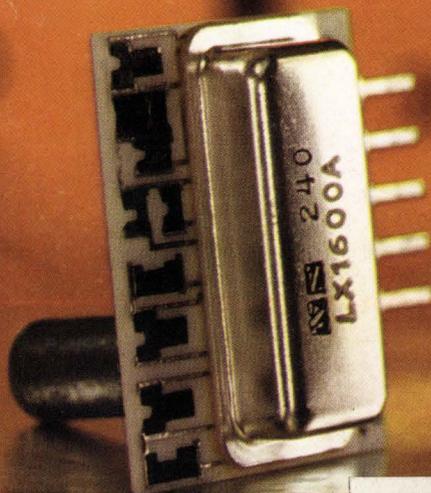


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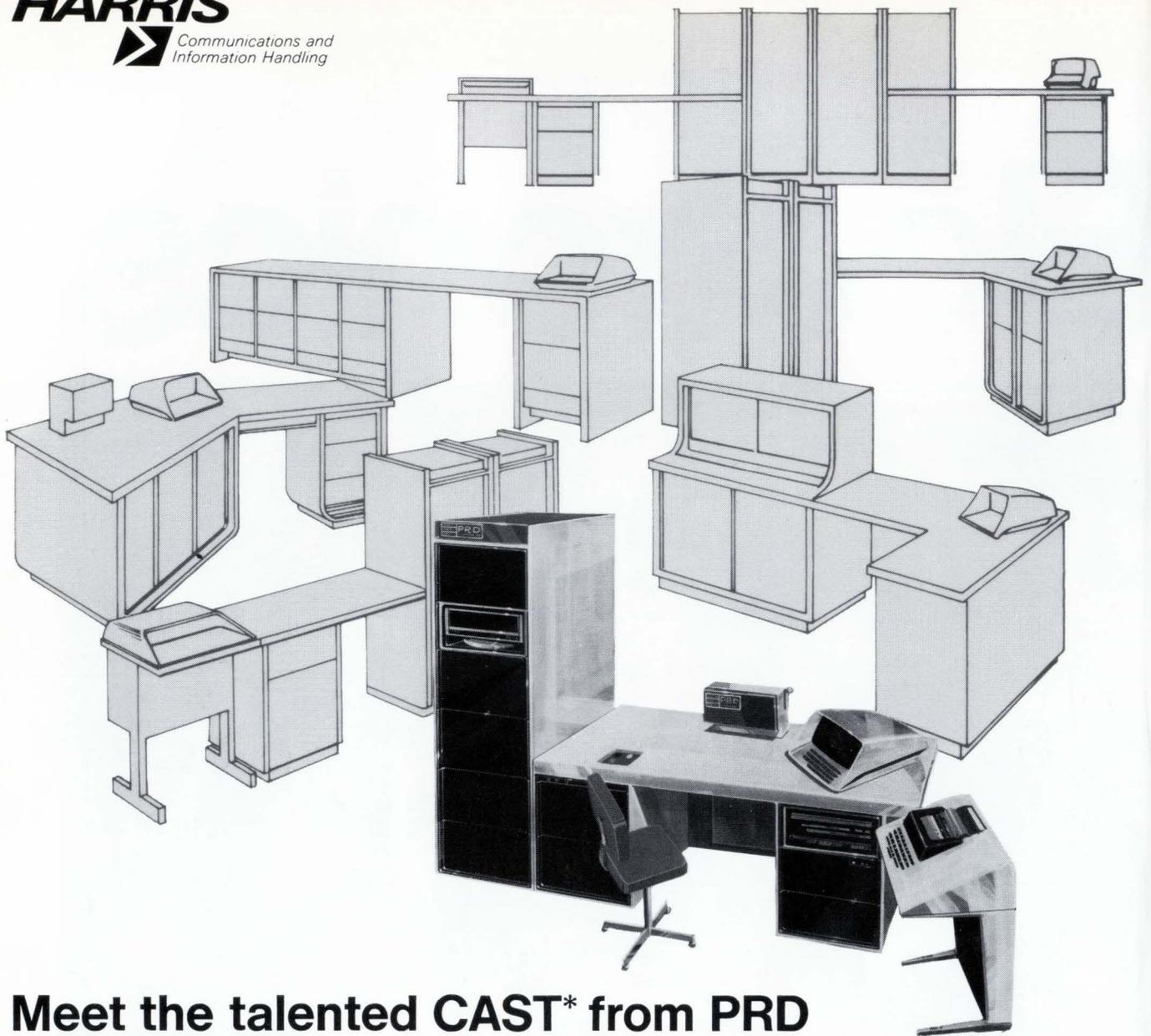


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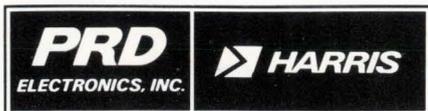
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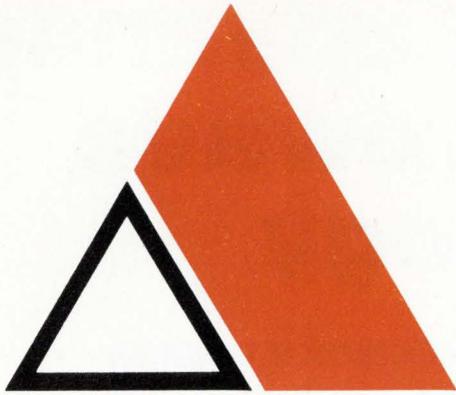
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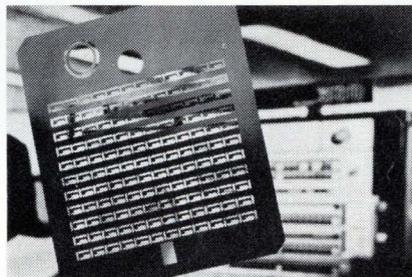
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## Until you try HP's new IC Troubleshooting Partners, you'll never know how simple logic circuit testing can be.

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And HP's new 10525T Logic Probe checks the result. A single, unambiguous light at your fingertips tells you exactly what's going on. If no pulse is detected, something's wrong.

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For other applications, the HP 10528A Logic Clip monitors all pins of DIP TTL/DTL IC's simultaneously. Use the Clip with the Pulser — the Pulser injects clocks, transfers, shifts, etc. HP 10528A Clip, \$125.

All three troubleshooters team up as the 5015T Troubleshooters Kit for \$285 which gives you a 10% discount and a handy carrying case to boot.

For more information on these and other IC Troubleshooters call your local HP field engineer or write Hewlett-Packard, 1501 Page Mill Road, Palo Alto, California 94304; Europe: P.O. Box 85, CH-1217 Meyrin 2, Geneva, Switzerland; Japan: Yokogawa — Hewlett-Packard, 1-59-1, Yoyogi, Shibuya-Ku, Tokyo, 151.

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### Where the new offshore labor markets are, 69

Malaysia and Portugal are already providing electronic-component manufacturers with low-cost labor. Hong Kong, an older offshore labor source, is suffering from the rising wages typical of economies with nearly full employment.

### The first IC-style transducer, 83

Fabricating transducers in the form of hybrid ICs not only brings them into line with the other components of an electronic system—it radically simplifies calibration and testing. High accuracy becomes practical at low cost.

### Japanese EEs are bidding to be No. 1, 94

The continued success of their electronic products has bred in Japanese EEs a self-confidence that now aims to originate, not imitate. They rely on a team approach to problems, but as team members work more interdependently than is usual in the West.

### Transferred-electron devices go commercial, 102

Now that practical TE oscillators and amplifiers have arrived, they demand—and in this article get—an evaluation of their merits in relation to other microwave components.

### And in the next issue . . .

*Electronics'* nation-by-nation forecast of the European market . . . optimizing a memory system with the 4-kilobit RAM.

### The cover

Pressure gage is upstaged by National Semiconductor's integrated-circuit approach to transducer fabrication.

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Japan is halfway around the world, but for Jerry Walker getting there to gather material for our annual Japanese market survey (see p. 91) was nothing compared with the hazards of getting around Japan.

Walker and our Tokyo bureau manager, Charles Cohen, visited dozens of companies and talked with scores of industry representatives both in Tokyo and other cities. Cohen snapped the photo below in Tokyo as Walker talked with Sony Corp.'s senior managing director, Noboru Yoshii.

It was on their way to Yokohama that the most dramatic of the travel hazards struck. A typhoon hit with its hurricane-force winds and heavy rains as they drove from Tokyo to interview executives at Nippon Electric Co.'s wireless communications division. "The main problem," Jerry recalls, "was that we were not the only ones crazy enough to be out in the storm. The traffic congestion was horrendous."

Another travel hazard occurred in Osaka on the way to interviews at

Sharp Corp. Cohen and Walker took a taxi that turned out to be one running on liquid petroleum gas, which is less expensive than gasoline but, at least in this taxi, produced a sickening exhaust odor. The taxi also had an exhaust leak that poured the fumes into the car.

"It took us 3 minutes of choking and gagging before we could go into the interview, which really scared the solicitous receptionist," Jerry reports. "I wished then that the Japanese had perfected the electric car."

But offsetting the hazards were some pleasant events. "For one, Matsushita raised the American flag at its corporate headquarters during our visit, a touch of hospitality typical of the company. For another, the trip back to the hotel from the Sharp visit was in one of the host company's fancy limousines. And it did not run on LPG."



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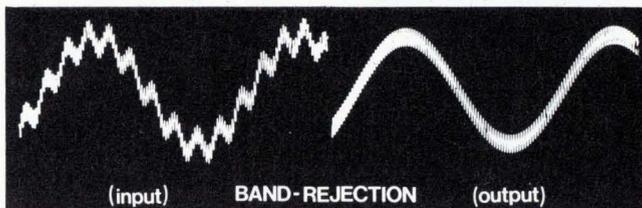
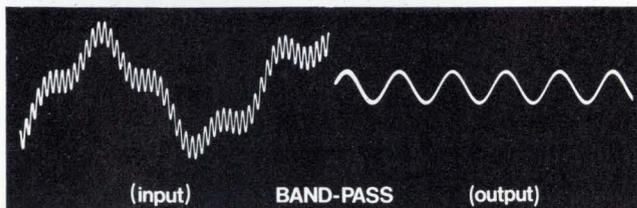
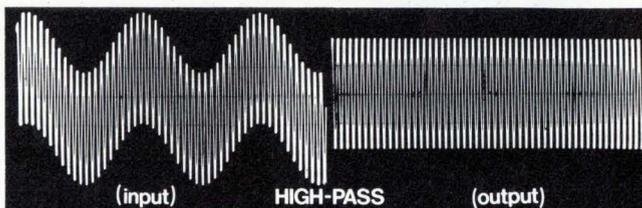
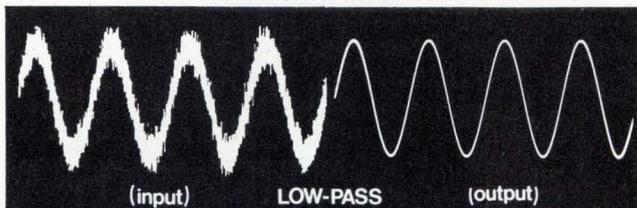
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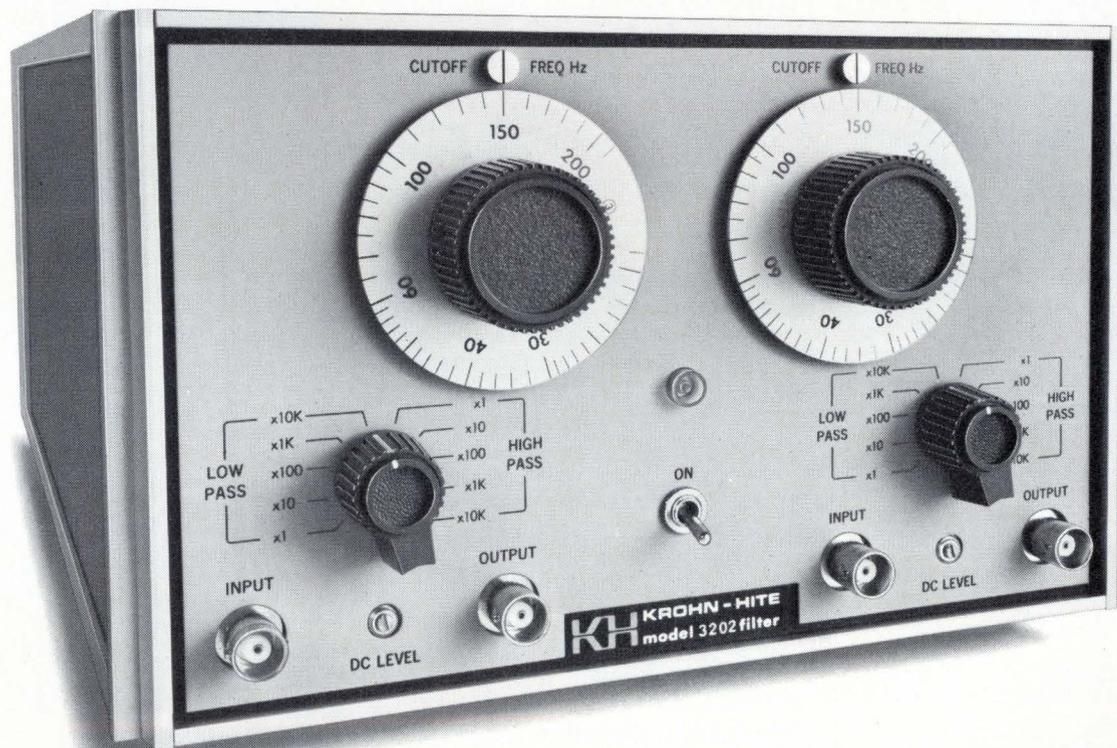
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## Readers comment

### Pioneer people mover

**To the Editor:** It is disconcerting to read your article on people movers [*Electronics*, Sept. 11, p.74], which omits credit to the pioneer in the field, Alden Self Transit Systems Corp., of Milford, Mass.

It was Alden that foresaw the need, developed years ago the system on which the Morgantown project is based, and did the preliminary work leading to that project. Others entered the picture much later. Alden, which has a major subcontract on the Morgantown project, also holds basic patents in the people-mover field.

Sidney Hoffman  
Senior vice president  
Proctor, Cook & Co.  
Boston, Mass.

### Signal generator noise

**To the Editor:** Your *Electronics* newsletter [Aug. 28, p. 22] contains an item stating that Hewlett-Packard is just announcing a new signal generator. It is emphasized that the noise feature of 140 decibels per hertz is an order of magnitude better than that of other solid-state signal generators.

Marconi Instruments' solid-state model 2012, which equals this performance, was introduced at the IEEE conference in 1970. Since that time, we have added to our line of low-noise signal generators with the models 2011, 2013, etc.

Keith Elkins  
Manager  
Marconi Instruments  
Englewood, N. J.

■ *We should have said that the H-P generator's noise figure is an order of magnitude better than that of other general-purpose solid-state signal generators, since it spans the frequency range from 450 kilohertz to 550 megahertz. The Marconi 2012 provides more limited coverage (400 MHz to 520 MHz), and it is specifically intended for testing uhf/fm narrow-band receivers. The other two Marconi instruments are also single-band units: the 2011 covers 130 to 180 MHz, and the 2013 covers 800 to 960 MHz.*



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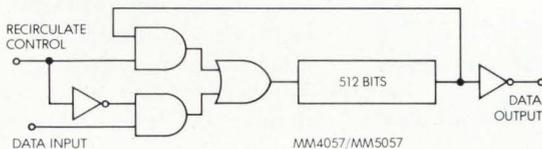
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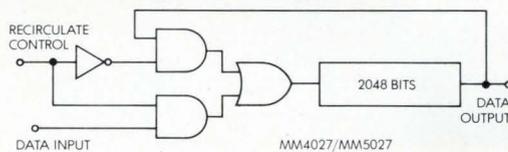
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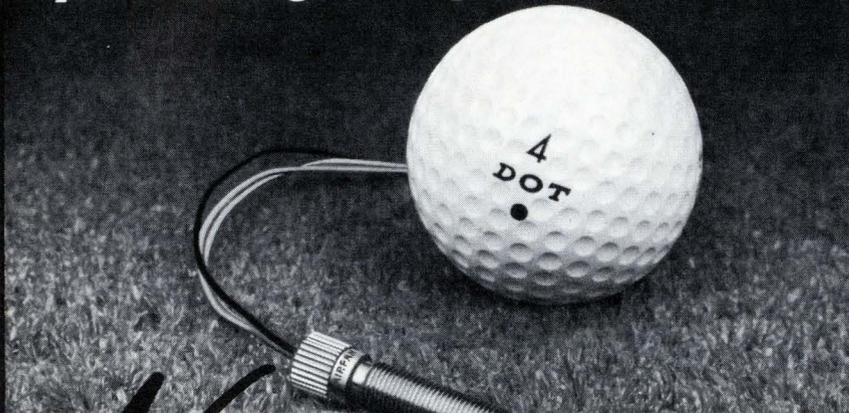
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## 40 years ago

From the pages of Electronics, November 1932

The coming of Dr. Albert Einstein to the United States to serve as a member of the Princeton College faculty will remind many electrical men here that the wizard of relativity has a personal reputation in electronics and electrical invention, quite independent of his mathematical abstractions. His best-known electrical device before the European public is undoubtedly the "Einstein piano," a musical instrument which employs the vibrations of piano strings to actuate microphones, the output of which can then be modified by electrical circuits to produce a variety of instrumental effects.

By changing switch contacts, various familiar standard instruments can be reproduced, or the player may soar off into new Einsteinian harmonies, creating musical notes of timbres and qualities never before heard in nature.

**Electrical failure** in radio and electronic circuits is too often caused by mechanical failure. This is mainly due to wear, inadequate strength, and insecure bracing.

Volume controls, rheostats, loudspeaker moving coils and cones, jacks, switches, and relay armatures and contacts are subject to mechanical wear when in use.

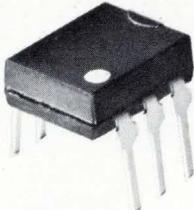
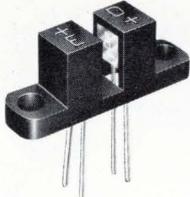
Tube-socket contacts, brittle lock soldering lugs, and insecurely fastened wires, especially when soldered too cold, often cause electrical trouble by their mechanical weakness. Overrated resistors get too hot and often change their resistance or break, rendering the circuit less sensitive or inoperative. Frequently the fastening and bracing of heavy parts is inadequate. Too often the electrical designer overlooks these points.

**When is a radio set not a radio set?** When it is mounted on an automobile, says Uncle Sam. For then, according to the obliging official interpreters of the United States Treasury, a radio receiver is no longer such, in the eyes of the law, but becomes an "automobile accessory," taxable at 2 per cent instead of 5 per cent.

# GENERAL ELECTRIC

# OPTOELECTRONIC

# COUPLER LINEUP

			
<p><b>H10 SERIES COUPLERS</b></p> <ul style="list-style-type: none"> <li>• 3 hermetically packaged models offer choice of SSL-Photo-transistor, SSL-Photo-darlington and SSL-light sensitive SCR</li> </ul>	<p><b>H11 SERIES COUPLERS</b></p> <ul style="list-style-type: none"> <li>• 6 models offer interchangeability with popular industry types</li> <li>• H11A1 and H11B1 offer 50% and 500% min current transfer ratios respectively</li> <li>• 2,500V isolation</li> </ul>	<p><b>H13 SERIES INTERRUPTER MODULES</b></p> <ul style="list-style-type: none"> <li>• 4 models offer "no contact" switching for use with shaft encoders, counters, position sensing, keyboards and limit switch application</li> </ul>	<p><b>H15 SERIES COUPLERS</b></p> <ul style="list-style-type: none"> <li>• 4000V isolation</li> <li>• 4 low cost models for pulse transformer replacement, SCR and TRIAC triggering</li> <li>• Solid State reliability at low cost</li> </ul>

OUR NO. 1 GOAL:  
TO MAKE  
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YOUR BEST BUY

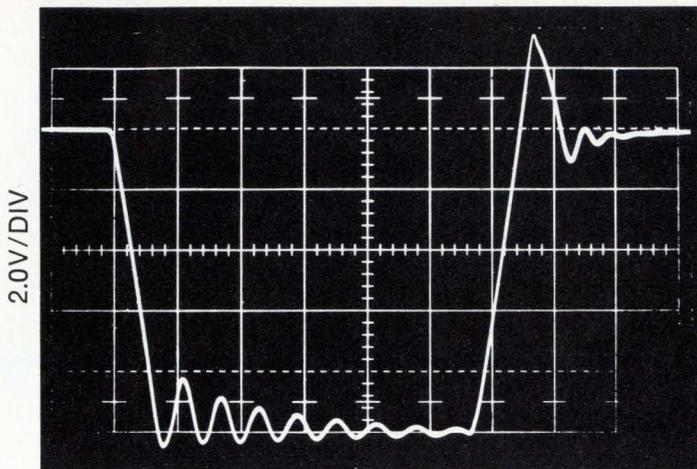


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# National's 118: Some good news. Some bad news.

If you only have a few National 118's in stock, you're in luck!  
Send us one and we'll send you two of our AMD 118's.  
(Put one back in stock and put the other into test.)  
Two to a customer, please. We're excited, not crazy.

## The National 118 is a good product.



0.2 $\mu$ s/DIV

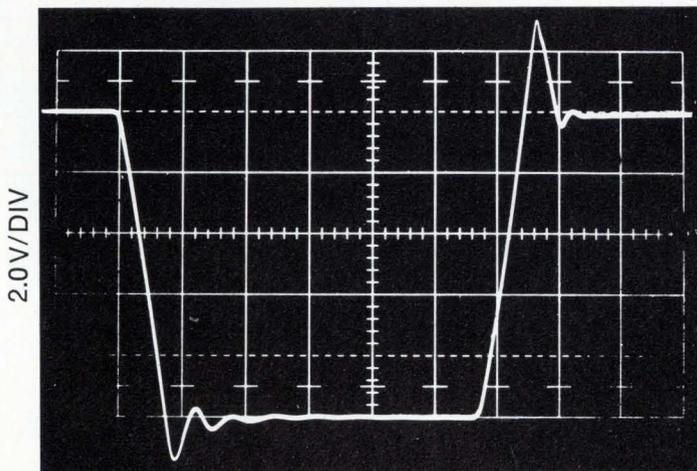
It's a high speed linear op amp that does magical things in A to D convertors, active filters, sample and hold circuits and wide band applications.

It comes in three temperature grades with these super specs: Slew rate, 70 volts per micro-second! Input offset voltage, 2mV. Input bias current, 120nA. Offset current, 6nA. Voltage gain, 200K.

It's internally compensated. If you want to add external compensation, you can double bandwidth and slew rate.

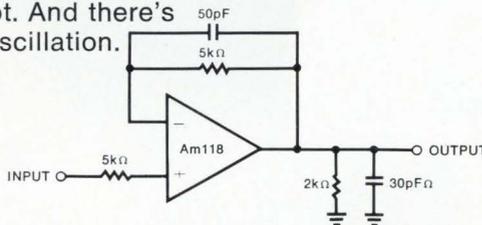
It's a good product.

## But AMD's 118 is a great product.



0.2 $\mu$ s/DIV

Significantly better. It has all those specs and something more. It's more stable. Its phase margin is 35° with less than 2db overshoot. And there's no oscillation.



Both scope pictures were made using this voltage follower, slew rate test circuit.

Did you know we're going to be the sixth largest integrated circuits company in the United States by 1975? Do you know how? One product at a time.



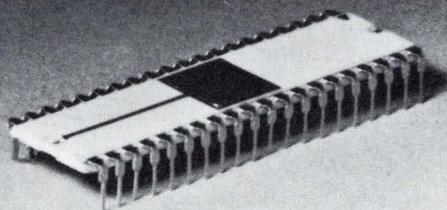
# Advanced Micro Devices

(We're going to be #6)

Distributed nationally by Hamilton/Avnet and Cramer Electronics. Telephone 800-538-7904 toll free, or in California 408-732-2400, and ask for Shel Schumaker. In Los Angeles, Steve Zelencik or Russ Almand at 213-360-2102. In Mid-America, Chuck Keough at 312-297-4115. In the eastern United States, Steve Marks or Bill Seifert at 516-676-4500. In the Northern California area, Dave Haun at 415-967-7031. 901 Thompson Place, Sunnyvale, California 94086/TWX 910-339-9280/TLX 346306.

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# THANKS TO THIS GREAT LITTLE NUMBER!



successfully manufactured in MOS before. Precise resistor networks so necessary for close harmonic control were a must, and a major breakthrough was made in this area. Using series and/or parallel combinations of single resistor geometry, matched and close tolerance networks, MOSTEK was able to meet HAMMOND'S requirements in significant fashion: the finished design

put 34 networks on a single chip! Coupled with proven technology, this unique technique has opened the doors to new solutions for other industries and a multitude of applications. What are the implications for your product? Call or drop us a line: we're ready to go to work on *your* challenge!

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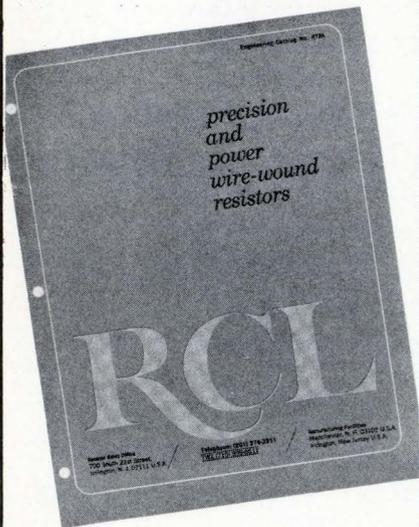
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## People

### Hart finds tight ship at TRW Components

Many executives would like to be in the shoes of George J. Hart. He's just officially taken over as vice president and group executive of the Electronics Components division of TRW Inc., and the division he has headed de facto since June is a profitable business; he's not expected by his superiors to do a house-cleaning job.

Until this promotion, Hart was vice president of the Cinch unit of TRW, where he worked 34 years. But he doesn't expect any big surprises: "The parts of TRW I now head serve much the same market as Cinch—my main concern is to continue the growth and profits." Under his wing are such diverse components operations as TRW Semiconductors, Globe Motors, UTC Transformers, Cinch-Graphik and Cinch Connectors, Holyoke Wire and Cable, IRC Potentiometers and Resistors, TRW Capacitors, and TRW Automotive Electronics. But the company is always looking for other opportunities through internal growth and acquisition.

"The company expects to grow about 10% across the board next year," says Hart. "But we want to grow in a very controlled manner, using a rifle, not a shotgun, approach. For example, our semiconductor operation is studying and working on integrated circuits—we even make SUHL [transistor-transistor logic] for the phone company—but we have no intention of pouring money in to go after Fairchild or Motorola."

Hart does feel that the biggest opportunities lie in development of markets the division already serves, observing that "we're very heavily involved in the computer business. We find our computer business improving, especially in a number of products we gambled on a few years ago."

Anticipating close relations with other parts of the TRW organization, Hart points out, "We use the marketing arm of automotive divisions in talking to people about our au-

tomotive electronic products, and also have close ties with our systems people to take advantage of their technology and talent, as in compacting powders, their work in LSI, and in packages. They also look at trends for us."

Hart finds overseas promising. "There are many opportunities offshore, especially in Europe," he remarks. "Because of antitrust problems here, we expect to be more active in acquisitions in Europe than in the U.S."

### Litton's EW team enlists "fastest human"

Competition is still the name of Mel Patton's game, but as the new marketing vice president for Litton Industries' Amecom division outside of Washington, he is running a different kind of race than he has in the past. He achieved fame in 1948 at the University of Southern California, where he was tagged by sportswriters as "the world's fastest human" after running 100 yards in what was then a record-shattering 9.3 seconds. That same year, the 24-year-old Patton won two gold medals for track performances at the Summer Olympic Games in London. And in 1949 he added two more world records while running for USC.

Now 48 and somewhat heavier,



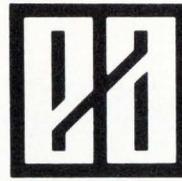
Patton: Sprinter runs Litton's "spook shop."

## INTRODUCING THE EA 1502 BIPOLAR COMPATIBLE 1024-BIT RAM

The EA 1502 is another new addition to the growing line of N-Channel silicon gate products from EA. The EA 1502 accepts TTL inputs without external level shifting and sinks 1.6 mA on the output. It has an access time of typically 130 nanoseconds and dissipates only 115 mW (typical). In fact, in a systems configuration the EA 1502 outperforms the so-called high performance versions of the 1103, with lower power, bipolar compatibility, automatic refresh and low cost to boot! Oh yes, there's no address cycling requirements either. A single write pulse refreshes all data independent of the state of the address and chip enable inputs. Place your order early, everyone else is. \$27.50 in 100 quantities.

To make it easier for you to evaluate our EA 1500 series RAM's, we have an evaluation P.C. board available which contains all of the necessary interconnections for building a 2K by 4 memory. Ask about it!

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# hp MEASUREMENT NEWS

innovations from Hewlett-Packard

DECEMBER edition

## in this issue

New calculator-based network analyzers

Quick and quiet digital plotter

The "portables" get a lift

## A new standard in AM/FM generators

HP's solid-state successor to the time-proven 608 signal generator.

For more than 20 years, the HP 608 series VHF signal generators have generally been recognized as the standard of the industry. Now, we introduce a solid-state VHF generator series with wider frequency coverage (450 kHz to 550 MHz), increased modulation capability (FM as well as AM), better stability, and impressive spectral purity.

The 8640 generators deliver low-noise signals that, until now, could be attained only with vacuum-tube generators. Non-harmonic and sub-harmonic outputs are down more than 100 dB and noise is less than -130 dB/Hz at 20 kHz offset from the carrier. Extremely clean

*(continued on page 4)*



Texas Instruments Incorporated  
Keyboard Products Marketing  
MS 12-33/DE  
Attleboro, Mass. 02703

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Company \_\_\_\_\_

Address \_\_\_\_\_ City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Keyboard application: Pocket Calculator  Computer Terminal  Desk-top Calculator

Credit Card Verifier  Personal use  Other \_\_\_\_\_

Application is new  or existing  Approximate annual usage \_\_\_\_\_ units

Application requires: Basic 1KS keyboard array  Complete 6KS keyboard assembly

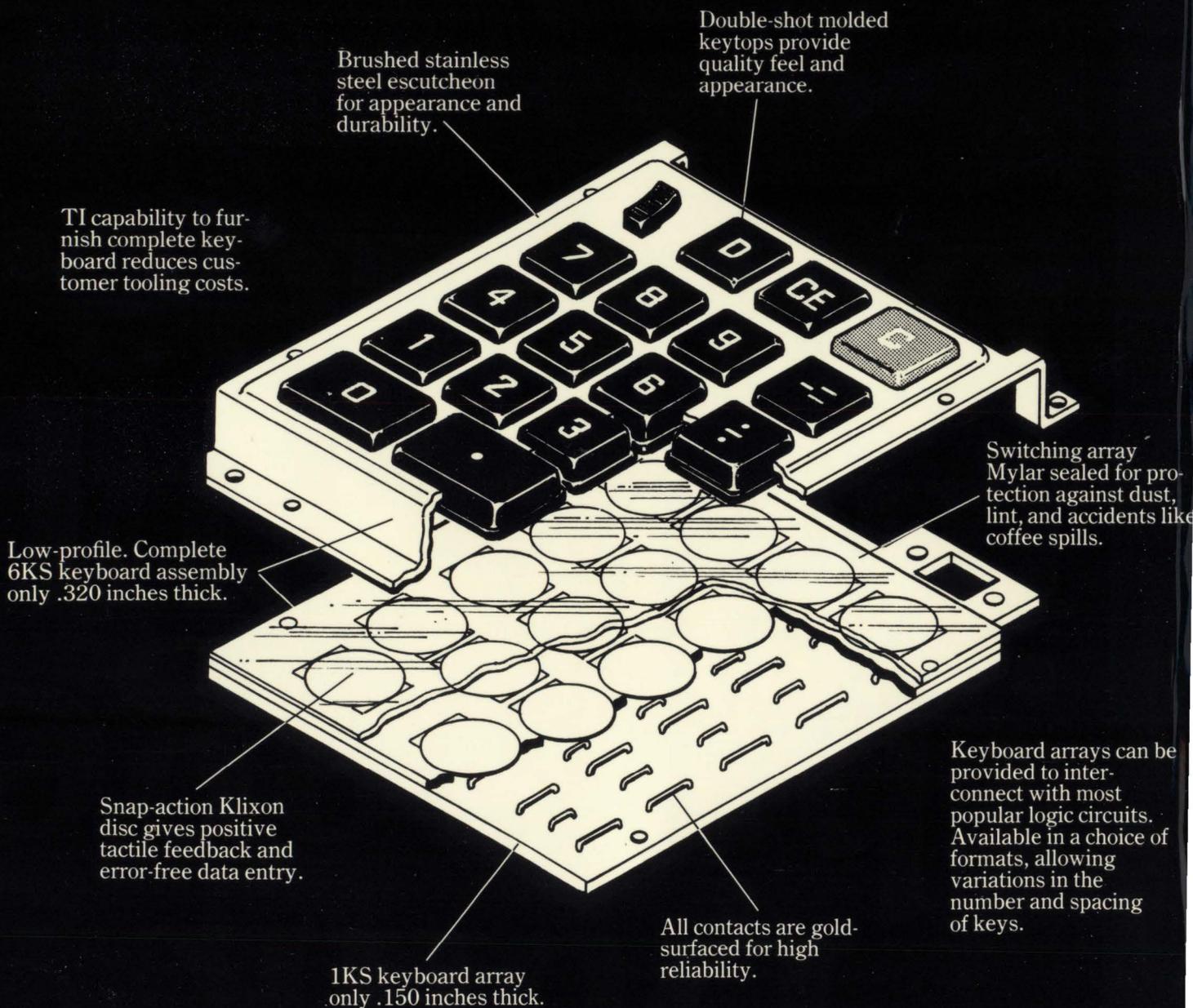
Please send additional information on:

TI optoelectronic displays  TI calculator integrated circuitry

Please have a TI Sales Engineer call



## Now read about the exclusive gold disc keyboards from Texas Instruments.



## Choose independent or tracking power outputs

# Three new solutions to your network analysis problems

You don't have to run diagnostics; the HP calculator executes network analysis self-calibration programs to maintain system accuracy.

Two versatile lab supplies each house two identical 50W regulated power supplies. A convenient front panel switch lets you select either independent or tracking operation. In the tracking mode, the right supply tracks the left within  $0.2\% \pm 2 \text{ mV}$ . Tracking mode is especially useful for powering operational amplifiers, push-pull stages, deflection systems, or any application where plus and minus voltages must track with insignificant error. The independent mode lets you operate the two supplies individually, in auto-parallel or in auto series.

Each side of the dual supply can be operated as a constant voltage or constant current source, and each has its own crowbar for overvoltage protection. In the tracking mode, an overvoltage condition in either supply trips both crowbars.

Output ratings for the 6227B (each side) are 0—25 V at 0—2 A; for the 6228B (each side), 0—50 V at 0—1 A. Price: \$495.

For specifications, check J on the HP Reply Card.

HP 6227B dual-output power supply.



What happens when you combine a network analyzer with a calculator? You get automatic testing of gain, phase and group delay.

Designed primarily for the production line and R & D lab, HP's new 3040A, 3041A and 3042A network analyzers measure gain with 0.01 dB resolution, phase with  $0.01^\circ$  resolution, and delay with 20 choices of split frequencies (or an unlimited number under calculator control). Point-by-point, swept and differential measurements can be made.

The 3040A is a manual network analyzer with a frequency synthesizer as the source and a two-channel selective tracking detector. With the synthesizer as a stable, accurate frequency standard, all measurements are precise. Use the 3040A to characterize narrow-band devices with extremely high Q.

The semi-automatic 3041A is controlled by a marked card programmer via the new ASCII interface bus. The card programmer adds limit testing capability. Simply mark the test on a card, then run it.

The 3042A runs under control of an HP 9820 programmable calculator. An ideal manufacturing and research tool, this automatic network analyzer can be operated manually or programmed by magnetic cards. The ASCII bus simplifies programming and interfacing. The calculator handles simple decision-making and performs high-level statistical manipulation of test data.

Prices range from \$6,900 to \$22,900.

For network analyzer information, check C on the HP Reply Card.



# Hewlett-Packard Series 9800. The Name And Number That'll Shorten Your Path From Concept To Final Solution.

Get your hands on a Series 9800 Calculator System and you'll experience why it's the shortest, simplest path. From the outset you're certain to notice four outstanding features.

The modular, *plug-in architecture* that lets you design your own keyboard. The choice of *memories* that lets you pick the capacity you need today — with room to grow for tomorrow. The extensive line of Series 9800 *Peripherals* that lets you handle data in the form best for your operation. And the *instrument interface* that lets you plug in test instruments for real-time data acquisition.

But one Series 9800 feature really stands out. *Conversation*. Our calculators "speak" English, German, French, Italian, Spanish — even Japanese. In complete words and sentences, and scientific symbols. To solve a problem you set up a dialogue with your 9800 Calculator. Talk to it through the key-

# New automatic system delivers accurate RF signal analysis

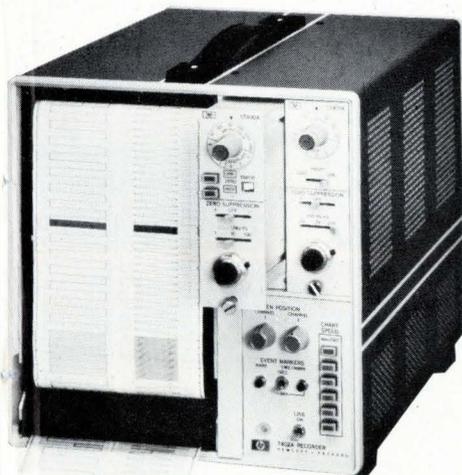
## New two-channel recorder sets new standards for sensitivity and trace

Any two-channel oscillographic recorder offers the versatility of plotting two events at once, but HP's new 7402A recorder lets you select and vary the sensitivity according to your requirements. A choice of three preamplifiers plug into the mainframe for sensitivities of:  $1\mu\text{ v/div.}$  with differential, floated and guarded input;  $1\text{ mv/div.}$  with differential, balanced to ground input; and  $20\text{ mv/div.}$  with single-ended input.

Because the 50 mm chart width is 25% wider than other comparably priced recorders, the writing resolution is 25% better. After two months of continuous use, HP's new stainless steel pens with carbide tips had no measurable pen fatigue.

Select chart speeds from 1 to 125 mm/sec. Frequency response is  $\pm 2\%$  of full scale from dc to 40 Hz, and rise time is 7.0 to 7.5 ms. A complete working system starts at \$1740.

To learn more about the new two-channel recorder, check L on the HP Reply Card.



Preamplifier modules easily slip into the 7402A recorder mainframe.



Shown here testing a UHF component, the HP 8580B serves as a cost-effective production test station.

Knowing signal power at critical frequencies is essential for communications system operators; for agencies that manage the radio spectrum; and for manufacturers who design, build and maintain RF systems.

Now, HP's 8580B spectrum analyzer performs frequency-selective signal strength measurements automatically, from RF through microwave. This new system measures signal characteristics in a congested environment to aid in spectrum management or in the control of communications systems. The 8580B also characterizes signal sources and frequency translators as well as linear networks—which means you can test mixer, modulators, oscillators and receiver front-ends.

Wide frequency coverage, 10 kHz to 18 GHz, is automatic. Multiple inputs measure signals from several sources. Frequency accuracy is better than 3 parts in  $10^7$  at 18 GHz. The receiver can tune in increments as small as 5 Hz, with analyzing bandwidths as narrow as 10 Hz. Measurement range is +30 to -130 dBm.

Automatic operation, combined with an easy-to-use keyboard and control panel, means your operator won't require extensive training. Or let the system run unattended, with HP software doing the work.

Prices start at \$96,400.

To learn more, check O on the HP Reply Card.

Dear Gabby

"They laughed when I sat down at the TTY. Until I started programming our New Automatic Test System!"



Datatron's Girl Gabby

**D**EAR GABBY: I'm an ordinary test operator (blonde, beautiful and 36/23/36) and what I know about computer programming you could put on the head of a pin. Yesterday, our Datatron 4400 Automatic Test System was installed, and I spent this morning with your people learning how to program. After lunch they said: "Go ahead and run a test." A bunch of the guys in our department started laughing when I sat down at the Teletype. That is, until I started operating your beautiful tester. Believe me, I had the last laugh.

NOT A PROGRAMMER



**D**EAR NOT: Your experience is typical. Datatron's IC testers are the easiest of all to program. We train operators in the morning and by afternoon they're running tests and writing new programs in simple English merely by responding to questions from our com-

puter. As you well know, programs are assembled into machine language while being generated, editing is done on line, and new programs can be generated while tests are underway.

GABBY

★ ★ ★

**D**EAR GABBY: I'm mad. When our firm bought one of your IC testers I thought I'd get a two week trip to your plant to learn how to program the beast. That's what your competitors promised me. And I was looking forward to visiting Disneyland.

BROKEN HEARTED TEST OPERATOR

**D**EAR BROKEN: Sorry about that. But it's wise to beware of the tester manufacturer who insists on operators taking two or more weeks of intensive factory software training. Your company might have ended up with a programmers' nightmare instead of a functioning system. And your IC tester might have turned into an IC-berg with thousands of added dollars in submerged software charges.

GABBY

★ ★ ★

Send your questions — either straight or humorous — to Gabby. We'll mail a Flair pen for all received and pay \$100 if we use question in future ad.

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## Meetings

**International Conference on Magnetism and Magnetic Materials:** AIP, IEEE, et al., Hilton, Denver, Nov. 28-Dec. 1.

**National Telecommunications Conference:** IEEE, Astroworld, Houston, Dec. 4-6.

**International Electron Devices Meeting:** IEEE, Washington Hilton, Washington, D.C., Dec. 4-6.

**Annual Fall Conference:** IEEE, Sheraton-O'Hare, Chicago, Dec. 4-5.

**Fall Joint Computer Conference:** AFIPS, Convention Center, Anaheim, Calif., Dec. 5-7.

**Nuclear Science Symposium:** IEEE, Deauville, Miami Beach, Dec. 6-8.

**USNC/URSI Meeting:** URSI, IEEE, Williamsburg Conference Center and College of William & Mary, Williamsburg, Va., Dec. 12-15.

**Business and Equipment Exposition:** NRMA, New York Hilton, New York, Jan. 7-10.

**Aerospace Sciences Meeting:** AIAA, Sheraton-Park, Washington, Jan. 10-12.

**International Solid State Circuits Conference:** IEEE, Marriott, Philadelphia, Feb. 14-16.

**Aerospace and Electronic Systems (Wincon):** IEEE, Sheraton-U. of Pa., Philadelphia, Feb. 13-15.

**IEEE International Convention (Intercon):** IEEE, Coliseum and New York Hilton, March 26-29.

**Southwestern IEEE Conference and Exhibition (Swieeco):** IEEE, Houston, Texas, April 4-6.

**International Symposium on Circuit Theory:** IEEE, Four Seasons Sheraton, Toronto, Canada, April 9-11.

**International Magnetics Conference (Intermag):** IEEE, Washington Hilton, Washington, D.C., April 24-27.

## The lowest noise yet for HF transistors

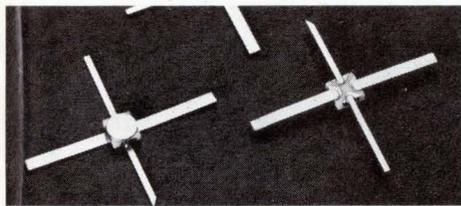
The lowest guaranteed noise figure ever offered in a microwave transistor is here—and it's priced below all other low-noise transistors on the market. The new 35870 series small signal NPN device boasts a guaranteed *maximum* noise figure of 2.3 dB at 2 GHz and 3.3 dB at 4 GHz. *Typical* noise figures are lower, of course: 2.0 dB at 2 GHz and 3.0 dB at 4 GHz.

The new transistor has plenty of gain, too: typically 14.8 dB at 2 GHz, 9.6 dB at 4 GHz, and 6.4 dB at 6 GHz ( $f_{max}$  is 14 GHz).

Price: only \$90 each in 100+ quantities.

For details, check D on the HP Reply Card.

HP's new low-noise microwave transistors come in a rugged metal-ceramic package.



## New low-cost beam-lead Schottky diode

High-level detection, switching, gating, A/D conversions, sampling and wave shaping are only a few applications for HP's new beam-lead equivalent of our 5082-2800 Schottky diode.

With fast switching, this device is ideal for applications that require large numbers of high frequency diodes or as replacements for P-N junction diodes.

Breakdown voltage is 70 V; reverse leakage current, 200 nA; capacitance, 2 pF; and carrier lifetime, 100 pico-seconds. At UHF frequencies, the diode has 95% rectification efficiency. Priced at 99¢ in small quantities.

To learn more, check F on the HP Reply Card.

## New packaging protects PIN diodes

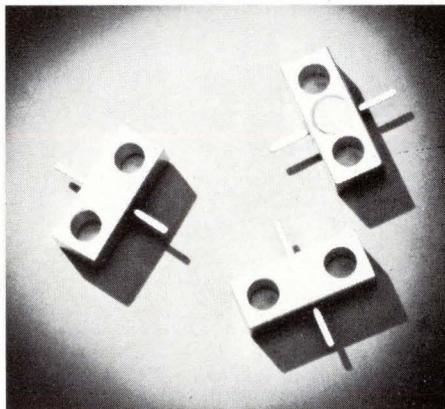
Three new 100 MHz to 12 GHz PIN diodes are available in hermetically-sealed stripline packages which pass MIL specs for a variety of environmental tests. The 5082-3140 device is for general applications from VHF through X band. Model 5082-3170 has similar characteristics but is reverse polarity. Both handle 30 W of power; dissipation is 2.5 W.

The fast-switching 5082-3141 device is also useful where low bias current is needed for maximum attenuation. Switching time is 5 ns. Power handling ability is 13 W; dissipation is 1 W. Isolation is > 20 dB for all three devices.

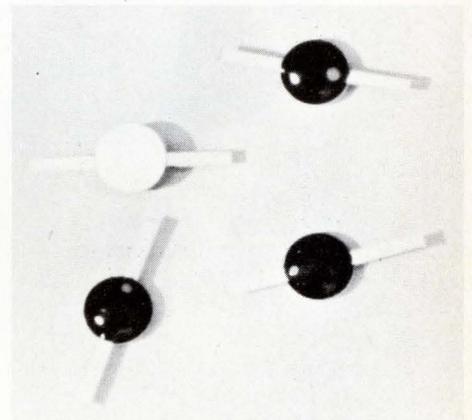
Prices: \$25 each in quantities of 1-9, and \$21.50 each for 10-99. Delivery is from stock.

For hermetic diode details, check G on the HP Reply Card.

The HP 5082-3140 hermetic stripline diode.



## New microwave stripline Schottky diodes



These low-noise stripline diodes are only 0.1 inch (2.5 mm) in diameter.

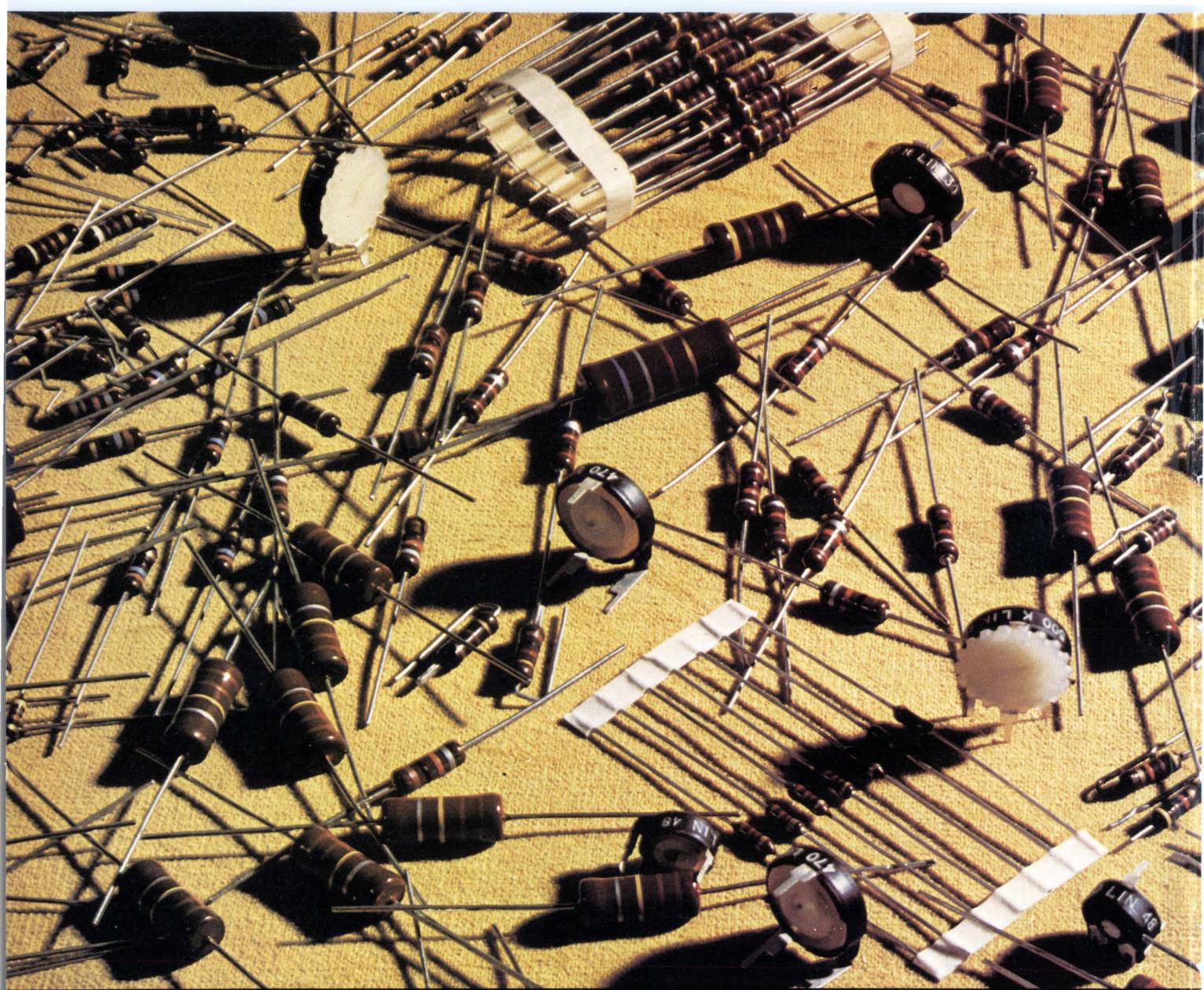
For economically-priced microwave mixer Schottky diodes, consider four new low-noise devices from HP. In the 1-4 GHz range, the 5082-2213 diode has a maximum noise figure of 6.0 dB and a VSWR of 15:1. The lower-priced 5082-2215 model has a typical NF of 6.5 dB and a maximum VSWR of 2:1.

From 4 to 12 GHz, the 5082-2217 diode has a maximum NF of 6.5 dB and a VSWR of 1.5:1. The lower-priced 5082-2219 series has a typical NF of 7.0 dB with a VSWR of 2:1.

Uniformity of RF characteristics is assured so that you can replace these components in the field without circuit adjustment. Typical applications include telecommunications receivers, microwave synthesizers, ECM and radar front ends.

In quantities of 1 to 9, the 5082-2213 costs \$8.25 each; 5082-2215, \$6.00; 5082-2217, \$12.50; and 5082-2219, \$9.00.

For more information, check E on the HP Reply Card.



# From start to finish



No licence agreements, no sub-contract work. From start to finish we are in control of every product that goes out to you, the customer, bearing the name Piher. We take a pride in the name. We take a pride in our products. That's why we are now a world leader in component technology.

Don't take our word for it. Let the facts speak for themselves.

We produce over 7 million carbon film resistors per day to meet world demand and have the largest variety of quality preformed resistors available anywhere.

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# We pack more performance into less space



## and save you up to 50¢ on your dollar.

Amphenol's new 303 Series MINIform coaxial switch line is the answer to today's biggest component problem: Getting higher performance, using less space at the lowest possible cost.

High performance we have. From 0 to 1.0 GHz, the MINIform switches handle up to 150 watts CW, maintain maximum VSWR of only 1.1:1, 80 dB minimum crosstalk attenuation and 0.1 dB insertion loss. Maximum VSWR over the 1.1 through 3.0 GHz range is only 1.2:1 with power handling capabilities up to 70 watts CW.

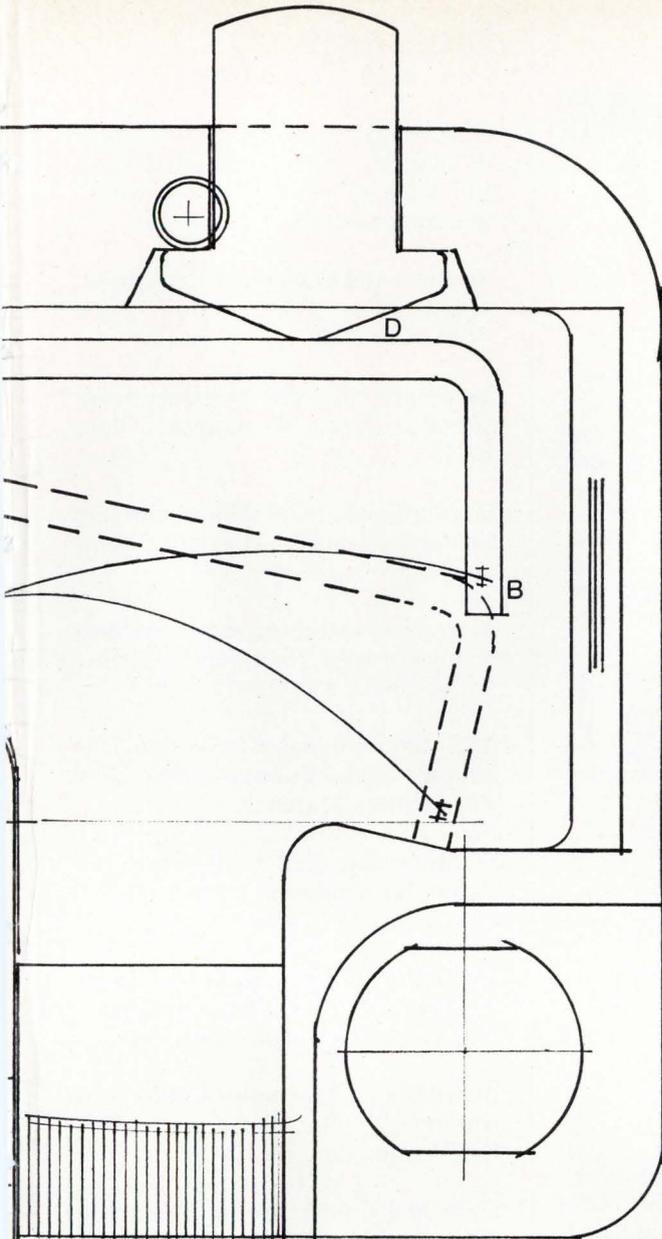
True to their name, MINIform switches weigh only 1.2 ounces and occupy less than ½ cubic inch of precious space.

Three popular termination styles are available: SMA connectors, Amphenol SUB-Minax 27 Series connectors and pc contacts for solder or solderless wrap terminations.

To find out more about MINIform and how it can cut your switch costs in half, write to Amphenol RF Division, Bunker Ramo Corporation, 33 East Franklin Street, Danbury, Connecticut 06810.

**BUNKER  
RAMO**

# AMPHENOL



# We're big in basics.

**W**e invented the basic switch. So it's no wonder we offer more of them than anyone else in the world.

## THE WAVE OF THE FUTURE.

The SV is our newest basic. It uses a revolutionary spring concept to provide reliability unique to a miniature snap-action switch.

## BACK TO THE BASICS.

When space and weight are critical, a snap-action subminiature such as the SM (up to 10 amps AC) or the smaller 1SX (up to 7 amps AC) more than likely will be perfect. When cost is also critical, the small, versatile V3 (up to 15 amps AC) is ideal.

For maximum dependability and repeatability, there are our thousands of standard-size switches. The BZ and BA are among the most popular (up to 20 amps AC).

## DOWN TO THE SPECIFICS.

For special situations, we have special basics. The DT (DPDT) and the HT, a high-temperature basic, (up to +1000° F) are good examples. SE and XE are small switches offering environmental protection (MIL-S-8805). While HM and HS offer true hermetic sealing (MIL-S-8805).

Actually, these are only a few members of our basic family. To meet the rest, contact your MICRO SWITCH Branch Office or Authorized Distributor (Yellow Pages, "Switches, Electric"). Or write for our complete literature.

*MICRO SWITCH makes your ideas work.*

## **MICRO SWITCH**

FREEPORT, ILLINOIS 61032  
A DIVISION OF HONEYWELL

Signetics, National Semiconductor, and Texas Instruments as a supplier of the new ECL family.

But the Fairchild parts will not be exact copies of the Motorola circuits. The Motorola devices, as well as those from Signetics and National, are uncompensated; **the Fairchild parts will be voltage-compensated, making them similar to the TI devices.** Recent additions to Fairchild's proprietary 9,500 line of ECL components, which is both voltage and temperature compensated, had 10,000-series pinouts, and it is believed that the temperature-compensation feature could easily be eliminated by a metal-mask option. Thus, no circuit redesign appeared to be necessary for the new 10,000 parts.

## Roadside radio getting popular

An experimental a-m radio service to give traffic and parking reports to motorists at Los Angeles International Airport on their car radios may signal the beginning of a small boom in such limited-range systems. The so-called roadside radios have been used in wildlife parks; the Department of Transportation has considered them to give directions at complex highway intersections. **Now, an FCC spokesman says that a number of license requests have been filed, and some have been granted.**

The Los Angeles system operates at 530 kilohertz and blankets the airport by means of a 15,200-foot cable system that parallels the main roads. A 10-watt transmitter feeds the network. The installation was by RTV International Inc. of New York on a \$130,000 contract.

## White House and Congress slow education R&D

Prospects for Federal funding of research and development in electronic educational technology appear dim, at best, as both the administration and Congress appear to be against it. As a forerunner to his newly announced "no-fat" administration, President **Nixon has twice vetoed the Department of Health, Education, and Welfare budget containing some \$30 million in educational R&D funds.** And Congress, which doubts the utility of teaching machines, is **unlikely to pass an education-technology bill in the new session.**

## Addenda

NRMEC has developed a pocket calculator with an ambient-light liquid-crystal display; it's tooling up to manufacture the unit for market next year. **The passive LCD display permits 30 hours of battery life, up to 10 times that of LED units.** Also, World Book is in the NRMEC fold as a customer for complete desk calculators, joining Sears and Rapid Data, and replacing Logic Data, which canceled its order. World Book will sell the \$99.95 unit by direct mail. NRMEC also will provide chips for the Bowmar calculators. . . . Fairchild has received an order from Delco Electronics to supply **a hybrid electronic ignition system for General Motors.** The system will become standard in all GM cars by 1975. Cars at the top of the Pontiac line have offered electronic ignition as an option for several years. . . . Standard Microsystems Corp., Hauppauge, N.Y., says prototypes of an n-channel, 4,096-bit RAM chip will be available in January. . . . Varian Associates has introduced its Multipoint Distribution System, a limited-access institutional service to provide omnidirectional microwave broadcasting. **The forecast is for 150 systems by 1976, with revenues of \$300 million and an equipment market of \$27 million.**

Fluke problem solvers

# A new AC calibration system with wide range, superb stability, high accuracy and complete programmability.



Here's the best ac calibration system you've ever seen. It's designed to give you state-of-the-art performance in the cal lab, in the factory or in automatic test systems.

The new system consists of the Model 5200A AC Calibrator and the Model 5205A Precision Power Amplifier.

Covering a frequency range of 10 Hz. to 1.2 MHz, the Model 5200A output is from 100 microvolts to 120 volts at current levels up to 50 milliamperes. Mid-band accuracy is  $\pm 0.02$  percent. Short term amplitude stability is  $\pm 10$  ppm. Six month stability,  $\pm 0.01$  percent. Working with the 5200A, the Model 5205A provides output voltages from 100 volts to 1200 volts at current levels up to 200 milliamperes. Combined 5200A/5205A amplitude accuracy is  $\pm 0.03$  percent.

The 5205A can also be used as a stand-alone amplifier providing programmable gains of X10 and X100 for frequencies from dc to 120 kHz. Output amplitudes from 1 millivolt to 1700 volts peak are offered for a wide variety of waveforms including pulses, sawtooths and triangles. All functions are remotely programmable with standard TTL logic levels. Uniquely, the 5205A can be programmed by both the 5200A and another control source so that it can be time-shared in an automatic system to perform a multitude of functions.

Price of the Model 5200A AC Calibrator is \$3,995. The Model 5205A sells for \$2,495.

To arrange a demonstration or get more details just dial 800-426-0361 for the location of your nearest Fluke sales office. Call it free anywhere in the contiguous United States.

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Circle 31 on reader service card

# DOOPS!

## The Heavy-Duty DMM Bounces Back.

Don't worry about missing with the rugged Hickok 3300A Digital Multimeter. Its tough ABS case and shock-mounted components will take plenty of hard bounces.

Besides being tough, this 3½-digit Multimeter is versatile. It measures:

- DC/AC voltage from 100  $\mu$ V to 1.5 kV;
- DC/AC current from 100 nA to 2 A;
- Resistance from 100 m $\Omega$  to 200 M $\Omega$ .

And accuracy is good for 12 months.

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Notice the handy form factor — unique among digitals. It's made to carry around or to hang from a convenient spot by its handle.

You'll also like the automatic polarity and decimal point position, the out-of-range indication, 1500 volts off ground operation, and the continuous automatic zeroing. But you expect these from the company which was first with LSI circuits in digital multimeters.

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**We've got Digivue.**

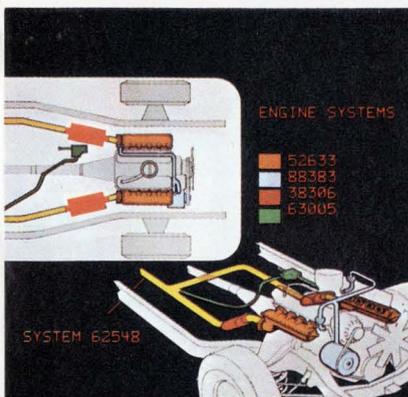
**INVENTORY STATUS**

CUST NO	PART NO	QTY	TYPE	SHIP VIA
05731	46200	100	JB	AIRFREIGHT
08252	46200	150	JB	AIRFREIGHT
15773	2089H	2000	OJ	RAIL
20412	2749B	15	P	SPECIAL
23674	7266Z	55	AD	AIRFREIGHT
48750	2000L	98	T	REA
54621	6429B	83	PL	AIRFREIGHT
54687	3511C	5	T	HAND CARRY
54687	6331M	600	P	SPECIAL
54687	9447S	1000	AB	REA
86446	6328D	60	J	AIRFREIGHT
86500	7265X	1	OW	UPS
96636	7337M	35	BZ	HANDCARRY
96636	46200	100	JB	AIRFREIGHT
96636	2000L	50	T	REA

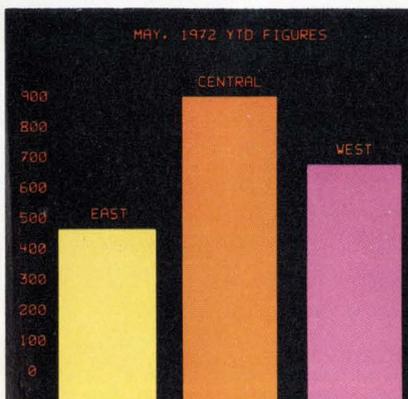
**a**



**b**



**c**



**d**

Communicate. That's the watchword for the Seventies. And that's just what Digivue® Display/Memory units do—with impact, immediacy and memorability.

Digivue Display/Memory units deliver computer-generated alphanumeric or graphic information at microsecond speeds. And a Digivue Display/Memory unit is a digital plasma display device—the space age display system that's a technological giant step beyond the cathode ray tube.

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Digivue Display/Memory units are now available in three different sizes: A 256 x 80 addressable line panel at a resolution of 33 lines per inch; a 256 x 512 addressable line panel at a resolution of 50 lines per inch; and a 512 x 512 addressable line panel at a resolution of 60 lines per inch that offers an active display area for up to 4,000 characters.

If you need fast, multi-purpose visual communication with impact—in a business, school, hospital, transportation center—we've got what you need. Digivue Display/Memory units.

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Electro/Optical Display  
Business Operations C,  
Owens-Illinois, Inc.,  
P.O. Box 1035, Toledo, Ohio 43601  
(419) 242-6543.

*Communication with Digivue units begins at a data processing center like the one pictured on the opposite page, where computer-generated information is directly addressed to Digivue units at various locations.*

*a/A Digivue unit in a shipping department relays the day's orders by catalog number, type, quantity and method of shipment. Digivue's inherent memory allows instant retrieval of this information without refresh requirements at any time.*

*b/A Digivue unit on the desk of a financial vice president transmits a twelve-month cost projection. Terminal manufacturers note: Digivue's slim panel depth allows for high-styled consoles and attractive, unobtrusive placement in an almost limitless variety of situations and locations.*

*c/Digivue units help a sales training class with assembly techniques for a new product line. Because Digivue panels are transparent, rear-projected graphics in every color of the rainbow deliver high-impact visuals no CRT system can even come close to.*

*d/With the help of a Digivue unit, a busy executive secretary prepares information for an important meeting—utilizing a combination of rear-projected graphics and computer-generated alphanumerics.*

**DIGIVUE**

**Owens-Illinois**

Circle 33 on reader service card

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Display/Memory Units

nounced by Fairchild Semiconductor almost two years ago. Already a mature technology for random-access memories, passive isolation is now being applied to read-only memories—programmable ones at that.

Harris Semiconductor, Melbourne, Fla., is first to do it with a new 2,048-bit PROM that permits twice as many bits on a chip no bigger than the one used in Harris' 1,024-bit PROM built by a standard technique. This leads to significant savings in system package count, board space, and power needs.

Pepe Pietra, a Harris spokesman, points out that the isolation technique, called Polyplanar because it's essentially a notch backfilled with polysilicon, can't show its greatest potential with PROMs, since a good portion of that device is passive to begin with. Space is saved principally in the decoding and output peripheral circuitry and not in the memory array itself. In fact, to get the 2-kilobit density meant tightening fabricating rules in the array, as well as using Polyplanar in the periphery.

Harris will make optimum use of Polyplanar in soon-to-be-announced 1-kilobit bipolar and 256-bit C-MOS RAMs, as well as a host of linear products. Harris designers feel that their process, which is similar to the Motorola VIP technique, has the advantage of simple metalization, because it's planar; unlike other air-notch isolation techniques, it does not require metal lines to traverse valleys. Another advantage is Polyplanar's ability to function with conventional epitaxial thicknesses (say, 5 to 6 micrometers) instead of the very thin epi layers that appear to be required by most oxide-isolation techniques.

The new Harris PROM has conventional Nichrome fusible links for programming; a 10-millisecond pulse is required to open the link. The part, which comes in a 16-pin package, will fit the same sockets as most of today's 1-kilobit PROMs by converting one of the existing chip-select pins to address the 2,048-bit product. Organized as 512 words of four bits each, the Harris unit is

available with either three-state or open-collector outputs. □

### Industrial electronics

## ICs help control diesel locomotive

The latest market to be cracked by integrated circuitry may well be the toughest commercial environment in existence: diesel railroad locomotives. The product is a solid-state control system.

The new IC "transition programmer" replaces the 100 relays that control the switching between various drive motors, the constant-speed dc generator, and other parts of the drive system. But the big problem is the horrendous electrical and physical environment. A typical locomotive generates and consumes 1 million to 2 million watts, say, 1,000 amperes at 1,000 volts. Switching this power among the inductive components generates spikes of up to 20,000 volts.

"You wouldn't believe the EMI!" says Robert R. Shepard, manager of railroad products at Genisco Technology Corp., developer of the system. In addition to the electrical problems, locomotives, covered by grime and oil, operate in temperatures that range from -40° F to deserts where the electronics will reach 160° F. Parts of the system are subjected to greater shocks than the

products Genisco builds for space. Nevertheless, the units have come through three-year field trials on Union Pacific locomotives, and will go into production in January.

In developing the systems, Shepard discovered that the railroaders didn't really know what they needed. Switching transitions (equivalent to gear shifting) were controlled by sensing voltage and current, but he found that the switching should occur at certain speeds that weren't directly related to the power. So Genisco developed a tachometer sensor coupled to the drive wheel. The most rugged part of the system, it is encased in a 40-pound steel casting.

**Stopping.** Transitions also occur in braking: going downhill, the drive motors turn into generators, and their output energy is dissipated in resistors to effect dynamic braking. The six resistors are typically 0.84 ohm, quite a load for 1,000 v.

The unit uses about 80 series 5400 military-grade ICs, carefully isolated from the 74-v control power of the locomotive and from controlled relays. It's not a plug-in replacement for the relays, but Shepard says that the salvage cost of the relays is more than the \$1,500 price of his system. After installation, the unit can be serviced rapidly because of its self-test facility, fault detection, and modular construction.

Shepard says that Genisco is still alone in the field, and he is optimistic about cracking what was a huge new industry. "There are about



**All the live-long day.** ICs have been introduced to the violent environment of the diesel locomotive in a "transition programmer."

## Dielectric isolation used in power ICs

Dielectric isolation, the IC technique that was used only recently to build the first commercial C-MOS logic devices, **is now making its way into the world of power ICs.** In fact, the developers at RCA's Solid State Technology Center in Somerville, N.J., have worked out a unique way of dielectrically isolating silicon wafers by inserting a silicon-dioxide layer between them and then forming the various circuit elements by diffusion. **The technique already has been used to build a power chip consisting of three transistors and six resistors.** And the transistors' base voltages,  $V_{CBO}$ , of 450 to 500 v are far in excess of anything attainable by conventional monolithic junction-isolation techniques.

In contrast to the problems encountered building power ICs by conventional methods, **RCA's dielectrically isolated devices achieve high reliability by using silicon-nitride layers over the junctions.** Field electrodes, which are kept at collector potential, are then used to prevent surface-ion buildup, as well as to prevent induced channels from occurring beneath the interconnections, a condition that could cause reduced voltage capability. The silicon-nitride overcoat also prevents the migration of ionic contaminants into the passivating film, preventing another cause of device failure in power chips.

## National using Planox for p-channel part

National Semiconductor has joined the short list of manufacturers offering parts made with the Planox process, a technique designed to increase the density and speed of MOS devices and developed in Italy at Società Generale Semiconduttori [*Electronics*, Dec. 20, 1971, p. 44]. In this country, Standard Microsystems of Hauppauge, N.Y., also makes the devices.

**In production at National is a 2,048-bit p-channel shift register that operates at 6 megahertz, faster than the 2 to 4 MHz common with standard p-channel construction.** However, a typical n-channel device built with National's Planox would have speeds around 100 nanoseconds; standard n-channel would be in the 150-ns range.

## New engineer jobs opening in CATV

A Department of Commerce report released late last month has predicted a need for from **35,000 to 62,000 new technical and engineering personnel in the cable television industry within the next five years.** According to a survey of cable operators, CATV construction firms, and cable equipment manufacturers, there are now 2,000 unfilled technical and engineering positions in this industry. The study concludes that, though these are ballpark estimates, there is clear need for the Government to initiate training programs to bring technical people into CATV.

## Printed-circuit TWTs promise cost cuts

A radically new approach to traveling-wave-tube design—the use of printed-circuit technology—could lead to impressive cost reductions. Allen W. Scott, manager of advanced development at Varian Associates' TWT division, predicts that eventually **production units made by printed-circuit technology will sell for under \$100, less than one-fifth the cost of conventional tubes with the same performance.** Applications range from phased-array radars to microwave relay transmitters.

All tube elements, including the beam-forming electrodes, the mi-

paying last month's bills out of current receipts. And in the highly seasonal high-fidelity industry, this fast became an impossible situation. Finally, on Friday, Oct. 13, Scott simply shut down when it couldn't meet its payrolls. Now, after several abortive negotiating sessions with Eastern over purchase of the company, Scott has found itself forced to declare bankruptcy.

What happens now? Some creditors look toward buyers who have been in the wings for some time,

said to include Fairchild, GTE Sylva-  
vania, and several Japanese firms. The Japanese may bid highest in order to acquire manufacturing facilities on U.S. soil, something that would give them a tariff advantage over competition still forced to manufacture in Japan. Sony management already is on record as hoping to switch to Sony-owned U.S. production facilities within the next few years. And Pioneer, another Japanese firm, is also said to be interested in Scott □

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## Manufacturing

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### Etching done with beam of ions called cleaner, more accurate

In manufacturing ICs, whether monolithic or thin-film, cumbersome wet-chemical solutions are generally used to etch out desired circuit patterns. But they present difficulties. For one, a variety of chemicals must be kept on hand to etch different materials. Then, too, chemical undercutting of areas that are not to be etched often limits the depth of etch. What's more, new pollution laws are making it increasingly difficult to dispose of processed chemicals simply by flushing them down the drain.

But now Veeco Instruments Inc., a Plainview, N.Y., manufacturer of vacuum equipment and mass spectrometers, has a system—called Microetch—that applies a relatively low-energy beam of ions to metals, semiconductors, and insulators, to etch, mill, and surface-clean them. "It's a brand new technique," says Edward H. Braun, director of marketing at Veeco, which is selling the system under license from France's Thomson-CSF.

The etching system's "solution" is actually a beam of argon ions generated in a vacuum chamber. The beam, at a relatively low energy level ranging between 500 and 2,000 volts, is passed through a set of optically aligned grids that form it into a 3-inch diameter. Then the beam

continues into the cooler work section of the chamber, where it is focused on the material.

A "neutralizing" filament, past which the beam travels, can contribute a small cloud of electrons to the ions. This cloud ensures that the beam is no longer positively charged when it hits the target, Braun explains, so that it can be used on semiconducting and insulating materials such as silicon, gallium arsenide, and quartz. "If the beam remained positive, charges would collect on the material, repel subsequent ions, and bring the etching process to a halt," Braun says.

**Narrower.** With the beam, line widths are limited solely by mask-making technology and can be etched down to 0.2 micrometer, according to Braun. This is almost an order of magnitude smaller than is possible chemically. And there is none of the undercutting and subsequent structural distortions associated with chemical means, he points out. "And the etch depth is independent of either its width or the material itself," he says. Some typical etch rates are: 130 angstroms/minute for alumina, 360 for silicon, 420 for silicon dioxide, 2,500 for gallium arsenide, and 3,000 for silver.

In cleaning the surface of, for example, semiconductor material in preparation for scanning electron

microscopy, the risk of distorting the crystal structure with Microetch is less than if conventional sputter etching were used, Braun says. This is because as much as an order of magnitude less energy need be used. In addition, the vacuum of 10<sup>-6</sup> torr is one or two orders of magnitude lower, so there's less danger of bombarding the material with undesirable entrapped gases.

So far, Veeco has delivered eight systems to "R&D labs and pilot production facilities," Braun says. Optics and power supply cost about \$20,000; with the vacuum system, the price is about \$35,000.

A rotary table in the unit can index 20 wafers, but Veeco is working on a substrate handler suitable for the production line. The company has also set up a special lab where customers can try out their own applications. "The system is so new," says Braun, "we're still trying to find out all that it can do." □

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## Packaging

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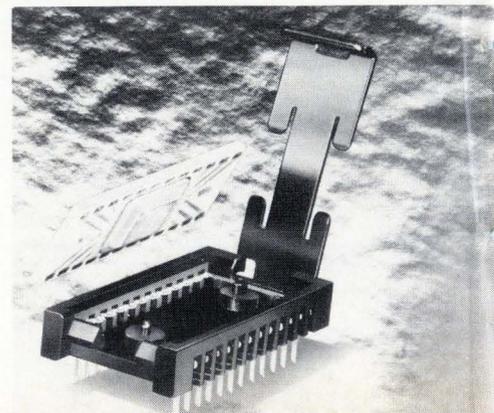
### Leadless plug-ins gaining ground

System and device designers have, for a number of reasons, been slow to commit themselves to solderless plug-in and leadless IC packages and sockets. But interest in the technique is beginning to heat up as it becomes increasingly clear that this path reduces fabrication costs and enhances maintainability.

As evidence of this, representatives of major computer makers will gather in New York on Nov. 29—at a meeting of the IEEE Computer

---

**Facing up.** This is Burndy's face mount leadless IC package.



# match this



## an 8K mini with cassette and software for \$3,950\*

*An operating system*—including the GRI-99, 8K word computer; the GRISSETTE II, a full duplex read-write cassette system; interface and software.

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The unique GRISSETTE II cassette system is the logical, low-cost, high-performance replacement for paper tape.

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\*OEM quantity price

The GRI-99 computer is a Direct Function Processor utilizing our original Universal Bus System. It is unequalled for ease of programming and exhibits unusually simple operating characteristics. Software development costs are the lowest in the industry. Debugging of software and hardware are also big dollar savers.

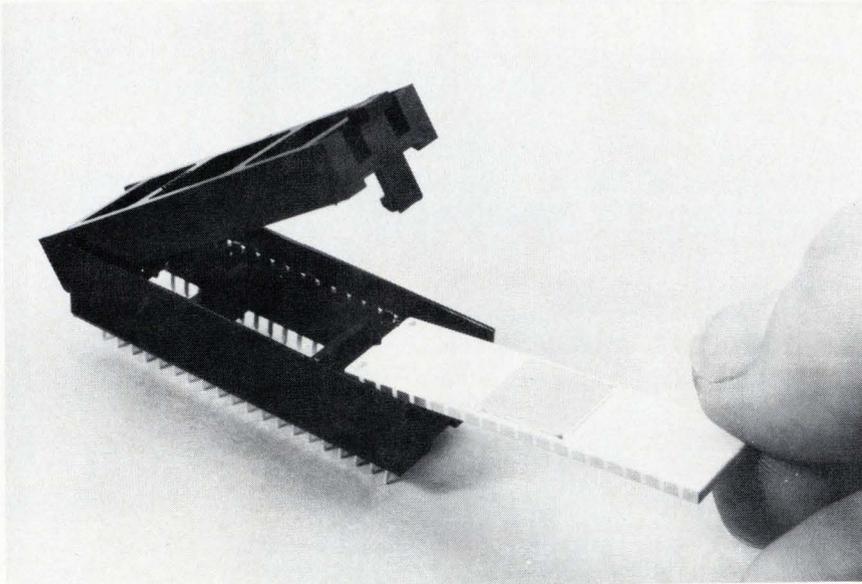
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# gri

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**On edge.** AMP's dual in-line edge connect joins outside world via metalized pads.

Society packaging committee—to listen to du Pont, Burndy, AMP, and Texas Instruments explain the virtues of leadless packaging, including details on the three types of packages—edge-mount, dual in-line face-contact, and dual in-line side-contact.

Each of the types has its proponents. Edge-mount, which is similar to mounting a printed-circuit board in a pc connector, was pioneered by Texas Instruments. Says TI's Maxwell Peel, chief design engineer for connector products, "Since the package mounts on the edge, the density of packing on a motherboard exceeds the two dual in-line techniques." But on the minus side, the profile is high and the reliability of edge connectors historically has been questionable. Still, SCM Marchant and Hammond Organ have designed them into products and say they are satisfied [*Electronics*, Sept. 13, 1971, p. 106].

The face-contact DIP has a substrate with face metalization and a receptacle with mating contacts. Amphenol uses gold contacts, but polished tin also is available. Lee Eichenseer of the Amphenol Industrial division, says: "our leadless connector is end-for-end and side-by-side stackable. This ensures maximum use of the available pc-board real estate."

Burndy is marketing a version with tin-plated contacts that em-

ploys high-pressure to make it gas-tight. Mike Lazar of Burndy says face contact has an advantage over the side-metalized contacts because the manufacturer does not have to metalize the sides of the package.

The dual in-line edge-connect is wed to the outside world via metalized pads along the edge of the package. Ron Boyer of AMP points out that this technique permits larger die cavities—300 mils square, compared with 210 mils square for the face-contact package. Also, the substrates tend to be thicker, and thus more rigid than the face-mount, face-contact substrate.

Significantly, the military is adopting a wait-and-see attitude. Joseph Brauer of the Rome Air Development Center says, "Our experience with the edge-board connector, in regard to both the copper-gold interface and marginal contact pressures, causes us to be somewhat skeptical of plug-in ICs." Brauer is chief of solid-state applications in the Reliability branch. □

## Memories

### AMS unveils 7001 with Toko deal

When Advanced Memory Systems of Sunnyvale, Calif., said that its

new 1,024-bit n-channel memory would be on the market in the first quarter of 1973, it was only telling part of the story. Introduction of the part also will signal an increased emphasis by AMS on sales to original-equipment manufacturers and, equally significant, the start of an international cross-licensing agreement. [*Electronics*, Nov. 6, p. 57].

The licensee is Japan's Toko Inc., a maker of plated-wire memories, which initially will import packaged chips for its own systems. Eventually, the chips will be built at a Toko subsidiary, Kyodo Electronic Laboratories. Toko plans to invest \$1.6 million in the new operation for, among other things, LSI testers and wafer facilities. And AMS will expand into plated wire. What's more, the California firm hopes to increase OEM sales to 50% of its total.

The new AMS 7001 is aimed at high-density, ultrahigh-performance memory systems that require rapid access and cycle times typical of the main memories of the latest computers, including many still in the design stage. Until now, this performance was available only from bipolar memories at rather high prices; the 7001 gives it for little more than the price of much slower, p-channel memory of similar size. Despite improved performance, the new memory uses standard aluminum gates because AMS engineering manager Thomas Palfi believes in getting more out of the process by circuit techniques, rather than harder-to-handle fabrication techniques. He says that aluminum-gate technology is the best compromise between process simplicity and density. Access time of the memory chip in the TTL-compatible mode is typically 50 nanoseconds, although it can be shortened to 40 nanoseconds when a sense amplifier is used. The read/write cycle time is typically 150 nanoseconds.

The new device is suitable for add-on memories that can replace the bipolar memories in the IBM/370 models 125 and 135 and

## Software patent hot potato winds up in Congress' lap

Supreme Court action ruling out patents on ideas leaves question of whether those already granted are invalid

The 94th Congress of the United States, due to convene in January, looms as the court of last resort for proponents of computer software patents. Ironically, that was the judgment of the U.S. Supreme Court in its Nov. 20 ruling that computer programs derive from ideas that are mathematical formulas and that "one may not patent an idea."

The 6-0 decision was clouded by

what some lawyers on both sides of the patent issue called "a bad case" for a Supreme Court precedent. It involved a petition for a writ of *certiorari* by acting Commissioner of Patents Robert Gottschalk, which sought to overturn an earlier judgment by the Court of Customs and Patent Appeals supporting the attempt of two Bell Laboratories employees, Garry R. Benson and Arthur C. Tabbot, to patent a digital computer software program. Already known as the Gottschalk-Benson decision, the new ruling was written by long-sitting Associate Justice William O. Douglas, generally regarded as the Supreme Court's most liberal member. Asso-

ciate Justices Potter Stewart, Harry Blackmun, and Lewis Powell did not participate in the case.

Justice Douglas's opinion reversing the lower court action conceded that the high court was overwhelmed by the technological complexities of the issue, as well as by the tight budget of a Patent Office physically unable to cope with software patent claims. Thus the court bucked the issue to Congress.

"If these programs are to be patentable," Douglas wrote, "considerable problems are raised which only committees of Congress can manage, for broad powers of investigation are needed, including hearings which canvass the wide variety

### Software, hardware people see it all ways

The software industry is split on the patentability issue. This is reflected by Dick H. Brandon of Brandon Applied Systems, New York, who clearly prefers the laws of copyright and trade secrets to protect his software programs. "The Supreme Court decision was correct," he declares. "I've never felt that software should be patented. There is no merit in it. A set of instructions to run a computer is no more patentable than a set of instructions you give a clerk to run an adding machine." Besides, he adds, patent law requires full disclosure; common law covering trade secrets doesn't.

Brandon's view that "we've lived all these years without patenting programs" is supported by the Supreme Court's citation of the 1966 report of the President's Commission on the Patent System. "The creation of programs," the commis-

sion observed, "has undergone substantial and satisfactory growth in the absence of patent protection" and with coverage by copyright.

Varying degrees of industry indifference to the judgment are reflected in Brandon's belief that Gottschalk-Benson's effect on computer hardware makers would be "none," as well as the view of software patent holder Martin Goetz of Applied Data Research that the court's judgment "won't significantly hurt the industry" built up around software.

Computer manufacturers have subdued the champagne-cork pop while privately toasting their successful opposition in the supreme test. "It can hardly be called the final judgment," cautions one computer company counsel in the capital. "Mister Justice Douglas copped out and just lobbed the ball up to the Hill." What Congress will sooner

or later have to face is the question most computer makers believe the court dodged. That question, in the court's decision, "is whether a [computer program] method described and claimed is a 'process' within the meaning of the Patent Act." The act provides that "whoever invents or discovers any new and useful process . . . or any new and useful improvement thereof, may obtain a patent therefor. . . ."

Where the Douglas opinion for a unanimous court is alleged to have dodged the ultimate issue is its warning that: "We do not hold that no process patent could ever qualify if it did not meet the requirements of our prior precedents. It is said that the decision precludes a patent for any program servicing a computer. We do not so hold."

Thus there is still caution in the manufacturing community and a ray of hope for software patents.

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## Electronics review

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also for add-on memories that can replace MOS memories in the models 158 and 168.

Toko, however, says that there is no significant add-on memory business in Japan yet, but that the company will concentrate on getting manufacturers to design the system into their computers. By the end of 1973, Toko expects to be able to sell memories with these chips at 1 to 1½ cents per bit. □

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## Commercial electronics

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### TI to sell new calculator by mail

Texas Instruments is going to sell a calculator by direct mail for the first time since it entered the business. And the new merchandising approach will be used for TI's latest machines—the first of a series of hand-held electronic slide rules. The SR-10 is designed to fill the market gap between simple four-function calculators and Hewlett-Packard's

**New machine.** TI will sell this electronic slide rule through mail, a company first.

HP-35, a complete electronic slide rule. Interestingly, H-P is selling its calculator successfully through direct mail.

The initial slide rule, the SR-10 is a four-function machine with additional function keys for reciprocals, squares, and square roots. Because both entry and display can accommodate a two-digit exponent, the new TI calculator can handle eight significant digits in scientific notation through nearly a two-decade range, positive and negative numbers from  $1.0000000 \times 10^{-99}$  to  $9.9999999 \times 10^{+99}$ .

Entries in floating point and scientific notation can be mixed, and the calculator will switch automatically to scientific notation to preserve significant figures.

At \$149.95, about half the cost of the HP-35, TI's first electronic slide rule does not offer the trig and reverse trig functions of the H-P model, nor  $e^x$ ,  $x^y$ , or memory. Entry, however, is arithmetic, as compared to the HP-35's entry scheme.

The SR-10 also features a 12-character, light-emitting-diode display, positive and negative overflow indication, low-battery warning, and an ac adapter/charger that can be used for either 60 hertz/115 volt or 50 Hz/220 v operation. It will be available first off the shelves of retailer Nieman-Marcus. □

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## International

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### Another 2nd source for 10,000 series

After a slow start on the European market, demand is beginning to build up for the high speeds in ICs that emitter-coupled logic can deliver. With Motorola Semiconductor ECL circuits dominant in Europe, it has had trouble overcoming hesitation of users who always want a second source available.

"Now they will have it," says Alain Forgue of La Radiotechnique Compelec (RTC). "We are present—in force." The force is a fresh new line of ECL circuits that are pin-

compatible with Motorola's 10,000 series. Forgue is product marketing manager.

RTC is calling its new family the GBX 10,000 series, with product numbers identical to the Motorola equivalents. Among the circuits in development, due for introduction next year, are the GBX 10149 (a 1,024-bit PROM) and the GBX 95410 (a 256-bit RAM). The entire line is being introduced with ceramic packaging, but plastic packages are being studied.

This fall, RTC quietly began production of 18 ECL circuits at its big semiconductor plant in Caen, France. Thirteen more versions will go into production next year, all the result of a massive R&D effort "to close the technology gap to almost nothing—at least in the ECL area," says Forgue. In fact, he claims the 60-strong team of ECL researchers in Caen have managed to improve on the Motorola technique.

"When you're second-sourcing, you can't go in for much innovation," Forgue admits. But he says the RTC circuits include an additional stabilization network at each logic input to make sure the real part of the input impedance is always positive, eliminating the transistor oscillation that becomes negative impedance. "We can ensure positive resistance in a range from 50 to 500 megahertz," Forgue says. Just how the network was worked out, he's not saying.

RTC, a subsidiary of Philips Gloeilampenfabrieken, has given Forgue worldwide marketing responsibility for the new ECL line. All the circuits will be built in France and sold through Philips subsidiaries abroad, including Amperex Electronic Corp. in the U. S. Indeed, RTC hopes to get some U. S. computer firms committed to ECL so that when and if the firms set up manufacturing facilities in Europe, RTC will automatically become their ECL supplier.

In its U.S. market prospecting, the RTC team has estimated a demand of about \$130 million in ECL circuits by 1975. The European market will be \$12 million to \$18 million, RTC says. Forgue is hoping





to capture about 25% of the European market, "but God knows how well we will do in the U.S."

Motorola, far from being disturbed by having a new competitor

in Europe, seems delighted. "It's just what we need," says one Motorola executive in France. "A second source will help us in our own marketing." □

■ Put in one of its members, George Konkol of GTE Sylvania, Batavia, N.Y., as EIA chairman.

■ Accepted two Japanese corporate subsidiaries as members, raising the number of CEG members to 29, and set a precedent for group expansion by opening the door to U.S. branches of foreign corporations. The additions are Sony Corp. of America, which makes TV receivers near San Diego, Calif., and Matsushita Corp. of America, which has a TV receiver plant in Puerto Rico.

Konkol, who missed the EIA meeting at Beverly Hills, Calif., because of a schedule conflict, is senior vice president for entertainment products at GTE Sylvania. He had served previously in EIA's Parts and Tube divisions and had been a member of the EIA board.

Outgoing chairman J. Frank Leach, president and chief executive of Arcata National, Menlo Park, Calif., called on EIA members to "rally 'round the flag." The association's executive committee, he said, "very carefully examined whether or not the association is properly constituted and organized to do the most effective job in the light of certain questions raised by the resignation of Texas Instruments."

Declared Leach, "we concluded unanimously—with representation from all divisions and groups in the association participating—that we do have the best possible structure" for flexible headquarters operation to provide services to members on issues of engineering marketing services, legislative review, industrial relations, and international standards to members with diverse interests.

At the meeting, EIA also:

■ Created a tax panel "in anticipation of the next Congress," which is expected to consider a variety of pieces of tax legislation affecting the industry. The new panel, for which a chairman has yet to be named, will consider bills and make recommendations to the board, divisions, and their member companies on expected industry impact of the legislation, and handle appropriate industry responses, if any.

■ Heard its Solid State Products di-

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**Societies**

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## IEEE members okay amendments to involve society more actively

"Landslide" was the word at the IEEE, as well as across the nation in the Presidential election, as the institute's members voted overwhelmingly in favor of constitutional amendments that permit "greater involvement in the social implications of technology." Of roughly 50,000 votes cast, 85%, a 7-to-1 majority, were in favor of the IEEE's participating actively in legislative, social, ethical, and economic matters affecting the lives of electronics engineers. In the words of an IEEE spokesman, the result augurs "momentous change, insofar as the world's largest engineering society is concerned." The society's worldwide membership is 161,000, of which 88% are in the United States.

The IEEE has "for some time" been anticipating the vote, confides president-elect Harold Chestnut of General Electric's research laboratory in Schenectady, N.Y. Since last March, he has headed an ad hoc "shadow government," the U.S. Activities Committee, which has been "studying like mad" the ways to proceed, should the amendments be passed.

These include, says Chestnut, "participation in the legislative process" by preparing position papers on technological assessment and forecasting, establishing employment-practice guidelines for engineers and employers, and promoting Federal legislation for portable pensions. The IEEE plans to establish a pension plan of its own by the end of 1973.

As for direct lobbying in Congress itself, the IEEE will, for now, rely on its two-year-old affiliation with the National Society for Professional

Engineers, a registered lobbying organization. IEEE executive director Donald G. Fink is concerned that the organization's position papers might lose credibility if it began lobbying on its own. Position papers being considered for preparation, with the aid, if necessary, of paid consultants as well as volunteers, include such subjects as energy policy, cable television, and automation and productivity.

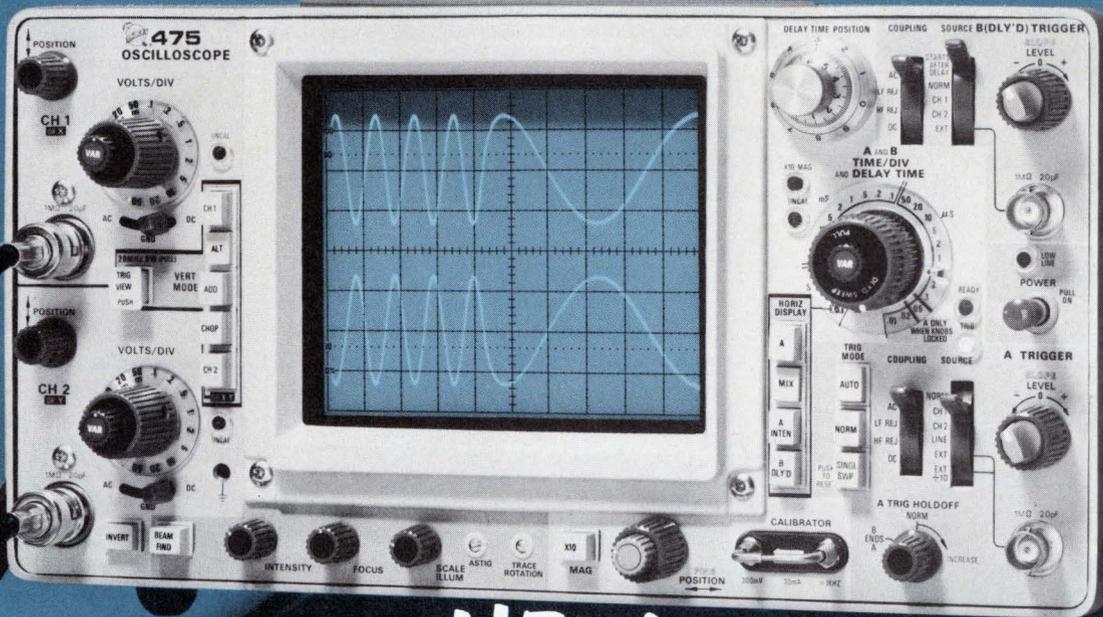
Chestnut adds that special attention will also be devoted to converting the defense and aerospace skill of its members, of whom 3% to 5% have been unemployed during the recession. Other areas to be considered include medical engineering, industrial safety, traffic control, environmental protection, criminal-justice automation, and power and utilities engineering.

The next steps for the IEEE include modifying the bylaws to legalize the new objectives and to "put the shadow organization into place." How much will it cost? Initially, not much. Dues will be increased Jan. 1 to \$30 from \$25, plus an additional \$5 "regional assessment" for the U.S. and Canada. □

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## EIA consumer group gains top spot

Consumer electronics manufacturers came out of the Electronic Industries Association's annual meeting looking like the organization's new men on horseback. At the meeting, the EIA Consumer Electronics group:



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vision say it will continue to collect and collate semiconductor industry statistics, despite the withdrawal of TI from the program. James Conway, head of EIA solid-state products operation, said in a post-meeting interview that the marketing-services job of data collection and evaluation will be more difficult without TI, considering its large market share, and that estimating its output will not be easy. Nevertheless, said Conway, "We have a good track of their history and know where they are today." With increased staff effort to track TI's output, "we should be able to keep a good, reliable tap on their sales."

Conway said he hopes TI, "despite its political problem with the association overall," will consider a role in the data collection and dissemination program "like other nonmember companies, on a fee basis, which is substantially lower than the dues they were paying." Moreover, he believes TI withdrawal from EIA and its resultant failure to participate in the Solid State group can eventually damage the company's position in the industry.

■ Formed an International Business Council to supersede its International Activities Council, authorizing a larger expenditure of up to \$50,000 annually for the IBC to "gather and disseminate international business information and data" to members, as well as to "coordinate and activate programs" on exporting, importing, licensing, and follow-on services. The new group is not expected to alter the positions of EIA divisions when it comes to matters of trade. □

## Optoelectronics

### Fm video system shines through rain

Although a promising idea for economic and high-speed data transmission, most laser communications systems are stalled in military and Government research because of their complexity and high develop-

ment costs. A small Washington, D.C. company, however, has developed a laser video system that's also aimed at commercial applications in facsimile and digital transmission.

Unlike systems using a-m or intensity-modulation techniques,

Georgetown Instruments' Light Line system employs an fm technique, called "pseudo-standing-wave modulation." Fm communications techniques are better able to penetrate rain, fog, snow, or dust—big problems with laser systems—be-

## News briefs

### Auto assembly lasers

Automotive manufacturers are beginning to try laser welders on their assembly lines. Two systems have recently been announced. Photon Sources Inc., Plymouth, Mich., says it has delivered a triple-beam carbon-dioxide laser system, developing 400 watts in each beam, to a General Motors Corp. plant for "on-line cutting of automotive subassemblies." And Hamilton Standard division, United Aircraft Corp., Windsor Locks, Conn., is developing a 4-kilowatt CO<sub>2</sub> laser welder to be installed in the pilot plant at Ford's Automotive Assembly division for "test and prove-out" as a production machine tool. The prototype laser should be able to make three welds on each underbody at a rate of 180 welds per hour. Thickness of the steel will range from 35 to 75 mils. United Aircraft's Research Laboratories, which has been working on laser welding technology for the past six years, will assist in the development.

### NEREM off slightly

The drop in attendance and booth rentals at NEREM earlier this month was less than expected. Paid attendance, estimated at 9,000, was down about 500 from 1971; booth rentals fell to less than 160 from more than 180. The attendance decline may be explained by a limit put on the number of student attendees, and the fact that more than three hours was cut from evening exhibition time by earlier closings. Many visitors traditionally attend NEREM late in the evening.

### Voice baggage system

Threshold Technology Inc., Cinnaminson, N.J., has developed and is installing a voice-encoding system to speed automatic baggage handling at United Air Lines' O'Hare terminal in Chicago. Baggage is tagged as usual, but then an agent reads the flight number or destination city into a head-mounted microphone, and puts the baggage onto a computer-linked conveyor-sorter that eventually unloads the bag at the appropriate flight-loading area.

The system stores each speaker's voice characteristics, verifies the destination via a CRT, and has a vocabulary that includes all the digits, eight key cities, and a few special control words.

### State faults BART

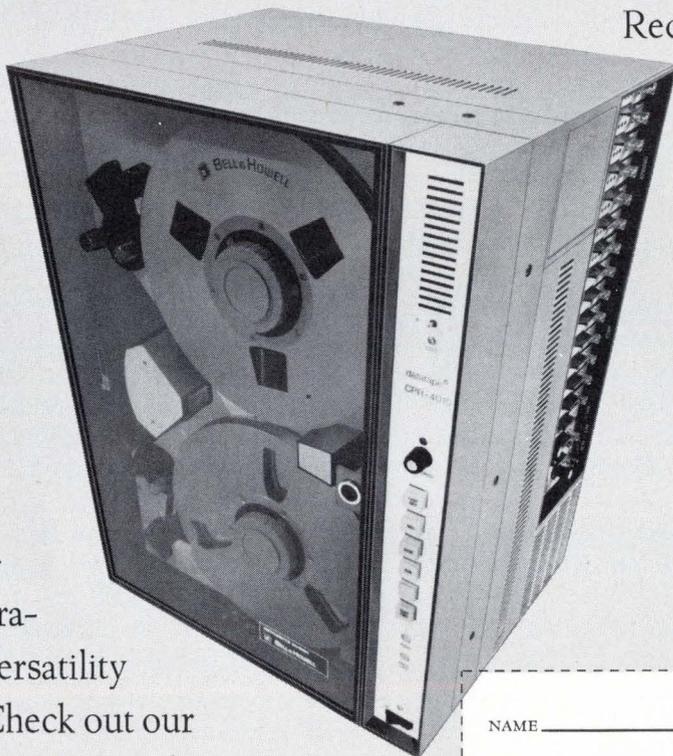
The first public report criticizing the safety operations and management policies of BART, the automated San Francisco Bay Area Rapid Transit, has been issued by the state legislative analyst, A. Alan Post. The report called the automatic train-control system "unreliable" and said that until it is fixed, trains should not be allowed to run to San Francisco and Concord. BART already has had one minor crackup [*Electronics*, Oct. 9, p. 36].

The San Francisco run was scheduled to open late next year, and the Concord line was originally scheduled to open this month, but BART had already delayed that opening for another six months. Post said that his two investigators, one a transportation economist, the other an engineer from the auditor general's office, based their report on information provided by BART itself.

"The system is inadequate in terms of what it was designed to do," Post said. He said the report was spurred by reports from the California Society of Professional Engineers, a group that pointed out the safety problems a year ago—many of the same ones that Post's report included.

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## Electronics review

cause these obstacles affect frequency shifting less than they do amplitude or intensity-shifting techniques, claims William F. Taylor, president of the company and head of Georgetown University's physics department.

The basic system uses a helium-neon laser that fires through acoustic cells, which are fed the video signal reformulated into fm radio frequency-spectrum information. The receiving end uses a photodiode, which reconverts the beam into a video signal through a wideband amplifier and a frequency discriminator. Heart of the proprietary Light Line system is the use of ultrasonic waves to impart the video information across the laser beam by frequency-shifting the laser light, explains Gerald M. Borsuk, research associate. Thus, the video waveform is frequency-modulated on a radio-frequency carrier, generating an fm rf spectrum, which is impressed onto the laser beam.

**Mixing.** On the receiving end, an optical mixing process occurs on the surface of the diode because of interference effects. The diode regenerates the fm rf spectrum of video information. The rf signal is limited to obliterate atmosphere effects and frequency-discriminated to recover the baseband video signal, Borsuk says.

Georgetown Instruments' unit, developed partially under U.S. Air Force contracts, has been delivered recently to the U.S. Department of Interior as a system to monitor power switches at Bonneville Dam. Company officials maintain that the unit will operate in snow, although it has not been tested in heavy snowstorms. However, fog would be the most difficult medium to transmit through, Borsuk says. In a recent 1.6-mile demonstration across the Potomac, the 6-megahertz system sent clear commercial-quality pictures in moderate rain.

Applying the same principle electro-optically by using electro-optic materials and "launching microwaves into them," under an Air Force contract, the company is aiming for 2- to 3-GHz bandwidths, Borsuk says. □

## Electronics review

a truck for the Army's tank-automotive command, Warren, Mich., under a \$500,000 contract, the latest in a series of small, continuing awards to RCA for vehicular test gear. □

## Commercial electronics

### Probes stir BART's pot

The Bay Area Rapid Transit system has been fraught with controversy almost from its inception, and it seems destined for more of the same as a number of investigations grind on into the cause of an Oct. 2 accident that injured five passengers [*Electronics*, Nov. 20, p. 42].

San Francisco's 75-mile suburban transit network began operation in early September—well behind schedule—with train-control methods that were mainly manual rather than the automatic operation that's still planned [*Electronics*, Sept. 25, p. 33]. Now the only thing that appears certain about the system is that service will remain curtailed until flaws in the automatic train-control electronics are corrected.

Four official investigating teams either have investigated or are investigating the cause of the accident, which has been traced by Westinghouse Electric Corp. to a crystal oscillator that should have caused the train to slow to 27 miles per hour or less. Westinghouse, which provides the automatic train-control system, including on-board and wayside hardware and the central computer, has made public the findings of its own investigation.

These exonerate the computer and wayside gear, but indicate that the Bulova-supplied oscillator that was in the car failed. Westinghouse officials say that when they tested the suspect oscillator in a different car, its speed ranged from 51 to 74 mph, even after the oscillator picked up the 27-mph command signal from the wayside. While Westinghouse investigations continue, a spokesman for the firm says investigators "have been unable to cause a

similar failure with this type of crystal."

BART officials also put the blame on the faulty oscillator. But others aren't as readily convinced. California state legislative analyst A. Alan Post termed the train-detection circuits "unreliable and, under some conditions, inoperative" in a report that goes on to express pessimism that the automatic train-control system for BART could work without the "rough job of reworking the system." □

## Optoelectronics

### NBS light-speed test opens frequencies

Using complex laser equipment, National Bureau of Standards scientists have opened up two new frontiers in measurement and communications: a new measurement of the speed of light that is 100 times more accurate than before and precise measurement of infrared frequencies and wavelengths that promises to multiply the number of available telecommunications frequency bands 1,000-fold because of more accurate measurement and stabilized lasers.

The new value for the speed of light will make fundamental physics and spectroscopic equations more accurate, states Kenneth M. Evenson, a physicist who headed the NBS teams at the Boulder, Colo., laboratories.

The new measurement capability extends possible available telecommunications frequencies into regions five times lower than visible light, or to 88,000 gigahertz, Evenson says. With increasing problems of frequency congestion, the new frequencies will be used when needed, he predicts, But much work needs to be done on the necessary transmitting equipment. Bell Laboratories is working on transmitting equipment for civilian and military applications, Evenson adds. A key to the concept is the stability of the lasers, which could mean that, in

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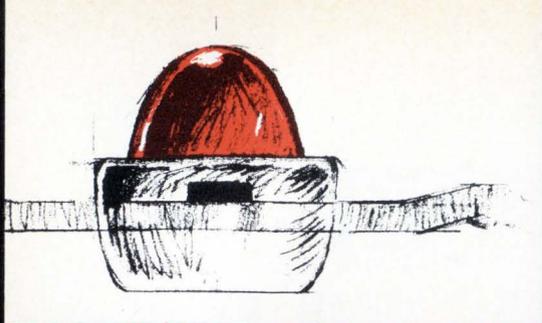
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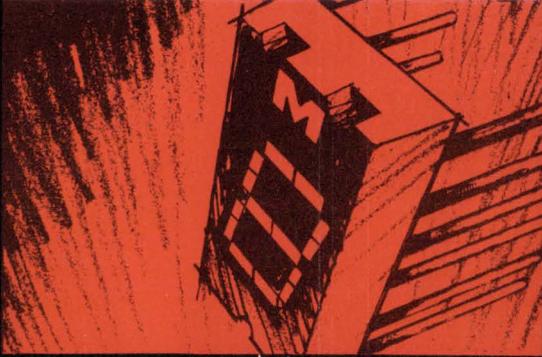
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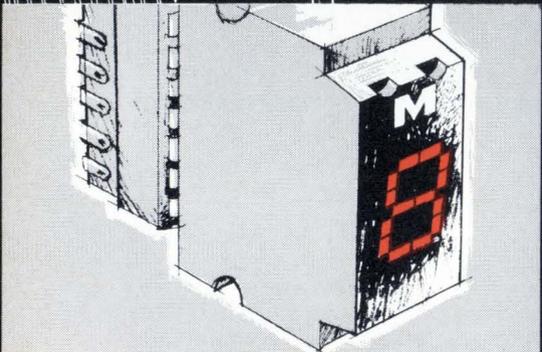
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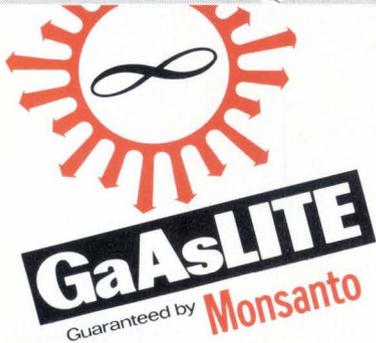
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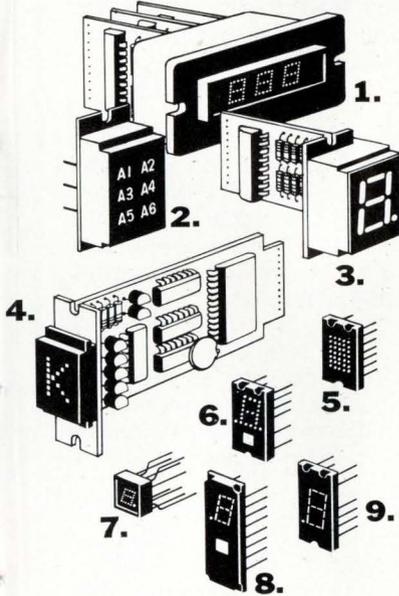


**INNOVATION NO. 6.** The Illuminating GaAsLITE. We keep constant pressure on the development and refinement of the materials we use to build our GaAsLITEs. Bright yellow and green devices were the two major innovative results. More recently, brighter material made possible the first solid state lights from Monsanto that actually illuminate a quarter inch circle. And we've put this innovation to work . . . in PBX panels, switches and—where would you like them?



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## Electronics review

practice, the transmitting instruments may not have to be precise.

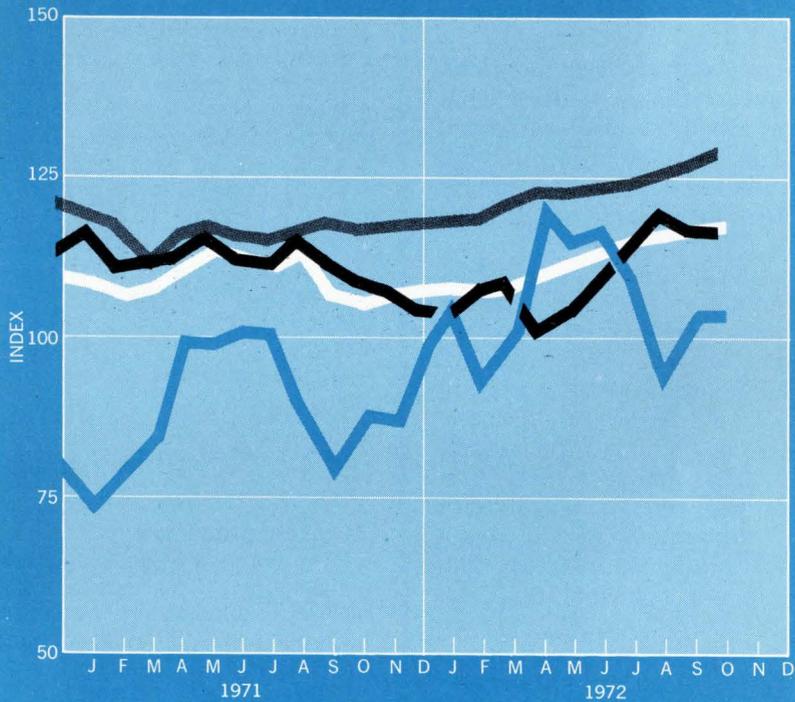
Employing six klystrons and five different kinds of 50- to 300-milliwatt cw lasers, three of them 8 meters long, the experiment made a "ferocious, hideous-looking scheme" that "filled a whole lab room," Evenson remarks. Two recent developments made the experiment work; a very-high-frequency 3.39-micrometer helium-neon laser that was methane stabilized and a tungsten point-contact cat-whisker diode.

The experiment, based on the relation between frequency and

wavelength of modulated laser light, was to obtain frequency and wavelength measurements and multiply them to derive the speed of light. The wavelength measurement was obtained by an interferometric comparison between the stabilized 3.39 $\mu$ m laser and a krypton lamp, whose emission serves as the standard reference.

After the year-long project, Evenson says, the next step will be to redefine the krypton wavelength standard for measuring the speed of light and "fix it so the speed of light may never have to be measured again." The new speed of light is

## Electronics Index of Activity



Segment of Industry	Oct. '72	Sept. '72*	Oct. '71
Consumer electronics	104.3	104.3	87.9
Defense electronics	116.9	117.1	108.2
Industrial-commercial electronics	129.8	127.4	117.7
Total industry	118.7	118.1	109.7

The index rebounded slightly in September from August's decline by inching upward 0.7%, leaving it 9.4% above its year-ago level. Once again, consumer electronics was the month's high gainer, up 1.8%. However, it was 2.3% below its corresponding 1971 month. Defense, unchanged on a month-to-month basis, was 14.3% ahead of its September 1971 performance, its biggest year-to-year gain of 1972. Industrial-commercial rose 1.4% for the month.

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.

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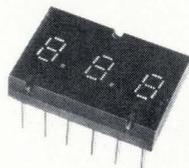
Volume production of LED products at Litronix is allowing Dan Davis to play Santa Claus to the makers of handheld calculators whose products must be on the shelf before Christmas.

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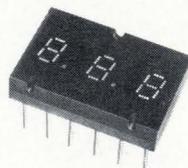
The DL-33 three-digit modules allow calculator and compact systems builders to extend their battery life, reduce pin count and cost per digit. Systems are easily built with displays in modules of 2 to 12 or more digits. The DL-33 is available in several versions including minus sign and one or two digits.

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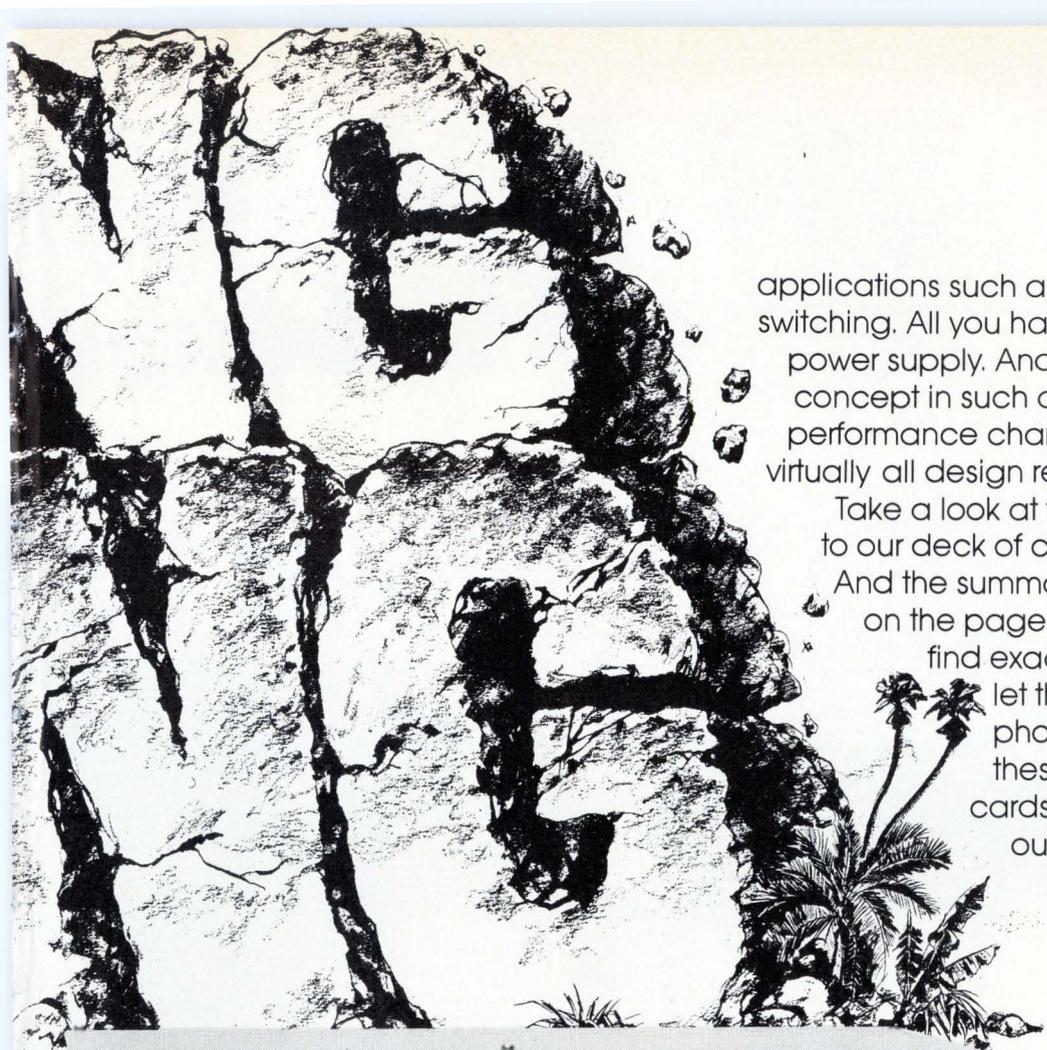


the bright guys

litronix

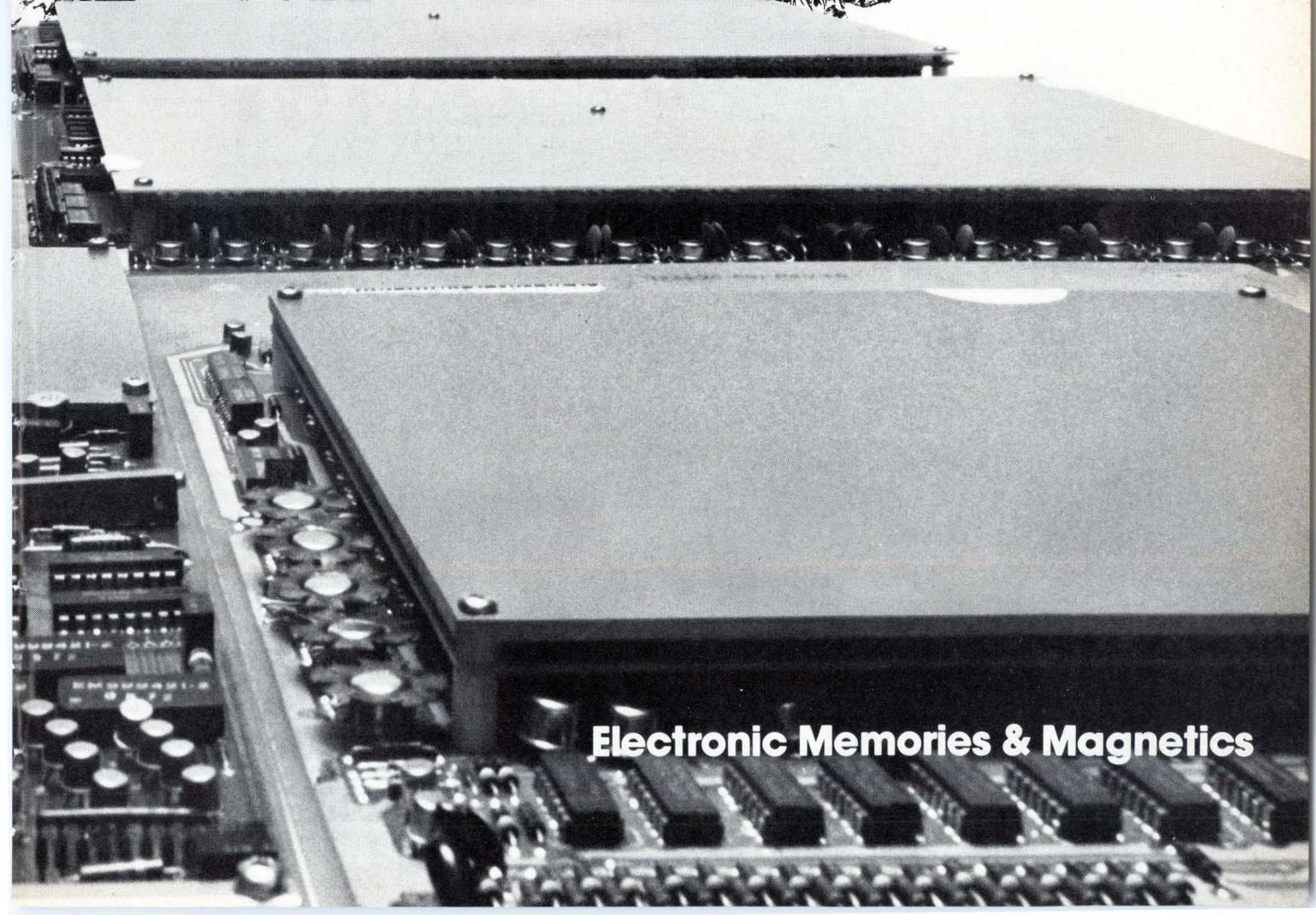


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**Electronic Memories & Magnetics**

## Four more years of what?

Tracking the decline and fall of George McGovern's presidential campaign is still a popular sport in the capital, though it is about as useful as asking a wounded lumberman which tooth of the buzzsaw cut him first. Far more interesting to electronics managers and engineers is what is in store during President Nixon's second and final term of office.

For the first time in his political life, Richard Nixon does not have to look forward to another election. Nevertheless, he is concerned about transforming his phenomenal personal victory into something the Republican Party can capitalize on during the congressional elections of 1974, as well as the presidential campaign of 1976. In that connection, he believes he reads the mood of the American people as one that is tired of bureaucracy and big Government in Washington. Thus he is moving to cut it, and moving quickly.

### Frozen funds

In a Nov. 9 interview with the *Washington Star-News*, the President indicated strong dissatisfaction with the "bloated" Federal bureaucracy, including the civilian staff of the Department of Defense, in which he promised cut-backs, confirming an earlier report [*Electronics*, Nov. 6, p. 51]. What he did not disclose, however, is that he has no intention of waiting until the beginning of fiscal 1974, next July 1, before acting. Other Federal sources forecast a freeze of some \$3 billion of the current \$81.5 billion in DOD's total obligational authority this year, part of the Nixon plan to put a \$250 billion ceiling on Federal spending.

While contracts for electronic hardware are expected to be least affected, some stretchouts are certain as the military services continue to bargain with DOD's civilian leadership on program tradeoffs. Big cuts are forecast in civilian as well as uniformed military personnel who perform staff, rather than line, functions. Other agencies specified by Nixon as "too fat, too bloated": the Departments of Transportation, Health, Education, and Welfare, and Housing and Urban Development.

But the President tipped his hand even before he spoke to the *Star-News*. On Oct. 21, in one of his little-noticed radio addresses during the campaign, he posed these questions: "Do we want to turn more power over to the bureaucrats in Washington in the hope that they will do what is best for all the people? Or do we want to return more power to the people and to their state and local governments?"

Some corporate representatives of the electronics industries in Washington sensed the White House attitude before the President spelled it out. They dutifully notified their managements to begin monitoring state capitals and city halls for programs supported by Federal grants that call for computers, communications, and comparable hardware for use in law enforcement, mass transit, health and education. And present indications are that those local markets will be ranked by the White House just about in that order during the next four years, even though the President pushes for greater revenue sharing.

### Confronting Congress

On the coin's other side is the 93rd Congress that convenes in January. It reads its election mandate differently from the President. Democrats are still in control, of course, with a net gain of two more seats in the Senate giving it a somewhat more liberal bent. On the House side, the cast appears to be more conservative and the Democratic margin diminished, yet there will be more first-termers than there have been in recent history. They are still unknown quantities.

More confrontations between the White House and Congress over Federal spending and program priorities seem certain. Defense programs seem relatively safe, although Wisconsin Democrat Sen. William Proxmire, foremost Pentagon critic, is readying a fresh series of assaults on major new efforts. Ironically, any hold on new military program starts could benefit electronics in terms of alternative efforts to update existing weapons systems.

Thus social programs, such as health and education and the taxes they will require, shape up as major sticking points in the coming year at least, with Senators Edward Kennedy (Mass.) and Walter Mondale (Minn.)—leading candidates in the Democrats' "winter book" for 1976—in the forefront of the opposition.

Thus bureaucrats and their Washington counterparts in industry are nervously asking: four more years of what? At worst, the answer is two more years of stalemate between the White House and Congress until the next congressional election. Yet the advantage now lies with the President—not so much because of the size of his overwhelming personal victory, but because of the continuing tendency of Congress to abdicate its role as a separate but equal branch of America's governmental machinery.

—Ray Connolly

# ATTRACTIONS!

**High capacity card that works from a plus five power supply 8Kx18** Our new 8Kx18 Micromemory 2000 series gives you a large capacity configuration that operates from plus five volts input only. This low cost card comes with edge connections that allow the memory to

be treated just like a logic circuit. The Micromemory 2000 series is also available in a 4Kx9 and many other configurations. All sizes are plug compatible.

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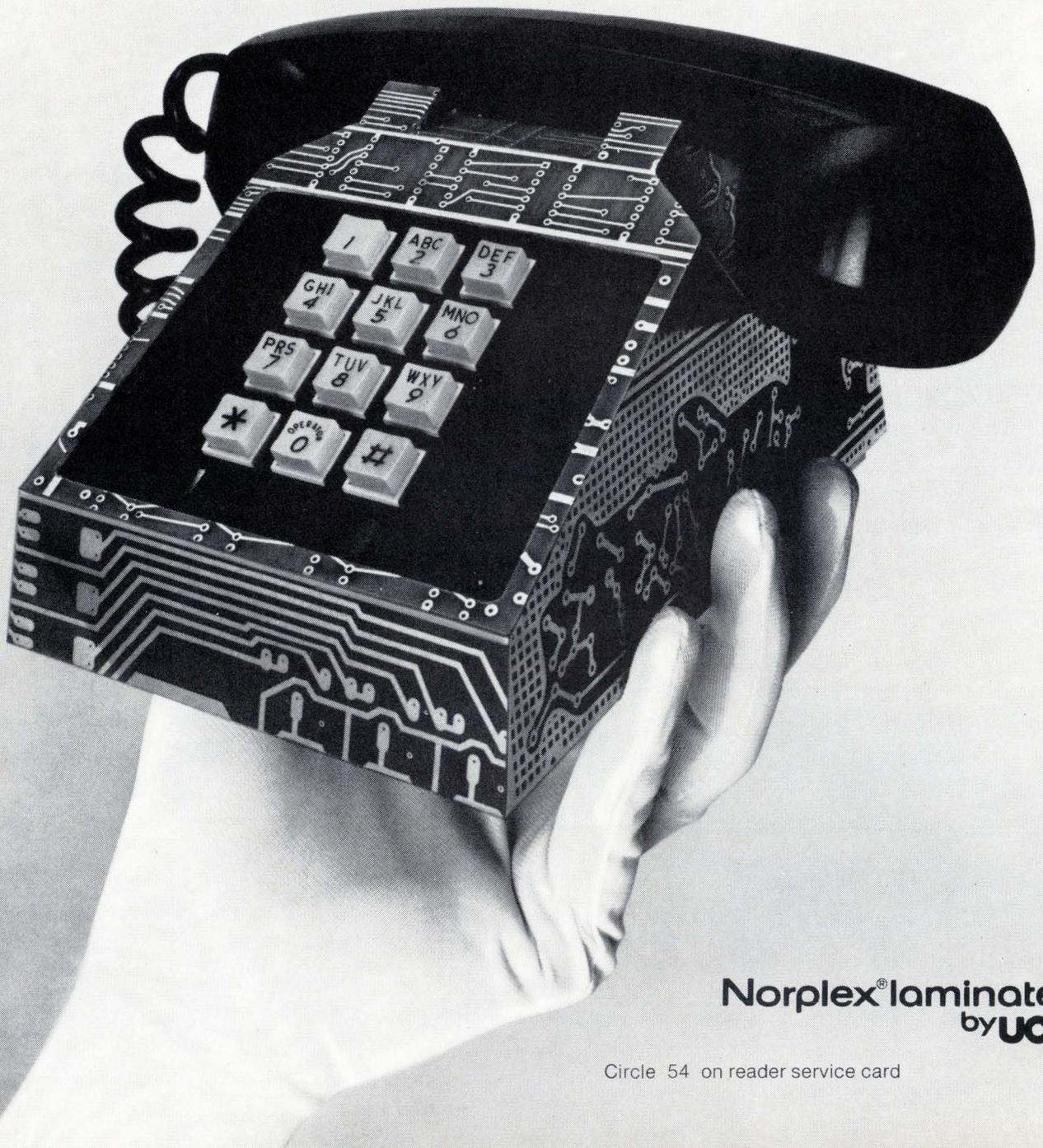
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## Industry favors proposed network interconnect

Equipment manufacturers are enthusiastic about a **new Federal Communications Commission plan to resolve the four-year-old issue of interconnecting** customer-owned and -maintained equipment to the switched telephone network. Technical report T-7202 from the office of the chief engineer **calls for "registration" of devices able to meet technical specifications that do not cause actual harm to the telephone network** or the customer equipment.

The proposal, disclosed in late November, would be **similar to the FCC-type acceptance program**; it would not evaluate device performance in use, but would permit the FCC to issue cease and desist orders for harmful devices and would allow common carriers able to prove harm to remove them. **The report includes an illustrative schedule of filing and grant fees for registrants.** Respectively, they are \$1,000 and \$500 for couplers and special equipment; \$800 and \$200 for network control signalling equipment; \$700 and \$100 for equipment without network control signalling, and \$500 and \$100 for data processing and handling equipment.

## Economics clouds NASA's outlook . . .

The future looks dark for companies pursuing near-term subcontracts or production awards on space programs. Although the space shuttle and other NASA programs looked as though they might bring needed contracts, **severe restrictions on fiscal 1973 spending and the highly uncertain fiscal 1974 picture are requiring NASA managers to delay** if not cut back several big projects.

For example, the \$400-million-plus plum for space shuttle orbiter avionics [*Electronics*, Aug. 14, p.44] has been pushed farther out of reach. **NASA isn't "going to buy anything next year" in shuttle avionics** as it tries "to hold down costs as much as possible," says one knowledgeable source. Because of White House demands for economy, **shuttle avionics funds for this fiscal year ending next June 30 were cut in half to about \$35 million**, eliminating spending for anything but manpower. Fiscal 1974 funding, in dispute between NASA and the White House Office of Management and Budget, is being subjected to strong budget-cutting pressures.

## . . . avionics funds, satellite programs delayed

NASA presently plans to have the major shuttle avionics subcontractors lined up by July 1973, but **hardware purchases will be put off as long as possible** so that scarce funds aren't committed until absolutely necessary. However, only one or two major shuttle subcontracts remain to be awarded, covering instruments and possibly guidance and control, should initial work by Honeywell and Intermetrics Inc. not be precise enough. Shuttle prime contractor North American Rockwell says it hopes to go out for bids on some avionics development next spring.

Also, several satellite programs are stretching out. The \$200-million-plus **High-Energy Astronomical Observatory program won by TRW Inc. has been cut 40%**. Hughes Aircraft Co.'s **Orbiting Solar Observatory has encountered what NASA calls "funding perturbations,"** and will need substantial fiscal 1974 money to keep it going on a revised schedule for 1974 launch.

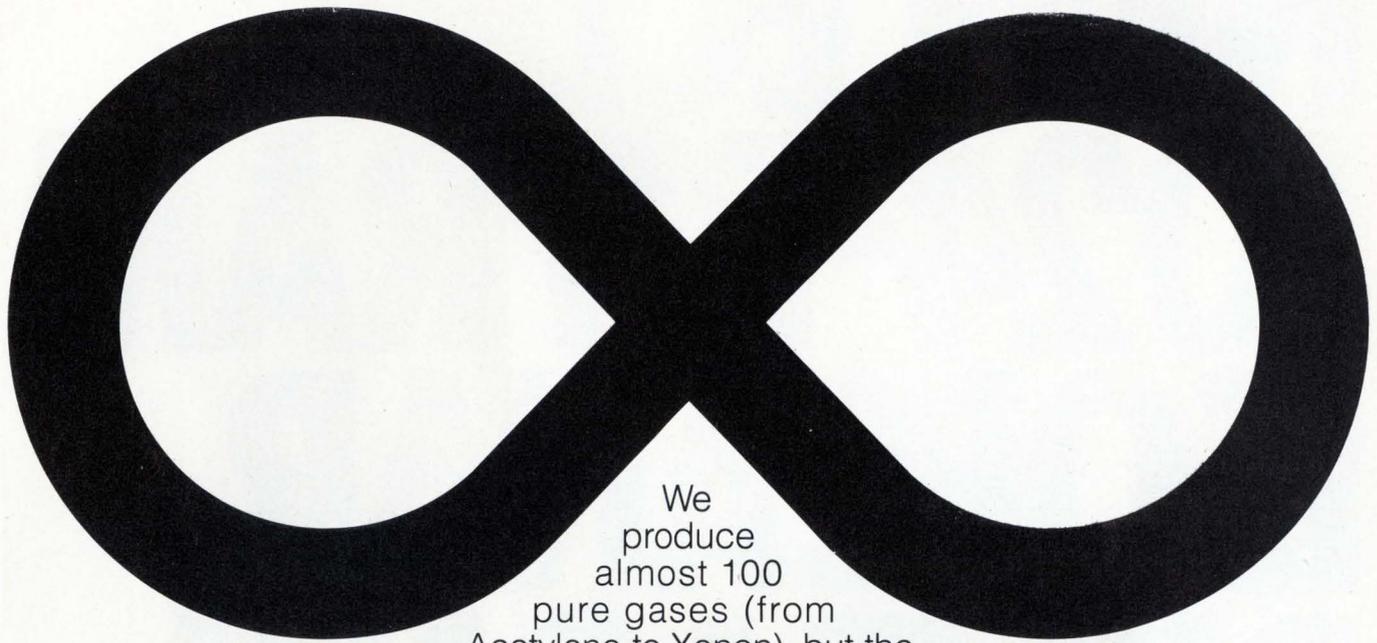
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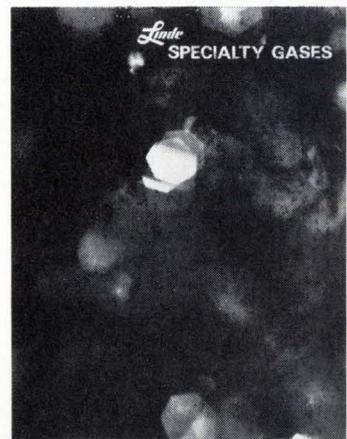
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would acquire Facit. **Facit has been hard hit by sharply increasing Japanese competition and last year lost \$11 million, with a similar loss expected this year.** A basic reason for Facit's troubles was its late start in getting into electronic calculating machines.

The take-over brings Facit into the so-called Wallenberg industrial empire and **brings the company closer to the giants in the Wallenberg stable—L M Ericsson, ASEA, and Saab-Scania—all with strong electronics operations.** The rescuer of Facit is Hans Werthen, once an electronics engineer at AGA, who was put in charge of the floundering Electrolux in 1967. **Within a year, he turned the company around, making it one of the most successful and profitable in Sweden.**

## France flooded with low-cost East German black-and-white tubes

A flood of low-cost black-and-white television tubes from East Germany has swamped the French market, causing concern among manufacturers who have been supplying France's so-called "independent" television-set makers. **The East German tubes are going for prices "that have no connection with the real business world,"** says one French company that is hurting. East German tubes were virtually unknown in France in 1970. Last year 37,000 were imported. And at the current pace the 1972 total will be around 100,000. This number represents about half the independent market—the TV makers that have not yet been swallowed up by the Thomson group, Philips, or ITT. Observers expect the flood to continue, **probably taking close to 100% of the independent market by the end of 1973,** or about 20% of total French black-and-white tube sales.

## Chinese up Trident orders to 20

British avionics companies hope that the new order by the Chinese civil aviation administration for eight more Hawker Siddeley Trident three-jet passenger transports, making 20 in all on order, indicates that the Chinese intend to standardize on Tridents for internal air services. If so, the ultimate number ordered could be very large. **Avionics orders for the 20 aircraft are valued at between \$7 million and \$8 million.** Equipment is different only in minor detail from standard Trident avionics fitted in British European Airways aircraft. The main avionics equipment, the flight control system, is by Smiths Industries Ltd. The first aircraft was handed over last Monday.

## Laser waveguide pumps data at 500 megabits per second

Using a double-heterojunction injection laser as the transmitting element, researchers at AEG-Telefunken have achieved a bit transmission rate of 500 megabits per second over an experimental mono-mode fiber-optics waveguide system. This bit rate, claimed to be the highest yet attained with such a laser, is made possible essentially by superimposing a dc biasing current on the laser's drive current.

Double-heterojunction lasers allow cw operation at room temperatures and, because they can easily be modulated, are one of the prime contenders as transmitters in future fiber-optics communications systems. However, they suffer from short lifetime, which may be from a few minutes to several hundred hours at best. To get around this problem, the AEG-Telefunken researchers are operating the laser in a quasi-cw mode: the pulsing process is maintained only for a few microseconds and is then periodically repeated.

## The 95415: 1024x1 bit. ECL. 45ns access time at 0.5mW per bit.

For designers of very high speed ECL systems, here's a 1024-bit RAM that can operate at speeds compatible with those of their system's logic. The 95415 features 15ns chip select time, full ECL compatibility, emitter follower outputs for ease of memory expansion, and *decreasing* power dissipation with rising temperature.

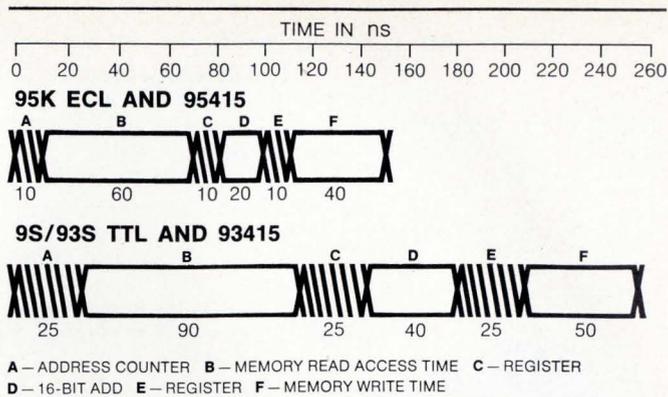
Because the 95415 is static, it's simple to use and requires no peripheral electronics. And because of its functional density, designers can save significant costs by reducing package count, circuit board number and size, number of connections and by increasing system reliability.

This fastest of all 1K RAMs is available now in limited quantity—in 16-pin hermetic DIP—from your friendly Fairchild distributor. The cost: \$109 (1-24) or \$100 (25-99).

### New Applications

The isoplanar process introduces very high speed operation at near MOS densities, opening up exciting new applications such as:

- Fast writeable control store for microprogramming, adding flexibility and eliminating the need for fixed ROMs.
- Large high-speed scratchpad to make multiprocessing more feasible.
- Simulation of long high-speed shift registers.
- Improvements of buffer or cache memory performance by increasing capacity without any power or size trade-off.
- Building cost-effective high-speed mainframe memories.



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Note that the ECL system is 105ns faster than the Schottky TTL design. In practice, ECL is even faster because of superior high frequency interconnection characteristics. And use of more complex multiphase clocking can give still better performance.

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DEVICE	TYPE	ORGAN- IZATION	TYPICAL ACCESS TIME (ns)	TYP. CHIP SELECT TIME (ns)	POWER (mW/bit)	INPUT LOADING
93410	TTL	256 X 1	45	25	1.8	0.50 U.L.
93410A	TTL	256 X 1	35	20	1.8	0.50 U.L.
93415	TTL	1024 X 1	60	30	0.5	0.25 U.L.
95410	ECL	256 X 1	25	7	1.8	50KΩ Typ.
95415	ECL	1024 X 1	45	15	0.5	60KΩ Typ.

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with a uniquely simple design that utilizes scanning technique. Key depression causes a matrix connection between decoder and multiplexer. The LOW output of the decoder appears at the corresponding multiplexer terminal. When the counter reaches the appropriate key code, cross matrix continuity is sensed. The multiplexer then provides a HIGH output to the monostable multivibrator causing a 1 millisecond pulse. This inhibits the clock and stops the counter on the desired code.

## Implanting of boron ions improves CCD memory elements

Charge-coupled devices, circuit developers have found, hold out promise for use in shift registers based on MOS technology [*Electronics*, March 15, 1971, p.31]. Such iterative arrangements of MOS storage elements could prove especially suitable for large-scale memory circuits because of the high degree of integration achievable with them.

There is one problem with CCDs, however. The coupling losses incurred during the transfer of charges from one element to another can lead to errors in the information stored. The answer has been to employ expensive manufacturing methods. But with a new ion implantation technique devised at Siemens AG's research laboratories in Munich, it is now possible to inexpensively fabricate CCD memory arrays in which charges are transferred with negligible loss.

To understand how coupling losses come about, consider a row of basic CCD elements. The devices are arranged as a string of closely spaced MOS capacitors which, in their simplest form, consist of a gate-metal electrode, an isolation layer—the gate oxide—and a homogeneous semiconductor substrate. The charges representing the information are transferred, or coupled, between the electrodes of adjacent elements by way of electric fringing fields.

**Barriers.** Crucial to the efficiency of the charge-transfer process are the potential barriers that exist in the gaps between the electrodes. These barriers are usually so high, however, that only part of the charges can get across them. This, then, is the cause for the transfer losses. They can be kept to a minimum only if extremely narrow gap widths are used between the electrodes.

To overcome the coupling losses, the new Siemens technique, worked

out by researchers K.U. Stein, Karl Goser, and Ulrich Ablassmeier, uses an additional step in the ion implantation process. In this step, boron ions are implanted into the gap area between the elements. These ions, in effect, lower the potential barrier, adjusting it to a value that insures virtually complete charge transfer. The boron ions build up a counter potential that acts to reduce the potential barriers.

Siemens researchers say that investigations carried out on experimental charge-coupled-device memories with up to 150 elements have shown coupling losses to be less than 0.5%. This level translates into a transfer efficiency of 99.8%. □

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### West Germany

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## Nixdorf buys first U.S. subsidiary

Takeovers of German companies by American firms have been reported frequently in recent years. But when a German firm buys into an American company, it's unusual—especially if the acquisition is in the highly competitive U.S. computer field.

Such an acquisition has just been agreed on. The buyer: Heinz Nixdorf, head of West Germany's Nixdorf Computer AG. The object: the computer division of Victor Comptometer Corp., Chicago, the company that has been the sole distributor of Nixdorf data processing equipment on the U.S. and Canadian markets since 1968. The takeover of the division, for which Nixdorf is paying \$10 million, takes effect at the end of December.

That Heinz Nixdorf, the 47-year-old president of the Westphalian firm, should move so boldly into the

hotly contested American computer market means that he is either an optimist, the maker of a wanted product, or a sharp business operator. Actually, Nixdorf is all three.

**Start.** Regarded in European computer circles as a tough entrepreneur and as one of the most active managers in German electronics, Nixdorf started out in the data processing field in 1952, when he was a physics student. That year, he set up shop in the Westphalian town of Paderborn. He aimed his first product, an electronic calculating machine, at a gap in the market that he thought needed to be filled, and he hit the target dead center. A few years later he followed up with an electronic tabletop adding machine, called the Wanderer Conti, which was distributed by the German office machine maker Wanderer Werke. In 1965, Nixdorf started to make calculators under his own name. Small computers and terminals have become his forte.

By deliberately thinking small in computers, Nixdorf has hit on a way to cut a big swath in world markets. Since 1967, his worldwide sales have mushroomed from about 3,700 machines to 29,000 now. Sales volume is expected to be around \$128 million this year, up from \$107 million in 1971. The more than 20 subsidiaries and service organizations in Europe, Asia, Africa, Australia, and North America are expected to do nearly \$30 million worth of business this year, 50% more than in 1971.

Unlike many other German electronics firms, which tend to shy away from what they think is a too-tough U.S. market, Nixdorf has moved vigorously into it. So far, about 1,000 systems have been installed there. And only recently a large-sized order—for no fewer than 1,000 systems—came in from the Commercial Credit Corp., a subsidiary of the Control Data Corp. □

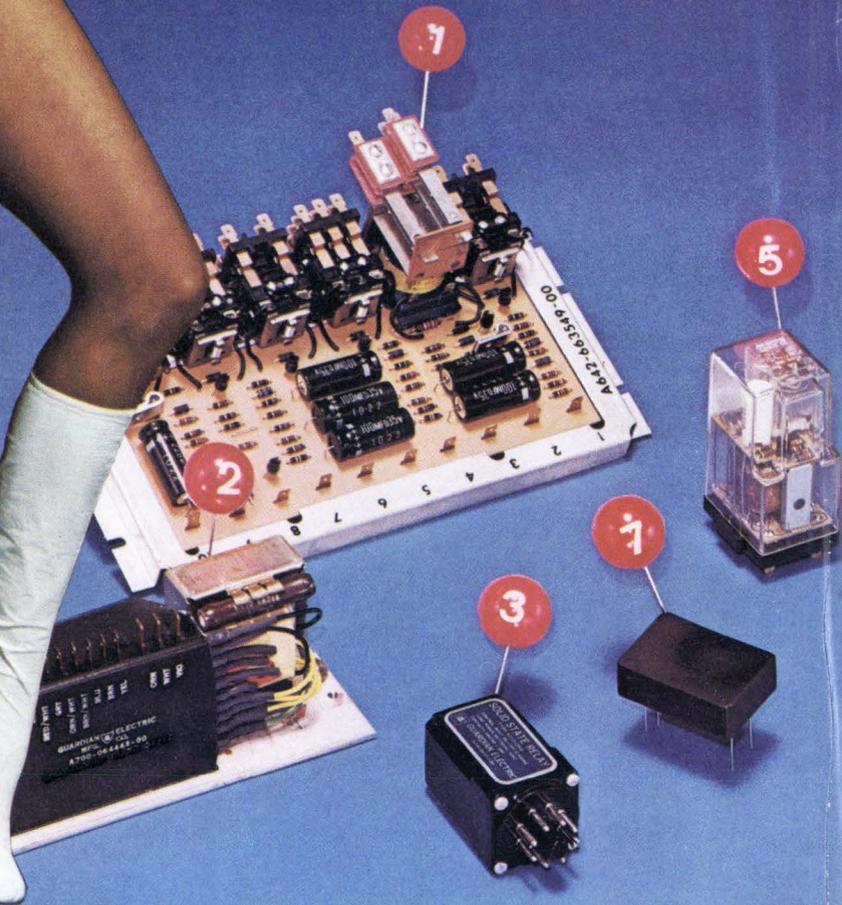
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## **Sweden looks abroad for Viggen missile**

A sharp cutback in funds has hit development of an air-to-air missile for the fighter version of Sweden's Viggen aircraft. So far, about \$2 million has been appropriated, of which almost half has been spent. An additional \$7 million, covering some initial production, was scheduled for the next five fiscal years, but will be cut out. The Swedish Air Force, forced now to turn to foreign-developed missiles, **has to decide whether the missiles will be purchased abroad or made in Sweden under license.** A spokesman for the defense staff says: "Of course, this does not mean we automatically turn to the United States. We have acquired missiles from various nations, with several from France." Total value of missiles in the program will amount to some \$20 million, once the fighter version of the Viggen is produced in the late 1970s.

## **Siemens markets Hall-effect switching IC**

Siemens AG is about to go to market with an integrated Hall-effect switch **featuring a built-in power supply and incorporating circuitry for the Hall generator, amplifier, Schmitt trigger, output stage, and voltage stabilizer.** Designated S059, the new IC is claimed to be less critical to operating voltage changes and less temperature-dependent than other magnetically controllable, contactless IC switches. The operating voltage is selectable between 4.5 and 30 volts. Two output transistors with a maximum output current of 20 milliamperes are turned on with a magnetic field of 600 gauss to generate an output pulse lasting about 100 microseconds. The output is TTL-compatible. Housed in a package measuring 10 by 6 by 2 millimeters, the S059 is **suitable for direct mounting into the keys of desk calculator and electric typewriter keyboards.** Other applications for the device are in touch-control panels for elevators and machine tools. Deliveries of the IC should get under way by January.

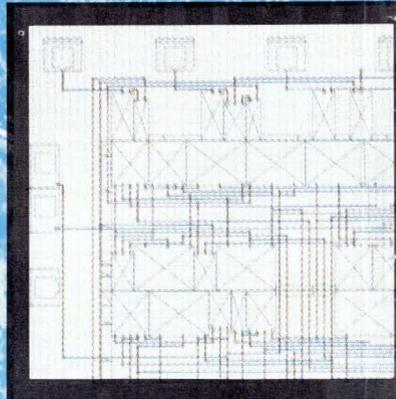
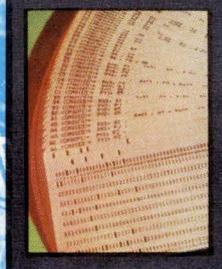
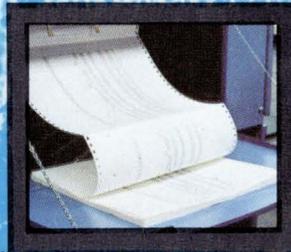
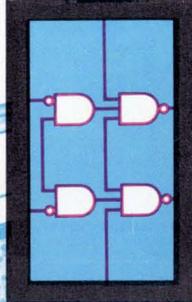
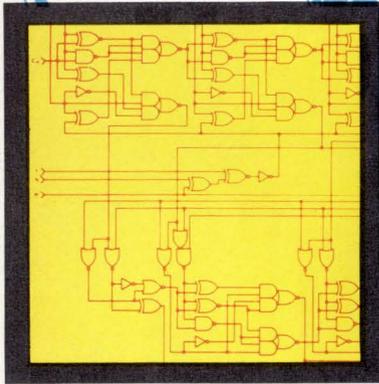
## **Vehicle-location system in Britain uses laser**

The nodding laser technique, devised by Marconi Co. for centralized monitoring of the progress of buses [*Electronics*, Oct. 27, 1969, p. 204], **will start its first full-scale trial in mid-January. Then Bristol Omnibus Co. will start to use it for monitoring 40 single-deck buses on four routes in the center of Bristol.** Each bus is equipped with a roof-mounted, side-pointing, low-power helium-neon laser, which scans roadside marker plates as the bus passes. The plates are covered from top to bottom with strips of reflecting material in two widths. Photodiodes on the bus pick up a digital code unique to each beacon location. The stored code is transmitted by vhf radio link to a central control room, on command from the central PDP-8E computer. A Tektronix display **will show the whole city center with all bus positions, or each route separately with its individual buses.** This initial scheme, with about 900 marker plates, has cost about \$300,000, provided partly by the government, which is interested in wider use.

## **Sweden to build computer-controlled submarines**

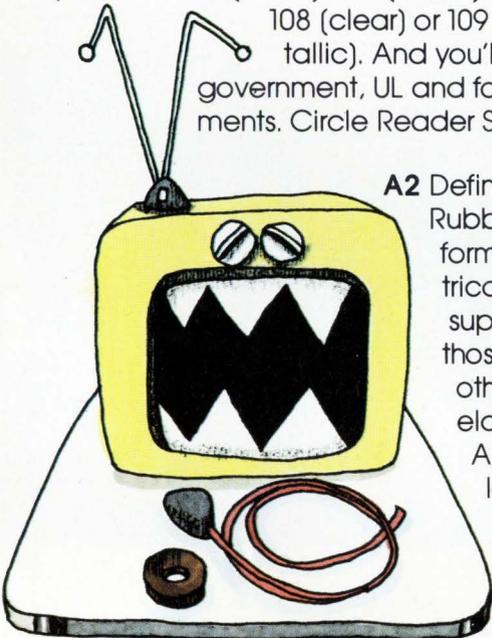
The Swedish government has given final approval for an order for three submarines of a new type—they feature a high degree of computer control and can operate with 18 men, **about half the number of crewmen used in other subs of similar size.** The submarines, each with

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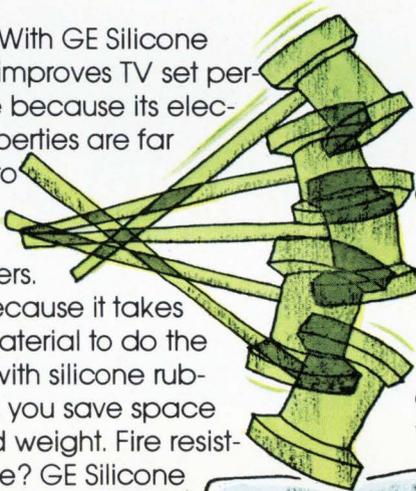
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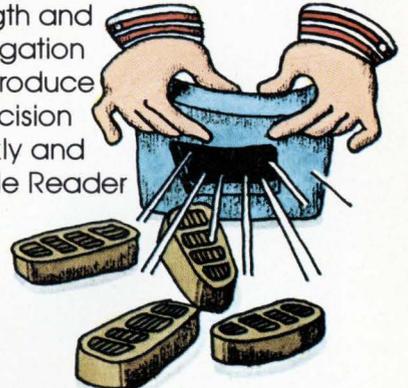


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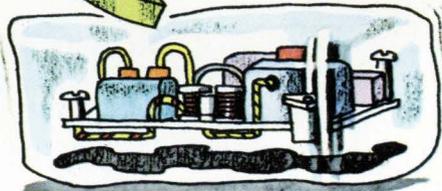
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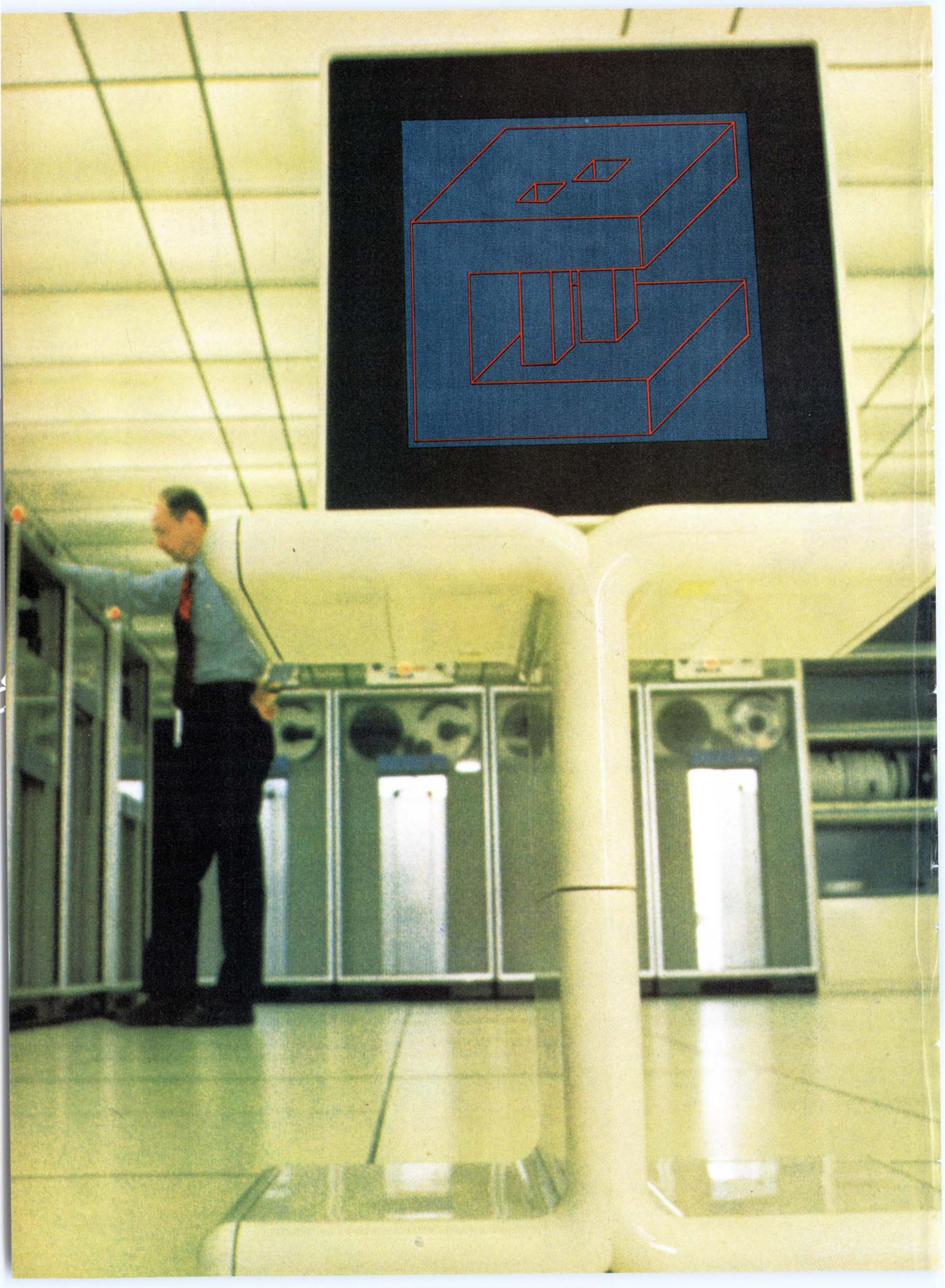


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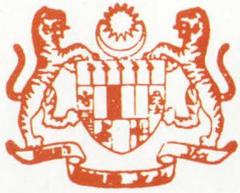
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# Probing the news

Analysis of technology and business developments



**MALAYSIA**

## New offshore explosion

Low-cost labor, credit, taxes lure world manufacturers to expand in Malaysia and Portugal



**PORTUGAL**

by Ray Connolly, Washington bureau manager

**Rising wages** and dwindling labor pools in the offshore markets developed during the '60s are driving the multinational corporations still further afield in their search for profitability in the '70s. Led by American components companies, electronics firms from the U.S., Europe and Japan are being attracted into countries as diverse as Malaysia and Portugal. And governments anxious to build an economy on something other than agriculture are doing their best to add to the initial attraction of low-cost labor.

Malaysia, for example, has drawn more than 30 electronics manufacturers to its shores since 1966, when Matsushita Electric Co. began to assemble its line of National television receivers at the Batu Tiga industrial estate or park, about 15 miles outside the capital of Kuala Lumpur.

Twelve of those electronics companies are U.S. operations, and indications are that Malaysia has applications to set up assembly and manufacturing plants from as many more American components and communications equipment makers. National Semiconductor became the first U.S. electronics manufacturer to begin producing in Malaysia, just last January.

**Jobs and output.** Electronics manufacturers operating in Malaysia from other nations—Japan, Britain, Holland, Sweden, the Philippines, Hong Kong, and the nearby Republic of Singapore—brought the 1971 job total in electronics to more than 6,000 workers, according to State Department estimates. Output was more than \$18 million Malaysian dollars, when one Malaysian dollar was worth 37.3 U.S. cents. This year employment and industry output

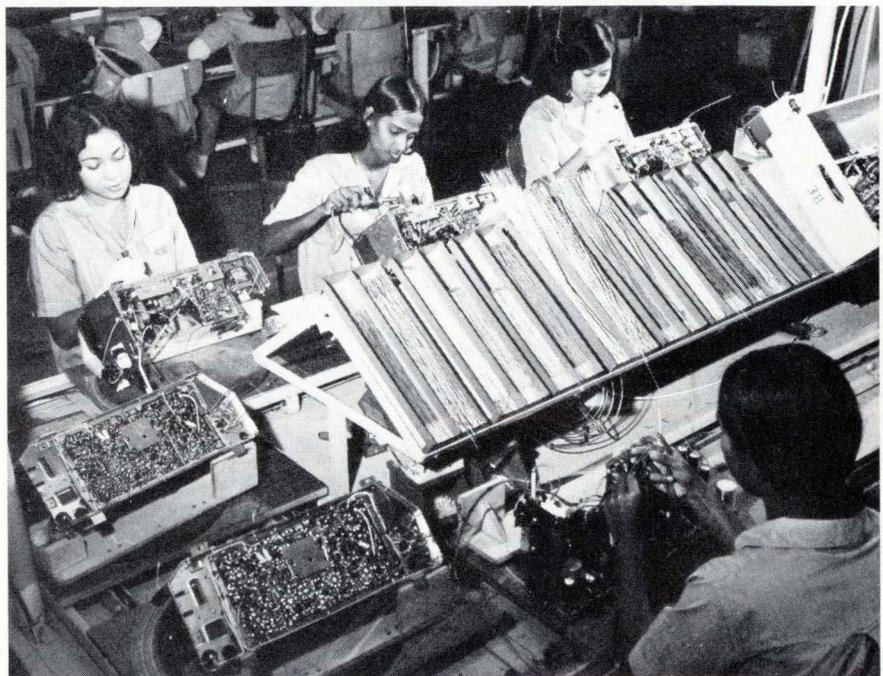
are both still rising sharply as more assembly-plant operations are being brought into service.

Where Malaysia has widely promoted its drive to develop an electronics capability through its Federal Industrial Development Authority, even to the point of establishing offices in New York City, the growth in Portugal has proceeded almost unnoticed. Starting virtually from scratch in 1964 with a total national output of 23,000 radio receivers, it now has a dozen foreign manufacturers, seven of them from the U.S. The industry's output reached "about \$30 million in 1970," according to a recent State Department estimate, which adds that "production today is believed

to be considerably larger as newly installed plants approach their normal levels of output." In 1972, Portugal will become a net exporter of electronics for the first time, with components shipments to the U.S. in the forefront.

The U.S. is by far the major importer of Portuguese components, which range from ICs to computer memories. Last year, for example, it took \$7.6 million in Portuguese components, more than two-thirds of the \$11.3 million export total, according to that nation's statistics. But of Portugal's \$15.6 million in exports of assembled products, mostly monochrome TV and radio receivers, the U.S. took only 3%. The rest went to Portugal's partners

**Labor haven.** Workers at the Matsushita plant in Malaysia assemble television sets. Japanese corporations were among the first to set up offshore assembly plants in Malaysia.

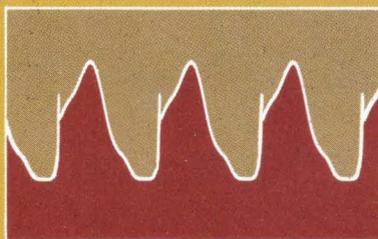


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## Probing the news

in the European Free Trade Association—West Germany, Britain, Austria, and Sweden.

With statistics showing Portugal's electronics exports in the first five months of 1972 ahead of last year by 25%, the U.S. Consulate at Oporto reports that "further spectacular increases may well take place" since many foreign-owned operations are new and not yet operating at full capacity. One estimate by a U.S. electronics manufacturer is that "Portugal's production of black-and-white televisions could make it the Taiwan of Europe, just as its output of components could turn it into another Mexico or Malaysia" for American industry.

**Advantageous location.** Malaysia, of course, is still far from becoming a net exporter. It consumed 111 million Malaysian dollars in electronics last year, of which more than \$102 million was imported. Nevertheless, it is experiencing a phenomenal growth rate as American and Japanese manufacturers move in. Be-



**Fertile ground.** Litronix is among the 12 U.S. electronics manufacturers that have opened up plants in Malaysia, and there are about a dozen more U.S. applications pending approval.

yond the appeal of low wages and tax benefits, Malaysia's geographical position helps—directly north of the Republic of Singapore, where there are 23 large electronics manufacturing operations, 16 of them owned by American companies. Several of the 16 plan on using their Malaysian facilities as "feeders" for operations in Singapore and even Taiwan. One pro-Malaysian source also cites the stability of that country's government as an added advantage to consider in contrast to "the uncertain political status of Taiwan."

U.S. operations in Singapore that could expand into Malaysia—but haven't yet—include: Aircor, Continental Device, Electronic Memories & Magnetics, Fairchild Semiconductor, General Electric, Sperry Rand, and Texas Instruments, reports the U.S. State Department. Even so, the fact that Malaysia already has acquired a dozen U.S.-owned companies since National Semiconductor first began operations in January indicates the country must be doing something right.

Motorola Semiconductor, for example, is setting up in a 100,000-square-foot plant in the new Sungei Way free-trade zone, investing about 15 million Malaysian dollars—about half of that anticipated in new projects by the government, according to the State Department. All told, new electronics plants being set up in Malaysia will generate 6,000 more jobs this year, and that figure is expected to jump an additional 10,000 by the third year of operation, for a total of about 17,000 electronics-oriented jobs.

**Government aid.** What Malaysia is doing right from the standpoint of manufacturers is the same thing that Portugal is doing right. Portuguese government incentives to industry, according to the Oporto consulate, include: "tariff protection, exemption on duties of imported equipment, tax advantages and credit facilities for certain types of investment." The outlook for the infant electronics industry in Europe's rectangular southwest corner is sufficiently bright for the Oporto Industrial Association to be planning an International Exposition of Electronics and Electronic Products for October 1973.

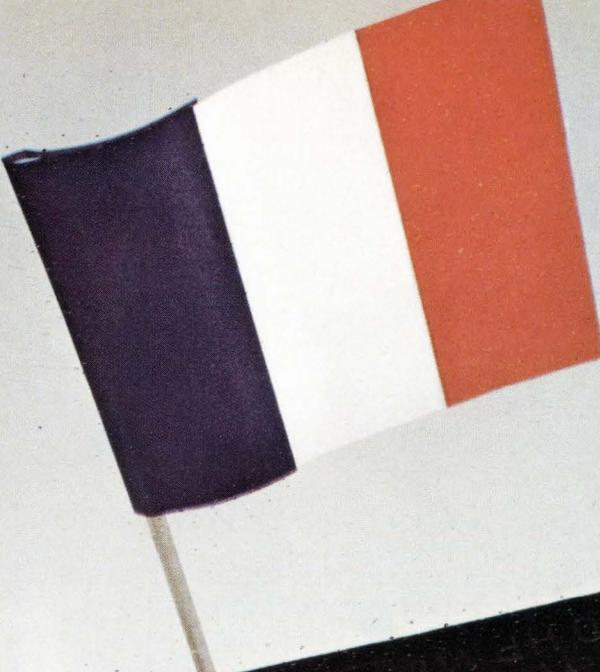
### New offshore growth at a glance

**Portugal:** had 12 major producers in 1971, including 7 U.S. who will become net exporters in 1972. Electronics output was \$30 million in 1970, and is rising rapidly. In 1971, exports of \$26.9 million included \$11.3 million in components; imports of \$27.8 million included \$19 million in assembled equipment.

Over 5,000 workers, mostly women, average 23–27 cents per hour in components plants, or 33–56 cents per hour in assembly plants. U.S.-owned companies include operations by General Instrument, Advance Ross Electronics, Duluth Scientific, Corning Glass Works (Signetics), Control Data, Applied Magnetics, and International Standard Electric. Largest operation belongs to Philips of the Netherlands; others, all West German, include: Gatag, with Relda and Max Grundig; Walter Preh and Grundig Werke; Ernest Roederstein and Grundig Werke; and Siemens AG.

**Malaysia:** has 30 major producers, including 12 U.S., and applications for at least a dozen more, mostly U.S. Net importer but growing fast; some new operations sought to feed plants in Republic of Singapore to the south (see below). Output in Malaysian dollars (with U.S. \$1.00 equal to M\$2.75) was \$18 million in 1971 with 14 plants operating. Malaysian exports in 1971 were M\$8.9 million; imports, M\$102.4 million. Consumption hit M\$111.5 million in 1971.

Workers, mostly women, number upwards of 7,000. Semi-skilled workers receive 43–56 Malaysian cents per hour. U.S. operations include: Electronic Arrays, Hewlett-Packard, Intersil, Litronix, Litton Industries, Monsanto, Motorola, Microsystems International, Monolithic Memories, National Semiconductor, Teledyne, and Union Carbide. Joint Japanese/Malaysian ventures include: Clarion Malaysia, Matsushita, Toshiba, Sanyo, Seiko, Sharp, Pension Components, Shinwa Industries, Tamura, and Communico Co. Others: Maltronics (Holland), Roxy (Hong Kong), L M Ericsson (Sweden), Plessey (Britain), Unilite (Singapore), Intron (Philippines), and Robert Bosch (West Germany).



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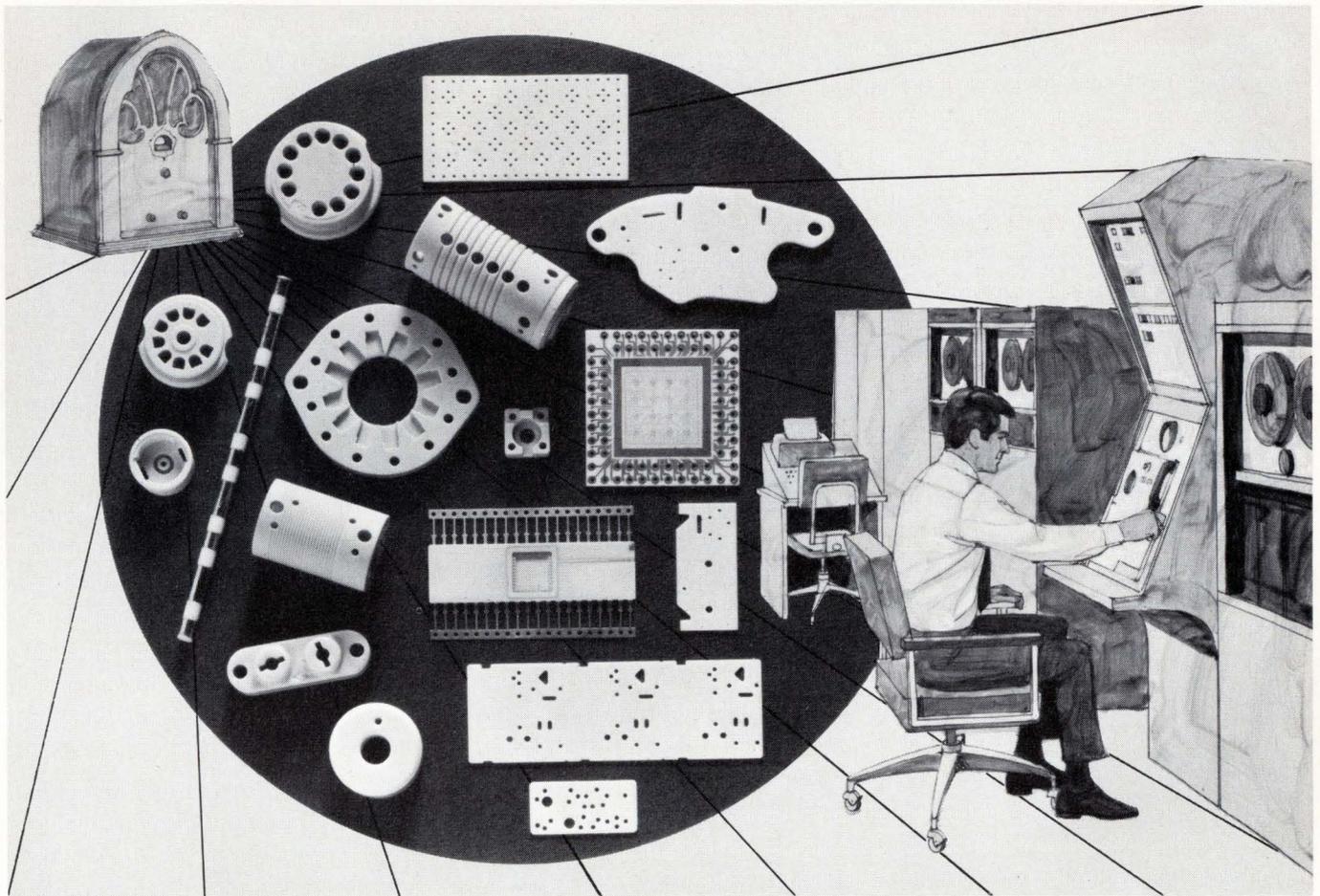
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Solid State

# Interface sales set growth pace

Economies through increasing complexity and second-sourcing attract buyers for applications like data communications and MOS interfacing.

by Paul Franson, Los Angeles bureau manager

**Interface circuits**, the stepchildren between analog and digital circuits, are approaching maturity, with rapid growth and extensive second-sourcing, accompanied by more interest in cost than technology or specifications. Sales of interface circuits have grown about 100% over last year, says Charles Phipps, manager of strategic planning at Texas Instruments, Dallas. "They're not the largest of the linear segments, but are one of the fastest-growing." Phipps says that the total interface market, by TI's definition, was about \$15 million in 1971, and it will be over \$25 million this year.

William Howard, linear IC product manager at Motorola Semiconductor Products division, Mesa, Ariz., defines interface circuits as those "connecting the analog and digital worlds." In practice at Motorola, he adds, "it's the parts that have an analog signal input and digital output, or vice versa." Larry Housey, linear product manager at

TI, defines interface circuits as ones with inputs and outputs at different logic levels. Generally, this means line drivers and receivers, sense amplifiers, peripheral and memory drivers, and sometimes, other parts.

However they are defined, the recent spurt in the development and sales of interface circuits can be attributed to several interacting factors:

- The growth of data-communications systems and a corollary interest in party-line applications.
- The realization that system costs can be cut through the use of more complex interface circuits and through the competition stemming from second-sourcing.
- The need to interface MOS circuits, particularly memory devices, with solid-state TTL and with power-consuming devices, such as transmission lines and light-emitting diodes.

One of the fastest growing areas, says Ronald D. Campo, manager of Motorola linear integrated-circuits planning, is line drivers/receivers, up 104% over last year. The present market, he says, is \$15 million. In telephones, Motorola's 1488/9 quad RS-232-C drivers and receivers seem the standard, but TI has just introduced a receiver, the 75152, that can be used in both RS-232-C and MIL-STD-188C applications. RS-232-C, an EIA specification for interface circuits, details the relationships among input resistance, voltage, and switching speed. MIL-STD-188C is essentially its military counterpart. Motorola's Howard is con-

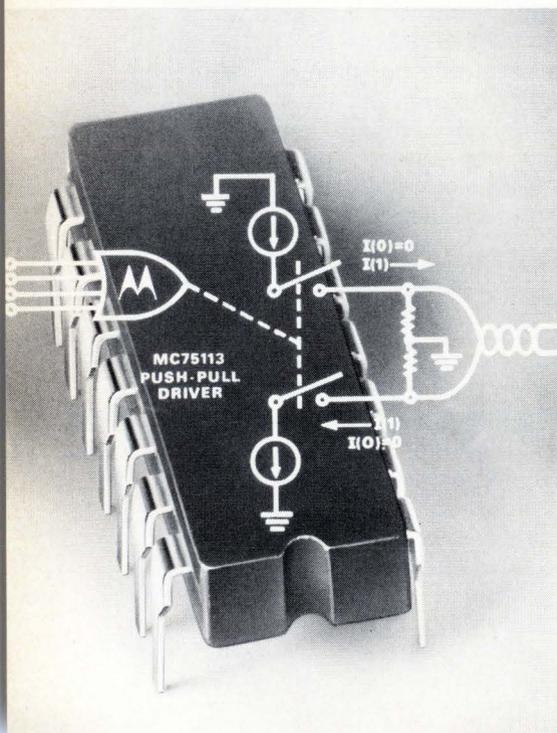
centrating on commercial parts because he sees a much larger market for them.

**Communications.** There's more new activity in twisted-pair line drivers and receivers than in RS-232-C, reflecting the growth and lack of standards in peripherals and other computer applications. The big push here is to party-line applications, including tri-state outputs that can be tied together to obtain an OR gate. A party-line connection is a parallel attachment of a number of units to a single bus line. For instance, a number of line receivers and transmitters may be connected in parallel to one line so that each one could talk with the others. An alternative is a switching system that permits any circuit to choose which other one to talk to. The Digital Equipment Corp. PDP-11 mini-computer uses this type of party-line circuit, which DEC calls Unibus. It's the coming thing.

Even in second sourcing TI's 75107 and 75108 receivers, Motorola has added diode-protected inputs to prevent damage to the receivers caused by circuit malfunctions or disconnected peripherals putting large common-mode voltages on party lines. Other attention to party-line operation is shown in the new TI 75150 dual-line receiver, with a low input current of under 100 microamperes, according to TI. This permits as many as 100 receivers to be used on a line in bus-operated systems.

Two new parts from TI and Motorola share type number 75113, but they are different. However, both are party-line-oriented. The TI SN75113 is a dual tri-state line driver with differential output for

**For party lines.** New Motorola line driver is useful where several drivers and receivers share a common line.



be provided. In particular, conflict detection, which takes a lot of computer time, will have to be increasingly computerized.

The British, too, have had to change computer horses in mid-stream. In November, a computerized flight-plan processing system built by Marconi Co. Ltd. to help ATC men control the middle air space over southern Britain was formally handed over to the Civil Aviation Administration. (In Britain, middle air space, used mostly by military aircraft, refers to all the air space not in the civil air lanes—which is called controlled air space—and below upper air space.) When conceived in 1966, this system was intended to carry out flight-plan processing for controlled, middle and upper air space.

**Buying American.** As at Maastricht, it became clear to the British CAA that the Marconi installation would not be able to process the vast quantities of information required for the system. After long consideration of alternative Marconi proposals, the CAA decided to relegate the original Marconi installation to middle-air-space flight-plan processing, and to buy an IBM 9020D installation, complete with software developed for the Federal Aviation Administration, for controlled- and upper-air-space flight data processing. The hardware and basic interfaces will come within a year, but the software has to be adapted to British conditions. The target operational date is 1975. Initially, the system will process about 250 plans simultaneously, but its capacity is well over 500.

CAA officials say the main reason for buying American was time: the IBM-FAA system is working, and it can be adapted to British conditions. On the other hand, Marconi's alternative hardware was not completed, and a lot of software would have had to be developed.

The IBM 9020D for controlled- and middle-air-space control will work as a flight data processor and print out strips in the usual way. It will use keyboards for most inputs, but Marconi will develop touchwires to update plans during flight progress. The display drive complex will also be built in Britain.

France is another nation keen on

touchwire controls. This fall, the French Air Navigation Service will install a touchwire system in its three major ATC centers—Paris, Bordeaux, and Aix-en-Provence—which will control all the civil air traffic in France. The system is designed specifically for transferring a plane from one control sector to the next. When a plane is due for handover, a touch by the disposing controller starts the existing flight plan flashing on a display in the control room in the next sector. If it is unacceptable, the new controller signals the unacceptable parameters, and his computer seeks alternatives and flashes up new possibilities. With another touch, he inserts the possibilities he prefers, and the new plan is filed.

The three centers each use duplicated Compagnie Internationale pour l'Informatique computers (based on a Xerox Data Systems license) with core store of 68,000 words of 32 bits each. One computer backs up the other. The civil system also uses Thomson-CSF primary and secondary radars, Philips Gloeilampenfabrieken displays and Siemens printers. The computers are interlinked and do secondary-radar plane-identification decoding for the display as well as flight-plan processing.

The French are working on a technique for continuous filtering of flight plans so that the controller will be presented only with those plans that don't fit in easily with the rest—all compatible flight plans will be filtered out. Hence his attention will be automatically concentrated where it's needed. This will be implemented within two years.

Because French airspace is a congested crossroad for a vast amount of overflying traffic, Frenchmen take ATC very seriously. Jean-Marie Giraud, assistant director of air navigation, explains that the Air Navigation Service has been implementing progressive computerization since 1962.

**Elsewhere in Europe.** Although not part of Eurocontrol, Sweden and Italy are involved in using computers to upgrade the efficiency of

en-route air traffic. The Swedes took to computers early. Arlanda airport, near Stockholm, had a computer for tracking and calculating vectors in 1964, and another at Malmoe that does secondary-radar decoding and data insertion as well. These are being updated, and a new terminal center is being built at Gothenburg. And, a new en-route control center will be built in southern Sweden.

Meanwhile, Stansaab Elektronik AB, an associate of Standard Radio and Telephone AB, the Swedish ITT subsidiary, which supplied the original computers, is doing good business selling more advanced systems abroad. It has sold systems to Copenhagen and Oslo airports for civil use, and to Holland and Belgium for military use. It has orders for civil and military systems for Yugoslavia and for a civil system for Austria.

The Dutch military system, installed this summer at Nieuw Milleneen in central Holland, uses two Stansaab Censor 932 computers in parallel operation, each with 48,000 32-bit words. It can handle 200 flight plans simultaneously, including updating of flight plans and conflict search, Stansaab says. The controller can obtain a projection of any flight on his synthetic display.

In Italy, the Air Force rules the air lanes and will add a computer system for controlling air space in the Rome-Naples region early in 1974. Selenia SpA has the order and says the system will handle up to 160 flight tracks initially, with an expansion capability satisfactory for probably 10 years. It will do flight-plan processing and conflict search, and suggest solutions when aircraft separation is insufficient. □

Contributors to this article include Arthur Erikson, Managing Editor, International; John Gosch, Frankfurt bureau; Michael Johnson, McGraw-Hill World News; and Robert Skole, McGraw-Hill World News, Stockholm. The story was written by Michael Payne, London bureau manager.



**A Myriad for military.** The Marconi computer for the British Civil Aviation Administration will handle military en-route air traffic.

driving balanced lines. The Motorola MC 75113 is a single differential party-line driver that takes another approach to disconnecting the part from a bus. Unlike most drivers that have a single current source switched between the two output lines, the Motorola device has a matched current source on one line and a current sink on the other.

The currents are switched on and off in response to inputs, and all drivers connected to a line appear as open circuits unless they are on. Compared to the tri-state connection, this eliminates the need to disable the drivers when not needed to transmit. This also provides twice the differential signal for driving signals over transmission lines nearly four miles long. The balanced currents in the line also reduce crosstalk.

Another factor is reducing costs.

Motorola's Campo says, "People are becoming much more cost-conscious." And Howard agrees, "Users want fewer packages—quads, not duals, for example. That's one reason we think our quad MC 1488 and MC 1489 RS-232-C line driver and receiver have become so popular with many second-sources."

Quads and duals account for part of the increased complexity in interface circuits, since these circuits reduce the number of parts and cut user costs. But even further integration is in the works. The leader here is probably TI with its new MSI TTL SN55329W eight-channel driver for core memories. This part, now available only in 24-lead flatpack with a \$50.50 price in quantities of 100, is for military applications, as is its complex complement, the 55236 dual sense amplifier and data register, which TI claims is the first MSI sense amplifier produced. Like the driver, it's a military part.

Another way to cut system cost is with combination line-receiver/transmitter circuits. National Semiconductor, Santa Clara, Calif., has announced four such transceivers—all quads and tri-state—called the 7833, -4, -5 and -9. But this increased integration in one package likely foretells other developments, although cost problems with large packages and power dissipation may limit the trend. In fact, Dick Brunner, Motorola applications engineer, sees little need to integrate further.

**Second-sourcing is active.** Just as increased complexity can reduce prices, so can second-sourcing, with its increased competition. Typical of the second-sourcing in the industry is Motorola's recent introduction of a number of TI sense amplifiers, such as the SN7520 series, line driver/receivers in the SN75107 series, peripheral drivers in the SN75450 series, and memory drivers SN55325. TI, in turn, has introduced its version of National Semiconductor's DM 7820 dual differential line receiver (75782), DM7830 driver (75183), and TTL-to-MOS voltage translators DM7800 (75180). TI is also making the Fairchild 9614 driver and 9615 receiver as the 75114 and 75115. Motorola is planning to introduce its version of the National Semiconductor MH0026

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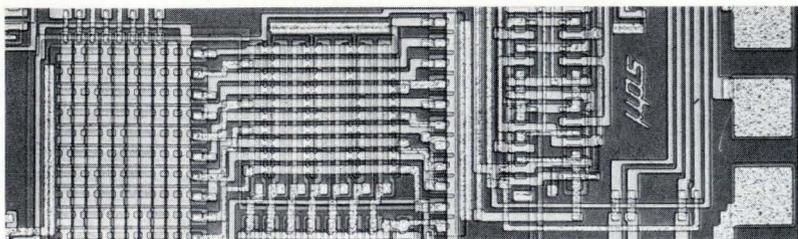
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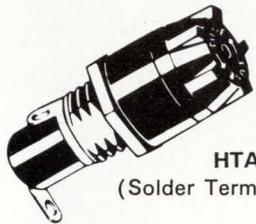
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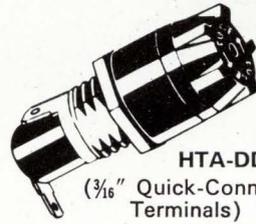
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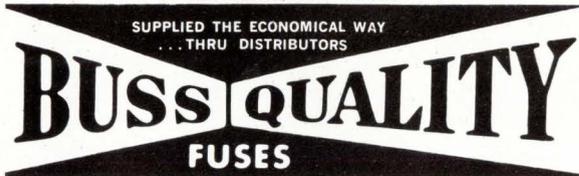
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Instruments

# Manufacturers streamline sales pitch

Direct mailing to engineers and return-coupon advertisements are among new marketing methods seeking to cut costs on low-priced lines

by Michael J. Riezenman, Instrumentation Editor

**Although the engineer may pay less** for his instruments from now on as instrument makers continue the trend to lower-priced models, this economy is not without its price: The salesman can no longer afford to treat him in the style to which he has become accustomed. As manufacturers try new marketing approaches to cut the costs of sales as they have cut the costs of production, they must modify their customary applications help and repair service—at least for the lower-priced models.

The buyer must carefully evaluate the warranties offered, particularly with inexpensive instruments, because the prices that go with the new marketing approaches leave little margin for service costs. These include direct mail, free trial offers, advertisements containing order blanks, and more widespread use of distributors.

One of the most talked-about instrument success stories of the year is H-P's electronic slide rule, the HP35. That this shirt-pocket calculator in itself has been a success is undeniable; that the credit for its tremendous sales should go to the direct-mail campaign used to market it is not nearly so clear. An H-P spokesman asserts that the company is being flooded with orders for the \$395 calculator. But he doesn't know how to compare the success of direct mail with that a sales staff would have had. "How do you compare what you might have gotten with what you've got?" he asks. The spokesman says that, although H-P is considering the mail-order approach for more products, the company will wait to see what success others achieve before proceeding.

Then, he says, "if it looks good, we'll do it."

**Getting sales costs down.** While manufacturers hesitate to try new marketing techniques, the proponents of the direct-mail approach claim that it is one of the few sales methods that can get the cost per sale down to a reasonable level. Raymond Daniel Speer, president of Speer Marketing Services Corp., New York City, for example, says, "Direct-mail is a versatile, strong communications medium in which the timing is under the complete control of the manufacturer, and the freedom for creative expression is wide."

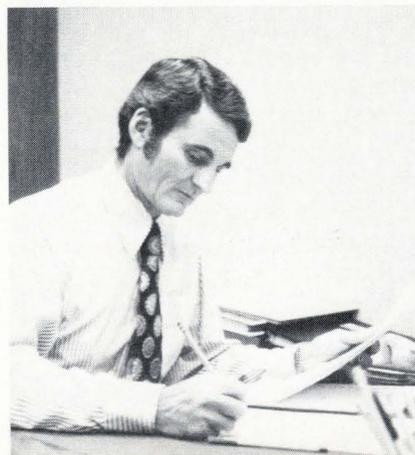
Don Kerr, manager of sales promotion at General Radio Co., Concord, Mass., seems to agree. His company, which has computerized its mailing list, includes qualifying data on each addressee. "Where before, the average mailing to customers interested in noise-measuring equipment might have reached 45,000 people, it now reaches about 30,000, and those 30,000 are more

apt to be interested," Kerr points out. GR can program its computer to select addressees by plant size, industry, title, occupation, or other parameters.

Tektronix Inc., Beaverton, Ore., began a direct-mail program for its \$800 J16 digital photometer-radiometer late in August, two months after the instrument was introduced. Bob Chamberlain, program supervisor, says that results of the sales program are not yet known. The J16 was chosen as the Tektronix guinea pig for the mail-order plan because, says Chamberlain, "it's simple enough, and it doesn't need a demonstration." Other instruments, he adds, "need a complete technical explanation so a guy can understand their full capabilities."

Although the J16 direct-mail pro-

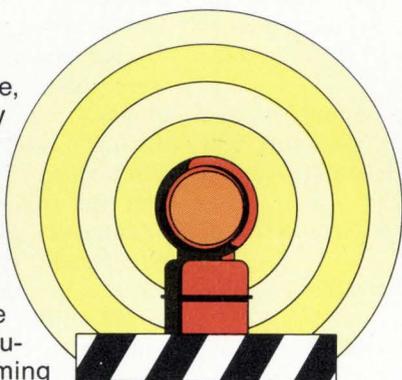
**Throwaway.** Fred L. Katzmann (right) president of Ballantine Labs, feels that new warranty concepts are needed for low-cost instruments. James F. Helfrich (below), marketing manager at Dana Labs, speculates that throwaways may be the answer.



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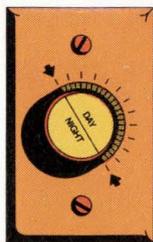


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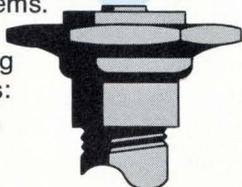
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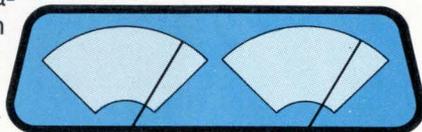
Anything in the automotive line. Like anti-skid braking controls, windshield wiper speed regulators, tachometers. Fuel injection and emission control systems.

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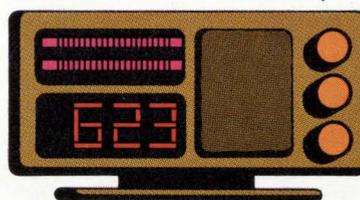


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Communications

# AT&T moves to capture data market

The Bell System's entry into data communications seems likely to get FCC approval by April, when the plan is to start building a 96-city network

by Ray Connolly, Washington bureau chief

**Success** appears likely to bless the Bell System's effort to gain the Federal Communications Commission's approval of its entry into the data-communications business by April 1973. And if it does succeed by then, the American Telephone & Telegraph Co. New York City, plans to have a nationwide Digital Data System linking 96 cities in operation by 1976, say sources in the communications industry and the White House Office of Telecommunications Policy.

FCC approval is particularly likely in view of the Nixon Administration plans for creating a stronger business-oriented majority at the commission. Speculation is that a re-oriented commission will approve in principle the AT&T application to interconnect Boston, New York, Philadelphia, Washington and Chicago as the beginning of its network using Bell's data-under-voice (DUV) technique [*Electronics*, Oct. 25, 1971, p. 34]. This will leave the resolution of the stickier issue of what represents "fair competition" and the related questions of cross-subsidization of services by AT&T to a more prolonged inquiry.

"There is about five years of work for lawyers in Washington in the chewing over of the whole subsidization issue," says John Sodolski, communications and industrial division vice president at the Electronic Industries Association, Washington, D.C. Nevertheless, he believes other specialized carriers like Microwave Communications Inc., who will be offering broader chunks of bandwidth than with DUV. "will be able to compete" with AT&T. "It will be like selling computers against IBM—it's hard, but it can be done."

However, James J. Lenehan, vice president of Collins' Microwave Div. does not believe AT&T will hamper the growth of specialized common carriers. "I would suspect that AT&T just wanted to show that it was aware of what was happening in the marketplace, and wanted to show its stockholders and the industry that it was going to take an aggressive posture," he says. "But I don't think that this will affect the viability of the MCIs and Datrans," Lenehan insists.

AT&T Long Lines officials say the company doesn't expect to file with a new tariff for the Digital Data System until market studies are complete and that this could take "about six months" after FCC approval of its entry into the private-line digital market. But their competitors are expected to challenge them on this point before the commission. Says one, "How can the commissioners judge the 'fair com-

petition' issue if no one knows what it will cost?"

Speculation that AT&T may be asked to set up a separate corporate entity for its DDS is an issue AT&T says it has "under consideration." Still, the company makes clear it is not anxious to do so, noting it is "quite pleased with the way we are meeting the needs of data users" with the existing organizational structure.

There is also the possibility, according to Washington sources, that the FCC will grant AT&T approval of its data system, provided the communications giant agrees to chop off Western Electric, its manufacturing arm. But AT&T is expected to fight such a proposal, and "resolution of that point could take years," says an FCC source.

**Technologies.** Through the data-under-voice (DUV) technique, its initial approach to digital transmission, AT&T says it will use "a new

## Equipment suppliers have other worries

The prospect of competition from AT&T is arousing surprisingly little concern among other U.S. communications-equipment manufacturers. They are presently much more worried by competition from foreign suppliers offering appealing credit terms on the microwave hardware needed by U.S. specialized carriers—terms that U.S. makers cannot match.

"We are concerned that large, foreign, government-supported electronics industries can come into this country and get a foothold that could affect our day-to-day business," says James J. Lenehan, Microwave division vice president of Collins Radio Co., Dallas. "We have to be very aggressive and come up with something to counter it," he says, noting that Collins' recent contract with MCI included some financing.

Nevertheless, General Electric of England recently became the third foreign vendor to supply MCI with hardware financing, following CitCom Systems of France and L. M. Ericsson of Sweden. Dallas-based University Computing Co.'s specialized carrier, Data Transmission Co. of Vienna, Va., says it is still negotiating with Nippon Electric Co. of Japan and other "vendors" for hardware in its proposed switched digital net [*Electronics*, May 22, p. 49].

he admitted, "For years, I have labored under the illusion that I am an expert prognosticator; my father was a prognosticator, also my father's father. My mother was a Methodist."

His self-chosen characterization is apt. Noble has the canny ability to calculate the variable forces at work in the electronics industries—research, development, markets, sociological trends, politics, and government. As a corporate planner, he shares the glory for the achievement by Motorola of \$1 billion in sales this year for the first time. And Noble predicts that IC technology will make possible within five years electronic watches selling for less than \$25 that will be as accurate as \$2,500 watches are today.

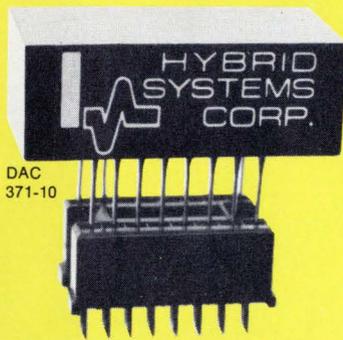
But Noble's vision also extends to people. He views the human condition optimistically: "The Industrial Revolution was a revolution in increased productivity due to adapting machines to extend our muscles. Now we're entering a period of extension of creativity due to brain extension with computers and electronics. We may have 25 to 50 years of stumbling as we try to find our way, but that will be followed by a period of creativity unimaginable now."

In his later years, Noble, a devout believer that "A high percentage of the positive forces for good that make life viable have been started by science and engineering," has tried to educate people to recognize the transition to this new era.

Noble's foresight is not restricted to technical creativity, either. He is a painter whose works abound in the lobbies and executive suites of Phoenix, and he has exhibited his paintings and sold successfully. However, he claims no more than an experimental interest. The paintings, including symbols, and even parts familiar to anyone in electronics, suggest both a view of man alienated from his environment and an intellectual sense of humor—perhaps a put-on.

Concerning his own future, Noble still has plenty of projects to work on: "A thing like retirement isn't something I can accept with equanimity, and I expect to keep on working until about 1975 if my health holds up." □

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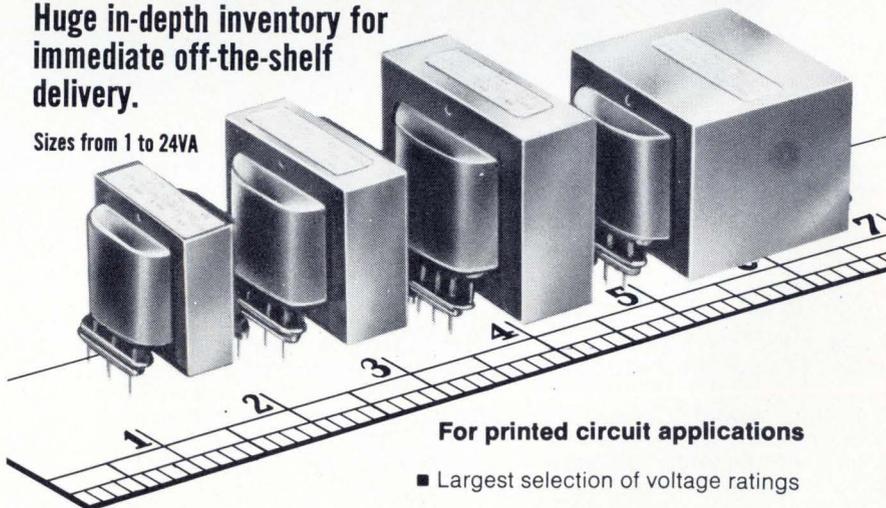
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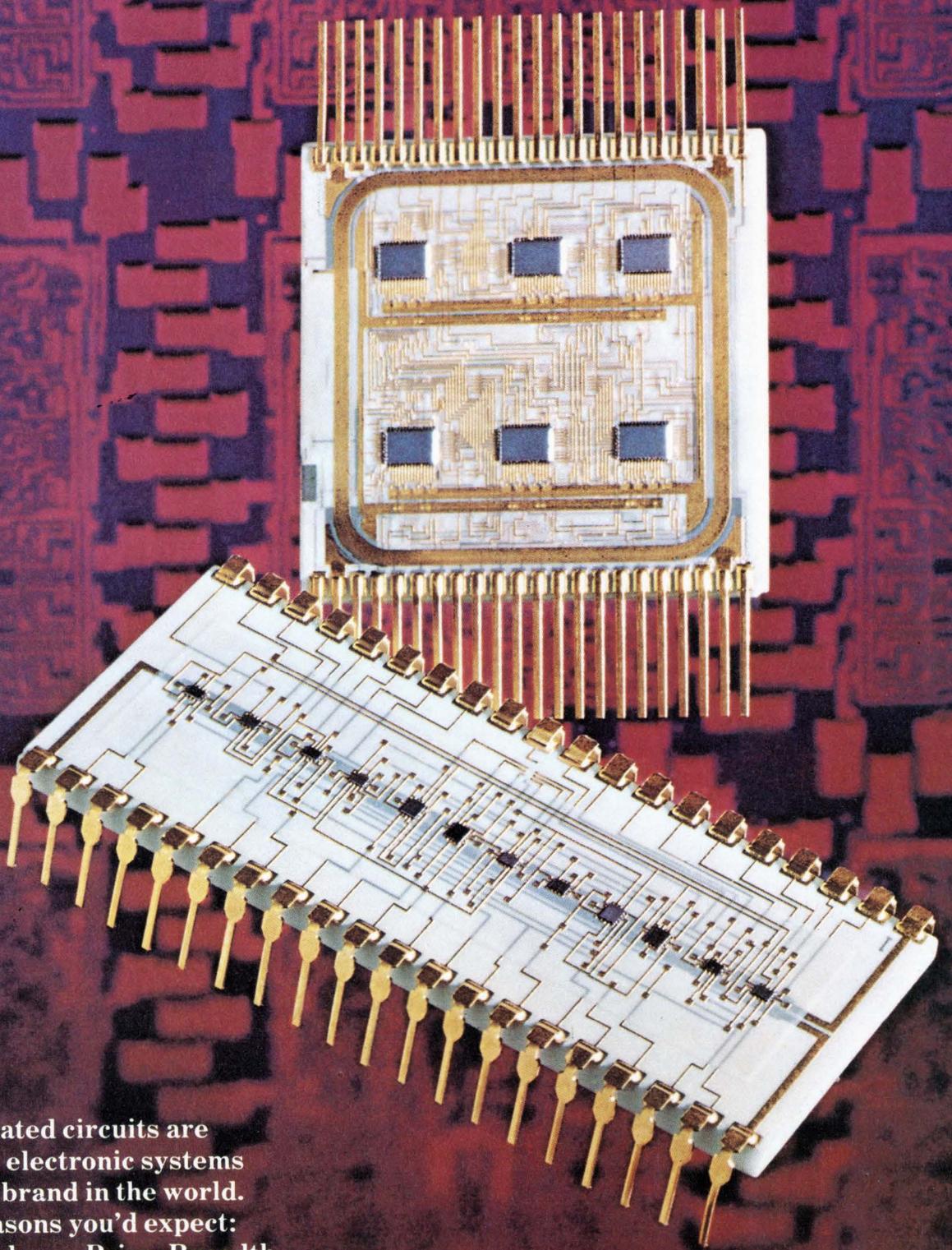
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# BEAM-LEAD ICs

# Integration brings a generation of low-cost transducers

This pressure transducer uses an all-silicon vacuum reference chamber with a Wheatstone-bridge arrangement of diffused piezoresistors to measure pressures ranging + between 0 and 1 atmosphere

by Arthur R. Zias and William F. J. Hare, *National Semiconductor Corp., Santa Clara, Calif.*

□ Considering that virtually all electronics instrumentation ultimately must interface with the larger mechanical world through one type of transducer or another, it is surprising that these transducers have not long ago benefited from the advances that have been made in integrated-circuit technology. The development lag appears even more surprising when one realizes that transducers have routinely set the price and performance boundaries of most measurement systems.

Although the reasons behind the delay are fairly clear (see box, "Why the lag?"), they have recently lost much of their validity. Hence, a growing supply of transducers is expected to become available in the near future. Standard high-volume IC techniques will be used to build, test, calibrate, and package these transducers. And they

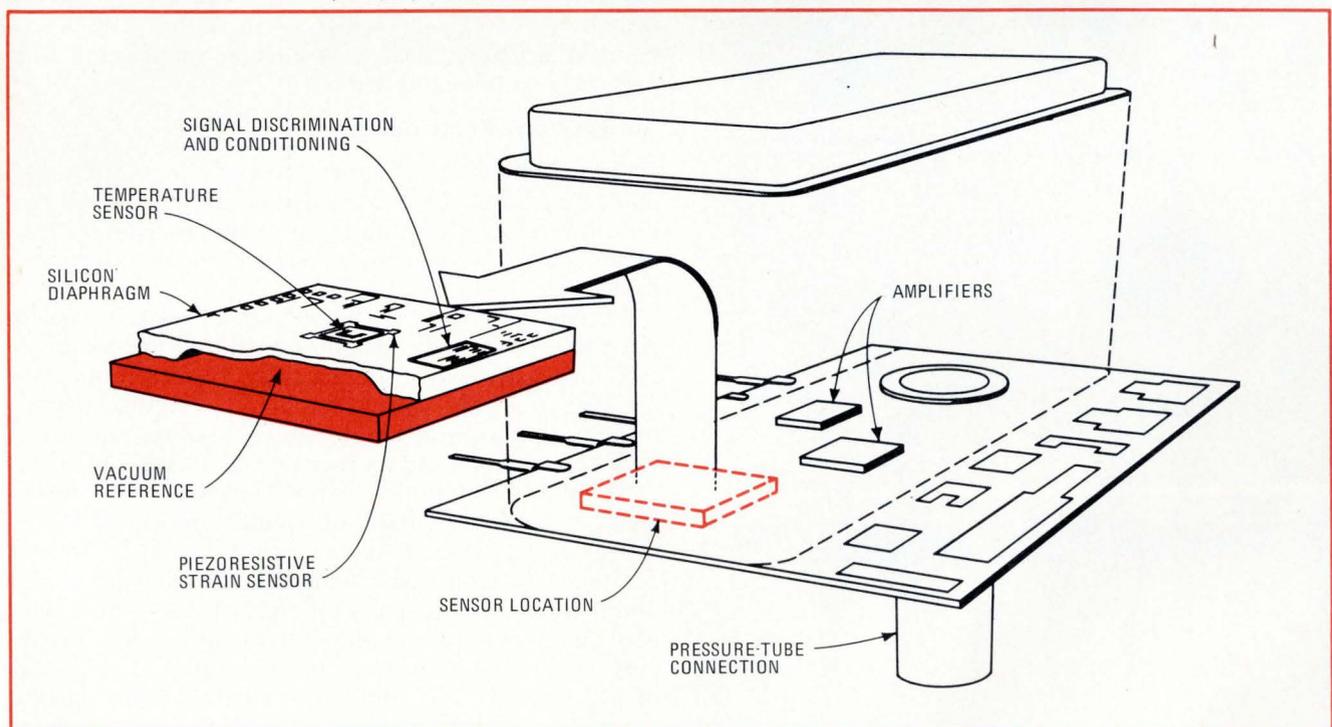
will be priced like ICs. A sample of these good things to come is National Semiconductor's new pressure transducer, the LX1600A.

### An all-silicon vacuum chamber

The new transducer, which sells for about \$10 in large quantities, consists essentially of a Wheatstone-bridge arrangement of four piezoresistors diffused into a silicon chip. The silicon chip is actually a 1-mil-thick pressure diaphragm that has been etched out of one wall of a vacuum reference cavity (Fig. 1). The rest of the cavity wall has a thickness of 12 mils.

The Wheatstone bridge consists of four p-doped (boron) regions diffused into the etched chip of n-type silicon. Unlike a conventional metal strain gage, whose

**1. Pressure transducer.** Hybrid device is contained on a single ceramic substrate, along with array of thick-film signal-processing resistors, mechanical enclosures, and two op amps (a 747 and a 741) that serve as buffer amplifier and output amplifier, respectively.



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acteristics and leakage currents, as well as the bridge resistances, can be measured quickly and easily at the wafer stage. Assuming these tests are handled with a computer-controlled microprobe, increased accuracy and lowered costs through early culling are compatible.

The stability characteristics—linearity, hysteric error and deadband—are by far the most expensive to measure. (Hysteric errors are ambiguities caused by slight differences in the response of the transducer to increasing and decreasing pressures. The transducer's deadband is the maximum shift in the null characteristic that can be caused by a pressure excursion up to the transducer's rated overpressure limit.) These tests tend to be subtle and time-consuming, and hysteric error and deadband are so small that they present major instrumentation problems. Worst of all, these parameters require checking, not at the wafer-probe stage, but late in the assembly process. In fact, the IC's absence of linkages and mounting stresses and the single crystal's characteristic freedom from diaphragm hysteresis make these parameters exceedingly hard to measure outside of a specialized lab.

Obviously, the nominal, qualification specs, such as shock, vibration, and electromagnetic interference, affect package requirements and design. But they have little over-all effect on the testing costs of a high-volume item.

Because this tight production control is an economic necessity, and because production and test entail an automaticity uncommon to transducers in general, IC transducers are best calibrated and specified in ways novel to conventional devices. For example, IC units are trimmed and calibrated as they are built. The computer-controlled mass-production routine is arranged so that the specified nominal output is achieved by trimming the null and full-scale end points to a specified tolerance and using a single input-output curve for all units (Fig. 2).

This type of calibration is also a major departure from conventional practice for individually fabricated transducers. It eliminates field calibration and facilitates complete field interchangeability within the spec, but it sacrifices some of the "outer-edge" performance claims that might otherwise be made. In fact, it costs the spec writers 2% in the null voltage and full-scale voltage claims. These are errors that, in individually calibrated units, would disappear in shifts of the "best-straight-line" from unit to unit. That  $\pm 2\%$  figure notwithstanding, the device is suitable for a wide variety of fuel-metering, volume- and density-measuring, and anticipatory proportional control applications.

In final calibration, a computer-controlled laser trims a matrix of output resistors deposited on the hybrid ceramic substrate (Fig. 3). The substrate also holds the IC sensor cell, a buffer amplifier (a 747 operating at unity gain), and a 741 operational amplifier that raises the balanced and compensated sensor signal to a nominal full-scale value of 7.5 vdc. The laser trims that voltage to within 2% of FS. It also trims the null to 2.5 vdc  $\pm 2\%$  of FS, the null temperature coefficient to  $0 \pm 1.0$  mV/ $^{\circ}$ F, and the full-scale TC to  $0 \pm 1.5$  mV/ $^{\circ}$ F.

Such errors as nonlinearity, deadband, and hysteric error aren't trimmable; they're slaves to the sensor con-

## Why the lag?

Why has the transducer industry allowed so much time to elapse between the development of integrated-circuit technology and its application to the fabrication of mechanical transducers? For force and pressure transducers particularly, a good deal of this lag can be traced to a highly fractionated, low-volume, nonstandard market environment inherited with the old electromechanical tradition. A recent industry compendium, for example, lists (after eliminating duplications) some 75 manufacturers supplying the entire \$2.5 billion IC market, including all categories—linear, digital, MOS, LSI, MSI, and all the rest; but the same source lists some 90 makers of pressure sensors alone. And pressure accounts for much less than half the annual \$320 million transducer market.

Furthermore, since good-quality devices—that is, devices that can make measurements that are reproducible to within approximately 0.1% of full scale—cost from \$150 to \$500, this is plainly a market of short runs. And since the suppliers average less than \$1 million a year, it's also plain that this field, at least, has heretofore offered few occasions for major investments in high-volume, high-quality product innovations. In general, therefore, progress has been a painfully slow evolution from watchmakers' delights, featuring potentiometer wipers and unbonded strain gages, to cemented gages and, recently, deposited and diffused pickoff elements. In all cases, these have been produced singly or in small batches.

They have also been tested and calibrated singly, an important disadvantage, since test and calibration—across the price-range—account for between 30% and 50% of a transducer's over-all cost. In addition, individual calibration adversely affects interchangeability; in many systems, transducers are the only elements that require recalibration of the entire system when they are replaced.

Recently, however, this picture has changed. Automotive, appliance, and certain high-volume industrial requirements have made major investments in high-volume, high-quality force and pressure transducers a good bet, especially for companies with linear IC capabilities already in hand. The result of these efforts will be a growing family of transducers manufactured completely by high-volume IC techniques.

struction. Hysteric and deadband errors are, however, very much smaller in ICs than in conventional transducers, and since nonlinearity is mainly a function of design, it's very predictable, stable, and reproducible from IC to IC.

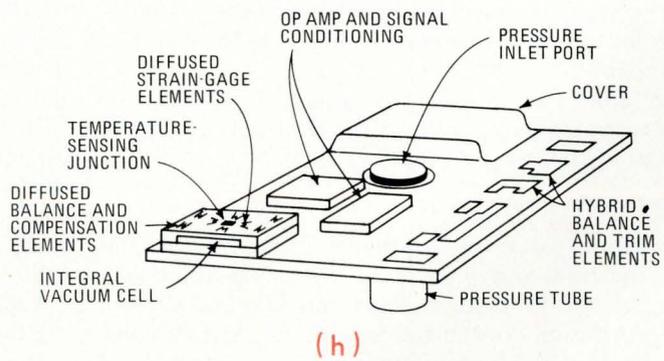
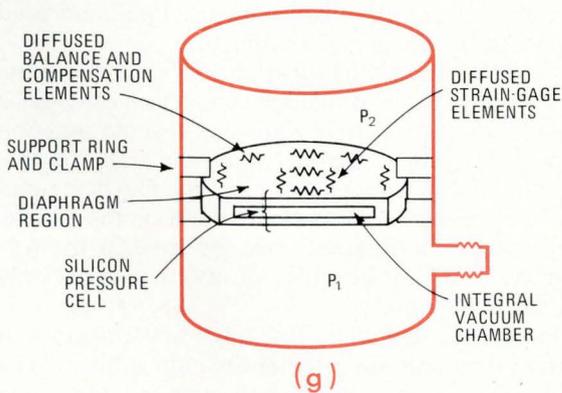
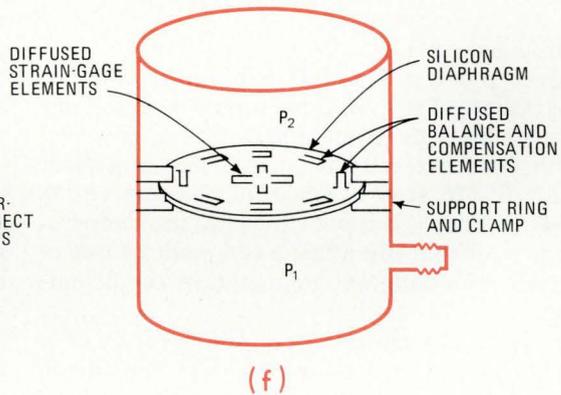
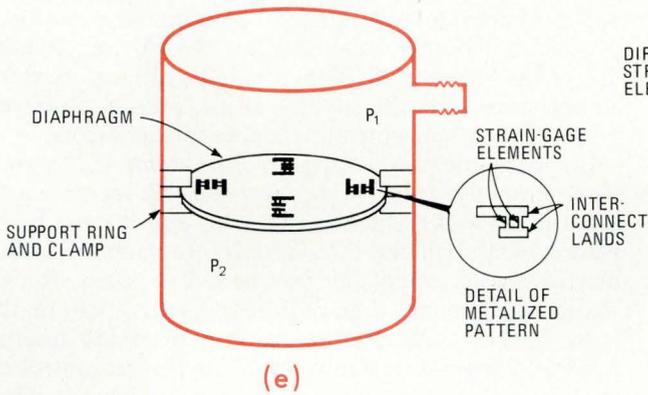
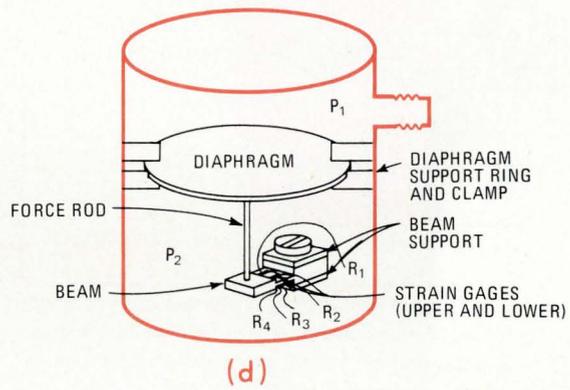
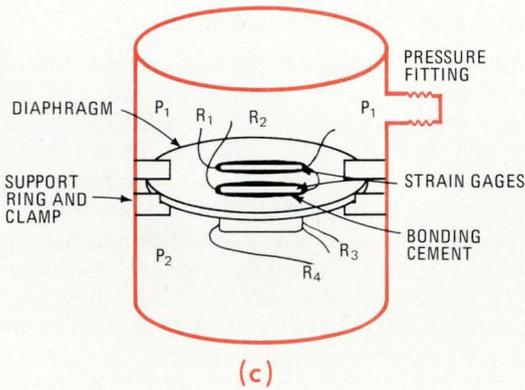
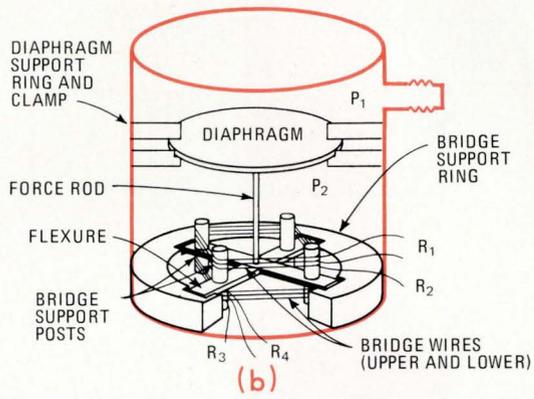
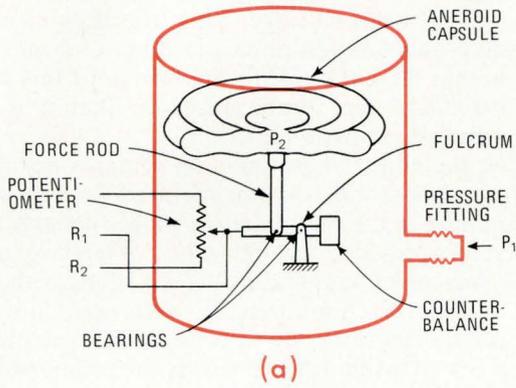
## Physical construction

The pressure transducer is built on a 165-mil  $\times$  115-mil silicon chip of which a 90-  $\times$  65-mil area is the pressure diaphragm. This leaves more than enough area for temperature-compensating diodes, bridge-balancing resistors, and a zener regulator for the bridge power supply. In fact, there is enough extra room to put the op-amp buffer and output amplifiers on the sensor chip, should this become desirable (Fig. 4).

The vacuum cavity is formed by etching the back side  
*(continued on page 88)*

# NEW TES





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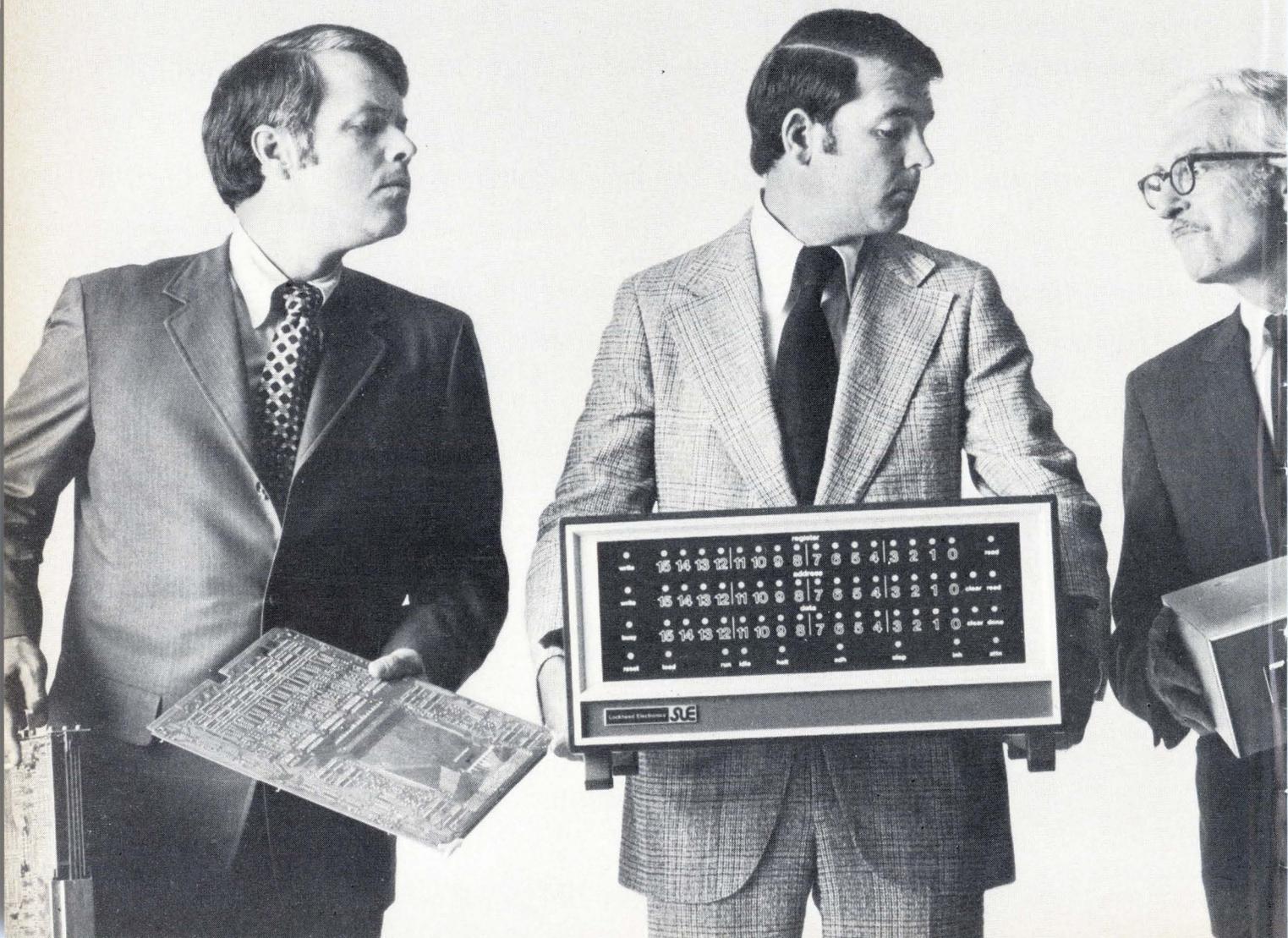
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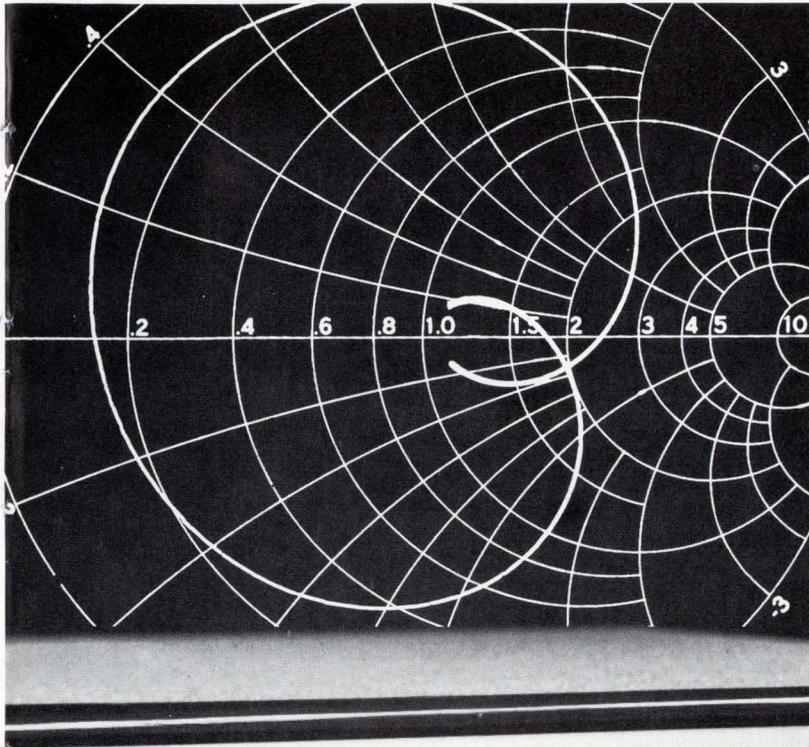
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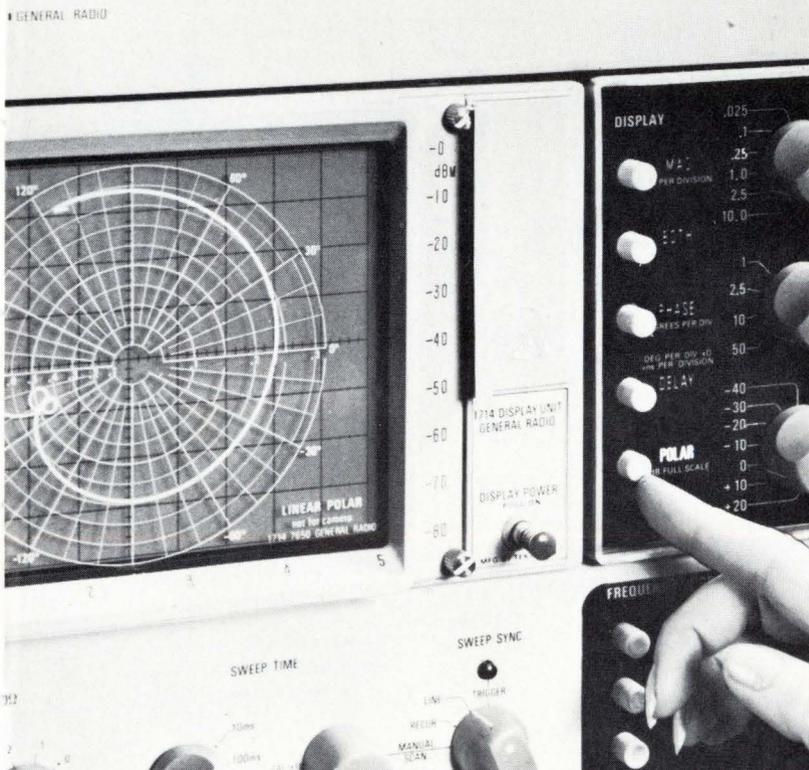
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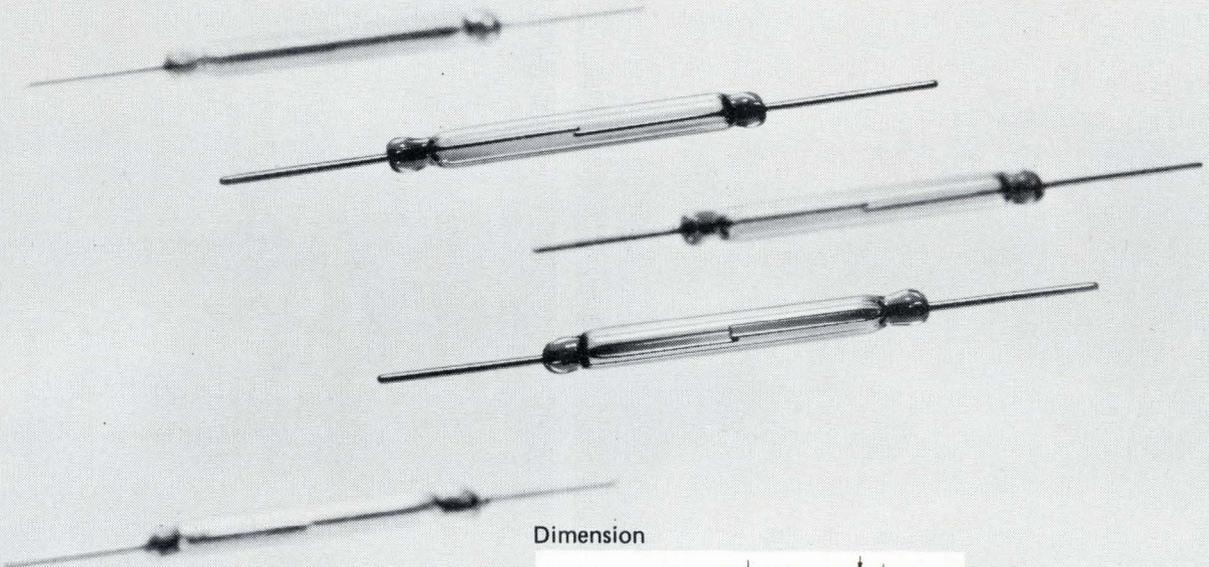
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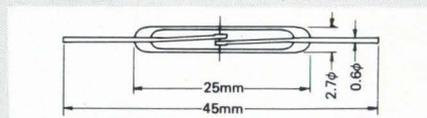
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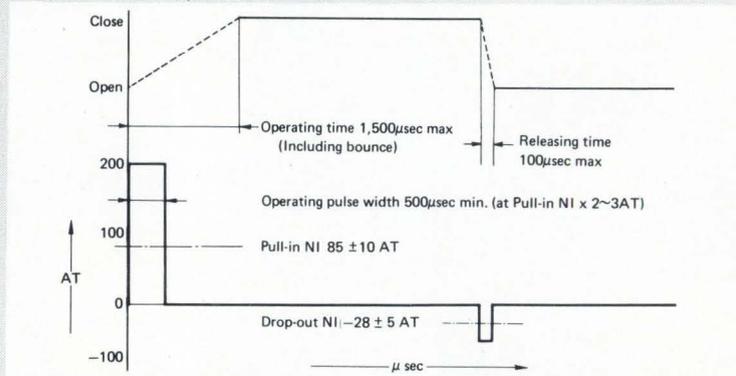
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## Four-ampere power supply costs just \$13 to build

by Joseph Ennis  
Automation Industries, Inc., Vitro Laboratories Division, Silver Spring, Md.

The cost of building a regulated power supply can be lowered to around \$13 if a large capacitor is used to store energy at a higher voltage than is necessary. Under normal operating conditions, the supply, which is primarily intended for powering a stereo amplifier, can deliver an output of 4 amperes at 20 volts with load fluctuations down to 18 hertz and with regulation to better than 5%.

A high-value capacitor, one measuring tens of thousands of microfarads, stores charge so that only a small amount of transformer iron is needed to produce the 4-A operating current. The resulting higher-than-required capacitor voltage is then dropped to the desired 20-v level with a transistorized series regulator. Moreover, two inexpensive incandescent lamp bulbs are used for short-circuit protection, rather than a more costly current foldback technique.

With no load at the output, the transformer charges

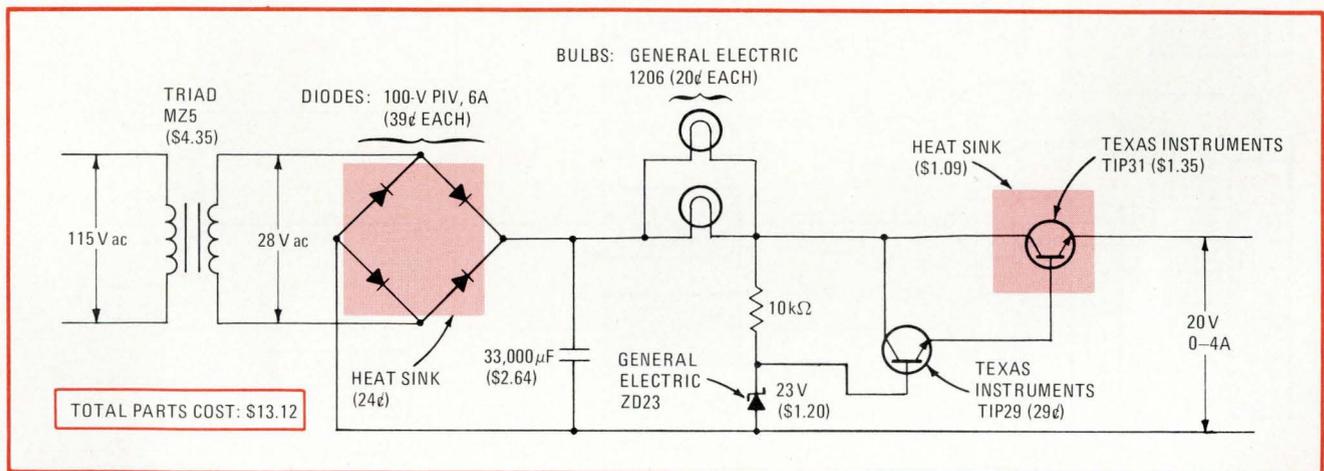
the capacitor to about 39 v through the diode bridge. The transformer, which has a no-load secondary voltage rating of 28 v ac, can deliver the 4-A operating current but will not deliver this voltage under loading because of its core and copper losses. Although capacitor voltage may drop to around 24 v during peak loading, the series regulator will continue to provide a smooth 20-v output.

A current of more than 4 A could be controlled by the regulator transistor with the appropriate heat sinking, but the heat sink would cost more than the transistor. The heat-sink area is designed to handle only normal worst-case operating conditions and does not allow for any current foldback dissipation.

Instead, this dissipation is provided by two replacement-type automobile lamp bulbs. Besides acting as fuses when there is a short circuit at the output, they reduce the voltage drop across the regulator transistor, thereby decreasing the power it has to dissipate during normal supply operation.

To change the supply's output voltage to 15 v, the 23-v zener is replaced by a 17-v one. If a 5-v supply is needed, a transformer with a secondary voltage lower than 28 v should be selected to reduce the voltage drop that the regulator must handle. A negative-voltage supply can be constructed by substituting complementary transistor types TIP30 and TIP32 for the type TIP29 and TIP31 transistors. □

**Economical regulated supply.** Parts cost for power supply is pared to absolute minimum by storing energy in 33,000-microfarad capacitor at higher-than-required voltage level. This allows a fairly lossy, and therefore inexpensive, transformer to be used. Incandescent lamp bulbs serve as fuses in case of a short circuit and reduce voltage seen by series-regulator transistor. Output is 20 volts at 4 amperes.



## Binary division produces harmonic frequencies

by Donald DeKold  
Santa Fe Junior College, Gainesville, Fla.

Harmonically related frequencies—more specifically, a fundamental frequency and its first nine overtones—can be generated with binary division of a blanked pulse

train. The harmonic frequency generator, which consists of a clock pulse generator, a decade counter, and a few NOR gates and flip-flops, produces square-wave outputs at frequencies  $f_0$  through  $10f_0$ .

The clock frequency must be  $2^n$  times faster than the frequency of the highest harmonic of interest ( $n$  is the number of flip-flops used for the binary division). Therefore, to produce the highest harmonic,  $10f_0$ , in this case, the clock output is simply divided down by  $2^n$ . For all harmonics but the fifth, however, the clock signal must be properly gated before it can be divided.

To understand why this is so, consider what happens

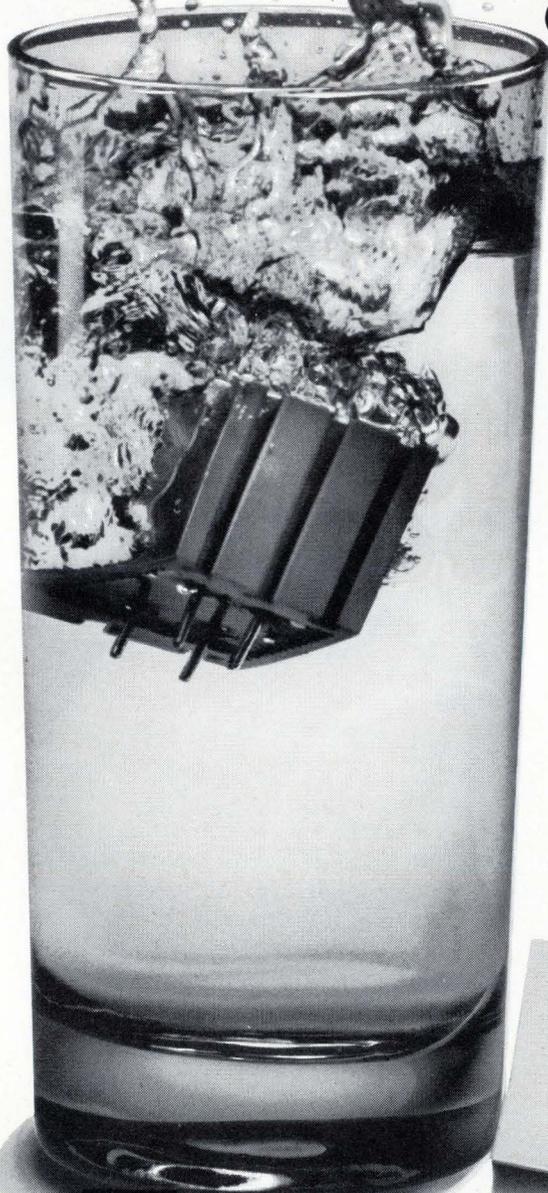
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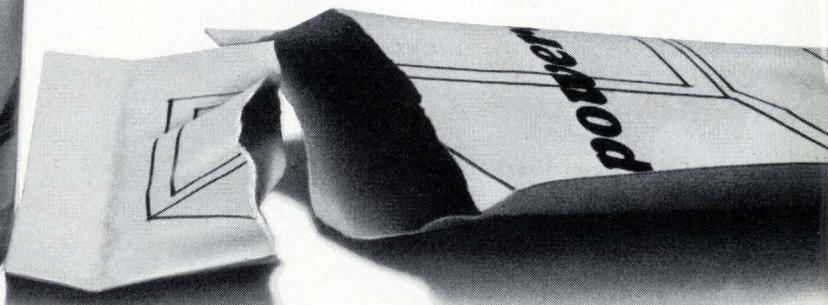
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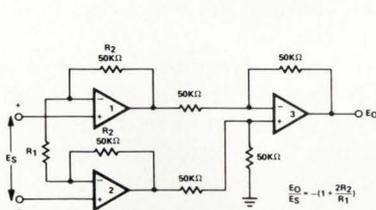
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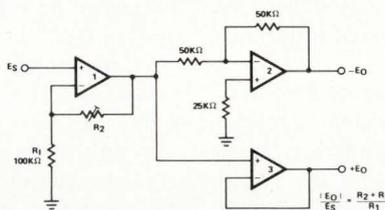
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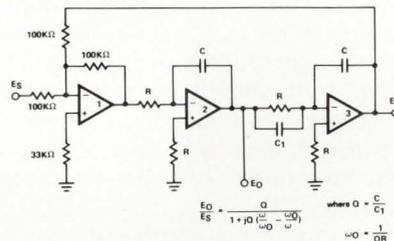
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# Special report

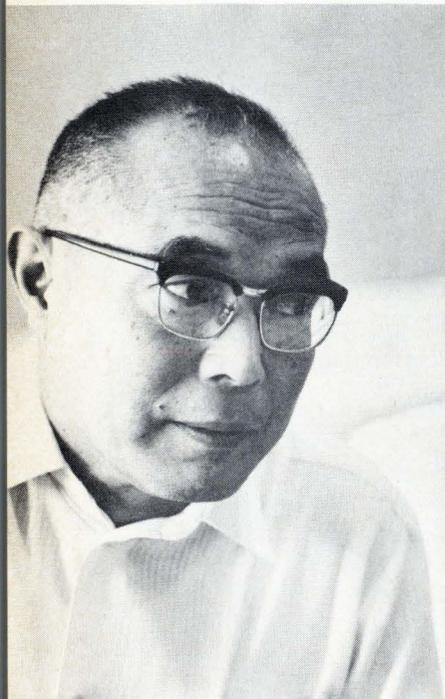
□ The economic tremors that have rocked Japanese electronics industries for the past two years have subsided. The conscientious Japanese have turned 1972 into a recovery year, and they are confident that business will resume profitable growth in 1973, although the electronics industries may not match the remarkable expansion of the 1960s.

Revaluation of the yen, the culmination of the "Nixon shocks," rattled the domestic economy, which is accustomed to unhindered growth, at a time when it was depressed. And the revaluation made the nation's precious overseas markets difficult to hold as Japan's price advantage, particularly in consumer products, was narrowed. The nation's woes were compounded by the well-ordered society's emerging clamor for control of the pollution that has accompanied its industrialization binge.

As a result the electronics industries had been lost in a fog. But now that fog has lifted, says Tamefusa Onoye, executive director of the Electronic Industries Association of Japan. Although they have not been great, the past 12 months have not been as disastrous for electronics as many had feared a year earlier.

The economic consequences of the most important political event of the year—establishment of diplomatic relations with mainland China, and thus the end to formal recognition of Taiwan—are not yet clear. It appears that, despite Taiwan's howls, electronics business will continue as usual between the two nations. On the whole, Japan's electronics industries are not deeply

**Mitsuo Kawasaki**, (left) EIA-J chief of statistics, believes that "international division of labor" will mean more Japanese plants overseas.



**Tamefusa Onoye**, (right) EIA-J executive director, says that the fog over the industry is lifting, business was not as bad as feared.



enough imbedded in Taiwan to be crippled, should conditions deteriorate. One Japanese executive likened Taiwan operations to having a plant burn down—a problem, but not a disaster.

## China market limited

As for Red China, the electronics industries are not carried away by dreams of opening a vast new market. China has made it clear that its first interests are for industrial plants and heavy vehicles. If anything, electronics firms have cause for concern. "What happens," a consumer-firm executive muses, "when the Chinese begin to export cheap radios and TVs made with Japanese plant equipment? We may be cutting our own throats."

Soon after the yen revaluation, with the attendant decline of consumer-product exports to the U.S., outside observers predicted a Japanese push toward the less-saturated European markets. But that hasn't happened to any significant extent. Instead, Japanese executives are talking about international division of labor. It's an updated version of an old economic concept based on the premise that every country should produce only what is economically feasible—high-labor-content products in developing nations, high-technology products in advanced countries—and then market these products freely throughout the world.

The result is two parallel movements, observes Mitsuo Kawasaki, chief of statistics and research section of EIA-J. On the one hand, companies will continue to invest in offshore production facilities to shift labor-intensive products away from steadily rising Japanese labor costs. On the other, as overseas markets have grown, it becomes more efficient to build assembly plants within those markets, rather than shipping finished products. This trend will continue in the United States and Europe, particularly because another revaluation of the yen some time in 1973 is virtually certain.

Despite solemn declarations from the politicians and a new five-point plan to defend the yen at its present level, revaluation is so probable that companies have gone to a kind of double value in planning—what the yen is worth now, and what it may become next year. Japan's favorable trade balance is a real embarrassment because it increases the pressure to raise the value of the yen in relation to the U.S. dollar. Efforts to lessen the pressure by boosting imports of manufactured goods, such as a "buy-American" campaign, appear to be too little to stave off another currency change; however, it's clear that this time it won't be a shock.

## R&D must continue

Confidence restored, Japan's electronics industries are not satisfied simply with recovery. The country is on the same technological bicycle that the U.S. is riding, and it can't afford to stop pedaling. So in 1973, expenditures for R&D will increase. No longer content to play catch-up with American technology, Japan's giant enterprises are gearing to take over leadership wherever they can. They plan to jump off the springboard in 1973.

However, the country's star performer, the consumer electronics sector, has been slow to recover. And next year's sales may also register a flat curve. Unfortu-

If anything, his salary may be decreased, since it is based on longevity, as well as rank and performance. His semiannual bonus, also based on longevity, will certainly be decreased in a switch of companies.

Because of the social attitude about jumping companies, it is also quite likely that an engineer would find it difficult to find employment at a competitor's firm. Toshiaki Irie, manager of microwave transistor engineering, Semiconductor division, Nippon Electric Co., points out that if he were unhappy at NEC, competitor Fujitsu probably wouldn't hire him because the philosophies of the two companies are different.

"Why wouldn't Fujitsu hire a NEC engineer? It's a national trait—and it's unfair," he shrugs.

### Alternatives are limited

Another reason that there isn't much company-to-company job-changing is that the electronics industries are dominated by a small number of huge enterprises. This means that there are not that many different employers from which to choose.

Says Tomoo Okada, section chief in the Telephone Switching Engineering department of Fujitsu: "In my case, there are only four companies working in the field. No matter which company I would work for, I'd still be in the same environment. The main customer would be the same. I would still see the same group of engineers at conferences. Unless I would change my field completely, there is no merit in changing companies."

This commitment by employer and employee from graduation to retirement leaves the impression that engineering departments would probably be inflexible prisons. It may seem that the engineer could quietly goof off for 30 or 40 years, knowing that his benevolent big-brother employer would carry him along in the womb of security.

For some reason, neither of these impressions is correct. A look at the engineering career requires a look at the Japanese character. At first, the EE appears to be a highly disciplined worker, a machine that the company clicks on every Monday and doesn't turn off until he leaves for home Friday night.

Strangely, Japanese workers, including EEs, still indulge in what many Americans consider "Mickey Mouse" activities. Many must wear company uniforms—drab, shapeless dust jackets—at work, or else attach the company pin to their lapels. They sing company songs. Every day, they join in five minutes of office-wide calisthenics, usually starting at 3 p.m.

And—horror of horrors—Japanese engineers don't even think twice about joining the company branch of the electrical workers' union and holding membership until they reach the bottom rung of the management ladder. During that time, they're in the same union with the hourly wage-earners, and it doesn't seem to sully their professional pride. (Industry-wide unions, such as the electrical workers or teamsters, don't exist in Japan, yet. Engineers usually belong to the All-Japan Federation of Electric Machine Workers Union, which has some 540,000 members.)

Thus, with the union negotiating his salary and benefits in a company that won't fire him, what provides the incentive? A closer look reveals that it is old-fash-

ioned company loyalty. As Namio Yamaguchi, an engineer in the TV Research Laboratory for Matsushita Electric Industrial Co., declares, "Because home electronics is so competitive, the future of Matsushita is on our shoulders. If we don't develop competitive products, and there are no sales, the future of other people at Matsushita who depend on us is on our shoulders."

Rather than being an automaton, the average Japanese EE feels that the company needs him to survive.

*(continued on page 98)*

## Education: not so inscrutable

Enrollment in engineering courses has not declined in Japan. In fact, the competition to enter top-ranked schools is as stiff as ever. Entrance examinations are difficult, primarily because the competition is heavy, and the universities prefer to weed out potential failures before they are accepted.

Probably the most influential engineering school among the national institutions is at the University of Tokyo, which sets the pattern for other engineering schools in Japan. For the first two years, most U. of T. engineering students may not see a member of the engineering faculty, for they are enrolled in general courses taught by different faculty members. By the second year, the student begins basic engineering courses, and in the third and fourth years, the curriculum is completely devoted to engineering.

By the fourth year, the embryonic engineer is hard at work on his graduation thesis. The Japanese school year begins in April, so that the summer vacation falls within the year. As a result, the U. of T. engineering faculty "encourages" fourth-year students to work for a month during the summer vacation. (At one time, it was required.) This month in the fourth year is usually the first taste of actual engineering working conditions that the EE student receives. Students usually make short weekly reports on their jobs and final reports at the end of the month. (Quite often, these summer jobs lead to permanent employment with the same company after graduation.)

Even though graduate work is not common in Japan, the U. of T. has 170 applicants for its 43 openings in the master's program for 1972, reports Sogo Okamura, professor of electronic engineering. Of these, only 31 were accepted. Graduate students normally conduct projects at one of the 14 research institutes in the university.

Like their U.S. counterparts, Japanese engineering departments are concerned about cramming the maximum practical lab work into the limited time available, while providing all the engineering basics possible. Also as in the U.S., the Japanese schools have added computer-science courses, although these courses may not be taught by the engineering department.

While interest in engineering is high among students now, Prof. Okamura is concerned about the future. He recently visited the United States and learned first-hand about the decline in students, as well as the disillusionment among working EEs about their engineering careers.

"Sometimes, U.S. problems reach Japan three or four years later," he observes. "We should be preparing for this situation now."

# Special report

gin to pay off this year, thanks to performance improvements. Matsushita Electric Industrial Co., for example, has developed an infrared remote device slated to sell for about \$50. An infrared signal is picked up by a receiver on the TV set. Although designed to be more reliable than other remote tuners, the hand-held unit must be "aimed" at the receiver. The General Corp. has started selling a 20-inch TV with an ultrasonic controller that has a telephone-like dial with 14 holes for channels 1 through 12, plus one each to increase and lower the volume.

## Gadgets added

Sharp Corp. has introduced an electronic channel display to flash a channel number that covers almost half the screen for 1.2 seconds after tuning. This feature, which adds \$17 to \$27 to the price of the set, is available in three models, two of which have remote tuning. The display should help sell more remote tuning sets.

Tokyo Shibaura Electric Co. (Toshiba) has just announced an IC digital selection system in a 20-inch color set and plans to start sales in February. The 500-plus-element MSI device, a first in Japan, adds more than \$30 to the selling price. Not to be outdone, Matsushita promises to have available "a revolutionary-type" digital tuner that a team from three separate R&D labs has taken two years to develop. Hayata Tokizane, managing director of Matsushita's Television division, promises that the tuner, to be available early next year, will perform an order of magnitude better than previous electronic tuners and will handle both vhf and uhf. The company has not priced it yet. The channel-selector portion of this design was revealed last June. It has a "binary" memory corresponding to channel numbers and a "decoder" circuit on MOS LSI devices.

The other major effort among TV manufacturers has been directed toward picture tubes. The 110° deflection

tube has spread rapidly through all product lines. Sanyo Electric Co. plans for 90% of its 18-in. and 20-in. color sets to have 110° tubes by the end of this year, and some 14-in. models will join the ranks by mid-1973. Sony, meanwhile, has brought out a model with 114° deflection, scoring merchandising points by advertising "the plus 4°." Toshiba also has 110° tubes in nearly half of its large-screen sets. Space-saving offered by these tubes is a definite selling point for the typical small Japanese home.

Sony's stripe-format in-line-gun tube is being challenged. Toshiba says its "brick-wall" shadow-mask tube can be made with black matrix surround, and it is not limited in screen size. The Hitachi Consumer Products group is featuring tubes in which dots are baked on the faceplate with a multifacet correction lens for improved registration at the periphery. Mitsubishi Electric Corp. and Matsushita also use the black-matrix-surround tube. The next major push by the TV companies will most likely be toward flat-screen picture tubes.

## Circuit integration continues

As for the application of integrated circuits, the consensus is that fewer or the same number of circuits in the next year's chassis will probably perform more functions. Color processing now accomplished by three separate ICs can be combined into one. Most sets already have six to 10 ICs of 40 to 50 elements each. Next, there will be six to 10 with 50 to 150 elements each. A larger scale of integration had been artificially stimulated by an anticipated tax break favoring sets with a certain percentage of ICs. However, when this reduction failed to materialize, manufacturers dropped some ICs that are not economical.

Not much can be said for black-and-white television these days. The decline in sales has continued as expected. Price cuts and way-out cabinet designs have superseded new features in the last significant years of monochrome. Developing countries still constitute a market, but they demand on-site plants and oppo im-

**Keiichi Takeoka**, Matsushita Radio & Stereo division, expects cassette/radio combinations to increase sales in '73.

**Noboru Yoshii**, Sony Corp. senior managing director, confidently predicts that "color is forever," despite the leveling of sales.

**Heitaro Nakajima**, Sony audio, has an 80-man research center striving for improvements in components, starting in '73.



**Mainstream.** Feeling that his move two years ago to calculator design put him in the center of action at Matsushita, Sasaki begins his busy day conferring with general manager Akira Harada (left) about sales acceptance of his product designs. Pains are taken in Japanese companies to make engineers aware of the end-products they manufacture, and EEs tend to feel personally responsible for the success or failure of their products. Based on a lifetime devoted to a single company, the commitment is to the employer first; personal recognition, second. This philosophy is at work in the engineering team that Sasaki heads (top right). He disputes the U.S. contention that Japanese teams are usually overloaded with engineers. His team of four EEs and four technicians has developed five calculator models. There are four engineering sections within the calculator department, three responsible for a group of complete designs. The fourth section is a pool used to help out any of the other three, as needed.

Sasaki's immediate supervisor, Sadamichi Sameda (right), senior development manager, is also a personal friend who helped him move to calculators. Their relationship is easygoing, marked by good humor and mutual respect. Far from being a regimented cog in the design machine, Sasaki has leeway to thrash out differences of opinion with his boss and his junior associates. Although the parent company has a components division with one of the world's most diversified product lines and a semiconductor subsidiary, Sasaki and his team call in outside salesmen to obtain additional information. Below, he discusses batteries with a General Electric salesman. Sasaki began a search for improved batteries because, faced with the same pressure from consumerism as in the U.S., he and other Japanese engineers now must stress product reliability, along with cost and performance. Perhaps Sasaki's ambitions are well summarized by a sign hanging in the plant that reads, "Gather all of your strength for promoting the development of products that are commercially attractive." His satisfaction with the product is apparent.



# Special report

materials to psychological studies of listening habits. Next fall, Nakajima promises, the lab will celebrate its first birthday with a number of new announcements, which will probably include a new type of speaker.

Compiling statistics for tape cassettes and radio sales is complicated more than ever by the raft of cassette-radio combinations on the market. As a result, manufacturers are not sure whether to report these sales as radios or tape cassette players. In some cases, both tape and radio divisions of the same company are making the combinations and reporting sales separately. In any case, these products have beefed up business for cassette players or radios, depending on how you slice the statistics.

This situation points up a basic trend in radio these days—unique packaging and price competition, rather than technical development, is the name of the game. Because Japan has been feeling the squeeze from Taiwan and Hong Kong for low-end models, companies are looking for new ways to attract buyers with, for example, a-m/fm/tape combinations or three-band, wireless-microphone units with fancy tuning controls, starting at about \$50. The next burst, predicts Matsushita's Keiichi Takeoka, managing director of the Radio and Stereo division, will be four-channel radio.

## Export caution exercised

Most of the conjecture concerning Japan's interest in Europe has centered on consumer products; however, company spokesmen are playing down its importance. Indeed, the obstacles are not to Japan's liking. France, which has the Secam color TV system, has legislated trade barriers. Italy has not yet decided whether to adopt Secam or the West German PAL system.

This leaves Great Britain and West Germany as the most likely openings. But here too, licensing of PAL has been tricky. Hitachi, which has a license, is selling PAL color sets in Hong Kong, as well as in some European countries, excluding West Germany. Matsushita is renegotiating with AEG-Telefunken, the cautious holder of the PAL licensing power. Other companies are waiting for resolution of these negotiations before proceeding. Sony, among others, has a PAL-like receiver that it claims does not infringe on Telefunken patents. The company has gone after sales there, even though Europe accounts for a minor percentage of business.

All hands are proceeding slowly for fear of frightening Europe into a more protectionist stance. Clearly, America continues to be the consumer industry's favorite export market, despite the price buffeting received in the yen revaluation and the countervailing tariff issue. With prices of its exports forced up, setting up plants in America is becoming both an economic and political benefit.

## More to the U.S.

Matsushita has a TV assembly facility in Puerto Rico that has been supplied with Japanese-made parts. However, the company affirms that, eventually, practically all of the parts will be purchased in the U.S. Sony's San

Diego plant, which went into operation at the end of July, is producing about 5,000 units a month. Early next year, this facility, located in an industrial park, should be turning out 20,000 color TV sets a month. In the first stage, 80% of the components will be shipped from Japan; in the second stage, it will be 50%; and, finally, 80% of the components will be American-made. Hitachi also recently announced plans to begin TV assembly on the West Coast.

Taking a different tack, Toshiba has ordered one line of 18-in. TV sets from Admiral Corp., to be delivered to New York in time for the Christmas-buying season. "One way of doing business in America," says Tatsuya Inamiya, general manager of Toshiba's Video Development department, "is to share production. We have had a long relationship with Admiral through selling them parts. We knew that Admiral could produce these sets to Toshiba's specifications and have delivery in New York by Christmas." Toshiba doesn't care where Admiral builds these receivers—just so they arrive on time.

Another strategy that may pay off in business and good will is Sony's program to help U.S. companies market products in Japan. As of September, some 1,000 prospects had expressed interest in the plan. While the bulk of the U.S. firms are in home appliances, 8% are marketing office equipment, 6% electronics and hi-fi, and 6% computers and measuring equipment.

## Semiconductors: calculated boom

The wild pace of calculator growth has turned the Japanese semiconductor market into an uproar. In an all-out dash to keep up with the demands of calculator manufacturers, domestic MOS makers have developed MOS LSI devices, knocked the stuffing out of prices, and rearranged the market shares of domestic and foreign producers to a 50-50 split. In doing so, the shaky domestic semiconductor manufacturers have found solid and profitable footing. In contrast to the U.S. experience, some leading calculator manufacturers have even started producing their own integrated circuits.

Japanese producers were already ahead of their U.S. counterparts in the manufacture of linear ICs for color-television and audio equipment. And semiconductor makers are anticipating booms in the adaptation of ICs to watches and automotive equipment on a scale that will rival the calculator explosion.

The future also looks rosy for semiconductors in computer memories. Fujitsu Ltd. has already introduced a minicomputer with semiconductor memories. Moreover, Hitachi and Nippon Electric Co. agree that core memories probably won't be designed into computers after 1974.

On the negative side, semiconductor firms predict that heavy demand will continue to depress prices. The picture is grimmer for manufacturers of other components. Although they enjoyed a good year in 1972, components makers are facing rising labor costs, coupled with declining prices.

In 1972, domestic semiconductor houses have captured 50% of the MOS LSI market, previously dominated by Americans Texas Instruments, Mostek Corp., National Semiconductor Corp., and North American

specialized products or sharp, creative engineering teams are practically nonexistent. Some Japan EEs feel that this situation restricts progress because such flexible, high-technology companies can theoretically vitalize the industry and usually advance the state of the art. For a Japanese manufacturer to accomplish the fast reactions typical of electronics firms that have been nurtured by venture capital in the U.S., it must surmount a lot of inertia and pay heavily in overhead. This lack of venture capital for brash new firms is unlikely to change much in the near future.

### Educational development differs

Another noticeable difference between the Japanese and American EE concerns advanced education. Hardly a U.S. engineer has not felt the pressure to get an advanced degree to keep up to date and improve his career prospects. That pressure is not exerted in Japan. Very few engineers continue schooling for masters' degrees or doctorates. There are no night schools for post-graduate programs, nor do companies make much effort to encourage more degrees. Sometimes a research lab may tap a certain individual to take a master's degree or doctorate, equating the program to a job assignment. Sony Corp., for one, assigns some EEs to the U.S. and Europe to advance their education.

The entire procedure for keeping abreast of technology appears to be uncoordinated in Japan. Company training programs are few, technical conferences tend to be superficial, and formal outside courses are unavailable. Ask EEs how they keep on top of what's new, and they say, "Read the literature."

This informal approach tends to work, but the reason appears to be buried in the subtle interplay that takes place in the Japanese engineering team. Practically everyone belongs to a team; some members work on a specific design problem, while others appear to be contributing nothing—they're off in a corner reading the literature, immersing themselves in the technology related to the design problem. Then the readers rejoin the workers, and the design jells, somehow, through the exchange of information between the two. This description of the procedure is oversimplified, but it typifies the team approach.

On this subject, an American engineer who has ob-

**Toshiaki Irie**, Nippon Electric Co., points out that engineers find it difficult to job-hop in Japan because companies frown on it.



**Satoshi Shimada**, Sony Corp., expects the need to develop pollution control will show true worth of engineers.

served these teams for nine years points out, "It may not be possible to convey in English what goes on inside the Japanese engineering department because there's an organizational chemistry incomprehensible to an American." The key seems to be that the division of labor does not cause friction, nor are the EEs overly concerned with individual glory for a design if the team can achieve the desired goal. Essentially, the Japanese EE does not take an ego trip with his work. He doesn't mind borrowing others' ideas, adapting bits and pieces from other designs, licensing patents, and mixing it all together into a new application. This readiness to adapt other ideas has led to the cliché about Japanese copies.

### Adaptations pay off

The issue of copying is particularly sensitive to Shigeo Shima, director of the Sony Research Center. Sony takes pride in its innovations and has the reputation of achieving results by going in unexpected directions. This philosophy has also produced its share of bombs, but on the whole, doing the unexpected, as Shima characterizes it, has worked.

He points to the development of the in-line-gun TV picture tube and the all-solid-state television chassis as two contributions launched on the Japanese industry's desire to "do something different." Sony's first two versions of the tubes were failures, but seven years of effort have produced what is today promoted as the Trinitron tube.

The solid-state chassis was an outgrowth of experience gained in developing the transistorized radio. And behind the radio is a story that Shima relates with obvious relish. He recalls that in 1952, when the head of the company that was to become Sony visited the U.S. to complete arrangements to obtain a license to manufacture the then-new transistor, its developers asked the visiting Japanese what he intended to do with it. They were astonished when he said he planned to build inexpensive radios. The rest is history.

Shima himself went through a replay of this story 12

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year because demand will continue to use up capacity as fast as it's added.

The second strong demand for ICs is in linear devices for color television and audio equipment. In this segment of the market, domestic manufacturers have an edge because Japanese consumer electronics companies had been ahead of the U.S. in developing all-solid-state TV chassis and in applying ICs. In addition, the big TV manufacturers, Matsushita, Hitachi, and Toshiba, also have semiconductor divisions to design and custom build the circuits. The leveling of color-TV sales has not put a damper on IC makers because they expect to develop newer devices that combine in a one-chip package all the functions now performed by two or three separate ICs or discrete-component circuits.

The goal is to integrate all but the video power functions. Also, more action is anticipated in the audio sector, so that total linear IC consumption next year should jump to \$75 million, 27% ahead of this year.

With 6 million cars and trucks rolling off the Japanese assembly lines every year, hardly a semiconductor company hasn't studied the potential for automotive electronics. But so far, the auto industry has put up more resistance than a bumper, primarily because electronics firms have to prove high reliability at low cost.

Most of Japan's semiconductor manufactures have been raised on reliability at low cost through their long relations with consumer-electronics firms. The hope is that in two or three years the untapped potential of cars and trucks will be open. Sumio Imaoka, of Toshiba, reveals that his company has top-secret projects with automobile manufacturers and predicts that by 1975 there will be as many as seven LSI devices in every Japanese car. Likely applications for ICs are fuel-injection, ignition systems, and exhaust-emission controls.

The all-solid-state wristwatch is another large-volume market standing in the wings. Here, low-power operation is mandatory, indicating that C-MOS is the way to

**Hiroe Osafune**, NEC Semiconductor division, expects Japanese firms to have 2- to 4-kilobit memory devices in one to two years.



go. Another must is a reliable display. The Japanese semiconductor firms are cautious about liquid-crystal displays, but concede that this is the way to go for a digital-display watch.

Japanese manufacturers will be watching Motorola's movements in the watch business during the coming year. The U.S. firm, it is believed, will come on strong with its timepiece package, which includes the quartz crystal, the MOS circuits, and the power supply ready to be put into a case.

Matsushita officials have hinted that a consumer firm with a semiconductor division such as theirs might well make and market its own electronic watches in the coming year. If this happens, and other Japanese companies conform to their habit of following the leader into a market, other consumer-electronics firms with semiconductor divisions would sweep into the watch business, thereby creating another frenetic demand, similar to the calculator situation.

## Computer demand

Semiconductor firms confirm the computer industry's interest in semiconductor memories. NEC's Osafune asserts that all computer systems under development will use semiconductor memories, utilizing either p-MOS technology, which holds the lead, n-MOS, which is backed by NEC, or bipolar. Although still behind the U.S. in this area, he adds, Japanese producers are expected to have 2- or 4-kilobit memory devices in one or two years.

## Worry over other components

Other electronic components have also apparently weathered the economic tremors. But Taro Kuninobu, director of the Electronics Components division for Matsushita, warns that any components company that is not worried should be. He points out that business in the first half of 1972 was excellent, and that the situation should carry into the second half.

However, next year presents a question. First of all, manufacture of products that are no longer competitive in Japan—such as resistors, capacitors, coils, and speakers—will continue to go offshore. Matsushita, for example, has plants in Taiwan, the Philippines, Burma, Thailand, Malaysia, Iran, Venezuela, and Mexico. Only 15% of its Japan-produced products are exported, 60% are used by Matsushita divisions, and 25% are sold to other Japanese customers.

As the large components manufacturers set up offshore facilities, the small companies will find it more difficult to compete. Both large and small plants will end up with surplus capacity and know-how in Japan, which is now a matter of national concern. Matsushita, for one, is putting its resources into expansion of industrial sales.

On a larger scale, MITI is setting new goals for the languishing components companies. Some will be guided toward systems developments and others toward development of unique new components for new markets, similar to what Matsushita is doing on its own. MITI's assistance will include subsidies and loans for product development during the transition. A study to work out this national plan should take about a year.

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the Japanese companies are incompatible in business philosophy and product line. Nevertheless, all agree that the government will not let the ventures fail. Despite the edge that the Japan Six have in government sales and the vigor they have shown in the non-government competition, U.S. companies feel that there is room for growth. "Our slice of the pie will stay about the same," says an IBM spokesman, "but since the pie is getting bigger, we will benefit."

Nippon Univac is more optimistic. Its large-scale computers are considered imports, but the medium-range machines sold by Oki Univac are counted as domestic, giving Univac a position in both camps. Kyoji Matsuda, managing director for Nippon Univac, expects an 11% increase in income in 1973. He claims a 35% market share in major real-time systems for financial applications and a 12% share in medium-scale computers. He does not expect the Japanese joint efforts to upset the market, though he concedes that Univac's large-scale machines will not have much chance for sales to government agencies, now that Japanese manufacturers are developing complete competitive lines.

## Japanese lead in sales to institutions

This contention has its basis in statistics from Japan Electronic Computer Co. Japanese manufacturers have a lopsided lead in local public facilities, hospitals, education and electrical machinery firms in value, but foreign imports close the gap in the far more lucrative general-purpose business market, thus bringing the total to over 54% for domestic computers.

Of the Japanese manufacturers, Fujitsu has the largest commitment, for 60% of its business is in EDP. While competitors consider this position risky, Fujitsu disagrees. Says Kobayashi, "Some say Fujitsu is on a dangerous path. But, because the Japanese government is helping, it's a safe course. Fujitsu did not enter into any technical licenses with foreign companies; therefore, the government considers Fujitsu a special case and doesn't want to see it go down the drain."

Fujitsu recently startled the industry when it announced its use of semiconductor memories in a new minicomputer at lower prices than core. However, com-

**Yujiro Degawa**, NEC director, explains that it will be two or three years before the results of the joint computer efforts will be seen.



pany officials reasoned that core-memory designs have reached their lowest cost point. But, since semiconductor versions have more potential for decline in price than core, eventually they will cost less. Both Hitachi and NEC agree that after 1974 there will probably be no new core-memory designs and that increased quantities of semiconductor memories will drive down prices.

Nippon Telegraph and Telephone soon will cause two major impacts on the computer business. Within the next year, NTT will have converted its switching system to open up data communications among unrelated companies using time-sharing computers. Heretofore, users could only obtain leased-line connections for data communications. But the new NTT switching facilities should stimulate a significant increase in the market for data terminals and related data-communications equipment by 1974.

In addition, NTT expects to go on line next fall with the first of its expanded scientific and engineering computer services. This service will use a large-scale computer, called DIPS, developed by NTT and built by Fujitsu, Hitachi, and NEC. NTT also has a real-time sales and inventory management system (Dress) that will use DIPS computers.

If the schedule holds, the first expanded scientific and engineering series will go on line in Tokyo next fall. Osaka will get a DIPS computer with this system in March 1974. Both cities are scheduled to get the Dress systems by the fall of 1974. NEC will supply both scientific and engineering systems, and Fujitsu and Hitachi will each build a system for the Dress installations.

Oki stands to get some communications business too. Its latest model 4300C, a minicomputer used for terminal control of data communications and other control applications, had received 150 orders in the first month. The machine, which has 4,000 16-bit words of core memory, sells for 1.6 million yen (\$5,333).

## Minicomputer future is bright

The over-all minicomputer business potential looks good for Japan. The *Electronics* consensus puts this year's figure at \$15.3 million—more than 27% higher than in 1971—and \$20.5 million is projected for 1973. The lion's share of this business will go to domestic producers, including Nippon Mini-Computer Corp., a joint venture engineered by MITI that uses Data General Corp.'s technology. Other U.S. firms are shut out of significant OEM sales.

## Banking on point-of-sale systems

Point-of-sale systems are just getting underway in Japan. Toshiba has started deliveries, Fujitsu has announced a system, and NCR Japan is marketing a system developed in America. Other companies are also moving into POS, but sales have not yet materialized.

Unlike the U.S., where large retail merchants are the prime potential customers, in Japan, the banks will probably be as important as the stores in initiating POS systems. Masanubu Watanabe, director of the Industrial, Financial & Commercial Systems division for NCR, explains that banks want to link the stores to their computers via point-of-sale terminals. The banks are mainly interested in verification of credit transactions,

with TEOs, are at last being demonstrated in the form of new heat-sinking technology. New material systems, such as indium phosphide, are being developed that should further boost performance of both oscillators and amplifiers. With these advances, new data as a basis for comparison will need to be consulted before selecting the proper device for a system.

### Material concerns

Key to the growth of transferred-electron technology is the gallium-arsenide material that goes into most of the devices. Indeed, it was the development reliable methods of growing GaAs that got transferred-electron devices into the commercial realm. By now all commercial devices use epitaxially grown material, that is, single crystal layers grown on a single crystal substrate. This method yields material with far better uniformity than the old bulk material method.

This improved uniformity results mainly from the low temperature needed to prepare epitaxial material—700°–900°C, as compared with 1,238°C or higher for bulk material. In addition, epitaxial material, because of its positive temperature coefficient of resistance, is not susceptible to thermal runaway as is bulk material. Moreover, the device thickness in epitaxial material can be finely controlled during growth, whereas bulk material requires abrasive or chemical thinning to achieve the final active layer thickness—often 10 micrometers or less.

Recently a new fabrication process has been developed, in which heat sinks are plated onto the devices before the wafer is separated into chips, and then chip and heat sink are bonded directly into packages. This process is cheaper than adding the heat sink after packaging, since chip and heat sink can be batch-processed and high yields result from reduced operator skill requirements. Moreover, the integral heat sink makes handling easier during the wafer thinning process because it provides a surface to grip on. Figure 1 shows a device with heat sink bonded directly into a standard varactor package.

### Taking the heat off

Since it's the high, uneven temperature of the device during operation that limits its performance, much of today's device fabrication is directed toward reducing thermal effects. Figure 2 shows the theoretical relationship of the variation in ratio of peak electron velocity to valley electron velocity with temperature, and compares it with experimental data.

To obtain these sets of data, some devices were uniformly heated, and others were operated at power levels high enough to cause uneven internal heating. For the case of uniform heating, the experimental results are in reasonable agreement with the calculations. However, for self-heating, where the heating comes from operating a device at high average powers, the peak-to-valley ratio of the velocity curve drops significantly when compared to the curve for uniform heating. Unfortunately, this ratio drop is accompanied by a drop in efficiency: in a sample uniformly heated at 350°K, the efficiency drops approximately 10%, whereas in a sample that is self-heated at the same temperature,

**TABLE 1:**  
STATE OF THE ART COMPARISON OF  
TRANSFERRED-ELECTRON OSCILLATORS AND AMPLIFIERS  
WITH OTHER TYPES OF MICROWAVE DEVICES

TE oscillators compared with:	Strengths	Weaknesses
Impatt diodes	Lower noise. Higher pulsed power. Higher pulsed efficiency. Lower bias voltage.	Lower cw efficiency and power.
Trapatt diodes	Lower noise. Higher duty cycle operation. Higher frequency operation. Lower bias voltage.	Lower pulsed power and efficiency. Less temperature-stable. Si vs GaAs.
Transistors	Higher frequency operation. Higher pulsed power. Less complicated structure.	No cw L and S band devices. Si vs GaAs.
Tubes	Longer life, more reliable. Equivalent noise performance. Lower bias voltage. Simpler power supplies.	Lower power and efficiency. Less temperature-stable.
Baritt diodes	Higher power efficiency.	Si vs GaAs
TE amplifiers compared with:	Strengths	Weaknesses
Impatt amplifiers	Greater bandwidth. (Higher voltage gain-bandwidth product.) More linear. Lower noise. Wider dynamic range.	Lower cw efficiency and power.
Trapatt amplifiers	Much greater bandwidth. (Much higher voltage gain-bandwidth product.) Much more linear. Much lower noise. Much wider dynamic range. Higher frequency operation.	Much lower pulsed power and efficiency. No UHF or L-band operation. Si vs GaAs
Transistor amplifiers	Greater bandwidth. (Higher voltage gain-bandwidth product.) Higher power in C, X and Ku bands.	Two-terminal device. Si vs GaAs.
Tubes	Longer life. More reliable low bias voltages. Simpler power supplies.	Less power and efficiency. Less temperature-stable.
Baritt diodes	Greater bandwidth. (Higher voltage gain-bandwidth product.) Higher power and efficiency.	Si vs GaAs.

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filling electromagnetic spectrum can stay this industry from its usual round of steady profits.

Wireless communications, telephone switching, wire message equipment, and wire carrier equipment sales—all are increasing by 6% to as much as 45% this year. Next year holds much the same in store.

NTT budgeted 300 million yen (\$1 million) for equipment in fiscal year 1972, ending next March, and another 350 million (\$1.17 million) for fiscal 1973, ending March 1974. Top priority goes to preparations for data communications, followed by addition of electronic exchange centers and expanded microwave transmission systems. Almost every manufacturer stands to benefit, because NTT always spreads its procurement to all the competitors.

The data-communications conversion consists of combining 5,000 message areas in the country into 560 and changing the message and unit recording system in order to time, as well as count, local calls. The larger message areas, together with lower rates to neighboring areas, will keep average charge to subscribers the same, but will enable NTT to charge data communications subscribers for line use within a message area. According to NTT, the year-long changeover will cost about 70 to 80 billion yen (\$233 to \$267 million), mostly for labor.

By the beginning of April, NTT had started eight electronic exchange centers, each with a maximum capacity of about 40,000 subscribers. Between April and next March, 10 more will have been started, for a total of 18. There will be 20 in the year following. Each new exchange is expected to cost about 1 billion yen (\$3.3 million) when fully equipped.

NTT has ordered from Nippon Electric transmitter-receivers for a 5-gigahertz microwave transmission system that will have 2,700 voice channels, a new high for Japan. NEC estimates that the main transmitter and receiver, plus auxiliary equipment for each installation, will cost 4 to 5 million yen (\$13,000 to \$17,000), but the final price has not been set.

## Cable net being installed

For cable transmission, NTT is installing a 60-megahertz coaxial line from Tokyo to Nagoya to Osaka. This line will handle color television, which until now has been transmitted by microwave. It is also part of the preparation for TV telephones. While the market potential for video telephones is still in question, NTT intends to go ahead with a five-year plan, delayed until 1973, that is to have 3,000 subscriber lines completed by 1977.

The obvious target for video phones will be industry and government agencies. Yet even Fujitsu, one of the experimenters in this medium, is not sure how well it will be accepted. Says Kanji Yamamoto, a Fujitsu director, "A cheap method of transmitting pictures is the biggest need now." He adds that the advent of data transmission requiring a fraction of the bandwidth of the TV phone is more important now. There is a pent-up demand for data communications that will begin to be served as conversion is completed.

Thus, the near-term possibilities for facsimile are good. Yuichi Makino, director and general manager for the Telecommunications division of Toshiba, estimates that fax business was 3.8 billion yen (\$12.7 million) last year, 6 billion yen (\$20 million) in 1972, and will reach 8 billion yen (\$27 million) next year. Then he forecasts a 10 to 12 billion yen (\$40 million) market in 1974.

Toshiba, which is developing fax equipment to use the switched-dial network of NTT, bases its growth figures on the availability of inexpensive facsimile machines, probably nondevelopment types that use ink jets and inexpensive paper. Band-compression types that reduce transmission time will also be available.

While microwave equipment is the mainstay of NEC's wireless communications division, this category has matured, while others have picked up in growth rate, such as mobile radio and telemetry. Toshiba is also enthusiastic about telemetry. The company has a joint effort with NTT on remote meter-reading for utilities.

## Telemetry forecasts rain

Another real-time telemetry program is underway with Japan's meteorological agency to warn against the sudden heavy rainfalls that cause havoc in concentrated areas. This plan will be tested the end of this year and could go into operation next year, Toshiba reports.

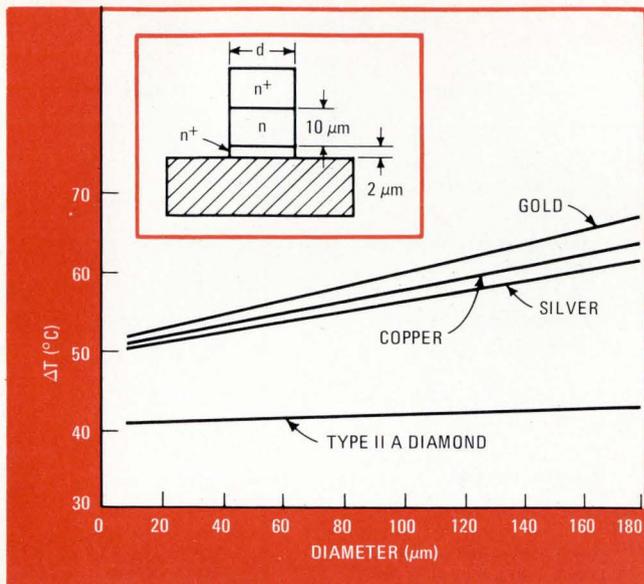
Telemetry and telecontrol equipment were the best performers for Mitsubishi this year, increasing by 10% to 20% more than 1971 sales. Utilities were the predominant buyers, but, Japan's space program and future pollution-control projects should aid continued expansion.

Overseas sales have also been steady, and they have not been restricted to the developing nations. NEC is selling its earth stations for satellite communications in 20 countries, including West Germany and France. The firm also supplied equipment to New York Telephone Co. during its expansion crisis. Fujitsu recently landed a 2 billion yen segment of a communications program for Nigeria. And Toshiba has microwave contracts in Latin America and India.

Back at home, NTT is experimenting with the possibility of widespread installation of telephones in automobiles. Looking at Japan's crowded highways as another source of business is enough to gladden the heart of any telecommunications company.



**Yuichi Makino**, Toshiba Telecommunications, is sure that facsimile sales will take off with liberalization of data communications.



**3. Diamonds forever.** The best heat-sink material is Type IIA diamond. Other heat-sink materials are shown for comparison, however, since processing difficulties can wipe out diamond's advantages. Also emphasized is the effect of device diameter—the smaller the diameter, the less the change in temperature.

help in dealing with temperature gradients. Improvement is seen when the heat-sinking material goes from gold to copper to silver to Type IIA diamond. Also possible is double heat-sinking, which cuts the gradient across the device by a factor of two, and boosts efficiency by a factor of 25% to 50%.

### TEO performance

Better GaAs and more advanced temperature-compensating techniques are adding up to TEOs with higher performance. Figure 4 displays the best results achieved with TEOs.

The best pulse efficiencies reported to date are from RCA—32% in L band and 28% in X band. Others have reported pulse efficiency in the 20% to 25% range. Since the quality of the GaAs material to a large extent determines the efficiency of a transferred-electron device, these improved ratings imply that good material is widely available.

For continuous-wave devices, efficiencies of 14% in X band have been achieved at RCA. Others have achieved efficiencies greater than 10% in X and Ku band, a marked improvement over the 1% to 2% of only a few years ago. This indicates improvements in materials as well as in heat-sinking techniques. This level of efficiency in cw devices is particularly important because it means that TEOs will make ideal local oscillators in a great many of today's microwave systems, and could challenge Impatt for dominance of high-power systems.

Noise ratings have also been improved. In some commercial devices, a-m noise in two sidebands at 100-hertz bandwidth is greater than 140 decibels down at a point 5 kilohertz from the carrier, and fm noise is 1 Hz rms in a 100-Hz bandwidth 100 kHz from the carrier for a cavity with a Q of about 3,500. Such figures indicate that today's solid-state devices have noise specifications comparable to those of a typical reflex klystron.

Recently even better results have been recorded. For example, fm noise of 8 Hz in a 1-kHz bandwidth, 2 kHz from the carrier, has been obtained for TE devices with a Q of 500—a threefold improvement over the best previously reported results. On this point, too, Table 1 summarizes the relative positions of TEOs and competitive devices.

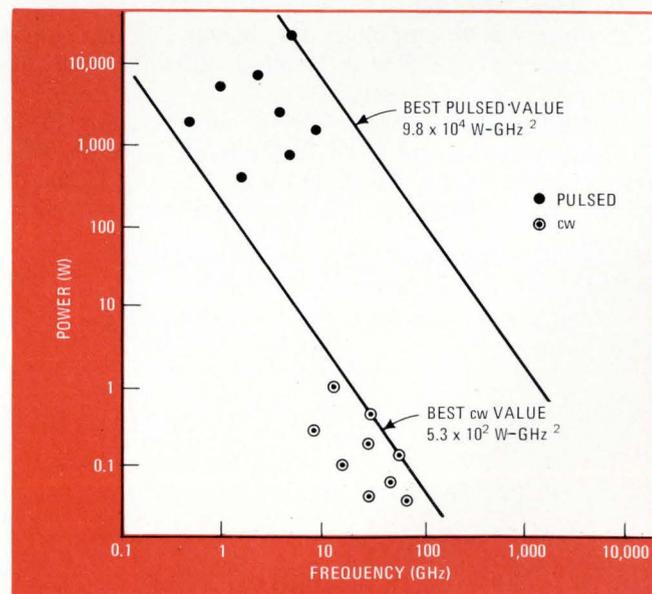
Improvements in frequency stability with temperature, a key performance factor in many systems applications, are shown in Table 2. Best reported stability is seven parts in  $10^7$  at X band, exhibited by a device mounted in a high-Q cylindrical cavity operating in the  $TE_{011}$  mode.

It should be pointed out that, although the high-Q cavity improves stability, it also reduces bandwidth and must be restricted to fixed tuned circuits. But stabilities of one part of  $10^5$  are available for TE devices from L band through X band with simple wideband coaxial cavities. This means that suitable stable TE microwave sources are now available for most data links in use today.

A particularly significant result is the temperature stability of three parts in  $10^6$  reported recently for a Cayuga Associates limited space-charge-accumulation TE device. This previously unpublished result is especially important because the poor temperature stability of LSA devices, typically one part in  $10^3$ , has restricted their general use in commercial systems.

### TEA performance

Great strides have been made in building transferred-electron amplifiers, as Table 3 indicates. It tabulates the performance of TEAs in various frequency bands. Amplifiers are available that cover all of C band and X band, and new devices extend coverage to the 8–16 gigahertz range. Experimental devices have exhibited the negative resistance required for amplification over an



**4. More power to them.** Performance of a microwave source is rated by the product of its power and frequency squared ( $Pf^2$ ). This figure of merit has increased by orders of magnitude in the last two years. Present TE oscillators have achieved as much as 100,000 W-GHz<sup>2</sup> for pulsed devices, and 530 W-GHz<sup>2</sup> for cw operation.

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a signal-analysis system. Producing about 10 systems a month, Takeda uses processors from Nippon Mini-Computer Corp. in almost 90% of its systems. Of 125 engineers, 70 are working on systems programs. Under a government subsidy, Takeda has developed and built a big tester, which generated know-how fallout that the company now uses in other equipment.

But the real competition in the test and control systems business, says Takeda's Yoshizumi, is in the software. That is why a disproportionate number of engineers is assigned to systems and why the matching of computer programs to test equipment is vital. It is largely on the software side that the competitive battle will take place next year.

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## Space: still looking up

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The National Space Development Agency (Nasda) is on a crash program, Japanese style. Dedicated to practical applications of space technology, the young agency has been growing up, but concentrating on neat, small projects.

This year, Nasda received a jolt from NTT and NHK, Japan's public broadcasting system, in the form of a demand for a communications satellite to meet television and voice-transmission needs in the late 1970s. What's more, NTT and NHK want the 250- to 300-kilogram satellite up in the air by 1976.

Nasda's original long-range plan had called for launching an experimental 100-kg communications satellite in 1977. Now the space agency is up against a new and difficult set of demands. It does not yet have a rocket powerful enough to orbit a payload of 250-300 kg, nor does it have a design for a usable satellite.

In addition, Japan is committed to launching a meteorological satellite as part of a global atmospheric program involving coordination with space shots in the U.S. and Europe. In U.S. terms, these may seem like relatively simple problems, but Nasda must try to solve them with a budget of \$60 million for the fiscal year ending next March. The agency has requested an 80% increase for the next year, and will probably get it.

The simplest solution to the time-and-money crunch is to get the rocket and satellite technology from the U.S.; however, there is internal pressure to make the space effort all-Japanese. And the final complication is that Nasda must deal with the ministers of Posts and Telecommunications, Science and Technology, and Transportation, as well as the University of Tokyo's Institute of Space and Aeronautical Science, which has a budget of its own and pioneered Japan's space effort.

If Nasda were to buy parts and knowhow from the U.S. for the satellites, and NASA were to launch them, the communications project could be completed in three years, estimates Dr. Yasuhiro Kuroda, director of systems planning department for Nasda. If not, it might take seven years before the satellites could be launched. By using nine boosters strapped on Japan's "N" rocket (same configuration as the Thor Delta first stage), it would be possible to launch a 250-kg satellite, he adds.

Specifications for the communications satellite have not been set; however, it's assumed that there will be transponders for multiple voice channels and TV. Also both broad-beam and narrow-beam broadcast capabilities will probably be required.

Besides the communication satellite, Nasda has ongoing plans for other projects of practical and scientific nature. Projects are scheduled to map the ionosphere and measure radio noise for data pertaining to communications use. Two others—both for scientific purposes—are to conduct plasma and positive-ion density and composition measurements.

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## Defense: more yen, but when?

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All of the new spending plans set by Japan's Defense Agency under the fourth defense plan have been hanging fire, awaiting action by the government. By neglecting to obtain required final approval of the five-year plan by the National Defense Council, former Premier Eisaku Sato gave opposition parties an opportunity to freeze defense funds. The freeze was part of a compromise devised to pass the rest of the national budget.

The return of Okinawa to Japan then took precedence, and when that transfer was concluded, there was a change in leadership to Premier Tanaka. Soon thereafter, Tanaka began the long, careful plans to visit China and re-establish diplomatic relations. This effort has not only delayed approval of the new defense plan, but it took away the sense of urgency, since peace with China looked encouraging.

During the Tanaka visit, the pall of gloom hanging over Self-Defense headquarters was thicker than Tokyo smog. Since his return, however, the National Defense Council has belatedly approved the new plan, unfreezing funds for new aircraft, a tank, and a missile.

The delay has taken its toll. Although it was possible to continue programs previously established, no new efforts could be started. It's not clear whether or not research can proceed on an airborne early-warning system or anti-submarine patrol planes. A tactical computer project involving all of Japan's computer companies that was started under the third plan has continued. But there is no guarantee now that there will be enough funding to install the system.

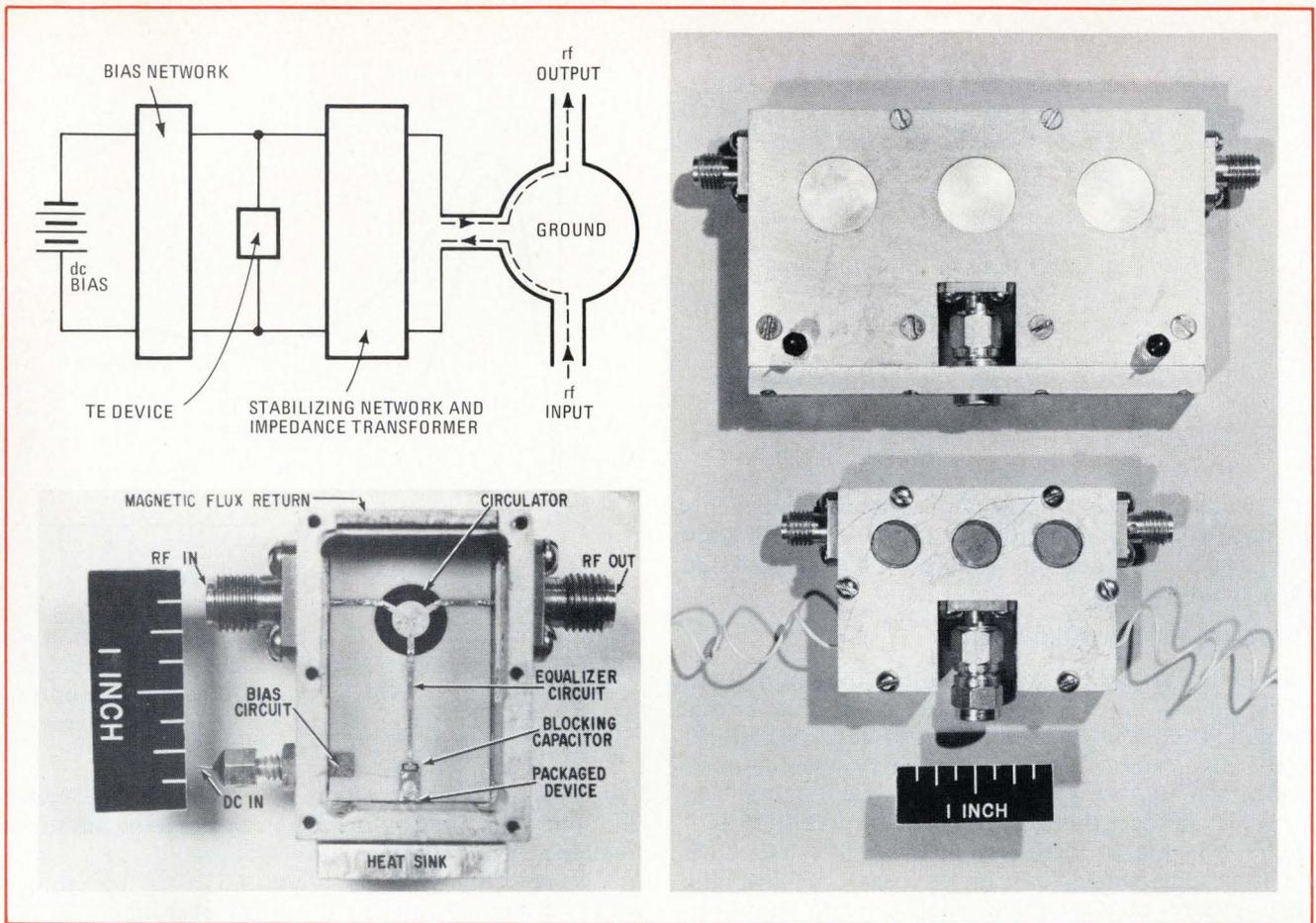
Equally frustrating to the agency is the fact that delay of this year's spending has squeezed together next year's budget. It has been impossible to settle next year's budget without firming up this year's.

An artillery-shell-spotting radar will go to completion, but there also will be procurement of less costly mortar radar. Placement of Mitsubishi's three-dimensional radar systems is continuing too. The Defense Agency will say nothing about plans for backup mobile 3-d radar made by Nippon Electric, except that it will not buy as many portable sets as fixed units.

Since some form of the 90 billion yen (\$300 million) fourth defense plan will eventually be adopted, the defense agency's next task will be to try to catch up the lost year, or at least minimize the delays it has caused. □

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**5. Transmitting microwaves.** TE devices are packaged as complete transmission circuits, including bias and stabilizing networks, plus circulator to decouple input and output. Amplifier schematic shown in (a) also includes dc bias source, which could be a simple battery. Completed circuit is shown in (b) and commercial package in (c). (Photographs courtesy R. Paglione, B.S. Perلمان and L.C. Upadhyayula.)

type TEA is shown in Fig. 5a. Needed along with the TE device itself are: a bias network to supply the drive field; a stabilizing network and impedance transformer to provide the proper matching between the device and the cavity; and a circulator to separate the rf input from the rf output.

Previously this circuit was built up from discrete component and then packaged, a process that often made for reduced performance and bulky layouts. Now a technique has been devised to build the entire circuit on an integral substrate (Fig. 5b) in much the same manner as is used to build a conventional hybrid circuit. As a result, an integral amplifier component can now be obtained which has low parasitics and minimum area, and can be batch-processed for cost savings. A finished package is shown in Fig. 5c.

Another type of TE amplifier that has recently been developed is built on the same principles as the conventional traveling-wave amplifier. The traveling-wave TE device shown in the schematic in Fig. 6 is divided into three regions: the input coupling region, the output coupling region, and the amplification region. In the amplification region a growing space-charge wave amplifies the input signal, where the gain is proportional to the length of the sample. Since the gain occurs only in the direction of the space-charge wave, the device has unilateral gain, and no circulator is required.

A problem area is the input couplers which, being lossy, reduce gain and also increase the noise of the devices. A remedy involves building a FET-like input coupler which can provide input gain.

This first of the traveling-wave amplifiers had gains as high as 18 dB in pulsed operation over the range of 1 to 4 GHz. Cw devices use a small ratio of material thicknesses to provide stability. Recently, continuous gain from 7.2 to 15.3 GHz has been demonstrated at RCA.

Traveling-wave TE amplifiers, however, are low-power devices—a problem which can be alleviated by adding a negative-resistance amplifier to the output of the devices. Work toward this end is presently under way at RCA.

### The switch to LSA

For unusually high power, the LSA type of transferred-electron device is much more suitable than the Gunn type. Indeed, the highest power ever obtained from microwave solid-state oscillators has been obtained working with harmonics in the LSA mode—6 kW at 1.75 GHz with 14.6% efficiency, and 2 kW at 7 GHz with 4.1% efficiency. In this mode the device is operated in a low-Q circuit to achieve a multi-frequency non-sinusoidal waveform. Although Copeland of Bell Labs, who invented the LSA mode, worked primarily with sinusoidal waveforms, he points out that harmonics could

# EQUIPMENT

	1971	1972	1973
<b>CONSUMER PRODUCTS</b>			
Audio tape recorders and players	212.3	250.0	291.7
Citizen band transceivers	7.0	7.3	7.7
Electronic ranges	69.0	89.0	108.3
Hi-fi component equipment	66.7	85.7	108.7
Musical instruments	43.3	45.0	45.0
Stereo phonograph and radio combinations	313.3	324.0	345.3
Radios (including car radios)	161.0	167.7	172.0
TV sets, black and white	112.5	93.3	85.5
TV sets, color	1,788.3	1,773.7	1,767.3
Video tape recorders (for consumer use)	21.7	51.7	71.3
<b>Total</b>	<b>2,795.1</b>	<b>2,887.4</b>	<b>3,002.8</b>
<b>COMPUTERS AND RELATED HARDWARE*</b>			
Analog and hybrid computers	6.3	7.0	7.8
Converters, a-d and d-a	85.0	110.7	144.0
Digital computers (except minicomputers)	461.7	583.3	733.3
Digital minicomputers (valued up to \$10M)	11.7	15.3	20.5
Data storage devices	359.8	481.3	646.0
Data entry and output equipment	193.3	261.0	339.3
Remote terminal equipment	25.5	38.2	53.3
Electronic calculators	176.0	193.7	197.0
<b>Total</b>	<b>1,319.3</b>	<b>1,690.5</b>	<b>2,141.2</b>
<b>COMMUNICATIONS EQUIPMENT</b>			
Broadcast equipment	46.7	57.0	73.3
CATV	2.2	2.8	4.2
Closed circuit TV	14.3	16.3	19.0
Intercoms and intercom systems	14.0	15.3	16.7
Microwave relay systems	76.7	80.0	85.0
Navigation aids (except radar)	23.3	25.8	28.8
Radar (air, ground, and marine)	51.2	56.7	62.7
Radio communications (except public broadcast)	156.5	168.3	183.3
Telemetry and guidance systems (except industrial)	38.3	46.7	60.0
Telephone switching, electronic or semielectronic	26.2	36.7	53.3
Wire message equipment	156.3	178.3	203.3
Wire carrier equipment (includes FDM and PCM)	185.0	206.7	246.7
<b>Total</b>	<b>790.7</b>	<b>890.6</b>	<b>1,036.3</b>
<b>INDUSTRIAL EQUIPMENT</b>			
Machine tool controls	20.7	30.5	39.0
Motor speed controls	73.0	82.7	95.0
Power electronics equipment	91.3	113.9	126.7
Process controls and related equipment (includes computers)	326.7	333.3	400.0
Simulators, trainers, and teaching aids	13.3	16.7	23.3
Ultrasonic cleaning and inspection equipment	7.0	7.8	9.1
<b>Total</b>	<b>532.0</b>	<b>584.9</b>	<b>693.1</b>
<b>TEST AND MEASURING INSTRUMENTS</b>			
Amplifiers, laboratory type	13.3	14.2	15.0
Calibrators and standards, active and passive	9.2	9.2	10.3
Components testers	15.8	16.7	20.0
Counters and timers	9.3	8.8	10.0
Electronic meters, analog	7.5	7.5	7.5
Electronic meters, digital	5.3	5.5	5.8
Generators and synthesizers (to 1 GHz)	10.3	10.8	12.2
Lasers, all types	3.3	3.0	3.3
Microwave test and measuring instruments (above 1 GHz)	12.0	12.8	14.2
Oscillators	7.5	7.8	7.8
Oscilloscopes and accessories	30.5	31.7	35.8
Power supplies, laboratory type	5.0	5.0	8.3
Recorders (analog and digital)	11.7	13.3	16.7
<b>Total</b>	<b>140.7</b>	<b>146.3</b>	<b>166.9</b>
<b>MEDICAL ELECTRONICS EQUIPMENT</b>			
Diagnostic equipment, except X-ray	33.3	35.0	36.7
Patient monitoring equipment	6.7	8.3	10.0
Prosthetic equipment	10.7	11.3	13.0
Therapeutic equipment, except X-ray	8.8	9.3	10.0
X-ray equipment	83.3	90.0	96.7
<b>Total</b>	<b>142.8</b>	<b>153.8</b>	<b>166.4</b>
<b>TOTAL EQUIPMENT CONSUMPTION</b>	<b>5,720.6</b>	<b>6,353.5</b>	<b>7,206.7</b>

(factory prices in millions of dollars)

\* Not including navigation, radar, process-control, and similar systems

# Dynamic zero-correction method suppresses offset error in op amps

In data-acquisition systems, the offset voltage and offset voltage temperature drift of a FET-input op amp can be held to only a few microvolts by a sample-and-hold correction technique

by Richard C. Jaeger and George A. Hellwarth, IBM General Systems Division, Boca Raton, Fla.

□ Although today's monolithic FET-input operational amplifier offers the advantages of high input impedance, large open-loop gain, fast slew rate, and low input-bias current, it often has a high initial offset voltage that drifts with time and with changing temperature.

However, certain dynamic zero-correction techniques can drive the initial offset voltage to zero and reduce the effect of initial offset current when the amplifier is used for signal conditioning in a multiplexed or sampled data-acquisition system. One such scheme keeps the amplifier's input voltage to only a few microvolts and its offset voltage temperature drift to merely a few hundredths of a microvolt per degree Celsius.

This method overcomes the shortcomings of previous dynamic zero-correction techniques. One method, for example, controls drift by inserting a dc correction signal into the amplifier's input with a periodically operated switch or modulator, an auxiliary ac-coupled amplifier, and a demodulator switch and filter. This scheme is not only expensive, but it produces carrier-frequency noise from the switches and recovers slowly from an overload condition.

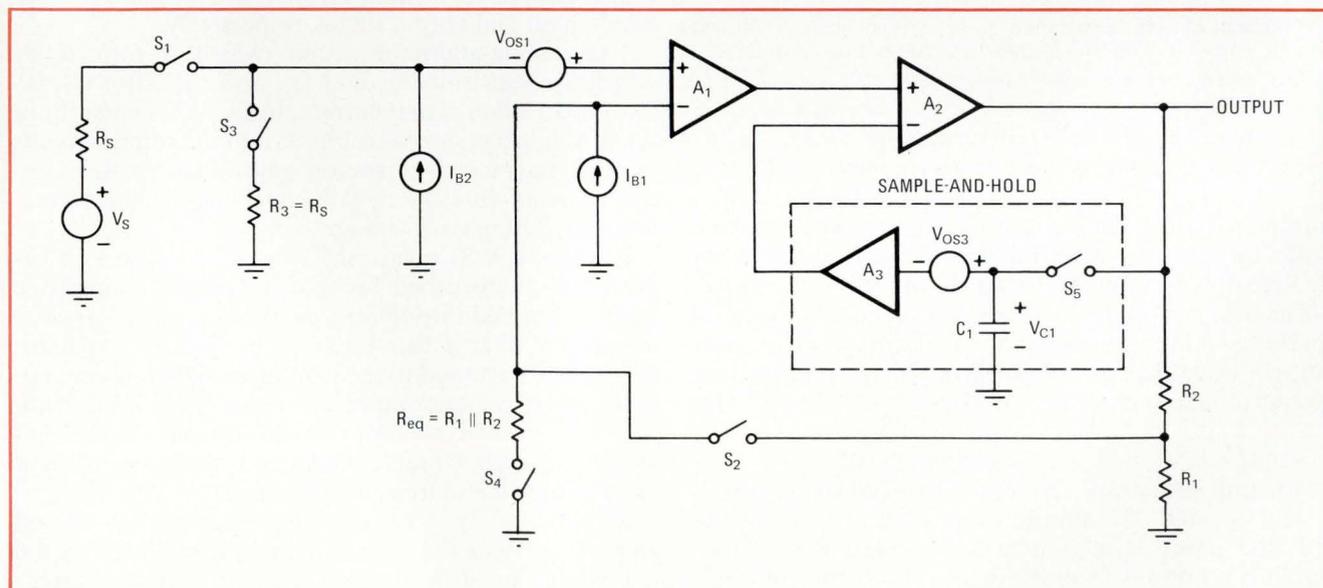
Recent methods require switches operating synchro-

nously between the cycles of a multiplexer or an analog-to-digital converter so that the switches and demodulation filter become a measure-and-hold circuit. After measuring the magnitude of the input offset voltage (with the amplifier input shorted by a switch), the circuit holds the correction voltage inserted at the amplifier input. This technique is sometimes hampered by errors in the sample-and-hold circuit and by feedback instability during the correction cycle.

## Zeroing out offset error

In the improved zero-correction scheme (Fig. 1), the amplifier is also driven by a multiplexer, and the offset voltage is dynamically eliminated between multiplexer cycles. A set of switches, which are synchronously linked to the multiplexer timing control, change the amplifier's operating mode to eliminate offset error. MOSFETs are usually used as the switches because of their operating speed and predictable switching action.

Zero correction is implemented by disconnecting and grounding both inputs of amplifier  $A_1$ , allowing the forward gain of the over-all amplifier to generate a large output voltage that is fed back to the input of interstage



1. **Dynamic zero-correction.** Offset voltage of over-all amplifier is held to a few microvolts by inserting correction voltage at input of amplifier  $A_2$ . By applying correction voltage at interstage between  $A_1$  and  $A_2$ , errors due to sample-and-hold inaccuracies can be minimized. Sample-and-hold circuit stores correction voltage while over-all amplifier has its feedback loop open and is disconnected from source.

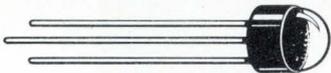
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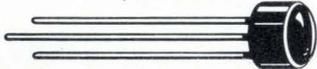
Standard — Dome Lens  
Phototransistor

FPT 100, FPT 120



Standard — Flat Lens Precision  
Package Phototransistor

FPT 110, FPT 130



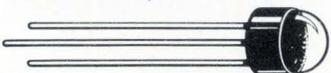
Metal Package — Phototransistor

FPT 101, FPT 102



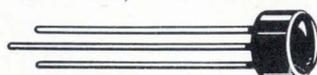
Matched Sensitivity Dome Lens  
Phototransistor

FPT 220, FPT 320  
FPT 100 A, 100 B



Matched Sensitivity Flat Lens  
Precision Package Phototransistor

FPT 110 A, FPT 110 B  
FPT 230, FPT 330



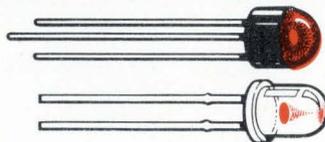
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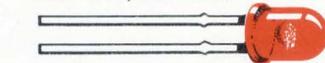
Wide Angle Panel Indicators

FLV 102, FLV 108  
FLV 116, FLV 115



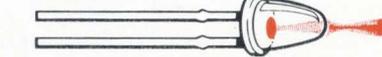
Panel Indicators

FLV 110, FLV 112  
FLV 117, FLV 119



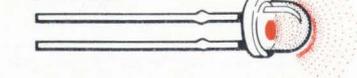
Narrow Beam Emitters

FLV 104



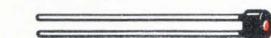
Backlighting Illuminator

FLV 103



Subminiature Lamps

FLV 107



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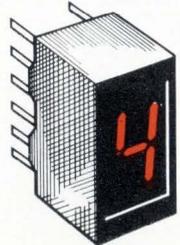
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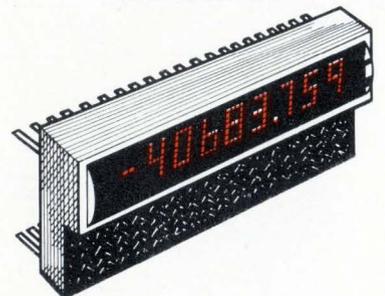


FND 70 1/4"



FNA 45 9-Digit DISPLAY  
with drivers

FNA 25 9-Digit DISPLAY  
without drivers



Circle 212 on reader service card

## Evaluating power dissipation in microcircuit design

by Lyle F. Pittroff  
Microcircuit Operations, Helipot Div., Beckman Instruments, Fullerton, Calif.

Converting a circuit from the discrete-component concept into a single miniaturized microcircuit is analogous to the design and development of a larger system. Although specific design problems must be handled on an individual basis, several key areas must be considered early in the game.

This Engineer's notebook covers package-temperature rise, component ratings, and component compatibility; a later notebook will focus on a shortcut technique for estimating the substrate area required for any given circuit. This latter article will also discuss component density and hopefully answer the question, "Will it fit?" when circuit designs have been finalized.

Microcircuits shrink the package size, but package power remains the same, and the power density can be increased significantly. An estimate of the temperature rise in a new microcircuit design can be a critical step in the package-selection process. Two specific areas must be evaluated:

- Substrate/package temperature rise above the ambient or heat-sink maximum operating temperature.
- Individual component/junction temperature rise above the substrate/package temperature.

A simple review of the thermal model for the package and those components dissipating significant power will quickly reveal whether or not the design is in the right ball park for most hybrid-circuit configurations. With the fundamental thermal model shown in the first figure, a steady-state Ohm's law network analogy can be used to evaluate component temperature rise.

For the initial approximation, transistors and diodes dissipating less than 100 milliwatts, resistors, and most ICs are assumed to be operating at the case temperature. It is also assumed that all of the heat generated by internal circuit elements is being conducted away by the case (there is no radiant energy).

Conventional thermal model designations for a hybrid microcircuit are outlined in the second figure. The package temperature rise is a function of the total power dissipation ( $P_T$ ) of all internal circuit elements:

$$T_R = T_C - T_A = P_T \Theta_{CA}$$

where  $T_R$  is the temperature rise between two specified points,  $T_C$  is the case temperature,  $T_A$  is ambient temperature, and  $\Theta_{CA}$  is the thermal resistance from the case to ambient without a heat sink.

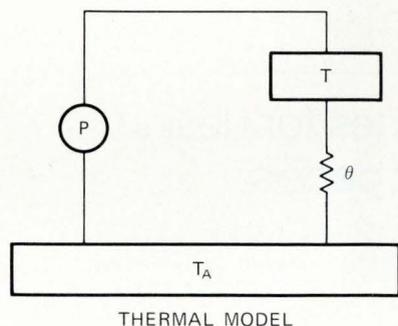
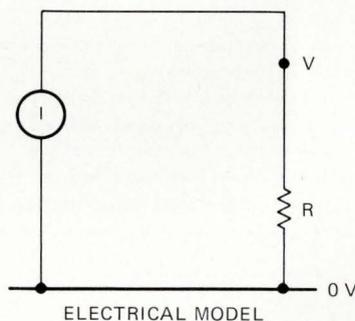
As a rule of thumb, the thermal resistance,  $\Theta_{CA}$ , of a package in free air (no forced cooling and minimum pin conduction) causes a temperature rise of about 35°C per watt of power dissipation per square inch of package

area (35°C/w/in.<sup>2</sup>). For example, the temperature of a circuit dissipating 1 w would rise approximately 35°C above ambient in a 1-inch-square package or 70°C above ambient in half that package area. This general rule is conservative and should prove a safe first approximation for most pc-board applications.

The individual component temperature rise above the substrate temperature is a function of the component's power dissipation and thermal resistance. Although significant temperature rises are usually limited to the larger devices, some typical values of chip thermal resistance for smaller semiconductors are given.

The maximum allowable junction temperature ( $T_J$ ) for silicon devices depends on the application, and in

THERMAL MODEL/OHM'S LAW ANALOGY



### ANALOGOUS TERMS

#### Electrical Model

- Ground reference . . . . . (0 V)
- Current source . . . . . (I)
- Electrical resistance . . . . . (R)
- Voltage rise (above 0 V) . . . . . (V)

#### Thermal Model

- Ambient temperature . . . . . ( $T_A$ )
- Power source . . . . . (P)
- Thermal resistance . . . . . ( $\theta$ )
- Temperature rise (above  $T_A$ ) . . . . . (T)

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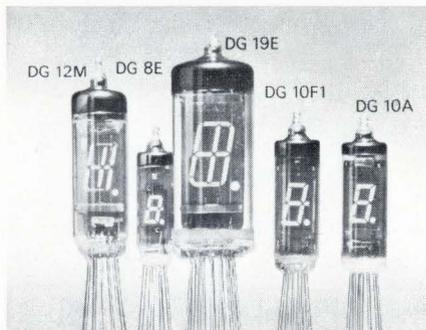
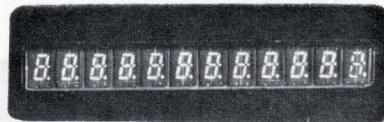
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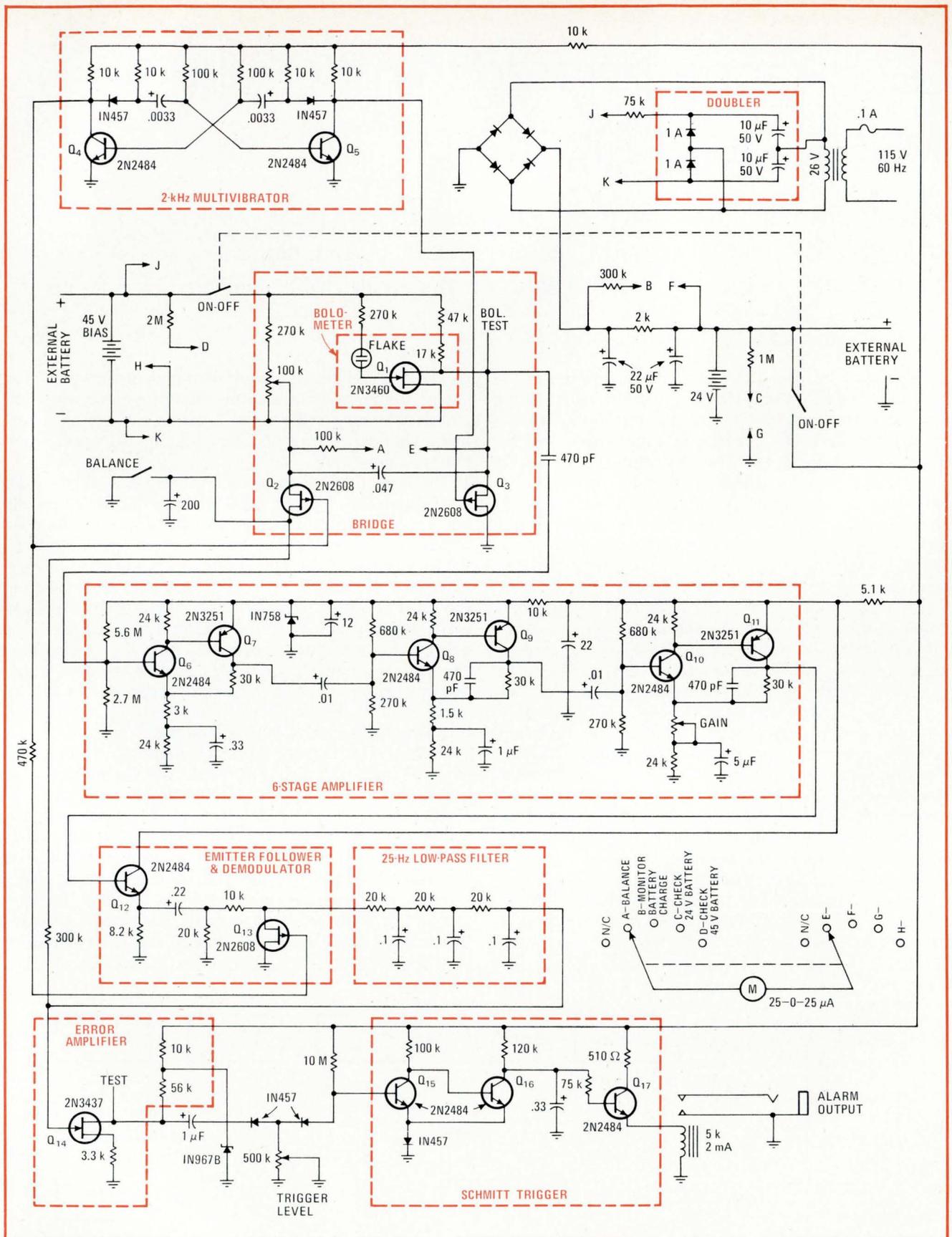
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**2. Bridge unbalancer.** Bolometer is part of bridge circuit that becomes unbalanced when illuminated by infrared radiation. Six-stage amplifier is conventional circuit with small negative feedback. Main power source is 24-volt nickel-cadmium battery; 45-V NiCad battery biases the bolometer. Alternatively, an external battery or standard 120-V ac source may be used.

## **New ROMs ease logic design**

Designers who have been using bipolar read-only memories to perform control-logic functions will be pleased to hear that more and more sophisticated ROMs are becoming available, both electrically programmable and mask-programmable. **And to make matters even better, 2,048-bit programmable ROMs are now appearing.** The first was introduced recently by Harris Semiconductor, and other semiconductor makers are not far behind. One big advantage in using ROMs is the saving in board space, meaning that fewer packages are needed to perform the logic.

With the programmable ROMs, **the user needn't carry a large inventory because he is able to use the same basic unit for many programs.** And many new universal programmers, such as the Spectrum Dynamics model, are already available to simplify programming.

## **Adhesive is quick, withstands high temperatures**

If you need an adhesive that sets up fast and withstands temperatures to 475°F, then Eastman's 910 MHT may be the one. Applying adhesives prior to high-temperature encapsulation often results in subsequent bond failures. **However, 910 MHT, a member of the cyanoacrylate adhesive family, sets up in seconds and withstands the temperatures encountered in curing processes.**

For example, the adhesive solved a problem that American Aerospace Controls Inc., Farmingdale, N.Y., encountered when securing magnetic components to a pc board. With previous cyanoacrylate adhesives, the bias magnets shifted before the encapsulation step. But with the Eastman product's fast setup, the magnets stayed in place. No shifting occurred during curing of the encapsulant material. For further information contact Emerson & Cuming Inc., Canton, Mass.

## **Components here in beam-lead packages . . .**

Designers of uhf equipment should welcome the appearance of many conventional components in beam-lead packages at prices they can afford. **They will now have the opportunity to specify the devices for high-volume applications.**

An example is Hewlett-Packard's new beam-lead Schottky diode, which the company says is the beamed version of its old 5082-2800 Schottky diode. **The nice feature of the new device is that small quantities are available at less than \$1 each.** The part is aimed at such applications as high-level detection, switching, gating, and logarithmic and a-d conversion. Also look for beam-lead power devices. Suppliers now feel they can use beams with powers of 1 W and above.

## **. . . as multiple devices share single package**

Users of discrete semiconductors have been talking about the increased availability of packages containing such multiple discrete devices as duals, quad transistors, Darlingtons, double emitters, and diode arrays. **The key is that the technique offers big savings in device costs, assembly costs, and board space.** The packages also contain a design bonus: individual devices can be matched for a particular device parameter. Perhaps the most complex of these multiple discretely are the quad transistors and dual field-effect transistors. The latter have become popular for applications where FET inputs have to be matched. Suppliers do the matching, designers get the benefits.

## Temperature-stable decoder for modulated pulse widths

by H.R. Beurrier  
Bell Telephone Laboratories, Murray Hill, N.J.

Besides offering exceptional temperature stability, a pulse-width-modulation decoder for remote proportional radio control produces a presettable fail-safe analog output when the input control signal is interrupted. The circuit converts a time-modulated pulse input to an analog output.

Transistors  $Q_1$  and  $Q_2$  form a sawtooth generator with a ramp output that starts when the input control signal goes positive and that resets when the input goes negative. The control signal switches  $Q_2$  alternately on and off.

When the base of  $Q_2$  is driven positive by the input, this transistor turns off and capacitor  $C_1$  charges with the constant current supplied by transistor  $Q_1$ . (The longer the input pulse duration, the higher  $C_1$ 's ramp voltage and the resulting output voltage.) When  $Q_2$  is driven negative, it conducts, pulling its emitter voltage in the negative direction and partially discharging capacitor  $C_1$ .

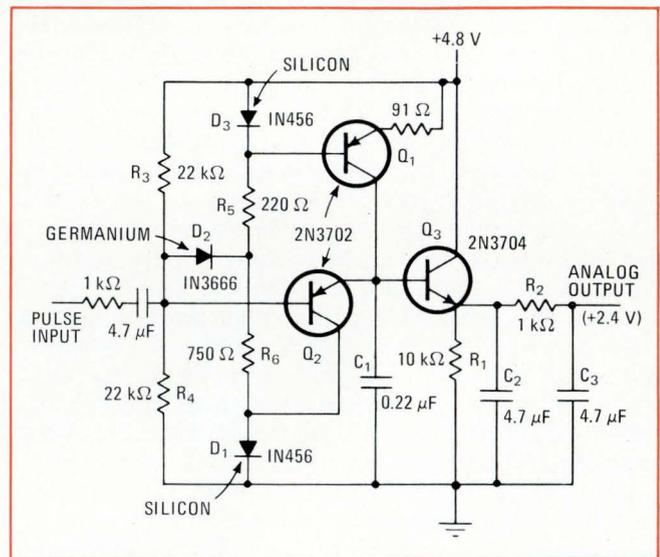
Emitter-follower  $Q_3$  acts as a peak-voltage detector that charges capacitor  $C_2$  positively when its base is driven positive by the ramp voltage of capacitor  $C_1$ . If the voltage across  $C_1$  is too negative to forward-bias the base-emitter junction of  $Q_3$ , capacitor  $C_2$  discharges through resistor  $R_1$ . This portion of the circuit, therefore, acts as a diode peak detector with power gain. Resistor  $R_2$  and capacitor  $C_3$  are connected as a simple first-order output filter.

Once the input signal is terminated, the base voltage of transistor  $Q_2$  settles to a level determined by the voltage divider of resistors  $R_3$  and  $R_4$ . This voltage level is coupled to the output through transistors  $Q_2$  and  $Q_3$ , which are connected as cascaded emitter-followers. The complementary arrangement of  $Q_2$  and  $Q_3$  causes any

temperature-induced change in the base-emitter voltage of transistor  $Q_2$  to be cancelled by an equal-in-magnitude, but opposite-in-polarity, change in the base-emitter voltage of transistor  $Q_3$ .

The circuit's output voltage is referenced to the lower point of capacitor  $C_1$ 's charge/discharge cycle. When the input is negative, diode  $D_1$  reverse-biases transistor  $Q_2$ 's collector so that capacitor  $C_1$  always discharges to the same level. Diode  $D_2$  and resistors  $R_5$  and  $R_6$  clamp the capacitively coupled input control signal so that transistor  $Q_2$ 's base is driven slightly negative. Diode  $D_3$  simply fixes the base voltage of transistor  $Q_1$ .

With the component values shown, the circuit will convert a pulse width of  $1.25 \pm 0.63$  milliseconds to an analog output of  $2.4 \pm 0.6$  volts dc. The 1-kilohm input resistor simply reduces the loading on the driving source. □



**PWM decoder.** Circuit detects pulse-width-modulated signals, supplying dc analog output over wide operating temperature range. If input control signal is interrupted, decoder output goes to preset fail-safe level. Transistors  $Q_1$  and  $Q_2$  and capacitor  $C_1$  make up sawtooth generator that drives transistor  $Q_3$ , which acts as peak-voltage detector.  $Q_2$  and  $Q_3$  are cascaded complementary emitter-followers.

## C-MOS sums up tones for electronic organ

by Robert Woody  
Hercules Inc., Radford, Va.

An electronic organ that produces a wide variety of voices, either singly or in combination, can be built with relatively simple circuitry if complementary-MOS logic

circuits and linear diode gates are used. The organ, which requires only one gate for each frequency, adds tones to derive the harmonic content of each voice. Sound reproduction varies smoothly, too, so that there are no displeasing key clicks.

The circuit shown generates the eight frequencies of note A. Adjacent frequencies of the same note have 2:1 ratios and are separated by an octave. Similar circuit arrangements generate frequencies for notes B through G and five sharps, for a total of 12 notes. These 12 notes, each having eight frequencies, comprise the 96 frequencies in the organ. Individual frequencies are spaced

# Converter resolves 16 bits in 8 $\mu$ s

Analog-to-digital unit is made out of 11 basic building blocks; special comparator has gain of 12,000 and fast settling time

by Stephen Wm. Fields, San Francisco bureau manager

**When the subject** of a 16-bit analog-to-digital converter is brought up, the discussion of how to use it turns out to be almost as important as the one on how to build it. Intech Inc., of Santa Clara, Calif., has built a fast a-d converter and is putting together material on how to use it.

Gil Marosi, designer of the model A-856 modular unit, points out that building a 16-bit device, especially a fast one, poses some peculiar problems. Since the A-856 has a conversion time of only 8 microseconds, each bit must be resolved in 0.5  $\mu$ s. And the converter has an input signal range from -10 volts to +10 V, which means that it can resolve one bit as 305  $\mu$ V.

Linearity error of the converter is specified at 0.001%, and a full-scale accuracy is within 0.0015%. Temperature drift is no more than  $\pm 7$  parts per million/ $^{\circ}$ C. Long-term stability is to within  $\pm 30$  ppm per month; and short-term,  $\pm 5$  ppm.

**Fast.** The A-856 employs a successive-approximation technique. "And with this method," says Marosi, "the worst case occurs when the input (after being converted from a voltage somewhere between -10 and +10 V to a unipolar current of from 0 to 32 milliamps) is exactly 16 mA, and it is balanced against the most-significant-bit (MSB) current, which is also 16 mA. Between the moment the MSB current is off (no signal), and when it is switched on and balanced against the input current, only 0.5  $\mu$ s is allowed for settling the MSB current, the comparator, and any logic delays."

This restraint is combined with the fact that the wideband noise of the A-856 must be kept at about 100  $\mu$ V peak to peak, or in any case, it is

not to exceed half a bit or 120  $\mu$ V pk-pk for the total result to be meaningful, Marosi adds. "When an instrument of such a complexity is designed, some means must be found for the performance capabilities of any part of the blocks to be measured and monitored," he says.

It's one thing to design a 16-bit a-d converter, but it's another thing to design one that can be manufactured. Intech approached the problem by splitting the system into 11 basic modules (see diagram).

This modular approach reduces the problem of a cumulative error in the finished product. For instance, if all of the components were first assembled into the final product before the device was calibrated, the chances are that, if it could be done at all, it would take many hours of hand-tweaking. But with the modular approach, each module is assembled, tested, and brought to specifications. Therefore, only minor hand-tweaking is required.

"One of the most important building blocks in any a-d (and especially in a 16-bit a-d) is the com-

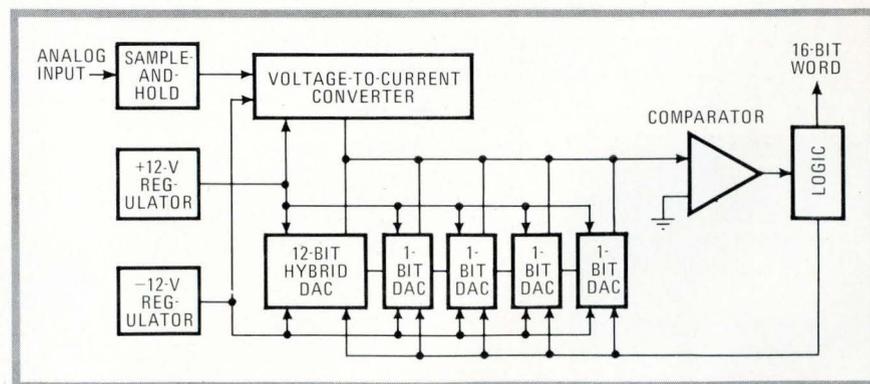
parator," Marosi points out. In the A-856, "it has to be able to determine within a half-bit or less if the input current is exactly balanced by the output current of the 16-bit DAC, and it must be able to do this at any step in the sequence."

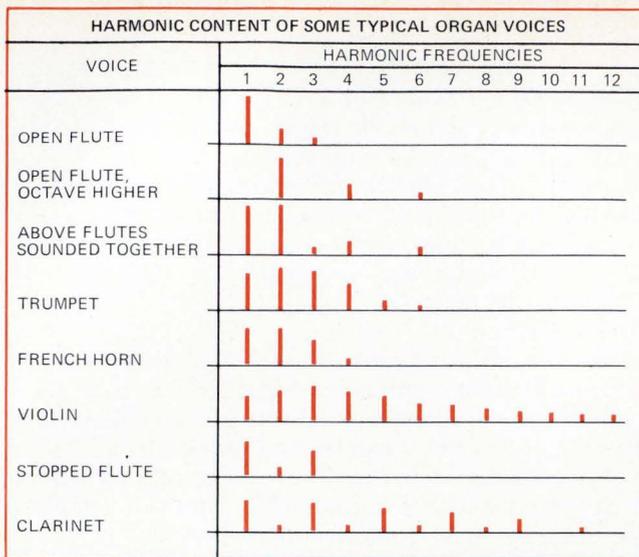
The comparator is also required to amplify a half-bit signal of 0.25  $\mu$ A into a 1-kilohm resistor—0.25 mV—to a 3-V swing at the output, suitable for driving a TTL or DTL load; thus it must have a gain of 12,000, and, as Marosi puts it, it's not too easy to find a comparator that has a voltage gain of 12,000, settling time of less than 0.35  $\mu$ s to 0.25 mV, input bias current of less than 100 nA, and a voltage-offset drift of less than 20  $\mu$ V/ $^{\circ}$ C. Since this was not to be found in any integrated-circuit comparator on the market, Marosi turned to discrete and designed one from scratch.

The A-856 which requires  $\pm 15$  V and +5 V, comes on a printed-circuit card measuring 4 by 5 inches by 1 in. high. It is priced at \$1,300.

Intech Inc., 1220 Coleman Ave., Santa Clara, Calif. 95050 [338]

**Modular way.** Standard parts were used wherever possible to keep down cost of 16-bit a-d converter. The 12-bit DAC, for example, is a commercial hybrid device.





down to the simplest voice produced in the organ, namely the flute. Since the eight frequencies of a note are multiples or submultiples of each other, they can be handled by one low-pass filter. This means that only 12 low-pass filters are needed for all 96 frequencies.

The diodes between the gates and the key switches—diode  $D_2$ , for instance—allow a given tone to be sounded by a number of different key switches. All of the key switches indicated are operated by the key for note A1. The voltages ( $V_1, V_2, V_3, \dots$ ) on the key buses determine the amplitude at which the tones are sounded ( $V_1$  controls the fundamental frequency tone,  $V_2$  the second harmonic,  $V_3$  the third,  $\dots$ ). The key bus voltages set the harmonic content and, therefore, the voice of all the keys on the keyboard.

To conserve circuitry, the third harmonic, note A3, borrows a tone from the gate (not shown) used for note E3. The resulting 0.2-Hz frequency error cannot be heard. □

## Transistor gating circuit cuts signal delay to 100 ps

by Arthur J. Metz  
Tektronix Inc., Beaverton, Ore.

Frequently in emitter-coupled-logic design, a high-speed data signal must be gated by a dc control signal that is generated by a contact closure or a transistor-transistor-logic gate. When the propagation delay in the high-speed signal path must be held to a minimum, a simple transistor circuit can probably provide the fastest way to perform the gating function.

Propagation delay for the transistor gate is as low as 100 picoseconds, compared to the 1-nanosecond delays of the fastest integrated-circuit gates presently available. Moreover, the transistor gate consumes less power and costs less than the IC gate, especially if an additional IC gate package is needed to perform the gating function.

A typical application for the transistor gate is shown in the figure. Here, signal delay between the flip-flop's  $\bar{Q}$  output and its D input must be minimized to realize the fastest possible toggle rate.

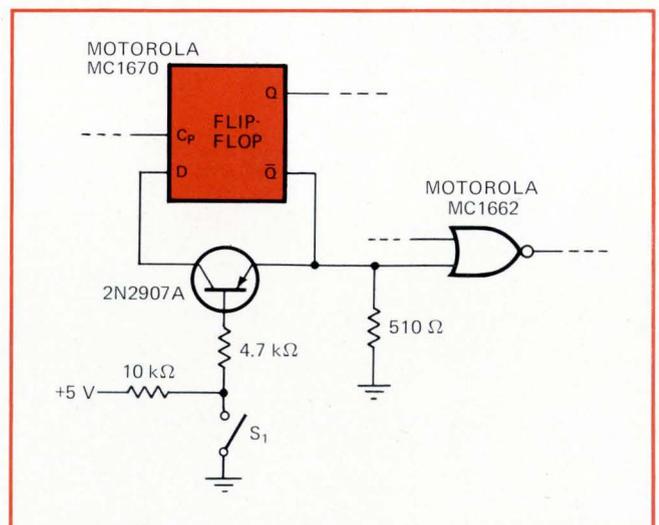
With switch  $S_1$  open, the transistor's base-emitter junction is reverse-biased. An internal pull-down resistor of about 50 kilohms at the flip-flop's D input holds all data inputs near ground potential, reverse-biasing the flip-flop's input stage (by more than 3 volts) and assuring the rejection of any signal that passes through the internal capacitance of the transistor. When the switch is closed, the transistor saturates and provides a low-impedance signal path. For TTL applications, the function of switch  $S_1$  is implemented by the appropriate TTL device.

The noise immunity of the gating circuit is maintained by keeping the transistor's collector-emitter voltage drop low. (With the type 2N2907A transistor, which

has excellent saturation characteristics, the  $V_{CE}$  drop can be held to approximately 10 millivolts by using a forced beta of 0.1.) Driving several high-impedance inputs or perhaps one low-impedance input will cause some loss of noise immunity. Although driving a terminated line is not recommended, the gate may be driven from a terminated line.

As with any ECL design, care must be taken in laying out the circuit to realize maximum performance. Since the full logic-voltage swing appears at the transistor's base terminal, the base biasing resistor should be located close to that terminal to eliminate the transmission line effects of an interconnecting lead. □

Designer's casebook is a regular feature in Electronics. We invite readers to submit original and unpublished circuit ideas and solutions to design problems. Explain briefly but thoroughly the circuit's operating principle and purpose. We'll pay \$50 for each item published.



**Gating ECL signals.** Bipolar transistor gate can transfer logic signals with propagation delay of as little as 100 picoseconds. With switch closed, transistor saturates and gates signals from flip-flop's  $\bar{Q}$  output to its D input. When switch is open, transistor is cut off, and strong reverse bias at D input rejects all unwanted stray signals. The switch can be a pair of contacts or a TTL device.

## New products

### Instruments

# 80-MHz counter costs only \$325

5-digit unit automatically handles wide range of input-voltage levels

There was a time when a frequency counter was a major investment—and a backbreaking piece of equipment to move around. Just how much progress has been made in the last 10 years is illustrated by Ballan-



tine's latest counter—the 5725A.

It spans from 5 hertz to more than 80 megahertz, weighs only four pounds, costs only \$325 (less in OEM quantities), and is so simple to operate that controls are practically non-existent.

The counter's input sensitivity is 75 millivolts rms up to 40 MHz, decreasing to 120 mV rms at 80 MHz. Maximum input voltage is 240 volts rms up to 1 kilohertz, decreasing to 10 V rms at 10 MHz and above. The FET input circuit has so large a dynamic range that the input sensitivity control seldom needs adjustment. For this reason, the usual front-panel knob has been replaced by a screwdriver adjustment.

While not a super-precision laboratory instrument, the 5725A does contain a crystal-controlled 1-MHz reference source with an aging rate of less than two parts per million per month and a temperature sensitivity of less than five parts in  $10^7/^\circ\text{C}$  from  $0^\circ\text{C}$  to  $40^\circ\text{C}$ . A ceramic trimmer capacitor is provided for tuning the crystal to a 1-MHz frequency standard.

In addition to performing as a straightforward five-digit frequency counter, the 5725A can operate as an event counter and as a frequency ratiometer. In its event-counting mode, the counter's gate is opened and closed by a pair of front-panel pushbuttons. The display is stored when the gate is closed, so if it is reopened without being reset, the count will continue to accumulate from where it left off.

When used as a ratiometer, the counter will display a ratio  $F_1/F_2$ , where  $F_1$  is any frequency between 5 Hz and 80 MHz applied to the front-panel connector, and  $F_2$  is any frequency between approximately 10 kHz and 2 MHz applied to a rear-panel connector.

Power consumption is 10 watts. Ballantine Laboratories Inc., P.O. Box 97, Boonton, N. J. 07005 [351]

## Precision digital voltmeter is completely self-balancing

Combining modern a-d conversion techniques with classical potentiometric and differential measurement methods, a self-balancing digital voltmeter keeps its maximum error below  $\pm(0.0015\%$  of reading +  $0.001\%$  of range). The model 2760 has five standard ranges—0.1 to 1,000 vdc—plus an optional 10-mV dc range and other optional ranges for resistance, ac voltage, and ac and dc current. The 5-digit instrument provides 60% over-range on most ranges.

Leeds and Northrup Co., North Wales, Pa. 19454 [352]

## Microwave stabilizer tunes over 1 to 40 gigahertz

A microwave synchronizer-stabilizer, model 251, is a solid-state source covering 1 to 18 GHz with no holes and with frequency stability of one part in  $10^8$  per second ( $10^7$  per day). The unit, which can impart crystal stability to any type of voltage-tunable microwave source, is continuously tunable from 1 to 40

GHz. A built-in rf mixer covers 1 to 18 GHz, and two plug-in mixers cover 18 to 26.5 GHz and 26.5 to 40 GHz respectively. Price for the basic 251 is \$2,900. The mixers are \$400 and \$500 additional.

Sage Laboratories Inc., 3 Huron Dr., Natick, Mass. [354]

## Digital ohmmeter reads low resistance within 0.02%

The model SP 3789 digital ohmmeter measures resistance below 200 ohms with a maximum error of  $\pm(0.02\% + 1 \text{ digit})$ . Four ranges cover values from 10 microhms to

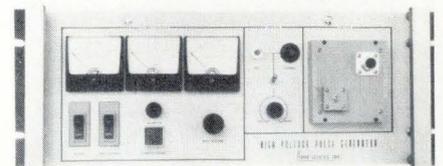


200 ohms. Measurements are displayed on a  $4\frac{1}{2}$ -digit light-emitting-diode readout, and operation may be in a single- or continuous-measurement mode. Ac noise rejection is better than 80 dB at 60 Hz. Test leads may have resistance to 5 ohms with no effect on accuracy.

Electro Scientific Industries Inc., 13900 N.W. Science Park Dr., Portland, Ore. 97229 [353]

## Generator delivers variable output pulses to 30 kV

A nominal rise time of 6 nanoseconds is a feature of the model PG-030 high-voltage pulse generator. The unit delivers variable output pulses to 30 kilovolts and offers negligible time jitter and total trigger-



# Automatic control of speaker output compensates for noisy background

Output level of speaker system is increased by more than 30 dB to automatically compensate for changing background noises; the system is suited for such environments as those encountered by mobile radios

by David B. Hoisington, *Naval Postgraduate School, Monterey, Calif.*, and Andrew F. Hobson, *U. S. Coast Guard, Washington, D. C.*

□ Noise in the surrounding environment can mask information coming from audio speakers. Mobile communications receivers in cars and trucks, for example, frequently have to compete with varying levels of audible background noise.

If the level of background noise were constant, it would be relatively easy for a listener to adjust the signal to an optimum level. However, in most situations, the audible noise is constantly changing.

To continuously adjust for optimum signal level in the presence of changing noise, then, an automatic volume control is highly desirable. In an automatic control system that was designed and tested at the Naval Postgraduate School, a balancing arrangement prevents the circuit from interpreting the received audio signal as noise. To further refine the control's ability to sort wanted from unwanted signals, a frequency-weighting technique was incorporated to approximately match the peculiar characteristics of the human ear.

By applying integrated-circuit technology to implement the design, the system should provide operator comfort and listening convenience, not only in mobile communications systems, but in such applications as public-address systems and home-entertainment radios, where mass-production methods are required.

## The system design

Any noise-compensation system must be able to measure the background-noise level in the presence of the speaker signal, but independently of it, and then rapidly adjust the speaker volume accordingly. Independent measurement of the signal level is necessary for system stability because if the control circuit interprets the speaker signal as noise, a runaway increase in signal volume results.

Since the noise-measuring system must be subjected as nearly as possible to the same ambient noise as the listener, the detector will usually pick up both the speaker output and the background noise. The compensation system must then be able to separate the noise from the intelligence.

In the system design chosen (Fig. 1), a microphone is placed near the listener, where it picks up both signal and noise. The microphone output is amplified, rectified, and filtered. At the same time, a sample of the audio control-amplifier output is rectified and filtered, and then it is subtracted from the rectified microphone

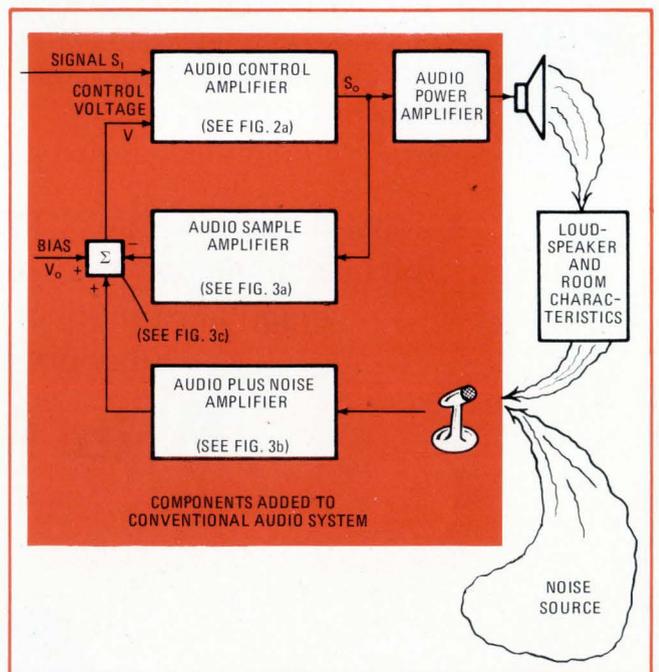
output, which consists of signal plus noise. The resulting voltage level, which is approximately proportional to the noise level, then adjusts the gain of the control amplifier to maintain the desired relationship between signal and noise level.

## Ideal control characteristics

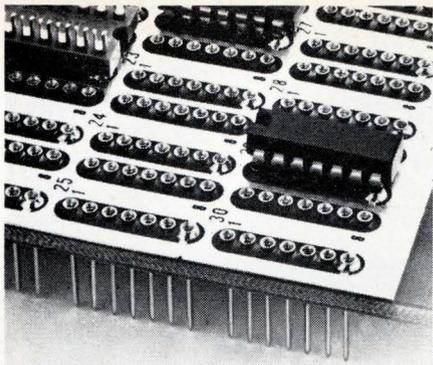
This discussion assumes that the signal-level input to the audio-control amplifier remains constant. The audio-control amplifier has a power gain that is proportional to the control voltage,  $V$ , or

$$S_o = kVS_I \quad (1)$$

where  $S_o$  and  $S_I$  are the amplifier-signal output and input powers, respectively. The control voltage consists of the sum of a fixed component,  $V_o$ , plus a component proportional to the total sound power picked up by the microphone,  $A_N(N + \alpha S_o)$ , less a component proportional to the output of the audio control amplifier,  $\alpha S_o$ . Here,  $\alpha$  represents the signal loss from audio-con-



1. Battle with noise. Feedback system compares sampled signal output to ambient signal plus noise to generate a control voltage proportional to background-noise levels. The resulting speaker output is thus automatically adjusted to changing background noise.



## All plug-in panels are not the same.

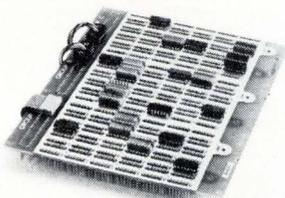
It's one thing to want plug-in flexibility in your circuit. It's another to get flexibility plus all the other things you'd like in a dependable point-to-point system.

Like easier IC insertion. Precision-machined contacts. Tighter contact retention. Greater reliability (we'll prove it). Unique tapered entry sockets (patent pending). Lower profile. Plus the versatility to accept 14, 16, 18, 24, 28, 36 or 40 pin IC's in a choice of panel sizes.

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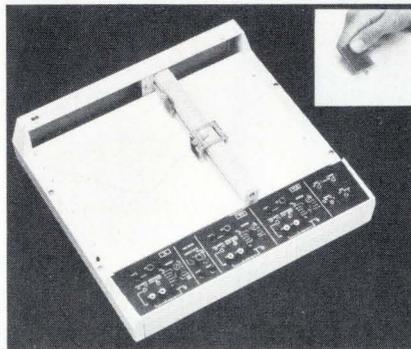
## New products

to-output delay of less than 100 nanoseconds. Output pulse widths from 5 ns to 10 microseconds are available by using auxiliary plug-in pulse-forming networks. The PG-030 is used in light-modulation and laser-control applications, especially in driving Kerr electro-optical shutters.

Kappa Scientific Corp., P.O. Box 30585, Santa Barbara, Calif. 93105 [355]

## Plotter handles two signals with 1.3-mm pen separation

Using flat visible-ink cartridges, the model 7046A X-Y plotter handles two signals at one time with a pen separation of 0.05 inch or 1.3 millimeters. Acceleration on the Y axis



exceeds 2,500 in./s<sup>2</sup> and on each X axis it is 1,500 in./s<sup>2</sup>. Slewing speed is 30 in./s, and overshoot is less than 1% full-scale. The unit writes traces with separation of 0.05 inch, and input ranges are from 0.5 mV/in. to 10 V/in., with continuous vernier settings between ranges. Input resistance is 1 megohm on all ranges. Price is \$2,650.

Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304 [356]

## Counter-timer measures intermittent pulses

A counter-timer updates its display only if a pulse is available for measurement, as shown by a gate indicator. This indicator, in conjunction with the trigger level, simplifies setup and permits single-pulse sampling. Frequency range is from

0 to 50 megahertz, and the unit measures periods from 100 nanoseconds to 99,999 seconds, elapsed time, and totalizing to 99,999

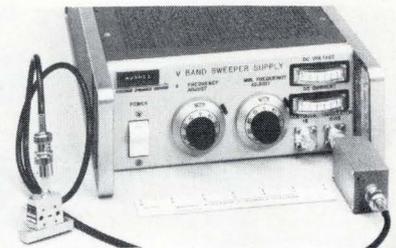


events. Price is \$350.

Bartronics, 10507 S.E. 30th St., Bellevue, Wash. 98004 [357]

## Sweepers with Impatt diodes cover 32 to 90 GHz

Millimeter-wave sweep generators covering 32 to 90 gigahertz use Impatt diodes as sources. The diodes are mounted in cavities separated from the power supply by diode-protecting circuits. The power supply can be used with each of five different sources in the line. The models 44056H and 44056H-001 cover 32 to 40 GHz, the former with a bandwidth of 5 GHz and the latter



with one of 8 GHz, both putting out 5 milliwatts. The model 44066H covers 40 to 60 GHz; the model 44016H, 50 to 75 GHz; and the model 44076, 60 to 90 GHz. Price is \$1,000 for the power supply, and \$1,500 to \$3,275 each for the sources.

Hughes Aircraft Co., P.O. Box 90515, Los Angeles, Calif. 90009 [358]

## Bit-error tester also checks clock slippage

The model 7191 bit-error test set measures and displays bit errors of the type produced by digital mag-

## How the ear hears

The key to the design of a volume-compensating system for noisy environments is some understanding of the properties of human hearing. While the ear and brain have the ability to detect sound over a range of greater than 100 decibels, the human hearing system performs many other functions. Among other things, it provides a unique filter that weights differing frequencies and distinguishes between various characteristic sounds.

The response of the human ear for 10-dB increments of signal levels is shown in Fig. A. An intensity of 0 dB corresponds to a reference level of  $10^{-12}$  watts per square centimeter. The 0-level contour is the average human's minimum level of detectable intensity. Notice that the response bandwidth becomes broader as the intensity level is increased.

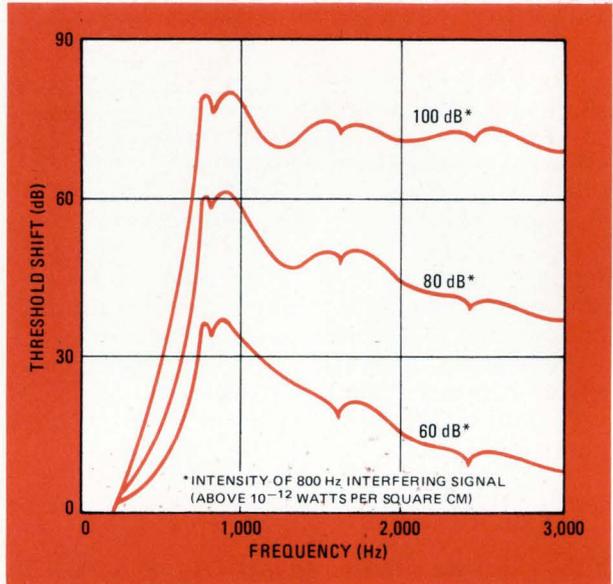
Approximations of the levels of typical noises encountered in our daily lives are added to the graph to place the intensity-level contours in perspective. Also shown is the nominal range over which the automatic volume-compensation system operates.

The contours in Fig. A were generated for single frequency components in an otherwise totally quiet environment. As might be expected, the minimum detectable intensity levels would increase in the presence of unwanted noise. To measure this effect, H. Fletcher, in "Speech and Hearing in Communications" (Van Nostrand Co., 1958), characterized the apparent shift in minimum detectable signals (MDS) as a function of the intensity of a single frequency masking tone.

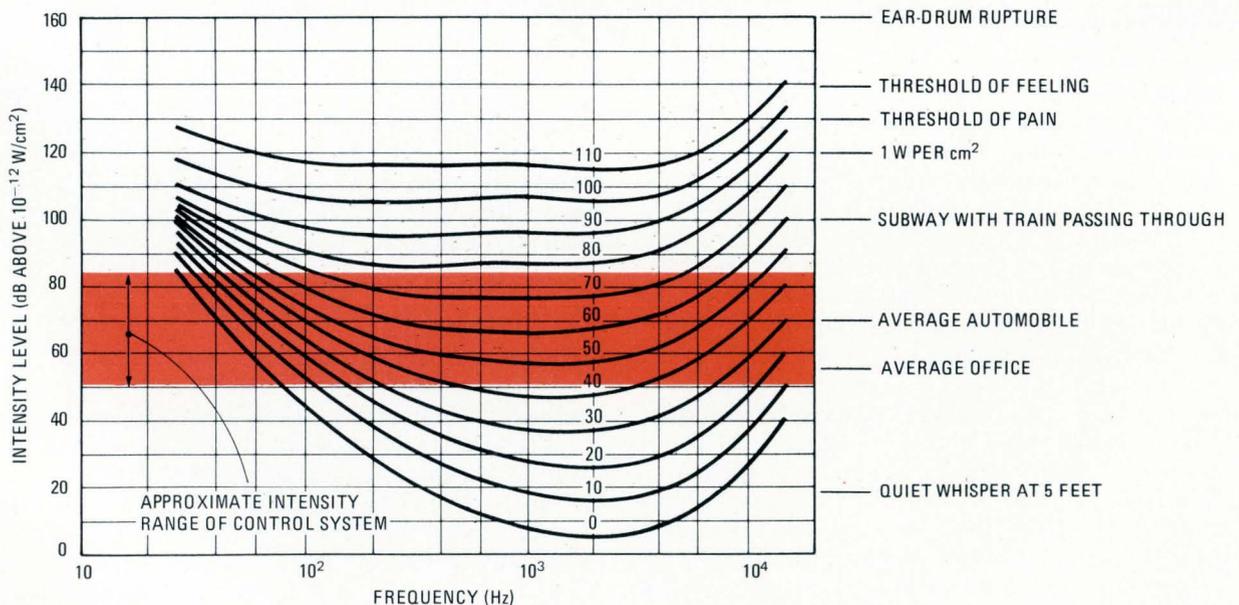
An example of this increase in MDS threshold in the presence of a masking tone of 800 Hz is shown in Fig. B. From these curves, it is apparent that the presence of pure tones increases the MDS threshold at frequencies above the masking tone.

The masking effect is not changed significantly in actual environments where multiple frequency components

are encountered. In this case, the broadband noise tends to raise the MDS level for desired signals of the same or higher frequencies. On the other hand, higher-frequency noise has relatively little effect on the ear's detection of lower-frequency audio signals, a fact that fixes the upper filtering limits in the signal-plus-noise amplifier portion of the volume-compensation system.



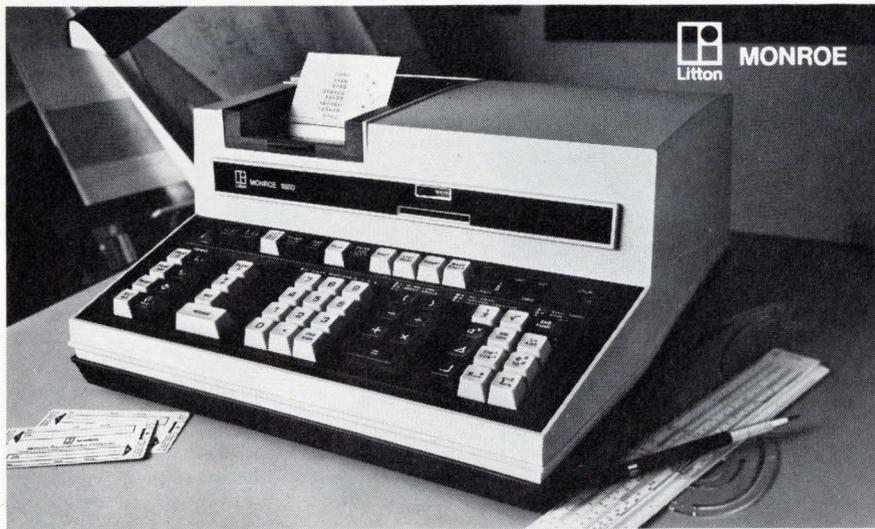
**B. Noise mask.** Minimum detectable signal intensity rises at frequencies near and above an 800-hertz interference signal. The masking effect is less significant at frequencies below that of the interfering tone. Notice the faster fall-off in detectable signal threshold at frequencies above 800 Hz when the weaker interfering signal levels are used.



**A. Human response.** Human ears act as narrowband filters at very low signal intensities, but responses increase to a 3-dB bandwidth of several thousand hertz at an intensity of 1 watt per square centimeter.

# The Uncomputers.

## An unabashed attempt to uncomplicate mathematics.



Until today, everybody who needed a computer to help with his job was faced with a far greater decision than a simple choice of hardware. He literally had to go back to school to learn a whole new language. Indeed a science. Just to be able to translate his job (which he knew well in the first place) into something computers and programmers could understand.

This is utter nonsense. So we decided to bring out a kind of computer that works from the job up instead of from computerese down. What follows is a glossary of the terms that guided us and can help you understand what the Uncomputers are all about.

### **Unlearn.**

This is what you do with Fortran and Cobol and all the other ungainly languages you need for ordinary computers.

### **Uncomputerese.**

This is the language we use. It's made up of algebra, trigonometry, basic arithmetic and common sense.

### **Unbudgeted.**

When you bring out a computer everybody can use, you have to be sure everybody can afford it. Uncomputers are for sale for around \$3,000 and lease rates start at under \$20 a week.

### **Unlimited.**

We didn't forget anything. With the Uncomputers over 4,000 steps of programming

and up to 522 complete arithmetic registers, symbolic logic, sub-routines, and capability for up to 22 simultaneous equations fit into a space no bigger than the corner of a desktop.

### **Unessential.**

With the Uncomputers you don't need a lot of extra-cost extras either. The basic unit creates, debugs, and updates its own magnetic program cards. You will however be able to get a lot of pretty advanced peripherals if you really need them.

### **Uninformed.**

If you have a computer everybody can use and everybody can afford, the next thing is to be sure everybody can get to see it at least. And try it at most. We went for most. Just call your local man from Monroe, and we'll let you try one in your office for a week free of charge and obligation.

**Monroe.**  
**The Calculator**  
**Company.**

## Multiplying scheme offers alternative to count-down timers

by Elbert L. Cole  
Westinghouse Systems Development division, Baltimore, Md.

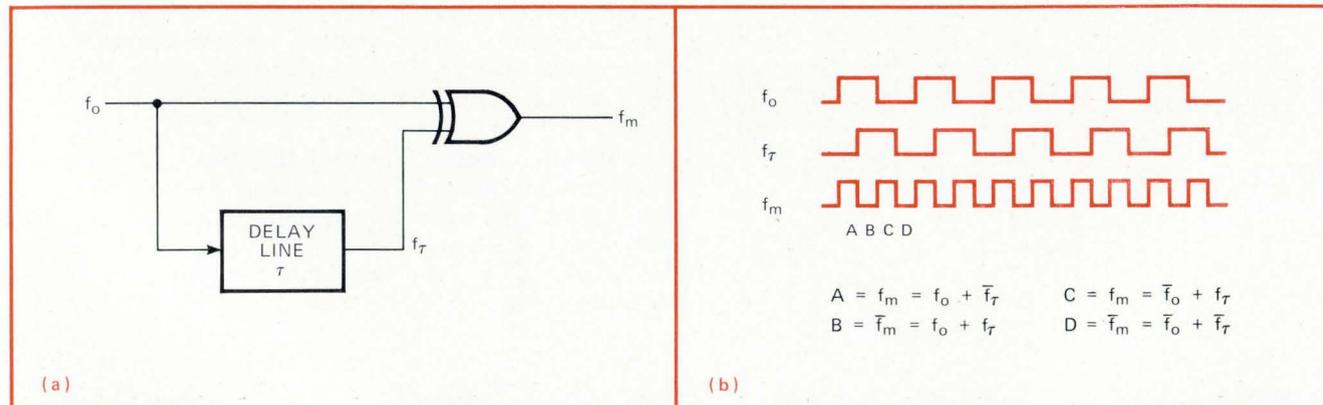
Most timing networks, such as those used to synchronize radar and digital communications systems, use a clock oscillator at the highest timing rate needed, then divide down the clock frequency to synthesize all of the various gating pulses and waveforms required in the system. The clock thus generates the highest pulse rate in the system; all other waveforms have frequency components at clock rates or lower.

An alternative to this conventional timing system has been proved successful at Westinghouse. A lower clock frequency is used, and the waveforms required are generated by multiplying up from the clock frequency.

The frequency-multiplying, or count-up, technique is of particular advantage when used at frequencies higher than about 20 MHz, where inexpensive MSI count-down circuits are not available. The multiplying approach is also highly desirable when used in subsystems that get their fundamental timing from a low-frequency clock at some central location in the system.

Key to the count-up approach is a simple and inexpensive multiplying scheme, based on fundamental properties of the binary-numbering system. The basic frequency-doubling circuit (Fig. 1), consists of a delay line, followed by an exclusive-OR gate, which has the following truth table:

	0	1
0	0	1
1	1	0



**1. Frequency doubler.** Basic multiplier circuit (a) consists of a delay line and a single exclusive-OR gate. Timing diagram (b) illustrates frequency-doubling operation. Any  $2^n$  multiple of  $f_0$  is generated by cascading multiplier circuits.

The timing diagram (Fig. 2) for the multiplication circuit illustrates the circuit's operation. As can be seen, the delay line must be adjusted so that its propagation delay  $\tau = 1/4f_0$ , when  $f_0$  is the frequency of the waveform to be doubled.

Any number of frequencies can be generated by cascading the multipliers, limited only by the operating speed of the circuitry used. Thus,  $n$  multipliers will generate  $n + 1$  frequencies, each of which is a  $2^n$  multiple of  $f_0$ .

The amount of delay required, of course, varies with each cascaded stage. Screwdriver-adjustable dual in-line delay packages are readily available to provide variable delays from less than 1 millisecond (corresponding to a clock frequency of 1 kilohertz) to devices with delays of 0 to 2 nanoseconds (corresponding to frequencies higher than 100 MHz). Integrated-circuit delay-line costs range from about \$2 for nanosecond delays to \$8 for delays of as long as 1 millisecond.

TTL exclusive-OR gates that operate at speeds to several tens of megahertz are readily available in TTL packages at costs well under \$1 per gate.

Two important performance parameters for timing circuitry are frequency stability, which is determined by the stability of the clock oscillator, and pulse-to-pulse jitter, a little of which is introduced in each multiplier stage. For a single multiplier stage, this jitter is typically 500 picoseconds peak-to-peak, and the jitter adds randomly as multiplier stages are cascaded.

The frequency-multiplying scheme has been used in several operating systems, including a ground station for the synchronous meteorological satellite network scheduled for launching early next year, and a drone-tracking radar for range instrumentation installed at White Sands Missile Range.

In the radar system, 22 cascaded frequency doublers are used to multiply a 23-Hz clock frequency up to 96 MHz. The wide range of frequencies generated is needed in tracking missiles of widely varying speeds. A target range resolution of less than 5 meters is maintained by keeping the over-all system-timing jitter below 30 ns. □

## New products

### Subassemblies

## Photoelectric units use LEDs

Complete line of controls built for high-ambient-light, other industrial conditions

One of the first complete lines of photoelectric controls using solid-state light sources has been introduced by General Electric Co.

The Mod-U-Ray line, with light-emitting diodes as light sources, complements the family of incandescent-lamp devices produced by GE. Use of the LED devices, which emit a modulated infrared beam, provides operation under wider voltage variations, extreme ambient light, and higher temperatures—from  $-25^{\circ}\text{F}$  to  $122^{\circ}\text{F}$  for amplifiers and  $-50^{\circ}\text{F}$  to  $160^{\circ}\text{F}$  for heads. Because there is no filament, the LED-based device can better withstand shock and vibration, and the range of controls has been doubled in some cases.

The new line includes two self-contained reflex controls, one with a 25-foot range, the other with a 60-foot range, and both available with plug-in options; a 400-foot-range transmitted-light control; micro-miniature heads with a range of four feet; miniature heads with a range of 60 feet; right-angle min-

iatures with a range of 36 feet; and two coaxial scanners with ranges of 20 and 40 feet. An amplifier designed for indoor or outdoor use is available for all heads.

Applications include area protection with invisible barriers of light, high-ambient-light locations, applications where lamp burnout cannot be tolerated, and conventional industrial tasks such as detecting, counting, flow control, and sorting.

General Electric Co., Drive Systems Product Dept., Waynesboro, Va. [383]

## Analog divider features high untrimmed accuracy

Optimized for one-quadrant division, the model 4290 analog divider is specified for 0.5% maximum error, without external trimming, for a 100:1 range of denominator values from 100 millivolts to 10 volts. Drift is specified at  $.02\%/^{\circ}\text{C}$ . With external trimming, either the range can be extended to 1,000:1 without affecting accuracy, or accuracy can be improved to within 0.1% over the 100:1 range. Two-quadrant operation is possible with one added op amp. Small signal bandwidth is 100 kilohertz for a 10-v denominator, 50 kHz for a 0.1-v denominator. Price in 1-9 quantities is \$175.

Burr-Brown Research Corp. International Airport Industrial Park, Tucson, Ariz. 85706 [385].

## A-d converters operate on system dc power

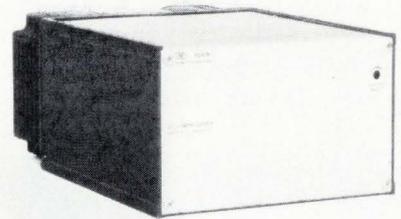
Designated the "Bare Bones" line, a series of analog-to-digital converters is designed to operate as system components, using the dc power supplies in radar, data-communications equipment and other systems. The eight models in the line offer 6-, 7-, and 8-bit resolution at a 10-megahertz encoding rate; 6-, 7-, 8-, and 9-bit resolution at 5 MHz; and 10-bit resolution at 3 MHz. Three input ranges are offered as no-cost options: 0 to 2.048 volts,  $-1.024$  v to  $+1.024$  v, and 0 to

$-2.048$  v. The units measure 7 by 8 by 9 inches.

Computer Labs Inc., 1109 S. Chapman St., Greensboro, N.C. 27403 [386]

## Transistor-switching supplies offer 9 voltages

A series of transistor-switching power supplies offers nine commonly used voltage outputs. The 62600 series provides output ratings from 4 volts at 40 amperes to 28 v at 10.7 A. All units deliver full rated

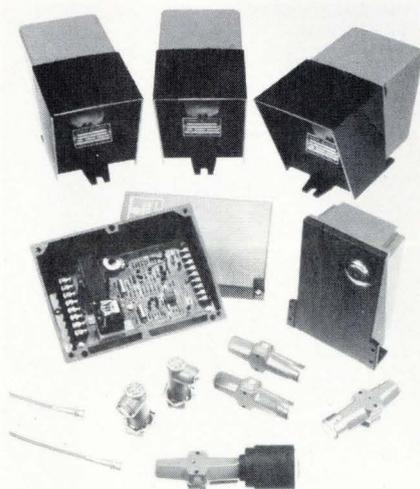
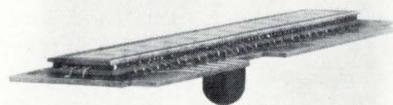
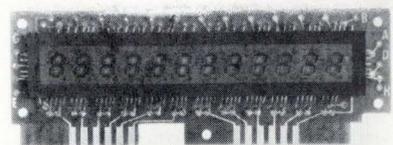


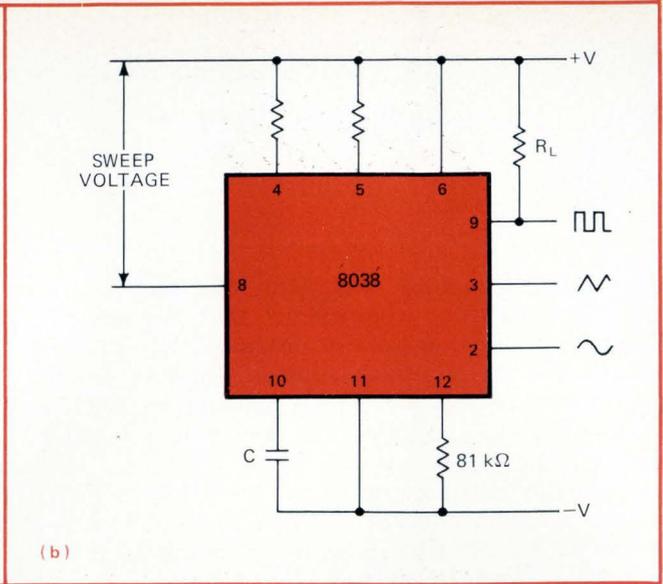
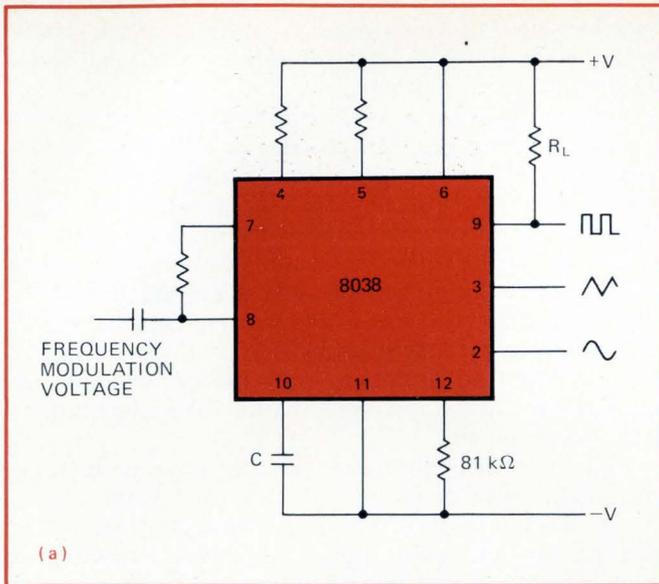
power up to  $50^{\circ}\text{C}$  with linear derating by 50% at  $71^{\circ}\text{C}$ . All models are specified to 0.1% line or load regulation, 20 mV rms, 60-mV peak-to-peak ripple and noise, and 3-ms transmit response following a halving or doubling of load. Price is \$395.

Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304 [384]

## Cold-cathode flat display is compatible with MOS

A series of flat-panel cold-cathode displays is designated the CD-1201 Decapac. The 12-digit display features a cathode construction that eliminates gaps between the seven segments of the numerical display. A decimal point is provided in each





**2. Modulation schemes.** Generator outputs can be frequency modulated or swept over 1,000:1 frequency ratio with dc control voltage.

output can be connected to a different power supply altogether, as long as that supply's voltage remains within the waveform generator's 30-v breakdown capability. This arrangement permits the square-wave output to be made compatible with TTL circuits by connecting the load resistor to a 5-v supply, while the waveform generator itself is powered from a much higher voltage.

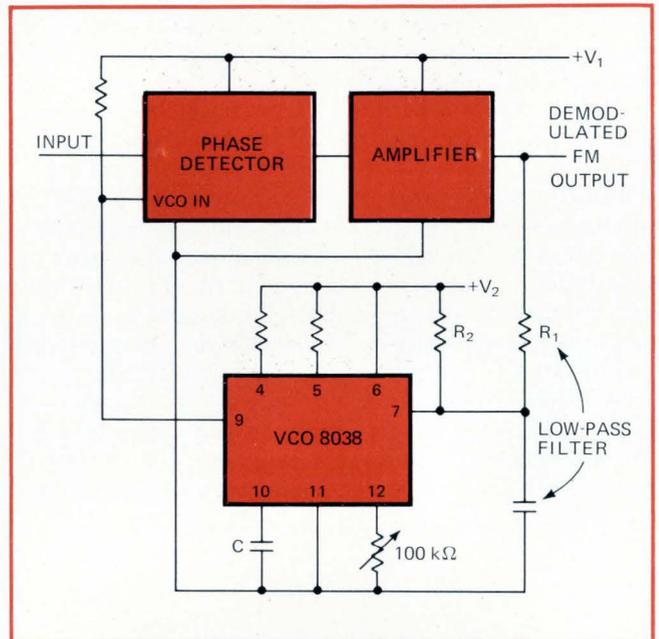
An external dc voltage (measured from the supply voltage), as well as the traditional external RC timing network, can be used to control the frequency at which these waveforms are generated. Altering this dc voltage produces either frequency modulation or sweeping.

For small ( $\pm 10\%$ ) fm deviations, the modulating signal can be applied directly, as shown in Fig. 2a, with a capacitor to provide dc decoupling. The resistor inserted between package pins 7 and 8 increases device input impedance, which is nominally 8 kilohms when pins 7 and 8 are shorted together.

For larger fm deviations or for frequency sweeping, the modulating signal is applied between the positive supply voltage and pin 8 (Fig. 2b). This means that all of the bias voltage for the current sources is created by the modulating signal, permitting a sweep ratio as high as 1,000:1 to be obtained. However, the supply voltage must now be regulated, because capacitor charging current is no longer a function of the supply voltage, and the operating frequency becomes dependent on the power-supply voltage level.

Since the waveform generator exhibits good frequency stability, it can serve as the voltage-controlled oscillator in a phase-locked loop. Figure 3 illustrates an fm demodulator circuit, where, along with the waveform generator, a phase detector and an amplifier are the other building blocks in the loop. The circuit provides a free-running output frequency, offers very low temperature drift, and produces a large reconstituted sine wave having the same frequency as the input.

Naturally, the three building blocks must be matched to each other. For large-amplitude VCO signals, it may be necessary to use two different supply voltages and to return the square-wave output to the supply line of the



**3. Fm demodulator.** Employing monolithic generator in phase-locked loop simplifies the job of matching loop building blocks.

phase detector. This prevents the VCO signal from exceeding the input levels acceptable to the phase detector. To attenuate the VCO signal, a simple resistive voltage divider can be connected between the VCO's output and the phase-detector's input.

Also, the dc output level of the amplifier must be compatible with the dc level required at the modulation input of the waveform generator. A direct solution is to set up a voltage divider to the generator's supply (like the one shown for resistors  $R_1$  and  $R_2$ ) if the amplifier's output level is lower than desired. Or, if the amplifier's output is higher, place the divider between the supply and ground. One of the divider resistors can even be used as part of an output low-pass filter. □

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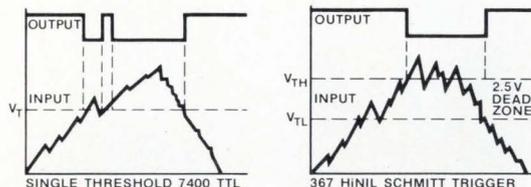
# Schmitt, the name that made the trigger famous, now makes HiNIL universal.

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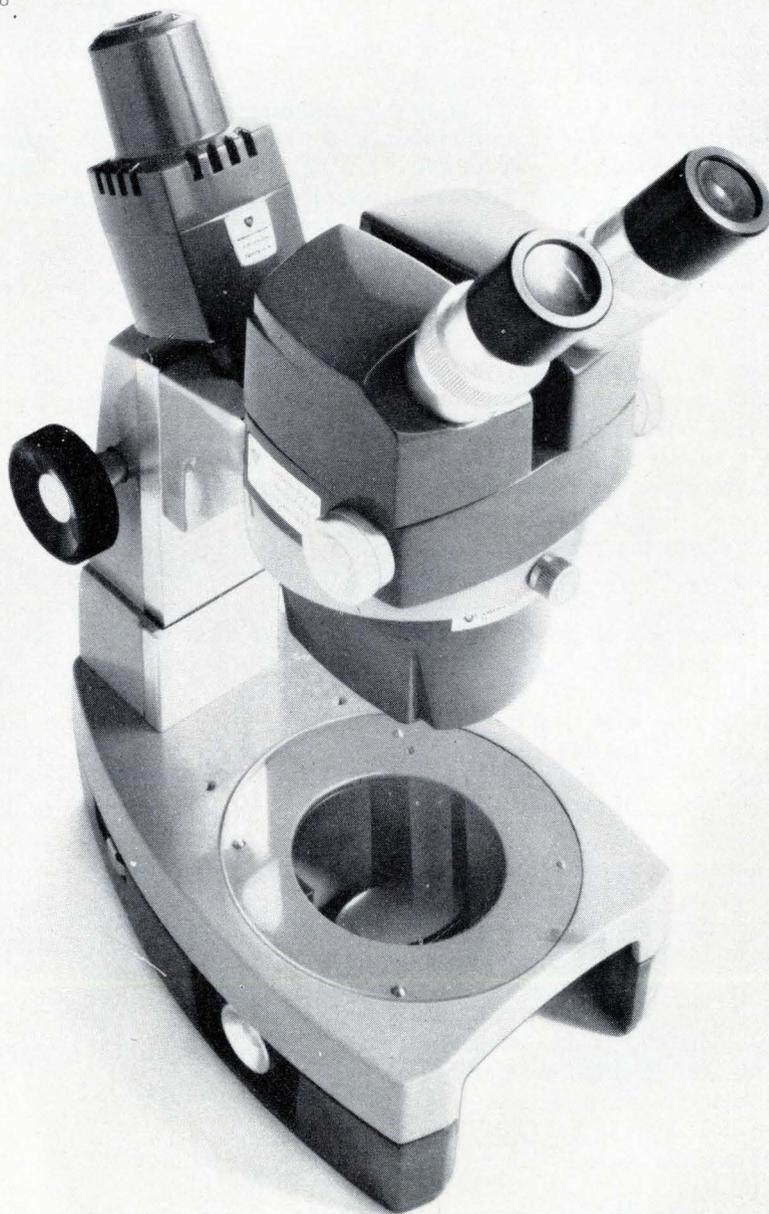
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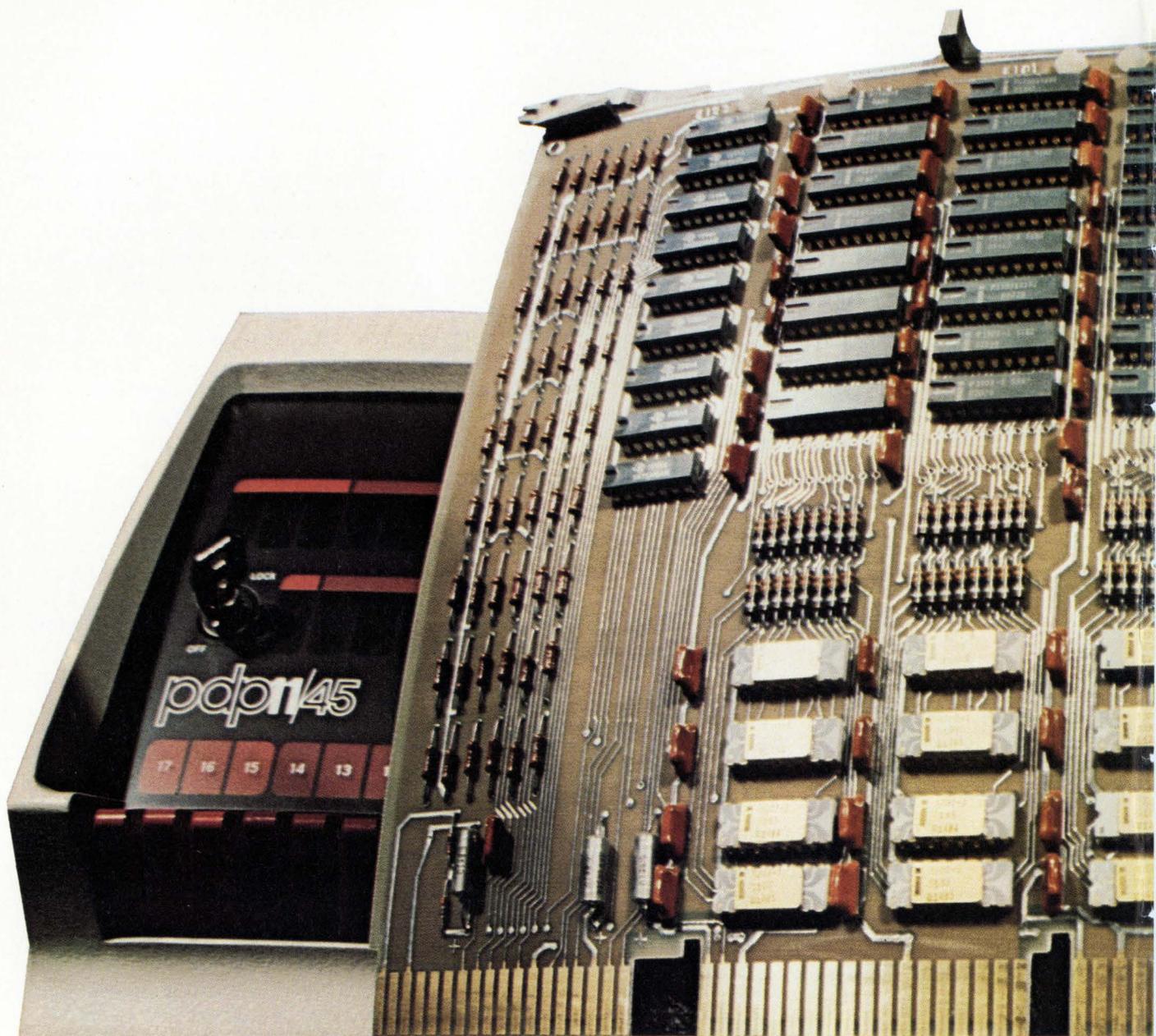
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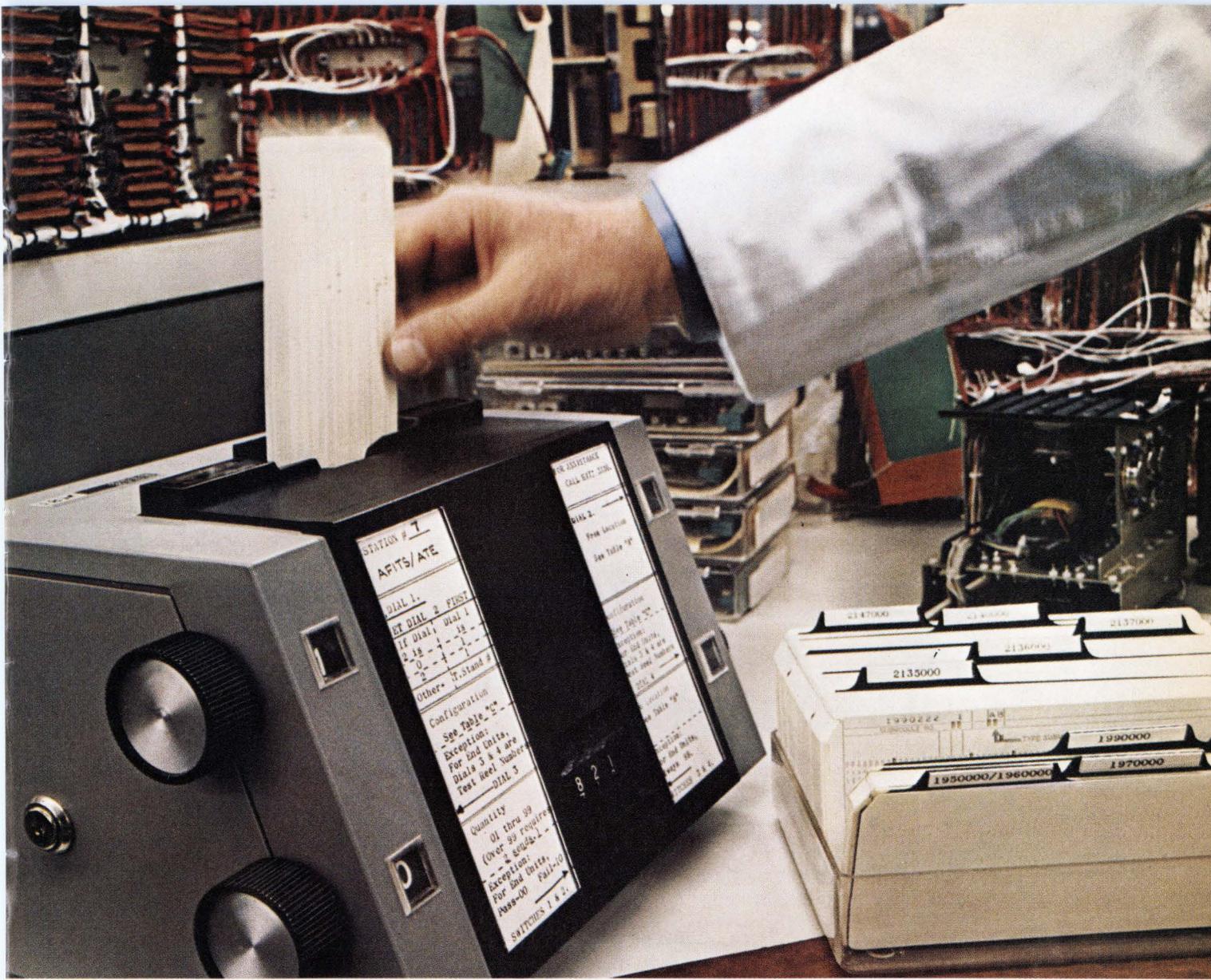
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## IBM System/7 installed at Bendix to speed production reporting.

Until recently, production control reporting at a Bendix Corporation plant at Teterboro, N.J. was a 4-day process. It took that long to ascertain the status of some 10,000 electronic subassemblies moving through the shop.

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The plant, part of the Navigation and Control Division of Bendix, produces components used in the PB-100 Flight Guidance System which Bendix manufactures for the McDonnell Douglas DC-10 aircraft.

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the subassemblies are entered at fourteen IBM 2796 Data Entry Units on the shop floor. The units are controlled by the System/7, which edits the data input for accuracy. The data is then transmitted to an IBM System/370 Model 155 at a nearby Bendix plant, which updates production records and compares actual performance with planned schedules. Items not following schedules are singled out for immediate attention and corrective action.

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Data handling

## Core memory challenges ICs

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Ampex aims its 9100 core model at semiconductor's strong spot: small memories

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As semiconductor memories get larger, they are increasingly attractive in areas where cores now reign supreme. But Ampex, a major core producer, is hitting back with an inexpensive core memory intended to compete with semiconductor memories where they've been strongest—in relatively small, fast memories.

Ampex' new 9100 core memory offers a better cost/performance combination than semiconductor memories in capacities under 4,096 words of nine bits each, asserts Eugene E. Prince, vice president and general manager of Ampex Computer Products division. The 9100, with access times under 400 nanoseconds, is priced below 1½ cents per bit, in large quantities, for a complete, packaged system ready to be plugged in and used. MOS memories, says Prince, offer similar speeds and prices, but require additional circuitry to store and protect data in case of power failure.

The OEM-oriented module is the first Ampex memory to use the 18-mil temperature-independent cores developed by the company. The cores eliminate the need for temperature compensation and forced-air cooling. The cores also require low drive current, allowing the use of IC drivers rather than more expensive discrete ones and thus contributing to the low cost.

Charles E. Priddy, national OEM sales manager at Ampex, finds requirements for a wide temperature range growing as the memories are used more often in locations other than temperature-controlled computer rooms. Priddy expects the new modules to find most use in applications where their nonvolatility

gives them the edge over semiconductor memories with similar specifications: factory automation, communications control, data entry, and point-of-sale systems.

He also says that the unit, which measures 9.2 by 6.4 by 1 inch, is the smallest fully operating self-contained memory available. Capacity is 1,024, 2,048, or 4,096 9-bit words, or 1,024 or 2,048 18-bit words. The three-wire, 3d memory is sealed and no cooling is required, simplifying application to less-than-ideal environments.

The memory will be shown at the Fall Joint Computer Conference in Anaheim, Calif., Dec. 5-7.

Ampex Computer Products division, 401 Broadway, Redwood City, Calif. 94063 [361]

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## Plug-in modules turn digital printer into data system

Taking advantage of IC functions included in its digital panel meters, Newport Laboratories Inc. has designed a data-acquisition system that is based on adding plug-in modules to its digital printer.

The new modules are a \$275 multiplex controller and \$175 function programmer module. They provide the capability to multiplex up to 16 Newport digital panel meters, sequence and identify readings, and correctly place decimal points and engineering units. By way of comparison, a more conventional type of data logging would require an analog scanner, analog-to-digital converters, and a data recorder.

The key to the Newport system is the use of the circuitry, especially the a-d circuitry, already in the panel meters. Any variable, such as frequency, voltage, and time also can be logged, since the output of the meter is binary-coded-decimal rather than analog signals.

In operation, the DPMS are connected in a party-line arrangement, with the controller calling on each in turn. The system is organized rather like a computer with a data bus, and each meter acts like a peripheral. The controller can se-

quence at the same rate as the printer advances: 2.8 seconds per black reading, 2.3 seconds for red.

The function programmer allows predetermined engineering units and decimal points to be selected. It can form different limits for each channel to permit a single digital comparator to be used for overrange indication or other purposes. Sixteen single-line addresses enable 12 output lines via a programmable discrete-diode matrix. Eight output lines drive two four-bit characters while four lines are available for driving decimal-point-enable circuits. The module can also program instrument functions and ranges with single line or BCD-coded addresses. Units and functions can be intermixed.

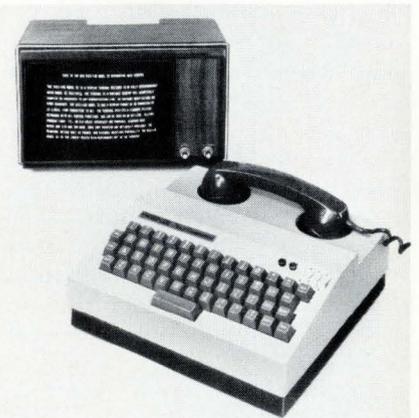
Both modules are options that plug into the Newport model 800 printer, which has 21 columns, including engineering units. They derive power from the printer and can be field-inserted with no additional hardware.

Newport Laboratories Inc., 630 East Young St., Santa Ana, Calif. 92705. [362]

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## Desktop CRT terminal uses standard keyboard

Designed to be completely interchangeable with the model 33 Teletype terminal, the Digi-Log model 33 is a portable desktop cathode-ray



tube terminal that can be acoustically coupled or hard-wired to any communications line. No software modifications are ever required, ac-

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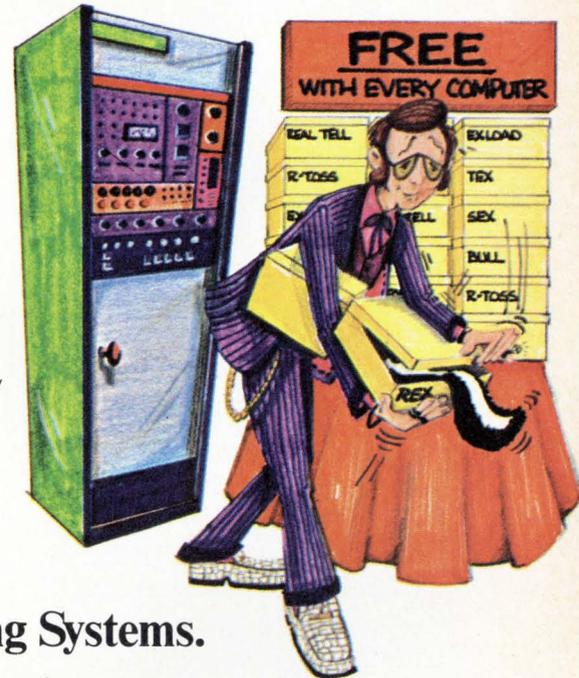
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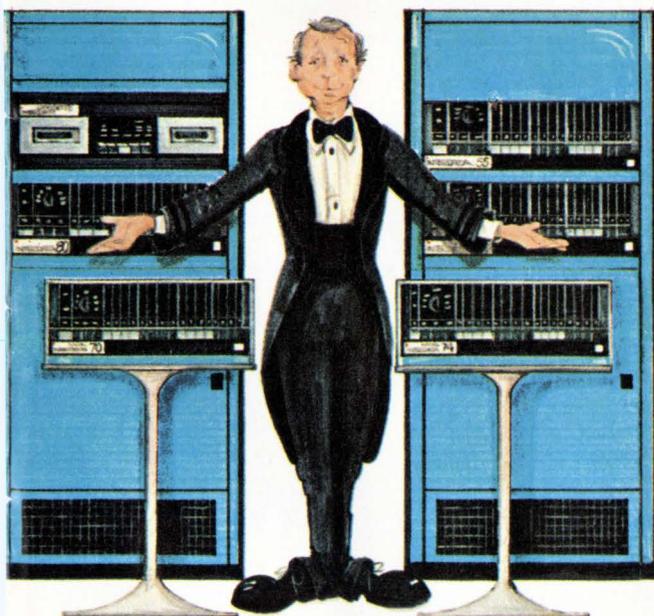
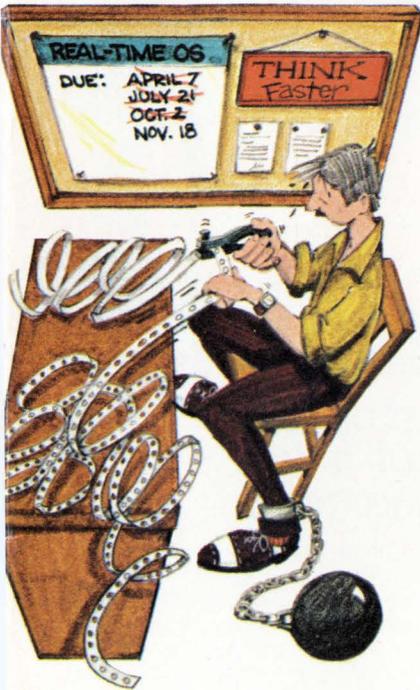
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Circle 136 on reader service card



**First Stop**

**ELECTRONICS  
Markets Tour**

The annual Electronics Tour of World Markets begins with Japan in this issue. This 16 page on-the-spot report features an in-depth analysis of the Japan markets plus 1973 and 1976 forecasts of components and equipment. **Next stop: Western Europe in the December 18 issue.**

**New products**

zontal positions. Applications include scientific and hospital systems.

Datalog, 1770 Walt Whitman Rd., Melville, N.Y. 11746 [363]

**Cassette recorder meets international standards**

The model 135 digital cassette recorder is compatible with international standards, including those of the European Computer Manufacturers Association, the American National Standards Institute and the International Standards Organization. Designed for the OEM market, the unit reads and writes phase-encoded data at 12.5 inches per second, providing a rate of 10,000 bits per second at a packing density of 800 bits per inch. Start and stop times are 20 and 25 milliseconds, respectively. Price is \$525.

Sycor Inc., 100 Phoenix Dr., Ann Arbor, Mich. 48104 [364]

**Card-input system is designed for minicomputers**

The model 251X card-input system, designed for minicomputer applications, consists of a 600- or 1,000-card-per-minute card reader and interface equipment, including cables.



Documentation and supporting software are supplied with each unit. The system is compatible with the Data General Nova; Digital Equipment Corp. PDP 11 and PDP 8/E/L/I; Honeywell 316/516; Hewlett-Packard 2114, 2115, 2116 and 2100; and Digital Computer

Packaging & production

### Interconnections reduced by half

On 2-layer board, pressfit back-panel system gets double duty from wire-wrap

Connectors are easier to design with these days because many of the new entries offer the user the convenience of standard units with the features of a custom line. Belonging to this new breed, Elco's pressfit back-panel connecting system promises to reduce costs significantly by slashing the number of wire-wrapped interconnections by 50% to 75%. Elco is introducing at the same time a novel three-dimensional multi-tier card-edge connector that doubles contact density for a fixed area.

The new pressfit connecting system is literally based on the square peg in a round hole. Square contact posts that are suitable for wire-wrapping are pressed into round plated-through holes in either a single- or multi-layer board. The pressfit provides ample mechanical support, and each post makes electrical contact with only the desired board plane. Soldering is unnecessary.

With the pressfit system, the same board can be used to carry either power and ground planes or a number of different supply voltages. Earlier systems required separate boards because each contact post had to be soldered to its plated-through hole. Moreover, the pressfit system allows changes and additions to be easily implemented.

Once the posts are installed, insulated connector housings are placed over them so that the final assemblies appear to be conventional wire-wrap card-edge connectors. These modular insulated housings are provided for any number of even contacts. The new system is available for immediate installation. Cost is typically 5 to 7 cents per con-

tact, depending on the number of board layers and the number of plated-through holes.

The other new card-edge connector, the multi-tier design for hybrid microelectronic packaging, increases contact density by giving height to a second level of contacts. The first unit employing this concept has 80 contacts on a 0.3-inch grid by 2-in. length; contact spacing is 0.025 in.

The two main levels in the receptacle use short and long (lower and upper) contacts. In each level, adjacent contacts are 0.1 in. apart, one row at each side, with the rows and levels being offset by 0.05 in. The contact tails are in four offset rows, with a spacing of 0.075 in. between rows and 0.1 in. between contacts.

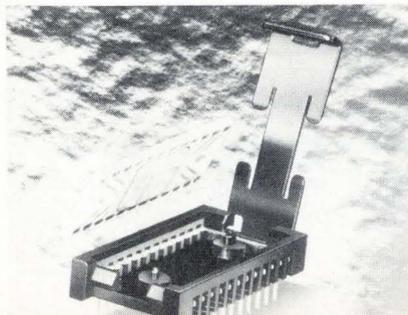
The multi-tier contact will be released by January.

Elco Corp., Willow Grove Div., Willow Grove, Pa. 19090 [391]

### Leadless IC receptacle uses base-metal contacts

It performs as well as gold-plated versions, says Burndy Corporation of a leadless integrated-circuit receptacle that employs tin contacts. Unlike conventional pin-type receptacles, the new unit, called Hypoint, uses chisel-pointed contacts that penetrate the solder pads on the substrate, making a gas-tight connection.

Leonard H. Feldberg of Burndy's Advanced Development division, says that the contact force of 175 grams minimum that is developed in the receptacle insures a gas-tight, low-resistance contact of 2 milliohms or better. "The technique is a carryover from wrapping wire around posts," he adds. "We examined the wire-to-post contact and learned that high force would insure that the brittle oxide formed on the tin would crack, separate, and enable fresh metal to establish a re-



liable, low-resistance connection."

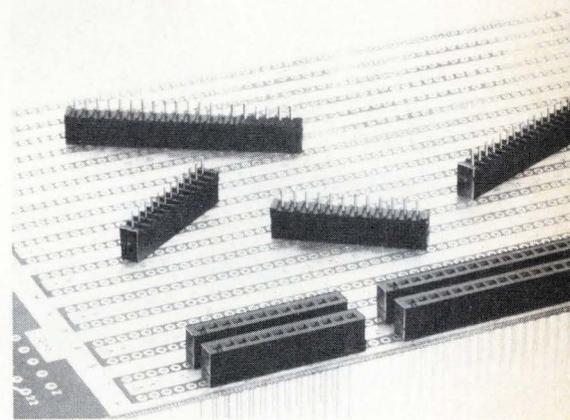
Burndy says that the IC package can be removed and replaced 40 times or more without appreciable loss in contact resistance. A test probe can reach each contact at the side of the package for troubleshooting purposes.

The receptacle is available in 24-, 28-, and 40-contact versions.

Burndy Corp., Norwalk, Conn. 06852 [392]

### DIP strips accommodate jumbo IC packages

A family of dual in-line strip connectors, to be used in pairs, provides sockets for 24-, 28-, and 40-lead packages recently introduced by semiconductor manufacturers. Contact spacings are on 0.100-in. cen-



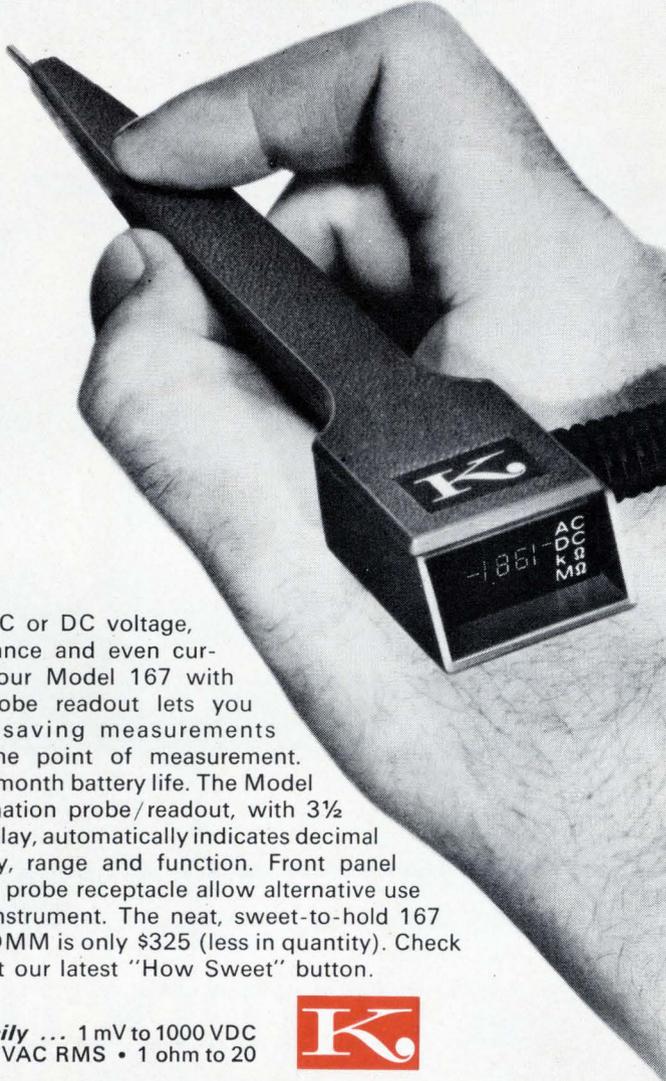
ters, and strip pairs are positioned according to package width. The 2300 and 3000 series have wire-wrapped and DIP solder leads respectively, and both series have phosphor bronze contacts plated with gold or bright tin. Price in 1,000-lots ranges from 35 cents to 40 cents.

Stanford Applied Engineering Inc., Advanced Packaging, 2165 S. Grand Ave., Santa Ana, Calif. 92705 [393]

### Circuit board serves also as heat dissipator

Developed for power supplies used in plating rectifiers, welders, computer equipment, and other appli-

**NEW AUTORANGING  
DIGITAL MULTIMETER...  
IN-PROBE DISPLAY,  
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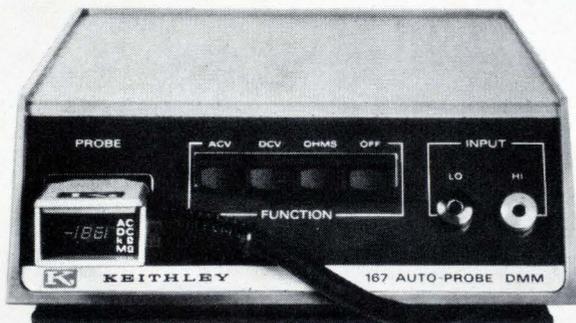
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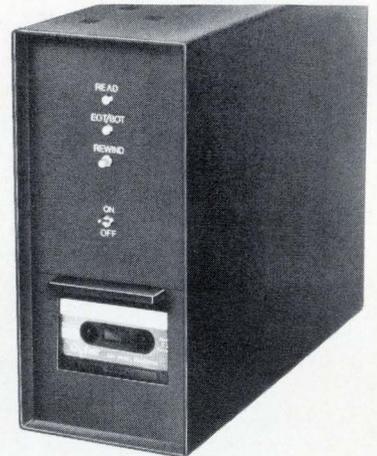
The Model 167... another how-sweet-it-is Keithley Multimeter  
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**New products**

Control Corp. D112 and D116.  
Price starts at \$2,595  
Media III, 2454 E. Fender Ave., Fullerton,  
Calif. 92631 [365]

Cassette system operates  
at 600 characters a second

A cassette tape system conforms to the EIA standard RS-232 bit serial interface between data terminals and data communications equipment operating in the synchronous mode. Called the Mini-cette 2200,

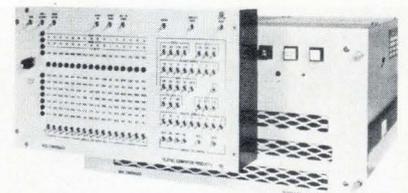


the drive system includes a controller and one bidirectional dual-differential capstan cassette transport with a speed of 6 inches per second. The system's packing density is 800 bits per inch with 8-bit characters. Read-write speed is 600 characters per second. Price is \$2,450.

Cipher Data Products, 7655 Convoy Court,  
San Diego, Calif. 92111 [367]

Disk controller provides  
simultaneous seek operation

The model DC-36 disk controller is designed to link the IBM 2311, 2314 compatible disk drives to Univac 418 II computers. Features of the



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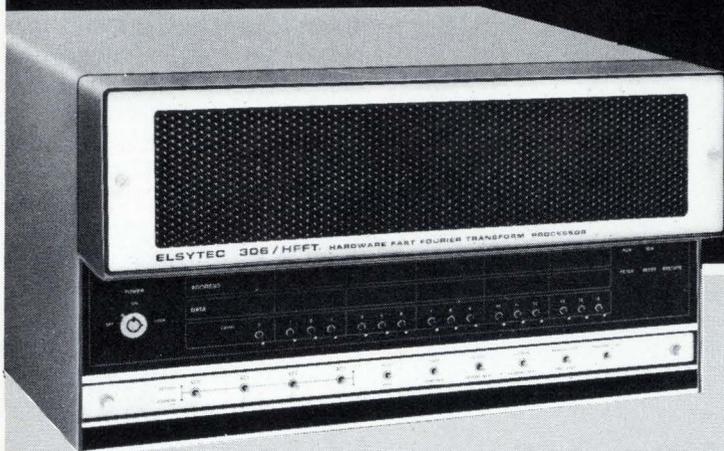
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The 306/HFFT is a digital processor that performs forward or inverse Fourier Transforms of time or frequency domain data. It is contained within the mainframe of its host NOVA 800 computer for efficiency, smaller size and cost saving.

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- Transform from 16 to 16384 real points.
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electronic systems technology

## New products

DC-36 include simultaneous seek operations, programing requiring eight commands, verification of track location by hardware, error checking of all data transfers by hardware, and read or write multiple records with one command. The unit provides direct transfer to or from memory for data, thereby eliminating blocking I/O channels. Price starts at \$17,000.

Telefile Computer Products oc., 17785 Sky Park Circle, Irvine, Calif. [368]

Plotter operates at  
1,800 increments per second

Bidirectional paper movement is offered by the Complot DP-7 digital plotter, a 36-inch wide unit, which performs 1,800 increments per second, at a continuous speed of



0.0025-inch increment size. The unit is available with up to three pens, available in colors, and automatically selectable. The pens provide a rectilinear trace.

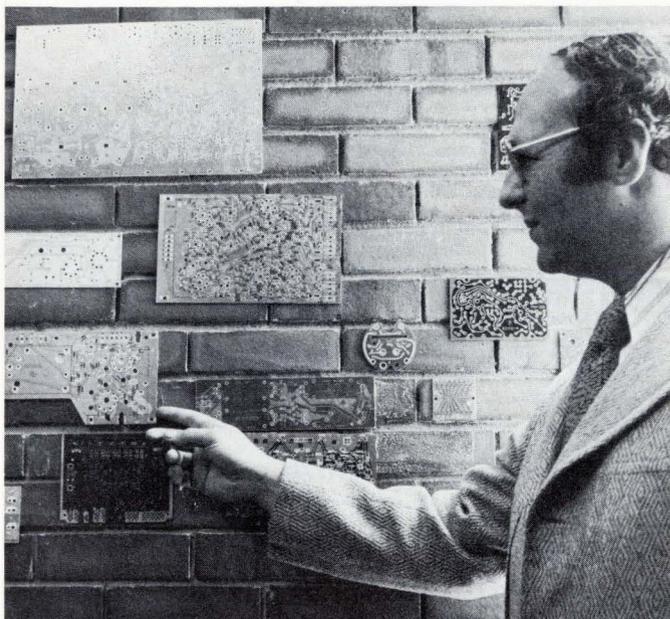
Houston Instrument Division, Bausch & Lomb, 4950 Terminal Ave., Bellaire, Texas 77401 [369]

Interconnection chassis  
forms a microcomputer

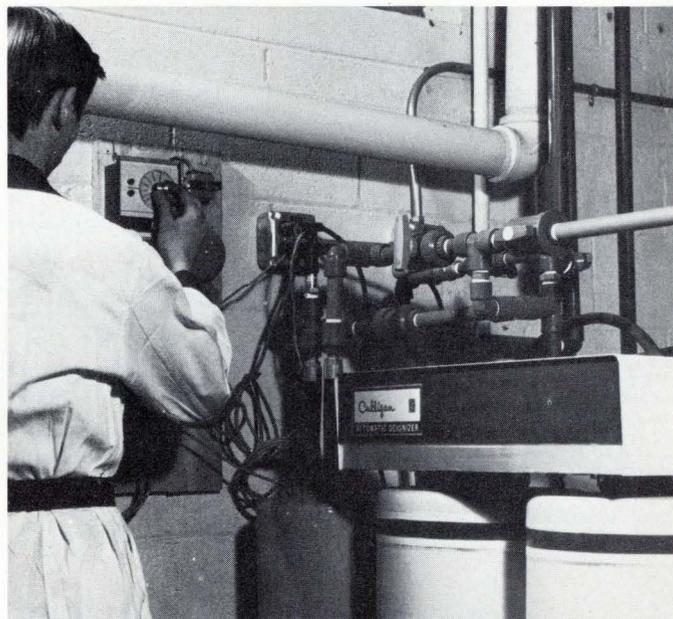
The model MCS-4 microcomputer system can be assembled without hand-wiring by using the MCB4-10 interconnection chassis that links the SIM4-01 prototyping board and the MP7-02 programable read-only memory programing board to form a PROM programing system, a PROM test system and a functioning micro-



## How Deionized Water Aids Quality Control In Making Printed Circuit Boards



Some of the many printed circuit boards made by Poncher Industries, Inc., Cary, Illinois—shown by President Charles Poncher. Very high quality water is a production "must."



To provide water for plating solutions and ultra-clean rinsing of circuit boards—the treatment system includes a Culligan deionizer, activated carbon filter and deionizer exchange tank.

□ Rejects stay low and quality stays high at Poncher Industries, Inc., Illinois manufacturer of sophisticated printed circuit boards for commercial and consumer applications. A key supplier to such blue chip electronics makers as Zenith, Motorola, Stewart-Warner, Seeburg, Oak Electro-Netics and others, Poncher stresses perfection in every step of manufacture.

"Our job is to make sure the printed circuit board is as reliable as we can make it," says Mr. Poncher.

"This, of course, includes using the cleanest water possible in plating solutions and in rinsing tanks. The only answer to the contamination problem is deionized water."

The deionizer chosen was Culligan's Model DA.

The high-quality deionized water provided is used for rinsing at critical points in the cleaning, sensitization and electroplating processes. General Manager Andy Walsh emphasizes—

"I knew from long experience with printed circuit manufacturing that deionized water is vital, so we ordered the deionizer right from the start. It has proved to be a wise decision."

For detailed information and additional case histories, write to Will Sanders for our 4-page Job Report No. 137—or call your local Culligan Man for a consultation. □

Culligan USA, One Culligan Parkway, Northbrook, Illinois 60062.

**CUSTOMER:** Poncher Industries, Inc., Cary, Illinois

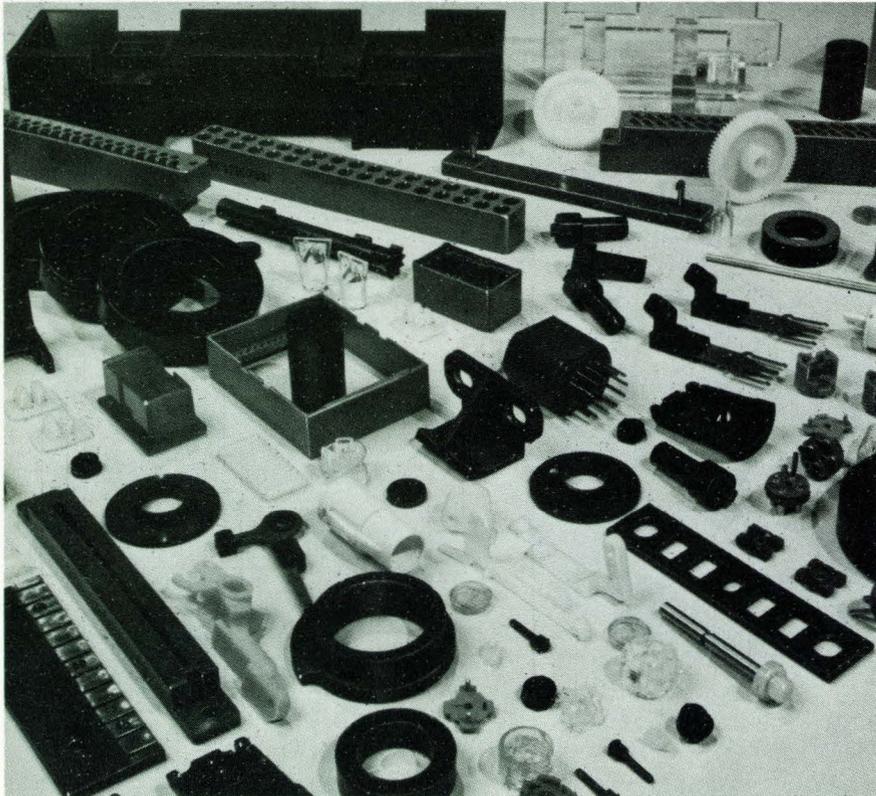
**PROBLEM:** Need for high quality water for plating and rinsing circuit boards

**SOLUTION:** Deionized water

**EQUIPMENT:** Culligan Model DA Deionizer, Activated Carbon Filter, Deionizer Exchange Service

# Try us on the parts they say can't be molded of plastics

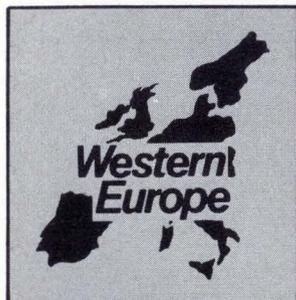
The fact is, when many electronics manufacturers have augmented their engineering and production people with our specialized staff in the design, development and material selection, plastics usually is the answer to a superior product. These same manufacturers rely on us to proceed with mold making integrated to production on our own in-plant injection, compression or transfer molding machines. Deliveries are always on a satisfactory schedule regardless of the precision and volume demanded by the customer. Thermoplastic or thermoset—our versatility in design engineering, mold making and production is unlimited. Sophisticated electronic parts often require precise, secondary operations—drilling, tapping, grinding and polishing—all provided by Del-Val. In addition, parts are ultrasonically cleaned before delivery to assure better parts, uncontaminated and ready for assembly. If you've been thinking plastic components, think Del-Val—the people who offer the most comprehensive service in the plastics industry.



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Circle 142 on reader service card



## Second Stop

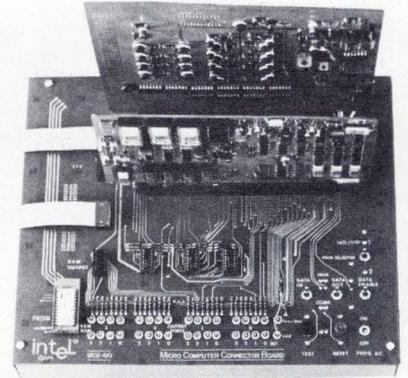
## ELECTRONICS Markets Tour

The annual Electronics Tour of World Markets makes its second stop in Western Europe in the December 18 issue. This 24-page on-the-spot report will feature an in-depth analysis of the Western Europe markets plus 1973 and 1976 forecasts of components and equipment.

Next stop: The U.S. in the January 4 issue

## New products

computer. Each has a Teletype interface, control switches, and a binary LED display of data and addresses for PROMs and random-access memories. The chassis includes a zero-insertion-force socket



for the PROM being programmed, a source of 50-v peak-to-peak programming voltages, and a 16-lead cable for direct connection to a teletypewriter, which is used to program the PROMs, test them and communicate with the microcomputer prototype. Price is \$375.

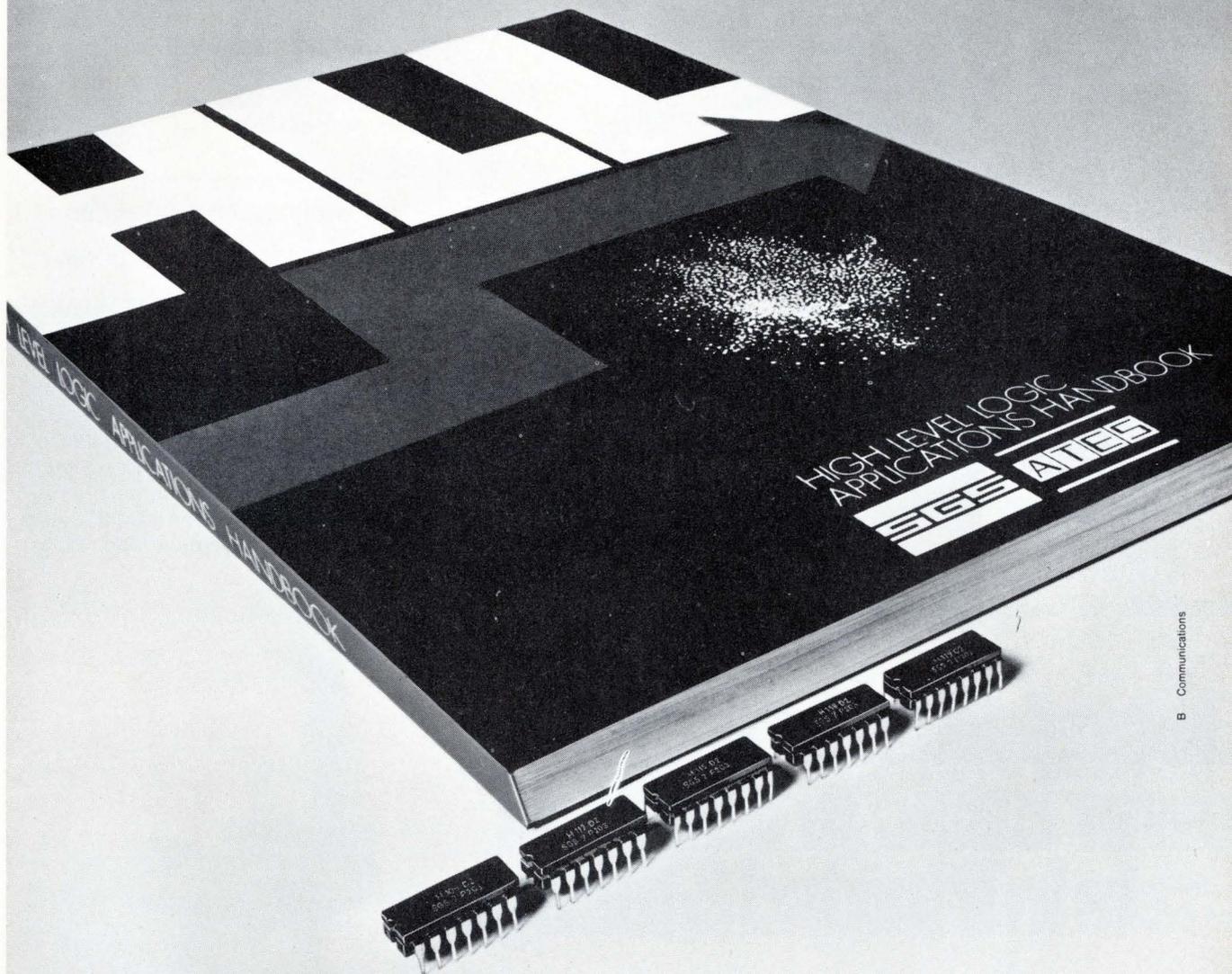
Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051 [366]

## Computers expandable by adding memory, power units

Two additions to the company's series 2000 family of computers are the model 2040A and 2050A that can be expanded on site by the addition of power modules or memory units. The power modules provide increases in cycle time or input/output capabilities, or both, and more main memory can be added in standard increments to provide a maximum of 524,288 characters. The model 2040A central processor is a small-to-medium programming computer with 65,536 characters of main memory. The model 2050A is a medium-scale multi-programming unit with 131,072 characters of main memory. The computers may not be leased, but purchase price for a basic 2050A is \$595,000. For the 2040A it is \$335,000.

Honeywell Information Systems, 200 Smith St., Waltham, Mass. 02154 [370]

# Bestsellers



B. Communications

## 6 additions to our High Level Logic family (five new circuits and a book)

SGS/ATES' High Level Logic elements, the H 100 series, feature the widest supply voltage range in the market — 10.8V to 20V — allowing them to work efficiently even with poorly stabilized supplies.

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Design information and applications are provided in the SGS/ATES High Level Logic Applications Handbook, available at US \$ 3.00. Order your copy now.

The complete H - 100 series from SGS/ATES (\* new type):

- H 102 Quad 2-input gate
- H 103 Triple 3-input gate
- H 104 Exp. dual 4-input gate
- H 105 Exp. dual 2-wide 2-input AND-OR inverter
- H 109 Exp. dual 4-input AND power gate
- H 110 Dual JK flip-flop with separate preset
- H 111 Dual JK flip-flop with separate preset and clear
- H 112 Hex inverter (open collector)
- H 113 High to low level quad converter
- H 114 Low to high level quad converter
- H 115 Hex inverter with strobe (open collector)
- H 117 One shot multivibrator
- H 118 Hex inverter with active pull-up
- H 119 Hex inverter with strobe active pull-up
- H 122 Quad 2-input gate with passive pull-up
- H 124 Quad 4-input gate with passive pull-up
- H 156 4-bit binary counter
- H 157 Decade counter
- H 158 BCD to decimal decoder and driver



Italy: Via C. Olivetti 1, 20041 Agrate Br., tel.: 039-65341  
USA: 435 Newtonville Ave., Newtonville, Mass. 02160, tel.: 617-9691610  
UK: Planar House, Walton Street, Aylesbury, Bucks, tel.: 0296-5977  
France: 58, rue du Dessous des Berges, Paris 13e, tel.: 5895223  
Germany: 809 Wasserburg/Inn, Post Box 1269, tel.: 08071-721  
Sweden: Postbox, 19501 Märsta, tel.: 0760-40120  
Singapore: Lorong 4 and 6, Toa Payoh, Singapore 12, tel.: 531411



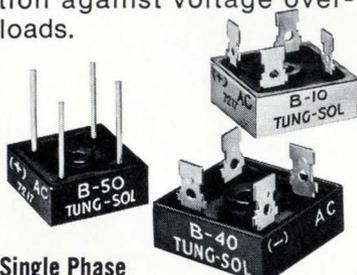
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### Modular Bridge Rectifiers 10 to 35 Amps

Highest surge ratings give designers maximum protection against voltage overloads.



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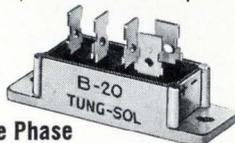
50 to 600 PRV. 300 Amps surge.

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## New products

### Instruments

## Low-power DPM priced at \$100

Aimed principally at the portable-instrument market, unit uses less than 0.75 W

Two distinct trends are becoming apparent in the market for digital panel meters. The first is a move toward lower prices; the second, and more recent, is the effort to decrease power consumption. The goal is to make prolonged battery operation possible, and so enable DPMs to compete with analog meters for the OEM portable-instrument market.

The latest low-power design is Weston's model 1220/1221. Built around the same custom p-MOS chip as the company's model 4440 multimeter, the 3½-digit panel meter uses less than 750 milliwatts with all display segments turned on. This gives the meter a minimum of 13 hours of continuous operation with four standard C cells.

Since the meter is intended principally for portable-instrument applications, special attention was given to minimizing size and weight and maximizing ruggedness. The package, which measures slightly less than 3 × 3 × 1.5 inches, is completely sealed. The meter's low power consumption makes venting louvers unnecessary. Weight is under 4 ounces. To better enable it to cope with the rigors of field use, its designers made the 1220/1221 tough enough to meet the MIL M10304 vibration specification.

Two mounting options are available: the standard rectangular mount with access from the front panel and a special recessed mount, through which only the LED display is visible. Since the p-MOS chip and the LED display were made plug-gable for easy servicing, it is possible to mount the display at a location remote from the rest of the meter. This remote operation is not offered as an option by Weston, but

the user can make the necessary modifications himself.

The meter is accurate to within ±(0.1% of reading + 1 digit) over a 20°C temperature range centered at 25°C. For prolonged operation at a temperature away from this standard, the unit can be calibrated at any temperature from 10° to 50°C, and it will then meet its accuracy spec over a 20°C span centered at that temperature. Operating temperature limits are 0°C to +60°C.

Price in single quantities is \$175, but this drops to below \$100 in lots of 100. Delivery is from stock.

Weston Instruments Inc., 614 Frelinghuysen Ave., Newark, N.J. 07114 [351]

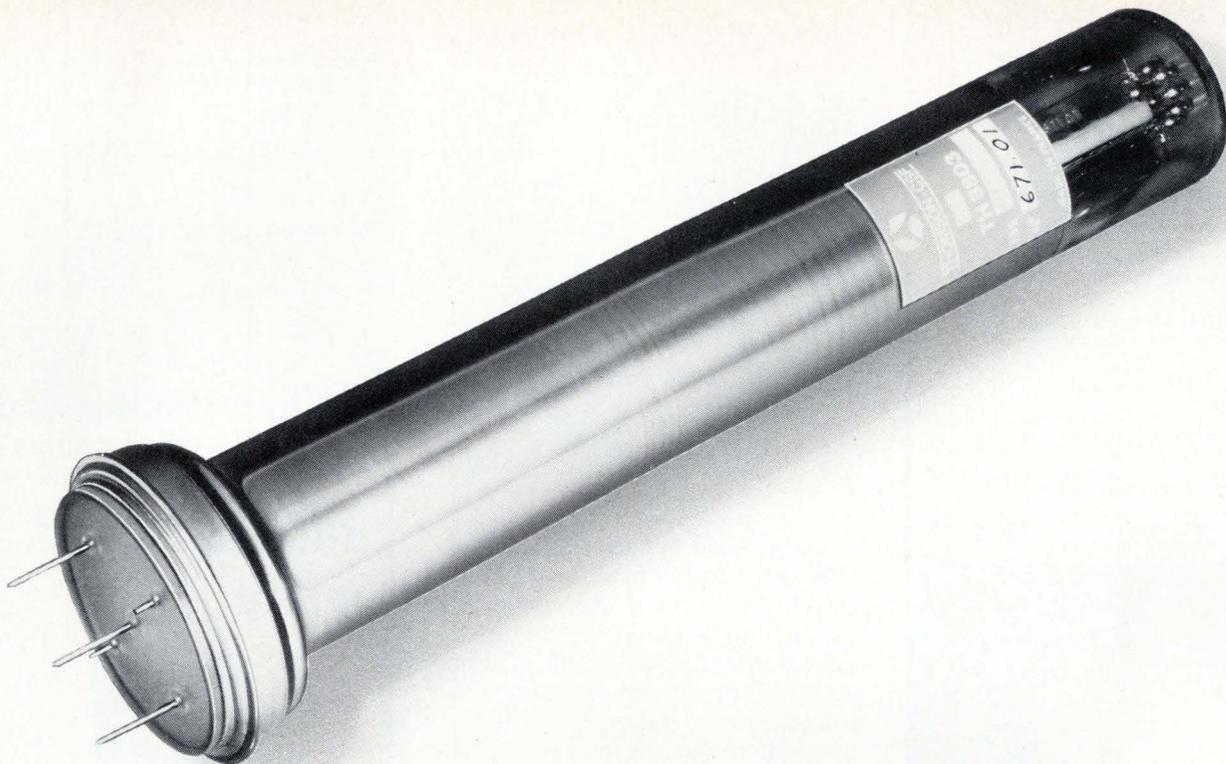
### Low-priced line monitor spots 0.5-microsecond pulse

With brownout happening more frequently, the need to know exactly what's going on in the ac power line becomes increasingly important, especially in large data centers, where a single line transient can mean false data.

Power-line monitors that can spot such things as under- or over-voltage conditions, have been available, but these usually catch disturbances only if they repeat for several cycles. Equipment that can respond faster usually costs between \$15,000 and \$20,000.

Now, however, Programmed Power Inc., Menlo Park, Calif., has developed a portable power-line-disturbance monitor that sells for \$2,995. The model 3200 checks for under- and over-voltage conditions, under- and over-frequency conditions, and 50-600-volt positive or negative transients lasting 0.5 to 100 microseconds. The instrument can be set for either 50 or 60 hertz, can monitor either single-phase 90- to 140-v rms or three-phase 90- to 140-v rms input lines to neutral voltages, or 208/120 v in a four-wire Y configuration.

When a preset line condition is exceeded, the 3200 gives both an audio and visual alarm, records the event on the proper event register (a digital counter—one for each condi-



## We proudly present our new high resolution storage tube...

Over 4000 lines resolution, with the same long storage and fast erase features of our mini tubes.

Our TH 8803 storage tube is a single ended design in a two inch diameter Vidicon configuration that provides a limiting resolution performance of 4300 TV lines per diameter. It can store 16 millions of bits, in the digital form or the equivalent in the full TV gray-scale image form, for more than 20 minutes under continuous readout scanning operation.

A unique feature of the TH 8803 is its fast erasing capability by means of a special gun design\*. Two TV frames are sufficient to erase the whole surface down to the noise level of a good amplifier. Because the display function is separated from the storage system, the user can selectively edit the stored image or, if he is interested in blow-up, zoom-in on any portion of the image.

The two-inch diameter structured silicon target of the TH 8803 permits a resolution of 2700 TV lines at 50 % modulation level. It also permits operation with standard Vidicon hardware, and low voltage levels.

The high performance level reached makes the TH 8803 ideal for a number of applications such as buffer memory, high density data storage and retrieval, bandwidth compression or expansion, scan conversion, etc.

For more information about this tube and our entire line of storage and display tubes, please circle the appropriate number on the Reader Service Card, or contact us directly.

\* Thomson-CSF patent.



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1652



# Good Listeners maintain a low profile

Even in the solitude of the forest depths, from rooftops, arctic tundra, swamps to sweltering tropics, 'neath snow, sand or ice, the Hermes Loop antenna keeps an ear to the sky. The amazing aperiodic antenna does away with vast log periodic and rhombic arrays - those towering antenna farms.

In rosette configuration, the Hermes loop antenna provides an omnidirectional broadband receiving array in space merely 1/100th that of the traditional antenna farm.

More than 53 government agencies around the world have pressed the loop antenna into service.

A new, even more compact version is available. Only Hermes Electronics makes it.

**2-32MHz  
BROADBAND**

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Suite 315  
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Washington, DC 20006 USA  
202-296 2978  
TWX 710 822 1106



## New products

tion), and provides a hard-copy printout of the event, including the type of disturbance, the time of day, and the date it occurred.

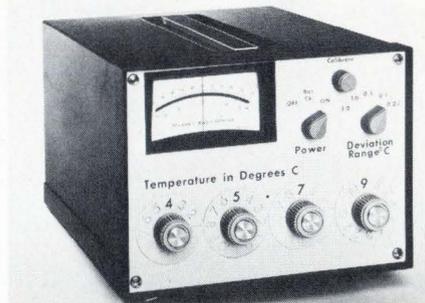
Lee Cooper, president of Programmed Power, says, "We had planned for some time to produce an instrument like the 3200 as an aid in selling our uninterruptible power systems. We could use it to indicate what was happening on the power line and thus prove to a potential customer why he needs a backup system." But in the meantime, the Naval Civil Engineering Labs studied the monitors available and came up with specifications for a new one [*Electronics*, Sept. 11, p. 133]. This got Programmed Power rolling. As a result, the 3200 was developed and the Naval labs has purchased several units.

Cooper points out that the 3200 can be employed in applications other than data centers, such as in production-control equipment, electronic instruments, and synchronous communications equipment, which are also highly sensitive to line fluctuations.

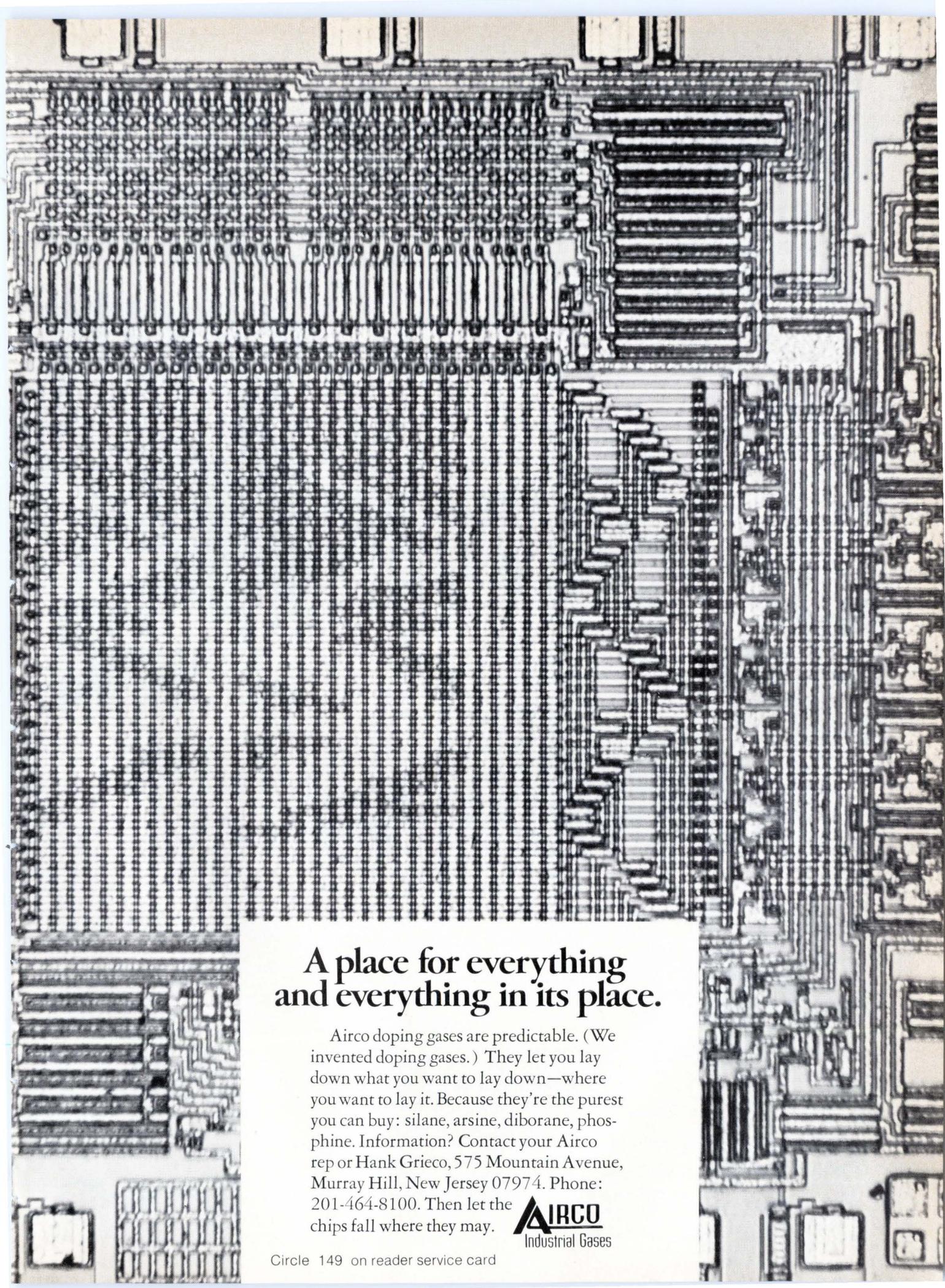
Programmed Power Inc., 141 Jefferson Dr., Menlo Park, Calif. 94025 [352]

Linear thermometer offers resolution of 0.001°C

A four-digit readout, portable linear thermometer operates at 990 hertz. Sensor self-heating effect is less than  $5 \times 10^{-4}$ °C, and quadrature rejection is -20 dB. The unit offers a reso-



lution of 0.001°C, and long-term deviation from accuracy and stability is rated as  $\pm 0.01$ °C. The thermometer, designated model LD-1, provides a 60-hertz rejection ratio of 70



## A place for everything and everything in its place.

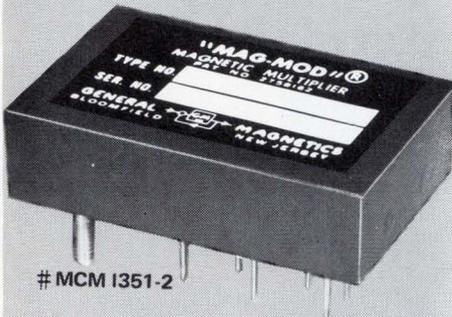
Airco doping gases are predictable. (We invented doping gases.) They let you lay down what you want to lay down—where you want to lay it. Because they're the purest you can buy: silane, arsine, diborane, phosphine. Information? Contact your Airco rep or Hank Grieco, 575 Mountain Avenue, Murray Hill, New Jersey 07974. Phone: 201-464-8100. Then let the chips fall where they may.

**AIRCO**  
Industrial Gases

Circle 149 on reader service card

# 4 Quadrant Magnetic Analog Multiplier

DC x AC = AC Output



# MCM I351-2

**Product Accuracy  
is  $\pm 1/2\%$  of all  
readings Over Full  
Temperature Range  
of  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$**

- Product accuracy is specified in % of reading for all output analog voltage product points over the full military temperature range instead of % of full scale error giving superior results for small values.
- Linearity, product accuracy, and zero point virtually unaffected by temperature changes.
- All units are hermetically sealed and completely shielded from external electric or magnetic fields.

### Specifications Include:

Transfer equation:  $E = XY/3$

X & Y input signal ranges:  
0 to  $\pm 3\text{V}$  Peak

Maximum static and dynamic product error:  $1/2\%$  of point or 2 MVRMS, whichever is greater, over entire temperature range

Input impedance:  $X = 10\text{K}$ ;  $Y = 10\text{K}$

Full scale output: 3 VRMS

Minimum load resistance for full scale output: 2000 ohms

Output impedance: Less than 50 ohms

X input bandwidth:  
 $\pm 0.5\text{db}$ , 0 to 200 hertz

Y input bandwidth:  
 $\pm 0.5\text{db}$ , 20 hertz to 1000 hertz

DC power:  $\pm 15\text{V}$  unless otherwise required @ 20 ma

2

There is No Substitute  
for Reliability



**GENERAL MAGNETICS, INC.**

135 Bloomfield Avenue  
Bloomfield, New Jersey 07003  
(201) 743-2700

## New products

dB. Battery life is 1,200 hours. Price of the unit is \$1,495.

Massey Engineering, 202 North Highland St., Arlington, Va. 22201 [353]

Bipolar digital panel meter  
is accurate to within 0.05%

The model 36 bipolar  $3\frac{1}{2}$ -digit panel meter features a maximum error of  $\pm 0.05\%$  of reading plus one count. Also featured is a stability of 50 parts per million/ $^{\circ}\text{C}$  over a 0-to- $50^{\circ}\text{C}$  operating range. The unit has an instrumentation-type front end with floating differential input, which provides more than 1,000

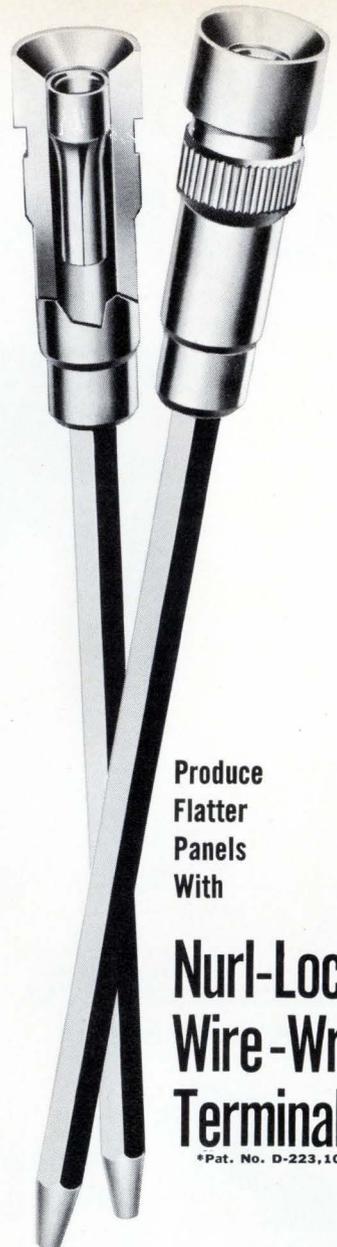
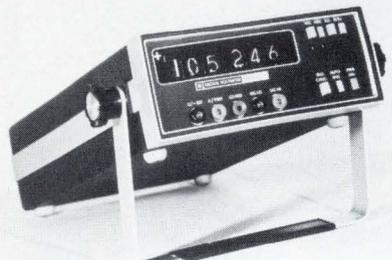


megohms input impedance and more than 70 dB common-mode rejection ratio. The unit is available with either a seven-segment planar or Nixie display, and BCD outputs are provided. Price is \$95.

Gralex Industries, 155 Marine St., Farmingdale, N.Y. 11735 [356]

Multimeter provides five  
ranges from 0.1 V to 1,000 V

A  $5\frac{1}{2}$ -digit multimeter, the MX-1, measures five ranges of dc from 0.1 volt to 1,000 volts full scale. Also provided are automatic or manual ranging, a wide range ratio, a fast active filter, and a sixth digit for



Produce  
Flatter  
Panels  
With

**Nurl-Loc<sup>®</sup>  
Wire-Wrap<sup>®</sup>  
Terminals**

\*Pat. No. D-223,109

- Time-proven Nurl-Loc features a knurled cylinder for greater torque resistance; distributes pressure evenly to avoid board warp; permits removal without damage to board.
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- 4-Finger contact assures a positive electrical contact.
- Terminals available separately or assembled in panels.

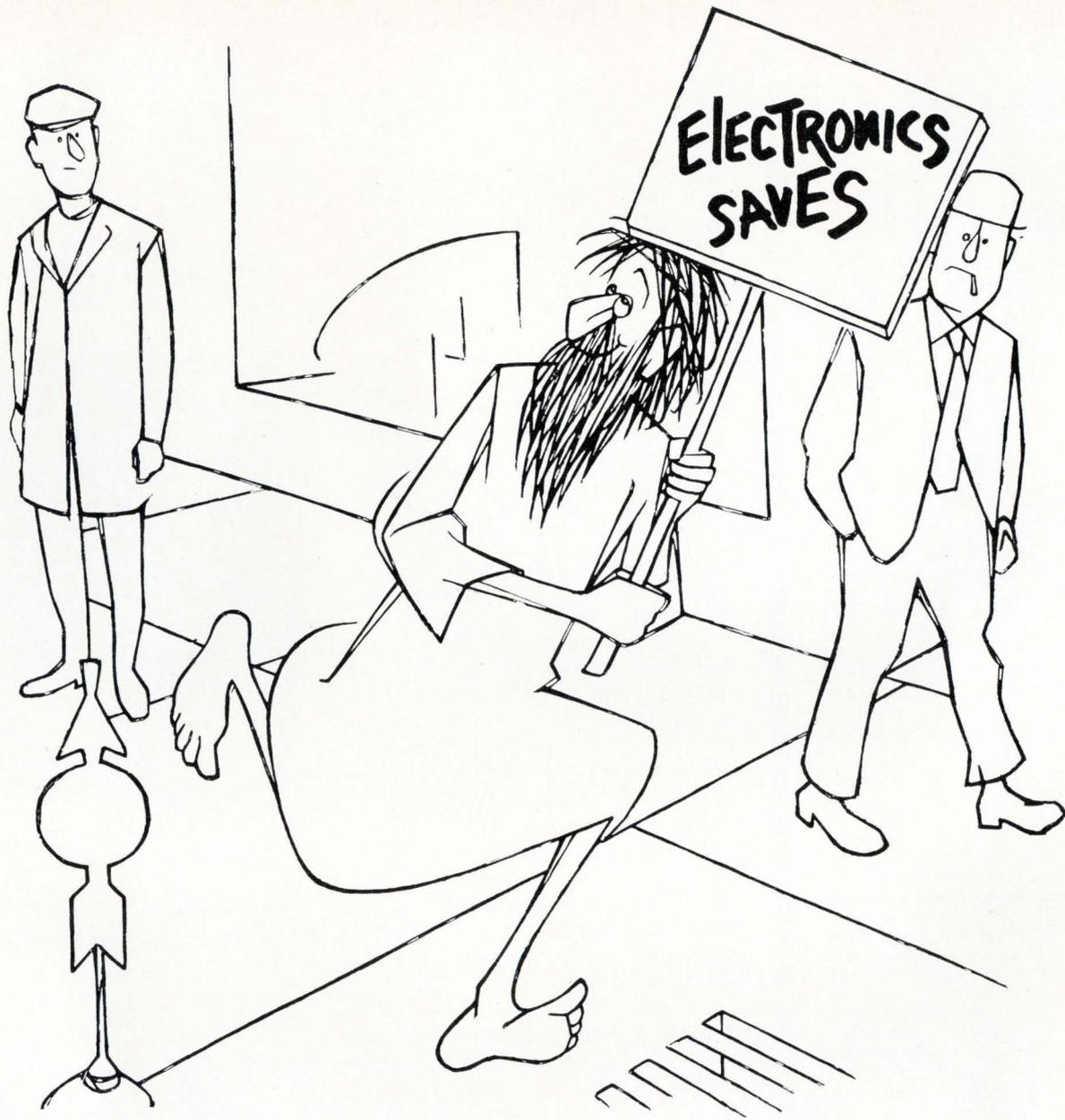
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Wire-Wrap<sup>®</sup> Gardner-Denver Co.



# 1973: The Year of the Advertiser

Beginning January 1, Electronics is dropping all bleed charges! And there'll be no full-run rate increase in 1973. Actually, Electronics hasn't had a rate increase since January, 1970. While in the same period, circulation is up nearly 10% and will continue to rise in 1973.

What does this mean to you?

- You can now reach an Electronics reader at nearly 10% less than you paid in 1970. You save!
- If you use bleed, you save an additional 15% on the cost of a full page ad. 25% savings in all!
- Free bleed allows you to be even more creative by using the additional 29% area available!

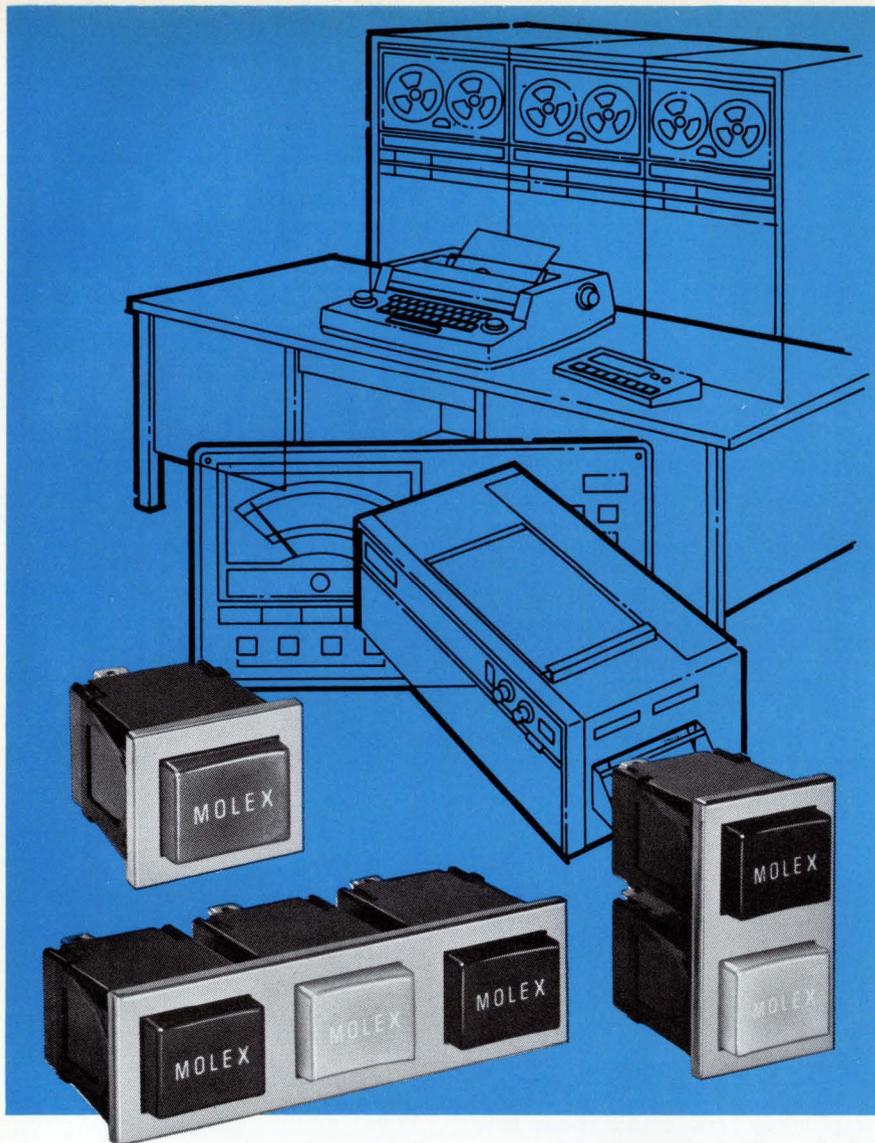
Why are we setting a precedent by lowering your advertising costs? Because we want 1973 to be the year of the advertiser. How can we do this? By

giving you an extra return on your investment. And, speaking of investments, leading advertisers have already increased our ad revenue by 22% over last year.

What else does Electronics give you? Only the most authoritative editorial in the technical publishing business, delivering the most involved readers in your markets.

**Electronics is THE SOURCE for advertiser benefits in 1973—the year of the advertiser. Because Electronics saves ad dollars!**

**Electronics**   
**THE SOURCE.**



## Push a button and Molex, backed by Plenco, lights the way.

You see them on computer panels, home entertainment products, business and vending machines, and in the instrumentation industry. Illuminated by neon or incandescent bulb, they're Model 1175 Lighted Pushbutton Switches, produced by Molex Incorporated, Lisle, Ill.

That's our Plenco right behind the button.

And how does Molex find our Plenco 512 General-Purpose Phenolic Molding Compound, used to mold the housing of these functional and attractive, U. L. approved switches? "Versatile, sturdy, exceptionally fast curing and low in cost," reports this manufacturer.

Molex adds that the compound has been used by them for years in a variety of other electrical applications and has always proved satisfactory.

Push for Plenco and see how quickly Plenco selections, experience and service can help light the way for you.

**PLENCO**  
THERMOSET PLASTICS

PLASTICS ENGINEERING COMPANY  
Sheboygan, Wis. 53081

Through Plenco research... a wide range of ready-made or custom-formulated phenolic, melamine, epoxy and alkyd thermoset molding compounds, and industrial resins.

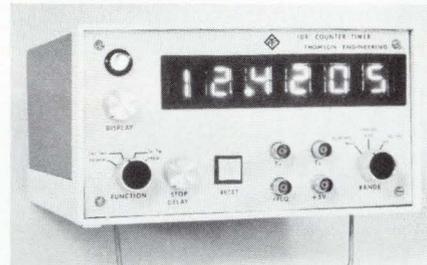
## New products

20% overrange. Options include 10 kHz and 100 kHz ac in four ranges from 1 v to 1,000 v full scale, resistance in six ranges from 100 ohms to 10 megohms full scale, and isolated data outputs. Price of the model MX-1 is \$1,000.

Non-Linear Systems Inc., P.O. Box N, Del Mar, Calif. 92014 [357]

## Counter-timer features six-digit frequency readout

The model 109 counter-timer, designed as an OEM instrument, boasts a six-digit readout of elapsed time and frequency. Elapsed time can be measured with a resolution of 0.0001 second on the 100-second

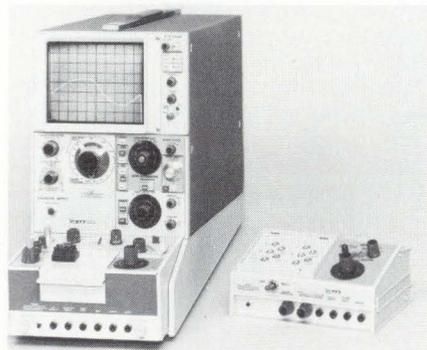


range and 0.01 second on the 1,000-second range. Frequency of any ac or positive dc pulse may be measured to 2.5 MHz in three ranges. Price is \$400.

Thomson Engineering Co., 511 Old Lancaster Pike, Berwyn, Pa. 19312 [358]

## Curve tracer checks ICs, discrete components

The model 577 curve tracer plots and displays parameters of linear ICs, transistors, FETs, tunnel diodes,

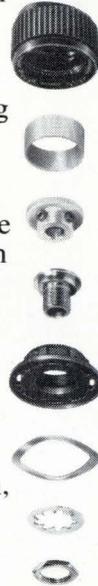


# Every single thing about our new fine tuner is fine. Even the price.



Precise fine tuning has always been a problem. Until now. Raytheon's new Microvernier control knob utilizes the principle of harmonic drive to provide a new, low-cost method of obtaining high-resolution tuning or precise zero setting.

The patented performance-proven Microvernier control knob is more economical. Because it's gearless. Yet its zero-backlash performance is precise enough to meet the most sophisticated electronic standards. It features both 40:1 and 1:1 tuning ratios. And it's available now in three sizes to keep all your fine tuning under control. Write Raytheon Company, Fourth Avenue, Burlington, Massachusetts 01803.



Circle 153 on reader service card

## A CAMBION® Double "QQ" Product Line

As often as you want, too. The design of the jack and the materials from which it is produced give it the strength to be cycled more than 50,000 times (we've done it) without appreciable change in contact resistance.

And we didn't just do it once "in the lab."

We have tens of millions of these jacks out, in use by customers. ID's range from .016" to .080". And are available in different shapes and types for mounting components, patching, plugging, or whatever you have in mind.

All CAMBION cage connectors are standard, immediate delivery items. You can have them fast in whatever number you want. That's the CAMBION Double "QQ" approach, the quality stands up as the quantity goes on. Ask for a sales engineer or a catalog. Cambridge Thermionic Corporation, 445 Concord Avenue, Cambridge, Mass. 02138. In Los Angeles, 8703 La Tijera Blvd. 90045.

## This cage jack was built for recycling!



Circle 172 on readerservice card

## NEW Heathkit 2½ Digit DMM

only 79<sup>95\*</sup>



A compact, solid-state multimeter with digital readout — at a fantastic kit-form price. The new Heathkit IM-1202 has four overlapping ranges to measure voltages from 10 mV to 1000 V on DC (either polarity), 10 mV to 700 V rms on AC, 10 uA to 2.5A on AC or DC current. Five resistance ranges measure from 1 ohm to 2.5 megohms. Front panel polarity switch reverses inputs without changing leads. 6 lbs.

## NEW Heathkit 30 MHz Counter

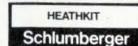
only 169<sup>95\*</sup>



The Heathkit IB-1100 gives 1 Hz to over 30 MHz counting on a full 5-digit readout with 8-digit capability. The lighted overrange indicator makes misreading virtually impossible. Stable time-base circuitry assures accuracy better than ±3 ppm from 22° to 37° C. Diode protected J-FET gives improved triggering over 100 mV to 150 V input range. Solid-state circuitry mounts on one large board for easy assembly. 6 lbs.

## Send for FREE '73 Catalog

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Benton Harbor, Michigan 49022



- Please send FREE Heathkit Catalog.  
 Enclosed is \$ \_\_\_\_\_, plus shipping.  
 Please send model(s) \_\_\_\_\_

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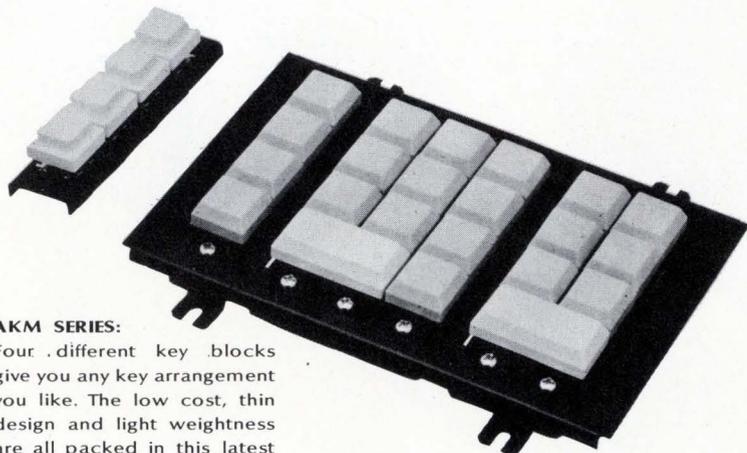
TE-275

Circle 173 on reader service card 153

# ALPS KEYBOARD SWITCH

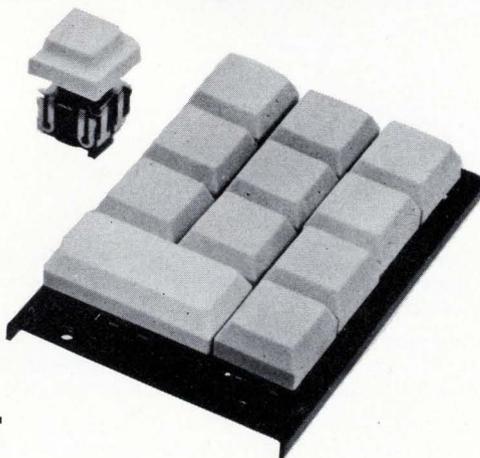
4-BLOCK KEYBOARD SWITCH AKM SERIES

MECHANICAL CONTACT POINT KEYBOARD SWITCH AKC SERIES



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Four different key blocks give you any key arrangement you like. The low cost, thin design and light weightness are all packed in this latest developed, highly dependable switch.



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This keyboard switch incorporates our own coil-spring contact point as well as the independent one-key unit feature for free key arrangements.

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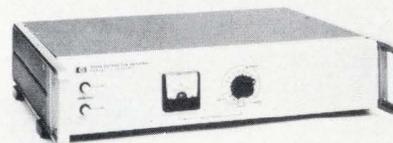
Circle 152 on reader service card

## New products

SCRs, zener diodes, and other electronic components. The 577 shows characteristics for entire ranges of operating conditions, instead of single points, for parameters that include random noise, popcorn noise, thermal feedback, and phase-shift effects. Storage display is also provided. Prices range from \$1,850 to \$3,200, depending on configuration. Tektronix Inc., P.O. Box 500, Beaverton, Ore. 97005 [354]

Distribution amplifier handles signals, even if power fails

Distribution of up to three sources to as many as 12 outputs is a capability of the model 5087A distribution amplifier, which keeps on working when power fails. The sources may be 10 MHz, 5 MHz, or 100 kHz,



in any combination. Interference or short circuit in one output will not materially affect the others. An option provides for the amplifier to accept a single 5-MHz or 10-MHz input and deliver a choice of 0.1-, 1-, 5-, or 10-MHz outputs. Price is from \$1,500 to \$1,630.

Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304 [355]

Picoammeter offers 11 bipolar ranges of current

A general-purpose picoammeter with a cancellation circuit includes dual output for recorders or oscilloscopes. Bipolar output is also provided. The model 1012 offers 11 ranges of bipolar current measurement, from 10 microamperes full scale to 100 picoamperes full scale. Resolution is 1 picoampere on the most sensitive scale.

Gencom Division, Emitronics Inc., 80 Express St., Plainview, N.Y. 11803 [359]

★ ★ ★ ★  
★ ★ ★ ★  
**UNITED STATES**

## ELECTRONICS Markets Tour

The annual Electronics Tour of World Markets ends in the U.S. with the January 4, 1973 issue. This 24-page on-the-spot report will feature an in-depth analysis of the U.S. markets plus 1973 and 1976 forecasts of components and equipment.

### Last Stop



**Everything you need  
to know about power  
supplies is right here  
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complete**

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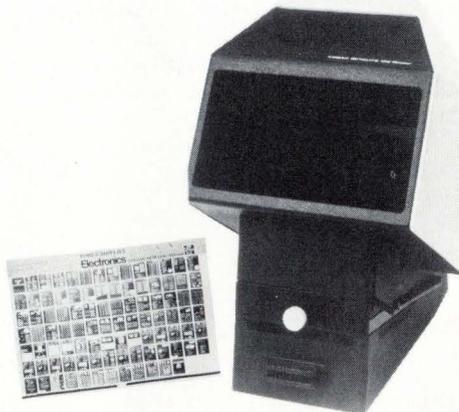
**Never before available:** This is the first microfiche series from the Electronics Catalog Retrieval System. The microfiche cards fit any

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The Ektalite 120 is a desktop reader weighing less than five pounds. It's compact, noiseless, easy-to-use. All you do is feed in the microfiche from left to right, and manipulate the control knob to locate the image you want.



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# Has Spectrol invented the "universal" pot?

## The Model 534 is a pot that can be made to fit almost every application.

Never before has a low-cost pot been made available with such quality, flexibility, and versatility. Take a look at the superior design features of the basic Model 534, and look at the "special" variations available. Then look at the low prices — often from 1/2 to 1/3 the price of other models which offer some of the same "special" features. With everything going for it, the low-cost Model 534 may prove to be that "universal" pot you've been waiting for.

The features shown are just a partial listing. Many more options and special design features are available. So why wait? Why not get your hands on a 534, and see for yourself? For a data sheet, just use the reader service card; and for price and delivery, call us directly.

**Standard Design Features** — • 3/4" long; 7/8" diameter • 10 Ω to 200KΩ  
• 3 turns (Model 533), 5 turns (Model 535), or 10 turns (Model 534)  
• Rugged construction, 75 oz.-in. stop strength and Thermoset plastic housing • Stainless steel front lid and shaft • Welded terminations • Bushing or servo mount.

**Special Features Available** — • Resistance tolerances to ±1%, linearities to ±.075% • High torque, 2 to 6 oz.-in. • Non-turn lug • 1/4-32" bushing with 1/8" shaft • Non-linear functions • Extra taps • Screw mount • Added sections • Locking bushing • 1 thru 8 turns rotation • Pot-switch combinations • Shaft variations: dual concentric shafts, various shaft lengths, shapes, materials — slots, flats, plastics, splines, and metal-plastic combinations.

# Spectrol

## SPECTROL ELECTRONICS GROUP

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17070 E. Gale Avenue, City of Industry, Calif. 91745, U.S.A.  
(213) 964-6565 • TWX (910) 584-1314

### UNITED KINGDOM

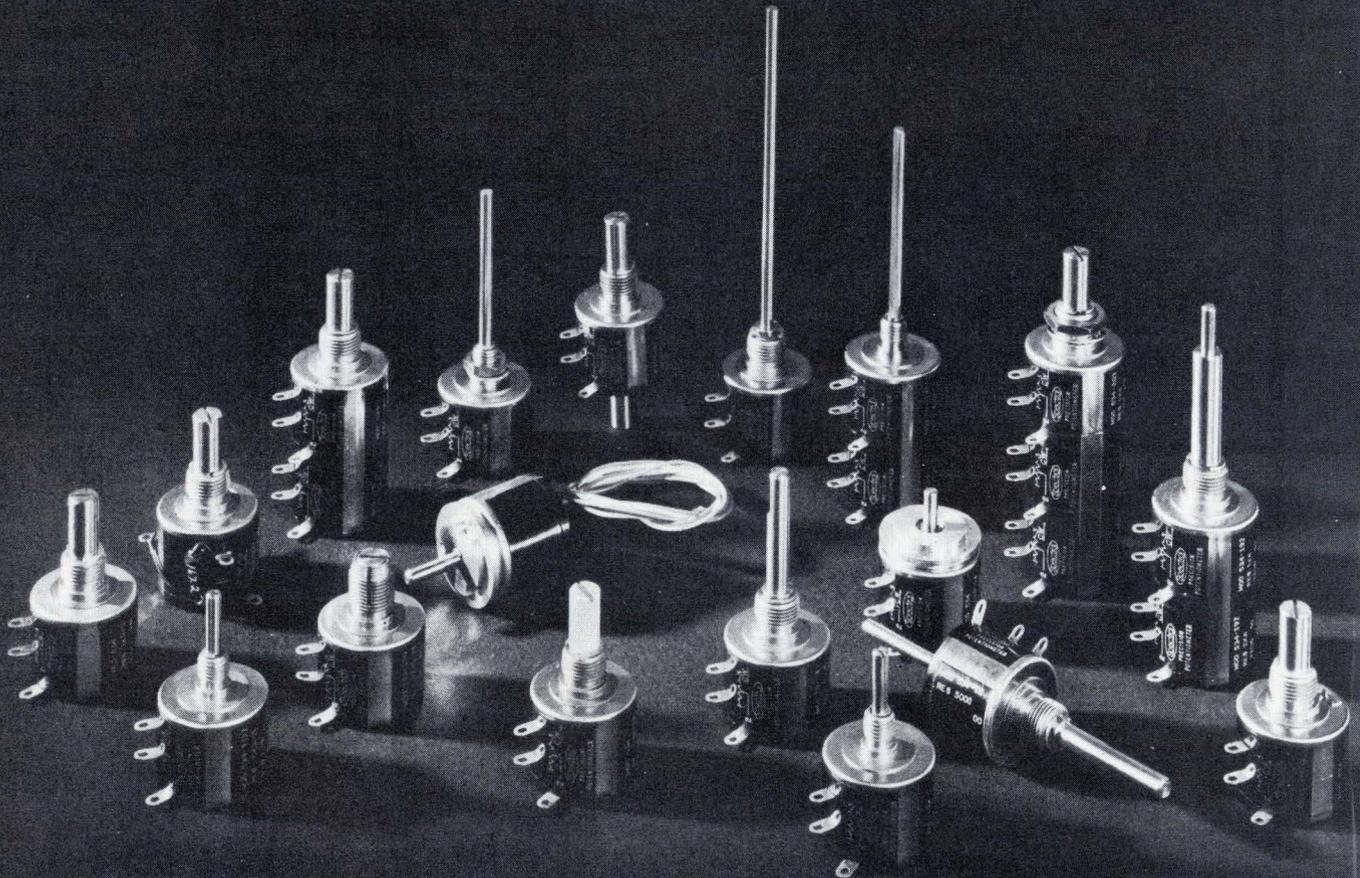
#### Spectrol Reliance Ltd.

Drakes Way, Swindon, Wiltshire, England  
Swindon 21351 • TELEX: 44692

### ITALY

#### SP Elettronica spa

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**Self-cleaning non-focussed heaters** provide uniform, full width heat distribution — no windows or reflectors to clean.

**Proven control system** with automatic stabilization — no interaction between zones — no false turn-ons — wider operating ranges. All components conservatively rated.

**More versatile** — new modular design provides a broader range of optional features, enabling a buyer to tailor the machine to his needs.

**Faster** — Belt travels up to 20 ft./min., fuses up to 4800 sq. ft. (double sided circuit boards) per hour — more than twice as fast as our competitors.

15" machine with  
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**\$7900**

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# COMPRESSED VIDEO

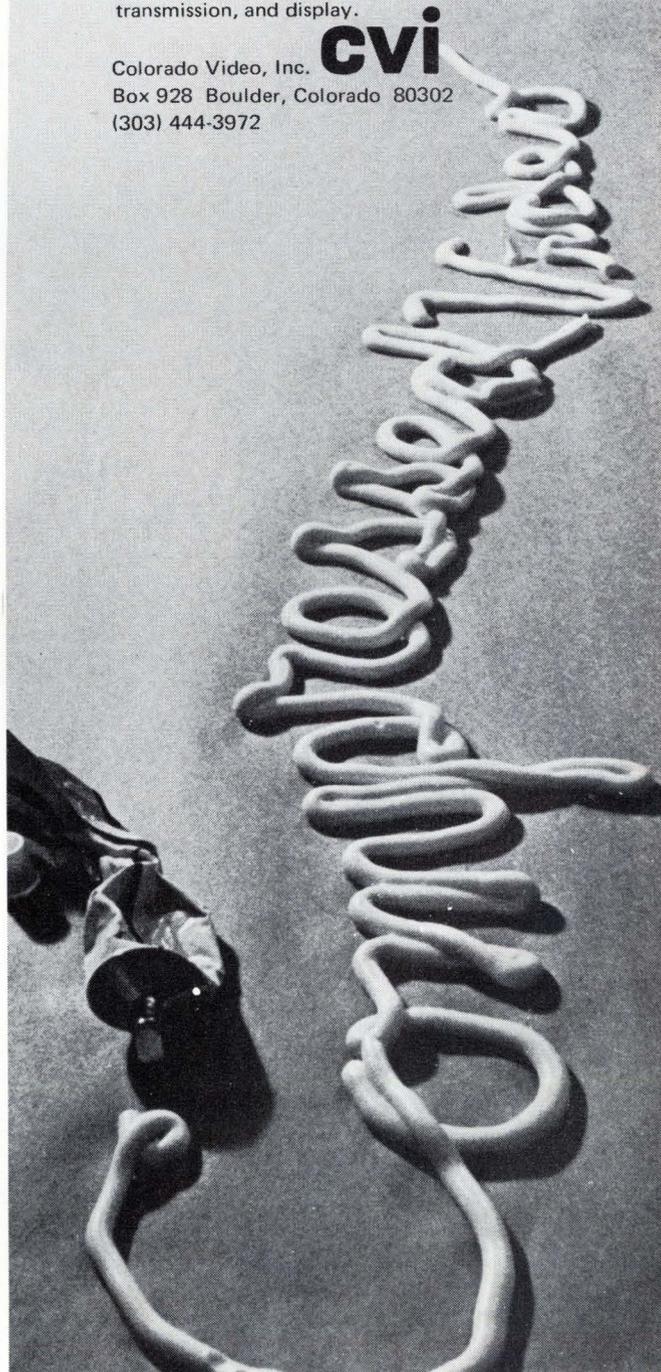
- Starts with a standard CCTV camera
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The CVI 200 series Video Converters provide for single frame TV picture transmission over audio bandwidth circuits. Options include multiple image storage, hard copy, computer I/O, and color.

Video instruments for data acquisition, processing, transmission, and display.

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(303) 444-3972



Circle 177 on reader service card

157

**Decision:** Assume you need an alterable, non-volatile memory in your system, what choices do you have *right now*? And at what *true and complete* cost-per-bit?

Cores and plated wire—patchboards—diode arrays? Fine. Providing you need lots of memory—and you're not concerned about size, bulk and speed. Or power consumption. Or compatibility with existing and future logic forms. Or the additional cost of power-fail detection circuitry, or retrieval software and reload hardware—and the like.

*Let's talk*

**Cost-per-Bit**

Semiconductor memories? If you go with RAMs your bit cost per se may be lower. But you'll have to consider the extra cost of providing an uninterruptable power source. Or power-fail detection circuitry and battery back-up. Or retrieval software and reload hardware. Just to compensate for their inherent volatility.

If you consider ROMs—either the fixed or one-shot programmable variety—your cost-per-bit for memory alone could be even lower. Until you start adding up all the extra peripheral costs involved in trying to overcome their inherent unalterability. Simulation systems. Special masks and programmers. Surplus capacity for unused future options. Not to mention multiple spare parts inventories, field retrofits, obsolete stock, and spoilage due to errors.

So where do you go from there? *Take a good look at RMMs!*

**AMORPHOUS RMM**  
**ALTERABLE / NON-VOLATILE SEMICONDUCTOR MEMORIES**

They're the only *inherently* non-volatile, *fully* electrically alterable semiconductor memories in production—*now!* You can use them just like any other hard-wired memory elements—but without having to buy and build a bunch of superfluous circuitry into your system just to protect stored data or correct program errors.

In fact, you can take Ovonic RMMs completely out of your system—for days, weeks, years at a time—without loss of data. And you can also change, up-date and re-alter stored information at will. Quickly, selectively and *repeatedly*—by simple electrical means.

Easy to apply, too. Standard packages. TTL/DTL compatible. Compatible with each other. Which means you can mix or intermix them any way you like to create flexible, expandable memory systems to meet present and future needs—*exactly!*

Cost-per-bit? Still a bit more than RAMs or ROMs on a straight device comparison basis.

But considering the fact that bit cost is the *only cost* with RMMs, you'll find they're worth it! Important, too: RMM costs have dropped dramatically in the past 18 months and haven't reached bottom yet. So if you start using them now, your true bit costs will be a lot less by the time you hit volume production.

Call or write for complete information today!

**Energy Conversion Devices, Inc.**  
1675 WEST MAPLE ROAD • TROY, MICHIGAN 48084  
TELEPHONE 313/549-7300

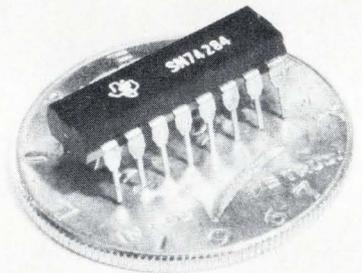


5,000 at 5 A. Applications include power switching, inverters, converters, and stereo and audio amplifiers. Price is \$2.60 in lots of 100.

Soliton Devices Inc., 1177 Blue Heron Blvd., Riviera Beach, Fla. 33404 [414]

TTL/LSI multipliers contain 200 gates on a single chip

Two TTL/LSI circuits can be used together to generate an eight-bit binary product in 40 nanoseconds. Designated types SN54/74285 and SN54/74284, the four-bit-by-four-bit parallel binary multipliers each contain the equivalent of over 200

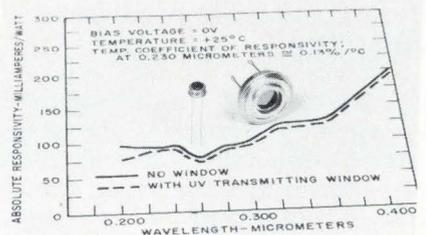


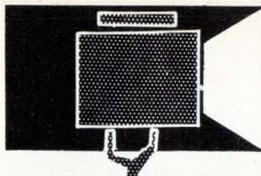
gates on a monolithic chip. If the multipliers are combined with the company's carry-save adder, arithmetic logic unit, and lookahead generator, expandable n-bit-by-n-bit applications are possible. Price in 100-lots ranges from \$8.10 to \$36.45 depending on packaging.

Texas Instruments Incorporated, P.O. Box 5012, M/S 308, Dallas, Texas 75222 [415]

Silicon photodiodes designed for analytical instruments

The UV series of photovoltaic silicon photodiodes is suitable for use in analytical instrument applications where high spectral respon-





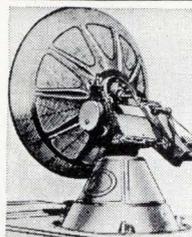
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#### MIT MODEL 9 PULSER 1 MW—HARD TUBE

Output 25kv 40 amp., 30kv 40 amp. max. Duty cy. .002. .25 to 2 microsec. Also 5 to 5 microsec. and .1 to .5 microsec. Uses 6C21. Input 115v 60 cycle AC. Mfg. GE. Complete with driver and high voltage power supply. Ref: MIT Rad. Lab. Series. Vol 5, p. 152.

#### 2 MEGAWATT PULSER

Output 30 kv at 70 amp. Duty cycle .001. Rep. rates, 1 microsec. 600 pps. 1 or 2 msec. 300 pps. Uses 5948 hydrogen thyatron. Input 120/208 VAC 60 cycle. Mfr. GE. Complete with high voltage power supply.

#### 17 MEGAWATT LINE PULSER

Output 17KV at 1000 Amps. Rep. rate 150-2000 PPS 2.5 Microsec. Keyer tube 5948 thyatron. Pwr: 208V, 3Ph, 60HZ, 38KVA.

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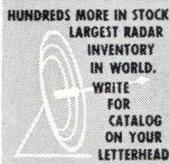
CW 1.5mhz-10.5ghz 5 WATTS

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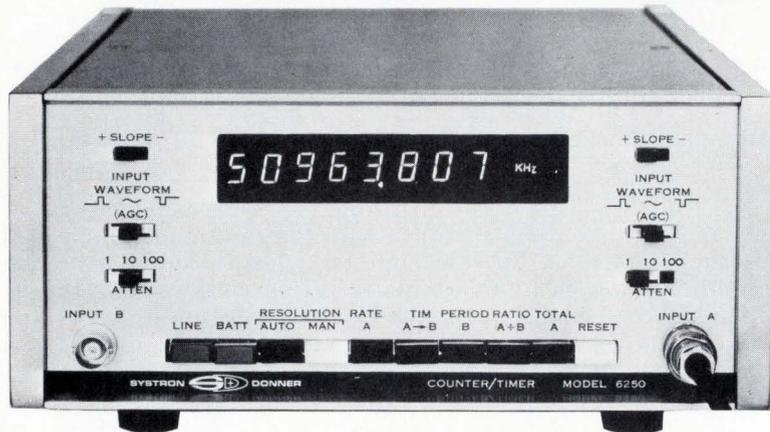
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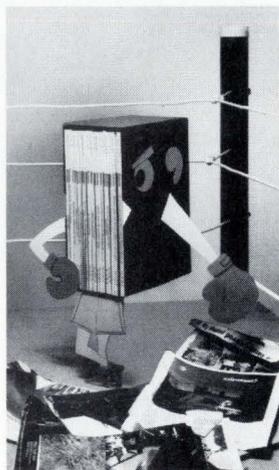
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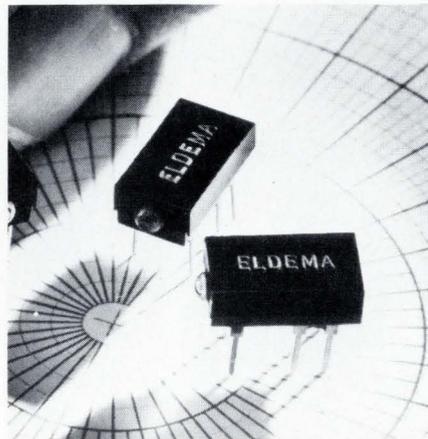
## New products

sivity, ultra-low noise, spectral stability, and response linearity are prime factors. Features of the unit include a spectral responsivity at 230 micrometers of 90 milliamperes/watt, spectral stability at 230 micrometers of 0.13%/°C, equivalent Johnson noise current in the range of  $2-5 \times 10^{-14}$  amperes per root hertz, and a response linearity to within 1% over seven decades of irradiance.

EG&G Inc., Electro-Optics Division, 35 Congress St., Salem, Mass. 01970 [416]

Solid-state status indicator is aimed at computer uses

Designed to visually describe the status of the circuit or board on which it is installed, a status indicator integrates LED and resistor construction in one package. The unit is



suitable for computers, computer peripheral equipment, and many types of instrumentation. Encased in a phenolic housing, the device is designed for 5-volt, 10-milliamperere operation, with other voltages available.

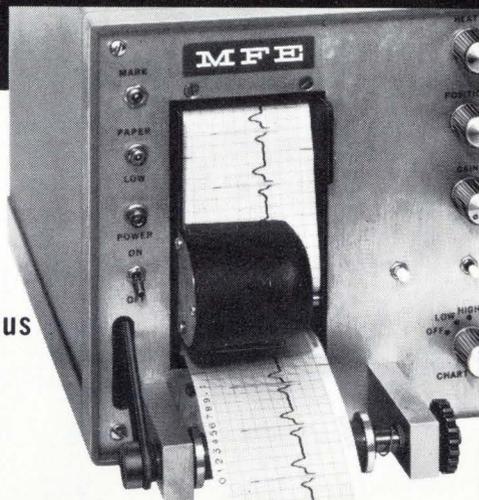
Eldema Division, Genisco Technology Corp., 18435 Susana Rd., Compton, Calif. 90221 [417]

MOS line drivers provide 1-A output current

Hybrid MOS line drivers offer a peak output current of 1 ampere and output voltage swings of up to 30 volts.

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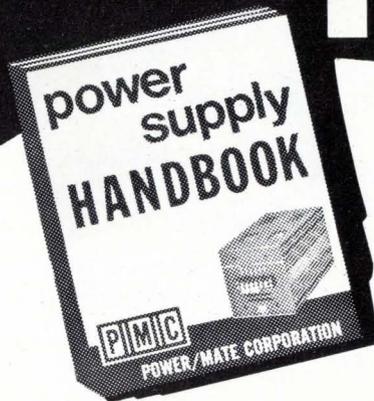
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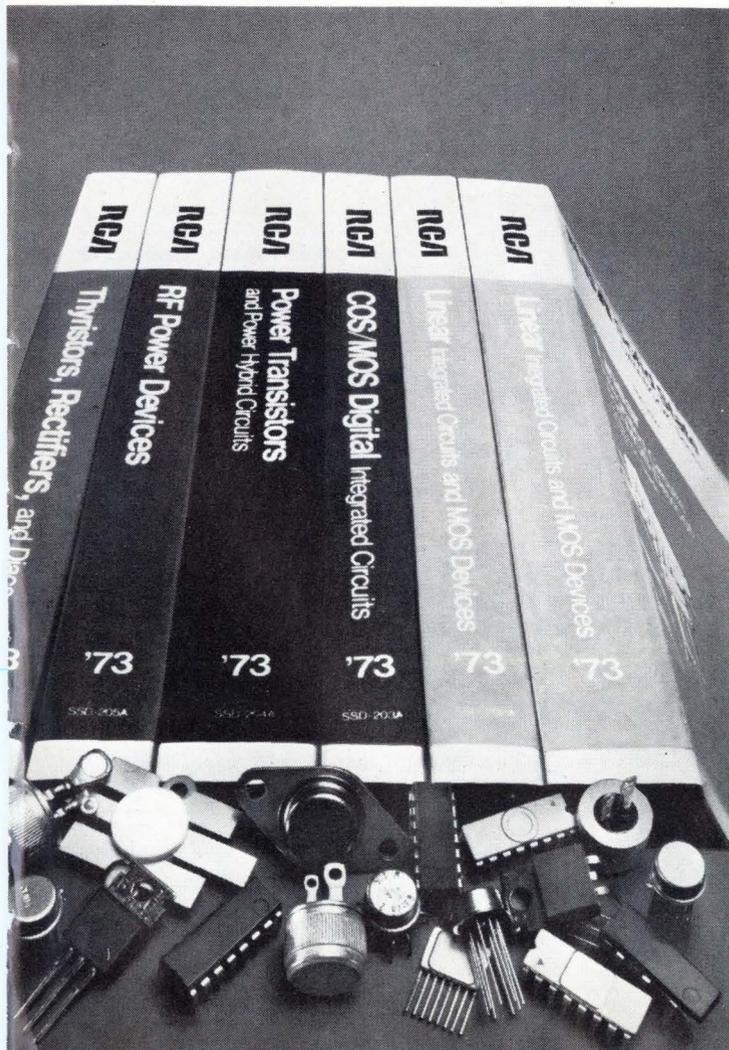
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The tape drive on Model 330 is fully bi-directional at 25 ips normal speed, resulting in a data transfer rate of 40,000 bits/second at 1600 cpi recording density. Forward and reverse search modes as well as rewind speed is 90 ips. With 300' of high-grade .25" one mil tape, total data capacity (gapless) is  $23 \times 10^6$  bits for 4-track operation. And Model 330 meets the proposed ANSI Standard.

Model 330 is equipped with a dual gap read/write head for read-after-write operation. One, two and four track versions are available. Each track is treated independently allowing cartridge interchange between transports of differing track configurations. Each track is equipped with a separate erase gap to ensure against inadvertent data erasure.

Mechanically, Model 330 is a jewel. The unique isoelastic cartridge and high-performance dc motor/tachometer velocity servo system provides both tape and reel drive. Manual controls are designed for simplicity—insert the cartridge and tape automatically advances to load point.

Model 330 is a product that's long overdue. And it's the kind of product that Kennedy makes best—reliable, economical and ahead of its time. Write or call today for complete details.

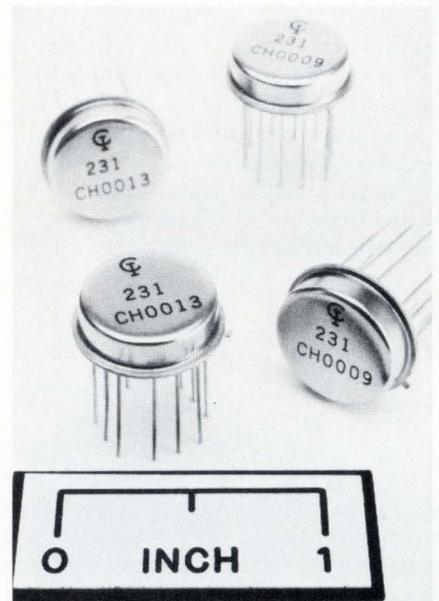
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## New products

Typical rise and fall times are under 50 nanoseconds when driving 1,000-picofarad loads. The CH0009 series may be direct-coupled to the driving source, or may be used in capacitor-coupled applications. The CH0013 series is designed for capacitor-coupled applications only. But both



are packaged in 12-lead TO-8 cans. Operating temperature range for the basic device is  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . Price of the units ranges from \$9.75 to \$16.25 in 100-lots.

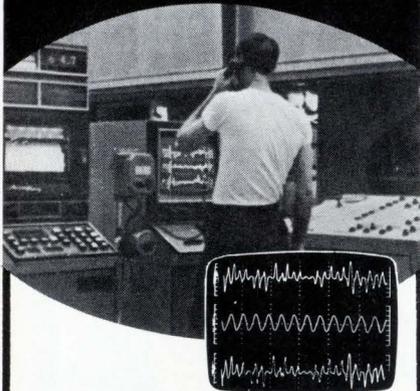
Cermetek Inc., 660 National Ave., Mountain View, Calif. 94040 [418]

## Fast-recovery silicon rectifiers deliver 100–600 V

Twelve 100–600-volt fast-recovery silicon rectifiers are designated the TA series. Models TA 8411, 8412, 8413, and 8414 are 6-A forward-polarity types. Models TA 8415, 8416, 8417, and 8418 are 12-A forward-polarity versions, and the models TA 8419, 8420, 8421 and 8422 are 20-A forward-polarity units. Four reverse-polarity versions are also offered and are suitable for applications that require the anode to be at ground potential. Price in 1,000-lots ranges from \$1.49 to \$6.

RCA, Solid State Division, Route 202, Somerville, N.J. 08876 [419]

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## New products

Packaging & production

### Reactor handles larger wafers

Epitaxial unit can process  
21 3-inch wafers or 44  
2-inch types per tube

To meet increasing demands of the semiconductor industry, Hugel Industries has developed an epitaxial reactor system that can double the throughput of a semiconductor production line [*Electronics*, Oct. 23, p. 26]. Called the Unipak X, the new dual-tube machine can process up to 44 2-inch wafers or 21 3-in. wafers in each tube. Present machines usually handle up to 20 2-in. wafers.

Part of the problem in building large horizontal-tube reactors (and the susceptors on the Unipak X are large—they measure 9.5 by 23 in. each) is in getting large quartz tubes. But Jerry Bowers, production manager at Hugel, says, "Once the market for large reactors became obvious, the quartz people made the investment in equipment that could make large tubes."

The Unipak X employs Hugel's automatic flow, time, and temperature controls, as well as a novel rf layout, to achieve a thickness uniformity within 5 to 10%. Resistivity uniformity is within  $\pm 10\%$ .

The range of performance for the Unipak X includes silicon epitaxy resistivities from 0.005 to 20 ohms/cm and thicknesses from 0.5 to 100 micrometers; background resistivities greater than 100 ohms/cm for n-type; polycrystalline silicon deposition with rates from 0.1 to 8  $\mu\text{m}$  per minute; graded and multiple layers of the same and opposite conductivity type; and deposited single and multiple dielectrics such as  $\text{Si}_3\text{N}_4$ ,  $\text{SiO}_2$ , with over-all uniformity better than to within  $\pm 10\%$ .

The gas-control system of the Unipak X reactor can be operated either manually from the graphic panel or automatically by the real-

time programmer. The system features Hugel Industries' gas-injection block system with positive-acting 24-v dc solenoid valves. The injection block system provides independent vent/deposit selection for each flow line. The pressure balance between vent and deposit is controlled by inert purge flow.

As many as 16 flowmeters or mass flowmeters can be incorporated into the gas-control system.

Unipak X is available 12 weeks after receipt of order. The complete system, including the reactor with automatic time and temperature controllers and rf generator, sells for about \$85,000.

Hugel Industries, 625 N. Pastoria Ave., Sunnyvale, Calif. 94086 [391]

### Bonder can attach 1,000 light emitters an hour

An epoxy lead-frame bonder that attaches 800 to 1,000 light-emitting diodes per hour promises to give a big boost to the art of fast epoxy-chip attachment. The LF 251, developed by Laurier Associates of Westford, Mass., offers a 10-fold improvement over manual placement rates of no more than 100 an hour, according to the company.

What's more, even though the machine is designed for LEDs, feed mechanisms are available for handling virtually any kind of lead frame.

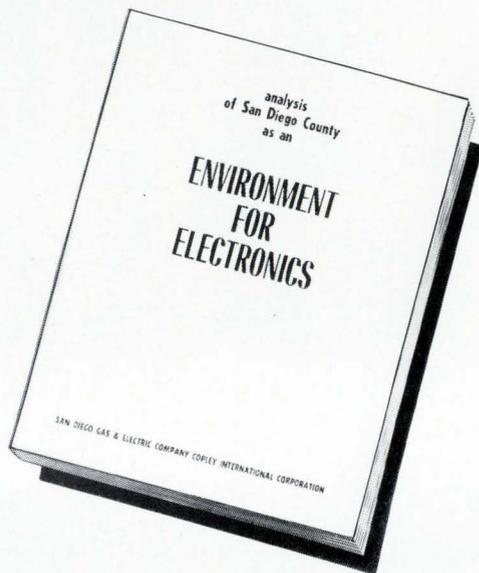
Lead frames are advanced automatically. Indexing is performed by a tapered pin so that errors are non-cumulative. The company says that die-placement accuracy is within 2 mils.

The operator begins the attachment sequence by aligning the die-pickup arm with the chip and pressing a handle to simultaneously pick up the die and dispense the epoxy on the lead frame. The LF 251's sliding table is then moved toward the operator, and the chip is precisely placed on the lead frame. Then the slide moves back and automatically indexes the lead frame to the next position.

The die-placement pick-up arm is

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## New products

counterbalanced, and an adjustment enables placement force to be adjusted from zero grams upward.

Base price of the machine is \$3,900, plus whatever lead-frame mechanism must be built for a particular customer's requirements. Delivery time is 12 weeks from receipt of order.

Laurier Associates Inc., 2 Vose Rd., Westford, Mass. 01886 [392]

## Positioning of load board optimizes IC test conditions

Effective IC testing requires simulated input and output circuit loading during the application of dynamic signals. In its new test handler, International Production Technology accomplishes this by placing the circuit load board right at the contactor that engages the pins of the IC. This means that the connections from IC to load board are less than one inch and exhibit low inductance and low inter-lead capacitance - crucial requirements for valid testing at speeds of 1.5-2 nanoseconds.

The handler, called the IPT-701-37, is designed for table-top mounting, and performs static and functional tests at throughputs exceeding 5,000 units per hour. Virtually all DIPs with 0.300-inch (center-to-center) pin spacing can be tested. This includes devices with 8 to 18 leads, and package thicknesses ranging from 0.11 to 0.200 in. Most 0.600-in. ICs can also be handled; other package sizes can be accommodated on special order.

The contactor grips each device lead just below the lead neck, and thus below the region where lead flash sometimes occurs, so a positive contact is assured. However, virtually no cosmetic damage is done to the leads, and the company says the contactor itself has endured better than 3 million cycles without any discernible wear.

The handler mechanism is hinged to a baseboard so that it may be tilted to afford access to the contactor assembly and load board. The electro-pneumatic drive system is

**birth defects are forever.**



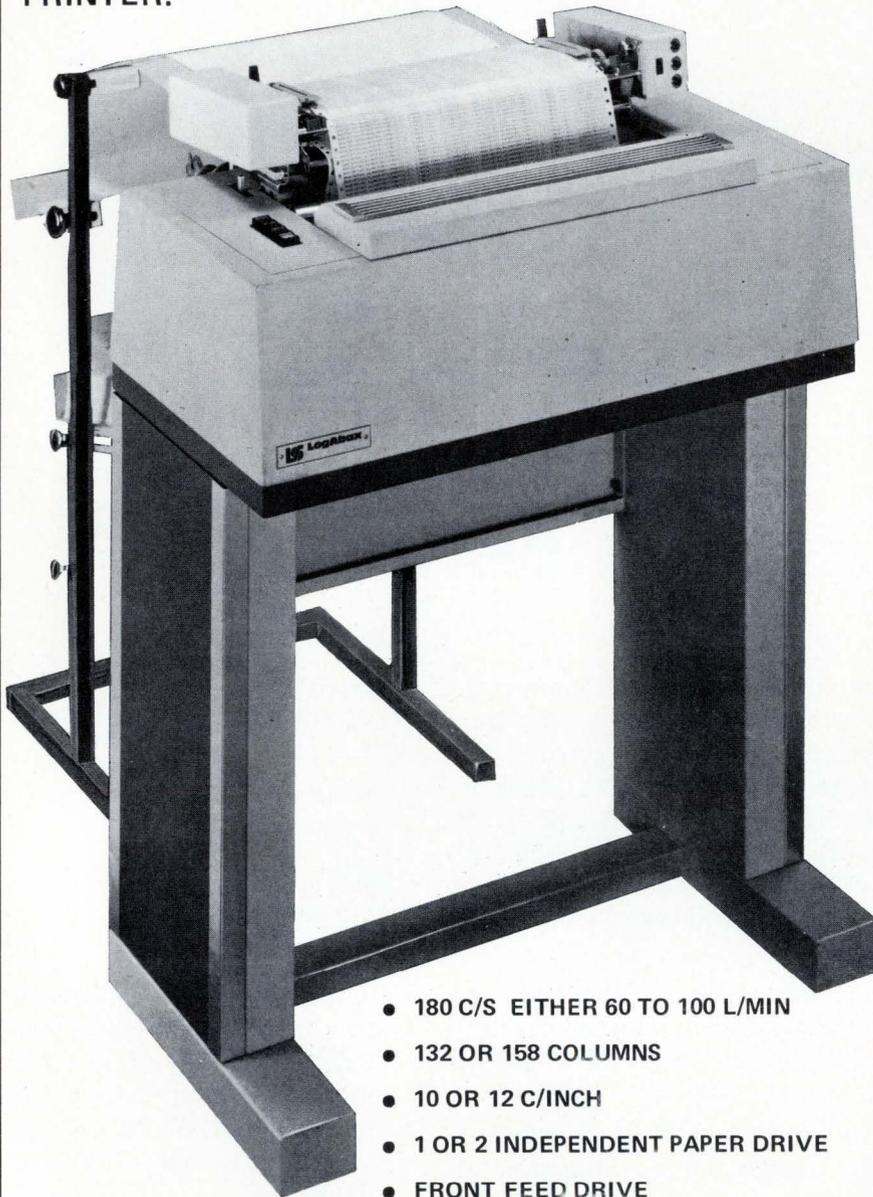
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### New products

inoperative during each device test, and this minimizes test contamination from spurious electrical signals. The open construction of the feed chutes enables clearance of any jam which might occur. In addition, the



IC under test is observable during the handling cycle.

Operation can be either manual or automatic. In the automatic mode, the device will continue to cycle ICs as long as there are devices in the input reservoir and as long as there are unfilled output tubes.

International Production Technology, 185 Evelyn Ave., Mountain View, Calif. 94040 [401]

### Limit bridge for production testing goes to 100 megohms

A limit bridge includes all the equipment necessary for making accurate four-terminal resistance measurements from 1 ohm to 100 megohms. The unit is for production



and inspection testing and includes a modified six-dial Wheatstone bridge, a linear amplifier, and a solid-state bridge power supply. The model 4271 is equipped with "low," "go," and "high-limit" lights, and provides 10 switch-selectable limit ranges. In addition to percentage

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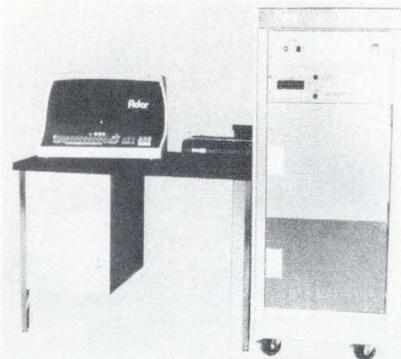
## New products

limit measurements, the unit can be used for null measurements.

Leeds & Northrup, North Wales, Pa. 19454 [393]

Memory tester can check up to 16 million locations

A computer-controlled micro-programable test system can check memory cards or memory systems at up to 16,000,000 locations by 72 bits. An optional test head converts



the Doctor 12 unit into a chip tester. Test programs are activated by a CRT-keyboard link, and both program and results are displayed on the CRT. In addition to go/no-go testing, the unit performs memory system debugging and engineering evaluation. Price is about \$25,000.

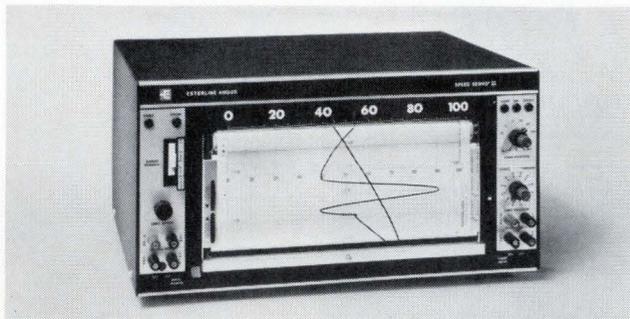
Adar Associates Inc., 85 Bolton St., Cambridge, Mass. [394]

Plastic plated DIP sockets eliminate separate contacts

A range of dual in-line sockets is designed so that the need for separate contacts is eliminated. Contact between the integrated-circuit leads and pins connecting the socket to the printed-circuit board is made by gold- or tin-plated copper deposited on the plastic body. The plated body is in the form of a saddle over which the IC leads are slipped and located in open-sided slots. The IC is held in place by a plastic retainer that presses the leads inward to contact the plated areas. Four sockets are available, ranging in price from

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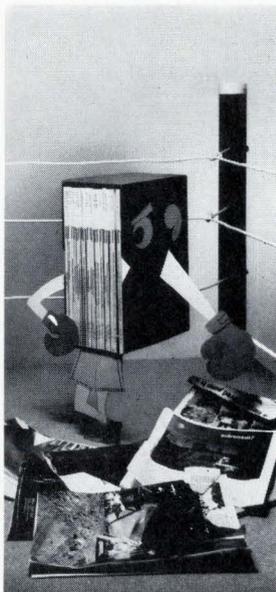
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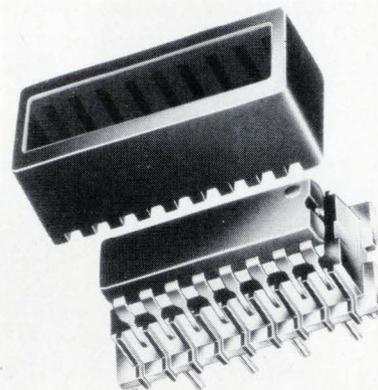
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## New products

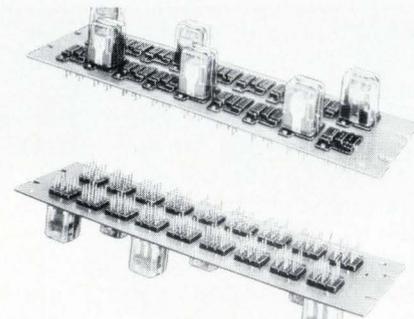


45 cents in 100 lots to \$18 for 10,000 pieces in quantities of 1,000.

Jermyn, 712 Montgomery St., San Francisco, Calif. 94111 [395]

Socket panel assembly  
is solderless-wrap type

The series 203 assembly is a 19-inch panel capable of accepting several common contactor relays, including the type 157 triple-pole double-throw relay or the type 113 solid-



state time-delay relay. Up to nine sockets can be mounted per row, with from one to four row assemblies available. The solderless-wrap sockets have 11 terminals of 0.031 by 0.062 by 0.75 inch.

Midtex Inc., 10 State St., Mankato, Minn. 56001 [397]

Flat-cable connectors act  
as contacts to pc boards

The series K interconnection system is designed so that the connector body and flat multiconductor cable are a single unit. Solder joints are eliminated, since each conductor in

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## New products

the cable serves as its own contact. Electrical and mechanical connections are made simultaneously, facilitating installation or removal of the printed-circuit board. The K series is adaptable to almost any

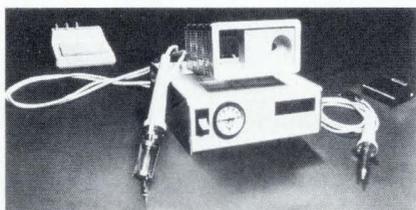


packing design or circuit requirement, and the cable section of the connector can be supplied to any length with any number of conductors and with contact spacing as close as 0.010 inch.

Teledyne Kinetics, 410 South Cedros Ave., Solana Beach, Calif. [396]

## Soldering-desoldering station works from on-site air source

A portable power soldering-desoldering station operates directly from the factory compressed-air source. The model DS100 is suited to production rework, as well as electronic



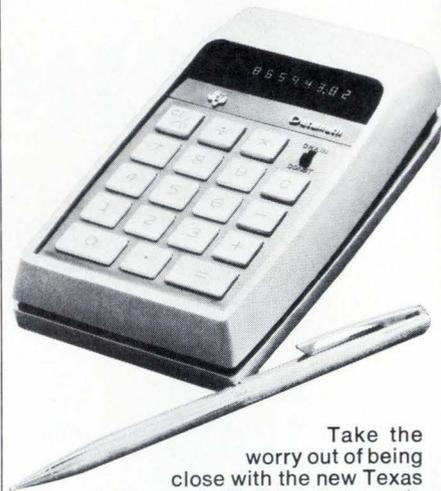
service applications. Temperature control and output control are automatic, and operation is at 24 vac from 110-v supply.

Weller Division, The Cooper Group, P.O. Box 728, Apex, N.C. [398]

## Ribbon bonder is pulse-heated

A pulse-heated thermocompression ribbon bonder is designed for large production rates on devices using

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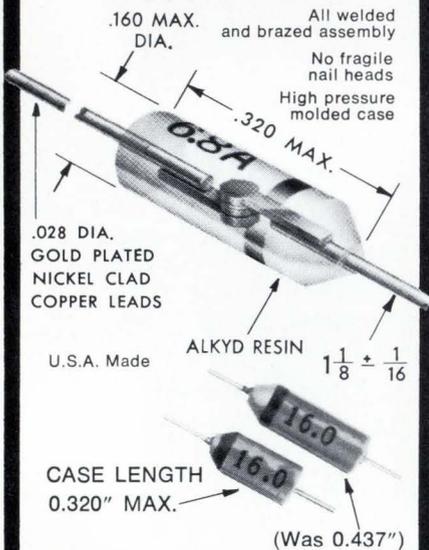
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## New products

ribbon instead of wire. The model HPB-360/RB is for applications in the fabrication of microwave devices, hybrid circuits, and tunnel diodes. Operation is by a current pulse of extremely short duration passing directly through the capillary tip. Thus, the substrate is not heated, and damage to heat-sensi-

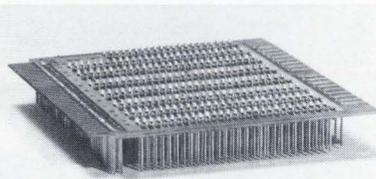


tive devices or adjacent components is prevented. The bonding cycle is programed, but the operator has a manual override control to permit any number of stitch bonds. Price is \$4,250.

Hughes Metal Bonding Equipment, 2020 Oceanside Blvd., Oceanside, Calif. 92054 [399]

## Solderless interconnectors feature low socket profile

A solderless interconnect system features a low socket profile, one-piece construction, and a design that provides good lead retention and surface contact, while allowing the use of very short IC lead lengths.



The unit is designated Allochiral and is made specifically for high-volume production applications. It can be machine-inserted in pre-drilled pc boards, becoming a self-supporting connector socket or a complete back-panel solderless interconnection system.

Robinson-Nugent Inc., 800 E. 8th St., Box 470, New Albany, Ind. 47150 [400]

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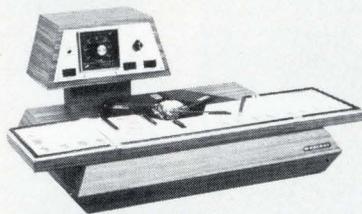
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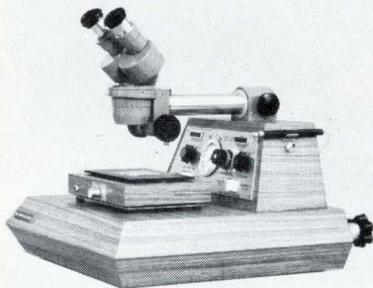
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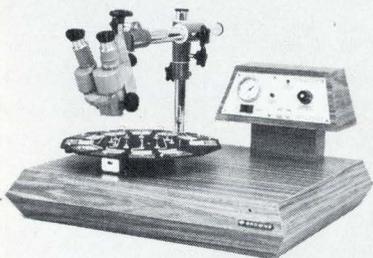
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**New literature**

**MOS handbook.** Fairchild Camera & Instrument Corp., 464 Ellis St., Mountain View, Calif. 94040, will distribute an MOS handbook to readers who submit a written request on a company letterhead. The handbook provides data on products, including application information, in addition to basic design information.

**Connectors.** A short-form 20-page catalog has been published by Elco Corp., Willow Grove Division, Willow Grove, Pa. 19090. Described are product lines, consisting of solder receptacles, terminated packages, and other connectors. Circle 422 on reader service card.

**Crimping.** Buchanan Electrical Products, 1065 Floral Ave., Union, N.J., has published a brochure on crimping tools for pin and socket connectors. [423]

**Capacitor matrix.** Fourteen-pin dual in-line multi-layer ceramic capacitor matrices are described in two bulletins being offered by the Potter Co., a division of Pemcor Inc., 10441 Roselle St., San Diego, Calif. [424]

**Microwave components.** A four-page brochure details the miniature directional couplers, diode switches, isolated power dividers, terminations, and 15 other stripline assemblies available from Norsal Industries Inc., 34 Grand Boulevard, Brentwood, N.Y. 11717. [425]

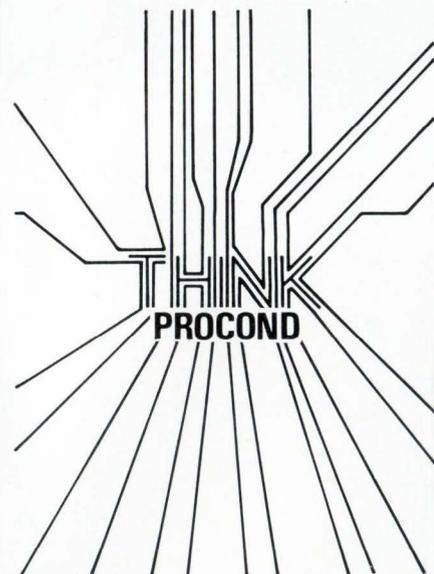
**D-a converter.** Perkin-Elmer Corp. describes its multiplying digital-to-analog converter, model 2000, in a data sheet available from the company's Industrial Products Division, Main Avenue, Norwalk, Conn. 06856 [426]

**Induction heaters.** An eight-page catalog covering solid-state induction-heating inverter power units, called Statipower III, has been published by Induction Process Equipment Corp., 32251 North Avis Drive, Madison Heights, Mich. [427]

**Solid-state components.** AvanteK Inc., 2981 Copper Rd., Santa Clara,

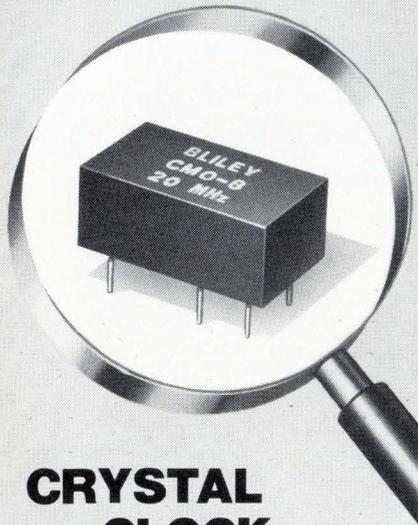
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## New literature

Calif., has published a 16-page catalog detailing the company's solid-state component line. These products include high-frequency transistors, YIG-tuned oscillators, unit amplifiers, and amplifier modules. [428]

**DIP sockets.** Medium-range-profile sockets designed in a dual in-line configuration are described in a bulletin released by Berg Electronics Inc., New Cumberland, Pa. [429]

**Counter-display circuit.** Mostek Corp., 1215 West Crosby Rd., Carrollton, Texas 75006. A revised eight-page applications note on the operation of the MK 5002 p-MOS four-digit counter decoder contains new information on display interfacing, cascading, and annunciator applications. [430]

**IC testing.** An applications note on the techniques of linear integrated-circuit testing is available from Sitek Inc., 1078 W. Evelyn Ave., Sunnyvale, Calif. 94086. [431]

**Components.** EMI Electronics and Industrial Operations, Blyth Rd., Hayes, England. Details of a range of electronic components including miniature transformers and potentiometers, switches, capacitors, and printed-circuit amplifiers are given in a new brochure. [432]

**Shaft encoders.** Bulletin 67-21A, available from Theta Instrument Corp., Fairfield, N.J. 07006, is a four-page description of the company's line of shaft encoders. [433]

**Product catalog.** ITT Semiconductors, 3301 Electronics Way, West Palm Beach, Fla. 33407, has published a catalog containing over 700 pages on integrated circuits, transistors, and diodes. Electrical characteristics, circuit diagrams, and packaging dimensions are given. [434]

**Microwave instruments.** A microwave-instrument catalog from Polarad Electronic Instruments, 5 Delaware Dr., Lake Success, N.Y. 11040, summarizes specifications for modular signal generators and signal sources, antennas, receivers, field-in-

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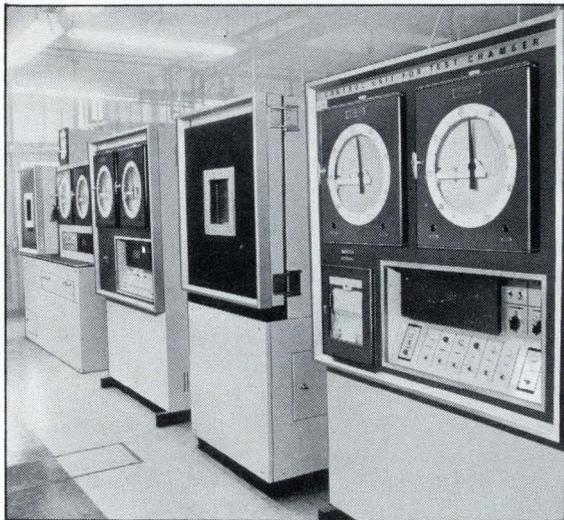
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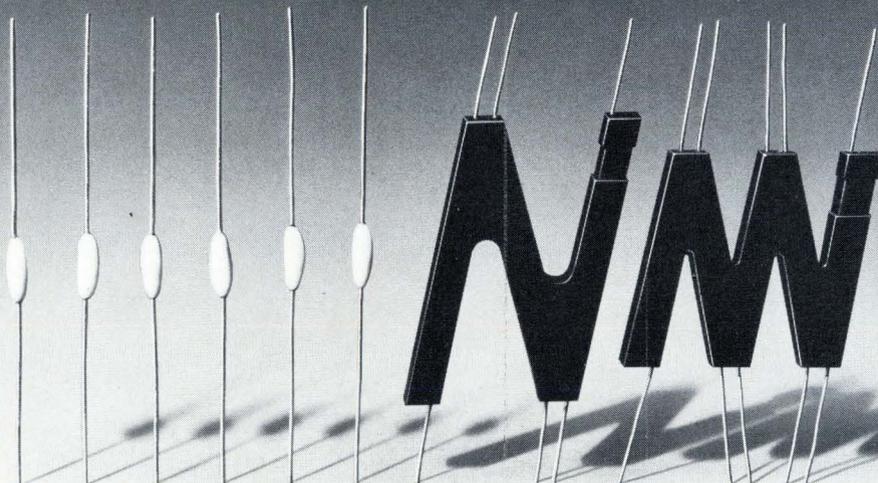
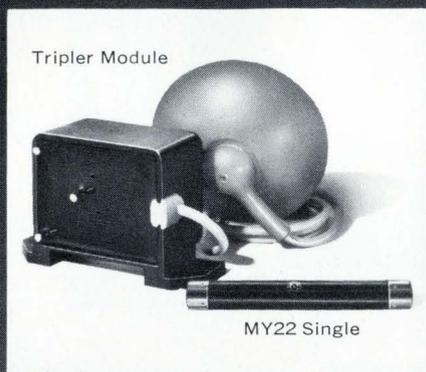
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Ratings of Device						
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Average Forward Current (mA)		10.0	10.0	10.0	1.5	1.5
Max. Reverse Current ( $\mu$ A)		2.0	2.0	2.0	5.0	5.0
Max. Reverse Recovery Time ( $\mu$ S)		0.25	0.25	0.25	0.25	0.25
Max. Surface Temperature ( $^{\circ}$ C)		100	100	100	90	90
Storage Temperature ( $^{\circ}$ C)		-40 to 100	-40 to 100	-40 to 100	-40 to 100	-40 to 100
TV. Applications						
Color T.V.		Tripler Quadrupler	Tripler Quadrupler	Doubler	Single	Single
B/W T.V.		—	Shingle	Single	—	—
D.C. output voltage (kV) DC	No Load	30.0	9.5	30.0	25.0	27.0
(15.75 kHz Capacitive Load)	On Load	25.0	8.5	25.0	23.0	25.0
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Y15 diodes

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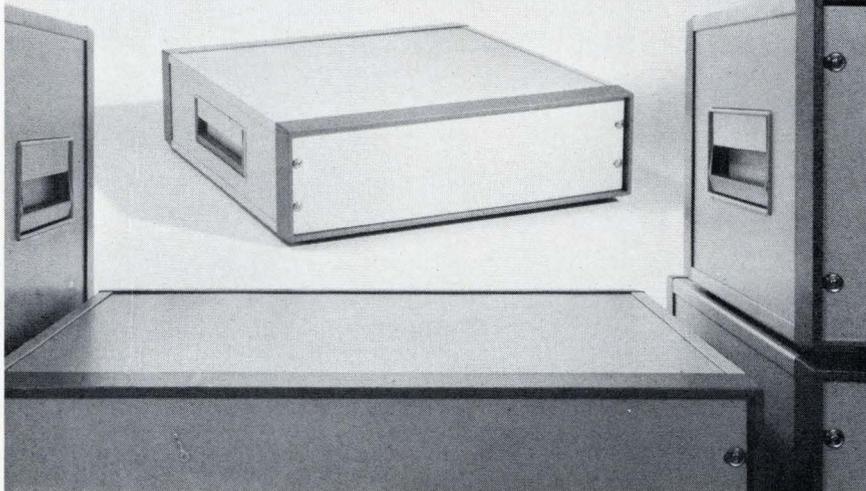
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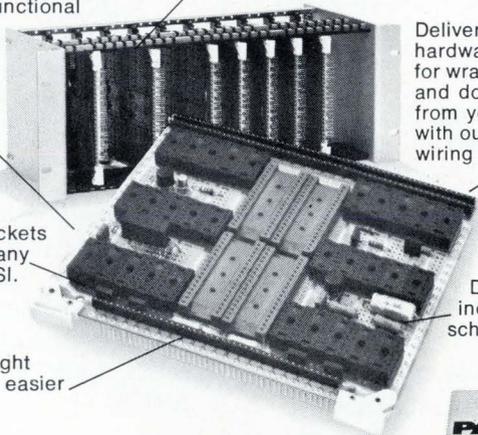
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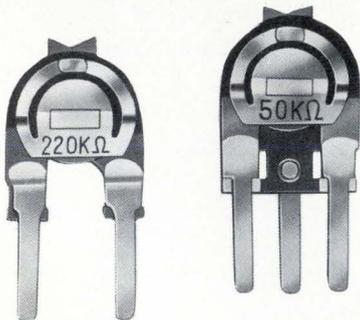
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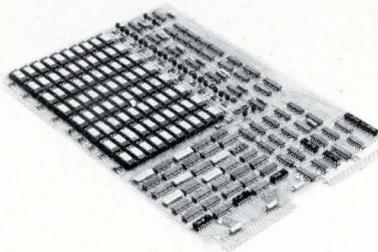
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a list of your special people  
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You give your clients  
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down now?



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and it's all your fault!*



*John—A growing  
plant for your  
growing plant  
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Best wishes.*



*Marje—It was a fresh,  
alive year topped with a lot  
of green. Soooo...*



*Banning—I dub thee  
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and wish you many  
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## MISSISSIPPI

State of Change

WILLIAM L. WALLER, GOVERNOR

adds the CPA. Generally, two early sessions with the accountant are needed, and then two sessions a year thereafter: one for the annual chore of filing tax returns, the other to update and discuss the audit. Getting records together at the outset is tedious—but rewarding.

The accountant (or possibly lawyer-accountant) won't come up with ironbound rules for planning a client's dollar flow. But he will give some reasonable guidelines. Consider, first, the case of a management executive, with some conclusions that are valid for most income brackets. Jones is 45, married, has two teenagers in high school. His salary is \$50,000, and he has income of \$2,000 from investments. His assets include \$35,000 of equity in his house, life insurance cash value of \$10,000 (\$50,000 coverage), cash savings of \$10,000, common stocks worth \$20,000, personal property worth \$10,000 (including two cars, paid for), and vested pension funds worth \$15,000. Liabilities include \$2,000 in debts and \$2,000 in taxes payable. So, net worth is \$96,000.

Generally, the advice is that a man in roughly these circumstances should save *at least* 10% of his after-tax income. Thus, Jones—who pays about \$16,000 in taxes—should be putting away \$3,500 a year, or more. Note that a man in a more *modest bracket* might be advised to save at the very least 5% of his after-tax net. “It really should be 10% minimum, too, for someone in, say, the \$25,000 range,” notes a CPA, “but few people will hold to that, what with today's prices.”

On the budget side, one rule of thumb is that a man in the executive salary range should turn over to his wife 40% to 50% of his net income after both taxes and savings, for running the house (excluding mortgage payments and utilities). In the example, Jones has \$2,625 a month for his budget. If he gives his wife, say, 45%, she gets about \$1,200 a month—leaving Jones with \$1,425. The \$1,425 must cover the mortgage, property taxes, all types of insurance, household repairs, new furniture and equipment for the house, auto expenses, entertainment, vacations, the husband's expenses—plus at least a modest sinking fund for special purchases. “The formula varies family to family,” says a CPA. “But once arrived at for a family, the budget ought to stick, and not flip-flop with everybody's whims.”

Investment objectives can be sharpened, too. Broadly, the annual audit will give a clear idea of how much can safely be put into the stock market each year (if

any)—and how prudently or speculatively this amount should be managed. A very rough rule followed by some investment advisers says that a business executive or professional man, in fairly average circumstances, ought to put no more than 10% to 15% of his total market investment into speculative stocks. In the example, Jones's bare minimum \$3,500 savings should probably go into safe growth investments—not speculation. “Some people actually find it a relief to learn that they really shouldn't be in hot new issues or \$10 high flyers,” says a Connecticut adviser.

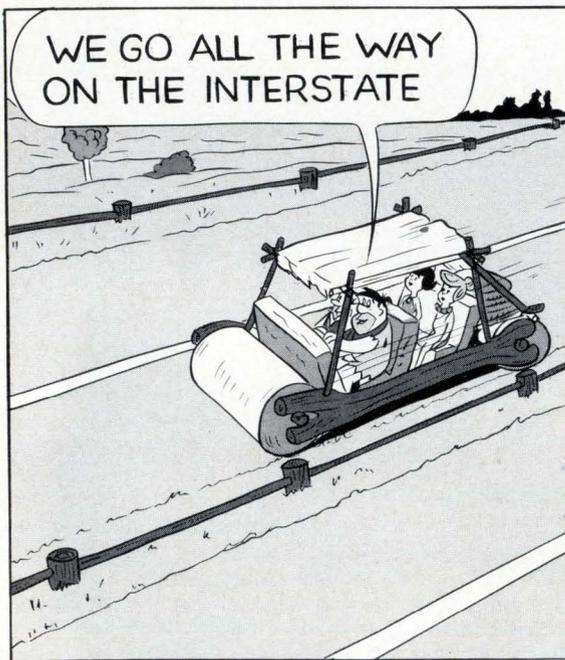
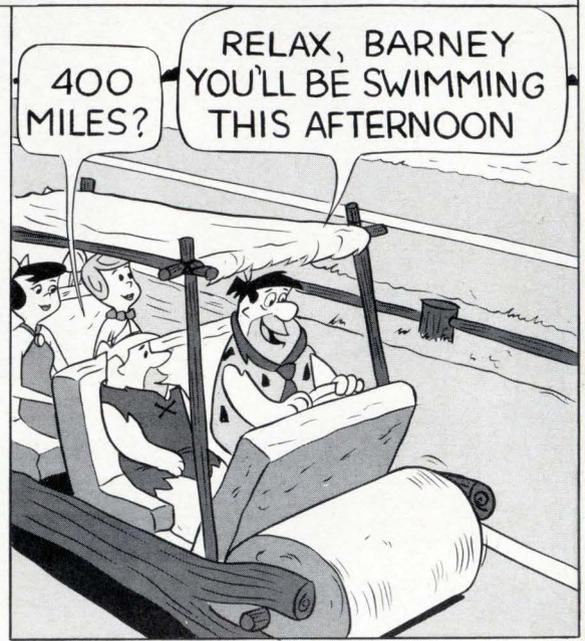
College financing is a must for most families, and many people find that they are aiming under the mark. Costs vary, depending on many variables. For instance, state college costs can be as much as 30% cheaper, overall, than comparable private college costs. Three-year degree programs (a new trend) can sometimes save up to 25% of the total cost. At best, though, for most families the total college tab comes as a rough blow. Annual accounting, if nothing else, gets a father on the road to smart college financing years in advance—it gives him a clear idea of how much he can and should be putting aside. Thus, the sooner annual-audit thinking begins, the better.

On housing, there is a somewhat traditional estimate that the average family can “afford” a house that cost up to 2½-times pretax income (so, Jones, with a \$50,000 salary, might go to \$125,000). But rules bend, and today most conservative advisers suggest twice the income as the *top* figure. It may be more practical to budget for housing in terms of annual outlay. Accountants note that businessmen and professionals prudently will spend about 10% to 12% of pretax income on family housing. There are also recommended ranges for other expenses; for example, about 10% for food, 5% to 7% for life insurance, 4% to 6% for recreation, and 4% to 6% for clothing. The annual accounting, properly handled, therefore lets the individual compare his own expenses with suggested standards.

Pre-audit paperwork pays. Dusting off old records and making careful computations *before* the first formal session with the accountant will ease the strain—and maybe cut the fee. Accountants and similar consultants charge on a time-basis, and the fee can run from about \$20 an hour, up.

In picking an auditor-adviser, it is wise to think in terms of hiring a younger man instead of a senior member of a firm. He will more likely be interested in a small-ish account, and will give the time and attention needed. He will also be around to handle the work in later years. A senior man in an established firm will usually be happy to suggest the younger man you seek.

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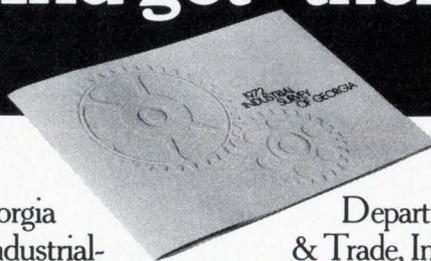
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## THE MARKET

### The "municipals": the good and bad of tax-free bonds

The market for tax-exempt bonds—the so-called "municipals"—was once the exclusive sanctuary of the ultra-rich and their financial advisers. Now, for one reason or another, nearly everybody seems to want to get in, and already enough bumpkins have arrived trailing sharp-eyed predators to alarm the landlords. Wall Street houses which deal in these securities have begun posting a few warning signs for the uninitiated at the gates.

One reason is that municipal bonds have suddenly become big and important business. Last year, U.S. communities floated \$24-billion worth of them; U.S. industry at the same time issued only \$9-million worth of common stocks. Another reason is that a lot of American families suddenly find themselves in income tax brackets where the tax exemption of municipals makes sense.

For instance, you and your wife need only be filing a joint return on between \$16,000 and \$20,000 in combined *taxable* income (after deductions) to find yourself in the 28% bracket. A single man paying taxes on \$14,000 is in the 29% bracket. For either of them, a municipal bond yielding 6% to maturity *tax-free* is worth its weight in taxable securities paying 8.33% and better. In New York, where (as in other metropolitan areas) city and state income taxes add to the bite, the tax-exempt municipals are even more attractive.

With more and more U.S. families attaining those income levels—and with many still leery of common stocks—municipals have understandably captured their investment imagination. Unfortunately, this interest has also drawn some shady operators. A variety of sleazy tactics were exposed in a crackdown in Memphis last year, and early this year Florida state authorities detected so much smelly dealing in tax-exempts that they circulated a warning pamphlet, *How Not To Get Burned in The Municipal Bond Market*.

Bond men suspect that broad changes lie ahead. They predict strict



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regulation in the near future, and probably tax reforms to sharply alter the privileged status of municipals. (Indeed, some foresee the evolution of *taxable* public securities eventually.) The net result: Generally tougher going for the market, its customers, and its dealers.

With so much negativism in the air, reputable bond dealers are trying harder than ever to educate their expanding audience in the pitfalls, as well as the benefits, of municipals. A recent advisory of T. J. Holt & Co., for instance, puts emphasis on some of the caveats.

"Municipals are not really top-notch bonds across-the-board," says Thomas Holt. "Many are by no means risk-free, or even low-risk. Many municipalities are for all practical purposes bankrupt, or close to it. They face tax revolts among their citizens. It's not inconceivable that some could go under."

His message: Investors can no longer blindly accept general-obligation bonds—the blue-chips of the tax-exempts, since they are backed by the unlimited taxing authority of their issuing municipality—as the Gibaltars they would seem to be.

Certainly revenue bonds (which depend on such things as bridge tolls and stadium ticket sales for their return) are hardly meat for the average investor. "He has all he should worry about in evaluating the yields and ratings" (i.e., in Moody's or Standard and Poor's), says one top dealer, "to be trying to guess what the traffic on a highway may be." Most reputable dealers also warn firmly against certain bonds that some municipalities have been issuing which may not be true "municipals"—or even tax-exempt. These include "arbitrage" bonds, with which some towns have sought to raise funds to re-invest for a higher return, and so-called "industrial revenue bonds", the proceeds of which are used to encourage new industry.

The biggest danger, as Holt sees it, lies in the sheer volume of issues. Mainstay of the tax-exempts market has always been the U.S. commercial banking community, he notes. Commercial bankers bought up more than half of last year's record \$24-billion in bonds. Lately, however, the commercial banks have showed some signs of saturation; their holdings of U.S. bonds, for instance, are the lowest since 1929. "If another \$15-to-\$20-billion worth (of new issues) comes in without the commercial banks to support it," he warns, "there is no telling what might happen."

Such warnings, of course, are not intended to scare new investors out of the market, but merely to open their eyes. "There is no such thing, for instance, as

a *bargain* in municipal bonds—at least from a reputable dealer," says Gerard Bissinger, a principal in Lebenthal & Co., which deals exclusively in tax-exempts for individual accounts. "Beware of the salesman who calls and says he has 'some awfully good buys today.'"

Indeed, the bid-and-asked prices of municipals are fairly well circumscribed by going interest rates and their own *yield to maturity*. The latter is the single most important figure for the investor. He should know, for instance, that a \$1,000 bond (\$1,000 and \$5,000 are standard units) maturing in five years, with a coupon rate (annual return) of 4¼%, should cost him no more than \$885.65 if he is to realize a 7% *yield to maturity* on his investment. Indeed, every bond dealer keeps a book at his elbow containing tables that work out these relationships at a glance. This yield is, of course, quite apart from the tax-exempt feature which is an added attraction.

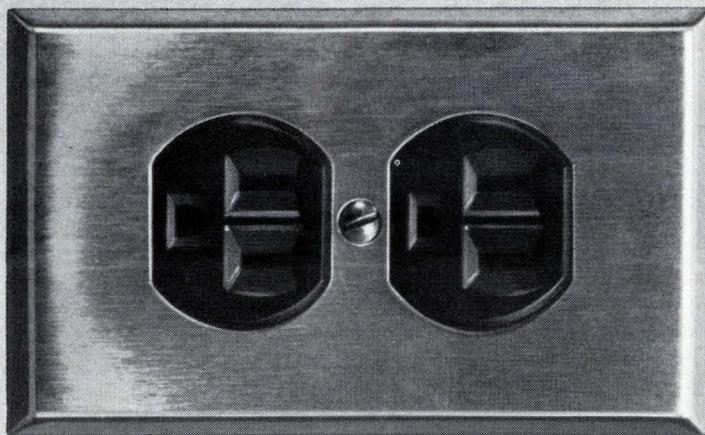
"The salesman who touts price alone can be misleading you; it may well be that a bond discounted at \$750 is a poorer buy than one offered at a premium (above \$1,000), in terms of yield to maturity," says Bissinger. "Such a salesman also is likely to forget to mention the effect of capital gains taxes on the discount bond."

His recommendation (seconded by a number of other top dealers) is this: "Buy to *maturity*. In other words, if you want to invest some money for five years, buy a bond maturing in five years, not a 10-year one with the idea of selling it in five at a profit—you probably will lose."

This underlines a basic rule for investors in municipals: Use only that money which you can afford to leave alone for awhile. Money that may be needed on fairly short notice is better off in the bank. Indeed, the parallel with banking is quite close. "The big advantage of municipals," notes Bissinger, "is that you know to the penny how your money is working for you." In other words, with the right bond in the right portfolio, it's just like money in the bank—and there's no tax on it.

Here, for instance, is what tax-exemption can mean for persons in various tax brackets. According to figures compiled by *The Bond Buyer*, a single person with taxable income of \$14-\$16,000 and a couple filing a joint return on \$20,000 are roughly in the same bracket (31%) where a 6% yield on a municipal bond is worth an 8.7% return from securities on which they must pay taxes. Single persons reach the 50% bracket at around \$32-\$38,000 and joint filers at \$44-\$54,000. At this level, of course, a taxable investment would have to yield 12%—or twice as much—to match the municipal's 6% return.

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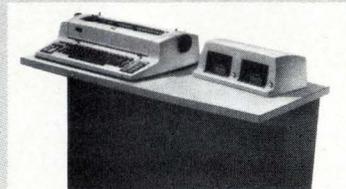
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## Blowing gold dust off Oriental art (or how to make 10% on a teapot)



Sung Dynasty figure at recent auction.

Right now it's Oriental art (rare, fine, and not-so-fine) that has appreciation-minded collectors raising their hands at auctions and ignoring do-not-handle signs in galleries from London to San Francisco. Chinese art, especially, has become the most "interesting phenomenon" in the market today, say the experts at London's Sotheby's and New York's Sotheby Parke Bernet galleries. President Nixon's China visit spurred an already established upward trend. Sales of collectable Oriental items were *up* about 50% for the 1971-72 season, over 1970-71. Appreciation has been *up* at a 10% clip since 1965. Outlook: also *up*.

But before buying an ebony chest in which to stash his treasures, the average collector must do some research. "First decide just *what* you want to collect," says Martin Lorber, Parke Bernet's Oriental art expert, "—prints, bronzes, paintings, porcelain, fine 'china', or whatever." He adds: "It will be difficult enough to learn the essentials of your specialty, let alone all Oriental art." See first, *The Arts of China*, by Hugh Honour, and then *The History of China*, by C. P. Fitzgerald (American Heritage). And steep yourself in the specialty you've picked, particularly in the museums—and only then venture into a gallery or fine antique house with a meaningful purchase in mind.

Sharpest recent rise in values has been in Japanese swords and prints, with interest stimulated by some major auctions last month. On a lower investment scale, the familiar "rose medallion" china, and blue-and-white Canton china, have lately increased in value in a \$25 to \$250 price range—and more appreciation is predicted for authentic 19th century pieces (despite the rash of recent copies). . . . A Chinese understatement: In the Oriental art field, the chance of fraud is present. *Greatest danger*: the highly skilled copyist.

## Tax brew: dollar-savers on the fire

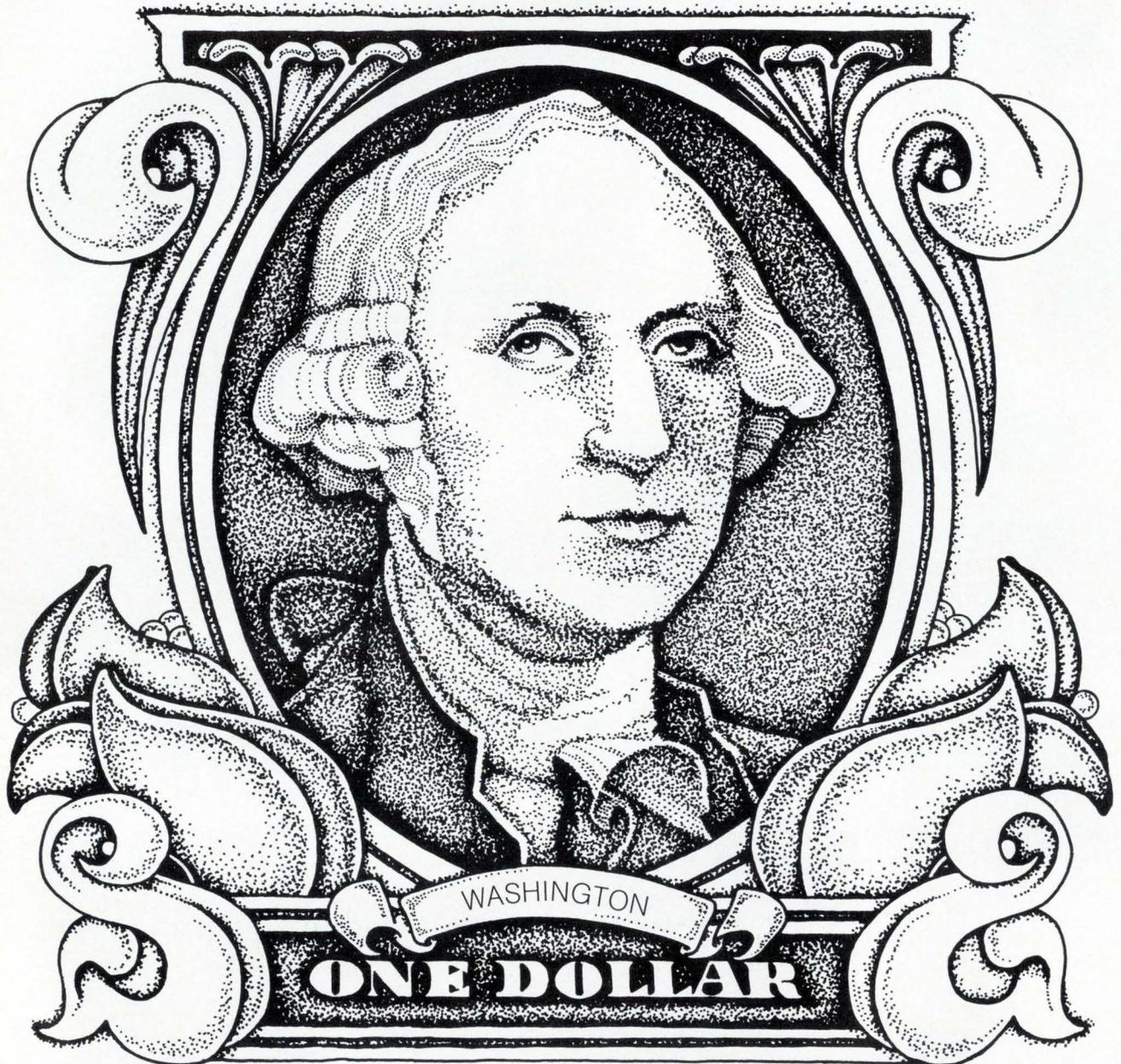
*Custodian accounts* let you split off taxable income by gifts to children (usually securities), and if it's handled properly, the assets will be outside the father's taxable estate. A new Tax Court case shows that a father can avoid the danger of having estate tax levied simply by naming *another* person as "custodian." Says a top New York tax man: "Why name yourself—why not your brother, or your cousin? Or why not your wife?" . . . *Hobby losses* get liberal treatment. The law says that a business-hobby (like a farm) justifies tax deductions *if* there is a true underlying profit motive. The Tax Court allowed the deductions by two wealthy weekend farmers, even though they showed operating losses for eight years. They *proved* a profit motive—or, at least, sold the court on the idea. . . . *Political gift deductions* aren't allowed for the *true value* of money-raising shindigs such as black-tie dinners and dances, nor for political raffle tickets, says Internal Revenue. But the *excess* tab charged by the political group (over and above true value, or regular cost of, say, a dinner or show) can be deducted. . . . *Office-at-home*: New case shows, in effect, that the homework must have *practical value*, not just convenience value.

## Who will get your money?

John Barnes' *Who Will Get Your Money?* provides a sensible, painless passage through the tedium bounded by wills on one side and trusts on the other. In a word, this review tells you how best to transfer your assets to your heirs, in terms of least trouble and expense. Cutting "probate" down to size is included (Morrow, 250 pp., \$8.95). . . . In his new book, *Being Safe*, Mel Mandell argues against, among other things, the idea of owning a weapon for home protection. His guide to protecting your property and, more importantly, your person, is good solid stuff and recommended to any nervous, crime-conscious apartment dweller or suburbanite (Saturday Review Press, 312 pp., \$6.95).

**Executive chef:** Put *fresh strawberries* into bowls and sprinkle with fresh lemon juice and sugar; at the last minute pour ¼-cup Grand Marnier over each serving—then add on top some whipped vanilla ice cream. From *The Plaza Cookbook*, by Eve Brown, which has many fine mixes from Manhattan's fine Plaza Hotel.

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