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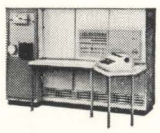

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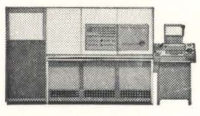

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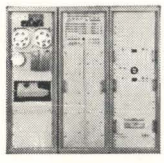

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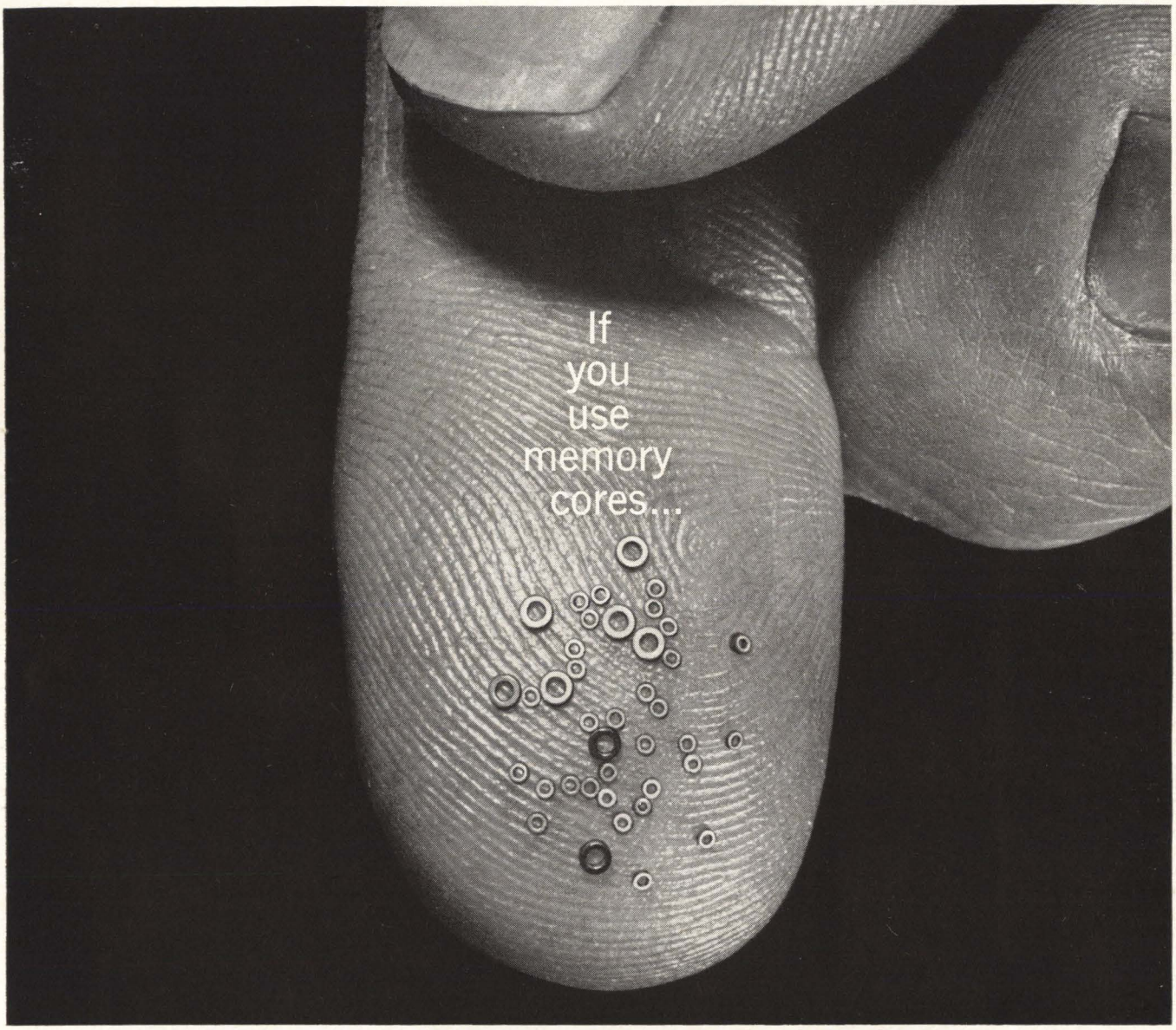

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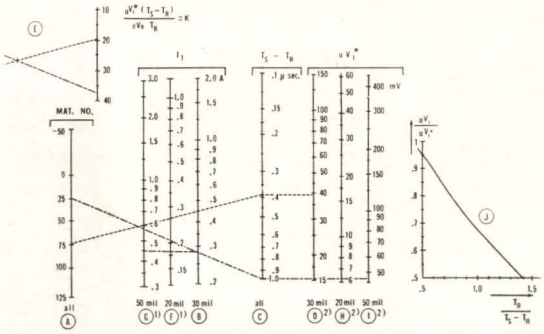

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OCTOBER 1964 • VOLUME 3 • NUMBER 10

COMPUTER DESIGN

FOR ENGINEERING PERSONNEL RESPONSIBLE FOR THE DESIGN & APPLICATION OF DIGITAL CIRCUITS, EQUIPMENT, AND SYSTEMS IN COMPUTING, DATA PROCESSING, CONTROL AND COMMUNICATIONS.

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Editorial & Executive Offices
Professional Bldg.
Baker Ave. • W. Concord, Mass.
TEL: 369-6660

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PART 2 – NOISE ELIMINATION IN DIGITAL MODULES
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37 TELEMETRY DATA SAMPLING
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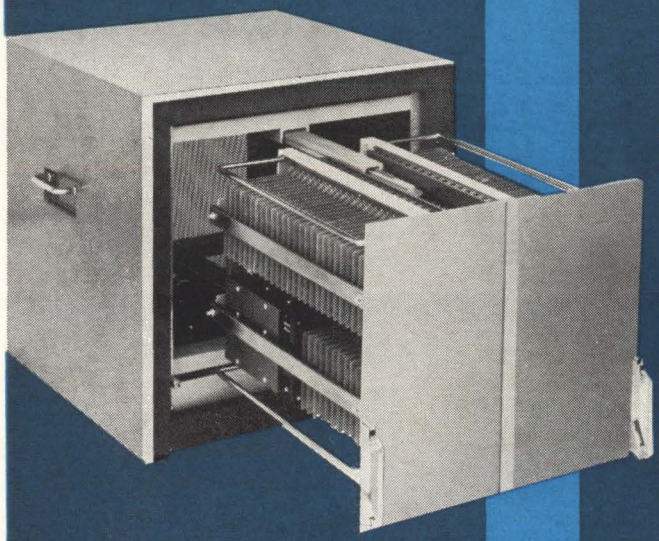

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Editorial Notes

MUCH ON HARDWARE AT FJCC

The technical program of the coming 1964 Fall Joint Computer Conference promises to be the most hardware-oriented program of any past JCC. As you will note in reading the preview of the program presented in this issue, the scheduled papers will cover nearly all significant aspects of computer and digital design technology.

It is difficult to pinpoint those papers that appear to be more interesting than others, however, we call your attention to Session 3 — "expansion of functional memories", Session 4 — "new computer organizations", Session 9 — "input and output of graphics", Session 10 — "mass memory", Session 16 — "hardware designs and design techniques", and Session 17 — "hybrid/analog computation, applications and hardware". If the presentations of the papers in these sessions live up to their abstracts, then your attendance will be well rewarded.

In addition, the program will also include an experimental series of sessions at which representatives of various computer manufacturers will describe their latest high-speed computers. In past JCC's, new computer systems were described in bits and pieces. In this new program, each manufacturer will be allotted a full session to describe the basic system philosophy, hardware and software characteristics, and, hopefully, the compromises and trade-offs that had to be made to achieve the final design.

We offer our congratuations to the planners of the San Francisco conference for coming up with a well-balanced program and we heartily recommend the conference to our readers. We will be there at our booth No. 512, drop in and see us.

S. Henry Sacks
EDITOR

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Lindsay H. Caldwell
Professional Bldg.
Baker Ave.
W. Concord, Mass.
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CHICAGO
Phil Holmes
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Chicago 11, Illinois
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From flip-flops and counters to amplifiers and decoders, the line encompasses all functions necessary for building complete systems. And complete complementary hardware and power supplies are available.

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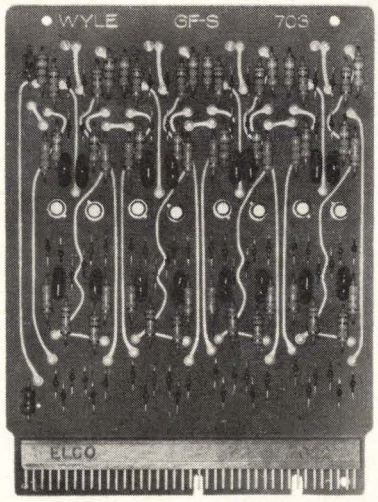

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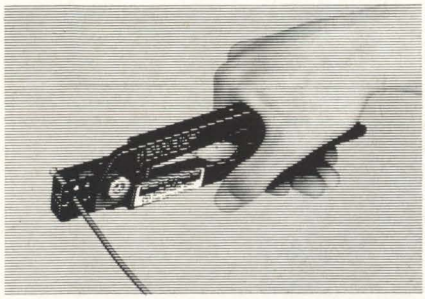
"Microcrimp" coaxial crimp-type slide-on connectors are commercially priced, and offer high reliability, small size and ease of assembly. Cable-mounted connectors are available in three mounting versions: line-cable mounting, bulkhead mounting, and snap-lock mounting. Bulkhead receptacles with solder turrets are available with bulkhead or snap-lock mounting.



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CIRCLE NO. 6 ON INQUIRY CARD

INDUSTRY NEWS

THE MILITARY ELECTRONICS DIVISION OF LORAL ELECTRONICS CORP. HAS AWARDED ELECTRONIC MEMORIES, INC. A CONTRACT IN EXCESS OF $25,000 FOR A HIGH-SPEED, SEVERE ENVIRONMENT CORE MEMORY SYSTEM. According to Trude C. Taylor, EMI president, the memory will have a capacity of 512 words and be designed to operate over a temperature range of −55C to +100C. Shock and vibration requirements are in accordance with MIL-E-5400.

A TWO-STAGE PROGRAM FOR THE EVALUATION OF ADVANCED CONTROL TECHNIQUES EMPLOYING DIRECT DIGITAL CONTROL AS ONE METHOD OF PROCESS IMPROVEMENT IS CURRENTLY BEING UNDERTAKEN BY THE DOW CHEMICAL COMPANY OF MIDLAND, MICHIGAN, AND THE FOXBORO COMPANY, FOXBORO, MASS. In the initial stage, Foxboro will design and furnish a direct digital control system, incorporating the Foxboro Model 97600 computer. It will be installed in a selected plant in Dow's Midland Division in the fall of 1964. "Stage two," according to W. E. Vannah, Foxboro director of research, "will involve concentrated studies aimed at improving the process, its equipment, and its operating routines in light of the new 'shared-time' control concept. Using the digital control system as an automatic processor of measurement signals and as a multi-loop controller, personnel from Dow and Foxboro will jointly evaluate improvements in control and processing. Within the scope of the program are alterations of plant structure and operation, should these be necessary to take full advantage of the control system's flexibility in the handling of information and control signals."

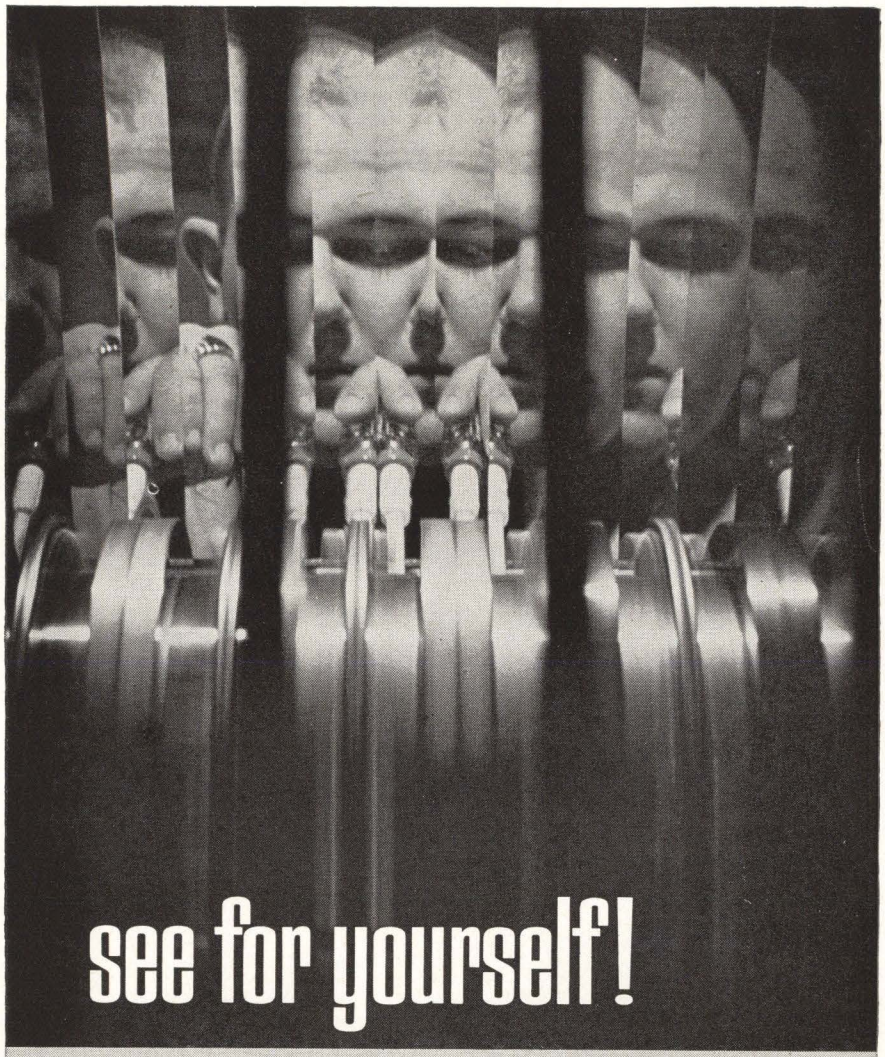
BECKMAN INSTRUMENTS HAS RECEIVED A $1.3 MILLION CONTRACT FROM LEAR SIEGLER, INC., FOR TWO DATA ACQUISITION SYSTEMS AND DATA PROCESSING DIGITAL COMPUTERS TO BE USED IN DEVELOPMENT OF THE SATURN SPACE VEHICLE. Louis B. Horwitz, manager of Beckman Systems Division, Fullerton, Cal., said the equipment is scheduled for delivery next September to Lear Siegler at NASA's Marshall Space Flight Center, Huntsville, Ala. He said the systems will be the fifth and sixth that Beckman will have delivered to the Huntsville complex, but the first to include the Beckman Model 420 Systems Computer, a digital computer designed specifically for real-time data acquisition and processing. Horwitz said the systems will monitor and record information from static test firings of the Saturn rocket engines at speeds to 5,000 samples per second. He said the systems will edit, correct, and tabulate test data for evaluation by the computers.

AN L-2010 RUGGEDIZED COMPUTER HAS BEEN ORDERED BY THE U. S. NAVY MINE DEFENSE LABORATORIES, PANAMA CITY, FLA., from the Librascope Group of General Precision, Inc. The Navy will use the 65-pound computer to solve complicated problems associated with navigation of minesweeper vessels, according to R. W. Lee, Librascope president. The L-2010 features a disc memory of 4096 words. It can be mounted in a 19-inch wide rack. The computer is capable of functioning on-line in real time with radar and sonar devices. It can sample up to 128 separate instrumentation points during each 10-millisecond cycle of a special high-speed buffer track on its memory. Where desirable, smaller numbers of input points can be sampled more frequently.

TIME-SHARING OF A COMPUTER OVER INTERCONTINENTAL DISTANCES HAS JUST BEEN DEMONSTRATED BETWEEN EDINBURGH, SCOTLAND, AND CAMBRIDGE, MASS. In the demonstration, a scientist appearing before the annual meeting of the British Computing Society at Edinburgh, was connected — via a telegraph and transoceanic cable line — to an IBM 7094 computer at the Massachusetts Institute of Technology. At the same time he was demonstrating his transoceanic use of the computer to his colleagues at Edinburgh, four other individuals at consoles in various parts of M.I.T. also were using the same machine to deal with their own individual research problems. The Scotland-to-Massachusetts demonstration was carried out under auspices of M.I.T.'s Project MAC. MAC is part of a major national program of research on advanced computer systems being sponsored at several locations by the Advanced Research Projects Agency of the Department of Defense.

COMPUTER CONTROL COMPANY, INC. HAS RECEIVED AN ORDER FOR THREE DIGITAL COMPUTER TRAINER AND LOGIC DEMONSTRATORS FROM THE U. S. NAVAL TRAINING DEVICE CENTER, PORT WASHINGTON, N. Y. The devices will be used in classrooms to train navy technicians in digital programming principles, digital logic, troubleshooting strategy, information flow, and to demonstrate the organization of a general purpose digital computer.

RCA ANNOUNCED THAT ITS ANNUAL REVENUE IN ELECTRONIC DATA PROCESSING WOULD PASS THE $100 MILLION MARK FOR THE FIRST TIME IN 1964. "Domestic orders for RCA EDP equipment in the first six months this years were up 104 per cent in dollar volume over the like 1963 period, and computer production at the RCA Palm Beach Gardens, Fla., plant is being stepped up sharply to satisfy this demand", according to A. K. Weber, Vice President and General Manager, RCA EDP.



see for yourself!

ONLY BRYANT SERIES 4000 DISC FILES OFFER UNRESTRICTED PARALLEL-FORMATING CAPABILITY. Buy Bryant and you buy ultra-reliable parallel transfer of data from the largest-capacity, high-speed random-access memory in existence! For example, one Bryant customer has effected 28-bit parallel operation on a Series 4000 Disc File *without* complicated and expensive de-skewing buffers. Instantaneous bit transfer rates range up to 7.11 megacycles; data is transferred at an instantaneous rate of 125,000 28-bit words a second. □ All this has been accomplished at the extraordinarily low error rate of one recoverable error in 10^{11} bits processed. At a single customer facility, a bank of seven Series 4000 Disc Files operates on-line in the parallel mode with an average of 1200 hours mean-time-between-failures; the maximum value ranges up to 3,000 hours. However, this performance does not represent the full capability of a Series 4000 Disc File. □ *See for yourself,* write our Information Services Department for Series 4000 Disc File brochure No. BCPB-101-4-64-R1 and/or article reprint entitled "Criteria for Selecting Random-Access Mass Memories," No. BCAR-101-4-64.

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INDUSTRY NEWS

A COMPUTER PROGRAM, CALLED SIMITT, THAT BUILDS MATHEMATICAL "MODELS" OF COMMUNICATION SYSTEMS WAS DESCRIBED AT THE IEEE'S SIXTH INTERNATIONAL SYMPOSIUM ON GLOBAL COMMUNICATIONS. David Kaplan of the ITT Data and Information Systems Division, Paramus, N.J., explained that SIMITT models would permit communication system designers to conduct numerous "experiments" on networks during the design stage. SIMITT is written for use in the design of real-time, store-and-forward communication systems in which messages are collected at switching stations and re-forwarded. By feeding data on the system under consideration into a computer along with the SIMITT program, the engineer can determine in advance what arrangements of lines, switching equipment, and communication stations will best serve the requirements of the communication system. In addition to communication network, Kaplan said that SIMITT has application in designing command-and-control systems, management information systems, parts production assembly systems, and multicomputer operations.

THE BUNKER-RAMO CORP. HAS BEEN AWARDED A CONTRACT BY THE NORTH ELECTRIC CO., GALION, OHIO, TO SUPPLY TWO BUNKER-RAMO 340 COMPUTERS THAT WILL BE A PART OF THE SUPERVISORY CONTROL FOR THE MASSIVE 2,900-MILE PETROLEUM PRODUCTS PIPELINE SYSTEM BEING BUILT BY THE COLONIAL PIPELINE CO. BETWEEN HOUSTON AND THE NEW YORK HARBOR AREA. The supervisory system will control operation of the entire network of 1600 miles of mainline and 1300 miles of spur lines. The mainline system, 36-, 32-, and 30-inches in diameter, will have an initial throughput of approximately 650,000 barrels per day of liquid product. Estimated to cost more than a third of a billion dollars, the pipeline will be the largest transportation facility ever created as a single project entirely financed by private capital. The twin Bunker-Ramo 340 systems will be used initially to scan the remote stations for abnormal conditions and log out flow data through the entire pipeline. The computers will update all dispatcher information every ten seconds, thereby making it possible for the dispatcher to take instant corrective action in the event of any malfunction anywhere along the pipeline. It is planned eventually to have the computers operate closed-loop, allowing complete automated flow control.

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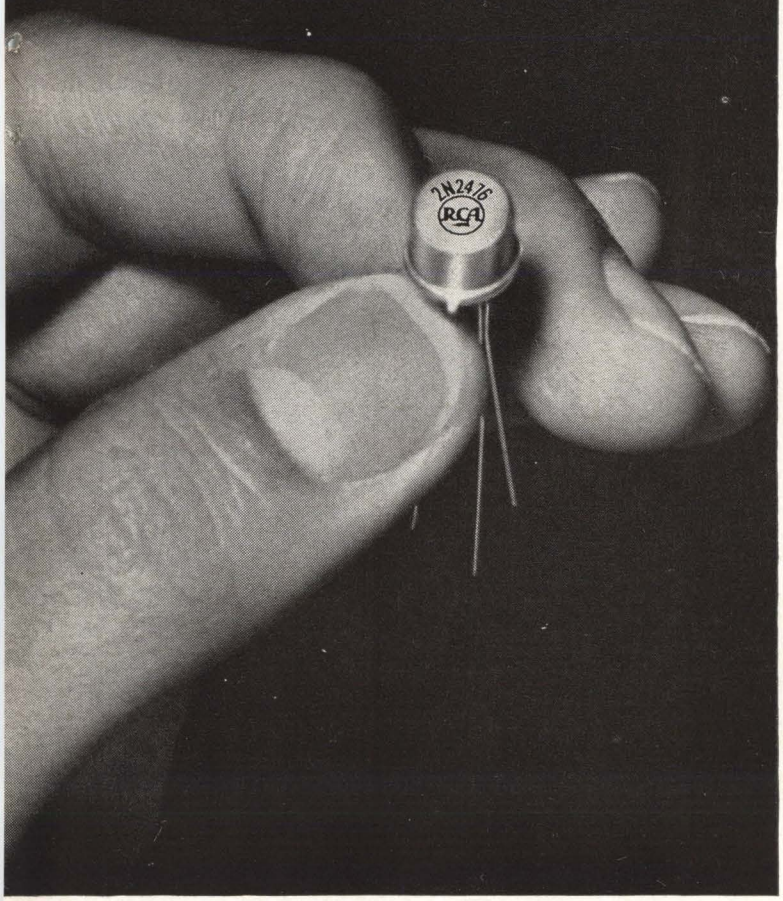
RCA ANNOUNCED THAT IT HAS BEEN SELECTED BY THE BUREAU OF NAVAL WEAPONS TO INSTALL AN UNPARALLELED NETWORK OF SEVEN ADVANCED COMPUTERS as part of a unique electronic management information system linking key industrial naval air stations in the United States. The nationwide computer complex, valued at $6 million, is the most comprehensive real-time data system ever selected by the Government, according to Rear Admiral Frank L. Pinney, Jr., Inspector General and Assistant Chief for Administration, Bureau of Naval Weapons. The data network includes seven large-scale RCA 3301 computers and 14 random access memory units. The first system will be ready for delivery in December, Mr. Weber said, with the others to follow in rapid succession. The total complex is expected to be in operation by the end of 1965.

NASA's MANNED SPACECRAFT CENTER IN HOUSTON, TEXAS, WILL USE A PDP-5 COMPUTER BUILT BY DIGITAL EQUIPMENT CORP. TO ANALYZE THE PERFORMANCE OF DEVICES FOR THE APOLLO PROJECT. Voltage controlled oscillators being developed for Apollo will be subjected to varying input voltages at varying temperatures to determine their stability, linearity, and other characteristics. The data recorded during these tests, output amplitudes and frequencies, will be fed into the PDP-5 for calculation of the required results. The oscillators will be used to generate flight operating status information. At Houston, the PDP-5 will include 4096 words of core memory, a 63-character-per-second tape punch, a 300-character-per-second tape reader, and two tape spoolers.

COMPUTER CONTROL CO. HAS RECEIVED AN ORDER FROM HUGHES AIRCRAFT CO. FOR AN ALPHA SCATTERING EXPERIMENT DATA TRANSLATER (ASEDT). The ASEDT is a digital data processing instrument which receives telemetry data from spacecraft experiment instruments and converts the data into a form compatible with the storage equipment. This unit is an essential link in the processing of data obtained from the experiment.

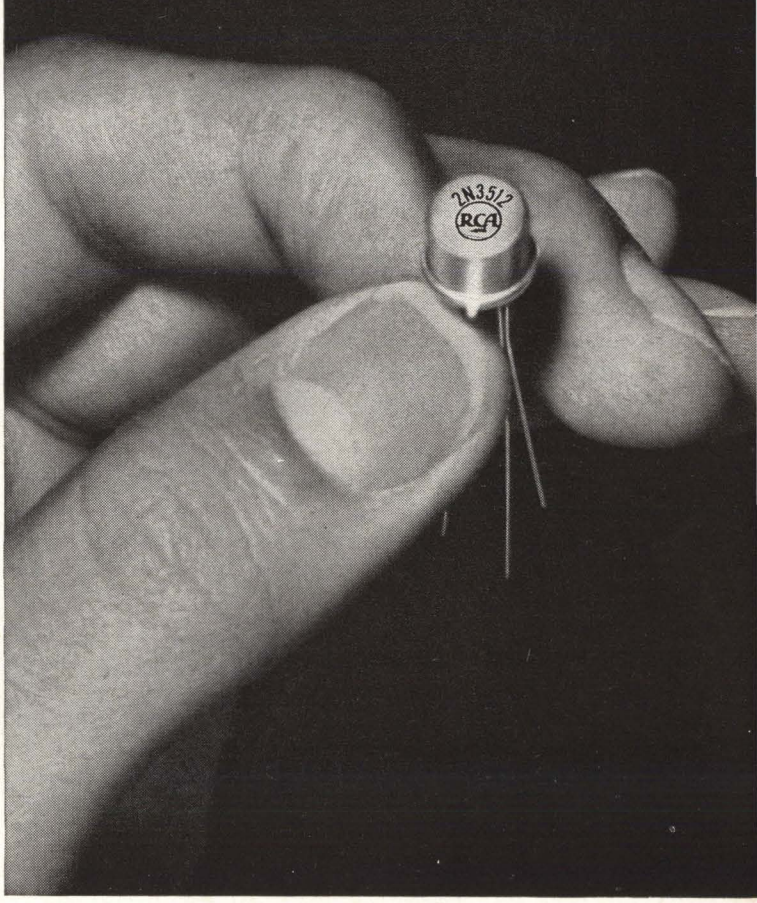
Here is an excellent core driver

...One that's been popular for two years



Here's an even better one

... Delivers 75% more driving voltage without sacrificing speed *(at only slightly higher cost)*



That's right! A 75% boost in collector-to-emitter voltage capability ($BV_{CEO} = 35$ volts as compared with 20 volts for the popular 2N2476, 2N2477) makes the new RCA 2N3512 ideal for high-voltage, high-speed, high-current switching applications.

Current capability is the same: 500 ma.

Because of its high voltage capability, the 2N3512 is particularly useful in large, modern computers where memories are both faster and larger...with higher inductive voltages. The high-speed, high-voltage capabilities of the 2N3512 make it applicable not only to large-scale commercial computers, but also to special-purpose digital test and communications equipment.

RCA ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

Other outstanding features of the 2N3512:

- **Turn-on time:** 16 nsec typical, at $I_C = 150$ ma
- **Turn-off time:** 27 nsec typical at $I_C = 150$ ma
- **Storage time:** 17 nsec typical at $I_C = 150$ ma
- **Gain-bandwidth product:** 375 Mc typical
- **V_{CE} (sat):** 1.0 volt maximum, 0.45 volts typical at $I_C = 500$ ma, $I_B = 50$ ma

For full technical information call your RCA Field Representative. Or write: Commercial Engineering, Section C-ZB-10, RCA Electronic Components and Devices, Harrison, N.J.

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By Wm. D. Rexroad

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The Handbook is based on an article that appeared in the November issue of COMPUTER DESIGN. The demand for reprints of the article was so overwhelming that it has now been expanded, giving more details on some of the topics previously-covered, *and* adding up-to-date information on 8-level codes, the standard code adopted by the ASCII, frequency shift keying systems, radio teletypewriter techniques, and descriptions of the latest in teletypewriter machinery.

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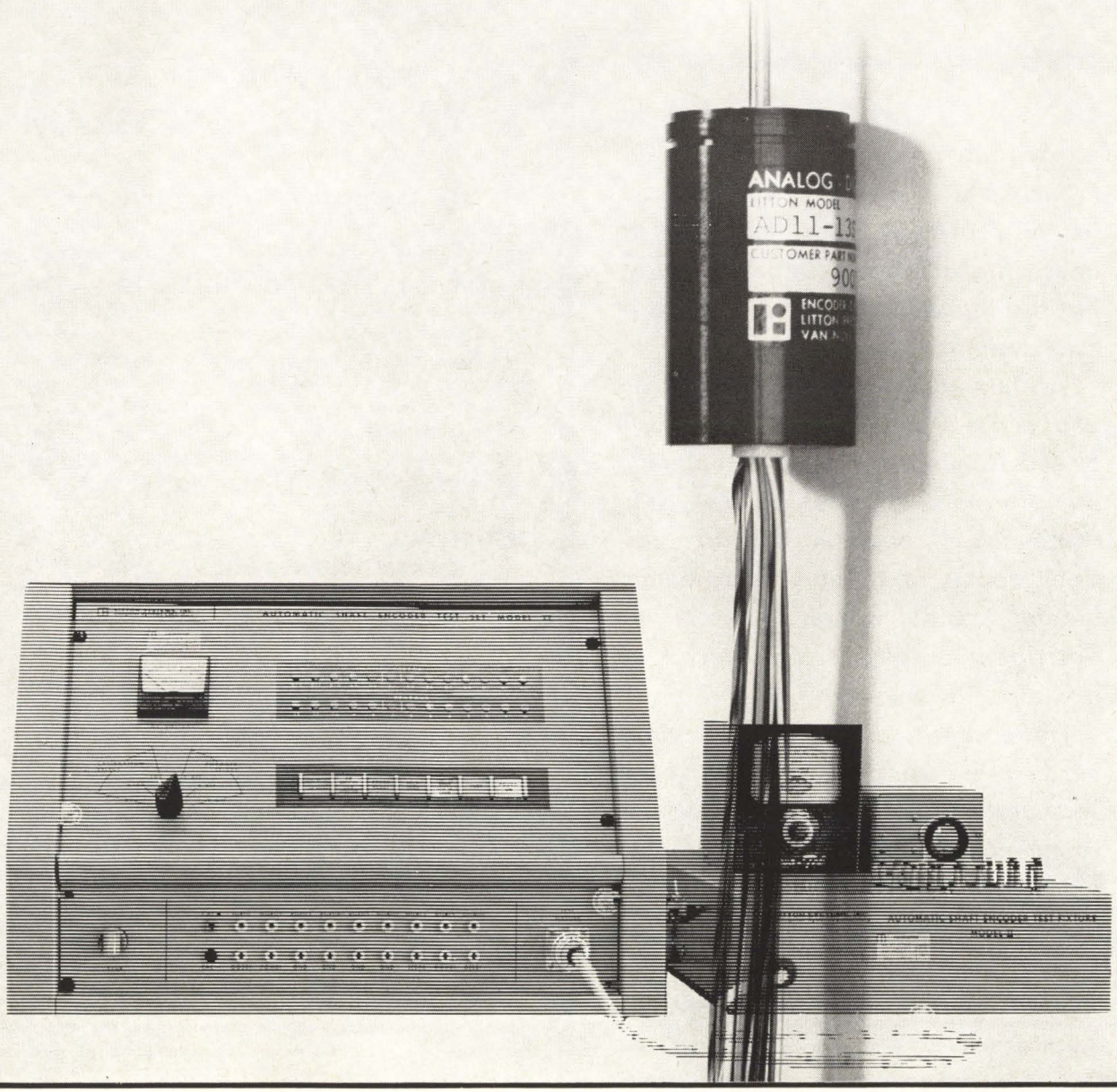

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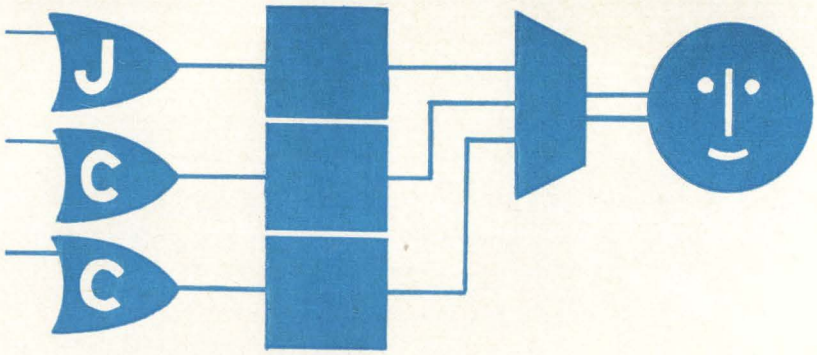


THE 1964 FALL JOINT COMPUTER CONFERENCE
BROOKS HALL – CIVIC AUDITORIUM
SAN FRANCISCO . OCTOBER 27, 28, 29, 1964

The 1964 FJCC will occupy most of the newly-renovated facilities of San Francisco's Civic Auditorium and adjacent Brooks Hall — the latter to house the exhibition booths displaying the latest in computer equipment and systems.

An innovation to the program this year is a 4-part session on "Very High Speed Computers, 1964." Beginning the afternoon of opening day, and continuing through 4 half-day sessions, teams of authors representing leading computer manufacturers will describe new systems with which they are currently involved.

Hotel headquarters for the conference is the Jack Tar on Van Ness Avenue, where early registration will commence Monday, October 26, between 6 P.M. and 10 P.M. Registration will continue at the Jack Tar on Tuesday morning between 7:30 and 10:30 A.M. and after that at the Civic Auditorium.

SUMMARY OF TECHNICAL PROGRAM

TUESDAY, OCTOBER 27

SESSION 1 ..... 2 P.M. MAIN ARENA
VERY HIGH SPEED COMPUTERS, 1964 – PART 1

In this 4-part series of sessions, manufacturers of recently-announced systems will be given the opportunity of describing their respective systems. The papers will describe the basic system philosophy, hardware and software characteristics, and, hopefully, the compromises and trade-offs made in reaching the final design. For the purpose of these sessions, very high-speed computers are defined as those capable of approximately 1 million instructions per second.

SESSION 2 ..... 2 P.M. POLK
PROGRAMMING TECHNIQUES AND SYSTEMS

2.1 CPSS – A COMMON PROGRAMMING SUPPORT SYSTEM

Dushan Boreta, System Development Corp., Falls Church, Va.

Many computer software systems have been developed to serve the program production process. These systems (called utility systems, production systems, etc.) provide one common service: to provide programmers a means for producing computer programs. The CPSS project was initiated to design, develop, and produce an "off-the-shelf" program production system.

2.2 ERROR CORRECTION IN CORC

David N. Freeman, IBM Corp., Endicott N.Y.

CORC is an experimental algebraic compiler language developed at Cornell University to provide a practical computing tool for novice programmers. CORC has an unusually simple syntax, so that students can learn it rapidly and recall it easily after prolonged disuse. CORC also provides unusually elaborate error-detection and error-correction features, so that erroneous programs can be furnished complete and explicit diagnostic information.

See us at our Booth #512 at the FJCC

2.3 THE COMPILATION OF NATURAL LANGUAGE TEXT INTO TEACHING MACHINE PROGRAMS

Leonard E. Uhr, University of Michigan, Ann Arbor, Mich.

The development of methods that make it as simple as possible to get a large collection of good teaching machine programs is a major bottleneck in programmed instruction. The programs reported here are a first step in this direction.

2.4 METHOD OF CONTROL FOR RE-ENTRANT ROUTINES

Gerald P. Bergin, IBM Corp., Los Angeles, Cal.

The use of on-line consoles may require routines to permit multiple entrances and executions before prior executions are completed. Routines which permit multiple entrances of this nature are called re-entrant. This paper defines the major problem involved in utilizing re-entrant routines, and suggests a method of monitor control.

2.5 XPOP: A META-LANGUAGE WITHOUT METAPHYSICS

Mark I. Halpern, Lockheed Missiles and Space Co., Palo Alto, Cal.

XPOP is a programming system that enables its users to implement in quick and easy fashion practically any desired language.

SESSION 3 ..... 2 P.M. LARKIN
EXPANSION OF FUNCTIONAL MEMORIES

3.1 A 10MC NDRO BIAX MEMORY

William I. Pyle, Robert M. MacIntyre, and Theodore E. Chavannes, Philco Corp., Newport Beach, Cal.

This paper describes a 10 megacycle non-destructive read-out BIAX memory of 1024 word, 48 bit per word capacity. The memory, which operates with one BIAX element per bit, is word organized, random access, and exhibits a maximum access time of 85 nanoseconds to any word location. The memory is electrically alterable in less than 5 microseconds. The paper describes in detail the system organization utilized to achieve the read access and cycle times, and describes the circuit and packaging techniques used to mechanize the system. A brief summary of test results on the operating memory is given, and possible extensions of the techniques and future development plans are outlined.

3.2 ASSOCIATIVE MEMORY SYSTEM IMPLEMENTATION AND CHARACTERISTICS

J. E. McAteer, J. A. Capobianco, Hughes Aircraft Co., Fullerton, Cal., and R. L. Koppel, North American Aviation, Anaheim, Cal.

The ultimate objective of an associative memory (AM) is to interrogate all words and all bits in the word simultaneously and to indicate whether any word or words match the interrogate criteria. As with any system, the realization of a practical AM is subject to

CONFERENCE HIGHLIGHTS
TUESDAY, OCTOBER 27

OPENING SESSION ..... **9 A.M. Main Arena Civic Auditorium**

INTRODUCTION: David R. Brown, Stanford Research Institute, Program Chairman, 1964 FJCC

OPENING REMARKS: Richard I. Tanaka, Lockheed Missile & Space Co., General Chairman, 1964 FJCC; J. D. Madden, IBM Corp., Chairman, AFIPS Board of Directors

KEYNOTE ADDRESS: David Sarnoff, R.C.A. Chairman of the Board

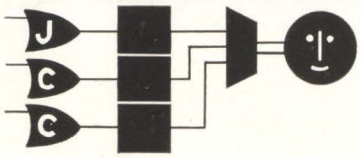
EXHIBITS ..... 11 A.M. - 5:30 PM.
SESSIONS 1-3 ..... 2 P.M. - 5 P.M.
MOVIES ..... 1 P.M. - 6 P.M.
COCKTAIL PARTY ..... 6 P.M.
EVENING PANEL SESSION ..... 8 P.M.
("Training for the Computer Field")

WEDNESDAY, OCTOBER 28

SESSION 4-7 ..... 8:30 A.M. - 11:30 A.M.
EXHIBITS ..... 10 A.M. - 6 P.M.
MOVIES ..... 9 A.M. - 6 P.M.
CONFERENCE LUNCHEON ..... 12 NOON
GUEST SPEAKER: GERARD PIEL, *PUBLISHER OF SCIENTIFIC AMERICAN*
SESSIONS 8-10 ..... 2 P.M. - 5 P.M.
EVENING PANEL SESSION ..... 8 P.M.
("Input and Output of Graphics")

THURSDAY, OCTOBER 29

SESSIONS 11-14 ..... 8:30 A.M. - 11:30 A.M.
EXHIBITS ..... 10 A.M. - 5:30 PM.
MOVIES ..... 9 A.M. - 12 NOON
SESSIONS 15-17 ..... 2 P.M. - 5 P.M.



HIGHLIGHTS OF THE FJCC

(continued)

many engineering trade-offs which approach the ideal. This paper concerns itself with the practical realization of an AM utilizing available components and the resulting implications on the searching, retrieval, and writing functions. A description of a laboratory demonstration unit is presented.

3.3 A 16-K WORD, 2-MC MAGNETIC THIN-FILM MEMORY

Eric E. Bittmann, Burroughs Corp., Paoli, Pa.

This memory operates with a 0.5-microsecond cycle and a 0.3-microsecond access time. The storage cells are planar ferromagnetic thin-films, produced by vacuum deposition of Ni-Fe alloy onto glass substrates. The 16K words are stored in two stacks, each containing 8K words of 52 bits each. The two stacks perform electrically as one unit. The 8K words in one stack are stored in 32 memory frames, each frame containing 20 glass substrates, each substrate bearing 768 rectangular spots. Edge-board connectors on the frame allow easy insertion in or removal from a stack.

3.4 A SEMI-PERMANENT MEMORY UTILIZING CORRELATION ADDRESSING

George G. Pick, Sylvania Electric Products, Inc., Waltham, Mass.

A mechanically changeable, semi-permanent, random access memory with a 16,384 word capacity is described. This solenoid array memory is useful for storing programs, tables, and character generation matrices as well as a combined input and storage device for special purpose computers. It utilizes an associative technique to allow addressing any of its 1024 sheets, each containing sixteen words of twenty-bit length, which completely avoids any need for electrical connection to the data-containing sheets, or for any ordering of the sheets within the memory.

3.5 A 10^5 BIT HIGH SPEED FERRITE MEMORY SYSTEM

Hiroshi Amemiya, Thomas R. Mayhew, and Richard L. Pryor, R.C.A., Camden, N.J.

Design of large high-speed memories is complicated by the generation of noise and transient conditions that consume large parts of the memory cycle. Control of these transients is the most important consideration in the design of a high-speed memory. As a new approach to this problem, digit lines are treated as a system of mutually coupled parallel transmission lines and are terminated for all the existing modes of wave propagation. The memory system presented employs two cores per bit and is operated in a partial switching mode using transformer-coupled word lines to reduce noise generated when a word is selected. Signal sensing is accomplished with a differential amplifier using a tunnel diode as a threshold in the final stage. Cable and strip lines are used throughout for interconnection, and some circuits are located on the memory stack to aid high-speed operation. The system provides an operating cycle time of less than half a microsecond.

WEDNESDAY, OCTOBER 28

SESSION 4 ..... 8:30 A.M. MAIN ARENA
VERY HIGH SPEED COMPUTERS — PART 2

SESSION 5 ..... 8:30 A.M. POLK
NEW COMPUTER ORGANIZATIONS

5.1 AN ASSOCIATIVE PROCESSOR

Richard G. Ewing and Paul M. Davies Abacus, Inc., Santa Monica, Cal.

An Associative Processor design is presented based on Plated Wire Memory and integrated circuitry. The Associative Processor extends the principles inherent in associative or parallel search memories to permit numerous logical or arithmetic operations to be performed simultaneously with the memory. The logic within each word of the Associative Processor is controlled by microinstructions, which allow the execution of a variety of searches and data processing operations. This word logic also provides communication so that operations can occur between operands in different words. Techniques are described by which a large portion of the associative processor can be made tolerant of certain local malfunctions. The paper is concluded by a discussion of the Associative Processor mechanization.

5.2 A HARDWARE INTEGRATED GENERAL PURPOSE COMPUTER/SEARCH MEMORY

R. G. Gall, Goodyear Aerospace Corp., Akron, Ohio

The purpose of this document is to present a method of integrating the Goodyear Aerospace Corporation's Search Memory with the Univac 1206 (AN/USQ-20) Computer, more intimately than is possible through a standard I/O channel, effecting a saving of search time which approaches that of a completely integrated system. This can be provided with relatively minor hardware modifications and therefore, minimum cost. A typical four-variable search problem was formulated and its solution by three separate systems was analyzed.

5.3 A BIT-ACCESS COMPUTER IN A COMMUNICATION SYSTEM

Edmund U. Cohler and Harvey Rubinstein, Sylvania Electric Products, Inc., Waltham, Mass.

This report describes a multi-processor system for communication switching which employs a unique interfacing technique. Through the use of a direct access of external communication lines to main memory and externally modifiable instructions, these computers are five-to-twenty times more efficient than conventional computer systems in handling the serial bit streams of a number of communications lines. As a result, a small digital processor, without external buffering equipment, can handle 30 kilobits per second throughput.

5.4 VERY HIGH SPEED SERIAL AND SERIAL-PARALLEL COMPUTERS

K. Murata and Kisaburo Nakazawa, Hitachi Central Research Lab., Tokyo, Japan

The general purpose medium and large scale computer systems HITAC 5020 and 5020E have completely upward and downward compatibility. Both systems employ 18-megacycle 2-phase synchronous logic and helical wired transmission lines for various registers such as accumulators, index registers, and control registers. The systems have word lengths of 32/64 bits and bit-wise variable length data handling capability.

5.5 IBM SYSTEMS 360 ENGINEERING

J. L. Brown, Peter Fagg, J. W. Fairclough, J. Greene, J. A. Hipp, and P. N. Stoughton, IBM CORP., Poughkeepsie, N.Y.

The design philosophy of the IBM System 360 represents a unique system approach to computing. This paper describes the engineering considerations that influenced the development of this system. A detailed description of the IBM System 360 Models and the reasons for the various key decisions made in implementing them in a particular manner are also discussed.

SESSION 6 ..... 8:30 A.M. LARKIN
MANAGEMENT APPLICATIONS OF SIMULATION

6.1 UNISIM — A SIMULATION PROGRAM FOR COMMUNICATIONS NETWORKS

Lester A. Gimpelson and Joseph H. Weber, Bell Telephone Laboratories, Inc., Holmdel, N.J.

A simulation program has been developed to examine various strategies of routing and control in commercial and military communications networks. The program will accept large networks (up to 63 nodes) and process calls quite rapidly, and is constructed in a modular manner so that changes can be made without excessive difficulty.

6.2 DATA PROCESSING SYSTEM SIMULATOR (DPSS)

Donald D. Rudie, Michael I. Youchah, and Edward J. Johnson, System Development Corp., Paramus, N.J.

The Data Processing System (DPSS) using Monte Carlo techniques simulates the central processing unit (CPU), its peripheral equipment, and the Executive and Operational program systems operating on the CPU in a wide variety of data processing systems. The DPSS is used to simulate and evaluate the design of the data processing system before implementation permitting selection of the best of several possible designs prior to making equipment selections or performing any significant computer program design.

6.3 THE USE OF A JOB SHOP SIMULATOR IN THE GENERATION OF PRODUCTION SCHEDULES

Donald R. Trilling, Westinghouse Electric Corp., Pittsburgh, Pa.

A scheduling procedure applicable to large job shops is described, which takes advantage of the capabilities of job shop simulators to act as events generators.

SESSION 7 ..... 8:30 A.M. ROOM 416
DIGITAL SOFTWARE FOR ANALOG COMPUTATION

7.1 HYTRAN — A SOFTWARE SYSTEM TO AID THE ANALOG PROGRAMMER

Wolfgang Ocker and Sandra Teger, Electronic Associates, Inc., Princeton, N.J.

HYTRAN is a software system written for the HYDAC 2400 hybrid computer to supply digital assistance in the programming of its analog consoles. The program input is punched on paper tape in an analog-oriented language.

7.2 PACTOLUS — A DIGITAL ANALOG SIMULATOR PROGRAM FOR THE IBM 1620

Robert D. Brennan and Harlan Sano, IBM Corp., San Jose, Cal.

PACTOLUS is an attempt to demonstrate that the operational flexibility of analog simulation can be achieved with digital simulation.

7.3 MIDAS — HOW IT WORKS AND HOW IT'S WORKED

Harry E. Petersen, Digital Computer Facility and F. J. Sansom, R. T. Harnett, and L. M. Warshawsky, Analog Computer Facility, Wright-Patterson Air Force Base, Ohio

MIDAS is a digital computer program, developed primarily for the analog programmer, to enable him to obtain dynamic digital check solutions as well as optimal scaling (time and amplitude) information. Over a year's operational experience has demonstrated conclusively the value of MIDAS as a complement to an analog facility.

SESSION 8 ..... 2:30 P.M. MAIN ARENA
VERY HIGH-SPEED COMPUTERS — PART 3

SESSION 9 ..... 2:30 P.M. POLK
INPUT AND OUTPUT GRAPHICS

9.1 THE RAND TABLET: A MAN-MACHINE COMMUNICATION DEVICE

Malcolm R. Davis and T. O. Ellis, The Rand Corp., Santa Monica, Cal.

This paper describes a low-cost, two-dimensional graphic input tablet and pen for conducting research on man-machine graphical communications. The tablet is a printed-circuit screen complete with printed-circuit capacitive-coupled encoders, with only 40 external connections.

9.2 A SYSTEM FOR AUTOMATIC RECOGNITION OF HANDWRITTEN WORDS

Paul Mermelstein, Bell Telephone Laboratories, Inc., Murray Hill, N.J. and Murray Eden, MIT, Cambridge, Mass.

An operational procedure is presented for the recognition of handwritten words when written on-line on a special transmitter. Experiments carried out by computer simulation of the recognition system reveal that the system is capable of recognizing well-formed, legible, handwritten words with a reliability that depends on the correspondence between the script of the writing samples and that of the ensemble on which the machine's representation of handwriting is based.

9.3 A LABORATORY FOR THE STUDY OF GRAPHICAL MAN-MACHINE COMMUNICATION

Edwin L. Jacks, General Motors Corp., Warren, Mich.

The general field of mechanical design has for years depended on the techniques of drafting as a means of design prior to the making of models. Graphics serve as the basic means of man-to-man design information transmittal. The General Motors Research Laboratories, in 1963, placed in operation an experimental facility for man-to-computer and computer-to-man graphic communication. The paper reviews the design requirements and the objectives of the system.

9.4 OPERATIONAL SOFTWARE IN A DISC ORIENTED SYSTEM

M. Phyllis Cole, Philip H. Dorn, and C. Richard Lewis, General Motors Corp., Warren, Mich.

A complete programming system designed and implemented to utilize a large scale random access storage device as the permanent residence for programs and data is discussed. A technique for achieving maximum utilization of disc space is described.

9.5 IMAGE PROCESSING HARDWARE FOR A MAN-MACHINE GRAPHICAL COMMUNICATION SYSTEM

Barrett Hargreaves, J.D. Joyce, and G. L. Cole, General Motors Corp., Warren, Mich., and E. D. Foss, R. G. Gray, E. M. Sharp, R. J. Sippel, T. M. Spellman, and A. Thorpe, IBM, Kingston, N.Y.

This paper is divided into two parts. Part I by IBM, describes the design of special image processing components and system. Part II is a review of GM's experience with the hardware as a component in the General Motors Research Laboratories man-machine graphical communication system.

9.6 INPUT/OUTPUT SOFTWARE CAPABILITY FOR A MAN-MACHINE COMMUNICATION AND IMAGE PROCESSING SYSTEM

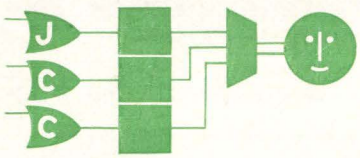
Thomas R. Allen and James E. Foote, General Motors, Warren, Mich.

A set of subroutines and source language input/output statements are described which permit use of the man-machine communication capabilities of an on-line console and image processor system with ease and flexibility.

9.7 A LINE SCANNING SYSTEM CONTROLLED FROM AN ON-LINE CONSOLE

Fred N. Krull and James E. Foote, General Motors Corp., Warren, Mich.

A Line Scanning System is described which utilizes a programmable



cathode ray tube (CRT) scanner and an on-line console. An image processor is used to photograph documents onto 35mm film, rapid process the film, and scan the resulting images. Line patterns on film are detected and digitized by programming the position of the CRT spot and the detection sensitivity of a photomultiplier tube.

SESSION 10 ..... 2:30 P. M. LARKIN
MASS MEMORY

10.1 THE INTEGRATED DATA STORE — A GENERAL PURPOSE PROGRAMING SYSTEM FOR RANDOM ACCESS MEMORIES

Charles W. Backman and Stanley B. Williams, General Electric Co., New York, N.Y.

A description is given of the Integrated Data Store, a general purpose programming system developed for random access memories. The data organization techniques, the data definitions and procedural language aspects, and the Input/Output controller are discussed.

10.2 THE IBM HYPERTAPE SYSTEM

B. E. Cunningham, IBM Corp., Poughkeepsie, N.Y.

The Hypertape system consists of the IBM 7640 tape control unit and the IBM 7340 tape drive. The 7640 has two channels which time share a single read and a single write section, and each can control up to ten 7340's. A modified version of the Hypertape system, for use as I/O with the new IBM System/360, is also described briefly.

10.3 DESIGN CONSIDERATIONS OF A RANDOM ACCESS INFORMATION STORAGE DEVICE USING MAGNETIC TAPE LOOPS

Andrew Gabor, Janos T. Barany, Louis G. Metzger, and Eleuthere Poumakis, Potter Instrument Co., Inc., Plainview, N.Y.

The random access information storage device described in this paper is a cartridge-loaded machine which uses continuous magnetic tape loops for storage medium. Cartridges are built to cover a range of storage capacities. Storage capacity of the smallest cartridge is 3 million alphanumeric characters. Average randou access time is 168 milliseconds. In the interest of long tape life the loops are air floated and are stopped when not engaged in data processing. During read-write operation only the one selected loop is in motion, all other loops remain stationary until specifically addressed.

THURSDAY, OCTOBER 29

SESSION 11 ..... 9 A.M. MAIN ARENA
VERY HIGH SPEED COMPUTERS — PART 4

SESSION 12 ..... 9 A.M. POLK
TIME SHARING SYSTEMS

12.1 THE TIME-SHARING MONITOR SYSTEM

Hollis A. Kinslow, IBM Corp., Yorktown Heights, N.Y.

IBM's Advanced Systems Development Division is currently operating, at its Yorktown Heights, N.Y., Laboratory, a time-sharing system based on IBM 7090 Data Processing Equipment. This paper is intended to provide readers with an understanding of the system's capabilities, usage, and basic structure.

12.2 JOSS: A DESIGNER'S VIEW OF AN EXPERIMENTAL ON-LINE COMPUTING SYSTEM

J. C. Shaw, The Rand Corp., Santa Monica, Cal.

JOSS (Johnniac Open Shop System) is an experimental on-line, time-shared computing service. It is in daily use by staff members of the Rand Corporation for the solution of small numerical problems. The system is described with emphasis on those features of JOSS which have led to its acceptance by the users as a new, convenient, easily used tool.

12.3 CONSEQUENT PROCEDURES IN CONVENTIONAL COMPUTERS

D. R. Fitzwater, Iowa State University, Ames, Iowa, and E. J. Schweppe, University of Maryland, College Park, Md.

The use of consequent procedures in designing programming systems and languages for real time, on-line or multi-programming applications is discussed. Consequent procedures differ from normal procedures in that the flow of control between procedure is defined by the consequences of previous procedure rather than by the programmer. The use of these concepts leads to comparatively simple system and language design for general purpose systems. Interactions with the external world of human and non-human users are simply described and implemented.

SESSION 13 ..... 9 A.M. LARKIN A
COMPUTERS IN SPACE PROGRAMS

13.1 THE JET PROPULSION LABORATORY EPHEMERIS TAPE SYSTEM

E. G. Orozco, Jet Propulsion Lab, Pasadena, Cal.

This paper describes the system set up at JPL for the generation and processing of ephemeris data on the IBM 7094. Source theories have been evaluated to produce master ephemerides for each planet. These ephemerides have been combined to produce the final JPL Ephemeris Tapes.

13.2 JPTRAJ (THE NEW JPL TRAJECTORY MONITOR)

Nicholas S. Newhall, Jet Propulsion Lab, Pasadena, Cal.

The Jet Propulsion Lab has developed an automatic programming system to operate its space flight programs. The system is known as JPTRAJ, the JPL Trajectory Monitor. It can operate programs that supervise a mission in a real-time sense or can be used for production and design studies.

13.3 ACE-S/C ACCEPTANCE CHECKOUT EQUIPMENT

R. W. Lanzkron, NASA, Houston, Texas.

This paper represents the current development of Acceptance Checkout Equipment for space flight as being built currently for the Manned Spacecraft Center in Houston, to be used for checkout in the Apollo Program. The system is a digital checkout device utilizing a set of 160G computers which are programmed to checkout either the Command and Service Module or the Lunar Excursion Module, as required. A system description and detail operation of the different pieces of equipment are discussed.

13.4 SATURN V LAUNCH VEHICLE DIGITAL COMPUTER AND DATA ADAPTER

M. M. Dickinson, J. B. Jackson, G. C. Randa, IBM Corp., Owego, N.Y.

This paper describes the system application of the Saturn V Launch Vehicle Digital Computer and Data Adapter and their use in pre-launch checkout, injection guidance, orbital checkout, and lunar transfer trajectory inspection for Apollo missions. It also describes the micro-miniature packaging approach utilized to minimize equipment size and weight.

13.5 THE 4102-S SPACE TRACK PROGRAM

E. G. Garner, J. Oseas, R.C.A., Moorestown, N.J.

The Space Track program is a real-time application written for the 4102-S, a multilevel interrupt processing computer. This paper deals

with the Space Track mission and the organization of the computer program to meet that mission. The hardware will be explained in general terms as background for the particular program arrangement.

SESSION 14 ..... 9 A.M. LARKIN B
HYBRID/ANALOG COMPUTATION — METHODS AND TECHNIQUES

14.1 A HYBRID COMPUTER FOR ADAPTIVE NONLINEAR PROCESS IDENTIFICATION

Bruce W. Nutting, Burroughs Corp., Paoli, Pa., and Rob J. Roy, Rensselaer Polytechnic Institute, Troy, N.Y.

This paper treats the problem of designing a general model for continuous nonlinear processes, which are subject to a switched two-level input, with only the input-output operating record of the process available. Interestingly enough, the general model for this type of process is a synchronous sequential machine whose state outputs are non-binary. The machine which was constructed is a hybrid analog-digital computer whose memory organization is determined by the input data. This computer cannot only adapt to changing process parameters, but is capable of predicting future process behavior based upon the present state of the process. As such, this model is ideal for predictive-adaptive control systems with a least time optimization criterion.

14.2 SYSTEMATIC APPROACH TO PROGRAMMING AN ANALOG COMPUTER TO GENERATE A LARGE CLASS OF TRAJECTORIES

Albert I. Talkin, Harry Diamond Laboratories, Washington, D.C.

The negative gradient method is extended to the stable analog computer programming of a class of nonlinear time varying trajectory problems.

14.3 QUANTIZING AND SAMPLING ERRORS IN HYBRID COMPUTATION

Charles R. Walli, North American Aviation, Inc., Downey, Cal.

The errors generated by the quantizing, sampling, and date reconstruction operations in a hybrid computation loop are examined individually and in combination.

SESSION 15 ..... 2 P.M. POLK
NON-NUMERICAL INFORMATION PROCESSING

15.1 REAL-TIME RECOGNITION OF HAND-DRAWN CHARACTERS

Warren Teitelman, MIT, Cambridge, Mass.

A system designed to recognize hand-drawn characters in real-time is described. The central feature of the system is the use of the time sequence information of the input character. Recognition is achieved via decision trees based on sequences of property values for the input character.

15.2 A COMPUTER PROGRAM WHICH "UNDERSTANDS"

Bertran Raphael, University of California, Berkley, Cal.

This paper shows, by means of a working question-answering program, that use of an appropriate internal model can enable a computer to "understand" relational information normally conveyed by simple conversational sentences. The author discusses the difficulties of generalizing the present system and outlines how to construct a more general, more powerful, "formalized" question-answering system.

15.3 A QUESTION-ANSWERING SYSTEM FOR HIGH SCHOOL ALGEBRA WORD PROBLEMS

Daniel G. Bobrow, MIT, Cambridge, Mass.

The STUDENT problem solving system, programmed in LISP, accepts as input a comfortable but restricted subset of English which can

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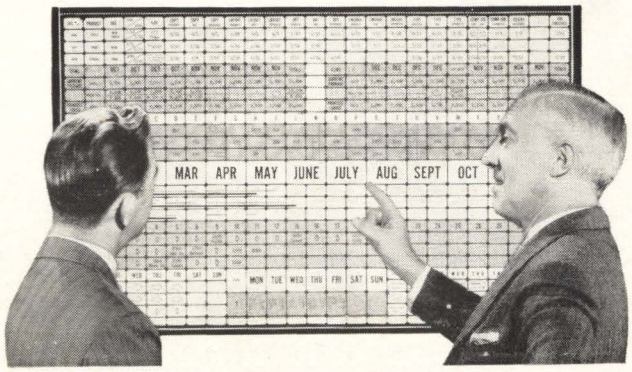

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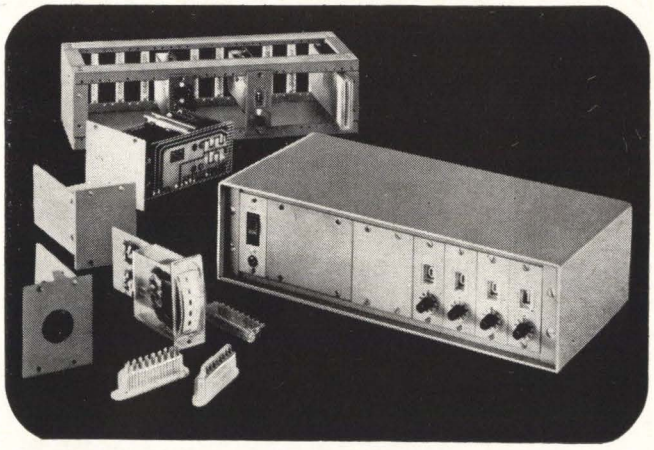

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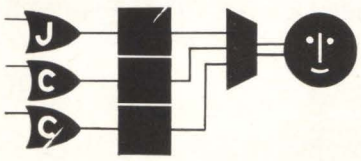


express a wide variety of high school algebra word problems. STUDENT constructs appropriate algebraic equations, and finds the solutions for a wide class of these problems.

15.4 THE UNIT PREFERENCE STRATEGY IN THEOREM PROVING

Lawrence Wos, Daniel Carson, and George Robinson, Argonne National Laboratory, Argonne, Ill.

In proving theorems with the aid of the computer, the emphasis has been placed on discovering computer-oriented rules of inference and corresponding methods for a rapid but exhaustive examination of the inferences resulting therein. In this paper, the emphasis is changed to consideration of the strategies of search involved in avoiding the examination of many of the possible inferences not germane to the theorem under consideration.

15.5 COMMENTS ON LEARNING AND ADAPTIVE MACHINES FOR PATTERN CLASSIFICATION

C. Hugh Mays, IBM. Corp., Poughkeepsie, N.Y.

This paper is a survey of what has been accomplished in the field of adaptive machines and the problems remaining to be solved before the value of the approach can be determined. Some of the problems that adaptive machines may be able to solve are outlined. The mechanization of adaptive machines with threshold elements is discussed. Performance criteria for evaluation of adaptive machines are presented.

SESSION 16 ..... 2 P.M. LARKIN A
HARDWARE DESIGNS AND DESIGN TECHNIQUES

16.1 FLODAC — A PURE FLUID DIGITAL COMPUTER

Richard S. Gluskin, Marvin Jacoby and Trevor D. Reader, Sperry Rand Corp., Blue Bell, Pa.

FLODAC is an experimental general purpose, small scale, digital computer built entirely from fluid logic elements. All of the common logic functions currently performed by electronics can also be implemented by devices which use gases or liquids as their working substance and employ no moving parts. The basic principles of operation of these fluid devices are discussed and the specific configurations which give flip-flops, inverters, AND gates, OR gates, and NOR gates are described. The overall logical design of FLODAC is described and the memory circuits are discussed in some detail. The four instructions of FLODAC, which are Add, Transfer, Conditional Jump, and Halt are described and a typical test program is presented.

16.2 DESIGN AUTOMATION UTILIZING A MODIFIED POLISH NOTATION

William K. Orr and James M. Spitze, Friden, Inc., San Leandro, Cal.

A new approach to Design Automation is discussed. The approach is unique in that a modified form of Polish notation is used to describe the logic of a given system. The notation leads to a simple solution of the central problem of relating the logic to the hardware. This hardware logic inter-relationship is established in such a way that it is possible to process the design information of a large class of digital systems. Specifically, it is possible to accommodate systems whose low cost precludes the use of "standard module" construction techniques, as well as the larger systems which are fabricated using standard modules.

16.3 SYSTEMATIC DESIGN OF CRYOTRON LOGIC CIRCUITS

C. C. Yang and Julius T. Tou, Northwestern University, Evanston, Ill.

A systematic synthesis of the cryotron circuit to realize complementary Boolean functions is presented. To facilitate the synthesis, each cryotron switching circuit is split into two separate parts, the gate network and the control network. The gate network may be synthesized somewhat similarly to the design of a relay contact network. The control network consists of a number of cryogenic current switching devices.

16.4 BINARY-COMPATIBLE SIGNED-DIGIT ARITHMETIC

Algirdas Avizienis, University of California, Los Angeles, Cal.

Signed-digit number representations are positional, constant radix $r \geq 3$, redundant number forms with both positive and negative values of individual digits. Carry-propagation chains do not occur in the addition and subtraction of signed-digit operands. This paper presents a set of algorithms for a signed-digit arithmetic unit which accepts input operands either in the conventional binary or in signed-digit form and generates signed-digit results.

SESSION 17 ..... 2 P.M. LARKIN B
HYBRID/ANALOG COMPUTATION — APPLICATIONS AND HARDWARE

17.1 A TRANSFLUXOR ANALOG MEMORY USING FREQUENCY MODULATION

Walter J. Karplus and James A. Howard, U. of Cal., Los Angeles, Cal.

The design and operating characteristics of a device for storing continuous analog voltages are described. A multi-aperture ferrite core is used as the control element in a closed loop including a multivibrator, a frequency-to-DC converter, a comparator, and a pulse generator.

17.2 THE USE OF A PORTABLE ANALOG COMPUTER FOR PROCESS IDENTIFICATION, CALCULATION AND CONTROL

Louis H. Fricke and Robert A. Walsh, Monsanto Co., St. Louis, Mo.

This paper reviews various process simulation devices, and compares their advantages and disadvantages, and describes a relatively new portable analog computer.

17.3 PROGRESS OF HYBRID COMPUTATION

Gerard A. Paquette, United Aircrafts Res. Labs., E. Hartford, Conn.

At the end of 1962, United Aircraft Research Laboratories acquired a hybrid facility consisting of general purpose analog and digital computers with inter-connecting linkage. This facility has been used to simulate aircraft, engine, and space systems. A Sikorsky Aircraft, single rotor helicopter real-time, hybrid simulation is discussed.

17.4 STROBED ANALOG DATA DIGITIZER WITH PAPER TAPE OUTPUT

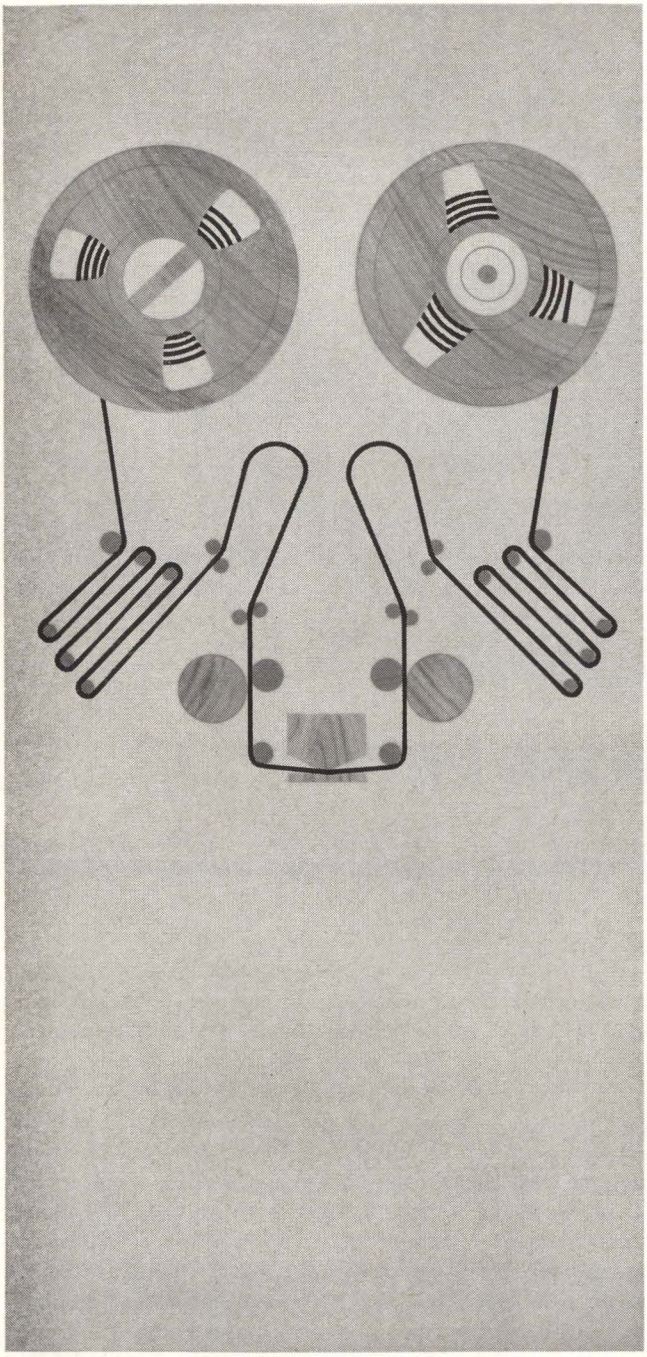
R. L. Carbrey, Bell Telephone Labs., Inc., Murray Hill, N.J.

A sampling oscilloscope, twelve digit analog-to-digital-to-analog converter with a maximum rate of 40,000 conversions per second, and a 4096 word memory have been combined to permit conversion of samples of repetitive waveforms with rise times as short as 0.3 nanosecond to twelve digit binary words. Stored words are split into six-bit characters and punched into paper tape along with appropriate control information. This tape serves as peripheral input.

17.5 HYBRID SIMULATION OF A LIFTING RE-ENTRY VEHICLE

A. A. Frederickson, Jr., R. B. Bailey, and A. Saint-Paul, Electronic Associates, Inc., El Segundo, Cal.

This paper describes a six-degree-of-freedom hybrid simulation for the optimum design of a space vehicle re-entry flight control system, utilizing the EAI HYDAC 2400 Combined Hybrid Computing System. The specific purpose of the simulatoin was the evaluation of a Temperature-Rate Flight Control System (TRFCS) which utilizes temperature sensors to provide short-period stabilization and long-term guidance during atmospheric re-entry.



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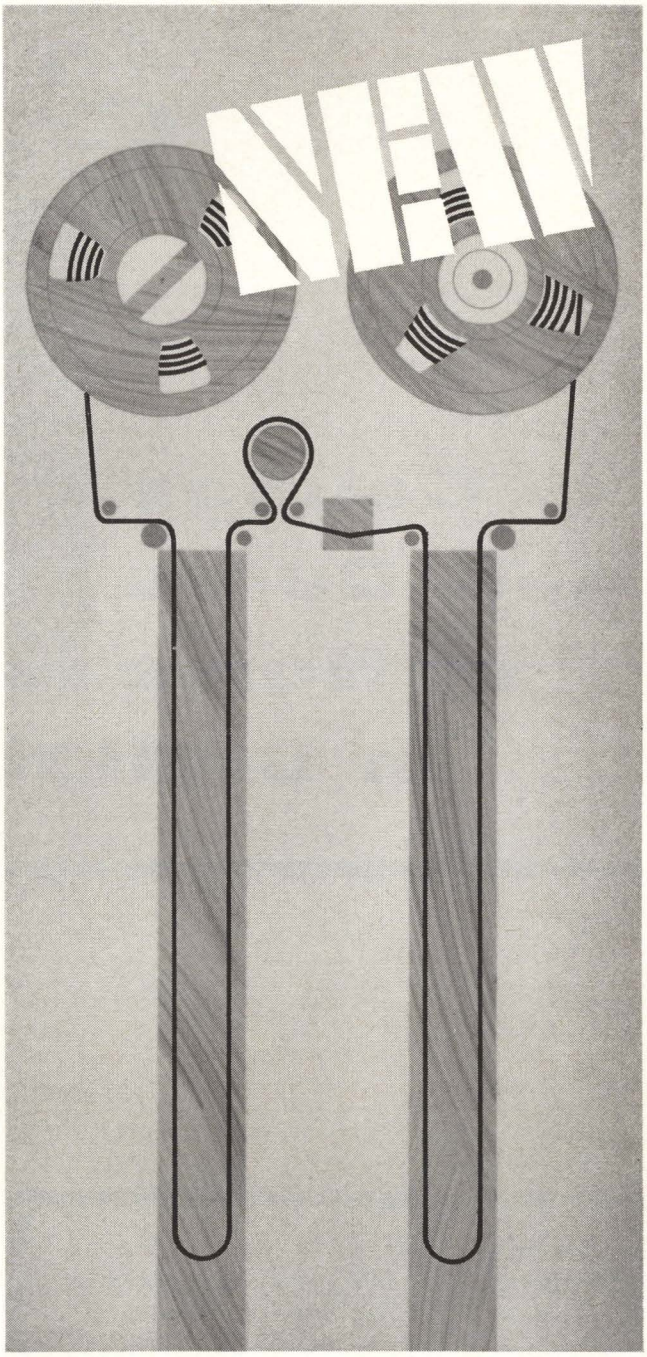

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AMPEX

CIRCLE NO. 13 ON INQUIRY CARD

Causes and Cures of Noise in Digital Systems

CORRECTION FOR PART 1

Unfortunately, some of photos were transposed in the printing of the September issue's Part 1 article of this series. Fortunately, the mistake was of such an obvious nature that the reader was well aware of what had happened. But for those of you who are planning to file this series for reference, it will be well to make note of the error. On page 29 in the September issue, the photo of a backplane designated and described as Fig. 1.9 and the photo of a waveform designated and described as Fig. 1.10 should belong with the descriptions designated as Fig. 1.11 and Fig. 1.12 respectively, and, of course, the other two photos belong with the Fig. 1.9 and Fig. 1.10 designations.

If an overall circuit schematic of a large digital system were shown in true electrical detail, it would be necessary to introduce little series inductance elements and series resistive elements into all interconnecting leads, including both the power and ground return lines. In high frequency digital circuitry, both the series inductance of running wire lengths and the small resistive drops made up of the ohmic resistance of the wire and connections become important circuit design parameters which must be considered. In typical digital systems, pulse transients on the lines may reach the 5 to 10 megacycle range, and peak currents may reach several amperes within the same frequency range.

As an example, consider the inductance of a 3-foot length of wire which is approximately 1.1 microhenries. At a frequency of 10 megacycles, the inductive reactance of this wire would be approximately 70 ohms. If this lead were used as a ground return for a typical switching load of 500 ohms at 6 volts, the "noise" generated across this ground return would be 0.74 volts for a *single* switching logic stage. In the typical system logic case, many stages may switch simultaneously and the momentary deterioration of the 6-volt logic level due to this ohmic drop could cause a transient malfunction.

The best means of reducing noise generation in power leads and ground returns is to keep the high frequency circulating currents within the individual circuit modules. This can be accomplished by separate power filter networks on each of the individual circuit cards to isolate internal switching transients from the main power busses and by providing very heavy ground bus returns in the rack housings.

J. PAUL JONES, JR. *President, Navigation Computer Corp., Norristown, Pa.*

PART 2 – NOISE ELIMINATION IN DIGITAL MODULES

The first part of this 3-part series which appeared in last month's issue discussed the sources of noise generated within the backplane wiring of a system. Here in this second part, the sources of noise within digital circuitry itself are considered, and methods of eliminating noise by proper circuit design are presented.

Localized Filtering

Each circuit module should be provided with a filter network, mounted on the etched-circuit card itself, at the input from the main power busses. This filter network generally consists of a bus filter capacitor of at least 22 microfarads and a series input inductance of at least 1500 microhenries. The equivalent circuit of a local filter network, as associated with the main power bus system, is shown in Fig. 2.1. Referring to Fig. 2.1, the digital circuitry on the card is represented by a switch closure in the equivalent network. The filter capacitor (C_f) acts as the main source of current for current surges or current transients and it therefore by-passes most of the surge current from the main power and ground busses. The series input inductor (L_f) is designed to provide a large amount of inductance compared to the series inductance of the power busses. It therefore absorbs most of the series voltage drop (e_1) from current transients. The voltage (e_2) is the total inductive drop to the first large bus filter capacitor. The bus filter capacitor acts as a back-up for the –22 uf filter on each card and is designed to isolate all of the internal transients from the leads running to the power supply (which may be located remote from the system).

The inductive reactance along ground return lines can be minimized by using heavy (typically ¼" square) bus bars. When these bus bars are used in conjunction with the series input filter inductors L_f, the ratio of the voltage drops e_1/e_2 will be greatly increased, resulting in a minimum of "noise" at PT#1 shown at the module input of Fig. 2.1.

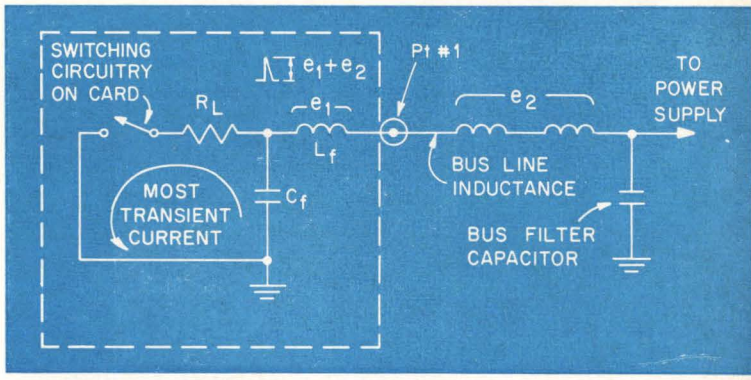


Fig. 2.1 When filter capacitors are located at the input of each module most of the transient currents are contained within the module and do not appear on the main power busses. Dotted outline represents digital module area.

Routing Of Circuit Grounds

One of the most important considerations in avoiding internal system noise problems is the proper routing of circuit ground busses, ground leads, and chassis or cabinet ground connections. Within the wiring structure of a backplane, all grounds *must* be considered as "just another wire". When dealing with high speed switching circuitry, the erroneous concept that ground is "cool", or that any point connected to ground is automatically at *zero reference*, should be quickly dispelled. The ground leads and ground bus system must be considered, in terms of inductive voltage drop, exactly as any other wire in the logic system.

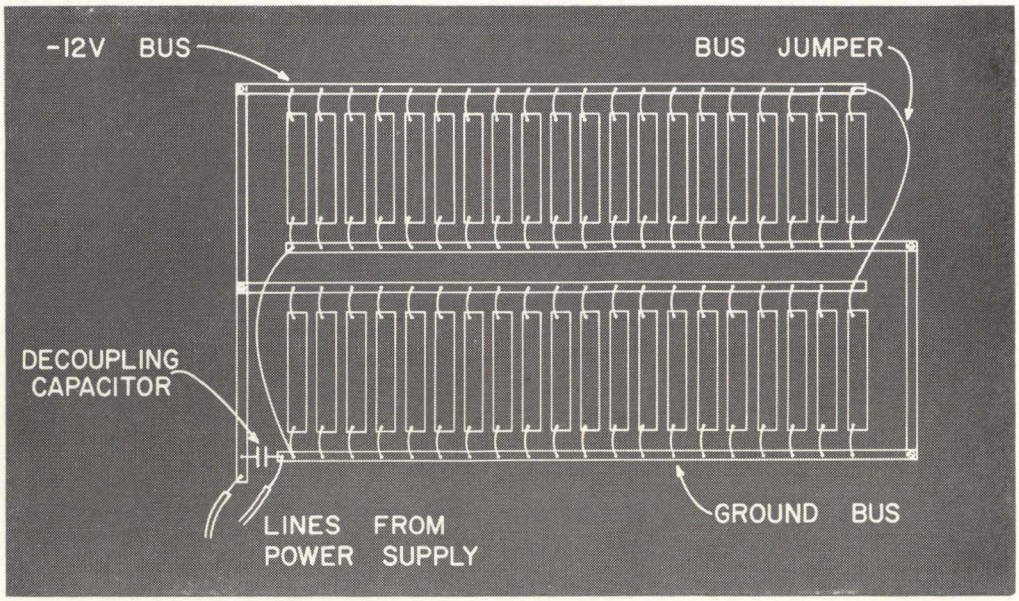


Fig. 2.2 Backplane ground busses should provide means for parallel wiring to the connectors and should converge toward a central point.

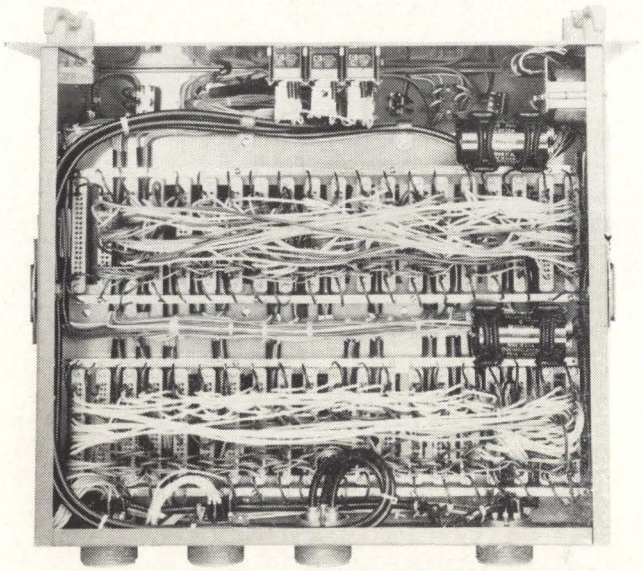


Fig. 2.3 Good wiring practice includes point to point logic connections, heavy power busses and local filter capacitors.

RULE: GROUND SHOULD NOT BE CONSIDERED A ZERO REFERENCE UNTIL IT HAS ARRIVED AT THE FILTER POINT ON THE MAIN POWER SUPPLY.

By using large filter capacitors at the termination of the ground busses on each row of connectors on the backplane, most of the circulating currents in the logic circuitry are confined to a local area. However, any low frequency noise that is generated, either internally or externally, may not be fully filtered until it has reached the main brute-force filter capacitors in the power supply.

Large electrolytic filter capacitors (in the order of 1000 microfarads) often exhibits a series inductive drop because of the spiral foil of its internal structure. To offset this effect, a smaller bypass capacitor of approximately 0.01 uf can be connected in parallel with the electrolytic.

If there are several large sections of backplane wiring (such as the one shown in Fig. 2.2) mounted in one rack housing, then each of the power and ground cables which are connected at the lower left hand corner of the bus system *should converge individually* to a common point at the power supply for the system. Conversely, the power busses *should not be connected in series* nor should they be connected by hopping from one terminal block to the next until they reach the power supply.

RULE: WHENEVER POSSIBLE, ROUTE POWER AND GROUND BUSSES FROM SYSTEM SECTIONS DIRECTLY TO THE POWER SOURCE TO AVOID CUMULATIVE BUILD UP OF COMMON POWER AND GROUND CURRENTS.

Fig. 2.3 illustrates good backplane wiring practice showing point-to-point logical connections, power busses, local filter capacitors, and the use of shielded cable for input signals.

Damping Relay Coils

When inductors (such as the drive coil on relays or solenoid key actuators on adding machines) are driven by fast switching amplifiers, the collapse of the inductive field can generate very high amplitude "flyback" voltages which create noise both through radiation and through large currents that may result on the power bus. For example, the overshoot voltage on an undamped key solenoid which is being driven from a 48 volt source can be as high as 1800 volts peak. As shown in Fig. 2.4, proper damping with a rectifier and a resistor of several hundred ohms (R_d) can reduce this overshoot voltage to 10-20 volts peak, and currents will be confined to the coil area.

RULE: ALL SOLENOIDS OR RELAY COILS, THAT ARE DRIVEN BY AMPLIFIERS IN THE SYSTEM, MUST HAVE DAMPING RECTIFIERS DIRECTLY ACROSS THE COILS TO CLAMP FLYBACK VOLTAGE AND CURRENTS.

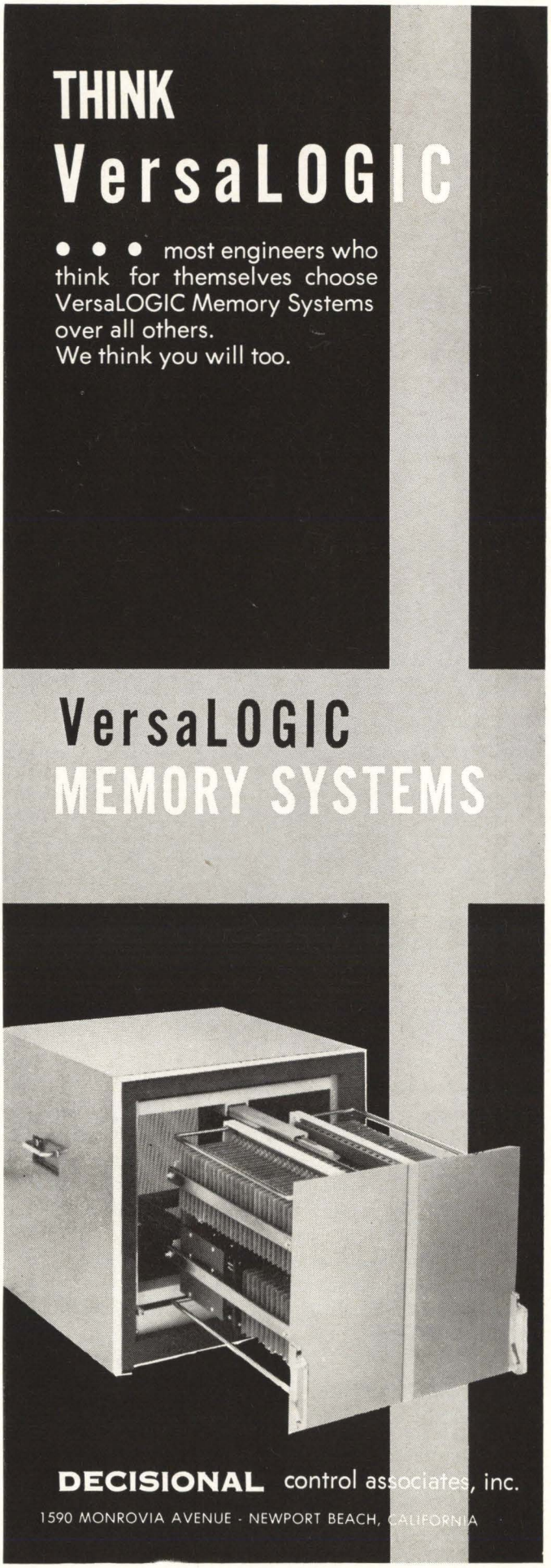
All relay modules should have a clamping diode network mounted directly on the card next to the relay solenoid so that the overshoot or flyback current from the induction of the relay coil is absorbed directly on the card and does not flow through the power bus lines. Additional filter capacitors, which are part of the power filter on the relay modules, absorb most of the power transients in the high frequency ranges. The pulse noise from the relay solenoid which then appears on the power busses will usually be in the millisecond range, which will not have a drastic effect on very high frequency triggered circuitry.

As discussed in Part 1 of this series, it may also be necessary to use a *separate ground system* for solenoid or relay drivers, and *not* to use the common bus system of the logic circuitry as a return for the high currents involved in the relay drivers. If, for instance, a separate filter network for the relay cards is located in the main power supply, a *separate ground* wire should be provided with a *separate power wire*, for the relay cards, *routed directly* to the filter point in the main power supply.

Input Transfer Gates

Among the important features of digital modules are the parallel transfer input gates used with flip-flop type circuits, such as used in binary counters, shift registers, etc. The use of diode transfer gates for each input protects the individual module against noise in several ways.

With reference to Fig. 2.5, notice that each diode input gate is made up of diode (D_1) to a common transfer bus, and diode (D_2) from the input connection. The gating or transfer bus is normally held to ground potential by the gating bus amplifier, which keeps any extraneous noise from passing the gate. At a specific time, when it is desirable to transfer a ONE (−6v) input level into the flip-flop, the gating bus is momentarily allowed to go from ground potential to −6v. If a noise pulse should occur during the short transfer (strobe) period it would add or subtract from the ONE (−6v) input level, but would probably not affect the setting of the flip-flop. If, on the other hand, the input had a ZERO (ground potential) at the input, and a noise pulse occurred during the transfer period, it would not appear at the input gate because of



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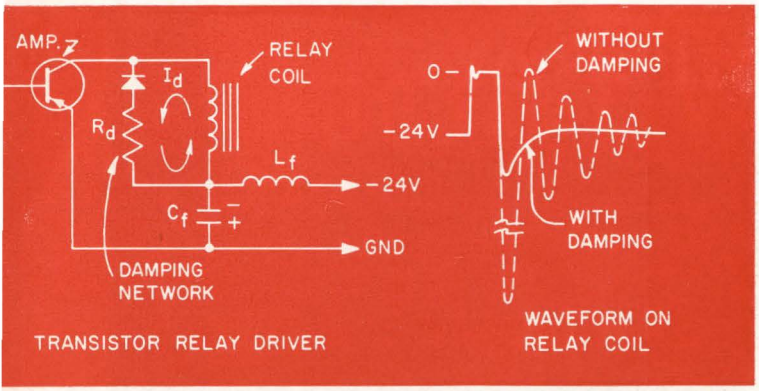


Fig. 2.4 Solenoid coils should have separate filter networks from the main power supply and a damping diode across the coil to (1) avoid high amplitude "flyback" voltages, and (2) to confine the damping current to the area of the coil.

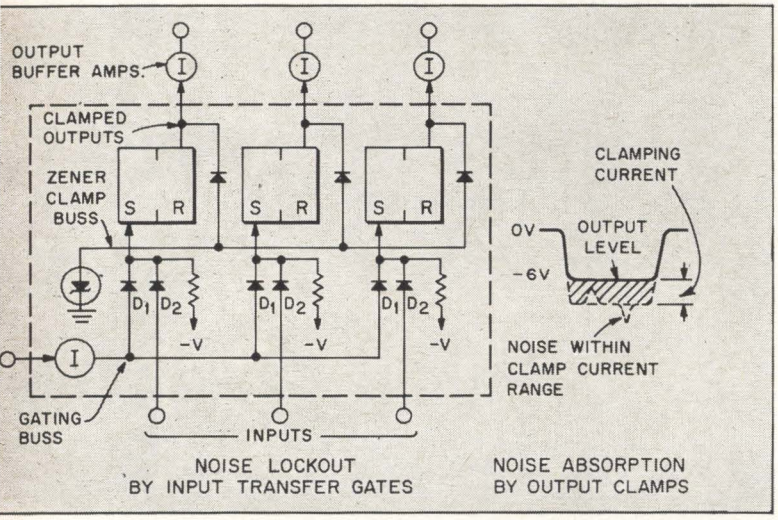


Fig. 2.5 Output buffer amplifiers, output diode clamps and normally off input gates are all important for isolating flip-flops from external and internal noise.

the extremely low impedance of the input line; which is being held to ground potential by an external amplifier.

When transistor logic circuitry is used with external, relatively low speed mechanical devices, it is desirable to arrange for the transfer time to occur *after* all solenoid drivers, switch closures, and solenoid fly-back transients have occurred, and the external equipment has ceased to generate internal or external noise. In this way the "noise" is simply avoided, rather than being attacked by brute force methods.

Use Of Output Clamps

When flip-flops or other triggerable circuits are connected directly to other noise generating circuits, without buffer amplifiers, there is a danger of false triggering because the output lines have *direct access* to the cross-over capacitances in the flip-flops. Noise can then trigger the dynamic loop gain of the circuit. It is desirable, therefore, that all outputs on such circuits have diode clamps, which limit the outputs to approximately 6 volts. Use of a Zener diode reference on each circuit card will draw some clamp current.

In the typical output pulse illustrated in Fig. 2.5, note that the clamp current that is being drawn by the clamp supply prevents either positive or negative energy pulses from changing the −6.8 volt level. As long as the energy of the noise pulses does not exceed the clamp current, in a direction opposite to the clamp current, there will be no observable modulation of the clamped output level. This clamp current protection is essential if the flip-flops are to drive other elements at some distance, or if they are used to drive diode OR gates. Diode "mixing" circuits would ordinarily cause transient fluctuations on the output of a grounded emitter amplifier, such as used in flip-flop circuits.

The clamping of output levels has many additional advantages which include (1) standardization of all drive levels regardless of power supply or load variations, (2) elimination of both positive and negative noise pulses which could otherwise reach the crossover capacitors of flip-flops, and (3) reduction of the effective rise and fall times of the pulses by truncation of the normal RC step. If, however, a separate power supply and wiring bus must be supplied for the clamp voltage to the clamp diodes, another source of interactive noise is introduced. In addition, all of the diodes and transistors in the system become vulnerable to mass parallel blow-out if an incorrect voltage is momentarily applied to clamp power bus.

One way to eliminate both the "noise" and blow-out problems of clamp busses is to include a separate Zener diode reference on each individual module. The cost of the individual reference on each card is probably less than the "10% overhead" of an additional power supply and its associated wiring.

Output Buffering

Whenever triggerable circuits such as flip-flops or one-shot delays are used as a source of waveforms to external equipment, it is usually necessary to use buffer amplifiers on each output line. Output lines can appear as large RF antennae to pick up all varieties of electrostatic or inductive noise from outside the equipment and conduct it to the interstage wiring of the system logic. Grounded emitter type amplifiers should be used for output buffers whenever possible, since accidental grounding of the external wires would not blow out the buffer stage — as it most surely would with an emitter follower configuration.

Electrostatic Shielding

With the packing densities that are now being achieved with digital modules, the components are very close to each other. With the very high frequency switching transients that are involved in high-speed switching circuitry (1 megacycle and above), the inter-component capacitance can be an appreciable factor and must be carefully considered in the circuit layout on an etched circuit

board. If the circuit impedance of adjacent wires is sufficiently low (for example, 1000 ohms, or less) this intercomponent or interwire capacitance can be neglected. If, however, close parallel wiring is part of a higher impedance circuit, such as the input of an emitter follower amplifier, sufficient coupling may cause differentiated noise spikes that will detract from the total noise immunity of the circuitry.

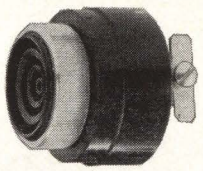
If there is sufficient space on the card, one simple technique for providing partial shielding between parallel etched wiring is to inject a third grounded wire between the two adjacent conductors. A cross-section of such a three-wire configuration is shown in Fig. 2.6. Note that in this configuration, and in the equivalent circuit that is shown, C_1 represents the equivalent capacitance between the two logic circuit conductors (conductor 1 and conductor 2). Without any special precautions, the interwire capacitance, C_1, looks exactly like a small coupling or differentiating capacitor from one wire to the other. When a third wire is inserted between the two conductors and placed at ground potential, two conditions drastically reduce the effect of capacitance coupling between conductor #1 and conductor #2. First, a capacitance divider network is set up, as shown in the equivalent diagram of Fig. 2.6, which is made up of the interconductor capacitance (C_1), and the conductor #2 capacitance-to-ground (C_2). The second condition is that there is a voltage gradient set up between conductor #1 and the center grounded conductor. Conductor #2 then falls essentially outside of this voltage gradient. Also notice in Fig. 2.6, that the dividing action of C_1 and C_2 in series is improved by the fact that the capacitance of C_2 is much greater than the capacitance C_1, because of the closer proximity of conductor #2 to the grounded conductor.

In some cases it may be necessary to bring the grounded conductor out through the wiring connector, however, this has the disadvantage of requiring additional pin connections and additional wiring.

The most effective method of intercomponent shielding is to incorporate a complete ground shield on the component side of the module, allowing only circular ports through which component leads can pass. The insulated leads make connection to the etched wiring on the opposite side of the card. A high frequency 1 megacycle module which utilizes a ground electrostatic shield is shown in Fig. 2.7. This conductive ground plane serves not only to reduce all intercomponent coupling effects, but also acts as an inter-module shield to cut down electrostatic coupling from one card to the next. When the cards are stacked in a housing side by side, this ground shield acts as a vertical screen between the components on each card.

With reference to the second diagram in Fig. 2.6, notice that the cross section of the ground plane shield and an equivalent circuit are shown. The shielding effect is represented by small capacitors ($C_2 + C_3 + C_4$, etc.), which represent small capacitances in many directions to the ground plane. Also, the highest voltage gradient between conductor #1 and ground is confined to the area directly under the component.

The use of a high efficiency ground plane in high den-



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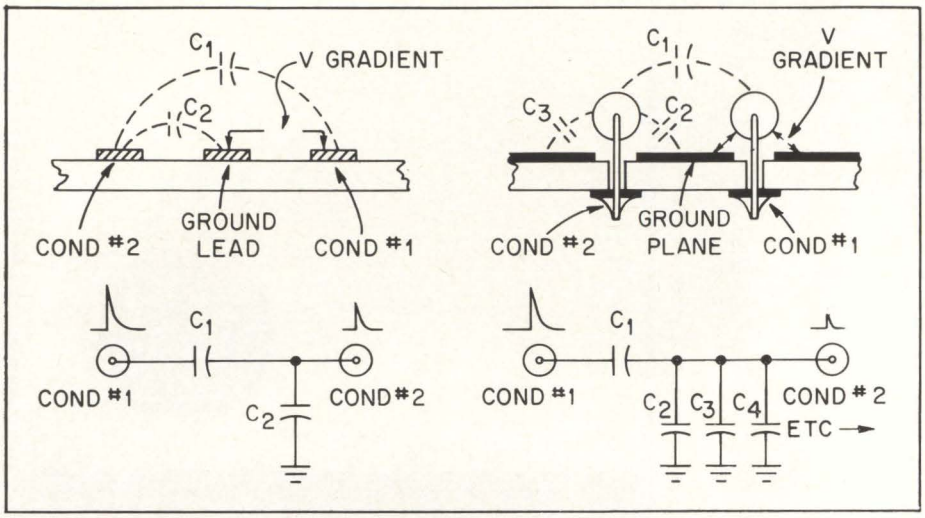


Fig. 2.6 Ground "shielding" against electrostatic interference may be accomplished on PC boards by running a grounded conductor between parallel circuitry or by using a solid ground plane on the component side.

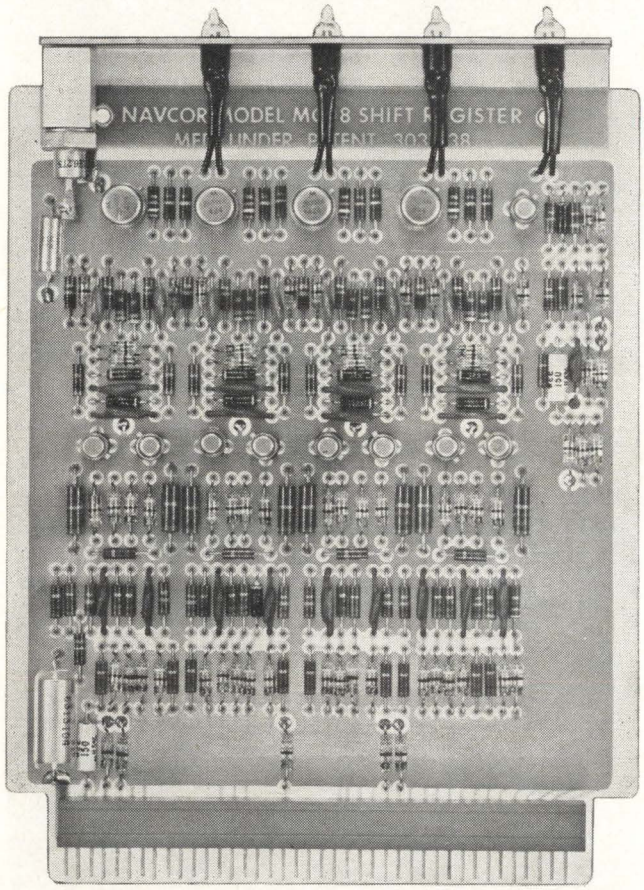


Fig. 2.7 A high frequency module, made by Navigation Computer Corp., has a solid ground plane beneath the components to allow higher frequency pulse transients without capacitive noise coupling.

sity circuit modules of 1 megacycle and higher is an additional expense to the module maker, however, it allows much higher performance specifications on the high frequency circuitry, since the voltage transients can be made much faster without creating noise problems. To the circuit designer, this means less circuit delay to complicate system design, which must include consideration of time "races" and other time "crossover" problems.

Fig. 2.8, shows the superior pulse shaping that is made possible by the ground shielding that has been described. Notice that the typical rise and fall time transients of this 1 megacycle pulse are in the order of 30 nanoseconds, which is as good as can be expected in 5 to 10 megacycle circuitry. Notice also that the initial delay is only 12 nanoseconds. There is very little circuit ringing in the waveform even though the transients are in the 5 to 10 megacycle range. The speed of the waveform permits parallel logic circuitry to be used. Parallel counters of 12 stages and higher can settle, after a clock pulse is introduced, with adequate time for gating or shifting within the same clock period. The extra fast transients, which are controlled by the noise suppressing backplane, also permit pedestal gating to be used throughout the high frequency circuitry. Pedestal gates, in combination with parallel circuitry, eliminate all time races in the system by providing 100% parallel simultaneous shift of information throughout the system.

Test Points And Noise

Testing or debugging new systems usually means using test points leading from the circuit card, and card extenders, which move the modules out to a point that brings the individual components within reach of an oscilloscope probe. One difficulty that these techniques encounter is the "law of indeterminability". This law states that the original condition cannot be determined if the observing technique alters the original condition. With the exception of outright wiring errors, which are usually picked up during "buzzout", the most subtle system debugging

problems usually involve a *marginal* condition (for instance, an "extra" pulse may be occurring approximately once every two hours). Unfortunately, this kind of case is more the rule than the exception. Since any subtle problem is by its nature a very marginal thing, and caused by small interwire or intercomponent capacitances, the addition of any similar amount of capacitance will rapidly alter the original condition.

A good high impedance scope probe alone may, for example, add 20 to 50 uuf. An extender card with its associate wiring, extra connector, etc., may also add over 20 uuf capacitance load to a circuit under observation. Since actual circuit capacitors in very high frequency logic may only be in the order of 47 uuf, the effect of the testing tools may be quite drastic. The only way that the loading effect of test equipment can be completely avoided is to utilize buffer amplifiers at all testpoints. In addition, the buffer should have its input at the closest possible proximity to the test point.

Built-in lamp indicators with associated buffer amplifiers is one answer to the problem of interference via testpoints. Neon or lamp indicators built directly into the cards (see Fig. 2.7) have the added advantage of showing exactly what is occurring in the circuitry at a slow or pushbutton rate without the need for any external test equipment such as oscilloscopes, etc. Indicator lamps may be further augmented by test pushbuttons directly on the modules, which further reduce the chance of *noise* or extraneous pickup in the leads running from the test pushbuttons to the circuitry under test. When lamps and test pushbuttons are incorporated into the design of the modules, extremely simple operator test procedures may be set up that do not require external test equipment which

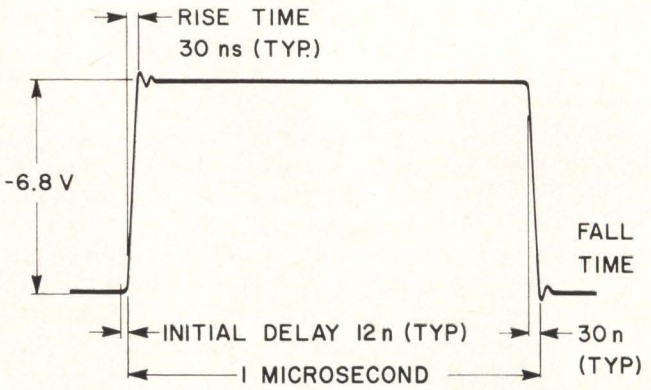
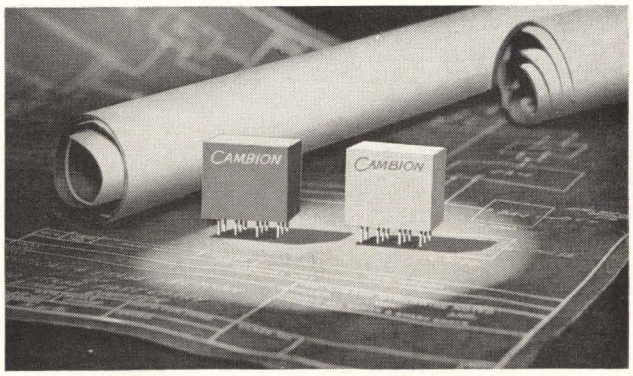


Fig. 2.8 With proper circuit layout precautions extremely fast waveforms, such as the one shown, may be obtained without "crosstalk" noise.

may inject unwanted noise into the system.

Gaining system noise immunity through proper circuit design becomes even more important when there are connections to external or remote equipment. Methods for isolating digital systems from external noise, and transmitting signals over long lines without external interference, will be discussed in the third and final article of this series.



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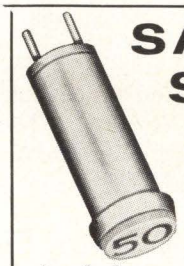

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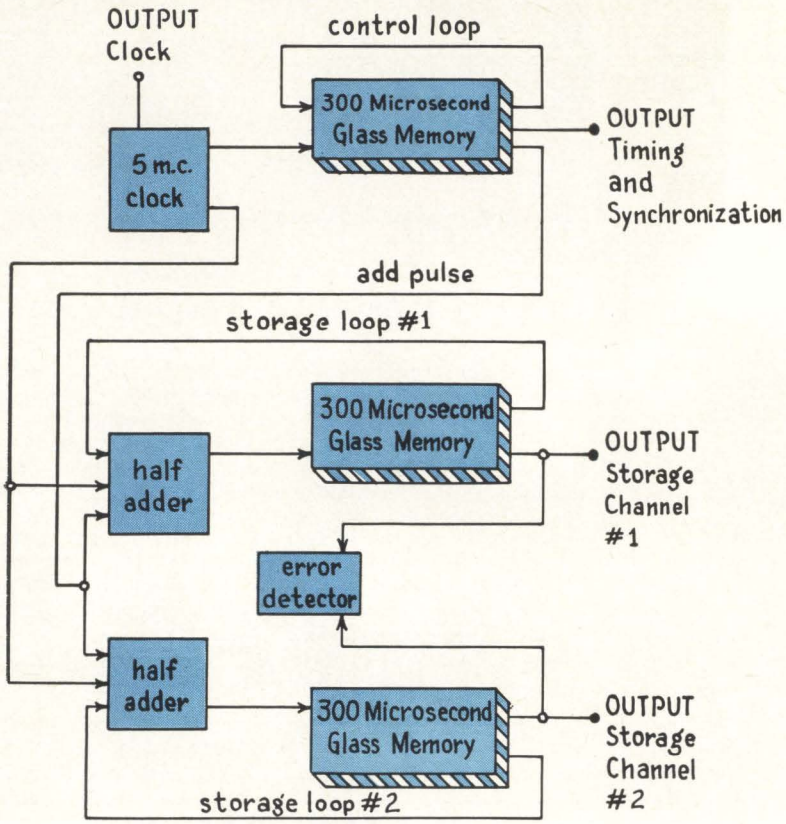
UNITY-GAIN MODULE OF GLASS DELAY-LINE MEMORIES



To illustrate glass delay-line memory tracking capability, a unity-gain module of three memories with associated circuitry was demonstrated by Corning Glass Works at a recent conference. The module consists of a control loop and two storage loops, each containing a 300-microsecond glass memory, all fed by a 5 mc clock (see block diagram).

A single pulse circulates continuously in the control loop. Every 300 μsecs, this pulse is added to the train of pulses circulating in both storage loops. The effect is a constantly changing storage pattern of random combinations of ONEs and ZEROs. Spectators at the conference demonstration observed, from waveforms on an oscilloscope, that the output of each storage loop remains perfectly matched, despite the variations in signal patterns. An error would activate a light in the display if the outputs did become mis-matched, Corning engineers said, but they added that the light probably will come on only if an error is deliberately induced, perhaps by interrupting the circuitry. They pointed out that an error probably could not be induced by physically banging on the solid-state glass memories almost up to the point of fracture. This insensitiveness to shock, acceleration forces, and vibration is one of the reasons glass memories were chosen for shift registers in the IBM Gemini computers.

The module also illustrates the independence of signal-to-noise ratio from storage patterns in glass memories, which, according to Corning, is not notable in other types of memories. Also demonstrated by the module is glass memory stability. This is shown by the long-time capability of the memory in the control loop to retain perfect synchronization with the clock.

Corning said the module is primarily a conference demonstration device, not a product, although such modules could be used in high-speed DELTICS, for example, or as main memories in small, low-cost, special purpose computers.

At the display, probes can be inserted into the module so that waveforms can be observed on the oscilloscope at six different points. The six types of information that can be extracted are: (1) the 5 mc clock signal; (2) a single ONE pulse as it comes directly out of the memory in the control loop every 300 μsec; (3) the same pulse coming out of the control loop memory after it has been amplified and reconstructed. This is the timing and synchronization pulse; (4) a train of pulses as they come directly out of the memory in storage loop 1 in continuously changing binary combinations. The ONE pulses are tripolar, the typical shape of glass memory pulses. ZEROS are represented by zero voltage. The excellence of the S/N ratio is seen at this point by the height of the ONE pulse and the relative absence of spurious energy in the ZERO pulse positions; (5) the output of storage loop 1 after the train of pulses is reconstructed by amplifier circuitry. The tripolar signal is shaped by a detector working on the threshold technique. Each ONE consists of a square pulse of positive voltage, while each ZERO again is zero voltage; (6) similarly, the output of storage loop 2, showing exactly the same waveform that comes out of storage loop 1.

According to Corning, advantages of these glass delay-line memories include bit costs as low as one cent, 0.5 to 500 μsec access time, 1-50 mc data rates, stability of 1/8 bit, and less circuit complexity.

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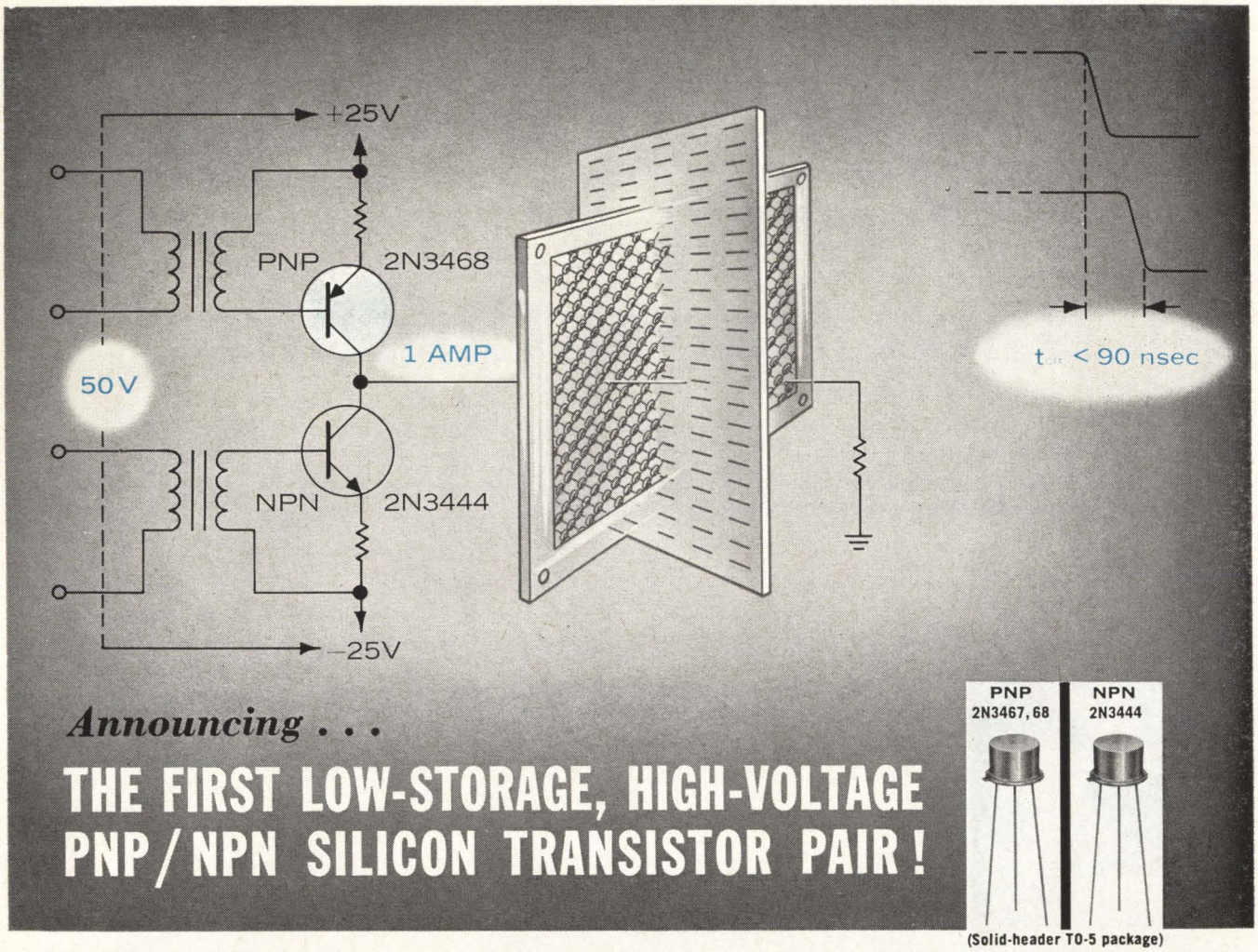

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Because these new low-storage devices retain their valuable high current-gain characteristics, they offer a solution to the speed/voltage/current "trade offs" encountered in earlier complementary core driving circuits.

		BV_{CEO}	h_{FE}			T_{off}	$V_{CE(sat)}$	f_T
		$I_C = 10$ mA	@ 500 mA 1 volt V_{CE}		@ 1 amp 5 volts	$I_C = 500$ mA $I_{B1} = I_{B2} = 50$ mA	$I_C = 500$ mA $I_B = 50$ mA	$I_C = 50$ mA $V_{CE} = 10$ volts
		min	min	max	min	max	max	min
PNP types	2N3467	40 V	40	120	40	90 nsec	0.5 V	175 mc
	2N3468	50 V	25	75	25	90 nsec	0.6 V	150 mc
NPN types	2N3252	30 V	30	90	25	70 nsec	0.5 V	200 mc
	2N3253	40 V	25	75	20	70 nsec	0.6 V	175 mc
	2N3444	50 V	20	60	15	70 nsec	0.6 V	175 mc

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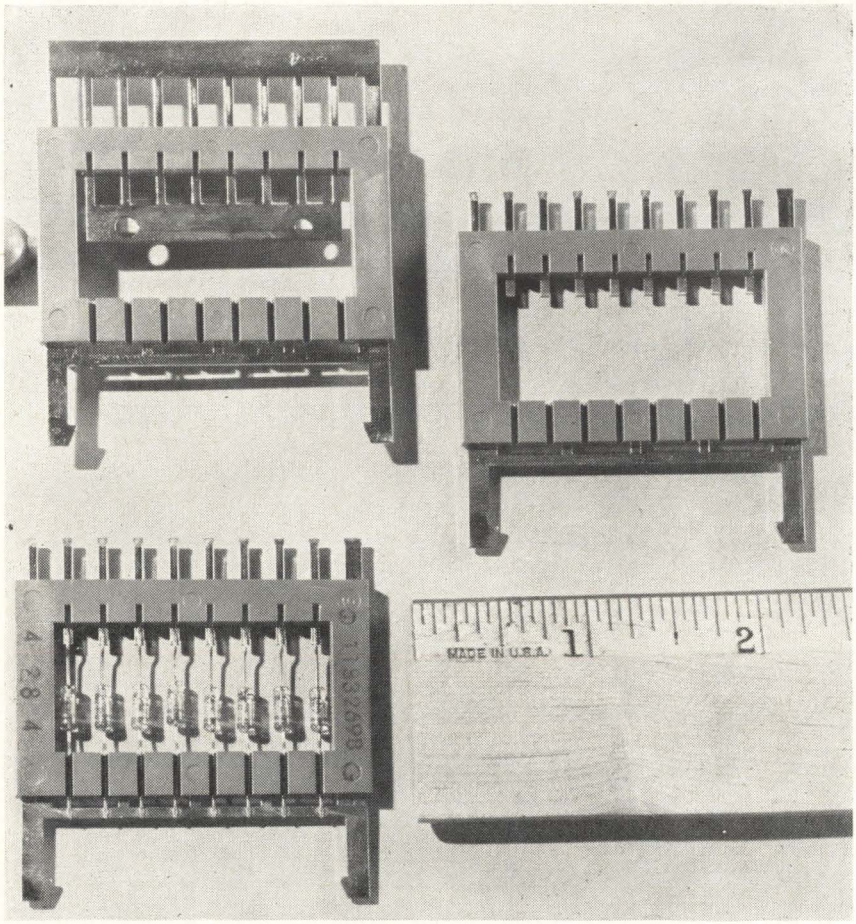
New Look to Back Panel Circuits

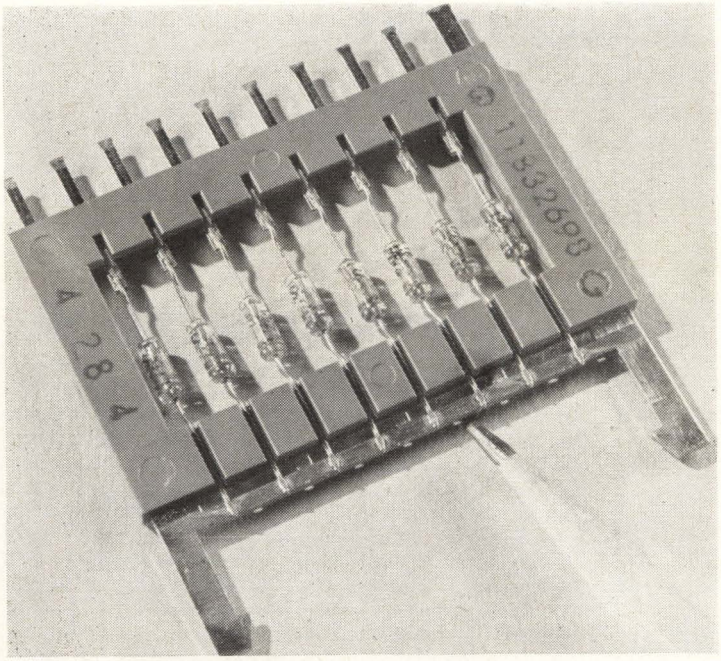
Plastic Frames Increase Packaging Flexibility



Production sequence: At upper left is diode stick with gold-plated, nickel-silver contact piece embedded in phenoxy plastic as it comes from the mold. At upper right, portions of metal comb have been removed — these served to position contacts until insert is molded in place. At lower left, discrete elements have been welded in place.

Development of a new modular packaging scheme has resulted in major economies in Burroughs Corp.'s production of its B200 and B5000 EDP systems. As heart of a back panel system, the circuit packages consist of precision-molded phenoxy plastic frames, measuring 1.25″ x 2″ x 0.15″ thick, with embedded, gold-plated, nickel-silver, male, plug-in contacts and bus bar. These packages, commonly-called diode sticks, are assembled with any desired combination of diodes, resistors, capacitors, thin-film or hybrid circuits and are plugged into back-panel connectors. Approximately 15,000 units are used in the central computer of the B5000 system. According to reports, use of the diode stick modules provides more flexibility in logical, digital circuit placement, and because the gating is closely-placed in relation to its associated circuitry, better driving or fan-in/ fan-out capabilities are achieved. The discrete elements can be either welded or soldered to the contacts and bus bar. Although the module is repairable, the low cost of the plastic carrier, components, and assembly, along with the high reliability, has enabled this module to be considered a throw away, as the cost to repair approaches the cost of a completely assembled, tested unit.

Each diode stick makes connection with the back panel by means of ten male contacts. The two outer contacts can be active or passive, one being oversized to insure proper polarity of the module when it is plugged in. The diode stick provides



Uncut, the diode stick shown can be either an AND or OR gate in the logic circuit. Snipped at the point indicated, it converts to a five input OR and a three input OR, feeding into a switch or flip-flop. Snipped at two other points, it can provide two AND gates and an OR diode.

all the logical gating for the system and allows for almost infinite variety of gating configurations. Many component types and values have been packaged in this module, providing circuits for filtering, terminating, and trimming. The large variety of gating circuits is made possible by snipping the common bus bar at the top of the stick at one or more predetermined points. This modification to the basic module can be easily made in the field. This means that only one part need be assembled, inventoried, or stocked as spares, resulting in lower in-plant and field inventory costs.

Production of the basic diode stick unit in quantities of millions and to strict specifications represented a major materials selection and molding problem. The most critical specification required that the ten contacts, positioned only by the plastic in which they are embedded, must not deviate from a straight line by more than 0.004″. This means that the plastic must undergo minimal shrinkage when it is removed from the mold and must have excellent dimensional stability or freedom from warpage. Other requirements included good dielectric properties, capacity to reproduce fine mold detail, toughness and high strength, and self-extinguishing properties.

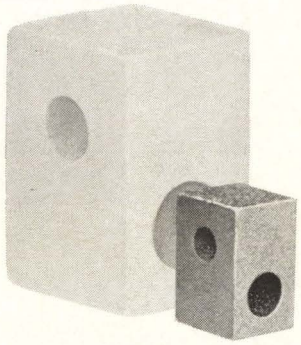
Of the numerous plastics evaluated and molded, the best results were obtained from polycarbonate. To obtain the desired warpage control it was found necessary to use a glass-filled variety that increased basic material cost and was more difficult to mold. Although the material met the self-extinguishing and flame-retardant parameters, it was not "non-dripping." A relatively new plastic — phenoxy, developed by Union Carbide's Plastics Division, was investigated under a value analysis program.

One member of this group of high-performance, engineering plastics — Bakelite Phenoxy PRDA-8160 — was found satisfactory for the application because it met all the requirements without the addition of a reinforcing filler. In addition, because the material was non-dripping as well as self-extinguishing, it facilitated Underwriters' Laboratories' listing. The molding process allows the stick to be color coded for instant identification, both in-plant and at the field locations.

The phenoxy diode sticks are molded by International Pipe & Ceramics Corp., Plastics Div., Santa Ana, Cal.

For more information on the molded frames, Circle No. 102 on Inquiry Card

For more information on the plastic-phenoxy, Circle No. 103 on Inquiry Card



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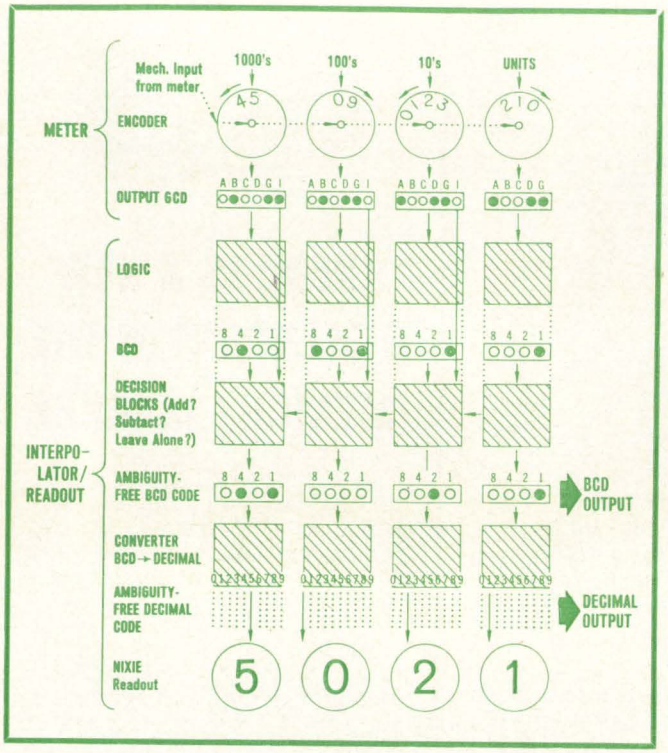
INTERPOLATING DIGITAL READOUT UNIT



A typical configuration of the interpolator illustrates the interpolative logic function in simplified form. A typical input from a multiple decade encoder is in decimal Gray code and, due to transition states between discrete encoded numbers, plus interdecade alignment tolerances, it contains ambiguities. This data is immediately converted to BCD, but retains the ambiguities. On entering the "Decision Blocks", however, the preceding decade is automatically examined to determine its state — which reveals whether the questioned decade is reading one digit high, one digit low, or is correct. An interpolative signal from the encoder bypasses the GCD/BCD converter to assist in the "Add, Subtract, or Leave Alone" decision, which in turn yields corrected BCD data. BCD/Decimal converters for each decade complete the conversion to drive the appropriate Nixie tube element for readout.

Providing off-line services otherwise demanded of far more expensive EDP equipment, a new interpolating digital readout unit, developed by Lutkin Research Labs, Inc., of Los Angeles, Cal., is a solid-state data processing tool for rapidly displaying decimal data from incoming raw parallel Gray coded decimal. Among the typical functions performed by the new unit are self-correcting monitoring of multiple encoders; meter/encoder trouble-shooting and maintenance; system simulation; training of EDP and maintenance personnel; and testing of digital instrumentation during manufacture.

Parallel BCD or decimal outputs permit the unit to be used in the feedback loop of digital control systems for printing out data from film readers, plotting tables, automatic scales, tracking systems, tool positioners, and similar devices and/or systems.

Logic circuitry acts on all incoming Gray code and interpolative data to remove all ambiguities before displaying corrected values on Nixie readout tubes.

Multiple meter encoders may be monitored by manual pushbutton selection, but the inherent speed of the unit permits high-speed scanning of dozens of data sources if desired. Synchronized output communication can also be provided to deliver the corrected data to their appropriate recorders or control functions.

Any number of decades may be read in parallel, to the specific application requirements, and special Gray or binary codes can be accommodated by expansion of the unit's logic circuitry. Features and specifications include accuracy — enhances encoder accuracy, completely eliminates ambiguity; resolution — equal to maximum resolution of encoder, one part/million obtainable; and speed — 0.4 millisecond/display decade, parallel input or 0.4 millisecond/frame, serial-parallel input.

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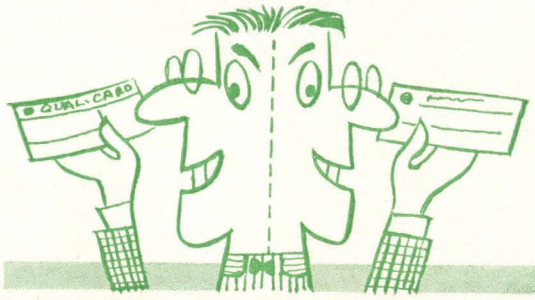

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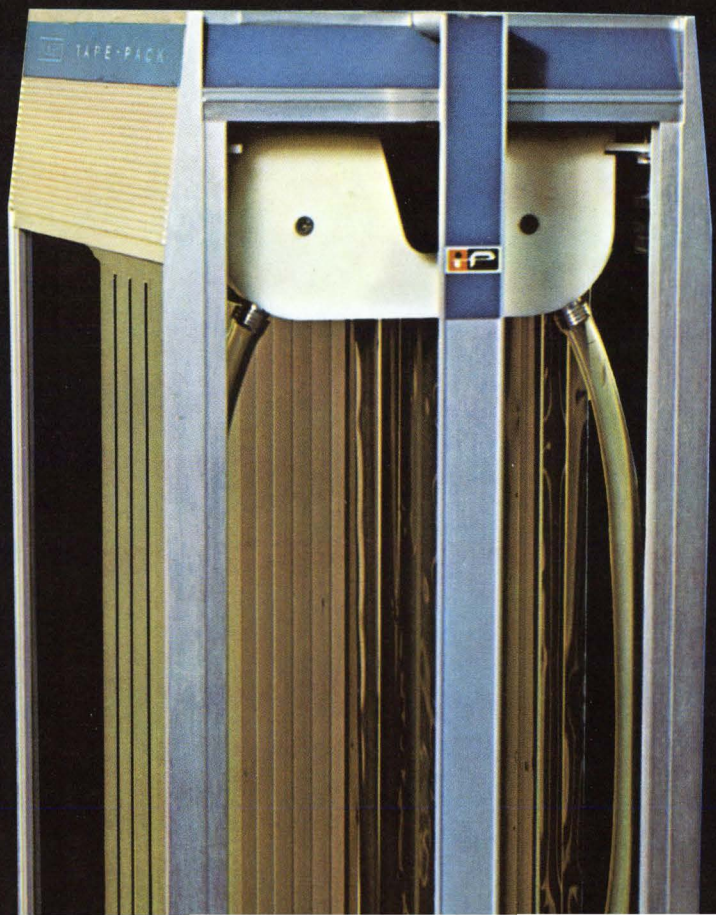
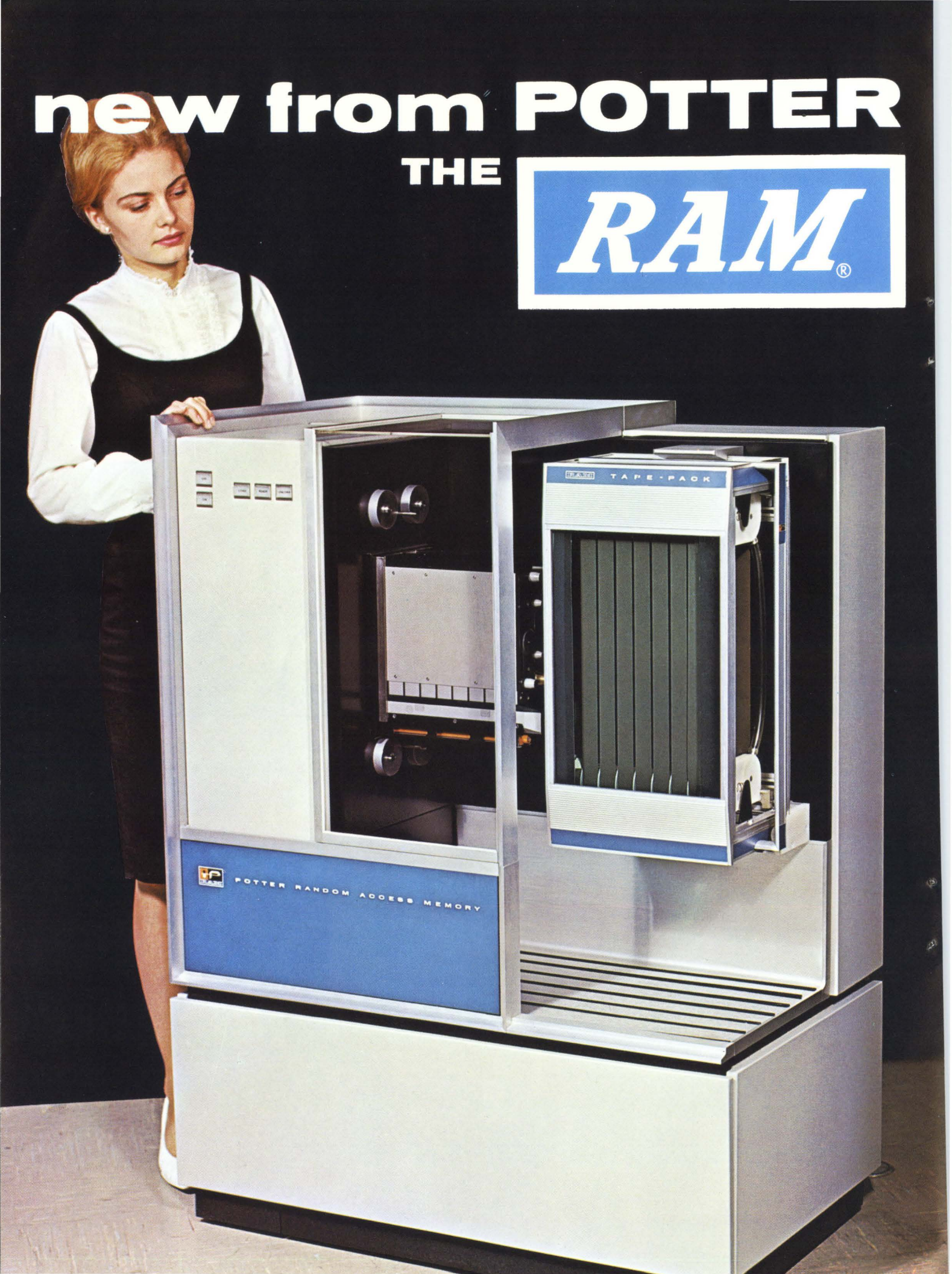
Announcing a major breakthrough in random access memory!

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LOWEST PRICED UNIT AVAILABLE TODAY

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The RAM* is a fast access, infinitely-expandable cartridge-loaded memory device. Its revolutionary new drive system permits using high density magnetic tape loops in random access memory applications for the first time. Still another revolutionary development — a read-after-write head — permits a complete write and check read operation in less than 90 milliseconds. The fastest available!

Potter's unique Tape Pack cartridge is another feature that really sets the RAM apart. Tape Pack cartridges need no more special handling consideration than a brief case. Even if a cartridge is accidentally dropped to the floor, data remains secure. And because critically fabricated disks are eliminated, Tape Packs are less than half the cost of disk packs.

But these are just the highlights of this remarkable breakthrough in random access memory equipment. Get the full details on the new Potter RAM for yourself. Write or wire Potter today.

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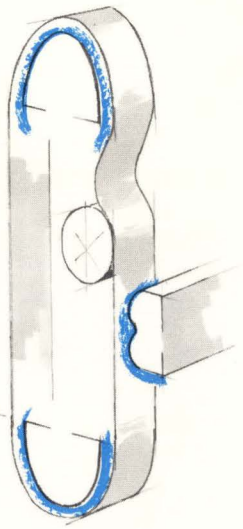
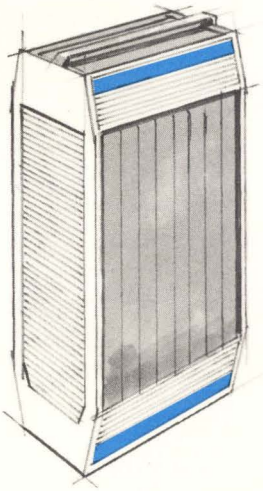


tape loops float over stationary bearings on cushions of air . . . "fly" past write/read head without making physical contact. Years of trouble-free operation are assured.



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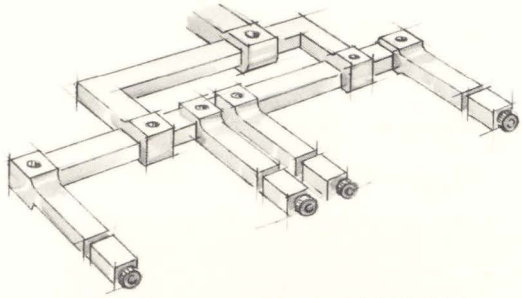
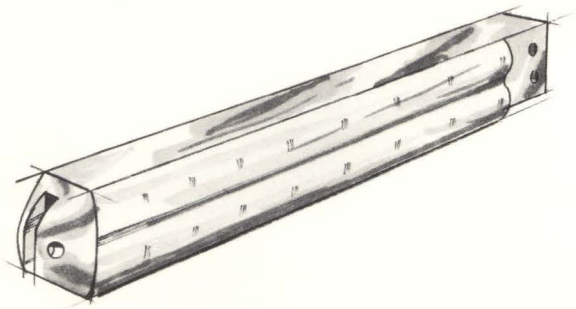


SIMPLE CONSTRUCTION

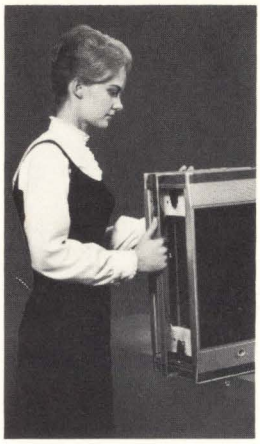
rugged "whiffletree" binary head positioning mechanism combines simplicity with precision . . . eliminates complex servo mechanisms.



MINIMUM MOVING PARTS

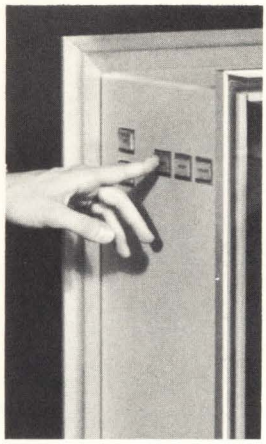
single write/read head post assembly is positioned by simple linear movement.

EASY TO OPERATE — INFINITE CAPACITY

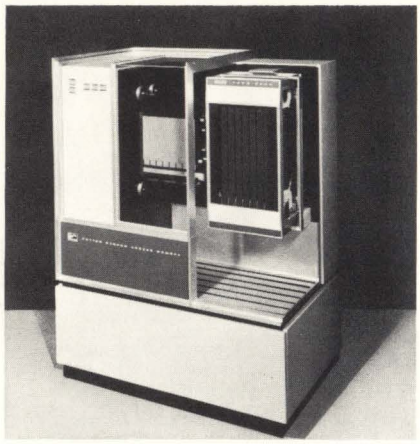


operator selects proper Tape Pack

latches Tape Pack into RAM



touches start button



loading operation is completed automatically. RAM capacity is infinitely expandable. Each cartridge adds 50 million bits of memory.

SUMMARY SPECIFICATIONS

Cartridge Capacity	50.3 million bits
Average Head Positioning Time	62.5 ms
Average Latency Time	25.0 ms
Average Access Time	87.5 ms
Check Read Delay	1.7 ms
Check Read-After-Write Cycle Time	89.2 ms
Data Transfer Rate (Bits)	600 kc/s

POTTER

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THE LEADER IN EDP EQUIPMENT

Telemetry Data Sampling

Low-Offset Solid-State Gates Replace Electromechanical Commutators

To meet the requirements of reliable high-speed switching of extremely small or low-level signals in telemetering applications, Stellarmetrics, Inc., of Santa Barbara, Cal., has developed a solid-state gate that replaces conventional electromechanical commutators. Designated the SSG-100, the gate is a two-pole, single-throw switching device which may be operated at any rate from dc to 40,000 times per second. A photo of a gate is shown in Fig. 1. The guaranteed maximum dc offset is 100 microvolts, differential, as a double-ended switch, or 500 microvolts per pole as two independent single-pole switches. It is believed to be the first wide-range, low-offset, solid-state switching device with such low power requirements. It will react to signals as low as 0.0018 watts. The device is equally useful as two independent single-pole, single-throw switches, as a chopper controlled by a common drive signal, or as a synchronous switch or chopper into a common load. As shown in the block diagram of Fig. 2, the SSG-100 is driven by a very high-frequency oscillator circuit. A low power dc pulse may be supplied continuously to the drive circuit, which is isolated from switching circuits, and the switch used for continuous duty. A transformer output couples this high-frequency energy into one or more isolated transistor chopper/switches. Each transformer's secondary winding contains semiconductor micro-diodes for rectification, and the transistor input capacitance characteristics are sufficient for filtering the rectified drive signal. The transformer was made specially for this application with performance characteristics tailored for the number of poles.

There are no potentiometers or selected components in the module. In place of an expensive and time-consuming selection process, the chopper devices are measured and sorted into broad groups according to offset. Since all the devices fall well within the highest offset group, rejections are virtually nil, according to the company, and the high yield was a major factor in determining the low price of the solid-state units (approximately $56.00 to $91.00 each, depending on quantity.) In operation, the new gate succeeds another more recent development, the use of matched-transistor-pairs as low-level choppers.

It should be noted that the new switch is not applicable for high power switching, only signal switching. Also, there is a level beneath which offsets cannot be reduced, but by using double-pole switching configurations, they tend to cancel and the company reports it does get rather high accuracy from the new development.

One advantage of particular interest, according to the company, is that the new switch permits "do-it-yourself" engineering groups to build special-configuration commutators and multiplexers at a minimum expense and still retain the capability of switching low-level signals.

Circle No. 109 on Inquiry Card

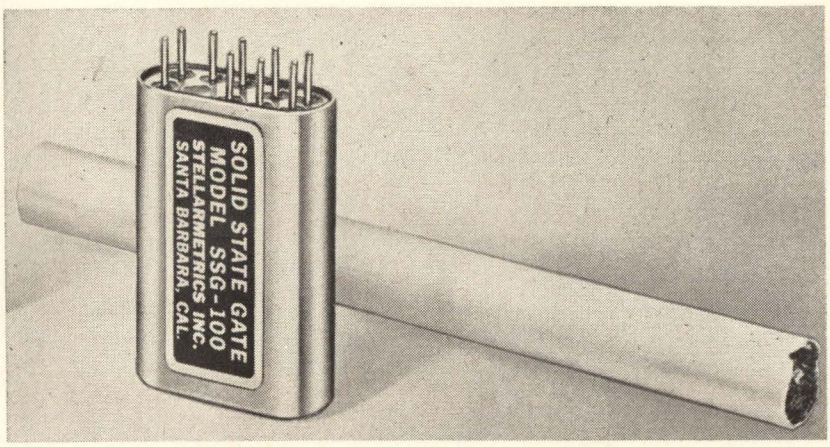

Fig.1 Specifications of a new low offset solid-state switching device include a driving voltage of 6.5 volts at 2.5 milliamps; nominal drive circuit input resistance of 4K ohms; operating temperature range of —20 to +100C; and overall dimensions of 0.35 x 0.6 x 0.8".

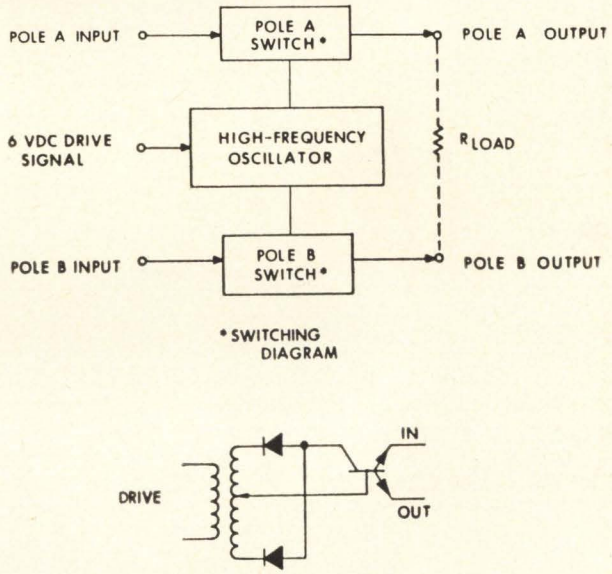

Fig. 2 Block diagram of SSG-100 gate illustrating the circuit diagram of the transistor chopper/switch poles.

Versatile High Pressure Blower

Unit's performance can be trimmed to meet exact requirements of a particular installation

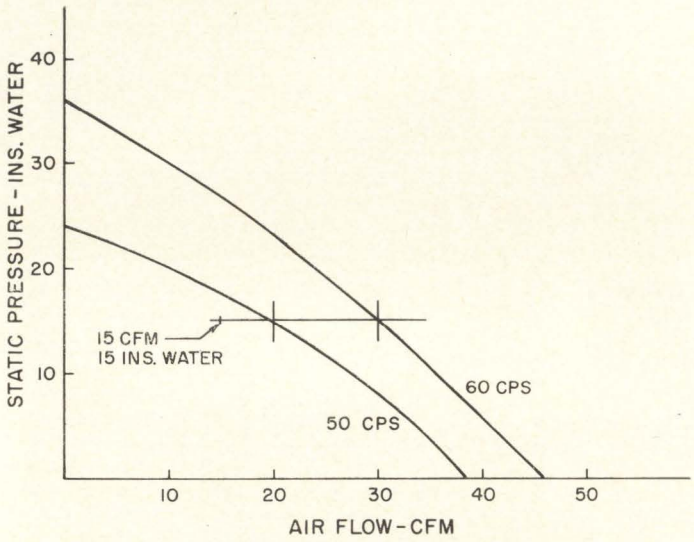

Fig. 1 Performance curves for the Spiral blower.

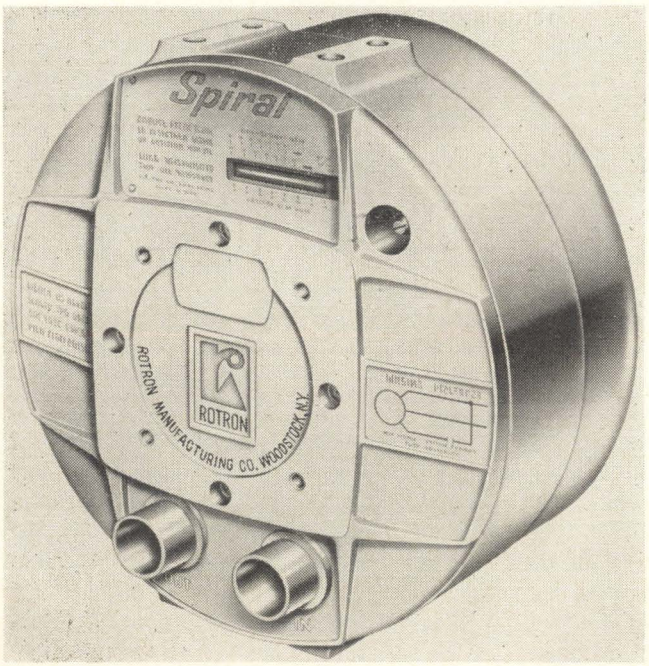

Fig. 2 Photo of the Spiral blower showing adjustable bleed valve on upper right and to the left of that is differential pressure gauge.

For use in a variety of computer applications including a vacuum source for card handling systems, a cooling air supply for extremely high density packages, and a differential pressure source for pneumatic tape and card readers, a new high pressure blower has been developed by Rotron Manufacturing Company of Woodstock, N.Y. At 60 cps, the new unit, called the Spiral, develops a maximum head of 32 inches of water; at 50 cps this reduces to 24 inches. The Spiral is supplied with either a single phase or a three phase 50-60 cps directly-driven induction motor.

Life expectancy is said to be enhanced by the relatively low speed of this motor, as well as by the absence of brushes and commutators. The nominal operating speed of the 60 cycle Spiral is 3300 rpm; a comparable brush type blower, according to Rotron, would operate in the range of 12,000 to 14,000 rpm. The use of this type of motor is said to eliminate the RF noise which is characteristic of universal motors generally used to drive the vacuum cleaner type of blower.

One of the most useful Spiral accessories is an integrally mounted, screwdriver adjustable bleed valve on either the suction or the discharge side of the unit. This valve makes it possible to trim the performance of the blower to the exact requirement of a particular installation, regardless of altitude or power supply line frequency. As an example, a typical operating point for a computer tape may well be 15 cfm at 15 inches of water. The performance curve in Fig. 1 indicates that this point lies well within both the 60 cps and the 50 cps performance characteristics. By bleeding 15 cfm at 60 cps, or 5 cfm at 50 cps, the differential pressure requirement of the tape handling system can be precisely matched. Furthermore, for

this assumed system requirement, sufficient margin is still available to handle 60 cps installations at elevations up to 13,000 feet, and 50 cps installations at elevations up to 6,000 feet.

To facilitate setting the bleed valve, the Spiral can be fitted with an integral differential pressure gauge (see Fig. 2). This optional accessory is calibrated in inches of water as well as in nominal cfm at sea level for the zero bleed condition with 60 cps and 50 cps input power.

The unit has been designed for rugged and long-life operation. The three major aerodynamic components are fabricated of high strength aluminum die castings. The integral induction motor is a new Rotron design, equipped with precision cartridge ball-bearings and lubricated for years of trouble-free life.

Circle No. 108 on Inquiry Card

GOVT. REPORTS

TECHNIQUES OF SERIAL COMPUTATION

Study investigated feasibility of serial computation, sign determination, magnitude determination, and module selection for a particular system. Report also describes basic number theory for further application of residue number theory. **Order from: Office of Technical Services, U.S. Dept. of Commerce, Wash., D.C. 20230. Order No. AD 427355. Price $3.50.**

COMPUTER DEVICE AND CIRCUIT RESEARCH

Recent research on computer devices and circuitry includes a phenomena survey intended to develop new avenues for study. The information is presented both as descriptive of the various phenomena, and as summary lists from punch card abstracts. Experiments in solid-state physics are explained. **Order from: Office of Technical Services, U.S. Dept. of Commerce, Wash.. D.C. 20230. Order No. AD 435760. Price: $5.00.**

NEW

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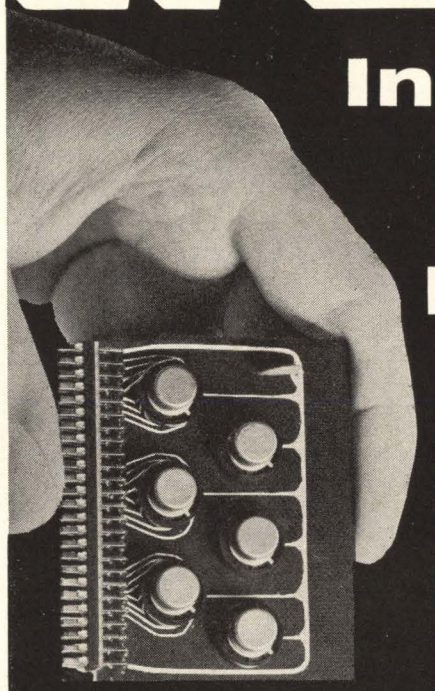
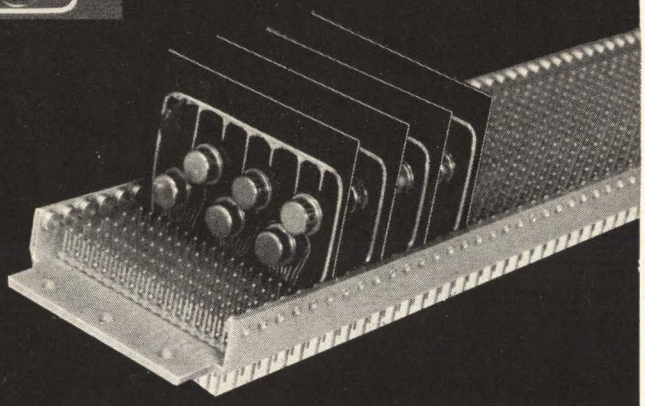


Abacus has developed a full line of integrated circuit modules—for the specific purpose of providing the systems engineer with all the necessary building blocks to build a complete, integrated circuit digital system.



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CIRCLE NO. 19 ON INQUIRY CARD

Magnetic Encoder Replaces 13-Bit Brush Units

Familiar circuitry used in magnetic pick-off devices is adapted to design of low-cost, reliable "magnetic brushes" that provide excellent signal levels without sacrifice of resolution.

Fig. 1 Model of a new magnetic encoder, called "Fast", that was designed as a direct replacement for the very popular 13-bit, Size 18, self-selecting V-brush encoder. As is characteristic of magnetic encoders, the great reliability of this model will cause failure only when the bearings wear out. The device is mechanically interchangeable directly with the brush encoder (with the possible exception of somewhat higher inertia). The electrical output can be readily converted to the present type by the use of one transistor per channel, rather than the diodes now used. Ambiguity resolution is then easily accomplished through a three-transistor network similar to the drive circuit of the self-selecting V-brush encoder.

Although there is a great variety of special-application shaft-angle encoders, general-purpose types fall into three groups: brush-type, magnetic, and optical. In the intermediate resolution range (13 bits, or so), the brush type has been unbeatable with respect to simplicity, flexibility, and economy. Clearly, no other design technique has provided as clean an on-off indication with favorable impedance levels as a brush on a commutator which opens or closes an electric circuit. With suitable logic circuitry, a good variety of linear and non-linear output codes is generated. Size 18, two-speed, brush-type encoders, with high and low speed code discs rotating at a speed ratio of 64:1, typically develop a total count of 2^{13}. The major deficiency in the brush-type unit is the relative unreliability of the brushes, with life measured in some millions of revolutions at hundreds of rpm.

For really high resolution (19 bits and more in a single turn), the optical encoder has the advantage. These find wide application in precise positioning and data transmission systems where angular inaccuracies are measured in seconds of arc. The optical encoder requires more complex electronics than the brush type and its reliability is limited by the reliability of the internal lamps.

Unfortunately, the lack of reliability of the brush-type unit is a major draw-back, even though some manu-

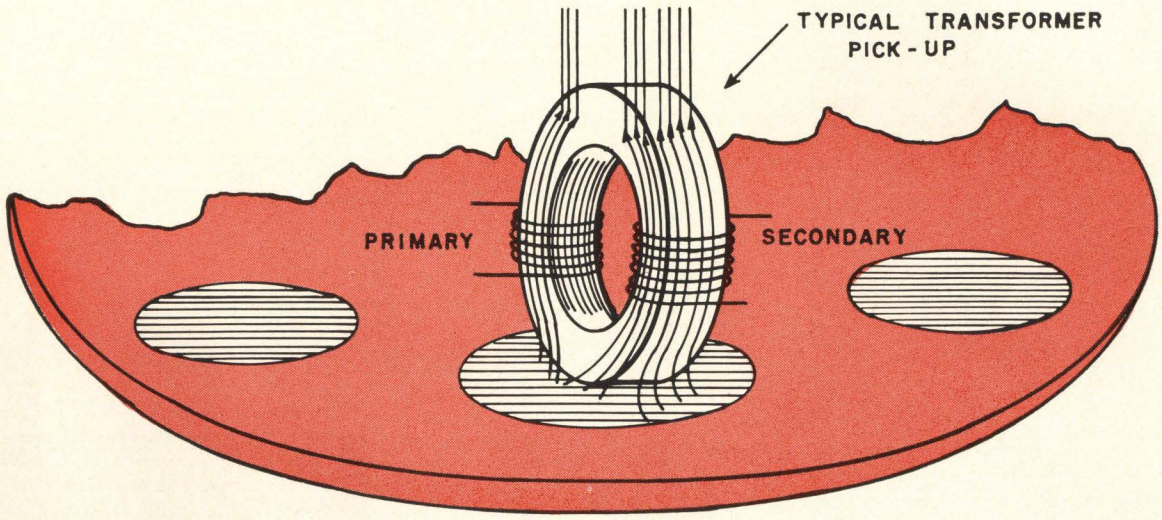


Fig. 2 Magnetic circuit of conventional magnetic encoder. Read head position illustrates saturation of core by flux from disc spot.

facturers now claim 10 or more million cycles, as compared with previous performance of about 2 million. With today's emphasis on reliability, the brush-type encoder often sets the limit to system performance. Furthermore, the use of multi-turn units for increased resolution means high operating speeds (on the 64-speed shaft of the example above, for instance). For a 300 rpm limit on code disc speed, an output speed of 5 rpm (on the 1-speed shaft) would be maximum. Above these maximum speeds, the encoder may miscount, and wear becomes excessive.

Because of limits to the reliability of brush-type units, emphasis has been placed in recent years on so-called *magnetic encoders*, where no sliding contacts are required. The performance of these has been essentially based on the magnetic circuit concept of Fig. 2. Here, a small transformer is used as an effective substitute for a brush — the primary is excited, and the output is taken from a secondary winding. The rotating code wheel is made of permanent magnet material, with alternating areas of strong magnetization and unmagnetized areas describing a pattern on its surface. A magnetized area in the vincinity of the "pickup" transformer saturates the transformer so there is no output. Moving the code wheel so that a non-magnetized area faces the transformer leads to a generated output voltage in the transformer secondary. The presence or absence of transformer voltage corresponds to the desired binary output.

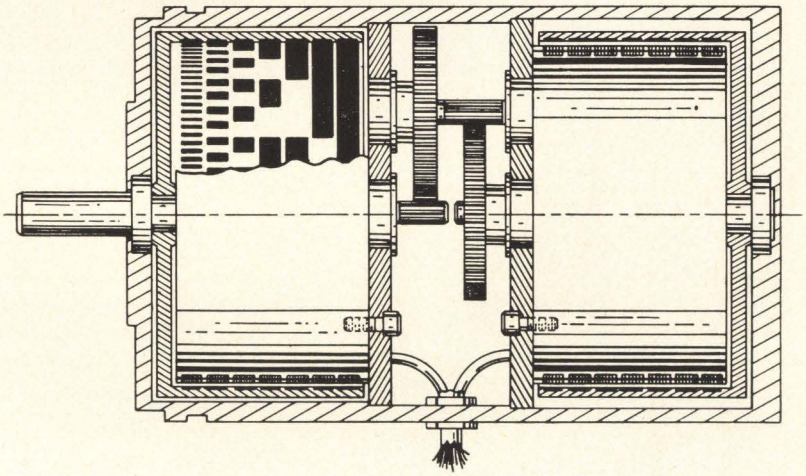
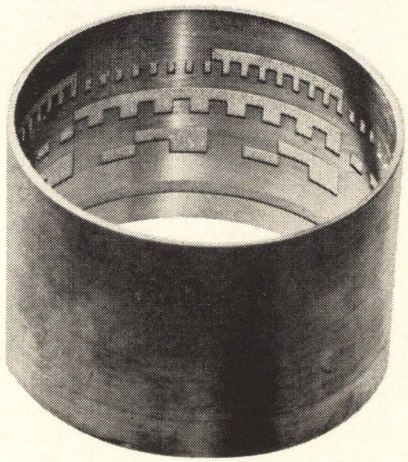
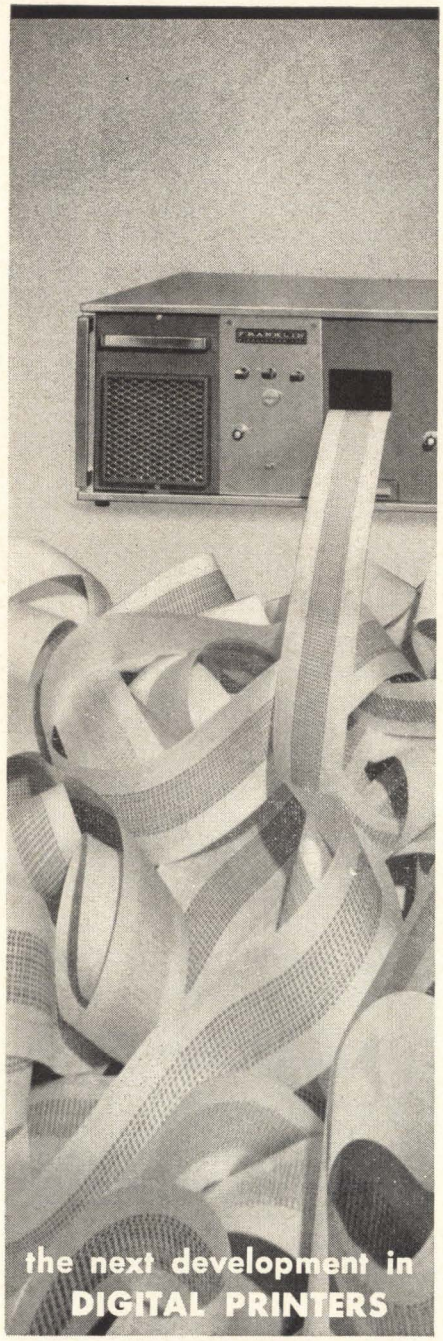


Fig. 3 Basic construction features of the new magnetic encoder that provides 13-bit resolution in 64 turns. This novel unit uses drums with variable reluctance code patterns etched on. One such typical drum is shown here.



The magnetic encoder, based on the above principles, offers interesting possibilities. Life of thousands of hours at thousands of rpm is easily attained. The main limitations are cost and resolution. The individual transformer windings are expensive to install and hard to adjust. Leakage fluxes limit the ratio of binary one to binary zero outputs, and design



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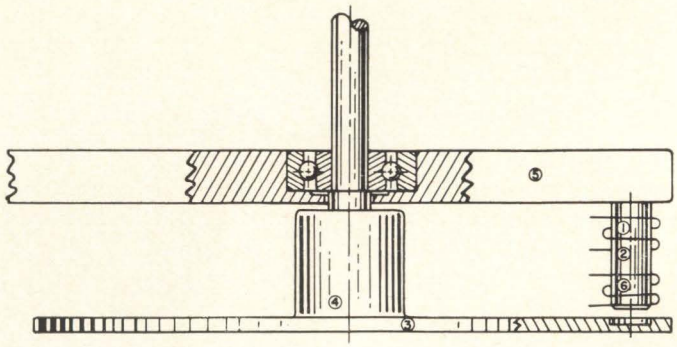

Fig. 4 Theory of operation of the new "Fast" magnetic encoder. In any transformer the transformation ratio can be controlled by varying the number of flux lines, due to primary current, which link with the secondary winding. This is most conveniently accomplished by controlling the magnetic permeability of the space surrounding the two coils. Thus, for instance, one can improve the coupling of an air-core transformer by introducing an iron slug into it. This is exactly what happens in the variable reluctance, two-winding transformer of the "Fast" magnetic encoder. In the above figure, excitation of winding 1 causes an mmf to be impressed on the magnetic circuit consisting of core 2, code disc 3, hub 4, and bridge 5. The flux in this circuit will then be dependent on its reluctance. But the reluctance is a function almost exclusively of the air gap at the core tip, and this is varied by the presence or absence of a recessed portion on the code disc. Thus, one has flux through the pick-off winding 6, which is a function of the code pattern on the disc. Since the flux is ac in character, a voltage will be induced in the pick-off winding as a function again of the code pattern. Either a disc or a drum can be used for the code number.

features tending to improve this ratio generally lead to poor resolution. Furthermore, the signal levels from the magnetic encoder are low and require considerable additional electronic circuitry.

Notwithstanding these limitations, the good features of the magnetic encoder are so substantial that a major effort is being made to overcome the disadvantages by improved magnetic circuit design. Atlantic Instruments and Electronics, Inc., of Boston, Mass., using designs developed at Machine Tool Automation, Inc., of Southport, Conn., has made major strides in the development of the magnetic encoder by utilizing familiar circuitry used in magnetic pick-off devices as the basis for the "magnetic brushes". This new design is called the "Fast" magnetic encoder, derived from the descriptive phrase "Flux amplitude switching transformer". In this design, *soft iron* transformer-like lamination stacks are fixed to the frame of the encoder, while the rotating disc (or equivalent drum) serves as a soft iron variable reluctance member (such as the "I", for example, of an E-I pickoff). Only low-cost, reliable, bobbin-wound coils are used, permitting large numbers of turns, and wide control over impedance and voltage levels. The efficient magnetic circuit design means high output, minimum leakage flux, and good resolution. The reluctance pattern on the code wheel is easily obtained, at low cost, by an etching process. Excellent signal-level ratios, as well as high output voltages, are obtained for the binary output levels. All the code outputs of the brush-type unit are obtainable from the "Fast" magnetic encoder. Fig. 3 shows the basic construction features of the Fast encoder, and Fig. 4 briefly describes its operation.

This new pick-off design, in effect, puts the magnetic encoder in direct competition with the brush unit, but with just about all life problems resolved. Life is now limited essentially by the bearings, much as in most inductive rotating devices.

Circle No. 107 on Inquiry Card

GOVT. REPORTS

LOGIC DESIGN RESEARCH

Threshold logic and ternary logic are discussed in a new report on one phase of research on automatic computer electronics. Described are theoretical results on synthesizing threshold functions by means of orthogonal expansions, Boolean techniques, and decomposition methods. Design techniques which consider constraints imposed by practical circuit considerations are also covered.

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DIGITAL ANGULAR ACCELEROMETERS

An angular accelerometer was designed to provide digital readout. This report discusses its actual and potential performance, cites advantages and disadvantages, and compares new unit with a high-accuracy gyro. It has a detailed analysis of transducer, electrical-circuit, and digitalization errors and ways of reducing them.

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MICROCIRCUITRY IN A TYPICAL LOGIC FUNCTION

Feasibility of the use of single-chip integrated circuitry was established in a study of a binary-to-decimal converter. The converter is capable of decoding, simultaneously, two 12-bit words (coordinates X and Y) transmitted from a device which simulates realistically the transmission of coordinate data words between the unit computer and the display consoles.

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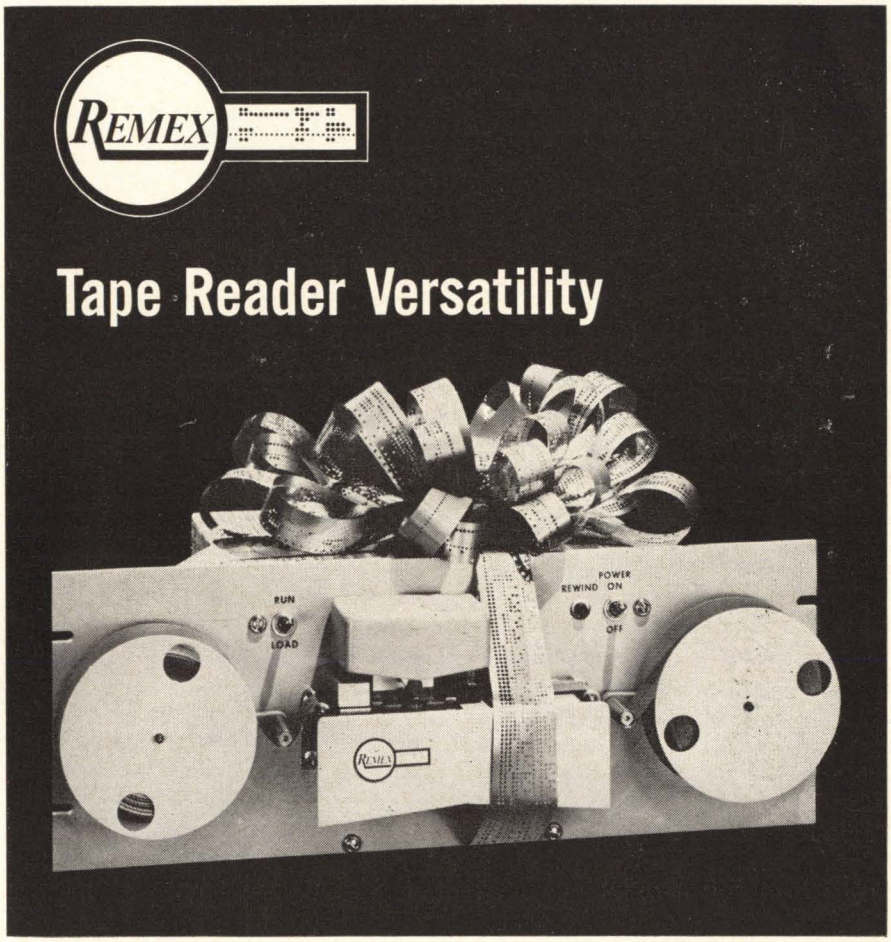

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NEW PRODUCTS

DELAY PROGRAMMING SWITCH

For applications requiring a command pulse, a program step, a prescribed waiting period, and a second program event, a new programming switch contains a built-in delay circuit. Accuracy of the delay can be specified within 5ms. The switch may be specified for as many as 240 discrete program positions on the memory drum. It can control up to 51 electrical circuits, each seeing a different series of program patterns. Detailed literature is available. Sealectro Corp., Mamaroneck, N.Y.

Circle No. 146 on Inquiry Card

DIGITAL TRANSMISSION UNITS

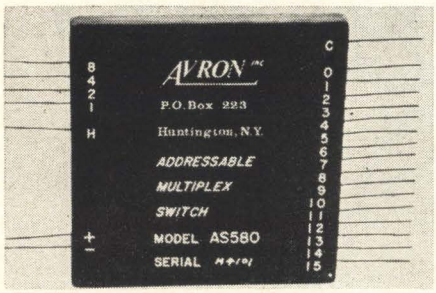
New line of digital data transmission equipment is said to offer data rates up to twice those currently available. The new models are designed for use on 3,000-cycle, 48-kilocycle and 240-kilocycle communication channels. In configurations arranged for maximum data rates, the 3,000-cycle units are capable of transmitting 6000 bits-per-second, the 48 kc units transmit 96,000 bits-per-second, and the 240 kc units have a capability of 480,000 bits-per-second. Collins Radio Co., Newport Beach, Cal.

Circle No. 177 on Inquiry Card

AUTOMATIC FILM READER

New device automatically "reads" data from 16mm film and renders an output in digital form. Unit can be used for automatic readout of sequential photographs of simple pointer type gauges or more complex instrument arrangements where a number of measurements are simultaneously recorded on each film frame. Projected film images are scanned photoelectrically and the film automatically advances after each frame scan. Output will operate conventional digital readout equipment. MacLeod Instrument Corp., Ft. Lauderdale, Fla.

Circle No. 136 on Inquiry Card



SOLID-STATE MULTIPLEXER

Ability to switch multiple outputs in any desired or changing sequence is provided by a new solid state multiplexer for industrial and laboratory monitoring, control, and data gathering applications. The multiplex switch incorporates in a single 4 by 4 by ½" encapsulated package, all the functions, according to the company, that previously required a separate diode matrix amplifier, and relay bank. The module may be used as an output device for data display or channel selection from a single input. The new multiplexer provides 16 switched outputs, controlled by four input lines operating from straight binary signals. Operation, accordingly, is "addressable", with closure of the various output channels determined by the input intelligence. A fifth input, the "Inhibit", opens all contacts and permits the binary address feature to be maintained when several switches are used together to increase the number of channels. A noteworthy feature of the unit for many industrial applications is its ability to operate at any single negative or positive voltage from 6 volts to 10 volts, with a constant current drain. As a result it may be operated from any higher voltage source through a simple dropping resistor. The operating threshold voltage is maintained at 50% of the net supply voltage. Suitable mother cards and compatible logic modules are available for use with these switches in complex control, measurement or monitoring functions. Avron, Inc., Huntington, N.Y.

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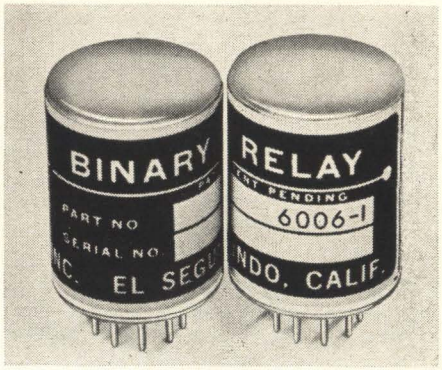

HIGH SPEED BINARY RELAY

A DPST, 9 pin, plug-in unit combines a new concept in positive contact wiping action with a high-speed (300 μsec), two position, mechanically-latched actuator. The armature of the "binary relay" is driven to one of two stable positions by a ± voltage drive pulse of 300 microseconds' duration, and then contained in either position by permanent magnetic means. Since the drive pulse is turned-off prior to contact closure, noise, due to electromagnetic and electrostatic coupling, is eliminated. Furthermore, the average drive-power required is reduced to almost zero and the undesirable spring-return is eliminated. The positive wiping action of the gold alloy contacts is said to ensure constant and low interface resistance (microhms) and to eliminate bounce. It is designed to meet the low-level and high-speed switching requirements of data acquisition and data transfer equipment. Data, Inc., El Segundo, Cal.

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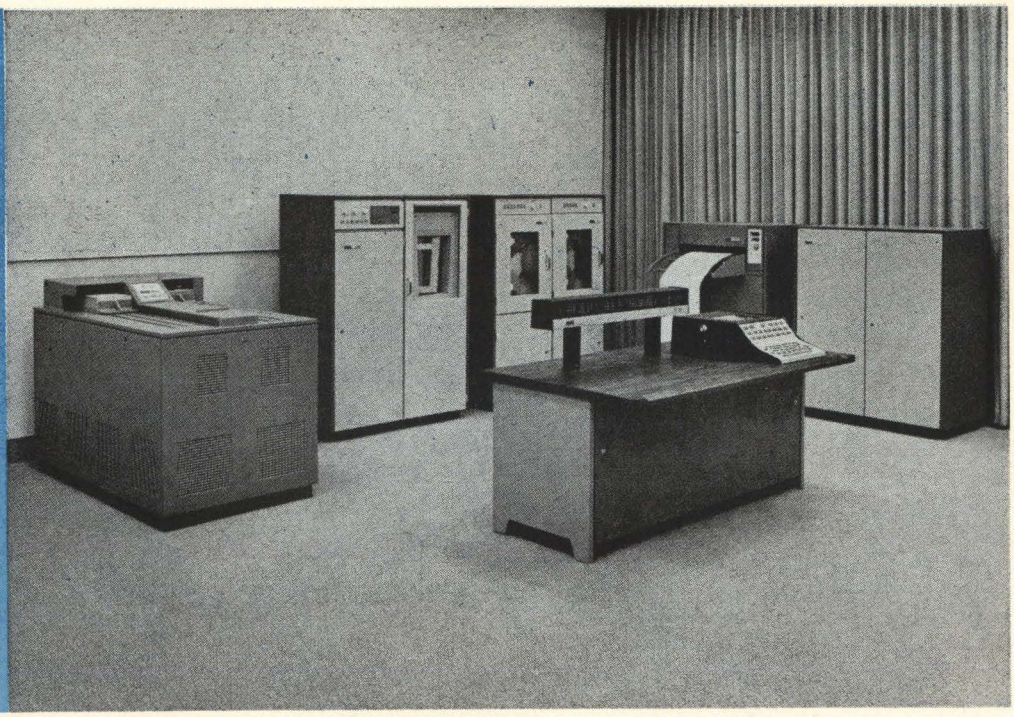
ACROSS-THE-BOARD OPPORTUNITIES IN DIGITAL SYSTEMS AT NCR, LOS ANGELES



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Experience in analyzing requirements to prepare functional specifications for processors, controllers, buffers, peripheral equipment, random access memories, etc. Knowledge of logical design and programming helpful, essential at higher levels, where candidates should also have heavy experience in advanced system design—multiprogramming, list processing machines, complex on-line systems, or other specialties.

On-Line—Intermediate and Senior

Experience in analyzing requirements and preparing functional specifications for on-line systems and selected devices. Should have good knowledge of data transmission techniques, and be able to carry out studies of traffic loads, scanning and polling schemes, etc. Knowledge of programming and elementary logical design essential.

Evaluation—All Levels

Experience in preparing comparative analyses of data processing system, using analytic techniques including queuing theory and simulation. Knowledge of programming essential.

PROGRAMMERS

Software—All Levels

Requires experience in designing and writing compilers, operating system, generators, etc.

Research—Senior Level

Must have extensive experience in advanced programming techniques and applications such as list processing systems, syntax-directed compiling, information retrieval system, and natural language processing.

Design Automation Programmer

This position requires a man who has had previous experience in programming, for design automation. Requires an understanding of engineering and hardware problems. Bachelor's degree in math, engineering, or related fields required.

Advanced Mechanisms Specialist

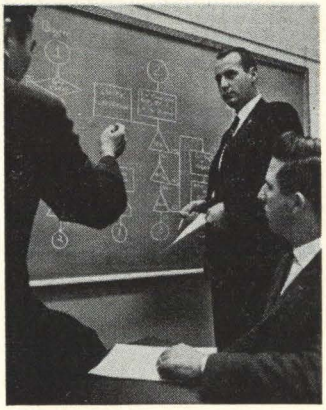
Position will entail analysis and advanced design of complex mechanisms and applied mechanics problems. Experience highly desirable in design of computer peripheral equipment, such as disc files, drums and drum memories; floating-head background helpful. Should be equally skilled in mathematical analysis and laboratory measurements. PhD preferred.

Systems/Communications Designer

This senior position will involve analysis and advanced design of on-line, real-time systems. Requires BSEE, MSEE desired, with good knowledge of digital computer technology.

Advanced Magnetic Recording Specialist

Intermediate to senior engineer with BS degree, MS desired, with 3-4 years' experience in advanced magnetic recording techniques. Requires detailed knowledge of media, circuitry and magnetic head design.



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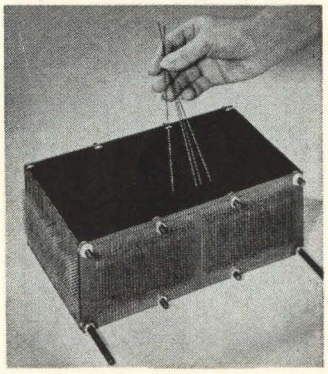
Intermediate and Jr. Computer Engineers

Experienced graduate EE's with 3 to 5 years in logic design and transistorized circuit design of digital equipment. Assignments



will entail logic and circuit design of buffer storage units and digital peripheral equipment.

INTERVIEWS AT THE FALL JOINT COMPUTER CONFERENCE, SAN FRANCISCO, OCT. 27-29

To arrange an appointment, call Ed Free during FJCC at the conference hotel, 362-3021. If you are not attending FJCC, please send resume immediately, including training, experience and salary history, to Bill Holloway, Personnel Department, or telephone collect.

The National Cash Register Company

NCR

ELECTRONICS DIVISION
2815 W. El Segundo Blvd.
Hawthorne, Calif.
Telephone: Area Code 213-757-5111

an equal-opportunity employer

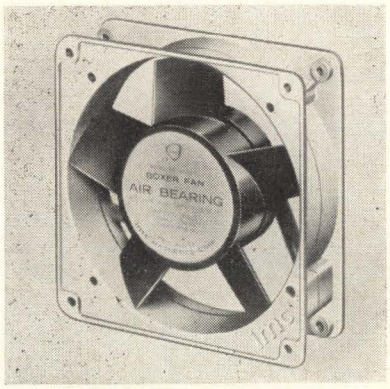
CIRCLE NO. 902 ON INQUIRY CARD

NEW PRODUCTS

CARD RECEPTACLE CONNECTOR

New single-side card receptacle connector provides 36 contacts on 0.100" centers for microminiature uses such as computer circuitry. The new connector is said to accommodate the 36 contacts in the same area normally accommodating only 24 contacts on 0.156" spacing centers in an overall insulation body length of 4½". The connector has two 0.142" diameter mounting holes and is 0.458" high. Methode Electronics, Chicago, Ill.

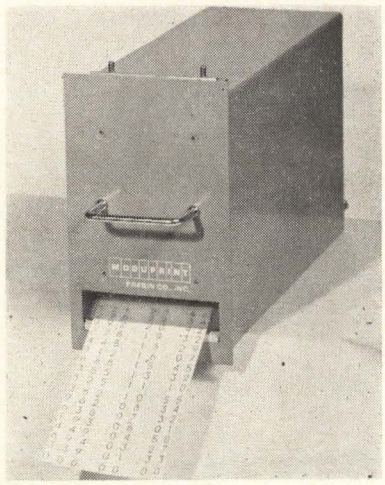
Circle No. 156 on Inquiry Card



"NO-WEAR" FAN

Said to be completely free of bearing wear and able to operate almost indefinitely, a new air-bearing fan is, according to the manufacturer, the first fan of its type ever developed for commercial use at commercial prices. Available at under $20.00 each in production quantities, the "Boxer" fan is 4-11/16" square and 1½" deep, with a metal frame to withstand breakage. Rated for operation over a range of −55C to +80C, the unit has a life expectancy of at least 100,000 starts and stops, or more than 20 years on an average of 10 starts and stops a day. Electrically it is rated for 115 volts, 50/60 cps, single phase. In free air, it delivers 115 cfm which is said to be 15 percent more than available equivalent types. The "Boxer" is suitable for all types of electronic cooling including computers. IMC Magnetics Corp., Eastern Division, Westbury, N.Y.

Circle No. 182 on Inquiry Card



DIGITAL TIME PRINTERS

New tape or card printers were designed for printout of accumulated or entered time plus serial or parallel input data. Range is from tenths of seconds, to minutes, hours and days of the year, with a total number of 9 digits. The smallest frame size registers on 2½" tape, and up to 20 digits on 6" tape for the largest. Printing time is 100 milliseconds; maximum stepping rate is 80 per second for the data section and 3 lines per second for printing. Reset time is 250 milliseconds. Standard adding machine and typewriter ribbon tapes are employed and control sections may be included within the unit. Presin Co., Inc., Bridgeport, Conn.

Circle No. 167 on Inquiry Card

MAGNETIC COMPUTER TAPE

According to the manufacturer, a new magnetic computer tape offers more durability, longer life, and lower operating cost than any other tape available. Based on a new, proprietary formula, this tape meets or exceeds the specifications of all widely used computer systems, says the company. It also is covered, the company reports, by the longest guarantee in the industry: 30 days' additional life beyond the normal "Read-Pass" guarantee given by other tape manufacturers. New coating formulation is said to produce a smooth coated surface of extremely low abrasive quality resulting in extended life for computer heads. U.S. Magnetic Tape Co., Huntley, Ill.

Circle No. 150 on Inquiry Card

TUNNEL DIODES

A new line of silicon tunnel diodes consists of JEDEC Types 1N4393 through 1N4399 with peak current ratings of from 0.47 to 100 ma. These new devices are said to offer extreme stability over a wide temperature range, and feature closely-controlled electrical and mechanical tolerances. These tunnel diodes are specifically designed for applications in low-level, high-speed switching circuits where operating temperatures may vary from −65C to +150C. Heliotek, Div. of Textron Electronics, Sylmar, Cal.

Circle No. 147 on Inquiry Card

DIGITAL MODULES

All-silicon digital circuit modules operate at a frequency range of dc to 5 mc and have a delay time of only 25 nanoseconds. The line includes flip-flops, AND and OR gates (with NAND and NOR capabilities), amplifiers, clock generators, gate expanders, and inverters. Worst case design techniques and extremely conservative component derating increase reliability of the modules. Special attention has been given to noise rejection — the circuits, according to reports, reject twice as much noise as competitive units. Model FL21 with four gated JK flip-flops costs $136. Scientific Data Systems, Santa Monica, Cal.

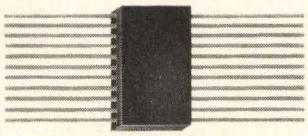
Circle No. 163 on Inquiry Card

COMPACT POWER SUPPLY

Power modules provide 650 watts from a size of 5⅛" high x 5½" wide and 17" deep and are available with panels, meters, slides, and rack-adapter. These solid-state dc power supplies have an output of 0 to 20 amps over the continuously adjustable range of 24 to 32 volts dc. Regulation is 0.1%, line and load combined. Units are said to have unique self-protective features — there are no positive output voltage transients under any conditions, and the supplies are protected against all overloads. Chalco Engineering Corp., Gardena, Cal.

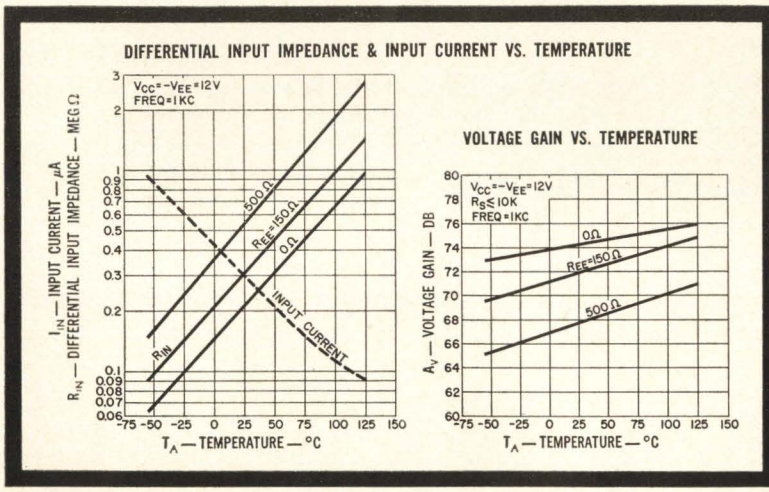
Circle No. 179 on Inquiry Card

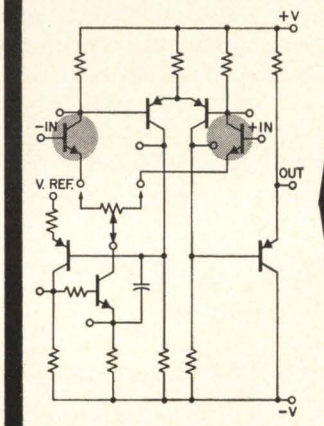
NOW... A Microelectronic Differential Amplifier with an Input Offset lower than any other... anywhere!

This  is it.

PC-201
(actual size)

(plus a Common-Mode Rejection Ratio > 100 DB)





ONE SECRET of the extreme stability and high performance of the General Instrument PC-201 Differential Amplifier is the exact matching of two 2N930-type input transistors, **shown in the shaded areas,** with an initial V_{BE} match typically 1mV (Industry Standard, 10mV) and a V_{BE} match with temperature, typically 5μV/°C from −55°C to +125°C (Industry Standard, 25μV/°C). Incidentally, such matched transistors are available as duals for your own custom-designed circuitry, on order.

BECAUSE GI's advanced Multichip technology permits exact matching of discrete components such as transistors (a technique impossible in conventional monolithic microcircuitry) —

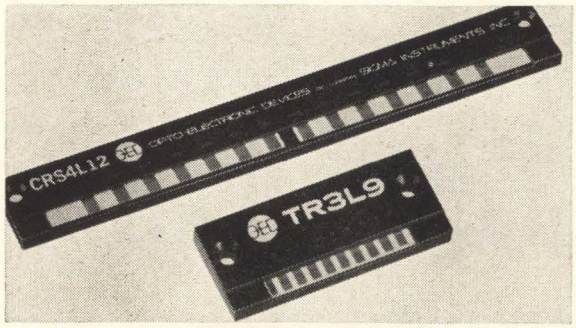
AND BECAUSE (unlike bulky, conventional circuit-boards) matching parts are so close together physically, no significant temperature gradient exists between them —

AND FOR a variety of other significant reasons inherent in GI's Multichip know-how, this General Instrument ultra-linear, high-stability Differential Amplifier achieves performance characteristics not only hitherto impossible in any integrated circuit, but largely impossible in conventional circuits of any size! Complete specifications and data are available on request.

GENERAL INSTRUMENT CORPORATION
SEMICONDUCTOR PRODUCTS GROUP
600 West John Street, Hicksville, New York

CIRCLE NO. 23 ON INQUIRY CARD

NEW PRODUCTS



PHOTOCONDUCTIVE READ HEADS

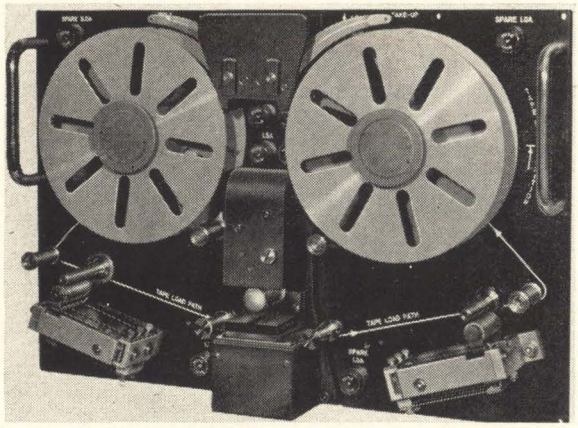
For use in card and paper tape reader equipment, six photoconductive read heads convert punched card and paper tape data to electrical impulses. The units are said to offer a totally new approach to photoelectric sensing featuring higher signal-to-noise ratios, simplifications of associated electronic circuitry, and component and system economy, packaging, and reliability. Fast dynamic response types are available for sensing over 1000 holes per second or moderate dynamic response types for reading over 500 holes per second. All are constructed as complete multiple photoconductive cell arrays and are assembled on compact aperture plates in configurations designed for standard IBM 12-row serial (Series CRS) and 80-column parallel (Series PCR) punched card reading, as well as for 9-channel paper tape reading (Series TR). Switching ratios as high as 500 to 1 are obtained by selecting photocell peak spectral response to minimize the signal developed from infrared light transmitted through standard card and paper stock. Opto-Electronic Devices, Inc., Sub. Sigma Instr., Braintree, Mass.

Circle No. 164 on Inquiry Card

PROCESS CONTROL COMPUTER

With a memory rated at 2 microseconds, General Electric's new GE/PAC 4060 is termed the fastest computer designed specifically for process control. Its speed provides extra capacity for off-line process studies, order scheduling, and process data collection. Powerful programming features are incorporated in the design, including circular list processing, variable-field arithmetic, and the ability to use every word in memory as an accumulator. In addition, the GE/PAC 4060 computer is compatible with present GE/PAC equipment and is built from standard GE/PAC 4000 functional modules. A user can tailor his initial purchase to his exact immediate requirements, and then later expand computer functions at his site when needed. These standard packages include choices of core memory sizes, automatic program interrupts, multiplexing of memory, input-output controllers, input signal conditioning, and various types of peripherals. Internal circuits are diode NAND logic using silicon semiconductors which give it an ambient temperature range from 32 to 131F, without refrigeration. GE/PAC 4060 computer uses digital, binary, fixed point arithmetic, with 24-bit word size. Special instructions provide high-speed floating-point arithmetic. Core storage is dierctly addressable, access time is less than one microsecond, with memory read-write cycle of two microseconds. A completely new concept in logic commands is said to provide major advantages in real-time process monitoring and control. Process Computer Section, General Electric, Phoenix, Ariz.

Circle No. 159 on Inquiry Card



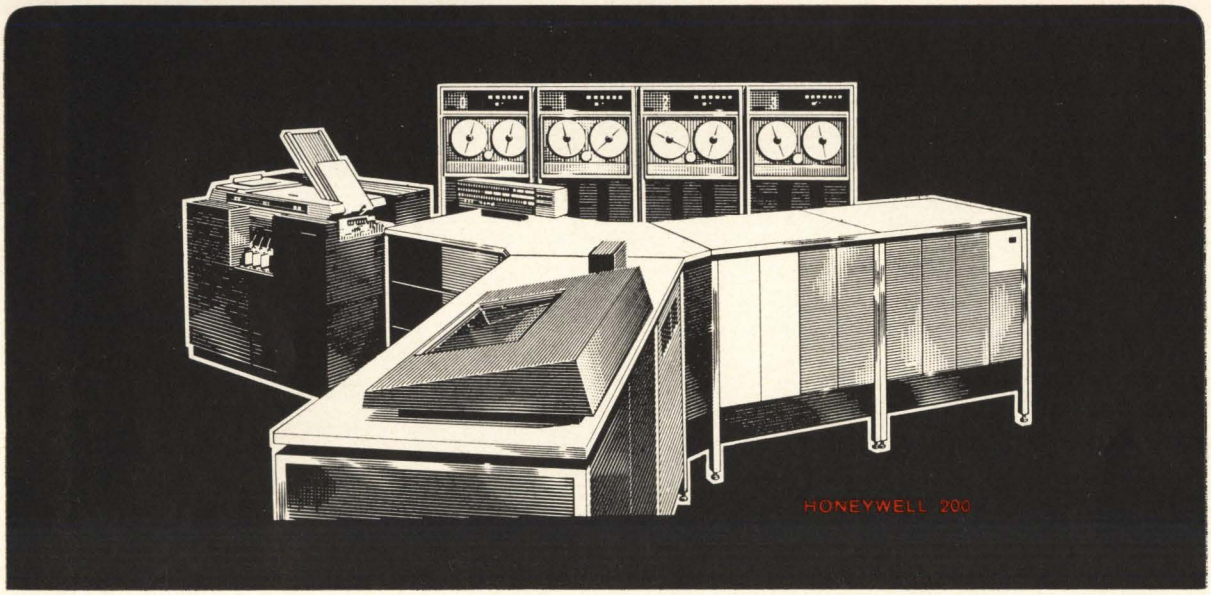
TAPE READER/SPOOLER

Militarized perforated tape reader and spooler operates bidirectionally at 200 characters per second. A photoelectric tape handler with silicon reading head, the unit is easily adaptable to system requirements. Self-contained, regulated power supplies, amplifiers and start/stop circuits are completely transistorized with silicon semiconductors. Information and sprocket channel amplifiers contain individual sensitivity adjustments. All operations are externally-controlled. Designated the PSR-200, the reader and spooler is designed to meet applicable environmental requirements of MIL-T-21200C for Class 2 equipment. Specifications include standard tape speed, 200 characters/second; rewind speed, 300 characters/second (minimum), 450 characters/second (nominal); rewind time, less than 3 minutes for 500 feet; storage capacity, 500 feet of 2.5 mil tape (maximum); number of channels, 8 standard, 5, 6, or 7 optical; start time, 30 milliseconds to read next character over complete temperature range. Potter Instrument Co., Plainview, N.Y.

Circle No. 154 on Inquiry Card

Honeywell
uses CTC memory
test systems

and so do its
core and stack
suppliers



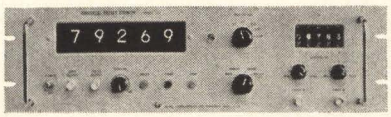
...those who build the
most reliable digital systems
standardize on
CTC test equipment

COMPUTER TEST CORPORATION
CHERRY HILL, NEW JERSEY

CIRCLE NO. 22 ON INQUIRY CARD

WANG DIGITAL SYSTEMS ENGINEERING

UNIVERSAL PRESET COUNTER
MODEL 2019



SPECIFICATIONS:

A. **Sensitivity:** 100 mv to 10 volts RMS Channels A & B.
B. **Inputs & Controls:**
(1) Two Channels, A & B, by BNC Connector on front panel.
(2) Sensitivity & Test Controls on front panel for Channels A & B.
(3) **Time Base Multiplier Control:** 5 position switch in units of seconds, for 1, x 10, x 100, x 1000, and x 10,000.
(4) **Function Switch:** 4 positions for:
(a) Rate (for frequency, rate and ratio N x A/B) 2 cps to 300KC on input A for rate. For ratio, 2 cps to 300KC on input A; input B, 2 cps to 100KC on x 1 and to 300KC on x 10, 100, 1K, and 10K.
(b) **For Time Interval & Period Measurements:** 2 cps to 100KC on input A; to 300KC on x 10, 100, 1K, & 10K.
(c) Count (for manual count control) Input A 2 cps to 300KC.
(d) Preset Gate (for batch and preset counting) 2 cps to 100KC on Input A; to 300KC on x 10, 100, 1K, & 10K.
(5) **Reset, Start & Stop:** By front panel push buttons and rear panel connectors.
(6) **Display Control:** Continuously adjustable from .2 to 5 seconds and infinite position.
(7) **Preset:** 5 decades of in-line Digital Switches on the front panel for control of Input A.
C. **Output:**
(1) Four line 1-2-4-8 BCD suitable for peripheral equipment.
(2) Gate Output for Time Base & Pulse Output when reaching end of preset count available on rear BNC connectors.

REVERSIBLE COUNTER AND OPTICAL ENCODERS

Standard Features:

- 3-6 Decades plus Sign
- Transistorized
- NIXIE readouts
- DC to 200kc frequency
- Compact—5¼"H x 19"W x 15"D
- Function to:
  a. add and/or subtract counts directly
  b. add and/or subtract counts on "gate" command
  c. inhibit, with no count

Many other modifications available. Consult factory for details.

NON-CONTACT ENCODERS

- Available with Incremental, Direction Sensing Outputs, and Non-ambiguous. Absolute Outputs.
- Resolution covers from 1 to 1000 parts per turn and up to 10,000 turns.
- Size: 2" to 4"D & 1.5" to 6"L.

Wang Laboratories, Inc.
NORTH STREET • TEWKSBURY, MASS.
617-851-7311

CIRCLE NO. 24 ON INQUIRY CARD

NEW PRODUCTS

TAPE TRANSPORT

A new magnetic tape transport is said to be a low cost unit providing many features found only in higher priced units. The new transport uses one-half inch tape with multiple recording channels. Dual-gap head construction provides read-after-write capabilities as well as format compatibility with existing company's transports. The system uses vacuum columns and photo-electric monitoring to provide minimum tape tension. The tape runs at 37.5 inches per second. Recording densities are 200 and 556 bits of digital information per inch, providing transfer rates of 7500 and 20,850 characters per second respectively. Other basic features include a hi-speed rewind, separate manual control panels for operation and maintenance testing, and full computer control with no programming restrictions. Control Data Corp., Minneapolis, Minn.

Circle No. 135 on Inquiry Card

PUNCHED TAPE READER

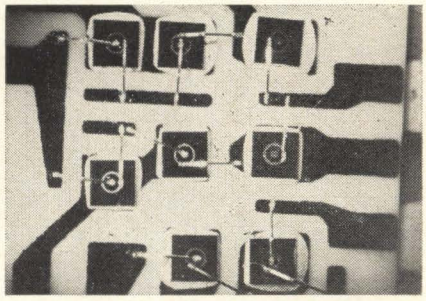
Photoelectric punched tape reader, Model 92, was designed for "on-line" service in computer, communication, and control applications. The new unit has "stop on character" capability, and fast stepping rates, and is designed to Minuteman missile and MIL-E-4158B specifications. The reader has a 200 character-per-second, bi-directional reading speed and a 600 character-per-second, bi-directional search and rewind speed. Stepping rate is asynchronous at any rate up to 80 characters-per-second at reading speed. It will stop on the "stop character" at speeds up to 200 characters-per-second, and will stop on the next character at speeds up to 450 characters per second. Start time is 22 milliseconds to within 10 per cent of nominal speed. Cook Electric Company, Data-Stor Division, Skokie, Ill.

Circle No. 199 on Inquiry Card

GLASS REED RELAYS

Complete protection for a new Series 262 glass reed relays is provided by a steel snap-on cover and a special resilient shock-absorbing frame to which the leads are anchored. Ideally suited for printed board mounting, the relays are available in a variety of configurations, and offer operating times faster than 1.0 millisecond, low power consumption, long life (up to 100,000,000 operation) and a selection of coil voltages. The contacts are rated up to 250 volts maximum and 4 watts minimum. Minimum breakdown voltages are as high as 300 volts rms. Wheelock Incorporated, Long Branch, N.J.

Circle No. 141 on Inquiry Card



HYBRID CIRCUITS

Company will mount transistor or diode chips to customers' thin-film or to any other type substrate. Using an advanced method of ultrasonic lead-bonding, corrections can be made at temperatures as low as 80C. The company is also able to provide multi-chip devices in a variety of packages, including a flat glass pack. Continental Device Corp., Hawthorne, Cal.

Circle No. 139 on Inquiry Card

DIGITAL INDICATORS

Digital indicator has 1 inch characters and is said to give excellent readability at 60 to 70 feet. It was designed for ground and process control and can be supplied with many options, including integral driver — decoder circuits and independent feedback. Patwin Electronics, Waterbury, Conn.

Circle No. 123 on Inquiry Card

INTEGRATED CIRCUIT CAPACITORS

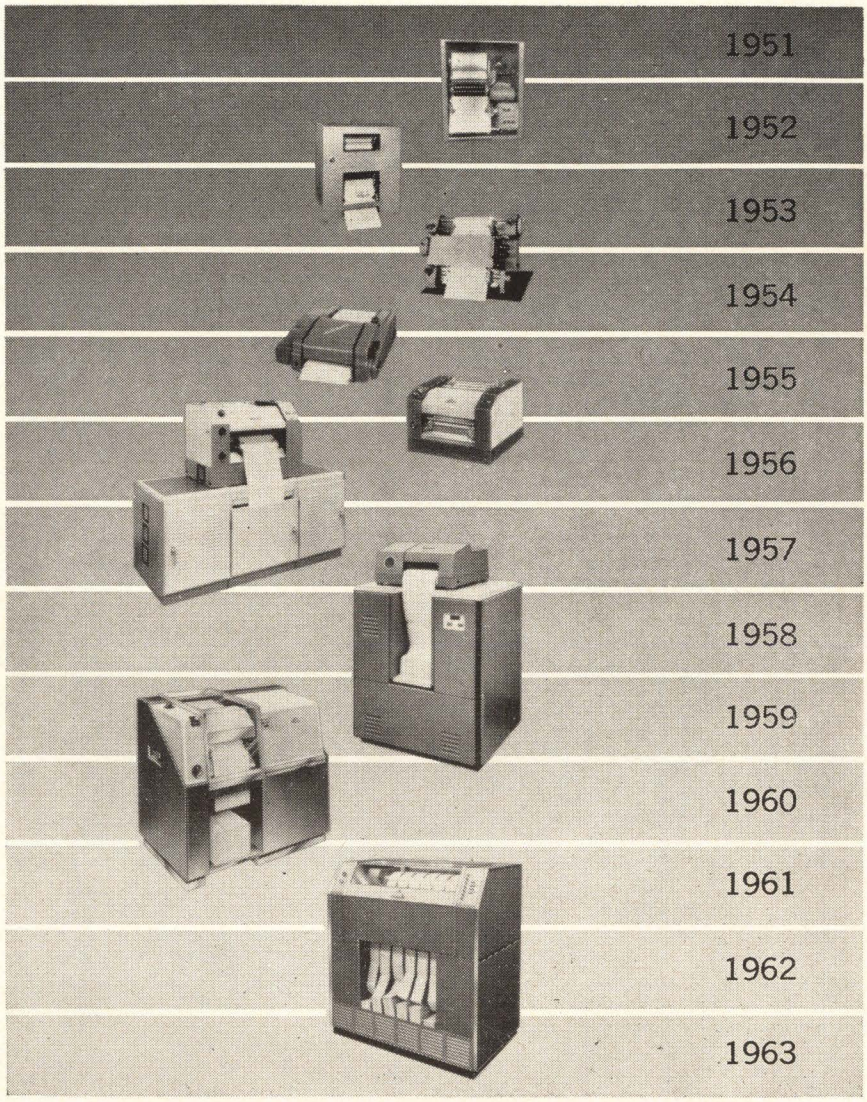
Layered construction, uncased "Ceralam" capacitors are said to offer several advantages for application to integrated circuits. Because of the dense, stacked structure, Ceralam capacitors have a higher capacity to volume ratio than other ceramic capacitors. Any geometric configuration is possible so that Ceralam capacitors may be readily fitted to any packaging requirement. Ceralam capacitors are available with either axial or radial leads of tinned copper, weldable and weldable/solderable alloy materials. Capacitors can be mounted directly on to the circuit substrate. Hi-Q Division, Aerovox Corp., Olean, N.Y.

Circle No. 127 on Inquiry Card

SYNCHRO EQUIVALENT TRANSLATOR

Solid-state "Synchro Equivalent Translator" employs time-shared multiplexing to convert many channels of synchro or resolver data to digital format, and vice versa. It is designed for use in computer-controlled systems where sensors or transducers are analog (synchro or resolver), and the computer is digital. The Servoset, as it is called, can handle from one to more than 100 channels in any mode and is capable of conversion to digital at speeds of 100 microseconds, and conversion to synchro, resolver, or dc sine and cosine at 25 microseconds. There is no restriction for initiation of a conversion in any mode, and any sequence of channel selection or mode can be employed and changed at will. Internal programming can also be provided. Accuracy of 11-bit single speed can be maintained with reference line voltage and frequency variations up to 20% of nominal. Servo Corp. of America, Analog/Digital Products Div., Hicksville, L.I., N.Y.

Circle No. 145 on Inquiry Card



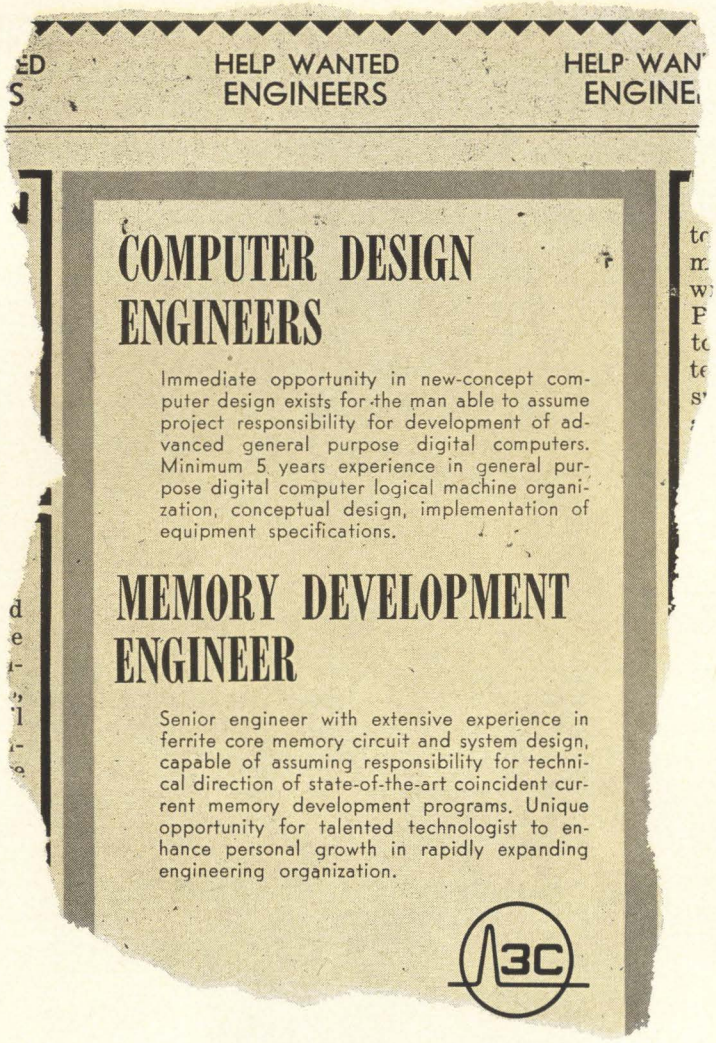
How to Select the Most Reliable Printer

Look first at the manufacturer's record and the standards he builds to. At Anelex, printers are designed for 10,000 hours of reliable operating life before major overhaul. △ And what is the record? More than 13 years ago, one of the first printers ever built was bought by the U. S. Government. Another early Anelex model stayed on duty 24 hours a day, 7 days a week, 52 weeks a year for 10 years . . . until it was replaced with a new Anelex Printer. △ Through five generations of printers, Anelex has consistently increased reliability with improved design and updated components. That's why today almost all major computer manufacturers and system builders consistently select Anelex Printers . . . for high speed, medium speed, low speed, communications, and any other common or uncommon application. Anelex builds them all and all of them are reliable. △ Anelex Corporation, 166 Causeway Street, Boston, Massachusetts 02114

ANELEX

Anelex® for Reliability

CIRCLE NO. 25 ON INQUIRY CARD



MEMORY CIRCUIT DEVELOPMENT ENGINEERS — nanosecond low current switching, high power ultra speed pulse sources, and wide band low level differential amplifiers.

CIRCUIT DEVELOPMENT ENGINEERS — digital and analog instrumentation, high power pulse generation, and delay line I/O circuit development.

COMPUTER SYSTEMS ENGINEERS — project responsibility for wide variety of special purpose digital systems utilizing 3C DDP computers as macromodules.

I/O DESIGN ENGINEERS — project responsibility for the specification of peripheral equipment and the design and release of interface for DDP computers.

COMPUTER PRODUCT DEVELOPMENT ENGINEERS — project responsibility for GP computer product release, design improvement, manufacturing support, and prerelease document control.

DIAGNOSTIC PROGRAMMERS — to specify, design, code, and debug diagnostic routines for digital computers and related peripheral equipment.

Computer Control Company has for over ten years been an established leader in the digital electronics industry with activities in the design and development of standard products, special purpose systems and general purpose digital computers. These challenging opportunities reflect 3C's growth profile. We are seeking responsible professionals to continue this corporate trend.

Qualified applicants are invited to send resumé to Mr. Michael C. Sandler for prompt action. Or circle reader service number 900 for more information about opportunity at 3C.

COMPUTER CONTROL COMPANY, INC.
OLD CONNECTICUT PATH • FRAMINGHAM, MASSACHUSETTS

An Equal Opportunity Employer

CIRCLE NO. 900 ON INQUIRY CARD

NEW PRODUCTS

WELDED MODULES

Circuit-module family consists of three low-cost units and is said to satisfy 99% of all digital logic reguirements. With the new circuits, called the EECO Q-Series, a flip-flop can be made quickly and easily for less than $5.00. Two Q-Series units can make a T flip-flop, a one-shot, a squaring amplifier, a free-running multivibrator, a pulse amplifier or a pulse gate. Modules measure ½" x 1", 1½", or 2", depending on the component. The complete family consists of a three-input NAND/NOR, a multicircuit, and a power driver. Modules are encapsulated, welded, and made of materials that meet high reliability standards. Input logic levels: 0 to −6vdc. Power required: −12vdc, +12vdc. Frequencies: 25 and 100kc. Circuits range in price from $1.57 to $2.94 in quantities of 100, depending on the model. Engineered Elec. Co., Santa Ana, Cal.

Circle No. 143 on Inquiry Card

SUBMINIATURE INDICATOR LIGHTS

Claimed to be one of the smallest, longest life indicator lights, a new subminiature unit contains fully moisture-proof, integral lamp and lens assemblies molded to stainless steel cases. Rated to consume 0.024 ampere at 28 volts, the units contain rugged incandescent filaments that operate for an average of 16,000 hours. The three types currently available all contain 10-32 mounting studs and stranded wire leads. Type L10,400 has a wide-visibility domed lens measuring only 7/32 inch in diameter by 9/32 inch beyond the panel. Type L10,500 has a stainless steel lens cap with a flat 0.200 inch diameter plastic face that can be engraved with a legend if desired. Lens of Type L10,-600 is flush with the panel surface when the unit is mounted in a countersunk hole. Control Switch Div., Controls Co. of America, Folcroft, Pa.

Circle No. 148 on Inquiry Card

READ/WRITE CIRCUITS

Four new circuit modules — a read amplifier, a write amplifier, a single-head select, and a multi-head select — are part of a complete family of modules designed for use in electronic interface packaging compatible with fixed — and flying-head magnetic drums and disc files. The Read Amplifier 8005 has been specifically designed for use in systems employing a modified return-to-bias (MRB) recording method. However, it can be utilized in systems employing a phase-modulation (PM) recording method providing no voltage dwell occurs in the playback or near the crossover. This read amplifier module will handle clock, index, and register inputs as well as general storage inputs from a read-write bus. In both these instances, the amplifier is capable of working with low-playback signals exhibiting poor resolution. The Write Amplifier 8010 contains two independent circuits and is custom designed for use with specific inductance recording heads. Each module is designed for use with any writing mode. The Single-Head Select Module 8020 contains 16 head select circuits with each circuit capable of selecting 10 heads provided write current is gated to only one of the selected heads at a time. The Multi-Head Select Module 8025 contains eight circuits, with each circuit capable of supplying the current requirements of eight recording heads operating in parallel. This configuration enables the one card to serve the writing and/or reading requirements of 64 recording heads in a memory system. Bryant Computer Products, Walled Lake, Mich.

Circle No. 155 on Inquiry Card

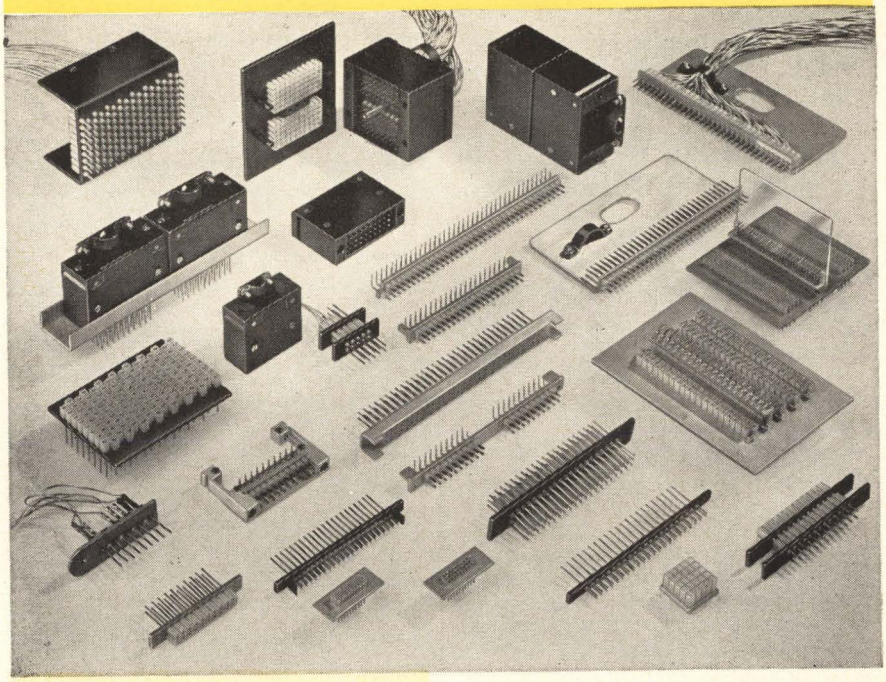
PULSE GENERATORS

All-solid-state pulse generator features a 10 cycle per second to 20 megacycle rep. rate with variable delay, width and amplitude; and voltage control of frequency, delay, width and amplitude. Simultaneous outputs of ±20 volts from a 50 ohm source have individual amplitude controls. Rise and fall time is less than 5 nanoseconds. Electro Design Inc., San Diego, Cal.

Circle No. 166 on Inquiry Card

Package Engineering Ideas by Malco

A New Modular Electronic Packaging concept . . . . . .



Made Possible By Wasp* Connectors

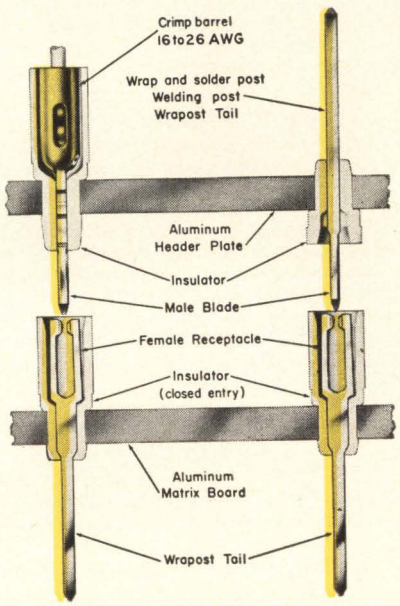
The unlimited versatility of the Wasp concept allows a "Complete Plug-In Modular Package" to be designed to your requirements. Variations in panels and terminal placements will give your products broad flexibility. Panel configuration can vary from a single row strip to an impressive 24"x 24" panel with up to 10,000 accurately spaced terminals. The use of the aluminum panel matrix gives the "Modular Package" exceptional mechanical stability.

FEATURES

- Flexible plug-in design
- High density of connectors
- High reliability
- Extremely accurate terminal placement
- Adaptability to high speed automatic wiring
- Superior electrical and mechanical characteristics
- Low cost

Ask for recommendations on your requirements. Request Bulletin 631 for general information.

*Wrapost Aluminum Systems Panel



SEE OUR EXHIBIT
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20th ANNIVERSARY

MALCO MANUFACTURING COMPANY, INC.
4021 West Lake Street, Chicago, Illinois 60624
Wasp CONNECTORS

CIRCLE NO. 26 ON INQUIRY CARD

logical designers with a

pro-clivity

FOR WORKING WITH THE MOST ADVANCED CIRCUITRY AND COMPONENTS.

You owe it to yourself to investigate new opportunities at UNIVAC-Twin Cities. The spirit of exploration is uncommonly strong here. New techniques and devices that flow from UNIVAC laboratories are never allowed to miss a minute of uptime. They are subjected to the test of practical application immediately. Check this list of UNIVAC specialties, now released from our labs, which you might consider incorporating in *your* logical design work, if you join us...

new techniques in meshing multi-processors that can increase general purpose computer capabilities nearly an order of magnitude... new connection and packaging techniques that go a long way to solve the systems problems of nanosecond logic circuits... new microelectronic integrated circuits... evaporated circuitry operating on low drive currents... techniques in overcoming radiation effects in space computer systems... real time data links... ground support and test recording devices.

Programs at UNIVAC in the Minneapolis-St. Paul Twin Cities area range from a system with an eventual capacity equal to 100 of today's largest real-time computers to miniaturized, radiation resistant computers to ballistic missile re-entry systems.

CURRENT ASSIGNMENTS OPEN TO LOGICAL DESIGN ENGINEERS WITH A BS OR MS DEGREE, PIONEERING VIEWPOINT, AND SOUND TECHNICAL BACKGROUND.

To perform logical design of high speed digital equipment using solid state circuitry and the logical design of systems taking into account the interfaces between the central computer and its input-output equipment.

For more information or to apply, send your resume to Mr. R. K. Patterson, Employment Manager, Dept. K-9, UNIVAC Division of Sperry Rand Corp., Univac Park, St. Paul 16, Minnesota, An Equal Opportunity Employer

UNIVAC

DIVISION OF SPERRY RAND CORPORATION

NEW PRODUCTS

SLOW-SPEED TAPE READER

Said to be the first of its kind, a new slow-speed computer tape reader will read computer output tapes at up to 800 character-per-inch density at speeds down to zero inches per second. Using IBM format magnetic tape as an input and a Teletype printer as an output, the printer will operate at a maximum speed of 600 words per minute with a tape movement of only 1/80 inch per second. Under these conditions, a standard 2400-foot computer reel provides output for 640 hours through the reader, resulting in a large saving of buffer storage capacity. Key feature which permits the slow-speed reading is a flux-responsive head which allows tape reading at any speed since it responds to the tape flux instead of the voltage induced by tape motion. General Kinetics Corp., Arlington, Va.

Circle No. 122 on Inquiry Card

MINIATURE ROTARY SWITCH

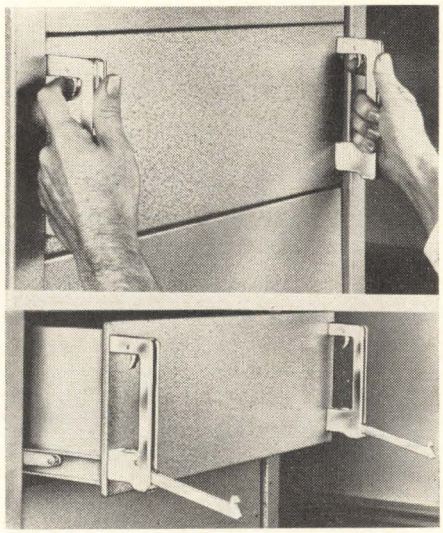
Mounting directly on printed circuit cards, a new single-pole rotary switch is ½" in diameter and less than 1/5" high in profile. It can have up to 10 positive, non-shorting, rotary indexing positions and is completely sealed by a silicone rubber case liner. Current rating is 100 ma at 28 vdc. One of the unique design features is the wiper action. Unlike previous rotary switch designs with wiping contacts traveling only in one plane, the new unit has a wiper detent combination which actually lifts the wiper contact off and away from each fixed pad as the circuit is broken. This feature widens the "break" gap and thus reduces switch arcing. On the "make" portion of the cycle, the contact is dropped onto the next pad. The force of this impact and the resulting scrubbing action is said to result in low contact resistances. Spectrol Elec. Corp., San Gabriel, Cal.

Circle No. 181 on Inquiry Card

MAGNETOSTRICTIVE DELAY LINE

New sonic wire packaging techniques have led to the development of a module that permits up to 10 milliseconds of delay time and 10,000 bits of data storage capacity. Measuring 7/16" x 10½" x 11½", the Model 214A is said to achieve the same performance as the previous 10-millisecond model in less than half the volume. Deltime, Mamaroneck, N.Y.

Circle No. 183 on Inquiry Card



INJECT-EJECT LATCH

Specially designed for opening and closing of electronic circuit module-drawers, a new latch makes or interrupts circuits with smooth mechanical action over a full 13/16" travel. Called "Modulatch", it is trigger-operated for convenience and has positive locking action for safety. Position of trigger is such that accidental bumping cannot release the latch. When the unit is closed the keeper disappears into the base of the contoured handle. Pressure on the trigger releases the camming lever and drops it into actuating position. Swinging the lever through a downward arc disconnects the circuits, permits safe withdrawal of the entire unit. The Modulatch then serves as a carrying handle, and as a stable base for bench servicing. After the unit is replaced, raising the lever smoothly re-establishes the circuit. Southco Div., South Chester Corp., Lester, Pa.

Circle No. 125 on Inquiry Card

SILICON POWER MODULE

New Series 20-S power supply modules feature remote sensing, remote voltage adjust, automatic current limiting, all silicon semiconductors in a high temperature, quick maintenance package. Models in this series are available in ratings from 1v to 100v and may be adjusted ±10%. Dressen-Barnes Electronics Corp., Pasadena, Cal.

Circle No. 180 on Inquiry Card

POWER FANS

Series of fourteen 8″ power fans delivers from 200 cfm to 1000 cfm (nominal) and are designed for commercial cooling applications requiring high air-moving efficiency. Ball-bearing versions are permanently lubricated for the life of the fan, sleeve bearing models are factory-lubricated for the first year, but must be oiled every six months thereafter. Drive motors are available in single or three phase, for 50, 60 cps at 115v or 230v. Temperature range is −20F to +180F; speeds are 1200, 1500, and 3000 rpm. Dynacool Mfg. Co., West Hurley, N.Y.

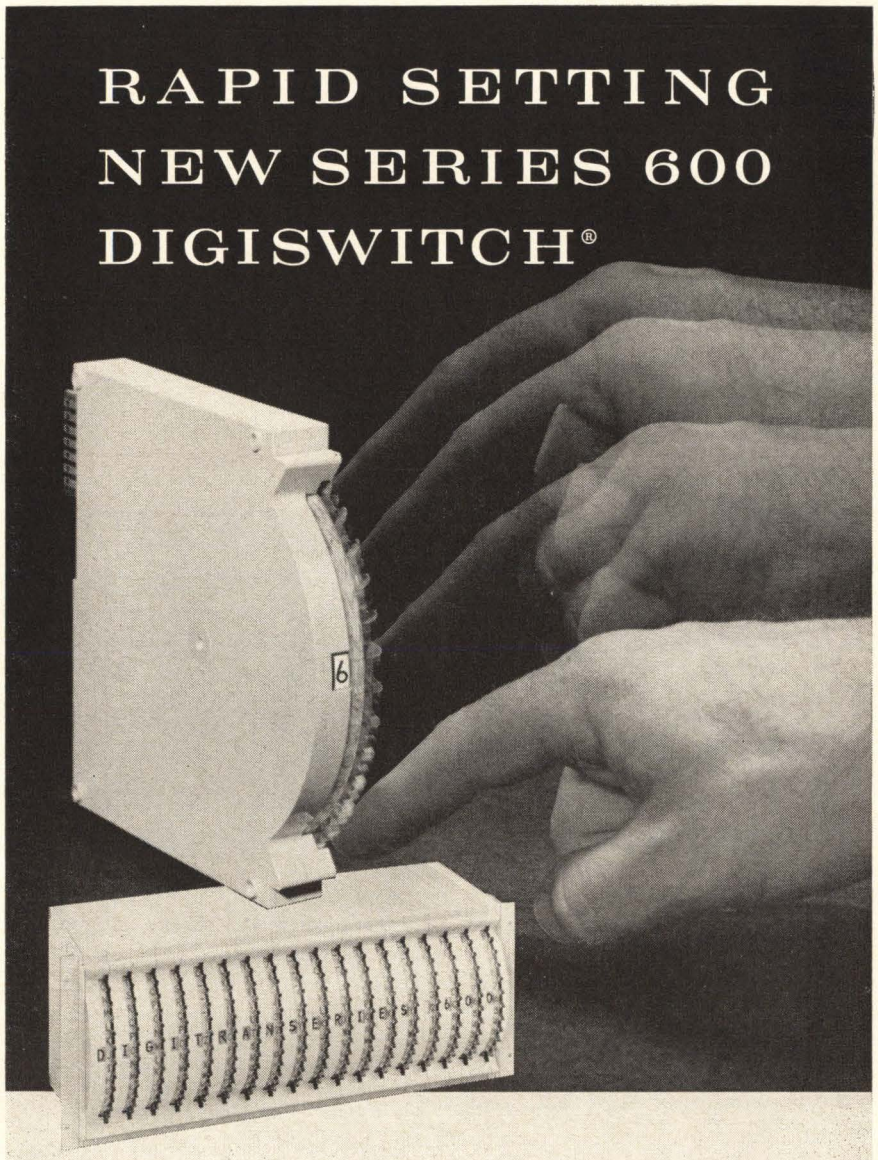
Circle No. 174 on Inquiry Card

PLUG-IN OSCILLATOR

High stability 1 mc plug-in oscillator, which ages less than 2 x 10^{-9} per day, is compatible with most existing instrumentation using plug-in time base generators. New proportional oven control enables fast warmup and stable regulation of the precision crystal temperature over a wide range. Using 60 minutes as a reference point, and warming up from −40C ambient, the oscillator is within 40 x 10^{-6} or 40 cycles of desired frequency in 10 minutes, within 5 x 10^{-7} or 0.5 cycles in 20 minutes and within 5 x 10^{-9} or 0.005 cycles in 30 minutes. Dimensions of the unit are 2″ x 2″ x 4½″ and it weighs 12 ounces. Operating on 28 vdc, the completely solid-state unit is available in either a manual or voltage frequency adjust models. Communications Div., Motorola, Inc., Chicago, Ill.

Circle No. 185 on Inquiry Card

RAPID SETTING
NEW SERIES 600
DIGISWITCH®



The Series 600 DIGISWITCH offers the operator the selection speed of a push-button or slide-bar switch yet retains the most important features of a thumbwheel switch—**INLINE VISUAL READOUT** to promote operator efficiency—**MODULAR CONSTRUCTION** to simplify mounting and save panel space—**DIRECT CONVERSION FROM DIAL SETTING TO CODED ELECTRICAL OUTPUTS** to save on logic, wiring and increase reliability.

The Series 600 has a unique setting wheel with up to 40 positions available for selection. The setting wheel consists of two parts. The right hand side indicates the dial position available to the operator. On a 40 position wheel, 12 positions are exposed, anyone of which may be entered in one quick motion. The left hand side of the setting wheel is covered except for an inline readout window in which appears the actual position of the set switch.

Alpha numeric or straight numeric information can be displayed in either a continuously rotating dial or with provision for reset to a predetermined position. Extensive electrical output capabilities are available. For complete information contact Digitran.

THE DIGITRAN COMPANY

855 S. Arroyo Parkway, Pasadena, California
Phone: 449-3110 Area Code 213
A Division of Endevco Corporation

MANUFACTURED UNDER PATENTS 3,089,923 AND D188,724. OTHER PATENTS PENDING.

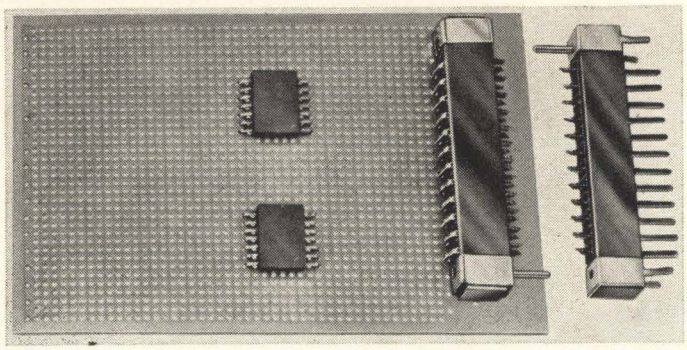
CIRCLE NO. 27 ON INQUIRY CARD

NEW PRODUCTS

MERCURY-WETTED RELAYS

Non-bridging, mercury-wetted relays were designed for the high-speed switching requirements of computer, control and data processing applications. Operating at speeds as high as 1 millisecond or on power as low as 1.2 milliwatts, these relays have a contact breaking acceleration of 1500G's. Five individual types are available, each designed to meet specific applications. All models feature a mercury switch element that is said to provide billions of trouble-free operations, constant contact characteristics and permanent, low contact resistance without erosion, bounce, or chatter. Babcock Electronics Corp., Costa Mesa, Cal.

Circle No. 168 on Inquiry Card



PLUG-IN BOARDS

"Micro-Plugboards" are 1/32" thick, prepunched epoxy glass with 0.025" diameter holes on 0.05" center-to-center spacing, or 0.042" diameter holes on 0.1" spacing. Lengths and widths vary from 1.5" to 5". Matching receptacles for "mother" board mounting are offered with the plugboards. The units may be used as plug-in mounts for integrated circuits or discrete components. Vector Electronic Co., Inc., Glendale, Cal.

Circle No. 134 on Inquiry Card

1 MC LOGIC MODULE

Each card in a new series of 1 megacycle silicon logic is equipped with an integral plastic card ejector for safe, easy removal from card slots. The series has a "true" logic level of +8.2v ±0.5v and a "false" logic level of 0v ±0.5v. Standard load, ac, is 7.6 ma and standard dc load is 2.3 ma. Rise time is 0.1 μsec. and noise rejection is rated at 3v. The modules operate in an ambient temperature range of 0 to 85C and withstand relative humidity of 95%, and vibration of 2g from 0 to 500 cps. All modules feature integral input and output gating, inverted signal outputs, functional gate groups and emitter-follower outputs on all OR gates. Applied Development Corp., Data Product Div., Monterey Park, Cal.

Circle No. 128 on Inquiry Card

INTEGRATED MULTIVIBRATOR

One-shot multivibrator is a 6-NAND-gate array fabricated in a single monolithic silicon chip. Delays from 30 nanoseconds to 10 milliseconds may be implemented with this circuit. Designed for single power-supply operation and electrically compatible with the thirteen other company DTL circuits, this Model AO8 is available in the modified TO-5 package and a 150 x 370 mil 14-ribbon-lead "FlatPac". Typical dc stability margins vary from 1.2 volts at −55C to 0.5 volts at 125C under combined worst-case conditions of input and output loading. Complementary outputs provide more versatility in systems design with a minimum number of circuits. Siliconix, Inc., Sunnyvale, Cal.

Circle No. 144 on Inquiry Card

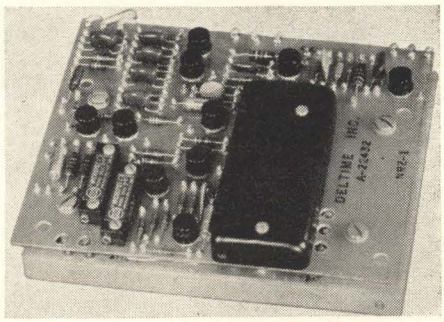
HYBRID INTEGRATED CIRCUITS

Analog circuits, digital interface circuits, and digital logic circuits can be readily reduced to microelectronic form by a company's new "CHIC" (Cermet Hybrid Integrated Circuit) technique. The customer's circuit is reduced directly to microminiature form and packaged in a TO-5 enclosure or in standard flat packs. Resistors — which may have values from 10 ohms to 3 megohms and tolerances to 1 per cent — and capacitors as large as 1000 pf are combined with appropriate passivated active elements to form the required circuit. Passive components are silk-screened on a high-density alumina substrate, active devices are alloyed to metallized areas on the substrate, then the entire circuit is mounted in the appropriate enclosure. National Semiconductor Corp., Danbury, Conn.

Circle No. 121 on Inquiry Card

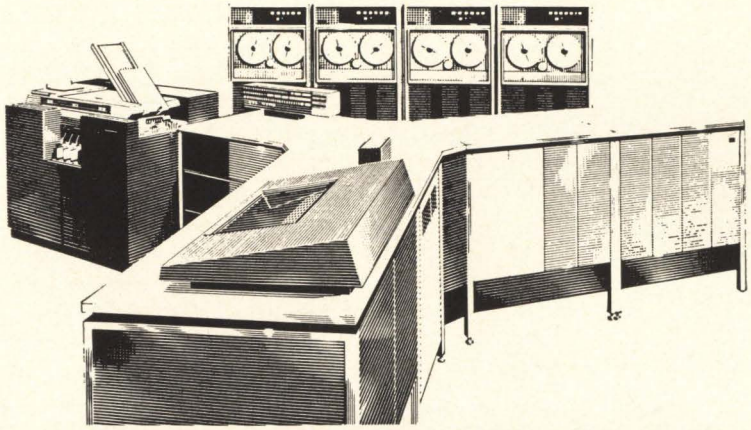
DELAY LINE MODULE

Unity gain NRZ digital circuit module for magnetostrictive delay line application provides storage of up to 10,000 bits of binary information at a 2 mc/s bit rate when combined



with a 5,000 usec. delay line and an external logic-controlled recirculating loop. Complementary NRZ input logic is required. Input and output NRZ logic levels are 0 and −9 volts. Input rise and fall time requirements are 0.070 usec. and 0.150 usec. respectively. Output pulse rise time is 0.075 usec. and fall time is 0.050 usec. NRZ complementary output logic is identical to the input logic but delayed by the delay time of the delay line. Sealectro Corp., Deltime Div., Mamaroneck, N.Y.

Circle No. 131 on Inquiry Card



NEW OPPORTUNITIES

The continuing, planned growth of Honeywell EDP has created new professional opportunities at our Engineering and Research Center in suburban Boston.

This growth is more than just an increase in numbers.

The steadiness of our expansion, based on the commercial success of nine advanced computer systems, has allowed our engineering team to develop an inherent stability and a depth of experience which is unsurpassed.

Opportunities exist across the entire spectrum of advanced computer technology, with emphasis in the following areas.

RAM Development

Intermediate, senior and staff positions exist for engineers to work on Random Access Memories for advanced magnetic recording techniques including magnetic drum, disc and card mass storage systems. Design of magnetic heads and associated read/write circuitry plus drum and disc surface preparation and plating. Three to five years' experience in magnetic recording devices with a Bachelor's degree in Mechanical Engineering, Electronics or Physics is desirable.

Memory Development

To investigate advanced memory techniques including thin films, large-scale partial switching linear select core memories, coincident current core memories and read only memories. A minimum of two years' experience in transistor circuit design is sought, preferably in memory development.

Microelectronics Packaging

Intermediate and senior positions exist for engineers to investigate, design and evaluate various techniques of microelectronic packaging. This includes hybrid and monolithic designs, interconnection techniques and manufacturing processes. Some knowledge of materials, heat transfer, electronic circuit design and laboratory operation is desirable. One to three years' experience in microelectronic packaging is required, with a degree in Physics or Mechanical Engineering.

In addition, new assignments exist for engineers with a professional background as:

Logic Designers
Systems Designers
Circuit Designers
Software Development
Electromechanical Engineers

Interested candidates should mail their resumes to:
Mr. D. C. Turner, Employment Supervisor

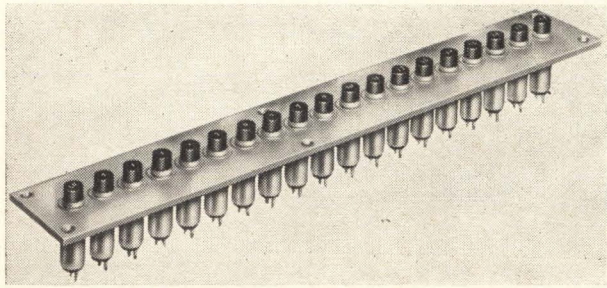
Honeywell

ELECTRONIC DATA PROCESSING

151 Needham Street Dept. CD-03 Newton Highlands, Massachusetts

Opportunities exist at other Honeywell Divisions. Send resume to F. E. Laing, Honeywell, Minneapolis 8, Minnesota.
An equal opportunity.

NEW PRODUCTS



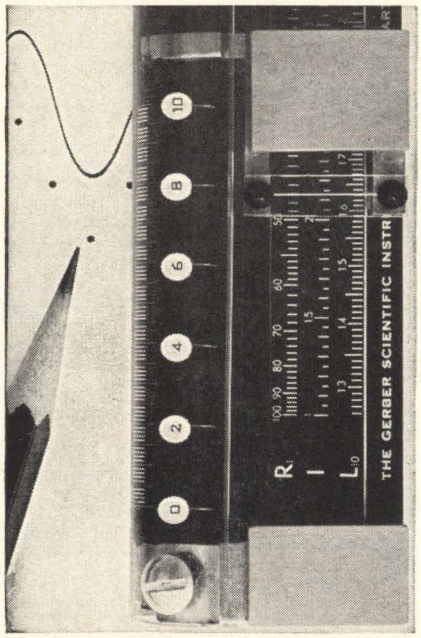
INDICATOR LIGHTS

New multiple-mounted indicator light unit saves product assembly time by being press fitted into the panel. Panels can include an individual indicator light, to over a hundred units in single or multiple rows. Minimum spacing between centers is ½". Duplicate operations can be eliminated where a series of lights is to be mounted on the same panel by installing them while they are being fabricated. Almost 300 neon and incandescent "Bi-Pin" cartridge lamps are available for use in these holders. Proper alignment of the legend is assured by the indexing of the pins to the lampholder. Drake Manufacturing Co., Chicago, Ill.

Circle No. 175 on Inquiry Card

READ, PLOT, OR SCALE CURVES WITHOUT CALCULATION

The Gerber Variable Scale is based on a precision extensible spring, calibrated in hundredths. It allows you to read curve amplitudes directly, read frequencies directly, multiply by scale factors, plot with correction factors or other constants included, interpolate, normalize, etc. It eliminates routine calculations. Accurate to 0.05% in full scale of ten inches. ■ Partially shown below (actual size) plotting curve from original. ■ Send for literature: THE GERBER SCIENTIFIC INSTRUMENT CO., P.O. Box 305, Hartford 1, Connecticut



CIRCLE NO. 28 ON INQUIRY CARD

INTEGRATED CIRCUIT DESIGN KITS

New designer's kit for the layout of "truly-custom" integrated circuits permits the design engineer to arrange and define his own schematic in a format compatible with the microcircuit state-of-the-art. Company utilizes the integrated circuit technique of diffused active devices with thin-filmed passive devices deposited directly upon the silicon dioxide layer covering the diffused portion. This technique, known as the MOSAIC monolithic circuit is said to offer many engineering advantages over the more common all-diffused technique — wider resistance value ranges, tighter tolerance and matching on resistors, low parasitic capacitance, improved temperature stability, and greater circuit density. Even more significantly, according to the company, the process allows participation in design by the customer due to the compatibility of the "building block" approach. The user is offered the option of several active device specifications in the kit (amplifier and switching transistors or diodes). These basic specifications represent active device geometries which are already tooled and manufactured as "master slices". Device parameters can be further adjusted by such techniques as varying diffusion depths and doping levels, which do not require any additional masking costs. Upon completion of the custom layout, the user is invited to forward the circuit to the manufacturer for development of a firm engineering proposal and quotation. The cost of such circuits is said to be attractive since the active devices are already tooled and are manufactured by well proved processes. The only additional cost in this MOSAIC custom circuit approach is the masks relative to the passive components and interconnecting contact patterns. Some representative cost examples are: custom buffer amplifier $55 each for 100 pieces; custom DTL single NAND circuit $22 each for small quantities; and diode ring modulator $11 each for 1000 pieces. Bendix Semiconductor, Holmdel, N.J.

Circle No. 151 on Inquiry Card

SMALL SCALE DISC FILE

Low cost, random access disc storage system has a storage capacity of 27,600,000 bits per disc kit. It was designed primarily for use with medium scale to small scale data processing systems and sub-systems, but its flexibility in data packing makes it suitable for application to large scale systems in many instances. The disc kit is a modular package containing six discs. Kits are light and easily interchangable, and the self-storing packages provide complete protection for the discs when not in use. Solenoid-actuated mechanical linkage automatically retracts the read/write heads in cases of power failure. In a simple mounting operation, the disc kit package itself is positioned and exposed for automatic insertion of the head array and shaft. Anelex Corp., Boston, Mass.

Circle No. 191 on Inquiry Card

Sometimes we have to watch our language.

(Especially when engineers visit our labs.)

There tends to be a lot of computer language bouncing around Xerox these days. Some people might jump to the conclusion that we're going into the computer business. That's not exactly true.

There's a simple answer to why all the talk about information storage and retrieval, communications theory, bandwidth compression, transmission, digital analysis, coding, and the rest. It is all related to Graphic Communications. Can you see where we're going? There's ample room for some canny computer-based systems people to join us.

Write us about what you've done in the field and we'll try to pinpoint your most promising opportunities at Xerox today. Address your letter or resume in strictest confidence to Mr. Robert Conboy, Xerox Corporation, Dept. CD-10, P. O. Box 1540, Rochester, New York 14603.

XEROX

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COMPUTER DEVELOPMENT OPPORTUNITIES

Opportunities exist throughout the country for computer oriented people to work on a myriad of projects, both commercial and military. These clients' sole interest is in developing and manufacturing the **BEST** computer system for the application. They realize that they must attract (and keep) people who are in short supply and great demand. Along these lines, they provide access to the most advanced computing hardware in existence, the opportunity to work with some of the outstanding professionals in the field (in hardware and software) on applications that will challenge your best efforts, and provide an income compatible with professional competence and experience.

LOGIC DESIGNERS
Three or more years in logic design for high speed digital equipment using solid state circuitry.

PROGRAMMERS
Technical or military applications experience on 7000-series equipment or equivalent.

SYSTEMS ANALYSTS
Technical or military applications experience, to be responsible for systems from inception to implementation.

MEMORY/CIRCUIT DESIGNERS
Three years high speed memory or solid state circuitry design for digital or peripheral equipment.

Please write outlining your experience, education and objectives to:

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COMPUTER SALES
$10-$12,000 + AREA BONUS + CAR + EXP.
Outstanding leader in field has openings due to several senior men being retired. Prestige company with virtually no turnover in Sales dept. Call on process industries of all kinds. Primary prerequisite a high interest in building a good sales career.

PRODUCT DEVELOPMENT ENGR.
$8,000-$10,000
Electronics Engineer with good circuitry background. Excellent opportunity in small branch plant of AAAA co. Opportunity to work with high-level engrs. on all aspects of a product from initial concept to finished item. Highest salary – prestige company.

APPLIED PROGRAMMING
$9,000-$13,000
Hardware is useless without software. This truth implies the gap to be filled by our client as they continue their consulting service to computer manufacturers and users. The software needs are innumerable. Imagination and creativity in programming techniques are the requirements. Company atmosphere encourages freedom of thought and expression.

CIRCUITRY DESIGNER
$12,000-$16,000
An exceptional opportunity for the engineer who really knows digital circuitry and would like to be paid well for it. Challenging position with a fine future.

SR. SYSTEMS ANALYST OVERSEAS
$14,000-$18,000
International consulting firm needs a strong computer-oriented Systems Analyst to work with clients in Germany. Will advise and evaluate for customer systems requirements. Full relocation expenses and cost of living allowance. Report to International Director.

(16) OPTICS SPECIALISTS
$7,000-$22,000
From non-degree engineering majors to directors with advanced degrees. Four of our top accounts need optics people to all levels – production, test, research & development, theoretical. Positions in line or staff. Boston, New England & East Coast locations.

PROJECTS LEADER
$10,000-$13,000
Top EDP consulting firm forming new commercial/scientific programming staff. Need Chief Programmer to lead & coordinate group activities; also initiate systems designs. Must be able to assume responsibility and supervise 9 Programmer/Analysts. Report to President.

(24) MECHANICAL ENGINEERS
$8,500-$11,000
College men who have management potential. Production design, administration, applications, sales, plant engineering. These are non-defense industry positions with a good sound future. Company interviewing our offices.

Client companies assume all service charges
Send resume in confidence

SHAMROCK PERSONNEL
P.O. Box 175 **W. Concord, Mass.**

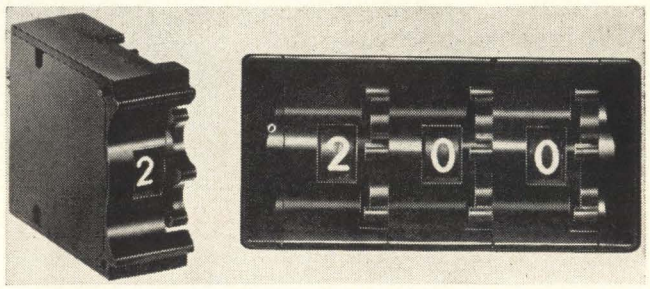
CIRCLE NO. 901 ON INQUIRY CARD

NEW PRODUCTS

THIN-FILM MEMORY COMPUTER

New computer is said to be the first commercially-available data processor with a main memory made entirely of thin-film storage elements. Designated the NCR 315 RMC (Rod Memory Computer), the general-purpose system can execute approximately 100,000 instructions per second and control a wide variety of input/output equipment. The internal memory is fabricated from cylindrical thin-film, rod-like magnetic storage elements. It can store up to 240,000 decimal digits (4 data-bits each) or 160,000 alphanumeric characters (6 bits each). Basic cycle time is only 800 nanoseconds. Average access time per digit is 267 nanoseconds. Although it is designed primarily for business applications, the 315 RMC has built-in floating-point arithmetic, will be available with FORTRAN, and is a well-balanced scientific and engineering data processor. The basic system will handle from one to eight of high-density 120 kc magnetic tape units. With the addition of magnetic tape controllers, up to 16 tape units can be used on-line with the processor for simultaneous reading, writing and computing. A 315 RMC processor and memory with a capacity of 60,000 digits will rent for $6,000 monthly. This compares with $4,800 to $5,150 for standard 315s with comparable memory capacity. First deliveries of the 315 RMC are scheduled for mid-1965. National Cash Register Co., Dayton, Ohio.

Circle No. 130 on Inquiry Card



MINIATURE THUMBWHEEL SWITCH

Claimed to be the smallest, sealed, thumbwheel switch ever made commercially for industrial and military applications, a new unit, called the Miniswitch, converts directly from decimal dial setting to coded electrical output. It is modular in design with each module requiring a panel output of only 0.96″ high x 0.5″ wide. Any combination of switch modules may be ganged into a single unitized assembly for ease and simplicity of mounting. All switch elements are sealed in a separate chamber within the switch and are thoroughly protected from severe environments. Digitran Company, Pasadena, Cal.

Circle No. 152 on Inquiry Card

COMPUTER WIRE

Total-coverage shielded construction of new wire is recommended for critical applications such as computer and data inputs where low-noise signals are required. The new line of two-conductor and three-conductor single-group cables is available in shielded or non-shielded construction in standard factory coils of 500, 1000 or 2000 feet. Their round configuration makes the new single-group cables easy to handle, and provides better conduit fill for more compact installations. Rugged, stranded conductors give the product high flexibility and pulling strength. The strands are twisted to a close lay to prevent fraying when insulation is stripped off. Dekoron Division, Samuel Moore & Co., Mantua, Ohio.

Circle No. 133 on Inquiry Card

PULSE GENERATORS

Repetition rates to 12 mc, pulse amplitudes to 12v into 50 ohms, and single or double pulse outputs are features of a new pulse generator. Other characteristics include effective 20 mc rep rates on double pulse mode and pulse widths from 25 nanosec. to 5 millisec. Jitter is less than 0.1% and accuracy is within ±5%. Waveform aberrations are typically less than ±2% above 300 mv. Automatic scaling and amplitude reduction occur at duty cycles greater than 70%. Output stages are also protected against short circuits of any duration and tolerate back voltages to ±10 v. Datapulse Inc., Inglewood, Cal.

Circle No. 170 on Inquiry Card

INCANDESCENT LAMPS

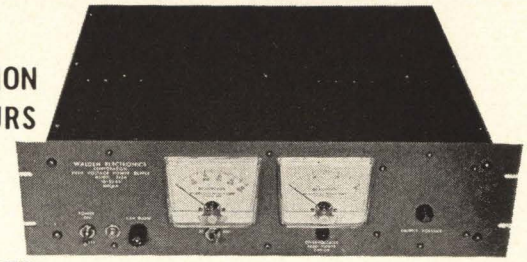
New series of based and unbased T 1, T 1¼ and T 1¾ incandescent lamps have MSCP tolerances of ±15% and life expectancies said to be up to ten times more than similar units. Lamps are individually hand-blown claiming exceptional dimensional accuracy, near-perfect centering of filaments, and flawless glass envelopes. Unatco, Inc., Los Angeles, Cal.

Circle No. 169 on Inquiry Card

A NEW STABLE SOURCE OF

HIGH VOLTAGE for COMPUTER DISPLAY

★ 10-30 KV, 500 μA
★ 0.01% TOTAL REGULATION
★ 0.01% DRIFT IN 8 HOURS
★ ALL SOLID STATE
★ FLASHOVER PROOF
★ ONLY 5 1/4" HIGH
★ OUTPUT CURRENT LIMITER
★ OVERVOLTAGE PROTECTION
★ PROVEN, DEPENDABLE DESIGN
★ SOLID INSULATION FOR RELIABILITY
★ NOW IN USE IN DISPLAYS ACROSS THE NATION



Model 545A

The Walden Model 545A, one of a family of solid state high voltage supplies for display applications, utilizes a unique SCR-power transistor regulator with a dc-dc low-to-high voltage converter to deliver stable, dependable acceleration voltage for CRT displays. All temperature-sensitive components are oven stabilized for excellent stability.

Walden has created other high voltage systems to customer specification. Send your requirements for a prompt quotation to:

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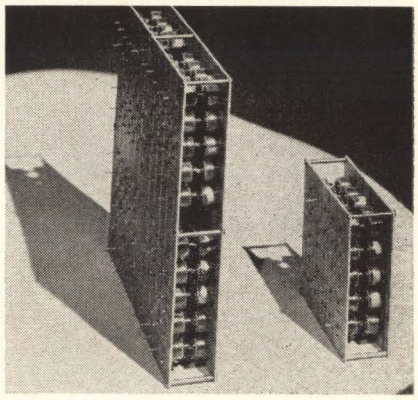
ARLINGTON, MASS., 02174

CIRCLE NO. 29 ON INQUIRY CARD

REED SWITCH MATRIX



New product is said to revolutionize the application of magnetic reed switches. This new product, for which patents have been applied, is called the Loc-Reed Switch Matrix and utilizes the simple law of physics, "Like magnetic poles repel". The basic part of the matrix, the switch assembly itself, consists of a reed switch, two simple coils, and a permanent magnet. The magnet, which encircles the reed switch, moves back and forth from the face of one coil to the other to open or close the contacts. When "Coil A" is energized, it repels the magnet to the soft iron core of "Coil B". With the magnet adhering to the core of "Coil B" the reed switch has been factory positioned in such a way that the switch is now closed. When "Coil B" is energized, the magnet is repelled to the soft iron core of "Coil A", thus opening the switch. Power failure does not affect the position of the magnet or the reed switch contacts. Any reed switch in the matrix may be opened or closed without the spurious or accidental operation of any other point. The result is that one or hundreds of points may be operated independently of each other. McKee Automation Corp., North Hollywood, Cal.

Circle No. 142 on Inquiry Card

NEW PRODUCTS

DISPLAY GENERATOR

New alphanumeric display generator permits the display of computer Teletype data on a standard television receiver. The all-microelectronic system is adaptable to a variety of applications. It can be used in information systems for military command and control, weather forecast reporting, airline schedule reporting, stock quotation displays, factory data reporting — in short, in any system requiring the rapid distribution and display of data. The generator is capable of accepting six Teletype messages of up to 180 characters each and displaying two messages simultaneously. The generator was developed as an "around the base" display device for the presentation of weather data at Air Force installations. Norden Div., U.A.C., Norwalk, Conn.

Circle No. 132 on Inquiry Card

PC REED RELAYS

Extra small size combined with fast, low level switching and quick, secure printed circuit mounting are featured in new encapsulated dry reed assemblies. The subminiature reed relays have pre-adjusted gold contacts, hermetically sealed in a glass capsule with an atmosphere of inert gas. The rigid, pin-type terminals literally plug into printed circuit boards. Wide spacing between terminals facilitates printed board design and permits wide margins in insulation and dielectric strength. SPDT assemblies measure 1½ x ½ x 9/16 high; DPDT assemblies, 1½ x 11/16 x 9/16 high. Operate time, 1 ms average; release time, 1 ms average. Contacts are rated at 3va at 0.25 amp max or 28v max, non-inductive load. Life expectancy, 10 million cycles at rated load. Contact bounce, normally open contacts, 0.5 ms max; normally closed contacts, 2.0 ms max. Magnecraft Electric Co., Chicago, Ill.

Circle No. 208 on Inquiry Card

"LOGIC DESIGNER"

With a new system called Logic Designer LDE 100, engineers can simulate a logic design by simply patching connections on a patchboard which in turn is wired to as many as 72 logic cards. The cards are standard NOR/NAND systems cards especially for use in digital systems. The user can easily verify his logic or add special auxiliary functions to the system on a temporary basis. He may also use the device to familiarize himself with NOR/NAND logic and the operating characteristics of the cards preparatory to systems design. Consolidated Systems Corp., Pomona, Cal.

Circle No. 126 on Inquiry Card

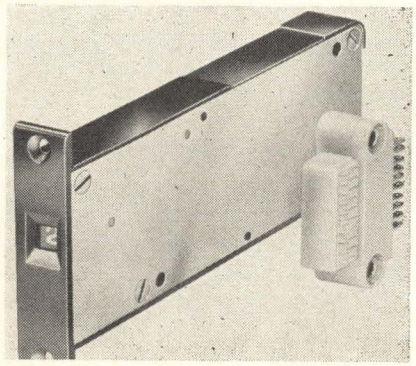
DUAL LINEAR GATE

High-speed gating of linear signals in the range of ±1 volt with 1% linearity can be achieved with a new dual linear gate unit. Designed specifically for high energy physics research, unit may also be used in radar studies and in video and communications systems. To facilitate operation as an SPDT switch, controlled by a logic signal, two independent gate circuits are included, and all signal and control paths are direct-coupled. Gate opening and closing time is less than 2½ nsec. Edgerton, Germeshausen & Grier, Inc., Salem, Mass.

Circle No. 124 on Inquiry Card

SINGLE DECADE READOUT COUNTER

Unique and patented form of multicontact through the figure wheel to printed circuits at either side is said to be the feature of a single decade readout counter. Any figure, or group of figures, can be interrogated or predetermined. For examples, a multifigure counter can be interrogated while moving or at rest to initiate some further process; to display or print the result; to add the result to data from another source; to perform a logic function; etc. By applying one or more 10-way switches to each decade it is also possible to provide one or a series of preset numbers, all of which are instantly variable. Although the drive mechanism incorporates a patented method of retaining and springing the armature, the basic escapement movement is employed. For resetting to zero, however the possibilities are again extended with two circuits available. Both are self-interrupting — one on



dc, the other on ac at 50 cycles. Contacts of one of the readout circuits can be used to transfer at any figure other than 9 for non-metric indications, thereby introducing a new concept of counter application both directly and in conjunction with logic circuits. The counter provides, for example, not only simplification of computer feeding stages, but also the basis of low-cost, special purpose computers. Hengstler Numerics, Inc., Palisades Park, N.J.

Circle No. 173 on Inquiry Card

LOW-COST POWER SUPPLIES

New series of power supplies features constant-voltage with current control for automatic E/I crossover. Other features include programmable, remote sensing, series and parallel operation, front and rear terminals, calibrated controls, and main and vernier controls. Voltage ranges are 0-20, 0-40, 0-60, and 0-100 with current ranges up to 0-4a, depending upon model. Regulation is 0.04%. The units measure only 3-1/2" H x 9-1/2" W x 12" D. Price of a unit, complete with meters, is $250. Electronic Measurements Company, Eatontown, N.J.

Circle No. 129 on Inquiry Card

ALPHA-NUMERIC DISPLAY

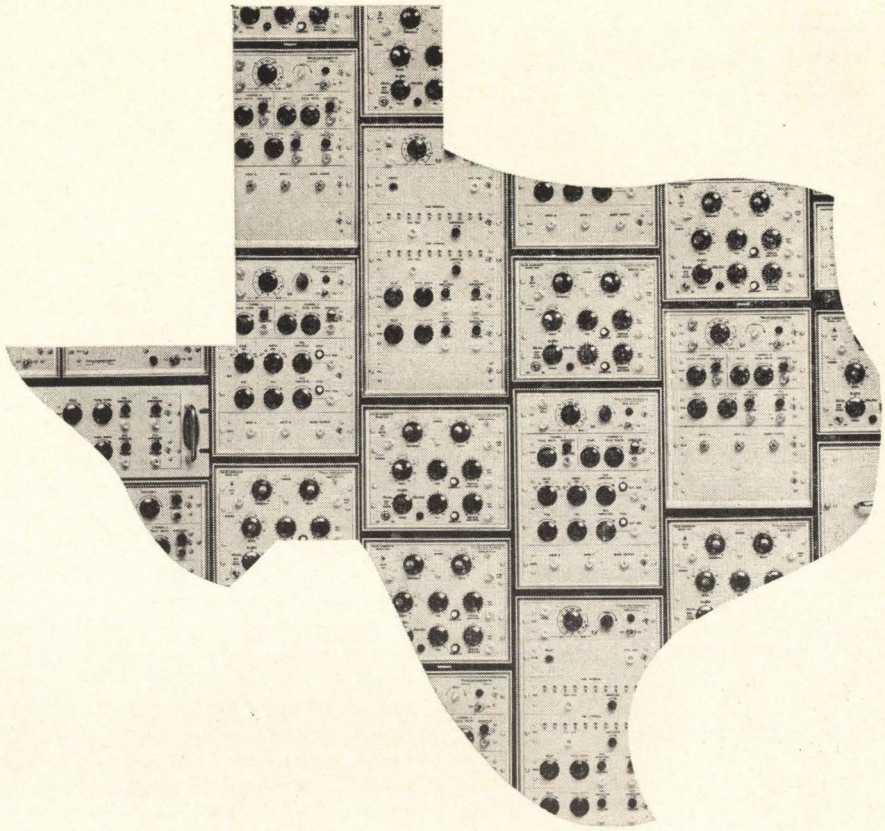
Newly-developed long life, gas glow-display alpha-numeric tube graphically displays all letters of the alphabet and numerals 0 through 9 as well as special characters. The characters displayed are 2½" high, and are visible at distances up to 100 feet. The single plane construction of the tube permits viewing over a 150 degree angle. Basic construction features include 15 cathodes which are mounted on an insulating ceramic substrate positioned behind a common anode made of mesh screen. The red-orange glow display is achieved by applying dc voltage between the anode and a combination of the cathode segments. A special neon gas, that produces the red-orange glow when voltage is applied, is used because of its acuteness to the human eye. Sylvania Electric Products, Inc., Buffalo, N.Y.

Circle No. 160 on Inquiry Card

A-D CONVERTERS

Voltage pulses, with different amplitudes, are accepted by a new analog-to-digital converter and are digitized by the pulse height-to-time conversion technique. The resulting output is a number directly proportional to input amplitude. The register of the A-D converter counts the 8mc digitizing pulse train and holds this number until it is transferred into a random access memory for storage. Appropriate flag signals are provided for compatibility with digital computers. Designated SCIPP ADC, the converter is available in both BCD and binary versions (400/1600 words, or 10 bit, respectively). One or two ADC's may be packaged in a single chassis. In a dual configuration, timing circuits are provided for two-parameter coincidence operation. The instrument is stable to within 0.4%/20°F within the temperature range of 25° to 130°F. Integral linearity is ±0.25% over top 99% of range; differential linearity 2% over top 98%. Input signal repetition rates up to 50,000 pulses/sec cause less than 1% full-scale shift in address position. Tullamore Div., Victoreen Instrument Co., Oak Lawn, Ill.

Circle No. 149 on Inquiry Card



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Makes 247 Pulse Generators

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- Repetition Rates to 100 MC
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- Pulse Shaping and Programming
- Solid-State Construction
- Easy to Use, Easy to Expand
- Prices from $950

TI's complete line of flexible, high performance signal generating equipment offers units to satisfy any test or design application. Fixed, fast or variable rise and fall times; standard special or mixed waveforms; variable amplitude, width and delay . . . all with characteristic, stable, clean waveforms. Available as portable or rack-mounting instruments, TI Pulse Generators are lightweight, compact and extremely easy to use. Write for information, wire for demonstration, call collect to order.

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CIRCLE NO. 30 ON INQUIRY CARD

LITERATURE

Module Breadboard Kit

Descriptive data sheet describes a breadboard kit and its uses in designing, testing, and checking-out digital circuits for digital circuit and systems engineering and for logic instruction. Features and uses of module adapters, module symbol cards, signal generator, and other elements of the kit are covered in detail. Three models of the kit plus a listing of the assortment of digital modules supplied with various models are discussed. Packard Bell, Santa Ana, Cal.

Circle No. 209 on Inquiry Card

Intergrated Circuit Welder

A 4-page bulletin contains specifications on a high-speed, integrated circuit welder, plus an interesting discussion on the economics of assembling integrated circuits to printed circuit boards, entitled "Why Weld?". The bulletin also covers a precision shear designed to remove integrated circuit packages from their carriers, speeding up the assembly process. Texas Instru. Inc., Houston, Tex.

Circle No. 202 on Inquiry Card

Ultrasonic Delay Lines

A combination delay line primer and product brochure discusses the relative merits of fused quartz vs. low temperature coefficient glass compositions; compressional waves vs. shear waves; transducer equivalent circuits; measurement setups; etc. It takes up definitions important when specifying delay lines, such as carrier frequency, time delay, acoustic bandwidth, electrical bandwidth, spurious signals, and attenuation. The literature lists tapped delay lines, isothermal delay lines, three-dimensional delay lines, and complete serial memory systems. Laboratory For Electronics, Inc., Boston, Mass.

Circle No. 153 on Inquiry Card

Digital Products

Logic modules, store exercisers, and test equipment for digital systems are covered in a new catalog. Included are complete specs and schematics for a line of digital logic, from 500kc to 25mc. Modules described are flip-flops, pulse generators, pulse amplifiers, dual inverters, and others, totaling over 30 different basic types. Model 200 store exerciser is capable of testing random access, high speed, digital stores with read-write cycles down to 200 ns. The catalog also includes brief descriptions of an electronic code detector, special digital test equipment, and computer subsystems. Information Storage Systems, Pompton Lakes, N.J.

Circle No. 223 on Inquiry Card

Wire Wrapping Connectors

Connectors for a wide variety of low-cost, high-reliability customized interconnections junctions are described in a new 12-page catalog. How automatic wire-wrapping cuts assembly time and increases connector reliability is explained. Typical applications and special shapes available are pictured and diagrammed. Contact ratings and dimensions are given along with drawings of all available male and female contact types. Amphenol, a Division of Amphenol-Borg Electronics Corp., Chicago, Ill.

Circle No. 178 on Inquiry Card

Switching Matrices

Technical data sheet describes a line of coaxial switching matrices for analog and digital switching up to 5 mc, and coax or twinax video switching up to 60 mc. It introduces the concept of remote-controlled, pre-programmable video and data switching and its various applications. Trompeter Elec., Inc., Canoga Park, Cal.

Circle No. 171 on Inquiry Card

Sample & Hold Amplifier

Technical data covering a new sample and hold amplifier includes general and functional descriptions, a block diagram of the module, specifications, and application information. The sample, and hold amplifier was designed to follow rapid moving waveforms and then, on digital command, to hold the sampled value accurately for relatively long periods of itme. Response time is less than 10 microseconds to reach 0.01% of final value for a full-scale input step change. The amplifier is assembled on a standard 5" x 8" epoxy fiberglas, plug-in etched circuit card. Adage, Inc., Cambridge, Mass.

Circle No. 197 on Inquiry Card

Power Supply Catalog

A 52-page catalog is said to contain a wealth of useful information of interest to all power supply users. Technical information includes new application notes some of which are particularly useful for constant current operations, an up-dated glossary of power supply terms, and expanded explanations of regulated power supply capabilities. Of special interest are new current regulated power supplies, VIX mode signaling devices, two new lines of modular power supplies, various programmers, high voltage isolation enclosure, and various rack and panel adapters. Kepco, Inc., Flushing, N.Y.

Circle No. 161 on Inquiry Card

Silicon Switching Transistors

Data sheets on switching transistors contain limit curves which are directly applicable to "worst-case" switching circuit design. The new annular silicon devices include NPN types 2N3252, 2N3253, and PNP types 2N3244 and 2N3245. Units are complementary, high-current, high-speed switching devices for line and core driver applications. NPN types 2N2369 and 2N3227 and PNP types 2N3248 and 2N3249 are for high-speed, low-current switching applications. Motorola Semiconductor Products, Inc., Phoenix, Ariz.

Circle No. 157 on Inquiry Card

Display Modules

New catalog on single plane readouts contains full descriptive data covering modules with neon or incandescent light sources for operation on 160 vdc, 120 vac, 14-16 v, and 24-28 v. Discussed are the choice of light sources with appropriate resistors; display modules with or without diode matrix for decimal input; lamp replacement; module components and construction; mounting bracket; choice of readout windows; readout display capability. Dialight Corp., Brooklyn, N.Y.

Circle No. 213 on Inquiry Card

Relays and Switches

"In-Stock" report on relays and switches lists more than 200 kinds of relays, stepping switches, and accessories available "off-the-shelf". They include EIN (plug in) relays with or without power contacts, rotary stepping switches with gold levels for low-level circuits, ERM (magnetic latch) relays, Class E relays equipped with taper-tab terminals for easy adaption to EIN, Correeds (reed relays) and many more. Automatic Electric, Northlake, Ill.

Circle No. 194 on Inquiry Card

Computer Diodes

Engineering data sheet covering miniature glass silicon computer diodes lists the specs and the characteristics for more than 150 different EIA types including pertinent military specs where applicable. ITT Semiconductors, Inc., National Transistor Div., Lawrence, Mass.

Circle No. 226 on Inquiry Card

Coaxial Transmission Lines

Technical bulletin details the influence of temperature on coaxial transmission lines. The 14-page engineering report outlines the calculations and methods used to reach the summary of results. Seven pages of performance curves offer useful data. Phelps Dodge Electronic Products Corp., North Haven, Conn.

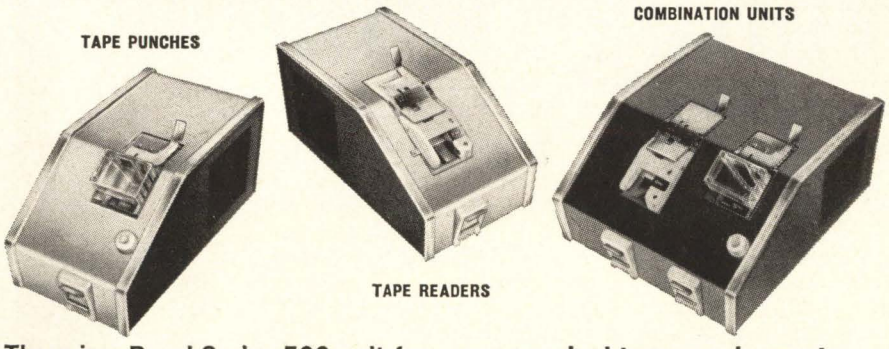
Circle No. 190 on Inquiry Card

NOW...FROM ROYAL McBEE A NEW COST/PERFORMANCE STANDARD IN PAPER TAPE EQUIPMENT

New... from the research and development facilities of Royal McBee comes the Series 500... a complete range of precision punched paper tape units that operate smoothly, with less noise and greater reliability over longer periods than previously possible. And, their simple, foolproof construction permits significant cost savings.

New design features give new standard of performance

Efficient electro-magnets and off-center springs provide smooth, trouble-free punching ■ Reluctance type pick up for timing eliminates contacts and cams... reduces arcing and system noise and increases reliability ■ Bi-directional reader operates with high reliability at low noise level through action of sensing pins on wire contacts and strobe-like interrogate pin ■ Sealed read station protects mechanism... saves maintenance ■ Semiautomatic feed allows fast tape loading (operator merely places tape in head assembly throat).



There is a Royal Series 500 unit for every punched tape requirement.

Basic punch and reader mechanisms that can be built into equipment with the means for mechanical drive.
Desk or Panel Mounted Units, with and without logic and circuitry.
Combination Reader/Punch Units share drive, but are electrically independent.
Send for complete specifications today to Royal McBee Corporation, Industrial Products Division, 50 New Park Ave., Dept. 35JV, Hartford, Conn.

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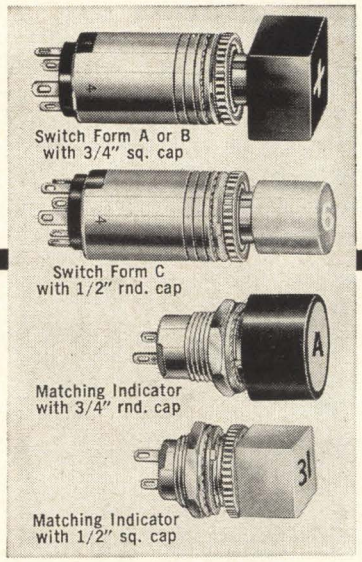
CIRCLE NO. 31 ON INQUIRY CARD

Subminiature
ILLUMINATED PUSH BUTTON SWITCHES
and matching
Indicator Lights



DIALCO Switches and Indicator Lights provide almost limitless applications—are flexible in arrangement—economical in price—and feature high reliability.

Switches are the silent, momentary type—requiring 24 oz. (approx.) operating force. Contact arrangements are: S.P.S.T., normally open or normally closed; S.P.D.T. two circuit (one normally open, one normally closed). Ratings: 3 amps, 125V A.C.; 3 amps, 30V D.C. (non-inductive). The switch is competely enclosed and independent of the lamp circuit. The light source is the T-1¾ incandescent lamp, available in voltages from 1.35 to 28V. Units are made for single hole (keyed) mounting in panels up to 3/16" thick and mount from back of panel in 1/2" clearance hole. Switch forms for dry circuits are also available.

Other features include: 1/2" or 3/4" interchangeable caps, round or square, rotatable or non-rotatable, in a choice of 7 color combinations.

Request Catalogue No. L-169A. Complete specifications and technical data, including catalog number charts are included therein.

Illust. approx. 75% actual size

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FOREMOST MANUFACTURER OF PILOT LIGHTS

DIALIGHT CORPORATION

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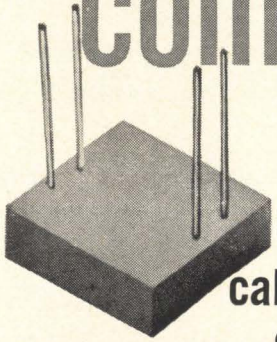
evenwolt

voltage reference units in modular component size



ACTUAL SIZE "700" SERIES

small ■ printed circuit or chassis mounting ■ simplifies circuit design ■ no temperature compensation needed ■ low priced—unlimited variations of voltages, current, temperature coefficient, regulation, output impedance, case and mounting.

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CIRCLE NO. 33 ON INQUIRY CARD

LITERATURE

Logic Module Catalog

A 118-page catalog describes new silicon and germanium high-speed logic modules. Speeds up to 10 mc, exceptional noise rejection, clamped circuit outputs and high fan-out capability are claimed for these units. Also described is a line of analog modules. The catalog includes a comprehensive "design guide" useful to digital system engineers. Mounting hardware, power supplies and other accessories are described, and prices of all of the products are included. Abacus Inc., Santa Monica, Cal.

Circle No. 193 on Inquiry Card

Tantalum Capacitors

Short-form catalog contains condensed information on a line of tantalum capacitors comprising fourteen different series with over 2500 separate standard units. The catalog covers plain and etched foil units, as well as sintered anode and wire anode types, with wet and dry electrolytes. Temperature rating ranges extend as low as −80 C and as high as 150 C, while voltage ratings range from fractional values to as high as 300 volts. The smallest unit listed is 0.065 inch in diameter by 0.108 inch long. Tansitor Electronics, Inc., Bennington, Vt.

Circle No. 222 on Inquiry Card

Numerical Displays

Data sheets describe two completely-packaged readouts. The ND-100 is designed especially for use as a dependable building block module in timing, industrial control and computer systems, as well as all other applications where an exceptionally clear display and wide angle of vision are desired. The ND-200 incorporates a latching storage feature which makes it possible to sample, at any time, the BCD data being presented to the display unit, and to indicate and hold this sampled data for convenient visual observation. Complete specifications are given. Transitron Electronic Corp., Wakefield, Mass.

Circle No. 198 on Inquiry Card

Pulse-To-Step Translators

New "Slo-Syn" translators are pulse-to-step converters designed for use with appropriate synchronous motors connected for incremental stepping. They convert low-level signal pulses or square waves into the correct 4-step switching sequence needed to drive the motor at 200 discrete steps per revolution. Input signals entering the translator are shaped by monostable circuits before going to the logic elements. Power input is 105-125 volts ac, 0.5 ampere for Type ST250B and 105-125 volts ac, 1.0 ampere for type ST1800. Signal input impedance consists of a 2200 ohm, 0.5 watt resistor shunted by a series RC of 390 ohms and 0.1 microfarad. Typical applications as outlined in brochure include translating input signals received from tape readers, oscillators, photodevices, digital computers, pulse generators and other devices. Superior Electric Co., Bristol, Conn.

Circle No. 195 on Inquiry Card

Power Supplies

Described in a new bulletin are two ruggedly-constructed, virtually foolproof series of power supplies, that are said to provide tremendous amounts of highly-controlled power in a small package. The two series are system-type units for semi-fixed (wide adjustment slot) voltage ratings. The advanced circuitry of both these series eliminates the need for output fuses or circuit breakers, yet provides fully automatic service under all normal operating conditions and automatic recovery after any abnormal operating situations. Deltron, Inc., Philadelphia, Pa.

Circle No. 187 on Inquiry Card

Panel Meters

New 20-page bulletin lists over 1300 types and ranges for panel meters available from stock. Specifications and prices are shown for pivot and jewel meters, taut band units, contactless meter relays, "Rugged Seal" meters, Edgewise type, segmental voltmeters, and elapsed time meters. Also included are shunts, current transformers, and multipliers plus a three-page glossary of instrument terms. Simpson Elec. Co., Chicago, Ill.

Circle No. 201 on Inquiry Card

LOCAL INTERVIEWS

call (collect) area code 312

427-2036

to arrange for an interview in the near future in New York City, Boston, Philadelphia, Minneapolis, San Francisco, Los Angeles and other major U.S. cities.

Salaries: $7,200 to $20,500

Urgent requirements exist at several client companies for degree engineers with experience in RAM devices development; Discs, Drums, and magnetic card mass storage systems; Microelectronics Packaging; and Core Memory Development, in addition to most other areas of advanced computer technology. Specific assignments include:

Senior Projects Manager	$17,000 to $20,500
Staff Engineers	$15,800 to $18,500
Senior Engineers and Engineers	$9,500 to $15,600
Computer Technicians	$7,200 to $9,500 plus

To arrange for an interview, call (collect) or mail your resumé directly to Mr. Robert Reilly at:

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Client companies are equal opportunity employers.

SEAL DUST AND MOISTURE OUT, SEAL ARCS IN

with an illuminated EECoSWITCH*

Destructive environments—even explosive ones—need no longer be a problem in choosing a coded switch. This thumbwheel unit meets MIL-S-22710 *and* is sealed against moisture, dust and similar penetrants. Seal prevents ignition of explosive gases by contact arcing. Units meets explosion requirements of MIL-STD-202B, Method 109. Available with 8-, 10- and 12-position thumbwheels and in assemblies with as many units as desired. Custom requirements met. Write for full information.

Lamps are easily replaced, meet MS-24515.

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CIRCLE NO. 34 ON INQUIRY CARD

LITERATURE

Diode Catalog

Complete line of silicon semiconductor diodes is described in the catalog. Information is given on general purpose diodes, fast switches, 1 watt Zeners, glass Zeners, temperature-compensated Zeners, Codistors (new multi-junction forward regulator diodes), 1 watt rectifiers, and 1.5 amp full-wave bridges. Computer Diode Corp., Lodi, N.J.

Circle No. 188 on Inquiry Card

Stepping Switch

A 6-page bulletin describes a new stepping switch that has a life of 50,000,000 steps and a capacity to transfer 144 two-position circuits, or to handle complex switching programs. Switch can make and break 5 amps at 115 vac or 10 amp loads at 28 vdc. Bulletin describes form "C" contacts which, on rotary circuit decks, offer increased flexibility to remote control programming. Ledex, Inc., Dayton, Ohio.

Circle No. 184 on Inquiry Card

Transistor Catalog

Short-form catalog gives salient characteristics of 163 different silicon and germanium transistors. Included are silicon epitaxial planar types, silicon precision alloy types, ECDC germanium types, and MADT, MAT, and SBT germanium designs. Sprague Electric Co., North Adams, Mass.

Circle No. 196 on Inquiry Card

36 Power Supplies

Performance features of 36 standard, regulated dc power supplies are given in new catalog. Dc output voltages range from 10 to 250 volts with power capabilities up to 2400 watts. The stated line regulation is ±1% for ±13% line voltage change. Load regulation of ±2% is met for any load change between ½ load and full load. Output ripple is less than 1% rms. Acme Electric Corp., Cuba, N.Y.

Circle No. 192 on Inquiry Card

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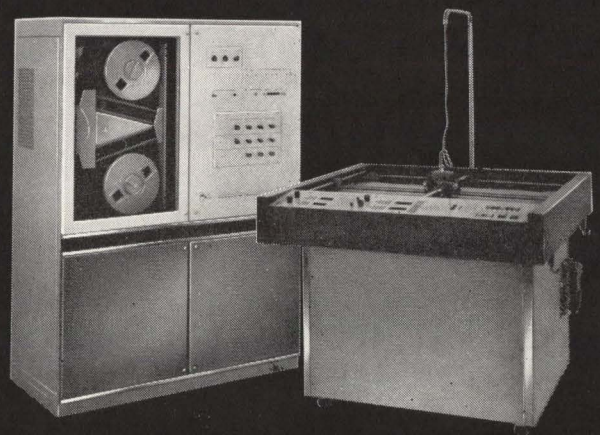
shortest distance between two points···

■■■ SAVES COMPUTER TIME

Most computer prepared digital plotting tapes require a ¾" record gap to separate the data points. But, not at Benson-Lehner. They have found a way to take the gap out of the tape. Therefore, by eliminating the *time*-and-*space* consuming record gaps, the shortest distance between two points on magnetic tape is Benson-Lehner's new tape format. By using this gapless method, the computer write time is shortened to **1/14** of the time previously required. This means that you can **write 14 times more information** on the same length of tape! Or if you prefer, have some tape left over. And when you think of what it cost for computer time, the gapless way is the least expensive way to travel across a tape transport.

The Magnetic Tape Plotting System shown is capable of performing multi-color point-to-point plotting and line drawings, with scale markings, curve identification and alpha-numeric symbol printing.



benson-lehner *corporation*

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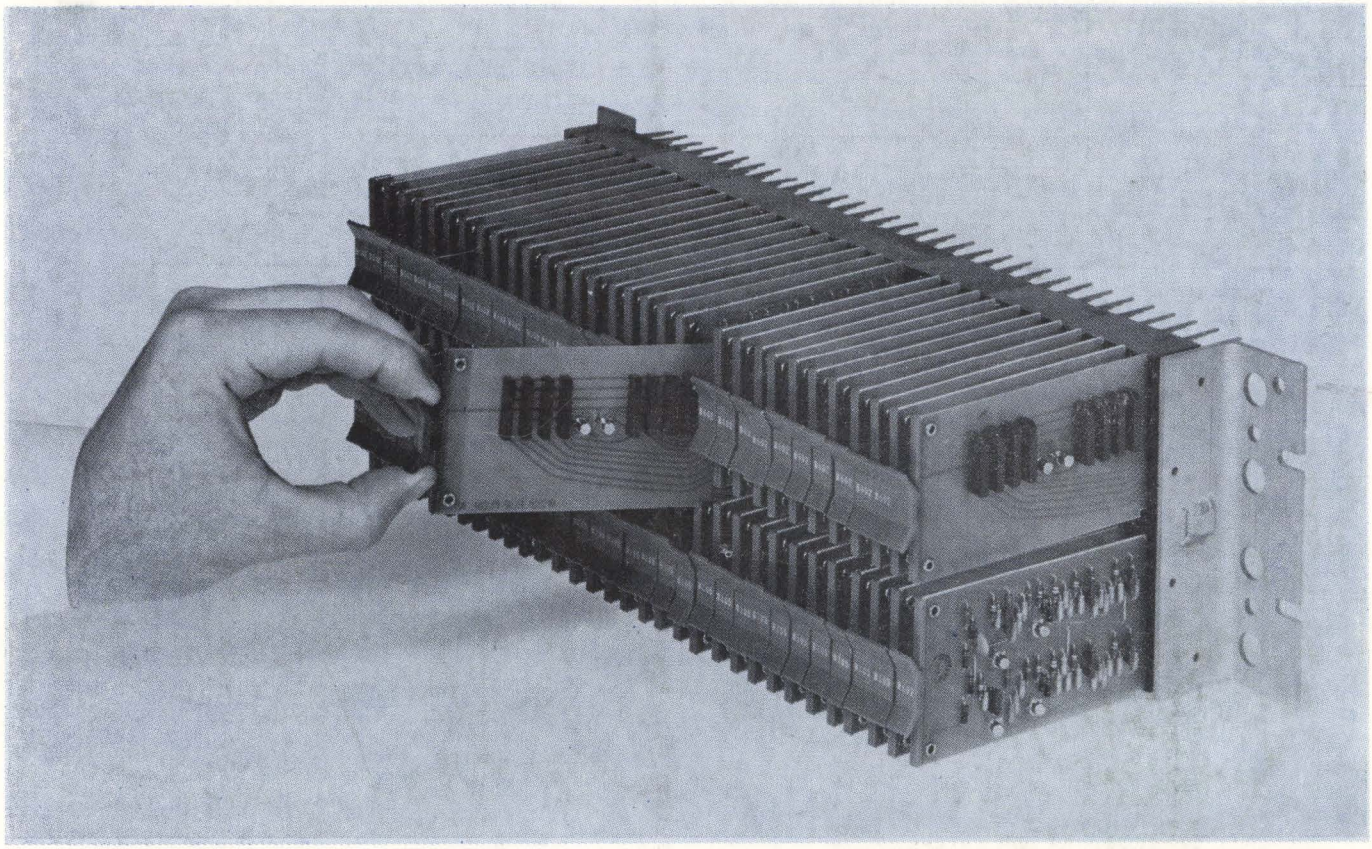
CIRCLE NO. 35 ON INQUIRY CARD



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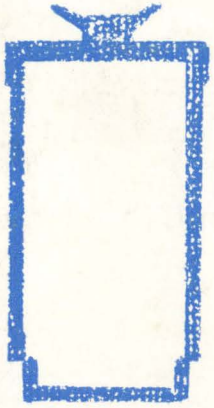

Four series of FLIP CHIP MODULES offer the designer a wide choice of most needed circuits, including basic 0-2 megacycle DTL silicon logic circuits, basic 0-10 megacycle silicon logic circuits, and silicon analog-digital modules.

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