

Figure 2 — This is an Oil Man's Eye View of a Refinery

(cont'd on next page)

WHO'S WHO ENTRY FORM

"Computers and Automation" publishes from time to time a Who's Who or roster or individuals interested in the computer field. Edition No. 1 of a cumulative Who's Who appeared in the June 1955 issue of "Computers and Automation". During the autumn of 1956 we plan to publish an extra number (not included in the subscription) of "Computers and Automation", which will be over 100 pages long, and will consist of Edition No. 2 of a cumulative "Who's Who in the Computer Field".

If you are interested in computers and desire to have your entry appear (at no cost to you), following is the form of entry. To avoid tearing the magazine, the form may be copied on any piece of paper:

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

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

_____

7. Year of Birth? _____
8. College or last school? _____
9. Year entered the computer field? _____
10. Occupation? _____
11. Anything else? (publications, distinctions, etc.)

_____

Signposts — Unquestionably, 1955 was a turning point — a year in which many companies abandoned hesitancy, began stepping up purchase of computers. Best estimates are that there are about 3,000 machines of all sizes now in operation. Alfred M. Wilson, executive vice-president of Minneapolis Honeywell Regulator Co., summed up the picture this way in New York a few weeks ago:

"From the standpoint of management understanding the potential value of data processing, more progress has been made in the last year than in any year previous."

Here's another signpost: According to Benjamin F. Butler, manager of General Electric Co.'s operations research team at GE's Hanford, Wash., plutonium plant, computers now in plants and on delivery within the next two years represent a $1-billion investment.

GE has jumped in with both feet as a producer of computers, with the confident prediction that the computer industry's sales will hit $500-million a year by 1960. GE itself is without doubt the most heavily computerized company in the U.S. — it has 144 computers of various kinds and sizes in use or on firm order.

The government, of course, was deep in computers well before GE. Security veils the use of computers in many Armed Forces installations. But in other agencies such as the Census Bureau — which probably processes more data in more ways than anybody — computers are somewhat old hat. Census got a Sperry-Rand Univac in 1951, ordered another in 1954. The Air Force's Air Materiel Command is fully sold on big computers; it has two installed, five coming.

New Approaches — Probably more important than numbers, though, are the fresh approaches to computer utilization — the new kinds of things that are being fed to the big machines. Management shows a growing readiness to try tougher, trickier, more complicated problems on data processing machines. Here are some examples found by BUSINESS WEEK reporters in a tally of statistical, decision-making, and top-level commercial uses of computers.

III. Management's Helper

United Air Lines, Inc. has been working for two years on development of a logical model to simulate all the conditions affecting airport maintenance. The simulation, still cloaked in corporate wraps, will be run through a giant computer at International Business Machines Corp.'s New York headquarters later this year.

UAL officials are excited about the possibilities — but frankly confess that the program is an experiment, and at this point hard to evaluate in terms of savings.

Obviously, if such a model will accurately portray what happens at a big air terminal, management can use it for an inexpensive tryout of changes to improve operations.

Deep in Oil — Other oil companies besides Texaco are taking to computers. Standard Oil Co. (Ohio) plans to simulate three refinery operations mathematically on an IBM 705. Petroleum Week, a McGraw-Hill publication, reports that "ten of the 200 big machines that IBM has installed or has on order are ticketed for oil companies."

Sohio is going all-out. In a big, new building in its Cleveland headquarters, Sohio's 705 will first try out its electronic brains on bulk-sales accounting. Then the refinery operations will be programed for the machine (in computer parlance, "programing" means setting down a plan for processing data through a computer).

After that, the machine will figure out optimum pipeline schedules and finished product inventory, and tip off purchasing men on smarter use of seasonal buying trends. Ralph Martin, Sohio comptroller, feels that competitive advantages of computer use are so great that "delay in installing electronic computers is no longer wise."

Petroleum Week predicts that as oil companies take to computers, "the result will be felt from the drilling rig to the directors' meeting."

Missing Link — Refinery simulation comes close to establishing the long sought link between an automated plant (such as a refinery) and an automated office. That's a connection that one data processing expert, R. Hunt Brown, president of Automation Consultants, Inc., New York, calls the "missing link".

Wayne University's Computation Laboratory is programing right now for an IBM machine a problem that takes a step toward full office-factory integration through a computer. In this case it's what is called an "explosion" problem. Crawford Door Co., a Detroit neighbor of Wayne, wants a system

that will feed incoming orders into a computer, and have the computer "explode" each order into the many parts required to carry it through — that is, orders on the factory, on the assembly line, on inventory; notices to billing and costing departments, and so on.

Variations — Many problems involving handling of orders, distribution, and the like are being put to computers for answers.

A giant computer at the National Bureau of Standards in Washington helps the Army's Quartermaster Corps award contracts by digesting such variables as substitute items, shipping costs, state of inventory, allocations to bidders in various parts of the nation. The same operation obviously could be performed for a big manufacturer with subcontracting headaches.

The effect of various possible bombing patterns on U.S. industry is being computed for the government, to find out how atomic attack might cut the nation's productive capacity.

A major car maker has worked up a program that tells management the cheapest distribution pattern from plant to dealer. Some 8,000 unknowns went into the program — abstracting details of plant production schedules, orders, inbound freight costs for parts, assembly plant production costs, cost of shipping finished cars, and the like. It takes a Univac in Sperry Rand Corp.'s New York computation center about 10 hours to run the problem. The initial run cost $12,000; subsequent monthly runs, $5,000. But the manufacturer figures monthly savings will be a half-million dollars.

One-Shot Jobs — Besides big jobs, requiring continuous processing of masses of data, use of a computer in a one-shot problem will often bring a return greater than the costs of operations analysis, programing, and machine time. Dr. Lawrence Rosenfeld, operations researcher at Melpar, Inc., research subsidiary of Westinghouse Air Brake Co., outlined such a "one-shotter" in a recent paper.

A big trucking firm, with more than 250 vehicles, became dissatisfied with congested traffic conditions around its headquarters. It could save $20,000 a year in lost motion and overhead by moving to another part of the city. But, management asked itself, would increased over-the-road operating costs from the new starting point to the 50-odd shipping destinations more than offset the savings?

Rosenfeld found route combinations were possible over six dual highways, 40 two-way streets, 130 one-way streets, two toll bridges. Ruling out obvious absurdities, there were still about 10-million possible combinations. He had to find out, by use of high-powered mathematics and a computer, what additional cost, if any, would be incurred in trucking over the best routes that could be picked out.

The program took three hours to check, three more to run on an IBM 701. Result: The best new routes would add $14,000 a year to operating costs, leaving a $6,000 saving. Cost to the trucker for research, development of data, machine time was $13,000. He'll recover it in little over two years.

What's in a Name — Another recent one-shot operation was Chas. Pfizer & Co.'s use of a giant IBM 702 computer to think up new names for drugs. Pfizer fed the 702 — in computer language — common medical word endings, instructions to combine them in new ways. It got a 198-page book of such names: Byulamycin, Starycide, Cliohacyn — and 42,000 others.

III. Accounting Geniuses

Besides the new applications of computers in questions of high management policy and decision-making, you see today greater and greater clerical and accounting use of currently installed machines by companies with some experience under their belts.

Monsanto — Near the top in this respect among pioneer data-processing companies is Monsanto Chemical Co. Besides running a heavy schedule of technical calculations on its IBM 702, Monsanto now regularly computes general accounting records, financial reports, departmental expense reports, production cost reports, plant service accounts.

For marketing strategy, the machine prepares statements of sales, cost of goods sold, gross profit by products, over-all sales analysis. The company also processes property accounting records, computes dividends, employee bonuses, pension reserves. Soon it expects to compute raw materials and finished goods records, return on investment by product groups, budgetary control, and payroll.

The IBM system Monsanto uses rents for about $30,000 a month — but Monsanto says the computer is more than paying its way.

How to Save — Many other companies are effecting big savings through electronic processing of payroll and similar data.

At General Electric's Major Appliance Div. in Louisville, six hours a day of Univac payroll calculation saves the company some $500,000 a year. A Univac system sells for about $1.5-million, rents for about $30,000 a month.

Chesapeake & Ohio Ry., a pioneer computer user among railroads, feels the Univac it has been operating since January has more than paid off — even though C & O uses it about one shift a day, hires it out when possible. C & O puts in the machine data from waybills, car orders, rates, payrolls — gets out (1) fresh data for management decision, (2) danger signals, (3) reference statistics.

Perhaps the most ambitious general-accounting approach is that being made by E. I. duPont de Nemours & Co., according to a new book on Electronic Computers and Management Control, by Kozmetsky and Kircher (McGraw-Hill). The authors say du Pont is "testing both a Univac and an IBM 705 on a tentative lease basis," for all sorts of calculations — costs, payroll, production scheduling, billing and sales, personnel and property records, accounts payable, stockholder lists — as well as for technical and scientific computation. What makes du Pont's program interesting, of course, is its size.

Checking on Checks — Insurance companies find plenty of data to feed into their computers, too, but aside from the massive amount, there's little to tax the computers' electric brain cells. Some of the financial institutions are giving their computers more complicated problems. The Bank of America, for example, now uses a special purpose giant computer — ERMA, developed by Stanford Research Institute — for all the data processing connected with checks at its San Jose branch, may put ERMA's in 37 more branches.

Each check is pre-coded with magnetic ink. When a check is presented for withdrawal, the teller inserts it in a machine, punches in the amount. The machine "reads" the magnetic code, taps a magnetic memory at the central computer, subtracts the amount of the check from the customer's account (or flashes a stop order to the teller), strikes a new balance. At day's end, the computer sorts the day's transactions, enters them on a tape in account serial order. From this tape monthly statements, and other information for management, are prepared.

Developing — Large special purpose computers like ERMA may be another developing phase of the computer picture. Several airlines have installed or will soon set up special purpose reservation control computers — following American Airlines' happy experience with its Reservisor. In addition to reservation calculations, Pan American World Airways is working on plans to compute flight schedules, maintenance, crew assignments, and many accounting functions.

2. AUTOMATING THE BOSS' OFFICE

Next month, the little town of Camillus, N. Y., outside of Syracuse, will become the center of attention of Sylvania Electric Products, Inc.

On May 15, the first figures will be fed over special Western Union wires into the company's new Data Processing Center there and will be transferred to a large electronic computer — a Sperry Rand Univac — for processing.

Within five years, if all goes according to schedule, Camillus will become the nerve center of the entire communications system of Sylvania's nationwide spread of plants, sales offices, and warehouses.

Significance — Sylvania's leap into the age of electronic computers and data processing involves more than just the operations of that one company. It is a major step toward the day when U. S. business generally — especially nationwide corporations like Sylvania — link themselves together by high-speed communications systems that go far beyond the mere transfer of information. Daily, statistical data will be fed into one or more centers of a company, be processed through a computer, and be analyzed in any fashion management desires.

Don G. Mitchell, board chairman and president of Sylvania, describes this whole electronic control process in two words: "administrative automation."

Complete Tie-In — Many companies besides Sylvania already link together numerous facilities outside headquarters with vast teletype systems or even punched-tape networks that can activate other office machinery as they do a teletype. Aluminum Co. of America (BW — Nov. 6 '54, p91), Acme Steel, Olin-Mathieson Chemical Corp. all have what is called common language data systems using punched-tape and leased wires. Last week Diamond Alkali Co. also installed such a system.

Many other companies also use computers — with applications running from simple accounting procedures to simulating airports and refineries.

But Sylvania is probably the first to tie in a company's whole operations by such a network and, in addition, feed the information into a computer for analysis.

Mitchell described the opening of the Data Processing Center in Camillus this way:

"Western Union, Sperry Rand, and Sylvania look upon this project as a revolutionary step in industrial communications. It is, as far as we know, the only existing concept of an entire company tied together communications-wise from a data processing standpoint."

I. What it Will Do

There are two major elements in Sylvania's system. One is the 12,000-mile private-wire network connecting 55 locations in 51 cities in 19 states. This network went into operation a couple of weeks ago to handle normal administrative messages — 5,000 the first day. Over it eventually will flow statistical data using what the technicians call a five-channel punched tape.

The other element is the Univac — one of the major computing machines developed for commercial use since World War II.

This processing machine can store data in its electronic memory, accept new information, analyze the data, supply the results through a high-speed automatic printing machine — and can do it fast.

Sylvania lists four basic reasons for the installation of its electronic control system:

To speed up normal computing activities.

To achieve closer liaison with outlying plants and warehouses.

To provide top management with data when they need it most.

To decrease overhead costs for clerical personnel.

Eventually, all of the company's statistical and accounting work will be handled at Camillus.

Payrolls First — As a starter next month, the Data Processing Center will begin handling the payroll accounting — including the writing of paychecks automatically — for the TV picture tube plant at Seneca Falls, N. Y. That will be the first concrete use of the center. The information will be sent by wire to Camillus where it will be punched out on the five-channel tape, then be converted to punched cards, thence to a magnetic tape, and finally into the Univac. A high-speed printer will roll out the checks once the computer figures correct amounts and deductions.

When the system is in full-scale operation, this payroll accounting function will encompass all of Sylvania's 27,500 employees. This master payroll file also will provide data on labor distributions and other statistics, personnel data, and material needed for government reports.

Future Objectives — Laid out on a five-year plan, the data processing system's program for 1956 includes the spread of the payroll job through the company plus two other definite goals.

First, the center will tie in all warehouses. Daily reports from each point will record sales of individual warehouses, byproducts. Weekly there'll be available an inventory listing for each.

Under the present setup, each division gathers figures on inventory from warehouses by mail. That's slow, and it fails to give an over-all composite picture of the inventory position. The Camillus center will collect all the figures in one spot — have divisional requirements available much faster and, besides, have a company-wide picture.

Much of Sylvania's line of products is mass produced, many of them fast-moving traffic items. So the need for such up-to-date information on what is selling where is obvious.

Second Goal — Sylvania's second goal is to take the first step in providing complete accounting and statistical services to all operation divisions.

The center is starting with the Lighting Div., picked as a guinea pig for the first over-all programing of a division's operations because it is the oldest and most stable in the corporation.

"Once it works with the easiest one," says Dunn, "we'll go on with the others."

This will involve putting into a computer

program all 30 statistical reports that are now used to keep management control over the division. A customer's purchase report, for instance, will show what he bought in what quantity and compare that against a year ago, will break down the figures by salesmen, show how the division sales effort is working for each product. In addition, all accounting reports for the division will be put together at the center — making them available the third or fourth day of the month rather than the 15th.

Dunn hopes that the real end products of the Lighting Div. experiment will be the ability to supply sales forecast information and provide decisive data for market research and production planning.

For more sophisticated data, Dunn says that the center will eventually go to management, ask the executives what their maximum requirements for statistical breakdowns are, and "if we can do it economically, we'll supply that information."

The five-year plan for Sylvania's data center is to be able to provide a similar service for every division of the corporation.

II. How the Center Works

Sylvania has set up its electronic information center as a separate unit in the company, housed in its own building, and staffed with its own personnel.

Dunn, the manager, describes its organization status this way: "We'll operate for all divisions, but be independent of all."

The center will report directly to the corporation's controller who, along with the treasurer, will have offices in the building which they plan to occupy on a part-time basis.

Centralization — Once management looked into the problem, there was no question in their mind that the company would be better off having one big centralized computer, rather than many small ones.

For one thing, top management can get consolidated reports of company activity faster if it is all handled in one spot. For another, it's cheaper this way, according to Dunn. Several computers would have meant greater manpower needs, for instance. Besides, a decentralized system might not have provided the essential contact with Sylvania's widespread warehouse operations.

Why Camillus? — The question of where to locate the Univac — Sylvania's corporate headquarters are in New York City — was based simply on a matter of evaluating costs of communications. Mathematical plotting of the 55 locations, including the nine divisions involved, would have placed the center 40 miles south of Camillus. And the Syracuse area is a Western Union headquarters, an important reason for the choice.

III. Management Effect

There is no question that Sylvania's decision to put in this vast network was a major one. On cost alone, the annual operating budget will run $800,000 — $270,000 rental for the computer, $240,000 for transmission facilities, and the rest for general expenses, including 80 or more technicians and clerks.

Also involved was a long-range program of arranging company reporting to jibe neatly with the requirements of the center. This means an important educational program all through the organization — admittedly not yet completed — to make sure everyone understands what is happening.

A tight system of timing in order to get reports in from outlying units in proper rotation is going to be essential to efficient operation, says Dunn. Thus each reporting unit, whether it is a warehouse in Fullerton, Calif., or a location in Salem, Mass., is going to have to adhere to a strict time schedule — and know why.

More Effective — Naturally, the question also arises about the effect the center will have on Sylvania's well developed decentralized management system. Operating people, such as division managers, in Sylvania are given lots of authority to make their own decisions.

Will this change? You can find plenty of management experts who believe that any such system will intrude on some operation functions. But Pres. Mitchell insists: "This centralized facility will be making even more effective a fully decentralized operating organization."

Faster — Actually, the kind of work the center will do already is being done — statistical reports and accounting for top management control purposes. But with the Data Processing Center, Sylvania believes it will so speed these reports that the whole company can move faster — not only in top policy decisions, but at division levels.

Dunn describes what Sylvania has created with its statistical center as something approaching a "figure factory — as though an outside firm, such as an IBM Service Center, was called in to do a chore, except in our case we will be serving all the operating divisions."

Dunn's reference to outside service centers points up a fast-growing development in the use of big computers. That is the establishment of computing service centers — run by the manufacturers, colleges, or independent consultants.

3. EVERYBODY'S IN

For smaller companies that can't afford their own, a rash of computer service centers is springing up.

In the computer revolution that's spreading through industry, the little fellow has a special problem.

A giant like Sylvania Electric Products has the cash and staff to go all-out on application of computers. Other big companies can put a million or more into buying or renting a machine, and carry the operation along until it reaches a payout.

But a raft of smaller firms — though they can make good use of what computers offer — can't afford computers of their own, don't have the trained staff to develop applications, or just don't have enough work to keep one busy full-time. They're worried about being left out in the competitive race, they want to do something about it, and they represent a sizable market.

So, to meet their needs, computer service centers are springing up.

What It Is — Basically a service center represents a staffed computer on which a number of different companies can buy time. Its services may extend to feasibility studies, operations research, programing, and training of a client's personnel. A company can rent services for special one-shot problems or use them regularly on a part-time basis.

In this way it gets many of the advantages of owning its own machine, even though it wouldn't be justified — by its volume of business, its cash position, or its technical knowhow — in investing in its own computer center.

Small, but Fast — Actually, say the consultants who specialize in this field, the very smallness that handicaps some outfits in buying computers can be turned to advantage. For most of the larger companies, massive adjustments — say, complete conversion of costing to computer systems — can take months, even years. The smaller fellow, being flexible, can convert faster, and get a jump on the field.

What's more, he can skim off much of the experience of the pioneers and avoid many of their pitfalls, say the consultants, who look for big growth in computer usage through the multiplying service centers.

Variety — Companies looking for computer centers will find at least five types of service available:

- Companies that own computers and rent out unused time.
- Mechanical punch card service centers that have expanded into computers and simple programing.
- Computer consultants who also own computers.
- Service centers operated by computer manufacturers.
- A growing number of college and university service and research centers.

Reluctant — Companies, such as the Chesapeake & Ohio Ry., that rent time on their computers usually do this only as a last resort. Owners generally prefer to keep their machines to themselves. Rentees worry about the continuity of such relationships and are accounts through some other company's machines and office.

Branching Out — That doesn't mean that a number of companies won't use the same service center. Many mechanical punch card tabulating firms are already established as payroll, sales, or inventory processing centers for local firms, handling dozens of accounts at a time — and many of them are planning expansion into electronic computers.

They have a bread and butter base in their existing business and the cash or credit to carry them into the new field. (It takes $50,000 a year for rental of a small IBM computer, plus at least

another $50,000 for the first year's overhead.) What they have to learn or buy is the programing and systems analysis skills that efficient usage of computers calls for.

Using Knowhow — This knowhow is something that computer consulting companies have plenty of. They already sell operations research, programing skills, and feasibility studies. A number say they plan to round out this package with their own computers.

You can spot the trend by these signposts:

• Arthur D. Little, Inc. of Cambridge, Mass., prodded by its operations research group, set up, two months ago, a computer center to handle engineering problems, business applications, and its own internal accounting.

• A new outfit, Computing Consultants, Inc., of Atlanta, plans expansion through use of an IBM 650.

• Most significantly, Ebasco Services, Inc., the big engineering and consulting firm, says it is getting a large computer for a service center. Its target is the great market it foresees for business applications.

Here's how the consultants see their business developing over the next few years. A large part will come from big outfits which — even though they may have computers of their own — want to draw on the background the consultants have built up, to solve special problems. Most of this work will be in engineering at first, but gradually more and more of it will come from business applications. The consultants see another big hunk of business coming from smaller companies that will buy time and services over long-term periods.

Aiding Sales — Manufacturers' service centers (International Business Machines Corp., Sperry Rand Corp., and others), long used as an effective sales tool, are also growing with the demand. Conforming to its recent antitrust consent decree (BW — Feb. 4 '56, p26), IBM centers will be set up under a separate, wholly owned subsidiary. But that should be no deterrent to further growth. IBM now has five centers in operation, plans at least 10 more in the near future (BW — Feb. 11 '56, p62).

Sperry Rand has two in operation and is building a new one in Boston. ElectroData Corp. (soon to become a part of Burroughs Corp.) wants to start one on the East Coast and General Electric Co. will probably set up centers to push its newly announced line of computers.

Growth Prize — But the greatest growth of all is in college and university service centers. Last year nine computers were set up at various schools. Now the number is close to 15, and by late this fall there will be about 30 campus computer centers, says Dr. A. J. Perlis, head of Purdue University's computer group.

Soon you'll see centers extending from Harvard, Massachusetts Institute of Technology, and Georgia Tech on the East Coast, through the Universities of Chicago, Michigan, and Wisconsin in the Midwest, to Stanford, Washington State, and University of California (at Berkeley) in the West.

The spread of university service centers should prove a boon to smaller firms that can't afford to buy their own. But perhaps the most important job they'll do is train the growing number of technicians needed to keep the computers growing. That's the big reason why manufacturers often sell computers to schools at a cut price (up to 60% off) on the condition that computer theory be taught as part of the curriculum.

Wayne University's computation laboratories, headed by Dr. Arvid Jacobson, a leader in the field, are a good example of what universities can do in this area. Since the laboratory was set up, some 600 men have taken courses on Wayne's big computer (and an IBM 650 has just been added). The laboratory services heavily industrialized Detroit with informal courses, seminars, lectures, conferences, and a basic course in business data processing.

- END -

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SPECIAL ISSUES OF "COMPUTERS AND AUTOMATION"

The June issue of "Computers and Automation" in each year commencing with 1955 is a special issue of "The Computer Directory" containing a cumulative "Roster of Organizations", and a cumulative "Roster of Products and Services in the Computer Field", and other reference information.

In the autumn of 1956 we shall publish Edition No. 2 of a cumulative "Who's Who in the Computer Field", as an extra number of "Computers and Automation".

AN OCEAN-BASED AUTOMATIC WEATHER STATION

National Bureau of Standards
Washington, D. C.

A prototype marine weather station that automatically reports local weather data by radio has been developed by the National Bureau of Standards. The unit is incorporated in a buoy that can be anchored in remote locations and left unattended for periods up to six months. At regular intervals throughout the day, the station broadcasts in code the air temperature, water temperature, barometric pressure, and wind speed and direction. Preliminary tests in Chesapeake Bay show that the station has a radio range in excess of 800 miles. The equipment was developed by P. D. Lowell, W. Hakkarinen, and L. M. Allison of the Bureau's electronic instrumentation laboratory for the Navy Bureau of Aeronautics.

At the present time the gathering of comprehensive weather data from many ocean areas outside of regular shipping lanes is haphazard and limited. Both military and civilian authorities would be better able to predict weather conditions if they received continuous weather reports from a much wider area. If a series of stations similar to the Bureau's prototype station were placed over wide areas of the Pacific Ocean, for example, they could give operations officers and meteorologists frequent reports making possible a complete weather picture for the entire ocean. If moored in certain areas of the Caribbean, these stations might also give warning of hurricanes as they begin to form.

The automatic station translates information from each of five weather sensing elements into three-letter groups in continental code and transmits the coded signals on a pulse-modulated carrier frequency at about 6 megacycles. These signals can be received on standard communications receivers and compared with a decoding table which gives numerical values for each of the meteorological variables measured. A single transmission takes three minutes. During this interval six items of information are broadcast. The first transmission is a three-letter signal identifying the station. Coded transmissions follow containing information on (1) air temperature between -25° and $+110^{\circ}$F, (2) water temperature between 15° and 90° F, (3) barometric pressure between 950 and 1050 millibars, (4) wind speed from 0 to 68 knots, and (5) wind direction oriented from magnetic north.

The vessel which carries the weather-sensing and radio transmitting equipment was designed by the David Taylor Model Basin and is 20 ft. long and 10 ft. wide. It is constructed of aluminum and other non-magnetic alloys to avoid undesirable effects on the compass. The vessel can be anchored in waters as deep as 3600 ft. Two masts and four water-tight wells extending below the boat deck hold all the electronic and meteorological equipment assembled in compact, shock-mounted units. Each unit may be replaced independently of the others.

The weather sensing elements convert variations of water surface conditions into variations of resistance for measurement by a motor-driven self-balancing bridge circuit. The air- and water-temperature sensing devices are simple thermistors. A precision barometer measures air pressure. This barometer is so modified that a slave needle rides above a resistance strip and is clamped to the strip at the time of measurement. An especially rugged three-cup anemometer drives a small magnetic generator whose output is applied to the grid of a vacuum tube. Plate resistance of the tube is measured in the bridge. The wind vane is connected to a selsyn transmitter and receiver circuit activating a servo system. The servo positions a magnetic compass synchronously with the wind vane. Mounted on gimbals, the compass has a slave needle and clamping system that gives resistance values corresponding to the wind direction relative to magnetic north.

Primary power comes from 180 4FH dry cells connected in series-parallel to give 13.5

(text cont'd on page 25)

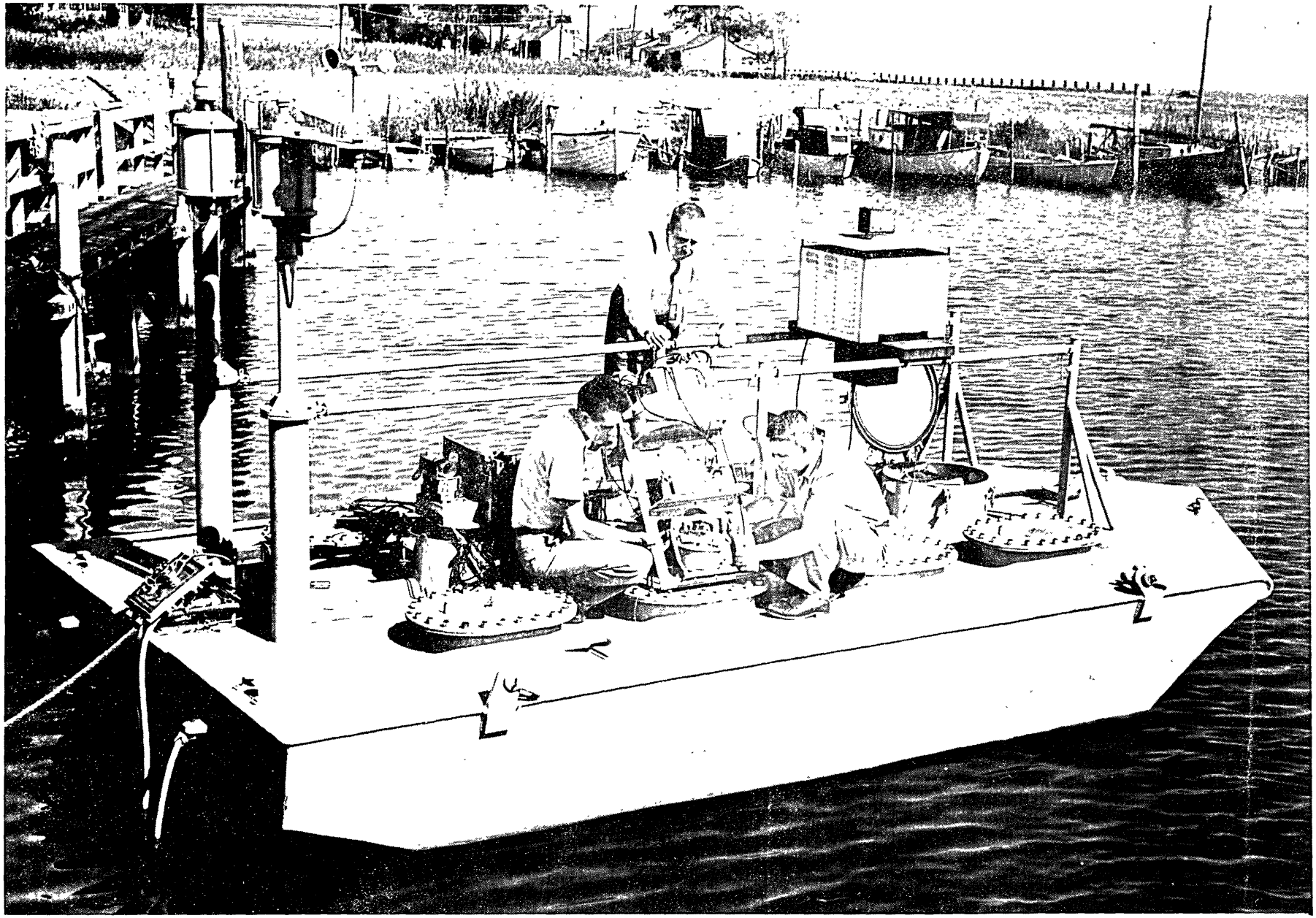

Figure 1. This ocean-based weather station developed by the National Bureau of Standards automatically reports local weather data by radio. It can be anchored in a remote location and left unattended for as long as 6 months.

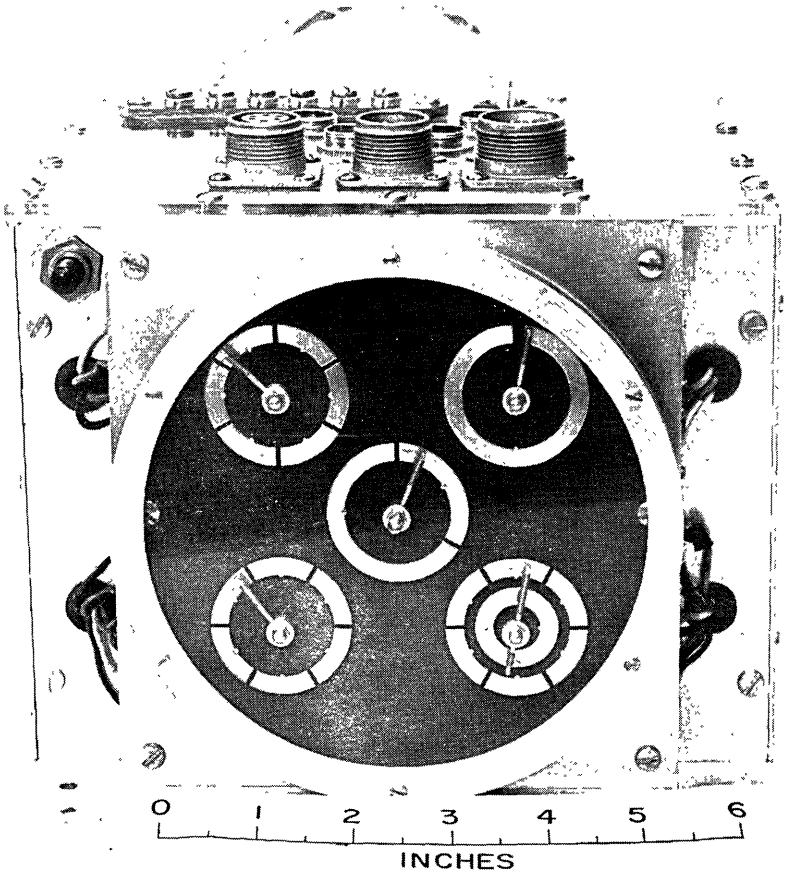

Figure 2. Part of the control equipment for the marine weather station. At regular intervals throughout the day, the station broadcasts in code the air temperature, water temperature, barometric pressure, and wind speed and direction.

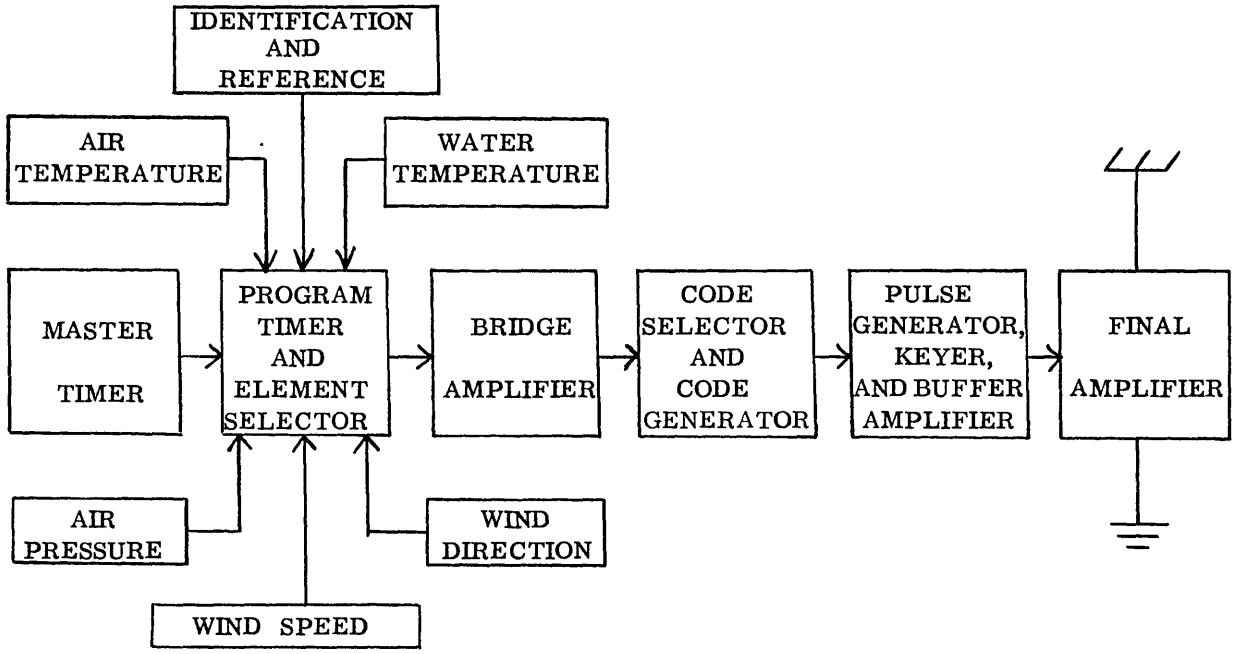

Figure 3. Detailed views of the control equipment in the NBS automatic weather station. Circular switches in these timers turn equipment on and select in turn each of the weather sensing elements whose data are to be transmitted in code.

(cont'd from page 24)

volts at 15 amperes. A rotary converter changes the low-voltage dc to 120 volts at 60 cycles to operate the power supply for the electronic components. In future models of the boat stations, a gasoline-powered generator and storage battery will replace the dry battery supply.

At some predetermined time after a suitable warmup period, a master timer closes the contacts that feed power to all circuits. A chronometer watch, rewound by motor at the time of station activity to ensure accuracy over extended periods of time, furnishes reliable master control. When the power is applied, a program timer, consisting of a number of circular switches driven by a constant speed motor, inserts a precision resistance into the self-balancing bridge. As the first radio signal to be transmitted is the station identifying signal, this precision resistor, instead of one of the weather variable resistances, is the first contacted in the program timer. The resistance of a helical potentiometer at the bridge balance point matches this resistance. On the same shaft with the potentiometer is a rotary code selector switch that selects letters on a code generator; these letters then correspond to the value of the resistor inserted into the bridge. The code generator, a drum made up of eight metal rings insulated from each other, has the code characters machined in relief on the inner circumference of the rings. A comb-type brush contactor sweeps inside the drum contacting the raised segments. The raised code characters designated by the selector switch, when in contact with the comb, close a keying relay circuit. Then, over a 20-second interval, the transmitter is keyed in code with a three-letter group. Sending speed can be controlled by the comb speed, and a rate of five to seven signal repetitions during the 20-second interval permits even inexperienced operators sufficient time to copy the signal.

During the interval when the station is identifying itself, a resistance determined by the first of the five weather variables is connected to the bridge circuit. At the end of the identification interval, a 10-second delay ensues while bridge balance and code selection occur. Then the first of the weather data is broadcast. While this signal is being transmitted, the next weather variable is selected and then transmitted at the end of the first weather signal. The remaining variables are transmitted in like manner. Altogether, the three-minute transmission period contains six transmission intervals of 20 seconds duration, each preceded by 10-second balancing intervals. At the conclusion of the transmission period, the master timer contacts are broken to remove power from the equipment until time for the next period of station activity.

- END -

Forum

UNITED STATES DISTRICT COURT, FOR THE SOUTHERN DISTRICT OF NEW YORK:

UNITED STATES OF AMERICA, PLAINTIFF,

vs.

INTERNATIONAL BUSINESS MACHINES CORP., DEFENDANT:

FINAL JUDGMENT

Plaintiff, United States of America, having filed its complaint herein of January 21, 1952; defendant International Business Machines Corporation (hereinafter called IBM) having appeared and filed its answer to the complaint denying the material allegations thereof; and plaintiff and defendant, by their attorneys, having consented to the entry of this Final Judgment, without trial or adjudication of any issue of fact or law herein and without any admission by either party with respect to any such issue;

NOW, THEREFORE, before any testimony has been taken herein, and without trial or adjudication of any issue of fact or law herein, and upon consent, as aforesaid, of each party hereto,

IT IS HEREBY ORDERED, ADJUDGED, AND DECREED as follows:

I

The Court has jurisdiction of the subject matter of this action and of the parties. The complaint states a claim upon which relief can be granted against IBM under sections 1 and 2 of the Act of Congress of July 2, 1890, entitled "An act to protect trade and commerce against unlawful restraints and monopolies," commonly known as the Sherman Act, as amended.

II

As used in this Final Judgment:

(a) "Tabulating card" shall mean a unit record card designed for the recording of data in the form of punched holes to be sensed by mechanical or electrical (including electronic) means.

(b) "Tabulating card machinery" shall mean machines and devices, and attachments therefor, used to make tabulating cards.

(c) "Tabulating system" shall mean any group of machines capable of entering, converting, receiving, classifying, computing and recording alphabetic and/or numeric accounting and/or statistical data by means of tabulating cards, and in which tabulating cards are used for storing data and communicating it within the system; provided that "tabulating system" shall not include "electronic data processing system" as hereinafter defined.

(d) "Tabulating machine" shall mean a machine or device and attachments therefor used primarily in a tabulating system.

(e) "Electronic data processing system" shall mean any machine or group of automatically intercommunicating machine units capable of entering, receiving, storing, classifying, computing and/or recording alphabetic and/or numeric accounting and/or statistical data without intermediate use of tabulating cards, which system includes one or more central data processing facilities and one or more storage facilities, and has either

(1) the ability to receive and retain in the storage facilities at least some of the instructions for the data processing operations required, or

(2) means, in association with storage, inherently capable of receiving and utilizing the alphabetic and/or numeric representation of either the location or the identifying name or number of data in storage to control access to such data, or

(3) storage capacity for 1,000 or more alphabetic and/or decimal numeric characters or the equivalent thereof.

(f) "Electronic data processing machine" shall mean a machine or device and attachments therefor used primarily in or with an electronic data processing system.

(g) "Standard tabulating machine" or "standard electronic data processing machine" shall mean a tabulating machine or an electronic data processing machine manufactured by IBM and made generally available to its customers.

(h) "Special purpose tabulating machine" or "special purpose electronic data processing machine" shall mean a tabulating machine or an electronic data processing machine designed and produced by IBM for use by a limited number of customers but not made generally available to all IBM customers.

(i) "New" machines shall mean tabulating or electronic data processing machines produced (1) by original assembly of new and/or used parts of components or, (2) as to any type of machine generally offered for lease which is not currently being so assembled but is being produced by rebuilding existing machines, by such rebuilding.

(j) "Point value" shall mean the dollar amount of the monthly charge made by IBM in respect of a tabulating or electronic data processing machine leased by IBM to its customers under its machine service agreements.

(k) "Service bureau business" shall mean the preparation with tabulating and/or electronic data processing machines of accounting, statistical and mathematical information and reports for others on a fee basis.

(l) "Service bureau" shall mean an organization engaged principally in the service bureau business.

(m) "Existing patent" (or "existing patents") means any United States letters patent (including, but not limited to, the patents listed in Schedule A to be filed in this Court within 30 days after the entry of this Final Judgment) or patent application, and any division, continuation, reissue or extension of such patent, relating, but only in so far as it relates, to tabulating cards, tabulating card machinery, tabulating machines or systems, or electronic data processing machines or systems, owned or controlled by IBM on January 1, 1956, or under which IBM then had the power to grant licenses or sublicenses to other persons.

(n) "Future patent" (or "future patents") means any United States letters patent or patent application (exclusive of existing patents), and any division, continuation, reissue or extension of such patent, relating, but only in so far as it relates, to tabulating cards, tabulating card machinery, tabulating machines or systems, or electronic data processing machines or systems owned or controlled by IBM during the period of five years following January 1, 1956, or under which IBM during such period has the power to grant licenses or sublicenses to other persons.

(o) "Subsidiary" shall mean a corporation more than 50% of whose stock entitled to vote upon election of directors (other than preferred stock entitled to vote upon the failure of the corporation to pay certain dividends) is, directly or indirectly, owned by IBM.

(p) "Person" shall mean an individual, partnership, firm, association, government, governmental institution, or corporation other than individuals who are directors, officers, employees, agents, and representatives of IBM, but shall not include subsidiaries of IBM unless such inclusion is specifically provided for.

III

The provisions of this Final Judgment applicable to IBM shall also be applicable to its subsidiaries, officers, directors, agents, employees, successors, assigns, and all persons acting under, through or for IBM, but shall not impose any obligation to do or omit any action outside the United States unless specifically provided for hereinafter.

IV

(a) It is the purpose of this Section IV of this Final Judgment to assure to users and prospective users of IBM tabulating and electronic data processing machines at any time being offered by IBM for lease and sale an opportunity to purchase and own such machines at prices and upon terms and conditions which shall not be substantially more advantageous to IBM than the lease charges, terms and conditions for such machines.

(b) IBM is hereby ordered and directed, beginning not later than one year after entry of this Final Judgment, to offer

(1) to sell, at any time during the period of 18 months next thereafter, to the lessee of any IBM tabulating or electronic data processing machine each such machine being used by such lessee;

(2) to sell new standard tabulating and electronic data processing machines of each type at any time thereafter currently being manufactured and offered for lease or sale by IBM; and

(3) to sell any new special purpose tabulating or electronic data processing machine to the user for whom it has been designed and produced by IBM.

(c) IBM is hereby ordered and directed to:

(1) establish a sale price for each machine offered for sale pursuant to paragraph (b) (1) of this Section IV which shall not be greater than the sale price for a new machine of the same type and model less 10% for each full year of age, computed from the date of first installation after original assembly or rebuilding, except that for machines more than eight years of age the price may not be more than 25% of such sale price;

(2) establish a sale price for each machine offered for sale pursuant to paragraphs (b) (2) and (b) (3) of this Section IV which shall have a commercially reasonable relationship to the lease charges for such machine;

(3) establish such other nondiscriminatory terms as may be appropriate to the sale of tabulating or electronic data processing machines,

including, at the option of the purchaser, reasonable credit terms for purchasers having satisfactory credit ratings and such warranties as are customary for the sale of similar business machines;

(4) afford to its salesmen compensation for selling tabulating and electronic data processing machines which shall be not less favorable to them than their compensation for leasing the same machines;

(5) make a full and fair disclosure, in the solicitation of orders for tabulating and electronic data processing machines, of the prices and terms for the sale and lease of such machines;

(6) furnish in writing, upon written request, to each person inquiring concerning the lease or purchase of IBM tabulating or electronic data processing machines complete information concerning delivery dates and terms and conditions of lease and purchase of such machines; and

(7) fill purchase and lease orders for machines required to be sold by paragraph (b) (2) of this Section IV without discrimination between lease and purchase orders and, to the extent administratively practicable and permitted by law, in the order of their receipt.

(d) In any civil suit or proceeding instituted by the Plaintiff between two and ten years after the entry of this Final Judgment, in which IBM's compliance or noncompliance with the provisions of this Section IV shall be an issue, the burden of proof shall be upon IBM to establish that it has complied with the provisions of this Section IV.

V

(a) IBM is hereby enjoined and restrained from acquiring any used IBM tabulating or electronic data processing machine owned by another person or the Service Bureau Corporation hereinafter provided for in Section VIII of this Final Judgment otherwise than as (1) a trade-in on a purchase of a tabulating or electronic data processing machine from IBM or (2) a reasonable credit against sums then or thereafter payable to IBM by a customer.

(b) IBM is hereby ordered and directed to solicit, in the manner specified in the provisions of paragraph (c) of this Section V, from dealers in second-hand business machines orders for the purchase of any used IBM tabulating or electronic data processing machines acquired by IBM pursuant to paragraph (a) of this Section V. The price charged by IBM for any such machine shall not exceed 85% of the price computed pursuant to paragraph (c) (1) of Section IV of this Final Judgment.

(c) IBM is hereby ordered and directed:

(1) within one year after the entry of this Final Judgment, and each six months thereafter for a period of five years, to cause the provisions of this Section V to be published in at least two trade journals of general circulation among dealers in second-hand business machines;

(2) commencing one year after the entry of this Final Judgment, to furnish at intervals of not more than 30 days to all dealers in second-hand business machines who shall within the preceding 180 days have made written requests therefor, and to at least one national trade association of such dealers, a list of all tabulating and electronic data processing machines acquired by IBM pursuant to paragraph (a) of this Section V since the date of the making of the last such list, and the prices thereof; and

(3) to keep all machines listed in the information furnished pursuant to subparagraph (2) of paragraph (c) of this Section V available for inspection and purchase by one or more of such dealers for a period of 60 days after such information shall have been furnished.

VI

IBM is hereby ordered and directed:.

(a) to offer to render, without separate charges, to purchasers from it of tabulating or electronic data processing machines the same type of services, other than maintenance and repair services, which it renders without separate charge to lessees of the same type of machines;

(b) to offer, commencing one year after the entry of this Final Judgment and so long thereafter as IBM shall continue to render repair and maintenance service, to maintain and repair at reasonable and nondiscriminatory prices and terms IBM tabulating and electronic data processing machines for the owners of such machines; provided that, if any such machine shall be altered, or connected by mechanical or electrical means to another machine, in such a manner as to render its maintenance and repair impractical for IBM personnel having had the standard training and instruction provided by IBM to such maintenance and repair personnel, then IBM shall not be required by this Final Judgment to render maintenance and repair service for such IBM machine; and

(c) to offer to sell at reasonable and nondiscriminatory prices and terms, to owners of IBM tabulating or electronic data processing machines (whether or not the purchaser receives IBM repair and maintenance service) and to persons engaged in the business of maintaining and repairing such machines and during the period when IBM has such parts and subassemblies avail-

able for use in its leased machines, repair and re - placement parts and subassemblies for any tabulating machines or electronic data processing machines manufactured by IBM.

VII

(a) IBM is hereby enjoined and restrained, for a period of ten years after entry of this Final Judg - ment, from entering into any lease for a standard tabulating or electronic data processing machine for a period longer than one year, unless such lease is terminable after one year by the lessee upon not more than three months' notice to IBM.

(b) IBM is hereby enjoined and restrained from requiring any lessee or purchaser of an IBM standard tabulating or electronic data processing machine to disclose to IBM the use to be made of the machine.

(c) IBM is hereby enjoined and restrained from requiring any purchaser of an IBM tabulating or electronic data processing machine to have it repaired or maintained by IBM or to purchase parts and subassemblies from IBM.

(d) IBM is hereby enjoined and restrained from:

(1) requiring any lessee or purchaser of an IBM tabulating or electronic data processing machine to purchase tabulating cards from IBM or directly or indirectly discriminating against any such person by reason of the fact that cards not manufactured by IBM are used,

(2) prohibiting, or in any way subjecting to IBM control or approval, alterations in or attachments to such machine;

provided, however, that this Section VII (d) shall not be construed to restrain IBM from including in any agreement with any lessee of such a machine provisions reasonably designed to prevent such interference with the normal and satisfactory operation and maintenance of such machine as will substantially increase the cost of maintenance thereof.

VIII

(a) IBM is hereby ordered and directed to transfer, within one year after the date of the entry of this Final Judgment, all its contracts for service bureau business to a corporation (hereinafter called the Service Bureau Corporation), which may be wholly owned by IBM, and IBM shall thereafter be enjoined and restrained from engaging in the service bureau business except on a non-discriminatory basis for the Service Bureau Corporation and for service bureaus operated by other persons.

(b) The Service Bureau Corporation shall be enjoined and restrained from:

(1) using any corporate name containing the words International Business Machines or IBM;

(2) employing any person also employed by IBM, or any person to solicit for IBM any order for the sale or lease of any IBM tabulating or electronic data processing machines or systems;

(3) after three years following the date of the entry of this Final Judgment, subleasing space from IBM at the locations of more than 20% of its bureaus; or

(4) for a period of five years after the organization of the Service Bureau Corporation, having a board of directors the majority of which is constituted of persons who previously have not been approved by this Court.

(c) The Service Bureau Corporation shall be ordered and directed to:

(1) maintain, in accordance with good accounting practice, separate and complete corporate records and accounts which shall be audited annually by independent public accountants; and

(2) charge for services rendered by it prices based upon rates which shall fairly reflect all expenses properly chargeable thereto provided, however, that nothing herein contained shall prevent the Service Bureau Corporation from reducing any price to meet an equally low price of a competitor.

(d) IBM is hereby ordered and directed to notify promptly service bureaus using IBM machines of the availability for purchase or lease as required by this Final Judgment of each new type of standard tabulating machine and electronic data processing machine offered by IBM for general use by its customers and of each new type of special purpose tabulating machine and electronic data processing machine made available to the Service Bureau Croporation, and the prices, terms and conditions for the sale or lease thereof.

(e) IBM is hereby enjoined and restrained from furnishing to the Service Bureau Corporation any tabulating or electronic data processing machines except upon the same terms, conditions and delivery schedules that such machines are furnished to any other service bureau.

(f) IBM is hereby ordered and directed to furnish, upon written application and at reasonable and nondiscriminatory charges, to any person engaged, or proposing to engage, in the operation of a service bureau using IBM machines copies of any pamphlets, books or instruction or other similar documents which it furnishes to the Service Bureau Corporation relating to the operation and application of IBM tabulating or electronic data processing machines for service bureau business.

IX

IBM is hereby ordered and directed:

(a) For a period of five years from the date of this Final Judgment, upon written request, to afford to any person (other than agents or employees of a manufacturer of tabulating or electronic data processing machines) who is engaged, or proposes in good faith to engage, in the repair and maintenance or distribution of IBM tabulating machines and/or electronic data processing machines the opportunity to obtain training in the repair and maintenance of such IBM machines, which shall be substantially equivalent in method and nature to such training then being given by IBM to its customer engineering employees. Reasonable and nondiscriminatory charges may be made to reimburse IBM for the cost of furnishing such instruction and any materials furnished to such person taking instruction.

(b) Upon written request to furnish, at reasonable and nondiscriminatory charges made to reimburse IBM for the cost of furnishing them, to any owner of an IBM tabulating or electronic data processing machine and to any person eligible to receive training pursuant to paragraph (a) of this Section IX copies of any technical manuals, books of instruction, pamphlets, diagrams or similar documents, which it furnishes generally to its own repair and maintenance employees relating to tabulating or electronic data processing machines and which pertain to such training.

(c) Upon written request to furnish, on a nondiscriminatory basis, without charge or at a reasonable charge made to reimburse IBM for the cost of furnishing them, to purchasers and lessees of IBM tabulating machines and electronic data processing machines, copies of manuals, books of instruction, pamphlets, diagrams, or similar documents which pertain to the operation or application of such machines owned or leased by such purchasers or lessees.

X

(a) IBM is hereby enjoined and restrained from:

(1) Entering into, maintaining, adhering to, or furthering, directly or indirectly, any contract, agreement, or understanding with or otherwise inducing any manufacturer, distributor, or vendor of raw materials suitable for the manufacture of tabulating cards to discriminate against or refuse to deal with third persons who buy or offer to buy such raw materials.

(2) Discriminating in price between different purchasers of tabulating cards of like grade and quality, provided that this provision shall not prevent differentials which (A) make only due allowance for differences in the cost of manufacture, sale, or delivery resulting from the differing methods or quantities in which such commodities are to such purchasers sold or delivered, or (B) are made to meet an equally low price of a competitor. In any proceeding to enforce the provisions of this paragraph, IBM shall have the burden of establishing to the satisfaction of this Court that its price differentials are in fact so justifiable.

(3) Prescribing, fixing, establishing, or maintaining arbitrary, unreasonable, or unnecessary specifications for tabulating cards used in standard and special purpose tabulating machines leased or repaired and maintained by IBM.

(4) Entering into, maintaining, adhering to, or furthering, directly or indirectly, any contract, agreement or understanding with or otherwise inducing any manufacturer, distributor or vendor of tabulating card machinery to discriminate against or refuse to deal with third persons who buy or order to have manufactured and buy such machinery.

(b) IBM is hereby ordered and directed, for a period of five years following the date of entry of this Final Judgment, to offer to sell rotary presses in good condition, of the types used by IBM for the manufacture of tabulating cards, upon reasonable and nondiscriminatory terms and conditions to any person who (1) is engaged, or proposes in good faith to engage, in the manufacture of tabulating cards and (2) has been unable to obtain delivery of such presses, as required for his needs within a reasonable time from manufacturers of printing presses; provided, that IBM shall not be obliged to deliver more than 30 presses in each year.

(c) IBM is hereby ordered and directed, for a period of five years following the date of entry of this Final Judgment, to offer to sell, from its reserve stocks of paper suitable for the manufacture of tabulating cards, any such paper not required for the reasonably anticipated need of IBM, to any person who (1) is engaged, or proposes in good faith to engage, in the manufacture of tabulating cards and (2) has been unable to obtain delivery of such paper, as required for his needs, from manufacturers of such paper in the United States. IBM may charge for such paper amounts sufficient to reimburse IBM for its costs.

(d) Seven years from the date of entry of this Final Judgment IBM shall divest itself, upon terms and conditions approved by this Court, of such part of its then existing capacity for the manufacture of tabulating cards as may be in excess of 50% of the total capacity for the manufacture of tabulating cards in the United States, unless subsequent to four years after the entry of this Final Judgment IBM shall have shown to the satisfaction of this Court that substantial competitive conditions exist in the manufacture, sale and distribution of tabulating cards or that such divestiture is not then necessary or appropriate.

XI

(a) IBM is hereby ordered and directed to grant to each person making written application therefor an unrestricted, nonexclusive license to make, have made, use and vend tabulating cards, tabulating card machinery, tabulating machines or systems, or electronic data processing machines or systems under, and for the full unexpired term of, any, some or all IBM existing and future patents.

(b) IBM is hereby enjoined and restrained from making any sale or other disposition of any existing or future patent which deprives it of the power or authority to grant such licenses, unless the purchaser, transferee or assignee shall file with this Court, prior to consummation of said transaction, an undertaking to be bound by the provisions of this Section XI with respect to such patent.

(c) IBM and its subsidiaries are ordered and directed, in so far as they have power and right to do so, to grant upon written request and without compensation to a person licensed under any IBM existing or future patent or patents pursuant to Section XI of this Final Judgment, with respect to any products manufactured in the United States pursuant to such license, a nonexclusive grant of immunity from suit under any corresponding foreign patent or application owned or controlled by IBM or a subsidiary of IBM.

(d) IBM is hereby enjoined and restrained from including any restriction whatsoever in any license granted by it pursuant to the provisions of this Section XI, except as hereinafter provided:

(1) the license may be nontransferable;

(2) a reasonable royalty may be charged (except for licenses under existing patents to make, have made, use and vend tabulating cards and/or tabulating card machinery, which shall be royalty-free), which royalty shall be non-discriminatory as among royalty-paying licensees procuring the same rights under the same patents, provided that the royalty charged an applicant who grants a patent license to IBM may reflect the fair value of such license;

(3) reasonable provision may be made for periodic royalty reports by the licensee and inspection of the books and records of the licensee by an independent auditor, an independent engineer or any person acceptable to both licensor and licensee, who shall report to the licensor only the amount of the royalty due and payable;

(4) reasonable provision may be made for cancellation of the license upon failure of the licensee to make the reports, pay the royalties or permit the inspection of his books and records as hereinabove provided; and

(5) the license must provide that the licensee may cancel the license in whole or as to any specified patents at any time after one year from the initial date thereof by giving 30 days' notice in writing to the licensor.

(e) Upon receipt of written application for a license under the provisions of this Section XI, IBM shall advise the applicant in writing of the royalty which it deems reasonable for the patent or patents to which the request pertains. If the applicant rejects the royalty proposed by IBM and if the parties are unable to agree upon a reasonable royalty within 120 days from the date such rejection is communicated in writing to IBM, the applicant or IBM may, upon notice to the Attorney General, apply to this Court for the determination of a reasonable royalty. In any such proceeding, the burden of proof shall be on IBM to establish the reasonableness of the royalty requested by it. Pending the completion of negotiations or any such proceedings, the applicant shall have the right to make, have made, use and vend under the patents to which his application pertains without payment of royalty or other compensation. A final Court determination of reasonable royalty shall be applicable to the applicant, and to any other licensee then having or thereafter obtaining the same rights under the same patents, at the option of such other licensee, from the date upon which the applicant requested such license. If the applicant fails to accept a license, such applicant shall pay the court costs in such proceedings and any royalties found by the Court to be due to IBM.

(f) Nothing herein shall prevent any applicant from attacking, in the aforesaid proceedings or in any other controversy, the validity or scope of any of the patents, nor shall this Final Judgment be construed as imputing any validity to any of said patents.

(g) The provisions of this Section XI shall not require IBM to grant a license to any applicant unless:

(1) for a license under an existing patent (except an existing patent relating to tabulating cards and/or tabulating card machinery), said applicant agrees not to bring suit under any, some or all of the United States patents and patents issued on applications owned or controlled by said applicant or under which said applicant has the power to grant licenses on the date of the request by the applicant for a license, for infringement by IBM arising out of the manufacture, use or sale of tabulating machines or systems or electronic data processing machines or systems of the types and models being manufactured or used by IBM in its regular line of business on the date of the request by the applicant, without first having offered to IBM a nonexclusive license for a reasonable royalty under and for the full life of said patent or patents claimed by the applicant to be infringed;

(2) for a license under a future patent (except a future patent relating to tabulating cards and/or

tabulating card machinery), said applicant agrees upon request to grant to IBM, for a reasonable royalty and for the full, unexpired term of each licensed patent, a nonexclusive license, or the right to obtain a nonexclusive license, to make, have made, use and vend tabulating machines or systems, or electronic data processing machines or systems under any, some or all of the United States patents and applications owned or controlled by said applicant or under which said applicant has the power to grant licenses on the date of the request by the applicant for a license;

(3) for a license under a future patent relating to tabulating cards or tabulating card machinery, said applicant agrees upon request to grant to IBM, for a reasonable royalty and for the full, unexpired term of each licensed patent, a non-exclusive license, to make, have made, use and vend tabulating cards or tabulating card machinery under any, some or all of the United States patents and applications owned or controlled by said applicant or under which said applicant has the power to grant licenses on the date of the request by the applicant for a license; and

(4) in any event, the applicant agrees upon request to grant without compensation, for any products manufactured in the United States pursuant to such license to IBM, a nonexclusive grant of immunity to IBM and any subsidiary of IBM from suit under any corresponding foreign patent or application then owned or controlled by said applicant.

For the purpose of this Section XI (g), a patent shall be deemed to be owned or controlled by an applicant if it is owned or controlled by the applicant, a subsidiary of the applicant, by a person whose subsidiary the applicant is, or by a person on behalf of whom the applicant then is acting as an agent with respect to the manufacture, use or sale of tabulating cards, tabulating card machinery, tabulating machines or systems, or electronic data processing machines or systems or parts for such machines. Determination of a reasonable royalty for any license to IBM under this Section XI (g) shall be made in the same manner as provided in Section XI (e) for determination of the reasonable royalty for a license granted by IBM, provided that in any proceeding for determination of a reasonable royalty under this Section XI (g) the burden of proof shall be on the person from whom IBM has requested a license to establish the reasonableness of the royalty requested by it.

XII

IBM is enjoined and restrained from instituting, or threatening to institute, any action, suit or proceeding under Section 281 et seq. of Title 35, United States Code (1953), against any person for acts of infringement of existing patents alleged to have occurred prior to the entry of this Final Judgment, except by way of counterclaim in any action brought by any person against IBM; provided, however, that such counterclaim shall not include any claim for infringement of any existing patent relating to tabulating cards or tabulating card machinery.

XIII

(a) IBM is ordered and directed to terminate upon the request of the licensee any existing patent-licensing agreement which is inconsistent with the provisions of Section XI of this Final Judgment and to grant new licenses to licensees affected by this provision upon the terms and conditions specified in Section XI of this Final Judgment.

(b) IBM is hereby enjoined and restrained for a period of five years from the date of entry of this Final Judgment from entering into, adhering to, maintaining, furthering, or renewing, directly or indirectly, any contract, agreement, understanding, or arrangement with any person relating to tabulating cards, tabulating card machinery, tabulating machines or systems, or electronic data processing machines or systems which:

(1) grants exclusively to IBM a license, sub-licensing right, or immunity under any patent, unless (A) IBM shall have failed in a bona fide effort to obtain a nonexclusive license under such patent and (B) such grant shall permit IBM to grant sublicenses under such patent as required pursuant to Section XI; and

(2) provides for disclosure to IBM on an exclusive basis of any invention, formula, process or technical information, other than the results of joint development programs undertaken by IBM and such person or work done by established research or engineering organizations on behalf of IBM.

(c) IBM is hereby enjoined and restrained for a period of ten years from the date of entry of this Final Judgment from retaining any individual inventor or engineer for work on the design and development of tabulating cards, tabulating card machinery, tabulating machines or systems, or electronic data processing machines or systems except:

(1) as an employee having regular hours of employment, or a retired IBM employee; or

(2) under contracts for research, development or engineering services which commit the inventor or engineer to provide personal services for periods of not more than one year.

XIV

(a) IBM is hereby ordered and directed for the period of five years after the entry of this Final Judg-

(cont'd on page 34)

MANUSCRIPTS

We are interested in articles, papers, reference information, science fiction, and discussion relating to computers and automation. To be considered for any particular issue, the manuscript should be in our hands by the fifth of the preceding month.

Articles. We desire to publish articles that are factual, useful, understandable, and interesting to many kinds of people engaged in one part or another of the field of computers and automation. In this audience are many people who have expert knowledge of some part of the field, but who are laymen in other parts of it. Consequently a writer should seek to explain his subject, and show its context and significance. He should define unfamiliar terms, or use them in a way that makes their meaning unmistakable. He should identify unfamiliar persons with a few words. He should use examples, details, comparisons, analogies, etc., whenever they may help readers to understand a difficult point. He should give data supporting his argument and evidence for his assertions. We look particularly for articles that explore ideas in the field of computers and automation and their applications and implications. An article may certainly be controversial if the subject is discussed reasonably. Ordinarily, the length should be 1000 to 4000 words. A suggestion for an article should be submitted to us before too much work is done.

Technical Papers. Many of the foregoing requirements for articles do not necessarily apply to technical papers. Undefined technical terms, unfamiliar assumptions, mathematics, circuit diagrams, etc., may be entirely appropriate. Topics interesting probably to only a few people are acceptable.

Reference Information. We desire to print or reprint reference information: lists, rosters, abstracts, bibliographies, etc., of use to computer people. We are interested in making arrangements for systematic publication from time to time of such information, with other people besides our own staff. Anyone who would like to take the responsibility for a type of reference information should write us.

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ment to furnish to each licensee under Section XI of this Final Judgment making written application therefor the technical information enumerated in paragraph (b) of this Section XIV, with respect to, and for use in the manufacture in the United States of:

(1) the IBM tabulating machines listed in Appendix A of this Final Judgment;

(2) tabulating cards; or

(3) tabulating card machinery

manufactured by or to the order of IBM and used commercially at any time during the five years immediately preceding the date of entry of this Final Judgment. IBM may make reasonable and nondiscriminatory charges for furnishing such technical information pursuant to paragraphs (b) and (c) of this Section XIV which shall not exceed the costs to IBM of furnishing it.

(b) The technical information to be furnished pursuant to paragraph (a) of this Section XIV shall consist of copies of the most current documents (including, but not limited to, schematic and detailed working drawings, specifications of material, prescribed production methods, and assembly drawings) employed by IBM prior to the date of the entry of this Final Judgment in the manufacture and assembly of such tabulating machines, tabulating cards, or tabulating card machinery, but shall not include information relating to typewriters or machines and devices for controlling, measuring, or recording time, tolls or production.

(c) In the event that any applicant represents to IBM in writing that the technical information furnished by IBM is inadequate to enable him satisfactorily to manufacture or assemble the standard tabulating machines, tabulating cards, or tabulating card machinery covered thereby, IBM shall supply such applicant with such further explanation of the information supplied as may be reasonably necessary for that purpose.

XV

(a) IBM is hereby enjoined and restrained from entering into, adhering to, maintaining, or furthering, directly or indirectly and whether inside or outside the United States, any contract, agreement, understanding, plan or program with any person engaged in the manufacture, sale, distribution or repair and maintenance of tabulating cards, tabulating card machinery, tabulating machines or systems, or electronic data processing machines or systems to:

(1) divide sales or manufacturing territories;

(2) allocate markets among manufacturers; or

(3) limit, restrain, or prevent the import into, or export from, the United States, its territories and possessions, of tabulating cards, tabulating card machinery, tabulating machines or systems, or electronic data processing machines or systems.

(b) IBM is hereby enjoined and restrained from conditioning the sale or lease of any standard tabulating or electronic data processing machine (which shall include any machine unit on a separate base even if in normal use it is mechanically or electrically connected with another such machine unit) upon the purchase or lease of any other standard tabulating or electronic data processing machine.

XVI

(a) IBM is ordered and directed (1) within 90 days after the entry of this Final Judgment (A) to furnish a true and complete copy of this Final Judgment to each of its officers, directors and employees at the policy level, its engineering personnel, its employees engaged in selling tabulating machines, tabulating cards, and electronic data processing machines, its patent licensees and all its present lessees, and (B) to notify all its lessees that their leases shall be deemed to have been modified to the extent, if any, necessary to conform to the provisions of this Final Judgment, and within 15 days thereafter to file with the Clerk of this Court its affidavit affirming that IBM has complied with the foregoing terms of this paragraph (a) of Section XVI; and (2) at any time within ten years after the entry of this Final Judgment to furnish to anyone, upon written request, a copy of Schedule A.

(b) IBM is ordered and directed, on or before March 31 of each of the first ten years following the year in which IBM first offers machines for sale pursuant to Section IV of this Final Judgment, to furnish to the Attorney General, for the preceding calendar year:

(1) a statement showing the sales and lease prices effective during such year, for each type of IBM standard tabulating and electronic data processing machine;

(2) a statement showing the number and the aggregate point values of each class of standard tabulating and electronic data processing machines sold by IBM in the United States pursuant to Sections IV (b) (2) and V of this Final Judgment, less the total point values of such machines reacquired by IBM, during such year;

(3) a statement showing the number and the aggregate point values of each class of standard tabulating and electronic data processing machines owned by IBM and placed in use by customers in the United States, less the total point value of such machines owned by and returned to IBM, during such year;

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(cont'd from page 33)

Fiction. We desire to print or reprint fiction which explores scientific ideas and possibilities about computing machinery, robots, cybernetics, automation, etc., and their implications, and which at the same time is a good story. Ordinarily, the length should be 1000 to 4000 words.

Discussion. We desire to print in "Forum" brief discussions, arguments, announcements, news, letters, descriptions of remarkable new developments, etc., anything likely to be of substantial interest to computer people.

Payments. In many cases, we make small token payments for articles, papers, and fiction, if the author wishes to be paid. The rate is ordinarily 1/2¢ a word, the maximum is $20, and both depend on length in words, whether printed before, whether article or paper, etc.

- END -

EDITOR'S NOTES
(cont'd from page 4)

We plan to publish a full entry for everyone from whom we have current Who's Who information in our hands by October 10. In regard to any other person, we expect we shall list only his name and location, as we did in the July 1955 cumulative "Who's Who", since basically we have not been authorized to publish his address.

If we get out the mailing in August and September, assemble and type entries in October, we should be able to publish the Who's Who by early December. If there are any left-over copies of the "Who's Who" after the date of publication, we plan to sell them at a higher price than $15.

Your comments and suggestions will be welcome.

- END -

FINAL JUDGMENT
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(4) a statement showing the number and the aggregate point values of each class of tabulating and electronic data processing machines sold by IBM during such year pursuant to Section IV (b) (l) of this Final Judgment; and

(5) a statement showing the number of tabulating machines acquired by IBM pursuant to paragraph (a) of Section V of this Final Judgment and in respect of each such machine resold to a dealer in second-hand business machines pursuant to paragraph (b) of Section V, its type, age, resale price and the price of a new machine of the same type.

XVII

For the purpose of securing compliance with this Final Judgment, duly authorized representatives of the Department of Justice shall upon request of the Attorney General or the Assistant Attorney General in charge of the Antitrust Division and on reasonable notice to IBM made to its principal office be permitted, subject to any legally recognized claim of privilege approved by this Court, (a) access during the office hours of IBM to all books, ledgers, accounts, correspondence, memoranda and other records and documents in the possession, custody, or control of IBM relating to any matters contained in this Final Judgment, and (b) subject to the reasonable convenience of IBM but without restraint or interference from it, to interview officers, directors, agents, or employees of IBM, who may have counsel present, regarding any such matters. For the purpose of securing compliance with this Final Judgment, IBM upon the written request of the Attorney General, or the Assistant Attorney General in charge of the Antitrust Division, and upon reasonable notice to its principal office, shall submit such written reports with respect to any of the matters contained in this Final Judgment as from time to time may be necessary for the purpose of enforcement of this Final Judgment.

XVIII

Information obtained by the means provided in Sections XVI and XVII of this Final Judgment shall not be divulged by any representative of the Department of Justice to any person other than a duly authorized representative of such Department, except in the course of legal proceedings to which the United States is a party for the purpose of securing compliance with this Final Judgment or as otherwise required by law.

XIX

Jurisdiction is retained for the purpose of enabling either of the parties to this Final Judgment to apply to this Court at any time for such further orders and directions as may be necessary or appropriate for the construction or carrying out of this Final Judgment, for the modification or termination of any of the provisions contained herein and for the enforcement of compliance therewith and the punishment of the violation of any of the provisions contained herein.

XX

The provisions of this Final Judgment shall not be deemed to have any effect on the judgments entered in this Court on December 26, 1935, and January 29,1936, in United States v. International Business Machines Corporation, et al.

Dated: January 25th, 1956.

DAVID N. EDELSTEIN
United States District Judge

We consent to the making and entry of the foregoing Final Judgment:

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a member of the above firm;

COOPER, DUNHAM, KEITH & DEARBORN
by DRURY W. COOPER, JR.
a member of the above firm.

(cont'd on page 38)

FINAL JUDGMENT
(cont'd from page 36)

Appendix A

IBM STANDARD TABULATING MACHINES

Type	Class and Name
	Key Punches
001	Mechanical Punch
010	Card Punch
011	Electric Punch
012	Duplicating Punch
015	Motor Drive Punch
016	Motor Drive Duplicating Punch
024	Card Punch
026	Printing Card Punch
031	Duplicating Punch
036	Alphabetic Printing Punch
	Key Verifiers
051	Mechanical Verifier
052	Motor Drive Verifier
053	Motor Drive Verifier
054	Alphabetic Verifier
055	Verifier
056	Verifier
	Card-Paper Tape Punches
043	Tape-Controlled Card Punch
044	Tape-Controlled Card Punch
046	Tape-to-Card Punch
047	Tape-to-Card Printing Punch
063	Card-Controlled Tape Punch
	Typewriter Punches
824	Typewriter Card Punch
826	Typewriter Card Punch
884	Typewriter Tape Punch
	Data Tranceivers
065	Data Transceiver Card Unit
066	Printing Data Transceiver Card Unit
067	Telegraph Signal Unit
068	Telegraph Signal Unit
	Reproducers, Gang Punches and Summary Punches
501	Numbering Gang Punch
512	Reproducing Punch
513	Reproducing Punch
514	Reproducing Punch
516	Duplicating Summary Punch
517	Gang Summary Punch
518	Gang Summary Punch
519	Document Originating Machine
522	Duplicating Summary Punch
523	Gang Summary Punch
524	Duplicating Summary Punch
526	Printing Summary Punch
528	Accumulating Reproducer
549	Ticket Converter

Type	Class and Name
	Sorters
071	Vertical Sorter
075	Card Counting Sorter
080	Sorter
082	Sorter
083	Sorter
	Collators
077	Collator
089	Alphabetic Collator
	Interpreters
550	Numeric Interpreter
551	Check Writing Interpreter
552	Alphabetic Interpreter
557	Alphabetic Interpreter
	Accounting Machines
090	3-Counter Accounting Machine
091	3-Counter Vertical Accounting Machine
092	5-Counter Accounting Machine
093	5-Counter Accounting Machine
222	Type III E, 5-Counter, 5-Bank Accounting Machine
232	Type III G, 5-Counter, 5-Bank Accounting Machine
285	Electric Accounting Machine
297	Electric Accounting Machine
298	Electric Accounting Machine
376	Utility Biller
402	Alphabetic Accounting Machine
403	Alphabetic Accounting Machine with Multiple Line Printing
404	Alphabetic Accounting Machine
405	Alphabetic Accounting Machine
407	Accounting Machine
416	Numerical Accounting Machine
419	Numerical Accounting Machine
916	Bill Feed
920	Bill Feed
921	Automatic Carriage
922	Tape-Controlled Carriage
923	Tape-Controlled Carriage
924	Dual-Feed Tape Carriage
933	Carbon Ribbon Feed Device
934	Carbon Ribbon Feed Device
	Calculating Punches
601	Multiplier
602	Calculating Punch
602A	Calculating Punch
604	Electronic Calculating Punch
521	604 Punch Unit
	Cardatypes
854	Cardatype
856	Cardatype
857	Secondary Document Writer

(cont'd on page 42)

BOOKS AND OTHER PUBLICATIONS

(List 20, "Computers and Automation", Vol. 5, No. 9, Sept. 1956)

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

Woollard, Frank G. / Principles of Mass and Flow Production / Philosophical Library, Inc., 15 East 40 St., New York 16, N. Y. / 1955, printed, 195 pp., $7.50

After defining the terms "mass production" and "flow production" the author, an Englishman, briefly traces the history of this type of manufacture. He then lays down a series of 18 basic principles that relate to the setting up of a flow production plant, and considers the implication of each in much detail. The author stresses that the methods of flow production can be applied with the same benefits to small quantities in small firms, and that large capital is not essential to their introduction. The book also deals with some of the practical problems arising from the onward march of automation, and there is a significant chapter devoted to the automatic factory of the future. Illustrated with numerous photographs and diagrams.

Craig, Harold Farlow / Administering a Conversion to Electronic Accounting / Division of Research, Graduate School of Business Administration, Harvard University, Soldiers Field Rd., Boston, Mass. / 1955, printed, 224 pp., $2.50

(Review by Ned Chapin)

The title of this book is misleading in one respect, but very accurate in another. It is misleading in its use of the term "Electronic Accounting". A more accurate term would be "Further Punched Card Accounting with a CPC". But the title is very accurate in its use of the term "Administering" because the book is about the situations facing administrators, the attitudes of employees and administrators. In short, this book is not a "computer" or even a "punched-card" book; it is a book on business administration, or perhaps even personnel administration. And it is not an elementary book; it is recommended only to persons already well versed in business and personnel administration.

The setting of the book is the office of an insurance company, where the author worked as an observer gathering data for a thesis. Part One of the book, covering 86 pages, describes the administrative situation in the office before and after the conversion of the accounting procedures. The organization, the volume of work, the equipment used, the jobs and salaries of the employ-

(cont'd on page 42)

COMPUTERS AND AUTOMATION

BACK COPIES

REFERENCE INFORMATION: (with notes regarding latest issues containing same)

Organizations:
Roster of Organizations in the Computer Field (June, 1956)
Roster of Computing Services (June 1956)
Roster of Consulting Services (June 1956)
Computing Machinery and Automation:
Types of Automatic Computing Machinery (Dec. 1955)
Roster of Automatic Computers (June, 1956)
Outstanding Examples of Automation (July 1954)
Commercial Automatic Computers (Dec. 1954)
Types of Components of Automatic Computing Machinery (March 1955)
Products and Services in the Computer Field:
Products and Services for Sale or Rent (June 1956)
Classes of Products and Services (June 1956)
Words and Terms:
Glossary of Terms and Expressions in the Computer Field (Jan. 1956)
Information and Publications:
Books and Other Publications (many issues)
New Patents (nearly every issue)
Roster of Magazines (Dec. 1955)
Titles and Abstracts of Papers Given at Meetings (many issues)
People:
Who's Who in the Computer Field (June, 1955, and later issues)

BACK COPY PRICES: If available, $1.25 each, except June 1955, $4.00, and June 1956 $6.00 (the June issue is the Computer Directory issue).

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HONEYCOMB MEMORY
(cont'd from page 11)

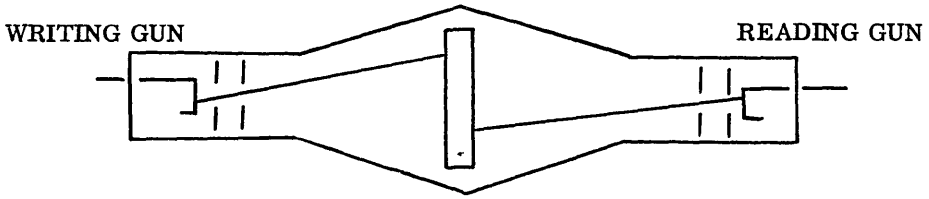


Figure 3 — Schematic Drawing of the information storage tube using the new high-resolution honeycomb memory plate developed by Dr. Harold R. Day at the General Electric Research Laboratory. The "writing gun" places information on the cell by a scanning method similar to that used in ordinary television. The "reading gun" picks up the information from the opposite side of the mesh.

IBM COMPUTER
(cont'd from page 9)

formed on the machine while SAGE data continues to be processed. The equipment going to McGuire is the first production computer. Engineering models of the computer have been installed for several months at Kingston and at the Lincoln Laboratory of Massachusetts Institute of Technology in Lexington, Mass., where the system is being tested.

Other contributors to the SAGE system include Western Electric Co., Bell Telephone Laboratories, and Rand Corp. of Santa Monica, California. The SAGE system was developed by scientists and engineers at MIT's Lincoln Laboratory under contract with the Air Force. This program is being implemented through the joint efforts of the USAF Air Materiel, Air Research and Development, and Air Defense Commands.

- END -

FINAL JUDGMENT
(cont'd from page 38)

Type	Class and Name
971	Auxiliary Keyboard Unit
858	Cardatype Accounting Machine
534	Cardatype Card Punch
536	Cardatype Printing Card Punch
863	Arithmetic Unit
866	Non-transmitting Typewriter
868	Transmitting Typewriter
961	Tape Punch Unit
972	Auxiliary Keyboard Unit
	Miscellaneous
101	Electronic Statistical Machine
954	Facsimile Posting Machine
955	Numbering Machine

- END -

BOOKS
(cont'd from page 40)

ees, the layout of the office area, the morale of the employees, and employee security features, are all described in varying detail. Paraphrasings of the words of administrators and employees are frequent to help convey the tone of the situations presented. Little attention is given to the way in which the data processing work was accomplished either before or after conversion.

Part Two of the book, covering 100 pages, is in effect a chronology of the changing administrative situations over the period considered. Much of it is told in paraphrasings of the words of employees and administrators, with comment, observations, and explanations provided by the author. The situations presented are largely independent of the particular equipment used in data processing. The situations cited often could easily have arisen from other stimuli.

Part Three, covering 15 pages of the book, summarizes the author's views about the administrative handling of the situations he previously described. The author highlights what he believes to be the administrative strength and values displayed in the situations, and comments upon the organizational situation that contributed to these strengths and values. The author closes the book with a list of sixteen questions to help in the development of "administrative awareness" in handling situations involving technological change. The Appendix of the book consists of two Harvard Business School Cases.

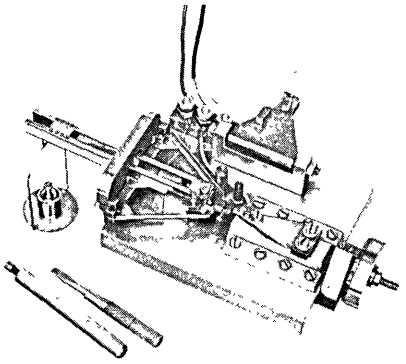
- END -

putting IDEAS *to work—research at* IBM

- **Whisker Loader: allows accurate measurement of contact area between pointed .005″ diameter wire and semiconductor surface. IBM Bulletin No. 300.**
- **Thimbleful of Liquid Memory: using the nuclei of hydrogen to store information. IBM Bulletin No. 301.**

Whisker Loader

Transistors are a "natural" for computers because of their small size, long life, and lower power needs than vacuum tubes. While most transistors used today are of the junction type, some applications require the point-contact type. In this type, the desired trace element is introduced into the germanium "heart" by

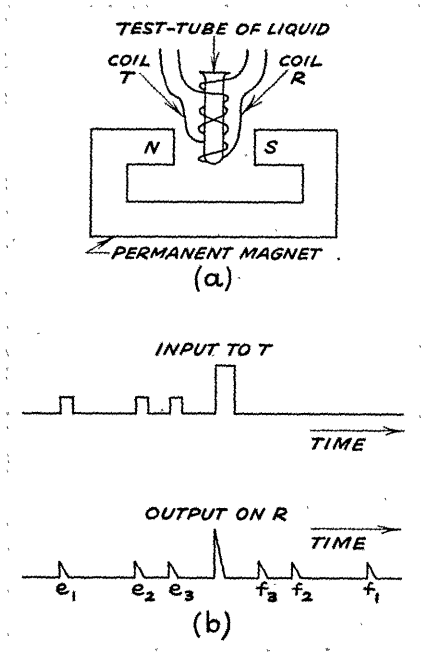


passing a large pulse of current through the pointed wire—which contains the desired trace element and which is in contact with the germanium. The result: heat causes the element to penetrate—or diffuse into the germanium. An important problem in the development of a manufacturing process for this type of transistor was to determine—one at a time—the influence on the diffusion process of each of the various factors involved. Jim Hanson, of our Poughkeepsie Research Laboratory, tackled this problem and came up with some of the answers by using what he calls the Whisker Loader. This precision instrument which he developed makes it possible to place the point of a five one-thousandths inch diameter wire upon the germanium surface; momentarily press the point against the surface with an accurately determined force of several grams; remove the wire and measure and inspect the area of contact between the wire and the germanium with a microscope (as small as one hundred-millionth of a square inch); and then replace the wire on the germanium, in the same position it first occupied, for electrical pulse forming. Our knowledge and understanding of pulse-forming techniques have been greatly increased by the use of this instrument.

A full report that clearly details test procedures, test results and other pertinent data is available in IBM Bulletin No. 300. Write for your copy.

Liquid Memory

Put a small amount of liquid such as glycerine in a d-c magnetic field, apply radio frequency pulses, and one can obtain radio frequency "echoes" of the applied pulses! This is the essence of the spin-echo effect which has been used by IBM scientists to store information in



liquids containing hydrogen nuclei. By proper combinations of r-f pulses, hundreds of echoes in "mirror order" or in "normal order" can be obtained. Referring to schematic below, when a liquid containing hydrogen—such as water or glycerine—is put into the test tube and pulses of r-f current are applied to coil T, pulses will be produced across the terminals of coil R as shown. The pulses e_1, e_2, and e_3 are found only if pulses f_1, f_2, and f_3 have been applied and hence are called "echoes."

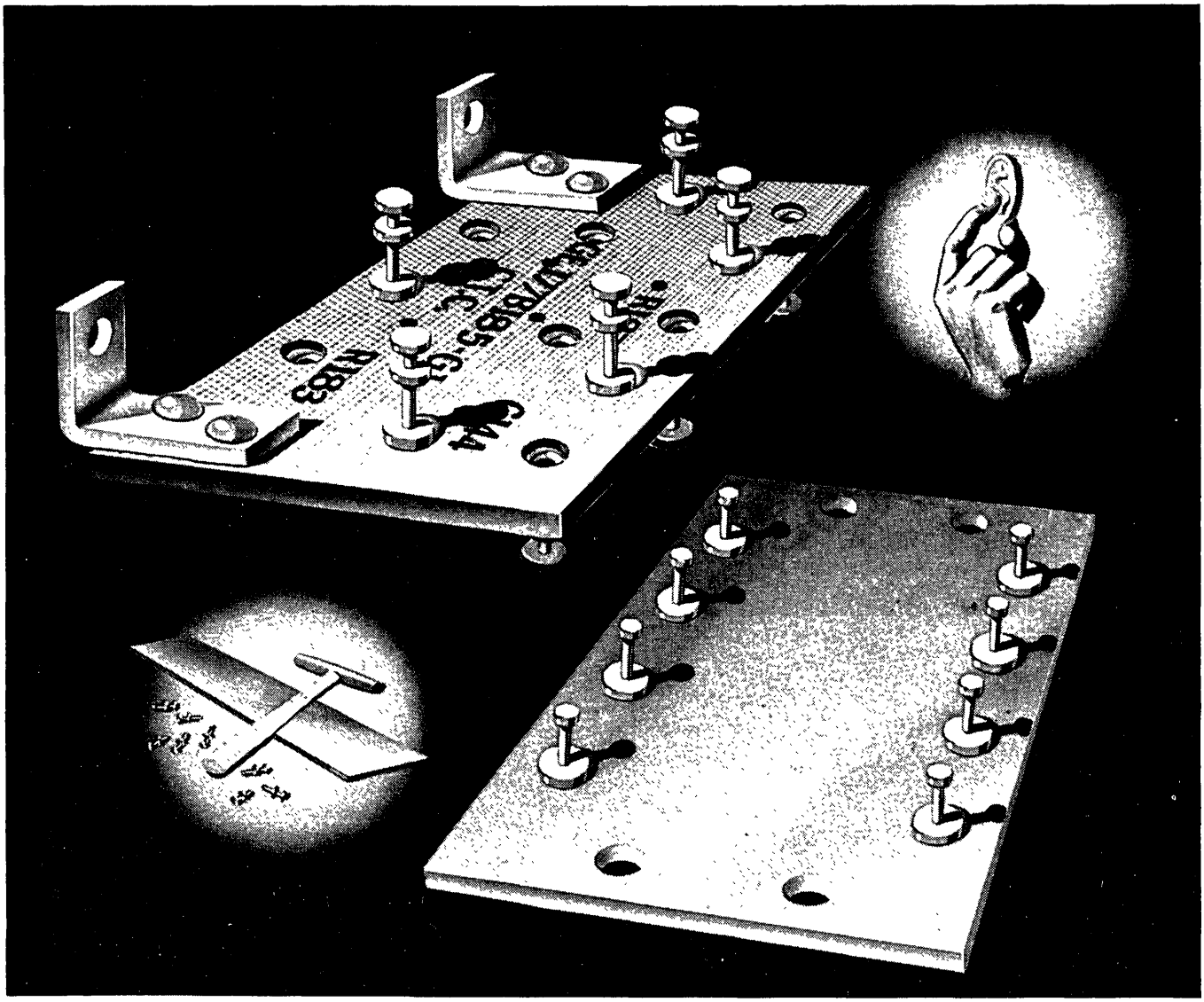
The effect may be understood in terms of the magnetic moments and angular momenta or spins of the hydrogen nuclei. In the d-c magnetic field, the nuclear moments are aligned so that the net moment throughout the sample is parallel to the field. A weak r-f pulse tilts the net moment away from the d-c field, about which it then precesses. But, due to inhomogeneities in the field, moments in different parts of the sample precess at slightly different rates . . . get out of phase with one another, and hence cannot be detected. The strong r-f pulse rotates all of the moments so that those which were farthest ahead in phase become farthest behind, and conversely. Subsequent precession brings the moments back into phase, giving rise to the echo signal.

A research group at the IBM Watson Laboratory in New York City, headed by Robert M. Walker, has investigated this effect and succeeded in storing a thousand "bits" of information in a thimbleful of liquid. Some day this form of memory may be an important component of a computing machine.

This method of storage based upon the principles of free nuclear induction is more fully described in IBM Bulletin No. 301.

• RESEARCH at IBM means IDEAS at work. For bulletins mentioned above, write International Business Machines Corp., Dept. CA-9, 590 Madison Ave., New York 22, N.Y.

IBM DATA PROCESSING



Make or buy — which is best for you?

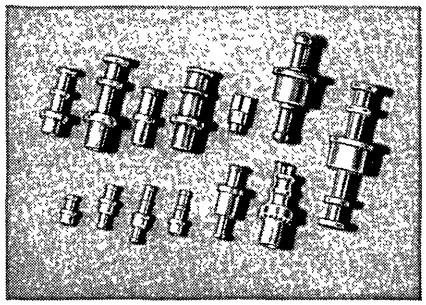
You'll make out better if you let CTC make your terminal boards. Why? The answer is simple.

CTC is equipped to produce quality terminal boards economically. The two key words in that sentence are "quality" and "economy." Here's how CTC can guarantee both.

Our swaging machines use tools we designed ourselves that prevent cracked boards and "cracked" rivets. Each terminal is fastened securely — *and carefully*. CTC terminal boards have no "weak spots".

Our finishes and coatings are applied smoothly. There are no wrinkles or heavy deposits. CTC terminals are selected from certified stock that is free from defects. CTC guarantees the terminals themselves — even to the thickness of plating!

The result of this is you are *sure* of the finest terminal boards in the quantity you want them in — and at a price you couldn't duplicate if you made them yourself. Get all the facts. Write for specifications and prices. You'll agree, you'll make out better if CTC makes your boards. Cambridge Thermionic Corporation, 437 Concord Ave., Cambridge 38, Mass. On the West Coast contact E. V. Roberts and Associates, Inc., 5068 West Washington Blvd., Los Angeles 16, and 61 Renato Court, Redwood City, California.



A LARGE VARIETY OF CTC SOLDER TERMINALS is available ranging from the miniaturized to the larger regular type. Each can be obtained in a variety of shank lengths and finishes and coated with water dipped lacquer for protection during storage.

CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components
custom or standard

40-6-21

Electronic Design — May 15, June 15; Electronics, Electrical Manufacturing — June, July; Proceedings of I.R.E. — July; Computors & Automation — September, October, 1956

ADVERTISING INDEX

The purpose of COMPUTERS AND AUTOMATION is to be factual, useful, and understandable. For this purpose, the kind of advertising we desire to publish is the kind that answers questions, such as: What are your products? What are your services? And for each product, What is it called? What does it do? How well does it work? What are its main specifications?

Following is the index and a summary of advertisements. Each item contains: Name and address of the advertiser / subject of the advertisement / page number where it appears / CA number in case of inquiry (see note below).

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If you wish more information about any products or services mentioned in one or more of these advertisements, you may circle the appropriate CA Nos. on the Reader's Inquiry Form below and send that form to us (we pay postage; see the instructions). We shall then forward your inquiries, and you will hear from the advertisers direct. If you do not wish to tear the magazine, just drop us a line on a postcard.

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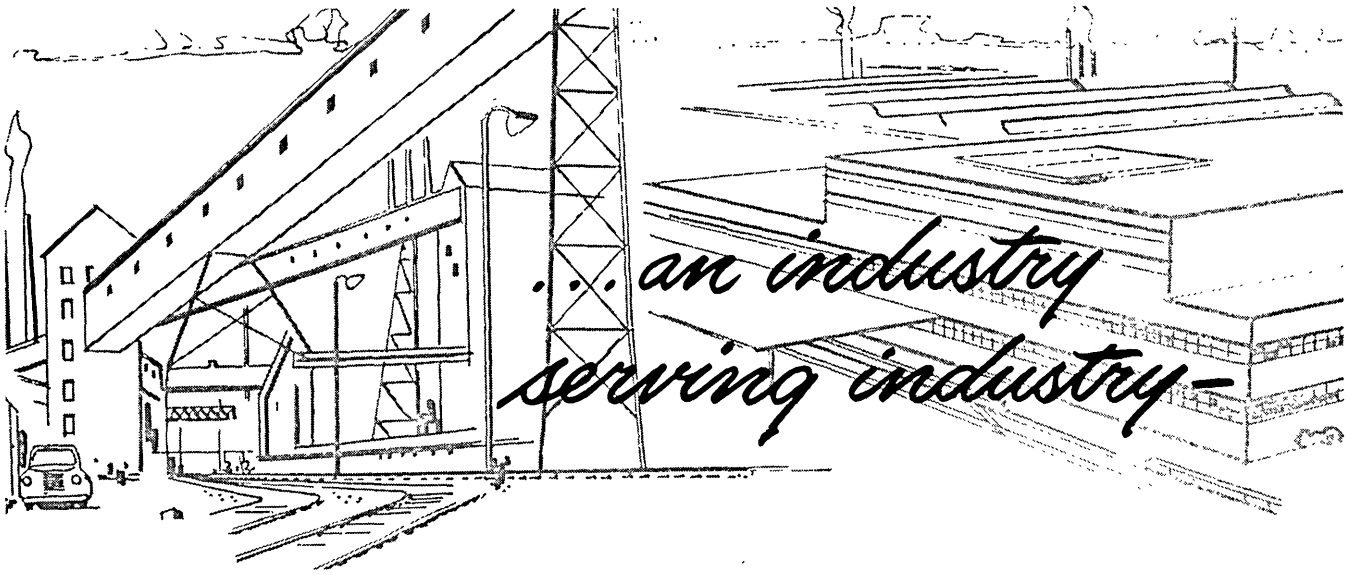
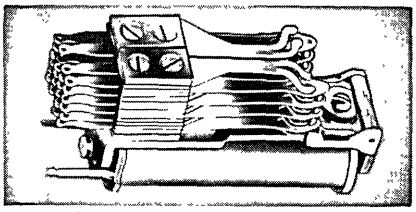
11	12	13	14	15	36	37	38	39	40	61	62	63	64	65	86	87	88	89	90	111	112	113	114	115	136	137	138	139	140
16	17	18	19	20	41	42	43	44	45	66	67	68	69	70	91	92	93	94	95	116	117	118	119	120	141	142	143	144	145
21	22	23	24	25	46	47	48	49	50	71	72	73	74	75	96	97	98	99	100	121	122	123	124	125	146	147	148	149	150

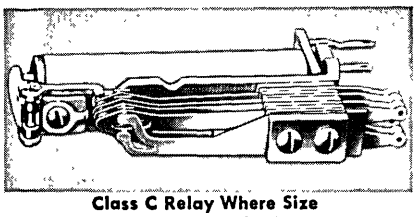
REMARKS:



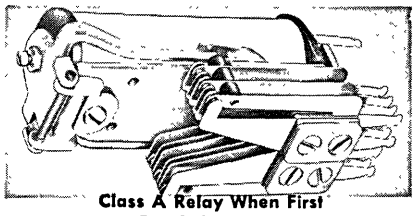
. . . an industry serving industry—



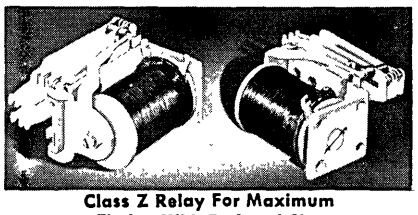
Class B Relay For Outstanding Endurance And Dependability



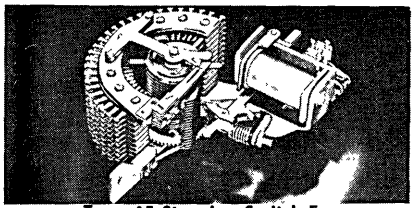
Class C Relay Where Size Limits Relay Selection



Class A Relay When First Cost Is Important



Class Z Relay For Maximum Timing With Reduced Size



Type 45 Stepping Switch For Large Capacity Requirements

Of all the dial telephones now in service throughout the world, over two-thirds operate on the principles which Automatic Electric originated and developed... In addition to its service to the telephone industry, Automatic Electric has for many years offered communication and electrical control equipment to *all* industry.

P-A-X BUSINESS TELEPHONE SYSTEMS

Company-owned *inside* telephone systems—entirely separate from the public telephones. P-A-X Systems are completely private, completely automatic—give you lightning-fast service 24 hours a day—no matter how busy the city switchboard may be. Thousands in use, in organizations of all sizes.

ELECTRICAL CONTROL COMPONENTS

Built to the exacting standards of the telephone industry, Automatic Electric relays and switches are vital components of many electrical and electronic devices. Available in scores of basic types, each with numerous varieties of coil and contact combinations to meet any electrical control need. These Automatic Electric components are finding innumerable uses in industry.

For further information on Automatic Electric's P-A-X Business Telephone Systems or on Relays and Switches for Industrial Control, write: Automatic Electric Sales Corporation, 1033 W. Van Buren Street, Chicago 7, Illinois. In Canada: Automatic Electric Sales (Canada) Ltd., Toronto 16.

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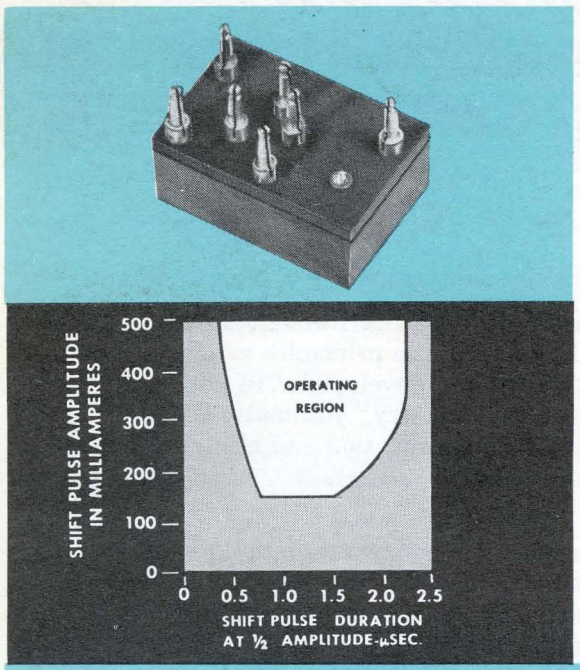
AUTOMATIC ELECTRIC

Originators of the dial telephone • Pioneers in automatic control

GENERAL SYSTEM

now . . . magnetic shift registers from SPRAGUE



operating frequency	0-200 kc
shift pulse	
Nominal Operating Current	300 ma
Voltage Drop Per Stage	6.5 volts
Duration (at half amplitude)	1.2 μsec
Rise Time	0.3 μsec
Fall Time	0.3 μsec
Peak Pulse Power	2 watt
input pulse	
Amplitude	10 ma
Duration	3 μsec
parallel output pulse	
Amplitude	15 volts
Ratio (Minimum)	10:1
Load Impedance (Minimum)	1500 ohms
diode	
Type	T-5 or equiv.

Nominal Performance Characteristics of Typical 200 kc Magnetic Shift Register

Now, from one reliable source, you can get a complete series of magnetic shift register assemblies . . . with read and write provisions . . . terminal wired and packaged to your special needs. *Plus* complete field engineering service for arriving at specifications and procuring registers that meet them.

Sprague's new registers are not only suitable for counters in computers and industrial controls, but for a wide variety of logical functions in "and", "or", and "not" circuits.

Five packages are standard, with others available if needed. The 71Z series have mounting ears, that simplify assembly of large arrays of bits in a single rack or frame. Series 70Z registers can be had in several terminal designs for mounting on etched wiring boards, or may be plugged into each other for permanent system flexibility. All 71Z units are mounted in hermetically sealed, corrosion-resistant metal cases with glass-to-metal solder-seal terminals for complete humidity resistance. Type 70Z units are embedded in resin for less demanding environments. Semi-conductor diodes may be externally connected between terminals, or integrally packaged in each assembly.

All Sprague shift register cores are subjected to rigid tests, assuring reliable operation in the final circuit use. Finished assemblies are 100% pulse performance tested to assure conformity with engineering specifications. Specifications for a typical 200 kc shift register, are shown above.

Complete specifications for all standard registers are in Engineering Bulletins 550C and 551, available on request to the Technical Literature Section, Sprague Electric Co., **377** Marshall St., North Adams, Mass.

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