

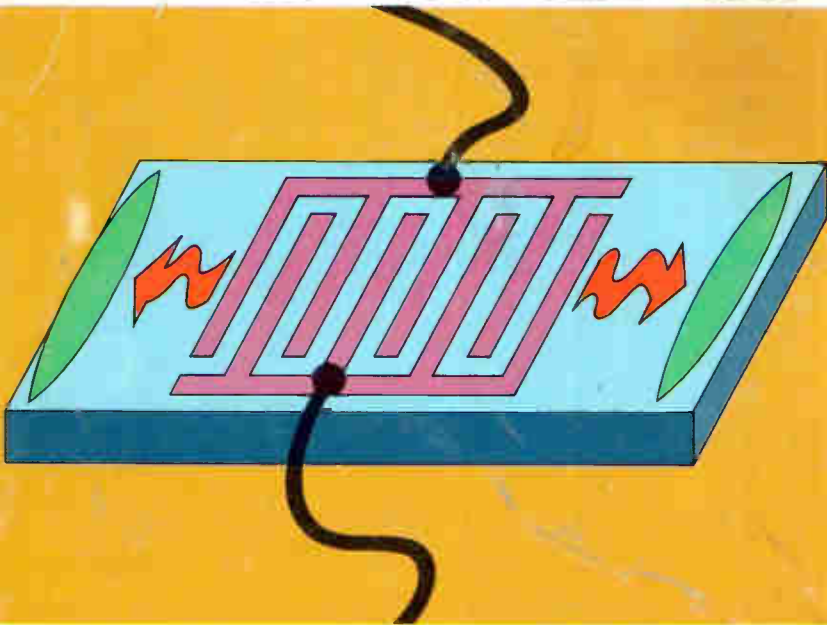
A McGraw-Hill Publication

**How RCA puts lasers and holograms to work for low-cost tv playback**

page 108

November 10, 1969

# Electronics



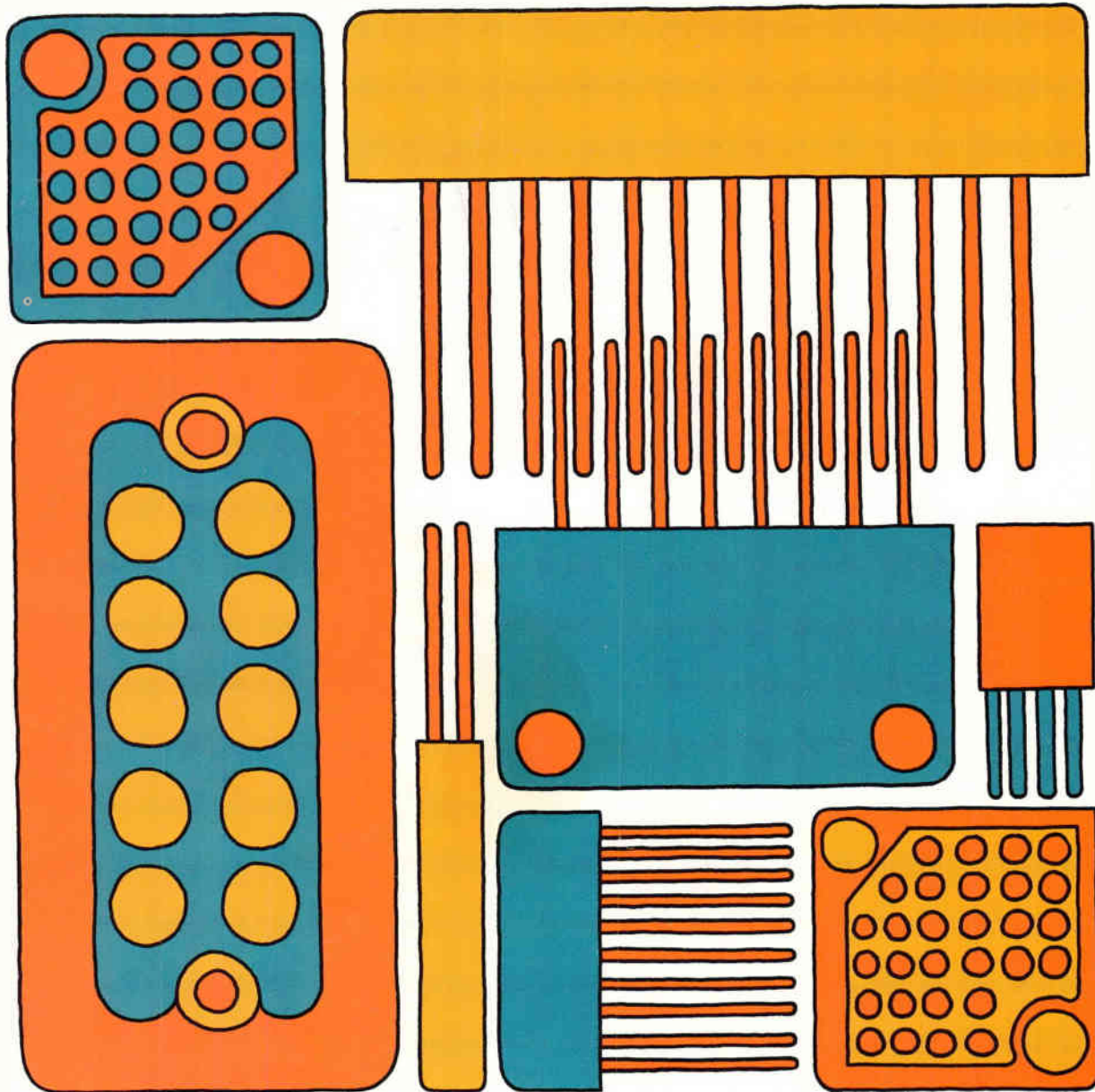
***What makes microwave acoustics attractive for signal processing***

page 94



**Why Supernova is**

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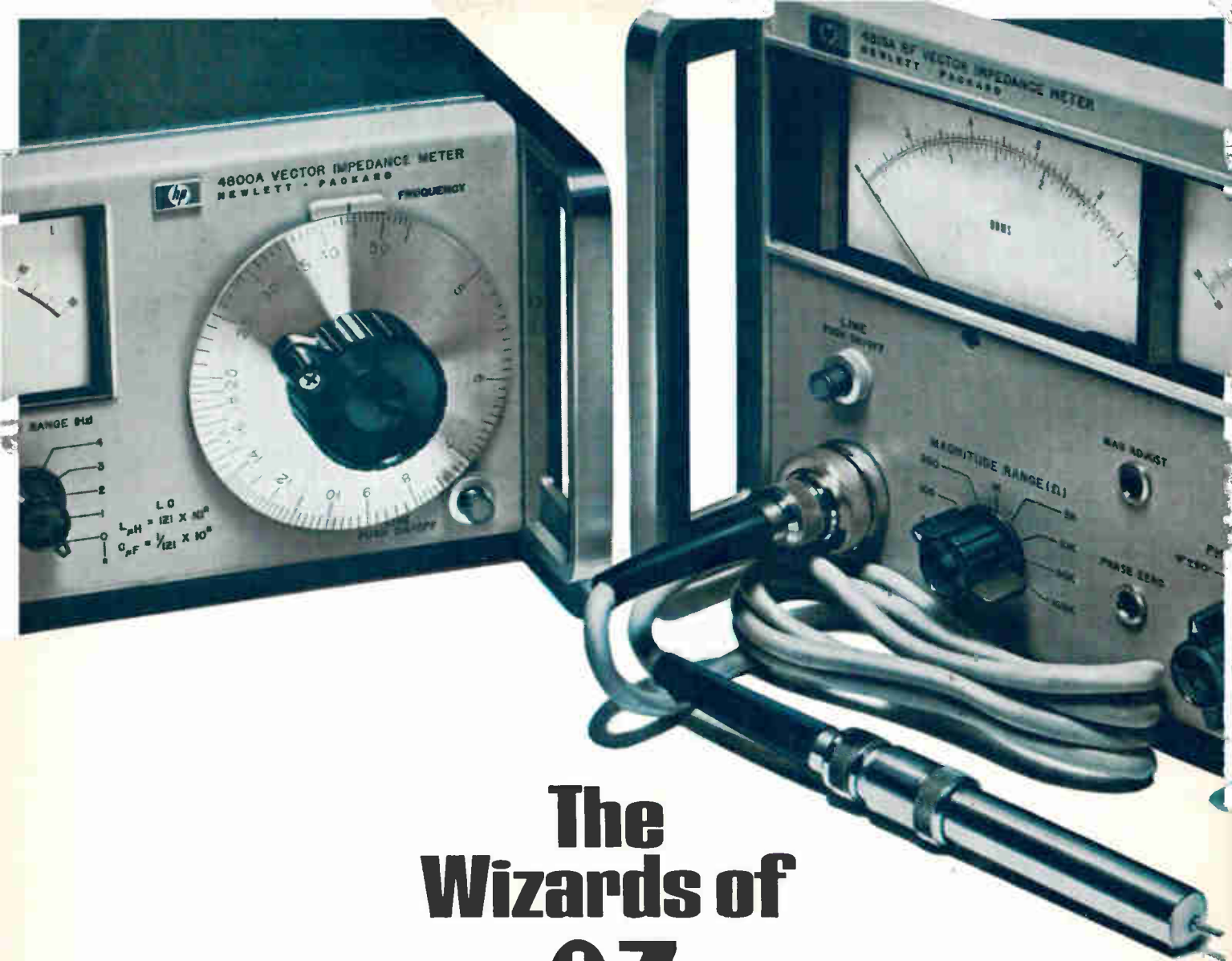


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Application Note 86 describes many applications of the 4800A and the 4815A Vector Impedance Meters including the measurement of  $Z$ ,  $R$ ,  $L$ , and  $C$ . For your copy and complete specifications, contact your local Hewlett-Packard field engineer or write: Hewlett-Packard, Green Pond Road, Rockaway, New Jersey 07866. In Europe: 1217 Meyrin-Geneva, Switzerland.



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The same ac converter (Option 001) also provides true four-terminal ac ratio capability. Gives you the com-

plete isolation you need between X and Y inputs to make accurate ratio measurements between two ac voltages. Four ranges (1:1 to 1000:1) of true four-terminal ac ratio are provided. Option 001 gives the 3450A the capability to make fast, accurate ac readings for **all** the ac information you need.

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Price: Basic 3450A, \$3150; AC Option 001, \$1250; Ohms Option 002, \$400; Limit Test Option 003, \$350; Digital Output Option 004, \$175; Remote Control Option 005, \$225; Rear Input Terminal Option 006, \$50.

## True rms readings! Just one face of the Incredible Dodecameter —

**HEWLETT  PACKARD**  
DIGITAL VOLTMETERS

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## Readers Comment

### Participation

To the Editor:

Concerning your article about Mil Std 883 [Aug. 18, p. 131], I would like to point out that participation in EIA engineering committees is open to all technically qualified members of the industry irrespective of membership in the association. It has always been EIA's policy to provide opportunity for the broadest representation of those companies having a significant interest in the activities of these committees.

J.A. Caffiaux

Engineering department manager  
Electronic Industries Association  
Washington

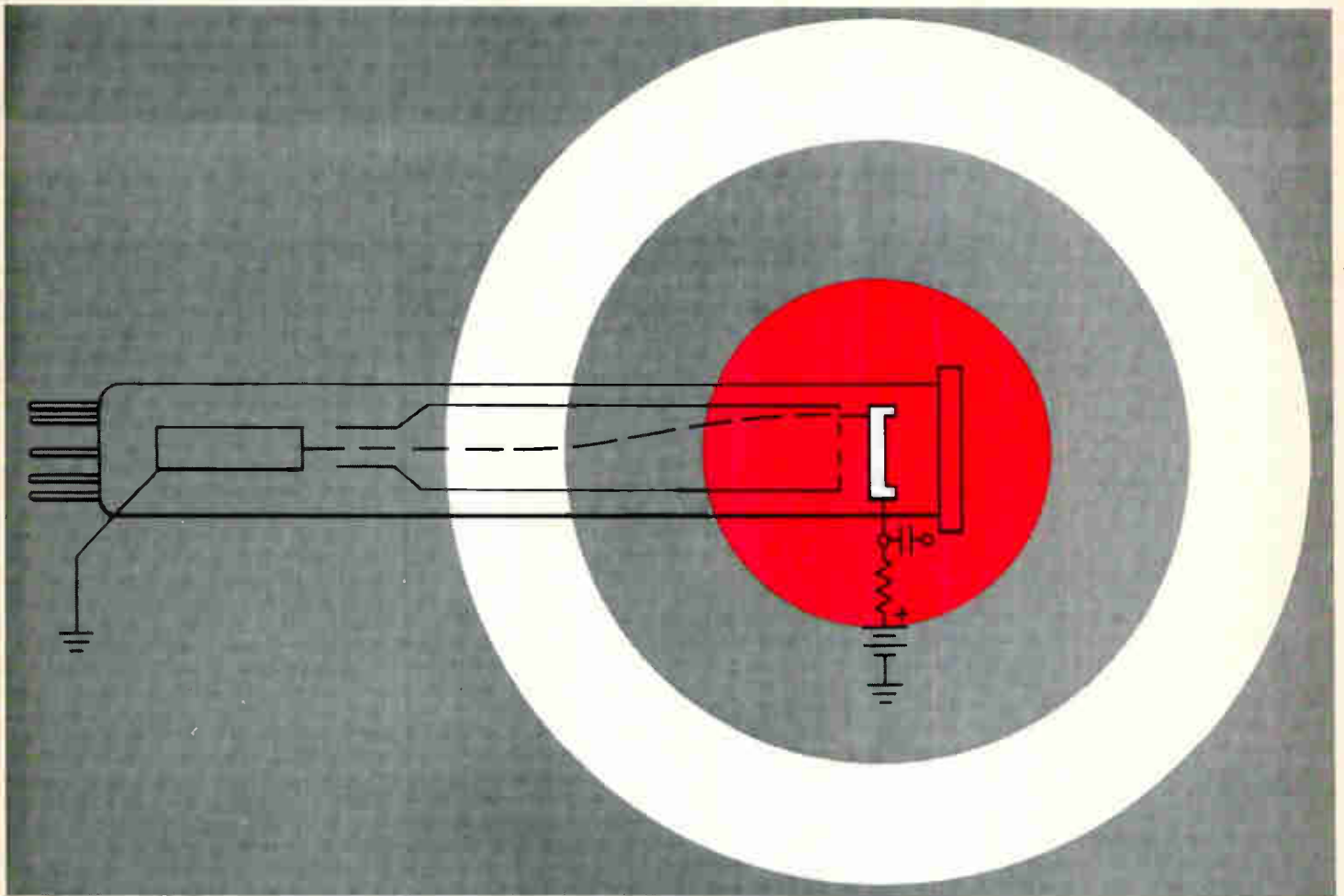
■ Edward Keonjian of Grumman says that the question hinges on the word "participation." Any organization—including NASA and the Defense Department—may send representatives to participate in EIA committee work. Nonmembers may also vote if they pay a \$50 fee per meeting. However, he says that the majority of nonmembers elect to act as observers and participate in discussions without voting.

### Historical perspective

To the Editor:

The article by Paul V. Wanek [Sept. 15, p. 119] omits some information that can put the technical material in better perspective. The general ideas expressed in the article—namely, the use of a notch filter in a feedback circuit to provide a selective circuit and, going one step further, to make this circuit into an oscillator—were described by Hermon H. Scott in 1937. And they are the subject of two patents assigned to the General Radio Co. The same material was also covered in a paper published that year in the Proceedings of the Institute of Radio Engineers.

The patents and the IRE paper were also the basis for numerous commercial instruments that included not only oscillators and sound analyzers manufactured by General Radio, but similar prod-



**A solid state target in a camera tube**

Bell System PICTUREPHONE® service will need small, reliable TV camera tubes for use in offices and homes, where lighting ranges from dim to very bright. Conventional vidicon tubes are unsuitable, so Bell Labs developed a new kind.

The heart of the new tube is a light-sensitive target containing nearly 700,000 silicon photodiodes in an area less than a half inch square. They are made by diffusing boron, a p-type impurity, through a silicon-dioxide mask into n-type silicon.

A scanning electron beam charges the p material negatively, reverse-biasing the diodes. Holes, created by incident light, are collected by the electric field at the p-n junctions, and individual diodes discharge by an amount proportional to the local light intensity. Recharging of the diodes by the scanning electron beam produces a varying current . . . the output signal.

Among the tube's advantages: Its target tolerates high-temperature baking . . . a processing step to improve reliability. Conventional vidicon targets cannot stand this.

Silicon's high thermal conductivity and chemical stability help make the new tube immune to "burn-in" (degradation of performance from continuous exposure to a fixed image, very bright light, or

a strong scanning electron beam).

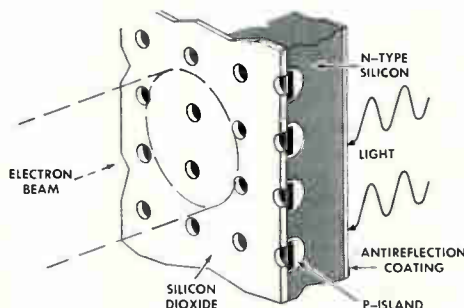
The time between a change in target illumination and a like change in output is much shorter with the new target. This improves response to fast-changing scenes.

The light-sensitive face of the new target is optically flat. So, a multi-layer antireflection coating can be applied for better sensitivity and minimum received-picture "halo"

Silicon targets have relatively uniform response through the visible and near-infrared—from 4,000 to 9,000 Å. Quantum efficiency (electrons per photon) exceeds 0.5. So, these targets have at least 10 times the sensitivity of a standard vidicon camera tube in incandescent light.

This new camera tube is in the latest model PICTUREPHONE set, now undergoing field trials.

**From the Research and Development Unit of the Bell System—**



**Bell Labs**

# SCIENCE/SCOPE

The TOW anti-tank missile scored "ten for ten" in a recent test by the U.S. Army Missile Command at Redstone Arsenal, Ala. All ten missiles struck targets more than a mile away "with pinpoint accuracy." They were part of the first TOW production hardware delivered to the Army by Hughes. Wire-guided TOW, which can be fired from a ground emplacement or from helicopters and a variety of vehicles, can knock out field fortifications or destroy any known enemy armor.

Ion beam "sputtering" -- the life-limiting erosion that plagues designers of vacuum tubes and ion-propulsion engines -- has been turned into a precision tool for microelectronic fabrication by Hughes research scientists. Their ion-beam micromachining technique can remove and create patterns in any substance and permits the use of new materials. The ion beam's directionality makes it superior to wet chemical etches for removing material in very fine patterns (line widths down to 1/2-micron have been achieved).

The prototype of an advanced radar -- forerunner of what could be the world's most powerful for defense against missile attack in the 1970s and beyond -- is now undergoing system tests at Hughes. It is being built under a multi-million-dollar Advanced Research Projects Agency/U.S. Army contract administered by the U.S. Air Force's Rome Air Development Center. Though the prototype will be only 1/50 the power of the proposed long-range system called ADAR (for Advanced Design Array Radar), it will be the most powerful radar yet built by Hughes.

The first Phoenix missile system trainer, delivered recently to the U.S. Navy at the Pt. Mugu, Calif., Naval Missile Center, will be used to train missile control officers for the Navy's new F-14A fighter. The Hughes-built simulator eliminates costly, time-consuming in-flight training. Using computers, tapes, and displays, it simulates a complete mission profile, from target acquisition to lock-on and missile launch.

Hughes needs experienced engineers: Microcircuit, digital communication system analysis, computer systems, digital systems test, signal processing, circuit design, microwave solid state, radar systems. Also: real-time and weapon system programmers. A B.S. degree, two years of related experience, and U.S. citizenship are required. Please write: Mr. J. C. Cox, Hughes Aircraft Company, P.O. Box 90515, Los Angeles 90009. Hughes is an equal opportunity employer.

The U.S. Air Force's new Maverick missile passed its first air-launched test at Edwards AFB, Calif., recently -- just over a year after it went into development at Hughes. It was launched from an F-4, but is also designed for use on the A-7D and other aircraft. Mission of the air-to-ground Maverick is to attack small, hard, tactical targets, such as tanks and field fortifications. Automatic TV guidance will enable it to track its target after launch without further help from the launching aircraft.

*Creating a new world with electronics*





## Readers Comment

ucts built by Hewlett-Packard and other licensees.

Victor H. Pomper  
President,  
H.H. Scott Inc.  
Maynard, Mass.

### Added inputs

To the Editor:

Regarding your article on the IBM 360/195 [Sept. 1, p. 39], may I point out two additional significant operating features. The central processing unit of the 195, which operates at a 54-nanosecond cycle time, almost always will get data directly from the 54-nsec buffer memory, rather than from the 756-nsec main memory. Also, the central processing elements that operate in parallel have a high degree of overlapping, or concurrency: for example, the floating-point processing element alone can perform two additions and a multiplication concurrently.

R.W. DeSio  
Director,  
High-performance systems  
International Business Machines  
Corp.  
White Plains, N.Y.

### From the start

To the Editor:

As a footnote to your article about the Army's Tactical Operations System [Sept. 1, p. 49], I would like to add that the TOS

effort was initiated in Stuttgart, Germany, in the latter part of 1964 as a joint Army/Bunker-Ramo Corp. project. Bunker-Ramo has been the prime system contractor—as opposed to the Control Data Corp.'s role as prime development contractor—since its inception (estimated \$15 million contracts to date) and has been responsible for problem definition, system design, implementation of all TOS software, total system integration, and system testing. Exercise Cardinal, held in Germany, represented the most recent in a long series of developmental steps which had led to the successful implementation of TOS by Bunker-Ramo.

R.J. Brousseau  
Director,  
TOS operating system  
Bunker-Ramo Corp.  
Canoga Park, Calif.

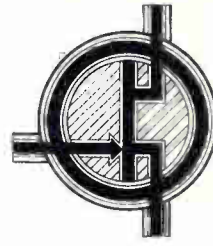
### In the works

To the Editor:

In regard to your article [Oct. 13, p. 165], although the Cogar Corp. has applied to the IBM Corp. for patent licenses, they have not yet been issued. As a minor point, it should be also noted that the IBM solid-logic technology uses a metal can with a non-hermetic organic backseal whereas the Cogar packaging technique will employ plastic caps.

Robert M. Meade  
Planning manager,  
Cogar Corp.  
Poughkeepsie, N.Y.

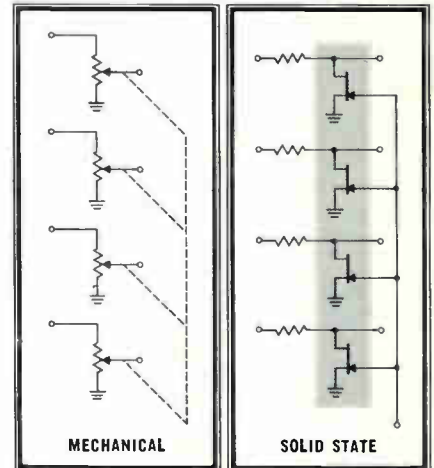
## Applications Power\*



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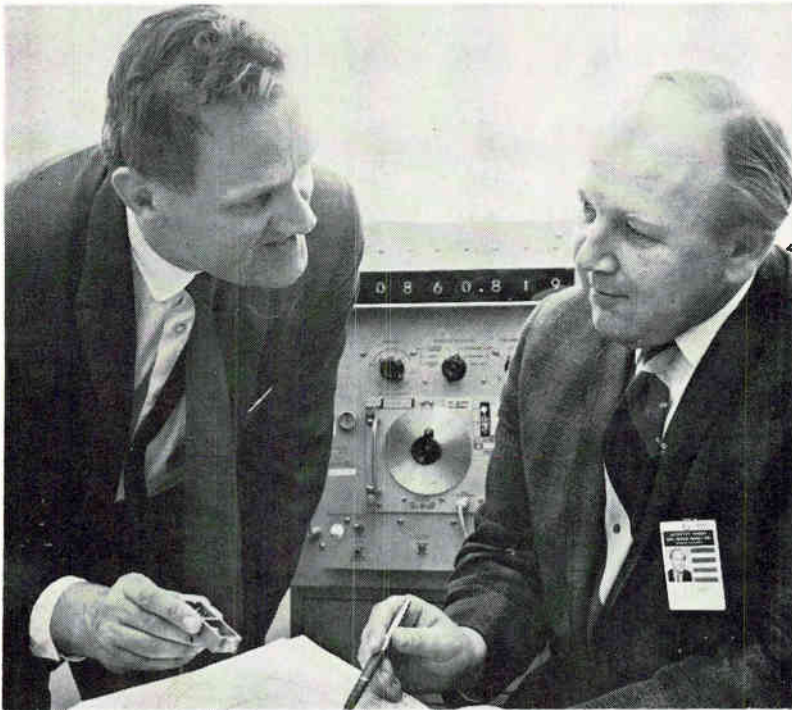
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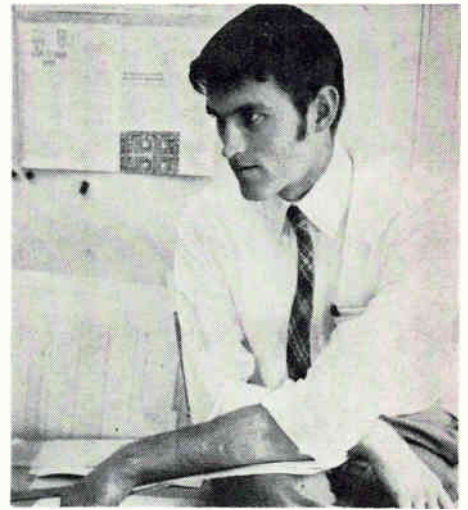
## Who's Who in this issue



Collins

Hagon

**At home among** acoustic surface waves, J.H. Collins and P.J. Hagon of Autonetics explore key features of this new field and particularly delay lines in the first of a two part article starting on page 94. A graduate of London University, Collins researched at Stanford before joining Autonetics as director of physical sciences in 1968. Hagon, also a London grad, joined the firm in 1962 after nine years in the semiconductor industry. Currently, they're working on the interface between novel acoustic surface wave elements and micro-electronic integrated circuits.



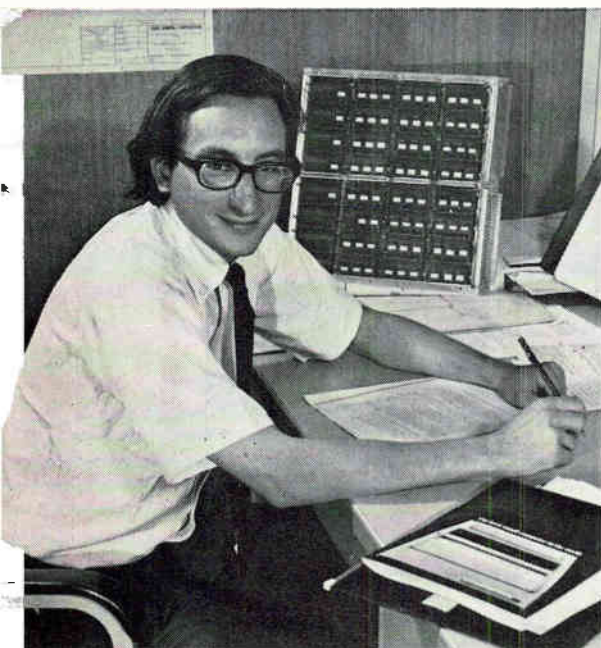
Doyle

**When RCA introduced** SelectaVision, *Electronics* instrumentation editor, Owen Doyle saw something else besides a video playback system. He tells about it starting on page 108. Holding an EE degree from Notre Dame, Doyle, who spent a year designing airplane guidance systems for the Navy, came to *Electronics* in 1967 after serving in the Army.



Cowdell

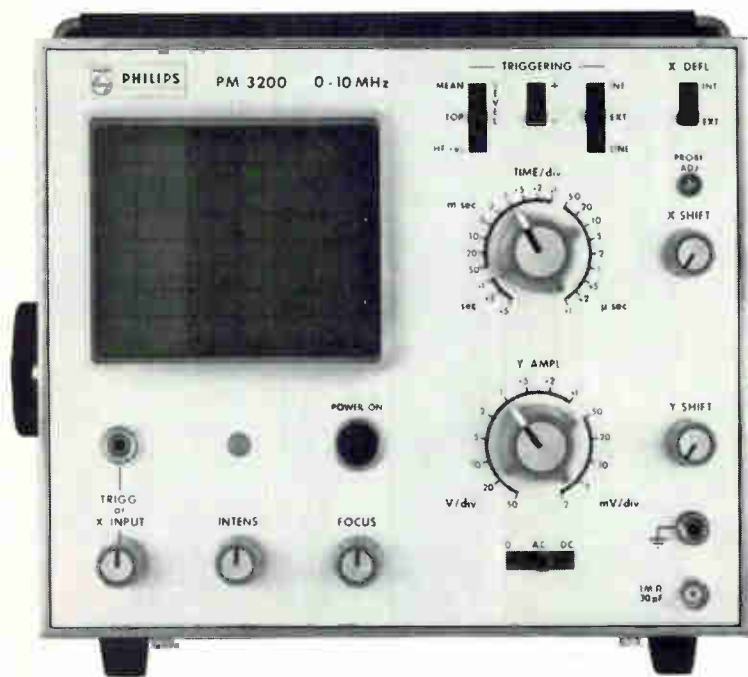
**While technical director** of Genisco Technology's components division, Robert B. Cowdell wrote the article on mismatched low-pass pi and tee filters, starting on page 121. His graphs, generated by computer, offer a direct route to filter design. Now at General Steam, Cowdell received BSEE and MSEE degrees from the University of Southern California.



Seligman

**Ever since 1964** when he received both his bachelor's and master's degrees from the Massachusetts Institute of Technology, Lawrence Seligman has been working on the design of digital processors. After he joined Data General last February, he optimized the design of the Supernova computer. Starting on page 116, he describes this new machine, which is the third system to reach production under his guiding hand, no mean feat. And besides these, he has several "paper" computer designs to his credit as well.

# Look at the screen, not the knobs.



PM 3200  
10MHz  
2mV/div  
\$480



More of the Unbeatable  
Philips Scopes

PM 3231  
15 MHz: 10mV  
Dual Beam Delay Lines  
\$975



PM 3250  
50 MHz: 1mV  
Dual Trace  
\$1995

**Three fewer controls mean you spend more time measuring, less twiddling.** Dc balance, trigger stability and manual level are out. So triggering is fully automatic.



Explanation. When waveforms start looking like this: all other automatic trigger circuits stop triggering. So you have to switch to manual and start knob twiddling. With the PM 3200 you switch from "mean" to "top" and stay with signal-derived, fully automatic triggering.

In either position automatic means automatic over the whole of the 10MHz range. And then on to at least twice this nominal bandwidth figure.

This unique Philips circuit has yet another feature. Whatever the signal, even no signal and whatever the sweep speed, the trace is always clearly visible.

There's no dc balance control because none is needed. Drift is feedback and virtually eliminated. (At max. sensitivity (1/4div/24hours).

The PM 3200 is highly portable (11.7 lbs.). Battery pack optional.

Available in U. S. from Philips Electronic Instruments, 750 S. Fulton Ave., Mt. Vernon, N.Y. 10550



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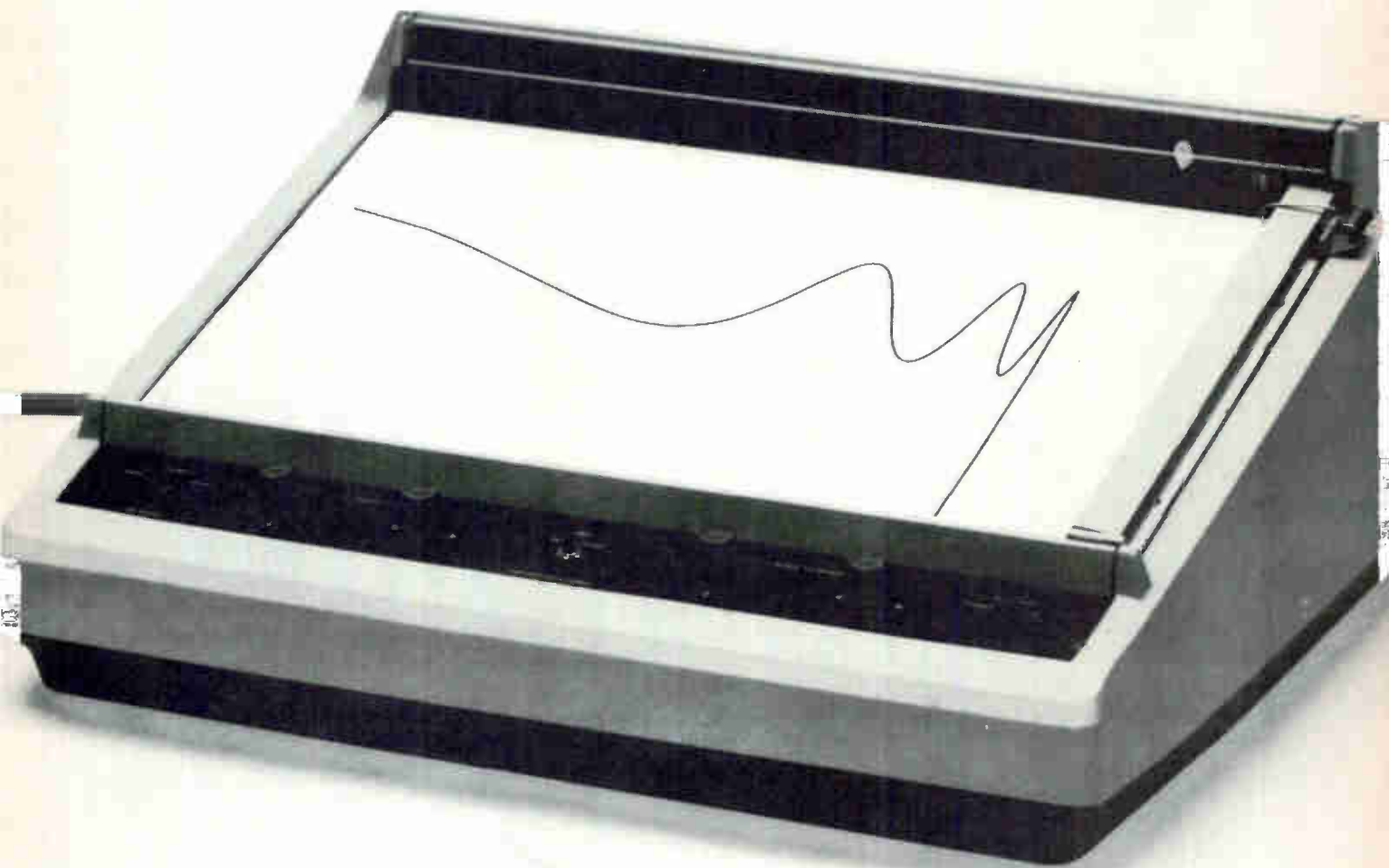
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# FET FACT

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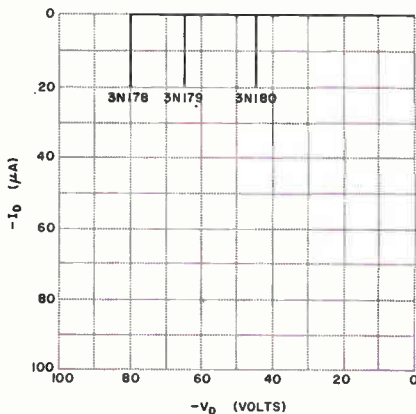
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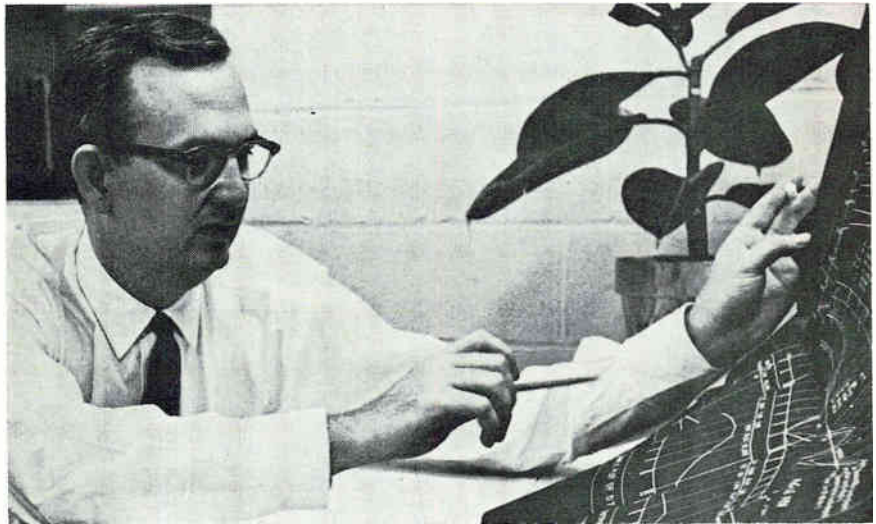
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## Who's Who in electronics



Charles L. Miller

When the guard changes at MIT's Instrumentation Laboratory on Jan. 1, so will the famed lab's direction. That's when C. Stark Draper will retire, to be succeeded by Charles L. Miller—chairman of MIT's civil engineering department, founder of the Civil Engineering Systems Laboratory, and head of the Urban Systems Laboratory.

Miller's appointment will mean an emphasis on applying the I-Lab's systems approach to social and urban problems—both of the other labs with which Miller has been associated apply technology to such areas. Up to now, most of the I-Lab's work, mainly in guidance and control, has been funded by NASA and the Defense Department. But the final report of an MIT panel appointed to "review . . . the procedures of the lab with respect to public service obligations" has recommended that the lab "not assume responsibility for developing operational weapons systems" such as Poseidon, but shift a balance of the work toward solving domestic problems. Other classified defense work still will be accepted, however.

**Merger.** Miller plans to effect this change in emphasis by incorporating the urban and civil engineering labs into the I-Lab. "The urban lab and the I-Lab are cooperating now in the design and development of a public transit system," he says. "The I-Lab's technology and sys-

tems approach is needed. I would expect to see more of this sort of thing." However, Miller does not expect to cut back on the amount of defense work done. Rather, he says, "I would hope to build up what we have started in urban problems rather than make any reductions in space and defense programs. I would like to see a parity among civilian, space, and defense, each doing about a third of the work, although this may take five years."

Looking to the future, Miller hopes the mergers eventually will "generate new technology for urban problems, but first we will turn to new applications and open up additional ways to use the computer. The main thrust of our work is apt to be in urban transportation at first."

**A knowledgeable outsider** describes Varadyne Inc. as "one of the most significant semiconductor operations to hit the Los Angeles area for some time." But to Charles Tobias, president, chairman of the board, and yacht racer par excellence, such a description is merely a cue for his pitch about vertical integration and the warning that he doesn't intend to be in the "jelly bean business" of making semiconductors only.

Tobias will admit, however, that integrated circuits are the keystone



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In the Model 6401 Programmable Counter and Timer, Beckman offers a general purpose laboratory and production instrument that does what you want it to, at a price you can't resist... \$1375.

The 6401 provides direct frequency measurements to 136 MHz and complete programmability from contact closures. And the 6401 makes new measurements that were "unheard" of in the Good Old Days—like pulsed RF frequency or burst frequency measurements and period measurements from both channels for calibrated phase timing.

Timing measurements are a breeze with the exclusive trigger point monitor lamps in the 6401 for optimum attenuator and trigger adjustments. And maximum utilization of field replaceable IC's assures highest reliability and the lowest cost of ownership.

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Regardless of what "programmable" meant in the good old days, take advantage of what Beckman has

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### Specifications

*Measurement Modes:* Frequency: Input A, 0-136 MHz; Input B, 0-10 MHz. Burst Frequency: 0-136 MHz. Time Interval: A to B, 0.1 μsec to 10<sup>9</sup> sec. Period: Input A, 0-10 MHz. Period Average: Input A, 1 to 10<sup>9</sup> in decade steps. Ratio: (F<sub>x</sub> ÷ F<sub>y</sub>) × M with F<sub>x</sub> = 0 to 136 MHz, F<sub>y</sub> = 0 to 10 MHz, M = 1 to 10<sup>9</sup>. Totalize and Scale: Input A, 0-10 MHz scale; 136 MHz count, 1 to 10<sup>9</sup> in decade steps. *Sensitivity:* Inputs A & B, 100 mV rms. *Crystal Frequency:* 10 MHz. *Stability Aging Rate:* Temperature: 2.5 × 10<sup>-6</sup> from 0°C to 50°C; Line Voltage: 1 × 10<sup>-1</sup> for ± 10% line voltage change. *Oscillator Output:* 10 MHz. *External Oscillator Input:* 10 MHz. *Time Base Output:* 3 V p-p. *Display:* 8 digits with overflow indication. Storage ON-OFF. Sample Rate: fast recycle and .1 sec to 10 sec display. Gate Lamp. *Remote Programming:* by switch closure to ground; BCD data at rear panel. *Temperature:* 0-55°C. *Power:* 115/230 V ± 10%; 50-400 Hz. *Price:* \$1375. *Options:* ACL: Laboratory Stability Oscillator, 3 parts in 10<sup>9</sup> per 24 hrs; \$400. ACN: Ultra-high Stability Oscillator, fast warm up, 5 parts in 10<sup>10</sup> per 24 hrs; \$800. 9 digits: \$100. Rear Inputs (A and B): \$50.

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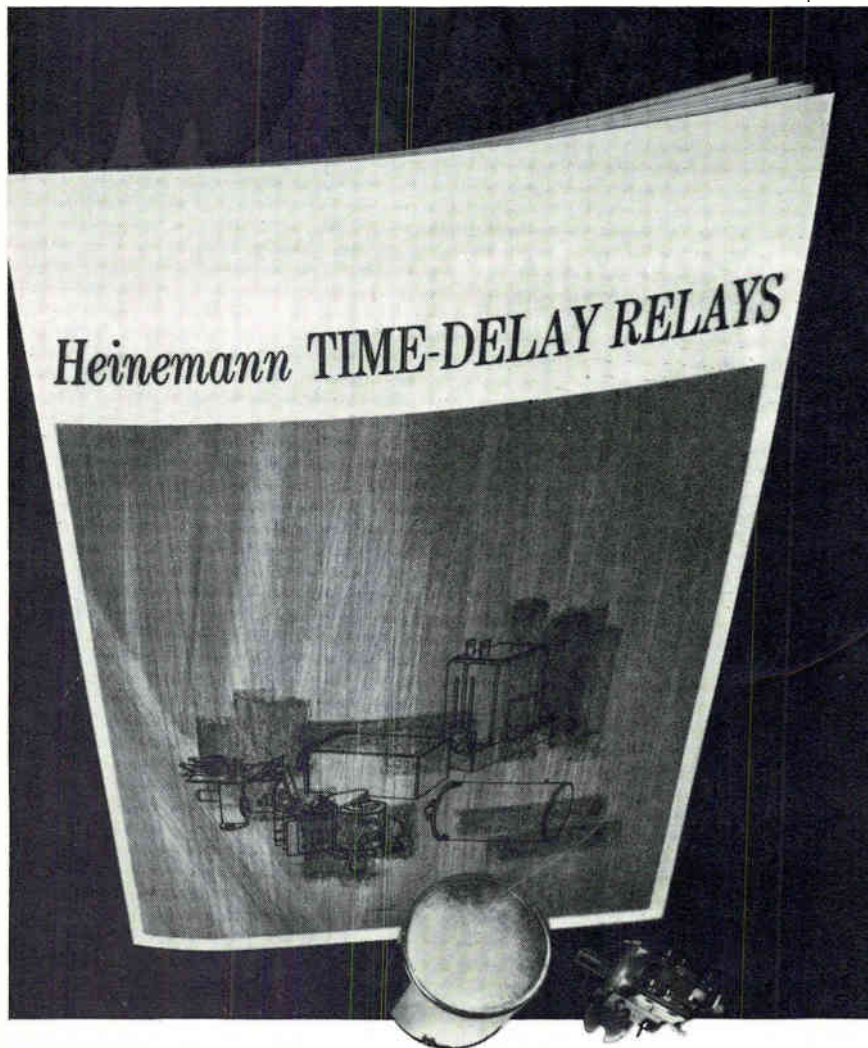
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## Who's Who in electronics

to his vertical integration—from components up through subsystems and systems—so he lured Chaz Haba, 34, a human dynamo like himself, from Fairchild Semiconductor to head the semiconductor division. "Within a year or two," says Tobias, Haba will become president of the Santa Monica-based firm.

**Second source.** Varadyne recently produced its first set of IC wafers—the VA 741 operational amplifier. It's the company's version of the popular Fairchild op amp, and sets the pattern for the initial thrust in linears—second-sourcing of industry standards, with some proprietary circuits to come. The amazing thing is that the first wafers came out of the ovens of the \$1.2-million, 16,000-square-foot facility only 4½ months after the building was gutted, rebuilt, and equipped. Even more amazing is Tobias's goal for Varadyne, which did \$4.5 million in sales for the year ended last June 30, and earned 30 cents a share. The goal: \$100 million in sales through internal growth and acquisition, a goal that Tobias says could be reached "within 40 months."

That goal must send shivers down Haba's spine, though he doesn't outwardly quarrel with it. Besides being vice president and general manager of the semiconductor division, he's corporate marketing manager, handling products including chip capacitors (which have been paying the bills), chip resistors, thick-film substrates, inks, packages and hybrid circuits, and now IC's. Combinations of these go into "subsystems" such as a line of active filters.

**Success—or else.** Haba maintains he'll sell IC's outside only when there's an established market. That's why he's picked up popular linears to start. The 741 will be followed by a Varadyne version of the Fairchild 723 op amp. Haba is considered an achiever by those who know him. One says, "He's always busted his gut to do what he sets out to do, but I wouldn't want to be in his position now because he's a success-oriented person."



Sprague Semiconductor Chips and Packages. Illustration: 3 wafers, 8 packages, many chips

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455-9130R1



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Its members are some of TI's top

managers in the areas of reliability engineering, process engineering, product sales, military marketing, product planning, product engineering, quality control engineering, manufacturing and HI-REL assembly.

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The Task Force's assignment starts with your problem: determining the specific test procedures and levels you'll need to satisfy 883 requirements.

Once the most practicable test plan has been devised, the Task Force sees it through. Thousands of TI personnel in many departments may be involved in your program, but the Task Force is responsible for its success.

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Write for "MACH IV High Reliability Procurement Specification MIL-STD-883." Texas Instruments Incorporated, PO Box 5012, MS 308, Dallas, Texas 75222. Or just circle reader service number 256.



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## Meetings

### NEC: 42 sessions for silver year

It's **Silver Anniversary** time for the National Electronics Conference in Chicago, and this year's 25th renewal, to be held at the Conrad Hilton Dec. 8-10, will be celebrated with 42 technical sessions. There will be 197 papers; three intensive refresher seminars covering mini-computers, MOS-LSI, and monolithic IC's will be available to those wishing to keep abreast of the latest advances.

The IEEE Communication Technology Group has invited papers for 16 sessions, while the IEEE Consumer Electronics Symposium has four sessions consisting only of invited papers.

**Color tv.** Session 1, consumer electronics, features a comparison of solid state subcarrier oscillators for color tv receivers presented by N. Doyle of Fairchild Semiconductor. An analysis of X-ray attenuation by glasses and resins in color tv picture tubes will be offered by G. Anderson, R. Tell, and H. Youmans Jr. of the U.S. Public Health Service.

Session 3 deals with the traffic service position system No. 1 and features a paper by J. Jacoby and B. Yokelson of Bell Labs on the

system's objectives, organization, and operation.

Recent advances in satellite communications are covered by session 31; it leads off with a discussion of satellite communication systems and follows with papers on antennas and amplifiers.

Developments in the Picture-phone encompassing service, design, planning, and transmission are taken up in session 29. Also dealing with the telephone system are sessions 36, new concepts in switching and customer equipment, and 17, switching systems and their control.

**Life.** Session 5 deals with engineering in medicine and biology and features a paper evaluating biomedical instrumentation and one outlining the use of the small computer in intensive-care units.

For the microwave engineer, session 18, microwave switching devices, presents papers covering such topics as microwave acoustics and microwave IC's. IC design also is discussed in sessions 33 and 41, while general circuit design is explored in session 27.

For further information, contact R.J. Napolitan, NEC, 1211 W. 22nd St., Oak Brook, Ill.

## Calendar

**Symposium on Adaptive Processes, IEEE; Pennsylvania State University, State College; Nov. 17-19.**

**Fall Joint Computer Conference, IEEE; Convention Hall, Las Vegas; Nov. 18-20.**

**Commerce Laser Colloquium, Electronic Industries Association and the U.S. Commerce Department; Paris, France; Nov. 18-20.**

**Conference on Magnetism and Magnetic Materials, IEEE, American Institute of Physics; Benjamin Franklin Hotel, Philadelphia; Nov. 18-21.**

**Conference on Image Storage and Transmission for Libraries, U.S. Dept. of Commerce; National Bureau of Standards, Gaithersburg, Md., Dec. 1-3.**

**Annual Conference, IEEE Group on**

**Vehicular Technology; Columbus, Ohio, Dec. 4-5.**

**Conference on Applications of Simulation, Association for Computing Machinery, IEEE; International Hotel, Los Angeles, Dec. 8-10.**

**Fall USNC/URSI Meeting, IEEE; The University of Texas at Austin, Dec. 8-10.**

**Symposium on Circuit Theory, IEEE; San Francisco, Dec. 8-10.**

**National Electronics Conference, Conrad Hilton Hotel, Chicago, Dec. 8-10.**

**International IEEE G-AP Symposium, The University of Texas at Austin, Dec. 9-11:**

(Continued on p. 24)



NEW



*New Allen-Bradley  
hot-molded Type GD  
dual variable resistor  
shown actual size*

TWO  
IN  
ONE

## Allen-Bradley hot-molded dual variable resistor

Here's the most compact two section variable resistor currently available—the new Allen-Bradley dual Type GD. It's one-half inch in diameter and only a fraction of an inch longer than the popular single section type G control. The case is dust-tight as well as watertight. ■ Both resistance tracks in the dual Type GD are solid, hot-molded elements, which provide long operating life. As with the single Type G, the noise level is low initially and actually decreases with normal use. Adjustment is smooth at all times with virtually infinite resolution. And low inductance permits operation at frequencies far beyond the usable range of wirewound controls. ■ In addition to standard application, these new dual Type GD controls are ideally suited for use in compact attenuators. ■ Dual Type GD controls are available with nominal resistance values from 100 ohms to 5.0 megohms. You can get immediate delivery at factory prices from your authorized A-B industrial electronics distributor. Or write: Marketing Dept., Electronics Div., Allen-Bradley Co., 1201 S. Second St., Milwaukee, Wis. 53204. Export Office: 1293 Broad St., Bloomfield, N.J., U.S.A. 07003. In Canada: Allen-Bradley Canada Limited.



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Tactfully: "I knew you'd be the one person around here to ask. Isn't there something about the rare earths that we can use?"

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## Meetings

(Continued from p. 22)

**Symposium on Application of Magnetism in Bioengineering**, IEEE, Israel Society for Biomedical Engineering; Rehovot, Israel, Dec. 9-11.

**Asilomar Conference on Circuits and Systems**, Naval Postgraduate School, The University of Santa Clara, Stanford University, and IEEE; Asilomar Hotel and Conference Grounds, Pacific Grove, Calif., Dec. 10-12.

**Winter Power Meeting**, IEEE; Statler Hilton Hotel, New York; Jan. 25-30, 1970.

**Annual Symposium on Reliability**, Group on Reliability of the IEEE, American Society for Quality Control, American Society for Nondestructive Testing, and the Institute of Environmental Sciences; Ambassador Hotel, Los Angeles; Jan. 27-29, 1970.

**International Solid State Circuits Conference**, IEEE, University of Pennsylvania; Sheraton Hotel and University of Pennsylvania, Philadelphia, Feb. 18-20, 1970.

**Symposium on Management and Economics in the Electronics Industry**, IEEE; University of Edinburgh, Scotland, March 17-20, 1970.

**International Convention**, IEEE; New York Hilton Hotel and the New York Coliseum, March 23-26, 1970.

## Short courses

**System Effectiveness—From the Support Point of View**, University of California at Los Angeles, Dec. 1-5. \$275 fee.

**Characterizations and Models of SCR Circuits**, University of Wisconsin, Madison, Dec. 9-10. \$70 fee.

**Computer Control**, University of Wisconsin, Madison, Dec. 11-12. \$70 fee.

**Electronic Components**, University of Wisconsin, Madison, Feb. 19-20. \$70 fee.

**PL/1-Techniques and Perspective**, Association for Computing Machinery; Nov. 10, Sheraton Ritz Hotel, Minneapolis; Nov. 12, Sheraton Motor Inn, New York; Nov. 14, Sheraton Park Hotel, Washington. \$90 fee.

**Managing Systems Analysis and Design**, Association for Computing Machinery;

(Continued on p. 26)

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EC69-1A

A-B Type W  
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shown about 5 times  
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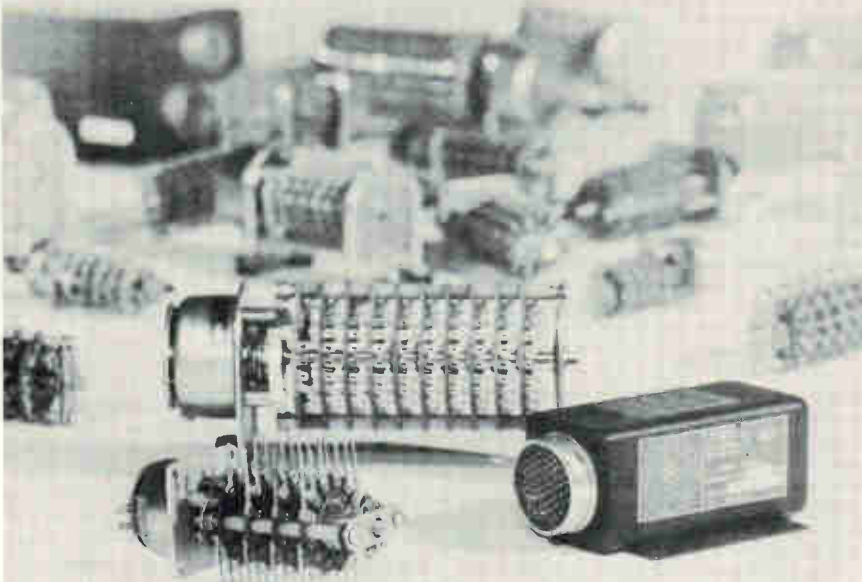


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Circle 25 on reader service card

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**Exceptional variety, too**—open switches, hermetically sealed packaged switches and special designs. New PC leg terminals (optional) eliminate hand wiring and permit quick installation.

**Ledex also manufactures solid state switches** functionally interchangeable with other Ledex stepping switches. Check them when long life and speed are more important than price.

If one of these stock models doesn't meet your exact requirements, we'll custom design for you . . . whether it's an open circuit selector, a packaged switching network, a solid state selector or some combination of these. We've the people, facilities and capability to get the job done—fast and right.

Write or call today for our new stepping switch/circuit selector catalog or the new packaged switch catalog.



**Specialists in remote switching**



**LEDEX DIVISION, LEDEX INC.**

123 Webster Street, Dayton, Ohio 45402 • phone (513) 224-9891

## Meetings

(Continued from p. 24)

**Nov. 13-14**, Sheraton Motor Inn, New York; **Dec. 4-5**, Sheraton Cadillac Hotel, Detroit. \$165 fee.

## Call for papers

**National Aerospace Electronics Conference (NAECON)** IEEE and American Institute of Aeronautics and Astronautics; Sheraton-Dayton Hotel, Dayton, Ohio, May 18-20, 1970. **Dec. 1** is deadline for submission of abstracts to Mrs. Rita Gustin, 5455 Flotron Ave., Dayton, Ohio 45424.

**Southwestern IEEE Conference**, Memorial Auditorium, Dallas, April 22-24, 1970. **Dec. 1** is deadline for submission of abstracts and summaries to Prof. Andrew P. Sage, Information and Control Sciences Center, SMU Institute of Technology, Dallas, Texas 75222.

**Symposium on Management and Economics in the Electronic Industry**, IEE; University of Edinburg, Scotland, March 17-20, 1970. Synopses should be sent immediately to Conference Department, IEE, Savoy Place, London WC2.

**Conference on Gas Discharges**, IEE; London, England, Sept. 15-18, 1970. **Dec. 1** is deadline for submission of synopses to Conference Department, IEE, Savoy Place, London, L.C. 2.

**International Geoscience Electronics Symposium**, IEEE; Washington, April 14-17, 1970. **Dec. 1** is deadline for submission abstracts to Ralph Bernstein, IBM Corp., 18100 Frederick Pike, Gaithersburg, Md. 20760.

**National Telemetry Conference**, IEEE; Statler Hilton Hotel, Los Angeles, April 27-30, 1970. **Dec. 12** is deadline for submission of papers to A.V. Balakrishnan, 3531 Boelter Hall, University of California, Los Angeles, Calif. 90024.

**Frequency Control Symposium**, U.S. Army Electronics Command; Shelburne Hotel, Atlantic City, N.J., April 27-29, 1970. **Dec. 15** is deadline for submission of summaries to Director, Electronics Components Laboratory, Army Electronics Command, Fort Monmouth, N.J. 07703.

**ASTM-NBS Symposium on Silicon Device Processing**, American Society for Testing and Materials, National Bureau of Standards, Gaithersburg, Md., June 2-3, 1970. Papers should be sent immediately to C.P. Marsden, Electronic Technology Division, National Bureau of Standards, Washington, D.C. 20234.



**The solid state numeric  
is ready at Monsanto.**

**So are 19 other LED's.**

## **Send a P.O.**

MAN 1 shown 6 X actual size.

You know we've been working on the MAN 1 visible diode numeric for several years. Well, now we're ready to take orders.

It offers all the good things you expect from microcircuits. Low power drain. Shock resistance. Happy interface with your solid-state circuitry. Plus it gives you design flexibility you've never had before. And the multi-segmented construction avoids the danger of a number being altered by a small circuit failure.

Send a P.O. and be the first designer on your block to give your

digital readout the look of the 70's.

The 19 other low-cost, long-lived LED's? Four are bright red light-emitting semiconductors that have ns switching time, diode reliability and million-hour\* life.

One of our LED's emits amber light, one green light. Five put out frequencies in the infrared. One is a coupled pair, with detector and emitter in the same package to give you a light-quick switch (5 ns rise and fall) with 3 kV isolation.

Six are room temperature lasers in a variety of miniaturized configurations. Number 19 is a bunch of new

CO<sub>2</sub> laser modulator components.

So there's the whole line. They're all currently available from Schweber, Kierulff, K-Tronics, or Semiconductor Specialists. Or from us: Monsanto Electronic Special Products, 10131 Bubb Road, Cupertino, California 95014. Phone (408) 257-2140.

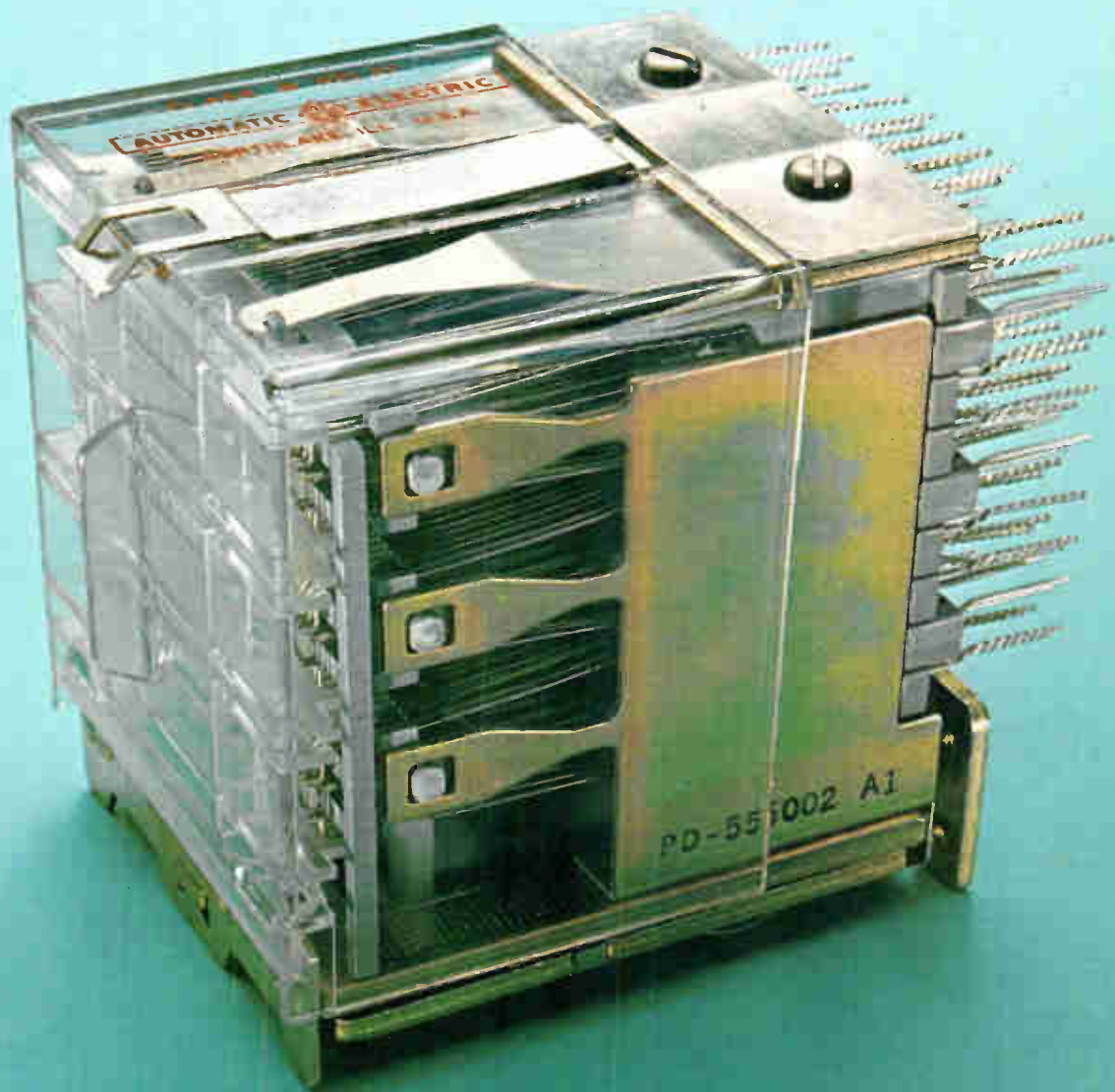
Want more information on our new numeric, the MAN 1? Circle reader service #317.

For specs on the other 19 LED's, circle #318.

\* T<sub>A</sub> = 25°C, I<sub>F</sub> = 50ma. Result of step-stress testing with end of life projections.

# **Monsanto**

# Reliability is staggered steps and a hunk of DAP.



### Expect over a billion operations.

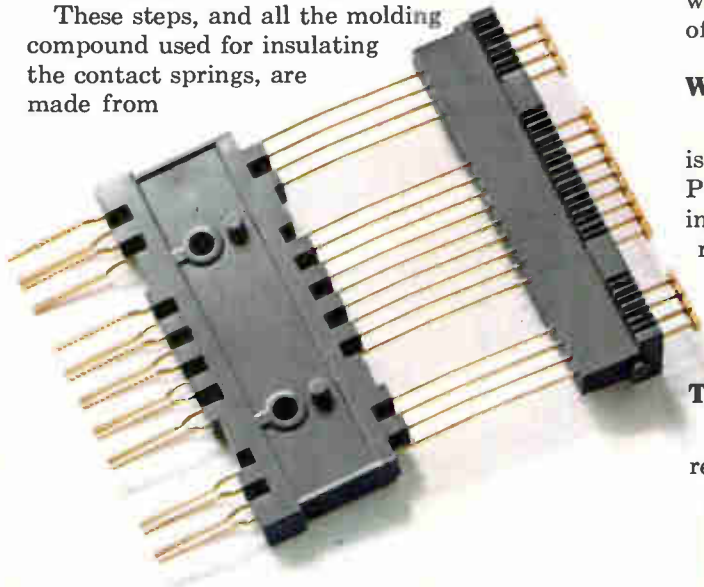
Our Class W wire-spring relay is different. In fact, there's nothing like it in the entire industry. Where else can you find a relay with lots of contacts and a mechanical life of more than a billion operations! That's about two and a half times the life of the best conventional relay around.

Another nice thing about our Class W is that it takes up a lot less space and costs less than using a bunch of other relays. That's because we build our Class W relay with one, two or three levels of contact assemblies, with 17 form C combinations per level. By the way, they're available with gold contacts for low-level switching.

### Making it tough on creepage.

All those staggered steps you see on the side were put in to raise the breakdown voltage between terminals. These molded steps add extra creepage distance between the terminals. This really counts for high voltage testing, or when using our Class W in unfavorable ambient conditions.

These steps, and all the molding compound used for insulating the contact springs, are made from



diallyl phthalate. (They call it DAP for short.) It has great insulating properties and it wears like iron. Even if the humidity is high, you have excellent protection.

### Redundancy—two springs are better than one.

Each of our long wire-spring contacts has an independent twin with the same function. One tiny particle of dust could prevent contact on other relays. Not with our Class W. You can be sure one of the twins will function. That's back-up reliability.

The twin contacts are twisted together at the terminal end. Then we give them a spanking (you might call it swedging) to provide solderless wrap.

### We're for independence.

Our springs are longer, because the longer the spring, the more independent they get. And the better contact they make. Don't forget, the wire-spring relay is the most reliable way to get a permissive make or break contact. You can rely on it.

The middle contact springs have to be stationary. To make sure they stay that way forever, we actually mold them between two thick pieces of DAP on both ends. Just try to move one.

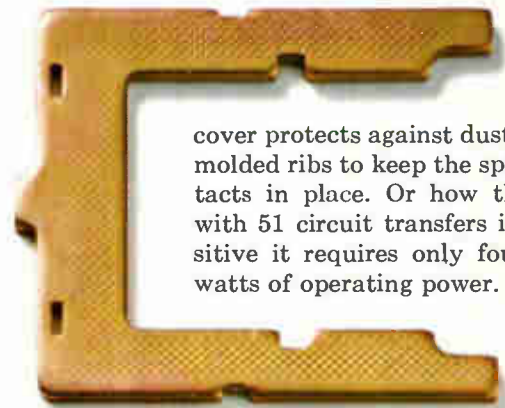
### When we say flat, it's flat.

Each frame, banged out by a gigantic machine is extra thick and extra flat. Then they're planished. Planishing is another step we go through in forming the frame to add strength and stability by relieving surface strain.

We've made our spring-loaded pile-up clamp extra thick, too. Once it's tightened down, the whole pile-up is nice and tight, and stays tight.

### There's more.

We could tell you a lot more about our Class W relays. Like how the tough high-temp molded



cover protects against dust and has molded ribs to keep the spring contacts in place. Or how this relay with 51 circuit transfers is so sensitive it requires only four to six watts of operating power.

But why don't you let us prove how much reliability we put into our Class W? We'll be waiting to hear from you. Industrial Sales Division, Automatic Electric Company, Northlake, Ill. 60164.

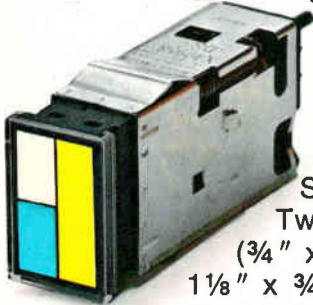
**AUTOMATIC ELECTRIC**  
GENERAL TELEPHONE & ELECTRONICS

# Announcing a new panel savings plan.



## Big dividends from small pushbuttons.

It doesn't take much to reduce the size of your control panels and cabinet fronts.



All it takes is compact miniature pushbuttons. Like the new MICRO SWITCH illuminated DS.

Two sizes are available ( $\frac{3}{4}$ " x  $\frac{3}{4}$ " for our 1-unit and  $1\frac{1}{8}$ " x  $\frac{3}{4}$ " for our  $1\frac{1}{2}$ -unit). And both can be matrix mounted on  $\frac{3}{4}$ " or  $1\frac{1}{8}$ " centers. So there's no need for spacers or barriers.

## A long-term investment.

A rugged metal housing encloses each switch and protects against the bumps and bangs of military and commercial use.

The housing also helps provide our DS pushbuttons with exceptional RFI attenuation capability. Incorporated into the housing are welded skirts that assure positive metal-to-metal grounding between the switch and adjacent units. And also between the switch and our rigid, box-girder matrix frame.

## Your choice of options.

Pick the mounting that best fits your application. Either individually mounted switches (meet the requirements of MIL-S-22885) or custom matrix configurations featuring plug-in switches that are best for remote stations or indicating functions.

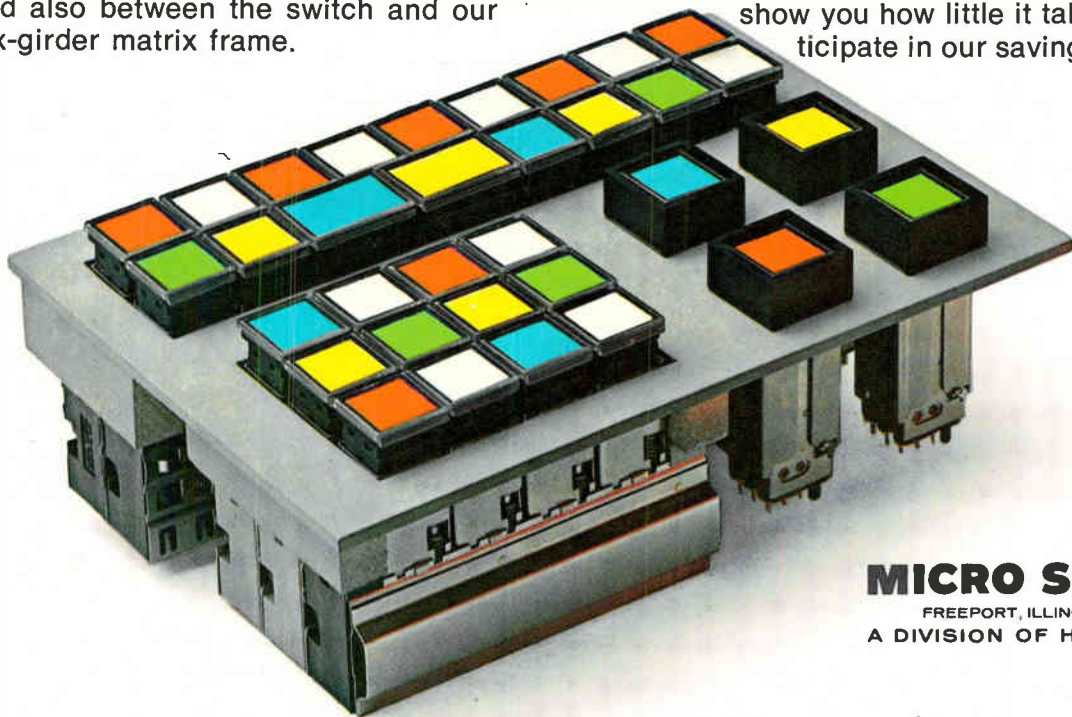
You can have up to four lamps in every switch. And either one, two, three or four-way split section screens. (The  $1\frac{1}{2}$ -unit provides more than one-third additional legend area.) Full guards are available for single-unit switches.

Then save even more space by combining both 1-unit and  $1\frac{1}{2}$ -unit switches in the same matrix. A single frame will handle up to sixteen 1-unit switches or up to ten  $1\frac{1}{2}$ -units.

## Who can participate in the plan.

MICRO SWITCH DS pushbuttons meet both commercial and military requirements. So they can be used in almost any panel from power plant control to tactical ground support equipment.

For more information, call your MICRO SWITCH Branch Office or Distributor (in the Yellow Pages under "Switches, Electric"). He'll show you how little it takes to participate in our savings plan.



**MICRO SWITCH**

FREEPORT, ILLINOIS 61032

A DIVISION OF HONEYWELL



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## Editorial Comment

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### Doing what comes naturally . . .

**Important decisions** in the industry often are reached when engineers and managers put their heads together. Traditionally, engineers on the one hand and managers on the other assume specific roles in the decision-making process. Engineers basically tend to be thing-and-fact oriented, while managers take the people-and-profit tack. Thus, while engineers bring to bear technical objectivity and expertise, managers traditionally play the role of devil's advocate, demanding proof that a new technology can save time or money. As a result, wise decisions are reached.

The system usually works because both sides observe the ground rules; through their respective roles they function in check-and-balance fashion.

Occasionally, however, the system gets out of whack. It can happen when the engineer turns supersalesman, touting an idea or development out of all proportion to its technical worth. And sometimes the manager's sales resistance may be inad-

quate; he buys the concept based on the engineer's enthusiasm, not on the substance of his technical proposal. Too often, this unfortunate combination of role rejections happens when the stakes are especially high—as in the installation of capital equipment for production, or in the purchase of a new computer. In the latter case, engineers may feel professionally obliged to believe that a sophisticated computer ought to be able to alleviate their design problems or easily be plugged into the loop of a process control system. Managers may okay the investment merely to keep up with the Joneses. The result is overoptimism, oversell, and "overbuy."

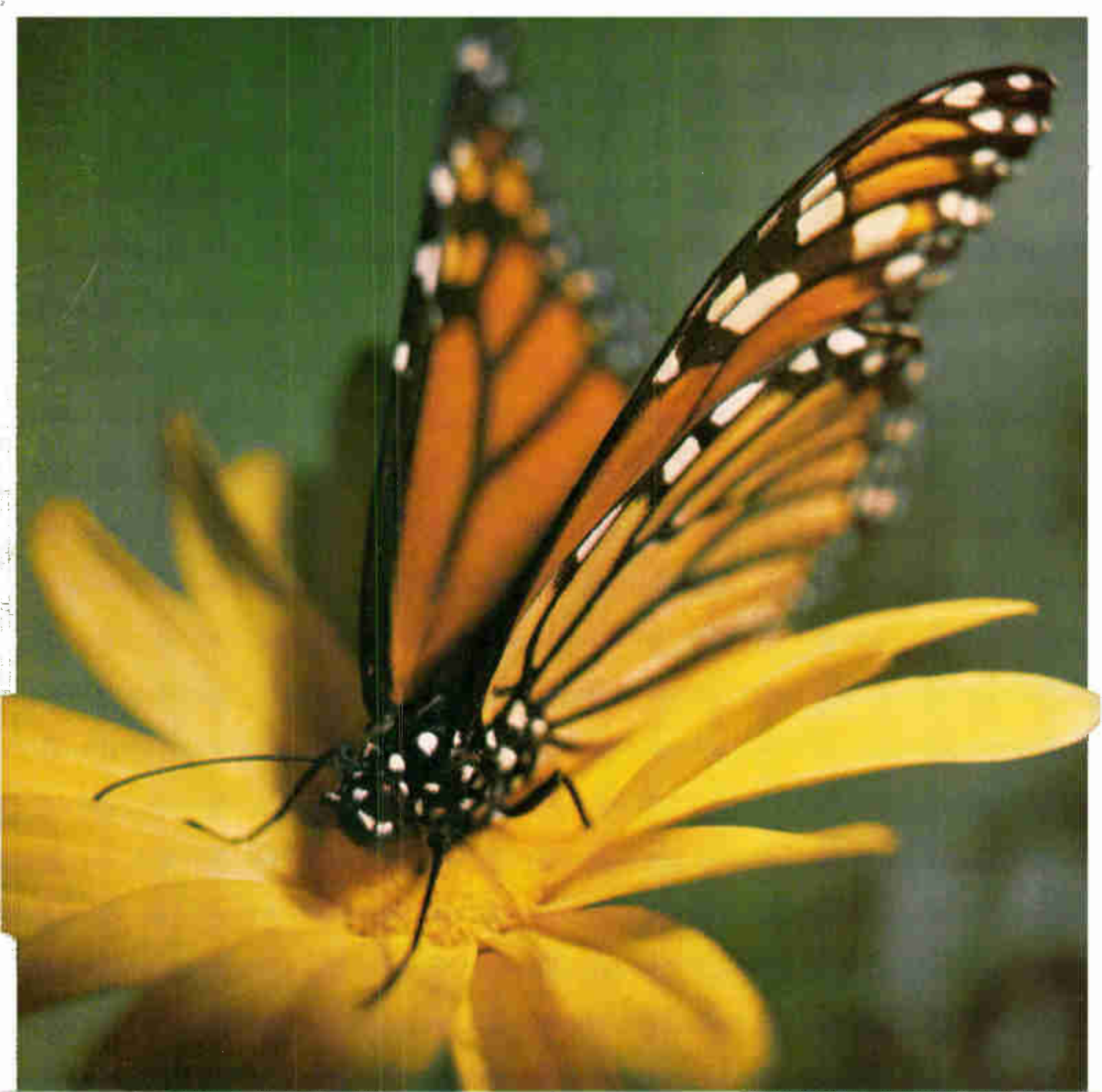
All this may sound like a plea for unimaginative and intuition-free decision making, but it is not. It is a suggestion that when engineers and managers get together to make high-risk decisions they must operate from a base of their own expertise, and recognize emotional and intuitive factors for what they are.

### . . . in this case, too

**One of the reasons** automatic control systems have not made the giant strides they were supposed to may lie in the failure of hardware suppliers and users (processors) to stick to their own knitting. Honeywell's chairman, James Binger, upheld this viewpoint before a meeting of the ISA in Houston last month. Binger said if there is any confusion about the roles and responsibilities of either the processor or the hardware house, it can lead to "motion lost and money lost in earnest, but misguided, rain dances." Neither processor nor hardware maker should assume too much responsibility in the wrong places. Hardware manufacturers, Binger asserted, are in no position to guarantee operating results, yet they have sometimes accepted this responsibility, invariably with bad results. The processor, he noted, is the only party who ultimately can be liable for operating results. If he delegates his liability to the hardware maker, the project's success is threatened. Any hardware manufacturer who takes responsibility for operating results makes

a promise on which he cannot deliver. Both he and his processor-customer are headed for disillusionment and disappointment, Binger concluded. Conversely, the hardware manufacturer must stick to developing computers and control devices that meet system requirements and advance the state of the art.

It is our opinion that designing computers and control systems that work—in both performance and in cost savings—may be enhanced through temporary role reversal. That is, if the hardware or software designer looks at the task from the viewpoint of the customer his perspective may be augmented. Likewise, the user may profit from "playing vendor." But the knowledge gained through role reversal may backfire—it could tempt one or both parties to assume part of the other's job. Thus it is important that both manufacturer and customer return to, and jealously embrace, their original roles. It is a matter of each holding the responsibility for what he does best. ■



DOWCLENÉ WR Solvent, The Dow Chemical Company, Inorganic Chemicals Department, Midland, Michigan 48640.

## How would you clean his scanning devices?

With great care and a super-clean solvent. That's DOWCLENÉ<sup>®</sup> WR chlorinated solvent. Pure enough to meet NASA spec MSFC 471. Less than one part per million residue. And one of the safest chlorinated solvents you can use. Cost? About half of other white room solvents. We're proud of DOWCLENÉ WR. That's why you'll find a certified analysis for particulate matter on every drum. For more information and a free sample, why don't you send out a feeler? Today.

Circle 32 on reader service card



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# Electronics Newsletter

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November 10, 1969

## Multilayer MOS knocks on door

Watch for MOS circuits with more than one metalization layer to reach market next year. A number of firms are studying multilayer metal in MOS—the idea is to improve yields by reducing chip size. At Texas Instruments, where such wafers are being made in the semiconductor R&D laboratories, one spokesman forecasts products will be introduced in 1970. Although multilayer metalization necessitates additional process steps, TI looks for the extra cost to be more than compensated for by increased yields with the smaller dice, some of which can be reduced in area by as much as a factor of 2.

The TI spokesman stresses, however, that the company can meet present MOS requirements with single-layer metal. Fairchild Semiconductor and Hughes Aircraft also are examining multilayer MOS metalization, but a spokesman for the Newport Beach, Calif., division says Hughes “won’t have to worry” about producing such circuits until 1971, unless that custom job moves faster than expected. And while Fairchild Semiconductor also is doing research work, there are no plans to bring out a product line now.

## Librascope drops woven wire line

The Librascope Group of Singer-General Precision has abandoned the woven plated-wire memory business. Although the group still maintains its license to use the process developed by Toko Inc. of Japan, the production equipment is crated and the people who staffed the operation have left.

Librascope had problems with the weaving process [*Electronics*, Nov. 11, 1968, p. 132], but the principal reason for dropping the business appears to be that librascope management didn’t see the aerospace and commercially oriented products planned by the woven wire group meshing well with its primary emphasis—antisubmarine warfare. Librascope spokesmen will say only that it was a “management decision to drop the line.”

## TRW's 2-watt, 3-Ghz power transistor finally makes it

Despite designer concern over the exclusive emphasis by most r-f power transistor producers on higher frequency and higher power [*Electronics*, May 26, p. 84], the power-frequency horse race continues. To gain the lead, TRW Semiconductor last spring promised a 2-watt, 3-gigahertz device off-the-shelf in time for Wescon, but stumbled and wasn’t ready for the August announcement date.

Now TRW has finally done it, and because of improved yields the top-of-the-line model—the PT6635—has gone up to 2.5 watts with a 4-decibel gain. It’s priced at \$170 in lots of 100. As part of the same 3-Ghz family, TRW is offering a 300-milliwatt unit with a 6-db gain, and a 1-watt model with a 5-db gain.

What wasn’t announced was TRW’s planned blockbuster—a 5-watt version with 3-db gain at 3 Ghz. This unit probably won’t be introduced until early next year, because TRW is having problems with yield and reliability.

The 3-Ghz family is aimed at replacing traveling wave tubes in electronic countermeasures, surveillance, weather radar, and telemetry applications.

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# Electronics Newsletter

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## Bell displays 5-psec optical gate

One little-noticed development presented at the International Electron Devices meeting in Washington was Bell Labs' 5-picosecond optical gate. The device could have major significance as a laser shutter in high-speed photography.

Bell builds its gate in much the same fashion as traditional Kerr liquid cells, using optical rather than electrical pulses to power the gate, and says it obtains 200 times faster gate time. Bell says that the present electro-optical liquid, carbon disulfide, prevents speeds faster than 2 psec. However, say the developers, gate times as low as 0.1 psec should be attainable with other liquids.

An attention-getter at the meeting was the ultrastable (1 part in  $10^9$ ) CO<sub>2</sub> laser system developed by Sylvania. The company says it can achieve continuous-wave beams of 20 to 30 watts with the same high stability as the source—a medium-level oscillator operating in the infrared—in conjunction with Sylvania's new 1,000-watt laser, which is the amplifier. What's more, Sylvania expects to obtain the full output capability of 1,000 watts by passing the source beam through the amplifier many times.

## Collins introduces solid state VOR

Collins Radio is showing customers a prototype of the first all-solid state vhf omnirange (VOR) receiver for commercial craft. The navigation receiver—the VOR-70—uses digital integrated circuitry to perform analog computations. The development illustrates the trend in avionics away from electromechanical components and toward very reliable and potentially low-cost digital IC's.

However, the cost of the IC's, even though they're available off-the-shelf, is still too high to make the receiver price competitive. Next step for Collins is to redesign some of the circuitry to dissipate less power. Test flights could begin in the first half of next year.

## U.S. safety report spurs crash program for color tv makers

With threats of Government action ringing in their ears, 17 color tv set manufacturers this week are in a crash program to develop safety standards and uniform methods of recording safety data. Deadline is Nov. 14. Estimating 10,000 tv set fires causing 10 deaths a year, the National Commission for Product Safety told the companies "we would have a national scandal" if the present rate continued.

This is in sharp contrast to the initial response of the EIA, which had dismissed the investigation by saying the ratio of sets catching fire was "infinitesimal" [*Electronics*, Oct. 27, p. 78].

The commission worries most about the aging characteristics of tv components. Manufacturers probably will be looking closest at horizontal output (flyback) transformers, which according to manufacturer-supplied data caused 29.2% of the fires. Another likely area would be inadequate or broken-down insulation of wires carrying high voltages which can result in arcing. This causes the wax insulating the transformer to become brittle and change its dielectric properties. The commission identified other hazard areas: uninsulated wires between high-voltage components; reduced space between the transformer and components such as ceramic transistors, cardboard-covered capacitors, a-c switches, the deflection yoke surrounding the crt; and automatic tuning devices. One of the color tv set components most susceptible to burning because of high temperature is XXXP, paper-based phenolic circuit boards, which are being replaced by polyester fiberglass-reinforced boards.

# fresh new Omnigraphic Recorder<sup>™</sup>



BETTER, FASTER, LOWER PRICED, EXPANDABLE

**COMPARE  
FEATURES...**

**COMPARE  
PRICE...**

Here they are... model for model

## HOUSTON INSTRUMENT X-Y RECORDERS

Both 8½" x 11" and 11" x 17" charts with English/Metric scaling switch and interchangeable plug-in ability

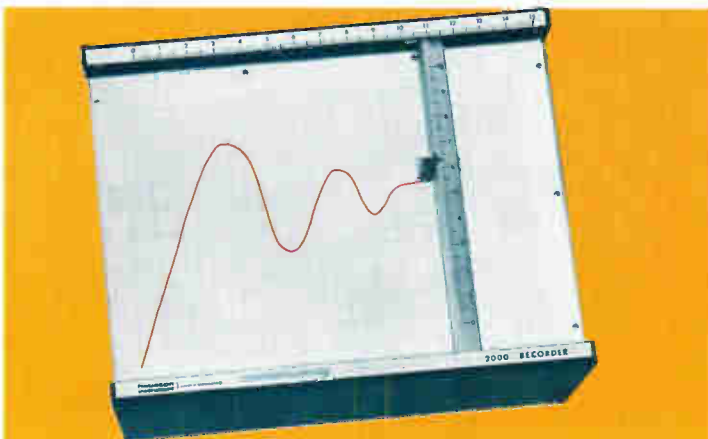
Houston Instrument Model No.	Houston Instrument Price	Houston Instrument Advantages
2200-3-3	\$ 975	Input resistance, Zero check
2200-3-4	\$1105	Input resistance, Zero check, Time base accuracy, no mercury cells
2200-5-6	\$1265	Input resistance, time base accuracy
2200-5-6	\$1265	Input resistance, X or Y time base accuracy
2200-7-8	\$1675	Time base accuracy
2211	\$995 + modules	

## HOUSTON INSTRUMENT 10" STRIP CHART RECORDERS

3300-50	\$835 + module	Differential inputs, electric pen lift, built-in chart and event marker
3200-50	\$835 + module	Differential inputs, electric pen lift, built-in chart and event marker

### For OEM:

**The Main Frame:** Dedicate its use, or command it from your control panel, for it's a complete X-Y recorder having 1 mv/inch sensitivity with remote control. Unhesitating  $\pm 0.2\%$  accuracy coupled with ultra-reliability, 1 megohm input resistance and electric pen lift. And plug-ins can expand its use later without modification via the remote connectors. \$770 in single quantities.



Circle No. 280 on Readers' Service Card

### For X-Y Plotter Users:

A flexible delight for the operator. Choice of twelve modules, interchangeable between axes, plus English/Metric switch selectable scaling gives total control. True differential inputs, >20 in/sec. slewing speed and paper sizes to 11 x 17 inch are standard, yet at prices less than smaller and slower units. \$795 + modules.



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# COMPARE SPECIFICATIONS...

... Is there any choice?

## HEWLETT PACKARD X-Y RECORDERS

8½" x 11" charts only		11" x 17" charts	
Hewlett Packard Model No.	Hewlett Packard Price	Hewlett Packard Model No.	Hewlett Packard Price
7035 B	\$ 985	7005 B	\$1195
7035 B with 108 A time base	\$1160	7005 B with 17108 A time base	\$1370
135	\$1650		
135 A	\$1650		
7030 A	\$1895	7001 A (with DC offset)	\$2175
7034 A	\$1195 + modules	7004 A	\$1295 + modules

## HEWLETT PACKARD 10" STRIP CHART RECORDERS

7101 B	\$1000 + module
7127 B	\$ 850 + module

## For Strip Chart Users:

Instant solution to previous inadequacies. Multi speeds and the multiple choice of input functions from the wide range of modules. Inherent are electric pen lift and event marker. Positive paper feed or roll take up in rack, panel or bench mounting without modification. \$710 + modules.



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## Let the features speak:

- A choice of twelve interchangeable and inexpensive modules
- Truly differential inputs
- >20 in/sec. speed
- ±0.2% accuracy
- Local or remote control
- Electric pen lift
- Disposable non drying pens
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- Interchangeable amplifiers
- Wear compensating drives
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- English/Metric scaling at flick of a switch
- State of the art electronics with IC's and all solid state
- Accepts any paper size up to 11 x 17 inch in X-Y's; 10" strips
- X-Y vacuum hold-down independent of humidity, dust or line voltage
- Sealed re-balance potentiometer
- Sensitivities to 100 microvolt/inch (50 microvolt/cm)
- Over-range protection
- Electronic dead band detection eliminates servo wear
- Totally accessible in minutes by modular assembly
- Independent of ambient environment
- Unexcelled acceleration with critical damping.

**Truly—the finest, least expensive, most reliable line with total recording capability.**

OMNIGRAPHIC™

graphic recorders

houston  
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DIVISION OF BAUSCH & LOMB

# doubly fresh — doubly interchangeable

**Plug in Modules  
For X-Y, Strip,  
T-Y® and Specials**



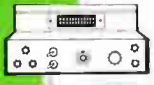
**\$100**  
**50. Time Drive**  
Nine ranges for strips or T-Y's with digital based accuracies.



**\$25**  
**0. Customizing**  
A box of air for the customizer or do-it-yourselfer.



**\$60**  
**1. DC Coupler**  
Fixed sensitivity of 1 mv/in. (and 0.5 mv/cm) for single purpose or customizing.



**\$320**  
**12. Precision Attenuator/ Offset**  
Take Module 5 and add 0-1 volt calibrated offset for suppressed signals.



**\$340**  
**11. DC-1 mv Full Scale**  
1 mv full scale for dedicated low level application.



**\$75**  
**2. DC Ranging**  
Inexpensive and versatile for continuous calibration from 1 mv/in. (and 0.5 mv/cm).



**\$210**  
**9. DC Precision Ranging**  
Continuously calibrated attenuator from 1 mv/in. (0.5 mv/cm) with calibrated zero allows precise ranging at all times.

**3. DC Switching**

5 calibrated ranges from 1 mv/in. (and 0.5 mv/cm) at modest expense.



**\$490**  
**8. DC Pre-Amp Attenuator/ Time Base**  
Take module 7 and add time/volt switch and reset/sweep switch. 100µ/in. (50µ/cm) with eighteen ranges eliminates pre-amp.

**7. DC Precision Pre-Amp Attenuator**

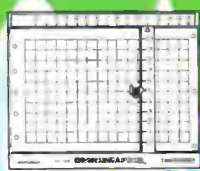
Take Module 5 and add eleven time sweeps from 0.1 to 200 sec/in.

**6. DC Precision Attenuator/ Time Base**

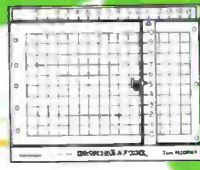
Fourteen calibrated ranges from 1 mv/in. (and 0.5 mv/cm) in 1-25 steps.

**5. DC Precision Attenuator**

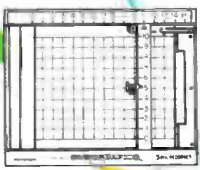
Take Module 3 and a selectable Time Base; again at modest investment.



**X-Y dedicated \$770 complete**



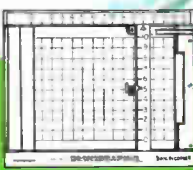
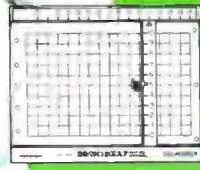
**X-Y user flexible \$795**



**Strip-multispeed \$710**

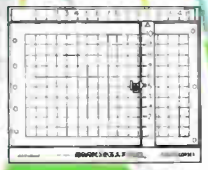
**80% Interchangeable Module, Assembly, and Parts**

**T-Y® multispeed \$710**



**Strip-fixed speed \$660**

**T-Y®-fixed speed \$660**



## UNIQUE MODULE WARRANTY

Should your application requirements change or if for any other reason you desire to exchange your Houston Instrument plug-in modules on this recorder for any other Houston Instrument modules, the following trade-in discount schedule has been set up to assure your satisfaction:

- Within 30 days—90% credit towards purchase of a new module
- Within 3 months—85% credit towards purchase of a new module
- Within 6 months—65% credit towards purchase of a new module
- Within 1 year—25% credit towards purchase of a new module

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L. C. Bower, General Sales Manager

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MOX-750	1 - 5000 megs	.50W	2,000V	.790 ± .050	.130 ± .010
MOX-1125	1 - 10000 megs	1.00W	5,000V	1.175 ± .060	.130 ± .010
MOX-1	10K - 500 megs	2.50W	7,500V	1.062 ± .060	.284 ± .010
MOX-2	20K - 1000 megs	5.00W	15,000V	2.062 ± .060	.284 ± .010
MOX-3	30K - 1500 megs	7.50W	22,500V	3.062 ± .060	.284 ± .010
MOX-4	40K - 2000 megs	10.00W	30,000V	4.062 ± .060	.284 ± .010
MOX-5	50K - 2500 megs	12.50W	37,500V	5.062 ± .060	.284 ± .010

\*Applicable above critical resistance. Maximum operating temperature, 220°C. Encapsulation: Si Conformal. Additional technical data in folder form available upon request. Or telephone: (216) 795-8200.



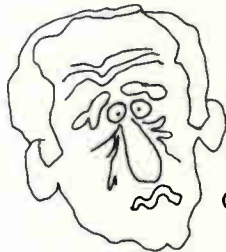
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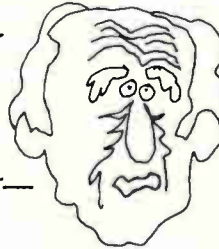
**SO** ON THE THIRD GO-AROUND WE HAD A CIRCUIT OUR SUPPLIER SAID HE COULD MAKE BECAUSE THEY WERE GETTING THIS NEW EQUIPMENT...

ONLY IT DIDN'T TEST TOO WELL BUT THEY COULD FIX THAT WITH SOME NEW STUFF THEY WERE GETTING...



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AT REVISED REVISED REVISED COST—



THAT'S WHAT THEY SAID...



SO, I'M CELEBRATING THAT ALONG WITH MY THIRTY-THIRD BIRTHDAY.



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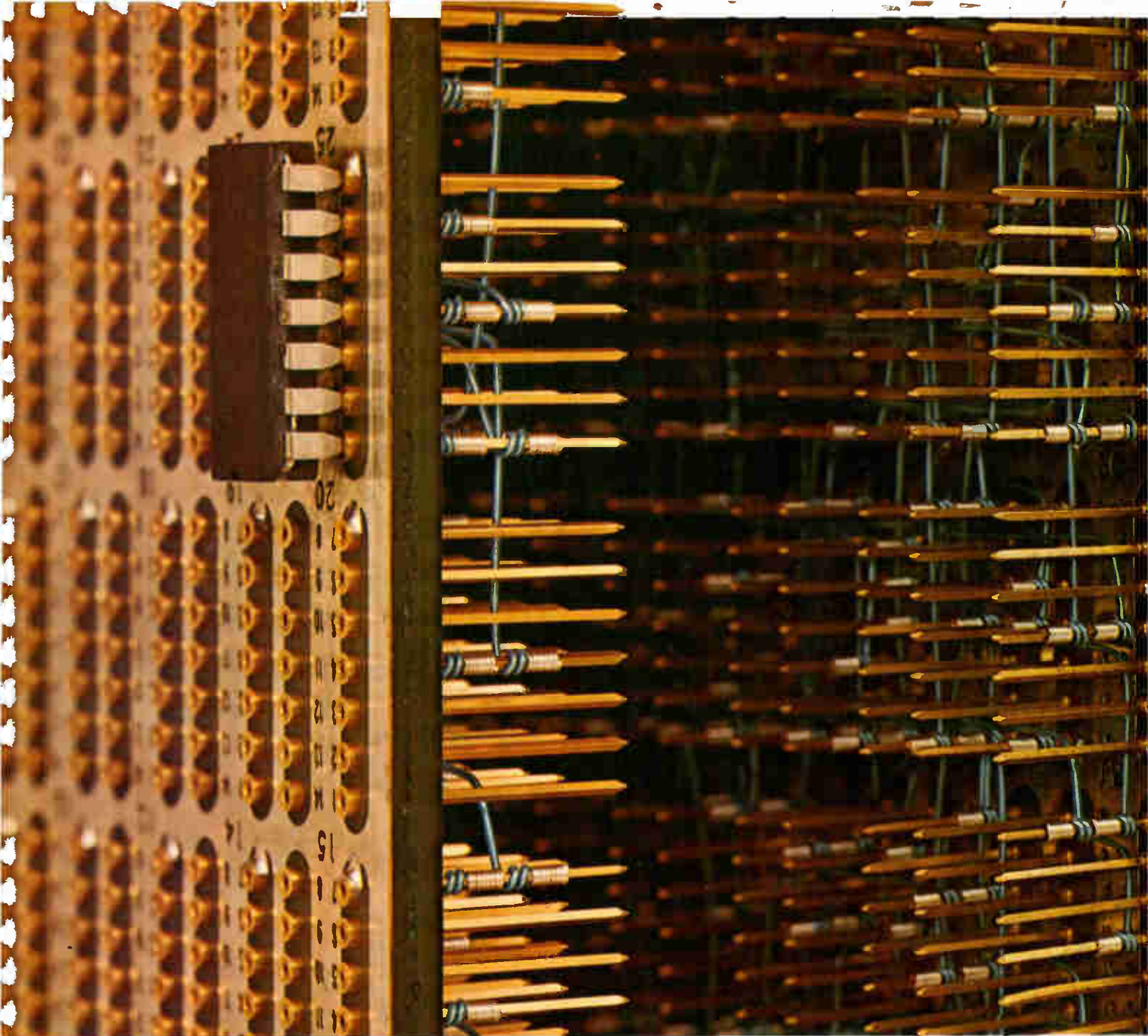
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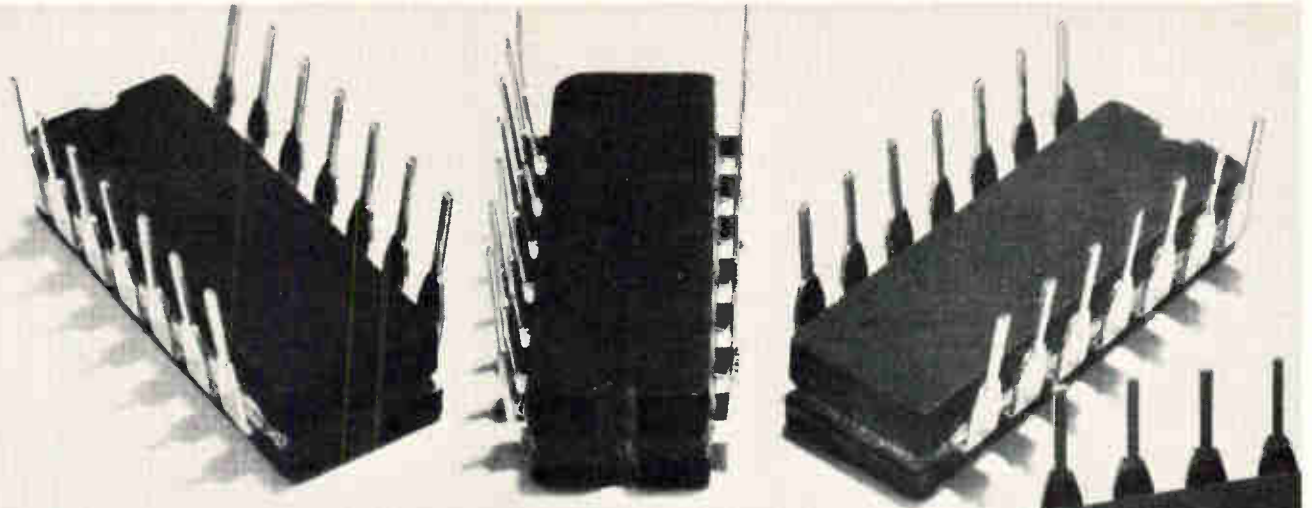
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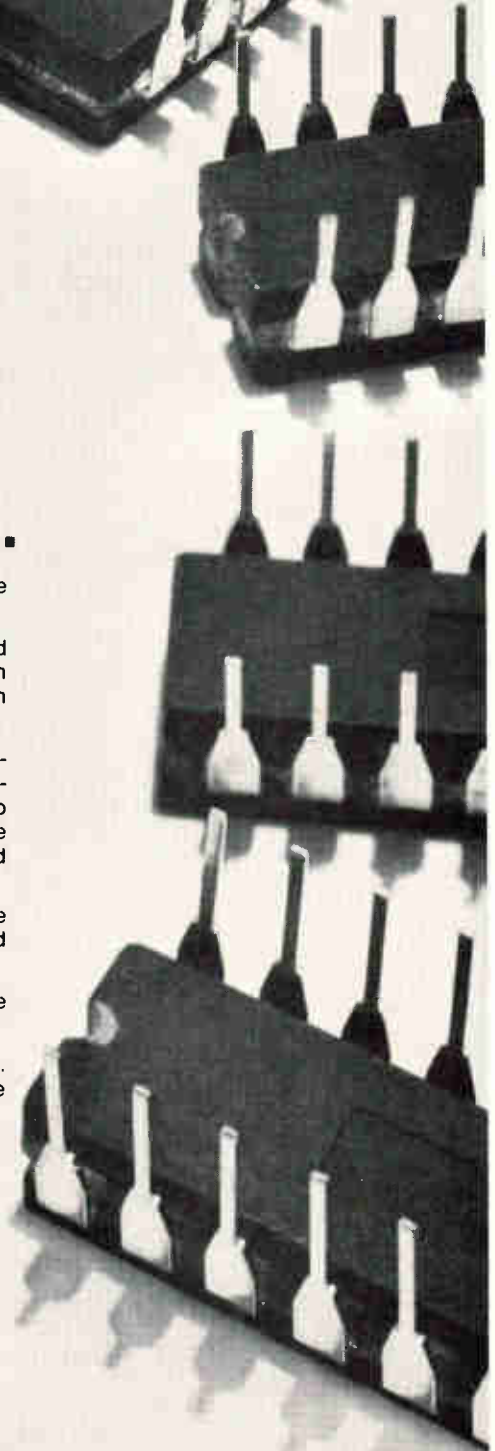
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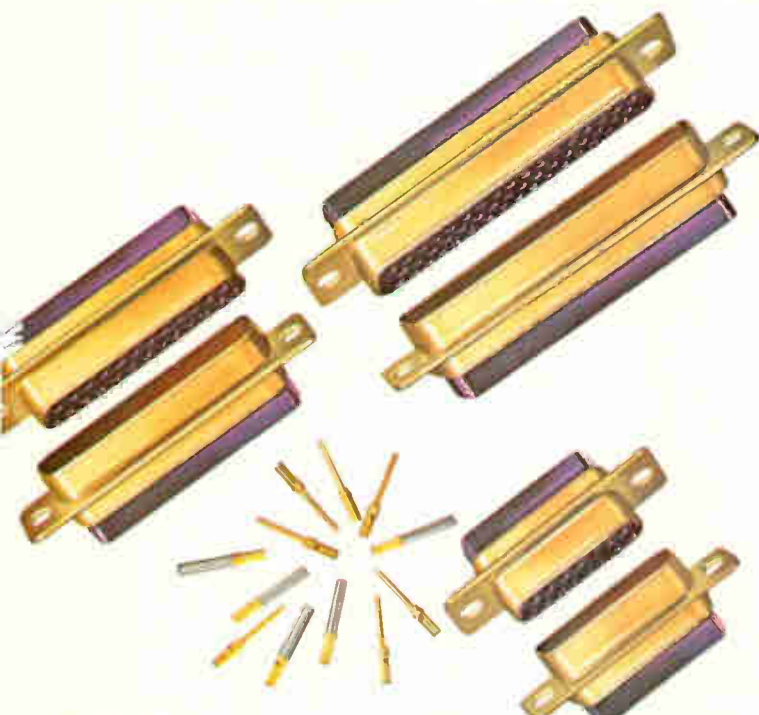
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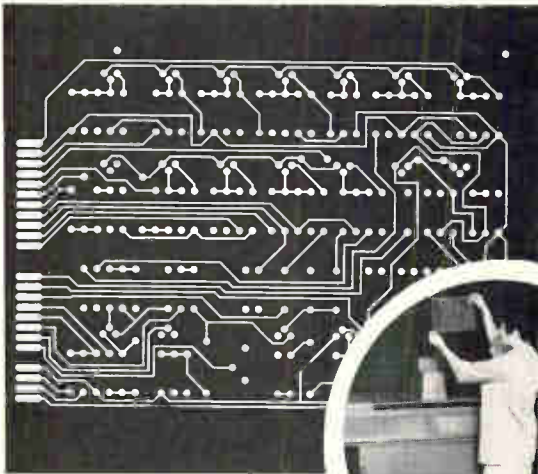
C-6912

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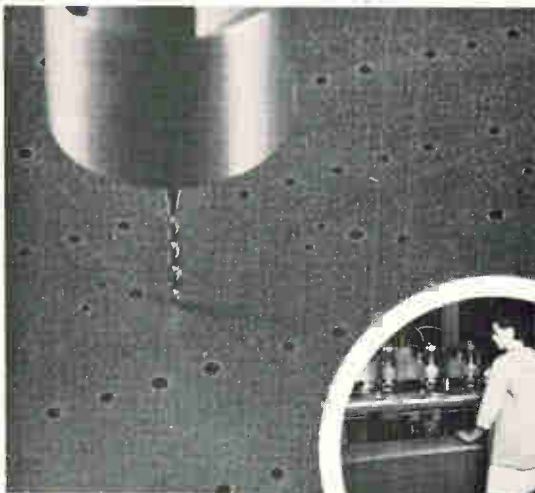


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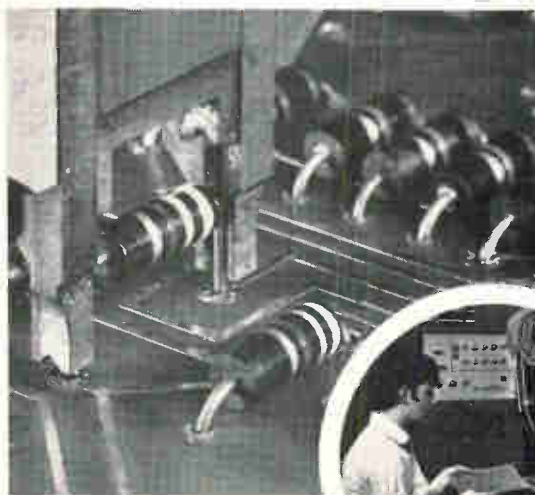
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produce artwork



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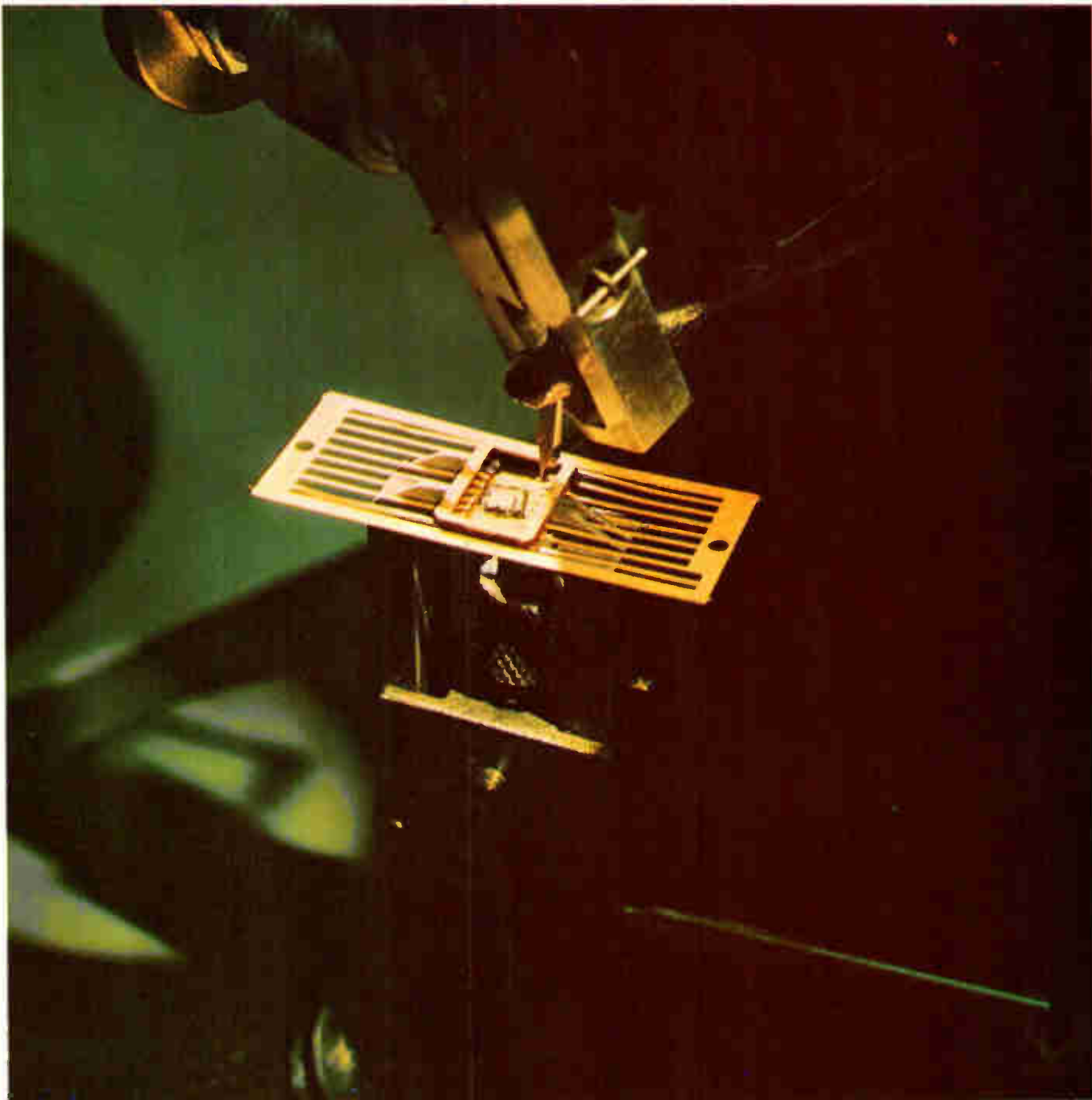


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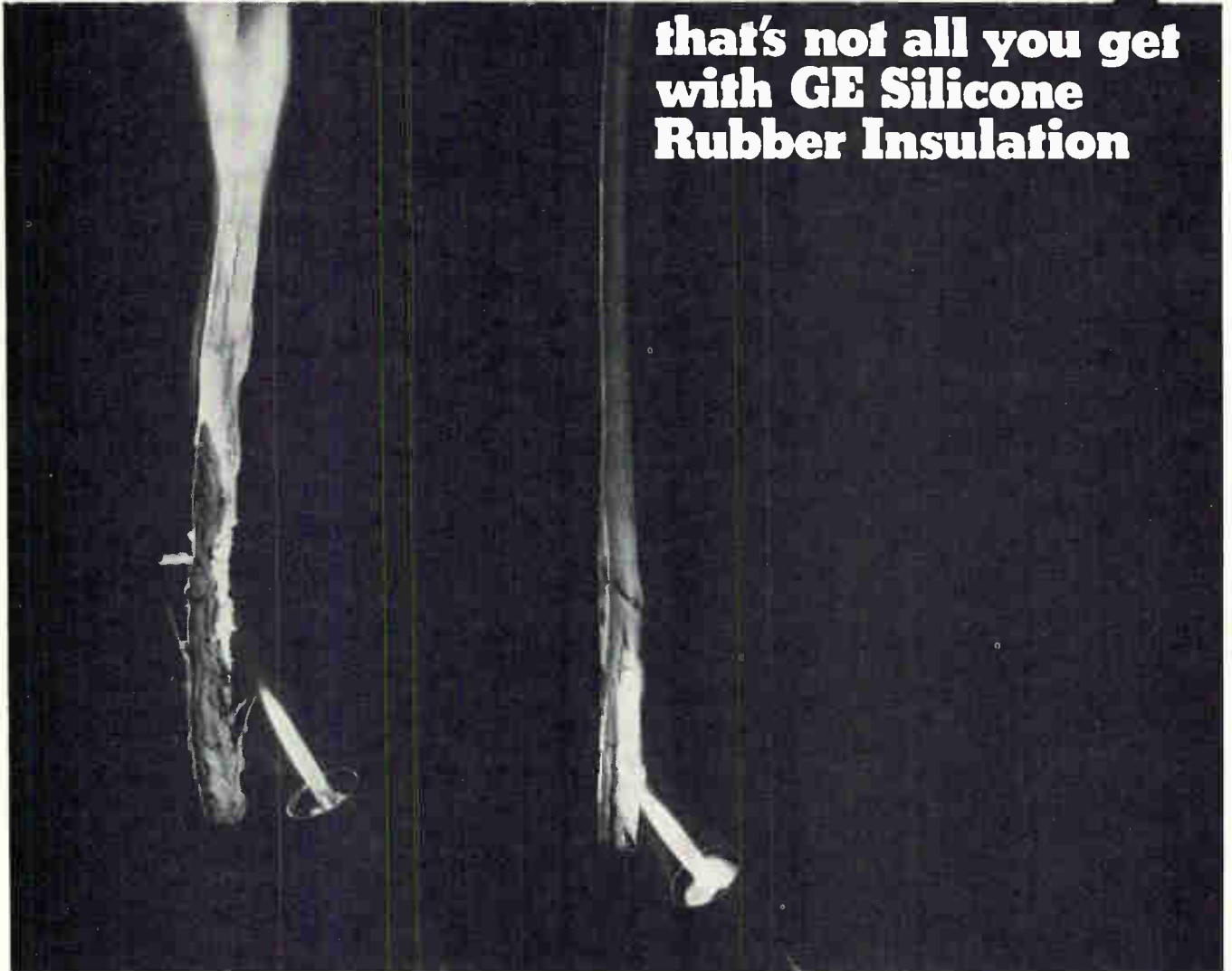
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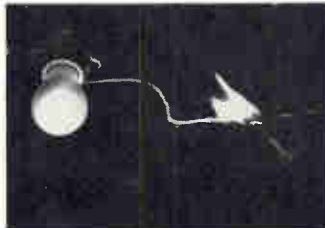
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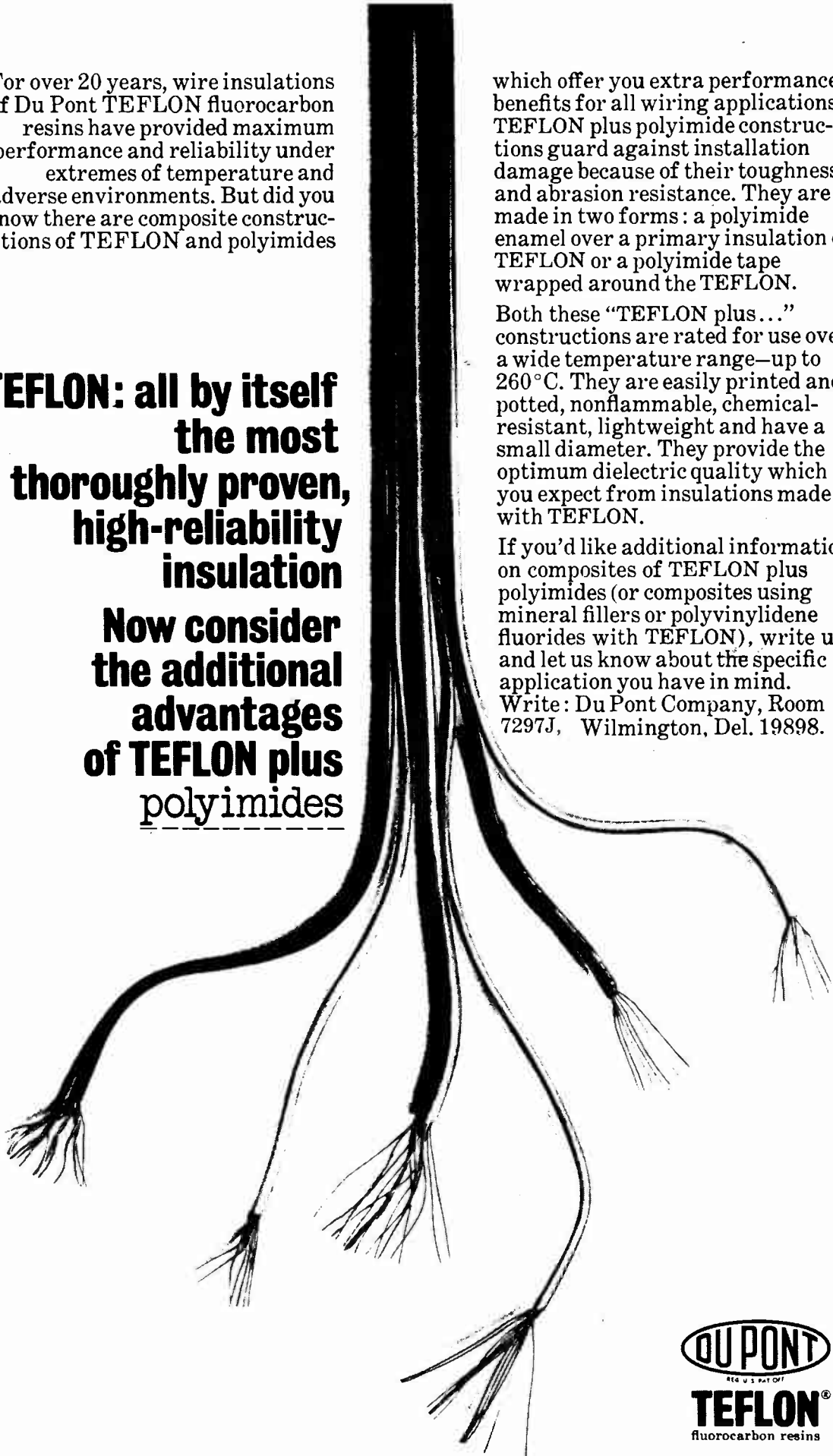
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**FUNCTION SELECTION** Selects the output voltage range, and isolates the three input bits to the current limit D/A converter.

**OUTPUT VOLTAGE D/A CONVERTER** Converts one polarity bit plus 16 BCD voltage bits or 15 binary voltage bits to an analog voltage for input to the power amplifier. Thus, resolution is 0.5mV for straight binary and 1mV for BCD operation.

**REFERENCES** Provide voltage for the Output Voltage and Current D/A Converters.

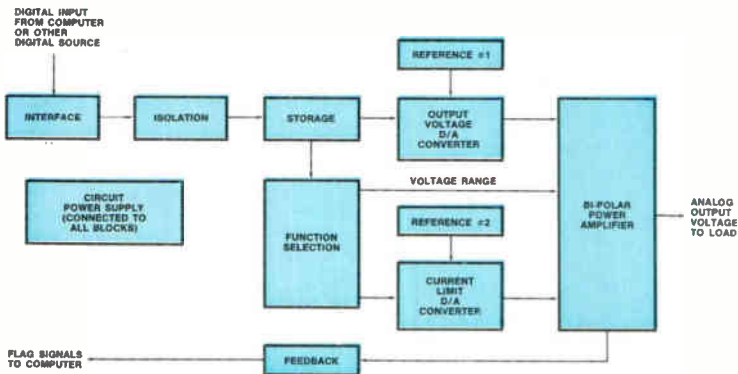
**CURRENT LIMIT D/A CONVERTER** Sets current limit of power amplifier to one of eight values.

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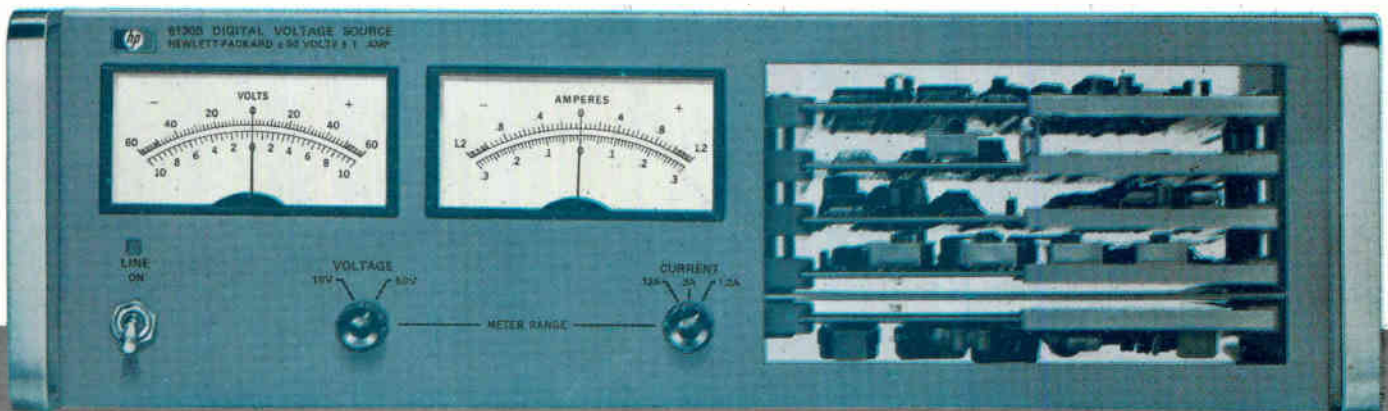
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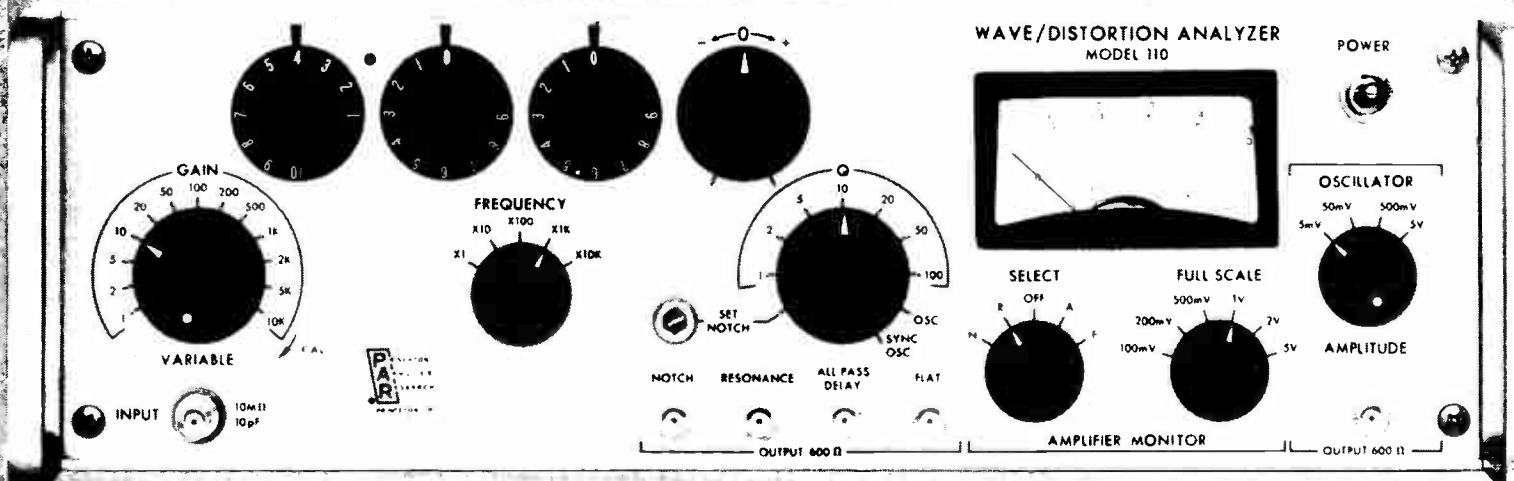


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# Administration infighting delays improved frequency management

In a private exchange of letters, Defense Secretary rejects plan to allow Commerce to take over telecommunications policy

By Ray Connolly

Electronics staff

Every new Administration that arrives in Washington has its share of empire builders whose infighting frequently subordinates the public interest. The Nixon Administration is no exception. Nevertheless, specialists in communications anxious to implement at least some of President Johnson's task force recommendations for a modern communications policy are becoming increasingly frustrated by the existing Administration's lack of action.

What's the reason? Some lay the problem at the doorstep of that old Nixon campaign manager, Commerce Secretary Maurice Stans, and his current effort to acquire responsibility for national telecommunications affairs. Support for this criticism comes from two pieces of hitherto private correspondence between Stans and Defense Secretary Melvin Laird, an exchange that left Stans—clearly out of his political depth when he tangled with the former Congressman—the loser.

**To the letter.** On October 1, Defense Secretary Melvin Laird wrote a "Dear Maury" letter to Stans. It was a reply to Stans's September 2 "Dear Mel" letter outlining how, in Laird's words, "Commerce would effect leadership in the telecommunications management area." Laird's salutation is the only bit of cordiality in the private four-page rebuttal of the Stans proposal, a proposal put forth earlier in an interview by his assistant secretary for science and

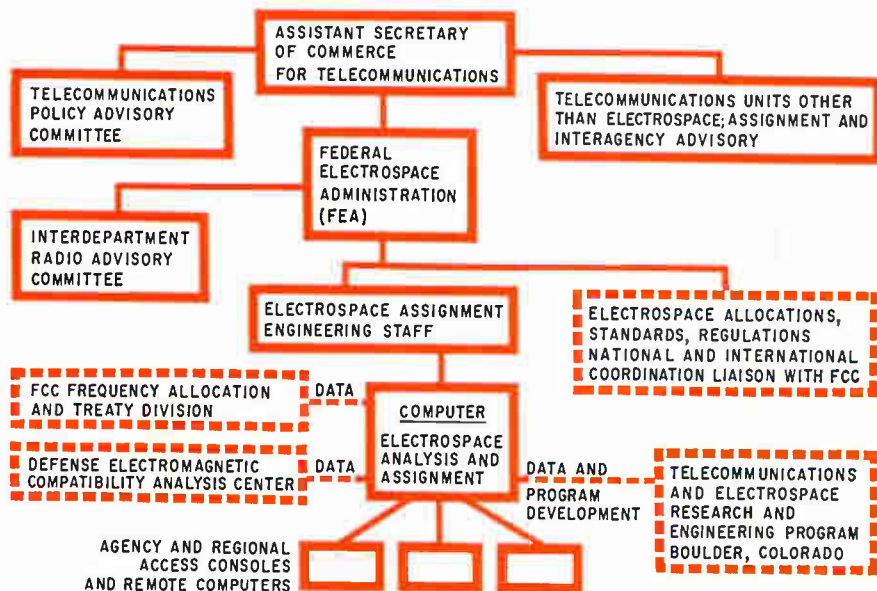
technology, Myron Tribus [*Electronics*, Sept. 1, p. 14].

The Secretary of Defense, citing his role as executive agent for the National Communications System (NCS) and the fact that "my Defense Communications System (DCS) constitutes 80% of that system," does not take kindly to the idea of concentrating telecommunications responsibility within Commerce or any other department. What would happen, for example, if NCS chief Laird were unable to resolve a communications policy conflict involving, say, Commerce's weather bureau networks and another agency? "Under your proposed arrangement," Laird points out, "I would go to an

assistant secretary of commerce for a policy decision, rather than to the President as I do now."

Overlooked in the praise of communications specialists familiar with Laird's surgical destruction of Commerce Department's empire builders is the Defense chief's inadvertent exposure of a principal weakness of the whole Federal structure of telecommunications management. By pointing out to Secretary Stans that "instances where your networks were a party to the dispute," the role of Commerce "as disputant and adjudicator would be a most difficult one," Laird leaves his letter readers to recall that DOD's own dual role as NCS executive agent and

## How Commerce was going to do it



## U.S. Reports

Defense Communications Agency operator came in for exactly the same criticism in a General Accounting Office report to Congress this summer.

**Change in plan.** An apparent uncertainty within Commerce as to just what would comprise "a new Federal Electrospace Administration," as Stans calls it, gave Laird just the opening he needed: "Comparing the September proposal with the correspondence and study previously provided on July 3," Laird remarks, "I find it significant that your department no longer proposes transfer of certain statutory responsibilities of the FCC to the Executive branch. I am gratified by this change since I did not consider it appropriate for the Executive branch to propose that Congress transfer responsibility to regulate interstate and foreign commerce, insofar as telecommunications is concerned, from the FCC to the Executive branch."

Under the Commerce Department plan, drafted by assistant secretary Tribus, it would take over virtually every telecommunications policy function within the Government as well as "allocation, assignment, and regulation of Federal use of the electrospace"—a favorite Tribus expression—plus "guidance and coordination of Government systems development, standards and procurement criteria; interagency and Federal-state telecommunications coordination."

As the Commerce secretary put it to his Pentagon counterpart: "We propose introducing to the electrospace assignment process a central engineering assignment staff with a substantial computer facility. The Interdepartment Radio Advisory Committee would be retained, with responsibility for oversight of this process rather than the day-to-day assignments."

The Stans concept also includes "activities of the Institute for Telecommunication Sciences of the Environmental Science Services Administration, the Radio Standards Divisions, the Technical Analysis Division, and other units of the National Bureau of Standards, and other appropriate government and private resources."

**Unimpressed.** But as Mel told Maury, "The fact that the Department of Commerce has certain radio research and analytical resources is not, to my mind, a compelling argument for the relocation of telecommunications management to Commerce."

The bitter choice to a proposal that offers no "significant advantages but does present many disadvantages," according to Laird, is to provide the FCC and the Director of Telecommunications Management "with more resources" and "elevating the DTM to separate office status within the Executive Office of the President, as has been recommended by the Comptroller General."

With those closing words, the Secretary of Defense finally comes down on the side of the GAO report which this summer spoke critically of DOD's own conflict of communications interest with its Defense Communications Agency overseeing operation of the larger National Communications System.

## Communications

### It works

Can you picture a portable satellite ground station in New Zealand transmitting, noisily but readably,

with its parabolic antenna pointed at the satellite at a 0.4° down angle? Or another small terminal at Scott Air Force Base in Illinois, turning down its amplifier power to 2.5 watts and still getting through loud and clear via satellite relay to a man-carried terminal in front of a Washington hotel?

You can, because results like those are bringing smiles to military communications people as testing with the tactical communications satellite picks up speed.

**They came.** Whether it was to check out reports that Tacsat I wasn't working as planned, or the likelihood of massive future terminal purchases, an overflow crowd jammed the Tacsat session at the Electronic and Aerospace Systems Convention (Eascon) in Washington late in October. It was the most detailed unclassified briefing yet on the R&D program.

To find out if the tests were working, all the engineers had to do was step outside the convention hall. There, they could listen to a TRC-156 teampack terminal, operating with 11 other ground terminals and at least one EC-135 jet transport flying off Bermuda.

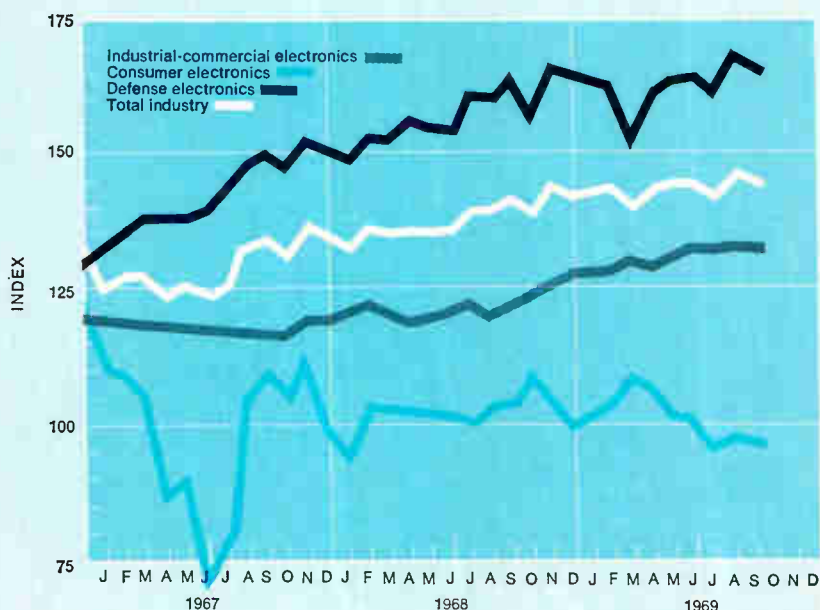
The satellite, built by Hughes Aircraft and launched in February, is now performing all its scheduled tests. Earlier problems with super-high frequency (shf) tests were



**Mighty mite.** Three GI's can carry the 120-pound uhf satellite terminal. The Collins-built TRC-156 puts 20 watts into its 5-foot dish.

## Electronics Index of Activity

November 10, 1969



Segment of industry	Sept. 1969	August 1969*	Sept. 1968
Consumer electronics	97.0	97.7	105.3
Defense electronics	166.1	170.0	166.1
Industrial-commercial electronics	134.1	134.2	122.9
Total industry	144.9	147.1	143.1

After back-to-back record month-to-month gains, total electronics production in September dipped 2.2 points from August's 147.1. But the index still maintained a 1.8-point lead over the September 1968 level.

The defense sector, which led the August spurt, also was the September leader—in the opposite direction—with a 3.9-point loss. Consumer electronics fell 0.7 point, while industrial-commercial production was fairly steady with a mere 0.1-point decrease.

Indexes chart pace of production volume for total industry and each segment. The base period, equal to 100, is the average of 1965 monthly output for each of the three parts of the industry. Index numbers are expressed as a percentage of the base period. Data is seasonally adjusted.  
\*Revised.

traced to ground stations; they have since been resolved. The only problem remaining in the spacecraft was a degradation of the uhf effective radiated power, down 3 to 5 decibels. This was described as "not too serious" by Peter T. Maresca, deputy director of engineering development at the Army Satellite Communication Agency, Fort Monmouth, N.J. No tests have been affected, he maintains.

Hughes engineers believe the dropoff in signal is due to a damaged antenna, possibly one of the helices in the five-element uhf array. At first they were afraid to turn on all 16 uhf amplifiers, but they did, and everything on the bird is working. At any rate, no one seems to be particularly worried about the uhf degradation. One reason: Hughes says that overall, it's getting 3 db of effective radiated power over design specifications—or 40 db over 1 watt rather than the 37 dbw called out in the specs. This just about makes

up for the loss, which averages around 3 dbw, Hughes engineers say.

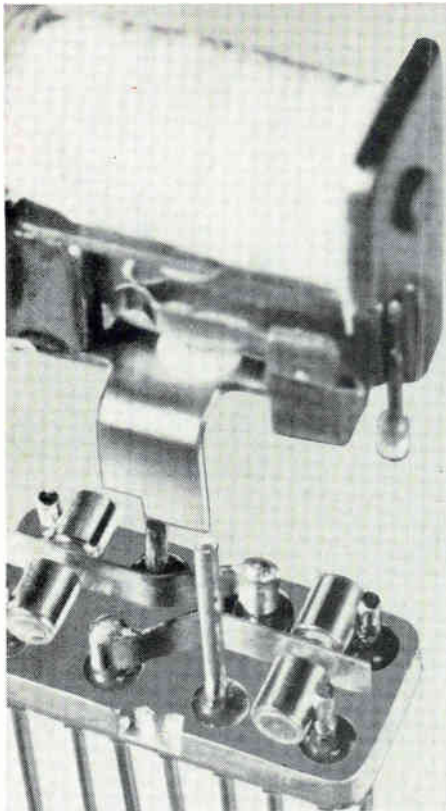
**Punch.** That's a lot of power for a communication satellite. For example, Tacsat, with its high effective radiated power, would be capable of supporting more than 20,000 high-quality telephone channels if it were working with a standard commercial ground station with an 85-foot antenna, low-noise receivers, and high-power transmitters. This compares with only 1,200 channels relayed by the Communication Satellite Corp.'s currently operational Intelsat 3, and the 10,000-channel Intelsat 4 now being designed and built for Comsat by Hughes.

The 1,600-pound Tacsat puts out 980 watts of solar power into a uhf and an shf frequency-translating repeater, each capable of operating on selectable bandwidths from 50 kilohertz to 10 megahertz. The final uhf output level with all 16 amplifiers on its 23.6 dbw, while

the shf transmitter, by combining the output of any two of its three 20-watt traveling-wave-tubes, puts out a carrier power of 14.6 dbw.

Until now, Tacsat has been used primarily for checkout and initial compatibility testing between ground terminals and spacecraft, but Hughes engineers claim that feasibility has already been proved. Very little multiple-access testing has been done yet, though as many as 11 terminals have operated at the same time, all on 2,400 bits-per-second vocoder voice. But even this takes careful power balancing, done manually to within about 1 db.

Several prototypes of a modem designed for multiple access in tactical satellite communications have been designed and built by Massachusetts Institute of Technology's Lincoln Laboratory. The TATS (for tactical transmission system) modems have already been operated successfully through Tacsat as well as Lincoln experimental satellites (LES 5 and LES 6). Sylvania is



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building R&D versions (MD-801), in a pilot production run, that have been reduced to one rack-mounted drawer including the power supply.

**Hippity.** The modem employs coded multiple frequency-shift keying message modulation and band-spreading by frequency-hopping the signal over the total transmitted bandwidth. The hopping pattern of the carrier is made up of a repetitive sequence of seven frequencies (a carrier frame). The modem can handle inputs at both 75 and 2,400 bits per second for teletypewriter and vocoder inputs.

In flight tests using the LES 6 satellite as the relay, Lincoln Lab was able to squeeze 17 carefully balanced power users at the high data rate (2,400 bps), which is "quite close to the theoretical capacity of the modem," says Steven L. Bernstein of the lab. With all 17 channels, the transmissions started breaking up; it's essential to get near power balance among users, he points out. About 544 low data rate (75 bps) users could be handled in the multiple access mode with the TATS modem.

Already demonstrated as feasible, Bernstein says, is that allocations can be shared by conventional equipment and satellite users, and uhf satellite communications can be handled from aircraft with simple blade antenna structures. Coding and frequency diversity of the TATS modem can minimize multipath propagation, while they can combine with the matched filter output limiting to provide protection against sporadic r-f interference usually found in a tactical environment.

**Sales.** As to the potential modem and terminal market, consider the numbers in a Tacsat computer model employed by Stanford Research Institute to come up with a control system that could handle the mixing of tactical satellite terminals. While it was emphasized that the model was not representative of any planned number, the SRI force was a large force in Europe with 4,208 satellite terminals. This included 22 ship units, 265 aircraft units, 128 in helicopters, 252 teampacks, and 1,200 truck-mounted terminals.

## Brave new network

Imagine, if you can, communities of homes and offices interconnected in modules of 6,000 units by a 300-megahertz broadband cable able to fulfill man's every communications need and you will see the electronics industry view of the future. It's a vision conceived by the Electronic Industries Association's Industrial Electronics division and delivered to the FCC. It's also a picture drawn many times by industry's best-known expert on spectrum management, Richard P. Gifford [*Electronics*, Sept. 29, p. 14]. Gifford also heads CE's Communications Systems division.

The EIA concept of a broadband net is its 41-page response to the FCC docket seeking guidance on the "broad question of how best to obtain . . . the full benefits of developing communications technology for the public, with particular immediate reference to CATV technology and potential services. . . ."

**Space.** On the premise that America's life style in the next two decades will continue to be marked by affluence and an increasing demand for services, Gifford poses an almost poetic question: "Why then, oh why, must we jam into stacked cells, follow rivers of steel and flesh, and force ourselves into social orders that regulate crowded living and destroy the individualized human thrust to be found in more open family and home-based living?" The answer, of course, is we don't—if the nation can be wired with a broadband, nonswitched network to accommodate that 80% of the population living on less than 10% of the land mass and, most likely, accommodating the remainder via point-to-point and broadcast satellites.

What will it cost? Conceding that cable technology for commercial use has a long way to go to achieve a 300 Mhz capacity, the ability to carry multichannel video more than 15 miles without repeaters significantly degrading the signal, and the necessary development of digital systems to insure privacy in two-way services, the EIA does project costs of wiring households.

Drawing on a Rand Corp. model



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for 12-channel distribution with no converters, cost per home would be \$240 for the first 50% of the nation, or an investment of \$4 billion for the densest area, or \$11 billion on the basis of random selection. From there the estimate soars to \$66 billion—or \$11,000 for the last home to achieve 100% coverage—suggesting the less costly alternative of broadband signal distribution by satellite.

Though the industry position is that a broadband communications network—as opposed to the services offered—would have public monopoly characteristics comparable to the switched telephone net, it urges local regulation rather than strong Federal control. It is a position compatible with the “modular wiring” concept of Gifford, but not one that all industry sources buy—particularly in view of the generally ineffective nature of local regulatory agencies. And, while urging competitive systems development be left to industry, the EIA also notes that growth is more likely to come from “good reliable service” rather than “overeager cost-cutting.”

**Terminals.** Significant growth potential for terminals to be used in homes, education, and industry tied to a broadband net is forecast, including 0.3 kilohertz band teleprinters, 3 khz voice carriers, 4 khz to 10 Mhz facsimile systems, as well as video phones requiring 1 Mhz plus voice, color tv at 4.2 Mhz plus sound, and data channels ranging upward from 40 khz. There will also be a major requirement for “comparatively simple digital circuits” for coding and decoding transmissions addressed to specified recipients, as in the case of first-class mail.

### Integrated electronics

### No depletion allowance

One of the unresolved questions in Schottky-diode integrated circuits [*Electronics*, July 21, p. 74] has been what's the best method for eliminating high-field edge effects. Even when the Intel Corp. intro-

duced the first commercial Schottky IC's in August, the company wasn't favoring one of the two available methods at the expense of the other. But at least one company is now taking a stand; Fairchild Semiconductor views the extended-metal technique as clearly superior to the guard ring. Albert Y.C. Yu, of Fairchild's Research and Development Laboratory, reports that after 1½ years of work the technique is advanced enough to be adapted to factory production in large numbers.

Schottky diodes, of course, can greatly increase the speed at which IC's operate and decrease the power that they consume. The diodes couldn't be used in IC's until recently, however, largely because of an edge effect. Essentially, the diode is nothing more than an aluminum electrode on a silicon substrate, and the trouble is that there is a very high concentration of electric field around the periphery of the aluminum electrode that can generate noise and spurious currents which completely mask the diode current.

**Both ways.** The two contending techniques for eliminating this edge effect have helped make Schottky IC's possible. In the guard-ring technique, a p+ ring is diffused into the silicon substrate under the periphery of the electrode. This ring prevents the depletion region, with its high electric field, from getting near the edge of the electrode. In the extended-metal technique, the aluminum overlaps the silicon dioxide passivation layer with the same effect: the depletion layer is prevented from contacting the edge of the substrate's electrode.

A major advantage of the extended metal structure, in Fairchild's view, is that it makes the fabrication process simpler and more economical, since there's no need for diffusion of the p+ guard ring. But even more important, Yu says, is the fact that the guard ring adds significant capacitance to the circuit, since it forms a parasitic junction with the n-substrate. Its elimination therefore enhances the speed of the IC.

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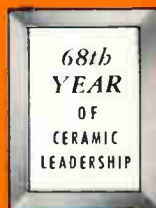
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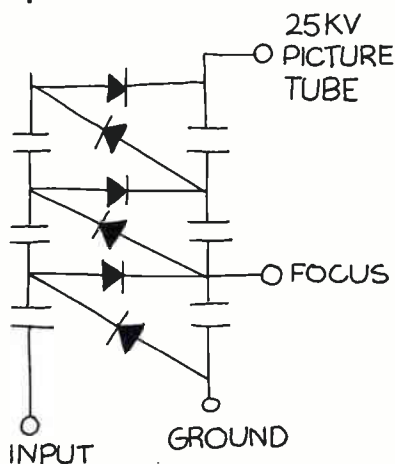
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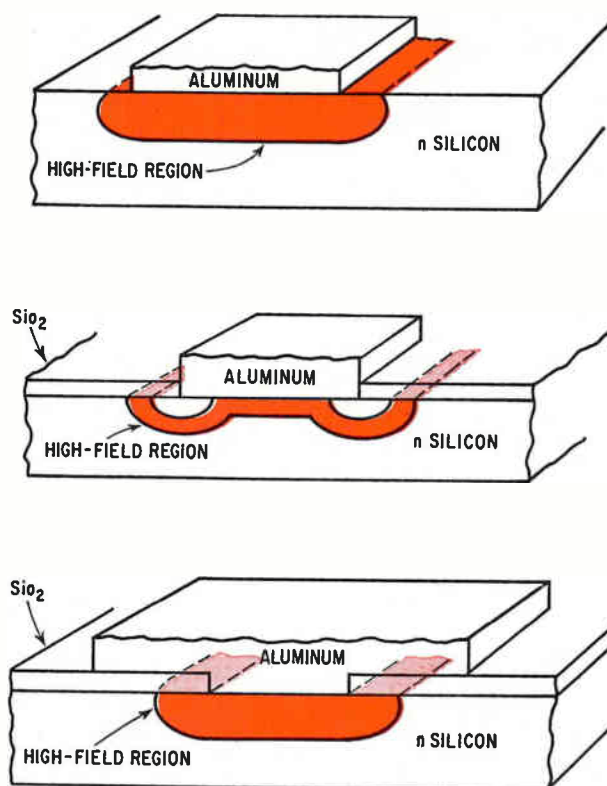


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**Away from the edge.** For good performance, high-field depletion region must be kept away from the edge of the aluminum Schottky-diode electrode. Two approaches are the guard ring (center) and extended metal (bottom). Both methods interpose material—either p-type silicon or silicon dioxide—between the depletion region and the electrode.



tended-metal structure was its poor noise performance. Typically, noise would increase with frequency up to the megahertz range. The cure, Yu says, was good oxides; oxide defects such as pinholes allowed the depletion region to contact the electrode. By concentrating on producing a near-perfect oxide under the electrode, Yu is making Schottky diodes in which the noise-frequency curve turns flat at 1 kilohertz at 10 microamperes forward bias. This, he says, is comparable to the best p-n junction and guard-ring Schottky diode devices made.

Yu's work is now cut out for him: he's advising Fairchild engineers during the transition of extended-metal Schottky-diode IC's from R&D to the factory.

### Space electronics

#### Solar color

Harvard's astronomers can turn in their crayons when NASA's Goddard Space Flight Center finishes debugging its first color cathode-ray display for real-time observa-

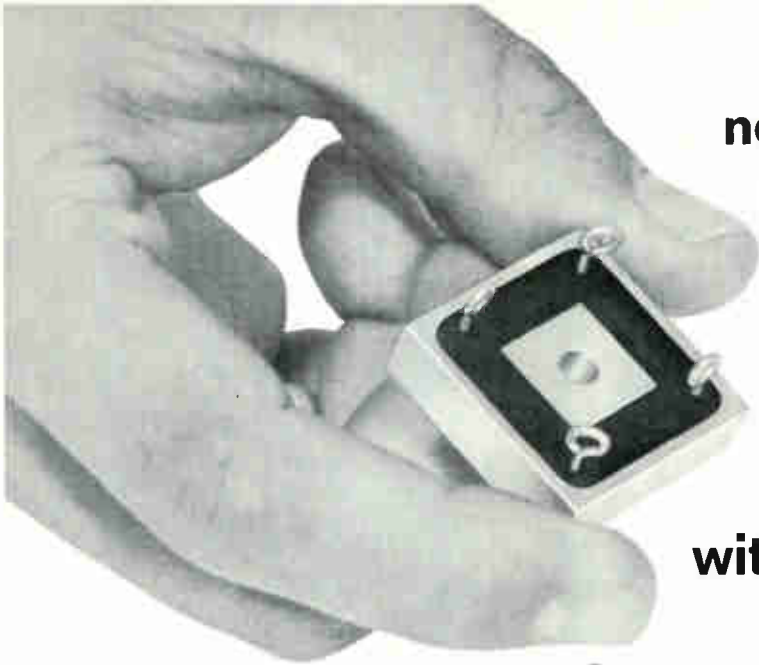
tion of solar activity transmitted from orbiting solar observatory (OSO) spacecraft.

The display was produced under a \$50,000 contract with NASA by Systems Technology Associates of Falls Church, Va. George Anikis, coordinator of the OSO experiment at Goddard, calls the piece of equipment a "giant step in solar observation."

"Now we can make intelligent use of OSO and tell it what to do soon enough so as to see the development of flares and sun spots," he said.

Experiments aboard the OSO examine the sun with a scanning spectroheliograph. The device scans a raster of 96 by 64 elements, which are first stored on tape recorders and transmitted from the OSO in the form of 16-bit binary words when the spacecraft is over a land station. They are received, along with other data, by Xerox Data System 930 computer at Goddard and fed into the color sun display in real time.

**Show and tell.** Previously, this data printout was retransmitted to the Harvard College Observatory. Dr. Leo Goldberg's graduate students would color intensity blocks



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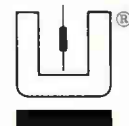


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with color pencils, pretty much the same way would-be artists fill in the blocks of a color-by-number painting set. Once they had discovered what activity they wanted to take a closer look at on OSO's next orbit—96 minutes later—they would contact Goddard and OSO would get a command.

But with the use of the sun display, the observers will be able to see the intensity in real time and be able to tell OSO where to point within a few minutes.

The display converts the binary data into colors that represent the specific energy ranges on the surface of the sun, explains Joseph S. Harrison, its designer. The color transformation is selected from among five function curves stored in a small SPC-12 computer that serves as a data processor and refresher memory for the color crt, which gives the display a flexibility "... not to be found in handwired displays," the company claims. The data, in the form of 3-bit color words, is displayed in a tv raster form on the color monitor. The sun can be shown in four raster sizes from 96 by 64 to 1 by 1.

## ERTS gaps

The Earth Resources Technology Satellite, long a political football [*Electronics*, March 17, p. 58; May 12, p. 98], may just get off the ground on its latest schedule—early 1972—but it may go up without a key part of its electronics.

Although NASA is "in pretty good shape with regard to instrumentation for the first spacecraft," according to Leonard Jaffe, director of the agency's space applications programs, there's a chance that the wideband 10 megahertz tape recorder, which was to store video data on the satellite before it's transmitted to ground stations, may not be ready in time. However, the satellite would fly without it. "It just means we'll need direct readout," Jaffe says. "And because initially we'll mostly be interested in the United States, we'll have the ground stations to enable us to do this."

Rerun. What's more, you'll be

right if you think you've seen the ERTS before. Rather than build a completely new spacecraft, NASA has decided to adapt an old one. Hence, the two design studies awarded for ERTS have gone to old hands in the satellite business who'll rework tried and tested designs: TRW of Redondo Beach, Calif., will make over its Orbiting Geophysical Observatory (OGO) and General Electric's Space Systems organization, Valley Forge, Pa., will modify its Nimbus meteorological craft.

The studies, to proceed in parallel, will aim at the spacecraft system—with a minimum of modification to the basic satellite, specifies NASA—and the ground system that will process the data relayed by the ERTS. Each of the \$500,000 studies, which combine Phases B and C of the NASA procurement cycle, should last five months. When they're completed, NASA will award a contract for the final ERTS hardware.

Stabilized about three axes, the ERTS will circle 500 miles above the earth in a high-inclination orbit. Even though the first craft will be experimental, NASA hopes to obtain useful information. Data from sensors will be used for such tasks as developing land-use and agricultural maps of the U.S., classifying geological and soil features, and collecting data from remote stations that measure such things as river flow and water depth.

**Bit picture.** The sensor payload on the first ERTS will include three return-beam vidicon cameras for taking television pictures of the earth through three different spectral bands, and a multispectral point scanner which will operate into the near infrared band. RCA is building the vidicons and NASA has selected Hughes Aircraft to build the scanner. The award to Hughes, made early last month, could reach \$1.8 million.

NASA recognizes the vast problem faced in translating the ERTS data into useful form. Accordingly, a major part of the study awards are given over to establishing the data processing requirements on the ground. TRW, for one, has teamed with IBM's Federal Sys-

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tems Division in Washington and the Optical Systems Division of the Itek Corp. in Lexington, Mass., to help solve the data problem. IBM will develop concepts for the data processing center that will process, store, and retrieve information; Itek will concentrate on the system for processing and re-constructing the digital images. GE's teammates are Bendix and EG&G's Wolf R&D.

## Military electronics

### SAM faces life

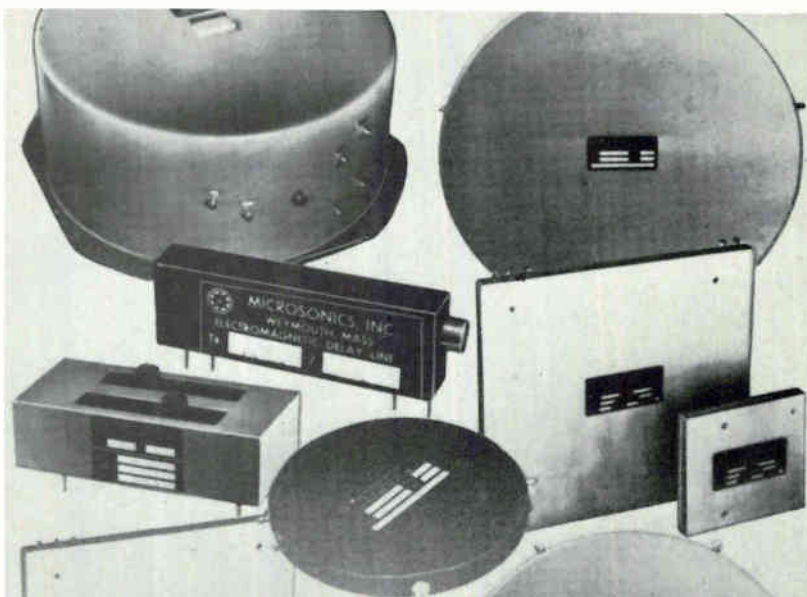
Pentagon rumblings hint that the Raytheon Co. is having technical problems with the SAM-D air defense missile system. But Raytheon disagrees, noting that while there has been some slippage, it's only a couple of months—not much by military contract standards.

Nor are there said to be any unexpected development problems. "The system's technical merits aren't being challenged," according to an insider. "All of SAM-D's key concepts have been demonstrated individually, and all worked."

The slippage may be due partly to some unintentional psychological warfare waged by the House of Representatives when it sliced the entire \$75 million SAM-D appropriation out of the fiscal 1970 defense budget—not the first time SAM-D money has been cut—holding Raytheon to about \$80 million through fiscal 1969. While the Senate restored the money, funding still is to be decided in a Congressional conference committee.

Also, there's talk that the sort of threat SAM-D was to have dealt with in the mid-1970's won't materialize until as late as 1980. Because of this threat revaluation, SAM-D may be in for a stretch-out five years beyond its planned 1974-1975 operational date. Ironically, Raytheon's own improved Hawk missile is supposed to bear some of the Tactical Air Defense burden formerly slated for SAM-D.

**Bills.** The effect this is having at Raytheon is hard to measure. One spokesman at the firm's Bedford



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5/16" HEX BUSH: #1/4-28 THD.	 STAND OFF 54 751 001	10A	500V	10,000	.42	
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## U.S. Reports

laboratories wonders who is going to pay the bill for equipment already ordered in anticipation of fiscal 1970 development money.

Another notes that engineers today can't get dumped from one company and quickly plug into another—with the defense budget tightening there aren't many places to turn if your program gets axed." Thus, he wonders if slippage in SAM-D might not be traced to a case of the fidgets by the men involved. He adds that he's hearing more talk about engineering unionization and job security than ever before.

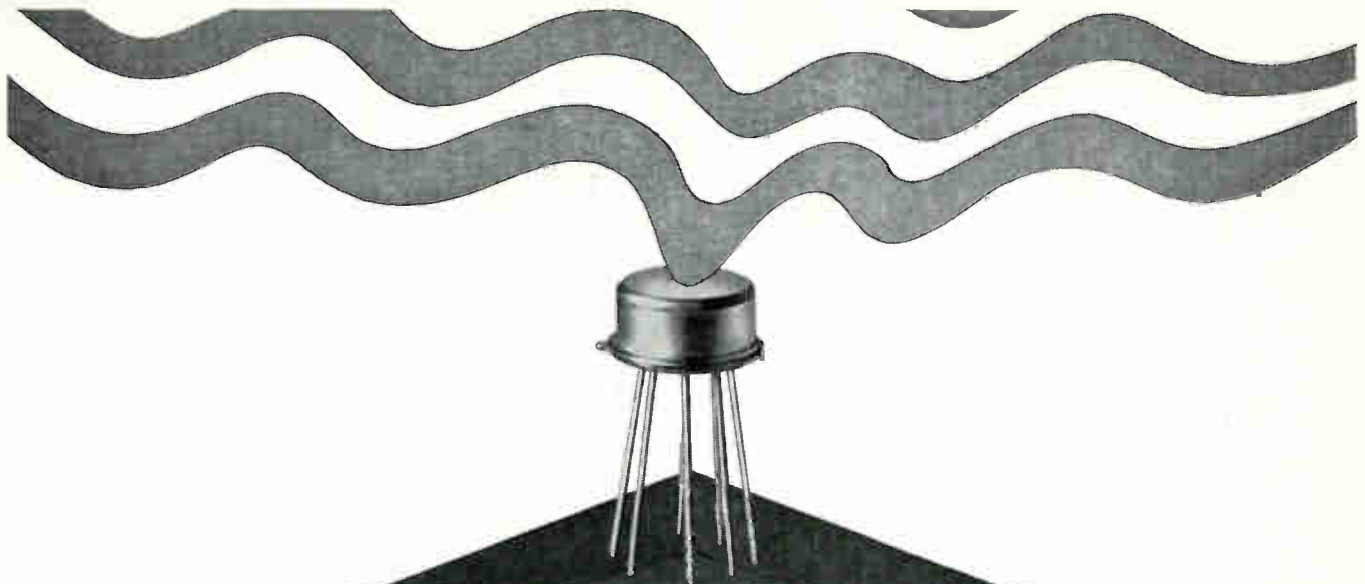
If SAM-D goes down the drain, it will take a well organized development scheme along with it. Learning from experiences with the Hawk and improved-Hawk missiles, Raytheon invested time and talent in several computer-based design aids for SAM-D. Both its radar-data-processing and guidance computer, and the missile-control system itself, are to be tested with thorough computer simulation. The first model of the SAM-D computer already may have been delivered and hitched to a DDP-124 to be tested in an electronic interchange.

"The environment this computer will deal with—radar, countermeasures, multitarget tracking, multi-missile guidance aid, target priority assignment, and so on—is so complex that the only way to check it out is to let it talk with another computer. There's nothing else big enough to exercise it except the real world," says an insider.

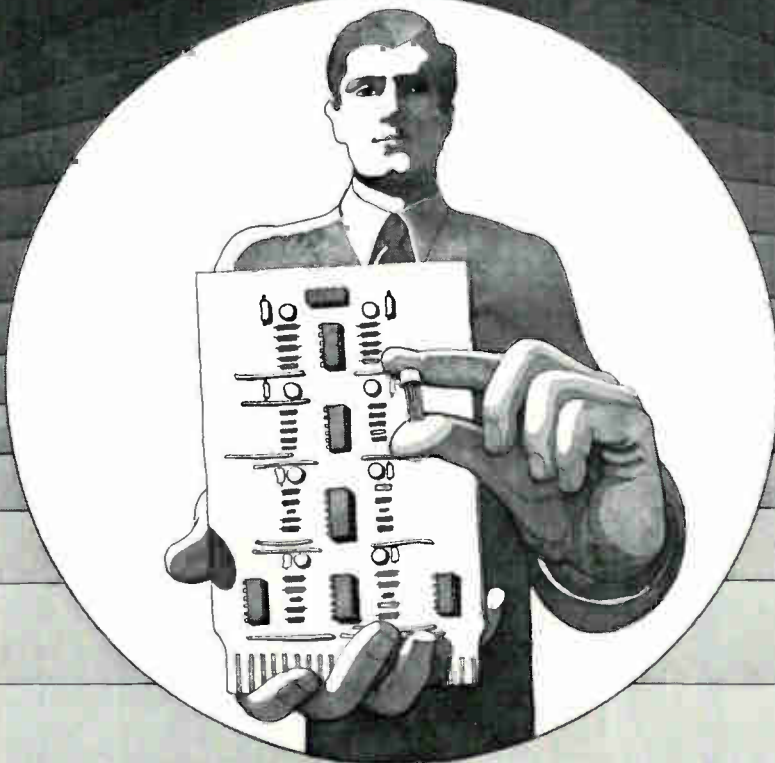
**Computer.** Meanwhile, the missile would be put through its paces by what may be the world's largest and fastest hybrid computer.

A phased array of horn antennas would face a missile nose cone in an anechoic simulation chamber, emitting the sort of countermeasure-filled, misleading, scintillating signals expected as returns from mid-70's targets. "The seeker and guidance head is going to be presented with multiple targets in its field of view, and some of the ground-based SAM-D computer gear will help the seeker ignore decoys and pick the proper target," says a spokesman.

Also on the simulation list are



RCA-CA 3055



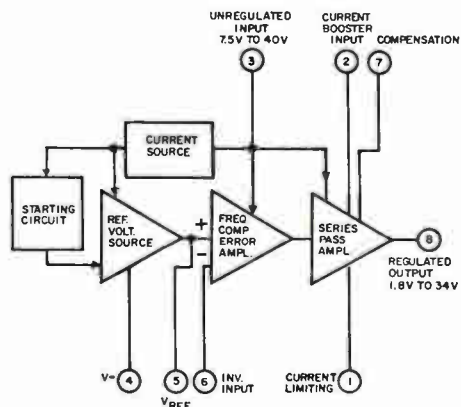
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erence and output voltage temperature coefficient, and  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  operation.

Wherever size, performance, and economy are requirements, use the CA3055. Its price is right. For details, see your local RCA Representative or your RCA Distributor. For technical data bulletin, File No. 395, write RCA Electronic Components, Commercial Engineering, Section N11-1/CA19, Harrison, New Jersey. In Europe: RCA International Marketing S. A., 2-4 rue du Lièvre, 1227 Geneva, Switzerland.

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The procedure is quicker than pin-by-pin checking and is simple enough to have non-technical people relieve skilled personnel of the testing chore. This does not make them circuit designers or service-men, but it does save valuable time.

Dual-in-line and flat-pack types — digital DTL, RTL, and TTL's are checked on Testex 410. Other specifics — function, applications and economics — are found in our literature. Testex

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# TESTEX



## Introducing The Pin Pointer

## U.S. Reports

lift, drag, and control surface pressure effects at speeds from zero to more than Mach 2, and tests of the missile's guidance-control actuators. More than 25 control loops will be tested this way, eventually simultaneously, using a combination of a Control Data Corp. 6600 digital computer and a Comcor 5000 analog system. These computers, plus their interfacing electronics, are the basis of Raytheon's "largest, fastest hybrid computer" claim.

As the tests progress, the hybrid installation, the SAM-D computer, and the missile will be linked. It's claimed that this will come about as close to a field test as possible without moving outdoors.

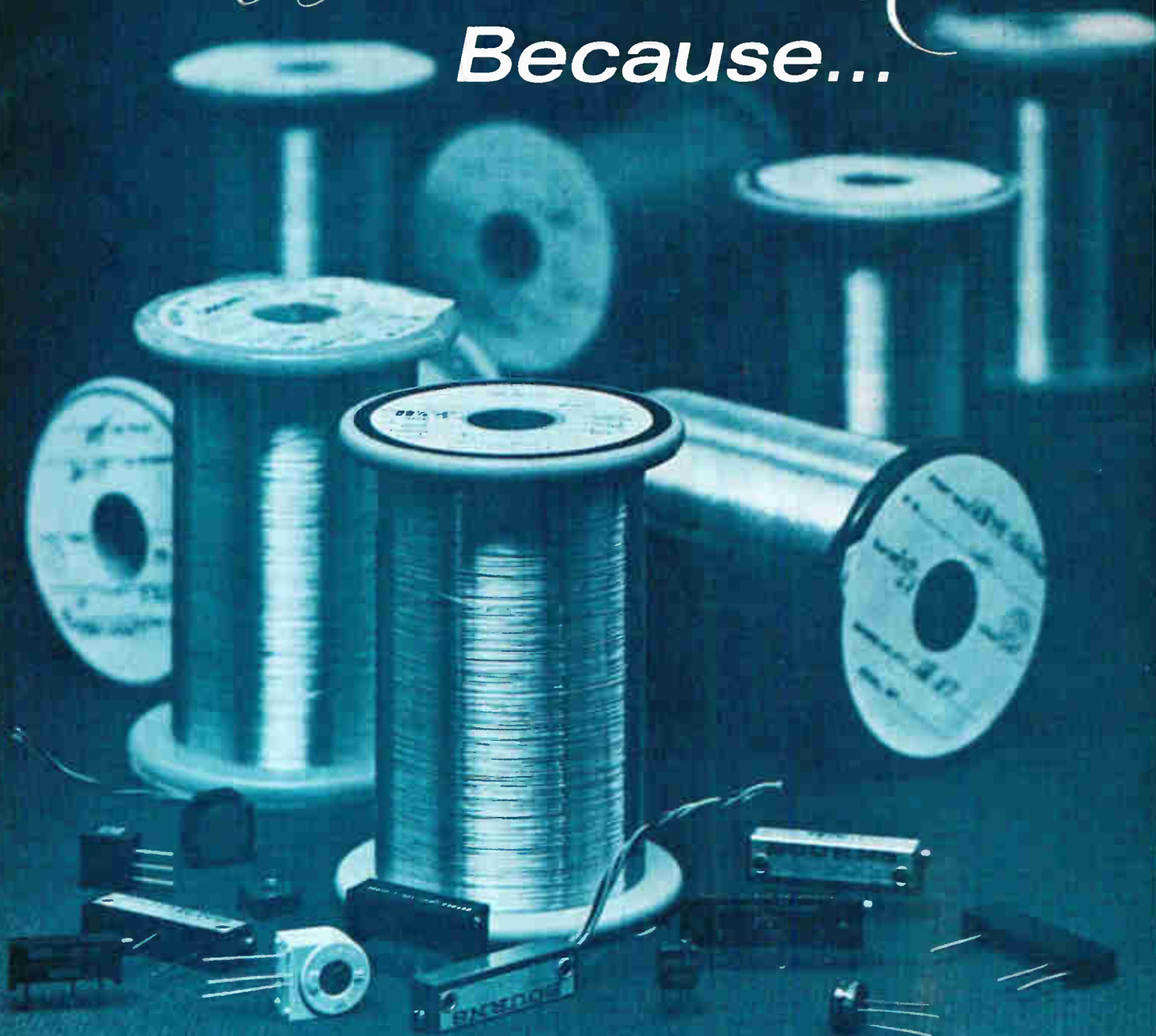
But for now, despite these preparations, morale at Raytheon-Bedford is getting low, and it won't climb until an answer comes from Congress on SAM-D funding.

## For the record

**Up, up—and leveling.** Electronics firms' capital expenditures will rise by 16% next year, according to McGraw-Hill's fall survey of businessmen's plans for plant and equipment investment. In addition, the industry is expecting an 8% jump in sales volume for 1970. The survey also finds that electronics firms currently project a 5% increase in expenditures during 1971. However, this figure will be affected, in part, by the expected elimination of the 7% tax investment credit as well as by other anti-inflationary measures.

**Go-ahead.** The Air Force has awarded a \$5.2-million Phase 2 cost-plus-award-fee contract to Honeywell for Geans—gimbaled electrostatic aircraft navigation system. Geans incorporates an improved electrostatic gyro in an inertial nav system. Flight tests in the 28-month advanced prototype development project are scheduled for 1970. The heart of the system, the inertial platform, houses two gyroscope packages, an accelerometer group, and IC electronics. The computer is a digital Honeywell 601P.

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That makes the 483 the cost/performance leader in the mini computer field. And we're making it the best serviced computer in any field.

Frankly, the kind of people who take a chance on the 483 are the kind of devil-may-care people who take a chance on t.v. sets, the horseless carriage and peanut butter in the jar.



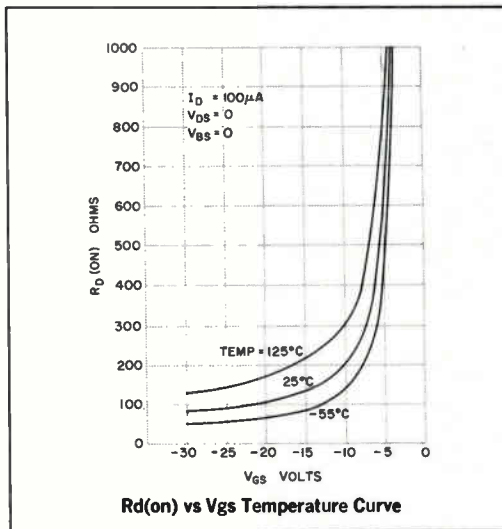
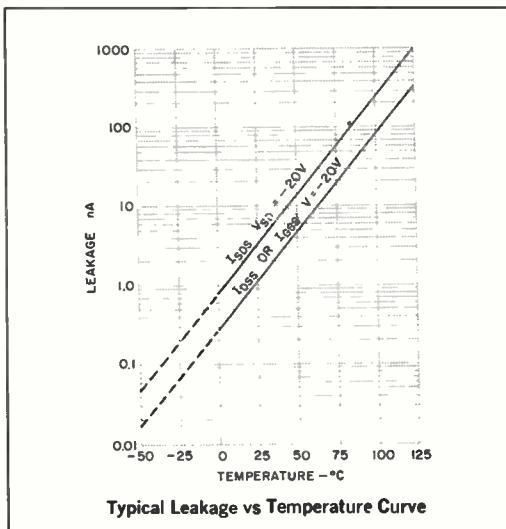
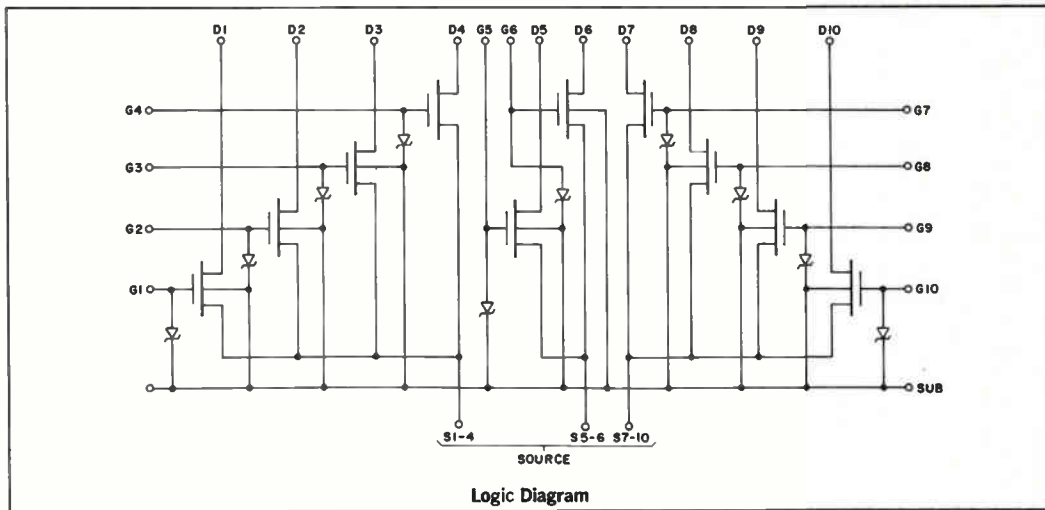
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## MICROWAVE IC MODULES PROGRESS REPORT #8: PRODUCTION

Sperry Rand's PACT (Progress in Advanced Circuit Technology) program has moved microwave integrated circuits and modules out of the laboratory and onto the production line. As far as we know, Sperry Rand is the first company in the industry to take this revolutionary step.

Our functional assignment was to design the world's first radar performance analyzer for end-to-end testing of doppler radars. For a Navy program, our customer wanted a portable tester that could exercise navigation radar without radiating energy and without making any interconnection with the aircraft. Since size, weight and power consumption are critical, all the microwave functions were integrated. The result: three microwave integrated modules replacing 32 conventional microwave components.

At one time or another, Sperry Rand had produced fully integrated versions of every microwave component in the test set. Why not reduce the whole circuit to integrated modules? First, integrated modules have fewer interconnections, and are therefore more reliable. Second, integrated modules cost less to produce than present day collections of discrete components. Third, by making all of the circuit elements ourselves, we sidestepped a lot of procurement problems.

Development of the microwave integrated circuit modules for the doppler test set proved to be well within Sperry Rand's capability.

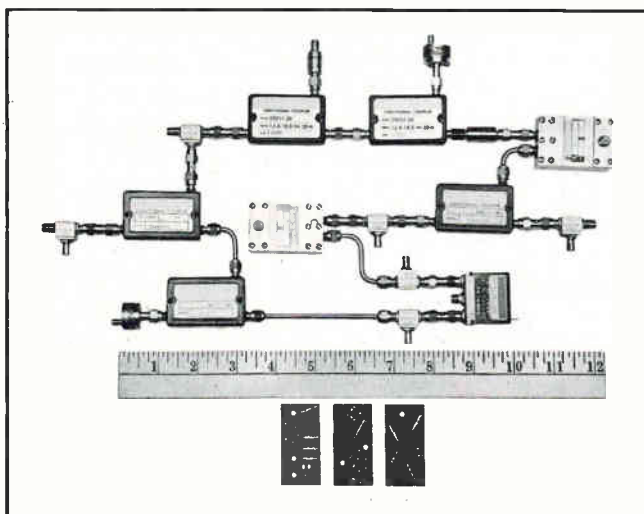
The unit works well. In the old days (last month) the microwave section would have occupied 90 cubic inches. Today it takes up 3 cubic inches. Our ferrite-

substrate modules have a low-pass filter, 6 circulators, 11 attenuators, 5 diodes, 2 mixers, 2 converters and 4 thermistors. The old way would have required 25 more flange connections than the integrated modules use. The microwave circuit functions within the same tight tolerances that it would have under the older technology.

Now that we're delivering integrated modules, you can't afford to pass up our experience. In fact, if we're not helping design your microwave system, it's probably obsolete.

A letter will start us working on your next system improvement. Write: Sperry Microwave Electronics Division, Sperry Rand Corporation, P. O. Box 4648, Clearwater, Fla. 33518 or call us at (813) 784-1461.

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**SPERRY**  
MICROWAVE ELECTRONICS DIVISION  
CLEARWATER, FLORIDA

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# Washington Newsletter

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November 10, 1969

## Micom to file for giant step: a national hookup

Microwave Communications Inc. will cap its Nov. 3 petition to the FCC for a West Coast network with a much grander effort the week of Nov. 17. It plans another filing and a Washington press conference outlining a national microwave net of more than 100 U. S. cities. Micom president John D. Goeken says MCI Pacific Coast Inc. will employ 56 microwave dropoff sites to serve 15 California cities from San Diego north to Stanford; three in Oregon—Eugene, Salem, and Portland, and five in Washington—Longview, Olympia, Tacoma, Seattle, and Everett [*Electronics*, Sept. 29, p. 133]. United Artists Theater Circuit will be the largest shareholder in the \$6.5 million West Coast system, with 21% of the stock and options that could raise its holdings to 30%. Micom will retain about 20%, with the remainder distributed among other investors.

## Trouble forecast for computer utility plan going to FCC

University Computing Co.'s plan to file with the FCC a proposal to build and operate a nationwide digital data transmission net—in effect, a computer utility—is expected to run into trouble in the capital. Though FCC won't talk until it gets the filing, sources are quick to point out that a favorable ruling permitting the Dallas-based computer service company's new subsidiary, Data Transmission Co., to compete with common carriers like AT&T and Western Union for EDP transmission would run counter to an earlier FCC recommendation that carriers be barred from entering the computer service business.

Other sources note that UCC may have blown its case by revealing that its Falls Church, Va., subsidiary, Microwave Transmission Co., has been developing its computer utility plan for more than 15 months. This disclosure, some feel, runs contrary to UCC's claim before the FCC last year that it contemplated no expansion of services such as data processing transmission.

## Can cablecasters find success using new signal booster?

A solution to the problem of video signal degradation caused by repeaters in cable transmission (see p. 54), could come from the Zenith Radio Co. technique for upgrading low-quality, low-resolution signals by passing them through an acoustic lens scanner in sync with the tv beam. Using this approach—one of two key concepts presented at the IEEE International Electron Devices meeting in the capital—Zenith claims it can get a hitherto unattainable 17-to-1 increase in signal resolution. The technique uses an acoustic beam traveling in a water medium arranged in such a way that optical beam focusing is obtained.

RCA's Princeton operation says it has come up with a low-power—one milliwatt-per-centimeter—filter it can make at an unspecified low cost to electrically pulse liquid crystals and produce color changes. Called flat, rugged, and lightweight, the filters have 1-to-5-millisecond response times with 30-to-200-msec relaxation, which could make them useful in commercial display applications where high speed is not a requirement.

## Military halts retreat from Proxmire guns

Military leaders are no longer running from Sen. William Proxmire (D., Wis.) now that virtually all his efforts to achieve major budget cutbacks have failed in Congress [*Electronics*, Oct. 13, p. 65]. Some

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# Washington Newsletter

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resent Proxmire's latest assertion that Defense Secretary Melvin Laird's panel to examine DOD operations is "at best a sham"—based on the fact that panel members' companies hold a total of over \$1 billion in DOD contracts or in securities of DOD-contractor companies. Says a senior Air Force officer, "Who would the Senator suggest be on the panel? Should they be totally ignorant of defense programs and their management?"

Members of the "in-house Pentagon pet" group singled out by Proxmire include Robert C. Jackson, chairman, Ryan Aeronautical Co., 23rd largest DOD contractor with \$293 million; Ruben F. Mettler, TRW director, 52nd, \$127.5 million; Wilfred J. McNeil, director and adviser, Fairchild Hiller, 56th with \$121 million in DOD contracts; and Gilbert Fitzhugh, panel chairman, who resigned the chairmanship of the Metropolitan Life Insurance Co.

## Think-tank outlook —2 opposing views

Plans at technology-oriented universities such as MIT to sever their ties to the Pentagon are producing a surge of optimism within some of the 16 Federal contract research centers. Planners at these think tanks see more defense R&D money coming their way (they got \$263 million last year) as military researchers seek new brainpower sources. However, some Congressional sources consider the optimism premature, citing continuing Congressional criticism of some apparently thoughtless performances. Latest target is the Hudson Institute, which, Sen. Thomas F. Eagleton (D., Mo.) observes, "contributed the suggestion that we dig a moat around Saigon."

## \$78.6 million sought for storm radar ...

Criticized for letting Hurricane Camille catch its victims unprepared, the Environmental Science Services Administration (ESSA) is responding to President Nixon's call for a study of meteorological services with a \$78.6 million plan to upgrade airborne weather radars and other instrumentation. Some who have seen the proposal say it's inadequate, since the figure includes aircraft replacements for six weather-beaten Navy RC-121's and is spread over two fiscal years. Guts of the plan include \$68 million in fiscal 1972 for instrumentation for the replacement planes; another \$9.2 million for new weather sensors and on-board data processors for refitting the Air Force's WC-130's; plus \$1.35 million for ESSA in fiscal 1971 to update two DC-6's with surveillance and doppler radars, digital data recording units, and Omega navigational systems.

## ... and Air Force has its own battle plan

The Air Force, making its own technical study to find the most effective weather radar for its aircraft, warns that availability of hardware before the next hurricane season is unlikely since its effort is only a development program in its present form.

Capabilities ESSA wants for hurricane reconnaissance craft include: an in-flight visual recorder, from which maximum gradients of critical elements (wind, temperature and humidity) can be reported in flight, plus a doppler radar wind-finding system with minimum attenuation from rain beneath the aircraft. Also needed, says the ESSA, are an S-band weather radar, PPI mode, with a beamwidth less than 3° and a range of at least 200 miles; a radar, X or K band, for measuring cloud tops; and an i-r sensor for measuring sea-surface temperature gradients.

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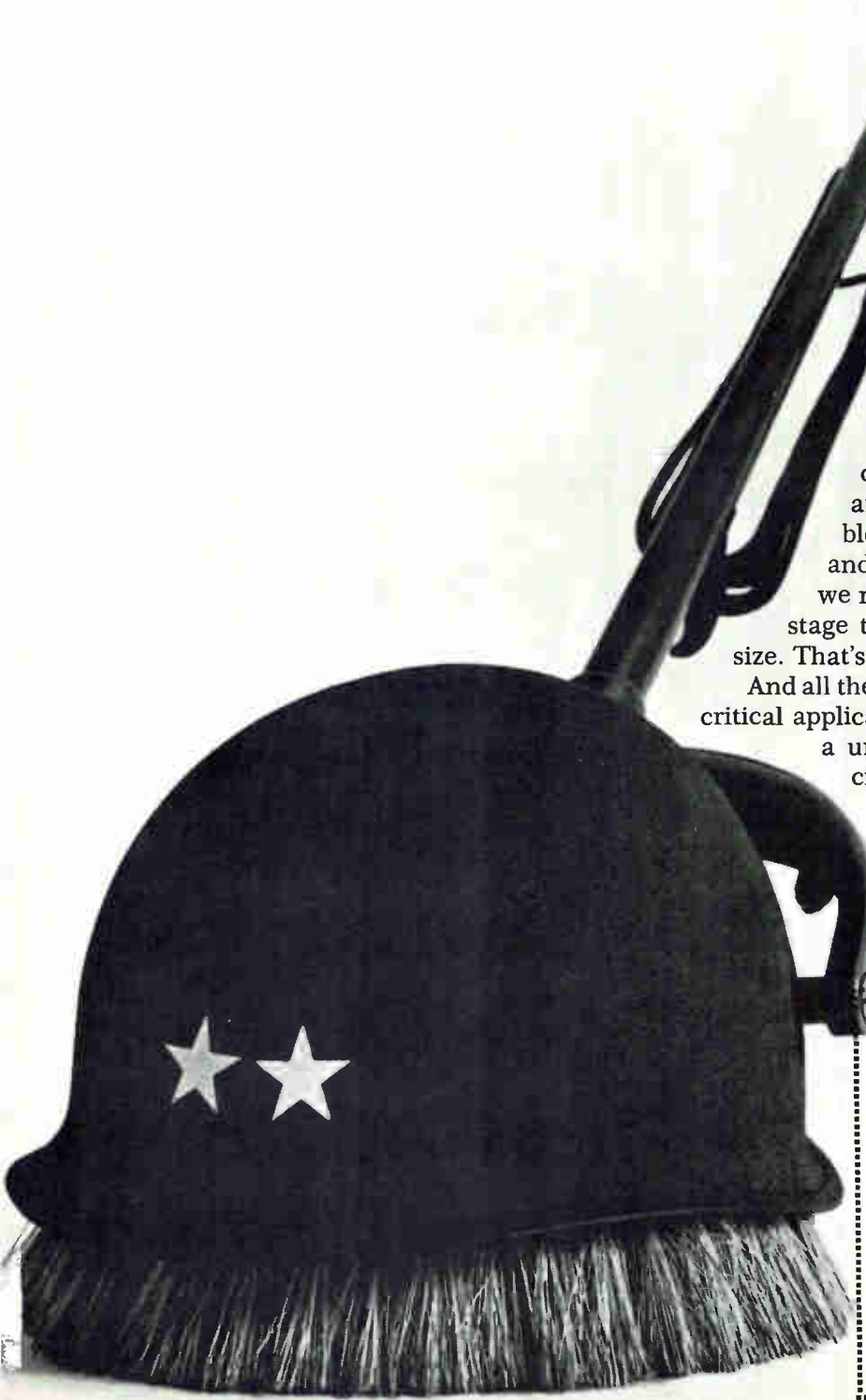
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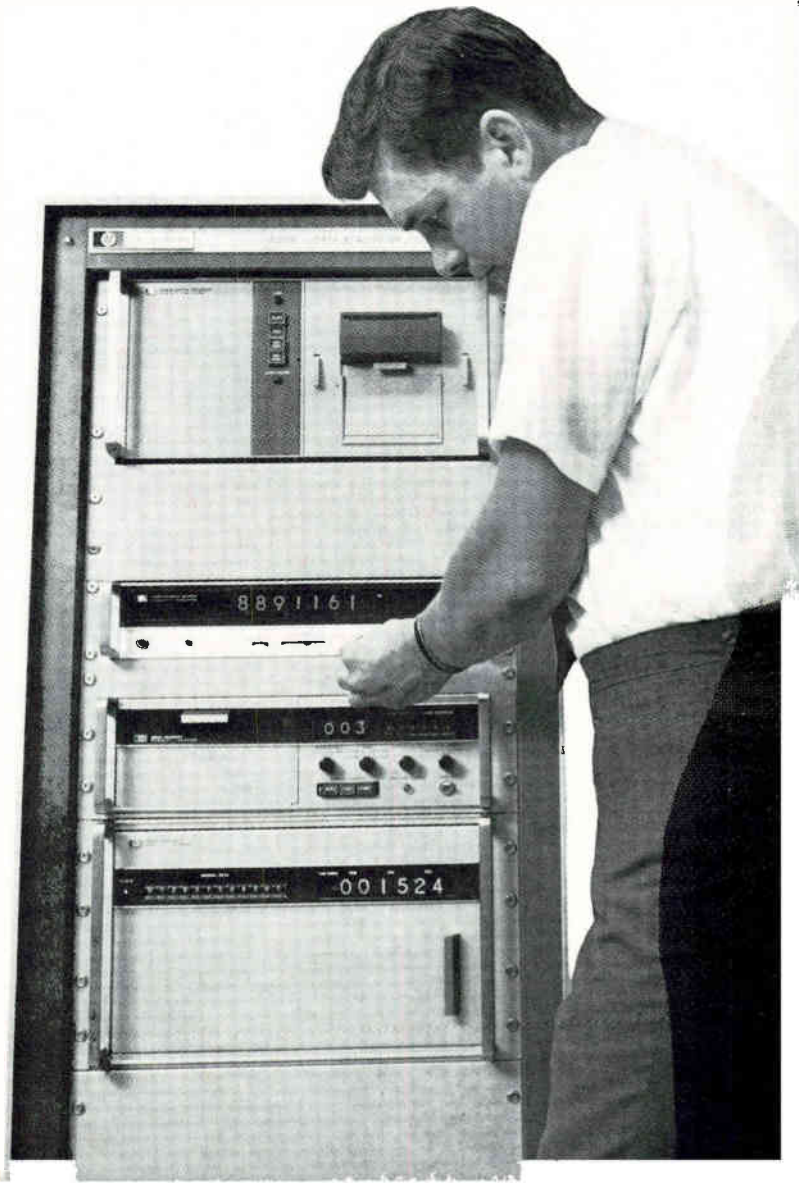
On the left you see the HP 5323A Automatic Counter at work in a system. On the right is our HP 5325B Universal Counter, making a hard test easy.

The counters could easily be reversed. Because both are programmable and with either of them you can count up to 20 MHz in a system or on your bench. The one you choose depends on what you need.

The Automatic Counter has automatic range selection from 0.125 Hz to 20 MHz. And it needs no switching from frequency measuring mode for high frequency measurements to period measuring mode for accurate low frequency measurements. That's because all measurements are made in the period mode, and internal

computing circuits invert the period measurements to frequency. Thus you get the speed and accuracy benefits of period measurements at low frequencies coupled with the convenience of direct readout in frequency at all frequencies. There's no accuracy penalty at any frequency. The 5323A has a score of other advantages built in. For instance, it can automatically measure the carrier frequency of pulsed signals. Some people buy the 5323A for bench and production line use because its simple, automatic operation and direct readout in frequency reduce errors, even with untrained users. It even keeps tabs on the user by refusing to display more digits than it should for a given measurement speed. For easy use in systems, it's programmable, of course.

## These two counters make systems run smoother.



# Know your d-a converter's capability

Differential amp with offset provides added gain and sensitivity to accurately measure d-a unit's settling time on an oscilloscope

By James J. Pastoriza

Pastoriza Electronics Inc., Newton Upper Falls, Mass.

and David R. Weller

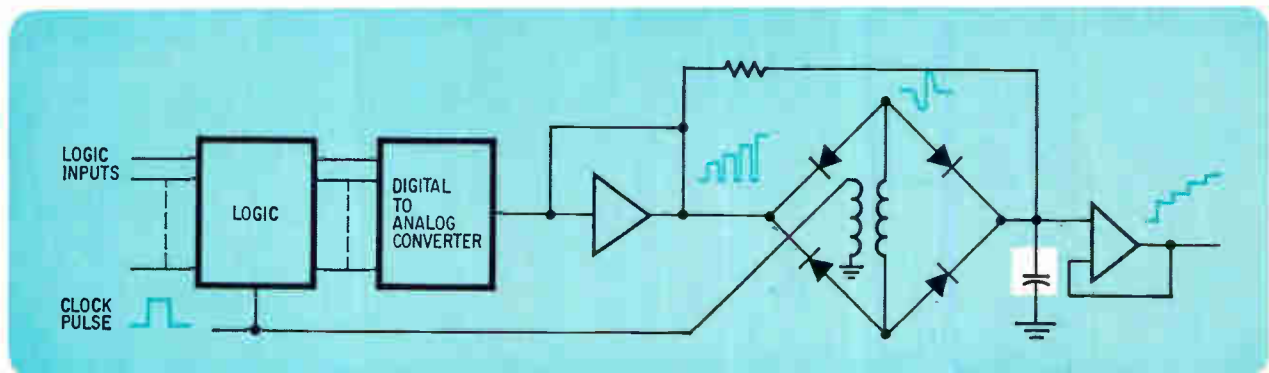
Bell Telephone Laboratories, Murray Hill, N.J.

**Speed in itself** isn't inherently a virtue if it's accompanied by harmful side-effects, as, for example, in a high-speed digital-to-analog converter. The task is either to overcome the bad effects or simply avoid them while, at the same time, taking advantage of the speed.

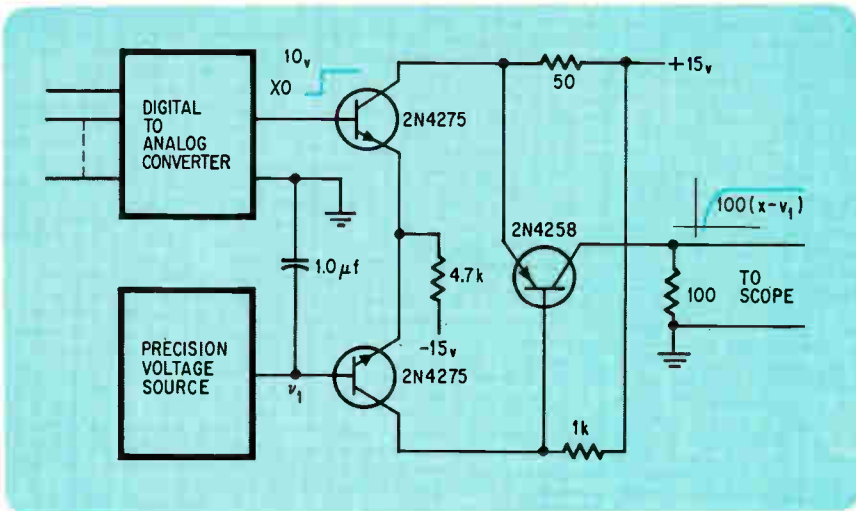
In a typical digital-to-analog converter, particularly high speed units, troublesome transients are generated. These transients, if fed to subsequent slower circuits, would be integrated over many microseconds, thus increasing the effective settling time, and perhaps slowing the effective conversion speed by an order of magnitude or more. This would be intolerable for applications such as non-flickering cathode ray tube displays of high-speed computer readouts.

Usually neither the transients nor their effects are included in device specifications and engineers must check the output responses of the d-a converters themselves. To do this they rely on the oscilloscope. However, regardless of how good their oscilloscopes are, the engineers find it somewhat difficult to obtain the necessary gain and sensitivity to measure pulse settling times—particularly to within a few millivolts resolution over a full scale voltage range that may be 10 volts or more.

But by using a simple preamplifier ahead of the scope with a special offset input to suppress the large d-c component in the converter's output, the rise and settling times of the pulses can be measured accurately and the transient behavior can be observed. This preamplifier consists of a high-



**Track-and-hold.** This circuit transmits only the voltage increments and bypasses the transients. The clock pulse is differentiated by the pulse transformer into a bipolar signal; this contains a negative backswing and positive frontswing which alternately opens and closes the diode bridge. When the diodes are forward-biased, the d-a's output charges the capacitor which also holds the charge when the bridge opens during the clock pulse's negative swing. Transients occurring during this negative swing never get through to discharge the capacitor.



**Booster.** Most scopes have neither the gain nor sensitivity to accurately measure the d-a's rise and settling times. With the differential preamplifier circuit, enough offset is provided by the voltage source to look at just the top of the converter's waveform while the circuit's gain of 100 gives the needed amplification. The difference between the step function at the converter's output and the voltage offset is delivered by the output transistor to the 100-ohm resistor connected to the scope's input terminals.

frequency, high-gain differential amplifier with a reference source at one amplifier input that provides the right voltage offset.

If transient behavior of the converter proves unacceptable, an additional circuit operating on the track-and-hold principle can be used to store the output amplitude while ignoring the switching transients. The primary cause of the transients is the unsymmetrical logic switching gates in the d-a converter. Since they open slightly faster than they close, it takes longer to complete a transition from the binary 0 state to the binary 1 state where the switches must close than to complete the reverse transition 1 to 0 where the switches must open.

To illustrate the effect of these transients on the output waveshape, suppose a four-bit flip-flop register that drives the d-a converter has a binary count of 7. Its most significant bit is a 0 and the other bits are 1's. If the next logic state adds a binary 1 to the count, three switches in the d-a converter would have to toggle from 1's to 0's while the switch driven by the most significant bit would have to toggle from a 0 to a 1.

However, since it's faster to switch from a 0 to a 1 state, the three 1's shift to 0's before the most significant bit changes to 1; thus the converter registers a count 0 before the next higher count of 8 is completed. Therefore, instead of moving directly from 7 to 8, the converter goes from 7, briefly to 0, and then to 8. Consequently, the output goes from the equivalent voltage level that represents a binary 7 to the level of a binary 8, but with a sharp negative spike between the two steps.

Though a track-and-hold technique seems a good way to sidestep the transient problem, most of the track-and-hold circuits haven't been effective—they're slow, inaccurate, and often introduce transients worse than those they're supposed to remedy.

The track-and-hold circuit on page 129, however, effectively eliminates transients in the d-a converter's output by only transmitting the meaningful part of the waveform. It does this by sensing a clock pulse delivered simultaneously to the converter's input logic and the diode bridge of the

track-and-hold circuit via the pulse transformer.

The transformer differentiates the timing pulse into a positive frontswing and a negative backswing. The pulse, inductively coupled to the bridge, opens and closes the diode paths transmitting the signal when the diode paths are closed, and blocks the signal when the paths are open.

During the backswing, the diodes are forward biased and the capacitor charges to the d-a's output. The capacitor stays charged during the frontswing while the diodes are back-biased. Since transients occur during the frontswing they are blocked from discharging the capacitor, preventing them from being transmitted to subsequent circuits.

The transient-free signal at the output of the track-and-hold circuit now must be amplified and the voltage level offset so that its settling time can be accurately measured on an oscilloscope. To do this, the differential amplifier circuit shown above with a gain of 100 and an offset range of 10 volts (for a converter with a full-scale range of 10 volts) increases the scope's sensitivity for accurate settling-time measurements.

To see how long it takes a d-a converter to reach its final value, a 10-volt step function is applied to its input. The d-a's output is applied to one side of the differential amplifier and the reference signal to the other. The difference between the d-a's output and the reference voltage is generated across the 100-ohm resistor—but amplified 100 times.

With the reference set at 10 volts, just the top part of the waveform is visible on the scope; the reference can be lowered slightly to observe more of the slope or slew in the converter's output. For example, if the reference is decreased 20 millivolts, the top 20 millivolts of the converter's output become visible. In fact, by setting the reference to an appropriate voltage, any d-a output through its 10-volt range can be closely observed and its settling time measured.

The differential amplifier's gain and linearity can be checked by varying the reference voltage in 10-mv steps and observing the corresponding variations in the output signal on the scope. ■

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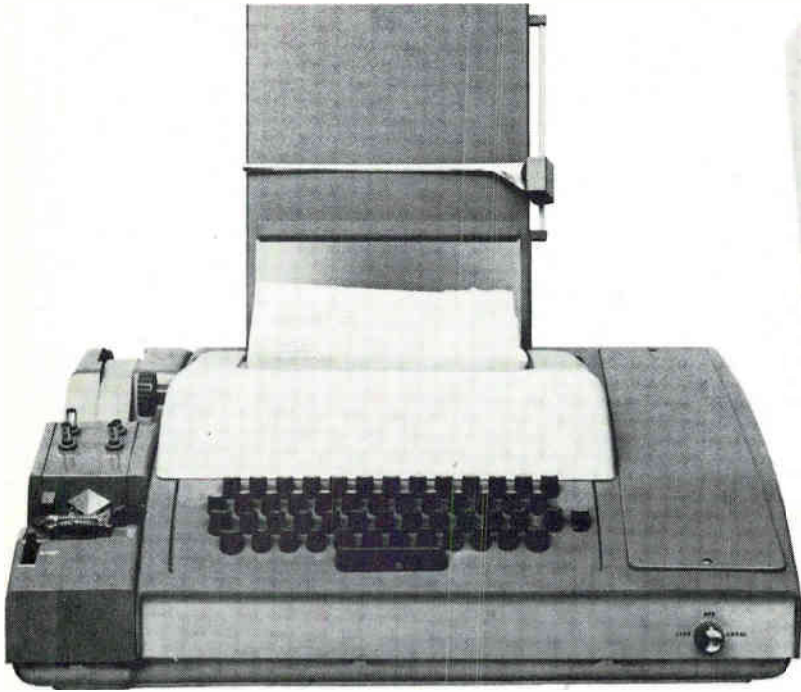
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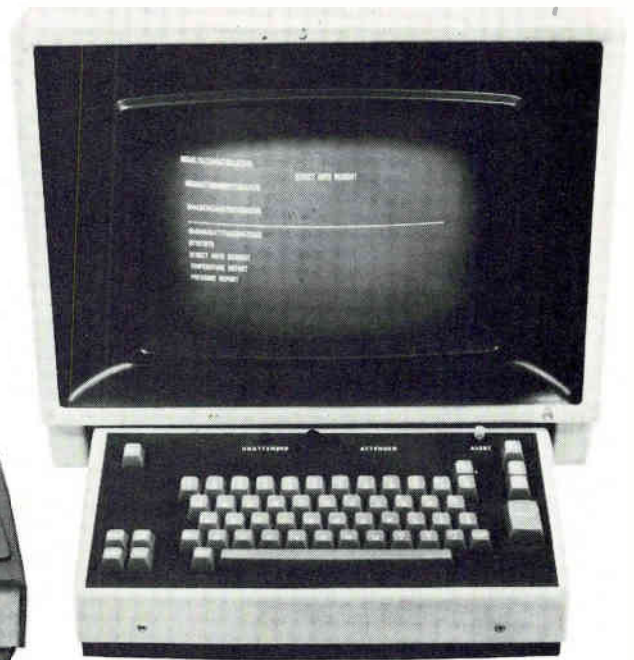
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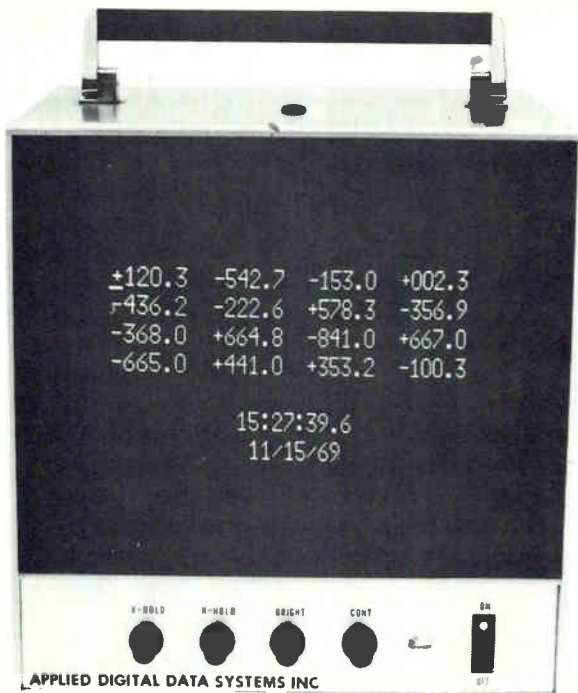
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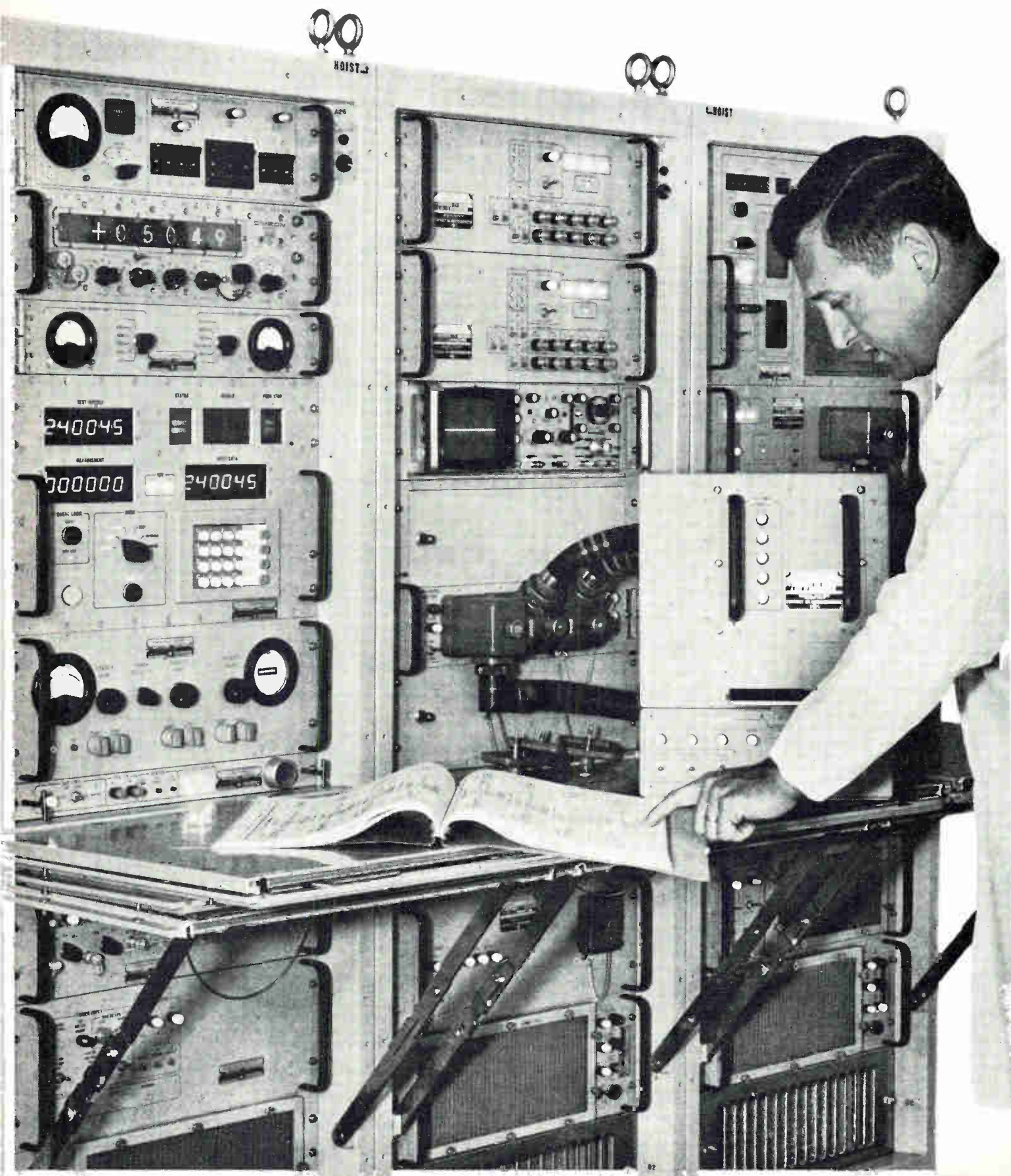
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## Program

1. Evolution of large scale integration (LSI)
2. MOS device structure and characterization
3. Basic MOS circuit techniques
4. Topological design and layout
5. Advanced circuit techniques
6. LSI artwork generation
7. Logic implementation with LSI
8. Design examples
9. MOS/Bipolar interface techniques
10. Low threshold technology
11. Cost consideration for LSI
12. Computer aided design
13. MOS structures and fabrication techniques
14. Process constants and minimum design rules
15. Yield factors and process control
16. Facilities and equipment requirements for LSI
17. Applications and product types most suited to LSI
18. Currently available MSI/LSI products
19. Advanced technology trends
20. Technological controversies

## Purpose

The MSI/LSI seminar is designed to acquaint systems designers with the capabilities and limitations of the LSI technology. It will provide for more effective product planning through knowledgeable appraisal and proper use of LSI for specific applications. Attendees will receive instruction in MOS device models and characterization, and in MOS circuit forms and their performance comparisons. They will also learn topological rules that permit multiple sourcing of LSI arrays, procedures for the design of a standard cell library, how to make an LSI composite plan drawing, and how to determine transient response and propagation delay. LSI cost factors will be discussed, and systems designers will be instructed in the preparation of specifications for LSI.

## Faculty

Presentations, discussions, and work sessions are under the direction of the staff of Integrated Systems Technology, Inc. of Santa Clara, California. Each member of the staff has wide experience in the areas of circuit design, systems application and semiconductor research and development.

*Donald E. Farina*—President, Integrated Systems Technology, Inc. One of the contributors to the design of the first micrologic integrated circuit families. Served as head of the R&D department in digital circuits for Fairchild Semiconductor, responsible for both digital circuit and bipolar device structure development. For the microelectronics division of Philco-Ford Corporation Mr. Farina served as Director of R&D and was responsible for device and research devoted to MOS large scale integration. He received his BSEE at New York University in 1953.

*Ronald Pasqualini*—Vice President, Engineering. Widely experienced in

R&D on MOS memory systems for Philco-Ford Corporation. Performed initial logic design, circuit analysis, and composite layout of a monolithic read-only memory. Was responsible for the interface between R&D processing and R&D design.

Systems design experience in integrated circuits includes shared responsibility on an Air Force large scale array navigation computer, and Ranger spacecraft. Also designed a monolithic 2-MHz binary/BCD converter employing 4-phase circuit techniques.

Mr. Pasqualini holds a BS in Aeronautics from M.I.T., 1962, and an MSEE from U.S.C., 1966.

*Richard Craig*—Vice President, Technologies. Mr. Craig has devoted the major portion of his career to the semiconductor. With three major semiconductor manufacturers his experience includes developments in planar and epitaxial processes and structures. He received his BA in Physics from Fresno State College in 1958.

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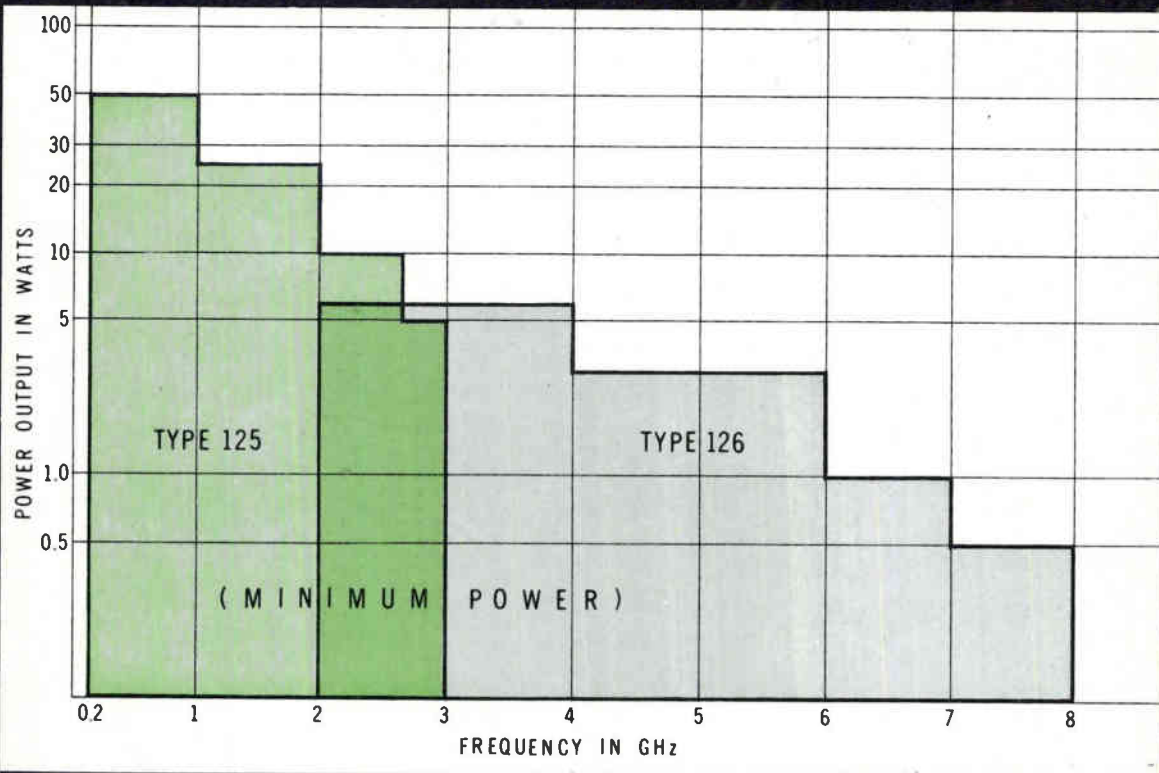
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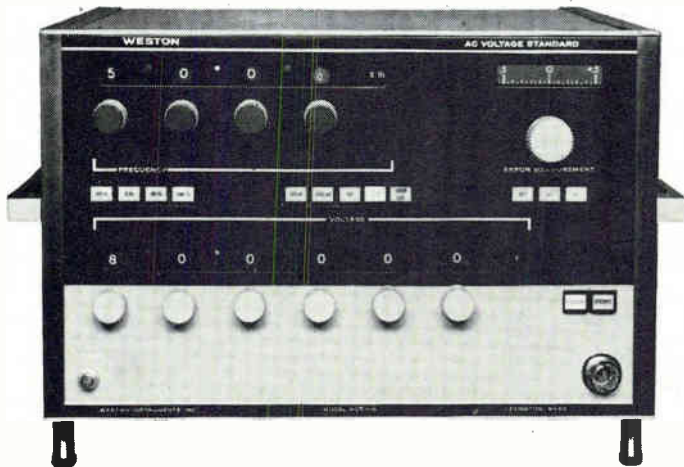
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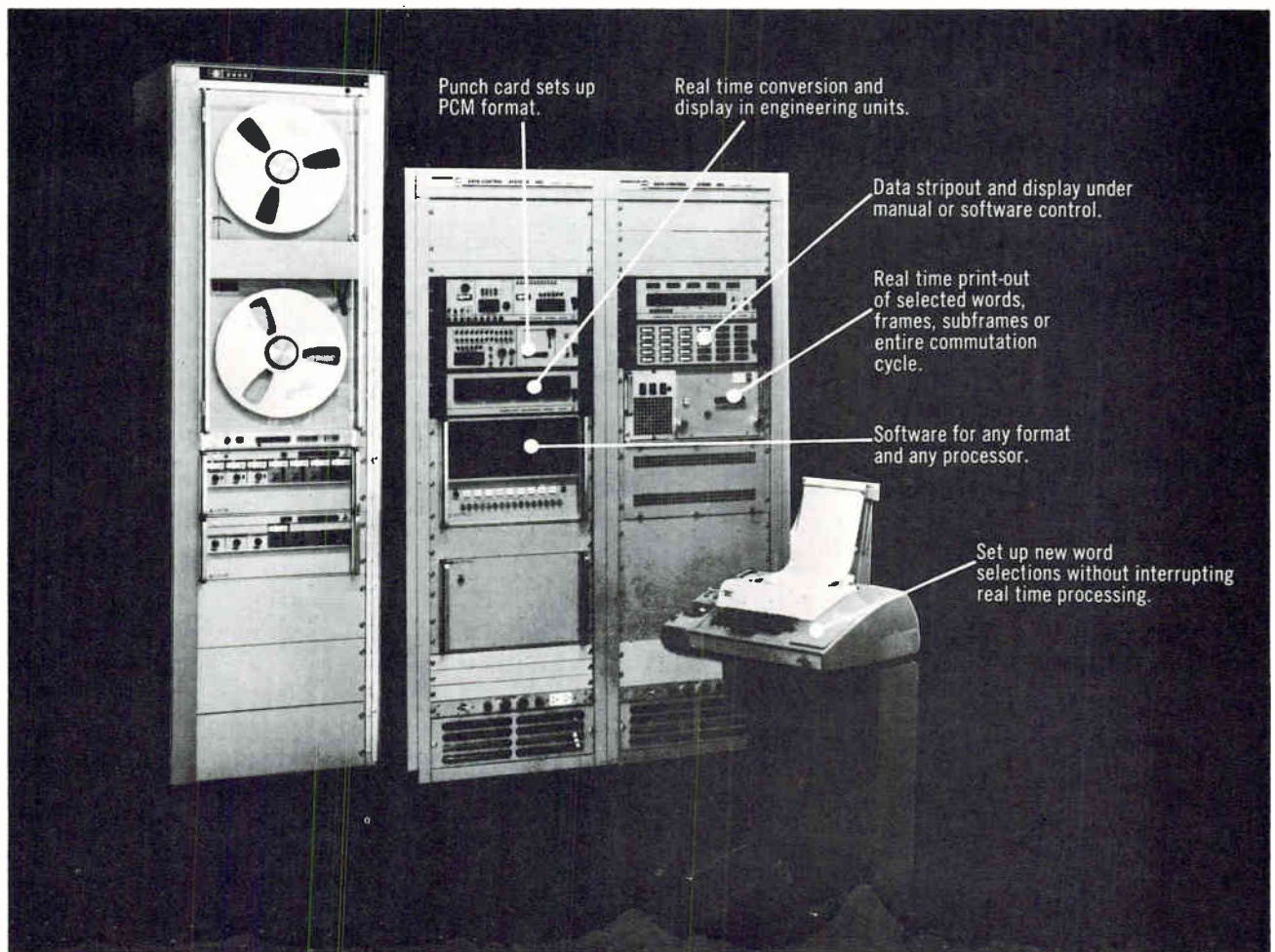
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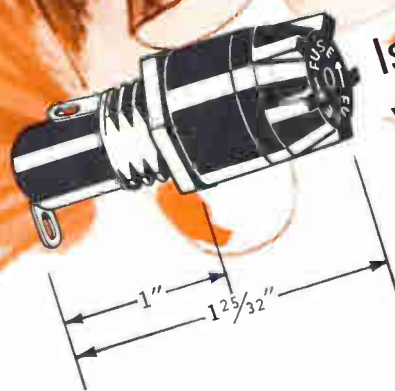


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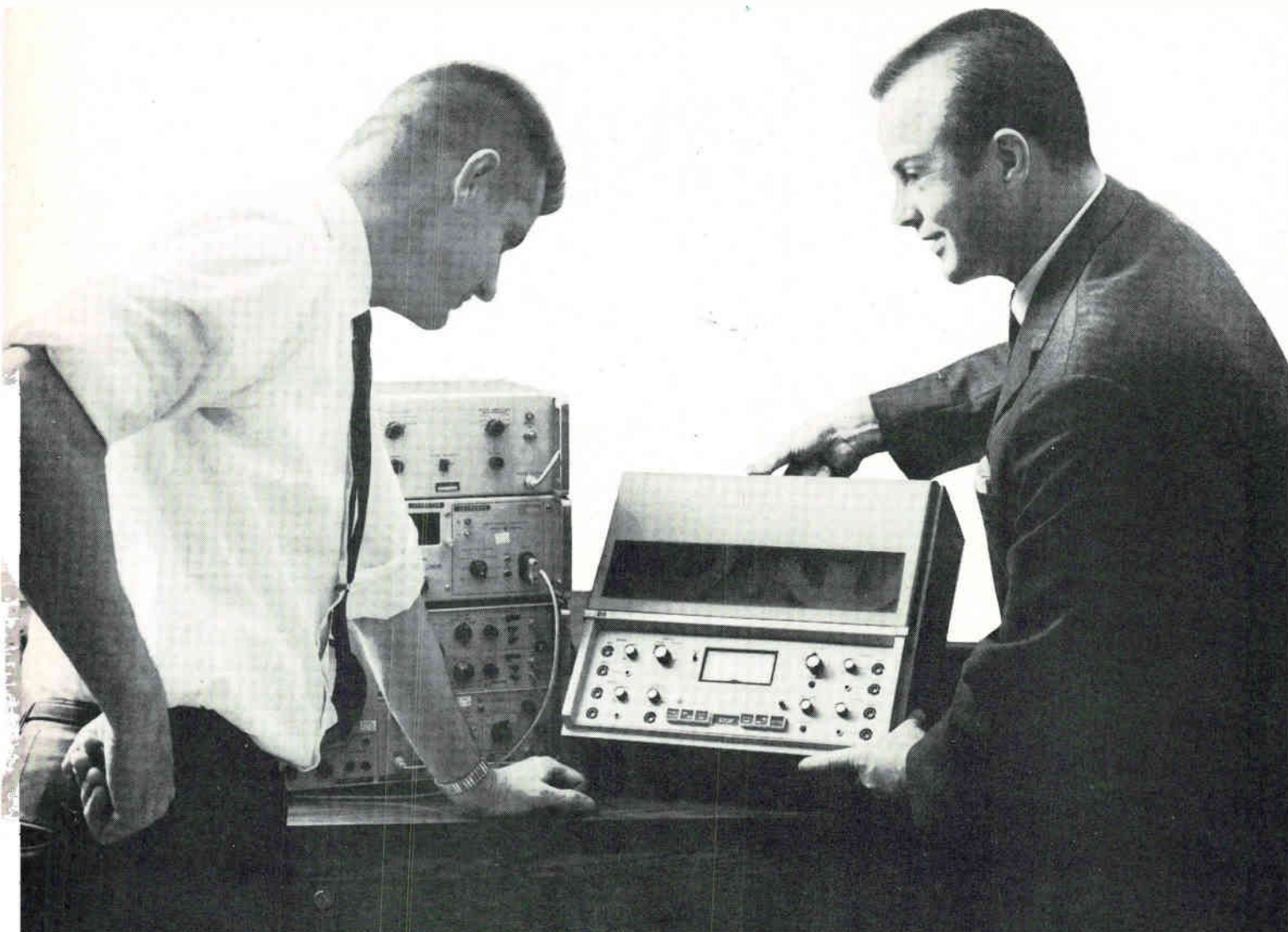
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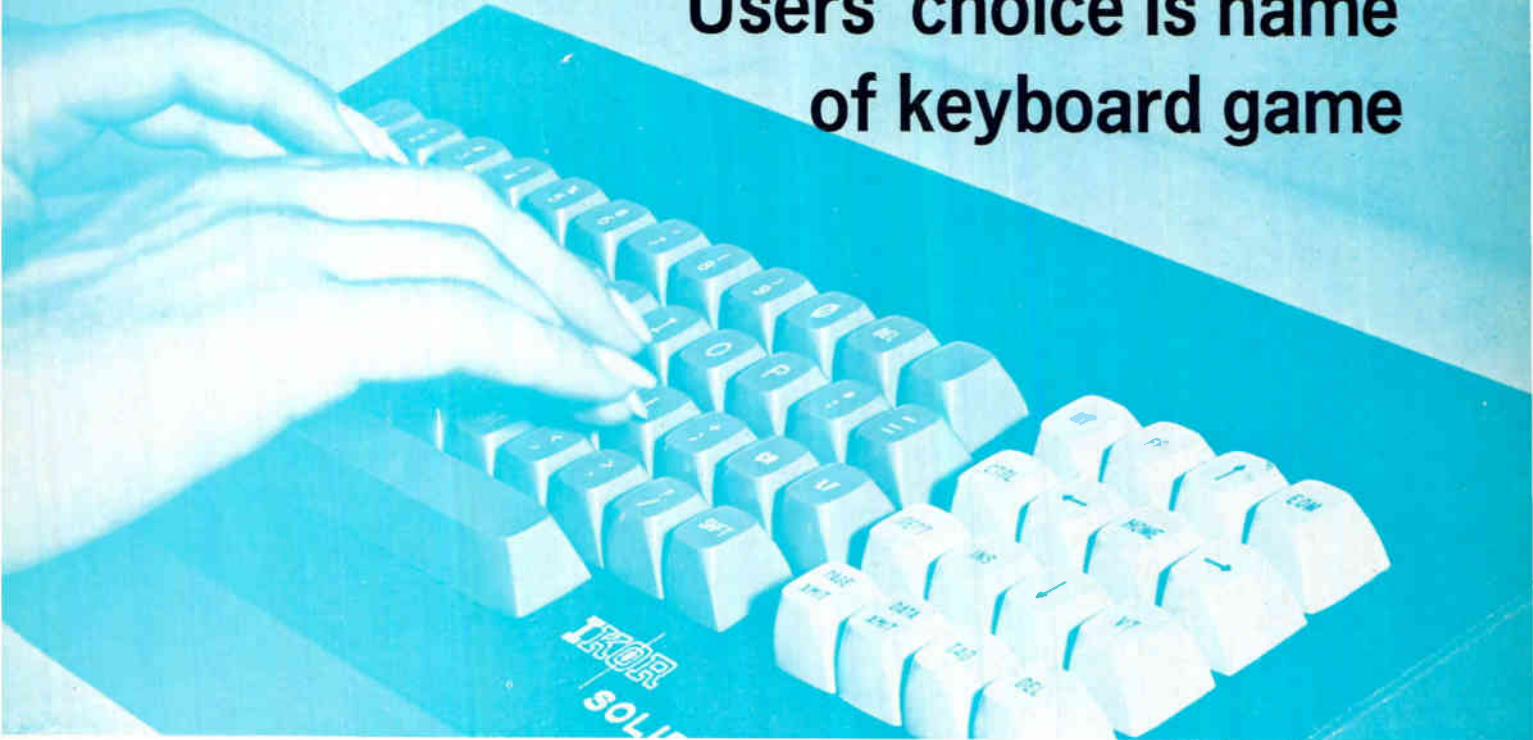
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# Users' choice is name of keyboard game



Variety of electromechanical and solid state devices with multiplicity of logic circuits offer buyer different performance, reliability claims

By Leon Magill

*Electronics staff*

**Spurred by the growth** in time-sharing terminals, the keyboard industry's expansion presents engineers with an increasingly wide choice of units for computer terminals. But although companies are claiming high reliability, they use different yardsticks to measure life-time and vary strongly in their approaches to achieving it.

Reliability primarily depends on the type of device used to obtain key closure and on the encoding circuit. Most companies are pushing electromechanical reed switches, although some strongly maintain that contactless types, such as capacitive-coupled or Hall-effect units, offer the highest reliability. But few agree on the optimum encoding circuitry; some favor diode logic while others criticize this approach for its excessive use of components and complicated

wiring interconnections.

However, the engineer at least can specify any code to the keyboard manufacturer and get the unit he wants—provided he's willing to pay the price. All keyboards now handle the American Standard Code for Information Interchange (ASCII) and many can handle the extended binary coded decimal interchange code (EBCDIC).

But even if special codes aren't designated, keyboard price remains high because of the custom nature of the business—most manufacturers don't have product lines but fill each special order as it's received.

Prices could drop in the near future if the industry booms as expected. Estimates of the present keyboard market range from \$5 million to \$10 million. William Polley, marketing manager of Ikor, Inc., sees sales reaching \$75 million

by 1975, and George L. Rice, vice president of Synergistics Inc., anticipates a growth rate of 50% a year with no end in sight.

**Old standby.** Most keyboards today use electromechanical reed switches whose contacts are in the open state. One of the big drawbacks is that reed tips may bounce away from each other as they are brought together, rebounding several times before they make contact. Wetting contacts with mercury eliminates bounce, but also boosts price, increases susceptibility to damage from shock and vibration, confines the switch to a fixed position, and slows operating speed.

Other approaches to reducing bounce include use of buffer circuitry or of strobes indicating that encoded outputs are ready to be read. KDI-Navcor Inc. installs an optional r-c network to completely



**All in one.** MOS encoding circuit replaces multitude of discrete components.

eliminate bounce. All three techniques are costly.

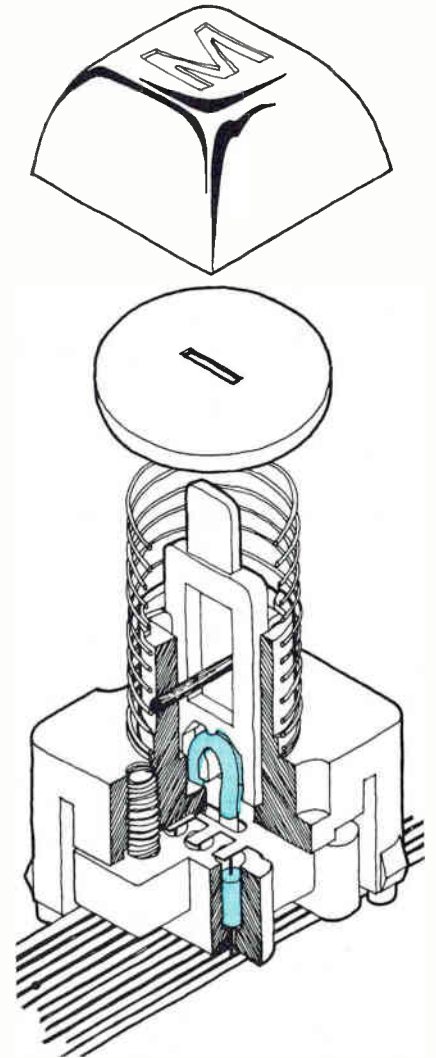
But in spite of the bounce problem manufacturers like George Risk Industries of Columbus, Neb., KDI-Navcor Inc. of Norristown, Pa., and Killian Engineering of Braintree, Mass., stick with reed switches. The newer, more exotic keyboards just don't make it, asserts Killian's marketing manager, William Bixby. "Keyboards incorporating oscillators such as proximity pickups, transducers, capacitive-coupled and magneto-resistive boards, are subject to frequency drift, while the more esoteric types such as the Hall-effect keyboard, require expensive tooling

and IC manufacture leading to the development of new technologies at the user's expense," he says.

Another approach to the electro-mechanical switch is taken by Synergistics Inc. of East Natick, Mass. The basic element of its modular keyboard is a three-part keyswitch consisting of a key, key strip, and terminal strip. The key assembly, the guts of the Synergistics keyboard, is capable of producing a 9-bit code using preset pins and a mechanical switch. A code mask is provided in the form of a plastic material to allow contact with only selected pins. The code contact comprises a stamped spring metal plate with 10 contact arms to join with the unmasked pins when the key is depressed. The key strip is a flat plastic wire with 10 conductors into which the key assembly pins are embedded to contact with the wire conductors. The pins form the contact point for the code contacts of the key assembly. The plastic terminal strip contains 10 conducting wires; the wires contact each key strip to form a given keyboard configuration.

The Synergistics keyboard is the least expensive unit on the market. The company says it keeps the price down because no printed-circuit boards are needed; there are no switch placement changes, only pin layout alterations, and there's no tooling necessary for any number of rows. Yet the reliability claimed—over 10 million keystrokes—compares with similar claims made by other manufacturers.

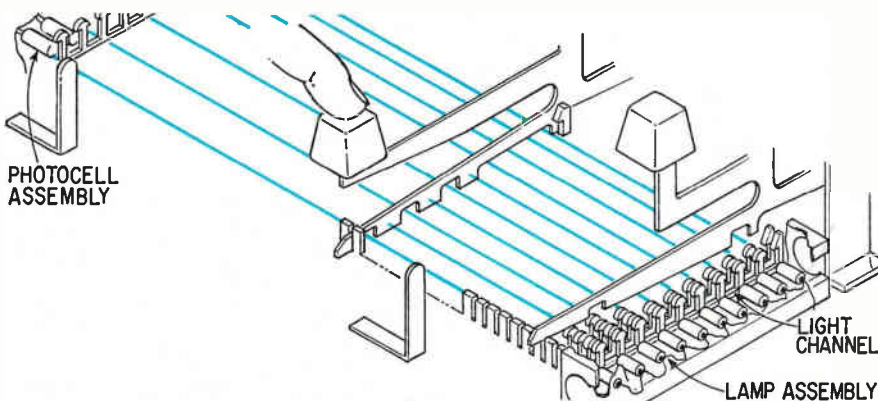
Another keying approach—taken by Mechanical Enterprises of Alexandria, Va., in its Mercutronic Coding Keyboard makes use of a



**Squeeze play.** When pinch is removed, mercury flows in tube (inverted u) and circuit is formed with diode (cylinder).

mercury movement in a sealed, flexible tube that is pinched in a normally closed position. When the key is depressed, the pinching action on the tube is relieved and an electrical circuit is formed. The key module itself is snapped into an aluminum extrusion containing a flat 11-wire cable. Diode encoding circuits are located in the key module and make permanent contact with the wires; the number of diodes in the key module determine the code for that particular key.

"This mechanical approach to the solution of an electronic problem has yielded a reliability of better than 3 million keystrokes", says Ted Watts, marketing manager of ME, adding that "There have been no life measurements on the ability of the natural rubber tube to withstand the corrosive properties of the mercury. A new silicate compound



**Beaming in.** Depressing the key allows only light beams predetermined by the "shuttered" keylever to pass, thereby forming the correct code.

## Who's offering what and at how much

Company	Keying Mech.	Logic	Max. Bits Per Key	Quantity Price	In Lots Of	Unit Price	Keys Per Board
George Risk	reed switch	diode matrix	9	\$190	1000	\$500	73
KDI-Navcor	reed switch	diode matrix	14	\$125	1000	\$350	67
Killian	reed switch	diode matrix	8	\$150	1000	\$500*	50
Synergistics	mechanical spring loaded	diodes in key	9	\$ 50	1000	\$125	50
Mechanical Enterprises	sealed mercury movement	diodes in key	10	\$ 75	1000	\$235	50
Datanetics	diaphragm switch	diode matrix	8	\$150	500	\$350	60
Micro Switch-Honeywell	Hall effect device	DTL	8	\$100	2500	\$250	50
Ikor	capacitive coupling	TTL	12	\$140	1000	\$375	67
Transducer Systems	proximity transducer	TTL	8	\$150	5000	\$500*	67
Digitronics	photo cell	photocell & op amp	14	\$325	1000	\$650	64

\*Plus non-recurring charge

is being tested for use as the mercury holding element," he says.

**Multilayers.** A keyboard making use of multilayer diaphragm mechanical switches as the keying element is produced by Datanetics of Redondo Beach, Calif. The switch is placed above three layers of plastic: the top layer has conductors in the X-direction and the bottom layer in the Y-direction, while the middle layer has holes over the conductor intersections. When the key is depressed the conductors touch, making the circuit. The epoxy-sealed p-c board switching module has two gold contacts per key to insure circuit continuity.

"The Datanetics keyboards have been tested to 14 million keystrokes without a failure" says marketing manager Jerry Satuloff, "and can stand temperatures from  $-40^{\circ}\text{F}$  to  $140^{\circ}\text{F}$  in high relative humidities.

**Hall-effect.** When keyboard manufacturers talk about the competition, the name that usually pops up first is the Micro Switch division of Honeywell Inc. of Freeport, Ill. In place of its old switch, the company employs a Hall generator on an IC chip located in the key [*Electronics*, Sept. 16, 1968, p. 169].

When the key is depressed, a magnetic field surrounds a metallic epitaxial layer on a chip of p-type silicon, whose current is perpendicular to the field. The Hall voltage, developed perpendicular to both the current and field, is in the order of microvolts. An amplifier increases this voltage to a usable level and then flips the trigger which switches the amplifier's output to the proper lines to represent the binary codes for the depressed key. E.C. Leibig, product manager at Micro Switch, says, "Since the output voltage of the Hall generator as a function of magnetic flux is linear, it is not a switch," and engineers at Micro Switch claim there's really no yardstick for life in number of keystrokes; however they have been cycled more than 100 million times without failures.

**Jury-rigging.** Micro Switch has been receiving some bad publicity recently as a result of keyboard failures [*Electronics*, Oct. 13, p. 35] due to temperature instability of the Hall-effect device and poor workmanship. But Leibig blames improper supply voltage and jury-rigged circuit boards by one customer. However, the consensus



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throughout the industry is that the Hall-effect keyboards do not live up to all the hoopla that preceded them. In fact, several large computer console manufacturers, including Honeywell's computer division, are sticking with the older Micro Switch reed keyboard.

Ikor Inc. of Burlington, Mass., is pinning its hopes on a solid state keyboard using capacitive coupling to perform the keying operation. "We aren't going to exotic techniques, but are using proven ones that offer simplicity and reliability; after all, the capacitor has been known since Ben Franklin flew his kite," says Polley. Each key is made of two metal plates, each with a specific hole pattern of from one to seven holes, producing a key with a 12-bit code capability. When the key is depressed, the plates lower into a space between a transmit bar (tied to a 50-kilohertz oscillator) and a receive bar (feeding into an operational amplifier), allowing the 50-khz signal to be capacitively coupled. The amplified a-c signal is sent to logic circuitry when the signal strength is at maximum.

"Since the keyboards don't use switches, reliability is measured as mean-time-between-failures (MTBF) and is in excess of 30,000 hours," Polley says. Manufacturers differ on standards for reliability in quoting either key cycles or MTBF, but both methods have flaws. The key cycle standard overlooks the fact that the keyboard is only as good as the most frequently used key; on the other hand, MTBF includes terminal-on time but not in-use time. The user is largely on his own determining which method is best.

**A-c excitable.** An a-c excited electromagnetic proximity transducer is the keying mechanism nucleus in a new electronic keyboard manufactured by Transducer Systems Inc. of Willow Grove, Pa. The proximity transducer, excited with a specific voltage at a particular carrier frequency, produces an output signal which is a function only of the item or material being detected and is independent of the movement speed of that item. The output response of the transducer can be improved by decreasing the air gap between transducer and detecting element. Since the keying transducers are a-c excited, a 5-khz oscillator is an integral part of the

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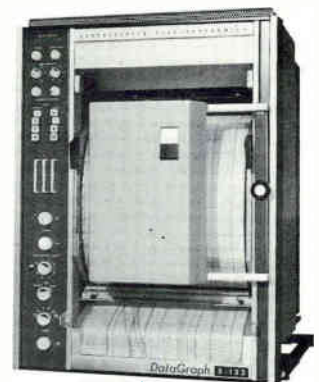
CEC 5-124



VR 3700



VR 3400



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keyboard. Even though it employs a contactless switch, TSI chooses to quote reliability in terms of key depressions—more than 200 million without a failure, it claims.

**'Shuttered.'** The interruption of a collimated beam of light is the keying mechanism method used by Digitronics of Albertson, N.Y., in its photocell keyboards. The board, available in either a 10- or 14-bit version, consists of a row of miniature light bulbs on one side of the keyboard and a corresponding row of photocells on the other. Each keylever is notched, or "shuttered," on the underside in a pattern to determine the number of light beams to be passed by that key. Depression of a particular key will interrupt specific light beams, thereby yielding its binary code. Electrical characteristics of the photocells change from 3,000 ohms in the "light" condition to 200,000 ohms in the "dark" state; the photocell output goes directly to an operational amplifier to produce a logic output at the required voltage level.

The lamps used to produce the light beams are connected in series, so a failure of one lamp will produce an easily sensed condition—all lights out. "The MTBF for the lamps is greater than 20,000 hours," says Kenneth Whitehouse, special projects manager at Digitronics. "However we are investigating the use of single, operator-removable light sources in conjunction with fiber optics. This will allow the operator to replace a light failure without waiting for the service man," adds Whitehouse.

On the other side of the coin the Digitronics keyboard requires more power than others—2.2 volts d-c at 350 milliamps for each lamp and 60 volts d-c with power dissipation up to 50 milliwatts at 25°C, derating to zero at 75°C for the photocells. The 14-bit keyboard with data strobe and mechanical interlock requires 30.8 volts d-c at 350 ma to power the logic circuitry.

Keyboard logic ranges from diode matrices to the new metal oxide semiconductor encoding packages. Included in present keyboard logic packs are diode-transistor logic (DTL), transistor-transistor logic (TTL), photocells, and diodes mounted directly in the key module.

Several reed switch keyboard manufacturers consider diode

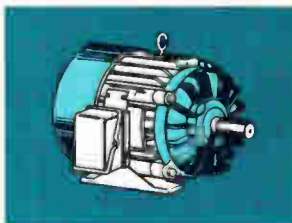
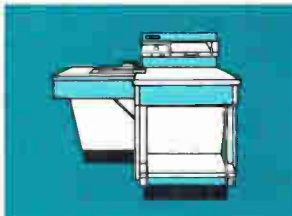
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Another **big** breakthrough from the "little relay" people

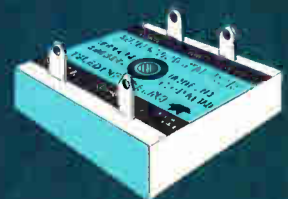
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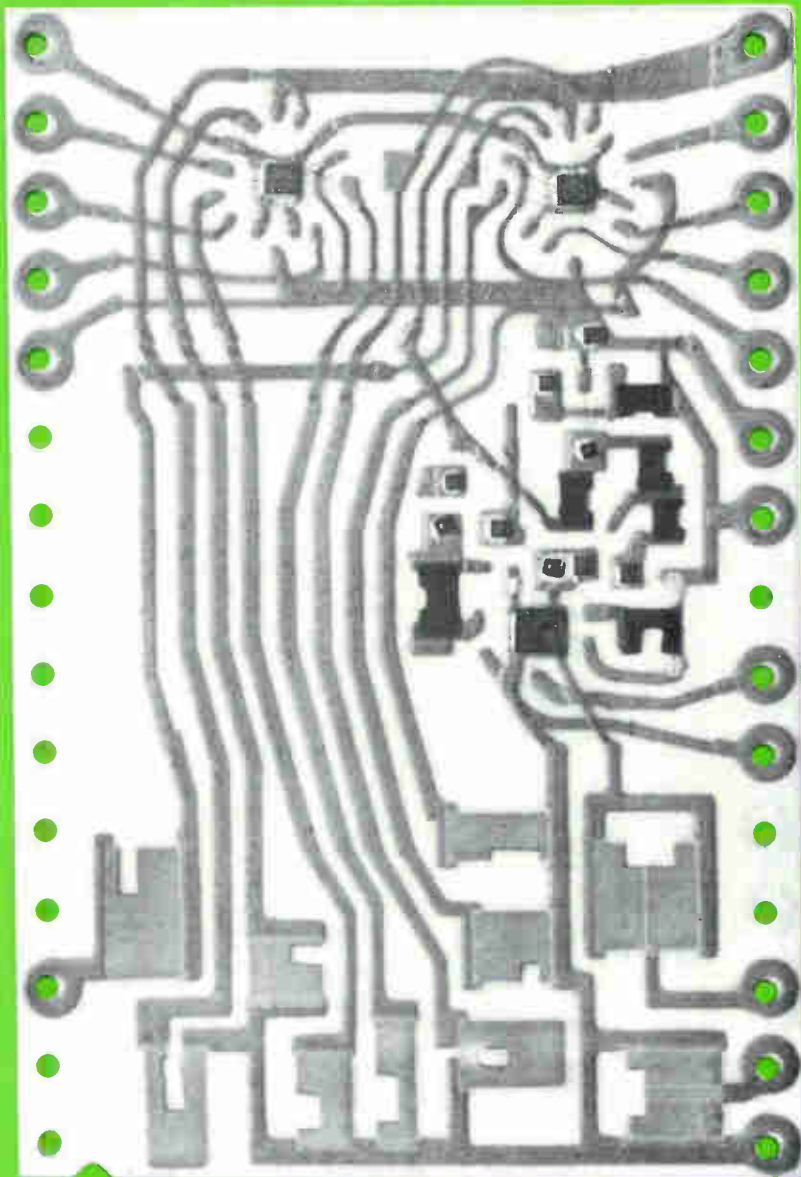
matrices the best approach to low cost and high reliability. Micro Switch does not share this point of view: its older reed switch keyboard and its Hall-effect unit utilize DTL encoding to provide the required speed at reasonable cost. However, to provide higher reliability at lower cost, they are introducing a new keyboard featuring an MOS encoding circuit enabling the operator to generate up to four levels of code from the same key. The keying mechanism still will make use of the Hall-effect device used previously. MOS will reduce the number of discrete components in the DTL pack significantly—the actual number of components replaced by MOS package exceeds 100. And fewer components means fewer solder joints, and increased logic reliability. Micro Switch is counting on Texas Instruments, producers of the MOS circuit, for the dual in-line encoding pack to be used in their new keyboards.

The new MOS encoded keyboard will go into production in 1970 and is expected to be available in volume quantities by 1971. The new keyboard, in a 50-key array, will be demonstrated for the first time this month at the Fall Joint Computer Conference in Las Vegas.

**Faster logic.** The TTL pack offers speed at an increase in cost. But the cost/volume ratio decreases as the size of the order increases, offering the big-volume user a faster logic circuit at a decreasing premium. Ikor and TSI use TTL packs to perform the encoding function in their solid state keyboards.

Finally, the photocell encoding is done without the use of diodes or special encoding packs such as DTL and TTL. Photocell output is raised to the desired level by an operational amplifier, with the binary code formed by selection of the desired photocell outputs. The photocell offers simplicity at a sacrifice in speed.

Although the keyboard manufacturers note that savings increase with large orders, the newness of most of the manufacturing companies limits high-volume production capabilities, which vary from 200 to 1,000 units per month. However, most firms, seeing which way the wind is blowing, are beginning to tool up for the anticipated large orders of the early 1970's.



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Because of its operating temperature range ( $-20^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ), Model 845 can be used for any industrial digital-to-analog conversion, process control being a typical application. Price is \$75/unit in 1-9

quantities (less in greater numbers). The package size is 1.0 inch x 1.5 inches x 0.170 inch. The unit accepts an 8-bit, parallel, binary word that is TTL- and DTL-compatible, and an enable gate is provided. Four different output-voltage ranges are available as standard models: two unipolar (0 to +5 v, 0 to +10 v) and two bipolar ( $-5$  to +5 v,  $-10$  to +10 v). Power-supply requirements are +15 v at 60 ma and  $-15$  v at 10 ma. The output accuracy is  $\pm 1/2$  least-significant bit at  $25^{\circ}\text{C} \pm 1$  mv

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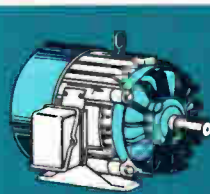
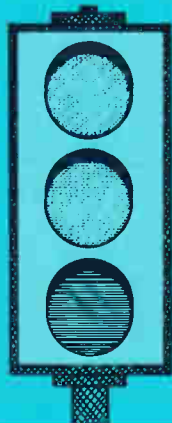
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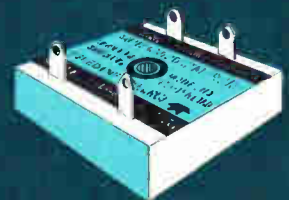
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# Worldwide system or backup —which role will Omega play?

Some advocates feel the low-frequency concept will fill most navigation needs for the next two decades; others see it augmenting present-day techniques

By Ralph Selph

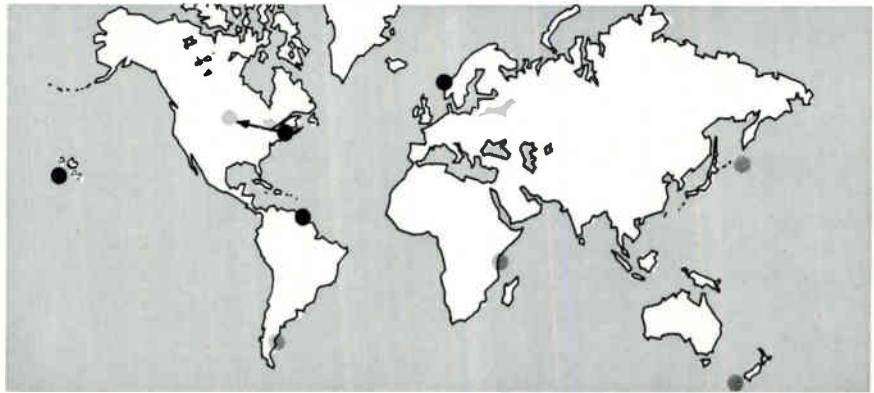
*Electronics staff*

**Nurtured by more** than \$30 million in Navy research and development funds since the mid-1950's, the Omega navigation system is coming to fruition at a time when the significance of its role is under close scrutiny by military planners and electronics firms alike. Some proponents of the system regard it primarily as a means of augmenting doppler and inertial units; other backers of the very-low frequency Omega concept see it as a relatively inexpensive interim worldwide system that can meet most navigation needs over the next 10 to 20 years until a truly global satellite system is a reality.

The military users of the system—both shipboard and airborne—want to know they're buying advantages over other navigation techniques—Loran, for example, or at least that they're getting a system that can augment the accuracy of airborne doppler and inertial navigation systems. Some potential commercial users of the system, such as Continental Airlines, want to find out if an airborne Omega receiver/computer can refine the accuracy of their inertial navigation systems [*Electronics*, July 21, p. 33], and allow them to cut costs by installing fewer inertial units.

In Omega, position is fixed by measuring the phase difference of signals from three stations. Since the signals always intersect at a relative phase angle of 0° at eight-mile intervals, it can be determined how far a ship has traveled from the last wave intersection.

Michael Turney, who is the



**Global coverage.** Worldwide navigation will be provided using only eight Omega stations. Presently, there are four operating stations located in Norway, Trinidad, Hawaii, and New York. Ultimately the N.Y. station will be moved to Minnesota, and four additional stations located in southern South America, the South Pacific, the Far East, and in the Indian Ocean. These locations insure that a ship or aircraft will always be within the range of at least three stations.

Omega project manager at Northrop Corp.'s electronic division, has strong views on Omega's future. But then his firm is prime contractor to the Navy for 140 shipboard Omega receivers and is also developing the first four airborne units for the Naval Air Systems Command under a \$1.6-million contract. Says Turney, "Today you'd have to consider Omega a backup system. But when all of the eight transmitters become operational in 1972, I think it will be the prime navigator, with inertial as a backup." Turney believes the only system likely to supplant Omega is a navigation satellite system with 100% global coverage, such as the tri-service 621B Navsat program, which has

run into many uncertainties.

"That kind of coverage involves a lot of money, and I just don't see it on the horizon," Turney asserts. A Navy study estimates the total Omega shipboard market at 20,000 units over the next 20 years; Northrop feels the airborne market will be 15,000 units between 1971 and 1980.

A number of U.S. firms either are producing Omega receivers or doing research and development on the system. ITT's Defense/Space Group Avionics division was early into the field, producing its first receiver for the Navy nine years ago. The company has a contract for 24 AN/SRN-14 shipboard and AN/BRN-4 submarine receivers. Lear Siegler's instrument di-

vision also has done development work for the Navy and Coast Guard, and is working on a low-cost airborne/receiver/computer that would sell for \$15,000 to \$20,000. Tracor Inc., a Texas firm, has delivered 50 shipboard sets to the Navy under a \$500,000 contract, and also is competing in the low-cost commercial shipboard receiver market.

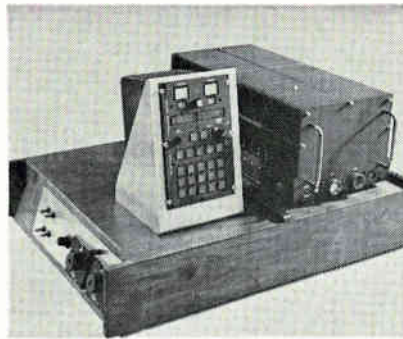
The Navy is expected to invite proposals for 800 additional shipboard receivers soon, and also will ask for bids on 500 airborne receivers, both under three-year buys. Navy officials look for refitting of their aircraft for Omega to begin in fiscal 1971; shipboard installations are already underway.

Although several hundred shipboard receivers have been obtaining navigation information from four makeshift, low-power transmitters operating in the 10.2-to-13.6-kilohertz range since last year, a real test of the system's potential must await completion of a worldwide network of eight 150-kilowatt stations in 1972.

**Looking up.** With shipboard systems already in operation, most of the attention is now focused on the airborne system. The first of a year-long series of crucial airborne Omega flight tests in military and commercial aircraft began recently when a Navy P3A Orion lifted off from Los Angeles International Airport. Aboard was the first of four AN/ARN-99 airborne navigation units produced for the Navy by Northrop. The second unit is being prepared for six months' environmental acceptance testing at Northrop's Hawthorne, Calif. plant. The other two units, to be completed in March, will be flown in a P3C Orion and other subsonic Navy aircraft. These two units will include only receivers and buffers, using the Orion's onboard Sperry Univac computer.

Flight tests are being conducted over the next several months by Continental Airlines over its Pacific routes, using a Boeing 707. Beginning in mid-March, the Federal Aviation Administration will test the system for 2½ months in a Convair 880.

One airborne unit will be installed in a submarine, the USS Lapon, for testing with a Mark 3 ship's inertial navigation system.



**Airborne omega.** The AN/ARN-99, designed and developed for aircraft navigation, includes a receiver/computer, control/indicator, and an antenna (not shown).

Northrop will use its own F-5 and T-38 aircraft and a corporate Gulfstream 2 for additional flight testing during the first half of 1970. The Air Force's strategic air command also will place a Northrop unit in a C-135 in January for four months of testing. SAC is also evaluating a Lear-Siegler airborne computer programed with a Mark 3 Omega receiver developed by the Naval Research Laboratory.

Finding the right antenna configuration has been a problem in airborne Omega development, according to Turney. To avoid introducing noise into the Omega system, it has been necessary to measure the skin currents on each aircraft to determine the best antenna position. Antenna design is also critical in airborne Omega because the signal strength may be as low as 1 microvolt per meter, with a ½ millimeter antenna effective height. This results in a ½ nanovolt receiver input that usually must be separated from 10 nanovolts of white, or noncoherent, noise.

**Key component.** An antenna furnished by the Navy has proven less than satisfactory, Turney indicates. "The antenna is oriented toward Loran and isn't optimized for Omega. It became apparent to me over a year ago that the key to the whole thing was the antenna," he adds. "We are still using the original antenna, but we're also building our own now and expect to test it before the year is out. The effective height is vastly better than that for the old antenna," says Turney.

Line noise from 400- and 60-cycle power used in aircraft poses a difficulty because it tends to creep into the Omega signals. The 400- and 60-cycle noise are subharmonics of 10.2 khz and 13 khz, two of the Omega frequencies. Although airborne Omega is supposed to be able to navigate for any aircraft flying at speeds up to 1,000 knots, Turney says ionized air from the skin of a high-speed aircraft may cause a signal interference problem.

**Answers by July.** "We expect to get answers to some of these questions by July of 1970, after flight tests in high-speed aircraft. We're attempting to obtain a French Mirage for some of the tests," Turney says. The French Navy has indicated an interest in Omega, and a licensing agreement with a French company might be in the cards, he says. Northrop already has a marketing agreement with a British firm, Marconi International Marine Ltd., for its low-cost Omega 1 commercial shipboard navigation receiver, is now operating aboard the Cunard Line's Queen Elizabeth 2, and the Challenge, a container cargo ship.

Whether production models of airborne Omega will end up as a stand-alone system or will be used primarily with inertial or doppler systems, still is not certain. One such hybrid being considered by Northrop for submission to the Air Force would mate a small 5 miles-per-hour accuracy inertial platform with Omega to achieve a 1-to-2 mph position accuracy. The cost for such a hybrid would be less than \$100,000, compared to \$150,000 or more for a pure inertial system of comparable accuracy, says Turney.

Commercial versions of airborne Omega will sell for much less than the \$50,000 price tag on military models, because less accuracy is required. According to Turney, most airlines will settle for an error of less than 5%, 92% of the time—enough to bring the aircraft within range of Vortac stations.

**Cause errors.** Because the vlf waves essentially use the ionosphere and the earth's surface as a waveguide, changes in the height of the ionosphere from day to night, together with variations in ground conductivity, the earth's



magnetic field, solar activity, and other factors can change the apparent speed of the signal and cause serious navigation errors.

In airborne Omega, propagation corrections are computed in Northrop's unit using the firm's NDC-1070 general-purpose, 16- or 32-bit computer, which has an 8,000-word memory. The propagation phenomena are mathematically modeled and contained in a 600-word real-time computer program. Besides the propagation model, which contains six more or less predictable parameters, the program includes a scatter model that uses redundant information obtained from the transmitted signals to optimize correction of the propagation prediction model. Omega researchers predict that within five years, better data on solar anomalies and weather conditions will permit position accuracy to within  $\frac{3}{4}$  mile during the day and  $1\frac{1}{2}$  miles at night; the best present accuracies are about one mile during daylight and two at night.

The Navy appears to be more enthusiastic about Omega than the U.S. Coast Guard. The Navy has begun replacing its Loran A shipboard receivers with Omega, and, depending on budgets, expects to have Loran A phased out by the mid-70's. Loran C equipment, however, aboard the large capital ships, will not be replaced, at least not by Omega. The Coast Guard, which has a different set of customers than the Navy, has no plans to dump either its Loran A or C equipment. The Coast Guard users, according to one source, range "from a Maine fisherman trying to find a net he snagged at the bottom to the navigator of a DC-8 in transoceanic flight."

The Coast Guard has been evaluating Omega receivers aboard five ships, but has not asked for funds to purchase any of the units. Navy sources say Omega's accuracy is equal to or better than that of Loran A, but not as good as Loran C (there is no Loran B). Coast Guard officials claim Loran A is accurate to within  $\frac{1}{4}$  mile; Navy sources say Loran A accuracy is more like 1 to 5 miles. Omega's accuracy has been pegged to less than 2 miles on the surface and to within 300 yards for the airborne version.

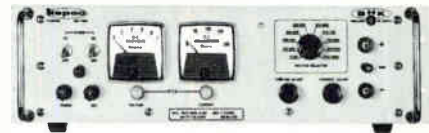
Other differences between Loran and Omega include base line lengths (maximum distance between stations), ground-sky wavelengths (distance signals can be used accurately), frequencies and number of transmitting stations. Loran A has a 500-mile baseline, 700-mile ground wave and a 1,500-mile sky wave. The figures for Loran C are 1,000-mile base line, 1,500-mile ground wave and a 3,500-mile sky wave. Omega, on the other hand, has a 5,000-mile baseline, ground and sky wave. The 123 present Loran stations operated by the Coast Guard, by foreign governments and by private organizations cover only about 17% of the earth's surface; Omega will be world-wide once all eight stations are on the air by 1972.

**Building costs.** Individual Omega station construction costs are higher than they are for Loran, but because fewer of them are needed, the total expenditure for the stations is less. Also, the Omega site location isn't as critical as it is for a Loran station, which means that the site can be chosen to minimize its cost, the cost of access roads, and a remote airstrip.

Between now and 1972, the U.S. share of the tab for fully implementing Omega—stations and equipment—is expected to be \$50 million. But many nations are eager to help with their share of the costs, because as a Navy spokesman puts it, "Omega is not peculiarly a military system, or even a U.S. system. It will undoubtedly be used by all seafaring and airline operating nations."

Overall accuracy will be improved when all eight stations are in use, because to get the greatest accuracy, the three best signals of five that can be heard anywhere in the world should be used to get position triangulation. Stations are now located on Oahu; at For-estport, N.Y.; Bratland, Norway; and Port of Spain, Trinidad. Four more are needed in the Pacific Ocean. Japan is the strongest contender, having done site studies and because it is already operating a monitoring station. Other locations being considered are New Zealand and Australia, Madagascar or La Reunion in the Indian Ocean, and Chile or Argentina in South America.

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# Unplug the computer

MONTHLY INVENTORY

TAG	AC	COST	ACQ. DATE	COST	COUF	MANUFACTURER	INV. CATEGORY	DESCRIPTION	WDFL	SERIAL	AP NO
								4 DR LETTER FILE	00194L		10503
								HIGH-LOW TEMP	100350		0047
									L#-212		00407
									00300H	00001121	00501
CF312	29	201	03-68	83.17	2	COLUMBIA	CABINET	YES' CHAMBER			00501
CF313	24	130	05-54	2,444.30	2	IFMKEY	TIME D				00501
CF314	24	130	05-54	25.45	2	LUMINITE	CHAIN				00501
CF315	29	101	11-51	48.00	2	BALLANTINE	VOLTMETER				00501
CF316	24	130	03-68	250.00	2	GEN RADIO	DRIVE	ELECTRONIC	01650A		00501
						GEN RADIO	OSCILLATOR	IMPEDANCE TEST JIG	01311A		00501
						GEN RADIO	CABINET	AUDIO	00093P	00001769	00501
						FLUXE	VOLTMETER	FILE GRAY	00230R	00000947	00501
						RESKELET	EMPT 4 THERM	DIFFERENTIAL			00501
CF317	26	130	03-68	100.00	2			MODIFICATION			40501
CF318	26	130	03-68	50.99	2						10501
CF319	29	010	09-53	175.00	2						10006
CF321	26	140	03-68	701.05	2						10003
CF322	26	140	04-68	1,687.50	1						00501
CF323	29	181	03-68	12,071.05	1	CONTINENTAL	SAB 4 FILE	SEE C5500 YEAR 1954	000100	00074137	10501
CF324	24	181	03-68	1,207.68	2	UNIVERSAL	MILLING MACH	SEE C5500 YEAR 1953	000151	00005303	10006
CF325	24	181	03-68	4,481.00	1	KEARNEY	PARTS MILLING	CENTOUR WATER	00721A	00014410	00501
CF326	24	130	03-68	738.70	2	ODALL	SAB				00501
						SELLER	ORLANDER	MANUAL STAPLER 4 -HT	0030NS		00501
									00144L		00501
									00156L	0181733A	00501
CF327	24	175	12-63	10,016.98	1	MORTON	DRILL PRESS				00501
CF328	26	140	12-63	173.29	1	ATELAS	CREATING MACH	PLAIN			00501
CF329	26	140	01-64	1,447.00	1	MORTON & SHAR	CUTTER GRINDER				00501
CF330	29	230	01-64	1,810.00	1	CINCIN MELL	NYPLING MACH				20017
CF331	29	230	01-64	1,810.00	1	AMER CHATE					20017
CF332	29	230	04-68	690.00	1	IDEAL TOOL	PUNCH	BENCH TYPE DIE FILLER	D7C475		00501
						ONEIL	SURFACE PLATE	AND OPERATOR	000393		00501
						COLLINS	AIR COND	BLACK GRANITE	0027J5	00440112	00501
								3/4 HP			20017
CF333	29	230	08-68	141.00	1						00501
CF334	29	202	03-68	225.00	1						20017
CF335	24	050	03-68	415.01	2						30501
CF336	29	170	08-68	183.90	2						30501
CF337	29	170	08-68	183.90	2						20501
CF338	29	302	08-68	143.90	2						20501
CF339	29	302	08-68	143.90	2						20501
CF340	29	300	01-64	143.90	2						10502
CF341	26	302	04-68	143.90	2						10003
CF342	24	303	05-68	143.90	2						10003
CF343	24	303	04-68	250.00	2						00101
CF344	26	307	07-68	250.00	2						00101
CF345	26	307	07-68	250.00	2						00101
CF346	29	101	08-68	205.53	2	NEW BRAND	CABINET	ELECTRIC	00131A	01707020	10502
CF347	29	101	01-64	502.23	2	BOLD STAR	TYPEWRITER	4 DR FILE GRADE 4 10	000043	00000162	10504
CF348	29	101	03-68	48.28	2	STONCREST	CABINET	WITH LIGHT	000043	00000364	00101
CF349	24	130	12-63	630.00	2	WHITEFIELD	BENCH	ATTN LIGHT	000043	00701226	00003
CF350	29	200	12-63	487.63	2	TIME MASTER	BENCHES		000043	0067410P	10005
CF351	26	030	05-68	475.00	2	WHITEFIELD	VENTILATING MACH		000100	00001119	00504
CF352	29	067	01-51	77.07	2	HEMINGTON	ADD'D		000043		00501
CF353	29	067	01-51	77.07	2	FLUXE	VOLTMETER		000043		00501
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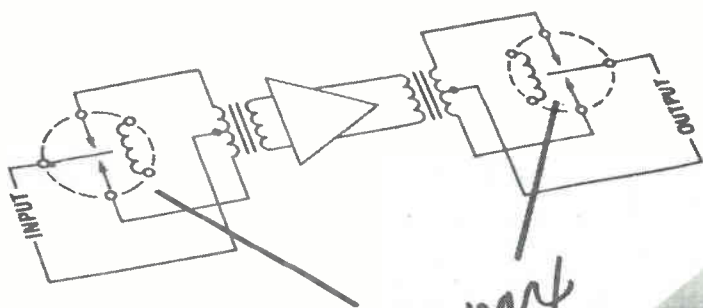
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# Self-cycling display is processor too

Versatile system aimed at builders of time-sharing equipment  
has basic price of \$6,545; will bow at Fall Joint Computer Conference

Some users of time-sharing terminals still gripe about having to employ the main computer's core memory to refresh their cathode-ray tube display, using memory space and mainframe time as well as transmission channels. For several years, firms have used devices ranging from delay lines to storage tubes at the terminals to get around this problem.

But the Imlac Corporation has another idea. Rather than using mainframe core for display refreshment, Imlac's new PDS-1 display system—to be shown at the Fall Joint Computer Conference, Nov. 18-20, in Las Vegas—uses a built-in 16-bit processor and refreshes its 14-inch alphanumeric and/or graphic display out of its own core memory. And since the basic PDS-1 includes a 4,096-word stack, and needs only 2,048 words for vector storage, there's still half the memory left for such routines as editing, formatting, verification, and standard processing.

The \$6,545 price quoted to original equipment manufacturers is well below that of many crt consoles that display only alphanumerics and have no built-in processor. Besides price, says Imlac's vice president, John M. Colburn Jr., the firm's sales pitch will be keyed to versatility. "One of our first units went to Columbia University," he says, "and the user is happy to find that he isn't a slave to the English alphabet. Through simple reprogramming, he now gets a Hebrew display." And if he wanted it, he could program for Greek, Cyrillic, or cuneiform—the PDS-1's characters all are generated through software routines.

Not only is it compatible with the alphabet of choice, but the PDS-1 interfaces with any transmission line and has a data transfer capability of up to 9,600 bauds.

The PDS-1 "just hangs on the



**Companion.** To use the computer capabilities of the PDS-1 to best advantage, a separate control console, shown at left, is required.

end of any voice grade (or better) phone line," he says; "no re-engineering of an existing system is needed to add or substitute a PDS-1, neither is added core, nor increased transmission cost."

He calls the PDS-1 the "great impostor" because it can replace "any and all on-line communications terminals—even teletypewriter installations using five-level ASCII code." He adds that the PDS-1 may be the only crt display to take the five-level ASCII character code: "While the trend is to eight-level ASCII transmission, the vast majority of teletypewriter terminals still use five-level coding."

"Interstate costs for eight-level quality conditioned lines can run to twice the price of a line good enough for five-level transmission," he says.

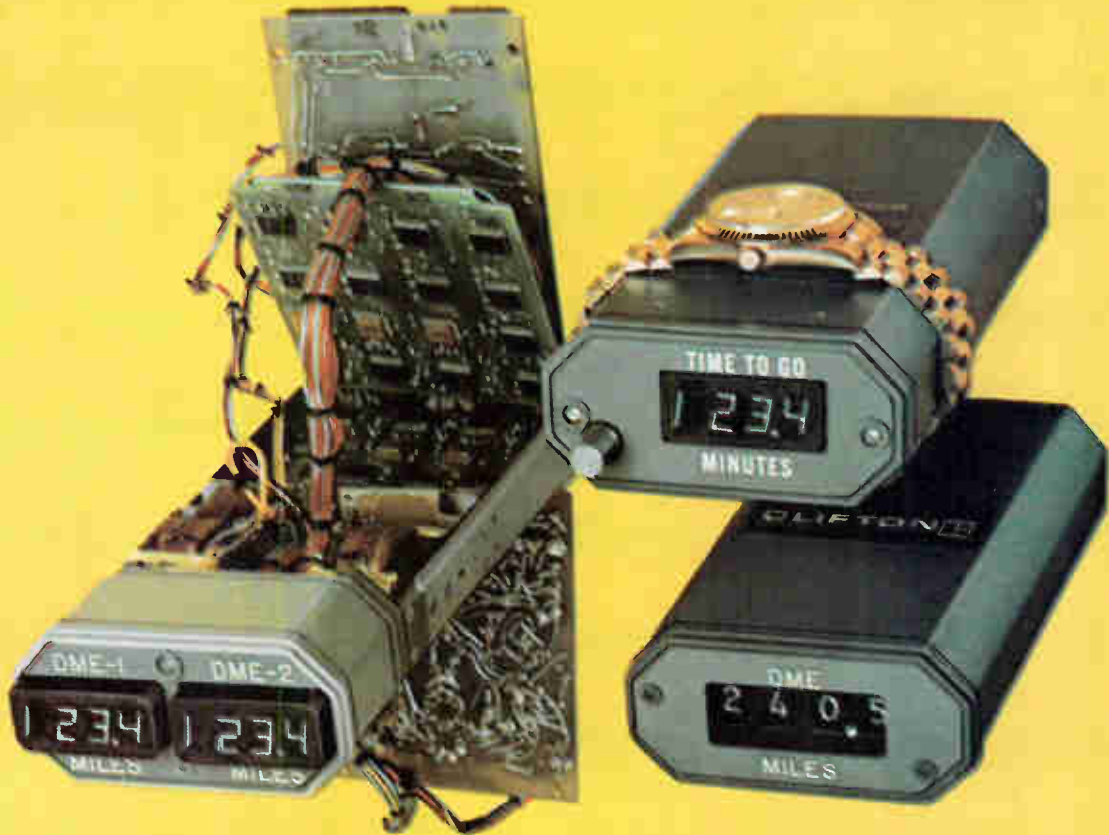
At \$6,545 in lots of 50 or more, the PDS-1 seems like a lot of hardware per dollar. James E. Cunningham, chief systems engineer and chairman of Imlac's board, is per-

haps most responsible for this. "We had to design a processor which could work without a display bias, and yet control a display as well. So we used a central processor unit—and a peripheral display processor which accesses memory through the CPU on a cycle-stealing basis. Also, we wanted the machine to be easily programmed, but couldn't see spending large amounts on hardware registers—but we do have eight autoindex registers realized in core and a general-purpose register in hardware at a significant saving in logic costs."

**Saving a bit.** Imlac also pays less for memory by buying only core stacks and diodes, then assembling the circuits it needs around the stack. Cunningham feels the modular memories now available often use logic inefficiently—to help the maker easily test the module rather than to aid the end user.

"We also avoided hardware multiply-and-divide features," says

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Cunningham. "The PDS-1 is largely aimed at applications where arithmetic speed isn't a priority. It does math in software instead.

"Finally, a 16-bit word gave a good combination of instruction set length, handy page size, and the economy of widely available 8- and 16-bit oriented hardware," he notes.

Specifications for the PDS-1's built-in processor include: a 2-microsecond cycle time; optional memory protection; input-output word rate of 500 kilohertz; optional direct memory access; single level priority interrupt; optional real time clock, and optional restart.

Medium-scale integration is used wherever practical, and more will be added as it becomes deliverable. Metal oxide semiconductor devices also are on Cunningham's purchase list, and PDS-1's architecture is designed to absorb such differing and developing logic without major production-line changes. Meanwhile, Cunningham conducts a continuing re-evaluation of available logic, seeking the next lower price level for a given amount of performance.

**Words and pictures.** Cunningham felt that a graphic capability would be necessary in Imlac's market area—and more so in time—but didn't like the combined cost of character and graphic generators.

So he uses the machine's graphic capability to draw alphanumerics too. "It's not as inexpensive as alphanumerics alone," he says, "but it beats the price of separate generators."

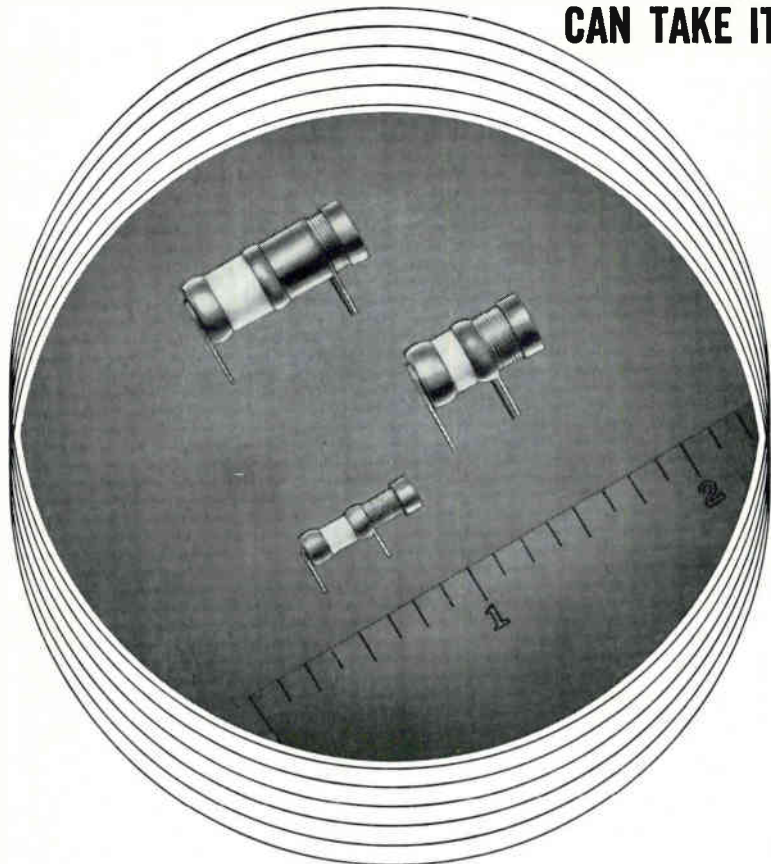
Also, this approach gives the PDS-1 its variable fonts—Greek, Hebrew, and other alphabets. Instructions for writing any symbol are pulled out of core—and even the alphanumeric dot matrix size can be changed through software from its standard 7-by-9-dot format to a faster working 5-by-7 matrix, though the display loses some definition.

Cunningham adds that instead of drawing discrete dots in its alphanumeric matrix, the PDS-1's graphic character generator connects dot positions, for improved definition.

Instead of using a hardwired unit to create vector instructions, Imlac uses push-down and pull-up

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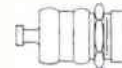
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Illustrations actual size.

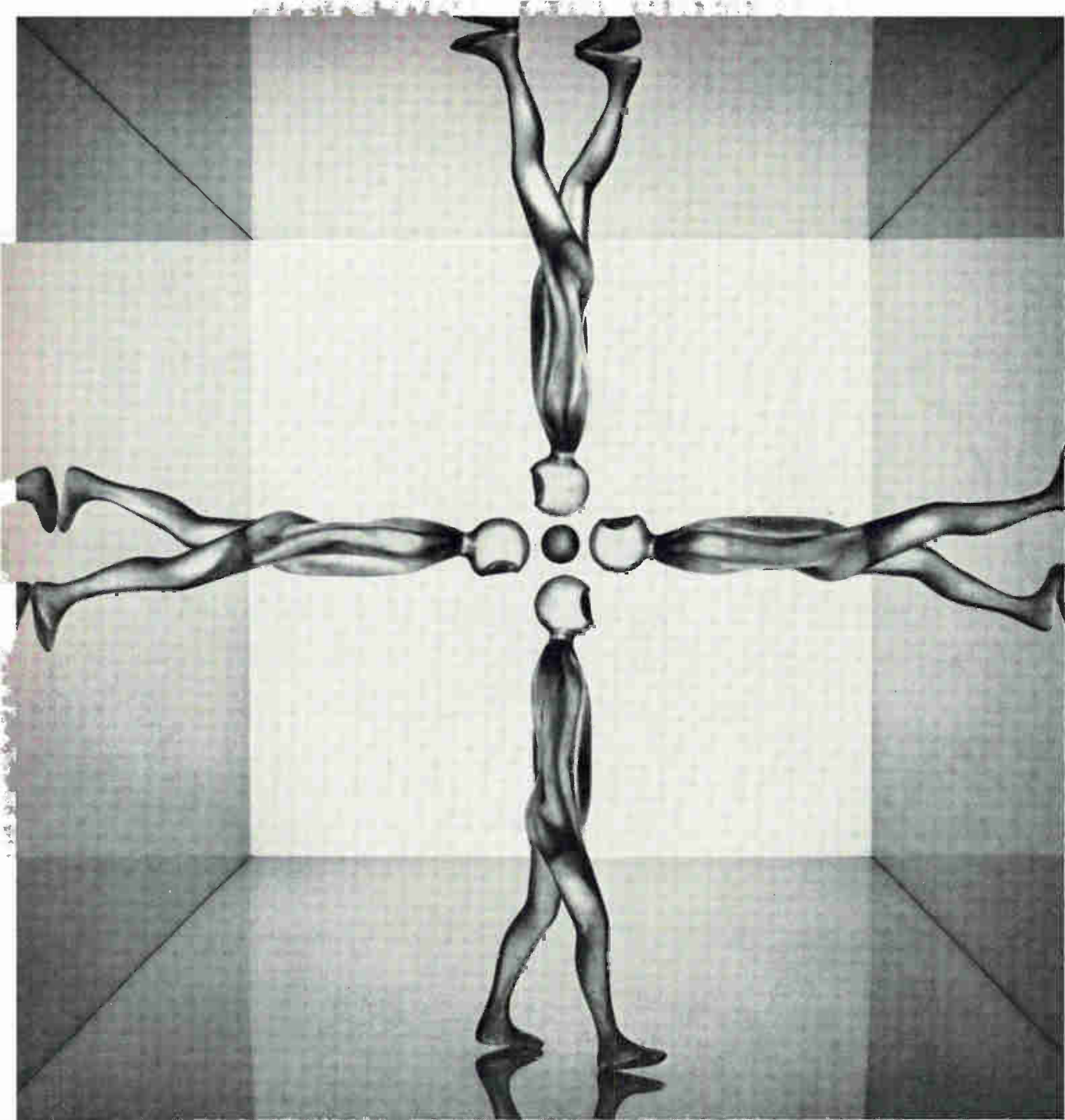
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**MARTIN MARIETTA**

lists that store vector instructions originating in software. Thus to fill a 1,040-character display frame, the display processor just moves down a list; and if on the way, it encounters a pure graphic vector instruction among alphanumeric instructions, it can treat it like any other list member.

After readout to the display computer, the lists are restored to core where they await the next cycle for either refreshment of the display or change.

The processor memory can be expanded to 32,768 words, thus the PDS-1 can store routines for a large number of jobs at a console location. And the more work done off-line, the less port time is re-

quired at the main computer, and time-sharing charges should fall off accordingly. But to use the computer capability of the PDS-1 to best advantage, a separate control console is required. This rents for \$40 monthly, or sells for \$950, or about 10% of the total cost of a single installation.

From one such control console, several PDS-1's can be controlled, creating in effect a manually operated multiprocessor. It is even conceivable that PDS-1 computers might be linked in some future system configuration into a true multiprocessor. Though Cunningham doesn't foresee this replacing large central computer systems ("some central mass memory controller

still would be needed," he feels, "and perhaps a high-speed arithmetic unit"), a PDS-1 multiprocessor system could be configured as a low-cost solution to slow-speed processor needs.

Single-unit cost of the PDS-1 is \$9,450 and includes a 4,096-word memory, keyboard, display, and computer control console. PDS-1's can be leased for \$250 to \$285 per month. Prices fall to \$6,545 each for 50 or more units similarly equipped, but without control consoles. First deliveries already have been made, and Colburn estimates an output of about 35-40 units per month by January.

The Imlac Corp., 296 Newton St., Waltham, Mass. 02154 [338]

## Modem on a card

### User's choice.

Modem card, center, is shown at right in one type of packaging for an EDP system. At left is a modem pack that includes power supply.



The company that went mod with memory systems [*Electronics*, May 12, p. 180] now has a new line of modules, called Modem Cards.

First of the new series from Sanders Associates is the Model 18A. It's said to be the only digital, asynchronous, full-duplex modem available in the 0-to-1,800-bits-per-second range, and it sells for about \$550 in its simplest form, a 7-by-9-inch plug-in card.

A 12-by-12-inch card also is available at about \$550; both modules are compatible with transistor-transistor logic, and plug into computers or peripheral equipment on 0.75-inch centers, taking power from these mainframes. Back-to-back (two-way transmission) error rates are said to be 1 in  $10^5$  bits at 1,800 bps over a phone line with a 16-decibel signal-to-noise ratio, Sanders says.

**Inboard.** With a Modem Card

module, a computer maker could replace an outboarded data set or an EIA standard RS 232B interface. And since the modules operate throughout the 0-to-1,800 bps range, they might replace two or more modems aimed at narrower speed ranges. For existing installations, Sanders will sell a modem pack—a box holding a Modem Card and the requisite power supply—for about \$750. The company will show the new line at the Fall Joint Computer Conference.

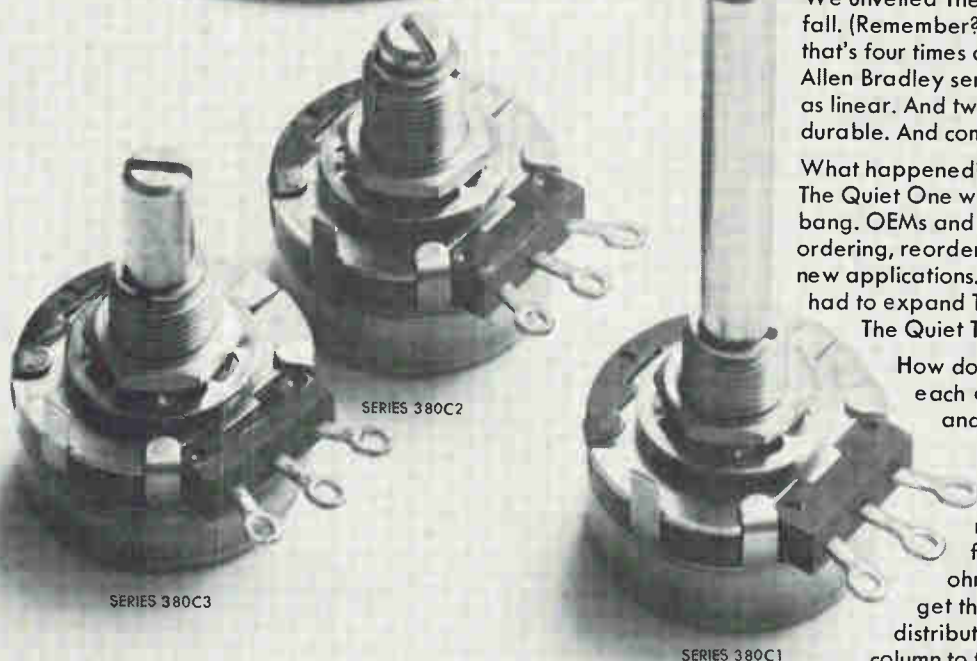
The Modem Card grew less out of a management plan than out of dissatisfaction with other firms' modems. Sanders data processing and transmission engineers needed equipment that could overcome noisy phone lines, accommodate varying transmission rates, and—naturally—be bought or built at relatively low cost.

The engineers were working in

the full-duplex mode (simultaneous transmission and reception) with frequency-shift-keyed teletype-writer signals. The modems available were analog devices, and, according to Jack R. Glover of the technical staff, each had its problems.

Error rates were higher than Sanders desired, some modems needed frequent adjustments, and false alarm rates were said to be high on others. To get around these problems, Sanders built its own in a crystal-controlled, all-digital format.

"High-speed FSK operation can be tough to achieve with low error at low cost," says Glover. He notes that at 1,800 bps, the shift from the lower to the higher of the two tones making up the frequency-shift-keyed signal is quick—a modem often has less than one cycle of a given tone in which to identify



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## CLAROSTAT

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# FET FACT

## 3N175

## 3N176

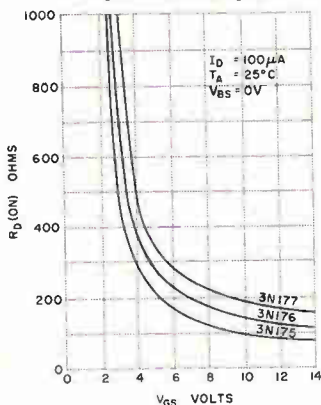
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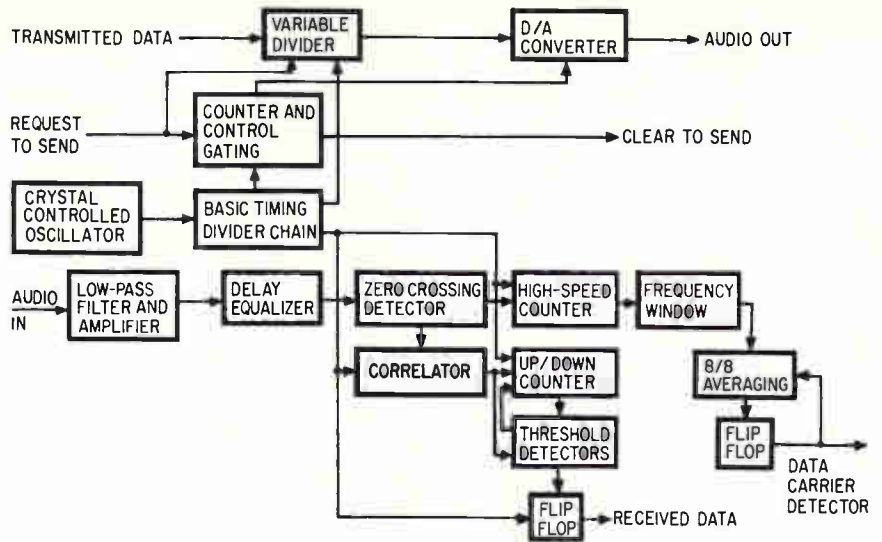
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In the beginning, A crystal-controlled oscillator, highly accurate and stable, initiates the frequency-shift-keyed tones for transmission.

it. This explains why lower bit rates generally give lower error rates with analog modems—there are more cycles with which to make an identification.

But Sanders needed 1,800 bps; at that rate, its modem would have to spot the 1,200-hertz component in about 0.6 cycle, and would have only about 1½ of a cycle's worth of the 2,200-hertz component with which to make a decision.

**Stable.** To generate their FSK tones for transmission, Sanders engineers began with a crystal-controlled 1.056-megahertz oscillator accurate to 1 in 10<sup>4</sup> hertz and stable over 0°C to 50°C. Glover claims: "Our oscillator scheme is easily 100 times more stable than that of competitors. We specify our 1,200- and 2,200-hertz signals to within ±0.01% versus ±1% for other units, High accuracy and low drift make it easier for us to detect the two tones at fast switching rates [high bit rates]."

TTL flip-flops clocking at 105.6 kilohertz divide the oscillator signal by 6 and 8 or by 11 and 8 to get the two frequency-shift-keyed output signals in response to TTL control signals from the mainframe. And these are sent to the transmission line.

On the receive or demodulation side, the incoming signal first encounters an impedance matching transformer, then an active low-pass filter—an operational amplifier that has a parallel resistance-capacitance network in its feedback loop.

It lops off undesired high frequencies, mostly noise and transients.

Then the signal passes to an active delay equalizer. This is the only adjustable part of the Modem Card, and it's only adjusted once, to match its characteristics with that of the transmission line the modem is working with. Telephone lines can have varying amounts of delay at frequencies near the edges of the audio bands they transmit, and the equalizer's job is to make delay constant over the full band.

**Clean.** From there, the sanitized signal passes to a limiter-cum-zero-crossing detector. Noise doesn't perturb the locations of zero crossings and so the limiter-detector discriminates against it.

Afterward, it's necessary only to count zero crossings to determine if the incoming signal is data. If so, the modem forwards a "data coming" signal to the mainframe. Meanwhile a correlator, an up-down counter, a threshold detector, and a flip-flop convert zero crossings into a serial binary bit stream (at TTL levels) for mainframe consumption.

Sanders also claims a 36-month mean-time-between-failure and points to the built-in loop testing features of Modem Card, among others. But the features that probably will matter most are modular convenience, 1-to-1,800-bps all-digital operation, and low error with noisy phone lines.

Sanders Associates Inc., Spit Brook Road, Nashua, N.H. 03060. [339]



Model 58364  
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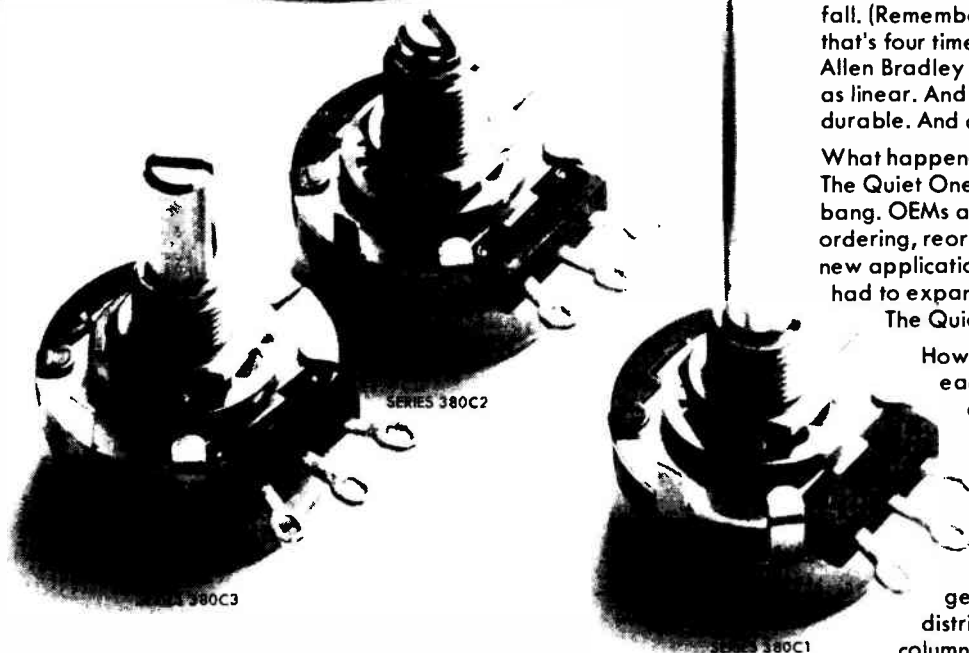


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## Data handling

# Rugged Nova in uniform

Traditionally a commercial version of a device has been evolved from a military-spec design. But the Rolm Corp. took the opposite route, making a ruggedized computer for military jobs out of Data General's Nova [*Electronics*, Sept. 30, 1969, p. 147].

Rolm says its model 1601 is more than just a rugged version of an existing computer—it is a completely redesigned machine. The 1601 is a small, general-purpose, 16-bit computer whose instructions, software, and electrical input/output circuits are identical to those of the Nova—the difference is in the options.

The 1601 employs metal oxide semiconductor read-only memories containing three kinds of programs, available as options. One of these is a binary loader that loads programs written in the Basic language into the computer's main memory. Another is a floating-point interpolator program, and the third is a system diagnostic program.

Says Ken Oshman, president of Rolm: "We can have up to 8,000 words with MOS ROM's. The Basic binary loader requires only 133 words." Oshman says the MOS diagnostics can track down 85% of any errors that can occur. "They pinpoint the bad card and in a minute or so, the system is running again."

Another difference between the Nova and the 1601 is a multiply/divide option. In Rolm's unit, a hardware multiply/divide function can be supplied. With it, multiplication of two 16-bit words takes only 10 microseconds.

Basic core memory is 4,000 words. But the 1601's power supply can drive seven more memory blocks for a total of 32,000 words. An additional 12,000 words of memory can bolt on to the back of the 1601 package in 4,000-word blocks, and the other 16,000 words in a separate case. The core memory may be intermixed with MOS ROM's which are available in 256-word increments.

Five printed-circuit boards make up the central processing unit and there are five slots available for input/output interface cards. These include digital-to-analog and analog-to-digital converters, channel controllers for direct memory access, buffer registers, and line drivers. Part of the problem in converting the Nova to a rugged computer was that the Nova used 15-inch-square boards. Aside from being too large to fit into a standard military box, they were not ridged and their thermal properties did not meet mil specs. But a unique packaging arrangement solved both problems.

For the central processing unit, five 6½-by-9½-inch boards are used. The integrated circuits are arranged in six rows, seven in each row. Before the IC's are attached, a copper heat-sink, shaped like a comb, is bolted to the board. The teeth of the comb are about ¼-inch wide, ⅜-inch high, and are spaced about one inch apart. The IC's straddle the teeth, so heat is directed out toward the edges of the boards. And because the comb is closed all around and is made from one piece of copper, it adds strength to the boards. The final assembly step is to attach a cover—an aluminum "cookie sheet"—which also adds stiffness and acts as a radiator to draw heat away from the boards.

The operating temperature range of the 1601 is -55 to +95°C. Since the 1601 and the Nova are software-compatible, Oshman points out, "You can write and de-bug programs on the Nova back at the home office and be sure that these programs will work in the field on the 1601."

Delivery for the 1601 is slated to begin by the end of February; it will sell for about \$20,000 with 4,000 words of memory and a teletypewriter interface. The system will be demonstrated at the FJCC.

Rolm Corp., 10925 North Wolfe Road, Cupertino, Calif. 95014 [340]

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*For engineering bulletins on the capacitor styles in which you are interested, write to Dearborn Electronics, Inc., Box 530, Orlando, Fla. 32802.*

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Data handling

**Kit provides acoustic terminal**

Hardware package converts teletypewriter into time-sharing station

In less than an hour, a teletypewriter can become an advanced acoustic data terminal, says the Omnitec Corp., a subsidiary of Nytronics Inc., of its model 701C, a fully asynchronous coupler kit that converts the audio tone from a standard voice-quality telephone line into error-free digital signals. All operational hardware in the compact kit fits within the standard Teletype housing, eliminating the need for external boxes and cords.

The kit allows any model 33 Teletype to operate with a standard office-type phone. After plugging the Teletype power cord into a standard outlet, the phone receiver



Conversion. Coupler on right side of Teletype transforms it into terminal.

is placed into the coupler's cushions, power turned on, and the desired destination dialed. As soon as the carrier tone is received, the unit is ready for two-way communication. The unit will be shown publicly for the first time at the Fall Joint Computer Conference, Nov. 18-20, in Las Vegas.

The full duplex operation of the coupler divorces the transmitter from the receiving circuit, and the teletypewriter can be used simultaneously for receiving one message and transmitting another. In the

# Don't buy another chart recorder... until you learn about VIDAR 5400 Digital Data Acquisition Systems

The VIDAR 5400 D-DAS™ can economically upgrade data recording where you have used strip-chart or graphic recorders. Although useful in many situations, chart recorders suffer from many shortcomings which are overcome by VIDAR systems which offer new benefits you'll want to consider:

**Relative cost per channel** — of VIDAR D-DAS is comparable to chart recorders for a few channels and much more economical above 10 channels. Chart recorders require an amplifier for every channel, but VIDAR Systems use a single amplifier with a built-in 0.003% 1-volt standard for calibration.

**Data interpretation** All chart-recorded data must be visually interpreted and translated into numerical values by people. VIDAR D-DAS gives "instant results" in numerical (digital) form that eliminates human errors in interpretation and allows computer data processing.

VIDAR D-DAS records absolute digital readings which are not subject to visual/manual setting or reading/interpretation errors. Chart recorder accuracy and human reading uncertainty produce errors ranging from 2% to 5% under the best conditions. Superimposed noise can further degrade chart trace uncertainty. VIDAR digital systems offer 15 times better linearity and produce absolute reading accuracies in the range of 0.025% to 0.2%. Data averaging (integration) eliminates superimposed noise effects.

When an event occurred or a value was reached may be very significant. Interpretation of time based on measured chart distance is subject to cumulative chart-speed errors, marking errors and interpretation errors because the chart speed is not auto-

matically recorded. The VIDAR 5400 systems eliminate these errors by recording the time with the data, or recording the data at precise time intervals.

**Dynamic range capability** — ratio of the highest to the lowest discernible value — is a measure of precision. Single-channel pen recorders may achieve 46dB (200:1), but multi-channel ones seldom achieve better than 26dB (20:1) . . . a reading uncertainty of 5%. VIDAR Digital Data Acquisition Systems provide over 80dB (10,000:1) regardless of the number of channels.


**Amplitude-ranging problems** — pen recorders require known signal amplitudes so that amplifier settings will keep each channel's readings "in scale." Not all phenomena "cooperate," and regardless of care, operators frequently find pen recorders pinned against full scale. You just can't turn your back on a pen recorder. VIDAR Systems automatically change ranges within 4 milliseconds to stay "in scale," maintaining the best accuracy range for all data channels. Range is identified in the recorded data, so there is no ambiguity or error in interpretation.

**Partnership with pen recorders** — VIDAR 5400 inputs can be connected to chart recorders to provide digital data logging on punched tape or magnetic tape to allow your computer to analyze the process or test measurements — without need for intermediate interpretation by people.

**Have the best of both worlds** — with the monitor and display options of the VIDAR data systems, you can have all of the advantages of automatic digital data logging and still observe selected data in numeric form — or on a monitor pen recorder.

## VIDAR D-DAS

**DATA INPUTS**  
Up to 1,000 channels.  
Data amplifiers not usually required.  
Systems expandable in 10-channel increments.

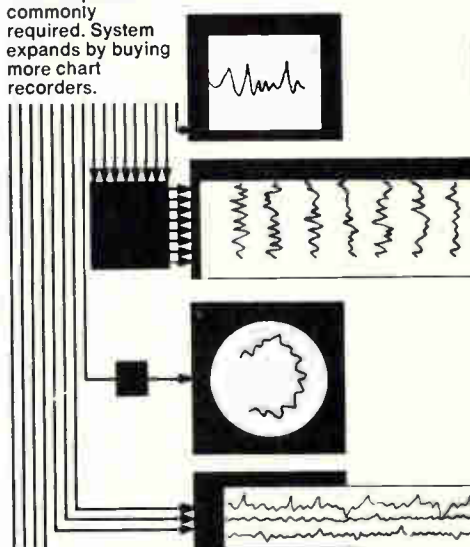


Output is digital data ready for use when the test is completed.

Punched or magnetic tape recorded data is ready for entry into a computer. Printed tape or typed page data format provides numerical data for manual computation. Accuracy is 0.025% to 0.2%. Time can be a permanent part of the record.

## CHART RECORDERS

**DATA INPUTS**  
Data amplifiers commonly required. System expands by buying more chart recorders.

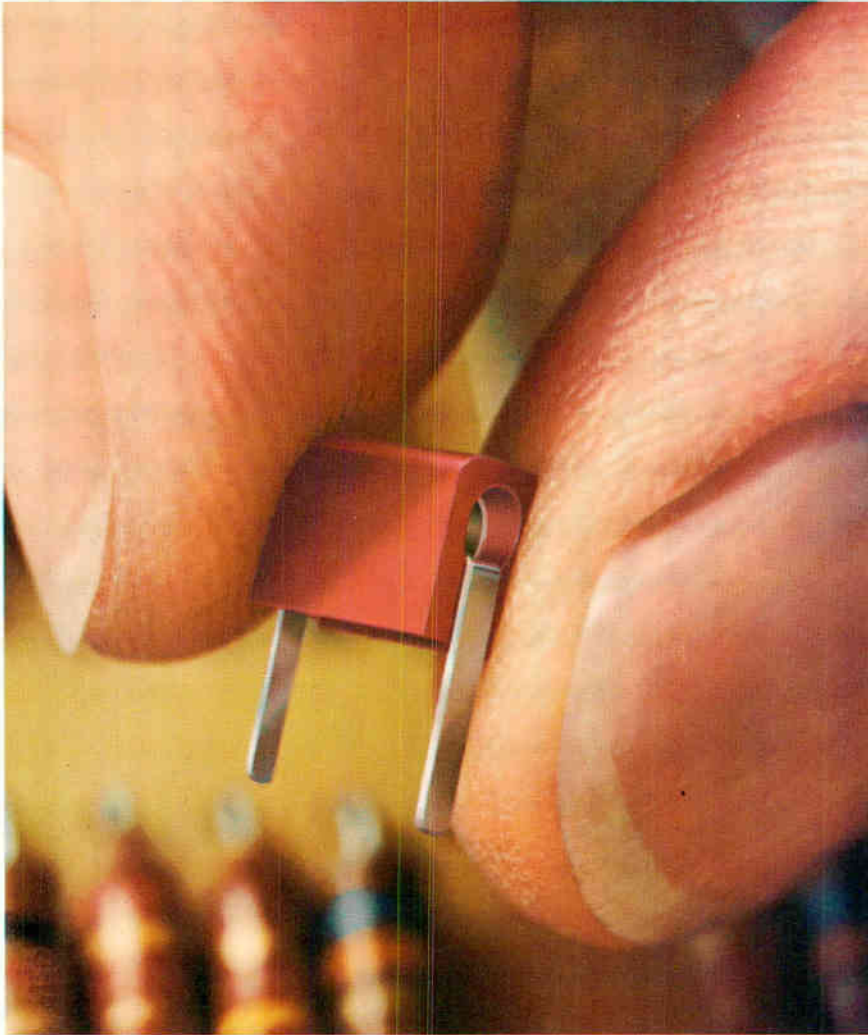



Data is not ready for use after the test run. Data traces or "pictures" must be manually sorted out, measured, and converted to numbers before any computation can be accomplished manually or with a computer.

For all the facts on VIDAR D-DAS  
versus Chart Recorders,  
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**E. F. JOHNSON COMPANY**

half-duplex mode, transmission is identical with the terminal readout. A slide switch selects the operating mode.

The 701C kits will be sold to companies supplying terminal equipment to time-sharing network users. The price will be \$345 each in quantities of 50, with off-the-shelf delivery.

Omnitec Corp., 903 North Second St., Phoenix, Ariz. 85004 [500]

## Data handling

### Acoustic terminal adds and records

Conventional tape cassette and MOS shift register keep price down on numeric unit

**Tie together** an adding machine, a cassette tape recorder, and an acoustic coupler—and what have you got? Applied Peripheral Systems, Inc., calls it the DC-4 adding machine terminal, and general manager Leslie Jasper says it's aimed at applications in which the user needs to enter numeric data at a remote site into a central collection system—say, for accounting and inventory.

Applied Peripheral's unit contains the acoustic coupler and modem, which makes the information compatible with 103-type data sets; the firm buys the standard Philips-type cassette recorder and the 10-key adding machine. The latter is equipped with a cable connection that carries data to the cassette recorder after it's dumped from a metal-oxide-semiconductor shift register, which stores the numbers until one of the adding machine function keys (plus, minus, subtotal, total, non-add), is actuated.

After being recorded on the cassette unit, the data is transmitted over the telephone coupler to a computer or central collection center for storage on computer-compatible magnetic tape.

The ASCII-coded characters are transmitted in standard teletype-writer format and speeds, using a



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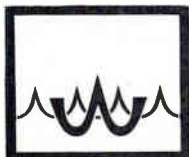
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## ... printout records system input ...

standard telephone set.

Jasper believes his company has the jump on others, which he says are just beginning to come out with equipment to perform numeric data-entry functions. For one thing, he says the use of conventional tape cassettes (instead of incremental tape) in combination with the MOS shift register, which can store 11 characters, keeps the DG-4's price down—\$1,850 vs. up to \$2,500 for similar units, one of which, he says, does not include the acoustic coupler. The DG-4 will lease for \$50 a month.

Jasper notes that the adding ma-



Tieup. Terminal for computer input consists of adding machine, cassette recorder, and acoustic coupler.

chine printout—although not unique for numeric data-entry devices—provides a record of what has been entered into the central system—a feature not always included in such devices.

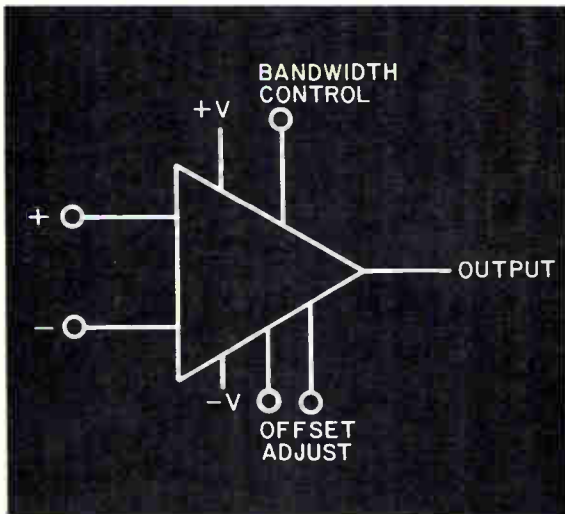
The cassette tape accommodates 33,000 characters per side—66,000 total characters for a 30-minute tape and twice that for a double-sided, one-hour tape, which is also available. Errors may be cleared, or a correction entry may be recorded.

Since the terminal is designed for accumulating and transmitting data for applications where numbers are the primary input, the company will aim at accounting tasks, the taking of inventory by merchandising outlets, and for other jobs where an adding machine is the basic tool. The terminal will be introduced at the Fall Joint Computer Conference.

Applied Peripheral Systems Inc., P.O. Box 36221, 7121 Harwin, Houston, Tex., 77036 [501]

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## FASTEST SLEW RATE



	RA 2520	RA 2510	RA 2500
● Slew Rate	$\pm 120\text{v}/\mu\text{s}, \text{Av}=2$	$\pm 60\text{v}/\mu\text{s}, \text{Av}=1$	$\pm 30\text{v}/\mu\text{s}, \text{Av}=1$
● Voltage Gain	15000	15000	30000
● Large Signal Bandwidth	2000kHz	1000kHz	500kHz
● Gain Bandwidth	24mHz	12mHz	12mHz
● Offset Current	10 nA	10 nA	10 nA
● Offset Voltage	4 mV	4 mV	2 mV
● Output Current	$\pm 20\text{ mA}$	$\pm 20\text{ mA}$	$\pm 20\text{ mA}$
● Input Impedance	100 megohms	100 megohms	50 megohms
	Non-Compensated	Fully Compensated	Stable at Unity Gain

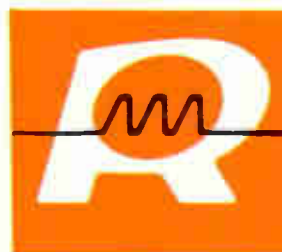
## HIGHEST IMPEDANCE

- |   |  |
|---|--|
| <p><b>RA 2600</b></p> <ul style="list-style-type: none"> <li>● Input Current = 2 nA</li> <li>● Input Impedance = 200 megohms</li> <li>● Slew Rate (at unity gain) = <math>\pm 7\text{v}/\mu\text{s}</math></li> </ul> | <ul style="list-style-type: none"> <li>● Gain = 200,000</li> <li>● Gain Bandwidth = 12 mHz</li> <li>● Short Circuit Protected</li> <li>● Fully compensated (stable at unity gain)</li> </ul> |
|---|--|

## LOWEST NOISE

- |  |  |
|--|--|
| <p><b>RA 909A</b></p> <ul style="list-style-type: none"> <li>● Equivalent Noise Input = <math>1.0\mu\text{V RMS}</math></li> <li>● Gain Bandwidth = 7 mHz</li> </ul> | <ul style="list-style-type: none"> <li>● Slew Rate (at unity gain) = <math>+5, -2.5\text{v}/\mu\text{s}</math></li> <li>● Gain = 45000</li> <li>● Power Dissipation = 52 mW</li> </ul> |
|--|--|

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Circle 176 on reader service card



# Two-gap head verifies recorded data

Unit designed for cassette-type EDP equipment checks data immediately to prevent error input to system

**Check as you go**—that's the idea behind a two-gap head developed by Michigan Magnetics for computer equipment using cassette tape recorders. The two gaps make it possible to enter data on a tape and check the entry immediately after it's written. Thus, flaws—such as dust particles or missing oxide—will not transmit erroneous data.

The head, called KRW-3, has

dual-shielding construction. This permits all four gaps to ride comfortably on the tiny pressure pad of the cassette. The shielding holds crosstalk and crossfeed levels to a point where usable verification is not swamped out by succeeding write current signals.

The dual-channel head has write-track widths of 0.041 inch on 0.070-inch centers, and read-track

widths of 0.029 inch on 0.070-inch centers. These track widths have been selected to maximize signal levels while allowing sufficient coil spacing within the head to keep channel 1 to channel 2 crosstalk to a -45-decibel level.

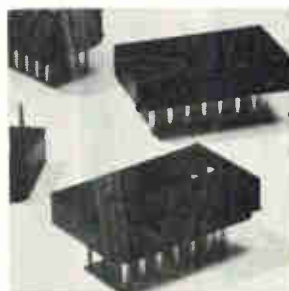
**Two levels.** Shielding is provided on two distinct planes—one is between the channels, and the other is a perpendicular one parallel to



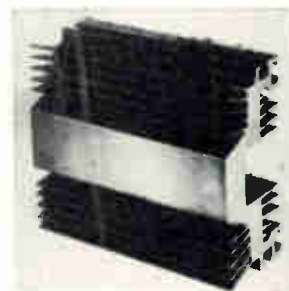
Half-size microminiature, crystal-can relays require only 100 mw pull-in. The 2pdt series is rated at 2 amps and meets MIL-R-5757E electrical requirements, while surpassing the environmental requirements. Units withstand vibration of 20 g to 2,000 hz, acceleration of 100 g minimum, and 50 g shock. Welch Relay Co., 11161 W. Pico Blvd., Los Angeles [341]



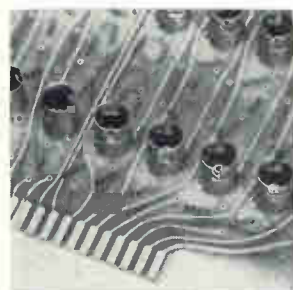
Synchronous hysteresis, heavy-duty gear head motor MA20 provides an output torque of 15 pound inches for speeds of 1/60 rpm to 14 days per revolution. It is available with optional size output shaft, anti-backlash gear train, and voltage range of 24, 120 and 240. Motor is custom built to meet exact OEM needs. General Time Corp., Route 8, Torrington, Conn. 06790 [342]



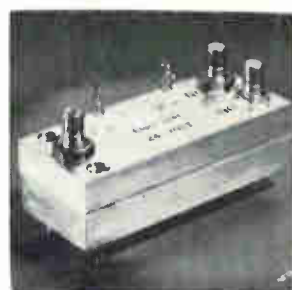
Low-profile IC-compatible connectors can terminate round conductors of up to 30 Awg into p-c boards, motherboards, backplanes and other IC elements. They can also serve as jumper blocks to switch or interconnect pins in a given IC socket by use of internal wiring. The 0.2-in.-high units are 14 or 16-pin type. Spectra-Strip Corp., Box 415, Garden Grove, Calif. 92642 [343]



JEDEC-approved, high-power heat sink model 2570 is designed for use with "hockey-puck" or flat-pack type rectifiers. The broad base provides an efficient heat transfer surface and permits secure mounting of the scr's when two such heat sinks are mounted back-to-back under pressures typically 700 lbs or greater. Astrodyne Inc., 207 Cambridge St., Burlington, Mass. 01803. [344]



Bayonet base T-3/4 lamp socket is for pcb mounting in back-lighted panel uses. The socket rests firmly and flat on single-sided 0.062 in. boards, with minimum protrusion on the back side. The units, either cadmium or gold plated, are available as component items for customer installation using conventional mounting tools. Display Devices Inc., 2nd & E Sts., Encinitas, Calif. [345]



R-f coaxial switches have spdt contacts. They switch in 1 msec, have coil resistance of 2,700 ohms for 24 v operation, and are 0.50 x 0.75 x 1.80 in. R-f characteristics are 50 ohms impedance, and insertion loss is under 0.003 db at 500 Mhz. Vswr is 1.10 up to 400 Mhz, and useful performance is to 1 Ghz. Electronic Instrument & Specialty Co., Winchester, Mass. [346]



Miniature transformers feature a frequency range of 0.1 to 700 Mhz and have insertion loss of less than 0.5 db. Impedance transformations include 50 ohms to 12.5, 25, 50, 100, 200, and 800 ohms. Six transformers are balanced with both amplitude and phase balance specified. Four units are single ended Relcom, Charleston Rd., Mtn. View, Calif. [347]



Solid state relay designated Mini-tactor model 751 is activated by a-c signals as low as 10 mv. It is suited for industrial, aerospace and military applications where environmental conditions, miniaturization or power conservation are required. It will switch up to 2 amps at 200 v rms. Price is \$25 in small lots. E.D.C. Data Components Corp., Massapequa, N.Y. [348]

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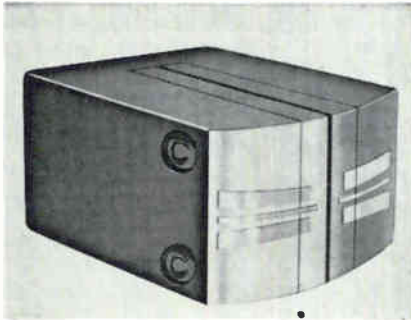


**CLARE** ON GENERAL PURPOSE RELAYS

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the dual gaps. The base of the housing is ground perpendicular to the gap planes to eliminate azimuth adjustments and to insure interchangeability of cassettes from machine to machine.

Typical specifications are 16 millivolts peak-to-peak playback voltages, when recorded with a write current of 4 milliamperes peak-to-peak amplitude at 3 kilohertz (using two flux reversals per bit with a 5 kilohm load).



Verifier. Two-gap design permits real-time check on recorded data.

Several companies including Sycor, International Computer, and Viatron have announced low-cost computer hardware designed to use the Philips cassette tape cartridges, and have been very optimistic regarding the potential sales of such equipment. It is believed by most that the equipment will be priced low enough for high-volume use of computers by small businessmen, for example. One of the major pitfalls, verification of data, will be avoided by the two-gap head, according to the designers.

Now that such a device is available there are several applications that will be possible. For example, a gas station attendant can enter the amount of oil and gas used in a day's time into a computer terminal and the data can be checked at a remote location. In addition, department stores and other small businesses may want to do their billing directly into a computer terminal and have it verified at another location down the line.

The device will sell for \$70 to \$80 in quantities of 500 or more and will be available on three-week delivery.

Michigan Magnetics, Vermontville, Mich. 49096 [349]

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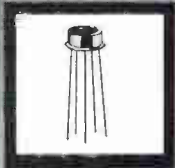
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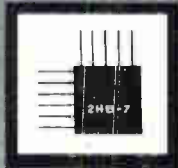
SAA 4061-2

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New components

## IC filter goes broadband

Monolithic crystal unit provides high selectivity in 0.3-cubic-inch package

Originally designed for military use in the VRC-12 mobile transceiver, a monolithic crystal filter now is available for commercial and industrial applications where a broadband, highly selective filter is required at the commonly used intermediate frequency of 11.5 megahertz.

The unit, model 6508 MA, was developed by Damon Engineering. Because of its wideband characteristics, it is not included in Damon's standard monolithic crystal filter line.

The 6508 MA is a product of computer-aided design and of advances in vacuum deposition techniques. The required geometric parameters, such as electrode size, spacing, and thickness, are determined by feeding the desired bandwidth, center frequency, and number of poles into a computer program.

Once the geometry is determined, the electrodes are vacuum-deposited on a quartz substrate in the form of circular disk resonators, with the first pair becoming the filter input and the last pair becoming the output.

The intermediate resonators are used to acoustically couple the signal. Because of the elasticity of the quartz substrate, the coupling is performed there.

"The uniqueness of the device", says Robert Kent, general manager of the division, "lies in its large fractional bandwidth of 0.3% and its high rejection of spurious signals. Small size is also a definite asset." The filter is a 7-pole design at a center frequency of 11.5 Mhz  $\pm 2.0$  kilohertz with a 3-decibel bandwidth of 35 khz minimum. The 60-db bandwidth is 75 khz maximum and the shape factor (ratio of the 60-db BW to

# THE SUPER SWEEPER



**Alfred introduces the pushbutton, programmable sweeper with up to ten different heads for complete coverage from 250 MHz to 40 GHz. (And if you already have a sweeper, we'll show you how to make your own "super sweeper").**

If you are working in a wide range of microwave frequencies, you know how much time it takes to change heads and how cumbersome it is to set up automatic programmed testing. Now you can relax.

Alfred's new multi-band sweep oscillator solves both problems and at the same time offers you all the performance proven features of the Alfred 650 Sweep Oscillator.

**Front Panel Plug-in.** For convenient head changes, the "super sweeper" offers Alfred's exclusive front plug-in design. Alfred multi-band sweep oscillators provide sweep coverage of the complete range from 250 MHz to 40 GHz or any portion thereof. Systems consist of the Alfred 650 Sweep Oscillator, any combination of up to ten 650 series plug-in oscillator units, Model 9510 Push-button Control Unit, and the Model 9511 Plug-in Container Unit. A rear panel connector can be used for remote programming.

**Calibrated Frequency Dial for All Ranges.** Read frequency directly as soon as you switch to a new range. A preset sweep range can be set independent of the 650 sweep control for each plug-in oscillator.

**So I already own an Alfred 650 and a set of oscillator plug-ins, what about me?**

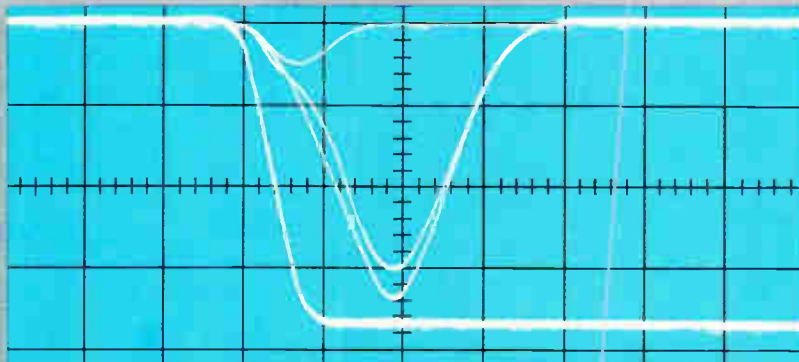
**You're in luck.** You simply buy the Model 9510 Push Button Control unit and the Model 9511 Plug-in Container Unit and make your own "Super Sweeper" just like the one shown above. Add more container units to bring the system up to its 10 head capacity.

**For more information.** To arrange a demonstration and secure complete technical information, please call your Alfred sales engineer (listed in EEM and EBG) or write us directly. Please address Alfred Electronics, 3176 Porter Drive, Palo Alto, California 94304. Phone: 415-326-6496. TWX: 910-373-1765.

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sense line noise level at 15ns rise time . . .  
delivers clean, precise drive waveforms  
and noise-free sense outputs!**



700 ma pulse amplitude (uncalibrated): Vert: 10mv/cm (core) Hor: 20ns/cm (both)

It's logical: a memory core or plated wire test output waveform can be only as good as the input. That's why we designed the Unidriver as an integral part of a test fixture. Our Unidriver is faster than the fastest memory elements, and quieter because of unique noise cancellation circuitry. So you get precise, undistorted waveforms at both input and output ends, for accurate test results. Send for literature and tell us your memory test requirements. We'll put you in the Unidriver seat.



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Circle 182 on reader service card

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## **. . . military model covers wide temperature range . . .**

the 3-db BW), which is a figure of merit of the filter, is 2.14:1. The insertion loss of the filter is less than 3 db, and the ripple is less than 1 db. The stopband rejection is greater than 70 db, and the spurious return level is specified at 55 db. The terminating impedance of the device is 15 kilohms, resistive.

The Damon monolithic crystal filter provides the circuit designer with a smaller broadband intermediate-frequency filter than was previously available in the company's discrete filter line. The new IC design, a result of thick-film technology, is also said to be less costly than comparable discrete crystal filters.

The unit occupies 0.3 cubic inch and operates over a temperature



**Spacesaver.** Wideband IC filter measures 1.25-x-0.625-x-0.35 inch.

range of 0°C to +60°C. It is priced at \$52 in quantities of 100, and \$295 singly. Delivery is scheduled at 3 to 4 weeks, with delivery from stock anticipated by February. A military version can be ordered, to cover a much larger temperature range.

Electronics Division, Damon Engineering Inc., 115 Fourth Ave., Needham Heights, Mass. 02194 [350]

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if you don't know  
you have a problem?)



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But chances are we can show you ways to improve your present process, ranging from suggesting

minor improvements up to proposing a totally new set of specifications and the mechanical changes necessary to maintain those specs on a continuing basis.

**DO IT NOW:** send us a representative sample of your process filtrate, together with a note telling us your filtering specifications and the nature of your process and product. We'll return to you an analysis report within 24 hours after receiving your test sample. There's no obligation.

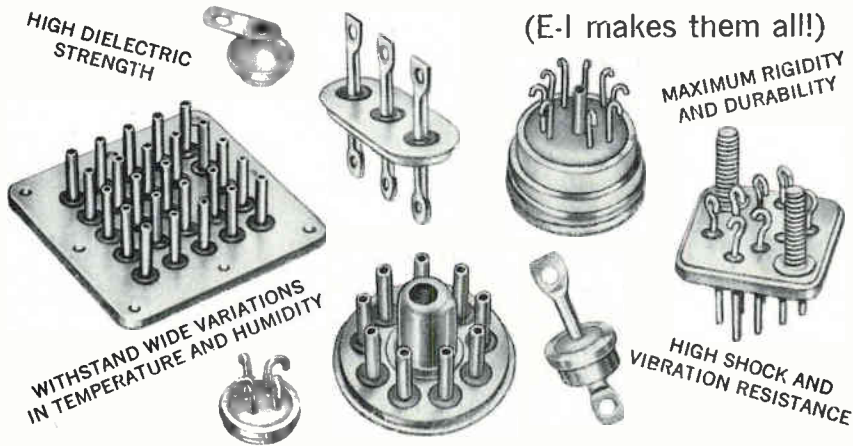


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DIVISION OF LYNCH CORPORATION

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Circle 183 on reader service card

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Plug-in Connectors  
Vibrator Plug-in Connectors  
High Voltage Glass-bonded Ceramic Seals  
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Patented in U.S.A., No. 3,035,372; in Canada, No. 523,390; in United Kingdom, 734,583; other patents pending.

New components

## 2-pound battery delivers 100 amps

Lead-acid power source has built-in charger, protected by zener diode

A lead-acid battery that weighs only two pounds but can deliver bursts of 90 to 100 amperes has been developed by General Motors' Delco-Remy division. And the battery, a spinoff of a silver-zinc unit developed for missile applications, is fully rechargeable. A simple built-in charging unit protected by a zener diode, can keep the battery on the line for an indefinite period without being damaged.

The battery, called Energette, has a spill-proof design that permits mounting in any position for greater flexibility. It's 1/20 the size



and weight of a typical automotive battery, yet it produces more than twice the number of watts per pound. The first unit, soon to be demonstrated, has a power rating of 540 watts at 14 volts. But a GM spokesman says the battery will be tailor-made to practically any standard voltage.

Applications include emergency communications facilities, military backpack equipment, television sets, and emergency lighting.

### Specification

Voltage range	6-14 typical
Current	100 a max surge
Watts per pound	257
Watts per cu. in.	9
Volume	29.4 cu. in.
Net weight	2.1 pounds
Power	540 w at 75° F

Delco-Remy Division, General Motors Corp., Anderson, Ind. [351]





# Room for improvement

General Electric's TO-5<sup>2</sup> transistor-size sealed relays give you more room for increased power, improved performance

We didn't cut any corners on this high-reliability, transistor-size sealed relay. We left them on so there'd be more room for a more powerful magnet—2½ times more powerful.

This added power means this type 3SBS, 2PDT, 1 amp relay gives you higher contact forces, larger contact gaps, and greater overtravel to minimize mechanical shifts. Shifts which usually increase early-in-life failures.

Though there's more room inside to give you all these advantages, the outside dimensions—top-to-bottom (.275") and side-to-side (.370")—are the same as any transistor-size relay.

So don't cut corners on your next transistor-size relay application. Specify GE's square Type 3SBS. For full details, write General Electric, Section 792-45, Schenectady, New York 12305.



ACTUAL SIZE

**GENERAL**  **ELECTRIC**

# Amplifier modules deliver 250-watt pulses

Units can be combined to provide 1-kilowatt output; realignment, testing unnecessary in field repair

**Ease of replacement** was a prime design consideration for a series of ultrahigh-frequency amplifier modules now being marketed by Microwave Power Devices Inc. Each module can produce at least 250 watts peak pulse power, and 120 watts continuous-wave. The center frequency is 300 megahertz with a bandwidth of 25 Mhz. They can be combined to provide powers

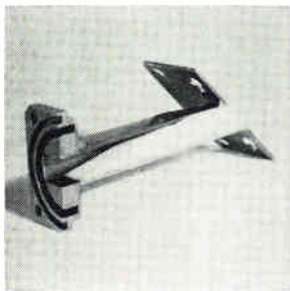
in the range of 500 to 1,000 watts, and defective modules can be replaced by semiskilled personnel with a minimum of downtime.

Each module's gain and phase characteristics are marked on it, permitting installation without realignment or testing. Simple companion circuitry controls the output over a minimum 10-decibel range while maintaining a leveled output

over temperature extremes.

A module measures approximately 0.75 inch by 1.75 inches and can be replaced by removing four screws and unsoldering three connections. A defective unit can be replaced in 15 to 30 minutes, allowing operation 99.9% of the time, according to Samuel Bayer, president of the company.

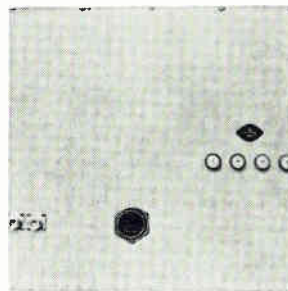
The power module of the over-all



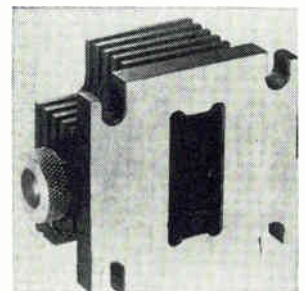
Loaded waveguides eliminate the potential for flashover from internal condensation or ice formation, without relying on pressurization and air-dryer equipment. They are designed with X-band and higher-frequency capabilities for airborne radar applications. Fabrication of copper plated directly to Teflon saves weight and space. Polyflon Corp., 35 River St., New Rochelle, N.Y. [401]



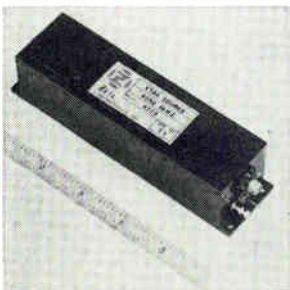
Continuously variable coaxial attenuators come in tiny packages. In both narrow and broad bandwidths, the units are available for frequencies from 2 to 12.4 Ghz. Typical maximum vswr's range from 1.5 for narrowband (20% bandwidth) units to about 2 for octave bandwidths. Power rating for all units is 6 watts, average. Solitron/Microwave, 37-11 47th Ave., L.I.C., N.Y. [402]



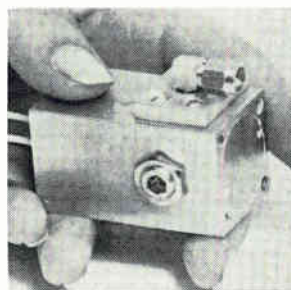
Militarized microwave synthesizer 710M provides a remotely tunable output from 1 to 2 Ghz. It is designed for system applications in a rugged environment where reliability and maintainability are important. The circuitry is packaged in functional modules with output test points for simplified maintenance. Frequency Engineering Laboratories, Farmingdale, N.J. 07727 [403]



Gunn-effect oscillators VX2020 have minimum c-w output power of 100 mw. They are mechanically tunable over a 20% bandwidth from 8.2 to 12.4 Ghz. Output power varies less than 2 db over the entire tuning range. F-m noise is less than 0.7 hz rms in a 1-khz bandwidth 1 Mhz from the carrier. Monsanto Co., 11636 Administration Dr., St. Louis, Mo. [404]



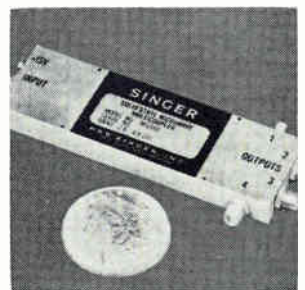
Crystal-controlled source model 4213 provides 10 mw minimum power output in the frequency range of 1 to 5.5 Ghz. Frequency stability is  $\pm 0.003\%$  over the temperature range of  $-20^\circ$  to  $+65^\circ$  C and into any phase of a 3:1 load vswr. Spurious and harmonic outputs are rejected by 60 db minimum. Zeta Laboratories Inc., 616 National Ave., Mountaint View, Calif. 94040 [405]



Microwave oscillator module C-2014 is designed for grid pulsed service at S-band. Typical applications are high data rate transponders, fusing, altimetry, and lightweight radar. Specifications include: peak power output of 1,500 w; peak plate current, 3.5 amps; heater voltage, 6.3 v a-c; heater current, 1.2 amps; pulse duration, 500 nsec. General Electric Co., Owensboro, Ky. [406]



Broadband tunnel diode detectors series D cover the 1-12.4 Ghz range. They come with either type N or miniature inputs and are available with maximized sensitivity over octave or multioctave bands. Prices for the type N range from \$75 for octave band coverage without a d-c return to \$95 with integral d-c return. Electro/Data Inc., 1621 Jupiter Rd., Garland, Texas [407]



Miniature, microstrip, transistorized multicouplers model MS2040 covers the frequency range of 2 to 4 Ghz. The octave band units provide 4 outputs from a single input with no reduction in signal level, and a minimum isolation between outputs of 20 db. Package size is  $1\frac{1}{4}$  in. wide x  $\frac{3}{8}$  in. thick x  $4\frac{1}{8}$  in. long. HRB-Singer Inc., Microwave Laboratory, State College, Pa. [408]

### MOLY-PERMALLOY POWDER CORES

16 standard sizes with ID's from .110" to 1.40", and OD's from .250" to 2.25". Guaranteed  $\pm 8\%$  inductance limits on toroids with permeabilities of 14, 26, 60, 125, 160, 200, 300 and 550. Available either stabilized or unstabilized with temperature.

### TAPE WOUND CORES

Made from nickel, silicon, or cobalt irons. We supply all AIEE standards plus special sizes in thicknesses from  $\frac{1}{2}$  through 14 mils. All sizes boxed in phenolic or plastic, aluminum or GVB-coated aluminum boxes.

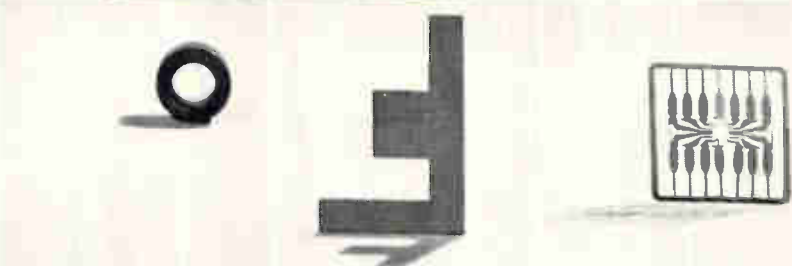


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Model 6000 adaptable to a number of jobs in the field and in the laboratory. Designed for portable and bench use. Self-contained, rechargeable, nickel, cadmium batteries.

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amplifier consists of four transistors, each capable of a 40-watt output. These are operated at approximately a 1.5/2.0:1 safety factor. Each transistor is capable of dissipating 70 watts, with a minimum derating of 2:1, resulting in long life-expectation.

The submodules, each consisting of one transistor and associated circuitry, are driven by a four-way combiner. After each submodule is gain- and phase-tracked, its power is recombined in the four-way combiner to provide the total power output.

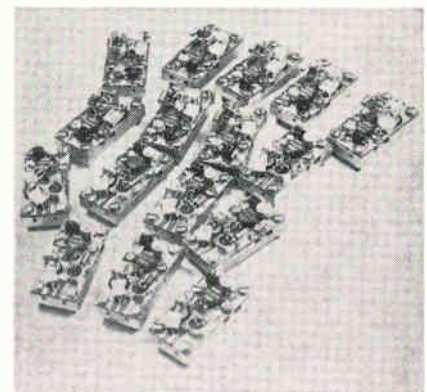
In tests, modules were made inoperative to test the effect on the over all operation. Failure of one of four submodules causes a power drop of no more than 3 db, depending on the failure modes; failure of two of four submodules causes a maximum power drop of 6 to 9 db, and failure of three of four submodules drops power 12 db maximum. During the tests, performed under operating conditions, no degrading due to the resultant mismatch conditions was detected. Replacing one submodule with another of similar characteristics returned the amplifier to normal performance.

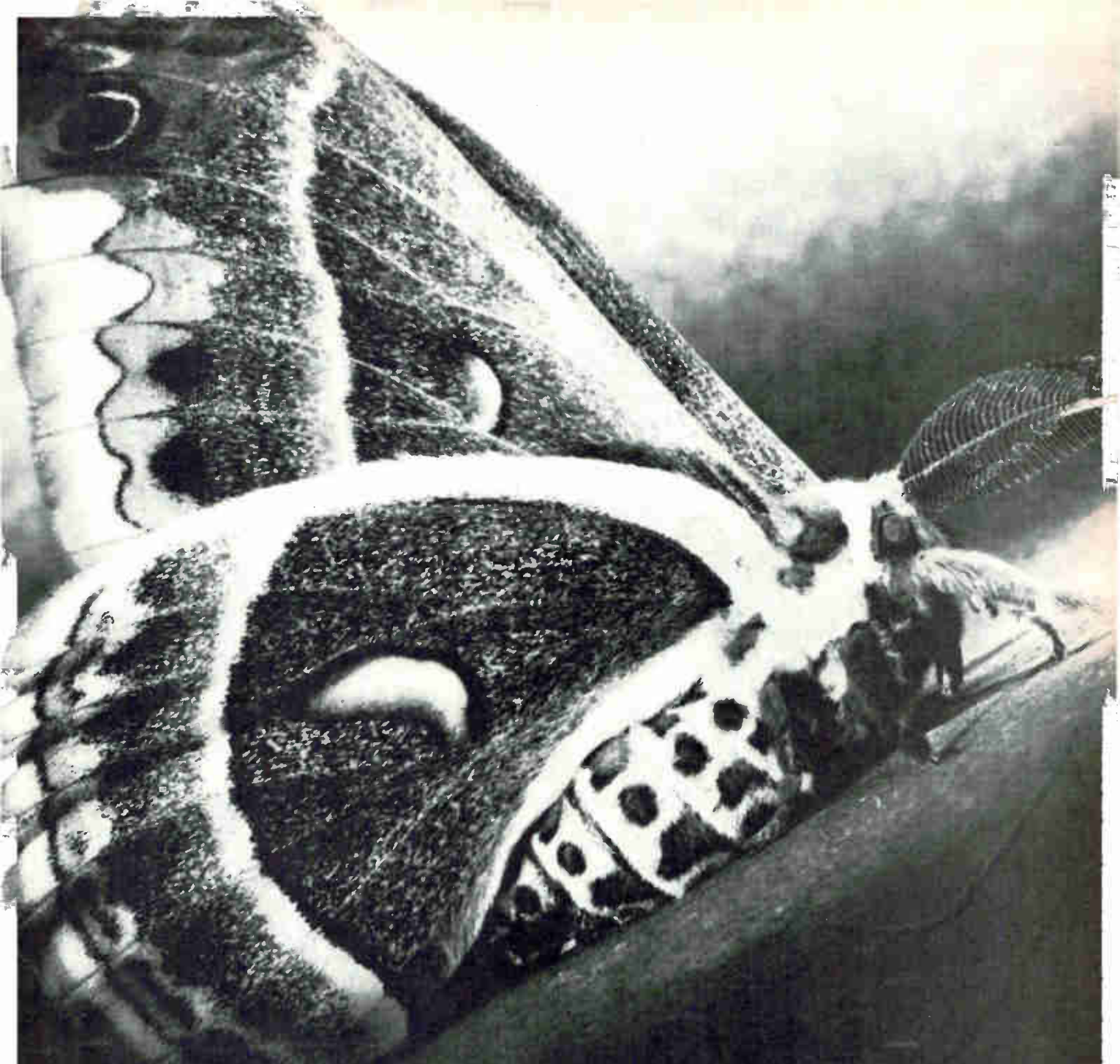
The amplifiers are intended for use in highly reliable communications circuits, covering the range from transmitter outputs through electronic countermeasures and Sonobuoy applications.

### Specifications (model 300-25-120-0.1)

Center frequency	300 Mhz
Bandwidth	25 Mhz@ 1 db points
Power Output (50 ohms)	120 watts c-w 250 watts pulse
Power gain	6-45 db, as required
Overall efficiency	45-60%
Voltage	+28 v d-c
Impedance	50 ohms
Harmonics	-20 db min
Connectors	Type N standard

Microwave Power Devices Inc., 556 Peninsula Blvd., Hempstead, N.Y., 11550 [409]





For half a century, ultrasound was regarded as a curiosity—an obscure principle employed by moths in flight. Then Branson happened. A generation of research and discovery was under way.

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pioneered. More useful because our new solid-state Powerpack generator can power an entire series of tanks, automatically adjusting frequency to a different load in each. More versatile thanks to the wide range of models, from small standard and custom units to large systems.

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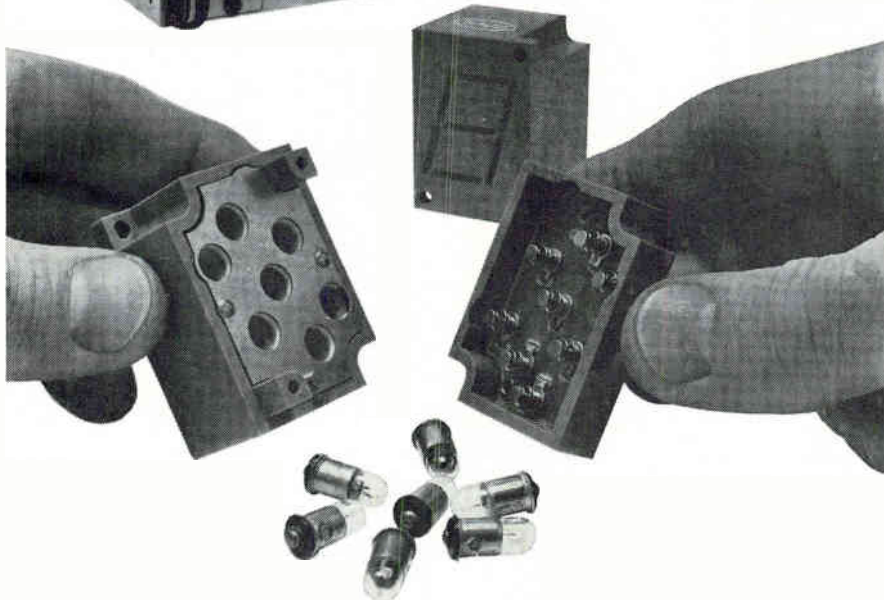
can, or cannot do for you. If that's the case, see Branson. We've had time to get our feet on the ground.

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# **DIALIGHT**

DT-126

New microwave

## **Micrometer tunes coax attenuator**

3 models initially designed  
for military applications  
cover 0.8 to 11 Ghz range

**Engineers** who require coaxial attenuators in the standard 0- to 30-decibel range for laboratory and production test applications can choose from among three new units made by the Royal Microwave Devices division of Solitron Microwave. The devices, designated models 5444, 5445, and 5446, had been aimed primarily at military customers.

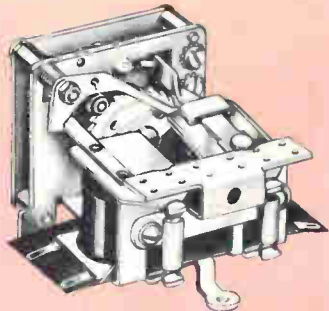
Each of the three new attenuators is continuously variable, and each can handle 10 watts average power and a peak of five kilowatts. The model 5444 covers a range from 0.8 to 2.5 gigahertz, the 5445 accommodates 2 to 6 Ghz, and the 5446 is for use from 7 to 11 Ghz. Insertion loss is 0.2 db maximum. The voltage standing wave ratio for the 5444 and 5446 is 1.5; the 5445 has a maximum VSWR of 1.3.

The attenuators include micrometer drives to vary the attenuation element loading angle, and the low insertion losses and VSWR ratings are achieved by using hand-selected, film-deposited attenuation elements. These also contribute to longer life, the company says.

Standard connections are female type N, and impedance is 50 ohms, but custom units with other impedances and frequency ranges also are available. The units are 5 inches in diameter and 1 inch high, excluding the connectors and micrometer drive. They're suitable for testing and attenuating signals from transmitters, oscillators and other frequency sources, as well as for buffering signals. Price is \$225 each or \$650 for a set of three. A company official says the price is "slightly less" than that of competitive devices.

Royal Microwave Devices division, Solitron/Microwave, 37-11 47th Ave., Long Island City, N.Y. 11101 [410]

# We Androids absolutely demand Guardian Steppers



If there's one thing a robot hates it's that embarrassing maintenance check! That's why we want long-life components built for dependable operation. Like Guardian stepping relays (some humans call them rotary stepping switches). They average over five million operations on the life-test rack.

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Circle 191 on reader service card

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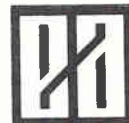
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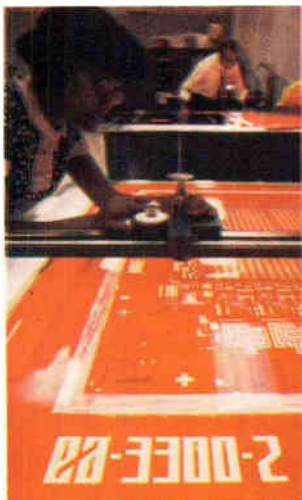
- EA 1400 64 word, 2 bits/word RAM
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# Small computer is expandable

Low-priced modular unit is software-compatible with larger machines of same maker; can be satellite, remote terminal, or stand-alone

As Control Data sees it, there are plenty of customers who need small-scale computers for business and scientific purposes, but don't want to buy a minicomputer because they might want to expand their system later on. The solution: the SC 1700. Because of its modular construction it can be expanded to any degree while still offering the basic package at small-computer

prices. And since it is software-compatible with Control Data's larger computers, the 6000 and 7000 series, the SC 1700 can be used as a satellite of the bigger systems.

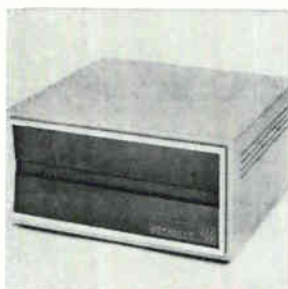
The SC 1700 doesn't markedly differ in capability or size from the 1700 model that came out in 1967—the big difference is in price. And Control Data is keeping that a secret until the Fall Joint Computer

Conference, where the SC 1700 and several pieces of peripheral gear will be unveiled. But the company says the price will be substantially lower than the \$30,000 tag on the 1700.

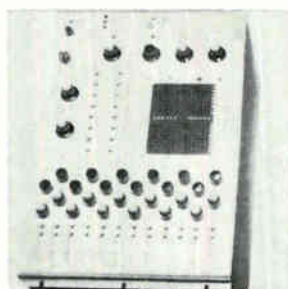
"The price difference results from the new logic circuits in the computer. We're using our own standard logic circuits instead of going to outside sources," says a



Crt computer display terminal Alpha 101 is an 800 character, Teletype compatible unit. It measures 12 in. wide, 14 in. high and 20 in. deep. It has an adjustable internal clock, making it possible to transmit data at any synchronous rate up to 2400 baud. Unit has both MOS memory and MOS character generation. Beehive Electrotech Inc., Salt Lake City, Utah. [381]



High speed modems designated the Astroset 400 series can interface with Bell Telephone's 301/303 data sets. Data transmission rates are available from 10 kilobits per sec for the series 410 to 96 kilobits per sec for the series 496. Units come equipped with built-in repeaters to increase the distance of transmission. Astrocom Corp., 293 Commercial St., St. Paul, Minn. [382]



Data generator model SQ260/280 is for versatile and high speed data generation in dynamic testing of digital devices, packages and subsystems. A 12 bit by 16 word plugboard programs the input pattern for the device under test. The SQ260 has a 10 Mhz word rate and the SQ280 has a 15 Mhz word rate. Adar Associates Inc., 85 Bolton St., Cambridge, Mass. 02140 [383]



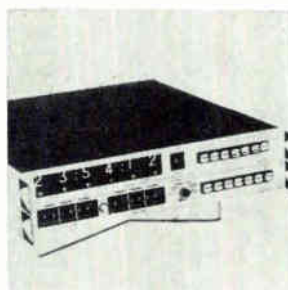
Magnetic tape transport C-200, designed around the stability of the Norelco cassette, is for digital applications. It is for remote terminal and keyboard entry, intermediate storage, as well as computer input/output and medical data acquisition. It replaces punched paper tape with faster, quieter data storage. Cipher Data Products Inc., 7545 Convooy Court, San Diego, Calif. [384]



Simultaneous data communications between 120 remote terminals and a central computer over a single voice grade line is possible with the Dyne-Com 70 multiplexer. With a synchronous line efficiency of over 80%, it can handle 6 or 7 times as many terminals as conventional time division multiplexers. Prices start at \$60,000. Dynelec Systems Corp., Glen Rock, N.J. [385]



Data collection terminal DG-3 may also be used at the computer center to collect data off line. Data is received over the telephone from a remote DG-3 and is written off line on a computer compatible magnetic tape (7 track, 556 bpi or 9 track, 800 bpi). Data tape is then mounted on computer tape drive for processing. Applied Peripheral Systems Inc., Houston [386]



Tape search and control system, occupying 3½ in. of panel space, is comprised of a model 9300 time code generator-reader and a model 9240 tape search and control unit. During periods of data acquisition the system supplies serial hours, minutes and seconds in the IRIG B format on a 1 khz sinewave carrier. Datum Inc., Liberty Ave., Anaheim, Calif. [387]



Interface unit 114A converts line voltage command signals to TTL or DTL logic levels. It performs the direct interface between IC logic and machine tool control circuit. Immunity to false actuation in either the "1" or "0" state is incorporated. Unit will not actuate on any noise signal up to 3 msec duration. Price (1-10) is \$19.50. Flight Systems Inc., Mechanicsburg, Pa. [388]

# NEW VACTEC



## Hermetic TO-5 Vactrol Photon Isolators

Vactec's new photocell-lamp control module is filled with clear flexible resin to provide high vibration immunity. It is hermetically sealed in a TO-5 enclosure, and available in low voltage (incandescent) and high voltage (neon) types.

These devices are widely used for signal isolation, audio level controls, SCR and triac turn on, and noiseless switches. They are priced less than \$1.25 in 1,000 quantities for some models. Write today for Bulletin PCD 4C3.

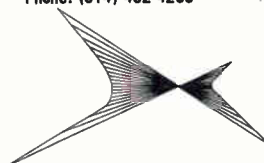
### Specifications at 25° C

Minimum off resistance	10 <sup>7</sup> ohms
Cell voltage max.	150 V.
Cell dissipation	100 MW.

Part Number	LAMP		PHOTOCELL		
	Voltage max.	Current (ma)	Max. ON (ohms)	Ascent Time ms	Decay to 100K ms
VTL1A1	1.5	50	400	80	350
VTL1A2	6.0	40	200	75	400
VTL1A3	10.0	14	800	60	150
VTL1A4	12.0	25	250	120	500
VTL1B5	*150	1.2	1000	80	65
VTL1B6	*90	.3	5000	6	50

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company official. "This provides us with a considerable savings and is advantageous to our customer because he goes right back to Control Data for repairs and extra parts whenever he needs them."

The chief difference between the new model and its predecessor is the memory cycle time—the SC 1700 is a little bit slower at 1.5 microseconds, compared to 1.1  $\mu$ sec for the 1700. However, memory capacity is the same. Core memory contains 4,096 18-bit words which can be expanded to 32,768 words in increments of 8k, 16k, and 32k.

Slanted toward applications encompassing scientific computing, industrial control processing, high-speed data acquisition, and hybrid applications (analog-to-digital conversion), the system can include various pieces of peripheral equipment. Among some of the attachments that Control Data offers are drums, disk packs, magnetic tapes, teletypewriters, printers, card readers and punches, optical character recognition equipment, and cathode-ray tube displays for alphanumeric readout and graphics.

The customer will have the option of using the computer as a small satellite scientific or business data processor for the larger Control Data 6000 and 7000 series computer systems; a data collection concentrator; a remotely programed terminal for large computing systems; or as a stand-alone system for process control, graphics, and automatic testing.

Control Data Corp., 8100 34th Ave., So., Minneapolis, Minn. [389]

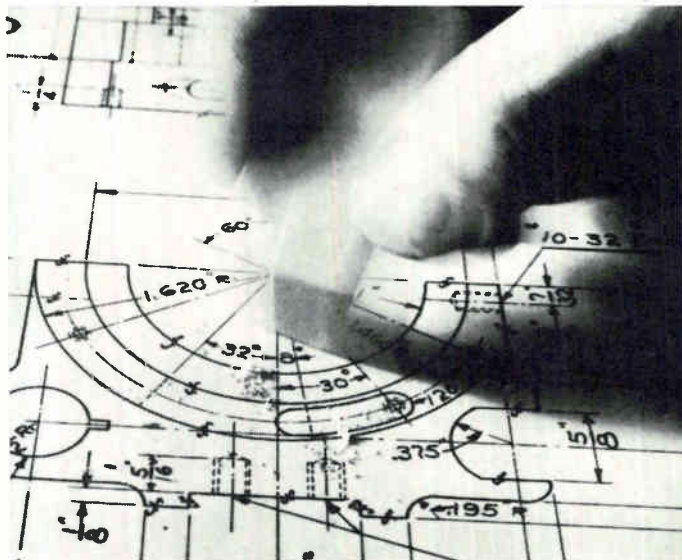
### Data handling

## Microfilm printer takes direct route

Dense alphanumeric storage provided at low cost; conversion is eliminated

Microfilm and computers have been teamed up before, but to put computer output on film, expensive digital-to-analog converters and

# RUB-OUT PROOF



**After as many as 10 changes,  
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That's right. KODAGRAPH ESTAR Base Films have surface toughness that stays ahead of your eraser. This rugged matte drafting surface retains its "tooth" under repeated same-area changes, and always maintains its smooth acceptance of your ink and pencil lines.

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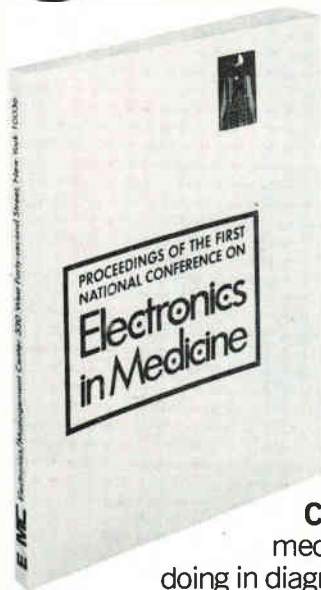
They're easier to handle and correct. For example, KODAGRAPH Wash-Off Film wet-erases in seconds with a drop of water and a few swipes of your eraser. And it's so easy to process; you can count on getting your prints back faster than ever before.

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**Kodak**

**DRAWING REPRODUCTION SYSTEMS BY KODAK**

# What happened when doctors and engineers got together:



Doctors told engineers how they were using electronics and revealed their most urgent needs. Engineers described and demonstrated their newest equipment for diagnosis, treatment, and prevention. And hinted at things to come.

Their complete dialogue, with illustrations, makes pretty informative reading on a vital and growing market.

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cathode-ray tubes were required. The Memorex Corp. has eliminated the need for these devices in a new computer-output microfilm device that employs a light-emitting diode matrix.

Designated the 1603 microfilm printer, the device is hardware- and software-compatible with IBM 1403 and 1443 line printers, and operates as a standard peripheral with the IBM 360 model 25 and above. The 1603 prints out 10,000 132-character lines per minute—10 times faster than line printers.

According to Laurence Spitters, president of Memorex, "The 1603 will cost about half as much as other microfilm printers because it has a control unit that allows it to interface directly with IBM data channels. Other printers require converters." As an example, Spitters cites a Stromberg-Carlson system that sells for \$100,000; the 1603 will sell for \$44,250 or rent for \$895 per month.

Three major components are used to generate the output characters: a translation matrix, a bank of light-emitting diodes, and a fiber optics bundle. Digital signals from the computer are decoded by the matrix and directed to the proper diodes, where light then is piped to a lens assembly by the fiber optics bundle. The entire assembly is aligned and sealed at the factory and never needs adjustment.

Maintenance also is easy on the 1603 compared with other microfilm units or even standard line printers. The 1603 doesn't have the mechanical complexity of a line printer or the electronic adjustments of a crt or electron-beam recorder system. The only moving parts are the shutter and the film transport, and since the film moves at only six inches per second, the mechanical system is kept simple.

The 1603 uses 16-millimeter microfilm, supplied in cartridges that hold 500 feet of film—enough for 80 minutes of continuous output, or about 12,000 pages of fan-fold paper printout. Spitters says that paper-printout costs about 0.5 cent per page for single-copy paper, or about 0.8 cent per page for carbon paper, but the microfilm costs only 0.04 cent per page.

Delivery will begin in early 1970.

Memorex Corp., 1180 Shulman Ave., Santa Clara, Calif. 95050 [390]

# The non-catalog connector.

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Tell us how many positions, how many contacts. And what kind of shape it ought to be in.

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As a result, our contacts are the best you can buy. (Maybe that's why many of our competi-

tors use them.)

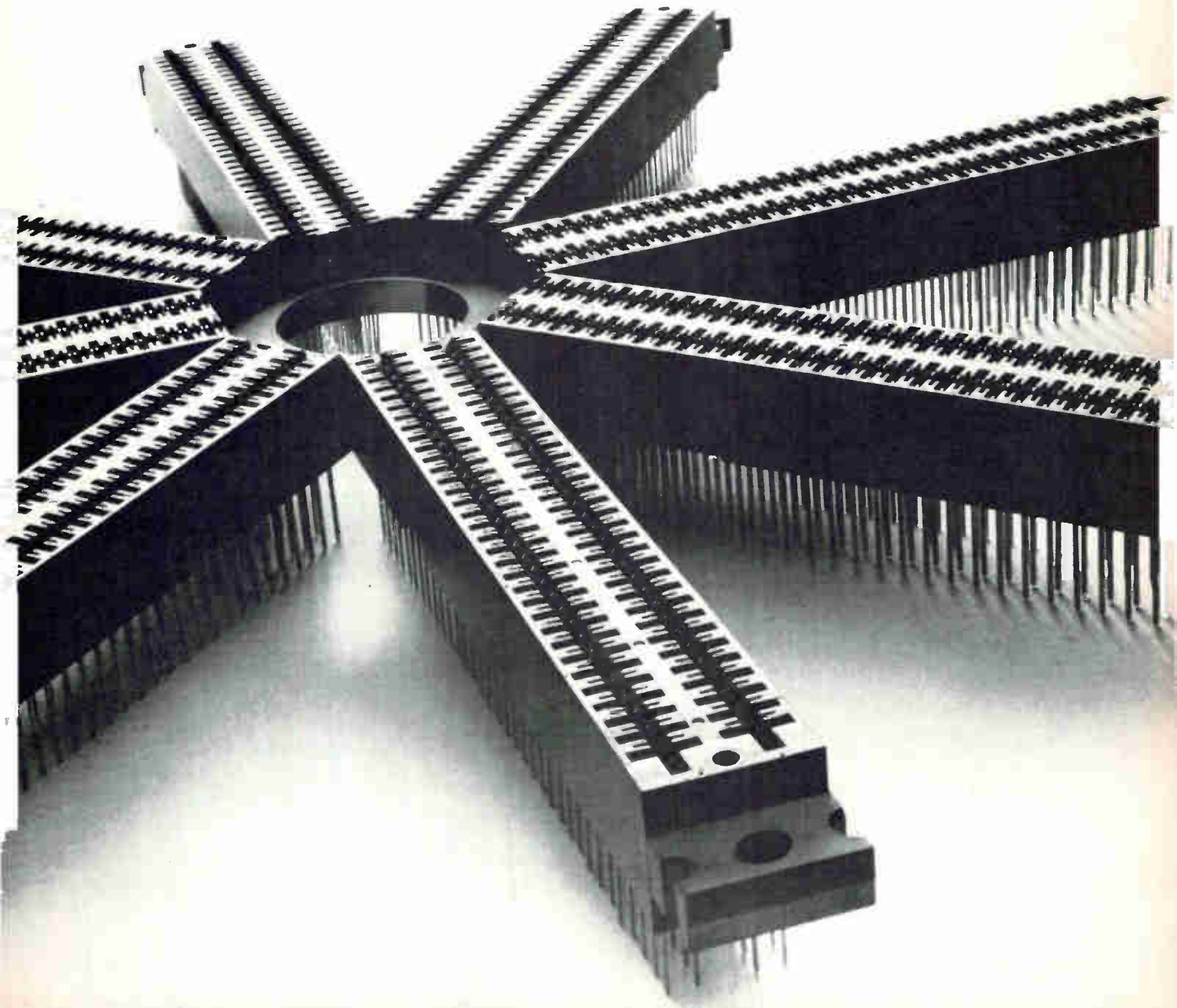
We also do our own wire drawing, coining, forming, bending, and solder plating. We design our own tooling and mold our own plastic bodies. And we assemble and test the whole connector ourselves.

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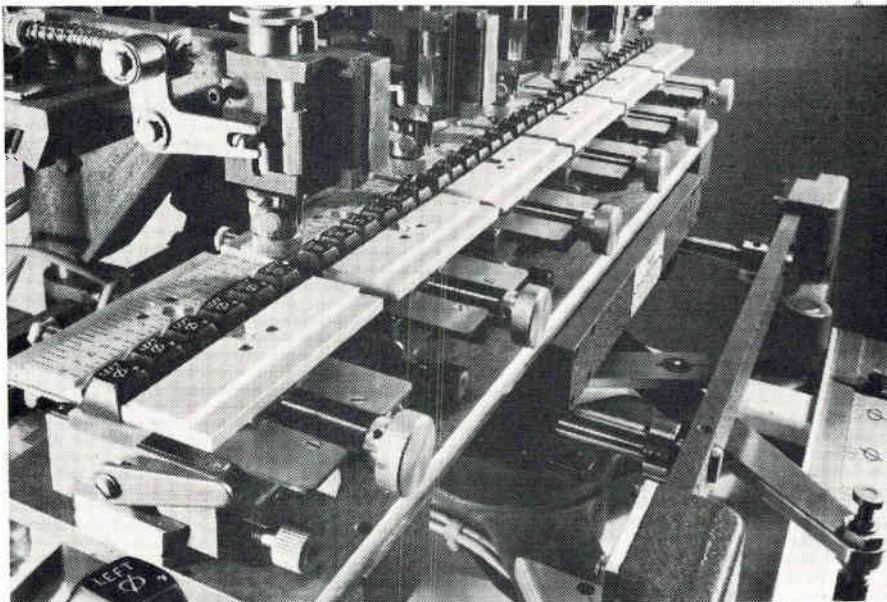
Patwin's Series 18000 indicators operate from pulsed DC voltages in decimal form to display digits or symbols. They have the same reliability, readability and memory as other MAGNELINE models but are more compact and lower in price. The new indicators are only .29" wide and .92" high yet digit size is a full ¼ inch. Unit price is \$33.80 in quantities of 100.

The Series 18000 has many applications in aviation and general instrumentation, especially where extreme reliability and low maintenance cost are important. Open construction of the unit gives instrument designers a wide choice of mounting methods. Full information available from Patwin, 41 Brown Street, Waterbury, Connecticut 06720. Telephone (203) 756-3631.

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Data handling

## Calculator is interruptible

Easily programmable unit resumes automatic mode after manual operation

Branching out from its well-established niche in consumer electronics, the Sony Corp. is seeking to tap the office-machines market with its new programmable electronic calculator, designated the ICC-2500W.

The unusual feature about this calculator, the company points out, is ease in programing. There are no complicated routines such as jumps and transfers which an operator has to learn from an instruction manual. Equation steps can be keyed in almost as exactly as when writing them on paper. Once the program has been entered, the operator just keys in the variables and can forget about pressing add, subtract, or square-root buttons.

In addition, the operator can interrupt a program at any point to run some calculations manually, and then return to the original program without having to re-enter the program or re-start calculations. Furthermore, should a wrong program instruction be entered, that instruction can be erased immediately without wiping out any of the previous instructions.

The calculator is equipped to handle 111 instructions, and has a display capability of 15 digits with automatic decimal placement.

The main memory consists of a 360-bit magnetostrictive delay line and 15 registers.

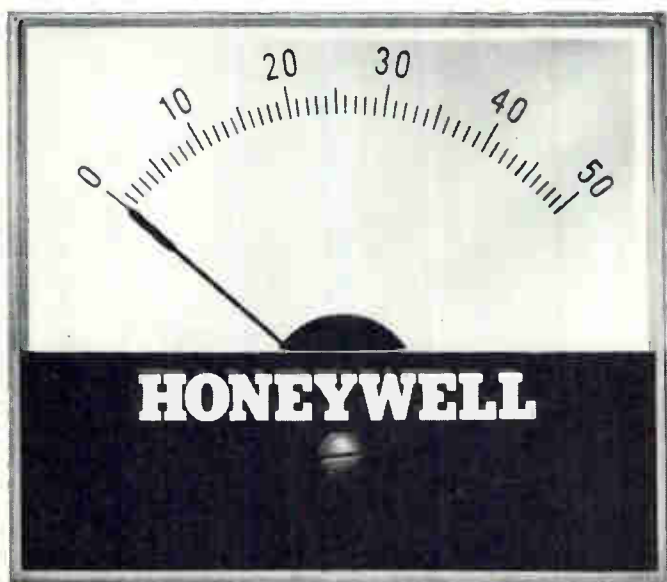
One of the options is an electrostatic printer.

Sony also will be offering in the first half of 1970 an external cassette storage unit for quick programing input to the calculator and for storing programs in library use.

The price for the calculator is \$1,695. The printer goes for \$550. When cassette storage becomes available, Sony says, the total price will be under \$2,000.

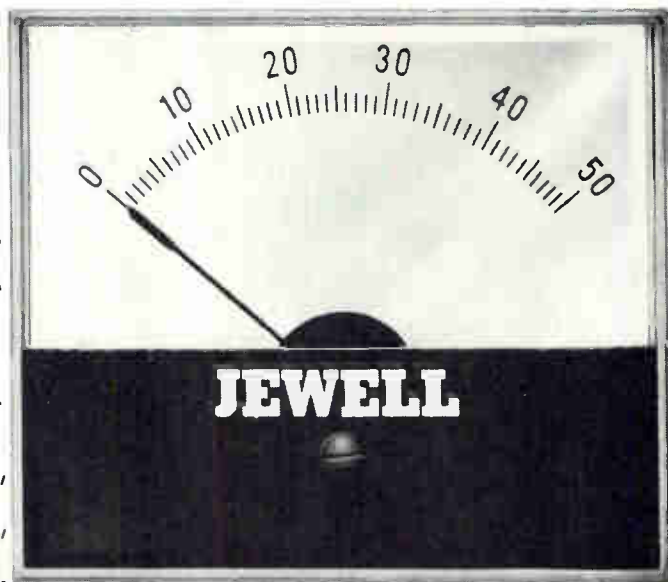
Sony Corp. of America, 47-47 Van Dam St., Long Island City, N.Y. [391]

# It's not easy to forget a name like Honeywell. But try.



This used to be a Honeywell meter. Now it's a Jewell.

The quality is the same. The performance is the same. Even the face is the same. Only the name is changed.

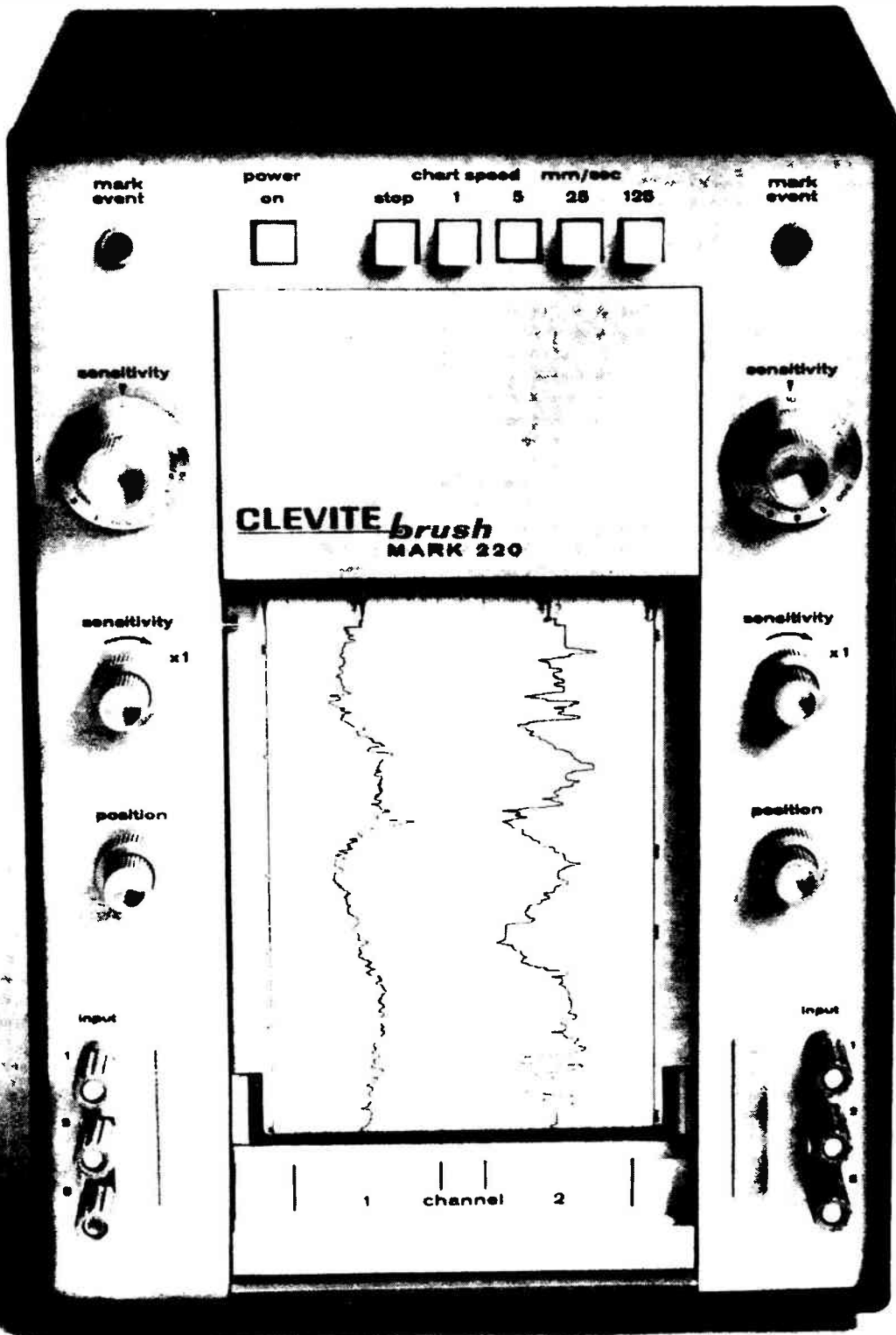


So please remember. Jewell Electrical Instruments now has the process, the people, and the plant to make the meters that Honeywell made famous.

Jewell Electrical Instruments, Inc.,  
Grenier Field, Manchester,  
N.H. 03105 — 603/669-6400.

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more facts in less time, at less cost  
than any other 2-channel recorder  
on the market.**



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And once we put it through its paces for you, you'll call it the most amazing piece of recording gear around.

To begin with, we *guarantee* the Mark 220 to be 99½% accurate. Which is a good deal better than almost anything else on the market... regardless of size or price. The pressurized ink-writing system is the same one you'll find in our six and eight channel systems. Instead of laying the trace on the



paper, it forces it *in*. Run your finger over it. There's no smear, no smudge. And trace crispness and uniformity is in a class by itself.

Built-in preamplifiers give you measurement range from 1 mV per division to 500 V full scale — and you never have to re-calibrate. Pushbutton controlled chart speeds. Two handy event markers. Ink supply is a disposable cartridge, good for a year.

Yes, for a 25 pound portable that's no bigger than a breadbox, the Mark 220 is quite a recorder. Ask your Brush representative for a demonstration. Or, write for complete details. Brush Instruments Division, Gould Inc., 3631 Perkins Avenue, Cleveland, Ohio 44114. We'll include our informative booklet "Elimination of Noise in Low-Level Circuits".

**GOULD BRUSH**



# Noncontact IC printer loads manually

Japanese machine trades cycle time to avoid alignment woes; second-generation equipment, in two models, aimed at U.S. market

**Optical masking**, or noncontact printing, of integrated circuits looked like a natural to revolutionize the industry a few years ago. The technique—projecting circuit patterns through the mask directly onto the photoresist covering the wafer—promised pattern accuracy equal to that of conventional direct-contact printing, and with higher device yields. Further, because the

mask never touches the wafer, there is less chance of scratching and having to replace the costly masks frequently.

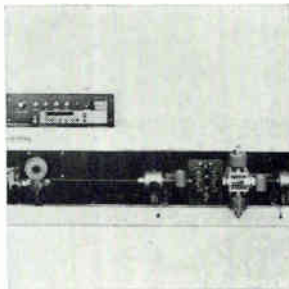
Yet IC makers generally remained cool toward the process, citing image distortion in the optics, and problems with the automatic feeding mechanisms which load and align the wafer in the printer.

Now, however, Ushio Electric Inc. hopes to eliminate these woes with its Unimask 101 noncontact IC printer, which will be marketed in the U.S. It will be available in two models, one for 1.5-inch wafers and the other for 2-inch wafers.

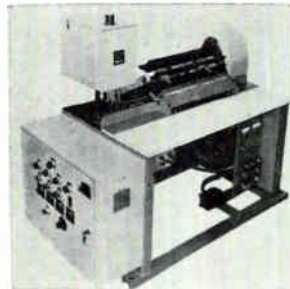
The Japanese firm's improved optics design includes Nikon lenses and a 500-watt mercury lamp that projects powerful 400,000-lux light



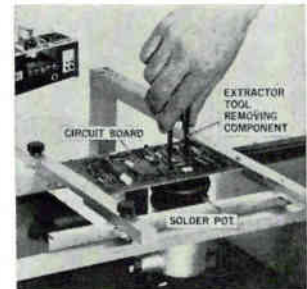
Optoline assembly director uses fiber optics to provide visual instruction to the operator in the positioning of printed-circuit board components. Components are selected from a rotating tray, and a central member indexes the power source current through a program module to the visual fiber optic readout panel. Hollis Engineering Inc., Nashua, N. H. 03060 [421]



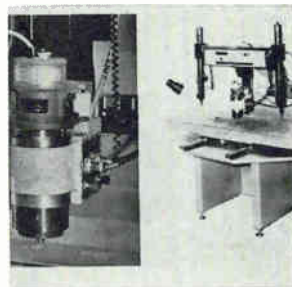
Automatic wire stripper 2600 has electronic measuring devices which speed set-up and enhance operating speeds. Wire cutting lengths are set up by pushbuttons in 0.1 in. increments, providing for lengths ranging from 0.1 in. to 999.9 in. Unit measures, cuts and strips wire for leads and cable harness in sizes from 32 to 10 Awg. Eubanks Engineering Co., Monrovia, Calif. [422]



Coating machine CC3 uses the fluidized bed principle. Intended for epoxy-resin coating of radial lead components such as small printed circuits, capacitors and resistors, it provides a truly conformal coating with re-cycling possibilities. An unskilled operator can turn out 15,000 units max. per hour, depending on component size. English Electric Corp., 1 Park Ave., N.Y. [423]



Automatic de-soldering machine for multilead components causes molten solder to flow beneath the p-c board, covering only the total area of the component leads. This allows all lead joints on the component to become molten simultaneously. The component is then removed by hand with an extractor tool. Model DSM-2A costs \$1,500. Air-Vac Engineering, Milford, Conn. [424]



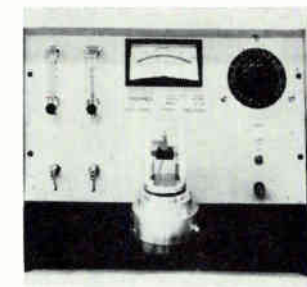
Accessory called Auto Drill 65 allows two models of wire terminating systems to be used as numerically controlled p-c board drilling machines. Unit can be installed singly or ganged in groups of up to 5 drill heads. Each head has a speed control allowing rates from 10,000 to 45,000 rpm. Prices \$1,600 to \$2,850. Synergistic Products Inc., Santa Clara, Calif. [425]



Portable hot melt adhesive system Thermopulse 1500 series is designed to provide efficient, high-production, thermoplastic application in assembly, packaging and various manufacturing operations. Other features include temperature control throughout, variable voltage adjustment, minimum operator controls, and no clean-up. Spraymation Inc., 52 Sindle Ave., Little Falls, N.J. [426]



Universal laser system 202 is for production of semiconductor devices including IC design and fabrication. The solid state system has been successfully applied in effecting various changes in silicon wafers through precise irradiation. It permits a component to be made at a specific point on a wafer without disturbing surrounding material. General Laser Corp., Natick, Mass. [427]



Strip heater HVT-600, for sealing hybrid circuit packages, provides rapid temperature acceleration up to 600°C for a variety of uses. Unit can also be used to seal crystal and relay cans, and for die attaching, wafer alloying, metal sintering and annealing, and low-temperature glass-to-metal seals. Price is \$1,600. Hughes Equipment, 2020 Ocean-side Blvd., Oceanside, Calif. [428]



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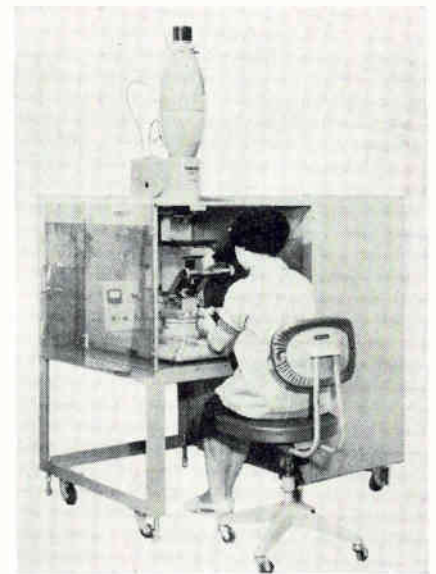
DIVISION OF  
**SIFCO**  
INDUSTRIES, INC.

rays onto the photomask.

The Unimask 101 is a 1:1 re-production system. In terms of resolution, it can print approximately 300 lines per millimeter at the edge of a wafer and 400 lines at the center. Effective line-width resolution is about 4 microns, the company says.

Both models have a manual feed. To some, this might seem like a step backward, particularly because it means longer cycle times—between 1 and 2 minutes depending upon the operator. But Ushio engineers say that automatic feed mechanisms present alignment and other problems that no amount of cycle-time advantage can compensate for.

Because the Unimask is manually operated, the machine has a

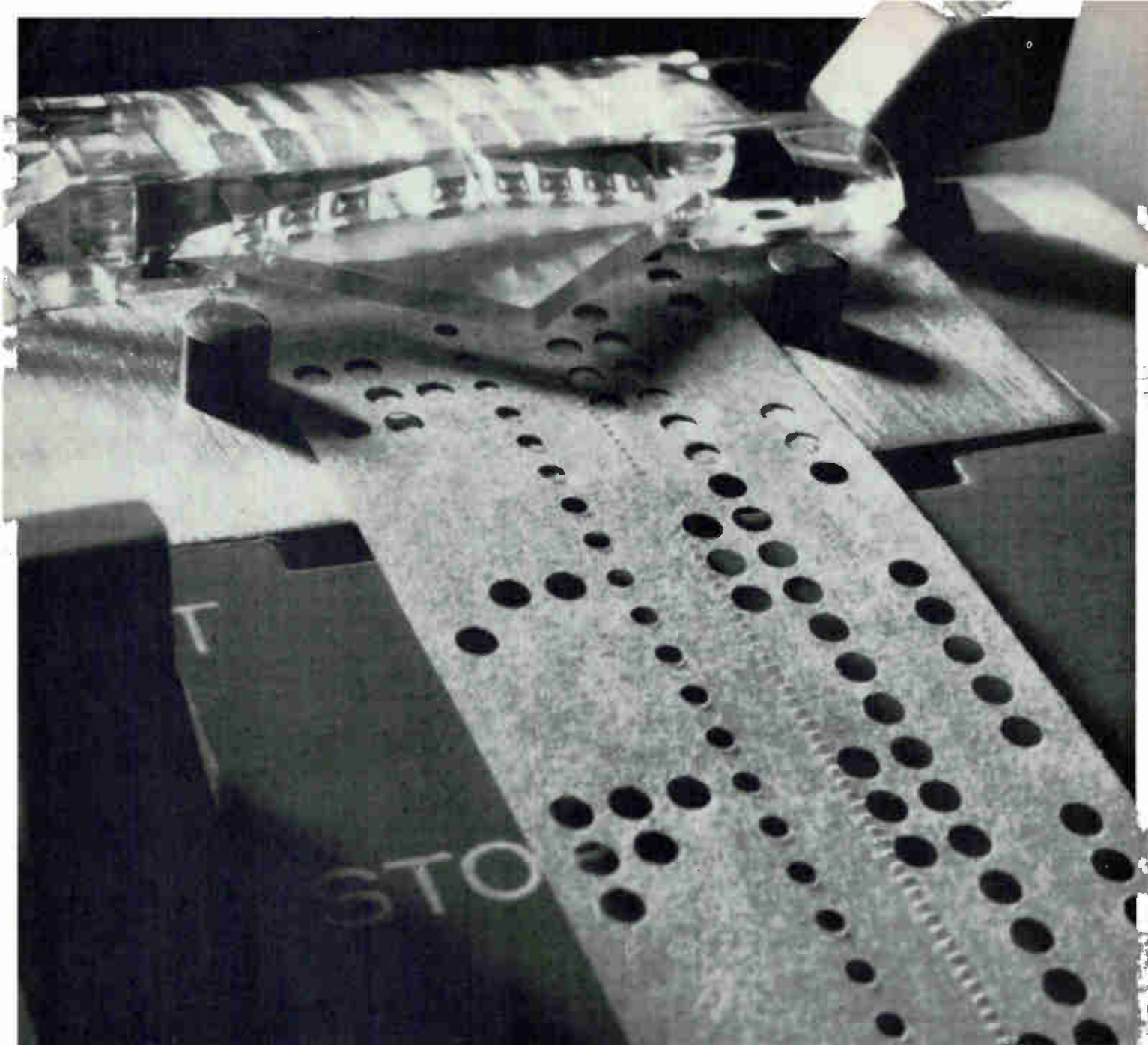


**Untouched.** IC pattern is projected through mask onto wafer. Assembly atop enclosure holds lenses.

binocular, or split-field, alignment system that provides the operator with 2-micron resolution as well as a focal depth of 30 microns. Exposure time is approximately 8 seconds.

The 1.5-inch version, which is being tested by several large semiconductor houses, sells for about \$23,000, and the 2-inch machine, which will be brought to the U.S. later this month, will sell for about \$34,000.

Kurt Orban Co., Orban Way, Wayne, N.J. 07470 [429]



## Couple your measurements to a time-sharing terminal. On-line or off.



With HP's 2547A Coupler, raw BCD data from up to six instruments at a time can be

processed in seconds. On-line, through your commercial or in-house time-sharing system. No special programming is required, and any language can be used.

Where data is generated too slowly to process economically on-line, you can

record through the 2547A on your terminal punch, for later reduction. For rapid data acquisition, an optional high-speed punch enables you to record at 120 char/sec. Off-line recording also lets you take measurements when the time-sharing system isn't available.

The 2547A Coupler works with more than 40 different HP measuring instruments—and most other instruments with BCD output.

Cost for the complete package, including coupler, 10-digit data input

interface, and EIA compatible output, is only \$3550. For complete information on the 2547A Coupler and time-sharing applications, contact your local HP field engineer. Or write to Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

**HEWLETT**  **PACKARD**

**DATA ACQUISITION SYSTEMS**

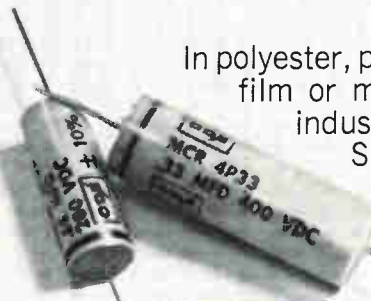
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# Putting products in their place

Materials-handling control system, using manual, card, tape, or computer inputs, directs stacker to store and retrieve items

**Riding along** on a stacker crane, an integrated-circuit warehouse control system designed by Cutler-Hammer's Industrial Systems division assures maximum utilization of expensive building space, and rapid storage and retrieval of products and materials. Each storage bin, in racks that can be as high as 80 feet, is assigned a unique binary address in both hori-

zontal and vertical directions. These addresses, sensed on-the-fly by an unattended moving stacker crane, are one set of inputs of the stacker control that performs two basic cycles. The other set of inputs are specific commands for the desired operation.

In one cycle, material is picked up at an entry point, moved to a selected bin location, and stored.

In the other, the crane moves to a bin, retrieves the bin's contents, and delivers it to the exit point of the storage area.

**Done with magnets.** Small permanent magnets imbedded about 2 inches apart in the floor and oriented magnetically to provide a binary 1 or 0, establish the horizontal-address code. The vertical address is coded on the stacker. A



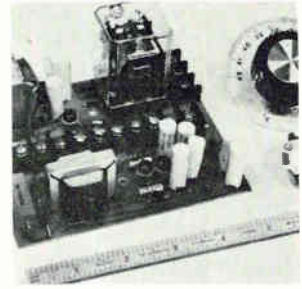
Control processors series 1200 are for on line, real time, monitoring and control systems. Six units offer word sizes of 12, 16 and 20 bits, with memory cycle times of 1.9 or 3.5  $\mu$ sec. A feature is the capability to test or modify individual bits of information within a word, by means of a set of bit manipulation instructions. Philco-Ford Corp., Palo Alto, Calif. [361]



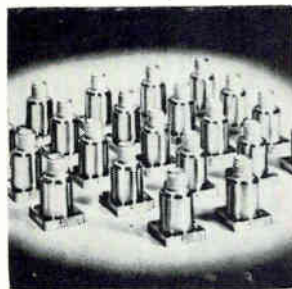
Solid state relay type SSR can be used interchangeably with conventional electromechanical relays in electrical control systems. It is equipped with suppression circuits in both its input and output sections to counteract the kinds of electrical noise commonly found in industrial installations. Surge capacity is up to 20 amps. Westinghouse Electric Corp., Beaver, Pa. [362]



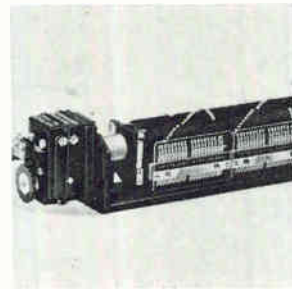
Accumulator model 4038, which can count events at rates up to 1 million per sec, is for systems use. Events counted may be repetitive, intermittent, or random. Typical sources in the system would be the opening or closing of a relay, changes in the voltage output of a photocell, or individual cycles of a sine wave. Beckman Instruments Inc., Harbor Blvd., Fullerton, Calif. [363]



Remote mounting on-off temperature controller series 931 is sensitive to 0.005°F. It can control temperature in discrete ranges from -300°F to +1700°F. Unit features all solid state components and a dpdt covered plug-in relay mounted on a p-c board measuring 5 x 4½ x 2¼ in. Price in lots of 1,000 is \$32.95. Pak-Tronics Inc., 4044 North Rockwell St., Chicago [364]



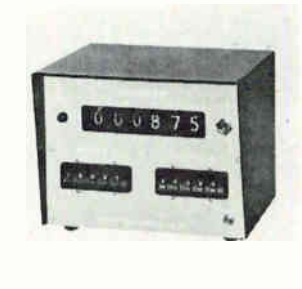
Aerospace type sensors series IV-400 detect and measure vibration as low as 0.01 g or explosive blasts as high as 100,000 g either dynamically in microseconds or over indefinite periods of time. They are for interfacing production control and alarm in commercial and industrial plants. Price (10 to 10,000) is as low as \$25. Columbia Research Laboratories Inc., Woodlyn, Pa. [365]



Replaceable 15-amp contact is a feature of a stepping motor now available for Sealectroswitch programming switches. The motor has a capacity of 180 steps-per-minute and is equipped with a replaceable position sensor and a replaceable relay control. It operates on 117 v a-c, 60 hz power supply and has a one-way friction clutch. Sealectro Corp., 225 Hoyt St., Mamaroneck, N.Y. [366]



Stepper motor 2.75-100-1-8 uses a nutating disk principle. The disk has a bevel gear and is attracted by 8 solenoids. By varying gear ratios and switching sequences, from 200 to 1,600 steps per revolution may be obtained. Standard unit offers 800 or 1,600 steps/rev, 30 in. lbs of torque at stall, 5 in. lbs at 4,800 steps/sec. Mesur-Matic Electronics Corp., Warner, N.H. [367]



Standard models of solid state preset counters have from 2 to 6 digit capacities and have either dual, single or no built-in preset comparators. Others have up to 6 set point controls. Units are designed so input counting circuitry will operate either directly from contact closure or from voltage level signals. Digital Instruments Inc., Merriam Lane, Shawnee Mission, Kan. [368]



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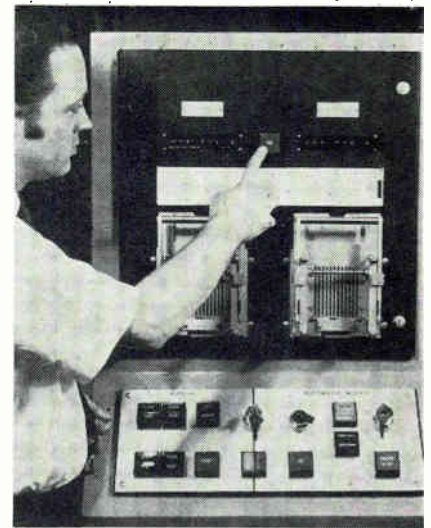
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For computer input, a special version of the address selection and compare board containing IC shift registers receives commands for insertion into the system.

Cutler-Hammer officials say price depends on the application.

Cutler-Hammer Industrial Systems Div., 4201 N. 27th St., Milwaukee, Wis. 53216 [444]

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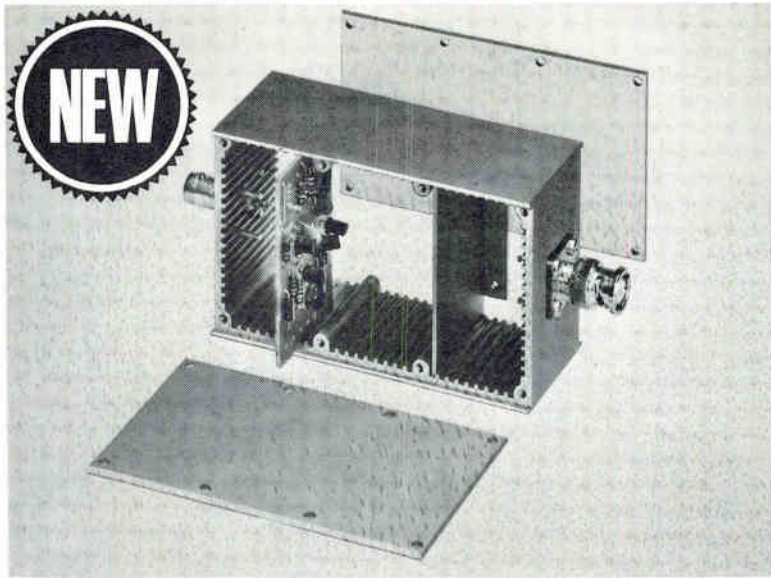
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## New Books

### Body engineering

*A Systems Approach to Biomedicine*  
William B. Blesser  
McGraw-Hill, 615 pp., \$19.50

When applying engineering principles to the study of biological systems, no single discipline can do it alone. For example, the electrical engineer may be right at home tracing the interconnections of the central nervous system, but when he tries to study the nature of the hormones that affect the nervous system, he'll find he needs the skills of a chemical engineer; or when he looks into the interaction of the nervous system with the motion of a limb, he'll find he needs the knowledge of a mechanical engineer to understand muscular dynamics.

The fact is that the human body contains complicated machinery: a digital computer (the brain); a complex logic network (the central nervous system); and, among other things, a two-pump plumbing network (the heart and the circulatory system); a sewage treatment system (digestive tract) and a pair of gas exchangers (lungs).

Therefore, as electronics engineers become more and more involved in biomedicine, they'll find themselves needing to learn not only the disciplines of the life scientists but also the studies of other types of engineers. And in learning the latter, they may find this book useful.

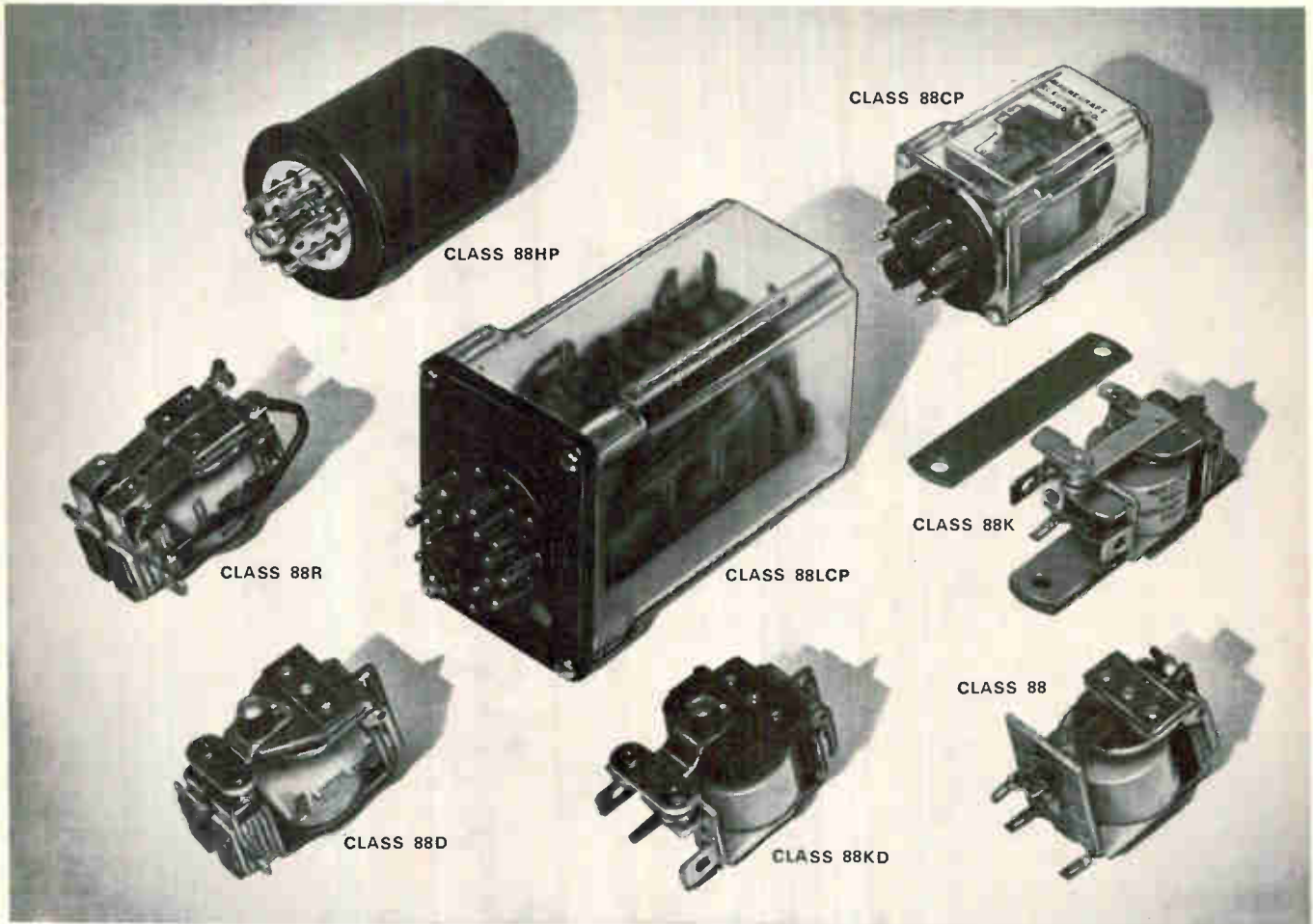
The author says that the book is for life scientists out to learn engineering, but it can also be used by electronics engineers who want to know how other engineering specialties fit into biomedicine.

Blesser's drawings and explanations of physiological measurement setups are good, as are his discussions of the physiological bases for these measurements. Some of the topics he describes are the response of the eye, dye dilution studies, and muscular activity.

The treatment of the respiratory system is particularly good. The author develops a model of the system, explains the compliance of the lungs, and then studies the effects of a step input to the system. Another valuable feature is the appen-



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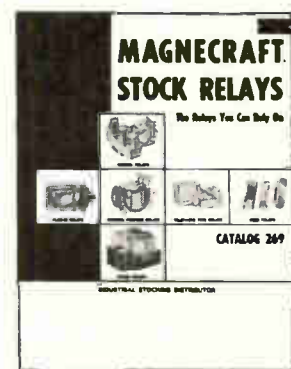


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## New Books

dix that deals with nodal analysis.

There are a few things that may put an engineer off, however. First, much in the book is basic. An engineer may be reluctant to lay out nearly \$20 for a text that spends 70 pages explaining LaPlace transforms and 56 pages discussing "The Impedance Concept."

Another problem: the author assumes that his readers are pretty well versed in physiology and anatomy. For the uninformed, he does put in a glossary, but it isn't much help. If you don't know what a bronchiole is, Blesser's explanation that it's "the last and tiniest subdivision of the bronchial tree opening into the alveoli" isn't going to clear things up much. On the other hand, some of the definitions are obvious; it's not big news that respiration is "the act or function of breathing".

To help the reader learn about the systems approach to biomedicine, Blesser does put in a lot of problems at the end of each chapter; and many of these problems are quite challenging. On the other hand, however, he neglects to put in any answers.

### Recently Published

**Sources of High-Intensity Ultrasound, Vol. 1**, edited by L.D. Rozenberg, Plenum Press, 309 pp., \$25

First of a two-volume work, this text covers work done by the Russians in applied acoustics. It describes theory, analysis, and engineering design of devices and techniques for generating powerful ultrasonic fields used in laboratory and industrial requirements. Topics include gas-jet sound generators, magneto-strictive ferrites, ultra-high-intensity focusing systems, and ultrasonic focusing transducers.

**A Systems Approach to Biomedicine**, William B. Blesser, McGraw-Hill, 599 pp., \$19.50

This book introduces biomedical workers to engineering and mathematical concepts relevant to the study of living systems. Included are discussions of linear-resistance analysis, distributed and lumped systems, the electrical analogs of compliance and springiness, pulse response of a dye-dilution system, transfer functions, the impedance concept, transient oscillations, and resonance and feedback.

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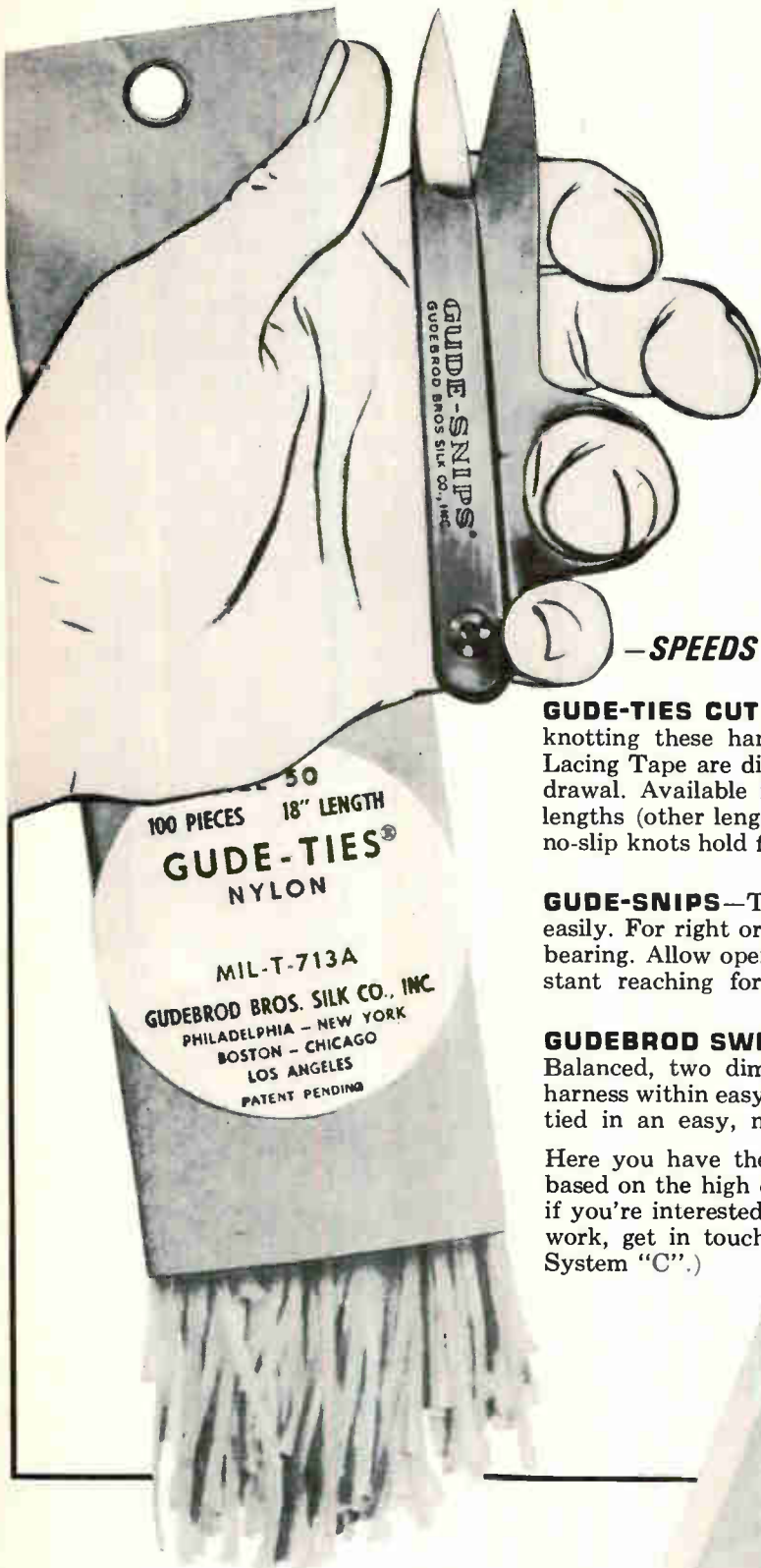
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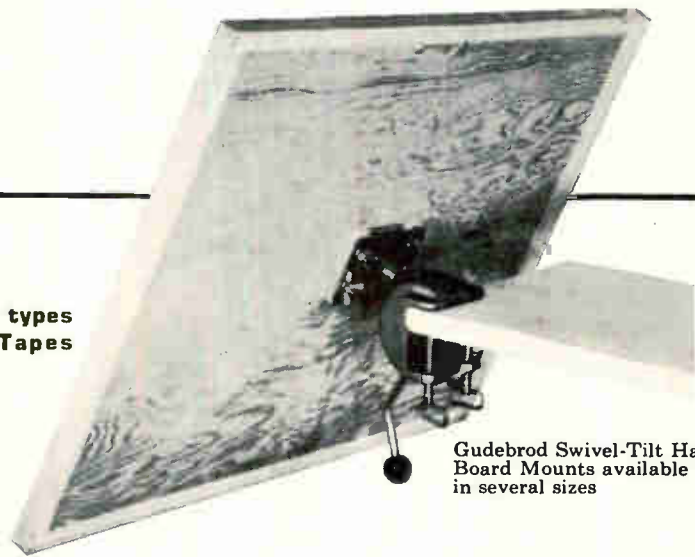
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MAL 20	RL-20	70°C	1/2	10Ω-470K
MAL 32	RL-32	70°C	1	10Ω-1 meg
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## Technical Abstracts

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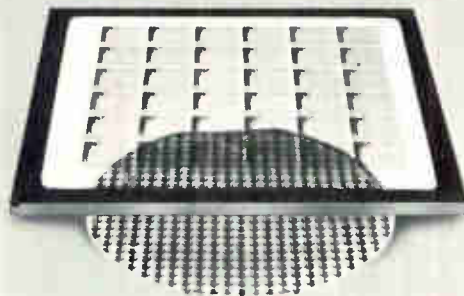
Large linear system transient analysis via frequency domain, mathematical models, Fourier integral, and computer Joseph J. Ellis and Edward A. Dobberstein  
IBM Corp., Kingston, N.Y.

Although programs are available for transient analysis of both linear and nonlinear electrical systems, these depend on conventional numerical techniques that bog down when the system is described over a long time period. When this happens, the designer is forced to break the defining transfer function into many increments and integrate each of them over the range of zero to infinity. This takes a long time to reach a numerical solution, and taking larger time steps does not produce accurate results.

A new approach, called Tabfit, for transient analysis by Fourier integral theorem, links the time domain and frequency domain rapidly. No physical model is needed to perform the desired integration. Instead, the function is subdivided into many segments and represented by a series of equations, each of which—one for each segment—is similar in form but differs only by coefficients. Each of these coefficients are solved. The coefficients are not a function of the requested solution time. Therefore, if a transient solution for 100 different time points were desired the designer would need only one set of coefficients. Using this technique, it takes about 1 to 4 seconds to reach a solution for each requested point, based on using an IBM 360 system.

The program accepts system input information as transfer functions of frequency in magnitude and phase for a set of discrete frequency points over the significant portion of the spectrum. A complicated function may require 70 such points; a simple one may require only two. This type of data is easily obtained for large electrical networks via an a-c analysis program. Excitation functions of almost any description are easily inputted as a function of time. The output is the time domain response of the given transfer function to the given

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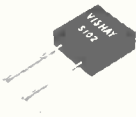
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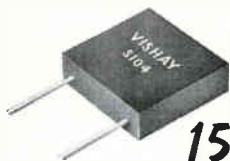


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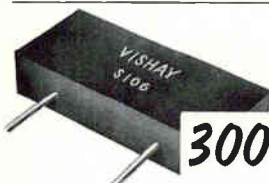
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## Technical Abstracts

excitation. Another feature of the program is the availability of the Fourier integral transform of the excitation function.

The program, written in PL/1 programming language for IBM system 360, fits the input data to mathematical models for the description of the drive and transfer functions. The Fourier integral theorem then is involved to effect the desired time domain solution from the frequency domain. Numerical integration, in the conventional sense, is avoided because each equation is similar in form and not represented as a set of complicated definite integrals. Since each solution point is evaluated in the same amount of time the designer can predict in advance just how long the solution will take. In the conventional technique each solution varies. In addition, this method allows for the study of a large group of transfer functions in a laboratory for which no physical system exists or at least has not yet been fabricated.

Presented at Joint Conference on Mathematical and Computer Aids to Design, Anaheim, Calif., Oct. 26-30.

### Antenna polarization

#### S-band antenna systems for missiles

John E. Hill  
Granger Associates  
Chatsworth, Calif.

Since the transfer of telemetry activities to S-band four years ago, engineers have sought an antenna system that would provide an omnidirectional, or null-free, radiation pattern at reasonable cost. Although such an antenna is not yet a reality, a considerable amount of information has been gathered from the design and test of S-band telemetry antennas used on missiles. Perhaps the most significant realization is the importance of polarization, and the earlier concern that full-pattern coverage could not be achieved by the newer shorter wavelength S-band antennas, flush-mounted on a missile whose diameter was several wavelengths, may be allayed through employment of polarization diversity receiving systems.

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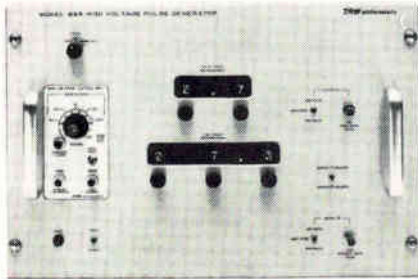
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## Technical Abstracts

mission requirements, vehicle trajectory, transmitter power, and ground station capability, the systems engineer can establish minimum pattern levels which will vary over the sphere depending on the trajectory. Once the polarization characteristics of the ground station used to track the missile are known, the airborne antenna can be evaluated. The losses encountered when the ground station and the airborne system are polarized differently have been labeled polarization mismatch loss and have been determined for many polarizations: vertical, horizontal, right-hand circular (RHC), left-hand circular (LHC), slant linear, and elliptical.

The polarization mismatch loss was tabulated when encountered at ground stations of various polarizations, including circular and linear diversity, and when the missile polarization was vertical, horizontal, RHC, LHC, and slant linear. The circularly polarized diversity system showed no polarization mismatch loss greater than 0.5 decibel for any missile polarization, while the loss for a linearly polarized diversity system was no greater than 1.6 db. Polarization diversity assumes a 2.5 db enhancement of signal level when two equal signals are received, and no enhancement of the stronger signal when the two signals received by the antenna are unequal.

A radiation distribution printer, modified to type out particular levels of antenna radiation as they were selected, was used to scan the entire sphere and record the antenna pattern in angle increments of 2° and amplitude increments of 1 db. The tape was rerun and only values less than -10 db isotropic were typed out; a counter counted the number of typewriter strikes per row, and through a normalization process the percentage of the total area in which the signal level was below the selected level was determined. Areas of the radiation pattern that fell below the selected level were termed nulls and were categorized as either polarization or power nulls. Polarization nulls are a result of a polarization mis-

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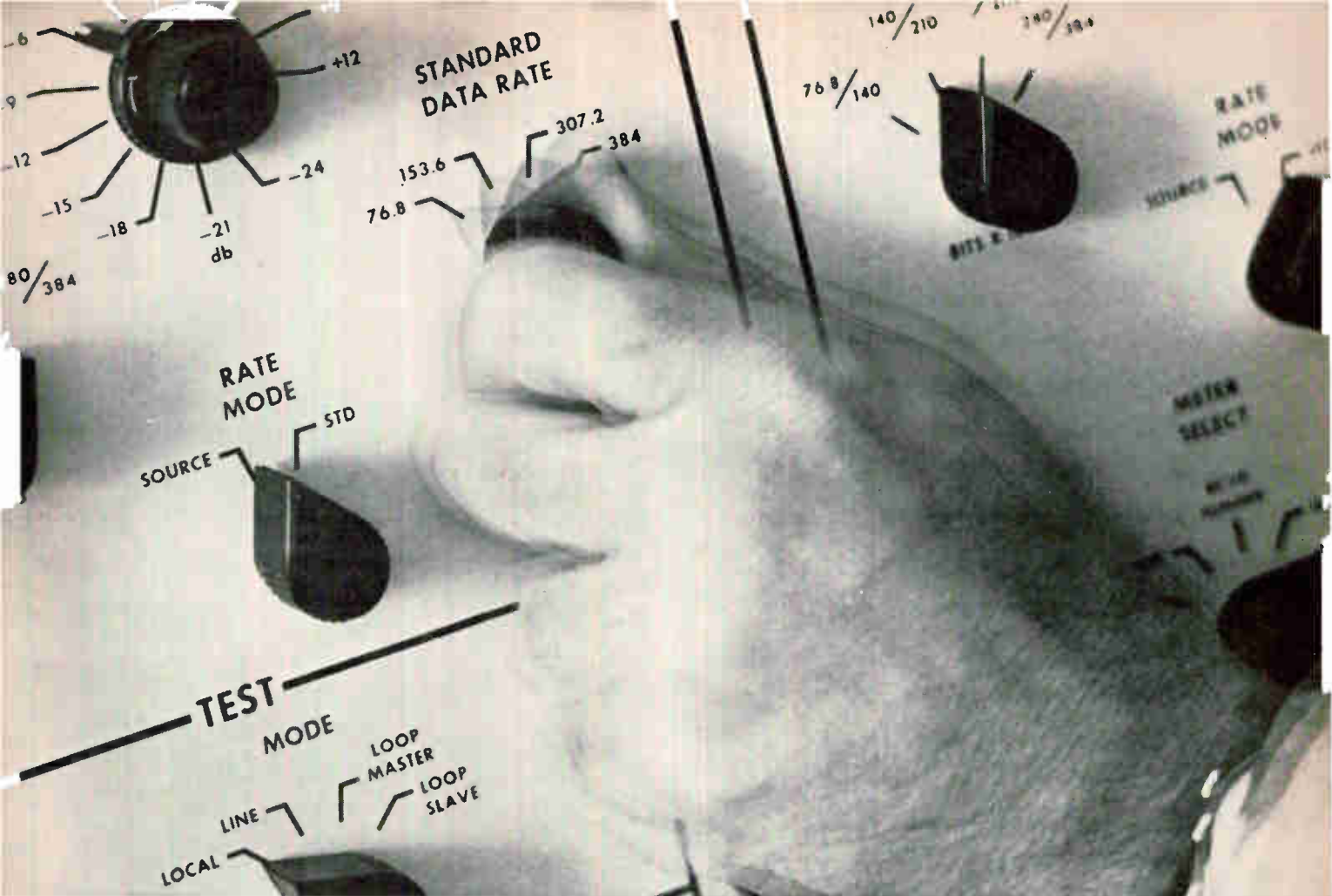
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## Technical Abstracts

match between the transmitting and receiving antennas while power nulls are a result of signal cancellation and are independent of the type of receiving antenna used in the system.

Experiments performed on the Athena H antenna system showed that when the number of antennas on a missile were considered, the best pattern was not necessarily produced by a large number of antennas. A set of six monopole elements was arrayed circumferentially around the missile and fed to produce phase rotation resulting in RHC polarization in the direction of vehicle travel and LHC in the opposite direction. The result was a multilobed pattern whose null depth could not be reduced. A three-element array was tried and produced a better null structure than the six element array. Two three-element arrays were used to provide the required redundant S-band telemetry system using two transmitters without a diplexer; the three antennas and associated cables and power divider resulted in a lower cost and weight system than one that uses a diplexer instead.

Presented at the International Telemetering Conference, Washington, Sept. 15-17.

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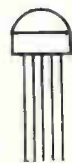


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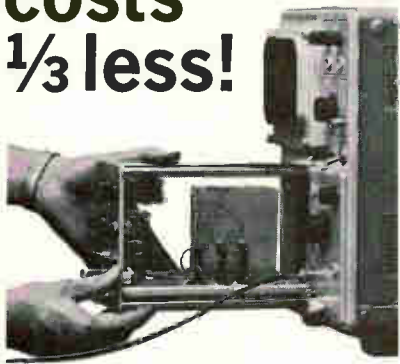
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## Technical Abstracts

sensed by a detector antenna, which feeds a 10-microsecond bias pulse to the diode. The energizing signal from the probe is delayed 50 nanoseconds so the diode can become fully forward-biased before receiving the energizing signal. Since GaAs radiates only when forward-biased, it must be biased "on" previous to the appearance of the data so that the negative-going portions of the waveform are not clipped.

A 10- $\mu$ sec bias step was selected to accommodate long-duration data pulses. But the output of GaAs diode is a function of temperature, and if the diode is warmed excessively during the bias step, a non-linear effect is introduced. Bias steps up to 100  $\mu$ sec can be used without excessive heating of the GaAs diode.

The system transmits data over a 40-foot flexible fiber optic light guide. This guide conducts light, including infrared, by the phenomenon of total internal reflection. If the glass fiber light guide is surrounded by material with a lower index of refraction than the glass fiber in the guide, light will be completely reflected at the interface of light guide and the surrounding material, and the transmitted signal will suffer little or no reflection attenuation.

The receiver chosen was a photomultiplier tube which has a response time of 2.4 nsec, compared with an entire-system rise time of 4.5 nsec. The receiver converts the a-m infrared radiation signal to an electrical signal for display on a recording oscilloscope. The oscilloscope has a bandwidth of 150 megahertz when used with minimum sensitivity of 20 millivolts division.

Overall system performance was measured from probe input to oscilloscope display. Input sensitivity is 240 microvolts; output noise level, 2 mv peak to peak; maximum output signal, 120 mv peak; maximum signal-to-noise ratio: 40.1; dynamic range: 32 db; linearity:  $\pm 5\%$  over the entire dynamic range.

Presented at the International Telemetering Conference, Washington, Sept. 15-17.

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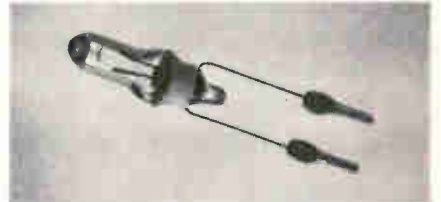
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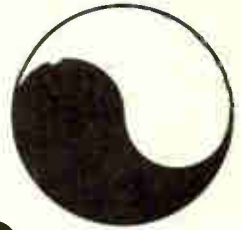
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## New Literature

**Instrumentation.** North Atlantic Industries Inc., Terminal Dr., Plainview, N.Y. 11803. An eight-page condensed catalog gives application and a summary of key specifications for some 40 items—eight of them introduced during 1969—in the firm's instrumentation product line.

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**Design assistance.** Texas Instruments Inc., P.O. Box 5012, Dallas 75222, has published a directory that describes all literature and personal consultation services offered by the company to designers using semiconductor devices and integrated circuits. [447]

**P-c connectors.** Elco Corp., Willow Grove, Pa. 19090, has available the revised, 52-page 1969 edition of its p-c connector guide. [448]

**Electrical insulation.** Johns-Manville Dutch Brand division, 22 E. 40th St., New York 10016. An electrical insulation selection chart contains actual samples and data on 20 different thermosetting electrical insulating tapes for OEM use. [449]

**Crystal can timing modules.** The A.W. Haydon Co., 232 N. Elm St., Waterbury, Conn. 06720. Two-page brochure MD407 describes a line of crystal can timing modules designed to provide selectable or fixed time delays. [450]

**Coaxial cables.** Andrew Corp., 10500 W 153rd St., Orland Park, Ill. 60462, has released a mailing piece on Heliac coaxial cables for a-m broadcast arrays. [451]

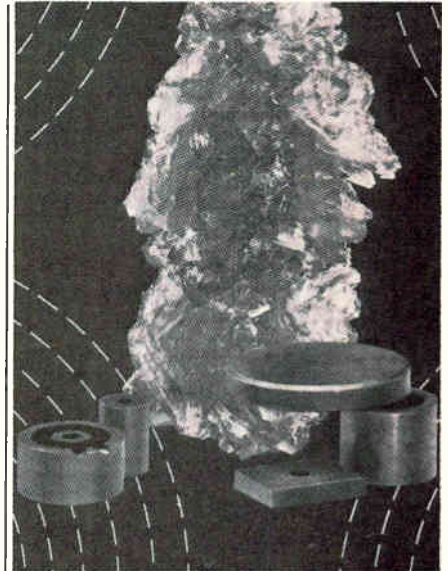
**High-voltage capacitors.** AMP Inc., Capatron Division, Elizabethtown, Pa. 17022. Over 300 high-voltage capacitors and nearly 70 capacitor stacks are described in the 28-page Amplifilm capacitor catalog 710-8. [452]

**Silicon power transistors.** Power Physics Corp., P.O. Box 626, Eatontown, N.J. 07724, has available a four-page catalog listing a complete line of diffused mesa and radiation-hardened silicon npn power transistors. [453]

**Solderable conductive coatings.** Aremco Products Inc., P.O. Box 145, Briarcliff Manor, N.Y. 10510. Product bulletin 536 describes a single component pure silver filled polymer alloy used to produce conductive coatings. [454]

**Electronic signal selector.** Fischer & Porter Co., 641 Jacksonville Rd., Warminster, Pa. 18974. Specification 55ES3000 describes a solid state electronic signal selector. [455]

**Semiconductors.** Centralab Electronics division of Globe-Union Inc., 5757 N. Green Bay Ave., Milwaukee 53201,



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## New Literature

offers a catalog covering silicon semiconductors including chip devices, zener regulators, reference diodes, solar cells, and photovoltaic assemblies. [456]

**Remote-controlled attenuators.** Texscan Corp., 2446 N. Shadeland Ave., Indianapolis 46219. Catalog sheet RC gives complete description and technical parameters of a newly developed remote controlled attenuator line which has a life expectancy of 100,000 revolutions minimum. [457]

**Silicon power rectifiers.** Edal Industries, 4 Short Beach Rd., East Haven, Conn. 06512. The F4 series of silicon power rectifiers is fully described in bulletin 124. [458]

**Precision switches.** Chicago Dynamic Industries Inc., 1725 Diversey Blvd., Chicago, Ill. 60614. Ten series of precision switches for industrial and military applications are described and shown in a four-page, two-color condensed catalog. [459]

**Capacitor additives.** Aerovox Corp., New Bedford, Mass. 02741. A four-page technical bulletin provides detailed information on additives "A" and "AH" for a-c capacitors. [460]

**Servo recorder.** Esterline Angus division of Esterline Corp., P.O. Box 24000, Indianapolis 46224. A revised catalog sheet provides details about a truly portable recorder that operates on rechargeable nickel-cadmium batteries for 12 hours, on conventional 1½ "D" cell batteries for eight hours or on a-c indefinitely. [461]

**MOS FET's.** Union Carbide Corp., P.O. Box 23017, 8888 Balboa Ave., San Diego, Calif. 92123, has released a brochure on the 3N172, 3N173 P-channel enhancement mode MOS field effect transistors. [462]

**Circuit card guides.** Calabro Plastics Inc., 8738 West Chester Pike Upper Darby, Pa. 19082, has issued an eight-page brochure describing Unitrack circuit card guides. [463]

**Miniature electric counter.** Durant Digital Instruments, A Cutler-Hammer Co., 622 N. Case St., Milwaukee 53201, has published technical literature describing a miniature electric counter series for the OEM. [464]

**Attenuators.** Greenpar Engineering Ltd., Station Works, Harlow, Essex, England, has published a catalog sheet on its new range of precision coaxial attenuators and attenuator kits. [465]

**Hybrid computing system.** Electronic Associates Inc., West Long Branch, N.J. 07764. The versatile and economical

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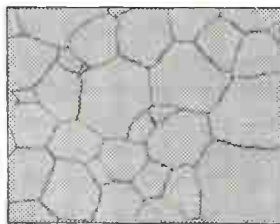
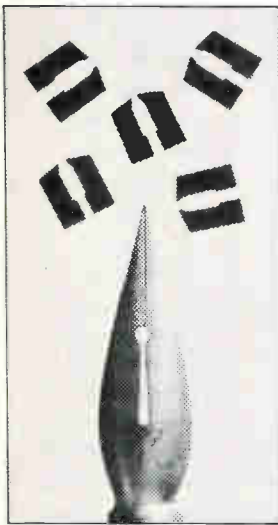
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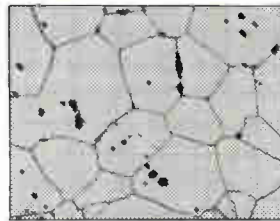
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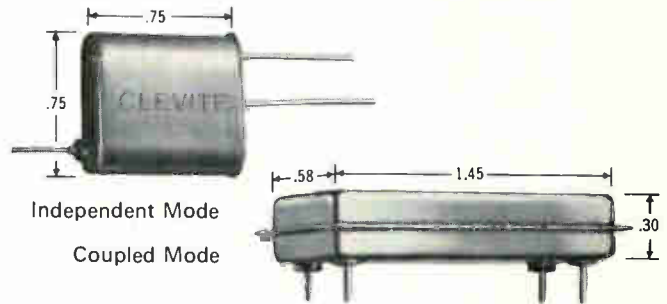
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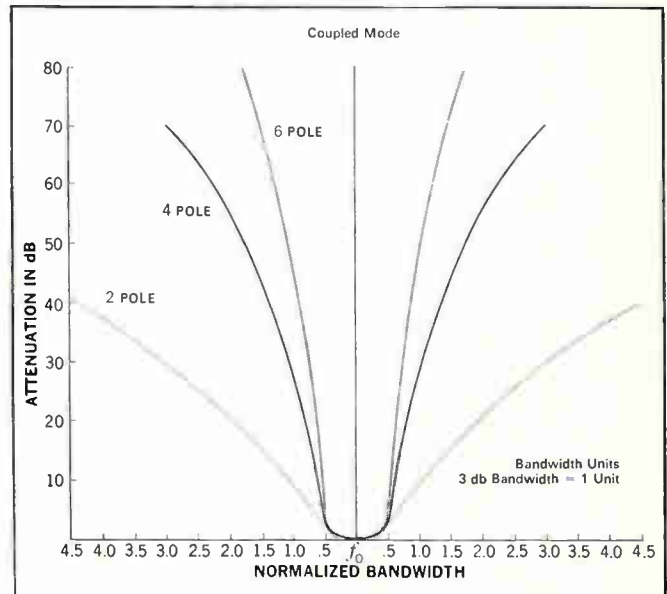
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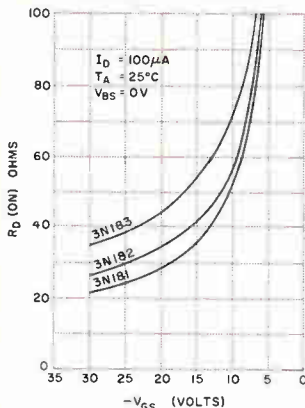
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## New Literature

590 hybrid computing system is the subject of a 16-page brochure. [466]

**Data acquisition system.** Systems Data Inc., 1951 W. Market St., Akron, Ohio 44313, offers a data sheet on the model 1001 short burst, high-frequency data acquisition system. [467]

**Plated-wire element testers.** Computer Test Corp., Three Computer Dr., Cherry Hill, N.J. 08034. A bulletin features two new instruments, models E-310 and E-310A, designed for production or laboratory testing of magnetic plated-wire elements. [468]

**IC logic manual.** General Dynamics, Dynatronics Operation, P.O. Box 2566, Orlando, Fla. 32802, has available a 122-page manual with descriptions, specifications and construction details for over 60 TTL IC logic cards. [469]

**Dielectric materials.** Emerson & Cuming Inc., Canton, Mass. 02021, has released a folder describing its line of thermally conductive dielectric materials. [470]

**Laminated plastics.** UOP Norplex, Norplex Dr., LaCrosse, Wis., 54601. A 20-page catalog details the company's broad line of laminated plastics and the quality assurance program under which they are manufactured. [471]

**Microwave equipment.** Sivars Lab, Box 42018, Stockholm 42, Sweden. A catalog on microwave components and instruments contains 75 pages giving full details on switches, rotary joints, coaxial equipment, yig devices and test equipment. [472]

**Linear devices.** Linear Motion Technology Inc., 39 Central Ave., Farmingdale, N.Y. 11735. A design guide issued as a boon to designers and engineers gives the total picture on X-Y tables, positioning systems and other linear devices. [473]

**Induction motors.** Eaton Yale & Towne Inc., 3122 14th Ave., Kenosha, Wis. 53140, has published a bulletin containing cutaway drawings of open drip-proof and totally enclosed fan-cooled electric motors available in standard and special designs. [474]

**Ultrasonic die bonder.** Mech-El Industries Inc., 73 Pine St., Woburn, Mass. 01801, offers a technical data sheet introducing the model UW-700 ultrasonic die bonder. [475]

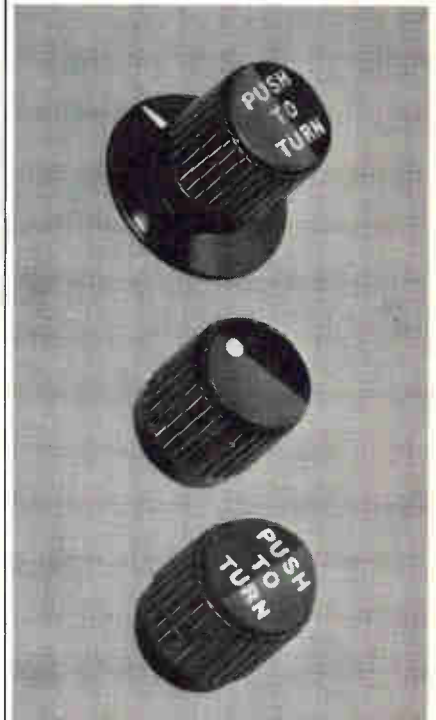
**Insulated terminals.** Electronic Molding Corp., 40 Church St., Pawtucket, R.I. 02860, has released a 72-page catalog packed with photos, drawings, specifications and details on a complete line of molded insulated terminals. [476]

**Encoder electronics.** Dynamics Re-

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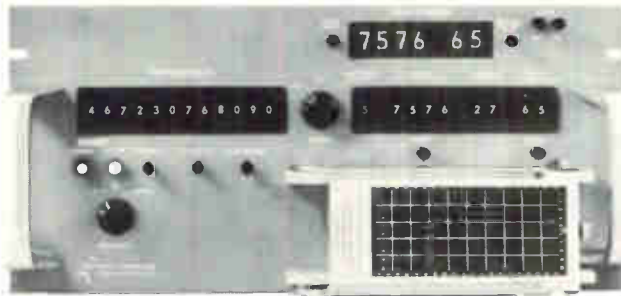


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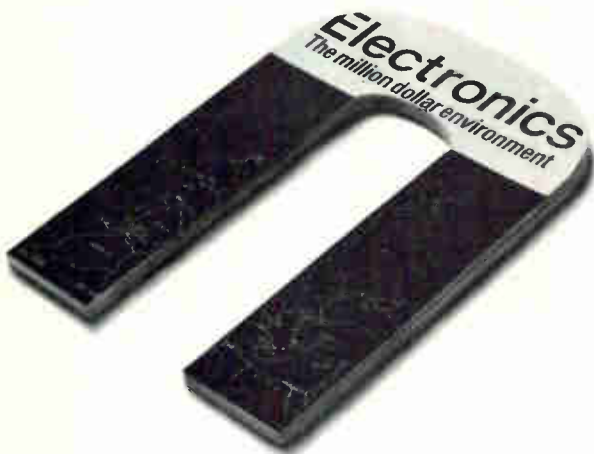
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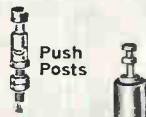
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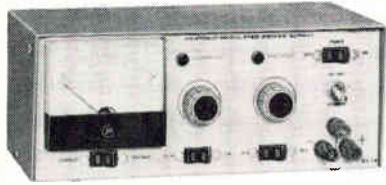
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## New Literature

search Corp., 38 Montvale Ave., Stoneham, Mass. 02180, has issued a technical bulletin describing its series EI incremental encoder electronics modules. [477]

**Breadboard data.** AP Inc., 72 Corwin Dr., Painesville, Ohio 44077. A data sheet describes in detail a highly versatile solderless breadboard providing over 2,000 instant plug-in tie points for use with all dual-in-line packages, TO-5's and discrete components. [478]

**Variable transformers.** The Superior Electric Co., Bristol, Conn. 06010. Sixty-four page Powerstat variable transformer catalog P869 gives ratings, dimensions, performance curves and schematic connection diagrams in easy-to-read, efficient format. [479]

**Trimming potentiometers.** Vishay Resistor Products, 63 Lincoln Highway, Malvern, Pa. 19355, has released a catalog sheet illustrating and describing a line of precision trimming potentiometers with temperature coefficient of  $\pm 10$  ppm/ $^{\circ}\text{C}$  from  $-55^{\circ}$  to  $+125^{\circ}\text{C}$ . [480]

**R-f toroidal inductors.** Vanguard Electronics, Division of Wyle Laboratories, 930 West Hyde Park, Inglewood, Calif. 90302. Miniature and subminiature r-f toroidal inductors are the subject of a six-page brochure bulletin 100. [481]

**Elapsed time indicators.** The A.W. Hayden Co., 232 N. Elm St., Waterbury, Conn. 06720. Seventeen different subminiature, hermetically sealed elapsed time indicators are described in bulletin MI 606-R2. [482]

**Tantalum capacitors.** P.R. Mallory & Co., 3029 E. Washington St., Indianapolis 46206, has available a technical bulletin describing its division's line of TDC solid electrolyte tantalum capacitors. [483]

**Radiation monitoring systems.** Victoreen Instrument Division, 10101 Woodland Ave., Cleveland 44104. A comprehensive 25-page literature package provides a wealth of information on engineered systems for radiation monitoring. [484]

**Automated accounting system.** Clary Datacomp Systems, 408 Junipero Serra Dr., San Gabriel, Calif. 91776, has published a six-page three-color brochure on an automated accounting system for the building materials supply field. [485]

**Transistor chips.** Sprague Electric Co., North Adams, Mass. 01247. Comprehensive short-form catalog CN-164 describes 26 different silicon planar epitaxial transistor chips for use in hybrid circuits. [486]

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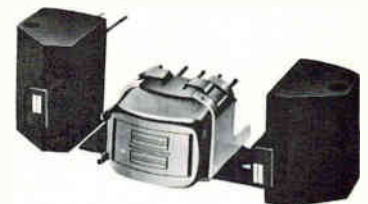
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## New Literature

**Hybrid IC capabilities.** Dickson Electronics Corp., P.O. Box 1390, Scottsdale, Ariz. 85252, has released a brochure dealing with its hybrid integrated circuit capabilities. [487]

**Rfi filters.** Components Corp., 2857 N. Halsted St., Chicago 60657, has issued a catalog describing an expanded line of miniature rfi filters covering 50 wvdc, 100 wvdc, 150 wvdc, 115 wvdc, and 400 wvdc types. [488]

**Subminiature lamps.** Chicago Miniature Lamp Works, 4433 N. Ravenswood Ave., Chicago 60640. A 21-page catalog contains valuable basic design information, technical discussions of the various parameters involved in lamping, and a usable cross reference guide to lamp substitution. [489]

**Test and measurement.** Julie Research Laboratories Inc., 211 W. 61st St., New York 10023, offers a catalog covering the latest d-c techniques for precision test and measurement in general production and engineering areas, as well as in standards and calibration laboratories. [490]

**Component contactor.** Daymarc Corp., 40 Bear Hill Rd., Waltham, Mass. 02154. A revised condensed bulletin describes a triple head contactor for inspecting taped diodes in an automatic system. [491]

**Microwave connectors.** Phelps Dodge Communications Co., 60 Dodge Ave., North Haven, Conn. 06473. A six-page catalog bulletin MMC-1 describes a line of miniature microwave connectors. [492]

**MOS/LSI implementation.** Cartesian Inc., 10432 N. Tantau, Cupertino, Calif. 95014. A 12-page brochure is available to original equipment manufacturers interested in designing their own MOS/LSI circuits and having masks and wafers fabricated by an outside source. [493]

**High-gain antennas.** Andrew Corp., 10500 W. 153rd St., Orland Park, Ill. 60462. Bulletin 8577 covers new high-gain antennas suited for wide area coverage in the 450-470-Mhz band. [494]

**N/C machine systems.** CompuDyne Controls Inc., Hatboro, Pa. 19040. Model "C" N/C machine systems for point-to-point and contour milling are described in the eight-page Bulletin 0569. [495]

**Analog and digital building blocks.** Analex Instruments Inc., 7833 Haskell Ave., Van Nuys, Calif. 91406, has completed an eight-page catalog on its line of electronic solid state digital counters and frequency instruments. [496]

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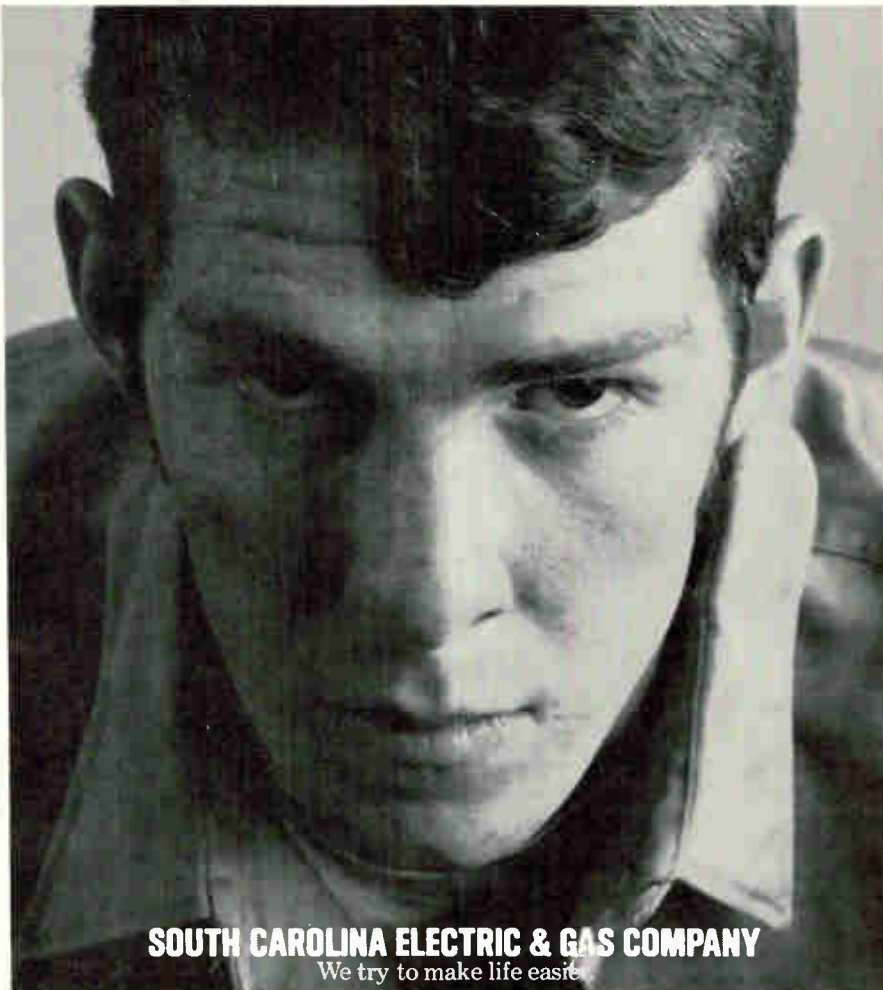
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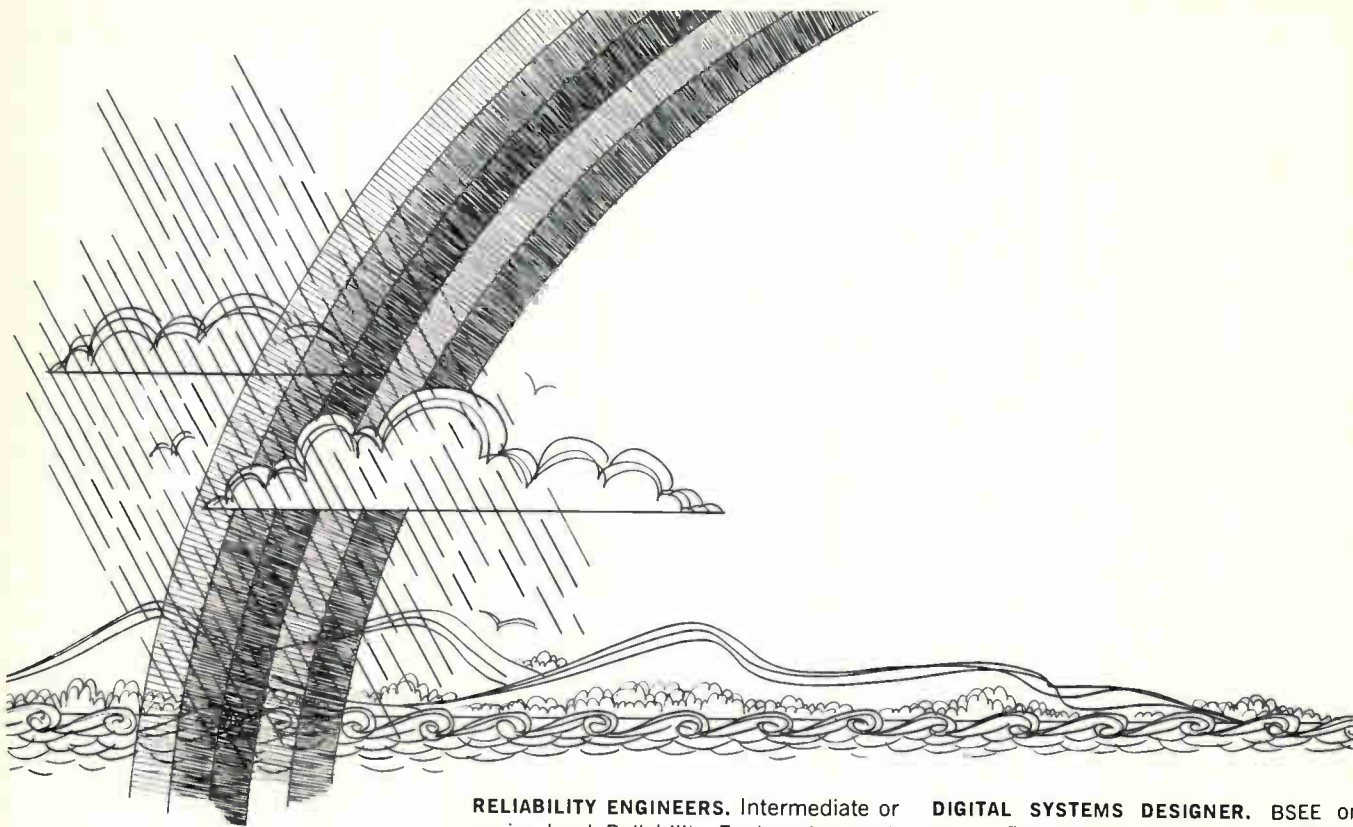
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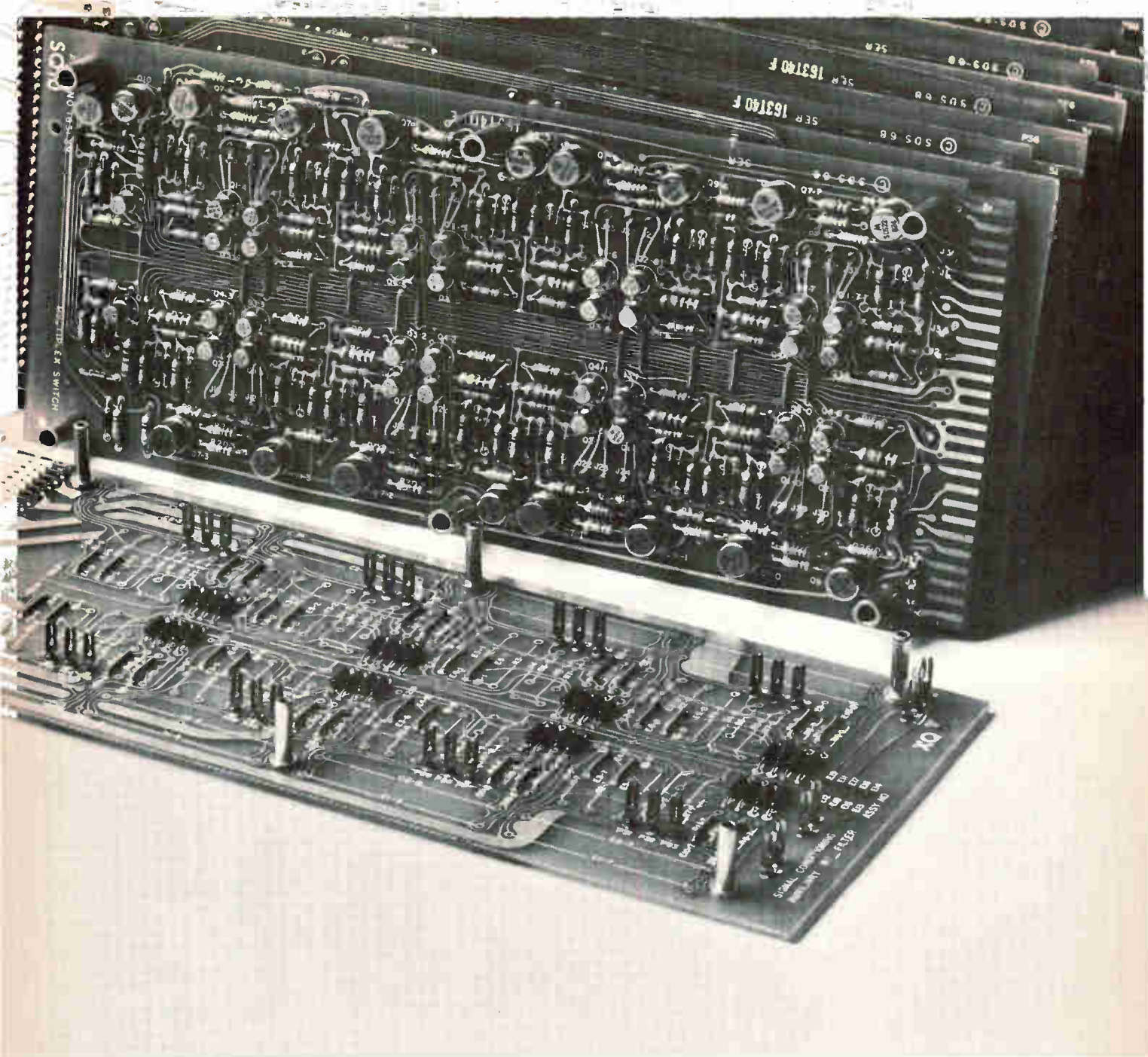
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# International Newsletter

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November 10, 1969

## Mitsubishi expands its computer line with XDS machines

Mitsubishi Electric Corp. has confirmed that it applied for a government go-ahead to manufacture Xerox Data System's Sigma 5 and 7 computers for control applications. Approval is expected in November. Mitsubishi's computer position is the weakest of Japan's six domestic computer manufacturers. At the top of its line are a small, general purpose computer and a process control machine whose capability is near the bottom of the medium-size range.

Competitors are watching with interest. Apart from conceding a good market for the computers in control applications, rival makers wonder whether Mitsubishi will use these computers to attempt a comeback in the general-purpose field. One competitor points out that the Sigma 7 is a rather advanced time-sharing device and with appropriate input-output equipment and programs would be a very respectable general-purpose machine.

## Plessey may gain British NC monopoly

Numerical control of machine tools in Great Britain may get a shot in the arm if the Plessey Co. manages to pull off negotiations for the acquisition of Ferranti's NC division. That step, following its purchase in September of Airmec-AEI Ltd. from Racal Electronics, would give Plessey control of well over 90% of British NC output. It would also lay a foundation for profitable NC activity, which has so far eluded most British efforts. No anti-monopoly action is expected, because U.S. and German companies hold about half the British market, concentrating on the more sophisticated ware. A revitalization of interest in NC should benefit them all, since only about 1% of the nation's machine tool population is NC-equipped now.

## Europe gets another US IC competitor

Another U.S. semiconductor firm is joining the scramble for a piece of the European integrated circuit action. Transitron Electronic Corp. in a few weeks will start assembling dual in-line TTL packages at its two-year-old French semiconductor plant in Normandy. Assembly of U.S.-diffused linear IC's may start by next spring, and the company will push to diffuse IC chips in France "as soon as possible," says French general manager E. Louis Huguenin.

Some sources say Transitron plans to build a new IC plant in the south of France, where Motorola and Texas Instruments already have plants; the company "can't confirm or deny" the report. The French government offers attractive credit incentives and other inducements to firms willing to settle in underdeveloped areas, a factor that could tempt Transitron to go south rather than expand its Normandy facility. The company already diffuses IC's in a plant near London.

## Japan government uneasy over computer export agreement

Long a promotor of exports and a restrictor of imports, the Japanese government is—surprisingly—far from overjoyed by the latest computer export deal. Fujitsu Ltd. has agreed to send two of its Facom 230 model 25 batch-processing computers to Automation Sciences, one of its U.S. representatives. Automation Sciences, based in Jersey City, will supply software and provide maintenance. What troubles Japan's Ministry of International Trade and Industry is that successful export and operation

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# International Newsletter

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of the computers raises the danger that U.S. industry and Government agencies will increase pressure on Japan to liberalize its restrictions against the import of computers.

## Politics, price lead AEG-Telefunken to Asia again

West Germany's chronic labor shortage has become so bad that, instead of importing more workers from the Mediterranean countries, electronics firms are stepping up the export of work to Asia. AEG-Telefunken, the country's No. 2 electronics-electrical company, is combing Asia for its third semiconductor assembly plant there. The company has reportedly narrowed the search to three cities—Manila, Seoul, and Singapore. It already assembles discrete devices at plants in India and Hong Kong. While an inexpensive labor force is one inducement to farm out more work to Asia, the remembrance of a recession two years ago is as important. As one company official points out, it is politically far more palatable to curtail production abroad than it is to lay off workers at home.

## Philips puts fingers in three more pies

Philips Gloeilampenfabrieken, already Europe's top electronics producer, stands to grow even larger—by tapping other company's know-how. In one week it revealed it was entering into a technology-exchange agreement with Fairchild Semiconductor, will promote a video tape recorder cassette system with West Germany's Grundig and Japan's Sony (see p. 236), and will go fifty-fifty with Japan's Matsushita on a dry battery plant. In all three deals, Philips will contribute its marketing or management expertise in return for technological information.

In the potentially most significant agreement, that with Fairchild, Philips will also trade know-how. All the companies will say now is that the agreement covers cooperation between the semiconductor and microwave optoelectronic groups of Fairchild and Philips' Elcoma Division. Fairchild, says one company man, also expects to lean heavily on Philips' marketing organization to gain a larger share of the European market.

## Spain opts for PAL over Secam; Italy, Portugal may follow

Now that Spain has decided to broadcast color television using the PAL system developed by West Germany, other nations are expected to choose PAL over France's Secam plan. Officials of AEG-Telefunken, owners of PAL rights, are understandably happy, since the Spanish move greatly improves the chances for neighboring Portugal to land in the PAL camp. Furthermore, they expect it to strongly influence Italy's decision, as well as that of Spain's overseas territories—Spanish Morocco, for example. Having a foot in North Africa may help PAL beat back Secam there; up to now the split between the two has been more political than technical, with the East Bloc nations going for Secam and Western Europe for PAL.

## Austria may get new Bull-GE plant

General Electric is looking in both Spain and Austria for a site to build a new computer manufacturing plant. And Austria may have the edge. Josef Krainer, governor of Styria province, visited GE's computer headquarters in Phoenix, Ariz., went home to his capital, Graz, where it's understood that GE would be more interested if the city decided to install a Bull-GE time-sharing computer. What's more, Austria would be a good base for more Eastern European business; Bull-GE has already granted a manufacturing license to Czechoslovakia's Tesla plant.

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# Silicon-target video tube moves toward commercial market

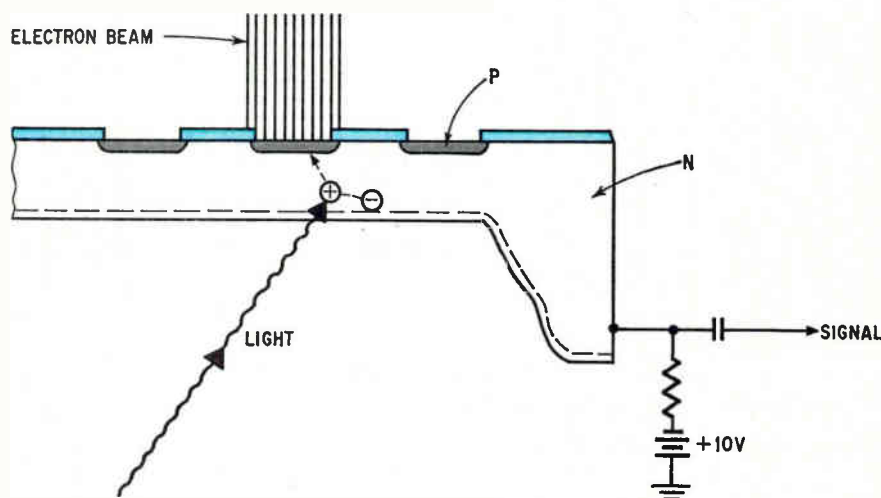
West German firm's Telecon is unaffected by high light intensities, yet performs at lower light intensities than vidicon and plumbicons and has a longer lifetime; serial production will start sometime next year.

**Silicon**, a basic material for the solid state devices that have replaced vacuum tubes, may even find a place in television pick-up tubes. In West Germany, AEG-Telefunken has just released details of a promising commercial video tube built around a silicon light-sensitive target. Called the Telecon, the tube is superior to the widely used vidicon and plumbicon tubes in almost every respect. Its operation is unaffected by high light intensities, yet it exhibits a much greater light and spectral sensitivity, and it can last longer in harsh environments.

To be sure, tv camera tubes with silicon targets, have already been built in the U.S. and are now also being developed elsewhere in the world. But those of U.S. origin are intended primarily for military purposes and are therefore too expensive for commercial applications. AEG-Telefunken, however, could well be the first—at least in Europe—to market a silicon-target pick-up tube for commercial and industrial uses. Serial production will start sometime next year and first units should hit the market early in 1971.

The Telecon's basic construction and operation are roughly the same as those of ordinary video pick-up tubes. A highly concentrated electron beam scans one surface of the target. The image to be transmitted is focussed on the other surface. The target converts and stores the optical image as a charge pattern until the electron beam starts its scanning operation.

In conventional tv camera tubes this conversion and storage proc-



**On target.** One million diodes on the surface of the silicon target serve to store then convert light image into signal during electron beam scan.

ess takes place in thin amorphous semiconductor layers—in an anti-monide tri-sulphite layer in the vidicon and in a lead oxide and lead sulfide layer in the plumbicon. These layers, however, are sensitive to mechanical forces, to high temperatures and especially to high light intensities—and are limited both in application and operating life.

**Diode.** The Telecon's target is a multidiode disk about the size of a quarter-dollar coin and from 10 to 25 microns thick. There are about 1 million planar diodes on an area of 1.28 by 0.96 centimeters in size. The diode diameter is from 5 to 8 microns and the distance between the centers of adjacent diodes is from 10 to 15 microns.

The scanning electron beam charges each diode to a reverse voltage whose magnitude is from 5 to 10 volts. Light hitting the

other side of the target produces electron-hole pairs which cause the diodes to discharge. The charging current required is proportional to the light intensity, giving video signals that vary as a function of light intensity.

At a signal current of, say, 200 nanoamperes, the Telecon's sensitivity to light is around 20 times greater than that of the vidicon or plumbicon. AEG-Telefunken gives credit for this to the considerably higher quantum yield possible with single-crystalline silicon compared with that of the amorphous semiconductor layers, which have many recombination centers.

The silicon target's spectral sensitivity range, too, is higher than the vidicon's or the plumbicon's. In fact, its sensitivity extends well into the near infrared region, thanks to the characteristic distance between energy bands in the

silicon. And the maximum sensitivity is shifted further towards the longer wavelengths in the spectrum—an important plus in color-tv applications.

The Telecon also shows excellent resistance to residual signals, or afterglow, an effect which shows up as blurs that follow a moving object across the screen. In the Telecon, residual signal effects are caused only by the energy distribution of the scanning electron beam and are relatively low, 4% compared with the vidicon's 20%.

Still another Telecon feature is the insensitivity to high temperatures and high light intensities. With vidicons and plumbicons elevated temperatures or light intensities tend to set off thermal and photochemical reactions in the semiconductor layer. These reactions form bad spots in the layer which, in turn, lead to tube failure. The Telecon has no such troubles. Not even a camera flash unit set off directly in front of the tube will harm the target.

Therefore, the Telecon's operating life is determined only by the life-time of its cathode and not by the semiconductor material. If long life cathodes are used, the Telecon can, under optimum conditions, last twice as long as the other types—up to 20,000 hours. Under non-optimum conditions, such as prevail in steel plants and in traffic control, the Telecon's life can be 100 to 1,000 times longer than that of the other two tubes.

**Bugs.** AEG-Telefunken says for perfect picture reproduction, 99.999% of the diodes would have to be absolutely perfect—no more than 10 diodes out of 1 million could be defective. So far, the company has obtained a yield of 99.99%. For many closed-circuit tv applications—in traffic control, for instance—such yield can be tolerated. But the firm is striving to obtain a better diode yield.

AEG-Telefunken says that initially at least the Telecon will cost more than either a plumbicon or a vidicon. However, the company expects the Telecon's long life, together with its other performance

characteristics, to more than offset its initial higher costs.

### Japan

#### Toward compatible vtr's

With video tape recorder magazines and cartridges beginning to proliferate (see below), one Japanese maker has decided to hold back until 1972—even though it has a complete working system ready for production right now.

Matsushita Industrial Co. Ltd., which is more widely known by its Panasonic brand name, wants to avoid a repeat of the initial fiasco in reel-to-reel video tape recorders—when no two companies used a compatible format, making interchange of tapes from machine to machine impossible, and seriously hampering market growth. Instead, Matsushita has scheduled a long lead period—not for product development, but for selling the vir-

tues of its system to other companies and for making any changes necessary to secure industry cooperation.

Matsushita's vtr can record and playback a half hour of color or black-and-white program material. Developed jointly by the company's production development laboratory and video tape recorder department, Matsushita considers the system satisfactory in its present form. Prototype units directly record and play back NTSC color signals—and color reproduction is clear and faithful. Sound is on the tape, and everything needed in a commercial product is included. Only thing missing is agreement from other Japanese companies that the new system is the most suitable—so that production can be standardized. The prototype measures a compact 13.9 inches wide by 14 inches high by 5.1 inches high. It can be played while being carried as well as stationary.

The company says that with development of a magazine-type vtr

### And another vtr from Sony

Even in electronics six months may seem like a short lifetime, yet the color video tape recorder with magazine load announced by Sony just last spring [*Electronics*, May 12, p. 239] is already dead. In its place the company is promoting a machine with a far smaller tape cassette. And, the company says it has reached tentative agreement with Philips and Grundig on the tape format and cassette design—and is aiming at establishing the system as the worldwide standard.

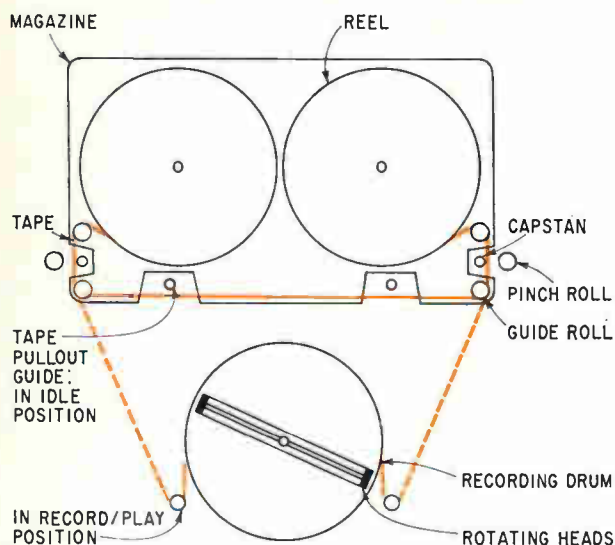
Sony's video cassette measures 8 by 5 by 1¼ inches and weighs one pound. Inside is enough ¾-inch tape operating at 8 centimeters per second for 1½ hours playing time. The cassette contains a counter so that borrowed tape can be charged for by the number of plays. There are two sound channels for stereo or for two languages.

Sony says it started work on this unit because the magazine introduced earlier was too large. It says it expects to start sales in Japan toward the end of next year, and



in its largest market—the U.S.—at some later date. Sony feels that with mass production the price in the U.S. will be about \$350, and the 90-minute cassette about \$20.

The Sony cassette is designed so that the magnetic coated side is in, and the tape is pulled out of the cassette and over the recording drum. Tape wind on the drum is equivalent to the omega wind, but because of geometry it is a U wind, because it doesn't double back. Reels are omitted as in Philip's audio cassette for compactness. The recorded signal is processed NTSC signal, rather than pure NTSC signal as recorded by Matsushita.



Inside. Matsushita's magazine holds tape, coated side in, on two reels, but rollers turn it around for correct wrapping at recording drum.



Outside. The magazine, the size of a large book, drops into recorder. The reels can be removed for operation on reel-to-reel machines.

it has solved the three basic problems associated with these units. First, earlier this year it solved the problem of high speed tape duplicating [*Electronics*, March 31, p. 181]. Second, the automatic loading feature of the new recorder makes for easy handling. Unlike the earlier-announced Victor recorder [*Electronics*, June 23, p. 213], it can record a full hour and the magazine can be removed from the recorder at any point on the tape. Third, the new recorder provides inexpensive NTSC-compatible color.

**Package.** The new Matsushita magazine looks like an oversize version of the Philips cassette used in audio recorders, but it is relatively longer because it includes two reels. Matsushita opted for the reels for two reasons. They provide smoother tape feed and takeup, which is very important in video recorders where jitter causes serious picture degradation. And reels allow the tape to be removed from the magazine and played on a standard reel-to-reel video tape recorder conforming to the new standard format [*Electronics*, September 29, p. 197].

Even with reels, the magazine is no larger than a book and can be stored on a bookshelf. It measures 10.6 by 6.4 by 0.9 inches.

For compatibility with reel-to-reel operation the tape is wound

coated side in, rather than out as in the Philips cassette. Then the magazine has four slots, which fit over two capstans and two movable tape guides. Two capstans are used to insulate motion of the tape at the recording drum from vibration at the reels. They also make it possible to play the recorder while it is being transported. Two-capstan drive has been limited to use on professional video tape recorders and on computer tape handlers. The two guides are moved outward during recording and playback to force the tape against the drum.

**Advances.** Two developments, have enabled Matsushita to allow direct recording of NTSC color—without any preprocessing or use of a pilot signal. Improved hot-press ferrite magnetic recording heads designed for improved magnetic circuit efficiency and better gap geometry make it possible to record frequencies up to 10 megahertz on 0.5-inch magnetic tape operating at 7.5 inches per second.

Also, Matsushita has developed an improved double heterodyne automatic phase control system that removes jitter from the playback signal. Double heterodyne APC systems have been used on costly studio recorders for this purpose, but Matsushita engineers had a more difficult job than the studio designers. Inexpensive recorders

have more jitter, so the new system had to be able to pull in a signal over a wider range of phase difference—and be inexpensive.

### Cutting cost of DDC . . .

High cost of backup controls has kept Japanese users from rushing to adopt direct digital control, despite its many promised advantages. To ensure that a plant will remain in operation even during digital computer failure they feel they must provide conventional analog-type controls as a backup for the digital computer. Thus the system costs almost as much as conventional controls and computer hardware combined.

Now, Toshiba has come up with a far less expensive answer. It has designed an input-output station that handles both the hold function needed for computer output interface and the analog-type control needed for backup. A single operational amplifier is used for both functions, and it can be switched from one mode of operation to the other without change in output for bumpless changeover.

Although the new Toshiba controller performs the same functions as standard analog controllers, it has been simplified because it is used as an analog controller only when the computer is down. For

example, meters replace servo indicators. Thus, the controllers are suitable for some users who want an economy line of instruments—only operating convenience is sacrificed to obtain low cost, not accuracy or reliability.

**In parallel.** Process variable signals are fed in parallel to the central processor and the input-output station. During normal DDC operation, however, only the input to the central processor is effective. Output from the computer is fed through the station—which operates as holder—to process the unit being controlled. In this mode the operational amplifier feedback and input resistors are not required.

If the computer fails, the input end of the hold capacitor is switched to ground so that the output value remains the same, and passive components needed for analog control are switched into the circuit. Process variable signals now feed directly into the station, through a subtracting point where the set point value is compared to give error voltage.

If the set point of the controller is the same as that of the computer the switchover will be bumpless. For most DDC controls the computer set point doesn't change, so that once the controller set point is adjusted to match the computer set point no adjustment is needed. If the station's process is operating normally the error voltage meter on the panel should be in zero center position, the controller set point can be adjusted to equal the computer set point by adjusting the set point control until the meter reads zero.

### ... and an end to hunting

Toshiba has already modified its DDC analog controllers for processes that have dead times as long or longer than system's time constant. Dew point controls and conveyor belts are examples.

Ordinary analog controls tend to hunt or respond sluggishly when used to control processes of this type. Toshiba engineers say that two general methods of handling this problem are to use rather

expensive digital controls, or to simply give up on automatic control. Digital controllers can be used because they can make control action proportional not only to error at a given time but also to errors at previous times.

Toshiba engineers analyzed the problem mathematically and discovered that they could perform automatic control with a modified conventional analog controller. It is essentially the controller developed for DDC applications with the addition of motor-driven sampling switch and with a few circuit modifications.

Toshiba's new control is designed so the change in output is proportional not merely to error signal at the instant of sampling but also to the previous error signal—which is stored in the input capacitor. If the present error signal is smaller than the previous error signal, the amplifier input signal is the difference between the present and previous signals, with polarity opposite to that of the previous signal. This mode of operation prevents the control from greatly overshooting the target value.

For proper operation of this control it is necessary to match the operational amplifier gain, integration time constant, sampling period, or time from one sample to the next, and length of time that the process is sampled to the process being controlled. Matching of controller parameters to process can usually be performed empirically.

When error voltage is sampled, controller output voltage changes abruptly by an amount dependent on controller gain and error voltage. Output then continues to change during the remainder of sampling time because of integration. A hold capacitor between output and ground is charged up to amplifier output voltage at the end of the sampling time. After the sampling period this capacitor is reconnected between input and output terminals of amplifier to hold output voltage steady until the next sample is taken. At the same time, another switch disconnects one end of the input capacitor so that it stores voltage across its terminals until the next sampling period. Actually,

voltage across input capacitor is a function of all previously impressed error voltages.

Proportional gain of this controller can be adjusted continuously between 2% and 500%. Integration time constant can be adjusted between 0.01 minute and 3 minutes in 11 steps. Typically sampling time is 3 seconds, with a maximum of 30 seconds. Maximum hold time between samples varies with the model from 3 to 60 minutes.

## France

### Solar power from CdT

A major thrust in bringing sun-power to the consumer is being prepared these days in, of all countries, France—whose third place in the space race has generated scientific prestige though little industrial fallout up to now. But at a photography show now being held in Paris, a French firm is showing the world's first amateur movie camera powered by solar cells. A French sun-powered wristwatch is also being developed, and an inexpensive, 8-watt array of solar cells capable of running a tv set is ready for a buyer.

All these developments are the result of research work in cadmium telluride solar cells done for the French space program by a Paris subsidiary of Philips Gloeilampenfabrieken, La Radiotechnique-Compelec (RTC). Virtually the only company with an important CdT effort—most of the world's other solar cell makers concentrate on silicon or cadmium sulfide—RTC has refined its CdT production techniques to the point where it can turn out a continuous thin-film sheet of the pliable material and literally slice it with a paper-cutter into low-cost squares that convert light into electricity. RTC's production process involves evaporating evenly-sized grains of cadmium telluride onto a molybdenum backing. Copper telluride is then vacuum-diffused over the CdT, forming the p side of a semiconductor junction of which the CdT is the n side.



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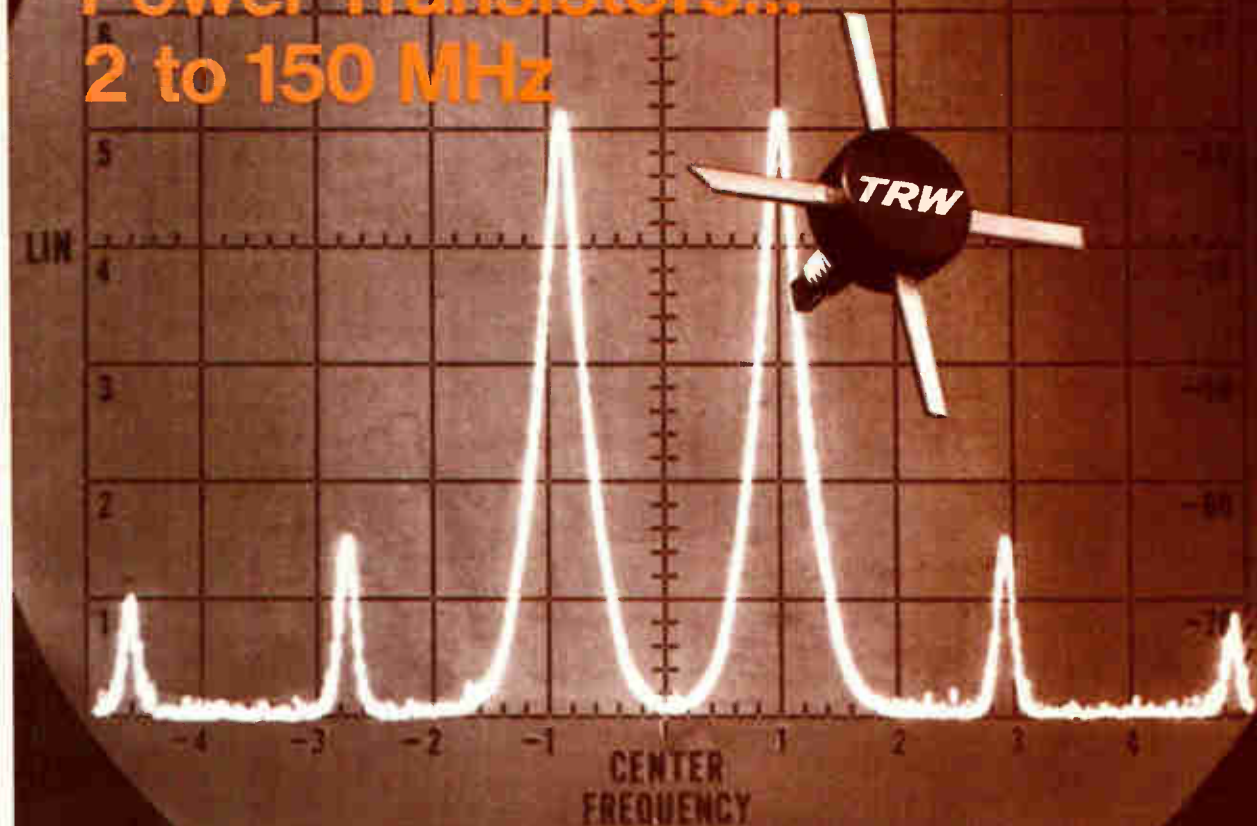
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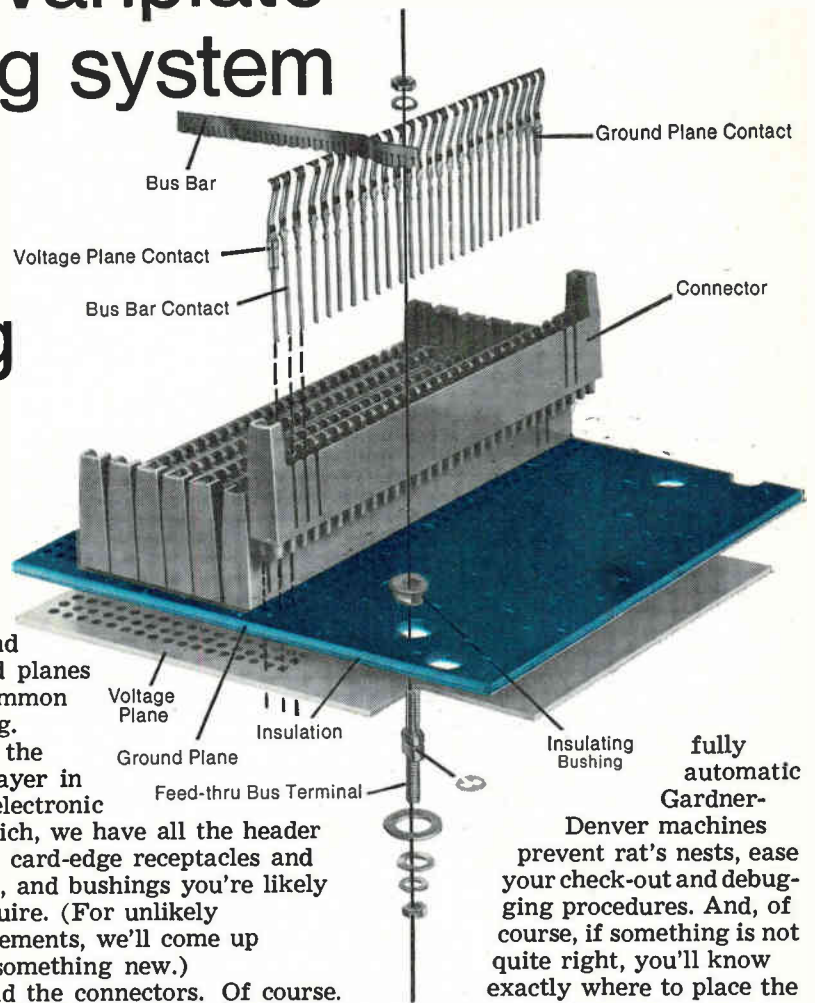
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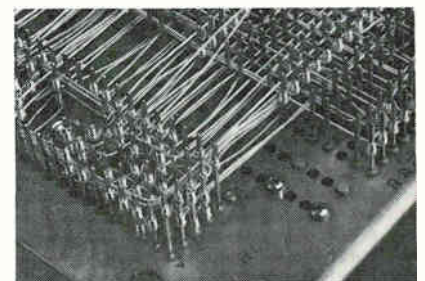
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3	22	41	60	79	98	117	136	155	174	193	212	231	250	269	288	307	326	345	364	383	402	421	440	459	478	497	516	964
4	23	42	61	80	99	118	137	156	175	194	213	232	251	270	289	308	327	346	365	384	403	422	441	460	479	498	517	965
5	24	43	62	81	100	119	138	157	176	195	214	233	252	271	290	309	328	347	366	385	404	423	442	461	480	499	518	966
6	25	44	63	82	101	120	139	158	177	196	215	234	253	272	291	310	329	348	367	386	405	424	443	462	481	500	900	967
7	26	45	64	83	102	121	140	159	178	197	216	235	254	273	292	311	330	349	368	387	406	425	444	463	482	501	901	968
8	27	46	65	84	103	122	141	160	179	198	217	236	255	274	293	312	331	350	369	388	407	426	445	464	483	502	902	969
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15	34	53	72	91	110	129	148	167	186	205	224	243	262	281	300	319	338	357	376	395	414	433	452	471	490	509	957	976
16	35	54	73	92	111	130	149	168	187	206	225	244	263	282	301	320	339	358	377	396	415	434	453	472	491	510	958	977
17	36	55	74	93	112	131	150	169	188	207	226	245	264	283	302	321	340	359	378	397	416	435	454	473	492	511	959	978
18	37	56	75	94	113	132	151	170	189	208	227	246	265	284	303	322	341	360	379	398	417	436	455	474	493	512	960	979
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**Power Loading:** 16 watts/in.<sup>2</sup> standard with aluminum oxide substrate .015"-.040" thick. Substantially higher with heat sinking and beryllia substrates.

**Terminations, Conductors and Land Areas:** Platinum gold, palladium gold, gold and silver, depending upon application. Crossovers can be made. Lands for attaching active or passive components can be provided.

**Moisture Changes:** Meet Method 103, MIL-STD-202.

**Resistor Patterns:** Thick film resistive materials with resistivities from 1 ohm/sq. to 1 megohm/sq. can be used. Patterns can be made from 1/10 square to 10 squares.

**Capacitors:** Screened = .01  $\mu\text{fd}/\text{Chip}$  = up to 5  $\mu\text{fd}$   $\pm 10\%$  to  $\pm 20\%$  or GMV. Dissipation Factor = Less than 1.5%. Working Voltage = 50V.

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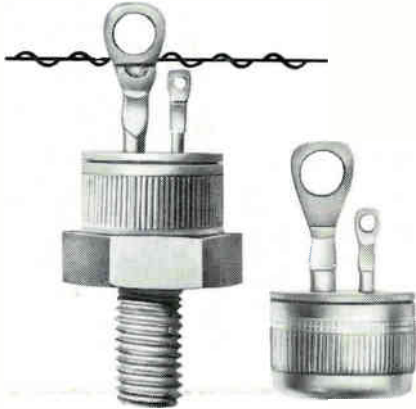
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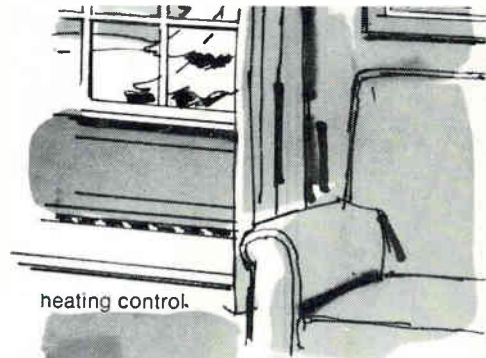
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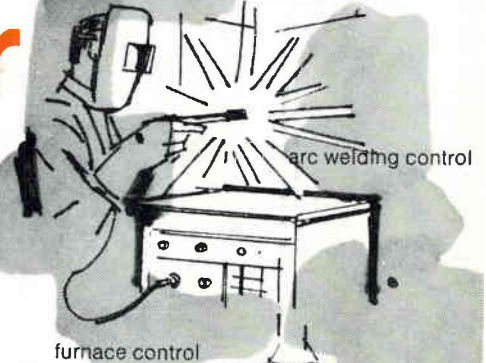
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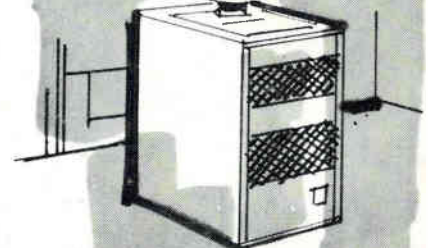


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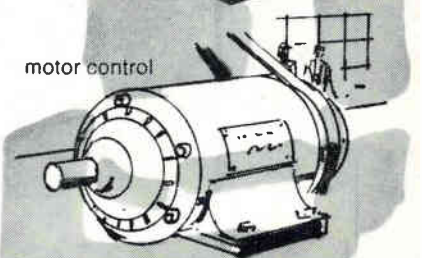


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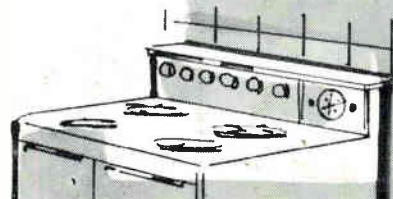
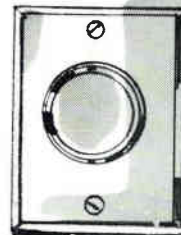
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