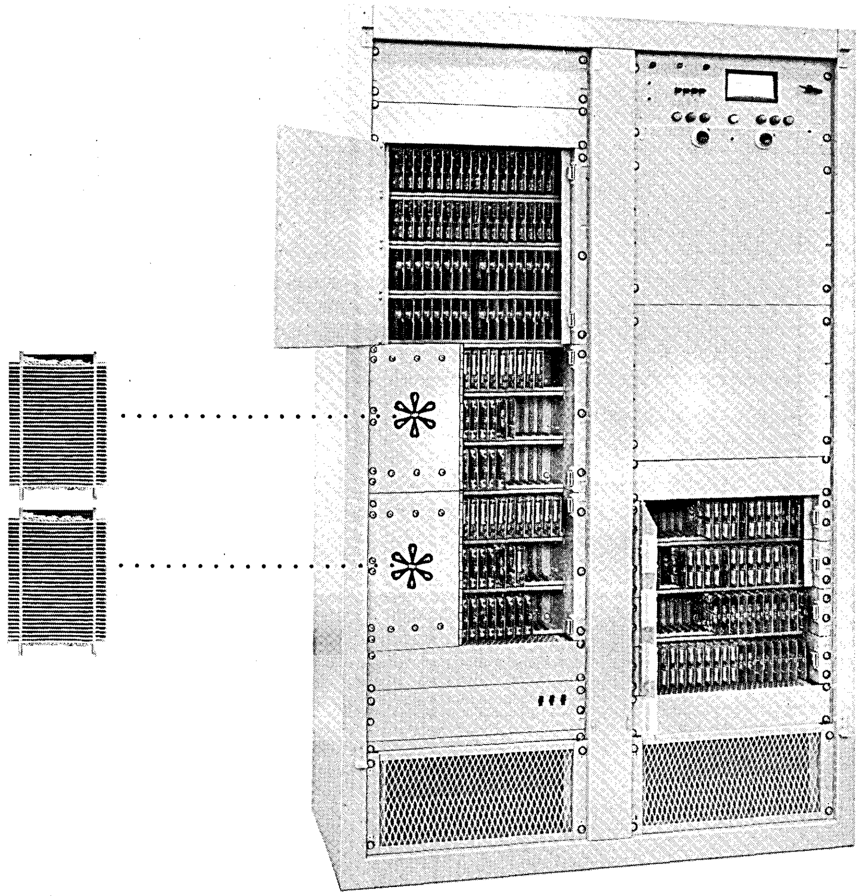
DATAMATION 60

May/June

page 15 TUNNEL DIODES AND COMPUTING

$$w_0 = \left(\frac{1 - R_T g}{LC}\right)^{\frac{1}{2}}$$



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Low in cost and high in performance, Telemeter Magnetics Type RQ memories solve the problem of designing economical, high speed storage for computers and data processing systems. These reliable units, offering five microsecond cycle operation, are available on an off-the-shelf basis in a wide range of capacities and word lengths. ■ **A combination of economy, speed, and reliability** is achieved through modular design, utilization of advanced solid state circuits, and quantity production of memory building blocks such as **Digi-Pak and Drive-Pak modules.**

■ **Type RQ memories** are available in capacities from 512 to 16,384 words with word lengths from 8 to 56 bits. Larger capacities available on special order. ■ **Type RQ memories** now in service are establishing new records of reliability. This is a natural result of TMI's completely integrated engineering and production facilities, from ferrite material to complete memory systems, permitting lower manufacturing costs while achieving high performance. ■ **To discuss your needs** with a TMI applications engineer, write or call today.

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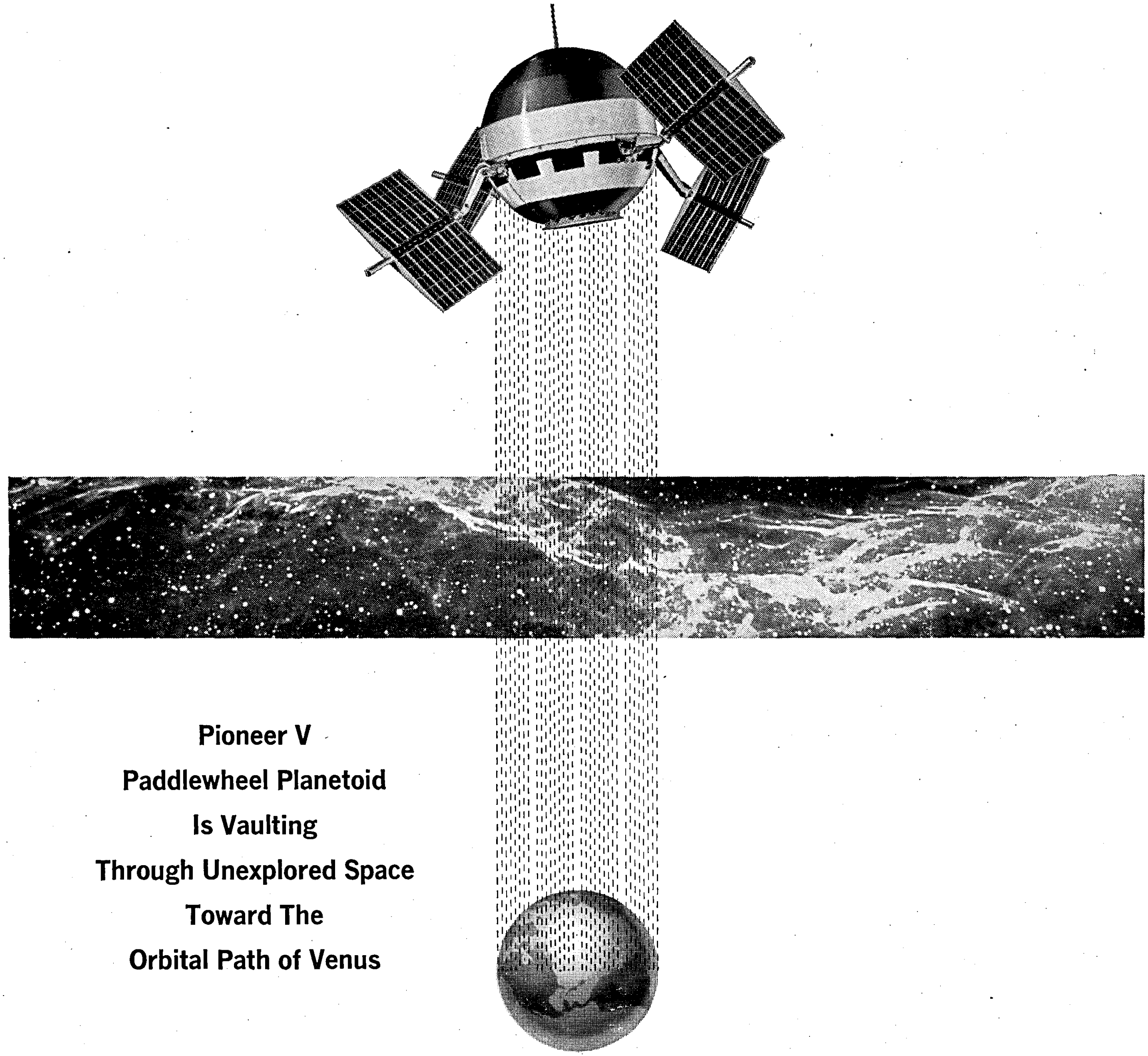

Pioneer V
Paddlewheel Planetoid
Is Vaulting
Through Unexplored Space
Toward The
Orbital Path of Venus

At this moment Pioneer V, one of the most advanced space probe vehicles ever launched, is on a course toward the path of Venus—26 million miles from earth. Blasted aloft March 11 by a Thor Able-4 rocket booster, this miniature space laboratory will reach its destination in about 130 days.

The project, carried out by Space Technology Laboratories for the National Aeronautics and Space Administration under the direction of the Air Force Ballistic Missile Division, may confirm or disprove long-standing theories of the fundamental nature of the solar system and space itself.

Energy from the sun—captured by almost 5,000 cells mounted in the four paddles—is used to supply all of the electrical power to operate the sophisticated array of instrumentation packed into the 94-pound spacecraft which measures only 26″ in diameter.

By combining a phenomenal digital electronic brain (telebit) with a powerful radio transmitter inside the satellite, STL scientists and engineers expect to receive communications from Pioneer V at their command over interplanetary distances up to 50 million miles.

STL's technical staff brings to this space research the same talents which have provided over-all systems engineering and technical direction since 1954 to the Air Force missile programs including Atlas, Thor, Titan, Minuteman, and related space programs.

Important positions in connection with these activities are now available for scientists and engineers with outstanding capabilities. Inquiries and resumes are invited.

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P. O. Box 95004, Los Angeles 45, California

to the editor . . .

Dear Sir:

I am writing you to comment on the digital magnetic tape recorder survey which appeared in your most recent issue. Before taking issue with Mr. Berlant, I would like to say that the survey was both useful and informative and I am looking forward to more data of this type on peripheral equipment.

In his article on "Digital Magnetic Tape Recorders" (March/April, 1960), Mr. Bert Berlant describes what he considers a typical use of magnetic tape transports as a memory bank in digital computers. He discusses a shuttling scheme in which the tape is repeatedly scanned until the information has been fully utilized by the computing system. He further suggests that tapes are normally scanned for particular items which can be located by an address system on the tape.

Both of these operations are highly atypical of the use of magnetic tape in a data processing application. Data is written on magnetic tape in blocks which are arranged in a serial manner along the tape. One or more blocks of data may be transferred in a single operation to or from the high-speed memory of the computer. Once data has been entered into the memory, further manipulation is done internally by the computer without any necessity for repositioning and rereading the tape. Rescanning of the data, as described by Mr. Berlant, would be prohibitive in terms of tape-unit time.

In typical data processing applications, tape motion is, for the most part, uni-directional. Tape motion is reversed only when it is necessary to reread or rewrite a data block in

(Continued on page 71.)

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Whatever you need a data printer for, Clary has a __proven__ model to do the job

At Clary you'll find the world's largest selection of solenoid actuated digital data printers.

These include Parallel Entry Printers, Printing Timers, Time-Data Printers, and Serial Entry Printers. All are reliable, proven printers ... printers whose simple circuitry, low cost, small size, desk top mounting, and modern design have made them the most "asked for" printers in the world.

Clary Printers are now being used in the following applications:

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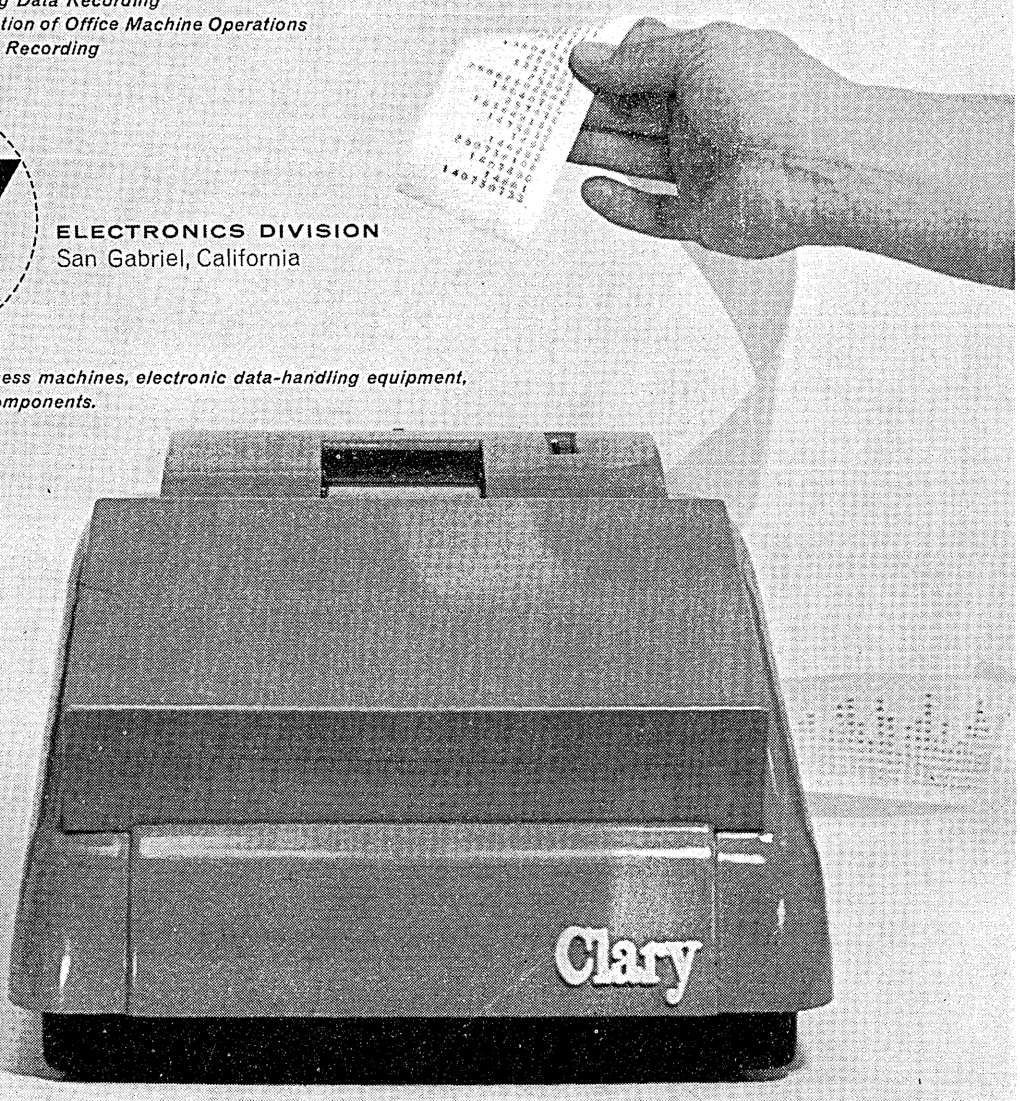
Automatic Engineering Data Recording
By-Product Accumulation of Office Machine Operations
Process Control Data Recording

Clary

ELECTRONICS DIVISION
San Gabriel, California

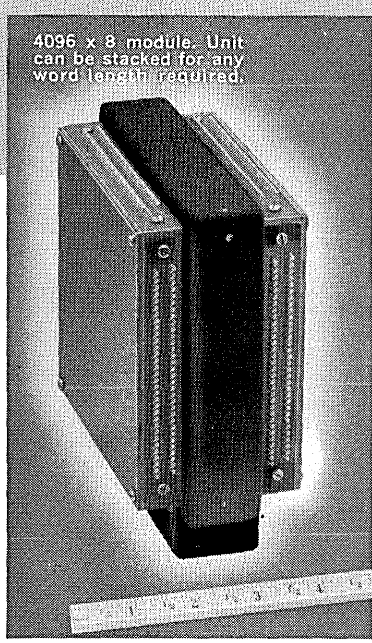
Manufacturer of business machines, electronic data-handling equipment, aircraft and missile components.



New temperature controlled MICROSTACK® meets

-55°C to +85°C

MILITARY REQUIREMENT



4096 x 8 module. Unit can be stacked for any word length required.

The General Ceramics MICROSTACK, one of the most important advances in memory core packaging, now operates in a temperature range of from —55°C to +85°C. Core characteristics remain constant. By maintaining temperature stability inside the MICROSTACK unit, General Ceramics engineers have developed a memory core package that is smaller, more rugged, requires no external cooling or heating, and meets MIL shock and vibration specifications.

For additional information, please write on company letterhead. Address inquiries to Section D.

DIVISION OF INDIANA GENERAL CORPORATION

APPLIED LOGIC DEPARTMENT

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KEASBEY, NEW JERSEY, U.S.A.

TECHNICAL CERAMICS, FERRITE AND MEMORY PRODUCTS

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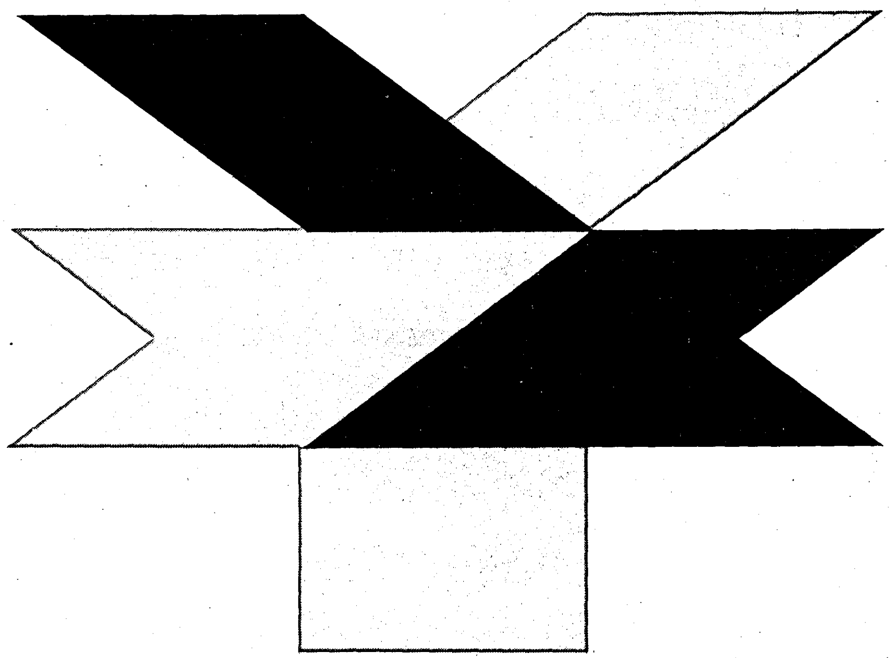

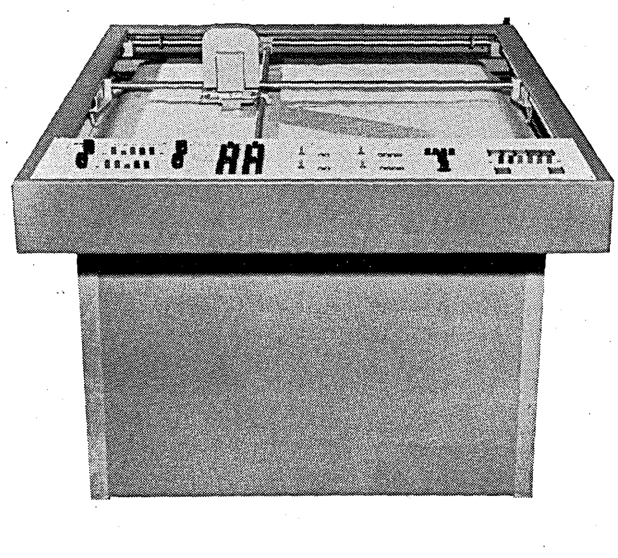

Bendix G-20

the new data processing system with the ORGANIZATION CHART *concept*

"Organization Chart" design in the Bendix G-20 means far faster, more efficient processing of scientific and business problems. The reason is clear:

The electronic manager of every data processing system is a computer. But most are poor "bosses" because they cannot delegate authority, or even supervise more than one operation at a time. Many computers run operations as complex as your own business, but with an inefficiency that you would never tolerate. Bendix engineers saw this shortcoming, and turned for a solution to the organization chart common to any well-managed business.

The G-20 Central Processor, or computer, has a staff of well-taught subordinates that can take instructions from the "boss" and go to work on their own, directing the workers that perform such tasks as reading punched paper tape and cards, looking up data on magnetic tape, and printing results. The "boss" can direct numerous subordinates, and without human intervention, schedule the work for each, making sure the most important work is done first. While the subordinates handle the details, the Central Processor is free to do the all-important computing.

This "organization chart" delegation of authority means several operations may be performed simultaneously, and with a minimum of equipment. The results? Call it "low cost per operation", or "just plain efficiency", but it is all the same . . . the Bendix G-20 gives you more performance per dollar than any other data processing system. The actual performance specifications listed at the right show the tremendous speed and power of the G-20. Components and design are the most modern in the industry today. System sizes can vary from a medium-scale system to a very large system with remote on-line or off-line sub-systems. Write for complete descriptive literature.

BENDIX AVIATION CORP., COMPUTER DIVISION Dept. E25 Los Angeles 45, California

SPECIFICATIONS:

MEMORY: Core, to 32,768 words in 4096 word modules.

EXECUTE +: 7 μs. avg., fixed point, one-word precision. 13 μs. avg., floating point, one-word precision.

EXECUTE ×: 49 μs. avg., fixed point, one-word precision. 49 μs. avg., floating point, one-word precision.

ARITHMETIC: Built-in floating pt., 12 dec. digit precision.

CIRCUITRY: Solid-state; parallel; 2.5 kva.

PROGRAMMING: Symbolic assembler or algebraic compiler.

INPUT/OUTPUT: 165,000 char./second max., asynchronous.

MAGNETIC TAPE: 120,000 decimal digit/second read-write.

LINE PRINTERS: 600 lines per minute.

PUNCHED TAPE: 500 or more character/second readers. 100 or more character/second punches.

PUNCHED CARDS: Standard high-speed 80 column units.

CONTROL BUFFERS: 1024 character memory for data and commands. Controls transmission on-line or off-line.

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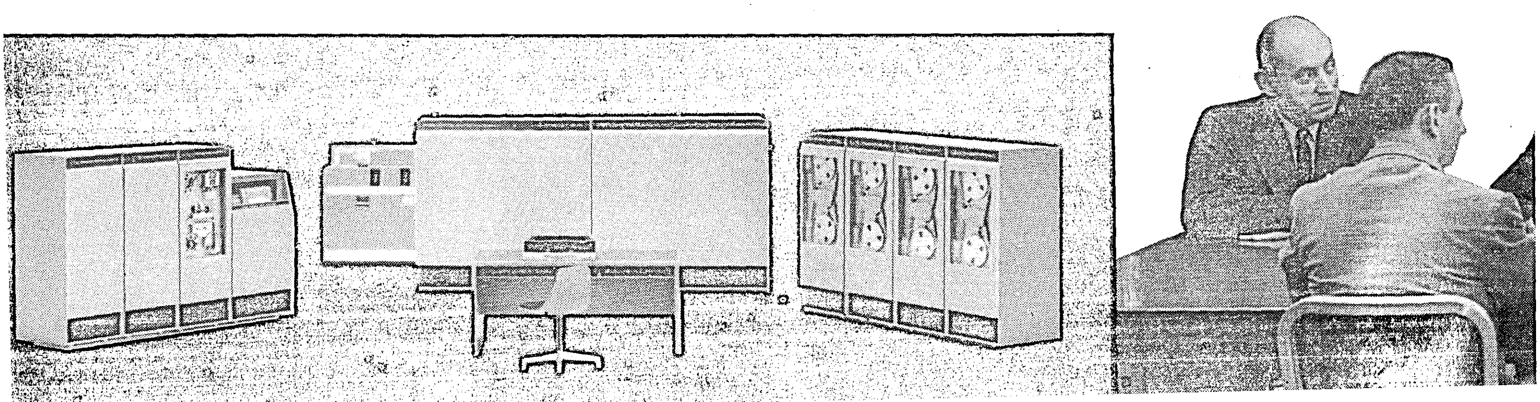
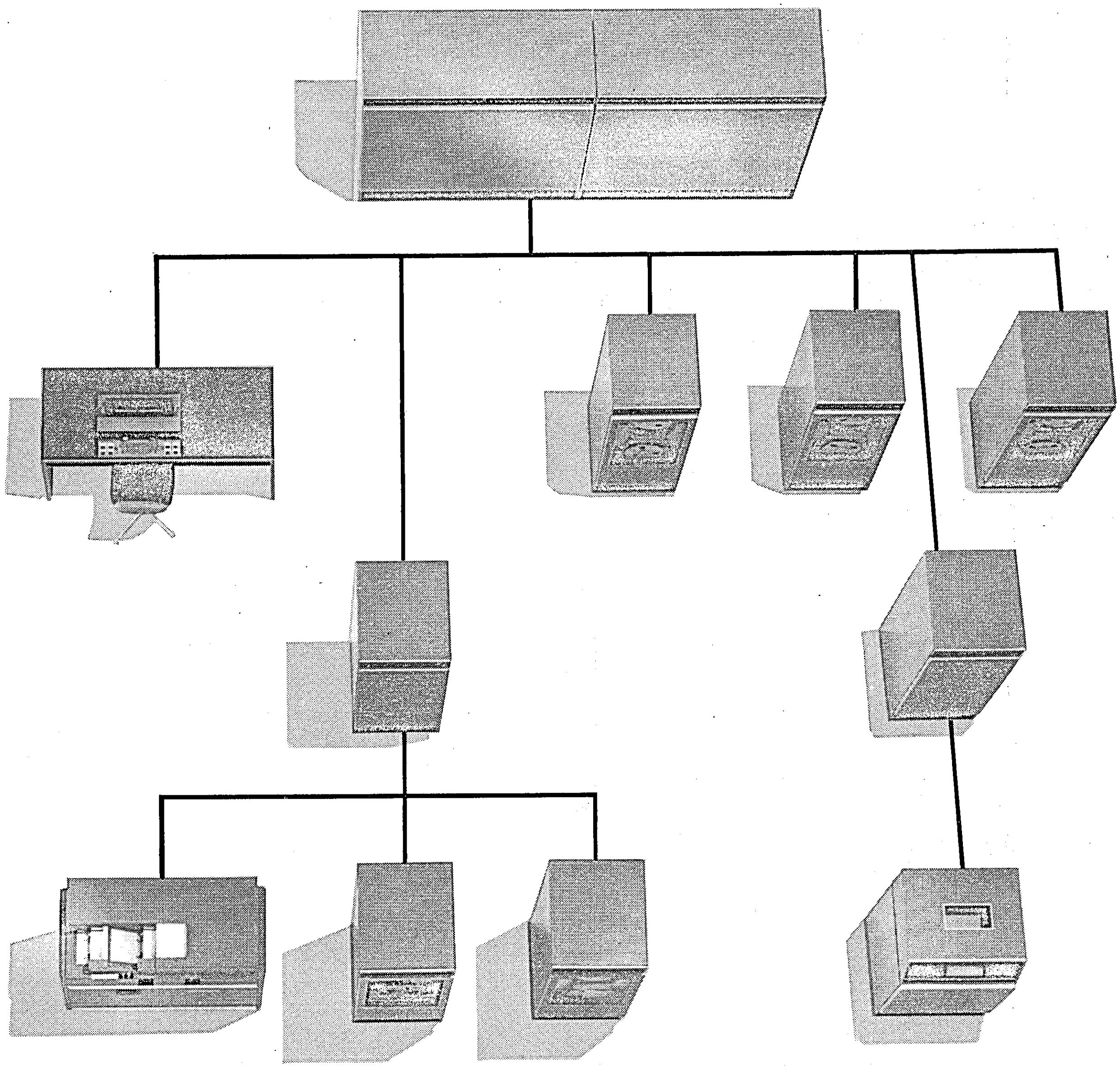
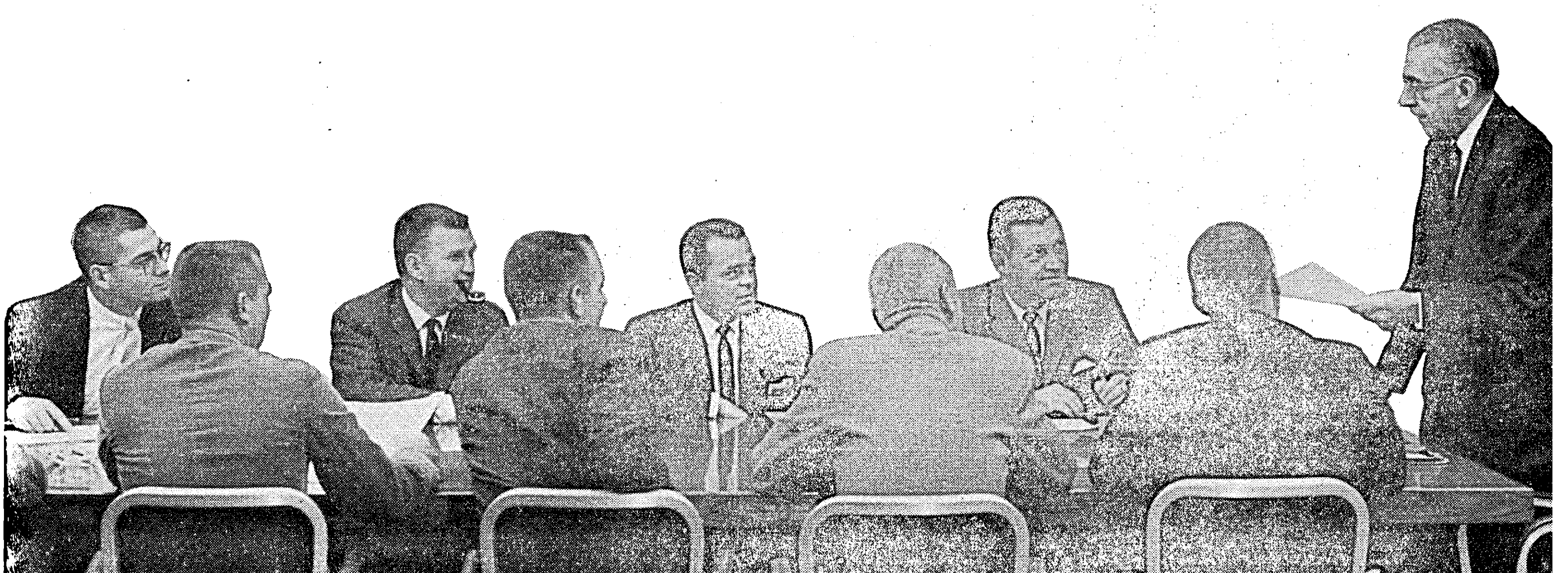






DATAMATION 60

the automatic handling of information

volume 6, number **3**

ARTICLES

DEPARTMENTS

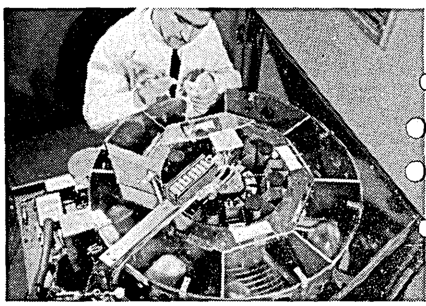
EDITORIAL OFFICES — 10373 W. PICO BLVD., LOS ANGELES 64, CALIF.

THIS ISSUE—30,000 COPIES

DATAMATION is circulated without charge by name and title to the manufacturers and users of automatic, information-handling equipment in all branches of business, industry, government and military installations. Qualified individuals in the United States and Canada are invited to request this publication on their company letterhead, stating position and firm's business. Available to others by subscription at the rate of $5.00 annually; single issue, $1.00 when available. No subscription agency is authorized by us to solicit or take orders for subscriptions in the United States, Canada or overseas.
DATAMATION will accept and consider articles dealing with small, medium and large electronic data processing systems; articles covering development and application of components, subsystems and systems; and other general articles of interest to those in the data processing industry. Material submitted should be accompanied by pictures and illustrations when possible. Unsolicited manuscripts to be returned to writer should include return postage but editor assumes no responsibility for their safety (although all reasonable care will be taken).

A Statement from Francis C. Brown, Chairman of the Board and President, Schering Corporation:

"In behavioral research alone, our Burroughs computer has multiplied our productivity by 100 times!"



Dr. Francis Mechner checks computer's daily results with Ronald Ray.

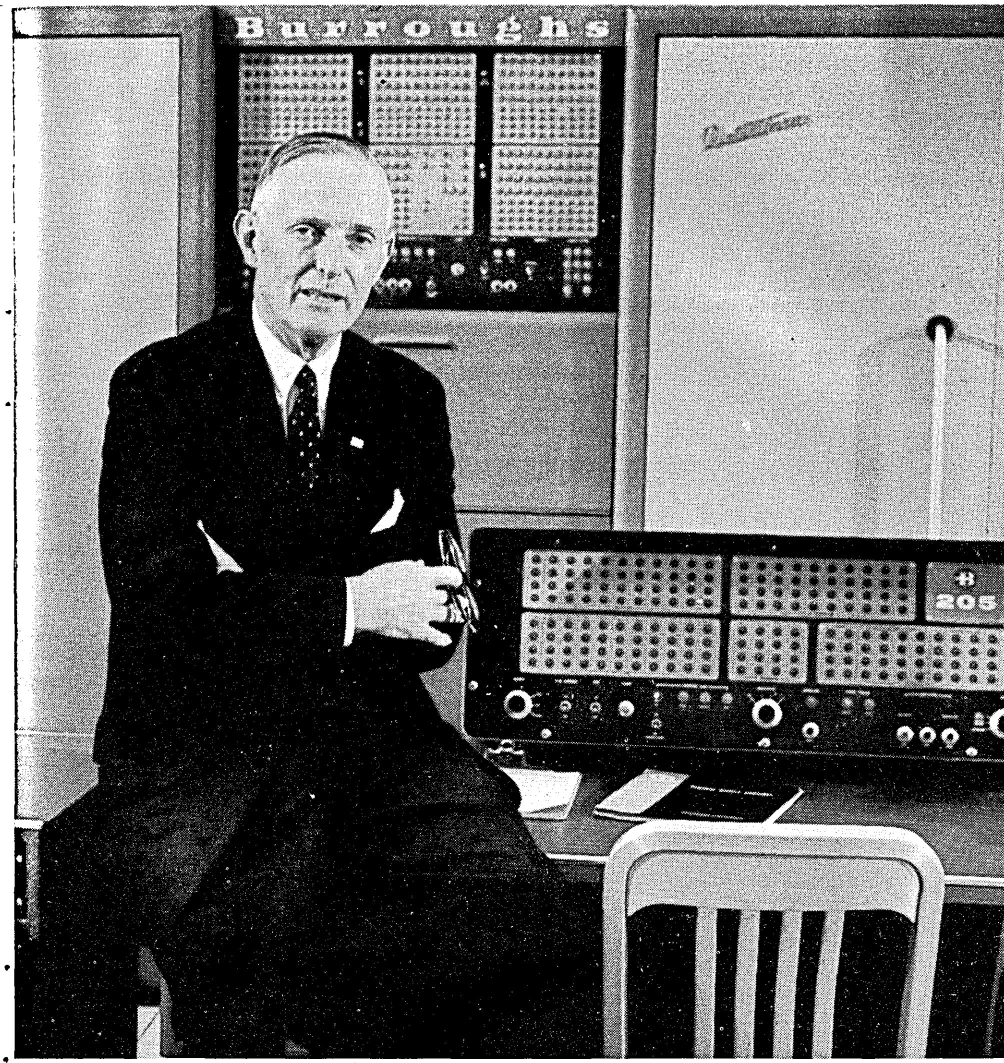
"We, at Schering Corporation, have grown accustomed to miraculous developments in our industry. So many advancements have been made in pharmaceutical research in the last two decades, we are convinced that we may indeed be on the brink of a pharmacological revolution.

"Yet, there is so much more to be done, so many new avenues to explore, that we recognize the only real source of continued development is through expanded research efforts. Through research, Schering has already created several of the world's leading ethical drugs...major emphasis has been on cortical hormones and antahistamines. Some, like Coricidin, have become household words.

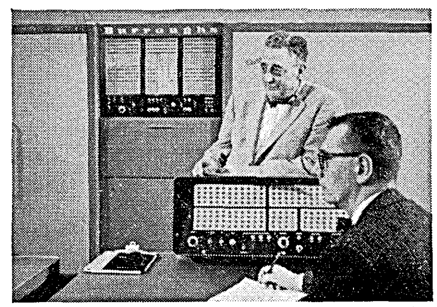
"While the results of research are sometimes dramatic, there is little of the miraculous in the day-to-day explorations made by pharmaceutical scientists. For one thing, pharmaceutical research is expensive...costs are over three times more per sales dollar than all other industries and rising substantially each year. Findings are often inconclusive and only a small portion ever reach fruition in a marketable product. And with a diversified line of products such as ours, we must maintain research projects in many different areas simultaneously. Even with the newest and most successful discovery, a competitor may enter the market with a better product that puts yesterday's 'miracle' out of favor.

"Yet, a relentless search for new products is a necessity. It is the only reasonable assurance of the continuing health of our own business enterprise. Today we are conducting extensive experimentation with chemical molecules of known pharmacological properties. The object is to achieve radically new pharmacological results by means of various alterations in chemical structure. Once achieved, these new compounds must be evaluated in laboratory animals. The methodology of this program is exemplified by an experiment carried out in Schering's Behavorial Research Laboratory. Here, eight highly trained rats take their turn in succession night and day, at a testing station where their behavior is recorded and then analyzed by computer. This is the type of experimentation in which the behavorial effects of drugs are tested in animals. The results of these experiments permit predictions concerning the effects these drugs will have on man.

"With thirteen experiments of this type proceeding on a continuous basis, the volume of data generated could never be handled without the aid of a computer. The Burroughs 205 performs computations every day which the staff



PHOTOGRAPHS BY J. ALEX LANGLEY



Dr. Bradley Whitman, Director of Research Services, confers with Gordon B. Thomas, Biometrics Manager.

of Schering's Behavorial Laboratory would require years to complete. The computer's final output is in the form of tables and graphs which are then studied and interpreted by psychopharmacologists.

"The decision to install a Burroughs 205 computer was upheld by a need to provide rapid, complete and economic analysis of the data which is produced by the research division at great cost. We investigated the computer field thoroughly, and after careful study and professional consultation, our technical people believed no other computer met our requirements so well. One of our scientific programmers, Biometrics Manager Gordon B. Thomas, was particularly impressed with the 205's ability to handle large masses of data with the power of a large scale computer... and at less than half the cost. Mr. Thomas felt the 4000-word memory of the 205 greatly facilitated the execution of research programs, many of which exceed 10,000 steps.

"In our research projects alone, the 205 has earned its keep. Dr. Bradley Whitman, head of Research Services, reports our 205 computer is turning out fast, accurate results at a cost we could never have realized by any other method. Research scientists are freed from time-consuming data collecting and may now spend more time on creative work.

"In addition to serving as a research aid, our 205 has provided us with other benefits as well.

"Our Procedures Department Manager, William B. Spencer, points out that the 205 is completely compatible with our commercial needs as well as research. In fact, our recent purchase of additional Burroughs peripheral equipment will allow us much greater capacity for commercial applications.

"As we expand and broaden our search for new products, we expect commensurate growth in other areas of our company as well, and we are confident that our 205 computer, with its modular expansion features, will keep pace with our computing needs."

FRANCIS C. BROWN
Chairman of the Board and President
Schering Corporation

Hundreds of other scientific and commercial users of Burroughs computers are confirming the same experience. Burroughs complete line of electronic data processing equipment is backed by a coast-to-coast team of computer specialists, all eager to tell you how Burroughs can help in your business. For additional information, write ElectroData Division, Pasadena, California.

Burroughs Corporation

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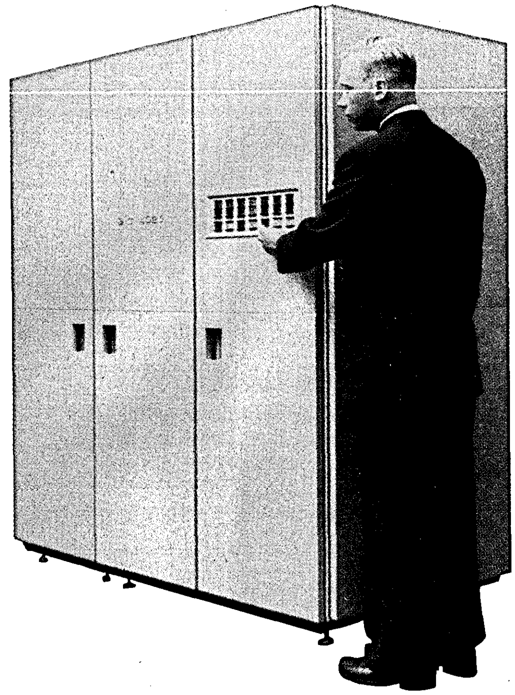
"NEW DIMENSIONS/in electronics and data processing systems"



NEW MICROFILM PRINTER DOES WORK OF 25 MEN AT 1/2 THE COST!

TWENTY FIVE MEN plotting graphs at top speed could not keep up with Stromberg-Carlson's S-C 4020 High Speed Microfilm Printer. In a typical graph plotting application, the S-C 4020 can do the job *better* – at ¼ to ½ the cost! And the S-C 4020 can save you money in dozens of other important applications. It will accept the output – on-line or off-line – of most major computers and produce accurate, high-quality recording on microfilm at rates of 15,000 plotting points or alphanumeric characters per second.

The S-C 4020 may be used for plotting graphs, drawing axes, drawing vectors or printing full pages of tabular data. Mathematical formulas used for design of mechanical components may be printed as drawings with significant dimensions superimposed on the design. Ship's hull equations, aircraft wing sections and other critical design components requiring descriptive geometry may be graphically displayed. With an optional automatic processing camera, graphs or tabular data may be viewed on a special screen only 8 seconds after film exposure.

LITERATURE AVAILABLE: Learn the complete story of the S-C 4020. Write to Dept. A-49, Stromberg-Carlson-San Diego, 1895 Hancock Street, San Diego, California.

STROMBERG-CARLSON-SAN DIEGO

A DIVISION OF **GENERAL DYNAMICS CORPORATION**

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DATAMATION GOES MONTHLY

Just over two and a half years ago, the first issue of DATAMATION was published. In an editorial, the magazine was dedicated to the goal of becoming the spokesman for the field of automatic information handling. We have, we feel certain, made real progress toward attaining that goal and the time has come for DATAMATION to take a most important step.

We have seen the field we serve grow from a half-billion dollar industry to one which will approximate two billion by the end of 1960. This fact, plus repeated requests from both readers and advertisers, have led us to the decision to begin monthly publication with the January, 1961, issue.

During the time which has elapsed since its early issues, DATAMATION has endeavored to chart a true course in the tempest of this exploding technology. The field of automatic information handling incorporates many areas of interest: computing, data sensing, recording, conversion, acquisition, transmission, storage, retrieval, reduction and display, to name a few. In order to perform these functions, complex equipment and highly developed methods are required. The equipment includes analog and digital computers, general purpose, special purpose and process control machines, a tremendous range of peripheral gear, literally millions of components. At the same time, intensive research and development, careful design, and imaginative programming efforts are evolving.

DATAMATION's goal has been to provide individuals in many of these areas with the most significant information available. Thus, top management in government and industry can follow information processing trends and interpretations of these trends to assist them in decisions affecting the purchase or increased use of datamation systems or sub-systems. Supervisors of computer installations and centers can find details on new equipment and articles covering such topics as equipment selection and personnel training. Researchers, designers, manufacturing personnel, programmers, consultants — a nearly infinite variety of users and potential users — can find in DATAMATION technical articles designed to explain, news articles designed to inform, feature articles designed to broaden and survey articles designed to contrast.

Readers have also found a wide range of departments to provide the latest news of the industry, both at home and abroad. Departments were established and maintained to cover spot news, new products and new literature, important dates and important personnel changes.

By making the decision to publish monthly, we are further binding DATAMATION's growth, development and its very future to an industry which, we are certain, has barely started a dynamic, prosperous and fascinating climb.

FRANK D. THOMPSON
Publisher

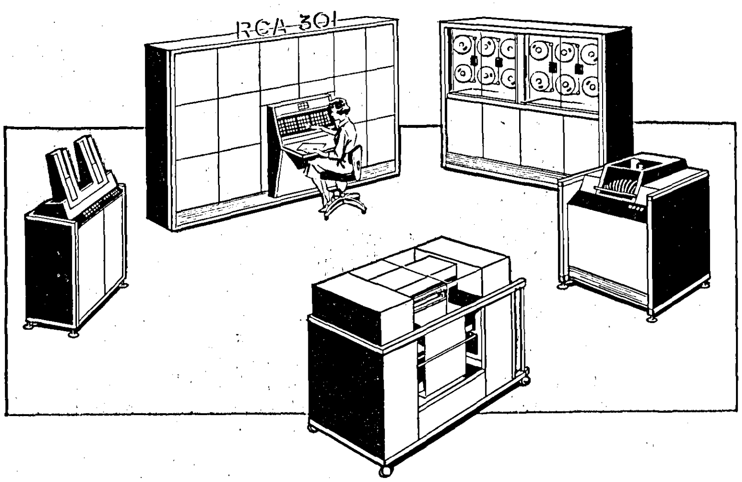
BIG NEWS

in ELECTRONIC DATA PROCESSING

Two new systems, latest in a series of EDP Advancements from RCA —world leader in electronics—join the established RCA 501

For Business in the Smaller Ranges • Divisional Operations

THE NEW RCA 301



COMPLETE, Compact EDP System at Low Cost... with Optimum WorkPower and Speed

- DATA STORAGE OPTION: magnetic tape or new design discs that switch easily for changing jobs—23 million character capacity
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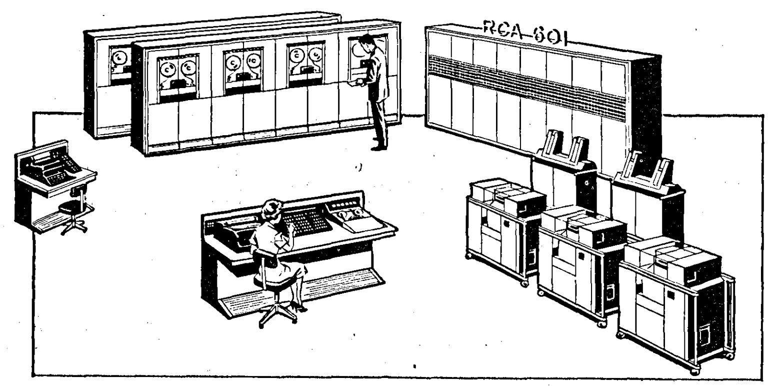
- FULL SPEED—reads 600 cards/minute; prints 600 alpha numeric lines per minute
- AUXILIARY ROLE—feeder or extender to 501 or 601 EDP Systems
- SIMULTANEITY OPTION permits large increase in workpower

For Large Business or Scientific Operations

THE NEW RCA 601

TREMENDOUS WorkPower . . . in Every Field of Data Processing . . . with Previously Unattainable CAPACITY—EXPANSIBILITY—ECONOMY

- ULTRA-FAST—to 180,000 digits/second with magnetic tape
- EXCEPTIONAL COMPUTING SPEED, 1.5 millionths of a second "add" time, 1.5 millionths of a second memory access time
- PARALLEL PROCESSING permits handling a multiplicity of independent programs with changeable priority
- UNPRECEDENTED COMPATIBILITY—with RCA data processing and communications equipment and other processors
- OMNI-CHANNEL INPUT/OUTPUT permits transfer of information to and from as many as 64 sources, with concurrent computing



For information about the complete transistorized line, write: Electronic Data Processing Division, Radio Corporation of America, Camden 2, New Jersey.

The Most Trusted Name in Electronics
RADIO CORPORATION OF AMERICA

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TUNNEL DIODES AND COMPUTING

Because of the intense interest shown in the Esaki or tunnel diode, as evidenced by such events as a special session at the 1960 Solid-State Circuits Conference entitled "Applications of Tunnel Diodes," DATAMATION feels that a special article on the tunnel diode and its expected impact on the computer industry will be of major interest to its readers. With this in mind, and to make the results as meaningful as possible, three general questions were sent to a number of manufacturers of semiconductor products and electronic computing equipment with the request that they comment on them. The questions were general in nature so as to provide as little bias on DATAMATION's part as possible.

DATAMATION would like to express appreciation to the companies and persons responding to the questions. We want to assure all concerned that comments and predictions of the type requested in this report are opinions only and should be looked upon by all as just that. They should be used as a means for guidance and enlightened discussions on the future of computing machines and related equipment and devices. If used in this way, the results of this inquiry will be beneficial.

In addition, DATAMATION would like to encourage free participation of all companies and persons in future requests for information of this type. It is due to the cooperation and freedom of comment by all concerned that these articles are successful and meaningful.

The questions asked with reference to the tunnel diode and its computer implications, along with the appreciated comments of responding companies follow. No attempt has been or will be made to interpret the comments of individuals or companies since this would be in disagreement with our policy of remaining neutral and performing what we believe is a useful information service for our readers. (Introduction and questions were prepared by C. L. Wanlass, editorial adviser for DATAMATION.)

What do you believe are the major assets of the tunnel diode with respect to its extensive use in future digital computing equipment? Which of these is the greatest asset?

FRANK J. HIERHOLZER, JR., Ass't. Head, R & D
Semiconductor Division, Sperry Rand Corp.
So. Norwalk, Conn.

Tunnel diodes have many advantages over the more conventional methods of switching which are presently used in computers. A few of these advantages or assets are:

(1) Extremely fast switching speed considering only the physical phenomenon of tunneling;
(2) Negative resistance region which can be used to obtain power gain;
(3) Low power dissipation when the device is used in the switching mode;
(4) Two leads of the diode might eventually reduce the space taken up in computers by interconnections;
(5) Surface conditions such as water and many other impurities do not influence the operation of the tunnel diode appreciably (we have actually operated unprotected tunnel diodes under water);
(6) Less sensitivity to radiation;
(7) High temperature of operation for given materials;
(8) Reliability and low price in the future.

Perhaps the two most important assets of the tunnel diode are the potential extremely fast switching speed and the power gain capability of the device.

HUGH R. LOWRY, Mgr. Application Engineering
Semiconductor Products Dept., General Electric Co.
Syracuse, N.Y.

Major assets of the tunnel diode with respect to usage in digital computers are: 1) Fast switching speed, 2) tight tolerances, 3) low cost, 4) reliability.

Switching speed – The basic mechanism of current flow in tunnel diodes takes place at close to the speed of light. The only restriction on switching speed is the capacitance of the PN junction in a T.D. plus any associated wiring capacitance. With presently available low capacitance T.D.'s (G-E ZJ56), switching will occur in the order of two millimicroseconds with a constant current drive having a magnitude only slightly greater than the peak current of 1 ma. Shorter switching times can be obtained with overdrive. This switching time is one or two orders of magnitudes faster than that obtainable from transistors operating at current levels of 1 ma. The tunnel diode, therefore, represents a real breakthrough in the search for a fast switching device having low power requirements.

Tolerances – Tunnel diode computer circuits consist almost entirely of T.D.'s and resistors. Such circuit simplicity is obtained only by requiring fairly tight tolerances ($\pm 3\%$ or better) on the tunnel diode peak current and to a lesser degree on the other parameters. Fortunately, it has been our experience that tunnel diode characteristics can be controlled by manufacturing techniques rather than selection and classification of the finished product. This is quite different from transistors which even today, after five years of production experience, still must be sorted into categories having current gain variations of $\pm 50\%$ or greater. Over the moderate temperature excursions encountered by most computers, germanium tunnel diode characteristics are either essentially invarient or else predictable enough so that allowable tolerances between units can be maintained. Gallium Arsenide or other new materials hold the promise of extending the allowable temperature variations to those encountered in military equipments.

Cost – The tunnel diode consisting as it does of only one PN junction, should eventually cost substantially less than a comparable two junction device such as a transistor. The exact cost in large quantities will depend on allowable tolerances, packaging techniques, environmental processing and other factors not capable of exact specification at this time. Our experience to date indicates that the overall yield on tunnel diodes to a specified characteristic may well be higher than yields of transistors. Increasing the overall yield still remains one of the most fruitful methods of cost reduction in the semiconductor industry.

Reliability – The reliability of tunnel diodes still must be proven. Our results after only a few thousand hours of life testing show essentially no change in characteristics. This data, although encouraging, makes it somewhat difficult to predict how many thousand hours tunnel diodes will operate without drifting out of tolerance. Studies of the mechanism causing gradual degradation of performance in transistors and diodes shows that it is due primarily to surface effects. The heavy doping of tunnel diodes makes surface effects negligible so that tunnel diodes offer the hope of no long term drift in characteristics. Obvious causes of failure such as high transient currents will burn out T.D.'s or cause a permanent change in characteristics just as with any semiconductor. The diameter of high performance T.D.'s is only a few tenths of a mil so that packaging methods must be used that prevent thermal or mechanical stress from being transmitted to the junction.

In summary, there is no single asset of the tunnel diode that by itself permits its extensive use in digital computers but rather a fortunate combination of factors that make it a high speed, low cost, reliable bistable element capable of being manufactured to tight tolerances.

A. K. RAPP, Group Supervisor
Digital Circuitry Research Div., Philco Corp.
Philadelphia, Pa.

The major assets of the tunnel diode are its high speed, compactness, and potential low cost. Its compactness stems from the facts that: individual diodes need not be hermetically encapsulated; very low power dissipation makes possible extremely high component density.

DR. J. W. PETERSON, Dir., Research and Development
Pacific Semiconductors, Inc.
Culver City, Calif.

The Esaki (tunnel) diode represents the simplest negative-resistance device yet achieved. For this reason, and because it offers exceptionally high speed, it has been received with a great deal of enthusiasm. It appears to have excellent potential for high-frequency amplification, oscillation and fast switching. It can be expected that, because it represents such a radical departure from previous devices, a great deal of circuit and device research will be needed to fully assess its proper role in the electronic art. One very promising application of this device is that of digital computation. In this application it will be competing with a number of existing devices, as well possibly as with some still-unknown devices.

In discussing how well suited a device is for a given purpose, it is necessary to consider it from two points of view. First, how well will the device do the job; and, second, how difficult and expensive is the device. A component which is prohibitively expensive or difficult will not succeed, no matter how high its performance.

The Esaki diode looks attractive from both points of view.

Its negative resistance provides a simple switching action, making possible relatively simple circuitry. It is inherently a fast device, since tunnelling is a very rapid operation. Injection of minority carriers is not involved; hence, there is no delay resulting from diffusion or recombination of carriers. Switching time depends primarily on the $|-R| \times C$ product (where $-R$ is the value of negative resistance). This time constant can be made as low as 10^{-11} seconds. Sensitivity to the effects of temperature and radiation appears to be less than that of many semiconductor devices. Like any device, it has its problems in use; problems which the present intensive circuit research is seeking to define better and to solve. It operates at very low impedance levels, at relatively high current. High power gain in switching has not yet been achieved, so that large "fan out" is not practical. Since it is a bilateral device, special precautions are necessary to prevent signals propagating in both directions.

The Esaki diode is very simple in construction, consisting of a single p-n junction between heavily-doped regions. It appears to impose relatively non-stringent requirements on material perfection and surface condition. On the other hand, the required doping level is difficult to obtain in some semiconducting materials, and may make it difficult to meet even the reduced requirement on crystal perfection. The high junction capacitance per unit area requires the use of very small junction area, making it a somewhat difficult device to assemble. The important parameters of peak current and value of negative resistance vary rapidly with doping level. It is therefore necessary to have a high degree of control over impurity concentration. It is thus a very simple device, but requires great precision in its construction. There is every reason to believe that the problems of manufacture can be adequately solved, given a little time.

DR. JAN A. RAJCHMAN, Assoc. Laboratory Dir.
RCA Laboratories, Radio Corp. of America
Princeton, N.J.

The tunnel diode has the following outstanding advantages in digital applications:

1. Fractional nanosecond switching times, higher than transistors by an order of magnitude. This, associated with input resistances which have a convenient impedance for transmission line coupling, make them very attractive for high speed circuits with switching delay times per logic step of nanoseconds or fractional nanosecond. They seem to offer by far the best promise for attaining such speed.
2. Very low power requirements. A one milliwatt circuit can be built which switches at the speed of the fastest present computers, around 50 nanoseconds. These will be important for missile and space applications and portable equipment.
3. Circuits can be built requiring only resistors and tunnel diodes which lend themselves to cheap mass production techniques, by means of which whole circuits, including connections, can be made in a single step.

For these reasons, though the prospects are not fully proven, the tunnel diode is likely to take over a substantial fraction of the computer logic circuit market.

What do you believe are the major liabilities of the tunnel diode with respect to its extensive use in future digital computing equipment? Which is the most critical liability?

J. N. MARSHALL, Mgr. Advanced Systems Eng.
Electronic Data Processing Div., RCA
Camden, N.J.

Tunnel diodes have the following apparent liabilities for logic switching circuits, but they are not severe disadvantages:

1. Two-terminal device requiring artifices to separate input and output functions. This is the most serious liability. However, separation of inputs and outputs can be obtained easily with clocked power supplies which may be simple sine wave supplies.
2. Triggered operation which requires in combinational logic circuit special resetting systems. However, bistable operation with reset signals is a very convenient way to use triggered circuits. Monostable self-resetting circuits also are possible.
3. Requirements of tight tolerance to obtain reasonable gain. However, it appears that maintenance of adequate tolerances for practical gain requires fabrication techniques that are well within the realm of practical possibilities.

ROBERT A. TRACY, Mgr., Applied Research
Research Center, Burroughs Corp.
Paoli, Pa.

The tunnel diode, like DCTL, will require a low impedance ground plane and will deal in low-voltage signals. Furthermore, flexibility in applications is limited by the Bi-polar pulse input required to initiate and terminate a given conductive state.

FRANK J. HIERHOLZER, JR., Ass't. Head, R & D
Semiconductor Division, Sperry Rand Corp.
So. Norwalk, Conn.

Tunnel diodes have several disadvantages which will retard their acceptance as switches. Although the tunnel diode has potentially extremely fast switching speeds, the physical dimensions of construction of the tunnel diode device leading to capacitance, series resistance, and lead inductance limit the maximum switching speed available. Secondly, the ratios of on-state to off-state switching voltages are marginal. Unilateralization or elimination of feedback from output terminals to input terminals of tunnel diode network is a major circuit problem. For maximum utility in applications of the tunnel diode a re-orientation of thinking from more conventional circuits using voltage change, to tunnel diode circuits using current change might be necessary.

Finally, two terminal switching devices in general pose special control problems for circuit designers in pulse amplifier applications. Because the switching speed and switching ratios will improve with both new materials and new technology in being able to handle much lower power levels in extremely small physical packages, the most formidable problem appears to be the circuit design considerations mentioned above.

J. F. KALBACH, Assoc. Dir. of Engineering
Electrodata Mfg. and Eng. Div., Burroughs Corp.
Pasadena, Calif.

For application in the immediate future, perhaps the most critical liability of the tunnel diode is its "immaturity" – or lack of empirical evidence in depth concerning its operating characteristics and reliability as used in the circuits of practical operating systems. It is possible that better means must be developed for isolating tunnel diode input and output signals. Also, in order to take advantage of its high speed capabilities, the tunnel diode should be very close-coupled to other components. These will undoubtedly result in new circuits and new manufacturing techniques which must also be evaluated for performance and reliability before they can be used extensively.

Too, a computer using tunnel diodes at very high data processing rate may also require development of compatible peripheral and sub-system equipment.

Certainly, based upon what we know now, the tunnel diode still promises to be very attractive.

What impact do you believe the tunnel diode will have upon digital computing equipment in the next five years?

R. L. PETRITZ, Dir. of Device Research
Central Research Lab.,Texas Instruments Inc.
Dallas, Tex.

The effect that tunnel diodes will have on the digital computer market in the next five years can be discussed with relation to two broad areas. The first area concerns the general purpose digital computer that operates at clock rates slower than one millimicrosecond; the second area is the extremely high speed computer that operates at clock rates faster than one millimicrosecond.

High speed transistors can serve the first areas and have a number of desirable features. Tunnel diodes, on the other hand, can be a serious competitor to the transistor for this market if it proves to be a more economical and more reliable device. However, the tunnel diode has a stiff competitor in the transistor and will have to win its way into this market by virtue of economy, simplicity, reliability, or some similar feature. In our opinion, the tunnel diode is not likely to be a major factor in the general purpose computer market in the next five years.

Depending on the development activities in tunnel diodes and transistors during this five-year period, the ten-year period will be dominated by one or the other of these devices. It is not possible to predict accurately whether the transistor or the tunnel diode will be the dominant device in the ten-year period. However, if a prediction must be made, we believe that the transistor will dominate the general purpose computer field over the indefinite future.

For the second major area, that of high-speed computers with clock rates faster than one millimicrosecond, the conventional transistor is being pushed beyond its easily attainable speeds. The tunnel diode has an inherent speed advantage over the transistor for such high-speed computers. However, the tunnel diode must be considered in competition with other devices such as ferromagnetic films, cryogenic devices, parametric diodes (phase-lock computers) and other approaches to very high speed computation. Remembering, also, that electromagnetic energy travelling only about one foot in a millimicrosecond must be designed as an integrated unit considering devices, circuitry, and interconnections. Thus the device which will succeed depends on a completely integrated approach to the computer.

While it is still too early to predict accurately which device will be the dominant one, the tunnel diode achieves the necessary speed so easily that it has a better than average chance of succeeding in this field. In our opinion, the tunnel diode is the favorite to dominate the very high speed computer field by the end of five years.

In summary, it is felt that the tunnel diode is not likely to displace the transistor from the general purpose computer field in the next five-year period, and has only a moderate chance of displacing it even beyond that time period. However, for the very high speed computer, the tunnel diode is favored over the transistor and other competing devices. Therefore, the tunnel diode and transistor will complement each other in the total computer market, each performing the function for which it is best adapted.

B. N. SLADE, Semiconductor Manager
Data Systems Div., IBM Corporation
Poughkeepsie, N.Y.

If the Esaki diode finds extensive application in digital computers, it will be for two basic reasons. First, of course, will be the number of very attractive characteristics of the device itself; these include power consumption as low as 1 microwatt, unusual temperature stability, speed to fractions of a nanosecond (1 billionth of a second), low noise level, moisture resistance and small size. Second will be the development of efficient techniques for using such a two-terminal device in logical circuitry.

At present, it would appear that the diode's characteristics make it superior to transistors for applications in many high-frequency local oscillators and mixers, switching circuitry and low noise amplifiers. It must be realized, however, that some of these advantages over present day transistor technology may be matched or even exceeded by advances in transistors or other semiconductor devices.

At the same time, difficult problems must be solved before the diode can find wide application. Control of the device's parameters is extremely difficult because the physics is not yet completely understood.

In addition, the low impedance of the device puts severe restrictions on package design. As a result, conventional techniques of encapsulation are inadequate for the Esaki diode. In order to realize the high-frequency potentiality of the diode, the resistance and inductance due to the bulk diode and its soldered connections must be kept as small as possible. This implies large leads and small dies and the attendant problems of their connection. Furthermore, because the dies will be small (approximately 2 mils thick with junction areas of only a few millionths of a square centimeter) problems will doubtless arise in handling and in geometric positioning.

Such problems in fabrication are not insurmountable. The rapidity of their solution, however, will depend primarily upon what specific applications of the diode are developed and how compelling these uses are.

It is too early to say what impact the Esaki diode will have on digital computer technology. So far, some circuits employing the diode have been suggested. However, a new and imaginative philosophy of circuit design must be developed before the device's full significance can be evaluated. That the Esaki diode is an important and promising advance is evident, but the extent and magnitude of this importance must remain to be seen.

ROBERT A. TRACY, Mgr., Applied Research
Research Center, Burroughs Corp.
Paoli, Pa.

The tunnel diode can have a considerable effect on the design of digital computers in the next five years. I expect the tunnel diode will merely be one of the many components which will be available in "molecular electronics." "Molecular electronics" is going to make a real impact in the area of specialized applications.

J. F. KALBACH, Assoc. Dir. of Engineering
Electrodata Mfg. and Eng. Div., Burroughs Corp.
Pasadena, Calif.

Five-year crystal-balling in a dynamic field such as digital computing can be a highly hazardous sport.

Today's spectacular technological advances may fall by the wayside in favor of even more startling discoveries just around the corner. Or promising areas such as deposited circuits and "moletronics" may hasten the practical application of tunnel diodes.

An appreciable portion of the manpower, facilities and fundamental experience accumulated for more than 15 years on solid state diodes and transistors can now be applied to tunnel diodes. Therefore, the tunnel diode should become established in computers more rapidly than did transistors. However, it is more likely to establish itself in combination with other circuit elements, perhaps manufactured together in a single process, rather than as a single isolated circuit element. Although we do not look for full-scale commercial systems using tunnel diodes to appear in significant number within the next five years, it appears highly probable that some special-purpose machines or military equipment will make use of them.

The next five years should unveil advances in electromechanical areas which presently limit performance and reliability of large scale memory and input-output devices. Such advances enhance the usefulness of high speed computers and help prepare for tunnel diodes. It is hopeful that inexpensive static devices with high reliability can ultimately be developed to replace mechanical dynamic devices for bulk storage. Whether or not some form of the tunnel diode will prove suitable for a large scale memory storage is still open to question.

A. K. RAPP, Group Supervisor
Digital Circuitry Research Div., Philco Corp.
Philadelphia, Pa.

Within the next five years, large-scale digital computers based upon tunnel diodes will probably not appear; more engineering time will be required. The transition from vacuum-tube to transistor computers required considerably less drastic changes in circuit philosophy than will be required in the change to tunnel-diode computers.

Even with relatively minor modifications in circuit discipline, the switch to transistorized computer circuits took about five years. However, we can predict the development and manufacture of small, specialized computers utilizing the tunnel diode in a very few years.

F. J. VAN POPPELIN, JR., Mgr. of Sales
Semiconductor Products Div., Motorola, Inc.
Phoenix, Ariz.

Motorola is willing to make an educated guess as to the future use of tunnel diodes. We think the tunnel diode is a very exciting new device and will certainly find a place in the family of semiconducting devices which will be used in the future. However, there appears to be a relatively long development cycle ahead of us before the tunnel diode can come into wide scale usage even if it proves to have capabilities that go beyond our wildest expectations. In the first place, since it is a two-terminal device rather than a three-terminal device such as a transistor, it can not be used in any present day computing machines. Before it can be put to use, new computers will have to be designed around it.

We hope, and we expect, that within the year Motorola along with other companies will be able to improve the characteristics of these devices so that they will be good enough to arouse more interest on the part of the systems design engineer. After we have aroused his interest, there will then be at least a three-year period of design effort (and perhaps a five-year period) before any of these new computers could go into production.

If at that time tunnel diodes could be mass produced with performance levels that are adequate and cost levels that are quite a bit lower than transistors, they could go into large scale production and gradually take over a large portion of the transistor business. It should be remembered that during this intervening period, there will be major cost reductions in transistors, particularly the Mesa type, and therefore economic comparison would have to be projected in all of these areas.

Because the tunnel diode is bilateral, circuits employing it tend to be unstable and oscillate. This can be corrected by separating tunnel diode stages with transistor stages or by clamping voltages at many places by means of computer diodes. In either case, the circuit becomes complex and one questions whether it will not be simpler and cheaper to use a Mesa transistor. Due to the present non-uniformity of tunnel diodes, we cannot reliably fan-in or fan-out by more than a factor of two where we need a factor of five in order to make tunnel diode computers exciting. These are but a few of the major problems that stand in the way before tunnel diodes can come into wide scale use. We hope, and we expect, that we can solve these problems. If we do, the tunnel diode can take over 50% to 75% of the applications of transistors in computing machines.

It appears that the tunnel diode will make only slight inroads into the future uses of Mesa transistors for radio communications systems, and thus the Mesa transistor market will grow by many fold during the next five to ten years.

We believe there will be a large market for both tunnel diodes and transistors ten years from today and whichever way the major volume goes, the industry will be prepared to produce for it. ●

AN ADVANCED ANALYSIS METHOD FOR INTEGRATED ELECTRONIC DATA PROCESSING

(The Intermediate Range Committee of the Conference on Data Systems Languages is now investigating a method for communicating data processing information from the systems specialist to a compiler or programmer. DATAMATION presents a brief summary of the method written by its originator.—Ed.)

by ORREN Y. EVANS
Manager, Data Processing Department
Hunt Foods and Industries, Inc.

This method offers new concepts and is a major breakthrough in analysis work. It presents a definite, uniform, orderly and integrated method of analyzing and documenting; tends to force a complete analysis; reduces to a minimum the description of the processing methodology; provides material for near maximum ease of communication and near maximum flexibility for changes; permits delineation of the line between Analyst and Programmer; and eliminates the need for the analyst to draw logic and detail flow charts; provides a straightforward method of preparing exhaustive test data.

The method begins by documenting in great detail data definitions and characteristics from the smallest piece of data to entire files of data. Special forms are used to gather and keypunch this information. A by-product of this is a mechanized company dictionary of data element definitions. This glossary also contains cross references between synonyms and the corresponding definition.

The Process Flow Chart shows the big picture of a functional process and consists of inputs, outputs, volumes, sequences, sources, dispositions, frequency and a brief description of processing. The Systems Flow Chart is used to present the total integrated data processing system. It shows all of the data flow interrelationships among departments regardless of the processing media.

The Data Rule Form is used to present, in a tabular format, virtually all the processing methodology (procedure statements and calculations). This tabular rule presentation, perhaps, is the most important single concept and, to a degree, may be used independent of the remainder of the method. A data rule consists of a unique group of conditions: the actions to be executed when those conditions are satisfied; the weekly frequency of the actions; and prior rules which must be considered before the current rule. Each rule is stated as a separate entity. It is linked with other rules only by mandatory rule sequence considerations. This enables the changes to be made with a minimum effect on other rules. A very simple illustration of the rule format is illustrated below.

A "Y" (yes) in a condition column means the condition must be met for the rule. An "N" (no) in a condition column means the condition must not be met for the rule. A blank means the condition is not relevant to the rule. When all the yes and no conditions are met for the rule, the "Y" (yes) actions are taken for that rule. The condition and action headings in actual rules are fully described in the English language and mathematical symbols.

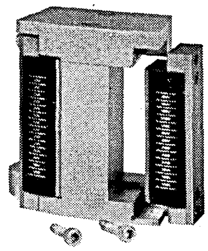
Mechanized correlations are effected by using the EAM cards containing the documented analysis. The use of these correlations permits accurate evaluation and scheduling of changes to the system and a thorough review of the analysis for omissions, inconsistencies and errors. An example of the use is: It is required to increase the number of characters of a data element. What are the consequences? With the correlations one can readily identify every record, report, form and data rule which uses this element. From this point the change can be evaluated considering its effect at each place the data element is used.

The analysis and documentation method ends up being a data processing system. The mechanization of the process (thus far) is a successful and specialized information retrieval program.

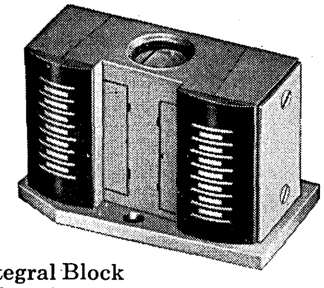
The complete paper is being published by NMAA in the proceedings of the seminar "Computers in Business." Copies, for a nominal price, can be obtained from NMAA, P.O. Box 1888, Long Beach 1, California.

RULE NUMBER		WEEKLY	CONDITIONS						ACTIONS						
CURR-ENT	PRIOR	FREQ-UENCY	A	B	C	D	E	F	1	2	3	4	5	6	7
001		1100	Y		Y				Y		Y				
002		300	Y	Y		Y				Y	Y	Y			
003	002	1000		Y	N			Y			Y	Y	Y		
004		50	Y	N			Y							Y	Y
005	001-004	30	N	N	N	N	N	Y					Y	Y	

CLEVITE 'BRUSH'



"Gap-Mounted."*



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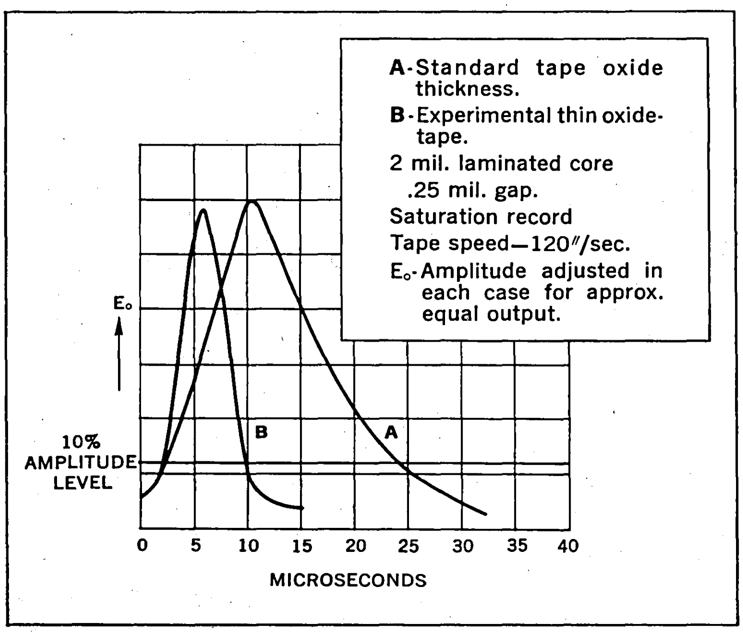

Pulse width comparison—standard and thin oxide tape.

CAPACITY— Five series of Clevite "Brush" multichannel heads give channel format variety for standard tape widths from ¼″ to 2″. A single block will handle up to 16 channels per inch of media width—an interlaced block up to 32 per inch. Clevite heads read pulse widths down to 1½ mils recorded to saturation on 0.3 mil coating instrumentation tape—approximately 600 pulses per inch with self-erasing saturation recording. More than 300 ppi packing is possible on 1 mil coated drums, operating 0.2 mils out of contact with a 3 mil pulse width on the drum.

ACCESS—Careful choice of material plus unique design and construction techniques enable Clevite "Brush" heads to provide uniform performance at very high processing rates. The heads themselves respond to wave lengths down to .15 mils (1.5 MC at 240 IPS) but standard instrumentation tapes and transports usually reduce the practical repetition rate of saturated recording to approximately 30 KC and 15 KC for RTZ and NRTZ respectively.

RELIABILITY— Clevite "Brush" tape and drum heads hold track width and location to ± 0.001-inch tolerance. Azimuth, contact angle and gap perpendicularity are true ± 0 deg., 5 min. and can be held even closer when required. "Gap-mounted" head (see photo) has lapped bracket and cartridge surfaces for fast replacement without critical adjustment. Redundant and interlaced (see photo) designs provide immediate checking of recorded data and higher output per channel respectively. All multichannel heads available in epoxy or full metal face (to reduce oxide pickup) at no extra charge.

* Patent Pending

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1960 WJCC a look back

(DATAMATION has called on one of the planners of the 1960 Western Joint Computer Conference to prepare a report of the San Francisco meeting of May 3, 4 and 5. We feel this evaluation by an individual closely associated with this year's WJCC will provide our readers with a "different" view of the conference.—Ed.)

by G. A. (BUD) BARNARD
(Ampex Data Products Co.)
Vice Chairman, WJCC

How was the show?

It was a definite success – and for good reason: We were successful in accomplishing our principal aims, which were to have high quality papers, better-than-average exhibits, and pre-conference publication of the proceedings.

A few follow-up statistics are of interest, although not all of our books have been closed. Hal Wells and John Stokdyk report a near-final official registration attendance of 2,081, which is an increase of about 18.5% over last year. A little more than 700 exhibitor personnel were in attendance also. In addition, many attended only the exhibits without registering for the sessions.

Of the registered attendants, 37.5% were not members of any of the sponsoring societies, while ACM members amounted to 25.7%, IRE members 24%, and AIEE members were 3.1%. 1.8% were members of the Simulation Council, 3.4% were students and 4.1% consisted of the steering committee, speakers, panelists, etc., leaving less than a half of 1% unaccounted for. These figures were compiled by C-E-I-R from the registration cards which were key-punched by society according to the first listed society membership which had been checked. The societies were listed on the cards in this order: ACM, IRE, AIEE, Simulation Counsel, Non-Member, and Student. (Because of this fact, the percentages given for IRE, AIEE and Simulation Council are probably increasingly inaccurate in that order since members of those societies who were also members of ACM were counted as ACM members only, IRE members who also belonged to the AIEE and/or Simulation Council were counted as IRE members only, etc. – Ed.)

Listed by occupation, the registration shows 24.8% were in R & D, 23.5% were in engineering, 21.8% in programming/applications, 11% in management, 6.5% in sales/applications, 2.9% students, 2.5% administration, 2.1% teaching and instruction, and 1.6% other.

Out of the total registration, 41.3% had not attended a WJCC before, 46.5% had, and the rest did not say. Mary Frazer reports that 130 registered for the women's activities, with 110 attending the fashion show. Everyone seemed to enjoy the program very much, according to Miss Frazer.

Denny Willard and Earl Lincoln on the Publications Committee are to be commended for getting the Proceedings out before the conference. Actually it was printed and available a week early. Those who registered on Monday the 2nd were able to peruse the papers before any sessions began.

The Message Center activity was fairly successful; a total of 535 messages were handled, with a verified 40% successfully delivered. We handled 729 hotel rooms with sleeping accommodations for 1,066 people.

Having been associated with the last two WJCC's and having been called on to do virtually no substituting for absent committee chairmen this time, I have agreed to put together a "handbook" for the WJCC's: "Hints and Tips on How to Run a WJCC." This will consist mostly of procedures, differing from the book on basic policy being issued by the NJCC. In compiling data for this handbook, I have been gathering comments about the way the show was run. The praises are, of course, welcome, but I have been especially eager to hear gripes, since correction of these is the best way to help the function grow and serve a wider need. There were surprisingly few, however; most of the suggestions concerned building up the successful operations we had already established. But, there were a few – most of the gripes were heard during the cocktail party! I guess we did run out of drinks rather quickly – and the first batch were mixed fairly strong, which didn't help. Incidentally, this is the one place where we went quite heavily in the red. One of our recommendations for the next conference is that the committee furnish the party room at a moderate fee – around $1.50 or so – and ask the hotel to furnish limited appetizers and have a bar open continuously, where people can buy their own drinks.

Gene Morrison did a yeoman's job at handling the one most difficult task: breaking in a new hotel. This problem was exemplified by crowded elevators, conference rooms without enough ventilation, and some confusion in the handling of room reservations.

Regarding discussions following the sessions, at future conferences these might be included in the following year's Proceedings, or possibly they could be issued as a separate supplement mailed to the addresses on the registration cards.

Bob Isaacs handled our mailing list differently this year, in a very simple manner. He mailed directly to a combination of five separate lists; three furnished to us by each of the sponsoring societies, one from last year's registration, and one was the list of exhibitors. 22,000 program booklets were mailed with less than 1% returned by the Post Office as undeliverable! The good attendance at the show attests to the effectiveness of our mailing procedure, and is also demonstrable proof of the excellent publicity which we received through the efforts of Chuck Elkind and Bill Estler.

the sessions

How about the papers? One important item – all the papers and sessions scheduled were presented. The consensus of comments I heard confirmed the fact that "Zeid-

(Continued on page 52.)

CODASYL'S PHILLIPS WRITES ABOUT COBOL

language's past and future explored

On May 20, DATAMATION received the following letter from Mr. Charles A. Phillips, Chairman of the Executive Committee, Conference on Data Systems Languages.

Dear Sandy:

Some readers of the article "COBOL is the Language!" in the January-February 1960 issue of DATAMATION and your editorial report "SOME MORE FACTS ABOUT COBOL" in the March-April 1960 issue, may have reached wrong conclusions because of the omission of some information or the manner in which the facts were presented. You have kindly agreed to publish a letter giving further information on the matter.

At the outset, I should say that the two articles evidence a thorough familiarity with the written material that has emerged from the CODASYL effort, presented in a detached and critical way which may have been influenced by the reporting of such efforts. The articles do not reflect a knowledge of some of the things that were done or said in committee but either not reported or reported inaccurately. I think it probable that poor communication or semantics may be the root of our problem.

It was this same basic problem – the need for better understanding – that, in part, gave rise to the CODASYL program. A force that motivated both the computer users and the computer manufacturers who are voluntarily participating in this effort was the pressing need for a business data processing language which was understandable both to the user and to the computer. Rather than an idealistic approach, the CODASYL program was a practical approach to a recognized problem since five computer manufacturers had automatic programming systems under development when the effort was launched in May 1959. Another motivating factor was the very high programming costs in both government and industry and the real potential for minimizing such costs, as well as getting programs "on the air" without excessive delay, offered by automatic programming techniques.

Of major importance to large users, particularly the government, is the objective given to the Short Range Task Force, of developing a language that would be common to all computers in order to save reprogramming and retraining costs and facilitate program interchange between installations using different makes or models of equipment. Understandably, not all the computer manufacturers might be expected to give the same enthusiastic support to this objective but certainly the timing was opportune with five manufacturers having business data processing languages (computers) then under development.

The Short Range Task Force, which developed the initial specifications for COBOL, was composed of representatives of six manufacturers and three users, with the Chairman from government. It was recognized at the outset that the manufacturers would necessarily bear the major part of the load in developing the language as well as the total load of preparing compilers to implement it on their respective equipments. At no time was there any evidence of serious pressure from any manufacturer to influence the language and there was much difference of opinion; in fact, at times the committee witnessed different viewpoints even between representatives of the same manufacturer. If there had been no differences, the entire industry would probably have been doing the same things in the same way and the CODASYL effort would have been unnecessary. Actually, the different convictions were healthy, vital ingredients in the design of a language to reflect the diverse and substantial experiences of the committee members. The final product necessarily reflects some compromises but we believe these are the best possible compromises arrived at after careful consideration by some of the best programming specialists in the profession. Opinions will continue to differ as to the relative merits of alternative approaches to any problem involving commonalty but that does not mean that the objective should be abandoned.

Some criticism has been directed toward the Executive Committee and the Short Range Task Force for their apparent neglect of the excellent Honeywell Business Compiler "FACT." While this is "water over the dam," it may clear the air a bit to explain that the original terms of reference setting up the SRTF instructed them to study existing business compilers (such as FLOW-MATIC, AIMACO, and COMMERCIAL TRANSLATOR) and come up with a composite, or something that would work, with the emphasis on speed and a recognition that the initial product would probably be deficient in some respects. "Fact" was non-existent as a compiler when the task force began its work and by the time the FACT specifications were released, the Short Range Task Force was nearing completion of its work. I am sure that the SRTF did consider at least some of the features of FACT, so far as they had been developed, since Honeywell had members on the SRTF who had every opportunity to present proposals for COBOL based on plans for FACT. It should be kept in mind that FACT was designed only for one computer while COBOL was designed for use with a variety of computers. It should also be stated that Honeywell has always supported the COBOL effort and the Honeywell member of the SRTF voted for the adoption of the group's final report which included the COBOL specifications. He did suggest some desirable additions and refinements which were well recognized by the SRTF and have been identified by the Executive Committee in the Introduction to the COBOL report.

From the very first meeting, the SRTF agreed that it was not possible to develop a language which was completely compatible across all machines within the time permitted, if ever. However, the approach taken by the group of separating the COBOL specifications into three divisions: Procedures Division, Data Division and Environment Division, has confined most of the problems of compatibility to the Environment Division. This means that COBOL procedural statements are essentially computer-independent; that is, any user of COBOL can understand the information appearing in these statements without regard to any particular computer. While compatibility among computers cannot, in general, be assured in the data descriptions, careful planning in the data layout will usually permit the same data descriptions to apply to more than one computer. In the environment description, almost all information is computer-dependent and therefore the compatibility is based on ease of understanding rather than direct transference.

Although the COBOL language is not completely com-

(Continued on page 34.)

SYSTEMS TESTING AT IBM

by DANIEL D. McCRACKEN
Computer Consultant, Ossining, New York

How would you like a job which only exists because your product is so complicated that it never works the first time you put it together? That's the story of the final test activity at IBM's plant in Poughkeepsie, New York, where the 700 and 7000 series systems are built.

Final test, or systems test, is the last stage of computer manufacture, where the individual units that make up each complete system are hooked together and tested to see if they will operate as a system. Some of the units and components, such as the tape drives and the pluggable units that hold the tubes or the printed circuit cards that hold the transistors, are tested thoroughly at the unit stage, before they come to systems test. Others, such as storage units, are tested to a certain extent previously, but with no attempt to exercise them as completely as the computer itself will. A unit such as the central processing unit on a tube machine, with its backpanel wiring which interconnects the pluggable units, is given only a few spot checks because of process controls. And some things come from outside approved vendors and are given only a quick inspection for gross damage in shipment.

There are a number of things that can be wrong with a unit when it comes to the test cell for systems test. There can be errors in design which have not yet been cleaned up; these may be logical design errors which show up for the first time in some new combination of operations, or circuit matters which keep it from operating reliably. These engineering problems are to be expected, especially in the early stages of a machine's life, since engineers as a breed rarely, if ever, have as much time to work out the problems as they would like. Once a whole shipment of tubes appeared to be causing failures in systems test. It turned out that the mutual conductance was significantly different from previous shipments, although still within specifications; it hadn't been realized that the specs were too loose. Occasionally it happens that there are errors in the backpanel wiring which carries supply voltages to the pluggable units and interconnects them. A unit was once found which had all its rectifiers installed backwards, i.e., with the leads to the plates and cathodes reversed. The unit worked, but not for long.

This kind of "bug" slips through, of course, only if the unit is not thoroughly tested at the unit level, which it may not be because the cost of the required specialized test equipment would be excessive at the unit test stage. And at any rate, even with unit testing, many disabling bugs may slip through, since the tester may not provide the exact conditions that exist in the computer. This usually applies to electrical conditions, but it can occur with mechanical elements, too. A solder splash which shorts out two leads may not show up in the pluggable unit tester because the tester and the computer do not put the same twist on the pins. And so it goes.

The technician in charge of the system test must accept the units as they are handed to him, and make the whole system work. No matter that it is not economical to give the central processing unit a previous thorough test. No matter how reasonable the explanation that is given afterwards to explain some fiendish trouble. No matter how much of the grief is caused by everyone's desire to get into production. No matter who is at fault, or really, if anyone is. No matter anything. The technician simply takes the equipment as it is given to him, and makes very certain that when he says it's OK, every last cold solder joint and marginally weak diode has been cleaned out. One is reminded of the motto Harry Truman had on his desk in the White House – "The Buck Stops Here."

a typical test sequence

Some of the concepts of systems test can be clarified by following the sequence of events in the testing of a typical machine. The general principles are much the same for any machine; a few of the details mentioned below apply only to the 705-III. It should be understood that the vacuum tube 704, 705, and 709 are being phased out now, with more and more of the manufacturing effort being placed on the transistorized 7070, 7090, STRETCH, and the 7080, which is IBM's recently announced large-scale business data processor. However, the transistor machines have not been in production long enough to permit large generalizations on the specialized systems test problems which may arise.

The final test of a 705 III system at present requires an average of nine weeks. The first day or so is spent in making sure all the parts are available, hooking up the cables, and generally getting organized. The next step is to make sure that the pluggable units have all the latest engineering changes, because new EC's, as they are called, might have been issued since the assembly of the units. This is not much of a problem on the 705, which has been in production for several years, but it can be a big headache on a new machine.

Most of us have wondered whether, when power is first turned on, the whole computer might go up in blue smoke. Blue smoke may indeed appear, but not from the whole computer at once, because power is only applied to little parts at a time. As a matter of fact, when power is first applied to the central processing unit, or main frame, sometime during the first week, there are no pluggable units installed. The first test merely establishes that there are no shorted power cables and that the supply lines are actually carrying the advertised voltages. Seldom is anything found wrong at this stage, but why risk burning out a hundred tubes or ruining the power supply, when an hour's checking can largely eliminate the possibility of that kind of damage?

Next, the power is turned off and the pluggable units installed, twenty or so at a time, with a blue smoke check each time a batch is put in, until all 400 are in place.

At this point in time (second week) the "computer" consists only of the central processing unit and the memory; no input/output equipment has been tied in other than the console typewriter. Now, for the first time, the technician keys in an instruction and attempts to execute it. The odds are excellent that it won't work so the detective game begins, a game which will continue in some form for most of the next two months.

If an entire instruction won't work, the technician tries to find out where in the sequence of sub-phases the breakdown occurs. He checks to be sure the master clock pulses are getting through. Maybe he runs the clock one pulse at a time and checks to see that the crucial flip-flops are set as they should be after each clock time. He hangs an oscilloscope on the control flip-flops in memory to see if the signals are getting to memory from the main frame, and vice-versa. If he is lucky, it may happen that one of the things he tries actually pinpoints the trouble, but that isn't really the intention. The aim here is to systematically narrow down the area in which the trouble could be until finally there are only a few pluggable units or interconnections which could possibly be at fault.

Once the source of the trouble has been located to within a couple of units, it isn't too hard to pin it down, by brute force if necessary. Of course, a good technician devises the tests he makes shrewdly, taking into account the symptoms, so as to eliminate suspicion from as much of the machine as possible. And naturally, since the machine at this stage has never worked at any time, there is no guarantee that only one bug is causing the trouble. Such a guarantee would make life much simpler.

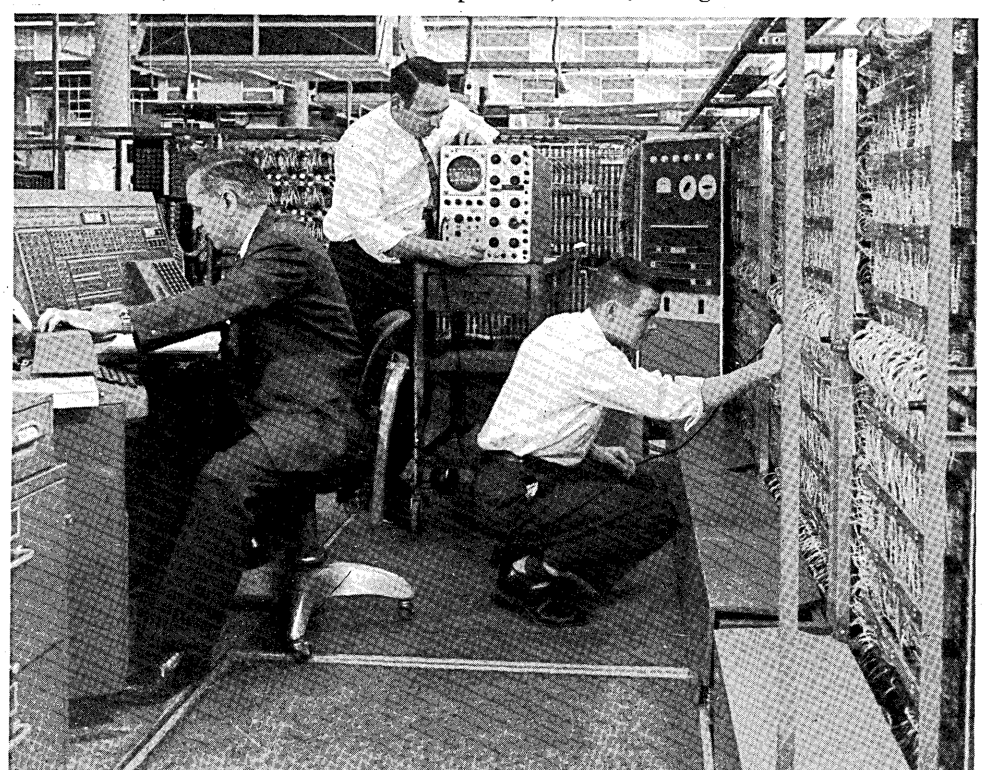
diagnostic and bias tests

On a machine which has been in production for a year or two, it usually doesn't take too long to clean out the big, obvious faults and get the machine to carry out simple sequences of instructions. Along about the third week the technician begins to run the diagnostic routines. These are programs which put the machine through its paces. They test every machine instruction, every register, every flip-flop, and in the process use many different combinations of data. This last is because it frequently happens that a bug can depend on chains of logic or on peculiar combinations of marginal circuits in such a way that it will only happen under certain special conditions. Since at this stage there are no tape drives and usually only limited card equipment available the complete diagnostic package cannot be run. The part that can be used, however, is enough to provide plenty of cleanup work. When a section of a diagnostic finally will run repeatedly without error, the technician is largely able to eliminate that part of the machine when looking for other troubles.

After the diagnostics are running pretty well, the machine is given a few vibration tests, to try to catch poor connections, microphonic tubes, and the like. The vibration is created simply by tapping tubes with a pencil, kicking the cables (gently), pounding (also gently) on the sides of the frames, etc. This may not sound like a very effective vibration test, but it apparently does the job: the truck ride given to most machines when they go to the customer seldom causes any further trouble.

During most of the three weeks that have now gone by, another technician has been working in a corner of the test cell, getting the magnetic tape system ready for tie-in to the computer. By the third or fourth week, the tape system is connected briefly. A short session usually gives the tape man a few days more work and may bring to light some main frame troubles, too. For the next few weeks the tape system will be hooked in occasionally to see how things are progressing.

By the fourth week, the diagnostic tests should be running pretty well, so the bias tests can be started. In these, the various voltages are raised or lowered, one at a time, by about ten per cent, and the diagnostic tests re-run. Now



Ralph Savoy, Robert E. Bow and William T. Durkin (l to r) conduct tests on a 705 Model III main frame at IBM final test facility in Poughkeepsie. The scope pattern indicates output of a trigger. Savoy, at the console, is running the test while Bow and Durkin monitor circuits.

the less obvious troubles begin to appear. Maybe there is a solder joint which causes no trouble at normal voltages but sometimes fails when one of the supplies is lowered; maybe one of the pluggable units has an unlikely coincidence of resistors all of which are just on the low edge of the allowable variation, which causes the loss of a signal on certain combinations of data if the grid supply is high.

And so the detective game goes on, except now the troubles become more challenging, since they are now much more likely to be of the intermittent type. Everyone who has faced the problem agrees: a bug which is solid is no real problem. The ones that lead to the gray hairs are the ones that only happen under certain rare combinations of circumstances, and not always them. The circuit only fails once out of ten thousand times, and only if both adder inputs were negative, and only if the instruction was in a memory location with an address which contains a one in the fourth bit of the second digit, and only if the room temperature is slightly above normal. Besides all that, the trouble goes away if the clock is slowed down, and the circuit seems to be so sensitive to external loads that putting a scope probe anywhere on the machine makes the bug disappear. If there is any exaggeration in this recital of possible troubles, it is only in the implication that all these things might happen at once. And don't forget that when something goes bad, no one knows **then** that it depends on what section of memory you're in, or that the room temperature has something to do with it. It may happen that a particular diagnostic routine uses a different section of memory and therefore shows that nothing is wrong. Things like this can take days to find, and then turn out to be nothing more that a loose ground connection that jiggles whenever anyone touches the frame.

Another favorite of the systems test personnel is the bug that gives symptoms far removed from the real source of the trouble. One such incident turned out after four days to be a 35¢ signal fuse that had blown but hadn't signalled. It was in a low voltage diode bias supply line, and didn't disable things enough to draw attention to itself, but still managed to make circuits all over the computer look sick. (The fuse design was changed!)

By the end of the fifth week, if there has been no undue difficulty, the bias testing of the main frame and the memory should be about done. The tape system should be working with the computer, and the rest of the input/output equipment ought to be looking pretty good. During the sixth and seventh weeks, tests are run in which voltages are raised and lowered in the main frame but not in the tapes, and vice versa; this should help clean up things further. It should be possible to run part of the acceptance test during this period. These are complete diagnostic tests which exercise every part of the computer, and which must run without error — except, of course, for the deliberate errors which test the error checking circuits themselves.

The eighth week is devoted to the completion of the systems acceptance tests, and to the running of a few standard customer-type programs. For example, a standard 705 sorting routine is to run for two hours, on the theory that it is at least a pretty good diagnostic program in that it uses almost all machine features, and that furthermore it comes closer to the type of routine the customer will actually perform with the machine than an ordinary diagnostic does. No matter how carefully designed, a diagnostic routine cannot test for everything that a programmer might do (or even everything legal that he might do). A sort routine, or any other standard customer routine, tests a few more of the possibilities. The test personnel at IBM point out that you never know about an error you didn't check for, and the more routines you use in testing the more chance you have of catching subtle bugs.

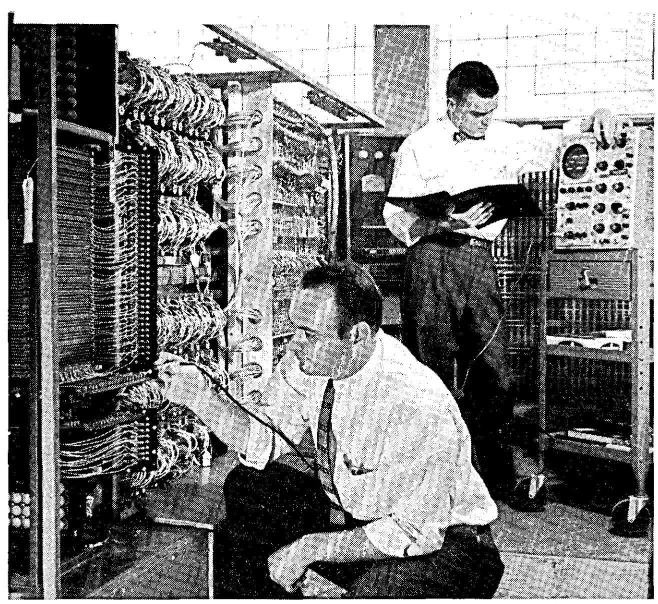
At about the end of the eighth week, the covers are put on the machine and the bias test run to see if anything that has been done in the meantime has affected the machine's operation. The ninth week is spent in finishing up this testing, getting the machine ready for shipping, and cleaning up the test cell for the next system.

no crystal balls

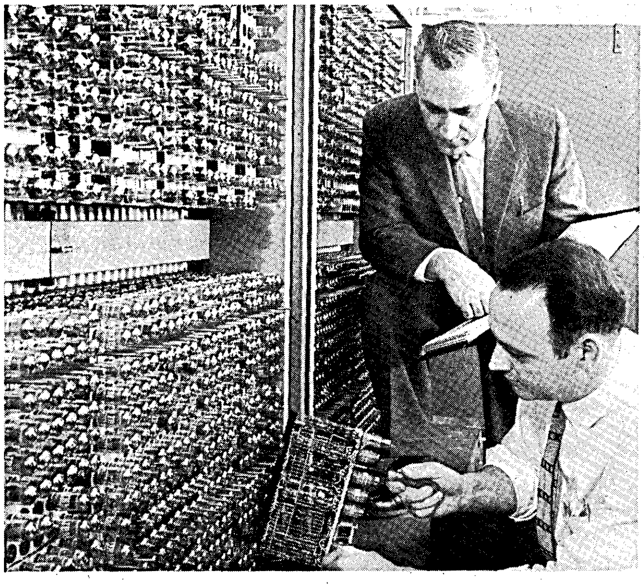
Of course, the schedule isn't all as cut and dried as this description may make it sound. No one ever knows what is going to turn up in systems test. If anyone **could** predict what the troubles would be, naturally they would be corrected beforehand; the essence of the job is uncertainty.

It may easily happen that an experienced man working on a good machine will get a week or so ahead of schedule, while a new man may be unlucky and get a system that is flat on its back most of the time. When this happens, which it not infrequently does, one obvious maneuver is to have the lucky man help the one who is behind. Another trick is to use the good machine for the tie-in tests of the tapes from the slow machine. One recent instance of this caused an outbreak of feigned biliousness: the good machine had chartreuse covers, which did not harmonize too well with mustard yellow tape covers.

It can also happen that the testing causes troubles which were not there to begin with. A new man is trying to read a print and hold a voltmeter probe at the same time. The probe shorts out two lines, and there go two dozen diodes. Somebody drops a pair of sidecutters on



Bow holds a probe on one of the signal leads for a 705 core memory unit while Durkin checks the oscilloscope pattern against the reference pattern in the Central Processing Unit book.



Savoy and Bow check one of hundreds of 705 eight-tube pluggable units.

the bank of filter capacitors in the power supply, and a surge goes out that damages components which aren't cleaned out for several days. Looking at the Big Picture, such incidents have to be expected, but they can be heartbreaking to the guy who has to clean up the mess.

Besides the unpredictability inherent in the nature of systems testing, another major problem is that the machine and the testing procedures change as the job proceeds. Louis Voerman, manager of manufacturing for the Poughkeepsie Plant, feels that the problem of machine changes is the biggest single complicating factor in systems testing. The problem is, of course, especially severe with a new computer, but changes are made throughout the life of any machine; a logic error was discovered in about the 100th 704! For instance, this type of thing can happen when a new combination of program functions is tried for the first time. Only a small fraction of modifications are required because of outright errors, however. Most are introduced to improve reliability or safety, or to make servicing easier. They may be initiated by design engineering, customer engineering, or by the systems test people themselves. In the life of a machine there may be as many as several thousand such changes. After a machine is in the field, EC's are installed by the customer engineers, and they are installed during manufacture on all machines built after the EC is put out. But in between these two steps, the EC's must be installed during test. However, there has to be a cut-off somewhere. Changes are not ordinarily made in the last several weeks before shipping, unless they involve safety or the meeting of machine specifications. This is how it can happen that there are EC's waiting to be installed when the computer arrives at the customer's receiving dock.

Engineering changes are only part of the story, however. Also subject to wide variation is the complement of equipment which the customer orders. It is possible to get the idea that a 709 is a 709 and that's that – but not so. There is a great deal of variation possible in the makeup of a system, even without getting into the special devices which the customer may have ordered. For comparison, it may be noted that there are some 14,000 possible configurations of the basic 82 sorter, and that only about half of the sorters actually ordered could be called standard. If this is the situation with sorters, think what can happen with a major computer! All this variation requires supporting paperwork; it may affect the work which the systems test personnel do in putting together the units of the machine; it certainly affects their testing procedures, sometimes drastically.

Not only the machines, but the test procedures themselves are subject to modification. If it is discovered in the field, for instance, that a customer's routine will not work even though the final test diagnostic routines show no trouble, something needs to be done about the diagnostic routines. In some cases where the engineers in the field have found a bug which the diagnostics didn't catch, the systems test men have had to put the bug into the computer deliberately in order to help devise a satisfactory test program.

unit or system testing?

This matter of establishing and modifying the testing procedures leads to a major policy question: should more emphasis be put on testing the individual units before they are hooked into the system, or on testing the complete system? There is a lot to be said for both approaches. The ideal would appear to be, offhand, to do all testing on a unit basis, because of the time it would save. Testing needed to make sure the computer performs as advertised could be done by the customer engineers when the machine is installed. This would have the added virtue of saving some of the present overlap between plant systems testing and the testing which is done in the field at installation time.

On the other hand, going to complete unit testing naturally means that you have to have specialized test equipment to prove the correctness and reliability of each individual unit, and this equipment can be expensive. Furthermore, there are some types of equipment malfunction that are very difficult to detect without actually hooking together the whole system, or most of it. TV repairmen have an axiom to the effect that the set is the best possible tube tester, and the principle carries over here to a certain extent. It appears that to really prove that a unit is going to operate properly when put into a complete computer, you just about have to build a test set-up which does everything the computer does, i.e., you need a complete system to test the unit. And this is what you set out to avoid.

It isn't quite that bad. Some things, such as the tape drives and some of the input/output control devices, can be unit tested without too much trouble because they do not really communicate with all of the rest of the system. Some of these units are now shipped directly to the customer as the result of a test equivalent to an actual systems test without ever having been hooked into a system. The question isn't entirely one of deciding whether to ship directly without systems testing; there is considerable latitude possible in drawing the line between unit and systems testing even for units which are to be given a systems test.

A. E. Nervik, project manager, final test, who is responsible for the testing of tape drive units as well as the testing of the STRETCH equipment, points out that the decision on where to draw the line depends largely on economic factors: are the savings in time, floor space, etc., that are saved by going to unit testing, worth the cost of the specialized test equipment? Nervik says that these considerations, along with such factors as type of equipment, volume, and testing experience, have so far indicated that full unit testing be employed only on certain models of tape drives and on some input/output control units. He notes, however, that the trend is toward more unit testing, particularly on the transistorized equipment which is rapidly becoming the major concern of the Poughkeepsie plant.

how many test shifts?

Another matter of policy, also depending in the end on a balance of economic considerations, is the question of how hard to push testing. Should you run one shift a day or three? There is strong pressure, naturally, to try to get the equipment out the back door as quickly as possible. Doing so holds floor space costs down and brings in the income sooner. On the other hand, hurrying is expensive, too. Above the obvious costs of night shift premiums and keeping the cafeteria and stockroom open around the clock, there are indirect costs of lowered efficiency and more difficult personnel scheduling. When there is only one shift, a man coming to work in the morning knows where he left off the day before, but with two or three shifts there has to be overlap (which means overtime) and each man wastes some time getting oriented on what the man before him did. Furthermore there are certain stages of testing when it does no good at all to have night crews, because the testing work has to be closely tied in with the work of other groups which only work days. IBM's decision, on normal production programs, based on the factory and pricing economics of the situation, was to work two shifts, with about 60% day shift work being done.

Naturally, if there is enough urgency about rapid delivery to override cost considerations, the test crews are put to work three shifts.

What kind of person does it take to do this work well? In a nutshell, it takes a man with a logical mind, who has thorough understanding of the equipment, who adopts a questioning attitude about everything that happens, and who has a strong interest in his work.

There are at present some 500 people in what is called final test. This includes the men who work on unit testing of units built at Poughkeepsie, such as tapes and pluggable units, in addition to the systems testing of the 700 and 7000 series machines and STRETCH. The majority of these men, or about 400 of them, came to IBM with two year technical institute training or military experience in electronics. They had no computer experience, in general.

The training of a new man begins with a few weeks of classroom work on basic circuits, after which the man spends a couple of months working in the testing of pluggable units or cards. This gives him a good grounding in the operation of the electronic building blocks which have much of the machine's circuitry on them. When an opening occurs in some other testing area, he moves up to the testing of a complete unit, such as a printer control unit. At about this time he begins going to half-day classes covering the machine on which he was hired to work. For the 7090, for instance, the classes run for about three months. During this time the trainee has been working close to those with responsibility for the entire system, and has been getting the benefit of experience on how to go about testing. After about a year, more or less, a man may be given a complete system to test.

The formal training emphasizes factual knowledge about the equipment: basic machine circuits, tape drive adjustments, machine logic, how to use an oscilloscope (of which there are only 500 in the plant, incidentally). It might seem that there should be a series of lectures called something like, "A Step by Step Method for Locating Bugs." In a certain limited way this can be done, although mostly by on-the-job contacts. A man should learn fairly soon that it is seldom good practice to go after a bug by ploddingly testing all pluggable units; the better way, as noted before, is to devise some test, based on a careful analysis of the known symptoms, which will narrow down the possible location of the trouble. There are a few other general principles of this sort but put all together they wouldn't fill two lectures.

Most of the real "technique" of trouble-shooting lies in figuring out a short test program which will quickly pinpoint the trouble, or making an inspired guess and then knowing how to check it out. The job seems to require a kind of trouble-shooting attitude toward life. This can be developed in a man who has the underlying attitudes and abilities, but cannot be force-fed to a man.

The various project managers naturally have given a lot of thought to the qualifications of a good systems test person. It is pretty hard to isolate and identify those underlying attitudes and abilities which make a man a good candidate. The detective game aspect of the job is probably the crucial part beyond a basic aptitude for work in electronics. J. W. Kerr, project manager of systems test for the 7090 systems, points out that the job is similar in many ways to the solving of puzzles. He notes that there is a periodic epidemic of puzzles of one sort or another in the shop and a lot of the people play near competition level bridge as a hobby.

E. J. Burke, project manager of systems test on the 700 series equipment, tells his people to try to get "inside" the machine. They should try to visualize what is happening on a pulse-by-pulse basis and be able to figure out the implications of the various possible sources of a bug. This requires complete knowledge of the equipment, of course, but it also requires a high degree of skill at a specialized kind of deductive logic. Burke also places heavy emphasis on the need for stubbornness in asking questions. Exactly why did the adder diagnostic fail the time before and not this time? And does that ripple in the +150 supply really explain all the memory trouble yesterday?

Clearly, systems test is not the place for a man who regards a job as something which takes eight hours out of his life each day. It is the place for the man who goes home but can't concentrate on the TV program he's watching because he keeps coming back to that little spike on the reset side of the sign trigger; he figures it out on the way to work the next morning and nearly gets a speeding ticket because he can't wait to see if he's right.

IBM doesn't really demand that kind of after-hours devotion to duty, but it does require a man to feel personally responsible to the customer for his machine. Ed Burke puts it to his men this way: "Suppose you were going to have to pay out your own money for this machine. If you'd buy it, we'll ship it." ●

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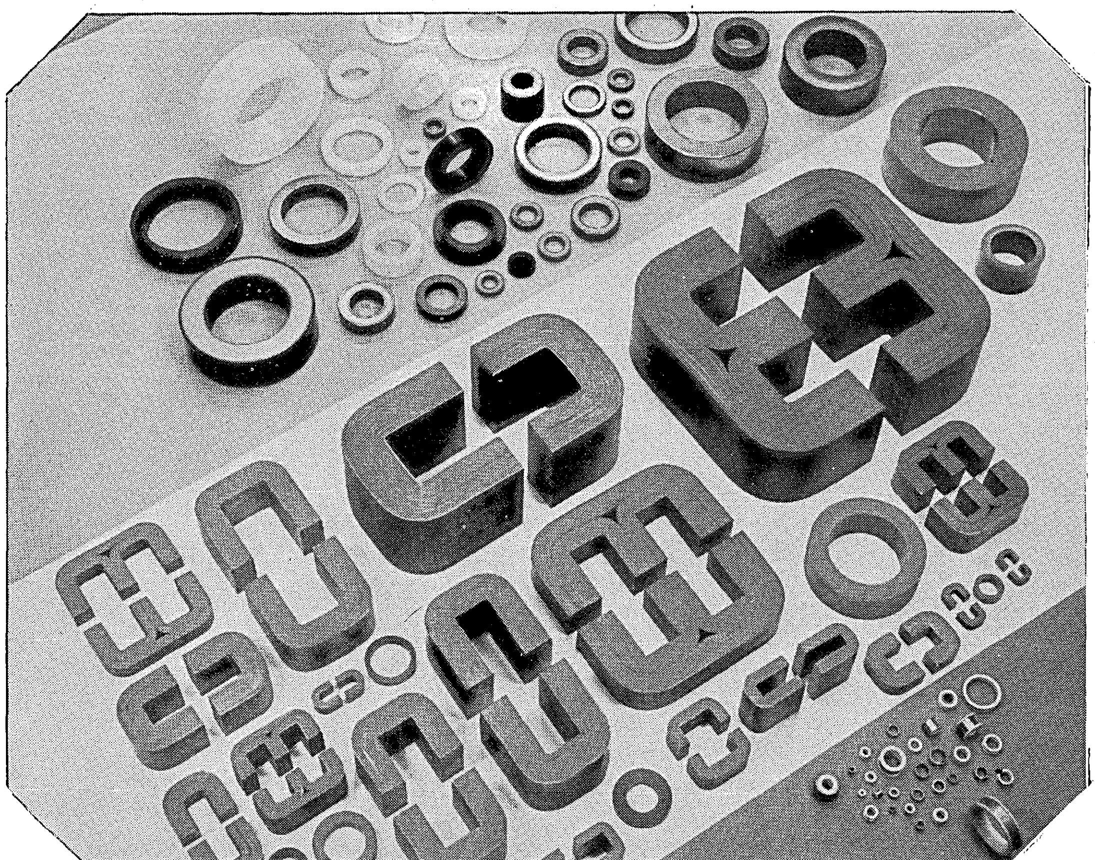

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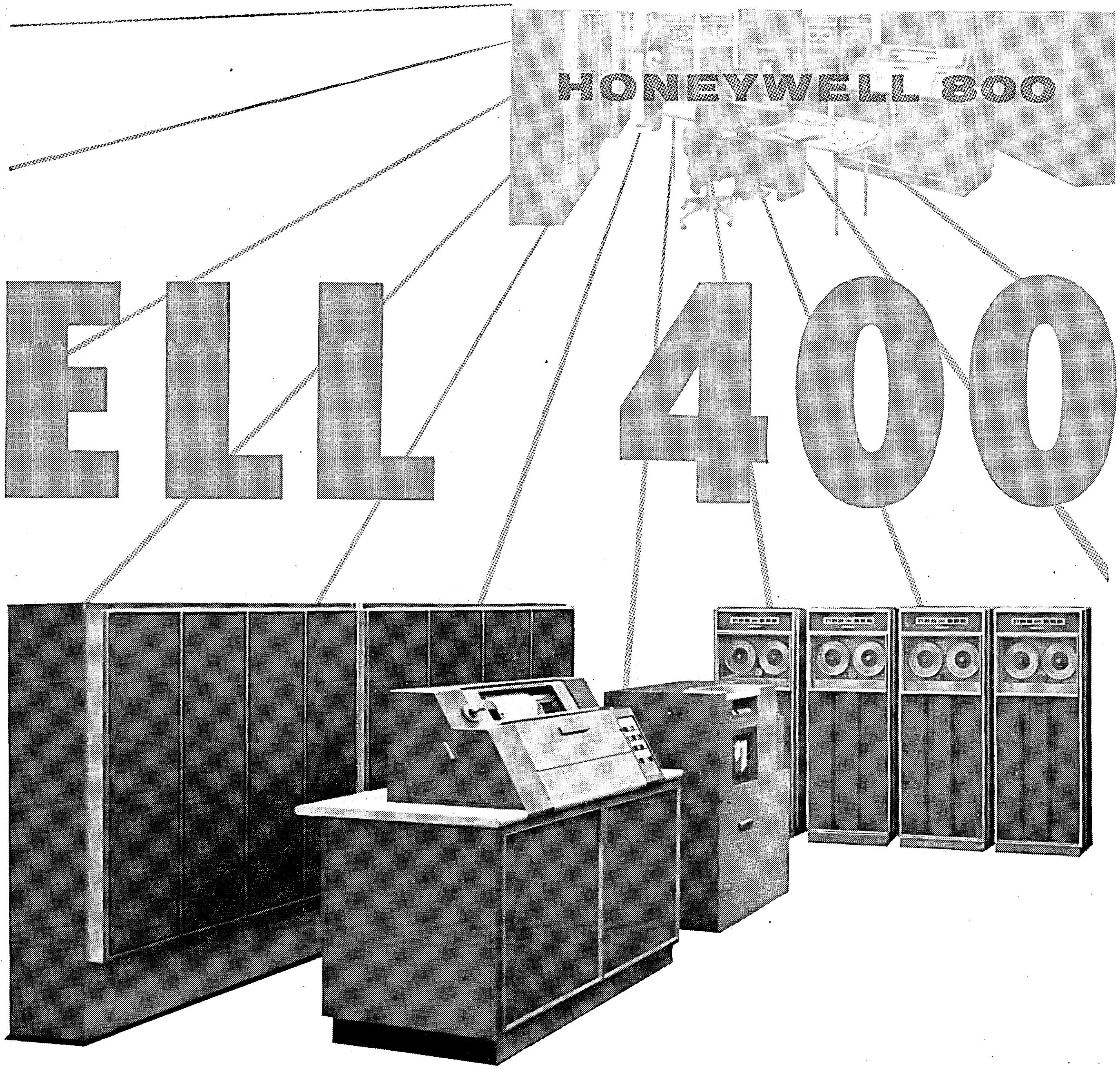


will accommodate reasonable growth. And, importantly, when still greater processing power becomes necessary, the graduation to a Honeywell 800 is a very logical and economical step.

Compatibility is inherent

Information can be readily interchanged between Honeywell 400 and Honeywell 800 systems because they use the same magnetic tapes (as well as the same high-speed printer and card reader). Most important, a programming language is provided that can be processed by either system. When it becomes desirable to step up to a still more powerful system, there is no need for costly reprogramming. This compatibility also means that Honeywell 400 programs can be checked out on Honeywell 800 systems, an advantage that could hasten the application of work to your Honeywell 400 by as much as six months to a year.

For more facts about the new Honeywell 400, just get in touch with your nearest Honeywell Datamatic Sales Office. Or, write to Minneapolis-Honeywell, Datamatic Division, Wellesley Hills 81, Massachusetts.

Honeywell Datamatic Division Sales Offices in: ATLANTA • BOSTON • CINCINNATI • CHICAGO • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES • NEW YORK • PITTSBURGH • PHILADELPHIA • SAN FRANCISCO • WASHINGTON, D. C.
In Canada: Honeywell Controls Limited, Toronto 17, Ont.

Honeywell

H HONEYWELL *Electronic Data Processing*

Circle 16 on Reader Service Card.

PHILLIPS' COBOL LETTER . . .

(Continued from page 25.)

mon nor fully compatible, it does enable the users of different equipment in the same or related installations to define a large class of their problems in mutually understandable terms. If a problem is to be transferred to a different computer, it will be necessary to rewrite the entire Environment Division. It may also be necessary to modify or even rewrite part or all of the data description. At worst, this is far better than the prevailing situation in which the entire program must be rewritten including the procedural statements.

It is true that the Executive Committee rejected a proposal to establish a group responsible for COBOL "marketing, public relations, publication and publicity," essentially because it appeared to be an effort to commercialize COBOL which we believe should be preserved as a spontaneous cooperative effort of computer users and manufacturers. We have recognized the need for better communication, both within the CODASYL program and with the data processing community and at the last meeting of the Executive Committee, a group was set up to deal with this problem. At no time has there been any intent to withhold information unless it was incomplete or premature and would be more detrimental than beneficial.

Your Editorial Report in the March-April issue covers completely the recent reorganization of the CODASYL effort as reported in the minutes of the Executive Committee meeting of February 12, 1960. There is enclosed, a copy of the minutes of the last meeting held on April 7th from which it will be noted that the Technical Committee membership has been extended to include two additional manufacturers who expressed a desire to participate. Dr. Richard Clippinger of Honeywell is the current Chairman of the Technical Committee. A total of eight manufacturers are now represented. Similarly, twelve users are represented on the Maintenance Committee. With a preprint of the initial COBOL report as a point of departure, these two groups have already agreed upon a substantial number of proposals for clarification, amendment or change to the initial specifications. Such proposals will be published as "supplements" to COBOL and furnished to the entire CODASYL mailing list.

Readers of DATAMATION will be interested in the current status of COBOL, a preprint of which is enclosed for your editorial review. The edited manuscript is now in the hands of the Government Printing Office and the initial distribution to the CODASYL mailing list should be made by the end of June or early July and concurrently placed on sale by the Superintendent of Documents at a nominal price. The principal manufacturers have stated their intent to produce compilers (or processors) which will make machine translations from the source programs written in COBOL into object programs for their respective equipment. Considering the manpower, time and over-all costs involved in the implementation of a business data processing compiler, it seems doubtful that there will be many manufacturers who will concurrently develop their own independent language and compiler and offer COBOL on the side.

Sincerely,

C. A. Phillips

(Due to the late receipt of Mr. Phillip's letter and due to a critical space shortage the final two and one-half paragraphs were omitted. These may be presented in the next issue. pending word from Mr. Phillips.—Ed.)

DATAMATION *in business and science*

IBM ANNOUNCES STRETCH; REACTIONS NOTED

". . . to be built under contract for business firms and government agencies . . ." IBM used these words to begin its news release announcing a "STRETCH class computer" which will sell "in a price range upwards of $10,000,000." IBM's proposals to potential customers include these points: Though these are "contract" machines and will be custom built and sold (and now leased, rumor has it), customers may lease those parts of the system also found in other IBM systems, memory and tape units, for instance. A down payment of 7½ percent of the purchased parts of the system is being asked which means that a "normal" (our quotes) down will run between a half and three-quarters of a million dollars. . . . After the long wait for word on STRETCH, the actual announcement evoked mixed industry emotions. The general concensus was that the initial price bite was indeed a big one (contracts are non cancelable).

Specifically, the reaction of one interested firm was fairly swift. Although C-E-I-R has said nothing officially, they are reportedly re-evaluating their plans concerning STRETCH centers in Los Angeles and elsewhere. In this connection, C-E-I-R's STRETCH-man, Dr. Herb Grosch, is no longer a C-E-I-R-man, as of May 4. This would seem to confirm the company's reappraisal of their machine future.

Another firm, The RAND Corp., which earlier this year expressed interest in setting up a co-op STRETCH center in L.A., has an IBM proposal under consideration.

LIVERMORE LARC IN; SYSTEM MARKETED

Remington Rand's LARC was delivered to the AEC Lawrence Radiation Lab at Livermore, Calif. early in May. A company spokesman said no details of either the installation or check-out tests would be available for about six weeks. Another LARC is scheduled for delivery to the David Taylor Model Basin near the end of this year . . . A LARC user group has been formed. Its name -- LINC. . . . A commercial version of LARC, featuring high density tape units (200 KC) not now part of the Livermore system, is being marketed. Eighteen months delivery for LARC is being promised and the typical system will lease for $135,000 per month . . . Some computer users who consider such things are casting a skeptical eye at the claim of 200 KC tape speeds. They point out that this quoted speed is based on the use of four-bit characters and that if the more commonly accepted six-bit characters are substituted, the speed is reduced to something like 133 KC.

PHILCO SHIPS FOUR 2000's; MORE DUE

DATAMATION learned that Philco Corp. shipped four large scale computers during March and April. Three were Philco 2000's. The first system replaced prototype equipment at the firm's Western Development Laboratories in Palo Alto. The second system was delivered to AEC Bettis Laboratories, operated by Westinghouse and the third to the AEC Knolls Atomic Power Laboratory, operated by GE. Philco also shipped a special purpose large scale computer (the CX2Q system) to BuShips' David Taylor Model Basin. The AEC systems each had 32,000 words of memory and 18 mag tape units. These systems also included Philco card readers which operate at 2,000 cpm . . . DATAMATION heard from industry sources that the Bettis system was in operation four days after delivery . . . the first production 2000 has been in continuous use at Philco (two shifts a day) since last September. It has been used for customer debugging and internal program debugging . . . Over twenty 2000 systems are currently in production at the new Philco plant . . . Within the next three months, deliveries of 2000's will be made to the White Sands Missile Range, Signal Corps; Pratt-Whitney Research Division of United Aircraft, Hartford, Conn.; and the Naval Supply Center in Oakland, Calif. (Reprinted from DATAMATION's WJCC supplement dated May 3, 4 and 5, 1960.)

SS 80, H-800 DONATED TO SOUTHERN CAL

Minneapolis-Honeywell has donated an H-800 and Sperry Rand's RemRand an SS-80 system to the University of Southern California. This may be the first time a campus computer center will be equipped with major systems manufactured by rival computer firms. RemRand has promised delivery of a $600,000 Solid State 80 system this fall and Honeywell says they will roll in an 800 next June. The latter machine and all peripheral gear will approach the $2,000,000 mark. The University is laying plans for undergraduate and graduate courses and is training selected faculty members on both machines.

USERS MEET, AGREE ON RESOLUTION

More than forty representatives of seventeen computer user groups met May 6 in San Francisco to discuss common problems, aims and objectives. The day-long meeting resulted in the adoption of the following resolution: "We believe that the need exists for the establishment of communication among computer user groups to promote studies, exchange of information and cooperative efforts in areas of common interests, such as: Common programming languages and other means of communication among computing machines; establishment and maintaining of standards for communication and distribution of computer programs; exchange of information related to the management of organizational components operating computers; communication of methods and techniques for comparing the effectiveness of computer techniques and devices; and consideration of hardware standards and cooperation with other interested agencies." It was also agreed to hold a second user meeting to discuss methods of implementing such a program on August 26, immediately following the national meeting of the Association for Computing Machinery in Milwaukee. For further information regarging the past or forthcoming meeting, write Jerry L. Koory, System Development Corp., 2500 Colorado Ave., Santa Monica, California.
For further information regarding the past or forthcoming meetings, write Jerry L. Koory, System Development Corp., 2500 Colorado Ave., Santa Monica, California.

New from Royal Precision... RPC-9000

THE LOWEST-PRICED COMPLETE DATA PROCESSING SYSTEM ON THE MARKET TODAY!

Economical design: The new, completely-transistorized RPC-9000 is designed for serial mode of operation. This feature utilizing magnetostrictive delay lines for high-speed memory permits great reduction in original equipment costs. Tape transports using continuously revolving loops of magnetic tape rather than "start-and-stop" techniques further cut initial investment.

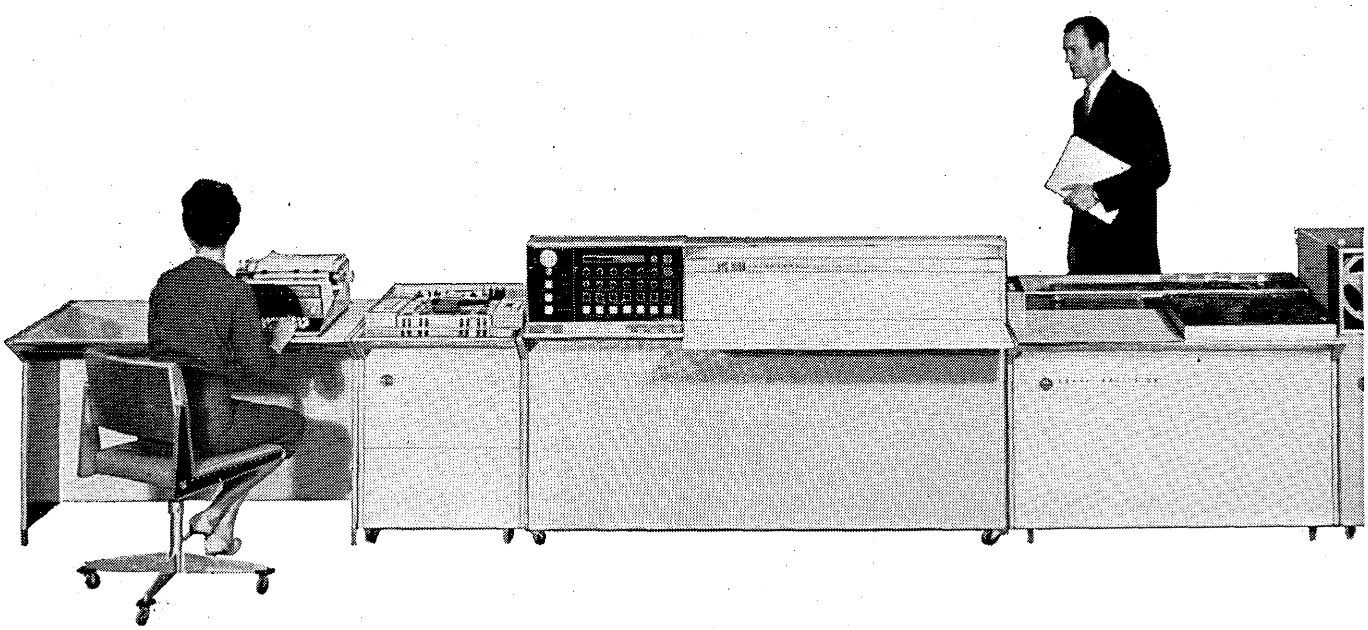
Efficient operation: The RPC-9000 processes data "in line." Data are accepted in random order, and all affected records are automatically updated in a single uninterrupted sequence of operations. No batching or sorting is necessary. Data are recognized by content, not location. This eliminates the need for location codes, and allows efficient utilization of storage capacity. Eight separate records are searched simultaneously. Completely buffered input-output permits simultaneous operation of all system components.

Tailored to your needs: With the RPC-9000 you buy the exact amount of data processing you require. Start with the basic system—computer, tape-typewriter, magnetic tape storage unit. Then, as your volume grows, you can add high-speed paper-tape punches and readers; punched card readers; line printers; additional tape typewriters; more magetic tape cartridges; more internal memory. You can operate up to 30 of these devices at the same time.

Economical in use: The RPC-9000 is designed for ease of operation and maintenance. It uses power from any ordinary wall outlet, requires no air conditioning or site preparation. This low-cost system will perform the full range of your data processing needs. See your nearby Royal McBee Data Processing Systems Sales Representative without delay, or write to the address below for comprehensive brochure.

Royal Precision Corporation

Royal Precision—producers of the LGP-30, the RPC-4000 and the RPC-9000—is jointly owned by the Royal McBee and General Precision Equipment Corporations. Sales and service are available coast-to-coast, in Canada and abroad through Royal McBee Data Processing Offices.



MARKETED BY ROYAL McBEE, DATA PROCESSING DIVISION, PORT CHESTER, N. Y.

If you have sales ability, and are interested in electronic data processing contact your nearest Royal McBee Data Processing Office, or write Sales Administration Director, Royal McBee Corporation, Port Chester, New York.

Circle 18 on Reader Service Card.

DATAMATION *news briefs*

NATIONAL ACM MEETS AT MARQUETTE IN AUG.

The fifteenth annual meeting of the Association for Computing Machinery will be held at Marquette University, Milwaukee, Wis. on August 23-25.

An unusual feature is that any paper concerned with phases of analog and digital computation, business applications and data processing will be allotted a maximum of 10 minutes in the program followed by five minutes for discussion. The papers will not be referred and comments are expected from the audience.

The program will include a substantial number of invited 35 minute papers, survey talks, round-table discussions and a "Hall of Discussions." Local arrangements are under the direction of Prof. Arthur Moeller, Marquette University.

ROYAL McBEE INSTALLS 400TH LGP-30 COMPUTER

Royal McBee recently installed its 400th LGP-30 electronic computer at the Continental Oil Co. in Ponca City, Okla. J. R. Bowden of Conoco stated:

"The computer will be used on an open-shop basis by Research and Development scientific personnel for the solution of problems of moderate complexity. The machine will supplement a larger computer now available in the company's computer department."

IBM R&D JOURNAL FEATURES THIN FILMS

A special issue of the quarterly IBM JOURNAL OF RESEARCH AND DEVELOPMENT devoted to recent work with thin films has been published. Included are research and development results in IBM laboratories at Poughkeepsie, Kingston, New York, Zurich and San Jose.

Of great interest is the potential that thin-film devices possess for possible applications in computers. They show promise as replacements for more conventional circuits which use individual components such as resistors, capacitors, magnetic cores, transistors and diodes, according to a recent IBM release.

NEW OFFICERS ELECTED AT SECOND POOL MEET

POOL, the LGP-30 users organization, held its second annual meeting on March 29 to 31 in Cleveland, Ohio. Papers covering automatic programming, literature search, statistics, and business data were presented.

New officers and executive board members are: chairman, Prof. William A. Smith, Jr.; secretary, Mrs. Junita Vanderford; board members, E. D. P. Gross, Jr., Allen G. Renz, Bernard A. Sobel, G. Leonard Waters, and Kenneth Davis.

The organization has just issued a manual of "Programming and Publication Standards" in loose-leaf form to accommodate supplements and replacements.

CEC, SANGAMO MAGNETIC TAPE FIGURES GIVEN

In the last issue of DATAMATION (March/April, 1960), a survey of digital magnetic tape recorders was presented. Inadvertently, coverage of Consolidated Electrodynamics Corporation's CEC Type 5-682 was omitted. The figures for this unit are herewith presented.

Name – CEC Type 5-682; reel size – 10½″; hub – NAB, Opt.; maximum tape width – 1″; maximum read/write tape speed – 150 ips; metered rewind speed – 300 ips; rewind time – 3½ mins. for 3600′ of tape; maximum tracks – 16; start time – 3 ms; stop time – 3 ms; buffering – vacuum and mech.; character transm. rate – 45 KC ½″ tape, 90 KC 1″ tape; circuitry – solid state; write method – NRZ; power – 115 V 60 cycle 15 amp.

The following survey items listed for the Sangamo digital tape transport, manufactured by The DGC Hare Co., were in error: reel size – listed as 14″ should have been 10½″; maximum tape width – listed as 2″ should have been 1″; max. read-write tape speed – listed as 90 ips should have been 75 ips; and maximum number of tracks – listed as 32 should have been 16.

The Hare Co. also provided answers for the "No Answer" slots to wit: Metered rewind speed – 150 ips; buffering – mechanical; character transfer rate – 37.5 KC; write method – RZ, NRZ.

By error (**not** DATAMATION's), a price was transposed between two advertisements in our last issue for the Gerber Scientific Instrument Co. The price in question of $1,845 should have appeared with Gerber's Goat Scanner System ad and not the 15-Channel Data Reading System ad.

EJCC, WJCC PROCEEDINGS AVAILABLE FOR $3.00

Proceedings of two computer conferences are now available. "Proceedings of the 1959 Eastern Joint Computer Conference," a 260-page volume containing the 31 papers prepared for the Boston meeting last December and "Proceedings of the 1960 Western Joint Computer Conference," a 382-page account of the sessions held in San Francisco in May are available for $3.00 each.

Orders are being accepted by the Institute of Radio Engineers, 1 E. 79th St., N.Y. 21, N.Y.; the Association for Computing Machinery, 2 E. 63rd St., N.Y. 21, N.Y. and the American Institute of Electrical Engineers, 33 W. 39th St., N.Y. 18, N.Y. Prior JCC proceedings are also available in limited quantity.

COMPUTER CANDIDATES TRAINED IN PRISON

Twenty young men, now serving sentences in a Pennsylvania State correctional institution, have just embarked on a unique program of rehabilitation through which they hope to return to life outside the walls as computer specialists.

The state's Dept. of Property and Supplies has joined with Pennsylvania Dept. of Justice officials in setting up the pilot training project, and will make its Univac computer in Harrisburg available to the class. Remington Rand conceived and designed the project and with representatives of the state's Central Data

Processing Bureau is providing instructors and training equipment. Classes two evenings a week for 24 weeks will emphasize programming techniques.

COMPLETE PROCEEDINGS OF ICIP AVAILABLE

Complete proceedings of the International Conference on Information Processing are now available. This conference was held in June 1959 and attended by some 2,000 representatives of 39 different countries. The 600-page volume, INFORMATION PROCESSING, is priced at $25.00 and may be obtained from the International Publications Service, 507 Fifth Ave., New York, N.Y.

Contents of the book are: Methods of Digital Computing; Common Symbolic Language for Computers; Automatic Translation of Languages; Pattern Recognition and Machine Learning; Logical Design for Computers; Computer Techniques of the Future.

APPLICATIONS LIBRARY PLANNED BY IBM

A wide range of pre-tested computer programs, each designed to handle a major data processing function common to all firms within a specific industry, will be made available through IBM's new Programmed Applications Library.

Included on the library shelf at present are a utility customer billing and accounting program for the solid-state 7070 data processing system and a RAMAC 305 hospital accounting program. Programs for other major industries, as well as for smaller data processing equipment, will be announced as soon as developed.

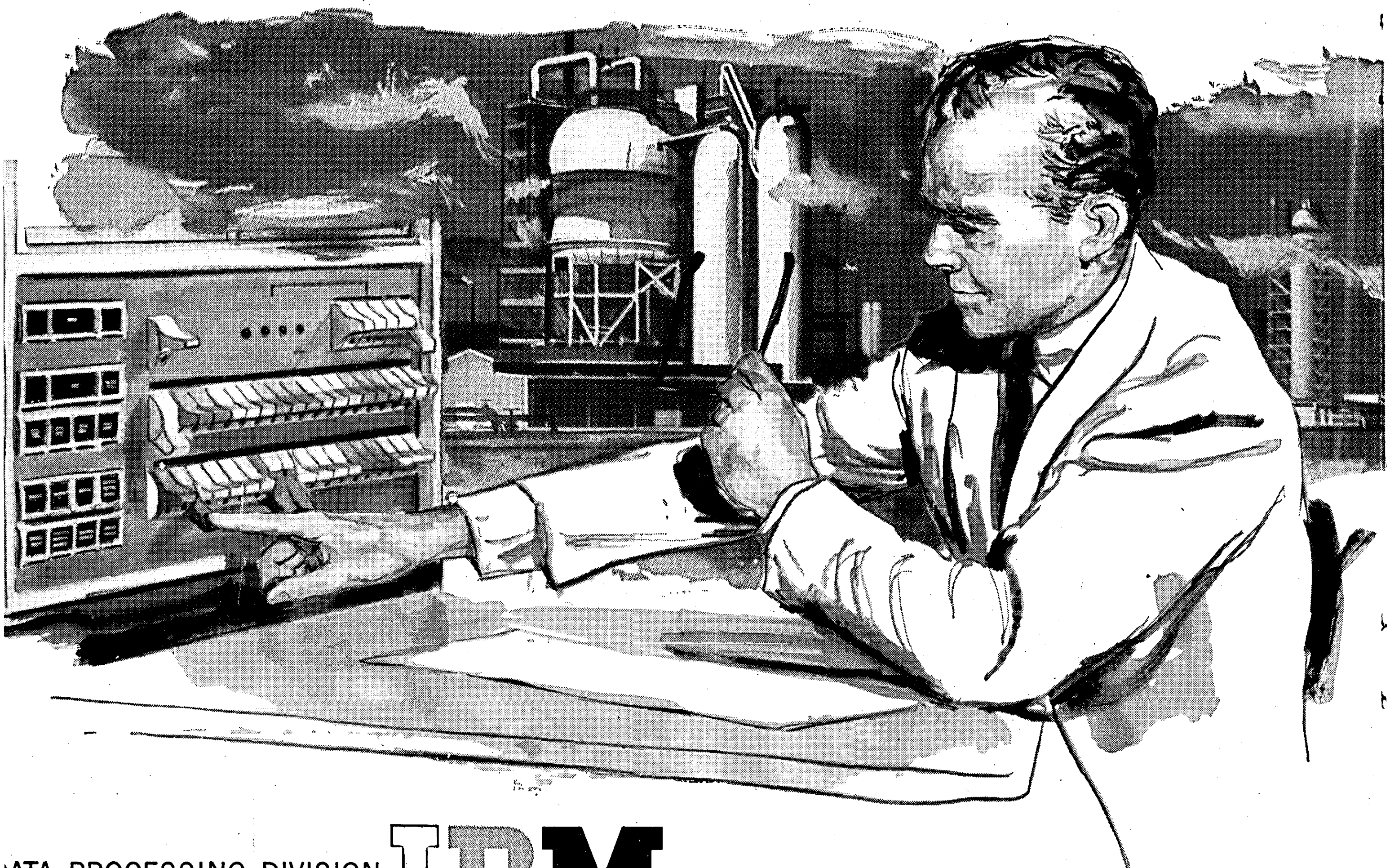
Each program will include the program instructions, block diagrams and problem definition which the user needs in preparing for computer processing of his industry application. The individual customer will only have to make limited modifications or additions of about 20 per cent to the program to meet his special requirements.

Circle 100 on Reader Service Card.

THREE RCA COMPUTERS WORK WITH SATELLITE

Specially designed computers, produced by the Radio Corp. of America, are helping scientists to orient the television pictures of cloud formations taken by the Tiros weather satellite.

The computers — installed at Tiros ground stations at Kaena Point, Ha-



NEWS BRIEFS

waii, Fort Monmouth, N.J., and RCA's Princeton Space Center – calculate the relative position of the satellite with respect to the sun at the time each TV picture is taken.

McDONALD AIRCRAFT OPENS DP CENTER

McDonnell Aircraft in St. Louis has established a new division, the McDonnell Automation Center, according to President J. S. McDonnell. This new center offers complete data processing services to industry and commerce in both scientific and administrative work.

The company is presently IBM equipped with a 709 and 705 II, as well as smaller computers. A 7090 will be delivered in October and a 7080 is currently on order.

MARINES USING 304'S

The Marine Corps. has installed a nationwide computer network which hopefully will streamline handling of all Marine Corps personnel. The system consists of three NCR 304 computers and will maintain service records on about 475,000 Marines. One 304 is in Marine headquarters in the Navy Annex, Wash., D.C.; one at Camp LeJeune, North Carolina; and one at Camp Pendleton, Calif. The three are linked by leased wire.

Circle 101 on Reader Service Card.

G-20 TO CARNEGIE TECH

Announcement has been made of the installation of a Bendix G-20 data processing system at Carnegie Institute of Technology. The computer is capable of 50,000 computations a second and can be remotely controlled from different buildings on the campus.

Circle 102 on Reader Service Card.

✔Stockholders of both companies recently voted in favor of a merger of Control Data Corp. and Control Corp. Control Corp. will be an independent subsidiary corporation and will continue to function as in the past. Control Data manufactures large scale and desk-size solid state computers. Control Corp. produces electronic supervisory control systems.

Circle 103 on Reader Service Card.

✔Stanford University and the First National Bank of San Jose will share a Burroughs 220 data processing system. By day, the system will do work for university physics and statistical investigators. By night, the 220 will process magnetically-encoded checks,

NEWS BRIEFS

perform demand deposit accounting, prepare statements and other accounting functions for the bank.

✓Telemeter Magnetics Inc. here received a $600,000 add-on contract from the General Electric Co.'s Computer Dept. at Phoenix, Ariz. for solid state memory systems. The memories are being used in a line of computers manufactured by General Electric for commercial applications. Two types of memories are included in the contract.

Circle 104 on Reader Service Card.

✓The digital computer is now helping industry select new locations for plants and improving efficiency of distribution systems. This is the result of new techniques developed by Armour Research Foundation of Illinois Institute of Technology in the location-allocation field. Key tool in the technique is the Univac 1105.

✓Cornell and Virginia tied for the championship of the Collegiate Management Games at IBM's Education Center in New York, March 24-26.

dates

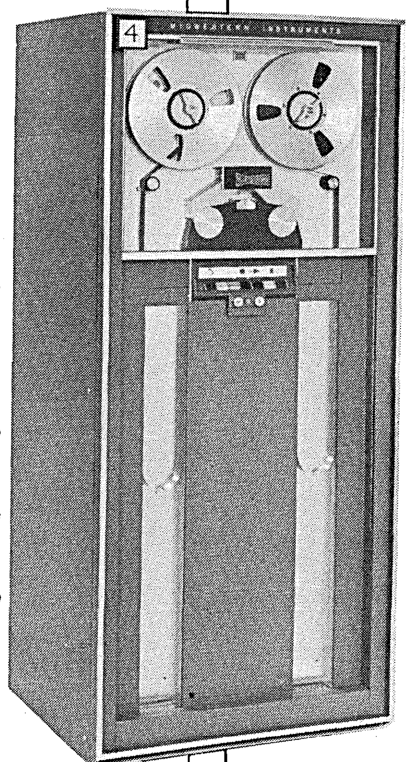
✓The Fifth Annual Conference of the G-15 Users' EXCHANGE Organization will be held on August 10, 11 and 12 at the Pittsburgh-Hilton Hotel, Pittsburgh, Pa. For more information write Harvey Chiat, Bendix Computer Div., Bendix Aviation Corp., 5630 Arbor Vitae St., Los Angeles 45, Calif.

✓The 1960 Fall General Meeting of the American Institute of Electrical Engineers will take place in New York City, October 9-14. All correspondence concerning the meeting should be sent to Clarke S. Dilks, Assoc. Director, Burroughs Corp. Research Center, Paoli, Pa.

✓The Univac Users Association has scheduled its fall meeting for September 22 and 23 in Washington, D.C. Inquiries concerning this meeting should be addressed to W. C. Rockwell, Remington Rand, 315 Park Ave. S, New York 10, N.Y.

✓The Institute of Management Sciences will hold its Seventh International Meeting October 20-22 at the Hotel Roosevelt, New York City. For further information write James Townsend, 30 East 42nd St., New York 17, N.Y.

✓The next meeting of the Burroughs 220 computer user group – CUE – will be held October 4-6 in Philadelphia.



A CUSTOMIZABLE COMPUTER

by ROBERT L. PATRICK
Computer Specialist, Manhattan Beach, Calif.

The paper proposes a meld of read-only memory, micro-programming, and automatic coding in a computer of unique design. A piece of hardware and related programs are offered as a partial solution to the problem of reprogramming. This combination also offers higher efficiencies on huge production jobs through an order list which is best suited to their needs.

Every existing computer is the result of a design compromise. This design compromise is wired into the back panel wiring of our present machines and results in a machine which has a "characteristic application." Each task the machine is required to perform matches to a greater or lesser degree this "characteristic application," and each task obtains to a greater or lesser degree the inherent efficiency of the computing system. It follows that if the characteristic application were to exist for a given machine, its requirements would be so compatible with the capabilities of the computer system that each and every component would be loaded precisely to its design point.

Actually, this balance between the task and the componentry hardly ever exists in real life. We have all seen examples of a machine forced to do a task which it found very unnatural (such as floating point computations on the 702). The idea that is outlined below hopes to offer a solution, through micro-programming, to this uneconomical dilemma.

As each new computer is presented to the field, we are informed that it offers increased computing power per dollar. While it's true that the rentals usually spiral upward, the computing power in our large systems spirals upward at a greater rate. Hence, each new machine offers us a potential economy. If we have no equipment installed at the present time, then we are free to choose the "best" of the offerings. Whereas if we have a piece of equipment presently installed we must choose more carefully what to order and when to install it. This choice does not solely depend on the basis of what the new machine offers us, since we must carefully consider our vested interests in applications and systems programming.

There is proposed here a customizable computer which may offer a better solution.

The heart of this idea is a combination of read-only memory and micro-programming. Instead of the basic functions of the machine being controlled through permanently wired back panel wiring, it is proposed that the basic functions of the machine be made addressable and programmable at the micro level. It is also proposed that these basic circuits be manipulated by a program which is stored on a memory plate of the read-only type. Furthermore, let us presume that this plate is read by a very rapid scanning device and, as each micro order is read from the plate, that it would be interpreted and executed before the next order is scanned. In addition, let us assume that these plates are stored in a removable magazine and that mechanical hardware is available so that plates could be called from the magazine, indexed in the reading holder, and made available for execution.

A plate would be selected from the operator's console while the machine was at rest. After the plate had been placed in its holder and properly aligned, the machine would then become "ready." When the machine was in ready, the plate would have converted the basic computer into a device which would respond at the program level to some well known and documented order list. The plate would contain the coded equivalent of the back panel wiring for a particular order list.

Let us also presume that a special output device were made available as an attachment This output device would allow the computer to write on the face of blank plates (similar to a CRT). These could be processed and inserted in the computer's magazine. Hence it would be possible to change the repertoire of the computer.

programming

First, let us presume that when the machine was delivered the manufacturer would provide you, the customer, with a standard order list of an advanced type; a set of manuals to support this order list; and a plate in the magazine which would cause this order list to be properly interpreted. Assume further that you could request from the manufacturer logic plates for any historical computer that had been devised. These additional plates could be had for a nominal fee. Assume for example that a 704 plate would be available, as would those for an 1103A, etc. With these historical logic plates, one could either wait with his reprogramming until his current staff got around to it (thereby avoiding huge peak staff loads), or if a job were of fixed duration merely run that job with the appropriate logic plate in the machine until that job was deceased. Each time the old job in its old form was run on the new computer with the historical plate in the new computer, the new computer would behave exactly like the historical computer.

Assume further that the manufacturer provided a program we might call EDCOM which, as its name implies, would be a combined EDitor and COMpiler, EDCOM would, of course, be written in the standard order list chosen by the manufacturer and would be an operating program when the manufacturer's standard plate was called from the magazine. The COMpiler portion of EDCOM would take in a specification for any computer; test this specification for consistency and compatibility; generate the micro routines necessary to implement this specification; and output these micro routines to a blank new logic plate. (The manufacturer used this program to produce the logic plates for the historical machines.)

The EDitor portion of EDCOM would be a program, written in the standard order list, which would interpretively execute other programs which were written in the standard order list. While this interpretive execution was being carried out, statistical counts regarding the frequency of operations, combinations of operations, and machine component usage would be built up. Additionally the EDitor portion would determine the optimum word length and minimum order list for the job that it was interpretively executing and for the sample data that was being processed by that job. These statistical counts would be additional input to the compiling section, which in turn would compile an order list and a new logic plate based on these statistics. This new plate would define a new logical organization. The characteristic application of this new organization would be matched to that application and those data which were input to the interpretive section of EDCOM.

examples

Assume for a moment a program with high production which was to work with the differential equations concerning a body moving through space. Obviously for such a trajectory program you would want a computer which did vector arithmetic well, which evaluated the trigonometric functions with ease, and which had a powerful list and table handling structure. This type of computer, if it were ever built by a manufacturer, would be a fairly specialized computer and hence the cost of this computer would be high due to its low production volume. A computer which had the above-mentioned facilities would have as its characteristic application that of solving trajectory equations; hence, these would run at the maximum efficiency on such a machine.

Consider on the other hand a payroll application. While this type of application would require no transcendental functions, it would require buffered input and output to manipulate large files of data. It would also require partial field arithmetic in fixed point (rather than floating). Furthermore it would be desirable to have an arithmetic unit which handled decimal arithmetic to avoid the bi-directional conversion problems. For a computer program of this type, a new logic plate could offer a considerable saving over some compromise which did not specifically have the payroll application in mind.

Of course, the final output of EDCOM would be 1) A new logic plate which represented the new back panel wiring. 2) A new program which was translated from the previous program into the newly-generated order list.

The above idea seems to be practical; only study would determine whether it were economical or not. It appears to be a concept in computer design which does not require an advance in the state of the art.

The savings to be obtained by avoiding reprogramming are gigantic. In addition, the costs of having to lap the incoming new computer and the outgoing old computer until a reasonable sized programming staff can get the work turned over are also of appreciable size.

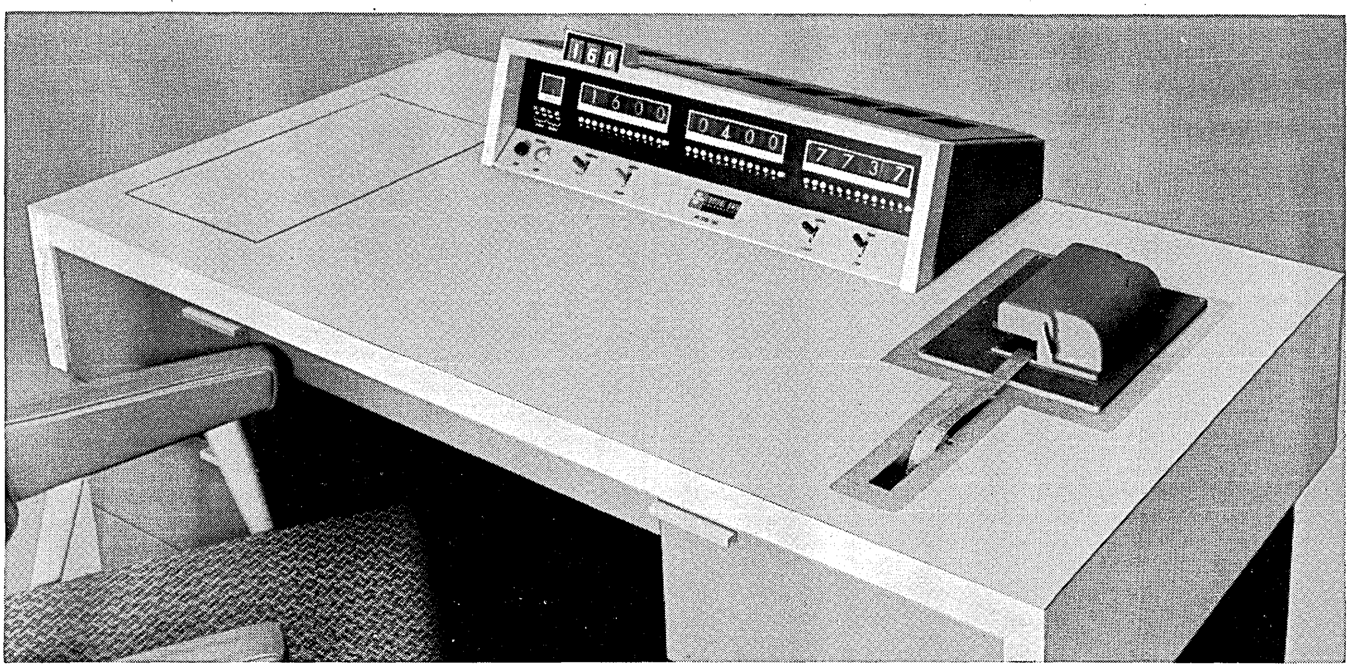
Last, the inconvenience caused by having a job suddenly come back to life after the old computer is gone could also be avoided. With it would go the usual frantic search for a machine of the same type and configuration as the one you just released.

Ideally the plates would be large enough so that the order list of a present machine could be held on half of one; this order list could then be augmented by other features. It's conceivable that interpretive programs would come back to life, but at the micro level. ●

Announcing the most versatile solid state computer in the low price field

Small as an ordinary desk, the Control Data 160 has the capability of computers many times its size.

IN THE 3 SECONDS IT TAKES YOU TO READ THIS SENTENCE... THE NEW CONTROL DATA 160 EXECUTES 180,000 INSTRUCTIONS



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VERSATILE: Offers broad use in fields of engineering and scientific calculation, real-time data processing, data conversion, data logging and data acquisition, industrial control, communications systems, statistical and business data processing.

FAST: You can execute 60,000 instructions per second. The 160 uses solid state circuits and a *magnetic core memory* like those used in the Control Data 1604 — one of the newest, most advanced large-scale computers made today.

POWERFUL: The desk-size 160 gives you performance better than that of many large-scale computers in use today.

EASY TO USE: Experienced programmers can learn the 160 in one day. A two-week course is available for inexperienced personnel.

AND LOW IN COST! $60,000 for the basic system.

QUICK FACTS FOR THE TECHNICAL STAFF

1. MAGNETIC CORE STORAGE: 49,152 bits. Storage cycle time, 6.4 microseconds. Basic add time, 12.8 microseconds. Information read available 2.2 microseconds after start of cycle. Average execution time, 15 microseconds per instruction. 5 megacycle logic. Will handle input-output speeds of up to 65KC.

2. OPERATING MODE: Operation controlled by an internally stored program. Single address logic, one instruction per word.

3. PROGRAMMING: Repertoire of 62 instructions. Ease of programming features flexible addressing modes — no address, direct address, indirect address and relative address. Complete programming package includes 22-, 33-, 44-bit fixed point arithmetic, floating point, complex floating point, decimal, floating decimal, and algebraic compiler.

4. INPUT-OUTPUT: Versatile instructions provided to handle available line of input-output devices: 350 character/second paper tape reader, 60 character/second paper tape punch, electric typewriter, up to 8 magnetic tape handlers (either 15KC or 30KC), card reader, card punch, and line printer.

CONTROL DATA CORPORATION

501 PARK AVENUE • MPLS. 15, MINN. • FEderal 9-0411

Circle 25 on Reader Service Card.

OPERATION OF A FLIGHT TEST DATA HANDLING SYSTEM

Automatic acquisition and telemetry of data is now regarded as an integral function of the flight testing of most aircraft and missiles, even to the extent of introducing the art of computer processing to the aircraft and missile field to compute data gathered in flight.

Between the two functions of gathering flight test data and entering it into a computer however, there has been an undeveloped area that slows the progress of engineers trying to put flight test data to work perfecting the missile under development. This undeveloped area was the time spent by engineers in record selecting, editing, and preparation of data in a form acceptable by digital computers.

To help close this gap, the Datalab Division of Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell Co., has developed and built a flight test data handling system. This system automatically performs all the functions of data acquisition, telemetry, editing, selection, routing, and assembly into a format compatible with magnetic tape input into a high-speed data processor, and allows for human monitoring and control from the ground or in the air. It is possible for several hundred physical phenomena to be transduced into equivalent voltages and for these voltages to be time-division multiplexed, amplified, converted to digital form, telemetered to the ground, recorded, edited and processed by a computer before the aircraft returns to its base.

The Automatic Data Handling System, developed jointly by Datalab and Douglas Aircraft Company, consists of three separate but integrated groups of equipment: airborne data acquisition equipment, Ground Control and Record Station, and Computer Input Facility.

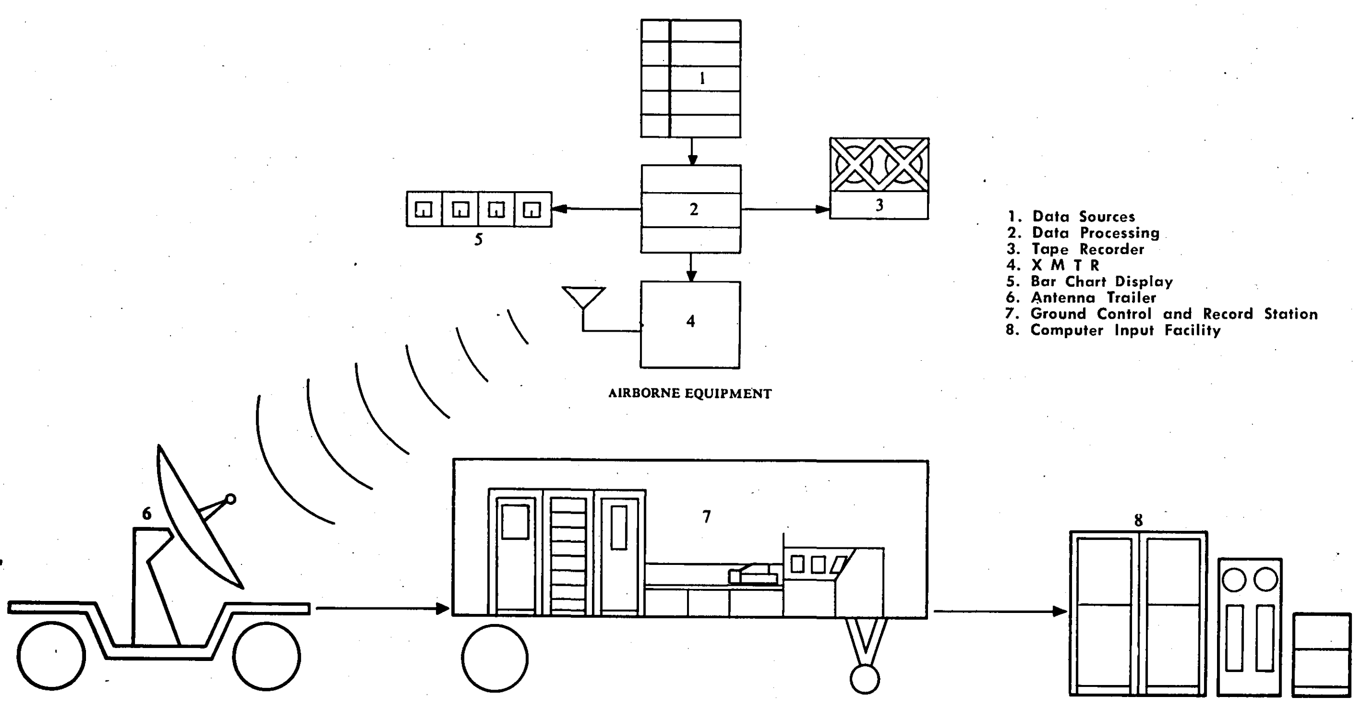
In the airborne data acquisition equipment each of up to 100 primary input channels can be sampled at rates up to 500 times per second with errors not exceeding one part in 1000. Each primary channel can be subcommutated in ratios of 10/1 and/or 100/1 to make possible a maximum channel capacity of 10,000 inputs, each sampled five times per second. Airborne electronics are modular for flexibility in the number of channels and sampling rates desirable to the flight test program.

The timing and synchronization of data sampling is controlled directly by a Program Control Unit, the basic timing and programming source in the airborne system.

An analog-to-digital converter is capable of converting incoming signals into an 11-bit binary equivalent in less than 18 microseconds. It also buffers time code and digital input information and converts gray coded digital inputs to straight binary words. The ADC is internally programmed and starts its cycle at the command of the Program Control Unit. Serial output from the ADC goes to the telemeter transmitter while parallel output goes to the airborne tape recorder and the bar chart display.

Up to 100 data channels may be presented simultaneously on the cathode-ray bar chart display consisting of up to five tubes which display 20 channels each. This allows the pilot or flight engineer to monitor selected transducer signals visually.

High-density recording techniques were developed to accommodate the quantity of digital data generated by the



Block diagram of Automatic Data Handling System shows how airborne equipment, Ground Control and Record Station, and Computer Input Facility are integrated via telemetry link.

airborne system. All phenomena during an hour's testing can be stored by the tape recorder at a minimum expenditure of weight and space in the airborne vehicle. The airborne tape recorder stores 2.4 billion bits on the one-inch tape at a density in excess of 1500 bits per inch per track. Eleven of these tracks carry the data sample, one is used for parity check, one for event marker, and three are "clock" tracks. Because accurate time correlation between recording and playback is necessary, time resolution, a function of a Time Code Unit, is .01 second. Time is recorded in binary form, like other data, once each frame.

From the air, this binary-coded test data from transducers and digital input devices is telemetered to the Ground Control Record Station via Pulse Code Modulation/Frequency Modulation.

The Ground Control and Record Station receives telemetered signals from the airborne vehicle and, after serial-to-parallel conversion, provides a digital tape record, a 100-channel bar chart display, time history plots of up to 20 channels, digital display of elapsed operating time, event mark indication, and a counter which indicates dropouts and system errors. The bar chart display, elapsed time indicator, and voice communication equipment are located in a control console which serves as the observation and control center for the test flight. From this station engineers can guide the test flight to a successful conclusion through VHF and UHF voice links with the test vehicle.

The tape transport in the station duplicates the record in the aircraft, and CRT bar charts make possible the same visual displays. This duplication can be treated as "back up" data, or, the duplicated facilities in either the airborne or ground station facilities can be eliminated.

In addition to bar chart displays, there are provisions for decommutating and converting digital data to analog for quick-look display on recording oscillographs.

This station is housed in a 33-foot air-conditioned trailer for transporting to any test site. A 12-foot dish-type telemeter antenna and its rotating mechanism are mounted on a separate trailer, as is a power generator unit that allows the trailer to function independently.

Magnetic tape from either the airborne system or ground station is played back by the Computer Input Facility, which has editing and selection facilities for selecting the channels that are essential for each particular computer program. The Computer Input Facility is at a fixed location, probably at the aircraft or missile manufacturer's main location where development engineers can have unlimited use of the computer data.

Tabulated and plotted results that the computer operator places on the desk of the development engineer are "untouched by human hands" so there has been no opportunity to introduce error.

Analysis of the effects of a flight test maneuver usually requires only a percentage of the voluminous data gathered during the flight, so editing facilities were important to the computer facility to conserve computer and operator time. Five modes of editing are provided: flight test data tape search, time selection, channel selection, frame selection, and editing of superfluous data by the computer station operator.

Editing is done from the original magnetic tape recording. Displays of data by oscillographs and bar charts facilitate editing. The first step in editing is to search the tape for the events that are significant to the analysis program being run. The operator can set his event search equipment to stop the tape at any event listed in his log of the day's flight. Tape is transported at 100 inches per second in the search mode in order to quickly locate the section of the tape on which is recorded the data gathered during that phase of the flight test.

Data is extracted from the tape during the editing process and is entered through a buffer storage unit into a magnetic tape transport whose output is compatible with the computer. Thus, segments of the original data can be selected based on time, channel, and frame and transferred into the computer. In addition, the system can be programmed to enter all calibration data into computer memory. The editing facilities make it possible to select the channels that provide pertinent information and also to skip frames or any number of frames on which are recorded redundant data from very slowly changing phenomena. Averaging methods can be used effectively by operator selection of contiguous frames, separated by an arbitrary number of frames.

Computer tape, bearing only the necessary data and its channel address, can then be quickly introduced into the computer.

Plus & Minus

by Herb Grosch

Papeete, May 8, 1960

Tomorrow I shall be in the unique position of calling to order the newest, smallest, and most remote of computer societies: the Polynesian Information Processing Society (PIPS). The agenda for the meeting, to be held at the Royal Tahitian Hotel, is quite limited: constitutional matters, a report on the WJCC just concluded in San Francisco, appointment of a delegate to ANCCAC in Sydney (May 24-27), appointment of the official Society representative to IFIPS, and choice of the location of the next meeting place – possibly Easter Island.

It is also probable that PIPS will create its first honorary member; a motion will be made on behalf of Cecil Hastings. Honorary membership does not carry voting rights, but entitles the holder to attend the quadrennial meetings and to use the phrase "He's a PIP" on business cards and letterheads.

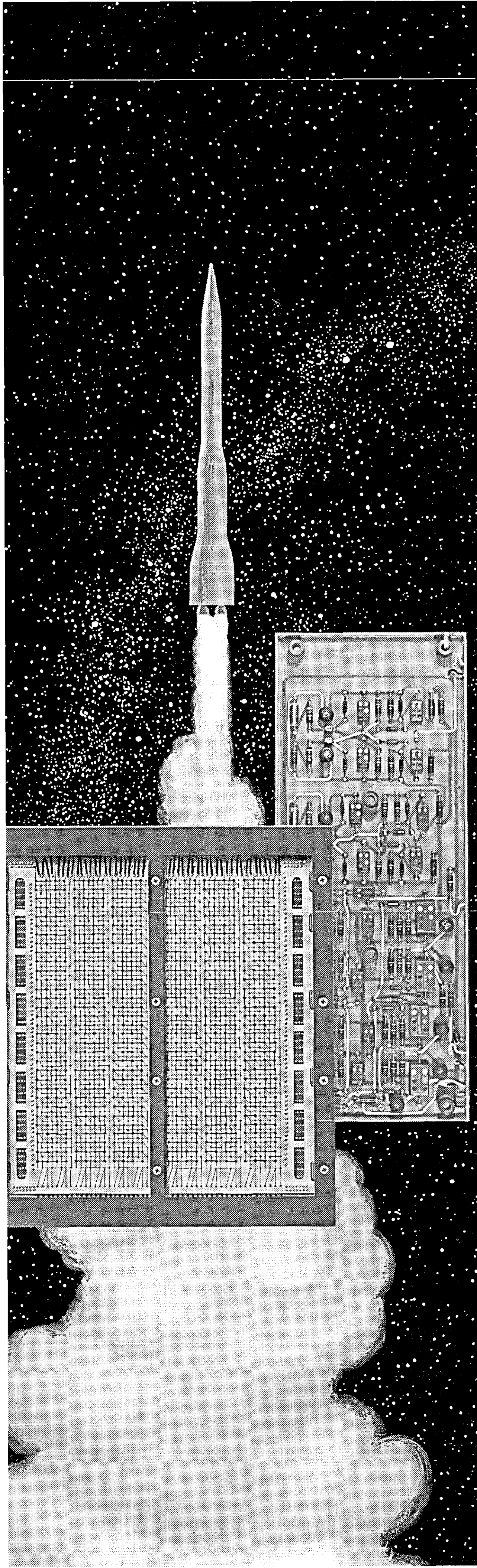
The closest thing to an Antipodal Joint Computer Conference is the meeting convening at the University of Sydney May 24, sponsored by the Australian National Committee on Computation and Automatic Control. Over a hundred papers on all aspects of data processing – hardware and applications, technical and business – will be presented. I've been invited to chair a session or two, and will have a report in the next issue if I don't lose my vaccination certificate.

There will be other reports on the papers, the exhibits, and the social activities at the Western Joint. I'll confine my own remarks, then, to the really very promising developments at the long NJCC committee meeting May 4.

At the last Eastern Joint, the member organizations of the JCC expressed clear if somewhat divergent intentions of reformulating the extremely limited charter. Harry Goode took a first run at a new constitution, on behalf of the ad hoc committee; the AIEE people then rewrote and polished; finally, on May 4 the full NJCC hacked out enough additional underbrush to augur well final ratification by the three memberships.

Briefly, the suggested constitution is of an American Federation of Information Processing Societies, a federation of societies rather than of individuals. Charter members would be ACM, IRE, and AIEE, but other full members with equal rights and responsibilities is envisaged. Two classes of limited membership, plus corporate support, are also provided.

The directing board would be able to engage in much broader activities than the present two conferences. The type of reasonable, non-competing decisions needed to really represent the computer field nationwide ought now to be possible, without advance unanimous agreement from all member organizations. I'm pretty sure the ACM membership, which will ultimately vote on this under the "important matters" clause of the new constitution, will ratify. ●



Expanding the Frontiers of Space Technology in

COMPUTER DEVELOPMENT

Space Vehicle Command – An important advance in the control of space vehicles has been accomplished with the development by Lockheed scientists of space-borne, command decoders and sequence programmers. Basically, the programmers store information and, at a predetermined time when the vehicle is out of contact with ground stations, cause commands to be executed by the various subsystems. In this way, versatility of vehicle missions can be markedly expanded.

In addition, when the vehicle comes in range of ground command stations, the programmer can be given new instructions for either future or immediate action. All of the programmer's components are solid state devices. There are no moving parts nor vacuum tubes. The ferrite core memory in which information is stored is a two core-per-bit matrix.

A primary design goal was to reduce power requirements. Although the Lockheed programmer is highly complex and employs over 600 transistors, the average power consumption is only 3.5 watts, less than a Christmas tree light bulb. The development of such complex circuitry that will withstand the shock, vibration and a temperature range from −40°C to +85°C is in itself a significant achievement.

The highly precise timing necessary for the execution of the various programmed assignments is accomplished by means of a crystal oscillator – maintained at an exact temperature by means of a two phase mixture of solid and liquid inert chemical.

Engineers and Scientists: Lockheed's capability in design and development of computers is contributing to the advancement of the state of the art in a number of areas. Work is being carried on in research and development of ultra reliable digital circuitry, ferrite logic systems, and millimicrosecond switching techniques; radically new devices for pattern recognition operations; high speed digital plotters; self-organizing systems; large scale systems for the automatic storage and retrieval of information; microminiature packaging techniques; and systems research and engineering of large scale information handling complexes.

If you are experienced in work related to logical design or computer development, you are invited to inquire into the interesting work being conducted and planned at Lockheed. Write: Research and Development Staff, Dept. F-46, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

Lockheed

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A COMPARISON OF COMPUTER INDUSTRIES IN THE U.S. & THE U.K.

by BRIAN POLLARD
Burroughs Corporation

While computers were originally developed for scientific applications in both the U.S. and the U.K., the evolution of the information processing industries of the two countries since that time has diverged widely.

Computers have traditionally been a side line for engineering firms in Great Britain. For instance, Ferranti – the largest British manufacturer of computers – produces heavy electrical engineering products as its standard fare and is one of the leading transformer manufacturers. Other British engineering firms operate similarly; it is clear that their basic business is not computers.

In the United States, on the other hand, computers have become an industry in themselves. A number of major firms are competing for the market, and smaller ones are producing peripheral equipment – all are existing on a single commodity: computers.

The British computer market has fairly well contained itself in the scientific realm. Generally speaking, the basic scientific research market is very near saturation. And, contrary to the market in the U.S., no insurance firms had installed domestic computers as of January, 1959.

Similarly, the aircraft industry – a heavy consumer of computer equipment here – has not shown the same interest in computers in the British Isles. The U.K. industry's installation of computers has been slower and was just beginning to gather speed when general business activity slowed down.

The computer market pendulum in the U.S. has been making a steady swing toward the commercial field. A greater emphasis on user-oriented product planning has resulted in the development of computers that are better suited to commercial applications than the original, scientifically oriented models.

With well-known British conservatism evidenced by both manufacturers and consumers in the U.K., there has been a hesitancy to make any definite moves. The general feeling is that United Kingdom firms are waiting for more testing and acceptance of domestic computers.

Brian Pollard is assistant to the vice president, manufacturing and engineering, Burroughs Corporation. He came to that company from the United Kingdom's largest manufacturer of computer equipment — Ferranti. A graduate of Clare College, Cambridge, Pollard was the first manager of Ferranti's computer division.

Medium-scale computers have been preferred to large-scale systems.

One possible index to the overall interest in computers in both countries is the extent of investment in the manufacturing and development of computer equipment. The tendency on the part of British manufacturers is toward conservative spending, stemming from the British view of computers as a "side line." One of the results: investment in computers in the U.K. has been on a small scale. There has been no large sum of government money invested in computer development either. The British National Research Development Corporation lends money to firms who **do** seek development contracts, but it lends its money at the current rate and assumes a profit.

investments, expansion

The U.S. Government has made heavy investments in computer development, especially for defense purposes, such as guided missile programs. And the expansion programs of U.S. manufacturers have shown phenomenal growth in the past few years.

U.S. manufacturers subcontract a large proportion of their work, assembling parts from a wide assortment of subcontractors, concentrating on general development.

In the U.K., manufacturers produce every part possible in their own plants, subcontracting only when special techniques are involved and when plant facilities do not offer appropriate capacity. But production in the U.K. is no less efficient: production procedures are firmly established, and therefore effective, in both countries.

There seems to be a greater individuality in English systems. Very small teams develop the command and logic structures, which hang together better than in some American systems. The command structure or logic may be more limited in British models, but, in looking at some American systems, the command structure has been created by committee . . . by compromise.

difference cited

One big difference is seen by Pollard in the way the U.S.-made systems can be manipulated. Citing the Burroughs 220, Pollard notes that it can be tested as one system; then, later, the units can be switched. The British system is "tuned up" as a single unit, making it difficult to switch individual pieces of gear. This is fine – if production volume is small enough, as it is in England.

There is a chronic shortage of skilled engineers in the United Kingdom. At Manchester University, there are perhaps ten people a year doing work in computer techniques – most will go into government service, which in the U.K. requires high standards and in return offers good pay and ideal conditions. Generally the government offers the equivalent of 10% under the going rate in industry. Nevertheless, private industry has a difficult time attracting the personnel it requires.

Also, the proportion of college graduates is smaller in the U.K. There, major universities are more the equivalent of our best: Harvard, MIT, Cal Tech, etc., although England does have technical colleges with part-time and full-time students.

Because of the shortage of skilled personnel, highly trained engineers are used sparingly in the U.K. Computer systems in Britain may be developed by as few as a dozen men, with usually two or three in control.

However, draftsmen, particularly in the north of England, are really mechanical designers to whom the engineers can turn over all the details. In this way, the engineers that are available have strong reinforcement.

To state a general view of the computer industry in the United States – it is far more established and active than in Great Britain. The monthly output of the smallest of the American Big Three manufacturers is probably greater than the yearly output of the largest British manufacturer.

A vast difference in economic bases in the two countries' computer manufacturers can be seen in the fact that there is very little leasing of equipment in the U.K., in comparison to the U.S. The explanation of this is that engineering firms, which dominate the British computer industry, have had little experience with leasing. Their capital structure is better suited to selling. The offer of lease by U.S. companies, however, has had a strong effect in the British Isles.

While the U.S. is swinging toward the commercial field, with interest in product planning and active market reinforcing expansion plans, the future of the British computer market is a question mark. Though the scientific market is slackening, the commercial field does not seem to be providing the incentive for British computer manufacturers to seriously consider major development programs in this direction. But if only because of the natural course of events and Britain's continuing remarkable recovery, the U.K. offers an expanding commercial market.

And, given this expansion, the American firms already established there will move to take advantage of it. Burroughs, with two manufacturing facilities in Scotland, is in a good position to grow in the United Kingdom. IBM and Remington Rand round out the major American computing firms competing in the U.K.

Perhaps the major factor influencing the invasion of the U.K. by European computer manufacturers is the marketing alliance between France's Compagnie Machines des Bull and Thomas De La Rue, a British firm specializing in bank-note printing, but which has recently branched out into the manufacture of etched circuits.

Olivetti is also moving into the computer field, and may become a force in the United Kingdom. And various German firms now working on computers may sell in England.

The computing "Battle of Britain" shapes up as an interesting, international affair. ●

WJCC — a look back

(Continued from page 23.)

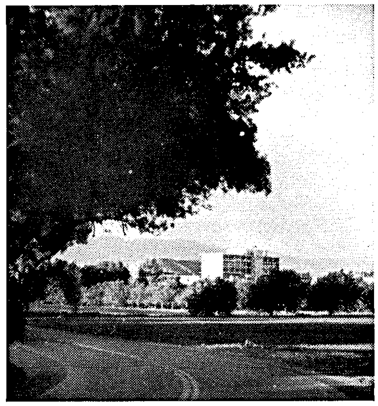
ler and Sherman picked a darn good selection of papers!" My informal polling shows that Lou Fein's session on Micro Electronics was one of the most successful; much interest was shown in Ken Shoulder's prognostications on the shape of computers in the future. In the Data Retrieval session, it was too bad that one of the speakers was not able to attend, but this offered a good opportunity to illustrate the value of panelists really able to discuss their topics: one of the panelists for this session filled in the void and gave an extemporaneous dissertation about the missing speaker's paper, followed by a worthwhile panel discussion. More than one comment was made about the tremendous advantage of having well prepared panelists at this year's WJCC.

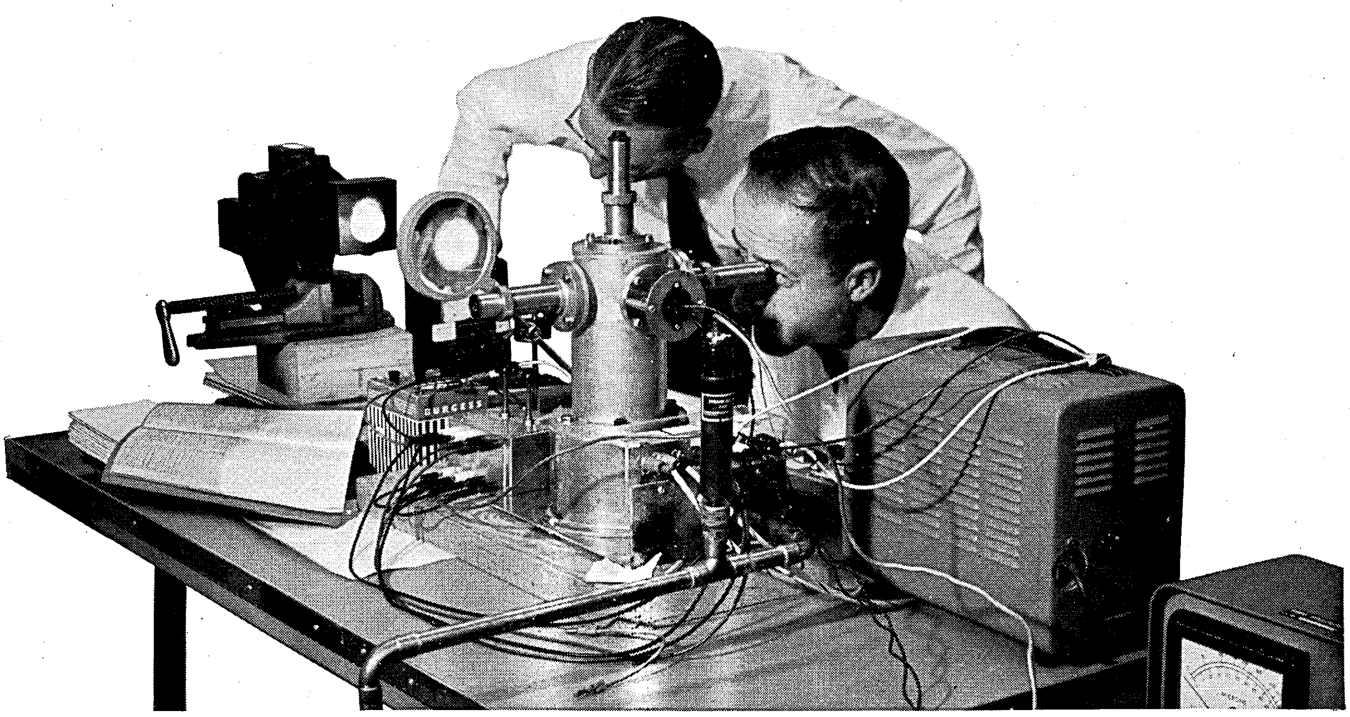
Personally, I heard no complaints at all about the paralleling sessions. What I did hear indicated that the papers and the sessions themselves had been picked so well that there was almost no conflict of interest. Regarding the analog papers, unsolicited remarks expressed gratitude that interest in them was being renewed by a Joint Computer Conference. We all know the marriage between analog and digital techniques is becoming a reality.

comments on exhibits

All mention of the exhibits indicated their quality was high. The exhibitors seemed pleased at both the attendance and the level of technical knowledge displayed by those touring the exhibit area.

It's true that the equipment space was fairly restricted. This was caused partly by the fact that we had an unusually large request for exhibit space this year. As a matter of fact, Harry Farrar had a long waiting list which just could not be accommodated. He comments that unless a more spacious exhibit area is offered by one of the hotels in 1962, it looks as though we might have to go to Brooks Hall (better known as "Mole Hall") located at the San Francisco Civic Center. ●





new products in DATAMATION

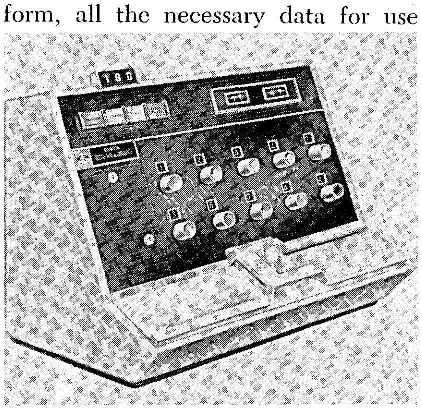
solid state computer

The UNIVAC III's processor and control console operate with a main memory core storage of from 8,192 to 16,384 words with an access time of 4.5 microseconds and an add time of nine microseconds. Words can be pure binary, binary coded decimal or other forms. As many as 16 tape units can be used for input/output. Reading and writing rate of these Uniservo III's is 200,000 four bit digits per second. An on-line card reader operates at 700 cards per minute and a card punch at 300 cpm. An on-line printer operates at 700 lines per minute. Floating point can be programmed on the III and the manufacturer says the system will have "a compiler which accepts as its basic input . . . COBOL." For information write REMINGTON RAND, Division of Sperry Rand Corp., 315 Fourth Ave., New York 10, N.Y., or use card.

Circle 200 on Reader Service Card.

data collector

Model 180 Data Collector collects and records in computer-intelligible form, all the necessary data for use

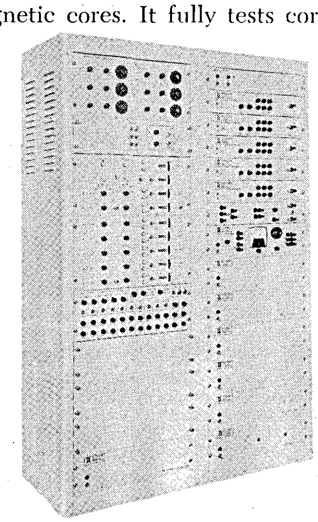


by computers to process such items as payroll, work-in-process inventory, costs and scheduling operations. The 180 Data Collector automatically assembles into a punched paper tape variable data (such as job-lot number and amount produced), identification data from pre-punched IBM cards (such as employee number & item number), fixed data (such as department number and Data Collector number), and time from an internal clock (to the nearest 0.01 hour). The variable data are inserted very simply from 10 manually-operated dials. The identification data are selectively read from punched cards by a unique card reader. This card reader employs a pneumatic principle. Variable card lengths may be used; bent or wrinkled paper cards and plastic cards can be read with high reliability. Output data is recorded at the rate of 15 characters per second on 5, 6, 7 or 8 level punched paper tape. Each 180 Data Collector is a modular self-contained unit which can be either wall-mounted or placed on a table or desk. It can be moved wherever needed, and there are no installation costs. For information write CONTROL DATA CORP., 501 Park Ave., Minneapolis 15, Minn.

Circle 201 on Reader Service Card.

core tester

Type 2101 is designed for production-line testing of mass produced magnetic cores. It fully tests cores at

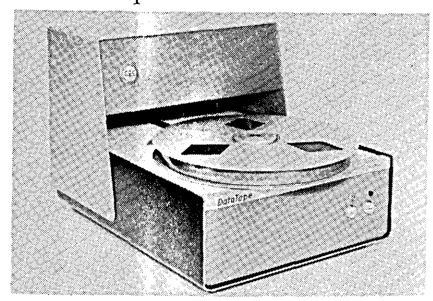


the rate of three per second. The 2101 uses a decision-making logic which can be programmed to accept or reject cores to a variety of specifications. The logic circuit is driven by the output of a comparator circuit which compares six calibrated flat-topped pulses with core amplitude measured by two highly stable linear calibrated sense amplifiers. Amplitude difference between the pulses and the test core is then subjected to seven accept-reject decisions based on the predetermined specifications. For information write DIGITAL EQUIPMENT CORP., Maynard, Mass., or use reader service card.

Circle 202 on Reader Service Card.

automatic degausser

The new type 5-055A automatic tape degausser can be used with tapes from one-quarter to two inches in

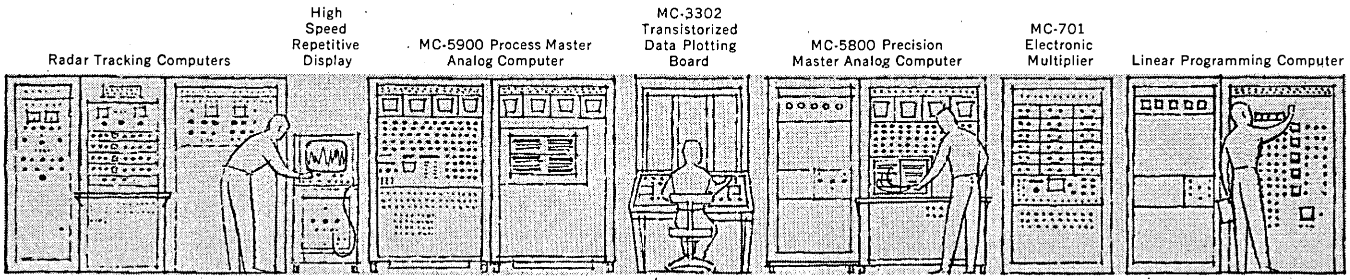


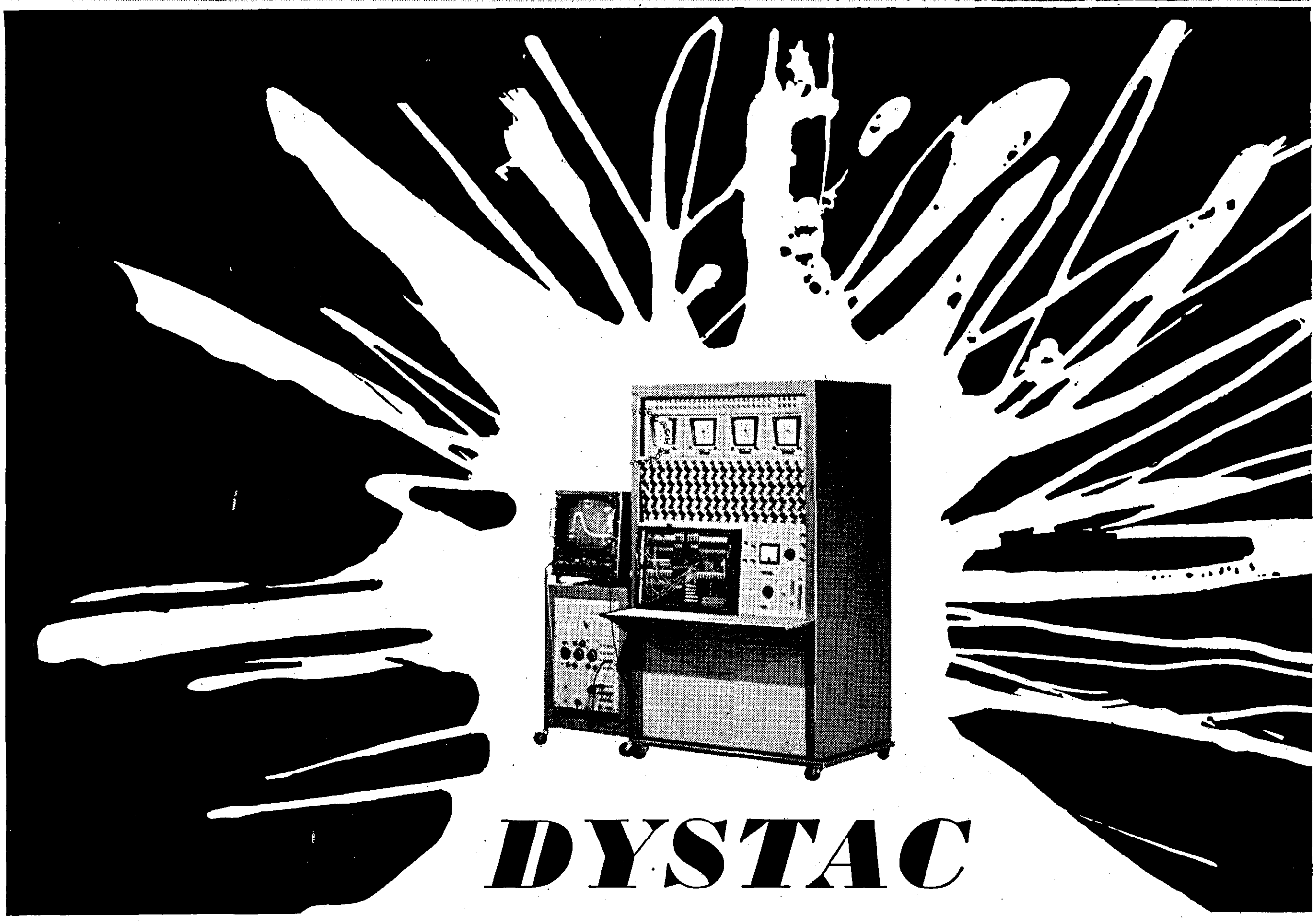
width, reels from seven to 14 inches in diameter, and reel hubs of all dimensions. A reel of instrumentation tape recorded to saturation is erased to at least 50 db below normal record level. Uniform degaussing is achieved with automatic time cycling of reels in the magnetic field. After a reel of tape is placed on the turntable spindle and the button pressed, capacitor-type motors slowly move the reel into the erasing field, rotate it several times, and slowly withdraw it. When the reel returns to its original position the degausser shuts off. The degaussing cycle is completed in approximately 60 seconds. For information write CONSOLIDATED ELECTRODYNAMICS CORP., 360 Sierra Madre Villa, Pasadena, Calif.

Circle 203 on Reader Service Card.

analog computer

Featuring all solid state electronics, the CM-3 provides continuous real time solutions for mathematical computations and real time control of variables in the chemical, petrochemical, refining and process industries. A single CM-3 cabinet contains a maximum of 12 amplifiers. There is no electronic limit to the number of amplifiers which can be used. Any number of amplifiers, square root and logarithmic networks may be specified according to functional require-





A NEW COMPUTER TECHNOLOGY

solving problems hitherto unsolvable

DYSTAC (Dynamic Storage Analog Computer) synthesizes the advantages of both analog and digital computers. DYSTAC combines the analog's speed, lower cost, ease of programming, and improved output data presentation with the digital computer's unique capacity for data storage and time sharing of computer elements. With DYSTAC you can now solve the most complex problems, ranging from distillation column design to multidimensional heat transfer...from boundary value problems to transport lags.

In distillation column design, for example, DYSTAC employs only 44 amplifiers on a four-component problem; the number of amplifiers required is independent of the number of plates. With any other analog computer each plate must be reproduced in the circuitry—for a 30-plate column, over 1200 amplifiers are needed unless manual reprogramming is employed. What's more, only DYSTAC yields a plate-by-plate display of all column conditions.

In heat transfer studies, DYSTAC will speedily and accurately solve hitherto unsolvable partial differential equations. It also makes practical for the first time instantaneous solutions to such trial-and-error problems as automatic optimization, automatic correlations, data fitting, probability distribution, Fourier analysis, convolution and superposition integrals and eigenvalue.

When you buy a CSI computer with DYSTAC you are buying more than the finest general purpose analog computer. You buy additional capacity as well as capability. For when DYSTAC elements are not in use as memory devices they are available to the computer as operational amplifiers. Planning to interconnect digital and analog computers? DYSTAC is the answer.

See DYSTAC in operation at our plant. If you can't attend a demonstration write, phone or wire for full information.

COMPUTER SYSTEMS, INC., Culver Road, Monmouth Junction, N.J. • DAvis 9-2351
A Schlumberger Subsidiary • formerly Mid-Century Instrumatic Corp.

Circle 29 on Reader Service Card.

ments. When necessary, two or more CM-3's can be used with their programming boards interconnected. For information write SOUTHWESTERN INDUSTRIAL ELECTRONICS CO., P.O. Box 22187, Houston 27, Tex.

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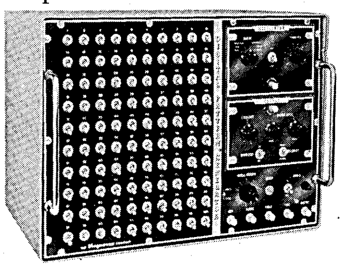
digital pattern generator

The Digital Pattern Generator is a transistorized piece of test equipment which provides a simulated and flex-



ible time division pattern output. It is designed to supply a repeating bit pattern for the testing and development of a wide range of computers and communications systems. Modular techniques have been used to allow for future expansion of present capabilities. The unit features an adjustable pattern length from one to 100 bits with the state of each bit independently controlled as to "1" or "0" from the front panel. For information write MAGNAVOX COMPANY, Government and Industrial Div., Fort Wayne, Ind., or use card.

Circle 205 on Reader Service Card.

tele-processing

Two tele-processing data machines – electronic devices that talk to one another in computer language via regu-

lar toll telephone calls – have been announced. The 7701 magnetic tape transmission terminal sends business and scientific data at the rate of 150 characters or thirty words a second. The data transceiver equipped with a dial-up telephone feature, can transmit 10 eight-column punched cards a minute. In each case a twin device at the other end of the telephone circuit, which may be across the country, automatically recreates the original magnetic tape or punched card data. Both of these terminals are also capable of operating over telegraph lines.

In use, the sending operator places a data-filled tape reel on the 7701 and then dials the telephone number of the receiving location. Learning that data is to be sent, the receiving operator verifies that the receiving terminal is prepared to record the transmitted data.

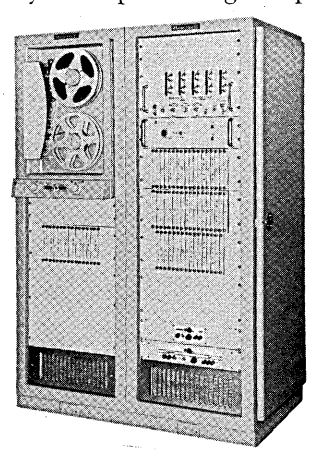
As the operation begins, data passes at the speed of 150 characters a second from the 7701, through a modulating subset provided by the telephone or telegraph company, through the communication circuits, to a demodulating subset at the other end, and into the receiving 7701.

The procedure for transmitting standard punched card information via dial-up data transceiver equipment is similar. For information write IBM CORP., EDP Div., 112 E. Post Rd., White Plains, N.Y., or use card.

Circle 206 on Reader Service Card.

solid-state modules

With these solid-state modules — each making use of standard logic circuitry and performing a specific



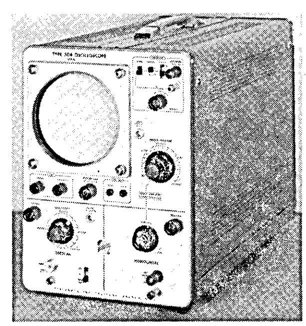
function — digital systems can be assembled to multiplex and digitize data at rates up to 15,000 samples per second within an accuracy of 0.05 per cent, according to the manufacturer. Using the modules in various arrangements, it was explained, operators can engineer digital systems to

perform these functions: magnetic tape system record and playback electronics, high and low level multiplexing, analog-to-digital and digital-to-analog conversion, format conversion, editing and transcribing, and tape-to-card and card-to-tape conversion. Thirty-seven modules currently make up a basic "library" of digital components. Indicative of the modules are printed circuitry for: ring counter flip-flops, set and reset flip-flops, trigger and reset flip-flops, playback amplifier, NRZ read logic, NRZ record, NRZ playback amplifiers, binary coded decimal to decimal matrix, binary coded decimal parity check (even), indicator driver (nixie), head driver (NRZ or RZ), gate buffer (not), "and" gates (2 input; reverse polarity gives "or"), one shot multivibrator, pulse "or" gate, and gate card 6 input. For information write MINNEAPOLIS - HONEYWELL REGULATOR CO., Industrial Systems Div., Beltsville, Md., or use card.

Circle 207 on Reader Service Card.

oscilloscope

Type 504 is in the dc-to-450 range. Basic sensitivity is 5 mv/cm. Vertical amplifier characteristics include: in-

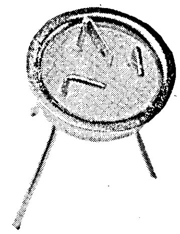


put stage electronically regulated, calibrated steps to 20 v/cm, adjustable between 12 steps and to over 50 v/cm uncalibrated, and constant input impedance (for easy probe use) at all sensitivities. Other features include: functional panel layout, 8 x 10 cm viewing area, 18 calibrated sweep rates, electronically-regulated power supplies, and extremely adaptable trigger facilities. For information write TEKTRONIX, INC., P.O. Box 831, Portland 7, Oregon, or use card.

Circle 208 on Reader Service Card.

micro energy switch

The micro-energy switch represents a new concept in the design of switching transistors for high speed computer use, according to the manufacturer. The micro-energy switch is a

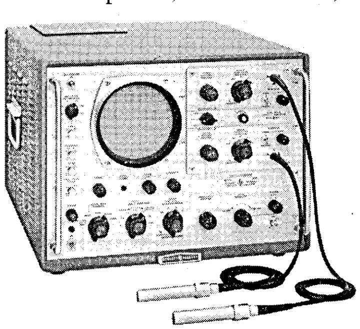


transistor which has been designed and constructed so that all internal device capacities are exceedingly small. At the same time the static characteristics of the device are optimized for operation at low collector voltages and collector currents. The result, the manufacturer states, is a transistor device which will operate at the high repetition rates of today's most modern high-speed switching transistors but can do this in circuits operating at much lower power levels. In micro-miniaturized equipment it is imperative that the circuits operate at lower energy levels than those presently used for high-speed computer design. This is important because, with the exceedingly high packing densities being visualized, the dissipation level of presently used high-speed circuits would cause an intolerable amount of heating. The first micro-energy switches to be supplied will be packaged in the TO-18 package but the device will be offered in a considerably smaller hermetically sealed package in the near future. For information write PHILCO CORP., Lansdale Div., Lansdale, Pa., or use card.

Circle 209 on Reader Service Card.

oscilloscope

A new 500 mc oscilloscope which provides viewing of repetitive millimicrosecond pulses, Model 185A, is

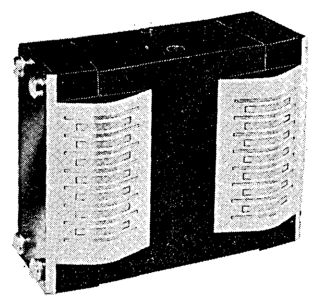


a single package, conceived to permit operation similar to a conventional oscilloscope. Model 185A has a rise time of less than 0.7 mus. Its full 10 centimeter vertical display and high vertical amplifier sensitivity permit pulse analysis in greater detail than previously possible, according to the manufacturer. A fast rise sync pulse, suitably delayed from the start of the oscilloscope trace, is available for triggering external circuits. In situations where the test circuit will respond to this trigger, a delay line is unnecessary. For information write HEWLETT-PACKARD CO., 275 Page Mill Rd., Palo Alto, Calif.

Circle 210 on Reader Service Card.

magnetic heads

A new series of integral interlace magnetic heads is designated Series 2000. The interlace feature of the

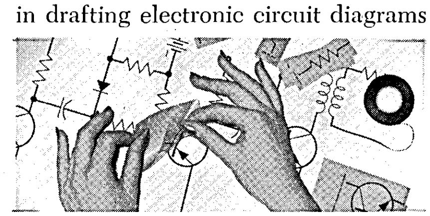


series nearly doubles the number of channels which can be recorded on a given tape width. A higher signal-to-noise ratio is attained due to the wider track or increased winding made possible by interlacing. An added advantage of the wider spacing is that a greater amount of shielding can be inserted in the head to reduce crosstalk to a minimum. For information write CLEVITE ELECTRONIC COMPONENTS, 3405 Perkins Ave., Cleveland 14, Ohio, or use card.

Circle 211 on Reader Service Card.

circuit diagrams

Select-a-circuit is intended to reduce substantially the time presently spent in drafting electronic circuit diagrams

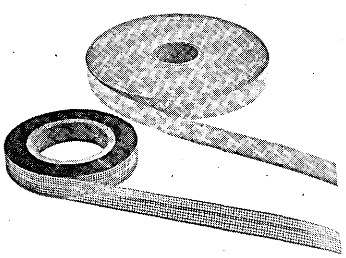


for displays and technical presentations. The product consists of all A.S.A. and I.R E. electrical symbols, individually printed on self-adhesive transparent plastic. Select-a-circuit preprinted symbols are available in 2½″ or 4½″ lengths, and vary in height according to the particular symbol. With the smaller size, a complete circuit can be constructed on standard 8½" x 11" sheets. For information write ENGINEERING AND SCIENCE AIDS CO., 435 West 119 St., New York, N.Y., or use card.

Circle 212 on Reader Service Card.

computer tape

Two new types of reinforced, opaque computer tape have been developed for use in programming applications



with photo-electric or mechanical readers. High tear and tensile strength, together with dimensional stability, permit both types to be run through readers many thousands of times without breaks and without malfunction due to deformation or elongation of code signal holes or feed holes, the manufacturer states. Type R-V-CT 52 is .0025" thick for photo-electric reading and comes in continuous lengths of 1800 ft., 1200 ft., 1000 ft and 500 ft. without splices. Type R-V-CP 23 is .0045" thick for mechanical or photoelectric reading and is available in overall diameter rolls of 8", 6" and 4". Both types are offered in standard and special tape widths with tolerances of +.003", wound on either 2" or 3" I.D. cores. For information write ARVEY CORP., Lamcote Div., 3500 N. Kimball Ave., Chicago 18, Ill., or use reader card.

Circle 213 on Reader Service Card.

business computer

The NCR 390 computer is able to read and process a conventional business document, the manufacturer states. This computer employs a new input concept by utilizing magnetic coatings on the back of regular ledger cards. The magnetic coatings, consisting of four vertical strips, records account data and controls the computer's handling of the account. The front of the ledger card looks like any business form containing printed information. The 390 is solid state, has a 200-word magnetic core memory and internally stored programs. Input

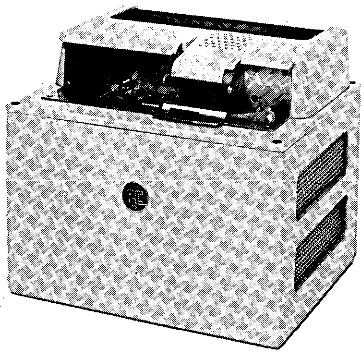
Circle 76 on Reader Service Card.

includes the above-described ledger cards, punched cards, punched tape or keyboard. Four output methods are ledger cards, punched cards, punched tape and machine printed forms. For information write NATIONAL CASH REGISTER CO., Dayton 9, Ohio.

Circle 214 on Reader Service Card.

punched tape equipment

Model 100 slow to medium speed tape reader is designed for line-by-line reading up to 60 lines a second.

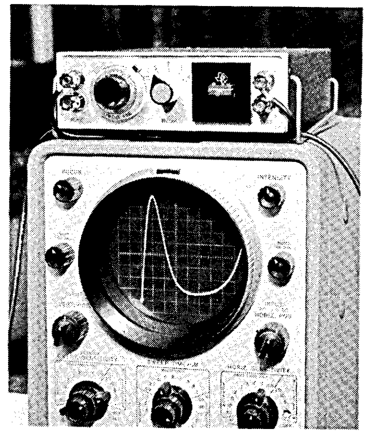


The Model 300, now undergoing final evaluation tests, is for higher speed slewing operation at speeds of 250 characters per second. It will stop on command on a required character. Both models are contained in cast aluminum housings, approximately 10¾″ x 8¾″ x 9″. A simplified drive mechanism controls the advance of the tape from one line of characters to the next. Directly coupled to the motor shaft is a drum which provides the friction drive necessary for the tape advance, the movements of which are related electronically to the position of the tape. The response is controlled by an external command. For information write PHOTOCIRCUITS CORP., 31 Sea Cliff Ave., Glen Cove, N.Y.

Circle 215 on Reader Service Card.

curve tracer

A new tunnel diode curve tracer permits the study of forward characteristics of tunnel diodes made by various manufacturers, including gallium arsenide tunnel diodes. A plug-in adapter can be changed to accommodate different package configurations. Any sensitive oscilloscope may be used with this curve tracer to create current and voltage wave forms. The instrument creates a sharp representation of the entire critical region of the forward characteristics curve of the tunnel diode under test

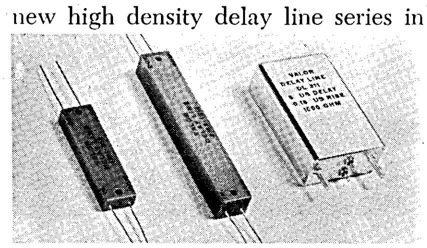


rather than just a portion of that curve. Through the use of an external decade box shunted across the horizontal terminals, it is practical to read the actual negative resistance of the tunnel diode at any point on the curve. For information write TEXAS INSTRUMENTS, 3609 Buffalo Speedway, Houston 6, Texas, or use card.

Circle 216 on Reader Service Card.

delay lines

A 10:1 size and weight reduction over conventional lines is featured by a new high density delay line series in



which up to 150 lumped constant sections are packaged per cubic inch. New construction and network techniques plus the use of subminiature toroidal inductors and disc capacitors permit the high density package to be attained, the manufacturer explains. Loss distortion, low insertion loss and wide range of characteristics are other features claimed in addition to compactness. Units with delays of 0.1 to 20 microseconds, 100 to 2000 ohms impedance, 100:1 delay to rise time ratios and attenuations as low as 0.008 db (1%) are available in the new series. For information write VALOR INSTRUMENTS, 13214 Crenshaw Blvd., Gardena, Calif.

Circle 217 on Reader Service Card.

switch assembly

Designed for pulse and digital electronic systems, a new series of one-shot switch-circuit pushbutton assem-

blies generate a single square-wave pulse synchronized with a clock pulse at each operation, with pulse frequencies ranging from 4 to 500 kc. The mechanisms save space and design engineering time required to develop flip-flop and gating networks for synchronizing one-shot circuits, according to the manufacturer. All circuit components are sealed in resilient potting material for protection from physical damage and moisture. For information write MICRO SWITCH, Freeport, Ill., or use card.

Circle 218 on Reader Service Card.

digital tape transport

The M3000 uses a linear action electropneumatic reeling and tape drive system. This, along with the elimination of reciprocating parts subject to impact, avoids wear on both the machine and tape, according to the manufacturer. The precision heads and tape guiding together with advanced read and write techniques permit information to be accepted by or read from the tape at high speeds. All electronics associated with the reel servo, file marker sensing and other machine controls are of solid-state design. The basic equipment includes the tape transport, rack cabinet, reel servo, tape drive electronics, high resolution magnetic heads (read and write) and the auxiliary equipment such as power supplies, etc. For information write MID-WESTERN INSTRUMENTS, Tulsa 18, Okla., or use reader service card.

Circle 219 on Reader Service Card.

flip-flops

The TF4 dual flip-flop is one of a series of new three-megacycle, transistorized, digital modules. These highly reliable solid-state devices use neither eyelets nor printed circuit connectors. Specifications of the TF4 dual flip-flop include: voltage, "one" . . . —7 to —10V, "Zero" . . . 0 to —0.3V; maximum rise time, no load . . . 0.04 microsecond, full load . . . 0.08 microsecond; maximum load per output, number of clocked or DC gates . . . 7. Dimensions of the laminated epoxy mounting board are 3¾ inches x 4 inches. For information write PACKARD BELL COMPUTER, 12333 W. Olympic Blvd., Los Angeles 64, Calif., or use reader card.

Circle 220 on Reader Service Card.

DATAMATION *abroad*

BRITISH HOLD COMPUTER CONFERENCE

The 2nd Annual Conference of the British Computer Society Ltd. will be held July 4-7 in the Sun Pavilion, Harrogate, Yorkshire. The following sessions will be included in the program: Tues., July 5 -- Progress Towards a Common Language for Computers, The Use of Computers in Market Research and Statistical Analysis, The Role of Small Computers in Science and Industry; Wed., July 6 -- The State of the Art in the United States, The Organization of a Computing Centre, Simulation Studies in Process Control, and Planning, Symposium on Numerical Analysis; Thurs., July 7 -- Large Scale Data Processing in Government Departments, Symposium on Accounting Applications.

NEW COMPUTER DEVELOPED IN JAPAN

A Japanese computer "20 times faster than the IBM 704" and selling for about $222,000 has been developed, according to the JAPAN TIMES. In an article appearing on March 12, the newspaper described the machine which was invented by Isayoshi Kuroyanagi, a staff engineer at the Nippon Telegraph and Telephone Corp. The article states, "With technical advice by Dr. Tokio Sakurai, the corporation, preparing for mass production of the new machine, has already applied for a patent in eight countries including Japan, England, France, Germany, the U.S. and others."

ERSHOV HEADS PROGRAMMING IN SIBERIA

Andrei Petrovich Ershov, former Chief of the Theoretical Programming Department of the Computing Center of the USSR Academy of Sciences in Moscow and one-time DATAMATION contributor (July/August 1959), was promoted in April to Chief of Algorithm Theory and Programming of the Institute of Mathematics of the Siberian Section of the Academy of Sciences. This new institute, located in Novosibirsk, Siberia, is slated to become one of the largest mathematical and computing centers in the USSR.

TRANSISTOR PRODUCTION UP IN JAPAN

Japanese computer transistor production is increasing at a tremendous rate, DATAMATION has learned. The seven principal firms engaged in this work will turn out an estimated 2,000,000 computer transistors this year. In 1958, the figure was 80,000 and in 1959 this increased to approximately 800,000. By 1962, it is estimated that the 1960 figure will be at least doubled.

CONFERENCES IN ROME, VIENNA NOTED

A symposium on the numerical treatment of ordinary differential, integral and integro-differential equations will be held at the Univ. of Rome, Italy, from September 20 to 24. The meeting is sponsored by the International Computation Center . . . A seminar on Codes for Reactor Computations was held in Vienna late in April. Twenty countries sent 90 participants and 30 papers were presented. Also discussed -- a universal computer language.

new DATAMATION literature

DIGITAL COMPUTERS: Details of this company's role in the computer industry are described in a 10-page, fully illustrated brochure. Included are specifications, facts and photos showing the major steps taken in the development of two general purpose computers: the 2001, designed specifically for field applications, and the 2003. Some of the activities covered are applications engineering, logical design, circuit design, packaging, and development work in the company. For copy write to GENERAL MILLS, Mechanical Division, 1620 Central Avenue, Minneapolis 13, Minnesota.
Circle 260 on Reader Service Card.

TRANSISTOR GUIDE: Information regarding proper selection of transistor types for specific applications is available in this illustrated booklet. Information is primarily presented in graphs and curves. Data given by charts is intended to be reasonably typical of performance that has been obtained in practical circuits. Applications covered include: untuned amplifiers and switching circuits (computer applications). For copy write PHILCO CORP., Lansdale Div., Lansdale, Pa., or use reader card.
Circle 261 on Reader Service Card.

DATA TRANSMISSION: Operation of a radar data transmission system designed for the Pacific Missile Range is described and illustrated in bulletin CR-WD-1004. The system transmits information from six tracking radars to and between two computer sites where missile course and impact prediction point are continuously computed in real time. For copy write COLLINS RADIO CO., Western Div., 2700 W. Olive Ave., Burbank, Calif., or use reader service card.
Circle 262 on Reader Service Card.

DIGITAL CATALOG: Includes a reference table showing 85 of the manufacturer's digital building blocks and 22 accessory units by type and price. The folder also gives descriptions of their Programmed Data Processors 1 and 3, and three types of memory testers. For copy write DIGITAL EQUIPMENT CORP., Maynard, Mass., or use reader card.
Circle 263 on Reader Service Card.

GP COMPUTER: An illustrated folder describes the 250, a general purpose digital computer. Specifications, and outstanding features and a command list are included. For copy write PACKARD BELL COMPUTER, 1905 Armacost Ave., Los Angeles 25, Calif., or use reader service card.
Circle 264 on Reader Service Card.

RELAY MANUAL: 30 types of relays for use in computers and other areas are featured in this detailed publication. Photographs, line drawings and tables are included. The 46-page manual covers many pile-up relay types, variations in spring arrangement, timing, coil voltage, contact ratings and other related material. For copy write COOK ELECTRIC CO., Diaphlex Div., 2700 Southport Ave., Chicago 14, Illinois.
Circle 265 on Reader Service Card.

COMPUTER APPLICATIONS: Charts and descriptive text cover the following applications for this manufacturer's LGP-30: incentive payroll program, sales analysis program, and finished goods inventory. Application report #14 also includes four samples of payroll reports compiled on the computer. For copy write ROYAL MCBEE, Data Processing Div., Port Chester, N.Y., or use reader card.
Circle 266 on Reader Service Card.

PULSE GENERATOR: Description of Model 1051 Millimicrosecond Current Pulse Generator, a periodic pulse generator, is offered in Technical Bulletin 59-G. This generator delivers stable, high amplitude (current pulses to 4 amperes), ultrashort (10 to 100 millimicroseconds), positive or negative, current or voltage pulses for laboratory research and development in high speed logic and memory problems, solid state research and high speed transistor and diode switching. The two-page illustrated sheet provides details and complete specifications of the product. For copy write RESE ENGINEERING, INC., 731 Arch St., Philadelphia, Pa.
Circle 267 on Reader Service Card.

CARD PUNCH: Port-A-Punch, a means of manually punching holes in specially scored cards, is reviewed in this 22-page illustrated booklet. Actual case histories are listed describing procedures which can be employed in many different applications. For copy write IBM Supplies Division, 590 Madison Avenue, New York 22, N.Y., or use reader service card.
Circle 268 on Reader Service Card.

MANUFACTURER'S FACILITIES: "Digital Components and Systems Designed for Reliability" is the title of an eight-page booklet describing this company's background and facilities for the design and manufacture of digital components and computer and data processing systems. Included are photographs of plant areas, large scale digital systems designed, and short biographical sketches of the engineers/directors of the company. For copy write TECHNITROL ENGINEERING CO., 1952 E. Allegheny Ave., Philadelphia 34, Penna.
Circle 269 on Reader Service Card.

COMPUTER ACCOUNTING: An illustrated 2-page bulletin describes an application of a computer system to accounting procedures. Facts and charts show how this system is used for invoice preparation and account up-dating. For copy write BENDIX COMPUTER DIVISION, 5630 Arbor Vitae Street, Los Angeles 45, Calif.
Circle 270 on Reader Service Card.

WIND TUNNEL SYSTEM: Application of this company's 210 System to wind tunnel data reduction at a National Aeronautics and Space Administration test center is the subject of a 2-page bulletin, Application Data Sheet 101. Included are system specifications, a block diagram and operation explanation. For copy write

BECKMAN SYSTEMS DIV., Technical Publications Dept., Anaheim, Calif., or use reader service card.
Circle 271 on Reader Service Card.

GERMANIUM TRANSISTORS: Availability catalog lists 412 Germanium transistor types that are currently in stock or in production by the company. Virtually every known Germanium transistor used in computers and other areas is included. For copy write ELECTRONIC TRANSISTORS CORP., 9226 Hudson Blvd., North Bergen, N.J., or use card.
Circle 272 on Reader Service Card.

DELAY LINES: A data sheet provides information about the type 5802 torsional mode delay line. Ratings, typical operating conditions, construction and environmental conditions are included. For copy write FERRANTI ELECTRIC INC., Electronics Div., 95 Madison Ave., Hempstead, L.I., N.Y., or use reader card.
Circle 273 on Reader Service Card.

ACADEMIC COMPUTERS: "The General Purpose Computer in Academic Life" (Application report no. 9) summarizes the work being done at installations in 14 various educational centers. Some of the applications described are geophysical research, theoretical chemistry, engineering executive programs, farm animal studies and other academic-type work. For copy write BENDIX COMPUTER DIV., 5630 Arbor Vitae St., Los Angeles 45, Calif., or use card.
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ENCODERS: A 10-page brochure "Shaft Position Digital Encoders With Magnetic Readout" provides complete specifications of the manufacturer's 13-bit, 8-bit and incremental encoders. Details of the magnetic readout operation and recommended simplified transistor circuitry are included with illustrations. For copy write ASCOP, P.O. Box 44, Princeton, N.J., or use reader service card.
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DIODE TESTER: A complete diode evaluation system is described in this four-page folder. Illustrations of the products and cabinet models are included. For copy write to FLITETRONICS, INC., 3312 Burton Ave., Burbank, Calif., or use reader card.
Circle 276 on Reader Service Card.

to the editor...

(Continued from page 2.)
which an error has been detected. This occurs relatively infrequently with today's equipment.

Mr. Berlant described the technique of scanning a tape for a particular address. This scheme is used in a very limited number of machines on the market today. It does have certain applications in information retrieval systems. However, most data processing applications require that each block on the input tape be brought into the computer memory for examination. Here the decision is made either to update, delete, extract, or copy the block verbatim onto the output tape.

In a file maintenance application, selective-updating requires that the input tape be repositioned so that the updated block can be written on the tape in the space formerly occupied by the input block. The alternate, and by far the more prevalent, method is that in which each block is transferred to a new tape. During the transfer, updating is performed if required. This is referred to as the "father-and-son" technique in that a new tape is written each time the file is updated. This technique has a significant advantage in that the information on the old tape is not destroyed in the updating process.

In those cases where tapes are selectively updated (that is, the old block is destroyed in writing the new) auditing becomes nearly impossible. Furthermore, an error on the updated tape may require many hours of reprocessing the source data in order to re-create the file. If a new master file is created each time the file is updated, only the most recent pass must be repeated to reconstruct a file which contains an error.

Regards,
R. George Glaser
Product Planning Engineer
Computer Products Division
Ampex Data Products Co.

ADVERTISERS' INDEX

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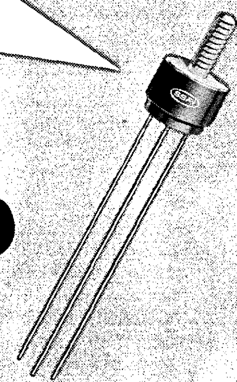
NOW... IN MINIATURE

SSPI

SILICON CONTROLLED RECTIFIERS



actual size

...FROM SOLID STATE

For control circuit application in the 10 to 1250 ma output current range

- **HIGH SENSITIVITY**
  only 2 mA input to control one ampere (continuous) at 100°C.
- **HIGH TEMPERATURE**
  stable operation to 150°C.
- **LOW LEAKAGE**
  10 uA cutoff current at full voltage.
- **SIMPLIFIED MOUNTING**
  no need for insulating hardware — stud is electrically isolated.

Type	Maximum Anode Voltage (DC or Peak AC) ± Volts	Maximum Average Forward Current 100°C Case Amps	Maximum Gate Current to "Fire" mA	Gate Voltage to Fire + Volts	
				Min.	Max.
3B30S	30	1.0	2	.40	2.5
3B60S	60	1.0	2	.40	2.5
3B100S	100	1.0	2	.40	2.5
3B150S	150	1.0	2	.40	2.5
3B200S	200	1.0	2	.40	2.5

These devices offer significant circuit advantages in that they are specifically designed for operation in the 10 to 1250 mA current range. It is no longer necessary to derate higher power units, with attendant losses in efficiency.

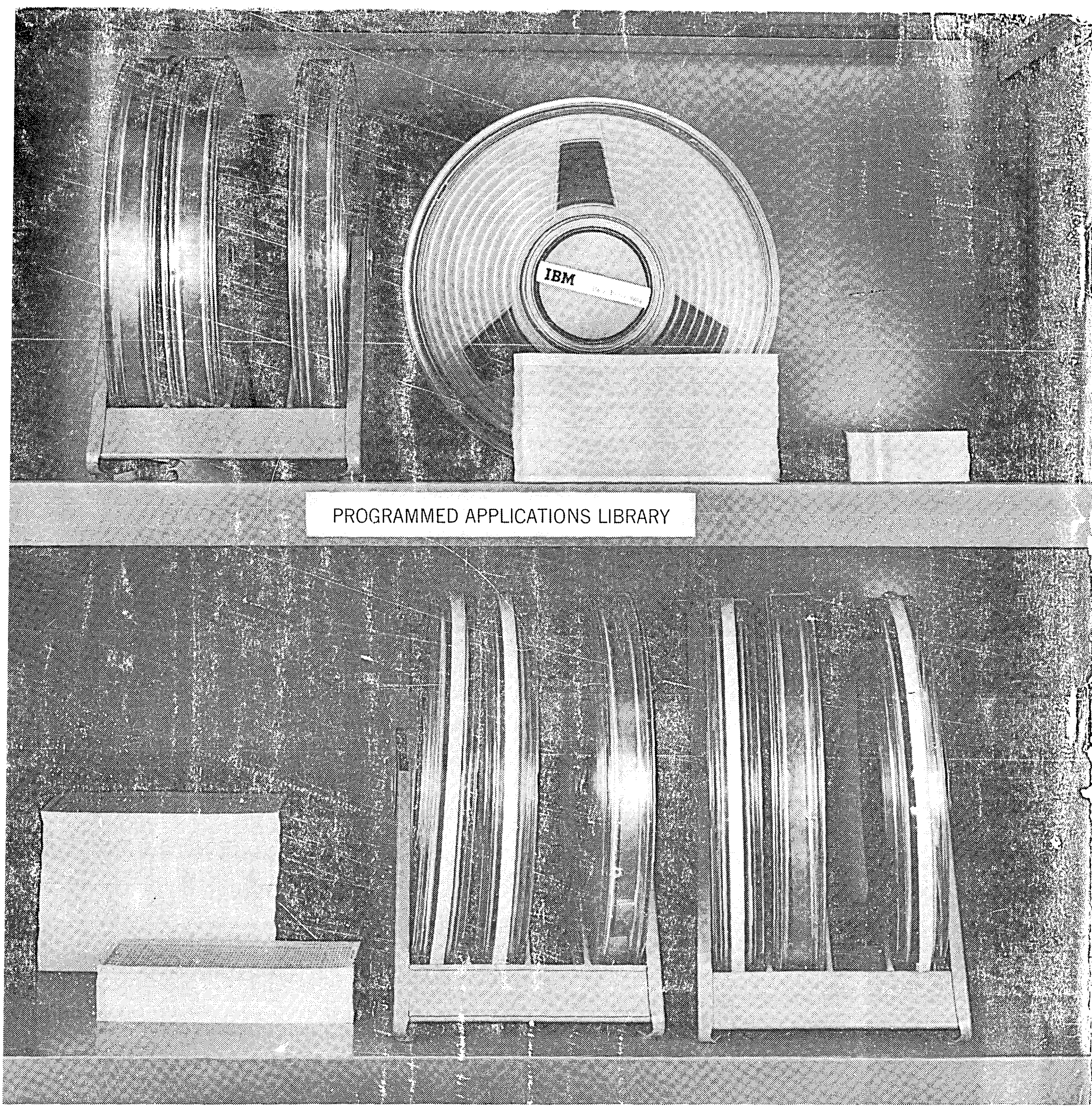
The miniature SCR combines a current rating of 1 ampere at 100°C with extremely small size. It features high peak recurrent and surge current ratings. Switching efficiency up to 98% is practical. High gain, low loss control of loads up to 300 watts can now be achieved along with significant miniaturization. The internally insulated junction eliminates the need for external mica washers. Assembly is therefore simplified and reliability improved.

The miniature SCR is useful in applications such as AC and DC static switching, proportioning control, D.C. to D.C. converters, servo motor driving, squib firing, protective circuits, and related applications.

Encapsulated in the unique SSPI cold welded copper case, the SCR offers a high degree of mechanical ruggedness and long term reliability.

WRITE FOR BULLETIN C415-01

SOLID STATE Products, Inc.
ONE PINGREE STREET • SALEM, MASSACHUSETTS
PIONEER 5-2900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